UNIVERSITY OF SOUTHAMPTON

Faculty of Science

School of Ocean & Earth Science

SEA LEVEL VARIABILITY:
EXAMPLES FROM THE ATLANTIC COAST OF EUROPE

by

Isabel Gonçalves de Barbosa Araújo

A thesis submitted for the degree of

Doctor of Philosophy

OCTOBER 2005

Graduate School of the
National Oceanography Centre, Southampton

This PhD dissertation by

Isabel Gonçalves de Barbosa Araújo

has been produced under the supervision of the following persons

Supervisor/s

Prof. David Pugh
Prof. Michael Collins

Co-supervisor

Dr. João Miguel Dias

Chair of Advisory Panel

Prof. Carl Amos

Member/s of Advisory Panel

Prof. David Pugh
Prof. Michael Collins

This thesis is dedicated to my father

"…best is the enemy of the good."

Voltaire

UNIVERSITY OF SOUTHAMPTON

ABSTRACT

FACULTY OF SCIENCE

SCHOOL OF OCEAN & EARTH SCIENCE

Doctor of Philosophy

SEA LEVEL VARIABILITY: EXAMPLES FROM THE ATLANTIC COAST OF EUROPE

by Isabel Gonçalves de Barbosa Araújo

This thesis investigates the statistics of the long-term variability in sea level records and trends along the Atlantic coast of Europe. This is undertaken for a range of regionally-representative open-sea sites. Tidal variability on a shorter time-scale is also investigated, for a local area subjected to intense natural and anthropogenic activity.

The longest available records of hourly sea level data have been analysed for (6) ports around the English Channel, and (5) around the Iberian Peninsula. A separate statistical analysis is used for the components of sea level variability: mean sea level, tides and meteorological residuals (surges). Extremes and percentiles of some of these components have also been studied. This shows that mean sea levels are increasing at between 1 and 3 mm yr^{-1}. Strong influences are found in the standard deviation of the total observed sea level. The various tidal constituents show interesting, localised short-term variations in amplitude and phase. Some long-term trends exist and are mainly associated to local effects. There is no evidence of an increase in weather effects on sea levels, over the period analysed. Some trends are identified in extreme maximum and minimum levels; however, in most cases, they are influenced only by mean sea level. Sea level response to the NAO has been analysed. The NAO was found to influence extreme levels in the meteorological residual (standard deviation), at stations where the NAO´s centre of action are known to be strongest. Mean sea levels, detrended sea levels and non-tidal residual sea level standard deviations around the western European coastline are generally correlated negatively with the NAO index; the only exception to this is Dover, which is correlated positively to the NAO. This observation is consistent with the known positive correlation in the south eastern region of the North Sea. Sensitivity to the NAO varies, with the highest values found along the northern Spanish coastline. Overall, Coruña shows the greatest influence of the NAO, and, in the English Channel, this is found at Newlyn. Influences on the non-tidal meteorological residuals are also found within the northern region of Spain, suggesting that variance in this component is influenced considerably by the NAO.

More locally, the responses of coastal lagoons, to long-term sea level trends, are crucial for coastal management. Pressure measurements collected in the Ria de Aveiro Lagoon, Portugal, show a general increase in amplitude and decrease in phase, over the past 16 years. The causes of these changes are investigated using: (a) an analytical model of a wave propagating through a narrow inlet, into a Lagoon (analogy to RLC-circuit); and (b) a Bi-Dimensional Horizontal (2DH) hydrodynamic (vertically-integrated) model of the Ria de Aveiro Lagoon. Results suggest that changes in the bathymetry are the most significant contribution to the changes identified in the tides.

CONTENTS

List of Figures

List of Tables

DECLARATION OF AUTHORSHIP

I, Isabel Gonçalves de Barbosa Araújo, declare that this thesis entitled

Sea Level Variability: examples from the Atlantic Coast of Europe

and the work presented in it is my own. I confirm that:

- this work was done wholly or mainly while in candidature for a research degree at this University;
- where any part of this thesis has previously been submitted for a degree or any other qualification at this University or any other institution, this has been clearly stated;
- where I have consulted the published work of others, this is always clearly attributed;
- where I have quoted from the work of others, the source is always given. With the exception of such quotations, this thesis is entirely my own;
- I have acknowledged all main sources of help;
- where the thesis is based on work done by myself jointly with others, I have made clear exactly what was done by others and what I have contributed myself;
- parts of this work have been published as:

Araújo, I., Pugh, D. & Collins, M (2001). An intensive analysis of sea level trends at Newlyn. *Proceedings of the EOSS Sea Level Workshop*, Dubrovnik, September 2001. Ivica Vilibic, Hans-Peter Plag and Mirko Orlic, Split, Hydrographic Institute of the Republic of Croatia, 90-92.

Araújo, I., Pugh, D. & Collins (2002). Trends in components of sea level around the English Channel. *Proceedings of Littoral2002*, *6th International Symposium- The changing coast,* Porto, September 2002. CD-ROM.

Araújo, I.B., Dias, J.M. & Pugh, D. (2003). Alterações do nível do mar associadas á variabilidade climática na Costa NE Atlântica. *II Congresso de Planejamento e Gestão das Zonas Costeiras dos Países de Expressão Portuguesa*, Recife, September 2003.

Araújo, I., Pugh, D. & Dias, J.M. (2004). Sea level variability and its impacts in a NW European Lagoon: Ria de Aveiro, Portugal. *Proceedings of the 12th International Biennial Conference on Physics of Estuaries and Coastal Seas*, Mérida, October 2004.

Signed:

Date:

Acknowledgments

This work has involved extensive searching for sea level records and therefore would not be possible without the generous contributions by the generations of anonymous tide gauge operators, several colleagues and institutions, namely the Permanent Service for Mean Sea Level, British Oceanographic Data Centre (Lesley Rickards), Associated British Ports marine environmental research (Dr. Ian Towned & Dr. John Harris), Service Hydrographique et Océanographique de la Marine, Instituto Español de Oceanografia (Dr. Maria Jesus Garcia) and Instituto Geográfico Português (Engª. Helena Kol & Eng. Gonçalo Crisóstomo). I would like to thank Administração do Porto de Aveiro for authorising our access to the Aveiro tide gauge and for providing the bathymetric data of the Ria de Aveiro.

This research has been funded by the Portuguese Fundação para a Ciência e a Tecnologia, to whom I am very thankful.

My work has been encouraged and supervised by:

Prof. David Pugh, who led me to pursue this work. I feel extremely privileged and grateful to have had the opportunity to work and learn with David. He has given me a lesson in life. No words are enough to describe my appreciation;

Prof. Michael Collins, who I thank for his trust, support and encouragement in my work and for the friendship shared throughout these years;

and Dr. João Miguel Dias, at the University of Aveiro. João´s enthusiasm, support and interest have been essential in achieving some of the aims set in my project. The use of his hydrodynamic model, access to local sea level data and all other contributions are very much appreciated. I am also thankful to the Physics Department of the University of Aveiro for housing me during my visits to Aveiro.

I would like to thank my examiners Prof. Philip Woodworth and Prof. Ian Robinson for their review of this thesis and useful comments.

I am also very grateful to all my colleagues and friends who have, in many ways, contributed to my experience in Southampton and Aveiro. Amongst these are Nuno Vaz (thanks for making me feel at home in Aveiro), Marilu, Ana Paula, Lola, Erica, Cat, Jacob, ORC-Italy, SOC-Brazil, Clarisse, Mikis Tsimplis and Andrew Shaw.

Finally, I thank my family and Carlos for all their support and encouragement.

Acronyms & Abbreviations

ABPmer	Associated British Ports, marine environmental research
APA	Administração do Porto de Aveiro
BODC	British Oceanographic Data Centre
CTD	Current Temperature Depth metre
ENSO	El Niño Southern Oscillation
EOF	Empirical Orthogonal Function
GIS	Global Isostatic Adjustment
GLOSS	Global Sea Level Observing System
GMT	Greenwich Mean Time
HHW	Highest High Water
IEO	Instituto Español de Oceanografia
IGEO	Instituto Geográfico Português
IOC	Intergovernmental Oceanographic Commission
IPCC	Intergovernmental Panel on Climate Change
LLW	Lowest Low Water
MHW	Mean High Water
MLW	Mean Low Water
MSL	Mean Sea Level
MSLP	Mean Sea Level Pressure
MTR	Mean Tidal Range
NAO	North Atlantic Oscillation
NCEP	National Centers for Environmental Prediction
NH	Northern Hemisphere
NTRstd	Non Tidal Residual standard deviation

PC	Personal Computer
PCA	Principal Component Analysis
PCs	Principal Components
POL	Proudman Oceanographic Laboratory
PSMSL	Permanent Service for Mean Sea Level
RBR	Richard Brancker Research
RLC	Resistance Inductance Capacitor
SHOM	Service Hydrographique et Océanographique de la Marine
SLP	Sea Level Pressure
Std	Standard Deviation
TGBM	Tide Gauge Bench Mark

M_2	Lunar semi-diurnal tidal constituent
M_4	Lunar quarter-diurnal tidal constituent
S_2	Lunar semi-diurnal tidal constituent
MS_f	Lunar - solar fortnightly tidal constituent
ζ	Sea level

Chapter I

INTRODUCTION

1.1 General

Estimates of global past and future mean sea level changes have been the focus of many scientific studies throughout the last decades. Although there is a consensus in favour of a global mean sea level rise over the past century, much doubt still exists on the rate of increase, which lies between 1 and 3 mm yr^{-1}. There is no evidence for acceleration in the rate of rise in the 20^{th} century alone (Douglas, 1992; Woodworth, 1990; Douglas *et al.*, 2001), but a possible small (0.4 - 0.8 mm yr^{-1} $century^{-1}$) acceleration in the 20^{th} century (Woodworth *et al.*, 1999; Church *et al.*, 2001) and 19^{th} century (Woodworth, 1999).

The variations among different estimates can be found in recent literature (see, for example, Munk (2002) and Meier & Wahr (2002). These variations appear to be related to the difficulty in understanding the multidisciplinary processes that cause global mean sea level rise.

Chao et al. (2002) summarise the causes for change in sea level as outlined below:

(1) Changes in the oceans volume (steric effect), as a response to thermal expansion and temperature-salinity variations; these include processes such as El Niño Southern Oscillation (ENSO), the North Atlantic Oscillation (NAO), and other meteorologically-forced oscillations;

(2) Exchange of water between the Earth-atmosphere-hydrosphere-cryosphere system i.e. polar ice sheets, glaciers, and other hydrological variations;

(3) Vertical movements in the solid earth, related mainly to tectonics and isostatic adjustments i.e. rebound of the mantle caused by deglaciation events;

(4) Dynamic responses to forcing of the sea surface; these include waves, tides, wind-driven circulation, responses to atmospheric pressure in the form of the inverse barometer effect (Pugh, 1987) and density-driven currents (thermohaline circulation).

Climate change is expected to accelerate sea level rise and increase storm events, which will subsequently impact the coastlines and their coastal systems. This process will exacerbate the economic and social vulnerability of the growing populations in coastal regions, increasing the pressures that already exist in these environments.

The consequences of sea level rise associated with climate change are inter-related; this is illustrated in Figure 1.1. A rise in sea level and storm surge activity increases usually the chances of coastal flooding and the rates of erosion. In turn, these contribute to salt water intrusion and the loss of land or salt marshes. Consequently, local ecosystems and the human population are affected.

The greatest impacts will occur on small islands in developing states, followed by low-lying deltas in low-income developing states, and coastal lowlands throughout the developing world (Turner *et al.*, 1996). The lack of resources for mitigation, or relocation, can cause great political and economical stresses in poorer states.

Only a summary of the impacts of climate change and sea level rise is given here. For further reading, see Leatherman (2001) and Turner *et al.* (1996).

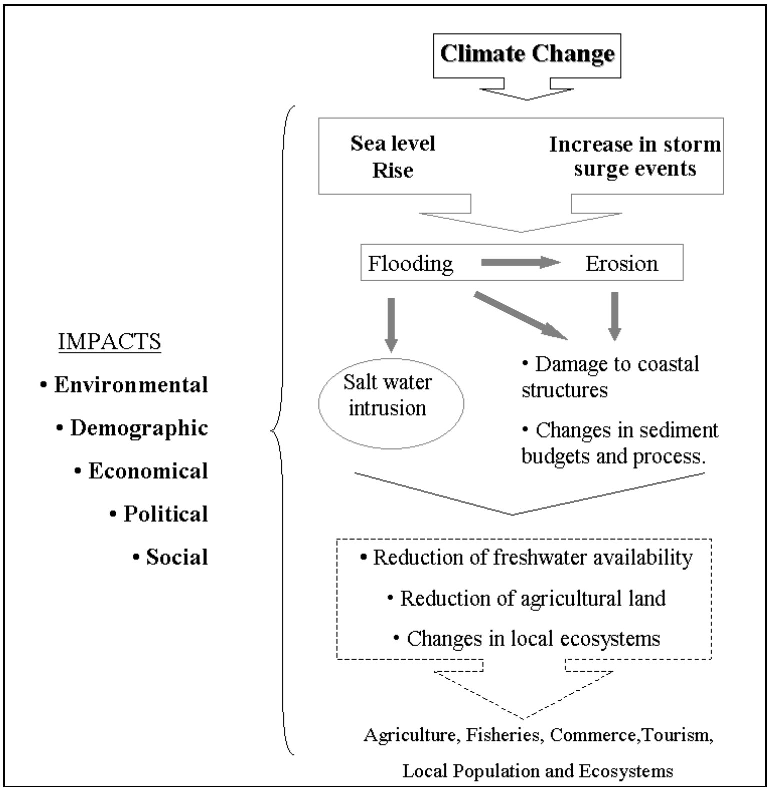


Figure 1.1 Effects of climate change and their interactions.

Sea level changes relate to different time-scales (from seconds to centuries) and spatial scales: local (storm surge, land subsidence), regional (North Atlantic Oscillation, El Niño); and global ocean/climate processes (temperature and density influences) and a range of geological processes (Glacial Isostatic Adjustment, GIA) which result in vertical land movement. All these different scales complicate the scientific interest in the global monitoring and interpretation of sea levels.

A global network of tide gauges has been established to provide reliable long-term sea level measurements. Unfortunately, the geographical distribution of the gauges throughout the world is not ideal: there is a deficit in the southern hemisphere, which has led to speculation on the validity of any global or regional interpretations, based upon these data (Gornitz, 1995). However, improved geographical coverage would not necessarily ensure quality measurements. Tide gauges need maintenance in order to function properly and, most importantly, it is necessary to ensure that there is a good knowledge of the vertical movements of land upon which the gauge is established so that corrections can be made (IOC, 2002). Nevertheless *in-situ* gauges still provide the longest sea level records available, for essential long-term studies.

The launch of satellite altimetry (especially with the TOPEX/POSEIDON joint venture, 1992) has led to a new generation of sea level measurements that overcome the tide gauge's levelling and distribution problems, but still present some limitations, especially in terms of global coverage (Nerem & Mitchum, 2001). The fairly recent launch of this type of sensor means that the data collected so far is insufficient for long-term studies, but future measurements make it very promising for sea level work.

Depending upon the length of the record, sea level analysis can provide an understanding of long-term (secular) changes of sea level, interannual sea level variability, evolution of the tidal constituents, and can indirectly estimate vertical land movement.

With increased evidence of climate change, sea level studies based upon tide gauge records became the best compromise for long-term analysis, until further technological progress is made and/or longer oceanographic and meteorological datasets, with wider coverage, become available.

1.2 Thesis Aims and Structure

This thesis covers two different time and spatial scales of sea level variability: the long-term study of sea level variability for the NW European shelf and the local short-term tidal variability study of the Ria de Aveiro. Chapter I-IV and the final chapter cover common ground. Chapter V is specific to sea level variability along the NW European coastline; Chapters VI to VII are specific to local sea level variability, the case of Ria de Aveiro Lagoon.

The first theme of study examines some of the longest sea level records available for the NW European coastline, to investigate regional sea level variability associated with climate change. An intensive analysis of changes in the statistics of tides, meteorological surges and mean sea level is undertaken, following robust editing of the data, to correct for calibration, blockage and timing errors in the gauge (IOC, 2002; Araújo *et al.*, 2001).

The second theme is to investigate an example of local sea level variability impacts on an estuarine system: an understanding of sea level changes occurring at the coast as well as establishing knowledge on tidal changes inside the system are essential. Therefore, past (1987/8) short-term (1-3 month) sea level measurements available from a low-lying coastal Lagoon, the Ria de Aveiro (Portugal), on the western coast of Europe, are compared with measurements collected during this study (2002/3), to investigate tidal variability at a local scale.

Chapter I provides a general overview of sea level change studies, in terms of causes and consequences.

Chapter II introduces both of the (regional and local) areas under investigation.

Chapter III presents the current state of knowledge of sea level variability along the NW European coastline, together with sea level variability in the Ria de Aveiro Lagoon.

Chapter IV covers all the methods and approaches used in this study. Basic background to sea level measurements and analysis is incorporated, together with a description of the approach adopted to analyse the long-term data and a description of sea level data available from the Ria de Aveiro. The description of the 2-D hydrodynamic model used to investigate changes in tides in the Ria de Aveiro is also presented, together with a simple analytical approach, used to model the tidal response of an estuary system, connected to the ocean through a narrow channel.

Chapter V The statistics of the different sea level components (observed sea level, mean sea level, tides and meteorological residual) are discussed. Some of the trends found are investigated further, in terms of their correlation to meteorological forcing mechanisms such as, for instance, sea level pressure and other climate anomaly patterns, e.g. the North Atlantic Oscillation (NAO).

Chapter VI The results obtained from the sea level measurements during the survey of several stations in the Ria de Aveiro are presented. These are compared with those from a previous (1987/8) investigation. Changes in both amplitude and phase of the tidal constituents, during the last 16 years, are discussed. These are than compared to the long-term sea level data from a permanent tide gauge, located at the mouth of the tidal inlet.

Chapter VII Results from the 2-D model, using two different bathymetries, are presented. The model was run initially using the bathymetric data from 1987/8, then re-run using digitised updates to the earlier bathymetry. The results for both runs of the model, using different bathymetries, are discussed and compared with bathymetric and observed tidal data.

Chapter VII This chapter provides the overall achievements of the current work before presenting the general conclusions for: (a) the long-term sea level variability for NW Europe; and (b) short-term sea level variability in the Ria de Aveiro Lagoon. The text concludes with suggestions for further work.

Chapter II

AREA OF STUDY

2.1 Regional Sea Level Variability: W Europe

The section of the European coastline investigated here covers the coastline between approximately 51ºN and 35ºN, i.e., from the English Channel, down to the southern coast of the Iberian Peninsula (Note: in most other sea level (SL) studies, NW Europe usually refers to European coastline above 48º, i.e., from the English Channel up to Norway). The locations from which sea level data will be used are given later, in Chapter IV.

Some of the world's largest tidal amplitudes can be found in the NW European Continental shelf. In this region, some of the shelf areas are extensive and shallow; therefore, tides are influenced by non-linear effects, due to shallow water processes and local resonance. According to Anderson (2001), the regional large shallow water constituents, such as the lunar quarter-diurnal, M_4, can have amplitudes up to 0.5m (e.g. north-central English Channel), which is larger than the values usually found in the oceans for the lunar semi-diurnal, M_2, constituent. In turn, the amplitude of the M_2 is significantly greater than the amplitude of the diurnal tides, because of the ocean's near-resonant response to forcing at semi diurnal frequencies and, because the diurnal tides are especially small in the region (Pugh, 1987).

As the semi-diurnal Kelvin wave travels northwards along the European shelf edge, from Portugal, considerable tidal energy is transferred to the surrounding shelf areas. As the wave propagates north and reaches the Celtic Sea, part of its energy propagates into the English Channel and the Irish Sea. The wave progressing from the Irish Sea, around the Shetlands, enters the North Sea transferring some of its energy into the English Channel, where it travels south as a Kelvin wave. Some of the energy from the wave travelling from the Celtic Sea, through the English Channel, gets transferred into the North Sea (Banner *et al.*, 1980). The Kelvin wave that propagates eastwards along the French coast, reflected westwards along the English coast, is responsible for the larger tidal amplitudes found in the French side of the Channel.

2.2 Local Sea Level Variability: Ria de Aveiro Lagoon, Portugal

The Ria de Aveiro is the most extensive shallow coastal lagoon in Portugal (Teixeira, 1994). It is located on the Western Atlantic coast of Portugal, between Espinho and Cabo Mondego, at 40° 38′ N and 40° 57′ N, respectively (Figure 2.1). The area covered by the lagoon corresponds approximately to a minimum of 66 km^2, at low spring tides, and a maximum of 83 km^2, at high spring tides (Dias *et al.*, 2000).

An extensive sand barrier exists along the coast, protecting and separating the enclosed lagoon from the Atlantic Ocean. The barrier's width varies alongshore depending upon the local availability of sand and the associated rates of erosion and deposition.

The connection between the ocean and the Lagoon is through a single artificial inlet with an approximate 5500m^2 cross-section, connected to a channel 350m wide and with an average depth of approximately 20m. The entire entrance and adjacent channel have been excavated and stabilised, for navigation and flushing purposes. The average overall depth of the Lagoon is approximately 1m (Dias *et al.*, 1999), with the greatest depths found at the lagoon entrance.

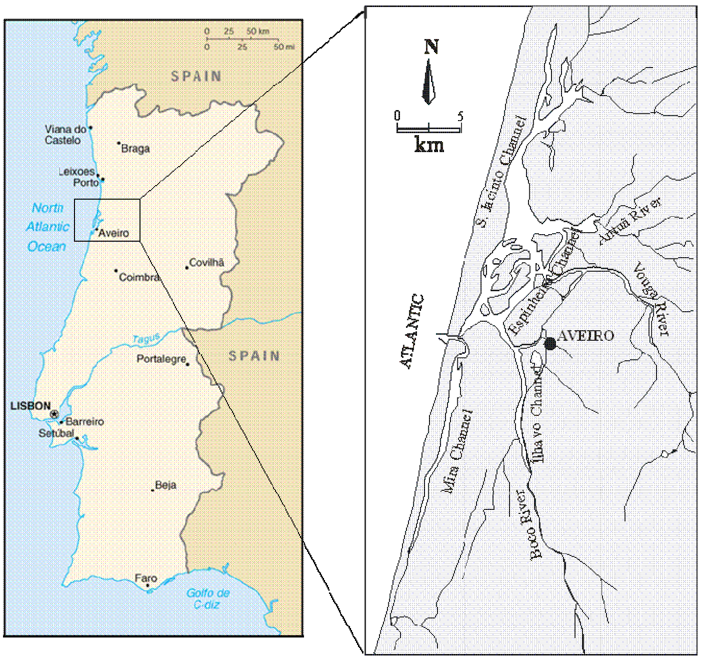


Figure 2.1 (a) General location of the Ria de Aveiro mapa, and (b) a more detailed location of the lagoon, on the Portuguese coastline (courtesy of Dr. João Dias).

A series of narrow channels, into which flow several rivers, radiate from this inlet in a very complex pattern. In between these lie significant intertidal areas, namely mudflats, salt marshes and old saltpans that provide a haven for a wide diversity of flora and fauna. The main channels are: Mira and Íhavo running parallel to the coastline from the south; S. Jacinto and Ovar flowing from the north; Espinheiro and the Vouga River, the main river, flowing from the east (Figure 2.1). From these, the Vouga River is the main source of fresh water, supplying 2/3 of the fresh water that enters the Lagoon, followed by the Antuã River. All the main channels are supplied with freshwater from a series of rivers: the Boco River, flowing into the Ílhavo Channel; and the Caster, Fontela and Gonde, flowing into the northern end of the Ovar Channel. The Mira Channel's supply is via a small dam, Barrinha de Mira, which links to the channel at the southward end.

The total mean river discharge into the lagoon, during a tidal cycle, has been estimated by Morreira *et al*. (1993) as being approximately 1.8 x 10^6 m^3, whereas the exchange of water between the Lagoon and Ocean is estimated to range between 25 x 10^6 to 90 x 10^6 m^3 during a tidal cycle with amplitudes of 1 to 3m, respectively (Barrosa, 1979). Freshwater inputs are small compared to salt water input from the oceanic tides; however, they are important in controlling the salinity patterns and residual circulation within the Lagoon (Dias, 2001). The waters in the Lagoon are assumed to be vertically homogeneous (Dias *et al*., 1999).

Water circulation in the Lagoon is dominated by the influence of the oceanic tide (Dias, 2001). As in most parts of the world, the tidal pattern in the Lagoon is influenced mainly by the semi-diurnal constituent which, in this case, has a mean tidal range of approximately 2.0 m, with minimum tidal range of 0.6 m (neap tides) and a maximum tidal range of about 3.2 m (spring tides); these correspond to a maximum and a minimum water level of 3.5 and 0.3 m (relative to the local datum, i.e., -2.0m below MSL), respectively (Dias *et al*., 1999).

As the oceanic tide reaches the entrance inlet, there is an imbalance between the water level outside and inside the inlet. The pressure gradient created by this difference causes water to flow into the Lagoon, at a velocity which depends upon the cross-sectional area and bottom friction. The tide propagates into the Lagoon as a damped progressive wave, suffering a time delay due the complex morphology of the system (Dias *et al*., 1999). However, when freshwater input is significant, usually during wet season, and the tidal range is small, freshwater flow may dominate the tidal flow in some of the upper reaches of the Lagoon.

The flux of water through the inlet depends upon the freshwater and tidal inputs. These vary considerably with the lunar-solar fortnightly tidal cycle; with each season and with the occasional (dryer season) damming of rivers, as a result of land management (to avoid saltwater intrusion on agricultural land) and industrial activity. The tidal prism, i.e., the volume of water within the estuary between high and low water (Dyer, 1997), is estimated to be 34.9 x 10^6 m^3 for lower low water (LLW) neap tides, 136.7 x 10^6 m^3 higher high water (HHW) spring tides, and approximately 95 x 10^6 m^3 for a mean tidal range of ~ 2m (Dias, 2001).

The highest current velocities, which can reach values greater than 2 ms^{-1}, are found in the inlet channel. Inside the Lagoon, current velocities decrease, especially when there is no river flow and the tidal forcing is reduced, which may occur up small creeks. The residence time, which is the time needed to replace all but 37% of an original material, varies from less than a day in the central areas of the Lagoon, close to the inlet, to over 15 days for remoter areas (Dias *et al*., 2001).

The sediment distribution is highly linked to the current pattern throughout the Lagoon and to sediment supply sources. Hence, the coarsest sediment is found in the inlet, where the currents are strongest and the finest sediment is found away from the inlet, where currents are weaker, especially at the uppermost reaches of the Lagoon.

The climate pattern is common to those of coastal regions at mean latitudes, with periods of rainfall concentrated mostly during winter. Annual mean air temperature range between 12-14 ^oC. The wind pattern is seasonal, with winds predominantly from west to south in winter, with varying intensity and direction. In summer, there are large fluctuations in wind direction throughout the day, caused by a thermal diurnal gradient between the ocean and the coastline. Wind direction can shift from a weak easterly wind in the morning, to a stronger northerly or westerly wind in the afternoon, gradually decreasing in the evening to a westerly wind (Teixeira, 1994).

The salinity regime is typical of a region with seasonal variations, according to precipitation rates and evaporation. In dry seasons, river runoff and precipitation are scarce, allowing seawater intrusion to penetrate farther up the lagoon. This pattern, combined with a significant increase in evaporation rates, explains the high salinity values found within the Lagoon. This is especially in some shallower areas, with salinity values higher than those found in the ocean. In the wet season evaporation is insignificant, precipitation and river flow is increased, therefore decreasing salinity.

The wave climate inside the Lagoon is not well documented. Occasional measurements at specific sites exist, for short periods only. According to Teixeira (1994), outside the lagoon the annual mean wave height reaches 1.8m, with 11s period. Wave height related to storm events, which might occur about 10 days per year, can exceed 5m. During summer the wave direction is predominantly from the NW and southwards during winter (Teixeira, 1994).

Chapter III

BACKGROUND

Sea level variability is an area of active research. A summary of recent evidence for change, with emphasis on the West of Europe, follows. Further references will also be made within the context of some of the following Chapters, where they are more relevant to the specific content under discussion.

3.1 Regional Sea Level Variability: West Europe

Most studies of sea level changes in the past, or for future projections, have focused mainly on changes in mean sea level (MSL). Secular changes of the MSL, based on the longest available tide gauge data, suggest a 1-2 mm yr^{-1} average rise (IPCC TAR, 2001).

Climate change projections of global warming associated with greenhouse emissions could increase mean sea level, as a result of thermal expansion and the melting of ground ice. Furthermore, climate change is considered to be responsible for increased storminess in the North Atlantic. The importance of these factors on sea level trends has been addressed, through different approaches.

Rates of change in MSL (accelerations in MSL) were studied by Woodworth (1990) as an improvement on linear trends in MSL records. This author considered that linear trends could not necessarily be considered as manifestations of real sea level change alone, because of the ambiguity between ocean water level and changes in vertical land movements. Therefore, a second-order or quadratic time dependence of MSL was tested, as an improved representation of climate signal in tide gauge records.

Estimated accelerations in MSL, for some European tide gauge records, since 1870-1986, provided little evidence for significant accelerations. Instead, a weak deceleration was shown. This could be associated to small acceleration in the North European air-pressures over the same period, although other meteorological and oceanographic forcing also contribute to MSL changes.

In the same account, Woodworth (1990) analysed the three longest European records (Brest, since 1807, Amsterdam, since 1700 and Stockholm since 1774) and concluded that there have been significant accelerations, with coefficients close to 0.004 mm yr^{-2}

(0.4 mm yr^{-1} per century) over the last centuries (confirmed in Woodworth, 1999). This acceleration is considered to appear typical of European Atlantic coast MSL over the last few centuries. Near-zero acceleration values were also obtained for Southern Europe with the exception of Cascais (Portugal), which has a positive acceleration coefficient, with a 99% confidence level. The unusual effect in Cascais may result from local fluctuations in ocean circulation, river flow or land movements. Although the Cascais results are different from the regional pattern, similarities have been found to the accelerations in the very long San Francisco (U.S.A) record (Sturges, 1987).

Gornitz & Lebedeff (1987) found a decrease of 0.1 mm yr^{-1} in the European trend of sea level between 1932 and 1982 relative to 1880-1931.

Ekman (1999) has utilised the annual average and monthly average MSL from the world's longest sea level series (Stockholm), together with temperature and wind data, to study climate change in the Baltic region. The rise in MSL agrees with the European estimate for the last centuries. Interannual MSL variability decreased between 1700-1900 and began to increase significantly after 1900. Such variability was also found in the temperature and wind data. Changes in sea level variability are associated with changes in the wind pattern, which might be related to long-term changes in the NAO.

The problem with the estimated acceleration lies in the different statistical techniques used in the analysis, together with the series of MSL records used. With the exception of atmospheric pressure, historical meteorological, oceanographical and hydrographical data are as yet insufficient for a study of possible MSL accelerations (Woodworth, 1990).

Tide gauge records have also been used to investigate long-term secular changes in Mean Tidal Range (MTR), related to MSL changes. MTR is defined as the difference between mean high water (MHW) and mean low water (MLW). It is considered that MTR changes might be expected to depend upon changes in MSL, or water depth. This is important, considering the shallow nature of waters of the NW European continental shelf.

Secular trends in the MTR around the British Isles and along the adjacent European coastline have been studied by Woodworth *et al*. (1991). Trends in MTR in the British Isles are mostly positive and of the order of 1 mm yr^{-1}. This is less than, but comparable with, typical MSL trends (Woodworth, 1987). The trend in Scotland and in the central and western Irish Sea was small and even negative, whilst in most of England it generally lies between 0.5 - 1.0 mm yr^{-1}. For the European coastline, French, Belgium and Irish data were found to be consistent with the results for the British Isles, providing a regional picture without, however, explaining the controlling mechanism of MTR changes as a function of MSL change. Holland was an outlier to this pattern, with approximately two to three times larger MTR secular trends than expected. No uniform secular trend was found in the German tidal regime.

The mean tidal range (MTR) along the North Sea coastline is reported to have increased because of increasing mean high water (MHW), whilst the mean low water (MLW) decreased slightly (Jensen *et al.*, 1993). The North Sea MSL has also increased (Shennan & Woodworth, 1992), as has the storm surge frequency and duration (Jensen *et al.*, 1993).

Long-term sea level time-series recorded at stations on the northern and eastern coast of the Iberian Peninsula are less well documented, when compared to the British Isles and North Sea stations. This situation should change in future, as there is on-going progress in recovering chart data and maintaining the tide gauges to ensure good quality data. Digitisation of the data from the north Spanish gauges has led to a recent study of interdecadal trends for Santander, Coruña and Vigo (Marcos *et al.*, 2005). Sea level is considered to have been rising at a rate of 2.12, 2.51 and 2.91 mm yr^{-1} in Santander, Coruña and Vigo, respectively. Furthermore, it is also suggested that regional meteorological forcing tends to lessen the sea level rise, contributing (by a third) to its increase. The remaining contribution is attributed to spatial differences in the increase of the ocean heat content. Garcia-Lafuente (2004) investigated some aspects of seasonal variability around Spain, which exhibit a well defined annual cycle and a small, but distinguishable, semi-annual cycle.

Sea level studies have focused on the effects of MSL changes associated to climate changes. However, as mentioned previously, meteorological effects also influence observed sea levels, especially the extremes.

Woodworth & Blackman (2002) investigated changes in extreme high waters at Liverpool (England) and, subsequently, have extended their research to a set of 141 tide gauges with the aim of establishing evidence for significant changes during recent decades in the occurrence of extreme high water levels, with differences to MSL changes (Woodworth & Blackman, 2004). The relationship between regional climate indices and MSL was also investigated. This research found that there has been an increase in extreme high water levels since 1975, with variations in the extreme related to changes in regional climate. However, for most of the stations, secular changes and interannual variability in extremes are similar to those in MSL; hence, they are consistent with being produced by the same atmospheric and/or oceanic forcing (Woodworth & Blackman, 2004).

Lozano *et al.* (2004) have examined the evolution in the occurrence of storms, along the Atlantic coast of Europe, since the 1940s, as well as their relationship with the NAO. These investigators have identified a seasonal shift in the wind climate, with regionally more severe winters and calmer summers, which might be associated with a northwards displacement in the main North Atlantic cyclone track. Furthermore, the number of cyclones crossing the North Atlantic is found to have decreased during 1965-1995. This appears to be consistent with longer-term patterns of decrease in the North Atlantic storm records, since 1900. The impacts associated with these changes are considered to affect low-lying and soft sedimentary coasts, by significantly increasing coastal erosion and flooding.

The non-tidal residual most commonly referred to as surge, is forced by atmospheric pressure and winds; therefore, it can be used as an estimate of climate (storminess) variability. By investigating long-term trends in non-tidal residuals (surges), it is possible to analyse climate variability (storminess).

Bromirski *et al.* (2003) have used the San Francisco hourly tide gauge records (150 years) to investigate interdecadal storminess along the West Coast of the U.S.A. No substantial change was found for monthly mean (positive) non-tidal residuals although extreme winter non-tidal residuals have increased significantly since 1950. This is said to agree with other climate-related trends found in cyclone frequency and wave height studies.

Few studies of this nature have been made using European tide gauge records. Bouligand & Pirazzoli (1999) have examined secular trend evolution for Brest, since 1860. No statistically significant trend was found, when considering the entire record. However, important fluctuations were evident, associated with periods subjected to varying surge activity. For short periods, stronger interannual variability was found: for medium-term periods, the variability oscillated non-linearly between increase and decrease, whilst a recent acceleration in positive extremes was found, between 1953-1994. This study was followed by a farther investigation (Pirazzoli, 2000), relating to how positive and negative surges associated with climate variability have changed along the NW French Coast; likewise its implication on flooding risks.

The North Atlantic Oscillation (NAO) variability has been the focus of much recent attention, because of its relationship to the European climate (Hurrell, 1995) and as a major forcing parameter for sea level variability (Tsimplis *et al.*, 2005). For example, Tsimplis & Josey (2001) have described how the inverted barometer effect, linked to the NAO, is the mechanism responsible for sea level variability in the Mediterranean Sea. Wakelin *et al.* (2003) used a two-dimensional model of tides and storm surges, to study the connection between changes in the NAO and sea levels over the northwest European continental shelf for 1955-2000. These investigations found a clear spatial pattern in the correlation between sea level and the NAO, on a winter-mean timescale. This correlation was positive in the northeast and negative in the south, where most of the sensitivity is also in the non-hydrostatic component of sea level. These results have been confirmed by Woolf *et al*. (2003) who, using tide gauge data and altimeter data, found a positive sensitivity to the NAO index in the North Sea and Baltic regions. This is caused mainly by increased westerly winds and a negative sensitivity in the north eastern coastline of America. However, this effect is only significant around Vigo and in the western Mediterranean and Adriatic. A negative response was also found in the southern west part of the U.K. Further to these results, Yan *et al*. (2004) have found unusually strong and weak annual cycles in sea level, which tend to lag those in the NAO by a month for most sites analysed. Such a lag suggest that sea level does not respond simply to pressure forcing, but is additionally responsive to changes in thermal conditions and fluxes, associated with the NAO.

The severity of the impact of sea level rise at any location will depend upon whether the land is locally lifting or subsiding, and on changes in wind and wave direction (Tsimplis *et al*., 2005). Relatively little is known about long-term changes in winds and waves. Whilst mention has been made of an increase in wave height in the northeast Atlantic (Bacon & Carter 1991, 1993; Woolf *et al.* 2002, 2003a), little is known about variations in wave direction. Changes in wind patterns in this region have focussed lately on the much studied NAO (for instance, Lozano *et al.*, 2004; Dawson *et al.*, 2004; and Rogers, 1997). Otherwise, only local accounts, for example, sush as that for the NW region of France by Pirazolli (2000) and Pirazolli *et al.* (2004), are available.

3.2 Local Sea Level Variability: Ria de Aveiro, Portugal

The importance and interest in regional sea level changes has been explained above, together with a review of some of the results of regional sea level studies. However, understanding sea level changes and influences at a local scale is of greater practical interest. Engineers and Local Authorities need such an understanding, as a basis for decision making on coastal management issues.

Low-lying coastal areas are subject to great vulnerability, when considering increased risks of flooding as the result of both mean sea level rise and increase in the amplitude and frequency of sea level extremes. The human population is usually attracted to coastal areas, adding extra pressure to these environments.

A comprehensive review on the background to the impacts of future sea level rise on the European coastline, within the context of climate change, is given in Church *et al.* (2001); similarly, on European coastal lowlands, i.e. the low-lying coastal system, in Tooley & Jelgersma (1992).

Sea level variability is potentially affected by climate change, as a result of ocean-atmospheric interactions. The full understanding of sea level variability along the European coast has not yet been attained, despite the severe impact it can have on the coastline, especially if considered in addition to estimates of MSL increase. According to Tooley & Jelgersma (1992), shorelines around the English Channel and the Atlantic coast of the Iberian Peninsula are considered areas of ‘high risk’, as they lie below spring tide levels and are affected by large tidal range, persistent onshore winds and the regular occurrence of storm surges. However, some regions in Portugal and France are said to be of ‘low risk’ if they are 5m above tide level, i.e. low-lying coastal systems protected by sand dunes.

The present investigation examines tidal variability in the Ria de Aveiro Lagoon, situated on the low-lying NW Atlantic coast of Portugal. Mean sea level rise is estimated in order to describe qualitatively future sea level risks to the region.

Silva et al. (2002) have mentioned that there have been considerable changes in the tidal regime of the Lagoon. Seasonal variability associated with climate forcing is reported to cause a 0.12 m difference in observed MSL, between the summer (March-September) and winter (October-February) months. Future estimated increase in high water level is believed to be similar to the increase in mean water level. Climate change, together with anthropogenic influences, are considered to have increased the risk of flooding during high tides, with the greatest impacts on areas near the Lagoons banks.

Only a brief summary is presented here of the relevant, available, literature for this Lagoon. The limited physical publications available include: (a) project reports, with a much focused interest (Rodrigues *et al.*, 1989; and Costa, 1990); or (b) local port authority reports, usually related to construction work at the Lagoon's entrance access. However, recent work includes three PhD. dissertations in the hydrodynamics (Dias, 2001), water quality (Silva, 1994) and sediment morphodynamics (Teixeira, 1994) of the Lagoon. Most notable of this work is that of Dias (2001), which uses a 2-Dimensional hydrodynamic model to study tides and some other physical properties of the Lagoon, on which several papers have been published (see References). The model was validated with field data, providing an overall picture of the hydrodynamics of the Lagoon.

Only limited literature is available on studies similar to what is outlined above, especially for a single inlet tidal lagoon. Most research focuses upon characterising tides in estuaries or rivers, based usually upon no more than a month of sea level observations. Nevertheless, there are a few investigations using long series of observed sea levels. Amin (1983) used harmonic analysis results of 51 years of observed sea levels in the Thames Estuary (SE England), to estimate perturbations in the tide and to compare the previous tides with those at present. Pugh (1978) used a year of sea levels from Aldabra Atoll, Mombasa and Mahé (western equatorial Indian Ocean), to analyse for tides and regional meteorological effects.

Short-term sea level changes have been monitored by Wong (1986), to assess the characteristics of the volume exchanges, at different time-scales, and the relative importance of tidal and sub-tidal exchanges within the coastal lagoon of the Great South Bay (south shore of Long Island, New York). The results obtained established that the dominant, M_2 constituent, suffered a 50% reduction in the interior of the lagoon, due largely to the narrow inlet at the mouth.

Sea level measurements, together with models, have been used to study changes in the tidal characteristics in estuaries that are known to have changed; for example: Kang (1999) has investigated the tidal characteristics as a results of the coastal construction of sea-dike/sea-walls in the Mokpo coastal zone in Korea; Liu *et al.* (2001) have analysed the influence of bathymetric changes on hydrodynamics and salt intrusion in the tidal

Tanshui River system, in Taiwan; and, more recently, Lane (2004), has examined how a continuous series of field measurements and model studies have developed the understanding of the evolving interactions between tidal dynamics, sediment regime and bathymetry of the Mersey estuary, England.

The published literature available on tidal propagation in shallow inlet/estuarine systems is more extensive than for previous studies, as it is very relevant within a broader scientific interest; these include vertical and horizontal tidal displacements. A review on this subject has been provided by Aubrey & Speer (1985), Speer & Aubrey (1985) and Friedrichs & Aubrey (1988).

3.2.1 Historical Evolution

Prior to its formation, the area where the Ria de Aveiro Lagoon presently lies used to be open to ocean influences (Figure 3.1a). A long shallow bay would have been formed by erosion of the coastline, as a result of strong (wave) action by the adjacent ocean. At the same time, considerable amounts of sediment were being exported from the main river tributaries to the north of Aveiro (Douro, Vouga, Águeda and Cértima). These were transported to the south by the coastal currents, depositing at the mouth of the Vouga river. A deltaic-type system emerged, incorporating several sandbanks, which later contributed to the development of a sand barrier along the coastline. It has been estimated that this barrier originated in the XI or XII Century (Oliveira, 1988).

Between the XII and XVI Century the barrier developed slowly, from N-S along the coastline, consequently separating the fluvial delta system from the ocean (Figure 3.1b). The tidal amplitude within the Lagoon decreased, small islands emerged and the salt water intrusion became limited to the area covered by the newly-formed lagoon.

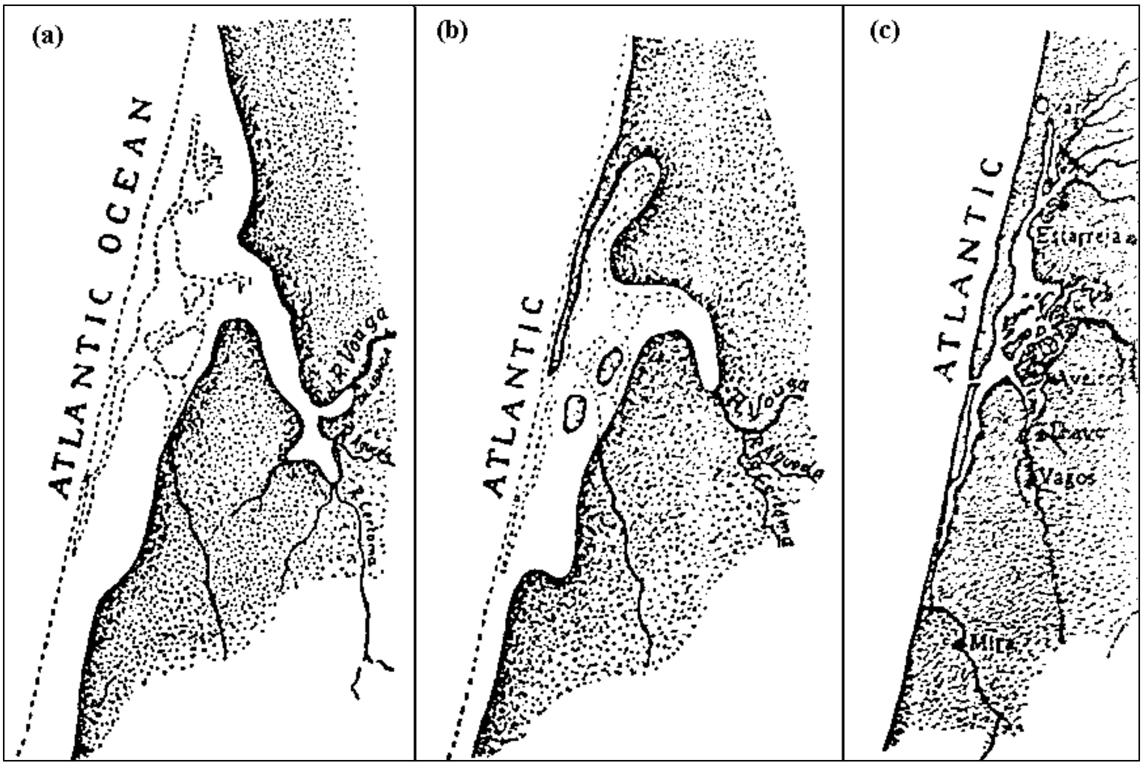


Figure 3.1 Main stages of the evolution of the Aveiro Lagoon: (a) coastline before the lagoon formed (Note: the dotted line shows the present outline of the Lagoon); (b) sand barrier advancing from N-S, the Lagoon starts to form, however, there is still significant exposure to the ocean; and (c) the Lagoon is separated from the ocean by a sand barrier, parallel to the old coast and connected to the ocean via an inlet (after Oliveira, 1998).

These times are documented as being prosperous for agriculture, the salt industry, maritime-related commerce, lagoon-coastal-open-ocean fishing activities, which resulted in a demographic increase. This situation changed in 1575, as the connection between the Lagoon and the ocean decreased, controlling the salt water flux, affecting the water quality; this affected most activities that, by then, were dependent upon the Lagoon. The XVII Century has become associated to the commencement of a severe crisis for the local community, as the Lagoon became dominated by freshwater. Eventually, unsuccessful attempts were made to maintain an opening at Vagueira (Figure 3.2A) until 1808, when a connection to the ocean was established at the location of the present inlet (Barra). This ended the crises that had befallen the Lagoon. Figure 3.2 shows the various locations of the inlet, prior to 1808.

At the same time that the Lagoon was reconnected to the sea, a dike was constructed along the southern bank of the inlet channel, isolating the Mira Channel from the main section of the Lagoon. In 1877, the Mira Channel was reconnected to the Lagoon, causing deepening and meandering of the channel bed.

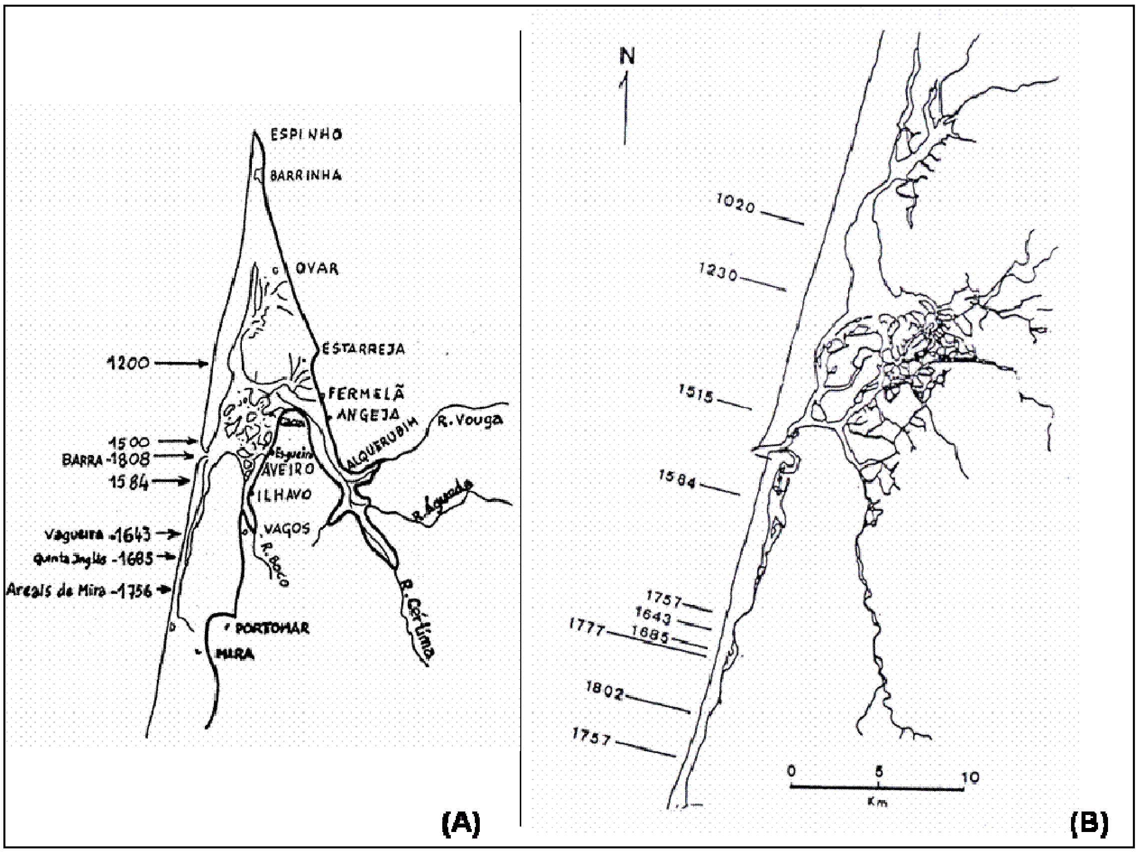


Figure 3.2 Maps of the Lagoon, illustrating the different locations of the inlet, over time. In (A) the bolder contour line delimits the coastline when the Lagoon started to evolve (from Oliveira, 1988); whilst (B) shows a more recent configuration of the Lagoon (from Teixeira, 1994).

Despite the reopening of the Lagoon, several problems, caused mainly by the prevailing weather conditions, persisted. Solutions presented by some engineering construction works (e.g. breakwaters), throughout the 19th Century, were never efficient. Thus the stability of the inlet was compromised continually until 1932, when two new engineering-structures were built within the inlet channel.

A breakwater was constructed on the northern side of the inlet channel (seaward section of N, in Figure 3.3) whilst a dike (triangular shaped) was constructed at the end of the same channel, in order to regulate the tidal flow (shown as T, in Figure 3.3). This development improved the flood tide, directing the currents towards the navigation channels and, consequently, improving their accessibility. During the ebb, currents were re-directed, affecting the channel depth and reducing the bottom friction, such that the ebbing tide at the inlet became stronger, increasing the depth of the inlet. The increase in the tidal prism and tidal amplitude, at the inlet, allowed the saline water and tidal currents to penetrate farther in to the upper reaches of the Lagoon, changing the intertidal boundary.

Figure 3.3 Inlet of the Lagoon, since 1984/85. Arrows show location of: (N) the northern breakwater; (T) the triangular shaped dike; (S1) the first southern breakwater to be constructed; and (S2) the second southern breakwater.

The northern breakwater was extended subsequently in 1948, by 710m. At the same time, a 900m breakwater was constructed on the southern side of the inlet channel (Figure 3.3 - S2), farther south than the other constructed previously. This structure required approximately 10 years, before completion. It was accompanied by considerable amounts of dredging in the inlet channel and in the channels connecting it to the major ports.

Construction work on the breakwaters ended around 1984/85, after a further 520m were added, in a WSW direction, to the northern breakwater (Figure 3.3 - N), this changed substantially the influx of the tide. The tidal prism is estimated to have doubled within the previous 40 years (1949-1954), prior to completion of the works performed on the inlet (Teixeira, 1994).

Until 1950, the instability of the inlet could be associated with a reduction in the cross-sectional area, as a result of accretion. This decreased the current velocity and, consequently, further decreased the cross-sectional area of the inlet. On the other hand, any increase in the current velocity would subject the channel to erosion, increasing the cross-sectional area of the inlet (Teixeira, 1994). Before 1940, there was a tendency towards accretion within the inlet channel which, from the two scenarios presented, indicates a tendency towards the closing/blockage of the inlet section. After the construction of the breakwaters, the inlet was able to remain unblocked as it naturally tended towards stability (Teixeira, 1994).

According to Teixeira (1994), substantial changes occurred until 1950, to tidal propagation and the tidal prism within the Lagoon. The changes found in the tidal characteristics of the Lagoon between 1987 and 1994 are small when compared with records prior to this period. This is based upon the data obtained by the Portuguese Hydrographic Office in 1987/8 and that collected by APA, in 1994, i.e. after the inlet became fixed at its present position. This pattern is illustrated in Figure 3.4, by the general increase in the amplitudes of the M_2, S_2 and K_2 constituents, at the mouth. The largest increase is found between 1934 and 1953 (Figure 3.4). The tidal range at the mouth of the inlet, during a spring tide, is estimated to have ranged from 1 to 1.5m during the 18^{th} Century, reaching 2m in 1950 and being 2.6m around 1994 (Teixeira 1994).

The historical description of the evolution of the Lagoon illustrates the many changes and pressures to which this system has been subjected, over the centuries, as well as the consequences they have on the local community and on all activities that are directly, or indirectly, dependent upon the Lagoon.

The most significant hydrodynamic changes identified for the Lagoon, consequent to the anthropogenic interventions during the 20^{th} Century, have been associated with processes related to the changes in the tidal regime, i.e., the morphology/bathymetry of the channels and the associated sedimentation rates.

Changes in the tidal characteristics of the Lagoon, at an early stage, have been related to the geomorphologic changes caused by the lagoon’s evolution; more recently the main influence are the changes in the tidal prism at the inlet, as a result of the intensive engineering work to permanently ‘fix’ the inlet channel. The present work examines, in detail, how changes to the inlet’s dimensions, and other factors, may have influenced the tidal dynamics of this Lagoon.

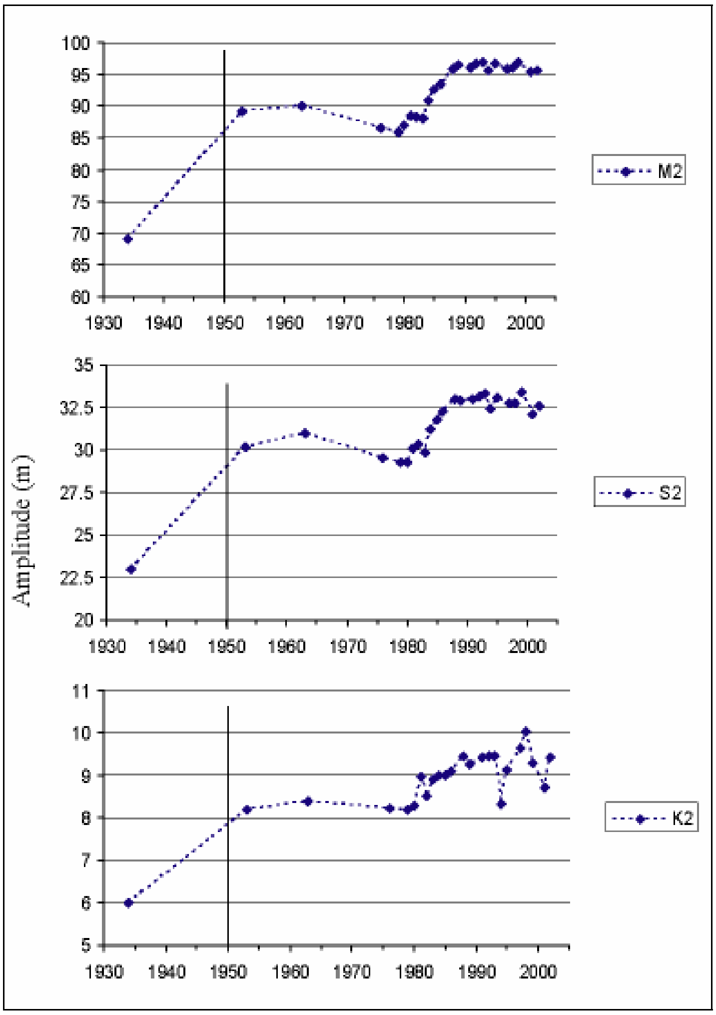


Figure 3.4 Amplitude of some of the tidal constituents, from 1934 – 2002 (1934-1963 values have been obtained from Teixeira, 1994). Vertical line indicates the year when the inlet became 'fixed' (for details, see text).

Chapter IV

METHODOLOGY

Sea level changes occur over different time-scales and different spatial-scales, as a result of different forcing mechanisms. The present study investigates secular or long-term changes at a regional level, i.e., NW Europe. The study examines also an example of short-term changes on a local scale; for this, a particular lagoon (the Ria de Aveiro in Portugal) was tidally surveyed.

This Chapter will commence by summarising the approaches that have been used to analyse the data obtained, for both regional long-term sea level variability and local sea level variability study. It will explain then how these were applied to the different datasets.

4.1 Measuring Sea Levels

For many centuries, human curiosity has led to several theories to explain the mechanisms related to tides and extreme events, such as storm surge and tsunamis. It is clear from on-going research that this is a subject yet to be fully understood (see Chapter 1).

When measuring sea levels, the aim is to measure the vertical distance between the average surface of the sea and a fixed datum level (Pugh, 2004). As sea level changes in time-scales from seconds, due to wind waves, up to centuries, as a result of tectonic (geological) movement, measuring sea level is not a straight forward task. The difficulty in making these measurements is enhanced further by the conditions on deployment (pressure, corrosion, biofouling, security, datum stability, etc), as well as instrument capabilities and/or limitations.

Many different measuring instruments are available, ranging from the simple and cheap tide pole or staff to the sophisticated and expensive satellite altimeter (refer to Pugh, 2004 and IOC, 2002, for a detailed description). A brief description is provided here on the float gauge and the pneumatic bubbler gauge, which are two different sea level measuring instruments that are relevant to this study.

Float Gauge

Until recently, this particular system was the most standard method of measuring and recording long-term water levels, i.e., providing historical sea level records. It consists of a stilling well, above which can be found a recording device (Figures 4.1 & 4.2).

The stilling well is a vertical tube opened at the top end and closed at the bottom, with a single orifice or pipe inlet on the lateral bottom tube wall for water to flow in and out (Figure 4.1). The narrow connection at the lower section of the tube works as a filter, to dampen high frequency perturbations at the sea surface, such as waves and ship wash. Long-period variations, such as tides, are not affected.

A float will move freely within the well, according to the sea surface movement. It will be connected to the measuring device by a system of pulleys and gearing, which allow a pen to move over a chart mounted on a circular drum (Figures 4.1 & 4.2). Charts records are, nowadays, substituted sometimes by an electronic counter that automatically digitises the data, which in some cases, may be transmitted by telephone line or via satellite.

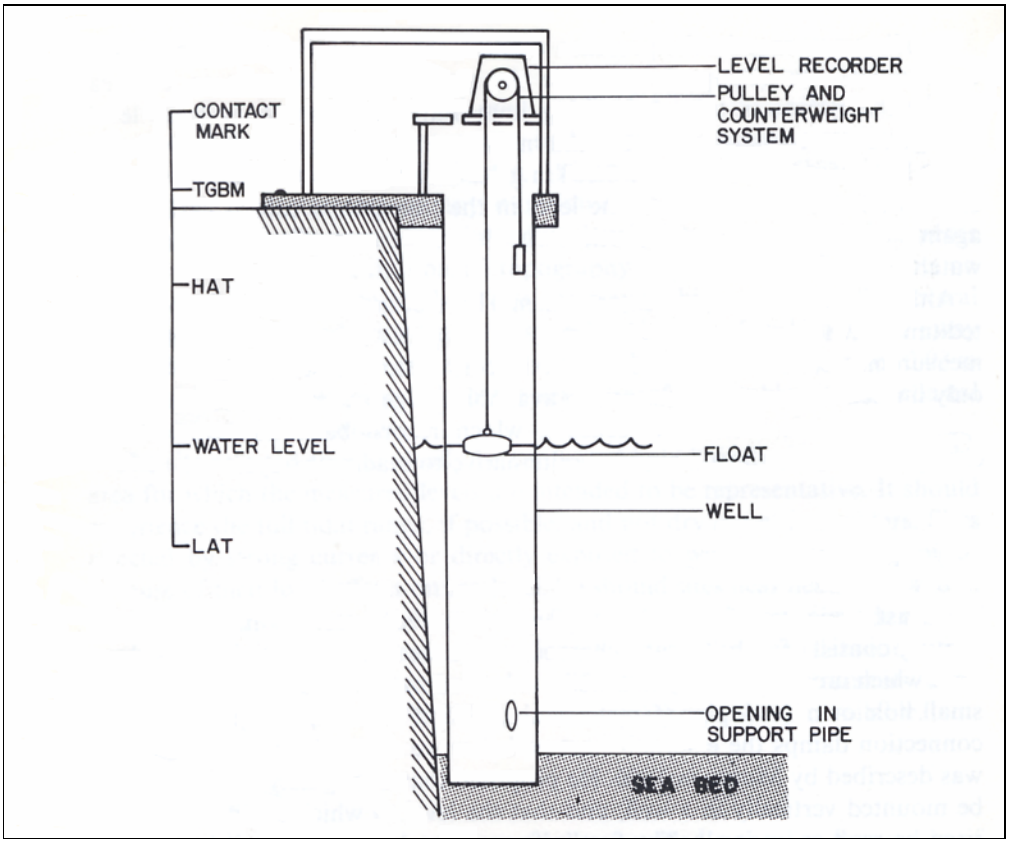


Figure 4.1 A basic stilling well float-operated gauge (based upon Pugh, 1987).

Figure 4.2 Stilling well float-operated tide gauge structure at Aveiro, Portugal: (A) tide gauge hut, with exterior of stilling well; (B) vertical drum recorder, with opening to the stilling well beneath the recording instrument; (C) upper opening of stilling well; (D) Tide Gauge Bench Mark (TGBM) on the floor inside the hut, beside a small opening to the exterior of the structure.

This system requires routine checks, as part of the measuring programme. These should include timing checks and 'zero reference checks'. The latter consists of measuring the distance between the contact point and the water surface (Figure 4.1), to calculate the difference between the measured and recorded data. For 'proper' measurements, the difference should be zero. Although less routinely, it is also necessary to check the contact point against a designated Tide Gauge Bench Mark (TGBM), i.e., a stable bench mark, near to the gauge to which the tide gauge datum is referred. The TGBM (Figures 4.1 & 4.2) is usually levelled to the national levelling system.

The accuracy of the stilling well system is affected mainly by systematic water density differences (temperature and salinity), between the inside and outside of the well. This can lead to differences in level and also, where there are strong currents, the water flowing past the submerged well orifice can lead to a drawdown in the well levels (Pugh, 2004).

Pneumatic Bubbler Gauge

The basic bubbler gauge system, shown in Figure 4.3, measures hydrostatic pressure at a fixed point below the sea surface. Compressed air or nitrogen gas is released at a certain rate along a thin tube and allowed to escape through an orifice drilled in a cylinder, which is submerged at the other extremity of the tube. This cylinder is referred to as the pressure point. As sea surface level varies, the pressure ($p = \rho g h$) exerted on the pressure point changes. The variation in pressure is transmitted up the pipe to a recording instrument, connected to the supply tube. The water level is calculated according to $h = (p - p_a)/\rho g$, where h is the water level, p the measured pressure, p_a the atmospheric pressure, g the gravitational acceleration and ρ the mean density of the overlying water column. A constant value can be used usually for ρ; however, in estuaries where ρ tends to vary substantially during the tidal cycle and seasonally, variation in density should be included in the processing of the results.

In this system, the dampening of waves is, to a certain extent, achieved by maintaining the pressure at the pressure point.

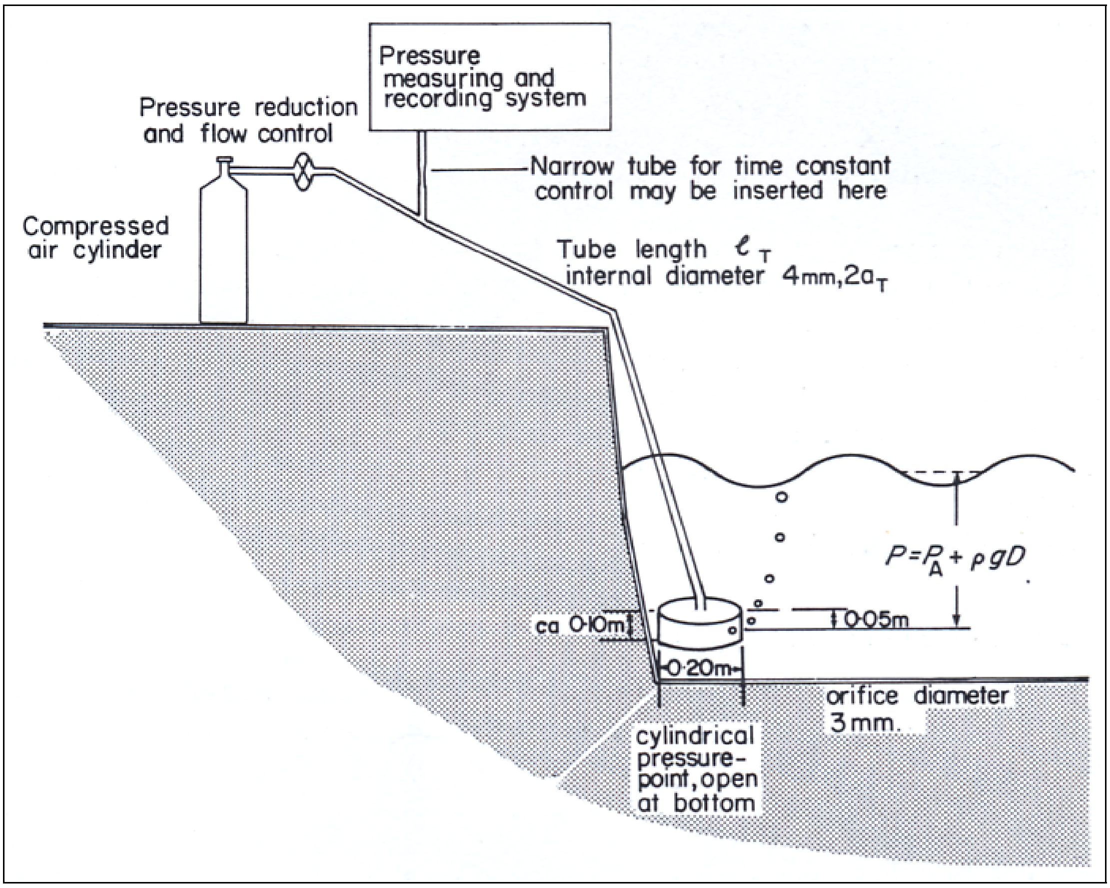


Figure 4.3 A basic pneumatic bubbler gauge (from Pugh, 1987).

Data reduction and assimilation

Once data has been measured and collected it should undergo some form of data control to ensure a better quality dataset. A dataset that has been processed and which is well documented should reduce possible errors in future analysis and results.

Databanks have been created to store and document available sea level measurements, obtained under the Global Sea Level Observing System (GLOSS) (Woodworth & Player, 2003). One of these databases is maintained by Permanent Service for Mean Sea Level (PSMSL), in the U.K (Woodworth & Player, 2003). The data covering 1800 tide gauges worldwide usually available to the research community, from www.pol.ac.uk/psmsl.

BADC collect, quality control, and document U.K. sea level data, from the tide gauges under their responsibility. Other national networks, such as the Instituto Oceanografico Español (IEO) in Spain, have also adopted recently this centralisation as a procedure and are even revising their long-term dataset (personal communication, María Jesús García, from IEO).

This Section has described briefly, two instruments used in the measurement of sea level. After the raw data undergoes a quality check, it is then ready to be analysed. Several methods exit to analyse sea level measurements. However, the choice of method depends usually upon the aim of the research. The next sections describe the approach and procedures adopted in this study.

4.2 Sea Level Components

Tide gauge wave-averaged sea level (ζ) measurements can be studied as a sum of three separate time-dependant components: tides, meteorological-induced surge (non-tidal residual) and mean sea level, represented as:

$$\zeta(\mathrm{t}) = Z_0(t) + X(t) + Y(t) + XY(t) \qquad (4.1)$$

where $Z_0(t)$ is the mean sea level, $X(t)$ the tidal component, $Y(t)$ the meteorological non-tidal residual and $XY(t)$ represents the interaction between tidal and non-tidal levels, which is usually only significant in extensive shallow water areas. This fairly simple approach to the statistics of sea level is explained by the relative independence of the physical forces, which produce the different components (Pugh & Faull, 1983).

A more elaborate description of the above procedure is given by Pugh & Maul (1999), where ζ is further broken down so that, for the meteorological surge component, the effect of wind and air pressure are considered separately. Also considered separately are the influences, on MSL: of oceanic currents; temperature and salinity (i.e. changes in density known as steric changes); fluctuations in the mass of water in the ocean (sometimes called eustatic); and geological effects (post-glacial adjustments). The independent understanding of all these different contributions is, as yet, far from accomplished; similarly, their interaction. Here, their characteristics are summarised individually.

The simplest way to define local **mean sea level (MSL)** is as the level the sea surface would have if tides, waves and meteorological surges did not exist. In practice, it is the level of the sea surface, measured with respect to a fixed landmark (bench mark), which is used as a datum. This level is usually averaged over a month or a year, to remove all frequencies other than long period tides. The commonly used annual MSL averages out seasonal effects, but still incorporates wind and atmospheric pressure influences, that occur over periods longer than the year. Therefore, obtaining a good MSL value depends upon: the ability to remove unwanted frequencies, the accuracy of the measurement, and the stability of the datum.

Oceanic **tides** are periodic water movements generated by gravitational forces, which result from the interaction between the moon, sun and the Earth systems. As they propagate throughout the ocean basins onto continental shelves and into coastal waters, their energy is dissipated at rates that depend mainly on local topography and water depth (refer to Munk, 1997).

Tides at a particular location are represented usually as a sum of tidal harmonic constituents, each with a phase and amplitude, derived from observed sea levels. The number of harmonic constituents obtained for a region depends on the number of available sea level observations. For instance, a year of observed hourly levels usually allows definition of approximately 60 constituents. A lunar month provides fewer constituents, which might be insufficient to describe adequately the tidal forces. Tidal analysis, to calculate tidal harmonic constituents, is referred to as harmonic analysis. It should be noted that tidal constituents are often in literature, referred to as tidal constants; this is incorrect as they vary with time.

Changes in the astronomy of the earth-moon-sun system are extremely small and proceed over extremely long-time scales. For sea level statistics, based upon tide gauge data, these changes are negligible. Other factors that are considered constant over our relatively short time-scales, are changes in the shape and depth of the ocean basins.

Although previous influences can be considered constant, on the time-scales referred to above, others vary significantly over shorter time-scales. The astronomical or gravitational forcing is not constant over time, varying significantly over the 14-day period (spring-neap) cycle and even over a 18.6-year lunar nodal cycle (Pugh 1987). This pattern is taken into account theoretically, in the tidal harmonic analysis.

Cartwright (1972), Pugh (1981), Pugh & Faull (1983) conclude that ocean and shelf-tides are considerably stable over centuries although, at local scales significant variations in tides, associated to river or coastal geomorphology changes, can occur. These changes in tides are extremely important, when considering their interaction with extreme events related to storms; they may, for example, increase the risks of local flooding.

Following the explanation of MSL and tides, the definition for **meteorological surge or non-tidal residual** is simply presented. By removing the MSL and the predicted tidal levels, from the observed sea levels, the result is a series of levels that is influenced by errors (‘noise’) introduced via the measuring system and are forced by meteorological influences, i.e. weather - winds and atmospheric pressure. These levels are the non-tidal residuals, which have the higher frequencies in the record, due to the relative short time-scales (a couple of days) of storm surge events. Seiches and tsunamis can also form part of this signal, but are excluded within the context of the present investigation.

The meteorological forcing behind the standard deviation of the non-tidal residuals allows these to be used as estimates of storminess and, hence, climate change.

4.3 Harmonic Analysis

The previous Section explained how sea level measurements can be represented by separate components such that independent physical forces can be identified and investigated. The series of observed ζ measurements or readings, obtained from the tide gauge, have to undergo some analysis before the different tidal components, specific to that record, can be obtained.

The analysis of tidal data, i.e. ζ records or currents, can be used for either future prediction of tides or understanding the hydrodynamics of a system and the tide-forcing mechanisms acting upon it. Several methods have been developed to analyse tidal data (see Darwin, 1892; Doodson, 1921; Lecolazet, 1956 and Horn, 1960) but, for routine processing, the traditional *harmonic analysis* is sufficient (Godin, 1972). Other methods of analysis include the non-harmonic method and the response analysis method (Munk & Cartwright, 1966).

Harmonic analysis is the mathematical tool used to study the periodic oscillation of the tide, based upon the equilibrium tide principal. The assumption made is that the tidal variation can be represented by the sum of a set of n constituents or harmonic terms, such as $H_n \cos(\omega_n t - g_n)$, defined by an amplitude H and a phase lag g_n, relative to a defined time zone (usually, the phase of the Equilibrium Tide at the Greenwich Meridian). The angular speed ω_n, for each term, is equal to $2\pi/T_n$ where T_n is the period of the nth constituent.

This method of analysis is used extensively throughout the present study. However, a detailed description is not provided here, as it not within the scope of the present work and is already available (refer to Doodson, 1921; Doodson & Warburg, 1941; Cartwright & Edden, 1973; Schureman, 1976).

4.4 Statistics of Sea Level Variability

The four components that together account for the total observed sea level in Equation 4.1 (Section 4.2) can be determined by performing a harmonic analysis on the series of sea level measurements, $\zeta(t)$. In addition to determining the tidal components, some basic statistical concepts can be used to describe those components, without the need for very elaborate analysis procedures.

This Section summarises how some of the statistical concepts (e.g. mean, standard deviation, linear regression, percentiles, etc.), as well as some other data analysis methods (e.g. Empirical Orthogonal Functions) are used in the present study.

4.4.1 General statistic for sea level components

A series of hourly values of sea level measurements, *ζ(t)*, taken over a lunar month (at least, so that it includes major frequencies in the overall signal), can be defined by the **mean** value of the observations

$$\bar{h} = \frac{1}{N}\sum_{n=1}^{N} h_n = \frac{1}{N}(h_1 + h_2 + ... + h_N) \tag{4.2}$$

where N is the number of h observations, and by the **variance** defined as the mean of the square of the individual deviations, i.e., mean square of the difference between each observed value and the mean value

$$\sigma^2 = \frac{1}{N-1}\sum_{n=1}^{N}\left(h_n - \bar{h}\right)^2 = \frac{1}{N-1}\left[\left(h_1 - \bar{h}\right)^2 + ... + \left(h_N - \bar{h}\right)^2\right] \tag{4.3}$$

The positive square root of the variance, called the **standard deviation**, also gives the spread (variability) about the mean.

By applying the definition of variance (Equation 4.3) to Equation 4.1, the total sea level variance over a period of observation N, is given by

$$\sum_{n=1}^{N}\left(\zeta(t_n) - Z_0\right)^2 = \sum_{n=1}^{N} X^2(t_n) + \sum Y^2(t_n) \tag{4.4}$$

The sum of the variance of the individual sea level components is equal to the variance of the total observed sea level. This relationship stands due to the fact that the tidal (X) and surge (Y) components of sea level are forced by different physical parameters, i.e., they are usually independent.

Fourier analysis can also be used to represent a sea level time-series, in terms of the distribution of its variance at different frequencies. By application of this method, the total variance of observed sea levels can be shown to be equal to the sum at each harmonic frequency (refer to Pugh & Maul, 1996, for more details).

Fitting a curve (trend) to a set of measurements, using **regression analysis**, is another way of characterising the data. This is done by the **method of least squares**, i.e., for $y_1 \ldots, y_n$ measurements at time $x_1 \ldots, x_n$, a line is fitted trough the sample so that the sum of the squares of the distances of these points, from the straight line, is minimum (in a XY-plot the minimum distance is in the *y*-direction). Pugh & Maul (1999) provide description of this method and its application to sea level study, which is suggested as a further published reference.

It is very important to consider that the confidence in the above statistics depends upon the number of observations, the time over which they have been obtained, together with their noise/residual content.

4.4.2 Other methods

In the previous Section, a description of a few statistical parameters has been provided. This will form the basis, for the simple statistical method of examining the various sea level components adopted in this study. However, there are a few more methods that need to be described, as they are used when studying specific aspects of the different sea level components.

(a) Statistic of extremes

Several statistical methods are available to study extreme sea levels. Traditionally, estimates of extremes have been derived from the frequency distribution of annual maximum (or minimum) sea levels (e.g. Lennon, 1963 & Graff, 1981), or by joint probabilities of extreme high and low sea levels (Pugh & Vassie, 1980).

A separate summary of the most common approaches adopted presently to study extreme water levels is presented below. Some of these are not used in the present study (refer to Section 4.5.1c, for details).

Annual maximum observed sea level. This method considers the maximum of the total observed sea level in 1 year, i.e. a single value represents a year of data. This provides no information on the contributing factors to those changes, i.e., MSL, tides and residual surge are all included within the signal analysed.

Generally, there is a strong link between the occurrence of extremes and the seasonal cycle and, hence, the averaging over a year (Pugh, 2004). Considering an annual value avoids seasonal changes (in Europe, tides are large in September and October and weather effects are more severe in winter).

Annual maximum residual (surge) level. The annual maximum non-tidal residual level associated with the result of the tidal harmonic analysis of the observed sea level data, or as defined by Woodworth & Blackman (2002), the residual of the tidal parameterization of the data. These authors consider the study of these values of greatest interest for climate research.

Annual maximum residual (surge) at High Water (HW). The annual maximum residual surge level, occurring at the time of HW. This value is useful when only HW levels are available, for instance, when examining historic records.

Residual surge level, at the time of maximum annual HW. Initially, this appears very similar to that described previously, but differs by the fact that this residual level at the maximum HW is not necessarily larger than the residuals at a HW. This is not the maximum, i.e., a residual surge at a non-spring HW. An observation that must be considered is that surges may not occur at HW, this implies that the statistical results, between this and the previous 2 approaches, might not be the same.

Percentiles. Selection of the N-largest and, in some cases, lowest observed sea levels for each year. The **reduced (observed) sea level percentile**, used also commonly and of greater interest, is obtained by subtracting the 50-percentile (equivalent to the median), from each individual percentile. The reasons for the use of reduced sea level percentiles are: (1) the ability of identifying whether the forcing factors behind extreme high water changes and MSL changes are the same, or whether they are a result of different forcing, i.e., if after reduction, the percentiles show similar result to those with no reduction then the forcing mechanism that originate extremes are the same as those influencing MSL; and (2) to avoid problems related to datum control, which are of relevant importance to MSL work. By studying a time-series, relative to the median, one is not affected by considerations of vertical land movement or datum uncertainties (Woodworth & Blackman, 2004).

Although percentiles are associated most commonly with the total sea level, they are also used here in the analysis of other tidal constituents.

(b) Empirical Orthogonal Functions (EOF´s)

The well known method of Principal Component Analysis (PCA), in oceanography referred to more commonly as Empirical Orthogonal Function (EOF) analysis, is used to study spatial or temporal variability of physical fields, in meteorology and oceanography. This method is explained briefly as it will be used further in this study (refer to Sections 4.5.1b, 4.5.1c).

The advantage of EOF analysis is that a spatial dataset of individual time-series can be represented by a small number of patterns that vary in time and may explain most of the variability in a dataset. Furthermore, energetic events with different temporal structure should appear in different modes, i.e., the pattern of variability can be specified or linked to possible dynamic mechanisms (Hardy, 1977).

If a physical parameter that has been measured many times is taken (e.g. sea level), at a number of fixed locations, these data can be ordered by measurement, location and time into a rectangular matrix (covariance matrix). Subsequently, two numerical approaches can be taken in the analysis (refer to Emery & Thomson, 2001, for details). Whichever approach is adopted, the objective is to derive with suitable accuracy (each method has a different degree of accuracy (refer to Preisendorfer, 1988)), the eigenvalues and eigenvectors of a square matrix derived from the initial rectangular matrix. The magnitude of the eigenvalues indicates the percentage of total variance explained by the eigenvalue (Klinck, 1985). The dimension of the data series have been reduced into principal components, i.e., the first principal component is the (normalised) linear combination of the series, with maximum variance; the second principal component is the (normalised) linear combination of the series with maximum variance of all the combinations orthogonal to the principal component, and so on. Three (or four) principal components are usually used in most studies, as they account for most of the variance of the series. It should be emphasised that no direct physical or mathematical relationship exists between the statistical EOF´s and any related dynamical modes (Emery & Thomson, 2001); however, they can be inferred by subsequent analysis.

For further details, refer to Preisendorfer (1988) and Emery & Thomson (2001).

(c) Models

Although not used in the present study, a mention must be made of the use of numerical models in the study of extremes. The use of hydrodynamic models, to generate storm surge data, was adopted to overcome the poor spatial coverage of long-term observed sea level series obtained from tide gauges.

According to Flather (1987), the general approach adopted in most models follow the following steps: hurricanes that generate surges in the area of research are identified; surge heights are computed using the model; and surge and astronomical tides are combined and extreme levels derived by statistical analysis of the results. The author estimates extreme currents and water levels due to tide, storms and their combination for the NW European continental shelf, by employing spatial distribution of tide and surges from an established numerical model and existing statistical analysis of coastal sea level data. Some examples of other models and variations to this general approach are also mentioned.

For further reading on this subject, Flather (1987, 2000, 2001), Anderson *et al.* (1995), Shum (1997) and Wakelin *et al.* (2003) are suggested. These publications include more details on errors, accuracy and limitations of models, together with the comparison between the different models. The last reference provides an example of the use of tide-surge models to investigate the connection between sea levels and atmospheric parameters.

4.5 Regional Long-term Sea Level Variability

4.5.1 Approach used for Western Europe

To recall, this section of the thesis aims to study the long-term variability and trends in sea level around the western European coastline, by analysing separately the observed sea levels and its three component: MSL, tides and the meteorological surge or non-tidal residual. Evidence for increased ´storminess´ is also investigated.

The different techniques used to achieve this objective have been explained previously. Details on the data used, together with how they were analysed, are described in the following sections.

(a) Sea Level data

For long-term trend analysis, long sea level records of good quality are essential. Therefore, a selection of the data sets was made, to obtain sea level records from the main ports around the West European coastline. Initial selection required that these listed, at least, 40 years of data. The location of each of the ports for which the sea level record was used is shown in Figure 4.4 and given in Table 4.1.

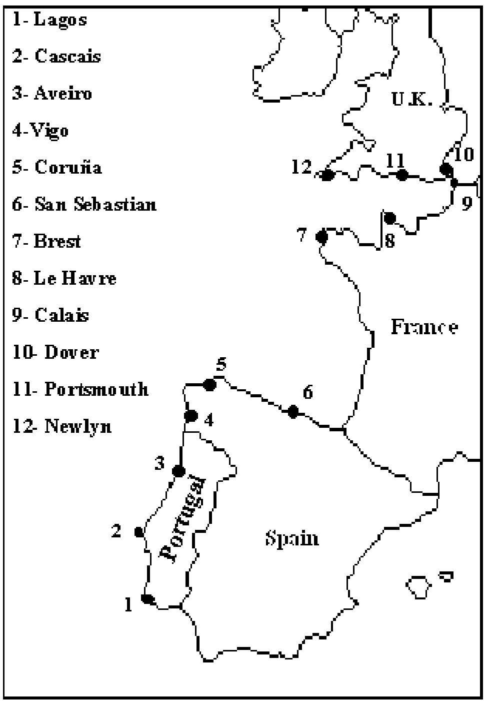


Figure 4.4 Map showing location of the stations used in the long-term sea level variability study: Note: further information on stations and data is given in Table 4.1.

Further examination of the data showed that there were other restrictions. Sometimes, a discrepancy between the listed and the available data was identified. Another problem arose when there were gaps in the data, within a certain year. This, in turn, could bias the derived statistics, because of seasonal cycles. In order to be able to consider a year of data for this analysis, a minimum of 300 days of valid data was required. Therefore, the data set used, was reduced greatly from that apparently available (Table 4.1).

Port	Coord.	Data available (years)	Data used (years)	start	end	Source
Newlyn, U.K.	50º06´N 5º32´W	85	84	1915	2000	BODC
Portsmouth, U.K.	50º48´N 1º06´W	39	39	1962	1997	ABPmer
Dover, U.K.	51º06´N 1º19´E	40	32	1961	1999	BODC
Calais, France	50º58´N 1º51´E	16	16	1965	2000	SHOM
Le Havre, France	49º29´N 0º07´W	31	29	1938	2000	SHOM
Brest, France	48º23´N 4º29´W	131	123	1862	2000	SHOM
Santander, Spain	43º28´N 3º48´W	59	53	1944	2001	IEO
Coruña, Spain	43º22´N 8º24´W	59	56	1944	2001	IEO
Vigo, Spain	42º14´N 8º44´W	59	57	1943	2001	IEO
Aveiro, Portugal	40º39´N 8º45´W	27	18	1979	2002	IH
Cascais, Portugal	38º41´N 9º25´W	41	30	1960	1994	IGEO
Ceuta, Africa	35º54´N 5º19´W	59	51	1945	2002	IEO

Table 4.1 Details of the ports and sea level records used in the study of long-term sea level variability along the Western European coastline (for location, see to Figure 4.4).

The tidal data analysed consists of digitised hourly sea level for each year, up to the most recent year available. The data collection was a substantial task and there were several sources for these data sets: English sea level data were provided by the British Oceanographic Data Centre (BODC). Data for the French ports, collected originally by the Service Hydrographique et Océanographique de la Marine (SHOM) were provided by BODC, in relation to this project. Associated British Ports marine environmental research (ABPmer) provided data for Portsmouth, as they held more years of data than by BODC. The Spanish data were obtained from the Instituto Espanol de Oceanografia (IEO). The data for the Portuguese station of Cascais was provided by BODC and Instituto Geográfico Português (IGEO), whilst that of Aveiro was obtained through Dr. João Miguel Dias from the Department of Physics, University of Aveiro.

The data selection procedure used for Iberian Peninsula was the same as that used for the English Channel. However, more flexibility was required in the selection and processing, because digitised hourly records for this area are scarce. Long records exist, but consist only of either High/Low water values or monthly MSLs.

The records selected for analysis were Santander, Coruña, Vigo (Spain); Aveiro, Cascais and Lagos (Portugal) which was substituted subsequently by Ceuta (North Africa). The station details are given in Table 4.1 and their location is shown in Figure 4.5.

Figure 4.5 Map representing the Iberian Peninsula, with the location shown of the ports for which data are being used for long-term trend analysis. Portuguese ports are shown in blue whilst, the Spanish are in black.

The choice of using Ceuta as an alternative station for Lagos was made after finding that the Lagos dataset had considerable gaps and was of poor quality. By applying the data selection procedure mentioned previously, the data were reduced considerably to a number of years unsuitable for long-term studies. As no other long-term hourly sea level record was available for the South Atlantic Iberian coastline, Ceuta has been selected and is used here as a reference station, as it is already located in the Mediterranean Sea (North African coast), near to the Gibraltar Strait.

There is reason to consider (personal communication, María Jesús García) that the data provided for the Spanish stations on the Iberian Peninsula, including Ceuta, have had some form of data quality check undertaken before it were obtained. However, no details on this particular approach are available.

The Portuguese data, obtained from the tide gauge located at Cascais has been provided by PSMSL; however, the record originates from 2 different sources. These data were measured using an old float gauge, which is no longer in use due to the construction of a marina located seaward of the site. Present day sea level measurements are available from an acoustic-type gauge, which has been fixed to the structure of the new marina.

The historical sea level data from Cascais were collected and edited by the Portuguese Hydrographic Office. In the 1980´s, the maintenance and data collection/processing responsibility for the tide gauge at Lagos and Cascais were passed to the IGEO. For this reason, the record from Cascais, provided by POL, has data until 1985. This was collected and edited by the Hydrographic Office, whilst data after 1985 was collected and processed by IGEO.

The quality of the data obtained has been considered here in great detail. A robust editing of the data, correcting for calibration, blockage and timing errors in the gauges has been performed for all the stations, with the exception of the Spanish data (Vigo, Coruña, Santander and Ceuta). This procedure is explained below.

Data Editing

The non-tidal part, or residual, of the overall sea level signal being analysed not only includes information related to the meteorological forcing, but also the errors in the measurements. By analysing this signal, it is possible to assess the quality of the data. Strong intermittent tidal signals in the residuals show potential timing and calibration errors. This principal has led to the development of an editing technique, which has been applied on most of the long-term data analysed as part of this research.

A tide gauge is a complex system, both in its structure and operation. As such, there can be several factors that might present problems to its functioning perfectly and introducing a series of errors in the gauge's readings. Some examples of the nature of such errors are: calibration; sliding of the pulley cable; timing and obstruction; or sedimentation in the well.

Some of these errors can be identified in records, by examining the non-tidal component of the observed sea level values (meteorological residual). Tidal period variations in residual levels must always be regarded with suspicion; these can distort the statistics of the non-tidal effects. It is possible to perform a diagnosis of a well's behaviour, by comparing the phase of the tidal signal (in the residual) to the predicted tidal values for the same interval (Figure 4.6). For instance, if a well were lagging on true oceanic water levels, because of a partial blockage, then the residual reading would show a tidal signal with a shifted phase from the predicted signal. A calibration error would be in phase with the tide, whilst a timing error would be ± 90º out of phase. A sudden jump in the signal could correspond to the removal of a pipe obstruction, the correction of a timing error or a datum shift perhaps due to fitting of a new chart.

The above text illustrates briefly the approach that can be adopted to identify and understand errors that are common in tidal records. Using this approach, an editing process was elaborated, in order to improve the quality of the data analysed, by reducing all errors found.

The initial data set was analysed, individually for each station, using a program written in Matlab (programming language). Ten hour intervals of residual and predicted values were studied, to determine for possible errors (Figure 4.7). Values believed to be incorrect were replaced by the corresponding residual low pass filter value. This was undertaken for each year, separately. The residual and predicted values were obtained previously, on the basis of harmonic analysis, using the TASK2000 package (Section 4.5.1c).

Correcting data sets with these dimensions and using such small time intervals has proven to be an arduous and time-consuming job, which imposes certain limitations. Ideally, correcting the entire record with no threshold would be the best choice but, for studying extremes, this is essential and seemed the most feasible and reasonable approach.

To make this process more manageable, a residual threshold level was established, at a value equal to ± 2 standard deviation of the mean non-tidal residual. Beyond this, extreme residual levels were scrutinised individually.

A second harmonic analysis was undertaken on the new time-series, obtained by replacing 'suspect' residual values. The results were plotted and the trends in the different sea level components were compared with the original values. This editing process did not appear to change the different sea level component trend values, by an amount that justifies all the work involved in the editing. However, the same does not occur when examining the statistics of the extremes (Figure 4.7). Here, editing has proven essential. Reference should be made to Woodworth & Blackman (2002), Appendix 1, for further discussion on this particular point.

(a)

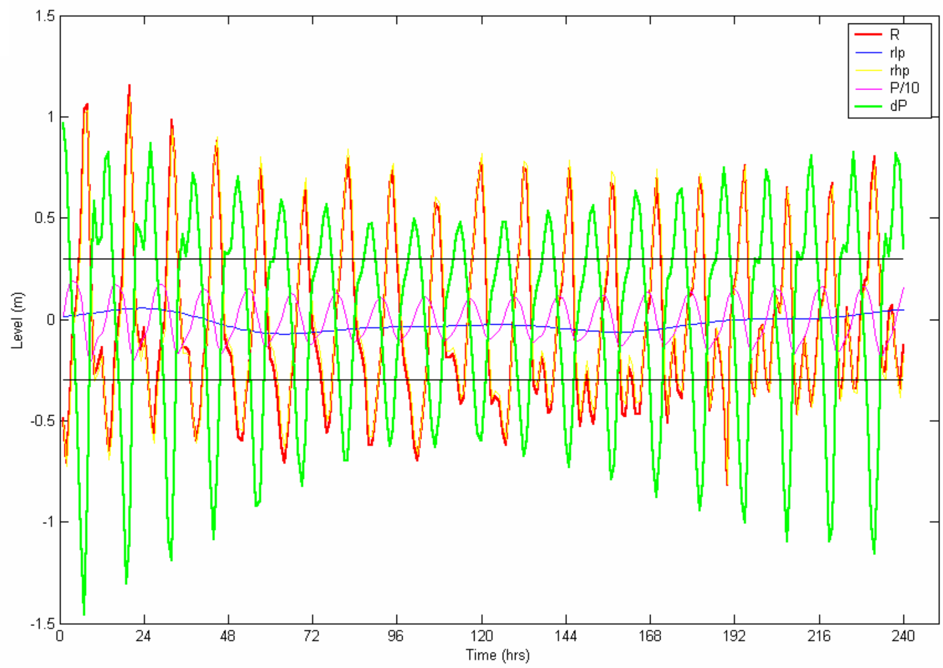
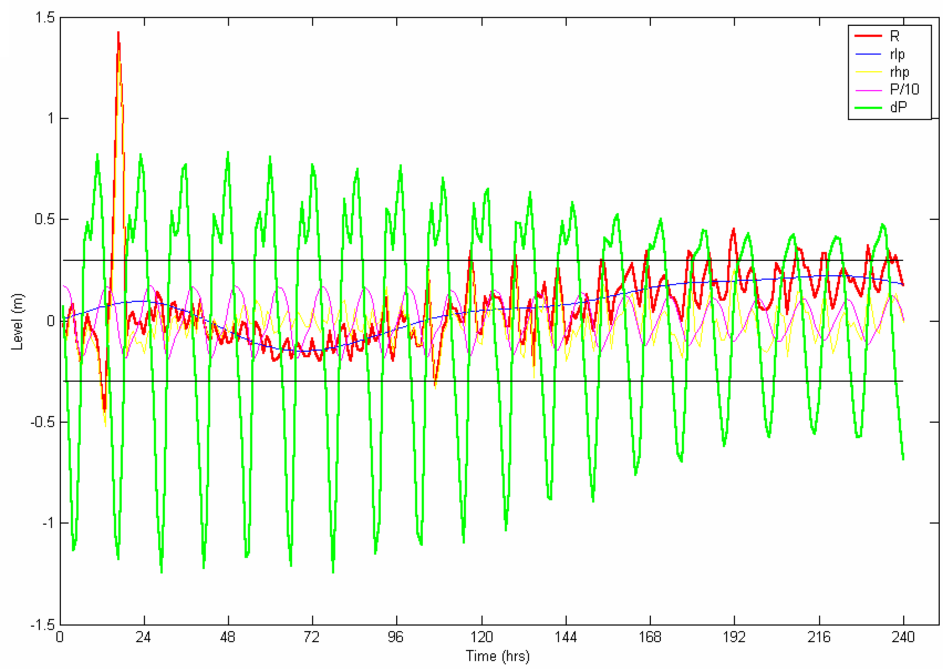


Figure 4.6 (continued on next page, see caption)

(b)



(c)

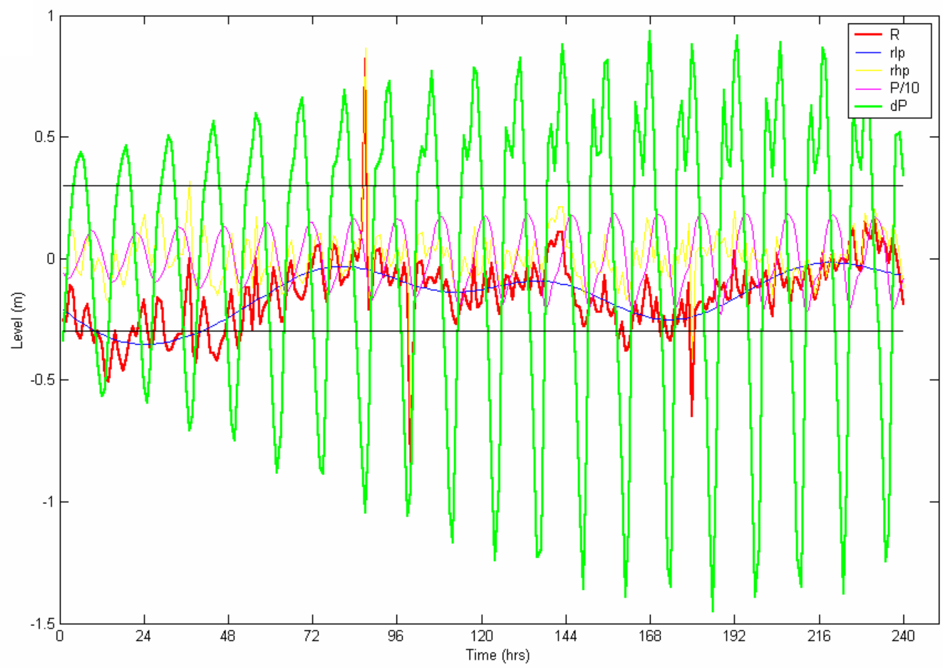
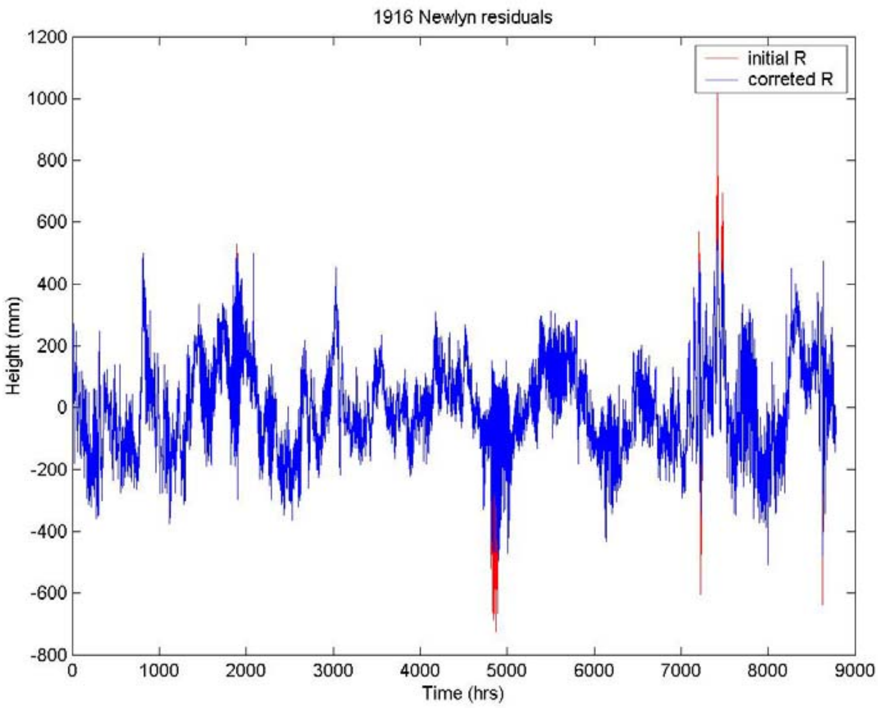


Figure 4.6 Window used in the Matlab editing program with examples of typical patterns. The red line represents the non-tidal residual levels, turquoise the predicted sea levels (divided by ten, for scaling), green the gradient of predicted sea level values, blue the residual low pass filter values and yellow the residual high pass filter values. (a) Example of a tidal residual signal slightly out of phase, with predicted values (P and dP) and with dips and spikes. These suggest that the gauge's float is getting 'stuck' as the tide falls; (b) & (c) examples of a non-tidal residual, with occasional spikes at maximum and minimum levels.

(a)



(b)

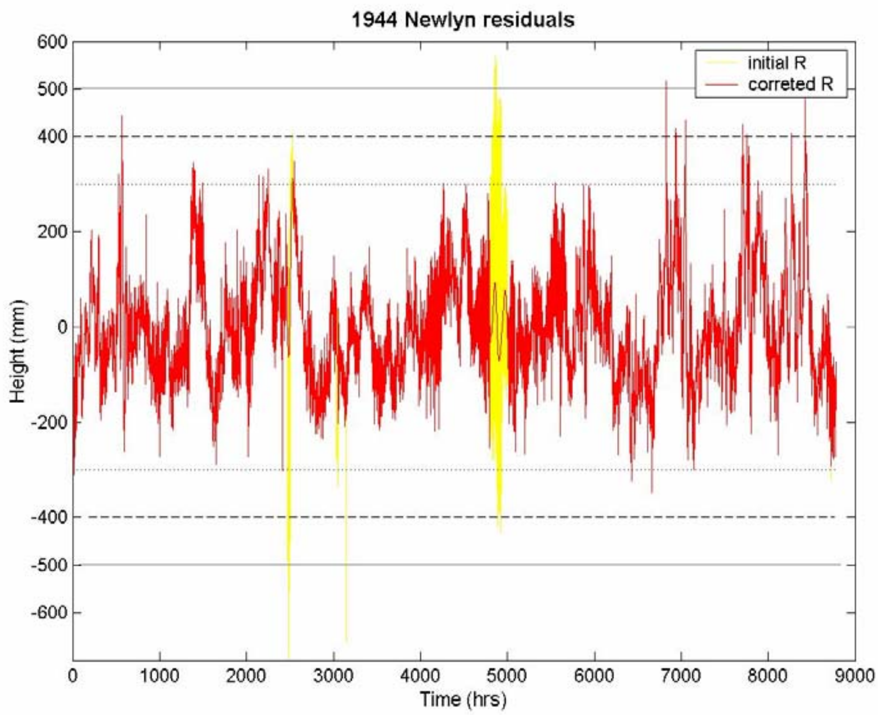


Figure 4.7 Examples showing the difference between non-edited and edited residuals, from 1916 (a) and 1944 (b) sea levels measured at Newlyn.

The procedure described above was used on most of the edited sea level records, with the exception of a few cases where accessing true extremes from errors could not be made with reliability. This was due to the 'noisy' nature of the non-tidal signal, believed to be associated with poor quality data, or to data belonging to stations more prone to storm activity. For such cases, the data from a neighbouring station were used for cross-checking, whereby the non-tidal residual levels of both stations were compared (Figure 4.8). Differences in signal were corrected using the low pass filter values, as described previously, on the time interval for the discrepancy. This cross-checking can only be applied if the two datasets being used correlate well.

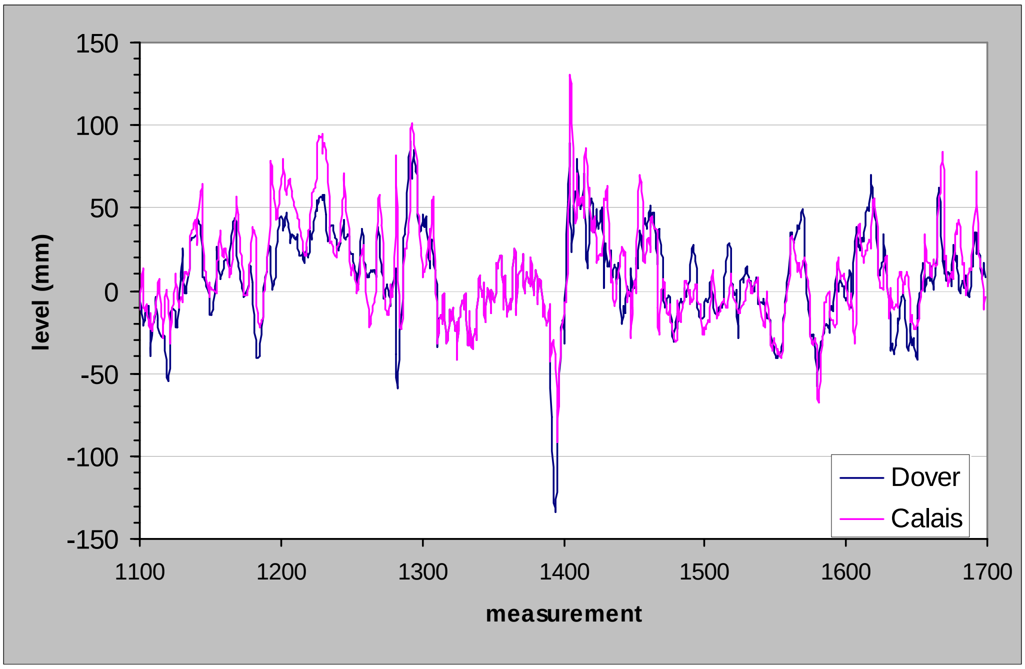


Figure 4.8 Section of the 1966 data for Dover (blue) and Calais (pink) used for cross-checking the data. Both ports have a similar signal, with high variability. The spike at -140 mm illustrates the problems that could arise by just using the first editing process, to "correct" extreme levels using each record individually.

(b) Data on Forcing Factors

The non-tidal part (or residual) of the overall signal, explained in Section 4.2, is said to account for meteorological forcing and errors in the measuring gauge system. Assuming that the measuring errors are negligible, then any variability in the extremes of the non-tidal residual should be related to variations in the regional climate. These are represented, generally, by pressure or climate indices, like the North Atlantic Oscillation

(NAO). The response of some of the sea level components to pressure and the NAO is investigated. The various data needed for this is described next.

Pressure Data

The well-known effect of air pressure is the `inverted barometer effect´ that represents the simple local sea level response to the vertical pressure force exerted by the atmosphere (Pugh, 1987).

Air pressure variations are essential for a study of MSL interannual variability, but are generally not so important in terms of the analysis of secular changes. This is because their long-term trends are small (Woodworth, 1987).

Northern Hemisphere Monthly Mean Sea Level Pressure (MSLP) values were obtained from the Climate Research Unit (CRU), University of East Anglia web site (http://www.cru.uea.ac.uk/cru/data/nao.htm). These values are an average, computed from daily gridded 5º latitude by 10º longitude MSLP values, forming one of the longest continuous time series (1873 - 1999) found for the Northern Hemisphere (15ºN to the 85ºN). The sources of the original data are given in Jones (1987). The dataset is continually being update or corrected, thus, it is important to refer to the site, for further information.

North Atlantic Oscillation

Wind effects were not accounted for directly in this study. Instead, correlation with air pressure gradient, parameterised as the North Atlantic Oscillation (NAO), were studied as being more regionally representative. The NAO index is determined (generally) in terms of the normalised pressure difference between the Azores High and the Icelandic Low. Thus, the NAO represents a pressure gradient, associated with changes in westerly winds across the North Atlantic, onto Europe. This index is used to quantify large-scale variability in atmospheric pressure over decadal time-scales. A positive NAO index corresponds to a strengthening (increase) of the Azores High and/or Icelandic Low pressure systems. A negative NAO would represent the inverse, i.e., weakening of the Azores High and/or Icelandic low (refer to Hurrell *et al*., 2003, for further reading).

Most modern NAO indices are derived either from the simple difference in surface pressure anomalies between various northern and southern locations (based on individual station data or gridded SLP), or from the Principal Component time series of the leading Empirical Orthogonal Function (EOF) of Sea Level Pressure (SLP) (Hurrell *et al.,* 2003).

The advantage in using the station-based indices is their extension back in time (mid-19th century or earlier), whilst the disadvantage is that they are fixed in space, only capturing the NAO variability for parts of the year and being susceptible to small-scale and transient local meteorological phenomena not related to the regional NAO. The PC time-series are a more optimal representation of the full NAO spatial pattern, yet its limitations are based upon the time-span (extent) of the gridded SLP data (Hurrell, 2004).

The relationship between the annual sea levels and the non-tidal meteorological residuals, with the annual NAO index, are investigated in order to study the influence of the NAO on sea levels along the western European coastline. Furthermore, as the surge component of sea level is generally larger in winter, when storms are stronger and more frequent and as the NAO´s strength are also greater (Wakelin *et al*., 2003), the relationship between winter (December to March mean) values of the NAO and winter sea level and non-tidal levels are also investigated.

Many of the indices mentioned previously are readily available on the internet and can be downloaded free from several sites. The present work uses the annual NAO index (Figure 4.9) computed from the difference between the normalized sea level pressure measurements from Gibraltar (Spain) and Reykjavik, southwest Iceland (Jones *et al*., 1997) available from 1825 until 2003, from the Climate Research Unit (CRU), University of East Anglia web site (http://www.cru.uea.ac.uk/cru/data/nao.htm). The winter NAO index (Figure 4.9), defined as the mean sea level pressure difference for December to March means, has been calculated from the same data used for the annual NAO index.

A PC time-series for the 2nd EOF (Figure 4.10b), calculated from gridded monthly mean sea level pressure data from the National Centre for Atmospheric Research (NCAR), has been provided by the Met Office and is used here as a more optimal representation of the NAO influence.

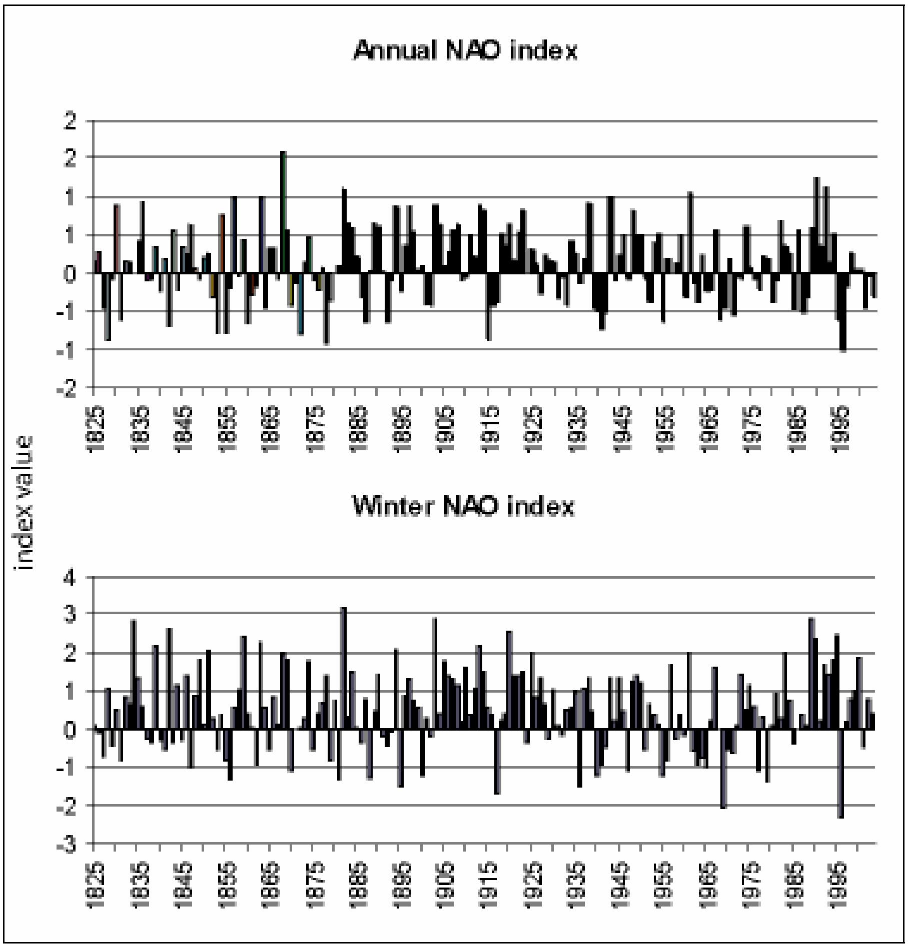


Figure 4.9 Annual NAO index and Winter NAO index (December - March), based upon normalized MSLP difference between Gibraltar and Iceland (CRU dataset).

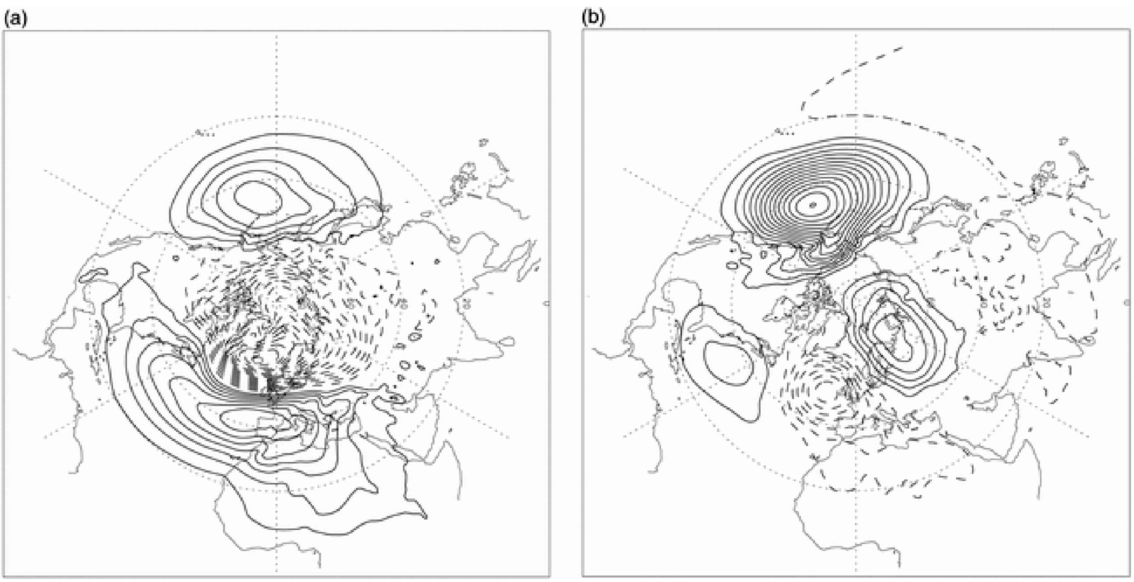


Figure 4.10 Patterns of the first 2 EOFs: (a) First EOF; and (b) Second EOF, calculated from NCEP re-analysis data (courtesy of the U.K. Met Office).

(c) Data Analysis

Section 4.2 provided a brief summary of the different analysis techniques used as part of this study. A description of how those methods are applied is presented below.

Harmonic Analysis

Harmonic analysis of the data is performed extensively, throughout both the long-term and short-term analysis of sea level data. As mentioned earlier, to be able to edit the data it was necessary to calculate predicted and residual levels from the original observed sea level series. After editing, this analysis is again performed to obtain the different sea level components which are of further interest (see next Section).

The PSMSL/POL Tidal Analysis Software Kit2000, TASK-2000 package (Bell *et al*., 1998) was selected from the several programs currently available to perform tidal harmonic analysis, of each year of data. This choice was based on the familiarity and versatility of the program. The TASK-2000 package is a set of *PC*-based DOS programs for tidal analysis, derived primarily from the TIRA tidal analysis programs (Murray, 1964) (for more information, refer to http://www.pol.ac.uk/psmsl/training/task2k.rtf). The program provides predicted and residual values, as well as values relating to specific tidal harmonic constituents. The amplitude and phase of up to 63 constituents can be determined, from a year of hourly data.

The TIRA program requires the data to be in a specific format, which means that the original data has to be re-formatted. The data available from each country is usually in a different format. Therefore, a series of programs had to be written to achieve the required format.

TIRA produces 2 output files from which it is possible to obtain predicted sea levels, residual of the sea level (observed - predicted), 63 constituents for a 1 year of observed sea level values and some basic statistic values, such as mean observed sea level (MSL), sea level standard deviation (deviation about MSL), mean non-tidal residual (approximately zero by definition) and non-tidal standard deviation.

Trends in different sea level components

Trends have been computed using a simple linear regression on several sea level parameters. These parameters include MSL, observed sea level standard deviation, Non-

Tidal Residual standard deviation (NTRstd) and, amplitude and phase of some of the tidal constituents obtained from the harmonic analysis. The standard error was used as a measure of the trend's statistical significance: a trend value greater than two standard errors was considered statistically significant. This interpretation is based upon the fact that for an approximate normal distribution a ± 1 standard error interval contains 69% of measurements, whilst ± 2 x standard error interval contains 95% of measurements.

When considering the typical length of a dataset needed to determine a secular MSL trend, with a standard error of the order of 0.5 mm yr^{-1}, 30 years of data are said to be required and 50 years for an error of the order of 0.3 mm yr^{-1} (Woodworth *et al*., 1999). This depends upon 'noise'; see Pugh & Maul (1999), for a fuller discussion.

Extremes

Secular trends in sea level extremes (maximum and minimum values) are investigated using some of the methods previously described, on the hourly datasets for the 12 station on the Western European coastline (Table 4.1).

The aim of this investigation is to check for evidence of an increase in storminess, by examining increases in extreme sea levels (without the effects of MSL increase). Increasing extremes may be a result of interannual variability, long-term MSL changes or to other effects, such as increased storminess. In addition to this, the interannual variability in extreme sea levels related to regional climate will also be investigated, using the relationship between the NAO index and extreme sea levels.

To achieve these aims the trends in extreme levels are studied. MSL and tides are removed from the signal, such that their variability can be decoupled from other forcing mechanisms, such as meteorological influences. Nevertheless, the results from tidal and non-tidal signals will still be compared.

Trends in percentiles for observed and non-tidal sea levels are also investigated. The use of the 99.9 and 99 percentile levels has been selected, assuming that a small number of measurement errors will not affect the hourly distribution from which the percentiles are calculated (Woodworth & Blackman, 2003). The results for the 99.9 percentile, using the robustly-edited data, should therefore be reliable. However, caution should be taken on results of non-edited data, especially for the 99.9-level (which represent approximately 8 hours of the year).

The previous results will be correlated with annual NAO index (as described in Section 4.5.1b), and with a winter NAO index based upon the average December to March monthly values.

Finally, a inter-station comparison is made, to check if changes are similar between the different stations and the regions analysed.

A summary of the approaches and objectives of the study:

- Use the sea level data from tide gauges located along the western European coastline, to investigate if there are trends in the different sea level components (MSL, tides and non-tidal residual). Some of these trends will re-evaluate past results using edited hourly sea level records, as opposed to results obtained from monthly mean sea levels.
- To investigate whether there is any evidence for increased storminess, by looking at trends in sea level extremes with emphasis on the non-tidal component.
- Correlate pressure variability and NAO indices (annual and winter), with observed sea level and non-tidal sea level, to investigate local to regional climate patterns influences on sea level variability.

4.6 Local Sea Level Trends

4.6.1 Past Survey (1987/8)

During 1987 and 1988, the Portuguese Hydrographic Office surveyed the Ria de Aveiro lagoon, collecting tidal data at a series of locations (stations) (Figure 4.11). Due to the extent of the Lagoon, the limited number of instruments available had to be moved progressively between stations, in order to obtain a general coverage. Consequently, the measurements, distributed over time, were not simultaneous.

A stilling-well float–operated gauge (Section 4.1) was used at the stations recording for long-periods (AOTT-BOSUM at the inlet, AOTT-R2OT others). For the shorter measurement periods, pressure bubbler gauges (METERCRAFT) were used (Section 4.1). All of the analogue data obtained from these instruments are available through a series of published reports by the Portuguese Hydrographic Office. Access to this information, in digital form, has only been possible through the University of Aveiro (Dr. João Dias).

The data are available in a series of volumes published by the Portuguese Hydrographic Office. These publications contain Tables and Maps, incorporating the results of detailed analysis. These include amplitudes and phases of several tidal constituents obtained from harmonic analyses, as well as a brief description of the work undertaken. All of the data are referenced to the Portuguese Datum, located at Farol da Guia, Cascais. During the survey, gauges were levelled according to local levelling references (see Instituto Hidrográfico (1987) for more details).

4.6.2 Present Survey (2002/3)

The availability of data from the earlier surveys, especially the 1987/88 survey, justified undertaking a new survey to examine sea level variability in different parts of the Ria de Aveiro Lagoon. Sea surface elevations were collected at several locations (Figure 4.12) such that distinct periods could be compared for possible changes within the past 14-15 years, for example, as a result of dredging; sea level rise; climate change; and urbanisation. These are among the several reasons considered to affect tides and sea levels in the Lagoon.

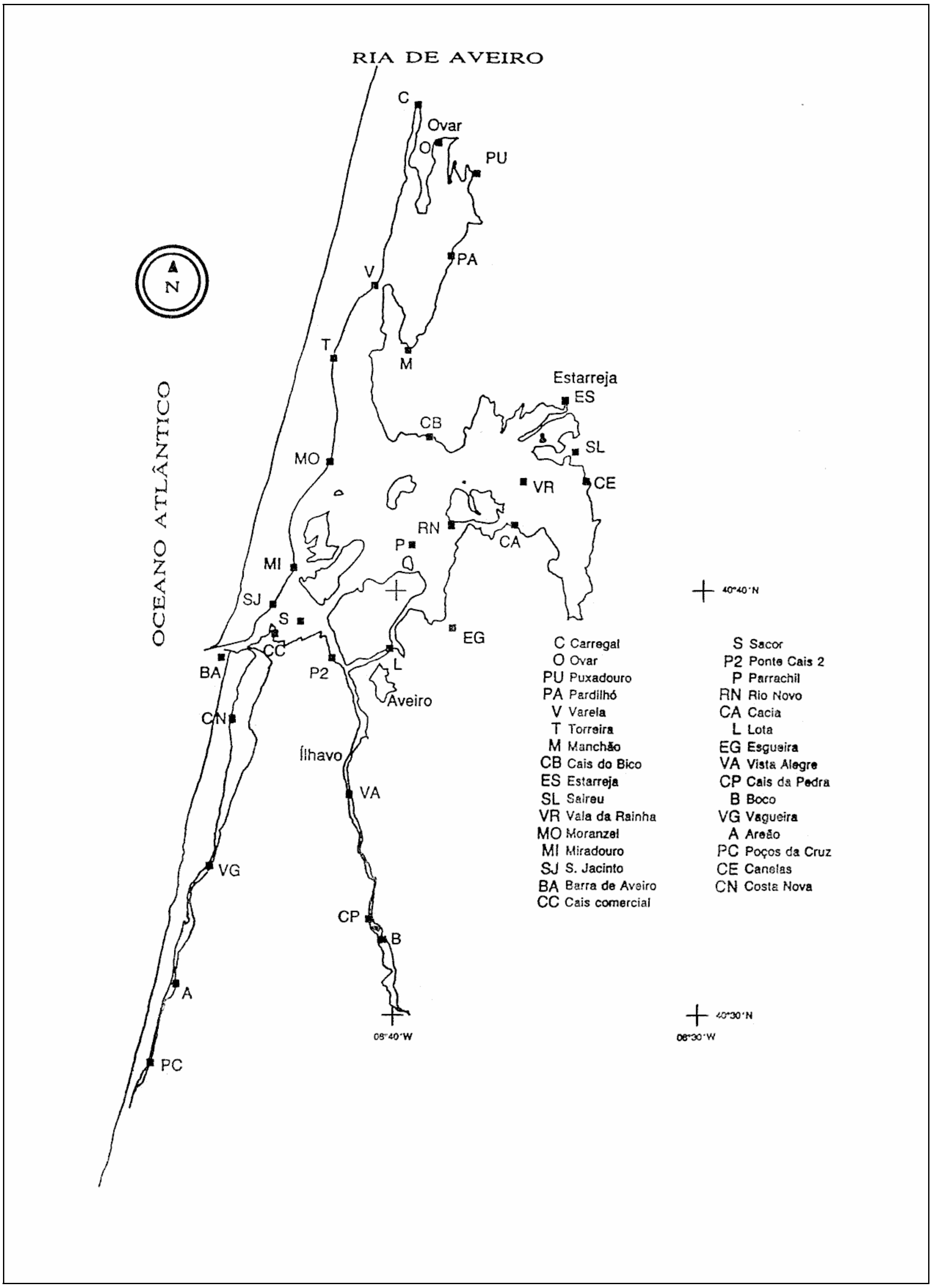


Figure 4.11 Stations surveyed in the Ria de Aveiro Lagoon, during 1987/8 (from Instituto Hidrográfico, 1987).

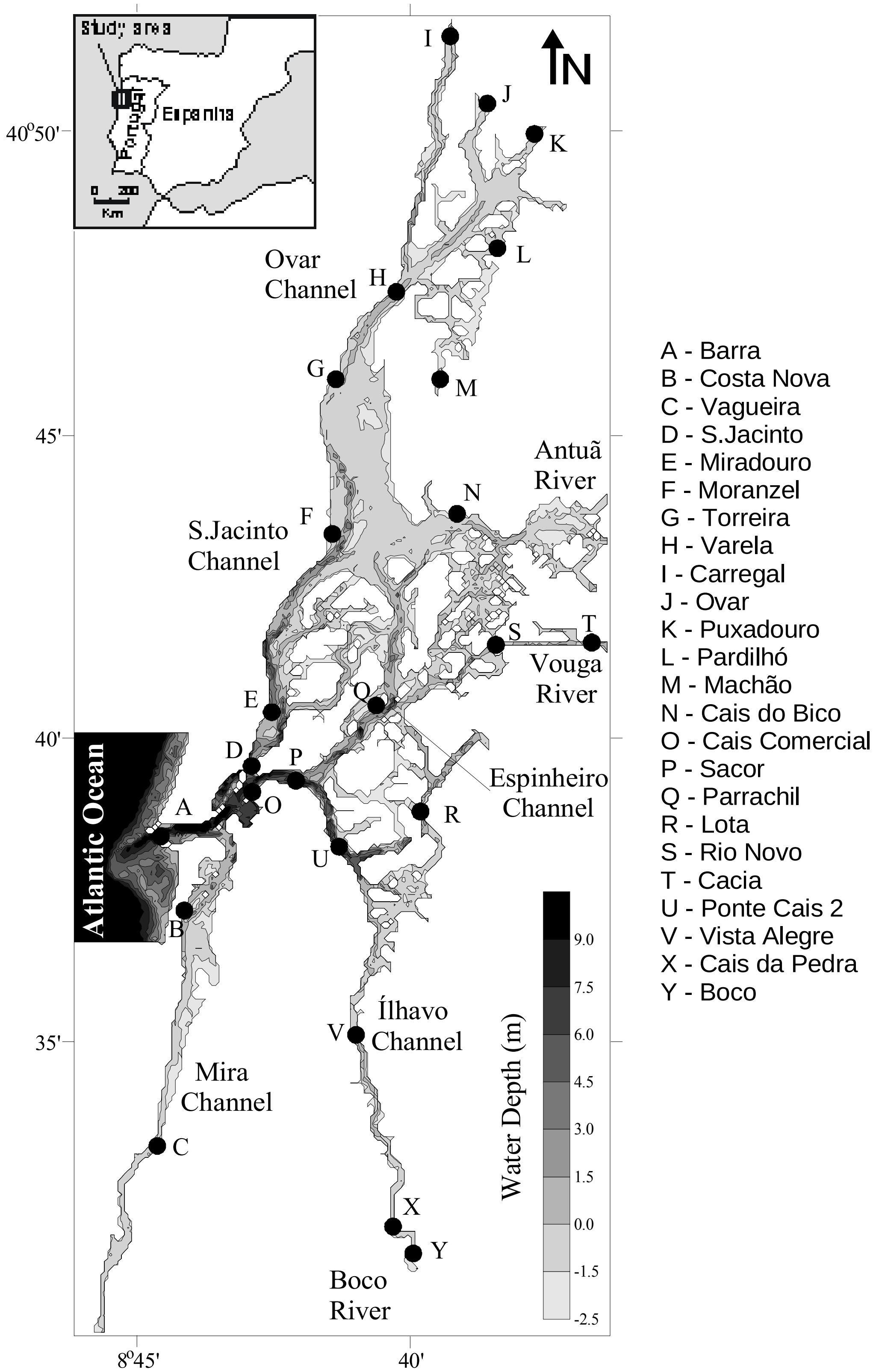


Figure 4.12 Map showing sites used by the Portuguese Hydrographic Office in the 1987/88. Some of these sites (Table 4.2) have been subsequently used for the 2002/3 survey (courtesy of Dr. João Dias).

(a) Equipment description (pressure sensors)

At the start of this new survey, 6 Vemco Quicklog-TD data loggers (Figure 4.13) were used to record both hydrostatic pressure and temperature. The Quicklog is a microprocessor data logger, lodged inside a waterproof cylinder (73 mm diameter and 32 mm thickness), its weight is 180g, in air, and there is space for a 9V lithium battery. The sampling period can be selected to be from 0.1 seconds to 90 minutes; this corresponds to a deployment time of between 36 minutes to 3.7 years.

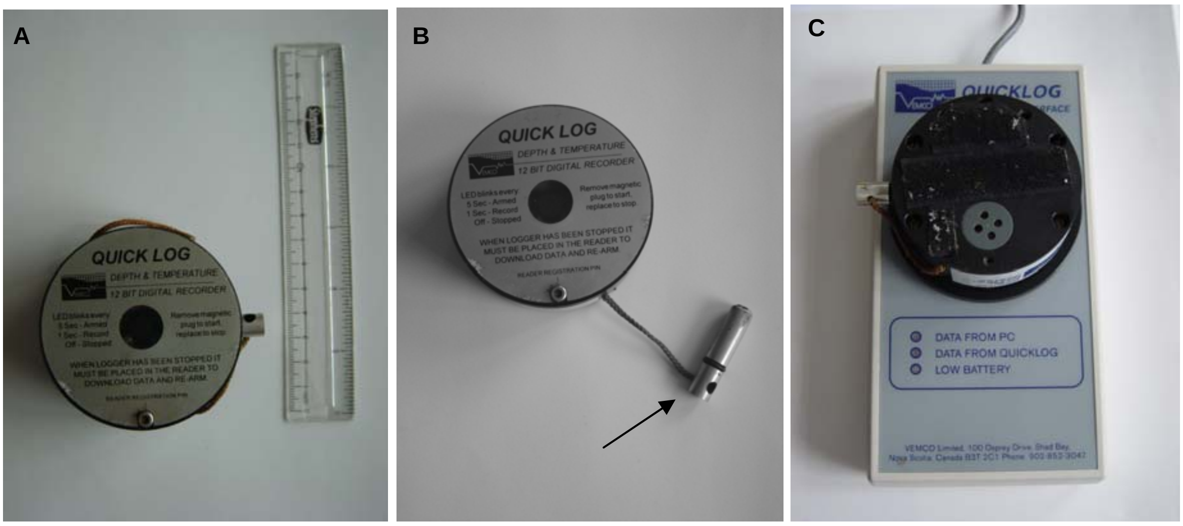


Figure 4.13 Vemco Quicklog-TD data logger: (A) instrument and a 15cm ruler for scale; (B) arrow points towards the trigger pin (used to initiate data collection), which has been removed from the sensor; and (C) instrument mounted on the logger, that connect to a *PC* enabling measurements stored in the memory to be downloaded. The pressure sensor is lodged behind the four holes, seen in the lighter grey circular section, within the image.

Programming and downloading data is undertaken using a *PC* (DOS interface), through a wireless infrared interface. The temperature resolution depends upon the temperature range recorded by the Quicklog, but it should be ± 0.2 °C, between -5 to 35 °C. The pressure sensor's sensitivity to temperature can cause a ± 1 to ± 3 % error.

In areas where wave action is significant, aliasing becomes a problem when trying to measure levels for sea level or tide investigation. To overcome this issue, a wave dampener was improvised, by using a simple device that replicates a stilling well (Pugh, 1981). This consisted of fixing the sensor to the upper part of a small box, with a hole with a diameter equivalent to a tenth of the box's bottom diameter (Figure 4.14A). The water is allowed into the box through the small hole, which dampens the waves. A column of air initially resides inside the box, but is gradually dissolved by water over many weeks, giving a datum drift of a few centimetres. Although this would be unacceptable for MSL, it is not a problem when analysing tides.

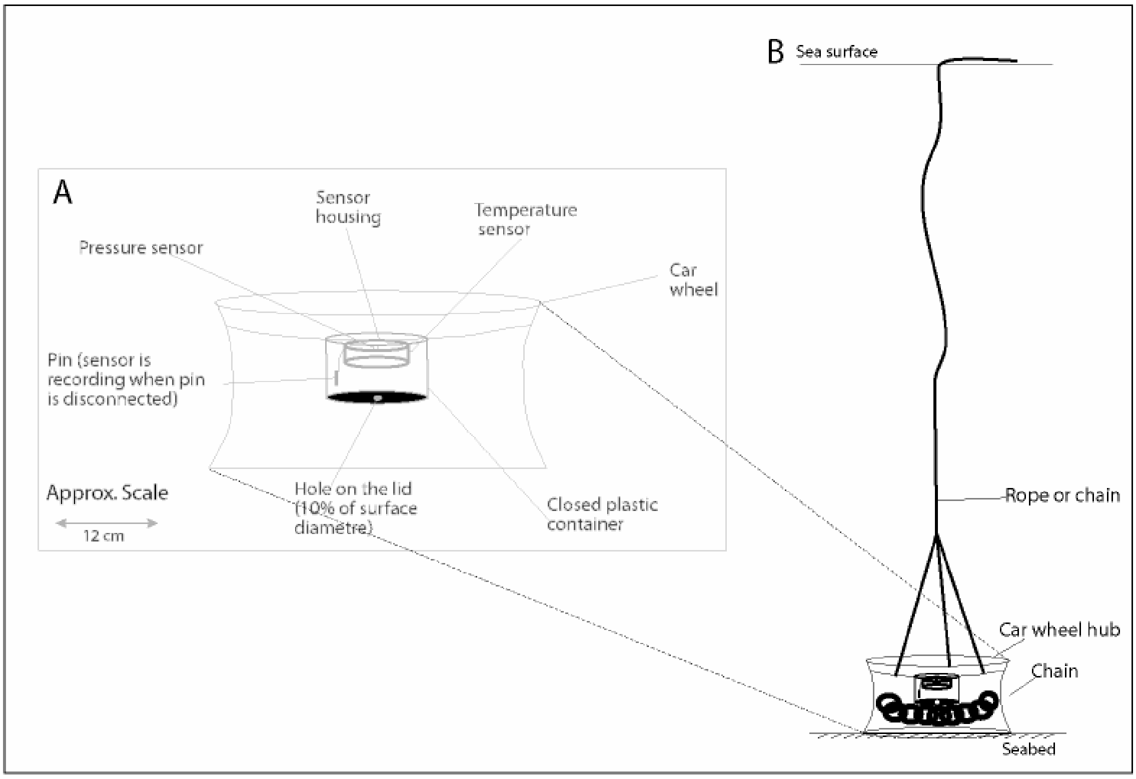


Figure 4.14 Sketch of pressure sensor deployment: (A) detailed view; and (B) deployment (courtesy of Dr Ana Paula Teles).

As the survey progressed, most of the Vemco Quicklogs were stolen from the deployment sites. These were substituted by the Richard Brancker Research, RBR, XR-420 series (Figure 4.15) which have many advantages over the more basic Vemco Quicklogs.

The RBR logger consists of a plastic cylinder (40cm long with 6.4cm diameter) with two end caps, one of which lodges a pressure and a temperature sensor. The logger is powered by 4 3V lithium cell batteries and has a memory capacity of 4Mb. Its programming requires interfacing with a *PC* with the operating software installed. Connection of the logger with the *PC* is made via a cable similar to a phone cable. The data port and battery carousel are both located behind the end cap with no sensors, i.e., the instrument has to be opened so that data can be downloaded. The software provided is Windows compatible and allows the user to set up the logger, retrieve data, set the calibration coefficients and preview the data graphically.

This software also allows the user to define the units in which the recorded data are to be displayed, by setting calibration parameters that will be used to calculate derived units, i.e., derived depth requires an input value for atmospheric pressure and density. This option has not been used in the data analysed here; however, this issue is still accounted for in the present analysis (see Section 4.6.2c). More detailed specifications of the RBR are given in Appendix A1.

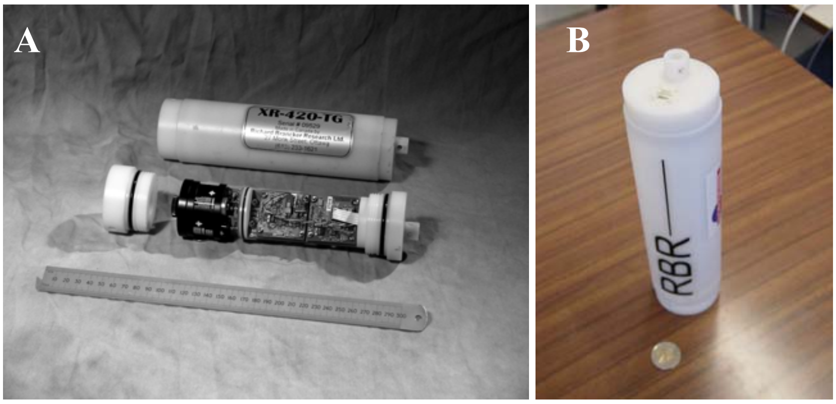


Figure 4.15 Richard Brancker XR-420 Recorder: (A) with breakdown showing the casing of the logger (top), the internal components (battery holder, electronic circuits and a connector for the data transfer cable) and a 300mm ruler (courtesy of Prof. David Pugh); and (B) RBR end cap showing the temperature and pressure sensor (and 1 euro coin).

Compared to the Vemco, the RBR is a much more robust logger. A feature found in the RBR and absent in the Vemco is the averaging of samples. In other words, the number of seconds that can be defined for averaging, so that the samples taken at 6HZ are averaged over the user-specified period. This is useful for ‘averaging out’ frequencies which are not of interest to the measurements being studied.

Another useful feature that the RBR had over the Vemco was the possibility of accessing the logger to download the data on site, without disrupting the pre-set definitions. This approach is extremely useful in safeguarding data in long-period deployments.

(b) Data Collection

The new survey was organised as a series of sampling campaigns. These started in September 2002 and were concluded at the end of January 2004.

For simplicity and direct comparison, whenever possible, measurements were carried out at the same stations and at the same time of the year as in the previous (1987/8) survey (Table 4.2). The purpose of reproducing measurements at the same time of the year was to avoid seasonal bias (discussed in Section 6.4).

One aspect which has been impossible to reproduce within the present study is the datum referencing. In order to achieve this objective, a local stable fix point (datum) would have to be established, for example, at the level which each sensor it located. Subsequently, each individual datum would have to be tied into the national levelling network. Sensors with long-term datum stability would also be required. Hence, in this study, tidal variability is being investigated without considering MSL changes inside the Lagoon.

The pressure sensors described previously (Section 4.6.2a) were usually programmed to sample every 6 minutes, for a 1-3 month period. When the RBR was used, this sampling period was averaged generally over 30s to filter fluctuations caused by waves. Averaging for RBR sensors deployed inside the tide gauge stilling well was of 10s (in theory, the stilling well already filters wave frequencies).

For key sites such as, for example, Barra (the station at the Lagoon inlet), Varela (constriction between S. Jacinto and Ovar Channel) or Cais do Bico (Laranjo Bay), the sensors were deployed for longer periods (> 3 months). Ideally, these sites would have been monitored continuously by the same sensor throughout the entire survey, to provide a good referencing dataset as well as an idea of seasonal variability in different key sections of the Lagoon. However, the small number of sensors available for the survey, their battery life and memory capacity, were limiting factors. The theft of equipment later became another reason to reduce sampling to the 1 month minimum period required for harmonic analysis.

The method for deploying the sensors varied to accommodate different physical conditions (Figures 4.16 - 4.18). For the sites (see Figures in Appendix A2) located in creeks, which are not susceptible to wave action, the sensor was attached directly to a brick (acting as a weight) with an identification tag. This was then wrapped in fishing net, with a rope tied around. This arrangement was used to ensure that the instrument would not move if it parted from its attachment. For the Vemco wave dampener device system, an identical procedure was used; the box with the sensor was attached to a wheel hub (Figure 4.17 & 4.18), to ensure that the gauge was approximately horizontal. This approach was also used sometimes with the RBR to provide weight and stability, since the sandy bed and stronger currents increased the possibility that the bricks could be displaced. The hub can provide sufficient additional weight and stability. If not, additional weight can easily be attached. The use of the hub also provided a good arrangement when, after the theft of some of the sensors, additional security measures had to be taken.

Figure 4.16 Vemco sensor inside a box attached to concrete bricks.

Figure 4.17 Arrangement used to deploy the sensor, in locations with rough topography. The sensor is contained inside the inverted box, fixed to the centre of the hub. The lid of the box (at the bottom) has the hole, through which the water is allowed to enter.

Figure 4.18 Same principal as shown in Figure 4.17, except for the use of chain instead of rope (this was also applied to RBR deployment). When extra weights were required they were added on the top of the box/sensor and the entire hub was then wrapped in fishing mesh.

The small water depth and absence of any currents, at the majority of the sites, meant that the package containing the sensor could be lowered to the bed, then tied to the shoreline with a rope or chain (Figure 4.17 & 4.18). In some cases, the instruments were exposed at very low water; as such, only higher water values have been measured. It has been found that the sensors are still capable of measuring overlying water level pressure, even if they became buried in mud (personal communication, Prof. David Pugh).

Some stations, i.e.,Varela, Parrachil, Salreu and Poço da Cruz were sampled; however, they are not included in Table 4.2, either because the data were considered inadequate for analysis or because no data were retrieved from the sensor, due to its theft. Furthermore, the stations of Vale da Rainha, Esgueira, Canelas and Boco could not be sampled, since on-site changes have occurred since the last survey. For example: the site at Boco was dry, whilst Esgueira had a water depth < 20cm; the channel at Vale da Rainha was cut-off from the Lagoon by a large electric dike-sluice system (part of reclamation/protection of agricultural land or drying out due to obstructing barriers); and at Canelas the sensor was moved considerably). Moranzel and Miradouro were considered unsafe (as theft was very likely) sites and, therefore, were never sampled.

Station	Coordinates	Start		End		Reading
		date	time	date	time	
Areão IH	40º 30.5´N 8º 46.5´W	29-4-87	19:00	9-6-87	16:00	982
Areão May	40º 31.45´N 8º 46.47´W	9-5-03	17:48:17	9-6-03	8:42:17	7350
Barra IH	40º 38.5´N 8º 44.9´W	13-5-87	15:00	6-8-87	22:00	2048
Barra Sep. 2002		27-9-02	11:27:31	5-11-02	9:00:31	11204
Barra Jan-Mar		3-1-03	11:02:25	6-3-03	10:02:25	14871
Barra Mar-May		6-3-03	11:11:09	7-5-03	9:29:09	14864
Barra May-Aug		7-5-03	11:00:00[1]	6-8-03	14:06:00[1]	21872
Barra Aug-Nov		7-8-03	8:14:30[1]	28-11-03	23:20:30[1]	27272
Cacia IH	40º 41.6´N 8º 36.0´W	11-2-88	23:00	30-4-88	22:00	1920
Cacia	40º 41.73´N 8º 36.02´W	6-3-03	13:40:55	9-4-03	14:10:55	8166
Carregal IH	40º 51.6´N 8º 39.3´W	8-10-87	18:00	13-11-87	0:00	843
Carregal 2002	40º 51.63´N 8º 39.45´W	27-9-02	16:22:44	18-11-02	10:16:44	12420
Cais do Bico IH	40º 43.6´N 8º 38.8´W	18-6-87	23:00	6-12-87	14:00	4096
Laranjo	40º 43.40´N 8º 38.19´W	13-6-03	16:15:31	14-7-03	9:57:31	7378
Costa Nova IH	40º 37.1´N 8º 44.8´W	27-5-87	18:00	30-6-87	21:00	820
Costa Nova May	40º 37.29´N 8º 44.89´W	7-5-03	10:12:00[2]	9-6-03	9:54:00[2]	7918
Cais da Pedra IH	40º 32.3´N 8º 40.4´W	28-9-88	13:00	10-11-88	4:00	1024
Cais da Pedra	40º 32.37´N 8º 40.47´W	9-9-03	23:58:40[2]	10-10-03	11.52:40[2]	7320
Lota IH	40º 38.6´N 8º 39.7´W	23-3-88	15:00	17-5-88	14:00	1320
Lota	40º 37.43´N 8º 39.81´W	6-3-03	17:26:05	9-4-03	11:02:05	8097
Manchão IH	40º 45.6´N 8º 39.5´W	13-10-87	21:00	25-11-87	12:00	1024
Manchão	40º 45.72´N 8º 39.58´W	27-9-02	16:02:13	18-11-02	9:38:13	12417
Ovar IH	40º 50.5´N 8º 38.5´W	13-10-87	13:00	25-11-87	4:00	1024
Ovar	40º 50.80´N 8º 38.47´W	26-9-02	16:53:37	18-11-02	10:23:37	12656

Pardilhó IH	40º 48.0´N 8º 38.2´W	13-10-87	22:00	25-11-87	13:00	1024
Pardilhó	40º 47.52´N 8º 38.57´W	26-9-02	15:23:21	18-11-02	11:53:21	12686
Ponte Cais 2 IH	40º 38.3´N 8º 41.5´W	28-9-88	16:00	10-11-88	7:00	1024
Ponte Cais 2	40º 38.07´N 8º 41.19´W	7-8-03	17:41:50[2]	4-9-03	18:17:50[2]	6727
Puxadouro IH	40º 50.0´N 8º 37.3´W	13-10-87	23:00	25-11-87	14:00	1024
Puxadouro	40º 49.98´N 8º 37.43´W	26-9-02	16:17:53	18-11-02	11:23:53	12672
Rio Novo IH	40º 41.6´N 8º 38.2´W	31-1-88	23:00	19-4-88	14:00	1888
Rio Novo	40º 41.69´N 8º 38.10´W	8-3-03	12:25:05	9-4-03	1:00:05	9368
Sacor IH	40º 39.5´N 8º 42.6´W	11-8-87	18:00	17-9-87	6:00	877
Cires	40º 39.53´N 8º 42.82´W	7-8-03	18:25:27	8-9-03	9:31:27	7592
S. Jacinto IH	40º 39.7´N 8º 43.6´W	23-6-87	7:00	4-8-87	22:00	1024
S Jacinto	40º 39.90´N 8º 43.55´W	11-12-03	10:54:00[2]	9-1-04	10:06:00[2]	6953
Torreira IH	40º 45.6´N 8º 41.9´W	24-6-87	7:00	5-8-87	22:00	1024
Torreira Jun	40º 45.85´N 8º 41.88´W	12-6-03	11:06:00[2]	7-8-03	10:36:00[2]	13436
Torreira Aug		7-8-03	11:30:00[2]	9-1-04	10:30:00[2]	7439
Torreira Jan 04		9-1-04	12:52.38	9-4-04	7:04:38	21783
Vagueira IH	40º 33.6´N 8º 45.4´W	28-4-87	17:00	10-6-87	8:00	1024
Vagueira	40º 33.64´N 8º 45.47´W	8-5-03	10:36:30	9-6-03	9:12:30	7667
Vista Alegre IH	40º 35.2´N 8º 41.0´W	26-9-88	20:00	8-11-88	11:00	1024
Vista Alegre	40º 35.30´N 8º 41.15´W	9-9-03	23:31:04	9-12-03	9:49:04	21704

Table 4.2 Information on the stations and all the data used. 'IH' after the station name refer to the 1987/8 survey; all data refer to the 2003 survey, except when otherwise stated. Indices 1 & 2 refer to an averaging time of 10s and 30s, respectively. This time interval was used to filter higher frequency SL variations and has been accounted for in the analysis.

(c) Data Analysis

Analysis of the data sought to obtain the amplitude and phase of the main tidal constituents, from sea surface elevation measured with the pressure sensors. Experimental logistics produced data records of varying duration, although all covered enough data so that the major tidal constituents (M_2, S_2, N_2, etc.) could be estimated through harmonic analysis.

The harmonic analysis, which used the Tira-1 month program from the TASK2000 package, was performed on both the 1987/8 and 2002/4 concurrent data. Amplitudes and phases of 36 constituents have been determined; however, only the analysis of 6 main constituents is presented. These constituents are used to analyse for changes in amplitude and phase throughout the 15-16 years between the records, as well as for determining the change from the mouth to the upper reaches of the Lagoon.

The results from the analysis of these data will be investigated, in association with changes in the Lagoon's bathymetry (caused by dredging or erosion), through a 2DH Hydrodynamic Model (Section 4.7.2).

However, before a final analysis, the pressure readings forming the dataset from Aveiro Lagoon have to be calibrated to a standard, in order to obtain sea levels. The procedure used for this purpose is described next. The influence from air pressure tides, i.e., atmospheric tides, has not been accounted for.

Calibration adjustments

Measuring instruments have some kind of sensor, which converts a physical parameter into a recordable number. For example, it can be a voltage or frequency count, generated by an oscillator containing a variable resistance. Calibration of the instrument, against a standard, allows for the conversion of the recorded number into a physical value, with units.

The principle of all pressure systems is the measurement of the hydrostatic pressure of the water column above a fixed pressure point and the conversion of that hydrostatic pressure into sea level equivalent, after correction for water density and local acceleration due to gravity,

$$h = (p - p_a)/\rho g \tag{4.5}$$

where h is the sea level above the pressure point, p is the total pressure due to both the sea level and atmosphere measured at the pressure point, p_a is the atmospheric pressure at the sea surface, ρ is the average water density in the water column (above the sensor) and g is the local acceleration due to gravity (IOC, 2002).

Measurements from the instruments used in the Ria de Aveiro (RBR and Quicklog) were calibrated against sea level readings recorded by the tide gauge at Holyhead (53.3ºN, 4.5ºW, Liverpool Bay), U.K. A calibration adjustment was applied to the pressure readings taken at Holyhead, and then applied to those from the Lagoon, converted subsequently to adjusted levels.

If p_a (in Equation 4.5) was known, the water levels at Holyhead could be determined (assuming a constant g). As p_a is not known, the calibration is undertaken at the M_2 frequency. This assumes it to be the same, at all frequencies. This is acceptable for slow changes, but not for changes that are rapid compared with the sensor response, i.e., a few seconds (personal communication, Prof. David Pugh). This approach takes advantage of the fact that there are no atmospheric pressure variations at M_2 frequency, at the latitude considered here. Hence, the pressure measured by the RBR at Holyhead can be calibrated according to

$$p_{(RBR)} = N \times \rho g M_{2(Holyhead)} \big/ M_{2(RBR)} \qquad (4.6)$$

where N is the quantity measured by the RBR, $p_{(RBR)}$ is the pressure measured by the RBR, and ρ is the average water density in the water column at Holyhead, g is the gravitational acceleration (assumed constant) and M_2 the amplitude of the semi-diurnal constituent. The same calibration adjustment is applied to the readings from the Quicklog.

To use this calibration on the readings from Aveiro, it is necessary to first apply the calibration to the pressure levels as shown above (Equation 4.6) and next convert the pressure readings to levels. This has been undertaken by using

$$h_{Aveiro} = N \times \left(\frac{\rho_{Holyhead} g M_{2(Holyhead)}}{\rho_{Aveiro} g M_{2(RBR,Holyhead)}} \right) \qquad (4.7)$$

g has been considered as constant. As the water column density for each of the surveyed sites at Aveiro is not known, an interval between which the level could vary was estimated, based upon estimated maximum and minimum water density value (see Section 6.4.1).

4.7 Model Simulations of Hydrodynamic changes in the Ria de Aveiro Lagoon

4.7.1 Simple Analytical Approach

Modelling is used generally as a mathematical tool, to help understand the processes involved in a physical system. The qualitative and quantitative analogy between mechanical and electrical systems is used commonly, as they can be represented, or modelled, by similar mathematical Equations.

For instance, Miles (1971) used circuit analysis to study the resonant response of harbours. Prandle (1980) referred to AC circuit theory, to analyse the open-boundary problem in the modelling of tidal barrier schemes. Pugh (1978) and Wong (1986) have used this analytical approach to evaluate the theoretic dampening effect on the surface elevation of a tidal wave, propagating into an estuary or bay through a narrow inlet.

The surface elevation response of an estuary to an incident external wave, can be studied by analogy to a RLC-circuit (Figure 4.19), where the surface displacement at the inlet or mouth can be represented by a voltage (*E(t)*) and the flow through the inlet by a current (*I(t)*). A RLC-circuit consists of a resistor (of resistance *R*), inductor (of inductance *L*) and capacitor (of capacitance *C*), connected, in series, to a source of electromotive force (*E(t)*), which varies as a function of time (*t*).

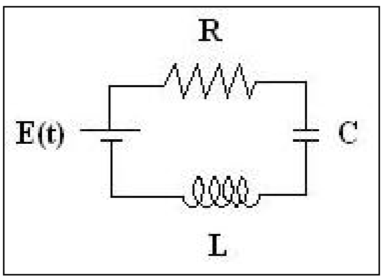


Figure 4.19 Example of a RLC-circuit

Following Kirchhoff´s Law, the total voltage drop *E(t)* is given by the sum of the voltage drop at each circuit component

$$E_R = RI$$
$$E_L = LI'$$
$$E_C = \frac{1}{C}\int I(t)dt$$

$$E(t) = E_R + E_C + E_L = E_0 \sin \omega t$$

If E_o is the amplitude of a sinusoidal function of ωt, *E(t)* can also be written as

$$E(t) = LI' + RI + \frac{1}{C}\int I(t)dt = E_0 \sin \omega t$$

which, differentiated with respect to *t,* gives the second order differential equation

$$LI'' + RI' + \frac{1}{C} I = E_0 \omega \cos \omega t \qquad (4.8)$$

Solving Equation (4.8)

The solution of a second-order differential equation is given by the sum of a particular solution (I_p), with the general solution of the homogenous equation (I_h). If I_p is considered as a **particular solution** of (4.8), whereby

$$I_p = a\cos \omega t + b \sin \omega t \qquad (4.9)$$
$$I'_p = -a\omega \sin \omega t + b\omega \cos \omega t$$
$$I''_p = -a\omega^2 \cos \omega t - b\omega^2 \sin \omega t$$

Sustituting (2) into (1)

$$L(-a\omega^2\cos\omega t - b\omega^2\sin\omega t) + R(-a\omega\sin\omega t + b\omega\cos\omega t) + \frac{1}{C}(a\cos\omega t + b\sin\omega t) = E_0\omega\cos\omega t$$

$$\Leftrightarrow \left[\left(\frac{1}{C} - L\omega^2\right)a + R\omega b\right]\cos\omega t + \left[-R\omega a + \left(\frac{1}{C} - L\omega^2\right)b\right]\sin\omega t = E_0\omega\cos\omega t$$

$$\Leftrightarrow \left[\left(\frac{1}{C} - L\omega^2\right)a + R\omega b\right]\cos\omega t = E_0\omega\cos\omega t$$

$$\left[-R\omega a + \left(\frac{1}{C} - L\omega^2\right)b\right]\sin\omega t = 0$$

where

$$a = E_0\omega\frac{\left(\frac{1}{C} - L\omega^2\right)}{\left(\frac{1}{C} - L\omega^2\right)^2 + (R\omega)^2} = E_0\frac{\frac{1}{\omega C} - L\omega}{\left(\frac{1}{\omega C} - L\omega\right)^2 + R^2} = -E_0\frac{S}{S^2 + R^2} \qquad (4.10)$$

$$b = E_0\omega^2\frac{R}{\left(\frac{1}{C} - L\omega^2\right)^2 + (R\omega)^2} = E_0\frac{R}{\left(\frac{1}{\omega C} - L\omega\right)^2 + R^2} = E_0\frac{R}{S^2 + R^2} \qquad (4.11)$$

for

$$S = \left(L\omega - \frac{1}{\omega C}\right) \qquad (4.12)$$ (defines reactance in electric circuits)

Equation (4.8) can be presented also as

$$I_p(t) = I_0\sin(\omega t - \sigma) \qquad (4.13)$$

Using the trigonometric function for sin$(\omega t\text{-}\sigma)$, in (4.13)

$$I_0\left(\sin\omega t\cos\sigma-\cos\omega t\sin\sigma\right)=a\cos\omega t+b\sin\omega t$$

$$\begin{cases} I_0\sin\sigma=-a=E_0\dfrac{S}{R^2+S^2} \\ I_0\cos\sigma=b=E_0\dfrac{R}{R^2+S^2}\end{cases}$$

$$\begin{cases} tg\sigma=-\dfrac{a}{b}=\dfrac{S}{R} \\ I_0^2=a^2+b^2\end{cases}$$

$$\sigma=\arctan\left(\frac{S}{R}\right) \qquad (4.14)$$

and

$$I_0=E_0\frac{1}{\sqrt{R^2+S^2}}=(R^2+S^2)^{-\frac{1}{2}} \qquad (4.15)$$

($\sqrt{R^2+S^2}$ defines the impedance which, from the above, is given by the ratio E_o/I_o)

The **general solution** of the homogeneous Equation (4.8) is

$$I_h=c_1e^{\lambda_1 t}+c_2e^{\lambda_2 t} \qquad (4.16)$$

where λ_1 and λ_2 are the roots of the characteristic equation, given by

$$\lambda^2+\frac{R}{L}\lambda+\frac{1}{LC}=0$$

$$\lambda=-\frac{R}{2L}\pm\frac{1}{2L}\sqrt{R^2-\frac{4L}{C}}$$

For R>0 (which holds true for electric circuits), the general solution of the homogenous equation $I_h(t)$ (given in Equation 4.16) will tend to zero, as t tends to infinity. Therefore, the current $I(t) = I_h(t) + I_p(t)$ tends to $I_p(t)$, which means that the output signal will be a harmonic oscillation given by (4.13), with a frequency equal to that of the input.

(a) Application to an estuary

The solution for the second order differential equation of the RLC-circuit analysed is of considerable use to the modelling of the (water) surface displacement response that is developed subsequently.

The system modelled consists of a lagoon, with an area A_L, connected to the ocean by a narrow inlet channel of width w, length l, depth h and bottom frictional coefficient K. The definition of narrow implies $w/l \ll 1$. The lagoon is forced at the inlet by an oscillation $\zeta_0 = H\cos(\sigma t)$, with an amplitude H and angular velocity σ. To understand the response of the lagoon to this forcing, it is necessary to start by analysing the parameters that will influence the surface level, inside the lagoon.

Assuming the surface displacement inside the lagoon is ζ_L and that, in the narrow channel connecting the lagoon to the ocean, it is ζ_o, the fluid in the channel will be accelerated by the pressure gradient. This is caused by the difference in pressure, between the inlet and the lagoon. This acceleration will be opposed by the effect of the bed friction.

From Newton's Second Law of Motion, the acceleration, for a total force F acting on a particle of fluid per unit volume, is:

$$\frac{\partial u}{\partial t} = \frac{1}{\rho}\sum F_x$$

$$\frac{\partial v}{\partial t} = \frac{1}{\rho}\sum F_y$$

$$\frac{\partial w}{\partial t} = \frac{1}{\rho}\sum F_w$$

The forces acting on a fluid particle in the inlet are pressure and friction. The acceleration caused by gravity changes and/or Coriolis force are neglected, due to the small channel dimensions considered. Wind stress is also neglected. Assuming the fluid is incompressible, non-viscous and of constant density, the two forces per unit volume that act on the fluid particle along the channel (y direction, see Figure 4.20) are pressure and friction (see below).

Pressure

The pressure gradient created by the surface slope (ζ), along a channel of unit width, depth h and water mass ρ, is given by

$$\frac{\partial P}{\partial y} = \frac{\partial}{\partial y}\left(\rho g h - \rho g (h+\zeta)\right)$$

$$\frac{\partial P}{\partial y} = -\rho g \frac{\partial \zeta}{\partial y}$$

$$\textit{Pressure force = Pressure gradiente x h} \Leftrightarrow P = -\rho g \frac{\partial \zeta}{\partial y} h \qquad (4.17)$$

Friction

$$G = -K\rho v \qquad (4.18)$$

where G is the linearised form of the quadratic kρu|u| and K is the linear bottom friction coefficient, in ms^{-1}.

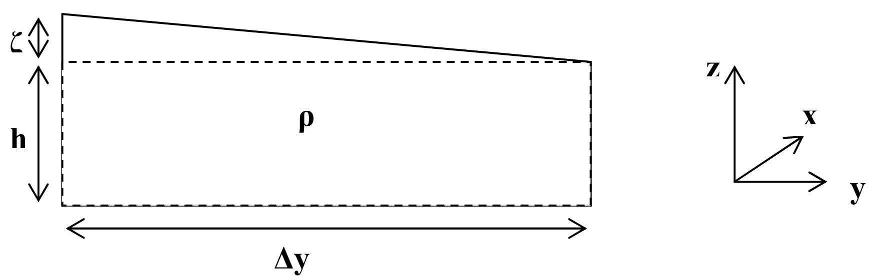


Figure 4.20 Section illustrating a volume of fluid of constant density (ρ) moving along a channel (y-direction).

Using Equation (4.17) and (4.18), the **total force** exerted on the water column is:

$$\sum F = Pressure + Friction = \text{mass x accelaration} = \rho \frac{\partial v}{\partial t} h$$

$$-\rho g\frac{\partial\zeta}{\partial y}h+G=\rho\frac{dv}{dt}h$$

$$\frac{\partial\zeta}{\partial y}=-\frac{1}{g}\frac{dv}{dt}+\frac{G}{\rho gh} \qquad (4.19)$$

Assuming that mass is conserved, the flux into the inlet = flux into the lagoon, so that,

$$whv=A_L\frac{d\zeta_L}{dt} \qquad (4.20)$$

Using $v=\frac{A_L}{wh}\frac{\partial\zeta_L}{\partial t}$, from (4.20) and (4.18) in (4.19), gives

$$\frac{\partial\zeta}{\partial y}=-\frac{1}{g}\frac{A_L}{wh}\frac{\partial^2\zeta}{\partial t^2}-\frac{KA_L}{gwh^2}\frac{\partial\zeta_L}{\partial t} \qquad (4.21)$$

If K, w and h are independent of y, then integrating (4.21) along the inlet channel (y)

$$g(\zeta_0-\zeta_L)=\frac{A_L l}{wh}\frac{\partial^2\zeta_L}{\partial t^2}+\frac{KA_L l}{wh^2}\frac{\partial\zeta_L}{\partial t}$$

which re-arranged is

$$g\zeta_0=g\zeta_L+\frac{KA_L l}{wh^2}\frac{\partial\zeta_L}{\partial t}+\frac{A_L l}{wh}\frac{\partial^2\zeta_L}{\partial t^2} \qquad (4.22)$$

This result is a second-order differential equation, equivalent to that obtained for the RLC circuit, as analysed previously. Thus, if the lagoon is driven by an harmonic variation of level,

$$\zeta_0=H\cos(\sigma t)$$

the **solution to (4.22)** is

$$\boxed{\zeta_L = \alpha H \cos(\sigma t - \theta)}$$

where

$$\boxed{\alpha = \left(\phi^2 + \psi^2\right)^{-\frac{1}{2}} \qquad , \qquad \theta = \arctan\left(\psi / \phi\right)}$$

and

$$\boxed{\phi = \left(1 - \frac{A_L l \sigma^2}{whg}\right) \qquad , \qquad \psi = \left(\frac{K A_L l \sigma}{wh^2 g}\right)}$$

The full demonstration of how to obtain the solution for (4.22) is presented in Appendix A3, since it is the same as for the differential Equation (4.8) in the RLC-circuit. The analogy is simple, considering that the surface elevation may be related to voltage, fluid flow to the electric current, bed friction to resistance, the surface area to capacitance and the inertial term to inductance.

By analysing Equation (4.22), it is possible to determine how the phase and amplitude of the surface elevation changes, as a function of the variable parameters. For the particular case of the Ria de Aveiro, the length and width of the channel are considered constant, whilst all the other parameters are variable. Therefore, an analytical analysis of amplitude and phase changes, as a funtion of the lagoon area (A_L), inlet depth (h) and bottom friction (K), is presented below.

<u>Amplitude change, as a function of lagoon area</u>

Substituting $C_1 = \dfrac{l\sigma^2}{whg}$ and $C_2 = \dfrac{Kl\sigma}{wh^2 g}$ into φ and ψ, then solving α with respect to A_L, shows how the amplitude of the ζ_o, or, for instance, M_2, will change inside the lagoon.

$$\alpha = \left[(1 - C_1 A_L)^2 + C_2^2 A_L^2\right]^{-\frac{1}{2}}$$

$$= \left[1 - 2C_1 A_L + \left(C_1^2 + C_2^2\right) A_L^2\right]^{-\frac{1}{2}}$$

This expression will have a maximum or minimum, when

$$\frac{\partial \alpha}{\partial A_L} = -\alpha^{-3/2}\left[(C_1^2 + C_2^2)A_L - C_1^2\right] = 0 \qquad (4.23)$$

i.e. a resonant condition exists.

The same approach is applied in relation to changes in the channel depth and bottom friction coefficient, as well as for changes in phase, as a function of lagoon area, channel depth and the bottom friction coefficient.

<u>Amplitude change as a function of inlet channel depth (*h*) and bottom friction (*K*)</u>

$$\alpha = \left(1 - 2\frac{C_2}{h} + \frac{C_2^2}{h^2} + \frac{C_3^2}{h^4}\right)^{-\frac{1}{2}} \qquad \text{where} \quad C_2 = \frac{A_L l\sigma^2}{wg} \text{ and } C_3 = \frac{KA_L l\sigma}{wg}$$

$$\alpha = \left(1 - 2C_4 + C_4^2 + \frac{K^2}{\sigma^2 h^2}C_4^2\right)^{-\frac{1}{2}} \qquad \text{where} \quad C_4 = \frac{A_L l\sigma^2}{whg}$$

<u>Change in phase, as a function of the lagoon area and inlet channel depth</u>

$$\theta = \arctan\left(\psi/\phi\right)$$

$$\psi/\phi = \frac{KA_L l\sigma}{wgh^2 - A_L hl\sigma^2} = \frac{1}{\left(\frac{wgh^2}{KA_L l\sigma} - \frac{\sigma h}{K}\right)}$$

when $\psi/\phi = \left(\frac{wgh^2}{KA_L l\sigma} - \frac{\sigma h}{K}\right) \rangle 0$, θ>0 and for $\psi/\phi = \left(\frac{wgh^2}{KA_L l\sigma} - \frac{\sigma h}{K}\right) \langle 0$, θ<0.

Using Figure 4.21, which illustrates the arctan function, it can be seen that θ will increase with positive increases of ψ/φ and decrease with negative increases of ψ/φ. The maximum y values are equivalent to ± π / 2.

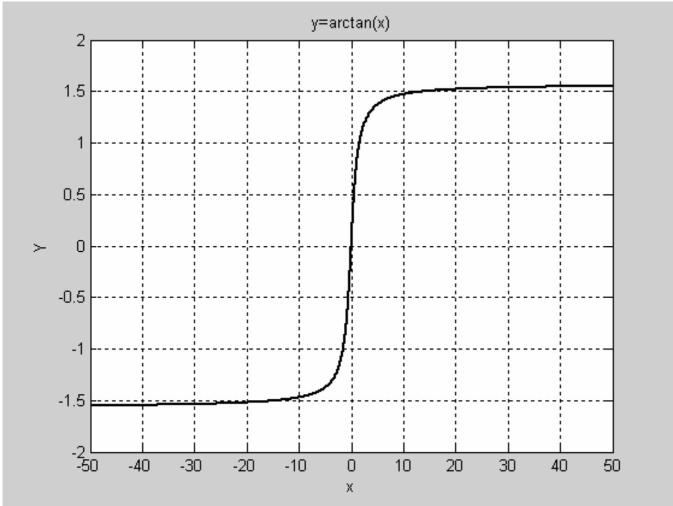


Figure 4.21 Illustration of the arctan function.

For there to be a positive change in the phase, as a function of the lagoon area, $A_L \langle \dfrac{wgh}{l\sigma^2}$ must apply; and as A_L increases, so will the phase. For a positive change in phase as a function of the channel depth, $h \rangle \dfrac{A_L l\sigma^2}{wg}$ must apply; as h increases, so will the phase. If, however, $A_L \rangle \dfrac{wgh}{l\sigma^2}$ and $h \langle \dfrac{A_L l\sigma^2}{wg}$, then θ will be negative and increases as either A_L or h increase.

<u>Change in phase, as a function of bottom friction</u>

φ is independent of K and ψ is directly proportional to K, hence, ${}^{\psi}\!/\!_{\phi}$ is also directly proportional to K, i.e. $\theta = \arctan(KC)$, where C is a constant . This relationship means that an increase in K corresponds to an increase in the phase lag.

(b) Application to the Ria de Aveiro

The complexity of the previous results means that their understanding is simplified by using a computer simulation, to analyse the numerical solution obtained from Equation (4.22). The aim is to investigate the sensitivity of M_2 amplitude and phase, inside the Lagoon, in terms of lagoon area (A_L), inlet channel depth (h) and bottom friction coefficient (K) change.

The amplitude and phase of M_2 inside the Lagoon, for 1987 and 2003, have been estimated, considering the observed 1987/88 values (based upon Dias, 2001). An exception is the M2 amplitude at the lagoon entrance, which has been calculated from data analysed as part of the present work and the 2003 values (approximations, due to the absence of any updated measurements), as given in Table 4.3.

The results presented in Table 4.4 show good agreement with the observed values obtained for the central area of the Lagoon, i.e., in the vicinity of Cais do Bico, Cacia, Vista Alegre and Vagueira. Estimates for both years are fairly consistent with the observed data, despite the absence of information on the precise value for the lagoon area, at mid-tide, in 2003. The increase in amplitude and decrease in phase, as presented in Table 4.4, agree with the results obtained from data collected during the 1987/88 and 2003 surveys, carried out in the Ria de Aveiro (as discussed in Chapter 7).

	A_L (m^2)	L (m)	w (m)	h (m)	K (ms^{-1})	H_{M2} (m)
1987/88	$7.70 x 10^7$	1300	350	7.2	0.018	0.9617
2003	$8.30 x 10^7$	1300	350	9.6	0.018	0.9988

Table 4.3 Values representing the parameters used in the solution to Equation (4.22), for 1987/88 and 2003. The amplitude of M_2 was calculated from data collected at the lagoon entrance, Barra, during the 1987/8 and 2003 surveys.

	Φ	Ψ	α	Amplitude αH (m)	Phase (º)	ζ_L (m)
1987/88	0.9200	1.4239	0.5899	0.5675	136.5	0.3080
2003	0.9353	0.8634	0.7856	0.7847	120.8	0.5767

Table 4.4 Results obtained by applying the parameters listed in Table 4.3, to the solution of Equation (4.22).

Observed values, from the Ria de Aveiro, have been used in the computer simulation. This approach simplifies the equation used, since length and width of the inlet channel are effectively constant, as it is a man-made concrete structure. The inlet's depth has varied throughout the years, despite the dredging undertaken to mantain the channel at a constant depth, for navigation purposes. The amplitude and phase of M_2 at the Lagoon entrance are based upon measurements obtained at Barra, during 1987/88. All the other values are also known measurements, for that period.

To investigate the sensitivity of M_2 to changes in the lagoon area, channel depth and bottom friction, different ranges for each of these parameters were selected and used, sequentially, to calculate amplitude and phase values inside the Lagoon. Thus, one of the variables was allowed to change, whilst the others were retained constant. The results obtained are listed in Table 4.5 and shown in Figure 4.22.

A_L (m^2)	ψ	φ	α	θ (º)	Amplitude αH (m)	Phase (º)	ζ_L (m)
55x10^6	0.943	1.017	0.721	47.2	0.694	126.6	0.472
66 x10^6	0.931	1.221	0.651	52.7	0.627	132.1	0.380
77 x10^6	*0.920*	*1.424*	*0.590*	*0.568*	*0.568*	*136.5*	*0.308*
83 x10^6	0.914	1.535	0.560	59.2	0.539	138.6	0.276
100 x10^6	0.896	1.849	0.487	64.1	0.468	143.5	0.204
120 x10^6	0.875	2.219	0.419	68.5	0.403	147.9	0.148
h (m)							
5	0.885	2.953	0.324	73.3	0.312	152.7	0.090
7	*0.918*	*1.506*	*0.570*	*58.7*	*0.545*	*138.1*	*0.284*
9	0.936	0.911	0.766	44.2	0.736	123.6	0.528
11	0.948	0.610	0.887	32.8	0.854	112.2	0.718
13	0.956	0.437	0.952	24.6	0.916	104.0	0.833
K (ms^{-1})							
0.010	0.920	0.791	0.824	40.7	0.791	120.1	0.600
0.015	0.920	1.187	0.667	52.2	0.639	131.6	0.392
0.018	*0.920*	*1.424*	*0.590*	*57.1*	*0.566*	*136.5*	*0.307*
0.020	0.920	1.582	0.546	59.8	0.525	139.2	0.264
0.025	0.920	1.978	0.459	65.1	0.440	144.5	0.186

Table 4.5 Values used in the computer simulation, to analyse variations in M_2 phase and amplitude (αH) across the inlet, according to changes in the lagoon surface area (A_L), channel depth (h) and bottom friction coefficient (K). The values used for the "fixed" parameters lie within the range of actual measurements (Note: the approximate value for 1987 is highlighted, in grey *italics*).

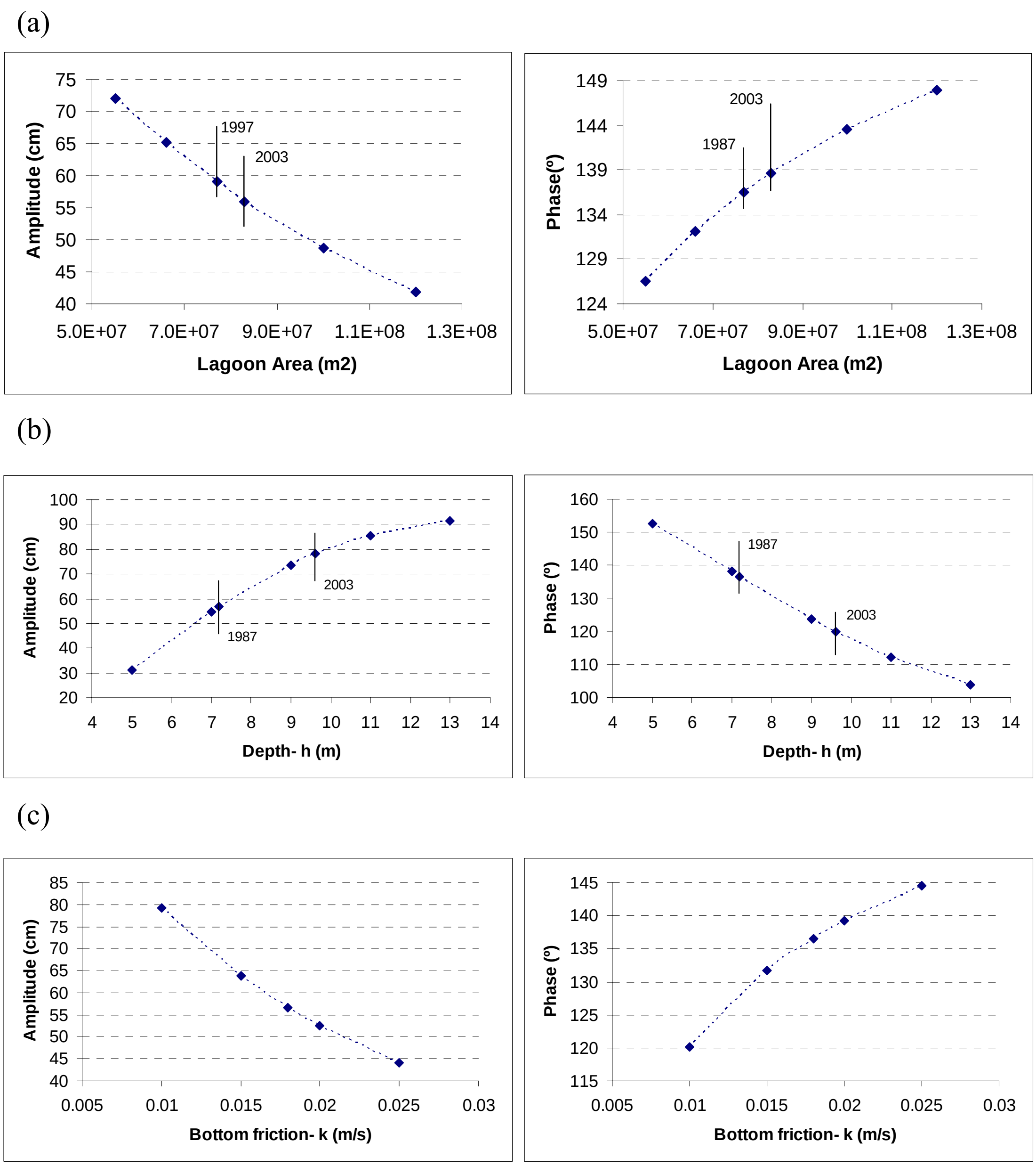


Figure 4.22 Changes in the amplitude and phase in the Lagoon, as a function of: (a) lagoon surface area; (b) inlet channel depth; and (c) bottom friction coefficient (Chezy).

The possible responses of the Ria de Aveiro to changes in the inlet channel depth, bottom friction coeffient and lagoon area, are summarised below:

(1) An increase in the total **area of the lagoon (*A_L*)** (for instance, as a result of land reclamation, dredging and/or erosion) decreases the amplitude and increases the tidal phase, inside the lagoon. A dramatic change in the lagoon's area could lead to resonance, i.e, if a maximum or minimum value of A_L is attained, that would satisfy the condition presented in Equation (4.23). This situation is not attained

in the case of Ria de Aveiro, unless the total area were to chang to an unrealistic dimension.

(2) As the inlet **depth (*h*)** is increased, so is the amplitude inside the lagoon; however, the phase lag decreases. The rate of change, in both the amplitude and phase, is greater for small inlet depths. This tends to stabilise, for depths greater than 14m.

(3) A increase in the **friction coefficient (*K*)** decreases the amplitude and increases phase, within the Lagoon .

(4) If the **amplitude of the forcing wave** (**M_2**, in this case), at the entrance, were the only parameter to change, then the amplitude inside the Lagoon would also increase, but with the same dampening, due to α. For this particular case of linearised friction, there would not be a change in the phase lag (see the solution to Equation 4.22).

It is now also possible to relate the observed amplitude and phase changes between 1987 and 2003, to the estimated changes in the channel depth (7.2m and 9.6m as an average assumption respectively) and the lagoon area (7.70×10^7 m^2 and 8.30×10^7 m^2 as an average assumption respectively) over that time. If only the channel depth had changed, from Equation (4.22) and Figure 4.22b, the amplitude would have increased by 0.212m and the phase would lag by 15.7º (~32.5 minutes). Similarly, if only the lagoon area A_L had changed, the amplitudes would have decreased by 0.029m and the phase lag would have increased by 2.1º (~4.3 minutes). These amplitude and phase changes can be compared with approximate observed changes, measured from surveyed *in situ* data (see Results and Discussion). Clearly, the channel depth changes are the more important.

The results, as presented above, are an oversimplification of what may be happening overall, in the system. These simulations are restricted by the analysis of the independent effect of varying parameters when, in fact, they are known to depend upon each other. For instance, a change in the area of the lagoon can alter the depth of the

inlet channel which, in turn, might influence the bottom friction coefficient, consequently influencing the amplitude and phase lag in the Lagoon.
However, the overall result suggests that the tidal response of the lagoon can be modelled and that the tidal (wave) distortion found is greatly dependent upon the inlet channel dimensions, bottom friction and the lagoon area.

The objective of this Section was to illustrate and simplify the problem of modelling the basic response of a complex system, connected to a narrow inlet. The next Section will describe a more elaborate 2-D hydrodynamic numerical model of the Ria de Aveiro which will, once again, be used to investigate the responses of the system to changes in the bathymetry.

4.7.2 2DH Hydrodynamic Numerical Model

The analogy presented previously, between the RLC-circuit and a estuary connected to the ocean via a single narrow channel (together with its application to the Ria de Aveiro), has provided a simple qualitative understanding of the sensitivity of the response of a tidally-induced wave, at the entrance of the Lagoon, to changes in the inlet, channel depth, lagoon area, and bottom friction.
In this Section, a numerical model is used to obtain the main tidal characteristics at several locations throughout the Ria de Aveiro, during 1987/88 and 2003/04. This approach is used to evaluate whether changes in bathymetry are reflected in the tidal characteristics of the Lagoon, within a 16 year period.
The model used consists of a 2-D vertically integrated (2DH) hydrodynamic numerical model of the Ria de Aveiro, developed at the University of Aveiro (Dias, 2001). The model is based upon Leendertse & Gritton (1971) and Leendertse (1987). As such, it solves the second-order partial differential equations for depth-averaged fluid flow (shallow-water equations), derived from the 3D Navier-Stokes equations. The model has been calibrated and validated using the 1987/8 data (Dias, 2001; Dias & Fortes, 2005).
Note: for the purpose of this study, the model developed by Dias is used as a ‘tool’ to analyse changes in the tidal constituents of the Ria de Aveiro, over the last 16 years. Thus, only a summary of the information believed to be of greatest relevance to the present work will follow. For further details, refer to Dias (2001) and related published papers (see References).

Governing equations

2D equations, based upon continuity and depth-averaged shallow water equations (integrated vertically between the sea bed (z = -h) and the free surface (z = ζ)), have been utilised.

$$\frac{\partial \varsigma}{\partial t} + \frac{\partial (HU)}{\partial x} + \frac{\partial (HV)}{\partial y} = 0$$

$$\frac{\partial U}{\partial t} + U\frac{\partial U}{\partial x} + V\frac{\partial U}{\partial y} - fV + g\frac{\partial \varsigma}{\partial x} - \frac{\tau_x}{\rho H} - A_h \nabla^2 U = 0$$

$$\frac{\partial V}{\partial t} + U\frac{\partial V}{\partial x} + V\frac{\partial V}{\partial y} + fU + g\frac{\partial \varsigma}{\partial y} - \frac{\tau_y}{\rho H} - A_h \nabla^2 V = 0$$

where $U = \frac{1}{H}\int_{-h}^{\varsigma} u dz$ and $V = \frac{1}{H}\int_{-h}^{\varsigma} v dz$ are the depth-averaged velocity components in the *x* and *y* direction, respectively (see Figure 4.20, for reference), ζ is the free surface elevation, *h* is the water depth, $H=h+\zeta$, $f\,(=2\omega\sin\varphi)$ is the Coriolis parameter, *t* is time, *g* is the gravitational acceleration, ρ is the water density and A_h is the horizontal eddy viscosity. τ represents the total stress at the bottom and surface boundary, i.e., the magnitude of the wind stress at the water surface, together with the magnitude of the bottom shear stress. However, since no wind stress (and river runoff) was considered in the calibration and validation of the hydrodynamic model, τ is considered equal to the bottom shear stress in both the *x* (eastwards) and *y* (northward) directions. As such, $\tau_x = g\left(U\left(U^2+V^2\right)^{1/2}/C^2\right)$ and $\tau_y = g\left(V\left(U^2+V^2\right)^{1/2}/C^2\right)$. This is related to the frictional dissipation of momentum at the water-sediment interface and is approximated by the quadratic drag law (Dronkers, 1969; Leendertse & Gritton, 1971), using the Manning-Chezy formulation. *C* is the Chezy coefficient, $C = H^{1/6}/n$, adjusted by model calibration and dependent upon *n*, the Manning's coefficient.

The governing equations were approximated to a set of numerical finite difference equations and solved by the ADI (Alternating Direction Implicit) method, using a space-staggered grid (refer to Dias, 2001, for a detailed description).

Boundary Conditions

Bathymetry

The hydrodynamic model uses a rectangular grid containing 160 x 393 cells, with $\Delta x = \Delta y = 100$m dimension. This resolution implies that some of the channels in the model are represented with a larger width than their real dimensions. However, the water volume is conserved, i.e., the volume of water in a cell is the same in the numerical, as in the real bathymetry (Dias, 2001). There is one open boundary on the western side of the grid, which represents the inlet of the Lagoon. This is the only link with the (Atlantic) ocean (Figure 4.23).

The numerical bathymetry was determined by application of the Monte Carlo cubature method (to determine the depth of each grid point, from the volume integrals in each cell (see Dias, 2001)), to the data obtained by the Portuguese Hydrographic Office, in 1987/8 (Instituto Hidrográfico, 1991). Full technical details are given in Dias (2001).

The flooding and drying of the intertidal flats and salt marshes, which occur commonly in the Ria de Aveiro, is accounted for by using a land-water boundary determined as a function of the water depth (Leendertse & Gritton, 1971; Dias, 2001). In other words, the cell will shift between land to water, depending upon the depth information within the cell.

Initial Conditions

The initial boundary conditions used include zero normal velocity along the closed boundaries. At the open boundary, the free surface elevation is specified, at each time-step, by sea surface elevation at this location. This was determined from the harmonic constants obtained from the Portuguese Hydrographic Office. The initial water level is considered to be constant, whilst the velocity is zero, for the entire domain.

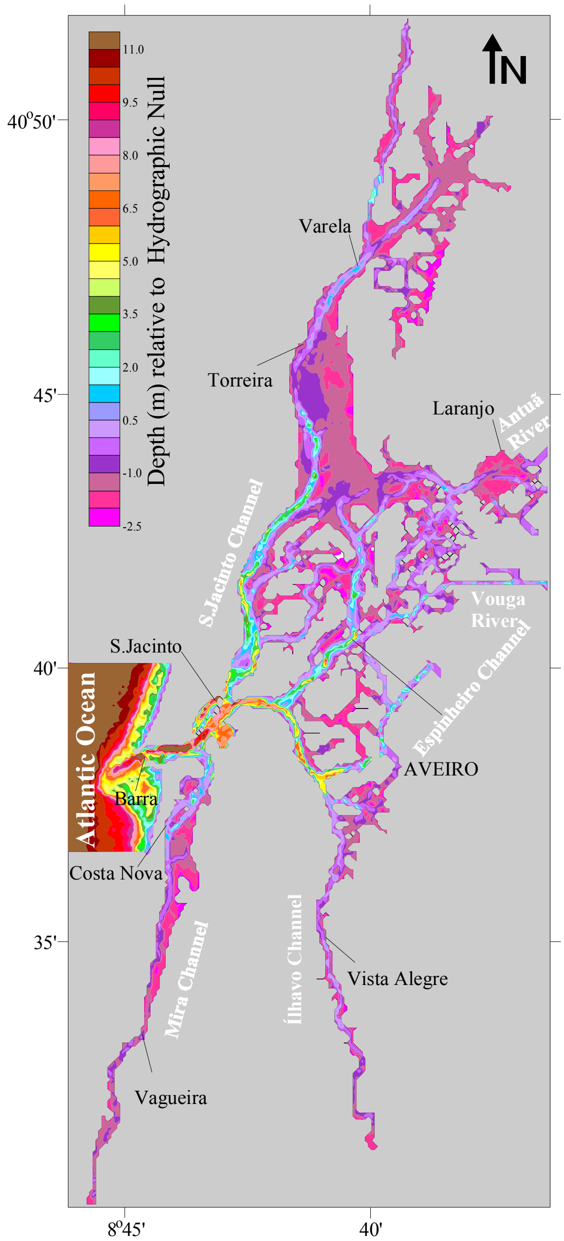


Figure 4.23 Bathymetry used in the 2DH hydrodynamic, model based upon the survey undertaken, in 1987/8, by the Portuguese Hydrographic Office. Depth is given in metres, relative to the local datum (-2.0 m below MSL) (courtesy of Dr. João Dias).

Calibration & Validation

The calibration of the model, applied to the entire Ria de Aveiro, consisted of comparing results from the analyses of the tides, generated by the model for 21 different stations, located along the main channels of the Lagoon, with the results from equivalent field data available from the Portuguese Hydrographic Office (1987/8) survey (Dias *et al*., 1998; Dias, 2001; Dias & Fortes, 2005).

The calibration also included the adjustment of the bottom friction coefficient, in the Manning-Chezy formulation for bottom stress. This approach was made possible by optimising the agreement between amplitude and phase, of the computed and observed water levels at the different stations. The parameters used in the adjustment were (water) depth and the Manning's coefficient. The Manning's coefficient was assigned initially according to a range of water depths, as shown in Table 4.6. It was then adjusted locally, until the model outputs agreed with the field data. This comparison was necessary, as the bottom roughness also depends upon the type of bottom sediment and the presence of bedforms.

Bottom friction coefficients	
Water Depth (m)	Manning's *n* value
$-2.5 \leq h < -2.0$	0.042
$-2.0 \leq h < -1.5$	0.038
$-1.5 \leq h < -1.0$	0.034
$-1.0 \leq h < -0.5$	0.030
$-0.5 \leq h < 0.0$	0.027
$0.0 \leq h < 0.5$	0.024
$0.5 \leq h < 1.0$	0.022
$1.0 \leq h < 3.0$	0.020
$3.0 \leq h < 10.0$	0.018
$h \geq 10.0$	0.015

Table 4.6 Manning's value adopted, according to water depth.

Water circulation in the Lagoon is driven by the wind, river runoff, and by the pressure gradient generated at the mouth, by the tide. For this particular application, where the aim is to characterise the tidal characteristics of the Lagoon, the forcing has been considered purely tidal (Dias & Lopes, 1996; Dias, 2001).

The total mean estimated freshwater input is considered to be approximately 1.8×10^6 m^3, during a tidal cycle (Moreira *et al.*, 1993). The tidal prism of the Lagoon, for (maximum) spring tide and (minimum) neap tide, are estimated at 136.7×10^6 m^3 and 34.9×10^6 m^3, respectively (Dias, 2001). Hence, the total mean estimated freshwater input is very small (2.5%), when compared to the mean tidal prism at the mouth (approximately 70×10^6 m^3) and, as such, it has been neglected. This also explains why the Lagoon has been considered vertically homogeneous, allowing the 3D governing equations to be simplified so that the model can be based on a 2DH approach.

In Dias & Lopes (1996), the importance of wind-induced circulation was evaluated, with emphasis upon extreme wind conditions. Three simulations were performed, considering tidal forcing, tidal + wind forcing and wind forcing alone. The results showed that wind-induced currents were larger, when including tidal forcing. Extreme strong wind conditions were found to induce particular (water) circulation patterns, especially within shallow and wide channels. In similar studies (Dias *et al.*, 2000; Dias, 2001), the residual circulation was determined considering tide-wind-river freshwater-driven circulation. The wind and river-induced residuals were obtained by removing the tidally-induced residual, from the total computed residual. The residual currents induced by the tides were found to be 2 orders of magnitude smaller than the tidal currents. The effect of wind stress was found to be small, compared to that of the tidal currents, but significant when considering the residual tidal currents. Therefore, the effects of river runoff and wind are only considered significant over long periods of time, i.e. when considering residual circulation.

The values used in the model calibration procedure, selected after validation, are presented in Table 4.7.

Time-step	40 s
Simulation duration	≥ 33 days
Forcing	Sea level, at the inlet
Manning's coefficient n	Varies with depth (Table 4.6)
Horizontal eddy viscosity, A_h	20 m^2s^{-1}

Table 4.7 Values used in the calibration of the model. Validation showed that the value for A_h and n optimised the results of this particular model.

Model validation is used to verify how well the simulated results fit to a set of field data. During the model's calibration, the results from the model and the observed data were compared, based upon frequency domain properties. Dias (2001) considers this procedure to be sufficient, as a way to validate the model. However, water levels and velocity measurements from June 1997, available for 10 stations, have been compared. This latter test ensures that the measurements used in the model validation are independent from those used in the model calibration.

The comparison between the model results and the observed data, for both the calibration and validation processes, are considered to be in good agreement (Dias & Lopes., 1996; Dias, 2001; Dias & Lopes, 2005). These authors observed that the validation tests show that the model can reproduce an independent observed dataset, despite having identified some discrepancies in some of the results. These differences can, amongst others, be attributed to factors such as: local inaccuracies in the bathymetry's definition; poor resolution of the very narrow channel, imposed by the horizontal grid; and uncertainties in the field data.

(a) Present Application

In the present study, model data is sought for the stations for which there are historical and recent observations. This is undertaken to see if the observed changes are consistent with the changes in the model properties, i.e., bathymetry.

The calibrated 2DH hydrodynamic model developed by Dias (2001), as described previously, is used to predict tidally-induced water level time-series, at 18 stations, throughout the Lagoon. These data are then analysed, using harmonic analysis, to characterise the tidal properties of the Ria de Aveiro during 1987/8 for which the hydrodynamic model was calibrated (to reproduce the hydrodynamic characteristics of the Lagoon).

The model was re-run with a bathymetry based upon that of 1987/8, but with some changes made to the sections for which updated data, collected during 2000-2003, were available. Forcing was purely tidal, using data collected at Barra during the 2002/3 survey (part of the present work, refer to Section 4.6.2). Generally, the model was run for a period equivalent to approximately 3 months (very long simulations are restricted by computer processing power). To assure model stability, all the runs started 3 days prior to the date of start of the data later to be analysed. The periods simulated (Table 4.8) used a 40s time-step.

The simulation produced computed sea level time-series for each station, corresponding to the dates of the available observed data. A harmonic analysis, using the Task-2000 (Tira 1 month) package, was performed on all the time-series, to obtain the amplitude and phase of the tidal constituents of the 1987/8 and 2002/3 model runs.

	Start date	End date
1987	26-4-87	30-6-87
	15-6-87	18-9-87
	5-10-87	26-11-87
1988	28-1-88	30-4-88
	23-9-88	11-11-88
2002	23-9-02	31-12-02
2003	7-3-03	6-5-03
	8-5-03	5-8-03
	8-8-03	28-11-03
	1-11-03	10-1-04

Table 4.8 Periods for which the 2D Hydrodynamic model was run.

Boundary conditions

Ocean boundary

The ocean boundary conditions used in the 1987, 1988 and 2002 simulations are based upon hourly observed sea level data, from the permanent tide gauge, located at the entrance of the Lagoon (Barra). Data at this station were required for the dates at which sea level data had been collected within the Lagoon, during the 1987/8 Hydrographic Office survey, as well as for those collected during the 2002 survey. This approach was adopted to ensure that, for comparison purposes, the simulated results and the sampled data corresponded to the same period.

An alternative to this would have been to run the model just for M_2 as the boundary condition. However, this approach would not include the response of the total tide in the results estimated by the model. Important non-linear effects, common in shallow water estuarine/lagoon systems (e.g. non-linearities generated by friction), would not be accounted for in the results computed from a single tide.

To overcome existing discontinuities or gaps in these data, missing data (1987, 1988 and 2002) were replaced by the corresponding predicted value, calculated by previous harmonic analyse of that particular year. As the model requires a 2 minute interval, sea level time-series input for the boundary condition, a cubic spline interpolation was performed on the data, using the MATLAB spline function (refer to MATLAB Function Reference, for further details).

The boundary conditions for the 2003 simulations are based upon data collected during 2003, through a series of pressure measurements recorded in the permanent tide gauge well (Barra). Data from the permanent recorder were not available at the time so, instead, several series obtained during the 2002/3 survey were used (refer to section 4.6.2). These data are continuous, at a 6 minute sampling interval. Although most of it cover the periods sampled during 1987/8, there was a period (during 2003) where no data were available. For this case, tidally-predicted values (for every 2 minutes) were calculated using the tidal prediction routine, in Task-2000. The tidal constituents required the calculation of the predictions, which were obtained from the preceding month of data. The mean sea level in the different data series used for 2003 was reduced to that of 2002 obtained by harmonic analysis, since no MSL value for 2003 was known at the time. This approach was necessary, because the series used were obtained from different instruments.

Bathymetry

The other boundary conditions that need to be discussed are the bathymetries used for the present 1987/8 and 2002/3 runs.

The present 1987/8 run utilises the same bathymetry as that used in the calibrated version of the original model (described previously, Figure 4.23); however, some differences are found at the stations for which the model outputs data. The stations Varela, Moranzel, Miradouro, Parrachil and Cais Comercial, used in the calibrated model, have not been used in the present study (Figure 4.24), as no observed data were available for these stations in 2003/4. Instead, 4 new stations (Sacor, Lota, Rio Novo and Cacia) for which observed data were available, have been added (Figure 4.24).

The results for the additional stations should have been validated. Consequently, some discrepancies are anticipated between the model results and those obtained from the observed data. In addition, the results for the stations Rio Novo and Cacia, both located on the Vouga Channel, may be further compromised, as the length of the Vouga Channel is not fully represented in the model. Cacia has been positioned at a lower location in the channel. As such, its distance to Rio Novo has been reduced. This modification could cause larger amplitudes and smaller phases in the tide found for Cacia, with less significant differences between Cacia and Rio Novo.

A bathymetric survey of all the main channels of the Lagoon was due in 2004. This survey, to be carried out by the Administração do Porto de Aveiro (A.P.A), would have provided a general update of the 1987/8 survey which, until this date, is the only one covering the majority of the Lagoon, for a specific period. Although initial plans were compromised by faulty equipment, A.P.A still managed to survey the main entrance channel and a section of the Ovar Channel (the northern end of the S. Jacinto Channel). This limitation has meant that the 2002/3 bathymetry, as used in the present application (Figure 4.26), incorporates the few data surveyed by A.P.A. in 2004 and other recent (2000-2004) available bathymetric data covering other areas (Figure 4.25B), in the bathymetry surveyed in 1987/8 (Figure 4.25A).

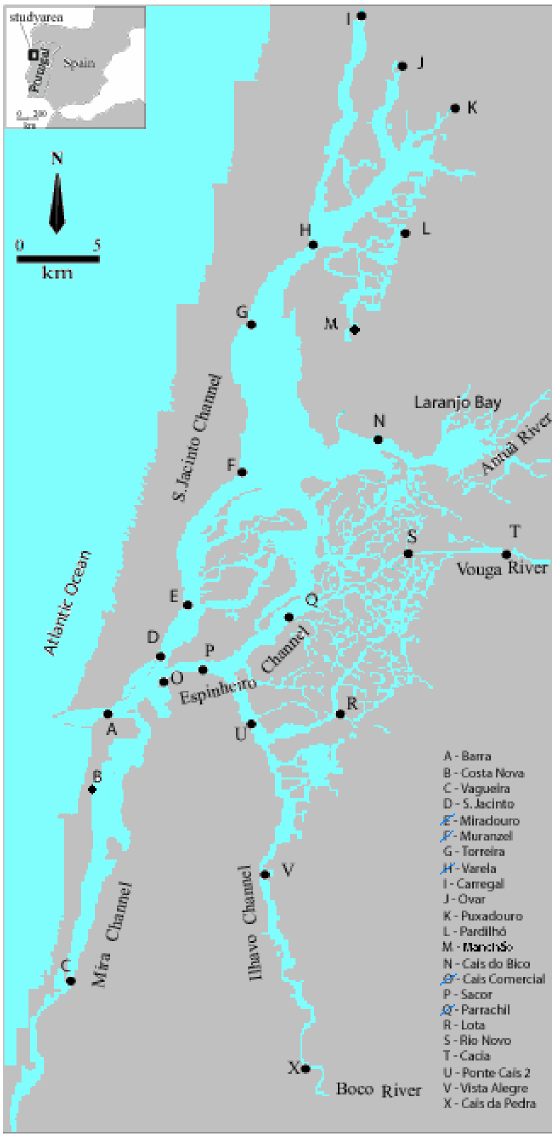


Figure 4.24 Stations used in 2DH model (those used by Dias have been crossed through).

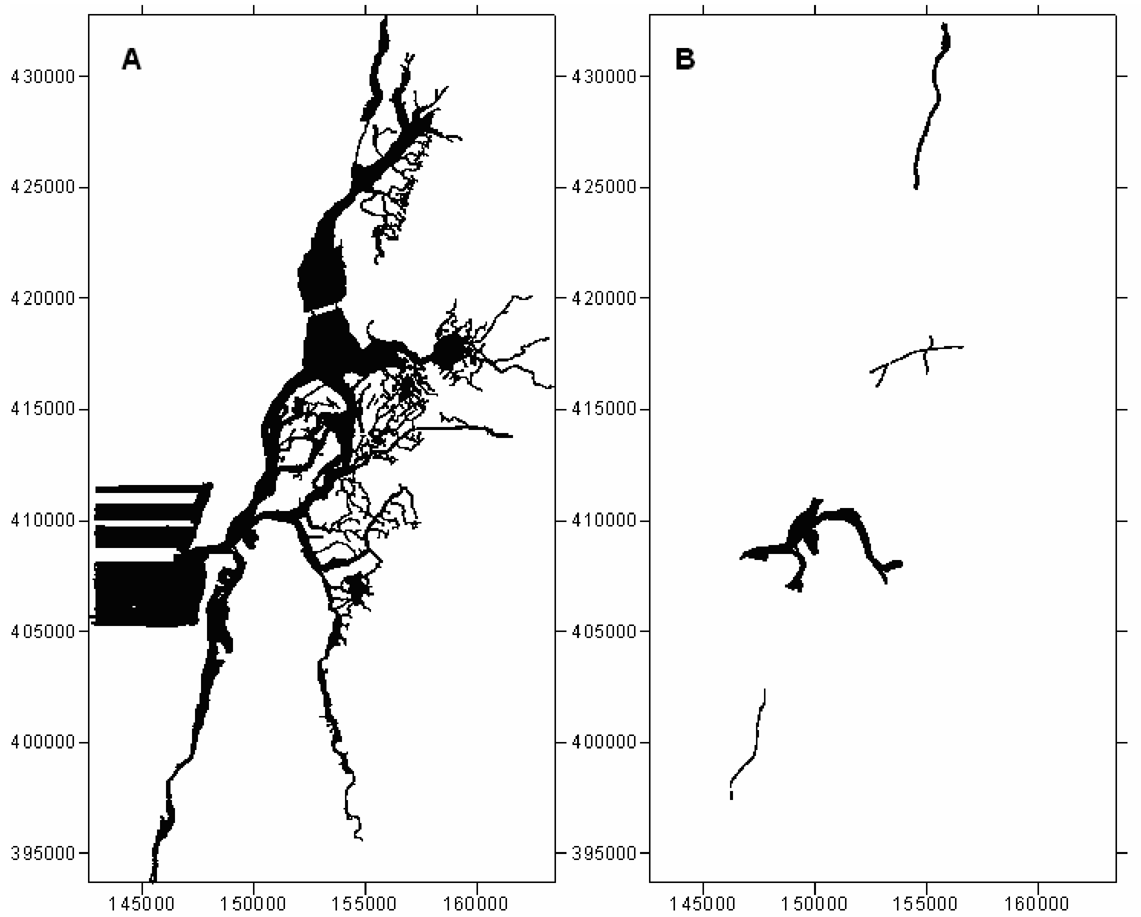


Figure 4.25 (A) Points surveyed during 1987/8 by the Portuguese Hydrographic Office and used to create the bathymetric grid, used in the 1987/8 model simulations. (B) Recent surveyed points, used to update the older bathymetry. This illustrates the lack of coverage of the updated data.

Figure 4.26 shows the bathymetry used in the 2002/3 simulation, as well as an enlargement of the sections for which bathymetric data were changed. Changes comprise the main inlet channel and its access to the main ports (Figure 4.26-4); a section in the Mira Channel (Figure 4.26-2); Murtosa (Murtosa-Gramatal, Murtosa-Moacha, Murtosa-Pardelhas (Figure 4.26-1); and the Ovar Channel (the final section of the S. Jacinto Channel, Figure 4.26-3). The scale represents the differences (in metres) between the recent 2002/3 bathymetry and the 1987/8 bathymetry (Figure 4.23).

Analysis of Figure 4.26 shows that all the changes for the surveyed areas represent a deepening in some sections of the channels. These channels are used usually for leisure sailing, local fishing activity or more industrially-related navigation. As such, they are subjected to dredging. Overall, dredging is considered to be the reason for the channel deepening, identified over the past 16 years.

The stations removed and added in the 1987/8 run were also changed for the 2002/3 simulations. The simulations were performed without changing the values of the friction coefficient, adjusted during the calibration.

As mentioned previously, there was no validation of the results for the stations added to the 1987/8 bathymetry; and, since there have been no changes to that bathymetry, there is no need to re-calibrate the model for 1987/8 runs. This is not the case for when the model is run with the (partially changed) 2002/3 bathymetry. The lack of calibration (e.g. by adjusting the friction coefficient) and validation of the model, run with this modified bathymetry, will unarguably have significant consequences on the results. However, the limited aim is to assess qualitatively whether changes in the bathymetry contribute to, or are responsible for, changes in the sea level data (reproduced by this hydrodynamic model), i.e. not quantifying or predicting the magnitude of the possible changes. It is believed that, under this assumption, this study is still reasonable, although somewhat limited.

In summary, the results from both the 1987/8 and 2002/3 model runs are used to investigate if there are any trends in the tidal characteristics in the Ria de Aveiro, that might indicate changes during the past 16 years. These results are also compared to observed data. This is presented and discussed in Chapter 7.

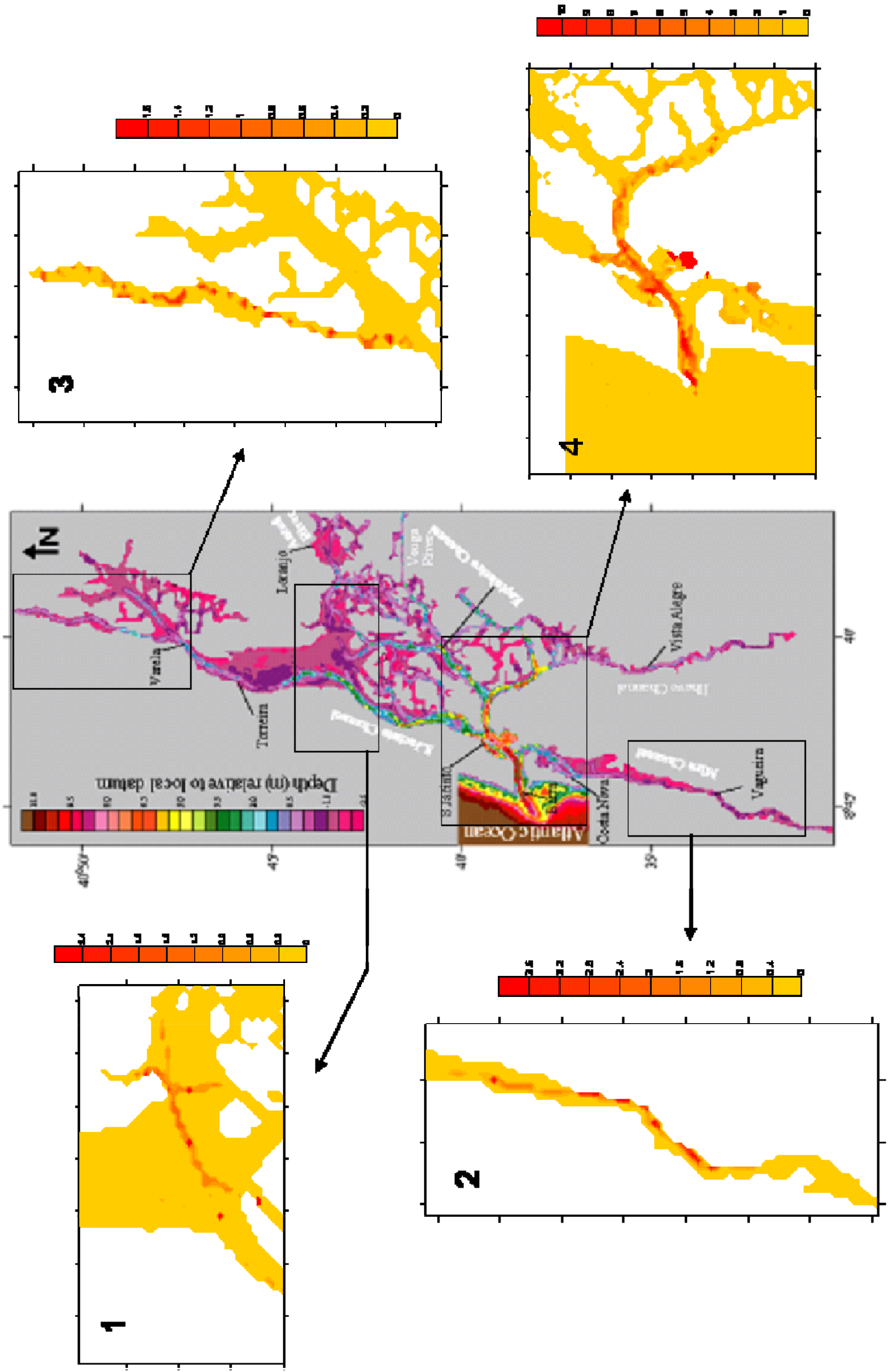


Figure 4.26 1987/8 bathymetry, including detailed changes in depth at Sections (1-4), which have been surveyed until 2004. The scale corresponds to the increase in depth between 1987/8 and 2003/4 (in meters) numerical bathymetries, used in the model simulations (for further details, refer to Section 7.2).

Chapter V

LONG-TERM REGIONAL SEA LEVEL VARIABILITY: RESULTS AND DISCUSSION

5.1 Introduction

Sea level data retrieved from 12 tide gauges along the Western European coastline (from 38ºN to 51ºN longitude and from 8ºW to 1ºE) have been analysed, by separately characterising the different sea level components: tides, non-tidal (surge) residual and MSL.

This Chapter starts by discussing the results obtained from the analysis of the robustly-edited data from the English Channel. The different sea level components are analysed separately, followed by a brief assessment of their correlation with MSLP and atmospheric indices. Extremes are also briefly discussed.

A similar analysis is then presented for the Iberian Peninsula data which has not been edited in the same way as that of the English Channel (refer to Section 4.5.1a). Finally, the results for both regions are compared.

5.2 The English Channel

Yearly records, with hourly sea level data from 6 tide gauges located in the English Channel (3 in France and 3 in England), were selected and analysed (Figure 5.1). These records cover different time intervals, as some extend further back in time than others. Some records are reduced, due to gaps in data; however, they have still been included as they have been complied with the selection procedure (refer to section 4.5.1a). All records have at least 30 years of data (except Calais), such that sea level trends can be determined with a standard error of the order of 0.5 mm yr^{-1} (refer to Douglas, 1991; Shennan & Woodworth, 1992; and Tsimplis & Spencer 1997).

From the six records analysed, Newlyn is of outstanding quality, where data are approximately continuous since 1915. This is a result of continuous maintenance of the gauge. Besides being the subject of many scientific analyses, it has also been used as a reference station. Brest is known as being one of the longest sea level records in the world. However, most of the longest sea level records consist of monthly mean data (e.g. Cascais), which are substantially reduced compared to those of hourly series. Le

Havre and Calais are the shortest records, with many gaps. This further compromises these data, which were already of poor quality. The Portsmouth dataset is based upon data processed by the (U.K.) Hydrographic Office and there are doubts on the stability of the datum (Woodworth *et al.*, 1999).

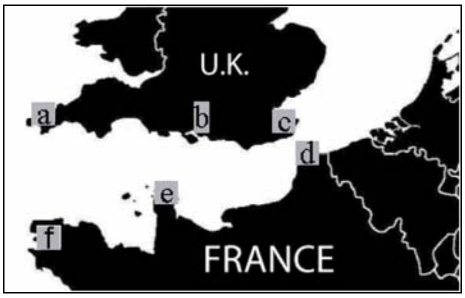


Figure 5.1 Location of the tide gauges in the English Channel, from which data have been analysed. There are three stations on each side of the Channel. The English stations are: (a) Newlyn; (b) Portsmouth; and (c) Dover. The French stations are: (f) Brest; (e) Le Havre; and (d) Calais.

In order to examine separately possible changes in MSL, tides and surges, defined in this study as non-tidal or meteorological residual, a linear trend was fitted to the different sea level component time-series. The statistical significance of these trends is determined by the standard error of the trend value. As a general rule, trends (although possibly indicative) are not considered statistically significantly different from zero unless their magnitude exceeds two standard errors.

The results of the analyses described in Section 4.5 are discussed next and generally summarised, in the following Tables and Figures. All of the records showed considerable interannual variability, against which trends are often not easily identified, especially in the shorter records.

For **mean sea level** (Table 5.1 & Figure 5.2), 5 of the 6 ports show significant upwards trends, close to the recent IPCC global range of 1 to 2 mm yr^{-1} (IPCC TAR, 2001). The Brest and Newlyn trends are significantly different from each other, probably due to different vertical rates of land movement at the two locations. These trends take local vertical land movement into account. The large reduction in sea level at Calais cannot be explained, but is anomalous. It is probably related to the lack of data. Further, it is noticeable that the Calais trends for other components of sea level also show large standard errors; they often diverge from the behaviour of the remainder of the ports analysed.

	Trend (mm/yr)	Standard error
Brest	1.29	0.07
Newlyn	1.73	0.13
Calais	-1.48	1.30
Dover	2.44	0.42
Le Havre	1.44	0.47
Portsmouth	1.38	0.51

Table 5.1 Trends in mean sea level (see also Figure 5.1).

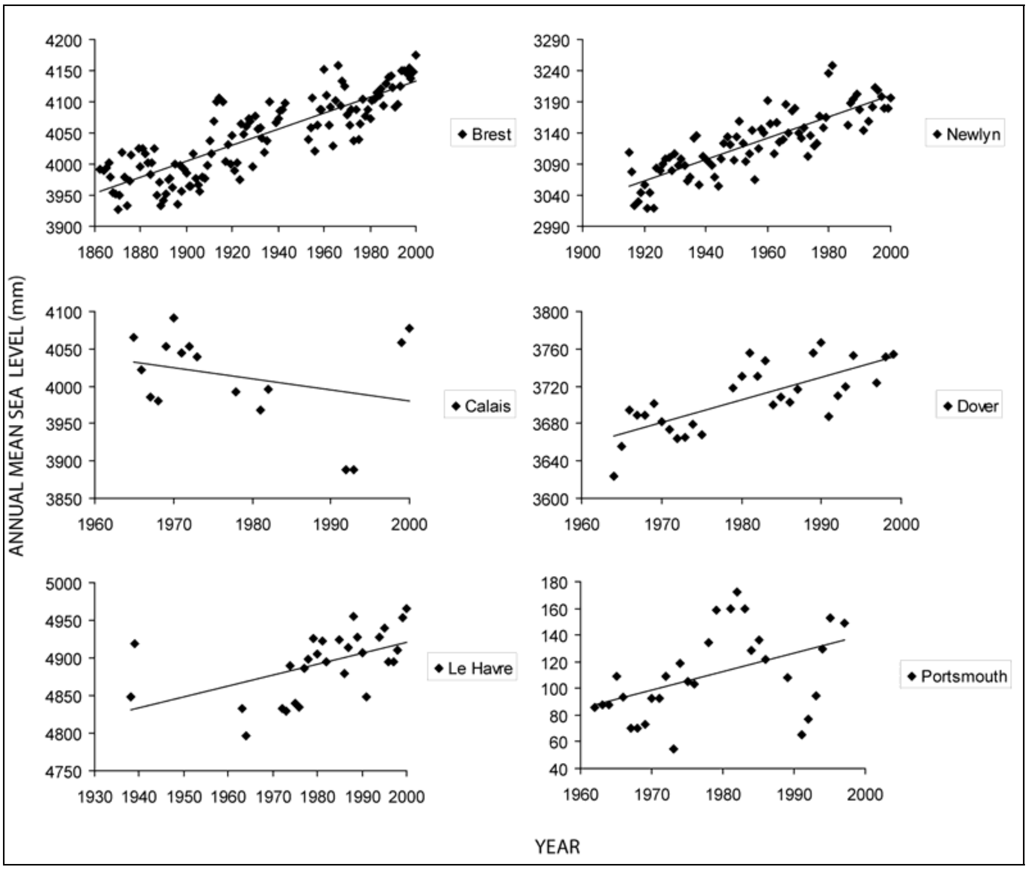


Figure 5.2 Annual mean sea level trends at ports in the Channel. For locations, see Figure 5.1. Note: The datum for values at each port is arbitrary.

For the annual variation in **total observed sea level**, the standard deviations were computed and are listed in Table 5.2 and shown in Figure 5.3. The results are influenced strongly by the 18.6-year nodal cycle and often have large standard errors in the trends. At Brest, Dover and Le Havre, the trends are not significantly different from zero.

However, although other trends are different from zero, they are not statistically significant except at Newlyn where there is a significant increase in the standard deviations. This pattern may be related to increased tidal ranges as the MSL increases, allowing low water to fall further below the increasing mean, as the harbours dry out. No explanation is available for the very large trends in the amplitudes at Calais, but the short data set and possible nodal 18.6-year distortions may be contributing factors.

	Trend (mm/yr)	**Standard error**
Brest	-0.04	0.08
Newlyn	0.24	0.11
Calais	3.32	0.46
Dover	0.68	0.38
Le Havre	-0.16	0.51
Portsmouth	0.63	0.32

Table 5.2 Trends in total observed sea level standard deviations (see also Figure 5.2).

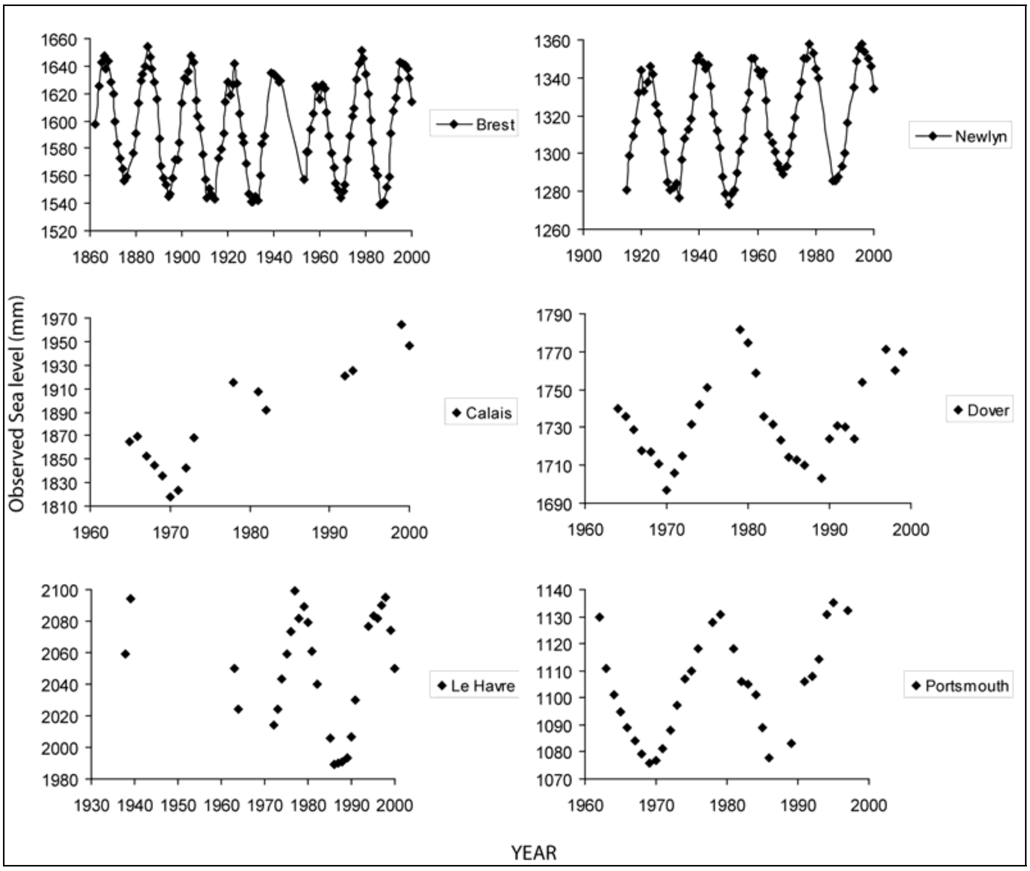


Figure 5.3 Total observed sea level standard deviation. For locations, see Figure 5.1.

Lunar constituents are affected by an 18.6-year nodal cycle. This means that, over this period, maximum lunar monthly declination north and south of the equator varies between 18.3º to 28.6º, consequently, affecting M_2 amplitude variations by ± 3.7% about the annual mean (Doodson & Warburg, 1941). However, this can be significantly lower in shallow parts of the ocean (Amin, 1985). Maximum amplitude in the nodal tide should be found during March 1969 and November 1987. These are also the times of minimum M_2 amplitudes because of the nodal modulations (Pugh, 1987). The M_2 has maximum amplitudes in July 1978 and March 1997.

In order to better estimate the trend found in the sea level standard deviation results, a linear least square method was used to fit a linear model to the data. The model relates the sea level data to the estimated values, through one or more coefficients. The result of the fitting process is an estimate of the unknown coefficients of the model. To obtain the coefficient estimates, the least squares method minimizes the summed square of the residuals. The residual is defined as the difference between the sea level value and the fitted value (residual = data – fit). This method is similar to the least-square fitting procedure used in the harmonic method of analysis, using computer matrix inversion for calculations.

The coefficients determined by the model are a_1 (intercept for year zero), a_2 (slope of the nodal fit), a_3 and a_4 for the fitted function

$$SLstd = a_1 + yr \times a_2 + H_{nodal} \cos(\phi/18.6 + \phi_{nodal})$$

where

$$H_{nodal} = \sqrt{a_3^2 + a_4^2} \qquad \text{and} \qquad \phi_{nodal} = \arctan(a_3/a_4)$$

SLstd corresponds to the sea level standard deviation, *yr* the year, H_{nodal} the amplitude of the nodal cycle, $\phi = yr \times 2\pi/18.6$ *and* φ_{nodal} is the phase of the nodal cycle. The results from the model are shown in Table 5.3. The plots of the fit to Newlyn and Brest data (Figure 5.4) have been selected to illustrate the result of the model.

Station	Trend, a_2 (mm/yr)	H_{nodal} (mm)	φ_{nodal} (°)	% H_{nodal}
Newlyn	0.16	33.9	68.8	2.6
Portsmouth	0.26	26.1	74.1	2.4
Dover	-0.60	39.6	78.2	2.3
Brest	-0.04	47.8	70.1	3.0
Le Havre	0.09	52.2	67.1	2.6
Calais	2.14	31.1	178.1	1.6

Table 5.3 Values from the regression fit to the sea level standard deviation results. All the nodal phases, φ_{nodal}, have been calculated to 1900. The percentage of the M_2 amplitude variation about the mean, due to the 18.6 year cycle, is given by % H_{nodal} (± 3.7 % for the equilibrium tide).

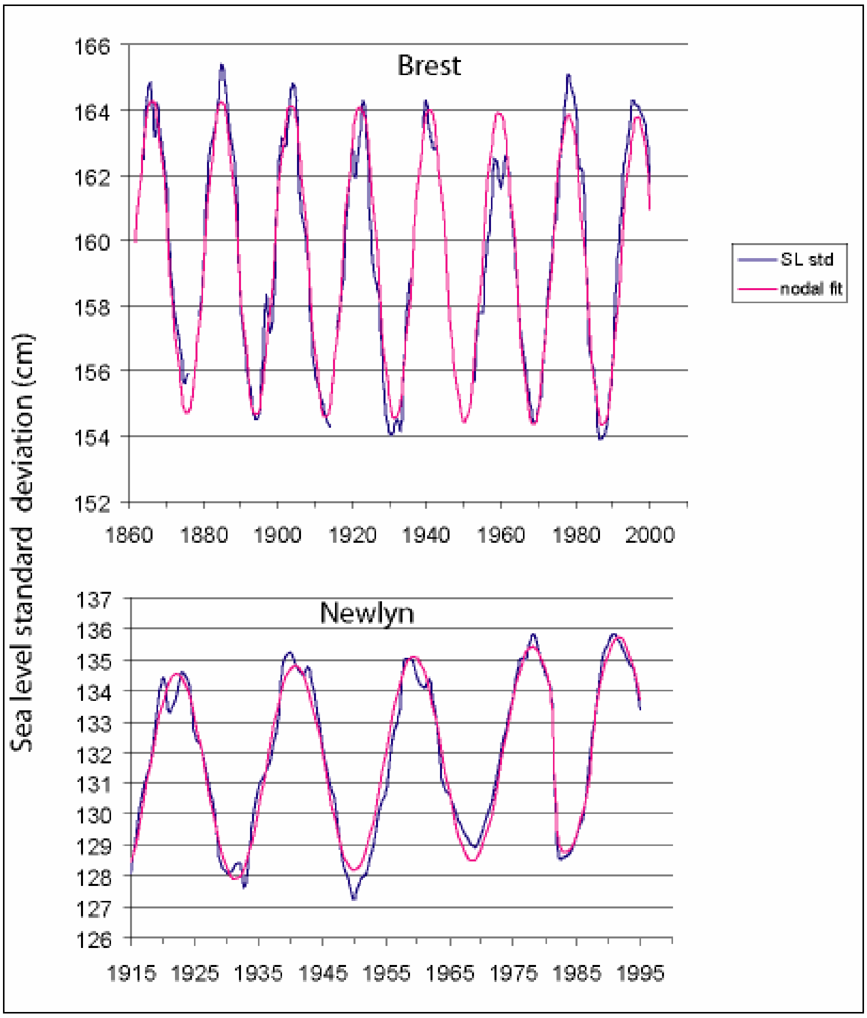


Figure 5.4 18.6-year nodal fit to total observed sea level standard deviation results, for Brest and Newlyn. There is an upward trend in the Newlyn nodal fit, whilst Brest has a very small downward trend.

The striking difference between the results from Calais and other stations (Table 5.3) is caused by the number of years of data used in the fit. Calais has less than 18 years of data, with many gaps in the mid 1980s and 1990s. An 18.6-year cycle fit, based upon that data, does not work. This result has only been included to stress the importance of use of good quality data.

All the stations, except for Dover and Brest, have positive trends. All the percentages of the nodal amplitude are below the 3.7% theoretical value (for M_2), for variations about the mean. The nodal phases for Newlyn and Brest, both to 1900, are 68.8º and 70.1º, respectively, i.e., in very good agreement, as should be expected since they are driven by the same astronomy. This result extends to values found at the other stations.

The harmonic analysis performed on a yearly record of sea levels generates amplitude and phase for 63 tidal constituents. The discussion of trends in the **tidal sea level component** focuses upon 5 major constituents (M_2, S_2, M_4, MS_4 and Sa), out of the 63 available. Tables with the amplitude and phase for all 63 constituents, computed for each station, are provided in Appendix A4. The results for M_2, S_2, M_4, MS_4 and Sa, are given in Tables 5.4 - 5.8. For presentation purposes, only the results for the longest records (Newlyn and Brest) have been plotted (Figures 5.5 - 5.8).

Amplitude trends for the M_2 constituent are presented in Table 5.4. Statistically significant trends in the M_2 amplitude are observed at Brest, Newlyn Calais and Dover. However, although the theoretical 18.6-year nodal cycle in M_2 amplitudes is removed in the analysis procedure, the shallow-water effects leave a residual 18.6-year cycle. This, in turn, distorts trends based upon only short records. For the two longest records shown in Figure 5.5, there is a small but significant reduction in the M_2 amplitude at Brest and an increase at Newlyn. The apparent increase in the M_2 amplitudes at Newlyn has been attributed partly to changes in the measuring procedures, in 1983 (Araujo *et al.*, 2001). The small decrease in the M_2 amplitude at Brest is equivalent to 0.4% decrease per century, i.e. less than the 1% reported by Cartwright (1972), but in the same direction.

Statistically significant trends in M_2 phase have been found at Newlyn, Calais and Le Havre. The trend in the M_2 phase at Brest has not been tabulated since from 1862 until 1885 the phase is approximately constant at 137º (Figure 5.6). This pattern could be associated to a timing adjustment in the data to compensate for the use of different time references, i.e., Brest local time or Paris mean time (currently there is a version of the Brest hourly data available at SONEL for which most of the important errors found have been corrected) (personal communication, Guy Woppelmann). However, when considering changes in tide, one should consider possible effects due to harbour developments. Cartwright (1972) described some of the harbour developments which occurred at the Brest tide gauge site, emphasising that such information should be used when analysing that sea level record. M_2 phases for Newlyn (Figure 5.6) show a sudden decrease (jump) after 1983, which is attributed to the change in the gauge (as discussed previously).

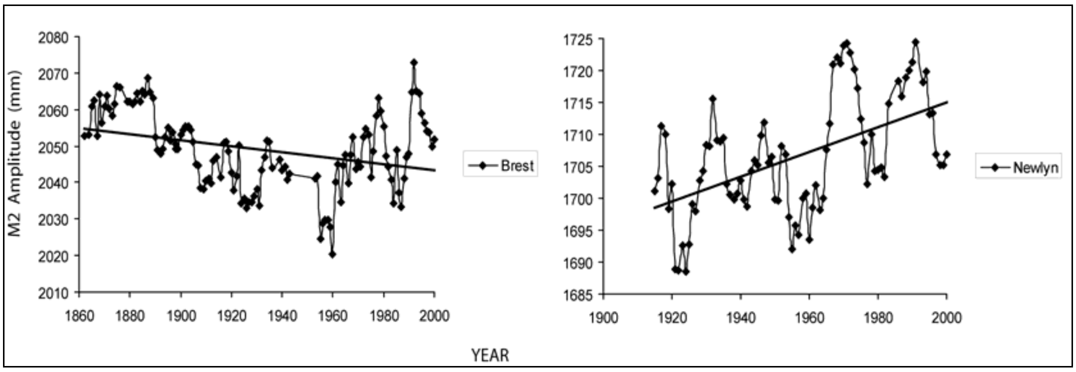


Figure 5.5 M_2 amplitude for the English Channel ports with the longest records. For locations, see Figure 5.1.

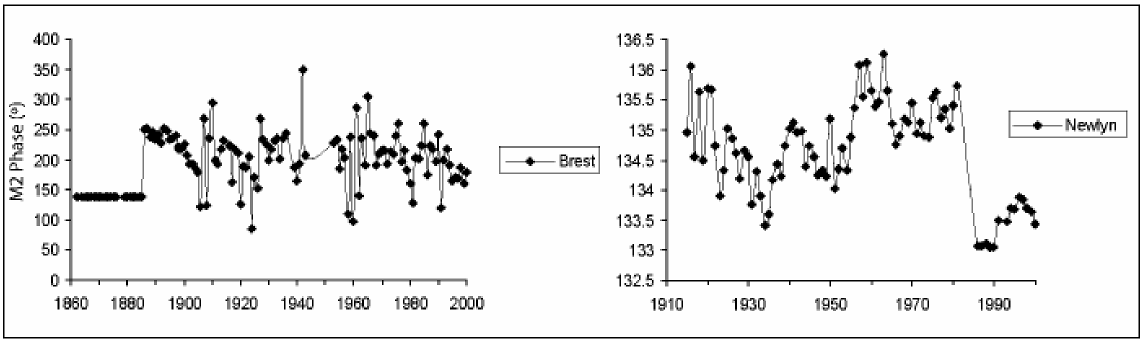


Figure 5.6 M_2 phase for the English Channel ports with the longest records. For locations, see Figure 5.1. The cause behind the constant phase, from 1862 until 1885, at Brest is not known. The effect of the change to the Newlyn tide gauge in 1983 can be seen in the phase decrease, after this date.

	M_2 Amplitude		M_2 Phase	
	Trend (mm/yr)	Standard error	Trend (°/yr)	Standard error
Brest	-0.08	0.02	-	-
Newlyn	0.20	0.04	-0.01	0.00(4)
Calais	1.50	0.44	-0.19	0.05
Dover	-0.93	0.29	0.00(4)	0.01
Le Havre	0.11	0.14	0.02	0.00(5)
Portsmouth	0.21	0.13	-0.03	0.02

Table 5.4 Trends in M_2 (see also Figure 5.4).

With regards to the other 4 constituents the only statistically significant trends found are as follows: the semidiurnal solar tide, S_2, has a negative trend in amplitude and phase at Calais; and, whilst the trend is also negative in amplitude at Dover, the phase appears positive. Positive trends in phase are also found for Newlyn and Le Havre. The higher harmonic of M_2, i.e., M_4 has a positive trend in amplitude and negative in phase for Newlyn and Brest. Dover has a negative trend for this amplitude and positive trend in phase. Positive trends have been found in the MS_4 amplitude at Newlyn and Brest and phase at Calais, Dover and Le Havre. The trend at Calais is extremely high, compared with all the other values obtained. Brest has a negative trend in MS_4 phase. No trends of statistical significance have been found in the seasonal, semi-annual, Sa component.

Further analysis of secular trends in tides should take into account any harbour developments that might have occurred, during the period of sea level data under investigation. This will increase the reliability of the estimated trend and be of value in the understanding of its possible cause.

	S_2 Amplitude		S_2 Phase	
	Trend (mm/yr)	Standard error	Trend (°/yr)	Standard error
Brest	0.00	0.01	-0.08	0.13
Newlyn	0.04	0.03	0.01	0.00
Calais	-0.15	0.03	-0.19	0.05
Dover	-0.57	0.19	0.04	0.01
Le Havre	-0.03	0.15	0.04	0.01
Portsmouth	-0.11	0.12	0.03	0.02

Table 5.5 Trends in the principal semidiurnal solar tide, S_2 (see also Figures 5.7 & 5.8).

	M_4 Amplitude		M_4 Phase	
	Trend (mm/yr)	Standard error	Trend (°/yr)	Standard error
Brest	0.06	0.01	0.05	0.03
Newlyn	0.10	0.01	-0.02	0.00
Calais	0.09	0.19	-0.38	0.10
Dover	-0.19	0.07	0.04	0.02
Le Havre	0.07	0.05	0.02	0.01
Portsmouth	-0.11	0.06	-0.08	0.05

Table 5.6 Trends in M_4 tide (see also Figures 5.7 & 5.8).

	MS_4 Amplitude		MS_4 Phase	
	Trend (mm/yr)	Standard error	Trend (°/yr)	Standard error
Brest	0.04	0.00(4)	-0.05	0.02
Newlyn	0.02	0.01	-0.01	0.01
Calais	0.12	0.16	10.4	2.68
Dover	-0.10	0.10	0.11	0.03
Le Havre	0.10	0.07	0.04	0.02
Portsmouth	-0.12	0.08	-0.01	0.06

Table 5.7 Trends in MS_4 tide (see also Figures 5.7 & 5.8).

	Sa Amplitude		Sa Phase	
	Trend (mm/yr)	Standard error	Trend (°/yr)	Standard error
Brest	0.07	0.06	0.04	0.04
Newlyn	0.16	0.11	0.05	0.15
Calais	0.67	0.60	-0.57	0.39
Dover	-0.01	0.28	-0.05	0.28
Le Havre	0.42	0.32	0.00	0.60
Portsmouth	0.24	0.46	-0.28	0.42

Table 5.8 Trends in the annual solar, Sa, tide (see also Figures 5.7 & 5.8).

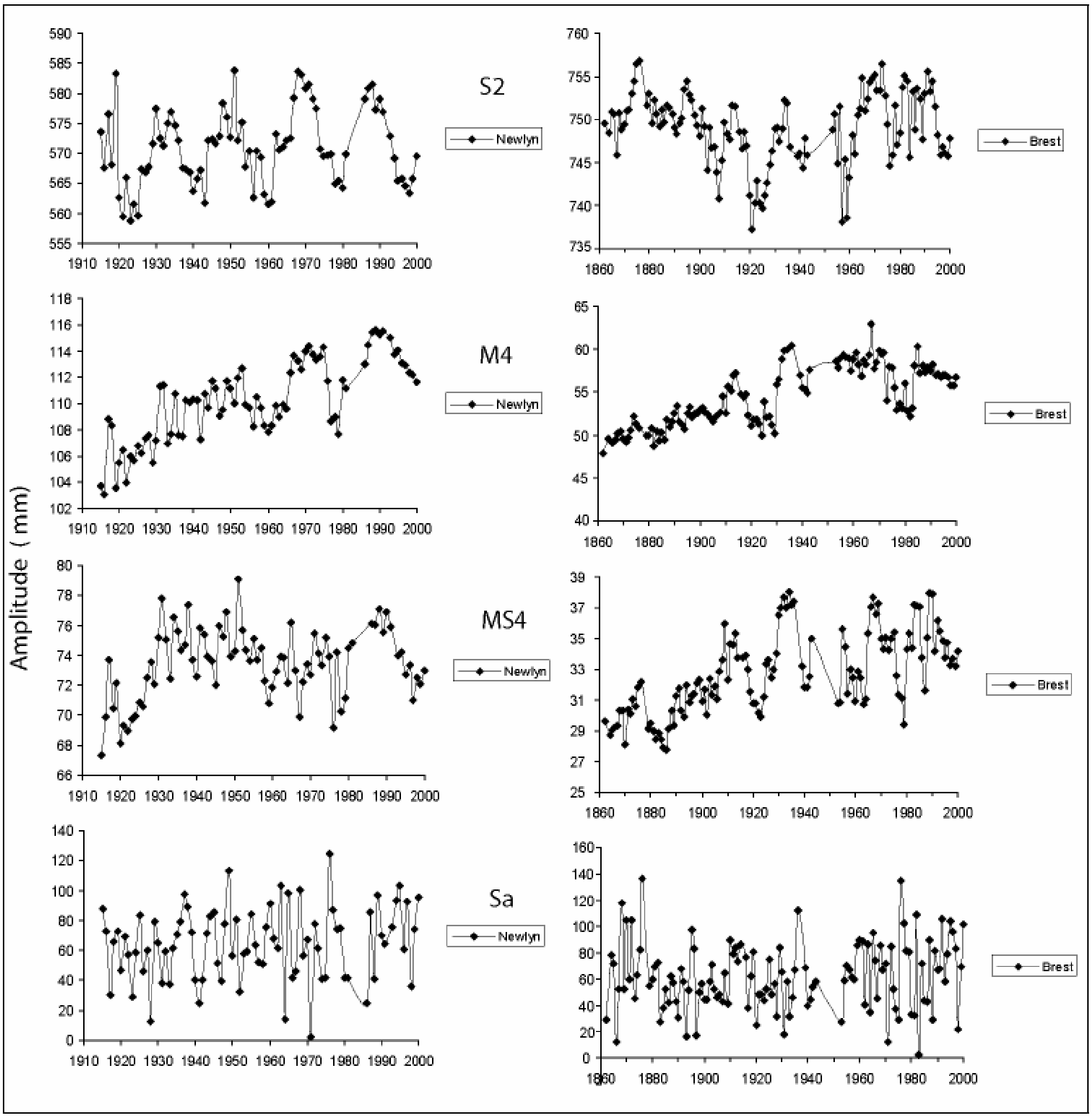


Figure 5.7 Amplitude (in mm) for the S_2, M_4, MS_2 and Sa constituents for Newlyn and Brest (trends and their standard error are given in Tables 5.5 to 5.8).

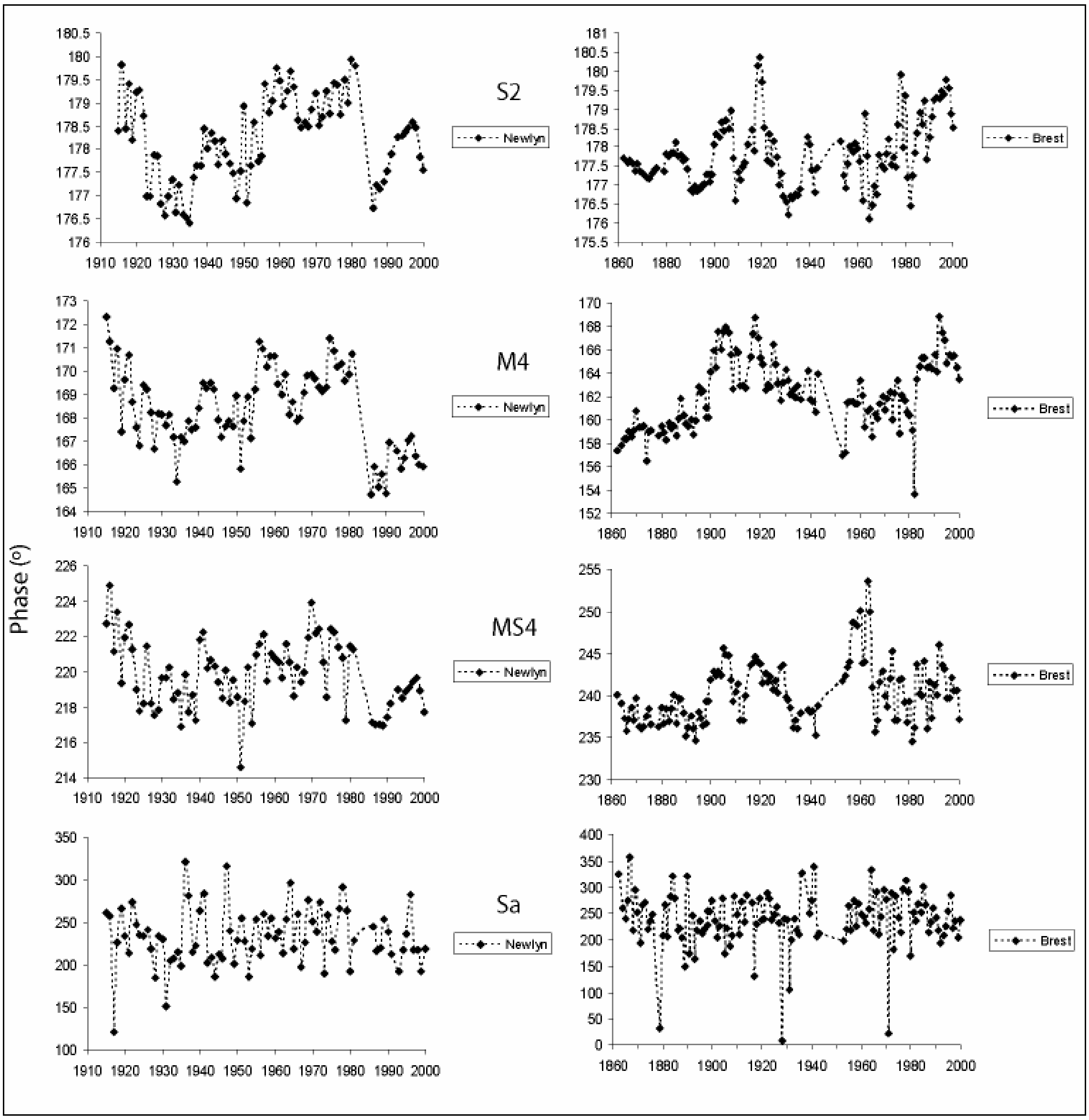


Figure 5.8 Phase (in degrees) for the S_2, M_4, MS_2 and Sa constituents for Newlyn and Brest (trends and their standard error are given in Tables 5.5 to 5.8).

The **meteorological or non-tidal residual**, used here to represent storminess, is parameterised as the standard deviation in the non-tidal residual, i.e., the standard deviation of the values computed by removing the MSL and astronomic tides from the observed sea levels. This approach has the advantage of removing uncertainty due to errors in the tidal predictions, as well as removing seasonal cycles.

Table 5.9 and Figure 5.9 show the trends and standard deviations of the non-tidal (meteorological) residuals. Only two of the trends are significantly different from zero. Whilst the trend at Brest is positive, at Newlyn the trend is higher and negative.

The negative trend at Newlyn has been attributed to the change in the measuring procedures in 1983 (see above), with the new bubbler-gauge contributing fewer errors to the non-tidal residuals, than the old stilling well system.

The result for Brest is also consistent with that of Bouligand & Pirazzoli (1999). Furthermore, these investigators refer to a positive trend from 1980-1994 and a decreasing trend from 1953-1994, which are also observed in Figure 5.9. Pirazzoli (2000) and Pirazzoli *et al*. (2004) have associated this behaviour in the meteorological residual to local storms and changes in wind local patterns.

Annual residual standard deviations at Brest and Newlyn are strongly correlated (Figure 5.10). This relationship provides clear evidence of the oceanographic significance of the residual sea levels, following the careful editing undertaken of the data sets.

	Trend (mm/yr)	**Standard error**
Brest	0.06	0.03
Newlyn	-0.11	0.05
Calais	-0.26	0.21
Dover	0.20	0.16
Le Havre	0.14	0.10
Portsmouth	-0.13	0.12

Table 5.9 Trend in non-tidal residual standard deviation (see also Figure 5.5).

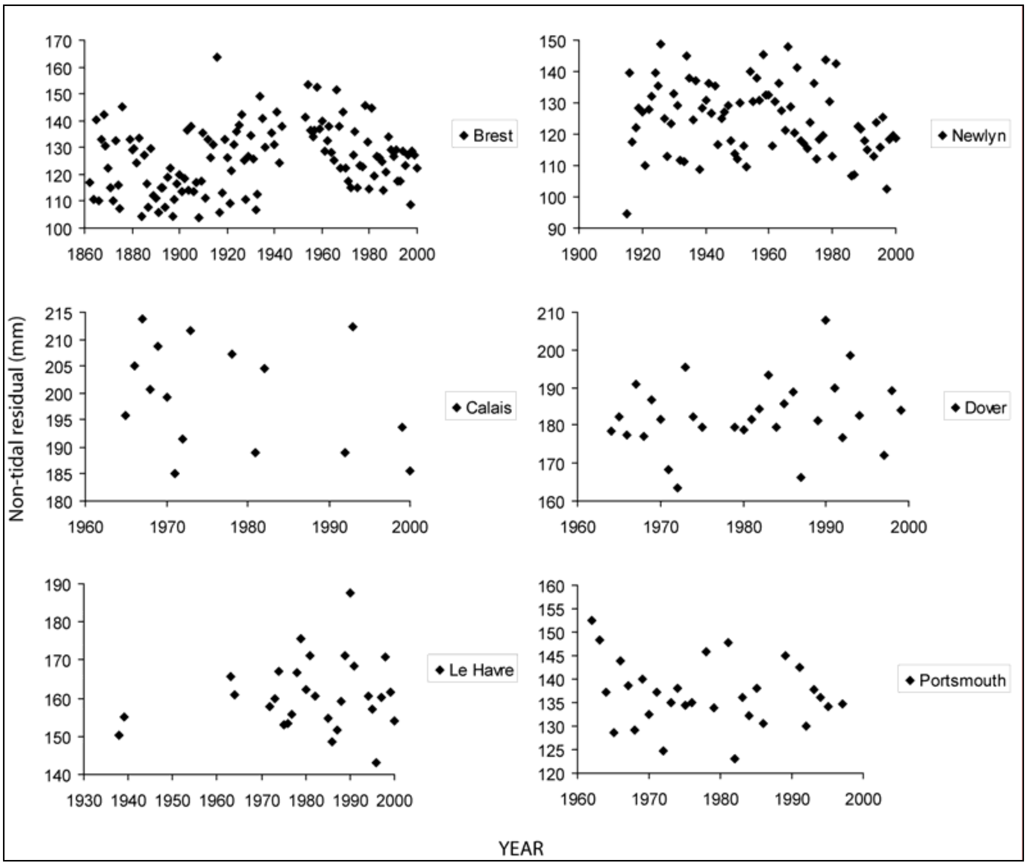


Figure 5.9 Non-tidal (meteorological) residual standard deviation (NTRstd). For station location, see Figure 5.2.

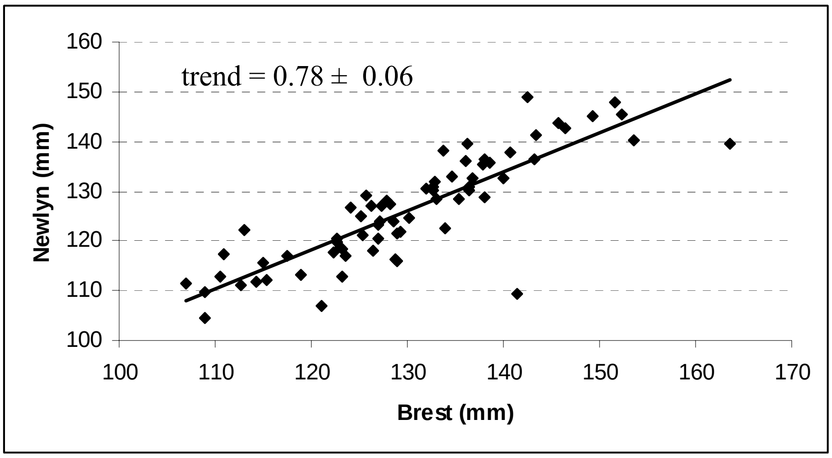


Figure 5.10 Correlation between non-tidal residuals standard deviation (NTRstd), for Newlyn and Brest.

Forcing

Detailed statistical analyses have shown that, by removing air pressure and wind effects, the variance in sea level records of the Eastern North Atlantic can be reduced (Pugh & Maul, 1999; Thompson, 1986; Tsimplis *et al*., 1994).

An analysis into the possible forcing mechanisms responsible for trends in the different sea level components is beyond the scope of the present study. However, a very brief description is presented here on the results obtained for the influence of atmospheric pressure on sea level. This is an important contributing factor towards the interpretation of the trends analysed previously.

The number of long-term **Mean Sea Level Pressure** (MSLP) datasets is very limited. This has led to the use of annual MSLP gridded data (Section 4.5.1b), for each individual station. However, as a result of the coarse 5ºx10º grid, all the stations except for Newlyn have a common dataset of MSLP.

The complete MSLP data series (1873-2000) for the grid-point selected for Newlyn has no trend. A small negative -0.01 ± 0.00(3) mbar yr^{-1} exists in the equivalent time-series for all the other gauges. The MSLP trends, covering the same period of the sea level series of each individual station (Table 5.10), show small positive and negative trends for the majority of stations, except at Newlyn where the trend is zero. The only significant trend found is for Le Havre and Brest. This leads to the conclusion that trends in MSL are only slightly influenced by the local trends in air pressure.

	Trend (mbar/yr)	**Standard error**
Brest	-0.01	0.00(3)
Newlyn	-0.00(4)	0.01
Calais	0.01	0.02
Dover	0.02	0.02
Le Havre	-0.02	0.01
Portsmouth	0.02	0.02

Table 5.10 MSLP trend for the analysed span of sea level data.

Table 5.11 & Figure 5.11 show the correlation at each of the ports, between the annual MSL and the annual mean air pressure (both detrended). In this particular analysis, the expected theoretical inverted barometer relationship would have been –10 mm/mbar.

All of the correlations show the expected negative relationship, whilst none fall outside more than two standard deviations from the theoretical value. The theoretical value was not anticipated here, as air pressure and winds are dynamically linked. In practice, it is rare to find the exact theoretical value.

	Trend (mm/mbar)	Standard error
Brest	-14.16	2.07
Newlyn	-11.67	1.48
Calais	-17.28	11.46
Dover	-8.47	3.40
Le Havre	-15.03	5.59
Portsmouth	-10.50	3.93

Table 5.11 Regression of annual MSLP with annual MSL (both detrended, over the whole MSL record).

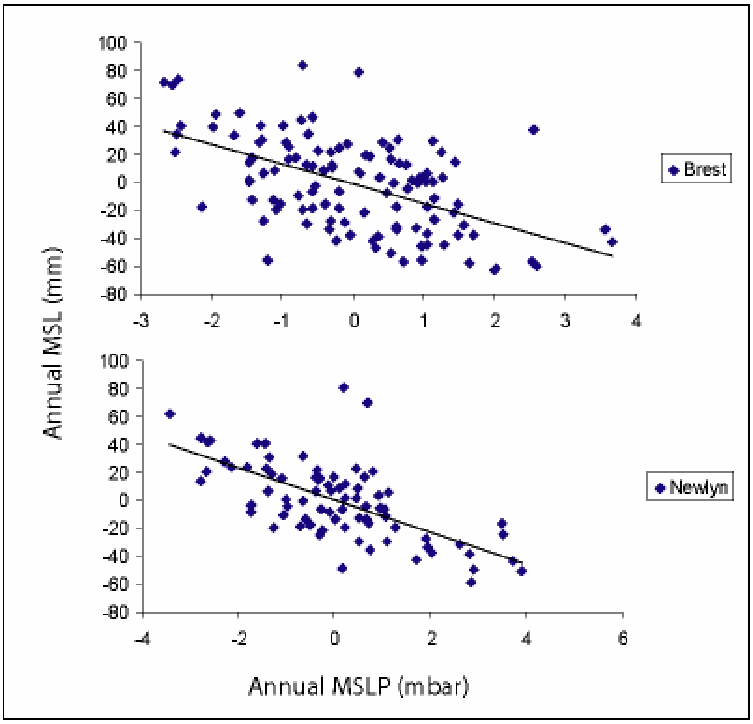


Figure 5.11 Correlation between annual mean sea level and annual MSL pressure (both detrended, over the whole record), for Newlyn and Brest.

The most reliable records, i.e. those with smallest standard errors, indicate collectively that wind effects slightly enhance the effective inverted barometer effect within the

English Channel. Cartwright (1983) found that atmospheric pressure contributed only about 10% to the total annual sea level at Newlyn (for 1915-1980).

The pressure anomalies constituting the **NAO** have a hydrostatic effect on sea level, with an 'inverse barometer' response (as described above). However, there can also be more subtle, but substantial effects of the NAO through surface fluxes and oceanic circulation (Woolf *et al.,* 2003; Hurrell *et al.,* 2003).

The annual sea level dataset, as well for as a winter period have been analysed for correlations with the annual and winter NAO indices (Section 4.5.1). Winter values of both the NAO index and sea level are used, since there is substantial yearly variability for each individual month, as well as monthly variability related to seasonal Northern hemisphere climate variability pattern, i.e., the meridional pressure gradients cause stronger surface (westerly) winds, during winter.

Winter values are computed from the mean December to March data. Records where an entire winter month was unavailable were not considered for the winter correlation. Although the spatial structure of climate variability in the extratropics is strongly seasonally dependent (Wallace *et al.,* 1993), seasonal anomalies, i.e. mean computed over several years representative of the period under consideration, have not been removed. The analysis of the linear response of sea level to the NAO does not consider lagged effects and specific periods where the NAO is known to have greater influence, i.e., the second half of the 20th Century.

Table 5.12 shows the sensitivity of the annual MSL and detrended sea level, to both the annual NAO index and the winter NAO index measured by the slope of the regression line estimated on the assumption that sea level is a linear function of the NAO indices. Once again, the results are erratic, with no apparent regional pattern. Newlyn is the only continuous dataset with a statistically significant trend in both MSL and detrended sea level correlations (Table & Figure 5.12). These correlations with the NAO are negative and consistent with the results obtained by Tsimplis *et al*., (2005); Yan *et al*., (2004); Wakelin *et al*., (2003); and Woolf *et al*., (2003). Sea level tends to decrease with the increase in NAO index values (Figure 5.15).

A negative trend of significance is also found for the MSL correlation at Calais; however, the gaps in the dataset are most certainly the probable cause of such trends. Therefore, following statistically significant results, for this station, are disregarded.

Sea level is generally strongly positively correlated to the NAO in the southeast region of the North Sea. A strong negative correlation is expected in the Baltic and Mediterranean Sea (Tsimplis *et al*., 2005 & Woolf *et al*., 2003). Although not all the results are significant, a positive correlation is found between sea level and the NAO at Dover (closest to the SE North Sea), whilst the remainder of the Channel stations are generally negatively correlated.

The connection between storm events and pressure patterns suggests that the NAO index could be influenced by the increase in storminess. Furthermore, as the sea level meteorological residual signal is forced by sea level pressure and winds and can therefore be used as an estimate of storminess, it seems reasonable to expect a correlation between this and the NAO. This has been investigated considering the annual winter (December-March) non-tidal residual standard deviation and extended winter NAO index. No significant result was found (Table 5.12).

Correlations between the non-hydrostatic sea level (corrected sea level using the inverse barometer effect) and the NAO index (not shown) have also been analysed but showed no significance.

	MSL vs. NAO (mm/unit NAO index)	**Detrended SL vs. NAO** (mm/unit NAO index)	**NTRstd vs. NAO** (mm/unit NAO index)	**Winter NTRstd vs. winter NAO** (mm/unit winter NAO)
Brest	-21.4 ± 11.7	-12.1 ± 6.2	-1.6 ± 2.4	0.4 ± 1.0
Newlyn	*-25.5 ± 12.2*	*-20.9 ± 6.5*	-1.3 ± 2.6	-0.9 ± 1.2
Calais	*-64.2 ± 31.8*	-47.6 ± 32.2	1.7 ± 5.8	*6.0 ± 2.3*
Dover	21.8 ± 13.7	2.4 ± 9.6	*9.4 ± 3.3*	2.4 ± 1.4
Le Havre	-9.6 ± 17.1	-5.7 ± 14.8	*7.5 ± 3.0*	-0.5 ± 2.1
Portsmouth	7.0 ± 14.3	-4.3 ± 12.7	-3.2 ± 3.0	1.7 ± 1.6

Table 5.12 The first column shows the trend between the annual MSL and annual NAO index together with the standard error; the second column shows the trend between annual detrended sea level and annual NAO index; the final 2 columns show the trends between the non-tidal residual standard deviation (NTRstd), i.e., the meteorological component, with the annual NAO index and winter (December-March average) NAO index, respectively. Statistically significant trends are shown in *italics.*

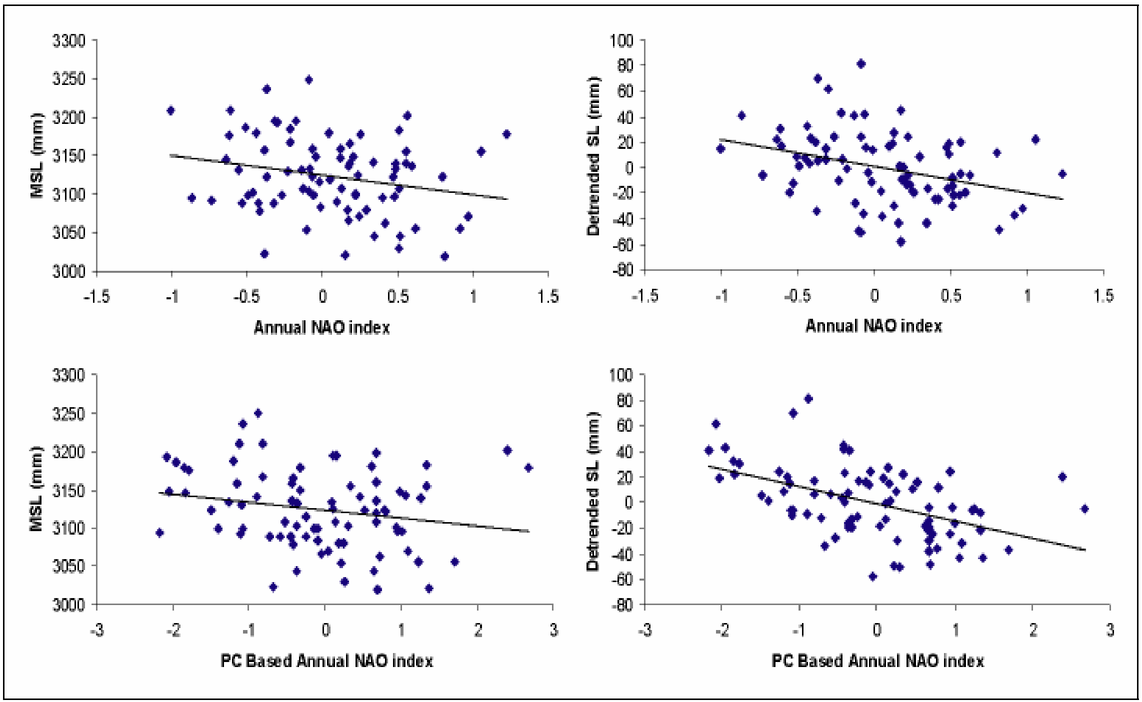


Figure 5.12 Correlation between annual MSL and annual NAO index, for Newlyn. The NAO in the upper graphs are station-based, and PC based in the lower bottom graphs.

As mentioned in Section 4.4.2.b, the use of a station-based index has the disadvantage of being fixed in space, therefore, only capturing the NAO variability for parts of the year, or containing noise created by small-scale meteorological phenomena not related to the NAO (Trenberth, 1984; and Hurrell & van Loon, 1997). Therefore, the correlation between sea levels and Principal Component (PC) based NAO is presented next. Although the PC time-series approach presents a more optimal representation of the full NAO spatial pattern (Hurrell *et al*., 2003) it is, however, based upon gridded sea level pressure data.

Most of the interest behind the use of EOF lies also in its explanation of the maximum variance related to the eigenvectors used. The leading EOFs are expected to represent the strongest patterns of variability. The NAO accounts for more than a third of the total variance in SLP in the North Atlantic, its second EOF generally accounts for about 15% of the total SLP variance, whilst the leading EOF explains 30% of that variance (Hurrell *et al*., 2003).

A PC time-series for the 2nd EOF, calculated from gridded monthly MSLP data from the National Centre for Atmospheric Research (NCAR), was used initially (refer to Section 4.5.1.b) to investigate the NAO influence on sea level. No trends have been found for sea level correlation with the 2nd EOF. However, as the 1st EOF of the Northern

Hemisphere (20º-90ºN) winter SLP data explains 23% of the extended winter mean (December- March) variance and is clearly dominated by the NAO structure in the Atlantic sector (Hurrell *et al*., 2003), a annual and winter PC-based NAO series has been used subsequently to re-examine the previous correlations.

The PC-based NAO indices used here are calculated from seasonal SLP anomalies in the North Atlantic (20º-80ºN, 90ºW-40ºE) between 1890 until 2000, normalised relative to the 1864-1983 period. Normalisation is used in the NAO computation, to avoid the series being dominated by greater variability (Hurrell *et al*., 2003). Both the annual PC-based NAO index and the extended winter PC-based NAO have been obtained from http://www.cgd.ucar.edu/~jhurrell/nao.pc.html. It is important to note that these are constantly being updated, which leads to changes in the base period and normalised period, i.e., accounting for differences between this and other indices that may seem similar. Some differences can occur between results for the station-based NAO indices and the PC-based indices. In the former NAO indices, Gibraltar is considered as the southern centre of action, whilst the PC-based NAO index used here appears as a north –south dipole, with the southern centre of action near the Azores.

The results for this analysis are shown in Table 5.13. Once again, Newlyn show a significant correlation between detrended sea level and the PC-based NAO and, contrary to the previous station based NAO results, also shows a significant negative correlation between the non-tidal residual standard deviation and PC-based NAO. No other trends are of significance. Nevertheless, all of the results, except that of Dover's detrended sea level, maintain the same sign as in station-based results.

	Detrended SL vs. PC-based NAO (mm/unit NAO index)	**NTRstd vs. PC-based NAO** (mm/unit NAO index)	**Winter NTRstd vs. winter PC-based NAO** (mm/unit winter NAO)
Brest	-0.6 ± 3.5	-0.6 ± 1.2	-
Newlyn	*-13.5 ± 2.7*	*-0.3 ± 0.1*	-0.3 ± 1.2
Calais	-8.3 ± 12.5	-0.7 ± 2.1	3.8 ± 2.2
Dover	-2.1 ± 3.6	2.1 ± 1.5	2.0 ± 1.2
Le Havre	-4.0 ± 6.6	1.8 ± 1.5	-0.3 ± 2.3
Portsmouth	-4.0 ± 4.7	-1.8 ± 1.1	2.2 ± 1.5

Table 5.13 Correlations between some sea level components and PC-based NAO index. Winter values correspond to the December to March average. Statistically significant trends are shown in *italics*.

Results from both the station based NAO values and PC-based values suggest that there is a negative sea level response in the English Channel. However, the only significant result found was a negative correlation between annual sea levels and the annual NAO indices. This correlation was greater using the NAO station-based index. However, when using the PC-based NAO, a negative correlation was also found with the non-tidal residual standard deviation. This would suggest that the NAO would contribute towards the meteorological variance in sea level. These results must be interpreted with care, as they represent a simple analysis of a complex problem. However, as mentioned throughout this discussion, these results are consistent with those obtained by other authors.

Extremes

In addition to the consideration of sea level rise in terms of flooding risk, changes in the occurrence (frequency) and amplitude of extremes must also be accounted for. When addressing the subject of extremes, one has to consider whether there is any evidence for an increase in extreme water levels, apart from MSL changes, as well as investigating whether interannual variability in extremes is dependent upon variations in regional climate, often represented by the NAO (Woodworth & Blackman, 2004).

This Section starts by investigating the variability in extremes, by examining trends in annual maximum and annual minimum observed levels. Most studies on extremes concentrate upon maximum levels and disregard minimum levels. The latter have been included as, together with maximum levels, they provide an indication of the tidal range variation. An investigation into the possible influence of variations in the regional climate, on maximum extreme sea level variability and maximum non-tidal (meteorological) residual levels, will follow.

Estimated annual maximum and minimum values have been calculated, based upon the hourly sea level data analysed. Results for both MSL maximum and minimum values, as well as non-tidal residual maximum and minimum values, are shown in Tables 5.14 & 5.15. Results relative to the mean level are presented as reduced levels. They have been calculated by subtracting the mean value for the entire data series, from each yearly value. This approach removes any common signal, i.e., MSL change or errors in the datum, enabling us to understand if the forcing mechanisms behind these extreme levels are the same as those of MSL.

Annual maximum and minimum observed values have increased significantly at Brest and Newlyn. However, these trends are not found when those values are reduced. Portsmouth's maximum level has also increased significantly. Other trends of significance are in the annual minimum at Dover, where there is an increase and at Le Havre, where there is a decrease. None of these trends exist when their value has been reduced, suggesting that MSL is the responsible mechanism behind these results.

Trends in observed sea level (mm yr^{-1})					
	Annual max.	**Reduced annual max.**	**Annual min.**	**Reduced annual min**	**Reduced Winter max.**
Brest	*1.15 ± 0.39*	-0.04 ± 0.32	*1.43 ± 0.33*	0.07 ± 0.26	-0.19 ± 0.31
Newlyn	*1.77 ± 0.48*	-0.17 ± 0.39	*1.48 ± 0.53*	-0.09 ± 0.42	-0.30 ± 0.43
Calais	-2.14 ±3.14	*-5.87 ± 2.51*	-1.11 ± 2.49	3.06 ± 1.66	-4.92 ± 3.27
Dover	1.10 ± 3.54	-3.06 ± 2.95	*3.80 ± 1.87*	1.57 ± 1.74	0.86 ± 2.70
Le Havre	3.12 ± 2.10	2.34 ± 1.70	*-0.85 ±0.08*	-2.03 ± 2.02	1.24 ± 1.61
Portsmouth	*4.91 ± 2.19*	2.87 ± 1.79	1.66 ± 1.51	0.89 ± 1.24	1.06 ± 1.65

Table 5.14 Trends in the observed sea level annual maximum and minimum. Statistically significant trends are shown in *italics*.

Reduced winter (December-March) maximum sea level trends (Table 5.14) have been estimated to check whether the increase in storminess during this season of the year would have any influence on these results. No trends have been identified.

This hypothesis is investigated further using the non-tidal (meteorological) residual standard deviation values (Table 5.15). Only 2 trends of significance are found, both for annual minimum values at Le Havre and Portsmouth. Le Havre also has a trend in the minimum annual sea level.

Although this type of analysis has shown some trends with significance, it can only be taken as a first approach, as a maximum or minimum level in a year, taken from an hourly series, may represent an error if the record has not been rigorously edited. Whilst these data have been edited, these results (based upon hourly extreme values) still cannot represent the increase in the frequency of occurrence of such levels, as well as, their influence by storm surge type events, which occur over timescales of hours to days.

This issue is resolved using a more robust percentile time-series analysis (refer to Section 4.5.1c), the results of which, are given in Figure 5.13 and Tables 5.16 - 5.18.

Trends in non-tidal standard deviation (mm yr^{-1})			
	Annual max.	**Annual min.**	**Winter average max.**
Brest	0.15 ± 0.57	0.11 ± 0.55	0.05 ± 0.20
Newlyn	-0.50 ± 0.44	0.37 ± 0.27	-0.47 ± 0.26
Calais	-7.69 ± 3.92	2.93 ± 5.30	1.54 ± 2.11
Dover	2.34 ± 3.78	-1.01 ± 3.68	2.31 ± 2.05
Le Havre	-2.22 ± 4.06	*7.56 ± 1.94*	-2.19 ± 2.86
Portsmouth	1.90 ± 2.01	*6.75 ± 2.51*	-1.91 ± 1.33

Table 5.15 Trends in the NTRstd (meteorological) annual maximum and minimum. Statistically significant trends are shown in *italics*.

All the results show significant interannual variability. Trends in all the percentiles for observed sea levels at Brest and Newlyn are significant and positive, i.e., maximum and minimum levels tend to increase. The only non-significant positive trend at Dover is for the 0.1 percentile. Portsmouth has a trend with significance for the 95 percentile.

Reduced percentile levels have been calculated by removing the median (50th percentile) of the distribution, from each individual year. When reduced, the 5 and 1 percentile at Newlyn and 99 percentile at Dover are the only trends which continue to show significance. Although the trend at Dover continues to be positive, showing a tendency towards an increase in higher sea levels, the values for the lower percentiles for Newlyn now show a decrease. This pattern seems consistent with the results obtained for the Newlyn sea level standard deviation. This suggests that other mechanisms, apart from MSL, are influencing these specific levels.

Significant trends in the non-tidal residual standard deviation have been found, mostly in the lower percentiles. Of these, Brest and Dover are negative, i.e., there is a tendency for the minimum levels to increase. The significant trend for the 95 percentile at Portsmouth shows a decrease, suggesting a reduction in the frequency of those levels.

As trends have been found in the reduced and non-tidal residual standard deviation percentiles, which suggest some other influence besides MSL, those percentile were correlated with annual NAO station-based index, to investigate possible influences.

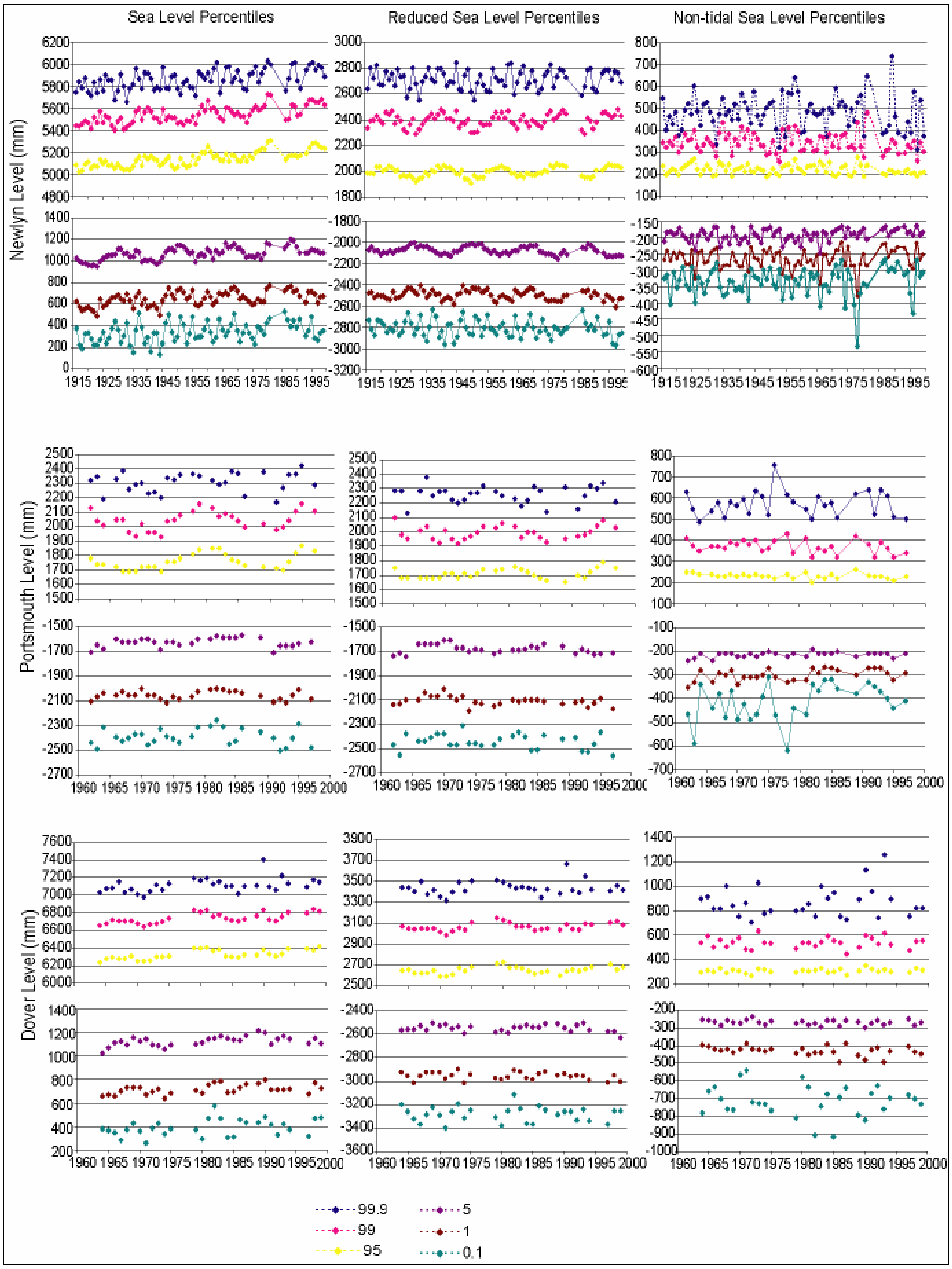


Figure 5.13a Percentile levels (99.9, 99 and 95, in upper graphs, and 5, 1 and 0.1, in lower graphs) for: observed sea level (left); reduced sea levels, i.e., relative to the corresponding median of each year (centre); and non-tidal residual (meteorological) standard deviation (right) for 3 English stations. Refer to Tables 5.16 - 5.18, for trend values.

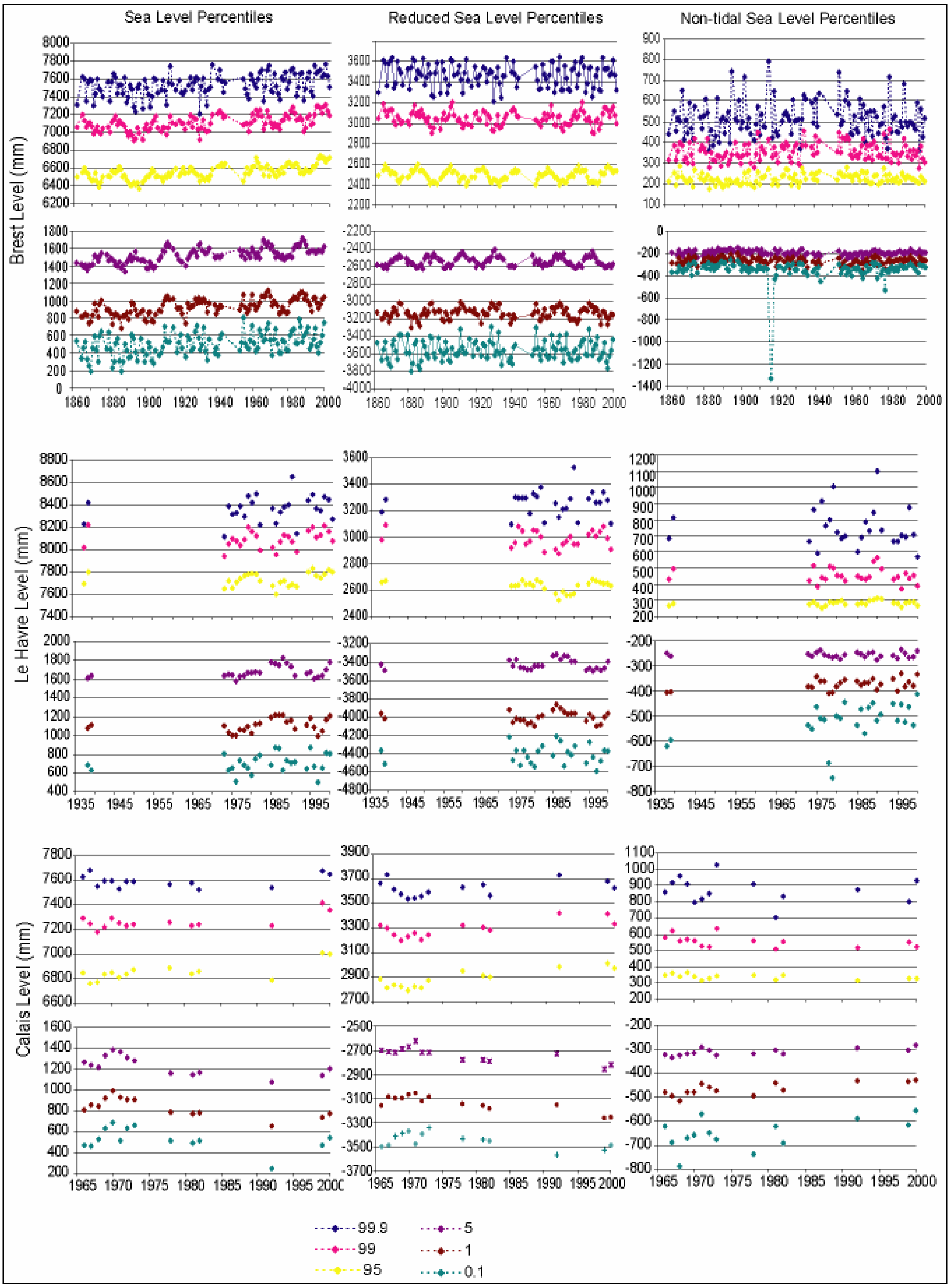


Figure 5.13b Percentile levels (99.9, 99 and 95, in upper graphs, and 5, 1 and 0.1, in lower graphs) for: observed sea level (left); reduced sea levels, i.e., relative to the corresponding median of each year (centre); and non-tidal (meteorological) residual standard deviation (right) for 3 French stations. Refer to Tables 5.16 - 5.18, for trend values.

	Trends in observed sea level percentiles (mm yr^{-1})					
	99.9	**99**	**95**	**5**	**1**	**0.1**
Brest	*1.06 ± 0.26*	*1.17 ± 0.17*	*1.19 ± 0.14*	*1.28 ± 0.14*	*1.35 ±0.17*	*1.36 ± 0.26*
Newlyn	*1.99 ± 0.37*	*2.10 ± 0.27*	*2.10 ± 0.21*	*1.38 ± 0.23*	*1.39 ± 0.27*	*1.30 ± 0.41*
Calais	*0.82 ± 1.26*	*3.34 ± 1.14*	*4.52 ± 1.26*	*-5.26 ± 1.72*	*-5.63 ± 1.58*	-4.00 ± 2.50
Dover	*3.29 ± 1.29*	*3.61 ± 0.77*	*3.38 ± 0.67*	*1.89 ± 0.61*	*1.69 ± 0.65*	2.17 ± 1.19
Le Havre	1.59 ± 1.53	0.58 ± 1.03	0.61 ± 0.78	1.43 ± 0.80	1.19 ± 0.92	1.36 ± 1.30
Portsmouth	1.08 ± 1.18	1.80 ± 1.12	*2.24 ± 0.90*	0.37 ± 0.68	-0.04 ± 0.65	0.17 ± 1.20

Table 5.16 Trends in observed sea level percentile (99.9, 99, 95, 5, 1 and 0.1). Statistically significant trends are shown in *italics*. Refer to Figure 5.13, for plots.

	Trends in reduced sea level percentiles (mm yr^{-1})					
	99.9	**99**	**95**	**5**	**1**	**0.1**
Brest	-0.21 ± 0.25	-0.10 ± 0.15	-0.08 ± 0.11	0.00 ± 0.12	0.08 ± 0.15	0.09 ± 0.25
Newlyn	0.18 ± 0.34	0.30 ± 0.23	0.30 ± 0.17	*-0.43 ± 0.17*	*-0.41 ± 0.20*	-0.50 ± 0.37
Calais	1.81 ± 1.52	*4.32 ± 1.16*	*5.50 ± 0.85*	*-4.28 ± 0.97*	*-4.65 ± 0.82*	*-3.02 ± 1.32*
Dover	0.94 ± 1.17	*1.25 ± 0.60*	1.03 ± 0.58	-0.46 ± 0.52	-0.67 ± 0.55	-0.19 ± 1.14
Le Havre	0.44 ± 1.30	-0.57 ± 0.80	-0.55 ± 0.55	0.28 ± 0.76	0.04 ± 0.82	0.21 ± 1.36
Portsmouth	-0.14 ±1.09	0.58 ± 0.86	1.02 ± 0.59	-0.85 ± 0.64	-1.26 ± 0.64	-1.06 ± 1.11

Table 5.17 Trends in reduced sea level percentile (99.9, 99, 95, 5, 1 and 0.1), i.e., annual median has been removed. Statistically significant trends are shown in *italics*. Refer to Figure 5.13, for plots.

	Trends in non-tidal standard deviation percentiles (mm yr^{-1})					
	99.9	**99**	**95**	**5**	**1**	**0.1**
Brest	0.0 ± 0.2	-0.1 ± 0.1	0.1 ± 0.1	*-0.1 ± 0.0*	-0.1 ± 0.1	-0.1 ± 0.2
Newlyn	-0.1 ± 0.4	-0.3 ± 0.2	-0.2 ± 0.1	*0.2 ± 0.1*	0.1 ± 0.1	0.1 ± 0.2
Calais	-1.1 ± 2.0	-1.5 ± 0.8	*-0.7 ± 0.3*	*0.9 ± 0.3*	*1.8 ± 0.4*	*2.8 ± 1.4*
Dover	1.4 ± 2.2	0.0 ± 0.8	0.4 ± 0.3	-0.3 ± 0.2	*-0.9 ± 0.4*	-0.9 ± 1.5
Le Havre	-0.6 ± 1.7	-0.3 ± 0.6	0.2 ± 0.2	-0.0 ± 0.1	*0.7 ± 0.3*	*2.4 ± 0.9*
Portsmouth	0.1 ± 1.1	-0.9 ± 0.5	*-0.5 ± 0.2*	0.3 ± 0.2	*1.1 ± 0.4*	*2.7 ± 1.3*

Table 5.18 Trends in NTRstd (meteorological) sea level percentile (99.9, 99, 95, 5, 1 and 0.1). Statistically significant trends are shown in *italics*. Refer to Figure 5.13, for plots.

The reduced sea level 99.9 percentile at Dover is the only result with strong positive influence, with significance (Table 5.19). Of the trends found in the non-tidal percentile residuals only the 1 and 0.1 percentiles at Portsmouth correlate with the NAO index. The 5 to 0.1 non-tidal residual percentiles, at this station, decrease with increasing NAO index values. The larger percentile levels at Le Havre show significant influence. Levels increase with increasing NAO index values. Dover 95 levels increase with increasing NAO index values, whilst the 5 level decreases.

Reduced Sea level percentiles vs. NAO index (mm / NAO index)						
	99.9	**99**	**95**	**5**	**1**	**0.1**
Brest	27.0 ± 21.4	10.4 ± 12.9	2.4 ±9.9	-5.9 ± 10.3	-2.6 ± 12.6	-0.5 ± 21.5
Newlyn	-9.7 ± 18.3	-4.8 ± 12.6	-10.6 ± 9.1	0.8 ± 9.3	-1.2 ± 11.1	17.9 ± 19.6
Calais	68.0 ± 34.0	*78.3 ± 34.8*	61.3 ± 40.3	-41.2 ± 36.4	-34.5 ± 37.1	-59.1 ± 34.7
Dover	*51.6 ± 25.5*	10.5 ± 14.8	8.1 ± 14.0	-6.2 ± 12.0	6.6 ± 13.0	25.6 ± 25.9
Le Havre	26.5 ± 43.3	-29.4 ± 25.2	-34.2 ± 17.1	16.5 ± 25.1	1.2 ± 27.6	11.6 ± 45.0
Portsmouth	-30.3 ± 23.4	-7.3 ± 19.0	-13.5 ± 13.4	-14.0 ± 14.2	-15.8 ± 14.7	5.0 ± 24.8

Table 5.19 Correlation between reduced sea level percentiles and the annual NAO index. Statistically significant trends are shown in *italics*.

Non-tidal standard deviation percentiles vs. NAO index (mm / NAO index)						
	99.9	**99**	**95**	**5**	**1**	**0.1**
Brest	21.1 ± 16.0	9.7 ± 8.1	5.3 ± 4.5	1.2 ± 3.8	2.5 ± 5.5	21 .0± 19.2
Newlyn	14.4 ± 20.2	10.0 ± 11.3	5.2 ± 5.9	7.0 ± 4.8	5.9 ± 7.4	7.3 ± 11.0
Calais	-11.1 ± 49.1	-1.8 ± 22.6	-0.5 ± 9.5	-0.2 ± 9.1	14.1 ± 16.0	17.0 ± 38.1
Dover	10.2 ± 50.3	30.4 ± 17.2	*19.3 ± 6.0*	*-16.6 ± 4.8*	-20.2 ± 10.2	-31.4 ± 34.9
Le Havre	*123.0 ± 49.2*	*55.7 ± 16.6*	*15.7 ± 5.5*	-8.3 ± 4.6	-8.5 ± 8.8	3.9 ± 32.2
Portsmouth	13.2 ± 23.6	-14.6 ± 12.0	-5.7 ± 5.0	*9.6 ± 4.0*	*20.9 ± 8.9*	*64.3 ± 28.2*

Table 5.20 Correlation between NTRstd (meteorological) percentiles and the annual NAO index. Statistically significant trends are shown in *italics*.

5.3 The Iberian Peninsula

The approach used to investigate sea level variability in the English Channel (Section 5.2) is applied here to the sea level time series from 5 stations located on the Atlantic coast of the Iberian Peninsula, together with Ceuta, a station located in the Mediterranean to the south of Gibraltar (Figure 5.14).

No editing was carried out on the data from the Spanish stations (Santander, Coruña, Vigo and Ceuta). However, the data for the Portuguese stations (Cascais and Aveiro) have been edited (explained in Section 4.5.1a).

The data from the Spanish stations are almost continuous. The data which pose more problems, for reliable results in long-term trends, are that of Ceuta. Analysis of data from this station showed that they were generally very 'noisy' throughout, with spikes that are not real and with some other errors (tidal signal in residuals). Significant outliers were found in the M2 amplitude and phase. These could only be explained by the poor quality of the data. Tidal signals with very large amplitudes, as well as non-tidal signal with considerable noise, were some of the other errors associated with large amplitudes. These would explain the large standard deviation values found in the analysis. As such, Ceuta is used only as a reference and it is suggested that the data be edited, in order to reduce the errors and improve the statistics, if further analysis of these data are to be considered.

Figure 5.14 Location of the tide gauges on the Iberian Peninsula from which data have been analysed: Santander, Coruña, Vigo and Ceuta (Spain); and Cascais and Aveiro (Portugal).

The trend in MSL shows an increase at all stations, which is of significance at the northern Spanish stations where the trends are largest (Table 5.21 and Figure 5.15). The trend at Coruña is below 2 mm yr^{-1}, in contrast to those which have been found at the other northern Spanish stations. The MSL increase at Vigo is the largest out of all the Iberian stations analysed.

Marcos *et al*. (2005) have, very recently, estimated trends using the same Santander, Coruña and Vigo datasets, which have resulted in trends of 2.06, 1.46 and 2.62 ± 0.05 mm yr^{-1}, respectively. These trends are based upon the unedited analysis of daily average data and the error corresponds to the standard deviation, estimated from a boot strap method (refer to Marcos *et al*., 2005). These results are reasonably consistent with the results of the present study.

The trend identified at Cascais is not within the 1.3 ± 0.1mm yr^{-1} estimate, based on monthly data for the longer dataset dating back to 1880 (Dias & Taborda, 1992; 1988). These authors have estimated a 1.7 ± 0.2mm yr^{-1} trend, considering the 1920-1987 period, which is also larger than what was obtained here considering the 1960-1994 period. However, the results of these investigators show that MSL is approximately 2100mm between 1880-1940, increasing to a level just above 2150mm considering 1960-1995. Furthermore, the trend for this latter period is much smaller than that of 1880-1940. Therefore, the difference between the trends can be explained by the different periods of data considered in their computation. This result provides an example of how the amount of data available/analysed influences the estimated trends. On the other hand, it also questions whether the MSL used in any coastal projection might be incorrectly estimated. The small trend obtained at Cascais is more consistent with what would be expected for the Mediterranean, seen here when comparing Cascais to Ceuta.

	Trend (mm/yr)	**Standard error**
Santander	2.18	0.36
Coruña	1.38	0.31
Vigo	2.62	0.33
Aveiro	1.15	0.68
Cascais	0.43	0.38
Ceuta	0.37	0.23

Table 5.21 MSL, for the Iberian Peninsula and Ceuta ports.

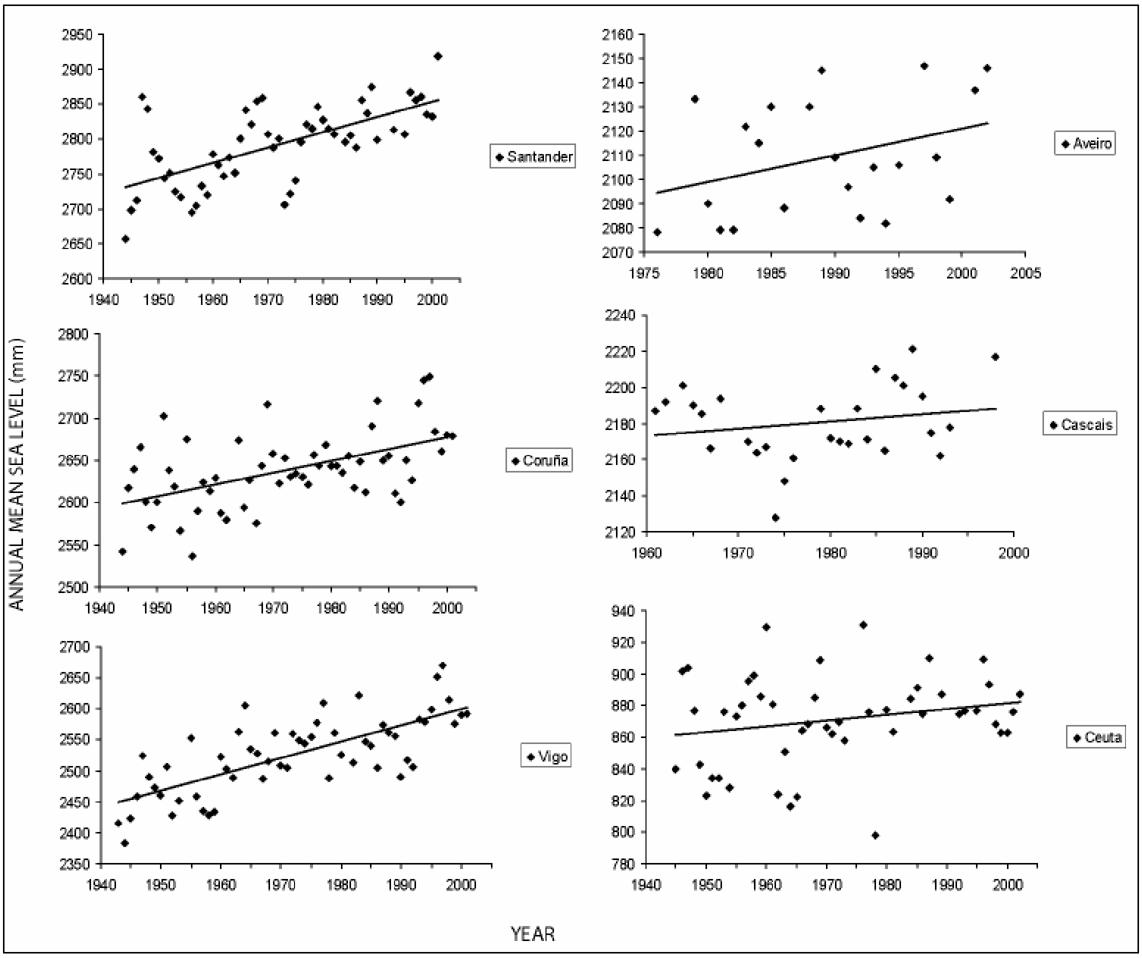


Figure 5.15 Trends in annual MSL for stations located on the Iberian Peninsula and Ceuta (North Africa). See Figure 5.14, for locations.

The observed sea level standard deviations, listed in Table 5.22, show positive trends at all the stations with large standard errors. These trends are only significant at Aveiro and Cascais. The observed sea level standard deviation in Figure 5.16, for Aveiro, shows a considerable increase in level around 1985. This increase peaks between 1995 and 2000 and, subsequently, starts to fall. This result is likely to be related to the change in the tidal prism at the inlet of the Lagoon, where the tide gauge is located (refer to Section 3.2.1 and Chapter 6, for further discussion). The result for Cascais is considered to be associated to changes in the area adjacent to the tide gauge site, as a result of the construction of a pier in 1997, and subsequently, the start of the construction work for a Marina. Although there are some gaps in the dataset in the late 1990s in the Cascais record, Figure 5.16 shows a clear increase in the observed sea level standard, deviation after 1990.

	Trend (mm/yr)	Standard error
Santander	0.38	0.21
Coruña	0.27	0.16
Vigo	0.04	0.14
Aveiro	3.59	0.46
Cascais	0.66	0.31
Ceuta	0.04	0.04

Table 5.22 Total observed sea level standard deviation, for the Iberian Peninsula and Ceuta ports.

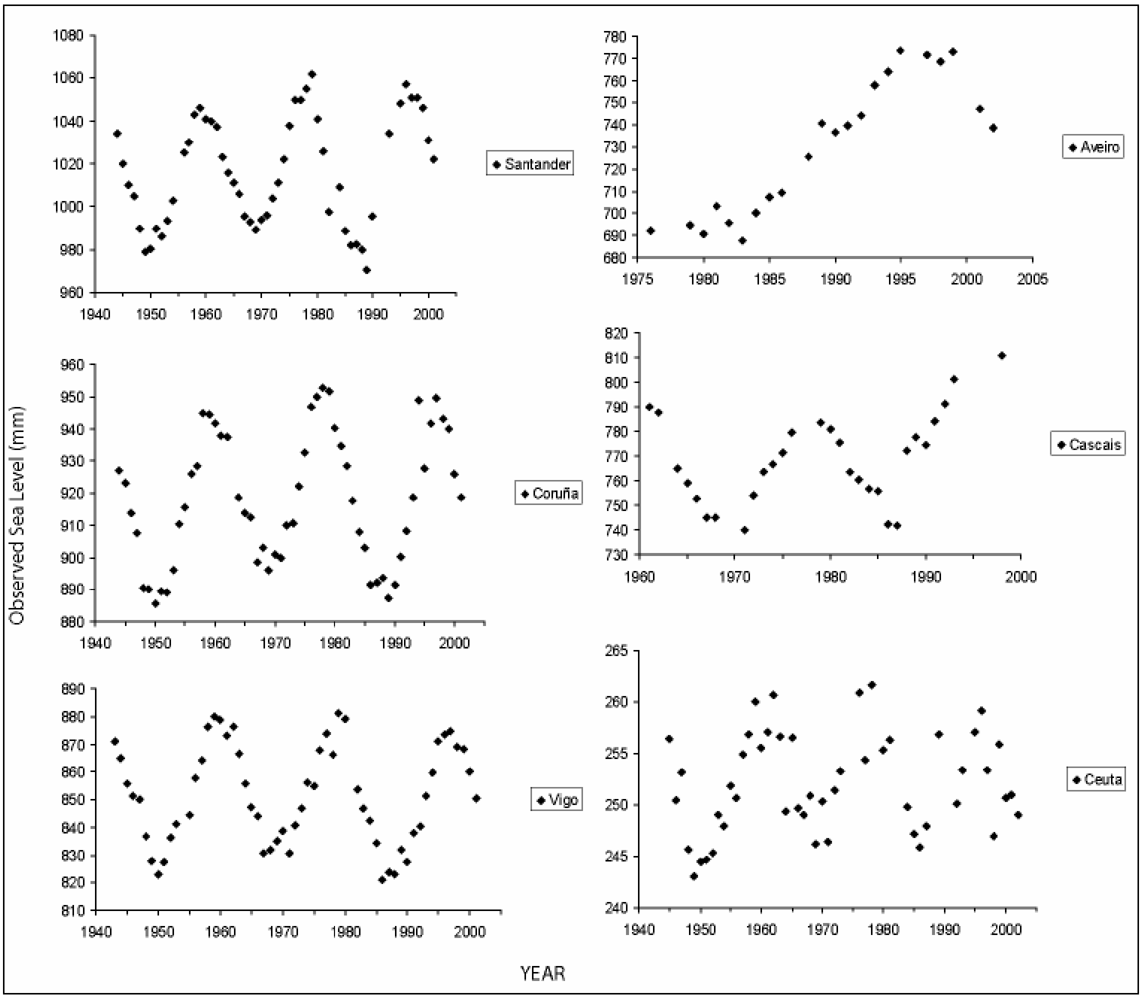


Figure 5.16 Observed sea level standard deviation, for the Iberian Peninsula and Ceuta ports.

Data from all stations show considerable interannual variability, dominated by the 18.6-year cycle (Figure 5.16). A nodal cycle was fitted to the data, using a linear model (Section 5.2). The trends in the fit are positive, with the exception of Vigo and Ceuta where the values are slightly negative (Table 5.23). The percentages of the nodal amplitude are below the 3.7% theoretical value, for variations about the mean. With the exception of Aveiro, all the other nodal phases are fairly consistent with the expected value. The result for Aveiro might be related to the short data series used in the fit computation. The values obtained for the nodal amplitude are generally smaller than those found for the English Channel stations (Section 5.2).

Station	Trend, a_2 (mm/yr)	H_{nodal} (mm)	φ_{nodal} (º)	% H_{nodal}
Santander	0.05	33.5	82.3	3.3
Coruña	0.00	27.4	76.3	3.0
Vigo	-0.12	24.5	70.0	2.9
Aveiro	3.44	17.4	11.9	2.4
Cascais	0.74	21.3	63.1	2.8
Ceuta	-0.02	5.1	71.5	2.0

Table 5.23 Values from the regression fit to the sea level standard deviation results. All the nodal phases, φ_{nodal}, have been calculated up to 1900, for the Iberian Peninsula and Ceuta ports.

The results for the tidal constituents are based upon the M_2 results; however, values of trends in another 4 components (S_2, M_4, MS_4 and Sa) are also presented (amplitude and phase for all other constituents are listed in Appendix A4). Trends of significance are found in the M_2 amplitude and phase, at Cascais and Aveiro (Table 5.24 and Figures 5.17 & 5.18). The reason for these trends is the same as explained for the observed sea level. The amplitude at Vigo and the phase at Coruña have, respectively, a negative and positive trend of significance.

There are abrupt peaks, corresponding to a sudden decrease in amplitude between 1980 and 1990, at Santander. Peaks are also found in the phase between these dates which correspond to an increase. The peaks in amplitude at Coruña do not coincide with those seen in the phase. Ceuta shows a sudden decrease in amplitude and phase, between 1995 and 2000. These peaks were checked for errors. The reason for these sudden changes is not known; however, the quality of the dataset is not believed to explain such large variations. Further research into the history of the tide gauge might further the understanding of such changes. For instance, the increase in amplitude and decrease in phase at Santander could be associated to changes in bathymetry in the area, as in the case of Aveiro.

	M_2 Amplitude		M_2 Phase	
	Trend (mm/yr)	Standard error	Trend (°/yr)	Standard error
Santander	0.01	0.08	0.03	0.02
Coruña	0.05	0.04	0.06	0.01
Vigo	-0.17	0.03	0.01	0.01
Aveiro	4.52	0.61	-0.09	0.03
Cascais	1.06	0.25	-0.03	0.01
Ceuta	-0.03	0.02	0.01	0.01

Table 5.24 Trends in M_2, for the Iberian Peninsula and Ceuta ports (refer to Figure 5.17 & 5.18).

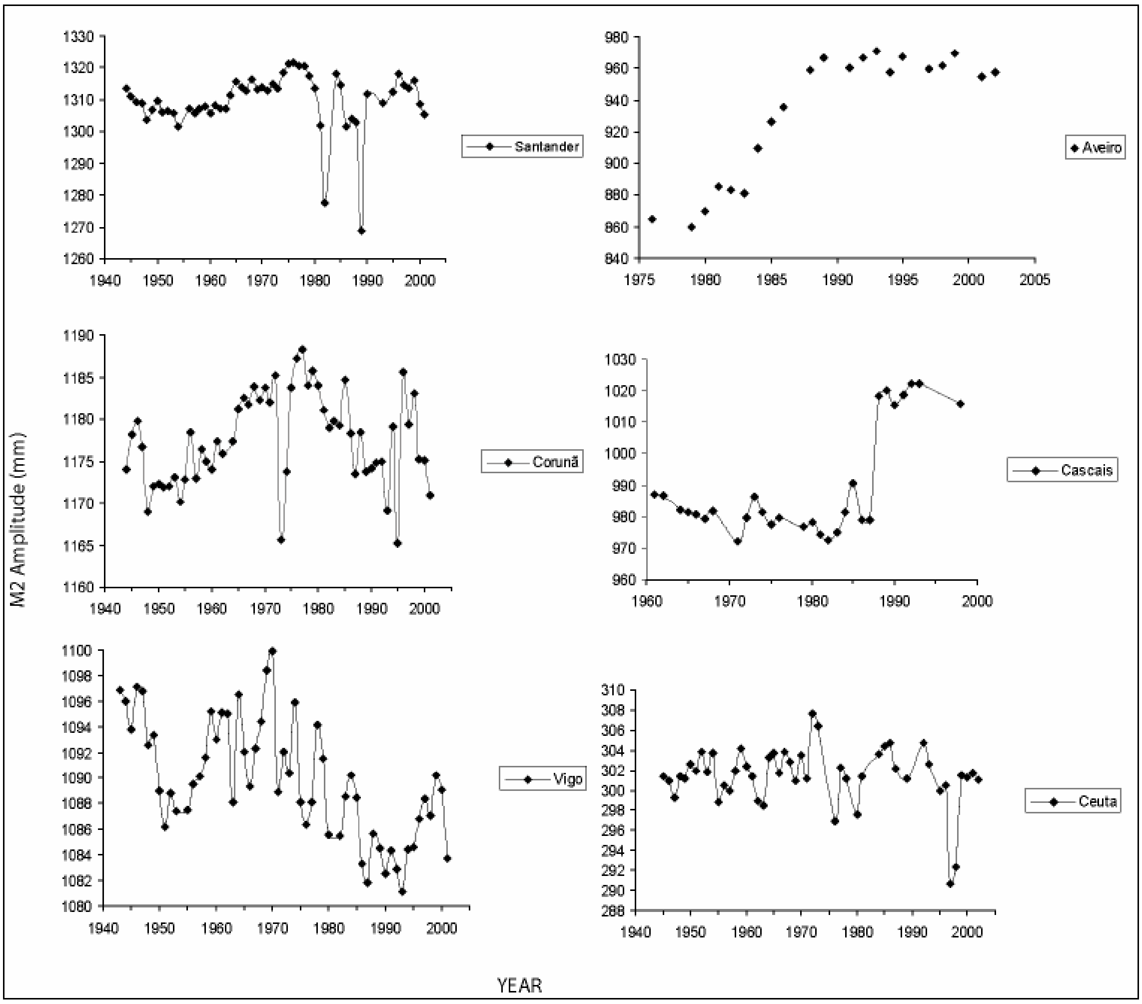


Figure 5.17 M_2 amplitude for the Iberian Peninsula and Ceuta ports. See Figure 5.14, for locations (refer to Table 5.24, for trends).

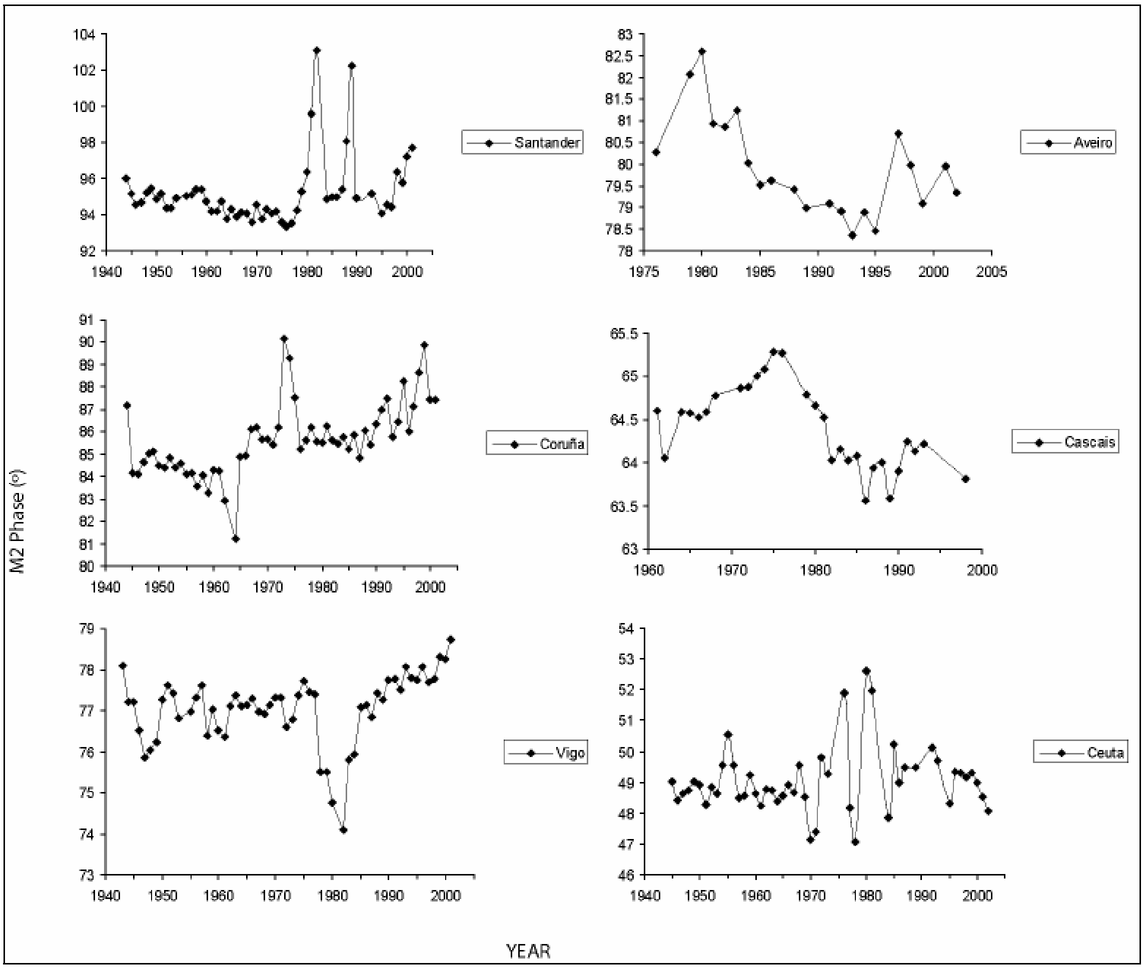


Figure 5.18 M_2 phase for the Iberian Peninsula and Ceuta ports. See Figure 5.14, for the locations (refer to Table 5.24, for trends).

A brief mention is made now to the trends of significance found for S_2, M_4, MS_4 and Sa tidal constituents. The amplitude and phase trend values for these constituents, together with their standard error, are given in Tables 5.25 - 5.28.

The S_2 tide has negative trends in amplitude, whilst it is positive in phase. A considerable positive trend at Aveiro is the only other significant trend in this constituent (Table 5.26). The higher harmonic M_4 tide (Table 5.27) shows a significant decrease in amplitude and phase at Santander, likewise, in phase at Aveiro. A positive increase is found in amplitude and phase at Cascais, and in phase at Vigo. The MS_4 amplitude at Coruña decreases, whilst at Ceuta, it increases (Table 5.28). The trend in phase at Santander is positive and it is negative at Aveiro. The only other trend of significance in the tidal constituents analysed corresponds to an increase in Sa amplitude at Vigo (Table 5.29).

	S_2 Amplitude		S_2 Phase	
	Trend (mm/yr)	Standard error	Trend (º/yr)	Standard error
Santander	-0.10	0.04	0.06	0.02
Coruña	-0.10	0.03	0.08	0.01
Vigo	-0.22	0.03	0.04	0.01
Aveiro	1.54	0.25	-0.05	0.03
Cascais	0.11	0.25	0.01	0.01
Ceuta	-0.03	0.01	0.04	0.01

Table 5.25 Trends in principal semidiurnal solar tide, S_2, for the Iberian Peninsula and Ceuta.

	M_4 Amplitude		M_4 Phase	
	Trend (mm/yr)	Standard error	Trend (º/yr)	Standard error
Santander	-0.07	0.01	-0.17	0.04
Coruña	-0.00	0.01	-0.16	0.10
Vigo	0.01	0.01	0.37	0.06
Aveiro	0.00	0.11	-1.21	0.18
Cascais	0.24	0.01	0.34	0.15
Ceuta	-0.02	0.01	0.03	0.03

Table 5.26 Trends in M_4 tide, for the Iberian Peninsula and Ceuta.

	MS_4 Amplitude		MS_4 Phase	
	Trend (mm/yr)	Standard error	Trend (º/yr)	Standard error
Santander	-0.03	0.02	0.28	0.10
Coruña	-0.06	0.01	-0.17	1.19
Vigo	-0.00(2)	0.01	-1.23	1.20
Aveiro	0.06	0.07	-0.96	0.18
Cascais	0.09	0.03	0.11	0.20
Ceuta	-0.02	0.01	-0.02	0.03

Table 5.27 Trends in MS_4 tide, for the Iberian Peninsula and Ceuta.

	Sa Amplitude		Sa Phase	
	Trend (mm/yr)	Standard error	Trend (º/yr)	Standard error
Santander	0.06	0.21	0.07	0.35
Coruña	-0.01	0.22	-0.14	0.49
Vigo	0.67	0.24	0.71	0.49
Aveiro	1.21	0.71	0.81	1.56
Cascais	0.10	0.33	-0.90	0.65
Ceuta	0.20	0.14	-0.07	0.36

Table 5.28 Trends in Sa tide, for the Iberian Peninsula and Ceuta.

No results with any significance exist in the non-tidal (meteorological) residual standard deviation (Table 5.29). Although there are positive trends along the northern Spanish coast, together with negative trends for the western Iberian coast and Ceuta (Table 5.29 and Figure 5.19), these have very high standard errors, most likely associated to the scatter in the data.

	Trend (mm/yr)	Standard error
Santander	0.09	0.07
Coruña	0.17	0.09
Vigo	0.03	0.10
Aveiro	-0.65	0.34
Cascais	-0.25	0.15
Ceuta	-0.05	0.06

Table 5.29 Trend in non-tidal residual standard deviation, for the Iberian Peninsula and Ceuta.

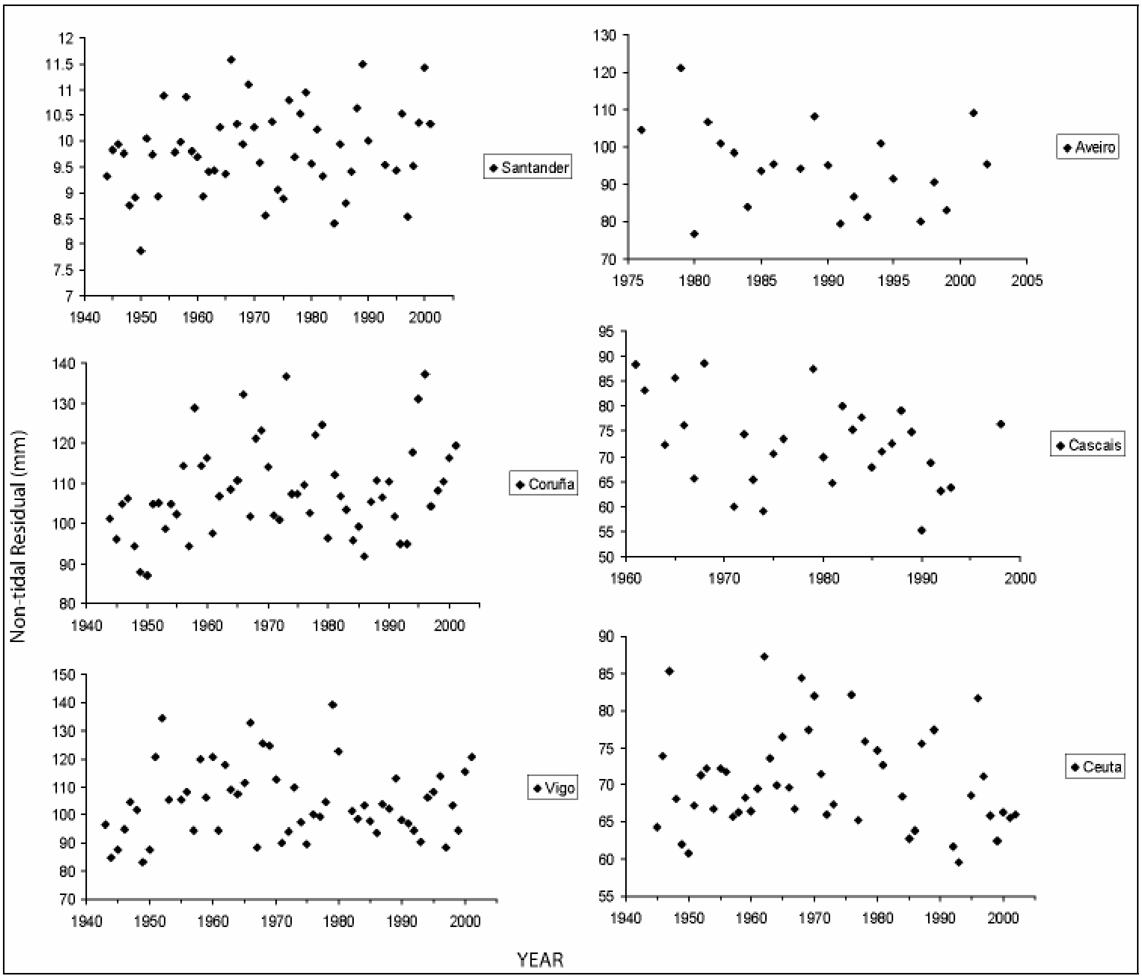


Figure 5.19 Non-tidal (meteorological) residual standard deviation, for the Iberian Peninsula and Ceuta.

Forcing

Table 5.30 lists the relationship between the detrended annual MSL and the detrended annual MSLP. As in the results found in the English Channel (Section 5.2), there is a negative correlation between the two, showing higher air pressures to be associated with lower MSL. The regression values deviate from the simple 'inverted barometer' -10mm per mbar value. This deviation has been attributed to the additional effect of wind which may also explain why Coruña, Vigo and Aveiro have statistically significant trends which are greater than those found in the English Channel.

	Trend (mm/mbar)	**Standard error**
Santander	-14.02	4.91
Coruña	-18.12	3.44
Vigo	-23.43	5.11
Aveiro	-20.17	5.60
Cascais	-8.98	4.65
Ceuta	-12.39	5.48

Table 5.30 Correlation between the annual MSL pressure and the annual MSL (both detrended, over the entire record), for the Iberian Peninsula and Ceuta.

The influence of the **NAO** on sea level has been investigated and the results obtained are shown in Tables 5.31 & 5.32. All the correlations with the station-based NAO show a negative trend. Significance was found between MSL and detrended sea levels and the NAO, for all North Spanish stations. The non-tidal residual standard deviation at Coruña and Vigo also show significance with the NAO (Figure 5.20). PC-based results are in agreement with these results and also reveal a significant result between the non-tidal winter residual standard deviation and the winter PC-based NAO index (Figure 5.21). Higher NAO indices are generally related to lower sea levels and NTRstd (Figures 5.20-5.22). Only the results for Coruña and Vigo have been plotted, as they are the only stations where sea level and NTRstd are both influenced by the NAO.

Interestingly, winter sea levels for all the Spanish stations, including Ceuta, reveal a significant correlation with the winter station-based NAO index (Table 5.33 & Figure 5.22). The values listed in Table 5.33, for Vigo, Coruña, and Santander, lie within the range of those found by Woolf *et al*., (2003). The result for Ceuta (Table 5.33) is lower than that obtained with satellite, by the use of the short (1992-2001) data series.

Other significant results related to the NTRstd are regarded with some suspicion as, in most cases, they are the only significant correlation found. Therefore, they are most likely to be related to the quality of the data, especially since they are found mostly in the NTRstd correlations (e.g. Aveiro and Ceuta).

	MSL vs. NAO (mm/unit NAO index)	**Detrended SL vs. NAO** (mm/unit NAO index)	**NTRstd vs. NAO** (mm/unit NAO index)	**Winter NTRstd vs. winter NAO** (mm/unit winter NAO)
Santander	*-35.6 ± 17.0*	*-18.4 ± 13.3*	-3.5 ± 2.5	-0.5 ± 1.2
Coruña	*-47.4 ± 11.3*	*-44.1 ± 9.5*	*-10.2 ± 3.2*	-0.3 ± 1.7
Vigo	*-40.7 ± 15.4*	*-38.4 ± 11.4*	*-10.6 ± 3.4*	-1.0 ± 1.2
Aveiro	-14.7 ± 10.7	-13.4 ± 10.0	-1.6 ± 5.7	*-4.4 ± 1.8*
Cascais	-6.0 ± 8.0	-8.0 ± 7.8	-1.3 ± 3.3	-1.4 ± 1.4
Ceuta	-12.3 ± 9.2	-9.0 ± 9.0	*-5.4 ± 2.0*	-0.5 ± 0.7

Table 5.31 The first column shows the trend between the annual MSL and annual NAO index, with the standard error; the second column shows the trend between annual detrended sea level and annual NAO index; the final 2 columns shows the trends between the non-tidal residual standard deviation (NTRstd), i.e., the meteorological component, with the annual NAO index and the winter (December-March average) NAO index, respectively. Statistically significant trends are presented in *italics.*

	Detrended SL vs. PC based NAO (mm/unit NAO index)	**Non-tidal residual std vs. PC based NAO** (mm/unit NAO index)	**Winter NTRstd vs. winter PC NAO** (mm/unit winter NAO)
Santander	*-11.2 ± 5.3*	-1.4 ± 1.0	-0.5 ± 1.2
Coruña	*-15.8 ± 4.1*	*-3.9 ± 1.3*	*-4.0 ± 1.8*
Vigo	*-12.2 ± 4.7*	*-6.0 ± 1.3*	-0.4 ± 1.2
Aveiro	-4.3 ± 4.5	-1.4 ± 2.5	1.8 ± 2.7
Cascais	-	*-0.1 ± 0.0*	2.1 ± 1.3
Ceuta	-	*-0.1 ± 0.0*	-0.2 ± 0.7

Table 5.32 Correlations between some sea level components and PC-based NAO index. Winter values correspond to the December to March average. Statistically significant trends are shown in *italics*.

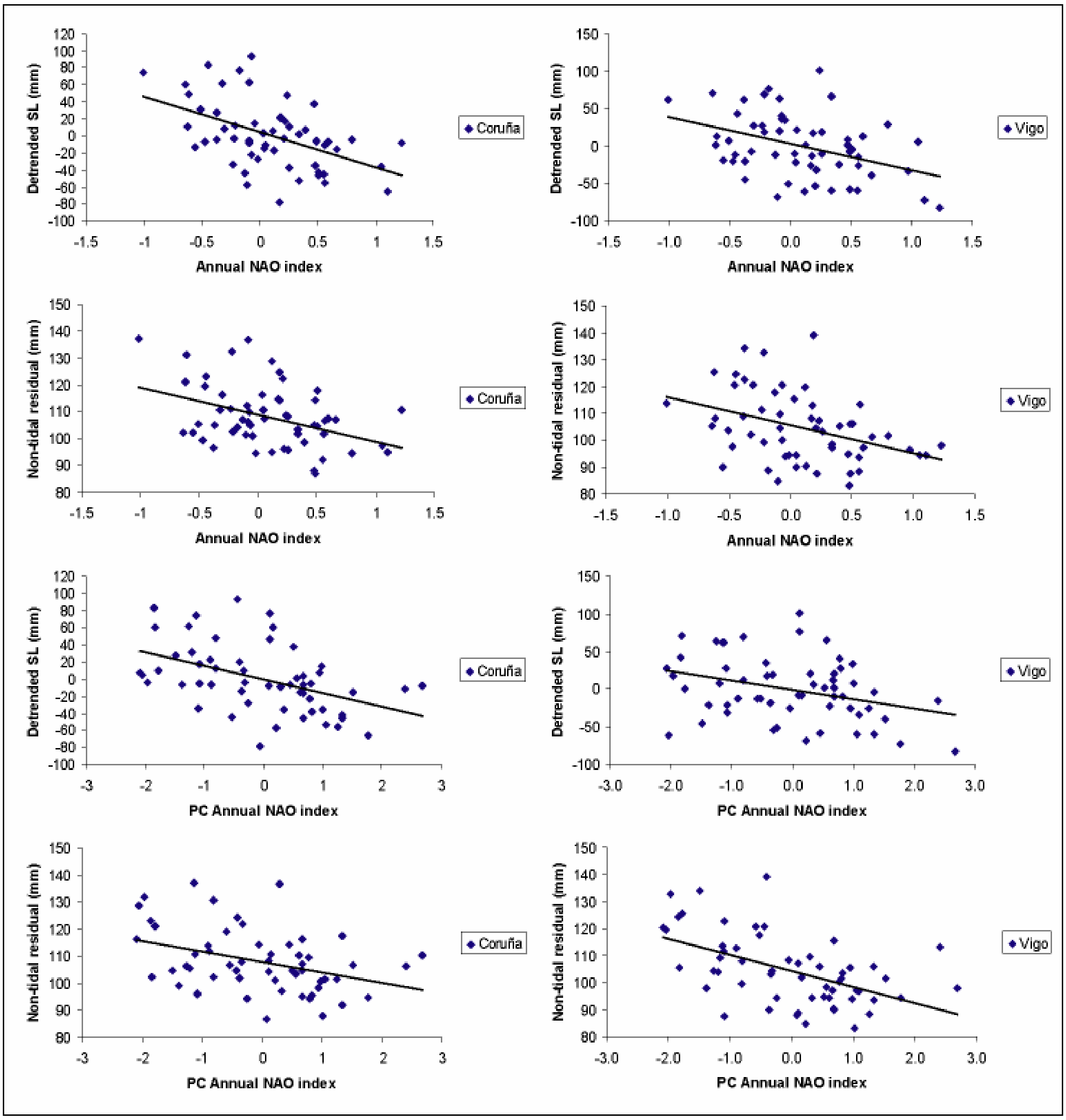


Figure 5.20 Correlation between detrended sea level and non-tidal residual standard deviation (NTRstd), with Annual NAO station-based index (upper 4 graphs) and the PC-based NAO index (lower 4 graphs), for Coruña (left) and Vigo (right) stations in the North of Spain (refer to Table 5.32).

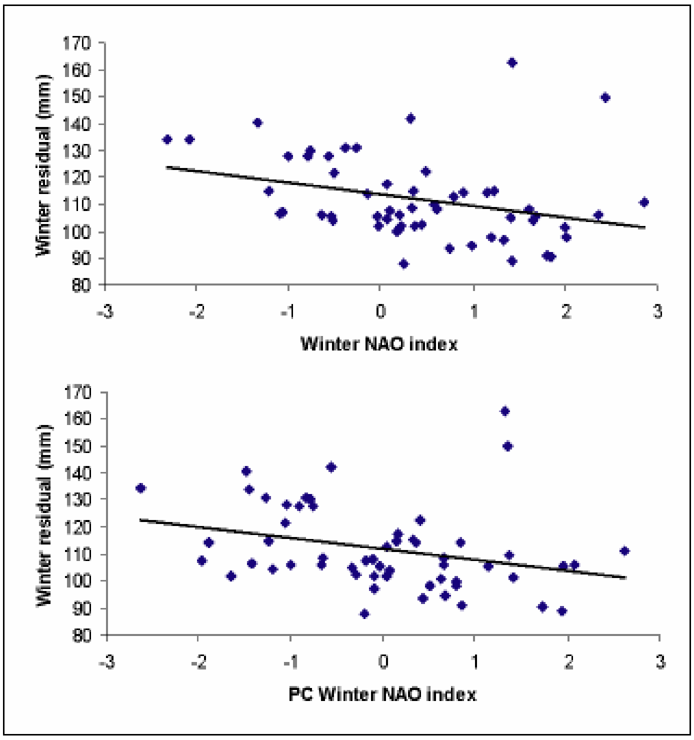


Figure 5.21 Correlation between the winter non-tidal residual standard deviation and the winter NAO index (station-based NAO in the upper graph and PC-based NAO in the lower graph) found for Coruña.

Winter SL vs. winter NAO (mm/unit winter NAO index)	
Santander	*-20.1 ± 9.0*
Coruña	*-30.0 ± 6.8*
Vigo	*-26.6 ± 9.2*
Ceuta	*-13.4 ± 4.7*

Table 5.33 Correlation between the winter (December - March mean) sea level data and the winter NAO index (December - March mean), found at Spanish stations. The trend for Ceuta is believed to be a consequence of the data quality, i.e., not due to the NAO´s influence on sea level.

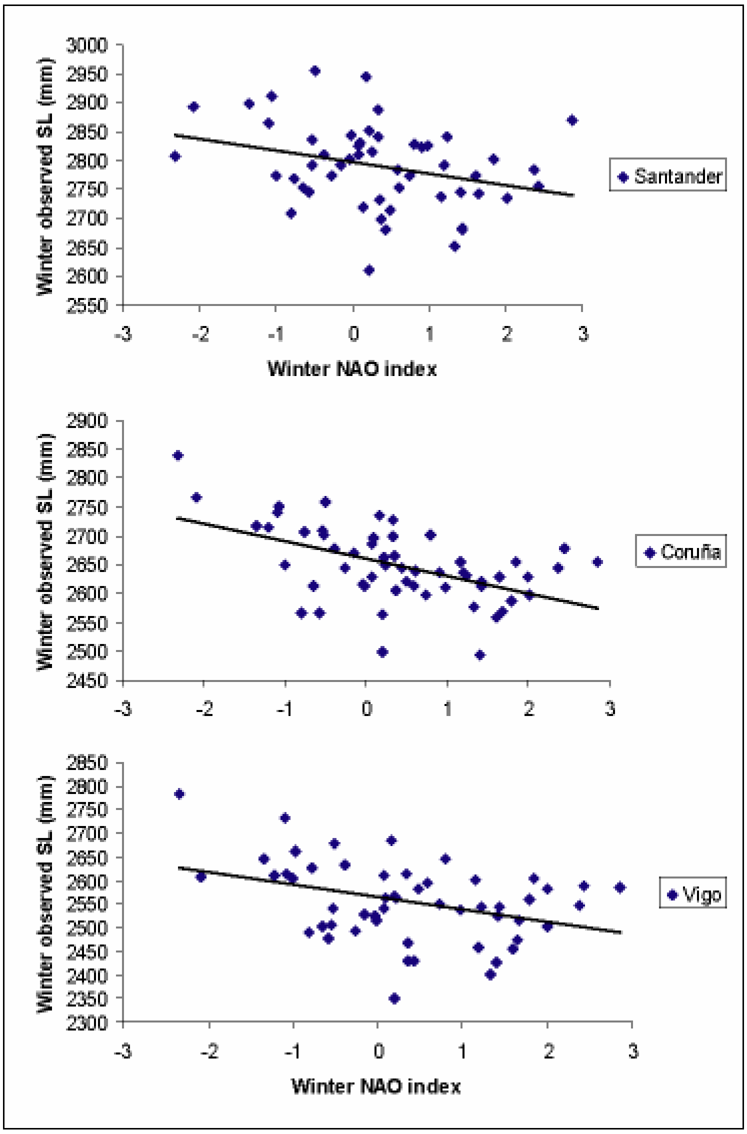


Figure 5.22 Correlation between the winter observed sea level and winter the NAO index (station-based) at the Northern Spain stations.

Overall, the results found are not unexpected, as the largest amplitude anomalies have been found to occur in the vicinity of Iceland and across the Iberian Peninsula (Hurrell *et al*., 2003). This also explains the larger trends obtained for the Iberian Peninsula, compared to those found for the English Channel. Furthermore, sea levels in the North Atlantic and in the Mediterranean Sea are strongly influenced by the NAO, with positive correlations in North Europe (Scandinavia until the North Sea) and negative southwards of the North Sea (Woolf *et al*., 2003). The present results for the Iberian Peninsula confirm those of Fenoglio-Marc *et al.* (2004), of a negative correlation between sea level and the NAO index, with higher correlation when the winter months were considered. These correlations are of significance in the Northern Spanish region, with Coruña showing the strongest response to the NAO index. These results are in disagreement with those of Woolf *et al*. (2003). However, the data of these authors is not directly comparable, as it covered a different period and includes hydrostatic pressure adjustments.

Extremes

The editing carried out on the English Channel hourly data series showed that a lack of quality in some of the series would have a large effect on the investigation of extreme levels. This is an important observation in relation to data which is collected and is not processed/edited, as such, it is important to the results which are presented below.

Although maximum and minimum annual values of unedited data are the most susceptible to errors, these results are still presented; however, more emphasis will be placed upon the results based on the percentile values. The 99-percentile level, which represents approximately 87 hours per year, should be less affected by measurement errors and, therefore, be less problematic than the 99.9 percentile (approximately 8 hours). Furthermore, inaccuracies in the data should affect the low percentiles in a symmetric way to high percentiles (Woodworth & Blackman, 2002).

Annual maximum and minimum trends of significance exist at Aveiro and Cascais (Table 5.34). The result at Aveiro was expected, following the results discussed previously for the sea level and tidal components. These are considered to be associated to changes within the area in which these gauges are located. Whilst the maximum level, at both stations, tends to increase, there is also a decrease in the minimum level.

The characteristics found for Aveiro has been described previously (Section 4.7.1), as a possible consequence of increased depth in a channel connected to a basin. The gauge at Aveiro is located within such a channel; however, it is interesting to identify the same result for Cascais, where the gauge is exposed to the open Ocean. Therefore, it appears that this pattern may be related to an increase in tidal range, as the MSL increases, allowing low water to fall further below the increasing mean, as the harbours dry out. Such characteristics have already been identified at Newlyn (Section 5.2; and *Araújo et al.,* 2001).

The only other trends of significance are for reduced annual maximum levels at Ceuta and reduced annual minima at Vigo. The result obtained for Vigo suggests a possible meteorological influence, as a correlation has been found here between sea level and the NAO index. The result obtained for Ceuta may be related to the quality of the dataset. The percentile analysis, which will follow, should provide a more reliable result.

No trend of significance is found, in the maximum and minimum values of the NTRstd levels (Table 5.35), except for the annual minimum at Ceuta. This once again, can be attributed to the quality of the data.

	Trend in observed sea level (mm yr^{-1})				
	Annual max.	**Reduced annual max.**	**Annual min.**	**Reduced annual min**	**Reduced Winter max.**
Santander	1.18 ± 1.00	-0.31 ± 0.75	1.55 ± 0.90	-1.01 ± 0.75	-1.97 ± 1.77
Coruña	1.11 ± 0.86	0.45 ± 0.69	1.44 ± 0.86	-0.40 ± 0.67	0.40 ± 0.89
Vigo	2.21 ± 1.13	0.18 ± 0.86	2.77 ± 0.64	*2.51 ± 0.89*	-0.42 ± 0.73
Aveiro	*10.06 ± 3.96*	-0.32 ± 3.07	*-10.05 ± 2.60*	-2.65 ± 2.66	-0.28 ± 3.40
Cascais	*3.67 ± 1.87*	1.12 ± 1.32	*-3.64 ± 1.38*	-1.67 ± 1.28	0.44 ± 1.24
Ceuta	-0.61 ± 0.56	*-0.87 ± 0.40*	0.61 ± 0.46	0.01 ± 0.38	-0.38 ± 0.32

Table 5.34 Trends in the observed sea level annual maximum and minimum. Statistically significant trends are shown in *italics*.

	Trend in NTRstd (mm yr^{-1})		
	Annual max.	**Annual min.**	**Winter max.**
Santander	1.05 ± 1.58	-1.80 ± 0.84	0.09 ± 0.56
Coruña	1.50 ± 0.65	-1.27 ± 0.75	-0.04 ± 0.41
Vigo	-0.37 ± 0.65	-0.61 ± 0.38	0.62 ± 0.44
Aveiro	0.89 ± 5.42	1.08 ± 0.95	1.92 ± 1.95
Cascais	-0.90 ± 1.34	-0.47 ± 2.21	-0.97 ± 0.87
Ceuta	-0.69 ± 0.55	*1.38 ± 0.63*	*-0.78 ± 0.29*

Table 5.35 Trends in the annual non-tidal residual standard deviation (meteorological) maximum and minimum. Statistically significant trends are shown in *italics*.

More robust results (Table 5.36 - 5.38 & Figure 5.23), for extreme levels at these stations, are provided through percentile analysis of the data. Observed sea level percentile trends (Table 5.36 & Figure 5.23) are, with few exceptions, of significance at most stations and for most percentile values. The most striking exception is the fact that no trends of significance exist at Ceuta. All the positive trends in the higher and lower percentile values are believed to be associated to increase in sea level. This is confirmed by the absence of any significant trends in the reduced sea level percentiles (Table 5.37 & Figure 5.23). However, an exception is found at Aveiro, where positive and negative trends have been found for higher and lower percentiles, respectively. This result reinforces what has already been discussed about this station.

When analysing the NTRstd component of the sea level signal, no trends of significance have been found. Interestingly, some trends of significance have been found in the lower percentile values of the NTRstdl at Santander and Coruña (Table 5.38 & Figure 5.23). These trends suggest a decrease in the occurrence of lower sea levels (negative surge). For Santander, the decrease is found for all the lower percentiles (5, 1 and 0.1). At Coruña, it is of significance only for the 5-percentile.

	Trend in observed sea level percentiles (mm yr^{-1})					
	99.9	**99**	**95**	**5**	**1**	**0.1**
Santander	*1.98 ± 0.85*	*2.30 ± 0.60*	*2.28 ± 0.54*	*1.72 ± 0.60*	*1.90 ± 0.69*	*1.97 ± 0.78*
Coruña	1.13 ± 0.65	*1.40 ± 0.44*	*1.62 ± 0.40*	*0.94 ± 0.40*	*1.18 ± 0.47*	*1.28 ± 0.61*
Vigo	*2.08 ± 0.75*	*2.25 ± 0.50*	*2.55 ± 0.45*	*2.39 ± 0.36*	*2.52 ± 0.42*	*2.49 ± 0.57*
Aveiro	*10.36 ± 2.41*	*8.55 ± 1.49*	2.07 ± 1.05	*-4.54 ± 1.66*	*-6.30 ± 1.66*	*-7.75 ± 1.94*
Cascais	*3.17 ± 1.35*	*2.37 ± 0.92*	*1.64 ± 0.71*	-0.45 ± 0.64	*-1.61 ± 0.79*	*-3.61 ± 1.00*
Ceuta	0.20 ± 0.41	0.39 ± 0.30	0.47 ± 0.28	0.32 ± 0.27	0.47 ± 0.28	0.56 ± 0.36

Table 5.36 Trends in observed sea level percentiles (99.9, 99, 95, 5, 1 and 0.1). Statistically significant trends are shown in *italics*. Refer to Figure 5.23, for plots.

	Trend in reduced sea level percentiles (mm yr^{-1})					
	99.9	**99**	**95**	**5**	**1**	**0.1**
Santander	-0.01 ± 0.76	0.31 ± 0.50	0.29 ± 0.42	-0.27 ± 0.38	-0.09 ± 0.47	-0.01 ± 0.60
Coruña	-0.15 ± 0.61	0.12 ± 0.37	0.34 ± 0.25	-0.34 ± 0.27	-0.10 ± 0.33	0.00 ± 0.50
Vigo	-0.60 ± 0.67	-0.42 ± 0.35	-0.13 ± 0.24	-0.28 ± 0.21	-0.15 ± 0.31	-0.18 ± 0.47
Aveiro	*10.03 ± 2.15*	*8.22 ± 1.25*	*6.73 ± 1.11*	*-4.87 ± 1.08*	*-6.64 ± 1.34*	*-8.08 ± 2.02*
Cascais	0.36 ± 0.65	0.35 ± 0.40	0.37 ± 0.24	-0.14 ± 0.25	-0.13 ± 0.36	-0.93 ± 0.58
Ceuta	-0.11 ± 0.34	0.08 ± 0.18	0.16 ± 0.10	0.01 ± 0.10	0.151 ± 0.13	0.24 ± 0.27

Table 5.37 Trends in reduced sea level percentiles (99.9, 99, 95, 5, 1 and 0.1), i.e., the annual median has been removed. Statistically significant trends are shown in *italics*. Refer to Figure 5.23, for plots.

	Trend in non-tidal residual standard deviation percentiles (mm yr^{-1})					
	99.9	**99**	**95**	**5**	**1**	**0.1**
Santander	-0.14 ± 0.62	0.15 ± 0.31	0.19 ± 0.15	-0.36 ± 0.15	-0.94 ± 0.33	-1.58 ± 0.60
Coruña	0.56 ± 0.48	0.22 ± 0.32	0.24 ± 0.17	-0.39 ± 0.16	-0.49 ± 0.25	-0.52 ± 0.37
Vigo	-0.09 ± 0.59	-0.06 ± 0.34	0.08 ± 0.20	-0.18 ± 0.17	-0.38 ± 0.30	-0.51 ± 0.35
Aveiro	-1.60 ± 5.04	0.73 ± 1.29	-0.11 ± 0.97	0.44 ± 0.49	0.15 ± 0.83	0.27 ± 0.84
Cascais	-0.34 ± 1.11	-0.30 ± 0.57	-0.41 ± 0.32	0.14 ± 0.26	-0.12 ± 0.37	-0-05 ± 0.66
Ceuta	-0.16 ± 0.32	0.04 ± 0.20	-0.11 ± 0.12	-0.01 ± 0.11	0.09 ± 0.15	0.28 ± 0.29

Table 5.38 Trends in NTRstd (meteorological) percentiles (99.9, 99, 95, 5, 1 and 0.1). Statistically significant trends are shown in *italics*. Refer to Figure 5.23, for plots.

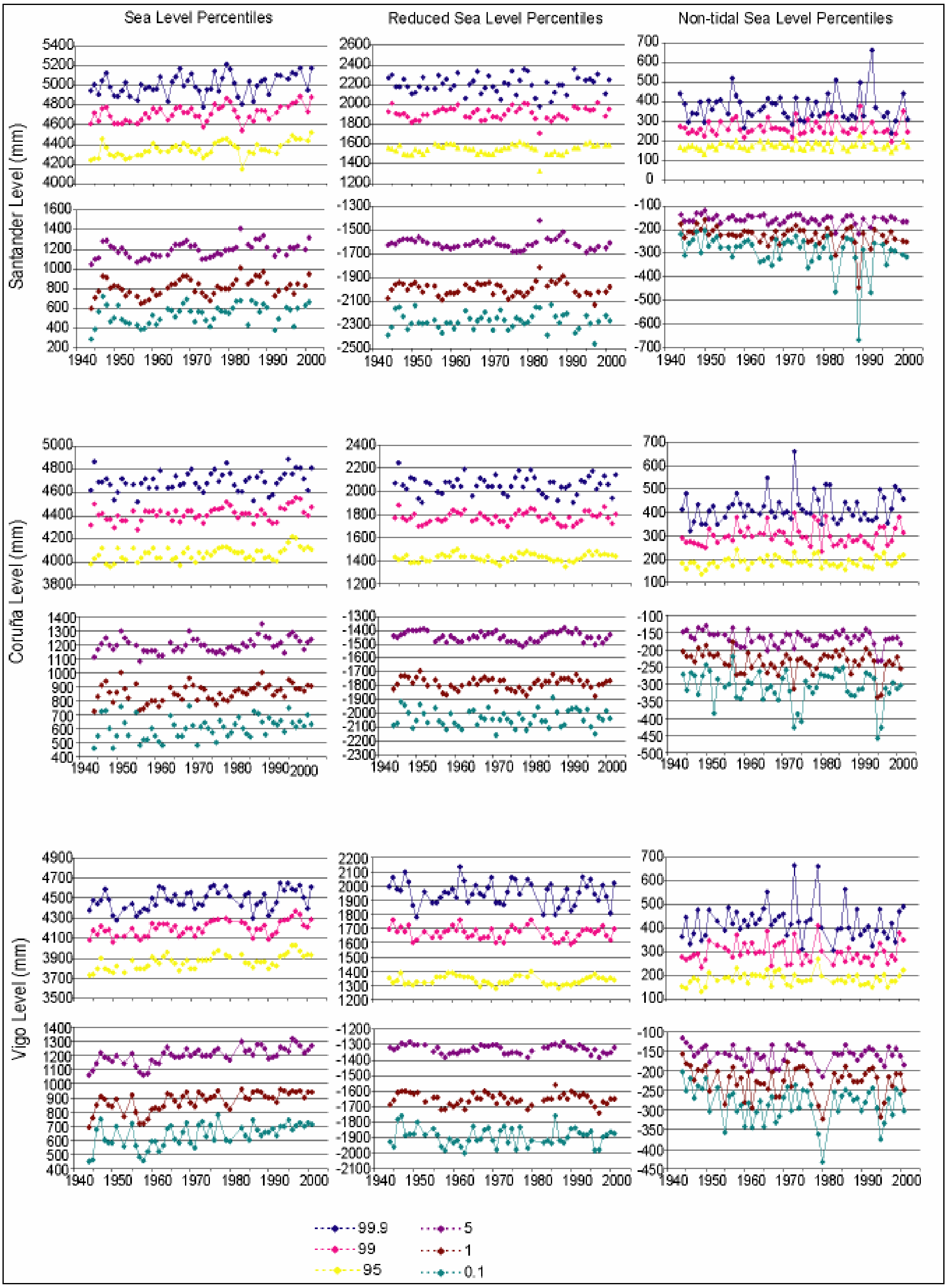


Figure 5.23a Percentile levels (99.9, 99 and 95 in upper graphs, and 5, 1 and 0.1 in lower graphs) for: observed sea level (left); reduced sea levels, i.e., relative to the corresponding median of each year (centre); and non-tidal standard deviation (right) for Santander, Coruña and Vigo.

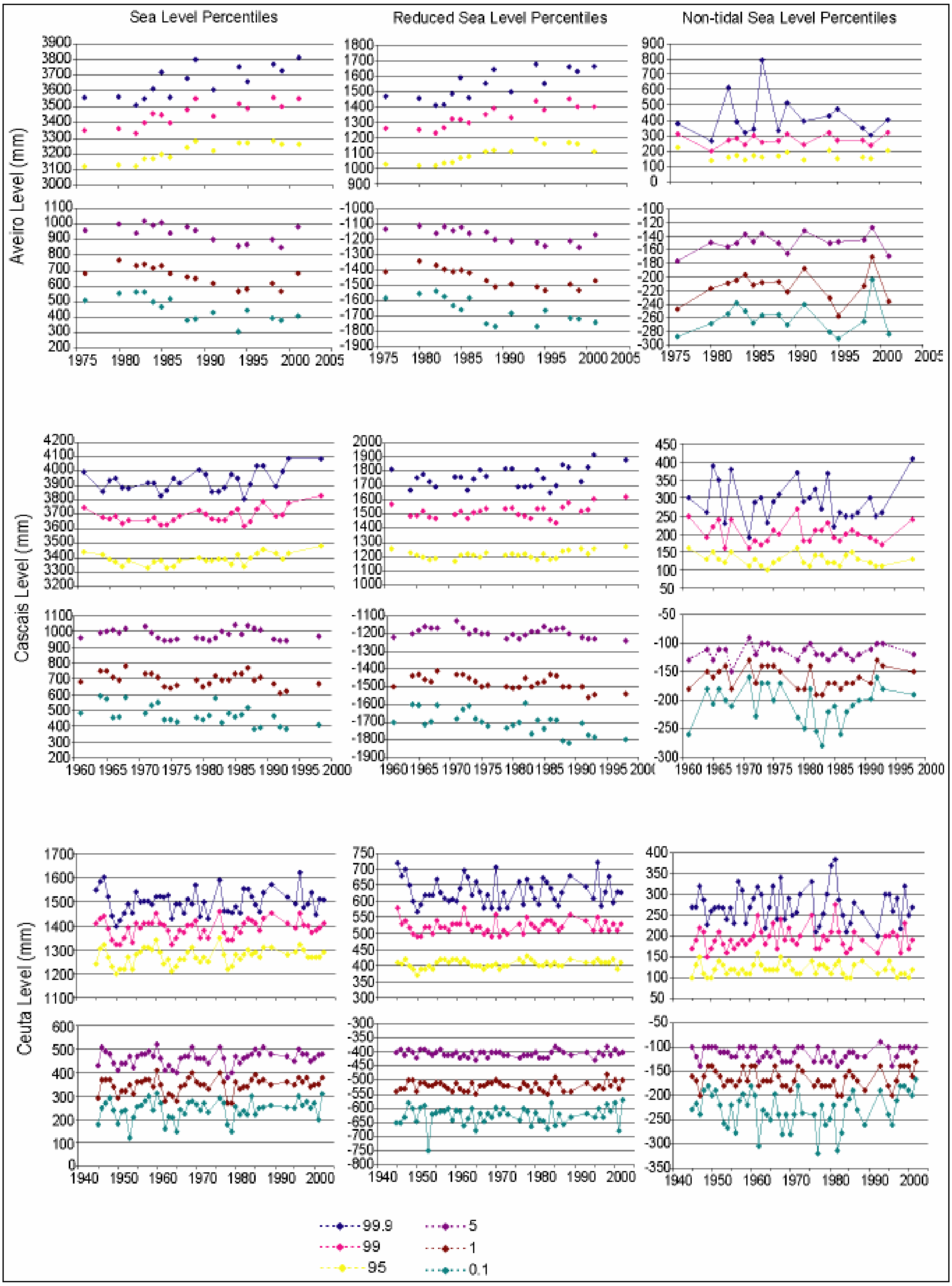


Figure 5.23b Percentile levels (99.9, 99 and 95 in upper graphs, and 5, 1 and 0.1 in lower graphs) for: observed sea level (left); reduced sea levels, i.e., relative to the corresponding median of each year (centre); and non-tidal residual standard deviation (right) for Aveiro, Cascais and Ceuta.

Forcing

Annual values of reduced sea level percentiles and NTRstd percentiles are now examined, in terms of their correlation, to the annual NAO index to investigate for possible influences. Results for the reduced sea level correlation with the NAO (Table 5.39) show that only the 5 and 1-percentiles at Cascais have a trend of significance. All the other trends have very high standard errors.

Trends in reduced sea level percentiles vs. annual NAO index (mm / NAO index)						
	99.9	**99**	**95**	**5**	**1**	**0.1**
Santander	-23.2 ± 28.0	-14.0 ± 18.8	-18.8 ± 15.6	17.1 ± 14.1	21.5 ± 17.3	20.8 ± 22.2
Coruña	-23.2 ± 21.8	-0.9 ± 13.4	-9.7 ± 9.3	9.3 ± 9.9	11.6 ± 11.8	25.4 ± 17.8
Vigo	-12.3 ± 24.4	-3.6 ± 13.0	-12.7 ± 8.6	6.1 ± 7.8	20.0 ± 10.8	21.8 ± 16.9
Aveiro	-37.6 ± 59.3	-9.5 ± 44.5	-3.8 ± 37.2	-15.3 ± 29.3	1.3 ± 39.0	17.5 ± 51.5
Cascais	16.2 ± 29.6	19.2 ± 18.3	17.1 ± 11.1	*-30.1 ± 9.9*	*-34.7 ± 15.1*	-23.8 ± 27.6
Ceuta	2.7 ± 13.9	2.2 ± 7.4	-2.5 ± 4.0	2.2 ± 3.9	-1.2 ± 5.2	2.8 ± 10.8

Table 5.39 Correlation between reduced sea level percentiles and annual NAO index. Statistically significant trends are shown in *italics*.

The NAO index correlates better with some non-tidal residual percentile levels (Table 5.40). At Coruña, a negative correlation of significance is found for the 95-percentile, whilst positive correlations are found between the NAO and the 5, 1 and 0.1 percentiles. A tendency towards an increase in the 99 and 95 percentiles is found at Vigo, whilst all the lower percentiles tend to decrease with increasing NAO index values. A negative response in the 99 -percentile and a negative tendency is found for the 5-percentile, at Ceuta. The positive trend in the 99.9-percentile at Aveiro cannot be explained. These results suggest that, at Coruña and Vigo, as the NAO increases, the extreme maximum levels tend to decrease and extreme minimum levels tend to increase. Evidence of this trend is also found at Ceuta.

Trends in non-tidal residual standard deviation percentiles vs. annual NAO index mm / NAO index						
	99.9	**99**	**95**	**5**	**1**	**0.1**
Santander	6.4 ± 23.0	-1.1 ± 11.7	-3.1 ± 5.8	2.1 ± 5.9	-1.4 ± 13.3	-19.3 ± 23.6
Coruña	-16.0 ± 17.7	-13.9 ± 11.4	*-18.7 ± 6.0*	*22.2 ± 5.4*	*31.6 ± 8.3*	*29.1 ± 13.2*
Vigo	-7.0 ± 21.6	*-25.2 ± 11.9*	*-19.3 ± 7.0*	*17.5 ± 5.9*	*37.8 ± 9.4*	*35.9 ± 12.0*
Aveiro	164.5 ± 74.7	7.2 ± 24.0	-0.1 ± 0.1	8.7 ± 8.0	21.4 ± 13.0	19.7 ± 13.8
Cascais	-7.9 ± 23.9	1.9 ± 12.3	-2.9 ± 7.0	3.6 ± 5.6	0.5 ± 8.0	-11.3 ± 13.9
Ceuta	-21.6 ± 13.0	*-16.0 ± 7.9*	-8.0 ± 5.0	*9.1 ± 4.2*	11.0 ± 5.7	16.4 ± 11.5

Table 5.40 Correlation between NTRstd (meteorological) percentiles and annual NAO index. Statistically significant trends are shown in *italics*.

The data plotted in both Sections 5.2 and 5.3 both reveal that trends in MSL are dependent upon the location and timing of the readings. Therefore, it may be interpreted that it is imperative that trend analysis be performed on long records, i.e., periods greater than 30 years, and that the data between stations is available simultaneously. As there are restrictions on the availability of long-term simultaneous data from different stations, this requirement is not always achievable. To complete the analyses presented in this chapter, the longest and simultaneous data sets have been selected from the stations discussed previously, such that trends in the different sea level components could be computed in relation to a common time-span.

Data were available from 8 stations, which could cover approximately 57 years of data. This is an acceptable length of data for long-term studies (e.g. Pugh 1987). These stations also provide a reasonable geographical representation of the western European Coast.

MSL trends are positive for all the stations and lie below 3 mm yr^{-1}, except at Ceuta where no trend of significance is found (Figure 5.24 and Table 5.41). The increase in MSL is above 2.0 mm yr^{-1} at Dover, Santander and Vigo, this latter having the largest trend. The remaining stations all increase at approximately 1.4 mm yr^{-1} and Newlyn at 1.7mm yr^{-1}. These values do not take into account associated local land movement.

Observed sea level standard deviation show significant interannual-variability and influence of the 18.6-year nodal cycle, which is in phase at all of the stations. The only statistically significant trends, both positive, are found at Newlyn and Portsmouth. The result for Portsmouth (as presented earlier), considering the entire available dataset, was not of significance; however, the value of the estimated does not deviate by much.

The only trends of significance found in the **non-tidal residual standard deviations (NTRstd)** are for the same stations as for the previous results. Brest and Newlyn both have negative trends. When the entire dataset was used, Brest showed a positive trend.

MSL	Trend (mm/yr)	Standard error
Brest	1.44	0.30
Newlyn	1.70	0.24
Dover	2.44	0.42
Portsmouth	1.37	0.51
Santander	2.04	0.37
Coruña	1.38	0.32
Vigo	2.66	0.35
Ceuta	0.37	0.26

Table 5.41 MSL trends between, 1943-2000.

SL std	Trend (mm/yr)	Standard error
Brest	0.33	0.34
Newlyn	0.52	0.20
Dover	-0.12	0.46
Portsmouth	0.67	0.30
Santander	0.40	0.21
Coruña	0.28	0.16
Vigo	0.04	0.14
Ceuta	0.06	0.04

Table 5.42 Observed sea level standard deviation trend, between 1943-2000.

NTRstd	Trend (mm/yr)	Standard error
Brest	-0.39	0.09
Newlyn	-0.19	0.08
Dover	0.04	0.17
Portsmouth	-0.11	0.12
Santander	0.09	0.07
Coruña	0.16	0.09
Vigo	0.00	0.10
Ceuta	-0.03	0.06

Table 5.43 Non-tidal (meteorological) residual standard deviation trend, between 1943-2000.

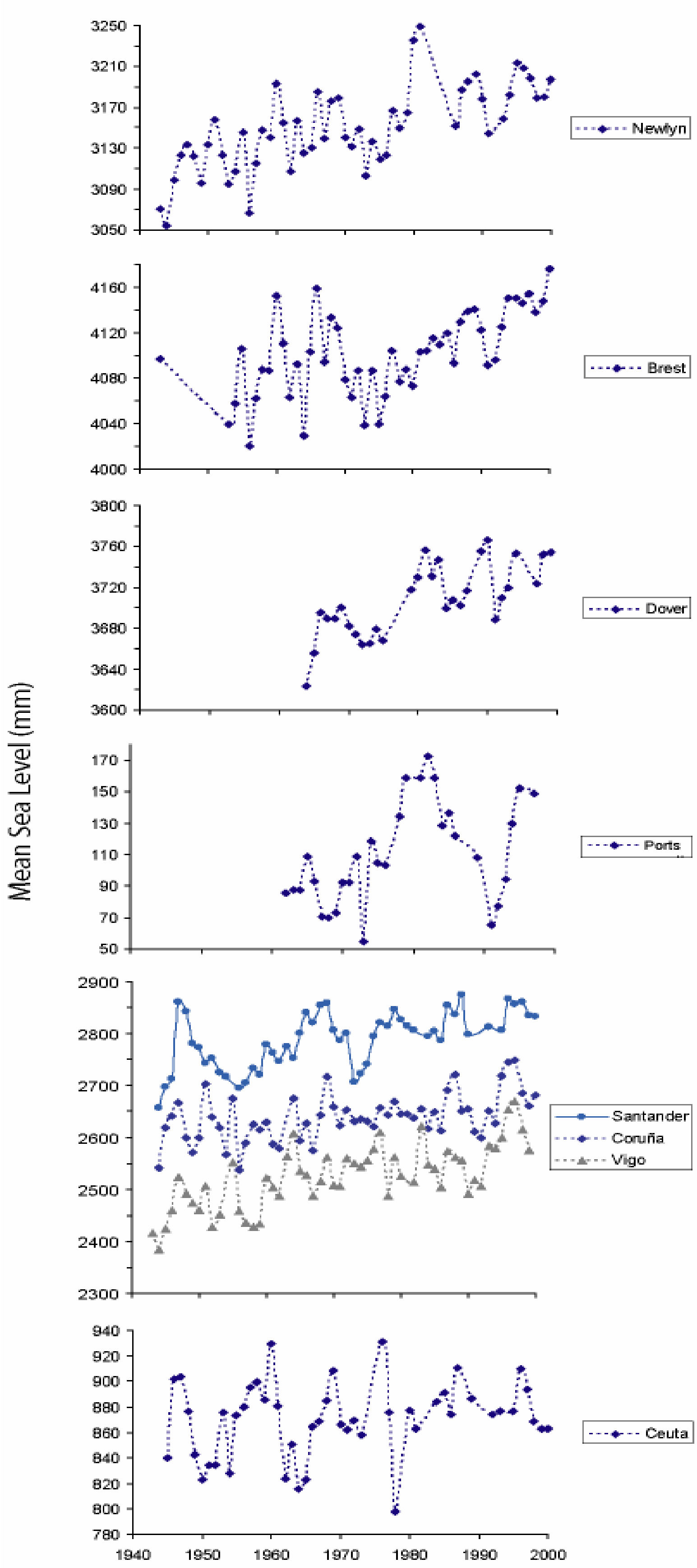


Figure 5.24 Annual MSL (in mm), for stations with more than 30 years of data, between 1943-2000.

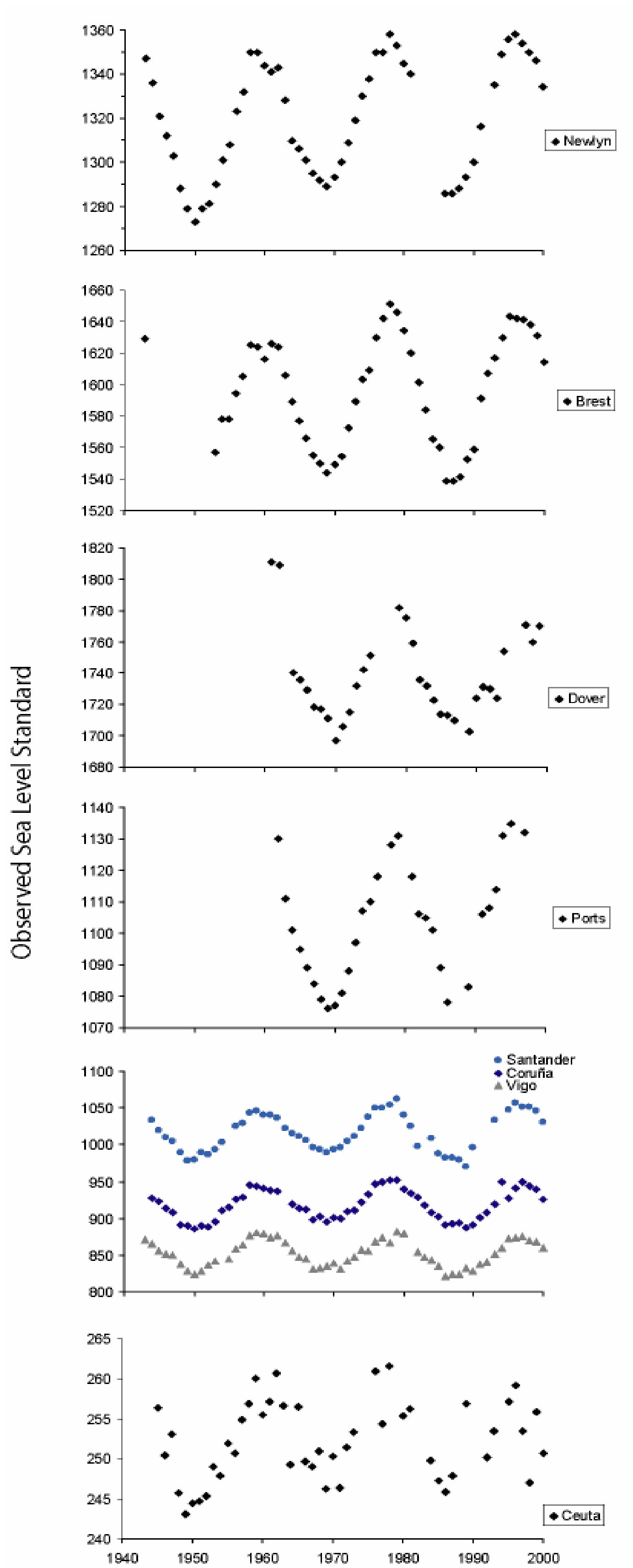


Figure 5.25 Observed sea level standard deviation (in mm), for stations with more than 30 years of data, between 1943-2000.

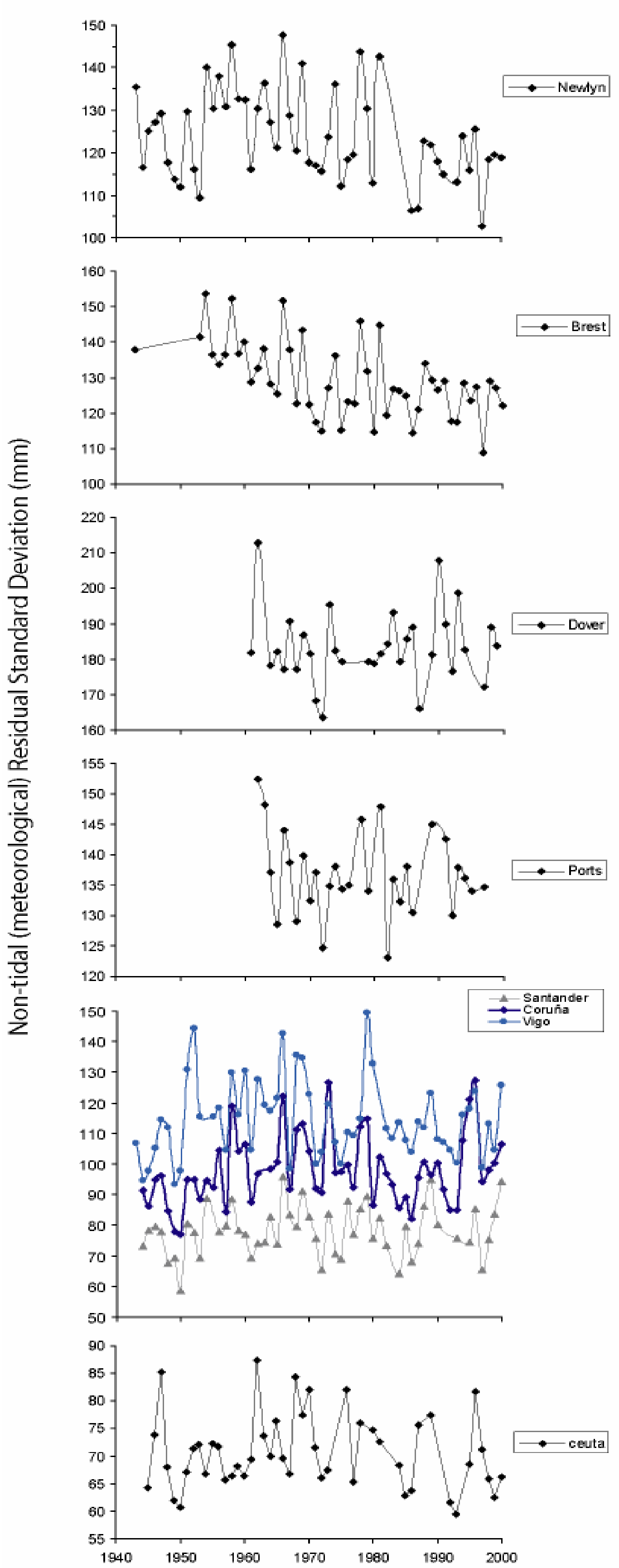


Figure 5.26 Non-tidal (meteorological) residual standard deviation (in mm), for stations with more than 30 years of data, between 1943-2000.

5.4 Concluding remarks

The statistical analysis of sea level variability for the western European coastline (38ºN - 51ºN) has been investigated for trends in observed sea level, in 3 separate components: mean sea level; tides; and non-tidal (meteorological) residual standard deviation (surge). The longest available hourly sea levels, recorded at sites in the English Channel (South England and North France) and the Iberian Peninsula (north and west coasts), together with Ceuta (Mediterranean African coast), have been used.

A critical assessment of the characteristics of the gauges used, based upon residual analysis was performed on of all the data from the English Channel, Cascais and Aveiro. A robust editing of the data confirms that these are mixed in terms of quality. The results obtained from Calais are presented. However, the quality of the dataset is compromised by several gaps in the record, which seem to contribute to large standard errors in the results. As such, this station is not considered in the discussion. Following this procedure, the difference between the edited and non-edited data is found to be most relevant within the context of extreme analysis.

The mean sea level at the majority of the stations along the western coast of Europe is increasing within the 1-2 mm yr^{-1} global estimate. The rate of MSL increase at Dover, Santander and Vigo is above 2 mm yr^{-1} and at Cascais it is below 1 mm yr^{-1}. These values do not include adjustments for land movement, i.e., isostatic corrections.

The difference between the rising level in the southwest of England (represented by Newlyn) and in the southeast (represented by Dover) have been associated with higher land submergence rates in the southeast of England.

MSL trends at Brest and Newlyn are significantly different from each other, despite the proximity of the stations, i.e., regional effects and residual variability should be similar. This is probably due to different land movement rates.

The small MSL trend found at Cascais is smaller than the 1.3 mm yr^{-1} rate obtained by other authors. The difference lies in the use of different data series. The larger rate of increase is based historical monthly mean data series, going back to 1880 whilst that used in this study starts in 1940.

For variations in the total observed sea level, the standard deviation results are erratic and influenced strongly by the 18.6-year lunar nodal cycle. Significant increases are found at Newlyn, Aveiro and Cascais. These may be related to local effects, i.e., increased tidal ranges as the MSL increases, allowing low water to fall further below the increasing mean, as the harbour dries out. Although this mechanism may explain the results for Newlyn and Cascais, those at Aveiro are believed to be related to changes in the tidal prism, associated to an MSL increase and changes in the depth of the inlet channel, where the tidal gauge is located.

Tides are dominated by semi-diurnal variations. Diurnal effects are small, but there are significant higher harmonics. The tidal constituents, determined by annual harmonic analysis, with nodal corrections made according to astronomical variations, show considerable inter-annual variability. Some amplitudes show a residual nodal variation, due to overcorrection in the analysis. At some stations, systematic changes are apparent and can be related to changes that have occurred either to the tide gauge (e.g. Newlyn), or within its vicinity (e.g. Cascais and Aveiro).

Trends in the meteorological or non-tidal residual standard deviations were analysed on an annual basis and taken as a measure of storminess. This was under the assumption that an increase in storminess would be reflected in the standard deviation of the values, computed by removing the MSL and the astronomical tide from the observed sea levels. The error in the reading can also affect these levels, but has been minimised at the stations for which the data were edited.

The mean value of the non-tidal residuals is zero, within each year. The non-tidal residual standard deviation (NTRstd) of significance is found at Newlyn, Aveiro and Cascais. The trends at Aveiro and Cascais are associated to changes in the area adjacent to the tide gauge, as a result of engineering work. The trend at Newlyn shows a decrease in level attributed to the changes in the measuring procedure in 1983, with the new bubbler gauge contributing fewer errors than the older stilling-well system. Brest shows a small increase that lies just within the standard error. The annual non-tidal residual standard deviations at Brest and Newlyn correlate well, providing a clear confirmation of the oceanographic significance of the residual sea levels, following the careful editing of the data. The lack of any trends suggests that there is no evidence of increased storminess, i.e., occurrence of storm related events, in the long-term sea level datasets analysed.

In addition to the increase in MSL, changes in the distribution of the extreme values have also been investigated, by analysing for trends in the annual maximum and minimum sea levels and in the non-tidal residual levels. Reduced levels, i.e., whereby the annual mean of value levels is removed from each individual year, have been considered. As such, the results cannot be influenced by MSL trends. The reduced average winter (December-March) maximum levels are also analysed since, at these latitudes, storms occur more commonly in the winter months.

Simultaneous increases in maximum and minimum levels occur at Brest and Newlyn, whilst at Cascais and Aveiro, the trends increase for maximum levels and decrease for the minima. None of these results show any significant trends when considering the reduced levels. Apart from a few other erratic results, no trends are found in the winter maximum levels.

The analysis of extreme levels, based upon a single annual hourly level, is very limited; however, they are very likely influenced by errors, especially when the data is unedited.

A more robust analysis followed, computing percentile levels from the hourly sea levels and non-tidal residual standard deviations.

The majority of the stations have trends, at most percentiles of observed sea levels. These, in most cases, were as a result of the MSL influence. However, lower percentiles at Newlyn show negative trends in the reduced levels, whilst they are positive in the observed levels. Furthermore, an increase in the higher percentile levels at Aveiro corresponds to a decrease in the lower levels, when considering the reduced sea levels. This result is attributed to the same influence as that discussed previously, for observed sea level standard deviations.

Trends of significance are found within the various lower percentiles of the non-tidal residual standard deviation at all the English Channel stations and for the stations on the Bay of Biscay, suggesting that the meteorological effects influence the minimum extremes levels, i.e., negative surges. Further analysis of the results obtained from the statistical analysis of trends in sea level variability included a brief study of the possible physical parameters influencing these trends.

All of the stations show the anticipated negative correlations between detrended sea level and gridded mean sea level pressure. None of these fall more than 2 standard deviations from the theoretical value. The results are larger for stations on the Iberian Peninsula, suggesting that, in this region, winds or oceanic circulation may be more important, as the deviation from the theoretical value is associated to a dynamical link between these parameters and air pressure.

Although a correlation exists between hydrostatic pressures and sea level, the average long-term pressure is approximately zero. This suggests that meteorological forcing is not the main forcing mechanism responsible for the observed sea levels.

Sea level response to the NAO has been analysed as the NAO is known to affect various meteorological parameters and wave height. Similarly, there is also the possibility that the NAO may be affected by climate change. The station-based NAO index (Iceland–Gibraltar) and PC-based (first EOF) NAO index (Iceland-Azores) have been used in the analysis.

In summary, without having removed seasonal anomalies from the datasets used, the results show that sea levels around the western European coastline are correlated negatively with the NAO index. The only exception to this pattern is Dover, which is correlated positively to the NAO. This pattern is consistent with the known positive correlation in the south eastern region of the North Sea. Sensitivity to the NAO varies, with the highest values found along the northern Spanish coast. Overall, Coruña shows the greatest sensitivity to the NAO, and in the English Channel, this is found at Newlyn (southwest England).

Influences on the non-tidal (meteorological) residual standard deviation are also found in the northern region of Spain, suggesting that the variance in this component is considerably influenced by the NAO in this particular region. Nevertheless, editing of the data would be necessary to reduce the standard deviation and noise in these datasets, to confirm the above results.

Trends in MSL are dependent upon the location and the timing of the reading. Therefore, the longest and simultaneous data, from the stations discussed previously, have been analysed. As such, trends in the different sea level components could be computed, on the basis of a common time-span. The results are fairly consistent with what has been discussed above. However, if short periods of time are considered, the results may be expected to vary. This is confirmed when these trends are compared to those obtained in various other studies, that focus upon recent changes, i.e., the last decades of the 20th Century.

Chapter VI

LOCAL SEA LEVEL TRENDS: RESULTS AND DISCUSSION

Historical descriptions of the Ria de Aveiro Lagoon, together with past data (Section 3.2.1) show that, over the last century, sea level has changed as the Lagoon has evolved.

In this Chapter, data are used to assess whether tides have changed within the Lagoon, over the past 16 years.

Two datasets containing sea level measurements undertaken in the Ria de Aveiro Lagoon, during 1987/8 and 2002/3 surveys, are available. These measurements have produced surface elevations of varying duration, for a series of stations throughout the Lagoon. Data from both surveys (with a common sampling interval for example, if data for a station covered January to February in 1987, the same months would be covered in the 2003 survey of that station) underwent harmonic analysis, in order to obtain the primary tidal constituents and their compound tides.

Presentation of the results is divided into the following sections: (1) past survey, 1987/8; (2) present survey, 2002/3; and (3) comparison between the two surveys.

6.1 Introduction

The offshore ocean tide is composed of a number of harmonic constituents each of different period, amplitude and phase. As the tide progresses through a narrow inlet into an estuarine/lagoon system, it is strongly distorted by linear and non-linear effects induced by bottom friction and other physical processes. This process leads to the generation of 'overtides', higher frequency harmonics, and compound tides which are a linear combination of the basic frequencies, generated by astronomic and/or hydrodynamic influences. For instance, the MS_f (S_2- M_2) and MS_4 (M_2+ S_2) constituents both arise from interaction between the M_2 and S_2 constituents.

The water depth is of great relevance to the distortion of the tidal wave as it propagates into shallow water, affecting two important physical parameters: the speed at which the wave moves and the bottom friction.

In shallow water, the tidal wave will propagate as a long wave, at a speed $c = \sqrt{gh}$ (g is the gravitational force and h is the depth of the water), assuming that the amplitude of the wave is small compared with the depth, and that h is small compared with the wavelength. In the case of a frictionless estuary, as the water depth varies between high water and low water, the wave crest will tend to gain or lose velocity with changes in water depth. The different movements of the crest of the wave, relative to the trough, will affect the duration of the flood/ebb and vary the speed of the currents. For instance, for a large variation in water depth, i.e. decrease in depth, the crest of the wave will tend to move more rapidly than the trough. This mechanism can lead to a shorter flood and longer ebb, whereby the highest velocities would occur during the flood.

However, friction has to be incorporated in these tidal variations as a frictionless estuary is far from reality. Friction between the sea bed and the tidal currents is directly proportional to the square of the mean current velocity ($\tau_0 = \kappa \bar{u}|\bar{u}|$, where τ_o is the bottom friction; κ is a dimensionless drag coefficient; and $\bar{u}$ is the mean current velocity). The friction is increased in shallow waters, where the currents are stronger.

The combination of both bottom friction and varying tidal water depth generate non-linear effects, which will distort the tidal wave causing asymmetries. These asymmetries can be analysed using tidal harmonic constituents. This is discussed further in Section 6.6.

The amplitude and phase of the observed tidal constituents, obtained from tidal analysis, can describe a tidal regime, and can also be used to further the understanding of the hydrodynamic processes of the coastal estuarine/lagoon systems.

The present Chapter focuses upon the analyses of the major tidal constituents, obtained from the harmonic analysis of observed sea level from 1987/8 and 2002/3 collected throughout the Ria de Aveiro Lagoon. These datasets are used to study whether any changes have taken place during these (16) years. No current measurement data has been collected, therefore the tidal asymmetries analysed will be related to sea level only.

6.2 1987/8 Survey

Results from the data collected by the Portuguese Hydrographic Institute are published in Instituto Hidrográfico (1991) and have been re-analysed by Dias (2001). As the present aim is to assess sea level variations between 1987/8 and 2002/3, it is essential to reduce any bias affecting the final results, in order to compare results. This approach has meant that the same methods of analysis had to be applied to both datasets which, in turn, have led to re-analysis of the original 1987/8 dataset. The results from the re-analyse of 1987/8 data are described here.

The amplitudes and phases of the major harmonic tidal constituents (Tables 6.1 & 6.2) confirm the known dominance of the M_2 constituent within the Lagoon, followed by S_2 and N_2. In addition to these semi-diurnal tides, higher harmonic overtides and compound tides, such as M_4, MS_4 and MS_f, are also significant, e.g. the M_4 is typically between 5% to 20% of the M_2. These relationships confirm the importance of non-linear interaction (friction and other forces), which occur as the tidal wave progresses along the shallow waters inside the Lagoon. Appreciable diurnal tides (K_1 and O_1) also exist. Only a summary of the main tidal constituents is presented here; however, the results for all the other constituents can be found in Appendix A5.

The dominance of the M_2 constituent provides information on the propagation of the tidal wave within the Lagoon. Figures 6.1 & 6.2 show the spatial distribution of M_2 amplitude (in cm) and phase (in degrees), respectively. The maps shown in these Figures are based on those presented in the Instituto Hidrográfico (1991). They are presented in this form, such that a direct comparison between the results is made easier.

These Figures illustrate clearly the rapid attenuation of the M_2 tide, within the Lagoon. This is shown by the average amplitude of 0.91 relative to Barra (9% decrease), at stations SJ, CN and S within approximately 5 km of Barra, just after the tide has passed through the inlet channel (note: Barra, BA, is used as a reference, as it is the closest station to the coast). As the M_2 tide continues to propagate the average amplitude becomes 0.61 (39% decrease) at CA and CB; and 0.51 (49% decrease) at Torreira (T), Vagueira (VG), Vista Alegre (VA) and Cais da Pedra (CP), reaching an average 0.33 (68% decrease) within the upper reaches (average 26.5 km).

The phase lag of the M_2 constituent increases, i.e. HW occurs later, with reference to distance from the inlet. The M_2 tidal phase increases by an average 13º (27min), within the first 5 km from Barra up to an average 119º (245min ~4.1hrs) in the upper reaches of the Ovar Channel (C, O, PU, PA, MA). Within the central section of the Lagoon, the average are 50º (104min ~1.7hrs) within a 12 - 15 km distance from the inlet, and 66º (134min ~2.2hrs) within 15 - 20km.

Although the decrease in amplitude and increase in phase lag can be linked to the loss of energy associated to the topography and channel depth, it also seems to be associated to the tidal propagation through the narrow inlet. This is discussed further in Section 6.7.

		1987/8 Tidal Contituents - Amplitude (m)							
		O1	**K1**	**N2**	**M2**	**S2**	**M4**	**MS4**	**MSF**
Carregal	**(C)**	0.035	0.040	0.047	0.338	0.077	0.064	0.035	0.093
Ribeira	**(O)**	0.037	0.037	0.038	0.351	0.077	0.050	0.025	0.058
Puxadouro	**(PU)**	0.033	0.037	0.039	0.319	0.074	0.048	0.026	0.052
Pardilhó	**(PA)**	0.035	0.038	0.041	0.328	0.080	0.035	0.019	0.077
Manchão	**(M)**	0.031	0.036	0.034	0.228	0.048	0.034	0.021	0.082
Cais Bico	**(CB)**	0.044	0.046	0.097	0.586	0.147	0.054	0.035	0.100
Torreira	**(T)**	0.038	0.036	0.088	0.476	0.121	0.057	0.027	0.110
S.Jacinto	**(SJ)**	0.048	0.056	0.174	0.861	0.291	0.048	0.027	0.014
Barra	**(BA)**	0.053	0.060	0.202	0.962	0.328	0.040	0.019	0.029
Costa Nova	**(CN)**	0.048	0.061	0.173	0.887	0.277	0.041	0.013	0.041
Vagueira	**(VG)**	0.046	0.047	0.089	0.489	0.136	0.133	0.066	0.118
Areão	**(A)**	0.011	0.009	0.014	0.037	0.021	0.012	0.009	0.075
Lota	**(L)**	0.052	0.054	0.150	0.834	0.241	0.097	0.074	0.121
Rio Novo	**(RN)**	0.048	0.032	0.131	0.631	0.171	0.045	0.038	0.195
Cacia	**(CA)**	0.039	0.038	0.091	0.580	0.170	0.039	0.038	0.122
Sacor	**(S)**	0.054	0.052	0.176	0.871	0.300	0.051	0.046	0.040
Ponte Cais II	**(PC2)**	0.052	0.051	0.165	0.839	0.256	0.063	0.050	0.075
Vista Alegre	**(VA)**	0.045	0.044	0.084	0.504	0.124	0.040	0.037	0.140
Cais da Pedra	**(CP)**	0.050	0.043	0.075	0.503	0.118	0.050	0.039	0.158

Table 6.1 Summary of the amplitudes of the major tidal constituents, for 1987/8.

		1987/8 Tidal Contituents - Phase (º)							
		O1	**K1**	**N2**	**M2**	**S2**	**M4**	**MS4**	**MSF**
Carregal	**(C)**	57.3	157.7	175.0	197.2	231.2	304.8	318.9	303.0
Ribeira	**(O)**	56.1	333.9	189.3	193.8	233.9	293.0	306.3	340.5
Puxadouro	**(PU)**	63.4	349.5	194.3	193.8	230.4	290.6	303.6	340.6
Pardilhó	**(PA)**	64.6	347.7	199.3	190.3	230.1	254.9	264.4	356.1
Manchão	**(M)**	92.0	337.8	267.2	218.6	273.0	300.4	310.6	358.1
Cais Bico	**(CB)**	22.2	234.2	128.6	137.9	179.1	164.4	201.2	29.0
Torreira	**(T)**	20.8	204.3	125.3	140.3	178.8	262.1	258.2	42.6
S.Jacinto	**(SJ)**	333.5	144.1	75.8	90.8	119.2	342.5	35.3	4.6
Barra	**(BA)**	319.7	81.3	61.6	79.4	107.9	205.4	307.4	279.9
Costa Nova	**(CN)**	332.7	138.7	81.1	95.7	129.5	25.7	28.9	353.2
Vagueira	**(VG)**	15.6	158.6	117.4	129.7	160.3	7.7	220.8	15.9
Areão	**(A)**	108.9	149.9	210.3	238.4	277.5	67.7	36.6	41.1
Lota	**(L)**	338.0	168.4	91.0	103.4	135.4	78.1	32.6	44.4
Rio Novo	**(RN)**	359.0	148.3	96.4	117.6	150.7	353.7	93.0	47.1
Cacia	**(CA)**	4.1	208.2	108.7	126.7	164.3	9.3	121.7	23.8
Sacor	**(S)**	334.0	86.1	74.6	91.4	121.7	153.2	34.6	121.0
Ponte Cais II	**(PC2)**	340.0	126.4	78.8	98.6	129.6	168.5	26.8	20.5
Vista Alegre	**(VA)**	24.7	87.4	118.0	145.2	193.2	344.3	191.6	15.9
Cais da Pedra	**(CP)**	35.8	216.8	135.0	159.1	211.2	214.5	193.1	17.5

Table 6.2 Summary of the phase of the major tidal constituents, for 1987/8.

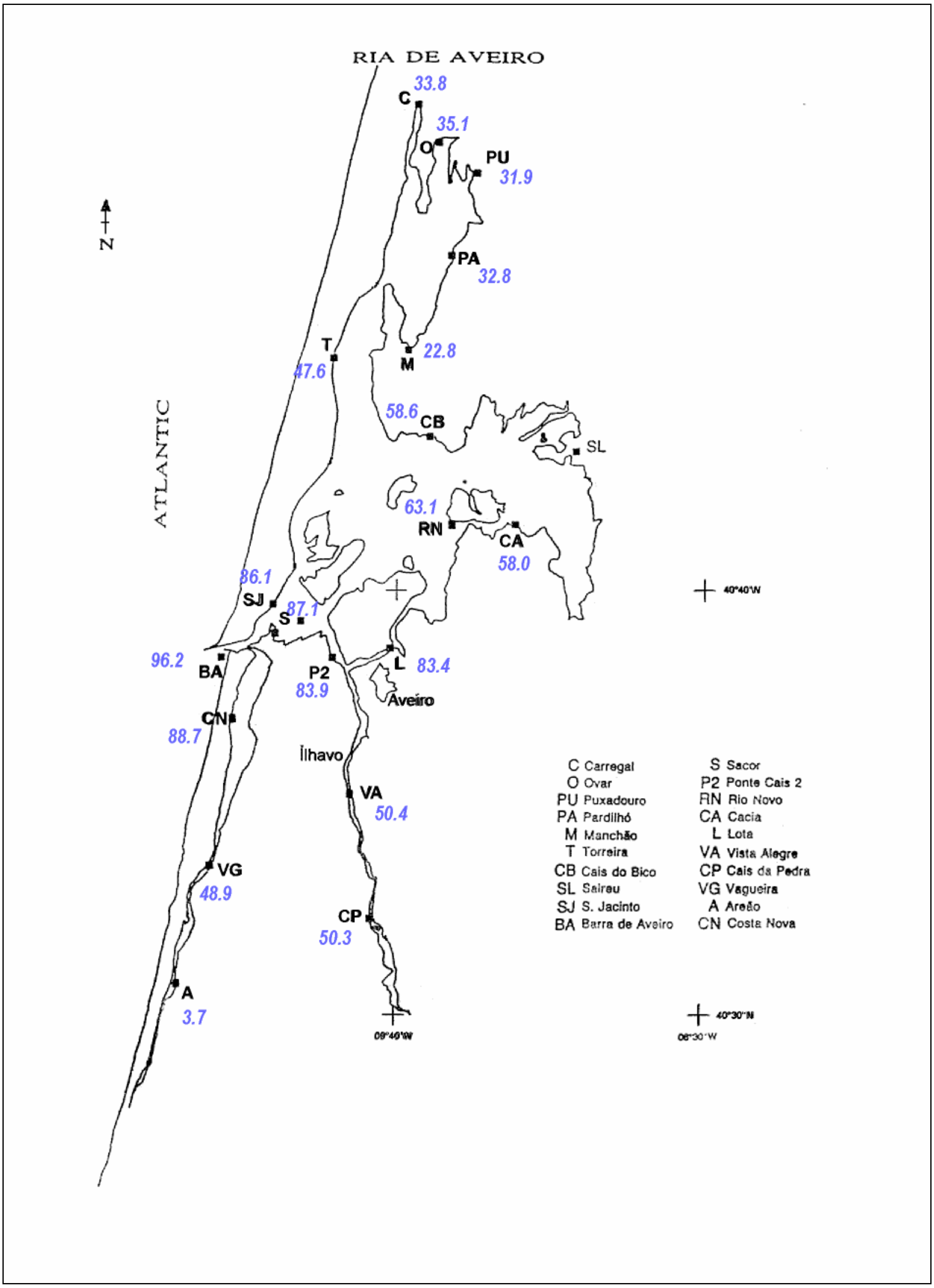


Figure 6.1 M_2 amplitude (in cm), obtained from sea level data surveyed in 1987/8, for stations in the Ria de Aveiro (map based upon, Instituto Hidrográfico, 1991).

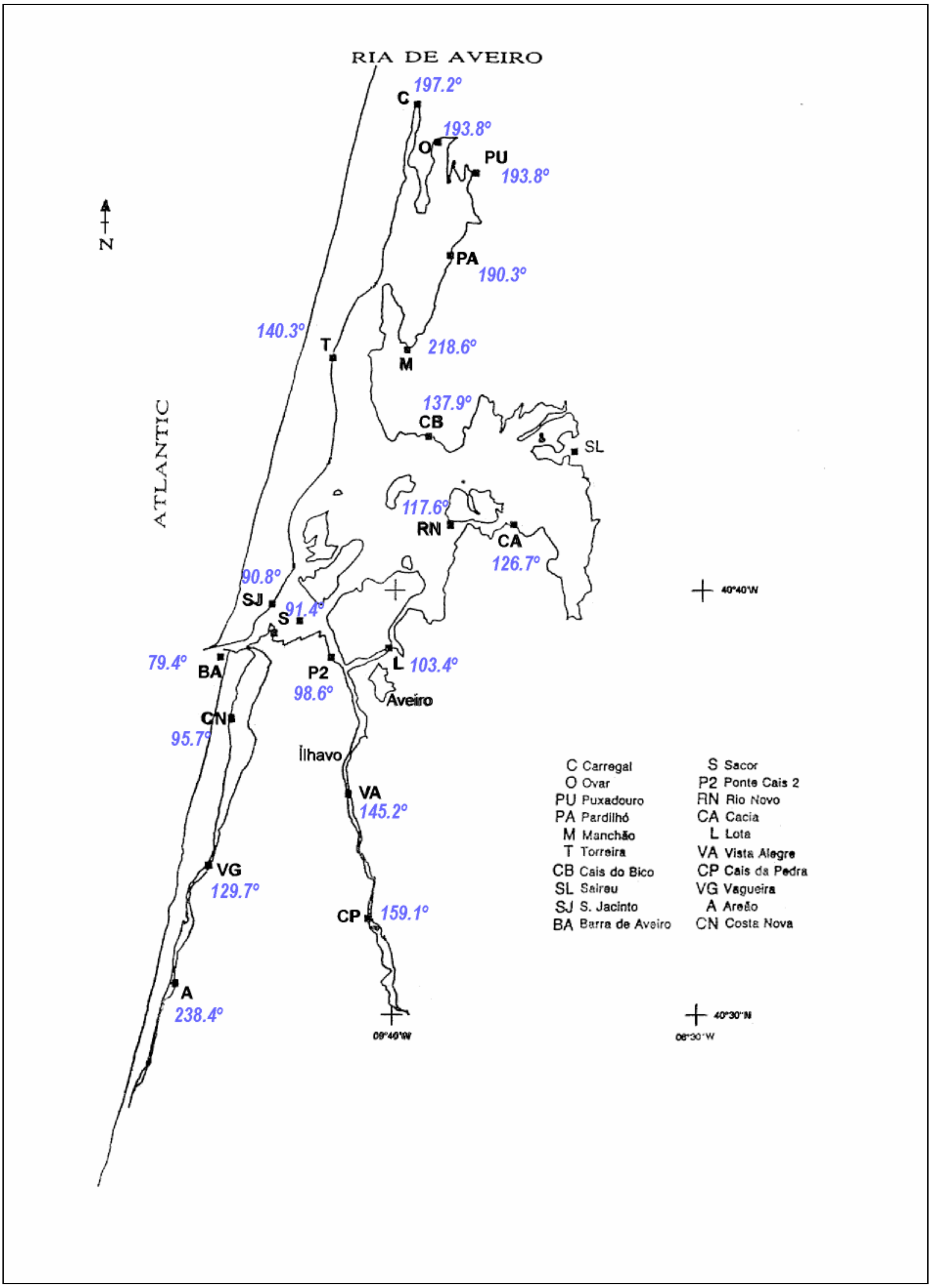


Figure 6.2 M_2 phase (in degrees), obtained from sea level data surveyed in 1987/8, for stations in the Ria de Aveiro (map based upon, Instituto Hidrográfico, 1991).

The results obtained from the harmonic analyses of the observed 1987/8 data agree closely with those given in Instituto Hidrográfico (1991). However, some differences have been identified between these results and those obtained by Dias (2001). These differences are considered to be associated with the fact that some stations had records longer than 1-3 months and that slightly different datasets may have been used; likewise, the IOS Tidal Package (Foreman 1977 & 1989 or refer to http://www-sci.pac.dfo-mpo.gc.ca/osap/projects/tid pack/tidpack_e.htm) was used in the latter case, whereas the present analysis used the Task2000 program, although the differences arising from this were probably small. This is explained in Section 6.4.

6.3 2002/3 Survey

Sea levels obtained from pressure measurements throughout the Lagoon, during 2002/3, were analysed using harmonic analysis. After this the data were adjusted as described in Section 4.6.2c. The results obtained for the dominant tidal constituents are given in Table 6.3 & 6.4, whilst M_2 amplitude and phase distribution are shown in Figures 6.3 & 6.4. Other constituents can be found in Appendix A6.

As described in the results obtained for 1987/8, there is a clear decrease in the M_2 amplitude (Figure 6.3) and an increase in the phase (Figure 6.4), as the tide propagates away from the inlet. The M_2 amplitude, for instance, has an average value of 0.96 (4% decrease) within the first 10km from the inlet, 0.71 (29% decrease) between 10-20km and 0.55 (45% decrease) between 20-30km, whilst its phase increases by an average of 14º (28 min) within the first 10km, 47º (97min ~1.6 hrs) between 10-20km and 80º (165min ~2.8hrs) between 20-30km.

The M_2 amplitude at Sacor (Figure 6.3 & Table 6.3) is larger than at the inlet station Barra. It is possible that the larger value at Sacor (S) may be consequence of an instrument datum shift. The sensor was deployed from a pier that underwent maintenance, which led to it being vertically displaced from the original position. Although the data were adjusted, to compensate for the shift, the results are still influenced by this interference. Further measurements are needed to improve this result.

As described previously, the dominant diurnal tides are the O_1 and K_1 constituents with approximately similar amplitudes. The M_2 is the dominant semi-diurnal tide, with amplitude significantly greater than N_2 and S_2. The higher harmonic of the M_2, M_4, shows a general increase in amplitude with distance from the inlet. Such changes are to be expected when considering a tide propagating in a channel which depth is, on average, decreasing and with variable tidal flat coverage. The major quarter-diurnal compound tide is MS_4, as a result of M_2+S_2 interactions. The fortnightly compound tide, MS_f, responsible for lower low/high water levels during neap tides and higher levels during spring tides, also shows a tendency for its amplitude to increase towards the upper reaches of the Lagoon.

In Table 6.3 & 6.4 more than a single result is presented for Barra (BA) and Torreira (T). Barra was used as a reference station throughout the survey, as it is the closest station to the open sea, in comparison, the initial aim at Torreira was to obtain a set of measurements for 1 year, in order to investigate seasonal variability within the Lagoon. The loss of equipment reduced the period to 7 months, which was insufficient to fulfil the initial aims. However, the repeated analyses undertaken at both of these stations can be used to assess the natural 'month-to-month' variations in the local M_2 tides, i.e., the natural variability (Section 6.4.1).

		2002/3 Tidal Contituents - Amplitude (m)							
		O1	K1	N2	M2	S2	M4	MS4	MSF
Carregal	**(C)**	0.055	0.052	0.131	0.530	0.145	0.066	0.052	0.163
Ovar	**(O)**	0.054	0.059	0.113	0.516	0.136	0.054	0.024	0.135
Puxadouro	**(PU)**	0.047	0.054	0.113	0.493	0.114	0.061	0.036	0.160
Pardilhó	**(PA)**	0.064	0.039	0.127	0.541	0.148	0.068	0.056	0.180
Manchão	**(M)**	0.046	0.057	0.134	0.608	0.152	0.075	0.056	0.169
Laranjo	**(CB)**	0.054	0.045	0.158	0.863	0.206	0.078	0.035	0.115
Barra 9-02	**(BA)**	0.054	0.056	0.180	0.979	0.338	0.039	0.031	0.043
Barra 1-03	**(BA)**	0.051	0.055	0.204	0.941	0.326	0.042	0.028	0.027
Barra 3-03	**(BA)**	0.055	0.053	0.202	0.964	0.323	0.036	0.030	0.047
Barra 5-03	**(BA)**	0.054	0.065	0.203	0.977	0.324	0.038	0.018	0.006
Barra 8-03	**(BA)**	0.054	0.066	0.198	0.967	0.331	0.037	0.028	0.020
Costa Nova	**(CN)**	0.058	0.065	0.201	0.971	0.311	0.039	0.019	0.022
Vagueira	**(VG)**	0.046	0.034	0.151	0.851	0.229	0.040	0.036	0.121
Areão 11-02	**(A)**	0.049	0.051	0.085	0.519	0.137	0.118	0.052	0.051
Areão 5-03	**(A)**	0.032	0.026	0.068	0.432	0.121	0.127	0.062	0.077
Lota	**(L)**	0.051	0.029	0.198	0.918	0.291	0.090	0.082	0.063
Rio Novo	**(RN)**	0.048	0.044	0.170	0.794	0.237	0.066	0.063	0.083
Cacia	**(CA)**	0.040	0.042	0.171	0.685	0.194	0.040	0.038	0.161
Sacor	**(S)**	0.053	0.067	0.186	1.019	0.319	0.067	0.054	0.102
Ponte Cais II	**(PC2)**	0.054	0.066	0.180	0.950	0.305	0.084	0.063	0.052
Vista Alegre	**(VA)**	0.058	0.041	0.123	0.639	0.165	0.050	0.047	0.150
Cais da Pedra	**(CP)**	0.058	0.055	0.134	0.612	0.156	0.073	0.062	0.116
S.Jacinto	**(SJ)**	0.052	0.059	0.183	0.925	0.294	0.048	0.025	0.032
Torreira 6-03	**(T)**	0.047	0.052	0.104	0.736	0.167	0.056	0.027	0.079
Torreira 8-03	**(T)**	0.048	0.053	0.129	0.702	0.176	0.051	0.037	0.125
Torreira 1-04	**(T)**	0.048	0.052	0.110	0.700	0.176	0.050	0.042	0.097

Table 6.3 Summary of the amplitude of the major tidal constituents, for 2002/3.

		2002/3 Tidal Constituents - Phase (º)							
		O1	K1	N2	M2	S2	M4	MS4	MSF
Carregal	**(C)**	57.7	128.4	148.9	168.8	229.9	163.3	187.1	17.5
Ovar	**(O)**	49.7	103.6	144.6	165.1	212.9	246.9	275.8	18.6
Puxadouro	**(PU)**	51.5	134.3	147.9	164.8	218.4	242.9	280.6	27.4
Pardilhó	**(PA)**	24.0	92.1	145.8	163.7	224.3	141.7	167.9	28.6
Manchão	**(M)**	19.2	118.0	114.2	130.1	178.6	140.0	165.3	17.5
Laranjo	**(CB)**	18.1	96.8	109.8	120.0	171.5	39.3	108.6	17.9
Barra 9-02	**(BA)**	323.9	65.4	62.3	76.0	102.2	253.3	286.8	229.7
Barra 1-03	**(BA)**	319.1	70.4	62.9	78.8	107.6	252.5	313.5	152.2
Barra 3-03	**(BA)**	322.0	55.4	61.7	79.0	106.2	255.9	298.3	234.3
Barra 5-03	**(BA)**	319.5	58.7	59.8	78.1	106.1	256.8	301.6	195.0
Barra 8-03	**(BA)**	321.6	67.3	62.2	79.0	105.4	260.2	301.0	152.1
Costa Nova	**(CN)**	328.7	67.7	70.0	87.5	117.9	303.2	335.1	10.5
Vagueira	**(VG)**	352.9	68.4	93.3	107.5	145.1	138.5	157.9	349.2
Areão 11-02	**(A)**	13.9	99.7	126.7	130.4	180.9	217.7	238.3	359.7
Areão 5-03	**(A)**	19.0	191.8	127.7	136.5	181.1	241.3	255.0	9.3
Lota	**(L)**	351.3	96.4	90.9	100.5	131.8	341.3	20.8	53.6
Rio Novo	**(RN)**	350.4	84.1	102.5	108.4	142.1	21.6	57.1	28.3
Cacia	**(CA)**	0.4	142.8	109.0	119.7	158.3	49.9	97.6	61.4
Sacor	**(S)**	331.6	53.7	69.6	90.1	116.8	328.5	18.0	343.6
Ponte Cais II	**(PC2)**	339.8	79.8	79.3	93.3	125.3	330.4	25.6	34.9
Vista Alegre	**(VA)**	22.2	109.4	116.6	135.7	170.0	117.9	142.8	40.8
Cais da Pedra	**(CP)**	34.7	146.3	152.9	147.2	192.9	118.1	163.6	37.8
S.Jacinto	**(SJ)**	328.2	72.6	69.8	87.8	118.0	309.3	349.0	75.8
Torreira 6-03	**(T)**	13.4	109.5	115.9	126.8	174.1	145.3	206.5	40.7
Torreira 8-03	**(T)**	9.9	109.3	120.0	128.0	167.1	149.3	184.1	37.9
Torreira 1-04	**(T)**	8.7	125.3	120.3	129.8	172.4	159.6	208.2	38.8

Table 6.4 Summary of the phase of major the tidal constituents, for 2002/3.

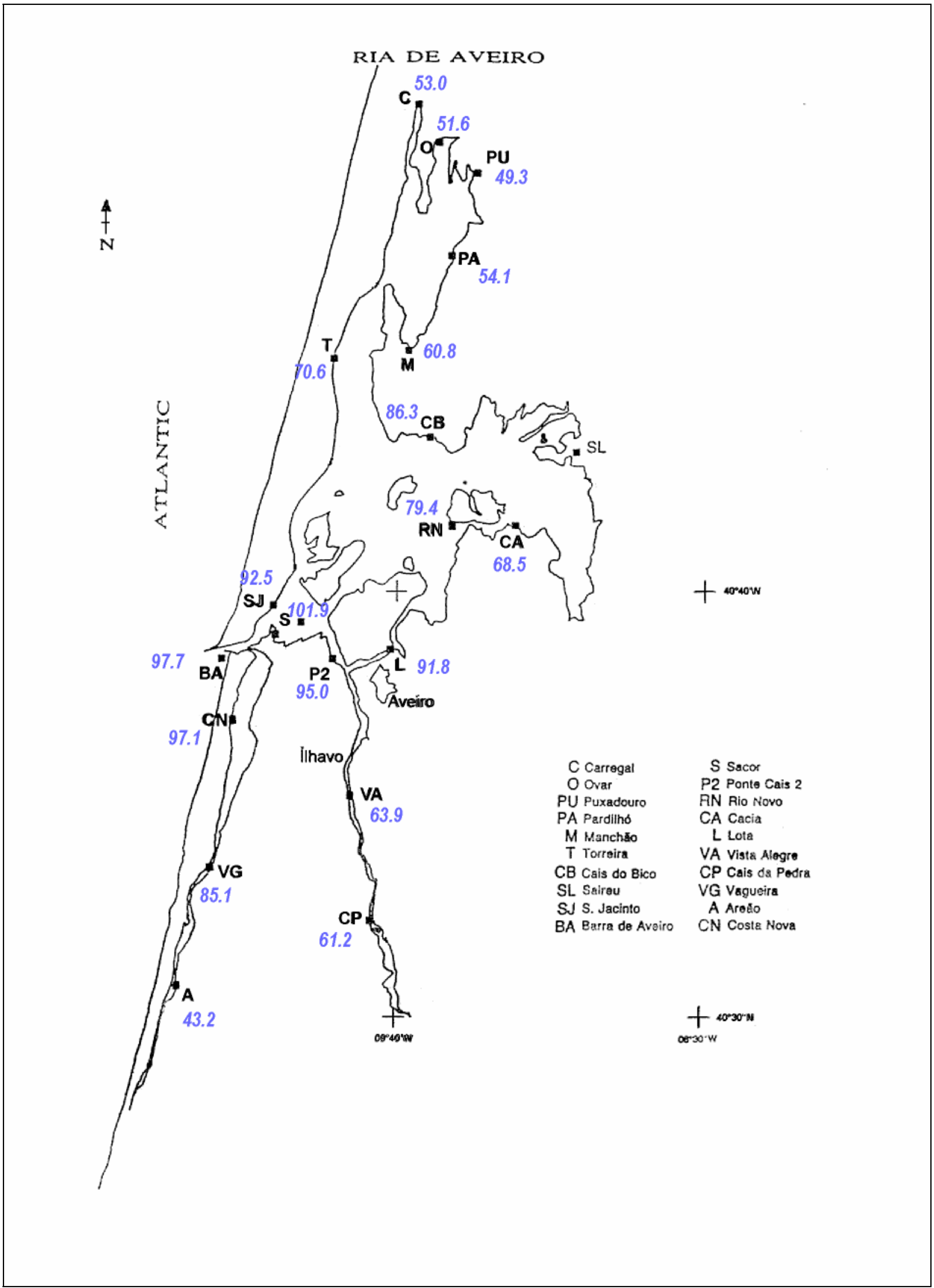


Figure 6.3 M_2 amplitude (in cm), obtained from sea level data surveyed in 2002/3, for stations in the Ria de Aveiro (map based upon, Instituto Hidrográfico, 1991).

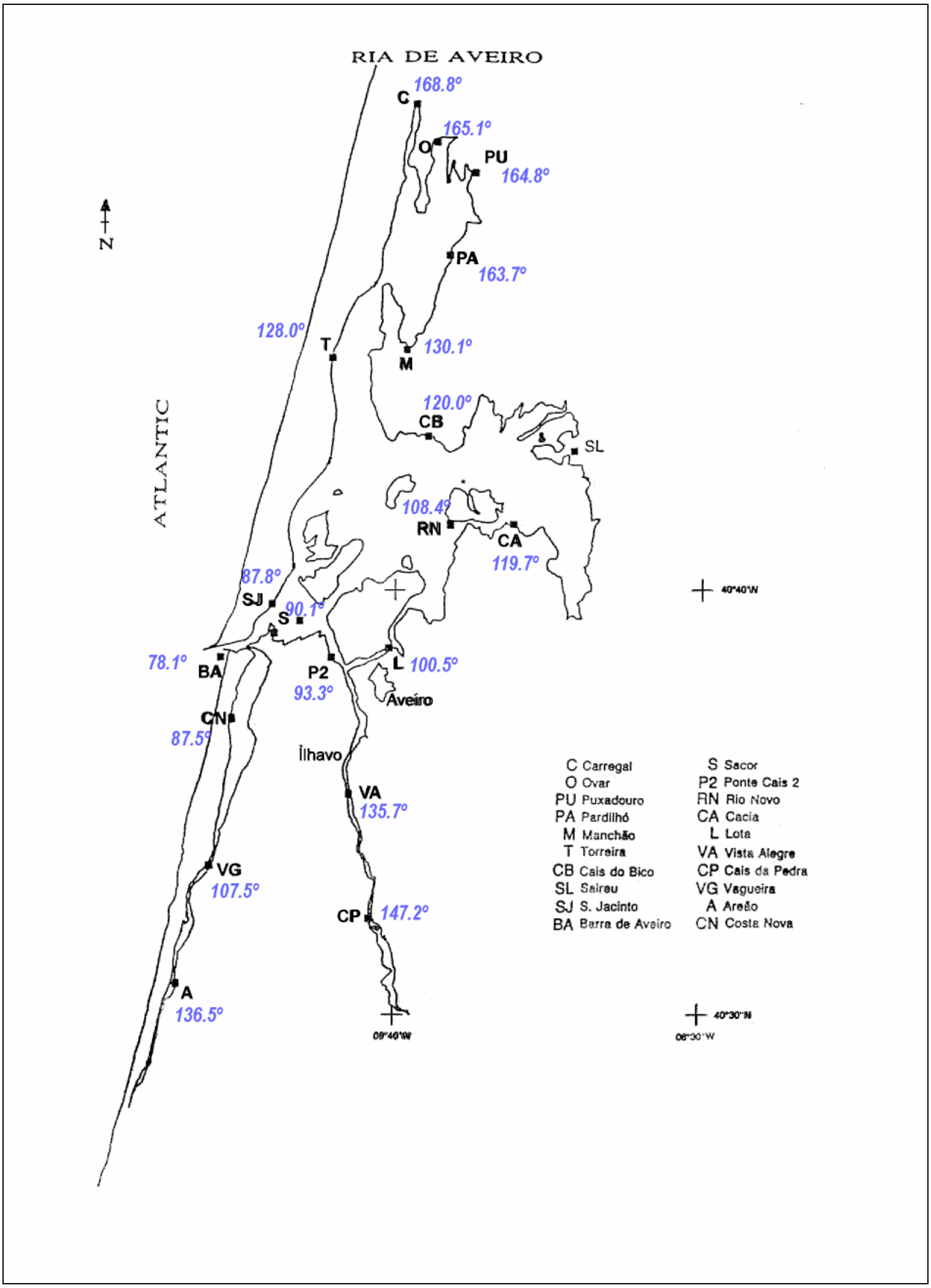


Figure 6.4 M_2 phase (in degrees), obtained from sea level data surveyed in 2002/3, for station in the Ria de Aveiro (map based upon, Instituto Hidrográfico, 1991).

6.4 Errors and adjustments to the results

Estimating the uncertainties associated with the measured levels within the Lagoon is a complex problem, since there are a number of contributing factors. Some of these factors can be quantified (instrumented) although those associated to the process by which the final result is obtained are non-quantifiable. In order to obtain the significance of the uncertainty of the results presented, a simplified approach is considered

The main objective, in terms of the present research undertaken in the Lagoon of Aveiro, is to determine whether there are significant changes in the M_2 tide over the period 1987/8 to 2002/3. Consequently, it is necessary to assess the uncertainties in the analyses from the two periods, to estimate the confidence with which any differences can be established as real. It appears that the uncertainties could arise from 4 principal causes: natural variability; sampling times; calibration adjustment; and different analysis techniques, used for 1987/8 and 2002/3.

$$\text{Uncertainty} = \text{Natural Variability} \pm \text{Sampling Time} \pm \text{Calibration Adjustment} \pm \text{Analysis Technique}$$

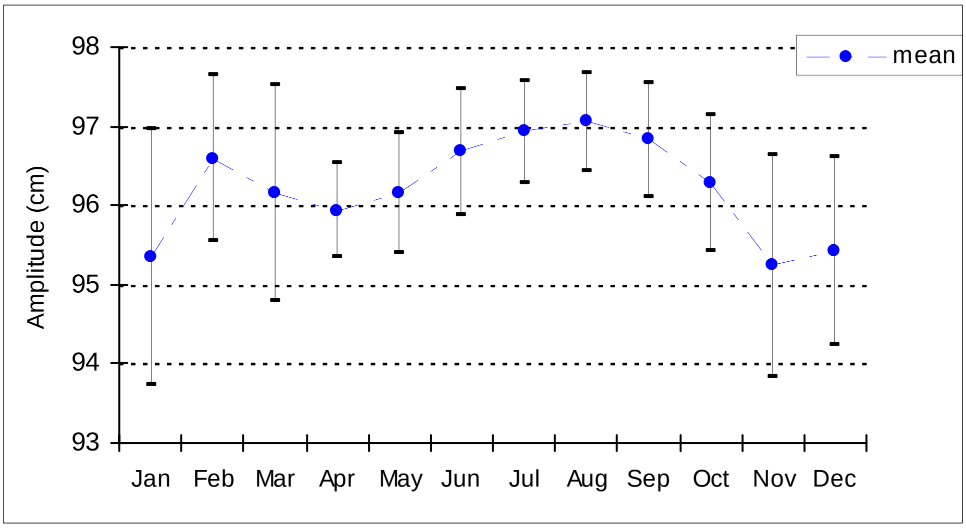
6.4.1 Natural Variability (natural month to month variations in the local M2 tides)

To some extent, seasonal tidal modulations (perhaps due to the presence of vegetation or changes in the sediment supply) have been addressed, by obtaining repeated measurements at the same time of the year. However, analysis of a single month may not be representative of, for example, annual mean values.

In order to attempt to quantify the effect of natural variability on sea level measurements, yearly data obtained between 1987 and 2003 from the permanent tide gauge at Aveiro, have been analysed month by month (distributed into calendar months).

A harmonic analysis was performed on each individual month for the entire record, providing a monthly mean value and the standard deviation about the mean, for 11 years of data (Figure 6.5). Figure 6.5 shows the amplitudes and phases of the M_2 constituent on a monthly basis, over a 12 month period. The Figure shows a seasonal cycle, whilst the scatter of the values in each month provides an indication of the variation within a particular month, from year to year.

(a)



(b)

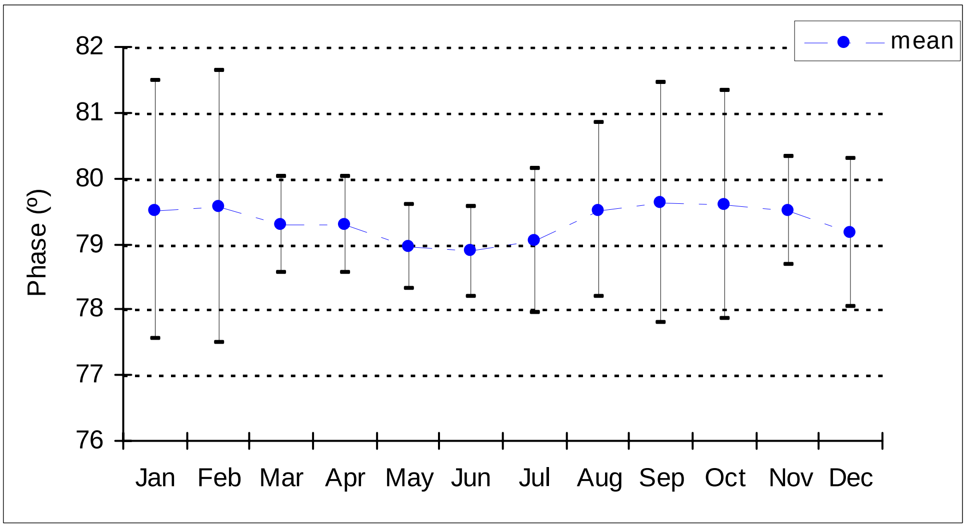


Figure 6.5 Seasonal variability in the M_2 amplitude (a), and phase (b), for 11 years of sea level data from the permanent tide gauge at Barra, within the inlet. The mean monthly (detrended) values are represented by the blue circle, together with +/- the standard deviation.

In general, the spread within a particular month is around 0.02m or 2% of amplitude, and 2.4º or 5 minutes in phase. The seasonal cycle is of comparable magnitude in both parameters. Although the standard deviation obtained for the 11 years of monthly data is related to the mean at the entrance and, as such, should not be transferred to the remainder of the Lagoon, this has been undertaken here because no other long-term (1987-2003) record is available for a gauge located inside the Lagoon. However, if these results are compared to those obtained for the monthly data collected at Torreira station, inside the lagoon (where, once again, the main sea level component value (M_2)

is used as being indicative, as it is the main constituent), the same spread is found for amplitude whereas, for phase the value is slightly smaller (2º, in phase).

6.4.2 Uncertainties due to sampling times

The discrete sampling of sea levels could produce different results, if samples were obtained at different times, for example, because of noise introduced by wave aliasing, that has not been accommodated completely by the instrument design (see Section 4.6.2a for details of the integration period and the mechanical damping system adopted). This uncertainty has been quantified here by using a set of 6 minute interval sea level measurements, for 1 month and 1 hour and creating 10 subsets of the initial data. Each subset would start 6 minutes from the previous set. A harmonic analysis was performed, individually, on the 10 subsets, in order to determine the mean and standard deviation of the M_2 amplitude and phase (M2, once again, used as an indicative).

The mean and standard deviation of the amplitudes were 0.984 ± 0.471×10^{-4} m, respectively; in terms of the phases, the mean and standard deviation were 79.0± 0.1×10^{-2} º. These results present very small differences, which can be ignored.

6.4.3 Different analysis techniques for 1987/8 and 2002/3

Different methods of tidal analysis can produce slightly different results from the same data. One reason for this is the way in which the 18.6 year nodal variations are accounted for, within the program. TIRA (a program in TASK2000 package) assumes Equilibrium Tide modulations (± 3.7% in M_2 amplitude) and adjusts accordingly.

This contribution to uncertainty is eliminated in this study, since all the older (1987/8) data were re-analysed using the same tidal package as used on the analysis of the recent (2002/3) data.

6.4.4 Systematic errors in the gauges

The measurements performed by the Hydrographic Office used traditional bubbler gauge equipment and, in the absence of any direct evidence, it is assumed they are free of systematic error.

The recent measurements were of pressure which, for comparison, was converted to level variations. Adjustments have been made for the calibrations based on the Holyhead data (Section 4.6.2c), but there remains an uncertainty about the density in the Lagoon and how it changes throughout a tidal cycle. A salt water density of 1.027 kg.m^{-3}

has been used for all the conversions, because salinity and temperature data taken simultaneously with the pressure measurements were not available. However, the density could have varied between 1.000 and 1.027 kg m^{-3}. As such, this renders an uncertainty in the measured tidal amplitudes (and, of the constituents) of about +1%. Phases and times will not be affected.

In summary, the first effect introduces uncertainties of the order of 1 to 2% in amplitude and 2º (5 minutes) in phase. The fourth effect influences only, the amplitude, once again by 1 to 2%. It should be noted that is not possible to be precise about these 'errors', in a formal sense; however, as will be seen, they are much less than the observed differences.

6.5 Comparison between the analyses

The amplitude and phase of the dominant M_2 constituent, between 1987/8 and 2002/3, have been compared in detail. Other constituents show similar changes, although these will be referred to only briefly. The ratio between the 2002/3 and 1987/8 amplitudes, calculated for each station, are shown in Figure 6.6. The phase difference between the 2002/3 and 1987/8 datasets are shown in Figure 6.7 (in degrees), and the equivalent value in minutes is listed in Table 6.5. Note that the results for the Areão (A) station will not be compared and discussed, since the data for 1987/8 is not suitable for analysis, i.e., the sensor was not submerged long enough for the dataset to be considered adequate for analysis.

The results obtained show that there is an increase in M_2 amplitude and a decrease in phase in the 16 years between both datasets. The smallest changes are found at the stations located closest to the inlet and the largest are usually located farther down the channels.

This pattern is confirmed in the plots showing amplitude and phase as a function of the distance from the station to the inlet (Figure 6.8). This trend is also found when considering the overall percentage increase of amplitude and decrease in minutes, between the 1987/8 and 2002/3 results, as a function of station distance to the inlet (Figure 6.9). Whilst, in 1987/8, the amplitude had an average 0.89 (11% decrease) in the first 10km, 0.56 (44% decrease) between 10-20km and 0.32 (68% decrease) between 20-30km, during 2002/3 they averaged 0.96 (4% decrease), 0.71 (29% decrease) and 0.55 (45% decrease), respectively. With regards to phase, the lag in 1987/8 in the first

10km averaged 17º, 57.3º between 10-20km and 119.4º between 20-30km. For 2002/3, the values are 14º, 47º and 80º respectively. These results suggest that the amplitude attenuation, affecting the tide as it propagated away from the inlet, was greater in 1987/8. The phase lag is also less affected in 2002/3, i.e., tide propagates faster at present.

Stations		M2 Amplitude (m)		Amplitude increase (%)	M2 Phase (º)		Phase decrease (min)
		1987/8	2002/3		1987/8	2002/3	
Carregal	(C)	0.338	0.530	56.7	197.2	168.8	58.8
Ribeira	(O)	0.351	0.516	47.0	193.8	165.1	59.4
Puxadouro	(PU)	0.319	0.493	54.8	193.8	164.8	60.1
Pardilhó	(PA)	0.328	0.541	65.0	190.3	163.7	55.1
Manchão	(M)	0.228	0.608	166.4	218.6	130.1	183.3
Cais Bico	(CB)	0.586	0.863	47.4	137.9	120.0	37.1
Torreira	(T)	0.476	0.706	48.3	140.3	128.0	25.3
S.Jacinto	(SJ)	0.861	0.925	7.5	90.8	87.8	6.2
Barra	(BA)	0.962	0.977	1.6	79.4	78.1	2.7
Costa Nova	(CN)	0.887	0.971	9.5	95.7	87.5	16.9
Vagueira	(VG)	0.489	0.851	73.8	129.7	107.5	46.0
Areão	(A)	x	0.432	x	x	136.5	x
Lota	(L)	0.834	0.918	10.1	103.4	100.5	6.0
Rio Novo	(RN)	0.631	0.794	25.7	117.6	108.4	19.2
Cacia	(CA)	0.580	0.685	18.1	126.7	119.7	14.4
Sacor	(S)	0.871	1.019	17.0	91.4	90.1	2.6
Ponte Cais II	(PC2)	0.839	0.950	13.2	98.6	93.3	10.8
Vista Alegre	(VA)	0.504	0.639	26.7	145.2	135.7	19.8
Cais da Pedra	(CP)	0.503	0.612	21.8	159.1	147.2	24.6

Table 6.5 Summary of changes the in M_2 amplitude and phase, which have occurred at the stations surveyed within the Ria de Aveiro.

The other dominant semi-diurnal constituents are S_2 and N_2 (refer to Appendix A5 & A6). Their variation in time and space is the same as M_2. However, the S_2 and N_2 amplitudes are, on average, 0.29 and 0.18 smaller than the M_2 amplitude. The 1987/8 results also show that the average N_2 amplitude is 50% smaller than that of S_2, whereas this value reduced to only 32 % in the 2003/4 results.

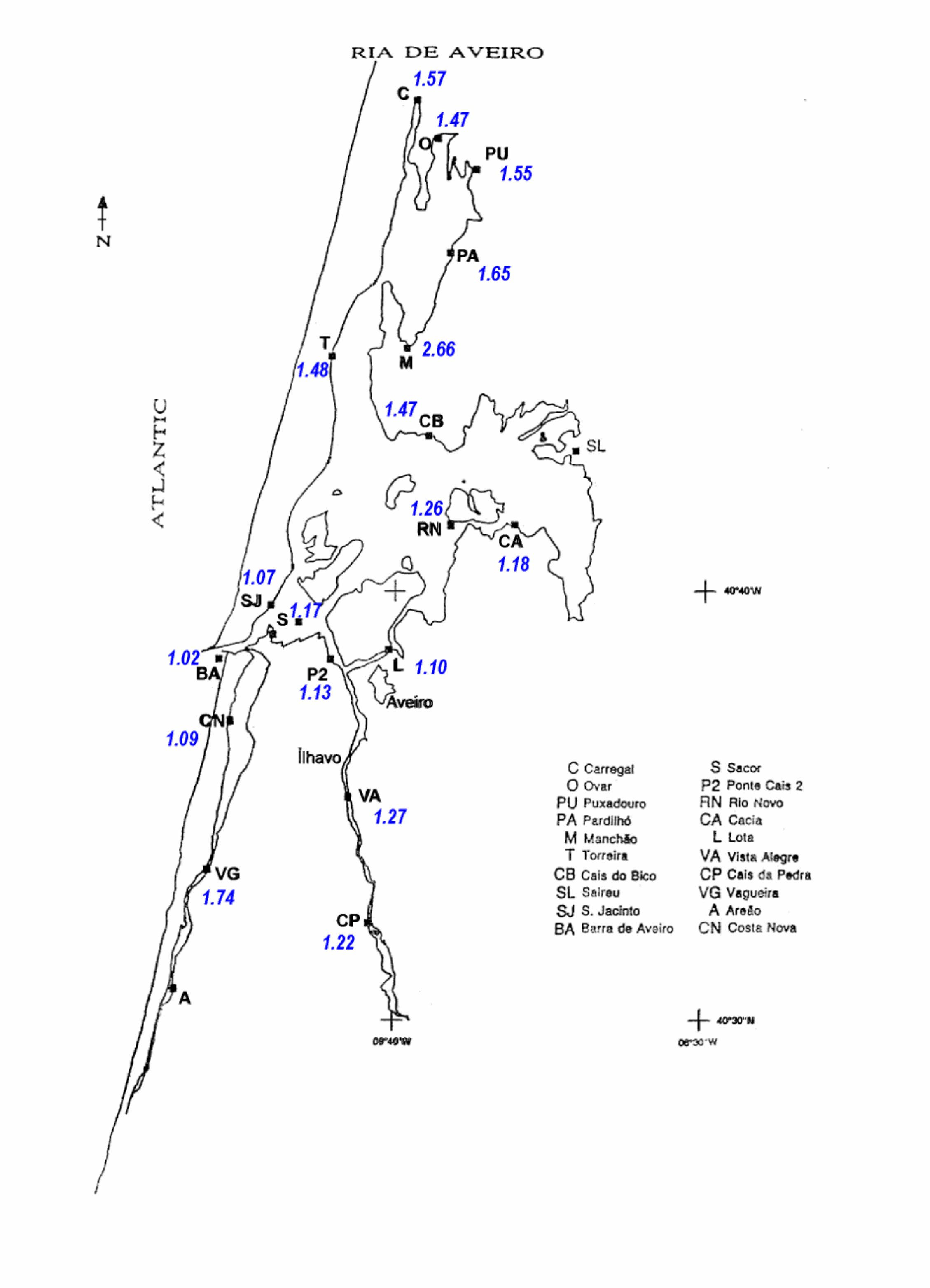


Figure 6.6 M_2 amplitude ratio, between 2002/3 and 1987/8 (for details, see text; map based upon, Instituto Hidrográfico, 1991).

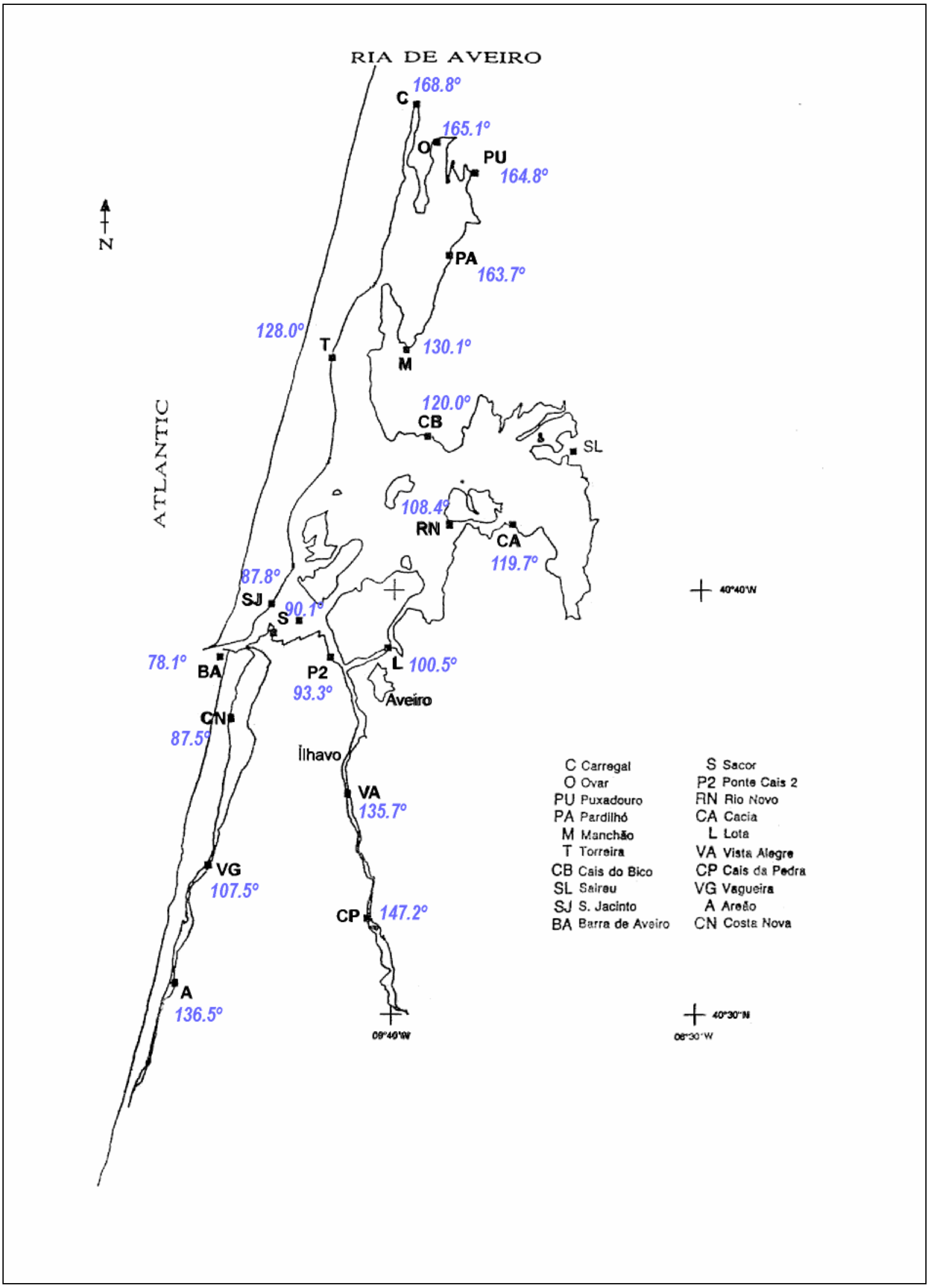


Figure 6.7 M_2 phase decrease (in degrees), since 1987/8, obtained from the phase difference between the 2002/3 and 1987/8 observed data. These results are the same as those presented in Table 6.5, considering 1º~ 2 min (map based upon, Instituto Hidrográfico, 1991).

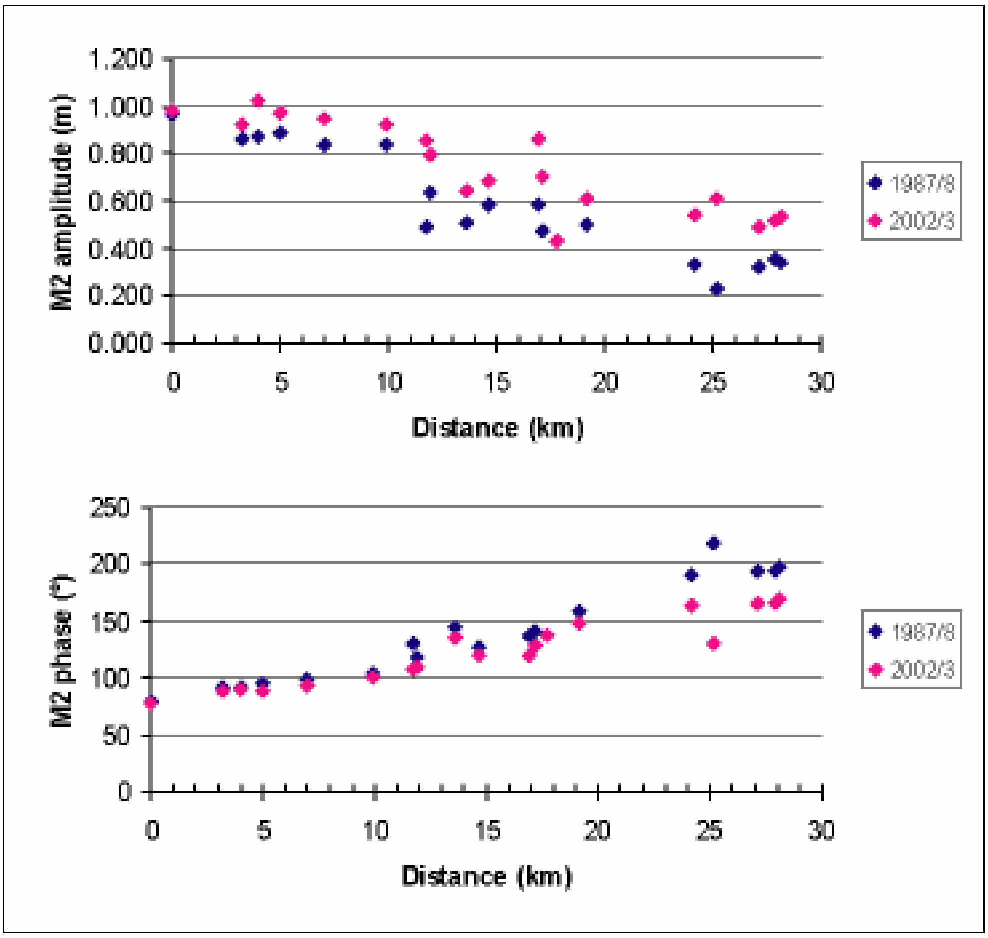


Figure 6.8 1987/8 and 2002/3 M_2 amplitude and phase variations with distance from the inlet station Barra.

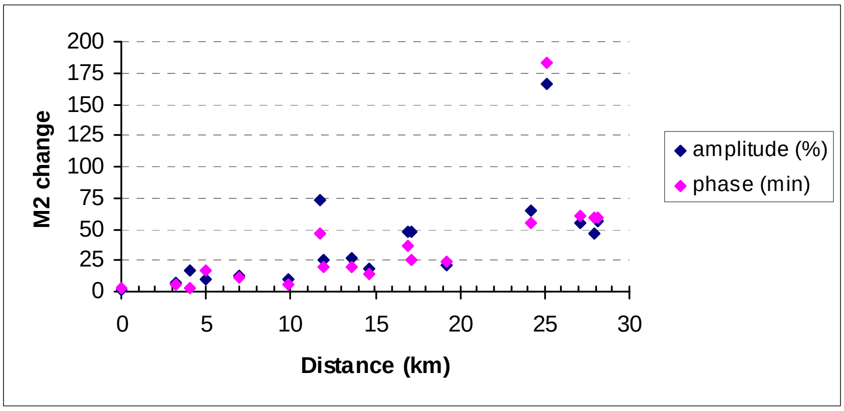


Figure 6.9 M_2 amplitude and phase variations relative to distance from the inlet station, Barra (BA). There is a general increase in amplitude since 1987/8, shown in %, and a phase decrease shown in minutes.

The higher harmonic overtide, M_4, and compound tide, MS_f, which represent respectively, 0.09 and 0.14, on average, of M_2 amplitude in the Lagoon, vary in a similar way to the M_2. The M_4 amplitude has increased with time, except at few stations located on channels or areas known to have undergone dredging (e.g. Vagueira, Costa Nova, Torreira, Carregal and Ovar) and engineering works (Lota). The largest increases, e.g. Manchão and Pardilhó, occurred up creeks subject to sediment infilling as a result of mudflat erosion. Whilst the amplitude of M_2 tends to decrease with distance to the inlet, there is no clear trend in the M_4 amplitude variation with distance from the inlet (Figure 6.10 & Table 6.6). The M_4 phase decreases (Figure 6.11 & Table 6.6) with time, except in the central section of the Lagoon and in the Mira Channel. There is no clear pattern of variability with distance from the inlet, illustrating the influences of complex channel geomorphology. The variations in M_4 (with similar variations in MS_f) reflect the new dynamics in the Lagoon, as will also be discussed in Section 6.6.

Stations		M4 Amplitude (m)		Amplitude increase (%)	M4 Phase (º)		Phase decrease (hrs)
		1987/8	2002/3		1987/8	2002/3	
Carregal	**(C)**	0.064	0.066	3.5	304.8	163.3	4.9
Ribeira	**(O)**	0.050	0.054	6.9	293.0	246.9	1.6
Puxadouro	**(PU)**	0.048	0.061	26.6	290.6	242.9	1.6
Pardilhó	**(PA)**	0.035	0.068	97.6	254.9	141.7	3.9
Manchão	**(M)**	0.034	0.075	118.1	300.4	140.0	5.5
Cais Bico	**(CB)**	0.054	0.078	45.7	164.4	39.3	4.3
Torreira	**(T)**	0.057	0.037	-34.7	262.1	149.3	3.9
S.Jacinto	**(SJ)**	0.048	0.048	0.0	342.5	309.3	1.1
Barra	**(BA)**	0.040	0.056	41.8	205.4	256.8	-1.8
Costa Nova	**(CN)**	0.041	0.039	-5.6	25.7	303.2	-9.6
Vagueira	**(VG)**	0.133	0.040	-69.9	7.7	138.5	-4.5
Areão	**(A)**	x	0.127	x	x	241.3	x
Lota	**(L)**	0.097	0.090	-6.7	78.1	341.3	-9.1
Rio Novo	**(RN)**	0.045	0.066	45.4	353.7	21.6	11.5
Cacia	**(CA)**	0.039	0.040	2.3	9.3	49.9	-1.4
Sacor	**(S)**	0.051	0.067	30.6	153.2	328.5	-6.0
Ponte Cais II	**(PC2)**	0.063	0.084	32.7	168.5	330.4	-5.6
Vista Alegre	**(VA)**	0.040	0.050	24.7	344.3	117.9	7.8
Cais da Pedra	**(CP)**	0.050	0.073	47.5	214.5	118.1	3.3

Table 6.6 Summary of the changes in M_4 amplitude and phase that have occurred in the Ria de Aveiro. A negative % increase in amplitude represents an amplitude decrease, whilst a negative phase decrease corresponds to a phase increase over the 16 year period investigated.

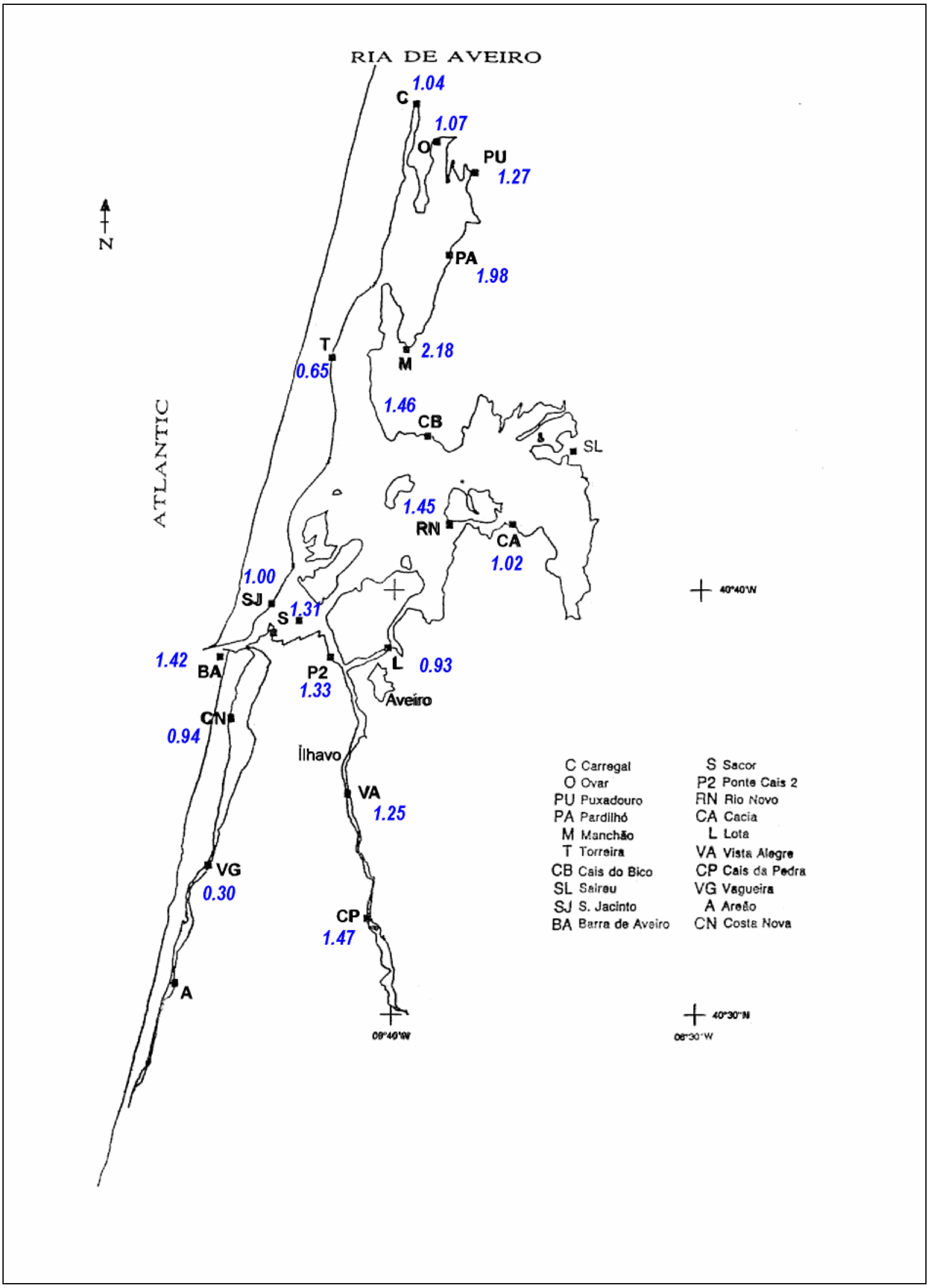


Figure 6.10 M_4 amplitude ratio, between 2002/3 and 1987/8. Note: values below 1 represent a decrease in amplitude, over the 16 year period investigated (for details, se text; map based upon, Instituto Hidrográfico, 1991).

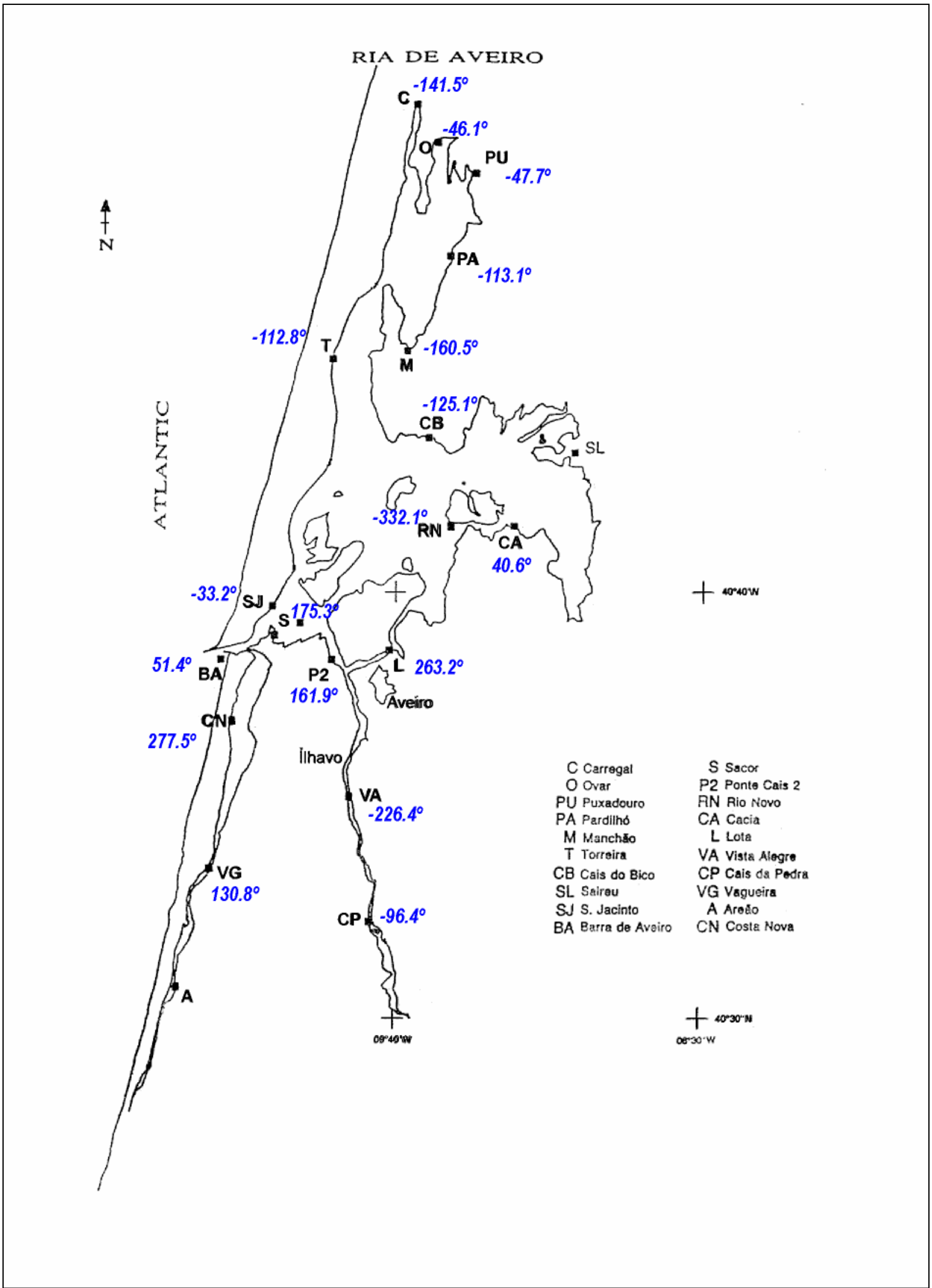


Figure 6.11 M_4 phase difference (in degrees), between 2002/3 and 1987/8 observed data. Negative values correspond to a decrease in phase, whilst a positive values correspond to an increase over the 16 year period investigated (map based upon, Instituto Hidrográfico, 1987).

6.6 Asymmetry

The results presented previously have quantified the main characteristics, amplitude and phase, of the dominant tidal constituents and described their variation in space and time. Distortions of the offshore tide, as it propagates through the shallow Lagoon, were found in the increase in the non-linear harmonics. These harmonics increase as a result of friction, non-linear advection, and interactions with channel geometry as the tide oscillates within the estuary (Aubrey & Speers, 1985). Asymmetries are generated during the rise and fall of the surface tide and depend upon the phases between the various tidal constituents. They can occur about the high or low water level, when considering tidal elevation (vertical water movements) or about slack water when considering tidal currents (horizontal water movement)(Teles, 2003).

According to Aubrey & Speers (1985) and Speers & Aubrey (1985), the M_2 constituent and its first harmonic (M_4) can be used to illustrate the dominant features of tidal asymmetries, in systems like the Ria de Aveiro Lagoon. The type of tidal distortion, flood-dominant versus ebb-dominant, depends upon the relative phasing of the M_2 and M_4.

Channels without inter-tidal flats develop a time-asymmetry, characterised by a longer falling tide. This is enhanced by friction and increases in the cross-sectional area. Currents are stronger during flood than ebb. Channels with these characteristics are designated as flood-dominant.

Channels with inter-tidal flats can have a longer rising tide and stronger currents, if the tidal area is large to compensate the effects of variable channel geometry. Channels with relatively small values of the *a/h* ratio (where, *a* is the sea level fluctuation and *h* is the water depth) and rectangular cross-section areas require a smaller inter-tidal flat area, to produce an ebb-dominant asymmetry (Speers & Aubrey, 1985).

The distortion of the tidal curve can be assessed, considering that the majority of the asymmetry of the tide can be represented by the superposition of the M_2 and M_4 constituents, such that, by defining M_2 and M_4 constituents as

$$A_{M_2} = a_{M_2} \cos(\omega_{M_2} t - \theta_{M_2})$$

$$A_{M_4} = a_{M_4} \cos(\omega_{M_4} t - \theta_{M_4})$$

the distorted sea surface height becomes

$$A = a_{M_2}\cos(\omega_{M_2}t - \theta_{M_2}) + a_{M_4}\cos(\omega_{M_4}t - \theta_{M_4})$$

where the sea surface $M_2 - M_4$ relative phase is $\varphi = 2\theta_{M_2} - \theta_{M_4}$

and where φ is the indicator of non-linearity, as a result of both energy transfer, from M_2 to M_4 and friction dissipation. The tide is undistorted or symmetric when $a_{M_4}/a_{M_2} = 0$ and asymmetric when $\varphi \neq 0^{o}$ and $\varphi \neq 180^{o}$. In the case of asymmetry, if φ is within 0º - 180º, the time of high water is advanced relative to the low water and there is flood-dominance, else if φ is within 180º - 360º, the opposite situation occurs, leading to ebb-dominance. These cases become more acute as a_{M_4}/a_{M_2} increases.

Changes to basin geometry, bottom friction or topography can change the prevailing tidal asymmetry (Friedrichs & Aubrey, 1988; Dronkers, 1986, 1998). Therefore, estuarine morphological changes in response to dredging or reclamation, or if the estuary naturally becomes in-filled or eroded, the tidal asymmetry can be expected to change, together with flood or ebb-dominance (Teles, 2003).

Tidal asymmetry has important effects on both the geological evolution of shallow estuaries and the navigability of estuarine channels, with implications for estuarine sediment transport, dispersal of water column contaminants and (over long time scales, estuarine/inlet stability (Aubrey & Speer, 1985). This relationship is because the physics of these processes is essentially non-linear.

The results obtained from numerical and field data suggest that an increased water depth reduces the flood-dominant nature of the shallow estuaries and, in some cases, may even cause a change to an ebb-dominant system (Friedrichs & Aubrey, 1988; Aubrey & Speer, 1985; and Speer & Aubrey, 1985). If sea level rise accelerates, increased water depth could decrease the flood currents and increase the ebb currents, which decrease the rate of estuary infilling. The decrease in estuary infilling may cause an inland expansion of the estuary, at a faster rate than might otherwise have been expected (Friedrichs & Aubrey, 1988).

To determine the tidal dominance in the Ria de Aveiro Lagoon, the amplitude and phase of M_2 and M_4 constituents, obtained from harmonic analysis of 1987/8 and 2002/3 sea level data (Section 6.2 & 6.3), are used to calculate the amplitude ratio and the relative phase (Table 6.7). The asymmetry calculated for each station, is shown in Figure 6.12.

The results obtained from the 1987/8 data (Figure 6.12a & Table 6.7) show that the Lagoon is predominantly flood-dominant. The exceptions to this pattern are the inlet, Station BA, together with the first station at the entrance to the S. Jacinto Channel, SJ. The middle sections of the two southern channels, Mira Channel and Ílhavo Channel, also have ebb-dominant stations (VG and VA). Finally, the last stations that show this type of asymmetry are RN and CA, located along the Vouga Channel.

Data collected from 2002/3 (Figure 6.12b & Table 6.6) show that there is a tendency for the central section of the Lagoon to be ebb-dominant whilst the northern section of the S. Jacinto Channel and Ovar Channel, together with the (two) southern Channels (Mira and Ílhavo), are flood-dominant.

A clear difference exists when comparing the results for 1987/8, with those of 2002/3 (Figure 6.12c). The spatial distribution of asymmetry has shifted from a flood-dominant, to one where both types of asymmetry seem to be equally present. The implication of these changes, in terms of sediment dynamics and other estuarine dynamics, are beyond the scope of the present study.

Station		Amplitude Ratio M4/M2		Relative Phase 2M2-M4	
		1987/8	2002/3	1987/8	2002/3
Carregal	**(C)**	0.19	0.12	89.7	174.3
Ribeira	**(O)**	0.14	0.10	94.6	83.3
Puxadouro	**(PU)**	0.15	0.12	97.1	86.7
Pardilhó	**(PA)**	0.11	0.13	125.7	185.6
Manchão	**(M)**	0.15	0.12	136.9	120.1
Cais Bico	**(CB)**	0.09	0.09	111.4	200.6
Torreira	**(T)**	0.12	0.07	18.4	106.8
S.Jacinto	**(SJ)**	0.06	0.05	199.0	226.3
Barra	**(BA)**	0.04	0.04	313.4	259.4
Costa Nova	**(CN)**	0.05	0.04	165.7	231.9
Vagueira	**(VG)**	0.27	0.05	251.7	76.5
Areão	**(A)**	0.32	0.29	409.0	31.6
Lota	**(L)**	0.12	0.10	128.6	219.6
Rio Novo	**(RN)**	0.07	0.08	241.6	195.2
Cacia	**(CA)**	0.07	0.06	244.2	189.6
Sacor	**(S)**	0.06	0.07	29.6	211.7
Ponte Cais II	**(PC2)**	0.08	0.09	28.6	216.3
Vista Alegre	**(VA)**	0.08	0.08	306.2	153.5
Cais da Pedra	**(CP)**	0.10	0.12	103.7	176.3

Table 6.7 Tidal distortion, based on M_2 and M_4 interactions and estimated from the relative M_2 - M_4 phase.

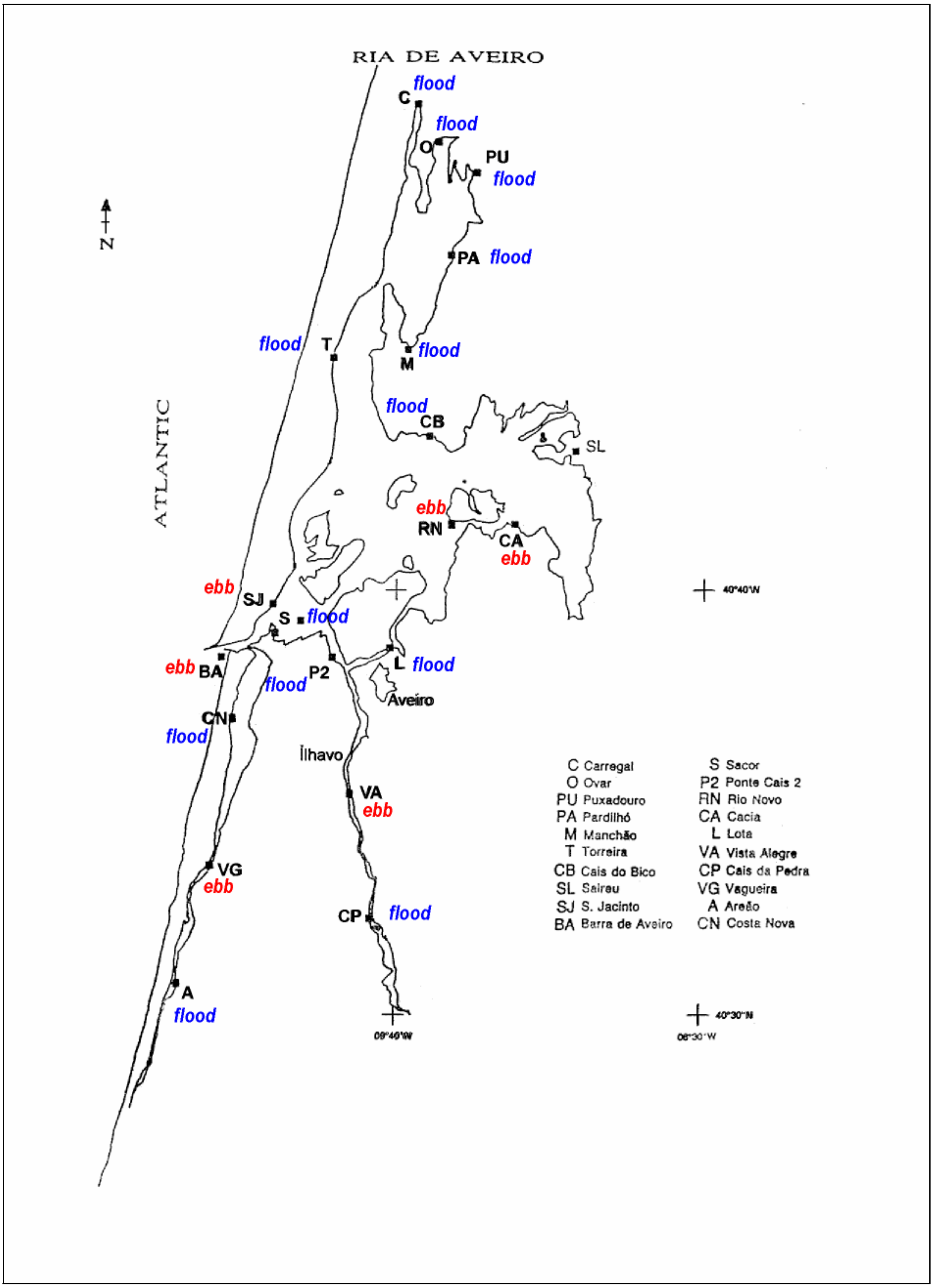


Figure 6.12a Asymmetry calculated for 1987/8 (map based upon, Instituto Hidrográfico, 1991).

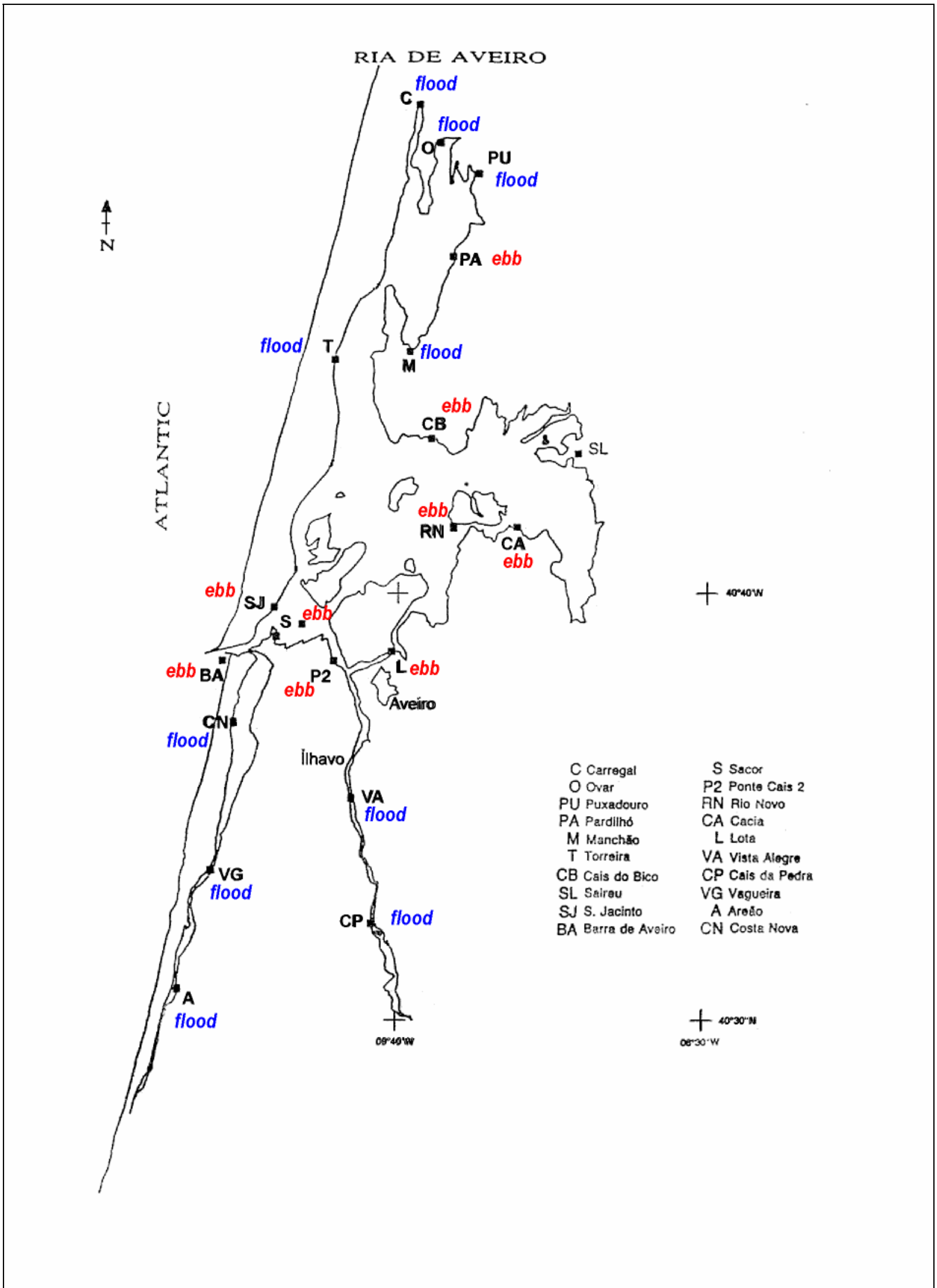


Figure 6.12b Asymmetry calculated for 2002/3 (map based upon, Instituto Hidrográfico, 1991).

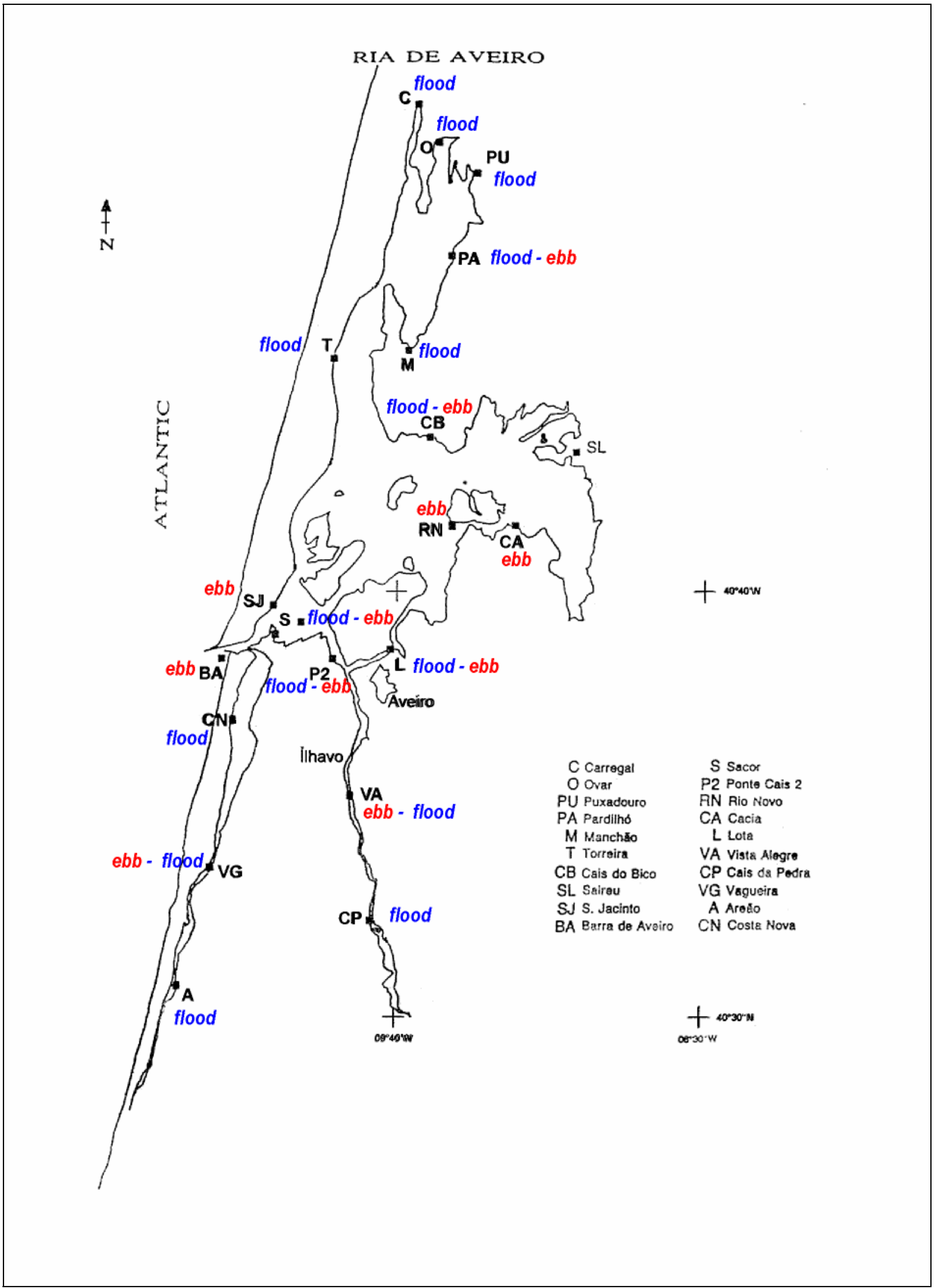


Figure 6.12c Change in the asymmetry in the Lagoon (combination of Figures 12a & 12b). If only a single asymmetry is shown, this means that no change has occurred over the 16 years of data analysed; otherwise, the first case shown is related to 1987/8 and the other to 2002/3 (map based upon, Instituto Hidrográfico, 1991).

6.7 Cause of Sea Level Variability

Sea level data collected in the Ria de Aveiro, 16 years apart, have been analysed by harmonic analysis. The resulting constituents have shown that there have been significant changes in the Lagoon, within the particular period analysed.

The processes influencing estuarine evolution and, consequently, its hydrodynamics are complex; hence, it is difficult to associate any changes identified in the M_2 constituent to any particular process. Attempting to identify a cause for the changes described would require more data than was available to this study.

This problem was mentioned previously and a simple analytical model of the Lagoon, by analogy to a RLC-circuit, was developed to analyse how the dimensions of a single narrow inlet (depth, width and length) or varying sea surface oscillation at the inlet, bottom friction and Lagoon surface area might affect the amplitude and phase of the wave inside the lagoon, after it has propagated through the inlet (Section 4.7.1). The inlet has been found to act as a filter on the coastal wave.

The Ria de Aveiro has an inlet where width and length are fixed by existing breakwaters. The parameters, relative to the inlet and that may change, are water depth and bottom friction. Changes in depth (Figure 6.13) have occurred in the inlet since 1987/8, due to dredging and bottom scouring (Rua, 2003). The M_2 tidal component, at Barra (inside the inlet) has increased by 0.015m and the phase has decreased by 1.3º. These changes are negligible, considering the tide gauge error.

No observed data are available to confirm whether the surface area of the Lagoon has changed. On-site observations suggest that breaching of tidal-barrier walls is happening in some areas of the Lagoon (personal communication, Dr. João Dias). This could lead to the assumption that the surface area may have increased. However, on the other hand, during the 2003 fieldwork some channels in the Lagoon were found to be closed off by sluice and dyke-type constructions. Such obstructions would retain water that otherwise would flow into the Lagoon, i.e. reducing the Lagoon area.

The average amplitude and phase change for the M_2 constituent, based upon the results obtained from all of the stations inside the Lagoon for 2002/3, is 0.245m and 17.4º, respectively.

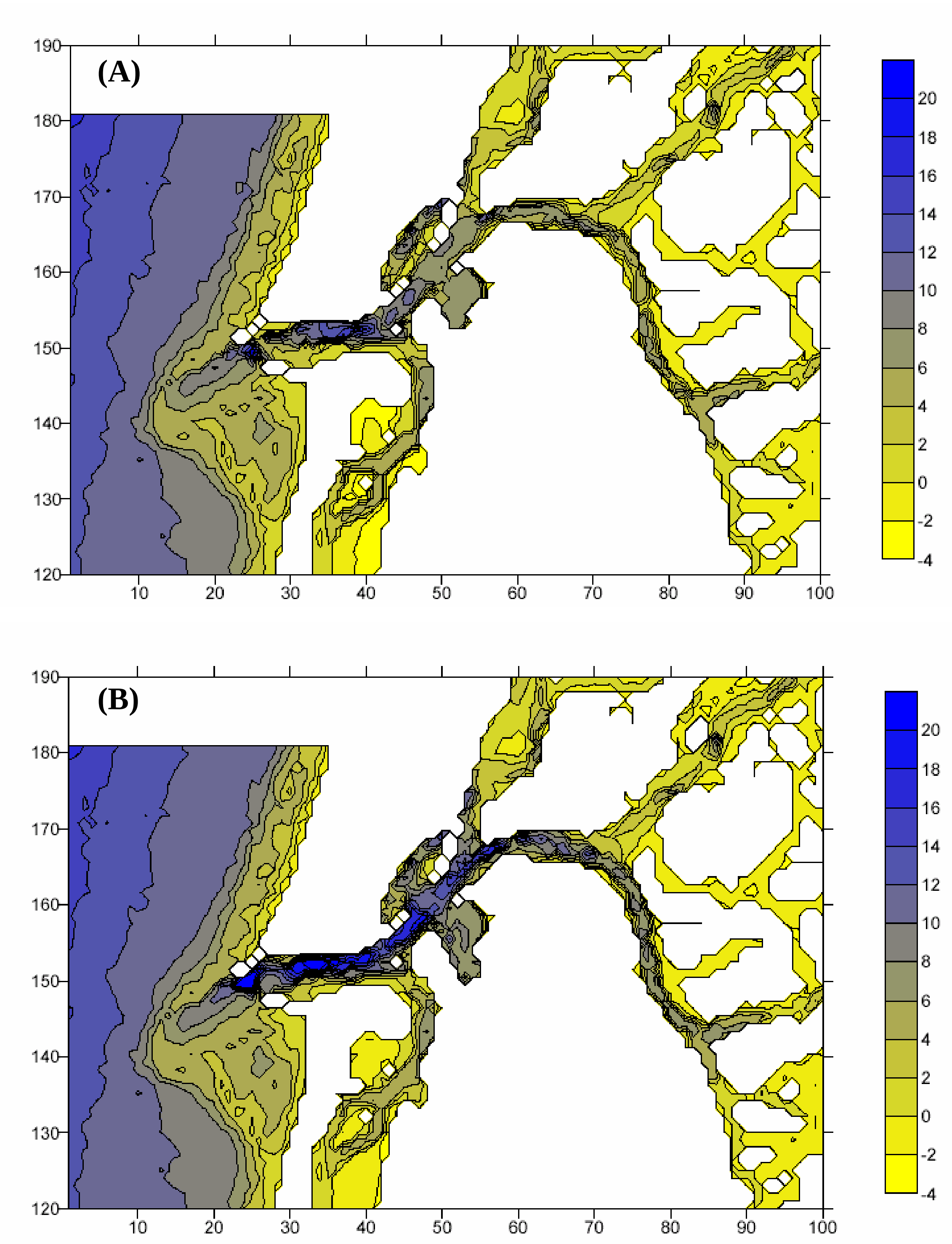


Figure 6.13 Bathymetry, based upon surveyed depth, showing the inlet and the central section of the Lagoon: (A) 1987/8 bathymetry - scale on the right hand side of the figure represents water depth, in metres, relative to the local datum (-2.00 m below MSL); (B) 2002/3 bathymetry, showing the same section as in A. Changes between A and B are a result of the update of the bathymetry. The greatest changes in depth are along the channel running from the mouth, in the eastward direction. This channel is dredged routinely, for navigation.

The analytical numerical approach for the tidal response of a Lagoon has demonstrated that an increase in tidal amplitude and decrease in tidal phase can be caused by changes in the depth of the inlet channel (Section 4.7.1). In terms of the application to the Ria de Aveiro, the response to an average 9.6m increase in the depth (estimated from the observed data), of the inlet channel, was a 0.212m increase in the amplitude and a 15.7º decrease in phase. The estimated values lie very close to the observed average value, although these are slightly larger than the estimated tidal changes. The comparison between average observed values and numerical estimates suggests that the response of the M_2 component, within the Lagoon, is affected predominantly by the changes in the depth of the inlet channel. The numerical model also suggests that the effect of a possible increase in surface area is small, compared to the effects from a change in the inlet depth. According to numerical results, the increase in surface area could lead to a 0.029m decrease in amplitude and a 2.1º increase in phase. Although this effect causes an opposite response in terms of the tidal characteristics within the estuary, it is approximately an order of magnitude smaller, i.e., less significant.

Changes in the depth of the inlet channel appear to explain the overall response of the M_2 constituent within the estuary, although the M_2 average for the whole of the Lagoon are, necessarily, a generalisation. However, the changes at different sites have to be analysed individually. Dredging of some of the sections of the navigation channel, together with the influence of friction and the inter-tidal flat, can cause localised effects. Data which are not available, for instance, regarding the change in the cross-section area of the channels, is needed in order to further explain the results found here.

6.8 Concluding Remarks

Harmonic analyses of sea level records show that the Ria de Aveiro Lagoon is dominated by the semi-diurnal tide. The M_2 constituent, which is influenced by strong non-linearities and frictional effects, was examined in detail. The non-linear response to tidal forcing is illustrated by an increase in the high frequency M_2 overtides, the compound tides and the MS_f constituent, throughout the estuary, whilst the friction interactions are demonstrated by the phase and amplitude changes in the tide.

Tidal variations within the Lagoon also shows that, for the past 16 years, there has been a general increase in the amplitude and a decrease in the phase, for most of the harmonic constituents. The asymmetry calculated for each station also shows that there have been changes over the past years. The results show that the majority of the Lagoon was flood-dominant, during 1987/8. Since then, the central section of the Lagoon (including Laranjo Bay and Vouga Channel) has become ebb-dominant, whilst the northern and southern sections are flood-dominant, i.e., presently, there is no clear overall dominance.

In order to investigate possible mechanisms responsible for the changes found in M_2 between 1987/8 and 2002/3, the observed results were compared with those estimated from numerical modelling of the tidal response of the Lagoon, connected to the Atlantic Ocean through a narrow inlet. The comparison, between average observed values and numerical estimates, suggests that the response of the M_2 component within the Lagoon is affected predominantly by changes in the depth of the inlet channel.

The deepening that has taken place in the main navigation channels (located mainly in the central section of the Lagoon) correlate with the asymmetry change, in the central section of the Lagoon, from flood-dominant to ebb-dominant.

Chapter VII

MODEL SIMULATIONS, RIA DE AVEIRO: RESULTS AND DISCUSSION

Local sea level variability was investigated in the previous Chapter, where the analysis of sea level records obtained from the Ria de Aveiro was used to study sea level changes, since 1987/8.

In this Chapter a 2DH- Hydrodynamic model (Section 4.7.2) is used to examine how changes to the Lagoons bathymetry might affect sea level estimated throughout the Lagoon. The model was run initially using the bathymetric data from 1987/8, and then re-run using digitised updates to the earlier bathymetry. The results for both runs of the model, using different bathymetries, are discussed and compared with the bathymetric and observed (sea level) data.

7.1 Model Simulations

The 2DH hydrodynamic model, described in Section 4.7.2, was run for the 1987/8 and 2002/3 bathymetries. The resulting sea level time-series, computed for 1987/8 and 2002/3 at all the 18 stations (Figure 4.24, Section 4.7.2a) were analysed by harmonic analysis, using the 1 month Tira programme, from the Task 2000 tidal analysis package. The time-span of the files used in the 1987 harmonic analysis and the model simulation are equivalent to those used in the 2002/3 analysis.

In order to simplify this discussion, the results for the dominant tidal constituent (M_2) are the only ones presented here, as they are considered representative of the other major constituents (refer to Appendix A7, for other constituents). The results obtained for the M_2 amplitude and phase, from the numerical data produced by the model run for 1987/8 and 2002/3, are shown in Figures 7.1 & 7.2, respectively; their values are listed in Table 7.1. The spatial distribution of the relative amplitude difference and the difference in phase lag, between 2002/3 and 1987/8, are shown in Figures 7.3 & 7.4, provide an overall view of the changes that have occurred.

Over past years, there has been an increase in amplitude for the majority of the stations and a decrease in phase, i.e., the time of high water occurs earlier.

The amplitude tends to decrease, with distance from the inlet and the corresponding phase tends to increase. As the tide propagates from the inlet (Barra) into the Lagoon, energy dissipation gradually dampens the wave, causing the amplitude to decrease with distance from the inlet.

Figure 7.1 shows that, between 1987/8 and 2002/3, the amplitude at each station has increased, with the exception of the stations located within the Northern section of the S. Jacinto Channel (Carregal-Manchão). The stations within the central section of the Lagoon (from Torreira until S. Jacinto (6-8) and Lota to Cacia (16-18)) show a gradual 5 to 14 % increase in amplitude. An increase is also found for the remaining stations, located at the southern Mira and Ílhavo Channels. The largest of the changes found are for some of the stations, located in the southern Mira and Ílhavo Channels. An increase in the M_2 amplitude, of the order of 73%, has been estimated for part of the Mira Channel.

Figure 7.2 shows a decrease in phase, between 1987/8 and 2002/3. The greatest changes are estimated for Areão (A) and for the stations located between Ponte Cais II and Cais da Pedra. The mean phase delay for these stations is 20.7º, i.e., approximately 43 min. The smallest changes, within the range of 3-5º (~ 6-10 min), are for the stations from Carregal - Torreira, Costa Nova - Areão and Lota - Cacia. The spatial distribution of these results (Figure 7.4) shows that the M_2 phase lag, for the section of the Lagoon above Torreira has, decreased by 5º (10min). This range is also found at the start of the Mira Channel (until Vagueira). The central section of the Lagoon has an estimated 5-11º (10-23min) decrease in phase, whilst the most substantial change, equivalent to a mean decrease of 21º, is found at stations within the Ílhavo Channel.

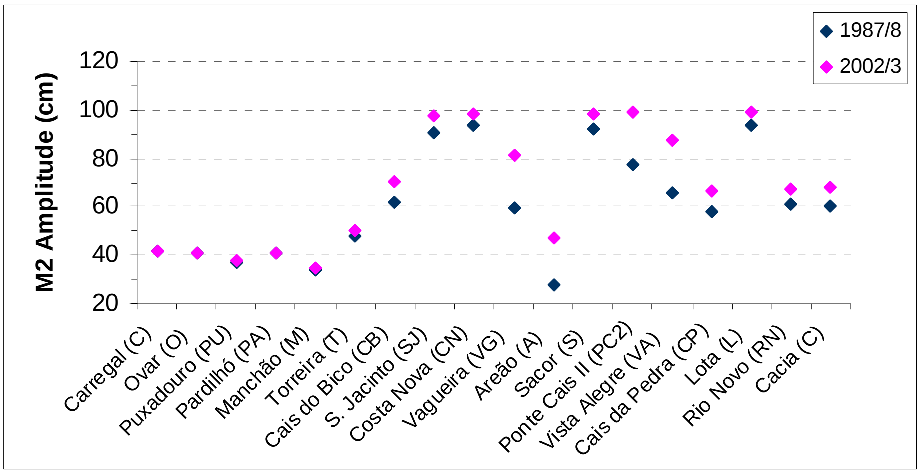


Figure 7.1 M_2 amplitude for the 1987/8 and 2002/3 model simulations, for 18 stations distributed throughout the Lagoon.

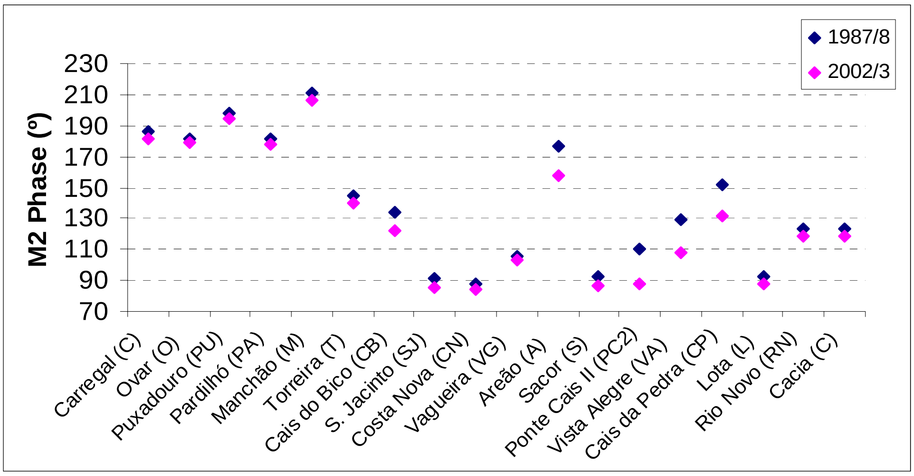


Figure 7.2 M_2 phase for the 1987/8 and 2002/3 model simulations, for 18 stations distributed throughout the Lagoon.

Stations		M2 Amplitude (cm)		Amplitude increase (%)	M2 phase (º)		Tide earlier by (min)
		1987/8	2002/3		1987/8	2002/3	
Carregal	(C)	41.49	41.37	-0.3	186.2	181.5	9.8
Ovar	(O)	41.13	41.12	0.0	181.9	179.1	5.8
Puxadouro	(PU)	37.28	38.02	1.9	198.1	194.9	6.7
Pardilhó	(PA)	40.61	40.9	0.7	180.9	177.7	6.6
Manchão	(M)	33.6	34.44	2.4	210.5	206.9	7.4
Torreira	(T)	47.83	50.26	4.8	144.5	139.4	10.6
Cais do Bico	(CB)	61.74	70.58	12.5	133.6	122.3	23.4
S. Jacinto	(SJ)	90.28	97.41	7.3	91.7	85.4	13.0
Costa Nova	(CN)	93.87	98.67	4.9	88.2	84.4	7.9
Vagueira	(VG)	59.81	80.88	26.1	105.9	103.0	6.0
Areão	(A)	27.58	47.49	41.9	176.9	158.2	38.5
Sacor	(S)	91.79	98.6	6.9	92.1	86.1	12.4
Ponte Cais II	(PC2)	77.14	99.32	22.3	110.6	87.5	47.8
Vista Alegre	(VA)	66.02	87.32	24.4	129.0	107.6	44.1
Cais da Pedra	(CP)	57.7	66.29	13.0	151.4	131.8	40.5
Lota	(L)	93.46	99.2	5.8	93.0	88.3	9.7
Rio Novo	(RN)	60.9	67.45	9.7	123.2	118.0	10.7
Cacia	(CA)	60.64	67.74	10.5	123.9	118.7	10.7

Table 7.1 Model results for the M_2 tidal constituent. Changes in amplitude and phase are relative to the 1987/8 values. Negative % corresponds to a decrease in amplitude.

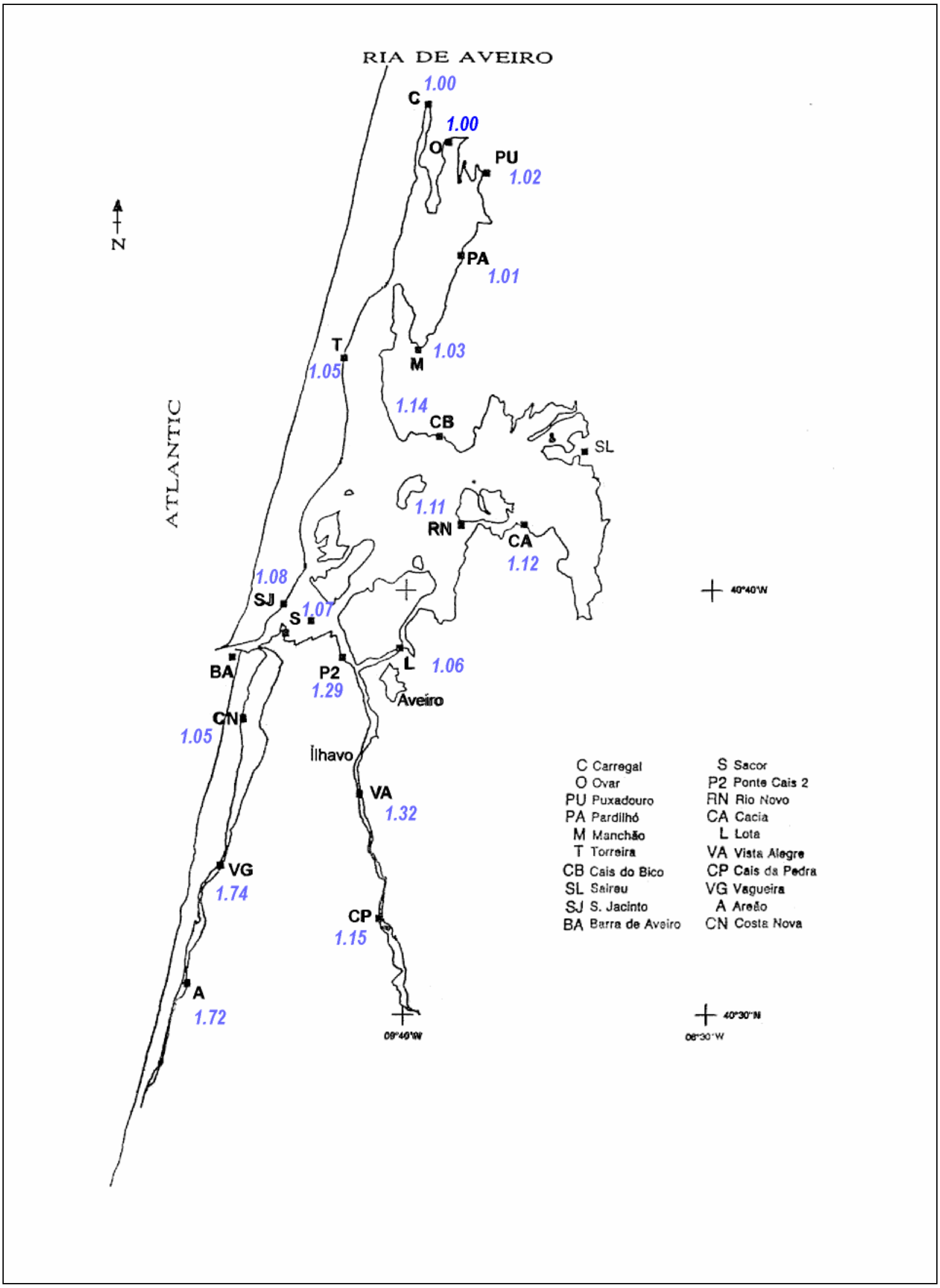


Figure 7.3 M_2 amplitude ratio between the 2002/3 and 1987 values, estimated from the 2DH hydrodynamic model simulations. Most estimated values are > 1 which shows a general increase in the M_2 amplitude, since 1987/8 (map based upon, Instituto Hidrográfico, 1991).

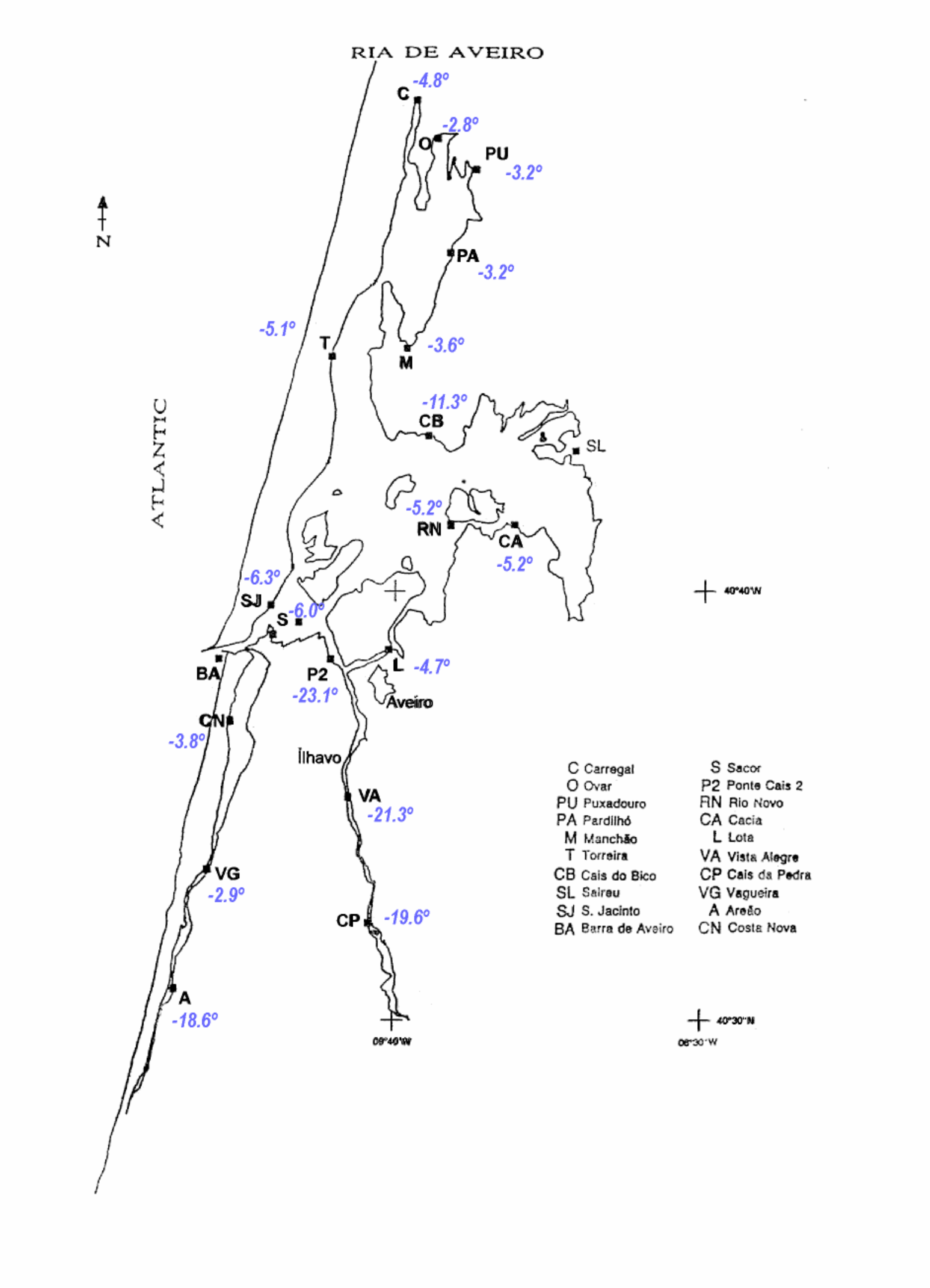


Figure 7.4a M_2 phase difference, in degrees, relative to 2002/3 and estimated from the 2DH hydrodynamic model simulations. Negative phase differences estimated at all stations show a general decrease in the M_2 phase, since 1987/8 (map based upon, Instituto Hidrográfico, 1991).

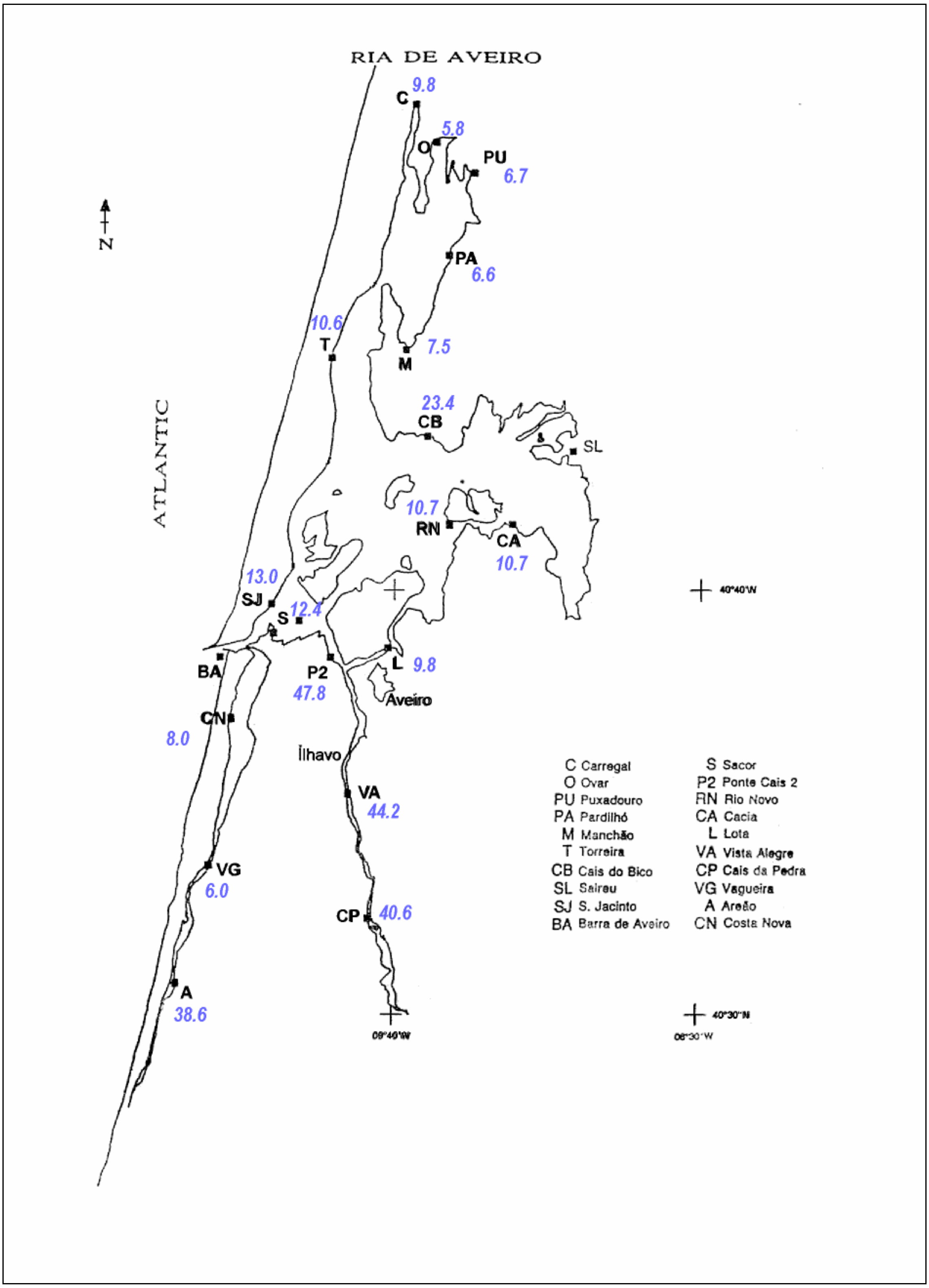


Figure 7.4b Increase in the M_2 phase, in minutes, since 1987/8, estimated from the 2DH hydrodynamic model simulations. These results are the same as those presented in Figure 7.4a, considering 1°~ 2 min (map based upon, Instituto Hidrográfico, 1991).

7.2 Interaction between Tidal Propagation and Bathymetry

Tidal propagation responds immediately and directly to changes in bathymetry and, to a lesser degree, to variations in bed-roughness determined by the presence of surficial sediments (Lane, 2004). Observed tidal propagation changes in the Lagoon are considered to be influenced significantly by the bathymetric evolution.

To understand further whether observed tidal changes are linked with bathymetry, the results described above are presented here, together with available bathymetric observational data of the sections of the Lagoon where changes have occurred between 1987/8 and 2002/3 model simulations. The results for the northern part of the Lagoon are shown in Figure 7.5, whilst the southern part is shown in Figure 7.6.

When considering the bathymetric changes that have been surveyed, it is important to note that, in most cases, data recording was restricted to the navigation channel, i.e., only part of the cross-sectional area may be covered by the survey. This limitation is due to the small water depth, in sections lying adjacent to the navigation channel. Although this limitation does not influence the model results, the sections shown in Figure 7.5 & 7.6, which indicate no changes, might, in fact, have deepened, accreted or even eroded. Even the width of the channels, which in the model is considered constant may, in reality, have changed. However, this would affect only results from the *in-situ* sea level data.

The bathymetric changes that occurred in the northern extension of the S. Jacinto Channel (above Varela) are restricted to the channel between Varela and Carregal (C) (Figure 7.5). Such changes correspond to a deepening of between 0-1.6 m along some parts of the navigation channel that links Carregal Marina to the remainder of the Lagoon.

No significant increase in amplitude has been predicted at the stations located above Varela. Associated (tidal) phases have decreased by an average 7.3 minutes, whilst Carregal (C) has the largest estimated phase difference. This could be a consequence of the, previously described, changes in channel depth. The small overall differences found in the amplitude and phases, for stations located within this section of the Lagoon, are probably a result of the deepening of the inlet channel section, until the S. Jacinto station (SJ).

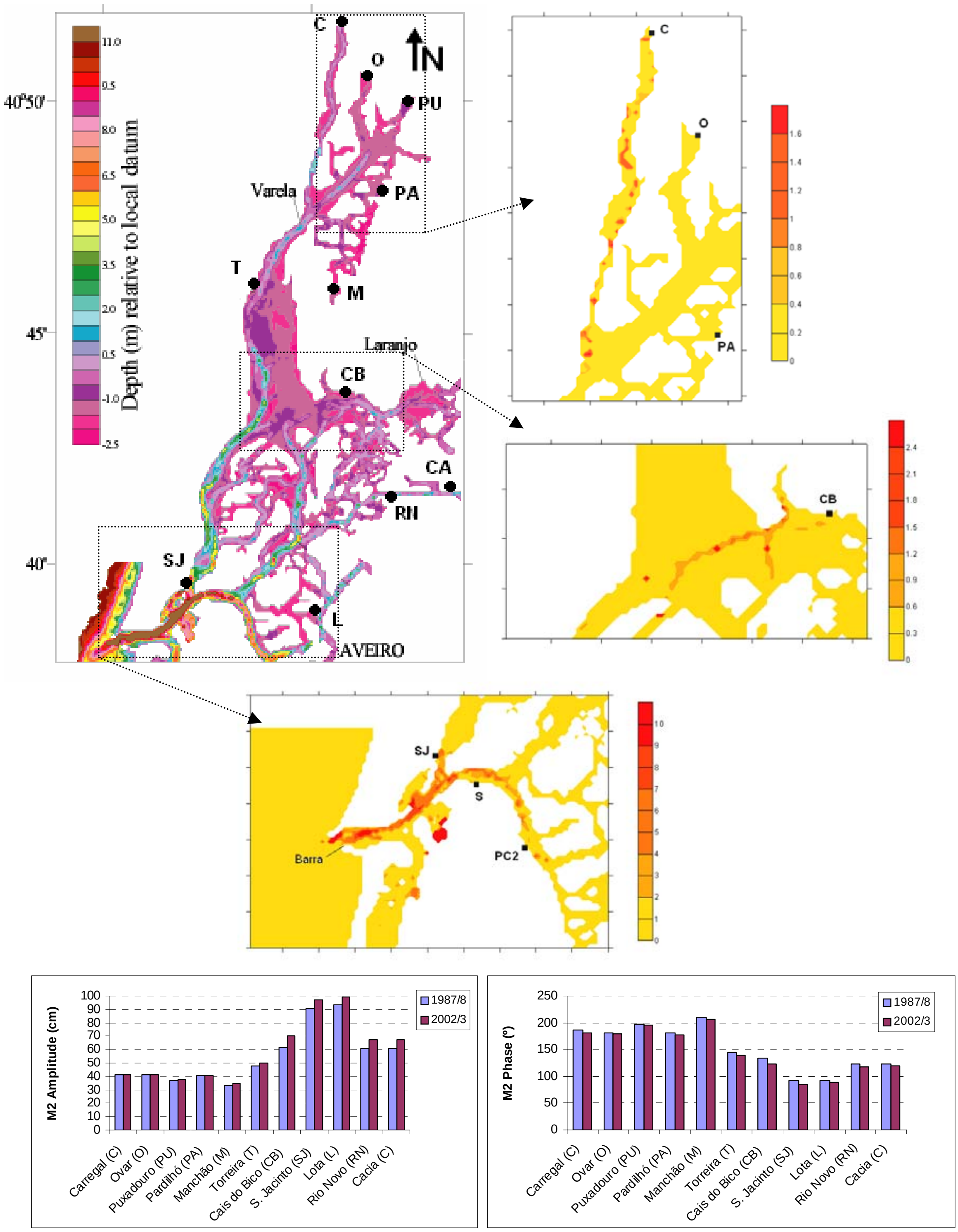


Figure 7.5 Bathymetry and M_2 results obtained from the northern area of the Ria de Aveiro. A few sections have been selected here, providing further details on the differences between the bathymetric data used in the 2002/3 and in 1987/8 model simulations (note: the scale represents difference in metres). Bar-chart illustrates the general trend, together with the differences found in the M_2 amplitude and phases.

The section of the Lagoon containing Cais do Bico station (CB, Figure 7.5) shows that most of the channel bed deepening ranges between 0-0.9 m, occasionally reaching 2.4 m. The pattern illustrating these changes clearly shows 2 navigation channels; one from CB towards S. Jacinto Channel and the other towards Espinheiro Channel. The changes to the bathymetry of both of these channels have contributed to the 12.5% increase in the amplitude and a significant 23.4 min advance in phase, calculated for CB. However, such differences in phase and amplitude are likely to have also been influenced by the larger increases in depth, found in the channels linking the inlet (Barra) with S. Jacinto Channel and with the Ílhavo Channel.

The different sections represented in Figure 7.6 show that the majority, as well as the largest (0–10 m), changes occurred in the Channels connecting the inlet to S. Jacinto (SJ), Sacor (S) and Ponte Cais 2 (PC2). The bathymetry from PC2 to Cais da Pedra (CP), in the southern section of the Ílhavo Channel, have remained the same as in 1987/8.

The increased water depths found along the channel, leading from the inlet to the Ílhavo Channel, seem to contribute to the increase in M_2 amplitude and decrease in phase at stations along that channel. However, the changes estimated for S are smaller than those of PC2 and Vista Alegre (VA), which might seem strange considering the fact that the depth has increased more, prior and around station S and less so close to the other 2 stations. The fact that the southern side of the channel, where station S is located, has no change in depth, whilst the dredged northern side of the channel has one of the largest depth increases in the Lagoon, suggests that this might influence the estimated sea surface elevation of the cell containing this particular station. The increase in water depth, in the channel leading to PC2 and VA, seems to have contributed to an increased M_2 amplitude and a decrease in its phase. Whilst there is an increase in amplitude along the channel, until VA, after this station the amplitude increase is reduced, as shown by the value at CP. The phase difference also increases until PC2, decreasing thereafter. The deepening of the channel section from the inlet until the start of the Ílhavo Channel may also contribute to this particular behaviour. As the tide propagates into the Lagoon, it responds initially to the changes in depth, propagating faster and with larger amplitude. As the tide propagates along channels that have not been affected by any bathymetric changes, the rate of change between past and present amplitude and phase difference is no longer sustained; hence, values after PC are smaller.

The small changes identified in (tidal) amplitude and phase for Lota (L), are a result of the changes within the inlet channel. The depth of the channel, connecting that to the one where Lota is located, has remained constant. The same scenario occurs for Rio Novo (RN) and Cacia (CA), which are not represented in the diagrams showing depth difference (as they were not included in the initial grid, as explained in Section 4.7.2a).

Some 0-2m, changes in depth can be observed at the start of the Mira Channel, close to Costa Nova (CN). Farther to the south, prior to and after Vagueira (VG), the channel has deepened slightly more, i.e., within the 0–3.6m range. The 5% increase in amplitude at CN is smaller than that estimated at the other 2 stations, VG and Areão (A), located farther south in the channel. The amplitude at VG has increased by 26%, whilst this reaches a maximum of 42%, at A. The phase difference between CN and VG does not differ as much, compared with the respective amplitude results; however, a significant 31 minute difference exists between the phase difference at A (39 min) and the value for the previous, VG and CN stations (6-8 min).

The bathymetric changes surveyed in the Mira Channel, together with those surveyed in the inlet channel, appear to be consistent with the changes identified in amplitude and phase estimated for the stations located within the Mira Channel.

Overall, the increase in water depth (which lessens the loss of energy, by effects related to the bed friction) appears to contribute to an increase in the amplitude of the M_2 constituent and decrease in phase lag (due to an increase in wave velocity). These differences are expected to be greater where the increase in water depth is significantly larger than the initial depth. This outcome is illustrated by the results obtained from those stations located close to the inlet channel; however, it cannot be taken as a rule for all of the stations, when considering the results obtained from these simulations.

The other factor that can affect M_2 values within the Lagoon are the sea surface levels, used as the boundary condition; these were measurements obtained from the permanent tide gauge located just inside the inlet, at the seaward end, instead of coastal measurements, i.e., which can cause a very small lag in the tidal phase.

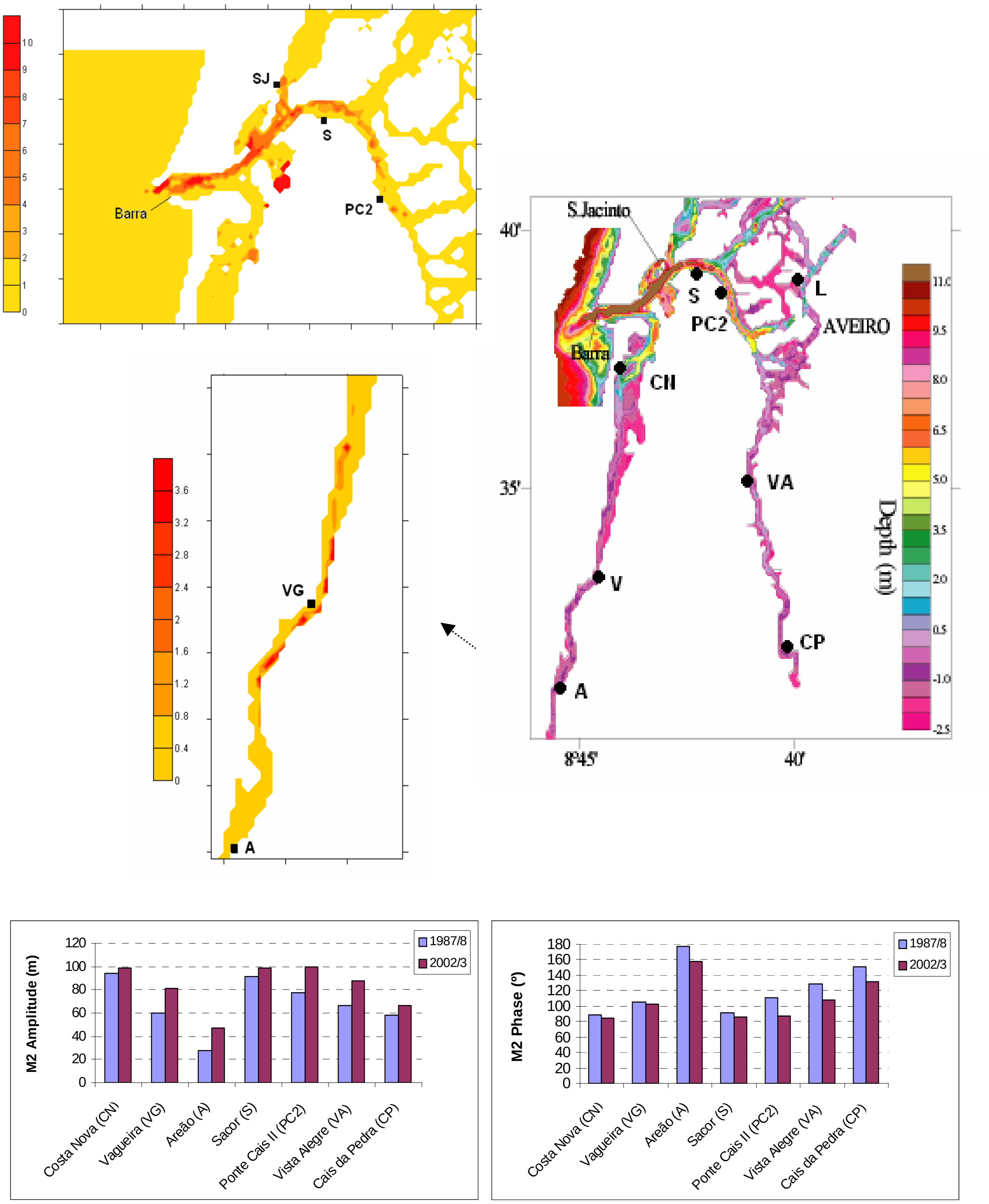


Figure 7.6 Bathymetry and M_2 results, obtained from the southern area of the Ria de Aveiro. A few sections have been selected here, providing further details on the difference between the bathymetric data used in the 2002/3 and in 1987/8 model simulations (note: the scale represents differences, in metres). Bar-chart illustrates the general trend and differences, identified in the M_2 amplitude and phase.

7.3 Comparison between Model and Observed Data

During the model validation, Dias (2001) found good agreement between the model and the observed results, for M_2 amplitude and phase for 1987/8. A mean difference, between model and observed results, of 7 ± 1.2 cm was found for M_2 amplitude and 4 ± 2º (~8 ± 4 min), for the M_2 phase (Dias, 2001).

The observed and modelled results obtained within the present investigation have also been compared with each other, for 1987/8 and 2002/3, and are shown in Figure 7.7 and Tables 7.2 & 7.3. The mean difference between the 1987/8 modelled and observed results, from all the stations considered, was estimated. A mean difference of 6.5 ± 3.8 cm was found for the M_2 amplitude and 8.3 ± 5.9º (~17 ± 12 min), for the M_2 phase. These results differ slightly from those obtained by Dias (2001); however, this can be explained by the use of different stations, which causes the mean to change in relation to the datasets. Some of the stations used in the present study and, hence, considered in the mean, have not undergone any calibration, possibly contribute to a greater variance. Furthermore, the small differences found between the harmonic constituents obtained by Dias (2001), and those from the present observed data (Section 6.2), can also contribute towards different reults.

The results for 2002/3 show a mean difference of 10.0 ± 7.5 cm for M_2 amplitude and 14.9 ± 17.6º (~30 ± 35 min) for the M_2 phase. Larger differences and standard deviation may be expected, as the model has not been calibrated for the respective observations.

Despite the differences described above, the overall present comparison, between the model's (simulated) results and those from observed data for 1987/8 and 2002/3, shows an identical trend in terms of the M_2 amplitude and phase (Figure 7.7).

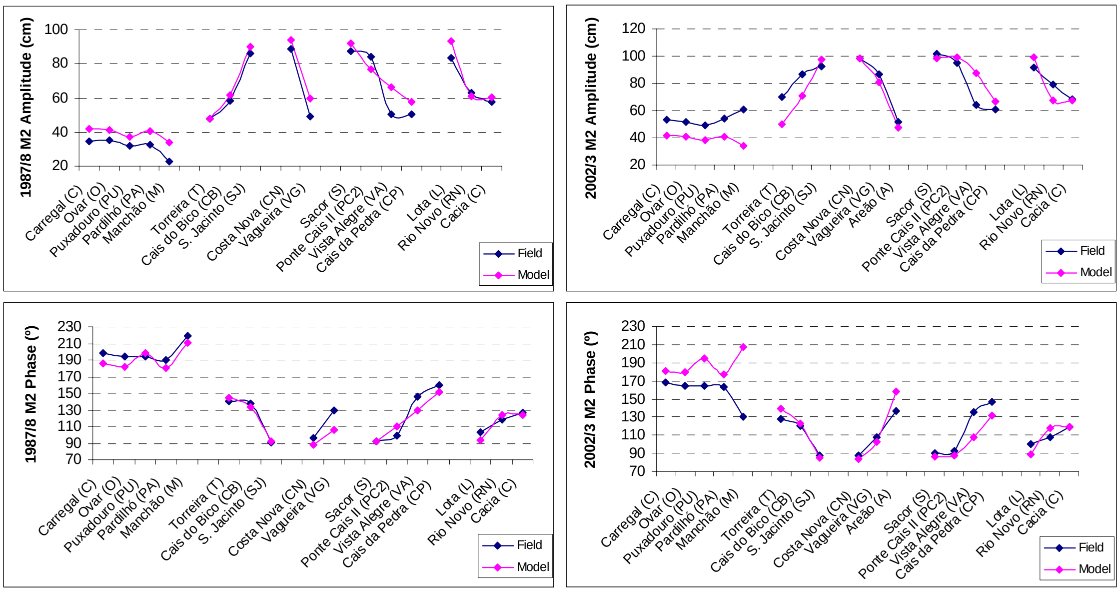


Figure 7.7 M_2 amplitude and phase results, from the observed data and the 2DH model simulations, for 1987/8 and 2002/3.

Stations		M2 Amplitude (cm)					
		1987/8			2002/3		
		Field	Model	Difference (%)	Field	Model	Difference (%)
Carregal	(C)	34.5	41.5	16.8	53.0	41.4	-28.1
Ovar	(O)	35.1	41.1	14.7	51.6	41.1	-25.5
Puxadouro	(PU)	31.9	37.3	14.5	49.3	38.0	-29.7
Pardilhó	(PA)	32.8	40.6	19.3	54.1	40.9	-32.3
Manchão	(M)	22.8	33.6	32.0	60.8	34.4	-76.7
Torreira	(T)	47.6	47.8	0.5	70.2	50.3	-39.7
Cais do Bico	(CB)	58.6	61.7	5.1	86.3	70.6	-22.3
S. Jacinto	(SJ)	86.1	90.3	4.7	92.5	97.4	5.0
Costa Nova	(CN)	88.7	93.9	5.5	98.1	98.7	0.6
Vagueira	(VG)	48.9	59.8	18.2	87.0	80.9	-7.6
Areão	(A)	x	27.6	x	51.9	47.5	-9.4
Sacor	(S)	87.1	91.8	5.1	101.9	98.6	-3.3
Ponte Cais II	(PC2)	83.9	77.1	-8.8	95.0	99.3	4.3
Vista Alegre	(VA)	50.4	66.0	23.6	63.9	87.3	26.8
Cais da Pedra	(CP)	50.3	57.7	12.9	61.2	66.3	7.6
Lota	(L)	83.4	93.5	10.8	91.8	99.2	7.4
Rio Novo	(RN)	63.1	60.9	-3.7	79.4	67.5	-17.7
Cacia	(CA)	58.0	60.6	4.6	68.5	67.7	-1.1

Table 7.2 M_2 amplitude results from the observed data and 2DH model simulations, for 1987/8 and 2002/3.

Stations		M2 Phase (º)					
		1987/8			2002/3		
		Field	Model	Delay (min)	Field	Model	Delay (min)
Carregal	(C)	198.2	186.2	-24.8	168.8	181.5	26.2
Ovar	(O)	193.8	181.9	-24.6	165.1	179.1	29.0
Puxadouro	(PU)	193.8	198.1	9.0	164.8	194.9	62.3
Pardilhó	(PA)	190.3	180.9	-19.5	163.7	177.7	29.0
Manchão	(M)	218.7	210.5	-17.0	130.1	206.9	158.9
Torreira	(T)	140.3	144.5	8.6	128.0	139.4	23.5
Cais do Bico	(CB)	137.9	133.6	-8.8	120.0	122.3	4.8
S. Jacinto	(SJ)	90.8	91.7	1.8	87.8	85.4	-4.8
Costa Nova	(CN)	95.7	88.2	-15.5	87.5	84.4	-6.5
Vagueira	(VG)	129.7	105.9	-49.3	107.5	103.0	-9.3
Areão	(A)	x	176.9	x	136.5	158.2	45.0
Sacor	(S)	91.4	92.1	1.4	90.1	86.1	-8.3
Ponte Cais II	(PC2)	98.6	110.6	24.8	93.3	87.5	-12.1
Vista Alegre	(VA)	145.2	129.0	-33.6	135.7	107.6	-58.1
Cais da Pedra	(CP)	159.1	151.4	-15.9	147.2	131.8	-31.8
Lota	(L)	103.4	93.0	-21.5	100.5	88.3	-25.2
Rio Novo	(RN)	117.6	123.2	11.6	108.4	118.0	19.9
Cacia	(CA)	126.7	123.9	-5.8	119.7	118.7	-2.0

Table 7.3 M_2 phase results, from the observed data and the 2DH model simulations, for 1987/8 and 2002/3.

7.4 Concluding Remarks

The 2-D hydrodynamic numerical model developed, by Dias (2001), was run using bathymetric data from 1987/8. The results were than compared to another run with a simulated bathymetry for 2003/4, whereby only some sections of the bathymetry were updated for the latter period.

The outputs from the model reproduce an increase in amplitude and a decrease in the phase of the semi-diurnal M_2 component, for the majority of the stations in the Lagoon, between 1987/8 and 2003. These trends are consistent with those found in the observed data; however, the magnitude of the change is not well reproduced by the model.

M_2 amplitude and phase changes, estimated from modelled sea levels, are coherent with bathymetric changes incorporated in the model. Although local bathymetric changes appear to contribute to the M_2 values of nearby stations, stations far from any local bathymetric change still showed differences in the M_2 constituent. This conclusion agrees with the theory illustrated by the simple analytical model, presented in Section 4.7.1, i.e., that bathymetric changes to the inlet channel are an important influence towards the tidal response at stations within the Lagoon.

Even if the model simulation for 2003 had been run with a bathymetry based upon a full survey of the Lagoon, for the corresponding date, in the absence of detailed adjustments an exact match should not be expected.

Chapter VIII

CONCLUSIONS

8.1 Overall

This work set out to investigate sea level variability in the Atlantic Coast of Europe. In achieving this general objective the work has:

- Demonstrated the novel use of a method for analysing long-term sea level records, i.e., by looking at the trends in the sea level components after a robust editing of the data, to correct of errors in the gauge.
- Shown the importance of the meteorological or non-tidal residual standard deviation as a measure of storminess. The lack of trends associated with meteorological affects has suggested that there is no evidence of increased storminess as a result of climate change.
- Investigated variations in the tidal range, and consequently in extreme levels, as a result of the 18.6-year (lunar) nodal cycle modulation of sea level.
- Proved the existence of very significant tidal trends at a local scale (for the case of the Ria de Aveiro, Portugal). Results show significant changes in the tidal characteristics of the coastal Lagoon which the work shows can be associated mainly to the changes in the inlet channel depth. The change in the inlet dimensions are shown to be more effective in the changes to the tidal characteristics within the Lagoon than the sea level increase at the coast.
- Used relatively inexpensive pressure logging equipment and shown it to be consistent and reliable for determining tidal components of sea level. The versatility obtained through the use of portable pressure sensor as a method of surveying extensive areas efficiently and in a cost effective way could be applied with defined confidence for other local tidal studies. This method of collecting data is valuable to monitor the evolution of coastal systems. The data that have been collected from the Ria de Aveiro under this study are at present unique and a valuable reference for future studies of this area, as they are the only update to the previous (1987/8) Hydrographic Office dataset, with respect to full coverage of the Lagoon.

8.2 General

Long-term regional sea level variability

Part of the present study focussed on the statistical analysis of sea level variability along the western European coastline (38ºN – 51ºN), by investigating trends in observed sea level, and in three separate components: mean sea level; tides; and non-tidal meteorological residual (surge).

Sea levels recorded at sites in the English Channel (South England and North France) and along the Iberian Peninsula (north and west coasts), together with Ceuta (Mediterranean Sea: African coast) have been used. The data selected form the longest available hourly digitised series, for the region under investigation. At the time of the study, no digitised hourly datasets for the southern Iberian Atlantic coast are extensive enough for the present analysis. As such, Ceuta has been used as a reference station.

A critical assessment of the characteristics of the gauge, based upon residual analysis was performed, on all the data available from the English Channel, Cascais and Aveiro. A robust editing of the data confirms that these are somewhat mixed in terms of their quality. Following this procedure, the difference between the edited and the non-edited data are found to be most relevant to the analysis of extremes.

The results obtained from Calais are presented throughout the discussion; however, the quality of the dataset is compromised by several gaps in the record, which contribute to large standard errors in the results. This station is not considered in the following conclusions. Nevertheless, direct comparison between these data and those of Dover showed good agreement, suggesting the few data available, for Calais, were of good quality.

Mean Sea Level

Mean sea level, at the majority of the stations along the western coast of Europe, is increasing within the 1-2 mm yr^{-1} global estimate. The rate of MSL increase at Dover, Santander and Vigo is above 2 mm yr^{-1} and at Cascais it is below 1 mm yr^{-1}. These values do not include adjustments for land movement, e.g., isostatic corrections.

The difference between the rising level in the southwest of England (as given by Newlyn) and the southeast (as given by Dover) have been known to be associated with greater land submergence rates in the southeast of England.

MSL trends at Brest and Newlyn are significantly different from each other, despite the proximity of the stations, i.e., the regional effects and residual variability should be similar. This is probably due to different rates of land movement.
The small MSL trend found at Cascais is smaller that the 1.3 mm yr^{-1} rate obtained by other authors. The difference lies in the use of different data series. The larger rate of increase is based upon historical monthly mean data series, going back to 1880, whilst that used in this study commences in 1940.

Total observed sea level

For variations in the total observed sea level, the standard deviation results are erratic and influenced strongly by the 18.6 year lunar nodal cycle. Significant increases are found at Newlyn, Aveiro and Cascais. These increases may be related to local effects, i.e., increased tidal ranges, as the MSL increases, allowing low water to fall further below the increasing mean, as the harbour dries out. Although this may explain results for Newlyn and Cascais, those at Aveiro are believed to be related to changes in the tidal prism, associated to MSL increases and changes in the depth of the inlet channel where the tidal gauge is located.

Tides

Tides are dominated by semi-diurnal variations. Diurnal effects are small, but there are significant higher harmonics. The tidal constituents, determined by annual harmonic analysis with nodal corrections made according to astronomical variations, show considerable interannual variability. Some amplitudes show a residual nodal variation, due to overcorrection in the analysis. At some stations, systematic changes are apparent and can be related to changes that have occurred either to the tide gauge (e.g. Newlyn) or within its vicinity (e.g. Cascais and Aveiro).

Non-tidal (meteorological) residual

Trends in the meteorological or non-tidal residual standard deviation (NTRstd) were analysed, on an annual basis. These were taken as a measure of storminess, under the assumption that an increase in storminess would be reflected in the standard deviation of the values (computed by removing the MSL and the astronomical tide from the observed sea levels). The error in the reading can also affect these levels, but has been minimised at the stations for which the data were edited.

The mean value of the non-tidal residuals is zero, within each year. The only non-tidal residual standard deviation trends of significance are found, at Newlyn, Cascais and Aveiro. These are due to local changes, e.g., the trend at Newlyn shows a decrease in level attributed to the changes in the measuring procedure in 1983, with the new bubbler gauge contributing fewer errors than the older stilling-well system. Brest shows a small increase, which lies just within the standard error. The annual residual standard deviations at Brest and Newlyn correlate well, providing a clear confirmation of the oceanographic significance of the residual sea levels, following careful editing of the data. The absence of any trends suggests that there is no evidence of increased storminess, i.e., the occurrence of storm-related events, in the long-term sea level datasets analysed.

Extreme levels

In addition to the increase in MSL, it is also important to understand how extreme levels might be changing. Two methods have been used to look at the distribution of extreme values. The first method consisted of the analysis of trends in the annual maximum and minimum sea levels and in the non-tidal residual levels. Reduced levels, i.e., whereby the annual mean level is removed from each individual year, have been considered, such that the results are not influenced by MSL trends. Since the increasing occurrence of storm events may affect the occurrence of extreme levels, reduced average winter (December-March) maximum levels are also analysed as, at these latitudes, storms are more common during the winter month.

Simultaneous increases in maximum and minimum levels occur at Brest and Newlyn, whilst at Cascais and Aveiro, the trends increase for maximum levels and decrease for minima. None of these results have shown significance, when considering the reduced levels. Apart from a few other erratic results, no trends are found in the winter maximum levels.

The analysis of extreme levels, based upon a single annual hourly level, is very limited as they are very likely influenced by errors, especially when the data is un-edited.

A more robust analysis followed, computing percentile levels from the hourly sea levels and non-tidal residual standard deviations. This method is less influenced by errors (especially if the 99 and 95 percentiles are considered) and is more representative of the distribution.

The majority of the stations show trends at most of the percentiles, of the observed sea levels. Two exceptions are Le Havre and Ceuta, where no trends are found. Most of these trends are of no significance, when considering the reduced value. This pattern confirms that, at most of the stations, changes in extreme percentile levels are influenced by the MSL. However, the lower percentiles at Newlyn show negative trends in the reduced levels, whilst they are positive in the observed levels. Furthermore, an increase in the higher percentile levels at Aveiro corresponds to a decrease in the lower levels, when considering the reduced sea levels.

In summary, trends of significance are found in various lower percentiles of the non-tidal residual, at all the English Channel stations and for the stations on the Bay of Biscay, suggesting that meteorological effects influence the minimum extreme levels, i.e., negative surges. Further analysis of the results, obtained from the statistical analysis of trends in sea level variability included a brief study of the possible physical parameters influencing these trends.

Forcing

Changes in detrended sea level, associated with changes in local air pressure, are considered by analysing the non-hydrostatic sea level, i.e., sea levels adjusted for contributions of hydrostatic pressure, using the inverted barometer effect, by which 1 mbar of air pressure is known to reduce sea level by 10 mm, at mid and high latitudes. However, due to the complex ocean-atmospheric interactions, air pressure influences may be linked dynamically to density, ocean circulation and/or currents.

All the stations show an expected negative correlation, between detrended sea level and gridded mean sea level pressure; none of these lie more than 2 standard deviations from the simple local inverse barometer (model) value. The results are larger for stations along the Iberian Peninsula, suggesting that, in this region, winds or ocean circulation may be more important, as the deviation from the theoretical value is associated to a dynamical link between these parameters and pressure.

Although a correlation exists between hydrostatic pressures and sea level, the average long-term pressure is approximately zero. This suggests that meteorological forcing cannot be the main forcing mechanism responsible for the observed sea levels. However, this needs to be confirmed, with further independent analysis of parameters such as wind.

NAO

Atmospheric variability in the North Atlantic is dominated by the North Atlantic Oscillation (NAO) which, in simple terms, is a pressure gradient between the Icelandic low and the Azores high pressure centres; this in turn is responsible for increased temperature, precipitation and westerly winds over Europe during high NAO index years (stronger during winter month).

Sea level response to the NAO has been analysed as the NAO is known to affect various meteorological parameters and wave height and as there is also the possibility that the NAO may be affected by climate change. The station-based NAO index (Iceland–Gibraltar) and PC-based (first EOF) NAO index (Iceland-Azores) have been used, within the analysis.

The results show significant negative correlation, between mean sea levels and the NAO index at Newlyn and northern Spanish stations. The correlations for the latter locations are much stronger than those found at Newlyn. Coruña is the station most influenced and with the smallest standard error.

The results obtained for the correlation between the non-tidal (meteorological sea level) residuals standard deviation and the NAO index are inconclusive, with the only consistency being a negative correlation at Coruña, Vigo and Ceuta. There are other results with statistical significance, although they are not found within both the PC-based and the station-based NAO correlations.

The annual winter (December-March) NAO index was also correlated with winter non-tidal residuals, as meteorological influences are strongest during this period of the year. Seasonal anomalies have not been removed. No results of significance are found for the English Channel; however, a correlation was found at Coruña.

Winter sea level values for Northern Spain are influenced by the winter NAO index. Coruña sea levels and non-tidal residuals correlate with annual and winter NAO indices; consequently, the NAO can explain much of the variability at this station. No other stations show such influence.

Annual extreme levels, using percentile values, have also been analysed for correlations with the annual NAO index. Reduced sea level percentiles (with the median removed) do not shown any conclusive results. Some trends of significance are found in the non-tidal residual, of which the most convincing, considering the previous analysis, are those for Coruña and Vigo. Lower percentiles levels at both stations show evidence of the NAO influence, although the higher percentiles show no influence.

In summary, without having removed seasonal anomalies from the data used, the sea levels around the western European coastline are correlated negatively with the NAO index. The only exception to this is Dover, which is correlated positively to the NAO. This is consistent with the known positive correlation for the south-eastern region of the North Sea. The sensitivity to the NAO varies, with the highest values found along the northern Spanish coast. Overall, Coruña shows the greatest influence to the NAO, in the English Channel, this is found at Newlyn (south-western England).

Influences on the non-tidal meteorological residuals are also found in the northern region of Spain, suggesting that the variance in this component is influenced considerably by the NAO, over this particular region. Nevertheless, editing of the data would be necessary to reduce the standard deviation and noise in these data.

Although the secular trends in the MSL records can be caused primarily by meteorological forcing, an understanding of this mechanism is still not fully known. This understanding is imperative, if the models used in future climate change scenarios are to be accurate, such that mitigation actions can be adopted for coastlines at risk.

Local sea level trends

The second theme under investigation consists in assessing local sea level variability impacts on estuarine systems, through an understanding of sea level changes occurring at the coast. Likewise, the knowledge of tidal changes inside the system.

The Ria de Aveiro Lagoon has been selected for investigation, as it is an extensive shallow coastal lagoon located on the Western Atlantic coast of Portugal, between 40° 38´ N and 40° 57´ N. The system is protected from the ocean by a sand bar (spit), which runs parallel to the coastline. The Lagoon is characterised by a series of channels, in between which lie significant intertidal areas that connect to the ocean by a single artificial inlet.

The average depth of the Lagoon is approximately 1m, with the greatest depths found at the lagoon entrance. Water circulation in the Lagoon is tidally dominated, with the tidal pattern influenced mainly by the lunar semi-diurnal constituent (M_2).

The evolution of the Ria de Aveiro, during the 20th century, has been characterised by the erosion of mud flats, salt marsh and old salt pans, together with the widening of most of the channels. These changes, together with other contributions are believed to have modified the tidal dynamics of the system, making it more vulnerable to risks of flooding and to sea level rise.

To investigate local sea level variability, impacts on a coastal lagoon such as the Ria de Aveiro, an understanding of sea level changes occurring at the mouth, as well as, knowledge on tidal changes inside the lagoon, are essential. Data collected since 1975 from the permanent tide gauge, located within the inlet channel, together with sea level data collected during 1987/8 and 2002/3 throughout the Ria de Aveiro Lagoon, are used to describe sea level variability within this region.
Data collected at various stations throughout the Lagoon have been used to assess whether tides have changed, over the past 16 years.

Two datasets containing sea level measurements undertaken in the Ria de Aveiro Lagoon, during surveys in 1987/8 and 2002/3, are available. These measurements have produced surface elevations of varying duration, for a series of stations throughout the Lagoon. Data from both surveys (with a common sampling interval) were subjected to harmonic analysis, in order to obtain the primary tidal constituents and their compound tides.

Harmonic analyses of sea level records show that the Ria de Aveiro Lagoon is dominated by the semi-diurnal (M_2) tide. The M_2 constituent, influenced by strong non-linearities and frictional effects, was examined in detail. The non-linear response to tidal forcing is illustrated by an increase of high frequency M_2 overtides, compound tides and the MS_f constituent, throughout the estuary. Frictional interactions are demonstrated by the phase and amplitude changes in the tide.

Tidal variations within the Lagoon also shows that, over the last 16 years, there has been a general increase in the amplitude and a decrease in the phase, for most of the harmonic constituents. The asymmetry calculated for each of the stations also show that there have been changes, over the past years. The majority of the Lagoon was flood-dominant, during 1987/8. Since then, the central section of the Lagoon (including Laranjo Bay and Vouga Channel) has become ebb-dominant, whilst the northerly and southerly sections are flood-dominant, i.e., presently, there is no clear overall dominance.

In order to investigate possible mechanisms responsible for the changes found in the M_2 constituent, between 1987/8 and 2002/3, the observed results have been compared with those estimated from numerical modelling of the tidal response of the Lagoon, connected to the ocean, through a narrow inlet. The comparison between the averaged observed values and the numerical estimates suggests that the response of the M_2

component, within the Lagoon, is affected predominantly by changes in the depth of the inlet channel.

The deepening that has taken place in the main navigation channels (located mainly in the central section of the Lagoon) correlate with the asymmetry change, over the central section of the Lagoon, of flood-dominant to ebb-dominant.

Changes in amplitude and phase, identified between 1987/8 and 2002/3, follow the same trend as those available from descriptions of the tidal historical evolution of the Lagoon. This pattern is not unexpected, since the factors contributing to these changes (dredging, pier construction and embankment alterations) are still being carried out. The tidal characteristics of the Lagoon will undoubtedly continue to evolve.

Following the previous results, a 2DH- Hydrodynamic model was used to test how changes to the Lagoons bathymetry, affects estimated sea levels, throughout the Lagoon. The model was run initially using the bathymetric data from 1987/8 and then re-run using digitised updates to the earlier bathymetry. The results for both runs of the model, using different bathymetries, have been discussed and compared within the context of bathymetric and observed sea level data.

The 2-D hydrodynamic numerical model, as developed by Dias (2001), was run using bathymetric data from 1987/8. The results were then compared to another run, with a simulated bathymetry for 2003/4, whereby only some sections of the bathymetry were updated for the latter period.

The outputs from the model reproduce an increase in amplitude and a decrease in the phase of the semi-diurnal M_2 component, for the majority of the stations in the Lagoon between 1987/8 and 2003. These trends are consistent with those found in the observed data; however, the magnitude of the change is not well reproduced by the model.

The M_2 amplitude and phase changes, estimated from the modelled sea levels, are coherent with the bathymetric changes incorporated into the model. Although local bathymetric changes appear to contribute to the M_2 values of nearby stations, stations located far from any local bathymetric change still showed differences in the M_2 constituent. This pattern agrees with the theory illustrated by a simple analytical model of a wave propagating into a basin, connected to the sea via a single narrow channel. This shows that bathymetric changes to the inlet channel are an important influence towards the tidal response, at stations within the Lagoon.

Even if the model simulation for 2003 had been run with a bathymetry based on a full survey of the Lagoon for the corresponding date, in the absence of detailed adjustments an exact match should not be expected.

Overall, the effects of sea level sea level rise seem to be of small consequence in this particular Lagoon, as sea level variability appears to be mainly influenced by changes in the dimensions of the inlet channel. This interpretation has reinforced the concept that the understanding of coastal sea level variability alone is insufficient, if impacts on coastal lagoons are to be fully understood.

8.3 Recommendations for Future Work

Long-term sea level variability

- The analysis of long-term data in this study has identified trends and interannual variability, in some of the different sea level components. In terms of trend estimates, it is suggested that the data from the Spanish ports should be edited using the method that has been applied to the data at the other stations. This approach would, most likely, have little influence on the trends of the sea level components; however, it would produce more reliable results on extremes and correlation with some forcing mechanisms.
- The strong influence of the 18.6 year nodal cycle, on the observed sea level standard deviation results, was investigated by fitting a linear model. An error to this fit must be estimated, as well as investigating whether the MSL and the tides are influenced by this cycle.
- A brief analysis has been undertaken into the influence of some forcing mechanisms on the estimated trends; however, this needs to be taken further. This could include the use of EOF techniques and other statistical tools, as well as the use of dataset from other parameters that contribute to sea level variability, i.e., sea surface temperature, wind and waves should be considered.
- Seasonal variability, within the data, needs to be addressed.
- The influence of a East-West pressure field across the Northern Atlantic (e.g. Azores - Gibraltar) should be investigated, as an alternative to the NAO indices used here, as the winds travelling parallel to the European coastline might cause a built up of water, increasing sea levels.

Variability in coastal estuaries:

- There is still scope for more work based on the sea level data analysed under the present study, e.g., use of parameters such as Mean Tidal Range (MTR), Mean High Water (MHW) and Mean Low Water (MLW). Asymmetry can also be further studied, e.g., investigating the skewness of the Probability Density Function (PDF) of the hourly sea levels to define ebb/flow dominance.
- In relation to the survey, the main suggestions would be to attempt to reference the data to a datum, to allow for the study of changes in MSL. If possible, to survey all the stations simultaneously with some additional key sites, to monitor seasonal variability. The collection of information on water temperature, salinity or density would also be advantageous.
- At present, it is not possible to quantify the other physical parameters contributing towards changes in tidal propagation within the Lagoon. This is due the lack of data available, together with the limitations imposed by the use of the 2DH model used. More elaborate modelling, combined with data from a complete bathymetric survey, would allow more detailed simulations to investigate: the consequences of changes in mean sea level; the consequences of changes in bed friction; and sediment flux influences.

REFERENCES

Amin, M. (1983). On perturbations of harmonic constants in the Thames Estuary. *Geophysical Journal of the Royal Astronomical Soc*iety, 73, 587-603.

Amin, M. (1985). Temporal variations of tides on the west coast of Great Britain. *Geophysical Journal of the Royal Astronomical Soc*iety, 82, 279-299.

Anderson, O.B., Woodworth, P.L. & Flather, R.A. (1995). Intercomparison of recent ocean tide models. *Journal of Geophysical Research, Oceans*, 102, C11, 25-173.

Anderson, O.B (2001). Tides in the Northwest European shelf region from satellite altimetry, 49. *Proceedings of the EOSS Sea Level Workshop*, Dubrovnik, September 2001. Ivica Vilibic, Hans-Peter Plag and Mirko Orlic, Split, Hydrographic Institute of the Republic of Croatia, 60.

Araujo, I., Pugh, D. & Collins, M. (2001). An intensive analysis of sea level trends at Newlyn. *Proceedings of the EOSS Sea Level Workshop*, Dubrovnik, September 2001. Ivica Vilibic, Hans-Peter Plag and Mirko Orlic, Split, Hydrographic Institute of the Republic of Croatia, 90-92.

Aubrey, D.G. & Speer, P.E. (1985). A study of non-linear tidal propagation in shallow/estuarine systems. Part I: Observations. *Estuarine, Coastal and Shelf Science*, 21, 185-205.

Bacon, S. & Carter, D.J.T. (1991). Wave climate changes in the North Atlantic and North Sea. *International Journal of Climatology*, 11, 545-558.

Bacon, S. & Carter, D.J.T. (1993). A connection between the mean wave height and atmospheric pressure gradient in the north Atlantic. *International Journal of Climatology*, 13, 423-436.

Banner, F.T., Collins, M.B. & Massie, K.S. (1980). *The North-West European shelf seas: the sea bed and the sea in motion II. Physical and chemical oceanography, and physical resources.* Elsevier Oceanography Series 24B, Amsterdam, Elsevier, 638pp.

Bell, C., Vassie, J.M. & Woodworth, P.L. (1998). POL/PSMSL Tidal Analysis Software Kit 2000 (TASK-2000), Permanent Service for Mean Sea Level, U.K., 21 pp.

Barrosa, J.O. (1979). A Ria de Aveiro e a sua influência na economia da região, *Recursos Hídricos*, Lisboa, 1, 83-96.

Bouligand, R. & Pirazzoli, P.A. (1999). Les Surcotes et décotes marines à Brest, étude statistique et évolution. *Oceanologica Acta*, 22, 153-166.

Bromirski, P.D., Reinhard, F.E. & Cayan, D.R. (2003). Storminess variability along the California coast: 1858-2000. *Journal of Climate*, 16, 982-993.

Cartwright, D.E. (1972). Secular trends in oceanic tides at Brest, 1711-1936. *Geophysical Journal of the Royal Astronomical Society*, 30, 433-449.

Cartwright, D.E. & Edden, A.C. (1973). Corrected tables of tidal harmonics. *Geaphysical Journal of the Royal Astronomical Society*, 33, 253-264.

Cartwright, D.E. (1983). On the smoothing of climatological time series, with application to sea-level at Newlyn. *Geophysical Journal of the Royal Astronomical Society,* 75, 639-658.

Chao, B.F., Farr, T., LaBrecque, J., Bindschadler, R., Douglas, B., Rignot, E., Shum, C.K. & Wahr, J. (2002). *Understanding Sea Level Change.* Available: http://esto.gsfc.nasa.gov/conferences/igarss-2002/02Papers/01061440.PDF (February, 2003).

Church, J.A., Gregory, J.M., Huybrechts, P., Kuhn, M., Lambeck, K., Nhuan, M.T., Qin, D. & Woodworth, P.L. (2001). *Changes in sea level.* Intergovernmental Panel on Climate Change Third Assessment Report. Cambridge: Cambridge University Press, 639-693.

Costa, C.N.L (1990). *Propagação da maré na Ria de Aveiro*. Projecto MC.06.01.90, Lisboa, Divisão de Marés e Correntes, Instituto Hidrográfico, 36 pp.

Darwin, G.H. (1892). On an apparatus for facilitating the reduction of tidal observations. *Proceedings of the Royal Society*, 52, 345-389.

Dawson, S.A., Elliott, L., Noone, S., Hickey, K., Holt,T., Wadhams, P. & Foster, I. (2004). Historical storminess and climate 'sea-saws' in the North Atlantic region. *Marine Geology*, 210 (1-4), 247-259 (doi: 10.1016/jmgeo.2004.05.011).

Dias, J.M. (1993). Comparação dos resultados de um modelo numérico bi-dimensional com observações de corrente no estuário do Tejo. Universidade de Lisboa, MSc. Thesis, 244 pp.

Dias, J.M. & Lopes, J.F. (1996). Modelling water circulation in Ria de Aveiro, Portugal. In *Hydrodynamics, theory & applications*: Proceedings of the 2nd international conference on hydrodynamics. Hong Kong, December 1996. A.T. Chwang, J.H.W Lee & D.Y.C Leung, Balkema, Rotterdam, 715-720.

Dias, J.M., Lopes, J.F. & Dekeyser, I. (1998). An exploratory study of the dynamics of Ria de Aveiro, Portugal. In *Hydrodynamics - Theory and Applications.* Kim,H., Lee, S.H. & Lee, S.J. (eds.), Seoul, Uiam Publishers, 619-624.

Dias, J.M., Lopes, J.F. & Dekeyser, I. (1999). Hydrological characterisation of Ria de Aveiro, Portugal, in early Summer. *Oceanologica Acta*, 22, 473-485.

Dias, J.M., Lopes, J.F. & Dekeyser, I. (2000). Residual Circulation in Ria de Aveiro Lagoon, Portugal. In *Hydrodynamics IV, theory & applications*: Proceedings of the 4th international conference on hydrodynamics. Yokohama, September 2000. Y Goda, M. Ikehata & K. Suzuki (eds.), Yokohama National University, 821-826.

Dias, J. M. (2001). *Contribution to the study of the Ria de Aveiro hydrodynamics*. Universidade de Aveiro. PhD. Thesis, 288 pp.

Dias, J.M., Lopes, J.F. & Dekeyser, I. (2001). Lagrangian Transport of Particles in Ria de Aveiro Lagoon, Portugal. *Physics and Chemistry of the Earth*, 26, 721-727.

Dias, J.M. & Lopes, J.F. (2005). Implementation and assessment of Hydrodynamic, salt and heat transport models: The case of the Ria de Aveiro Lagoon (Portugal). *Environmental Modelling & Software* (doi: 10.1016/j.envsoft.2004.09.002)

Dias, J.M.A. & Taborda, R.P.M. (1988). Evolução recente do nível médio do mar em Portugal. *Anais do Instituto Hidrográfico*, 9, 83-97.

Dias, J.A. & Taborda, R. (1992). Tidal gauge data in deducing secular trends of relative sea level and crustal movement in Portugal. *Journal of Coastal Research*, 8 (3), 655-659.

Doodson, A.T. (1921). Harmonic development of the tide-generating potential. *Proceedings of the Royal Society A*, 100, 305-329.

Doodson, A.T. & Warburg, H.D. (1941). *Admiralty Manual of Tides*. London: HM Stationary Office, 270pp.

Douglas, B.C. (1991). Global sea level rise. *Journal of Geophysical Research*, 96 (C4), 6981-6992.

Douglas, B.C. (1992). Global sea level accelerations. *Journal of Geophysical Research*, 97 (C8), 12699-12706.

Douglas, B.C., Kearney, M.S. & Leatherman, S.P. (2001). *Sea level Rise: History and Consequences*. Academic, New York, 232 pp.

Dronkers, J.J. (1964). *Tidal Computations in Rivers and Coastal Waters*. Amsterdam, The Netherlands, Holland: North-Holland Publishing Company, 518 pp.

Dronkers, J.J. (1969). Tidal computation in rivers and coastal waters. *Journal of Hydraulics Division*, ASCE, 95 (HY1), 44-47.

Dronkers, J. (1986). Tidal asymmetry and estuarine morphology. *Netherlands Journal of Sea Research*, 20 (2/3), 117-131.

Dronkers, J. (1998). Morphodynamics of the Dutch delta. In: Dronkers, J., Scheffers, M. (Eds.), *Physics of Estuaries and Coastal Seas*. Proceedings of the 8th International Biennial Conference on Physics of Estuaries and Coastal Seas, The Hague, Netherlands, 9-12, September 1996. A.A. Balkema, Rotterdam, 297-304.

Dyer, K. (1997). *Estuaries, A Physical Introduction*. Chichester, John Wiley & Sons, 195 pp.

Emery, W.J. & Thomson, R.E. (2001). *Data analysis methods in physical oceanography*. Amsterdam, Elsevier, 638 pp.

Ekman, M. (1999). Climate changes detected through the world's longest sea level series. *Global and Planetary Change*, 21, 215-224.

Fenoglio-Marc, L., Tel,. E., Garcia, M.J. & Kjaer, N. (2004). Interannual and decadal sea level change in south-western Europe from satellite and in-situ measurements. *Proceedings of GGSM2004, Interantional Association of Geodesy Symposia*, Springer Verlag.

Flather, R.A. (1987). Estimates of extreme conditions of tide and surge using a numerical model of the north-west European continental shelf. *Estuarine, Coastal and Shelf Sciences*, 24, 69-93.

Flather, R.A. (2000). Existing operational oceanography. *Coastal Engineering*, 41, 13-40.

Flather (2001). Storm surges. In *Encyclopaedia of Ocean Sciences*. Academic Press, New York, 2882-2892.

Foreman, M.G.G. (1977). *Manual for Tidal Heights Analysis and Prediction.* Pacific Marine Science Report, 77-10, Institute of Ocean Sciences, Patricia Bay, Sidney, B.C., 58 pp.

Foreman, M.G.G. (1989). The harmonic analysis of tidal model time series. *Advanced Water Resources*, *12*, 109-120.

Friedrichs, C.T. & Aubrey, D.G. (1988). Non-linear tidal distortion in shallow well-mixed estuaries: a synthesis. *Estuarine, Coastal and Shelf Science,* 27, 521-545.

Garcia-Lafuente, J., Del Río, J., Fanjul, E.A., Gomis, D. & Delgado, J. (2004). Some aspects of seasonal sea level variations around Spain. *Journal of Geophysical Research*, 109, C09008. (doi: 10.1029/2003JC002070).

Godin, G. (1972). *The analysis of tides.* Liverpool University Press, 264pp.

Gornitz, V. (1995). Sea-level rise – a review of recent past and near-future trends. *Earth and Surface Processes and Landforms*, 20, 7-20.

Gornitz, V. & Lebedeff, S. (1987). Global sea-level changes during the last century. In *Sea-level change and coastal evolution*. Tulsa, Oklahoma, SEPM, No.41, Society for Economic Palaeontologists and Mineralogists, 3-16.

Graff, J. (1981). An investigation of frequency distributions of annual sea level maxima at ports around Great Britain. *Estuarine, Coastal and Shelf Science,* 12, 389-449.

Hardy, D.M. (1977). Empirical eigenvector analysis of vector observations. *Geophysical Research Letters*, 4 (8), 319-320.

Horn, W. (1960). Some recent approaches to tidal problems. *International Hydrographic Review,* 37 (2), 65-84.

Hurrell, J.W. (1995). Decadal trends in the North Atlantic Oscillation: regional temperatures and precipitation. *Science,* 269, 676-679.

Hurrell, J.W. & van Loon, H. (1997). Decadal variations in climate associated with the North Atlantic Oscillation. *Climatic Change,* 36, 301-326.

Hurrell, J.W., Kushnir, Y., Ottersen, G. & Visbeck, M. (2003). The North Atlantic Oscillation: Climatic significance and environmental impact. Hurrell, J.W., Kushnir, Y., Ottersen, G. & Visbeck, M. (eds.) In *Geophysical Monograph,* 134, 279pp.

Kang, J.W. (1999). Changes in tidal characteristics as a result of the construction of sea-dike/sea-walls in the Mokpo coastal zone in Korea. *Estuarine, Coastal and Shelf Science*, 48, 429-438. (doi: 10.1016/j.ecss.1998.0464)

Klinck, J.M. (1985). EOF analysis of central Drake Passage currents from DRAKE 79. *Journal of Physical Oceanography*, 15 (3), 288-298.

Instituto Hidrográfico (1987). Levantamento hidrográfico da Ria de Aveiro : relatório final de trabalho. - Lisboa : IH, 1987-1988. Lisboa, Instituto Hidrográfico, 5 volumes.

Instituto Hidrográfico (1991). *Recolha e processamento de dados de marés, correntes, temperaturas e salinidades na Ria de Aveiro.* Relatório FT.MC. 5/87. Lisboa, Portugal: Instituto Hidrográfico.

IOC (2002). *Manual on sea-level measurement and interpretation. Volume III-Reappraisals and recommendations as of Year 2000.* Intergovernmental Oceanographic Commission. Manuals and Guides No. 14, 47 pp.

IPCC TAR (2001). Intergovernmental Panel on Climate Change: Climate Change 2001: Third assessment Report (TAR) 2001.Available at http://www.ipcc.ch/pub/pub.htm (2004). pp

Jensen, J., Hofstede, J.L.A., Kunz, H., De Ronde, J., Heinen, P.F. & Siefert, W. (1993). Long term water level observations and variations. In *Coastlines of the Southern North Sea*. R. Hillen & H.J.Verhagen, New York: American Society of Civil Engineers, 110-130.

Jones, P. D. (1987). The early twentieth century Arctic High – fact or fiction? *Climate Dynamics* 1, 63-75.

Jones, P.D, Jónsson, T. & Wheeler, D. (1997). Extension to the North Atlantic Oscillation using early instrumental pressure observations from Gibraltar and south-west Iceland. *International Journal of Climatology*. 17, 1433-1450.

Lane, A. (2004). Bathymetric evolution of the Mersey estuary, U.K, 1907-1997: causes and effects. *Estuarine, Coastal and Shelf Science*, 59, 249-263. (doi: 10.1016/j.ecss.2003.09.003)

Lecolazet, R. (1956). Applications à l'analyse des observation de la mare gravimétrique de la méthode de H. et Y. larbrose dite par combinations linéaires dórdonnée. *Annales de Geophysicae*, 12, 56.

Lennon, G.W. (1963). A frequency investigation of abnormally high tidal levels at certain west coast ports. *Proceedings of the Institution of Civil Engineers*, 25, 451-484.

Leatherman, S.P. (2001). Social and Economic Costs of Sea Level Rise. In *Sea Level Rise. History and consequences*. New York, Academic Press, 181-220.

Leendertse, J.J. & Gritton, E.C. (1971). *A Water-Quality Simulation Model for Well-Mixed Estuaries and Coastal Seas: Volume II, Computation Procedures*. Memorandum R-708-NYC. New York, USA: The Rand Corporation.

Leendertse, J.J. (1987). *Aspects of SIMSYS2D, a system for two-dimensional flow computation*. Report R-3572-USGS. New York, USA: The Rand Corporation.

Liu, W.-C., Hsu, M.-H., Kuo, A.Y. & Li, M.-H. (2001). Influence of bathymetric changes on hydrodynamics and salt intrusion in estuarine systems. *Journal of the American Water Resources Association*, 37 (5), 1405-1416.

Lozano, I., Devoy, R.J.N., May, W. Y. & Andersen, U. (2004). Storminess and vulnerability along the Atlantic coastlines of Europe: analysis of storm records and of greenhouse gases induced climate scenario. *Marine Geology*, 210, 205-225. (doi. 10.1016/j.margeo.2004.05.026).

Marcos, M., Gomis, D., Monserrat, Álvarez-Fanjul, E., Pérez & Garcia-Lafuente, J. (2005). Consistency of long sea-level time series in the northern coast of Spain. *Journal of Geophysical Research, Oceans*, 110 (3), C03009. (doi: 10.1029/2004JC002522).

Meier, M.F. & Wahr, J.M. (2002). Sea level is rising: Do we know why? *Proceedings of the National Academy of Science. USA*, 99, 6524-6526 (doi: 10.1073/pnas.112214499).

Miles, J.W. (1971). Resonant response of harbours: an equivalent-circuit analysis. *Journal of Fluid Mechanics*, 46 (2), 241-265.

Moreira, M.H., Queiroga, H., Machado, M.M. & Cunha, M.R. (1993). Environmental gradients in a southern estuarine system: Ria de Aveiro, Portugal, Implications for soft bottom macrofauna colonization. *Netherland. Journal of Aquatic Ecology*, 27, 465-482.

Munk, W.H. & Cartwright, D.E. (1966). Tidal spectroscopy and prediction. *Philosophical Transactions of the Royal Society A*, 259, 533-581.

Munk, W. (1997). Once again: once again tidal friction. *Progress in Oceanography*, 40, 7-35.

Munk, W. (2002). Twentieth century sea level: An enigma. *Proceedings of the National Academy of Science. USA*, 99, 6550-6555 (doi: 10.1073/pnas.092704599).

Murray, M.T. (1964). A general method for the analysis of hourly height of the tide. *International Hydrographic Review*, 42 (2), 91-101.

Nerem, R.S. & Mitchum, G.T. (2001). Observations of sea level change from satellite altimetry. In *Sea Level Rise. History and consequences*. New York, Academic Press, 121-159.

Oliveira, O. (1988). *Origens da Ria de Aveiro.* Aveiro, Câmara Municipal de Aveiro, 60pp.

Permanent Service for Mean Sea Level (PSMSL). *Tidal Analysis and Prediction Packages*. Available: http://www.pol.ac.uk/psmsl/training/task2k.hel (date 25th April 2002).

Pirazzoli, P.A. (2000). Surges, atmospheric pressure and wind change and flooding probability on the Atlantic coast of France. *Oceanologica Acta*, 23, 643-661.

Pirazzoli, P.A., Regnauld, H. & Lemasson, L. (2004). Changes in storminess and surges in western France during the last century. *Marine Geology*, 210, 307-323.

Prandle, D. (1980). Modelling of tidal barrier schemes: an analysis of open-boundary problem by reference to AC circuit theory. *Estuarine and Coastal Marine Science*, 11, 53-68.

Preseindorfer, R.W. (1988). *Principal component analysis in meteorology and oceanography. Developments in atmospheric science, 17*. (2nd ed.) Amsterdam, Elsevier, 425pp.

Pugh, D. (1978). Sea levels at Alabra Atoll, Mombasa and Mahé, weastern equatorial Indian Ocean, related to tides, meteorology and ocean circulation. *Deep-Sea Research*, 26A, 237-258.

Pugh, D.T. & Vassie, J.M. (1980). Applications of joint probability method for extreme sea level computations. *Proceedings of the international Institute of Civil Engineers*, 9, 361-372.

Pugh, D.T. (1981). Tidal amphidrome movement and energy dissipation in the Irish Sea. *Geophysical Journal of the Royal Astronomical Society*, 67, 515-527.

Pugh, D.T. & Faull, H.E. (1983). Tides, surges and mean sea level trends, in *Shoreline Protection*. Proceeding of a conference organised by the Institution of Civil Engineers, Southampton. London, Thomas Telford Ltd, 59-69.

Pugh, D.T. (1987). *Tides, Surges and Mean Sea Level: a handbook for engineers and scientists.* Chichester, John Wiley & Sons, 472 pp.

Pugh, D.T. & Maul, G.A. (1996). Coastal sea level prediction for climate change. In *CRC Handbook on Coastal Prediction.* C.N.K. Moores ed.

Pugh, D.T. & Maul, G.A. (1999). Coastal sea level, prediction for climate change. *Coastal and Estuarine Studies*, 56, 377-404.

Pugh, D.T. (2004). *Changing sea levels: effects of tides, weather and climate*. Cambridge, Cambridge University Press, 280 pp.

Rodrigues, A., Tele, M., del Negro, M., Ventura, A. & Rita A. (1989). *Modelação matemática da Ria de Aveiro: Relatório de progressão*. Lisboa, Hidroprojecto, 144 pp.

Rogers, J.C. (1997). North Atlantic storm track variability and its association to the North Atlantic Oscillation and climate variability in the Northern Europe. *Journal of Climate*, 10, 1635-1647.

Rua, J. (2003). *A actividade do porto de Aveiro e a erosão costeira a sul da Barra.* Press release available at: http://www.portodeaveiro.pt/html/informacoes.html (date 25th April 2005), 9 pp.

Schureman, P. (1976). *Manual of harmonic analysis and prediction of tides*. Washington, D.C., United States Government Priting Office.

Silva, J.F. (1994) *Circulação da água na Ria de Aveiro – contribuição para o estudo da qualidade de água.* Universidade de Aveiro. PhD. Thesis, 158 pp.

Silva, J.F., Duck, R.W, Hopkins, T.D., & Rodrigues, M. (2002). Evaluation of nutrient inputs to a coastal lagoon: the case of the Ria de Aveiro, Portugal. *Hydrobiology*, 475/476: 379-385.

Shennan, I. & Woodworth, P.L. (1992). A comparison of late Holocene and twentieth-century sea-level trends from the U.K. and North Sea region. *Geophysical Journal International*, 109, 96-105.

Shum, C.K. (1997). Accuracy assessment of recent ocean tide models. *Journal of Geophysical Research*, 100, C12, 25261-25282.

Speer, P.E. & Aubrey, D.G. (1985). A study of non-linear tidal propagation in shallow inlet/estuarine systems. Part II: Theory. *Estuarine, Coastal and Shelf Science*, 21, 207-224.

Sturges, W. (1987). Large –Scale coherence of sea level at very low frequencies. *Journal of Physical Oceanography*, 17, 2084-2094.

Teixeira, S. (1994). *Dinâmica Morfossedimentar da Ria de Aveiro (Portugal).* Faculdade de Ciências da Universidade de Lisboa. PhD. Thesis, 397 pp.

Tel, E. and Garcia, M. J. (2001). Mean Sea Level Change along the North Iberian Peninsula Coast. *Proceedings of the EOSS Sea Level Workshop*, Dubrovnik, September 2000. Ivica Vilibic, Hans-Peter Plag and Mirko Orlic, Split, Hydrographic Institute of the Republic of Croatia, 110-113.

Teles, A.P.S.S (2003). *Tidal asymmetry influence on sediment dynamics: the Solent region*. School of Ocean and Earth Science, University of Southampton. PhD. Thesis, 236pp.

Thompson, K.R. (1986). North Atlantic sea-level and circulation. *Geophysical Journal of the Royal Astronomical Society*, 87, 15-32.

Tooley, M.J., & Jelgersma, S. (1992). *Impacts of a future sea-level rise on European coastal lowlands*. N. J. Thrift, University of Bristol, 27, 267pp.

Trenberth, K.E. (1984). Signal versus noise in the Southern Oscillation. *Monthly Weather Review*, 112 (2), 326-332.

Tsimplis, M.N., Flather, R.A., Vassie, J.M. (1994). North Sea pole tide described through a tide-surge model. *Geophysical Research Letters*, 21, 449-452.

Tsimplis, M.N. & Spencer, N.E. (1997). Collection and analysis of monthly mean sea level data in the Mediterranean and the Black Sea. *Journal of Coastal Research,* 13 (2), 534-544.

Tsimplis, M.N. & Josey, S.A. (2001). Forcing of the Mediterranean Sea by atmospheric oscillation over the North Atlantic. *Geophysical Research Letters*, 28, 803-806.

Tsimplis, M.N., Woolf, D.K., Osborn, T.J., Wakelin, S., Wolf, J., Flather, R., Shaw, A.G.P., Woodworth, P., Challenor, P., Blackman, D., Pert, F., Yan, Z. & Jevrejeva, S. (2005). Towards a vulnerability assessment of the UK and northern European coasts: the role of regional climate variability. *Philosophical Transactions of the Royal Society: Mathematical, physical and Engineering Sciences*, 363 (1851), 1329-1358 (doi: 10.1098/rsta.2005.1571).

Turner, R.K., Subak, S. & Adger, W.N. (1996). Pressures, Trends, and Impacts in Coastal Zones: Interaction between socio-economic and natural systems. *Environmental Management*, 20, 159-173.

Wakelin, S.L, Woodworth, P.L., Flather, R.A. & Williams, J.A. (2003). Sea level dependence on NAO over the NW European continental shelf. *Geophysical Research Letters*, 30 (7), 56-1. (doi: 10.1029/2003GL017041).

Wallace, J.M., Zhang, Y. & Lau, K.-H. (1993). Structure and seasonality of interannual and interdecadal variability of geopotential height and temperature fields in the Northern Hemisphere troposphere. *Journal of Climate,* 6, 2063-2082.

Wong, K.-C. (1986). Sea-level fluctuations in a coastal lagoon. *Estuarine, Coastal and Shelf Science*, 22, 739-752.

Woodworth, P.L. (1987). Trends in U.K. Mean Sea Level. *Marine Geodesy*, 11, 57-87.

Woodworth, P.L. (1990). A search for accelerations in records of European mean sea level. *International Journal Climatology*, 10, 129-143.

Woodworth, P.L., Shaw, S.M. & Blackman, D.L. (1991). Secular trends in mean tidal range around the British Isles and along the adjacent European coastline. *Geophysical Journal International*, 104, 593-609.

Woodworth, P.L (1999). High waters at Liverpool since 1768: the U.K.´s longest sea level record. *Geophysical Research Letters*, 26 (11), 1589-1592.

Woodworth, P.L, Tsimplis, M.N., Flathers, R.A. & Shennan, I. (1999). A review of the trends observed in British Isles mean sea level data measured by tide gauges. *Geophysical Journal International*, 136, 651-670.

Woodworth, P.L. & Blackman, D.L. (2002). Changes in extreme high waters at Liverpool, since 1768. *International Journal of Climatology*, 22, 697-714. (doi: 10.1002/joc.761).

Woodworth, P.L. & Player, R. (2003). The Permanent Service for Mean Sea Level: An update to the 21st Century. *Journal of Coastal Research*, 19 (2), 287-295.

Woodworth, P.L. & Blackman, D.L. (2004). Evidence for systematic change in extreme high waters since the mid-1970s. *Journal of Climate*, 17, 1190-1197.

Woolf, D.K., Challenor, P.G. & Cotton, P.D. (2002). The variability and predictability of the North Atlantic wave climate. *Journal of Geophysical Research*, 107 (C10), 3145. (doi: 10.1029/2001JC001124).

Woolf, D.K., Shaw, A.G.P. & Tsimplis, M. N. (2003). The influence of the North Atlantic Oscillation on sea-level variability in the North Atlantic region. *The Global Atmosphere and Ocean System*, 9 (4), 145-167. (doi: 10.1080/102367303100016338039)

Woolf, D.K., Cotton, P.D. & Challenor, P.G. (2003a). Measurements of the offshore wave climate around the British Isles by satellite altimeter. *Philosophical Transactions of the Royal Society: Mathematical Physical and Engineering Sciences*. 361 (1802), 27-31. (doi: 10.1098/rsta.2002.1103)

Yan, Z., Tsimplis, M.N. & Woolf, D. (2004). Analysis of the relationship between the North Atlantic Oscillation and sea-level changes in Northwest Europe. *International Journal of Climatology*, 24, 743-758. (doi: 10.1002/joc.1035)

Richard Brancker XR-420 TG

Specifications (as in Manual, refer to www.brancker.com)

Body Size		
Length	CT/CTD Freshwater CT/CTD Marine Others	450mm 400mm 310mm or 240mm
Diameter		64mm OD

Operating Depths	740m plastic 4000m titanium CT/CTD Freshwater - 2000m titanium TD - 6600m titanium T - 8500m titanium
Power	x4 3V CR123A lithium batteries
Memory	4MB flash
Communications	RS-232
Download Speed	19.2 or 57.6 Kbaud (higher baud rate auto-selected)
Clock Accuracy	±1 minute / year

Temperature	
Measurement range	-5 to +35 °C T8/T16/T24 optional range -20 to +35°C
Accuracy	±0.002°C factory calibration (NIST traceable standards) T8/T16/T24 depends on chosen thermistor
Resolution	Better than 0.00005°C (24 bit A/D)
Time Constant	< 3 seconds < 95 milliseconds (optional) T8/T16/T24 depends on chosen thermistor
Drift	< 0.002°C/year T8/T16/T24 depends on chosen thermistor

Depth	
Full Scale Range	TG - 100m (suggested maximum) TD - 6600m maximum depending on case and transducer CTD Freshwater - 2000m CTD Marine – 4000m
Accuracy	±0.05% full scale (NIST traceable standards)
Resolution	< 0.001% full scale
Time Constant	10 milliseconds

Conductivity	*Freshwater*	*Marine*
Range	0 to 2 mS/cm	0 to 70mS/cm
Accuracy	±0.005 mS/cm	±0.003 mS/cm
Resolution	< 0.0001 mS/cm	< 0.0001 mS/cm

APPENDIX A2: Sites used during the 2002/03 Survey – Ria the Aveiro

Figure A1 Carregal Marina: sensor deployed close to the pillar shown.

Figure A2 Varela Bridge: sensor deployed between poles, to avoid the attention of fisherman.

Figure A3 Manchão: sensor deployed inside the boat wreck.

Figure A4 Manchão, illustration of creeks within the northern branch of the S. Jacinto Channel.

Figure A4.1 Manchão: sensor deployed in the partially-submerged boat, seen in the photograph.

Figure A5 Pardilhó: sensor attached to pole, as seen in the Figure.

Figure A6 Puxadouro: sensor deployed on the right margin, close to the breached wall.

Figure A7. Cais da Ribeira.

Figure A8 Vagueira: this small marina was used to secure the deployment, for this location.

Figure A9 Areão: the sensor was deployed off the pontoon (1st deployment). The pontoon was damaged at the time of the 2nd deployment, so was not used.

Figure A10. Poço da Cruz: sensor deployed under the bridge**.**

Figure A11 Cacia: sensor was deployed on the left margin of the river (Portucel Factory is on the upper right), on the upper side of the bridge.

Figure A12. Rio Novo: CTD was used at this site, attached to the wooden pole**.**

Figure A13 Parrachil: Vemco sensor was deployed in front of longer pole.

Figure A14 Lota: Sensor was deployed next to last post of the walkway (note: the channel was very deep and had some strong currents).

Figure A15 Bacia do Laranjo: lying somewhat to the East of the original Cais do Bico site. Last wood structure on the top right hand side of the picture was used for the deployment, as the only location where the sensor became submerged at low tide, whilst securely attached to shore.

Figure A16 Vista Alegre: sensor was deployed under the bridge at Vista Alegre, tied to a pillar (on the right side of the picture).

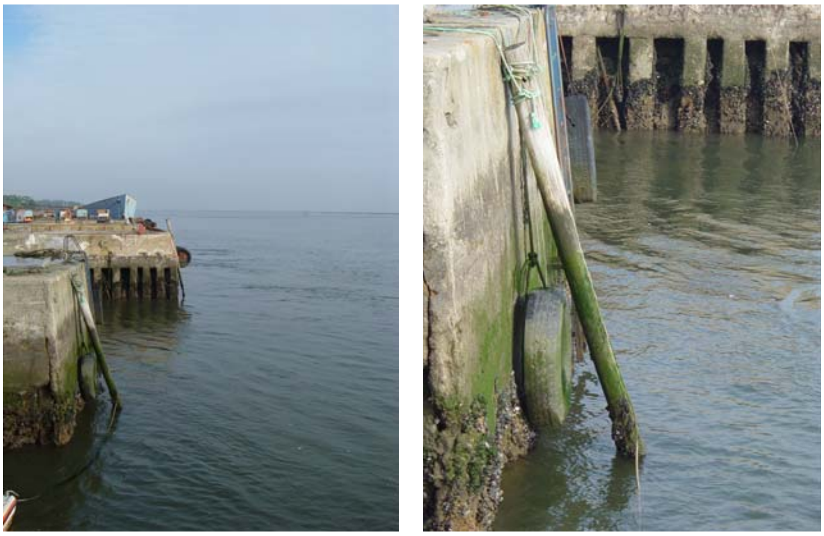


Figure A17 S. Jacinto (ship yard): sensor was deployed beside the tree trunk, tied to the iron ladder.

Figure A18 Sacor/Cires Sensor was deployed from the end of the Cires pontoon (past the ship, in the image).

Figure A19 Barra: The permanent tide well was used for all deployments, except when the CTD was used. In that case, the CTD was fixed to the outside of the well at LW, to ensure continuous submersion of the sensor.

APPENDIX A3 – Demonstration of the solution to equation (4.22) in Chapter IV, Section 4.7.1a.

$$\boxed{g\zeta_0 = g\zeta_L + \frac{KA_L l}{wh^2}\frac{\partial \zeta_L}{\partial t} + \frac{A_L l}{wh}\frac{\partial^2 \zeta_L}{\partial t^2}} \qquad (1)$$

Supposing that a lagoon is driven by a harmonic variation in level $\zeta_0 = H\cos(\sigma t)$, equation (1) becomes

$$H\cos\omega t = \zeta_L + \frac{KA_L l}{gwh^2}\frac{\partial \zeta_L}{\partial t} + \frac{A_L l}{gwh}\frac{\partial^2 \zeta_L}{\partial t^2} \Leftrightarrow \frac{A_L l}{gwl}L'' + \frac{KA_L l}{gwh^2}L + L = H\cos\omega t \qquad (2)$$

If L_p is considered as a *particular solution* of (1), whereby

$$L_p = a\cos\omega t + b\sin\omega t$$

$$L'_p = -a\omega\sin\omega t + b\omega\cos\omega t$$

$$L''_p = -a\omega^2\cos\omega t - b\omega^2\sin\omega t$$

Using the above equations in (2)

$$\frac{A_L l}{gwh}(-a\omega^2\cos\omega t - b\omega^2\sin\omega t) + \frac{A_L l}{gwh^2}(-a\omega\sin\omega t + b\omega\cos\omega t) + (a\cos\omega t + b\sin\omega t) = H\cos\omega t$$

$$\begin{cases} \left(1 - \frac{A_L l}{gwh}\omega^2\right)a + \left(\frac{KA_L l}{gwh^2}\omega\right)b = H \\ \left(-\frac{KA_L l}{gwh^2}\omega\right)a + \left(1 - \frac{A_L l}{gwh}\omega^2\right)b = 0 \end{cases}$$

By solving the above equations

$$a = \frac{H\left(1 - \frac{A_L l}{gwh}\omega^2\right)}{\left(1 - \frac{A_L l}{gwh}\omega^2\right)^2 + \left(\frac{KA_L l}{gwh^2}\omega\right)^2} = H\frac{\phi}{\phi^2 + \psi^2}$$

$$b = \frac{H\left(\frac{KA_L l}{gwh^2}\omega\right)}{\left(1 - \frac{A_L l}{gwh}\omega^2\right)^2 + \left(\frac{KA_L l}{gwh^2}\omega\right)^2} = H\frac{\psi}{\phi^2 + \psi^2}$$

Using the result for a and b in $L_p = a\cos\omega t + b\sin\omega t$

$$L_p = \frac{H}{\phi^2 + \psi^2}\left(\phi\cos\omega t + \psi\sin\omega t\right)$$

(by applying the trigonometric expression: $A\cos x + B\sin x = \sqrt{A^2 + B^2}\cos(x \pm \theta)$,

$\tan\theta = \frac{\sin\theta}{\cos\theta} = \mp\frac{B}{A}$)

$$L_p = \frac{H}{\phi^2 + \psi^2}\left(\sqrt{\phi^2 + \psi^2}\cos(\omega t - \theta)\right)$$

$$= \frac{H}{\sqrt{\phi^2 + \psi^2}}\left(\cos(\omega t - \theta)\right)$$

$$= \alpha H\cos\left(\omega t - \theta\right)$$

where $\alpha = \left(\phi^2 + \psi^2\right)^{-1/2}$ and $\phi = \cos\theta$, $\psi = \sin\theta$, which leads to

$$\tan\theta = \frac{\psi}{\phi} \Leftrightarrow \theta = \arctan\left(\frac{\psi}{\phi}\right)$$

APPENDIX A4:

Tidal constituents from the observed data collected along the European Coastline

The following Tables list amplitude and phase values of all the tidal constituents obtained by harmonic analysis of a year of data. Refer to each Table for the station name. Additional information can be found in Section 4.5.1.

	Newlyn - Amplitude (mm)								
	1915	**1916**	**1917**	**1918**	**1919**	**1920**	**1921**	**1922**	**1923**
ZO	3097.9	3077.8	3022.4	3029.3	3043.3	3055.6	3020.1	3044.6	3018.4
SA	88.0	73.1	30.3	65.5	73.0	46.7	69.3	56.9	28.8
SSA	47.8	45.2	40.9	10.9	32.3	47.8	15.0	31.4	72.7
MM	28.2	38.8	25.1	6.1	6.9	35.3	19.6	27.5	17.0
MSF	26.1	14.5	6.0	12.0	28.7	14.2	5.1	4.1	5.0
MF	11.9	16.0	13.8	18.3	4.7	30.3	30.9	52.2	25.0
2Q1	4.8	6.7	3.9	2.7	4.1	3.4	3.7	3.8	4.6
SIG1	0.4	3.2	5.3	2.5	2.7	4.9	3.1	0.4	2.9
Q1	17.4	18.1	18.9	19.2	13.4	13.4	15.3	14.3	15.7
RO1	3.9	6.7	2.7	4.1	3.6	4.3	6.3	3.6	3.4
O1	52.4	56.9	53.7	53.8	50.5	56.6	50.9	52.0	51.9
MP1	3.4	0.8	4.5	2.6	3.3	2.8	1.7	2.2	3.4
M1	5.8	3.2	0.7	1.5	3.4	4.5	6.6	7.0	4.8
CHI1	2.1	2.9	2.2	1.6	4.3	0.6	2.9	2.8	2.2
PI1	0.7	6.1	3.5	2.3	2.5	1.2	0.9	2.2	3.2
P1	18.1	23.6	21.9	20.7	21.1	20.8	21.0	20.4	21.5
S1	1.9	3.6	0.7	1.0	2.4	2.9	6.9	5.2	1.9
K1	63.8	60.9	60.1	61.0	61.4	65.5	59.0	61.8	63.4
PSI1	5.9	2.1	3.0	0.6	2.4	1.0	3.9	1.7	2.3
PHI1	2.9	2.0	2.3	0.3	3.5	1.9	1.9	2.8	0.2
TH1	0.5	3.5	2.5	5.1	3.3	2.6	0.9	3.8	4.5
J1	2.8	0.5	4.3	4.7	2.5	3.1	4.6	5.1	2.3
SO1	2.0	2.9	2.4	4.2	1.1	5.7	5.1	5.4	3.2
OO1	0.8	2.4	0.2	1.1	1.7	3.4	2.2	1.7	3.3
OQ2	10.0	8.0	5.7	2.9	9.8	9.0	9.8	8.3	1.0
MNS2	10.6	16.4	19.9	17.2	14.3	12.4	13.5	16.7	9.7
2N2	51.6	62.4	48.9	27.0	35.4	51.5	59.3	29.4	35.8
MU2	58.9	59.8	61.0	58.5	61.5	51.5	49.6	56.1	48.8
N2	327.6	327.7	325.0	325.5	323.7	321.9	321.7	323.9	327.6
NU2	88.3	76.1	69.6	65.8	66.8	71.6	69.7	59.4	68.3
OP2	17.1	11.5	13.4	21.4	18.3	9.3	4.5	21.1	12.4
M2	1696.0	1703.2	1711.3	1710.0	1698.3	1702.1	1688.8	1688.6	1692.6
MKS2	23.7	15.3	15.7	19.9	16.8	6.1	7.6	13.2	9.2
LAM2	42.1	45.5	30.4	31.4	34.3	32.8	28.6	19.6	26.5
L2	55.6	67.5	81.7	88.8	75.6	73.8	80.1	82.9	81.0
T2	17.0	31.6	29.7	22.1	26.9	28.4	29.7	37.2	28.9
S2	573.6	567.6	576.5	568.0	583.3	562.7	559.4	565.9	558.8
R2	23.0	6.5	6.3	3.4	8.0	8.2	10.5	2.4	6.7
K2	152.2	162.3	168.0	159.3	171.1	158.6	159.8	178.5	162.5
MSN2	25.3	21.6	13.1	7.5	11.3	14.7	15.8	13.9	14.6
KJ2	8.9	2.3	4.6	3.8	3.5	1.8	4.0	9.9	5.0
2SM2	23.0	20.9	16.3	23.9	9.8	18.8	15.8	18.3	22.5
MO3	2.8	4.4	4.1	5.3	0.4	4.7	3.6	1.3	1.7
M3	12.9	12.3	12.8	11.9	9.1	10.1	10.9	10.5	12.1
SO3	3.8	1.9	3.2	3.3	5.3	1.4	3.0	1.9	4.9
MK3	7.2	2.3	6.5	5.6	4.9	6.0	6.9	7.0	7.2
SK3	2.1	0.6	3.1	1.1	3.2	3.0	3.5	1.7	1.3
MN4	38.8	38.4	39.4	39.8	37.7	36.6	37.1	37.3	38.4
M4	103.7	103.0	108.8	108.3	103.6	105.4	106.4	103.9	106.0
SN4	4.4	7.4	9.8	9.5	9.5	7.4	8.8	10.0	8.9
MS4	67.4	69.9	73.7	70.4	72.2	68.1	69.3	69.0	69.8
MK4	18.6	20.1	20.0	19.1	21.9	20.5	19.6	20.9	19.0
S4	6.2	7.5	9.1	7.1	9.5	6.5	7.2	7.9	6.8
SK4	3.6	6.2	4.9	5.3	7.5	4.7	3.9	7.0	5.3
2MN6	7.5	5.1	5.0	4.6	4.2	4.3	4.2	4.3	3.8
M6	14.2	9.9	8.9	9.2	7.8	7.8	7.7	7.3	6.5
MSN6	5.0	3.2	2.7	2.0	2.5	2.2	2.5	2.5	2.1
2MS6	15.5	11.5	9.3	8.4	8.6	8.1	7.8	7.4	6.4
2MK6	5.2	3.9	2.5	2.2	2.3	2.8	1.8	2.7	1.2
2SM6	6.1	3.3	3.1	3.7	3.2	2.4	2.2	3.0	3.0
MSK6	3.5	2.8	1.8	1.8	2.1	1.5	1.8	1.8	1.8
MA2	58.1	25.6	11.2	33.2	26.8	7.4	17.1	17.9	17.9
MB2	47.6	13.8	11.8	21.0	27.6	16.9	18.4	2.0	16.6

	Newlyn - Amplitude (mm)								
	1924	**1925**	**1926**	**1927**	**1928**	**1929**	**1930**	**1931**	**1932**
ZO	3082.0	3079.7	3089.8	3097.6	3100.3	3080.0	3106.6	3087.2	3098.8
SA	58.3	83.3	46.2	60.3	12.9	79.0	64.9	38.0	59.2
SSA	23.3	51.8	31.1	14.7	68.7	48.7	6.5	37.9	40.6
MM	28.6	20.9	16.4	27.9	38.0	21.4	32.5	13.4	56.5
MSF	23.1	35.8	8.3	20.8	13.5	13.8	7.6	8.9	33.8
MF	46.4	23.2	37.0	44.8	28.1	12.7	3.1	5.6	16.0
2Q1	6.0	6.8	3.0	3.0	0.4	4.5	3.8	2.0	1.7
SIG1	5.0	3.6	2.0	0.6	2.5	2.4	1.5	1.8	3.0
Q1	13.3	17.4	15.8	16.5	17.8	14.0	11.8	14.3	16.8
RO1	1.1	3.1	1.2	4.0	3.5	3.2	3.7	2.3	1.3
O1	51.6	54.1	53.0	51.0	53.0	51.7	53.2	55.7	52.4
MP1	2.4	4.2	1.4	6.4	1.5	10.6	6.4	8.1	3.1
M1	8.3	9.6	1.4	2.6	1.4	1.7	4.0	2.3	2.5
CHI1	0.2	2.2	1.1	2.0	2.2	1.7	1.6	1.1	3.4
PI1	2.4	1.0	2.9	3.7	3.6	3.3	4.3	2.4	0.8
P1	20.5	20.8	22.7	23.0	22.3	20.6	21.7	21.2	17.3
S1	1.8	2.1	5.0	1.2	3.1	1.2	2.7	2.0	1.8
K1	59.7	62.0	65.9	61.9	62.6	59.3	60.8	56.9	62.4
PSI1	2.5	1.6	3.6	1.8	1.3	1.2	1.4	2.5	1.9
PHI1	0.5	3.0	1.5	4.0	2.0	4.8	0.8	2.1	1.2
TH1	3.0	1.2	4.7	1.8	1.4	2.5	1.8	2.2	1.0
J1	0.9	3.4	2.0	1.9	2.7	1.0	2.0	2.2	1.2
SO1	2.9	4.5	4.2	4.2	2.8	1.2	3.0	3.9	4.4
OO1	5.3	1.3	1.0	2.2	0.5	2.6	0.5	2.7	1.3
OQ2	6.9	15.4	9.7	6.5	2.2	8.6	9.1	6.0	2.3
MNS2	8.2	10.5	14.6	15.9	7.5	1.7	13.7	15.3	13.7
2N2	43.3	56.5	53.5	29.2	35.9	54.8	62.9	35.4	31.0
MU2	49.2	53.2	50.5	45.4	46.6	50.1	49.3	54.8	57.0
N2	330.2	324.9	330.7	330.8	323.7	326.6	323.3	326.7	325.3
NU2	70.7	71.9	71.1	70.3	71.7	75.6	75.4	75.4	73.8
OP2	16.5	5.0	3.4	12.5	12.6	6.4	1.1	15.7	1.8
M2	1688.6	1692.7	1699.1	1698.0	1702.8	1704.3	1708.4	1708.1	1715.6
MKS2	7.9	4.1	10.4	7.7	7.3	2.0	11.2	9.6	11.4
LAM2	28.7	34.5	26.3	24.1	28.8	33.5	32.3	26.4	34.6
L2	66.6	68.1	83.6	94.9	69.7	69.7	77.2	100.0	55.8
T2	31.4	25.9	32.2	29.8	28.4	27.9	33.6	36.3	31.1
S2	561.6	559.5	567.4	566.9	567.7	571.6	577.4	572.5	571.2
R2	12.4	5.9	9.8	1.3	3.1	2.9	0.7	7.0	11.8
K2	168.5	164.8	167.6	166.6	168.1	167.8	167.3	166.3	164.7
MSN2	17.5	18.7	15.6	13.1	9.6	18.1	16.8	12.8	12.2
KJ2	2.1	7.3	4.9	6.1	7.0	4.7	7.7	6.8	7.4
2SM2	19.5	21.0	22.4	21.5	20.6	20.1	20.4	21.7	26.9
MO3	3.0	5.9	4.1	4.4	2.9	0.9	1.3	1.4	0.4
M3	9.7	10.7	12.6	12.0	11.5	9.5	8.8	11.6	10.9
SO3	2.2	3.0	5.1	2.2	1.7	7.6	2.1	6.4	0.7
MK3	6.7	6.2	6.3	7.5	7.7	6.8	8.3	7.0	7.0
SK3	2.3	3.7	2.2	3.6	1.5	2.1	2.2	1.9	1.8
MN4	38.7	37.9	39.1	40.6	39.1	38.8	39.2	40.2	40.1
M4	105.7	106.8	106.2	107.3	107.6	105.5	107.2	111.3	111.3
SN4	8.2	8.7	8.8	9.0	8.2	10.0	8.7	9.2	6.2
MS4	70.0	70.8	70.6	72.5	73.6	72.1	75.2	77.8	75.1
MK4	21.7	21.4	21.4	21.0	21.8	21.1	20.0	20.8	22.0
S4	8.7	7.4	7.7	9.0	8.3	9.2	10.7	9.8	8.0
SK4	6.0	4.9	4.4	4.8	5.3	4.9	4.3	4.5	5.2
2MN6	3.7	3.8	4.7	3.9	4.1	4.2	4.5	5.0	5.5
M6	7.1	7.4	7.2	7.3	6.7	7.0	8.6	8.8	10.1
MSN6	2.5	2.0	2.3	1.3	2.3	2.2	1.4	2.3	2.1
2MS6	6.7	7.7	7.5	7.3	6.9	7.9	8.6	8.5	10.2
2MK6	2.7	1.7	2.4	2.3	2.4	2.6	2.9	2.0	2.3
2SM6	2.8	3.5	3.3	3.3	2.1	2.9	3.0	2.8	3.5
MSK6	2.0	1.8	2.0	1.7	2.0	1.8	1.6	1.5	1.8
MA2	4.3	20.8	10.1	8.1	6.1	13.4	8.8	9.6	3.8
MB2	16.9	16.0	19.0	12.6	13.0	20.1	16.4	15.7	12.7

	Newlyn - Amplitude (mm)								
	1933	**1934**	**1935**	**1936**	**1937**	**1938**	**1939**	**1940**	**1941**
ZO	3087.9	3062.7	3069.5	3130.3	3137.7	3057.0	3100.7	3097.6	3093.0
SA	37.8	61.4	71.0	79.1	97.8	89.3	72.1	40.4	25.1
SSA	30.2	47.4	58.0	68.2	22.3	56.2	14.7	27.9	32.3
MM	42.5	37.5	43.3	12.0	29.5	32.3	26.0	18.6	15.9
MSF	20.1	19.1	12.5	7.8	15.5	2.2	14.2	24.9	24.1
MF	16.4	22.6	12.3	16.2	29.3	30.2	30.8	18.0	15.5
2Q1	4.2	5.1	4.0	1.5	0.5	4.6	3.2	5.6	0.5
SIG1	4.4	1.7	4.8	1.6	1.7	3.6	2.0	2.2	3.8
Q1	15.8	17.4	18.3	16.7	16.5	12.0	15.6	16.2	18.6
RO1	4.5	2.4	4.8	2.8	2.7	2.2	5.8	3.6	4.5
O1	52.5	52.1	52.5	52.7	53.5	53.4	51.0	49.1	50.6
MP1	4.6	4.1	3.7	4.4	4.5	2.1	3.8	2.4	2.1
M1	3.4	1.6	1.1	1.1	3.4	4.8	4.8	5.2	8.4
CHI1	1.4	1.7	1.4	3.3	0.4	3.1	2.0	1.4	1.4
PI1	1.5	0.6	1.0	2.9	2.6	2.1	2.4	0.4	1.3
P1	22.3	19.1	20.0	23.9	20.9	21.3	21.5	19.3	21.4
S1	3.3	3.0	1.3	3.3	2.3	2.6	2.7	3.2	2.8
K1	60.6	60.7	63.9	63.7	63.2	64.7	59.6	61.6	65.1
PSI1	1.1	3.0	1.3	2.1	1.2	0.9	1.1	1.8	1.4
PHI1	1.6	1.3	3.1	1.8	3.3	2.5	1.2	1.9	1.6
TH1	0.1	1.4	1.3	0.7	1.1	1.7	1.9	1.2	0.8
J1	1.9	2.9	1.5	3.8	1.9	0.2	3.7	1.6	1.4
SO1	2.6	3.7	3.7	2.8	1.7	3.3	4.4	2.2	4.3
OO1	1.6	2.8	1.6	1.4	3.6	3.4	2.2	5.6	3.3
OQ2	8.5	11.2	8.6	2.0	5.6	10.8	16.7	6.0	6.2
MNS2	7.2	15.9	18.0	14.8	9.5	11.7	19.6	14.3	11.6
2N2	57.3	62.5	44.8	24.8	47.0	56.5	54.9	35.7	31.3
MU2	54.8	53.4	53.5	54.8	53.6	51.2	56.8	51.4	53.0
N2	325.4	324.9	328.6	330.9	324.0	320.9	324.8	325.0	332.5
NU2	68.5	66.1	68.0	74.1	69.1	71.7	70.5	69.7	70.8
OP2	7.4	9.1	7.0	12.0	8.7	7.8	5.0	14.3	10.4
M2	1709.0	1709.0	1709.4	1702.2	1700.5	1699.8	1700.7	1702.8	1699.8
MKS2	3.4	13.4	12.3	12.8	7.4	9.8	18.0	15.5	7.2
LAM2	30.8	27.7	25.4	27.8	29.6	31.3	39.8	29.1	28.4
L2	55.5	69.4	93.3	86.7	74.7	73.0	96.8	83.3	73.5
T2	35.5	34.6	29.7	30.9	29.1	29.7	33.2	32.2	33.1
S2	575.1	577.0	574.6	572.1	567.6	567.4	566.8	563.6	565.7
R2	10.9	5.2	5.9	2.2	2.9	5.2	4.7	12.6	9.4
K2	165.9	162.2	160.3	161.5	160.7	163.0	166.3	156.8	156.0
MSN2	16.2	18.5	11.0	13.4	17.3	15.4	20.4	11.8	14.8
KJ2	6.8	8.1	8.0	5.1	1.7	4.2	8.4	0.6	9.2
2SM2	20.8	21.6	19.3	18.9	18.9	16.7	18.5	15.8	18.0
MO3	5.1	5.5	3.6	6.1	1.9	3.4	1.1	4.1	1.9
M3	12.3	11.5	11.2	11.6	10.2	10.3	10.4	10.1	11.0
SO3	2.4	3.5	0.7	1.4	3.8	2.3	2.8	2.5	3.1
MK3	9.2	6.7	5.9	6.1	7.6	6.9	6.1	7.5	5.3
SK3	7.0	3.1	1.9	3.3	0.4	4.0	3.2	0.6	4.5
MN4	39.8	37.6	41.4	41.6	38.4	38.6	38.8	40.2	40.7
M4	107.0	107.6	110.7	107.5	107.5	110.3	110.1	110.3	110.3
SN4	9.6	9.3	10.0	8.9	8.5	9.0	10.3	8.4	9.6
MS4	72.4	76.5	75.6	74.4	74.7	77.4	73.7	72.6	75.8
MK4	20.5	19.4	20.0	21.2	18.8	21.1	22.6	18.4	20.0
S4	9.0	9.3	8.6	8.7	8.7	10.7	8.8	8.4	10.2
SK4	5.8	4.8	3.8	6.0	4.4	5.0	6.7	3.6	7.0
2MN6	5.1	3.8	4.9	4.5	4.2	4.0	4.6	4.2	4.3
M6	8.8	7.9	7.5	7.8	7.7	7.1	7.9	7.6	7.9
MSN6	2.6	2.1	2.2	2.7	1.8	2.0	2.7	2.1	2.2
2MS6	9.1	8.4	7.5	8.5	8.0	7.8	8.9	7.3	7.6
2MK6	2.7	2.3	2.4	1.6	2.3	2.1	2.4	2.7	1.9
2SM6	3.1	1.9	1.4	2.3	2.0	2.1	2.6	2.0	2.4
MSK6	1.8	1.8	1.5	1.8	1.3	2.0	1.5	1.8	1.2
MA2	17.2	14.1	21.7	20.1	15.6	14.2	6.3	16.5	19.6
MB2	25.1	20.3	22.3	21.9	19.1	16.9	17.3	31.2	28.4

	Newlyn - Amplitude (mm)								
	1942	**1943**	**1944**	**1945**	**1946**	**1947**	**1948**	**1949**	**1950**
ZO	3088.3	3070.3	3055.3	3100.0	3122.1	3131.8	3121.8	3096.3	3131.8
SA	40.6	71.6	82.5	85.5	51.4	39.4	77.9	112.8	56.8
SSA	58.8	7.7	23.4	91.2	46.8	33.1	55.1	54.7	17.2
MM	23.5	15.4	39.3	20.8	14.1	43.1	39.9	3.9	33.6
MSF	11.1	21.1	8.9	28.4	9.4	17.9	13.3	8.2	6.8
MF	6.1	24.1	28.0	12.3	21.5	13.4	4.5	23.7	12.5
2Q1	4.0	5.1	3.7	0.8	1.7	3.8	4.0	1.6	3.2
SIG1	3.4	1.3	2.8	1.2	3.1	1.2	5.5	1.5	0.8
Q1	15.5	18.9	17.1	15.8	15.7	10.8	8.5	16.3	15.9
RO1	6.2	4.9	2.0	3.9	4.5	3.2	4.1	2.4	3.2
O1	51.3	54.2	56.7	51.3	54.1	52.8	53.1	51.9	51.8
MP1	3.5	3.7	3.0	4.2	1.9	3.1	5.2	4.2	5.0
M1	7.8	3.1	1.7	2.0	1.9	5.0	2.1	1.8	2.7
CHI1	2.0	0.8	0.8	1.2	2.0	2.2	0.7	2.3	1.7
PI1	1.9	5.7	4.3	1.9	3.0	4.0	0.4	2.5	3.5
P1	22.1	21.2	22.9	19.2	21.5	22.7	22.0	21.8	22.8
S1	3.4	1.5	1.7	1.7	1.1	4.7	3.7	4.3	3.9
K1	58.9	63.3	64.2	60.6	63.7	61.3	63.7	61.3	62.3
PSI1	0.8	2.7	1.5	1.4	1.1	3.8	2.4	2.1	0.1
PHI1	1.5	1.3	3.6	3.2	1.9	3.8	4.0	0.9	2.8
TH1	2.2	3.8	0.8	0.3	0.9	0.6	3.9	0.9	1.7
J1	2.5	2.5	3.0	2.0	2.1	2.7	3.0	1.5	1.4
SO1	4.5	1.2	3.0	2.6	2.9	4.4	3.8	2.5	2.0
OO1	2.9	3.1	3.5	2.1	1.9	1.1	0.2	0.3	1.8
OQ2	12.6	11.4	6.9	4.2	6.1	9.5	7.6	4.3	4.3
MNS2	6.5	10.9	15.5	13.6	9.9	9.1	13.6	17.1	11.2
2N2	53.3	51.7	46.5	25.9	36.6	60.9	54.3	34.6	27.0
MU2	51.9	48.3	53.7	48.6	50.0	54.7	47.5	55.3	58.5
N2	324.8	325.7	327.2	329.0	329.0	323.9	327.1	328.3	333.2
NU2	76.3	68.9	70.8	72.0	75.4	75.6	77.9	67.3	73.8
OP2	12.0	1.6	13.6	7.7	8.8	8.0	4.4	8.1	19.2
M2	1698.7	1704.2	1705.9	1705.3	1709.7	1711.9	1705.5	1706.5	1699.8
MKS2	2.7	6.0	20.5	8.8	1.5	9.8	4.3	11.5	10.9
LAM2	34.7	28.3	31.9	29.3	32.5	33.2	32.2	26.6	33.5
L2	62.3	73.0	80.5	91.3	73.2	69.9	83.4	96.4	58.3
T2	32.2	31.7	32.5	31.8	30.7	35.6	30.6	24.5	34.2
S2	567.3	561.8	572.1	572.3	571.7	572.8	578.2	576.1	572.7
R2	4.0	7.4	6.0	1.5	6.7	11.4	2.6	14.2	9.6
K2	169.0	163.4	165.0	166.7	169.4	164.9	169.8	161.6	164.2
MSN2	12.4	17.3	12.5	12.7	17.7	17.7	13.0	10.6	19.8
KJ2	4.2	6.8	3.4	7.1	7.1	3.6	4.2	5.5	5.9
2SM2	17.3	19.9	20.5	20.2	19.3	23.0	20.4	20.9	25.0
MO3	6.7	4.2	4.3	5.3	2.3	2.7	1.4	1.6	2.5
M3	10.5	11.9	10.8	12.2	10.6	10.1	9.3	10.2	11.5
SO3	4.0	4.0	0.7	3.5	1.7	3.0	1.0	2.3	1.1
MK3	6.8	5.4	3.8	6.2	5.7	6.6	7.4	6.7	5.7
SK3	4.5	2.1	3.9	2.5	2.6	3.4	1.6	2.9	2.0
MN4	39.0	39.8	42.7	41.0	40.6	39.0	41.0	41.7	41.7
M4	107.3	110.7	109.6	111.7	111.1	109.0	109.5	111.7	111.1
SN4	7.9	10.7	9.0	5.6	9.2	8.9	9.3	9.8	9.8
MS4	75.4	73.9	73.6	72.0	76.0	75.3	76.9	73.9	74.3
MK4	20.5	21.5	20.4	22.4	21.3	21.6	20.8	20.7	20.6
S4	9.0	8.7	9.6	7.3	8.7	9.8	9.3	8.5	7.9
SK4	6.5	3.8	5.5	5.6	4.4	5.7	5.3	6.0	6.0
2MN6	4.3	4.2	4.1	3.5	3.9	3.8	4.7	3.9	4.3
M6	7.1	6.6	7.1	7.6	7.3	8.1	7.2	7.7	8.0
MSN6	2.3	2.4	2.3	2.6	2.1	2.2	2.3	2.0	1.8
2MS6	7.8	6.9	7.5	8.6	8.1	7.8	7.9	8.1	7.8
2MK6	2.2	2.8	2.2	1.7	2.0	2.1	2.0	1.9	2.0
2SM6	3.0	1.9	2.4	3.0	2.4	2.0	3.2	3.0	2.6
MSK6	1.0	1.2	1.0	1.5	1.7	1.8	1.4	1.2	1.3
MA2	11.5	5.7	11.5	7.5	15.1	24.1	12.9	11.9	12.1
MB2	19.5	20.5	27.7	17.1	15.7	29.6	22.9	19.1	23.6

	Newlyn - Amplitude (mm)								
	1951	**1952**	**1953**	**1954**	**1955**	**1956**	**1957**	**1958**	**1959**
ZO	3158.6	3123.7	3095.1	3106.2	3144.8	3067.1	3115.4	3147.3	3140.1
SA	80.3	32.3	57.8	59.4	83.9	63.4	52.5	51.1	76.0
SSA	13.4	41.5	56.0	18.4	41.0	36.0	25.7	39.6	31.9
MM	30.4	18.3	10.5	13.1	11.1	30.1	10.4	17.7	19.3
MSF	8.9	15.8	7.0	17.8	8.4	16.3	5.6	41.0	6.9
MF	14.7	5.8	14.4	14.2	10.8	26.4	12.7	31.1	28.5
2Q1	4.5	4.8	2.6	0.4	5.2	2.2	1.5	6.3	3.6
SIG1	2.7	0.7	2.0	3.9	3.1	2.1	2.1	1.4	2.7
Q1	17.3	18.9	17.7	15.8	15.8	14.7	12.4	14.6	14.5
RO1	5.2	3.5	4.0	2.8	3.3	6.6	2.3	2.5	3.6
O1	51.6	52.7	53.5	52.7	55.5	53.7	48.0	50.5	49.2
MP1	5.6	4.9	2.2	6.5	1.0	4.2	4.5	4.5	1.8
M1	3.9	1.0	0.2	0.5	4.4	4.6	3.9	5.0	6.3
CHI1	2.1	2.5	3.8	3.2	0.8	1.8	2.8	1.8	3.0
PI1	1.9	1.7	3.2	2.2	3.7	2.6	3.5	2.1	4.5
P1	21.0	19.4	20.5	20.1	22.2	19.9	20.6	20.6	23.8
S1	3.1	4.2	5.2	4.8	3.7	3.4	1.3	7.0	7.8
K1	60.7	60.3	63.0	61.4	60.3	60.2	64.6	62.8	63.8
PSI1	1.1	1.1	1.2	4.7	0.7	1.7	4.4	1.0	1.4
PHI1	1.5	1.8	1.0	0.5	1.7	1.5	0.1	0.6	1.4
TH1	2.3	1.1	1.4	0.8	1.8	0.4	2.4	3.2	3.1
J1	4.6	1.8	2.4	5.7	0.9	2.3	2.4	1.3	0.9
SO1	2.1	3.3	2.4	3.5	3.0	2.8	0.9	2.6	1.8
OO1	1.0	0.9	1.7	1.9	1.8	3.9	2.4	1.6	1.7
OQ2	11.1	6.3	8.9	0.9	14.3	15.0	15.4	4.2	4.9
MNS2	11.0	15.7	19.2	14.1	10.2	18.9	15.7	12.9	10.7
2N2	62.3	54.9	28.8	29.0	47.6	70.5	43.0	35.3	40.6
MU2	47.3	53.9	57.9	54.3	51.7	63.3	43.2	49.9	51.5
N2	329.1	324.6	318.3	330.2	317.6	327.2	329.8	319.7	319.3
NU2	71.1	65.8	73.0	74.2	70.3	81.1	56.5	77.6	74.1
OP2	11.0	4.5	7.0	15.3	4.9	8.5	7.4	13.5	16.5
M2	1699.6	1708.1	1706.8	1697.0	1692.1	1695.8	1694.2	1699.9	1700.7
MKS2	13.7	12.5	9.9	13.9	6.4	7.4	5.5	11.5	7.3
LAM2	30.0	27.1	34.3	30.2	30.7	36.1	18.7	34.5	34.1
L2	61.8	72.8	81.6	77.0	68.7	82.1	97.8	67.1	58.8
T2	34.4	28.6	36.7	30.0	29.3	22.2	39.3	32.4	36.8
S2	583.8	572.2	575.2	567.7	570.4	562.6	570.3	569.4	563.1
R2	9.4	8.8	10.9	5.5	6.1	2.4	4.5	7.1	6.0
K2	164.7	159.5	166.1	162.4	161.3	171.2	160.1	152.3	157.8
MSN2	26.1	17.2	10.2	13.7	21.5	22.1	15.4	8.9	14.7
KJ2	10.0	6.7	8.5	3.2	7.9	4.9	5.8	13.8	6.6
2SM2	18.5	23.4	20.8	19.0	24.0	27.4	13.4	22.0	17.6
MO3	3.1	4.1	2.6	3.8	1.7	1.6	0.9	2.3	2.1
M3	11.9	11.3	11.3	10.5	9.4	9.2	9.4	10.4	12.7
SO3	1.8	2.1	2.3	2.3	2.6	2.7	4.0	2.9	3.3
MK3	6.0	6.6	5.3	6.1	6.7	5.2	10.0	5.6	7.4
SK3	3.4	2.9	1.6	2.7	2.8	0.7	3.4	3.0	1.5
MN4	40.5	40.1	41.1	40.8	38.8	38.4	40.2	39.5	38.9
M4	110.0	111.9	112.6	109.9	109.7	108.2	110.5	109.6	108.3
SN4	10.8	9.6	6.4	8.2	10.0	9.3	11.3	6.6	7.8
MS4	79.1	75.7	74.4	73.6	75.1	73.7	74.5	72.3	70.8
MK4	21.5	19.3	22.2	20.1	21.3	21.8	20.5	19.5	21.1
S4	9.9	8.9	7.8	9.1	7.3	8.3	9.4	7.7	7.3
SK4	5.3	4.9	5.9	4.2	5.2	8.4	4.8	2.6	5.8
2MN6	4.2	4.7	3.6	3.5	4.0	3.5	3.4	3.7	3.3
M6	8.2	7.8	6.1	5.6	7.0	6.5	5.6	5.4	6.2
MSN6	1.8	2.0	1.7	2.0	2.5	2.5	2.3	2.2	2.1
2MS6	7.5	8.8	6.8	6.4	8.0	6.6	7.1	6.3	6.6
2MK6	2.3	2.2	2.0	1.6	1.8	2.4	1.2	1.5	2.0
2SM6	2.8	3.2	2.8	1.6	2.2	2.1	2.4	2.5	2.4
MSK6	1.8	1.6	1.7	0.9	1.0	3.0	1.1	2.0	1.0
MA2	21.2	14.0	5.3	9.9	12.9	14.1	1.9	7.3	10.9
MB2	36.0	27.2	26.5	24.3	19.4	13.4	12.1	21.9	22.4

	Newlyn - Amplitude (mm)								
	1960	**1961**	**1962**	**1963**	**1964**	**1965**	**1966**	**1967**	**1968**
ZO	3193.6	3154.5	3106.1	3157.5	3125.6	3129.3	3185.1	3139.2	3176.8
SA	91.3	68.2	61.3	103.6	14.0	98.2	41.7	46.0	100.2
SSA	52.9	60.1	16.1	42.5	32.1	49.1	45.5	32.5	61.8
MM	18.9	32.9	32.2	37.2	8.4	25.7	51.0	24.4	4.3
MSF	16.1	19.8	14.6	15.1	8.4	8.5	25.8	10.4	2.7
MF	1.2	45.6	25.7	37.4	24.6	8.4	15.2	7.0	29.3
2Q1	3.3	7.7	5.3	2.3	2.0	5.9	2.4	1.9	3.8
SIG1	2.9	4.8	1.0	1.8	1.7	1.5	2.2	2.2	1.5
Q1	13.0	17.4	19.9	18.5	16.5	12.1	12.3	16.0	16.7
RO1	5.0	2.7	3.8	4.9	3.8	1.5	5.0	3.5	2.7
O1	52.5	54.5	51.2	53.4	56.2	53.9	51.6	53.3	53.1
MP1	1.3	2.1	4.4	4.2	3.7	6.2	6.6	3.6	2.7
M1	6.9	3.8	1.0	2.2	2.4	4.3	2.7	4.1	5.4
CHI1	1.7	2.6	3.2	2.3	2.7	1.3	1.1	2.8	1.2
PI1	3.1	1.6	0.6	1.5	3.6	5.1	3.8	1.5	0.9
P1	23.7	22.1	22.8	23.0	20.9	22.0	21.3	22.7	20.2
S1	3.3	3.2	7.2	1.9	6.2	7.2	4.7	4.0	5.7
K1	60.0	61.2	60.4	62.3	61.6	59.6	63.6	64.0	61.1
PSI1	0.1	1.5	1.8	1.1	2.0	4.8	1.2	3.5	1.6
PHI1	3.0	2.4	1.5	2.9	0.6	3.4	1.8	1.5	3.1
TH1	3.1	1.7	1.9	1.6	2.1	0.7	2.8	0.3	1.4
J1	1.3	1.3	3.0	1.8	0.7	2.6	2.5	1.2	1.4
SO1	3.1	3.8	4.2	2.2	0.4	1.8	3.2	3.4	2.6
OO1	6.5	3.5	1.5	2.7	2.9	2.7	1.4	2.6	1.6
OQ2	14.2	7.6	8.7	7.7	10.5	9.7	9.6	3.2	5.7
MNS2	6.3	9.7	17.2	12.4	6.1	12.5	21.1	14.0	11.5
2N2	49.4	49.1	47.6	26.3	43.9	62.4	50.3	26.1	41.7
MU2	54.7	49.3	50.7	47.4	49.2	50.1	52.4	51.3	53.5
N2	324.5	323.0	328.5	323.3	324.1	327.2	326.6	331.1	336.9
NU2	76.8	65.0	72.7	76.4	74.1	70.4	73.4	74.9	69.4
OP2	1.4	3.6	13.5	18.0	19.5	8.3	16.3	14.8	12.1
M2	1693.5	1698.5	1702.0	1698.1	1700.0	1707.5	1711.8	1721.0	1722.0
MKS2	7.8	10.2	17.1	5.7	9.6	7.7	13.3	6.9	2.1
LAM2	35.6	24.8	26.1	29.1	36.9	32.0	31.4	30.1	32.4
L2	66.2	72.6	91.6	76.5	68.2	77.9	85.1	85.0	59.3
T2	31.8	31.5	23.5	34.6	37.3	33.8	35.1	33.4	31.7
S2	561.5	561.8	573.2	570.5	571.1	572.1	572.5	579.3	583.6
R2	6.4	3.4	13.8	2.7	8.4	6.7	10.5	6.2	3.2
K2	156.9	160.0	158.3	171.9	162.4	172.6	165.8	166.4	168.3
MSN2	19.5	13.0	12.9	11.7	14.5	20.1	16.3	14.7	21.2
KJ2	3.1	3.9	5.3	12.9	8.1	3.7	4.4	7.2	6.7
2SM2	22.1	17.1	21.4	18.1	21.0	20.6	23.0	19.4	22.1
MO3	5.3	4.6	5.7	4.0	3.9	1.0	1.5	0.6	3.6
M3	12.0	11.2	10.3	10.7	11.2	9.5	10.3	10.3	11.8
SO3	1.6	1.8	3.8	2.7	2.5	1.9	1.7	1.0	1.9
MK3	7.3	5.2	5.8	5.4	6.3	5.9	6.8	6.0	4.7
SK3	1.4	2.8	4.3	2.3	3.0	3.3	1.1	2.0	1.8
MN4	37.8	38.6	40.0	40.1	40.0	39.4	41.8	42.4	42.2
M4	107.8	108.3	109.9	108.9	109.9	109.6	112.3	113.7	113.2
SN4	6.8	9.3	8.4	8.7	8.3	9.8	9.9	6.9	9.4
MS4	71.8	72.9	73.9	73.8	72.2	76.2	73.0	69.9	72.2
MK4	19.3	19.2	19.0	21.7	22.0	21.9	20.2	20.4	23.9
S4	7.1	8.7	8.2	9.1	6.0	8.9	9.0	7.3	7.4
SK4	3.8	3.4	3.8	6.7	5.4	4.7	5.3	3.8	5.4
2MN6	3.7	3.6	3.5	3.5	2.8	4.0	3.9	4.0	4.0
M6	5.6	6.7	5.9	4.6	4.7	6.9	7.2	7.5	7.1
MSN6	2.3	2.4	2.2	2.3	2.6	2.3	2.6	2.4	2.8
2MS6	6.4	6.4	6.2	6.3	7.1	7.2	7.1	7.9	8.2
2MK6	2.2	1.8	1.5	1.7	1.0	2.2	2.9	1.4	2.3
2SM6	3.2	2.5	2.1	2.2	3.5	2.3	2.1	3.2	3.0
MSK6	1.7	1.2	1.4	1.5	2.4	2.1	1.6	1.6	2.1
MA2	11.5	12.7	13.1	10.1	6.6	6.8	7.1	7.6	10.0
MB2	8.6	20.0	22.1	6.3	7.2	15.3	10.2	14.2	5.4

	Newlyn - Amplitude (mm)								
	1969	**1970**	**1971**	**1972**	**1973**	**1974**	**1975**	**1976**	**1977**
ZO	3178.7	3140.5	3131.6	3147.8	3102.7	3136.1	3120.3	3123.0	3167.3
SA	56.3	67.4	2.1	77.5	61.2	41.3	41.7	124.6	87.3
SSA	4.9	48.3	28.4	23.2	25.2	37.2	38.7	35.9	24.8
MM	23.2	13.2	27.9	50.1	15.6	19.9	13.1	16.5	15.5
MSF	6.2	27.5	10.8	11.1	11.0	27.1	4.2	17.3	35.5
MF	8.1	13.8	23.3	12.7	35.6	21.4	26.1	25.3	32.8
2Q1	3.4	3.7	3.4	3.3	1.7	2.9	1.9	1.0	4.2
SIG1	2.3	1.1	4.2	4.3	1.0	2.3	2.7	1.9	1.3
Q1	16.2	17.6	17.4	16.9	12.4	11.7	14.3	13.4	17.1
RO1	2.8	1.3	3.0	1.7	4.9	6.1	1.7	6.0	5.0
O1	51.9	54.5	54.4	53.9	54.5	53.7	51.9	54.8	54.6
MP1	2.0	4.4	4.1	3.7	2.2	2.2	1.6	0.2	3.8
M1	4.0	1.0	0.8	0.3	2.8	4.1	4.5	4.0	6.1
CHI1	2.0	1.8	1.6	1.6	0.4	3.0	2.7	3.5	3.4
PI1	1.4	1.9	2.3	1.7	2.2	3.4	2.3	4.5	3.7
P1	21.7	21.2	22.0	21.2	21.1	23.7	21.2	20.5	21.0
S1	4.4	2.1	4.0	3.9	4.2	3.6	5.7	7.2	4.4
K1	62.2	62.7	61.6	63.6	62.2	63.6	65.5	60.6	62.4
PSI1	1.3	2.0	1.6	3.0	0.7	3.0	0.6	0.8	2.2
PHI1	1.7	2.0	1.0	2.2	4.3	1.5	1.0	1.9	1.0
TH1	0.7	0.8	2.8	3.5	0.9	1.9	3.2	1.5	1.5
J1	4.4	3.9	3.2	2.4	5.0	3.1	3.0	2.2	3.3
SO1	2.1	4.1	2.6	2.9	2.0	2.9	3.5	4.4	2.5
OO1	1.5	0.8	1.4	1.2	2.4	3.1	1.2	2.4	4.1
OQ2	7.0	8.5	3.4	6.2	8.1	11.7	7.5	3.7	7.7
MNS2	11.4	17.6	16.5	9.1	12.7	18.1	13.1	9.3	10.9
2N2	59.7	52.0	28.1	37.7	55.1	54.7	41.0	34.8	46.7
MU2	54.8	54.4	54.0	54.9	58.3	56.1	55.7	54.6	48.7
N2	327.4	327.8	333.3	330.6	326.1	326.7	329.7	328.6	325.4
NU2	73.0	75.3	72.5	74.0	74.5	68.6	70.2	72.0	73.6
OP2	6.1	7.8	12.3	5.4	6.8	3.7	8.6	14.8	5.4
M2	1721.2	1723.8	1724.3	1722.7	1720.2	1717.2	1712.3	1708.8	1702.3
MKS2	2.9	6.6	9.6	1.9	6.0	9.7	11.3	7.9	6.9
LAM2	31.8	32.4	29.6	35.6	34.9	34.1	27.9	30.1	30.4
L2	57.1	76.1	101.3	72.5	70.4	83.8	87.9	71.3	61.4
T2	32.9	35.4	34.2	31.6	33.4	34.5	32.4	34.6	30.8
S2	583.1	580.8	581.6	579.0	577.5	570.7	569.6	569.7	569.9
R2	5.6	5.6	9.5	2.7	2.1	5.2	3.7	3.1	8.1
K2	165.3	168.0	166.1	166.5	160.1	162.3	162.1	163.0	160.4
MSN2	20.3	13.6	11.5	14.5	19.1	18.2	12.4	13.1	15.3
KJ2	7.7	6.6	6.0	7.4	2.8	4.0	5.6	5.3	6.1
2SM2	24.7	21.2	22.9	23.6	20.2	23.1	19.6	18.6	19.3
MO3	4.3	5.1	3.6	2.4	2.2	0.3	0.7	3.4	4.5
M3	11.5	11.3	11.6	10.5	9.5	10.4	10.2	11.6	12.5
SO3	2.1	1.0	2.6	0.5	1.8	2.7	0.5	0.9	2.6
MK3	6.2	5.0	4.0	6.1	6.9	6.1	5.8	4.8	4.3
SK3	2.0	3.0	2.3	1.9	1.2	1.0	2.1	2.8	1.5
MN4	39.2	41.2	44.1	43.5	39.7	41.1	41.6	41.7	38.8
M4	112.6	113.9	114.4	113.7	113.3	113.5	114.3	111.7	108.7
SN4	8.2	9.5	9.6	8.7	8.1	10.0	9.3	7.2	8.1
MS4	73.5	72.8	75.5	74.1	73.4	75.2	73.9	69.2	74.2
MK4	21.6	21.8	20.3	21.6	20.3	20.9	19.5	20.6	18.3
S4	8.1	8.2	9.3	8.5	8.2	9.0	7.5	7.3	10.0
SK4	5.0	5.7	5.0	5.4	4.4	5.4	4.7	4.4	5.1
2MN6	3.8	4.1	4.5	4.3	4.2	4.4	3.9	4.3	4.4
M6	6.7	6.3	7.5	7.7	7.9	7.4	7.5	7.8	8.0
MSN6	2.7	2.1	2.6	3.0	2.0	2.1	2.2	2.0	1.6
2MS6	8.8	7.4	7.3	7.6	8.0	6.7	7.1	7.8	7.7
2MK6	1.9	2.0	2.0	2.5	1.8	1.8	0.8	1.4	1.2
2SM6	2.9	1.9	3.6	3.0	3.1	2.8	2.8	1.8	2.1
MSK6	1.7	1.8	1.6	1.9	1.6	1.8	1.0	1.9	1.2
MA2	7.9	9.7	0.3	12.7	6.0	7.6	9.7	3.9	8.4
MB2	11.1	8.6	12.7	15.5	13.3	18.3	12.5	13.0	15.0

	Newlyn - Amplitude (mm)								
	1978	**1979**	**1980**	**1981**	**1986**	**1987**	**1988**	**1989**	**1990**
ZO	3148.9	3166.0	3236.2	3248.8	3152.7	3187.1	3194.1	3202.3	3178.9
SA	74.5	74.9	41.9	41.7	24.8	85.5	41.2	96.5	69.7
SSA	33.7	19.1	8.1	56.7	9.3	34.9	32.3	52.5	13.1
MM	17.9	24.5	19.9	27.6	13.7	38.1	18.4	42.7	23.1
MSF	11.4	5.4	21.0	17.7	11.5	21.0	31.1	23.9	25.9
MF	41.8	12.3	4.0	21.0	13.8	18.7	7.7	19.2	5.6
2Q1	4.9	0.9	2.7	0.8	8.4	5.0	5.8	4.6	3.5
SIG1	4.5	1.9	4.3	3.1	3.3	2.7	2.6	2.3	3.0
Q1	17.4	16.7	16.3	14.8	17.7	19.2	19.2	16.5	15.4
RO1	5.0	0.6	2.3	3.6	2.9	5.0	3.4	2.9	3.9
O1	51.9	49.8	55.8	56.7	49.1	53.6	54.0	56.5	55.2
MP1	1.5	2.0	2.1	1.7	4.8	0.9	1.8	3.9	3.2
M1	9.6	2.1	1.8	1.1	4.2	1.8	0.7	0.7	2.5
CHI1	2.2	1.6	1.7	3.8	2.1	1.7	1.9	1.1	0.5
PI1	1.7	2.3	2.3	1.1	2.5	1.9	2.0	2.1	3.1
P1	22.8	19.6	22.4	20.2	21.4	21.0	20.0	20.4	21.4
S1	5.6	4.6	3.1	1.9	3.3	2.8	2.2	3.6	4.2
K1	62.9	60.3	63.1	61.8	62.4	63.8	62.3	64.1	64.9
PSI1	1.1	1.3	1.3	2.3	0.8	2.0	1.2	3.3	3.3
PHI1	1.0	0.6	1.7	3.1	2.3	1.7	1.1	0.2	3.1
TH1	3.1	1.4	1.1	1.5	0.5	1.8	3.0	1.3	1.8
J1	4.8	1.3	0.2	7.0	1.3	2.0	3.5	1.7	2.8
SO1	1.2	3.1	3.2	2.8	3.0	2.3	4.4	2.5	2.3
OO1	5.4	4.9	4.7	3.7	1.7	1.0	2.5	1.8	2.3
OQ2	14.4	10.9	1.1	2.0	6.5	9.3	6.3	1.6	5.5
MNS2	13.7	15.0	14.8	12.1	8.1	15.0	20.8	15.1	9.1
2N2	53.5	48.5	36.6	31.0	50.7	63.6	48.9	24.0	46.1
MU2	53.8	50.6	54.9	52.2	53.2	53.7	52.4	55.4	57.7
N2	327.6	326.4	326.5	331.0	331.1	329.8	331.5	332.9	330.9
NU2	75.0	69.5	75.5	70.3	72.9	72.4	74.0	72.4	73.3
OP2	6.9	4.8	20.5	12.7	9.9	3.8	8.1	12.8	7.8
M2	1710.0	1704.2	1704.4	1704.9	1718.3	1715.9	1718.8	1720.0	1721.3
MKS2	6.3	9.5	8.8	3.5	7.3	8.3	9.2	7.9	4.4
LAM2	33.1	30.7	26.9	27.7	31.7	32.5	27.5	28.1	32.2
L2	70.6	82.0	91.3	78.1	56.1	61.9	88.0	93.0	70.1
T2	36.0	36.4	26.2	34.5	32.2	33.4	33.0	33.2	33.3
S2	564.8	565.5	564.1	569.8	579.0	580.7	581.5	577.3	579.1
R2	10.7	6.1	11.9	9.2	3.9	3.1	1.8	4.6	3.6
K2	159.0	167.8	168.9	169.5	167.0	166.6	165.6	163.1	164.3
MSN2	16.4	15.6	14.1	13.9	23.6	23.1	16.5	13.8	20.5
KJ2	4.0	5.4	2.5	2.8	6.5	7.8	6.6	5.5	4.7
2SM2	19.3	15.8	19.6	18.3	23.4	22.9	23.1	21.6	22.1
MO3	4.1	5.7	5.2	5.8	2.6	3.9	4.3	4.0	3.0
M3	11.3	11.4	11.3	10.0	11.9	11.1	11.1	10.5	10.9
SO3	2.6	3.4	2.0	1.5	0.8	1.3	1.2	1.6	1.8
MK3	4.9	4.0	5.2	4.6	4.9	5.3	5.3	5.3	5.6
SK3	3.0	2.5	2.7	2.9	1.5	1.7	1.1	1.5	0.8
MN4	38.5	39.9	40.0	39.5	41.0	42.0	43.0	44.2	44.0
M4	109.0	107.7	111.8	111.2	113.0	114.4	115.4	115.6	115.3
SN4	9.7	7.6	8.2	8.7	10.1	8.6	9.5	8.0	9.3
MS4	70.2	71.1	74.5	74.8	76.1	76.0	77.1	75.6	76.9
MK4	19.8	19.4	20.2	20.7	22.0	21.8	21.2	21.5	21.7
S4	7.6	8.5	8.6	9.4	9.6	8.5	8.9	9.1	10.0
SK4	4.3	3.5	3.5	5.7	5.0	5.5	5.1	4.8	5.3
2MN6	4.5	4.3	4.3	4.2	5.2	5.0	5.2	5.5	5.3
M6	8.1	7.5	8.0	8.3	8.7	9.4	9.3	9.4	9.4
MSN6	2.4	2.4	1.7	2.6	2.6	2.4	2.3	2.7	2.7
2MS6	7.1	6.6	7.3	8.1	9.1	9.4	9.1	9.2	9.7
2MK6	1.6	1.6	2.5	1.9	2.8	2.6	2.3	2.2	2.2
2SM6	2.4	2.2	1.9	2.2	3.0	2.8	3.0	3.1	2.9
MSK6	1.4	1.5	1.7	2.6	1.8	1.8	1.6	1.7	1.8
MA2	4.2	9.0	18.1	9.9	6.1	4.8	11.8	9.0	8.5
MB2	16.3	13.0	21.2	10.2	12.2	7.9	6.4	7.8	12.9

	Newlyn - Amplitude (mm)								
	1991	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
ZO	3144.9	3158.1	3181.8	3212.4	3207.4	3198.7	3178.9	3179.6	3196.0
SA	64.6	75.5	93.4	103.3	60.6	92.4	35.7	74.6	95.7
SSA	20.1	59.0	35.9	31.1	19.1	82.1	20.1	28.5	92.8
MM	31.4	36.0	36.8	26.1	5.1	23.5	33.3	18.8	32.7
MSF	15.4	20.7	8.3	3.8	6.6	6.0	12.1	6.6	11.9
MF	19.0	14.4	27.5	44.1	32.8	25.4	21.8	38.9	7.1
2Q1	3.4	4.9	1.6	2.5	7.4	5.4	3.1	5.0	3.6
SIG1	2.3	2.9	0.5	0.7	5.1	3.2	5.2	2.3	3.0
Q1	13.4	13.5	15.6	19.2	15.3	18.2	17.7	16.0	15.4
RO1	6.4	2.2	2.0	1.6	2.5	2.6	2.2	3.3	3.3
O1	54.2	53.4	53.1	55.0	55.4	55.0	59.3	52.5	55.2
MP1	2.9	3.0	0.9	0.5	2.1	1.5	2.3	2.5	2.9
M1	4.2	4.1	6.6	9.9	5.7	2.5	2.7	2.2	6.6
CHI1	2.1	2.5	2.2	2.8	0.9	1.5	1.4	1.7	1.5
PI1	2.7	2.4	2.3	3.3	3.3	1.3	3.2	1.5	0.8
P1	21.0	19.0	20.8	20.6	21.8	20.5	22.3	20.7	21.0
S1	3.3	2.2	2.6	3.8	2.6	4.6	2.8	4.6	6.2
K1	62.6	63.3	64.9	60.2	65.0	63.8	65.0	62.5	64.0
PSI1	0.9	2.2	2.9	3.0	1.8	2.5	1.2	0.7	1.6
PHI1	1.4	2.0	2.0	2.9	1.7	0.7	1.9	1.6	2.4
TH1	1.4	1.7	3.2	2.1	1.7	2.6	2.4	2.5	0.6
J1	4.1	2.5	0.4	1.1	3.7	5.3	1.9	2.6	2.1
SO1	1.4	3.8	2.6	2.7	2.0	5.3	2.8	3.4	3.2
OO1	1.4	1.8	3.4	2.6	6.2	0.9	2.7	1.9	1.0
OQ2	9.4	3.9	4.0	11.4	13.1	8.7	3.3	8.8	10.2
MNS2	10.9	15.8	10.4	10.6	13.3	14.7	10.9	9.0	10.6
2N2	58.7	34.0	36.0	50.0	54.6	44.9	31.6	39.2	54.1
MU2	56.3	55.3	55.3	53.9	52.0	53.1	50.0	51.1	49.5
N2	327.2	333.8	331.5	328.6	329.7	327.1	330.0	329.2	325.4
NU2	71.9	71.3	72.5	72.4	73.0	73.2	72.3	71.5	70.2
OP2	3.4	11.9	14.5	9.4	1.1	9.6	15.3	11.6	5.2
M2	1724.5	1718.2	1719.8	1713.3	1713.5	1706.9	1705.2	1705.0	1706.9
MKS2	5.0	10.1	3.7	0.1	10.1	5.9	5.2	4.8	2.4
LAM2	33.6	29.7	30.7	31.4	31.7	29.8	29.0	29.3	32.4
L2	73.8	89.9	66.9	65.7	72.0	84.1	87.1	75.6	72.8
T2	31.7	32.4	34.2	31.1	32.5	33.0	32.9	33.5	34.8
S2	577.0	572.9	569.2	565.3	565.7	564.6	563.3	565.8	569.5
R2	2.8	3.8	4.8	3.1	5.6	5.9	2.6	4.5	3.2
K2	164.9	160.9	159.1	158.3	161.5	164.2	164.8	164.5	165.4
MSN2	17.8	14.7	14.6	17.6	17.6	12.6	12.1	16.2	16.7
KJ2	4.3	4.1	4.9	3.8	4.8	5.5	4.5	5.2	4.1
2SM2	21.8	20.3	20.1	18.6	19.0	18.8	17.7	19.5	20.2
MO3	2.0	1.0	2.7	4.5	5.4	5.8	5.5	4.0	3.3
M3	10.3	10.8	10.6	11.1	11.4	10.9	10.7	10.5	9.9
SO3	1.0	1.8	1.9	1.3	1.8	1.2	1.8	1.4	1.9
MK3	5.7	5.7	4.2	4.8	4.2	3.8	4.4	5.2	5.8
SK3	0.9	1.7	2.3	2.1	1.8	1.8	1.6	2.4	2.5
MN4	41.5	43.6	42.0	40.5	40.3	41.8	41.9	41.0	39.9
M4	115.5	115.0	113.7	114.0	113.0	112.9	112.4	112.2	111.6
SN4	9.3	8.4	7.9	8.7	8.1	8.0	7.9	8.6	9.2
MS4	75.9	74.0	74.2	72.7	73.3	71.0	72.5	72.1	73.0
MK4	21.7	20.2	20.6	21.5	20.5	22.4	21.2	22.3	21.0
S4	8.7	7.7	8.3	8.0	7.8	7.2	8.2	8.4	8.1
SK4	5.2	5.5	5.1	3.6	5.0	5.4	5.1	5.3	5.8
2MN6	4.5	5.3	5.5	4.7	4.9	5.2	5.5	5.1	4.6
M6	9.1	9.1	9.2	8.9	8.8	9.3	9.0	8.9	9.0
MSN6	2.4	2.6	2.5	2.3	2.2	2.5	2.1	2.5	2.5
2MS6	9.5	8.9	9.0	8.8	8.7	8.8	8.5	8.8	8.7
2MK6	2.4	2.1	2.4	2.4	2.6	2.7	2.5	2.7	2.7
2SM6	2.9	2.7	2.7	2.8	2.8	2.7	2.8	2.9	2.6
MSK6	1.8	1.6	1.8	1.8	1.6	1.5	1.7	2.0	2.0
MA2	7.5	7.9	6.3	8.3	9.3	10.1	7.6	5.8	5.9
MB2	11.7	12.1	10.0	8.0	5.4	14.1	8.5	7.1	7.6

	Newlyn - Phase (º)								
	1915	**1916**	**1917**	**1918**	**1919**	**1920**	**1921**	**1922**	**1923**
ZO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SA	260.8	257.5	121.4	226.3	266.0	233.9	214.2	274.0	248.1
SSA	187.8	86.8	300.9	224.6	284.4	88.9	165.0	333.3	31.7
MM	319.8	259.3	197.8	251.8	75.6	316.8	178.8	104.8	137.9
MSF	153.6	279.2	199.4	162.7	110.0	181.9	147.0	142.3	58.2
MF	122.4	234.0	124.7	130.2	69.5	189.9	170.3	161.1	168.5
2Q1	226.4	252.8	260.8	287.3	214.8	186.3	269.5	167.9	310.9
SIG1	327.9	227.4	318.8	305.0	280.7	287.6	101.2	216.7	227.1
Q1	278.2	292.4	291.2	301.1	293.3	306.4	287.3	280.3	268.4
RO1	292.0	289.2	316.9	288.2	285.9	268.6	277.6	271.3	236.6
O1	343.6	344.3	347.0	341.7	338.6	342.2	340.5	342.3	339.3
MP1	261.6	180.4	244.6	192.6	104.6	170.3	148.1	352.4	182.3
M1	82.7	159.7	175.4	196.1	239.6	300.1	337.0	355.7	34.1
CHI1	126.7	140.7	51.0	59.8	135.6	327.0	340.9	219.6	40.9
PI1	216.7	69.2	64.1	114.7	320.9	137.9	42.2	112.8	102.8
P1	100.3	89.0	99.2	98.4	97.4	101.8	101.8	106.1	101.8
S1	187.9	114.9	4.2	355.1	352.4	1.3	20.6	37.3	324.5
K1	107.7	107.3	107.1	107.4	109.2	106.2	109.7	106.2	106.5
PSI1	123.5	9.0	318.3	156.3	243.4	31.7	65.8	27.4	305.8
PHI1	1.6	127.6	174.9	35.5	166.8	84.4	177.1	128.0	155.3
TH1	335.8	168.9	82.7	194.5	204.6	346.2	160.9	181.2	200.8
J1	235.2	137.2	221.7	199.9	142.7	129.2	107.0	121.6	90.5
SO1	11.3	325.0	63.2	336.0	47.0	9.1	356.7	331.6	340.5
OO1	282.0	263.0	252.4	279.6	214.1	281.7	259.8	156.9	216.9
OQ2	40.4	13.3	356.3	335.7	110.1	30.3	15.8	4.4	299.2
MNS2	164.9	145.9	167.2	168.3	183.3	149.7	134.1	156.5	156.6
2N2	74.3	97.3	124.7	101.8	68.6	90.2	98.0	125.9	91.0
MU2	174.6	167.7	177.0	171.0	185.6	167.7	171.4	179.2	166.4
N2	118.7	116.9	113.4	114.9	117.6	115.7	115.2	112.7	115.1
NU2	105.4	115.6	113.4	122.3	112.5	105.8	108.4	114.3	107.5
OP2	342.2	46.8	98.0	37.9	177.0	30.4	276.7	120.4	27.1
M2	134.9	136.1	134.6	135.6	134.5	135.7	135.7	134.7	133.9
MKS2	321.8	236.1	246.2	262.5	60.8	205.6	260.7	208.0	322.7
LAM2	131.8	128.7	122.2	101.4	103.3	129.5	130.3	85.0	115.0
L2	133.2	146.4	150.1	135.6	120.8	138.3	141.7	141.9	123.8
T2	123.1	165.3	178.1	153.2	177.6	175.8	188.8	169.1	171.9
S2	178.4	179.8	178.4	179.4	178.2	179.2	179.3	178.7	177.0
R2	332.9	328.0	224.8	285.9	318.3	201.2	124.6	322.2	222.4
K2	175.9	177.8	176.5	177.7	173.0	177.1	180.8	176.8	175.8
MSN2	355.1	348.0	347.4	345.2	328.6	349.9	355.4	354.5	11.2
KJ2	57.2	61.1	9.3	18.3	343.0	24.2	2.9	76.1	51.6
2SM2	6.1	33.2	15.8	37.5	341.8	30.4	20.4	13.3	28.9
MO3	209.0	190.2	118.3	120.6	324.1	39.7	148.5	215.2	258.5
M3	46.3	42.4	31.8	23.4	39.0	24.2	31.2	29.5	38.8
SO3	186.1	27.3	201.8	292.7	304.8	297.1	264.1	78.4	276.2
MK3	300.5	285.2	308.0	267.1	230.3	261.5	285.8	277.5	280.8
SK3	41.9	130.4	69.7	86.8	241.1	110.3	10.8	79.5	68.8
MN4	146.2	145.0	137.1	144.2	145.7	143.1	141.2	138.0	141.0
M4	172.3	171.3	169.3	171.0	167.4	169.6	170.7	168.7	167.6
SN4	223.8	225.2	212.3	221.9	219.4	208.4	214.7	212.6	217.3
MS4	222.8	224.9	221.2	223.4	219.3	222.0	222.7	221.3	219.0
MK4	226.0	222.2	220.0	224.2	216.4	225.4	229.1	224.6	216.7
S4	291.7	301.9	285.9	285.1	279.2	281.0	286.9	290.1	281.6
SK4	300.3	282.7	281.0	281.1	277.4	283.8	308.8	276.1	277.1
2MN6	330.1	327.4	306.9	315.8	309.3	315.0	302.4	307.5	304.1
M6	355.8	353.5	336.8	340.5	335.6	340.3	342.6	340.4	327.8
MSN6	51.6	53.0	20.4	35.9	36.1	38.6	31.7	32.8	41.0
2MS6	47.3	46.7	27.1	40.9	27.2	39.4	40.5	40.9	34.0
2MK6	44.5	53.5	47.8	49.2	27.8	33.8	67.2	35.5	57.6
2SM6	104.2	111.8	118.1	126.5	99.8	113.5	82.0	117.5	103.6
MSK6	110.6	107.0	98.2	110.0	119.3	112.2	115.3	68.1	140.6
MA2	58.0	75.6	54.1	45.3	11.9	18.6	358.7	74.9	37.8
MB2	36.1	47.5	145.5	74.7	105.2	132.2	134.1	249.1	101.0

	Newlyn - Phase (º)								
	1924	**1925**	**1926**	**1927**	**1928**	**1929**	**1930**	**1931**	**1932**
ZO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SA	235.2	233.5	240.9	219.1	184.9	233.7	230.5	151.4	204.9
SSA	98.1	149.9	88.7	187.7	49.2	137.0	188.3	85.5	104.5
MM	90.7	212.3	179.2	178.5	236.6	13.1	275.3	341.9	145.3
MSF	108.5	113.9	83.4	277.2	182.8	180.1	100.5	82.9	231.1
MF	209.7	338.0	134.9	137.1	202.3	206.8	314.5	126.7	217.3
2Q1	226.2	266.6	272.2	283.3	34.2	210.2	263.3	299.8	236.0
SIG1	262.5	312.3	174.6	145.3	0.1	170.8	235.3	70.3	308.0
Q1	286.0	296.8	290.8	297.0	297.0	298.4	279.1	282.0	278.3
RO1	291.2	325.1	310.6	241.5	303.1	274.0	245.0	345.0	30.8
O1	345.7	343.8	344.5	345.3	344.5	341.7	340.6	341.6	343.3
MP1	241.4	166.9	231.2	288.9	73.0	187.7	243.2	226.6	160.1
M1	54.5	126.8	166.9	208.0	196.1	226.0	350.6	27.0	47.0
CHI1	211.9	154.2	320.9	205.8	273.3	242.0	129.8	308.1	19.1
PI1	52.4	18.7	112.9	48.3	119.3	45.6	23.2	341.6	58.7
P1	94.6	101.7	99.7	101.3	104.5	92.2	105.6	105.8	107.3
S1	325.0	102.9	268.7	156.0	5.7	169.9	333.4	182.5	79.4
K1	108.2	109.1	109.9	107.6	109.4	110.2	108.9	109.1	106.8
PSI1	171.8	146.0	141.8	354.6	41.2	292.9	57.3	156.7	307.5
PHI1	59.4	123.4	228.8	134.2	117.6	122.9	128.6	307.1	182.4
TH1	37.7	112.0	348.7	238.5	59.6	203.9	17.0	119.1	115.3
J1	192.2	270.6	261.0	227.4	181.4	128.9	110.7	146.1	79.8
SO1	88.0	13.5	13.9	320.4	20.4	32.3	346.3	327.2	4.5
OO1	25.3	198.2	325.3	279.9	302.6	236.1	37.7	275.6	259.6
OQ2	74.0	46.8	2.1	344.3	98.0	39.4	32.8	336.3	67.0
MNS2	165.7	129.3	141.4	164.0	192.5	136.7	142.4	139.4	183.7
2N2	79.9	92.7	110.0	115.8	69.3	78.5	108.5	129.1	69.6
MU2	170.0	173.8	171.3	171.6	165.6	172.2	175.4	166.6	162.1
N2	114.8	115.7	114.8	115.3	114.9	114.1	113.5	112.8	114.5
NU2	106.1	114.4	108.7	109.2	107.2	106.9	104.6	104.3	108.0
OP2	54.0	288.4	147.5	79.9	54.5	59.5	160.9	116.6	36.1
M2	134.3	135.0	134.9	134.6	134.2	134.6	134.6	133.8	134.3
MKS2	174.5	12.7	251.2	283.8	276.6	221.5	278.7	222.2	324.1
LAM2	125.5	115.9	125.7	125.0	122.7	130.2	132.9	138.3	132.2
L2	135.5	143.6	149.8	137.6	128.2	141.8	146.3	135.9	120.1
T2	173.2	177.4	176.7	167.4	177.9	174.1	182.2	176.4	177.2
S2	177.0	177.9	177.8	176.8	176.6	177.0	177.3	176.6	177.2
R2	158.4	218.2	178.2	211.0	216.5	95.0	171.5	174.1	154.9
K2	176.6	177.0	176.5	175.5	174.6	175.2	174.9	174.4	172.6
MSN2	359.4	359.1	355.4	351.5	19.1	15.2	354.4	5.7	3.3
KJ2	28.8	42.7	56.6	28.4	17.2	45.5	13.9	43.5	30.8
2SM2	18.0	25.9	20.1	23.9	33.9	25.2	21.6	21.6	23.6
MO3	162.8	181.1	146.5	126.5	94.9	84.8	48.3	215.4	170.2
M3	32.5	36.9	33.0	27.8	19.5	12.1	33.5	32.4	41.4
SO3	239.6	275.1	268.9	187.6	349.1	277.4	218.9	227.4	30.9
MK3	289.9	288.5	284.2	298.2	273.9	276.9	270.7	266.3	272.3
SK3	96.4	50.5	53.1	45.9	45.7	76.9	5.2	71.6	98.6
MN4	141.2	139.9	140.1	140.7	140.3	138.6	136.8	135.8	140.3
M4	166.8	169.4	169.2	168.2	166.7	168.2	168.1	167.7	168.1
SN4	207.8	209.5	209.5	206.8	201.0	199.1	203.1	211.9	208.4
MS4	217.8	218.2	221.5	218.2	217.5	217.9	219.7	219.7	220.3
MK4	221.6	222.3	220.1	221.6	217.8	215.8	221.1	219.0	214.2
S4	284.8	274.2	295.2	282.4	275.2	269.3	279.8	285.7	286.3
SK4	293.2	273.0	280.1	282.9	271.6	287.2	277.1	279.3	270.6
2MN6	299.8	309.1	309.8	311.9	305.8	304.9	301.9	304.0	305.5
M6	328.0	340.6	335.1	335.3	334.1	339.3	337.5	333.3	333.2
MSN6	37.8	42.8	43.0	37.0	34.3	27.7	26.5	21.0	41.8
2MS6	33.8	33.6	31.1	37.7	39.1	36.6	32.3	25.9	28.8
2MK6	24.2	55.6	62.4	55.3	37.2	52.5	52.8	47.0	25.8
2SM6	93.2	108.9	97.8	119.0	106.3	91.3	85.4	77.3	79.7
MSK6	116.8	128.7	125.8	104.6	127.7	126.5	124.6	121.9	93.6
MA2	98.7	59.2	12.9	21.3	357.0	8.5	10.0	339.6	344.4
MB2	158.3	87.7	161.6	156.9	143.3	124.1	145.8	160.6	176.7

	Newlyn - Phase (º)								
	1933	**1934**	**1935**	**1936**	**1937**	**1938**	**1939**	**1940**	**1941**
ZO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SA	207.6	215.0	198.6	321.3	281.0	215.6	222.6	263.5	283.5
SSA	52.2	116.8	90.4	268.4	340.3	134.2	201.3	41.8	291.9
MM	189.3	49.6	252.7	344.5	3.6	57.0	29.9	90.5	312.8
MSF	167.8	258.7	142.0	49.3	86.4	228.1	23.8	126.6	119.6
MF	98.2	188.3	222.7	191.2	209.4	185.5	155.2	122.1	190.9
2Q1	221.9	266.3	271.0	309.5	44.6	223.9	253.5	219.4	63.4
SIG1	23.3	141.5	286.9	33.3	221.2	23.8	10.3	256.1	332.1
Q1	287.8	294.1	301.0	295.8	294.3	305.7	291.7	276.4	286.7
RO1	256.6	272.5	278.0	304.1	282.5	277.3	295.2	260.5	296.0
O1	345.7	344.9	344.5	344.2	342.8	339.4	344.7	340.9	342.8
MP1	203.1	167.3	209.2	236.5	186.0	206.0	187.0	209.8	158.3
M1	82.6	104.0	178.3	123.3	222.2	328.9	355.3	358.3	29.5
CHI1	16.3	61.8	39.3	1.3	292.5	69.3	85.9	86.5	1.2
PI1	70.1	18.3	46.1	117.3	76.2	67.0	98.3	15.4	127.2
P1	99.9	108.2	103.6	103.5	104.1	98.6	102.4	107.3	96.8
S1	117.3	60.7	86.5	325.4	298.1	263.5	54.2	11.7	296.8
K1	106.1	111.8	109.6	107.3	112.0	106.5	109.3	113.4	108.1
PSI1	216.6	50.9	154.2	110.4	81.1	225.9	97.0	196.3	170.1
PHI1	318.9	152.6	118.9	211.3	84.6	95.1	164.7	153.7	101.1
TH1	249.6	113.4	105.3	182.6	154.5	102.1	104.4	225.0	241.6
J1	308.4	256.5	282.8	194.4	179.0	137.9	111.0	5.8	246.4
SO1	33.4	299.1	58.7	325.8	10.9	27.9	9.9	18.5	35.4
OO1	285.4	251.2	255.0	308.3	234.6	260.6	190.6	277.7	114.9
OQ2	57.1	12.2	342.9	30.9	49.0	32.6	343.0	294.4	86.9
MNS2	169.0	146.2	155.4	174.7	157.0	161.5	144.2	157.0	158.9
2N2	72.7	102.1	117.9	89.9	81.2	89.5	118.9	101.4	93.1
MU2	170.1	169.7	169.2	168.5	170.0	170.9	172.3	168.7	173.5
N2	114.2	113.5	112.5	114.7	115.2	114.1	116.2	114.8	115.1
NU2	103.2	104.7	107.8	107.8	105.9	103.3	110.8	112.1	111.5
OP2	94.5	19.6	103.5	75.5	12.7	20.1	98.2	61.9	32.0
M2	133.9	133.4	133.6	134.2	134.4	134.2	134.7	135.0	135.1
MKS2	283.2	268.0	273.6	270.2	276.7	215.0	246.4	255.6	306.2
LAM2	126.3	126.5	122.7	129.0	120.0	134.9	122.1	124.2	111.8
L2	141.4	151.0	149.5	131.4	134.2	142.6	132.1	133.5	130.8
T2	186.7	181.0	190.3	188.6	183.1	175.3	169.2	185.3	188.4
S2	176.6	176.5	176.4	177.4	177.6	177.7	178.5	178.0	178.4
R2	131.0	123.9	175.0	70.4	187.8	158.0	6.0	193.3	121.5
K2	174.0	174.4	174.4	175.0	173.4	176.7	180.2	177.7	178.2
MSN2	3.0	343.6	347.5	3.1	8.3	349.4	333.8	355.4	10.8
KJ2	35.4	30.8	49.9	358.5	78.2	338.3	97.3	58.8	34.6
2SM2	14.0	14.9	25.3	22.7	24.2	26.1	20.4	19.3	22.4
MO3	140.7	183.5	109.1	98.1	87.3	354.0	48.7	254.1	217.1
M3	47.0	29.0	28.7	21.4	17.2	23.5	31.3	33.3	38.2
SO3	228.1	258.2	253.3	233.4	245.1	238.0	214.3	237.2	278.4
MK3	305.4	290.2	278.0	280.1	267.4	270.0	284.0	280.9	282.4
SK3	52.4	344.5	102.0	62.7	45.3	94.1	50.7	165.7	101.8
MN4	141.0	135.4	137.2	140.5	142.3	139.8	137.0	141.2	143.0
M4	167.2	165.3	167.2	167.0	167.9	167.5	167.6	168.4	169.5
SN4	206.5	207.0	203.5	198.7	202.7	205.1	207.6	213.8	213.7
MS4	218.5	218.8	216.9	219.8	217.7	218.7	217.2	221.8	222.3
MK4	215.4	215.1	216.4	217.7	217.7	221.9	217.6	221.6	222.4
S4	283.7	281.3	276.3	280.9	273.2	274.3	268.5	286.8	280.2
SK4	274.2	275.6	281.2	269.5	261.1	293.4	261.0	271.0	293.2
2MN6	308.6	302.1	316.0	312.6	305.6	315.0	298.8	304.8	310.1
M6	337.9	346.3	337.6	331.0	332.2	329.5	330.9	334.0	330.1
MSN6	25.7	25.0	37.2	22.0	25.9	21.6	9.1	32.1	11.3
2MS6	35.1	36.0	31.3	34.9	33.4	20.9	23.9	27.5	25.2
2MK6	32.7	40.8	45.6	17.0	29.5	51.8	20.0	28.1	37.6
2SM6	72.4	71.2	62.7	80.0	82.6	73.6	74.8	47.2	44.2
MSK6	116.3	102.9	111.8	118.6	110.3	94.9	76.7	111.8	138.3
MA2	297.0	335.2	1.4	354.9	3.3	9.2	32.5	313.1	352.1
MB2	169.6	132.2	122.7	129.3	128.2	123.5	130.0	153.1	134.6

	Newlyn - Phase (º)								
	1942	**1943**	**1944**	**1945**	**1946**	**1947**	**1948**	**1949**	**1950**
ZO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SA	202.0	209.1	186.1	212.5	207.5	316.6	239.6	200.6	228.6
SSA	70.7	206.9	149.6	128.0	94.5	322.2	171.3	92.4	208.4
MM	132.2	201.0	229.8	70.0	228.2	32.6	117.5	104.7	218.6
MSF	251.6	117.0	131.0	304.0	336.4	71.1	219.4	118.9	196.5
MF	47.0	133.9	206.2	123.1	188.4	203.4	226.6	173.6	207.6
2Q1	225.5	210.8	222.1	34.9	274.4	203.7	280.8	164.4	189.7
SIG1	76.4	335.2	276.9	332.0	338.0	329.9	274.2	306.3	221.7
Q1	278.6	284.2	299.7	295.7	308.3	295.6	300.2	276.6	279.7
RO1	231.8	269.9	281.3	322.2	253.5	267.5	318.3	244.8	238.6
O1	350.4	343.2	346.1	343.0	344.9	344.0	342.6	346.4	344.9
MP1	176.2	244.9	230.8	234.0	210.8	227.8	210.6	169.7	238.7
M1	60.5	159.8	125.4	195.7	222.9	275.9	342.6	2.1	26.0
CHI1	96.8	308.8	121.0	132.3	57.3	78.9	163.0	208.1	115.4
PI1	8.1	94.0	81.4	27.6	98.3	81.9	113.3	82.0	125.9
P1	104.1	102.3	94.3	100.1	99.0	107.1	102.8	105.2	105.0
S1	321.8	311.2	338.9	45.2	290.6	53.2	40.9	45.6	20.4
K1	108.7	110.6	108.1	109.1	108.0	105.7	110.2	107.5	112.9
PSI1	32.0	100.7	240.7	83.8	11.6	97.0	186.8	39.9	57.5
PHI1	90.0	343.8	107.2	122.6	168.2	87.0	80.9	175.2	148.7
TH1	2.6	90.3	145.8	164.4	292.4	207.2	176.0	266.6	322.6
J1	239.8	149.7	266.7	220.0	140.5	117.3	50.3	95.9	339.5
SO1	344.7	7.7	6.9	332.2	306.2	5.8	18.3	24.1	10.5
OO1	280.5	254.4	213.8	296.1	202.3	319.4	324.5	333.6	239.8
OQ2	76.6	21.1	334.1	27.1	65.3	27.0	347.7	338.5	39.2
MNS2	167.3	135.3	156.2	170.4	155.8	141.6	149.9	168.0	181.0
2N2	77.9	100.5	115.4	103.6	73.7	78.0	116.0	105.6	54.8
MU2	171.2	169.3	175.4	174.9	169.4	173.6	168.5	171.9	168.1
N2	115.3	115.7	114.0	115.5	115.5	114.6	114.0	113.6	114.9
NU2	107.0	109.0	112.4	106.4	104.9	104.0	107.8	107.8	107.5
OP2	41.7	47.3	23.0	48.9	65.2	2.1	166.6	74.8	64.2
M2	135.0	135.0	134.4	134.7	134.5	134.2	134.3	134.2	135.2
MKS2	185.6	215.0	254.3	320.4	322.9	293.4	317.9	290.4	226.3
LAM2	128.0	124.7	122.1	123.1	125.4	131.4	129.6	119.7	121.2
L2	139.0	144.6	145.4	130.6	131.2	140.8	143.6	125.8	121.2
T2	174.3	183.0	182.6	185.5	186.5	197.4	179.0	186.5	180.9
S2	178.2	177.7	178.2	177.9	177.7	177.5	176.9	177.5	178.9
R2	153.2	187.2	147.1	182.0	153.0	114.9	293.7	170.0	73.9
K2	179.2	176.0	177.0	176.3	175.4	176.2	173.6	173.6	178.1
MSN2	2.3	350.6	350.8	351.5	3.9	354.5	11.0	1.3	18.5
KJ2	2.0	95.4	22.1	33.4	51.5	86.3	60.2	63.1	31.7
2SM2	17.2	28.5	17.1	29.4	20.3	16.2	25.2	24.8	19.5
MO3	176.4	181.6	126.6	134.9	110.2	84.5	16.1	188.6	206.6
M3	39.3	35.3	28.6	23.4	16.5	21.5	24.9	38.7	36.5
SO3	251.1	257.5	224.2	263.9	259.5	245.4	220.3	264.6	227.8
MK3	306.3	292.7	293.3	280.5	279.7	288.4	289.8	289.8	293.5
SK3	52.3	145.1	78.7	36.9	85.4	54.5	91.8	70.1	34.4
MN4	142.1	140.3	138.2	143.3	142.0	139.0	138.9	140.0	141.0
M4	169.3	169.5	169.2	167.9	167.2	167.7	167.8	167.7	169.0
SN4	209.9	213.3	207.4	222.0	213.2	208.6	218.9	209.3	212.2
MS4	220.2	220.7	220.4	219.4	218.5	220.1	218.3	219.5	218.6
MK4	219.7	218.1	220.8	215.4	220.2	219.6	217.3	216.3	222.4
S4	271.1	279.3	283.5	289.4	281.7	279.6	281.0	288.4	277.1
SK4	281.3	271.9	282.2	267.8	283.8	288.3	271.6	269.8	284.1
2MN6	303.4	310.6	305.5	304.1	310.3	296.1	298.5	302.0	300.0
M6	332.1	337.4	339.1	337.3	330.4	328.2	329.9	328.6	327.4
MSN6	28.5	23.2	37.4	25.0	29.7	19.7	13.6	19.0	18.8
2MS6	31.2	30.3	37.9	36.0	29.8	22.7	25.3	29.6	36.4
2MK6	50.3	43.5	70.5	57.6	43.9	40.0	52.7	38.0	46.7
2SM6	81.2	98.1	105.6	111.4	82.4	93.7	105.3	108.6	116.0
MSK6	101.8	110.0	108.9	104.9	118.1	115.1	108.4	101.5	127.6
MA2	327.7	19.4	328.0	3.6	16.3	316.3	17.3	341.0	323.3
MB2	154.6	153.5	160.5	142.6	127.2	153.8	134.8	154.0	160.9

	Newlyn - Phase (º)								
	1951	**1952**	**1953**	**1954**	**1955**	**1956**	**1957**	**1958**	**1959**
ZO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SA	255.3	227.4	185.8	218.5	253.4	210.7	260.2	234.0	255.5
SSA	132.2	71.2	117.1	52.6	193.3	308.5	289.0	259.2	112.0
MM	149.9	322.9	185.2	194.1	163.2	295.4	116.5	137.4	117.1
MSF	75.5	239.3	99.5	214.7	66.6	269.9	222.4	141.0	18.8
MF	307.1	314.6	150.5	168.1	181.3	149.0	42.5	148.4	172.2
2Q1	213.8	266.3	307.3	69.7	247.4	229.0	230.6	256.9	217.7
SIG1	277.8	252.1	279.1	322.9	1.0	253.3	291.5	16.5	291.3
Q1	290.0	297.7	292.4	305.2	294.9	296.3	283.4	288.2	281.6
RO1	254.2	314.9	297.6	276.8	296.2	270.6	355.1	296.7	256.8
O1	342.4	344.2	344.4	340.5	343.2	344.3	347.0	347.3	341.6
MP1	196.1	221.8	207.6	237.7	231.1	211.4	177.4	210.3	233.2
M1	108.1	65.4	202.7	318.0	281.3	327.3	357.2	34.5	50.8
CHI1	72.1	91.6	61.8	5.8	9.4	11.6	17.2	36.7	164.2
PI1	108.0	40.5	45.2	74.7	124.3	208.6	91.3	101.8	126.1
P1	105.0	104.4	100.5	105.7	102.0	107.9	98.9	108.4	106.8
S1	3.3	38.8	12.8	29.0	1.2	40.0	311.5	25.7	22.4
K1	107.4	110.4	110.5	108.5	111.6	108.7	110.6	112.9	110.2
PSI1	165.8	172.5	231.0	171.4	138.0	332.1	104.8	203.8	40.5
PHI1	39.0	82.3	199.6	31.6	19.6	142.0	113.6	102.8	46.2
TH1	156.2	96.4	132.9	335.1	182.6	247.8	221.2	192.9	91.4
J1	274.3	237.8	221.6	140.9	219.6	138.7	13.4	339.5	192.1
SO1	347.2	331.8	348.7	354.3	350.8	334.0	37.8	330.6	126.5
OO1	306.9	43.6	275.2	298.2	260.5	135.0	224.1	258.2	40.4
OQ2	35.4	21.8	344.3	64.0	36.6	14.2	325.3	20.4	130.4
MNS2	127.1	152.9	157.1	174.9	142.1	136.3	148.6	176.1	158.2
2N2	87.2	106.0	129.8	73.2	83.1	101.8	115.0	111.6	81.1
MU2	176.8	167.0	169.7	166.0	173.6	167.0	177.7	166.2	172.2
N2	114.9	114.5	114.7	115.9	115.7	115.3	116.7	115.4	115.6
NU2	109.0	104.0	107.0	107.7	110.5	106.0	108.2	108.3	109.2
OP2	17.7	350.8	96.9	60.5	303.4	196.3	164.7	47.3	59.6
M2	134.0	134.3	134.7	134.3	134.9	135.4	136.1	135.6	136.1
MKS2	281.2	277.7	280.9	277.4	24.0	207.8	350.3	288.4	200.2
LAM2	110.5	127.4	138.2	126.6	116.8	134.1	100.4	142.0	127.8
L2	140.5	154.1	138.8	126.2	134.8	143.2	134.7	127.9	135.2
T2	191.4	184.1	184.9	185.0	179.7	183.8	180.0	185.8	182.4
S2	176.9	177.6	178.6	177.7	177.9	179.4	178.8	179.0	179.7
R2	170.9	178.8	138.3	141.9	195.8	110.4	148.0	121.8	182.0
K2	174.2	174.1	174.9	174.4	174.2	180.0	177.5	179.6	179.6
MSN2	355.3	340.6	346.0	348.9	357.9	357.7	346.8	10.8	2.6
KJ2	46.8	8.7	42.0	38.7	50.7	45.5	103.1	42.5	346.9
2SM2	24.2	29.4	24.2	25.6	28.2	10.9	43.3	23.0	19.7
MO3	146.5	155.0	124.4	78.2	94.3	27.5	69.4	226.1	234.9
M3	49.5	30.8	30.3	16.3	24.4	27.9	33.7	34.5	41.2
SO3	268.8	240.4	235.5	231.2	215.3	219.5	267.8	213.5	243.4
MK3	294.0	301.3	279.0	265.2	271.2	270.6	283.2	295.4	293.8
SK3	80.3	53.5	43.2	120.4	56.7	43.8	97.9	61.2	127.5
MN4	140.0	137.9	141.2	143.1	144.2	142.6	145.1	140.7	144.2
M4	165.8	167.9	168.9	167.1	169.2	171.3	170.9	170.2	170.6
SN4	206.4	206.3	216.1	222.0	206.5	203.8	213.3	206.3	209.3
MS4	214.6	218.3	220.3	217.1	221.0	221.6	222.2	219.5	221.0
MK4	216.4	217.6	218.3	215.6	216.3	224.9	225.2	223.1	221.0
S4	267.2	279.8	278.4	276.5	284.6	289.7	280.6	282.7	286.0
SK4	268.3	281.1	275.5	276.5	250.4	276.3	280.2	286.9	242.5
2MN6	294.2	303.1	292.9	299.8	302.4	305.9	308.3	304.8	306.4
M6	326.0	331.7	330.1	328.3	328.4	344.7	335.2	337.3	338.9
MSN6	35.1	12.2	44.2	21.0	16.4	36.3	46.3	34.9	32.6
2MS6	24.3	33.0	32.1	36.7	28.5	42.0	44.2	49.3	44.0
2MK6	19.4	38.5	65.7	23.5	42.5	54.7	99.6	49.2	67.5
2SM6	113.6	107.7	106.6	134.5	97.3	141.9	119.8	123.9	116.2
MSK6	114.3	113.7	119.2	105.3	121.8	117.6	149.0	110.2	124.2
MA2	290.1	338.3	257.6	7.7	35.1	11.1	180.4	329.2	359.1
MB2	152.5	133.9	182.2	146.0	132.3	122.9	192.0	150.3	149.3

	Newlyn - Phase (º)								
	1960	**1961**	**1962**	**1963**	**1964**	**1965**	**1966**	**1967**	**1968**
ZO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SA	231.3	238.4	213.6	253.8	296.2	218.2	260.1	197.5	225.9
SSA	24.0	109.4	21.4	131.7	22.1	109.8	321.2	22.9	96.8
MM	24.9	166.5	312.8	179.6	313.2	127.3	184.7	289.3	11.5
MSF	327.3	73.9	100.1	329.6	147.4	159.0	88.8	24.7	227.4
MF	254.7	174.8	304.8	115.8	219.5	209.5	197.1	265.9	160.6
2Q1	218.4	244.7	287.4	278.4	296.0	284.9	204.3	146.5	207.6
SIG1	278.0	237.1	245.3	351.9	277.1	264.1	288.8	333.1	301.0
Q1	298.0	288.9	296.9	297.1	300.2	283.2	270.8	276.8	283.7
RO1	249.9	238.7	307.3	274.6	305.5	232.3	285.1	301.5	294.4
O1	342.4	343.5	345.6	342.3	340.1	341.5	340.8	344.4	343.9
MP1	292.7	269.6	241.1	218.5	232.6	238.8	232.7	253.0	206.8
M1	107.6	137.5	138.1	173.2	181.3	266.8	13.2	20.7	71.3
CHI1	88.9	124.1	345.9	86.7	90.6	72.9	101.0	47.1	265.0
PI1	113.0	5.7	177.6	145.6	54.9	140.0	107.3	115.3	151.4
P1	99.1	99.3	95.1	103.1	102.3	109.1	103.3	95.4	107.9
S1	28.4	17.2	28.4	36.3	5.8	41.9	8.2	39.8	47.4
K1	108.8	110.1	108.2	109.0	109.7	108.5	109.1	107.1	108.9
PSI1	265.5	218.5	46.2	324.1	36.6	339.1	303.2	95.2	80.3
PHI1	265.4	125.5	199.3	144.4	180.8	147.8	214.8	103.8	99.6
TH1	229.3	123.3	164.5	169.9	28.1	126.4	129.5	113.0	215.7
J1	205.0	247.4	169.3	212.0	354.4	165.3	139.5	15.4	331.7
SO1	358.7	352.3	352.0	352.1	254.0	268.9	337.8	344.0	348.1
OO1	273.1	259.6	85.1	65.1	250.2	304.8	286.8	318.7	316.7
OQ2	59.1	353.5	333.6	98.0	66.2	21.7	348.4	4.0	63.6
MNS2	128.2	162.1	160.5	184.2	170.6	130.0	150.1	171.6	157.8
2N2	87.1	102.9	111.5	77.6	79.9	94.2	113.8	106.9	69.7
MU2	167.6	169.7	177.6	175.4	171.0	170.7	172.0	168.1	170.9
N2	116.5	116.1	115.8	117.6	115.3	114.4	114.2	114.8	115.5
NU2	111.9	108.2	109.5	107.5	113.6	112.6	112.5	108.8	110.7
OP2	94.5	33.8	73.5	87.1	53.2	100.7	110.5	84.0	103.7
M2	135.6	135.4	135.5	136.3	135.6	135.1	134.7	134.9	135.2
MKS2	265.5	269.1	253.6	177.2	217.2	178.5	233.6	286.2	91.1
LAM2	128.8	123.5	130.0	129.3	119.7	120.3	123.7	125.0	114.0
L2	138.5	144.6	142.8	132.6	136.8	142.5	142.9	118.4	129.6
T2	181.3	179.4	183.2	174.2	176.0	189.0	191.9	182.9	176.6
S2	179.5	178.9	179.2	179.7	179.3	178.6	178.5	178.6	178.5
R2	0.9	278.2	148.2	121.8	217.9	181.8	190.0	216.7	223.7
K2	179.2	177.1	179.9	177.1	178.4	176.9	177.8	177.2	175.8
MSN2	16.8	356.7	341.6	5.5	25.9	4.1	340.0	5.0	8.1
KJ2	104.8	56.3	80.3	18.4	45.7	70.4	53.3	48.7	44.4
2SM2	21.7	30.7	27.1	31.8	24.5	19.6	22.0	19.0	25.9
MO3	174.8	151.0	131.4	95.2	72.6	71.1	330.4	162.1	198.0
M3	35.8	29.5	28.3	19.4	18.5	21.7	36.0	38.5	47.5
SO3	249.8	276.8	220.8	266.8	240.5	263.1	245.4	317.6	247.1
MK3	299.4	277.0	289.7	278.7	282.0	270.3	281.0	273.6	300.4
SK3	97.8	125.7	67.7	52.1	88.2	85.7	64.9	79.0	40.5
MN4	143.7	142.3	140.7	145.1	140.0	139.9	139.2	138.9	142.3
M4	170.7	169.5	169.0	169.9	168.2	168.7	167.8	168.0	169.1
SN4	212.3	213.3	201.8	216.2	212.9	214.1	222.0	214.5	207.1
MS4	220.8	220.6	219.7	221.6	220.6	218.6	220.3	219.4	220.0
MK4	215.0	223.4	224.5	224.5	221.9	225.1	220.9	216.5	219.5
S4	285.5	284.1	287.1	283.0	277.6	280.8	288.7	287.7	284.5
SK4	278.3	288.3	266.8	277.8	277.4	279.4	284.1	278.6	281.4
2MN6	309.0	308.4	316.1	308.8	305.7	302.2	306.5	303.5	303.6
M6	335.5	337.0	342.9	337.6	340.6	342.0	332.6	334.2	331.9
MSN6	68.4	47.8	47.7	27.9	51.5	22.8	31.2	33.5	33.6
2MS6	39.8	36.3	40.1	45.0	40.9	39.4	26.3	41.0	41.7
2MK6	59.5	62.7	80.3	39.8	67.0	36.1	62.9	47.0	36.5
2SM6	122.0	133.8	125.7	138.5	120.3	139.8	121.5	129.0	120.1
MSK6	159.8	109.5	145.0	122.1	124.9	123.6	138.1	125.3	115.2
MA2	55.1	23.4	30.9	100.9	80.6	7.0	332.4	27.8	88.6
MB2	106.7	110.5	112.1	208.4	125.9	145.3	168.1	140.5	130.4

	Newlyn - Phase (º)								
	1969	**1970**	**1971**	**1972**	**1973**	**1974**	**1975**	**1976**	**1977**
ZO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SA	275.8	251.1	238.3	273.1	189.7	259.1	227.5	217.1	266.2
SSA	164.9	208.7	220.1	188.8	158.1	233.9	287.3	63.0	286.6
MM	358.9	159.4	245.0	208.0	283.4	116.1	231.9	162.8	107.3
MSF	201.6	94.1	132.5	213.1	262.6	194.5	302.5	58.2	211.1
MF	168.2	227.7	170.2	107.1	174.8	126.9	236.9	139.7	57.3
2Q1	241.7	275.5	279.4	205.9	243.5	214.9	223.4	312.5	278.7
SIG1	276.7	1.8	315.9	337.1	266.5	30.2	355.2	34.2	259.8
Q1	275.3	288.4	301.7	300.3	295.0	280.8	284.9	269.9	288.3
RO1	269.5	312.9	305.0	299.5	288.6	280.6	319.6	280.5	286.6
O1	342.0	343.0	345.2	340.6	342.4	342.6	340.1	340.8	341.6
MP1	240.5	197.5	287.9	177.1	171.7	198.1	226.7	261.4	213.9
M1	108.0	99.1	103.5	134.5	287.4	19.2	7.1	15.2	79.7
CHI1	319.3	91.3	137.2	42.2	90.4	98.3	142.5	55.8	59.7
PI1	107.7	76.5	69.7	94.9	66.0	71.6	109.2	203.6	126.6
P1	106.1	98.7	98.5	99.5	97.9	101.3	103.1	110.5	104.3
S1	25.9	44.6	35.2	13.1	25.9	348.9	357.2	29.8	11.2
K1	108.1	108.9	109.9	111.4	109.1	108.5	111.0	107.9	109.8
PSI1	109.5	137.3	26.3	158.0	120.7	30.5	111.7	317.0	356.9
PHI1	71.6	95.6	38.2	87.4	136.2	136.7	56.2	92.3	198.4
TH1	93.6	238.4	115.1	173.8	12.9	124.6	159.1	185.1	273.1
J1	241.0	194.3	207.5	148.5	147.3	48.6	26.9	357.5	329.0
SO1	26.2	1.2	353.4	15.8	352.8	28.0	12.8	314.3	302.5
OO1	271.2	328.5	269.6	285.5	340.9	6.8	54.6	37.4	243.3
OQ2	16.8	353.0	9.4	66.1	35.6	354.6	326.7	92.1	61.3
MNS2	147.2	153.6	173.6	169.2	154.1	146.0	152.1	171.4	168.5
2N2	88.0	117.4	113.0	66.6	79.6	104.9	112.2	86.9	85.2
MU2	170.7	170.4	167.3	167.3	169.4	168.7	166.0	165.2	171.2
N2	115.5	115.2	114.6	116.0	116.0	114.4	115.2	116.4	115.3
NU2	110.1	108.8	110.0	109.6	107.2	108.1	109.0	108.0	106.8
OP2	107.4	165.9	109.2	76.1	11.2	104.8	106.1	59.3	13.7
M2	135.1	135.4	134.9	135.1	134.9	134.9	135.5	135.6	135.2
MKS2	243.6	257.0	263.5	320.6	261.0	228.1	258.3	254.4	353.8
LAM2	127.7	130.5	126.7	124.3	126.8	125.4	131.1	132.4	128.8
L2	148.5	157.0	135.2	131.2	138.1	144.4	134.1	127.5	139.7
T2	181.8	181.2	187.3	178.7	184.7	184.4	182.7	189.7	183.4
S2	178.8	179.2	178.5	178.7	179.2	178.8	179.4	179.4	178.7
R2	176.7	158.7	183.7	170.6	173.6	206.9	166.5	150.4	131.3
K2	176.0	174.9	175.3	175.3	177.8	176.7	178.5	177.4	175.2
MSN2	350.7	345.8	2.4	10.4	351.2	350.5	3.2	7.3	2.0
KJ2	41.3	41.4	20.6	27.8	0.8	75.5	56.5	43.5	61.9
2SM2	24.3	23.0	31.5	30.3	19.3	22.4	33.9	34.2	24.9
MO3	128.8	125.7	121.0	66.3	94.2	152.4	274.2	196.3	178.1
M3	35.8	34.0	24.6	17.4	23.0	26.7	33.6	43.2	36.9
SO3	240.9	247.9	183.3	1.7	273.1	244.5	332.0	176.6	255.1
MK3	285.7	281.5	301.4	256.0	268.5	279.7	269.6	287.0	283.1
SK3	86.8	81.0	65.5	122.9	72.1	78.1	104.1	96.9	82.4
MN4	141.4	141.1	139.9	143.8	142.0	140.6	140.7	144.6	143.0
M4	169.8	169.9	169.7	169.3	169.1	169.3	171.4	170.9	170.2
SN4	209.9	213.7	220.9	216.5	206.7	217.0	220.2	219.2	210.4
MS4	222.0	223.9	222.2	222.4	220.6	218.6	222.4	222.3	221.4
MK4	221.6	220.4	219.2	218.2	221.0	220.1	221.1	217.6	218.0
S4	292.1	290.5	284.7	288.4	285.9	286.0	285.1	289.0	281.4
SK4	292.9	284.2	284.8	280.4	283.2	287.6	280.4	274.5	269.9
2MN6	304.7	303.0	293.4	300.2	307.0	294.2	300.5	311.2	299.1
M6	338.7	330.8	332.5	334.8	337.1	331.4	336.3	334.2	333.8
MSN6	29.4	23.5	32.0	21.3	33.2	31.4	33.4	46.1	34.6
2MS6	33.2	30.7	32.5	37.7	35.9	32.8	33.5	39.7	34.3
2MK6	38.3	44.9	40.9	41.4	42.8	46.5	81.8	50.8	22.6
2SM6	126.8	109.3	116.4	117.4	106.1	105.2	98.6	131.4	110.1
MSK6	118.5	123.1	125.5	120.0	124.2	127.1	115.9	124.2	110.3
MA2	38.0	68.5	292.1	48.3	359.1	342.7	47.0	67.6	356.7
MB2	126.3	142.3	188.8	113.5	131.6	126.9	129.1	154.6	126.8

	Newlyn - Phase (º)								
	1978	**1979**	**1980**	**1981**	**1986**	**1987**	**1988**	**1989**	**1990**
ZO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SA	291.0	263.8	192.8	229.1	245.4	216.3	219.4	254.1	239.1
SSA	195.8	306.4	20.0	71.8	117.0	62.8	142.2	131.8	219.4
MM	314.1	140.6	350.2	124.5	148.0	136.3	166.6	112.9	222.4
MSF	290.6	83.2	26.7	96.4	192.4	260.3	348.7	118.9	216.8
MF	160.4	272.0	352.7	191.7	115.3	208.3	111.2	248.2	23.4
2Q1	268.3	302.8	287.1	306.5	189.6	237.6	266.5	234.4	302.7
SIG1	277.9	229.3	276.8	49.0	215.8	328.6	309.5	265.3	29.0
Q1	290.2	290.8	293.6	294.1	287.4	288.5	293.7	305.3	306.5
RO1	333.4	323.5	266.4	306.8	324.0	286.2	307.6	275.6	291.8
O1	343.8	343.4	342.1	340.8	340.2	340.5	340.9	342.2	340.9
MP1	249.1	276.1	222.6	151.8	211.6	221.0	214.5	195.0	257.4
M1	119.7	121.6	160.1	178.2	63.7	117.8	275.6	228.9	194.3
CHI1	30.7	71.0	139.7	8.0	89.2	114.1	333.4	232.8	45.2
PI1	103.0	5.4	110.1	212.1	121.7	75.9	18.4	78.1	91.9
P1	102.9	99.7	100.4	97.4	101.5	101.7	96.8	103.3	100.8
S1	16.4	51.3	0.9	33.4	12.7	45.8	51.2	45.8	13.9
K1	110.8	112.6	111.0	107.6	109.6	109.2	108.5	108.8	111.5
PSI1	129.4	197.2	145.5	15.3	217.7	64.8	116.1	9.2	134.3
PHI1	139.2	38.5	87.5	121.6	67.7	149.4	243.6	139.8	61.0
TH1	34.1	123.1	257.4	153.8	308.8	117.1	130.2	148.7	163.0
J1	195.6	200.3	151.4	179.0	246.7	231.6	211.8	189.1	149.1
SO1	328.6	12.1	56.7	24.2	331.9	337.4	3.3	316.8	354.8
OO1	259.1	314.3	295.6	310.5	244.8	289.0	286.0	269.0	288.5
OQ2	25.7	356.9	36.7	69.6	52.4	22.4	5.5	13.7	65.9
MNS2	134.3	150.8	166.9	166.0	158.1	141.7	159.3	164.3	165.7
2N2	90.3	114.9	100.8	78.2	70.5	95.5	119.0	98.0	69.1
MU2	168.2	172.0	171.5	176.0	167.9	167.3	167.4	167.1	165.3
N2	115.5	115.1	115.4	116.1	113.5	113.5	113.0	113.2	113.6
NU2	108.2	111.4	108.0	107.5	106.8	106.0	107.7	104.6	107.3
OP2	332.1	59.8	125.9	93.1	59.0	59.7	118.4	86.4	36.5
M2	135.3	135.0	135.4	135.7	133.1	133.1	133.1	133.0	133.1
MKS2	282.4	262.1	152.4	41.6	252.8	248.8	253.0	267.7	268.6
LAM2	129.3	122.9	131.2	124.1	124.9	128.7	129.6	122.5	125.1
L2	145.5	145.1	141.3	137.1	133.7	148.4	156.3	126.7	130.1
T2	179.4	179.4	179.7	183.3	182.6	184.6	183.0	182.4	179.4
S2	179.5	179.0	179.9	179.8	176.7	177.2	177.1	177.3	177.5
R2	141.0	222.3	194.8	165.8	141.1	172.6	215.7	162.2	187.8
K2	178.5	179.5	177.2	179.2	174.2	174.4	174.5	174.7	174.3
MSN2	359.2	349.7	348.8	21.5	359.5	349.7	337.5	9.0	7.1
KJ2	34.5	82.7	31.8	357.1	33.6	51.4	32.3	17.8	30.1
2SM2	26.1	22.8	29.7	20.7	24.8	26.7	28.0	27.7	22.7
MO3	160.7	138.1	105.8	102.1	185.3	154.2	131.4	102.3	77.4
M3	36.7	28.4	26.9	27.6	36.2	33.0	25.9	19.3	16.6
SO3	223.8	239.7	248.1	232.9	213.5	240.3	259.3	227.3	236.0
MK3	294.4	295.1	278.4	270.3	288.6	285.2	280.1	269.4	264.1
SK3	85.2	76.4	120.7	84.1	39.7	77.6	63.2	37.3	100.3
MN4	142.5	140.8	142.4	145.3	139.4	137.8	136.4	137.9	137.8
M4	170.3	169.6	169.9	170.7	164.7	165.9	165.1	165.6	164.8
SN4	204.4	210.4	212.4	209.8	196.2	208.5	206.9	210.7	201.6
MS4	220.8	217.3	221.5	221.3	217.1	217.0	217.0	217.0	217.4
MK4	224.4	224.3	222.5	221.6	216.0	217.0	215.6	215.9	215.5
S4	281.9	271.5	283.7	277.2	274.4	276.7	280.6	274.6	279.3
SK4	291.0	285.1	280.5	294.2	274.9	278.9	274.6	276.8	266.4
2MN6	306.6	304.6	309.1	305.3	305.0	297.7	299.3	300.1	301.2
M6	334.1	338.8	337.5	338.1	326.1	326.4	326.2	327.1	325.8
MSN6	40.9	48.8	37.9	38.9	29.8	27.0	19.4	27.7	31.3
2MS6	39.0	46.0	39.7	35.6	28.2	23.3	24.5	24.4	23.6
2MK6	53.7	76.0	49.4	35.1	31.6	25.8	37.2	33.1	31.6
2SM6	138.2	143.2	130.2	113.6	112.4	112.8	113.0	108.0	113.5
MSK6	162.0	143.9	157.7	126.4	114.0	107.2	104.9	112.9	112.1
MA2	245.6	75.5	64.7	180.0	37.0	80.3	56.7	46.0	61.5
MB2	172.1	152.9	86.5	210.7	115.9	140.4	124.0	157.7	114.4

	Newlyn - Phase (º)								
	1991	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
ZO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SA	212.3	192.8	217.6	236.6	283.1	217.2	217.0	193.1	218.8
SSA	347.9	81.4	112.3	178.6	184.6	132.0	89.4	44.7	111.1
MM	212.4	301.5	24.5	19.3	217.5	126.0	71.0	282.9	204.5
MSF	160.3	138.3	316.8	91.2	160.6	153.3	140.9	149.0	15.8
MF	141.2	185.1	135.4	225.3	106.8	180.2	167.2	225.0	201.0
2Q1	240.2	269.9	277.5	250.3	221.9	285.4	293.3	244.2	254.9
SIG1	246.9	222.4	239.6	152.9	257.2	293.2	210.6	298.3	272.3
Q1	294.4	280.1	274.4	279.7	292.6	293.5	294.0	301.4	289.8
RO1	312.3	343.1	313.2	317.3	291.2	316.0	279.6	307.1	304.7
O1	341.8	342.0	343.2	345.7	344.2	340.2	341.0	338.8	341.8
MP1	154.3	233.3	359.8	313.9	237.7	171.6	272.0	229.2	273.6
M1	316.0	24.0	40.0	63.4	159.4	173.2	175.0	272.4	289.7
CHI1	351.8	96.0	51.4	146.4	351.7	199.5	338.2	146.0	354.1
PI1	50.3	53.9	136.3	178.4	77.6	72.1	136.6	136.7	231.8
P1	95.1	100.2	99.5	112.0	97.7	102.7	104.0	100.9	103.3
S1	31.5	17.5	51.7	46.0	46.5	40.1	343.6	22.0	31.6
K1	108.9	108.1	107.0	109.5	108.8	110.8	108.1	110.9	111.1
PSI1	91.8	45.3	90.3	255.4	52.5	86.8	105.3	55.4	165.0
PHI1	123.6	211.3	125.7	107.1	176.6	255.1	45.2	154.6	104.1
TH1	136.9	162.6	176.8	67.0	48.3	94.5	155.1	256.6	49.1
J1	135.9	109.0	218.3	220.5	246.8	187.5	177.8	178.7	101.7
SO1	345.7	352.0	327.2	35.4	327.3	335.0	8.4	333.1	353.6
OO1	313.6	282.0	283.4	318.8	253.0	263.5	331.5	236.9	138.2
OQ2	24.4	315.5	75.3	51.1	2.4	337.2	255.4	75.0	33.8
MNS2	149.5	157.0	156.7	138.5	147.4	144.3	159.0	157.0	143.0
2N2	88.5	109.9	78.4	85.4	99.5	109.6	98.5	77.4	85.3
MU2	166.2	164.9	165.3	167.7	164.9	163.8	167.7	168.7	171.4
N2	113.7	113.3	114.3	114.0	114.2	113.9	113.9	114.4	113.9
NU2	105.6	106.9	105.0	106.9	108.0	108.4	105.9	106.4	105.9
OP2	36.7	85.5	47.1	7.7	343.6	109.5	87.8	45.8	38.2
M2	133.5	133.5	133.7	133.7	133.9	133.8	133.7	133.6	133.4
MKS2	250.9	258.8	270.9	11.3	195.6	196.4	278.0	323.7	286.2
LAM2	125.9	124.6	124.5	127.9	128.5	128.1	123.0	120.8	125.2
L2	141.1	126.3	126.7	138.2	144.9	143.4	134.8	131.3	137.4
T2	185.9	182.9	185.7	182.0	185.3	185.8	184.9	184.8	188.2
S2	177.9	178.3	178.3	178.4	178.5	178.6	178.5	177.8	177.6
R2	196.2	174.3	190.1	171.6	168.0	182.0	150.2	172.4	153.3
K2	174.8	176.1	176.5	176.7	177.6	178.3	176.8	176.7	176.3
MSN2	356.3	7.9	10.2	2.3	352.8	356.8	4.8	12.4	357.2
KJ2	36.1	44.8	16.9	52.7	50.0	45.9	15.3	38.9	56.5
2SM2	25.4	25.6	31.0	25.8	22.2	30.0	31.2	29.5	23.8
MO3	51.2	241.4	175.0	163.4	142.0	118.7	106.2	86.3	64.8
M3	22.8	34.8	31.4	33.7	35.5	25.6	21.6	24.3	18.7
SO3	235.9	210.0	201.8	247.4	215.8	222.9	271.0	229.2	241.8
MK3	266.5	267.2	275.1	290.9	281.8	278.4	272.2	273.0	273.9
SK3	80.3	80.7	98.0	83.2	100.5	98.1	67.7	73.2	77.2
MN4	138.5	137.1	139.7	139.9	137.5	138.1	139.9	141.1	138.6
M4	167.0	166.6	165.8	166.3	167.0	167.2	166.3	166.0	165.9
SN4	206.4	214.8	207.1	201.4	210.6	217.7	198.1	196.9	204.3
MS4	218.2	219.0	218.5	218.9	219.1	219.4	219.6	218.9	217.7
MK4	218.6	216.6	217.9	220.2	221.7	221.5	216.8	218.6	216.2
S4	279.6	281.3	279.5	279.2	280.9	278.1	279.5	281.7	275.1
SK4	285.7	279.6	270.7	291.1	274.0	276.0	283.6	276.9	280.1
2MN6	298.7	301.1	301.8	303.4	301.4	301.8	302.9	307.8	303.2
M6	330.4	329.8	326.6	327.4	333.4	332.2	330.3	330.1	329.2
MSN6	41.2	38.3	39.2	34.4	40.9	47.7	35.2	38.1	43.5
2MS6	26.6	31.6	30.3	30.5	34.6	34.7	31.5	33.4	30.5
2MK6	36.5	42.1	34.3	33.3	57.8	51.6	34.2	31.1	32.7
2SM6	116.5	126.7	117.3	122.6	132.5	125.9	122.0	122.7	122.4
MSK6	119.8	114.0	111.5	130.2	136.2	122.9	121.3	111.0	123.1
MA2	50.9	62.6	75.5	45.3	74.7	81.5	48.4	34.4	102.9
MB2	128.2	114.2	142.4	122.9	146.5	146.3	107.0	142.4	138.5

	Portsmouth - Amplitude (mm)								
	1962	**1963**	**1964**	**1965**	**1966**	**1967**	**1968**	**1969**	**1970**
ZO	86.7	88.1	87.7	108.8	93.2	69.7	69.3	74.2	92.5
SA	78	80.7	64.8	79.5	39.7	50.8	97.5	54.4	66.4
SSA	19.8	45.5	29.5	54.5	33.7	39	37.6	10.8	16.8
MM	25.9	21.4	4.2	31.1	37.9	40.5	13.7	36.9	17.2
MSF	19.9	27	9.2	15.6	48.4	20.6	18.4	8.1	41.5
MF	9.3	17.8	13.7	19.3	14.8	9.8	28	13.8	13.6
2Q1	8.2	0.8	3.1	7.3	3.8	4.2	2.5	4.8	3.2
SIG1	2.5	7.9	7.6	3.3	3.4	3.5	7.5	5.8	4
Q1	17.6	5.7	8.3	1.6	1.4	4.2	5.9	2.3	2.4
RO1	9.6	6.7	5.8	3.4	4.3	0.5	2.5	3.1	1.7
O1	22.1	30.9	29	27	27.7	26.3	25.7	21.8	25.5
MP1	11.7	14.9	11	12.3	14.9	14	13.8	12.8	19.1
M1	3.1	2.9	5.2	5.1	2.6	2.5	6.5	7.1	6.2
CHI1	5.6	0.7	10.3	6.2	3.1	7.8	3.3	3.4	2.3
PI1	3.5	2.5	5.3	6.7	3.4	2	3.8	2.2	3.8
P1	29.5	34.3	33.3	33.1	37.5	32.5	35.7	35.4	31.5
S1	3.5	8.5	6.2	12.5	9.8	4.3	9.1	9.3	7.4
K1	88.8	87.5	84.1	85.2	87.2	94.9	87.8	89.3	87.5
PSI1	4.8	2.8	3.6	4.7	2.6	5.2	4.1	2.5	2.6
PHI1	4	3.7	5.7	4.1	4.7	3.4	4.4	3.1	2.8
TH1	3.6	8.1	6.3	0.7	3.9	2.4	5.8	0.8	2.9
J1	11.8	8	9	10.6	5.6	3.1	8.7	10	6.3
SO1	14.7	16.5	7	8.5	13.4	13.4	9.3	10.1	8.6
OO1	5.2	10.7	7.8	11.1	5.3	7.3	4.7	6.8	7.4
OQ2	4.8	3	8.9	6.5	4.8	3.8	8.1	8.2	6.7
MNS2	7.4	9.1	9.3	7.7	7.3	6.3	7.2	6.6	10.6
2N2	23.7	27.5	46.9	49.7	31.3	23.5	49.7	60.9	41.1
MU2	16.8	11.9	14.9	14.3	19.9	17.1	22.1	24.8	21
N2	275.9	269.8	268.6	263.7	280.5	282.7	282.3	277.3	274.7
NU2	65.2	56	53.6	50	59.6	54.9	58.1	56.3	56.6
OP2	13.4	11.9	5.7	6.4	16.8	16	12.5	9	7
M2	1409.8	1401.1	1408.3	1415.2	1415.2	1417.7	1418.2	1415.6	1415.4
MKS2	6	20.8	14.5	10.3	7.9	7.4	7.5	11.1	16
LAM2	32.4	30.4	29.7	24.4	34.7	29.5	34.8	32.5	31.7
L2	80.9	73.8	62.1	56.5	83.9	78.5	51.2	51.2	61.8
T2	25.1	27.1	27.4	32.7	28	25.2	31.3	29.9	31.7
S2	427.9	427	434.2	439	432.2	443.2	443.6	441.7	445.3
R2	5.3	6.4	6	10.5	6.1	5.2	4	4.4	6.1
K2	125.8	120.5	124.6	126.1	129.3	127.6	128.8	130.9	124.4
MSN2	17.1	17.5	20	19.9	22.9	21.4	26.8	25.8	17.6
KJ2	7.1	1.5	3.6	2.2	3	3.1	5.3	2.8	4
2SM2	23.5	27.8	28.7	32.2	31.2	29.7	30.7	30.9	30.5
MO3	8.1	7.6	7.9	6.6	6.7	6.7	6.7	7.8	8.5
M3	2.1	6.2	5.6	3.9	0.3	4.2	6.5	6	3.8
SO3	1.9	2.5	3	3.6	2.4	3	3.5	3.3	2.5
MK3	12.7	14.5	13.1	14.4	13.7	14.7	12.6	14.5	15.7
SK3	3.6	5.4	4.9	5.5	5.5	4.8	5	4.9	5.1
MN4	74.4	72.8	70	61	72	73.5	72	65.3	65.4
M4	201	198	197.4	197.2	199.8	201.1	198.6	200.5	196.2
SN4	16.3	16.8	19.8	15.8	16.3	14.8	17.1	16.3	14.7
MS4	125.8	127.1	128.8	135.7	122.9	130.9	133.6	136.9	131.1
MK4	37.1	34.8	39.3	37.8	42.4	36.7	41.8	41.6	36.8
S4	10.3	11.8	8.9	12.1	6.5	13.6	13.1	15.8	12.6
SK4	7.2	8.7	7.8	9.5	7.3	8	9.5	8.5	8.1
2MN6	60.4	59.6	54.8	49.2	62.2	64.1	61.5	57.4	59.1
M6	108.6	108.7	103.3	106.9	118.5	117.3	114.8	113.5	117.7
MSN6	27.2	26.7	31.3	26.9	27.6	29	31	23.9	28.9
2MS6	107.8	111.3	114.6	119.9	112.3	120.3	124.3	124.7	124.9
2MK6	34.5	29.7	30.8	30.9	37	34.1	34.7	34.9	33.3
2SM6	23.6	25.5	24.9	27.5	23	27.6	27.5	32.4	28.4
MSK6	17.6	17.1	18.5	15.4	17	19.3	19.4	16.7	17.7
MA2	20.3	17	7.1	13.4	6.2	7.2	4.3	9.6	9
MB2	5.3	8.2	13.6	18.6	5.6	6.4	9.4	10	9.1

	Portsmouth - Amplitude (mm)								
	1971	**1972**	**1973**	**1974**	**1975**	**1976**	**1978**	**1979**	**1981**
ZO	92.4	108.6	55.7	119.3	104.9	103	134	158.3	159.5
SA	5.8	41.8	60	89.2	39	132.5	54.5	86.5	67.9
SSA	32.1	34.7	24.6	51.9	37.7	38.1	29.5	17.1	47.8
MM	47.3	51.1	27.6	26	6.4	16.6	16.8	39.7	10.4
MSF	21.7	9.7	1.8	9.9	24.8	25	20	15.1	21.9
MF	21.3	25.9	31	26.3	9.9	13.9	45.7	5.3	17.7
2Q1	0.4	3.2	2.9	9.8	1.5	5	6	4.6	4.6
SIG1	5.9	8.3	2.4	2.4	8.2	6.6	5.9	8.1	11.9
Q1	5.3	4.7	4.1	6.8	4.2	4.3	9.7	7.1	6.2
RO1	0.9	3.4	7.5	7.5	4.3	12.1	3.4	6.5	3.2
O1	26.9	29	33.3	32.1	19.7	27	26.6	16.5	34.2
MP1	8.5	12.8	12.8	12.5	12.1	4.4	15	10.3	11.4
M1	1	1.5	4.1	3.8	3.7	4.1	13.8	4.6	0.4
CHI1	3	1.3	0.7	4.5	6.8	7.7	4.1	4.2	4
PI1	5.3	5.4	2.3	10	7.6	7.2	3.2	2	1.4
P1	25.3	35.1	32.8	35.5	35.2	31.6	32.5	27.8	30.5
S1	9.5	4.7	3.6	9.7	6.4	8.8	5.7	9.3	3.7
K1	90.3	90.4	89.3	89.8	93.6	85	81.4	81.1	81.2
PSI1	1.9	5.8	1.5	3	5.3	6	2	4.1	2.3
PHI1	0.9	3.8	3.7	3.7	1.3	10.3	1	1.3	1.7
TH1	7.5	6.6	1.7	2.3	7.1	7.1	1.7	4.7	6.2
J1	12.4	10.2	6.7	8.3	4.2	8.8	8.1	7.4	10.3
SO1	12.1	12.4	7.6	6.7	13.5	11.4	8.6	14.5	8.8
OO1	4.2	7.1	8.3	5.6	5.7	6	12.5	9.4	4.1
OQ2	4.4	8.8	11.3	4.4	2.3	11.1	10.9	9.3	7.8
MNS2	9.2	4.2	6.3	8.5	6.2	8.3	5.2	9.4	11.6
2N2	21.6	39.4	52.4	39	26.7	37.5	44.5	31.5	31.7
MU2	17.5	21	20.7	24.1	22.3	11.8	14.6	20.5	14.6
N2	274.9	275.4	275.3	272.9	267.2	273.9	271.8	270.5	270.7
NU2	57.4	52.6	61.1	59.8	56.6	63.1	55.5	56.3	55.1
OP2	14.1	6.6	1.5	16.4	13	24.2	5	25.9	13.9
M2	1411.1	1413.3	1410.9	1408.6	1399.5	1392.8	1401.1	1403.9	1403.5
MKS2	11.8	9.4	8.8	19.1	17.6	47.5	10.9	15.1	4.1
LAM2	35.1	31.2	33.7	36.6	37	44	30.1	29.3	35.3
L2	89	61.2	62.7	69.6	68.7	62	63.4	67.6	65.2
T2	27.5	25.2	25.1	29.4	26.6	33.9	31.1	33.4	22.8
S2	442.8	437.5	430.1	436.6	430.9	429	423.2	423.4	429.5
R2	6.2	8.1	3	1.5	12.3	8.9	8.1	17.8	2.3
K2	124.5	124.9	124.6	115.5	116.3	110.8	118.4	127.6	124.8
MSN2	17.7	21.7	24.3	16.8	17	16.5	22	13.3	16.5
KJ2	3	2.6	1.1	1.4	2.9	2.9	1.5	5.3	6.4
2SM2	25.9	27.9	29.9	24.7	23.9	22	24.8	27.3	23
MO3	6.9	7.5	7.2	8.3	6.4	7.8	7.1	7.8	8.4
M3	5.1	6.1	6.1	1.5	1.9	3.3	4.3	4	5.2
SO3	3.2	4.8	2.7	2.2	2.4	9.5	5.7	3.8	2.7
MK3	14.5	16.5	15.2	14.1	13.1	11.6	15.5	12.9	14.4
SK3	4.2	4.7	6.1	4.6	3.5	2.9	6.2	5.4	5.4
MN4	74.9	73.8	68.5	63.5	66.1	72.6	62.8	65.5	70.2
M4	198.2	194.7	197.2	191.2	192.3	189.5	192.8	193.2	196.1
SN4	18.6	19.3	11.1	15.4	18.2	10.5	16.7	10.8	15.7
MS4	130.7	128.5	131.5	127.3	124.4	118.6	121.5	123	124.1
MK4	34.7	39	37.8	32.9	30.6	34.5	33	36.9	35.4
S4	12.7	10.9	13.1	12.6	10.2	12.2	11.7	11.6	11.4
SK4	7.2	7.8	7.6	8.1	7	9.3	5.9	4.5	9.2
2MN6	64.4	61.9	57.4	55.2	58.5	58.8	54.2	57.3	60.4
M6	116.9	114.8	111.8	113.7	112.3	104.5	111.4	111.3	113.4
MSN6	29.9	29.9	25.9	25	24.8	22.3	23.6	23.2	25.5
2MS6	122.1	121.4	120.4	118.5	116.5	107.7	113.3	111.8	114.6
2MK6	32	33.8	31.8	29	28.5	27.2	29.8	38.3	30.9
2SM6	29.3	28.6	28.4	30.3	27.9	30.1	24.8	25.3	27.1
MSK6	17.6	20.3	15.3	13.8	15.2	16.4	10.5	14.2	17.1
MA2	4.9	5.7	10.7	7	18.6	23.7	15.3	28.7	4.1
MB2	8.5	4.2	4.4	16.8	9.7	29.6	15.5	29.3	10.8

	Portsmouth - Amplitude (mm)								
	1982	**1983**	**1984**	**1985**	**1986**	**1989**	**1991**	**1992**	**1993**
ZO	173.1	158.7	128.5	135.8	122.1	109.3	65.5	77.7	94.4
SA	99.7	19.1	95.4	25.9	52.3	73.9	76.6	74.5	61.3
SSA	22.6	54.9	58.1	19.9	43	32.3	17.8	35.1	35.1
MM	48.3	19.1	28.6	40.6	22.6	47	20.9	17	21.5
MSF	3.7	16	15	11.1	15	23.6	12.7	2.3	13.4
MF	19.1	33.8	3.7	15.2	18.8	13.6	13.9	6.7	12.1
2Q1	5.4	3.3	10.3	3.8	6.7	5.4	5.3	5.1	7.6
SIG1	3.2	9.9	7.3	2.7	2.5	4.6	6.9	8.8	8.7
Q1	3	1.3	7.6	6	5.1	5.9	1.3	3.7	1.2
RO1	1.3	8.1	6.2	1.5	6.4	4.4	8.1	1	4.9
O1	28.1	27.1	22.5	25.5	25.6	35.6	22.8	26.1	27.8
MP1	8.9	13.1	11.9	11.6	14.8	16.7	14.6	4.6	9.4
M1	1.5	5.3	1	1.2	4.1	2.2	3.9	1.4	2.4
CHI1	2.2	1.8	2.2	2.3	2.4	1.3	3.2	1.7	14.7
PI1	4.2	0.9	1.8	9.2	2.7	2.6	2.2	4	3.5
P1	27.4	34.7	37.8	32.8	33.9	37	28.1	30.4	27.1
S1	7	3	1.8	6.5	3.2	7.4	8.7	11.2	6.1
K1	89.5	86.3	89.4	85.3	84	93.3	85	93.3	83.4
PSI1	5.5	3.3	3	3.6	2.5	6	2.4	7.2	4
PHI1	0.5	1.5	5.4	3.3	1.5	3.1	2	8.8	6.6
TH1	2.8	2	2.4	9.5	6	5.3	1.1	2.5	4.9
J1	7	9.9	2.5	7.1	8.1	6.9	3.6	2.1	5.5
SO1	6.8	10.1	10.7	9.1	6.5	10.8	6.7	11.6	14.4
OO1	4.2	8	3.2	6.1	5.1	5.4	8.1	4.1	12.4
OQ2	9.4	8.3	2	4.5	10.9	2.3	8.2	4.1	3.4
MNS2	7.3	6.5	10.4	7.2	8.5	8.4	7.5	8	8.7
2N2	47.1	45.9	31	24.3	49.1	22.4	50.6	34.6	25.3
MU2	16.3	19.1	22.3	19.1	16.7	19.8	26.3	24.4	21.1
N2	272.8	275.2	278.2	278	280.1	278.6	277.4	275.3	281.2
NU2	63.9	54.5	58.8	58.6	61.5	58.3	62	57.8	48.6
OP2	6.9	0.4	21	13.9	5.6	20.1	4.7	10.1	16.2
M2	1404.2	1415	1422.1	1419.3	1416.2	1418	1426.5	1421	1415.7
MKS2	16.4	18.9	5.4	7.5	16.2	5.8	11.6	10	10.2
LAM2	34.4	28.4	31.9	33.5	35.8	29.9	32.3	31.8	22.4
L2	57.3	63.3	84.4	68.3	44.3	84.4	61.8	73.2	86
T2	30.7	28.9	30.5	31.4	33.1	26	22.9	29.1	22.8
S2	435	439.9	437.3	445.4	446.1	440.7	440.2	432.8	428.5
R2	9.6	8.1	10.8	6.6	6.7	8.7	4.4	8.1	4.9
K2	130.5	123.5	124.1	126.4	125.1	124.6	123.5	118.3	119
MSN2	19.3	17.5	17.3	22.6	22.9	21.1	20.9	18.8	23.3
KJ2	2.9	4.3	2	5.1	3.4	2.6	1.2	1.7	2.1
2SM2	23.3	23.3	28.1	29.3	29.9	27.5	28.9	28.4	27.4
MO3	6.4	6.5	6.4	6.5	5.6	8.8	8	7.6	6.8
M3	4.4	5.7	2.3	5.4	7.2	6.3	4.7	2.1	3.1
SO3	3.2	1.9	2.2	3.2	4.4	3.8	3.6	2.8	5.7
MK3	10.8	13	14.7	13.6	13.6	17.4	13.8	17.1	15.8
SK3	6	3.2	4.7	5.6	6.5	7.2	4.7	5.8	6.2
MN4	64.5	67.3	68	73.1	72	75.2	66.5	69.6	78.1
M4	191.6	193.6	197.7	197.8	198.2	200.2	201.4	198.1	192.2
SN4	16.9	11.6	14	14.4	15.8	13.3	14.4	15.2	13.6
MS4	124.9	133.1	130.6	133.4	133.8	128.1	132.1	125.5	126.7
MK4	36.9	39.1	37.1	40.1	41.6	39	37.6	35.3	33.6
S4	10.4	15.8	12.9	11.2	12	11.2	11.9	13.3	11.9
SK4	6.2	9.3	6.6	9.3	10.3	6.6	9	7.5	7
2MN6	56.5	58.7	63.1	64.6	64	65.7	58.1	61.5	67.3
M6	111.3	114.5	120.8	121	115.8	120.5	117.8	118.3	113.9
MSN6	27.9	26.9	25.3	29.2	27.6	32.1	26.8	28.5	28.6
2MS6	116.2	122.2	121.4	125.4	128	121.7	122.9	118.7	115.2
2MK6	32.7	30.6	33.4	34.8	33.9	36.1	34.9	31.8	31.3
2SM6	29	31	27.6	31.3	32.3	31.6	28.8	29.6	28.7
MSK6	16.8	15.7	16.1	19.7	19.2	18.2	15.9	15.4	16.3
MA2	8.7	9.9	8.9	12.2	7.1	5.4	7.1	9.3	10.5
MB2	2.4	5.2	16.5	1.2	6.1	8.7	4.3	7.6	2

	Portsmouth - Amplitude (mm)		
	1994	**1995**	**1997**
ZO	129	151.9	149.2
SA	88.6	75.7	73
SSA	24.6	27.1	52.6
MM	34.1	44.9	8.1
MSF	12.9	17.9	4.9
MF	20.5	29.2	19.8
2Q1	0.6	3.2	7.3
SIG1	3.3	8.3	11.7
Q1	1	5.8	4.7
RO1	6	1.1	2.3
O1	37.3	23.9	29.1
MP1	2.3	5	7.8
M1	2.2	13.8	6.3
CHI1	2.5	7	6.5
PI1	4.9	6.4	5
P1	30.6	34.6	34.8
S1	10.9	10.4	11.9
K1	88.1	85.4	87.6
PSI1	0.9	4.2	1.7
PHI1	4.7	7.9	3.5
TH1	6.3	2.9	8.9
J1	8.3	7.1	9.8
SO1	7.2	6.7	14.5
OO1	3.6	5.2	13.4
OQ2	5.3	11.8	4.5
MNS2	8.3	5.2	8
2N2	37.2	46.7	27.1
MU2	21.5	21.7	21.6
N2	275.9	275.7	269.4
NU2	59.9	57	57.1
OP2	9.6	13.3	8.3
M2	1420.2	1413.5	1407.8
MKS2	2.7	4.7	8.2
LAM2	33.8	32.9	32.2
L2	62.1	54.6	68.9
T2	32.3	27.5	29.2
S2	432	427	423.7
R2	3.7	4.2	8
K2	118.5	123.3	123.2
MSN2	16.6	21.5	15.6
KJ2	1.9	3.1	3.5
2SM2	27.8	26	24.7
MO3	9.3	8.6	10
M3	5	5.4	4.6
SO3	6.1	3	5.9
MK3	16.1	13.2	15
SK3	4.5	5.5	5.9
MN4	68.2	66.9	66.1
M4	191	194.9	192.4
SN4	13.5	10.1	13.7
MS4	125.7	120.4	120.6
MK4	35.4	36.7	36.5
S4	9.3	10	9.3
SK4	8.7	10.2	6.2
2MN6	63	57.7	58.7
M6	114.9	113.6	114.1
MSN6	22.2	22.4	24.5
2MS6	118.8	116.4	113.3
2MK6	32.6	34.8	29.9
2SM6	28.3	27.4	25.2
MSK6	17.7	15.7	17.8
MA2	6.7	5.5	14.4
MB2	11.2	6.4	5.3

	Portsmouth - Phase (º)								
	1962	**1963**	**1964**	**1965**	**1966**	**1967**	**1968**	**1969**	**1970**
ZO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SA	217.3	222.8	157.8	204.7	256.2	210.8	231.8	256.8	238.6
SSA	344.7	91.6	73.9	136.8	309.4	14.4	110.3	174.6	221.2
MM	19.2	179.2	177.2	121.5	212.1	337.8	69.4	355.4	320.9
MSF	81.1	17.5	39.0	56.2	75.0	340.8	95.9	357.5	89.5
MF	300.2	120.2	228.1	200.0	128.2	309.5	160.0	182.1	260.2
2Q1	271.0	330.9	49.5	301.4	276.1	325.7	273.8	293.3	326.7
SIG1	276.1	16.1	17.1	160.5	315.2	347.2	11.0	317.3	51.0
Q1	321.5	302.5	339.7	276.5	87.2	244.5	350.0	302.3	355.4
RO1	252.1	268.3	282.8	162.8	180.5	149.7	207.4	220.8	217.2
O1	12.2	348.8	340.2	357.1	345.9	354.8	353.7	345.6	342.8
MP1	188.9	221.6	217.3	185.8	198.7	207.6	175.4	162.7	174.9
M1	261.0	176.7	137.1	152.7	204.7	114.3	96.7	150.7	203.6
CHI1	178.3	76.7	75.5	24.9	195.7	32.8	188.2	303.6	118.3
PI1	232.4	127.7	79.0	189.0	66.9	12.3	129.5	75.0	49.7
P1	101.8	107.6	104.9	115.2	99.0	98.9	105.6	104.5	100.9
S1	92.3	25.4	62.9	43.4	36.4	106.3	60.4	74.0	60.4
K1	114.5	113.7	118.0	116.0	112.0	107.4	111.6	111.9	112.1
PSI1	108.4	233.3	290.0	265.2	298.6	88.4	95.3	325.4	225.7
PHI1	349.0	277.4	58.8	130.6	55.5	41.5	4.0	164.9	95.4
TH1	46.1	70.3	26.8	319.5	77.8	68.9	158.3	251.9	323.4
J1	197.2	242.5	229.8	197.5	197.3	255.9	221.6	223.1	221.6
SO1	286.4	287.1	282.4	262.4	289.2	273.9	270.5	298.7	296.0
OO1	173.3	257.2	264.3	300.6	277.1	267.9	277.1	226.6	290.3
OQ2	246.2	326.0	298.9	244.1	229.9	294.9	272.9	256.9	224.4
MNS2	63.7	72.2	83.2	57.6	41.3	68.4	54.5	67.6	66.4
2N2	299.6	256.8	271.8	292.5	308.0	255.6	262.1	288.3	312.7
MU2	43.4	42.9	49.8	46.3	15.8	35.9	21.6	20.6	38.1
N2	305.4	306.2	306.5	304.1	303.7	303.1	303.5	304.4	303.9
NU2	305.9	299.7	314.9	297.0	306.7	302.1	304.4	303.3	300.1
OP2	320.9	216.3	190.4	238.3	319.3	295.1	301.6	349.9	347.2
M2	327.7	328.4	328.3	327.9	326.5	327.1	326.4	327.2	326.8
MKS2	147.3	149.7	155.1	133.4	114.1	125.1	163.9	153.3	133.4
LAM2	333.4	345.1	305.8	339.5	322.5	324.7	326.2	332.1	331.3
L2	342.6	334.0	329.8	343.9	342.5	321.5	323.5	346.8	0.0
T2	12.0	9.4	12.9	18.8	5.8	11.0	12.9	18.4	8.8
S2	13.3	13.6	12.9	13.0	12.0	12.5	12.1	13.4	12.5
R2	20.2	78.4	73.8	18.6	9.3	65.7	18.0	95.1	23.0
K2	11.8	13.1	12.5	13.8	9.5	11.2	8.1	10.8	10.0
MSN2	195.6	223.2	211.0	196.1	205.8	221.4	216.6	202.5	206.1
KJ2	219.3	235.1	283.0	187.0	305.5	250.1	238.3	236.4	228.6
2SM2	237.8	238.5	233.8	231.1	226.9	236.5	231.0	224.7	227.7
MO3	321.4	309.3	309.1	320.6	308.1	309.4	310.7	312.2	302.2
M3	213.5	157.1	155.2	140.6	250.6	292.6	276.8	272.1	222.0
SO3	84.1	35.5	34.4	58.8	42.6	11.5	23.9	42.9	357.0
MK3	112.4	121.3	117.6	116.2	120.4	111.4	116.6	113.1	111.1
SK3	198.6	198.7	196.0	186.0	173.5	185.9	170.6	180.5	179.6
MN4	350.6	356.0	356.2	350.1	348.8	346.2	353.1	352.0	348.2
M4	16.0	16.7	17.3	16.9	13.2	13.2	13.1	14.1	12.4
SN4	85.0	91.1	97.0	86.8	93.6	94.6	85.8	92.8	76.1
MS4	71.0	72.6	73.3	71.0	66.2	68.4	68.1	71.1	67.5
MK4	73.4	67.4	74.7	73.0	67.0	66.4	62.4	71.8	69.4
S4	150.9	153.8	160.0	164.4	150.5	157.4	157.9	175.3	160.0
SK4	144.2	145.3	163.7	153.9	148.3	152.4	143.2	169.4	151.4
2MN6	123.8	129.0	127.5	124.0	121.0	122.7	125.1	126.6	119.9
M6	150.9	150.4	151.9	152.1	149.2	147.3	147.5	149.9	149.1
MSN6	188.5	187.8	199.3	186.9	182.4	191.1	189.8	192.4	180.0
2MS6	198.7	201.1	199.0	198.0	195.8	196.5	195.8	199.1	196.5
2MK6	203.3	204.5	203.0	202.9	199.8	197.8	191.4	198.6	199.3
2SM6	258.5	261.3	261.8	267.0	263.8	258.5	252.5	266.7	260.6
MSK6	256.9	265.5	264.2	262.4	253.6	256.3	257.7	262.1	253.1
MA2	288.3	321.8	153.4	28.2	356.0	283.6	73.8	356.8	357.1
MB2	233.2	138.5	338.7	40.0	24.9	332.5	0.7	79.8	30.1

	Portsmouth - Phase (º)								
	1971	**1972**	**1973**	**1974**	**1975**	**1976**	**1978**	**1979**	**1981**
ZO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SA	223.3	264.2	200.6	225.8	220.6	209.9	264.2	237.5	210.9
SSA	233.3	144.6	159.6	194.7	280.3	92.9	185.9	287.2	84.1
MM	270.2	217.8	358.0	128.1	15.0	163.7	280.4	117.3	76.0
MSF	78.6	48.2	98.4	169.2	15.4	57.5	16.7	4.2	54.4
MF	166.9	121.1	170.4	147.4	230.3	119.0	154.7	298.8	146.2
2Q1	234.9	250.1	55.6	227.0	344.8	39.1	231.4	44.3	78.1
SIG1	323.2	7.9	8.4	305.1	351.0	21.2	23.1	346.5	40.8
Q1	320.3	330.9	356.1	54.4	279.8	279.9	328.5	284.0	248.4
RO1	245.0	92.4	238.1	279.4	175.3	230.5	20.5	161.3	250.5
O1	354.7	356.1	353.8	354.4	15.8	340.0	13.1	339.0	345.0
MP1	184.2	185.1	176.0	170.5	196.8	143.5	199.4	199.0	197.9
M1	163.2	18.4	155.6	164.5	224.5	152.4	137.9	174.9	7.1
CHI1	68.9	327.1	133.2	110.5	176.3	16.1	92.2	27.4	23.2
PI1	308.9	179.3	120.4	103.3	117.8	175.2	48.0	89.6	140.0
P1	107.3	106.2	112.5	115.8	112.6	112.5	97.8	101.1	92.8
S1	79.8	69.1	72.8	9.1	16.0	46.4	63.6	80.9	54.1
K1	111.9	113.2	113.2	113.7	119.6	115.5	115.6	117.1	112.8
PSI1	25.4	28.3	172.7	16.1	149.8	286.6	218.8	155.2	17.5
PHI1	59.2	197.3	78.3	193.3	9.9	132.6	326.6	120.4	80.7
TH1	68.9	192.9	135.9	40.5	117.7	119.0	311.5	344.7	116.1
J1	233.5	183.6	181.4	302.0	307.1	207.6	228.8	163.7	193.0
SO1	278.1	309.2	294.3	249.8	302.4	299.6	278.4	287.2	293.0
OO1	254.3	287.5	258.2	305.0	322.9	351.4	232.4	264.7	317.6
OQ2	266.5	283.5	248.9	204.9	261.4	334.9	243.5	216.3	309.5
MNS2	68.7	92.5	94.6	64.4	51.8	122.4	73.6	54.8	84.5
2N2	282.2	258.6	278.0	300.1	294.2	276.9	288.5	295.0	258.6
MU2	38.3	26.2	18.7	33.7	41.3	18.6	33.9	23.7	33.7
N2	303.6	304.8	304.3	305.5	304.9	307.5	303.4	302.4	302.5
NU2	304.0	303.3	302.9	300.5	310.4	311.4	303.3	298.5	303.8
OP2	324.9	326.8	40.9	96.0	50.4	103.1	236.4	311.7	266.3
M2	326.5	327.2	327.7	328.9	329.7	330.7	327.3	325.7	326.1
MKS2	149.1	151.7	146.2	165.1	186.1	182.3	80.0	359.8	149.0
LAM2	334.8	329.9	339.2	333.0	329.7	343.4	340.0	344.4	328.1
L2	332.8	326.9	342.6	343.9	338.4	332.2	349.9	350.3	337.4
T2	9.0	5.9	13.4	23.3	10.3	0.2	7.6	16.5	4.2
S2	12.0	12.9	13.9	15.4	15.7	15.3	13.2	12.1	11.7
R2	359.5	20.6	97.7	16.4	47.8	35.1	18.0	358.1	360.0
K2	9.4	10.7	13.1	11.8	13.0	5.4	14.4	14.0	12.0
MSN2	207.2	216.4	223.2	205.0	212.1	220.9	217.9	203.1	224.1
KJ2	176.0	201.8	148.3	84.3	269.6	48.2	221.7	305.1	172.0
2SM2	236.3	233.9	233.1	222.8	237.2	234.6	234.3	228.5	230.8
MO3	301.0	301.4	311.9	315.1	317.7	309.4	312.5	301.1	315.3
M3	170.8	146.3	151.0	181.5	286.9	292.7	224.3	213.0	157.3
SO3	16.3	34.3	19.3	32.4	60.6	30.7	245.6	8.2	46.2
MK3	113.7	108.6	104.7	104.1	112.8	140.7	77.4	114.0	116.4
SK3	168.1	188.4	175.5	166.6	180.2	201.9	161.9	180.7	187.1
MN4	345.9	357.4	354.9	356.7	353.7	1.6	353.0	344.7	349.5
M4	14.8	15.1	16.8	18.2	22.8	22.2	13.4	10.6	11.7
SN4	98.2	91.0	95.5	106.3	106.5	121.6	79.6	99.2	100.1
MS4	69.3	72.6	73.6	76.0	78.2	76.7	71.8	69.3	67.2
MK4	68.8	66.7	76.6	71.7	77.9	58.6	76.2	69.3	68.9
S4	152.0	161.3	161.1	163.1	172.5	171.2	176.5	162.3	162.8
SK4	151.0	136.2	170.4	147.0	152.7	124.4	166.1	198.5	170.2
2MN6	120.3	127.0	127.3	129.7	128.1	134.9	121.6	114.3	119.1
M6	148.0	148.6	151.1	154.3	158.3	155.7	147.0	143.0	143.8
MSN6	185.2	192.6	189.9	190.5	201.5	200.3	186.6	178.9	190.8
2MS6	195.5	198.5	198.9	203.0	206.2	205.9	197.9	192.2	192.2
2MK6	195.9	193.0	201.7	202.1	202.1	177.8	205.0	199.0	197.3
2SM6	255.3	260.1	266.2	269.6	262.9	270.8	266.5	262.4	259.4
MSK6	251.9	259.4	265.7	257.4	255.4	255.7	272.0	240.0	265.2
MA2	283.4	257.3	291.1	203.8	320.3	36.3	5.7	26.8	223.1
MB2	23.3	350.0	231.5	325.2	119.7	89.0	71.9	58.2	286.8

	Portsmouth - Phase (º)								
	1982	**1983**	**1984**	**1985**	**1986**	**1989**	**1991**	**1992**	**1993**
ZO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SA	229.1	250.8	217.9	218.1	212.3	219.1	198.9	186.9	199.4
SSA	77.0	106.1	120.3	162.7	134.1	123.7	58.0	100.3	136.2
MM	103.5	67.8	86.6	260.1	182.2	113.9	209.2	297.0	342.5
MSF	175.8	25.0	33.7	78.3	43.5	121.7	127.5	245.8	113.9
MF	19.3	210.2	213.5	171.4	165.8	223.5	172.8	298.9	354.2
2Q1	86.1	284.6	327.7	220.7	191.2	50.9	237.9	264.1	271.2
SIG1	311.5	359.8	308.9	303.6	224.6	321.4	295.1	12.3	345.7
Q1	190.2	297.8	287.8	297.1	348.6	356.0	350.1	327.5	78.5
RO1	141.0	214.4	134.9	213.6	35.5	136.1	284.7	119.2	38.3
O1	353.1	354.0	342.2	349.3	350.2	351.0	346.9	348.5	352.9
MP1	236.8	216.3	201.2	201.2	193.4	189.0	149.7	216.9	190.9
M1	221.8	210.8	182.3	161.1	114.3	241.9	142.6	181.7	85.0
CHI1	128.9	216.3	47.1	16.9	192.0	358.7	272.8	196.2	86.1
PI1	35.0	17.1	158.2	35.1	202.8	153.0	51.2	298.8	153.7
P1	108.9	101.5	103.0	96.3	95.8	106.0	109.2	115.4	106.3
S1	27.9	232.0	111.3	48.4	345.2	39.1	52.9	14.0	78.8
K1	113.4	112.2	110.1	110.1	113.7	111.1	110.1	115.9	111.1
PSI1	44.7	38.8	75.7	157.7	140.9	359.3	157.7	111.3	17.2
PHI1	298.8	131.5	349.6	357.8	131.0	313.7	151.4	309.9	238.3
TH1	105.2	116.9	167.2	134.3	211.7	102.4	135.9	113.2	268.3
J1	172.9	154.9	179.4	211.3	221.6	248.5	160.0	225.5	215.2
SO1	269.9	284.3	278.7	277.4	276.4	244.6	277.8	295.6	298.9
OO1	201.5	271.0	252.6	231.5	236.8	254.0	279.0	194.0	241.8
OQ2	288.5	243.4	186.4	243.2	270.8	277.4	244.3	213.0	243.6
MNS2	64.0	75.9	46.8	65.1	76.3	65.8	88.5	43.5	67.2
2N2	275.8	291.7	292.1	257.2	265.4	263.2	286.3	301.3	287.2
MU2	18.5	17.6	19.6	28.9	11.3	25.5	22.1	20.5	24.4
N2	304.5	304.0	301.4	302.4	302.6	304.3	304.9	303.7	305.3
NU2	298.6	299.5	305.8	300.4	298.3	298.7	301.6	299.5	296.1
OP2	187.2	120.3	323.9	276.1	226.3	298.9	27.3	317.4	290.4
M2	327.0	326.6	325.2	325.4	325.5	326.5	327.7	327.7	327.3
MKS2	153.8	127.0	124.7	153.5	138.6	108.6	136.9	107.4	98.2
LAM2	340.9	335.1	324.2	325.8	337.3	335.8	333.1	338.6	346.7
L2	334.8	344.4	341.0	315.7	332.3	328.7	342.0	347.8	325.1
T2	13.0	9.8	23.9	5.7	4.8	14.6	15.5	20.6	16.9
S2	13.1	13.2	11.5	11.7	11.2	13.0	14.9	15.5	15.1
R2	10.6	62.2	2.7	24.5	34.2	13.6	68.7	47.8	345.4
K2	13.1	12.2	9.7	9.8	9.1	11.2	12.3	13.9	11.9
MSN2	203.1	200.6	206.9	220.1	210.6	214.7	214.2	209.8	220.6
KJ2	28.4	214.4	298.9	271.5	235.6	279.5	265.8	19.1	218.7
2SM2	232.1	223.4	223.7	223.6	227.8	228.3	228.0	229.3	237.1
MO3	302.7	318.6	315.2	303.6	314.8	297.6	304.1	309.2	304.7
M3	124.7	142.5	272.6	282.0	273.7	145.8	155.3	173.7	272.6
SO3	350.6	92.1	49.5	14.9	22.6	39.8	26.6	30.3	76.5
MK3	114.2	105.4	113.0	111.8	110.9	109.0	119.7	110.5	107.5
SK3	190.9	172.9	186.0	173.1	176.4	163.9	183.9	187.4	178.8
MN4	353.2	350.3	346.8	348.1	349.0	350.4	357.7	350.4	352.1
M4	13.5	13.1	10.4	10.7	10.2	12.4	16.1	15.8	15.3
SN4	86.5	85.3	111.0	93.8	80.9	98.2	98.8	86.4	100.0
MS4	70.2	69.2	67.0	65.4	66.3	68.2	71.4	72.4	73.0
MK4	70.9	69.1	67.4	66.7	64.9	69.2	77.6	76.5	69.8
S4	155.8	160.0	172.3	144.4	147.8	152.6	167.8	159.7	179.9
SK4	157.6	151.4	152.8	152.1	146.8	163.0	180.8	162.1	159.2
2MN6	123.4	120.8	117.1	119.2	119.0	120.6	128.0	123.0	125.7
M6	146.5	147.4	143.8	142.1	140.9	145.4	151.1	150.8	148.7
MSN6	186.2	186.4	184.2	182.0	183.9	186.2	194.0	183.5	188.1
2MS6	195.8	194.9	192.2	190.9	191.5	194.4	199.5	199.9	199.4
2MK6	194.8	199.0	192.9	191.4	191.1	196.9	201.6	203.2	199.2
2SM6	254.4	260.2	260.2	256.1	259.3	256.9	269.0	266.0	269.6
MSK6	263.4	251.1	247.1	253.0	254.9	256.2	270.6	258.9	258.6
MA2	352.6	305.2	54.1	303.9	338.8	216.6	272.4	328.0	306.8
MB2	11.2	194.6	26.7	273.9	98.4	32.9	306.2	11.5	133.5

	Portsmouth - Phase (º)		
	1994	**1995**	**1997**
ZO	0.0	0.0	0.0
SA	216.8	250.4	201.3
SSA	108.6	271.7	121.5
MM	23.8	11.2	45.6
MSF	344.0	43.8	340.7
MF	166.5	214.0	187.3
2Q1	188.2	268.2	268.3
SIG1	218.9	355.2	316.2
Q1	342.0	243.1	244.3
RO1	149.8	65.4	111.9
O1	338.1	344.5	331.3
MP1	159.3	187.9	147.1
M1	200.8	71.3	182.7
CHI1	15.1	192.8	224.1
PI1	163.5	130.8	111.6
P1	103.4	116.0	111.5
S1	69.3	80.3	55.3
K1	109.5	113.7	114.1
PSI1	266.7	229.3	99.6
PHI1	179.3	63.2	242.7
TH1	152.4	41.6	69.2
J1	212.3	205.7	184.1
SO1	265.7	312.1	274.3
OO1	269.6	272.9	221.3
OQ2	264.0	261.4	244.5
MNS2	67.9	65.6	48.1
2N2	263.7	279.2	299.3
MU2	27.7	35.4	24.8
N2	304.9	303.7	304.2
NU2	299.4	297.3	301.0
OP2	259.5	238.1	315.4
M2	327.2	326.3	327.1
MKS2	143.0	359.2	109.8
LAM2	334.7	342.5	336.3
L2	327.1	337.3	349.4
T2	16.9	16.6	19.1
S2	13.9	13.5	14.3
R2	37.4	50.9	31.6
K2	12.8	15.1	14.7
MSN2	224.2	208.3	211.9
KJ2	281.5	304.5	319.3
2SM2	233.8	228.3	236.2
MO3	306.2	315.1	305.4
M3	271.3	252.2	199.3
SO3	48.7	62.0	33.7
MK3	107.6	98.3	100.9
SK3	179.6	162.0	174.6
MN4	354.2	354.2	352.8
M4	13.3	12.4	14.2
SN4	119.5	90.0	107.7
MS4	71.5	69.6	73.6
MK4	68.7	76.6	68.0
S4	162.9	173.1	163.2
SK4	135.4	186.3	128.2
2MN6	127.2	126.6	124.0
M6	147.9	145.3	149.5
MSN6	196.1	189.3	190.6
2MS6	198.0	196.9	200.1
2MK6	199.5	198.4	200.0
2SM6	266.1	266.3	268.4
MSK6	260.8	275.0	248.8
MA2	329.2	256.2	319.6
MB2	46.4	345.2	45.4

	Dover - Amplitude (mm)								
	1964	**1965**	**1966**	**1967**	**1968**	**1969**	**1970**	**1971**	**1972**
ZO	3622.6	3655.9	3695.3	3687.9	3688.4	3702.5	3682.4	3673.8	3663.9
SA	59.3	108.3	55.0	76.8	73.4	68.6	43.1	51.9	42.5
SSA	20.2	49.6	15.9	23.6	21.6	21.0	13.5	33.7	45.2
MM	25.5	35.7	43.5	29.4	18.8	15.7	29.7	50.0	45.5
MSF	13.9	4.6	20.3	24.6	35.2	11.5	38.9	16.8	19.4
MF	12.9	40.1	18.4	24.1	26.5	18.8	17.5	23.3	29.7
2Q1	6.5	6.3	1.9	8.1	8.0	4.2	0.1	3.8	5.4
SIG1	7.7	6.9	5.0	4.7	7.6	1.2	4.3	5.1	6.7
Q1	15.8	22.3	24.7	25.6	24.3	30.0	32.5	22.4	22.4
RO1	3.6	5.1	11.2	6.7	5.2	8.9	3.1	6.0	5.2
O1	58.2	57.4	60.0	56.9	55.7	62.2	62.9	58.3	56.6
MP1	5.2	10.6	8.7	13.4	7.3	4.9	9.2	4.4	3.9
M1	9.4	11.6	7.4	5.6	1.9	7.0	3.1	1.2	4.8
CHI1	10.9	7.6	5.7	3.0	4.3	4.6	1.6	5.7	1.8
PI1	7.7	6.9	4.4	8.3	2.8	1.4	2.1	9.1	7.4
P1	21.4	16.9	23.6	22.2	20.3	22.7	15.2	21.8	17.9
S1	7.7	11.1	10.4	11.0	11.1	5.8	3.6	6.7	3.0
K1	47.4	44.2	51.4	59.1	48.0	49.5	51.6	48.9	52.5
PSI1	6.0	3.9	5.3	5.6	2.2	2.6	1.6	3.7	5.3
PHI1	4.9	6.2	5.3	4.0	7.9	0.5	3.3	2.4	4.6
TH1	5.9	2.3	5.1	2.4	5.2	1.8	1.9	9.3	6.1
J1	10.0	10.4	2.8	4.0	8.7	13.8	2.1	8.8	5.8
SO1	2.2	6.3	8.0	6.9	3.9	7.2	8.2	8.2	7.0
OO1	4.8	3.7	3.2	8.3	3.2	5.1	5.4	3.8	3.0
OQ2	14.3	18.9	14.3	10.5	14.6	14.7	16.9	12.7	12.5
MNS2	19.7	20.1	34.2	32.7	22.9	20.1	34.8	36.9	24.1
2N2	74.7	96.8	64.1	16.4	71.4	97.5	68.1	8.9	63.3
MU2	79.4	77.2	90.0	80.8	91.3	91.7	88.7	89.0	93.7
N2	412.5	409.6	414.7	417.9	418.3	410.8	413.0	423.2	415.4
NU2	98.0	100.7	106.6	92.3	98.7	107.3	101.3	101.2	101.1
OP2	15.3	16.6	19.3	30.4	26.7	10.4	23.4	32.4	22.4
M2	2257.8	2269.4	2276.4	2284.8	2291.3	2290.2	2269.0	2257.2	2252.3
MKS2	11.1	17.3	24.2	15.8	11.1	11.4	20.9	21.0	20.5
LAM2	56.0	61.6	58.3	53.8	57.7	65.9	53.7	53.1	55.8
L2	119.6	118.7	153.6	164.7	95.8	96.8	138.4	181.2	118.3
T2	37.1	38.9	36.2	40.1	36.1	38.3	39.4	38.8	40.0
S2	699.2	714.4	723.6	719.6	731.2	728.7	718.9	717.9	716.7
R2	9.7	8.1	9.3	9.6	10.2	6.4	6.3	4.0	14.7
K2	213.0	214.5	212.7	209.3	211.5	208.6	208.3	206.4	205.8
MSN2	37.3	39.0	35.8	37.5	43.1	41.4	33.8	31.5	33.2
KJ2	9.0	4.5	8.1	4.0	8.1	7.7	7.4	3.0	4.0
2SM2	44.4	45.0	41.8	47.7	43.1	49.4	44.7	42.4	44.2
MO3	0.9	2.3	1.8	1.7	0.8	3.0	3.9	3.1	2.7
M3	15.6	15.5	11.7	8.2	5.6	7.2	11.3	14.2	14.6
SO3	0.8	2.6	1.0	3.2	3.9	3.7	1.7	4.1	1.6
MK3	12.8	14.0	15.2	18.4	15.6	16.1	15.9	12.8	16.0
SK3	7.1	8.5	6.6	6.7	6.8	7.1	6.5	5.2	7.8
MN4	91.8	88.3	99.8	103.8	97.6	90.5	90.2	104.0	102.2
M4	257.6	257.0	263.6	268.5	267.5	267.3	267.4	266.4	267.2
SN4	17.6	15.1	19.9	13.1	18.4	18.4	20.1	20.2	25.0
MS4	156.9	170.5	172.0	169.2	175.4	176.2	168.2	173.4	175.1
MK4	49.5	51.3	52.9	48.7	55.8	50.1	49.9	49.3	53.5
S4	12.0	13.4	13.9	15.2	18.8	16.5	15.6	17.7	17.2
SK4	7.6	10.8	12.4	7.5	13.3	8.3	9.7	11.8	10.5
2MN6	36.6	34.7	39.7	42.4	39.4	36.3	36.0	41.5	40.0
M6	67.2	66.8	70.4	73.3	71.5	70.2	71.1	70.9	71.1
MSN6	16.3	14.0	17.6	18.2	18.2	16.4	17.2	18.1	20.2
2MS6	64.0	67.8	69.2	68.0	71.1	72.7	68.2	68.2	70.1
2MK6	18.4	19.8	19.2	19.4	22.1	19.8	18.9	19.2	19.9
2SM6	12.2	14.1	16.3	15.8	18.4	17.6	17.9	18.0	15.6
MSK6	8.3	8.6	10.2	9.1	11.2	8.2	9.7	10.5	11.0
MA2	22.4	28.0	28.7	24.4	22.4	33.9	36.5	20.1	28.2
MB2	4.2	4.8	6.8	9.1	11.8	7.9	10.1	12.3	9.9

	Dover - Amplitude (mm)								
	1973	**1974**	**1975**	**1979**	**1980**	**1981**	**1982**	**1983**	**1984**
ZO	3666.3	3679.4	3667.3	3717.9	3729.9	3756.4	3732.0	3746.3	3699.5
SA	69.2	104.3	65.5	63.6	71.8	79.7	67.7	56.9	78.4
SSA	25.1	48.3	14.6	7.4	25.7	45.8	18.3	41.1	37.4
MM	26.3	37.2	7.8	55.0	25.8	16.6	42.1	24.5	40.4
MSF	24.4	28.1	16.6	20.3	9.3	9.8	12.9	6.3	22.3
MF	30.3	27.2	14.7	49.2	32.4	16.9	20.8	34.4	11.4
2Q1	8.7	9.5	5.1	7.2	4.7	8.2	8.1	1.9	8.9
SIG1	3.0	4.2	9.7	10.4	4.7	14.0	3.1	4.3	2.3
Q1	17.7	23.2	20.8	24.4	20.0	27.1	31.0	18.6	20.7
RO1	8.5	7.8	6.2	9.5	7.5	7.4	8.6	17.8	18.0
O1	58.2	53.8	59.3	62.8	51.1	57.0	55.9	49.0	59.1
MP1	2.9	3.5	10.4	2.9	3.4	2.7	6.1	4.9	4.8
M1	4.1	7.4	7.7	5.2	1.3	3.6	11.0	13.1	6.6
CHI1	3.6	4.7	6.2	3.5	4.6	2.7	4.4	2.0	3.0
PI1	3.3	4.8	7.0	1.2	5.4	3.0	3.6	7.3	4.4
P1	16.5	17.7	20.5	14.7	21.7	23.0	18.1	20.7	21.6
S1	6.0	9.7	8.8	4.5	3.5	4.9	8.9	8.9	6.1
K1	48.2	50.8	52.2	49.8	60.2	44.4	53.3	49.1	50.4
PSI1	3.1	4.4	5.9	6.5	3.9	3.3	4.4	6.8	5.8
PHI1	9.2	3.5	4.0	3.0	2.0	5.0	2.5	10.0	2.2
TH1	2.9	5.7	9.4	5.6	3.7	6.3	3.4	6.5	3.1
J1	3.7	14.3	5.2	6.9	7.0	7.1	3.1	10.1	6.4
SO1	4.5	3.6	7.0	9.5	2.1	3.5	8.4	3.5	6.4
OO1	8.6	8.7	3.9	5.6	4.0	4.7	2.2	5.0	2.5
OQ2	17.9	17.8	10.3	13.7	7.1	13.9	17.2	17.7	10.2
MNS2	14.5	30.8	27.7	25.9	29.4	25.7	20.9	24.1	33.5
2N2	89.1	69.6	33.4	58.8	24.6	43.0	74.0	79.7	41.6
MU2	96.2	94.1	88.1	82.8	83.5	84.9	88.9	82.5	79.7
N2	404.3	402.2	410.9	404.5	407.9	413.4	399.3	401.7	407.8
NU2	98.7	104.3	97.1	103.0	102.9	100.6	103.8	96.5	98.3
OP2	9.7	3.2	18.1	14.0	33.0	26.8	15.7	15.5	24.0
M2	2249.4	2243.1	2232.0	2242.0	2244.8	2236.5	2231.6	2245.6	2258.9
MKS2	14.8	25.7	20.6	13.8	18.9	15.4	7.0	14.1	21.2
LAM2	61.4	65.1	53.4	58.6	54.8	55.6	65.0	56.2	55.0
L2	116.5	128.4	151.3	131.6	155.5	133.4	109.5	123.4	158.2
T2	37.3	44.4	34.3	32.0	39.6	34.4	35.6	35.2	38.4
S2	715.8	717.1	697.8	695.7	694.2	704.1	702.6	709.1	713.6
R2	8.7	7.2	6.5	3.2	14.6	7.4	9.0	11.5	8.5
K2	205.3	195.4	191.5	202.6	205.7	207.8	208.1	213.4	206.6
MSN2	39.8	32.1	31.0	26.6	30.2	32.8	32.2	31.0	28.5
KJ2	3.4	3.3	5.8	7.4	7.8	5.0	5.7	4.9	6.9
2SM2	36.0	35.3	39.9	40.7	41.1	44.2	44.2	48.0	46.4
MO3	3.1	3.2	1.1	3.7	4.9	0.7	1.9	1.6	1.3
M3	14.9	11.9	7.6	12.3	11.8	13.2	15.0	14.0	9.2
SO3	0.4	4.4	3.1	4.2	3.2	3.2	3.8	2.7	3.1
MK3	17.3	16.0	18.5	15.4	14.0	13.0	13.6	14.1	17.0
SK3	7.6	6.8	6.1	7.5	6.8	7.5	8.3	6.6	7.6
MN4	92.3	92.0	99.5	90.5	96.9	95.8	87.8	89.4	93.5
M4	267.9	263.6	269.0	257.9	261.7	261.8	255.9	263.3	266.6
SN4	16.7	19.6	25.4	15.7	15.5	15.7	21.1	14.5	13.4
MS4	179.6	177.6	175.4	164.2	166.3	168.5	166.3	172.9	175.2
MK4	48.9	47.2	44.4	46.9	45.3	51.2	47.9	54.6	50.2
S4	19.8	21.6	16.3	18.6	15.8	16.9	15.6	15.7	16.2
SK4	10.1	12.7	9.0	8.4	6.5	11.6	9.5	12.0	9.5
2MN6	35.4	36.2	39.7	35.8	38.3	35.7	34.2	35.2	38.3
M6	67.0	66.9	69.8	66.2	67.4	65.5	64.6	65.5	69.9
MSN6	16.8	15.8	18.4	13.9	14.6	15.3	15.4	15.7	15.6
2MS6	70.7	68.6	66.4	62.5	63.2	63.2	63.3	65.2	67.0
2MK6	17.6	16.9	16.1	18.0	16.2	17.9	18.8	19.8	18.8
2SM6	20.2	19.9	17.9	14.7	14.5	14.5	14.0	14.1	15.0
MSK6	8.0	9.5	8.2	6.4	8.2	9.4	9.1	8.6	9.7
MA2	19.5	24.9	31.7	41.4	22.7	21.2	26.5	26.6	28.6
MB2	5.9	14.5	3.6	8.9	19.8	8.6	2.8	9.1	13.2

	Dover - Amplitude (mm)								
	1985	**1986**	**1987**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**
ZO	3706.5	3702.8	3717.4	3758.2	3768.8	3688.1	3711.5	3724.0	3758.2
SA	39.2	69.8	88.9	73.6	59.1	84.5	69.8	70.3	73.3
SSA	44.6	31.4	24.9	3.8	30.3	30.5	30.5	25.2	15.1
MM	58.5	40.0	22.3	37.3	31.1	31.9	21.8	9.6	15.9
MSF	20.9	7.0	4.1	36.9	31.9	15.1	26.7	12.3	24.5
MF	20.1	27.1	10.8	18.4	17.2	22.6	18.5	30.5	26.0
2Q1	6.7	10.4	6.9	13.6	4.1	1.9	5.8	5.9	1.5
SIG1	3.1	4.9	7.1	2.8	12.6	2.3	11.3	9.7	10.6
Q1	23.7	20.0	27.8	23.0	12.1	24.0	17.4	24.3	27.0
RO1	5.4	6.6	9.5	13.4	3.3	7.4	7.4	5.5	7.2
O1	57.6	60.3	61.5	57.1	66.4	59.7	59.3	59.8	54.1
MP1	7.3	8.8	4.3	8.2	8.6	13.3	5.7	8.7	2.9
M1	4.9	2.9	3.0	3.4	2.3	11.4	7.2	5.1	11.0
CHI1	2.7	2.5	1.7	8.4	0.8	2.2	2.6	17.1	6.9
PI1	6.0	4.8	5.6	4.0	9.8	4.7	4.6	3.3	2.7
P1	24.4	27.3	20.6	16.3	27.2	9.6	16.5	21.9	19.8
S1	1.9	14.4	1.9	9.0	10.4	7.5	10.2	2.4	4.0
K1	52.3	46.1	55.2	52.0	58.7	48.1	53.2	46.9	52.4
PSI1	2.1	2.4	4.0	9.4	8.4	1.9	1.6	9.2	2.2
PHI1	7.1	4.5	6.1	2.5	10.5	2.6	4.2	2.6	4.3
TH1	6.3	5.6	7.1	8.8	3.4	3.6	2.1	3.0	9.4
J1	7.3	6.1	9.1	5.1	4.5	3.6	2.3	2.8	6.1
SO1	9.5	4.9	6.5	11.7	4.0	5.0	13.0	16.9	8.5
OO1	7.9	3.6	4.2	3.6	3.1	7.6	7.6	12.8	10.3
OQ2	10.7	15.5	16.9	5.9	14.9	18.7	15.7	11.1	15.3
MNS2	30.0	20.7	24.7	32.6	20.6	19.1	28.6	33.7	20.5
2N2	26.6	85.5	94.4	16.5	76.2	87.7	61.0	23.1	49.7
MU2	87.6	88.2	88.5	95.6	90.1	92.9	90.9	89.2	90.8
N2	418.4	417.7	415.2	415.1	418.4	404.2	403.5	411.6	406.1
NU2	102.8	101.9	104.3	105.0	101.9	98.5	96.7	101.0	98.1
OP2	27.9	25.4	17.0	35.5	5.6	18.4	21.7	22.3	22.5
M2	2266.3	2277.7	2280.7	2262.5	2265.2	2264.2	2245.7	2235.7	2238.4
MKS2	21.1	11.7	14.6	24.2	16.6	15.6	17.5	27.1	8.3
LAM2	55.9	58.6	64.3	59.2	63.6	64.8	57.1	55.5	61.2
L2	136.8	90.2	102.9	157.4	115.5	114.1	146.2	153.6	117.6
T2	40.0	34.7	40.9	35.5	41.6	34.8	42.2	38.9	38.0
S2	720.7	722.2	723.6	718.9	720.8	713.9	701.1	698.7	692.1
R2	8.8	6.5	6.7	8.9	12.0	6.5	10.3	11.4	13.6
K2	205.1	212.5	210.2	202.9	204.0	206.9	200.0	193.1	202.6
MSN2	35.0	44.7	44.2	30.7	40.1	35.2	29.7	34.3	30.8
KJ2	7.4	7.8	10.7	4.1	5.1	4.4	4.3	3.4	1.4
2SM2	44.1	44.5	47.1	42.2	49.0	44.8	43.0	44.3	42.6
MO3	1.5	0.7	2.8	3.2	4.4	1.5	2.3	1.3	4.9
M3	8.0	6.7	7.1	12.0	16.5	15.2	11.8	7.1	9.3
SO3	1.6	2.9	3.5	3.7	4.2	3.5	3.2	3.1	3.3
MK3	16.9	16.7	17.8	15.3	16.0	15.2	16.2	15.6	14.3
SK3	6.6	6.8	6.9	8.0	6.8	6.6	8.1	7.5	7.2
MN4	99.9	97.9	93.6	99.4	99.8	90.2	91.4	100.8	92.4
M4	268.7	263.5	269.7	264.7	261.5	263.6	263.0	258.8	258.2
SN4	18.3	20.2	12.9	16.0	21.3	16.5	19.3	20.0	14.8
MS4	175.9	174.4	176.0	175.7	175.7	175.2	170.6	166.7	166.3
MK4	50.9	56.0	51.4	48.7	46.8	50.4	47.8	47.4	47.3
S4	16.4	17.0	17.8	20.3	17.5	16.3	18.4	15.1	16.3
SK4	10.6	13.4	11.1	10.7	9.0	11.3	8.4	12.0	13.3
2MN6	39.0	36.7	34.8	38.4	36.9	33.7	35.2	38.5	36.3
M6	71.2	64.6	67.3	68.6	64.6	65.0	66.1	66.8	65.6
MSN6	17.0	16.9	14.0	17.9	17.8	14.9	15.4	16.8	14.6
2MS6	68.5	65.7	67.2	66.5	65.3	65.1	63.9	62.0	63.3
2MK6	17.8	19.1	19.3	17.6	16.4	18.3	17.0	16.7	17.8
2SM6	16.8	15.4	15.9	16.4	15.1	14.8	14.6	13.4	14.9
MSK6	9.5	9.7	9.2	10.0	8.7	8.0	7.6	9.1	9.9
MA2	24.7	25.3	15.4	38.8	31.8	25.6	30.2	30.4	33.9
MB2	6.2	9.2	10.1	11.2	5.2	4.7	6.9	4.4	8.3

	Dover - Amplitude (mm)		
	1997	**1998**	**1999**
ZO	3728.7	3755.0	3754.6
SA	63.0	52.3	75.0
SSA	29.8	18.3	12.4
MM	15.5	17.2	2.7
MSF	30.3	38.9	40.9
MF	20.6	22.2	38.7
2Q1	10.6	8.9	13.1
SIG1	9.3	6.1	2.8
Q1	27.8	29.5	19.6
RO1	6.7	9.0	13.6
O1	61.6	55.1	64.3
MP1	4.3	3.9	10.6
M1	3.2	1.7	4.7
CHI1	4.8	7.3	7.8
PI1	4.7	2.5	2.8
P1	16.9	18.4	18.7
S1	5.9	5.7	7.5
K1	46.9	50.3	45.2
PSI1	4.5	4.9	4.2
PHI1	2.5	2.1	2.7
TH1	8.6	9.3	5.3
J1	9.6	8.6	8.5
SO1	15.1	7.0	6.4
OO1	13.1	14.2	6.2
OQ2	12.2	6.8	14.8
MNS2	27.6	24.1	23.4
2N2	48.7	23.9	50.6
MU2	84.4	88.3	85.3
N2	403.5	406.7	406.7
NU2	101.8	97.7	94.7
OP2	24.5	32.8	23.6
M2	2227.9	2226.9	2229.8
MKS2	13.4	9.7	9.2
LAM2	55.3	49.0	54.0
L2	146.1	152.1	125.9
T2	37.8	42.0	36.7
S2	689.6	693.8	693.1
R2	7.0	6.8	8.7
K2	203.4	201.1	204.2
MSN2	30.9	31.5	36.5
KJ2	5.5	1.8	4.7
2SM2	39.5	38.8	42.0
MO3	5.6	3.7	2.9
M3	10.4	13.8	12.9
SO3	4.4	2.9	3.0
MK3	13.1	12.6	14.6
SK3	6.2	6.8	7.4
MN4	92.2	92.5	91.3
M4	256.2	254.7	254.4
SN4	19.8	19.3	18.6
MS4	161.0	166.9	161.0
MK4	52.4	52.1	53.0
S4	14.6	19.0	15.7
SK4	8.0	12.4	13.2
2MN6	35.7	37.6	35.1
M6	66.0	65.4	65.5
MSN6	15.5	16.2	18.3
2MS6	61.1	62.4	61.9
2MK6	18.8	19.8	19.4
2SM6	13.1	14.6	13.2
MSK6	8.9	9.9	9.9
MA2	32.2	27.3	20.3
MB2	6.1	7.3	9.8

	Dover - Phase (º)								
	1964	**1965**	**1966**	**1967**	**1968**	**1969**	**1970**	**1971**	**1972**
ZO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SA	180.2	229.0	217.3	217.2	229.2	203.2	218.1	228.5	193.1
SSA	96.7	153.7	329.1	51.3	88.9	54.4	59.1	147.9	97.2
MM	194.1	139.3	207.6	342.7	125.0	334.3	279.8	255.7	231.9
MSF	207.1	103.1	140.9	242.2	173.4	254.5	145.0	165.7	225.9
MF	198.4	202.4	132.7	245.2	168.3	192.5	230.1	199.7	154.2
2Q1	47.8	359.2	339.6	319.6	26.1	44.5	235.9	78.5	342.3
SIG1	15.4	83.9	232.2	298.9	335.1	175.1	356.2	249.1	21.4
Q1	125.8	111.3	103.9	113.5	104.9	106.7	117.4	135.9	146.9
RO1	264.1	152.1	133.7	121.4	103.2	146.4	133.9	136.7	110.9
O1	178.9	173.8	175.1	172.9	175.9	178.0	181.6	177.8	174.0
MP1	221.9	123.2	165.2	201.4	142.9	163.8	127.5	148.6	89.1
M1	84.2	142.5	179.0	204.9	322.2	99.0	189.4	351.0	17.3
CHI1	39.8	353.9	141.7	350.5	146.8	259.2	174.1	49.6	264.5
PI1	18.2	178.5	355.6	318.7	92.2	115.0	311.4	310.2	255.3
P1	15.3	25.4	22.4	8.0	33.1	25.5	6.8	354.8	15.8
S1	209.8	307.5	265.0	257.8	290.6	303.2	327.4	263.0	285.8
K1	38.5	42.7	38.7	41.2	42.6	45.9	37.0	45.1	43.9
PSI1	275.8	234.7	254.7	6.8	310.5	69.7	314.6	286.3	17.1
PHI1	3.5	69.0	68.8	12.5	319.9	83.0	67.8	83.1	240.9
TH1	324.2	316.4	27.4	31.8	141.7	54.6	267.8	40.9	156.4
J1	207.2	177.4	184.9	255.0	188.8	162.6	139.8	190.1	127.4
SO1	235.2	213.3	244.8	248.7	242.3	250.6	246.8	236.6	269.3
OO1	223.6	230.6	251.7	235.6	267.1	180.5	237.5	185.8	251.4
OQ2	255.2	241.9	223.3	257.8	260.2	234.4	216.0	234.0	278.0
MNS2	66.0	11.3	31.6	60.1	55.1	26.3	20.6	48.3	62.8
2N2	266.0	291.6	336.1	254.5	242.2	288.2	323.7	341.4	247.0
MU2	50.7	50.4	55.2	45.4	50.5	44.8	49.1	47.2	46.7
N2	311.5	308.7	308.6	308.2	309.6	308.6	309.3	309.0	311.7
NU2	303.1	299.6	302.1	298.7	300.9	304.0	301.5	303.4	302.6
OP2	297.4	265.5	319.6	311.7	285.2	276.4	331.7	307.0	262.0
M2	332.1	332.2	331.6	331.6	331.5	331.5	331.9	332.4	332.4
MKS2	171.5	95.2	133.0	140.7	113.7	109.0	106.7	115.6	116.6
LAM2	327.1	330.7	325.5	328.9	325.9	328.3	332.6	332.4	324.1
L2	333.4	346.7	344.9	324.4	327.1	349.3	0.1	332.8	325.5
T2	18.1	13.5	8.5	15.2	13.6	16.9	12.1	16.2	18.6
S2	23.4	23.0	22.3	23.0	22.2	22.9	23.3	23.8	23.8
R2	57.7	49.7	55.3	63.5	91.2	112.7	95.3	82.5	59.1
K2	21.5	24.4	21.0	21.5	20.7	20.5	21.0	20.8	20.1
MSN2	204.6	201.2	198.4	212.3	199.3	196.9	192.4	206.5	203.4
KJ2	328.9	305.2	282.0	269.2	271.4	262.0	265.1	243.2	210.1
2SM2	230.5	224.2	225.8	222.3	220.3	219.5	219.0	224.4	224.8
MO3	33.6	312.1	307.5	274.2	231.3	154.0	152.3	58.5	67.5
M3	30.6	29.6	27.4	29.3	51.6	66.6	45.0	44.3	30.0
SO3	270.9	60.4	325.8	29.9	359.2	351.3	104.4	329.7	327.5
MK3	16.6	7.1	1.5	5.7	14.2	7.6	359.4	4.4	5.0
SK3	85.5	79.1	67.2	78.9	82.4	70.8	75.7	70.5	87.7
MN4	199.7	192.6	192.5	191.7	198.3	192.9	195.5	195.2	203.6
M4	220.6	220.4	218.4	218.2	218.5	219.2	219.5	222.3	220.8
SN4	274.1	297.1	285.4	273.6	274.5	286.0	266.1	295.3	291.4
MS4	273.2	272.6	267.0	269.5	270.1	271.4	270.2	273.6	275.7
MK4	274.5	274.6	269.2	265.8	269.1	272.3	270.6	272.6	270.8
S4	342.3	349.8	324.2	355.8	345.4	1.4	343.5	341.5	357.3
SK4	354.9	345.7	332.5	343.8	338.2	350.4	342.6	348.0	329.9
2MN6	83.4	76.3	76.1	77.5	81.6	76.5	78.2	77.5	83.9
M6	102.8	104.6	103.9	100.9	100.7	102.1	104.0	103.7	100.5
MSN6	143.2	140.8	136.0	135.1	139.5	138.2	130.3	141.4	150.7
2MS6	148.3	149.1	145.6	146.2	146.8	146.9	147.1	149.4	151.0
2MK6	148.8	153.6	150.7	146.6	151.2	151.7	148.1	149.3	147.2
2SM6	199.4	199.4	187.2	198.1	201.3	206.1	202.8	205.4	208.0
MSK6	211.3	206.2	198.2	202.5	207.3	206.8	197.9	202.8	205.7
MA2	290.2	286.5	294.6	254.3	278.9	279.1	277.6	265.2	280.7
MB2	108.3	168.0	116.9	84.4	112.9	131.0	166.8	81.6	92.0

	Dover - Phase (º)								
	1973	**1974**	**1975**	**1979**	**1980**	**1981**	**1982**	**1983**	**1984**
ZO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SA	220.6	204.5	220.0	230.1	180.4	220.0	220.1	231.5	215.9
SSA	116.8	177.2	289.7	248.3	105.7	123.2	122.9	105.3	137.2
MM	2.8	160.4	110.7	124.3	195.5	305.8	137.0	90.1	176.0
MSF	189.3	230.7	289.2	323.4	304.9	281.6	170.8	62.5	323.5
MF	176.2	195.6	189.2	199.2	190.0	129.8	35.3	232.8	234.8
2Q1	50.2	183.6	9.8	50.9	66.2	54.9	36.0	178.2	313.3
SIG1	46.9	297.4	306.7	4.6	212.7	27.9	291.1	323.1	223.1
Q1	122.6	107.4	121.4	133.2	136.7	138.9	131.9	126.3	129.4
RO1	161.8	203.6	157.4	117.9	84.5	184.7	101.6	209.1	101.5
O1	174.9	180.5	170.8	178.7	180.2	180.9	179.1	175.0	170.3
MP1	167.6	181.2	174.1	191.0	271.0	232.8	291.1	222.4	101.4
M1	115.7	169.9	189.2	58.1	101.8	354.5	151.3	165.9	168.2
CHI1	162.8	121.7	164.5	318.4	118.0	292.4	105.8	159.0	358.0
PI1	190.7	86.2	54.2	330.3	27.5	112.3	19.6	301.0	202.5
P1	26.8	33.8	39.0	11.4	13.9	12.8	13.4	8.3	28.3
S1	272.9	299.5	272.7	345.0	269.2	249.7	315.0	214.8	264.0
K1	44.9	44.3	48.4	50.8	42.5	37.0	43.7	42.9	43.2
PSI1	199.9	267.0	94.7	119.3	32.4	288.2	30.6	314.1	335.1
PHI1	29.8	108.3	293.6	291.4	330.9	48.9	281.1	159.0	240.4
TH1	162.3	338.7	65.3	353.1	286.7	68.5	262.3	72.2	287.0
J1	77.1	275.0	276.6	148.1	189.9	142.2	252.3	103.5	141.1
SO1	256.6	205.9	269.0	266.8	322.0	260.5	202.7	238.6	222.2
OO1	217.3	236.7	291.0	178.2	202.6	248.7	115.1	252.8	190.9
OQ2	234.1	226.2	238.0	211.6	262.5	257.4	249.4	236.2	231.0
MNS2	31.5	26.7	38.6	32.0	44.6	55.8	48.7	22.0	36.0
2N2	279.6	311.5	311.7	317.3	296.9	248.6	276.3	302.4	336.0
MU2	47.5	50.4	46.3	49.7	50.5	53.0	50.0	51.2	51.7
N2	309.7	308.8	308.4	310.1	309.9	310.6	310.7	309.0	308.9
NU2	302.1	299.0	300.3	303.7	304.8	303.1	304.1	299.7	302.3
OP2	282.1	324.9	320.0	295.1	295.1	288.1	308.3	298.0	298.5
M2	331.9	331.7	331.7	332.9	332.8	332.1	331.8	331.9	331.9
MKS2	117.8	89.7	126.9	133.7	73.8	165.4	210.4	96.8	99.7
LAM2	331.1	329.2	331.5	334.8	327.0	325.8	325.1	331.8	331.2
L2	340.8	345.3	338.1	351.3	341.8	331.7	336.5	348.2	344.5
T2	26.4	13.7	20.2	16.7	23.2	19.5	26.0	25.0	19.7
S2	23.5	23.2	23.5	25.0	24.3	23.5	23.6	23.5	23.4
R2	63.9	26.1	116.3	65.9	32.8	55.2	77.9	71.4	51.1
K2	22.6	21.3	19.8	25.7	25.7	21.9	21.4	23.9	22.6
MSN2	206.2	193.2	206.5	206.7	205.2	207.4	201.9	201.2	207.5
KJ2	267.3	291.6	270.2	330.7	323.0	297.1	301.8	282.9	292.2
2SM2	218.8	216.8	220.2	223.3	227.1	229.2	224.5	224.2	222.2
MO3	357.3	260.7	316.4	115.3	133.7	124.1	82.4	288.5	263.5
M3	26.9	23.5	18.4	43.2	36.2	35.3	23.8	28.5	33.7
SO3	90.2	323.3	334.5	40.4	332.6	356.5	30.1	6.1	19.2
MK3	0.8	357.2	7.6	8.4	12.8	16.6	356.1	2.0	11.8
SK3	75.3	89.4	94.1	82.4	77.6	83.7	69.6	89.6	76.4
MN4	198.2	194.4	193.1	195.6	197.2	200.6	199.2	195.0	194.2
M4	221.6	219.9	221.6	222.8	222.7	221.5	220.4	221.3	220.2
SN4	281.3	290.1	293.4	299.0	299.9	283.4	294.7	272.2	289.3
MS4	275.0	273.2	274.7	276.8	275.6	273.4	273.7	273.1	273.4
MK4	273.8	270.1	272.1	275.2	275.5	273.0	270.1	275.1	272.1
S4	350.2	346.5	357.0	353.4	347.6	345.1	356.3	356.9	357.8
SK4	354.7	335.8	348.0	29.6	1.9	356.7	351.8	5.6	337.5
2MN6	80.2	77.0	76.4	79.7	80.8	85.3	81.4	78.7	76.5
M6	103.8	103.8	105.0	107.8	105.6	104.5	103.5	106.3	103.8
MSN6	143.5	141.0	148.3	145.0	145.7	144.0	147.7	137.3	135.1
2MS6	149.9	149.8	151.8	153.9	153.5	151.1	150.3	150.4	150.3
2MK6	150.3	152.3	144.2	157.3	150.0	152.7	149.6	155.8	152.1
2SM6	208.6	211.5	213.6	218.5	213.9	208.6	209.9	210.9	211.9
MSK6	216.8	203.6	195.5	214.3	206.8	218.0	213.1	219.7	203.9
MA2	270.0	299.5	266.7	275.7	285.5	276.8	275.4	284.0	276.9
MB2	87.2	90.1	9.7	262.1	46.1	118.7	298.5	118.7	97.8

	Dover - Phase (º)								
	1985	**1986**	**1987**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**
ZO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SA	222.5	215.8	186.3	235.6	234.4	191.4	190.9	209.1	206.8
SSA	141.8	160.6	97.5	249.3	320.5	90.0	92.3	181.2	101.3
MM	237.2	203.7	254.7	141.1	221.9	228.6	285.3	107.1	315.8
MSF	225.1	343.5	166.8	227.8	320.9	231.9	243.2	214.3	256.5
MF	202.5	188.7	192.4	195.2	66.9	183.3	238.9	318.0	227.2
2Q1	145.3	83.4	93.6	80.5	287.7	318.4	166.4	249.1	153.5
SIG1	299.2	195.8	345.4	341.7	356.9	330.8	15.1	33.4	119.6
Q1	105.4	97.9	110.0	126.0	153.3	110.4	102.1	101.9	119.8
RO1	112.0	54.9	186.9	121.8	174.9	227.3	139.7	67.1	138.6
O1	177.6	173.7	176.6	190.6	178.9	177.1	172.0	185.5	194.3
MP1	240.2	189.7	98.7	155.9	207.9	115.5	226.6	185.2	238.5
M1	224.9	292.7	185.8	217.8	128.5	120.8	187.0	159.4	230.4
CHI1	311.7	213.2	303.9	102.2	270.3	204.4	329.5	48.3	328.4
PI1	336.3	253.4	248.3	198.0	71.0	226.4	270.5	28.1	95.4
P1	11.2	26.7	23.6	56.1	40.8	11.1	38.8	19.4	24.9
S1	337.6	267.1	232.5	321.6	268.2	350.3	281.7	242.8	42.2
K1	35.4	45.8	42.2	40.0	48.8	41.1	43.3	31.0	32.9
PSI1	210.8	335.9	269.9	280.2	76.9	75.3	68.4	279.5	285.1
PHI1	337.7	202.9	6.1	75.7	315.6	355.3	309.6	186.6	16.5
TH1	92.4	196.2	4.0	21.8	80.7	93.5	335.2	198.1	88.2
J1	214.7	186.7	178.2	226.3	138.6	21.7	148.9	238.5	146.1
SO1	232.8	193.4	230.0	181.7	260.1	225.7	243.0	240.3	220.7
OO1	177.2	99.5	188.9	177.1	250.5	235.7	124.7	193.1	196.0
OQ2	242.8	240.7	229.1	265.1	258.9	227.3	220.1	223.6	265.0
MNS2	61.2	51.9	18.9	42.3	54.4	40.6	29.7	40.2	44.3
2N2	242.2	257.7	299.0	229.7	250.3	287.8	319.2	301.2	250.0
MU2	50.2	49.8	47.8	45.1	41.4	45.9	42.7	45.4	43.5
N2	309.9	309.9	309.2	310.1	309.7	310.0	308.8	308.9	309.8
NU2	303.2	301.9	300.3	300.2	302.6	297.8	300.4	302.2	303.0
OP2	281.6	273.5	318.2	294.0	227.5	266.3	325.7	283.1	264.4
M2	332.0	331.7	331.5	331.9	331.6	332.1	332.1	332.0	332.2
MKS2	123.7	101.2	102.7	96.9	130.6	89.5	83.9	101.1	133.7
LAM2	327.5	327.0	336.8	333.0	329.0	333.8	331.9	330.9	332.7
L2	317.5	334.7	354.7	325.7	327.2	345.3	348.5	332.1	331.1
T2	24.0	23.4	26.4	11.1	13.4	18.0	21.8	20.4	18.4
S2	23.2	22.9	23.1	23.7	23.3	24.1	24.7	24.6	24.9
R2	51.8	21.5	43.2	106.8	84.5	100.0	44.2	49.5	47.6
K2	21.9	21.1	20.7	22.0	21.6	22.8	23.3	21.8	22.8
MSN2	213.2	198.2	194.3	205.0	201.7	200.1	199.5	210.5	210.7
KJ2	286.2	291.8	282.4	269.0	309.6	303.9	318.3	10.6	241.9
2SM2	225.4	226.3	222.1	220.6	223.8	224.8	224.0	224.9	230.2
MO3	225.9	227.6	170.8	129.4	41.4	22.5	306.9	234.7	188.3
M3	32.8	57.4	67.7	33.7	26.6	26.3	23.4	35.1	40.9
SO3	300.9	358.0	17.8	351.4	334.4	355.4	337.6	323.6	351.5
MK3	9.6	19.7	13.1	7.6	0.3	5.3	6.5	2.5	6.0
SK3	66.9	66.3	81.3	62.7	83.8	72.8	87.1	86.6	83.7
MN4	199.6	200.6	198.3	198.6	198.8	199.7	194.7	195.8	197.7
M4	221.4	219.6	220.3	221.4	220.0	222.0	221.9	221.4	219.6
SN4	292.3	282.1	285.7	288.4	282.6	284.0	288.4	288.3	288.8
MS4	272.9	272.8	273.1	273.5	272.9	274.5	274.9	274.9	275.2
MK4	275.3	273.6	268.7	275.0	270.6	275.2	273.2	274.8	272.1
S4	335.4	341.5	351.8	350.7	357.5	352.6	359.4	353.1	351.8
SK4	356.6	346.2	352.3	342.4	334.1	12.0	335.7	352.5	330.1
2MN6	83.6	82.8	79.4	81.6	82.9	81.1	77.1	79.1	81.3
M6	103.9	100.1	105.0	103.0	101.8	105.1	105.2	104.1	102.3
MSN6	147.0	146.1	141.3	142.1	146.8	145.4	141.8	145.7	147.1
2MS6	150.2	149.1	149.0	150.6	149.7	151.1	150.7	151.6	152.1
2MK6	154.3	150.4	149.1	152.3	149.8	152.4	150.9	155.1	153.9
2SM6	202.9	208.7	210.9	212.6	216.7	211.6	214.2	210.7	211.9
MSK6	212.9	211.8	212.5	206.7	210.0	219.6	203.4	210.9	211.3
MA2	280.0	266.8	292.2	264.8	271.7	274.7	280.2	285.4	272.8
MB2	40.6	42.3	81.1	133.3	99.5	21.7	79.2	146.4	85.6

	Dover - Phase (º)		
	1997	**1998**	**1999**
ZO	0.0	0.0	0.0
SA	207.9	209.4	225.6
SSA	96.4	24.9	295.2
MM	295.1	80.3	92.1
MSF	255.3	175.9	186.1
MF	168.1	210.3	359.7
2Q1	209.6	117.5	128.9
SIG1	257.9	356.0	306.5
Q1	139.9	120.2	135.5
RO1	111.1	57.3	105.1
O1	191.4	180.8	175.4
MP1	45.4	15.6	176.1
M1	98.1	53.1	297.1
CHI1	187.6	122.9	100.9
PI1	117.1	168.5	59.5
P1	36.4	30.1	10.4
S1	322.0	259.9	303.7
K1	37.9	30.7	45.8
PSI1	310.4	261.9	254.0
PHI1	183.7	43.0	98.9
TH1	13.0	65.8	95.2
J1	122.6	183.1	167.9
SO1	208.9	229.3	202.4
OO1	140.6	249.4	117.0
OQ2	204.7	298.9	258.9
MNS2	29.7	49.6	53.3
2N2	315.3	271.2	258.3
MU2	47.9	49.9	52.3
N2	309.6	309.6	310.7
NU2	303.9	303.8	303.4
OP2	314.4	296.6	264.3
M2	332.4	332.2	332.1
MKS2	87.4	144.0	118.7
LAM2	330.3	328.8	327.8
L2	348.1	336.2	332.5
T2	25.9	23.6	19.5
S2	25.3	24.4	24.0
R2	71.3	71.2	44.3
K2	26.2	23.6	25.2
MSN2	205.7	212.5	210.1
KJ2	325.5	340.0	239.4
2SM2	231.7	228.2	226.1
MO3	145.7	139.7	105.4
M3	39.1	35.0	32.6
SO3	17.9	345.5	6.8
MK3	11.7	11.9	8.9
SK3	74.9	74.8	79.2
MN4	197.7	194.7	201.3
M4	222.3	220.6	220.4
SN4	293.2	271.3	263.9
MS4	276.6	274.0	274.4
MK4	276.3	277.5	281.2
S4	346.6	351.0	3.8
SK4	354.8	7.8	5.3
2MN6	79.9	78.5	85.2
M6	105.8	103.7	102.1
MSN6	147.9	139.9	142.4
2MS6	153.4	150.9	150.5
2MK6	157.9	157.0	156.6
2SM6	211.8	216.1	216.8
MSK6	212.9	225.1	228.3
MA2	285.8	282.6	282.4
MB2	50.6	86.5	115.1

	Brest - Amplitude (mm)								
	1862	**1864**	**1865**	**1866**	**1867**	**1868**	**1869**	**1870**	**1871**
ZO	3990.7	3990.9	3993.7	4001.7	3978.5	3953.5	3954.4	3926.6	3949.3
SA	29.0	78.8	72.2	12.2	52.5	117.8	52.5	105.1	60.0
SSA	22.6	41.1	39.0	27.9	13.4	47.5	21.0	16.8	48.2
MM	19.5	46.5	16.7	34.3	8.6	14.9	4.4	5.8	26.2
MSF	14.6	15.0	17.8	16.4	29.1	23.3	8.9	28.0	19.2
MF	21.2	17.5	27.3	29.1	32.4	17.2	23.9	22.1	23.5
2Q1	7.1	7.2	4.4	1.1	2.9	2.0	6.2	4.9	5.7
SIG1	3.9	6.1	3.3	5.5	5.1	6.6	5.9	6.4	3.4
Q1	22.7	24.9	23.4	23.1	18.8	18.3	18.5	18.9	24.9
RO1	3.6	4.6	2.4	1.1	4.4	7.3	5.0	3.3	5.2
O1	65.7	68.9	70.6	70.1	67.4	67.4	70.0	64.7	65.6
MP1	1.8	2.5	1.4	1.0	0.8	2.7	1.2	1.2	1.2
M1	8.4	4.5	2.6	7.2	9.5	6.1	7.8	6.3	7.9
CHI1	3.5	0.6	3.1	2.7	1.8	2.0	1.7	1.8	1.3
PI1	2.7	1.4	2.7	3.7	2.4	1.6	1.5	0.8	0.7
P1	23.9	24.1	22.4	24.8	21.7	21.2	20.9	22.9	20.7
S1	5.3	6.9	6.6	7.7	6.7	6.7	7.3	5.6	7.2
K1	67.1	66.2	66.4	64.4	64.1	66.6	67.1	67.3	62.6
PSI1	3.8	1.7	3.5	1.9	3.8	2.0	4.7	4.8	2.4
PHI1	1.9	3.0	2.8	1.5	0.3	4.1	2.2	2.2	2.3
TH1	2.2	1.1	2.6	1.0	0.5	4.7	1.7	2.7	0.9
J1	1.0	5.1	5.9	5.6	4.8	4.2	3.0	1.6	0.9
SO1	2.8	2.0	1.5	2.4	1.4	0.3	3.9	1.4	2.8
OO1	3.3	1.6	3.9	4.7	0.4	2.7	1.8	0.2	2.2
OQ2	6.9	10.3	4.4	6.0	11.4	13.1	8.4	3.6	6.0
MNS2	17.5	18.1	20.5	19.3	18.1	18.4	21.2	20.5	16.0
2N2	55.5	60.3	50.0	49.2	55.2	63.4	59.6	51.4	52.1
MU2	85.4	81.9	80.3	81.8	80.8	78.3	78.6	80.9	83.1
N2	421.5	415.5	415.0	413.4	413.2	415.0	416.4	420.2	423.7
NU2	78.4	75.7	77.8	79.0	78.3	75.0	75.3	78.4	79.3
OP2	13.3	2.8	13.2	20.5	18.3	11.1	4.8	16.4	20.1
M2	2052.9	2054.1	2060.8	2062.4	2052.9	2063.8	2056.3	2060.8	2063.7
MKS2	9.2	7.3	9.8	9.5	7.3	9.0	12.4	11.4	8.0
LAM2	25.3	26.8	25.5	24.8	25.1	25.4	21.8	24.6	25.1
L2	53.2	71.1	66.4	60.0	63.1	71.7	75.2	59.6	51.5
T2	41.6	41.6	42.4	40.3	40.3	42.2	39.8	40.1	41.3
S2	749.5	748.5	750.9	750.6	745.8	750.7	748.8	749.4	751.1
R2	6.5	4.7	4.3	7.7	5.8	6.7	4.1	6.5	5.7
K2	210.3	207.6	209.8	211.7	211.7	216.6	213.4	215.8	215.7
MSN2	13.6	13.3	14.1	13.6	14.4	16.5	14.0	13.0	14.6
KJ2	10.0	8.5	10.4	8.2	10.2	10.6	9.7	10.7	12.0
2SM2	18.5	16.0	16.9	16.0	16.1	16.8	16.9	17.1	17.8
MO3	3.4	5.6	5.3	7.2	6.9	6.5	4.6	4.9	4.7
M3	19.6	19.9	19.2	19.7	19.6	18.9	18.1	19.7	19.1
SO3	0.7	0.6	1.1	0.5	0.5	0.9	1.2	1.1	0.6
MK3	4.4	2.0	1.5	1.5	2.1	3.3	3.0	3.9	3.9
SK3	5.8	6.3	6.8	7.1	8.0	6.9	6.3	6.7	5.9
MN4	17.6	16.6	18.3	18.1	16.0	17.2	19.0	17.6	16.8
M4	47.9	49.7	49.4	49.1	49.5	50.2	50.5	49.6	49.2
SN4	3.1	2.9	2.6	2.0	3.8	3.4	4.4	3.0	2.1
MS4	29.7	28.7	29.1	29.2	29.4	30.3	30.3	28.1	30.4
MK4	9.0	8.0	7.2	8.5	8.1	7.7	7.1	9.4	6.8
S4	2.2	1.7	1.9	2.0	2.0	1.5	2.1	2.2	1.6
SK4	1.5	1.3	1.2	1.1	2.0	1.3	0.6	1.3	0.2
2MN6	21.3	19.6	21.7	19.7	18.1	18.5	21.2	20.9	18.1
M6	33.6	35.0	31.9	31.4	32.1	33.2	33.4	33.2	32.0
MSN6	4.0	6.4	3.9	3.6	4.4	5.3	4.8	4.2	4.2
2MS6	22.2	20.0	19.4	19.0	19.4	19.6	19.4	19.2	19.8
2MK6	6.2	3.8	5.1	5.3	4.3	3.5	4.7	5.7	4.5
2SM6	3.3	3.0	2.2	2.2	2.2	2.9	2.9	3.4	2.6
MSK6	1.1	1.6	1.5	1.9	0.7	2.2	1.9	1.1	1.9
MA2	7.9	13.7	15.2	13.1	9.8	16.9	15.9	18.1	12.9
MB2	12.8	16.5	18.0	14.9	15.6	18.7	13.1	11.9	16.8

	Brest - Amplitude (mm)								
	1872	**1873**	**1874**	**1875**	**1876**	**1879**	**1880**	**1881**	**1882**
ZO	4017.3	3980.6	3933.5	3971.8	4014.3	4023.5	3996.1	4025.1	4015.2
SA	105.0	45.2	62.9	82.3	136.3	54.8	60.1	69.4	72.8
SSA	34.2	11.9	22.0	21.6	52.8	46.7	33.1	33.6	94.4
MM	49.3	31.4	20.2	12.2	15.0	5.6	29.7	12.5	38.3
MSF	29.8	14.7	4.0	24.9	27.3	7.4	7.3	22.9	18.2
MF	24.7	6.7	29.3	18.8	8.9	10.9	29.8	12.3	12.2
2Q1	5.4	6.1	5.3	3.9	2.1	4.0	3.3	5.8	3.1
SIG1	3.3	4.8	5.2	4.9	2.2	4.7	4.0	0.9	4.0
Q1	21.8	26.2	21.8	21.7	17.0	23.1	21.8	21.2	21.3
RO1	3.1	4.0	5.8	3.4	4.7	3.8	4.4	6.3	2.9
O1	65.7	68.4	68.0	67.3	67.8	64.6	66.2	66.6	64.6
MP1	3.5	2.0	1.3	1.1	3.8	1.5	1.7	2.4	4.3
M1	3.9	2.8	0.9	0.8	3.5	5.3	7.8	3.8	1.3
CHI1	0.9	1.8	0.5	0.9	1.3	1.2	1.6	1.8	2.8
PI1	4.1	2.0	4.1	0.6	1.7	2.6	2.5	2.4	1.2
P1	18.8	20.7	24.6	22.6	22.4	20.5	20.7	24.2	22.7
S1	8.0	6.0	5.9	5.4	7.6	5.8	7.2	5.7	6.4
K1	63.7	63.9	65.2	63.3	62.4	61.9	64.7	64.7	63.7
PSI1	3.4	3.5	4.1	1.5	0.4	2.4	1.4	2.0	2.9
PHI1	1.2	1.7	1.6	2.6	0.8	1.9	1.9	0.4	2.7
TH1	2.5	1.4	1.5	0.4	1.2	2.0	1.8	1.1	1.8
J1	2.8	3.3	4.5	6.0	5.5	1.7	1.0	2.0	4.0
SO1	1.2	0.6	2.5	0.7	0.8	1.1	1.0	1.0	2.7
OO1	3.1	2.4	2.7	1.8	1.7	1.0	0.8	2.7	2.7
OQ2	7.8	7.3	2.5	3.1	6.7	2.4	8.2	11.4	8.8
MNS2	17.6	20.4	20.5	18.5	18.4	18.7	16.1	18.2	20.8
2N2	65.3	66.3	48.6	45.0	64.7	46.2	61.3	68.2	59.2
MU2	82.3	83.2	82.4	82.3	85.0	84.3	84.9	82.5	80.3
N2	420.9	418.6	417.5	415.9	415.8	426.2	424.1	420.0	418.7
NU2	78.0	77.2	77.5	79.9	77.2	78.8	78.9	77.5	76.7
OP2	12.4	6.4	11.6	15.5	13.5	13.6	13.2	7.8	2.2
M2	2059.7	2058.3	2061.6	2066.3	2066.1	2062.0	2062.1	2061.4	2062.2
MKS2	8.9	9.6	10.3	9.0	6.9	10.6	7.9	10.4	11.5
LAM2	27.5	27.0	27.4	26.8	27.6	24.8	25.6	25.2	26.7
L2	61.3	76.9	76.6	60.7	65.6	48.5	55.9	68.7	71.6
T2	39.9	40.5	41.9	42.9	43.2	41.4	43.9	42.2	42.7
S2	751.1	752.9	754.5	756.4	756.8	751.6	753.0	749.6	752.3
R2	4.7	4.1	6.2	4.4	5.4	5.5	7.8	4.7	5.9
K2	216.2	216.9	215.4	215.9	215.9	212.0	210.5	211.3	211.2
MSN2	15.8	14.1	12.2	14.5	15.4	14.3	15.4	15.5	13.7
KJ2	12.3	12.1	9.8	10.1	10.4	10.6	10.5	12.0	9.7
2SM2	17.1	16.5	18.0	17.1	18.4	18.2	18.0	17.2	16.7
MO3	3.3	4.4	5.5	5.0	5.1	3.9	4.0	4.7	6.9
M3	20.9	19.6	19.8	20.3	19.2	19.8	19.4	19.7	20.2
SO3	1.2	0.6	0.7	0.8	1.2	0.3	0.2	0.5	0.9
MK3	2.6	3.6	2.1	2.4	3.0	3.3	3.5	2.9	0.9
SK3	5.7	5.7	5.8	5.7	5.8	5.8	5.5	5.5	6.4
MN4	16.6	19.0	19.6	18.3	17.6	18.3	18.4	17.2	17.8
M4	49.8	50.6	52.2	51.3	50.9	50.0	49.9	50.9	48.8
SN4	3.3	3.4	3.4	2.5	3.1	2.5	3.7	3.6	2.5
MS4	30.1	31.1	30.6	31.8	32.2	29.1	29.5	29.0	28.5
MK4	9.0	9.0	8.9	8.8	8.7	8.0	8.2	8.4	6.9
S4	2.1	2.3	2.4	1.5	2.1	1.3	1.3	1.4	2.0
SK4	1.2	1.1	1.5	1.3	1.4	1.4	1.4	0.7	0.8
2MN6	19.4	21.7	22.3	20.9	20.0	19.8	19.6	19.6	20.2
M6	31.5	33.5	34.4	34.1	32.8	32.8	31.0	32.5	31.6
MSN6	4.5	6.2	5.5	4.3	6.3	4.3	3.9	6.0	4.5
2MS6	20.7	21.0	20.9	21.5	22.6	19.5	19.6	18.3	19.2
2MK6	5.1	5.2	5.1	5.2	4.9	5.2	4.1	4.9	4.5
2SM6	2.5	1.9	3.8	3.3	1.9	3.3	2.8	4.0	3.6
MSK6	0.6	1.1	1.4	1.2	1.5	0.9	2.0	1.6	1.9
MA2	10.3	15.5	15.5	11.7	12.0	9.0	11.3	11.7	11.6
MB2	12.3	11.5	10.2	13.4	15.2	14.3	16.8	14.0	14.9

	Brest - Amplitude (mm)								
	1883	**1884**	**1885**	**1886**	**1887**	**1888**	**1889**	**1890**	**1891**
ZO	4002.1	3984.4	4002.7	4025.4	3949.9	3969.8	3933.2	3940.3	3953.4
SA	27.5	38.3	52.9	41.8	62.0	57.6	42.8	30.6	67.7
SSA	8.0	49.0	21.3	45.9	13.7	55.9	49.9	27.5	74.7
MM	11.9	3.4	11.7	16.3	21.0	15.3	37.4	34.5	15.5
MSF	17.2	10.1	11.3	12.8	16.4	15.5	14.4	18.2	21.9
MF	2.9	25.7	6.1	35.7	7.1	43.7	17.8	22.1	10.6
2Q1	1.6	3.9	4.2	4.0	0.5	3.0	5.0	5.3	6.0
SIG1	4.2	3.6	2.6	5.5	5.5	2.9	3.2	5.0	3.3
Q1	23.6	20.7	19.4	16.9	20.1	18.0	23.1	24.4	23.4
RO1	3.3	2.0	5.2	4.2	3.1	3.7	4.0	4.3	3.2
O1	67.5	69.9	66.7	65.8	64.7	64.1	66.6	66.9	68.1
MP1	2.3	1.6	1.5	1.6	1.4	1.8	1.8	3.4	1.1
M1	4.2	5.4	8.3	6.5	7.1	7.3	8.4	5.2	2.3
CHI1	2.1	2.4	0.6	2.2	1.0	2.6	1.9	2.1	1.1
PI1	1.8	1.2	1.3	2.0	3.0	1.2	3.2	3.5	2.1
P1	23.4	22.9	23.4	22.3	22.3	23.4	22.8	23.1	22.8
S1	5.8	4.8	4.7	7.1	5.0	7.5	6.5	5.0	6.3
K1	64.0	65.3	65.7	64.8	63.6	64.6	62.3	64.0	64.5
PSI1	1.5	2.7	0.4	2.8	1.3	2.1	1.7	2.4	3.1
PHI1	1.7	1.3	1.0	2.4	1.2	1.0	1.5	1.5	1.6
TH1	0.7	1.7	1.3	1.2	1.1	0.5	0.8	1.6	2.6
J1	6.1	6.0	5.4	0.3	5.2	0.2	1.1	1.2	1.3
SO1	0.4	2.5	1.4	2.4	0.9	0.3	0.9	0.5	1.8
OO1	3.2	7.0	2.4	2.7	0.7	1.8	1.1	1.0	0.8
OQ2	4.6	7.6	14.3	10.6	8.5	5.4	8.2	9.5	8.4
MNS2	19.8	18.3	16.6	20.8	21.9	18.2	15.4	18.9	21.1
2N2	47.8	51.8	58.6	61.4	55.9	51.3	55.6	67.4	63.1
MU2	80.4	77.6	78.7	76.0	78.0	79.1	81.0	84.3	85.5
N2	412.8	413.4	416.7	415.7	418.0	420.5	422.0	416.4	415.9
NU2	79.2	80.3	77.4	76.2	78.1	76.2	77.6	77.1	77.6
OP2	13.1	20.3	16.0	7.3	10.3	21.9	21.3	10.9	7.3
M2	2064.4	2062.3	2064.9	2064.2	2068.6	2064.8	2063.1	2052.6	2048.8
MKS2	10.7	6.9	9.4	9.1	10.9	7.8	7.9	9.1	11.0
LAM2	26.7	24.5	26.4	26.5	22.8	26.8	25.4	26.8	27.6
L2	63.7	62.6	65.9	73.9	72.8	54.4	54.9	64.9	77.7
T2	40.9	41.9	42.3	40.7	39.5	41.9	42.2	41.1	40.5
S2	750.6	749.2	751.2	749.6	751.6	751.4	750.7	749.0	748.3
R2	4.7	5.7	4.9	3.1	5.3	5.4	6.1	6.3	5.2
K2	209.6	211.5	210.1	212.2	212.6	215.9	215.6	216.0	214.2
MSN2	14.0	14.8	15.0	13.8	14.1	13.4	15.0	16.7	14.8
KJ2	11.2	10.1	9.9	11.3	8.5	8.3	10.7	12.2	10.8
2SM2	16.3	16.0	16.9	16.6	16.7	15.6	16.5	18.1	18.4
MO3	6.9	6.5	6.6	7.2	5.4	5.4	3.4	4.4	3.7
M3	20.2	19.7	19.6	19.1	19.9	19.7	20.2	21.1	19.2
SO3	0.8	0.8	0.9	0.3	1.1	0.4	0.3	0.4	0.7
MK3	0.9	1.9	2.9	3.6	2.9	3.9	2.7	2.9	2.1
SK3	6.3	6.6	5.0	5.5	5.7	6.8	6.9	5.7	6.8
MN4	18.4	17.5	16.4	18.4	18.4	17.7	17.5	18.6	19.4
M4	50.5	49.3	50.3	49.5	51.8	51.0	51.6	52.6	53.5
SN4	2.3	2.7	3.5	3.5	2.8	2.3	3.0	3.5	3.4
MS4	28.9	28.5	27.9	27.8	29.2	30.3	29.3	31.3	31.8
MK4	8.5	7.8	8.2	6.3	8.1	7.9	9.0	8.9	9.2
S4	1.0	0.7	1.0	0.6	1.1	1.7	1.1	1.5	1.5
SK4	1.1	1.5	0.5	0.5	0.6	0.6	1.4	1.2	1.1
2MN6	20.3	19.3	18.0	19.4	20.4	20.3	18.7	18.8	20.6
M6	32.1	30.7	30.9	31.5	33.0	31.2	31.9	31.8	32.5
MSN6	3.8	4.6	4.4	4.6	4.1	3.9	4.5	4.6	4.3
2MS6	17.7	18.0	17.2	18.4	18.3	17.6	18.9	19.5	18.4
2MK6	4.7	4.0	3.5	2.0	5.0	5.2	5.5	3.7	4.0
2SM6	2.7	3.5	3.2	2.6	3.6	2.9	2.9	3.1	3.5
MSK6	0.8	1.9	1.3	1.4	1.3	1.5	1.0	1.7	1.5
MA2	13.7	10.7	12.3	12.9	17.9	16.1	15.9	15.5	18.0
MB2	18.2	17.9	15.6	19.1	15.3	16.4	13.9	15.5	15.1

	Brest - Amplitude (mm)								
	1892	**1893**	**1894**	**1895**	**1896**	**1897**	**1898**	**1899**	**1900**
ZO	3974.6	3977.3	3963.0	3999.2	3936.3	3996.7	3956.0	3991.8	3984.3
SA	58.6	16.3	52.1	97.7	83.1	16.8	50.4	56.8	45.0
SSA	11.6	26.4	56.6	29.1	30.3	30.5	85.3	23.8	9.9
MM	32.4	33.5	44.5	12.6	21.1	61.1	38.8	11.7	16.8
MSF	16.1	21.9	15.0	14.8	15.3	31.0	12.9	18.9	10.9
MF	5.9	34.7	15.3	5.5	15.9	23.4	4.7	17.6	29.0
2Q1	3.2	2.3	2.3	1.5	2.7	3.1	5.0	4.8	4.3
SIG1	5.4	3.3	3.5	5.6	5.4	3.6	4.4	3.9	5.3
Q1	23.0	17.9	17.8	18.6	20.1	23.1	24.7	22.1	21.3
RO1	4.4	5.2	2.9	3.7	5.5	3.3	4.5	2.4	2.3
O1	68.4	67.0	66.7	66.0	64.3	65.9	66.2	66.0	69.3
MP1	0.4	2.4	1.3	1.9	3.0	7.2	1.6	1.9	2.6
M1	1.8	0.9	5.2	4.6	4.3	4.7	6.0	2.6	2.9
CHI1	1.7	0.8	1.8	1.9	0.8	0.4	1.3	1.4	0.8
PI1	1.7	3.6	1.6	3.5	2.3	2.9	3.7	3.0	2.6
P1	22.4	24.4	20.5	23.6	21.4	19.9	22.0	23.9	20.4
S1	9.0	8.2	6.1	8.5	7.8	5.8	9.2	8.5	9.4
K1	64.8	64.1	65.8	63.8	64.0	64.9	64.8	65.4	64.9
PSI1	2.5	3.6	5.4	1.0	1.2	1.2	3.1	1.3	3.2
PHI1	2.4	2.3	1.7	3.2	1.3	4.3	1.0	0.4	0.4
TH1	0.7	2.5	1.2	1.7	1.1	2.5	1.1	0.4	3.2
J1	4.5	5.1	5.6	3.2	1.7	1.4	2.1	3.1	5.1
SO1	1.2	1.1	1.4	1.8	1.6	2.9	0.9	2.3	1.3
OO1	2.0	1.8	1.8	1.2	1.2	2.0	1.3	1.0	3.4
OQ2	1.3	4.0	8.6	8.7	2.9	4.5	8.0	11.8	7.0
MNS2	21.6	18.7	18.8	23.8	24.0	19.3	17.3	20.7	21.9
2N2	45.3	47.2	67.8	70.5	49.7	47.7	65.3	68.6	57.2
MU2	85.8	85.5	87.2	88.8	89.1	90.2	87.9	86.7	84.4
N2	413.7	413.0	412.9	418.9	423.0	424.4	419.0	418.6	416.3
NU2	78.2	79.8	78.2	73.3	75.9	78.2	77.1	76.2	79.4
OP2	13.3	15.0	9.4	2.9	11.1	16.5	9.9	1.8	8.2
M2	2047.9	2049.3	2052.4	2055.0	2051.6	2053.7	2050.6	2049.3	2053.0
MKS2	11.1	9.2	8.9	12.2	10.7	9.7	6.8	9.5	12.9
LAM2	26.6	28.3	24.7	21.0	22.2	23.9	24.7	24.8	25.0
L2	69.9	57.9	68.1	84.9	67.0	48.4	58.8	70.4	73.2
T2	41.6	42.5	41.8	44.1	42.0	44.7	42.3	43.1	41.3
S2	749.5	750.2	753.4	754.4	752.9	752.3	750.5	749.3	748.1
R2	8.0	5.1	5.2	7.8	5.6	5.2	6.7	7.1	5.6
K2	216.2	215.4	216.0	214.8	213.7	212.9	211.0	210.7	209.6
MSN2	13.5	15.4	17.4	13.2	14.1	14.8	14.5	13.8	14.5
KJ2	10.3	10.7	10.7	10.5	11.3	11.0	10.6	9.9	10.2
2SM2	18.0	18.6	18.8	18.7	18.3	18.8	17.7	17.1	14.9
MO3	4.7	4.3	4.9	4.1	3.8	4.0	2.8	4.8	5.2
M3	20.3	20.3	19.4	19.3	19.4	19.9	19.5	19.9	20.0
SO3	0.6	0.3	0.7	0.6	0.3	0.3	0.3	0.7	0.5
MK3	1.6	2.9	3.0	3.2	2.9	3.1	1.8	2.6	1.0
SK3	5.3	5.2	5.7	5.8	5.4	5.8	5.2	5.1	5.4
MN4	20.1	17.7	16.7	19.5	20.1	20.0	17.9	18.1	18.7
M4	51.6	51.2	50.7	52.6	53.3	52.1	52.6	52.6	53.1
SN4	2.8	3.5	4.2	4.0	3.7	3.9	2.5	3.9	2.8
MS4	30.3	29.9	31.9	30.9	31.3	31.4	32.1	32.3	30.9
MK4	8.8	9.5	8.7	10.0	8.9	9.4	9.2	8.8	9.4
S4	1.9	1.8	2.8	2.4	2.1	3.1	1.8	2.0	2.3
SK4	0.9	0.9	0.7	0.7	0.9	1.2	1.9	1.2	0.3
2MN6	22.0	19.3	17.8	19.2	20.5	18.6	18.3	19.0	19.2
M6	31.7	30.8	30.0	30.6	31.4	28.6	28.9	29.9	29.0
MSN6	3.9	4.7	4.6	7.1	4.5	4.0	3.3	5.0	4.4
2MS6	18.3	19.5	18.9	17.9	18.2	18.1	17.4	16.5	15.3
2MK6	5.2	5.4	4.8	4.5	4.5	4.0	3.8	4.5	3.3
2SM6	2.6	2.7	2.8	2.4	2.6	2.3	2.3	3.1	2.1
MSK6	1.0	0.8	0.9	1.0	0.7	0.4	2.2	1.5	1.2
MA2	18.5	13.1	12.5	16.8	13.3	9.4	6.8	11.8	13.0
MB2	14.3	13.0	11.3	13.4	12.4	13.3	10.5	10.9	11.8

	Brest - Amplitude (mm)								
	1901	**1902**	**1903**	**1904**	**1905**	**1906**	**1907**	**1908**	**1909**
ZO	3963.8	3964.8	4017.4	3978.1	3964.8	3956.1	3980.3	3976.2	3997.0
SA	44.8	58.2	71.3	52.5	46.0	48.8	43.1	65.0	41.5
SSA	18.9	31.9	39.5	36.7	43.3	31.4	138.6	42.0	46.7
MM	35.5	33.4	26.7	15.9	19.9	24.9	5.8	10.3	16.9
MSF	17.0	14.7	9.0	23.4	4.2	18.1	12.1	12.4	17.0
MF	50.1	32.3	33.5	41.8	53.1	16.1	13.6	18.8	5.8
2Q1	4.6	2.0	5.8	7.6	5.6	3.4	6.1	4.1	2.7
SIG1	6.0	2.6	5.7	5.5	4.5	5.6	6.1	3.1	4.4
Q1	21.1	17.4	17.6	18.5	20.2	20.7	23.8	25.0	24.9
RO1	4.9	4.1	5.9	4.7	4.3	3.9	3.0	2.3	4.0
O1	68.0	67.4	67.1	65.0	64.7	65.5	68.9	66.1	66.4
MP1	0.9	0.9	3.6	1.3	0.7	2.2	1.0	1.9	1.1
M1	2.7	8.3	7.6	7.6	8.2	8.3	9.1	4.4	1.4
CHI1	1.9	2.2	2.9	0.9	1.4	1.4	3.1	1.3	2.1
PI1	1.6	3.2	0.5	3.5	1.6	3.1	3.5	5.2	3.6
P1	22.3	23.7	19.5	24.0	21.5	24.2	24.4	22.9	22.8
S1	9.3	6.9	8.2	9.2	7.8	7.4	7.9	8.7	7.4
K1	66.2	66.1	67.1	65.3	64.7	69.4	65.3	64.0	63.8
PSI1	2.5	1.5	3.3	0.8	0.9	1.0	0.5	2.9	2.9
PHI1	2.1	0.6	2.3	2.5	2.1	1.3	4.3	0.3	1.7
TH1	1.3	2.3	1.9	1.0	1.3	2.3	1.9	0.5	2.3
J1	2.0	4.6	3.2	3.5	1.7	1.6	1.2	2.6	4.9
SO1	3.0	2.1	1.2	0.8	1.6	2.3	2.1	1.3	1.2
OO1	3.8	3.7	7.0	1.5	5.0	1.9	2.8	1.4	0.8
OQ2	4.0	8.9	14.6	13.4	8.7	5.6	9.5	11.6	6.4
MNS2	19.2	16.3	19.5	19.5	20.0	16.1	19.3	17.8	21.3
2N2	47.7	54.3	63.7	63.7	55.1	50.3	60.2	66.6	58.9
MU2	86.1	83.7	83.0	82.7	84.3	83.2	85.1	82.9	82.2
N2	416.0	416.8	416.3	414.6	418.1	421.8	417.6	419.4	414.6
NU2	80.6	78.1	75.5	77.9	80.2	76.5	78.6	77.6	79.4
OP2	16.6	15.2	2.8	2.9	12.1	12.3	19.6	18.1	10.5
M2	2054.4	2055.3	2055.5	2054.5	2051.1	2045.1	2044.9	2038.4	2038.2
MKS2	9.8	5.4	17.6	11.3	7.9	6.5	5.0	23.7	6.1
LAM2	25.5	25.6	30.1	24.6	23.7	28.1	26.3	23.1	23.1
L2	65.6	66.3	72.7	76.9	66.8	51.7	55.0	66.9	72.1
T2	42.8	41.1	40.7	42.7	43.1	44.7	40.4	56.9	42.3
S2	751.3	749.1	744.1	749.1	746.7	746.8	743.9	740.8	745.2
R2	4.6	4.7	8.1	4.5	9.3	6.8	3.1	22.6	6.5
K2	210.7	213.3	215.3	215.3	217.1	216.6	213.9	223.7	217.3
MSN2	10.5	13.3	13.9	12.7	12.8	12.0	17.7	17.2	13.3
KJ2	7.5	8.0	11.1	10.2	10.6	12.1	10.8	13.3	11.2
2SM2	17.5	15.5	14.9	15.6	17.0	15.9	18.4	19.3	16.1
MO3	6.9	7.0	6.5	6.6	6.1	4.8	4.2	5.0	4.9
M3	19.7	20.1	20.0	20.2	20.5	20.4	20.5	19.8	20.4
SO3	0.4	2.6	0.9	2.2	1.3	0.9	1.6	2.4	0.8
MK3	0.5	2.3	3.1	3.4	2.3	2.8	4.4	0.7	2.0
SK3	5.8	5.4	5.8	5.2	6.1	6.1	6.3	6.9	5.7
MN4	19.4	16.7	18.1	18.4	18.5	18.2	16.7	18.4	20.0
M4	53.2	52.7	52.4	52.1	51.6	52.0	52.3	52.7	54.5
SN4	3.0	2.4	3.9	3.3	2.7	3.6	5.1	4.0	2.5
MS4	31.7	30.0	32.4	31.3	31.9	31.1	32.9	33.6	36.0
MK4	10.2	9.4	9.4	9.2	9.4	9.9	10.4	11.3	9.9
S4	1.7	2.0	3.6	2.5	1.9	2.1	2.3	2.8	3.6
SK4	1.1	1.3	1.2	0.9	1.4	1.6	1.4	0.9	1.3
2MN6	18.2	16.7	16.1	17.7	18.6	17.3	15.1	18.0	20.1
M6	28.3	27.6	27.3	28.0	27.2	27.6	27.4	28.7	28.8
MSN6	3.2	3.0	3.6	3.3	2.2	2.3	3.6	3.5	3.2
2MS6	14.1	13.8	13.6	13.1	12.9	13.5	14.2	14.2	15.7
2MK6	3.8	4.0	3.4	3.0	3.6	4.0	3.9	3.2	4.4
2SM6	2.3	2.4	2.1	3.6	2.5	2.9	2.6	3.0	2.3
MSK6	0.3	1.2	1.4	1.8	1.2	1.3	3.7	1.4	1.7
MA2	10.4	11.1	15.7	12.8	9.7	8.9	20.2	31.9	16.3
MB2	12.0	13.1	11.0	19.7	19.5	14.1	22.9	22.8	13.8

	Brest - Amplitude (mm)								
	1910	**1911**	**1912**	**1913**	**1914**	**1916**	**1917**	**1918**	**1919**
ZO	4038.0	4016.9	4068.5	4099.0	4107.3	4098.7	4003.4	4031.2	4000.4
SA	89.4	79.1	83.9	73.7	86.9	76.5	38.0	62.4	81.0
SSA	74.3	77.1	97.6	65.9	19.7	49.4	43.5	5.4	31.5
MM	34.2	22.2	36.2	20.6	7.3	38.0	33.2	2.2	6.2
MSF	19.2	27.2	46.5	18.4	52.2	11.4	21.2	6.2	32.8
MF	16.5	14.3	6.6	9.1	14.1	13.8	10.8	22.3	6.9
2Q1	1.8	3.2	1.9	3.9	5.1	1.4	6.5	5.6	6.2
SIG1	4.4	3.4	1.8	3.9	3.4	0.5	6.1	2.4	4.4
Q1	20.2	17.2	16.9	18.0	20.3	22.3	24.3	23.9	19.9
RO1	2.4	2.6	3.2	2.6	3.3	6.3	3.4	2.9	3.1
O1	67.2	66.6	66.8	66.2	65.4	71.0	65.6	69.1	66.4
MP1	1.4	1.8	3.6	1.6	0.4	5.5	2.1	0.3	3.1
M1	0.5	3.7	4.3	3.4	5.0	1.8	2.9	2.1	3.2
CHI1	0.6	1.6	1.3	0.9	0.2	3.7	1.7	0.6	1.7
PI1	3.9	3.1	3.8	3.1	1.6	0.6	1.4	1.1	2.5
P1	24.6	22.9	23.9	22.0	20.5	22.4	23.7	21.8	22.7
S1	7.0	4.9	10.0	6.7	4.4	9.3	7.3	5.7	4.3
K1	63.4	65.4	59.6	64.0	65.9	62.6	63.2	66.6	64.9
PSI1	5.3	3.5	1.7	3.7	1.0	2.1	0.9	1.0	2.8
PHI1	1.5	3.8	2.0	1.0	3.5	4.0	3.5	1.5	3.0
TH1	1.0	0.7	2.1	2.2	0.5	5.1	0.5	3.1	2.6
J1	4.9	4.0	5.0	4.3	1.4	1.6	3.8	3.9	5.2
SO1	1.6	1.1	0.7	0.6	1.4	3.5	1.2	0.1	2.1
OO1	2.6	2.3	0.4	0.9	0.4	1.4	1.2	1.9	2.1
OQ2	1.4	4.3	6.5	6.2	1.6	7.1	8.7	5.4	2.5
MNS2	16.8	15.3	21.2	25.5	20.5	21.0	21.6	19.9	18.8
2N2	44.4	53.3	66.3	66.0	50.6	65.6	62.4	50.7	48.2
MU2	84.2	84.2	86.5	84.4	85.9	86.6	87.0	86.6	86.8
N2	415.2	412.0	410.6	414.1	419.4	417.0	418.5	415.9	416.8
NU2	77.6	76.6	75.2	77.3	78.3	77.1	81.4	79.2	79.8
OP2	14.7	16.2	5.8	6.5	13.8	13.1	8.6	9.6	11.0
M2	2040.7	2040.8	2039.7	2046.0	2047.0	2041.4	2050.3	2051.1	2048.7
MKS2	5.3	10.9	16.5	6.5	12.4	11.6	10.2	6.5	11.3
LAM2	25.1	28.4	27.1	21.2	23.0	29.5	27.8	24.3	24.1
L2	63.7	61.5	69.3	91.2	56.8	62.6	71.7	68.7	65.5
T2	39.7	40.5	46.0	36.6	45.3	44.0	29.0	44.1	43.9
S2	749.6	748.3	747.7	751.6	751.4	748.5	746.6	748.5	747.0
R2	2.8	7.9	8.7	5.7	9.1	5.6	11.7	6.4	10.6
K2	214.5	216.6	217.9	214.5	208.9	208.4	210.6	209.1	211.6
MSN2	10.7	12.3	15.7	14.6	13.7	17.2	14.2	12.3	10.5
KJ2	11.6	10.3	11.2	10.0	10.7	9.9	10.9	11.0	7.4
2SM2	17.1	17.7	16.5	18.8	19.0	15.0	19.3	15.8	18.0
MO3	5.6	6.2	5.2	4.7	3.1	3.4	3.9	6.3	5.9
M3	19.5	19.7	20.4	19.7	21.3	19.2	20.4	20.6	19.7
SO3	0.8	1.6	1.9	0.7	0.4	0.8	0.7	0.2	0.9
MK3	1.2	3.2	1.6	3.4	2.6	4.1	1.4	0.8	2.0
SK3	5.1	3.9	5.2	4.5	5.0	5.2	3.6	5.1	4.7
MN4	19.9	18.9	19.2	21.4	21.2	19.6	19.7	20.2	19.0
M4	52.6	55.6	55.2	56.9	57.3	54.8	54.4	54.8	52.4
SN4	5.0	3.5	4.1	5.0	4.2	4.0	5.4	3.9	3.2
MS4	32.3	34.6	34.6	35.4	33.7	33.8	33.9	33.0	31.5
MK4	10.7	10.7	10.4	10.4	10.3	11.0	9.1	10.3	8.7
S4	2.6	2.4	1.3	3.5	3.4	1.3	2.9	1.7	2.0
SK4	1.5	0.7	1.9	1.0	0.6	1.5	1.5	0.8	1.2
2MN6	18.2	18.9	17.9	21.2	20.9	17.3	20.0	20.1	18.7
M6	29.5	30.0	30.0	31.4	30.9	30.2	30.5	30.9	29.8
MSN6	4.1	3.4	4.0	4.5	4.4	4.7	5.5	4.0	2.2
2MS6	16.0	16.0	17.3	17.4	15.5	15.9	15.5	15.7	15.7
2MK6	4.8	5.4	4.6	4.7	5.2	4.1	4.7	4.8	3.6
2SM6	3.2	3.2	3.5	3.0	4.1	3.3	3.7	3.4	3.4
MSK6	1.6	1.5	2.6	1.4	2.0	1.8	1.5	1.7	1.6
MA2	16.1	9.5	16.4	24.6	10.4	13.2	39.9	4.6	7.7
MB2	11.4	13.6	4.3	20.9	10.7	6.9	38.4	15.5	17.7

	Brest - Amplitude (mm)								
	1920	**1921**	**1922**	**1923**	**1924**	**1925**	**1926**	**1927**	**1928**
ZO	4044.4	3989.3	4004.1	3973.4	4062.8	4049.1	4060.4	4072.6	4069.3
SA	25.6	48.3	48.4	43.7	52.6	75.6	48.7	56.6	31.6
SSA	72.9	7.8	44.8	85.7	33.8	54.2	30.5	12.4	66.4
MM	35.9	17.0	27.3	16.5	28.0	15.6	16.0	17.6	32.9
MSF	13.0	12.6	15.4	12.5	24.2	35.4	12.2	26.2	11.5
MF	29.7	29.8	36.8	19.7	52.4	25.9	39.2	46.7	18.7
2Q1	3.4	4.8	4.0	3.7	3.0	5.5	3.4	5.3	4.0
SIG1	4.7	4.3	2.8	5.7	4.5	4.9	3.9	4.4	2.5
Q1	18.1	19.2	19.3	19.0	18.3	25.5	23.3	23.8	20.6
RO1	3.0	4.8	3.5	2.5	1.8	2.6	4.0	4.7	4.3
O1	68.4	67.1	62.8	65.6	65.1	69.0	65.7	67.4	67.9
MP1	3.7	1.3	2.9	1.7	2.6	2.6	3.0	1.3	2.1
M1	9.4	8.2	8.1	7.2	9.8	9.4	3.9	2.3	2.1
CHI1	1.4	2.0	2.7	0.7	1.2	1.2	1.1	0.7	0.5
PI1	0.5	1.5	2.8	3.9	3.5	2.5	3.3	3.4	3.2
P1	20.4	23.7	19.5	24.0	22.2	23.0	24.3	22.4	22.1
S1	7.9	8.7	8.5	6.5	6.2	8.1	8.6	5.9	9.8
K1	64.6	67.3	66.3	67.5	64.6	65.8	67.1	64.1	63.6
PSI1	2.9	3.3	1.0	2.5	2.0	0.9	2.9	1.6	3.0
PHI1	2.0	0.9	5.3	1.2	1.9	4.5	0.5	2.8	2.1
TH1	1.2	2.1	2.2	3.0	2.1	1.2	1.3	1.6	1.6
J1	4.4	4.4	5.4	3.8	2.0	2.5	2.0	2.6	4.3
SO1	0.5	1.8	2.5	1.5	3.1	1.2	1.1	0.3	1.6
OO1	0.7	2.5	3.5	3.6	0.3	2.9	1.7	1.9	1.8
OQ2	10.3	13.6	13.1	4.1	4.8	11.9	10.7	6.8	1.3
MNS2	17.1	21.0	18.3	19.2	15.8	18.7	21.4	20.3	18.3
2N2	57.5	66.5	56.5	50.5	52.7	61.5	64.9	54.6	46.7
MU2	84.1	86.1	83.5	83.9	85.1	83.4	84.4	82.2	82.9
N2	418.0	414.3	413.8	418.7	415.6	413.7	410.6	415.1	414.8
NU2	71.6	79.0	83.1	77.7	76.2	78.5	79.4	78.5	79.6
OP2	4.1	0.7	17.4	24.9	15.1	10.1	4.6	10.8	20.4
M2	2042.8	2037.8	2041.5	2050.1	2034.4	2035.5	2033.0	2034.6	2034.5
MKS2	13.6	13.7	20.3	6.2	4.3	6.8	6.6	3.9	8.1
LAM2	27.1	27.1	25.5	22.1	25.8	27.5	24.7	22.1	21.1
L2	73.6	74.7	71.2	62.0	50.5	55.7	65.6	71.0	61.9
T2	50.0	38.2	44.6	43.7	40.5	40.9	45.0	40.8	42.8
S2	741.2	737.3	740.3	742.9	740.3	739.7	741.2	742.6	744.8
R2	10.7	6.8	10.7	9.9	4.6	4.6	10.0	5.0	9.6
K2	208.6	215.8	216.2	214.9	215.5	215.4	219.9	214.1	216.2
MSN2	15.8	15.5	12.4	13.9	12.9	17.1	13.2	13.2	12.5
KJ2	10.2	7.2	12.3	10.6	11.5	11.3	10.5	11.2	10.4
2SM2	15.2	15.3	13.9	15.5	17.3	16.6	18.6	17.6	18.3
MO3	6.5	6.3	6.0	5.1	5.2	4.8	4.9	4.7	4.9
M3	20.2	19.1	20.8	19.9	20.1	19.7	20.9	20.0	19.7
SO3	1.2	1.4	1.7	0.9	1.7	1.2	1.2	0.9	1.5
MK3	2.2	3.3	3.8	4.8	3.2	2.1	2.8	1.8	2.3
SK3	4.7	5.6	6.3	7.8	5.0	5.1	6.3	5.8	5.1
MN4	16.9	17.5	18.4	18.5	18.3	18.1	18.2	19.6	19.3
M4	51.1	51.8	51.9	51.3	49.9	53.9	52.1	52.2	51.2
SN4	4.1	3.3	3.9	3.9	3.9	3.8	4.1	4.1	3.2
MS4	30.8	30.8	30.2	29.9	31.2	33.4	33.6	32.4	33.0
MK4	9.1	8.0	9.1	7.4	10.5	10.4	9.9	9.6	10.0
S4	1.1	2.1	1.0	1.6	4.3	3.9	4.7	4.4	3.8
SK4	1.8	1.0	1.0	0.8	2.5	1.5	1.9	0.6	1.2
2MN6	18.8	18.2	18.7	19.6	18.3	17.9	18.2	21.1	20.1
M6	29.4	30.3	30.9	28.6	28.3	29.3	29.3	29.9	30.0
MSN6	2.8	4.2	2.5	1.3	2.8	3.1	3.4	3.3	3.3
2MS6	14.1	14.9	14.2	13.3	14.9	15.6	14.8	14.8	15.5
2MK6	3.8	3.8	4.7	4.7	3.9	4.0	3.5	2.9	5.0
2SM6	3.7	4.0	3.6	4.5	3.6	2.4	2.5	3.9	3.5
MSK6	2.0	3.2	3.3	2.3	3.1	1.7	1.1	1.0	2.2
MA2	14.3	11.2	9.4	15.1	11.3	13.8	5.7	8.9	5.3
MB2	18.7	7.5	7.6	11.3	19.1	14.5	10.8	11.6	15.7

	Brest - Amplitude (mm)								
	1929	**1930**	**1931**	**1932**	**1933**	**1934**	**1935**	**1936**	**1939**
ZO	3996.4	4078.0	4055.9	4057.8	4041.7	4020.1	4036.3	4098.3	4066.4
SA	84.5	65.9	17.6	58.0	31.8	46.1	66.9	112.3	68.8
SSA	64.3	11.7	24.9	48.7	31.9	59.8	65.3	82.4	34.3
MM	16.2	28.7	17.1	52.5	37.7	44.9	43.0	12.8	29.4
MSF	13.1	7.6	17.9	26.3	12.5	24.3	11.3	9.4	16.1
MF	4.9	6.9	8.3	15.3	19.9	20.5	7.3	17.5	35.9
2Q1	3.4	3.0	3.5		5.6	5.8	4.8	3.5	6.1
SIG1	4.8	3.7	2.1	4.9	4.2	4.3	5.5	2.2	4.6
Q1	16.5	15.9	18.5	21.6	22.7	23.1	22.1	20.8	19.3
RO1	4.3	5.9	3.3	1.8	3.0	4.2	6.0	3.0	5.9
O1	65.5	66.5	66.3	65.5	66.5	67.6	68.1	67.6	61.8
MP1	1.7	1.7	2.0	3.4	3.3	4.3	2.1	0.2	1.4
M1	4.9	5.0	4.6	3.8	5.2	3.1	2.6	2.7	8.5
CHI1	1.3	2.0	1.1	1.0	1.4	0.4	1.2	3.3	5.0
PI1	5.2	4.2	3.5	1.4	1.8	2.0	1.5	2.2	4.8
P1	24.1	20.5	21.3	20.2	22.3	21.1	22.4	23.7	17.2
S1	4.0	6.1	7.8	5.9	5.0	5.5	6.4	6.7	10.7
K1	65.1	62.3	63.2	62.6	64.4	65.3	66.4	64.8	63.4
PSI1	3.2	3.0	2.5	1.8	1.0	1.7	3.7	1.3	4.0
PHI1	1.4	1.7	1.5	2.1	1.0	3.3	2.2	1.4	4.6
TH1	0.8	0.5	0.3	0.2	2.3	1.8	1.2	0.6	5.2
J1	4.8	4.6	1.8	1.1	0.8	2.1	2.2	5.1	3.3
SO1	2.2	1.5	1.0	0.4	1.7	0.8	1.7	1.5	2.0
OO1	2.2	2.0	1.7	1.3	1.8	1.9	2.7	0.9	3.0
OQ2	6.7	7.5	6.3	0.5	5.1	8.3	7.3	3.2	11.6
MNS2	16.6	21.4	23.4	19.8	17.8	24.0	24.5	21.7	19.2
2N2	57.5	70.2	60.7	45.7	54.5	68.2	63.1	48.3	64.7
MU2	82.2	84.5	84.9	88.3	88.9	89.8	89.1	89.0	87.0
N2	411.7	413.9	409.9	417.7	421.5	413.9	417.2	415.6	414.7
NU2	77.0	75.2	76.1	79.3	78.6	75.5	76.6	80.1	74.5
OP2	8.2	5.0	10.2	14.3	8.8	3.6	6.2	10.4	4.2
M2	2036.1	2038.3	2033.7	2043.5	2046.8	2051.5	2051.2	2044.0	2046.4
MKS2	6.9	11.2	9.8	8.5	4.6	9.5	11.9	8.1	13.9
LAM2	23.3	25.4	20.9	25.0	28.5	27.6	25.0	26.5	24.6
L2	64.8	75.0	86.1	45.4	50.1	61.8	75.5	67.9	74.4
T2	40.7	43.6	41.2	41.2	39.3	40.4	41.4	41.6	47.2
S2	746.3	748.9	749.0	747.5	748.9	752.2	751.9	746.8	745.7
R2	2.9	10.0	3.1	5.4	0.8	3.6	6.6	5.3	9.2
K2	217.1	217.3	212.0	211.0	211.7	213.3	211.1	206.6	211.3
MSN2	15.9	16.6	14.3	11.8	16.4	16.4	14.6	12.8	11.9
KJ2	8.1	9.9	13.6	12.2	12.7	12.5	12.0	10.1	6.6
2SM2	15.0	17.6	16.9	19.0	16.5	18.6	17.4	17.1	15.4
MO3	5.2	4.7	3.7	3.1	3.0	3.9	4.7	5.9	5.0
M3	19.4	19.2	19.5	19.6	20.7	20.2	19.2	19.7	19.9
SO3	0.2	0.8	1.4	1.4	0.4	0.3	0.4	0.6	3.7
MK3	2.9	3.2	2.3	1.9	2.8	2.5	1.6	1.8	4.5
SK3	4.9	5.2	4.4	4.9	6.0	5.0	5.4	4.9	7.0
MN4	17.7	20.3	20.9	22.2	21.3	20.9	22.8	22.5	19.4
M4	50.2	55.9	56.5	58.8	59.9	60.0	60.2	60.4	57.0
SN4	4.4	4.1	4.4	4.1	5.6	4.3	5.0	5.7	4.6
MS4	34.0	36.5	37.0	37.7	37.0	38.0	37.2	37.4	33.2
MK4	9.8	10.8	10.6	11.5	10.8	10.4	11.5	10.8	9.3
S4	1.7	3.4	2.1	0.0	0.3	0.9	2.2	2.8	1.1
SK4	1.6	0.7	1.0	1.0	1.2	0.9	1.3	1.5	1.3
2MN6	18.7	19.3	20.5	21.8	20.0	19.3	20.4	22.2	18.6
M6	29.9	31.4	30.5	32.9	31.9	31.8	32.5	31.5	30.5
MSN6	3.3	3.7	5.1	3.8	2.8	4.8	5.5	4.4	4.5
2MS6	17.9	17.4	16.3	16.9	17.7	16.8	15.9	16.5	14.3
2MK6	4.7	4.4	4.0	4.7	5.0	3.8	4.5	5.0	3.8
2SM6	2.8	3.4	3.0	3.2	3.2	2.6	2.5	3.1	3.4
MSK6	3.3	2.7	1.5	1.8	2.3	2.3	2.1	1.8	2.4
MA2	10.2	7.6	9.9	7.0	10.7	6.0	9.2	8.1	1.5
MB2	9.4	14.1	10.4	11.4	11.6	16.1	12.7	14.5	17.8

	Brest - Amplitude (mm)								
	1940	**1941**	**1942**	**1943**	**1953**	**1954**	**1955**	**1956**	**1957**
ZO	4072.0	4086.4	4087.5	4096.3	4039.2	4057.9	4105.9	4020.8	4062.1
SA	39.7	44.5	54.6	58.0	27.5	59.3	70.4	67.4	61.5
SSA	35.7	49.8	78.6	7.8	51.2	5.7	26.3	39.9	9.6
MM	16.2	18.6	23.2	11.0	11.8	5.7	11.8	29.3	3.3
MSF	20.2	17.6	15.0	18.7	7.9	22.2	8.1	25.1	14.1
MF	20.7	13.6	15.7	24.9	18.7	18.7	12.8	26.9	17.9
2Q1	4.5	0.7	5.6	7.6	3.1	2.0	4.0	5.0	2.0
SIG1	2.7	2.7	3.4	3.5	6.3	4.7	3.6	7.8	3.8
Q1	17.5	22.4	21.0	22.6	22.8	20.9	19.6	16.6	16.6
RO1	4.2	2.9	3.2	3.5	1.4	5.1	3.1	6.4	4.0
O1	63.5	65.0	65.0	66.3	67.1	66.9	72.7	63.4	64.8
MP1	1.2	0.8	2.4	1.0	6.7	3.0	3.1	5.4	5.2
M1	7.4	9.2	11.3	6.7	1.6	0.3	4.1	8.0	6.6
CHI1	1.6	1.7	1.7	0.9	1.4	4.6	1.4	3.0	3.8
PI1	1.7	2.5	3.0	4.1	6.8	4.9	3.5	2.1	2.4
P1	23.3	23.3	23.0	21.1	20.4	20.5	24.4	24.2	22.5
S1	9.5	4.7	6.8	3.5	10.1	21.5	22.0	20.8	16.3
K1	64.6	68.6	64.6	68.0	69.4	61.8	61.4	60.1	63.2
PSI1	0.8	2.6	2.0	2.7	6.5	3.5	1.7	2.5	0.9
PHI1	0.7	1.9	1.6	0.2	5.2	3.1	0.5	0.9	1.1
TH1	1.2	2.1	2.3	4.4	3.9	1.0	2.1	2.2	2.8
J1	2.7	1.6	0.7	4.5	5.8	3.0	2.9	4.8	4.3
SO1	2.1	1.6	1.9	0.8	2.3	1.7	1.7	2.9	0.7
OO1	2.6	5.6	2.3	1.4	4.3	1.0	3.2	1.3	2.8
OQ2	7.8	5.8	9.7	11.8	6.2	2.5	5.9	12.1	10.3
MNS2	20.9	19.2	16.7	19.3	19.3	19.5	15.9	20.8	20.6
2N2	54.6	50.8	55.5	63.8	55.9	47.2	53.4	63.1	63.2
MU2	84.9	87.7	85.0	83.3	89.8	89.8	88.3	82.9	89.3
N2	412.3	419.4	418.5	414.1	409.9	414.7	406.9	410.9	411.6
NU2	79.5	83.2	78.8	73.9	74.1	80.7	76.7	73.4	72.6
OP2	12.0	38.5	21.5	12.2	15.2	12.2	16.6	2.2	10.5
M2	2043.7	2044.4	2040.7	2042.4	2041.2	2041.8	2024.4	2028.8	2029.7
MKS2	11.1	36.9	4.8	16.6	15.2	7.9	3.2	15.4	19.1
LAM2	26.1	26.6	26.2	25.2	25.6	25.2	25.5	28.6	27.8
L2	67.6	55.4	54.2	61.4	81.5	61.6	62.4	70.8	79.2
T2	48.2	45.4	38.4	38.7	49.6	36.6	42.4	42.3	42.4
S2	746.1	744.3	747.8	745.8	748.8	750.6	744.8	751.5	738.1
R2	11.5	10.9	4.2	4.0	5.1	4.5	4.2	10.8	8.0
K2	213.7	217.0	210.2	216.1	208.9	209.0	211.3	209.9	207.0
MSN2	10.8	12.6	14.5	16.7	10.5	12.0	14.7	19.9	16.0
KJ2	8.7	12.8	11.2	10.9	12.1	10.8	8.4	8.0	5.8
2SM2	17.6	18.5	16.5	16.6	19.6	20.4	18.5	17.7	22.2
MO3	6.1	6.0	5.4	5.1	5.5	4.2	5.9	5.8	5.7
M3	19.7	20.2	19.0	20.6	20.9	19.2	20.3	18.2	18.6
SO3	1.6	1.6	1.3	1.2	2.1	1.0	4.9	2.1	5.1
MK3	2.1	3.7	2.7	1.3	6.2	1.0	3.4	5.9	7.5
SK3	6.5	6.5	6.0	5.3	7.2	5.6	6.7	6.1	6.8
MN4	19.7	19.2	19.5	20.1	23.2	22.1	21.1	20.7	20.8
M4	55.5	55.2	54.9	57.7	58.6	57.9	58.9	59.3	59.1
SN4	3.0	3.2	4.2	3.8	4.6	2.6	4.1	4.3	4.7
MS4	31.8	31.8	32.5	35.0	30.8	30.9	35.6	34.5	31.4
MK4	10.2	10.3	10.0	10.8	10.4	9.7	9.0	10.4	9.6
S4	2.0	4.2	3.3	3.6	3.9	4.1	4.3	4.5	4.5
SK4	1.3	1.3	0.7	0.4	0.8	0.4	1.8	1.4	1.9
2MN6	20.7	19.1	19.4	18.9	21.3	21.0	18.8	19.1	20.7
M6	30.2	29.7	30.8	31.3	32.6	31.0	31.0	32.1	32.9
MSN6	3.5	4.0	3.1	4.1	5.6	3.2	2.7	3.1	3.5
2MS6	15.6	14.8	15.8	16.5	16.3	14.3	16.5	15.4	15.2
2MK6	3.2	4.8	3.8	5.3	3.7	4.5	5.0	4.0	2.5
2SM6	4.6	4.5	3.1	2.8	3.6	6.1	7.4	5.1	6.2
MSK6	0.1	2.0	2.0	1.2	2.2	1.5	3.2	2.6	1.7
MA2	7.3	2.0	22.4	13.5	11.4	11.7	9.5	6.0	7.8
MB2	19.4	21.0	16.6	19.5	6.0	18.8	16.7	10.6	10.8

	Brest - Amplitude (mm)								
	1958	**1959**	**1960**	**1961**	**1962**	**1963**	**1964**	**1965**	**1966**
ZO	4088.2	4087.2	4153.5	4110.2	4061.6	4092.7	4029.5	4102.1	4158.9
SA	60.3	85.5	90.0	88.7	40.4	86.2	35.1	95.8	74.7
SSA	44.6	27.2	62.3	42.9	14.5	61.5	35.1	61.7	62.4
MM	12.2	25.1	22.8	39.6	33.9	38.1	6.2	31.2	53.0
MSF	32.0	13.1	18.7	15.2	6.6	19.9	12.5	7.3	34.0
MF	25.9	30.9	7.9	39.0		31.4	23.1	5.3	10.1
2Q1	6.5	3.8	4.6	10.1	7.0	3.7		3.3	3.8
SIG1	5.2	5.2	3.1	6.1	5.2	4.8	2.4	4.8	3.2
Q1	19.3	20.6	19.3	20.7	24.8	21.8	21.2	16.7	17.0
RO1	4.1	2.8	6.7	1.8	3.0	5.7	5.8	1.2	3.6
O1	65.4	65.5	66.2	66.0	61.3	75.9	67.5	67.6	64.4
MP1	7.6	7.9	4.0	4.6	4.1	13.2	8.3	6.3	0.9
M1	6.7	11.2	10.8	9.2	2.5	1.5	3.5	4.9	4.0
CHI1	2.4	1.3	3.2	4.6	2.8	1.8	1.5	1.5	2.3
PI1	3.0	4.1	4.0	3.1	1.7	5.4	2.4	5.2	2.1
P1	27.1	25.9	27.7	23.2	25.5	23.3	23.8	26.4	21.5
S1	21.2	21.3	19.9	15.3	13.3	20.0	21.2	20.9	18.3
K1	59.8	66.6	62.4	65.0	64.4	63.9	60.6	59.7	64.4
PSI1	5.2	4.7	2.3	3.9	4.3	6.3	2.6	5.9	3.1
PHI1	2.6	1.4	2.0	0.2	1.6	3.8	3.5	2.7	2.1
TH1	1.4	3.1	3.4	2.4	2.3	1.9	0.2	2.4	0.9
J1	1.1	1.9	1.9	1.7	2.5	1.6	3.5	3.0	4.7
SO1	3.6	1.4	3.7	2.5	1.9	1.6	2.3	2.8	1.2
OO1	4.2	2.9	6.8	1.1	0.8	2.5	1.2	2.8	1.3
OQ2	7.0	9.1	13.8	15.3	3.8	5.6	4.5	6.8	8.7
MNS2	17.6	16.8	15.6	23.9	24.1	20.1	13.9	16.4	23.8
2N2	53.1	48.4	58.9	73.1	50.6	49.1	47.3	60.8	66.0
MU2	84.5	84.4	82.4	75.3	85.5	85.6	84.5	83.3	84.7
N2	414.6	416.4	411.4	415.0	415.3	420.2	417.2	415.4	415.7
NU2	74.5	79.0	73.7	74.6	71.7	89.2	70.0	77.4	73.2
OP2	4.5	24.8	8.2	37.4	12.5	48.0	17.5	12.0	8.6
M2	2029.6	2027.7	2020.3	2040.1	2044.9	2034.6	2044.5	2047.6	2039.8
MKS2	10.8	14.7	8.1	21.9	11.9	35.9	12.2	0.9	10.7
LAM2	22.4	24.6	22.6	36.3	17.7	22.1	20.8	17.2	26.2
L2	61.8	52.5	54.2	68.1	72.4	66.5	68.1	71.6	84.8
T2	45.6	41.3	40.2	48.3	36.4	20.7	42.8	40.0	45.6
S2	745.3	738.6	743.2	748.2	746.0	750.5	751.3	754.8	751.0
R2	4.6	5.2	3.1	24.4	7.1	22.3	2.3	2.2	8.1
K2	207.8	200.5	212.8	203.7	223.4	207.6	217.4	212.5	214.0
MSN2	10.0	12.7	12.6	24.1	14.6	9.7	12.3	16.5	17.1
KJ2	6.5	14.7	10.4	10.5	11.3	13.4	11.2	9.7	13.1
2SM2	17.9	16.1	18.7	9.7	20.9	18.9	22.3	18.9	17.0
MO3	5.2	3.2	5.0	5.5	5.6	6.8	6.8	5.9	4.3
M3	19.3	17.7	18.2	18.4	18.8	22.7	20.9	19.5	18.2
SO3	4.6	4.9	4.3	3.4	4.4	10.2	5.8	4.5	1.2
MK3	6.3	9.3	5.1	2.3	3.9	7.4	6.7	5.3	4.6
SK3	7.6	6.8	8.2	6.8	4.8	11.1	6.8	5.2	4.9
MN4	21.8	20.8	20.0	20.4	22.0	22.1	21.1	20.6	23.0
M4	59.0	57.5	58.8	59.6	58.3	56.9	58.7	58.2	59.4
SN4	3.7	3.6	3.0	4.8	4.4	2.9	4.6	4.3	4.5
MS4	33.0	32.4	31.0	32.8	32.4	30.8	31.1	35.4	37.1
MK4	10.3	9.5	10.0	6.5	8.9	9.1	10.3	11.8	10.6
S4	5.9	5.2	4.1	2.9	4.2	6.0	4.5	3.3	2.7
SK4	2.7	1.2	2.9	2.0	0.2	2.5	1.5	1.3	1.8
2MN6	20.5	19.8	17.4	18.0	22.0	21.0	19.5	18.5	20.1
M6	31.5	31.6	30.6	30.0	31.6	30.3	30.8	31.0	32.4
MSN6	3.8	2.4	2.7	3.5	4.7	3.4	2.8	2.9	4.5
2MS6	16.3	16.1	15.4	14.3	14.9	15.7	13.1	14.8	15.2
2MK6	3.6	4.4	3.8	1.7	3.6	3.5	4.6	3.0	4.2
2SM6	6.8	6.6	7.0	5.7	6.0	7.5	6.6	5.7	2.8
MSK6	2.4	1.6	3.4	1.5	2.5	1.9	2.2	2.8	2.0
MA2	13.1	25.2	10.7	47.0	26.3	73.5	15.3	22.6	5.3
MB2	13.5	21.0	6.5	33.2	18.6	67.4	10.0	14.5	12.4

	Brest - Amplitude (mm)								
	1967	**1968**	**1969**	**1970**	**1971**	**1972**	**1973**	**1974**	**1975**
ZO	4094.8	4133.1	4124.4	4079.3	4064.1	4086.6	4037.0	4087.0	4040.6
SA	45.4	85.5	67.3	71.9	12.4	84.7	52.9	37.4	29.0
SSA	38.1	61.2	12.4	43.8	20.0	20.8	24.3	23.7	40.5
MM	27.2	6.1	32.6	11.2	29.3	48.0	18.4	18.8	14.2
MSF	9.5	10.5	10.3	31.7	10.9	6.0	12.3	25.5	7.5
MF	2.8	28.6	7.7	11.4	23.9	16.2	34.8	27.3	18.6
2Q1	3.2	5.0	3.4	4.9	3.7	6.1	2.1	2.9	0.7
SIG1	3.7	4.1	5.5	2.6	4.9	3.8	3.6	2.2	1.8
Q1	18.7	21.6	22.0	22.5	21.1	20.4	17.3	17.1	16.3
RO1	4.1	4.7	4.6	2.9	2.0	2.7	5.2	4.3	1.7
O1	66.7	63.1	65.0	64.2	65.7	66.4	68.9	66.9	64.2
MP1	4.3	3.2	1.6	1.4	3.0	4.5	5.9	5.5	1.5
M1	5.6	5.9	2.5	3.4	2.0	2.2	5.3	4.7	6.5
CHI1	3.5	1.9	2.2	1.7	1.6	2.3	1.9	2.7	3.1
PI1	3.2	1.6	1.5	3.5	1.7	2.0	1.5	4.8	1.2
P1	22.5	19.4	21.9	22.2	20.1	22.5	22.7	24.9	24.2
S1	14.7	10.8	11.3	11.6	14.3	9.4	12.8	13.5	15.6
K1	65.0	62.9	63.5	63.6	62.5	63.1	61.4	65.5	63.3
PSI1	4.7	2.7	1.9	0.5	2.8	3.3	2.0	2.0	1.6
PHI1	1.4	2.6	1.3	0.6	0.5	1.7	1.5	1.5	2.2
TH1	3.0	1.1	0.3	3.0	0.3	1.4	2.5	0.5	2.1
J1	1.9	2.0	2.1	3.8	4.7	4.6	4.1	2.8	1.6
SO1	0.1	2.0	0.7	0.5	0.2	0.8	0.6	2.9	2.2
OO1	1.0	1.6	0.9	1.5	2.2	2.4	1.1	2.7	1.7
OQ2	2.9	3.3	6.8	8.1	5.4	3.7	8.8	9.2	12.4
MNS2	22.4	19.6	19.7	23.0	23.2	20.5	16.3	20.1	22.5
2N2	53.1	47.2	65.1	69.8	55.2	44.3	60.3	64.7	65.5
MU2	85.3	88.0	87.8	85.3	87.0	88.8	88.2	85.9	88.2
N2	416.4	422.7	418.8	413.1	415.8	415.3	417.4	416.6	421.0
NU2	78.4	75.3	78.1	74.3	81.6	81.2	74.1	79.4	72.6
OP2	13.6	11.5	5.9	4.4	11.8	15.5	12.8	8.7	5.7
M2	2047.7	2052.3	2043.8	2045.5	2044.3	2052.5	2054.6	2053.2	2041.4
MKS2	3.4	2.7	7.5	11.6	9.9	11.8	5.3	19.4	8.2
LAM2	25.5	21.7	25.5	26.0	25.7	29.5	30.1	32.4	21.3
L2	63.2	46.5	52.6	68.1	76.0	60.2	70.3	75.7	75.6
T2	46.6	46.8	38.8	44.2	39.6	38.1	42.1	39.6	38.9
S2	752.4	754.3	754.8	755.3	753.3	753.3	756.4	752.7	749.5
R2	8.1	6.0	3.7	3.6	4.8	6.2	4.1	6.5	2.1
K2	213.5	213.3	215.6	212.5	209.5	213.3	211.1	209.7	206.7
MSN2	13.0	14.9	17.7	18.9	13.0	12.3	14.8	11.6	11.6
KJ2	12.6	12.4	11.6	11.3	9.4	10.0	7.9	8.8	5.4
2SM2	16.8	19.4	18.3	17.1	17.9	18.7	15.7	17.3	14.9
MO3	3.0	3.9	3.2	3.8	4.5	5.2	5.3	5.3	4.9
M3	20.2	21.5	20.6	20.3	20.3	19.9	21.0	21.0	19.3
SO3	1.1	0.5	1.2	1.0	1.6	1.5	2.7	1.4	1.5
MK3	3.6	2.2	2.7	1.7	2.2	3.5	2.7	1.9	2.6
SK3	5.5	4.6	4.9	4.9	5.3	5.7	4.0	4.2	6.3
MN4	23.4	21.0	19.6	20.5	23.5	21.6	19.8	20.2	22.0
M4	63.0	57.8	58.5	59.8	59.4	59.6	54.0	58.0	57.8
SN4	3.7	3.6	4.1	5.1	3.7	4.9	4.1	4.6	6.0
MS4	37.7	36.6	37.3	35.0	34.3	35.1	34.2	35.0	35.4
MK4	10.5	10.6	10.2	9.9	10.0	11.0	8.1	9.6	9.0
S4	4.1	3.9	3.6	3.3	3.6	2.9	4.6	1.9	1.1
SK4	1.0	1.6	1.9	1.4	0.9	0.7	0.6	1.6	1.0
2MN6	23.0	20.5	20.0	20.2	22.3	20.6	19.1	17.6	20.3
M6	30.3	30.9	31.0	33.3	31.8	31.7	29.4	29.4	29.4
MSN6	2.4	2.9	2.4	4.5	3.9	3.1	2.6	3.4	4.2
2MS6	14.0	14.7	17.6	15.4	14.6	14.9	15.9	14.4	13.1
2MK6	4.1	4.4	4.7	4.8	3.6	5.3	3.9	4.1	2.9
2SM6	4.0	4.9	4.8	3.6	4.1	4.2	3.8	3.0	2.5
MSK6	2.6	2.0	2.5	1.5	1.4	1.7	2.2	2.2	1.2
MA2	8.3	3.6	14.8	14.8	13.2	15.8	13.4	20.7	19.3
MB2	10.6	18.5	7.4	7.9	9.6	12.2	11.6	15.7	14.7

	Brest - Amplitude (mm)								
	1976	**1977**	**1978**	**1979**	**1980**	**1981**	**1982**	**1983**	**1984**
ZO	4063.9	4104.7	4076.0	4088.8	4072.6	4101.8	4105.5	4115.6	4108.9
SA	135.0	103.1	81.6	80.9	33.5	32.5	109.1	2.6	72.0
SSA	67.7	34.4	39.6	15.8	23.1	81.6	24.3	72.8	79.2
MM	20.5	17.1	20.2	25.2	22.2	18.8	38.8	2.7	31.6
MSF	19.4	34.0	15.6	3.8	26.1	21.6	23.4	14.0	7.5
MF	20.4	37.0	42.9	19.4	18.1	22.1	20.1	35.4	9.7
2Q1	2.4	4.7	3.7	3.9	2.6	3.7	4.4	3.2	3.4
SIG1	3.1	3.2	3.2	7.5	3.8	2.7	2.0	4.1	4.3
Q1	20.0	21.3	23.2	22.3	19.5	20.1	18.7	16.0	18.7
RO1	6.7	4.9	3.4	3.9	6.3	3.4	3.8	3.3	5.1
O1	65.9	67.3	64.3	62.3	62.8	68.3	63.4	64.7	59.5
MP1	2.1	3.8	4.7	5.0	5.6	2.4	1.5	2.4	2.6
M1	8.1	8.4	13.6	4.6	4.4	1.7	5.4	6.2	4.9
CHI1	2.8	3.3	2.5	0.6	1.8	5.3	1.2	2.4	0.3
PI1	2.6	4.8	3.9	0.5	4.8	1.2	1.5	4.5	1.3
P1	23.2	22.2	23.5	21.8	23.6	21.2	21.9	25.0	24.8
S1	8.1	3.9	5.9	7.2	7.4	12.4	9.9	9.4	6.9
K1	65.4	63.2	66.2	63.7	61.6	61.0	63.7	65.7	65.9
PSI1	1.1	3.2	2.6	0.8	6.2	0.8	4.2	8.3	4.6
PHI1	2.3	1.0	2.0	0.9	2.8	3.4	3.4	5.6	2.9
TH1	1.4	4.0	3.9	1.8	2.3	1.2	1.0	3.2	2.1
J1	4.0	3.1	6.2	2.6	4.4	3.1	5.4	5.6	2.2
SO1	1.0	2.4	2.1	1.8	2.4	1.1	3.3	4.2	0.8
OO1	2.7	5.7	3.9	3.3	3.7	3.2	3.0	1.4	0.5
OQ2	5.4	6.1	12.8	14.2	6.1	3.7	5.6	7.5	9.9
MNS2	18.0	17.2	21.1	20.4	21.6	19.6	15.6	18.1	23.3
2N2	51.4	53.5	61.8	65.9	53.0	48.0	56.0	62.5	61.8
MU2	88.8	86.8	90.5	81.9	88.4	79.2	86.6	80.0	86.1
N2	417.3	416.6	418.8	416.5	412.7	416.4	417.1	404.7	416.3
NU2	78.0	78.3	77.9	82.5	78.2	73.9	76.3	75.2	80.7
OP2	19.8	18.0	10.0	24.4	21.0	19.7	11.4	6.2	17.0
M2	2048.7	2058.2	2063.1	2059.5	2055.2	2047.3	2044.2	2040.8	2034.3
MKS2	9.1	12.2	17.5	27.7	12.9	14.1	9.5	10.2	14.3
LAM2	26.0	25.9	35.3	25.2	22.5	20.0	34.7	28.1	18.8
L2	58.6	49.8	62.7	67.4	73.6	65.1	70.5	69.1	81.6
T2	46.7	39.0	39.9	43.7	37.5	36.9	42.6	41.5	37.8
S2	744.6	745.8	751.7	747.1	748.5	753.7	755.1	754.4	745.6
R2	10.1	5.6	5.7	10.2	7.4	5.4	3.6	7.4	0.7
K2	209.4	205.8	214.0	224.5	228.7	221.6	219.0	224.5	216.4
MSN2	15.2	11.8	17.9	12.3	15.9	12.9	12.3	16.4	14.8
KJ2	4.6	9.0	7.3	6.5	13.5	9.1	8.4	12.0	9.0
2SM2	15.6	18.9	21.2	17.0	22.5	15.4	19.3	16.9	14.4
MO3	4.0	4.3	6.7	5.7	7.6	5.9	5.6	4.4	3.3
M3	20.0	20.2	19.9	21.4	20.1	21.2	20.1	19.9	19.1
SO3	0.6	3.8	6.2	2.1	6.5	1.0	1.9	1.9	3.4
MK3	3.6	3.9	4.3	2.9	4.5	3.1	6.8	4.0	7.6
SK3	6.2	8.8	7.4	5.0	7.7	5.0	7.6	7.2	4.8
MN4	20.5	18.9	19.2	19.5	21.8	19.9	18.2	18.1	19.6
M4	55.5	52.9	53.7	53.2	56.0	52.9	52.2	53.2	58.1
SN4	3.4	2.1	5.3	3.2	5.2	5.8	6.4	2.1	3.0
MS4	32.6	31.4	31.1	29.4	34.3	35.4	34.4	37.2	37.1
MK4	9.8	7.4	8.7	8.5	9.2	10.4	11.0	11.5	9.6
S4	3.4	2.3	1.3	1.2	1.9	1.3	4.1	3.5	1.0
SK4	1.6	1.9	2.1	1.0	0.6	0.6	1.4	1.6	1.1
2MN6	19.9	18.1	18.2	20.1	21.3	20.5	20.1	17.5	20.9
M6	30.5	30.0	30.8	32.7	32.1	32.6	31.6	30.7	32.2
MSN6	2.6	2.8	3.9	2.8	3.2	3.4	4.1	5.3	4.4
2MS6	14.4	15.0	16.1	14.9	14.8	17.0	15.7	15.3	16.3
2MK6	4.0	2.9	3.7	4.9	5.9	4.6	5.3	2.7	4.0
2SM6	3.1	2.7	2.5	3.0	3.3	1.5	3.5	1.7	2.4
MSK6	1.0	2.3	3.4	2.1	3.1	2.3	3.3	2.2	2.2
MA2	11.8	19.5	17.0	8.5	21.5	12.4	21.2	7.6	23.9
MB2	9.7	17.6	27.1	17.4	20.3	21.4	14.2	18.9	13.2

	Brest - Amplitude (mm)								
	1985	**1986**	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**
ZO	4118.8	4094.1	4130.9	4138.3	4141.0	4122.1	4091.4	4095.3	4124.0
SA	44.0	43.3	89.5	28.9	82.0	67.3	67.9	105.8	58.7
SSA	24.6	13.0	46.6	34.8	61.6	20.6	22.8	46.0	56.3
MM	22.7	11.9	36.6	18.3	43.7	27.7	37.3	17.6	46.1
MSF	1.2	11.0	10.5	32.4	27.8	22.8	17.2	8.0	16.4
MF	18.5	10.2	17.1	8.5	19.7	10.5	16.5	10.5	10.7
2Q1		8.0	5.0	5.6	5.5	2.1	4.8	4.3	4.3
SIG1	6.1	4.7	3.2	3.7	3.7	1.8	3.6	3.3	5.2
Q1	21.7	20.3	23.9	21.7	20.9	20.1	16.9	16.0	19.3
RO1	2.3	3.2	3.2	4.3	2.9	3.5	4.7	5.0	2.5
O1	61.8	63.3	63.6	65.2	66.6	66.2	62.9	66.1	64.4
MP1	6.1	6.7	4.4	4.4	7.2	1.6	5.6	1.7	1.3
M1	5.8	5.1	2.8	0.8	0.5	4.0	6.5	5.3	5.5
CHI1	1.5	4.7	1.1	2.6	3.1	1.4	2.9	1.1	1.3
PI1	1.9	1.6	1.8	1.8	2.3	4.1	2.6	1.1	3.4
P1	21.2	22.6	21.7	22.0	22.8	23.6	21.4	22.4	21.1
S1	9.5	7.0	5.7	9.3	4.8	7.8	6.7	5.2	6.6
K1	61.3	61.3	63.3	63.3	65.6	66.1	62.9	65.7	66.8
PSI1	3.3	2.4	3.3	4.0	2.7	1.2	2.4	0.7	2.0
PHI1	3.6	3.3	4.1	4.0	1.3	2.5	1.9	2.3	1.9
TH1	2.3	2.0	1.4	0.1	1.6	0.3	0.8	3.7	0.8
J1	3.4	2.1	0.7	3.7	4.7	6.1	4.1	3.8	3.8
SO1	1.9	0.3	2.2	0.7	0.6	1.3	1.3	0.6	1.4
OO1	0.3	2.5	0.7	1.4	1.3	2.9	1.6	0.9	2.2
OQ2	1.4	1.5	6.7	7.3	3.0	3.3	9.5	10.1	7.7
MNS2	18.9	16.4	20.2	25.8	24.3	18.6	19.5	21.3	22.1
2N2	47.3	48.0	64.2	61.3	48.6	47.9	66.5	71.9	57.8
MU2	87.1	87.8	86.6	86.0	92.0	91.1	89.6	89.7	90.8
N2	415.5	418.8	415.6	405.6	420.3	417.1	415.4	419.5	422.6
NU2	77.7	81.5	78.8	75.6	80.4	77.5	73.4	75.6	76.5
OP2	16.9	15.5	11.4	11.2	9.2	9.7	15.7	7.4	11.6
M2	2049.0	2037.1	2033.3	2041.0	2047.1	2047.9	2064.8	2072.9	2065.1
MKS2	6.2	6.8	10.7	12.8	4.9	7.8	12.3	14.4	12.2
LAM2	25.6	22.9	30.4	24.4	21.5	24.7	23.4	27.9	26.4
L2	54.9	46.6	54.4	65.0	74.1	63.3	71.2	81.9	71.0
T2	45.3	43.6	43.8	39.9	43.4	41.0	39.4	42.7	40.8
S2	753.3	748.8	753.6	752.4	747.7	752.9	755.5	753.3	754.5
R2	8.1	2.0	10.6	5.7	9.3	13.2	5.8	5.6	5.2
K2	212.4	211.0	211.7	213.6	209.6	207.4	220.2	214.5	208.7
MSN2	11.1	16.5	18.2	17.8	13.0	14.8	17.0	15.6	12.9
KJ2	11.3	10.0	13.7	15.0	9.8	9.4	9.0	7.7	7.3
2SM2	18.1	15.7	17.6	18.6	17.9	18.8	17.3	16.8	17.2
MO3	3.1	3.2	4.4	5.1	6.3	5.6	5.0	3.2	4.2
M3	19.5	19.6	21.1	20.2	19.5	20.0	19.5	19.7	20.3
SO3	3.3	3.6	2.4	1.1	1.7	1.6	1.0	0.8	1.6
MK3	5.5	6.1	5.3	1.9	2.3	2.6	5.2	4.1	2.9
SK3	4.5	5.9	4.8	4.0	4.5	4.4	4.7	4.2	5.0
MN4	21.7	20.2	19.8	19.6	20.7	20.4	19.8	19.6	20.3
M4	60.3	57.3	58.0	57.3	57.8	57.5	58.2	56.9	57.1
SN4	4.3	5.3	3.1	4.6	2.8	4.2	4.8	3.8	3.6
MS4	37.1	33.8	31.6	35.1	38.0	37.9	34.2	36.2	35.5
MK4	10.5	10.6	9.3	9.0	11.1	10.7	11.4	9.6	8.1
S4	1.7	2.4	0.5	3.1	3.3	3.0	1.8	2.6	2.1
SK4	1.3	1.6	1.1	1.0	1.7	1.4	1.3	1.1	1.5
2MN6	21.2	19.3	19.7	20.2	21.2	20.6	18.4	18.8	21.1
M6	32.5	31.2	33.2	32.3	30.9	31.8	29.5	31.2	30.9
MSN6	3.6	3.7	4.7	4.4	4.8	3.4	4.0	4.9	5.2
2MS6	16.5	18.6	18.4	18.0	16.0	17.9	16.0	16.6	15.1
2MK6	4.2	5.0	4.3	5.2	3.9	5.8	5.5	3.0	4.0
2SM6	3.0	2.5	3.5	4.3	4.0	2.9	3.8	3.5	2.6
MSK6	2.0	1.1	1.6	1.2	2.1	1.7	2.3	1.4	1.5
MA2	11.8	5.8	7.5	14.3	10.8	17.4	10.6	17.5	13.0
MB2	11.1	18.7	15.7	12.9	26.4	9.7	15.8	15.0	14.6

	Brest - Amplitude (mm)						
	1994	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
ZO	4151.3	4150.6	4145.0	4154.8	4138.8	4147.7	4174.2
SA	79.2	104.5	96.5	83.3	21.8	69.9	102.2
SSA	37.8	25.9	29.9	96.1	26.4	34.2	116.7
MM	40.9	31.4	5.6	23.0	34.1	23.1	29.7
MSF	7.6	12.3	8.4	6.1	14.4	9.2	12.4
MF	30.2	41.6	23.3	21.7	11.4	37.5	2.0
2Q1	2.5	3.3	8.1	5.4	3.7	4.3	3.8
SIG1	3.2	5.4	5.2	4.3	7.8	3.7	4.2
Q1	19.9	23.2	22.9	21.4	22.0	19.5	20.3
RO1	2.6	3.8	2.1	5.5	3.5	4.9	2.2
O1	62.3	65.1	67.9	67.1	69.7	66.6	66.2
MP1	3.5	1.1	1.3	0.4	1.7	2.0	1.8
M1	8.3	10.2	7.0	4.1	3.8	2.9	7.5
CHI1	0.6	3.0	2.3	2.5	3.9	0.4	0.3
PI1	2.2	0.5	2.6	2.4	1.4	1.1	1.1
P1	21.4	20.5	24.1	22.8	21.9	20.6	22.2
S1	7.5	7.7	7.4	9.1	8.1	7.7	9.9
K1	65.6	64.5	67.1	64.5	64.8	64.8	65.2
PSI1	3.0	1.7	1.3	1.3	3.2	0.4	2.5
PHI1	2.7	1.5	1.7	1.9	5.1	1.0	2.5
TH1	2.8	1.1	1.5	1.1	0.3	2.4	0.3
J1	1.3	2.9	1.1	4.6	5.5	3.5	5.5
SO1	0.6	0.3	2.3	0.9	0.4	1.9	0.7
OO1	1.6	1.4	1.3	4.9	4.2	2.0	2.6
OQ2	4.8	9.0	14.6	12.5	7.0	5.1	8.7
MNS2	20.4	19.0	19.9	21.7	20.3	17.0	17.1
2N2	49.2	55.6	64.8	63.2	53.4	50.9	60.2
MU2	89.5	87.9	86.8	89.5	86.0	86.9	82.7
N2	421.5	418.4	420.3	416.2	419.1	418.5	414.6
NU2	78.4	78.1	78.7	80.4	77.9	78.5	73.6
OP2	19.7	15.5	5.9	9.0	18.8	16.3	11.5
M2	2064.4	2059.0	2056.4	2054.0	2053.7	2049.9	2051.9
MKS2	6.0	7.0	12.0	10.8	7.1	1.6	3.4
LAM2	26.7	26.0	26.6	27.2	25.7	25.2	24.9
L2	53.7	56.8	62.5	70.1	69.8	65.1	67.7
T2	44.5	39.1	39.8	41.5	41.7	40.8	41.5
S2	751.5	748.1	745.8	746.8	746.1	745.7	747.8
R2	6.3	4.1	7.0	7.1	4.4	5.8	7.5
K2	207.1	208.5	212.8	214.2	213.5	213.8	220.0
MSN2	13.3	13.2	15.9	13.2	11.9	13.7	14.7
KJ2	7.7	8.9	9.5	9.9	9.8	10.0	7.2
2SM2	15.3	16.2	17.7	16.9	15.7	16.1	18.3
MO3	3.2	5.1	7.1	7.2	7.0	7.2	6.5
M3	19.9	19.8	20.0	19.8	19.5	19.9	19.6
SO3	2.0	0.6	1.0	0.1	1.5	1.3	2.0
MK3	1.9	2.3	1.7	1.0	1.3	2.1	2.5
SK3	5.7	6.1	6.4	5.8	5.8	6.4	5.2
MN4	19.3	19.1	19.6	20.2	20.5	19.6	18.7
M4	56.8	57.0	57.0	56.8	55.7	55.8	56.7
SN4	3.2	4.5	3.1	3.5	4.2	3.9	4.5
MS4	34.8	33.7	34.7	33.2	33.7	33.2	34.1
MK4	10.6	10.2	9.2	10.7	10.0	10.5	10.4
S4	1.7	1.2	2.1	1.3	2.1	1.9	2.3
SK4	1.7	1.3	0.9	1.1	0.8	2.1	1.3
2MN6	20.0	19.1	17.8	19.0	20.4	18.8	16.7
M6	29.9	30.5	29.6	30.3	29.0	28.5	29.0
MSN6	2.5	3.7	3.7	3.0	3.9	4.0	3.3
2MS6	15.2	14.0	14.4	13.4	13.9	14.8	15.8
2MK6	4.2	5.0	3.2	4.2	3.7	4.4	4.4
2SM6	2.5	3.4	2.9	3.4	2.4	3.7	2.9
MSK6	1.7	3.4	1.5	0.7	2.2	3.1	1.8
MA2	8.7	14.4	14.8	14.3	14.0	11.1	9.1
MB2	15.0	10.1	8.5	16.1	10.2	11.3	9.4

	Brest - Phase (º)								
	1862	**1864**	**1865**	**1866**	**1867**	**1868**	**1869**	**1870**	**1871**
ZO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SA	325.3	259.8	240.4	274.1	357.9	218.9	295.1	251.8	194.0
SSA	16.5	64.2	120.7	7.7	266.8	142.8	236.4	163.3	29.6
MM	44.3	132.1	353.8	229.7	186.3	165.0	200.8	216.6	163.6
MSF	174.0	358.9	108.2	44.7	79.9	344.2	27.8	20.8	345.3
MF	136.6	79.4	189.1	341.7	218.1	122.3	255.2	190.6	161.2
2Q1	251.8	289.1	275.7	266.3	275.7	259.5	235.4	235.4	240.8
SIG1	285.5	282.1	312.2	231.7	276.1	252.3	226.6	241.1	258.2
Q1	287.8	297.3	300.4	302.4	291.9	296.0	289.1	288.4	287.4
RO1	323.5	318.6	10.5	121.3	310.2	286.1	269.9	246.6	285.8
O1	341.4	341.0	341.2	340.4	338.2	339.1	337.6	341.6	345.3
MP1	98.4	112.5	107.0	219.9	248.8	138.5	13.5	338.4	235.1
M1	70.9	155.6	172.3	235.8	282.9	335.2	11.5	18.6	53.1
CHI1	72.4	177.8	182.8	284.4	309.9	66.8	232.9	73.3	339.5
PI1	87.7	89.2	93.3	18.0	355.6	228.3	285.2	345.2	79.6
P1	76.9	74.2	76.4	80.4	78.6	77.7	73.8	80.7	83.7
S1	31.5	35.2	22.2	26.9	47.6	10.9	41.6	27.7	45.8
K1	90.1	89.8	90.5	89.0	88.8	89.2	87.0	89.7	90.1
PSI1	79.1	117.5	89.2	85.4	84.3	133.4	67.8	91.7	118.4
PHI1	228.9	71.2	157.2	59.7	243.5	60.2	98.1	106.6	103.0
TH1	183.1	79.1	246.0	72.6	311.6	56.9	38.6	100.7	240.4
J1	6.1	161.2	183.6	130.5	119.7	156.9	76.8	65.8	126.1
SO1	106.6	182.6	199.9	223.9	133.8	61.8	89.0	88.5	43.0
OO1	219.1	278.5	269.1	236.7	70.4	284.2	63.3	134.6	259.9
OQ2	62.0	323.7	261.2	121.9	66.3	8.6	317.9	213.4	115.9
MNS2	120.0	113.8	119.0	113.4	120.0	116.2	115.3	121.4	121.8
2N2	86.3	106.6	105.8	94.3	91.6	95.1	102.4	102.6	91.5
MU2	131.0	132.7	133.1	131.7	132.9	132.4	133.9	133.1	133.4
N2	118.2	119.0	118.5	118.1	118.0	117.8	117.7	117.8	118.6
NU2	115.0	115.0	114.9	114.7	113.3	114.8	115.9	114.9	115.3
OP2	348.1	340.2	30.6	6.4	335.6	322.7	47.3	20.4	7.5
M2	137.4	137.3	137.4	137.4	137.4	137.3	137.3	137.3	137.3
MKS2	241.9	247.6	236.0	246.0	241.0	229.8	247.2	240.9	265.8
LAM2	101.9	107.6	110.3	106.8	109.5	109.0	106.9	96.5	97.0
L2	139.4	136.2	129.1	131.1	135.2	132.6	123.9	116.9	131.1
T2	164.1	160.8	161.1	161.9	163.9	160.1	163.6	161.6	159.9
S2	177.7	177.6	177.6	177.6	177.4	177.6	177.4	177.3	177.3
R2	193.4	187.9	159.1	179.5	197.0	179.0	182.4	190.5	172.0
K2	175.3	175.5	175.3	176.0	176.0	175.1	175.5	176.0	175.0
MSN2	327.2	327.0	327.4	327.4	319.8	320.7	322.7	323.3	318.4
KJ2	36.5	49.1	43.7	51.2	33.4	42.3	40.5	45.3	34.6
2SM2	342.4	336.3	339.4	343.5	341.0	343.2	346.7	346.6	342.4
MO3	241.8	153.8	117.0	70.9	44.9	5.8	347.0	313.0	262.5
M3	59.8	55.7	56.4	58.9	54.3	55.7	55.6	60.6	60.0
SO3	187.4	297.6	304.5	296.5	87.3	104.0	182.4	88.8	77.4
MK3	13.3	31.5	354.2	356.2	295.9	337.9	338.1	352.0	19.8
SK3	122.4	115.9	125.5	126.6	110.7	120.2	108.6	109.1	104.2
MN4	113.5	107.5	112.3	114.5	113.6	109.9	112.9	116.3	112.8
M4	157.4	157.8	158.3	158.3	159.0	158.6	159.1	160.8	159.3
SN4	212.2	210.6	205.3	206.3	190.9	206.2	207.4	205.6	217.4
MS4	240.2	239.1	237.3	235.9	237.2	238.6	237.0	239.7	236.3
MK4	244.3	244.4	237.0	245.4	246.7	237.2	237.0	239.9	238.5
S4	345.5	14.6	316.5	332.5	359.2	8.2	334.7	324.1	317.6
SK4	3.6	55.3	39.5	280.3	4.4	1.5	328.2	10.3	4.7
2MN6	47.9	40.9	43.2	50.7	46.6	41.8	45.0	45.6	46.7
M6	71.8	70.9	71.4	72.2	73.5	73.6	73.6	73.2	73.4
MSN6	105.6	100.3	105.4	106.6	85.2	100.0	108.6	103.0	101.4
2MS6	127.0	124.9	125.8	126.4	127.8	129.0	128.0	125.8	128.3
2MK6	140.3	120.4	124.3	141.4	141.3	134.0	122.9	131.7	137.4
2SM6	86.2	68.8	107.2	84.6	91.8	79.8	90.0	100.0	93.7
MSK6	88.1	81.8	112.5	96.1	97.1	105.6	116.7	94.7	62.0
MA2	26.2	65.8	57.3	45.6	46.1	78.1	53.6	51.1	71.2
MB2	125.6	127.5	130.6	126.1	108.4	114.1	110.4	118.8	111.5

	Brest - Phase (º)								
	1872	**1873**	**1874**	**1875**	**1876**	**1879**	**1880**	**1881**	**1882**
ZO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SA	266.9	270.7	219.4	236.9	249.0	32.0	207.7	267.2	205.4
SSA	198.4	270.5	78.1	92.2	99.7	270.4	14.2	3.9	104.0
MM	227.4	345.3	213.0	335.9	9.0	235.5	217.1	156.9	182.9
MSF	17.7	108.9	24.9	13.0	14.2	314.1	97.1	14.6	289.2
MF	50.4	213.5	213.6	80.0	221.8	201.5	172.6	200.9	21.0
2Q1	249.6	268.2	270.8	281.7	227.0	255.2	260.5	247.7	248.1
SIG1	259.3	263.3	290.8	268.9	290.4	253.5	257.2	253.8	260.9
Q1	292.7	295.4	303.0	300.6	298.7	284.4	291.6	291.4	294.7
RO1	292.1	282.6	297.9	300.4	297.8	313.4	317.2	315.4	339.4
O1	341.1	343.2	343.0	340.3	339.7	341.2	341.3	342.7	344.0
MP1	165.0	138.6	156.9	7.6	175.2	136.9	100.8	90.7	70.0
M1	117.2	129.4	151.6	184.0	328.4	36.6	92.6	139.1	107.6
CHI1	115.1	47.2	10.7	61.9	12.9	110.9	144.8	92.8	111.7
PI1	344.5	307.6	84.3	320.0	340.5	61.6	50.5	83.4	131.5
P1	67.6	74.8	80.3	81.8	79.7	78.1	76.9	81.3	79.8
S1	44.4	27.7	21.0	44.1	9.1	40.3	29.3	24.7	24.2
K1	89.1	88.2	89.0	88.6	91.6	87.1	90.2	88.8	89.8
PSI1	48.0	75.6	133.7	59.4	208.4	65.9	93.0	70.5	56.9
PHI1	14.8	74.7	68.8	103.0	257.5	97.1	126.9	47.3	72.2
TH1	189.1	209.9	245.3	91.5	26.4	99.6	110.5	269.5	272.4
J1	218.0	213.8	136.2	145.7	131.6	164.7	243.3	199.2	158.2
SO1	126.8	124.1	171.6	306.8	279.0	159.6	41.6	117.6	232.8
OO1	218.3	214.3	247.5	227.6	243.3	87.8	137.6	174.9	273.5
OQ2	28.5	337.6	300.5	86.6	24.6	116.9	44.5	348.4	313.2
MNS2	116.5	110.6	113.9	115.0	114.1	126.9	116.2	117.4	115.2
2N2	93.0	106.0	112.4	89.9	86.1	95.5	87.0	98.6	109.1
MU2	134.2	133.8	132.9	132.8	131.9	131.0	130.0	132.9	130.4
N2	118.6	118.8	118.8	118.7	117.9	117.9	118.1	118.7	118.4
NU2	114.5	114.0	117.0	115.2	113.5	115.7	114.2	114.6	115.7
OP2	351.5	23.0	43.1	22.1	346.8	13.3	338.2	296.8	358.1
M2	137.3	137.2	137.3	137.3	137.3	137.3	137.4	137.4	137.4
MKS2	251.1	247.5	249.7	260.7	226.4	242.5	249.0	244.3	234.2
LAM2	95.0	98.3	102.4	103.5	103.6	105.5	104.7	103.9	109.5
L2	137.9	139.1	120.6	127.9	138.7	125.6	140.6	142.4	131.6
T2	165.1	162.3	160.0	160.7	164.2	162.1	165.3	165.6	165.8
S2	177.2	177.2	177.3	177.4	177.5	177.4	177.8	177.8	177.9
R2	170.2	173.8	185.1	162.7	166.5	184.1	172.5	176.5	172.9
K2	174.8	174.4	174.7	174.4	174.3	175.3	175.2	175.3	175.7
MSN2	319.1	316.2	315.8	329.0	320.3	327.8	322.5	319.6	318.0
KJ2	38.4	36.4	32.3	39.2	26.0	40.8	36.5	33.7	41.0
2SM2	346.7	343.3	341.3	341.4	340.9	346.0	346.2	346.6	343.4
MO3	222.5	157.3	109.2	71.1	43.2	280.4	222.8	171.7	134.3
M3	62.3	59.7	56.6	56.0	57.6	56.2	57.3	59.1	57.8
SO3	189.6	114.4	148.1	139.7	177.9	144.7	347.5	60.7	265.3
MK3	38.0	25.1	7.7	331.5	314.5	7.4	0.2	33.8	12.1
SK3	116.6	113.7	114.1	110.8	120.9	115.0	122.7	129.6	141.0
MN4	111.9	107.7	112.3	119.2	111.6	112.7	110.5	108.7	109.8
M4	159.3	159.5	156.4	159.0	159.1	158.7	159.4	158.9	158.3
SN4	219.6	211.8	221.9	204.2	206.2	222.1	222.1	197.6	214.5
MS4	236.1	236.3	237.5	238.4	236.5	236.3	238.6	236.6	238.5
MK4	232.6	237.6	233.7	233.1	240.9	239.1	247.9	241.4	239.7
S4	346.7	344.9	345.5	8.8	333.8	357.1	29.6	30.0	357.3
SK4	7.8	322.8	350.3	343.1	16.4	8.4	353.0	32.9	335.9
2MN6	46.3	44.3	48.3	51.4	48.2	46.9	48.3	45.7	42.0
M6	74.1	75.3	71.8	72.1	74.3	70.8	74.2	76.2	74.3
MSN6	107.5	99.0	110.0	101.4	112.6	119.0	106.4	102.5	104.9
2MS6	128.0	128.8	126.8	131.3	128.5	128.4	132.7	128.7	126.0
2MK6	139.0	137.8	121.6	136.4	132.3	139.1	140.4	136.4	109.3
2SM6	83.2	110.8	83.4	90.4	103.8	88.2	91.7	106.7	94.9
MSK6	47.6	84.5	120.6	65.9	63.1	10.0	58.1	78.5	111.2
MA2	70.0	75.3	62.7	77.1	92.1	65.4	61.4	74.2	58.1
MB2	92.6	104.8	118.7	121.8	117.2	134.5	133.4	133.5	119.1

	Brest - Phase (º)								
	1883	**1884**	**1885**	**1886**	**1887**	**1888**	**1889**	**1890**	**1891**
ZO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SA	282.5	321.3	279.3	219.0	222.2	204.2	150.0	321.9	174.1
SSA	225.9	343.3	42.8	98.6	144.5	127.2	70.2	117.5	87.9
MM	36.4	72.0	21.9	248.6	253.7	307.0	181.8	8.4	352.1
MSF	125.6	44.2	16.6	295.0	309.7	73.9	282.2	330.8	346.4
MF	293.2	243.1	159.1	219.5	318.6	291.7	150.1	202.9	153.2
2Q1	234.7	213.9	269.6	227.4	69.7	217.9	209.9	241.7	285.7
SIG1	280.8	266.3	238.8	247.5	245.4	247.4	265.0	280.6	264.6
Q1	299.5	301.0	295.7	282.1	289.9	287.4	289.6	296.0	297.4
RO1	290.6	348.8	293.0	318.7	295.6	286.5	290.5	326.1	297.2
O1	338.9	340.5	341.7	337.1	338.8	340.7	339.3	343.2	341.5
MP1	110.8	45.0	340.5	265.1	122.4	166.5	67.1	127.9	159.2
M1	203.7	217.8	317.6	4.2	15.2	31.4	63.8	85.3	163.8
CHI1	33.6	332.1	323.3	37.1	272.5	118.0	117.6	127.2	49.6
PI1	80.9	65.3	66.2	125.2	62.7	53.3	43.1	22.1	44.2
P1	76.2	76.5	79.1	84.3	79.9	76.7	72.6	71.8	77.7
S1	33.3	35.8	19.8	27.2	28.7	26.7	42.8	39.1	35.2
K1	90.6	88.9	88.4	88.6	89.7	89.9	89.1	90.6	88.0
PSI1	36.3	91.5	325.0	104.5	156.5	108.6	84.2	76.9	43.9
PHI1	142.9	201.4	98.7	126.0	96.8	120.4	126.0	18.8	149.9
TH1	221.7	10.4	228.0	217.9	150.5	326.6	316.0	89.3	148.6
J1	132.0	165.9	133.4	67.0	111.1	301.2	189.1	133.6	173.9
SO1	269.5	113.8	12.5	142.5	67.1	171.4	145.8	142.5	179.2
OO1	261.9	297.4	139.5	215.6	221.9	181.1	213.6	232.6	183.1
OQ2	235.0	94.9	34.3	342.2	298.4	172.0	82.1	17.9	326.3
MNS2	115.8	114.3	115.0	118.8	116.6	120.6	119.0	116.0	115.1
2N2	102.5	92.6	92.8	100.0	101.2	99.0	91.7	96.0	110.2
MU2	131.8	130.1	131.1	132.0	132.2	132.6	133.4	135.7	135.6
N2	118.6	117.9	117.8	117.8	117.8	118.0	118.7	118.9	118.8
NU2	115.5	114.5	112.8	114.6	115.8	115.5	115.2	114.0	113.9
OP2	32.1	354.1	316.1	304.0	29.1	11.7	347.0	336.8	50.5
M2	137.4	137.4	137.4	137.3	137.3	137.3	137.2	137.3	137.3
MKS2	253.2	265.8	254.6	250.5	251.6	236.6	245.5	233.8	240.4
LAM2	109.5	106.2	111.0	109.9	104.8	102.3	97.5	97.8	96.5
L2	129.2	132.9	134.4	131.6	120.5	120.5	134.0	138.6	135.2
T2	166.4	164.5	165.0	165.8	165.7	164.7	161.6	164.4	163.5
S2	177.8	178.1	177.8	177.8	177.7	177.7	177.4	176.9	176.8
R2	171.0	177.0	177.3	192.4	183.7	161.0	195.3	177.9	160.2
K2	175.8	176.2	175.7	176.3	176.8	175.8	175.4	174.2	174.2
MSN2	329.9	325.1	324.2	322.0	325.4	328.1	321.4	317.9	314.6
KJ2	33.1	36.6	39.9	42.0	46.7	38.9	33.9	32.8	32.6
2SM2	346.8	347.3	349.8	346.8	346.4	346.4	348.1	346.3	345.6
MO3	98.5	78.2	35.7	7.9	324.6	292.5	242.8	196.7	155.2
M3	58.3	56.1	56.3	57.0	56.0	56.4	59.2	60.7	60.2
SO3	206.5	279.4	186.9	262.5	94.3	22.4	145.9	51.7	276.5
MK3	240.4	291.6	306.8	304.6	339.4	16.2	12.2	37.3	36.9
SK3	126.4	132.5	122.6	115.4	118.8	110.5	110.7	104.3	125.5
MN4	113.3	115.2	107.2	109.4	114.9	117.8	113.0	109.3	111.6
M4	159.8	159.3	159.5	158.6	160.1	161.8	160.3	159.6	159.5
SN4	227.0	203.9	207.9	220.2	245.1	218.7	210.0	198.8	213.3
MS4	236.9	238.4	240.1	236.7	239.7	239.6	238.0	235.2	236.2
MK4	244.2	239.9	235.1	239.4	239.1	244.8	241.0	237.3	236.4
S4	1.9	354.2	17.3	281.6	336.5	353.6	3.3	338.7	20.9
SK4	30.3	40.0	24.4	359.0	333.3	43.5	3.3	350.6	308.4
2MN6	48.3	49.6	46.3	41.1	43.6	48.7	50.4	41.3	43.7
M6	75.0	72.2	74.6	73.7	74.7	73.8	72.7	73.4	73.1
MSN6	115.1	94.7	93.3	102.8	112.7	110.3	93.9	93.8	113.3
2MS6	130.9	127.9	126.7	127.4	126.9	126.9	126.4	128.9	129.1
2MK6	145.7	146.1	147.4	135.7	133.7	132.6	137.5	139.6	131.1
2SM6	98.5	96.9	88.4	86.7	91.1	105.9	106.8	75.5	93.2
MSK6	126.4	70.9	107.0	108.4	82.2	59.6	10.3	77.5	74.1
MA2	58.4	54.0	63.1	63.3	60.9	63.3	65.2	76.1	75.3
MB2	135.0	119.2	121.6	107.3	117.7	123.5	112.8	110.2	121.9

	Brest - Phase (º)								
	1892	**1893**	**1894**	**1895**	**1896**	**1897**	**1898**	**1899**	**1900**
ZO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SA	247.0	163.0	217.5	236.6	213.0	219.8	227.7	253.9	274.8
SSA	88.0	4.5	86.9	154.5	118.2	198.4	85.2	265.1	218.4
MM	181.4	53.7	328.7	300.0	199.9	168.9	208.9	276.1	310.2
MSF	141.0	258.8	161.9	19.9	5.6	104.7	326.8	305.4	128.7
MF	156.0	191.8	152.1	65.1	137.2	299.4	181.5	199.0	265.2
2Q1	240.3	241.7	241.9	219.3	229.6	244.4	256.9	265.7	307.1
SIG1	283.6	286.4	268.2	267.3	276.0	246.5	256.0	273.8	263.4
Q1	299.4	302.2	294.7	288.9	284.0	286.8	290.8	300.6	301.0
RO1	308.8	289.0	277.5	295.0	311.1	349.2	261.5	324.9	317.8
O1	341.8	341.0	340.4	340.1	341.5	344.1	342.7	343.5	339.6
MP1	25.9	173.3	239.1	107.9	167.6	121.9	143.7	168.2	192.3
M1	145.3	243.2	339.8	17.5	30.5	53.9	98.1	153.1	155.0
CHI1	37.9	230.9	11.4	0.9	354.2	183.6	54.5	279.4	30.0
PI1	84.3	69.0	341.3	33.8	30.9	49.7	63.2	68.3	76.3
P1	76.7	78.1	75.6	78.0	75.6	75.4	77.5	76.0	79.2
S1	33.4	24.3	41.9	30.0	41.6	56.8	35.3	41.8	36.6
K1	89.9	88.0	88.4	89.0	88.1	91.0	90.5	88.5	90.4
PSI1	75.3	115.3	64.6	25.4	120.8	105.0	14.1	86.8	28.7
PHI1	21.5	113.0	280.0	158.4	29.5	98.8	339.4	75.9	11.1
TH1	134.5	336.5	187.5	47.8	129.3	350.4	233.6	327.6	161.7
J1	174.2	151.1	121.7	113.1	53.7	82.2	181.1	181.3	150.8
SO1	207.9	69.5	143.9	81.5	134.0	122.6	214.3	229.5	319.2
OO1	192.5	254.1	212.3	249.1	254.7	257.7	185.3	83.1	271.9
OQ2	250.2	61.8	18.1	335.0	288.7	87.5	22.8	340.2	288.2
MNS2	116.3	115.5	116.4	119.0	122.6	127.3	117.3	113.5	121.1
2N2	112.4	83.2	89.7	107.2	112.0	86.8	88.3	103.0	111.3
MU2	133.9	134.8	133.5	132.5	132.1	132.6	131.5	131.8	132.6
N2	118.9	118.8	117.8	117.3	117.6	118.2	118.4	118.3	119.5
NU2	114.9	113.0	113.1	114.2	116.2	114.7	114.1	114.9	116.8
OP2	28.7	7.9	352.3	52.1	44.6	15.7	359.4	357.7	59.8
M2	137.3	137.3	137.4	137.4	137.4	137.4	137.3	137.3	138.3
MKS2	227.2	251.2	246.8	232.9	235.0	240.0	221.3	217.0	225.7
LAM2	100.3	104.9	105.4	110.6	106.6	105.9	101.6	106.9	113.8
L2	122.5	132.0	138.1	137.1	112.9	134.2	144.5	140.2	130.4
T2	165.3	163.1	166.1	165.3	165.5	164.6	166.2	167.5	167.3
S2	177.0	176.8	176.9	177.0	177.0	177.3	177.1	177.3	178.1
R2	168.6	169.6	163.4	168.3	165.8	174.5	170.8	173.1	179.0
K2	174.2	173.8	173.9	174.4	174.6	174.8	174.5	174.9	177.0
MSN2	321.4	327.0	320.7	314.2	316.6	320.7	321.7	313.0	313.0
KJ2	30.1	33.4	32.9	43.8	37.4	35.0	35.3	39.2	29.3
2SM2	344.4	340.6	341.1	343.7	339.6	338.9	340.8	341.5	347.7
MO3	102.2	65.3	35.4	1.5	314.9	260.2	215.5	152.0	127.4
M3	59.4	58.5	59.2	59.9	58.8	59.8	58.9	57.6	61.0
SO3	228.5	346.0	187.2	162.6	105.4	42.6	151.6	28.1	279.1
MK3	352.4	310.3	317.1	320.8	346.3	353.3	50.9	16.8	43.2
SK3	110.1	101.3	119.4	112.9	123.6	107.1	126.3	119.0	135.0
MN4	114.7	114.8	108.4	112.2	112.7	120.5	113.2	111.9	114.4
M4	160.0	158.7	159.9	162.9	162.3	162.4	161.0	160.2	164.1
SN4	212.0	200.0	187.5	211.0	214.3	205.3	194.9	195.9	240.2
MS4	237.5	236.1	234.7	238.0	237.3	236.5	236.7	239.3	241.8
MK4	237.9	241.3	236.2	238.6	235.6	236.4	239.0	235.7	238.7
S4	334.7	346.5	350.5	359.5	5.7	355.5	357.6	357.1	23.6
SK4	6.1	349.0	36.6	24.1	350.8	329.5	20.4	28.4	26.0
2MN6	48.0	53.9	48.1	40.8	46.6	59.1	44.4	45.6	50.9
M6	73.6	72.5	75.9	77.4	76.4	77.7	73.2	75.9	81.5
MSN6	122.7	112.4	110.8	111.4	129.4	105.4	99.7	102.1	138.8
2MS6	132.4	135.1	134.8	137.3	137.5	142.7	133.1	134.6	140.2
2MK6	135.1	141.5	140.9	130.3	136.9	147.7	147.1	141.7	134.9
2SM6	99.1	71.3	67.1	71.6	80.8	47.9	70.3	56.1	72.8
MSK6	88.6	41.3	32.7	71.9	97.6	17.4	40.6	48.4	72.6
MA2	62.7	72.8	80.8	76.4	64.0	51.9	85.7	80.6	69.4
MB2	136.2	118.3	113.7	141.0	139.1	138.4	131.1	144.3	138.6

	Brest - Phase (º)								
	1901	**1902**	**1903**	**1904**	**1905**	**1906**	**1907**	**1908**	**1909**
ZO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SA	235.7	204.1	226.5	278.5	172.8	221.7	188.2	207.2	283.7
SSA	62.2	50.5	101.3	252.7	77.8	106.3	106.6	115.1	52.0
MM	200.1	173.3	289.2	96.3	318.6	203.0	96.7	116.8	170.2
MSF	302.8	6.6	208.8	1.3	289.2	71.2	158.0	42.9	147.7
MF	214.5	312.6	356.2	160.0	175.7	120.8	134.5	222.3	287.6
2Q1	264.5	202.9	239.6	215.3	253.9	234.8	259.4	244.1	270.6
SIG1	275.2	286.5	273.8	251.6	287.9	278.5	245.9	258.6	246.2
Q1	298.1	306.2	301.8	282.1	290.9	288.3	290.6	299.2	299.6
RO1	327.7	280.2	260.0	287.1	270.8	278.3	286.7	302.0	285.8
O1	343.3	338.3	337.7	338.8	341.0	340.5	343.0	343.6	341.9
MP1	63.6	288.8	56.1	38.0	48.0	217.1	218.4	120.5	254.7
M1	233.1	266.9	340.2	16.1	35.6	37.5	76.3	130.9	150.2
CHI1	348.2	2.0	343.2	179.8	171.7	313.0	218.2	63.2	53.9
PI1	20.2	51.9	7.8	88.0	315.8	69.2	8.8	70.5	39.7
P1	79.8	74.8	80.2	88.6	76.0	76.9	72.0	79.9	76.0
S1	23.9	33.6	32.1	32.3	35.4	17.1	43.0	36.4	24.6
K1	92.1	88.7	90.0	92.0	89.9	91.7	88.2	90.3	90.0
PSI1	42.7	69.6	91.9	306.9	35.8	99.8	88.1	324.2	78.8
PHI1	104.5	247.2	109.2	164.2	104.6	152.9	117.7	248.7	115.8
TH1	265.9	93.8	325.2	37.9	86.4	48.4	78.1	150.6	119.7
J1	134.5	132.2	112.6	111.1	88.4	147.8	126.0	177.6	184.2
SO1	152.8	11.5	108.8	98.8	288.9	151.4	149.6	278.4	314.4
OO1	207.5	216.9	315.0	172.7	244.8	231.3	200.3	202.0	174.5
OQ2	163.1	58.7	9.5	324.7	258.7	163.1	44.2	3.5	311.2
MNS2	120.2	120.6	115.3	117.3	120.4	117.5	115.1	117.6	118.1
2N2	101.0	92.3	98.6	106.1	108.5	98.3	95.0	99.0	112.1
MU2	131.7	131.7	131.4	132.6	133.1	134.5	132.8	133.2	131.2
N2	119.8	119.6	119.7	119.5	119.1	120.1	120.7	119.1	118.2
NU2	115.3	113.7	117.6	116.9	116.7	117.9	117.4	117.4	114.5
OP2	41.7	347.4	347.0	84.3	70.4	33.0	334.4	168.7	54.7
M2	138.3	138.4	138.6	138.6	138.6	138.6	139.2	137.9	137.1
MKS2	206.8	193.6	192.9	185.6	178.6	121.8	268.7	123.4	236.4
LAM2	105.1	103.7	107.6	111.9	107.8	99.1	97.0	99.5	107.4
L2	128.7	133.3	131.2	125.2	118.7	122.5	137.5	145.4	134.7
T2	168.3	167.5	167.0	170.2	169.0	167.9	172.3	167.1	167.4
S2	178.4	178.3	178.6	178.4	178.7	178.5	179.0	177.7	176.6
R2	170.9	189.9	192.5	205.1	175.7	181.0	198.2	188.1	190.5
K2	176.0	176.6	178.5	178.2	178.3	176.6	176.4	174.7	174.5
MSN2	322.9	321.5	320.3	315.3	316.6	320.3	324.6	321.4	307.6
KJ2	30.2	36.9	37.4	39.5	40.8	47.3	57.6	58.6	28.8
2SM2	352.7	344.8	345.5	344.2	344.0	347.2	347.6	343.6	335.3
MO3	90.0	57.7	24.6	351.2	317.5	290.1	223.4	170.1	133.5
M3	60.2	59.8	58.9	60.7	62.5	61.7	64.3	60.3	56.8
SO3	298.8	224.2	208.2	197.6	93.2	125.3	209.4	53.3	104.1
MK3	326.6	295.4	303.7	308.5	331.7	5.8	31.5	124.2	11.3
SK3	120.0	123.7	130.3	120.5	119.9	125.2	103.9	119.4	109.9
MN4	123.2	118.7	119.8	116.8	120.3	124.1	122.6	115.8	119.6
M4	165.9	164.5	167.6	166.0	167.6	167.9	167.5	165.5	162.7
SN4	239.6	206.3	218.5	223.9	218.4	218.1	219.3	212.2	220.5
MS4	242.9	242.4	242.9	242.4	245.7	244.9	244.7	241.9	239.4
MK4	242.2	245.6	252.1	245.9	243.5	246.4	250.7	245.0	239.6
S4	6.7	358.2	341.5	2.4	355.3	11.8	338.3	343.1	327.8
SK4	21.2	52.7	37.2	331.6	357.0	344.8	15.1	359.2	5.4
2MN6	58.3	55.5	53.0	47.7	52.3	55.7	57.0	44.6	45.6
M6	82.3	81.4	81.9	81.0	78.2	80.8	80.1	77.6	74.0
MSN6	139.2	108.4	127.8	116.3	111.6	127.8	121.0	96.5	106.0
2MS6	142.7	138.8	140.5	135.1	139.6	134.2	136.7	132.8	132.2
2MK6	150.2	145.4	148.0	141.9	122.9	151.1	149.3	145.1	129.3
2SM6	74.0	81.3	78.3	68.4	64.1	88.3	85.4	44.2	58.4
MSK6	327.5	71.4	105.7	51.2	42.8	7.8	51.0	58.8	62.3
MA2	67.3	75.3	86.1	71.4	87.0	80.3	54.3	167.1	64.9
MB2	130.0	125.5	131.0	135.7	147.4	154.9	120.4	240.3	141.0

	Brest - Phase (º)								
	1910	**1911**	**1912**	**1913**	**1914**	**1916**	**1917**	**1918**	**1919**
ZO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SA	247.7	209.8	273.0	233.9	285.3	270.7	131.7	229.9	279.1
SSA	145.1	101.5	260.8	58.4	187.5	81.2	341.9	138.5	299.4
MM	4.1	143.7	216.6	73.8	37.5	254.2	206.9	282.2	28.0
MSF	199.1	37.2	79.2	320.7	305.8	323.2	290.5	144.5	89.8
MF	174.4	122.2	81.2	125.0	203.5	246.6	180.4	118.7	42.8
2Q1	217.1	238.8	227.9	233.5	231.9	253.0	273.2	284.9	247.2
SIG1	264.5	238.2	253.0	230.1	281.7	293.5	270.4	227.0	309.4
Q1	304.4	305.1	302.6	287.6	285.0	299.5	297.1	303.6	304.8
RO1	320.3	320.2	0.2	270.4	301.3	348.9	325.9	303.6	293.4
O1	341.7	342.5	339.9	339.9	341.7	343.6	342.4	341.2	341.2
MP1	159.4	134.6	159.6	153.6	149.8	44.2	111.5	327.0	186.6
M1	42.2	267.9	343.2	7.0	31.6	56.6	110.7	148.7	240.4
CHI1	21.7	297.0	164.2	308.9	128.4	7.9	98.1	227.0	136.2
PI1	19.2	90.1	120.5	108.7	13.0	189.6	28.7	94.5	316.9
P1	73.8	80.6	77.5	70.5	71.5	77.3	76.2	73.9	68.6
S1	27.4	38.6	29.8	43.7	40.2	37.0	31.5	32.4	33.1
K1	91.0	87.8	89.9	87.4	88.7	89.3	91.8	88.4	87.4
PSI1	49.0	23.7	188.8	19.5	87.1	278.1	102.8	101.5	317.7
PHI1	253.4	114.4	134.6	122.4	116.7	89.1	106.9	203.9	144.3
TH1	44.9	331.4	182.4	55.1	78.5	178.5	216.3	229.3	238.0
J1	149.3	130.5	133.9	131.9	43.1	259.2	164.7	145.9	124.9
SO1	54.1	44.8	214.7	295.4	348.0	130.2	156.9	118.6	122.7
OO1	212.8	241.2	305.5	254.4	324.7	310.9	200.8	207.7	238.0
OQ2	178.7	48.4	357.6	321.0	272.5	24.5	318.7	305.7	104.7
MNS2	121.3	109.8	106.3	114.6	119.7	115.7	115.5	125.2	121.7
2N2	104.5	86.4	91.7	108.7	110.2	94.2	108.0	115.4	100.2
MU2	133.8	132.1	131.6	131.2	132.2	131.4	132.6	132.7	134.3
N2	119.1	118.9	118.2	118.3	118.6	120.2	119.0	121.4	121.3
NU2	116.4	112.6	116.7	113.4	115.4	113.9	119.1	113.4	114.8
OP2	28.7	34.8	88.5	107.8	37.8	349.1	147.3	93.3	35.4
M2	137.8	137.7	137.6	137.6	137.9	138.4	138.2	139.9	139.9
MKS2	291.7	199.5	192.7	217.9	232.4	223.7	161.7	217.2	211.6
LAM2	99.2	95.6	117.3	113.1	105.8	101.6	112.8	120.1	108.7
L2	126.8	133.4	137.4	126.9	107.2	141.2	139.5	125.8	134.3
T2	167.1	168.1	164.7	169.3	169.8	167.4	162.4	174.7	175.4
S2	177.4	177.1	177.5	177.6	178.1	178.5	177.9	180.1	180.4
R2	224.0	181.2	191.5	345.2	190.7	197.2	326.4	189.7	189.2
K2	175.1	174.8	175.1	174.4	175.7	175.3	174.5	178.5	178.4
MSN2	320.7	320.5	325.4	311.5	321.0	314.7	315.5	314.3	332.3
KJ2	31.9	36.6	37.2	44.5	39.0	24.4	26.2	51.2	33.7
2SM2	341.2	336.9	339.0	334.3	335.5	342.6	333.1	341.3	340.3
MO3	95.2	63.2	33.6	341.5	300.4	163.8	139.7	111.9	81.2
M3	60.0	57.4	58.9	58.5	59.7	62.4	60.0	63.4	60.5
SO3	302.6	195.6	151.1	151.5	159.9	9.0	155.0	101.0	244.0
MK3	325.0	295.7	272.2	344.0	351.8	28.4	16.5	320.2	277.7
SK3	116.8	107.7	119.6	106.4	122.1	134.1	117.5	120.8	141.2
MN4	118.4	120.5	117.5	116.3	116.7	121.9	116.5	125.2	124.3
M4	166.0	165.7	162.9	162.9	162.7	165.3	167.4	168.8	167.0
SN4	218.3	207.5	199.6	209.1	210.4	200.8	211.8	216.1	218.1
MS4	240.5	241.3	237.1	237.0	239.9	243.6	243.9	244.7	244.0
MK4	241.2	238.9	243.8	239.7	237.0	240.4	241.4	237.9	240.9
S4	348.7	6.9	2.5	32.1	43.9	57.4	17.6	76.3	59.1
SK4	319.2	316.6	7.8	338.8	345.1	2.3	16.4	288.2	281.1
2MN6	51.1	49.4	51.5	47.1	50.4	54.9	50.7	58.5	61.9
M6	76.1	73.6	79.3	81.8	78.4	83.2	84.5	86.2	85.4
MSN6	136.7	106.3	100.9	118.7	127.9	106.4	122.0	138.3	127.4
2MS6	137.1	136.8	137.8	137.8	137.5	137.8	140.6	143.6	139.5
2MK6	129.6	131.1	161.1	138.0	146.2	150.3	142.2	147.4	131.9
2SM6	52.3	77.6	55.3	37.8	52.8	39.5	65.6	96.0	75.6
MSK6	35.5	47.8	20.9	357.7	23.8	64.5	63.7	64.8	54.5
MA2	64.7	89.7	121.1	53.5	96.1	124.7	41.3	46.0	72.5
MB2	91.6	105.7	245.6	87.6	154.4	295.7	80.5	146.5	150.1

	Brest - Phase (º)								
	1920	**1921**	**1922**	**1923**	**1924**	**1925**	**1926**	**1927**	**1928**
ZO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SA	239.1	240.0	289.3	278.7	239.2	248.5	263.5	231.8	8.2
SSA	82.9	127.2	337.3	45.7	87.2	161.8	97.7	171.9	37.7
MM	322.9	176.9	112.0	128.0	88.5	226.3	170.8	177.9	245.2
MSF	183.6	78.0	21.1	4.2	107.2	105.7	76.9	295.1	223.9
MF	216.0	169.5	150.2	155.6	205.0	346.5	129.2	137.0	195.4
2Q1	191.6	253.9	222.3	300.5	229.9	249.5	256.7	268.2	255.5
SIG1	249.9	240.9	220.8	227.8	269.6	290.9	248.2	233.9	274.2
Q1	306.0	292.5	288.2	281.8	294.0	293.6	299.8	302.3	300.0
RO1	291.9	282.8	301.5	275.0	350.1	343.2	287.1	268.1	291.4
O1	341.7	338.9	341.5	340.8	341.9	342.9	342.4	342.1	343.3
MP1	113.1	76.8	317.8	339.8	59.3	121.5	121.7	29.1	90.2
M1	318.6	349.3	7.2	30.5	59.0	118.5	141.5	172.0	172.9
CHI1	40.8	24.3	285.2	124.0	73.6	179.4	12.7	21.3	312.6
PI1	91.9	78.6	33.9	117.2	69.0	54.4	97.2	31.3	92.7
P1	80.0	76.1	79.8	81.7	76.1	76.5	78.9	78.7	82.9
S1	34.1	36.3	24.7	25.1	31.4	28.3	14.6	16.8	33.7
K1	87.8	91.6	89.7	87.0	91.0	89.5	91.1	89.8	89.7
PSI1	21.8	47.8	315.3	22.0	91.7	34.6	62.6	331.4	46.6
PHI1	140.4	124.0	131.6	311.4	344.7	141.8	250.5	136.1	124.8
TH1	281.6	67.5	77.7	131.5	75.4	159.1	146.9	177.8	21.1
J1	131.3	131.1	104.3	78.4	40.7	201.9	171.9	132.6	153.9
SO1	67.6	357.2	12.6	277.8	129.7	43.1	328.6	35.4	124.0
OO1	231.1	200.1	130.4	236.3	38.4	109.8	144.8	253.5	237.4
OQ2	43.1	352.9	305.7	272.6	112.1	41.4	349.4	297.0	164.2
MNS2	112.7	109.6	118.9	118.3	116.5	115.2	112.0	120.5	117.0
2N2	89.3	99.0	103.9	104.8	95.8	94.5	104.6	110.7	96.5
MU2	132.1	131.6	130.1	132.5	133.7	134.5	133.4	132.3	132.6
N2	121.1	119.2	118.1	119.4	119.5	120.1	119.3	119.1	119.2
NU2	119.4	115.6	114.5	114.9	114.9	117.3	114.8	116.5	115.0
OP2	280.9	248.5	110.3	24.3	359.2	342.0	139.1	50.7	30.7
M2	139.6	138.1	137.5	138.0	138.1	138.7	138.1	137.8	137.9
MKS2	126.3	189.4	188.1	206.1	85.1	169.6	151.8	267.1	232.8
LAM2	97.8	118.4	121.4	106.6	110.8	105.2	111.2	106.4	102.7
L2	133.1	130.1	122.4	114.3	129.8	139.4	137.7	130.6	129.5
T2	175.6	176.6	173.5	169.2	172.2	171.4	175.9	171.7	178.6
S2	179.7	178.5	177.6	178.4	177.6	178.2	177.7	177.0	177.3
R2	168.8	183.5	185.2	186.1	158.7	179.0	183.2	190.0	187.6
K2	177.9	178.1	176.9	178.5	175.2	177.1	175.8	174.8	175.0
MSN2	326.1	320.3	311.7	325.3	318.6	316.7	313.5	307.1	312.6
KJ2	64.8	43.4	47.9	58.8	40.2	38.6	47.3	30.2	30.5
2SM2	342.2	345.9	351.2	342.4	343.4	339.2	341.1	341.3	336.9
MO3	46.1	8.3	339.4	305.5	271.4	217.7	170.7	119.4	88.9
M3	62.4	58.3	55.9	61.3	61.3	60.1	59.0	57.7	58.5
SO3	145.5	178.1	144.7	194.4	68.0	111.4	254.8	258.4	231.9
MK3	278.4	326.4	323.5	3.5	354.8	26.9	46.8	332.3	309.6
SK3	134.3	118.6	121.0	108.7	111.4	109.5	113.7	105.8	105.0
MN4	120.4	115.6	113.5	116.2	116.1	120.0	115.2	114.8	119.4
M4	165.3	164.7	162.5	163.0	162.8	166.5	164.8	163.1	161.6
SN4	209.6	207.6	221.8	224.4	215.0	216.8	220.5	204.8	197.5
MS4	243.8	241.5	242.7	241.6	242.3	240.7	241.7	240.3	243.4
MK4	255.3	251.8	241.6	236.9	244.2	251.4	235.8	241.2	242.1
S4	61.1	258.8	248.5	358.4	356.6	3.4	355.6	1.3	9.4
SK4	13.9	352.8	319.5	300.7	303.3	336.0	339.8	329.2	319.2
2MN6	58.5	49.9	47.4	56.6	57.5	55.2	49.4	51.4	58.8
M6	84.2	81.7	81.0	82.9	79.6	86.3	82.9	80.6	79.5
MSN6	106.8	118.1	121.9	149.6	108.3	106.9	112.2	120.5	120.9
2MS6	140.1	135.9	140.0	135.8	138.8	142.8	143.1	133.9	141.3
2MK6	140.2	149.9	156.3	139.6	151.5	142.1	141.3	144.5	132.0
2SM6	59.4	63.2	70.3	74.1	34.9	74.6	66.5	59.5	77.6
MSK6	39.8	62.9	64.7	83.7	24.7	16.5	73.7	113.3	20.9
MA2	186.4	96.2	91.4	85.1	9.2	70.8	117.5	78.2	269.8
MB2	190.2	131.4	180.8	145.6	129.9	107.5	156.5	123.5	155.9

	Brest - Phase (º)								
	1929	**1930**	**1931**	**1932**	**1933**	**1934**	**1935**	**1936**	**1939**
ZO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SA	240.7	237.9	105.3	200.7	240.7	218.7	209.7	327.0	250.3
SSA	137.4	130.2	86.4	91.5	53.5	103.1	95.4	276.0	222.4
MM	24.8	264.4	341.9	138.4	186.8	44.3	256.9	345.6	10.9
MSF	202.7	350.8	22.2	245.9	150.1	285.7	125.7	347.8	16.2
MF	208.6	14.5	98.6	229.3	94.4	192.5	220.7	171.3	145.7
2Q1	228.7	244.3	250.2	214.2	240.4	264.9	275.2	251.0	248.4
SIG1	233.4	266.6	282.2	276.4	256.6	263.3	272.6	240.7	268.8
Q1	305.3	290.3	282.6	286.1	288.0	298.8	305.6	301.5	296.5
RO1	324.4	282.1	313.5	357.1	298.8	301.0	297.2	289.4	302.0
O1	339.3	340.5	341.8	342.4	343.0	342.6	342.4	341.5	340.4
MP1	136.4	212.2	106.4	149.3	132.4	112.5	61.8	286.9	146.4
M1	294.8	12.1	29.2	36.8	80.6	98.5	153.9	155.1	358.1
CHI1	228.3	313.0	7.3	355.2	12.8	126.9	31.3	352.4	320.6
PI1	89.3	45.3	33.3	357.4	79.9	30.9	133.5	73.5	177.9
P1	73.5	75.2	75.8	76.0	73.5	75.6	81.1	83.9	83.5
S1	45.9	43.0	27.7	42.0	41.0	57.2	49.2	9.8	69.6
K1	88.1	91.0	88.9	88.6	90.0	89.1	89.6	90.4	87.1
PSI1	23.6	129.6	35.0	280.9	69.6	51.8	106.7	85.2	10.2
PHI1	154.5	242.3	89.3	93.3	64.4	147.1	60.9	146.2	197.8
TH1	191.8	74.0	71.6	234.1	77.5	222.2	323.5	101.1	24.6
J1	131.5	92.3	98.6	100.0	157.2	154.9	206.4	168.0	62.9
SO1	198.8	221.7	191.5	158.9	197.6	282.2	113.7	197.5	39.0
OO1	265.5	207.6	211.4	219.1	222.6	195.4	234.1	207.1	243.3
OQ2	55.4	348.8	310.8	203.3	50.3	352.2	321.8	219.1	319.3
MNS2	111.7	108.0	118.0	118.7	114.2	114.1	119.2	121.0	110.4
2N2	85.2	97.4	112.2	103.8	88.6	96.2	109.1	106.9	103.0
MU2	133.1	132.6	131.5	129.5	131.5	131.9	130.6	130.9	131.9
N2	118.5	117.8	117.9	117.7	118.7	118.7	118.0	118.5	118.9
NU2	113.8	114.7	114.5	114.9	113.7	115.3	115.1	114.5	116.1
OP2	15.4	63.2	72.3	29.8	6.3	5.4	103.4	57.1	70.8
M2	137.6	137.3	137.0	137.1	137.1	137.1	137.1	137.3	138.3
MKS2	225.0	199.4	217.3	231.6	236.3	200.4	236.4	242.8	186.1
LAM2	97.8	107.4	108.5	104.4	104.2	111.3	104.7	108.2	107.2
L2	137.3	135.5	117.6	116.2	137.4	143.1	135.8	127.2	130.6
T2	168.0	174.3	171.4	174.8	174.4	177.5	174.7	175.6	178.1
S2	176.7	176.6	176.2	176.7	176.6	176.8	176.7	176.9	178.3
R2	168.8	177.0	182.2	184.4	179.5	144.0	168.2	191.7	153.4
K2	174.1	173.8	173.4	174.0	173.3	173.6	173.6	174.0	176.7
MSN2	321.4	317.1	305.8	324.5	324.0	308.4	305.9	308.6	318.9
KJ2	27.9	37.8	39.0	34.9	31.8	27.7	28.2	17.8	22.2
2SM2	337.5	338.1	340.6	341.2	336.9	336.8	340.2	341.5	344.9
MO3	53.1	21.3	334.4	283.1	230.8	175.5	141.4	100.1	354.4
M3	55.4	59.3	57.9	59.4	61.5	60.4	60.4	57.5	59.3
SO3	181.9	178.7	142.1	179.0	308.9	162.5	191.2	224.1	194.5
MK3	293.1	293.1	313.5	352.5	5.6	28.1	48.3	265.0	307.5
SK3	119.8	113.5	111.0	114.9	118.0	118.3	125.8	122.5	102.8
MN4	116.9	115.5	115.0	118.7	120.6	115.6	115.3	117.6	114.2
M4	163.2	164.3	163.4	162.2	162.5	161.9	162.9	161.7	164.2
SN4	208.9	220.1	212.9	207.9	210.4	197.6	214.7	205.1	216.4
MS4	243.6	239.9	239.5	238.5	236.2	237.0	236.1	238.0	238.3
MK4	240.9	242.5	241.7	234.6	234.7	234.9	235.6	233.5	245.5
S4	320.1	330.8	18.0	284.3	47.6	126.9	255.5	274.8	54.4
SK4	12.0	317.9	294.9	315.7	337.8	342.6	336.6	300.7	326.4
2MN6	53.2	48.9	48.2	54.4	52.1	49.8	51.6	56.4	52.5
M6	81.2	81.5	78.8	77.6	79.5	80.2	84.1	80.0	83.2
MSN6	106.0	116.6	119.9	126.2	125.9	98.5	133.3	129.2	122.0
2MS6	136.8	138.7	134.2	139.0	140.0	143.2	137.5	140.3	143.7
2MK6	142.5	136.8	137.4	145.9	145.9	135.3	145.4	146.8	155.3
2SM6	91.7	61.2	60.1	72.0	73.5	57.7	77.2	63.5	66.6
MSK6	29.8	56.2	38.3	29.3	45.4	53.0	78.1	24.3	74.5
MA2	83.7	128.0	39.5	38.3	37.2	39.6	57.8	37.3	64.7
MB2	114.8	160.9	112.0	152.9	107.5	114.5	134.9	126.9	170.2

	Brest - Phase (º)								
	1940	**1941**	**1942**	**1943**	**1953**	**1954**	**1955**	**1956**	**1957**
ZO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SA	274.0	339.1	207.0	212.7	198.2	221.2	264.4	219.0	273.9
SSA	58.4	310.6	77.1	218.6	118.4	57.7	215.3	295.5	295.2
MM	99.3	317.4	137.3	187.1	220.3	178.2	107.3	308.4	351.8
MSF	102.9	105.6	291.7	95.5	61.5	257.4	5.5	281.4	287.4
MF	95.2	159.5	50.6	117.5	160.0	167.7	182.7	151.6	11.5
2Q1	219.6	228.0	227.8	225.5	133.3	233.3	249.6	238.6	315.0
SIG1	219.9	238.9	312.0	252.4	305.9	253.3	277.0	267.1	277.1
Q1	285.5	286.8	288.5	296.4	294.0	308.2	299.8	296.9	294.7
RO1	261.6	310.6	243.8	293.4	294.5	341.2	314.9	308.1	269.2
O1	338.7	342.3	342.0	342.1	346.6	339.3	340.2	342.0	343.8
MP1	147.9	107.0	122.2	50.7	103.5	158.3	162.3	101.6	158.3
M1	15.6	33.6	59.5	114.7	240.7	157.0	282.9	329.8	25.3
CHI1	323.7	108.9	144.9	225.4	191.3	27.3	92.2	71.9	17.6
PI1	58.7	62.4	34.1	62.0	80.1	49.6	96.0	291.8	68.2
P1	77.5	80.1	83.7	77.1	86.6	79.2	81.0	87.5	85.9
S1	45.9	30.2	38.1	51.8	22.1	16.3	8.5	12.3	10.4
K1	89.7	88.5	89.0	91.0	86.3	90.8	91.4	91.1	92.7
PSI1	233.9	52.0	61.5	60.7	73.2	170.0	315.3	286.5	286.2
PHI1	201.8	139.4	157.8	310.1	226.9	49.6	115.0	28.0	93.5
TH1	30.9	87.9	349.7	141.6	285.5	1.0	231.3	135.3	171.9
J1	97.9	152.9	123.4	137.4	195.1	106.0	123.5	110.2	119.0
SO1	163.5	155.7	122.7	228.3	62.1	248.9	96.6	276.5	61.5
OO1	312.4	234.5	232.5	359.1	266.3	224.9	234.0	227.7	3.1
OQ2	270.9	138.4	74.5	27.9	291.6	195.0	48.7	356.8	293.6
MNS2	114.9	116.5	113.1	111.7	122.0	118.3	124.6	117.9	118.7
2N2	109.5	98.4	93.2	95.7	116.0	103.6	87.1	92.8	105.8
MU2	132.2	132.9	132.6	133.2	130.9	129.0	130.8	134.7	129.7
N2	119.1	117.7	118.6	119.1	118.7	118.1	118.3	118.2	118.7
NU2	114.9	113.7	114.2	114.6	118.5	112.0	110.3	116.0	118.9
OP2	120.9	65.1	336.0	25.2	58.4	47.5	325.3	287.7	74.0
M2	138.2	137.2	137.1	137.6	137.9	136.9	136.7	137.4	137.6
MKS2	166.1	193.3	348.8	207.2	227.0	232.6	184.9	217.3	203.9
LAM2	110.9	102.4	103.9	104.7	109.1	115.7	108.8	98.7	103.8
L2	115.1	122.1	132.7	137.2	128.1	125.5	129.7	129.8	121.0
T2	175.4	178.7	169.8	179.8	173.4	172.5	178.6	179.5	174.4
S2	178.1	177.4	176.8	177.5	178.1	177.3	176.9	177.6	178.0
R2	177.6	170.9	256.7	163.6	193.0	127.4	149.4	166.0	195.5
K2	176.8	177.6	174.3	176.8	176.0	173.7	173.4	174.9	176.7
MSN2	322.6	330.1	319.1	317.2	287.5	332.4	312.3	320.9	303.6
KJ2	58.5	37.8	41.6	46.4	12.5	21.8	27.0	48.3	35.1
2SM2	346.4	340.5	339.7	341.7	344.9	333.2	337.0	323.6	334.1
MO3	325.2	278.7	224.8	194.4	127.5	80.5	52.5	36.6	359.0
M3	63.0	58.7	58.4	57.8	59.3	54.3	57.7	57.2	58.8
SO3	151.3	158.6	305.4	254.0	270.7	236.4	246.1	327.7	270.1
MK3	318.6	347.3	17.4	47.5	341.1	7.5	36.6	328.0	3.6
SK3	107.4	99.0	109.1	114.3	93.0	117.0	114.2	131.5	117.5
MN4	116.1	117.4	116.9	116.0	116.5	117.4	120.7	113.9	116.0
M4	161.7	161.6	160.6	163.9	156.9	157.2	161.4	161.6	161.6
SN4	204.7	210.8	211.8	219.5	228.0	226.9	216.3	224.4	240.6
MS4	238.1	238.2	235.3	238.8	241.7	242.4	243.4	244.0	248.7
MK4	239.0	241.5	242.6	243.6	237.1	233.5	228.4	228.1	247.4
S4	37.8	10.7	12.1	351.7	5.1	351.6	340.5	344.0	5.5
SK4	6.8	334.7	6.1	325.5	20.7	290.6	332.8	15.5	359.1
2MN6	51.4	55.8	55.2	50.6	50.1	50.3	59.1	49.9	53.1
M6	84.4	81.5	78.3	82.2	78.9	77.1	80.0	83.5	83.1
MSN6	120.9	120.1	96.6	113.8	122.4	143.6	123.9	116.2	135.5
2MS6	139.1	141.4	137.1	139.4	133.6	132.4	143.4	140.4	138.7
2MK6	139.3	153.5	159.7	160.1	147.8	136.6	152.8	156.7	134.0
2SM6	91.0	66.6	63.4	68.4	56.6	38.4	40.7	40.2	51.0
MSK6	53.6	4.4	47.8	54.7	92.4	354.3	9.6	48.3	50.7
MA2	192.0	188.8	70.1	57.9	105.8	48.9	100.0	94.9	105.9
MB2	199.5	171.6	74.2	118.7	199.3	109.8	121.6	125.5	161.3

	Brest - Phase (º)								
	1958	**1959**	**1960**	**1961**	**1962**	**1963**	**1964**	**1965**	**1966**
ZO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SA	226.0	268.2	247.8	244.4	233.1	258.4	332.8	219.0	291.9
SSA	261.4	126.9	33.2	99.7	359.8	118.9	19.8	103.1	322.1
MM	111.1	113.5	21.5	176.7	315.9	166.6	295.2	129.4	185.3
MSF	157.0	262.9	316.9	33.9	103.6	312.2	225.7	240.1	84.8
MF	142.0	166.5	306.3	185.9	326.7	110.0	227.2	162.2	190.0
2Q1	237.2	255.3	225.6	249.1	274.1	294.0	289.2	265.6	226.2
SIG1	345.2	275.2	235.2	262.3	224.9	295.7	254.1	246.3	296.1
Q1	288.1	293.1	291.5	295.9	290.5	304.4	309.6	292.8	286.4
RO1	346.5	283.9	267.8	232.6	252.9	295.5	278.2	335.5	275.3
O1	347.5	346.7	344.7	341.4	342.5	345.5	344.2	344.3	340.5
MP1	152.6	138.5	175.1	319.9	130.0	207.8	182.0	182.1	174.3
M1	22.7	44.4	91.1	148.9	145.9	209.0	224.0	306.3	3.1
CHI1	94.3	303.7	54.5	62.9	13.9	92.6	294.8	202.3	20.2
PI1	84.9	133.3	81.3	344.1	48.7	29.3	82.2	107.2	91.8
P1	88.7	86.6	81.6	82.2	78.9	71.4	81.1	89.4	83.9
S1	10.7	11.7	5.1	8.8	0.6	7.0	12.6	11.3	4.8
K1	93.2	91.7	90.6	87.6	89.3	93.1	92.8	91.8	90.2
PSI1	285.9	33.0	348.5	7.8	12.9	32.3	353.5	328.6	37.8
PHI1	110.5	98.9	57.6	261.5	237.6	193.6	132.8	165.9	323.9
TH1	26.8	135.2	183.5	224.9	170.9	337.6	91.4	155.6	130.0
J1	41.9	76.3	174.5	204.9	166.2	129.3	175.4	125.8	100.7
SO1	16.6	350.9	68.1	84.2	223.9	15.0	341.2	256.5	244.3
OO1	70.4	121.8	250.0	83.4	171.8	173.6	227.0	272.4	154.1
OQ2	232.9	128.4	54.7	341.9	260.4	167.2	81.6	12.1	339.3
MNS2	118.7	114.0	110.1	111.0	108.7	105.8	105.4	108.1	112.2
2N2	109.8	100.6	94.2	101.5	107.9	105.7	89.0	89.4	106.1
MU2	129.7	130.9	133.4	129.3	131.1	129.7	130.0	127.2	132.3
N2	118.6	118.3	118.6	120.3	117.2	118.1	118.4	117.5	117.0
NU2	111.9	113.1	116.8	118.8	113.3	108.4	112.2	110.7	119.1
OP2	118.6	8.2	248.8	346.5	140.3	44.7	33.3	316.9	64.3
M2	137.5	137.6	137.6	137.8	136.4	138.3	137.4	136.3	136.4
MKS2	110.4	236.6	96.6	286.1	140.2	235.4	191.6	303.6	243.7
LAM2	111.1	110.0	101.3	98.5	90.9	114.6	91.0	108.9	91.3
L2	117.2	128.6	136.1	130.5	134.3	133.6	135.9	135.2	127.1
T2	176.6	170.4	175.4	175.3	167.0	179.2	178.5	171.5	174.0
S2	177.9	178.1	178.0	177.6	176.6	178.9	177.8	176.1	176.5
R2	189.0	224.6	150.5	185.6	300.0	0.8	194.1	25.0	195.6
K2	175.8	177.1	174.6	179.1	173.8	177.7	176.9	173.0	174.5
MSN2	322.9	332.4	326.4	333.8	320.0	342.7	348.2	314.4	313.1
KJ2	21.9	29.3	37.9	49.8	7.8	35.7	36.3	36.9	41.0
2SM2	329.4	333.6	332.3	325.2	335.4	328.2	332.5	331.2	337.1
MO3	312.4	270.8	208.4	178.2	132.7	108.7	83.9	36.4	358.6
M3	57.0	62.0	57.5	61.3	55.8	59.9	57.8	56.6	55.0
SO3	245.2	289.6	261.9	174.2	349.3	256.8	265.0	283.9	174.9
MK3	7.0	12.1	30.7	343.8	341.5	57.7	12.8	352.7	322.3
SK3	113.4	110.2	118.5	117.4	108.3	107.5	102.5	101.5	103.9
MN4	116.9	118.3	118.6	117.9	112.9	115.8	120.5	114.9	111.9
M4	161.3	161.3	163.4	162.1	159.3	160.8	160.9	158.6	160.5
SN4	230.7	225.2	226.6	228.5	214.0	259.0	221.5	199.6	208.4
MS4	248.6	248.3	250.1	243.9	244.0	253.6	250.0	241.0	235.7
MK4	232.0	234.0	236.6	230.6	230.6	238.9	234.1	238.3	229.6
S4	345.6	343.5	3.0	329.9	345.3	346.7	349.4	331.2	325.5
SK4	321.6	296.5	360.0	344.8	53.6	343.4	28.5	320.1	315.7
2MN6	53.0	58.7	53.9	49.2	46.8	51.3	55.1	45.4	44.1
M6	84.6	82.8	84.5	81.6	76.8	80.3	77.6	77.6	78.6
MSN6	129.9	121.2	94.5	130.4	109.6	166.9	128.9	101.9	125.3
2MS6	140.9	141.0	142.5	143.0	134.9	137.2	140.0	135.8	133.6
2MK6	142.0	154.4	157.0	180.7	121.5	134.3	152.1	166.2	150.9
2SM6	45.8	45.6	51.8	54.2	43.9	42.0	45.4	28.4	40.0
MSK6	358.9	21.2	22.0	136.3	80.1	18.2	31.6	20.6	18.6
MA2	82.5	66.6	111.2	170.9	58.7	44.0	81.2	69.2	106.6
MB2	118.9	78.9	83.4	262.6	72.5	83.4	73.3	69.7	183.7

	Brest - Phase (º)								
	1967	**1968**	**1969**	**1970**	**1971**	**1972**	**1973**	**1974**	**1975**
ZO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SA	210.8	244.8	294.5	276.7	21.6	289.1	182.0	282.8	242.0
SSA	38.4	96.1	119.6	224.2	242.3	176.1	171.7	259.7	288.9
MM	298.4	342.0	345.3	127.4	255.4	211.9	291.4	104.1	222.6
MSF	342.8	190.1	229.3	93.3	129.0	226.7	249.4	200.1	270.9
MF	348.6	151.0	158.2	232.0	166.3	107.3	175.3	128.7	239.0
2Q1	211.9	222.3	235.4	257.7	285.6	215.5	258.4	220.0	213.1
SIG1	243.9	271.4	268.2	255.2	277.2	294.6	235.1	246.5	281.6
Q1	279.3	288.4	287.8	294.3	304.5	306.4	301.6	288.6	289.1
RO1	314.5	317.1	262.7	257.1	289.2	331.6	298.1	285.0	350.1
O1	343.7	340.3	343.3	341.4	342.3	340.9	342.1	339.7	341.9
MP1	100.9	100.3	115.6	74.6	85.8	165.1	143.4	99.7	109.7
M1	37.6	54.0	79.9	108.7	138.7	256.0	299.2	20.7	356.9
CHI1	3.7	280.4	245.5	65.1	55.6	108.1	68.4	66.9	138.7
PI1	165.1	95.4	109.6	67.9	106.8	107.0	98.8	77.3	51.8
P1	76.5	76.7	77.4	78.7	76.1	73.5	82.2	84.1	79.1
S1	34.1	18.8	28.6	20.6	27.8	30.9	23.6	7.6	2.2
K1	87.8	89.6	89.8	91.4	89.9	91.4	88.2	90.2	92.5
PSI1	37.6	69.1	355.1	351.9	318.6	276.7	12.9	355.3	348.0
PHI1	255.6	105.0	150.1	64.7	111.9	139.5	129.1	82.2	142.6
TH1	88.6	163.0	214.7	191.6	355.5	197.9	12.5	128.4	116.3
J1	73.3	79.2	201.3	192.0	173.3	123.4	142.3	96.6	17.8
SO1	191.9	87.8	143.4	25.8	80.8	25.1	1.5	73.5	294.9
OO1	234.6	261.7	232.3	189.3	199.1	272.0	153.2	333.5	235.7
OQ2	255.8	94.7	15.3	332.3	283.8	147.7	27.3	339.0	272.7
MNS2	118.6	113.7	111.9	118.7	120.6	119.2	107.1	105.1	110.5
2N2	107.9	93.6	91.9	102.2	110.3	91.0	87.0	99.0	102.0
MU2	130.3	128.7	132.4	131.0	128.7	129.3	133.6	130.8	133.6
N2	117.4	117.7	119.0	119.0	118.2	118.4	118.5	117.8	116.9
NU2	117.3	113.4	113.5	117.2	116.1	114.1	118.5	116.6	114.8
OP2	47.2	24.3	20.1	84.0	71.9	48.4	342.0	36.8	37.3
M2	136.8	136.8	137.3	137.3	137.2	137.3	137.4	137.2	136.9
MKS2	239.7	191.2	209.8	214.9	215.5	193.0	213.6	209.9	239.5
LAM2	109.0	102.6	104.8	105.6	107.6	108.3	94.0	115.9	91.1
L2	107.1	129.6	143.2	144.0	128.1	131.5	135.8	132.1	124.9
T2	178.5	184.0	173.0	177.0	177.1	177.4	177.9	170.5	173.8
S2	177.0	176.7	177.8	177.5	177.4	177.8	178.2	177.5	177.7
R2	201.1	172.4	198.1	209.4	206.8	199.6	238.9	257.1	202.4
K2	174.6	174.0	174.1	174.4	174.3	175.0	175.6	176.3	175.0
MSN2	321.5	335.1	317.0	312.2	317.5	321.6	331.4	331.8	329.3
KJ2	33.1	36.5	38.2	30.7	23.6	20.6	43.2	34.1	8.3
2SM2	348.6	342.9	338.0	343.9	339.6	342.5	334.1	344.3	340.3
MO3	323.0	247.3	202.7	137.4	118.5	87.0	54.4	5.2	339.0
M3	59.1	61.1	56.6	62.1	59.1	54.5	60.4	56.4	55.3
SO3	63.8	174.1	201.9	245.0	301.4	270.8	270.3	334.7	193.2
MK3	335.7	348.6	8.0	0.7	343.7	302.9	278.0	307.9	358.5
SK3	106.6	109.6	117.0	112.8	116.3	140.1	117.6	116.0	119.7
MN4	114.1	116.6	113.9	114.7	116.0	120.0	113.3	116.8	113.2
M4	160.1	161.4	162.0	160.8	161.8	162.4	160.0	162.3	163.4
SN4	226.2	213.9	223.4	211.8	226.5	223.8	207.5	216.5	214.7
MS4	237.1	241.6	242.8	239.9	238.7	242.0	245.3	237.1	237.1
MK4	230.8	234.7	239.5	235.2	237.1	235.5	229.7	241.2	228.2
S4	341.7	337.5	345.9	6.8	341.0	352.2	347.8	321.5	313.6
SK4	291.2	354.3	19.0	338.1	323.0	344.7	7.1	308.5	298.1
2MN6	48.1	51.5	47.2	48.3	50.9	56.4	51.5	50.5	48.7
M6	78.2	76.2	79.0	78.6	81.8	81.2	79.6	83.9	82.5
MSN6	152.5	162.8	114.1	101.0	135.6	154.6	136.9	111.4	135.2
2MS6	138.3	136.7	142.8	137.8	142.1	146.6	146.2	149.5	148.5
2MK6	133.7	151.0	139.9	152.7	143.0	154.4	159.9	147.9	143.4
2SM6	16.4	17.9	25.8	31.8	51.4	31.4	8.5	22.9	39.4
MSK6	12.2	16.4	34.0	11.6	14.5	11.8	44.8	51.7	23.3
MA2	72.7	90.4	83.0	73.1	70.4	76.4	66.4	73.9	65.7
MB2	163.2	171.0	119.4	116.1	126.1	116.8	69.4	62.3	74.4

	Brest - Phase (º)								
	1976	**1977**	**1978**	**1979**	**1980**	**1981**	**1982**	**1983**	**1984**
ZO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SA	215.1	297.0	314.1	291.8	168.8	253.3	236.9	268.3	252.7
SSA	58.6	298.1	215.8	319.6	40.3	84.6	178.4	87.1	106.3
MM	173.3	96.3	319.2	142.0	340.5	115.1	119.0	301.1	82.2
MSF	64.3	212.0	323.7	353.1	9.4	84.6	183.7	308.4	177.2
MF	126.2	58.5	142.9	311.2	78.0	180.2	271.0	205.5	229.1
2Q1	194.2	278.0	247.7	296.1	324.1	249.1	224.8	226.7	268.2
SIG1	255.1	238.5	268.1	283.1	294.0	290.4	249.9	228.4	281.5
Q1	281.6	295.0	293.8	299.6	305.3	293.7	301.6	302.2	290.7
RO1	298.0	277.2	336.4	320.9	281.4	312.8	287.4	279.9	300.1
O1	341.1	345.5	347.5	342.6	341.2	341.8	341.0	339.5	339.4
MP1	85.4	176.9	142.5	135.3	173.1	153.1	184.5	115.3	201.6
M1	23.3	63.1	120.7	131.6	168.1	184.5	262.1	336.2	11.0
CHI1	101.0	70.7	33.1	302.8	295.5	10.5	309.0	144.0	265.5
PI1	345.5	138.5	59.9	144.6	70.9	85.7	64.7	95.8	51.5
P1	81.3	76.8	76.6	81.9	84.2	80.4	77.3	79.7	82.6
S1	5.3	2.7	358.3	46.0	44.2	37.4	21.5	342.1	37.7
K1	87.6	93.2	96.4	92.2	92.4	89.7	90.0	88.8	86.6
PSI1	332.6	350.8	86.4	129.4	89.7	50.3	348.4	8.3	57.9
PHI1	83.9	220.5	158.1	206.5	174.5	111.2	90.7	190.4	6.2
TH1	92.4	211.8	130.3	228.2	208.9	237.3	40.2	93.1	82.5
J1	121.9	76.7	202.1	123.9	167.8	184.4	81.7	88.4	45.9
SO1	350.3	226.3	250.4	178.0	179.1	156.6	188.2	231.6	239.7
OO1	114.5	236.6	250.6	207.6	264.8	225.9	297.7	222.2	154.6
OQ2	177.9	77.0	17.3	346.1	320.0	196.4	24.8	35.3	314.0
MNS2	117.6	120.7	117.0	116.6	119.9	128.1	110.9	121.8	121.4
2N2	102.5	93.9	98.3	102.5	105.4	98.4	82.2	95.7	105.8
MU2	131.8	132.2	137.6	127.4	137.1	134.3	134.7	135.4	130.5
N2	118.6	119.2	120.5	118.7	119.5	117.5	115.6	117.4	117.7
NU2	115.1	112.2	118.9	117.4	113.5	109.2	121.9	117.3	115.5
OP2	37.5	27.9	6.8	91.0	85.4	93.0	335.7	17.1	86.7
M2	136.9	138.1	138.7	137.7	137.8	136.5	135.6	136.5	137.3
MKS2	260.6	197.2	215.5	181.7	165.6	126.7	204.0	200.8	222.4
LAM2	105.1	109.4	98.0	122.2	105.7	91.8	87.8	101.4	118.7
L2	113.7	130.4	130.5	143.7	126.0	131.5	137.4	127.2	123.8
T2	174.6	182.9	188.5	176.7	165.0	190.3	176.4	181.9	176.1
S2	177.5	178.6	179.9	178.0	179.3	177.2	176.4	177.2	177.9
R2	168.5	297.9	77.4	147.9	200.2	213.1	307.9	123.6	177.8
K2	176.1	176.1	178.1	180.9	177.2	175.7	175.8	174.0	176.6
MSN2	320.5	322.9	318.3	324.7	311.4	321.7	350.9	304.6	319.2
KJ2	74.9	51.2	64.4	37.9	71.9	24.6	28.9	39.2	71.2
2SM2	343.5	340.7	347.7	352.2	338.1	354.5	349.5	342.1	340.6
MO3	303.3	238.4	213.0	163.5	126.3	83.7	55.0	31.4	350.8
M3	57.4	63.4	64.2	60.7	58.5	57.6	54.4	57.1	61.1
SO3	329.5	237.8	274.2	301.7	295.1	196.7	215.6	257.9	258.1
MK3	335.6	35.8	15.4	350.5	312.2	32.0	328.0	328.6	304.4
SK3	117.8	124.4	117.5	116.1	98.9	89.1	96.4	124.8	88.0
MN4	117.9	112.0	112.3	113.1	112.2	111.3	113.1	115.3	121.2
M4	158.8	162.1	161.7	160.6	160.4	159.0	153.7	163.4	164.6
SN4	212.1	212.2	220.0	222.0	238.0	200.9	209.5	223.8	221.5
MS4	241.9	241.9	239.2	236.8	239.4	234.6	236.1	243.8	240.2
MK4	220.3	239.0	247.1	236.5	212.8	219.8	233.2	239.4	240.9
S4	343.9	337.9	332.0	333.0	332.6	299.8	331.4	334.8	296.5
SK4	274.3	1.9	347.2	137.7	257.4	327.8	294.2	288.4	308.7
2MN6	57.6	60.5	62.8	52.8	57.2	59.2	48.8	54.5	50.8
M6	81.5	88.1	91.9	90.1	89.1	87.3	82.1	84.6	83.9
MSN6	139.1	131.6	142.3	128.8	142.0	119.9	123.0	104.7	105.7
2MS6	145.2	153.1	152.2	152.3	158.4	144.4	145.2	136.1	150.3
2MK6	156.5	148.6	155.5	157.5	154.3	153.7	167.9	157.8	142.6
2SM6	38.2	15.3	39.5	22.8	24.4	43.9	358.3	13.8	21.1
MSK6	16.1	32.6	44.5	46.8	55.0	24.5	46.1	61.3	75.8
MA2	122.5	35.3	8.9	133.6	83.3	19.5	87.0	48.9	44.0
MB2	191.1	78.5	121.8	166.0	90.8	127.6	56.9	133.8	109.8

	Brest - Phase (º)								
	1985	**1986**	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**
ZO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SA	300.5	266.8	214.4	234.6	260.7	242.4	217.3	193.9	208.6
SSA	217.8	104.8	69.2	146.1	124.4	195.0	334.7	106.6	84.6
MM	277.4	169.8	137.8	174.6	120.3	244.7	212.0	262.5	306.3
MSF	218.0	170.0	278.6	347.0	118.8	220.3	158.1	235.8	135.3
MF	161.0	148.8	195.2	103.8	247.0	7.2	137.5	5.2	175.4
2Q1	219.9	215.9	238.1	263.6	262.9	295.5	231.7	221.8	242.0
SIG1	240.4	229.0	271.4	276.5	250.4	248.9	249.9	255.5	241.7
Q1	284.7	287.8	294.9	303.9	302.6	307.1	305.2	287.6	286.9
RO1	276.7	303.7	303.7	321.7	306.2	293.3	322.1	292.9	346.8
O1	344.0	344.5	343.4	341.8	342.6	341.7	341.5	339.6	341.9
MP1	157.1	189.0	164.6	135.7	98.9	228.6	114.9	326.3	170.2
M1	30.9	48.0	104.2	134.6	238.8	214.4	328.4	8.1	17.7
CHI1	121.6	116.9	129.3	321.7	252.7	238.5	349.0	56.5	9.9
PI1	27.7	44.1	97.6	106.0	90.4	62.6	44.0	123.4	43.5
P1	85.7	80.2	74.8	76.3	80.0	76.3	74.9	79.8	73.8
S1	42.5	11.6	49.7	45.3	33.1	39.5	26.2	35.6	24.0
K1	90.9	92.8	93.4	90.0	90.8	90.9	90.4	91.5	89.1
PSI1	8.9	288.9	94.2	70.8	23.8	116.7	36.0	127.6	23.6
PHI1	264.9	116.2	200.0	274.3	97.9	113.2	90.9	220.5	181.8
TH1	67.9	191.7	34.5	48.9	323.3	47.9	16.0	124.9	141.7
J1	104.9	185.6	177.2	193.5	170.6	146.8	113.1	68.8	114.8
SO1	191.1	40.0	97.8	89.3	285.2	141.4	111.7	14.1	120.4
OO1	264.1	212.6	206.6	270.0	226.5	256.1	230.0	156.5	125.3
OQ2	264.5	117.0	18.5	347.5	279.6	103.7	22.0	324.8	264.8
MNS2	114.4	116.9	107.0	125.0	114.8	120.7	116.1	111.5	119.0
2N2	108.5	87.8	95.1	109.8	109.3	91.9	91.8	104.3	110.9
MU2	132.0	129.1	129.3	132.5	129.4	130.7	131.2	128.4	130.4
N2	118.5	118.9	120.0	119.7	117.3	118.2	118.4	117.8	118.5
NU2	117.7	114.4	115.2	113.5	113.1	113.1	114.1	115.1	115.2
OP2	16.4	22.2	1.0	93.0	61.2	23.7	5.1	320.2	65.9
M2	137.7	138.6	138.1	138.3	136.6	137.2	137.5	137.7	137.8
MKS2	260.6	175.4	224.1	217.9	196.1	240.7	120.3	198.3	216.9
LAM2	106.1	112.5	113.2	124.1	113.1	103.5	101.1	106.9	107.3
L2	107.1	139.6	141.2	142.6	124.9	133.3	138.4	129.5	113.9
T2	180.4	188.2	186.4	186.0	186.2	181.7	184.4	186.0	182.1
S2	178.4	178.9	178.6	179.2	177.7	178.3	178.8	179.3	179.3
R2	165.5	134.6	169.2	158.0	149.3	233.9	163.9	149.9	179.1
K2	175.9	175.4	175.7	176.0	174.8	174.9	174.8	176.9	177.3
MSN2	326.3	331.6	318.1	294.3	331.6	328.5	319.0	310.9	329.8
KJ2	39.0	21.0	33.2	35.2	9.7	32.6	42.8	39.8	49.5
2SM2	338.2	342.2	338.7	343.6	352.2	338.3	341.2	344.4	344.4
MO3	299.4	227.2	186.9	145.0	114.2	87.2	45.4	3.0	319.1
M3	62.3	63.1	57.6	57.1	59.1	55.9	57.6	58.3	59.1
SO3	275.1	227.2	293.7	267.4	338.1	224.3	306.4	221.7	189.0
MK3	338.8	15.7	328.0	11.2	311.7	292.5	306.0	302.4	309.4
SK3	101.2	108.5	105.6	118.3	119.5	120.9	110.5	122.7	128.1
MN4	122.7	120.4	119.7	117.8	122.4	125.1	118.5	121.7	119.6
M4	165.2	165.2	164.4	164.6	164.3	165.5	164.1	168.9	167.5
SN4	207.1	209.3	190.8	204.4	222.6	210.7	195.0	234.2	235.5
MS4	239.9	244.1	236.0	241.6	237.3	241.3	240.1	246.0	243.6
MK4	234.7	239.6	240.8	238.1	236.8	238.1	240.1	249.1	235.3
S4	290.3	334.7	221.5	348.5	307.3	326.2	332.0	350.2	14.0
SK4	352.8	343.2	5.5	351.9	338.0	326.6	4.2	13.2	331.2
2MN6	58.9	61.5	53.7	52.9	48.3	57.5	55.0	50.1	52.4
M6	87.0	89.7	87.6	89.0	78.8	79.4	83.4	84.1	83.0
MSN6	132.8	114.5	115.1	125.7	122.5	146.6	131.7	125.6	138.3
2MS6	150.6	156.4	150.4	156.4	148.9	150.1	153.4	148.7	148.3
2MK6	158.3	157.0	167.7	148.8	128.7	160.4	165.0	154.7	155.3
2SM6	34.1	43.9	47.9	38.4	83.5	31.0	46.0	42.2	47.6
MSK6	349.8	6.4	36.6	89.1	13.0	32.7	2.5	63.6	7.5
MA2	97.4	14.9	183.7	53.3	320.9	23.0	342.2	89.3	51.7
MB2	145.6	115.7	175.0	144.7	158.0	36.2	96.7	162.8	123.2

	Brest - Phase (º)						
	1994	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
ZO	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SA	226.9	255.1	285.1	223.2	236.3	203.1	238.6
SSA	107.2	201.8	177.8	136.8	83.0	61.2	113.5
MM	30.3	11.2	245.1	127.8	64.1	284.9	203.5
MSF	343.0	75.2	107.7	149.0	120.2	103.1	339.1
MF	129.7	225.7	113.8	189.4	166.9	229.2	325.9
2Q1	242.0	217.1	229.0	267.4	316.9	273.8	290.4
SIG1	269.0	255.5	238.7	282.8	241.7	266.8	276.7
Q1	284.6	289.1	297.4	300.4	307.0	308.0	294.9
RO1	355.4	304.2	281.0	339.1	280.7	313.7	297.8
O1	341.3	344.0	342.6	339.3	341.5	340.8	341.5
MP1	51.2	137.6	88.0	306.2	14.3	120.0	209.0
M1	51.8	70.3	144.6	161.2	182.5	217.4	292.3
CHI1	43.4	160.8	340.9	164.7	16.9	288.0	83.3
PI1	163.6	57.8	80.6	36.0	141.3	255.3	96.7
P1	77.7	77.5	77.5	77.6	82.7	75.6	80.3
S1	29.6	40.8	21.7	27.9	12.3	16.9	32.0
K1	89.9	88.9	91.7	91.6	92.8	92.3	91.8
PSI1	131.7	12.4	40.5	42.2	173.5	95.1	156.4
PHI1	149.9	339.5	95.6	175.3	51.9	157.8	83.6
TH1	155.4	64.1	65.3	93.1	289.2	302.0	311.9
J1	245.0	171.9	189.6	138.4	167.9	137.2	141.5
SO1	348.7	83.0	211.7	106.0	206.3	358.5	88.0
OO1	341.2	214.5	181.1	216.8	187.0	259.4	226.2
OQ2	140.8	63.3	357.6	326.7	250.7	119.3	36.1
MNS2	115.9	113.8	117.0	114.2	116.8	115.8	110.1
2N2	99.8	94.8	98.4	106.9	108.3	96.7	89.4
MU2	131.0	132.2	130.5	131.9	131.3	131.8	131.8
N2	119.2	119.3	119.6	119.5	119.1	119.3	119.0
NU2	113.9	115.8	115.9	116.3	113.9	114.2	114.5
OP2	28.4	5.2	6.2	66.5	68.1	36.4	355.5
M2	137.9	138.0	138.0	138.1	138.1	138.0	137.8
MKS2	190.2	164.8	169.8	168.7	185.8	159.7	183.0
LAM2	108.3	109.3	111.7	111.3	105.0	104.4	105.4
L2	120.2	134.0	137.5	135.0	130.4	129.8	134.8
T2	184.3	182.2	184.0	186.3	183.0	183.2	188.2
S2	179.3	179.5	179.4	179.8	179.6	178.9	178.5
R2	172.0	210.7	177.4	191.9	149.9	161.3	163.1
K2	177.4	177.5	178.4	179.4	178.1	177.4	177.1
MSN2	319.4	327.4	316.9	318.4	321.0	331.7	316.8
KJ2	35.0	30.3	49.5	48.7	42.8	33.7	49.2
2SM2	345.8	345.5	342.9	349.3	346.5	350.3	347.3
MO3	259.1	215.3	181.2	147.6	115.7	91.0	51.8
M3	58.9	59.6	59.0	59.1	57.4	58.6	57.1
SO3	169.9	203.3	216.2	196.9	262.0	186.7	189.8
MK3	348.2	24.0	27.1	60.9	260.8	292.8	290.0
SK3	131.0	124.2	126.5	120.7	113.6	118.1	111.0
MN4	124.4	119.7	117.3	118.3	119.3	123.1	120.0
M4	166.8	164.8	165.5	165.4	165.5	164.4	163.4
SN4	216.6	206.8	203.6	221.3	202.3	205.0	202.0
MS4	243.2	239.7	239.7	242.1	240.6	240.6	237.2
MK4	244.5	245.1	239.5	242.5	239.0	243.7	239.0
S4	334.4	307.7	317.0	333.2	324.4	326.6	329.5
SK4	341.3	35.5	320.3	315.2	12.5	5.9	357.8
2MN6	57.2	58.1	50.5	51.5	54.0	59.4	55.1
M6	83.3	83.9	84.0	84.0	82.6	81.7	82.9
MSN6	130.8	134.6	127.5	137.4	130.8	134.4	124.5
2MS6	152.2	151.4	147.1	150.5	149.6	148.3	148.8
2MK6	150.2	163.7	166.0	164.6	149.6	161.0	159.7
2SM6	37.2	47.2	53.0	55.0	59.7	45.3	37.8
MSK6	347.7	14.0	69.9	61.3	27.9	7.1	50.9
MA2	81.3	42.0	62.0	76.5	48.0	52.0	77.6
MB2	133.5	134.7	146.0	154.9	133.6	145.9	133.7

	Le Havre - Amplitude (mm)								
	1938	**1939**	**1963**	**1964**	**1972**	**1973**	**1974**	**1975**	**1976**
ZO	4848.7	4919.2	4832.8	4795.7	4833.1	4831.4	4889.1	4839.4	4835.0
SA	98.5	33.9	71.6	37.5	25.2	66.3	108.8	40.8	128.2
SSA	61.8	20.6	48.3	25.7	40.1	25.9	38.4	37.5	34.9
MM	7.3	29.6	14.0	5.4	36.6	35.3	27.3	8.2	12.2
MSF	17.7	27.5	32.5	19.9	32.1	3.6	7.7	27.0	24.6
MF	29.0	16.7	8.3	12.3	36.1	31.4	28.9	6.1	19.0
2Q1	0.6	2.4	5.2	4.7	7.1	1.9	9.4	2.9	3.6
SIG1	4.8	3.6	8.5	5.7	2.3	2.1	9.3	5.3	10.7
Q1	14.7	18.8	19.1	17.5	13.7	13.9	9.2	10.1	14.0
RO1	1.4	2.4	6.3	6.6	3.3	2.1	4.5	3.8	2.8
O1	49.5	52.9	56.2	57.7	55.9	57.0	57.9	49.1	49.3
MP1	12.4	7.0	14.3	13.2	11.8	10.4	8.7	7.9	6.9
M1	3.6	5.2	2.6	4.9	0.8	2.4	1.2	2.4	7.1
CHI1	7.1	6.7	2.5	9.2	3.7	3.7	1.9	2.4	2.2
PI1	4.1	4.5	6.2	10.9	3.9	2.8	10.7	6.7	7.1
P1	34.8	32.4	35.7	33.0	31.3	33.0	36.1	34.1	35.4
S1	3.5	4.0	10.0	2.7	6.0	6.1	12.5	7.5	9.5
K1	98.5	100.4	90.4	89.6	92.2	93.7	93.9	92.9	91.5
PSI1	7.8	3.5	4.3	1.9	6.3	1.0	4.0	2.0	2.4
PHI1	6.9	0.6	2.8	2.4	5.3	3.2	5.5	5.0	7.5
TH1	5.6	2.7	9.4	6.7	7.9	3.5	5.5	7.0	3.1
J1	7.8	7.8	10.4	11.3	9.2	5.1	9.5	5.1	8.8
SO1	11.4	11.8	16.1	5.8	8.8	6.3	7.7	13.1	9.7
OO1	10.8	7.8	6.0	9.0	5.6	8.9	6.0	5.5	6.5
OQ2	17.5	23.1	11.8	8.2	12.4	15.8	16.2	3.5	7.0
MNS2	13.2	19.4	24.1	11.3	14.4	10.8	16.9	19.2	14.8
2N2	80.6	70.1	44.9	64.2	63.2	89.6	81.7	49.3	49.6
MU2	73.0	79.9	54.3	63.1	72.5	83.0	79.5	75.1	78.1
N2	486.1	485.7	490.3	480.4	497.8	490.4	492.8	498.1	497.0
NU2	99.9	107.5	116.5	97.9	102.8	105.3	104.3	102.9	106.7
OP2	11.6	10.1	32.4	31.6	19.4	13.4	4.1	23.7	30.3
M2	2618.8	2630.1	2613.6	2608.5	2635.8	2623.1	2621.0	2617.4	2611.2
MKS2	12.5	20.7	5.4	13.8	26.9	13.8	17.9	19.3	9.1
LAM2	58.5	60.1	55.7	55.6	57.8	59.5	62.0	60.7	56.7
L2	123.7	146.7	139.1	110.8	119.3	121.6	140.7	159.4	127.2
T2	51.5	50.6	53.1	39.3	47.3	48.8	51.8	44.0	50.0
S2	870.5	880.4	872.3	880.6	888.5	880.6	881.4	869.4	867.8
R2	14.0	1.7	4.4	18.2	11.0	8.3	6.1	6.2	11.3
K2	254.0	252.0	270.3	258.6	252.4	250.7	250.0	248.5	246.1
MSN2	37.7	29.5	29.3	46.1	36.2	38.8	36.9	35.6	40.7
KJ2	4.9	10.8	11.3	4.2	7.9	6.9	2.4	3.1	2.0
2SM2	49.1	50.6	50.9	50.5	54.1	49.7	45.6	46.0	44.0
MO3	16.3	13.7	14.2	17.3	15.0	14.9	16.0	14.2	10.6
M3	10.1	11.7	8.5	9.9	8.5	8.7	13.3	14.3	13.7
SO3	7.7	6.3	5.7	1.9	6.3	6.5	8.2	7.2	8.0
MK3	7.8	10.2	9.5	12.0	10.6	9.4	10.6	8.3	7.9
SK3	3.0	6.4	3.6	5.3	4.7	5.3	3.3	4.9	3.1
MN4	83.5	84.4	88.1	85.0	96.4	84.5	83.8	91.0	93.9
M4	246.4	256.6	246.4	246.6	253.3	254.1	254.3	255.7	254.2
SN4	19.5	20.0	21.0	23.8	21.9	19.5	18.7	23.1	20.6
MS4	160.9	171.3	165.3	172.0	174.0	179.2	175.8	172.5	169.8
MK4	48.9	50.7	49.5	50.2	52.7	48.5	47.7	48.3	51.3
S4	16.2	22.7	16.3	19.4	16.1	21.6	20.2	18.0	19.7
SK4	9.2	11.3	11.6	11.6	10.8	10.4	12.4	12.3	13.6
2MN6	87.2	87.0	86.9	84.2	93.9	85.1	88.6	96.3	93.6
M6	158.6	160.6	158.5	155.8	165.4	161.9	165.9	166.7	162.3
MSN6	40.7	41.7	34.6	38.4	41.6	39.6	39.1	42.1	40.2
2MS6	157.9	155.3	150.3	160.3	163.9	168.3	162.4	160.3	156.9
2MK6	45.8	43.1	43.8	46.1	46.1	42.6	43.6	43.7	44.6
2SM6	36.3	33.6	33.7	37.6	37.4	40.5	38.4	37.7	36.9
MSK6	20.8	23.8	22.9	22.2	25.7	19.7	22.2	24.2	26.6
MA2	14.7	31.5	20.4	98.8	38.0	17.6	36.9	20.2	18.4
MB2	24.4	13.3	23.6	97.1	9.1	12.2	9.0	16.0	9.2

	Le Havre - Amplitude (mm)								
	1977	**1978**	**1979**	**1980**	**1981**	**1982**	**1985**	**1986**	**1987**
ZO	4889.0	4897.3	4925.9	4906.5	4922.4	4894.6	4928.6	4881.0	4914.2
SA	92.7	45.2	61.4	51.8	72.9	103.4	22.0	69.6	77.3
SSA	7.9	36.8	11.4	15.8	46.7	23.7	14.8	48.1	53.3
MM	30.2	15.2	34.6	5.5	11.6	48.4	54.6	49.6	23.7
MSF	14.5	29.4	30.5	40.7	24.5	10.5	12.2	19.7	15.9
MF	34.2	46.3	8.8	12.8	19.8	26.8	13.9	11.8	14.2
2Q1	3.2	6.0	4.8	2.5	2.5	3.6	4.5	3.1	3.4
SIG1	7.2	5.1	9.0	4.5	6.5	3.7	5.2	5.6	5.5
Q1	13.5	14.2	16.5	14.3	14.9	8.8	18.9	13.9	15.4
RO1	4.8	3.2	1.9	6.3	3.9	4.6	2.8	0.8	2.8
O1	53.1	51.0	49.1	53.5	55.7	55.2	53.3	49.0	52.5
MP1	10.5	7.4	9.0	9.3	12.4	10.0	10.3	18.0	8.8
M1	7.2	9.5	6.5	4.0	4.3	5.0	3.3	10.9	6.6
CHI1	1.8	6.0	5.5	5.8	4.3	2.0	1.3	9.3	1.1
PI1	2.2	0.9	3.8	6.4	2.2	4.0	6.2	5.5	2.7
P1	32.1	29.6	31.7	29.9	29.2	31.9	31.9	36.4	35.1
S1	9.3	9.0	10.0	9.6	6.0	4.6	9.4	2.5	4.9
K1	90.2	92.5	93.7	91.2	85.8	97.4	90.4	92.0	91.3
PSI1	2.9	2.9	3.3	3.3	4.4	5.7	1.8	8.2	4.9
PHI1	2.2	2.9	2.9	3.0	2.5	4.1	4.3	5.8	3.3
TH1	7.0	1.6	10.3	1.9	7.1	1.2	5.5	7.7	1.7
J1	6.5	3.5	8.8	10.9	7.8	8.2	5.0	8.4	10.6
SO1	4.3	6.5	12.1	9.0	3.7	9.2	9.9	2.5	12.0
OO1	7.3	7.2	7.2	9.4	8.8	2.5	5.3	5.0	6.6
OQ2	14.6	20.3	13.8	3.7	12.0	12.6	4.8	13.7	12.5
MNS2	16.5	15.0	16.0	19.7	18.0	12.2	20.2	11.6	13.7
2N2	68.7	80.8	68.2	43.6	53.4	75.6	37.0	81.1	96.4
MU2	76.1	71.8	71.4	70.9	69.9	75.0	73.7	73.0	81.3
N2	488.0	487.0	484.6	494.2	494.3	483.5	507.4	505.1	497.9
NU2	105.6	105.3	107.5	108.3	101.3	104.4	97.8	105.9	111.4
OP2	25.4	7.8	15.7	20.0	28.0	15.3	21.4	23.0	10.7
M2	2609.6	2610.7	2616.1	2614.0	2611.1	2610.6	2637.8	2629.9	2637.8
MKS2	10.9	20.3	7.6	15.1	14.9	11.9	15.7	15.3	14.9
LAM2	61.5	60.6	56.2	54.2	52.9	62.5	53.3	61.7	62.9
L2	107.6	115.8	132.8	152.3	135.6	112.7	142.6	94.0	100.4
T2	47.1	47.5	46.5	47.0	46.9	46.3	51.6	48.8	51.6
S2	864.8	860.6	869.8	875.0	873.3	885.1	898.7	889.9	899.0
R2	2.0	9.5	7.6	13.6	7.3	6.0	4.9	0.9	5.9
K2	242.3	251.6	253.9	251.7	259.1	258.7	256.2	263.8	257.6
MSN2	37.0	38.0	31.6	27.9	33.6	37.2	34.5	51.1	47.4
KJ2	4.4	10.4	4.5	4.1	6.2	3.9	13.3	9.9	11.4
2SM2	46.8	46.1	45.4	43.3	48.6	50.0	49.7	55.9	56.1
MO3	9.6	12.3	12.3	14.2	15.9	15.3	10.3	9.7	12.2
M3	12.9	12.1	11.2	7.9	8.8	10.2	15.9	15.2	13.4
SO3	7.9	8.4	8.0	8.0	5.0	6.9	6.3	6.1	6.6
MK3	10.1	8.9	9.7	11.9	10.1	10.3	7.2	7.3	9.7
SK3	3.6	2.8	4.2	3.1	2.5	3.5	3.1	2.4	2.9
MN4	85.2	81.5	84.5	91.6	90.3	85.0	95.7	94.3	83.7
M4	250.7	252.6	250.9	254.0	254.3	255.6	258.5	255.8	254.7
SN4	17.2	19.8	17.5	19.9	19.6	20.3	22.7	26.4	22.2
MS4	172.9	168.2	170.3	172.1	170.7	178.3	181.9	183.0	183.1
MK4	43.5	48.7	49.4	46.4	50.4	51.1	52.5	54.9	50.8
S4	20.9	17.1	19.9	20.9	17.9	21.7	20.0	21.8	20.8
SK4	10.3	10.7	11.4	9.8	12.6	11.7	13.4	13.3	13.2
2MN6	86.1	86.0	91.2	91.6	87.9	84.8	98.4	92.7	88.3
M6	160.1	164.3	164.5	165.7	164.3	165.5	172.3	166.1	164.9
MSN6	37.3	36.8	38.9	38.9	41.1	38.6	46.2	50.4	45.4
2MS6	162.0	160.3	158.7	159.3	160.9	169.2	174.9	177.2	178.4
2MK6	39.8	47.2	46.3	42.2	45.5	47.1	45.6	47.3	46.5
2SM6	39.9	33.9	36.6	39.5	35.6	40.0	44.7	46.1	42.8
MSK6	18.6	20.3	23.2	21.7	23.5	22.7	25.6	23.4	25.9
MA2	28.4	14.6	30.1	23.7	15.4	21.1	29.1	18.1	15.0
MB2	12.5	17.0	7.0	16.6	12.6	8.0	8.5	11.7	10.3

	Le Havre - Amplitude (mm)								
	1988	**1989**	**1990**	**1991**	**1994**	**1995**	**1996**	**1997**	**1998**
ZO	4956.3	4929.3	4905.8	4848.1	4925.6	4938.8	4895.4	4893.9	4908.6
SA	59.0	70.6	79.4	83.8	106.1	92.5	78.7	85.0	84.7
SSA	30.8	14.1	29.5	20.1	11.9	40.8	17.2	56.7	35.0
MM	32.9	44.3	40.5	16.6	36.5	53.5	10.3	8.6	42.6
MSF	57.8	20.8	24.8	3.1	17.0	27.1	20.5	8.8	38.2
MF	9.2	13.8	24.8	18.7	20.5	21.5	7.9	22.3	10.7
2Q1	3.9	5.4	4.5	5.8	2.6	9.2	3.4	9.7	5.4
SIG1	4.7	3.3	3.5	6.6	3.9	10.6	8.0	8.3	12.8
Q1	11.3	14.9	17.4	12.0	10.8	11.1	15.5	8.8	15.8
RO1	3.1	0.4	0.3	4.2	6.4	5.8	3.2	3.2	6.7
O1	53.9	54.3	48.6	51.5	50.6	45.8	51.4	49.5	53.9
MP1	9.8	10.9	10.6	15.3	9.6	5.6	9.6	4.9	5.0
M1	2.5	3.0	7.1	4.1	6.3	14.1	10.6	6.6	5.6
CHI1	4.4	1.4	2.7	0.5	6.2	3.0	5.7	6.1	6.8
PI1	2.7	5.1	9.6	3.5	1.5	2.3	8.4	3.5	2.5
P1	28.3	35.3	36.0	31.1	29.8	31.3	35.0	31.5	27.0
S1	6.9	8.4	7.9	10.5	8.3	4.5	6.1	6.0	7.4
K1	96.1	94.9	96.8	92.2	91.2	95.8	92.5	89.7	84.8
PSI1	7.7	1.7	4.2	5.2	4.6	5.1	3.7	1.5	4.5
PHI1	3.9	2.9	0.2	4.7	2.5	5.4	5.1	2.2	10.2
TH1	7.5	5.8	2.1	1.9	8.1	2.3	5.2	8.1	9.6
J1	6.0	10.2	12.0	6.9	2.0	5.1	8.1	11.2	15.2
SO1	9.9	7.2	7.7	6.2	1.3	5.5	10.7	12.6	7.7
OO1	4.7	4.2	6.1	8.1	8.7	10.3	7.2	12.6	18.6
OQ2	6.6	2.7	10.5	12.5	11.6	17.6	19.7	13.4	2.9
MNS2	24.5	22.4	15.0	11.8	17.1	11.5	15.5	17.5	16.4
2N2	68.4	32.1	72.5	92.3	54.9	76.2	79.7	61.9	45.1
MU2	73.4	80.1	84.2	84.9	81.2	77.1	74.4	76.8	73.0
N2	498.7	498.7	502.6	494.6	495.2	491.1	491.2	488.7	498.6
NU2	107.3	107.0	107.1	106.7	108.5	106.0	112.1	107.6	104.3
OP2	20.0	30.0	6.2	6.7	25.5	16.8	2.2	26.4	30.6
M2	2640.6	2636.8	2637.9	2642.1	2633.6	2617.0	2612.0	2620.8	2627.9
MKS2	25.5	16.3	11.1	9.2	16.8	11.0	10.0	15.1	12.0
LAM2	54.8	54.3	66.1	70.0	59.3	60.4	65.2	57.3	53.1
L2	145.4	153.8	112.5	118.1	115.0	112.6	121.8	144.0	152.2
T2	47.6	50.0	42.7	46.4	50.5	45.1	46.5	50.2	51.4
S2	896.3	893.5	889.2	888.4	873.5	866.1	863.3	866.3	868.1
R2	5.7	7.8	12.9	2.7	12.7	10.4	7.9	12.1	9.6
K2	257.0	250.4	250.8	256.3	245.0	239.0	248.6	250.1	250.8
MSN2	36.8	34.0	42.1	38.5	32.9	40.8	38.3	30.9	30.3
KJ2	4.4	3.8	4.2	5.0	4.2	6.7	5.2	6.6	3.7
2SM2	55.6	52.4	56.9	50.2	48.5	46.5	51.2	44.1	43.0
MO3	13.2	13.2	14.4	15.5	10.6	11.9	12.4	15.0	15.9
M3	10.5	7.6	8.1	10.7	15.0	13.5	11.0	9.3	7.5
SO3	5.6	7.2	7.2	8.8	7.7	8.3	8.9	7.8	7.7
MK3	10.0	10.2	11.1	9.0	9.9	9.9	11.5	11.3	11.0
SK3	3.3	3.9	3.7	3.5	2.6	3.6	5.1	3.2	3.1
MN4	90.2	94.4	96.5	86.3	89.7	86.3	86.1	88.8	90.5
M4	264.3	261.1	256.8	260.1	251.5	254.4	252.3	255.7	250.6
SN4	20.9	19.9	22.3	21.4	14.9	15.7	18.7	18.2	19.7
MS4	182.7	179.6	180.1	180.9	174.3	168.0	171.8	169.1	169.9
MK4	49.2	50.6	49.7	51.8	47.1	48.0	50.3	51.5	49.1
S4	18.5	21.1	20.3	18.8	21.3	15.5	16.8	17.1	18.8
SK4	10.6	11.8	10.8	13.0	13.6	12.5	11.0	11.5	10.9
2MN6	96.0	97.6	95.3	88.6	93.9	87.3	90.1	91.1	93.7
M6	180.1	175.6	164.5	165.1	166.1	163.3	159.5	166.1	162.4
MSN6	45.1	44.0	40.9	41.0	37.1	39.4	37.7	38.2	41.4
2MS6	176.7	172.9	168.6	171.4	166.6	159.2	157.6	155.5	159.1
2MK6	45.1	46.9	45.6	47.5	44.7	45.4	44.9	44.7	43.5
2SM6	43.4	43.2	40.8	40.5	39.7	36.0	35.0	34.9	38.7
MSK6	24.4	24.9	24.0	22.6	23.0	18.9	21.7	25.7	22.8
MA2	27.2	28.9	32.9	24.4	28.3	26.4	30.3	18.4	26.0
MB2	10.5	10.0	9.5	12.8	21.1	15.4	14.9	27.2	17.2

	Le Havre - Amplitude (mm)	
	1999	**2000**
ZO	4952.7	4966.3
SA	65.9	98.1
SSA	7.5	78.7
MM	22.9	24.6
MSF	33.9	25.7
MF	24.6	9.8
2Q1	3.0	3.5
SIG1	2.6	5.4
Q1	14.0	16.0
RO1	2.9	2.5
O1	50.8	51.6
MP1	10.3	11.5
M1	3.9	4.2
CHI1	5.7	1.1
PI1	1.5	5.4
P1	28.4	31.3
S1	12.0	9.0
K1	91.3	90.9
PSI1	3.1	3.0
PHI1	4.7	2.7
TH1	6.7	4.7
J1	11.5	8.6
SO1	4.2	8.6
OO1	4.5	6.9
OQ2	16.4	17.0
MNS2	17.3	12.6
2N2	62.2	82.1
MU2	68.6	71.0
N2	495.7	490.1
NU2	104.6	104.3
OP2	25.6	15.3
M2	2614.9	2613.7
MKS2	13.0	6.7
LAM2	59.4	64.3
L2	130.3	119.7
T2	49.6	52.3
S2	862.8	866.1
R2	9.3	12.7
K2	252.4	259.5
MSN2	35.7	39.8
KJ2	6.4	7.6
2SM2	49.6	50.6
MO3	15.5	15.9
M3	7.6	10.0
SO3	6.6	6.2
MK3	9.8	9.9
SK3	3.6	2.6
MN4	89.5	82.1
M4	249.6	249.1
SN4	18.8	17.5
MS4	164.3	166.7
MK4	53.1	48.2
S4	17.3	17.5
SK4	12.8	10.5
2MN6	90.8	84.9
M6	162.1	162.6
MSN6	42.2	39.0
2MS6	158.7	164.2
2MK6	47.8	45.9
2SM6	36.1	38.7
MSK6	23.3	19.0
MA2	18.3	15.3
MB2	9.4	13.6

	Le Havre - Phase (º)								
	1938	**1939**	**1963**	**1964**	**1972**	**1973**	**1974**	**1975**	**1976**
ZO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SA	215.5	229.2	200.3	196.9	261.6	195.7	225.0	227.9	215.2
SSA	137.0	249.3	87.7	27.1	151.8	149.5	201.3	298.0	92.8
MM	272.8	31.1	199.8	276.2	205.7	1.4	137.3	333.2	186.4
MSF	331.1	37.3	43.4	26.6	351.9	109.7	271.1	359.5	48.3
MF	204.4	98.4	128.8	253.9	139.7	175.3	154.2	240.6	105.6
2Q1	16.9	282.2	197.4	14.1	288.0	309.6	233.7	295.4	116.7
SIG1	45.2	31.1	313.7	321.5	4.5	319.8	245.2	313.4	333.0
Q1	330.8	329.6	330.1	345.3	9.0	358.5	348.7	343.0	358.3
RO1	235.9	10.9	280.3	268.2	116.9	305.1	274.7	192.2	300.5
O1	11.3	6.0	12.9	7.0	27.6	28.7	25.1	30.4	25.4
MP1	150.3	182.9	231.7	216.9	203.4	198.9	183.6	213.0	185.0
M1	32.9	73.0	171.5	110.9	42.0	290.1	183.2	66.0	125.6
CHI1	27.5	138.3	4.3	72.2	272.8	152.0	286.7	230.3	36.8
PI1	59.5	4.9	70.2	95.0	186.2	118.4	155.1	110.3	131.1
P1	111.1	95.9	116.2	105.5	125.5	128.4	139.1	131.1	128.4
S1	153.3	28.1	35.3	25.7	119.8	114.4	51.2	91.1	122.3
K1	116.6	117.8	117.1	120.9	133.2	131.5	135.8	136.3	131.7
PSI1	146.0	169.2	91.6	232.4	27.5	178.6	343.7	85.3	291.9
PHI1	24.5	265.5	285.6	48.4	229.1	72.5	162.8	260.3	136.3
TH1	168.8	248.7	42.5	353.1	219.2	142.0	20.1	136.9	131.1
J1	230.1	218.3	234.1	224.3	184.9	214.9	291.5	307.9	211.0
SO1	248.6	288.0	274.4	285.3	298.6	297.4	270.5	306.4	296.6
OO1	322.3	237.1	262.6	253.2	336.5	261.7	314.4	282.1	339.5
OQ2	186.2	147.3	252.3	252.7	246.3	223.2	202.2	152.9	259.7
MNS2	354.9	335.3	16.4	320.7	24.5	43.0	354.9	2.7	13.0
2N2	245.3	263.9	222.4	223.2	242.9	261.4	285.2	291.4	259.6
MU2	340.3	341.6	336.2	341.7	359.9	1.7	2.7	3.3	2.9
N2	264.4	263.5	264.8	265.2	294.4	294.0	293.3	293.4	294.4
NU2	254.2	255.5	256.1	257.2	289.5	284.4	283.7	287.7	285.0
OP2	179.2	263.8	257.3	243.3	205.0	230.4	350.2	294.8	270.0
M2	285.6	284.2	284.9	284.1	314.7	314.6	314.7	314.7	314.9
MKS2	17.8	34.3	97.0	230.9	117.1	111.0	76.7	68.6	94.7
LAM2	285.4	285.7	279.3	269.9	305.0	311.4	315.0	312.1	314.0
L2	295.9	290.2	284.1	286.4	305.7	320.7	325.2	315.0	305.9
T2	327.5	323.6	342.3	18.6	352.7	3.3	356.9	0.8	3.3
S2	332.3	330.6	331.2	330.9	2.9	3.1	3.0	3.0	3.3
R2	339.9	324.1	334.6	206.2	58.9	17.1	41.6	4.4	16.9
K2	330.8	331.3	329.6	330.1	358.7	0.4	0.7	0.7	1.2
MSN2	158.9	151.5	162.5	157.6	196.2	189.2	176.8	184.5	190.7
KJ2	223.8	269.4	222.4	296.8	269.8	222.5	248.4	248.3	6.2
2SM2	178.6	174.5	183.8	186.8	208.7	207.4	204.4	208.6	207.8
MO3	267.2	261.8	284.4	268.9	322.0	309.9	306.9	300.7	302.4
M3	277.9	271.5	284.8	289.2	329.6	329.9	324.6	316.1	312.7
SO3	334.9	344.5	345.6	5.9	4.0	14.8	17.6	21.4	24.5
MK3	47.3	42.8	40.1	42.1	86.4	90.8	78.7	82.6	73.8
SK3	40.3	40.0	32.7	67.3	79.3	89.5	95.8	103.9	82.6
MN4	52.9	47.8	54.0	54.3	119.2	113.5	111.6	109.3	114.7
M4	76.5	74.1	75.4	75.6	135.5	135.1	135.3	136.1	135.9
SN4	133.7	137.1	145.7	139.4	200.3	192.8	195.5	198.1	203.0
MS4	130.1	126.5	127.7	130.4	189.2	188.6	189.9	189.3	190.8
MK4	128.9	127.3	123.2	128.6	184.6	188.1	186.9	190.7	185.8
S4	218.0	204.3	209.8	196.5	271.9	263.9	257.2	262.9	264.3
SK4	215.3	203.2	183.2	205.6	245.6	259.0	252.1	252.3	244.9
2MN6	261.6	258.0	264.3	263.4	358.9	352.8	351.2	349.7	353.9
M6	288.6	286.1	286.5	288.1	15.9	17.4	17.7	18.4	16.3
MSN6	310.5	308.2	313.2	319.2	46.0	39.9	38.0	43.7	42.3
2MS6	333.3	328.5	331.9	332.5	63.3	62.8	62.8	62.9	63.6
2MK6	333.3	340.0	330.1	328.3	59.7	63.1	68.3	64.7	57.8
2SM6	24.4	15.1	22.6	19.3	112.7	113.0	115.1	111.8	115.4
MSK6	19.8	10.8	17.5	22.3	113.0	108.1	106.1	111.8	111.0
MA2	270.2	202.0	166.8	134.0	244.1	239.6	249.1	232.8	259.8
MB2	5.8	287.7	326.0	266.0	254.5	308.9	260.4	349.7	20.0

	Le Havre - Phase (º)								
	1977	**1978**	**1979**	**1980**	**1981**	**1982**	**1985**	**1986**	**1987**
ZO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SA	263.7	287.0	250.5	184.4	227.1	225.9	9.7	223.7	187.8
SSA	8.4	224.5	115.8	262.8	100.5	138.4	205.8	156.1	60.9
MM	65.5	283.1	128.6	355.3	15.8	116.9	254.7	200.3	202.7
MSF	186.8	10.1	345.2	38.0	38.9	150.4	167.9	59.5	58.1
MF	82.7	143.6	234.8	32.8	158.9	0.6	220.7	182.2	273.3
2Q1	143.4	229.3	322.2	110.1	288.8	42.7	198.5	341.7	280.2
SIG1	344.6	347.1	355.2	283.2	17.6	302.6	307.7	240.3	326.1
Q1	343.9	1.7	358.8	349.8	336.3	357.6	339.4	350.7	350.4
RO1	357.0	295.7	123.1	335.9	308.7	61.6	356.8	38.6	267.5
O1	30.0	30.7	28.6	29.3	23.1	22.4	29.8	32.8	25.8
MP1	166.6	177.9	215.3	233.9	232.4	232.5	207.1	225.9	190.6
M1	137.7	166.1	213.6	231.7	298.1	308.5	102.0	138.7	207.0
CHI1	243.3	110.1	56.5	100.1	63.6	53.0	70.9	223.8	70.3
PI1	133.4	102.1	144.0	150.8	96.9	123.2	39.5	262.8	337.1
P1	129.7	124.0	126.8	127.5	116.9	132.6	121.3	119.9	122.1
S1	118.8	82.2	99.5	98.8	134.7	40.2	95.8	70.2	104.7
K1	133.1	136.5	134.3	131.5	133.9	132.9	130.5	133.4	130.5
PSI1	48.0	145.0	185.4	166.8	306.2	48.1	72.2	42.6	294.1
PHI1	289.5	243.2	178.8	268.5	198.6	219.0	30.6	226.8	41.2
TH1	305.0	270.6	50.1	87.8	135.2	281.3	161.6	220.3	355.2
J1	215.7	263.9	237.6	223.4	192.7	193.1	265.2	234.5	220.6
SO1	279.0	278.8	304.0	330.7	266.6	267.6	301.1	285.1	267.5
OO1	263.1	253.3	283.3	292.7	282.5	309.0	249.7	259.9	246.1
OQ2	226.1	209.0	223.3	289.8	266.3	248.9	231.0	243.0	207.4
MNS2	32.7	6.9	349.2	18.4	34.3	38.5	32.0	39.7	347.3
2N2	258.6	275.2	291.2	276.9	250.8	260.9	257.6	249.0	277.9
MU2	5.4	6.7	7.7	4.9	5.6	8.8	1.8	359.3	0.3
N2	293.8	294.1	293.5	292.8	294.4	294.5	293.2	294.0	294.4
NU2	285.2	287.4	285.5	289.1	283.3	286.0	288.0	285.3	283.9
OP2	210.2	229.2	312.4	258.8	259.4	235.9	254.1	250.0	280.6
M2	314.9	314.8	314.7	314.7	314.8	314.8	314.6	314.6	314.7
MKS2	138.7	55.4	139.4	129.9	155.4	140.5	118.4	96.2	93.3
LAM2	312.8	312.1	316.5	308.5	310.3	306.8	304.2	307.4	314.5
L2	315.7	324.8	328.7	322.2	310.7	316.0	298.4	312.2	329.0
T2	3.2	3.5	5.7	1.1	6.8	8.1	3.8	3.6	9.4
S2	3.3	2.9	3.1	3.1	2.9	3.6	2.8	2.5	3.1
R2	101.7	14.0	56.6	2.1	14.6	18.8	57.2	12.4	359.2
K2	0.0	2.3	2.8	0.4	0.9	1.2	0.1	359.8	0.3
MSN2	189.2	182.7	182.7	191.3	189.3	186.1	198.9	192.5	175.9
KJ2	271.5	258.7	249.4	75.7	251.4	246.9	257.6	261.4	250.2
2SM2	205.3	210.8	209.1	209.1	209.5	208.2	208.9	204.1	203.0
MO3	315.6	322.8	325.9	330.4	318.4	312.9	306.6	309.7	327.1
M3	315.7	316.8	323.7	323.0	332.1	327.6	313.0	316.9	317.0
SO3	13.5	18.7	13.8	24.4	16.4	16.5	31.2	26.1	40.1
MK3	60.7	80.8	78.3	78.7	90.8	80.6	80.6	77.6	77.8
SK3	108.4	56.6	83.1	91.7	122.7	95.5	96.8	100.9	77.4
MN4	114.2	112.2	108.9	109.8	114.5	114.9	111.2	114.8	110.1
M4	135.6	133.8	135.2	134.7	134.6	133.8	135.0	134.0	135.0
SN4	198.7	192.4	201.5	206.1	194.7	200.8	200.7	182.0	204.2
MS4	190.0	188.4	189.2	189.1	188.3	189.4	187.8	188.3	188.8
MK4	188.8	188.9	188.3	183.7	186.4	189.3	188.9	186.4	182.4
S4	265.3	270.7	258.3	259.8	261.0	269.3	251.7	249.5	265.3
SK4	268.8	260.2	280.4	265.4	264.5	262.8	268.4	266.1	263.4
2MN6	353.6	348.9	349.3	352.9	353.9	354.2	353.6	356.3	351.7
M6	16.4	16.2	17.6	16.1	16.1	16.6	16.8	15.2	20.2
MSN6	39.6	37.3	39.9	41.4	43.3	40.1	45.3	41.7	39.5
2MS6	63.0	61.9	61.6	62.8	62.1	63.8	62.9	62.7	63.8
2MK6	62.7	63.8	66.2	55.6	60.7	65.8	64.1	63.6	62.3
2SM6	115.7	113.0	108.8	115.9	111.5	115.7	107.9	109.9	111.1
MSK6	114.1	108.3	109.8	109.6	117.4	111.8	120.6	115.2	112.2
MA2	235.0	248.2	256.1	247.4	214.9	272.1	246.5	216.7	234.4
MB2	279.7	19.9	264.9	323.5	344.0	314.9	319.2	325.7	359.6

	Le Havre - Phase (º)								
	1988	**1989**	**1990**	**1991**	**1994**	**1995**	**1996**	**1997**	**1998**
ZO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SA	247.9	253.4	264.4	197.2	230.4	257.0	239.1	207.5	206.4
SSA	276.2	67.1	285.4	39.4	65.9	294.8	127.1	136.2	78.0
MM	188.6	116.2	243.0	204.5	31.5	10.8	323.0	47.1	56.8
MSF	339.5	125.1	354.7	126.1	326.0	57.6	63.6	348.0	122.4
MF	100.1	226.5	47.5	169.0	142.9	207.9	225.4	157.1	283.6
2Q1	273.6	46.3	333.6	301.5	347.0	264.8	307.5	276.8	128.1
SIG1	349.7	346.9	332.5	291.7	285.8	329.7	320.9	328.7	316.1
Q1	345.1	7.9	355.0	2.7	4.8	330.4	2.8	332.0	17.6
RO1	338.8	356.7	359.3	313.1	175.4	15.3	267.4	41.3	318.0
O1	27.1	20.3	28.4	25.2	15.9	24.5	28.6	21.0	29.7
MP1	208.4	195.7	228.2	166.5	169.1	213.6	208.0	139.7	152.4
M1	191.6	236.1	304.1	98.6	173.4	116.6	227.7	214.6	265.0
CHI1	41.3	41.6	147.1	349.0	354.6	147.8	68.4	236.7	121.2
PI1	55.7	196.2	141.0	132.3	177.7	134.5	135.3	119.6	230.3
P1	116.8	132.1	130.8	137.5	120.7	124.8	125.6	129.3	136.5
S1	62.3	86.9	98.8	92.4	102.3	145.1	59.5	66.7	80.2
K1	132.2	131.7	133.4	131.1	130.2	134.2	134.0	138.0	135.9
PSI1	181.0	64.6	171.6	115.7	220.2	139.7	92.3	221.0	260.2
PHI1	67.0	334.7	12.5	323.1	230.6	67.8	179.8	240.2	119.7
TH1	47.8	99.3	78.9	241.5	169.0	334.1	39.9	38.1	96.9
J1	269.4	244.2	207.2	158.1	244.3	244.9	216.2	209.4	248.0
SO1	277.6	243.0	265.9	277.3	313.2	309.7	303.5	273.1	293.5
OO1	272.1	267.1	14.9	276.4	322.1	258.2	262.8	277.1	298.3
OQ2	219.2	219.0	245.3	209.2	272.4	251.9	189.1	187.1	292.3
MNS2	3.2	10.6	23.4	4.1	15.3	18.5	6.7	355.8	15.8
2N2	302.3	264.8	250.7	266.1	251.8	262.7	280.0	293.0	273.3
MU2	354.3	357.6	355.6	355.6	356.7	4.2	3.9	1.3	2.5
N2	293.7	293.2	293.6	294.1	294.1	294.3	294.4	294.0	293.8
NU2	286.7	282.5	289.3	284.7	285.2	285.9	285.6	287.3	286.5
OP2	298.8	280.6	236.2	244.9	260.3	205.2	254.9	273.0	268.4
M2	314.3	314.2	314.2	314.4	314.8	314.8	315.0	315.1	315.1
MKS2	87.4	98.7	116.7	97.3	101.4	93.3	39.3	42.3	104.1
LAM2	315.2	315.0	311.0	312.1	313.0	313.3	317.4	318.5	311.5
L2	335.3	305.6	307.5	321.4	307.1	317.6	326.2	324.0	316.0
T2	6.6	1.5	357.5	10.7	5.8	5.6	4.9	11.5	6.4
S2	2.9	2.8	3.0	3.5	3.9	3.8	4.2	4.5	4.0
R2	39.8	47.0	67.5	93.6	14.1	34.0	358.3	16.0	352.1
K2	0.4	359.4	359.2	0.3	1.9	4.2	3.0	4.7	2.4
MSN2	175.2	191.2	187.4	179.2	191.7	189.1	185.5	184.5	194.1
KJ2	228.6	242.8	223.7	263.4	232.1	239.5	272.6	279.9	281.1
2SM2	210.0	206.3	204.8	207.2	212.9	210.5	207.8	212.7	211.0
MO3	325.5	322.0	317.5	309.4	303.4	320.1	329.9	327.1	318.9
M3	328.4	335.0	324.5	326.8	315.3	315.5	317.5	321.5	330.5
SO3	8.0	20.6	13.6	16.0	30.1	28.2	24.3	29.8	35.7
MK3	81.1	87.2	85.3	85.9	69.7	66.5	69.3	79.9	85.8
SK3	93.7	115.9	103.4	104.9	96.3	109.5	108.5	103.5	99.3
MN4	108.8	110.7	111.8	111.8	112.6	114.5	111.1	113.1	110.8
M4	132.6	133.6	133.3	135.2	134.0	135.0	136.6	136.2	135.7
SN4	192.0	200.2	199.0	203.4	199.8	195.4	208.5	207.3	193.7
MS4	187.8	187.1	187.6	188.8	189.7	189.3	191.3	192.3	190.7
MK4	186.5	186.2	185.4	187.1	187.8	193.0	189.4	191.3	192.0
S4	266.4	259.3	268.6	270.1	268.2	267.6	268.8	263.2	258.5
SK4	247.0	254.1	253.4	276.7	251.9	282.9	259.0	249.9	272.9
2MN6	351.0	351.5	351.9	350.5	353.9	352.7	350.0	352.7	353.2
M6	16.8	15.7	13.8	17.9	16.1	17.3	19.0	19.3	17.8
MSN6	37.9	44.4	42.2	41.0	38.1	37.9	41.8	44.2	41.2
2MS6	62.6	61.4	60.9	62.8	63.2	63.0	65.1	65.4	64.7
2MK6	62.3	60.5	58.1	62.4	62.1	63.7	65.2	70.1	67.0
2SM6	113.9	112.4	113.9	114.5	117.9	112.1	115.2	115.8	114.3
MSK6	108.7	109.9	108.3	116.6	114.4	119.6	114.3	112.4	122.9
MA2	240.2	237.6	236.0	231.0	243.5	214.7	242.9	246.0	239.5
MB2	333.5	53.9	302.1	307.9	13.3	31.7	12.9	14.5	14.2

	Le Havre - Phase (º)	
	1999	**2000**
ZO	0.0	0.0
SA	217.1	221.3
SSA	4.5	102.5
MM	0.1	181.3
MSF	95.7	34.5
MF	305.0	241.4
2Q1	210.8	25.9
SIG1	7.9	284.6
Q1	343.3	351.2
RO1	46.3	208.6
O1	26.3	27.0
MP1	212.5	226.4
M1	295.8	14.2
CHI1	98.5	358.0
PI1	72.7	150.5
P1	124.4	118.6
S1	98.7	126.7
K1	135.2	133.8
PSI1	332.1	235.8
PHI1	167.0	110.9
TH1	94.1	162.7
J1	216.1	230.1
SO1	274.9	305.4
OO1	232.9	256.1
OQ2	270.3	231.7
MNS2	29.0	20.7
2N2	253.9	267.1
MU2	4.9	6.2
N2	294.2	294.0
NU2	283.8	284.6
OP2	240.4	250.0
M2	314.8	314.5
MKS2	157.9	185.6
LAM2	307.7	313.1
L2	312.5	318.9
T2	6.3	9.6
S2	3.2	2.8
R2	21.6	357.4
K2	2.8	2.2
MSN2	193.3	183.7
KJ2	237.0	272.4
2SM2	212.5	208.1
MO3	322.3	313.2
M3	333.7	323.3
SO3	21.7	33.9
MK3	83.4	85.4
SK3	58.4	67.6
MN4	114.3	112.6
M4	134.3	133.9
SN4	192.7	198.4
MS4	190.4	188.0
MK4	193.1	187.4
S4	275.5	259.1
SK4	270.3	269.8
2MN6	354.9	351.7
M6	17.4	18.0
MSN6	39.9	35.1
2MS6	64.9	62.3
2MK6	65.6	57.4
2SM6	116.9	109.6
MSK6	118.4	107.4
MA2	212.5	268.1
MB2	353.3	9.1

	Calais - Amplitude (mm)								
	1965	**1966**	**1967**	**1968**	**1969**	**1970**	**1971**	**1972**	**1973**
ZO	4068.1	4017.6	3984.5	3978.8	4053.6	4091.8	4043.9	4052.4	4042.2
SA	98.8	76.3	62.6	99.7	76.6	29.6	39.5	20.4	88.1
SSA	61.9	31.0	45.7	7.3	30.5	21.3	28.2	51.2	30.4
MM	32.8	39.7	60.6	24.8	43.1	25.0	57.2	45.4	37.6
MSF	14.1	32.6	41.1	17.3	30.0	26.9	10.8	11.8	29.5
MF	28.0	35.0	18.1	24.9	17.4	13.7	23.5	39.1	32.0
2Q1	3.8	2.4	7.7	6.3	5.4	0.3	4.1	3.2	6.8
SIG1	3.8	9.0	5.1	5.6	2.9	3.0	6.0	5.8	1.8
Q1	15.1	23.3	26.7	25.3	25.4	26.1	18.6	18.2	15.7
RO1	4.9	10.8	7.1	1.8	5.7	5.8	7.0	5.1	12.9
O1	54.1	48.6	51.9	50.3	53.1	50.8	44.9	48.8	52.4
MP1	2.2	10.3	10.5	3.7	4.2	5.5	2.5	6.3	4.0
M1	9.1	5.3	5.4	2.7	4.3	4.0	2.7	4.1	3.1
CHI1	2.4	4.5	1.7	4.0	4.4	1.3	3.8	5.6	5.6
PI1	8.9	8.8	2.3	4.0	2.4	2.9	6.2	13.4	5.4
P1	3.9	8.9	13.9	8.9	9.8	9.0	19.6	4.1	6.6
S1	16.4	18.3	19.0	28.7	21.9	19.5	22.9	22.3	31.5
K1	10.6	15.9	24.7	15.7	22.8	24.7	17.4	22.6	22.0
PSI1	9.7	5.4	7.7	9.5	7.5	7.0	9.3	10.2	9.1
PHI1	7.4	9.5	6.4	7.3	3.3	2.9	2.5	1.4	7.3
TH1	2.2	3.5	3.1	2.8	0.6	2.5	9.5	8.2	6.7
J1	6.7	3.0	3.6	7.4	10.1	3.7	2.5	2.8	2.5
SO1	3.1	3.0	4.5	2.2	3.9	5.1	3.5	5.0	3.1
OO1	2.5	2.8	4.6	3.1	2.9	2.3	3.2	3.3	8.3
OQ2	22.8	19.1	8.5	10.3	15.9	14.6	9.5	21.3	20.0
MNS2	21.7	37.4	43.4	28.1	19.0	31.9	40.8	21.4	16.2
2N2	99.6	67.5	20.1	73.3	113.3	67.4	23.6	74.3	102.7
MU2	102.8	95.9	99.8	115.0	105.6	116.0	112.1	90.6	108.9
N2	430.1	451.4	440.4	442.4	436.2	432.8	448.0	435.7	433.9
NU2	115.6	114.7	106.4	105.1	135.8	106.4	111.4	129.6	104.0
OP2	11.3	29.3	20.6	31.2	14.3	37.5	9.3	45.8	20.4
M2	2439.9	2456.6	2467.1	2469.2	2457.2	2441.1	2426.9	2429.6	2432.6
MKS2	25.9	38.7	32.6	22.6	25.1	11.3	35.9	25.5	14.9
LAM2	76.5	51.0	70.1	65.4	76.2	49.6	60.1	69.3	70.1
L2	125.4	185.4	179.1	108.8	112.0	163.0	214.9	129.4	139.0
T2	43.6	36.3	48.1	40.3	49.2	46.6	37.7	31.9	40.2
S2	776.5	764.0	774.8	788.3	777.2	772.5	771.2	753.8	761.8
R2	5.3	5.7	11.8	10.2	13.3	22.9	10.5	9.2	16.0
K2	229.1	216.3	213.5	222.8	224.5	228.3	207.0	225.6	221.2
MSN2	36.9	37.0	35.9	44.8	41.5	44.3	40.3	46.0	46.7
KJ2	5.5	9.8	0.9	3.0	5.1	2.5	1.8	9.2	4.8
2SM2	51.2	45.1	59.4	54.0	55.5	51.1	45.0	45.7	40.4
MO3	10.7	12.3	8.0	12.2	12.0	14.3	11.2	10.5	12.5
M3	12.2	14.4	13.4	11.3	10.9	9.8	10.2	11.5	8.1
SO3	4.6	9.8	5.0	8.4	10.0	4.1	6.0	8.1	11.4
MK3	1.6	11.4	5.5	7.9	2.7	2.7	9.5	2.4	2.9
SK3	3.2	3.7	2.4	5.6	4.5	5.9	6.2	4.3	3.9
MN4	77.2	95.0	97.4	92.7	89.5	90.7	101.0	92.0	83.6
M4	237.7	236.9	259.9	254.9	258.1	263.4	255.5	244.1	240.8
SN4	12.0	16.0	7.6	16.1	12.4	19.5	20.7	16.6	15.3
MS4	150.0	139.3	147.2	150.7	155.6	160.8	160.9	145.7	151.0
MK4	45.9	46.0	42.4	51.5	44.1	48.3	41.0	48.6	46.3
S4	11.6	10.9	11.4	17.6	12.8	12.4	16.3	14.4	13.5
SK4	13.5	10.9	4.1	11.4	10.7	9.8	7.3	9.7	8.4
2MN6	26.8	30.2	35.5	33.1	33.3	32.5	35.6	33.7	29.5
M6	56.3	54.4	66.1	63.6	63.5	63.6	63.3	57.9	54.4
MSN6	11.6	12.4	11.9	15.2	13.9	16.4	16.9	14.3	11.5
2MS6	56.4	53.3	58.9	61.5	63.6	62.4	60.0	54.6	54.6
2MK6	16.3	16.6	16.0	19.4	15.5	16.8	15.6	16.8	15.6
2SM6	15.8	16.9	15.3	21.1	19.2	20.4	22.2	20.0	21.5
MSK6	8.1	8.7	6.2	8.6	6.9	8.0	8.1	8.0	7.4
MA2	36.4	41.6	13.9	6.4	38.3	70.2	26.3	33.4	19.7
MB2	8.5	32.4	29.7	33.2	22.0	33.7	43.0	25.8	19.4

	Calais - Amplitude (mm)						
	1978	**1981**	**1982**	**1992**	**1993**	**1999**	**2000**
ZO	3993.3	3969.0	3995.8	3888.9	3899.1	4053.8	4076.8
SA	25.9	65.2	106.9	81.9	80.5	85.3	99.7
SSA	14.7	42.7	28.6	27.2	23.9	9.5	53.7
MM	22.3	20.0	52.4	31.9	3.9	16.1	30.9
MSF	21.6	5.9	11.6	17.5	22.1	33.2	7.5
MF	51.0	21.0	31.2	26.1	23.8	42.8	12.5
2Q1	8.0	8.8	7.2	2.6	1.5	7.2	7.2
SIG1	3.4	10.8	3.0	7.4	6.1	0.8	3.2
Q1	26.5	16.3	30.4	11.9	23.3	17.5	14.9
RO1	3.0	8.1	7.5	11.0	8.9	10.0	5.4
O1	49.9	45.0	45.0	53.9	53.0	55.6	56.1
MP1	8.7	4.1	15.7	4.9	3.8	5.4	6.1
M1	16.2	4.4	4.5	5.7	6.0	4.1	7.6
CHI1	1.8	3.0	5.0	5.9	9.5	10.6	0.9
PI1	4.4	3.1	5.4	2.5	4.5	3.0	3.7
P1	12.9	16.3	10.1	7.2	7.0	7.9	6.7
S1	28.5	22.8	12.8	7.3	9.7	4.3	10.0
K1	16.6	17.8	13.3	21.2	13.4	12.7	14.5
PSI1	2.7	7.6	3.0	4.3	5.2	5.1	2.8
PHI1	4.8	4.3	5.4	1.8	4.7	2.7	1.5
TH1	5.8	7.4	2.3	2.7	0.6	6.1	6.0
J1	2.6	3.4	4.0	2.4	1.6	4.6	7.3
SO1	4.0	5.2	5.3	7.8	8.6	6.1	5.3
OO1	9.9	3.9	2.4	4.0	10.9	3.5	2.4
OQ2	25.5	16.3	13.4	18.2	13.1	17.9	17.4
MNS2	21.2	28.8	18.3	30.2	39.1	25.3	22.6
2N2	81.4	50.4	79.0	68.7	23.1	57.7	89.8
MU2	89.5	94.7	93.2	96.5	99.3	99.8	97.5
N2	424.0	438.4	433.4	444.4	446.6	449.1	443.3
NU2	98.0	108.2	114.1	111.5	108.9	105.8	109.8
OP2	17.6	46.2	57.4	12.5	43.4	30.8	20.8
M2	2421.9	2436.8	2439.3	2496.2	2483.2	2494.1	2503.6
MKS2	33.1	29.2	36.5	28.4	20.0	8.7	4.0
LAM2	59.2	60.2	67.9	61.0	62.2	62.6	69.8
L2	130.6	154.0	127.2	169.6	178.5	146.4	132.3
T2	31.3	39.5	56.1	42.9	49.5	41.9	42.9
S2	731.3	753.3	751.3	775.7	759.5	771.6	773.0
R2	5.1	16.1	20.4	9.2	21.2	8.5	13.8
K2	213.2	226.1	231.2	219.1	228.3	222.9	233.0
MSN2	31.0	34.1	42.9	33.2	35.3	38.3	41.5
KJ2	8.5	8.1	4.9	4.9	6.1	3.3	7.2
2SM2	40.6	50.6	58.1	47.9	57.2	48.1	50.4
MO3	10.1	12.4	8.9	13.4	10.9	12.1	12.9
M3	16.3	9.9	13.5	12.8	11.2	11.7	13.6
SO3	9.2	6.3	16.2	5.2	7.5	5.7	5.5
MK3	7.2	11.6	23.3	7.9	6.6	4.4	5.6
SK3	1.5	2.3	10.2	3.9	3.2	5.4	4.6
MN4	80.6	88.1	86.2	95.6	98.0	90.8	85.6
M4	238.4	244.0	247.8	256.3	249.9	251.9	253.6
SN4	24.4	11.5	14.3	14.9	17.5	17.3	12.5
MS4	135.7	146.1	145.0	159.0	148.4	155.2	155.5
MK4	43.2	50.9	51.5	44.3	49.0	51.0	49.9
S4	7.8	14.6	9.5	12.8	13.0	11.2	13.1
SK4	13.7	8.6	9.6	9.3	8.1	9.3	8.8
2MN6	26.6	29.5	29.6	34.3	36.4	31.8	31.5
M6	52.8	55.7	53.9	60.3	59.7	59.0	61.2
MSN6	13.5	11.6	12.2	14.2	15.9	17.2	12.8
2MS6	46.6	53.1	49.6	59.4	52.5	55.5	59.3
2MK6	14.3	18.9	19.2	15.5	18.9	20.0	19.7
2SM6	15.4	16.1	6.9	13.0	11.6	12.0	13.3
MSK6	8.7	7.5	6.6	8.3	8.5	8.7	8.1
MA2	42.8	49.7	52.2	28.1	57.2	28.8	23.5
MB2	16.7	40.5	71.3	11.2	38.3	15.9	19.6

	Calais - Phase (º)								
	1965	**1966**	**1967**	**1968**	**1969**	**1970**	**1971**	**1972**	**1973**
ZO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SA	228.0	275.2	223.8	217.9	215.5	226.3	221.4	213.4	220.1
SSA	164.4	309.4	31.5	37.1	125.5	331.0	175.1	111.2	138.5
MM	147.8	231.7	339.0	91.6	341.7	316.4	269.2	236.1	11.6
MSF	159.5	94.6	287.6	158.4	300.3	94.7	44.2	270.6	220.6
MF	185.1	118.9	272.8	150.9	208.8	260.7	191.7	150.0	154.9
2Q1	350.5	101.2	332.0	9.7	40.6	235.7	39.7	1.3	35.9
SIG1	148.5	189.3	263.5	295.2	339.5	26.5	270.9	359.7	196.6
Q1	110.1	96.2	108.2	93.8	104.9	121.9	132.1	158.9	121.5
RO1	186.8	101.7	84.4	61.0	159.8	94.1	136.0	74.1	183.7
O1	162.9	146.4	153.9	154.0	167.9	175.1	165.0	164.2	162.1
MP1	156.8	146.0	264.3	157.8	4.4	119.5	209.7	63.1	354.7
M1	133.8	191.3	217.4	220.7	92.6	166.1	309.7	25.2	5.7
CHI1	35.8	195.9	325.5	146.8	289.1	339.0	20.6	304.1	176.7
PI1	189.4	84.8	279.7	125.7	114.1	280.8	342.1	258.0	190.2
P1	52.5	2.9	359.6	26.7	36.1	344.2	350.3	334.3	48.6
S1	320.7	280.5	298.3	305.4	313.6	302.4	291.1	284.9	292.8
K1	74.2	68.8	66.1	90.3	79.9	78.2	70.7	64.8	68.1
PSI1	257.1	269.0	340.9	316.8	286.1	329.7	283.2	325.0	250.5
PHI1	107.5	97.5	323.9	352.0	97.8	39.0	141.2	224.2	41.9
TH1	261.9	46.6	11.5	144.8	317.9	304.6	57.3	226.6	182.5
J1	208.0	143.5	281.5	200.9	176.1	114.8	207.8	89.0	19.3
SO1	19.1	235.1	334.0	338.4	321.0	262.5	286.5	317.8	342.8
OO1	245.7	302.3	271.1	334.8	176.4	257.8	218.9	245.7	231.5
OQ2	265.8	253.9	307.0	312.0	273.4	265.9	286.2	301.8	271.9
MNS2	75.6	89.9	103.1	104.3	71.0	48.8	87.8	94.3	67.7
2N2	333.3	14.2	331.5	278.4	332.1	15.5	24.3	284.0	324.1
MU2	94.2	88.2	87.6	88.4	87.8	98.2	95.5	91.1	91.4
N2	348.6	349.3	348.7	352.2	353.0	354.0	354.7	352.6	354.0
NU2	343.3	333.3	337.8	345.2	341.5	346.2	342.7	336.2	344.9
OP2	290.9	322.0	21.3	314.8	106.4	40.0	343.8	308.2	332.9
M2	12.4	11.9	14.0	14.9	16.5	17.2	17.5	14.8	15.6
MKS2	164.5	149.7	222.5	155.2	223.3	184.9	190.4	128.9	154.8
LAM2	16.9	16.0	19.3	11.6	29.8	20.5	19.9	33.6	17.2
L2	29.4	28.0	11.5	10.9	37.7	44.1	18.0	15.1	24.8
T2	52.8	48.9	56.4	66.1	81.7	51.5	67.0	91.0	71.9
S2	64.7	65.0	67.7	68.3	69.7	70.4	71.2	67.8	69.0
R2	79.8	251.2	36.6	99.1	110.2	172.2	87.9	101.1	102.2
K2	65.5	63.3	64.7	67.6	66.1	66.9	66.1	65.0	67.0
MSN2	249.8	251.5	274.9	251.9	251.0	248.0	259.3	253.2	252.8
KJ2	342.5	3.2	332.2	327.1	351.3	317.7	316.2	269.8	346.7
2SM2	261.9	277.1	264.3	259.7	272.0	268.4	268.4	265.4	271.1
MO3	73.4	52.1	82.4	61.6	109.0	102.5	94.7	97.8	90.4
M3	92.1	86.2	75.3	93.5	112.8	79.0	123.5	93.0	106.7
SO3	178.7	71.9	199.9	109.5	127.2	92.6	83.1	140.3	162.1
MK3	56.8	143.6	122.2	145.6	3.1	14.3	227.8	209.4	165.0
SK3	173.0	178.1	182.4	200.7	170.0	133.4	259.8	227.1	183.8
MN4	277.0	277.2	278.0	287.9	284.2	284.2	287.8	287.8	287.7
M4	303.9	303.6	306.9	307.9	311.4	310.5	315.3	306.3	312.7
SN4	6.0	27.9	17.5	25.3	26.3	2.6	30.8	34.9	15.6
MS4	0.6	355.5	2.2	5.1	8.5	7.5	13.0	7.0	10.9
MK4	1.1	3.8	355.0	1.6	5.5	357.5	3.7	4.1	5.8
S4	93.3	40.2	87.8	94.2	108.9	100.2	89.6	92.9	99.9
SK4	80.9	66.0	87.7	74.8	84.5	69.4	84.3	59.3	62.5
2MN6	201.2	196.9	199.5	214.6	211.1	210.3	214.2	210.2	213.1
M6	227.6	225.2	226.4	230.2	237.9	238.9	243.3	226.6	237.7
MSN6	258.1	258.2	273.4	276.8	267.5	270.0	287.1	289.8	288.8
2MS6	275.4	268.1	277.3	284.6	286.6	292.4	296.7	287.7	290.7
2MK6	279.0	289.3	269.6	286.8	284.7	281.4	283.7	280.6	288.7
2SM6	340.0	321.4	351.7	358.3	355.5	0.2	4.1	358.9	357.3
MSK6	347.3	338.7	335.4	344.9	341.8	344.5	351.6	347.4	13.9
MA2	301.2	267.0	296.1	30.0	358.5	321.9	6.6	276.5	303.6
MB2	275.3	22.1	124.1	112.6	137.3	245.7	148.6	17.3	129.5

	Calais - Phase (º)						
	1978	**1981**	**1982**	**1992**	**1993**	**1999**	**2000**
ZO	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SA	240.6	225.8	205.3	182.7	216.3	213.9	232.4
SSA	272.9	93.0	112.3	62.4	192.9	82.2	116.7
MM	213.4	299.4	131.9	346.4	31.9	24.8	197.3
MSF	329.4	293.2	69.0	349.5	327.7	150.5	332.3
MF	151.8	140.8	22.5	220.2	318.7	347.8	206.2
2Q1	165.3	30.3	73.6	185.5	247.0	126.7	73.8
SIG1	151.4	41.3	184.4	17.0	351.2	331.2	187.2
Q1	113.1	129.2	122.5	90.4	101.7	122.5	104.9
RO1	125.0	140.9	104.1	138.6	37.8	112.0	186.0
O1	163.6	177.1	130.0	150.8	167.4	158.4	157.9
MP1	116.3	340.8	235.7	283.5	208.9	203.7	265.5
M1	31.6	17.9	119.5	182.4	149.7	320.0	103.1
CHI1	118.1	0.9	26.7	13.5	59.0	100.9	87.7
PI1	274.9	138.9	19.6	93.7	294.7	38.4	138.5
P1	6.7	5.9	39.3	73.4	4.1	345.1	17.9
S1	304.3	286.5	303.0	252.8	225.0	248.8	260.0
K1	70.2	69.7	57.8	71.6	52.8	91.7	77.0
PSI1	257.5	327.0	312.4	204.0	297.6	264.6	312.8
PHI1	266.5	41.6	243.8	338.9	221.4	147.7	167.5
TH1	280.5	106.8	268.8	279.6	279.0	117.1	165.4
J1	90.9	135.3	269.0	97.7	317.6	194.4	265.6
SO1	130.6	279.0	139.7	254.6	270.5	174.1	351.9
OO1	160.2	8.9	25.1	148.9	234.7	75.6	195.5
OQ2	272.8	298.3	295.8	252.5	243.6	291.5	277.7
MNS2	86.5	109.8	92.3	66.8	65.0	95.9	79.6
2N2	334.4	288.6	309.2	356.1	342.1	295.3	319.7
MU2	94.8	99.1	95.7	84.2	82.9	94.1	96.0
N2	349.9	351.6	348.9	345.7	345.2	348.1	347.8
NU2	345.3	342.6	334.7	331.7	337.6	340.3	338.2
OP2	297.8	314.3	317.6	58.7	3.0	303.5	345.4
M2	13.4	13.6	9.0	8.9	8.7	9.9	9.6
MKS2	151.7	153.8	54.4	180.0	30.1	200.2	107.9
LAM2	10.1	10.9	3.6	16.9	2.0	9.4	13.0
L2	28.2	13.1	12.5	27.9	13.8	12.0	18.9
T2	58.0	60.1	64.0	67.2	53.9	58.9	63.6
S2	66.4	66.1	61.1	62.3	62.4	62.9	62.4
R2	26.6	134.1	58.7	103.2	61.2	87.5	65.6
K2	65.4	67.1	64.3	59.9	59.8	62.7	62.9
MSN2	253.0	264.0	243.1	245.7	254.6	254.4	243.9
KJ2	335.9	328.4	27.1	318.6	55.0	262.0	315.2
2SM2	271.1	277.4	278.0	279.3	267.3	274.0	271.7
MO3	118.8	106.8	64.5	53.7	61.9	86.6	78.5
M3	80.6	71.7	84.7	70.2	72.2	88.3	80.7
SO3	94.8	133.4	37.9	139.6	117.4	106.3	105.3
MK3	131.3	294.6	158.1	119.4	81.7	98.4	81.9
SK3	179.1	115.6	197.4	177.3	198.2	141.6	154.7
MN4	280.7	283.3	273.1	267.0	270.9	277.4	275.1
M4	303.7	306.1	292.3	298.2	297.9	298.6	296.1
SN4	13.6	4.5	357.5	17.5	3.4	339.3	4.0
MS4	3.7	3.4	347.5	353.1	355.9	352.9	350.2
MK4	4.7	355.6	354.8	347.1	346.6	358.0	349.7
S4	118.6	82.9	50.2	67.6	83.3	82.0	63.1
SK4	83.2	63.8	80.1	51.4	70.9	94.8	75.2
2MN6	199.6	203.3	185.3	188.5	191.5	198.2	195.5
M6	221.1	225.9	203.0	219.8	218.3	214.8	214.6
MSN6	276.9	273.6	250.3	265.0	260.6	255.1	260.1
2MS6	277.1	277.9	256.8	266.8	269.4	266.5	263.3
2MK6	288.3	277.9	266.3	254.5	266.3	274.9	263.0
2SM6	351.4	323.6	307.4	328.4	345.3	332.5	324.2
MSK6	4.0	335.5	329.3	320.7	326.0	341.7	326.1
MA2	310.5	345.1	48.7	305.4	341.5	309.9	318.4
MB2	203.9	189.2	121.4	149.3	159.0	140.2	133.5

	Santander - Amplitude (mm)								
	1944	**1945**	**1946**	**1947**	**1948**	**1949**	**1950**	**1951**	**1952**
ZO	2656.7	2698.3	2711.3	2860.0	2844.4	2784.4	2770.5	2743.5	2752.6
SA	72.5	76.5	31.3	52.0	59.3	88.8	39.9	80.1	30.4
SSA	22.7	77.1	64.3	43.0	28.4	62.9	34.7	17.3	32.7
MM	20.4	18.6	12.4	44.1	21.6	6.1	28.5	14.0	12.6
MSF	8.9	25.7	17.3	18.5	9.9	11.8	9.4	20.3	6.8
MF	7.1	4.0	7.7	10.4	6.1	17.9	5.2	12.0	2.3
2Q1	4.5	4.0	3.0	4.0	3.9	3.6	4.6	3.7	5.9
SIG1	4.6	4.7	2.6	3.8	4.0	3.9	4.4	3.3	5.2
Q1	24.7	23.2	20.5	17.8	18.3	20.5	23.5	23.5	25.9
RO1	4.6	5.0	4.2	4.9	4.5	4.2	4.4	3.6	4.0
O1	70.6	72.8	71.2	71.6	70.5	70.1	70.1	70.8	70.5
MP1	0.4	1.6	2.4	0.5	2.0	2.1	2.3	2.6	3.0
M1	2.0	1.7	1.7	4.6	4.5	4.7	4.1	4.9	1.8
CHI1	0.3	1.5	0.6	1.0	0.8	0.9	0.2	1.4	1.4
PI1	2.6	0.8	2.2	2.8	1.2	1.4	1.1	1.6	1.6
P1	20.8	20.4	22.1	21.4	19.8	21.4	19.9	20.9	20.0
S1	2.0	3.2	4.6	5.4	6.5	4.7	4.8	6.0	6.9
K1	64.4	63.1	65.7	65.2	64.1	64.3	63.0	65.0	64.7
PSI1	1.7	0.9	1.7	1.8	1.3	1.9	0.9	3.0	1.2
PHI1	1.9	1.1	0.9	1.5	1.7	1.0	1.2	0.8	1.1
TH1	0.6	0.8	0.3	1.2	0.3	0.9	0.3	1.8	0.8
J1	2.9	2.2	4.1	5.2	4.0	3.0	0.9	0.8	2.1
SO1	0.7	1.4	0.7	0.7	1.2	1.4	0.5	0.3	0.6
OO1	3.5	2.1	2.0	1.4	1.4	1.4	1.4	1.3	1.0
OQ2	4.3	2.8	2.7	4.5	3.7	2.3	2.5	4.0	3.2
MNS2	9.3	8.8	7.1	8.1	9.0	9.1	9.3	8.2	9.2
2N2	37.0	35.1	36.4	39.4	37.5	36.0	40.2	39.0	39.6
MU2	42.5	41.2	38.4	43.9	42.8	42.5	42.3	42.1	43.1
N2	272.6	273.0	266.2	273.2	270.3	272.9	277.6	275.6	270.7
NU2	56.7	55.8	47.1	57.8	53.4	53.9	48.3	55.5	51.2
OP2	5.3	15.5	12.6	18.0	6.9	5.7	13.3	5.7	3.8
M2	1313.6	1310.9	1309.1	1308.9	1303.5	1306.7	1309.6	1306.1	1306.4
MKS2	6.3	9.6	8.6	9.6	2.1	2.6	7.6	3.9	6.3
LAM2	9.9	9.3	9.8	13.1	10.7	10.1	6.3	15.0	9.4
L2	30.4	36.5	33.3	37.1	35.1	29.2	29.9	29.5	29.9
T2	18.6	24.5	22.6	32.4	26.3	27.1	24.9	26.7	24.1
S2	457.0	456.0	457.1	456.1	456.3	457.6	456.8	457.0	454.3
R2	4.1	7.8	6.0	14.3	4.4	6.6	3.1	2.8	4.8
K2	133.4	135.3	135.2	128.1	129.7	129.8	125.3	127.4	130.1
MSN2	2.1	1.4	2.1	3.4	2.5	0.7	2.4	4.7	5.1
KJ2	5.8	7.2	6.6	6.5	7.8	6.6	7.4	7.2	7.8
2SM2	1.9	1.2	3.1	4.3	4.1	2.9	2.4	2.9	2.7
MO3	3.1	2.8	3.1	4.0	3.3	3.1	2.1	1.9	1.7
M3	13.7	13.3	13.2	12.5	13.1	12.3	12.6	11.8	12.5
SO3	0.9	0.2	0.8	0.1	0.2	0.8	0.3	1.6	0.7
MK3	2.4	1.3	1.2	0.7	1.8	1.9	2.5	3.3	3.7
SK3	4.7	4.3	4.7	4.4	4.4	4.4	4.2	5.0	4.3
MN4	14.3	13.1	12.7	12.0	12.9	14.2	13.4	12.7	12.7
M4	25.9	25.7	27.0	25.5	26.7	29.0	27.0	25.8	27.2
SN4	1.2	1.6	1.9	1.4	1.7	1.2	1.9	1.9	1.4
MS4	10.5	9.3	12.2	11.4	12.1	13.0	11.5	11.8	12.7
MK4	2.2	2.9	2.9	2.0	3.0	3.4	2.3	3.1	3.0
S4	2.5	1.1	1.6	1.0	1.1	1.1	0.9	1.2	1.3
SK4	0.1	0.7	0.2	0.6	0.7	0.5	0.1	0.3	0.4
2MN6	8.4	8.6	8.6	8.5	8.6	8.9	8.6	8.7	8.6
M6	14.5	15.4	15.1	15.3	15.9	15.9	15.7	15.1	15.5
MSN6	4.9	4.9	5.4	5.3	5.3	5.5	5.7	6.1	5.5
2MS6	14.9	15.3	16.0	16.5	16.9	16.0	16.1	16.0	16.2
2MK6	4.4	4.7	4.9	4.4	4.6	4.7	4.5	5.0	4.8
2SM6	3.0	4.2	4.1	4.3	4.5	4.3	4.4	4.2	5.0
MSK6	2.3	2.8	2.7	2.4	2.6	2.8	2.5	2.9	3.1
MA2	18.8	5.7	17.8	19.7	10.1	1.9	6.5	7.3	7.8
MB2	17.6	3.1	13.7	20.7	3.7	4.7	13.1	12.4	13.5

	Santander - Amplitude (mm)								
	1953	**1954**	**1956**	**1957**	**1958**	**1959**	**1960**	**1961**	**1962**
ZO	2725.2	2715.7	2694.4	2704.2	2732.9	2719.9	2778.5	2761.2	2745.8
SA	40.3	29.5	46.9	46.4	34.3	65.4	88.2	87.4	61.1
SSA	43.5	16.2	49.3	5.1	25.5	42.7	50.6	75.4	31.1
MM	15.1	9.1	26.9	21.0	8.4	15.5	8.3	20.1	34.3
MSF	6.9	15.3	13.0	7.9	20.1	13.9	17.8	22.6	11.6
MF	4.1	17.6	13.1	14.8	31.7	15.8	16.6	40.5	27.9
2Q1	4.0	3.7	3.1	3.9	3.6	4.1	5.0	6.3	5.8
SIG1	4.7	3.1	5.3	3.9	3.6	4.3	3.2	4.5	4.2
Q1	24.7	20.5	19.5	20.0	21.4	21.6	23.3	24.4	25.4
RO1	3.6	4.2	4.9	2.9	4.8	3.4	2.9	4.2	3.6
O1	71.5	73.0	71.7	69.5	68.2	68.2	71.0	70.6	70.4
MP1	0.2	1.4	1.9	2.1	1.1	1.9	1.0	1.5	0.7
M1	1.1	0.7	6.7	6.9	7.3	8.8	8.8	5.1	2.0
CHI1	0.3	1.6	0.9	1.7	0.9	0.2	1.1	2.0	0.6
PI1	2.2	2.0	1.7	2.7	1.6	1.9	1.9	0.7	1.9
P1	21.0	20.3	20.7	21.9	20.6	20.2	22.5	20.6	21.7
S1	7.6	8.0	5.4	3.8	5.0	4.9	3.9	4.4	4.7
K1	63.5	62.9	63.3	64.7	64.6	66.4	64.9	64.6	62.9
PSI1	1.0	2.1	1.0	0.1	1.4	3.3	1.4	2.4	1.3
PHI1	1.2	0.7	2.5	1.9	1.0	2.4	1.2	2.1	0.6
TH1	0.7	0.9	0.4	1.2	0.6	0.8	0.9	1.1	0.8
J1	3.6	5.2	3.2	3.6	1.1	0.6	0.5	2.1	2.4
SO1	0.4	0.9	1.3	1.4	1.0	0.2	1.9	0.4	1.2
OO1	1.5	0.6	1.5	1.7	0.5	0.9	2.1	3.1	1.8
OQ2	2.0	2.9	6.1	5.9	3.8	8.2	9.6	7.7	3.3
MNS2	9.7	9.1	8.5	8.9	9.9	8.7	8.9	8.7	9.6
2N2	36.4	38.4	40.3	38.9	37.9	38.5	39.8	39.1	38.2
MU2	42.8	41.6	42.9	41.7	42.6	44.6	44.3	43.3	43.5
N2	275.3	275.8	269.5	273.3	274.3	276.8	275.7	274.4	276.6
NU2	54.4	48.7	53.3	49.4	52.8	52.7	51.3	51.3	54.6
OP2	5.3	4.0	2.0	5.9	3.8	7.1	16.4	10.6	11.5
M2	1305.7	1301.4	1307.3	1305.6	1307.0	1307.9	1305.7	1308.3	1307.0
MKS2	6.5	5.2	11.0	3.8	8.7	18.5	14.9	6.7	12.8
LAM2	13.9	5.5	13.9	8.5	9.0	11.7	9.0	8.4	9.4
L2	38.6	41.3	32.8	35.9	30.7	28.7	29.7	30.6	38.2
T2	26.5	27.7	26.0	24.2	28.0	26.9	24.6	24.1	25.9
S2	456.1	454.5	451.8	452.9	453.6	451.2	451.4	452.1	452.6
R2	2.1	7.0	5.2	4.9	5.9	4.2	4.0	3.1	3.9
K2	129.5	125.8	127.6	125.5	127.9	129.3	130.7	129.3	134.4
MSN2	4.8	4.2	3.0	4.9	2.5	3.7	3.3	3.0	5.3
KJ2	6.6	7.0	4.2	5.2	7.1	5.8	5.8	6.0	7.7
2SM2	3.0	3.3	6.5	5.5	4.4	4.7	4.9	4.2	4.4
MO3	2.5	3.2	4.2	4.6	3.8	3.9	3.0	2.7	3.1
M3	12.9	13.3	12.5	13.1	12.1	11.9	12.6	12.6	12.4
SO3	1.0	0.7	0.6	1.6	0.9	1.7	1.1	0.6	1.4
MK3	2.6	2.0	0.6	2.1	0.8	3.0	2.0	2.7	2.4
SK3	4.5	4.2	3.6	5.5	4.6	4.9	4.9	5.0	4.7
MN4	14.3	12.5	12.0	12.0	12.2	12.3	12.0	12.6	13.2
M4	29.6	26.3	25.8	25.7	24.5	24.5	23.6	25.0	25.3
SN4	2.1	1.7	1.8	1.5	1.5	1.2	1.8	1.9	1.8
MS4	14.2	12.2	10.5	10.1	9.6	9.8	9.6	9.7	9.8
MK4	3.4	2.5	3.6	3.0	3.6	2.2	2.9	1.8	3.4
S4	1.4	1.1	2.0	0.8	0.6	0.8	0.2	0.2	0.3
SK4	0.6	0.4	0.4	0.4	0.1	0.7	0.4	0.4	0.3
2MN6	9.0	9.5	8.9	9.0	8.9	8.8	8.3	8.1	8.7
M6	14.9	16.0	15.9	16.0	15.5	14.1	13.6	14.3	14.3
MSN6	5.3	5.8	5.4	5.7	5.1	4.9	5.0	5.0	5.2
2MS6	15.2	16.5	16.2	16.0	15.2	14.9	14.4	14.7	14.4
2MK6	4.4	4.9	4.6	4.1	4.9	5.2	4.4	4.5	4.3
2SM6	4.1	4.5	6.8	6.0	5.6	4.8	4.2	4.6	4.4
MSK6	2.7	2.8	2.7	3.1	2.4	2.9	2.5	2.3	2.7
MA2	3.8	10.8	5.0	7.7	11.1	4.8	6.2	6.1	10.7
MB2	4.1	17.9	4.4	1.6	2.7	2.0	8.6	7.8	6.5

	Santander - Amplitude (mm)								
	1963	**1964**	**1965**	**1966**	**1967**	**1968**	**1969**	**1970**	**1971**
ZO	2779.3	2752.1	2800.1	2841.5	2820.2	2854.0	2857.6	2806.7	2787.1
SA	79.1	33.8	96.6	60.7	58.3	80.7	55.9	33.5	28.9
SSA	27.2	40.7	44.3	26.6	51.3	41.3	5.0	48.3	10.5
MM	31.4	6.2	28.8	36.1	18.4	9.4	30.7	14.3	8.1
MSF	15.1	8.6	9.8	24.9	9.6	9.7	3.1	28.4	13.8
MF	18.1	13.8	1.4	13.5	5.2	17.0	6.2	9.5	18.5
2Q1	4.4	3.6	3.2	4.2	4.3	4.7	6.0	5.4	4.2
SIG1	3.8	3.7	3.6	5.1	3.4	5.2	3.2	4.0	3.9
Q1	22.9	21.0	18.7	18.7	21.0	23.5	24.3	24.5	23.3
RO1	4.1	5.0	3.6	4.7	3.8	4.3	2.8	3.9	4.5
O1	73.1	74.2	71.9	70.3	70.4	70.5	70.4	71.1	71.8
MP1	2.3	3.1	1.1	1.5	2.3	0.9	2.9	1.3	1.8
M1	0.8	3.1	6.2	4.5	4.4	4.8	3.5	2.1	1.5
CHI1	0.9	1.1	0.6	1.0	1.5	1.5	0.4	1.3	1.3
PI1	0.9	2.8	1.7	3.0	2.5	2.0	2.9	1.5	1.5
P1	22.4	18.8	21.7	19.9	20.7	20.9	20.6	22.2	20.6
S1	0.8	4.4	3.3	3.2	4.9	2.5	1.3	1.2	3.4
K1	64.3	62.6	63.2	64.0	63.2	64.9	63.4	63.9	63.9
PSI1	1.9	2.4	0.2	1.0	0.8	3.0	2.1	2.3	2.7
PHI1	1.4	1.9	1.0	0.6	1.0	1.5	0.3	1.0	0.9
TH1	1.5	1.1	1.1	1.7	1.1	0.9	0.6	0.2	0.4
J1	3.6	3.3	4.7	3.2	1.6	0.8	1.0	2.5	3.7
SO1	0.8	0.6	0.2	0.4	0.8	0.4	0.7	1.1	1.0
OO1	1.8	1.5	1.3	1.2	1.1	1.4	1.4	1.4	1.5
OQ2	4.0	4.7	4.3	2.8	2.1	3.7	3.6	2.8	2.5
MNS2	9.7	7.8	8.8	10.0	10.0	10.5	9.3	10.6	9.9
2N2	36.9	38.4	39.8	38.3	37.9	39.2	39.7	37.6	38.2
MU2	43.6	43.1	43.2	44.1	42.8	44.8	42.4	46.6	44.7
N2	274.1	273.6	273.9	276.6	273.4	277.8	278.0	276.0	275.8
NU2	52.9	50.8	49.7	54.6	56.7	55.7	51.5	55.8	54.9
OP2	6.0	11.4	9.9	1.7	11.9	13.9	5.1	8.8	2.3
M2	1307.2	1311.2	1315.6	1313.7	1312.7	1316.3	1313.0	1313.8	1312.8
MKS2	3.2	3.9	9.0	1.0	5.5	5.6	6.6	8.9	3.3
LAM2	9.8	7.9	8.9	10.7	10.9	10.8	7.2	10.8	9.5
L2	37.1	38.8	37.2	40.1	28.2	27.1	29.3	28.1	37.9
T2	26.9	24.0	24.5	22.8	23.8	25.7	24.2	27.3	27.9
S2	453.8	457.4	457.4	457.2	459.2	461.0	459.7	459.0	461.7
R2	6.1	4.2	4.4	2.6	4.0	3.1	3.9	5.1	6.0
K2	130.5	130.3	133.4	131.0	131.4	128.4	131.8	132.6	128.7
MSN2	0.9	2.6	4.4	5.6	2.9	2.6	3.7	3.0	2.7
KJ2	5.7	5.2	5.6	6.5	8.2	8.1	8.0	8.2	7.7
2SM2	3.2	3.4	3.2	3.2	2.3	3.0	2.4	1.8	1.6
MO3	3.6	3.3	3.7	3.7	2.4	2.5	2.1	2.9	3.4
M3	13.0	13.3	12.7	13.3	12.6	12.5	12.9	12.9	13.2
SO3	0.3	2.8	0.7	0.5	1.4	0.4	0.4	0.3	0.8
MK3	1.8	2.8	1.6	1.7	1.6	2.8	3.0	2.1	1.1
SK3	5.2	5.2	4.0	4.2	3.8	4.2	4.2	3.9	4.2
MN4	12.9	12.7	12.6	13.4	13.1	12.8	12.4	13.2	13.8
M4	25.1	25.3	26.5	26.0	26.3	25.5	25.6	25.5	25.4
SN4	2.3	1.9	1.9	1.8	1.6	2.5	2.1	2.0	1.7
MS4	9.6	9.4	11.9	11.2	12.7	13.0	13.6	11.8	11.8
MK4	2.5	2.8	2.6	2.5	2.3	2.4	2.2	2.4	1.6
S4	0.2	0.2	1.6	1.2	2.0	2.1	1.9	2.1	1.9
SK4	0.1	0.6	0.5	0.3	0.8	0.4	0.1	0.5	0.6
2MN6	8.0	7.3	6.6	6.6	6.1	6.0	5.0	5.4	5.4
M6	13.4	11.8	11.5	11.3	11.1	9.4	8.3	8.7	8.6
MSN6	5.1	4.7	4.3	4.2	4.2	3.4	3.2	2.6	2.9
2MS6	13.9	12.9	13.1	11.7	11.5	10.0	9.5	8.2	7.7
2MK6	3.6	3.6	3.1	3.6	3.5	2.4	2.7	2.6	2.5
2SM6	4.1	3.5	2.8	3.1	2.6	1.9	1.7	1.2	1.1
MSK6	2.6	2.4	2.0	2.1	2.2	1.8	1.4	1.6	1.7
MA2	12.4	10.5	6.6	9.8	4.5	4.0	2.5	10.7	4.3
MB2	5.6	13.0	5.6	3.0	5.5	4.5	5.8	5.2	4.0

	Santander - Amplitude (mm)								
	1972	**1973**	**1974**	**1975**	**1976**	**1977**	**1978**	**1979**	**1980**
ZO	2800.0	2705.4	2722.9	2741.4	2797.6	2821.9	2814.1	2845.9	2827.2
SA	54.2	43.1	32.0	63.7	108.9	48.7	64.1	72.3	34.1
SSA	13.5	17.7	21.6	16.4	46.5	15.9	38.4	10.0	17.3
MM	23.7	12.4	9.1	21.2	16.0	19.1	10.6	23.8	14.8
MSF	7.0	10.3	17.0	17.7	10.5	25.4	9.6	7.5	13.5
MF	6.5	33.2	14.1	11.3	24.9	41.1	20.3	22.2	19.4
2Q1	3.5	3.3	2.5	3.4	3.5	2.7	7.2	6.1	4.2
SIG1	4.0	3.6	3.7	4.1	4.0	3.5	5.2	4.5	5.0
Q1	21.7	19.9	18.6	19.5	21.1	24.0	24.0	24.1	23.9
RO1	3.5	3.9	3.7	3.3	4.0	4.2	3.6	4.2	4.5
O1	72.4	72.0	67.6	69.0	69.1	70.4	69.5	71.9	70.6
MP1	1.2	1.4	1.9	0.7	2.6	2.0	0.5	2.2	1.3
M1	1.2	4.5	5.9	6.6	6.9	7.8	7.0	3.9	2.9
CHI1	0.4	1.8	2.2	0.4	0.9	0.5	0.2	1.9	0.4
PI1	2.0	2.1	2.4	2.0	1.2	3.0	1.5	2.5	2.2
P1	23.3	19.5	21.6	21.1	21.9	22.1	24.5	19.7	20.5
S1	3.3	5.2	5.3	7.1	8.3	6.2	5.3	6.8	5.3
K1	63.4	65.4	65.6	63.1	63.6	64.7	68.9	64.4	63.8
PSI1	0.1	1.8	1.7	0.6	0.3	0.2	1.5	3.0	3.6
PHI1	2.0	1.9	0.9	1.7	0.4	0.7	2.8	0.9	0.8
TH1	1.2	0.8	0.8	1.1	0.5	2.4	2.0	5.7	1.6
J1	4.7	4.2	3.7	1.8	0.9	0.5	2.9	1.9	3.5
SO1	0.4	1.6	0.8	0.9	1.6	0.8	3.5	0.7	1.2
OO1	1.5	1.3	0.8	2.1	0.5	0.6	4.5	3.4	3.5
OQ2	3.9	4.1	4.4	5.2	6.4	5.4	9.8	6.7	3.7
MNS2	11.7	9.8	9.6	11.5	10.4	8.7	8.1	8.7	8.5
2N2	40.3	39.7	37.0	39.6	39.1	42.4	36.6	40.1	37.1
MU2	46.1	44.7	45.0	45.0	45.2	43.0	45.6	41.3	43.5
N2	272.9	277.5	275.3	277.2	275.8	278.6	278.4	279.5	277.3
NU2	54.9	48.7	50.3	52.7	54.1	51.6	52.9	48.7	44.0
OP2	11.2	5.3	1.5	1.6	10.0	18.6	4.0	5.6	14.1
M2	1314.7	1313.3	1318.3	1321.1	1321.4	1320.4	1320.4	1317.4	1313.5
MKS2	5.4	3.2	9.4	4.5	6.9	9.3	9.4	3.0	13.6
LAM2	11.2	5.8	9.5	9.3	8.8	4.7	7.4	4.6	5.4
L2	35.5	38.9	31.6	29.5	26.0	30.0	29.1	36.0	40.4
T2	22.9	24.9	25.2	26.2	25.2	28.2	22.3	23.6	20.6
S2	460.7	459.0	458.3	457.5	457.5	458.4	456.2	459.1	452.2
R2	4.9	4.7	5.4	5.8	3.1	2.5	2.9	2.7	3.5
K2	128.3	129.8	130.1	128.5	130.9	123.5	127.8	130.3	127.1
MSN2	1.3	3.0	1.9	2.6	2.9	3.2	0.9	3.2	2.8
KJ2	6.8	4.5	5.1	6.5	4.2	6.6	10.6	4.6	3.3
2SM2	1.6	0.8	2.4	1.9	2.0	3.3	3.8	4.4	6.7
MO3	3.6	3.9	4.0	3.3	3.5	3.6	3.6	3.4	3.8
M3	13.1	13.4	13.5	13.1	12.6	13.1	13.2	13.0	13.0
SO3	1.2	0.4	1.2	0.5	0.5	0.6	0.9	0.7	0.3
MK3	2.2	0.7	3.5	1.8	2.4	2.9	3.1	2.8	1.2
SK3	3.7	4.6	3.0	4.1	5.1	5.1	5.9	5.8	5.7
MN4	13.0	11.7	11.6	12.5	12.6	12.4	12.3	12.8	12.1
M4	24.7	21.9	23.1	24.2	24.6	23.7	24.5	24.1	23.0
SN4	1.0	1.3	0.9	0.7	1.0	1.2	0.5	1.3	1.4
MS4	10.0	8.2	8.0	7.2	7.5	7.4	7.2	8.1	7.3
MK4	3.1	1.7	2.0	2.2	2.0	2.0	2.0	1.8	1.6
S4	0.6	0.7	0.4	0.8	1.3	1.6	1.2	2.3	1.2
SK4	0.3	0.3	0.3	0.4	0.8	0.8	0.5	1.0	1.5
2MN6	5.7	4.7	4.5	4.1	4.1	4.0	3.8	4.8	7.0
M6	9.4	8.3	7.4	6.6	6.9	6.3	6.6	8.1	12.4
MSN6	2.8	2.3	1.6	2.3	1.9	1.9	2.0	3.0	4.2
2MS6	8.0	6.8	6.6	6.3	5.8	5.9	6.6	7.9	12.6
2MK6	2.3	1.8	1.5	1.9	2.3	1.6	1.4	2.5	3.0
2SM6	2.0	2.0	1.9	2.0	2.1	1.7	2.3	2.8	4.9
MSK6	1.5	1.6	0.8	0.7	1.0	1.1	1.4	0.9	2.4
MA2	7.5	6.8	2.9	3.8	6.6	6.2	5.6	8.5	13.1
MB2	4.7	4.4	4.5	4.7	7.2	2.3	6.3	7.1	11.2

	Santander - Amplitude (mm)								
	1981	**1982**	**1984**	**1985**	**1986**	**1987**	**1988**	**1989**	**1990**
ZO	2814.5	2808.0	2789.1	2804.6	2787.7	2854.3	2833.2	2857.0	2799.6
SA	33.1	85.6	31.6	9.2	20.0	88.3	76.4	37.3	52.1
SSA	56.1	21.8	63.6	31.5	17.8	43.4	41.1	63.4	26.4
MM	17.9	28.9	8.1	8.2	4.6	23.8	12.0	7.1	15.3
MSF	7.6	15.0	20.7	6.0	13.0	14.4	14.9	34.7	16.5
MF	14.7	12.0	21.2	18.4	6.3	17.0	4.4	16.3	20.8
2Q1	2.5	1.1	4.0	3.7	4.2	6.3	5.3	3.6	3.6
SIG1	3.0	2.4	4.9	5.2	4.6	3.9	3.5	5.3	4.2
Q1	22.6	18.2	18.9	22.0	24.0	24.9	23.4	22.2	19.0
RO1	4.5	3.3	3.3	4.5	3.5	4.9	4.3	4.5	3.9
O1	71.0	70.7	69.5	69.5	68.4	70.3	68.6	71.3	70.4
MP1	2.7	3.2	1.5	0.5	2.7	0.7	1.3	3.0	0.8
M1	1.5	5.5	5.5	5.1	4.3	2.6	1.4	0.7	1.0
CHI1	1.9	1.1	2.4	0.5	0.4	1.9	1.1	1.0	1.2
PI1	0.7	2.5	1.9	2.7	1.8	1.8	2.9	7.4	1.9
P1	20.4	22.9	20.0	19.1	19.3	19.2	20.2	22.6	16.6
S1	4.7	3.3	3.9	3.7	5.5	1.5	4.5	15.8	15.8
K1	61.0	63.9	63.8	63.6	60.4	62.5	61.9	59.8	62.3
PSI1	1.5	2.6	1.8	1.4	0.8	1.9	3.4	5.4	2.6
PHI1	0.9	0.6	1.6	2.1	2.6	0.6	1.2	3.1	3.6
TH1	1.8	1.3	0.5	0.6	0.2	1.0	0.6	1.0	1.2
J1	3.3	5.1	3.2	2.9	0.8	0.9	3.5	5.9	6.2
SO1	2.3	0.7	0.8	1.2	1.2	1.5	1.3	1.5	0.6
OO1	3.2	1.7	1.0	0.9	0.9	1.8	1.6	2.8	2.3
OQ2	3.3	4.7	3.1	2.9	4.1	4.9	3.8	3.6	3.5
MNS2	7.1	6.2	9.0	9.8	10.3	10.0	10.1	9.5	11.7
2N2	34.0	37.2	38.5	40.0	39.4	40.5	38.4	23.3	39.9
MU2	39.5	39.4	45.1	43.2	42.4	42.9	42.0	41.6	44.3
N2	273.7	264.4	277.5	278.5	277.8	276.0	268.4	268.2	273.4
NU2	50.1	49.4	51.1	53.4	51.2	51.8	53.3	77.1	53.5
OP2	16.4	4.9	2.0	3.5	6.1	13.6	6.5	52.1	22.4
M2	1302.0	1277.7	1318.0	1314.5	1301.6	1304.0	1302.9	1268.8	1311.6
MKS2	8.2	3.2	4.7	9.6	10.5	7.0	4.9	33.4	21.1
LAM2	10.5	14.7	8.6	9.8	7.3	9.3	10.5	18.3	11.7
L2	39.5	40.5	33.5	28.0	29.3	31.0	31.1	39.4	35.5
T2	20.4	15.9	30.2	25.0	29.9	26.5	17.9	33.2	22.7
S2	450.7	440.9	458.5	458.3	455.4	456.6	451.7	434.5	451.6
R2	0.6	11.9	6.8	3.0	13.7	3.0	4.1	18.3	7.9
K2	125.1	124.8	132.5	130.9	131.5	126.2	126.3	126.0	123.9
MSN2	4.2	8.6	2.1	1.6	5.3	8.3	5.7	8.2	2.7
KJ2	5.8	3.8	6.4	7.7	8.3	9.4	6.4	9.5	7.5
2SM2	8.6	10.7	2.3	3.2	2.3	2.6	3.2	5.0	5.5
MO3	3.1	3.7	3.4	2.3	2.4	2.3	1.5	2.3	4.0
M3	13.8	13.2	12.6	13.7	12.0	12.1	13.2	12.8	12.8
SO3	1.4	0.7	1.0	1.7	0.7	0.7	0.7	0.8	0.8
MK3	2.7	2.7	1.6	1.1	3.4	3.2	2.1	2.6	0.2
SK3	5.2	4.6	4.0	3.7	4.5	4.5	3.9	4.2	3.7
MN4	12.0	8.9	12.8	12.1	12.5	13.0	12.2	12.2	12.8
M4	21.9	19.7	24.7	24.0	24.2	23.5	22.6	21.2	22.4
SN4	1.1	1.4	1.6	1.2	1.3	1.4	2.4	2.1	1.3
MS4	5.4	7.5	8.5	7.3	10.6	11.2	10.8	9.4	11.8
MK4	1.8	2.7	2.1	2.2	2.0	1.9	1.3	1.6	1.8
S4	1.0	0.6	0.5	0.5	3.0	2.1	1.0	0.9	1.2
SK4	0.4	0.9	0.4	0.2	0.5	1.4	1.2	0.2	0.7
2MN6	8.9	11.2	3.9	4.5	4.7	5.3	8.1	8.8	2.7
M6	16.5	20.4	6.7	8.3	7.7	11.5	16.1	16.1	3.8
MSN6	6.1	6.6	2.7	3.1	3.4	4.5	5.6	5.7	1.8
2MS6	17.4	22.1	6.4	8.6	8.6	12.2	17.2	17.2	5.5
2MK6	4.3	5.8	1.7	2.2	2.5	2.9	3.6	6.2	1.3
2SM6	5.4	6.8	1.6	2.3	1.8	2.2	3.9	5.3	2.2
MSK6	2.5	2.8	1.1	1.5	1.6	1.8	2.6	3.5	0.3
MA2	10.9	33.0	7.6	5.1	12.3	12.7	15.7	66.3	3.9
MB2	12.0	31.0	16.0	13.6	15.0	7.9	12.3	33.2	10.6

	Santander - Amplitude (mm)							
	1993	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**
ZO	2811.7	2807.4	2863.7	2857.8	2859.5	2827.9	2831.2	2917.5
SA	54.7	42.7	100.9	96.1	11.4	83.0	113.6	34.0
SSA	73.3	29.6	24.9	101.9	32.0	35.4	106.2	37.4
MM	43.6	6.9	6.6	24.2	29.9	29.4	11.2	20.4
MSF	32.4	2.8	21.1	8.5	11.0	21.3	7.2	30.5
MF	8.9	40.7	24.1	20.9	4.8	28.0	7.3	19.8
2Q1	3.8	4.8	6.7	4.0	3.3	4.6	2.9	3.4
SIG1	4.9	5.5	3.9	6.5	3.4	3.7	3.8	3.8
Q1	19.3	24.9	22.8	24.8	21.8	21.0	18.0	18.4
RO1	4.5	4.5	3.7	6.0	2.6	3.8	3.5	3.6
O1	63.8	70.0	74.5	70.2	72.1	72.9	71.0	70.0
MP1	1.2	1.4	2.7	2.8	1.7	1.3	0.8	1.9
M1	6.2	8.9	4.0	3.3	3.0	2.3	7.8	6.4
CHI1	2.4	1.5	3.3	0.6	3.8	0.9	1.7	1.0
PI1	4.5	0.7	5.1	1.7	3.4	1.9	2.2	3.4
P1	21.0	22.2	23.0	19.2	24.0	22.7	17.9	20.1
S1	16.0	2.3	7.9	4.3	6.8	4.0	10.5	12.0
K1	69.4	66.9	61.4	63.5	69.3	64.4	64.9	62.9
PSI1	8.5	1.0	2.7	0.7	3.4	0.8	2.2	3.8
PHI1	3.2	0.6	2.2	1.6	3.6	5.6	0.7	4.4
TH1	1.6	0.4	2.6	1.5	1.0	2.1	0.8	0.4
J1	4.5	3.1	1.6	4.3	2.3	2.9	4.1	4.0
SO1	1.4	1.1	0.8	0.8	1.1	1.0	0.6	1.1
OO1	2.6	2.1	1.2	3.2	4.6	5.3	0.2	2.6
OQ2	6.1	5.2	6.4	3.1	4.1	7.3	7.4	5.9
MNS2	10.1	10.4	8.2	9.8	10.8	10.3	9.3	9.2
2N2	43.1	39.8	38.5	37.9	35.4	40.8	39.8	39.4
MU2	44.5	47.0	46.1	42.7	44.4	45.4	42.1	41.5
N2	282.4	275.5	277.4	279.4	278.0	269.6	268.2	277.9
NU2	57.8	56.1	48.9	49.4	54.2	54.9	51.7	55.0
OP2	8.5	5.5	14.8	4.5	6.8	13.1	9.5	2.3
M2	1309.0	1312.5	1318.1	1314.5	1313.5	1316.1	1308.5	1305.3
MKS2	13.6	16.5	17.5	2.1	5.4	2.4	5.4	3.2
LAM2	10.1	11.6	7.5	7.4	11.7	11.2	15.2	10.6
L2	34.6	26.4	31.3	38.1	36.4	31.1	33.2	41.0
T2	19.8	29.2	26.5	24.6	29.0	26.5	26.4	27.0
S2	451.3	448.8	450.3	455.8	451.9	451.1	450.1	451.2
R2	7.6	15.0	9.9	6.1	5.5	5.9	5.8	6.4
K2	127.1	131.3	123.8	128.7	126.5	126.8	133.5	132.2
MSN2	2.6	2.5	4.4	1.1	1.3	2.2	2.6	5.5
KJ2	7.9	7.6	7.0	8.4	6.6	4.0	8.8	4.7
2SM2	5.8	3.0	3.5	1.9	1.8	3.1	2.0	2.3
MO3	4.1	3.6	4.5	4.1	4.3	4.5	3.9	3.5
M3	12.3	13.0	13.2	13.5	12.4	13.9	13.6	12.6
SO3	1.8	2.2	4.3	2.1	0.3	0.8	0.1	1.8
MK3	2.4	3.0	5.0	1.5	0.7	1.9	3.1	3.3
SK3	5.0	4.0	5.5	4.6	6.6	5.4	4.8	5.7
MN4	12.5	12.9	12.5	12.9	13.2	11.9	11.9	12.2
M4	22.3	22.6	23.2	23.3	23.8	25.0	26.0	24.1
SN4	2.6	1.2	1.5	2.3	0.8	1.8	1.5	3.2
MS4	16.4	7.4	10.6	8.4	9.1	9.3	10.2	15.1
MK4	2.6	3.1	2.4	0.9	1.9	3.1	2.3	1.8
S4	3.2	2.4	1.1	1.3	1.2	1.6	1.8	1.7
SK4	0.1	0.9	1.0	0.4	1.8	0.2	1.5	1.1
2MN6	4.0	2.8	2.9	3.1	3.8	4.8	5.7	6.5
M6	5.5	4.0	4.9	5.9	7.1	8.2	9.7	11.5
MSN6	1.8	1.8	2.3	3.0	2.8	2.7	3.1	4.6
2MS6	5.2	4.8	5.5	6.5	7.5	8.9	10.2	12.5
2MK6	1.2	1.6	1.3	1.6	1.5	2.4	2.9	3.3
2SM6	3.6	1.2	1.5	0.3	0.7	0.3	1.2	2.4
MSK6	0.9	1.6	1.3	2.1	1.4	1.8	1.9	2.0
MA2	28.5	22.1	13.1	5.9	7.6	16.1	5.0	12.5
MB2	18.1	22.8	16.3	5.8	4.2	20.2	14.3	9.5

	Santander - Phase (º)								
	1944	**1945**	**1946**	**1947**	**1948**	**1949**	**1950**	**1951**	**1952**
ZO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SA	182.1	200.3	210.0	342.0	221.8	211.4	275.8	281.0	248.3
SSA	75.2	139.7	80.6	337.0	136.6	87.2	151.5	95.1	73.0
MM	233.3	45.2	295.0	15.8	69.5	130.3	181.5	116.8	299.3
MSF	90.4	311.2	333.3	54.4	272.3	70.4	139.1	56.6	300.0
MF	225.0	124.6	167.7	250.0	21.9	186.0	167.9	328.3	134.9
2Q1	235.7	241.1	238.0	220.6	236.6	218.5	220.6	218.7	239.5
SIG1	253.0	251.4	260.5	249.1	243.5	239.5	246.8	233.0	255.5
Q1	279.7	283.7	285.7	284.2	273.9	268.2	268.0	273.9	280.2
RO1	285.8	282.5	265.9	264.6	305.2	278.1	274.7	285.2	288.8
O1	325.1	323.9	324.0	323.5	323.8	325.4	325.4	324.6	324.9
MP1	105.8	200.0	147.9	110.5	117.7	122.1	118.3	96.7	103.9
M1	122.2	187.4	196.6	295.3	349.5	2.6	18.0	68.5	101.6
CHI1	269.3	15.5	355.1	4.5	45.7	86.2	180.5	40.9	6.5
PI1	55.1	130.3	65.4	45.1	114.1	61.8	59.4	77.5	39.6
P1	53.9	56.7	60.3	61.2	60.2	60.3	57.2	57.9	58.4
S1	325.6	355.6	3.3	4.4	7.6	5.5	2.8	353.3	354.4
K1	72.9	71.1	70.7	71.1	71.6	71.5	71.5	70.2	70.4
PSI1	126.8	5.8	95.7	57.5	81.1	66.0	82.5	73.5	312.3
PHI1	106.1	87.6	129.1	75.6	73.7	50.5	171.1	38.8	59.7
TH1	354.9	119.3	0.7	213.9	89.1	102.3	278.5	112.2	241.6
J1	185.9	153.6	113.4	106.3	81.2	59.8	5.2	196.0	154.1
SO1	266.2	315.7	70.3	21.8	33.6	39.8	353.6	287.5	5.8
OO1	172.5	203.6	210.3	260.2	210.6	254.6	207.9	208.3	211.6
OQ2	291.1	173.5	89.8	6.1	312.9	191.5	107.6	29.5	330.1
MNS2	37.7	37.9	34.4	40.2	42.6	26.0	40.1	48.9	53.4
2N2	61.2	56.9	53.5	59.6	56.7	56.4	56.3	59.8	59.8
MU2	64.3	62.0	66.3	67.2	65.8	65.6	64.7	67.0	64.1
N2	76.4	76.2	76.2	76.2	75.7	75.8	75.5	76.6	75.8
NU2	78.4	73.6	76.5	77.5	76.8	75.0	78.6	81.3	78.7
OP2	89.9	25.9	16.3	251.1	234.4	352.2	273.9	290.2	159.3
M2	96.0	95.2	94.5	94.7	95.2	95.5	94.9	95.1	94.4
MKS2	104.4	144.6	121.9	319.1	295.6	192.2	301.9	164.2	88.3
LAM2	114.7	102.7	49.2	89.2	85.8	103.7	80.0	67.4	78.2
L2	117.7	112.0	94.6	97.6	96.2	94.4	104.9	102.7	113.4
T2	132.9	115.0	121.2	137.4	120.6	131.6	129.8	137.3	134.8
S2	127.6	127.1	126.4	126.3	126.9	127.7	126.7	127.1	126.5
R2	317.9	122.8	201.5	126.6	171.8	130.4	111.5	118.9	89.1
K2	125.9	126.3	125.1	121.5	123.7	124.5	123.1	123.7	123.1
MSN2	253.9	278.0	195.2	266.5	236.7	129.4	329.2	280.9	250.3
KJ2	334.2	337.2	336.1	351.7	345.3	328.8	331.1	332.4	324.9
2SM2	320.0	308.2	267.6	313.3	285.4	274.0	310.3	273.8	293.6
MO3	56.0	42.3	345.8	305.1	272.7	246.1	200.1	167.0	83.4
M3	336.5	336.5	333.3	334.2	331.9	334.0	333.3	334.6	333.2
SO3	299.6	136.8	218.4	143.3	277.6	353.3	302.6	314.5	301.5
MK3	342.8	334.3	339.4	334.2	277.1	314.6	313.0	332.4	326.3
SK3	32.5	14.0	25.2	29.1	22.2	27.4	28.7	36.6	34.8
MN4	287.4	290.1	294.4	291.2	292.7	292.9	292.4	292.4	292.9
M4	332.2	332.4	335.9	337.2	338.7	337.0	333.6	339.3	340.1
SN4	8.2	22.1	22.0	48.8	25.9	358.6	2.5	17.1	59.2
MS4	50.4	49.1	49.4	54.6	52.6	46.9	46.4	56.8	51.4
MK4	47.3	50.6	54.5	56.9	54.4	35.9	35.8	55.2	41.9
S4	81.3	51.8	73.2	121.3	75.4	98.1	95.4	121.1	112.2
SK4	157.3	109.0	320.0	135.7	142.7	329.5	9.6	142.2	132.9
2MN6	176.5	180.2	179.5	176.4	177.1	181.2	174.0	179.3	181.4
M6	203.4	198.9	194.6	198.5	204.4	200.4	194.3	198.1	201.7
MSN6	222.5	220.6	225.9	223.5	231.2	223.1	224.3	227.3	223.5
2MS6	240.5	239.2	237.5	236.3	241.4	239.8	234.7	239.8	237.9
2MK6	238.9	241.0	233.3	233.1	233.9	234.1	229.5	236.1	234.5
2SM6	290.8	283.0	282.7	288.0	283.1	292.7	278.2	287.5	289.1
MSK6	281.1	282.2	288.4	271.1	276.2	278.4	270.8	276.4	276.3
MA2	355.3	122.5	52.6	178.0	62.4	261.6	320.9	296.2	285.4
CHI1	52.6	225.2	347.2	177.2	36.3	136.4	89.8	84.5	99.2

	Santander - Phase (º)								
	1953	1954	1956	1957	1958	1959	1960	1961	1962
ZO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SA	200.6	218.5	219.8	262.5	243.0	246.2	234.4	223.6	227.2
SSA	105.8	348.7	328.6	136.7	268.8	92.1	26.3	115.9	53.2
MM	336.1	310.6	327.7	327.0	79.0	95.4	13.0	162.9	337.2
MSF	42.8	284.0	308.4	342.8	132.2	325.6	349.3	70.6	75.8
MF	107.5	175.6	126.1	28.8	130.2	146.0	258.2	185.1	336.9
2Q1	247.2	239.4	241.6	241.6	215.8	213.1	225.8	239.0	240.0
SIG1	244.7	252.2	232.3	245.1	239.8	236.4	245.7	232.1	242.1
Q1	284.2	287.9	277.5	270.1	266.5	269.4	274.3	276.1	280.9
RO1	277.7	273.3	258.7	267.5	273.8	281.6	283.5	264.9	275.4
O1	325.1	323.5	321.7	323.8	324.6	326.1	324.3	324.6	323.3
MP1	70.2	103.3	53.9	154.1	347.2	54.3	8.4	104.0	151.5
M1	74.4	158.7	326.9	355.0	4.7	28.8	75.4	119.5	137.0
CHI1	8.0	9.6	336.7	335.2	48.7	243.7	65.8	12.8	14.3
PI1	80.3	39.5	43.9	48.3	30.3	94.3	42.3	288.9	84.4
P1	54.2	59.7	59.9	57.6	56.5	59.7	60.2	58.5	59.7
S1	4.6	5.5	354.3	336.5	345.4	4.7	1.1	33.8	18.9
K1	71.4	70.9	70.2	69.8	70.5	71.9	72.2	70.0	69.9
PSI1	41.1	111.0	315.5	44.8	300.2	55.8	101.6	4.2	0.6
PHI1	359.7	127.2	120.2	98.3	52.2	22.9	89.6	80.7	137.3
TH1	58.0	16.5	59.0	150.8	75.2	36.2	293.5	122.2	85.9
J1	158.7	125.1	97.8	85.6	36.3	202.3	136.2	168.4	153.9
SO1	308.1	281.1	298.3	82.1	343.4	263.8	315.0	351.3	344.9
OO1	217.0	229.7	260.5	273.5	235.6	188.4	161.8	220.5	226.8
OQ2	253.7	127.9	335.4	254.4	202.2	91.7	30.5	309.6	253.3
MNS2	49.9	48.9	47.6	52.0	45.4	47.2	49.1	41.7	41.8
2N2	58.6	58.2	54.3	56.9	60.0	55.9	60.2	57.4	57.9
MU2	67.0	66.0	65.6	63.6	64.4	63.0	67.6	63.0	63.6
N2	75.8	77.2	75.2	76.4	76.9	76.4	75.6	74.9	75.1
NU2	81.1	73.1	77.8	74.7	73.5	75.9	78.4	74.2	80.5
OP2	141.1	224.8	321.5	271.5	62.1	63.5	191.4	305.2	68.5
M2	94.3	94.9	95.0	95.1	95.4	95.4	94.7	94.2	94.2
MKS2	54.3	7.2	151.6	218.5	95.8	96.5	28.2	230.6	108.2
LAM2	64.7	91.5	89.2	85.9	100.3	78.3	83.4	88.4	71.9
L2	102.8	98.1	97.5	85.9	93.8	101.7	107.3	109.6	110.4
T2	129.3	139.1	124.7	128.6	123.6	132.2	137.7	133.1	123.3
S2	126.5	127.3	127.4	127.3	127.9	127.8	127.1	126.6	126.4
R2	126.0	64.5	121.8	143.6	144.9	134.5	100.9	133.9	160.8
K2	122.5	122.7	126.4	125.5	126.4	126.9	122.6	126.0	124.7
MSN2	244.5	271.2	240.7	232.2	268.1	264.9	280.6	266.2	272.9
KJ2	325.3	335.2	325.9	334.4	353.6	317.1	338.7	332.9	327.1
2SM2	289.9	261.7	293.0	293.8	298.9	301.0	288.2	295.3	282.1
MO3	34.9	356.6	287.8	257.3	221.0	190.6	142.7	96.1	49.6
M3	332.6	334.4	332.4	331.2	331.2	331.1	331.3	331.2	334.9
SO3	92.7	330.5	23.8	180.5	43.5	335.3	10.1	298.0	286.2
MK3	348.6	343.9	257.4	336.2	318.3	301.7	325.5	334.4	338.3
SK3	35.6	30.9	42.1	36.7	39.7	31.3	36.6	28.4	24.5
MN4	299.2	302.6	293.9	293.0	295.9	295.3	289.5	286.7	291.8
M4	343.2	343.0	339.5	338.9	338.0	337.3	337.3	334.1	335.5
SN4	36.1	37.7	342.5	15.5	28.4	15.2	13.0	7.7	18.7
MS4	51.2	58.7	34.5	40.6	41.9	45.7	46.9	38.0	39.7
MK4	46.5	58.4	47.0	48.3	52.1	59.7	43.6	58.1	51.5
S4	108.9	109.8	327.5	2.6	23.7	63.0	102.3	272.1	30.9
SK4	91.3	106.5	21.1	6.8	284.6	290.3	351.1	280.2	216.9
2MN6	176.6	185.7	182.1	183.9	184.2	183.9	179.6	175.1	174.7
M6	198.7	201.2	203.7	203.7	202.4	199.6	198.7	195.7	195.8
MSN6	227.0	228.6	230.8	226.7	231.5	231.1	222.5	218.4	220.5
2MS6	237.0	239.3	237.9	240.1	240.2	239.9	237.2	235.6	234.7
2MK6	230.3	236.7	247.1	232.9	241.2	239.2	227.3	238.3	236.9
2SM6	288.1	285.0	293.4	297.6	299.8	300.6	293.7	298.1	292.8
MSK6	270.7	264.9	287.1	268.1	275.7	284.3	282.6	269.6	274.8
MA2	9.4	263.2	40.1	56.2	67.2	54.8	290.1	2.7	25.2
CHI1	91.9	112.1	66.4	59.8	223.8	102.5	93.3	55.7	14.9

	Santander - Phase (º)								
	1963	**1964**	**1965**	**1966**	**1967**	**1968**	**1969**	**1970**	**1971**
ZO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SA	275.9	252.8	214.5	251.3	194.0	228.9	275.7	297.5	78.3
SSA	209.4	25.9	89.2	356.3	61.1	92.0	353.6	234.1	98.0
MM	181.7	207.7	146.7	170.4	277.5	310.5	329.8	103.4	241.0
MSF	329.1	125.8	31.4	91.6	12.4	154.4	128.9	93.3	139.4
MF	113.1	186.4	197.9	227.6	49.7	149.5	139.9	188.7	182.4
2Q1	259.5	242.2	194.1	228.4	207.8	208.5	220.2	230.4	250.4
SIG1	257.8	250.2	238.9	243.4	237.1	238.5	230.0	225.0	242.1
Q1	285.1	283.5	276.6	272.4	265.2	267.5	271.6	276.3	285.2
RO1	275.0	280.1	292.0	284.6	283.3	281.5	278.8	278.2	277.3
O1	323.6	322.4	322.1	322.0	323.4	323.7	323.3	323.4	323.3
MP1	128.6	215.0	244.4	142.0	98.6	188.5	136.6	219.9	160.9
M1	108.6	228.7	309.9	348.2	14.5	30.5	79.1	65.0	90.2
CHI1	141.0	15.5	302.4	232.6	352.0	26.2	339.4	73.8	8.7
PI1	32.9	33.3	81.9	78.3	43.3	79.1	69.8	43.7	47.1
P1	58.6	59.7	58.7	60.2	53.1	58.3	55.0	56.5	54.5
S1	337.4	21.8	35.3	4.8	17.1	338.8	41.1	39.7	40.8
K1	70.7	70.7	69.8	70.8	69.6	69.0	70.4	70.7	68.6
PSI1	53.0	346.8	98.0	25.4	121.0	68.9	100.6	76.8	60.7
PHI1	138.5	99.3	132.7	247.1	140.9	121.5	26.8	109.6	102.1
TH1	94.4	85.2	105.5	71.2	161.2	145.3	44.1	43.6	154.0
J1	138.6	117.0	95.9	74.9	52.0	21.6	183.9	170.5	153.7
SO1	148.5	34.6	158.2	228.8	37.5	54.3	32.0	55.4	322.8
OO1	170.3	231.5	245.2	238.8	215.4	212.1	196.3	220.1	195.7
OQ2	163.8	83.0	6.4	278.0	165.2	77.5	11.4	295.5	170.2
MNS2	34.9	39.0	45.4	43.3	30.0	35.7	35.9	37.1	36.1
2N2	54.4	55.7	57.0	58.0	54.3	53.3	59.9	57.6	54.0
MU2	62.6	59.7	61.0	60.0	58.3	58.3	57.9	53.7	52.9
N2	75.6	74.9	74.3	75.0	74.9	74.2	74.8	75.6	74.6
NU2	76.2	75.1	75.9	79.9	76.1	76.5	76.0	80.0	76.1
OP2	354.7	310.6	329.8	224.3	22.2	331.1	180.1	121.4	70.1
M2	94.7	93.8	94.3	93.9	94.1	94.1	93.6	94.5	93.7
MKS2	41.8	198.6	161.3	295.6	122.2	192.3	64.0	102.4	87.8
LAM2	80.0	76.8	84.3	79.7	95.2	90.7	98.3	94.5	88.9
L2	108.6	103.4	101.5	90.1	87.2	107.9	110.9	117.1	114.4
T2	127.2	129.3	129.2	123.5	131.8	130.3	132.1	128.1	130.3
S2	126.7	126.0	126.4	125.6	126.3	126.0	125.6	126.0	125.4
R2	161.9	216.5	140.3	171.8	125.3	164.1	130.5	164.5	146.2
K2	124.8	124.2	125.5	123.2	124.7	124.7	121.8	122.9	122.2
MSN2	305.5	299.1	283.2	251.3	235.2	304.7	280.4	262.4	242.3
KJ2	318.3	331.3	333.7	336.1	333.6	331.8	331.1	326.7	310.8
2SM2	300.4	287.0	293.1	300.8	314.4	344.2	318.5	354.6	20.4
MO3	17.1	337.7	305.9	264.7	229.1	190.7	133.3	71.9	25.8
M3	335.3	332.5	330.1	330.4	330.5	332.1	334.2	332.6	330.6
SO3	218.0	153.3	14.6	16.4	9.8	40.4	202.9	73.5	216.2
MK3	347.6	7.1	301.1	307.0	289.7	325.5	329.7	324.8	330.6
SK3	30.4	32.5	29.3	34.9	23.6	22.7	33.6	35.6	36.9
MN4	291.5	288.0	285.9	285.5	284.3	286.1	281.6	278.3	282.2
M4	335.0	329.6	331.7	329.7	330.9	327.6	327.9	327.9	326.9
SN4	1.6	357.1	27.0	31.4	32.9	17.4	17.4	27.0	17.7
MS4	44.1	42.9	51.4	43.1	47.1	47.7	41.3	49.6	49.7
MK4	39.4	60.8	44.6	42.3	50.4	46.8	36.3	34.3	33.7
S4	357.4	108.3	119.1	85.6	77.1	78.2	84.1	74.5	103.7
SK4	285.1	191.4	126.3	10.6	114.0	125.3	69.8	91.3	193.7
2MN6	175.9	168.8	168.4	166.0	165.3	158.7	153.6	141.4	127.0
M6	192.4	185.9	191.9	191.0	184.8	180.1	174.3	160.0	149.4
MSN6	227.2	212.9	216.3	212.9	208.8	208.6	210.0	195.2	197.6
2MS6	233.9	225.6	229.9	226.6	227.6	224.6	218.3	201.6	198.2
2MK6	227.5	226.2	231.1	223.0	221.0	224.2	216.7	205.4	195.2
2SM6	292.0	268.4	266.2	281.5	290.9	302.2	305.7	329.7	281.3
MSK6	276.6	260.4	273.1	260.5	256.7	269.2	252.1	238.4	235.3
MA2	74.9	15.1	358.2	32.0	17.5	350.4	20.7	54.7	78.1
CHI1	284.8	3.4	78.1	25.4	103.6	91.5	106.8	315.0	160.1

	Santander - Phase (º)								
	1972	**1973**	**1974**	**1975**	**1976**	**1977**	**1978**	**1979**	**1980**
ZO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SA	262.6	180.1	215.8	226.2	211.6	275.9	313.1	271.6	204.4
SSA	75.4	157.9	347.9	64.9	47.7	226.8	213.1	310.0	53.2
MM	208.3	272.6	104.8	203.9	186.8	78.5	356.0	174.6	348.8
MSF	201.1	235.1	207.9	276.5	76.1	217.9	282.8	290.0	20.2
MF	144.3	185.9	145.8	232.8	106.9	88.4	116.8	330.5	89.8
2Q1	218.5	238.9	200.8	243.5	212.7	220.7	226.1	247.5	244.5
SIG1	251.9	229.9	258.7	230.4	230.5	242.7	241.9	265.9	258.6
Q1	282.3	281.9	271.7	268.4	262.6	273.4	273.3	276.2	281.7
RO1	267.0	283.8	301.5	308.6	284.8	275.9	267.5	277.4	283.3
O1	321.9	322.7	323.4	322.2	322.8	323.4	323.9	324.5	324.4
MP1	137.3	141.7	55.0	81.7	98.1	81.7	136.3	114.9	173.5
M1	195.0	288.2	343.0	352.3	12.9	42.6	90.3	137.0	153.0
CHI1	247.4	354.1	28.8	150.4	223.4	49.4	146.3	113.5	137.4
PI1	63.5	44.6	37.2	67.1	0.7	84.5	124.5	161.4	106.2
P1	53.6	53.5	63.8	52.6	57.0	56.8	55.8	64.5	61.5
S1	30.3	38.9	17.6	15.6	46.2	45.7	348.3	39.7	34.0
K1	70.3	69.3	69.1	70.4	68.0	69.7	72.0	71.1	72.8
PSI1	232.4	57.5	16.0	181.5	288.4	307.2	56.9	338.8	37.9
PHI1	76.5	77.6	57.5	109.1	70.2	177.4	139.0	239.4	172.9
TH1	201.3	71.4	103.9	109.7	259.8	229.2	295.1	84.7	213.5
J1	118.4	94.3	75.7	54.8	103.2	171.5	206.8	109.1	153.7
SO1	32.8	3.0	29.6	38.0	47.3	128.9	30.5	81.6	37.2
OO1	222.8	195.6	315.5	205.6	230.5	271.5	209.9	174.4	221.6
OQ2	110.9	34.5	299.0	220.5	132.2	67.0	33.7	292.8	228.4
MNS2	29.6	26.9	33.5	36.1	31.9	30.6	26.1	43.6	48.0
2N2	53.5	59.7	55.1	52.9	55.0	57.8	52.2	56.3	63.7
MU2	52.1	52.9	51.2	54.9	54.5	53.4	54.3	62.6	69.0
N2	74.6	74.1	74.1	73.4	74.7	74.4	74.8	75.7	76.8
NU2	72.8	78.8	77.2	78.6	74.5	71.4	74.7	81.1	79.6
OP2	348.3	275.0	102.6	329.2	17.2	314.7	234.1	345.5	292.4
M2	94.3	94.0	94.2	93.6	93.3	93.5	94.2	95.3	96.3
MKS2	175.8	127.6	132.0	128.5	104.7	215.3	78.1	100.2	305.2
LAM2	110.3	71.9	101.3	89.7	97.5	117.5	106.1	55.3	53.3
L2	107.7	105.0	100.0	95.4	89.9	106.1	111.6	114.6	111.8
T2	126.8	125.2	130.4	130.6	133.8	126.9	133.3	129.1	134.7
S2	126.2	125.8	126.0	125.5	125.4	125.7	126.3	128.0	130.0
R2	150.6	151.9	134.5	122.2	117.5	147.3	138.3	126.8	147.2
K2	123.5	122.3	124.3	123.3	124.1	124.3	124.7	128.3	129.5
MSN2	247.3	312.7	238.6	259.1	251.2	298.8	165.4	293.0	245.5
KJ2	315.5	320.1	320.1	334.6	308.9	347.8	307.1	333.5	350.5
2SM2	308.5	304.5	308.9	314.5	269.0	306.1	340.2	294.2	277.3
MO3	348.9	312.3	284.9	243.5	206.1	160.3	117.0	67.8	35.6
M3	328.2	326.7	329.5	325.9	328.9	330.7	329.2	332.6	334.8
SO3	12.5	18.7	342.5	94.5	153.1	292.6	112.6	241.2	303.1
MK3	154.1	301.8	256.3	298.1	320.3	327.2	0.2	4.0	350.2
SK3	55.8	41.6	23.1	34.4	30.8	31.5	37.4	26.4	43.8
MN4	285.2	282.6	282.8	278.3	280.6	283.7	283.2	282.1	288.3
M4	327.0	327.9	328.8	326.5	324.2	324.6	325.3	328.7	331.6
SN4	353.5	24.5	1.9	346.2	333.0	331.2	358.2	348.6	30.0
MS4	47.3	54.5	51.1	32.0	21.8	21.3	24.0	20.5	38.1
MK4	39.0	39.2	52.1	37.4	11.2	43.7	41.0	77.8	47.5
S4	137.5	138.1	209.0	247.3	272.5	302.7	281.5	279.5	254.5
SK4	128.0	195.7	164.2	101.2	305.3	280.3	199.0	215.2	201.3
2MN6	132.2	123.8	122.6	127.7	124.4	128.6	130.8	153.0	173.1
M6	148.3	138.9	143.3	157.1	146.1	147.5	152.3	174.7	195.5
MSN6	200.9	200.0	202.5	196.3	191.0	184.0	195.3	210.1	227.7
2MS6	201.0	190.8	194.9	207.0	195.7	197.7	201.6	215.0	237.5
2MK6	198.9	195.0	188.0	192.7	191.9	198.1	212.4	224.9	250.2
2SM6	274.3	255.6	262.5	263.0	282.5	272.8	260.7	276.6	289.0
MSK6	241.3	251.2	244.7	239.7	216.1	265.7	276.0	276.0	266.8
MA2	29.9	55.5	65.8	52.6	4.1	40.5	41.2	16.7	29.5
CHI1	19.5	1.3	29.1	134.3	58.2	324.2	70.4	29.6	42.3

	Santander - Phase (º)								
	1981	**1982**	**1984**	**1985**	**1986**	**1987**	**1988**	**1989**	**1990**
ZO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SA	240.8	232.1	230.9	321.1	267.8	221.0	245.0	285.3	233.6
SSA	72.9	131.0	73.7	174.9	317.9	64.3	101.8	128.9	99.4
MM	102.7	108.4	67.7	164.5	129.4	150.6	182.1	199.6	244.9
MSF	129.6	194.2	201.7	354.3	181.4	310.3	343.9	112.5	190.3
MF	213.5	299.3	243.3	153.6	79.3	200.7	96.8	232.6	354.7
2Q1	248.3	168.7	210.2	221.9	212.6	234.7	254.1	257.8	228.4
SIG1	264.4	258.5	250.3	221.3	222.7	236.2	238.5	247.9	247.1
Q1	285.5	288.2	267.0	266.2	266.2	276.1	283.0	292.7	281.8
RO1	299.3	276.8	280.1	280.5	278.7	283.5	285.4	277.8	278.5
O1	326.5	328.1	321.1	322.6	324.1	324.1	323.8	327.4	322.8
MP1	147.5	133.8	230.1	81.8	127.9	188.9	19.4	168.1	189.1
M1	183.7	259.6	0.7	14.2	37.7	100.2	33.5	0.0	274.2
CHI1	292.8	299.0	19.6	4.4	327.1	32.0	41.8	192.2	14.9
PI1	144.0	50.5	44.1	41.7	82.0	27.9	36.3	52.0	40.6
P1	60.0	63.3	61.0	52.0	62.7	59.4	59.5	55.1	45.7
S1	28.6	31.9	356.0	345.7	277.8	347.1	43.4	103.9	79.9
K1	75.7	75.3	69.2	71.5	68.7	70.4	73.3	77.9	70.3
PSI1	108.9	48.9	34.4	35.2	27.6	126.6	99.9	111.7	85.8
PHI1	182.4	160.0	328.3	104.3	83.9	106.2	124.8	48.0	333.1
TH1	110.0	23.7	65.3	27.7	235.8	104.6	251.7	22.8	79.2
J1	150.3	113.3	53.9	44.9	151.1	185.1	206.1	180.2	107.1
SO1	308.7	91.9	133.3	29.9	339.6	130.2	317.1	292.9	113.4
OO1	219.9	278.4	229.4	208.3	222.8	208.1	229.9	243.7	258.4
OQ2	126.6	23.7	245.7	154.8	60.4	350.1	289.1	79.7	67.8
MNS2	65.3	98.1	31.6	27.5	45.8	62.9	84.4	76.1	33.5
2N2	62.1	60.7	51.9	54.8	57.8	62.4	68.1	52.7	54.6
MU2	86.4	104.0	57.3	56.8	61.5	66.4	75.1	96.3	60.0
N2	81.4	85.6	74.4	75.5	75.2	77.8	79.7	83.2	76.1
NU2	80.3	86.0	80.4	74.1	75.1	73.6	78.5	80.8	83.1
OP2	343.1	296.3	127.3	81.9	62.6	293.6	238.6	48.9	235.1
M2	99.6	103.1	94.9	95.0	94.9	95.4	98.1	102.2	94.9
MKS2	250.1	328.6	54.1	51.0	81.0	241.1	303.4	176.9	335.9
LAM2	65.9	66.0	86.1	100.8	97.4	80.7	79.4	117.6	104.4
L2	103.5	98.3	101.0	101.4	111.1	105.1	111.8	108.1	106.0
T2	137.9	115.5	138.4	136.6	140.7	135.4	126.9	93.5	144.1
S2	133.8	138.7	126.8	127.4	127.0	128.3	131.9	138.5	127.5
R2	237.4	306.8	110.1	78.3	104.7	196.2	271.0	274.7	94.6
K2	132.7	135.2	124.3	124.5	124.1	125.6	128.7	141.8	121.4
MSN2	261.0	269.1	250.1	275.8	299.9	255.0	238.4	315.1	269.6
KJ2	325.9	23.1	335.1	348.8	335.2	334.9	328.8	311.3	337.9
2SM2	277.1	288.8	289.6	294.5	307.8	293.1	302.8	332.6	17.0
MO3	359.5	335.7	254.4	211.7	164.1	115.5	85.7	17.2	344.3
M3	340.8	350.0	330.1	331.8	331.5	331.7	339.4	348.5	325.4
SO3	252.6	251.0	105.5	83.6	90.9	22.1	349.7	235.6	63.1
MK3	25.0	327.0	267.3	342.0	333.4	335.1	346.3	5.0	204.0
SK3	32.3	43.5	20.6	42.8	27.1	26.2	43.2	51.1	42.8
MN4	295.7	307.3	280.3	287.3	284.1	280.9	285.1	297.1	281.1
M4	331.9	347.4	330.2	328.5	324.4	330.7	334.9	334.6	325.7
SN4	24.7	59.3	38.8	10.5	26.6	22.3	36.3	50.2	39.8
MS4	38.2	75.4	41.9	37.0	49.3	59.2	65.0	69.2	58.8
MK4	61.2	67.0	43.6	42.3	40.8	54.5	20.7	75.6	37.6
S4	260.4	244.9	74.0	9.4	67.6	120.7	103.1	211.9	144.4
SK4	216.2	195.0	161.7	185.9	128.9	169.0	201.7	257.4	132.1
2MN6	202.3	233.8	132.8	154.6	152.0	175.4	191.6	239.4	160.9
M6	220.2	250.1	159.6	174.0	174.4	190.9	213.4	256.4	187.7
MSN6	245.6	282.8	186.6	204.9	220.0	217.0	232.4	268.7	204.3
2MS6	258.1	286.6	203.8	215.3	219.3	224.7	247.0	297.5	224.3
2MK6	264.1	293.8	198.3	212.1	213.6	218.9	250.7	287.2	211.2
2SM6	308.4	337.2	271.5	262.5	319.4	318.8	319.6	8.7	50.4
MSK6	305.2	339.3	237.6	246.3	264.1	277.8	287.7	345.3	257.7
MA2	5.0	35.1	244.2	298.7	210.5	37.3	12.3	74.4	275.4
CHI1	58.4	35.1	131.6	89.9	151.2	22.8	14.9	353.2	83.6

	Santander - Phase (º)							
	1993	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**
ZO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SA	183.8	247.8	282.6	222.5	194.1	204.2	229.8	255.6
SSA	83.4	150.3	197.9	131.0	78.2	49.6	105.4	345.8
MM	298.2	72.0	181.9	155.1	54.1	270.2	218.9	280.0
MSF	115.3	121.7	103.2	168.0	100.7	149.1	12.5	30.6
MF	196.8	225.6	130.0	219.6	175.0	247.5	234.8	228.3
2Q1	223.4	218.3	229.5	227.4	252.0	233.0	228.3	258.7
SIG1	236.0	219.8	247.5	252.1	221.7	229.8	232.8	257.8
Q1	267.3	268.6	278.1	279.0	283.6	282.3	281.6	277.8
RO1	301.6	286.0	311.1	297.6	275.2	268.0	282.3	321.2
O1	323.6	322.2	324.7	322.3	324.3	325.5	324.2	325.7
MP1	3.3	61.0	229.9	5.8	131.2	147.3	239.1	150.3
M1	18.0	78.9	127.8	157.5	140.7	216.6	282.3	339.6
CHI1	18.1	47.7	15.7	228.9	25.8	333.4	35.4	339.8
PI1	354.8	270.3	74.0	71.4	128.6	327.4	276.3	306.3
P1	56.5	53.8	48.4	65.5	72.5	55.5	67.5	57.4
S1	91.1	72.6	93.7	94.6	81.9	89.7	73.3	102.3
K1	70.3	69.6	74.8	71.7	71.4	73.3	69.1	74.7
PSI1	115.1	276.3	86.6	12.3	36.2	126.9	215.3	205.6
PHI1	193.7	87.0	131.9	268.8	72.9	64.0	141.7	137.4
TH1	225.9	2.8	63.4	104.5	259.3	273.0	218.3	43.4
J1	69.5	169.7	164.7	111.7	163.0	147.9	107.7	101.6
SO1	337.1	104.2	60.9	127.8	85.5	11.9	129.2	182.4
OO1	178.8	182.6	145.0	217.1	204.7	237.4	272.7	182.0
OQ2	181.0	36.3	329.0	285.9	171.4	105.8	44.0	326.4
MNS2	27.5	50.2	49.1	37.6	34.7	46.5	52.7	71.0
2N2	57.7	54.2	57.2	54.3	57.6	64.1	57.0	64.6
MU2	59.2	57.9	57.3	63.2	60.1	65.6	66.9	67.6
N2	75.2	74.1	75.4	74.2	77.3	77.6	77.9	78.5
NU2	78.1	78.7	69.4	79.4	80.8	81.5	86.8	78.0
OP2	128.5	68.5	336.6	270.1	349.9	322.4	253.6	293.4
M2	95.1	94.1	94.6	94.4	96.3	95.7	97.2	97.7
MKS2	59.6	94.8	180.8	96.1	336.1	134.0	358.1	244.5
LAM2	83.6	92.0	114.2	68.3	92.9	72.4	67.8	90.1
L2	101.8	111.4	111.3	118.6	110.0	98.2	100.9	98.0
T2	114.8	137.8	136.6	134.5	137.5	143.1	149.7	139.4
S2	128.1	126.7	127.7	127.6	129.5	128.8	130.2	131.0
R2	232.6	112.3	97.0	132.3	174.1	107.0	86.8	129.3
K2	124.9	127.0	128.2	126.6	129.7	126.6	128.6	128.4
MSN2	305.9	247.8	243.9	277.9	284.8	247.5	235.7	276.0
KJ2	302.8	305.2	340.1	334.2	298.6	340.3	314.5	356.0
2SM2	37.2	34.1	319.2	68.8	29.5	10.3	1.8	26.0
MO3	227.6	112.5	107.2	71.5	26.6	1.7	327.3	276.3
M3	331.1	335.1	324.8	333.3	332.8	339.0	332.4	330.5
SO3	324.5	355.2	121.1	32.2	287.8	114.1	277.8	178.6
MK3	264.5	2.1	1.0	26.9	327.6	329.1	259.4	298.5
SK3	50.2	53.6	48.0	25.6	27.1	39.3	20.5	27.8
MN4	284.3	279.8	281.6	278.7	290.6	293.0	295.2	292.0
M4	332.3	318.9	323.6	324.0	329.9	330.2	336.6	336.2
SN4	36.3	348.6	61.7	41.2	106.5	33.3	63.1	64.5
MS4	69.4	62.0	63.8	66.6	68.5	67.7	64.8	71.3
MK4	68.4	15.1	82.8	16.0	40.6	39.1	57.7	88.9
S4	141.7	140.1	161.8	99.4	187.0	137.4	226.2	137.0
SK4	299.6	172.2	182.6	160.7	205.1	304.5	82.2	100.2
2MN6	142.7	149.8	143.9	141.1	161.0	158.7	182.3	186.4
M6	165.0	164.7	176.0	178.0	192.9	192.5	203.8	213.0
MSN6	203.8	210.7	205.7	204.1	210.7	220.1	229.2	220.8
2MS6	222.9	208.8	216.8	223.3	232.9	231.5	239.7	250.1
2MK6	187.9	202.5	219.3	200.3	254.2	248.3	240.4	258.6
2SM6	72.3	90.0	74.2	310.5	250.8	222.6	293.8	11.5
MSK6	272.8	291.2	192.0	249.6	281.1	266.2	263.3	281.0
MA2	22.2	175.9	190.2	83.4	10.1	282.6	301.3	138.1
CHI1	354.1	188.6	166.4	138.2	83.5	107.5	92.7	208.8

	Coruña - Amplitude (mm)								
	1944	**1945**	**1946**	**1947**	**1948**	**1949**	**1950**	**1951**	**1952**
ZO	2542.9	2618.1	2639.9	2665.6	2599.4	2570.8	2599.4	2703.0	2638.2
SA	45.9	102.1	49.3	78.3	60.8	121.9	44.5	28.1	24.4
SSA	20.4	98.6	67.7	49.7	37.5	68.0	43.5	28.0	39.1
MM	15.1	25.3	5.4	30.2	30.7	19.5	24.3	22.9	7.5
MSF	9.1	31.7	13.6	18.9	8.4	6.3	6.0	13.6	1.1
MF	12.4	3.4	10.8	8.6	13.7	11.7	7.1	10.2	1.7
2Q1	4.9	3.9	4.0	3.9	4.0	4.0	5.4	4.1	5.7
SIG1	3.3	3.8	3.9	4.6	4.1	4.7	4.9	4.5	4.9
Q1	23.8	21.3	19.7	18.1	18.7	19.4	22.5	22.8	24.8
RO1	3.6	4.8	3.9	4.0	4.9	3.9	5.8	4.5	4.1
O1	68.0	68.6	67.0	67.3	66.4	65.3	66.0	65.7	66.1
MP1	1.4	1.5	1.3	1.5	2.8	1.6	1.7	2.4	2.8
M1	2.6	1.3	1.7	4.4	5.2	4.6	4.5	4.2	2.3
CHI1	0.2	2.7	0.7	1.7	1.5	0.2	0.7	1.4	1.8
PI1	3.6	1.5	2.4	2.7	2.9	0.8	1.1	1.9	0.8
P1	23.6	23.2	26.1	23.7	22.7	23.8	22.4	22.3	23.1
S1	4.2	7.3	5.9	3.5	5.9	8.8	6.0	7.1	6.1
K1	73.2	74.2	74.8	72.6	73.2	73.4	71.0	72.8	72.1
PSI1	1.7	2.7	1.5	2.1	2.5	4.2	0.4	2.5	1.6
PHI1	3.2	0.6	0.8	2.3	4.2	1.2	1.8	2.6	0.7
TH1	2.2	0.7	1.2	1.0	0.8	0.5	0.1	0.4	0.6
J1	2.3	3.7	4.7	4.4	4.7	2.6	0.9	0.8	2.0
SO1	2.0	0.8	1.6	0.8	1.8	1.5	0.5	0.9	0.1
OO1	3.6	2.2	1.2	2.0	0.6	1.4	1.4	1.4	0.5
OQ2	5.2	4.3	4.0	3.5	2.2	2.0	3.6	3.3	2.1
MNS2	11.7	10.5	9.8	8.0	9.1	10.5	10.1	8.5	9.4
2N2	31.3	32.4	36.0	33.6	33.2	37.0	37.7	34.0	33.4
MU2	43.2	41.8	40.9	38.5	42.3	41.0	41.4	42.4	40.7
N2	245.1	250.8	242.4	244.2	249.5	249.9	247.9	248.8	243.2
NU2	54.4	50.0	51.9	40.0	45.1	46.2	50.7	51.4	48.2
OP2	10.3	9.4	8.8	6.0	2.7	1.5	5.1	10.7	3.9
M2	1174.0	1178.1	1179.7	1176.6	1169.0	1172.0	1172.3	1171.9	1172.0
MKS2	16.7	9.8	6.6	1.6	2.8	1.2	4.0	4.5	8.1
LAM2	5.2	5.6	12.9	3.9	4.9	5.3	8.4	5.7	10.8
L2	26.1	35.2	28.2	29.5	33.9	28.2	25.6	25.1	23.0
T2	34.8	20.8	22.1	20.8	20.8	22.5	23.6	26.8	14.6
S2	406.5	410.2	415.2	414.8	412.0	414.5	411.3	414.5	414.4
R2	21.3	2.1	6.5	3.4	0.5	3.9	5.7	2.7	4.4
K2	121.3	124.2	119.2	118.8	119.2	117.3	118.6	114.9	120.0
MSN2	0.9	2.7	0.1	1.0	2.1	1.2	1.1	3.1	3.7
KJ2	6.1	7.8	7.2	5.4	6.5	6.3	7.8	6.6	8.1
2SM2	3.6	0.1	0.4	0.9	1.8	2.1	0.9	1.1	1.8
MO3	1.7	3.1	2.9	3.1	2.5	2.1	1.0	1.5	1.3
M3	8.4	9.7	9.9	8.9	8.7	8.7	8.8	9.5	9.0
SO3	1.2	0.4	1.1	1.0	0.7	0.6	0.8	0.7	0.1
MK3	2.5	0.6	0.6	0.4	0.9	1.6	1.8	2.1	1.4
SK3	3.5	2.8	3.2	3.8	3.1	3.6	3.1	3.0	2.9
MN4	6.1	6.1	5.3	5.2	6.0	5.3	5.4	5.6	5.0
M4	12.1	11.8	11.4	11.5	11.4	11.0	11.3	11.4	11.2
SN4	1.0	0.4	0.4	0.9	1.1	0.9	0.2	0.5	0.9
MS4	7.6	6.0	5.3	5.9	6.5	6.8	6.2	5.7	5.5
MK4	1.5	2.3	1.9	1.3	1.2	1.6	1.7	1.8	1.4
S4	2.4	1.0	0.0	0.9	0.4	1.2	0.4	0.3	1.1
SK4	1.0	0.4	0.7	0.3	1.0	0.1	0.5	0.7	1.1
2MN6	0.9	1.2	0.4	0.3	1.1	1.4	1.5	1.5	1.0
M6	1.5	1.7	0.8	1.5	1.1	2.3	2.3	2.7	1.9
MSN6	0.4	1.0	0.4	0.8	0.8	0.8	0.6	0.7	1.0
2MS6	2.2	1.5	2.4	2.2	2.0	2.2	2.5	2.2	2.2
2MK6	1.0	0.5	0.3	0.7	0.8	1.3	0.8	1.5	1.1
2SM6	1.7	1.1	0.6	1.1	1.5	1.4	1.2	0.8	0.6
MSK6	0.1	0.3	0.3	0.5	0.7	0.3	0.1	0.6	0.3
MA2	41.5	7.1	6.4	12.8	12.8	7.9	7.1	3.4	18.6
MB2	45.4	7.1	4.7	9.6	12.6	9.0	2.9	1.2	15.2

	Coruña - Amplitude (mm)								
	1953	**1954**	**1955**	**1956**	**1957**	**1958**	**1959**	**1960**	**1961**
ZO	2618.6	2568.4	2674.9	2537.2	2589.6	2624.0	2614.2	2629.4	2586.7
SA	33.3	46.3	65.0	75.5	30.3	75.2	66.5	83.2	55.6
SSA	28.0	25.4	19.3	46.7	41.3	29.8	11.9	55.4	65.3
MM	6.8	12.3	13.5	15.3	21.3	11.8	12.6	9.4	22.9
MSF	2.6	17.8	8.0	3.1	12.2	22.1	12.0	13.1	7.6
MF	6.3	5.8	14.2	10.2	14.1	37.2	17.1	12.4	32.6
2Q1	4.6	3.5	2.6	2.9	3.8	3.7	4.6	5.7	7.0
SIG1	5.4	5.0	4.5	5.1	4.1	2.9	4.4	3.4	5.6
Q1	22.7	21.3	19.0	19.0	19.8	20.7	21.5	23.9	23.7
RO1	3.6	3.2	4.3	4.6	3.3	3.3	4.3	4.8	3.8
O1	66.0	66.9	67.6	67.5	66.8	62.6	66.9	66.5	68.9
MP1	0.9	2.9	2.1	2.9	2.7	1.8	2.1	3.4	1.0
M1	1.6	2.0	5.3	6.4	7.2	6.4	8.2	7.3	6.7
CHI1	2.5	1.3	0.9	2.0	2.9	1.8	0.8	0.4	1.4
PI1	2.3	2.6	2.4	3.0	2.6	1.7	0.8	3.7	1.1
P1	21.5	22.5	23.3	24.6	24.4	23.8	23.6	26.5	23.5
S1	6.6	8.7	8.6	8.1	4.9	5.8	8.6	4.5	6.3
K1	73.2	71.5	72.2	72.7	73.0	72.1	74.6	74.4	73.0
PSI1	2.2	1.9	1.4	1.4	1.2	1.6	2.3	1.6	1.1
PHI1	0.8	2.1	1.9	1.1	1.5	1.3	1.7	2.6	2.3
TH1	0.5	1.0	0.5	1.0	1.2	1.2	1.6	1.6	1.3
J1	2.7	5.4	4.7	3.5	3.6	1.6	0.5	1.5	1.5
SO1	0.7	0.7	1.3	1.4	1.5	1.5	1.6	1.1	1.4
OO1	1.5	0.3	2.1	2.2	2.8	1.7	1.6	2.9	0.9
OQ2	1.4	4.0	4.7	4.0	4.2	5.3	9.5	8.9	4.5
MNS2	9.2	10.9	8.3	11.0	9.1	8.2	8.4	10.7	9.5
2N2	32.3	38.0	32.8	35.3	34.0	36.9	39.3	38.1	33.0
MU2	41.4	40.4	41.4	44.5	41.9	41.6	39.5	43.8	45.3
N2	248.3	249.0	244.3	244.6	249.4	242.3	246.9	250.4	248.1
NU2	49.1	49.9	51.4	46.4	42.9	50.0	51.3	50.4	47.5
OP2	2.3	7.2	9.0	8.0	5.2	7.8	23.6	8.2	8.8
M2	1173.0	1170.1	1172.8	1178.4	1173.0	1176.4	1175.0	1174.0	1177.3
MKS2	0.5	2.7	5.4	5.1	0.5	3.2	13.0	1.3	2.6
LAM2	10.7	7.8	9.4	8.4	6.2	11.9	8.7	6.9	8.0
L2	27.4	35.5	29.2	26.7	27.5	19.9	19.9	25.5	22.9
T2	22.8	26.3	24.4	27.3	26.3	24.1	22.0	22.3	28.1
S2	416.2	415.6	413.6	411.3	413.5	413.8	413.4	411.6	410.5
R2	4.9	2.2	8.7	5.1	3.6	1.7	2.0	5.5	7.4
K2	116.7	113.2	114.2	113.9	116.0	109.3	108.9	116.7	118.5
MSN2	2.7	1.1	2.6	2.2	2.6	4.1	1.9	1.3	0.6
KJ2	8.1	7.8	5.4	7.9	6.7	5.3	7.7	6.1	4.4
2SM2	0.2	0.6	1.3	2.9	3.4	2.0	2.9	3.2	3.7
MO3	2.4	2.7	3.3	2.4	2.4	2.5	2.1	2.9	3.2
M3	9.2	9.0	8.1	8.6	9.3	9.1	8.7	9.2	8.3
SO3	0.7	0.6	0.2	1.2	2.7	1.0	2.5	3.2	1.5
MK3	0.4	1.2	0.4	1.6	2.4	3.4	4.0	3.0	2.7
SK3	3.4	2.6	2.7	3.1	4.8	3.5	3.5	3.7	4.6
MN4	5.7	6.6	5.0	5.2	5.8	5.3	5.2	5.8	5.2
M4	12.4	11.3	12.2	12.6	12.7	12.0	11.7	11.3	11.6
SN4	1.3	1.4	0.9	0.5	2.0	1.5	1.2	0.9	1.1
MS4	6.6	7.4	7.0	7.0	8.1	9.3	9.3	7.3	6.9
MK4	1.7	2.0	2.2	1.9	2.4	2.7	1.8	0.8	2.1
S4	1.3	1.4	1.1	0.7	2.8	2.9	2.6	1.9	1.5
SK4	0.6	0.4	0.6	0.3	0.7	0.5	0.4	0.6	0.9
2MN6	1.3	1.2	1.3	1.4	1.1	1.6	0.2	0.6	0.6
M6	1.8	1.6	2.3	1.4	1.6	1.8	2.0	1.4	2.4
MSN6	1.4	0.9	0.6	0.6	1.5	0.9	0.2	0.9	0.7
2MS6	1.4	1.7	1.4	1.9	2.1	1.7	2.2	1.4	1.8
2MK6	1.0	0.6	0.4	1.1	0.0	0.6	0.9	0.6	0.2
2SM6	0.4	1.4	1.0	0.9	3.9	4.2	4.8	2.9	2.7
MSK6	0.4	0.6	0.7	0.6	1.1	0.7	1.4	1.9	0.3
MA2	4.6	5.2	1.8	1.9	6.9	12.6	7.0	4.7	5.9
MB2	7.1	3.8	5.8	5.3	2.6	4.8	13.3	3.7	6.6

	Coruña - Amplitude (mm)								
	1962	**1964**	**1965**	**1966**	**1967**	**1968**	**1969**	**1970**	**1971**
ZO	2579.8	2674.5	2593.8	2626.4	2577.1	2642.0	2717.3	2658.1	2623.2
SA	62.1	27.9	94.3	57.1	27.6	107.7	65.6	60.6	18.2
SSA	37.1	28.9	50.1	65.1	29.5	94.7	8.9	67.3	7.7
MM	35.1	12.0	29.2	42.5	33.0	13.5	17.7	13.9	6.4
MSF	10.5	8.8	5.9	16.3	13.1	0.4	17.6	24.1	8.2
MF	25.7	17.0	3.6	10.4	8.0	17.6	11.4	11.7	12.6
2Q1	6.3	3.6	1.2	4.6	3.9	5.4	6.0	5.6	4.1
SIG1	3.7	2.7	3.9	6.0	3.3	4.8	3.7	3.4	4.7
Q1	24.1	19.2	17.7	17.6	19.4	22.5	24.5	24.5	22.9
RO1	4.2	3.8	3.6	5.6	4.3	3.9	2.7	4.1	4.5
O1	65.6	69.4	67.3	67.7	66.9	66.8	66.1	66.3	67.3
MP1	0.7	4.0	1.7	0.8	1.9	2.0	2.2	0.8	0.4
M1	2.8	3.3	5.3	4.6	4.4	4.1	3.8	2.5	2.0
CHI1	1.4	0.3	1.3	1.8	1.1	2.1	0.3	1.6	0.7
PI1	2.3	2.5	3.0	4.7	0.7	2.5	1.7	1.7	0.7
P1	26.4	20.0	23.1	22.7	25.0	24.3	23.2	24.4	21.9
S1	5.2	8.1	4.7	6.0	5.5	5.1	5.4	5.3	7.5
K1	73.2	72.5	69.5	72.4	71.9	72.3	71.9	71.9	71.2
PSI1	1.0	2.2	0.7	1.2	0.8	2.3	0.8	2.1	2.0
PHI1	0.6	0.8	1.7	2.0	1.7	2.9	0.5	1.3	0.7
TH1	1.6	0.4	2.5	1.9	1.7	1.4	0.4	0.9	0.6
J1	4.5	3.9	3.9	3.7	3.1	2.7	1.8	2.8	4.5
SO1	0.5	1.2	0.2	0.6	1.1	1.4	1.0	1.6	0.6
OO1	0.5	1.8	1.4	1.3	0.5	1.6	1.2	0.8	1.1
OQ2	3.9	4.9	1.8	1.0	2.2	4.0	2.8	1.1	2.0
MNS2	8.7	9.3	9.3	8.6	12.1	10.2	10.0	7.4	10.6
2N2	32.4	37.5	33.1	31.5	37.0	37.8	34.7	34.2	36.2
MU2	40.9	45.2	41.1	46.8	42.9	39.0	44.7	39.2	42.0
N2	248.3	249.2	253.1	247.7	249.7	243.9	251.7	256.5	252.9
NU2	49.9	50.7	47.6	58.0	47.6	42.1	48.8	45.2	46.2
OP2	6.3	29.3	13.3	12.2	7.8	10.3	3.5	8.2	3.7
M2	1175.8	1177.3	1181.2	1182.5	1181.7	1183.9	1182.2	1183.8	1182.0
MKS2	6.9	25.2	6.0	11.9	3.0	18.3	4.1	8.6	0.8
LAM2	9.7	5.8	3.1	13.5	6.0	9.5	8.0	4.7	5.2
L2	24.3	36.3	33.3	22.0	26.4	19.5	24.0	32.5	34.8
T2	29.7	8.0	25.0	20.4	23.7	24.6	22.0	24.4	22.3
S2	414.2	417.4	418.3	416.4	415.9	415.5	412.9	416.6	415.7
R2	6.9	18.6	7.3	2.0	5.0	6.3	1.9	3.6	2.8
K2	121.7	111.6	114.1	116.5	118.2	120.3	116.9	118.3	116.6
MSN2	3.2	3.6	4.9	1.0	0.8	2.1	1.9	0.9	0.7
KJ2	6.5	4.9	6.2	8.9	7.3	7.7	6.5	7.6	7.1
2SM2	1.9	2.1	0.6	2.4	2.1	1.8	2.5	2.4	1.6
MO3	2.9	2.7	2.1	2.8	0.9	1.3	1.3	2.3	2.2
M3	8.9	9.4	9.2	9.6	8.3	9.6	10.0	9.4	9.6
SO3	1.2	4.8	0.7	0.6	0.9	0.6	0.1	0.2	0.6
MK3	2.0	4.6	1.7	1.3	2.3	0.9	1.6	2.2	0.6
SK3	3.9	5.3	1.8	3.4	3.5	4.3	3.3	2.8	3.0
MN4	6.1	5.6	5.6	6.3	5.7	5.5	4.9	5.3	5.8
M4	12.6	11.5	12.1	12.0	12.7	12.3	11.7	11.2	11.4
SN4	0.8	0.4	1.5	0.2	0.7	1.2	1.1	0.7	1.3
MS4	7.7	6.1	7.2	6.5	7.1	8.6	8.2	8.4	7.7
MK4	2.7	0.3	2.2	1.3	1.8	2.0	1.8	1.8	1.8
S4	1.3	1.7	3.2	0.8	2.2	2.1	2.8	1.7	1.7
SK4	0.7	1.1	0.7	0.3	0.6	1.2	0.7	0.7	1.0
2MN6	1.6	1.5	1.8	1.2	2.1	1.3	0.9	1.7	1.4
M6	2.5	2.9	2.8	2.6	2.7	2.7	2.4	3.0	3.3
MSN6	1.0	0.8	0.9	0.9	1.3	1.2	0.6	1.0	0.6
2MS6	1.9	2.6	2.6	1.8	2.5	1.6	2.0	2.6	1.7
2MK6	0.6	0.6	1.5	0.6	0.9	1.3	0.9	0.5	0.6
2SM6	3.2	1.5	1.5	1.5	1.9	1.9	1.7	1.1	1.5
MSK6	0.5	0.5	0.9	0.8	0.5	0.5	0.4	0.2	0.5
MA2	6.3	55.0	16.6	16.7	4.1	20.0	10.6	6.2	9.5
MB2	9.2	52.5	10.6	7.1	5.3	17.8	3.3	9.5	10.3

	Coruña - Amplitude (mm)								
	1972	**1973**	**1974**	**1975**	**1976**	**1977**	**1978**	**1979**	**1980**
ZO	2652.5	2630.6	2634.6	2631.6	2620.3	2657.6	2643.0	2668.0	2644.6
SA	73.3	45.5	21.1	29.5	89.9	94.4	81.9	54.3	16.1
SSA	5.4	49.5	27.2	26.6	30.5	14.8	26.4	32.0	36.4
MM	19.5	15.1	10.0	14.2	11.8	14.7	19.0	18.8	20.9
MSF	4.7	9.9	23.2	2.5	20.5	24.1	18.0	6.0	11.7
MF	4.9	32.7	18.1	13.5	17.1	39.3	15.3	21.0	5.8
2Q1	2.3	3.9	2.6	4.2	2.6	5.1	5.6	5.0	4.7
SIG1	5.4	3.4	3.6	3.5	3.6	3.9	4.8	6.1	4.8
Q1	20.8	18.2	19.0	18.9	20.1	23.0	23.3	21.4	21.5
RO1	2.5	3.1	4.4	3.7	5.1	3.1	3.2	5.0	4.4
O1	66.6	67.9	64.2	65.1	63.6	65.8	65.7	66.7	68.5
MP1	2.0	3.4	4.3	2.9	2.9	2.9	2.7	3.0	1.6
M1	0.9	5.8	5.6	6.3	6.2	8.6	8.2	3.4	2.5
CHI1	0.3	1.1	2.1	0.3	0.4	2.1	1.0	4.2	0.3
PI1	1.8	2.6	4.0	2.9	0.7	3.5	2.2	2.7	2.0
P1	25.5	21.2	24.6	26.0	23.7	23.9	24.6	23.6	22.9
S1	7.6	12.0	5.6	6.1	6.6	4.0	3.4	8.8	4.1
K1	71.3	72.7	74.0	72.4	72.3	74.3	76.6	72.9	70.9
PSI1	1.9	4.1	2.8	0.6	1.0	0.3	2.6	0.8	1.7
PHI1	2.2	1.1	3.2	2.0	2.7	1.2	1.4	2.0	1.4
TH1	1.9	0.8	2.2	0.9	1.7	0.8	2.2	1.9	1.4
J1	4.7	5.3	3.8	3.9	1.7	1.9	1.4	3.2	4.9
SO1	1.6	1.4	1.0	1.3	1.5	1.3	3.0	0.3	1.5
OO1	1.4	0.9	1.5	1.7	1.6	1.1	4.0	1.9	4.3
OQ2	4.4	2.9	3.2	1.8	6.2	4.6	5.0	3.2	4.8
MNS2	11.1	10.4	9.9	11.7	11.3	9.3	10.6	9.4	9.8
2N2	37.8	40.3	34.2	30.2	37.6	35.9	35.2	31.9	34.6
MU2	41.2	43.6	41.0	44.0	42.9	39.2	44.8	44.4	42.8
N2	249.8	241.6	251.2	246.0	251.6	244.2	258.5	250.1	238.5
NU2	46.3	46.6	58.2	50.2	58.5	48.0	52.1	55.7	49.5
OP2	8.0	51.2	38.8	12.3	3.5	13.7	6.5	8.8	20.7
M2	1185.2	1165.6	1173.8	1183.8	1187.2	1188.3	1184.0	1185.7	1184.0
MKS2	13.9	36.4	47.7	12.8	14.2	11.2	6.9	9.9	26.6
LAM2	9.1	17.0	17.7	8.1	16.2	10.2	9.2	14.4	12.3
L2	33.9	33.1	40.0	20.5	20.1	18.5	30.4	24.6	18.4
T2	23.1	10.2	30.8	27.2	18.6	24.1	20.2	20.9	17.6
S2	414.3	414.2	411.0	409.1	413.0	417.6	412.0	414.9	413.4
R2	4.3	11.7	17.6	5.0	6.3	2.7	4.2	5.1	3.4
K2	122.4	112.4	128.0	125.2	118.9	113.8	117.2	124.8	118.6
MSN2	1.1	2.2	4.4	1.0	3.1	0.8	2.7	1.6	3.8
KJ2	5.7	3.7	7.2	4.1	4.9	6.6	3.6	5.3	5.8
2SM2	1.1	1.2	0.4	1.0	1.8	1.8	3.5	2.5	3.0
MO3	2.5	3.5	3.2	2.6	2.4	1.7	1.6	2.7	2.1
M3	9.4	9.4	9.3	9.7	9.1	10.1	8.6	9.2	9.7
SO3	1.5	0.8	2.1	0.4	1.9	0.8	3.2	2.5	0.8
MK3	1.3	2.2	2.8	2.0	3.7	2.1	3.4	2.9	2.0
SK3	2.1	4.2	2.5	3.3	4.3	4.9	4.2	3.4	4.1
MN4	5.6	2.9	4.6	4.8	5.7	5.2	5.5	5.6	5.4
M4	11.4	9.2	13.2	10.4	11.8	11.6	11.0	11.3	10.9
SN4	1.2	0.9	1.7	0.7	1.2	1.6	0.8	1.5	1.0
MS4	6.7	9.0	8.7	5.4	6.0	5.7	5.8	6.2	5.6
MK4	1.6	2.2	4.7	2.3	1.1	1.4	2.8	2.1	0.2
S4	0.3	0.9	0.9	0.7	1.1	1.7	0.6	1.3	1.6
SK4	0.7	0.5	0.8	1.1	0.5	1.7	0.4	0.3	0.4
2MN6	1.7	1.0	0.9	1.7	0.8	0.7	1.4	1.3	0.6
M6	3.5	2.4	2.0	2.0	2.4	1.8	1.9	2.4	2.3
MSN6	0.4	1.3	1.3	1.2	1.5	1.3	0.5	0.3	0.9
2MS6	2.5	1.7	2.1	1.7	2.1	2.1	2.2	2.2	2.8
2MK6	1.1	0.8	1.8	1.0	1.6	0.7	1.5	1.0	0.7
2SM6	0.6	1.4	1.4	1.3	2.2	1.5	2.8	1.7	1.5
MSK6	0.1	0.5	0.3	1.1	0.1	0.9	0.7	1.1	0.8
MA2	17.3	60.7	45.4	8.0	10.7	5.8	9.4	12.5	14.2
MB2	13.5	50.0	29.2	2.8	19.7	7.7	4.8	7.5	11.5

	Coruña - Amplitude (mm)								
	1981	**1982**	**1983**	**1984**	**1985**	**1986**	**1987**	**1988**	**1989**
ZO	2638.3	2635.1	2655.6	2616.8	2648.6	2611.8	2690.5	2721.1	2653.8
SA	15.2	60.9	28.7	26.0	47.3	8.2	116.4	45.6	88.0
SSA	53.4	22.0	77.7	67.8	29.7	25.6	62.3	34.1	75.2
MM	13.5	21.2	22.4	11.2	21.2	16.2	13.4	7.3	26.7
MSF	12.2	22.2	11.3	7.2	7.1	7.0	21.3	14.9	37.2
MF	22.8	10.7	26.6	14.7	15.7	0.9	18.0	10.5	13.8
2Q1	4.7	2.0	4.2	4.0	4.4	6.2	6.0	6.1	3.6
SIG1	4.8	4.3	3.7	5.3	4.5	4.6	3.0	3.5	5.1
Q1	20.5	18.1	17.9	16.7	21.2	23.0	24.7	25.1	22.1
RO1	4.5	2.6	3.5	5.7	2.9	3.5	3.9	5.6	3.4
O1	66.1	66.1	65.7	65.2	63.3	66.5	66.5	65.4	63.9
MP1	3.7	4.5	2.5	3.0	3.1	3.2	1.6	1.8	2.5
M1	2.1	4.8	5.3	5.6	4.7	5.0	2.7	1.7	0.5
CHI1	1.6	0.2	2.2	2.6	0.8	0.4	1.5	0.3	2.4
PI1	1.9	4.1	2.3	2.1	2.1	1.6	2.9	1.5	1.8
P1	23.7	27.0	24.8	22.4	21.2	22.9	22.3	22.6	21.7
S1	3.8	2.4	3.7	2.8	4.0	7.9	7.6	9.6	18.7
K1	71.6	76.6	73.2	71.6	70.4	70.2	70.7	69.9	72.3
PSI1	2.3	2.6	0.7	2.1	1.8	1.3	2.6	2.9	1.1
PHI1	1.7	2.9	0.5	0.4	1.5	0.7	2.3	2.3	3.0
TH1	1.9	0.5	1.2	2.4	0.9	0.7	1.5	1.4	3.2
J1	4.0	5.8	3.9	2.9	2.8	0.8	1.2	2.6	3.6
SO1	1.3	1.5	1.4	1.0	0.7	1.5	1.0	0.3	3.6
OO1	0.7	0.5	1.5	1.0	0.3	1.0	0.7	0.9	2.0
OQ2	5.4	4.1	3.7	2.5	2.9	3.2	2.4	2.2	4.8
MNS2	9.0	11.0	8.2	10.2	11.8	10.5	10.0	7.8	9.2
2N2	36.4	37.5	31.6	37.5	37.9	37.5	35.2	35.8	36.7
MU2	37.0	41.2	37.6	39.0	42.4	41.6	40.9	40.2	38.3
N2	249.4	249.6	250.9	253.8	250.9	254.2	247.1	247.7	247.6
NU2	42.2	41.4	43.1	45.4	48.8	53.0	44.4	49.5	46.1
OP2	7.2	2.8	12.5	7.2	3.9	4.5	2.2	6.4	20.7
M2	1181.0	1178.9	1179.7	1179.2	1184.7	1178.2	1173.5	1178.4	1173.7
MKS2	5.1	6.1	5.5	3.1	2.3	7.2	4.9	10.7	13.4
LAM2	4.0	4.1	11.9	7.7	8.4	11.0	6.9	8.0	11.0
L2	32.8	35.1	31.3	31.5	26.8	26.4	22.9	26.2	32.1
T2	20.2	21.3	25.9	23.0	21.4	27.1	22.3	21.6	18.6
S2	419.4	414.0	417.1	417.4	415.2	412.7	412.8	410.8	407.7
R2	5.7	2.1	5.7	4.6	6.3	7.8	1.9	5.5	6.5
K2	120.9	121.8	117.7	116.7	116.9	119.0	116.2	116.8	108.2
MSN2	1.9	2.5	0.7	0.8	1.8	1.9	1.5	2.5	4.4
KJ2	2.6	6.7	6.3	6.9	6.8	6.6	8.6	9.0	5.8
2SM2	1.7	3.0	1.9	1.1	0.8	1.6	1.8	3.7	6.1
MO3	3.3	3.2	2.3	1.5	1.3	1.0	1.3	2.4	2.8
M3	9.3	9.5	9.2	9.5	9.3	9.1	9.1	9.6	9.8
SO3	2.1	0.8	1.1	1.5	2.4	0.9	0.9	0.4	2.1
MK3	2.3	2.0	1.1	2.6	2.9	2.9	1.8	2.4	1.9
SK3	3.4	3.0	4.1	3.8	0.8	3.6	2.3	2.5	3.5
MN4	5.4	5.4	5.4	5.9	5.6	6.0	5.8	5.3	5.5
M4	10.9	11.0	11.6	11.2	11.2	11.9	11.5	10.5	11.8
SN4	1.4	1.3	1.4	1.5	0.9	0.9	1.3	1.8	1.8
MS4	5.1	5.8	5.5	6.4	6.0	6.2	5.8	8.8	6.1
MK4	1.7	1.4	1.3	0.8	2.1	0.9	1.3	0.7	0.3
S4	0.7	0.9	0.6	2.9	1.1	0.5	2.5	2.1	1.4
SK4	1.0	0.9	0.4	1.1	0.2	0.7	0.7	0.9	0.3
2MN6	1.8	1.5	0.8	1.4	1.8	1.0	1.7	1.6	2.4
M6	2.3	1.9	1.3	1.1	2.0	1.4	2.4	3.0	3.7
MSN6	0.6	0.9	0.4	1.4	0.9	1.6	0.7	0.4	1.1
2MS6	1.8	1.6	2.5	1.6	2.5	1.9	2.6	2.5	3.3
2MK6	0.1	1.5	1.1	0.7	0.6	1.2	0.4	1.3	1.1
2SM6	1.1	1.6	1.2	0.9	1.3	1.9	1.8	3.3	3.2
MSK6	1.0	0.2	0.4	0.5	0.4	0.7	0.7	0.2	0.6
MA2	22.0	7.8	8.8	5.4	4.4	8.8	6.2	21.4	18.6
MB2	15.8	10.2	1.0	7.8	5.9	4.1	2.3	15.6	9.7

	Coruña - Amplitude (mm)								
	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**
ZO	2655.5	2602.9	2599.2	2648.2	2645.9	2711.0	2741.2	2749.5	2683.0
SA	28.0	82.3	41.3	67.2	97.9	91.8	98.0	62.0	32.2
SSA	15.7	13.2	17.8	61.5	81.9	56.3	27.2	89.6	25.2
MM	7.2	37.3	7.5	41.3	19.4	32.6	16.0	22.1	23.7
MSF	24.0	19.6	7.1	35.9	21.2	15.9	17.9	14.8	7.4
MF	16.3	15.4	2.4	7.7	15.7	13.1	35.7	17.1	25.0
2Q1	2.5	4.3	3.8	2.9	3.1	3.6	4.8	3.1	2.1
SIG1	3.9	4.0	1.5	2.3	2.9	2.5	3.7	5.0	3.7
Q1	17.1	17.0	14.6	18.5	22.2	24.0	21.7	24.0	22.3
RO1	4.1	5.7	2.7	4.5	1.1	7.0	1.4	3.6	3.6
O1	65.8	66.5	64.7	63.5	62.4	68.9	65.1	67.3	68.0
MP1	4.1	0.7	2.2	2.9	5.6	3.7	1.4	1.0	1.0
M1	3.1	5.0	6.7	5.6	5.2	3.6	6.4	4.6	2.3
CHI1	5.4	0.9	1.2	2.3	4.4	2.0	1.2	0.9	3.9
PI1	4.8	2.4	4.9	2.1	1.6	5.7	7.7	1.5	3.5
P1	22.3	26.7	24.6	19.7	19.5	19.5	25.5	21.2	27.0
S1	19.6	19.3	17.5	17.2	6.3	8.2	5.4	10.4	9.1
K1	71.5	74.2	75.1	73.5	69.1	70.3	76.1	73.2	72.1
PSI1	3.3	9.8	3.5	5.3	2.5	4.2	4.2	3.7	3.8
PHI1	4.2	3.3	4.2	4.6	1.1	2.8	1.6	4.2	3.4
TH1	1.3	3.7	1.7	1.4	0.9	5.1	3.3	2.1	1.9
J1	5.1	5.3	6.7	2.7	1.5	1.9	2.1	2.0	5.4
SO1	2.3	1.6	1.4	0.5	0.9	1.2	0.5	0.5	1.3
OO1	2.5	1.2	1.3	2.0	2.1	2.9	3.1	2.8	3.1
OQ2	4.5	4.4	2.0	6.1	5.0	5.2	2.8	5.6	7.7
MNS2	11.0	7.9	10.9	10.6	9.3	9.8	7.4	6.0	10.4
2N2	38.9	33.3	35.8	35.0	35.5	39.8	30.6	34.5	38.1
MU2	37.9	39.7	39.5	40.0	38.0	35.0	40.1	40.0	41.7
N2	246.2	246.1	246.6	247.0	250.3	232.0	249.6	249.8	241.6
NU2	42.4	55.1	46.0	45.5	47.2	70.4	43.6	52.2	49.3
OP2	3.3	5.6	4.2	5.4	8.6	30.1	30.4	33.2	15.7
M2	1174.1	1174.8	1175.0	1169.1	1179.1	1165.2	1185.5	1179.4	1183.1
MKS2	8.0	3.0	5.4	8.1	5.0	38.3	20.1	40.3	14.4
LAM2	6.6	17.1	6.5	9.3	6.6	33.0	4.2	5.6	9.0
L2	32.3	29.3	27.9	22.5	24.9	8.5	26.9	32.6	22.2
T2	23.2	19.7	21.5	22.8	23.3	39.1	18.7	14.0	25.0
S2	402.1	405.8	401.2	406.0	411.4	408.6	411.5	412.1	405.6
R2	6.8	2.6	5.2	4.0	5.3	22.3	4.6	3.7	8.0
K2	116.2	112.7	109.1	110.3	111.8	124.8	105.4	125.8	120.5
MSN2	3.4	1.6	2.9	0.8	0.4	7.1	2.1	1.3	1.9
KJ2	7.2	6.2	7.2	4.5	5.5	3.7	4.7	6.6	3.9
2SM2	3.0	4.2	4.0	2.4	4.0	3.7	3.4	6.5	1.4
MO3	2.7	3.4	2.8	3.0	0.7	2.6	3.6	1.8	3.6
M3	9.2	10.2	10.5	7.4	9.9	8.0	9.0	9.6	9.5
SO3	0.7	1.1	1.0	4.1	1.8	1.0	0.3	1.3	0.8
MK3	0.7	1.8	1.8	2.4	3.5	1.6	1.0	1.0	1.3
SK3	2.6	4.3	4.9	3.1	1.6	4.0	4.4	3.2	2.7
MN4	6.3	7.1	6.2	6.3	5.0	5.0	6.7	6.6	6.6
M4	12.3	12.2	12.1	9.5	10.8	12.2	12.2	11.9	11.5
SN4	1.4	1.1	2.1	1.2	0.4	0.9	0.9	0.8	1.2
MS4	6.5	5.5	3.1	5.3	6.7	3.0	2.1	2.2	2.9
MK4	0.5	1.6	1.1	0.6	1.0	1.1	1.7	1.1	2.5
S4	1.6	1.5	2.3	3.3	4.0	2.4	0.4	1.1	1.4
SK4	0.7	0.6	1.0	0.8	1.0	1.9	2.1	1.2	0.9
2MN6	1.4	0.9	1.3	0.1	1.2	0.6	0.6	0.7	0.1
M6	3.1	0.8	0.6	1.5	0.9	1.2	1.8	1.3	1.8
MSN6	1.7	0.6	2.0	1.1	1.6	0.9	1.0	0.7	1.3
2MS6	2.2	2.2	2.0	2.4	1.3	2.2	1.9	1.6	2.4
2MK6	2.1	1.5	1.0	0.8	0.8	2.3	0.7	0.4	0.2
2SM6	3.7	3.2	2.8	1.0	2.3	2.3	2.5	1.7	1.7
MSK6	0.5	0.8	0.2	0.6	1.1	2.5	0.8	0.6	0.2
MA2	9.6	11.1	15.7	19.8	6.2	24.2	14.8	29.5	12.4
MB2	4.3	8.0	1.8	6.9	5.1	37.5	14.4	19.1	17.3

	Coruña - Amplitude (mm)		
	1999	**2000**	**2001**
ZO	2658.8	2676.9	2678.0
SA	66.0	53.7	53.4
SSA	42.4	80.1	46.7
MM	28.8	17.4	31.2
MSF	9.9	3.5	6.8
MF	37.7	7.6	24.5
2Q1	5.1	2.7	3.4
SIG1	3.7	5.2	4.6
Q1	18.3	18.3	18.6
RO1	5.6	2.9	4.8
O1	67.5	67.8	66.1
MP1	2.6	1.8	2.5
M1	3.0	9.2	5.8
CHI1	1.0	4.3	2.9
PI1	2.7	2.3	5.3
P1	25.3	22.2	25.5
S1	16.1	16.2	13.5
K1	72.6	68.7	70.5
PSI1	2.6	4.6	6.8
PHI1	7.1	7.3	5.5
TH1	1.5	1.7	1.7
J1	4.4	3.5	6.5
SO1	1.3	0.8	1.1
OO1	5.0	2.7	2.5
OQ2	7.2	5.4	5.4
MNS2	10.4	10.1	8.8
2N2	37.0	38.5	36.8
MU2	37.2	43.9	39.6
N2	252.1	251.3	247.6
NU2	46.4	52.6	43.8
OP2	14.7	21.7	27.1
M2	1175.3	1175.1	1170.9
MKS2	8.0	15.6	33.7
LAM2	6.5	10.9	1.8
L2	36.8	35.0	30.0
T2	33.7	22.2	12.1
S2	407.0	405.9	404.8
R2	18.3	5.4	6.2
K2	118.6	115.7	129.0
MSN2	3.9	4.5	2.7
KJ2	5.2	4.5	6.8
2SM2	0.6	1.7	3.0
MO3	3.8	2.0	1.2
M3	8.8	10.5	8.6
SO3	0.6	0.6	0.4
MK3	1.0	1.7	2.4
SK3	2.8	2.7	3.6
MN4	6.1	6.0	7.0
M4	12.4	12.6	13.2
SN4	1.0	1.7	1.1
MS4	1.7	3.3	3.4
MK4	1.7	3.3	1.6
S4	1.7	1.8	1.0
SK4	0.8	1.9	0.8
2MN6	0.8	1.0	0.7
M6	1.4	1.6	0.6
MSN6	1.2	0.6	0.9
2MS6	3.4	2.3	2.5
2MK6	0.5	1.2	0.8
2SM6	1.3	1.3	0.6
MSK6	0.4	0.8	0.6
MA2	25.1	2.0	21.8
MB2	25.5	9.6	22.2

	Coruña - Phase (º)								
	1944	**1945**	**1946**	**1947**	**1948**	**1949**	**1950**	**1951**	**1952**
ZO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SA	158.6	223.5	277.6	339.2	246.7	189.9	291.6	273.1	13.3
SSA	88.2	100.5	76.3	309.0	138.2	78.4	153.7	59.6	71.7
MM	210.4	46.5	70.1	23.6	65.1	112.2	203.6	144.3	219.6
MSF	77.5	296.4	300.8	45.6	191.6	63.5	164.5	2.3	21.4
MF	186.1	356.1	198.9	226.2	300.0	165.1	229.6	275.3	142.8
2Q1	232.5	239.7	236.0	237.1	220.2	205.2	214.2	226.1	229.0
SIG1	223.8	228.0	259.5	223.9	249.7	232.0	235.6	242.3	233.4
Q1	275.5	278.3	283.2	279.0	271.3	263.3	260.6	268.4	273.3
RO1	296.0	283.2	271.3	249.6	280.8	263.7	267.0	278.3	270.5
O1	324.7	321.6	322.7	323.2	322.9	325.2	325.6	324.4	324.6
MP1	221.8	256.5	135.0	312.0	65.0	54.3	111.7	95.5	103.5
M1	106.1	133.5	184.1	291.3	345.3	0.6	15.7	58.3	79.4
CHI1	220.3	29.8	87.2	339.6	60.1	346.1	77.3	30.5	354.8
PI1	54.3	56.5	68.7	28.1	48.3	164.2	1.8	86.1	51.8
P1	61.4	58.5	62.9	58.9	59.2	62.0	56.9	59.2	55.4
S1	56.2	51.3	36.5	54.0	43.0	47.4	42.4	23.7	26.7
K1	71.5	70.8	69.2	70.3	70.1	69.7	70.5	69.2	69.8
PSI1	228.9	24.3	69.3	2.1	78.8	41.0	27.8	10.0	320.0
PHI1	109.3	159.2	65.7	110.7	40.2	5.2	132.5	132.7	88.2
TH1	75.3	108.2	346.0	151.0	52.2	53.7	342.8	131.4	143.7
J1	121.5	129.6	103.8	89.7	62.8	52.5	71.7	287.4	125.1
SO1	59.4	72.0	49.9	82.3	65.7	93.4	155.4	324.6	25.3
OO1	186.6	206.2	208.9	230.1	201.2	252.1	197.3	219.3	192.0
OQ2	266.8	145.8	87.1	21.7	280.7	197.5	85.6	51.9	355.5
MNS2	9.4	14.6	23.2	9.0	14.3	10.0	14.7	15.9	8.1
2N2	46.0	43.5	50.6	48.7	48.7	44.1	46.7	54.5	54.3
MU2	41.8	41.0	40.4	44.8	41.2	39.9	43.8	41.6	40.0
N2	68.6	65.2	64.7	64.7	66.6	65.6	64.8	66.3	67.5
NU2	69.9	63.1	60.6	69.7	69.8	66.7	62.3	65.8	73.5
OP2	115.5	68.5	292.2	289.4	216.2	223.0	340.7	252.1	115.2
M2	87.2	84.2	84.1	84.7	85.0	85.1	84.5	84.4	84.8
MKS2	67.5	70.6	312.5	205.1	37.4	42.1	99.7	304.3	92.8
LAM2	101.5	105.7	127.9	46.7	89.1	158.6	113.7	107.1	69.7
L2	111.0	109.3	104.7	96.6	88.1	101.1	106.8	96.8	93.0
T2	115.9	117.6	108.5	105.7	117.0	126.7	111.1	112.3	107.0
S2	115.9	113.8	113.5	114.0	114.2	114.6	114.4	113.7	114.2
R2	124.5	124.8	127.9	179.3	194.6	113.8	123.7	119.5	278.3
K2	113.7	111.9	110.0	110.7	111.1	111.9	111.5	109.7	111.4
MSN2	133.2	349.1	325.4	340.4	232.0	23.5	37.7	230.5	226.4
KJ2	338.9	319.0	307.3	307.3	344.1	323.5	322.1	301.6	313.7
2SM2	48.9	205.1	296.6	237.4	12.3	34.7	78.5	290.7	344.3
MO3	41.1	4.2	336.0	301.3	259.1	237.1	167.1	114.3	71.6
M3	320.6	314.8	317.7	317.0	318.7	318.4	319.1	318.5	320.2
SO3	138.1	131.3	72.3	7.8	313.7	50.7	32.9	268.5	24.0
MK3	348.5	78.7	214.5	229.9	274.4	297.1	290.0	284.8	302.4
SK3	26.1	4.5	21.2	2.6	15.7	16.3	15.1	21.4	12.8
MN4	254.1	247.5	245.2	249.2	253.6	242.8	241.7	246.9	244.7
M4	297.2	287.1	285.7	290.9	292.8	286.0	280.0	287.2	289.2
SN4	36.5	345.5	304.4	341.5	343.5	352.1	72.1	273.8	11.7
MS4	30.9	6.6	357.9	10.0	2.9	7.2	0.7	8.7	3.7
MK4	341.0	351.7	340.1	16.9	29.9	350.4	354.5	353.8	358.4
S4	83.7	223.9	153.7	108.0	250.4	94.7	23.8	207.7	88.0
SK4	61.5	54.9	117.5	76.1	57.8	146.2	71.5	95.1	75.5
2MN6	92.6	125.6	81.1	183.6	128.3	91.8	121.7	87.2	116.4
M6	159.3	137.5	206.4	178.4	159.0	140.6	140.7	121.0	121.8
MSN6	194.6	230.7	208.6	195.2	151.7	185.9	239.3	127.9	184.9
2MS6	228.5	216.9	206.1	230.7	231.6	213.4	176.1	196.8	189.0
2MK6	257.5	147.6	162.9	154.3	188.8	201.5	234.3	151.6	198.9
2SM6	41.7	15.1	344.5	16.2	324.6	9.0	329.4	14.9	38.9
MSK6	168.5	319.1	222.4	240.2	213.2	293.6	280.5	203.8	222.8
MA2	148.7	327.7	55.4	38.0	352.8	300.9	86.1	83.2	10.1
MB2	195.1	24.6	21.2	324.8	49.2	83.5	147.9	207.1	358.8

	Coruña - Phase (º)								
	1953	**1954**	**1955**	**1956**	**1957**	**1958**	**1959**	**1960**	**1961**
ZO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SA	195.3	263.1	262.6	237.0	332.1	223.8	309.5	267.7	270.0
SSA	148.6	67.0	135.8	329.9	324.7	31.8	21.7	22.8	103.8
MM	167.7	285.4	234.8	298.1	322.8	158.6	91.0	356.3	136.1
MSF	60.4	211.7	3.4	1.9	222.2	150.4	314.0	306.0	42.4
MF	138.6	198.8	153.8	178.0	5.9	113.0	200.9	273.2	141.5
2Q1	241.0	244.4	211.9	260.1	224.0	216.5	211.4	232.2	222.8
SIG1	228.3	232.3	260.5	237.9	233.2	226.4	236.5	240.2	221.3
Q1	279.0	280.7	275.1	273.8	264.7	262.1	265.8	262.8	274.3
RO1	281.6	274.9	250.8	262.1	273.4	270.3	286.9	302.7	274.5
O1	324.2	321.9	320.8	323.0	322.4	323.9	324.8	324.9	324.6
MP1	337.8	145.4	81.5	64.0	112.3	9.0	132.3	74.9	142.1
M1	81.2	136.3	259.8	319.9	350.7	358.5	27.2	67.7	92.0
CHI1	25.7	326.8	1.4	303.0	352.1	11.4	121.5	106.0	30.7
PI1	81.8	4.5	70.9	36.5	8.4	32.3	122.5	55.6	58.0
P1	57.8	59.5	59.6	61.2	58.5	57.6	57.6	57.6	58.6
S1	11.8	9.2	7.6	9.7	325.7	314.9	356.7	4.6	33.8
K1	68.8	69.7	70.4	67.9	71.5	71.2	70.5	72.2	70.8
PSI1	0.6	112.2	88.7	338.9	76.6	240.2	5.5	291.6	267.4
PHI1	357.6	103.5	81.4	161.3	67.4	93.3	350.3	81.4	62.4
TH1	77.8	237.6	154.0	111.7	140.1	230.1	341.3	291.1	165.1
J1	135.8	117.4	97.6	85.5	106.0	102.3	29.2	125.4	174.2
SO1	18.2	2.2	49.4	1.4	36.7	293.9	13.2	291.9	21.1
OO1	222.5	266.3	191.9	216.9	268.5	299.3	293.1	212.2	221.9
OQ2	195.6	104.8	36.5	334.4	209.6	156.1	98.5	22.0	272.3
MNS2	18.4	23.0	9.4	17.8	24.4	24.4	10.6	15.8	16.3
2N2	45.2	46.3	49.5	43.7	43.0	50.7	48.3	50.5	45.5
MU2	44.1	41.5	39.4	43.3	40.1	43.5	41.1	43.1	41.0
N2	66.6	65.2	65.9	64.7	64.7	66.3	64.3	65.4	64.9
NU2	70.2	68.8	67.8	61.7	70.9	73.4	61.7	68.2	60.3
OP2	225.3	300.1	288.8	215.4	245.1	301.4	263.6	273.8	277.1
M2	84.4	84.6	84.1	84.2	83.6	84.0	83.3	84.3	84.2
MKS2	86.6	198.6	126.2	78.1	135.0	194.5	262.2	163.4	251.7
LAM2	78.7	100.3	80.2	110.7	56.4	76.7	137.2	92.5	132.4
L2	92.8	102.5	86.9	90.8	80.8	71.1	98.7	100.6	113.2
T2	119.7	116.3	118.0	114.7	114.7	103.5	117.3	103.2	120.0
S2	114.2	114.7	113.4	113.9	113.3	113.9	113.4	113.8	114.0
R2	115.0	104.3	124.9	102.1	110.0	299.5	102.0	149.6	99.1
K2	110.8	111.3	111.4	111.8	110.5	111.7	109.8	113.0	111.6
MSN2	205.5	341.4	199.0	229.5	202.5	161.9	170.9	302.9	129.8
KJ2	306.7	309.0	303.3	301.0	316.4	328.5	280.6	314.2	301.5
2SM2	297.8	183.1	350.6	268.8	348.8	330.4	267.5	305.7	300.1
MO3	10.1	348.6	318.6	286.9	248.7	207.2	170.6	109.8	74.9
M3	313.1	313.1	316.6	309.4	313.0	316.8	315.1	316.0	314.8
SO3	32.6	185.9	299.0	277.7	188.7	292.0	186.3	262.1	202.5
MK3	270.9	254.6	197.6	288.7	357.2	274.5	322.5	288.8	316.3
SK3	10.4	12.1	22.1	4.4	32.6	16.8	11.5	10.9	20.9
MN4	252.0	250.2	255.0	252.1	246.7	244.9	245.4	248.4	246.4
M4	291.0	295.2	290.7	291.5	285.5	286.9	284.5	282.7	282.7
SN4	4.1	14.2	10.5	346.3	321.7	329.5	285.0	309.6	331.1
MS4	12.2	11.4	8.1	1.9	333.0	330.5	321.5	330.9	327.1
MK4	343.4	355.4	340.6	30.9	316.2	352.0	315.9	21.9	28.6
S4	89.2	85.0	68.6	40.5	19.6	350.9	1.5	320.0	276.9
SK4	102.3	32.7	273.5	63.9	317.1	35.3	43.2	126.3	69.0
2MN6	119.8	114.7	107.1	117.5	120.8	90.2	115.0	59.5	136.2
M6	132.1	114.9	123.7	142.3	138.4	122.7	130.4	131.2	121.5
MSN6	215.1	218.9	201.0	178.9	196.2	247.9	202.6	227.7	211.9
2MS6	197.7	184.7	187.4	210.2	223.6	211.9	197.6	224.5	212.4
2MK6	173.8	199.9	212.8	183.1	156.8	135.8	260.6	239.9	293.7
2SM6	349.5	356.8	17.0	326.9	313.6	326.4	314.0	314.5	315.9
MSK6	302.3	280.9	91.2	87.3	292.3	299.2	233.5	247.8	304.1
MA2	119.8	20.7	114.6	65.3	47.3	17.3	310.3	67.8	127.8
MB2	163.2	108.9	161.9	140.0	73.9	356.3	74.4	287.8	134.9

	Coruña - Phase (º)								
	1962	**1964**	**1965**	**1966**	**1967**	**1968**	**1969**	**1970**	**1971**
ZO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SA	214.1	323.8	281.9	287.2	223.2	230.1	291.0	269.8	26.8
SSA	45.7	349.0	8.5	322.2	46.4	87.3	350.9	215.6	215.1
MM	315.7	315.4	150.7	148.6	237.4	320.1	329.9	123.4	222.2
MSF	329.3	129.4	326.0	98.1	87.7	101.3	110.6	84.4	142.5
MF	320.2	175.9	246.9	225.8	245.6	157.8	128.7	182.4	171.9
2Q1	239.7	222.3	138.1	206.7	208.9	207.6	217.4	221.3	247.0
SIG1	245.5	219.8	256.9	212.8	236.7	230.7	226.8	237.9	243.2
Q1	276.6	280.9	271.8	269.6	265.6	266.1	268.7	271.7	280.6
RO1	262.4	262.3	278.9	285.8	287.2	283.1	274.9	276.3	269.4
O1	323.2	323.8	322.5	322.1	324.5	324.3	324.8	323.5	324.2
MP1	79.7	135.5	168.0	129.6	71.1	213.5	117.4	147.4	51.4
M1	115.4	178.5	307.9	356.0	15.0	26.7	90.6	54.6	82.7
CHI1	338.0	103.2	196.9	262.7	354.8	26.2	111.7	354.0	11.5
PI1	57.7	350.9	79.3	86.2	87.4	3.1	65.1	30.9	24.9
P1	56.7	58.7	58.0	64.8	59.7	65.6	55.1	57.3	55.2
S1	2.9	3.0	358.8	10.1	25.5	68.9	50.2	48.8	47.5
K1	68.4	69.0	71.0	69.1	69.6	68.9	71.0	70.4	69.8
PSI1	288.0	27.5	349.1	17.4	174.1	71.3	41.8	71.9	69.8
PHI1	133.3	120.6	119.7	233.0	107.3	29.3	135.3	23.7	74.5
TH1	103.4	149.2	134.9	39.3	138.7	77.6	43.8	67.3	117.2
J1	154.8	107.9	91.3	66.4	60.1	64.2	124.4	161.3	132.5
SO1	306.3	37.6	90.9	356.1	357.7	57.2	350.3	27.1	313.0
OO1	305.1	248.1	206.1	218.7	210.5	198.6	189.0	171.1	123.9
OQ2	191.7	86.8	4.6	256.7	144.5	101.2	355.2	287.8	171.5
MNS2	8.8	9.1	18.7	26.1	12.0	21.3	23.2	19.9	12.9
2N2	42.6	41.5	42.5	50.2	45.2	53.3	51.7	46.3	44.4
MU2	40.9	39.0	42.6	40.9	43.7	42.7	45.2	39.9	42.2
N2	64.0	61.2	64.8	65.9	67.8	67.3	67.0	66.0	66.5
NU2	70.1	61.8	69.4	62.3	68.8	72.5	76.6	63.3	69.5
OP2	22.3	281.7	253.9	220.0	336.7	136.4	199.5	166.4	258.1
M2	83.0	81.2	84.9	84.9	86.1	86.2	85.7	85.7	85.4
MKS2	148.8	243.9	296.5	301.8	137.6	45.0	44.2	41.3	189.3
LAM2	86.8	94.3	62.2	122.6	98.6	78.2	72.8	188.0	78.2
L2	104.7	99.6	98.5	91.8	84.3	107.8	101.7	121.3	112.2
T2	118.8	168.5	101.1	126.8	122.1	106.2	108.0	123.4	130.3
S2	112.8	111.4	114.5	114.1	116.1	115.9	115.4	115.7	115.5
R2	96.5	283.7	150.1	326.4	120.1	215.2	160.8	94.3	111.9
K2	110.7	111.3	111.9	112.9	113.7	110.8	111.6	111.6	112.4
MSN2	191.5	21.0	296.9	293.3	173.2	72.3	308.8	290.9	210.1
KJ2	306.3	293.4	304.5	327.6	330.0	311.8	312.7	297.5	319.0
2SM2	316.9	330.8	344.1	335.3	327.4	65.0	326.5	59.3	25.2
MO3	35.9	319.7	310.2	252.3	192.8	181.3	116.3	47.7	6.6
M3	314.7	308.9	312.6	314.1	318.8	322.4	321.3	320.8	317.3
SO3	252.7	192.8	319.7	342.0	143.4	28.5	112.4	328.6	343.3
MK3	298.0	293.6	233.7	316.9	296.1	281.8	316.0	312.3	302.6
SK3	356.7	355.1	37.9	13.2	1.8	9.1	22.0	18.6	21.1
MN4	249.0	242.5	243.1	243.3	253.8	253.5	258.2	238.0	246.8
M4	281.2	277.0	285.2	289.1	293.4	296.8	289.7	289.3	287.4
SN4	316.9	207.2	324.8	12.1	337.5	36.3	4.1	343.6	353.4
MS4	316.4	346.2	6.0	3.3	18.7	21.8	16.4	20.6	20.9
MK4	2.1	58.6	4.6	339.7	12.2	351.6	355.4	8.2	27.5
S4	294.9	122.7	77.5	79.3	53.8	80.8	75.0	89.0	99.4
SK4	133.3	163.2	72.9	129.5	57.5	116.5	87.2	119.8	75.2
2MN6	100.8	91.8	106.9	113.4	118.2	88.9	108.1	126.0	128.6
M6	118.0	102.2	123.0	129.3	123.0	111.3	115.4	132.3	112.5
MSN6	225.5	177.8	153.0	187.7	149.5	195.0	202.2	180.3	215.8
2MS6	189.1	183.7	185.9	196.6	184.1	183.4	178.0	177.0	191.3
2MK6	310.1	181.6	181.4	191.2	185.4	214.7	200.0	167.4	180.1
2SM6	318.2	231.2	4.1	348.2	24.5	37.6	25.8	31.1	37.7
MSK6	299.2	173.9	253.7	202.6	351.9	287.8	254.8	58.6	252.9
MA2	154.8	326.1	75.4	350.2	33.7	57.3	43.4	279.5	308.6
MB2	169.5	23.8	275.9	32.4	101.2	305.5	356.5	87.5	89.2

	Coruña - Phase (º)								
	1972	**1973**	**1974**	**1975**	**1976**	**1977**	**1978**	**1979**	**1980**
ZO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SA	245.5	212.6	115.3	246.6	210.9	277.4	288.2	277.7	223.5
SSA	354.5	139.9	241.7	288.8	46.8	266.2	208.4	296.5	28.5
MM	182.2	266.4	63.0	182.6	167.4	77.6	355.7	190.3	324.4
MSF	154.2	312.3	167.7	277.2	60.0	200.5	222.9	252.8	14.9
MF	25.4	166.7	89.5	249.7	120.6	75.2	59.5	313.7	125.4
2Q1	219.8	227.8	206.9	246.9	207.1	201.4	218.6	231.5	232.7
SIG1	241.0	222.0	261.2	236.4	216.5	259.7	241.2	243.4	241.6
Q1	281.3	281.4	272.5	270.9	262.2	270.2	268.4	276.6	278.7
RO1	269.2	298.3	283.1	281.1	277.8	268.8	284.2	279.1	267.1
O1	323.7	327.0	326.3	324.8	327.0	325.0	326.2	325.3	325.5
MP1	111.2	73.1	57.5	91.9	83.0	84.5	137.4	106.6	108.8
M1	211.7	283.2	339.5	350.3	4.9	38.2	87.8	122.8	136.9
CHI1	30.2	336.8	78.9	241.4	301.3	58.2	342.3	59.7	135.5
PI1	37.1	359.3	46.9	41.3	7.6	47.4	98.2	73.4	49.2
P1	58.3	63.8	66.5	61.6	59.9	63.2	57.7	64.3	63.7
S1	69.4	61.7	34.5	17.5	41.7	38.1	13.9	31.0	335.7
K1	71.5	73.4	70.6	73.8	69.1	68.5	72.4	71.1	71.6
PSI1	48.9	87.0	8.6	165.2	252.1	24.5	72.6	322.4	82.5
PHI1	69.5	23.4	57.0	39.3	76.0	112.0	76.1	87.1	81.6
TH1	148.7	121.5	135.8	144.9	127.3	275.5	268.7	79.6	132.1
J1	113.4	95.0	70.7	60.1	96.5	13.5	170.0	117.3	130.7
SO1	9.2	343.2	55.8	44.9	62.8	104.6	21.3	49.5	39.0
OO1	200.2	218.6	282.4	166.7	71.4	296.4	239.4	196.9	217.5
OQ2	96.0	36.5	319.1	190.3	111.4	54.9	349.7	273.4	182.3
MNS2	16.1	28.8	18.6	31.6	20.2	17.6	21.6	23.5	15.8
2N2	47.3	53.6	52.4	44.4	45.5	49.0	46.5	50.0	44.9
MU2	44.1	48.6	47.7	54.4	45.0	40.3	41.9	43.4	41.8
N2	67.7	69.2	73.3	67.1	66.9	65.8	66.1	66.4	67.2
NU2	69.3	94.4	99.8	76.9	63.9	72.1	78.0	77.2	54.5
OP2	103.9	238.4	129.5	133.2	186.2	236.3	224.3	83.2	172.1
M2	86.2	90.2	89.3	87.5	85.2	85.6	86.2	85.6	85.5
MKS2	59.5	347.6	79.7	57.8	13.6	355.0	103.5	69.7	359.0
LAM2	76.5	51.4	36.4	66.1	106.8	101.0	63.4	77.4	137.1
L2	95.8	96.2	78.5	95.3	93.3	113.4	107.5	105.1	109.2
T2	108.1	149.9	108.8	123.5	132.9	123.5	117.4	117.7	115.9
S2	116.5	120.1	118.8	118.1	115.5	115.6	116.1	115.7	115.4
R2	197.5	287.5	131.5	231.6	42.3	63.3	124.1	175.2	147.3
K2	112.9	112.7	115.3	114.4	112.0	110.8	114.2	113.7	109.9
MSN2	332.5	39.4	282.9	263.8	269.8	78.5	9.3	264.7	148.1
KJ2	306.7	268.9	323.9	317.6	297.0	318.9	324.3	311.5	328.0
2SM2	316.9	4.5	349.5	283.5	268.3	320.1	330.1	339.4	297.8
MO3	344.7	310.5	286.7	227.4	193.2	141.9	103.8	64.0	23.2
M3	316.8	326.9	317.5	321.3	314.3	316.6	324.4	324.1	317.2
SO3	303.7	240.4	340.4	173.0	245.6	283.5	249.2	221.1	235.5
MK3	218.4	350.5	238.0	311.5	302.8	307.0	331.2	325.6	317.0
SK3	36.2	38.8	345.6	16.7	7.4	3.6	12.1	359.4	15.8
MN4	258.7	245.1	304.9	251.6	248.3	247.5	241.4	246.4	245.8
M4	287.5	356.4	333.8	299.3	285.4	284.3	285.9	290.0	286.2
SN4	23.2	65.3	328.1	350.5	309.7	336.0	280.3	331.3	302.4
MS4	29.4	49.1	39.9	5.0	332.6	327.7	332.3	341.8	339.2
MK4	16.5	294.0	16.9	16.5	325.9	356.4	348.8	359.8	329.5
S4	179.9	194.4	92.0	119.6	308.3	351.9	10.9	283.9	355.7
SK4	87.0	53.6	80.9	48.7	189.7	337.1	37.5	101.0	189.8
2MN6	113.1	123.2	118.7	121.9	159.2	133.8	128.2	100.2	139.1
M6	122.4	135.2	150.6	140.1	137.8	157.2	140.0	133.0	133.9
MSN6	239.1	203.7	250.5	199.8	206.7	202.3	213.0	236.4	205.0
2MS6	221.7	214.3	264.5	208.2	215.8	213.4	202.5	232.6	213.2
2MK6	201.0	219.9	233.1	284.3	188.2	193.2	226.1	157.8	229.4
2SM6	352.1	314.3	282.8	326.5	297.7	287.0	308.8	302.0	326.1
MSK6	149.7	324.1	337.9	269.6	108.7	332.8	248.7	304.6	186.3
MA2	31.2	329.2	107.1	49.6	284.1	9.4	43.5	36.8	37.2
MB2	341.4	62.2	256.6	73.1	74.7	42.1	22.3	8.5	9.0

	Coruña - Phase (º)								
	1981	**1982**	**1983**	**1984**	**1985**	**1986**	**1987**	**1988**	**1989**
ZO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SA	226.1	232.9	247.1	245.1	274.6	169.6	235.6	230.2	235.4
SSA	59.6	126.3	104.5	82.9	168.5	325.5	74.3	117.7	141.3
MM	128.6	69.3	271.9	40.6	283.0	50.6	152.8	150.7	107.7
MSF	105.7	168.5	269.2	130.3	328.7	233.6	277.6	32.3	99.9
MF	207.7	273.0	170.3	238.4	148.6	37.7	183.4	141.6	222.8
2Q1	242.5	204.9	211.0	207.0	209.0	213.1	221.9	239.7	248.1
SIG1	247.6	240.2	233.1	238.4	216.8	211.9	245.0	227.0	254.7
Q1	276.6	282.7	268.8	265.5	261.7	263.6	270.9	278.3	282.9
RO1	296.1	305.5	278.7	284.8	280.7	273.3	287.2	290.8	294.2
O1	325.9	323.3	323.3	323.4	324.0	324.7	324.0	324.3	322.9
MP1	126.7	107.9	120.0	110.5	29.8	205.0	148.9	175.6	44.6
M1	136.6	241.2	325.5	357.5	19.6	30.1	70.2	69.9	49.3
CHI1	289.1	347.6	327.4	356.5	52.3	276.1	70.3	272.9	265.3
PI1	90.1	30.2	64.3	31.9	54.0	104.2	35.3	25.4	111.4
P1	59.5	60.8	58.7	61.8	55.1	60.6	54.1	63.3	59.2
S1	18.9	331.2	330.9	315.5	354.5	50.2	49.9	82.9	95.2
K1	72.0	69.5	70.3	70.0	71.5	71.9	71.3	73.3	70.6
PSI1	324.2	71.9	237.7	90.2	57.4	334.1	93.6	79.8	228.4
PHI1	125.9	37.5	138.1	191.0	118.7	265.7	118.8	94.0	46.9
TH1	125.0	36.9	98.0	76.1	302.6	270.3	103.3	90.7	173.3
J1	126.6	100.0	70.7	69.5	32.5	90.0	110.2	160.8	128.9
SO1	34.7	35.0	48.1	83.8	131.3	42.6	93.3	294.0	27.4
OO1	164.6	248.9	180.2	167.3	195.3	195.6	192.1	207.2	187.6
OQ2	147.7	53.6	353.0	250.9	140.8	79.7	355.7	279.2	140.5
MNS2	9.3	14.8	10.5	17.8	8.0	26.1	28.5	26.3	352.2
2N2	45.9	51.1	45.8	43.2	47.8	49.0	48.8	41.3	40.6
MU2	44.9	44.9	38.8	45.2	44.4	47.5	44.4	43.8	37.9
N2	67.8	67.1	64.5	65.8	66.6	65.6	64.6	66.6	65.4
NU2	70.6	64.5	51.5	77.9	71.5	69.3	70.3	66.5	64.6
OP2	320.6	212.6	259.4	318.6	333.3	348.8	279.3	77.1	271.6
M2	86.3	85.6	85.5	85.8	85.2	85.9	84.9	86.1	85.4
MKS2	293.7	38.2	267.9	195.5	99.3	56.9	112.3	99.7	259.1
LAM2	45.6	127.1	204.2	60.1	73.8	101.9	93.1	136.1	125.3
L2	100.9	95.9	108.1	95.1	89.1	111.1	111.9	125.8	115.1
T2	98.0	109.1	114.7	127.2	125.8	127.0	114.9	108.3	119.3
S2	116.1	115.8	115.7	115.9	115.4	116.3	115.2	116.7	115.7
R2	162.0	117.8	98.6	87.8	114.8	102.7	98.3	236.7	185.4
K2	114.1	113.6	111.6	114.5	113.6	112.5	112.1	114.0	111.8
MSN2	137.4	294.5	211.4	273.0	83.0	330.9	313.2	184.2	82.9
KJ2	337.7	325.5	323.5	319.5	322.8	320.4	315.6	301.8	303.0
2SM2	2.5	312.9	209.1	79.8	315.2	354.7	12.0	54.5	71.3
MO3	346.0	318.6	265.7	239.8	193.8	108.5	61.6	38.0	14.6
M3	314.4	316.4	314.8	314.9	321.8	313.6	317.8	329.3	305.6
SO3	253.6	234.8	222.5	240.0	345.1	114.5	39.2	249.3	65.3
MK3	303.9	242.4	289.7	273.2	226.2	1.6	293.9	300.4	295.1
SK3	5.8	4.6	14.6	359.5	339.1	27.6	20.7	21.5	25.3
MN4	250.3	248.7	246.7	245.6	252.4	238.8	233.9	238.9	248.1
M4	287.6	288.4	283.1	288.3	286.4	283.3	281.5	291.9	276.8
SN4	315.7	324.1	302.1	351.7	33.8	353.7	19.9	359.6	29.5
MS4	344.7	342.7	337.9	14.2	2.5	342.6	17.7	41.7	32.5
MK4	352.1	352.5	5.0	13.5	22.3	43.3	6.6	5.6	166.8
S4	320.7	39.3	12.7	64.3	65.8	321.6	96.6	99.0	137.6
SK4	143.8	74.6	131.7	92.4	106.2	151.1	62.9	67.4	238.3
2MN6	122.5	100.2	93.7	81.7	120.1	81.8	83.9	98.3	246.7
M6	142.9	152.8	169.4	148.9	137.1	120.8	111.0	88.1	266.7
MSN6	298.2	209.1	260.9	184.0	148.4	208.6	174.3	116.6	156.8
2MS6	211.6	226.8	191.9	198.8	214.7	255.7	198.3	153.5	270.6
2MK6	284.5	173.3	142.3	195.0	272.2	196.8	195.6	141.0	230.0
2SM6	337.6	312.2	296.7	46.4	328.7	332.9	45.2	51.3	29.4
MSK6	282.8	196.4	232.4	141.6	14.6	293.9	325.5	218.1	40.0
MA2	66.6	22.8	94.4	344.6	25.6	143.0	21.3	21.7	34.4
MB2	302.3	15.0	97.7	84.9	71.8	146.8	69.9	328.2	303.2

	Coruña - Phase (º)								
	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**
ZO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SA	229.8	183.5	158.5	205.7	220.7	230.7	304.2	243.7	296.3
SSA	166.0	96.4	81.6	78.0	119.4	145.8	210.3	117.3	334.2
MM	216.4	210.1	256.6	314.9	327.9	38.6	196.8	142.9	35.5
MSF	167.0	119.3	113.3	97.4	99.1	155.8	92.4	135.9	65.9
MF	307.7	104.9	298.5	157.6	93.5	238.9	109.5	215.9	118.8
2Q1	241.9	224.5	215.0	159.8	216.9	200.5	227.6	218.7	217.5
SIG1	261.9	225.6	244.8	223.3	217.4	216.2	224.8	243.4	231.6
Q1	280.0	272.5	268.9	271.9	263.3	260.3	271.0	272.5	278.7
RO1	276.9	276.1	333.9	264.7	301.6	270.8	294.3	302.8	292.6
O1	326.6	324.2	324.1	323.7	326.1	326.9	326.0	321.0	325.0
MP1	128.2	245.8	195.5	349.6	66.3	86.9	67.7	283.4	323.8
M1	224.0	325.3	342.9	7.9	18.7	87.1	127.9	145.6	153.5
CHI1	358.6	250.7	181.1	276.3	348.7	4.9	318.9	21.2	23.0
PI1	336.1	53.5	125.1	213.9	107.5	96.0	87.9	322.7	106.9
P1	62.8	57.4	69.0	57.6	66.8	64.8	55.9	68.7	60.1
S1	70.1	72.3	79.3	75.1	84.4	195.5	84.5	120.3	128.8
K1	73.0	70.5	72.4	72.5	72.3	66.1	73.4	72.6	75.2
PSI1	173.8	61.8	39.4	24.3	19.0	357.0	16.5	48.4	49.7
PHI1	53.6	59.4	202.0	266.0	96.5	194.8	97.0	76.0	121.9
TH1	260.5	26.9	103.2	275.5	227.3	220.6	10.4	87.9	333.0
J1	111.2	89.9	41.4	66.6	101.8	114.6	171.3	126.8	137.6
SO1	32.7	81.7	353.8	0.4	73.0	199.4	305.3	86.1	92.0
OO1	214.7	171.7	185.9	208.2	74.3	231.3	182.5	259.6	233.9
OQ2	66.4	5.9	281.5	144.9	110.5	29.0	341.4	236.7	151.4
MNS2	33.0	39.8	27.3	25.5	17.5	30.7	27.8	11.6	17.5
2N2	53.4	55.7	47.1	42.6	51.0	46.6	44.0	41.8	44.9
MU2	48.2	47.3	44.8	50.4	44.9	63.7	37.0	40.4	47.3
N2	68.8	67.9	67.9	65.9	67.6	65.0	65.2	65.9	70.5
NU2	67.4	64.9	67.4	69.2	69.1	73.5	64.0	82.4	74.0
OP2	184.7	305.2	259.3	246.4	345.5	333.9	260.5	79.6	54.2
M2	86.4	87.0	87.5	85.8	86.5	88.3	86.0	87.2	88.6
MKS2	72.0	146.6	184.9	220.7	118.0	189.7	281.6	86.3	119.7
LAM2	68.4	127.7	101.9	77.4	68.3	107.7	175.4	61.5	85.9
L2	87.3	97.2	94.7	108.1	103.0	161.0	118.2	125.7	101.0
T2	121.7	118.3	119.2	112.2	127.5	143.1	125.9	124.0	142.7
S2	117.6	118.2	118.9	117.8	116.7	120.4	116.3	117.2	119.5
R2	120.0	200.1	133.6	214.5	112.6	79.1	37.4	192.7	49.1
K2	112.3	114.9	116.6	114.3	118.4	125.3	110.9	118.3	118.2
MSN2	227.9	170.3	221.6	27.1	49.1	102.2	316.4	96.1	181.5
KJ2	312.0	308.1	341.9	290.1	338.0	260.9	263.0	286.1	280.1
2SM2	42.3	45.5	50.0	81.6	69.6	238.4	47.0	82.9	94.1
MO3	326.0	326.8	280.2	225.8	267.7	60.3	88.8	26.9	10.6
M3	317.6	318.3	315.2	317.8	315.7	325.1	325.4	319.1	323.1
SO3	47.8	55.8	183.9	286.0	248.3	95.6	80.9	82.4	263.3
MK3	306.9	52.9	331.3	174.3	273.8	58.7	304.8	5.1	285.9
SK3	53.6	53.2	34.9	41.3	11.0	31.9	35.2	8.1	38.6
MN4	246.1	228.3	246.6	254.8	246.9	259.1	241.4	246.2	261.6
M4	263.4	269.7	270.0	283.9	287.4	276.6	275.1	286.9	289.3
SN4	58.1	306.1	16.6	44.1	118.8	43.6	280.8	334.8	16.9
MS4	26.5	12.3	16.2	21.7	58.2	6.9	1.7	9.5	42.5
MK4	306.6	337.2	315.4	68.3	11.6	9.4	337.7	5.5	3.3
S4	200.5	166.3	182.2	152.3	93.5	85.3	43.6	81.6	304.6
SK4	149.5	244.4	152.4	152.1	123.6	99.9	218.7	149.0	112.0
2MN6	206.4	241.6	142.9	25.8	202.8	70.6	199.5	67.5	244.0
M6	249.0	217.1	92.7	315.9	221.5	324.9	184.4	160.6	203.8
MSN6	188.9	10.6	132.0	105.6	201.1	205.0	214.1	209.3	165.9
2MS6	249.1	240.6	230.7	262.9	289.8	274.9	233.2	238.2	240.0
2MK6	224.6	223.4	359.6	86.4	169.8	239.1	249.6	259.0	168.3
2SM6	45.3	21.5	61.2	56.1	55.7	21.9	73.5	79.5	76.2
MSK6	25.7	313.3	87.8	317.5	89.1	302.4	234.6	284.5	249.8
MA2	74.1	5.3	62.2	21.9	41.6	179.3	280.0	18.1	283.9
MB2	249.3	348.9	45.5	331.6	151.9	187.6	82.2	0.1	110.0

	Coruña - Phase (º)		
	1999	**2000**	**2001**
ZO	0.0	0.0	0.0
SA	181.7	222.0	310.7
SSA	57.4	106.4	304.6
MM	256.1	234.5	290.7
MSF	200.4	354.1	342.5
MF	209.4	89.2	224.9
2Q1	217.1	242.8	227.8
SIG1	217.5	210.2	218.9
Q1	284.4	279.2	273.6
RO1	288.2	271.2	297.7
O1	324.3	325.4	323.4
MP1	142.3	241.9	73.4
M1	215.2	310.3	342.0
CHI1	34.2	17.8	191.0
PI1	65.4	326.7	79.1
P1	66.6	65.2	67.9
S1	141.1	126.0	140.8
K1	71.2	73.9	68.9
PSI1	140.6	332.1	18.6
PHI1	93.1	140.2	5.1
TH1	284.4	199.4	123.5
J1	131.1	153.9	91.7
SO1	40.2	279.9	27.3
OO1	237.0	219.5	155.9
OQ2	83.4	33.3	304.9
MNS2	6.2	35.8	6.4
2N2	52.9	50.9	47.7
MU2	48.7	44.8	48.5
N2	69.7	68.9	66.5
NU2	78.5	67.8	79.0
OP2	352.0	264.4	91.3
M2	89.9	87.4	87.4
MKS2	88.4	304.3	73.3
LAM2	82.7	115.0	140.5
L2	104.0	98.2	99.6
T2	124.2	135.0	138.9
S2	120.3	117.8	117.4
R2	121.3	43.2	0.2
K2	120.0	114.9	117.9
MSN2	7.5	247.8	51.5
KJ2	293.3	320.6	334.9
2SM2	126.5	49.1	296.6
MO3	1.6	316.3	332.0
M3	324.5	322.4	321.4
SO3	21.6	305.6	327.3
MK3	202.7	303.0	224.0
SK3	25.5	7.0	6.2
MN4	244.7	247.8	248.3
M4	274.7	286.5	283.7
SN4	337.7	277.8	69.1
MS4	340.3	8.4	14.4
MK4	297.7	344.7	351.1
S4	280.7	246.2	22.5
SK4	262.9	77.8	184.5
2MN6	120.1	140.9	134.3
M6	208.5	193.1	232.4
MSN6	130.2	175.2	128.6
2MS6	231.2	205.5	212.2
2MK6	279.2	206.2	280.6
2SM6	87.9	83.8	97.5
MSK6	255.7	294.7	167.4
MA2	134.2	0.5	325.3
MB2	214.5	71.2	26.5

	Vigo - Amplitude (mm)								
	1943	**1944**	**1945**	**1946**	**1947**	**1948**	**1949**	**1950**	**1951**
ZO	2405.0	2384.5	2423.6	2458.5	2523.4	2490.8	2474.0	2458.6	2507.3
SA	22.1	28.8	65.1	45.9	85.6	62.1	74.5	11.8	5.8
SSA	49.7	21.3	89.4	77.1	65.6	42.4	45.5	22.3	30.7
MM	14.4	8.8	21.7	11.9	30.6	26.2	25.3	28.0	29.4
MSF	24.9	7.5	27.8	14.0	25.7	6.3	13.8	4.3	8.9
MF	9.1	10.0	8.3	11.1	10.9	12.6	6.8	9.6	13.1
2Q1	4.7	3.7	2.9	3.2	4.2	3.9	2.6	4.4	3.7
SIG1	1.8	4.5	3.9	3.4	3.8	4.2	4.8	4.1	4.1
Q1	22.2	21.8	18.9	18.7	16.5	17.7	18.4	20.9	20.5
RO1	3.4	3.9	4.9	2.8	4.0	5.3	4.0	5.1	3.7
O1	64.6	64.2	65.3	65.6	66.2	65.2	63.9	63.3	63.8
MP1	1.3	2.3	0.7	2.5	0.6	1.6	2.8	2.0	1.8
M1	4.0	2.9	1.7	2.1	4.2	5.0	4.6	4.2	4.3
CHI1	1.6	1.1	1.2	0.8	2.3	1.6	0.6	1.2	2.6
PI1	1.7	2.4	1.0	2.7	1.3	3.1	1.8	1.7	2.3
P1	21.5	22.3	23.5	25.9	24.2	23.6	23.8	23.3	23.1
S1	3.1	3.9	4.5	5.5	5.0	7.1	7.6	5.3	7.4
K1	72.6	74.2	73.9	74.3	74.1	72.9	73.8	71.6	71.1
PSI1	5.1	0.6	0.5	2.2	2.4	2.2	3.7	1.2	2.2
PHI1	0.3	0.9	1.9	1.5	1.3	3.6	0.4	1.3	1.4
TH1	1.6	1.0	1.3	1.0	0.8	1.6	0.8	0.2	1.1
J1	1.7	4.1	3.9	3.0	4.3	4.1	3.4	1.8	0.8
SO1	0.9	1.2	0.6	1.8	0.5	1.5	1.4	0.6	1.9
OO1	0.4	1.9	1.5	1.3	1.6	0.8	1.3	0.9	1.2
OQ2	3.9	4.2	2.9	2.6	4.0	2.7	1.7	3.1	5.2
MNS2	8.9	8.8	10.1	9.3	7.1	9.3	9.8	10.5	9.7
2N2	31.4	30.0	33.4	34.2	33.2	31.2	34.5	36.0	35.2
MU2	40.9	41.0	40.7	37.8	37.9	38.4	41.9	39.9	38.2
N2	231.6	232.9	233.3	231.9	233.4	231.9	232.7	233.4	229.7
NU2	44.2	47.0	45.3	40.2	43.5	45.1	42.2	44.0	41.3
OP2	0.5	9.5	3.8	1.0	9.1	4.9	3.7	9.0	13.7
M2	1096.9	1096.0	1093.8	1097.1	1096.7	1092.5	1093.3	1089.0	1086.2
MKS2	6.9	6.7	5.5	8.2	3.6	4.7	1.6	5.3	15.0
LAM2	5.2	6.7	5.7	3.5	5.3	9.0	4.3	4.6	4.4
L2	22.6	23.7	29.2	29.5	27.2	26.0	22.9	23.8	22.2
T2	22.4	21.6	24.2	21.1	20.3	21.9	21.2	25.7	23.9
S2	387.8	386.2	382.2	385.5	388.0	387.7	386.1	383.1	382.4
R2	6.0	3.7	6.9	3.9	3.0	4.5	1.5	5.4	4.6
K2	110.8	109.8	111.9	112.4	109.0	109.2	108.4	108.4	111.9
MSN2	1.3	2.1	1.8	1.4	2.9	1.9	3.0	1.3	2.2
KJ2	4.9	5.3	5.0	5.9	4.8	7.3	5.8	6.8	6.8
2SM2	1.9	0.7	0.5	0.6	1.0	0.8	0.6	0.7	0.6
MO3	1.3	2.3	2.4	1.6	2.3	1.7	1.6	0.6	1.6
M3	7.2	7.2	6.7	6.3	6.0	6.5	6.7	6.8	6.5
SO3	1.4	0.8	0.1	0.7	0.2	0.1	0.3	0.3	0.3
MK3	3.8	1.4	1.1	0.4	0.3	0.8	0.8	1.8	1.5
SK3	3.7	2.4	2.6	2.7	2.3	2.6	3.5	2.1	3.4
MN4	2.6	3.2	2.9	3.2	4.1	3.3	3.9	2.7	3.6
M4	6.9	6.1	5.1	7.5	7.8	7.9	8.1	6.8	5.9
SN4	1.0	0.5	0.7	0.3	0.5	0.5	0.1	0.3	0.2
MS4	5.1	3.7	3.4	2.3	1.4	1.3	2.4	3.7	2.8
MK4	1.5	1.4	1.1	0.8	0.5	0.7	0.8	0.7	0.9
S4	2.4	1.8	0.3	0.8	1.1	0.9	0.8	0.9	1.3
SK4	1.4	1.2	0.8	0.5	0.5	0.5	1.2	0.9	0.6
2MN6	1.3	1.2	1.4	1.5	1.4	1.5	1.6	1.8	1.5
M6	2.6	2.5	2.0	2.8	2.7	2.6	2.9	3.0	2.4
MSN6	0.7	0.5	1.1	0.6	0.5	1.3	0.7	0.7	1.0
2MS6	2.1	2.7	2.8	2.5	2.7	2.5	2.5	2.6	2.3
2MK6	1.0	0.3	0.5	0.6	1.0	1.2	0.8	0.7	0.9
2SM6	1.5	0.9	0.6	0.5	0.9	1.5	1.3	1.1	1.4
MSK6	0.3	0.4	0.5	0.6	0.0	0.5	0.3	0.3	0.5
MA2	4.4	8.7	6.5	5.5	12.5	2.5	11.2	8.7	11.9
MB2	8.4	2.3	9.3	6.2	10.5	10.2	8.7	3.0	9.6

	Vigo - Amplitude (mm)								
	1952	**1953**	**1955**	**1956**	**1957**	**1958**	**1959**	**1960**	**1961**
ZO	2427.4	2454.3	2550.1	2458.9	2435.4	2428.9	2433.9	2521.8	2503.0
SA	15.7	62.5	78.9	34.6	40.2	47.4	49.9	47.6	42.9
SSA	53.6	72.7	18.0	47.0	14.8	14.4	14.4	75.3	64.2
MM	14.7	4.6	24.2	17.7	35.2	15.3	1.8	13.2	25.9
MSF	2.6	5.1	4.7	7.7	15.5	25.2	16.1	16.0	7.5
MF	3.2	8.0	16.2	5.5	7.8	43.4	19.4	21.3	36.4
2Q1	4.8	3.6	2.3	3.0	3.9	2.5	3.8	6.1	6.7
SIG1	4.6	4.7	3.7	3.5	5.2	2.1	3.5	2.7	4.0
Q1	24.5	21.4	17.5	17.7	18.5	18.3	18.6	22.6	22.2
RO1	5.3	5.1	2.8	3.9	3.4	2.7	1.8	3.3	3.1
O1	62.7	65.2	65.6	65.4	63.7	61.7	62.9	64.8	66.2
MP1	4.3	1.2	3.0	1.2	3.3	3.1	0.5	2.6	2.7
M1	2.4	1.6	3.4	5.4	7.0	5.8	9.5	7.2	4.8
CHI1	2.4	1.7	0.8	2.3	0.4	0.1	3.3	0.9	0.8
PI1	3.2	2.2	1.7	1.1	3.0	0.9	0.8	1.9	1.5
P1	25.4	24.7	25.1	22.8	26.4	23.0	21.5	24.7	23.9
S1	3.9	6.6	7.5	6.8	4.3	4.1	7.7	4.0	3.7
K1	75.1	72.8	72.6	71.6	74.3	72.8	73.5	74.4	74.5
PSI1	1.4	1.1	0.9	1.1	1.5	2.8	2.7	1.7	0.7
PHI1	3.6	0.9	1.9	2.0	2.1	2.0	5.0	2.6	3.3
TH1	0.9	0.9	0.4	1.5	1.5	1.6	1.4	1.5	0.7
J1	1.8	2.3	3.8	3.7	3.1	1.0	1.4	1.0	1.0
SO1	1.3	0.8	1.0	2.0	1.2	0.8	1.8	1.8	1.7
OO1	1.0	1.2	1.5	2.3	2.1	2.0	1.8	1.8	1.0
OQ2	2.7	0.9	2.4	3.8	4.1	4.2	8.0	8.7	4.8
MNS2	9.4	9.7	8.4	9.8	9.3	9.9	10.4	10.1	8.2
2N2	28.0	32.2	31.4	33.3	32.6	32.2	34.2	33.9	29.7
MU2	39.0	41.6	39.5	38.9	41.8	41.0	41.4	41.2	40.0
N2	232.8	230.2	228.4	234.0	232.5	228.8	235.4	235.1	229.6
NU2	49.2	46.0	43.4	37.7	45.5	42.1	42.9	43.7	45.7
OP2	8.2	12.6	8.9	8.3	1.8	6.6	4.9	6.5	4.0
M2	1088.8	1087.5	1087.5	1089.5	1090.1	1091.6	1095.2	1093.0	1095.1
MKS2	10.5	11.6	5.5	8.1	4.1	7.6	11.0	4.2	8.8
LAM2	9.7	8.4	7.6	2.8	7.2	6.0	3.6	3.7	6.3
L2	23.0	25.0	26.0	28.8	23.6	18.9	20.6	25.1	20.7
T2	23.8	26.6	22.9	22.0	22.4	22.4	21.6	21.7	22.5
S2	384.6	382.0	384.3	383.2	383.9	385.4	382.7	383.9	385.3
R2	3.0	10.0	5.6	5.6	5.1	1.2	7.7	5.3	3.4
K2	111.3	109.9	104.7	109.8	108.4	104.4	108.0	108.6	108.3
MSN2	4.8	1.7	1.1	2.2	2.8	2.9	1.3	1.5	1.0
KJ2	5.9	5.4	4.4	4.9	5.3	6.3	6.4	5.1	5.8
2SM2	2.2	0.6	1.4	2.3	1.3	3.0	1.0	3.5	2.7
MO3	0.4	1.2	2.5	1.7	1.9	1.8	2.2	1.9	1.3
M3	8.1	6.8	6.6	6.5	6.1	6.6	6.1	6.1	5.9
SO3	1.8	0.2	1.4	0.8	2.6	2.0	2.1	2.1	4.0
MK3	2.9	1.2	1.0	0.9	2.1	1.3	1.3	3.5	4.7
SK3	1.6	2.4	2.0	3.2	4.2	2.6	2.1	3.6	4.7
MN4	5.0	2.1	2.7	2.9	2.8	2.9	2.6	2.8	2.5
M4	4.9	4.7	6.0	6.6	6.5	6.0	6.3	6.3	6.0
SN4	0.5	0.5	0.1	0.6	0.8	1.3	1.0	0.9	0.8
MS4	4.1	3.3	3.8	5.0	4.9	5.1	4.0	6.1	5.8
MK4	1.3	1.2	1.5	1.3	0.9	0.4	1.8	1.7	0.2
S4	1.2	1.2	0.2	2.1	1.8	1.5	1.6	2.2	1.4
SK4	1.8	0.3	0.6	1.5	0.7	0.8	0.9	1.1	0.3
2MN6	1.7	1.6	1.3	1.4	0.9	1.3	1.7	1.4	0.9
M6	3.6	2.4	2.1	2.7	2.8	2.5	2.0	2.0	2.7
MSN6	1.5	0.9	0.7	0.9	0.7	1.0	0.7	1.2	0.7
2MS6	3.5	2.6	2.3	2.5	2.4	2.5	4.0	2.6	2.4
2MK6	0.9	0.8	1.0	0.4	0.6	0.2	0.6	0.9	1.1
2SM6	2.5	0.8	1.1	1.6	1.3	2.1	1.4	2.4	2.5
MSK6	1.4	0.3	0.1	0.3	0.3	0.5	1.7	0.8	0.2
MA2	9.9	19.3	7.1	1.7	9.2	6.3	1.0	4.4	6.3
MB2	5.7	22.4	8.9	7.2	4.3	10.0	5.2	8.2	5.0

	Vigo - Amplitude (mm)								
	1962	**1963**	**1964**	**1965**	**1966**	**1967**	**1968**	**1969**	**1970**
ZO	2487.6	2564.7	2607.0	2537.2	2528.9	2487.6	2516.3	2560.8	2507.1
SA	44.4	145.3	56.4	97.6	49.2	23.5	33.1	53.6	45.8
SSA	45.8	58.6	43.0	48.9	61.9	36.9	45.9	25.4	75.6
MM	38.0	46.8	13.6	24.3	48.2	39.9	13.6	16.4	4.0
MSF	16.3	10.7	9.8	8.7	8.4	19.3	9.3	25.8	20.4
MF	25.5	15.9	16.2	0.4	7.1	13.9	11.9	13.2	11.1
2Q1	6.0	5.4	3.9	2.3	4.4	3.3	4.9	4.9	6.2
SIG1	3.9	3.8	3.1	4.6	5.0	2.4	3.4	3.0	3.7
Q1	23.1	20.4	18.2	15.3	15.7	17.9	20.6	22.3	23.1
RO1	4.5	3.4	3.0	2.8	4.8	3.4	3.9	2.5	3.2
O1	65.0	66.1	69.0	63.7	65.0	63.7	63.8	63.7	63.8
MP1	2.3	2.0	3.3	2.5	1.6	2.3	2.7	3.3	1.2
M1	2.9	2.3	2.5	5.1	4.3	4.8	4.6	3.4	2.4
CHI1	0.5	0.9	1.8	0.9	0.4	0.3	2.8	0.5	0.6
PI1	2.2	3.2	1.7	2.9	2.5	1.6	0.6	3.2	1.3
P1	22.7	24.7	24.1	23.7	23.9	26.3	23.1	23.1	22.6
S1	5.6	4.4	1.7	2.3	4.8	7.1	3.4	3.5	2.3
K1	70.8	69.5	69.7	71.8	71.1	72.8	72.8	71.0	71.6
PSI1	0.6	2.4	2.0	1.9	1.5	2.3	5.6	1.1	2.2
PHI1	1.3	0.6	1.9	2.3	0.7	1.8	1.2	0.8	1.6
TH1	1.8	1.9	0.8	1.5	0.9	2.1	0.7	0.8	0.3
J1	3.9	3.6	4.3	4.3	3.7	3.3	1.1	0.3	2.2
SO1	0.8	0.6	1.3	0.4	0.7	0.9	0.6	1.0	1.6
OO1	0.8	1.4	0.6	0.8	1.5	0.7	0.9	1.0	0.7
OQ2	5.3	4.2	4.8	3.3	3.0	3.6	4.0	2.6	2.2
MNS2	9.8	9.3	7.9	8.5	8.9	11.2	8.4	9.0	9.9
2N2	32.4	34.6	33.4	34.1	32.0	33.7	32.6	31.8	30.9
MU2	41.0	40.3	39.7	40.3	39.1	39.0	42.2	40.1	39.2
N2	234.2	232.3	229.1	233.1	234.0	230.1	231.9	238.3	236.9
NU2	46.5	43.0	42.6	43.2	49.6	41.3	46.7	43.2	43.6
OP2	6.1	8.1	2.9	3.9	2.6	4.3	13.2	0.2	2.8
M2	1095.0	1088.1	1096.5	1092.0	1089.3	1092.3	1094.4	1098.4	1099.9
MKS2	5.7	3.4	9.3	3.7	3.7	8.9	4.6	4.8	4.2
LAM2	7.7	3.1	7.2	4.5	9.8	4.1	9.6	4.2	4.0
L2	26.0	31.5	26.8	27.6	22.7	20.2	21.8	24.8	25.9
T2	21.3	21.8	26.4	21.1	21.5	25.5	20.6	21.3	22.5
S2	387.6	385.0	387.9	386.6	386.6	385.2	384.6	389.2	389.7
R2	8.3	3.3	8.3	5.1	4.7	6.2	5.6	4.3	4.0
K2	112.0	106.9	113.0	110.8	109.8	110.2	105.2	109.6	110.9
MSN2	2.3	2.3	0.3	2.2	0.8	1.8	2.2	2.6	1.8
KJ2	5.3	4.4	6.7	5.3	3.3	6.2	5.4	7.2	5.6
2SM2	1.2	0.2	1.4	1.7	1.6	1.0	0.4	0.6	2.2
MO3	1.3	2.0	2.0	2.0	1.9	1.2	2.3	1.1	1.5
M3	5.9	6.8	6.7	6.7	6.3	6.5	5.1	6.6	6.8
SO3	1.9	2.0	2.3	1.2	0.6	0.7	0.8	0.8	0.4
MK3	2.5	2.9	2.9	1.6	1.2	1.8	1.5	2.4	1.4
SK3	3.3	3.8	3.0	2.6	2.4	3.1	2.9	2.6	2.5
MN4	3.2	3.1	3.2	2.5	2.6	3.0	3.1	3.0	3.4
M4	6.1	6.4	6.6	6.8	5.6	6.5	7.1	7.0	6.8
SN4	0.7	0.5	0.0	0.5	1.0	0.4	0.9	1.1	0.7
MS4	4.2	3.2	4.2	4.1	4.0	3.2	4.6	6.0	5.6
MK4	1.1	0.7	1.0	1.2	0.9	1.2	1.7	1.4	0.9
S4	1.4	0.9	1.9	1.3	1.0	0.6	1.6	2.1	3.3
SK4	0.2	1.0	0.8	0.6	0.8	0.6	0.6	0.9	1.1
2MN6	1.1	1.5	1.2	1.5	1.1	0.9	1.5	0.8	1.2
M6	2.6	2.5	2.1	2.9	2.2	2.6	2.3	2.7	2.8
MSN6	0.9	0.9	0.9	0.8	0.8	0.7	0.8	1.2	0.9
2MS6	2.8	2.6	2.8	3.1	3.3	3.0	3.3	2.7	2.4
2MK6	0.5	0.9	1.0	0.6	0.6	1.2	0.5	0.8	1.0
2SM6	1.6	0.9	1.2	1.4	0.7	0.7	0.6	2.2	2.4
MSK6	0.3	0.8	0.3	0.5	0.1	0.3	0.7	0.5	0.3
MA2	10.0	5.9	11.6	4.8	5.3	2.2	11.0	6.8	5.0
MB2	3.4	1.3	4.7	1.2	1.8	4.7	4.5	0.4	2.5

	Vigo - Amplitude (mm)								
	1971	**1972**	**1973**	**1974**	**1975**	**1976**	**1977**	**1978**	**1979**
ZO	2505.3	2559.7	2548.5	2544.7	2555.2	2576.7	2612.3	2517.1	2563.0
SA	34.0	89.6	21.8	41.1	46.9	100.6	128.9	109.1	95.5
SSA	4.5	24.5	32.9	28.3	23.4	23.3	18.0	28.2	36.5
MM	5.3	15.9	13.4	15.1	10.9	8.7	13.9	20.1	14.9
MSF	11.3	5.1	11.8	30.3	4.5	24.7	25.5	27.3	10.4
MF	10.3	4.1	26.3	23.4	12.7	14.5	35.3	17.0	29.4
2Q1	4.6	2.6	2.4	2.3	2.6	2.4	5.0	6.3	5.4
SIG1	4.2	4.6	2.3	3.6	4.2	3.1	3.6	5.4	4.4
Q1	21.4	19.0	16.9	17.2	16.5	18.4	23.6	27.8	22.2
RO1	4.0	1.9	2.3	4.4	2.6	4.4	3.7	9.2	5.1
O1	65.5	63.9	65.4	64.4	62.9	62.9	63.8	65.0	65.8
MP1	0.9	2.3	2.6	3.7	3.0	2.9	1.4	3.0	3.2
M1	1.9	0.7	4.7	6.5	6.4	5.9	9.8	4.1	3.2
CHI1	0.6	1.9	1.0	2.2	1.4	1.4	2.3	4.4	3.4
PI1	1.2	3.5	2.0	1.9	2.5	1.7	3.3	1.3	2.7
P1	22.8	26.0	22.5	24.8	26.1	24.4	25.6	24.1	24.6
S1	3.5	3.9	5.6	5.3	6.1	15.4	13.7	11.4	4.9
K1	70.5	71.9	72.2	71.4	70.7	73.0	74.5	66.6	68.0
PSI1	2.2	1.8	1.9	2.3	1.8	1.8	0.8	3.6	1.4
PHI1	1.0	1.5	2.8	1.7	4.1	2.1	3.8	3.0	2.6
TH1	0.3	1.1	0.4	2.7	1.0	0.2	2.5	1.2	3.6
J1	3.5	4.1	4.0	4.2	2.7	1.5	1.6	1.4	2.7
SO1	0.3	1.7	0.6	2.5	1.3	2.0	1.1	2.1	1.3
OO1	0.8	1.3	0.5	1.9	1.1	3.5	4.1	0.9	3.8
OQ2	3.1	3.6	4.4	2.7	3.7	4.7	6.5	10.6	6.2
MNS2	11.2	9.8	9.8	8.3	10.2	10.9	10.7	7.2	7.8
2N2	33.6	34.6	33.4	29.0	33.5	36.5	32.9	35.8	32.8
MU2	40.0	40.2	38.5	38.7	40.9	40.3	40.4	38.0	38.8
N2	234.5	235.3	236.6	230.3	231.6	234.7	232.4	231.5	229.6
NU2	45.2	43.8	42.2	42.1	47.2	46.0	46.6	32.4	39.9
OP2	1.4	4.1	3.9	2.4	4.7	9.8	19.9	21.7	17.0
M2	1088.9	1092.1	1090.4	1095.9	1088.1	1086.4	1088.1	1094.2	1091.6
MKS2	1.8	5.2	5.2	7.5	8.0	1.7	15.0	37.1	22.1
LAM2	5.5	6.3	8.0	4.0	8.1	5.9	7.8	3.8	0.7
L2	31.9	31.1	33.4	23.0	20.0	23.3	22.9	23.8	24.2
T2	21.5	22.7	20.8	22.7	21.8	18.9	24.7	28.2	19.1
S2	385.4	385.2	384.8	384.7	379.5	377.4	374.5	385.3	382.8
R2	2.9	5.7	3.6	6.0	3.1	1.8	5.8	3.4	15.5
K2	106.6	106.1	106.9	108.8	107.3	104.7	105.6	129.4	116.9
MSN2	1.4	2.8	2.9	1.9	1.8	1.0	2.2	4.2	3.7
KJ2	6.3	5.2	5.2	3.5	5.7	4.6	5.7	8.8	6.7
2SM2	1.0	2.1	1.0	0.4	1.6	1.0	1.7	0.8	1.7
MO3	1.7	2.1	2.2	2.0	1.9	0.6	1.1	1.4	1.6
M3	6.9	6.8	7.4	7.1	6.8	6.5	6.0	5.9	5.9
SO3	0.2	1.2	1.2	1.1	1.9	1.6	0.6	1.6	1.9
MK3	1.1	1.6	1.5	1.3	2.3	2.2	2.4	1.9	1.8
SK3	2.6	2.1	3.0	2.7	0.9	3.4	3.9	1.3	2.3
MN4	2.7	3.6	2.2	2.6	3.2	2.8	2.4	2.9	2.6
M4	6.5	5.0	4.8	5.6	6.7	7.1	7.2	5.8	7.3
SN4	1.1	1.0	0.7	0.4	0.3	0.2	0.8	0.7	0.4
MS4	5.6	5.2	4.5	3.3	4.0	4.8	3.9	3.8	3.9
MK4	1.2	1.4	0.9	1.3	0.8	0.4	1.4	2.1	0.9
S4	3.4	1.9	1.7	1.5	1.0	2.1	2.0	1.1	0.6
SK4	1.0	0.8	0.7	0.4	0.8	0.8	0.8	0.9	0.9
2MN6	0.9	1.8	1.5	0.9	0.9	0.6	0.5	1.6	0.7
M6	2.7	2.6	2.8	2.7	2.0	1.6	1.6	2.9	1.9
MSN6	0.9	0.9	0.8	0.7	0.8	1.1	1.0	1.1	1.0
2MS6	2.3	3.2	2.3	2.5	2.3	2.2	2.0	2.7	3.0
2MK6	0.5	1.1	0.7	0.8	1.0	0.7	0.8	0.5	1.3
2SM6	2.2	1.9	1.3	0.5	1.4	1.9	2.1	0.2	0.8
MSK6	0.7	0.2	0.4	0.4	0.2	0.4	0.9	0.2	0.2
MA2	8.0	11.5	8.4	13.7	8.2	5.3	6.4	28.6	23.6
MB2	1.6	6.1	9.7	3.7	3.0	4.5	0.5	10.3	14.6

	Vigo - Amplitude (mm)								
	1980	**1982**	**1983**	**1984**	**1985**	**1986**	**1987**	**1988**	**1989**
ZO	2525.6	2507.6	2621.4	2547.8	2539.0	2504.5	2573.6	2560.9	2556.5
SA	63.5	112.6	11.2	63.2	117.4	17.6	102.8	52.1	117.5
SSA	32.5	15.2	68.6	89.3	36.2	31.5	35.9	52.8	105.6
MM	21.0	40.3	22.3	15.5	28.8	23.9	13.2	12.0	32.8
MSF	10.2	31.1	13.3	4.9	6.7	9.2	28.3	12.4	35.5
MF	19.2	6.1	23.3	13.3	13.9	1.8	14.8	10.3	9.0
2Q1	6.7	1.5	4.3	2.8	3.5	4.3	5.0	6.0	4.4
SIG1	3.7	3.8	3.2	5.2	4.2	3.9	3.6	3.4	5.4
Q1	22.2	15.9	15.5	15.4	18.6	21.2	23.1	22.3	20.1
RO1	6.2	1.8	2.8	4.4	3.7	3.3	3.7	5.0	5.1
O1	65.1	62.0	63.4	62.4	62.3	62.0	63.5	63.3	63.1
MP1	3.3	5.9	1.4	1.0	1.9	1.9	1.8	1.8	0.4
M1	2.4	5.8	5.3	5.3	4.3	3.9	1.4	1.8	1.5
CHI1	1.4	1.7	1.6	1.4	0.6	0.6	1.5	0.3	3.4
PI1	2.4	3.4	2.2	3.7	1.6	3.2	1.3	2.1	0.4
P1	23.8	26.2	23.7	24.1	22.3	24.8	22.6	23.1	21.2
S1	4.2	2.1	1.5	5.7	3.2	5.7	8.3	11.7	15.7
K1	71.5	75.6	71.1	69.8	70.2	71.1	71.4	70.6	71.4
PSI1	1.6	2.4	0.3	0.9	2.0	2.3	1.6	1.8	2.2
PHI1	2.2	1.0	0.8	0.4	1.0	1.2	1.4	1.7	1.0
TH1	2.0	2.0	1.6	1.6	0.8	0.9	0.6	1.3	0.5
J1	3.7	6.2	3.8	4.1	2.9	1.7	0.9	2.9	2.8
SO1	3.7	2.9	1.7	1.8	0.7	0.6	0.6	0.5	0.8
OO1	6.3	2.2	1.2	1.8	0.9	1.2	0.6	0.5	1.9
OQ2	4.2	7.3	5.6	4.4	3.5	3.3	2.3	2.0	3.6
MNS2	11.4	8.8	7.4	8.4	11.2	9.2	9.8	7.3	11.4
2N2	25.2	34.9	34.7	32.2	36.6	33.9	30.4	32.0	34.3
MU2	46.4	35.5	38.1	42.1	41.2	40.3	41.6	40.9	41.5
N2	225.8	230.3	232.7	232.0	230.4	230.5	233.2	231.0	229.7
NU2	44.3	33.6	33.1	35.6	43.6	42.4	41.8	45.2	44.5
OP2	66.3	19.1	24.5	19.1	3.6	5.5	4.7	2.1	5.0
M2	1085.6	1085.5	1088.6	1090.3	1088.5	1083.3	1081.9	1085.7	1084.6
MKS2	55.6	29.5	24.4	15.3	2.9	6.1	3.3	1.1	1.0
LAM2	3.0	2.7	3.3	6.8	8.3	6.4	4.1	7.0	5.9
L2	31.2	29.9	29.8	23.0	21.0	20.8	22.7	23.0	31.4
T2	23.7	25.0	18.5	22.2	20.9	24.1	22.3	21.6	23.2
S2	375.2	379.5	380.1	381.3	383.1	382.0	379.7	380.4	375.2
R2	13.9	8.7	2.4	10.0	3.7	4.4	6.1	6.3	4.7
K2	121.8	119.1	112.2	104.6	107.2	108.6	106.8	107.4	105.6
MSN2	5.1	4.4	1.8	4.5	1.4	2.4	2.5	2.5	0.1
KJ2	1.9	9.1	5.1	3.0	5.8	7.3	6.5	6.3	5.9
2SM2	1.9	0.7	2.5	1.3	1.1	0.5	0.5	2.8	3.9
MO3	1.6	2.5	2.5	1.6	1.1	1.1	0.9	1.4	1.0
M3	7.0	7.2	7.1	6.6	6.2	6.4	6.3	6.7	7.4
SO3	0.8	0.8	1.0	0.7	1.3	0.8	0.4	0.1	0.7
MK3	1.4	2.6	0.8	1.3	2.1	2.4	1.5	1.4	0.4
SK3	4.4	3.6	2.9	1.8	2.2	2.9	2.4	3.0	3.0
MN4	2.6	3.0	2.1	3.2	2.1	2.6	2.2	2.6	3.1
M4	5.9	6.0	4.3	4.9	4.4	4.8	5.5	5.4	7.2
SN4	0.2	0.8	0.7	0.3	1.0	0.9	0.5	0.7	0.8
MS4	3.9	3.8	3.6	3.1	4.9	4.4	4.8	4.7	7.1
MK4	1.0	0.9	0.3	0.8	0.8	1.0	1.3	1.1	1.0
S4	1.3	1.0	1.7	0.4	2.0	1.5	1.1	0.6	1.2
SK4	0.8	0.2	0.8	0.3	0.9	0.3	0.9	0.4	1.0
2MN6	1.3	1.3	1.2	1.1	1.5	1.3	1.7	1.6	1.9
M6	2.2	2.1	2.8	2.4	2.4	2.8	2.8	2.9	2.6
MSN6	1.2	1.1	1.1	0.6	0.9	0.8	1.2	0.9	0.5
2MS6	2.8	3.2	3.1	2.7	3.2	3.4	3.5	3.1	2.5
2MK6	1.4	1.9	0.9	0.6	0.6	1.2	1.1	1.1	0.7
2SM6	0.8	0.5	0.3	0.4	1.7	1.2	1.4	1.6	3.0
MSK6	0.8	0.9	0.2	0.1	0.4	0.4	0.3	0.3	0.4
MA2	49.9	19.1	19.7	40.0	13.3	7.5	9.4	1.9	5.2
MB2	35.1	9.7	11.4	35.1	5.8	2.6	3.8	2.0	7.3

	Vigo - Amplitude (mm)								
	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**
ZO	2491.5	2516.5	2505.7	2582.4	2580.0	2598.7	2655.5	2670.1	2613.9
SA	91.4	95.4	66.1	62.5	43.5	87.1	124.8	86.7	39.3
SSA	28.2	42.1	33.5	89.7	49.9	86.1	32.1	106.9	28.5
MM	21.8	23.3	13.8	42.9	39.1	14.6	14.1	25.3	24.0
MSF	22.3	21.6	8.4	36.7	17.5	10.1	16.2	14.6	4.9
MF	18.5	15.9	6.6	7.2	25.7	22.5	35.4	20.0	26.5
2Q1	2.6	5.5	4.2	3.3	4.8	4.8	4.6	3.9	3.3
SIG1	3.0	4.0	2.6	2.8	2.5	4.4	3.6	4.6	3.1
Q1	17.2	16.0	17.4	16.5	20.2	21.5	20.8	20.3	20.2
RO1	2.8	4.2	2.2	3.8	4.9	4.1	4.2	5.9	4.1
O1	63.9	64.2	63.5	59.8	62.3	62.1	63.5	63.2	66.9
MP1	1.3	1.1	1.9	0.9	0.3	2.4	3.9	1.8	1.4
M1	0.4	4.4	5.5	6.2	6.1	9.3	6.0	2.6	3.4
CHI1	1.8	2.2	1.9	3.9	1.3	1.9	2.8	1.2	0.5
PI1	1.3	1.2	4.0	1.5	6.0	1.2	8.4	2.4	1.5
P1	16.8	22.1	22.4	23.0	24.6	18.7	30.8	22.5	19.6
S1	14.8	22.7	17.8	28.8	7.1	5.1	14.2	8.9	10.4
K1	71.5	72.2	73.3	72.8	72.0	75.0	75.6	72.3	70.5
PSI1	4.6	3.3	3.1	3.3	2.5	2.5	5.4	3.2	1.0
PHI1	1.7	4.8	3.3	3.1	2.5	2.5	1.4	2.5	2.9
TH1	1.0	3.0	1.2	0.9	1.2	0.8	0.2	1.4	0.9
J1	5.6	3.8	4.5	2.1	1.6	2.0	0.5	4.7	4.2
SO1	0.4	1.7	1.8	3.4	1.4	0.4	1.7	1.3	1.2
OO1	0.5	1.9	1.3	1.7	2.5	3.5	0.5	1.3	3.5
OQ2	4.0	3.9	2.1	4.5	5.2	4.7	5.7	4.1	7.7
MNS2	9.9	8.4	11.1	9.6	11.1	9.8	9.2	9.5	9.0
2N2	34.6	30.2	29.7	33.4	34.9	33.7	32.3	31.2	33.8
MU2	39.5	36.4	39.9	40.6	40.3	38.3	43.2	41.2	38.5
N2	230.7	227.7	229.8	232.3	228.3	228.1	235.5	230.1	230.1
NU2	42.3	41.1	43.1	43.4	42.3	45.3	49.3	45.0	46.4
OP2	3.0	6.4	3.7	6.0	7.6	10.6	5.5	4.4	10.0
M2	1082.5	1084.4	1082.9	1081.2	1084.5	1084.6	1086.8	1088.3	1087.1
MKS2	3.2	3.0	5.4	4.3	7.9	3.4	15.4	12.3	7.8
LAM2	7.6	4.3	7.5	8.6	5.8	7.4	10.4	8.6	7.0
L2	30.7	25.9	25.2	23.8	22.4	21.4	26.5	22.3	26.1
T2	22.6	21.7	23.1	21.0	21.9	18.6	25.5	21.7	19.4
S2	374.1	374.3	371.4	369.6	377.0	378.2	371.0	376.1	376.3
R2	8.0	6.8	5.3	3.0	8.2	4.6	2.9	6.4	7.2
K2	104.8	105.1	106.5	104.2	106.8	105.7	106.8	108.0	108.2
MSN2	1.6	1.2	3.5	2.2	0.8	1.6	1.1	1.0	2.0
KJ2	5.5	5.7	3.8	6.3	6.1	4.8	6.5	4.0	5.1
2SM2	4.1	2.2	2.4	3.7	1.9	2.3	1.2	2.7	2.5
MO3	1.7	1.9	1.3	2.7	1.2	1.9	0.3	2.5	2.1
M3	6.2	6.6	6.4	7.2	6.1	6.3	6.2	7.0	6.2
SO3	0.2	0.8	0.9	2.3	1.1	2.0	0.4	1.0	0.8
MK3	0.4	1.2	0.8	0.7	1.9	0.2	2.2	1.8	1.0
SK3	2.4	3.4	3.3	2.3	3.4	2.9	3.3	3.6	2.3
MN4	4.1	3.4	4.8	3.5	2.7	2.1	2.5	3.3	2.8
M4	9.3	8.4	10.0	7.7	5.4	5.8	6.4	6.8	6.5
SN4	0.6	0.8	1.0	1.1	1.0	1.2	0.2	1.1	0.7
MS4	6.3	3.2	3.7	4.2	5.1	2.0	1.4	0.8	2.7
MK4	1.3	1.9	1.0	0.4	0.6	2.5	1.3	0.5	1.0
S4	1.3	0.7	1.9	3.1	4.2	3.9	2.5	1.0	1.0
SK4	0.5	0.2	0.4	0.8	1.9	0.7	0.4	0.9	1.3
2MN6	1.9	1.9	1.6	1.9	1.1	0.9	1.1	0.7	0.7
M6	3.0	4.1	3.0	2.4	2.7	2.5	2.7	3.0	2.7
MSN6	1.6	0.4	1.2	2.0	1.0	0.8	0.8	1.0	1.1
2MS6	3.3	3.2	3.8	2.4	1.9	1.8	2.8	2.8	3.2
2MK6	0.7	1.4	0.7	0.3	1.2	1.8	1.1	0.8	0.6
2SM6	2.9	1.8	2.0	1.7	1.6	0.6	0.9	1.5	1.1
MSK6	0.2	1.0	0.8	0.5	0.4	0.7	0.4	0.2	0.3
MA2	2.8	2.7	6.7	7.3	6.1	8.6	8.6	3.6	7.9
MB2	5.7	2.6	6.0	1.5	4.9	6.9	2.8	6.1	0.8

	Vigo - Amplitude (mm)		
	1999	**2000**	**2001**
ZO	2574.9	2589.9	2591.6
SA	56.8	54.2	79.7
SSA	44.6	88.9	52.0
MM	23.9	15.7	10.5
MSF	0.4	2.7	20.4
MF	20.3	3.9	22.7
2Q1	3.5	2.7	4.7
SIG1	2.8	3.4	4.1
Q1	19.8	17.2	17.2
RO1	5.1	4.8	3.6
O1	65.1	65.8	62.4
MP1	1.5	1.9	0.9
M1	1.9	3.7	5.0
CHI1	0.8	2.0	2.0
PI1	2.1	4.0	1.4
P1	24.9	22.9	20.8
S1	11.1	12.2	13.7
K1	70.6	71.0	71.1
PSI1	2.4	1.5	2.3
PHI1	1.4	4.0	2.6
TH1	1.7	2.2	3.4
J1	4.6	4.6	6.8
SO1	0.7	1.0	1.2
OO1	2.5	1.7	1.9
OQ2	4.8	3.8	2.8
MNS2	8.6	8.5	8.5
2N2	36.0	30.6	33.3
MU2	40.3	38.2	38.9
N2	230.3	228.1	230.9
NU2	44.1	40.8	45.2
OP2	6.8	5.2	2.3
M2	1090.2	1089.1	1083.8
MKS2	4.5	2.9	1.9
LAM2	6.3	6.0	7.9
L2	27.5	26.6	26.6
T2	21.1	21.9	18.7
S2	375.3	376.8	377.0
R2	2.5	5.6	5.2
K2	108.6	108.1	107.5
MSN2	1.0	1.0	1.3
KJ2	4.6	4.7	5.3
2SM2	2.0	2.9	2.4
MO3	2.4	2.4	2.0
M3	6.2	7.1	6.3
SO3	0.8	0.7	0.7
MK3	0.3	0.8	1.3
SK3	2.2	2.2	2.9
MN4	3.1	3.0	2.6
M4	7.5	7.9	6.9
SN4	0.1	0.5	1.1
MS4	2.9	2.7	3.0
MK4	3.1	1.3	0.6
S4	2.0	1.5	1.2
SK4	0.5	1.3	1.0
2MN6	0.3	1.0	0.8
M6	1.8	2.3	1.5
MSN6	0.6	1.2	0.7
2MS6	2.7	2.3	2.3
2MK6	0.2	0.6	1.4
2SM6	1.7	1.3	1.0
MSK6	0.6	0.7	0.7
MA2	9.7	2.7	4.6
MB2	5.0	5.4	2.3

	Vigo - Phase (º)								
	1943	**1944**	**1945**	**1946**	**1947**	**1948**	**1949**	**1950**	**1951**
ZO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SA	139.7	113.5	237.0	228.6	326.4	282.9	190.0	305.4	202.8
SSA	11.1	109.4	120.8	73.6	328.5	148.9	59.2	132.1	15.8
MM	210.8	203.7	40.5	26.2	24.3	48.8	115.1	204.3	149.8
MSF	75.7	39.3	302.7	318.9	34.1	140.1	43.5	98.4	21.2
MF	11.8	173.8	315.3	198.5	218.2	279.1	167.8	236.0	240.8
2Q1	217.0	223.6	234.0	229.0	241.5	206.1	201.3	202.9	223.8
SIG1	227.3	245.3	225.3	258.8	227.3	238.9	225.1	235.6	218.7
Q1	267.4	267.7	273.6	278.3	280.9	268.4	260.4	256.3	263.1
RO1	265.3	279.2	288.8	264.1	253.4	282.3	263.8	267.3	267.5
O1	323.1	320.4	318.8	319.6	319.8	318.4	320.6	321.5	320.4
MP1	147.2	13.7	204.6	126.3	259.1	91.3	107.0	110.5	109.4
M1	97.7	94.4	111.8	166.0	275.3	336.4	352.9	15.2	42.9
CHI1	91.2	346.5	20.4	75.7	335.6	58.9	56.1	37.8	29.4
PI1	129.3	17.5	94.5	16.4	82.2	75.2	32.7	17.5	18.7
P1	61.4	53.8	53.9	54.3	53.6	54.2	53.8	52.6	55.6
S1	38.7	53.5	29.7	32.8	23.8	11.4	35.1	24.6	4.5
K1	59.2	62.5	62.1	61.1	62.2	62.1	61.3	63.2	60.9
PSI1	356.0	183.5	108.4	91.9	36.3	121.6	63.2	48.5	352.8
PHI1	304.0	95.0	57.0	47.0	97.5	21.9	341.7	91.2	91.7
TH1	77.5	164.8	150.3	205.0	163.0	109.3	76.5	9.8	312.8
J1	90.6	120.9	110.4	110.2	88.3	50.0	65.2	25.6	0.3
SO1	277.8	78.6	316.4	49.1	340.5	0.9	26.7	59.9	344.5
OO1	160.4	183.6	185.0	166.9	262.6	183.2	228.9	173.8	194.6
OQ2	305.4	233.3	159.2	85.4	23.0	275.0	162.3	90.3	27.1
MNS2	5.7	10.0	4.2	7.3	2.8	8.5	0.3	5.9	33.7
2N2	44.0	36.6	36.8	41.6	40.4	37.5	35.0	42.6	51.5
MU2	30.8	35.5	34.4	33.0	34.6	31.7	31.5	32.9	40.0
N2	60.3	58.4	58.6	57.8	57.2	57.5	58.2	58.7	59.0
NU2	65.0	60.8	59.3	57.2	63.1	65.0	60.9	59.8	63.8
OP2	71.4	215.6	47.4	160.8	253.3	283.1	289.4	329.4	151.5
M2	78.1	77.2	77.2	76.5	75.9	76.0	76.2	77.3	77.6
MKS2	72.0	292.6	50.3	24.9	284.4	188.7	114.7	124.1	29.9
LAM2	77.0	88.9	91.0	93.2	61.7	80.7	94.9	63.5	91.3
L2	88.6	99.4	105.3	90.1	84.1	71.1	70.8	93.0	98.0
T2	106.9	104.9	108.8	101.4	95.7	114.3	106.3	104.3	93.0
S2	105.5	105.1	105.2	104.5	104.0	103.9	104.3	105.7	106.1
R2	88.5	124.9	89.4	142.0	191.3	99.7	162.7	122.7	207.5
K2	104.5	101.8	102.8	101.5	101.0	102.1	101.1	103.7	99.9
MSN2	225.1	209.8	61.5	7.2	255.0	217.2	132.6	350.5	281.5
KJ2	311.4	305.9	315.0	306.1	305.9	311.9	313.2	313.2	300.0
2SM2	33.6	49.8	262.9	121.2	187.4	219.1	80.3	126.9	241.5
MO3	83.2	26.2	1.3	321.9	278.3	280.5	241.9	162.0	123.1
M3	309.0	300.6	302.6	295.6	298.5	301.9	297.3	303.7	305.8
SO3	218.2	267.0	136.0	202.8	31.2	105.4	243.0	351.0	177.4
MK3	285.4	276.8	286.6	203.2	208.0	322.9	293.1	274.9	291.0
SK3	336.7	343.4	356.6	11.7	359.9	353.4	14.2	357.7	357.4
MN4	178.6	174.5	171.9	175.0	162.4	155.9	173.8	174.9	173.3
M4	231.2	225.2	216.3	205.7	199.9	201.1	205.9	218.9	213.4
SN4	343.8	352.7	21.5	35.1	133.7	33.6	6.7	102.8	62.5
MS4	9.4	1.6	350.1	335.8	349.0	330.7	345.1	339.9	4.0
MK4	336.8	317.1	310.5	293.1	326.0	352.2	291.3	320.0	317.9
S4	69.5	76.3	80.1	81.1	105.3	120.1	94.4	69.9	93.1
SK4	115.7	51.0	92.7	88.5	131.3	119.5	100.8	96.4	59.6
2MN6	121.1	88.7	112.6	103.3	82.0	94.4	102.7	89.2	101.9
M6	141.3	148.6	132.8	133.1	132.1	130.2	134.9	120.9	138.0
MSN6	193.4	183.7	182.2	164.1	145.8	134.5	143.2	204.5	174.7
2MS6	209.9	217.1	205.4	184.5	183.1	184.3	178.5	197.3	202.2
2MK6	236.8	147.0	157.5	200.2	191.2	201.5	177.5	208.2	209.1
2SM6	34.0	21.8	60.6	40.4	48.2	52.5	10.0	14.5	44.4
MSK6	180.6	209.7	262.1	313.4	253.5	107.6	259.8	347.4	307.2
MA2	175.0	79.5	185.2	17.8	33.6	168.1	357.9	71.5	63.3
MB2	115.0	196.7	119.8	1.9	340.6	86.8	10.2	207.3	301.5

	Vigo - Phase (º)								
	1952	**1953**	**1955**	**1956**	**1957**	**1958**	**1959**	**1960**	**1961**
ZO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SA	20.1	223.8	283.1	290.1	300.5	299.3	271.1	261.5	275.5
SSA	67.0	97.1	151.0	347.9	2.4	280.0	344.5	33.3	104.1
MM	184.7	291.2	239.3	287.8	324.0	172.3	50.4	349.9	127.2
MSF	29.3	252.7	320.2	65.4	193.9	149.0	309.2	290.5	50.1
MF	89.7	109.4	146.8	206.6	4.2	106.6	199.0	278.7	123.6
2Q1	221.6	233.6	194.8	236.4	234.8	239.5	211.3	227.4	226.5
SIG1	212.9	234.0	250.5	237.2	236.8	225.9	212.4	250.1	228.2
Q1	271.5	273.6	272.9	266.3	262.9	259.0	259.2	261.0	268.6
RO1	278.7	266.5	226.5	272.0	283.2	238.2	260.3	269.9	276.6
O1	321.9	319.5	318.8	317.5	319.6	318.6	316.8	322.3	322.6
MP1	122.9	44.3	42.8	90.5	107.8	326.0	122.3	81.5	90.7
M1	36.6	44.7	250.3	327.6	339.2	1.3	9.9	53.1	95.3
CHI1	349.2	20.9	229.9	307.8	186.3	203.7	75.2	178.1	326.8
PI1	356.6	43.0	100.3	32.2	12.2	32.5	202.4	70.4	288.5
P1	48.7	48.9	54.4	55.7	53.2	54.1	59.7	55.7	52.5
S1	342.8	33.5	2.8	352.8	326.9	322.8	339.5	314.5	347.9
K1	63.5	60.7	61.5	62.4	63.6	61.3	63.7	61.7	62.6
PSI1	111.3	328.1	53.9	165.1	116.4	120.3	90.4	273.6	272.9
PHI1	33.7	36.0	48.9	170.8	95.3	55.1	344.6	64.7	90.3
TH1	249.0	15.6	169.4	96.7	113.8	221.2	293.8	280.9	139.8
J1	206.1	120.7	86.9	86.4	74.0	359.5	358.6	128.4	144.6
SO1	28.6	312.5	65.0	23.6	14.3	212.6	48.2	318.3	332.0
OO1	282.7	219.3	179.5	227.5	261.0	192.8	201.5	329.2	88.3
OQ2	315.0	229.4	29.4	349.5	239.3	128.0	64.9	19.1	279.1
MNS2	14.2	10.0	15.4	1.9	11.6	11.5	5.3	7.1	8.5
2N2	41.3	41.5	42.6	40.8	40.3	38.6	42.9	42.7	36.1
MU2	33.5	33.0	31.2	32.4	32.1	32.6	31.6	33.5	32.3
N2	59.5	58.1	58.2	57.7	59.4	58.5	58.5	58.1	57.6
NU2	66.8	63.9	57.9	67.2	65.3	61.9	59.2	59.4	63.0
OP2	125.3	116.7	279.4	150.3	336.1	230.3	288.5	276.2	188.2
M2	77.4	76.8	77.0	77.3	77.6	76.4	77.0	76.5	76.4
MKS2	69.7	35.7	116.4	52.5	118.4	326.2	50.9	105.9	6.9
LAM2	80.0	73.5	96.2	7.6	78.8	83.0	85.8	90.0	75.5
L2	96.4	104.8	88.7	87.8	72.4	81.0	89.7	92.8	96.2
T2	99.9	120.6	115.7	111.7	104.7	108.9	107.5	116.7	105.3
S2	105.3	105.1	105.3	105.2	105.9	104.7	105.4	104.7	104.5
R2	129.2	82.5	99.0	73.4	117.1	34.0	80.6	105.6	136.6
K2	101.1	101.4	102.0	102.5	105.4	101.9	102.6	104.8	101.5
MSN2	257.0	147.1	183.5	304.5	193.5	165.2	56.3	302.1	227.7
KJ2	307.4	294.8	285.2	277.9	290.3	281.7	314.2	309.4	307.5
2SM2	71.5	305.8	327.1	2.6	346.4	330.9	286.4	318.8	320.0
MO3	260.7	351.2	295.1	261.0	229.9	209.7	182.8	97.0	76.9
M3	297.5	307.7	300.7	295.4	298.7	303.2	292.9	302.0	300.4
SO3	209.6	104.5	318.9	3.5	197.8	24.0	9.9	223.1	246.2
MK3	291.9	323.9	218.4	265.5	310.7	141.4	206.7	296.1	301.5
SK3	327.6	15.5	3.7	11.8	14.3	21.2	15.5	356.1	346.7
MN4	181.8	161.3	192.1	179.0	173.1	179.1	184.1	171.4	178.2
M4	225.2	221.4	224.4	223.1	221.3	222.5	216.3	225.1	224.8
SN4	122.5	344.3	192.2	310.8	293.0	326.5	284.6	258.3	270.1
MS4	340.0	4.1	342.7	342.2	335.5	329.7	333.8	300.6	307.9
MK4	262.0	333.0	338.7	359.8	291.6	340.7	265.6	318.1	118.0
S4	179.8	104.5	110.2	30.1	21.1	26.0	63.5	315.4	340.0
SK4	141.6	109.1	63.6	125.0	127.3	151.5	257.6	44.9	187.8
2MN6	56.6	78.2	98.0	98.0	112.8	74.1	112.7	123.5	103.7
M6	162.5	131.1	125.9	146.4	133.3	129.1	167.7	147.4	140.9
MSN6	294.5	163.2	184.9	181.9	193.7	191.3	109.4	189.5	192.0
2MS6	165.8	194.3	200.3	200.7	206.4	195.2	216.2	210.5	208.5
2MK6	74.2	188.7	193.4	212.5	257.2	180.9	97.4	206.2	217.1
2SM6	54.5	67.0	9.2	350.0	331.6	332.3	325.8	292.9	306.3
MSK6	327.4	289.4	37.0	82.9	189.5	137.0	332.2	310.0	179.8
MA2	72.3	176.8	262.5	232.2	82.5	356.2	32.3	286.8	30.3
MB2	251.6	152.5	94.8	84.0	190.2	62.2	113.5	76.0	3.4

	Vigo - Phase (º)								
	1962	**1963**	**1964**	**1965**	**1966**	**1967**	**1968**	**1969**	**1970**
ZO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SA	209.8	281.5	221.6	290.1	287.0	201.2	293.6	307.9	275.7
SSA	38.6	164.5	318.6	355.9	310.3	59.3	124.8	313.0	193.1
MM	324.8	161.6	314.7	137.2	142.8	234.9	313.4	341.3	62.6
MSF	319.5	14.7	159.3	346.9	120.5	105.4	57.9	98.3	65.4
MF	330.6	89.2	160.5	287.1	252.8	239.6	161.2	109.8	170.4
2Q1	224.0	254.9	230.0	204.2	203.9	210.0	200.7	210.0	221.3
SIG1	246.4	237.9	234.5	242.7	213.6	233.2	237.4	230.3	208.4
Q1	275.2	279.7	277.6	265.9	264.8	260.9	261.9	263.8	269.9
RO1	277.6	273.5	263.0	287.7	285.3	283.9	260.5	280.5	265.0
O1	320.2	320.4	318.5	318.0	317.8	319.7	318.8	321.0	319.6
MP1	129.1	122.9	134.5	102.6	120.2	62.2	219.7	100.3	171.2
M1	134.7	77.0	210.7	296.4	347.5	0.2	34.7	74.6	50.5
CHI1	17.2	18.8	12.1	125.8	263.1	348.9	39.1	10.7	134.6
PI1	50.0	43.0	291.3	97.2	54.4	30.2	133.4	35.2	6.5
P1	50.4	55.5	51.0	58.2	57.3	52.1	48.1	54.6	48.1
S1	326.9	61.7	12.3	66.1	63.6	65.5	100.7	66.5	82.5
K1	61.3	61.1	63.6	60.4	62.2	62.0	61.3	62.0	61.7
PSI1	46.3	40.7	298.2	32.6	335.6	74.1	38.6	31.8	62.6
PHI1	169.6	37.6	66.1	112.0	188.7	82.8	328.3	145.9	86.8
TH1	105.3	123.4	38.6	79.2	27.8	97.2	15.4	62.5	218.4
J1	158.4	99.3	99.4	88.3	61.3	29.9	61.7	251.2	120.3
SO1	25.4	321.5	11.5	359.8	347.0	332.9	129.8	345.6	25.6
OO1	181.9	226.4	247.8	230.5	237.5	162.1	144.2	200.7	232.2
OQ2	228.0	140.7	55.0	341.6	247.9	148.8	82.5	4.9	264.2
MNS2	0.6	3.4	2.1	5.2	11.6	8.6	4.1	4.4	12.7
2N2	37.7	39.1	42.5	37.8	36.3	37.3	44.7	45.1	39.7
MU2	31.4	33.9	32.5	32.3	34.2	32.3	31.8	32.9	32.5
N2	58.6	58.1	59.0	56.9	57.6	58.8	58.0	58.3	58.7
NU2	67.7	62.1	63.1	62.4	61.1	58.1	68.5	60.8	61.7
OP2	347.5	291.3	227.4	301.4	147.2	117.3	302.4	262.0	156.0
M2	77.1	77.4	77.1	77.1	77.3	77.0	76.9	77.1	77.3
MKS2	135.2	299.4	20.8	91.7	358.0	18.6	201.1	104.7	72.5
LAM2	66.0	108.2	82.4	129.0	104.1	85.1	46.2	106.8	95.7
L2	99.0	102.8	89.6	91.1	88.5	78.9	91.8	100.1	105.2
T2	104.9	108.9	101.6	109.8	107.1	107.4	106.0	108.5	113.3
S2	104.9	105.8	105.4	105.2	105.9	105.5	105.1	105.7	105.8
R2	125.0	110.8	104.5	125.6	105.5	83.0	150.0	120.7	120.0
K2	104.9	104.3	102.3	104.4	102.6	101.5	104.9	102.3	102.5
MSN2	243.8	44.1	312.4	297.7	286.1	160.1	143.0	301.2	255.3
KJ2	320.1	288.3	312.5	300.5	317.8	315.1	310.8	307.7	287.8
2SM2	340.9	333.8	77.8	352.1	187.7	15.6	5.0	45.9	83.2
MO3	359.7	340.7	304.2	286.4	253.3	226.1	178.4	87.4	37.0
M3	307.0	301.5	301.0	299.7	299.4	298.1	307.2	309.2	301.9
SO3	234.0	215.9	192.6	302.8	218.0	283.9	310.9	225.9	313.9
MK3	301.5	295.6	324.1	227.9	266.3	301.2	301.1	298.3	295.0
SK3	347.1	352.9	7.0	352.7	3.0	3.0	353.7	13.6	3.8
MN4	172.3	174.7	178.4	168.0	179.9	174.8	167.8	168.7	172.1
M4	224.4	213.0	225.5	218.1	223.7	224.6	224.0	225.8	229.2
SN4	275.1	45.8	79.8	358.9	0.1	359.6	264.0	5.7	354.4
MS4	297.9	325.5	342.7	345.6	347.5	350.6	353.5	4.1	14.7
MK4	356.1	276.3	314.5	309.0	348.0	307.8	290.8	311.1	316.5
S4	12.4	49.8	67.0	62.5	97.6	64.6	97.5	58.3	61.6
SK4	91.3	183.0	93.5	100.4	95.5	62.6	138.4	99.5	69.1
2MN6	107.9	114.1	113.2	111.6	101.6	110.0	128.3	91.2	98.5
M6	142.6	138.1	143.9	149.5	154.5	151.2	173.1	125.7	131.1
MSN6	167.1	187.8	141.2	167.8	178.4	153.0	186.5	153.7	142.7
2MS6	205.9	201.6	209.2	212.0	201.6	208.3	207.7	201.5	197.4
2MK6	199.8	214.3	170.2	211.4	182.6	197.9	224.8	192.7	209.2
2SM6	317.5	50.6	326.7	351.2	321.6	40.4	12.1	21.7	26.5
MSK6	248.7	223.0	265.7	267.3	286.6	314.7	316.8	274.2	216.0
MA2	56.9	63.0	97.1	36.4	62.3	92.6	60.4	52.3	36.6
MB2	310.5	32.3	205.5	297.6	182.7	137.7	272.4	164.3	131.5

	Vigo - Phase (º)								
	1971	**1972**	**1973**	**1974**	**1975**	**1976**	**1977**	**1978**	**1979**
ZO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SA	15.8	257.7	233.4	322.8	274.2	229.4	280.6	298.9	280.7
SSA	154.8	25.4	131.2	224.5	255.3	61.3	256.1	218.9	259.0
MM	192.1	169.0	243.5	49.2	192.9	188.2	83.0	31.9	181.2
MSF	135.8	107.1	310.3	153.1	83.7	67.7	169.0	225.9	278.5
MF	180.6	51.3	162.3	79.3	268.6	119.5	65.4	27.9	296.5
2Q1	238.6	197.3	220.7	206.9	207.9	218.7	200.0	238.6	243.2
SIG1	241.4	241.9	230.5	257.5	232.2	197.0	224.7	203.6	209.4
Q1	277.3	275.8	278.9	263.1	260.8	261.8	266.4	271.0	271.3
RO1	270.6	259.4	290.0	281.8	281.1	278.1	272.1	232.1	272.4
O1	318.7	317.7	319.8	318.9	318.6	319.9	320.0	317.4	320.9
MP1	80.1	108.2	110.8	78.7	38.7	59.9	64.1	237.8	119.9
M1	54.9	269.4	270.1	336.6	345.5	1.3	29.3	65.1	105.9
CHI1	337.8	332.2	277.0	57.6	142.7	153.9	66.6	275.0	62.8
PI1	55.6	52.3	40.2	35.2	23.8	316.7	25.5	188.4	91.0
P1	52.4	51.3	52.1	54.3	48.3	50.5	56.5	54.0	53.7
S1	47.3	82.8	78.2	59.2	60.2	75.8	80.4	44.0	19.7
K1	60.3	60.9	61.3	61.9	64.1	62.1	61.8	62.6	63.9
PSI1	57.4	66.0	42.7	13.6	87.8	293.4	215.6	267.7	326.6
PHI1	38.7	47.7	70.9	103.2	62.9	56.9	68.1	93.3	125.4
TH1	264.7	141.4	138.1	104.2	113.8	356.0	183.3	276.4	51.0
J1	125.1	98.5	95.6	51.8	61.6	58.8	68.9	129.6	132.0
SO1	2.4	344.9	347.4	8.0	137.4	12.6	97.1	139.9	328.9
OO1	136.7	188.5	218.9	279.4	292.0	141.6	294.4	192.5	199.9
OQ2	153.6	97.1	29.7	282.1	186.5	115.6	38.7	353.1	306.6
MNS2	3.8	9.4	2.2	5.7	14.5	10.5	12.3	13.4	349.7
2N2	36.1	43.7	44.5	37.8	37.8	39.2	43.0	47.1	40.8
MU2	31.6	30.9	32.9	31.1	35.0	36.0	33.7	32.3	28.8
N2	58.8	58.8	58.2	58.0	59.0	58.2	58.5	57.9	58.4
NU2	64.0	58.8	70.2	63.7	66.2	65.4	60.5	65.2	66.0
OP2	338.5	198.4	268.9	233.2	66.4	283.8	333.3	82.5	35.5
M2	77.3	76.6	76.8	77.4	77.7	77.4	77.4	75.5	75.5
MKS2	35.5	8.1	106.9	106.6	97.1	164.1	155.5	63.2	89.4
LAM2	68.3	92.5	30.3	68.1	80.1	64.0	59.2	200.0	81.4
L2	102.1	84.5	85.2	81.0	82.4	95.8	90.3	87.9	86.3
T2	105.8	104.7	110.8	106.6	103.7	112.9	115.2	82.9	99.7
S2	105.6	105.0	105.5	105.8	106.2	106.4	106.5	104.4	103.6
R2	125.6	136.7	167.7	124.9	93.2	135.8	112.3	112.0	145.2
K2	102.3	101.6	103.5	103.9	104.2	104.4	108.0	104.0	107.2
MSN2	247.9	232.7	326.0	151.7	219.9	312.6	314.4	162.4	162.7
KJ2	290.6	313.6	288.8	298.4	306.7	302.3	303.6	283.5	284.5
2SM2	38.9	146.3	115.0	25.7	345.0	258.4	292.2	276.4	333.9
MO3	358.1	316.1	290.9	259.1	216.9	196.7	142.9	136.0	61.6
M3	306.3	300.9	297.7	300.4	303.3	297.7	304.8	302.1	301.2
SO3	328.9	269.0	240.3	249.6	321.1	302.9	301.5	172.8	208.6
MK3	319.1	236.7	290.0	330.2	250.1	302.9	313.2	263.5	327.6
SK3	20.8	8.0	11.9	8.9	340.3	28.8	2.5	291.2	341.4
MN4	175.7	180.4	171.4	169.3	175.3	175.5	170.6	187.1	189.0
M4	226.2	231.7	226.7	225.6	219.4	220.4	224.3	217.3	230.1
SN4	48.6	58.5	20.1	309.5	43.4	326.5	302.7	315.0	254.2
MS4	14.3	17.9	20.5	21.6	339.4	325.2	320.7	328.8	300.9
MK4	336.4	337.3	312.8	326.1	347.2	312.2	323.3	346.4	231.7
S4	78.1	86.6	87.3	84.6	25.6	292.5	266.9	254.3	50.9
SK4	70.9	72.4	106.3	86.1	63.1	78.8	115.1	18.0	173.0
2MN6	76.4	113.3	92.6	101.7	105.5	131.7	134.7	102.1	124.0
M6	121.5	119.2	135.2	133.3	140.8	145.8	151.8	138.0	164.5
MSN6	171.5	185.5	197.5	180.1	181.4	175.4	183.4	139.6	132.9
2MS6	206.8	206.0	213.8	211.9	210.9	210.3	213.1	191.5	214.6
2MK6	181.9	193.1	209.5	203.2	210.3	195.0	188.1	251.5	210.9
2SM6	30.5	17.3	347.8	24.9	334.8	329.5	321.3	347.9	354.4
MSK6	299.6	335.6	318.0	295.5	342.9	89.9	242.5	275.9	149.4
MA2	35.1	42.6	30.1	70.4	42.3	48.1	82.7	60.5	67.4
MB2	264.0	306.1	346.5	280.4	15.2	10.9	172.5	293.7	271.5

	Vigo - Phase (º)								
	1980	**1982**	**1983**	**1984**	**1985**	**1986**	**1987**	**1988**	**1989**
ZO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SA	311.1	233.0	159.1	273.4	304.4	281.9	254.2	270.5	252.5
SSA	31.2	100.4	124.2	93.8	191.4	328.2	73.2	140.2	140.0
MM	308.5	71.7	289.3	3.5	283.8	45.8	169.4	91.4	121.2
MSF	21.8	187.0	230.1	171.5	21.3	189.9	275.1	36.1	95.5
MF	148.8	237.2	165.9	250.3	137.9	316.1	175.7	135.8	225.4
2Q1	236.3	265.1	198.9	210.4	211.1	205.8	217.2	227.5	241.4
SIG1	176.8	237.2	219.5	225.2	211.0	210.6	236.0	222.8	223.9
Q1	277.5	279.7	255.5	259.0	258.6	256.2	266.7	273.9	277.3
RO1	257.0	274.9	260.9	271.8	272.1	280.4	291.6	286.5	272.9
O1	320.2	316.2	317.6	316.5	320.6	319.7	319.6	318.7	317.9
MP1	179.4	89.5	150.5	326.7	83.1	135.9	112.3	131.6	103.2
M1	101.7	229.1	312.1	352.7	4.3	23.9	55.3	46.0	73.9
CHI1	297.7	262.0	307.5	354.6	165.4	302.7	352.1	276.0	243.7
PI1	9.8	28.0	46.2	337.3	72.5	37.3	337.4	25.7	173.0
P1	48.5	55.3	46.3	47.9	58.5	53.6	55.3	51.0	48.1
S1	64.5	150.2	143.2	98.2	72.7	84.5	79.3	71.5	77.5
K1	60.1	59.4	61.9	60.9	61.4	61.6	60.2	62.7	63.0
PSI1	90.0	19.3	10.0	97.5	21.4	115.6	48.4	81.9	96.4
PHI1	121.2	89.2	189.1	22.9	90.9	34.0	45.9	110.9	117.1
TH1	237.8	93.8	149.6	42.8	327.7	168.0	108.5	74.9	265.4
J1	108.3	86.2	88.3	53.3	25.5	75.9	162.6	140.5	142.5
SO1	11.7	337.0	27.2	95.5	300.9	11.0	123.9	329.3	325.5
OO1	190.6	57.9	172.4	152.2	178.8	191.2	257.2	221.4	208.8
OQ2	161.0	47.0	313.0	222.9	140.6	64.9	359.0	220.9	136.9
MNS2	4.7	349.9	3.7	352.1	2.2	16.9	15.2	13.1	3.4
2N2	39.8	42.0	36.7	37.7	39.9	45.0	42.8	34.0	37.9
MU2	29.2	29.1	35.1	29.1	35.6	35.5	35.6	32.7	33.7
N2	54.5	55.0	56.6	56.1	58.9	58.7	58.6	59.3	58.6
NU2	67.7	56.8	61.3	51.5	63.1	60.4	63.2	64.2	61.3
OP2	1.2	123.8	340.7	276.8	318.0	356.3	207.2	172.0	313.8
M2	74.8	74.1	75.8	75.9	77.1	77.1	76.8	77.4	77.3
MKS2	143.5	17.9	153.1	226.3	47.8	95.5	35.0	7.1	52.1
LAM2	186.9	185.7	90.3	144.1	69.8	86.7	80.7	78.3	88.1
L2	119.2	87.4	83.4	90.2	85.9	93.0	93.3	104.1	101.0
T2	62.9	97.4	96.8	80.7	103.8	106.9	112.4	114.9	116.2
S2	104.3	102.6	105.1	104.4	105.9	106.1	106.0	106.7	106.8
R2	194.4	112.4	161.6	195.0	123.4	104.1	91.7	97.2	72.8
K2	113.8	97.1	106.9	105.0	103.4	103.0	101.9	103.4	103.2
MSN2	4.4	327.4	300.5	103.2	89.9	238.2	253.5	196.1	62.2
KJ2	6.4	307.2	304.9	308.5	312.2	309.5	292.8	293.5	290.8
2SM2	231.4	290.6	265.6	263.1	155.9	176.1	86.7	71.9	78.5
MO3	310.4	296.8	257.5	238.5	238.0	134.1	80.7	35.8	343.3
M3	289.2	295.2	292.9	300.7	301.8	299.3	307.9	305.0	303.8
SO3	229.1	277.1	205.6	326.8	271.1	263.2	276.3	253.3	260.5
MK3	274.0	240.8	305.5	266.1	276.4	301.8	299.7	309.4	289.4
SK3	336.6	2.3	342.7	16.4	348.2	10.6	351.1	28.1	0.7
MN4	164.7	187.6	170.3	148.9	183.8	174.7	178.1	193.1	186.4
M4	218.5	225.1	231.9	223.9	232.9	243.2	241.9	241.6	231.9
SN4	263.5	217.7	116.5	49.2	352.8	59.6	346.5	11.4	19.9
MS4	320.4	306.0	327.6	330.8	21.1	4.0	6.3	12.9	16.4
MK4	283.7	338.8	218.3	342.3	353.7	331.5	350.5	317.6	346.1
S4	252.8	346.1	31.6	314.4	83.0	92.3	115.5	197.7	100.4
SK4	88.6	75.6	171.6	42.7	126.7	47.1	110.2	94.7	103.6
2MN6	166.4	131.6	172.3	114.1	111.2	131.0	125.5	103.2	174.8
M6	151.3	172.4	163.4	148.3	155.0	153.2	145.0	161.4	210.5
MSN6	145.5	74.6	168.1	150.3	140.9	171.9	141.4	135.5	223.3
2MS6	206.4	212.0	193.0	199.8	216.2	214.0	206.4	205.0	223.3
2MK6	209.9	209.9	233.4	236.0	192.0	220.5	212.4	226.0	186.9
2SM6	163.5	21.7	51.6	289.7	30.9	39.2	48.7	48.5	44.1
MSK6	351.9	245.7	295.8	306.4	319.9	217.0	167.8	288.0	306.4
MA2	40.4	100.5	36.1	44.2	55.9	70.1	101.2	88.4	13.0
MB2	292.5	233.8	328.3	294.5	329.0	292.9	173.9	144.5	63.2

	Vigo - Phase (º)								
	1990	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**
ZO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SA	270.8	255.5	237.3	195.0	218.4	231.1	307.4	263.3	321.8
SSA	126.8	345.7	108.8	94.3	116.6	132.6	195.4	131.5	304.6
MM	41.5	176.6	253.3	318.5	353.8	349.7	214.1	141.9	33.4
MSF	133.7	148.3	125.5	87.8	79.9	209.0	63.0	128.8	101.6
MF	299.7	101.7	39.6	26.5	148.5	242.2	139.0	182.9	106.6
2Q1	265.9	231.5	224.6	199.3	192.4	204.3	227.2	248.2	226.6
SIG1	221.1	241.7	252.6	227.9	227.2	208.3	237.8	221.5	228.0
Q1	279.9	274.3	259.5	261.5	254.2	258.3	270.8	268.7	277.2
RO1	262.3	250.5	266.4	273.3	266.6	266.5	304.2	273.5	277.7
O1	318.9	317.6	316.3	320.5	321.2	318.5	322.3	319.2	318.9
MP1	143.5	290.9	351.2	127.8	150.2	8.1	119.1	307.5	145.1
M1	89.3	311.5	343.3	0.6	27.6	60.7	115.2	122.5	141.0
CHI1	281.5	320.9	264.8	55.0	73.4	98.2	330.2	355.1	107.1
PI1	115.7	74.1	42.7	261.3	331.5	304.1	62.6	10.9	254.1
P1	48.7	50.2	55.5	49.1	50.2	40.2	50.2	55.9	55.6
S1	65.3	70.4	76.4	77.4	92.8	170.4	100.3	144.3	109.5
K1	60.0	61.0	62.5	64.7	61.2	60.3	67.3	61.2	62.2
PSI1	61.1	83.3	38.0	40.4	238.0	349.3	72.0	89.0	345.6
PHI1	51.8	49.2	57.7	50.0	91.4	265.5	88.3	345.0	56.6
TH1	321.5	92.9	79.9	118.4	208.4	312.8	128.5	68.2	352.1
J1	100.9	118.8	68.8	71.2	77.9	138.9	176.5	116.6	113.2
SO1	43.6	115.9	260.0	25.8	81.1	320.8	47.0	3.7	12.4
OO1	174.1	287.3	73.6	203.8	197.9	192.9	12.0	192.8	217.1
OQ2	96.0	346.8	244.4	149.4	76.2	32.8	322.5	240.1	160.6
MNS2	7.9	16.7	14.0	19.6	15.2	19.6	15.5	5.0	8.0
2N2	42.0	43.2	39.7	38.4	41.3	44.1	45.9	37.6	40.5
MU2	34.6	31.3	35.1	33.8	33.8	32.8	35.6	34.0	33.2
N2	59.2	59.0	58.0	59.4	59.0	59.5	59.9	59.4	59.6
NU2	64.1	63.9	59.0	63.9	61.6	63.4	67.2	67.7	60.4
OP2	261.1	246.5	192.8	306.3	327.0	288.0	184.1	63.3	14.9
M2	77.8	77.8	77.5	78.1	77.8	77.7	78.1	77.7	77.8
MKS2	50.6	356.1	83.6	235.1	82.3	151.2	49.5	107.5	127.3
LAM2	95.7	65.9	106.4	89.5	86.8	77.7	83.9	59.3	90.5
L2	90.9	84.9	83.4	90.0	90.7	91.7	96.1	96.8	94.8
T2	120.6	118.2	114.1	112.4	116.3	107.5	110.1	117.9	118.7
S2	107.3	107.3	107.4	108.2	107.0	106.6	107.3	106.7	107.2
R2	93.7	92.2	122.1	112.9	120.4	123.6	129.8	99.5	94.1
K2	103.3	103.6	102.7	105.4	106.7	106.6	105.6	106.6	107.4
MSN2	225.2	240.2	186.4	276.4	35.0	262.6	250.1	269.4	193.3
KJ2	300.8	310.9	291.5	300.8	290.6	306.7	292.4	340.3	282.2
2SM2	80.4	66.3	80.8	85.7	69.1	109.9	301.7	79.0	112.1
MO3	331.5	298.2	259.3	221.6	149.7	81.2	120.7	21.9	7.4
M3	294.9	306.8	312.3	304.4	303.5	310.1	312.8	304.6	303.5
SO3	93.9	89.7	315.9	247.4	61.2	8.7	203.9	277.2	233.6
MK3	311.8	130.0	233.4	33.9	271.5	288.0	306.2	335.5	333.6
SK3	347.4	12.6	52.1	66.2	359.7	22.4	34.1	8.6	340.2
MN4	191.8	184.3	213.8	180.6	165.6	182.5	196.2	199.3	199.7
M4	227.3	219.2	221.3	207.4	218.9	228.3	231.7	236.8	239.3
SN4	322.8	348.2	307.4	10.7	353.8	255.3	248.2	356.1	48.5
MS4	5.5	359.9	6.8	24.0	44.9	27.0	347.5	351.3	352.7
MK4	302.1	291.3	304.6	264.6	198.5	307.4	1.2	207.5	310.4
S4	88.1	172.3	102.8	182.2	92.2	72.7	249.3	18.2	351.3
SK4	67.0	188.6	173.3	125.4	57.4	55.0	237.6	333.4	141.3
2MN6	227.5	216.8	157.9	205.4	170.2	166.2	157.4	117.9	187.3
M6	205.6	236.3	211.1	224.9	205.7	203.9	194.2	194.9	192.9
MSN6	149.6	252.9	89.0	141.9	148.2	206.6	194.5	143.2	171.3
2MS6	226.9	235.8	223.8	225.8	213.0	216.9	226.6	216.9	230.8
2MK6	180.0	203.7	225.7	125.0	250.4	250.5	197.0	258.2	265.3
2SM6	33.4	25.2	18.7	51.6	38.9	341.3	40.1	65.0	38.2
MSK6	228.0	270.3	164.1	319.4	221.9	312.6	113.5	172.1	64.0
MA2	134.4	95.9	91.7	51.4	49.6	73.5	79.2	79.4	356.8
MB2	138.2	169.3	137.2	94.2	194.1	259.7	23.8	107.5	90.8

	Vigo - Phase (º)		
	1999	**2000**	**2001**
ZO	0.0	0.0	0.0
SA	189.7	268.3	300.7
SSA	59.7	131.1	332.7
MM	243.5	224.4	225.2
MSF	321.3	338.6	343.0
MF	202.0	100.3	215.6
2Q1	214.4	214.1	210.2
SIG1	238.4	209.6	220.6
Q1	274.5	272.8	265.7
RO1	255.1	267.7	295.1
O1	318.4	317.8	319.2
MP1	60.7	260.5	96.5
M1	230.6	332.9	319.4
CHI1	202.0	24.1	271.8
PI1	107.9	22.1	24.1
P1	47.0	49.6	52.2
S1	118.5	116.2	112.5
K1	62.8	63.5	61.3
PSI1	199.0	182.0	130.6
PHI1	254.3	91.6	68.9
TH1	13.8	96.0	81.4
J1	103.7	107.5	69.2
SO1	350.3	204.6	21.7
OO1	235.2	202.5	118.8
OQ2	85.5	30.9	297.3
MNS2	7.5	10.4	0.4
2N2	42.2	43.6	37.8
MU2	33.5	31.7	31.0
N2	60.1	58.9	59.1
NU2	61.9	60.1	66.7
OP2	321.7	284.9	238.9
M2	78.3	78.2	78.7
MKS2	35.4	10.3	1.7
LAM2	71.9	128.1	78.9
L2	89.6	92.1	86.9
T2	108.9	116.8	116.9
S2	106.9	106.7	107.2
R2	139.6	78.1	105.0
K2	106.0	103.8	106.1
MSN2	271.6	212.9	3.9
KJ2	321.9	306.0	307.4
2SM2	74.2	75.5	68.1
MO3	315.6	282.5	247.9
M3	309.2	298.8	304.5
SO3	17.2	96.6	37.4
MK3	222.0	300.8	258.8
SK3	21.7	340.8	352.2
MN4	223.7	212.3	197.4
M4	243.2	248.7	248.8
SN4	230.9	320.5	225.4
MS4	353.8	357.7	357.9
MK4	341.2	322.2	337.0
S4	349.0	357.9	311.0
SK4	108.6	36.4	0.1
2MN6	226.9	174.8	242.5
M6	217.6	207.2	224.0
MSN6	172.7	168.1	138.0
2MS6	229.7	237.2	245.5
2MK6	217.8	211.4	213.8
2SM6	55.2	55.6	40.7
MSK6	319.2	212.5	216.2
MA2	33.9	115.2	80.6
MB2	342.6	116.9	174.1

	Aveiro - Amplitude (mm)								
	1976	**1979**	**1980**	**1981**	**1982**	**1983**	**1984**	**1985**	**1986**
ZO	2067.8	2133.8	2090.7	2078.6	2079.1	2122.8	2115.1	2130.0	2088.1
SA	62.8	62.2	31.1	28.8	51.8	37.2	22.0	68.3	12.1
SSA	13.6	50.0	47.4	38.2	14.1	84.2	75.9	22.3	29.4
MM	12.3	29.4	10.4	23.1	24.3	25.1	11.3	25.9	12.1
MSF	15.9	11.7	3.8	26.8	38.5	15.0	20.9	10.3	36.4
MF	26.1	26.5	7.1	30.5	4.8	27.9	16.4	13.0	4.4
2Q1	1.9	5.7	3.5	2.5	1.8	2.0	2.0	1.8	4.6
SIG1	3.3	2.1	1.9	3.4	2.1	3.0	3.7	3.1	4.2
Q1	14.8	16.5	16.8	16.4	13.7	12.3	12.8	15.8	18.2
RO1	2.4	2.5	3.6	5.8	1.9	2.8	2.9	3.7	3.2
O1	46.6	49.1	50.4	51.2	49.8	50.1	50.8	52.5	53.3
MP1	3.3	3.3	4.8	3.3	2.9	2.0	1.8	1.2	4.1
M1	5.8	1.0	1.2	2.1	4.6	4.1	3.6	3.5	2.3
CHI1	0.9	1.2	0.4	1.6	0.9	1.8	1.0	2.0	0.7
PI1	1.7	1.2	1.3	0.5	2.8	2.1	1.8	1.0	0.9
P1	15.5	18.4	18.6	19.6	18.2	19.1	19.9	16.4	18.9
S1	7.9	3.6	2.7	6.6	3.7	4.1	4.5	6.0	4.2
K1	53.6	55.9	55.3	56.0	57.6	55.7	57.8	56.0	58.7
PSI1	3.2	1.9	0.8	1.8	1.7	1.7	1.0	0.4	2.9
PHI1	0.9	1.8	2.5	2.4	1.1	0.8	0.7	1.9	1.7
TH1	0.2	2.3	1.1	1.6	0.5	0.2	1.3	0.5	0.6
J1	3.4	0.3	1.7	2.6	4.0	2.6	3.2	2.3	0.3
SO1	1.1	2.5	1.0	2.4	1.6	2.4	0.6	1.3	1.8
OO1	2.5	2.3	3.1	0.9	1.1	1.2	0.8	0.9	1.0
OQ2	2.9	1.5	2.4	3.7	4.1	3.5	0.5	2.9	6.2
MNS2	6.3	1.5	3.9	5.2	3.8	3.4	4.5	6.3	6.1
2N2	22.7	22.7	20.2	29.0	29.0	22.6	23.7	27.4	32.5
MU2	16.4	17.8	19.1	20.1	22.8	18.5	22.6	23.3	26.7
N2	182.8	177.7	179.6	181.0	187.2	180.9	191.7	190.9	196.1
NU2	28.4	37.0	30.7	34.5	36.7	35.8	37.2	34.8	39.7
OP2	4.5	9.1	17.3	10.7	5.4	1.7	0.3	3.5	3.3
M2	865.3	859.5	869.4	884.8	883.4	881.0	909.1	926.4	935.1
MKS2	24.8	15.1	10.7	3.0	3.3	2.8	4.2	3.2	1.3
LAM2	6.3	7.4	5.6	6.9	7.4	11.7	8.5	6.5	5.8
L2	26.3	22.6	34.6	28.0	26.2	29.1	28.9	22.6	22.4
T2	16.0	17.3	12.6	20.4	12.7	12.9	14.7	19.9	19.7
S2	295.3	292.8	294.3	300.1	303.2	298.7	311.7	317.7	323.2
R2	6.8	2.8	2.1	6.6	2.5	4.2	6.5	7.9	7.4
K2	82.4	81.8	84.4	90.4	85.1	89.2	89.9	90.1	91.2
MSN2	5.5	3.3	3.3	2.1	4.3	3.6	1.1	1.5	2.9
KJ2	5.6	3.2	2.7	2.2	4.4	3.3	2.9	4.4	5.3
2SM2	2.5	3.2	3.9	2.5	2.5	5.6	2.3	2.4	1.4
MO3	5.5	3.6	3.1	3.3	4.6	4.8	4.0	4.3	3.7
M3	1.9	3.0	4.1	4.7	4.9	4.5	4.6	3.7	2.9
SO3	3.9	4.0	2.5	2.5	4.3	2.6	2.2	2.3	1.7
MK3	7.0	5.9	5.7	5.1	4.9	4.4	3.7	4.6	4.5
SK3	2.8	3.0	4.2	3.0	2.7	2.9	3.6	2.5	2.4
MN4	17.6	10.4	12.0	13.3	13.1	12.3	11.6	12.1	13.4
M4	49.4	34.4	39.0	41.4	42.9	37.0	34.0	35.0	38.6
SN4	3.4	3.2	2.5	2.0	2.9	2.6	2.3	2.4	3.2
MS4	31.2	22.7	23.5	26.4	27.5	22.8	21.6	23.4	25.9
MK4	8.8	8.1	7.1	9.2	7.7	6.7	6.2	6.6	7.1
S4	1.9	2.0	2.4	2.0	2.9	1.9	2.5	2.8	2.6
SK4	2.3	1.7	1.0	3.0	2.0	1.7	1.4	1.8	1.7
2MN6	6.9	8.8	8.0	7.7	6.8	7.6	6.3	5.7	4.1
M6	11.5	14.0	13.7	13.2	11.1	12.9	10.2	9.0	7.0
MSN6	3.3	4.7	4.5	4.1	4.6	3.4	3.7	2.8	2.3
2MS6	10.3	13.5	12.8	13.2	11.0	13.2	10.7	10.0	8.1
2MK6	2.6	4.1	4.6	3.4	4.3	4.0	3.1	2.7	2.0
2SM6	2.1	3.7	3.7	4.2	3.9	4.2	3.8	3.6	2.3
MSK6	0.8	2.3	2.2	3.0	2.1	2.1	2.1	1.5	1.4
MA2	2.4	14.9	15.8	16.2	15.7	10.7	14.8	11.3	5.7
MB2	20.7	8.2	4.9	20.3	12.3	8.7	12.6	6.5	7.7

	Aveiro - Amplitude (mm)								
	1988	**1989**	**1991**	**1992**	**1993**	**1994**	**1995**	**1997**	**1998**
ZO	2129.7	2145.5	2097.2	2078.8	2105.3	2081.6	2106.8	2148.0	2109.6
SA	47.5	101.3	13.7	38.6	44.5	77.7	56.4	62.3	25.7
SSA	47.7	89.3	35.1	39.2	63.7	79.4	57.7	89.8	32.2
MM	10.1	35.6	47.6	28.1	29.7	18.7	22.0	35.2	16.3
MSF	4.2	27.3	31.4	19.6	28.7	9.2	35.6	14.6	17.9
MF	10.7	9.7	12.9	0.9	6.6	19.4	18.0	16.0	21.9
2Q1	4.2	3.8	4.1	2.9	2.4	2.8	4.6	3.2	2.5
SIG1	2.6	4.2	2.3	2.2	3.3	3.5	3.2	5.0	4.1
Q1	18.4	18.1	13.3	15.7	15.3	18.6	18.7	18.7	16.4
RO1	3.6	2.3	3.1	3.7	3.3	3.0	5.2	4.4	3.9
O1	54.8	55.9	54.3	53.6	54.2	48.9	55.0	54.9	56.9
MP1	2.8	2.9	1.7	0.5	2.6	2.9	2.0	1.3	3.7
M1	1.2	0.9	5.3	5.0	5.6	4.5	7.0	2.8	1.7
CHI1	0.5	0.3	1.8	2.2	1.1	1.8	1.7	2.2	2.3
PI1	1.5	2.7	2.9	2.2	0.5	1.5	2.5	1.6	0.3
P1	17.8	18.4	19.8	18.8	18.2	17.2	18.3	20.6	20.1
S1	4.7	4.5	5.2	3.9	3.0	4.7	5.1	2.5	4.8
K1	58.9	59.5	61.0	61.1	61.7	61.4	61.1	62.3	62.3
PSI1	1.2	1.1	3.4	1.7	2.3	1.1	0.6	1.5	1.4
PHI1	0.8	1.1	3.1	0.1	2.4	1.2	1.0	2.5	2.9
TH1	1.4	0.4	0.5	2.5	1.2	1.0	1.3	1.0	1.3
J1	1.6	2.3	5.2	3.8	2.5	0.7	0.9	3.1	2.5
SO1	2.3	1.7	0.1	1.3	2.4	0.4	1.5	1.6	1.9
OO1	0.8	1.4	1.1	0.6	1.2	1.1	2.4	1.6	4.3
OQ2	0.2	1.8	3.4	2.4	3.0	4.8	5.2	5.9	5.4
MNS2	3.9	5.1	4.3	4.5	6.5	9.3	7.7	5.4	4.9
2N2	24.3	28.2	30.3	27.0	28.7	28.2	29.6	26.5	26.7
MU2	23.5	24.7	28.5	27.3	29.0	28.5	26.3	28.8	27.4
N2	199.9	202.4	200.5	202.0	203.4	205.1	198.9	204.3	201.9
NU2	42.1	38.3	43.2	32.1	41.0	42.6	39.5	40.5	40.9
OP2	3.7	3.5	1.8	7.7	6.9	18.3	7.9	5.7	17.3
M2	958.5	966.3	960.3	966.7	970.6	960.6	967.2	959.5	961.9
MKS2	4.0	4.0	0.9	6.4	2.2	4.0	1.5	9.6	21.4
LAM2	8.2	8.4	12.6	2.8	8.5	8.2	7.6	7.8	8.9
L2	23.1	32.3	28.1	28.6	25.5	30.0	20.6	25.1	29.7
T2	17.2	19.3	17.7	24.6	19.6	14.8	17.7	17.4	22.4
S2	329.5	329.0	330.0	331.3	332.8	325.2	331.0	327.7	328.0
R2	3.6	8.1	2.2	4.5	3.8	1.7	2.9	3.4	7.4
K2	94.7	92.5	93.9	94.5	94.5	86.5	91.2	95.9	100.2
MSN2	1.0	1.1	3.7	3.3	1.2	2.5	0.3	2.4	1.3
KJ2	4.6	4.6	4.0	6.2	4.8	7.0	5.4	1.2	7.0
2SM2	3.9	2.4	2.3	3.3	3.3	4.9	2.7	2.6	1.3
MO3	2.3	2.3	3.5	4.2	3.7	3.5	4.1	3.5	1.2
M3	4.4	5.9	5.2	4.2	3.5	3.7	3.5	4.8	5.1
SO3	2.5	2.9	2.1	3.5	2.2	3.5	3.7	4.5	3.2
MK3	4.3	4.1	4.3	4.4	5.2	4.3	6.1	6.7	4.9
SK3	2.6	2.8	3.2	2.4	3.5	2.1	3.2	3.0	4.1
MN4	13.9	15.3	14.3	14.6	15.6	16.0	13.8	16.0	15.8
M4	39.9	42.4	42.6	43.4	43.8	41.4	42.0	43.6	41.1
SN4	3.4	3.7	4.0	4.7	4.3	3.3	4.5	4.5	4.7
MS4	28.0	26.8	28.7	27.8	28.0	26.2	28.0	28.9	27.9
MK4	7.2	8.3	8.3	7.8	8.5	6.8	6.6	7.1	8.4
S4	3.2	2.9	3.3	2.8	3.9	3.3	2.8	2.6	4.1
SK4	1.6	1.6	2.0	1.4	2.1	1.1	1.9	1.9	1.6
2MN6	5.7	4.8	4.7	4.8	4.1	4.7	4.3	4.4	4.1
M6	8.9	7.6	6.9	7.4	6.9	7.0	7.1	6.4	6.4
MSN6	2.9	2.7	1.8	2.3	1.6	1.8	1.4	1.5	1.6
2MS6	8.0	6.9	6.4	7.0	6.2	5.6	6.5	6.1	6.4
2MK6	2.1	1.4	1.0	1.9	2.4	1.5	1.2	2.0	1.1
2SM6	2.3	2.5	2.3	2.1	2.2	2.3	1.7	1.8	1.9
MSK6	1.7	1.2	1.1	1.4	1.3	0.7	1.3	1.1	1.6
MA2	7.0	1.5	6.3	2.4	1.9	10.7	7.9	16.5	22.7
MB2	2.9	12.3	1.8	7.5	8.4	4.2	1.7	11.4	13.6

	Aveiro - Amplitude (mm)		
	1999	**2001**	**2002**
ZO	2092.0	2137.2	2150.1
SA	71.4	79.0	101.5
SSA	38.3	29.1	44.4
MM	29.7	18.4	41.8
MSF	20.5	17.7	29.4
MF	17.2	27.0	20.8
2Q1	2.4	3.4	4.7
SIG1	1.9	3.8	3.2
Q1	15.9	16.3	14.9
RO1	4.7	2.9	3.4
O1	56.8	55.5	56.0
MP1	1.3	2.9	2.5
M1	2.3	4.9	4.5
CHI1	1.7	1.8	0.2
PI1	2.4	0.9	1.3
P1	18.6	20.8	18.7
S1	3.1	3.8	6.5
K1	60.3	60.4	61.2
PSI1	1.3	1.5	1.4
PHI1	0.8	1.2	0.9
TH1	0.3	2.1	2.7
J1	2.9	3.7	2.3
SO1	0.4	2.9	1.6
OO1	3.3	0.2	0.8
OQ2	6.5	3.9	0.9
MNS2	6.0	8.7	7.2
2N2	32.6	27.3	27.1
MU2	26.2	28.5	27.7
N2	204.2	200.3	204.1
NU2	38.7	39.0	40.9
OP2	9.2	10.9	2.8
M2	969.2	954.6	957.3
MKS2	3.1	15.1	2.9
LAM2	5.3	9.0	4.8
L2	28.8	23.3	28.8
T2	19.1	19.0	18.0
S2	333.5	321.8	326.1
R2	3.7	4.7	6.5
K2	92.9	87.5	94.3
MSN2	1.2	4.2	1.1
KJ2	4.0	4.0	5.9
2SM2	2.4	3.0	4.1
MO3	2.0	3.6	3.4
M3	5.4	5.5	4.3
SO3	3.2	3.4	1.8
MK3	3.5	5.5	3.7
SK3	3.4	3.5	3.7
MN4	13.8	13.3	14.0
M4	38.3	38.6	37.3
SN4	3.6	3.9	3.2
MS4	25.8	26.3	24.6
MK4	7.6	7.6	7.6
S4	3.8	4.9	3.5
SK4	1.6	2.2	1.5
2MN6	3.8	3.3	3.9
M6	6.1	5.1	5.9
MSN6	2.0	1.4	2.2
2MS6	6.0	5.6	5.2
2MK6	1.3	0.3	2.0
2SM6	2.3	2.0	1.6
MSK6	1.0	0.3	1.7
MA2	2.9	11.7	9.5
MB2	2.6	4.6	7.3

	Aveiro - Phase (º)								
	1976	**1979**	**1980**	**1981**	**1982**	**1983**	**1984**	**1985**	**1986**
ZO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SA	233.0	292.1	63.8	207.1	251.7	241.0	263.6	300.9	214.8
SSA	67.6	277.0	12.4	74.2	96.3	113.5	88.7	152.0	322.4
MM	212.2	209.7	332.2	181.8	98.0	282.6	51.9	272.8	60.7
MSF	140.7	211.5	155.9	166.0	186.4	228.8	213.4	247.4	236.7
MF	128.1	292.1	77.3	224.5	190.5	156.8	250.5	128.1	95.8
2Q1	223.7	264.1	209.3	239.5	191.8	217.2	199.5	173.0	212.1
SIG1	160.5	211.2	248.6	246.5	224.5	234.9	231.8	206.9	202.5
Q1	267.6	272.2	274.7	268.8	282.1	267.2	263.1	259.6	258.4
RO1	290.4	237.9	290.2	291.8	291.2	282.7	281.5	268.7	278.8
O1	322.6	325.0	322.1	321.8	319.1	320.5	319.9	322.1	319.9
MP1	90.8	163.2	178.5	199.0	147.2	207.4	169.6	214.0	207.9
M1	4.6	160.7	171.4	224.1	257.1	310.0	2.2	16.2	47.7
CHI1	67.7	73.4	308.2	350.1	351.8	352.2	322.2	239.9	220.5
PI1	53.7	46.6	78.1	209.1	55.0	91.7	71.0	359.0	34.3
P1	69.4	67.9	68.3	66.1	65.1	65.4	65.0	66.6	61.5
S1	17.0	32.2	345.0	43.1	57.7	25.8	23.8	25.5	15.9
K1	63.2	68.0	63.3	61.6	62.0	64.2	62.6	62.5	61.8
PSI1	287.5	345.4	217.6	154.0	56.6	20.1	9.3	35.0	48.3
PHI1	47.0	71.2	92.9	109.9	28.2	229.1	65.4	52.2	356.5
TH1	358.5	34.8	278.6	102.0	21.8	183.4	67.2	58.0	247.0
J1	56.4	156.7	144.6	91.7	80.8	62.2	54.6	13.2	110.9
SO1	326.9	290.5	357.7	315.8	313.7	299.0	222.3	275.2	292.1
OO1	135.8	165.9	211.3	189.2	264.7	203.9	188.2	230.8	225.2
OQ2	42.5	245.0	270.1	113.6	26.4	336.4	249.9	112.0	55.1
MNS2	331.5	354.2	315.6	339.1	324.6	348.9	350.2	344.8	335.2
2N2	32.9	47.0	44.6	42.8	48.8	51.8	37.0	31.1	43.3
MU2	33.7	25.8	24.4	32.0	27.0	31.1	37.5	28.8	27.3
N2	61.7	63.3	64.4	64.0	63.4	63.0	62.3	60.6	61.1
NU2	66.2	71.8	59.0	64.6	67.3	70.3	66.3	65.9	66.5
OP2	218.4	185.3	110.7	85.9	270.9	53.7	48.4	288.0	145.1
M2	80.3	82.1	82.5	81.0	80.9	81.2	80.0	79.5	79.6
MKS2	359.0	27.2	106.9	221.5	313.6	20.6	10.9	257.1	354.6
LAM2	80.2	106.6	54.9	91.1	62.3	98.3	97.3	74.6	106.2
L2	93.4	103.1	98.7	93.9	97.6	92.0	91.6	83.4	95.3
T2	114.5	104.5	115.3	130.8	119.0	120.1	134.9	128.9	121.9
S2	108.2	109.9	109.9	108.5	108.1	109.1	107.5	107.1	107.3
R2	122.2	149.3	113.6	100.0	117.3	124.0	109.2	102.8	135.4
K2	98.6	105.7	110.6	105.4	105.6	106.6	105.7	104.1	103.1
MSN2	358.7	315.9	289.7	348.4	324.6	301.3	301.9	352.0	324.1
KJ2	15.6	297.7	250.8	291.2	291.5	294.6	322.8	319.1	323.5
2SM2	235.3	316.6	283.0	291.6	330.1	325.2	280.0	290.0	31.3
MO3	205.7	219.1	208.4	209.2	221.9	220.4	214.0	194.9	177.5
M3	251.8	320.2	328.0	316.8	301.6	303.3	299.0	289.5	294.6
SO3	283.9	295.5	283.8	256.1	289.5	285.9	275.4	250.3	217.0
MK3	307.8	309.3	309.9	316.8	291.8	302.7	297.6	298.4	311.4
SK3	1.5	11.4	12.8	3.9	16.7	9.5	14.9	350.4	4.6
MN4	262.6	271.3	277.0	272.5	267.5	259.6	255.5	257.9	254.1
M4	276.4	292.0	288.1	281.4	280.4	280.5	273.0	271.3	266.1
SN4	1.5	0.8	340.2	307.7	325.9	356.6	357.3	341.7	332.0
MS4	314.2	331.5	331.4	322.0	322.6	320.8	318.2	313.1	310.1
MK4	310.6	328.0	322.6	323.5	320.7	324.6	311.8	316.0	310.6
S4	352.0	53.3	40.1	24.0	35.9	46.8	23.7	21.3	2.2
SK4	36.3	29.5	37.3	37.4	20.6	69.4	49.1	12.1	4.5
2MN6	318.5	314.8	315.3	321.8	310.5	312.8	300.4	300.8	316.3
M6	329.9	326.9	328.4	330.5	320.1	322.4	317.4	316.3	325.0
MSN6	2.7	347.9	4.3	343.0	356.6	345.1	344.9	333.9	333.6
2MS6	358.4	353.4	352.8	354.0	350.0	347.9	340.2	340.5	342.1
2MK6	351.9	331.9	1.8	0.5	349.8	347.4	340.6	347.5	337.6
2SM6	33.9	37.2	25.2	32.7	27.1	29.0	17.8	16.5	17.9
MSK6	41.5	33.6	31.1	34.7	26.2	35.1	25.9	29.5	22.2
MA2	357.1	34.7	328.2	244.4	334.0	323.5	297.1	258.9	231.9
MB2	213.0	249.6	236.3	185.3	159.6	175.4	174.6	169.9	213.5

	Aveiro - Phase (º)								
	1988	**1989**	**1991**	**1992**	**1993**	**1994**	**1995**	**1997**	**1998**
ZO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SA	233.3	238.7	231.6	193.9	188.5	200.4	225.6	235.9	313.2
SSA	134.4	138.0	13.0	157.6	77.0	118.5	127.9	132.9	319.0
MM	158.5	139.7	181.7	224.5	293.1	342.0	264.8	152.2	96.7
MSF	234.0	128.9	167.5	206.4	147.6	147.6	216.9	202.7	214.4
MF	162.1	214.4	128.9	234.5	247.2	122.3	228.1	208.6	103.2
2Q1	240.7	247.9	216.5	207.0	184.4	178.9	215.8	236.2	213.8
SIG1	215.7	235.3	216.3	213.6	220.2	229.6	206.6	245.8	192.9
Q1	274.0	280.5	272.6	257.1	257.7	251.8	260.3	265.3	270.1
RO1	298.2	287.7	261.7	294.4	287.6	288.6	248.2	286.5	272.5
O1	318.7	320.2	319.3	317.9	320.9	319.5	320.8	319.0	318.9
MP1	173.5	132.9	160.1	189.0	197.5	0.7	146.2	193.9	185.1
M1	36.7	11.6	306.5	349.1	8.2	16.1	71.9	173.6	180.9
CHI1	349.7	140.5	329.9	296.0	89.3	13.3	178.7	159.0	21.5
PI1	23.6	24.5	26.2	61.5	343.5	113.4	11.9	97.0	74.7
P1	58.6	58.1	56.0	63.2	59.1	59.8	55.0	58.2	63.8
S1	33.6	28.2	25.7	2.3	14.8	27.5	40.4	19.7	357.9
K1	62.5	62.9	59.9	60.4	59.9	60.9	61.5	63.5	63.9
PSI1	38.3	15.5	57.3	21.4	31.6	40.1	85.3	36.5	144.0
PHI1	89.7	129.0	73.5	205.7	69.2	142.1	43.4	124.7	52.1
TH1	88.8	265.1	142.9	59.5	86.2	236.9	335.0	101.0	38.1
J1	162.5	132.5	90.4	63.4	29.1	355.0	34.5	117.4	162.0
SO1	289.2	356.6	272.2	313.9	320.2	137.6	61.0	343.5	277.6
OO1	212.1	185.1	237.9	225.2	216.5	150.7	253.3	164.3	210.1
OQ2	359.8	112.9	25.7	319.7	150.3	110.2	36.8	228.1	127.9
MNS2	5.2	349.4	358.4	17.0	13.4	356.3	359.8	3.1	349.5
2N2	48.3	32.7	50.3	49.7	38.3	43.8	44.0	41.3	33.4
MU2	33.7	41.5	34.1	26.9	37.2	35.0	34.3	36.2	40.6
N2	61.3	61.1	62.8	60.0	60.5	60.3	59.7	62.0	61.6
NU2	67.5	61.9	68.0	69.1	64.2	53.5	61.3	67.0	66.5
OP2	129.5	349.8	281.0	177.7	337.1	309.7	248.5	15.7	111.3
M2	79.4	79.0	79.1	78.9	78.4	78.9	78.5	80.7	79.9
MKS2	92.6	28.3	78.0	34.0	94.9	241.6	336.0	56.8	60.6
LAM2	82.7	87.5	70.8	28.6	80.2	154.6	100.3	91.1	58.9
L2	105.9	92.9	80.0	83.9	80.9	105.1	94.0	110.0	96.3
T2	110.7	120.5	116.7	118.7	115.2	100.4	111.6	115.2	136.4
S2	107.3	106.8	107.1	106.8	106.5	107.4	107.0	109.2	108.4
R2	111.1	95.4	82.2	53.1	80.6	60.8	145.2	223.9	69.6
K2	104.6	102.9	105.5	103.9	103.4	104.7	104.1	106.8	105.9
MSN2	267.1	13.9	246.8	206.3	283.1	5.5	283.6	2.4	210.0
KJ2	304.7	290.6	279.4	315.0	317.0	282.7	290.2	300.5	282.7
2SM2	296.5	316.2	316.7	325.3	343.8	303.6	300.9	336.0	248.5
MO3	176.0	194.3	214.3	195.8	189.9	177.2	175.1	173.1	180.2
M3	312.2	308.9	299.8	300.7	286.2	293.3	310.4	321.7	312.7
SO3	239.6	255.0	253.3	252.9	214.4	291.3	231.2	234.2	234.5
MK3	305.8	290.6	283.4	278.6	286.2	258.7	284.3	279.2	291.0
SK3	18.1	357.5	351.6	355.0	3.2	355.9	356.3	334.5	347.7
MN4	244.6	245.1	249.1	240.9	238.8	242.7	244.6	240.0	243.4
M4	266.0	262.9	261.0	262.0	256.6	257.4	258.2	257.2	257.4
SN4	332.1	328.4	309.2	301.5	313.1	305.4	298.7	305.5	318.4
MS4	309.5	306.3	303.5	302.3	304.0	303.4	302.3	301.7	301.4
MK4	304.1	306.1	307.6	301.0	304.0	295.4	301.7	302.8	291.1
S4	5.2	8.9	358.9	344.3	4.4	17.5	5.0	337.5	354.6
SK4	9.7	357.7	16.5	346.5	15.3	345.4	13.0	353.0	311.1
2MN6	308.9	322.6	324.7	324.1	332.6	334.4	322.1	311.5	320.9
M6	324.7	325.5	345.0	344.0	349.0	342.0	343.2	338.5	336.4
MSN6	340.5	353.7	0.7	358.6	360.0	337.1	340.9	337.0	334.0
2MS6	340.8	347.3	357.7	0.1	2.4	3.8	357.7	348.3	344.6
2MK6	351.8	347.8	348.7	351.0	9.8	4.6	310.8	11.5	349.6
2SM6	10.6	14.8	6.4	28.4	16.8	18.4	358.9	350.7	10.1
MSK6	20.0	9.6	24.7	16.6	4.2	348.2	17.4	63.0	30.2
MA2	314.5	294.1	289.9	182.8	341.1	1.4	303.8	356.9	219.9
MB2	186.7	149.5	255.9	129.0	94.9	222.5	226.4	15.6	137.9

	Aveiro - Phase (º)		
	1999	**2001**	**2002**
ZO	0.0	0.0	0.0
SA	174.3	280.5	242.2
SSA	76.5	315.6	80.1
MM	228.3	229.9	200.5
MSF	225.6	256.7	204.3
MF	190.6	228.7	313.0
2Q1	187.1	202.9	231.8
SIG1	214.7	197.9	241.7
Q1	278.7	264.9	263.3
RO1	265.1	291.1	246.3
O1	317.1	319.9	318.1
MP1	124.2	204.8	205.5
M1	255.5	323.2	9.3
CHI1	283.5	293.1	38.1
PI1	91.9	27.6	29.2
P1	60.1	59.6	61.3
S1	26.2	12.7	20.1
K1	62.1	61.7	61.7
PSI1	136.9	52.3	33.1
PHI1	54.4	41.6	28.0
TH1	279.3	37.8	60.9
J1	132.1	57.9	74.4
SO1	47.5	316.4	356.8
OO1	218.0	357.6	338.3
OQ2	84.2	241.3	103.8
MNS2	0.4	9.7	7.1
2N2	39.9	43.1	36.8
MU2	32.9	34.4	35.1
N2	60.3	60.0	62.2
NU2	62.5	58.1	61.3
OP2	330.4	345.9	357.0
M2	79.1	79.8	79.3
MKS2	243.8	186.6	312.2
LAM2	105.2	104.9	114.7
L2	95.6	90.7	78.6
T2	119.2	97.7	109.0
S2	107.3	107.8	107.4
R2	107.5	45.7	129.9
K2	106.9	107.6	103.2
MSN2	328.1	327.5	295.5
KJ2	280.9	235.1	316.0
2SM2	318.9	280.9	299.3
MO3	209.5	200.6	194.8
M3	306.7	286.4	290.4
SO3	267.4	218.2	237.3
MK3	284.9	302.8	301.2
SK3	0.4	0.3	8.1
MN4	242.8	237.3	241.8
M4	258.0	258.9	265.6
SN4	306.8	295.6	324.6
MS4	306.1	304.9	310.4
MK4	297.6	289.2	309.3
S4	5.3	10.0	18.9
SK4	353.9	338.5	15.1
2MN6	332.2	306.7	309.3
M6	333.7	317.5	315.7
MSN6	336.4	279.9	310.7
2MS6	348.9	328.4	330.2
2MK6	338.2	7.7	326.9
2SM6	18.3	347.5	17.8
MSK6	0.4	325.2	347.3
MA2	57.5	314.3	42.7
MB2	175.8	295.8	195.8

	Cascais - Amplitude (mm)								
	1961	**1962**	**1964**	**1965**	**1966**	**1967**	**1968**	**1971**	**1972**
ZO	2186.9	2191.6	2200.5	2189.8	2184.9	2167.1	2193.9	2169.9	2164.8
SA	36.7	45.5	21.8	56.3	37.3	23	45.1	7.9	63.3
SSA	59.5	40.7	19.6	52.2	18	51.6	48.1	37	39.7
MM	22.7	13.5	6.2	18.9	16.3	24.6	24.9	19.4	17.1
MSF	1.7	18.4	4.5	8.9	5.8	9.8	3.6	4.6	10.9
MF	22.8	20	9.5	6.6	6.2	9.9	5.1	2.7	9.4
2Q1	5.6	4.6	2.6	2.1	3.5	3.2	3.6	2.6	3.9
SIG1	3.7	3.9	3.3	2.6	3.7	2.4	3.6	4	3.4
Q1	22.6	21.1	16.6	15.3	15	17.5	19.2	20.2	17.1
RO1	5.3	3.7	2.9	4	3.9	2.4	3.3	3.5	2.9
O1	61.7	62.2	63	60.3	59.7	59.9	60.3	61.2	60.5
MP1	4	0.5	1.4	0.2	1.4	2.4	1.2	0.7	1.3
M1	4.1	2.2	2.9	4.3	4.4	4.7	4.3	1.5	0.8
CHI1	1.6	0.6	1.2	1.1	0.3	1.4	0.5	0.9	0.5
PI1	1.1	1.4	2.4	2	2.5	0.7	1.5	1.5	3.3
P1	20.7	23.1	22.6	22.5	21.4	22.2	22	21.8	24.2
S1	6.6	9	3.8	3.8	4.7	5.7	4.5	6.1	5.6
K1	70.8	70.7	67.5	68.2	69	69.4	69.1	66.9	68.3
PSI1	1.8	2	0.8	0.8	2.1	1	1.1	1.4	1.6
PHI1	2.1	1	1.7	2.3	1.5	0.7	1.5	1.1	2.2
TH1	1.3	2.1	0.4	0.8	1.1	1.3	0.2	0.8	1.1
J1	1.1	3.8	4.2	3.5	3.8	2.8	1.5	4	3.7
SO1	1.1	1.9	0.5	0.6	0.2	1.5	0.8	0.5	0.4
OO1	0.9	0.7	1.5	0.2	1.1	0.6	0.5	0.6	1.4
OQ2	4.2	3.6	6.5	3.3	2	2.9	4.1	2.2	2.5
MNS2	6.4	8.9	6.7	7.4	7.4	9.6	8.5	9.2	11.5
2N2	27.2	28.4	31.6	29.2	28.2	31	33.7	30.2	34.7
MU2	35.9	35.7	35.6	37.1	35.4	34.7	35	35.5	38.7
N2	213	210.2	209.1	208.3	208.3	207.8	208.8	208	211.5
NU2	38.8	41.5	37.9	39.4	37.5	37.2	37.1	40.3	40.8
OP2	4.6	0.4	1.6	1.7	3.3	2.5	1.1	4.3	7.6
M2	987	986.7	982.2	981.2	980.6	979.1	981.6	972	979.7
MKS2	10.5	9.1	5.2	5.4	1.4	2.4	6.7	4.3	4.8
LAM2	3.7	6.6	3.1	7.6	4	3.7	4.7	5.7	5
L2	21.2	20.4	28.1	24.1	20.2	20.2	21.7	25.3	21.4
T2	21.3	19.4	19	20.8	19.4	20.5	19.9	17.4	18.3
S2	351.2	352.6	353.2	348.6	349.4	348.2	348.5	347	346.8
R2	7.9	3.6	5.2	4.8	4.1	7.9	3.6	2.1	5.1
K2	103.3	101.7	102.7	101.9	99.1	98	98.2	97.7	97.4
MSN2	2	1.6	0.9	2	3.4	2.4	0.4	2.9	2.1
KJ2	4.7	5.7	6.7	4.7	5.1	5.9	6.1	7.2	4.9
2SM2	1.8	2.4	0.4	2.8	1.7	0.6	1.6	3	1.3
MO3	1	0.8	1.1	1.8	1.3	0.7	0.7	1.3	2.1
M3	4.9	3.7	3.8	4	3.2	3.9	4.2	3.8	3.6
SO3	3.2	1	0.5	1.3	1.8	2	0.5	0.5	0.8
MK3	1.9	0.8	0.3	0.1	1	0.7	1.4	0.9	0.1
SK3	1.2	2.3	1.2	1.3	1.2	1.2	2.1	1.3	1.8
MN4	5	5.6	4.9	4.6	4.4	5.1	4.7	4.8	5.1
M4	11.8	11.4	10.6	11.6	11.6	10.9	10.3	10.6	12.5
SN4	0.7	1.1	1.2	0.5	0.7	0.4	1.7	1	0.9
MS4	3.9	3.8	6.6	6.1	6	5.4	5.8	8.5	7.9
MK4	1.2	1.5	2.2	1.5	1.9	1.7	1.8	1.5	1.3
S4	0.4	0.5	0.4	0.6	0.9	0.4	0.6	0.8	0.8
SK4	0.2	1.2	0.8	0.4	0.3	0.5	0.6	0.2	0.3
2MN6	0.7	0.8	0.9	0.8	1.1	1.3	0.6	0.8	0.7
M6	0.9	0.8	0.9	1.3	1.1	1.6	1.2	1.8	1.2
MSN6	0.8	0.3	0.6	0.5	0.5	0.7	0.3	0.5	0.4
2MS6	0.8	1.1	0.3	1.2	1.1	0.9	0.8	1.4	0.8
2MK6	0.7	1.3	0.1	0.9	0.5	0.3	1.1	0.6	0.4
2SM6	1.4	1.7	1	0.7	1.2	1	1.4	0.4	0.7
MSK6	0.7	0.9	0.2	1.1	0.2	0.4	0.7	0.2	0.4
MA2	4.1	11.2	4.9	2.3	3.2	2.4	0.8	7.1	9
MB2	9.3	2.1	3.1	6.6	2.7	9	3.3	1.2	6.2

	Cascais - Amplitude (mm)								
	1973	**1974**	**1975**	**1976**	**1979**	**1980**	**1981**	**1982**	**1983**
ZO	2167	2128.3	2148.7	2160.3	2187.8	2171.8	2170.9	2168.8	2187.9
SA	39.3	40.7	22	34.4	30.9	17.3	38.2	25.3	38.3
SSA	39.7	9.1	10.6	4.7	33.4	53.5	31.4	27.1	66.3
MM	4.4	7.8	16.9	9.6	8.5	6.5	5.7	20.6	21.1
MSF	11.6	11.4	6.6	16.9	3.2	1.6	11.6	18.5	5.1
MF	13.7	18.5	12.8	16.6	15.2	6.9	21.6	3.6	15.2
2Q1	2.4	4.3	2.6	3.2	5.2	4.9	3	2.5	3.3
SIG1	3.3	3.9	4	3.5	3.5	3.1	5.2	4	4.2
Q1	15.9	16.3	16.8	16.8	19.2	20.2	19.5	16.7	15.9
RO1	3.3	3.1	2.9	2.5	3	3.1	3.8	3.7	3
O1	62.6	59.8	58.6	58.5	61.4	62	61.1	62.6	60.9
MP1	0	2	0.7	2.1	0.8	0.9	1.4	1.6	0.2
M1	3.9	5.4	6	6.2	2.8	2.5	2	3.7	5.1
CHI1	1	0.6	1	1.1	0.3	0.7	1	1.5	1.3
PI1	1.7	2.7	2	0.6	2.4	1	1.6	1.7	1.1
P1	20.6	23	22.2	22	23.5	21.6	22.1	21.5	21.2
S1	6.2	6.7	6.3	5.9	4.8	4.4	5.4	5.1	4.8
K1	69.3	68.7	69	70.2	68.2	69.9	68.8	69.7	69.4
PSI1	0.9	1.6	1.3	1.5	1.1	0.8	1.8	2.3	0.9
PHI1	2.6	0.7	1.8	1.2	0.4	1.2	1.5	1.3	1.1
TH1	1.2	0.2	1.3	0.8	1.6	0.6	0.8	1	1.6
J1	5.2	3.1	2.5	2.2	1.1	2.6	3.3	5.9	4.3
SO1	1.4	2.5	1.5	2.7	1.1	3.1	0.8	1.9	1.3
OO1	0.4	1.2	1	0.6	2.7	3.3	0.8	0.7	1.2
OQ2	3.8	2.8	3.1	4	2.7	5.5	4.5	4	2
MNS2	11.1	8.3	10.1	8.8	7.9	9.7	9.7	10.5	7.6
2N2	28.4	27.6	31.6	30.7	28.1	32.2	32.2	28.3	25.9
MU2	38.5	35.8	35.8	36	37.1	38.2	36.7	37.7	39.1
N2	214.4	209.9	210.3	206.4	208.8	210.6	210.8	210.6	208.9
NU2	40.6	38.4	41.3	38.7	38	38.5	38.7	39.3	40.6
OP2	9.9	8.5	1.9	8	3.2	3.6	4.9	6.9	4
M2	986.4	981.2	977.4	979.5	976.6	978.1	974.3	972.6	975.1
MKS2	2.5	4.2	5	4.2	1.8	4.9	4.4	4	5.8
LAM2	3.9	3.3	4.4	5.6	5.8	3.1	4	4.6	5.5
L2	23.6	21	20.8	16.7	20.7	22.3	24.1	23.8	21.5
T2	18.5	19.8	20	22	20.7	19.4	18.7	19.1	22.3
S2	350.7	348.4	348.2	350	349.6	350.3	350.9	348.8	350.1
R2	7.5	6.8	5.1	7	3.9	1.9	2.5	3.6	4.3
K2	96.2	97.1	97.5	96.5	98.4	97.5	101.9	99.9	103
MSN2	3.3	1.3	3	3.1	0.7	2	0.2	0.9	2
KJ2	4	5.2	5.5	4.8	4.9	4.6	5.2	5.6	3.2
2SM2	0.9	0.2	2	1.9	1	1.7	0.2	0.1	0.8
MO3	0.7	1.7	1.3	1.4	0.8	1.1	1.5	1.3	1.2
M3	4.4	4.2	3.6	4.6	4.1	3.9	4	4.3	4.6
SO3	0.5	0.7	0.7	1.8	1.1	1.9	1.9	0.6	0.3
MK3	0.4	0.3	0.3	0.4	0.7	0.8	0.4	1	1
SK3	2.2	1.7	1.6	2.1	2.1	1.8	1	2.2	2.9
MN4	4.1	3.7	3.4	3.2	3	3.8	3.5	3.3	4.2
M4	10.1	9.3	9	9.5	9.3	9.2	9.1	9.4	9.7
SN4	1	1.3	1.4	1.2	1.2	1.3	0.5	0.8	0.2
MS4	9.1	10.5	10.7	9.6	8.7	8.4	7.1	5.7	6.2
MK4	1.8	2.3	1.6	2.8	1.6	2.8	2.9	2.3	2.9
S4	1.7	2.3	2.9	1.7	2	1.8	1.5	1.1	1.3
SK4	0.6	0.6	0.7	0.3	0.7	0.6	0.5	0.6	0.4
2MN6	0.2	0.5	0.4	0.4	0.3	0.6	0.6	0.4	0.7
M6	0.8	1.4	1.6	1.2	1.8	1.8	1.3	1.5	1
MSN6	0.4	0.6	0	0.6	0.4	0.5	0.5	0.5	0.5
2MS6	1.4	2.3	1.9	1.4	2.2	2.4	2.5	1.8	1.9
2MK6	0.6	0.7	0.8	0.7	0.6	0.8	0.7	0.8	0.4
2SM6	0.5	0.7	1.6	0.5	0.7	0.9	1.5	1.5	0.9
MSK6	0.2	0.5	0.2	0.5	0.5	0.3	0.7	0.1	0.2
MA2	2.7	3.5	6.1	7.5	2.6	4.5	1.9	1.5	2.5
MB2	9.5	3.8	3.9	8.9	5.5	6.5	3.5	3	3.5

	Cascais - Amplitude (mm)								
	1984	**1985**	**1986**	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**
ZO	2171	2209.5	2164.5	2205.4	2200.7	2221.4	2195.4	2174.8	2162.1
SA	21.6	22.4	41.6	42.2	61.4	94.8	55.8	27.2	39.2
SSA	68.9	27.1	29.8	19.4	52.9	68.7	30.4	20.3	14.9
MM	5.3	19	25.4	15.5	5	6.8	13.3	18.2	12.8
MSF	1	17.7	13.9	20.7	24.3	31.4	27.1	12.4	3.9
MF	8	7.4	3	14.4	6	7.7	23.2	6.9	6.2
2Q1	2.8	2.6	3.6	4.3	4.6	4.2	3.2	3.9	3.6
SIG1	4.5	3.5	4.2	4.1	3.3	3.3	3.4	3.5	2.7
Q1	16.6	17.5	19.2	20	21.1	19.9	17.2	15.5	15
RO1	3.1	2.9	3.8	3.8	4.5	4.1	2.6	2.9	4.2
O1	60.6	59.8	59.5	58.7	62.1	61.8	62.6	62.2	61.1
MP1	0.6	1.2	2.6	3.2	0.7	0.9	1.6	1.5	1.6
M1	4.7	4.8	4.3	1.7	1.1	0.8	1.3	5.8	5.6
CHI1	0.4	0.5	1.5	2.8	1.1	0.7	0.7	1.5	0.4
PI1	1.2	1.6	2.6	3.3	0.3	2.9	2.2	1.5	1.9
P1	21.5	21.9	22.2	21.9	22.9	23.1	21.9	23.1	22
S1	4.6	5.1	6.4	3.9	2.8	2.5	2.3	3.4	4.5
K1	68.4	67.8	68.2	64.9	69.5	70.1	73.6	70.6	71.5
PSI1	1.9	1	1.3	2.7	1.5	1.7	1.8	2.1	1.4
PHI1	1.7	1.2	1.8	2	2.4	0.7	3.2	2	2.5
TH1	0.4	1	0.9	0.9	0.5	1.3	1.2	0.9	2.2
J1	3.9	2.6	0.8	1.6	2.1	3.4	5.8	4.6	3.8
SO1	0.7	1.4	1.2	1.3	0.5	0.4	1.5	1.1	0.4
OO1	0.7	0.7	0.8	0.6	1.1	0.8	0.9	0.5	1.1
OQ2	2	2.5	2.7	2.3	1.6	1.8	2	2.4	2.9
MNS2	8.5	11.8	9.7	10.5	8.1	9.9	11.8	8.4	9.8
2N2	29.1	32.8	30.6	30.4	27.7	31.7	33.5	29.7	29.7
MU2	39.3	40.2	37.2	36.7	37.7	38.4	36.8	37.8	36.8
N2	210.1	211.6	207.7	210.8	217.8	216.7	219.7	216.2	217.1
NU2	39.2	41.6	39.5	37.1	41.7	43.4	38.5	41.3	41
OP2	0.5	2.2	4.9	2.8	1.2	0.2	1.6	3	3.2
M2	981.3	990.4	978.9	979	1018.4	1020.2	1015.5	1018.5	1022.2
MKS2	3.3	5.7	1.1	0.8	2.4	4.9	0.8	2.7	3
LAM2	5.9	5.6	5.6	2	5.6	5.5	5.2	3.1	5.8
L2	19.4	19.6	21.2	21.1	22.4	29.8	27.9	24.6	24.7
T2	21.7	21.7	22.3	21.1	21.5	22.4	22.6	20	19.5
S2	347.9	350.8	348.7	349	360.3	358.2	358.5	358.8	356.9
R2	4	2.3	4	1.8	6.7	3.6	4.3	3.8	4.7
K2	100.6	101.6	98.1	97.2	102.2	101.1	101.1	100.6	100.2
MSN2	3	1.8	0.8	3.5	2	1.5	1.5	1.3	3.4
KJ2	6.5	6.9	6	6.8	6.4	6.2	7.4	5.3	5.9
2SM2	0.3	1.6	1.7	2.5	2.2	0.5	2.8	1.7	1.4
MO3	0.7	1.1	0.6	0.9	0.5	1.3	0.9	1.9	0.6
M3	4.3	3.9	4.1	3.9	4.8	4.2	5	4.5	4.9
SO3	1.2	0.6	1.3	1.3	0.2	1.1	0.4	0.5	0.5
MK3	1	1.2	2.6	1.5	1	1.1	0.8	1.1	1.6
SK3	1.6	1.4	2.3	1.9	1.5	2.4	2.8	1.8	2.5
MN4	3.7	5	4	4.4	4.5	4.8	4.4	4.6	3.8
M4	10.1	11.2	9.3	10.9	11.4	10.7	11.4	10.1	10.4
SN4	0.9	0.5	0.7	2	2.3	2.1	1.2	1.4	0.3
MS4	6.9	7.6	8.5	9.3	9	8.5	8.1	8.3	7.6
MK4	1.3	2	2.4	2.5	1.7	2	2.1	1.3	3
S4	0.6	2.1	1.5	1.5	2.2	1.4	1.1	1.9	1.1
SK4	0.6	0.3	0.7	1.1	0.7	0.3	0.2	0.5	0.5
2MN6	0.9	0.8	1.4	2	2.6	2.5	2.4	2.7	1.9
M6	2.1	1.8	4.6	4.6	5.5	6.2	5.6	4.7	4.5
MSN6	0.6	0.6	0.7	1.1	0.7	0.7	0.8	1.1	0.3
2MS6	2.1	2.3	4.8	4.1	4.9	4.6	5	4.5	3.9
2MK6	0.5	0.4	0.7	1.2	1.7	2.1	1.6	0.9	1.9
2SM6	1	1	2.6	2.1	1.9	2.6	2.1	1.9	0.8
MSK6	0.2	0.4	0.8	0.4	0.6	0.5	0.7	0.6	1.4
MA2	3	15.6	0.7	1.7	5.6	3.4	3.1	2.6	4.9
MB2	9.4	9.9	7.8	5.9	1.4	10.8	5.2	6.1	9.1

Cascais - Amplitude (mm)		
	1993	**1998**
ZO	2178.3	2216.3
SA	46.5	6.2
SSA	42.5	18.5
MM	17.1	15
MSF	10.9	10.9
MF	2	18.5
2Q1	4.1	3.8
SIG1	5	4.2
Q1	15.2	18.2
RO1	2.9	3.7
O1	59.6	62.8
MP1	1.8	0.4
M1	5.6	2.3
CHI1	1.5	2.2
PI1	0.3	1.1
P1	22.1	22.7
S1	2	3.2
K1	73	70.5
PSI1	3.2	1.6
PHI1	0.4	2.8
TH1	0	2.3
J1	3.4	4.3
SO1	1.2	0.3
OO1	2.9	2.3
OQ2	4.8	3.9
MNS2	8.7	10.5
2N2	33.4	31.4
MU2	38.6	39.5
N2	218.5	218.1
NU2	41.6	42.8
OP2	1.7	5.7
M2	1022.2	1015.9
MKS2	3.4	4.9
LAM2	6.2	5.3
L2	19.7	24.7
T2	19.3	23
S2	359.1	357
R2	1.9	5.2
K2	99.5	102.5
MSN2	0.8	2.3
KJ2	5	6.5
2SM2	2.7	0.6
MO3	1.2	0.7
M3	3.9	4.6
SO3	0.6	0.9
MK3	1.2	1.4
SK3	0.8	2
MN4	4.1	5
M4	10.9	11.5
SN4	1.3	1.3
MS4	8.1	10
MK4	2.1	2.7
S4	2	1.7
SK4	0.8	0.7
2MN6	1.4	1.4
M6	4.3	2.7
MSN6	1.3	0.5
2MS6	3.6	2.6
2MK6	1.1	0.7
2SM6	0.8	1.4
MSK6	1.1	0.8
MA2	2.4	1.1
MB2	9.1	2.9

	Cascais - Phase (º)								
	1961	**1962**	**1964**	**1965**	**1966**	**1967**	**1968**	**1971**	**1972**
ZO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SA	199.2	223.4	266.9	216.3	199.3	228.0	213.3	144.9	209.5
SSA	102.2	60.8	300.6	41.9	336.0	82.4	87.2	46.0	28.6
MM	98.4	320.6	272.1	179.4	147.1	209.0	311.2	70.5	70.2
MSF	149.3	282.0	118.9	331.0	274.7	90.2	315.9	216.0	50.6
MF	80.7	14.3	163.2	113.8	279.5	226.0	211.9	261.3	289.5
2Q1	233.1	229.2	221.6	212.7	185.4	187.7	195.8	225.5	245.8
SIG1	220.9	238.9	212.2	235.6	217.0	213.6	224.8	230.5	209.7
Q1	259.3	266.9	272.0	267.1	258.5	251.5	256.2	272.2	272.1
RO1	260.2	242.8	266.5	260.5	271.1	269.7	278.2	271.0	271.3
O1	313.0	313.4	312.5	313.0	311.6	313.1	313.9	313.7	312.5
MP1	20.8	269.1	109.4	152.7	16.7	3.5	75.2	12.7	28.1
M1	87.6	116.3	206.6	295.7	339.8	359.5	28.7	47.1	286.1
CHI1	356.6	316.5	345.7	315.2	164.8	76.9	328.7	14.0	229.4
PI1	310.4	51.8	20.3	99.1	40.4	44.1	45.8	13.2	33.4
P1	40.8	45.9	43.8	47.7	50.4	42.4	43.1	38.8	41.2
S1	353.6	332.5	18.5	21.4	333.5	7.6	356.9	344.0	347.4
K1	54.1	55.0	55.1	54.5	54.5	52.8	53.8	53.1	53.7
PSI1	355.8	16.7	304.0	292.0	311.3	18.5	37.2	345.1	171.8
PHI1	85.1	124.8	68.4	67.5	111.7	102.9	40.9	60.9	59.8
TH1	98.9	84.2	210.6	120.8	91.7	118.6	241.4	102.4	32.9
J1	109.0	110.7	94.8	70.6	71.4	45.0	85.0	112.9	99.4
SO1	73.6	18.6	338.2	341.6	237.3	3.4	30.5	302.3	351.1
OO1	9.1	71.3	191.4	141.0	211.5	181.7	218.9	154.5	180.2
OQ2	282.3	177.5	36.5	354.9	215.2	148.7	71.8	157.0	89.6
MNS2	359.3	346.8	357.4	360.0	0.2	342.9	353.3	341.9	350.5
2N2	28.7	25.0	32.2	37.8	24.5	24.2	33.3	26.6	29.5
MU2	22.7	20.8	20.6	23.7	22.3	18.3	19.0	19.8	20.8
N2	46.9	46.4	47.1	47.1	47.0	47.3	47.9	47.0	46.8
NU2	52.1	47.5	50.8	54.4	53.2	52.5	49.8	51.7	48.7
OP2	91.1	205.4	151.7	283.2	181.2	311.3	3.8	243.7	251.9
M2	64.6	64.1	64.6	64.6	64.5	64.6	64.8	64.9	64.9
MKS2	107.5	66.8	13.8	91.8	349.2	36.8	57.9	46.6	28.9
LAM2	106.8	105.3	81.1	57.4	54.1	65.6	42.6	41.9	134.3
L2	75.6	91.7	79.2	71.8	64.9	65.7	76.7	88.3	74.6
T2	104.0	84.9	93.5	92.4	96.1	97.9	102.3	103.0	87.4
S2	90.6	89.7	90.5	90.2	90.4	90.7	90.4	91.2	91.5
R2	106.0	124.5	130.4	108.7	109.3	67.1	100.5	225.2	108.7
K2	89.0	88.4	86.8	88.0	87.2	87.9	87.1	88.5	86.3
MSN2	165.7	259.7	261.8	270.9	183.7	128.2	331.1	124.1	126.6
KJ2	295.2	269.8	292.4	292.4	275.8	297.3	286.8	282.5	273.4
2SM2	172.0	146.0	209.4	250.5	186.7	274.3	164.8	231.2	232.1
MO3	53.2	351.9	275.7	251.6	228.3	213.1	143.7	282.7	300.8
M3	262.6	270.4	273.4	268.0	269.7	272.6	272.7	265.3	271.0
SO3	327.5	284.3	216.9	312.2	282.6	337.4	9.7	332.6	336.2
MK3	90.6	330.6	251.1	289.5	196.3	85.1	325.1	34.9	116.2
SK3	349.6	356.0	353.1	316.5	7.5	0.4	342.9	3.5	355.9
MN4	123.7	127.2	132.9	123.8	131.2	123.3	129.5	130.0	132.3
M4	176.3	177.5	179.6	180.1	182.3	172.3	176.9	184.3	176.4
SN4	134.8	124.0	202.4	156.3	228.6	222.7	181.3	210.3	191.3
MS4	263.3	248.6	260.7	258.8	264.9	260.1	262.7	270.2	265.0
MK4	247.3	288.3	250.0	259.5	274.7	246.4	286.7	271.7	258.9
S4	80.1	56.7	332.6	335.0	322.2	331.4	309.9	313.8	303.1
SK4	50.3	44.9	89.9	86.3	21.5	125.5	13.6	4.2	250.7
2MN6	355.7	356.1	346.0	344.1	47.8	10.8	47.8	72.6	21.6
M6	59.7	51.8	22.7	30.2	76.9	1.9	79.9	93.6	88.3
MSN6	235.4	321.3	310.6	309.1	154.3	297.1	343.5	249.6	65.8
2MS6	250.2	304.1	347.5	316.0	196.4	316.8	221.3	177.5	181.4
2MK6	243.0	189.9	165.7	301.7	222.9	210.8	244.6	178.1	202.5
2SM6	351.1	3.9	19.9	340.3	7.7	0.6	18.4	245.1	295.9
MSK6	281.6	321.1	335.7	331.3	339.4	329.7	282.2	9.3	348.2
MA2	211.4	349.9	351.1	87.9	9.6	220.8	138.6	326.3	350.9
MB2	164.1	309.8	355.6	184.0	144.4	109.6	103.0	62.1	86.7

	Cascais - Phase (º)								
	1973	**1974**	**1975**	**1976**	**1979**	**1980**	**1981**	**1982**	**1983**
ZO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SA	176.0	90.4	190.4	191.6	212.8	157.3	161.7	203.2	221.7
SSA	118.5	154.5	170.1	6.0	281.1	48.8	88.7	34.9	88.0
MM	215.5	34.4	155.6	231.4	208.6	272.6	266.2	62.1	257.8
MSF	334.1	111.6	7.4	84.1	345.3	53.2	168.2	141.8	172.5
MF	157.0	70.0	261.4	92.1	284.6	180.9	241.3	155.4	120.1
2Q1	217.1	196.0	220.8	198.3	234.4	223.2	198.0	171.6	203.9
SIG1	232.4	236.3	205.4	217.0	236.8	215.2	233.2	233.2	223.9
Q1	269.5	257.1	254.5	251.4	273.0	268.3	268.8	268.6	257.4
RO1	263.1	259.9	266.2	258.0	255.5	271.7	299.9	277.3	257.5
O1	312.7	312.7	313.2	313.0	313.5	311.8	311.5	312.4	311.9
MP1	137.4	45.8	81.4	19.4	132.2	278.3	24.9	60.0	34.8
M1	280.8	326.1	339.5	355.8	121.7	132.8	150.1	230.4	313.4
CHI1	334.2	75.6	350.7	331.0	160.5	240.6	287.7	13.9	358.2
PI1	44.1	36.0	29.9	9.4	45.8	54.1	12.0	16.1	72.2
P1	41.7	42.8	40.6	44.0	43.9	42.7	45.3	44.1	41.6
S1	356.9	355.2	357.6	354.8	356.9	348.6	338.7	349.1	339.8
K1	53.6	53.9	54.0	53.3	54.7	53.6	54.1	52.6	53.1
PSI1	132.7	308.0	237.4	261.8	32.3	26.3	328.6	16.9	303.9
PHI1	54.1	35.6	92.6	47.7	233.4	51.2	71.5	72.2	79.6
TH1	103.6	102.1	101.4	48.1	26.8	75.4	108.1	1.1	74.8
J1	87.5	56.4	25.4	55.9	104.9	95.9	99.7	79.1	75.6
SO1	30.8	26.7	34.6	54.9	8.0	37.9	61.4	27.7	4.9
OO1	209.2	235.1	185.4	161.7	194.6	200.2	80.5	238.7	227.7
OQ2	14.8	258.8	195.3	93.0	319.0	183.4	113.0	21.7	281.1
MNS2	2.4	354.8	3.2	3.8	355.6	354.3	355.0	356.0	347.7
2N2	32.9	26.2	26.3	29.8	27.4	27.8	29.6	31.8	30.6
MU2	19.7	18.5	24.3	22.1	18.2	18.9	24.1	19.9	19.7
N2	48.3	47.5	49.1	48.8	47.7	47.9	47.5	47.4	46.6
NU2	47.7	48.7	54.8	52.6	52.2	50.6	50.8	50.6	52.6
OP2	206.8	209.4	19.7	278.3	203.6	216.7	347.1	274.9	222.1
M2	65.0	65.1	65.3	65.3	64.8	64.7	64.5	64.0	64.2
MKS2	347.9	24.1	95.5	68.1	95.9	336.5	41.1	56.7	50.2
LAM2	64.8	94.7	40.5	57.0	87.1	54.6	28.4	59.7	90.7
L2	72.0	73.1	58.9	69.6	83.3	79.9	79.6	73.1	67.4
T2	106.3	100.3	95.7	97.1	101.1	105.9	93.8	98.9	101.5
S2	91.6	91.1	91.5	91.7	90.8	90.7	90.7	90.3	90.2
R2	62.7	93.7	108.2	74.7	75.6	89.9	97.2	58.1	130.6
K2	88.0	88.0	88.9	90.8	89.5	89.1	89.2	88.4	87.4
MSN2	217.4	151.3	211.3	167.8	263.1	173.2	52.7	288.7	189.4
KJ2	292.7	281.4	301.9	302.2	285.1	332.6	293.9	287.9	274.8
2SM2	174.7	261.7	216.4	194.8	56.4	135.0	67.8	150.7	326.8
MO3	270.2	234.3	211.0	146.3	16.2	334.6	280.7	260.7	234.7
M3	271.3	267.8	264.8	271.4	264.8	265.6	274.8	284.5	263.4
SO3	319.6	337.1	299.0	326.4	349.3	339.9	299.6	29.1	208.0
MK3	356.4	341.1	248.7	69.1	306.8	27.1	94.2	343.1	276.1
SK3	2.8	356.5	348.7	358.4	341.3	7.7	338.2	350.9	3.1
MN4	133.6	131.5	132.7	142.1	133.0	133.2	136.2	134.0	128.3
M4	189.0	201.3	199.1	193.0	204.6	196.2	198.5	194.0	193.3
SN4	233.1	267.0	266.0	279.9	275.2	244.8	208.4	207.8	216.5
MS4	277.2	286.1	285.3	287.1	288.0	281.4	281.6	288.0	275.1
MK4	280.3	286.2	286.3	267.0	284.5	272.0	266.0	272.8	266.9
S4	327.9	329.2	331.9	343.6	348.5	341.8	343.7	12.5	19.4
SK4	321.8	349.9	2.3	276.4	49.2	11.4	49.5	39.6	1.0
2MN6	195.5	115.9	149.9	122.3	88.4	144.7	111.0	124.4	116.9
M6	119.8	141.4	153.0	131.4	137.4	148.6	140.4	154.0	145.4
MSN6	179.0	167.7	273.6	182.1	187.0	212.1	219.8	185.6	158.5
2MS6	214.8	214.0	217.3	209.0	202.1	208.3	211.3	213.4	215.3
2MK6	233.8	190.8	213.4	241.9	211.4	192.2	230.9	194.5	184.5
2SM6	256.9	287.6	242.5	286.2	24.6	349.8	316.7	322.6	313.4
MSK6	36.9	313.5	306.1	330.9	308.1	334.9	276.7	314.3	11.6
MA2	165.7	119.8	59.6	85.8	310.8	312.1	340.2	34.0	58.9
MB2	55.8	128.5	239.1	109.0	106.1	36.5	15.1	57.7	53.8

	Cascais - Phase (º)								
	1984	**1985**	**1986**	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**
ZO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SA	167.0	250.8	137.8	228.1	201.8	209.2	184.9	179.0	154.5
SSA	70.9	137.4	346.8	46.6	91.0	125.6	61.5	356.1	161.8
MM	230.0	278.5	56.2	216.4	77.3	83.8	30.6	179.6	234.2
MSF	257.8	30.8	251.6	300.6	62.3	84.4	125.5	90.9	110.7
MF	263.1	130.8	4.7	157.9	190.9	31.8	272.4	107.2	210.8
2Q1	184.4	207.4	211.5	203.7	226.2	255.8	245.2	215.1	207.8
SIG1	227.9	207.6	219.5	221.5	218.4	219.2	229.8	236.2	234.2
Q1	253.4	251.9	251.4	261.8	266.6	270.2	270.1	264.4	257.3
RO1	251.6	272.9	268.1	273.2	269.3	282.2	261.1	257.7	276.2
O1	311.1	315.1	313.7	314.4	312.7	313.2	313.4	312.6	311.7
MP1	314.6	76.3	53.1	80.8	104.9	138.4	170.7	148.5	348.2
M1	353.9	3.9	19.8	7.0	63.3	43.5	202.0	302.1	332.5
CHI1	251.9	15.9	3.4	345.4	79.8	145.5	308.2	355.9	269.1
PI1	38.0	41.0	48.2	3.3	301.2	359.5	31.8	43.6	86.4
P1	42.7	49.7	47.0	38.5	36.9	40.1	41.7	40.5	39.3
S1	353.4	1.7	335.9	47.7	348.3	349.4	16.1	57.4	107.2
K1	53.4	53.3	53.7	53.5	54.6	53.6	53.7	52.8	51.9
PSI1	44.7	350.6	283.6	235.1	100.0	13.6	101.3	38.3	18.1
PHI1	7.3	89.0	310.9	46.9	23.7	151.9	52.2	69.2	73.9
TH1	337.1	334.9	55.0	355.9	100.2	32.1	66.9	46.4	27.1
J1	55.1	36.9	118.6	183.5	145.1	143.7	85.8	77.2	67.0
SO1	82.2	338.2	30.3	88.1	328.3	39.7	110.8	14.2	125.3
OO1	132.1	169.9	121.2	33.7	185.2	217.9	137.8	163.6	75.6
OQ2	215.1	120.1	63.7	342.0	217.8	157.6	67.0	344.0	226.5
MNS2	350.9	356.0	1.0	13.9	5.7	359.8	1.6	352.8	352.9
2N2	22.6	26.1	34.4	34.5	27.2	28.1	36.9	33.3	23.9
MU2	21.2	20.0	21.0	23.6	23.1	19.8	25.7	21.3	20.6
N2	47.1	46.9	47.0	47.6	47.0	46.7	47.8	47.0	47.0
NU2	48.9	50.7	44.9	51.7	51.1	48.0	52.0	49.5	54.3
OP2	306.6	245.4	279.5	201.3	4.3	302.3	209.2	213.8	207.1
M2	64.0	64.1	63.6	63.9	64.0	63.6	63.9	64.2	64.1
MKS2	20.3	107.0	57.3	69.4	92.2	15.8	324.9	22.3	75.3
LAM2	78.1	75.8	79.7	79.5	40.2	63.1	67.5	64.6	62.6
L2	57.5	83.8	75.1	75.0	83.9	78.9	71.6	71.1	59.5
T2	107.4	92.5	105.1	101.3	101.1	103.5	104.6	105.9	110.9
S2	90.0	90.5	89.9	90.2	90.7	90.6	91.0	91.1	91.5
R2	76.0	38.8	88.4	172.4	69.7	37.6	71.9	79.8	73.8
K2	87.3	89.0	86.4	86.7	87.1	87.5	87.6	87.0	87.2
MSN2	139.4	103.4	273.4	190.9	170.4	250.6	219.0	249.1	164.0
KJ2	283.7	297.7	278.5	288.4	286.1	275.2	274.7	289.3	293.6
2SM2	66.0	152.7	177.0	183.7	221.5	263.1	157.6	222.9	195.5
MO3	215.9	175.3	202.7	215.9	104.7	262.6	241.6	243.9	237.2
M3	268.8	271.1	270.1	265.3	273.2	265.9	282.2	264.8	268.4
SO3	2.6	258.6	295.6	195.9	311.6	117.6	249.7	295.7	253.5
MK3	328.2	201.1	265.5	259.3	334.1	354.2	286.1	306.0	279.1
SK3	348.7	325.9	327.7	358.3	358.9	334.5	5.0	341.0	344.3
MN4	132.7	128.8	135.3	140.0	126.1	127.8	136.3	135.2	124.0
M4	192.3	185.9	199.1	186.2	178.7	179.4	192.4	181.4	195.0
SN4	241.1	213.4	258.0	199.5	252.5	230.3	238.1	234.5	269.1
MS4	275.2	268.6	269.2	253.5	263.3	251.3	262.9	264.2	270.4
MK4	263.0	248.9	275.3	277.9	257.8	267.2	265.4	272.1	280.7
S4	322.4	321.7	355.3	310.5	343.4	320.9	322.5	316.2	294.4
SK4	89.4	338.8	331.4	1.5	276.2	338.9	243.3	15.5	300.3
2MN6	110.4	100.1	120.0	133.3	127.6	121.2	131.6	131.5	129.3
M6	143.2	126.6	159.3	171.5	158.2	159.2	154.5	160.1	160.3
MSN6	167.1	208.9	108.0	208.0	123.4	1.5	152.5	175.3	267.8
2MS6	212.3	201.0	205.7	209.8	201.9	197.8	202.5	201.7	227.9
2MK6	196.6	158.5	192.7	173.0	176.6	221.6	198.0	205.5	184.8
2SM6	306.8	322.0	225.9	240.9	219.4	211.1	229.9	206.3	162.4
MSK6	188.4	250.5	253.8	244.7	211.4	302.0	229.6	204.9	237.2
MA2	184.1	14.1	322.8	122.1	127.7	92.2	227.0	178.3	92.8
MB2	90.3	77.8	20.1	13.8	101.3	26.1	27.3	29.8	45.0

	Cascais - phase (º)	
	1993	**1998**
ZO	0.0	0.0
SA	160.7	191.8
SSA	60.9	289.9
MM	295.9	20.9
MSF	103.6	345.2
MF	30.7	86.1
2Q1	194.5	222.4
SIG1	221.9	244.1
Q1	255.0	264.3
RO1	249.7	267.0
O1	314.6	313.4
MP1	30.6	99.9
M1	0.4	125.1
CHI1	10.1	10.1
PI1	348.9	209.1
P1	41.9	48.2
S1	95.2	26.3
K1	53.5	55.5
PSI1	25.4	70.7
PHI1	103.7	22.8
TH1	230.3	50.4
J1	45.6	127.6
SO1	24.4	40.8
OO1	218.8	221.2
OQ2	155.7	157.5
MNS2	3.7	352.9
2N2	25.0	27.8
MU2	20.6	19.6
N2	47.3	47.1
NU2	52.1	46.6
OP2	256.0	354.6
M2	64.2	63.8
MKS2	88.2	66.1
LAM2	62.6	76.5
L2	74.6	79.6
T2	107.8	100.0
S2	91.5	90.7
R2	138.2	81.8
K2	89.3	89.6
MSN2	50.1	260.2
KJ2	276.7	304.7
2SM2	204.7	225.5
MO3	186.6	4.5
M3	259.0	276.5
SO3	330.3	168.9
MK3	288.8	252.6
SK3	328.6	317.4
MN4	125.8	129.8
M4	191.6	186.3
SN4	206.6	221.0
MS4	268.0	266.7
MK4	289.2	265.3
S4	302.7	306.8
SK4	339.6	3.1
2MN6	142.7	119.1
M6	156.6	153.5
MSN6	272.6	158.0
2MS6	214.2	207.0
2MK6	209.9	192.9
2SM6	216.1	263.0
MSK6	275.2	225.1
MA2	358.6	30.9
MB2	20.4	40.6

	Ceuta - Amplitude (mm)								
	1945	**1946**	**1947**	**1948**	**1949**	**1950**	**1951**	**1952**	**1953**
ZO	839.2	901.4	903.2	876.6	842.2	822.9	834.7	834.2	876.4
SA	68.5	28.3	55.5	33.1	44.3	50.7	28.8	18.2	43.5
SSA	61	44.2	19.4	20.3	31.1	19.3	25.5	15.3	41.5
MM	12.5	7.7	27.4	34.7	18.8	20.8	18.1	18	8.2
MSF	10.9	7.1	2.4	7.2	9.5	13.8	11.3	5	3.7
MF	4.9	7.1	4.9	4.5	4.9	3.3	1.7	7.1	8.3
2Q1	1.6	0.3	0.6	1.5	1.6	0.5	0.1	1.1	1.5
SIG1	4	3.1	2.4	3.3	3.5	3.1	3.2	2.7	3
Q1	2.4	0.5	0.5	0.9	2.4	1.6	1.1	1.4	2
RO1	1.4	1	0.7	0.7	0.6	0.3	0.6	0.9	1.1
O1	22.7	20.3	21.4	21.2	22.2	21.6	20.6	20.3	21.9
MP1	2.1	1.2	2.9	2.6	2.7	3.4	1.7	2.3	1.9
M1	2.7	3.4	1.4	1.7	1.2	2.3	2.1	0.6	1.8
CHI1	1	0.6	1.9	0.5	0.5	0.7	0.5	1.8	1.4
PI1	1	1.2	0.5	1.5	0.8	1.6	1.6	1.1	1.9
P1	9.5	10.9	8	11.7	10.5	10	9.7	10.9	11.1
S1	1.9	3.9	4.4	4.3	4.8	4.5	5	3.6	3.5
K1	40	37	36.9	40.4	38.2	39.5	37	38	38.7
PSI1	3.3	2.1	2.7	2.6	2.5	3.6	2.8	3.4	3.6
PHI1	3.1	2.1	1.3	0.8	1.6	1.9	1.2	1.8	3.3
TH1	2.1	2.5	0.8	1.5	0.7	1	0.9	0.3	0.8
J1	1.8	0.5	0.9	1	1.5	0.7	1.6	0.4	1.6
SO1	3.8	2.8	1.9	1.6	0.7	1.6	1.9	1.9	2.4
OO1	0.8	0.5	1.5	0.5	0.5	0.7	0.3	1	0.8
OQ2	0.9	2	1.7	1.2	1.8	0.4	1.2	1	1.2
MNS2	0.8	2.2	2.7	2.2	3.7	2.7	2.1	3.1	2
2N2	6.1	10.8	12.8	7.4	3.7	11.4	14	10.1	5.8
MU2	12.1	12.2	11.3	14.9	12	11.6	12	11.6	13
N2	64	61.5	63.5	64.7	61.4	63.6	63.3	62.5	65.8
NU2	10.1	10.8	10	10.6	12.8	12.5	15.1	10.5	11.6
OP2	1.9	0.7	1.7	1.1	2.2	1.2	3.1	0.6	1.5
M2	301.4	300.9	299.3	301.4	301.2	302.6	302	303.9	301.8
MKS2	2.6	1.4	1.2	2.1	2.3	2.4	4.3	2.7	2.5
LAM2	3.7	3.4	1.5	2.4	3.9	3.7	6.8	3.2	2.5
L2	8	9	10	10.3	7.2	5.7	8.9	8.4	10.8
T2	8.2	8.1	8	5.4	6.5	6.9	7.9	7.3	7.5
S2	113.7	113.3	113.1	113.8	113.5	114.3	115.8	115.8	114.1
R2	1.9	3	2.4	2.9	4.5	2.4	3.1	2.7	2.1
K2	34.5	35.7	33.7	34.5	35.5	34.4	34.5	35.3	33.8
MSN2	1.2	0.3	2.6	1	2.5	1	2.5	3.7	2.4
KJ2	2.9	2.3	1.5	1.9	3.2	3.3	1.9	2.3	3
2SM2	1.5	2.5	3	0.4	1.8	1.1	1.4	1.1	0.8
MO3	10.2	7.5	7.3	7.7	7.3	8.3	8.4	8.8	8.1
M3	4	3.9	3.9	2.8	4.2	5.5	4.3	2.9	3.8
SO3	4.2	2.6	2.5	3.6	2.6	3.2	2.4	3.4	3.6
MK3	9.3	8.3	6.9	8.7	6.9	7.1	6.3	6.8	7.2
SK3	2.2	2.1	2.3	3.3	3.2	2.5	3.2	2.1	1.8
MN4	9.3	10	9.8	8.8	9.6	9.1	10.5	9.6	7.8
M4	26.3	27	25.4	25	27	26.6	25.1	26.3	24.8
SN4	1.9	2.2	2.4	1.5	1.1	2.9	3.4	1.9	2.3
MS4	16.7	16.8	15.2	16	15.8	16.2	15.2	16	14.7
MK4	7.9	7	5.6	7.4	7	7.6	7.7	6.7	7.3
S4	2.4	0.2	1.6	0.5	1	1.6	1.5	0.8	0.8
SK4	1.3	1.1	1	0.8	1	1.3	1	0.9	0.7
2MN6	0.4	0.3	0.9	0.4	0.5	1.2	0.5	0.8	0.4
M6	0.4	0.2	0.1	0.5	0.5	0.5	0.7	0.4	0.5
MSN6	0.2	0.7	0.4	0.7	0.5	0.3	0.3	0.2	0.8
2MS6	0.8	0.5	0.8	0.4	0.4	0.9	0.7	0.6	0.5
2MK6	0.7	0.8	1	0.8	0.6	0.7	0.6	0.4	0.8
2SM6	0.2	0	0.1	0.3	0.5	0.4	0.4	0.4	0.3
MSK6	0.4	0.1	0.7	0.4	0.5	0.5	0.4	0.1	0.2
MA2	1.9	1.4	1.4	1.3	2.8	1.7	4.5	2.7	1.5
MB2	4.4	3.4	2.2	4.2	5.8	6	2.7	3.9	4

	Ceuta - Amplitude (mm)								
	1954	**1955**	**1956**	**1957**	**1958**	**1959**	**1960**	**1961**	**1962**
ZO	828.3	873.2	880.4	895.6	899.3	885.4	930.3	881	823.5
SA	21.6	61.7	24.3	53	48.4	64.6	29.3	17.1	47.4
SSA	11.6	9	25.5	34.9	11.7	6.8	19.1	60.7	29.7
MM	4.8	20.9	5.9	21.7	15.3	8.8	16.8	11.1	23.2
MSF	10.2	5	7.5	12.4	15.9	11.6	10.1	8.5	10.2
MF	6	13.4	11.3	12.8	20.8	4.7	24.1	14.7	19.2
2Q1	1.2	0.7	1.6	1.1	2.9	1	0.1	1.7	3.4
SIG1	2.5	1.6	3.5	3	2.9	2.8	2.5	3.2	1.7
Q1	2.9	1.4	0.9	1.8	3.4	1.3	1.9	1.2	2
RO1	0.4	0.8	1.6	0.4	1.9	1.3	2.5	1.2	1.2
O1	21.4	19.3	22.2	22.1	22.1	21.1	20.2	21	21.9
MP1	1.5	1.4	1	1.4	0.4	0.6	0.7	0.8	1.3
M1	1.8	3.5	2.5	2.4	2.1	2.9	2.4	1.2	1.1
CHI1	1.1	0.3	0.8	1.7	1.1	1.2	1.5	0.8	0.5
PI1	0.7	0.7	2.1	0.7	1	1.1	1.3	0.9	2.8
P1	9.2	9.2	9.5	11	8.9	10.1	10.7	10.6	11.5
S1	4	3.9	3.3	1.4	1.3	3.1	1.7	1.7	1.5
K1	37.2	37.4	38.3	38.4	35.4	39.1	36.9	37.9	38.1
PSI1	1.3	1.7	1.6	1.8	1.8	1.1	3	2.4	1.1
PHI1	2.2	1	2.2	0.8	1.1	1	0.5	1.5	1.9
TH1	0.4	1.8	2.3	1.4	1.3	0.7	1.7	0.5	0.3
J1	0.8	1.3	0.3	1.1	0.7	0.8	1.3	1.6	1.6
SO1	1.9	2	2.6	2.4	1.6	3.7	2.6	2.9	2
OO1	0.8	1.8	0.9	0.8	4.4	1.3	3.9	1.1	1.9
OQ2	0.6	1.9	3.8	0.5	2.3	3.4	3.5	3	1.2
MNS2	2.9	2	1.2	3.6	1.4	3.1	2.7	4.1	2.7
2N2	7.8	9.3	9.9	7.9	7.1	11.7	10.9	8.7	4.4
MU2	11.6	15.1	13.5	14	13	12.7	12.5	12.5	13.9
N2	63.7	60.1	62.1	62	62.2	62.4	63.3	61.9	65.3
NU2	11.4	13.6	13	10.4	11.6	11.5	12.5	11.3	10.8
OP2	2.8	9.7	1.4	5.9	2.3	2.6	2	2.7	1.5
M2	303.7	298.8	300.5	300	302	304.2	302.4	301.4	298.9
MKS2	0.7	10.8	1.8	5.7	4	2.6	0.6	5	1.3
LAM2	3.4	4.5	2.3	2.6	1.9	2	2.9	5	4.4
L2	8.4	6.2	7.6	9	8.6	7.7	7.9	8.4	9.8
T2	6.1	8.3	6.5	12.6	7.9	6.5	7.1	7.6	8.4
S2	114.4	113.7	113.6	114.7	116.6	114.6	116.4	114.3	112.8
R2	3.5	8.4	2.7	6.1	1.4	2.5	0.8	0.6	1.9
K2	34.2	30.5	35.4	35.8	33.2	32	34.6	36.5	34.5
MSN2	2.1	1.2	1.8	1.9	1.9	1.4	1.2	2.2	2.5
KJ2	2.9	3.7	4.2	1.5	1.9	3.7	2	2.9	1.9
2SM2	2.1	1.1	2.1	2	1.5	1.6	1.6	1.5	1
MO3	8.7	7.5	7.5	7.7	6.9	8.8	9.3	10.6	9.2
M3	4.9	3.7	3.9	4.7	4.7	4.7	4.3	3.9	3.7
SO3	2.6	3.3	3.4	4.5	3.4	3.5	4	4.7	3.9
MK3	6.9	6.6	7.9	7.6	6	9.5	7.3	7.9	9.3
SK3	3.1	2.1	1.6	1.8	3.1	2.2	2.8	2	2.3
MN4	8.6	9	10	8.9	9.8	10.9	9.9	9.4	10.3
M4	24.3	26.2	26.4	27.4	26	27.6	27.1	27.8	26.7
SN4	1.5	1.7	3.5	1.8	2.7	3	2.7	2	1.8
MS4	15.8	15.7	15.7	16.4	15.3	15.4	16.8	16.2	16.9
MK4	6.6	7.3	6.9	8	5.7	6.1	7.1	6.5	7.5
S4	1.5	1.9	0.5	1.2	1.1	1.2	0.4	0.4	1.1
SK4	0.3	0.2	0.4	0.9	0.8	1.8	0.7	1.1	2
2MN6	0.6	0.5	0.7	0.1	0.4	0.9	0.5	0.6	0.2
M6	0.6	0.3	0.1	0.5	0.3	0.1	0.3	0.3	0.2
MSN6	0.3	0.2	0.2	0.7	0.4	0.1	0.1	0.3	0.3
2MS6	0.8	0.7	0.2	0.4	0.5	0.4	0.5	0.2	0.5
2MK6	0.6	0.6	0.8	0.8	0.5	1.4	1	0.4	1.2
2SM6	0.1	0.2	0.4	0.7	0.6	0.8	0.6	0.3	0.7
MSK6	0.2	0.2	0.6	0.1	0.3	0.3	0.5	0.9	0.4
MA2	1.4	9.9	1.5	10.1	3.3	4	2.4	4.1	1.5
MB2	5.8	12.7	4.3	10.6	6.5	3.7	4.7	4.8	6

	Ceuta - Amplitude (mm)								
	1963	**1964**	**1965**	**1966**	**1967**	**1968**	**1969**	**1970**	**1971**
ZO	851	815.9	822.4	864.4	868.6	885	908.4	866.1	862.1
SA	59.4	11.7	69.3	62.5	49.5	40.2	34.9	34.2	5.3
SSA	57.1	11.7	40.2	16.3	45.7	31.3	24.7	29.2	30.2
MM	22	7.5	22.5	10.5	20.9	12.7	13.1	16.7	17.4
MSF	3.2	4.4	4	8.4	1.9	11.4	13.4	5.4	13.1
MF	5.8	11.3	10.5	6.7	0.8	8	6.3	5.2	4.7
2Q1	1.9	0.2	1.6	2.3	0.2	1.1	1.1	1	1.9
SIG1	1.8	2.4	3.8	2.6	1.7	3.6	2.7	3	2.9
Q1	2.3	2.4	1.6	3	3.2	0.4	1.3	1	2
RO1	1.1	0.6	0.7	0.2	0.8	2.5	1.6	1	1.8
O1	20.8	20	20.2	19.5	20	21.9	21	19.9	20.4
MP1	1.6	0.9	2.5	1.5	1.2	3.6	2.8	2.4	1.7
M1	1.7	2.2	3.1	1	2.8	1.7	1.6	1	1.7
CHI1	0.1	0.6	0.2	0.8	0.6	1.9	1.2	0.1	2.3
PI1	1.7	1.4	2.2	0.9	1.8	1.4	1.5	1.8	2.9
P1	11.5	10.7	11.4	10	11.2	10	8.7	8.4	11.6
S1	1.4	3.2	1.5	1.8	2.8	2	2.7	1.7	4
K1	37.7	37.9	38.5	35.9	38.8	37.3	37.4	36.2	36.9
PSI1	2.4	0.9	3	3.1	2.6	2.9	2.2	1.7	2.3
PHI1	1.5	2.3	1.6	2.1	1.8	0.7	2.2	0.2	1.5
TH1	1.3	0.9	2.4	0.7	0.8	1.7	1.7	1.1	0.3
J1	0.8	1.3	0.6	1.5	0.2	0.4	0.8	1.7	2.7
SO1	3.5	3.2	2	2.1	2.3	1.1	1.8	2.4	0.4
OO1	0.7	1.9	0.8	0.4	0.5	1.1	0.6	0.8	1.4
OQ2	1.5	2.8	1.2	0.8	0.8	1.3	1.2	2.8	1.7
MNS2	3.4	3.6	3.3	1.2	2.6	4.2	3.4	2.7	1.9
2N2	8.1	11.7	10.9	6.5	8.4	12.4	12.4	8	6.1
MU2	12.4	12.9	11.1	12.5	14	12.6	10.3	14.1	11.8
N2	64.7	62.4	60.3	62	66.6	63.6	61.3	59.8	66.3
NU2	12.1	12.3	12	10.3	12	14.6	12.4	12.9	9.7
OP2	3.5	2.3	0.6	3.4	2	1.4	1.6	1.6	6.5
M2	298.5	303.3	303.7	301.7	303.9	302.8	301	303.5	301.2
MKS2	3.4	1.5	1	2	1.3	1.4	1.6	4.6	9
LAM2	2.3	2	5.7	2.5	4.9	5.4	3.5	6.2	4.8
L2	7.2	7.1	9	8.7	7.8	6.3	8.1	6	5.5
T2	8.5	7	6.6	7.8	6.7	7.1	5.7	8.6	6
S2	113	114.6	116.6	116.6	114.7	115.6	115.9	117.4	118.9
R2	2.5	1.7	0.7	1.4	0.4	2.7	1.6	0.6	2.9
K2	35.3	36.2	35.5	35.1	34.5	36.2	33.8	35.2	33.2
MSN2	1.9	1.2	1.4	1.9	2.5	1.1	2.2	2.1	3.5
KJ2	2.6	2.5	1.4	0.9	1.8	2.3	2.7	3.6	4.4
2SM2	1.7	1	0.2	2.6	2.7	0.9	1	4.5	2.2
MO3	9.3	7.9	7.6	6.6	6.6	7	7.6	7.6	6.7
M3	3.2	3.8	2.5	3.1	5.4	5.2	4.2	2.6	3.4
SO3	3.2	2.1	3.1	2.7	2.8	3.8	3.1	3.5	3.3
MK3	6.8	7.1	5.8	6.6	7.6	5.2	6	5.9	6.7
SK3	2.3	2	2.7	2.4	1.8	2.5	3.5	2.8	3.1
MN4	8.5	9.6	10.3	8.6	8	9.4	10.8	7.6	9.9
M4	25.9	26.8	25.1	25.7	25.3	26.3	25	22.5	22.8
SN4	1.3	3.1	1.9	2.8	0.3	1.9	3.8	1	0.7
MS4	16.5	15.7	16.6	15.1	15.3	14.9	14.6	13.4	13.7
MK4	7.1	7	6.3	6.8	6.1	6.8	5.7	7	5.6
S4	0.9	1.2	0.3	0.9	1.5	2.2	1.4	2.4	1.6
SK4	1.6	1.2	1.2	1.2	1.2	0.8	0.8	0.8	1
2MN6	0.6	0.8	0.4	0.7	1.1	0.7	0.4	0.5	0.1
M6	0.3	0.5	0.2	0.5	0.7	0.7	0.4	0.9	0.5
MSN6	0.4	0.3	0.5	1	0.9	0.3	0.7	0.7	0.7
2MS6	0.6	0.7	0.1	1.2	0.6	0.6	1	0.4	0.4
2MK6	1.3	0.9	0.7	0.6	0.9	0.1	0.4	0.2	0.1
2SM6	0.2	0.4	0.4	1.7	0.8	0.4	1.1	1.2	1.1
MSK6	0.5	0.6	0.8	0.1	0.4	0.5	0.4	0.5	0.2
MA2	2.3	0.4	2.7	3.7	3.3	6.3	2.2	9.8	9.4
MB2	3.2	3.5	4.4	1.7	1.1	3.7	4.2	7	14.3

	Ceuta - Amplitude (mm)								
	1972	**1973**	**1976**	**1977**	**1978**	**1980**	**1981**	**1984**	**1985**
ZO	869.3	857.6	933.1	876.6	799.8	877.1	863.2	884.5	891.3
SA	48.5	46.1	71.1	23.2	38.8	58.4	51.9	37.3	28.7
SSA	26.3	23.8	4.8	10.7	51.1	35.1	33.3	40.5	38.4
MM	5.1	3.7	1.9	12	17	14.8	2.7	12.3	9.4
MSF	10	6.4	18.6	11	11.8	7.9	11.8	8.8	16.8
MF	4.6	16.7	25.6	11.7	31.1	11.2	14.2	2.3	9.1
2Q1	1.3	0.9	1.4	1.7	2.4	1.4	1.2	0.9	0.8
SIG1	3	1.9	3.5	2.7	2.5	3.8	4.2	3	1.9
Q1	2.6	2.3	2.9	0.6	1	1.9	1	1.5	3
RO1	1.8	1.8	1.9	1.5	1.1	0.4	0.9	0.5	0.9
O1	20.1	22.9	19.4	19.5	21	20.3	21	18.3	22.1
MP1	1	1.1	0.7	1.3	1.2	3.2	0.8	1.4	1.9
M1	2	2.3	2.3	1.8	1.3	1.9	2.3	1.8	1.6
CHI1	0.9	1.1	1.3	1.8	1.2	0.5	0.7	0.2	0.5
PI1	2.1	2.3	0.8	0.5	3.1	1.4	1.1	0.8	0.9
P1	9.3	11.8	10.1	11.8	10	9.1	9.5	10.5	10.1
S1	3.2	5.4	4.4	2.1	1.9	1.2	4	1.8	3.3
K1	40.5	39.2	39.2	35.3	38.4	36.9	37.4	37.4	38.2
PSI1	4.4	4.7	2.5	1.2	3.6	3.5	3	0.5	0.7
PHI1	0.3	2.1	2.1	1	2.4	1.8	1.6	0.7	0.7
TH1	0.5	0.7	1.4	0.9	0.8	2.1	1.6	1.1	0.7
J1	1.9	0.8	1.2	2.2	1.5	1.5	1.4	0.8	0.1
SO1	2.2	2.1	1.5	2.5	2	2.6	4.2	3.4	2.4
OO1	1.4	2.4	0.9	1.3	2.4	0.8	2.5	0.4	1.3
OQ2	2.8	1.6	0.7	3.1	4.2	3.4	0.8	0.6	1.5
MNS2	3.5	3.9	3.9	2.5	3.2	2.4	2.7	3.7	3.3
2N2	11.2	14.9	8.9	10.4	12.8	4.4	7.1	8	6.6
MU2	12.4	12	8.9	13.5	15.3	8.2	14.3	10.9	13.1
N2	65	61.7	60.7	64.3	66.7	57	62.1	64.3	64.5
NU2	11.3	13.5	8.1	10.2	11.7	14.8	15.5	14.1	12
OP2	0.3	2.3	25	2.9	10	9.2	11.2	7.1	3
M2	307.6	306.4	296.9	302.3	301.2	297.6	301.4	303.6	304.4
MKS2	0.4	2.8	26.4	5	16.7	18.1	13.4	3.8	1.4
LAM2	5	4.8	4.1	0.9	7.6	3.6	4.4	5.3	2.7
L2	9	10.9	5.5	7.1	11.6	5.5	6.7	12.3	7.4
T2	6.4	8.7	6.2	6.7	11	15.2	8.8	7.1	5.6
S2	115.1	115.1	116.1	116.1	112.9	116.1	113	115.2	114.8
R2	2.6	2.9	4	1.6	2.1	13.8	6.1	3.1	3.1
K2	34.6	38.4	34.2	33	37.2	33.6	33.5	32.8	35.4
MSN2	2.9	3.1	4.5	1.9	1.5	3.3	1.2	3.2	1.5
KJ2	2.8	1.5	1.1	4.6	6.8	3.6	2.4	0.9	2.5
2SM2	3.5	2.3	2.5	2.2	2.7	2	1.6	0.4	1.1
MO3	6.5	7.9	6.7	8.6	9.9	8.7	9.3	6.5	7.3
M3	5.5	4.4	3.4	4.5	3.9	2.5	3.9	3.8	5.1
SO3	3.4	4.9	3.4	4.9	4.5	3.2	2.8	3.1	2.8
MK3	8	7.4	8.2	5.9	7.3	7.9	7.7	7	5.9
SK3	2.5	2.3	2.5	3.2	1.3	2.2	2	2.3	1.7
MN4	9.2	10.6	8.5	9.3	10	7.5	8.7	8	9.2
M4	24.4	25.3	24.1	25.2	24.7	24.4	24.8	24.8	27.1
SN4	2.5	2.2	1.4	3.1	1.9	1.9	2.5	1.7	2.8
MS4	13.7	14.3	15.8	14.7	13.1	14.4	14	14.2	15
MK4	6.2	7.4	6	6.8	8	5.5	7.6	6.9	6.6
S4	1.8	1.1	0.6	1.1	1.9	0.8	0.6	1.5	2.2
SK4	1.3	0.3	0.6	1.1	1.5	1	0.8	1.9	1
2MN6	1.4	0.6	0.4	0.9	0.3	0.2	0.4	0.2	0.4
M6	1	1.1	0.3	0.4	0.6	0.2	0.6	0.1	0.5
MSN6	0.6	0.5	0.9	0.5	0.6	0.2	0.5	0.6	0.8
2MS6	1	0.5	0.5	0.4	0.6	0.3	0.8	0.3	0.6
2MK6	0.3	0.5	1	0.5	1	1.4	0.5	0.5	0.6
2SM6	0.9	0.4	0.4	0.4	0.8	0.4	0.1	0.7	0.5
MSK6	0.1	0.8	0.6	0.4	0.3	0.1	0.3	0.1	0.4
MA2	2	4	19.8	4	5.7	23	11.6	3.1	1.5
MB2	5.3	5.3	26.7	4	4.3	20.9	13.8	4	5.7

	Ceuta - Amplitude (mm)								
	1986	**1987**	**1989**	**1992**	**1993**	**1995**	**1996**	**1997**	**1998**
ZO	874.4	910.7	886.8	869.9	876.7	873.9	909.4	893.6	867.9
SA	49.9	58.4	87.4	32.6	52.7	66.6	48.1	63.2	39.1
SSA	26.1	16.1	65.2	12.2	46.7	41.8	22.5	56.8	7.6
MM	14.2	10.8	6.8	3.2	21.6	15.7	6.1	13.8	15.7
MSF	14.4	2.1	21.3	7.9	8.3	14.1	7	2.1	5.9
MF	7.1	10.5	3.5	3.9	6.4	19	13.7	8.4	16.3
2Q1	0.9	0.4	1.4	1.9	1.2	0.2	2.5	0.7	2.4
SIG1	3.3	3.3	2.6	2.2	3.6	2.8	4.2	3	3.5
Q1	1.7	1.3	1.9	0.5	1.4	1.5	1.3	1	0.7
RO1	1.7	1.4	2.5	1.8	0.6	2.5	0.4	1.2	1.9
O1	19.7	20.4	19.9	19.8	20.3	19.6	19.3	18.3	19.5
MP1	1.5	3.2	1.2	3	1.9	0.6	1.1	2.1	2.5
M1	2.5	0.2	1.1	2.9	2.3	2	0.8	1	2.5
CHI1	1.8	0.6	0.3	1.1	0.5	0.7	1.6	1	2.3
PI1	2	1.7	2.1	2.2	0.1	1.1	1.9	1.3	0.5
P1	9.8	9.4	10.2	10.5	11.5	10.6	10.9	10.9	10
S1	4.4	3.5	4.9	3.3	2.2	1.5	2.5	1.9	2.1
K1	36.8	35.9	37.7	37.2	37.4	37.6	38.1	37.5	37.1
PSI1	3.9	3.5	1.3	1.6	1.5	2.6	3.1	1.7	2.6
PHI1	0.4	2.2	1.4	1.3	1.3	0.6	0.8	2	1.4
TH1	0.8	1.1	0.4	1.7	0	2.1	1.1	1.5	1.7
J1	0.8	0.8	1.6	2.2	0.7	1.8	1.1	1.6	1.2
SO1	0.9	2.5	1	1.7	2	2.1	2.6	2.5	2.4
OO1	0.5	1.1	0.5	0.5	1	0.2	2.4	0.5	2.8
OQ2	2.6	3	0.3	0.9	0.8	0.8	1.6	3.4	1.5
MNS2	4.1	3.7	1.4	5.4	3.3	3.3	1.6	3.8	3.3
2N2	11.9	12.3	6.2	8.3	6.7	10.4	9.1	7.6	6.6
MU2	14.6	13.9	9.3	12.9	13.4	14.1	12.9	14.7	13.5
N2	63.2	64.7	64.2	63.9	64.4	62.5	61.3	60.2	64
NU2	12.9	10.7	9.5	11.8	12.7	12	10.7	10.7	9.4
OP2	2.5	0.2	3.3	1.1	1.3	3.4	2.6	2.5	1.7
M2	304.7	302.2	301.2	304.7	302.6	299.9	300.5	290.7	292.3
MKS2	2	1.9	3.1	3	2.2	2.1	3.7	2.4	2.8
LAM2	2.6	2.3	2.1	4.4	4.7	4.1	0.1	3.4	2.6
L2	8	8.5	10.3	10.2	8.5	8.8	8.5	9.5	8.2
T2	8.8	6.2	5.3	7.4	6.9	8.4	7.9	7.9	6.9
S2	113.8	113.1	114	116.2	114.1	113.1	113	109.8	109.5
R2	2.4	2.4	5.2	2.9	3.1	2.9	2	3.1	1.7
K2	34.5	34.8	31.6	33.9	33.1	31.4	33.8	32	33.5
MSN2	2.1	2.6	2.1	3.6	2.7	2.4	1.4	1.9	2.4
KJ2	2.9	3.1	0.7	1.1	1	1.3	1.2	3.1	1.4
2SM2	2.6	0.5	0.9	1.4	1.3	1.6	0.9	2.9	1.9
MO3	6.9	8.8	8.3	5.7	6.3	9.2	10.4	9.1	8.3
M3	4.6	4.1	2.5	4	5.7	4.1	2.8	1.8	3.2
SO3	2	2.4	3.7	4.1	3.8	2.8	3.9	3.2	3
MK3	6	5.6	6.3	6.6	7.2	7.6	8.1	7.2	7
SK3	3.1	2.1	2.6	3.3	2.5	2	1.9	1.6	1.9
MN4	10.1	10.6	9.1	10.5	8.9	10.3	9.1	9.3	9.1
M4	24.3	24.6	25.4	25.5	26.3	25.7	26.1	23.8	22.6
SN4	3.3	3	2.2	1.8	2	2.8	3.1	1.4	1.2
MS4	13.4	15	13.3	16.6	15.2	14.2	16	13.5	14.8
MK4	7.2	6.8	6.4	6.2	6.4	7.4	6.2	7.3	5
S4	0.2	1.8	1.6	0.4	0.4	1.3	1	0.4	0.3
SK4	0.7	1.1	0.9	1	1.1	1.1	1	0.8	1
2MN6	0.6	0.2	0.5	0.4	0.3	0.7	0.3	0.4	0.2
M6	0.5	0.1	0.5	0.5	0.5	0.5	0.2	0.3	0.2
MSN6	0.5	0.2	0.7	0.9	0.3	0.5	0.3	0.1	0.4
2MS6	0.4	0.6	1.2	0.5	0.4	0.3	0.2	0.2	0.3
2MK6	0.6	0.5	0.7	0.6	0.8	0.5	0.9	1	0.9
2SM6	0.5	1	1.7	0.2	0.1	0.3	0.4	0.2	0.2
MSK6	0.4	0.1	0.4	0.5	0.4	0.4	0.2	0.1	0.2
MA2	3.1	4.5	2.3	1.7	1.7	2.5	2.5	2.5	1.1
MB2	6.4	2.3	9.1	2.7	5.7	6.6	2.5	5.4	3.9

	Ceuta - Amplitude (mm)			
	1999	**2000**	**2001**	**2002**
ZO	863.4	862.8	875.7	887.5
SA	57.9	28.1	61.8	40.8
SSA	28.5	31.6	17.8	26.8
MM	17.4	4.9	8.6	31.2
MSF	13.3	5.5	4.7	4.7
MF	11	8.9	3.6	17.1
2Q1	0.9	1.4	3.2	2.1
SIG1	3.2	3.6	3.2	2.9
Q1	2	1.6	1.3	2.3
RO1	0.8	0.3	1.1	0.3
O1	19.8	21.2	21.1	19.4
MP1	0.6	3	0.4	0.8
M1	2.6	3.6	1.7	1.4
CHI1	1.2	0.9	1.4	1
PI1	1	1.9	0.9	2.9
P1	11.1	11.2	10.7	10.2
S1	1.6	3	3.6	2.5
K1	36.8	37.3	36.6	37.3
PSI1	1.9	2.2	0.8	2.1
PHI1	1.7	2.1	1.6	1.3
TH1	0.1	1.2	1.5	0.8
J1	1.2	0.5	0.6	0.4
SO1	1.9	2.6	2.3	1.9
OO1	2.7	1.2	0.3	0.3
OQ2	1.5	2	1.2	0.3
MNS2	2.6	3.4	3.6	3.8
2N2	9.9	11.2	9.1	5.2
MU2	13.4	12.7	13	13.3
N2	65.8	61.5	62.6	65.4
NU2	11.2	12.4	11.6	10.3
OP2	0.5	1.3	0.9	0.3
M2	301.5	301.3	301.7	301.1
MKS2	1.2	1.8	1	0.8
LAM2	3.1	3.6	2.9	3.2
L2	8.4	9.8	10.3	9
T2	7.9	6.9	7	7.3
S2	112.8	112.6	112.4	113.8
R2	2.6	3	2.1	2.5
K2	36	35.6	34.2	34.7
MSN2	2	1.3	2	1.8
KJ2	1.2	1.3	2.1	2.4
2SM2	2.4	0.7	2.8	2.1
MO3	7.2	7.8	7.5	7.3
M3	4.6	3.5	3.7	3.7
SO3	2.6	3	2.9	2.9
MK3	6.8	8.1	7.7	7.5
SK3	2.6	2	2.4	2.3
MN4	8.6	9	10	9.3
M4	25.9	25.9	24.2	27
SN4	2.4	3.1	1.5	2.2
MS4	16.3	17.1	15	17.1
MK4	7.6	6.2	6.9	7.5
S4	0.6	0.4	0.7	0.9
SK4	1.2	1.4	1.2	1.3
2MN6	0.5	0.8	0.5	0.4
M6	0.5	0.2	0.2	0.9
MSN6	0.5	0.4	0.1	0.4
2MS6	0.3	0.4	0.4	0.8
2MK6	0.6	0.5	0.7	0.7
2SM6	0.4	0.4	0.2	0.4
MSK6	0.2	0.1	0.5	0.1
MA2	1.7	2.4	1.1	1.4
MB2	5.9	2.4	5.2	4.7

	Ceuta - Phase (º)								
	1945	**1946**	**1947**	**1948**	**1949**	**1950**	**1951**	**1952**	**1953**
ZO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SA	214.4	115.5	247.0	149.5	175.5	201.3	198.9	152.2	175.7
SSA	141.7	62.4	90.9	102.7	91.2	125.8	75.7	68.0	117.4
MM	345.1	71.5	324.6	348.7	129.3	198.2	114.3	200.7	325.5
MSF	334.7	348.6	117.6	195.0	274.3	239.3	138.6	351.3	176.1
MF	323.3	206.2	283.9	7.0	93.2	353.4	298.1	76.6	130.6
2Q1	123.2	308.8	112.3	229.3	202.6	76.8	178.9	164.5	229.8
SIG1	200.1	213.7	213.4	194.0	199.4	186.6	215.5	190.3	232.0
Q1	90.9	80.5	90.0	112.0	134.0	167.9	179.2	173.4	75.9
RO1	173.2	60.2	272.5	21.1	325.1	355.4	265.5	92.2	7.1
O1	104.6	102.3	105.4	99.3	99.9	99.8	102.0	99.6	100.8
MP1	284.3	221.2	312.0	357.7	310.1	278.8	317.2	256.7	324.8
M1	154.9	206.0	272.4	52.3	97.7	158.9	228.5	79.4	117.2
CHI1	249.5	224.6	328.4	2.5	44.6	326.8	138.8	256.0	83.8
PI1	189.9	125.5	164.0	174.5	270.3	161.6	167.0	117.0	184.2
P1	148.6	144.3	142.5	144.8	149.0	142.0	144.4	139.1	142.7
S1	28.9	51.0	68.7	52.4	29.1	39.9	46.0	25.5	44.5
K1	144.9	143.0	143.0	142.8	144.6	143.7	141.1	141.8	144.6
PSI1	298.0	283.2	313.8	313.8	308.2	354.4	336.8	283.2	299.5
PHI1	175.6	75.8	119.6	123.0	183.7	168.4	146.1	129.7	198.8
TH1	224.6	290.6	308.4	41.5	200.2	269.5	259.0	64.4	329.9
J1	286.0	125.9	186.9	358.9	349.2	316.6	310.6	284.3	266.9
SO1	338.5	328.6	352.8	341.4	26.4	328.7	347.7	309.0	332.9
OO1	150.4	223.0	204.3	162.1	189.3	149.2	214.6	196.5	168.2
OQ2	72.6	52.6	344.2	289.8	322.6	3.8	351.2	4.4	356.7
MNS2	311.0	355.5	12.9	26.1	36.2	10.1	358.4	22.3	52.9
2N2	2.3	2.7	27.8	52.2	18.9	354.2	14.7	46.7	11.1
MU2	27.4	31.6	27.7	20.1	18.9	31.4	14.3	28.6	15.2
N2	37.1	35.2	33.4	31.6	36.6	37.7	38.3	33.6	34.9
NU2	31.5	31.0	34.9	28.0	40.1	37.9	50.9	38.5	35.7
OP2	350.9	268.8	267.0	119.9	35.5	317.4	297.8	339.6	354.3
M2	49.0	48.4	48.6	48.7	49.0	48.9	48.3	48.8	48.6
MKS2	49.0	306.8	138.5	102.6	97.4	110.5	113.1	96.8	130.5
LAM2	24.8	358.8	337.1	15.4	31.0	11.5	340.1	29.6	15.3
L2	17.5	47.2	37.9	38.5	6.3	40.8	25.8	47.7	33.2
T2	75.8	83.8	76.4	83.8	81.7	84.8	61.2	67.2	77.8
S2	74.8	75.1	74.2	74.5	75.5	75.6	73.4	74.9	74.8
R2	102.5	65.7	112.7	90.7	63.1	51.5	117.4	75.4	49.0
K2	65.1	64.8	65.8	66.0	66.3	65.3	67.8	67.4	63.7
MSN2	259.1	313.7	247.5	218.7	169.3	223.6	192.6	185.1	190.2
KJ2	286.8	253.9	299.3	316.8	296.2	299.9	235.6	269.1	279.6
2SM2	167.0	168.2	197.5	284.6	151.1	176.2	192.7	177.4	124.2
MO3	306.2	309.0	317.2	316.4	316.8	323.0	319.7	314.6	300.6
M3	150.6	139.6	148.5	211.4	215.1	238.2	256.4	196.7	141.3
SO3	21.4	29.8	24.2	31.3	26.8	3.5	20.3	18.0	15.7
MK3	48.9	38.3	39.2	42.9	52.5	43.9	40.5	39.8	49.1
SK3	57.8	77.6	54.5	71.4	72.1	84.8	74.9	88.7	98.6
MN4	125.4	119.6	124.7	126.5	120.9	117.2	119.9	126.6	122.1
M4	163.7	160.7	158.4	159.5	156.0	161.3	156.5	161.5	157.0
SN4	164.9	169.3	202.3	201.2	168.1	156.0	199.9	166.6	256.5
MS4	224.6	221.5	218.8	216.7	215.4	222.0	224.7	220.2	215.8
MK4	244.4	239.8	234.5	233.5	222.5	239.6	234.2	240.9	228.1
S4	46.9	158.2	55.8	313.2	61.7	41.7	36.1	28.9	57.0
SK4	20.3	7.0	321.1	342.3	344.8	16.6	334.9	317.2	335.9
2MN6	292.1	242.5	331.5	175.0	218.6	213.3	287.4	66.0	219.3
M6	74.4	313.4	76.5	215.4	283.3	220.5	199.1	326.0	302.0
MSN6	27.2	305.9	35.4	138.2	233.4	278.3	271.1	193.1	193.6
2MS6	120.9	188.8	125.4	198.5	182.6	196.9	211.7	218.0	209.7
2MK6	176.5	147.5	95.1	130.9	97.6	131.6	142.1	139.8	123.1
2SM6	251.7	123.7	101.6	339.5	302.3	351.8	304.4	34.2	343.8
MSK6	23.3	121.0	139.7	188.6	180.9	129.9	162.9	175.2	207.5
MA2	129.1	137.7	112.2	336.6	143.6	99.9	71.0	119.1	129.7
MB2	116.2	86.8	71.5	71.6	89.2	79.2	130.6	88.0	91.5

	Ceuta - Phase (º)								
	1954	**1955**	**1956**	**1957**	**1958**	**1959**	**1960**	**1961**	**1962**
ZO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SA	217.5	225.3	206.7	199.7	230.3	172.9	180.1	93.4	214.4
SSA	101.4	75.4	336.4	88.9	137.1	148.3	47.1	120.2	55.5
MM	284.4	280.8	316.1	324.8	224.4	108.4	294.2	127.3	302.6
MSF	250.1	333.8	340.7	192.3	202.1	291.5	320.2	181.9	302.9
MF	188.9	104.4	55.6	357.9	83.8	75.4	242.4	127.8	34.0
2Q1	107.8	115.1	189.3	141.1	282.8	9.6	89.4	258.9	199.7
SIG1	201.0	199.3	253.0	177.5	178.1	197.1	190.7	212.7	205.8
Q1	57.5	146.0	128.0	146.2	138.0	173.7	276.2	108.7	118.2
RO1	261.1	303.6	171.9	258.4	47.6	289.3	356.2	26.6	319.0
O1	98.5	102.2	101.9	99.6	104.6	96.5	104.9	94.5	103.0
MP1	258.8	322.5	312.5	208.1	249.4	297.7	210.4	294.6	223.9
M1	170.9	228.5	347.5	35.0	112.0	127.2	115.4	249.2	150.1
CHI1	57.1	281.4	204.1	231.8	279.4	172.4	221.1	170.8	62.3
PI1	75.8	275.4	185.8	105.4	101.6	72.5	215.7	282.9	116.8
P1	147.2	143.9	151.0	141.5	137.9	140.0	143.2	144.2	141.6
S1	52.0	21.1	66.7	15.9	38.2	36.3	130.1	59.8	65.7
K1	144.0	142.3	145.3	143.6	143.9	143.0	141.5	143.3	144.7
PSI1	313.1	3.4	298.0	288.2	326.4	17.3	306.9	325.0	360.0
PHI1	101.5	214.5	298.5	110.3	180.3	58.8	195.9	109.8	83.2
TH1	213.5	327.4	79.6	69.8	286.0	299.0	11.4	233.5	324.8
J1	279.6	164.0	356.6	283.2	46.1	321.1	301.7	259.4	305.1
SO1	323.1	350.3	350.2	346.9	357.1	339.4	4.2	338.5	297.8
OO1	141.3	189.1	167.2	226.8	73.6	121.4	195.8	163.7	150.9
OQ2	58.4	29.8	328.2	343.0	23.8	337.8	333.0	300.4	356.6
MNS2	8.9	6.2	13.8	20.3	72.7	19.5	0.3	43.5	1.3
2N2	0.3	21.7	35.6	34.8	1.2	10.9	12.7	32.9	21.1
MU2	27.0	31.7	30.9	27.8	23.1	23.4	31.9	28.8	27.0
N2	38.5	36.3	32.9	33.4	35.7	33.7	31.7	35.2	33.9
NU2	32.9	45.6	43.7	26.5	38.2	32.9	36.4	35.5	33.1
OP2	222.7	292.3	139.4	65.2	313.4	270.0	184.4	44.0	104.2
M2	49.5	50.5	49.6	48.5	48.6	49.2	48.6	48.3	48.8
MKS2	169.0	149.3	85.7	23.4	108.6	181.9	306.0	11.2	111.8
LAM2	8.1	37.4	334.4	59.0	358.6	335.4	349.3	30.4	356.9
L2	32.9	15.2	45.8	37.4	39.9	50.1	45.8	27.4	39.3
T2	83.0	97.5	85.3	80.4	72.5	80.3	81.1	82.7	67.3
S2	76.3	77.3	75.4	75.6	73.8	76.3	74.5	74.7	74.7
R2	64.0	66.4	58.5	63.0	10.5	62.0	263.6	44.5	49.7
K2	66.3	68.0	65.1	61.9	64.1	68.1	68.5	69.2	65.2
MSN2	192.7	166.0	271.1	237.2	105.6	116.8	282.1	181.8	234.6
KJ2	289.3	263.8	269.4	334.7	244.1	274.9	319.1	313.0	278.1
2SM2	169.9	214.7	200.7	246.9	210.9	256.7	175.9	215.6	201.0
MO3	315.0	301.9	318.0	310.5	328.9	316.3	313.6	299.7	305.8
M3	140.1	143.7	193.9	224.2	221.2	217.3	228.8	212.9	145.6
SO3	28.5	5.8	2.8	15.5	354.8	14.0	11.4	16.1	21.5
MK3	46.4	25.5	42.3	44.0	48.7	40.7	31.4	30.6	35.2
SK3	102.7	84.2	63.8	106.9	73.7	92.8	41.3	50.7	70.6
MN4	125.3	125.0	129.8	126.0	121.0	119.6	126.7	122.6	126.6
M4	162.6	164.4	160.5	158.7	157.3	160.6	163.6	161.2	162.2
SN4	129.7	161.4	214.6	155.2	173.5	166.4	210.9	165.6	181.8
MS4	224.4	227.1	217.8	223.5	219.4	220.2	223.0	220.0	216.0
MK4	247.9	228.7	238.8	232.4	234.7	227.7	252.7	236.4	240.4
S4	53.2	82.9	40.9	62.7	144.4	96.2	332.8	106.2	98.1
SK4	81.6	225.6	353.2	30.2	16.4	107.3	318.5	343.3	31.2
2MN6	268.0	268.9	280.2	165.2	302.8	307.1	310.5	6.4	191.6
M6	131.9	294.5	286.0	31.4	243.6	203.6	131.7	92.6	188.0
MSN6	6.4	330.7	39.5	232.0	328.6	2.9	237.0	47.3	328.3
2MS6	171.5	145.1	144.3	185.4	253.5	284.1	161.2	198.2	233.6
2MK6	136.9	83.5	118.2	131.9	146.6	144.9	129.9	159.4	119.0
2SM6	291.5	208.9	353.5	320.5	350.3	321.8	329.8	257.8	311.3
MSK6	225.8	16.2	91.6	183.5	252.2	294.9	84.8	174.1	148.1
MA2	201.5	142.8	205.4	116.3	268.1	122.7	106.3	98.1	133.2
MB2	83.1	121.8	64.4	132.5	55.3	86.9	60.3	83.7	86.2

	Ceuta - Phase (º)								
	1963	**1964**	**1965**	**1966**	**1967**	**1968**	**1969**	**1970**	**1971**
ZO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SA	257.0	212.3	207.3	175.2	175.4	203.2	261.8	249.5	66.8
SSA	182.2	277.1	49.3	338.1	97.5	94.5	313.2	232.8	64.9
MM	141.8	193.0	193.5	132.3	222.3	280.0	241.7	34.8	108.5
MSF	206.1	203.6	239.0	231.5	75.9	240.0	123.5	58.8	181.6
MF	54.5	156.6	117.3	254.9	330.3	86.1	93.6	139.5	326.8
2Q1	345.3	141.9	96.7	179.6	217.3	35.8	131.0	216.5	254.1
SIG1	202.5	217.4	227.5	183.3	181.6	181.3	219.9	204.3	192.2
Q1	178.5	131.5	217.3	180.5	162.7	167.9	253.0	306.2	90.4
RO1	355.8	359.3	294.0	82.7	332.9	114.6	16.0	34.8	28.6
O1	97.3	101.1	98.1	105.6	100.1	104.2	102.1	103.7	100.0
MP1	326.4	170.2	307.5	314.9	327.8	301.6	255.4	295.6	339.2
M1	127.4	212.0	299.7	100.2	89.1	160.4	198.5	92.6	141.3
CHI1	1.7	324.7	62.5	192.8	107.6	86.0	158.8	339.6	1.3
PI1	179.5	151.6	160.3	77.0	170.5	200.4	193.6	140.5	137.8
P1	149.5	144.7	149.8	145.5	153.8	139.5	134.8	147.4	146.2
S1	53.6	58.1	117.0	59.2	31.1	94.1	51.5	64.0	30.7
K1	146.1	143.2	140.1	143.0	144.5	143.7	141.5	143.0	146.3
PSI1	311.7	339.0	333.2	323.5	316.8	334.8	355.4	325.1	302.5
PHI1	205.1	25.9	170.6	107.0	123.8	186.0	74.0	268.4	217.1
TH1	287.4	294.5	54.4	80.5	277.7	274.6	320.3	65.9	221.8
J1	96.5	214.3	82.9	54.8	143.6	289.0	259.8	301.5	222.7
SO1	315.4	15.6	14.0	11.9	352.6	5.3	320.9	356.4	2.0
OO1	177.1	189.8	221.5	170.8	142.9	181.4	167.4	214.9	166.6
OQ2	0.2	351.0	346.7	274.3	59.9	50.6	337.5	308.1	49.8
MNS2	31.5	348.3	9.2	25.5	338.5	331.5	354.4	50.2	13.2
2N2	8.4	9.6	32.1	49.6	351.7	356.2	27.2	58.9	1.9
MU2	21.0	24.5	17.3	23.4	21.6	22.0	26.0	38.0	31.1
N2	35.6	34.3	35.0	35.2	35.3	36.1	33.2	32.1	31.8
NU2	43.4	30.0	33.1	43.4	34.7	35.0	32.3	38.5	39.3
OP2	345.3	219.2	182.4	202.3	237.9	356.8	196.2	323.7	239.2
M2	48.8	48.4	48.6	48.9	48.7	49.6	48.5	47.1	47.4
MKS2	69.4	276.1	7.3	202.9	267.0	62.2	181.3	99.0	170.9
LAM2	4.6	20.3	28.7	21.3	358.3	27.0	37.2	6.0	22.3
L2	27.8	44.0	30.6	39.2	25.8	43.0	43.1	34.4	30.5
T2	73.8	75.6	59.7	69.0	61.7	71.6	90.5	68.3	115.7
S2	75.9	74.4	74.3	74.8	75.1	75.5	74.3	74.5	73.9
R2	111.8	83.3	60.1	236.5	44.5	106.3	63.5	0.6	38.4
K2	65.7	66.5	67.1	66.5	65.9	67.4	67.1	66.1	63.1
MSN2	150.4	202.5	148.0	125.5	192.9	225.6	202.0	127.9	199.1
KJ2	287.1	267.6	268.6	275.3	319.2	283.9	306.2	278.0	272.5
2SM2	175.9	257.4	184.2	161.9	183.5	190.2	114.2	178.2	202.3
MO3	300.8	306.8	303.0	323.9	317.1	324.3	318.5	315.1	314.3
M3	137.0	136.5	156.5	216.1	236.8	238.8	235.7	167.1	154.0
SO3	38.8	6.7	38.3	22.9	15.9	1.8	5.6	1.2	27.1
MK3	34.7	36.7	42.5	50.5	45.3	60.3	38.5	42.7	41.9
SK3	97.3	48.1	47.6	64.9	61.8	97.8	78.2	68.8	87.3
MN4	121.7	114.1	128.0	120.1	117.9	119.1	122.3	117.3	113.8
M4	165.0	156.0	161.8	158.6	159.0	158.5	158.1	157.3	154.5
SN4	172.0	172.5	181.9	177.0	75.6	185.1	187.9	233.2	160.9
MS4	222.4	216.2	220.8	218.0	221.9	218.8	216.6	216.8	216.0
MK4	239.5	237.7	240.0	234.1	235.2	231.2	225.7	231.3	224.6
S4	35.6	69.5	356.2	55.7	10.3	93.0	78.0	82.3	57.6
SK4	48.9	52.2	346.6	40.9	347.3	21.0	352.9	327.0	351.2
2MN6	301.4	289.1	4.8	164.8	217.2	228.1	345.8	351.5	297.8
M6	108.6	333.9	4.4	320.7	269.5	284.5	8.0	304.3	267.5
MSN6	3.9	298.2	328.1	239.9	318.4	264.7	26.8	94.1	297.5
2MS6	179.1	166.4	24.9	208.9	255.8	210.3	242.4	242.9	181.7
2MK6	135.2	120.3	159.1	114.2	147.9	191.6	149.6	165.3	230.5
2SM6	139.6	294.5	353.2	332.1	344.3	19.0	331.8	323.5	339.4
MSK6	191.9	99.5	160.5	299.8	133.0	325.7	145.8	205.4	223.9
MA2	65.9	122.2	27.5	10.4	2.0	91.9	323.3	49.0	186.0
MB2	153.5	70.6	121.4	344.8	23.4	134.9	60.3	188.9	54.8

	Ceuta - Phase (º)								
	1972	**1973**	**1976**	**1977**	**1978**	**1980**	**1981**	**1984**	**1985**
ZO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SA	199.3	166.6	138.1	217.9	234.6	147.1	181.2	97.8	188.3
SSA	27.2	142.9	174.9	208.7	267.7	68.8	46.2	30.6	128.6
MM	157.4	154.9	241.0	119.5	57.4	265.1	180.6	283.5	233.3
MSF	145.0	289.3	100.5	244.6	123.5	303.7	184.8	279.7	33.1
MF	340.3	174.7	94.0	103.0	15.8	78.8	281.2	321.3	135.5
2Q1	171.4	179.1	286.5	31.0	253.5	131.5	151.6	257.7	267.4
SIG1	209.7	169.9	202.9	199.1	238.7	218.8	229.2	217.1	193.4
Q1	102.0	105.2	135.8	310.4	192.2	138.6	68.6	150.6	138.5
RO1	63.5	16.1	292.5	19.5	127.4	29.6	93.4	356.3	128.3
O1	100.0	95.5	105.1	106.2	103.7	104.9	98.3	105.7	104.6
MP1	294.3	9.9	132.9	283.2	305.7	307.3	313.4	316.4	301.6
M1	181.4	260.5	103.8	115.3	196.1	167.4	177.6	79.1	114.4
CHI1	260.7	307.2	2.6	166.9	262.4	341.1	240.7	305.5	79.7
PI1	207.1	165.7	83.2	209.6	127.1	349.9	91.5	104.3	159.6
P1	139.6	138.1	143.8	145.3	142.5	136.5	150.0	139.8	150.5
S1	39.9	62.8	69.1	45.8	13.5	19.2	86.4	29.6	46.4
K1	142.4	146.2	146.9	140.2	140.9	144.9	144.5	142.1	145.8
PSI1	13.4	329.8	264.6	269.7	28.1	312.8	317.4	29.0	257.0
PHI1	230.9	238.4	57.0	149.6	150.1	154.2	185.2	323.4	183.5
TH1	249.6	350.9	65.9	305.7	54.2	126.8	343.4	210.0	189.0
J1	155.1	101.5	44.3	245.3	323.9	210.3	215.2	300.3	175.3
SO1	345.6	331.4	332.0	293.5	342.8	314.8	346.5	344.9	330.7
OO1	196.7	208.3	117.9	194.7	151.2	178.8	259.8	314.3	170.7
OQ2	0.9	329.8	22.2	319.6	328.9	91.1	332.1	256.3	35.6
MNS2	337.6	37.2	50.0	0.2	16.7	340.0	5.7	28.6	345.9
2N2	4.2	25.0	14.4	15.3	28.0	7.6	2.5	34.7	347.8
MU2	29.7	26.1	46.4	27.5	17.3	356.3	37.1	14.4	24.7
N2	37.8	36.2	43.3	33.4	32.9	38.0	39.0	35.7	37.2
NU2	32.5	37.8	42.0	30.8	54.4	342.6	49.3	46.0	37.8
OP2	195.2	180.1	175.1	285.6	19.6	111.6	306.2	294.7	303.3
M2	49.8	49.3	51.9	48.2	47.1	52.6	52.0	47.9	50.2
MKS2	345.2	56.1	299.4	161.4	87.9	290.9	160.9	150.7	117.4
LAM2	31.7	53.6	12.7	159.2	5.1	157.1	24.9	16.6	21.3
L2	30.2	41.2	15.7	41.7	53.9	15.9	33.3	2.1	36.8
T2	87.7	91.0	100.4	74.3	65.7	70.5	119.4	71.9	91.0
S2	75.9	76.5	75.0	75.8	72.8	78.6	79.6	73.4	76.6
R2	34.4	57.6	139.1	304.9	26.7	56.5	47.2	112.4	42.5
K2	66.8	69.9	65.4	69.7	70.9	69.9	83.0	73.3	67.2
MSN2	220.4	209.1	188.3	262.7	235.7	134.0	146.7	183.0	224.8
KJ2	279.0	221.7	250.0	287.3	300.7	295.1	314.8	209.1	276.4
2SM2	171.6	211.4	142.4	168.7	206.1	95.2	240.1	169.1	169.1
MO3	314.1	325.7	321.3	318.9	318.0	307.8	306.5	304.3	321.1
M3	139.9	156.9	244.8	219.0	212.8	186.1	130.9	218.2	233.3
SO3	4.1	12.0	32.2	21.6	4.0	11.4	15.8	16.4	355.2
MK3	48.8	52.3	53.3	44.0	27.0	47.7	38.6	43.2	51.6
SK3	73.9	92.1	106.0	104.9	92.6	117.7	67.1	60.8	83.4
MN4	114.4	128.6	143.4	125.7	122.6	131.9	130.9	126.0	123.5
M4	159.8	159.4	169.8	164.5	158.6	167.5	170.9	157.7	158.8
SN4	158.7	174.7	178.0	181.9	164.1	145.8	189.2	230.7	158.7
MS4	224.4	224.3	221.4	222.6	217.1	220.7	232.1	216.9	223.8
MK4	238.9	244.1	238.3	237.5	239.8	224.0	265.3	236.7	235.3
S4	95.6	100.7	22.6	54.5	67.2	9.0	37.7	41.5	11.2
SK4	20.8	74.1	351.5	127.8	19.8	150.4	35.4	349.3	4.5
2MN6	269.6	343.4	317.5	225.6	321.3	69.3	275.6	173.4	226.3
M6	262.7	293.0	283.3	228.8	137.4	85.3	83.3	4.2	355.9
MSN6	299.5	24.6	342.0	284.9	10.8	331.2	307.6	327.9	265.2
2MS6	252.4	265.1	351.1	193.5	183.3	302.9	184.1	217.6	208.4
2MK6	168.5	187.7	114.4	35.6	130.1	149.3	159.7	113.2	155.7
2SM6	356.4	322.1	86.0	355.8	345.9	18.5	269.2	350.5	322.1
MSK6	173.6	246.6	141.4	6.2	16.0	76.5	122.5	4.3	232.0
MA2	77.5	130.5	256.4	346.8	48.9	114.2	183.3	36.4	79.4
MB2	88.0	100.3	43.4	33.5	170.9	170.6	95.2	86.3	92.3

	Ceuta - Phase (º)								
	1986	**1987**	**1989**	**1992**	**1993**	**1995**	**1996**	**1997**	**1998**
ZO	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SA	137.2	198.6	212.2	168.4	162.4	193.9	289.9	200.0	151.2
SSA	328.0	76.4	133.2	176.1	56.3	138.6	227.0	123.0	276.5
MM	64.4	261.8	242.2	6.2	294.7	261.7	261.2	195.3	22.7
MSF	246.0	343.5	79.8	197.5	160.0	234.4	51.8	210.9	319.6
MF	37.1	160.1	261.0	330.8	92.4	249.7	117.6	305.6	102.0
2Q1	241.3	165.5	251.9	192.6	259.1	124.4	166.4	58.3	196.5
SIG1	205.6	222.4	187.6	195.8	191.4	225.8	187.4	172.3	220.0
Q1	205.3	75.3	128.4	156.9	164.7	190.8	184.0	103.5	116.5
RO1	47.2	24.6	352.8	61.6	355.3	339.4	198.4	37.0	359.9
O1	101.8	106.5	100.9	106.8	100.5	97.4	97.6	95.3	101.7
MP1	312.6	235.4	254.7	234.4	293.4	300.6	255.0	241.7	284.3
M1	176.5	187.5	133.9	58.5	74.1	190.4	3.3	177.8	149.4
CHI1	213.5	76.8	216.8	169.8	86.1	215.6	244.4	153.4	5.0
PI1	179.0	241.8	136.1	138.2	127.5	136.7	108.2	135.7	185.3
P1	154.7	156.4	139.9	138.7	136.4	139.3	138.5	133.5	139.5
S1	66.9	90.6	62.7	354.7	347.6	18.2	96.2	26.3	38.3
K1	142.3	145.4	142.6	147.1	143.0	142.6	141.7	140.7	143.4
PSI1	359.8	308.2	257.1	288.4	309.2	281.3	345.8	308.3	303.1
PHI1	178.7	139.2	101.6	91.8	113.5	197.5	4.0	148.2	151.8
TH1	246.6	13.7	287.4	3.6	72.2	341.1	110.6	59.8	149.8
J1	120.1	245.6	143.1	28.1	21.7	344.8	305.1	233.0	235.2
SO1	23.7	323.0	344.1	318.6	359.7	12.2	333.7	335.8	336.3
OO1	225.6	181.8	220.8	172.1	105.1	96.9	11.2	82.2	103.5
OQ2	357.9	329.9	169.3	49.7	183.9	354.7	259.6	269.4	72.5
MNS2	11.9	21.7	63.4	33.6	28.2	358.1	22.3	19.3	11.2
2N2	16.7	28.0	6.5	30.7	12.3	12.7	32.9	29.2	17.2
MU2	26.0	25.6	16.7	33.6	39.9	27.4	31.3	32.6	29.2
N2	35.3	34.1	40.0	33.6	36.9	32.2	34.2	37.0	35.5
NU2	45.6	31.1	24.3	37.0	33.3	24.9	41.7	30.9	28.3
OP2	270.0	100.5	214.2	99.8	4.1	240.1	249.6	346.9	355.3
M2	49.0	49.5	49.5	50.1	49.7	48.3	49.3	49.3	49.2
MKS2	102.8	76.9	297.6	71.9	131.1	100.6	131.4	91.2	112.5
LAM2	340.6	70.9	336.3	18.0	2.9	6.8	21.7	22.6	357.6
L2	49.7	52.9	15.2	29.4	11.4	42.0	44.3	39.5	35.6
T2	89.8	73.8	98.7	91.7	89.2	90.0	89.5	91.5	81.6
S2	75.5	75.6	75.8	78.7	77.7	77.0	77.2	78.2	76.7
R2	49.9	116.8	41.8	65.9	61.8	70.7	107.2	86.8	33.3
K2	68.6	68.1	67.5	69.2	68.7	69.3	71.4	71.8	67.0
MSN2	251.5	180.3	162.8	225.4	218.5	223.2	192.1	209.4	223.0
KJ2	268.8	302.9	1.5	335.3	16.8	344.8	296.9	295.6	258.1
2SM2	195.6	108.3	45.5	295.8	241.8	143.0	216.1	226.1	199.8
MO3	316.0	316.3	306.0	317.0	318.7	310.7	305.7	295.1	300.7
M3	236.1	231.5	155.3	215.8	228.9	228.8	221.9	191.7	151.1
SO3	10.2	7.8	354.2	11.2	22.9	20.4	17.7	20.7	20.5
MK3	40.9	38.7	42.1	43.7	42.7	31.7	34.3	30.0	33.8
SK3	65.8	78.0	87.5	110.8	104.5	71.6	93.8	102.5	88.9
MN4	119.6	125.4	123.0	137.6	129.5	123.1	131.7	124.2	126.9
M4	157.5	164.6	157.1	165.3	161.9	156.7	167.3	161.6	163.2
SN4	178.6	191.9	186.3	261.7	198.7	204.3	209.3	209.1	150.1
MS4	217.4	224.2	218.2	223.7	218.4	218.3	222.4	219.6	217.7
MK4	234.6	234.4	236.2	242.6	238.7	225.3	243.3	216.4	236.4
S4	75.3	105.0	118.9	115.0	261.4	184.0	95.8	120.4	82.2
SK4	322.6	9.4	304.8	329.2	293.5	139.7	30.3	338.7	58.9
2MN6	257.5	0.9	240.6	84.5	43.6	356.7	26.0	9.8	92.1
M6	268.4	139.7	190.4	101.1	58.8	339.4	301.4	6.4	137.7
MSN6	55.8	134.3	253.3	205.1	226.8	334.5	84.0	139.6	286.4
2MS6	248.3	164.1	253.0	230.4	203.5	162.1	156.1	185.3	198.0
2MK6	86.6	120.0	120.6	121.7	113.9	83.9	107.4	87.9	124.9
2SM6	356.2	0.8	357.1	126.2	344.5	81.9	23.0	320.0	303.5
MSK6	139.5	213.0	186.1	265.8	137.7	110.6	175.5	239.3	114.8
MA2	120.6	70.1	126.6	161.7	90.8	116.3	71.9	75.6	105.6
MB2	82.3	73.5	92.6	62.1	69.4	101.2	58.7	99.0	72.9

	Ceuta - Phase (º)			
	1999	**2000**	**2001**	**2002**
ZO	0.0	0.0	0.0	0.0
SA	171.1	173.1	207.6	209.8
SSA	32.7	86.5	58.1	52.5
MM	238.9	22.5	263.7	173.0
MSF	268.2	23.5	254.8	144.4
MF	115.0	60.5	97.5	1.8
2Q1	240.9	22.9	176.2	199.3
SIG1	172.1	194.7	193.5	207.5
Q1	89.7	177.4	196.5	166.1
RO1	42.4	201.2	204.8	320.7
O1	104.8	102.6	105.2	102.3
MP1	313.9	240.6	330.0	258.5
M1	153.0	256.8	7.1	82.0
CHI1	96.2	264.9	221.6	233.1
PI1	150.7	191.9	135.1	172.0
P1	150.8	144.0	149.9	140.7
S1	34.6	47.2	19.9	10.0
K1	143.9	144.7	142.9	140.3
PSI1	301.6	283.1	304.7	320.4
PHI1	124.5	130.9	91.6	134.3
TH1	260.7	352.5	73.1	215.3
J1	206.9	4.1	75.9	246.0
SO1	345.5	326.5	338.1	347.8
OO1	161.3	133.9	229.0	187.9
OQ2	25.8	334.9	299.8	185.1
MNS2	29.7	45.0	16.0	18.0
2N2	4.9	13.5	41.2	41.3
MU2	29.7	33.3	27.5	25.8
N2	35.1	34.5	35.5	34.3
NU2	39.5	33.7	35.3	36.4
OP2	299.5	116.5	104.4	118.9
M2	49.3	49.0	48.5	48.1
MKS2	14.3	77.4	204.5	113.8
LAM2	15.3	355.6	355.7	4.4
L2	32.8	32.9	22.7	8.6
T2	83.4	105.9	83.2	80.3
S2	77.0	76.0	74.9	75.1
R2	68.4	62.6	73.7	75.6
K2	67.2	68.0	66.2	63.4
MSN2	238.6	149.8	219.1	137.8
KJ2	257.8	296.6	331.4	296.3
2SM2	210.5	193.6	204.8	211.9
MO3	304.1	305.6	312.9	311.7
M3	127.7	155.2	184.9	198.2
SO3	35.9	32.9	16.2	13.6
MK3	39.6	33.2	34.5	41.0
SK3	86.5	85.5	70.6	55.2
MN4	129.4	119.7	125.9	125.3
M4	163.2	162.2	156.8	155.9
SN4	183.4	200.1	223.6	175.6
MS4	222.2	216.6	216.4	218.3
MK4	240.0	239.2	229.7	230.1
S4	44.0	188.8	153.3	115.9
SK4	94.6	21.5	299.3	3.3
2MN6	290.0	298.6	77.4	161.4
M6	14.6	155.6	107.7	299.4
MSN6	348.4	92.6	101.1	137.8
2MS6	123.8	101.9	221.6	242.9
2MK6	116.1	144.7	124.8	111.2
2SM6	261.5	101.9	125.1	339.8
MSK6	58.4	197.2	83.8	112.1
MA2	139.2	127.1	60.7	121.5
MB2	83.8	72.8	75.4	103.9

APPENDIX A4: Tidal constituents from the observed data collected from 1987-1988 in the Ria de Aveiro Lagoon

The following tables show amplitude and phase values of all the tidal constituents obtained by harmonic analysis from the data collected during 1987-1988 in the Ria de Aveiro. Information (including dates) on the data used are given in Section 4.6 and Table 4.2.

	Amplitude (m)							
	Carregal	**Ribeira**	**Puxadouro**	**Pardilho**	**Manchao**	**CBico**	**Barra**	**Cnova**
MM	0.030	0.084	0.086	0.103	0.096	0.044	0.015	0.042
MSF	0.075	0.058	0.052	0.077	0.082	0.100	0.029	0.041
Q1	0.011	0.011	0.010	0.011	0.006	0.013	0.020	0.017
O1	0.035	0.037	0.033	0.035	0.031	0.044	0.053	0.048
M1	0.005	0.006	0.005	0.006	0.005	0.004	0.002	0.003
K1	0.043	0.037	0.037	0.038	0.036	0.046	0.060	0.061
J1	0.007	0.007	0.008	0.006	0.008	0.005	0.001	0.004
OO1	0.002	0.004	0.004	0.007	0.005	0.001	0.001	0.003
MU2	0.033	0.036	0.036	0.046	0.047	0.060	0.026	0.013
N2	0.050	0.038	0.039	0.041	0.034	0.097	0.202	0.173
M2	0.345	0.351	0.319	0.328	0.228	0.586	0.962	0.887
L2	0.007	0.005	0.010	0.014	0.018	0.045	0.030	0.038
S2	0.075	0.077	0.074	0.080	0.048	0.147	0.328	0.277
2SM2	0.018	0.022	0.018	0.018	0.023	0.018	0.003	0.008
MO3	0.013	0.011	0.011	0.009	0.010	0.013	0.004	0.009
M3	0.002	0.001	0.001	0.001	0.002	0.005	0.004	0.004
MK3	0.010	0.008	0.007	0.005	0.005	0.012	0.007	0.012
MN4	0.013	0.004	0.006	0.008	0.007	0.021	0.017	0.012
M4	0.066	0.050	0.048	0.035	0.034	0.054	0.040	0.041
SN4	0.004	0.006	0.007	0.004	0.003	0.008	0.003	0.012
MS4	0.033	0.025	0.026	0.019	0.021	0.035	0.019	0.013
2MN6	0.002	0.004	0.004	0.003	0.005	0.010	0.007	0.022
M6	0.003	0.010	0.009	0.010	0.008	0.021	0.009	0.040
MSN6	0.000	0.004	0.002	0.002	0.001	0.006	0.001	0.003
2MS6	0.002	0.006	0.009	0.008	0.009	0.019	0.006	0.023
2SM6	0.002	0.001	0.001	0.002	0.002	0.004	0.001	0.009
PI1	0.001	0.001	0.001	0.001	0.001		0.001	0.001
P1	0.014	0.012	0.012	0.013	0.012		0.020	0.020
PSI1	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.001
PHI1	0.001	0.001	0.001	0.001	0.001		0.001	0.001
2N2	0.007	0.005	0.005	0.006	0.005		0.027	0.023
NU2	0.010	0.007	0.008	0.008	0.007		0.039	0.034
T2	0.004	0.005	0.004	0.005	0.003	0.009	0.019	0.016
K2	0.020	0.021	0.020	0.022	0.013		0.089	0.075

	Amplitude (m)							
	Vagueira	**Areão**	**Lota**	**Rnovo**	**Cacia**	**Sacor**	**PCais2**	**Vista Alegre**
MM	0.096	0.052	0.080	0.047	0.148	0.023	0.046	0.052
MSF	0.118	0.075	0.121	0.195	0.122	0.040	0.075	0.140
Q1	0.006	0.003	0.013	0.018	0.017	0.018	0.017	0.014
O1	0.046	0.011	0.052	0.048	0.039	0.054	0.052	0.045
M1	0.005	0.004	0.001	0.002	0.005	0.001	0.001	0.000
K1	0.047	0.009	0.054	0.032	0.038	0.052	0.051	0.044
J1	0.006	0.002	0.003	0.005	0.004	0.001	0.002	0.002
OO1	0.002	0.003	0.005	0.006	0.008	0.003	0.004	0.006
MU2	0.025	0.005	0.048	0.072	0.062	0.018	0.020	0.093
N2	0.089	0.014	0.150	0.131	0.091	0.176	0.165	0.084
M2	0.489	0.037	0.834	0.631	0.580	0.871	0.839	0.504
L2	0.021	0.002	0.058	0.035	0.085	0.033	0.053	0.092
S2	0.136	0.021	0.241	0.171	0.170	0.300	0.256	0.124
2SM2	0.008	0.003	0.031	0.033	0.036	0.017	0.018	0.019
MO3	0.014	0.003	0.014	0.010	0.009	0.009	0.012	0.017
M3	0.007	0.001	0.002	0.001	0.001	0.004	0.003	0.007
MK3	0.018	0.003	0.007	0.010	0.007	0.013	0.007	0.010
MN4	0.047	0.005	0.027	0.016	0.014	0.018	0.021	0.007
M4	0.133	0.012	0.097	0.045	0.039	0.051	0.063	0.040
SN4	0.017	0.002	0.023	0.021	0.017	0.012	0.010	0.015
MS4	0.066	0.009	0.074	0.038	0.038	0.046	0.050	0.037
2MN6	0.013	0.002	0.016	0.012	0.009	0.009	0.014	0.006
M6	0.028	0.003	0.027	0.019	0.012	0.014	0.025	0.013
MSN6	0.008	0.002	0.016	0.012	0.006	0.009	0.008	0.009
2MS6	0.022	0.004	0.035	0.024	0.017	0.022	0.030	0.021
2SM6	0.004	0.001	0.013	0.007	0.007	0.006	0.007	0.007
PI1	0.001	0.000	0.001	0.001	0.001	0.001	0.001	0.001
P1	0.016	0.003	0.018	0.011	0.013	0.017	0.017	0.015
PSI1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
PHI1	0.001	0.000	0.001	0.000	0.001	0.001	0.001	0.001
2N2	0.012	0.002	0.020	0.017	0.012	0.023	0.022	0.011
NU2	0.017	0.003	0.029	0.025	0.018	0.034	0.032	0.016
T2	0.008	0.001	0.014	0.010	0.010	0.018	0.015	0.007
K2	0.037	0.006	0.066	0.047	0.046	0.082	0.070	0.034

	Amplitude (m)		
	CPedra	S.Jacinto	Torreira
MM	0.062	0.040	0.088
MSF	0.158	0.014	0.110
Q1	0.013	0.017	0.012
O1	0.050	0.048	0.038
M1	0.001	0.002	0.003
K1	0.043	0.056	0.036
J1	0.005	0.003	0.003
OO1	0.007	0.003	0.001
MU2	0.096	0.008	0.028
N2	0.075	0.174	0.088
M2	0.503	0.861	0.476
L2	0.092	0.044	0.039
S2	0.118	0.291	0.121
2SM2	0.028	0.003	0.006
MO3	0.017	0.008	0.006
M3	0.003	0.001	0.004
MK3	0.009	0.016	0.009
MN4	0.015	0.020	0.028
M4	0.050	0.048	0.057
SN4	0.012	0.009	0.009
MS4	0.039	0.027	0.027
2MN6	0.004	0.008	0.007
M6	0.019	0.013	0.007
MSN6	0.009	0.003	0.002
2MS6	0.025	0.009	0.005
2SM6	0.005	0.002	0.001
PI1	0.001	0.001	0.001
P1	0.014	0.019	0.012
PSI1	0.000	0.001	0.000
PHI1	0.001	0.001	0.001
2N2	0.010	0.023	0.012
NU2	0.015	0.034	0.017
T2	0.007	0.017	0.007
K2	0.032	0.079	0.033

	Phase (º)							
	Carregal	**Ribeira**	**Puxadouro**	**Pardilho**	**Manchao**	**CBico**	**Barra**	**Cnova**
MM	139.7	64.0	68.3	55.1	56.2	351.9	311.1	12.5
MSF	325.3	340.5	340.6	356.1	358.1	29.0	279.9	353.2
Q1	338.9	319.7	342.9	345.7	30.3	318.5	270.1	282.7
O1	60.3	56.1	63.4	64.6	92.0	22.2	319.7	332.7
M1	299.0	333.9	349.5	347.7	337.8	234.2	81.3	138.7
K1	155.8	156.2	160.0	167.2	184.9	123.2	61.3	78.5
J1	302.4	334.4	321.5	295.8	331.5	261.0	77.1	203.2
OO1	350.2	346.8	359.1	343.1	352.3	238.5	253.7	351.9
MU2	350.0	331.8	338.8	332.9	359.4	246.6	21.2	163.1
N2	189.3	189.3	194.3	199.3	267.2	128.6	61.6	81.1
M2	198.2	193.8	193.8	190.3	218.6	137.9	79.4	95.7
L2	220.6	234.9	241.8	234.7	264.0	149.2	92.3	87.6
S2	228.9	233.9	230.4	230.1	273.0	179.1	107.9	129.5
2SM2	47.0	38.4	38.1	30.9	59.0	1.8	335.5	286.5
MO3	116.1	105.1	103.9	69.8	111.1	1.7	188.3	260.3
M3	113.7	154.5	231.4	334.8	66.0	332.3	312.8	241.5
MK3	213.2	199.0	214.4	171.5	203.6	105.9	292.2	331.9
MN4	296.9	209.7	226.9	179.0	265.7	157.5	248.7	358.8
M4	308.7	293.0	290.6	254.9	300.4	164.4	262.1	342.5
SN4	269.0	344.7	333.3	339.2	337.1	250.6	103.0	160.8
MS4	317.3	306.3	303.6	264.4	310.6	201.2	307.4	28.9
2MN6	125.2	276.6	266.1	234.9	331.8	72.0	320.5	270.9
M6	91.4	306.1	328.5	261.8	357.2	95.3	332.4	281.8
MSN6	114.3	171.1	64.6	146.4	284.5	199.1	339.6	135.8
2MS6	132.4	297.1	348.5	271.9	4.1	128.5	355.5	309.3
2SM6	358.7	320.9	290.0	236.8	24.3	214.0	352.6	343.6
PI1	155.8	156.2	160.0	167.2	184.9		61.3	78.5
P1	155.8	156.2	160.0	167.2	184.9		61.3	78.5
PSI1	155.8	156.2	160.0	167.2	184.9	123.2	61.3	78.5
PHI1	155.8	156.2	160.0	167.2	184.9		61.3	78.5
2N2	189.3	189.3	194.3	199.3	267.2		61.6	81.1
NU2	189.3	189.3	194.3	199.3	267.2		61.6	81.1
T2	228.9	233.9	230.4	230.1	273.0	179.1	107.9	129.5
K2	228.9	233.9	230.4	230.1	273.0		107.9	129.5

	Phase (º)							
	Vagueira	**Areão**	**Lota**	**Rnovo**	**Cacia**	**Sacor**	**PCais2**	**Vista Alegre**
MM	31.9	21.6	6.7	276.9	13.1	265.4	281.2	330.2
MSF	15.9	41.1	44.4	47.1	23.8	121.0	20.5	15.9
Q1	324.7	57.6	280.7	304.7	288.2	277.8	285.3	312.4
O1	15.6	108.9	338.0	359.0	4.1	334.0	340.0	24.7
M1	158.6	149.9	168.4	148.3	208.2	86.1	126.4	87.4
K1	108.5	190.3	69.3	99.2	93.5	97.1	87.6	128.6
J1	245.1	351.5	180.4	259.5	263.5	259.8	223.7	263.9
OO1	315.2	280.3	301.1	246.8	242.3	120.9	303.9	335.4
MU2	258.9	209.3	192.6	213.2	237.7	152.3	218.7	284.0
N2	117.4	210.3	91.0	96.4	108.7	74.6	78.8	118.0
M2	129.7	238.4	103.4	117.6	126.7	91.4	98.6	145.2
L2	105.9	20.3	145.6	127.2	157.8	122.6	138.0	178.8
S2	160.3	277.5	135.4	150.7	164.3	121.7	129.6	193.2
2SM2	315.8	296.9	311.0	330.7	349.7	341.3	282.1	344.0
MO3	42.3	274.5	248.7	305.2	319.5	252.8	255.8	342.2
M3	3.9	160.2	43.5	169.0	174.7	251.0	353.9	142.3
MK3	146.1	315.9	338.9	80.8	77.2	25.5	354.5	84.7
MN4	205.2	355.4	0.3	29.3	89.8	341.3	340.1	116.9
M4	205.4	25.7	7.7	67.7	78.1	353.7	9.3	153.2
SN4	129.1	0.0	48.2	119.9	180.1	55.5	53.8	248.4
MS4	220.8	36.6	32.6	93.0	121.7	34.6	26.8	191.6
2MN6	256.0	153.1	296.6	356.4	41.8	278.9	278.7	23.3
M6	266.0	168.2	297.5	43.4	90.1	303.9	307.6	121.3
MSN6	230.6	168.3	320.7	64.6	123.1	339.2	324.8	172.4
2MS6	275.8	196.0	314.6	55.0	102.1	334.8	314.4	139.0
2SM6	299.0	217.9	14.3	109.7	148.4	29.3	352.0	183.1
PI1	108.5	190.3	69.3	99.2	93.5	97.1	87.6	128.6
P1	108.5	190.3	69.3	99.2	93.5	97.1	87.6	128.6
PSI1	108.5	190.3	69.3	99.2	93.5	97.1	87.6	128.6
PHI1	108.5	190.3	69.3	99.2	93.5	97.1	87.6	128.6
2N2	117.4	210.3	91.0	96.4	108.7	74.6	78.8	118.0
NU2	117.4	210.3	91.0	96.4	108.7	74.6	78.8	118.0
T2	160.3	277.5	135.4	150.7	164.3	121.7	129.6	193.2
K2	160.3	277.5	135.4	150.7	164.3	121.7	129.6	193.2

	Phase (º)		
	CPedra	**S.Jacinto**	**Torreira**
MM	325.0	16.9	3.3
MSF	17.5	4.6	42.6
Q1	327.0	279.5	324.1
O1	35.8	333.5	20.8
M1	216.8	144.1	204.3
K1	142.0	76.0	125.8
J1	266.4	260.9	292.5
OO1	332.4	169.1	150.9
MU2	286.5	51.0	244.2
N2	135.0	75.8	125.3
M2	159.1	90.8	140.3
L2	187.3	103.9	155.9
S2	211.2	119.2	178.8
2SM2	2.3	18.7	72.7
MO3	3.8	254.6	39.2
M3	120.8	219.7	351.5
MK3	99.8	352.5	144.0
MN4	145.4	328.0	197.3
M4	168.5	344.3	214.5
SN4	236.6	111.4	44.8
MS4	193.1	35.3	258.2
2MN6	85.5	308.5	64.5
M6	160.7	323.8	78.9
MSN6	201.3	45.0	239.6
2MS6	179.6	357.2	149.5
2SM6	231.9	59.2	196.8
PI1	142.0	76.0	125.8
P1	142.0	76.0	125.8
PSI1	142.0	76.0	125.8
PHI1	142.0	76.0	125.8
2N2	135.0	75.8	125.3
NU2	135.0	75.8	125.3
T2	211.2	119.2	178.8
K2	211.2	119.2	178.8

APPENDIX A5: Tidal constituents from the observed data collected from 2002-2004 in the Ria de Aveiro Lagoon

The following tables show amplitude and phase values of all tidal constituents obtained by harmonic analysis from the data collected during 2002-2004 in the Ria de Aveiro. Information (including dates) on the data used are given in Section 4.6 and Table 4.2.

	Amplitude (m)							
	Carregal	Ovar	Puxadouro	Pardilho	Manchao	Laranjo (CBico)	Barra 9-02	Barra 1-03
MM	0.042	0.064	0.021	0.074	0.047	0.032	0.017	0.015
MSF	0.163	0.135	0.160	0.180	0.169	0.115	0.043	0.027
Q1	0.009	0.011	0.008	0.014	0.011	0.008	0.021	0.016
O1	0.055	0.054	0.047	0.064	0.046	0.054	0.054	0.051
M1	0.008	0.009	0.009	0.013	0.007	0.006	0.004	0.001
K1	0.052	0.059	0.054	0.039	0.057	0.045	0.056	0.055
J1	0.009	0.013	0.011	0.006	0.006	0.005	0.007	0.003
OO1	0.011	0.005	0.009	0.007	0.007	0.004	0.004	0.002
MU2	0.133	0.088	0.105	0.123	0.107	0.051	0.043	0.033
N2	0.131	0.113	0.113	0.127	0.134	0.158	0.180	0.204
M2	0.530	0.516	0.493	0.541	0.608	0.863	0.979	0.941
L2	0.113	0.096	0.106	0.113	0.117	0.072	0.052	0.010
S2	0.145	0.136	0.114	0.148	0.152	0.206	0.338	0.326
2SM2	0.054	0.036	0.033	0.056	0.045	0.016	0.001	0.004
MO3	0.025	0.012	0.018	0.027	0.023	0.017	0.001	0.004
M3	0.012	0.006	0.006	0.013	0.008	0.008	0.004	0.004
MK3	0.011	0.007	0.010	0.006	0.007	0.025	0.003	0.006
MN4	0.025	0.027	0.030	0.029	0.028	0.021	0.015	0.011
M4	0.066	0.054	0.061	0.068	0.075	0.078	0.039	0.042
SN4	0.024	0.013	0.021	0.023	0.021	0.028	0.005	0.003
MS4	0.052	0.024	0.036	0.056	0.056	0.035	0.031	0.028
2MN6	0.011	0.007	0.009	0.013	0.013	0.021	0.009	0.001
M6	0.025	0.009	0.015	0.029	0.020	0.050	0.006	0.005
MSN6	0.010	0.012	0.013	0.008	0.004	0.026	0.005	0.003
2MS6	0.026	0.004	0.016	0.030	0.026	0.030	0.006	0.005
2SM6	0.011	0.002	0.000	0.012	0.010	0.006	0.002	0.003
PI1	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
P1	0.017	0.019	0.018	0.013	0.019	0.015	0.019	0.018
PSI1	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.000
PHI1	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
2N2	0.017	0.015	0.015	0.017	0.018	0.021	0.024	0.027
NU2	0.025	0.022	0.022	0.025	0.026	0.031	0.035	0.040
T2	0.009	0.008	0.007	0.009	0.009	0.012	0.020	0.019
K2	0.039	0.037	0.031	0.040	0.041	0.056	0.092	0.089

	Amplitude (m)						
	Barra 3-03	**Barra 5-03**	**Barra 8-03**	**CNova 5-03**	**Vagueira 5-03**	**Areão 11-02**	**Areão 5-03**
MM	0.009	0.013	0.009	0.068	0.386	0.026	0.101
MSF	0.047	0.006	0.020	0.022	0.121	0.051	0.077
Q1	0.019	0.019	0.018	0.013	0.013	0.009	0.009
O1	0.055	0.055	0.055	0.059	0.046	0.049	0.032
M1	0.005	0.004	0.002	0.007	0.011	0.002	0.005
K1	0.053	0.066	0.068	0.066	0.034	0.051	0.026
J1	0.003	0.002	0.001	0.006	0.006	0.005	0.006
OO1	0.003	0.001	0.001	0.006	0.009	0.001	0.004
MU2	0.028	0.035	0.023	0.020	0.020	0.027	0.007
N2	0.202	0.207	0.202	0.205	0.151	0.085	0.068
M2	0.964	0.999	0.988	0.990	0.851	0.519	0.432
L2	0.027	0.027	0.023	0.042	0.080	0.073	0.054
S2	0.323	0.331	0.339	0.318	0.229	0.137	0.121
2SM2	0.001	0.003	0.004	0.014	0.016	0.008	0.001
MO3	0.002	0.004	0.004	0.005	0.006	0.015	0.011
M3	0.004	0.004	0.004	0.002	0.004	0.002	0.011
MK3	0.003	0.003	0.003	0.005	0.010	0.008	0.025
MN4	0.016	0.014	0.014	0.015	0.026	0.045	0.055
M4	0.036	0.038	0.038	0.040	0.040	0.118	0.127
SN4	0.003	0.003	0.003	0.009	0.024	0.030	0.017
MS4	0.030	0.028	0.029	0.020	0.036	0.052	0.062
2MN6	0.003	0.004	0.004	0.011	0.017	0.014	0.026
M6	0.005	0.007	0.007	0.021	0.028	0.021	0.034
MSN6	0.003	0.003	0.003	0.005	0.014	0.012	0.004
2MS6	0.005	0.009	0.009	0.017	0.022	0.013	0.025
2SM6	0.002	0.003	0.003	0.004	0.003	0.003	0.005
PI1	0.001	0.001	0.001	0.001	0.001	0.001	0.000
P1	0.017	0.022	0.022	0.022	0.011	0.017	0.009
PSI1	0.000	0.001	0.001	0.001	0.000	0.000	0.000
PHI1	0.001	0.001	0.001	0.001	0.000	0.001	0.000
2N2	0.027	0.028	0.027	0.027	0.020	0.011	0.009
NU2	0.039	0.040	0.039	0.040	0.029	0.017	0.013
T2	0.019	0.020	0.020	0.019	0.013	0.008	0.007
K2	0.088	0.090	0.092	0.086	0.062	0.037	0.033

	Amplitude (m)							
	Lota	**RNovo**	**Cacia**	**Cires (Sacor)**	**PCais2**	**Vista Alegre**	**CPedra**	**S.Jacinto**
MM	0.103	0.072	0.344	0.145	0.009	0.122	0.122	0.072
MSF	0.063	0.083	0.161	0.102	0.053	0.150	0.118	0.032
Q1	0.016	0.012	0.015	0.020	0.012	0.024	0.015	0.019
O1	0.051	0.048	0.040	0.053	0.055	0.058	0.059	0.053
M1	0.006	0.004	0.003	0.006	0.002	0.012	0.005	0.003
K1	0.029	0.044	0.042	0.067	0.067	0.041	0.056	0.060
J1	0.006	0.002	0.006	0.009	0.003	0.007	0.007	0.001
OO1	0.008	0.005	0.006	0.003	0.001	0.011	0.004	0.002
MU2	0.033	0.056	0.054	0.033	0.037	0.112	0.125	0.024
N2	0.198	0.170	0.171	0.186	0.184	0.123	0.137	0.187
M2	0.918	0.794	0.685	1.019	0.969	0.639	0.625	0.944
L2	0.062	0.078	0.039	0.034	0.018	0.107	0.087	0.034
S2	0.291	0.237	0.194	0.319	0.311	0.165	0.160	0.300
2SM2	0.019	0.029	0.023	0.016	0.016	0.049	0.037	0.005
MO3	0.010	0.012	0.007	0.012	0.012	0.019	0.026	0.007
M3	0.004	0.003	0.005	0.007	0.004	0.011	0.006	0.001
MK3	0.007	0.007	0.007	0.017	0.018	0.012	0.019	0.010
MN4	0.048	0.041	0.029	0.023	0.026	0.035	0.039	0.017
M4	0.090	0.066	0.040	0.067	0.085	0.050	0.075	0.049
SN4	0.014	0.021	0.019	0.009	0.009	0.014	0.008	0.012
MS4	0.082	0.063	0.038	0.054	0.065	0.047	0.063	0.025
2MN6	0.019	0.021	0.013	0.005	0.010	0.017	0.020	0.007
M6	0.027	0.026	0.017	0.009	0.022	0.021	0.023	0.009
MSN6	0.013	0.016	0.013	0.003	0.008	0.014	0.012	0.002
2MS6	0.035	0.031	0.023	0.012	0.026	0.022	0.030	0.007
2SM6	0.014	0.011	0.008	0.004	0.009	0.019	0.014	0.002
PI1	0.000	0.001	0.001	0.001	0.001	0.001	0.001	0.001
P1	0.009	0.014	0.014	0.022	0.022	0.013	0.018	0.020
PSI1	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000
PHI1	0.000	0.001	0.001	0.001	0.001	0.001	0.001	0.001
2N2	0.026	0.023	0.023	0.025	0.024	0.016	0.018	0.025
NU2	0.038	0.033	0.033	0.036	0.036	0.024	0.027	0.036
T2	0.017	0.014	0.011	0.019	0.018	0.010	0.009	0.018
K2	0.079	0.065	0.053	0.087	0.085	0.045	0.043	0.082

	Amplitude (cm)		
	Torreira 6-03	**Torreira 8-03**	**Torreira 1-04**
MM	0.049	0.059	0.036
MSF	0.081	0.128	0.097
Q1	0.011	0.014	0.009
O1	0.048	0.049	0.048
M1	0.006	0.004	0.007
K1	0.053	0.054	0.052
J1	0.008	0.005	0.004
OO1	0.002	0.001	0.005
MU2	0.050	0.069	0.080
N2	0.106	0.132	0.110
M2	0.751	0.716	0.700
L2	0.057	0.060	0.025
S2	0.170	0.179	0.176
2SM2	0.012	0.019	0.025
MO3	0.013	0.012	0.010
M3	0.007	0.007	0.008
MK3	0.019	0.011	0.011
MN4	0.021	0.023	0.020
M4	0.057	0.052	0.050
SN4	0.012	0.008	0.010
MS4	0.028	0.037	0.042
2MN6	0.004	0.011	0.005
M6	0.021	0.018	0.014
MSN6	0.008	0.004	0.006
2MS6	0.010	0.018	0.017
2SM6	0.001	0.003	0.005
PI1	0.001	0.001	0.001
P1	0.018	0.018	0.017
PSI1	0.000	0.000	0.000
PHI1	0.001	0.001	0.001
2N2	0.014	0.017	0.015
NU2	0.021	0.026	0.021
T2	0.010	0.011	0.010
K2	0.046	0.049	0.048

	Phase (º)							
	Carregal	Ovar	Puxadouro	Pardilho	Manchao	Laranjo (CBico)	Barra 9-02	Barra 1-03
MM	105.9	103.2	266.6	295.9	135.5	263.4	179.3	213.7
MSF	17.5	18.6	27.4	28.6	17.5	17.9	229.7	152.2
Q1	344.4	353.0	349.4	6.2	316.3	293.3	256.1	251.3
O1	57.7	49.7	51.5	24.0	19.2	18.1	323.9	319.1
M1	63.9	50.8	50.2	38.5	24.3	99.1	48.8	0.1
K1	128.4	103.6	134.3	92.1	118.0	96.8	65.4	70.4
J1	314.4	292.7	315.6	313.6	273.1	275.4	73.7	63.4
OO1	263.8	265.5	283.6	268.8	272.0	90.8	323.6	133.1
MU2	288.8	282.2	295.3	284.5	259.5	202.5	16.8	61.8
N2	148.9	144.6	147.9	145.8	114.2	109.8	62.3	62.9
M2	168.8	165.1	164.8	163.7	130.1	120.0	76.0	78.8
L2	156.4	148.5	153.8	151.9	116.5	118.5	65.5	72.8
S2	229.9	212.9	218.4	224.3	178.6	171.5	102.2	107.6
2SM2	9.9	352.8	20.6	8.0	338.5	329.4	284.9	5.4
MO3	12.0	29.1	50.4	8.8	342.9	296.3	231.9	174.7
M3	287.0	290.6	321.1	267.0	255.4	287.5	271.8	299.6
MK3	105.4	88.0	157.8	44.0	86.6	28.6	334.7	278.8
MN4	132.0	239.7	236.2	107.0	118.2	36.9	226.9	245.5
M4	163.3	246.9	242.9	141.7	140.0	39.3	253.3	252.5
SN4	269.3	344.3	338.7	249.2	235.6	119.6	309.8	257.0
MS4	187.1	275.8	280.6	167.9	165.3	108.6	286.8	313.5
2MN6	158.6	267.1	262.9	109.9	12.9	337.0	314.9	301.0
M6	192.7	271.2	285.3	154.0	92.8	359.3	331.4	302.0
MSN6	280.0	1.6	352.7	226.4	135.8	70.2	23.6	323.9
2MS6	197.9	299.0	296.3	155.7	100.2	46.0	338.4	330.4
2SM6	233.8	244.7	308.7	201.5	193.5	110.3	263.6	352.5
PI1	128.4	103.6	134.3	92.1	118.0	96.8	65.4	70.4
P1	128.4	103.6	134.3	92.1	118.0	96.8	65.4	70.4
PSI1	128.4	103.6	134.3	92.1	118.0	96.8	65.4	70.4
PHI1	128.4	103.6	134.3	92.1	118.0	96.8	65.4	70.4
2N2	148.9	144.6	147.9	145.8	114.2	109.8	62.3	62.9
NU2	148.9	144.6	147.9	145.8	114.2	109.8	62.3	62.9
T2	229.9	212.9	218.4	224.3	178.6	171.5	102.2	107.6
K2	229.9	212.9	218.4	224.3	178.6	171.5	102.2	107.6

	Phase (º)						
	Barra 3-03	**Barra 5-03**	**Barra 8-03**	**CNova 5-03**	**Vagueira 5-03**	**Areão 11-02**	**Areão 5-03**
MM	341.3	255.3	224.5	113.9	7.0	0.0	19.8
MSF	234.3	195.0	152.1	10.5	349.2	359.7	9.3
Q1	270.0	249.0	263.2	248.6	302.1	309.5	315.6
O1	322.0	319.5	321.6	328.7	352.9	13.9	19.0
M1	16.8	26.1	30.2	29.2	57.8	18.0	91.7
K1	55.4	58.7	67.3	67.7	68.4	99.7	191.8
J1	39.2	353.1	34.6	26.4	275.5	243.7	229.3
OO1	266.7	192.6	28.9	298.3	299.2	355.9	248.7
MU2	3.8	39.0	34.9	67.6	196.8	219.8	189.4
N2	61.7	59.8	62.2	70.0	93.3	126.7	127.7
M2	79.0	78.1	79.0	87.5	107.5	130.4	136.5
L2	76.0	100.7	72.3	72.1	91.0	138.7	132.9
S2	106.2	106.1	105.4	117.9	145.1	180.9	181.1
2SM2	202.6	308.9	280.1	256.7	286.8	28.6	171.4
MO3	163.9	181.7	183.3	194.6	314.3	35.9	78.4
M3	293.0	302.0	298.3	183.6	311.8	345.2	41.0
MK3	257.9	279.6	308.9	255.0	71.5	180.1	192.3
MN4	246.3	231.1	253.3	281.2	129.9	193.0	219.8
M4	255.9	256.8	260.2	303.2	138.5	217.7	241.3
SN4	18.4	336.3	292.1	44.4	148.3	267.9	14.7
MS4	298.3	301.6	301.0	335.1	157.9	238.3	255.0
2MN6	296.1	289.2	316.0	215.8	278.8	260.9	298.2
M6	302.3	311.5	307.6	235.6	311.4	296.0	323.5
MSN6	319.0	337.5	316.6	278.3	87.3	312.3	39.5
2MS6	322.7	324.9	328.4	253.8	337.6	315.8	330.8
2SM6	347.5	337.5	355.5	292.3	67.2	335.3	304.4
PI1	55.4	58.7	67.3	67.7	68.4	99.7	191.8
P1	55.4	58.7	67.3	67.7	68.4	99.7	191.8
PSI1	55.4	58.7	67.3	67.7	68.4	99.7	191.8
PHI1	55.4	58.7	67.3	67.7	68.4	99.7	191.8
2N2	61.7	59.8	62.2	70.0	93.3	126.7	127.7
NU2	61.7	59.8	62.2	70.0	93.3	126.7	127.7
T2	106.2	106.1	105.4	117.9	145.1	180.9	181.1
K2	106.2	106.1	105.4	117.9	145.1	180.9	181.1

	Phase (º)							
	Lota	**RNovo**	**Cacia**	**Cires (Sacor)**	**PCais2**	**Vista Alegre**	**CPedra**	**S.Jacinto**
MM	92.7	53.0	118.2	162.4	129.5	7.9	10.9	332.7
MSF	53.6	28.3	61.4	343.6	34.9	40.8	37.8	75.8
Q1	275.4	290.7	306.3	266.2	271.6	309.7	353.8	259.6
O1	351.3	350.4	0.4	331.6	339.8	22.2	34.7	328.2
M1	51.2	51.6	11.3	49.6	53.3	102.9	84.9	79.5
K1	96.4	84.1	142.8	53.7	79.8	109.4	146.3	72.6
J1	70.1	46.3	70.5	294.7	315.1	347.3	236.2	266.5
OO1	227.5	216.4	178.3	283.9	175.2	288.3	228.1	107.0
MU2	182.9	207.0	219.7	188.0	157.1	254.2	244.7	57.3
N2	90.9	102.5	109.0	69.6	79.3	116.6	152.9	69.8
M2	100.5	108.4	119.7	90.1	93.3	135.7	147.2	87.8
L2	59.6	38.0	66.3	64.5	60.2	98.1	71.9	95.6
S2	131.8	142.1	158.3	116.8	125.3	170.0	192.9	118.0
2SM2	334.8	329.2	343.5	323.0	320.4	341.9	7.6	337.4
MO3	246.6	274.1	313.4	219.7	236.6	324.4	347.3	227.4
M3	277.4	289.6	1.5	233.7	273.0	249.4	286.4	299.1
MK3	11.5	38.7	83.9	347.5	3.5	84.3	119.5	311.9
MN4	342.9	15.2	35.7	334.4	338.6	99.4	119.0	288.2
M4	341.3	21.6	49.9	328.5	330.4	117.9	118.1	309.3
SN4	112.3	122.3	141.6	358.3	348.0	285.6	256.9	10.9
MS4	20.8	57.1	97.6	18.0	25.6	142.8	163.6	349.0
2MN6	268.2	321.2	3.6	276.0	257.4	85.7	94.0	281.7
M6	273.9	342.3	22.7	276.6	267.8	35.5	102.6	290.8
MSN6	318.6	22.8	66.5	315.8	293.9	100.9	180.0	283.0
2MS6	309.9	12.0	65.8	323.6	308.9	106.2	143.1	312.9
2SM6	344.2	51.3	116.6	23.2	17.1	130.3	221.7	339.1
PI1	96.4	84.1	142.8	53.7	79.8	109.4	146.3	72.6
P1	96.4	84.1	142.8	53.7	79.8	109.4	146.3	72.6
PSI1	96.4	84.1	142.8	53.7	79.8	109.4	146.3	72.6
PHI1	96.4	84.1	142.8	53.7	79.8	109.4	146.3	72.6
2N2	90.9	102.5	109.0	69.6	79.3	116.6	152.9	69.8
NU2	90.9	102.5	109.0	69.6	79.3	116.6	152.9	69.8
T2	131.8	142.1	158.3	116.8	125.3	170.0	192.9	118.0
K2	131.8	142.1	158.3	116.8	125.3	170.0	192.9	118.0

	Phase (º)		
	Torreira 6-03	Torreira 8-03	Torreira 1-04
MM	20.2	7.2	333.8
MSF	40.7	37.9	38.8
Q1	289.5	306.6	310.1
O1	13.4	9.9	8.7
M1	79.9	95.3	91.5
K1	109.5	109.3	125.3
J1	260.3	252.8	277.9
OO1	152.9	282.5	211.9
MU2	222.2	243.1	224.4
N2	115.9	120.0	120.3
M2	126.8	128.0	129.8
L2	129.2	97.4	130.7
S2	174.1	167.1	172.4
2SM2	19.0	339.9	16.4
MO3	345.6	352.0	2.2
M3	329.5	317.4	330.9
MK3	90.5	99.2	126.8
MN4	146.7	140.7	149.8
M4	145.3	149.3	159.6
SN4	199.4	222.8	216.0
MS4	206.5	184.1	208.2
2MN6	17.8	51.6	62.5
M6	50.9	56.7	62.7
MSN6	132.9	139.2	125.5
2MS6	106.9	87.7	118.9
2SM6	305.8	152.0	220.5
PI1	109.5	109.3	125.3
P1	109.5	109.3	125.3
PSI1	109.5	109.3	125.3
PHI1	109.5	109.3	125.3
2N2	115.9	120.0	120.3
NU2	115.9	120.0	120.3
T2	174.1	167.1	172.4
K2	174.1	167.1	172.4

APPENDIX A6: 2DH Model – 1987/8 and 2003 Tidal Constituents Results

2DH Model results for the tidal harmonic analysis of the data, from 18 stations throughout the Ria de Aveiro Lagoon. Amplitude and phase are given, for both the 1987/8 and 2003 runs.

	1987/8 Amplitude (m)							
	Carregal	**Ovar**	**Puxadouro**	**Pardilho**	**Manchao**	**CBico**	**CNova**	**Vagueira**
Z0	2.456	2.438	2.430	2.429	2.431	2.255	2.058	2.314
MM	0.048	0.079	0.081	0.086	0.083	0.063	0.023	0.067
MSF	0.101	0.094	0.075	0.079	0.077	0.078	0.039	0.094
Q1	0.012	0.010	0.009	0.008	0.008	0.016	0.019	0.007
O1	0.040	0.039	0.040	0.040	0.038	0.044	0.051	0.045
M1	0.002	0.001	0.001	0.000	0.001	0.003	0.002	0.003
K1	0.040	0.041	0.040	0.041	0.038	0.050	0.059	0.042
J1	0.003	0.003	0.003	0.003	0.002	0.003	0.001	0.006
OO1	0.003	0.002	0.002	0.003	0.002	0.001	0.001	0.002
MU2	0.030	0.026	0.019	0.027	0.018	0.014	0.015	0.015
N2	0.067	0.067	0.061	0.065	0.054	0.125	0.195	0.114
M2	0.415	0.411	0.373	0.406	0.336	0.617	0.939	0.598
L2	0.010	0.009	0.012	0.011	0.012	0.041	0.032	0.029
S2	0.108	0.111	0.099	0.108	0.088	0.183	0.314	0.177
2SM2	0.005	0.005	0.007	0.005	0.008	0.011	0.003	0.008
MO3	0.008	0.008	0.012	0.007	0.011	0.009	0.006	0.011
M3	0.002	0.003	0.002	0.003	0.002	0.007	0.004	0.007
MK3	0.005	0.005	0.010	0.006	0.010	0.016	0.010	0.011
MN4	0.016	0.016	0.019	0.015	0.017	0.048	0.016	0.039
M4	0.059	0.058	0.089	0.056	0.077	0.105	0.038	0.122
SN4	0.008	0.008	0.006	0.008	0.007	0.010	0.004	0.018
MS4	0.042	0.039	0.055	0.037	0.047	0.047	0.015	0.054
2MN6	0.004	0.003	0.007	0.004	0.008	0.006	0.008	0.023
M6	0.017	0.017	0.025	0.015	0.022	0.006	0.014	0.035
MSN6	0.004	0.005	0.006	0.004	0.005	0.005	0.003	0.006
2MS6	0.016	0.016	0.024	0.013	0.020	0.004	0.009	0.020
2SM6	0.003	0.003	0.006	0.002	0.006	0.001	0.002	0.004
PI1	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
P1	0.013	0.013	0.013	0.014	0.013	0.017	0.020	0.014
PSI1	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.000
PHI1	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
2N2	0.009	0.009	0.008	0.009	0.007	0.017	0.026	0.015
NU2	0.013	0.013	0.012	0.013	0.010	0.024	0.038	0.022
T2	0.006	0.007	0.006	0.006	0.005	0.011	0.019	0.010
K2	0.030	0.030	0.027	0.029	0.024	0.050	0.085	0.048

	1987/8 Amplitude (m)							
	Areao	**Lota**	**RNovo**	**Cacia**	**Sacor**	**PCais2**	**Vista Alegre**	**CPedra**
Z0	2.375	2.073	2.242	2.240	2.119	2.274	2.286	2.335
MM	0.079	0.046	0.058	0.063	0.031	0.049	0.042	0.038
MSF	0.111	0.014	0.136	0.120	0.008	0.033	0.034	0.075
Q1	0.006	0.021	0.017	0.018	0.020	0.014	0.014	0.013
O1	0.034	0.055	0.041	0.041	0.050	0.048	0.051	0.045
M1	0.003	0.000	0.004	0.004	0.002	0.002	0.002	0.002
K1	0.031	0.061	0.046	0.046	0.060	0.049	0.041	0.045
J1	0.005	0.003	0.003	0.005	0.001	0.003	0.005	0.004
OO1	0.001	0.001	0.003	0.003	0.001	0.003	0.006	0.003
MU2	0.007	0.017	0.016	0.021	0.019	0.017	0.018	0.032
N2	0.052	0.196	0.119	0.123	0.190	0.137	0.130	0.109
M2	0.276	0.935	0.609	0.606	0.918	0.711	0.660	0.577
L2	0.010	0.028	0.031	0.026	0.037	0.069	0.065	0.075
S2	0.079	0.315	0.186	0.182	0.318	0.224	0.203	0.164
2SM2	0.004	0.010	0.005	0.008	0.005	0.021	0.019	0.015
MO3	0.006	0.003	0.015	0.015	0.005	0.004	0.006	0.007
M3	0.003	0.004	0.002	0.004	0.002	0.004	0.003	0.002
MK3	0.007	0.003	0.007	0.010	0.011	0.006	0.004	0.005
MN4	0.020	0.014	0.052	0.050	0.022	0.003	0.005	0.028
M4	0.058	0.050	0.108	0.117	0.052	0.023	0.009	0.063
SN4	0.008	0.009	0.010	0.011	0.009	0.010	0.010	0.011
MS4	0.029	0.047	0.091	0.093	0.024	0.018	0.010	0.050
2MN6	0.003	0.008	0.013	0.013	0.011	0.010	0.019	0.008
M6	0.007	0.015	0.016	0.018	0.016	0.017	0.029	0.008
MSN6	0.003	0.006	0.004	0.005	0.002	0.011	0.010	0.000
2MS6	0.006	0.019	0.023	0.025	0.010	0.022	0.036	0.008
2SM6	0.002	0.006	0.005	0.004	0.002	0.006	0.007	0.003
PI1	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
P1	0.010	0.020	0.015	0.015	0.020	0.016	0.013	0.015
PSI1	0.000	0.001	0.000	0.000	0.001	0.000	0.000	0.000
PHI1	0.000	0.001	0.001	0.001	0.001	0.001	0.001	0.001
2N2	0.007	0.026	0.016	0.016	0.025	0.018	0.017	0.015
NU2	0.010	0.038	0.023	0.024	0.037	0.027	0.025	0.021
T2	0.005	0.019	0.011	0.011	0.019	0.013	0.012	0.010
K2	0.022	0.086	0.051	0.050	0.087	0.061	0.055	0.045

	1987/8 Amplitude (m)	
	S. Jacinto	Torreira
Z0	2.124	2.312
MM	0.020	0.082
MSF	0.019	0.072
Q1	0.020	0.014
O1	0.048	0.041
M1	0.002	0.003
K1	0.059	0.046
J1	0.002	0.005
OO1	0.001	0.002
MU2	0.021	0.015
N2	0.188	0.097
M2	0.903	0.478
L2	0.041	0.031
S2	0.317	0.141
2SM2	0.005	0.008
MO3	0.007	0.004
M3	0.002	0.004
MK3	0.013	0.009
MN4	0.026	0.029
M4	0.058	0.063
SN4	0.009	0.003
MS4	0.026	0.028
2MN6	0.012	0.015
M6	0.014	0.021
MSN6	0.002	0.005
2MS6	0.009	0.011
2SM6	0.001	0.001
PI1	0.001	0.001
P1	0.020	0.015
PSI1	0.001	0.000
PHI1	0.001	0.001
2N2	0.025	0.013
NU2	0.036	0.019
T2	0.019	0.008
K2	0.086	0.038

	1987/8 Phase (º)	
	S. Jacinto	Torreira
MM	352.1	16.4
MSF	230.3	44.8
Q1	279.8	327.0
O1	326.5	18.9
M1	119.7	187.5
K1	72.2	122.1
J1	154.9	249.7
OO1	156.7	160.1
MU2	56.0	249.9
N2	76.2	128.7
M2	91.7	144.5
L2	104.4	161.0
S2	121.6	178.0
2SM2	332.8	49.4
MO3	231.3	92.0
M3	347.2	2.3
MK3	326.4	192.0
MN4	288.5	231.4
M4	305.9	244.0
SN4	86.8	66.4
MS4	6.5	293.9
2MN6	334.1	52.4
M6	342.3	68.8
MSN6	164.5	282.9
2MS6	23.0	120.4
2SM6	338.3	118.0
PI1	72.2	122.1
P1	72.2	122.1
PSI1	72.2	122.1
PHI1	72.2	122.1
2N2	76.2	128.7
NU2	76.2	128.7
T2	121.6	178.0
K2	121.6	178.0

	1987/8 Phase (º)							
	Carregal	**Ovar**	**Puxadouro**	**Pardilho**	**Manchao**	**CBico**	**CNova**	**Vagueira**
MM	24.2	40.3	51.7	52.1	51.9	356.9	272.7	35.9
MSF	341.9	359.7	358.5	359.3	0.2	40.9	348.9	7.4
Q1	342.9	332.3	338.9	338.3	346.5	314.7	279.4	290.5
O1	36.0	36.2	43.9	36.0	51.2	1.7	324.5	358.6
M1	285.3	309.3	44.3	289.0	46.2	189.7	105.1	136.3
K1	148.0	145.1	154.2	145.1	162.4	104.5	66.7	92.5
J1	243.1	252.2	225.8	244.0	232.0	224.2	254.7	216.7
OO1	314.2	322.3	326.6	318.8	348.0	139.2	291.1	301.4
MU2	307.8	316.3	338.1	318.1	351.7	247.1	38.3	239.1
N2	175.8	167.6	172.2	164.7	182.0	117.7	71.3	88.5
M2	186.2	181.9	198.1	180.9	210.5	133.6	88.2	105.9
L2	197.3	162.7	131.2	152.6	134.7	157.2	96.7	91.2
S2	219.0	215.5	231.0	214.3	243.0	167.2	118.4	133.3
2SM2	64.8	72.2	145.1	55.6	165.3	40.8	278.4	296.9
MO3	142.8	122.3	163.8	122.1	183.5	72.8	229.3	28.1
M3	86.3	45.7	47.3	49.8	51.7	352.6	334.9	28.9
MK3	242.4	240.6	274.7	239.7	294.6	170.1	305.6	142.4
MN4	301.2	290.3	306.2	285.3	331.4	209.6	307.1	199.7
M4	317.5	307.8	341.3	305.9	5.9	221.4	305.8	194.8
SN4	320.3	305.6	333.0	291.1	339.7	40.3	155.3	113.4
MS4	329.7	319.3	354.0	315.2	18.5	270.9	350.5	201.3
2MN6	126.9	103.9	91.1	88.4	138.1	61.0	319.0	187.8
M6	156.4	143.9	137.4	139.8	184.0	95.0	324.4	174.8
MSN6	147.8	136.0	138.1	119.5	166.8	266.3	299.4	66.0
2MS6	171.1	156.2	148.1	150.7	195.4	172.9	358.0	194.4
2SM6	141.1	122.7	117.8	113.3	166.4	356.6	16.0	263.1
PI1	148.0	145.1	154.2	145.1	162.4	104.5	66.7	92.5
P1	148.0	145.1	154.2	145.1	162.4	104.5	66.7	92.5
PSI1	148.0	145.1	154.2	145.1	162.4	104.5	66.7	92.5
PHI1	148.0	145.1	154.2	145.1	162.4	104.5	66.7	92.5
2N2	175.8	167.6	172.2	164.7	182.0	117.7	71.3	88.5
NU2	175.8	167.6	172.2	164.7	182.0	117.7	71.3	88.5
T2	219.0	215.5	231.0	214.3	243.0	167.2	118.4	133.3
K2	219.0	215.5	231.0	214.3	243.0	167.2	118.4	133.3

	1987/8 Phase (º)							
	Areao	Lota	RNovo	Cacia	Sacor	PCais2	Vista Alegre	CPedra
MM	34.3	5.1	27.7	27.2	303.3	274.2	278.0	297.3
MSF	14.2	76.8	33.0	31.3	357.6	14.9	15.4	13.2
Q1	340.7	271.7	300.1	289.8	278.8	297.9	329.0	331.0
O1	49.4	324.7	356.8	359.1	328.8	346.2	0.9	13.3
M1	184.1	97.7	80.0	90.4	141.3	15.6	326.5	24.5
K1	148.6	66.5	103.5	103.8	71.6	88.9	102.5	118.0
J1	268.3	252.2	147.0	158.2	111.1	181.4	239.7	228.0
OO1	4.5	217.5	205.1	209.1	199.3	318.1	308.2	314.3
MU2	327.8	71.6	248.6	257.9	61.2	263.6	277.7	303.0
N2	160.2	74.7	103.0	104.2	75.3	94.7	112.7	136.4
M2	176.9	93.0	123.2	123.9	92.1	110.6	129.0	151.4
L2	163.8	130.1	175.7	174.0	100.4	149.9	169.3	195.3
S2	203.3	121.4	154.7	156.1	122.9	142.0	160.3	185.7
2SM2	16.2	290.1	348.0	346.2	14.9	294.9	325.6	8.8
MO3	130.8	209.4	86.3	88.4	225.6	253.5	305.1	101.9
M3	99.8	300.1	205.5	176.3	348.2	34.2	102.1	96.9
MK3	226.8	334.6	191.6	179.0	325.9	11.4	69.9	154.6
MN4	285.0	289.0	204.7	203.7	293.1	269.2	174.9	254.2
M4	287.7	318.5	234.8	233.3	306.9	344.3	35.7	279.1
SN4	227.4	357.5	317.2	314.4	100.4	122.3	170.1	282.1
MS4	298.7	345.8	268.0	265.3	6.5	16.8	76.9	292.7
2MN6	38.3	298.4	148.4	142.1	326.5	350.6	11.4	6.1
M6	60.1	320.6	175.3	181.2	329.4	29.0	42.3	40.9
MSN6	28.1	321.2	255.3	236.6	196.9	51.2	68.0	243.3
2MS6	70.1	332.7	211.1	216.8	20.2	30.2	49.5	53.5
2SM6	66.8	359.2	246.3	280.0	359.4	73.7	90.2	51.6
PI1	148.6	66.5	103.5	103.8	71.6	88.9	102.5	118.0
P1	148.6	66.5	103.5	103.8	71.6	88.9	102.5	118.0
PSI1	148.6	66.5	103.5	103.8	71.6	88.9	102.5	118.0
PHI1	148.6	66.5	103.5	103.8	71.6	88.9	102.5	118.0
2N2	160.2	74.7	103.0	104.2	75.3	94.7	112.7	136.4
NU2	160.2	74.7	103.0	104.2	75.3	94.7	112.7	136.4
T2	203.3	121.4	154.7	156.1	122.9	142.0	160.3	185.7
K2	203.3	121.4	154.7	156.1	122.9	142.0	160.3	185.7

	2003 Amplitude (m)							
	Carregal	**Ovar**	**Puxadouro**	**Pardilho**	**Manchao**	**CBico**	**CNova**	**Vagueira**
Z0	2.452	2.453	2.453	2.453	2.454	2.312	2.228	2.328
MM	0.025	0.025	0.025	0.025	0.025	0.081	0.052	0.025
MSF	0.129	0.129	0.125	0.130	0.126	0.064	0.045	0.087
Q1	0.009	0.008	0.008	0.008	0.008	0.011	0.021	0.014
O1	0.045	0.045	0.044	0.045	0.042	0.046	0.056	0.053
M1	0.002	0.002	0.002	0.002	0.002	0.004	0.004	0.004
K1	0.043	0.043	0.043	0.043	0.041	0.052	0.064	0.057
J1	0.006	0.006	0.006	0.006	0.005	0.006	0.005	0.004
OO1	0.004	0.004	0.003	0.004	0.003	0.003	0.001	0.006
MU2	0.027	0.026	0.019	0.026	0.017	0.006	0.038	0.018
N2	0.080	0.080	0.069	0.079	0.062	0.137	0.205	0.147
M2	0.414	0.412	0.378	0.410	0.342	0.706	0.987	0.809
L2	0.066	0.065	0.063	0.064	0.059	0.054	0.031	0.074
S2	0.117	0.116	0.107	0.116	0.097	0.200	0.324	0.233
2SM2	0.005	0.005	0.011	0.005	0.012	0.003	0.004	0.011
MO3	0.010	0.010	0.016	0.010	0.014	0.008	0.004	0.010
M3	0.004	0.003	0.005	0.003	0.005	0.008	0.003	0.005
MK3	0.006	0.006	0.011	0.006	0.010	0.013	0.006	0.009
MN4	0.030	0.029	0.041	0.029	0.035	0.040	0.019	0.039
M4	0.062	0.061	0.090	0.059	0.078	0.095	0.048	0.076
SN4	0.009	0.008	0.015	0.008	0.013	0.010	0.005	0.019
MS4	0.044	0.044	0.058	0.043	0.052	0.038	0.026	0.047
2MN6	0.012	0.012	0.019	0.011	0.016	0.004	0.003	0.009
M6	0.013	0.013	0.023	0.012	0.020	0.011	0.004	0.015
MSN6	0.001	0.001	0.007	0.001	0.004	0.007	0.001	0.013
2MS6	0.015	0.014	0.024	0.013	0.021	0.005	0.006	0.014
2SM6	0.003	0.003	0.006	0.003	0.007	0.002	0.002	0.005
PI1	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
P1	0.014	0.014	0.014	0.014	0.014	0.017	0.021	0.019
PSI1	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001
PHI1	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
2N2	0.011	0.011	0.009	0.011	0.008	0.018	0.027	0.020
NU2	0.016	0.015	0.013	0.015	0.012	0.027	0.040	0.029
T2	0.007	0.007	0.006	0.007	0.006	0.012	0.019	0.014
K2	0.032	0.032	0.029	0.032	0.026	0.054	0.088	0.064

	2003 Amplitude (m)							
	Areao	**Lota**	**RNovo**	**Cacia**	**Sacor**	**PCais2**	**Vista Alegre**	**CPedra**
Z0	2.418	2.164	2.316	2.316	2.107	2.107	2.224	2.316
MM	0.037	0.042	0.077	0.077	0.008	0.008	0.020	0.054
MSF	0.115	0.042	0.096	0.097	0.023	0.023	0.040	0.103
Q1	0.012	0.018	0.011	0.011	0.013	0.013	0.017	0.009
O1	0.047	0.054	0.044	0.044	0.052	0.052	0.053	0.047
M1	0.004	0.005	0.005	0.005	0.003	0.003	0.003	0.004
K1	0.046	0.046	0.048	0.049	0.070	0.070	0.059	0.061
J1	0.003	0.005	0.002	0.002	0.003	0.003	0.002	0.002
OO1	0.004	0.004	0.006	0.006	0.001	0.001	0.001	0.001
MU2	0.021	0.019	0.048	0.048	0.016	0.016	0.004	0.037
N2	0.088	0.205	0.148	0.148	0.199	0.200	0.174	0.124
M2	0.475	0.992	0.675	0.677	0.986	0.993	0.873	0.663
L2	0.046	0.028	0.037	0.038	0.016	0.016	0.034	0.021
S2	0.139	0.329	0.186	0.186	0.339	0.342	0.287	0.193
2SM2	0.002	0.006	0.019	0.019	0.007	0.007	0.013	0.009
MO3	0.013	0.003	0.013	0.013	0.005	0.005	0.003	0.012
M3	0.007	0.003	0.006	0.006	0.003	0.003	0.003	0.008
MK3	0.015	0.004	0.003	0.003	0.009	0.009	0.001	0.014
MN4	0.044	0.025	0.051	0.052	0.017	0.018	0.009	0.043
M4	0.096	0.057	0.129	0.131	0.056	0.059	0.024	0.119
SN4	0.005	0.004	0.009	0.009	0.009	0.009	0.005	0.023
MS4	0.052	0.050	0.106	0.108	0.043	0.046	0.021	0.093
2MN6	0.009	0.003	0.015	0.016	0.003	0.003	0.022	0.007
M6	0.014	0.006	0.018	0.020	0.008	0.008	0.036	0.012
MSN6	0.004	0.005	0.005	0.006	0.004	0.004	0.008	0.006
2MS6	0.011	0.006	0.026	0.028	0.010	0.011	0.044	0.014
2SM6	0.002	0.004	0.005	0.006	0.003	0.003	0.012	0.006
PI1	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
P1	0.015	0.015	0.016	0.016	0.023	0.023	0.019	0.020
PSI1	0.000	0.000	0.000	0.000	0.001	0.001	0.001	0.001
PHI1	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
2N2	0.012	0.027	0.020	0.020	0.027	0.027	0.023	0.017
NU2	0.017	0.040	0.029	0.029	0.039	0.039	0.034	0.024
T2	0.008	0.019	0.011	0.011	0.020	0.020	0.017	0.011
K2	0.038	0.089	0.051	0.051	0.092	0.093	0.078	0.052

	2003 Amplitude (m)	
	S. Jacinto	Torreira
Z0	2.149	2.312
MM	0.008	0.082
MSF	0.020	0.072
Q1	0.017	0.014
O1	0.054	0.041
M1	0.001	0.003
K1	0.051	0.046
J1	0.002	0.005
OO1	0.002	0.002
MU2	0.040	0.015
N2	0.177	0.097
M2	0.974	0.478
L2	0.044	0.031
S2	0.446	0.141
2SM2	0.017	0.008
MO3	0.006	0.004
M3	0.003	0.004
MK3	0.006	0.009
MN4	0.022	0.029
M4	0.056	0.063
SN4	0.005	0.003
MS4	0.041	0.028
2MN6	0.004	0.015
M6	0.008	0.021
MSN6	0.003	0.005
2MS6	0.010	0.011
2SM6	0.003	0.001
PI1	0.001	0.001
P1	0.017	0.015
PSI1	0.000	0.000
PHI1	0.001	0.001
2N2	0.024	0.013
NU2	0.034	0.019
T2	0.026	0.008
K2	0.121	0.038

	2003 Phase (º)	
	S. Jacinto	Torreira
MM	226.5	16.4
MSF	151.5	44.8
Q1	265.8	327.0
O1	326.6	18.9
M1	94.0	187.5
K1	71.7	122.1
J1	82.3	249.7
OO1	41.8	160.1
MU2	0.3	249.9
N2	79.4	128.7
M2	85.4	144.5
L2	86.3	161.0
S2	116.3	178.0
2SM2	341.7	49.4
MO3	186.8	92.0
M3	296.8	2.3
MK3	287.4	192.0
MN4	269.3	231.4
M4	277.8	244.0
SN4	334.3	66.4
MS4	315.9	293.9
2MN6	329.6	52.4
M6	330.8	68.8
MSN6	337.1	282.9
2MS6	349.7	120.4
2SM6	14.3	118.0
PI1	71.7	122.1
P1	71.7	122.1
PSI1	71.7	122.1
PHI1	71.7	122.1
2N2	79.4	128.7
NU2	79.4	128.7
T2	116.3	178.0
K2	116.3	178.0

	2003 Phase (º)							
	Carregal	Ovar	Puxadouro	Pardilho	Manchao	CBico	CNova	Vagueira
MM	135.6	136.5	137.1	136.1	136.6	348.2	224.6	346.0
MSF	9.2	9.4	10.1	9.4	10.5	25.6	107.3	41.7
Q1	338.8	336.8	342.8	336.0	348.9	282.6	258.9	285.8
O1	37.4	36.4	44.2	35.7	51.0	357.6	322.5	345.8
M1	74.4	74.6	82.5	74.7	88.2	69.1	12.8	37.8
K1	148.0	146.7	155.5	146.0	162.9	96.0	61.7	81.0
J1	219.1	217.8	226.9	216.2	233.2	268.4	53.6	176.4
OO1	304.6	303.4	318.4	302.2	333.5	56.6	276.1	298.6
MU2	327.4	324.4	356.5	323.8	17.8	242.6	32.8	297.8
N2	170.4	167.6	184.6	166.1	197.3	107.2	66.1	87.7
M2	182.8	180.5	196.0	179.1	208.0	122.3	84.4	103.0
L2	170.9	169.1	184.4	167.9	195.8	142.3	98.7	103.2
S2	213.2	210.6	222.5	209.0	233.5	154.1	112.0	135.8
2SM2	113.0	113.9	177.1	113.1	191.2	38.3	293.6	300.7
MO3	136.9	133.7	168.1	132.1	188.1	24.2	190.0	339.8
M3	73.8	73.8	103.8	72.0	123.9	344.7	315.4	310.5
MK3	247.5	243.2	273.3	241.0	297.6	144.5	269.5	74.9
MN4	293.9	289.2	323.8	286.4	346.2	174.9	251.5	138.0
M4	309.5	304.3	336.0	301.4	0.3	206.0	277.5	155.9
SN4	27.6	24.2	78.9	20.6	105.6	258.5	360.0	186.7
MS4	327.5	322.3	353.2	319.3	16.0	228.2	306.7	169.8
2MN6	113.9	107.1	111.8	102.9	155.5	26.3	313.1	83.6
M6	139.7	131.1	128.9	127.9	173.3	64.2	306.1	97.0
MSN6	201.1	201.7	168.5	199.4	221.8	161.1	251.6	155.6
2MS6	151.0	143.7	142.1	140.6	184.5	92.6	313.2	108.2
2SM6	131.8	122.4	127.9	118.4	174.9	110.6	325.9	131.7
PI1	148.0	146.7	155.5	146.0	162.9	96.0	61.7	81.0
P1	148.0	146.7	155.5	146.0	162.9	96.0	61.7	81.0
PSI1	148.0	146.7	155.5	146.0	162.9	96.0	61.7	81.0
PHI1	148.0	146.7	155.5	146.0	162.9	96.0	61.7	81.0
2N2	170.4	167.6	184.6	166.1	197.3	107.2	66.1	87.7
NU2	170.4	167.6	184.6	166.1	197.3	107.2	66.1	87.7
T2	213.2	210.6	222.5	209.0	233.5	154.1	112.0	135.8
K2	213.2	210.6	222.5	209.0	233.5	154.1	112.0	135.8

	2003 Phase (º)							
	Areao	**Lota**	**RNovo**	**Cacia**	**Sacor**	**PCais2**	**Vista Alegre**	**CPedra**
MM	3.6	7.5	14.0	14.0	286.8	288.1	350.1	2.6
MSF	37.1	214.0	38.3	38.4	155.3	155.6	45.5	41.1
Q1	325.1	271.7	307.4	307.2	266.4	267.5	283.4	306.4
O1	27.0	328.1	352.4	352.5	328.5	329.1	341.8	5.9
M1	79.9	33.8	310.9	311.6	34.4	35.7	58.3	77.1
K1	120.3	67.4	99.0	99.3	67.3	67.8	88.2	106.7
J1	222.0	38.8	225.1	229.7	44.8	44.7	260.4	188.3
OO1	327.2	268.3	212.5	212.2	228.1	215.6	31.2	211.1
MU2	0.6	13.7	261.5	261.6	83.1	82.9	13.1	273.4
N2	143.5	72.8	104.5	105.0	67.9	69.3	92.2	122.2
M2	158.2	88.3	118.0	118.7	86.1	87.5	107.6	131.8
L2	161.0	74.8	98.2	99.1	74.3	76.1	82.8	121.1
S2	192.8	116.2	148.1	148.9	113.3	114.7	135.1	162.9
2SM2	54.7	298.3	4.0	4.4	303.0	303.8	303.6	19.7
MO3	96.9	176.6	62.4	63.2	192.3	191.4	250.1	93.0
M3	52.6	311.6	88.9	89.5	296.0	296.9	348.2	32.3
MK3	186.6	290.7	146.1	145.3	324.5	324.9	229.5	218.9
MN4	234.2	271.9	212.4	212.8	281.4	282.9	323.6	239.2
M4	257.9	282.4	224.1	224.4	281.1	284.0	333.6	249.2
SN4	350.5	13.7	208.2	208.2	292.3	296.2	205.9	240.3
MS4	273.8	323.7	256.5	256.9	334.6	336.6	6.8	282.5
2MN6	358.0	311.2	159.3	165.0	325.8	321.5	324.4	288.0
M6	22.7	324.7	168.6	174.7	334.5	336.9	327.1	290.9
MSN6	312.6	336.7	195.3	200.2	347.4	348.9	316.0	317.0
2MS6	33.8	345.2	200.3	206.6	359.7	2.5	344.2	328.1
2SM6	22.6	2.2	259.0	267.1	46.3	55.0	32.0	28.0
PI1	120.3	67.4	99.0	99.3	67.3	67.8	88.2	106.7
P1	120.3	67.4	99.0	99.3	67.3	67.8	88.2	106.7
PSI1	120.3	67.4	99.0	99.3	67.3	67.8	88.2	106.7
PHI1	120.3	67.4	99.0	99.3	67.3	67.8	88.2	106.7
2N2	143.5	72.8	104.5	105.0	67.9	69.3	92.2	122.2
NU2	143.5	72.8	104.5	105.0	67.9	69.3	92.2	122.2
T2	192.8	116.2	148.1	148.9	113.3	114.7	135.1	162.9
K2	192.8	116.2	148.1	148.9	113.3	114.7	135.1	162.9

An Intensive Analysis of Trends in Sea Level Variability at Newlyn

Isabel Araujo, David Pugh and Michael Collins

Southampton Oceanography Centre, UK

Abstract

Predicted climate changes have increased interest in possible enhanced risks of coastal flooding. A long series (85 years) of sea level observations at Newlyn, southwest England, has been analysed for changes in the statistics of tides, surges and mean sea level. Both the observed mean sea level and the standard deviation about the mean showed an increase with time, whilst the standard deviation of the observed non-tidal residuals showed a decrease. Some of the apparent trends are due to changes made in the stilling well. We have revaluated these trends following a second robust editing of the data, correcting for calibration, blockage and timing errors in the gauge.

Introduction

One of the most valuable applications of long-term sea level records is the estimation of risks of coastal flooding. The recent Reports of the Intergovernmental Panel on Climate Change have again drawn attention to the possibility of enhanced risks of flooding in a world warmed by an enhanced greenhouse effect (IPCC, 2001). The best-known scenario is a rise of global mean sea level as a result of thermal expansion and the melting of grounded ice. Risks of flooding may also change as the frequency and intensity of storms changes. Observed sea levels are often dominated by tides, and these too may change locally with time.

The long record of sea level measurements at Newlyn in the southwest of Britain was begun in May 1915, to provide a mean sea level datum for the Ordnance Survey levelling of Great Britain (Close 1922). Subsequently the gauge was maintained by the Survey, originally with a full-time operator. Since 1983 the gauge has been part of the British national tide gauge network, maintained by the Proudman Oceanographic Laboratory. Because of the virtually continuous data, and the apparent high quality, Newlyn sea levels have been used in several detailed studies (Munk and Cartwright, 1966; Cartwright, 1983; Woodworth, Shaw and Blackburn, 1991; Woodworth et al 1999). This study, which uses data to 2000, begins with a critical assessment of the characteristics of the gauge, based on residual analyses, before separating the tidal, meteorological residuals and mean sea level components for trend analyses.

Data processing

Newlyn is a small fishing town in the southwest of Britain, open to the Atlantic Ocean influences, but separated from it by the broad shelf region of the Celtic Sea (Fig 1). The gauge itself is set into the end of a long jetty that forms the southern protection for the harbour .

The Carey Porter recorder installed in 1915 by the Ordnance Survey operated until 1983 when a replacement Munro gauge was installed over the well. At the same time the well connection to the sea, through a 0.20 m diameter (measured as 8Ó +/- 0.125Ó in 1983) connecting pipe was enhanced. The hole in the end cap was increased from 38 mm to 76 mm diameter. In fact divers measured the original hole in 1977 as only 32 mm diameter. The well itself has a large rectangular cross-section of 1.22 m by 1.45 m. In 1983 a bubbler gauge was installed with the pressure point mounted on the jetty outside the well. The Fundamental Bench mark for the United Kingdom is a brass bolt installed in the floor of the gauge building.

A tide gauge and well is a complex system both in its structure and operation. As such, there can be several factors that might present problems to its perfect function and introduce a series of errors in the gaugeÕs readings. Some examples of the nature of such errors are calibration, sliding of the pulley cable, timing and obstruction or sedimentation in the well.

Some of these errors can be found in records by looking at the non-tidal component of the observed sea level values (meteorological residual). Tidal period variations in residual levels must always be regarded with suspicion, and can distort statistics of non-tidal effects. It is possible to perform a diagnosis of well behaviour by comparing the tidal signal (in the residuals) to the predicted tidal values for the same interval. For instance, if a well were lagging on true ocean levels because of a partial blockage, then the residual reading would show a tidal signal with a shifted phase from the predicted signal. A sudden jump in the signal could correspond to the removal of a pipe obstruction or the correction of a timing error (see Fig. 2). This briefly illustrates the approach that can be taken to identify and understand errors that are commonly found in tidal records. Using this approach we have elaborated an editing process for Newlyn data in order to improve its quality by reducing all errors found.

The Newlyn sea level record for 1915-2000 was obtained from the British Oceanographic Data Centre (BODC) in the form of hourly levels for each year. They were of good quality and virtually continuous until 1982. Changes were made in 1983 as described. After 1985 the readings improved and an evident change in the pattern occurred. The residuals become less noisy and there are other subtle changes, which will be discussed later in this paper. All readings are relative to an Admiralty Chart Datum (ADC) zero, defined at 2.73m below Ordnance Datum Newlyn (ODN).

A harmonic analysis was made separately for each year of data, using the Proudman Oceanographic Laboratory Tidal Analysis Software Kit 2000 (TASK-2000). This provided predicted and residual values, as well as values for 63 harmonic constants. To improve the initial data set we analysed ten day blocks of residual and predicted values to determine possible errors and substituted values believed to be incorrect by the corresponding residual low pass filter value. This was done for each year separately. A threshold level was established at ± 300cm beyond which we assumed extreme levels could be found; corrections were made for tidal residuals by substituting low-pass filtered values. This threshold was also selected to limit our adjustments to a reasonable amount of editing. Correcting large data sets in such detail has proved to be an arduous and time-consuming job that imposes certain practical limitations. Ideally correcting the entire record with no threshold would be the best choice but for extremes this seemed the most feasible and reasonable. A second harmonic analysis was done on new observed values obtained by combining predicted values and the corrected residual values. The new tidal constants and residual statistics were plotted and analysed for trends.

Analysis

We have looked at variability and trends in the observed sea levels and in the three component parts.

Observed sea levels

Figure 3 shows the standard deviation of the sea level variability, plotted for each year of the observing period. The effect of the 18.6-year nodal cycle in the lunar tides is evident. Theoretically the M_2 modulation is 3.7%, but here it is around 2.5%; as in many other coastal locations there is a reduction due to non-linear interactions in shallow water. The other feature is a small increase in the variability over 85 years, although the increase is much smaller than the variations due to nodal variations. This is consistent with the increase in the mean tidal range reported for Newlyn by Woodworth et al (1991).

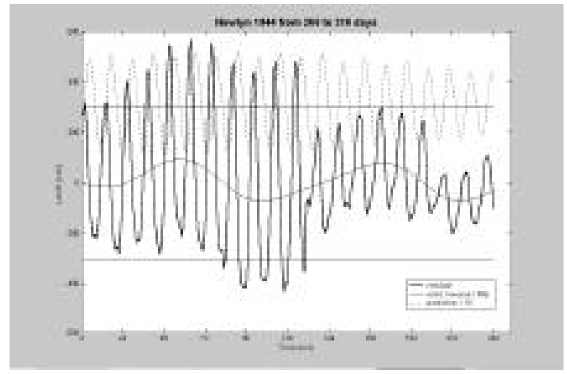


Figure 2. Showing sudden changes in the non-tidal residuals after gauge adjustments.

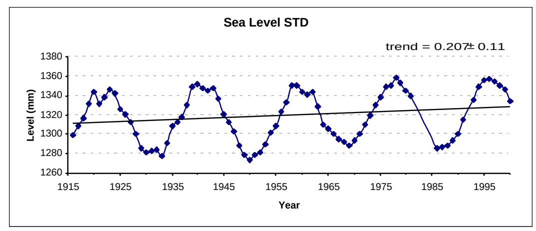


Figure 3. Standard deviation in observed sea levels

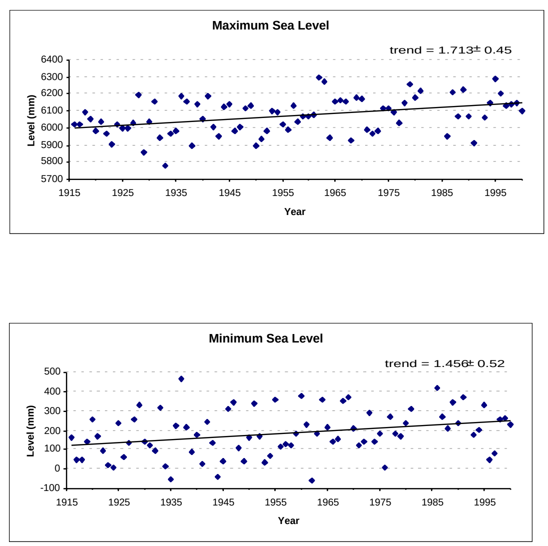


Figure 4 Tends in maximum and minimum levels

Figure 4 shows the maximum and minimum annual sea levels, both of which have upward trends, although the maximum levels are increasing slightly more rapidly than the minimum levels.

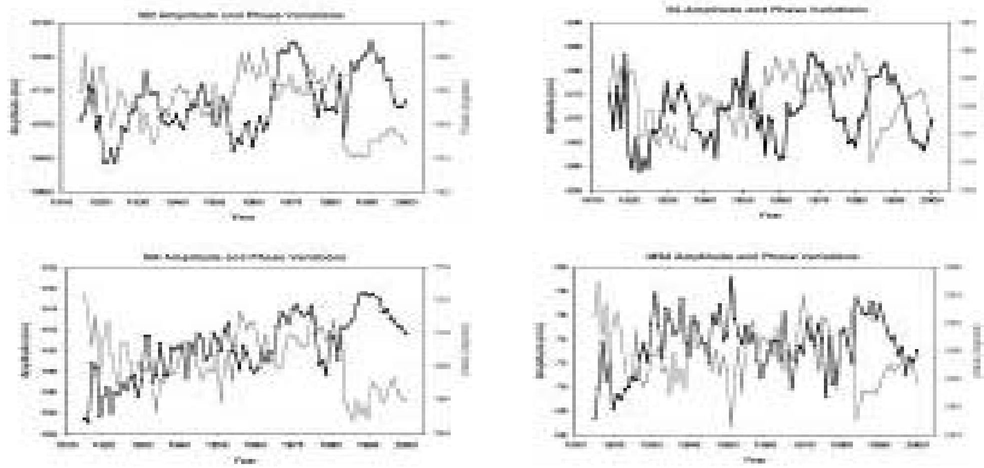


Figure 5. Amplitude and phase changes for tidal constituents

Tidal variations

Tides at Newlyn are dominated by the semi-diurnal variations. Diurnal effects are very small, but there are significant higher harmonics especially in the fourth-diurnal species.

Figure 5 shows the amplitudes and phases for M_2, S_2, M_4 and MS_4, determined by annual harmonic analyses, with nodal corrections made according to the astronomical variations. There is considerable year-on-year variability, but some systematic changes are apparent. The M_2 amplitude shows a residual nodal variation due to over correction in the analysis; S_2 also shows nodal variations in amplitude corresponding to those in $M_{2,}$ which must be due to shallow-water interactions, as S_2 itself has no nodal variations in the astronomical forcing. The most consistent change is a steady increase in the amplitude of M_4 by about 10mm, or 10%. All four constituents have a sudden phase reduction, with measured tides appearing earlier after 1983. This is because the subsequent measurements are made outside the well, whereas the earlier ones suffered a phase lag of about 4 minutes because of the narrow connecting hole (see also Pugh, 1981). Some constituents have apparently recovered some of the phase loss since, but M_2 remains some 2^0 (4 minutes) earlier.

Meteorological non-tidal residuals

After subtracting the tides from the observed levels and correcting as described earlier, the residuals were analysed on an annual basis. Newlyn residuals have an approximately Gaussian distribution, with a tendency to positive skewness and elongated tails. In general terms negative surges in excess of four standard deviations (0.15 m) occur about once every 5 years; positive surges in excess of four standard deviations about once a year, and in excess of five standard deviations once every 5 years.

We have used two methods to try to represent the annual statistics in a robust way, which is not highly dependent on a few extreme events. First, the principal three moments of the distribution were computed for each year. From the analysis method the mean value of surge (zero moment) is zero in each year. Figure 6 shows the standard deviation (first moment) of the residuals; there is an apparent downward trend but this is due to a significantly lower variability after the new external gauge was installed in 1983. If the residual standard deviations to 1983 are analysed separately, there is no significant trend.

The skewness (second moment) has a trend of (0.00048+/-0.00078) per year, not significantly different from zero. The flattening or kurtosis (third moment) has a small reduction (0.0047 +/- 0.0028), which is slightly significant.

The second method was to compute the percentile levels for non-exceedence. For example the 99% level is the level below which the residuals fall for 99% of the observations. Even more extreme percentiles can be computed, but they tend to become much more noisy and any trends fitted have larger standard errors.

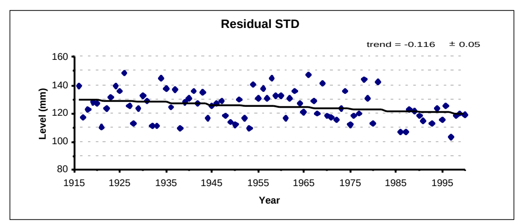


Figure 6. Trends in non-tidal residuals

Figure 7 shows the higher and lower surge percentiles and Table 1 summarises the trends. There is a fall in both the 95 and 99% percentile meaning that large surges are less frequent, but again this is partly due to the change in the well configuration in 1983. The 5% lower level percentile is increasing, meaning that the overall surge variations are reducing slightly, though this is less significant at the 1% level.

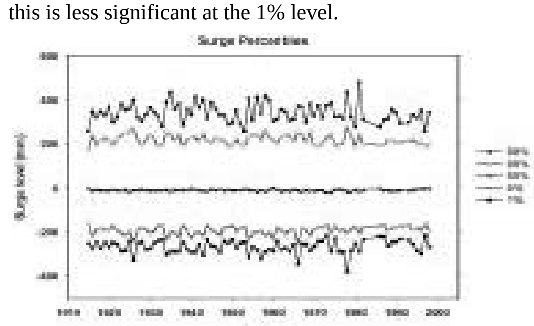


Figure 7. Percentiles of non-tidal sea level components

Mean sea level
The increase in the annual mean sea level is shown in Figure 8. The value of (1.175 +/- 0.129) mm per year is consistent with other increases observed worldwide (IPCC, 2001), although no correction has been made for vertical crustal movements.

Figure 8. Changes in annual mean sea levels

The mean sea level at Newlyn is now about 0.15 m above the Ordnance Datum for Britain, which was based on the 1915-1921 mean sea levels.

Table 1 Trends in residual percentiles

Discussion
The trends in the observed sea levels are shown in Table 3. Observed annual maximum levels are increasing at a rate indistinguishable from the rise in mean sea level, to which they are substantially attributed. The minimum annual levels are also increasing, but at a rate slightly below the mean sea level increases, but the statistical significance is slight.

Table 2. Trends in observation percentiles

However, the percentiles for the **total observed** levels, shown in Table 2 confirm more definitely that the higher observed levels are increasing more rapidly than mean sea level, and the lower levels are not. This is again consistent with the findings of Woodworth et al (1991) that the differences between high and low water levels are increasing.

This increase is reflected in the increasing standard deviation in the observed residuals shown in Figure 3. It is unlikely to be due to trends in the meteorological effects. Instead the effects are probably tidal and are reflected in the small systematic changes in the shallow-water tidal constituents particularly in the M4 amplitude.

It is not possible to say whether these shallow-water changes are local or regional. One explanation could be a dredging of the local harbour, which allows freer drainage at low water levels. Further work is in progress to compare trends at other ports around the English Channel, particularly with those in the long series of data from Brest.

Table 3. Trends in observed sea levels

Summary
It is valuable to analyse separately for trends in the various components of observed sea level. To do this it is essential to edit the non-tidal residuals to identify measurement problems. This is hard work and must be done in a consistent way. Care is necessary to understand possible small but consistent effects of changes in measuring methods. At Newlyn the measurement changes in 1983 are readily apparent. The mean sea level and the sea level variability have increases significantly at Newlyn since 1915. The increase in observed variability, much less than the nodal variations, is shown as an increase in the shallow-water M

Littoral 2002, 22-26 September. Porto, Portugal.

Trends in components of Sea Level around the English Channel

Isabel Araújo, David Pugh and Michael Collins
Southampton Oceanography Centre, Empress Dock,
Southampton SO14 3ZH, U.K _ixa@soc.soton.ac.uk

Abstract

The longest available records of hourly sea level data have been analysed for six ports around the English Channel. The quality of the data is extremely variable with the longest and most reliable records belonging to Brest and Newlyn. A separate analysis of the components of sea level: mean sea level, tides and meteorological residuals (surges), is used.

Results show a general increase in mean sea level throughout the period of observation. The various tidal constituents show interesting local short-term variations in amplitude and phase but no long-term trends. There is no evidence of an increase in weather effects on sea levels over the period analysed. De-trended sea level and pressure values show annual sea level fall as annual air pressures increase, as expected for the inverse barometer response. Meteorological residuals were compared to North Atlantic Oscillation (NAO) index values. The correlations are in general very small, especially for the annual mean NAO values. However correlations are slightly more apparent for the annual winter mean NAO values.

1. INTRODUCTION

Risks of coastal flooding and their consequences are the main reason for the wide interest in sea level variations at local scales. Demographic and economic pressures are imposed on coastal engineers and scientists to design systems to defy the natural evolution of coastlines.

One way of looking at sea level variations is by separately analysing tides, surges and mean sea level changes, as the forcing factors are essentially independent. This approach has been used to look at regional patterns of trends in long sea level records and their components around the English Channel.

The longest digitised hourly value records available for the Channel are from Brest (131 years) and Newlyn (85 years). A detailed analysis was carried out on these two ports (Araujo *et al.* 2001) and extended to four others, so that the set could be used to look at regional behaviour. Careful editing was undertaken to remove the worst effects of timing errors, well blockages, and general mistakes in data processing. This proved to be a necessary preliminary to analysis capable of determining trends in various components of sea level, particularly surges.

Earlier analyses have been published. Woodworth *et al.* (1991) estimated a rate of change of MSL of approximately 1-2 mm/yr around the British Isles and adjacent European coastline, from averaged values over the last century. Larger than average trends were found in southeast England and at mid-channel ports of England and France.

Cartwright (1972) has documented tidal changes at Brest 1711-1936), relating them to different tidal records available. The three sets of data that he used, chosen according to the two changes made to the port, indicated a 1 % per century decrease in semi-diurnal amplitude. However, he was unable to determine whether the effect was strictly local, or of wider oceanic significance.

Woolf *et al.* (2002) analysed mean monthly sea level data from the TOPEX altimeter from 1992 to 2001 around Europe and found the NAO to be a primary agent of inter-annual sea level variation, especially in winter. By comparing the satellite data results with those of a storm surge model they also suggest that the association of the NAO with surge dynamics explains most of the dependence apparent in the altimeter data around the British Isles.

Trends in related parameters have also been observed. Bacon & Carter (1993) have found strong evidence of wave climate change in the North Atlantic. Their data suggests an increase in mean wave height of approximately 2% per year, over the whole North Atlantic.

The problem in estimating genuine long-term trends in sea level statistics is the scarcity of good quality continuous sea level records covering the area of concern for a long enough period. This is compounded by a lack of information on vertical land movement. This might in future be solved when long altimeter records become available and the use of Very Long Baseline Interferometry (VLBI) or Global Positioning Systems (GPS) becomes standard for tide gauge sites.

Littoral 2002, 22-26 September. Porto, Portugal.

2. DATA AND METHODS

Sea Level

The location of each port from which the sea level record was used is shown in Figure. 1. The choice was made in the following way: a search was carried out in order to obtain tidal records from the main ports around the English Channel, which listed, at least 40 years of data. A discrepancy between the number of listed data and the available data was sometimes found. Another problem arose when there were gaps in a certain year. To consider a year of data for this analysis it was decided that a minimum of 300 days of valid data was required. The data set was therefore greatly reduced from that apparently available, Table 1.

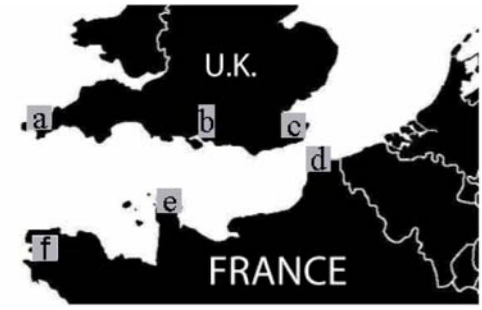


Figure 1. Map shows the study area. The ports from which data was used are Newlyn (a), Portsmouth (b), and Dover (c), for the English coast and Calais (d), Le Havre (e) and Brest (f) for the French coast.

Table 1. Details of the six ports from which data was used

Port	Coord.	Data available (years)	Data used (years)	Source
Newlyn	50º06´N 5º32´W	85	84	BODC
Portsmouth	50º48´N 1º06´W	39	39	ABP
Dover	51º06´N 1º19´E	40	32	BODC
Calais	50º58´N 1º51´E	16	16	SHOM
Le Havre	49º29´N 0º07´W	31	29	SHOM
Brest	48º23´N 4º29´W	131	123	SHOM

The tidal data analysed consists of digitised hourly sea level for each year up to the year 2000. There where several sources for this data. English sea level data were provided by the British Oceanographic Data Centre (BODC), who also obtained data for the French ports, original collected by Service Hydrographique et Océanographique de la Marine (SHOM). Associated British Ports (ABP) provided data for Portsmouth, as they had more years than the data set stored by BODC.

After overcoming the problem of data availability it is necessary to address the question on data quality. There are several factors that can pose problems to a tide gauge system's optimum function. These might introduce a series of errors in the gauge's readings that can be of the following nature: calibration, sliding of the pulley cable, timing and obstruction or sedimentation in the well. It is possible to find these errors (in records) by looking at the non-tidal component of the observed sea level values (meteorological residual).

Tidal period variations in residual levels must always be regarded with suspicion, and can distort statistics of non-tidal effects. It is possible to perform a diagnosis of a well's behaviour by comparing the tidal signal (in the residual) to the predicted tidal values for the same interval. For instance, if a well were lagging on true ocean levels because of a partial blockage, then the residual reading would show a tidal signal with a shifted phase from the predicted signal. A sudden jump in the signal could correspond to the removal of a pipe obstruction or the correction of a timing error. This briefly illustrates the approach that can be taken to identify and understand errors that are commonly found in tidal records. Using this approach, an editing process was elaborated in order to improve the quality of the data analysed by reducing all errors found.

The PSMSL/POL TASK 2000 program package was chosen from the several programs currently available to perform tidal harmonic analysis of each year of data. The TASK 2000 program is a general method for analysing hourly heights of the tide, derived from the TIRA tidal analysis program (www.pol.ac.uk/psmsl/training/ task2k.hel). It provided predicted and residual values, as well as values for 63 harmonic constants. To improve the initial data set we analysed 10-day blocks of residual and predicted values to determine possible errors. This was done for each year separately. A threshold level of approximately twice the residual standard

Littoral 2002, 22-26 September. Porto, Portugal.

deviation was established. This meant ± 300mm for the western and central ports and ± 400mm for eastern ports, where meteorological effects are greater. Residuals, which exceeded the threshold, were examined for authenticity; where appropriate, corrections were made for tidal residuals by substituting by corresponding low-pass filtered values. These thresholds were selected to limit adjustments to a reasonable amount of editing. Correcting large data sets in such detail has proved an arduous and time consuming job that imposes certain practical limitations.

The residual records for Dover and Calais showed larger amplitudes and higher frequency, associated with greater influence of non-tidal effects than the other ports studied. This can be explained by their close location to the North Sea that is considerably stormier than the Channel. The other noisy record was from Le Havre, but close examination suggested that the reason for this could be due to the poor quality of the data. To look at the Dover and Calais records individually in terms of separate residuals was not feasible. A 'buddy checking' method was applied whereby the records of two stations were compared to each other. For Portsmouth and Le Havre both methods were used. This proved an efficient way to confirm if surges were a result of a real event or an error. Calais individual surges were generally larger in amplitude than at Dover.

A second harmonic analysis was done for each year of adjusted observed values obtained by combining predicted values and the corrected residual values. The new tidal constants and residual statistics were the basis for the analyses for trends.

One of the problems when trying to estimate long-term trends is the different result obtained according to the time series selected. Since significant changes in sea level occur over decadal and even shorter time scales, it is important to be cautious when comparing trend in time series with different spans, or when calculating trends for short datasets. The lack of continuity and different record size were the main problems to estimating trends with confidence.

Pressure

Air pressure variations are essential for a study of mean sea level interannual variability, but are generally not so important for analysis of secular changes because their long-term trends are small (Woodworth 1987). The well-known effect of air pressure is the `inverted barometer effect´, that represents the theoretical sea level response to the vertical pressure force exerted by the atmosphere (Pugh 1987).

Monthly Mean Sea Level Pressure (MSLP) values (Figure 2.) were obtained from the Climate Research Unit of the University of East Anglia from a 5º latitude by 10º longitude grid (see http://www.cru.uea.ac.uk). The sources of the original chart data are given in Jones *et al.* (1987). The grid point at 50ºN, 5ºW was chosen as representative for the area.

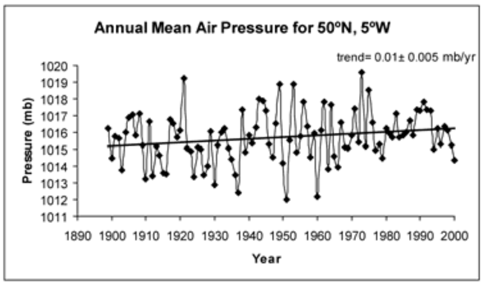


Figure 2. Annual mean air pressure for coordinate 50ºN, 5ºW.

NAO

Wind effects were not directly accounted for in this work; instead correlations with air pressure gradient, parameterised as the NAO, were studied. The North Atlantic Oscillation (NAO) index is determined by the normalised pressure difference between the Azores High and the Icelandic low. In other words it represents a pressure gradient, associated with changes in westerly winds across the North Atlantic onto Europe. This index is used to quantify large-scale variability in atmospheric pressure over decadal timescales. A positive NAO index corresponds to a strengthening (increase) of the Azores High and/or Icelandic low pressure systems. A negative NAO would represent the inverse, i.e., weakening of the Azores High and/or Icelandic low.

The NAO is a focus of much recent attention because of its relationship to the European climate (Hurrell 1995). Tsimplis (2001) has described how the inverted barometer effect, linked to the NAO are the responsible mechanisms for sea level variability in the Mediterranean. In order to assess whether such evidence exists in the Channel, NAO index values, also taken from the same source as the pressure values, and sea level data were compared.

Littoral 2002, 22-26 September. Porto, Portugal.

3. RESULTS AND DISCUSSION

The results of these analyses are summarised in the following Tables and Figures. All the records showed considerable variability from year to year, against which trends are often not easily identified, especially in the shorter records. Standard errors are also tabulated. As a general rule trends, though possibly indicative, are not considered statistically significantly different from zero unless their magnitude exceeds two standard errors.

For mean sea level (Table 2.; Figure 3.) five of the six ports show significant upwards trends close to the recent IPCC global range of 1 to 2 mm yr^{-1}.

Table 2. Trends in mean sea level

	Trend (mm/yr)	**Standard error**
Brest	1.29	0.07
Newlyn	1.73	0.13
Calais	-1.48	1.30
Dover	2.44	0.42
Le Havre	1.44	0.47
Portsmouth	1.37	0.52

Brest and Newlyn trends are significantly different from each other probably due to different vertical rates of land movement at the two sites. These trends do not take land

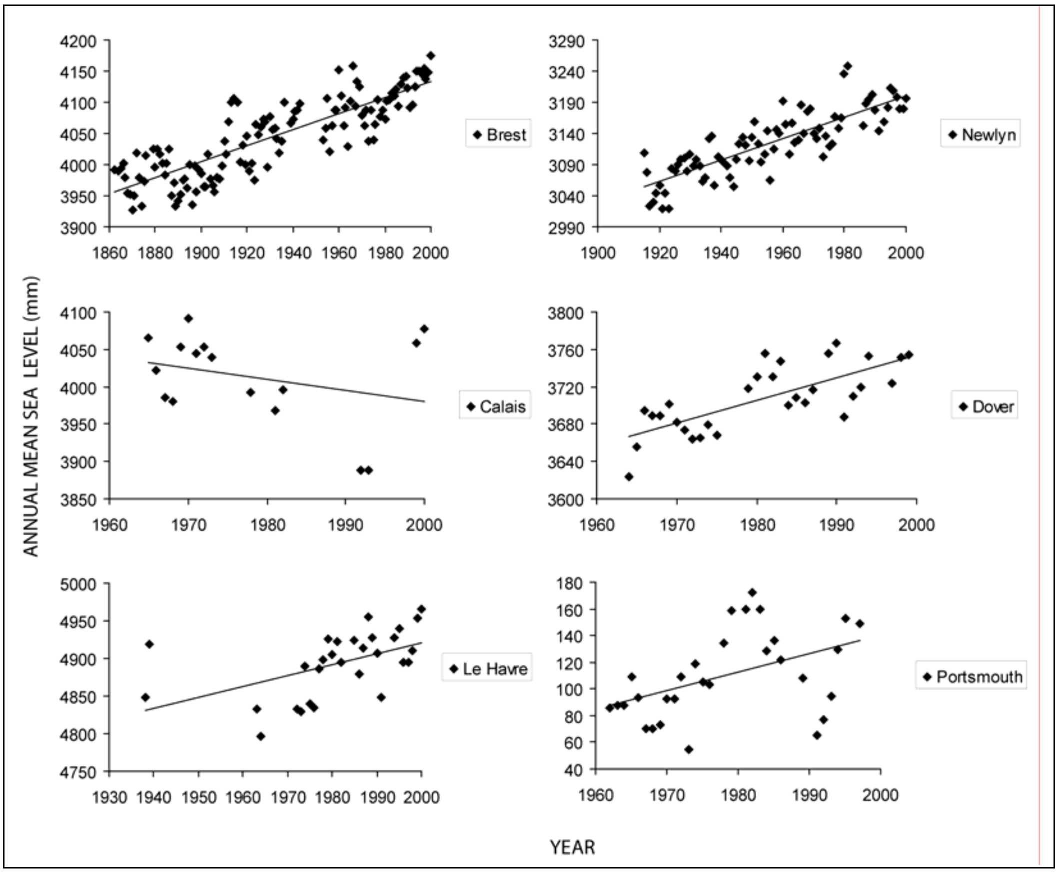


Figure 3. Annual mean sea levels. The datum for values at each port are arbitrary.

movement into account. The large fall in sea level at Calais cannot be explained but is related to the lack of data. It is noticeable that the Calais trends for other components of sea level also showed large standard errors, and often diverge from the behaviour of the rest of the set of ports analysed.

For variations in the total observed sea level, the standard deviations are shown in Table 3. and Figure 4. The results are erratic, and strongly influenced by the 18.6 year nodal cycle, with often large standard errors. At Brest, Dover and Le Havre the trends are not significantly different from zero.

Table 3. Trends in total observed sea level standard deviations.

	Trend (mm/yr)	**Standard error**
Brest	0.01	0.01
Newlyn	0.23	0.11
Calais	3.33	0.46
Dover	0.68	0.38
Le Havre	-0.14	0.45
Portsmouth	0.67	0.30

At both Newlyn and Portsmouth there are significant increases in standard deviations, which may be related to increased tidal ranges as the mean sea level increases, allowing low water to fall further below the increasing mean, as the harbours dry out. The Newlyn results are discussed in more detail in Araujo *et al.* (2001). We have no explanation for the very large trends in the amplitudes at Calais, but the short period of data and possible nodal 18.6 year distortions may be a contributing factor.

Amplitude trends for M2 are given in Table 4. Statistically significant trends in M2 amplitude were observed at Brest, Newlyn Calais and Dover. However, although the theoretical 18.6 year nodal cycle in M2 amplitudes is removed in the analysis procedure, shallow-water effects leave a residual 18.6 year cycle which distorts trends based on only short records. For the two longest records shown in Figure 5, there is a small but significant reduction in M2 amplitude at Brest and an increase at Nerwlyn. The apparent increase in M2 amplitudes at Newlyn has been partly attributed to changes in measuring procedures in 1983 (Araujo *et al.* 2001). The small decrease in M2 amplitude at Brest is equivalent to 0.4% decrease per century, less than the 1% reported by Cartwright (1972), but of the same sign.

Littoral 2002, 22-26 September. Porto, Portugal.

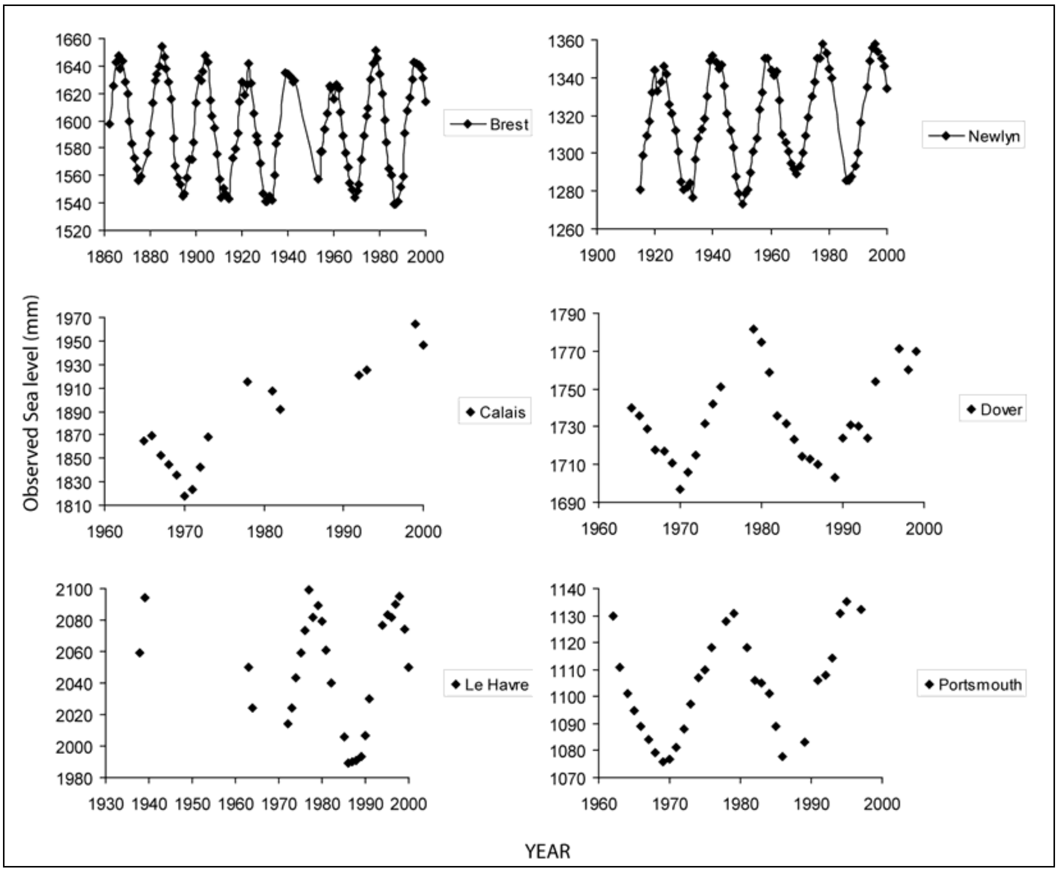


Figure 4. Total observed sea level standard deviation

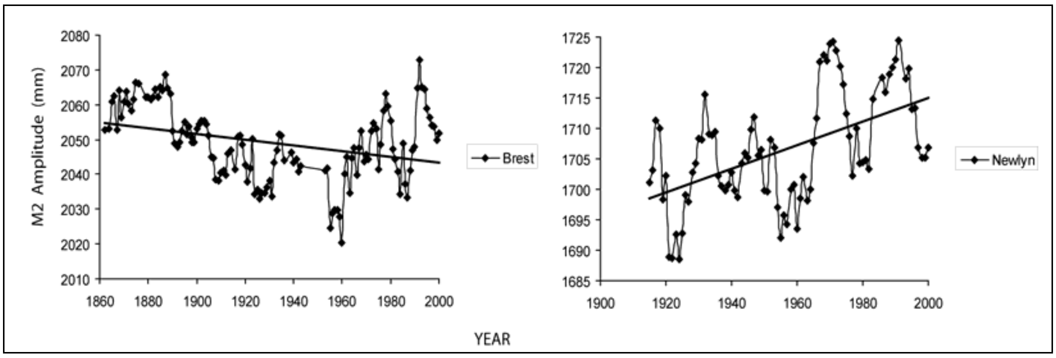


Figure 5. M2 amplitude for ports with longest records.

Littoral 2002, 22-26 September. Porto, Portugal.

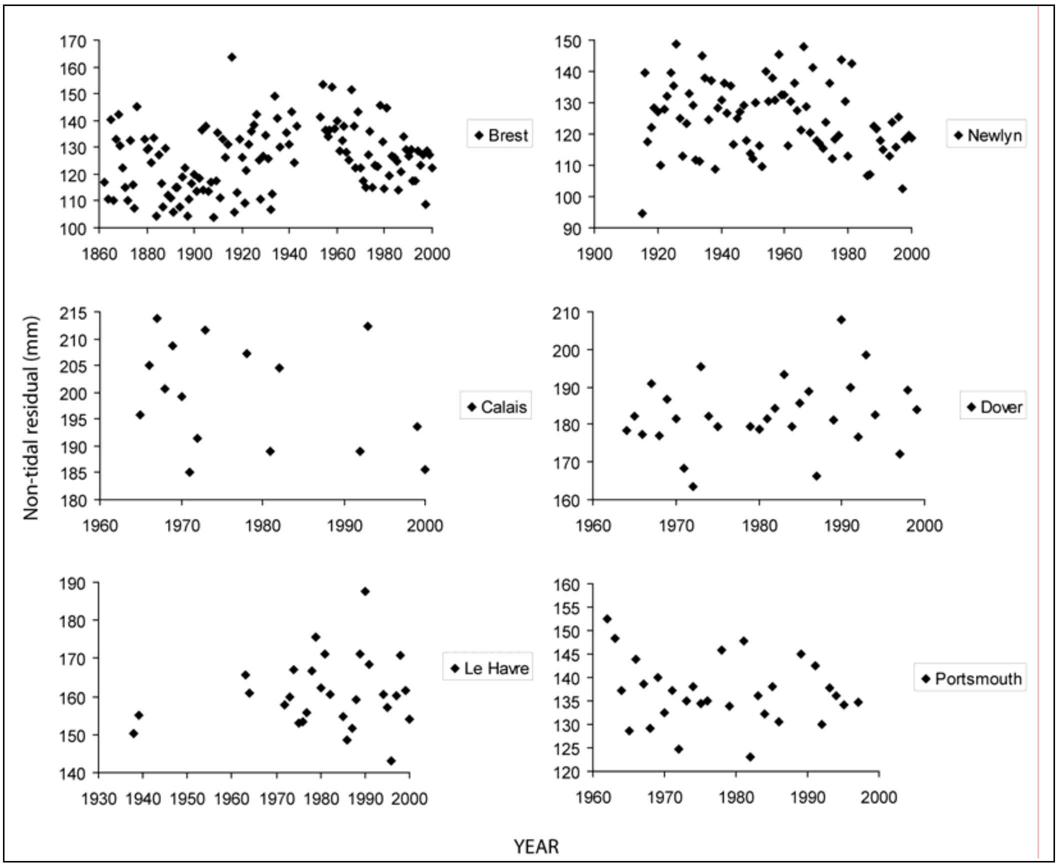


Figure 6. Non-tidal (meteorological) residual standard deviation

Table 4. Trends in M2 amplitudes

	Trend (mm/yr)	Standard error
Brest	-0.08	0.02
Newlyn	0.19	0.03
Calais	1.50	0.04
Dover	-0.93	0.29
Le Havre	0.11	0.14
Portsmouth	0.21	0.13

Table 5. and Figure 6. show the trends and standard deviations of the non-tidal (meteorological) residuals. Only two of the trends are significantly different from zero. The trend at Brest is positive. The trend at Newlyn, which is almost statistically significant, (Araujo *et al.* 2001) has been attributed to the change in measuring procedures in 1983, with the new bubbler-gauge giving fewer errors than the old stilling well system.

Table 5. Trend in non-tidal residual standard deviation.

	Trend (mm/yr)	Standard error
Brest	0.07	0.03
Newlyn	-0.09	0.05
Calais	-0.30	0.21
Dover	0.20	0.16
Le Havre	0.09	0.11
Portsmouth	-0.01	0.10

Annual residual standard deviations at Brest and Newlyn are correlated (Figure 7.). This gives clear confirmation of the oceanographic significance of the residual sea levels, after the careful editing performed here.

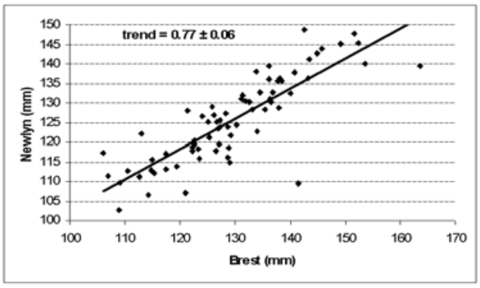


Figure 7. Correlation between non-tidal residuals for Newlyn and Brest.

Table 6. and Figure 8. show the correlation at each port between the annual mean sea level and the annual mean air pressure (both detrended). Here the expected theoretical inverted barometer relationship would have been –10 mm/mbar. All the correlations show a negative relationship, and none fall more than two standard deviations from the theoretical value. Because air pressure and winds are dynamically linked it is rare to find the exact theoretical value in practice.

Table 6. Correlation between annual mean sea level pressure and annual mean sea level (both detrended).

	Trend (mm/mbar)	Standard error
Brest	-14.77	2.04
Newlyn	-11.89	1.55
Calais	-14.42	10.24
Dover	-7.08	3.30
Le Havre	-14.20	4.83
Portsmouth	-9.74	3.60

The most reliable records, those with smallest standard errors, indicate collectively that wind effects slightly enhance the effective inverted barometer effect in the English Channel.

Finally Table 7. and Figure 9. show statistical relationship between the annual NAO index and the winter NAO index, and the annual standard deviations of the non-tidal residuals. Again the results are erratic, with no regional pattern apparent. None of the correlations are significantly different from a zero trend, although the long record at Newlyn suggests a reduction of surge activity as the winter NAO increases.

This is unexpected and calls for further detailed dynamic interpretation.

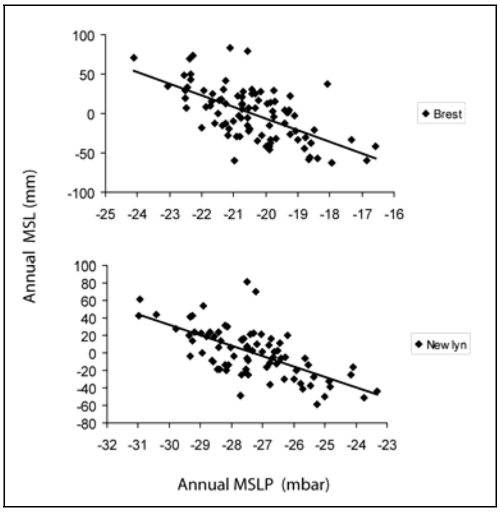


Figure 8. Correlation between annual mean sea level and annual mean sea level pressure (both detrended) for Newlyn and Brest.

Table 7. Upper section shows trend between non-tidal residual standard deviation and annual NAO index. Lower section shows results if winter NAO index values are instead considered.

	Annual Trend (mm/unit NAO index)	Standard error
Brest	0.29	2.31
Newlyn	0.95	2.78
Calais	1.58	5.58
Dover	9.38	3.30
Le Havre	9.28	3.14
Portsmouth	-2.70	3.00
	Winter Trend	
Brest	-0.74	1.13
Newlyn	-2.16	1.24
Calais	1.03	3.27
Dover	3.31	1.46
Le Havre	2.40	1.46
Portsmouth	-0.68	1.17

Littoral 2002, 22-26 September. Porto, Portugal.

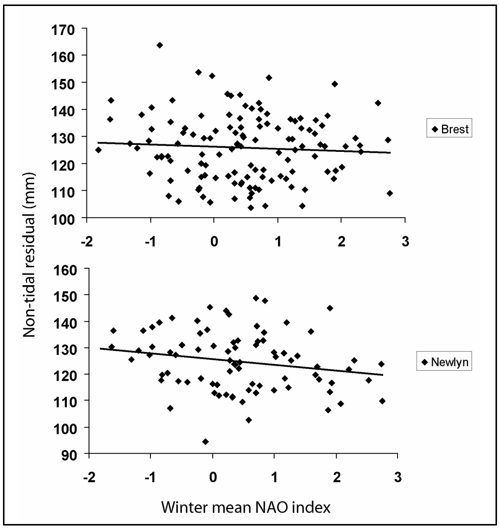


Figure 9. Correlation between non-tidal (meteorological) residuals and winter mean NAO index for Newlyn and Brest.

4. CONCLUSIONS

This work confirms a general rise in mean sea level in the English Channel. At Newlyn and Portsmouth the annual sea level variability has increased. No long-term regional trends were found either in tides or in sea level residuals related to storms. However, this should be further investigated with improved monitoring techniques and as longer records become available.

Substantial interannual variability is present in the records. For example, the annual non-tidal residuals at Newlyn and Brest are highly correlated. The inverted barometer effect is observed at all stations; at Newlyn and Brest the longest records, there are clear indications of slight enhancements, presumably due to correlated wind effects. The attempt to relate to atmospheric pressure and NAO index values proved only weak correlation. These results show how necessary it is to continue investing and improving the monitoring of parameters involved in sea level changes, in order to obtain more reliable understanding and predictions of future patterns. There are intentions of extending this study to the southern European Atlantic coast.

ACKNOWLEDGEMENTS

The authors would like to thank the British Oceanographic Data Centre, Associated British Ports and the Service Hydrographique et Océanographique de la Marine for providing the sea level data.

This work has been partially funded by the Fundação para a Ciência e a Tecnologia grant SFRH/BD/6924/2001.

REFERENCES

Araujo, I., Pugh, D. & Collins, M. 2001. An intensive analysis of sea level trends at Newlyn. Proceedings of the EOSS Sea Level Workshop, Dubrovnik, September 2001, 90-92.

Cartwright, D.E. 1972. Secular Trends in Oceanic Tides. *Geophys. J. R. astr. Soc.*, 30, 433-449.

Hurrell, J.W. 1995. Decadal trends in the North Atlantic Oscillation: Regional Temperatures and Precipitation. *Science*, 269, 676-679.

Jones, P. D. 1987. The early twentieth century Arctic High – fact or fiction? *Climate Dynamics* 1, 63-75.

Jones, P. D., Jónsson, T. & Wheeler, D. 1997. Extension to the North Atlantic Oscillation using early instrumental pressure observations from Gibraltar and South-West Iceland. *Int. J. Climatol.*, 17, 1433-1450.

Permanent Service for Mean Sea Level (PSMSL), 25th April 2002. *Tidal Analysis and Prediction Packages*, www.pol.ac.uk/psmsl/training/task2k.hel

Pugh, D.T. 1987. *Tides, Surges and Mean Sea Level: a handbook for engineers and scientists*, John Wiley & Sons, Chichester, 047191505X

TERI, 2002. *Intergovernmental Panel on Climate Change*, http://www.ipcc.ch/

Tsimplis, M.N. & Josey, S.A. 2001. Forcing of the Mediterranean Sea by atmospheric oscillation over the North Atlantic. *Geophsy. Research Let.*, 28, 803-806.

Woodworth, P.L. 1989. Trends in U.K. Mean Sea Level. *Mar. Geod.*, 11, 57-87.

Woodworth, P.L. Shaw, S.M. & Blackman, D.L. 1991. Secular trends in mean tidal range around the British Isles and along the adjacent European coastline. *Geophys. J. Int.*, 104, 593-609.

Littoral 2002, 22-26 September. Porto, Portugal.

Woolf, D., Wakelin, S., Flather, R., Tsimplis,. M & Yan, Z. 2002. Sea level in European Seas; The role of the North Atlantic Oscillation. *Geophysical Research Abstracts*, 4, 27th General Assembly, EGSO2-A-05998.

APPENDIX A10

PECS Paper: Ria de Aveiro

PECS 2004 – MÉRIDA – MÉXICO

Sea Level Variability and its impacts in a NW European Lagoon: Ria de Aveiro, Portugal

ISABEL ARAÚJO[1], DAVID PUGH[2], JOÃO DIAS[3]

1. Southampton Oceanography Centre, University of Southampton, European Way, Southampton SO14 3ZH, U.K. email: ixa@soc.soton.ac.uk

2. University of Liverpool, U.K. email: d.pugh@mac.com

3. Departamento de Física, Universidade de Aveiro, Campus Universitário de Santiago, 3810-193 Aveiro, PORTUGAL. email: jdias@fis.ua.pt

keywords: *Sea Level, coastal lagoon, Portugal*

ABSTRACT

Sea level variation is a main contributor in controlling the evolution of coastal lagoons as well as determining risks of coastal flooding.

This work investigates both long and short-term sea level variability in the Ria de Aveiro, a tide-dominated shallow coastal lagoon located on the western coast of Portugal. The 27 year series of available sea level observations from the permanent tide gauge, at the mouth of the Lagoon, has been analyzed for changes in the different sea level components: tides, surges and mean sea level. The various tidal constituents show interesting local short-term variations in amplitude and phase but no long-term trends. There is no evidence of an increase in weather effects on sea levels and of mean sea level over the period analyzed.

Short (1-3 month) sea level data collected during two surveys (1987/8 and 2002/3) in the lagoon are compared. Results show that there has been a significant change in the tidal characteristics of the Lagoon with a general increase in amplitude and decrease in phase for most harmonic constituents.

Introduction

The Ria de Aveiro is the most extensive shallow coastal lagoon in Portugal (Teixeira 1994). It is located on the Western Atlantic coast of Portugal between 40° 38´ N and 40° 57´ N (Figure 1A), covering a minimum area of approximately 66 km^2 at low spring tide, and reaching a maximum of 83 km^2 at a high spring tide (Dias 2001). The system is characterized by a series of channels in between which lie significant intertidal areas, essentially mudflats, salt marsh and old saltpans that connect to the ocean by a single artificial inlet.

The average depth of the Lagoon is approximately 1m with the greatest depths found at the lagoon entrance. The water circulation in the Lagoon is tide-dominated and with the tidal pattern mainly influenced by the lunar semi-diurnal constituent (M_2) with mean tidal range of approximately 2.0 m, with minimum tidal range of 0.6 m (neap tides) and the maximum tidal range of about 3.2 m (spring tides) (Dias *et al.* 1999).The main channels (Figure 1A) are: the Mira, Íhavo, S. Jacinto, Ovar and Espinheiro. The Rio Vouga is the main river, supplying 2/3 of the fresh water that enters the Lagoon.

The evolution of the Ria de Aveiro during the 20th century has been characterized by erosion of mud flats, salt marsh and old salt pans, and widening of most channels. These changes together with other contributions are believed to have modified the tidal dynamics of the system making it more vulnerable to risks of flooding and to sea level rise.

To investigate local sea level variability impacts on a coastal lagoon such as the Ria de Aveiro, an understanding of sea level changes occurring at the mouth as well as knowledge on tidal changes inside the lagoon are essential. Data collected since 1975 from the permanent tide gauge, located in the inlet channel (A in figure 1B) together with sea level data collected during 1987/8 and 2002/3, throughout the Ria de Aveiro lagoon, are used to describe sea level variability in this region.

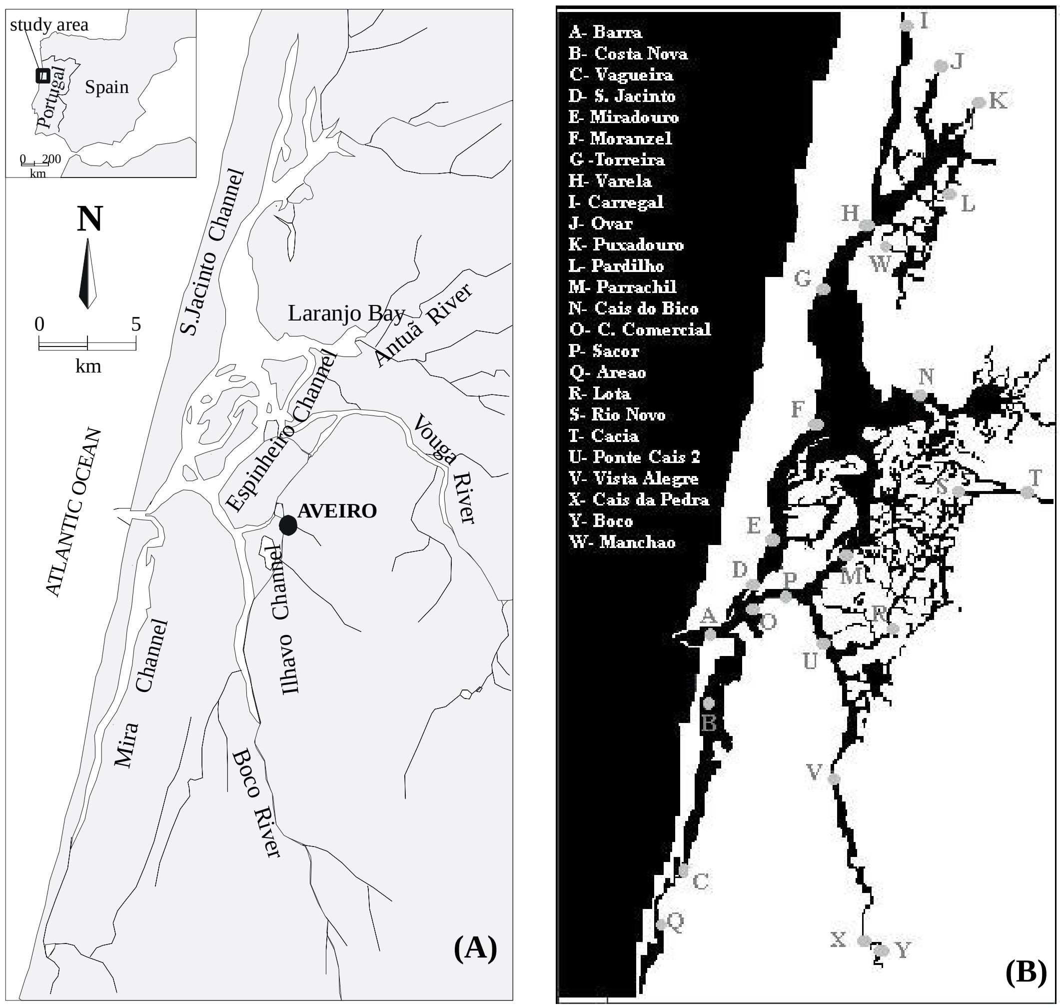


Figure 1. (A) General map of the Ria de Aveiro Lagoon showing it's location and main channels. **(B)** Detailed map with location of stations used in the 1987/88 and 2002/03 surveys.

Long-term Analysis and Results

The only long-term and continuous source of tidal data, collected in Aveiro, originates from the permanent tide gauge located at the inlet (A in Figure 1b). Hourly digitized sea level values are available since 1975 however, this potential long-term dataset is significantly reduced due to discontinuities in the records.

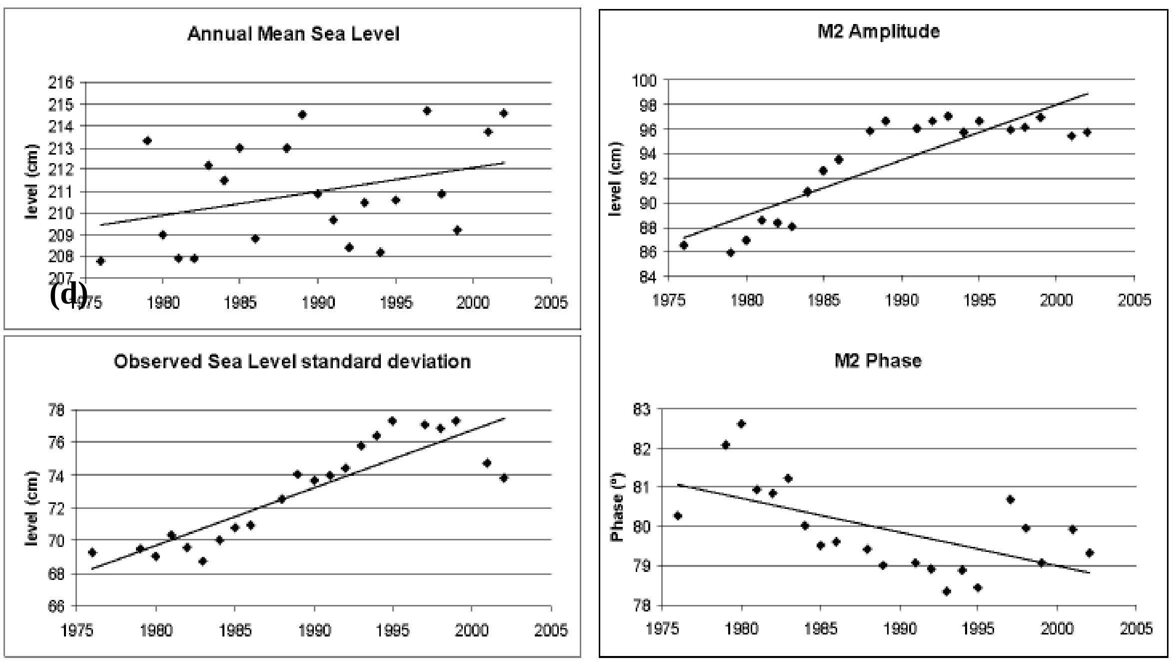
The years containing at least 300 days of data were selected and analyzed using the harmonic analysis program PSMSL/POL TASK 2000 package (www.pol.ac.uk/psmsl/training/task2k.hel), providing predicted and residual values, as well as values for 63 harmonic constituents for each year of data. To reduce the errors introduced in the tide gauge readings, a robust editing process (Araújo *et. al.* 2002) was applied to improve the data, which proved to be of very poor quality.

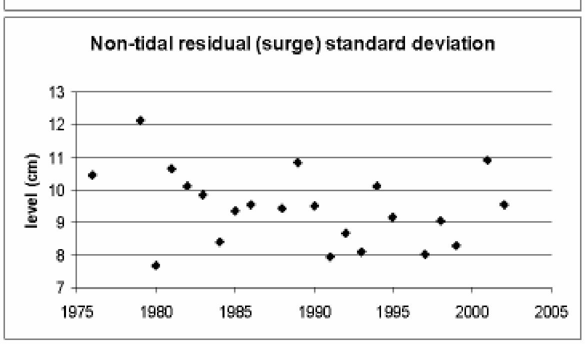
A second harmonic analysis was performed on the edited data. Statistics of sea level variations were investigated by separately analyzing tides, surges (non-tidal meteorological residual) and mean sea level

(MSL) changes, as the forcing factors are essentially independent. Land movement is not accounted for in these results.

No statistically significant increase in MSL has been found for the 22 years analyzed (Table 1 & Figure 2a). This might be explained by the shortness and discontinuous characteristic of the dataset used. The meteorological surge (non-tidal) component of sea level (Figure 2c) has no significant trend (Table 1). The observed sea level variability (Figure 2b) shows an increase until 1999, after which values slightly decrease. This small decrease may be related to improved maintenance of the tide gauge. The tide component of sea level shows significant trends (Table 1). The main tidal constituent M_2 used to illustrate the changes in the tide component shows that while M_2 amplitude has increased its phase has decrease (Figure 2d & Table 1).

The lack of continuity and the suitability of some records in the dataset analyzed is the main problem in estimating trends with confidence. Results should be treated with caution.





		Trend	Standard error
Mean Sea Level		0.110 cm/yr	0.066
Observed Sea Level std		0.345 cm/yr	0.043
Surge (non-tidal residual)		-0.043 cm/yr	0.032
Tides	*M_2 Amplitude*	0.451 cm/yr	0.061
	M_2 Phase	-0.087 °/yr	0.027

Table 1. Trend for each sea level component.

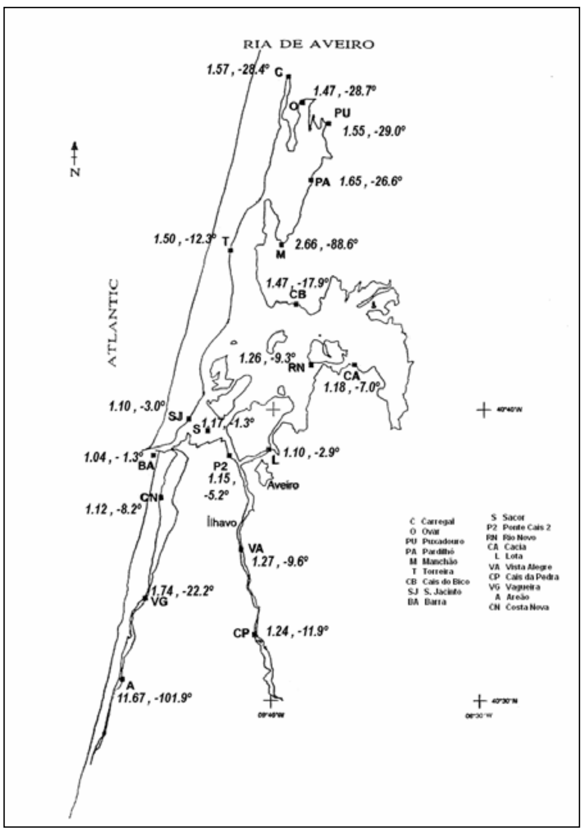
Figure 2. (a) Annual mean sea level; **(b)** Total observed sea level standard deviation; **(c)** Non-tidal (meteorological surge) residual standard deviation; **(d)** Tide component illustrated by M_2 amplitude and phase variations.

Short term Analysis and Results

During 1987 and 1988 the Portuguese Hydrographic Office undertook a detailed survey of the Ria de Aveiro lagoon, collecting tidal data at a series of stations (Figure 1B). The extent of the Lagoon and the limited number of instruments meant that these had to be moved progressively between stations, in order to obtain a general coverage. Consequently, the measurements were not simultaneous over time.

In the frame of this work a similar survey was undertaken during 2002/3 using the same stations (Figure 1B) in order to investigate changes that may have occurred throughout the past 15-16 years. Whenever possible, measurements were carried out at the same time of the year as in the 1987/8 survey to avoid seasonal bias. The impossibility of reproducing the datum referencing during last survey means that tidal variability is being investigated without considering MSL changes inside the Lagoon.

A harmonic analysis has been carried out on the data from both surveys using the PSMSL/POL TASK 2000 package, Tira 1-month analysis to obtain amplitude and phase values for the major constituents. The amplitude ratios and phase differences of the main constituent M_2, between 2002/3 and 1987/8 are presented (Figure 3). For the last 16 years, there has been a general increase in amplitude and a decrease in phase for most harmonic constituents (Figure 3 & Table2). Generally, channels in the central section of the lagoon, which are maintained for navigation, have undergone smaller changes, whilst biggest changes are found at the upper reaches of the Lagoon or in areas where the channel has been modified.



Station		1987/88 Amplitude (cm)	1987/88 Phase (°)	Amplitude increase (%)	Phase decrease (min)
Carregal	C	33.80	197.2	56.7	58.8
Ribeira	O	35.10	193.8	47.0	59.4
Puxadouro	PU	31.86	193.8	54.8	60.1
Pardilho	PA	32.78	190.3	65.0	55.1
Manchao	M	22.84	218.6	166.4	183.4
Cais do Bico	CB	58.58	137.9	47.4	37.1
Barra	BA	96.17	79.4	3.9	2.7
Costa Nova	CN	88.71	95.7	11.6	16.9
Vagueira	VG	48.93	129.7	73.8	46.0
Areao	A	3.70	238.4	-	-
Lota	L	83.41	103.4	10.1	6.0
Rio Novo	RN	63.14	117.6	25.7	19.2
Cacia	CA	58.00	126.7	18.1	14.4
Sacor	S	87.13	91.4	17.0	2.6
Ponte do Cais 2	P2	83.93	98.6	15.5	10.8
Vista Alegre	VA	50.42	145.2	26.7	19.8
Cais da Pedra	CP	50.27	159.1	24.3	24.7
S. Jacinto	SJ	86.08	90.8	9.6	6.2
Torreira	T	47.61	140.3	50.4	25.3

Table 2. M_2 amplitude and phase results from the past 1987/8 survey. Changes in M_2 amplitude and phase obtained by comparing 1987/8 data to that collected during 2002/3 are also given.

Figure 3. Map showing results obtained for each of the stations used in both surveys. The first value given beside the station code is the ratio between the M_2 amplitude in 2002/3 at that of 1987/8. The second value (negative) represents the phase difference between 2002/3 and 1987/8.

Conclusions

No significant increase in MSL and in the meteorological surge (non-tidal) components of sea level has been found from the analysis of the long term data over the last 28 years from the Ria de Aveiro's permanent tide gauge. Significant trends have been found both in observed sea level variability and in the tide component of sea level. However, a longer data set is needed to confirm these trends since the dataset used is short and of poor quality for long term statistics.

The present survey of tidal variations within the lagoon shows that, for the last 16 years, there has been a general increase in amplitude and a decrease in phase for most harmonic constituents. This follows past descriptions of the tidal evolution and is expected since changes in channel geometry by dredging; pier construction; and embankment alterations are known to have been carried out.

Further analysis will look at the roles of these factors in causing the changes found.

Acknowledgments

The authors would like to thank Administração do Porto de Aveiro, the Universidade de Aveiro – Departamento de Física and Nuno Vaz. This work has been funded by the Fundação para a Ciência e a Tecnologia grant SFRH/BD/6924/2001.

References

Araújo, I., Pugh, D. & Collins, M. (2002). Trends in components of sea level around the English Channel. Proceedings of the EUROCOAST conference - Littoral2002, Porto September 2002.

Dias, J.M., Lopes, J.F. & Dekeyser, I. (1999). Hydrological characterisation of Ria de Aveiro, Portugal, in early Summer. *Oceanologica Acta*, 22, 473-485.

Dias, J.M. (2001). Contribution to the study of the Ria de Aveiro hydrodynamics. Universidade de Aveiro. PhD. Thesis, 288pp.

Teixeira, S. (1994). *Dinâmica Morfossedimentar da Ria de Aveiro (Portugal).* Faculdade de Ciências da Universidade de Lisboa. PhD. Thesis, 397 pp.

Permanent Service for Mean Sea Level (PSMSL), 25th April 2002. *Tidal Analysis and Prediction Packages*. Available: www.pol.ac.uk/psmsl/training/task2k.hel (date 25th April 2002).