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INTERNAL DOCUMENT 10

I.O.S.

Sources of Open-Water Wave Climate Data

(IOS 10/1.1.1)

Mr L. Draper,
IOS, 1-2-77.

NATURAL ENVIRONMENT RESEARCH COUNCIL

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SUMMARY

Sources of wave data of sufficient duration for studies of wave climate are reviewed. There is a scarcity of open ocean measurements away from coasts. The world-wide instrumental data base is extremely limited and would need extensive support from the much larger set of less accurate visual wave observations for the interpretation of wave climate over wide areas. The availability of spectral data is even more limited and the only directional spectral data in existence have been calculated for a small number of research projects.

INTRODUCTION

Sources of wave information of value to the engineering user are of two classes, (a) visual observations, usually made over many years by vessels on passage across some generally homogeneous (as far as waves are concerned) sea area, and (b) instrumental measurements at specific locations over one or more years (or at the very least, one rough season). The latter class is much preferred because of its accuracy and the detail which it yields, but the number of stations is severely limited. Only in the waters around the British Isles is there adequate areal coverage and even here only the general picture is obtained; the fine structure still needs to be investigated. Advice on the availability and

interpretation of wave climate data from specific areas is available from the Marine Information and Advisory Service (MIAS) of IOS.

VISUAL OBSERVATIONS

Visual observations of wave height and period have the advantage that they require no equipment, and can be accumulated over long durations with very little additional expense. They are unique in that, in general, the direction of wave travel is also given (there is no instrument in routine use which reports wave direction or can be interpreted to give directional wave spectra or any information on wave direction). Their principal value is in the possibility of comparing one area with another. Data from any one area can be approximately converted into the equivalent of instrumental measurements by comparison with data from another area where instrumental measurements are available, provided that the measurements are representative of the whole area of visual observations.

There is reasonable agreement as to how visual observations can be interpreted. They can be shown to be correlated with the significant wave height (Hogben & Lumb, 1967, section 7), itself defined as the average value of the highest one third of the crest-to-trough wave heights present at the time.

Some studies (Hogben & Lumb, 1964) have suggested that visual heights and instrumentally obtained significant wave-heights are similar, but a comparison of British visually-observed data in the North Atlantic (Hogben & Lumb, 1967, Area 2) with measurements from OWS station India (Draper & Squire, 1967) suggests differences. Visual observations are uncertain at low wave heights, are a little lower, perhaps by about 20%, than

measured significant heights for the most common conditions, whilst really high waves with Hs > 10 m, which appear for about 1.5% of the time in measurements, are nearly non-existent in visual observations where they are reported for only 0.02% of the time.

Sources of Visually Observed Data

1. In 1967 the World Meteorological Organization arranged for the publication of marine climatological summaries including wave observations. Responsibility has been divided amongst nine nations, and their areas are shown in Figure 1. So far only a few publications have emerged. The WMO series is the only comprehensive and continuing one for visual wave data, and of necessity its sources are mainly on shipping routes.

2. One other source of such data effectively spans the world, again only on shipping routes. This is 'Ocean Wave Statistics' (Hogben & Lumb, 1967); it contains about a million observations unevenly spread over 50 areas. One of these areas "Area 2" can be calibrated against instrumental measurements from Ocean Weather Ship Station India (59°N 19°W). Hogben and Lumb's summary has several shortcomings. In general the areas are too big; regions of different wave climate conditions are compounded. For example, measured waves in the North Sea (Hogben & Lumb Area 4) vary by a factor of over 2 to 1 in height from North to South; Hogben and Lumb's Area 22, mostly in the east Pacific, contains an appreciable part of the Caribbean. It is unfortunate that the actual numbers of observations are presented instead of normalized values, so that comparison of one area with another is difficult. There is an error in the directions given; 30° must be added to all directions given in the book (Hogben, 1974).

3. USNOO publication 700 (1963) Section IV is a further source of visually-observed data for the North Atlantic, plus the Caribbean, Mediterranean, Black Sea, North Sea and Baltic Sea. A small amount of wave information is given in USNHO Publication 705 Part I (1957) for the Antarctic and Part II (1958) for the Arctic. Information is summarized in the form of wave roses plus a percentage occurrence bar. The data for the vicinity of OWS station India, for example, are similar to those given in Ocean Wave Statistics.

4. For nine years the IOS has been accumulating visual observations of wave height and period at stations around Scotland. An analysis of reports from 18 of these stations has been undertaken and a report is being written.

INSTRUMENTAL MEASUREMENTS

Most wave measurements have been made near to a shore where equipment can be fixed to a structure or placed on the sea bed in shallow water, usually not deeper than about 20 metres. For deeper water there is only a very small number of instruments which can be used. The IOS Shipborne Wave Recorder has been used extensively around the U.K. on Light Vessels and Ocean Weather Ships and also in other parts of the world. The Dutch Waverider is now more used than the Shipborne Wave Recorder, especially for positions in telemetry range of shore or other fixed stations.

Sources of instrumentally measured wave data

1. PIANC Inventory

An information system was devised by about 1973 by the Permanent International Association of Navigation Congresses (PIANC). It attempted to list all known sources of instrumentally measured wave data of at least 6 months' duration.

Virtually all the stations were close in-shore, the only deeper-water locations listed were those of wave recording stations originated by IOS. Unfortunately PIANC does not have the financial resources to update the system, so the IOC Intergovernmental Oceanographic Commission is considering the possibility of taking responsibility for running it through its committee on International Ocean Data Exchange (IODE). The present inventory lists about 350 locations, but if the IODE Task Team on Wave Data Management recommendations (unpublished letter from Chairman) are implemented it seems likely that a world-wide network of representatives will be established to seek out sources of wave data and report back to some central information body for wave data. This body will probably be a national oceanographic data centre. It has been suggested, and the possibility is being investigated, that the UK MIAS will undertake this task.

2. IOS Index

IOS already maintains a card index of publications relevant to measured wave data. Those which complied with the PIANC requirements in 1973 are included therein, many of the others refer to lesser amounts of data, or calculations of specific conditions at a particular location. Some are publications including analyses of certain aspects of wave data, or even of wind data relevant to wave forecasting. There are about 30 cards relevant to the Atlantic, a similar number for the Pacific and about 50 for the North Sea. A list of all the climatological wave data reports which have emanated from IOS is attached. (For brevity, only the titles are given).

A British Isles chart of wave recording locations has been produced for the Department of Energy, but is too large to reproduce here. Recent and continuing sources of instrumentally measured wave data indicated on the chart are the 3 UKOOA sponsored stations in the Celtic Sea and adjacent to Orkney and Shetland.

3. Source book on wave information

Dr N. Hogben, as chairman of the Working Group on Surface Waves of ECOR (Engineering Committee on Oceanic Resources), has compiled from his own and Working Group Members' indexes a provisional source book on wave information "A Wave Data Directory" November 1975. In the introduction he acknowledges that "It would be unrealistic to expect that such bibliographies can ever be made complete....". In a growing subject this is inevitable, and the best service can be provided by an active list of sources rather than by a published book, but the latter is a valuable guide to the types of source which might be available.

4. Spectra derived from instrumental measurements

Spectral data referred to in this document are non-directional. Hogben (1975) lists 31 sources of spectral data. There are few, if any, comprehensive spectral wave data publications. Almost all of them present a selected few spectra which had been obtained for specific purposes such as ship motion studies, and only one set of data, published separately by two organizations which co-operated in the analyses (Miles, 1971 or Hoffman, 1972), which can pretend to present a spectral wave climatology.

THE FUTURE

In a growing subject such as this the only practicable way to provide access to the index in the various ways called for (such as, for example, by geographical location, or for spectra) is to use a computer-based storage and retrieval system. This must be backed by an effective international network which identifies and catalogues sources of wave data as they emerge. Although there is no location at which a representative climatology of directional wave spectra has been obtained, a desire for such data is often expressed.

Intensive instrumental research is needed before such an objective can be achieved.

CONCLUSIONS

1. Visual data constitutes the bulk of the data and comprises three figures - height, period and direction.
2. Visual data is very inaccurate for higher waves.
3. Instrumental data, whilst more extensive in U.K. waters than anywhere else in the world, is still sparse.
4. Much of the instrumental data has been analyzed to yield wave climate statistics.
5. Spectral information is beginning to be used more widely now that digital logging systems are coming into routine use, but comprehensive spectral wave climatologies are still non-existent.
6. No instrument is yet available for the routine measurement of directional spectra.
7. No instrument is available for routine deployment more than, say 20 km away from shore or fixed platform (except for the Shipborne Wave Recorder which needs a dedicated vessel).
8. There is a proposal under consideration at this time that MIAS should extend its role internationally to act as a Responsible National Oceanographic Data Centre (RNODC) for wave data within the framework of IOC's committee on International Oceanographic Data Exchange.

REFERENCES

1. Draper, L. and Squire, E.M. 1967 Waves at Ocean Weather Ship Station 'India' (59°N 19°W).
Trans. Instn. nav. Archit. 109, 85-93, 1967.

2. Miles, M. 1971 Wave spectra estimated from a stratified sample of 323 North Atlantic Wave Records.
Canada, National Research Council, Divn. of Mechanical Engineering Lab. Technical Report LTR-SH-118.

3. Hoffman, D. 1972 Sampling of Ocean Wave Spectra at North Atlantic Station India (preliminary report).
Soc. nav. Archit. and mar. Engrs. SNAME Order 516.

4. Hogben, N. and Lumb, F.E. 1964 The presentation of wave data from voluntary observing ships.
NPL Ship Report No. 49.

5. Hogben, N. and Lumb, F.E. 1967 Ocean Wave Statistics.
HMSO.

6. Hogben, N. 1974 Ocean Wave Statistics - five minutes slow after six years.
NPL Ship Report No. 180.

7. Hogben, N. 1975 A Wave Data Directory (first draft, unpublished).

8. PIANC 1973 Final Report of the International Commission for the Study of Waves (Chairman: J. Larras).

9. USNOO Publication 700 (1963) Oceanographic Atlas of the North Atlantic Ocean, Section IV Sea and Swell.

10. USNHO Publication 705 Oceanographic Atlas of the Polar Seas. Part I Antarctic (1957) and Part II (1958) Arctic.

List of climatological wave data reports which have originated at IOS

Winter waves in the Northern North Sea at 57°30'N 3°E

Waves at North Carr Light Vessel off Fife Ness

Waves at Dowsing Light Vessel (in preparation)

Waves at Smith's Knoll Light Vessel

Waves at Galloper Light Vessel (in preparation)

Waves at Tongue Light Vessel, Thames Estuary

Waves at Varne Light Vessel, Dover Strait

Waves at Owers Light Vessel, English Channel

Waves at Shambles Light Vessel (in press)

Chesil Beach sea wave records

Waves off Land's End

Waves in Cardigan Bay, off Cardigan (in press)

Waves at Morecambe Bay Light Vessel

Waves at the Mersey Bar Light Vessel

Waves at Ocean Weather Ship station 'India'

Waves at Ocean Weather Ship station 'Juliett'

Waves off Benghazi Harbour, Libya

Waves at Sekondi, Ghana

Waves at Camp Pendleton, California

Confidential documents

Waves at DYCK Light Vessel, Dover Strait

Waves at Blackhead, Belfast Lough, Northern Ireland

World Meteorological Organization announces publication of marine climatological summaries

Marine climatological summaries for selected ocean areas of the world are now available on a sales basis from the various member countries of the World Meteorological Organization which were responsible for their development.

During the past several years, WMO has been engaged in the preparation of these summaries following a decision made at the fourth WMO Congress held in 1963.

It was decided that the most efficient system would be one whereby certain countries, on a voluntary basis, would undertake this responsibility for the ocean areas indicated on the facing map, while the basic data for the respective areas are forwarded to them by other countries.

The summaries contain information on dry-bulb and dew-point temperature; sea temperature and air-sea temperature difference; visibility; weather; wind direction and force; pressure; clouds; and waves. Summaries for the selected representative areas have been published for the periods indicated below and may be purchased directly from the following institutions:

Federal Republic of Germany 1964 and 1965
Deutscher Wetterdienst - Seewetteramt
D2 Hamburg 4
Bernhard-Nocht Strasse 76

Hong Kong 1964
Director, Royal Observatory
Nathan Road, Kowloon

India 1964
Deputy Director-General of Observatories
Meteorological Office, Poona-5

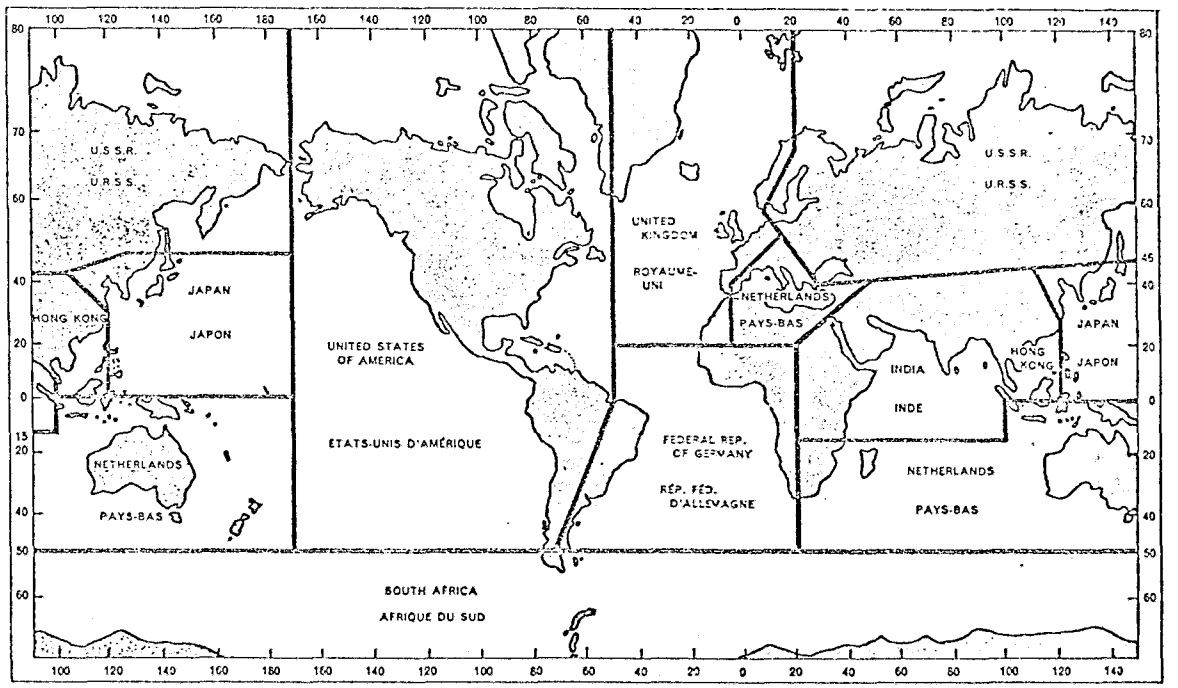

FIGURE 1

Japan 1963 to 1967
Marine Division,
Japan Meteorological Agency,
1-3-4 Ote-machi, Chiyoda-ku, Tokyo

Netherlands 1964
Koninklijk Nederlands Meteorologisch Instituut
Utrechtseweg 297, De Bilt

United Kingdom 1963 to 1966
Meteorological Office
London Road, Bracknell, Berkshire RG12 2SZ

United States of America 1961 to 1968
Director, Environmental Data Service,
NOAA, Asheville, N.C. 28801