FILE.

INTERNAL DOCUMENT 246.

I.O.S.

CONTINENTAL SLOPE EXPERIMENT (CONSLEX)

COASTAL SEA LEVEL DATA

by

S.M.Shaw, D.L.Blackman

J.Campbell, R.J.Maher, J.D.Richards

NATURAL ENVIRONMENT RESEARCH COUNCIL

INSTITUTE OF OCEANOGRAPHIC SCIENCES

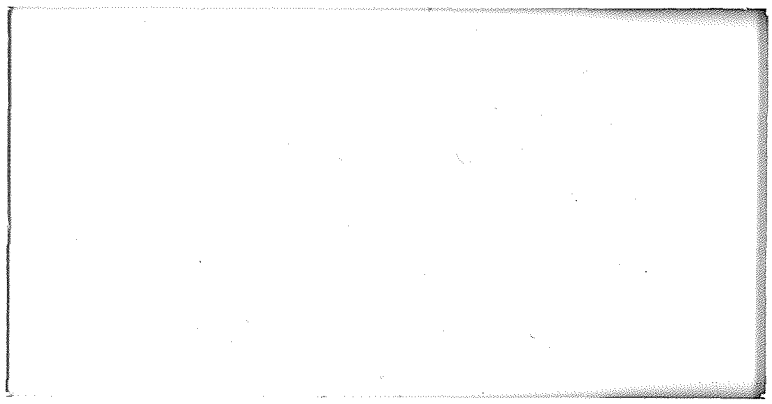
INSTITUTE OF OCEANOGRAPHIC SCIENCES

Wormley, Godalming,
Surrey GU8 5UB
(042-879-4141)

(Director: Dr. A. S. Laughton)

Bidston Observatory,
Birkenhead,
Merseyside L43 7RA
(051-653-8633)
(Assistant Director: Dr. D. E. Cartwright)

Crossway,
Taunton,
Somerset TA1 2DW
(0823-86211)
(Assistant Director: M. J. Tucker)



CONTINENTAL SLOPE EXPERIMENT (CONSLEX)

COASTAL SEA LEVEL DATA

by

S.M.Shaw, D.L.Blackman

J.Campbell, R.J.Maher, J.D.Richards

IOS Internal Document No.246

November 1985

CONTENTS

1 INTRODUCTION

The Continental Slope Experiment was undertaken to study in detail the interaction between the deep ocean and shallow seas at the western edge of the Scottish continental shelf over the winter period August 1982 to March 1983.Current meter moorings were maintained in six sections across the slope from 57 degrees North (west of Hebrides) to 0 degrees East (north of Scotland);to the west of Ireland,over the Wyville-Thompson ridge and in the Faeroe-Scotland channel.Bottom pressure gauges,for sea level measurements,were deployed at each end of the six sections and at four specially installed coastal sites,complimenting seven permanent tide gauges on the A-class network.

This report is a summary and quality review of the results obtained from the 11 coastal sites (Figure 1).

Of the 7 A-class installations, original records in the form of analogue charts were obtained from 5 sites, tabulated hourly values from Newlyn and Mylar tape recordings at 15 minute intervals from Stornoway.

At the specially installed coastal sites,Aanderaa gauges recorded pressure values at 15 minute intervals on magnetic tape which subsequently were translated to elevations through a standard computer program designed to take into account such parameters as gas flow rates,tube lengths and sea water density values.Wherever possible the observed levels obtained covered the period August 1982 to March 1983 (see Table 1).

In addition, values of mean sea level and residual levels (observed - predicted) were calculated.For the A-class gauges,the predicted values were the latest available to IOS, but in the case of the Aanderaa gauges these were derived from analyses of the data spans obtained during the experiment.

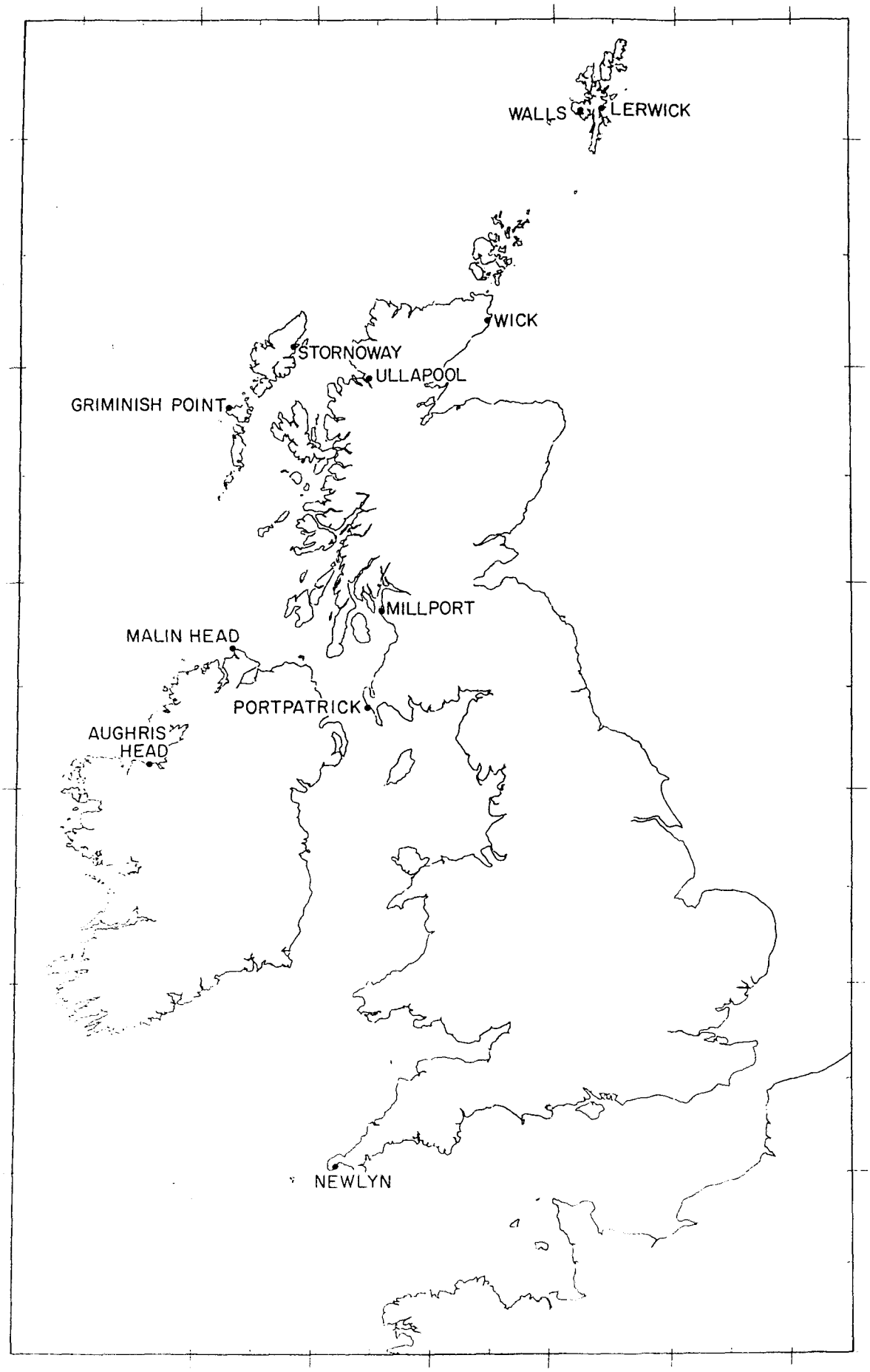

WALLS
LERWICK
WICK
STORNOWAY
ULLAPOOL
GRIMINISH POINT
MILLPORT
MALIN HEAD
PORTPATRICK
AUGHRIS HEAD
NEWLYN

Figure 1

Table 1

Installation details

1) A-class network	Location and gauge type	Data duration
i)LERWICK,SHETLAND	60 09'N 01 08'W	01-07-82 to 31-12-83.
	Lea analogue gauge, stilling well	
ii)WICK,SCOTLAND	58 26'28.8"N 03 05'05.7"W	01-07-82 to 31-07-83.
	Lea analogue gauge, stilling well	
iii)STORNOWAY,HEBRIDES	58 12'N 06 23'W	18-02-83 to 30-07-83.
	Ott digital gauge, stilling well	
iv)ULLAPOOL,SCOTLAND	57 53'44.7"N 05 10'27.0"W	06-12-82 to 31-07-83.
	Munro analogue gauge, stilling well	
v)MILLPORT,CUMBRAE	55 45'N 04 54'15.0"W	01-07-82 to 31-12-83.
	Lea analogue gauge, stilling well	
vi)PORTPATRICK,SCOTLAND	54 50'32.7"N 05 07'08.0"W	01-07-82 to 31-12-83.
	Lea analogue gauge, stilling well	
vii) NEWLYN,CORNWALL	50 06'08.7"N 05 32'30.0"W	01-07-82 to 31-12-83.
	Cary-Porter/Munro analogue gauge, stilling well	

2) Temporary sites	Location	Data duration
WALLS,SHETLAND	60 14'N, 01 34'W	07-09-82 to 14-06-83.
GRIMINISH POINT,N.UIST	57 40'N, 07 29'W	06-07-82 to 08-08-83.
MALIN HEAD, EIRE	55 22'N, 07 20'W	23-07-82 to 15-07-83.
AUGHRIS HEAD,SLIGO,EIRE	54 17'N, 08 45'W	25-07-82 to 16-07-83.

2. A-CLASS NETWORK SITES

2.1) LERWICK 1st July 1982 to 31st December 1983.

Weekly analogue records were obtained from the Lea tide gauge operating in a stilling well. The records are typified by a large seiche of up to 30 minute frequency and a height of 0.5m with occasionally a higher frequency (less than 1 minute) and 0.1m height wave action superimposed, particularly in high winds from the southerly quarter.

Hourly heights were extracted from the records by "filtering" through the trace by a combination of hand and eye. Although there was much evidence of small pen trace alterations coinciding with the tide gauge operator's visits (usually around 0930 each morning) any effects were nullified by filtering and no additional corrections were made to the extracted heights.

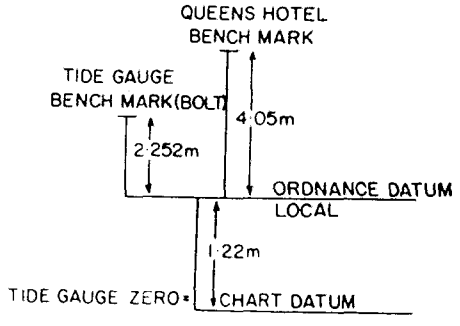
TIME ZONE

G.M.T.

DATUM REFERENCES

TGZ = OD local -1.22m

= TGBM -3.472m



Hourly heights were reduced to the zero of the records which is quoted to equal Chart Datum, 1.22m below Ordnance Datum Local. Other than checks made by the tide gauge operator against the tide staff alongside, this value has not been verified since a visit by Tide Gauge Inspectorate (TGI), IOS Bidston in September 1979. On that visit the datum of the gauge was confirmed by levelling via a TGBM bolt on the south side of the gauge (ODL + 2.252m) to the Queen's Hotel Bench Mark (ODL + 4.05m).

GAPS IN RESULTS

Nil.

INTERPOLATED VALUES

1982	
28 July 1400 GMT to 29th July 0900	No ink
1 August 03-0400 and 20-2100	Pen not inking
2 August 00; 02; 04; 06; 0800	Sporadic inking only
1983	
1 January 1200	Flat high water (counter-weight wire too short)
29 January 1200	Flat high water (counter-weight wire too short)

2.2) WICK 1st July 1982 to 31st July 1983

Weekly analogue records were obtained from the Lea tide gauge operating in a stilling well.

The records typically included seiches ranging from 10 minutes to less than 1 minute in frequency, and from a height of 0 to 0.4 metres on the chart scale with a minimum in Westerly winds.

Some examples are :-

			Freq.	Height
19 Aug. 1982	Westerly	Force 1	10 min;	0.1m to zero
26 Oct. 1982	SSEly	Force 9	1 min;	0.3m
08 Nov. 1982	Southerly	Force 4	3 min;	0.4m
01 Feb. 1983	Northerly	Force 8	1 min;	0.4m
05 July 1983	SWly	Force 1	10 min;	0.1m to 0.2m

Hourly heights were digitised by "filtering" through the trace by a combination of hand and eye. Corrections to the data were made to counteract the effect of badly fitting charts on the drum causing a gap of up to 10 minutes in chart scale at the midnight join.

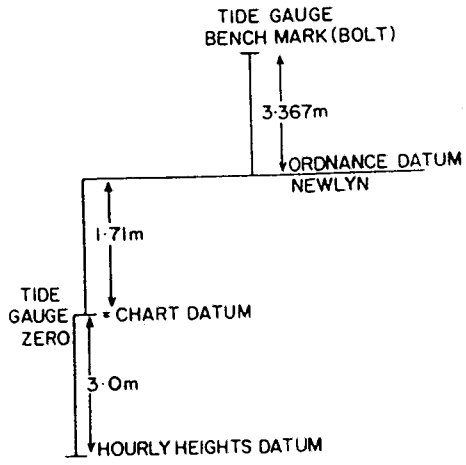
TIME ZONE

G.M.T.

DATUM REFERENCES

Hourly heights = ODN -4.71m

= TGBM -8.08m



Hourly heights were reduced to 3 metres below the zero of records, by adding 3 metres to the results to keep them positive and consistent with long period data sets.

Tide Gauge Zero is equal to Chart Datum, 1.71m below Ordnance Datum Newlyn and 5.08m below the Tide Gauge Bench Mark. (The TGBM referred to is OSBM bolt ND 3667 5080 on the east angle of the TG building (ODN + 3.367m).

GAPS IN RESULTS

1982	27-29 September	Pen not marking
	07-09 December	Pen not marking
1983	28 Feb. - 4 April	Counterweight down well

INTERPOLATED VALUES

1982	11 Oct. 00-0800 and 15-2300	Pen not marking
	12 Oct. 00-0800	Pen not marking
1983	08 Jan. 08-1000	Clock stopped
	27 Jun. 11-1300	Clock stopped
	29 Jun. 0900	Pen removed for checks on gauge.

ADDITIONAL OBSERVATIONS AND SITE VISITS

No visits were made by TGI to the gauge in 1982.

Well soundings were taken by the Ordnance Survey in March 1982 and October 1983 with mean values of ODN -1.80m and -1.71m respectively. The latter visit was made after a visit by TGI on 29 June 1983 when the

counterweight system was replaced and datums reset. It had been originally reported via the STWS that the counterweight wire had come adrift and the weight had fallen down the well (28 February 1983). The operator had replaced the wire and fitted a temporary counterweight in the form of a weighted pulley block. Thus there is a possibility of spuriously high or low values due to the temporary weight being too heavy or light,for the data period 4 April to 29 June 1983.

2.3) STORNOWAY 18th February 1983 to 30th July 1983

Mylar tape output was received in four sections, each containing 15 minute interval readings obtained from an Ott pneumatic system in a stilling well

TAPE 1	0930 February 18	to	1315 May 05
TAPE 2	1330 May 05	to	0845 June 24
TAPE 3	0900 June 24	to	0515 July 30
TAPE 4	Start not known	to	September 12

There were no processing problems with Tape 1,but Tape 2 had many parity errors on translation where the digits 8 and 9 were mispunched. Other than correcting these, there were no problems in processing.

Tape 3 was sent with Tape 4 by the operator. '3' was reported to have become jammed in the mechanism so that the end time was not known. '4' was labelled 'start time not known'. We were also informed that tape '4' ended, when it broke, on 12 September. Processing later revealed that '3' ended at 0515 GMT 30 July. Processing of '4' was abandoned. A further tape was sent by the operator covering the period 12 September 1983 to 9 January 1984. Several attempts at translation of this tape have failed to produce any data due to an excess of parity errors probably caused by mispunching.

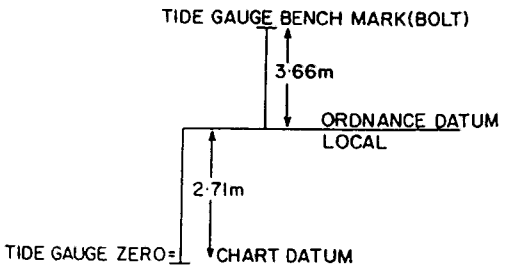
TIME ZONE

G.M.T.

DATUM REFERENCES

TGZ = OD local -2.71m

= TGBM -6.37m



Despite no Ordnance Survey visits since 1981 to confirm the level, the BM referred to is the OSBM bolt at grid reference NB 4228 3264 on the Quay on east side of Bank Street Wharf, which has since been destroyed.

GAPS IN RESULTS

Nil.

INTERPOLATED VALUE

0930 April 1st interpolated as 4.309m - missing value in middle of tape; reason not known.

All values were filtered to produce hourly heights for the period 1400 GMT 18 February to 0100 GMT, 30 July 1983.

ADDITIONAL OBSERVATIONS AND SITE VISITS

The last tape received having ended on the 22nd May 1982, the TGI visited the gauge site 6 and 7 December 1982 when they found the gauge mechanism locked due to the punch tape recorder having stopped in the middle of a punching cycle. The standby battery was exhausted.

They also discovered a broken air line,at the entry to an underground duct at the base of the jetty,which was detached from the jetty for about half its length.

The TGI returned on 15 February 1983 when they fitted a new air line with protective steel capping over its entire length. They reset the gauge datum and recording was recommenced on 18 February.

2.4) ULLAPOOL 6th December 1982 to 31st July 1983.

Hourly heights were extracted from the weekly Munro analogue records which display a generally smooth trace except during high winds in winter when there is a seiche of about 25 minutes period and up to 0.2m in height. There is no visual tide staff at the site due to extensive construction work. Recording at the site was discontinued on 3 June 1982 owing to severe clock problems and restarted with a new clock fitment on 6 December 1982. On 25 February 1983 there was a power cut and the back-up battery failed to cut in, resulting in a vertical trace up to high water. This was interpreted as a stoppage for 1 hour 10 minutes,making the remainder of the trace to the end of the record 1 hour 10 minutes slow.(The record was removed 1 March at 0840 GMT).

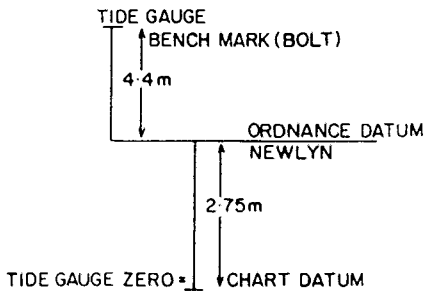
TIME ZONE

G.M.T.

DATUM REFERENCES

TGZ = ODN -2.75m

= TGBM -7.15m



Hourly heights were reduced to the zero of the records which is quoted as equal to Chart Datum, or 2.75m below ODN and 7.15m below the Tide Gauge Benchmark. This mark is the OSBM bolt on the North side of the pier, at grid reference NH 1288 9391.

GAPS IN RESULTS

Nil.

INTERPOLATED VALUES

1982	Nil.	
1983	25 Feb.1700 - 1800	Power cut - battery failure
	01 Mar.0900 - 1600	Interval between chart recordings
	30 Jun.0900 - 1300	Well blocked by marine growth

ADDITIONAL OBSERVATIONS AND SITE VISITS

No visits were made to the site by Ordnance Survey in 1982 or 1983. When the TGI visited the site on 30 June 1983 they discovered a blockage of the well. A diver reported that the orifice (cone shaped) was blocked by shellfish and rubble. Some of the debris was removed, but removal of the cone on 5 July allowed the removal of "a large amount of concrete debris and a number of counterweights from the bottom of the well".

Results show a distinct lag/timing error evident from about 20 May to 30 June 1983.

2.5) MILLPORT 1st July 1982 to 31st December 1983.

Hourly heights were extracted from the weekly Lea analogue gauge records,distinguished by notes in 'balloons' relating to regular,usually daily, time marks. Only occasional check sheets were completed.

There were many problems with the float or pen jamming at low waters in 1982 and problems with the counterweight wire in 1983.

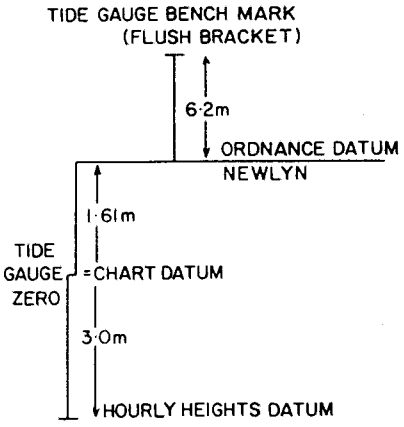
TIME ZONE

G.M.T.

DATUM REFERENCES

Hourly Heights = ODN -4.61m

= TGBM -10.81m



Hourly heights were reduced to a level of 3m below the zero of records (3m added). The zero of the records was taken as 1.61m below Ordnance Datum Newlyn, equal to Chart Datum, and 7.81m below the Tide Gauge Bench Mark. This bench mark is a Flush Bracket number G 4602 at grid reference NS 1757 5449 on the south angle of the NE wing of the Marine Station Building.

GAPS IN RESULTS

1982	27 Nov 0400 - 28 Nov 0400	Jammed at low water (0.72m on chart)
	29 Nov 0500 - 1400	" " " " (0.44m on chart)
	02 Dec 0700 - 03 Dec 1400	" " " " (0.3m on chart)
	05 Dec 2300 - 06 Dec 1400	" " " " (0.7m on chart)
	22 Dec 1000 - 23 Dec 0900	" " " " (0.95m reducing to 0.82m on chart)
1983	03 Jan 2000 - 06 Jan 1400	Clock stopped
	19 Jan 1100 - 20 Jan 1300	Problems with counterweight wire
	03 Feb 2300 - 04 Feb 1300	Counterweight fouling
	08 Feb 0001 - 24 Feb 1200	Counterweight wire fouled - TGI repaired

INTERPOLATED VALUES

1982	31 Aug 0700 - 0800	Pen or float jammed at 1.2m on rising tide
	31 Aug 1100 - 1200	Pen or float jammed at 2.55m on falling tide
	17 Oct 2000 - 18 Oct 0900	Part traces only - pen blocking
	10 Nov 1000 - 1400	Ink run out in high winds
	26 Nov 2100	Flat HW 3.03m
	17 Dec 0200	Flat HW 2.95m
	17 Dec 0800 - 1200	Pen or float jammed at 0.62m on rising tide
	21 Dec 2200 - 22 Dec 0400	Pen or float jammed at 0.6m at low water
1983	13 Jan 1900 - 2300	Pen or float jammed at 0.6m on rising tide
	03 Feb 1300 - 1900	Pen or float jammed at 1.67m on rising tide
	29 Sep 2000 - 2300	Pen off chart
	30 Sep 0001 - 0100; 2200	" " "

01 Oct 0001 - 0100	Pen off chart
02 Oct 0001 - 0100	" " "
03 Oct 0200 - 0300; 1300	" " "
04 Oct 1700	Pen off chart (Repaired by operator bending the pen arm).

ADDITIONAL OBSERVATIONS AND SITE VISITS

The Ordnance Survey visited the site in March 1982 and March 1983 when on each occasion they measured the mean well sounding as 1.61 below Ordnance Datum Newlyn. They visited again in March 1984, when the well soundings averaged out as 1.46m.

The TGI of IOS Bidston visited Millport three times in 1983. On 26th January they overhauled the gauge and replaced the float and counterweight wires. During this visit, it was noted that during a period of stormy weather the gauge house (built on 4 cylindrical piles driven into the seabed) was moving under the influence of wind and rough sea.

The site was revisited on 23rd February because the float wire had become entangled in the gauge mechanism.

On 29th September the TGI found the gauge to be operating satisfactorily on the correct datum,but they considered that some structural repairs would be necessary to maintain the pier in a safe condition.

2.6) PORTPATRICK 1 July 1982 to 31 December 1983.

Hourly heights were digitised from the weekly analogue records from the Lea tide gauge. Many of these charts were puckered and badly glued at the midnight join producing a slightly askew height scale and a gap up to the equivalent of 5 minutes of time scale.An effort was made to correct for these during reduction.There was severe seiching, predominantly over high waters during periods of high winds, e.g. 2 minute frequency and 0.8m in height on 17th October 1982 when a SSW gale force 9 was reported on the check sheet, and 2 minute frequency and 0.3m in height on 4 February 1983 during a Force 8 gale from the WSW.For periods such as these, the hourly heights were extracted by filtering by eye through the centre of the trace.

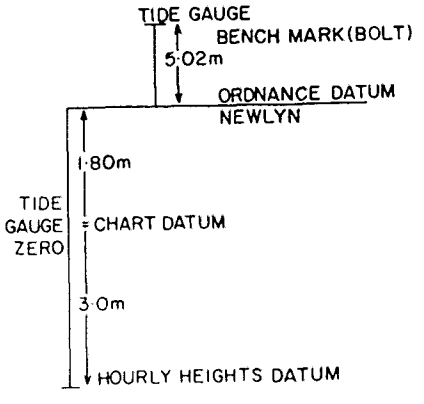
TIME ZONE

G.M.T.

DATUM REFERENCES

Hourly Heights = ODN -4.80m

= TGBM -9.82m



Hourly heights were reduced to 3 metres below the zero of the records. This zero was taken to be 1.80m below Ordnance Datum Newlyn, equal to Chart Datum, and 6.82m below the tide gauge bench mark. This mark is the OSBM bolt at grid reference NW 9976 5420, on the harbour wall 0.9m from the west angle of the tide gauge building.

GAPS IN RESULTS

1982	13 Nov 2000 - 15 Nov 1400	Clock stopped
	19 Nov 1800 - 20 Nov 1600	Ink run out
	22 Nov 1700 - 24 Nov 1100	Pen broken
	13 Dec 0001 - 1600	Clock stopped
	20 Dec 1700 - 21 Dec 1600	" "
	27 Dec 1800 - 28 Dec 1800	" "
1983	11 Jan 2100 - 12 Jan 1600	" "

INTERPOLATED VALUES

1982	25 Nov 0600 - 1100	Part feint ink traces only
	27 Nov 1400 - 1600	" " " " "
	28 Nov 0600 - 1500	" " " " "

A new pen arm and felt pen were fitted 29th November.

1983	11 Jan 0600 - 1500	Clock stopped
	18 Jan 0400 - 1200	Clock stopped
	26 Jan 1000	Pen off chart.

ADDITIONAL OBSERVATIONS AND SITE VISITS

The Ordnance Survey visited the site annually, each March. In March 1982 they measured the mean well soundings (TGZ) as 1.76m below ODN, and in both March 1983 and 1984 they measured it as 1.80m below ODN. In 1984 they also reported that the float wire was badly frayed.

The TGI of IOS Bidston visited the site twice in 1983. On the 25th January, they replaced the clock and counterweight wire. On their return on 29th August, the gauge was found to be working satisfactorily.

2.7) NEWLYN 1 July 1982 to 31 December 1983.

Hourly heights were reduced from tabulated values supplied by the Ordnance Survey. A Cary-Porter gauge was on site until 15 November 1983, when it was replaced by a new Munro gauge.

Some comments accompanied the tabulations:

1982	November 16 0740	Tidal chart approximately 1 hour slow due to wear on the clamping device which connects the cylinder to the clock and allowed slipping to occur. It was considered that the slipping occurred at some time after 0100 and a line has been pencilled in and figures abstracted from this 0200 - 0700 hours.
1983	April 26 1000	Considerable oil pollution in sea.
	October 2 and 3	Very strange tidal movements. Strong currents coming in and out at same time causing whirlpools etc.
	October 8	All readings between noon Saturday 8th and 0900 Sunday 9th are suspect due to faulty bearing on cylinder.
	October 17	Fault reported repaired.
	December 18	Unable to get to Observatory in daylight hours owing to a SE gale. Pier suffered damage to all wooden doors, windows, quarry etc.

N.B. A member of TGI was also in attendance on this day. Having negotiated the journey to the tide gauge hut he could not get back all day.

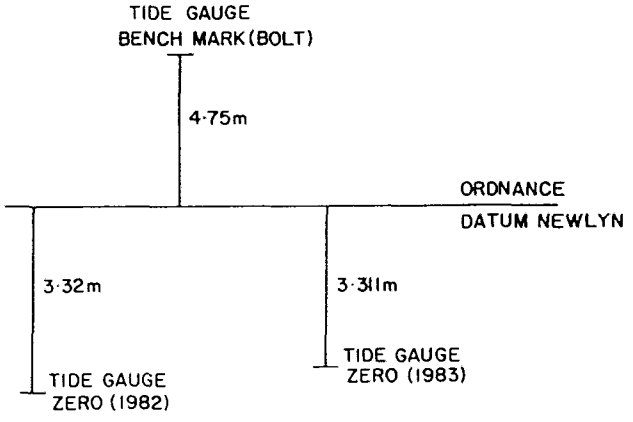
TIME ZONE

G.M.T.

DATUM REFERENCES

TGZ (1982) = ODN -3.32m = TGBM -8.07m

TGZ(1983) = ODN -3.311m = TGBM -8.061m



Hourly heights were reduced to Tide Gauge Zero.

For 1982, the datum of the values was taken as an average of mean well sounding 1981 and 1982 as supplied by the Ordnance Survey on their OS 319 summary sheets viz :-

1981 April = ODN -3.32m)

1982 March = ODN -3.31m) TGZ taken as 3.32m below ODN

September = ODN -3.32m) and 8.07m below TGBM

The tide gauge bench mark referred to is the brass bolt in the Observatory, grid reference SW 4677 2856.

In 1983 the TGI of IOS Bidston quoted ODN -3.311m as the zero of the gauge. This figure has therefore been used for 1983 data.

In addition to the well soundings on their summary sheets, the Ordnance Survey also carry out daily soundings culminating in "mean chart zero for week" figures which are supplied with the tabulated values.

These figures average out as -3.317m for 1982 and -3.306m for 1983.

GAPS IN RESULTS

1982 26-27 October	Clock stopped
1983 15-18 November	New gauge installed

ADDITIONAL OBSERVATIONS

1982 Some small time errors evident when compared with predictions. No corrections applied, no charts to hand.

1983 Problem with tidal profile 31 December - not resolved.

3. TEMPORARY INSTALLATIONS

3.1) WALLS SHETLAND

Aanderaa Gauge - no. 448.

15 minute data was filtered to produce hourly readings as follows :-

TAPE 1 1700 hours 07 September 1982 - 0500 hours 20 November 1982

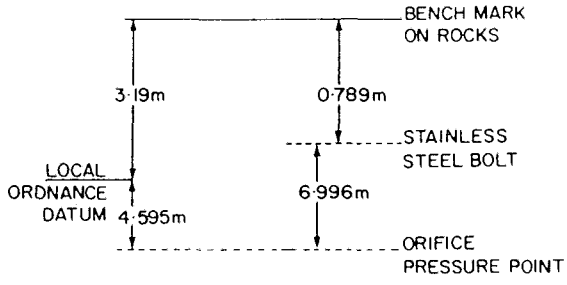
TAPE 2 1700 hours 20 November 1982 - 0400 hours 15 March 1983

TAPE 3 1500 hours 15 March 1983 - 0000 hours 14 June 1983.

The third tape was found broken on retrieval,but the timing interval was assumed to be the same as the previous two. Gaps between tapes were not filled.

TIME ZONE

G.M.T.



Height of mean sea level obtained from analysis =4.6761m above pressure point.

3.2 GRIMINISH POINT

Aanderaa gauge no. 447.

Gauge Deployment

1st 14.14.32 July 6 1982 - 12.30.42 November 24 1982

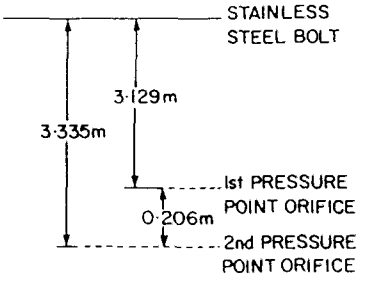
2nd 13.59.32 November 24 1982 - 11.00.00 March 11 1983

3rd 12.29.32 March 11 1983 - 14.47.32 August 8 1983.

The auger screw holding down pressure tube was found on its side with the beach scoured on 13 January 1983. The gauge was disconnected on 15th January at 1105, and reconnected at 1510.The gauge was again disconnected on 17th January at 1010, and reconnected at 1455 to change the tubing. A new pressure point was established on this date.

TIME ZONE

G.M.T.



No ordnance/local datums given.

The gauge dried out on spring low waters necessitating "clipped" analysis of 107 blocks. Height of mean sea level obtained from analysis=1.7714m above lst.pressure point

3.3 MALIN HEAD

Aanderaa gauge no. 286.

15 minute data was filtered to produce hourly readings as follows:-

TAPE 1 2300GMT 23 July 1982 - 0700GMT 15 November 1982

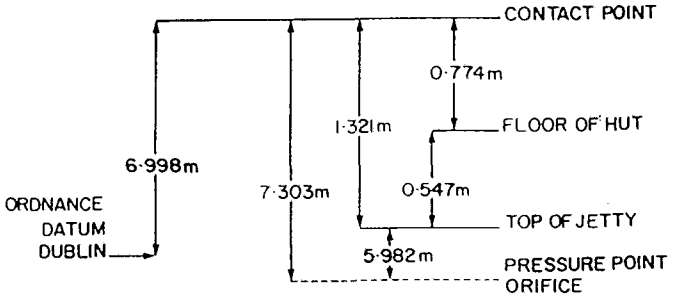
TAPE 2 1800GMT 15 November 1982 - 0600GMT 7 March 1983

TAPE 3 1700GMT 07 March 1983 - 0500GMT 15 July 1983.

Gaps between tapes were not filled by interpolation.

TIME ZONE

G.M.T.



Height of mean sea level obtained from analysis =2.8856m above PP orifice

and =2.5804m above O.D.D.

3.4 AUGHRIS HEAD

Aanderaa gauge no. 449.

Gauge Deployments

1st 15.44.27GMT 25 July 1982 - 11.44.38GMT 16 November 1982

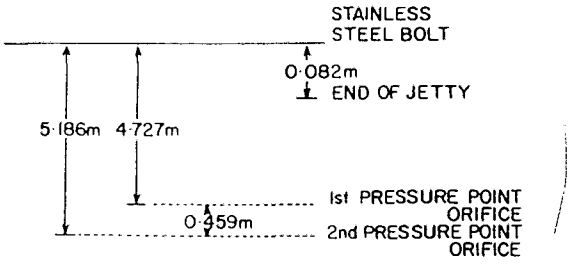
2nd 13.14.31GMT 16 November 1982 - 09.59.17GMT 28 March 1983

3rd 15.14.32GMT 29 March 1983 - 14.12.37GMT 16 July 1983.

The gap between the 2nd and 3rd deployments was caused by the cutting of the pressure tube by wave action. A new pressure point was established for the 3rd deployment.

TIME ZONE

G.M.T.



No ordnance/local datums given.

Height of mean sea level obtained from analysis =1.5036m above 1st pressure point.

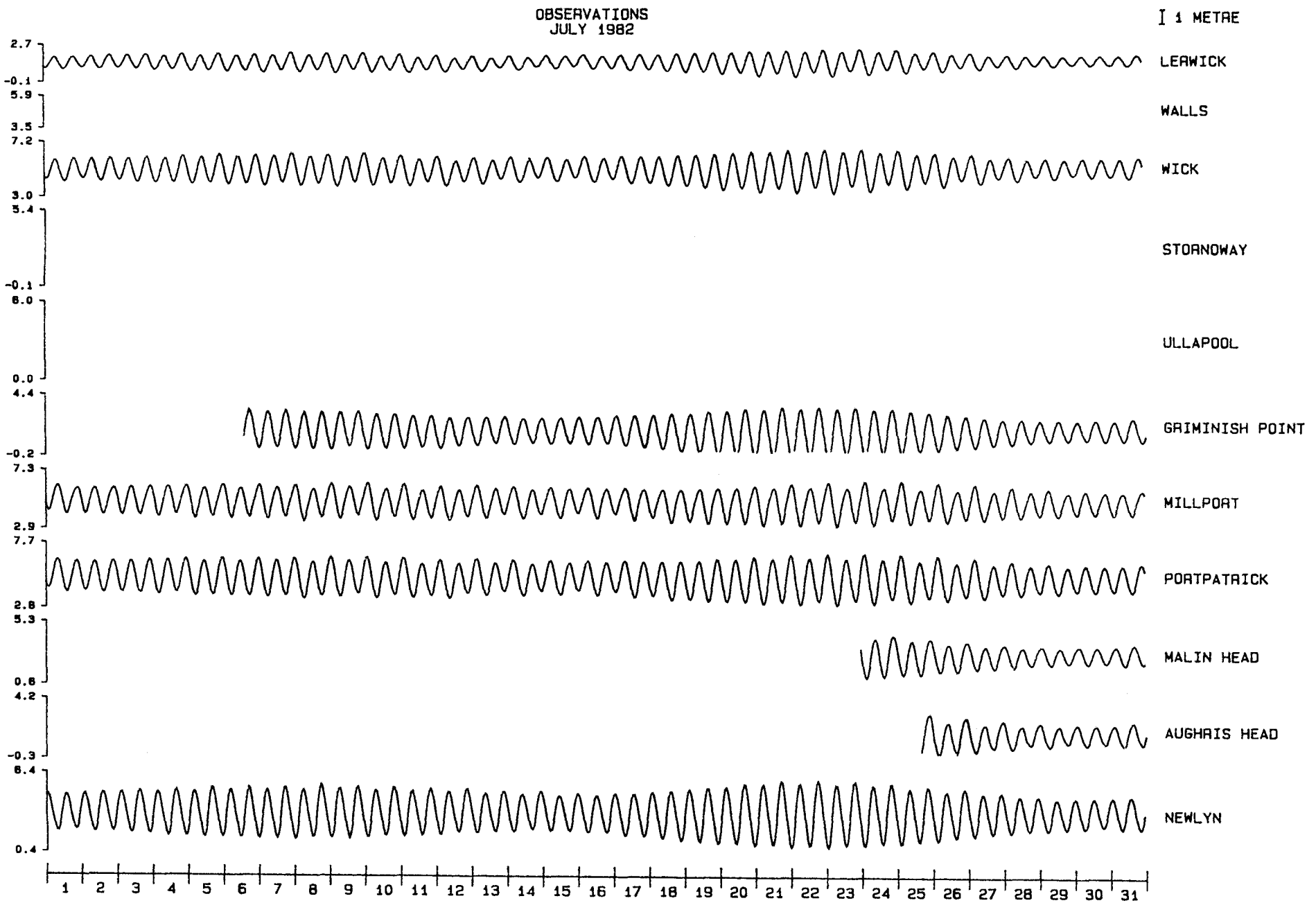
The gauge dried out on spring low waters necessitating "clipped" analysis of 202 blocks. November 1982 to March 1983 produced very noisy records, possibly caused by pressure valve or battery failure due to the extreme cold.

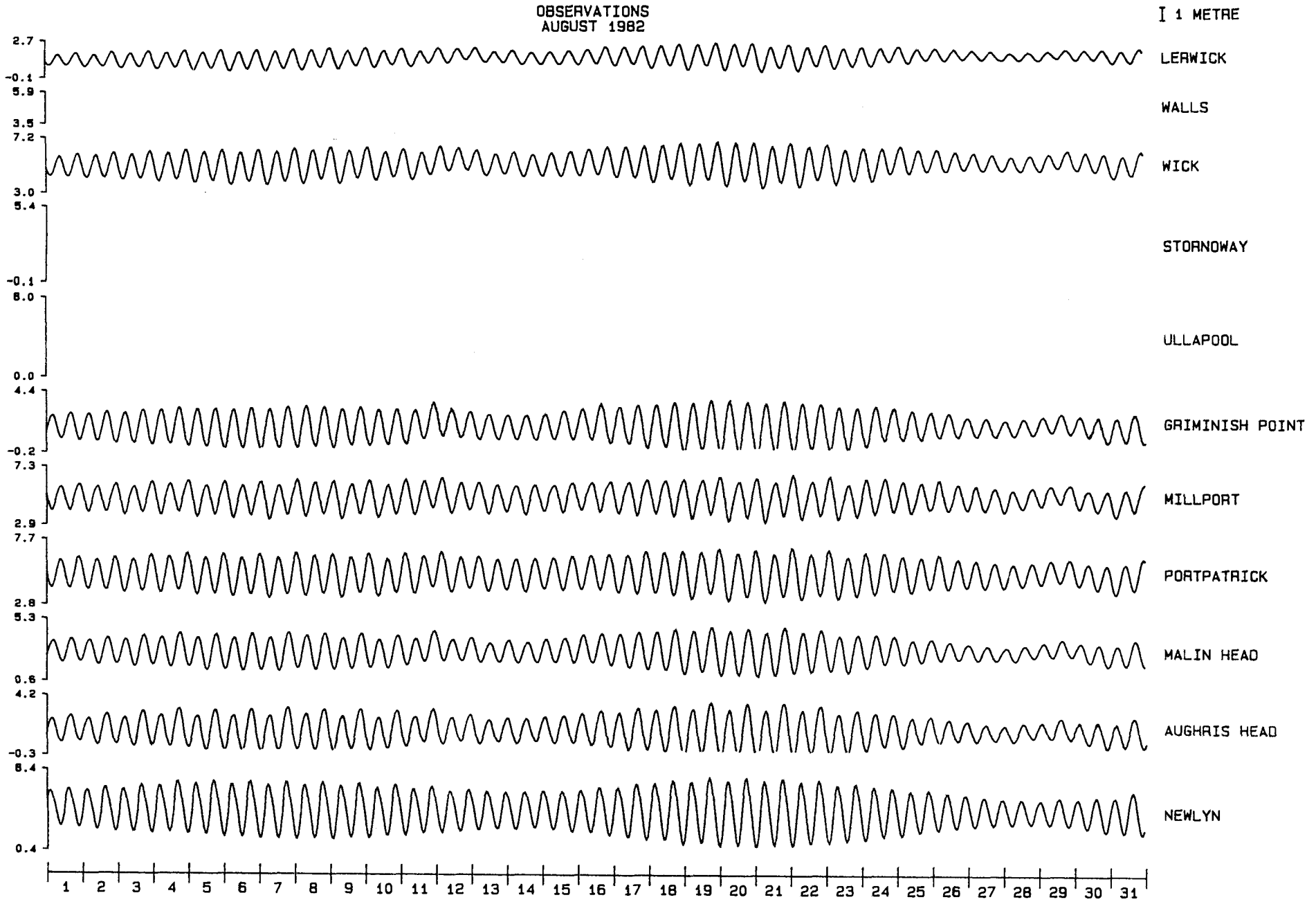
ACKNOWLEDGEMENTS

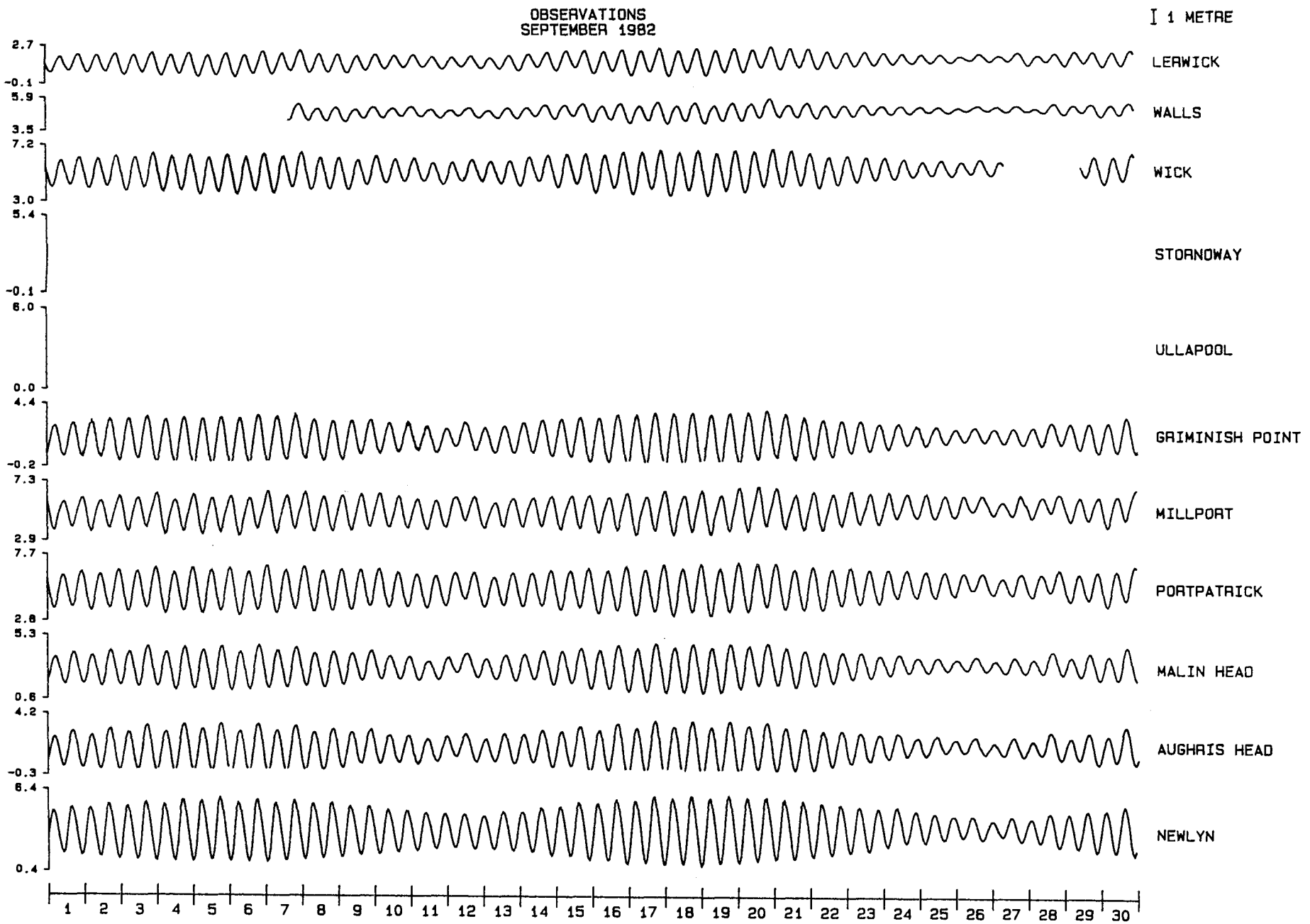
The authors are indebted to a number of authorities for the supply of A-Class tidal records,to Douglas Leighton for the gauge installations at the 'temporary' sites and to the Tide Gauge Inspectorate for their enlightening comments.

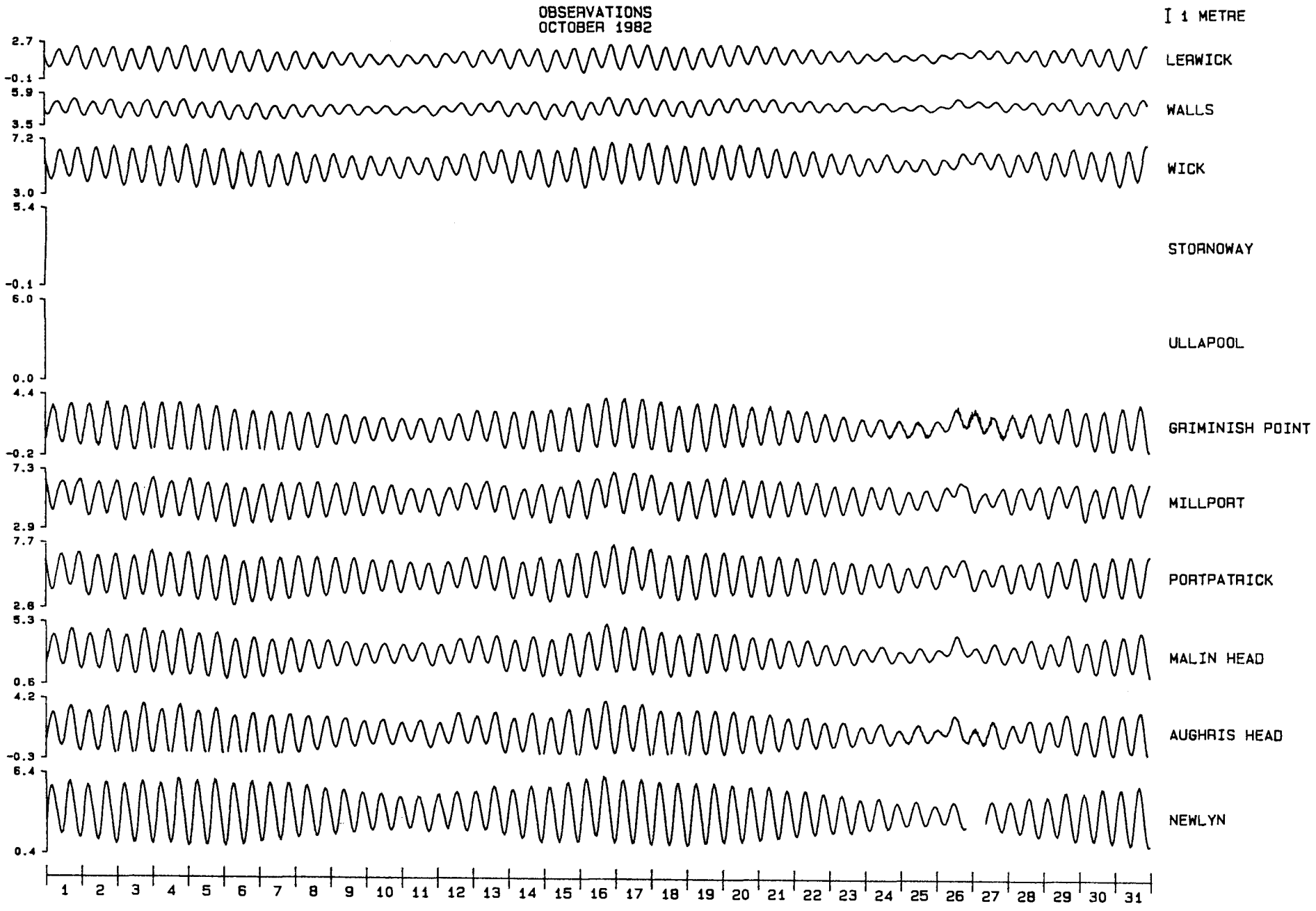
APPENDIX 4.1

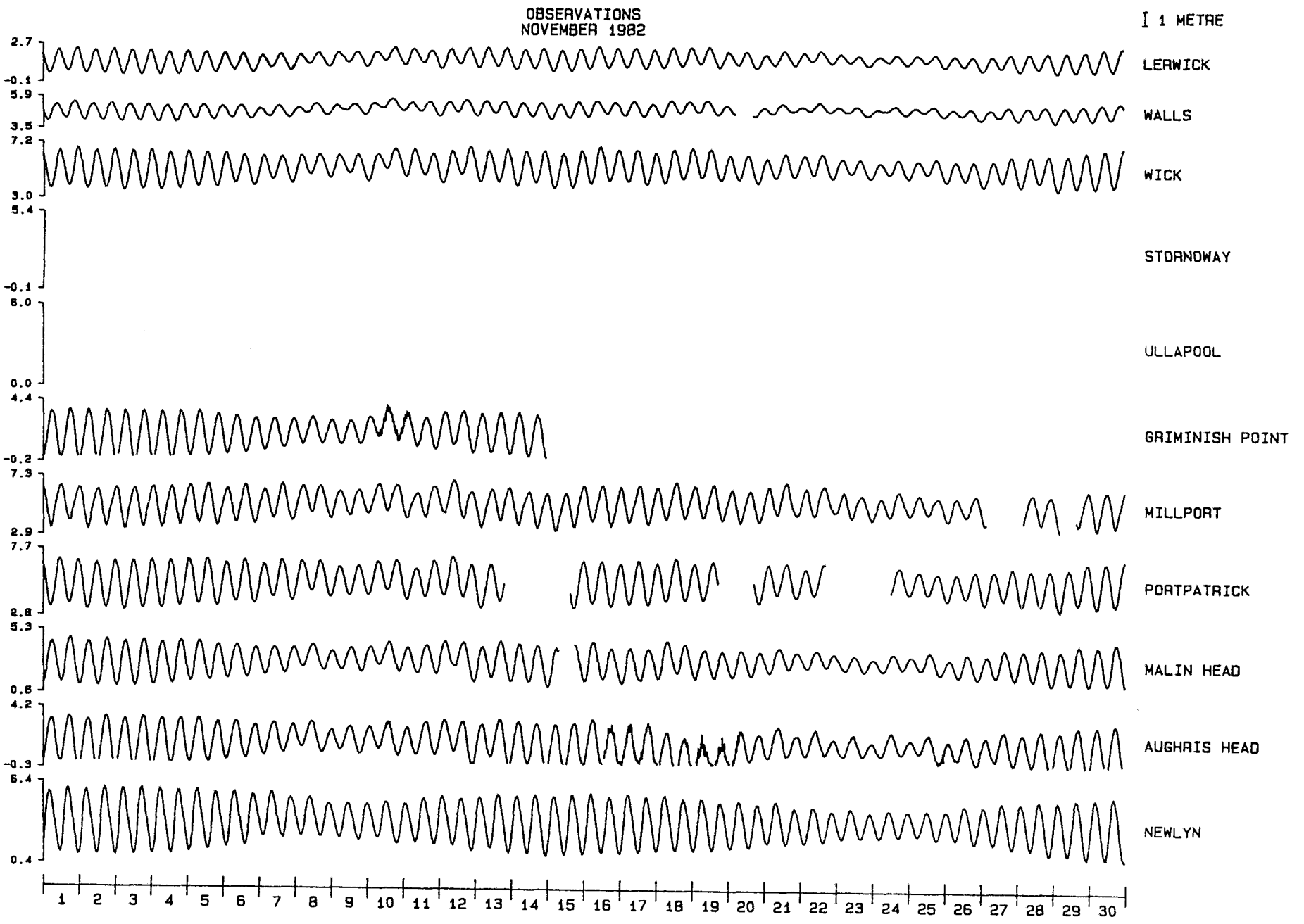
TIME SERIES PLOTS OF OBSERVATIONS

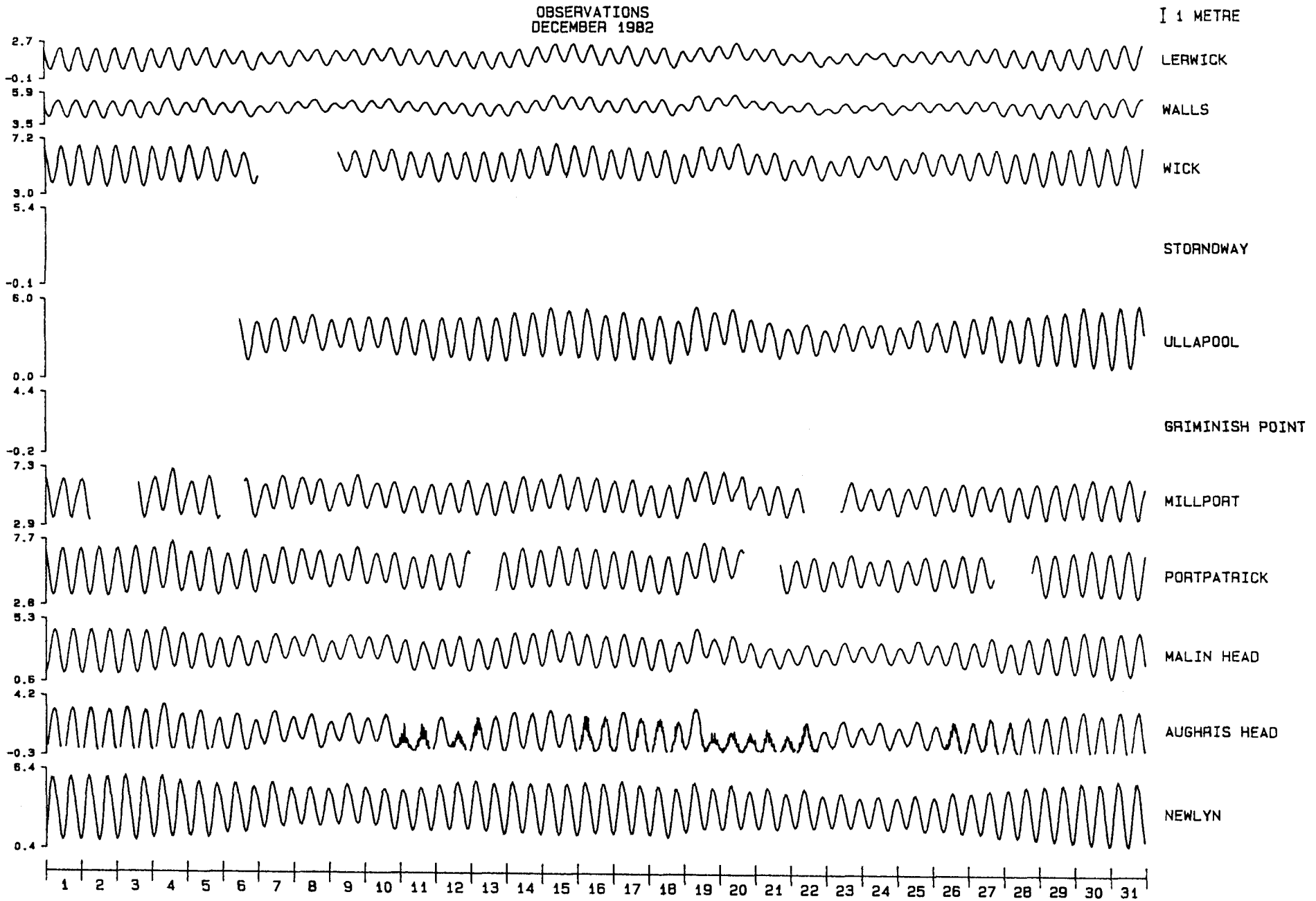

OBSERVATIONS
JULY 1982
I 1 METRE
2.7
-0.1
LERWICK
5.9
3.5
WALLS
7.2
3.0
WICK
5.4
-0.1
STORNOWAY
6.0
0.0
ULLAPOOL
4.4
-0.2
GRIMINISH POINT
7.3
2.9
MILLPORT
7.7
2.8
PORTPATRICK
5.3
0.6
MALIN HEAD
4.2
-0.3
AUGHRIS HEAD
6.4
0.4
NEWLYN
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31

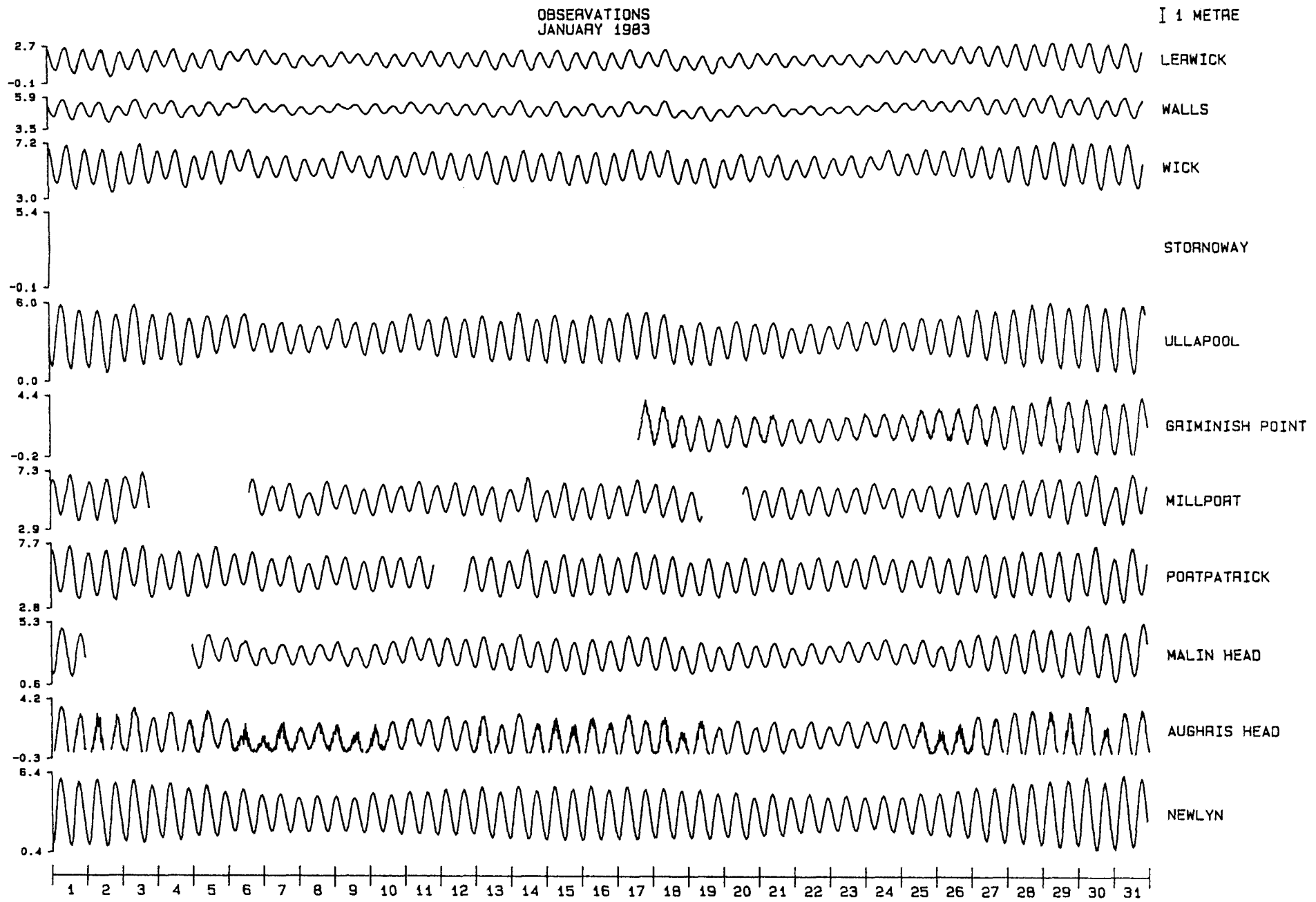

OBSERVATIONS
AUGUST 1982
I 1 METRE
2.7
-0.1
LERWICK
5.9
3.5
WALLS
7.2
3.0
WICK
5.4
-0.1
STORNOWAY
6.0
0.0
ULLAPOOL
4.4
-0.2
GRIMINISH POINT
7.3
2.9
MILLPORT
7.7
2.8
PORTPATRICK
5.3
0.6
MALIN HEAD
4.2
-0.3
AUGHRIS HEAD
6.4
0.4
NEWLYN
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31

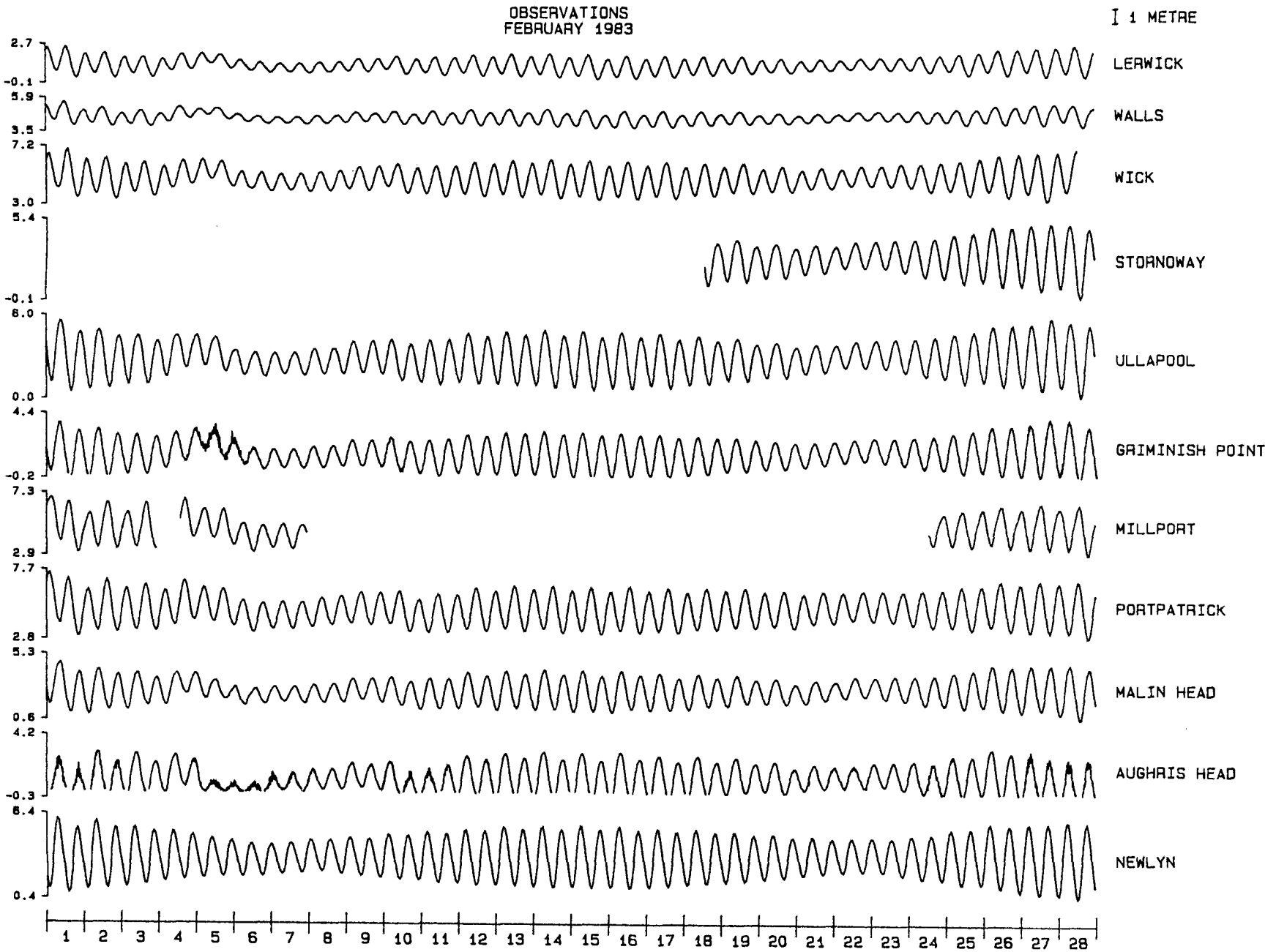

OBSERVATIONS
SEPTEMBER 1982
I 1 METRE
2.7
-0.1
LERWICK
5.9
3.5
WALLS
7.2
3.0
WICK
5.4
-0.1
STORNOWAY
6.0
0.0
ULLAPOOL
4.4
-0.2
GRIMINISH POINT
7.3
2.9
MILLPORT
7.7
2.8
PORTPATRICK
5.3
0.6
MALIN HEAD
4.2
-0.3
AUGHRIS HEAD
6.4
0.4
NEWLYN
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30

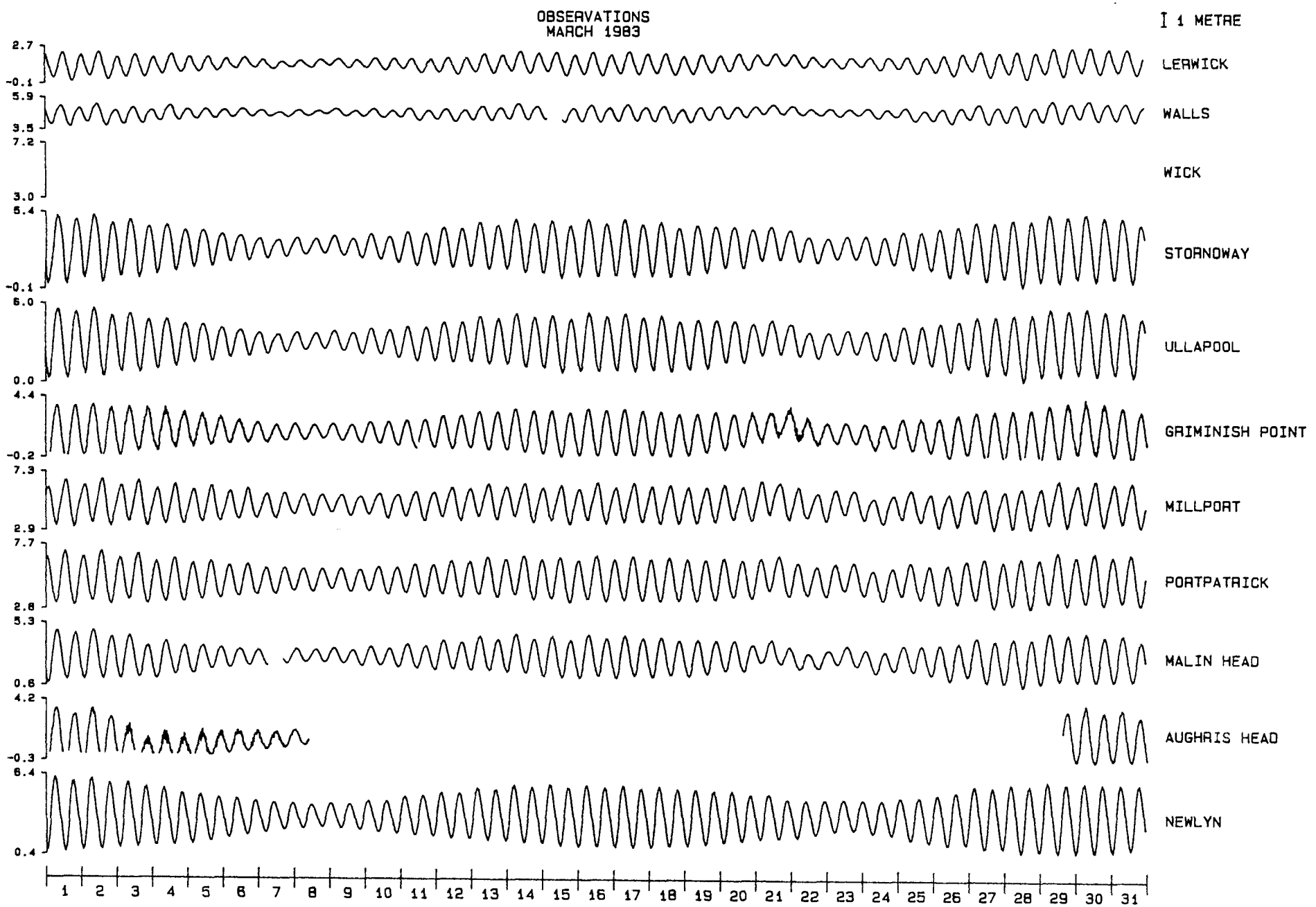

OBSERVATIONS
OCTOBER 1982
I 1 METRE
2.7
-0.1
LERWICK
5.9
3.5
WALLS
7.2
3.0
WICK
5.4
-0.1
STORNOWAY
6.0
0.0
ULLAPOOL
4.4
-0.2
GRIMINISH POINT
7.3
2.9
MILLPORT
7.7
2.8
PORTPATRICK
5.3
0.6
MALIN HEAD
4.2
-0.3
AUGHRIS HEAD
6.4
0.4
NEWLYN
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31

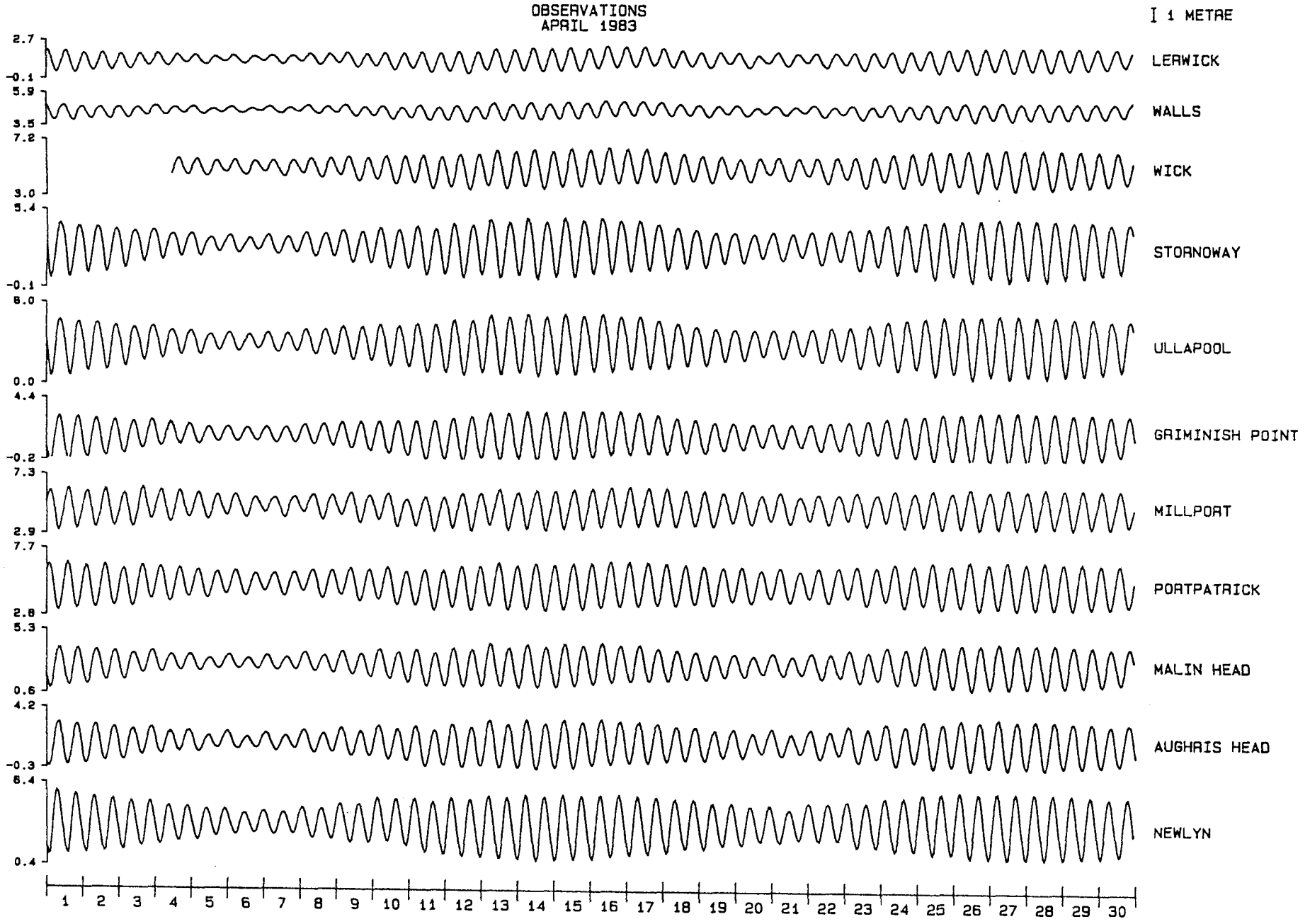

OBSERVATIONS
NOVEMBER 1982
I 1 METRE
2.7
-0.1
LERWICK
5.9
3.5
WALLS
7.2
3.0
WICK
5.4
-0.1
STORNOWAY
6.0
0.0
ULLAPOOL
4.4
-0.2
GRIMINISH POINT
7.3
2.9
MILLPORT
7.7
2.8
PORTPATRICK
5.3
0.6
MALIN HEAD
4.2
-0.3
AUGHRIS HEAD
6.4
0.4
NEWLYN
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30

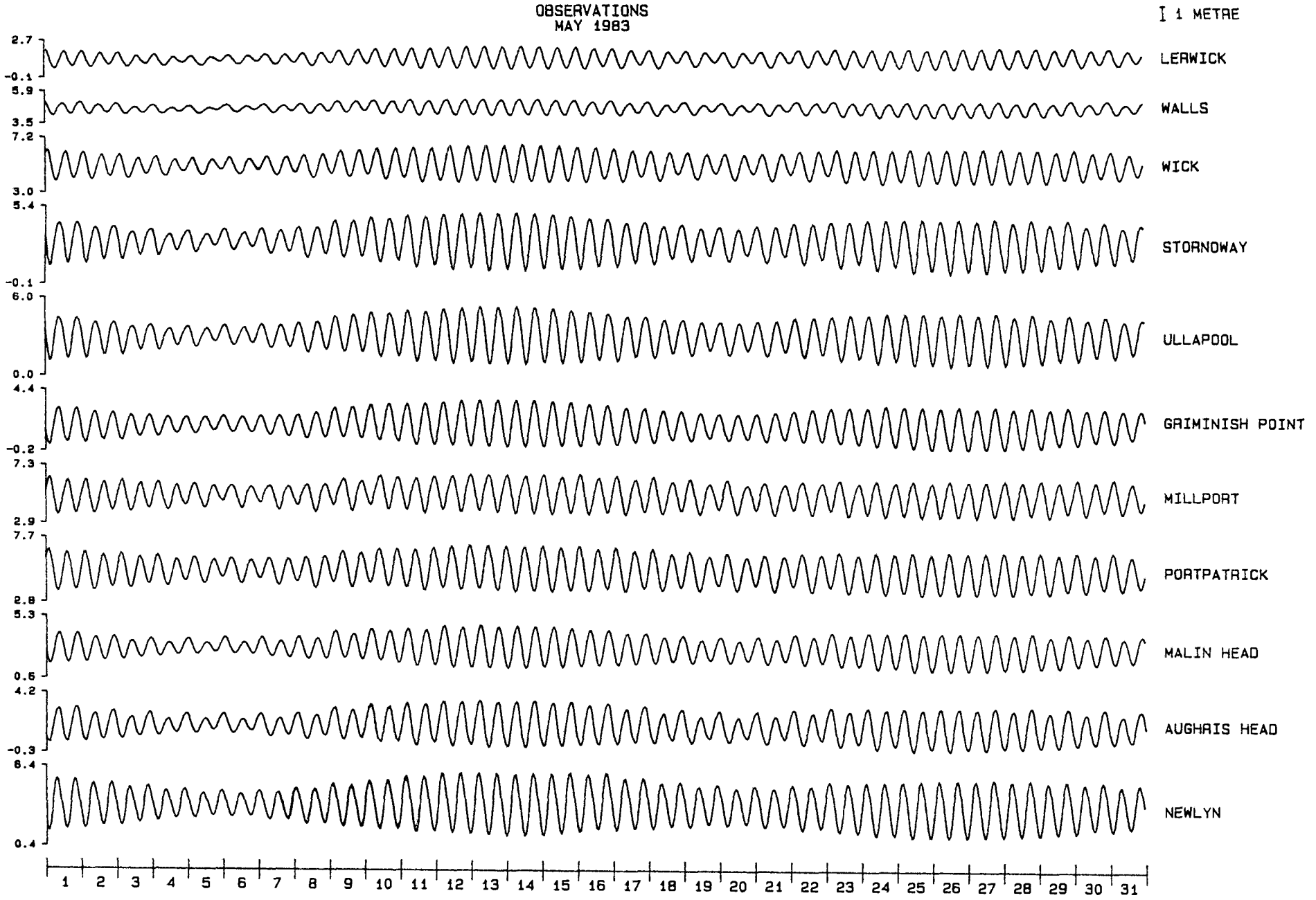

OBSERVATIONS
DECEMBER 1982
I 1 METRE
2.7
-0.1
LERWICK
5.9
3.5
WALLS
7.2
3.0
WICK
5.4
-0.1
STORNOWAY
6.0
0.0
ULLAPOOL
4.4
-0.2
GRIMINISH POINT
7.3
2.9
MILLPORT
7.7
2.8
PORTPATRICK
5.3
0.6
MALIN HEAD
4.2
-0.3
AUGHRIS HEAD
6.4
0.4
NEWLYN
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31

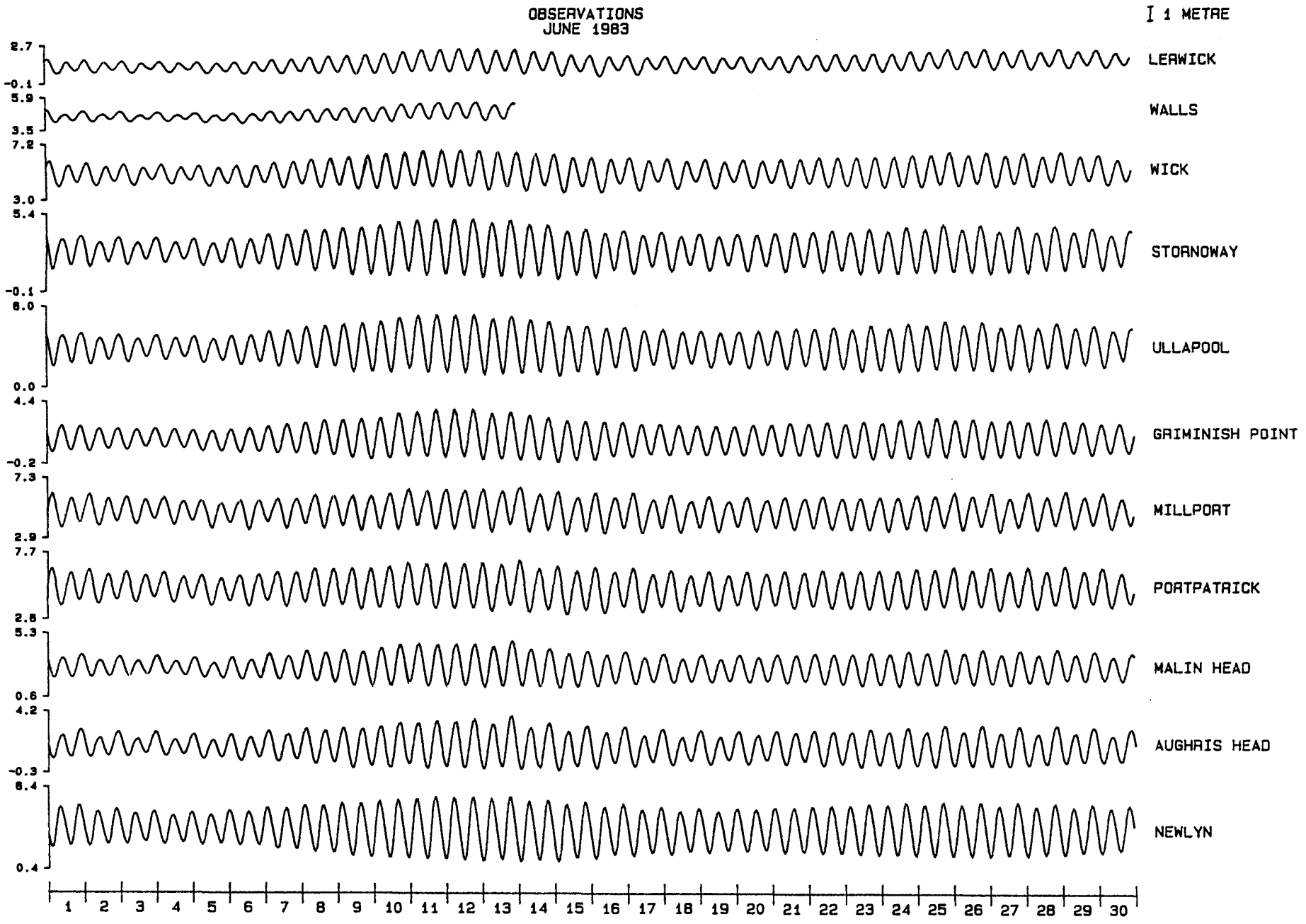

OBSERVATIONS
JANUARY 1983
I 1 METRE
2.7
-0.1
LERWICK
5.9
3.5
WALLS
7.2
3.0
WICK
5.4
-0.1
STORNOWAY
6.0
0.0
ULLAPOOL
4.4
-0.2
GRIMINISH POINT
7.3
2.9
MILLPORT
7.7
2.8
PORTPATRICK
5.3
0.6
MALIN HEAD
4.2
-0.3
AUGHRIS HEAD
6.4
0.4
NEWLYN
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31

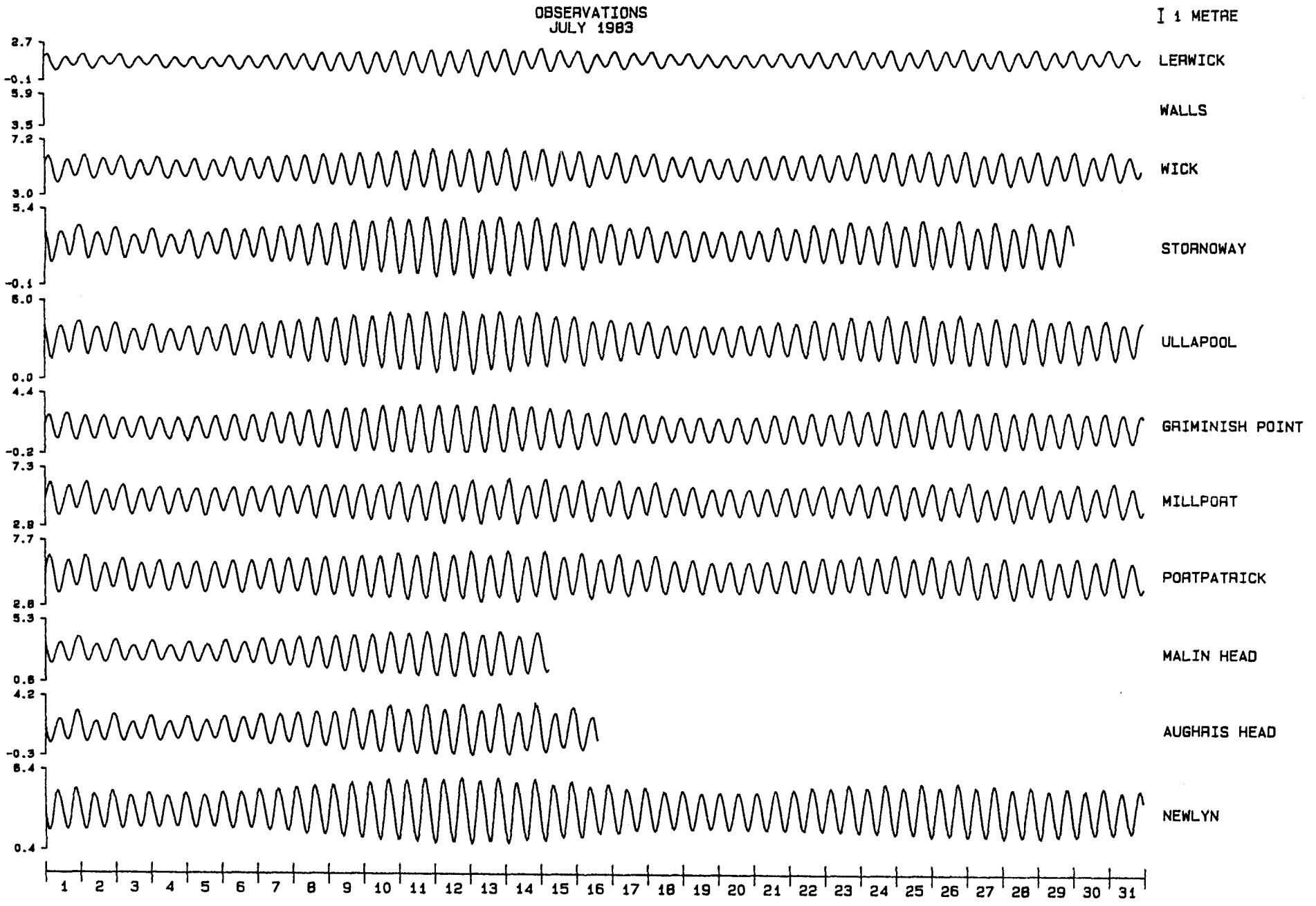

OBSERVATIONS
FEBRUARY 1983
I 1 METRE
2.7
-0.1
LERWICK
5.9
3.5
WALLS
7.2
3.0
WICK
5.4
-0.1
STORNOWAY
8.0
0.0
ULLAPOOL
4.4
-0.2
GRIMINISH POINT
7.3
2.9
MILLPORT
7.7
2.8
PORTPATRICK
5.3
0.6
MALIN HEAD
4.2
-0.3
AUGHRIS HEAD
8.4
0.4
NEWLYN
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28

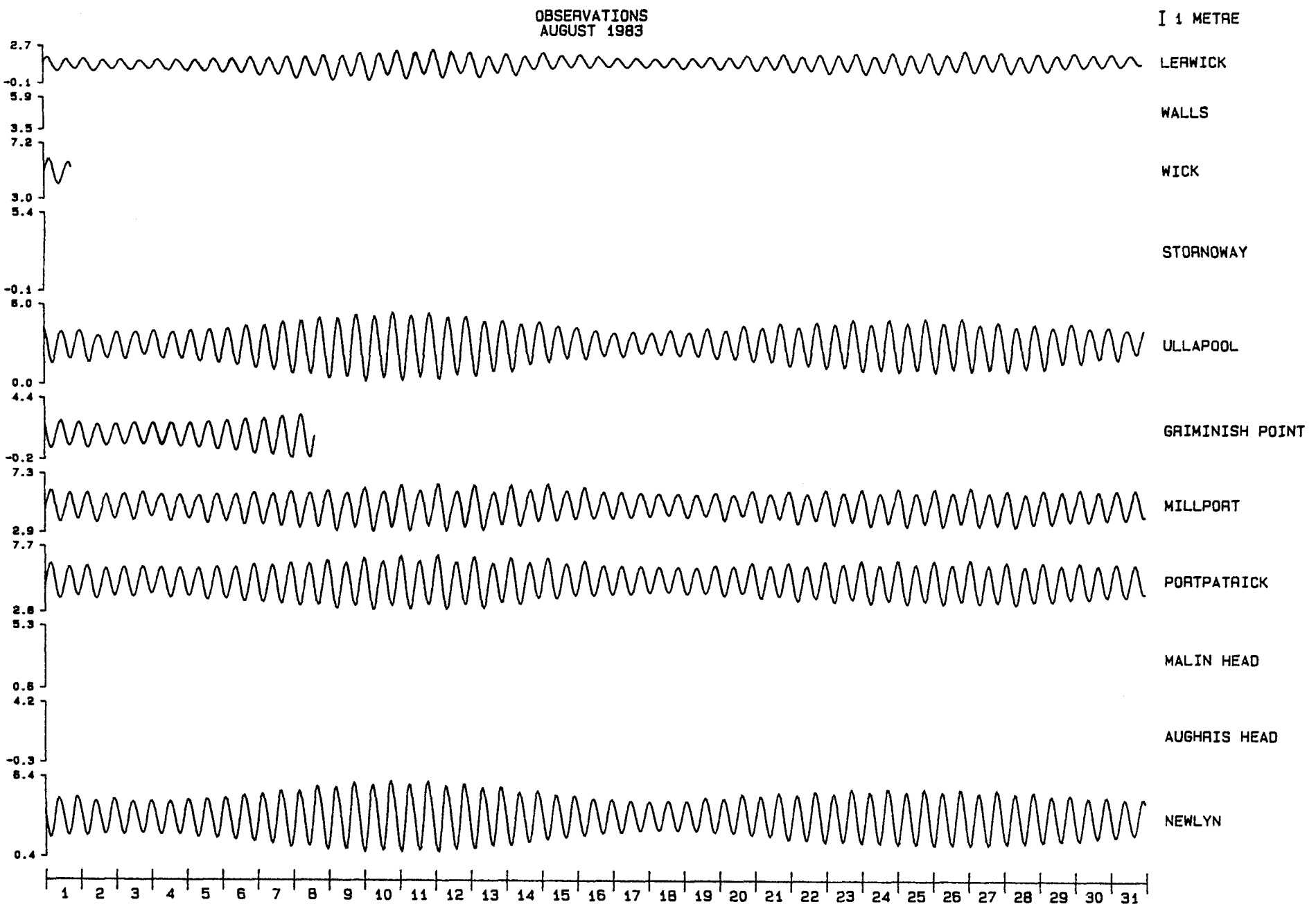

OBSERVATIONS
MARCH 1983
1 METRE
2.7
-0.1
LERWICK
5.9
3.5
WALLS
7.2
3.0
WICK
5.4
-0.1
STORNOWAY
6.0
0.0
ULLAPOOL
4.4
-0.2
GRIMINISH POINT
7.3
2.9
MILLPORT
7.7
2.8
PORTPATRICK
5.3
0.6
MALIN HEAD
4.2
-0.3
AUGHRIS HEAD
6.4
0.4
NEWLYN
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31


OBSERVATIONS
APRIL 1983
I 1 METRE
2.7
-0.1
LERWICK
5.9
3.5
WALLS
7.2
3.0
WICK
5.4
-0.1
STORNOWAY
6.0
0.0
ULLAPOOL
4.4
-0.2
GRIMINISH POINT
7.3
2.9
MILLPORT
7.7
2.8
PORTPATRICK
5.3
0.6
MALIN HEAD
4.2
-0.3
AUGHRIS HEAD
6.4
0.4
NEWLYN
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30


OBSERVATIONS
MAY 1983
I 1 METRE
2.7
-0.1
LERWICK
5.9
3.5
WALLS
7.2
3.0
WICK
5.4
-0.1
STORNOWAY
6.0
0.0
ULLAPOOL
4.4
-0.2
GRIMINISH POINT
7.3
2.9
MILLPORT
7.7
2.8
PORTPATRICK
5.3
0.6
MALIN HEAD
4.2
-0.3
AUGHRIS HEAD
8.4
0.4
NEWLYN
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31

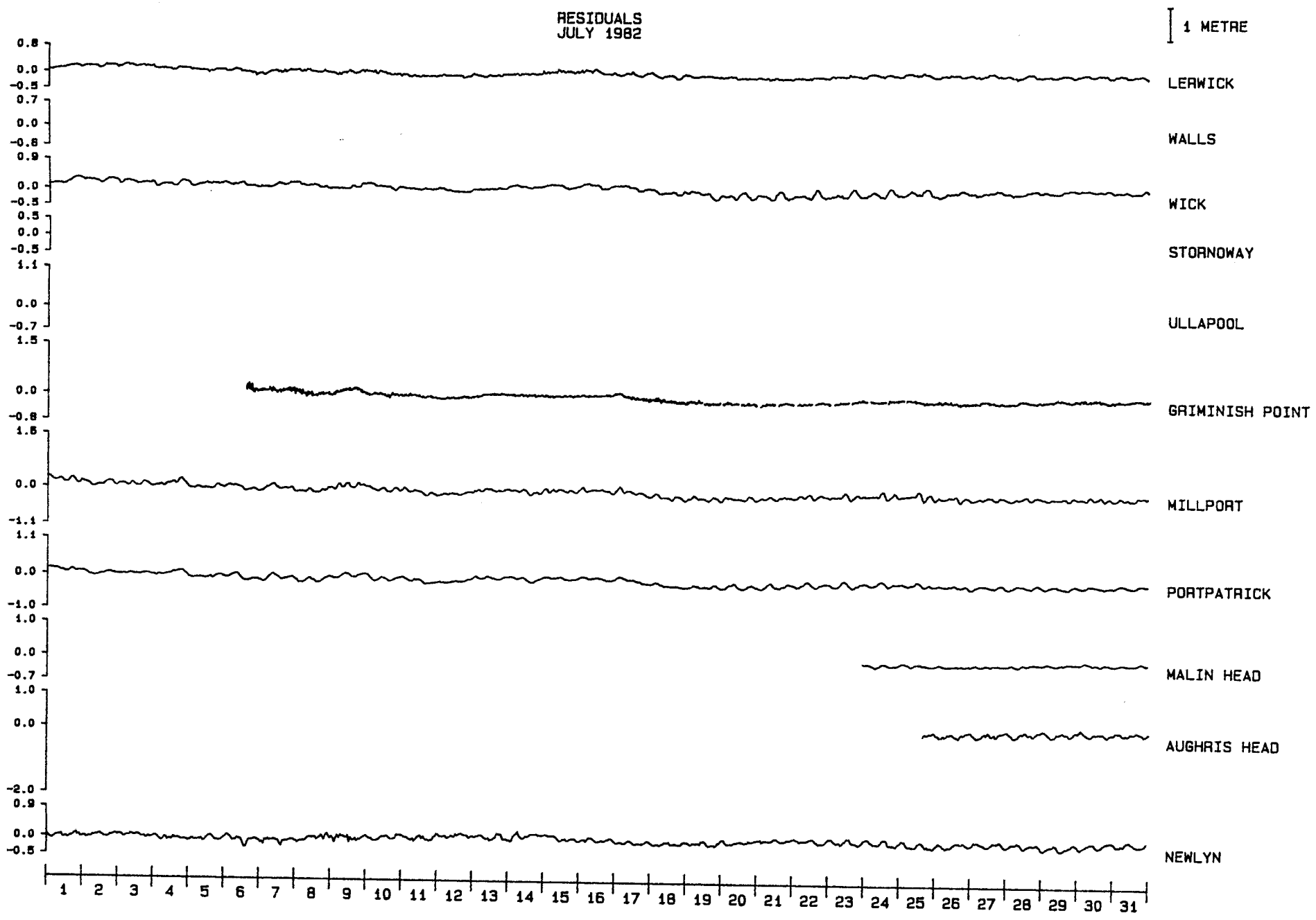

OBSERVATIONS
JUNE 1983
I 1 METRE
2.7
-0.1
LERWICK
5.9
3.5
WALLS
7.2
3.0
WICK
5.4
-0.1
STORNOWAY
6.0
0.0
ULLAPOOL
4.4
-0.2
GRIMINISH POINT
7.3
2.9
MILLPORT
7.7
2.8
PORTPATRICK
5.3
0.6
MALIN HEAD
4.2
-0.3
AUGHRIS HEAD
6.4
0.4
NEWLYN
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30

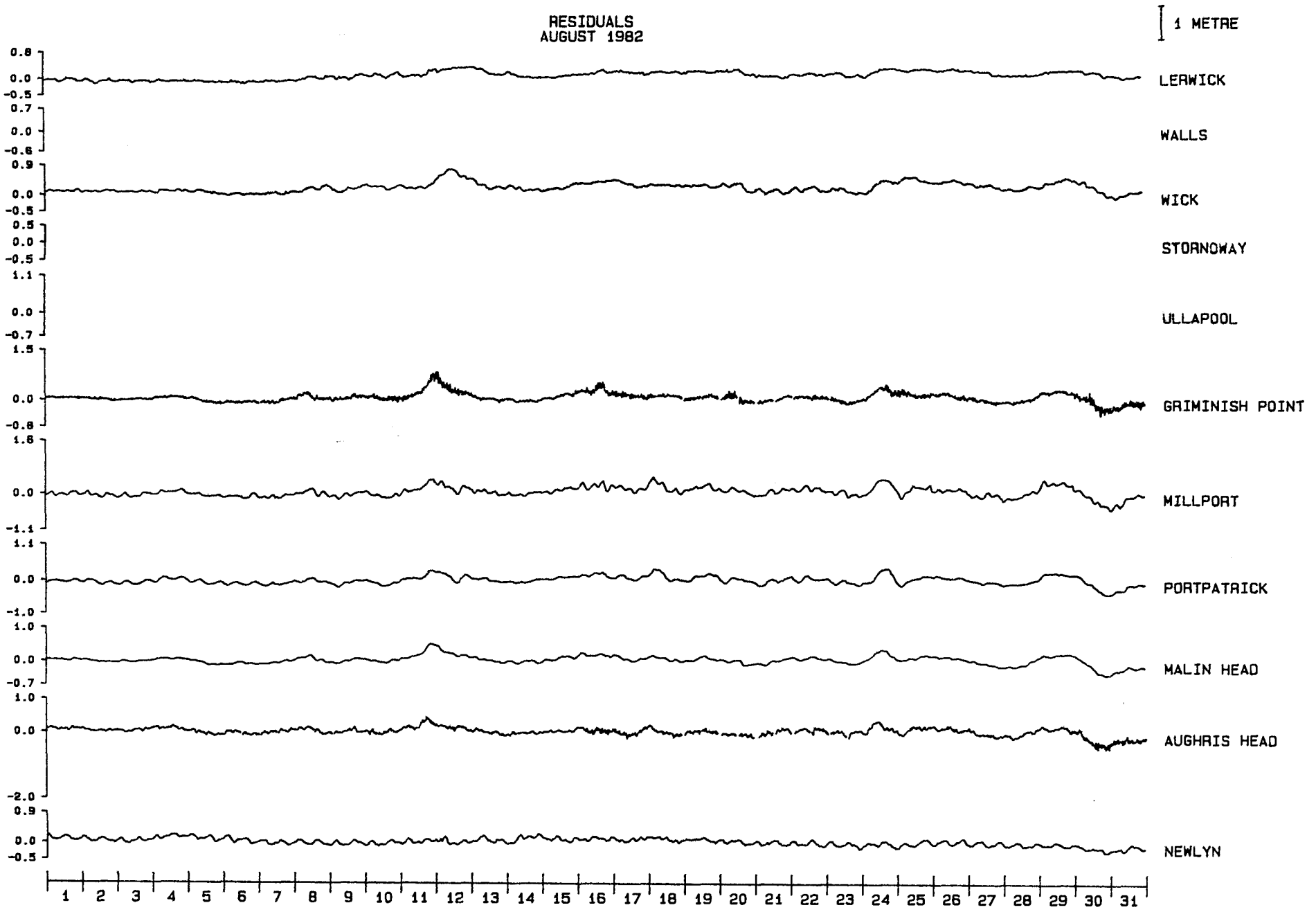

OBSERVATIONS
JULY 1983
I 1 METRE
2.7
-0.1
LERWICK
5.9
3.5
WALLS
7.2
3.0
WICK
5.4
-0.1
STORNOWAY
6.0
0.0
ULLAPOOL
4.4
-0.2
GRIMINISH POINT
7.3
2.8
MILLPORT
7.7
2.8
PORTPATRICK
5.3
0.6
MALIN HEAD
4.2
-0.3
AUGHRIS HEAD
6.4
0.4
NEWLYN
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31

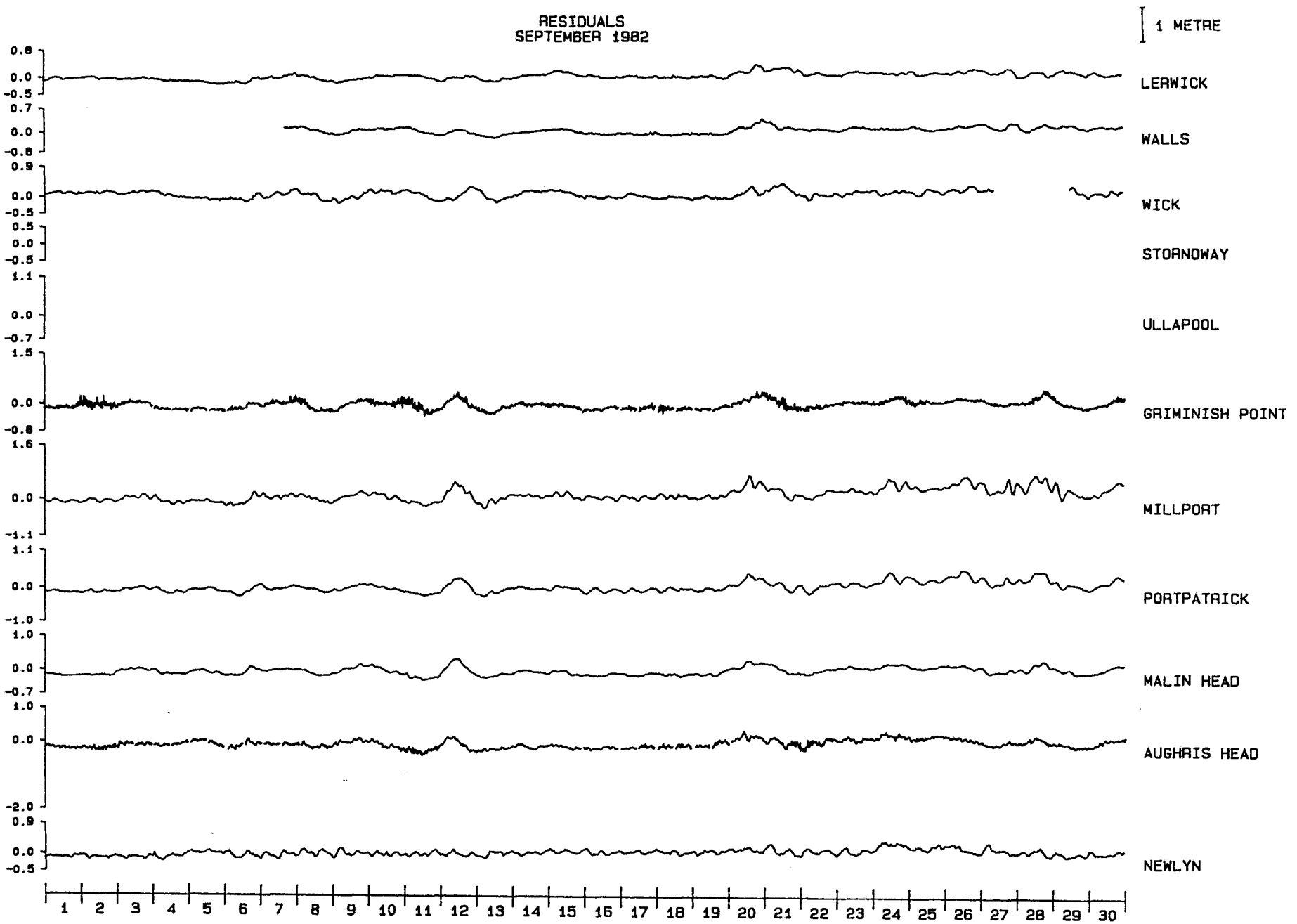

OBSERVATIONS
AUGUST 1983
I 1 METRE
2.7
-0.1
LERWICK
5.9
3.5
WALLS
7.2
3.0
WICK
5.4
-0.1
STORNOWAY
6.0
0.0
ULLAPOOL
4.4
-0.2
GRIMINISH POINT
7.3
2.9
MILLPORT
7.7
2.8
PORTPATRICK
5.3
0.6
MALIN HEAD
4.2
-0.3
AUGHRIS HEAD
8.4
0.4
NEWLYN
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31

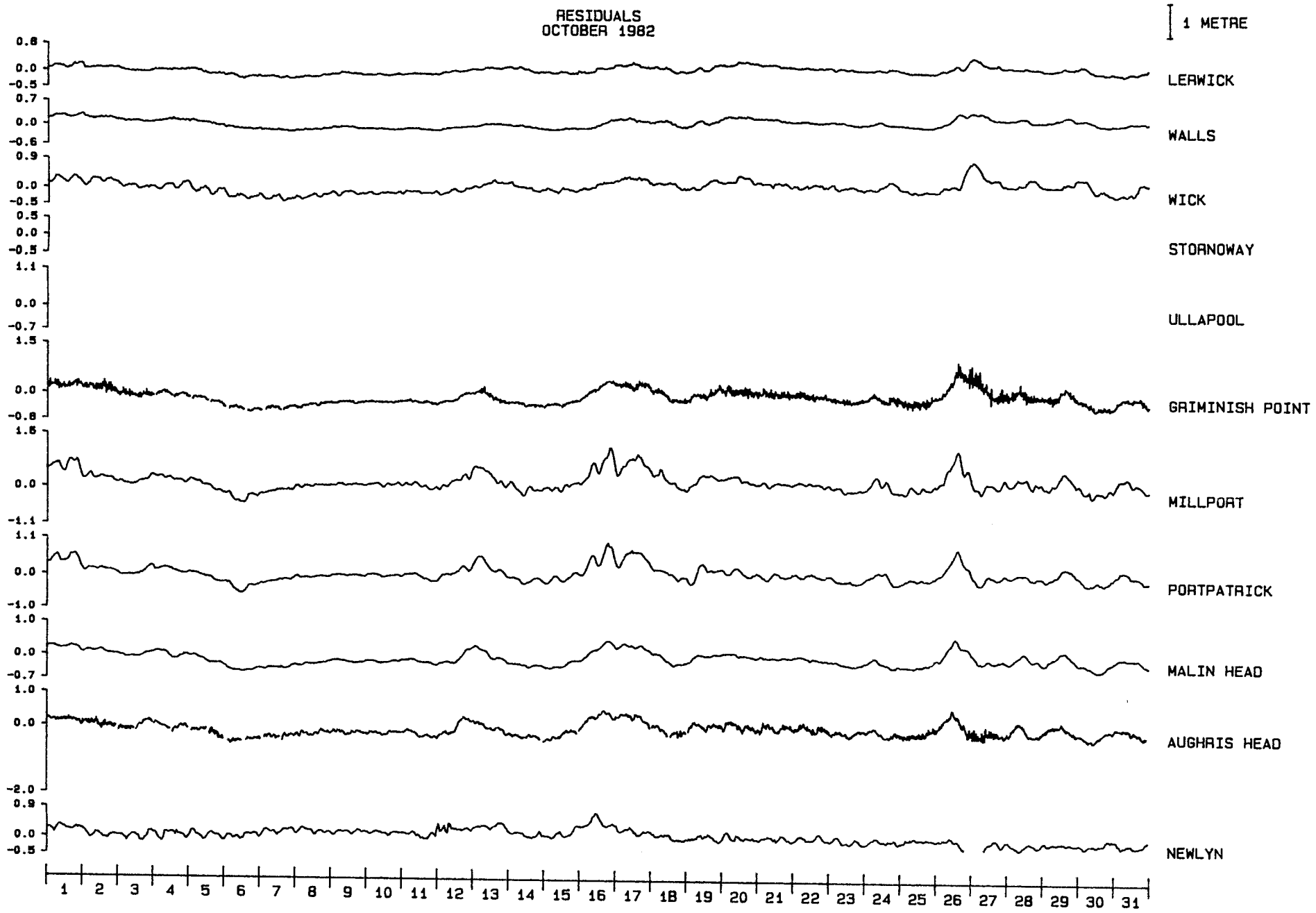
APPENDIX 4.2

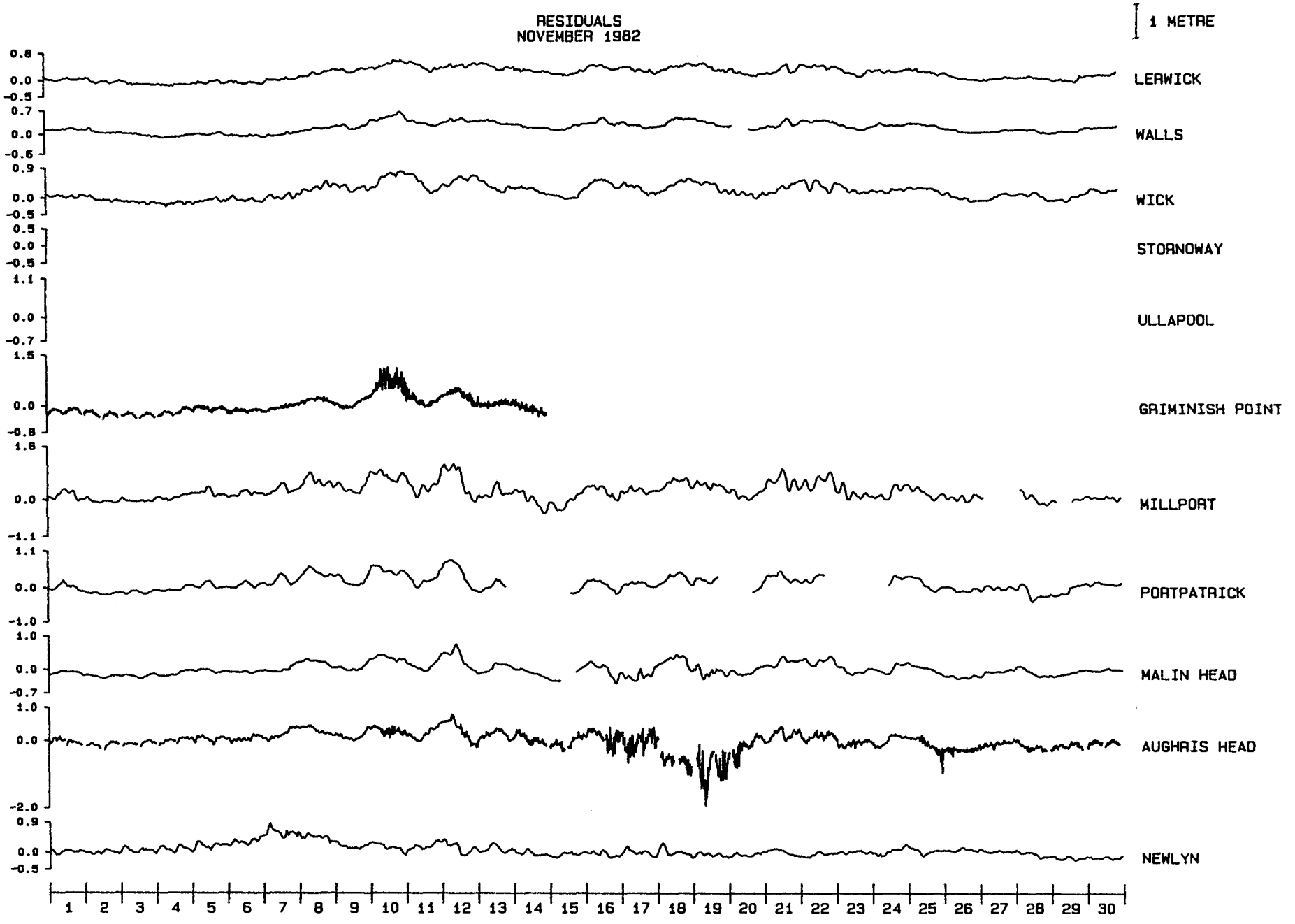
TIME SERIES PLOTS OF RESIDUALS

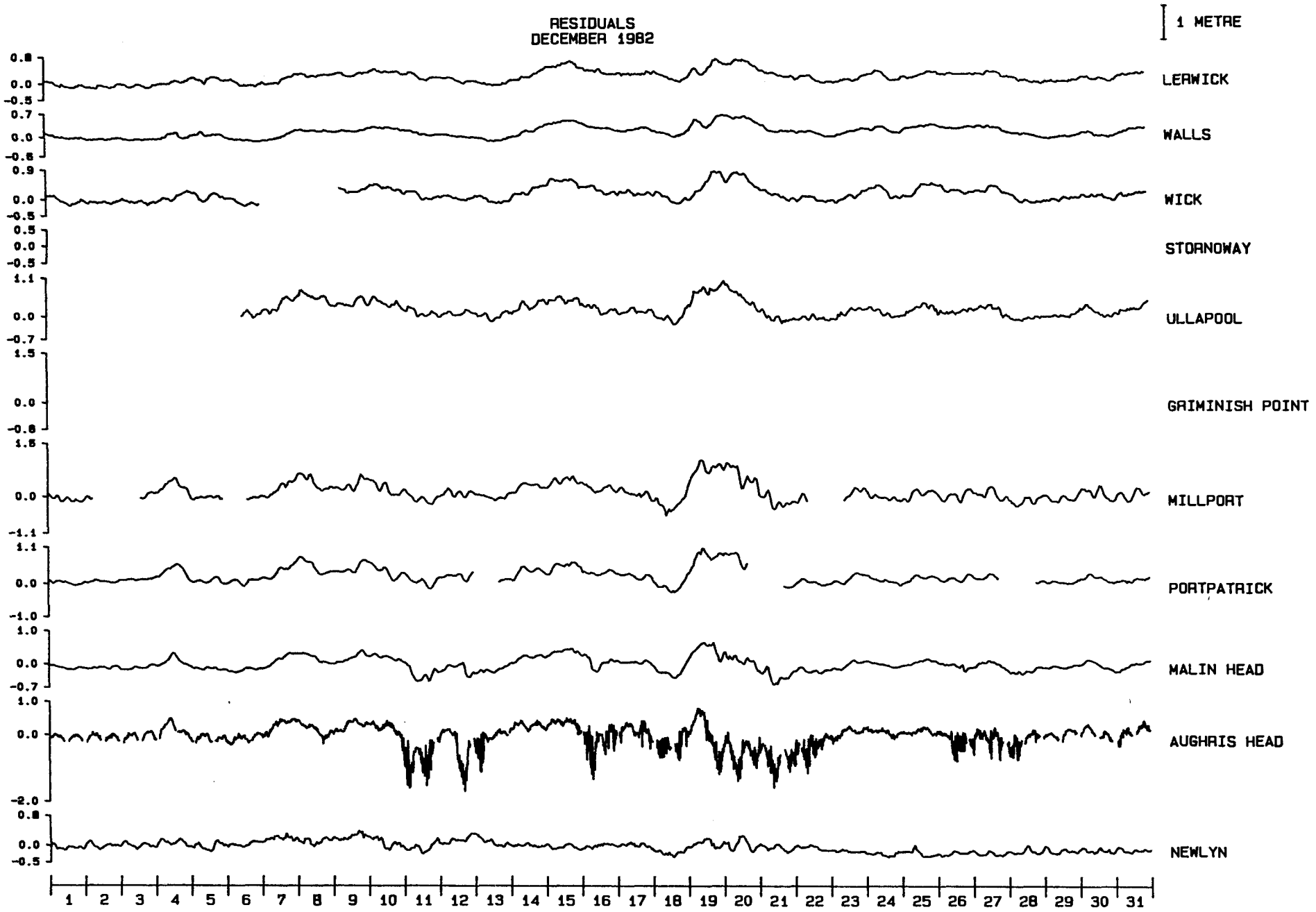

RESIDUALS
JULY 1982
1 METRE
LERWICK
WALLS
WICK
STORNOWAY
ULLAPOOL
GRIMINISH POINT
MILLPORT
PORTPATRICK
MALIN HEAD
AUGHRIS HEAD
NEWLYN
0.8
0.0
-0.5
0.7
0.0
-0.8
0.9
0.0
-0.5
0.5
0.0
-0.5
1.1
0.0
-0.7
1.5
0.0
-0.8
1.8
0.0
-1.1
1.1
0.0
-1.0
1.0
0.0
-0.7
1.0
0.0
-2.0
0.9
0.0
-0.5
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31

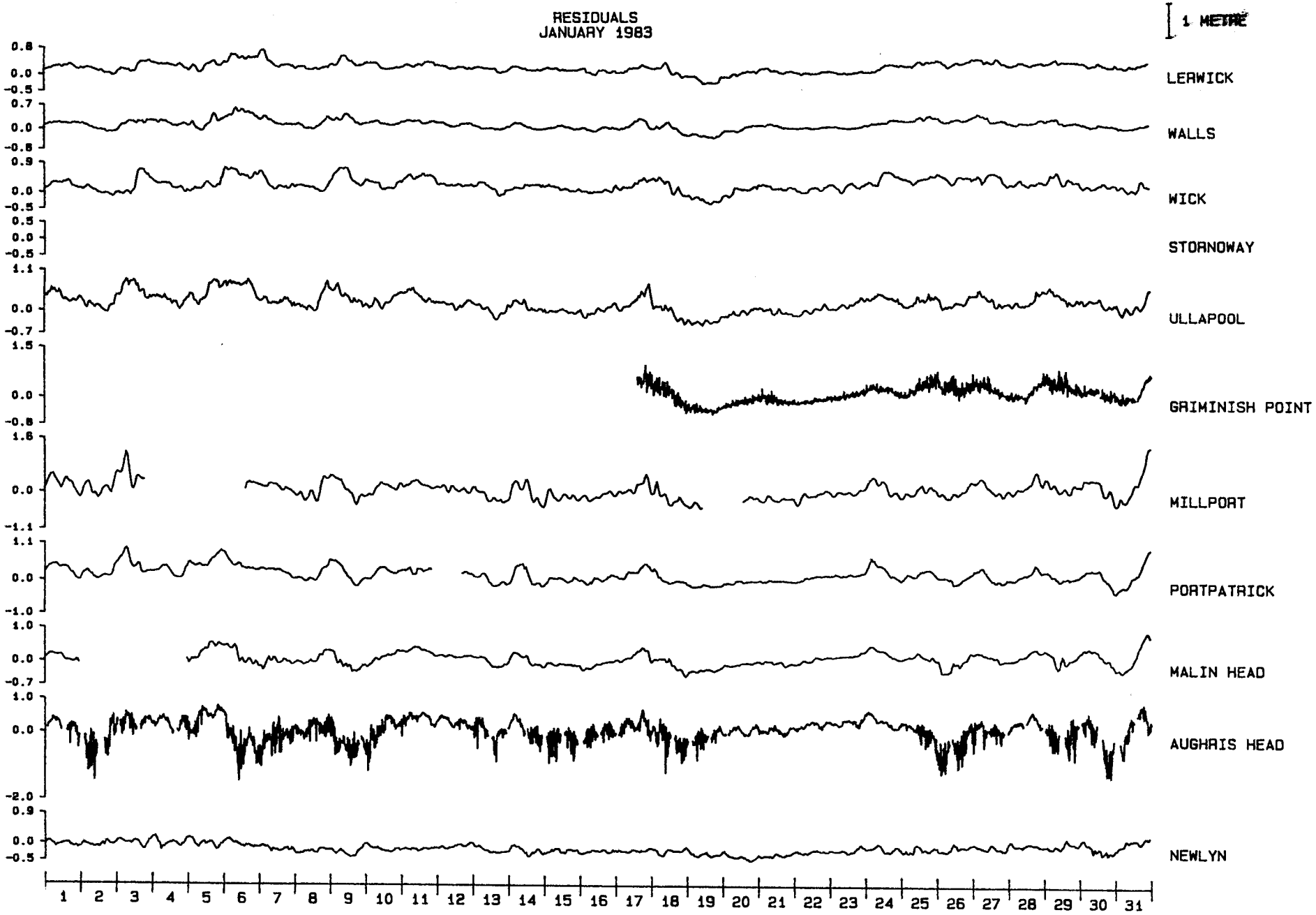

RESIDUALS
AUGUST 1982
1 METRE
0.8
0.0
-0.5
LERWICK
0.7
0.0
-0.6
WALLS
0.9
0.0
-0.5
WICK
0.5
0.0
-0.5
STORNOWAY
1.1
0.0
-0.7
ULLAPOOL
1.5
0.0
-0.8
GRIMINISH POINT
1.6
0.0
-1.1
MILLPORT
1.1
0.0
-1.0
PORTPATRICK
1.0
0.0
-0.7
MALIN HEAD
1.0
0.0
-2.0
AUGHRIS HEAD
0.9
0.0
-0.5
NEWLYN
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31

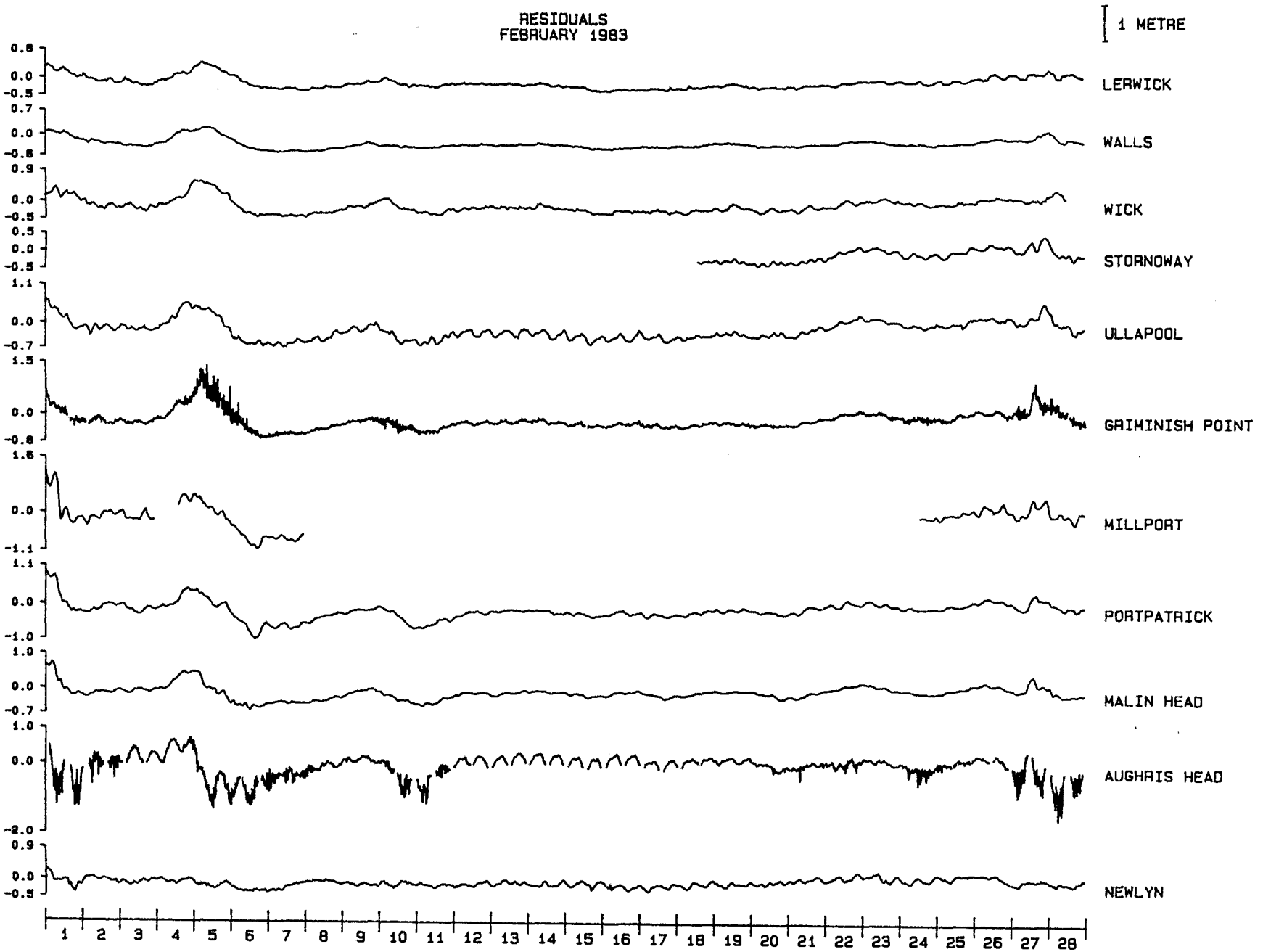

RESIDUALS
SEPTEMBER 1982
1 METRE
LERWICK
WALLS
WICK
STORNOWAY
ULLAPOOL
GRIMINISH POINT
MILLPORT
PORTPATRICK
MALIN HEAD
AUGHRIS HEAD
NEWLYN
0.8
0.0
-0.5
0.7
0.0
-0.6
0.9
0.0
-0.5
0.5
0.0
-0.5
1.1
0.0
-0.7
1.5
0.0
-0.8
1.6
0.0
-1.1
1.1
0.0
-1.0
1.0
0.0
-0.7
1.0
0.0
-2.0
0.9
0.0
-0.5
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30

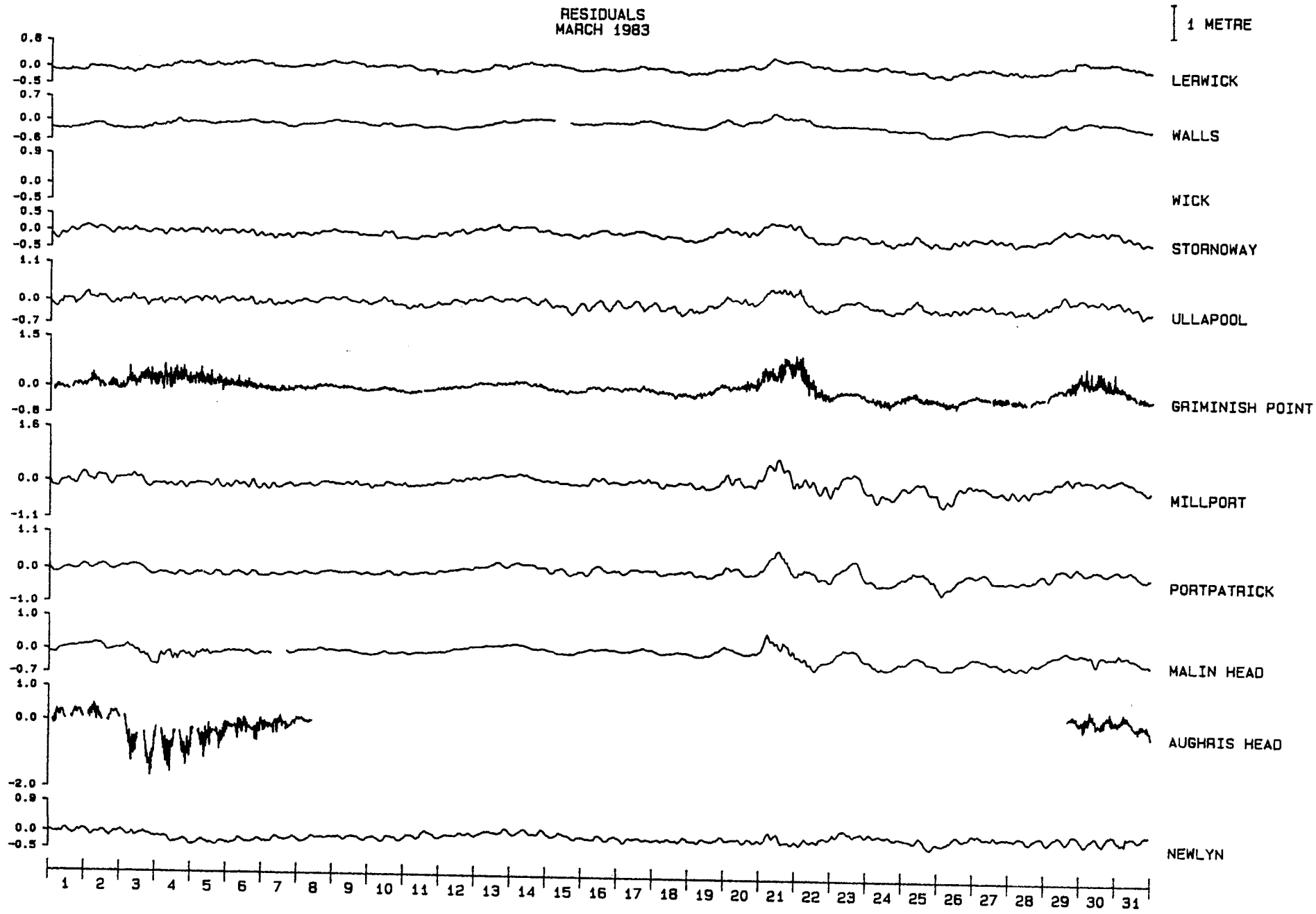

RESIDUALS
OCTOBER 1982
1 METRE
LERWICK
WALLS
WICK
STORNOWAY
ULLAPOOL
GRIMINISH POINT
MILLPORT
PORTPATRICK
MALIN HEAD
AUGHRIS HEAD
NEWLYN
0.6
0.0
-0.5
0.7
0.0
-0.6
0.9
0.0
-0.5
0.5
0.0
-0.5
1.1
0.0
-0.7
1.5
0.0
-0.8
1.5
0.0
-1.1
1.1
0.0
-1.0
1.0
0.0
-0.7
1.0
0.0
-2.0
0.9
0.0
-0.5
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31

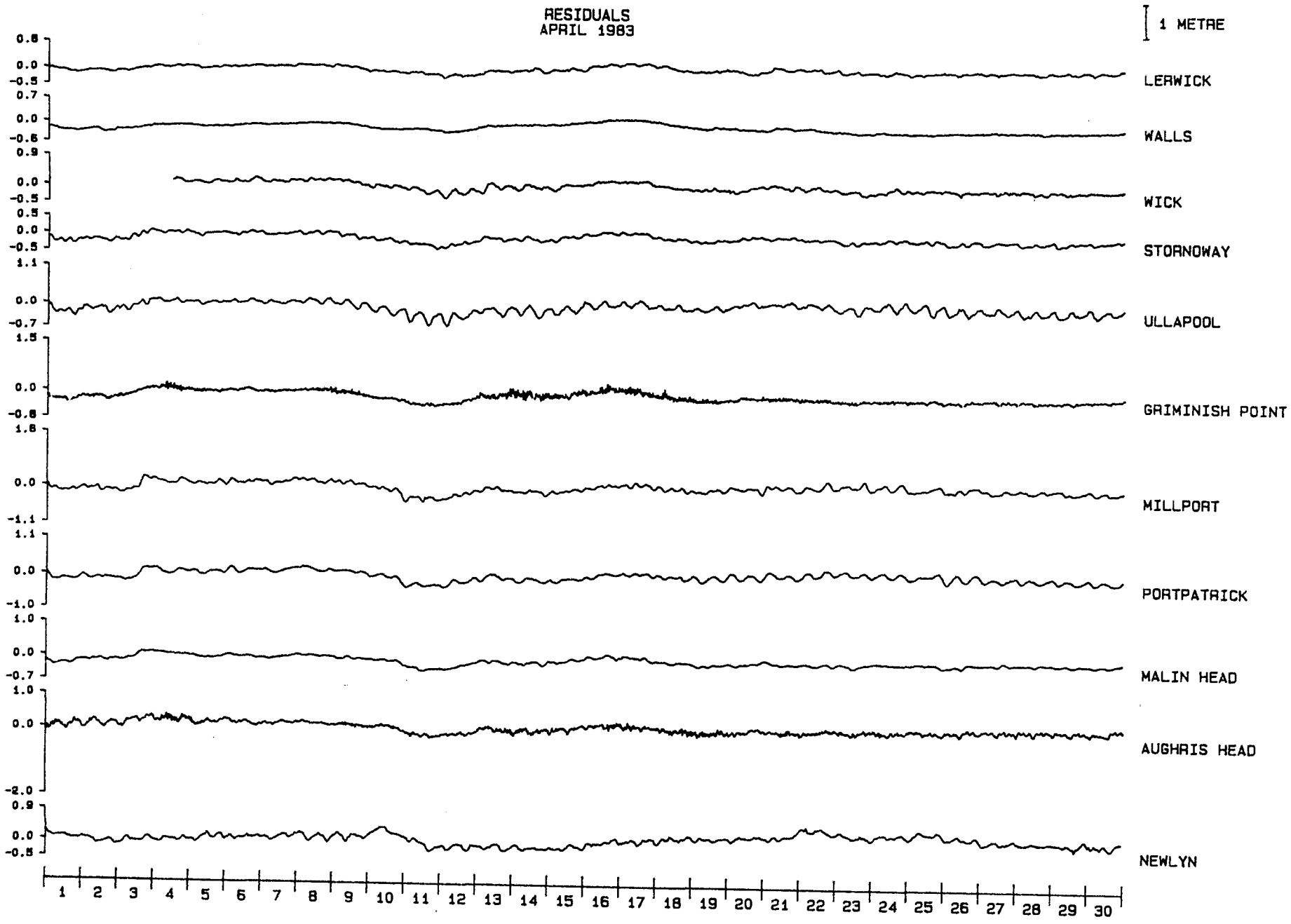

RESIDUALS
NOVEMBER 1982
1 METRE
LERWICK
WALLS
WICK
STORNOWAY
ULLAPOOL
GRIMINISH POINT
MILLPORT
PORTPATRICK
MALIN HEAD
AUGHRIS HEAD
NEWLYN
0.8
0.0
-0.5
0.7
0.0
-0.6
0.9
0.0
-0.5
0.5
0.0
-0.5
1.1
0.0
-0.7
1.5
0.0
-0.8
1.6
0.0
-1.1
1.1
0.0
-1.0
1.0
0.0
-0.7
1.0
0.0
-2.0
0.9
0.0
-0.5
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30

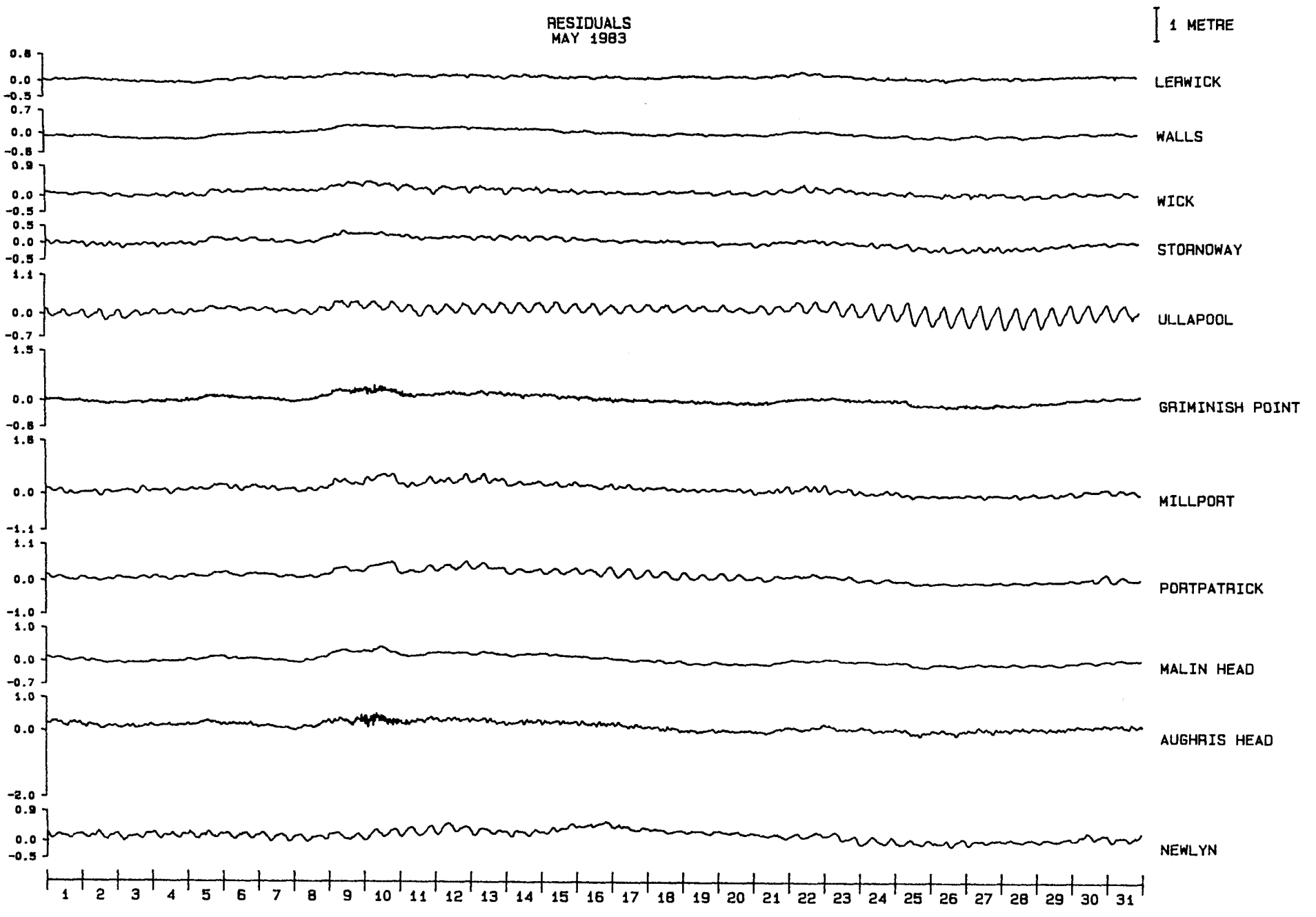

RESIDUALS
DECEMBER 1982
1 METRE
LERWICK
WALLS
WICK
STORNOWAY
ULLAPOOL
GRIMINISH POINT
MILLPORT
PORTPATRICK
MALIN HEAD
AUGHRIS HEAD
NEWLYN
0.8
0.0
-0.5
0.7
0.0
-0.6
0.9
0.0
-0.5
0.5
0.0
-0.5
1.1
0.0
-0.7
1.5
0.0
-0.8
1.6
0.0
-1.1
1.1
0.0
-1.0
1.0
0.0
-0.7
1.0
0.0
-2.0
0.8
0.0
-0.5
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31

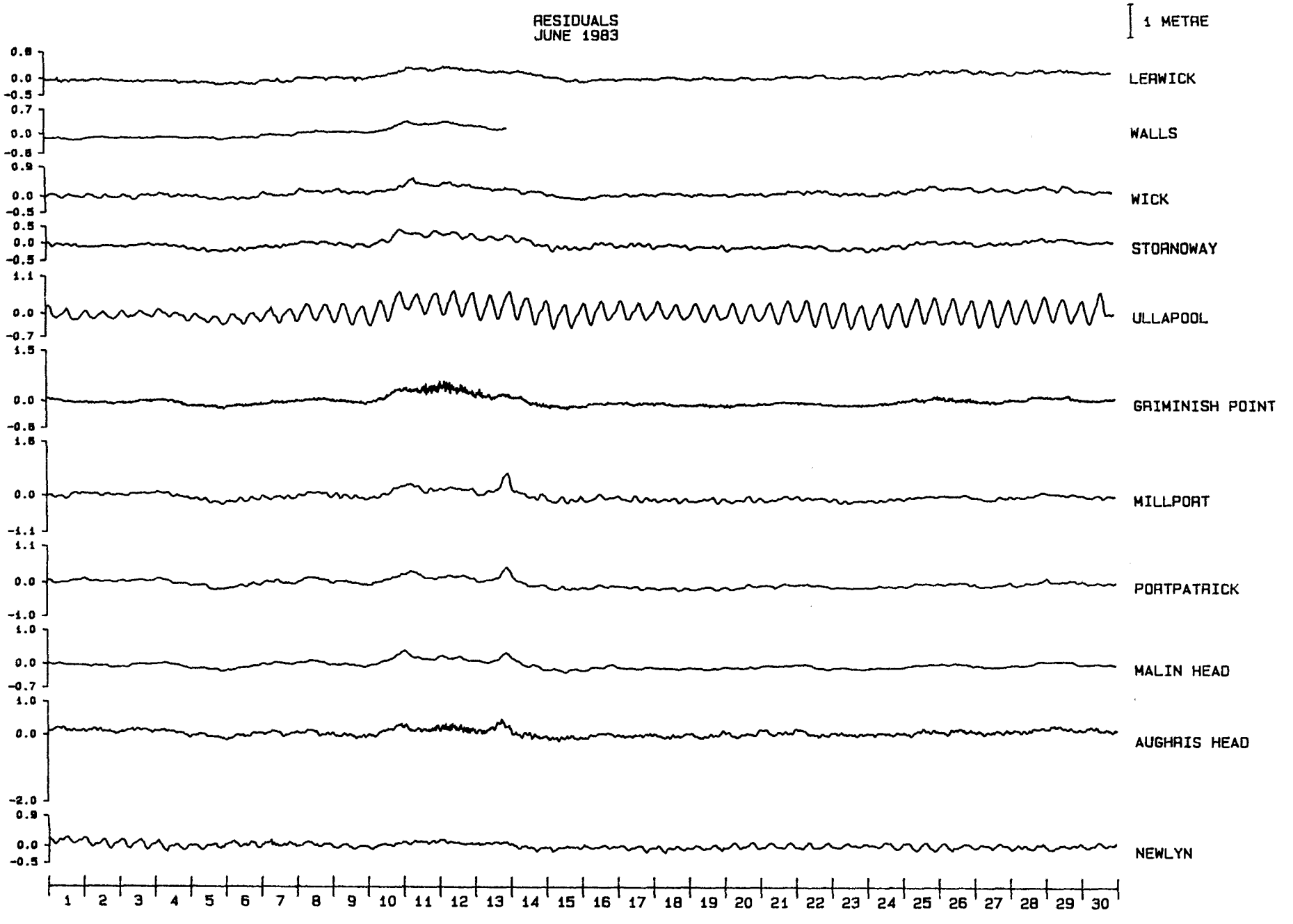

RESIDUALS
JANUARY 1983
1 METRE
LERWICK
WALLS
WICK
STORNOWAY
ULLAPOOL
GRIMINISH POINT
MILLPORT
PORTPATRICK
MALIN HEAD
AUGHRIS HEAD
NEWLYN
0.8
0.0
-0.5
0.7
0.0
-0.8
0.9
0.0
-0.5
0.5
0.0
-0.5
1.1
0.0
-0.7
1.5
0.0
-0.8
1.6
0.0
-1.1
1.1
0.0
-1.0
1.0
0.0
-0.7
1.0
0.0
-2.0
0.9
0.0
-0.5
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31

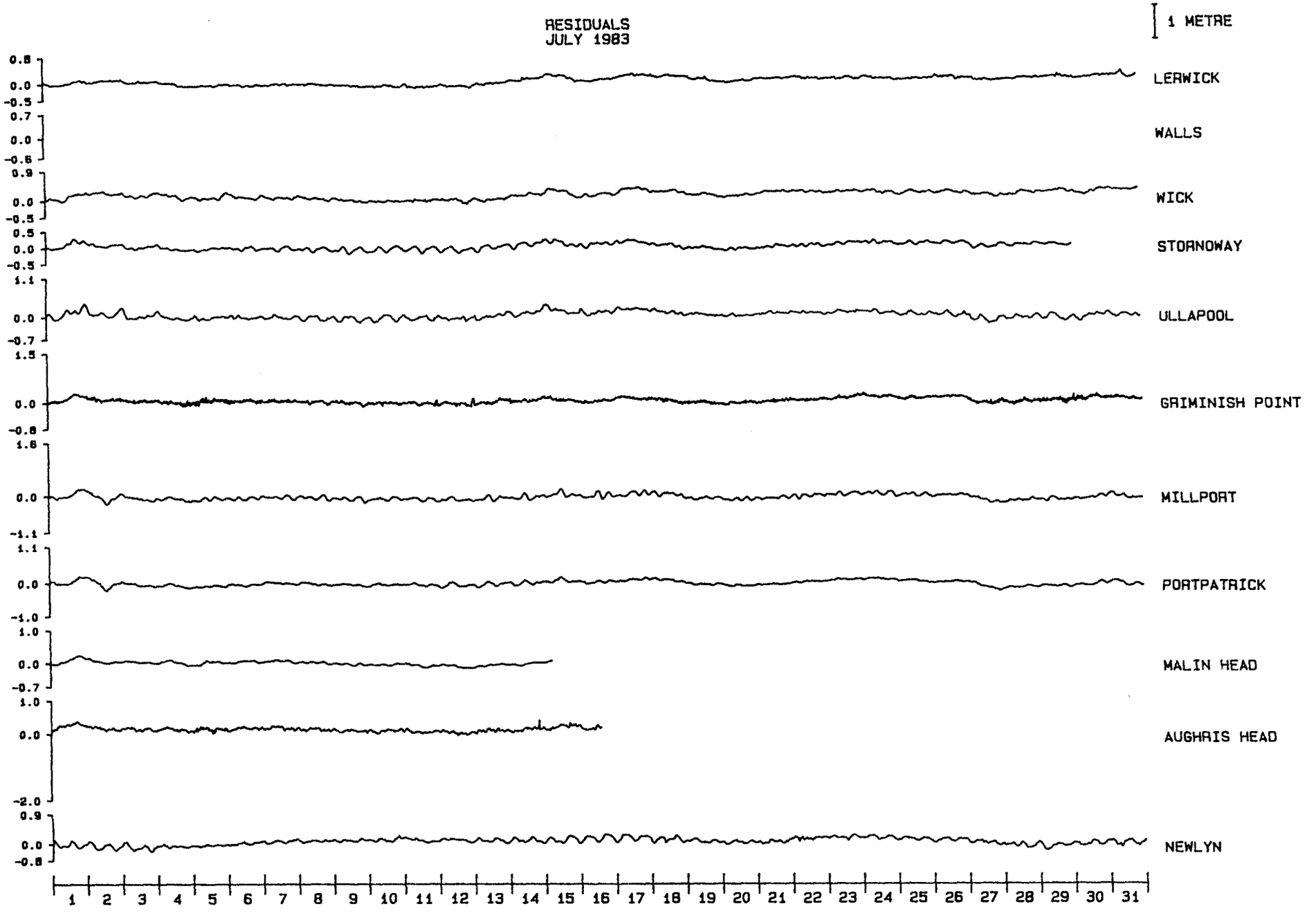

RESIDUALS
FEBRUARY 1983
1 METRE
LERWICK
WALLS
WICK
STORNOWAY
ULLAPOOL
GRIMINISH POINT
MILLPORT
PORTPATRICK
MALIN HEAD
AUGHRIS HEAD
NEWLYN
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28

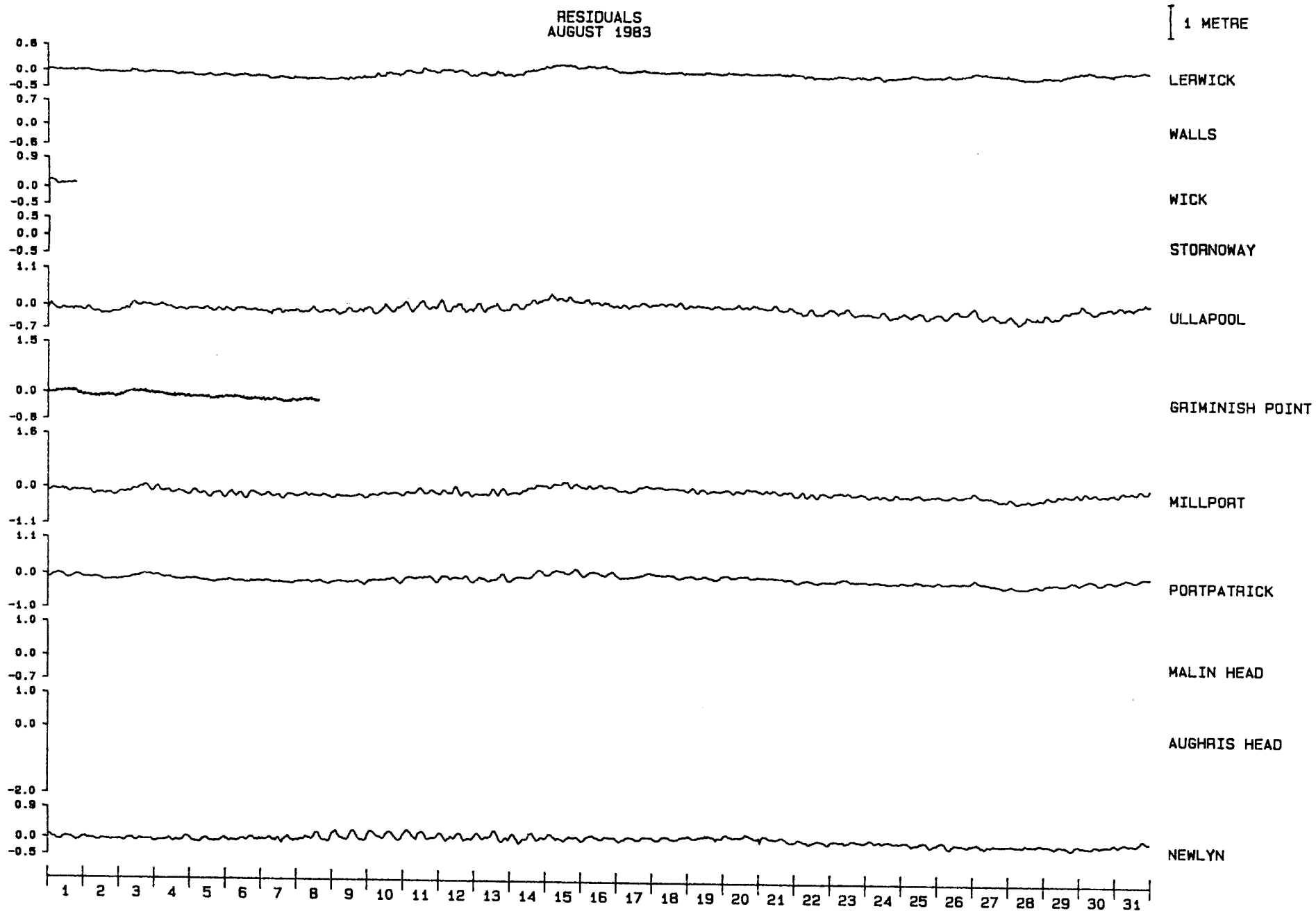

RESIDUALS
MARCH 1983
1 METRE
LERWICK
WALLS
WICK
STORNOWAY
ULLAPOOL
GRIMINISH POINT
MILLPORT
PORTPATRICK
MALIN HEAD
AUGHRIS HEAD
NEWLYN
0.8
0.0
-0.5
0.7
0.0
-0.6
0.9
0.0
-0.5
0.5
0.0
-0.5
1.1
0.0
-0.7
1.5
0.0
-0.8
1.6
0.0
-1.1
1.1
0.0
-1.0
1.0
0.0
-0.7
1.0
0.0
-2.0
0.9
0.0
-0.5
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31


RESIDUALS
APRIL 1983
1 METRE
LERWICK
WALLS
WICK
STORNOWAY
ULLAPOOL
GRIMINISH POINT
MILLPORT
PORTPATRICK
MALIN HEAD
AUGHRIS HEAD
NEWLYN
0.6
0.0
-0.5
0.7
0.0
-0.6
0.9
0.0
-0.5
0.5
0.0
-0.5
1.1
0.0
-0.7
1.5
0.0
-0.8
1.8
0.0
-1.1
1.1
0.0
-1.0
1.0
0.0
-0.7
1.0
0.0
-2.0
0.9
0.0
-0.5
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30


RESIDUALS
MAY 1983
1 METRE
LERWICK
WALLS
WICK
STORNOWAY
ULLAPOOL
GRIMINISH POINT
MILLPORT
PORTPATRICK
MALIN HEAD
AUGHRIS HEAD
NEWLYN
0.8
0.0
-0.5
0.7
0.0
-0.6
0.9
0.0
-0.5
0.5
0.0
-0.5
1.1
0.0
-0.7
1.5
0.0
-0.8
1.8
0.0
-1.1
1.1
0.0
-1.0
1.0
0.0
-0.7
1.0
0.0
-2.0
0.9
0.0
-0.5
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31


RESIDUALS
JUNE 1983
1 METRE
LERWICK
WALLS
WICK
STORNOWAY
ULLAPOOL
GRIMINISH POINT
MILLPORT
PORTPATRICK
MALIN HEAD
AUGHRIS HEAD
NEWLYN
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30


RESIDUALS
JULY 1983
1 METRE
LERWICK
WALLS
WICK
STORNOWAY
ULLAPOOL
GRIMINISH POINT
MILLPORT
PORTPATRICK
MALIN HEAD
AUGHRIS HEAD
NEWLYN
0.8
0.0
-0.5
0.7
0.0
-0.6
0.9
0.0
-0.5
0.5
0.0
-0.5
1.1
0.0
-0.7
1.5
0.0
-0.8
1.6
0.0
-1.1
1.1
0.0
-1.0
1.0
0.0
-0.7
1.0
0.0
-2.0
0.9
0.0
-0.8
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31


RESIDUALS
AUGUST 1983
1 METRE
0.6
0.0
-0.5
LERWICK
0.7
0.0
-0.6
WALLS
0.9
0.0
-0.5
WICK
0.5
0.0
-0.5
STORNOWAY
1.1
0.0
-0.7
ULLAPOOL
1.5
0.0
-0.8
GRIMINISH POINT
1.6
0.0
-1.1
MILLPORT
1.1
0.0
-1.0
PORTPATRICK
1.0
0.0
-0.7
MALIN HEAD
1.0
0.0
-2.0
AUGHRIS HEAD
0.9
0.0
-0.5
NEWLYN
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31

APPENDIX 4.3

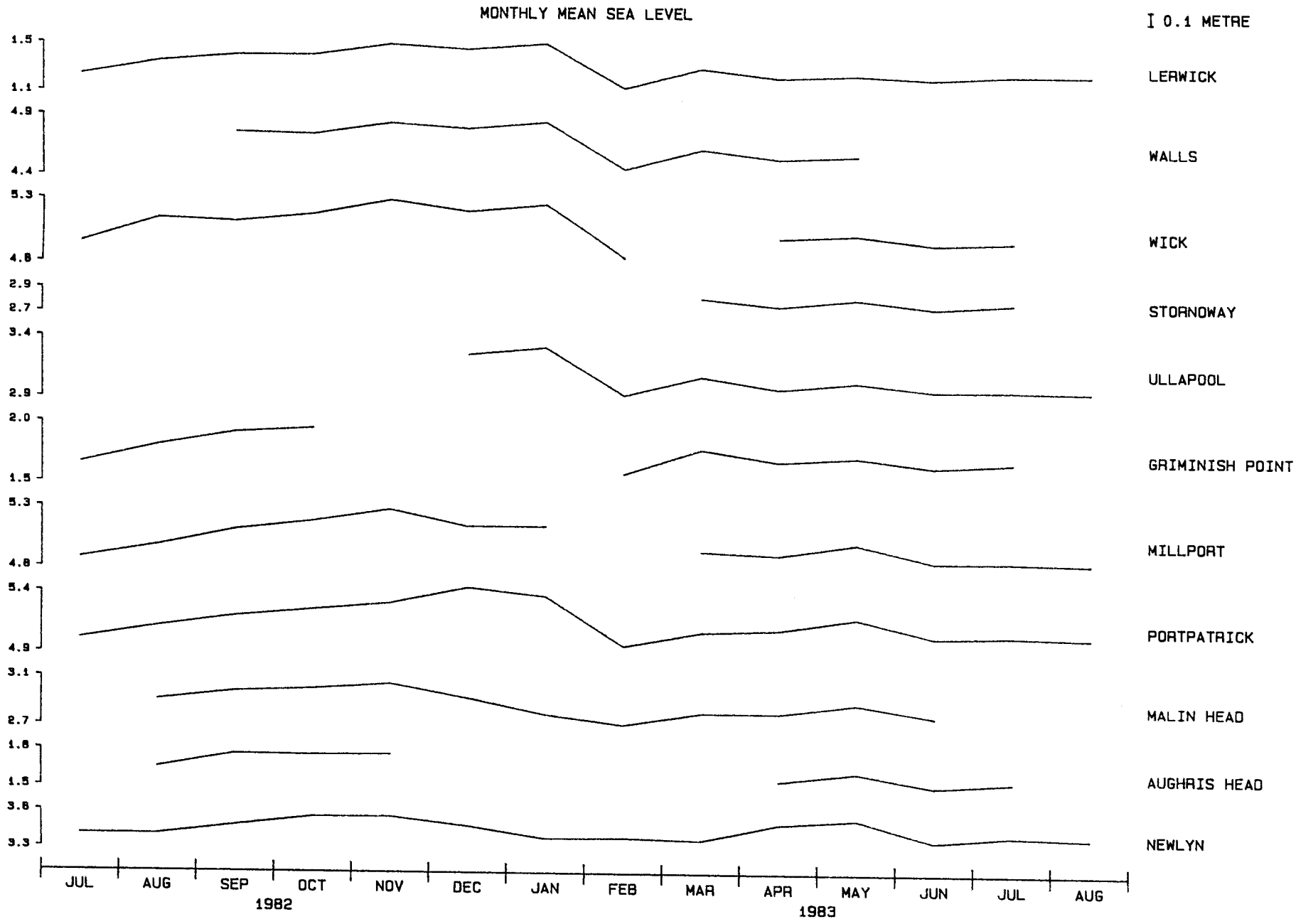
MEAN SEA LEVEL VALUES

	1982								1983					
	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG
LERWICK	1.232	1.345	1.396	1.396	1.485	1.440	1.491	1.118	1.284	1.200	1.226	1.187	1.222	1.214
WALLS			4.755	4.736	4.831	4.781	4.840	4.453	4.620	4.536	4.564			
WICK	4.949	5.140	5.109	5.174	5.290	5.197	5.258	4.836		4.991	5.017	4.940	4.964	
STORNOWAY									2.818	2.749	2.811	2.733	2.775	
ULLAPOOL						3.254	3.311	2.921	3.077	2.973	3.031	2.958	2.965	2.953
GRIMINISH	1.655	1.805	1.912	1.946				1.574	1.781	1.676	1.715	1.632	1.671	
MILLPORT	4.871	4.977	5.109	5.180	5.277	5.135	5.138		4.938	4.911	5.005	4.853	4.861	4.843
PORTPATRICK	5.008	5.113	5.201	5.256	5.310	5.440	5.366	4.961	5.081	5.102	5.195	5.038	5.056	5.039
MALIN		2.907	2.980	3.003	3.045	2.927	2.795	2.714	2.816	2.816	2.893	2.786		
AUGHRIS		1.651	1.764	1.754	1.766					1.559	1.632	1.515	1.558	
NEWLYN	3.404	3.405	3.482	3.554	3.557	3.480	3.383	3.395	3.374	3.511	3.550	3.370	3.423	3.401

MONTHLY MEAN SEA LEVEL VALUES TO TIDE GAUGE ZERO

APPENDIX 4.4

TIME SERIES PLOT OF MEAN SEA LEVEL VALUES


MONTHLY MEAN SEA LEVEL
I 0.1 METRE
1.5
1.1
LERWICK
4.8
4.4
WALLS
5.3
4.8
WICK
2.9
2.7
STORNOWAY
3.4
2.9
ULLAPOOL
2.0
1.5
GRIMINISH POINT
5.3
4.8
MILLPORT
5.4
4.9
PORTPATRICK
3.1
2.7
MALIN HEAD
1.8
1.5
AUGHRIS HEAD
3.6
3.3
NEWLYN
JUL
AUG
SEP
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
1982
1983