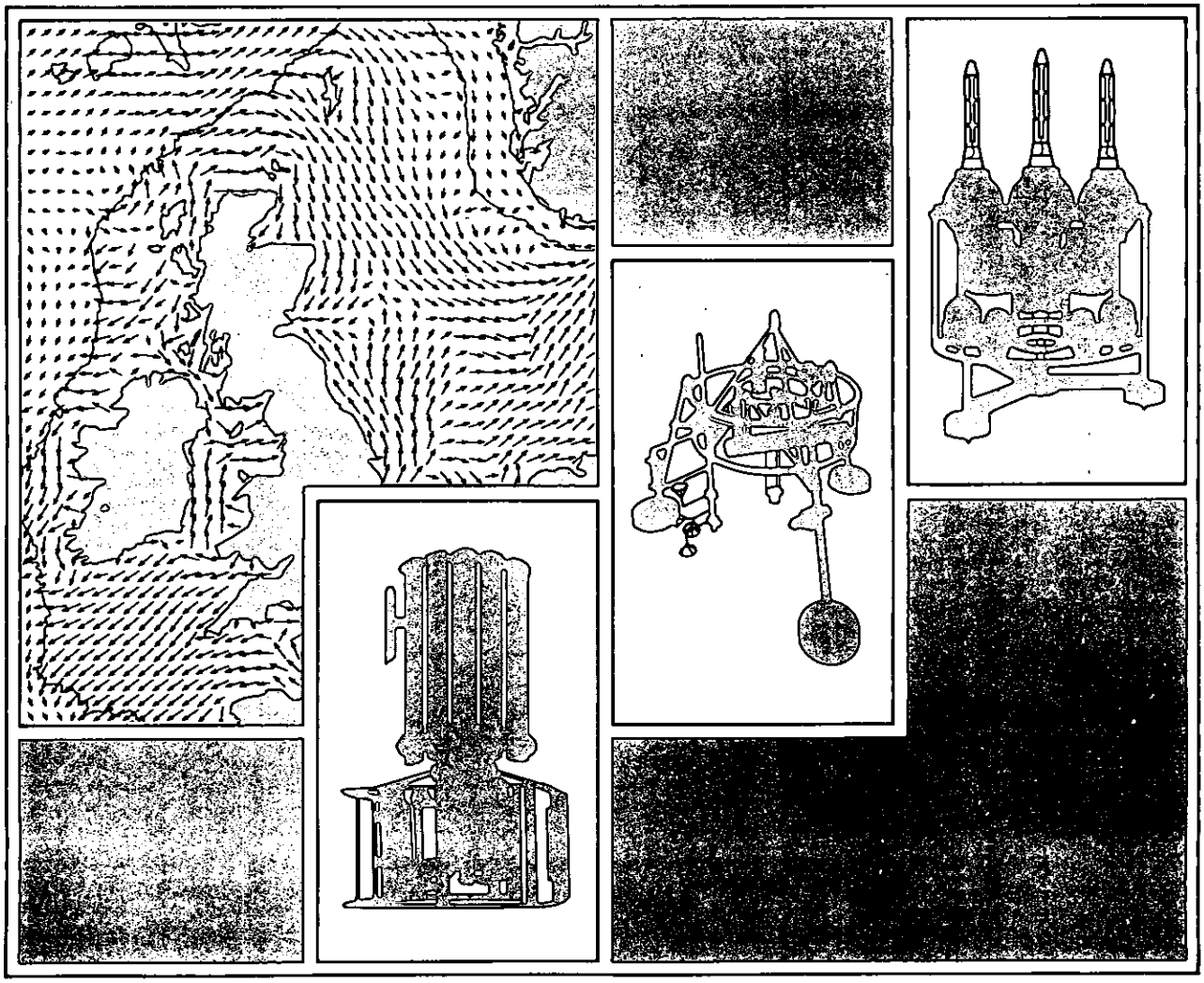
Proudman
Oceanographic
Laboratory

Class A Network Dataring gauges

1991 data processing and analysis

SM Shaw
Report No 26 1992



Natural Environment Research Council

PROUDMAN OCEANOGRAPHIC LABORATORY

Bidston Observatory,
Birkenhead, Merseyside, L43 7RA, U.K.

Telephone: 051 653 8633
Telex 628591 OCEANB G
Telefax 051 653 6269

Director: Dr. B.S. McCartney

Natural Environment Research Council

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S.M.Shaw

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SHAW, S.M.

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ABSTRACT

This report presents a summary of still water sea level data processing for 1991 from 34 modernised Dataring sites around the UK coast.

Details of geographic position, reference levels, processing, statistics and analyses are included.

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ISSUING ORGANISATION

Proudman Oceanographic Laboratory
Bidston Observatory
Birkenhead, Merseyside L43 7RA
UK

Director: Dr B S McCartney

TELEPHONE
051 653 8633

TELEX
628591 OCEAN BG

TELEFAX
051 653 6269

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CONTENTS

1. Introduction

This report is the fifth in an annual series presenting statistical results from tide gauge sites on the modernised U.K. Class-A network interrogated with the Data Acquisition for Tidal Applications for the Remote Interrogation of Network Gauges (DATARING).

A total of 34 Class-A sites had undergone modernisation as 1991 ended. (Figure 1)

Three sites modernised in 1990 were briefly introduced in the report for 1990, but now have sufficient data for analysis:- Hinkley Point, Portpatrick and Newhaven.

Other sites which have been modernised during 1991 include Weymouth in Dorset, Portsmouth Hampshire, Devonport, Liverpool Gladstone Dock, Port Ellen on the Isle of Islay, Kinlochbervie in North-West Scotland and Barmouth in Wales.

Maps showing the instrument sites and bench mark information for all the modernised installations are included in this report with statistical and analytical results for 1991 including frequency of level plots where sufficient data has been obtained.

Extreme, mean sea level and surge diagrams and statistics are also included.

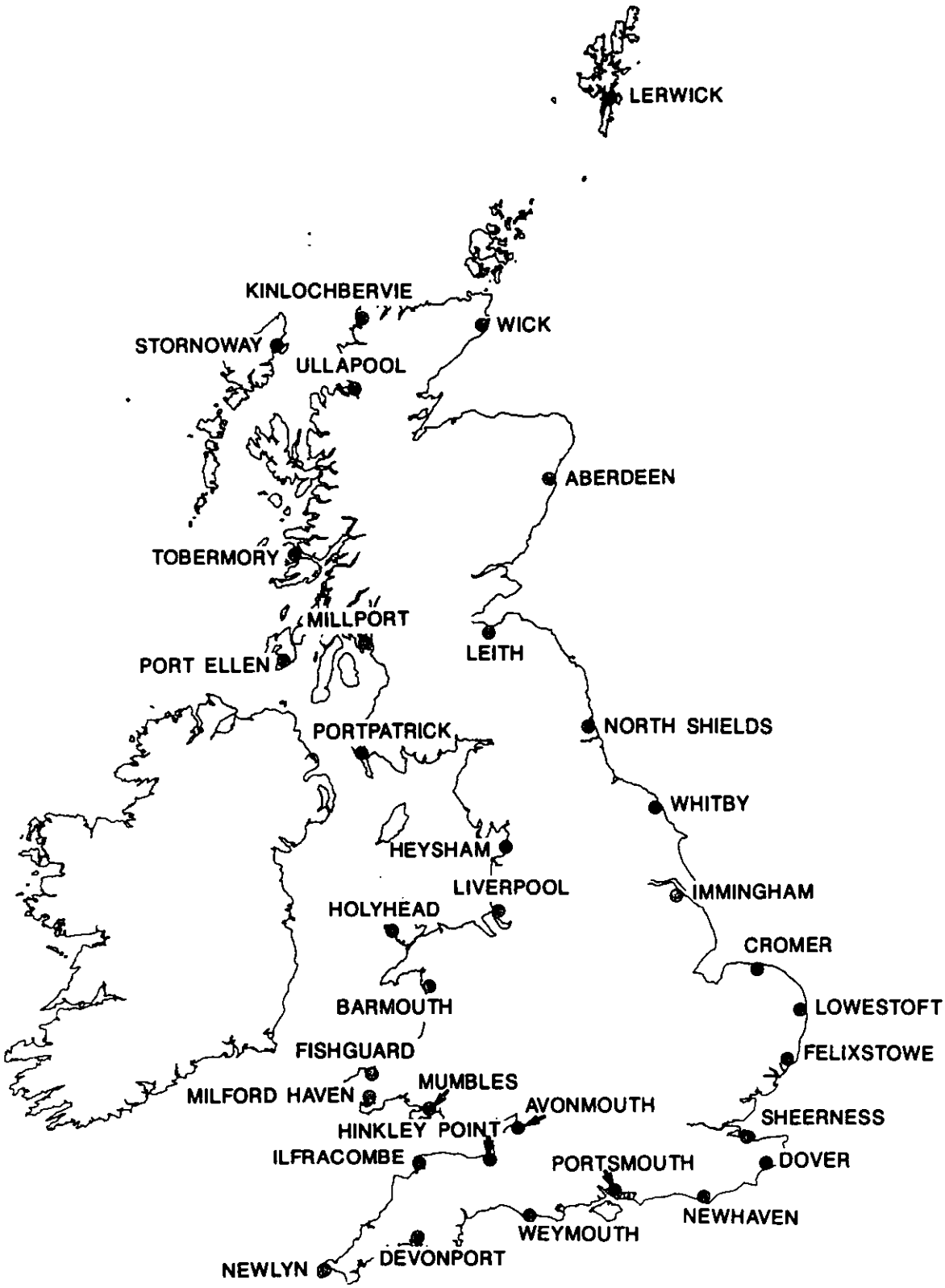


Figure 1. Class A Tide Gauge sites operational in 1991.

2. General description of sites and processing

All installations which have undergone modernisation are interrogated weekly from the Proudman Oceanographic Laboratory. Raw values thus collected undergo a vigorous checking and editing procedure before being filtered to hourly values at intervals of approximately a calendar month. Every effort is made to retrieve a maximum number of values from each site, and some interpolation over short periods takes place where considered to be a safe exercise in terms of accuracy.

Although all sites have a minimum of two recording 'channels' of data these are frequently from differing instruments. Elevations obtained from these, unless within a very few millimetres of one another are not mixed in the reduction process. For 'new' sites, a complete year's record from each channel is analysed before a decision is taken to adopt a 'Class-A' channel for continuing processing. The second channel of data is retained as a back-up series in its raw form.

Where suitable analyses of data exist, the processed hourly values are compared with predicted levels and storm surge 'residuals' are extracted for continual monitoring of storm surge model data.

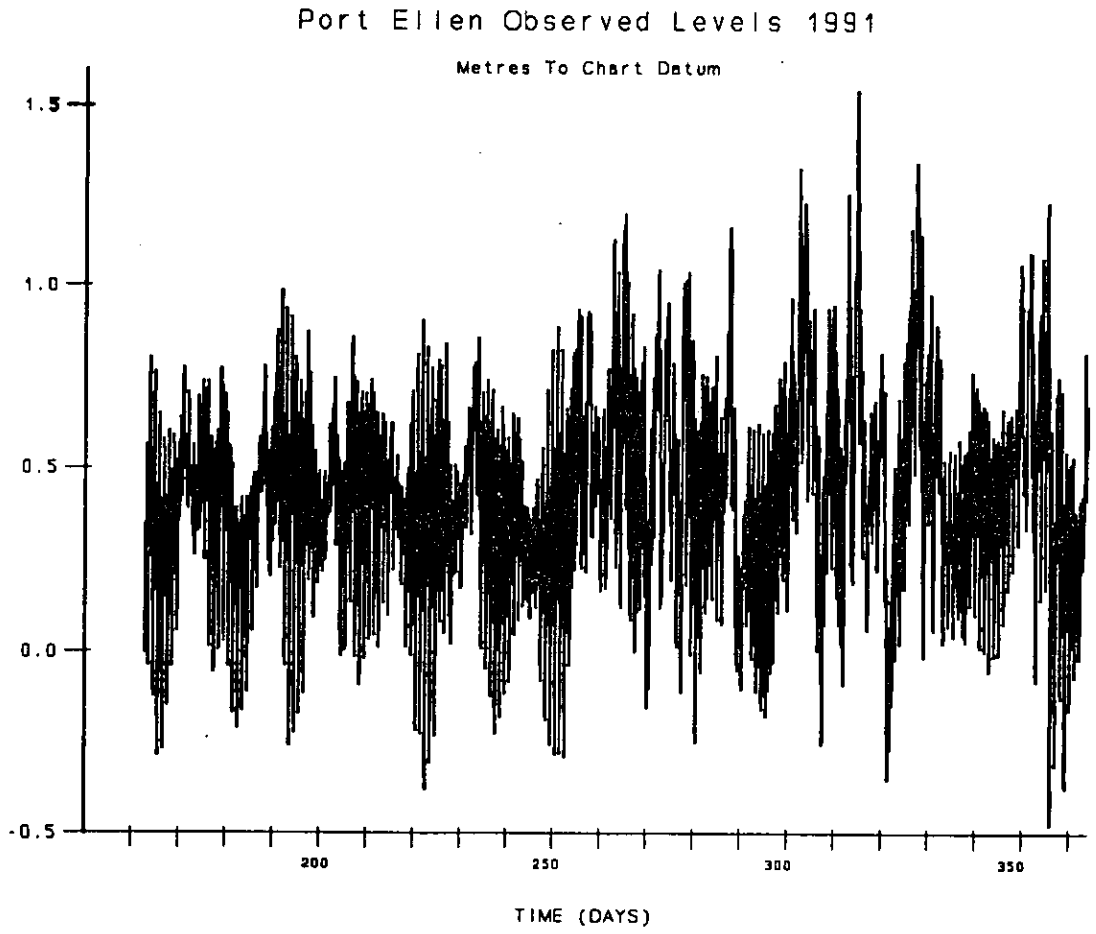
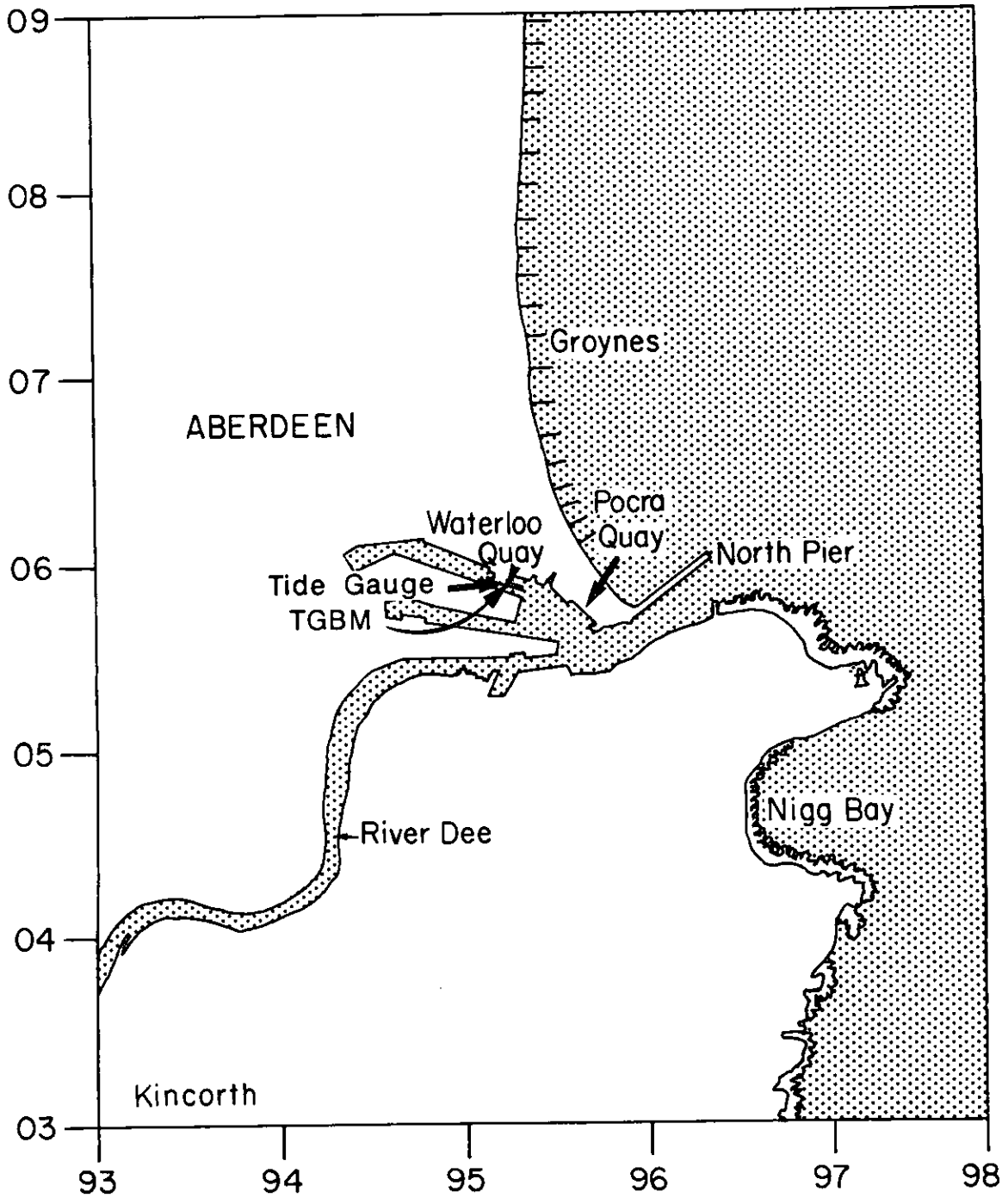


Figure 2. The small tidal range at the new installation on Islay is greatly affected by meteorological conditions.

Aberdeen

Latitude 57 deg 08' 38.9"N Longitude 02 deg 04' 43.2"W
National Grid reference NJ 9524 0590

Recording zero = Chart Datum = 2.25m below Ordnance Datum Newlyn
Recording zero = 6.091m below Tide Gauge Bench Mark



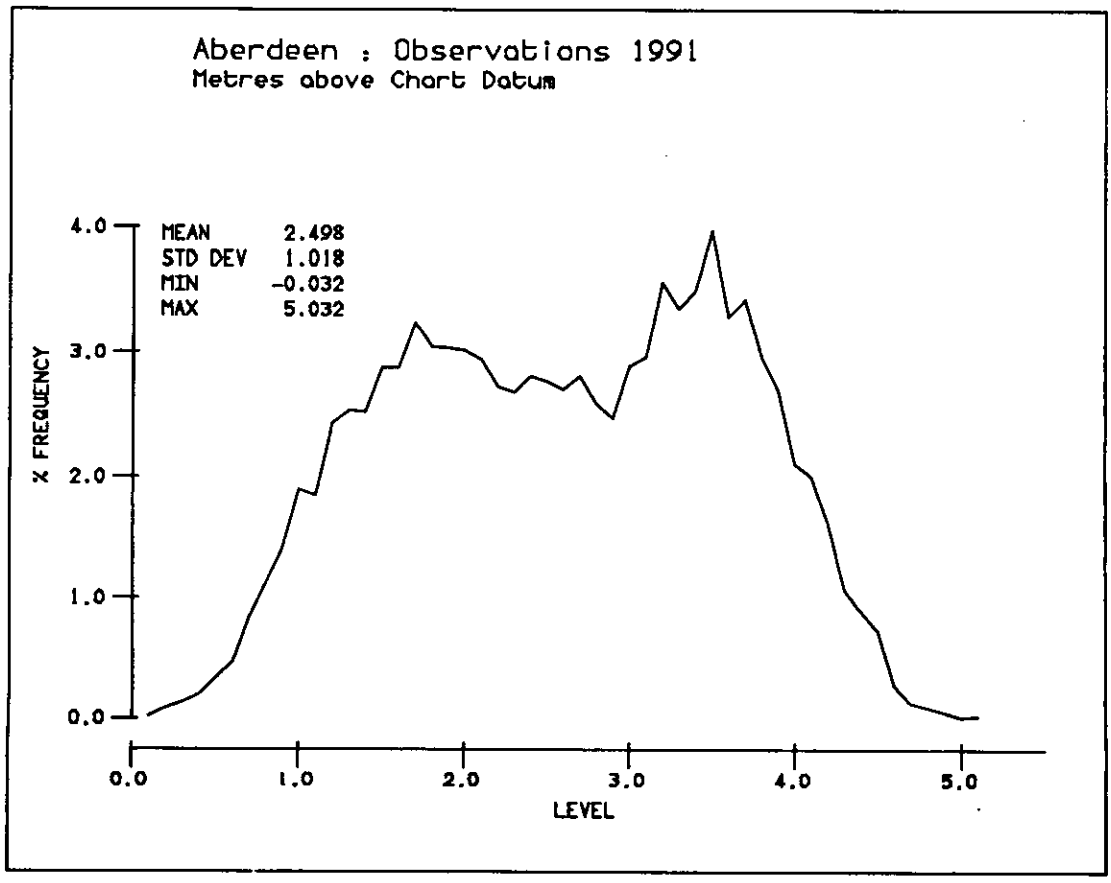
Bench Marks	NG co-ords	Description
TGBM	NJ 9524 0590	NBM OSBM bolt SE face of tide gauge housing.
Aux1	NJ 9572 0593	Public convenience east side of esplanade W face SW angle.

Upgraded to Dataring in December 1985 with a potentiometer linked to the Munro gauge in the stilling well and a digiquartz sensor attached to a pressure gauge.

The Tide Gauge Inspectorate (TGI) visited the site 9 April and 21-22 November.

Spurious values and isolated missing scans were edited at the raw stage for the following dates: 13,16 Jan; 6 Feb; 7,14 Mar; 4,6,30 Apr; 14,31 May; 26 Jun; 18 Jul; 8,25,28 Aug; 23,25 Sep; 24 Oct; 5 Dec. Scans integrated at 1 7/8 minute over the TGI visit of 22 November were edited down to 15 minute interval.

Ultimately, a **complete series** of hourly levels was collated from the digiquartz channel for 1991, which is the designated Class-A channel of data.



Harmonic Tidal Analysis.

Port: Scotland, East Coast - Aberdeen

Latitude: 57 08' 38.9" N
Longitude: 2 04' 43.2" W

Time Zone: GMT

Length: 365 Days

From: 1st January, 1991 To: 31st December, 1991

Units: Metres A0: 2.499

Hourly data from digiquartz sensor

Datum of Observations = ACD : 2.25 Metres below Ordnance Datum (Newlyn)

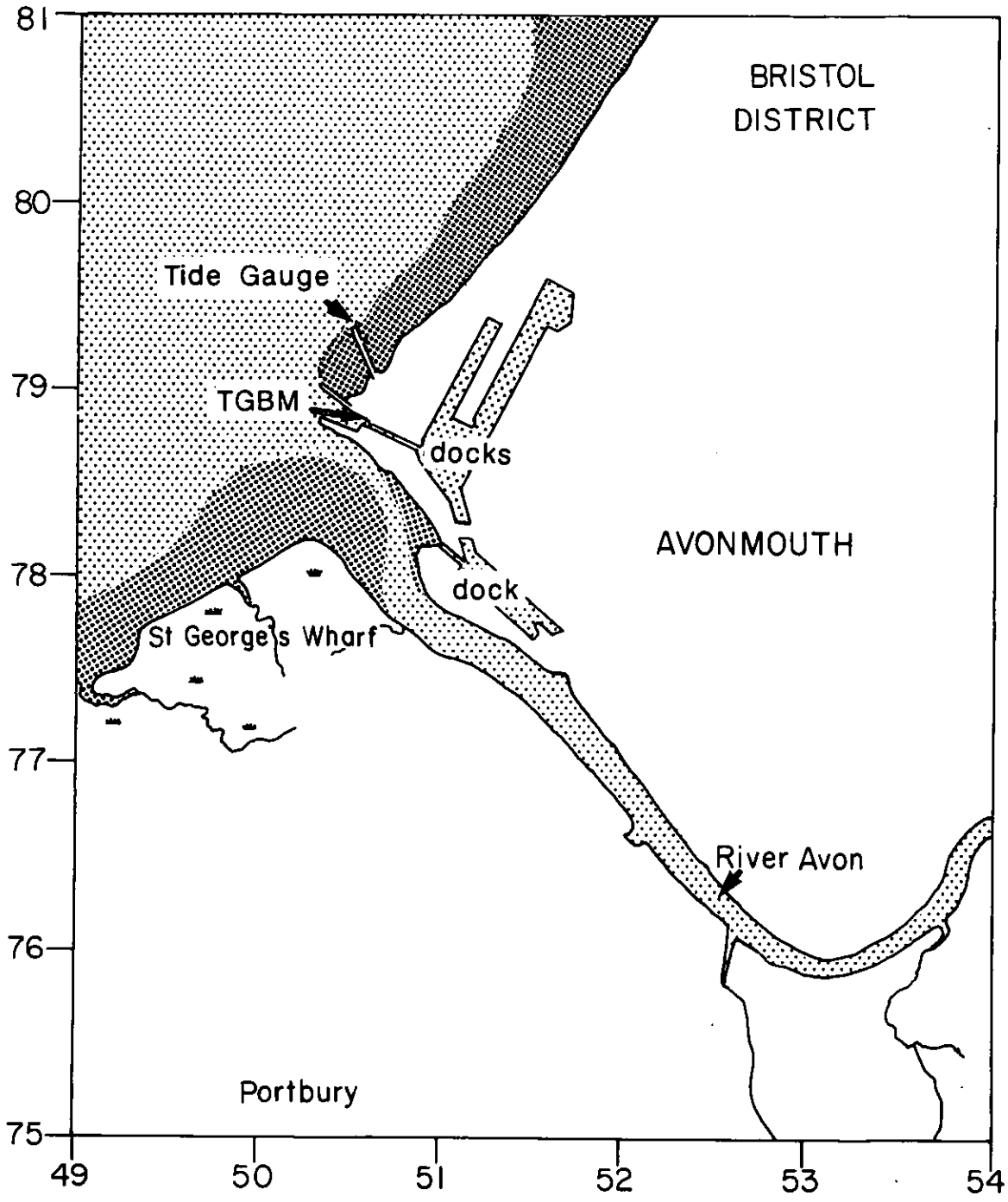
Observation Mean =	0.2499D+01	Residual Mean =	0.3415D-06
Std Dev =	0.1015D+01	Std Dev =	0.1656D+00

Constituent	h	g
Q1	0.037	0.03
O1	0.131	47.82
P1	0.032	186.35
K1	0.111	203.35
J1	0.009	221.68
2N2	0.040	348.92
N2	0.254	1.33
M2	1.304	24.67
S2	0.443	63.00
K2	0.126	60.85
M3	0.012	326.15
M4	0.033	168.00
MS4	0.032	245.04
M6	0.007	110.59

Avonmouth

Latitude 51 deg 30' 36.9"N Longitude 02 deg 42' 50.7"W
National Grid reference ST 5045 7933

Recording zero = Chart Datum = 6.5m below Ordnance Datum Newlyn
Recording zero = 15.711m below Tide Gauge Bench Mark



Bench Marks	NG co-ords	Description
TGBM	ST 5057 7881	OSBM bolt at base of bollard.
Aux1	ST 5072 7859	Rivet adjacent to transit shed NW face W angle.

This site was modernised in September 1986 with two digiquartz sensors attached to pneumatic bubbler system outlets. Channel 1 became the designated Class-A channel in January 1988.

The pneumatic tube for the back-up channel 2 started leaking in early February 1991 and became completely unservicable on 10 April. It is intended to replace the system to one more similar to channel 1.

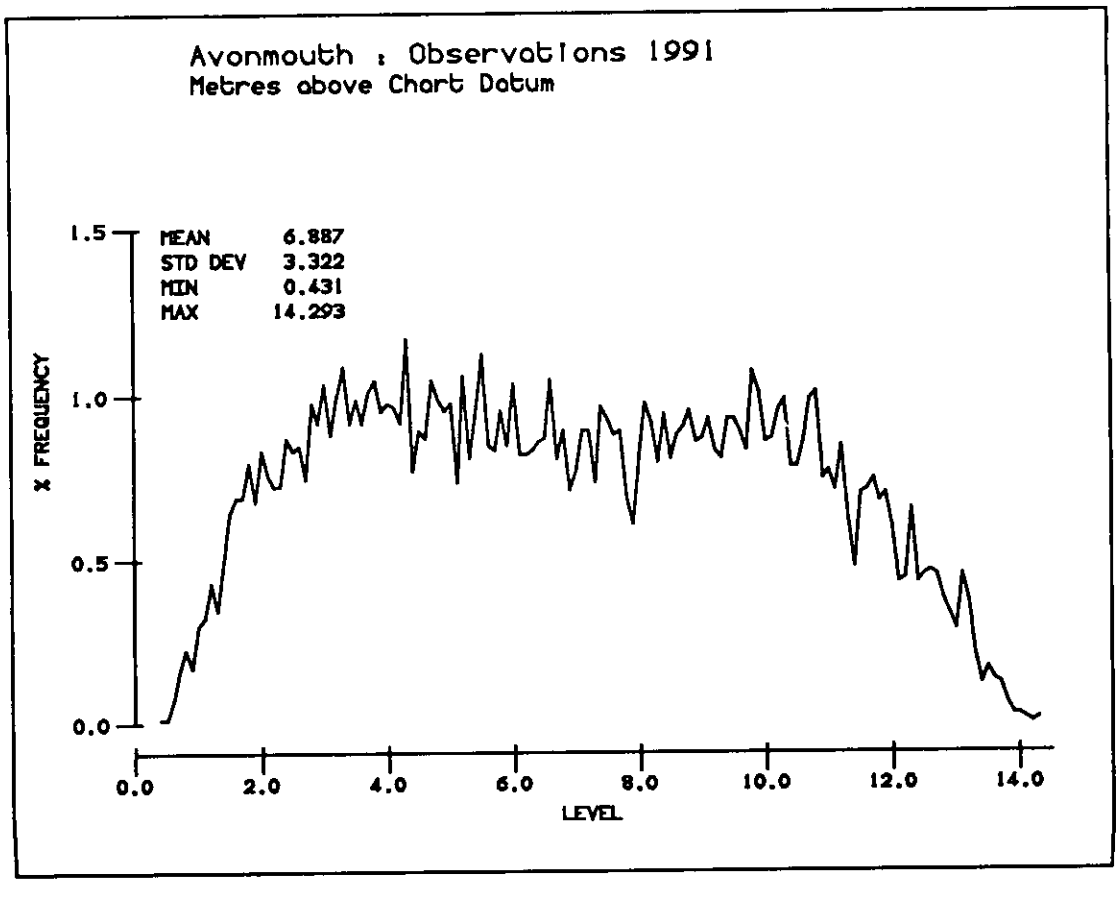
Isolated missing and spurious scans in channel 1 were interpolated on the following dates: 2,15 Feb; 16, 20(2) Mar; 2,15,18 Apr; 23 May; 10,26,28 Jun; 11,23 Jul; 6(3),28 Aug; 10,26,29,30 Sep; 4,8,12,24,31 Oct; 8,25 Nov.

Levels were interpolated over the periods 0830 GMT-0930 GMT 14 February and 0900 GMT - 0945 GMT 19 February when there appeared to be losses of pressure.

Scans integrated at 1 7/8 minute over the TGI visits of 11 March and 12 August were edited to 15 minute interval.

Gaps in final filtered hourly levels

2200 GMT	6 Feb	- 1400 GMT	10 Feb	System frozen.
0200 GMT	10 Dec	- 1600 GMT	13 Dec	Compressor apparently switched off
0200 GMT	17 Dec	- 0400 GMT	24 Dec	Modem and telephone fault.



Harmonic Tidal Analysis.

Port: England, West Coast - Port of Bristol (Avonmouth)

Latitude: 51 30' 36.9" N
Longitude: 2 42' 50.7" W

Time Zone: GMT

Length: 348 Days

From: 1st January, 1991 To: 31st December, 1991

Units: Metres A0: 6.889

Hourly data from digiquartz sensor 1

Datum of Observations = ACD : 6.50 Metres below Ordnance Datum (Newlyn)

Observation Mean =	0.6889D+01	Residual Mean =	0.1046D-05
Std Dev =	0.3319D+01	Std Dev =	0.2206D+00

Constituent	h	g
Q1	0.017	317.66
O1	0.074	1.60
P1	0.024	116.72
K1	0.062	143.59
J1	0.004	146.43
2N2	0.094	175.06
N2	0.756	188.69
M2	4.281	201.07
S2	1.520	260.65
K2	0.442	256.30
M3	0.055	211.89
M4	0.267	349.39
MS4	0.246	22.70
M6	0.118	274.11

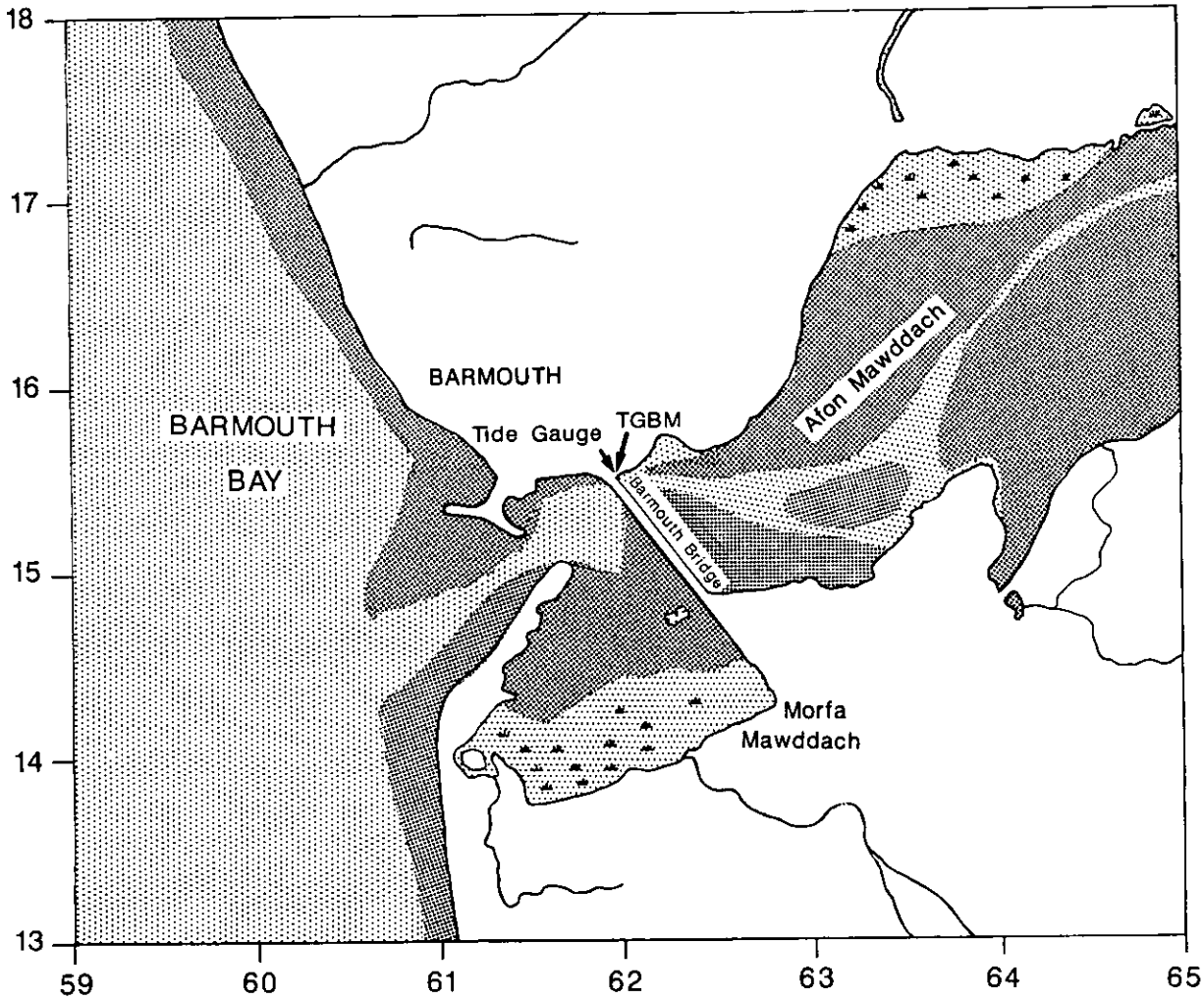
Barmouth

This is a completely new site on the Class-A network to fill the gap in coverage between Fishguard and Holyhead. The two Dataring digiquartz sensors became fully operational on **10 October 1991.**
A missing scan in the raw data from channel 2 was interpolated on the following date: 24 Oct.
Although there are insufficient data for Harmonic Constants or frequency/depth curves to be included for the 1991 series, limited extreme level and surge statistics are included in sections 3 and 4.

Geographic and reference details

Latitude 52deg 43' 8.4"N Longitude 04deg 02' 37.8"W
National Grid reference SH 6197 1548

Recording zero = Chart Datum = 2.44m below Ordnance Datum Newlyn.
Recording zero = 10.363m below Tide Gauge Bench Mark.

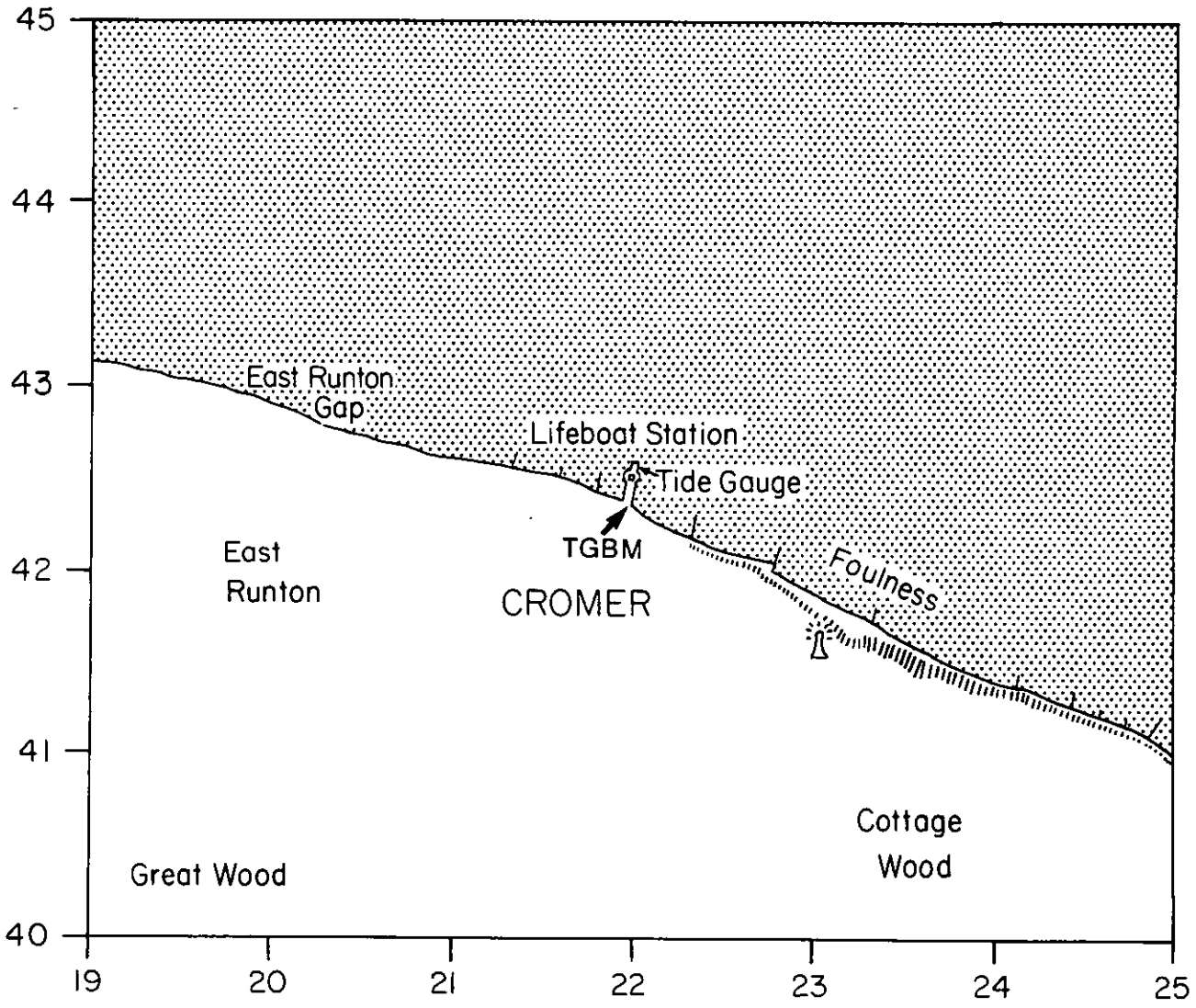


Bench Marks	NG co-ords	Description
TGBM	SH 6197 1548	NBM Rivet in concrete 2.9m NE of wall junction.
Aux1	SH 6173 1558	Rivet on step NE side of road NW of entrance to path.

Cromer

Latitude 52 deg 56' 1.9"N Longitude 01 deg 18' 12.5"E
National Grid reference TG 2198 4253

Recording zero = Chart Datum = 2.75m below Ordnance Datum Newlyn
Recording zero = 10.117m below Tide Gauge Bench Mark



Bench Marks	NG co-ords	Description
TGBM	TG 2193 4233	Stainless steel bolt on top of wall opposite E. side of pier.
Aux1	TG 2198 4253	Rivet on steps of C catwalk NE angle of Lifeboat Station.

Of the two recording channels both with digiquartz transducers, Channel 2 is the designated Class-A channel.

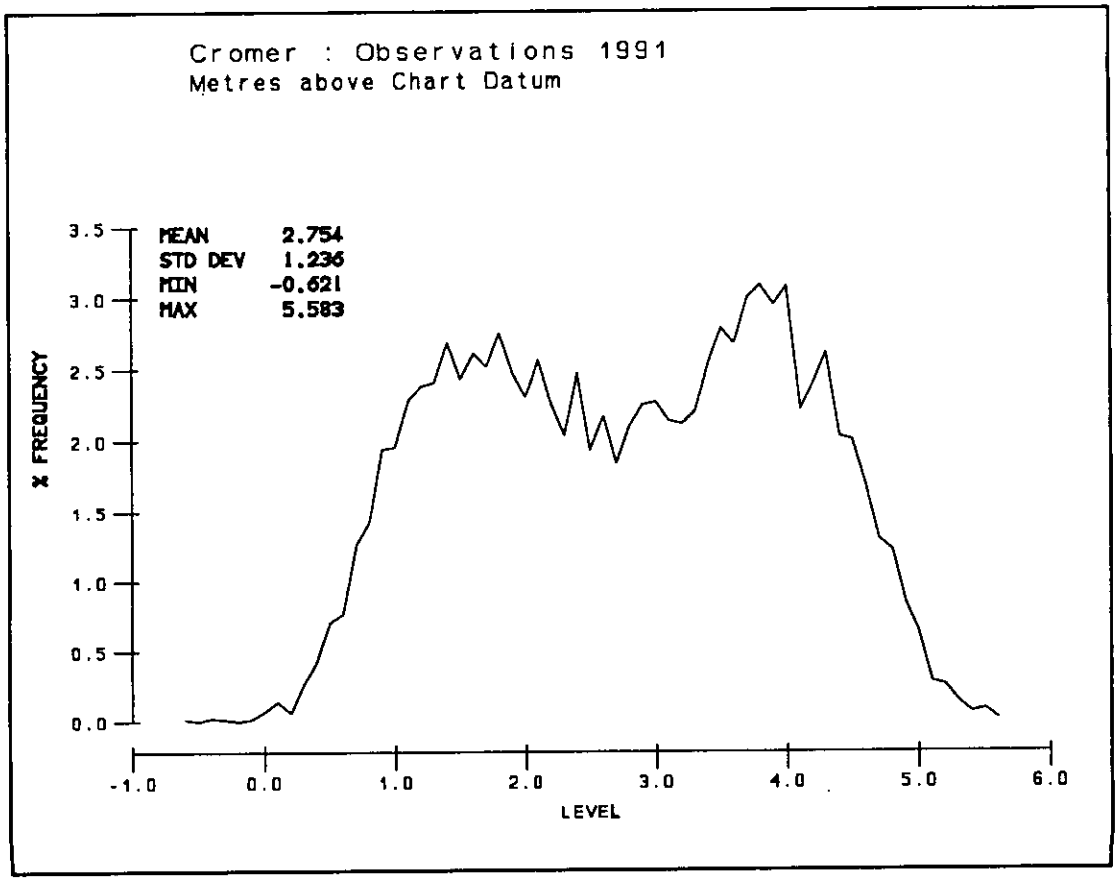
Isolated missing and spurious values in the raw data from channel 2 were edited for the following dates: 8 Jan; 7,22 Feb; 9,13 Mar; 18,29 Jul; 3 Aug; 2,9,24,26 Sep; 7,11 Dec.

Scans integrated at 1 7/8 minute during the visit by TGI on 30 April were edited down to 15 minute interval.

On a visit of 27 and 28 July, TGI again visited with the P.O.L. diving team who found both pressure points blocked and the cap missing from the back-up channel 1 point. Although not processed, the channel 1 data had displayed problems throughout the year particularly from March to the time of their visit. In late August further problems were revealed and the local operator purged the system on 2nd September. This did not seem to have any positive affect and he tried again 24 September. Thereafter values from the two channels show a difference in elevation of between 2 and 3 cm., with channel 2 reading high. Further examination of results have since shown that the back-up channel 1 series was the one in error and reading low.

Gaps in hourly filtered levels (Channel 2 digiquartz)

Nil gaps.



Harmonic Tidal Analysis.

Port: England, East Coast - Cromer

Latitude: 52 56' 01.9" N
Longitude: 1 18' 12.5" E

Time Zone: GMT

Length: 365 Days

From: 1st January, 1991 To: 31st December, 1991

Units: Metres A0: 2.757

Hourly data from digiquartz sensor 2

Datum of Observations = ACD : 2.75 Metres below Ordnance Datum (Newlyn)

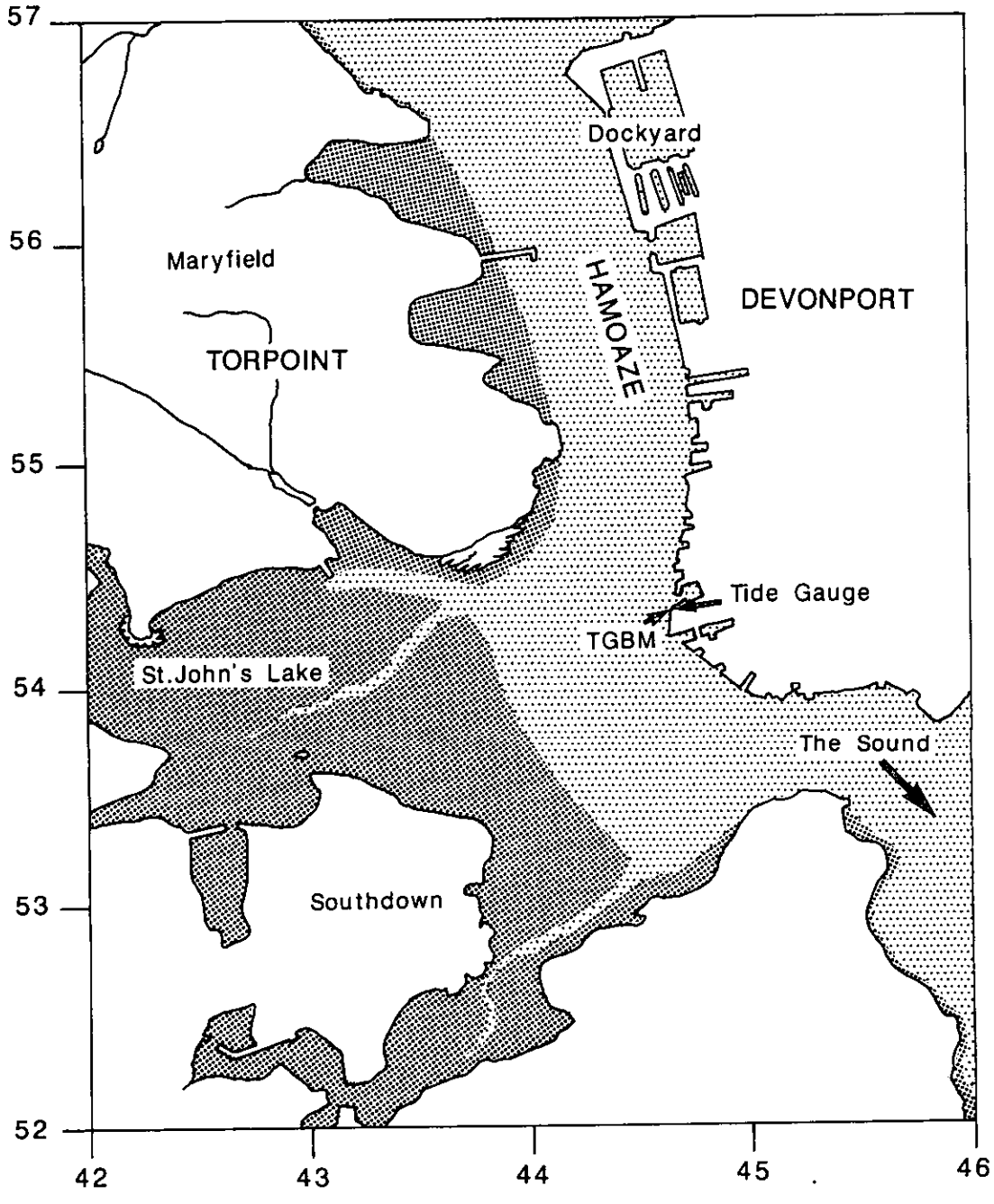
Observation Mean =	0.2756D+01	Residual Mean =	0.8268D-06
Std Dev =	0.1236D+01	Std Dev =	0.2198D+00

Constituent	h	g
Q1	0.049	73.95
O1	0.160	129.18
P1	0.043	276.75
K1	0.143	299.95
J1	0.015	320.35
2N2	0.052	148.99
N2	0.299	164.67
M2	1.578	188.37
S2	0.538	234.55
K2	0.153	233.34
M3	0.009	234.06
M4	0.090	282.40
MS4	0.075	327.17
M6	0.025	39.16

Devonport

Latitude 50 22' 4.2"N Longitude 04 11' 3.3"W
National Grid reference SX 4468 5434

Recording zero = Chart Datum = 3.22m below Ordnance Datum Newlyn
Recording zero = 7.631m below Tide Gauge Bench Mark



Bench Marks	NG co-ords	Description
TGBM	SX 4468 5434	Bolt on jetty wall 6.6m from NW angle of tide gauge building.
Aux.1	SX 4471 5433	On building, N.face NE angle.

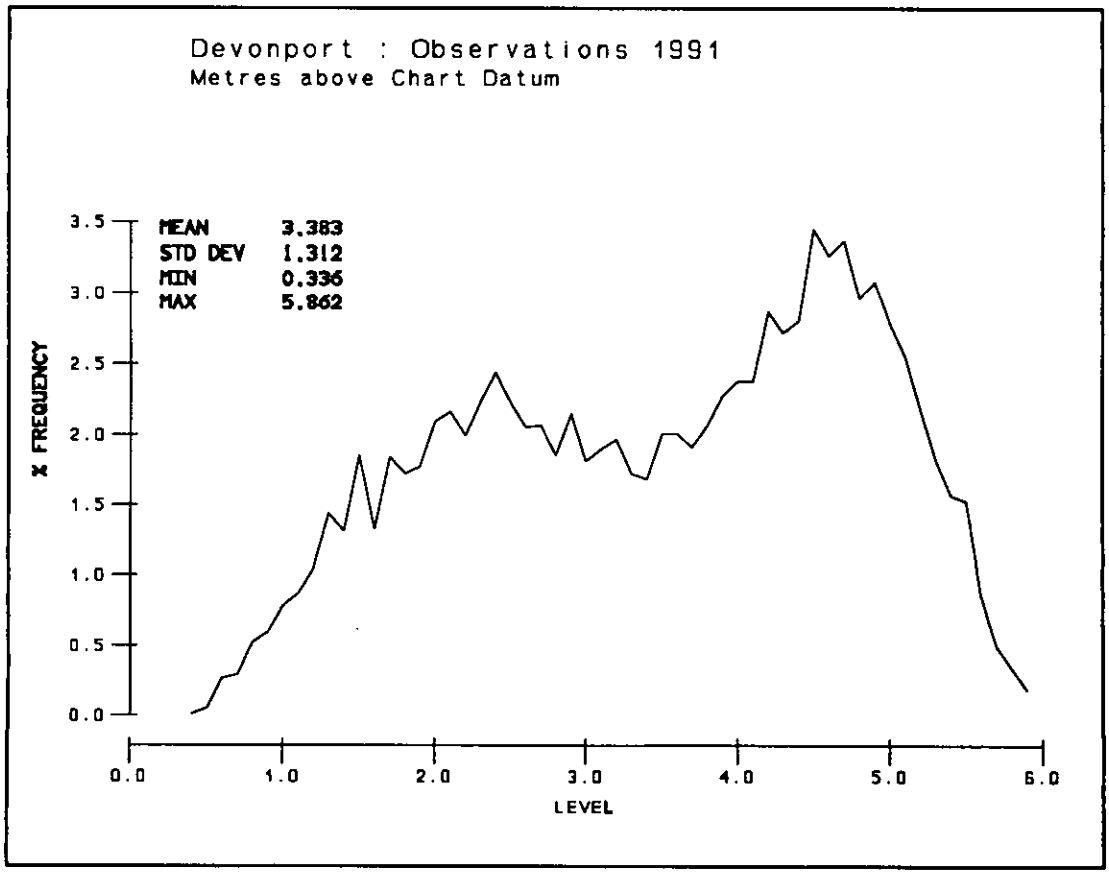
This site was modernised to accommodate Dataring on **13 March 1991** with two pneumatic bubbler systems connected to digiquartz sensors.

Isolated spurious and missing values were corrected at the raw stage for the following dates: 20, 26 Mar; 13,17,24 Apr; 28,30 May; 17 Jun; 31 Jul; 26 Aug; 28 Sep; 15 Oct; 8,13,26 Nov; 23 Dec.

From installation to 26 March, the datum was set 2.749m low and was corrected in the reduction process. From 26 March to 2 April the scanning time was 6 minutes in error and this was also corrected in the reduction process.

Gaps in hourly filtered levels (Channel 2 digiquartz)

Filtered hourly levels commence 1700 GMT 14 March; thereafter no gaps.



Harmonic Tidal Analysis.

Port: England, South Coast - Devonport

Latitude: 50 22' 4.2" N
Longitude: 4 11' 3.3" W

Time Zone: GMT

Length: 177 Days

From: 8th July, 1991 To: 31st December, 1991

Units: Metres A0: 3.417

Hourly data from digiquartz sensor 2

Datum of Observations = ACD : 3.22 Metres below Ordnance Datum (Newlyn)

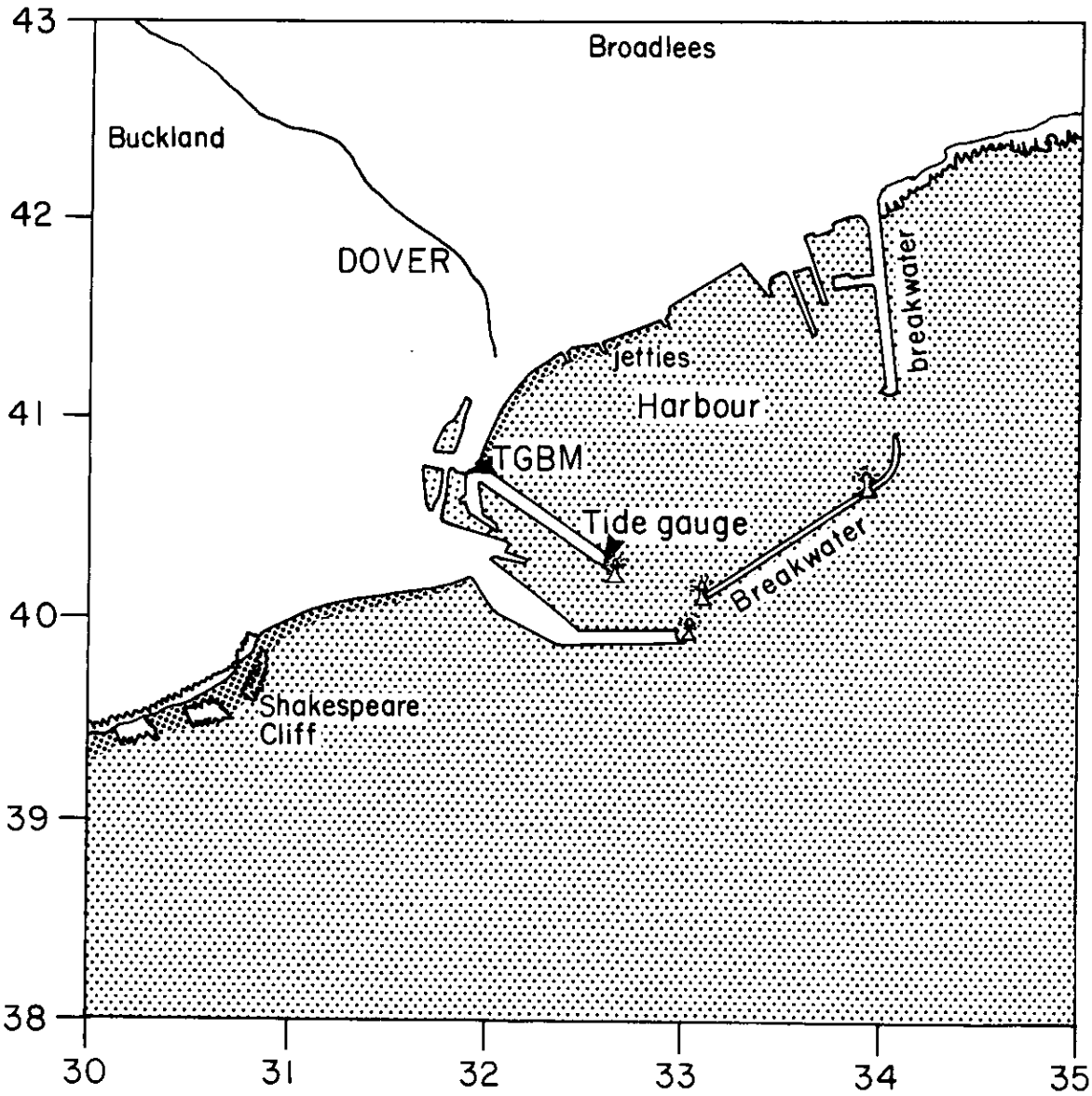
Observation Mean =	0.3418D+01	Residual Mean =	-0.6293D-05
Std Dev =	0.1312D+01	Std Dev =	0.1097D+00

Constituent	h	g
Q1	0.010	307.83
O1	0.055	345.73
P1	0.025	107.65
K1	0.075	111.27
J1	0.003	110.43
2N2	0.071	109.98
N2	0.313	138.79
M2	1.684	153.85
S2	0.615	206.93
K2	0.178	203.38
M3	0.003	147.57
M4	0.139	135.43
MS4	0.095	187.83
M6	0.024	172.34

Dover

Latitude 51 deg 06' 59.7"N Longitude 01 deg 19' 5.4"E
National Grid reference TR 3220 4055

Recording zero = Chart Datum = 3.67m below Ordnance Datum Newlyn
Recording zero = 10.491m below Tide Gauge Bench Mark



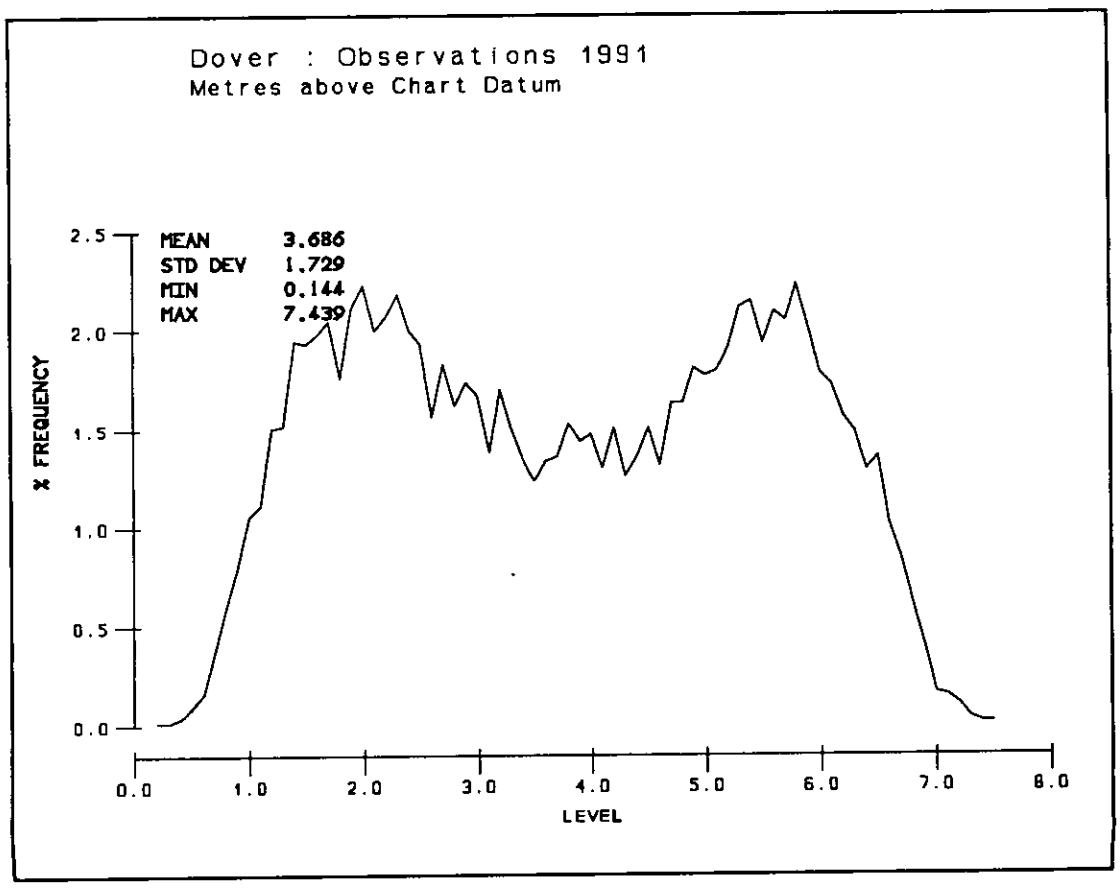
Bench Marks	NG co-ords	Description
TGBM	TR 3193 4074	Flush Bracket G4868 on building E.side of entrance to works.
Aux1	TR 3195 4095	No.29 Waterloo Crescent, SW face S angle.

Hourly levels were filtered from the channel 2 potentiometer attached to the Munro gauge.

Isolated missing and spurious values in the raw data set were edited for the following dates: 16, 22, 26 Jan; 1, 8, 19(2), 20, 26 Feb; 5(2), 6, 13, 22, 24 Mar; 4, 18, 19, 26, 27 Apr; 9, 14, 28, 31 May; 8, 11, 18, 24 Jun; 4(3), 9, 10, 18, 21, 23, 31 Jul; 7, 8, 12, 15, 18, 26(2), 28, 31 Aug; 1, 3(2), 9(2), 18(3), 20, 21, 24, 25, 26 Sep; 4, 6, 7, 13, 14(3), 17, 21, 22, 26 Oct; 6, 16, 29(2) Nov; 6, 8, 15, 18, 27 Dec.

There were ultimately **no gaps** in the filtered hourly values for 1991.

The Tide Gauge Inspectorate visited the site on 16 October to repair the float wire on the well-head unit of the back-up channel 1.



Harmonic Tidal Analysis

Port : England, South Coast - Dover

Latitude: 51 06' 59.7" N
Longitude: 1 19' 05.4" E

Time Zone: GMT

Length: 365 Days

From: 1st January, 1991 To: 31st December, 1991

Units: Metres A0: 3.688

Hourly data from potentiometer sensor 2

Datum of Observations = ACD : 3.67 Metres below Ordnance Datum (Newlyn)

Observation Mean =	0.3687D+01	Residual Mean =	0.7318D-06
Std Dev =	0.1730D+01	Std Dev =	0.1782D+00

Constituent	h	g
Q1	0.024	110.23
O1	0.060	176.99
P1	0.010	11.39
K1	0.048	41.11
J1	0.004	22.07
2N2	0.049	284.23
N2	0.404	309.97
M2	2.262	332.09
S2	0.715	24.16
K2	0.208	22.89
M3	0.015	26.04
M4	0.263	221.81
MS4	0.176	274.55
M6	0.065	104.76

Harmonic Tidal Analysis.

Port: England, East Coast - Felixstowe

Latitude: 51 57' 22.8" N
Longitude: 1 21' 00.0" E

Time Zone: GMT

Length: 362 Days

From: 1st January, 1991 To: 31st December, 1991

Units: Metres A0: 2.009

Hourly data from digiquartz sensor 2

Datum of Observations = ACD : 1.95 Metres below Ordnance Datum (Newlyn)

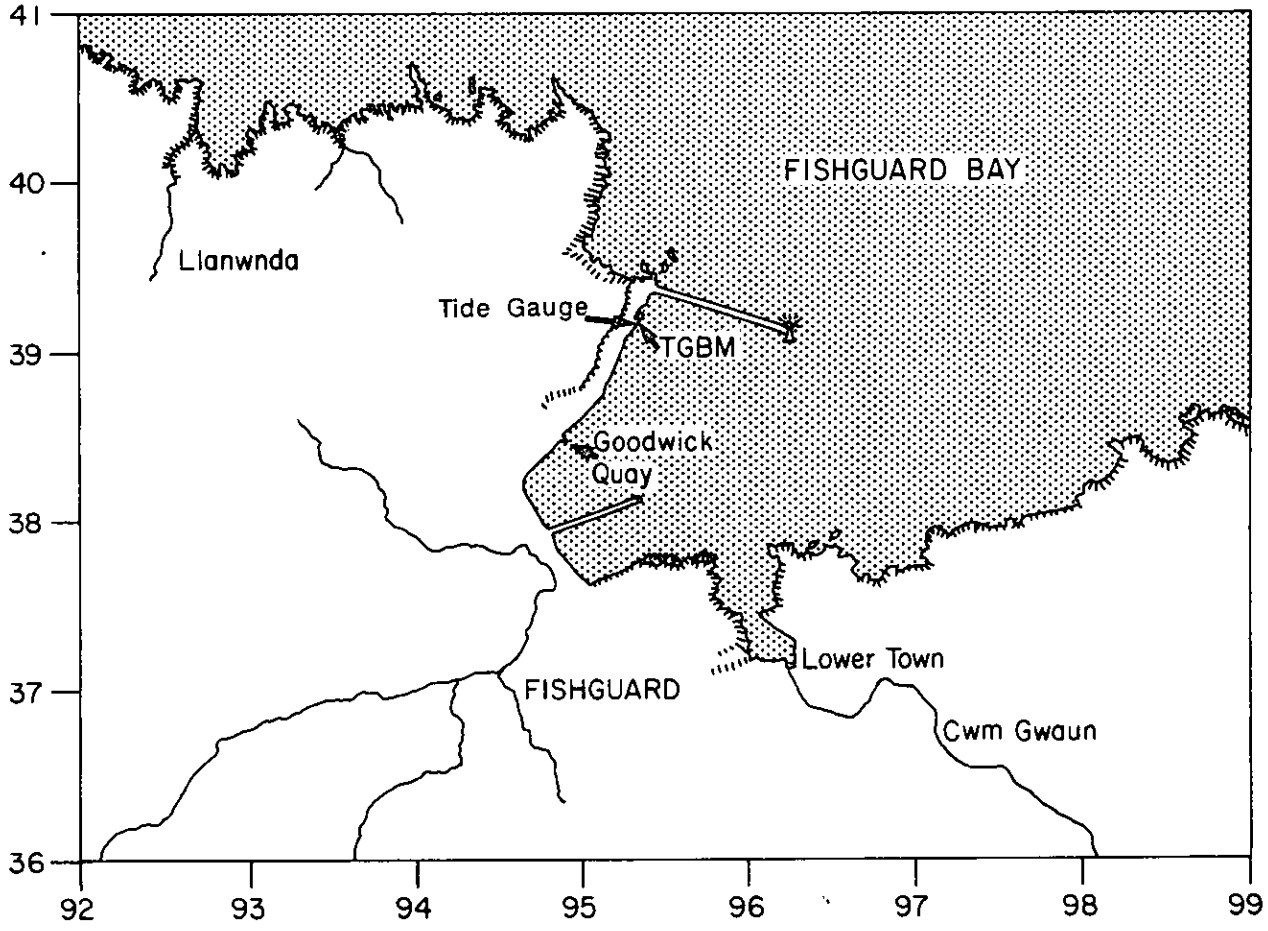
Observation Mean =	0.2008D+01	Residual Mean =	0.3958D-06
Std Dev =	0.9848D+00	Std Dev =	0.2102D+00

Constituent	h	g
Q1	0.041	109.30
O1	0.132	171.18
P1	0.035	320.41
K1	0.105	349.31
J1	0.010	9.96
2N2	0.057	281.61
N2	0.210	295.88
M2	1.270	321.65
S2	0.352	13.67
K2	0.105	15.09
M3	0.004	356.50
M4	0.077	324.11
MS4	0.054	36.78
M6	0.053	270.81

Fishguard

Latitude 52 deg 00' 46.2"N Longitude 04 deg 58' 57.5"W
National Grid reference SM 9534 3918

Recording zero = Chart Datum = 2.44m below Ordnance Datum Newlyn
Recording zero = 7.88m below Tide Gauge Bench Mark



Bench Marks	NG co-ords	Description
TGBM	SM 9534 3918	OSBM bolt on quay 3.6m NE end of railings.
Aux1	SM 9513 3874	OS bolt in concrete base of railings 6.4m NW angle of tide gauge hut.

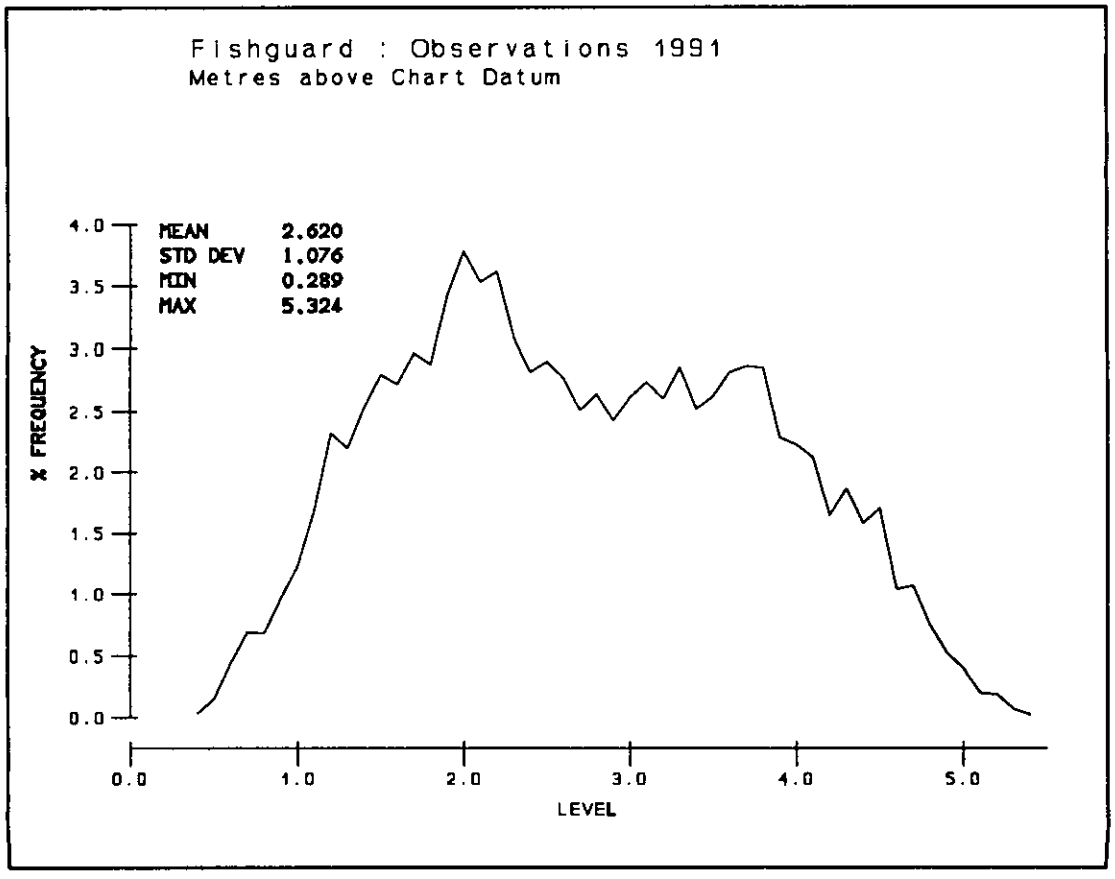
This site was completely refurbished in June 1988 with two digiquartz sensors attached to pneumatic bubbler systems. Values from the second channel of data were treated as Class-A.

Missing and spurious values in the raw levels for 1991 were edited for the following dates:- 12 Jan; 26 Mar; 18 Apr; 5,11 Jun; 1,2,19 Jul; 19,28 Aug; 3,15 Sep; 4 Oct; 4 Dec.

Scans integrated at 1 7/8 minute during visits by TGI on 20 February and 30/31 July were edited prior to filtering to hourly values. The TGI also visited the installation on 1 October to undertake general maintenance.

Gaps in filtered hourly values from Channel 2

1900 GMT 7 October - 1400 GMT 17 October	Compressor switched off in error.



Harmonic Tidal Analysis.

Port: Wales - Fishguard

Latitude: 52 00' 46.2" N
Longitude: 4 58' 57.5" W

Time Zone: GMT

Length: 354 Days

From: 1st January, 1991 To: 31st December, 1991

Units: Metres A0: 2.625

Hourly data from digiquartz sensor 2

Datum of Observations = ACD : 2.44 Metres below Ordnance Datum (Newlyn)

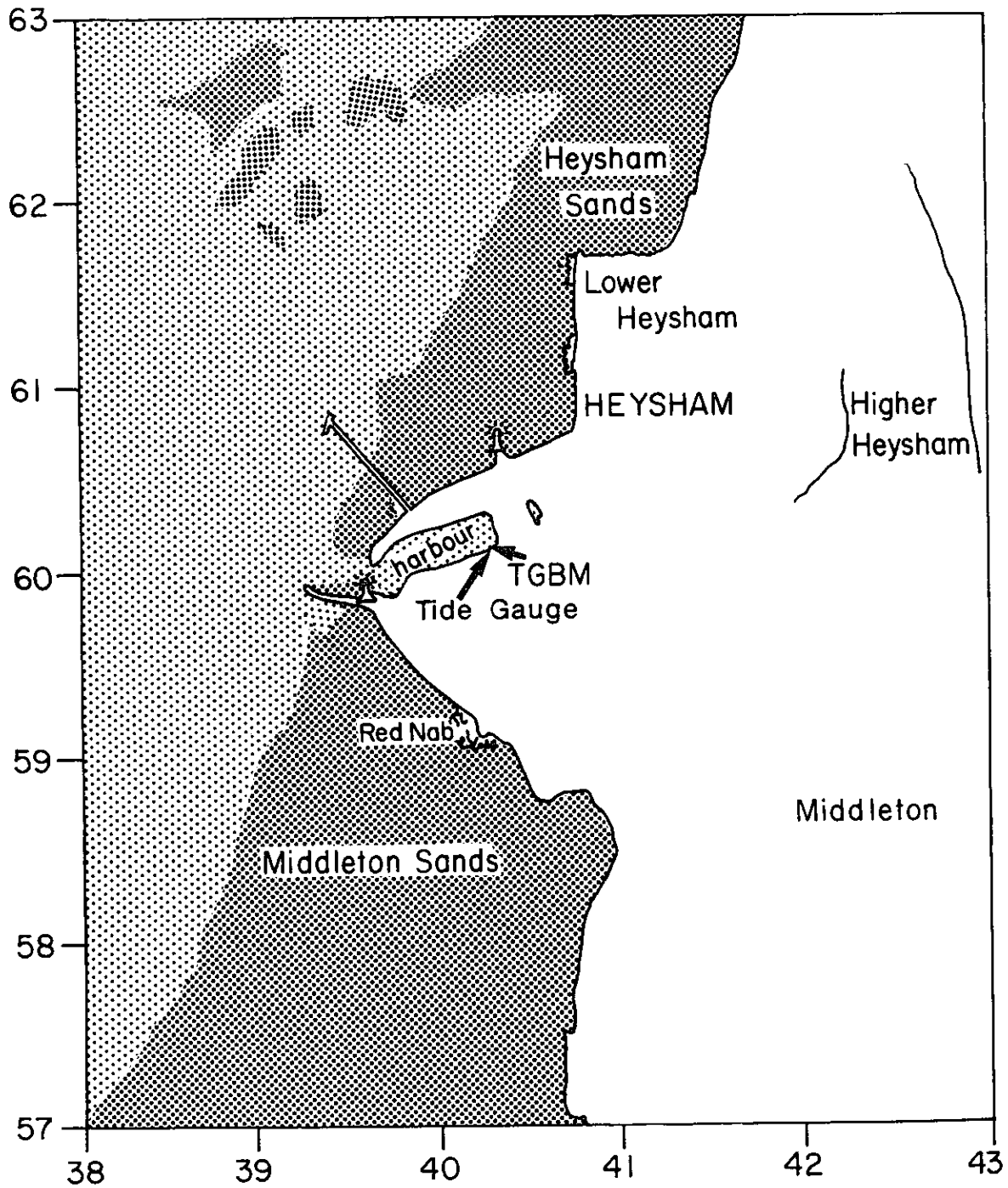
Observation Mean =	0.2622D+01	Residual Mean =	0.6143D-06
Std Dev =	0.1074D+01	Std Dev =	0.1481D+00

Constituent	h	g
Q1	0.021	318.39
O1	0.081	10.90
P1	0.025	136.58
K1	0.073	152.68
J1	0.003	135.81
2N2	0.036	167.84
N2	0.279	188.39
M2	1.362	207.51
S2	0.533	248.63
K2	0.154	245.06
M3	0.013	189.53
M4	0.115	20.93
MS4	0.055	66.03
M6	0.001	80.39

Heysham

Latitude 54 deg 02' 0.3"N Longitude 02 deg 54' 41.7"W
National Grid reference SD 4030 6012

Recording zero = Chart Datum = 4.90m below Ordnance Datum Newlyn
Recording zero = 12.095m below Tide Gauge Bench Mark



Bench Marks	NG co-ords	Description
TGBM	SD 4030 6012	OSBM bolt S quay 40.8m SW angle of dock.
Aux1	SD 4141 6005	Bridge parapet 3.4m North of fence at junction E side of road W face.

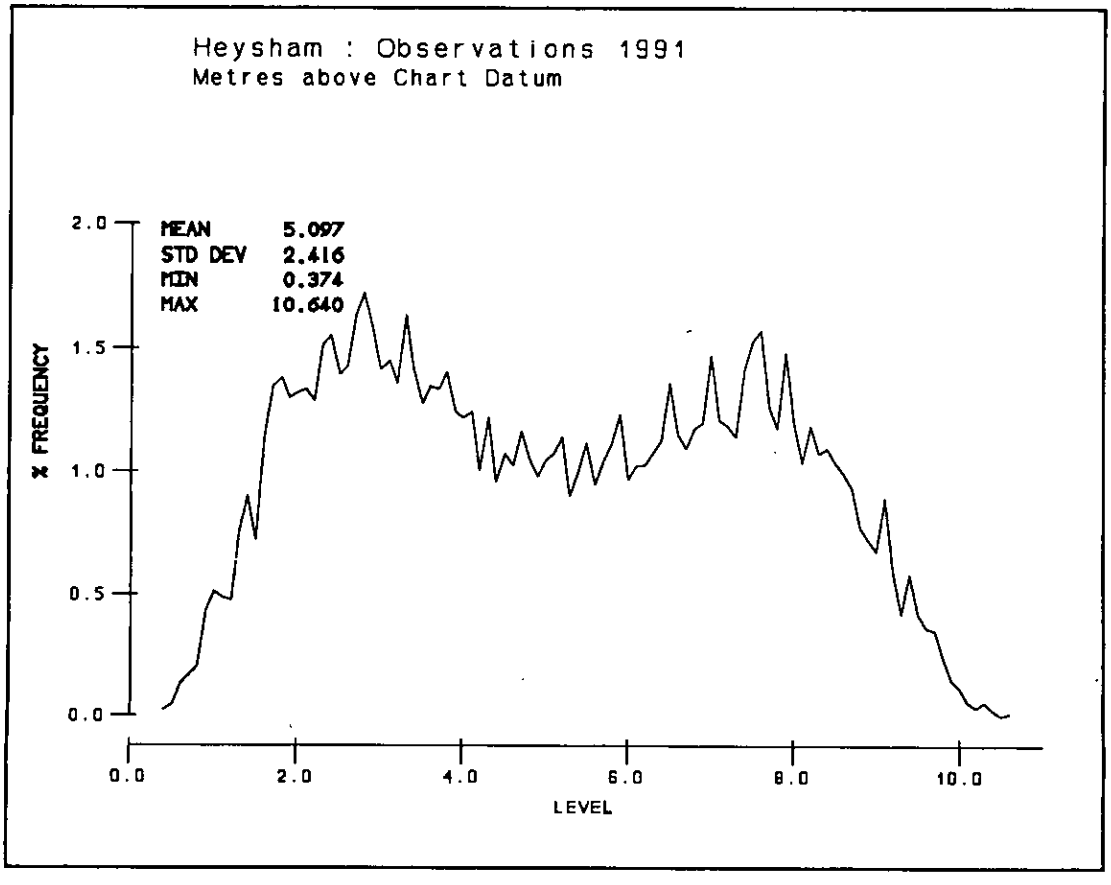
Of the two recording channels both with digiquartz transducers, Channel 2 is the designated Class-A channel.

Missing and spurious values in the raw data series from channel 2 were edited for the following dates in 1991 :- 2 Jan; 25 May; 24 Jun; 22 Sep; 12,28 Nov; 23 Dec.

Scans integrated at 1 7/8 minute interval during visits by TGI on 12 May and 10 July were edited to 15 minute interval prior to filtering.

Gaps in hourly filtered levels (Channel 2 digiquartz)

Nil gaps.



Harmonic Tidal Analysis.

Port: England, West Coast - Heysham

Latitude: 54 02' 0.3" N
Longitude: 2 54' 41.7" W

Time Zone: GMT

Length: 365 Days

From: 1st January, 1991 To: 31st December, 1991

Units: Metres A0: 5.099

Hourly data from digiquartz sensor 2

Datum of Observations = ACD : 4.90 Metres below Ordnance Datum (Newlyn)

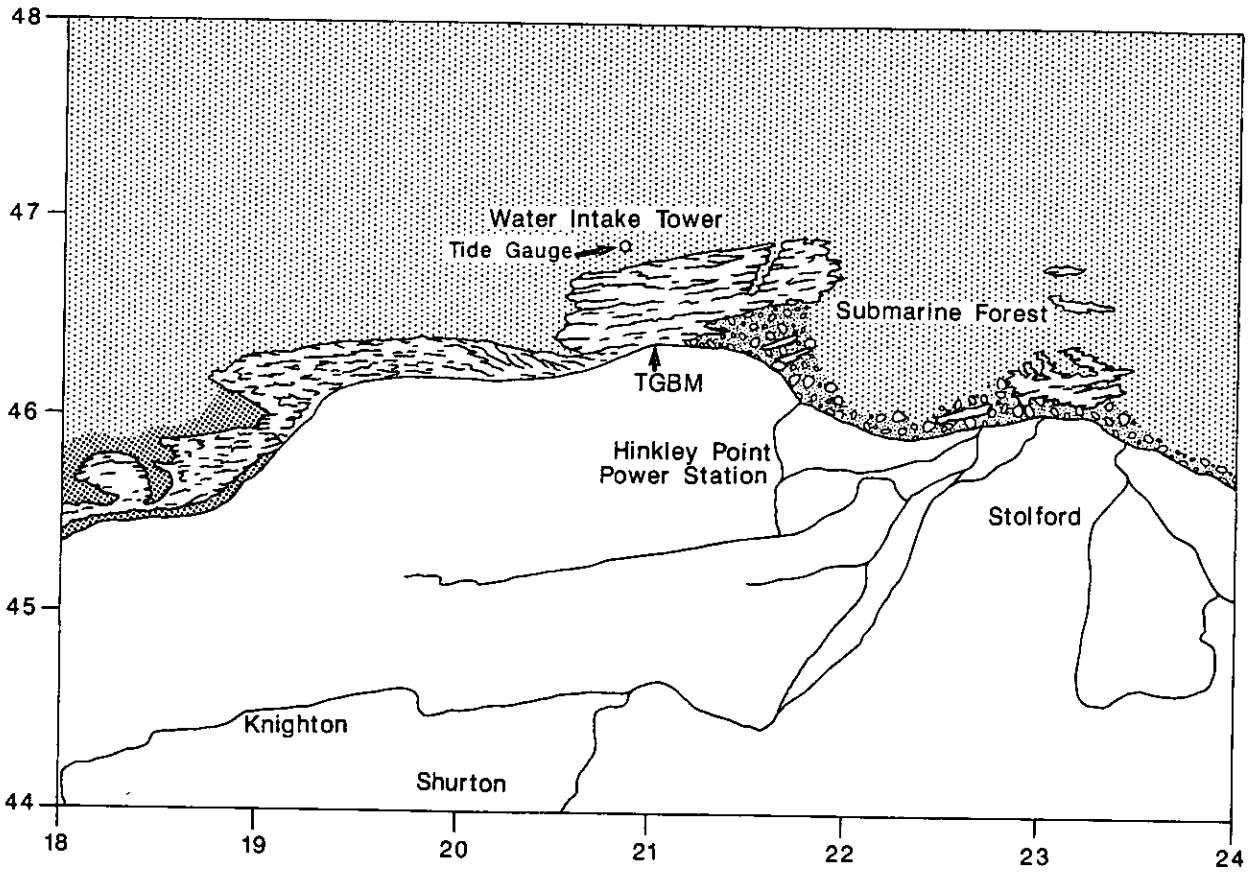
Observation Mean =	0.5099D+01	Residual Mean =	0.6514D-06
Std Dev =	0.2417D+01	Std Dev =	0.2456D+00

Constituent	h	g
Q1	0.027	352.81
O1	0.116	44.26
P1	0.039	181.43
K1	0.117	192.72
J1	0.003	58.73
2N2	0.076	274.54
N2	0.597	301.98
M2	3.175	325.77
S2	1.031	8.86
K2	0.299	6.60
M3	0.035	314.04
M4	0.203	248.66
MS4	0.116	300.62
M6	0.010	69.08

Hinkley Point

Latitude 51 deg 12' 54.1"N Longitude 03 deg 07' 59.0"W
National Grid Reference ST 2087 4687

Recording zero = Chart Datum = 5.90m below Ordnance Datum Newlyn
Recording zero = 14.739m below Tide Gauge Bench Mark



Bench Marks	NG co-ords	Description
TGBM	ST 2104 4634	Bolt on wall 0.962m NE of SE corner of steps.
Aux1	ST 2078 4626	Rivet on sea wall 41.28m SW of corner of outfall.
Aux2	ST 2091 4630	Bolt on sea wall 31.245m SW of end of railings.

This site became operational in March 1990 with two digiquartz pressure transducers sited underwater in vented chambers suspended from a steel pole connected to the structure of the power station cooling water intake tower some 400m offshore.

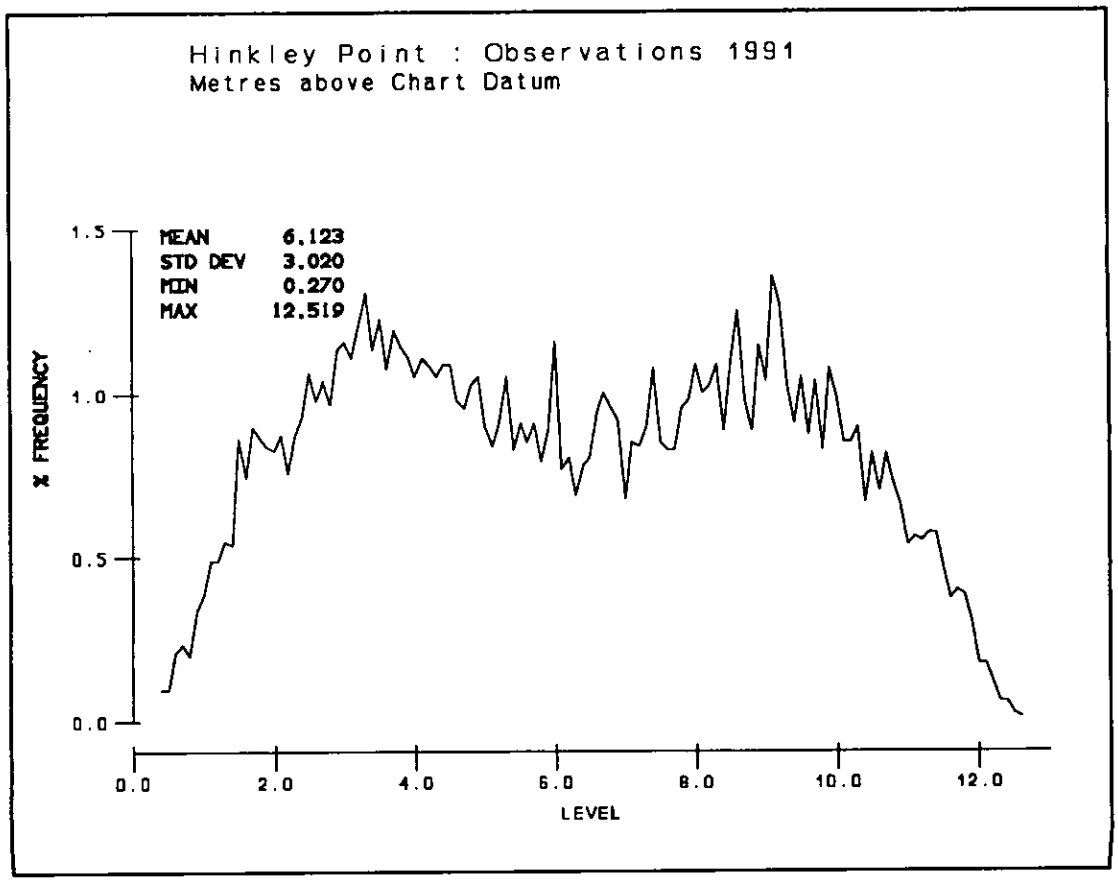
Apart from a short period in September, the back-up channel 1 system has been unservicable all year. Originally there was a fault on the pressure point transducer which was replaced in September, but an electrical fault developed shortly afterwards.

Isolated spurious and missing scans in the raw series for channel 2 were edited for the following dates in 1991 :- 14 Feb; 4, 15, 21, 30 Apr; 1 May; 14, 27 Jun; 7 Jul; 20, 21 Sep; 5 Dec.

Problems with the clock readout were encountered for the week 23 - 30 April, which was corrected in the reduction process.

Gaps in hourly filtered levels (Channel 2 digiquartz)

1100 GMT 24 January -	1600 GMT 25 January	Data lost at source
0800 GMT 9 February -	0000 GMT 11 February	Data lost at source.
2000 GMT 22 July -	0800 GMT 27 July	No response from site.



Harmonic Tidal Analysis.

Port: England, West Coast - Hinkley Point

Latitude: 51 12' 54.1" N
Longitude: 3 7' 59.0" W

Time Zone: GMT

Length: 354 Days

From: 1st January, 1991 To: 31st December, 1991

Units: Metres A0: 6.126

Hourly data from digiquartz sensor 2

Datum of Observations = ACD : 5.90 Metres below Ordnance Datum (Newlyn)

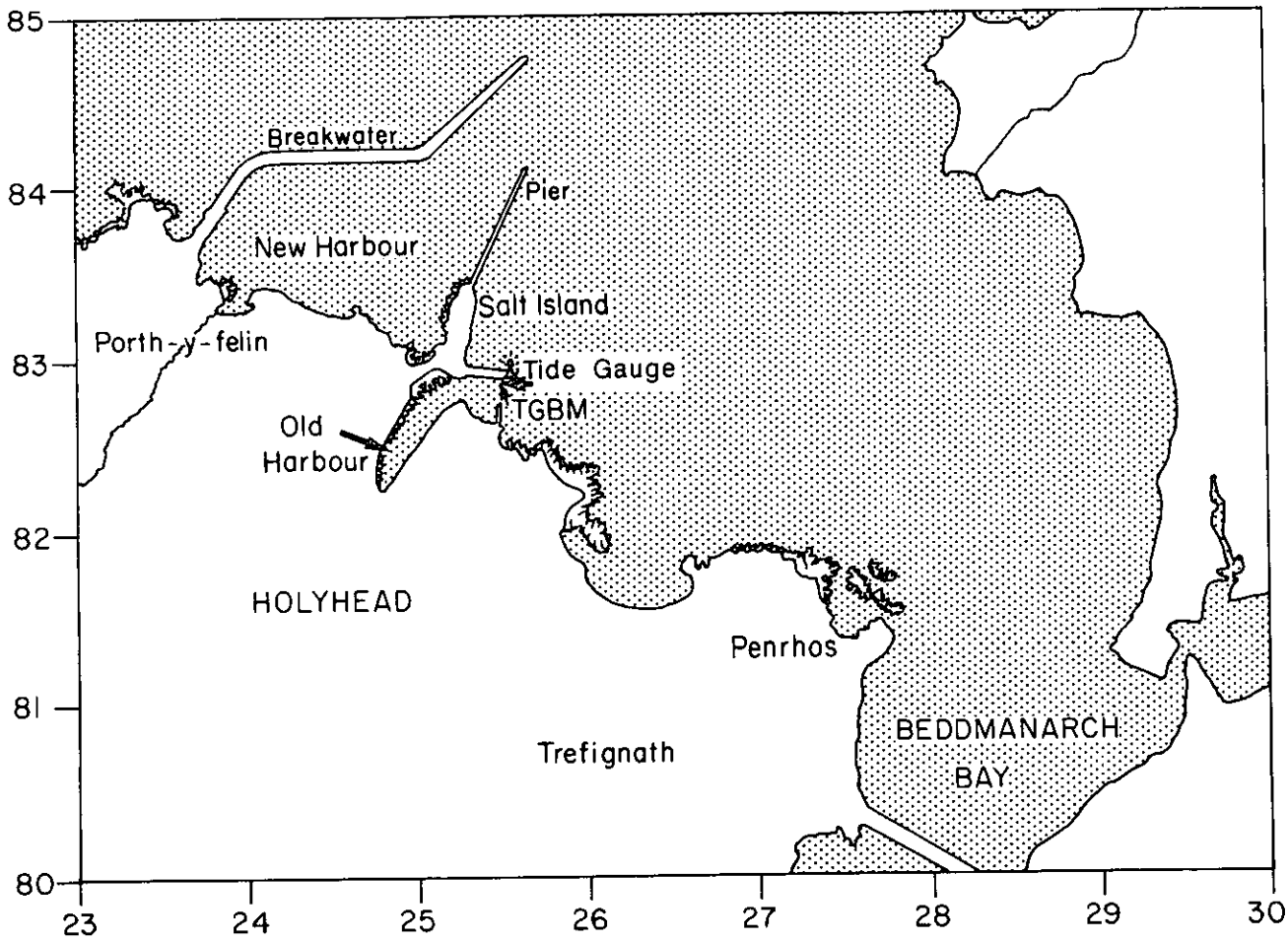
Observation Mean =	0.6125D+01	Residual Mean =	0.1274D-06
Std Dev =	0.3021D+01	Std Dev =	0.1870D+00

Constituent	h	g
Q1	0.017	308.07
O1	0.072	356.28
P1	0.025	115.98
K1	0.062	135.42
J1	0.005	123.29
2N2	0.162	127.44
N2	0.707	168.61
M2	3.918	182.83
S2	1.407	237.12
K2	0.410	233.17
M3	0.048	174.71
M4	0.099	21.05
MS4	0.027	22.20
M6	0.038	214.80

Holyhead

Latitude 53 deg 18' 49.3"N Longitude 04 deg 37' 9.4"W
National Grid reference SH 2553 8287

Recording zero = Chart Datum = 3.05m below Ordnance Datum Newlyn
Recording zero = 7.447m below Tide Gauge Bench Mark * Destroyed October 1991
Recording zero = 8.565m below Auxilliary 1



Bench Marks	NG co-ords	Description
TGBM	SH 2553 8287	Bolt on concrete foundation, NE side of tide gauge building.
Aux1	SH 2556 8289	PA Bolt on harbour lighthouse S. face.

This site is a major test site on the network for instrumentation. Much of this was lost when the tide gauge building was severely damaged by a ship collision on 12 October 1991.

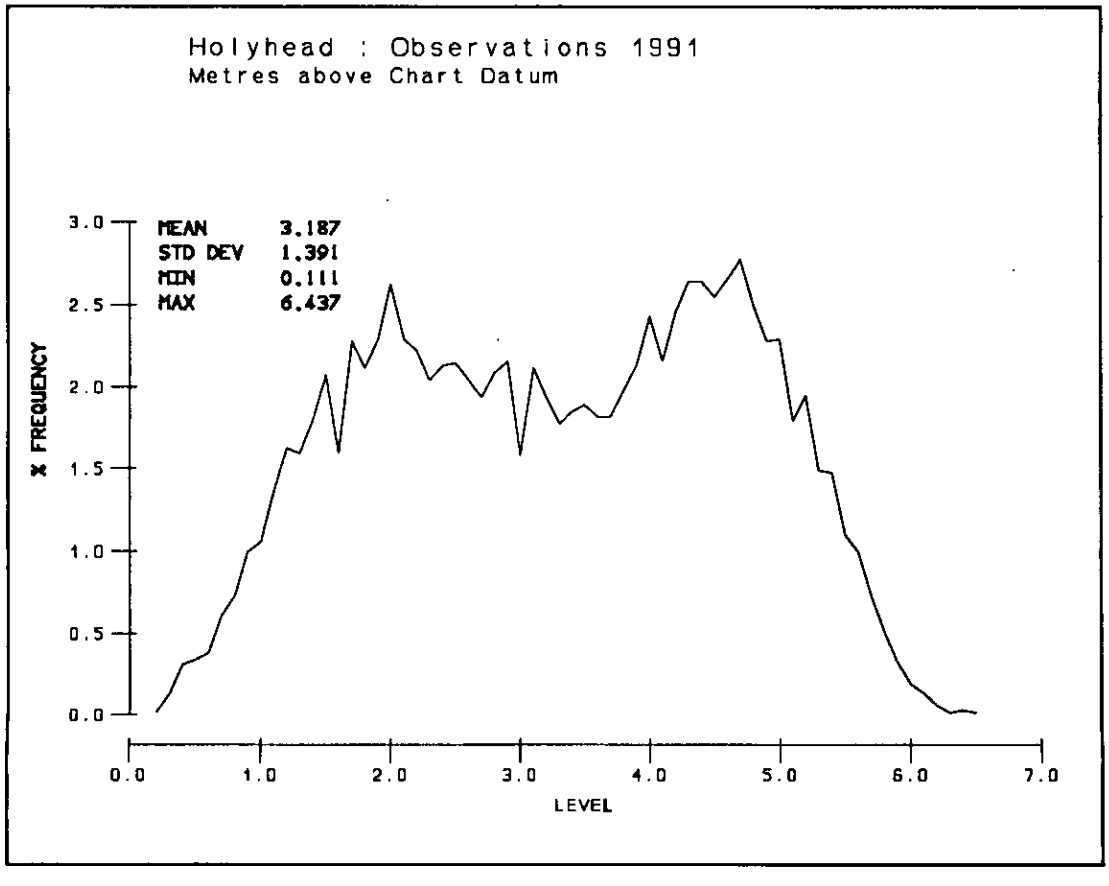
For the earlier period, spurious and missing scans in the raw values from channel 2 digiquartz were edited on the following dates: 17,18 Jan; 13(2) Jul.

Scans integrated at 1 7/8 minute during visits by TGI 4 January and 12 July were edited to 15 minute interval.

Gaps in hourly filtered levels (Channel 2 digiquartz)

2000 GMT 7 October - 2300 GMT 31 December	All data lost when tide gauge building destroyed by ship collision on 12 October.

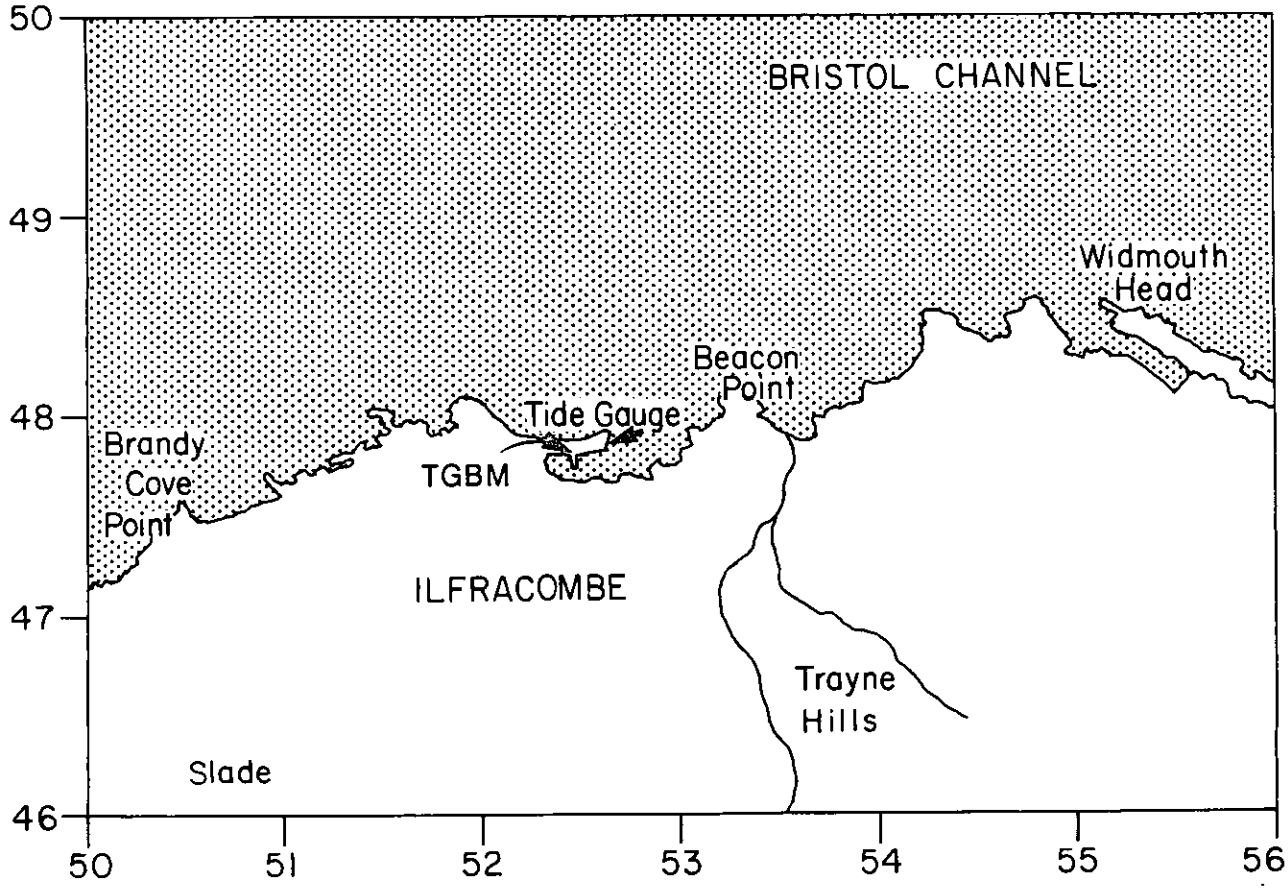
The resultant series for 1991 is considered too short for independently derived Harmonic Constants to be presented in this report.



Ilfracombe

Latitude 51 deg 12' 39.0"N Longitude 04 deg 06' 36.3"W
National Grid reference SS 5263 4791

Recording zero = Chart Datum = 4.8m below Ordnance Datum Newlyn.
Recording zero = 12.379m below Tide Gauge Bench Mark.



Bench Mark	NG co-ords	Description
TGBM	SS 5263 4791	OSBM Bolt on concrete pier S.angle of tide gauge hut.
Aux1	SS 5245 4782	Pier Hotel, The Quay.

As reported in the 1990 report, the pier sustained damage in 1990 such that the instrumentation had to be removed in March 1991 to facilitate repairs. It was reinstated in mid-September.

Spurious and missing scans in the remaining data series from channel 2 were edited for the following dates in 1991: - 23 Jan; 16 Sep.

Scans integrated at 1 7/8 minute during the TGI visit of 12 September were edited to 15 minute interval. However, it became apparent that the pressure point which was originally blocked when reinstated on 4 September had become loose creating a datum error in the recordings. These data were later deleted and the series amended to begin 16 September.

No harmonic constants or frequency/ depth curves are presented for 1991 due to insufficient data remaining. Storm surge residuals and limited mean and extreme sea level statistics are however presented for the relevant months (See sections 3 and 4).

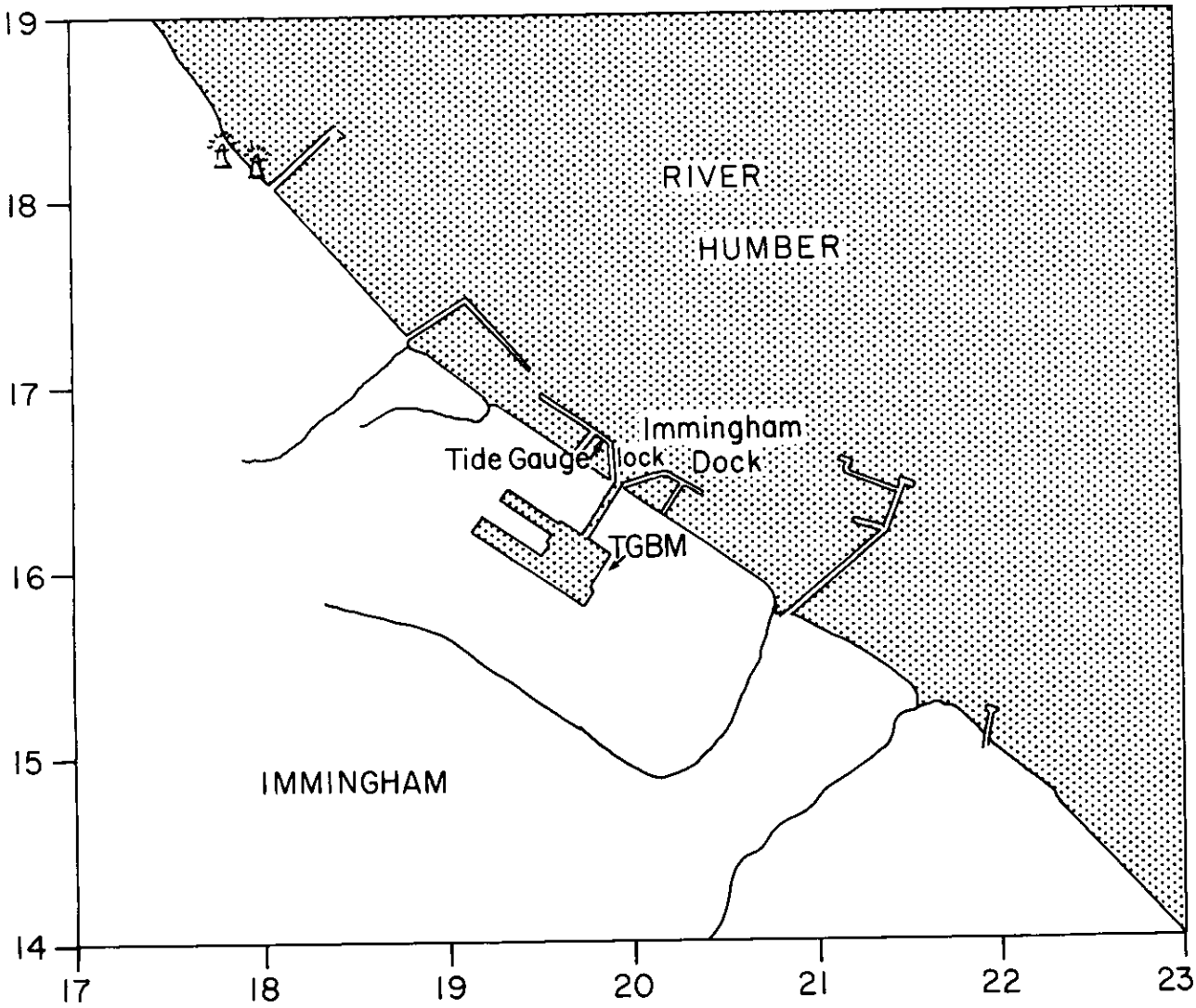
Gaps in final filtered hourly levels for Channel 2

2200 GMT 18 February -	1600 GMT 21 February	Integration error - data lost.
2200 GMT 11 March -	1800 GMT 16 September	Gauge removed for pier repairs.

Immingham

Latitude 53 deg 37' 58.9"N Longitude 00 deg 11' 13.0"W
National Grid reference TA 1987 1672

Recording zero = Chart Datum = 3.9m below Ordnance Datum Newlyn
Recording zero = 9.131m below Tide Gauge Bench Mark



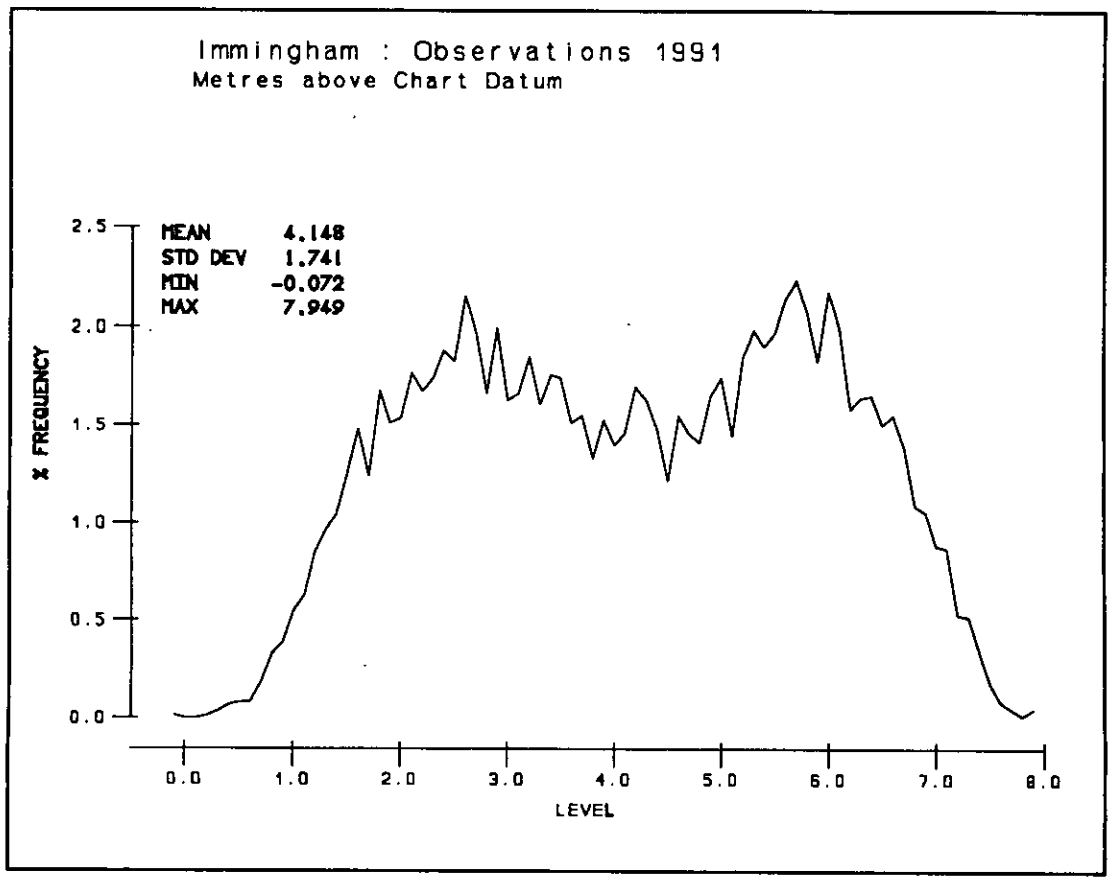
Bench Mark	NG co-ords	Description
TGBM	TA 1989 1630	Flush Bracket G4658 off building NE face,N angle.
Aux1	TA 2005 1631	Building,SW side of road NE face E angle.

Isolated spurious and missing scans in the raw data from channel 2 digiquartz were edited at the raw stage for the following dates in 1991: - 12,13 Feb; 30 Mar; 30,31 May; 1,14,19 Jun; 6,13,21 Aug; 13,25 Sep; 11,12,27 Nov; 12 Dec.

Scans integrated at 1 7/8 minute over the visit of TGI 15 July were edited to 15 minute interval.

Gaps in final filtered hourly levels for Channel 2

0300 GMT 14 July -	1900 GMT 15 July	TGI visit. Sensors recalibrated and compressor changed.



Harmonic Tidal Analysis.

Port: England, East Coast - Immingham

Latitude: 53 37' 58.9" N
Longitude: 0 11' 13.0" W

Time Zone: GMT

Length: 363 Days

From: 1st January, 1991 To: 31st December, 1991

Units: Metres A0: 4.150

Hourly data from digiquartz sensor

Datum of Observations = ACD : 3.90 Metres below Ordnance Datum (Newlyn)

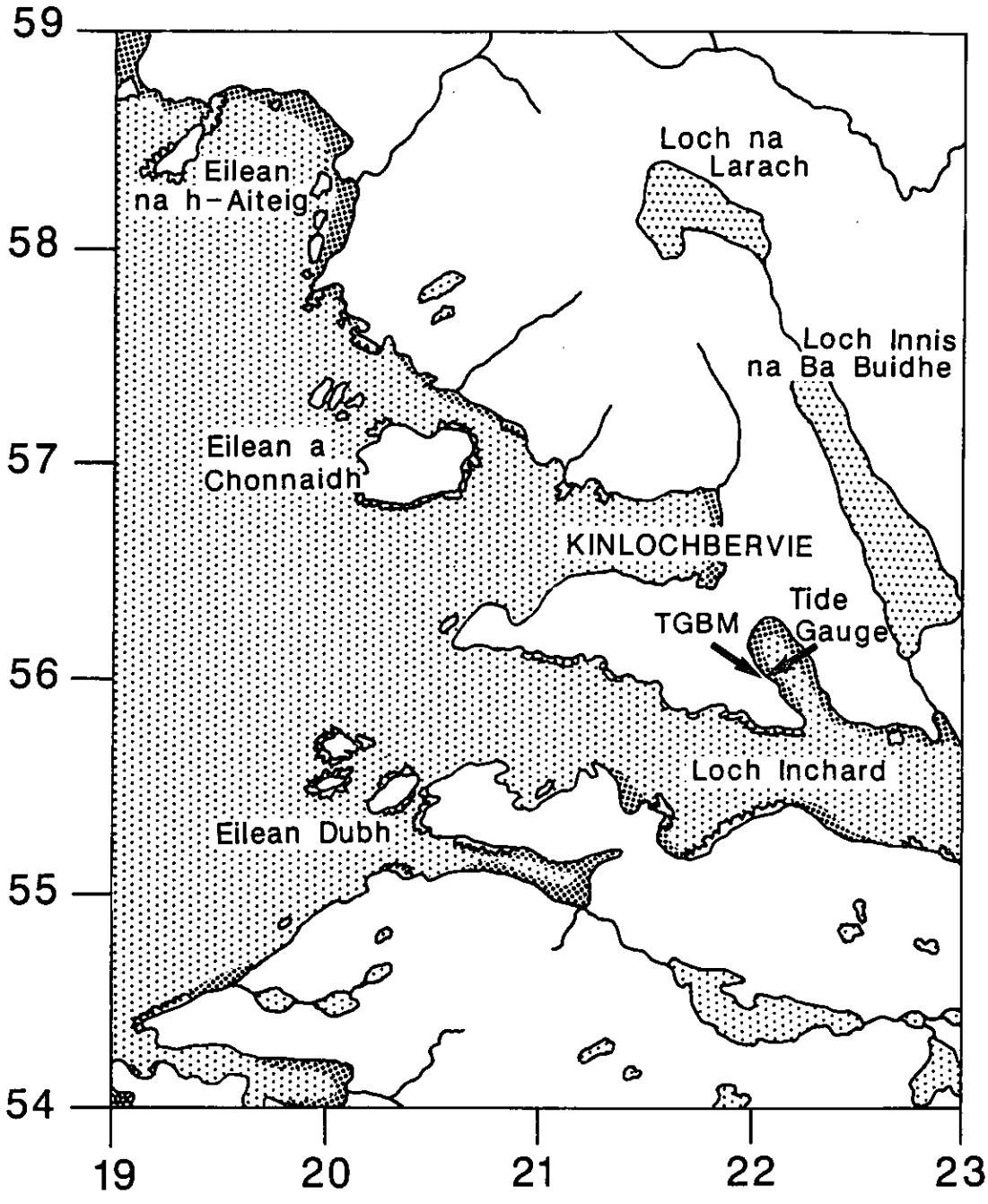
Observation Mean =	0.4150D+01	Residual Mean =	0.8564D-06
Std Dev =	0.1742D+01	Std Dev =	0.1913D+00

Constituent	h	g
Q1	0.051	58.35
O1	0.175	110.76
P1	0.046	257.30
K1	0.153	279.72
J1	0.019	309.16
2N2	0.056	120.55
N2	0.417	140.74
M2	2.280	161.83
S2	0.754	212.26
K2	0.217	210.36
M3	0.013	212.67
M4	0.021	190.04
MS4	0.035	251.26
M6	0.017	151.33

Kinlochbervie

Latitude 58 deg 27' 22.6"N Longitude 05 deg 02' 58.2"W
National Grid reference NC 221 560

Recording zero = Chart Datum = 2.5m below Ordnance Datum Newlyn
Recording zero = 7.213m below Tide Gauge Bench Mark



Bench Mark	NG co-ords	Description
TGBM	NC 2206 5613	Bolt south side of harbour 19.5m SE angle of building.
Aux1	NC 2210 5612	Rivet on ice plant 7.45m from S. angle of building.

This new site on the Class-A network came on stream **17 June 1991** with two pneumatic bubbler systems connected to digiquartz transducers. The instrumentation installed in the control-room of the ice-plant proved to be strongly affected by the power supply with many missing and faulty scans in the data retrieved, which amounted to an average of 4 missing scans per day up to a maximum of 16. The TGI rectified the problem on 18 November by installing an isolated battery-driven system. Since that date, the number of scan errors was reduced to a tolerable level - one each on 20,24 November and 13 December.

Unfortunately, the pneumatic tubing to the channel two pressure point was severed on 12 December. It was repaired early in 1992. As with all new sites on the network, data from both channels were processed for the year, but the series are not of sufficient length or quality for Harmonic Constants, frequency/depth curves to be presented and the hourly residuals graphically presented in section 4 of this report should be treated as highly suspect.

Gaps in final filtered hourly levels for Channel 2

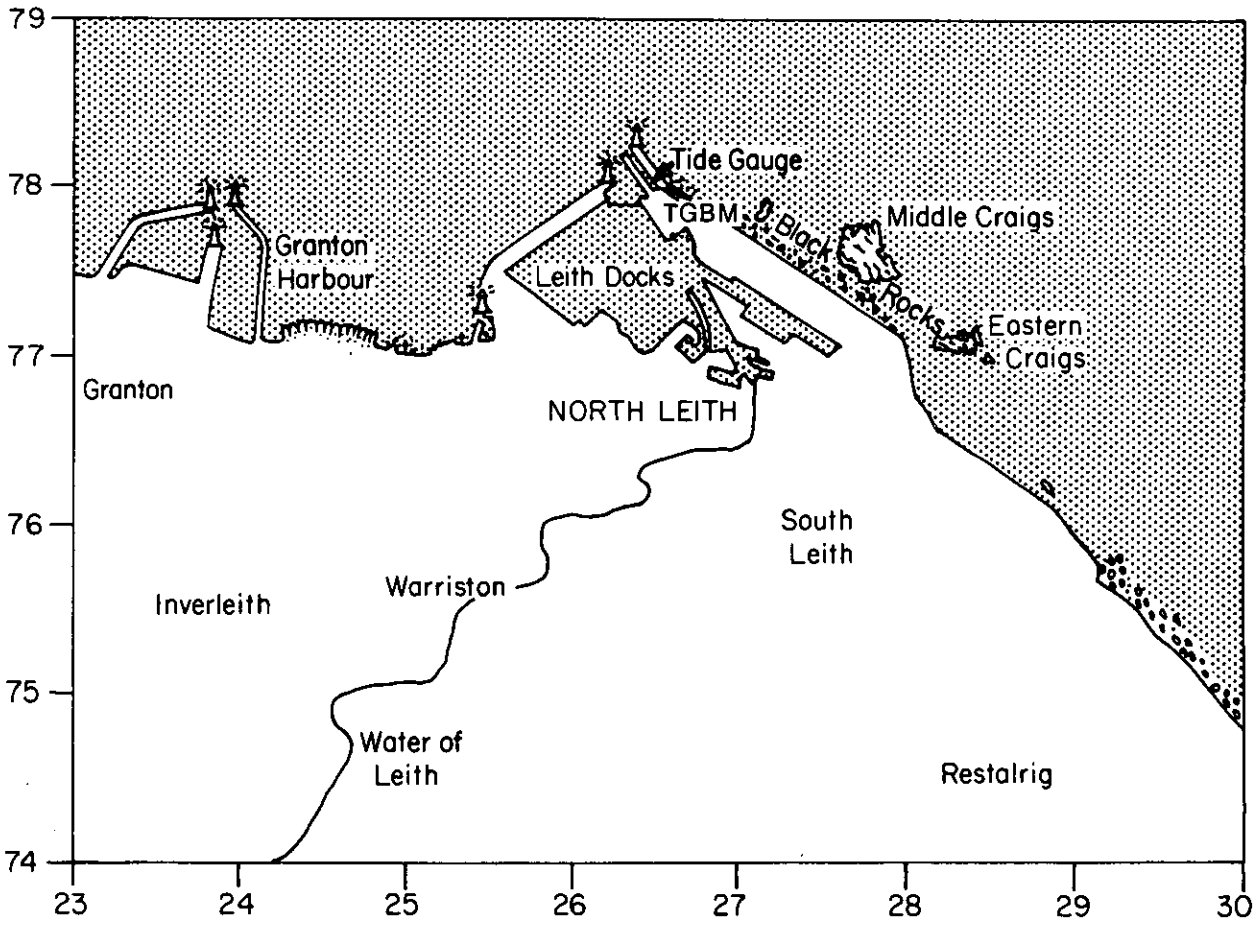
(Records begin 1600 GMT 17 June)

0300 GMT 07 August -	1300 GMT 08 August	New clock-board fitted.
1200 GMT 12 December -	2300 GMT 31 December	Pneumatic tube severed.

Leith

Latitude 55 deg 59' 23.3"N Longitude 03 deg 10' 48.9"W
National Grid reference NT 2638 7805

Recording zero = Chart Datum = 2.9m below Ordnance Datum Newlyn
Recording zero = 7.8395m below Tide Gauge Bench Mark



Bench Mark	NG co-ords	Description
TGBM	NT 2643 7797	OSBM Bolt SE end of TG pier 0.9m N angle of pier.
Aux1	NT 2648 7797	Rivet on top step SW side of road 1.6m S angle of building.

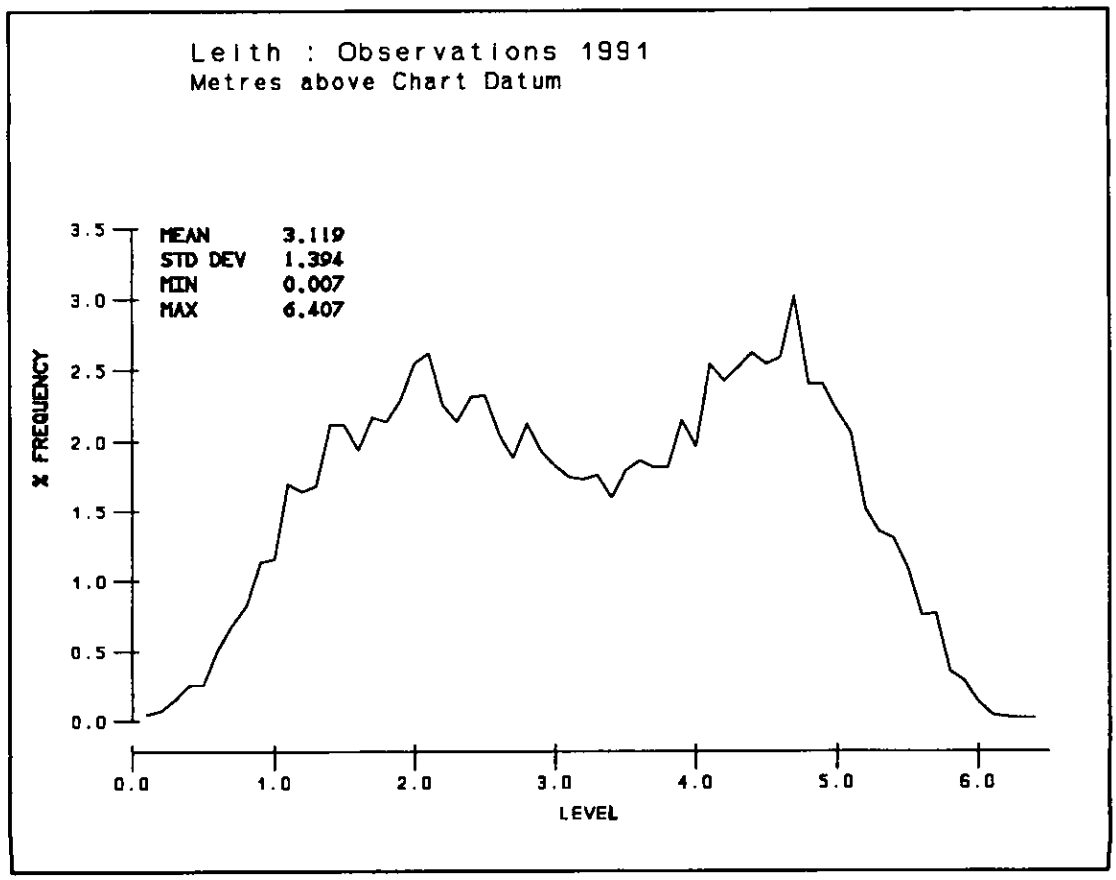
Originally furnished for Dataring in November 1988, with a potentiometer attached to the Munro gauge (channel 1) and another to a well-head unit of an Ott gauge well alongside (channel 2). From early January 1991 there were problems with the readings from channel 2 culminating in a loss of data to such an extent that results presented in this report are from what is normally considered the back-up channel 1.

Spurious and missing scans in the channel 1 series were edited for the following dates in 1991: 23,30 Jan; 13 Mar; 24 Apr; 31 May; 11 Jun; 14 Aug; 4 Sep(2); 22 Oct; 5 Dec.

Scans integrated at 1 7/8 minute during the visit of TGI of 22 November were edited to 15 minute interval before filtering to hourly levels.

Gaps in final processed hourly levels for channel 1

Nil gaps.



Harmonic Tidal Analysis.

Port: Scotland, East Coast - Leith

Latitude: 55 59' 23.3" N
Longitude: 3 10' 48.9" W

Time Zone: GMT

Length: 365 Days

From: 1st January, 1991 To: 31st December, 1991

Units: Metres A0: 3.121

Hourly data from potentiometer sensor 1

Datum of Observations = ACD : 2.90 Metres below Ordnance Datum (Newlyn)

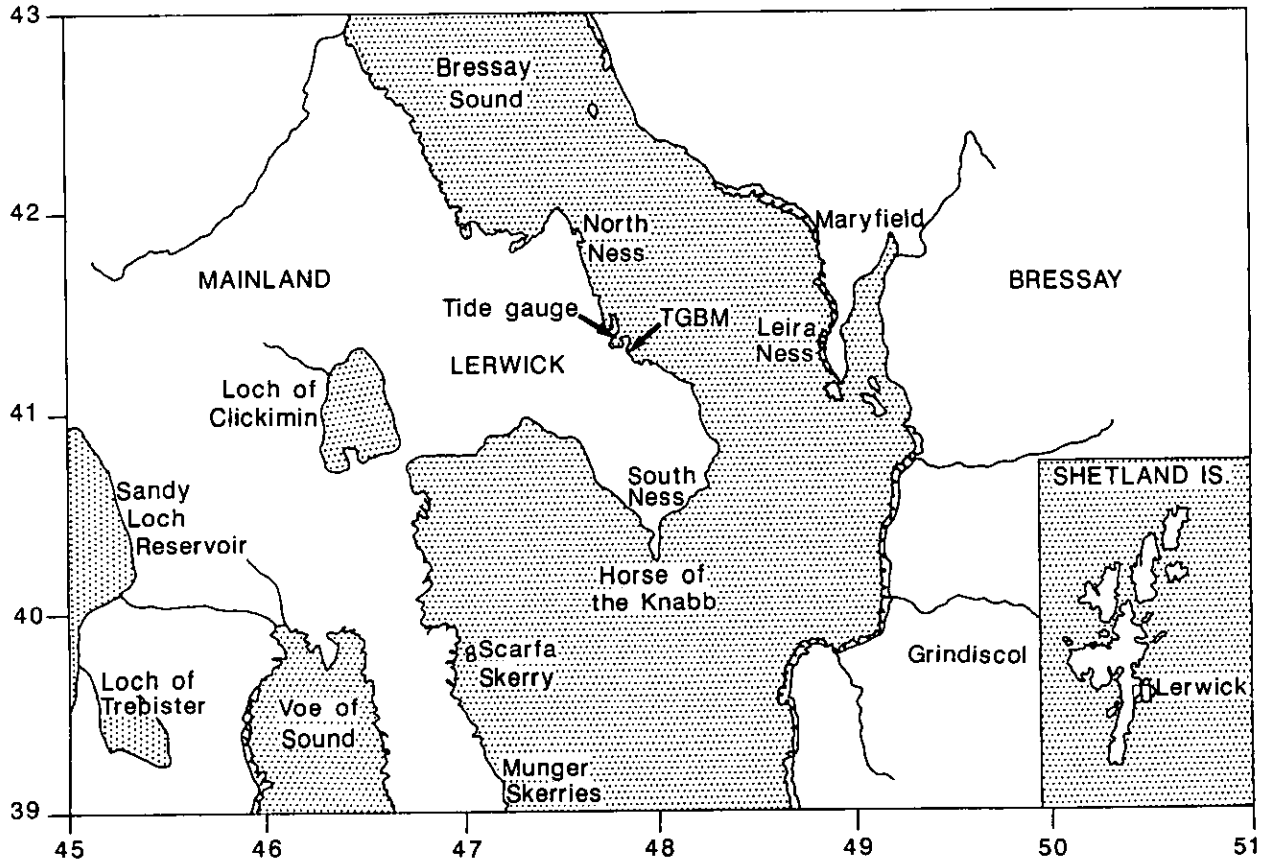
Observation Mean =	0.3121D+01	Residual Mean =	0.1190D-07
Std Dev =	0.1395D+01	Std Dev =	0.1597D+00

Constituent	h	g
Q1	0.040	14.42
O1	0.148	62.17
P1	0.034	199.38
K1	0.119	219.97
J1	0.011	249.50
2N2	0.055	17.27
N2	0.346	32.11
M2	1.808	55.59
S2	0.620	95.96
K2	0.178	93.44
M3	0.020	16.98
M4	0.082	187.43
MS4	0.077	299.94
M6	0.046	290.60

Lerwick

Latitude 60 deg 09' 13.8"N Longitude 01 deg 08' 18.2" W
National Grid Reference HU 4783 4129

Recording zero = Chart Datum = 1.22m below Ordnance Datum Local
Recording zero = 4.57m below Tide Gauge Bench Mark



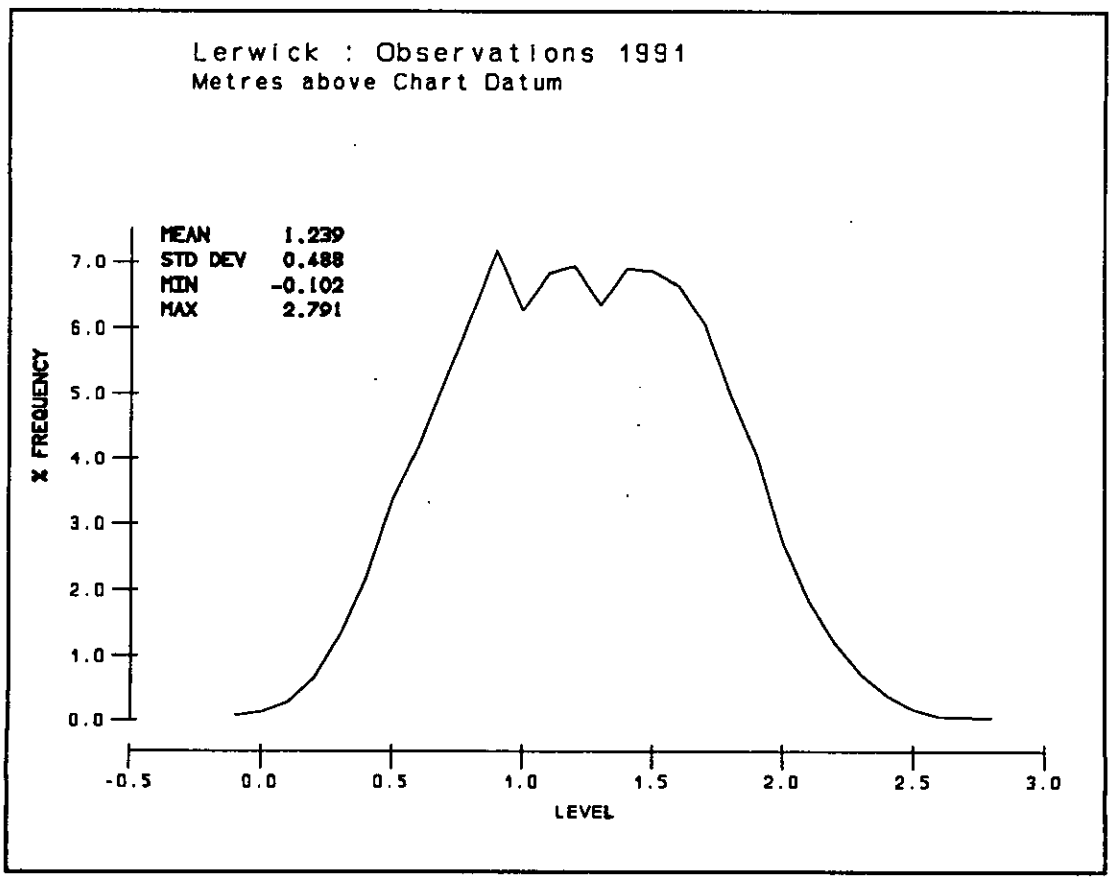
Bench Mark	NG co-ords	Description
TGBM	HU 4783 4129	OSBM bolt on breakwater wall.
Aux1	HU 4784 4125	Queen's Hotel 7.5m SW face south angle.
Aux2	HU 4777 4110	Lerwick Parish Church North face NW angle.

Sea levels from a site at Lerwick have been collected on a regular basis since 1959, but from chart records until modernisation in May 1989, when the jetty was completely rebuilt and furnished with a new stilling well with Munro gauge as well as a digiquartz sensor linkage to a pneumatic bubbler outlet.

Spurious and missing values in the raw data from channel 2 digiquartz were edited for the following dates in 1991: 21 May; 4,19 Jul; 12 Sep; 29 Oct.

Gaps in filtered hourly levels from Channel 2

Nil gaps.



Harmonic Tidal Analysis.

Port: Shetland Islands - Lerwick

Latitude: 60 09' 13.8" N
Longitude: 1 08' 18.2" W

Time Zone: GMT

Length: 365 Days

From: 1st January, 1991 To: 31st December, 1991

Units: Metres A0: 1.240

Hourly data from digiquartz sensor

Datum of Observations = ACD : 1.22 Metres below Ordnance Datum (Local)

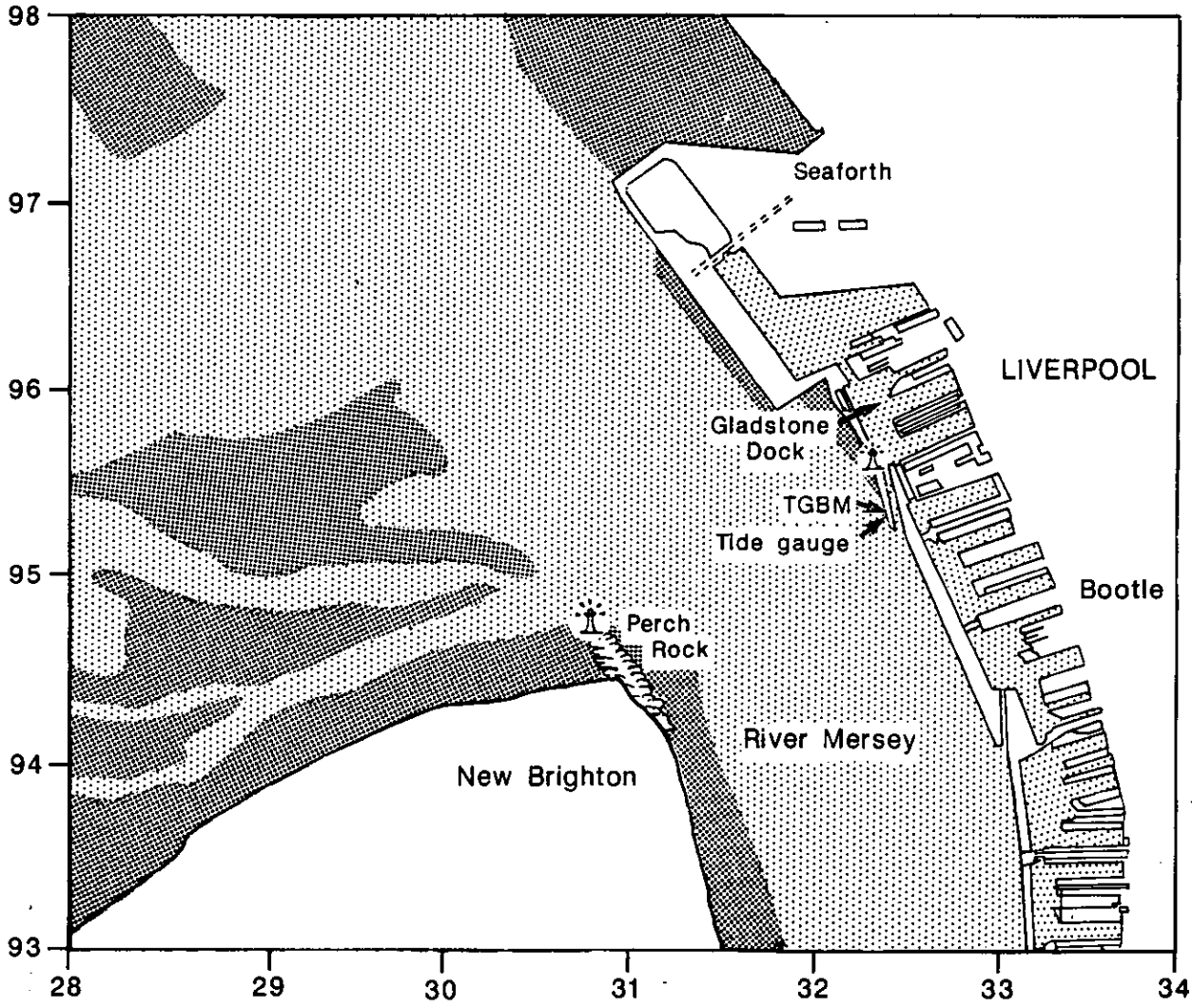
Observation Mean =	0.1240D+01	Residual Mean =	0.2728D-06
Std Dev =	0.4871D+00	Std Dev =	0.1521D+00

Constituent	h	g
Q1	0.023	341.73
O1	0.080	30.47
P1	0.022	145.83
K1	0.073	163.31
J1	0.007	194.05
2N2	0.017	276.91
N2	0.119	292.13
M2	0.583	311.94
S2	0.212	346.98
K2	0.059	343.54
M3	0.007	204.99
M4	0.017	278.86
MS4	0.014	5.71
M6	0.012	222.49

Liverpool, Gladstone Dock

Latitude 53 deg 26' 57.9"N Longitude 03 deg 01'00.0"W
National Grid reference SJ 3249 9525

Recording zero = 4.93m below Ordnance Datum Newlyn.
Recording zero = 14.475m below Tide Gauge Bench Mark.



Bench Mark	NG co-ords	Description
TGBM	SJ 3249 9525	NBM Rivet NE face E angle base of building.
Aux1	SJ 3250 9523	Rivet E side of quay above hinge SW dock gate.

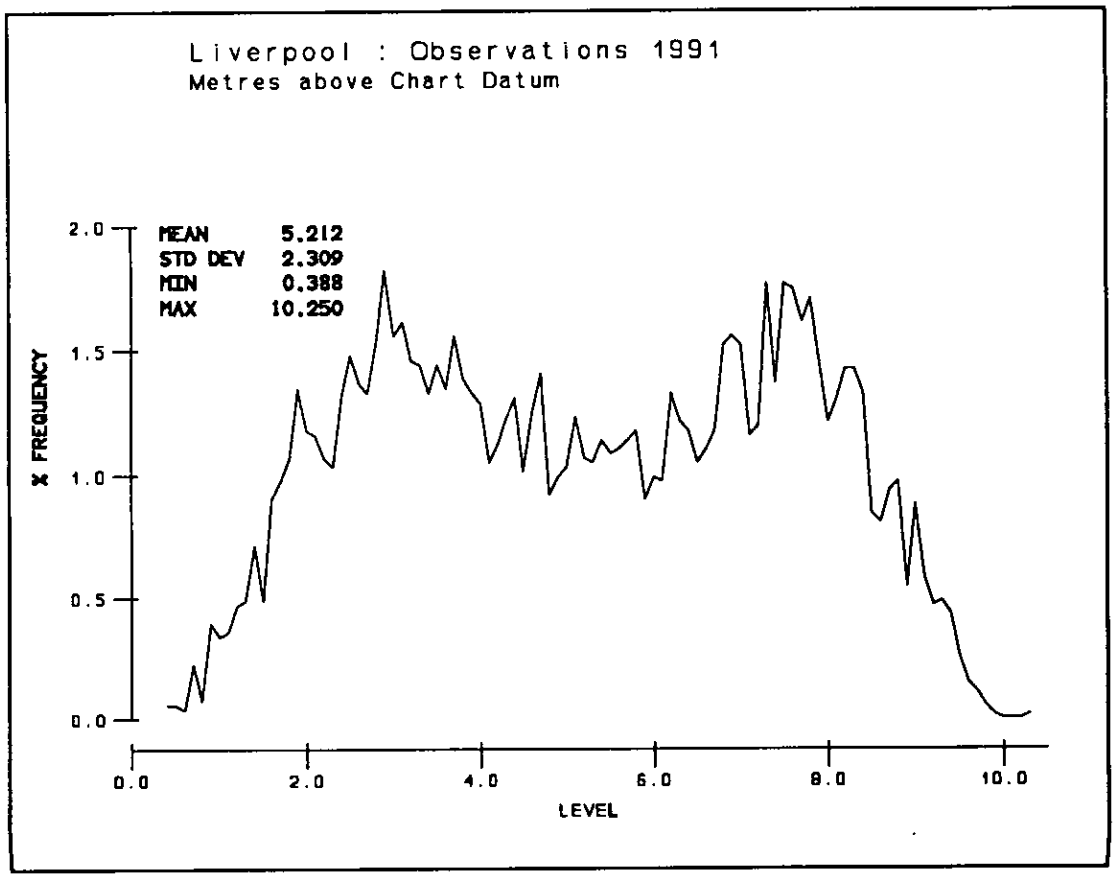
This site in the Gladstone Dock was completely refurbished to house Dataring equipment. Recording began from one digiquartz sensor linked to a pneumatic bubbler system on **23 May 1991.** The second digiquartz channel remained inoperative until 2 August and showed a datum error until corrected by TGI on their visit of 29 November. For this reason, results are presented from the channel 1 sensor for this report.

The TGI visited the site 3 June, 9 and 12 August and 29 November.

Isolated spurious and missing scans in the raw data from channel 1 were edited for the following dates in 1991: 22 Jul; 14 Aug; 24,26 Sep; 20,29 Nov, 16,26 Dec.

Gaps in filtered hourly values from Channel 1

Hourly records begin 23 May (1900 GMT) , thereafter no gaps.



Harmonic Tidal Analysis.

Port: England, West Coast - Liverpool, Gladstone Dock

Latitude: 53 26' 57.9" N
Longitude: 3 01' 0.0" W

Time Zone: GMT

Length: 177 Days

From: 8th July, 1991 To: 31st December, 1991

Units: Metres A0: 5.227

Hourly data from digiquartz sensor 1

Datum of Observations = ACD : 4.93 Metres below Ordnance Datum (Newlyn)

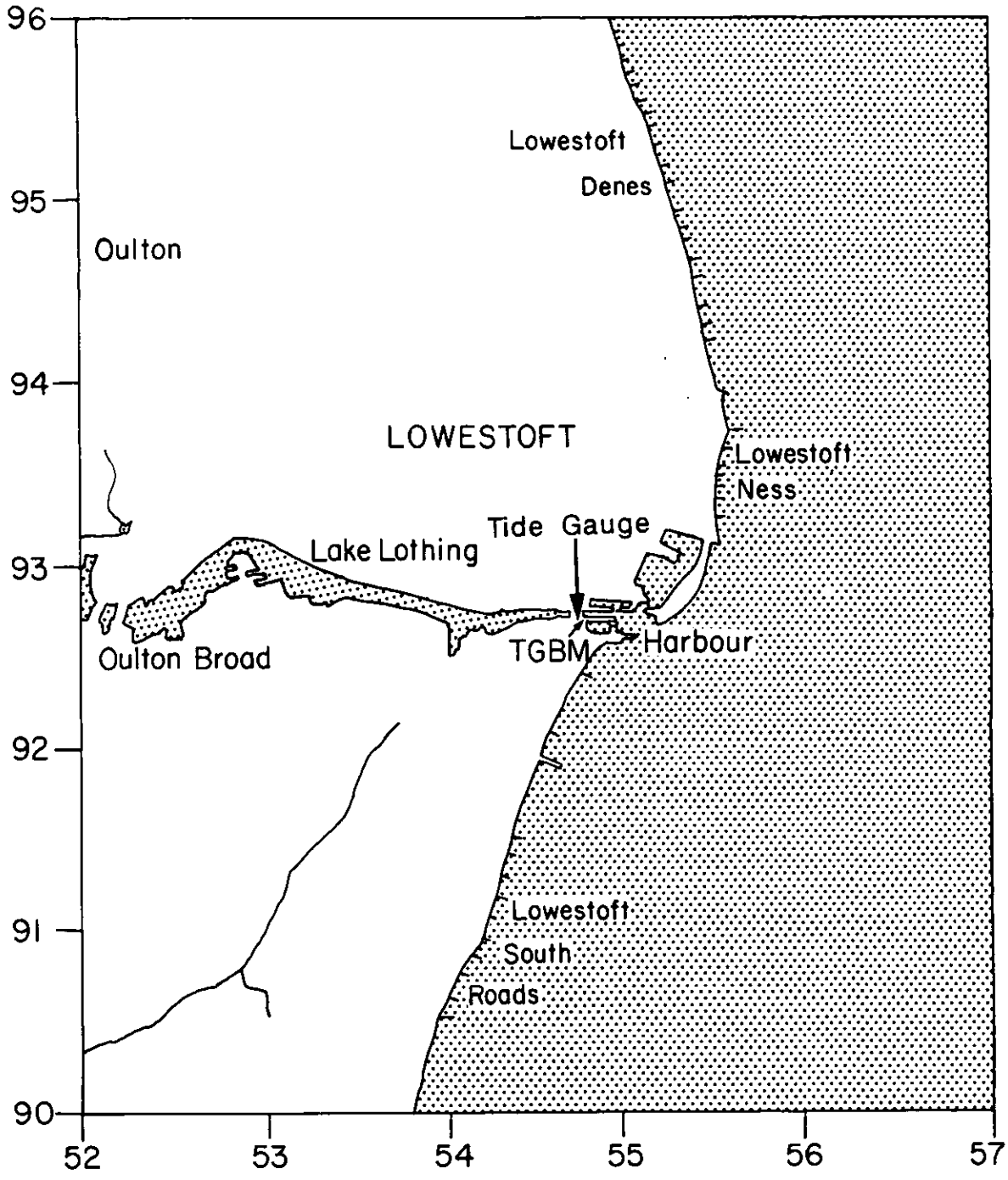
Observation Mean =	0.5228D+01	Residual Mean =	0.6830D-05
Std Dev =	0.2328D+01	Std Dev =	0.2128D+00

Constituent	h	g
Q1	0.020	339.19
O1	0.114	43.78
P1	0.041	166.88
K1	0.127	194.25
J1	0.006	98.64
2N2	0.100	290.72
N2	0.569	298.69
M2	3.038	321.47
S2	0.983	6.01
K2	0.291	3.49
M3	0.034	312.30
M4	0.242	203.49
MS4	0.146	242.01
M6	0.054	351.55

Lowestoft

Latitude 52 deg 28' 20.9"N Longitude 01 deg 45' 6.4"E
National Grid reference TM 5477 9272

Recording zero = Chart Datum = 1.5m below Ordnance Datum Newlyn
Recording zero = 4.485m below Tide Gauge Bench Mark.

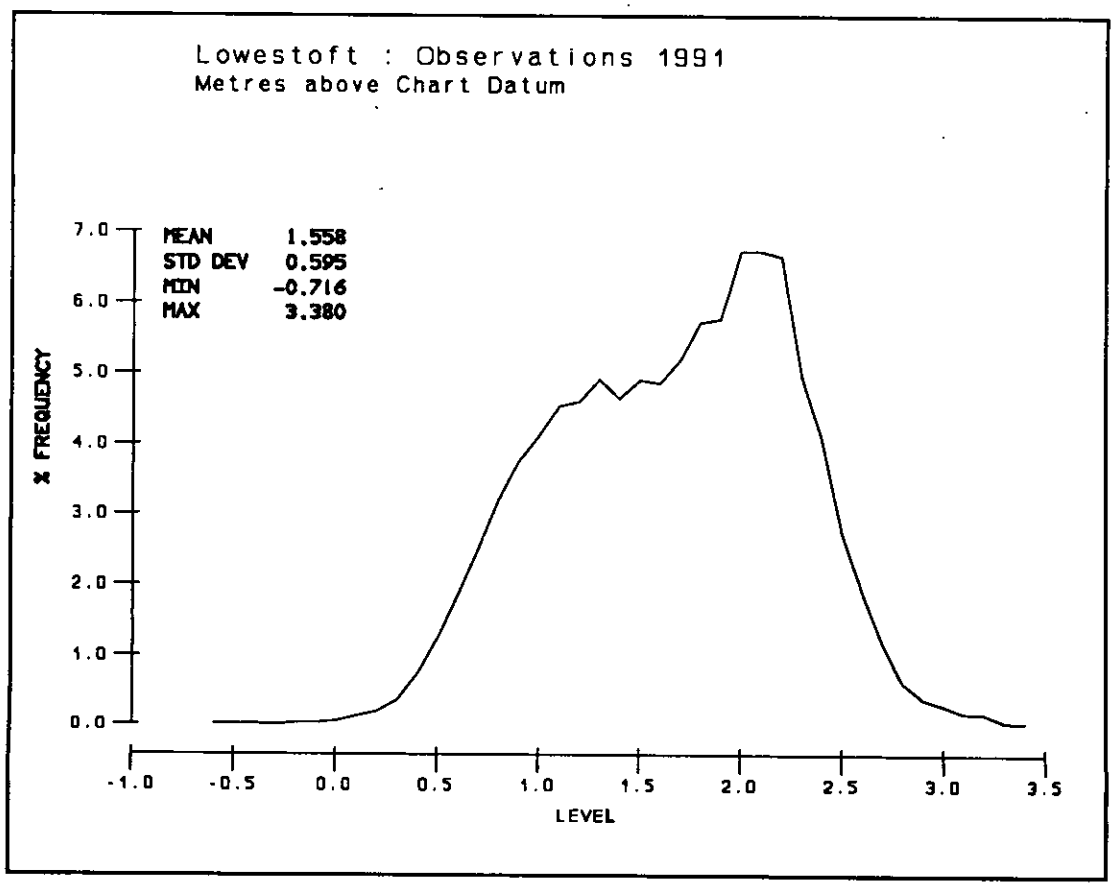


Bench Mark	NG co-ords	Description
TGBM	TM 5482 9273	Bolt on quay wall S. side of pier.
Aux1	TM 5477 9272	Bolt on concrete jetty at SW corner of automatic TG building.

Hourly heights filtered from channel 2 potentiometer attached to Munro gauge. A fault developed on the back-up channel 1 from early February. By late April, both channels showed faults and the TGI visited to make repairs 1 May.
Isolated spurious and missing scans in the raw data from channel 2 were edited for the following dates in 1991: 15,21,29 May; 5 Jun; 12,18 Jul; 5,7,23,28 Aug; 13,25 Sep; 9,24,6(2) Nov.
Scans integrated at 1 7/8 minute during the visit by TGI on 1 May were deleted.

Gaps in filtered hourly values from Channel 2

2100 GMT 29 Apr -	2100 GMT 1 May	Both channels faulty. TGI made repairs.



Harmonic Tidal Analysis.

Port: England, East Coast - Lowestoft

Latitude: 52 28' 20.9" N
Longitude: 1 45' 6.4" E

Time Zone: GMT

Length: 362 Days

From: 1st January, 1991 To: 31st December, 1991

Units: Metres A0: 1.560

Hourly data from potentiometer sensor 2

Datum of Observations = ACD : 1.50 Metres below Ordnance Datum (Newlyn)

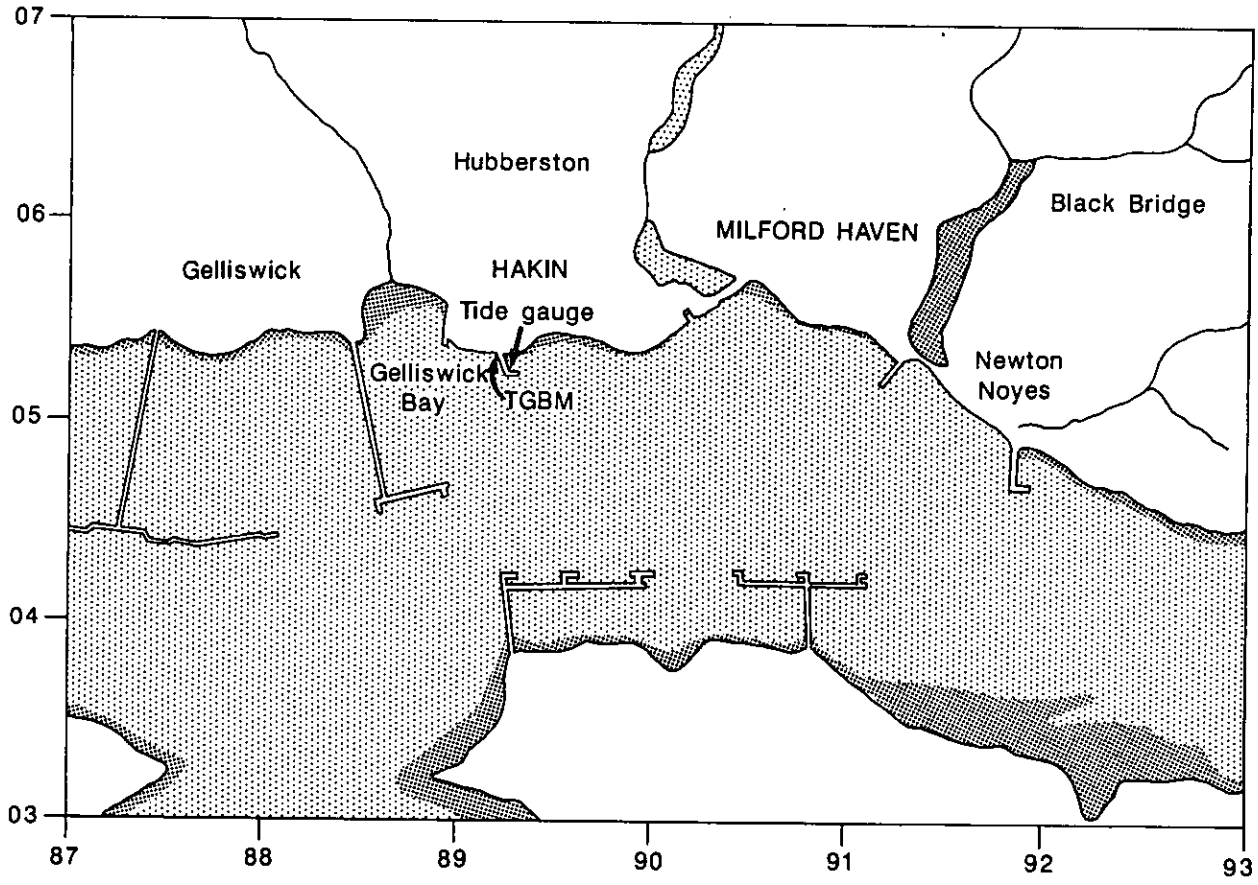
Observation Mean =	0.1559D+01	Residual Mean =	0.9653D-06
Std Dev =	0.5937D+00	Std Dev =	0.2155D+00

Constituent	h	g
Q1	0.043	99.83
O1	0.138	157.80
P1	0.037	303.61
K1	0.116	329.49
J1	0.012	351.78
2N2	0.026	232.53
N2	0.131	229.71
M2	0.699	259.94
S2	0.212	298.81
K2	0.059	300.26
M3	0.005	273.27
M4	0.050	334.48
MS4	0.042	27.13
M6	0.039	119.55

Milford Haven

Latitude 51 deg 42' 21.5" N Longitude 05 deg 03' 2.1" W
National Grid Reference SM 8925 0526

Recording zero = Chart Datum = 3.71m below Ordnance Datum Newlyn
Recording zero = 16.734m below Tide Gauge Bench Mark



Bench Mark	NG co-ords	Description
TGBM	SM 8921 0536	OSBM bolt on wall West side of entrance to jetty.
Aux1	SM 8918 0541	Flush Bracket G4977 office building, SW face, NW angle.

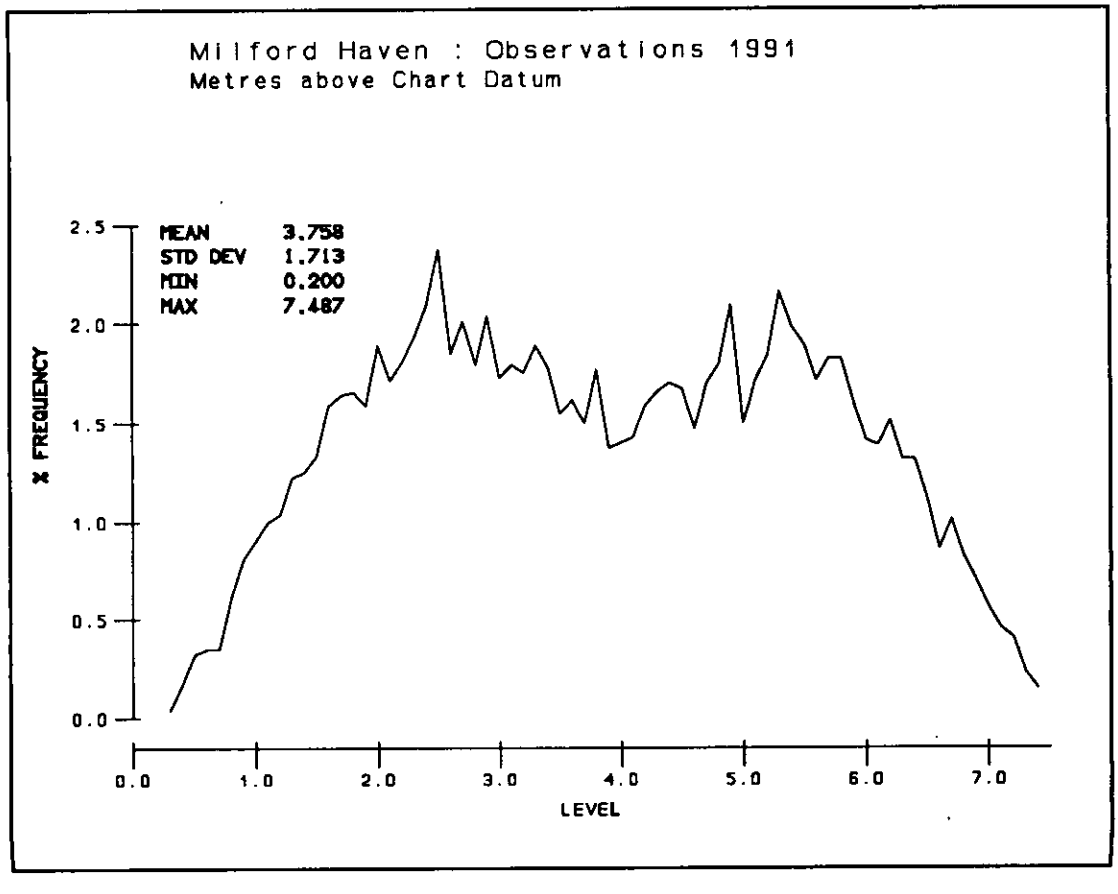
Values from a variety of tide gauge sites around Milford Haven have been collected since 1961. The Port Authority site at Hakin was upgraded and made operational via Dataring in December 1989 with two digiquartz sensors attached to pneumatic bubbler systems.

For 1991, the second channel was unserviceable from the beginning of the year until its repair on 25 February. TGI visited the site 29-31 July to change the compressor, and again 2 October to replace a leaking valve on the same compressor. Scans integrated at 1 7/8 minute over the periods were edited to 15 minute interval before filtering to hourly heights.

Isolated spurious and missing scans in the raw data for channel 2 were edited for the following dates :- 23(2),26(3) Feb; 27 Mar; 7,19,21 Apr; 31 May; 13,15,29 Jun; 1,7(2),8 Jul; 16 Aug; 19,28(3) Sep; 2,6,10,13,25,28 Oct; 3,10,15,16,24 Nov; 11(2),13,16,18,21,22,25(2) Dec.

Gaps in filtered hourly levels for Channel 2

Records begin 2100 GMT 25 February, nil gaps thereafter.



Harmonic Tidal Analysis.

Port: Wales - Milford Haven

Latitude: 51 42' 21.5" N
Longitude: 5 03' 2.1" W

Time Zone: GMT

Length: 369 Days

From: 25th February, 1991 To: 29th February, 1992

Units: Metres A0: 3.750

Hourly data from digiquartz sensor 2

Datum of Observations = ACD : 3.71 Metres below Ordnance Datum (Newlyn)

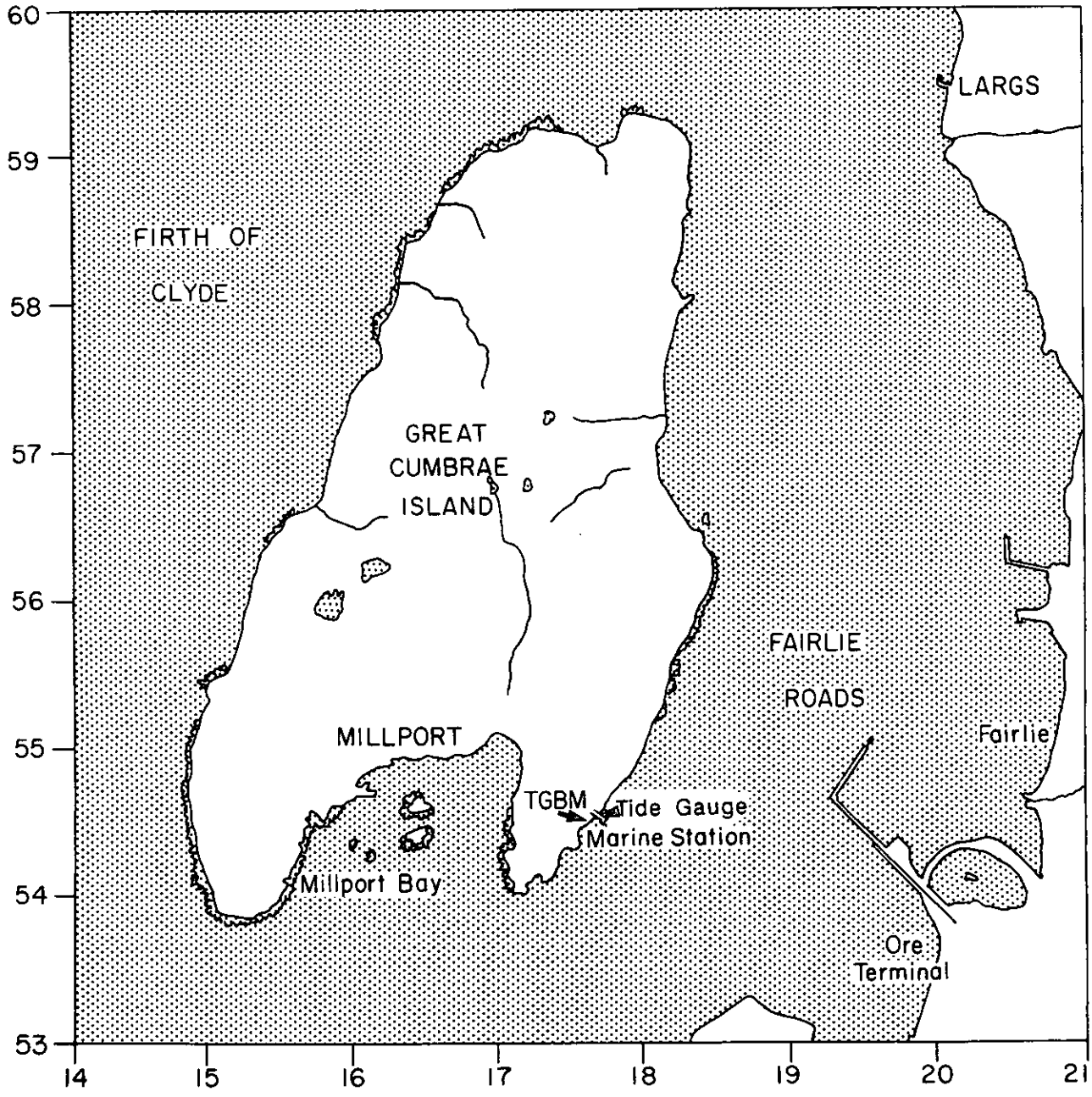
Observation Mean =	0.3749D+01	Residual Mean =	0.9746D-06
Std Dev =	0.1716D+01	Std Dev =	0.1427D+00

Constituent	h	g
Q1	0.015	308.34
O1	0.067	354.07
P1	0.021	111.59
K1	0.063	131.00
J1	0.003	132.38
2N2	0.056	133.88
N2	0.427	153.31
M2	2.227	172.84
S2	0.811	217.79
K2	0.236	214.21
M3	0.017	126.71
M4	0.066	307.80
MS4	0.033	357.73
M6	0.015	152.16

Millport

Latitude 55 deg 44'58.2"N Longitude 04 deg 54' 17.9"W
National Grid reference NS 1770 5450

Recording zero = Chart Datum = 1.62m below Ordnance Datum Newlyn
Recording zero = 7.825m below Tide Gauge Bench Mark.



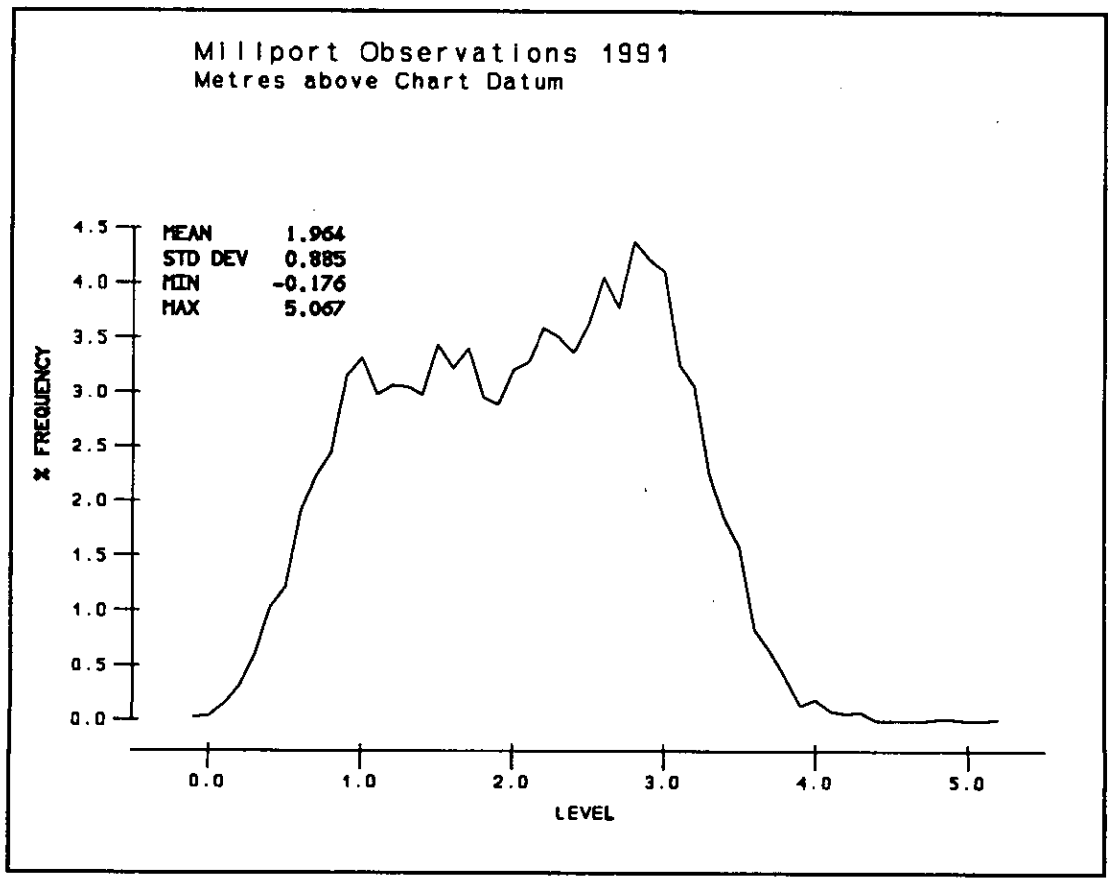
Bench Mark	NG co-ords	Description
TGBM	NS 1757 5449	Flush Bracket G4602 on Marine Station.
Aux1	NS 1772 5457	OSBM bolt on rock SE side of road 5m from NE end of wall.

Hourly heights were filtered from the channel 2 digiquartz for 1991. Many scan errors and gaps in the series retrieved during December were caused by the access to the tide gauge building being altered. Details of those dates on which interpolation was carried out are as follows:- 21 Jan; 15,27 Mar; 12,21 Apr; 21 May (2); 5 Jun; 25 Jul; 6 Aug; 26 Sep; 3 Oct; 11 Nov; 10,16(3),17,18,19(2),20(3),21,23(15),24(6),25(5),26(7),27,28(3),29(15) Dec.

Scans integrated at 1 7/8 minute during the TGI visit of 24 July were edited to 15 minute interval prior to filtering to hourly levels.

Gaps in final processed hourly levels for Channel 2

01hrs.	2 Jul	-07hrs.	10 Jul	Modem unserviceable.
23hrs.	13 Dec	-14hrs.	15 Dec	Data lost due to building works.
23hrs.	15 Dec	-20hrs.	16 Dec	Data lost due to building works.
04hrs	20 Dec	-16hrs.	20 Dec	Data lost due to building works.
06hrs.	25 Dec	-19hrs.	25 Dec	Data lost due to building works.
11hrs.	28 Dec	-06hrs.	29 Dec	Data lost due to building works.



Harmonic Tidal Analysis.

Port: Scotland, West Coast - Millport

Latitude: 55 44' 58.2" N
Longitude: 4 54' 17.9" W

Time Zone: GMT

Length: 370 Days

From: 1st January, 1991 To: 31st January, 1992

Units: Metres A0: 1.955

Hourly data from digiquartz sensor

Datum of Observations = ACD : 1.62 Metres below Ordnance Datum (Newlyn)

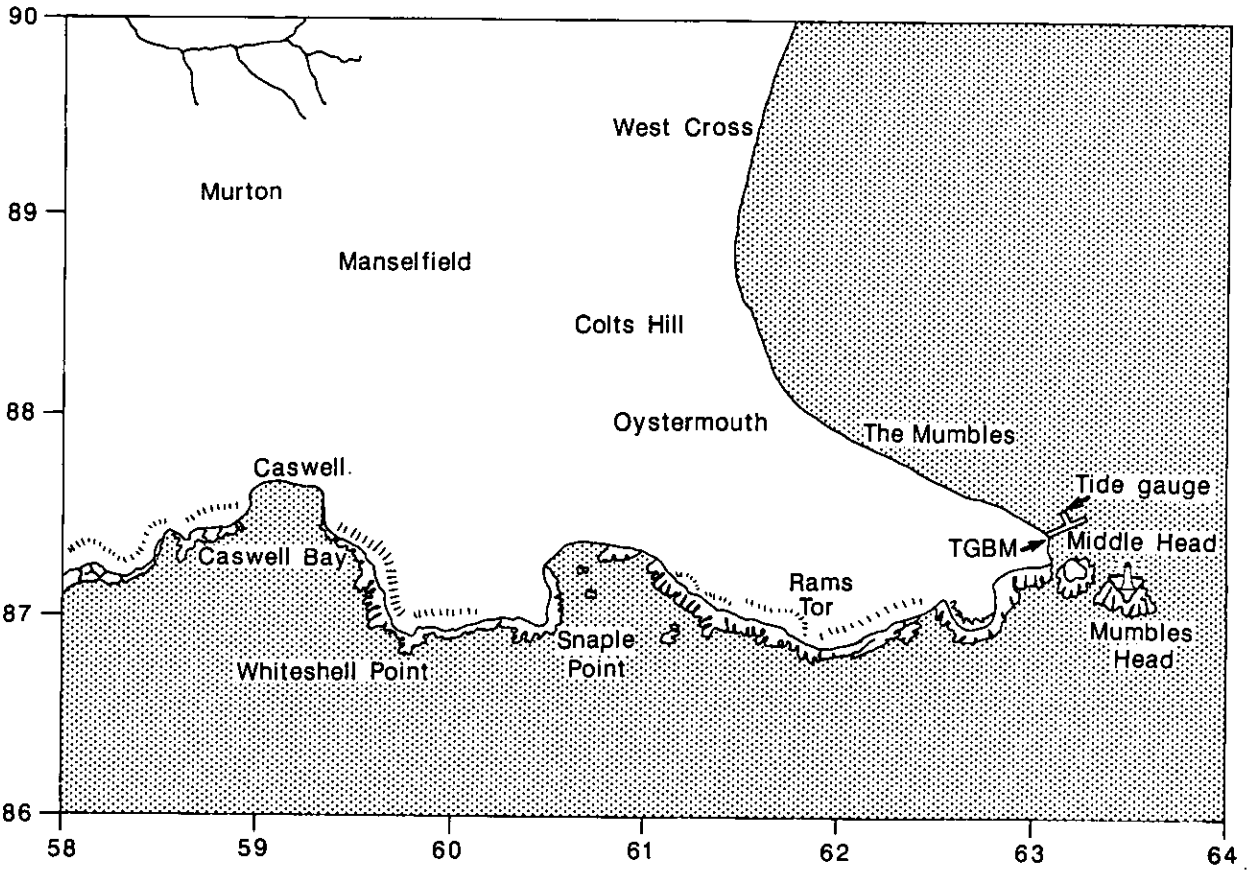
Observation Mean =	0.1959D+01	Residual Mean =	0.6346D-06
Std Dev =	0.8795D+00	Std Dev =	0.2193D+00

Constituent	h	g
Q1	0.029	344.35
O1	0.099	43.74
P1	0.034	178.28
K1	0.102	193.64
J1	0.001	299.05
2N2	0.028	285.02
N2	0.209	315.97
M2	1.122	343.04
S2	0.298	35.90
K2	0.089	33.55
M3	0.052	109.96
M4	0.090	90.34
MS4	0.086	117.12
M6	0.025	304.59

Mumbles

Latitude 51 deg 34' 10.0" N 03 deg 58' 28.3" W
National Grid Reference SS 6317 8752

Recording zero = Chart Datum = 5.0m below Ordnance Datum Newlyn
Recording zero = 13.821m below Tide Gauge Bench Mark



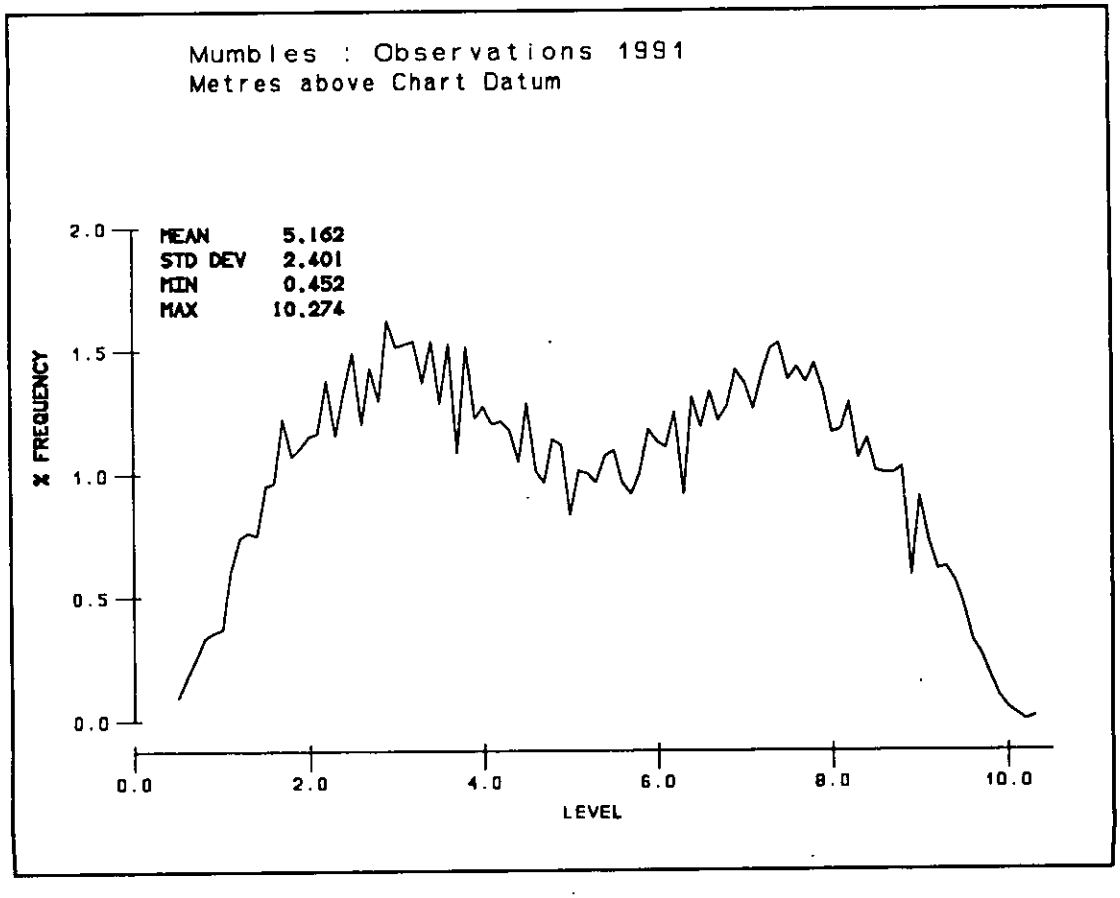
Bench Mark	NG co-ords	Description
TGBM	SS 6298 8743	OSBM bolt Living Rock South side of road.
Aux1	SS 6317 8752	OSBM bolt Lifeboat Station Mumbles Pier.

Hourly levels were filtered from the channel 2 digiquartz for 1991. Isolated spurious and missing scans were edited at the raw stage for the following dates :- 2 Jan; 5 Feb; 3,16 Mar; 30 Apr; 15 May; 26 Aug; 8,23 Nov; 7 Dec.

Scans integrated at 1 7/8 minute during the TGI visit of 11 February were edited to 15 minute interval before final filtering. The compressor developed a fault in December causing a loss of data from 17 December to the end of the year. Repairs were carried out early in 1992.

Gaps in filtered hourly levels for Channel 2

2300 GMT 16 December - 2300 GMT 31 December	Compressor fault.



Harmonic Tidal Analysis.

Port: Wales, - Mumbles

Latitude: 51 34' 10.0" N
Longitude: 3 58' 28.3" W

Time Zone: GMT

Length: 350 Days

From: 1st January, 1991 To: 16th December, 1991

Units: Metres A0: 5.166

Hourly data from digiquartz sensor 2

Datum of Observations = ACD : 5.00 Metres below Ordnance Datum (Newlyn)

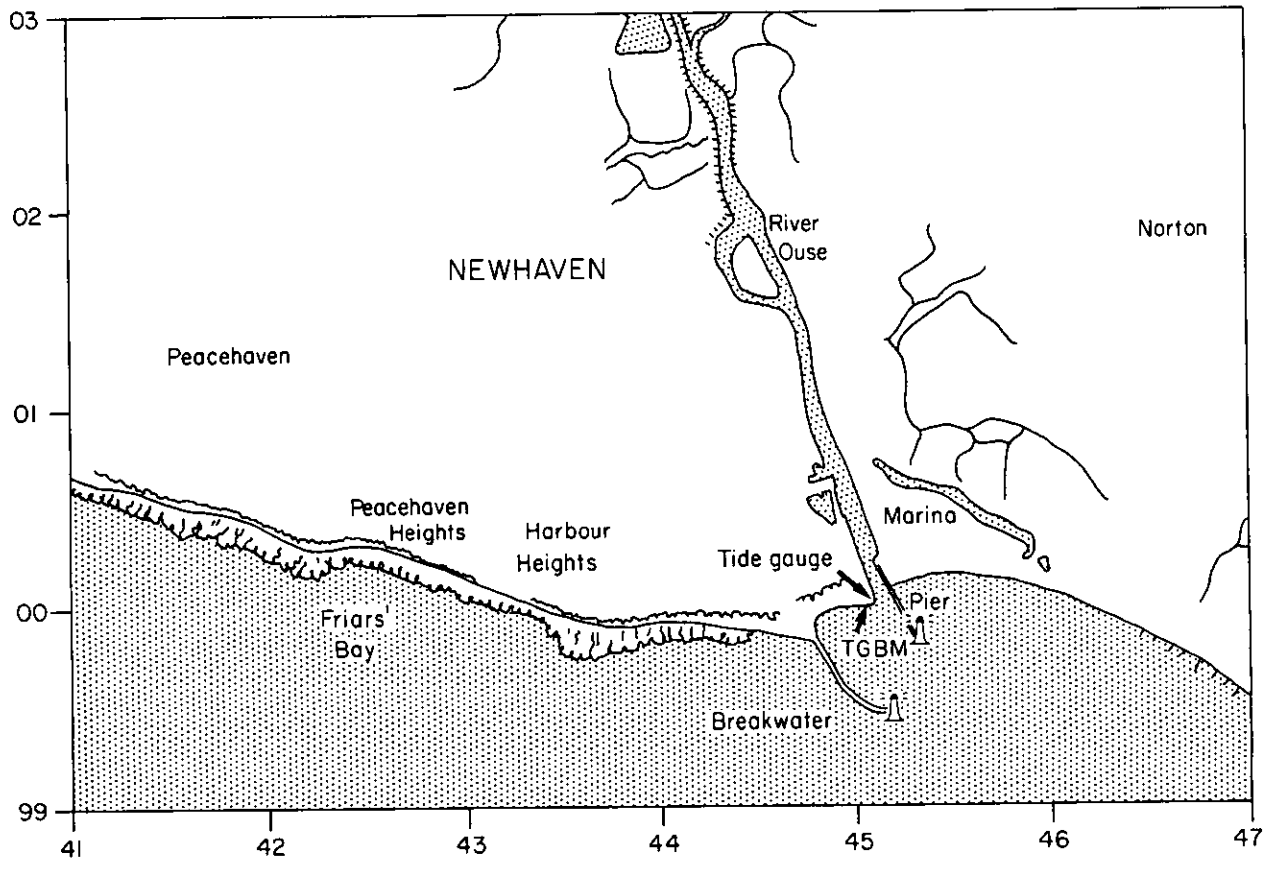
Observation Mean =	0.5164D+01	Residual Mean =	0.4171D-06
Std Dev =	0.2402D+01	Std Dev =	0.1591D+00

Constituent	h	g
Q1	0.018	300.05
O1	0.069	354.01
P1	0.021	111.87
K1	0.060	130.65
J1	0.003	117.07
2N2	0.111	122.35
N2	0.586	154.54
M2	3.138	172.58
S2	1.130	220.29
K2	0.329	217.37
M3	0.032	143.70
M4	0.074	14.25
MS4	0.040	86.01
M6	0.037	4.47

Newhaven

Latitude 50 deg 46' 52.6"N Longitude 00 deg 03' 30.0"E
National Grid Reference TQ 4509 0005

Recording Zero = Chart Datum = 3.52m below Ordnance Datum Newlyn
Recording Zero = 8.836m below Tide Gauge Bench Mark



Bench Mark	NG co-ords	Description
TGBM	TQ 4510 0003	OSBM bolt on concrete surround 7.4m SW of SW angle of tower.
Aux1	TQ 4495 0001	OSBM bolt on concrete sea wall 154.3m SW of tower.

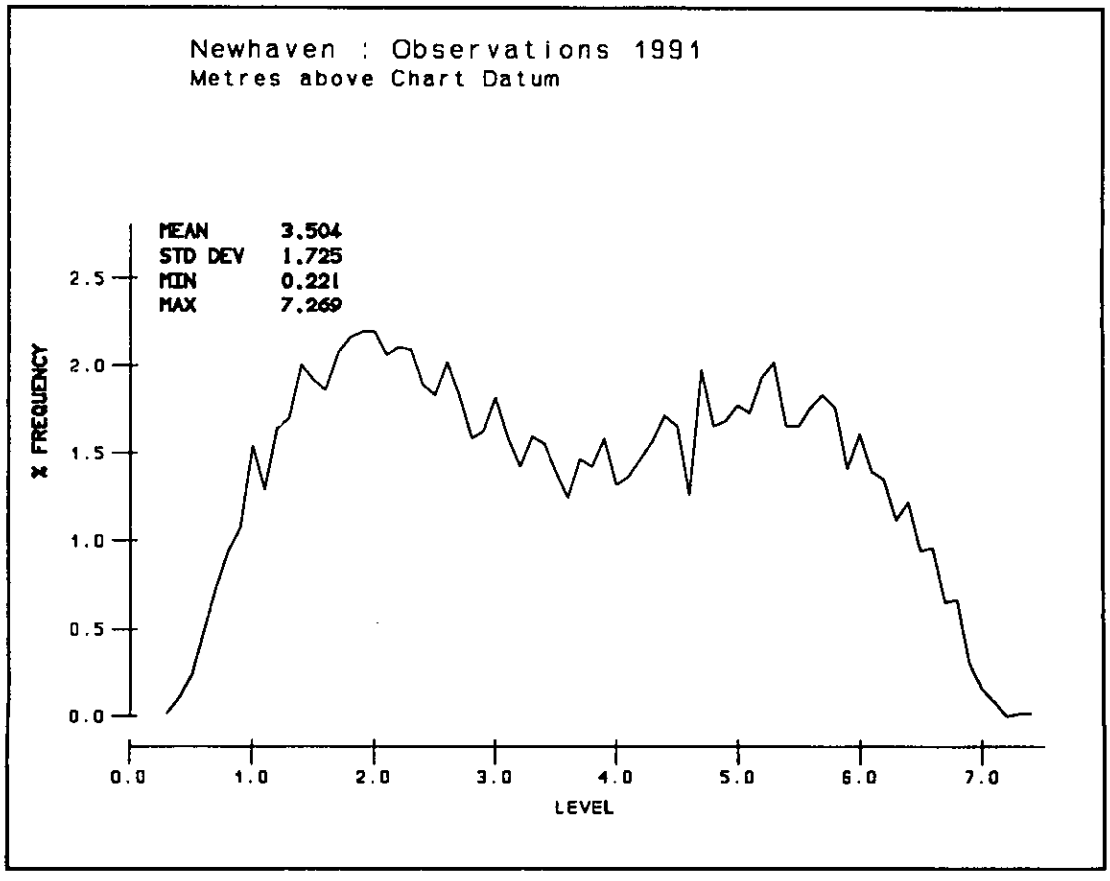
This site was upgraded to Dataring in November 1990 with two pneumatic bubbler systems to replace an Aanderaa pressure system.

Isolated spurious and missing scans in the raw data for channel 2 were edited for the following dates in 1991: 5,6,13 Feb; 8 Mar; 18 Apr; 22 May; 5,6,21 Jun; 22 Jul; 6,21,23 Aug; 5,20 Sep; 5 Oct.

The instrumentation was removed from the site 15 October to facilitate major harbour works. They are expected to be completed early in 1992.

Gaps in hourly filtered levels from channel 2

2300 GMT 14 October to the end of the year. Instrumentation removed.



Harmonic Tidal Analysis.

Port: England, South Coast - Newhaven

Latitude: 50 46' 52.6" N
Longitude: 0 03' 30.0" E

Time Zone: GMT

Length: 177 Days

From: 1st January, 1991 To: 26th June, 1991

Units: Metres A0: 3.478

Hourly data from digiquartz sensor 2

Datum of Observations = ACD : 3.52 Metres below Ordnance Datum (Newlyn)

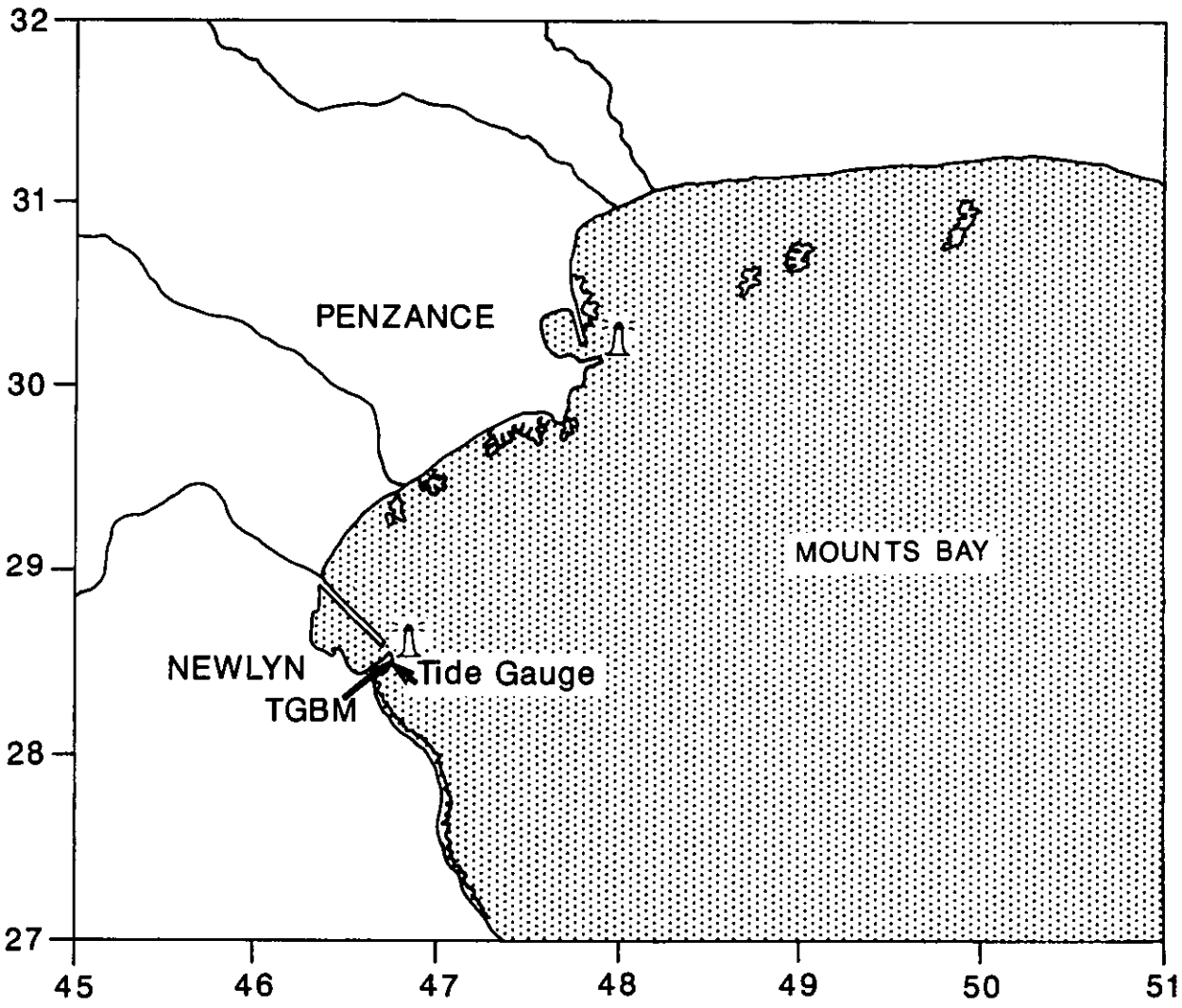
Observation Mean =	0.3476D+01	Residual Mean =	-0.4046D-05
Std Dev =	0.1723D+01	Std Dev =	0.1462D+00

Constituent	h	g
Q1	0.001	164.63
O1	0.013	343.94
P1	0.023	126.46
K1	0.075	96.98
J1	0.001	145.87
2N2	0.082	266.16
N2	0.428	299.70
M2	2.274	321.05
S2	0.738	10.64
K2	0.215	7.62
M3	0.008	12.13
M4	0.092	249.83
MS4	0.063	308.48
M6	0.021	164.46

Newlyn

Latitude 50 deg 06' 8.4"N Longitude 05 deg 32' 30.6"W
National Grid Reference SW 4676 2855

Recording zero = Chart Datum = 3.05m below Ordnance Datum Newlyn
Recording zero = 7.8012m below Tide Gauge Bench Mark



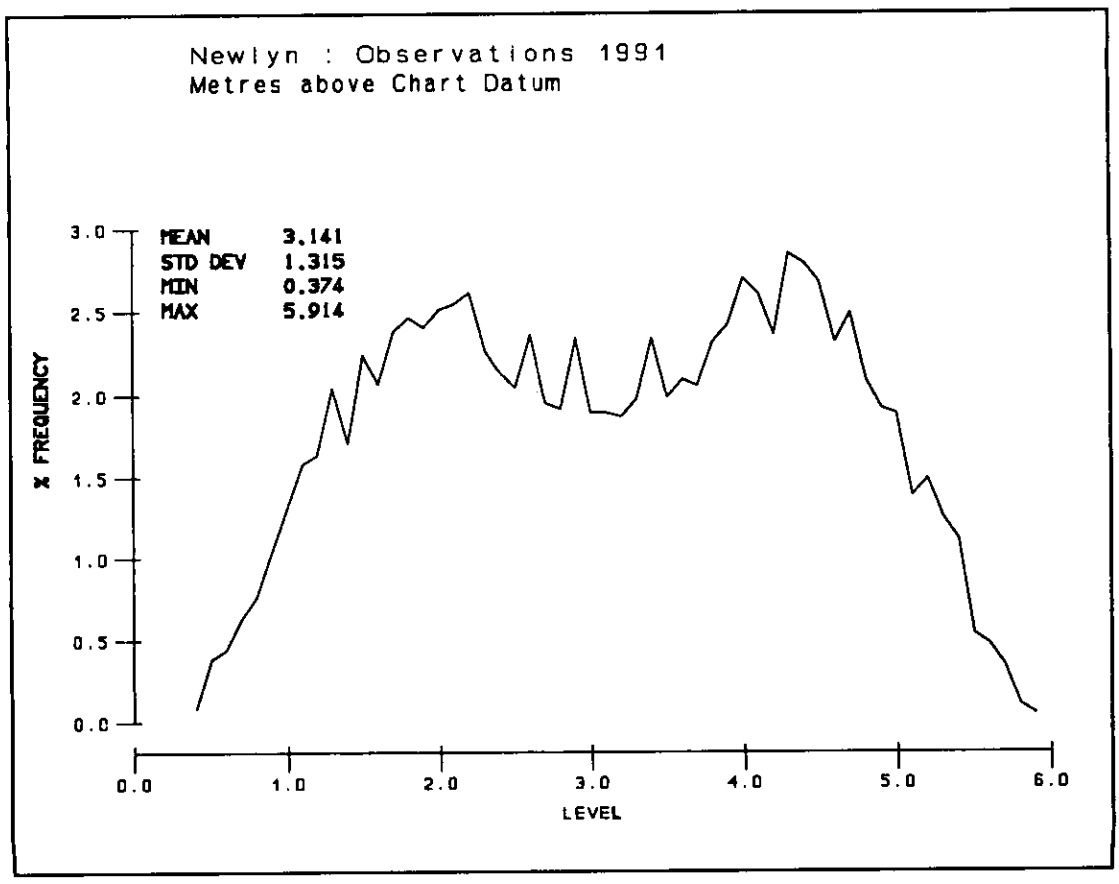
Bench Mark	NG co-ords	Description
TGBM	SW 4676 2855	OSBM bolt inside hut adjacent to well.
Aux1	SW 4673 2851	Flush Bracket 1565 on wall S. pier NW face 17.8m SW.

The back-up channel 1 connected to the Munro gauge was unserviceable from the start of the year until repaired by TGI on their visit of 13 March. Over the period of this visit in addition to scans integrated at 1 7/8 minute which were edited to 15 minute interval, spikes were edited on channel 2 for the following times on the 13th : 1515,1530,1715 and 1800 and 0900-0945,1145,1215,1630 and 1700 on the 14th. Isolated spurious and missing scans in the raw data were also interpolated for the following dates in 1991:- 10 Jan; 1,13 Feb; 7,15 Mar; 4,7,25 Apr; 10 May; 5,27(2) Jun; 21,31 Jul; 2,8,23 Aug; 27(2) Sep; 4 Oct; 13,14,28 Nov; 2,12 Dec.

The mains cable for the pier was struck by lightning 14 November which caused a power failure and subsequent values from the digiquartz to record low. Until the 17 November the error was 1 cm or less; data were deleted for the period 17 to 20 November.

Gaps in filtered hourly levels from Channel 2

2300 GMT 21 October - 1800 GMT 24 October	Sensors recalibrated.
0100 GMT 17 November - 0400 GMT 20 November	Power failure after storm.



Harmonic Tidal Analysis.

Port: England, South Coast - Newlyn

Latitude: 50 06' 08.4" N
Longitude: 5 32' 30.6" W

Time Zone: GMT

Length: 357 Days

From: 1st January, 1991 To: 31st December, 1991

Units: Metres A0: 3.145

Hourly data from digiquartz sensor

Datum of Observations = ACD : 3.05 Metres Below Ordnance Datum (Newlyn)

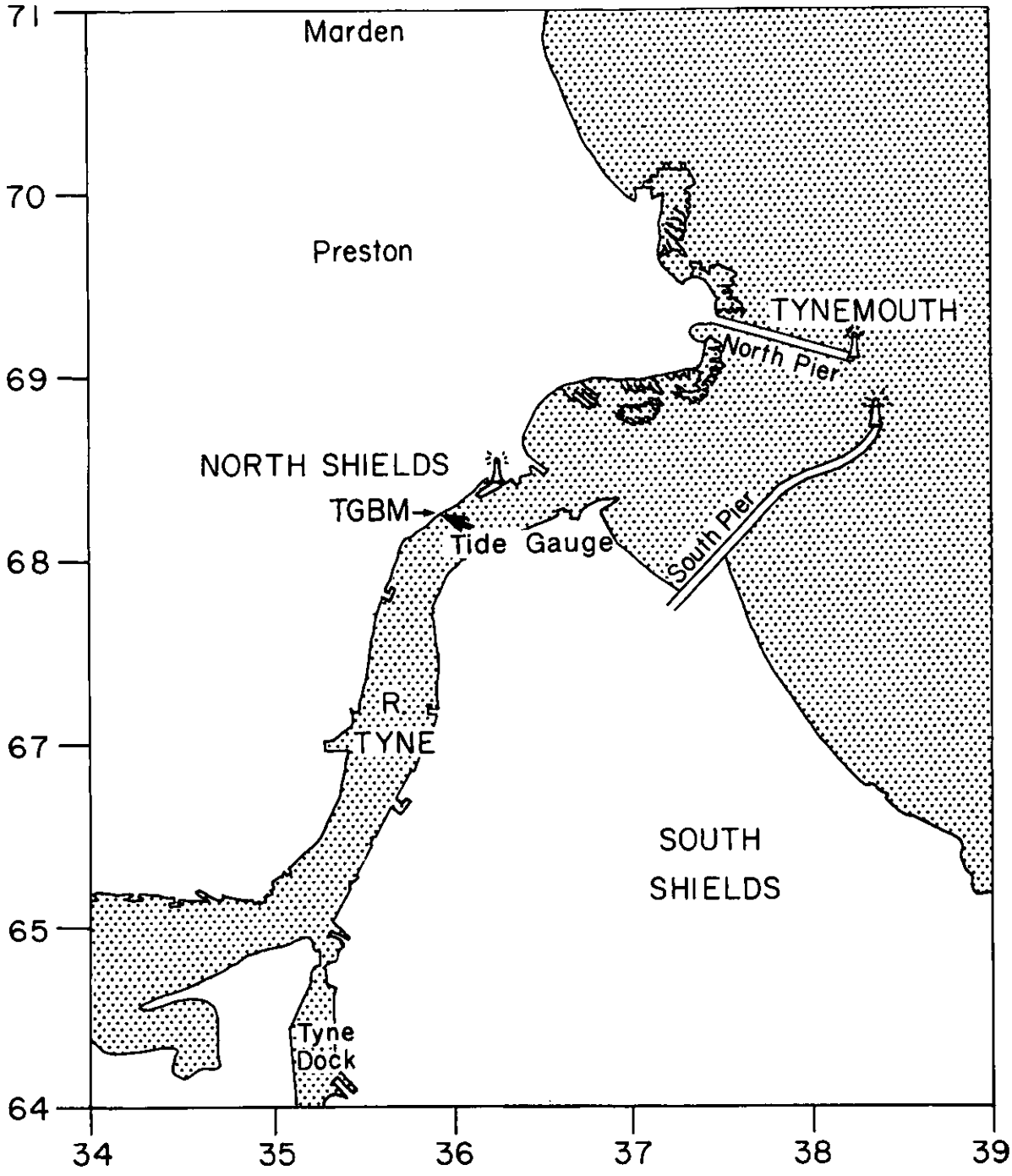
Observation Mean =	0.3143D+01	Residual Mean =	0.8779D-06
Std Dev =	0.1316D+01	Std Dev =	0.1169D+00

Constituent	h	g
Q1	0.014	293.17
O1	0.055	341.64
P1	0.020	96.71
K1	0.062	109.03
J1	0.004	129.86
2N2	0.059	87.81
N2	0.327	113.77
M2	1.723	133.50
S2	0.577	177.91
K2	0.167	174.96
M3	0.011	21.94
M4	0.115	166.68
MS4	0.076	218.21
M6	0.009	330.17

North Shields

Latitude 55 deg 00' 26.1"N Longitude 01 deg 26' 17.9"W
National Grid Reference NZ 3592 6823

Recording zero = Chart Datum = 2.6m below Ordnance Datum Newlyn
Recording zero = 6.515m below Tide Gauge Bench Mark

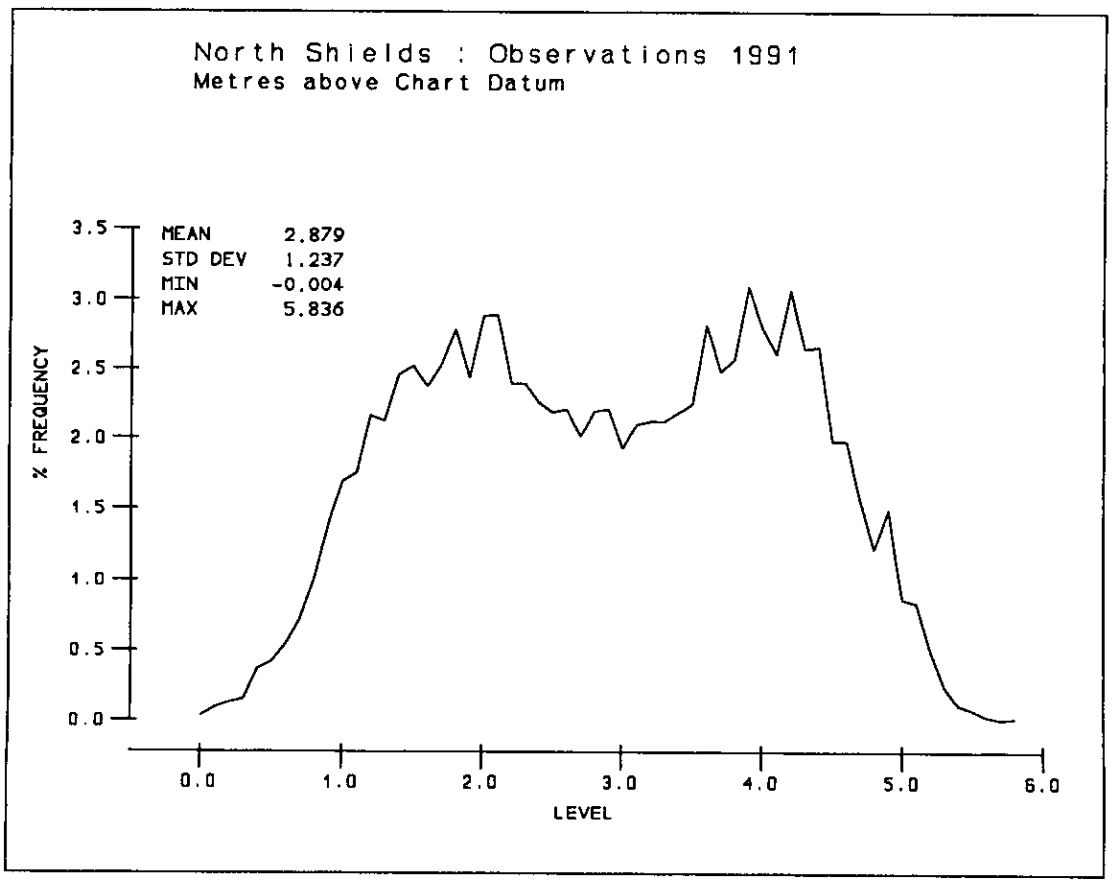


Bench Mark	NG co-ords	Description
TGBM	NZ 3592 6823	OSBM bolt in TG building.
Aux1	NZ 3626 6842	PA bolt low light house W face SW angle.

Hourly heights were filtered from the Class A channel 2 data series. From the beginning of the year right through to 15 November when a new processor board was fitted by TGI, there were many multiple and duplicate recordings. These were edited prior to the filtering process. There were three periods in October when the whole system locked up and data were lost. The remaining interim series were too short for processing and were deleted.

Gaps in final processed hourly levels from channel 2

00hrs. 2 October - 12hrs. 30 October System locked up - faulty processor board.



Harmonic Tidal Analysis.

Port: England, East Coast - North Shields

Latitude: 55 00' 26.1" N
Longitude: 1 26' 17.9" W

Time Zone: GMT

Length: 367 Days

From: 1st January, 1991 To: 31st January, 1992

Units: Metres A0: 2.888

Hourly data from potentiometer sensor 2

Datum of Observations = ACD : 2.60 Metres below Ordnance Datum (Newlyn)

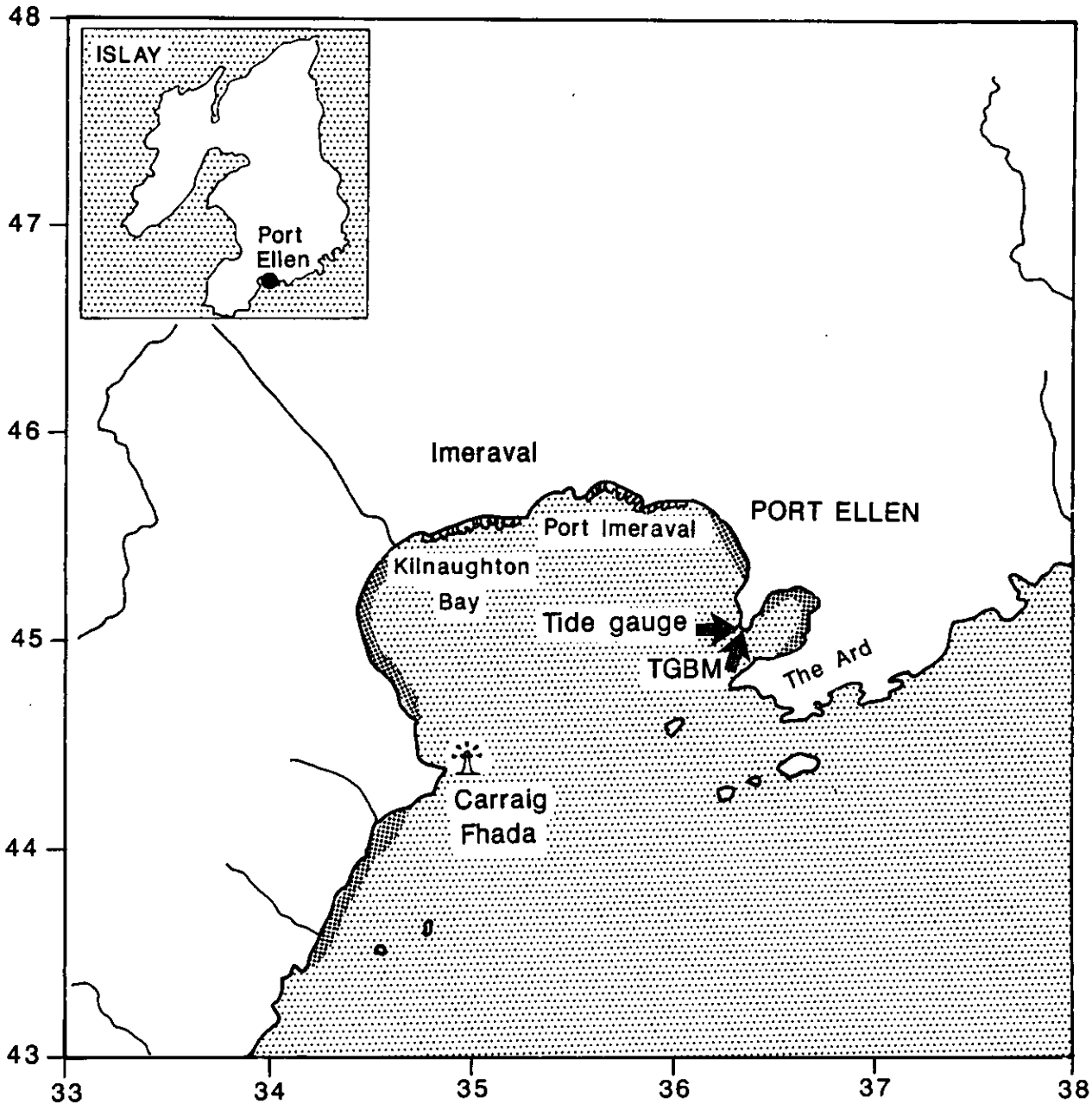
Observation Mean =	0.2881D+01	Residual Mean =	0.4434D-06
Std Dev =	0.1235D+01	Std Dev =	0.1694D+00

Constituent	h	g
Q1	0.041	33.19
O1	0.142	77.11
P1	0.035	221.25
K1	0.118	241.43
J1	0.015	268.51
2N2	0.050	51.84
N2	0.306	65.49
M2	1.607	89.20
S2	0.539	131.26
K2	0.155	128.61
M3	0.012	69.07
M4	0.022	109.41
MS4	0.019	87.67
M6	0.007	18.99

Port Ellen

Latitude 55 deg 37' 39.2"N Longitude 06 deg 11' 20.1"W
National Grid Reference NR 3635 4507

Recording zero = Chart Datum = 0.19m below Ordnance Datum Newlyn.
Recording zero = 2.839m below Tide Gauge Bench Mark.



Bench Mark	NG co-ords	Description
TGBM	NR 3635 4507	Bolt SE side Booking Office
Aux1	NR 3642 4515	Rivet on angle of wall NW side of entrance to pier.

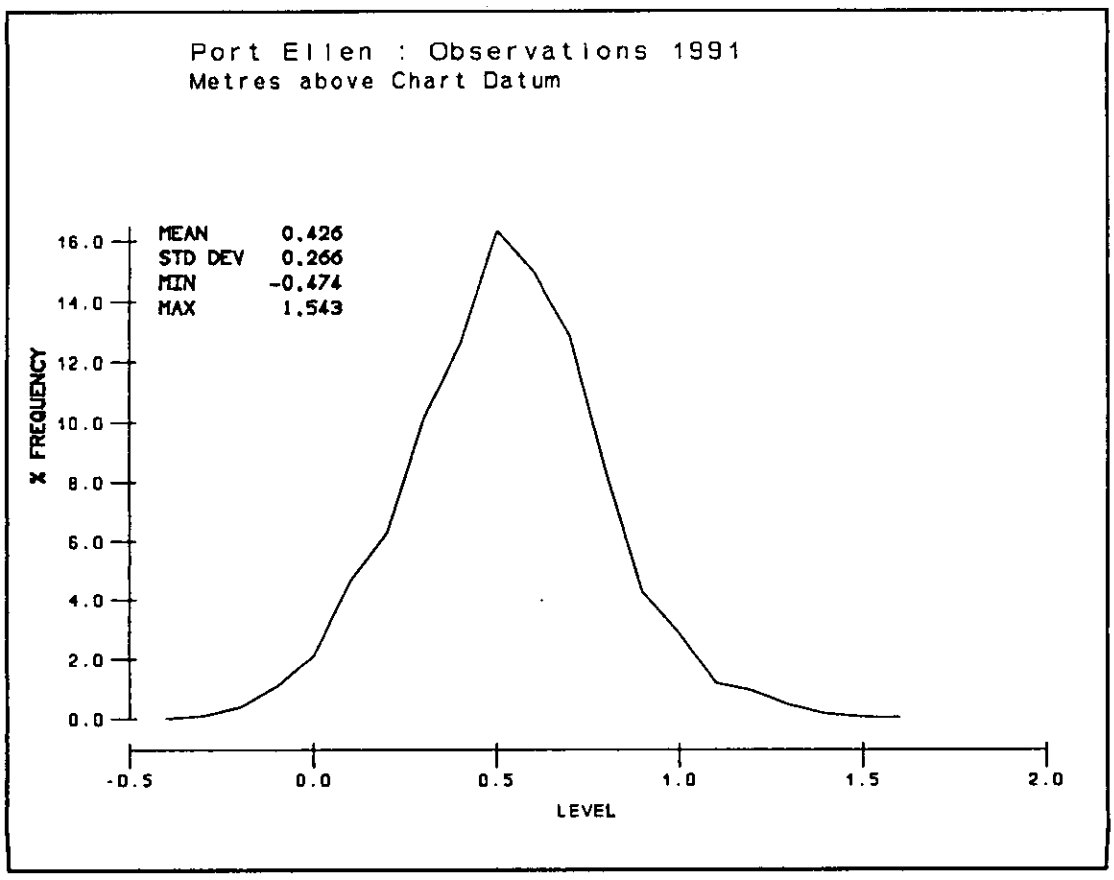
Originally a site of a temporary tide gauge, this harbour on the Isle of Islay was chosen to be a valuable extension to the Class-A network coverage. Two pneumatic bubbler systems were emplaced and operational from **13 June 1991.** Unlike other sites on the network the tidal profile is markedly 'mixed' diurnal and semi-diurnal and has a very small range in calm conditions.

Similar to other sites new to the network, data from both sensors were processed for 1991 with details and statistics given in this report for channel 2 only. After the normal editing of spurious values there were **no gaps** in the hourly series collated from either channel.

From the time of installation to 22 July, the reference to Chart Datum for both pressure points was incorrectly set and corrected in the reduction process. Isolated spurious and missing scans were also edited for the following dates :- 25 Jul; 11,25,27,28 Aug; 24 Sep; 20,30 Dec.

Scans integrated at 1 7/8 minute over the TGI visit of 22 July were edited to 15 minute interval and interpolated over the implementation of the datum correction.

N.B. The frequency/depth curve presented below may be biased due to the very short series of data available.



Harmonic Tidal Analysis.

Port: Scotland, Islay - Port Ellen

Latitude: 55 37' 39.2" N
Longitude: 6 11' 20.1" W

Time Zone: GMT

Length: 177 Days

From: 7th July, 1991 To: 31st December, 1991

Units: Metres A0: 0.437

Hourly data from digiquartz sensor 2

Datum of Observations = ACD : 0.19 Metres below Ordnance Datum (Newlyn)

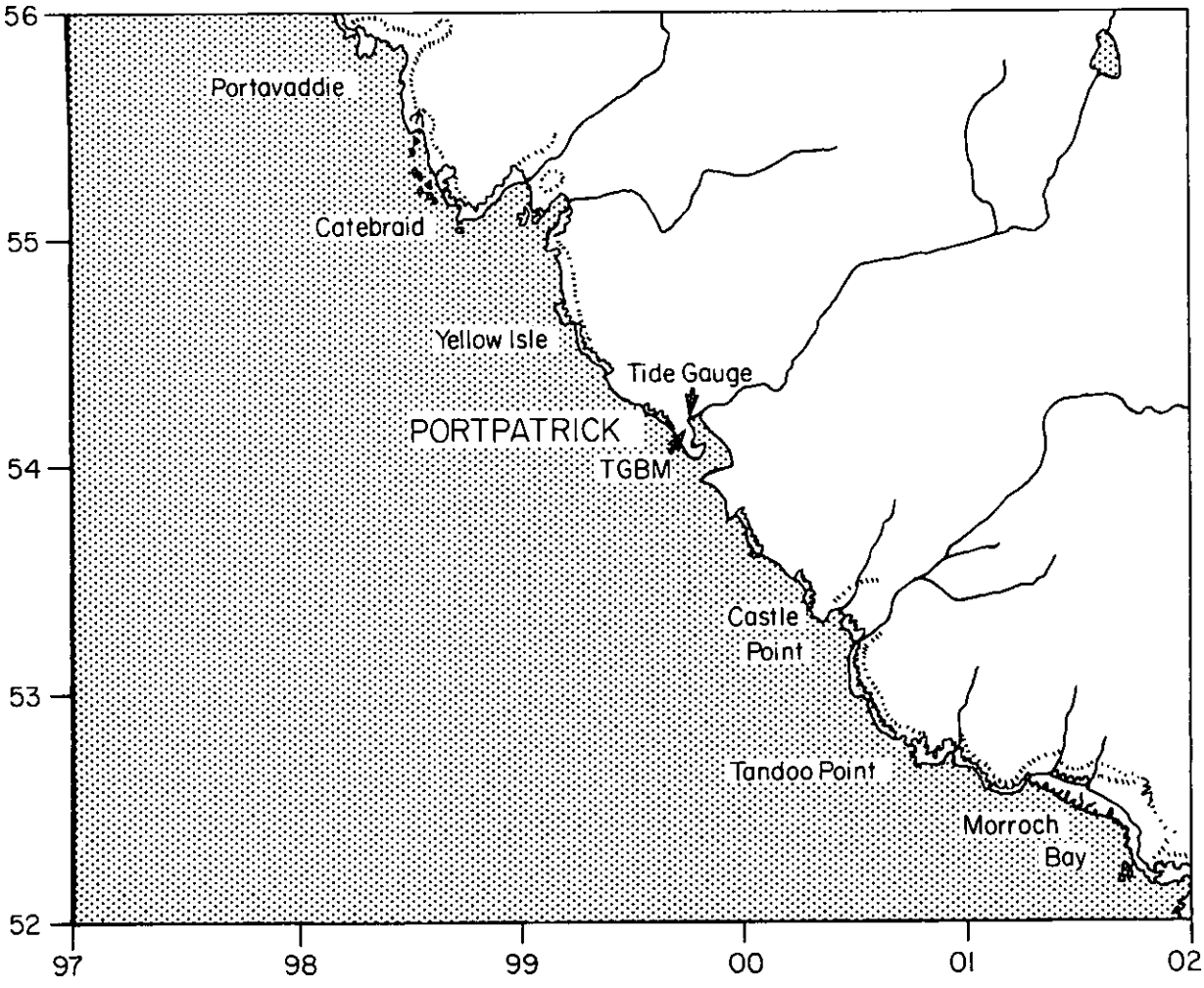
Observation Mean =	0.4374D+00	Residual Mean =	-0.4516D-04
Std Dev =	0.2716D+00	Std Dev =	0.1798D+00

Constituent	h	g
Q1	0.021	333.77
O1	0.081	39.06
P1	0.030	166.28
K1	0.081	188.30
J1	0.003	113.64
2N2	0.009	353.77
N2	0.025	81.85
M2	0.160	90.45
S2	0.143	154.74
K2	0.041	150.18
M3	0.039	108.77
M4	0.021	66.83
MS4	0.013	64.24
M6	0.026	119.62

Portpatrick

Latitude 54 deg 50' 32.7"N Longitude 05 deg 07' 08.0"W
National Grid Reference NW 9976 5420

Recording Zero = Chart Datum = 1.8m below Ordnance Datum Newlyn
Recording Zero = 6.827m below Tide Gauge Bench Mark



Bench Mark	NG co-ords	Description
TGBM	NW 9976 5421	Bolt on harbour wall 13.84m NE angle of building.
Aux1	NW 9977 5411	Rivet on E side of jetty wall 16.6m SE angle of Life Boat headquarters
Aux2	NW 9995 5412	Rivet S angle of No.53 Main St.

This installation was modernised to accommodate Dataring in July 1990 with a potentiometer linked to a new Munro gauge (channel 1 back-up) and a pneumatic bubbler system with digiquartz transducer (channel 2).

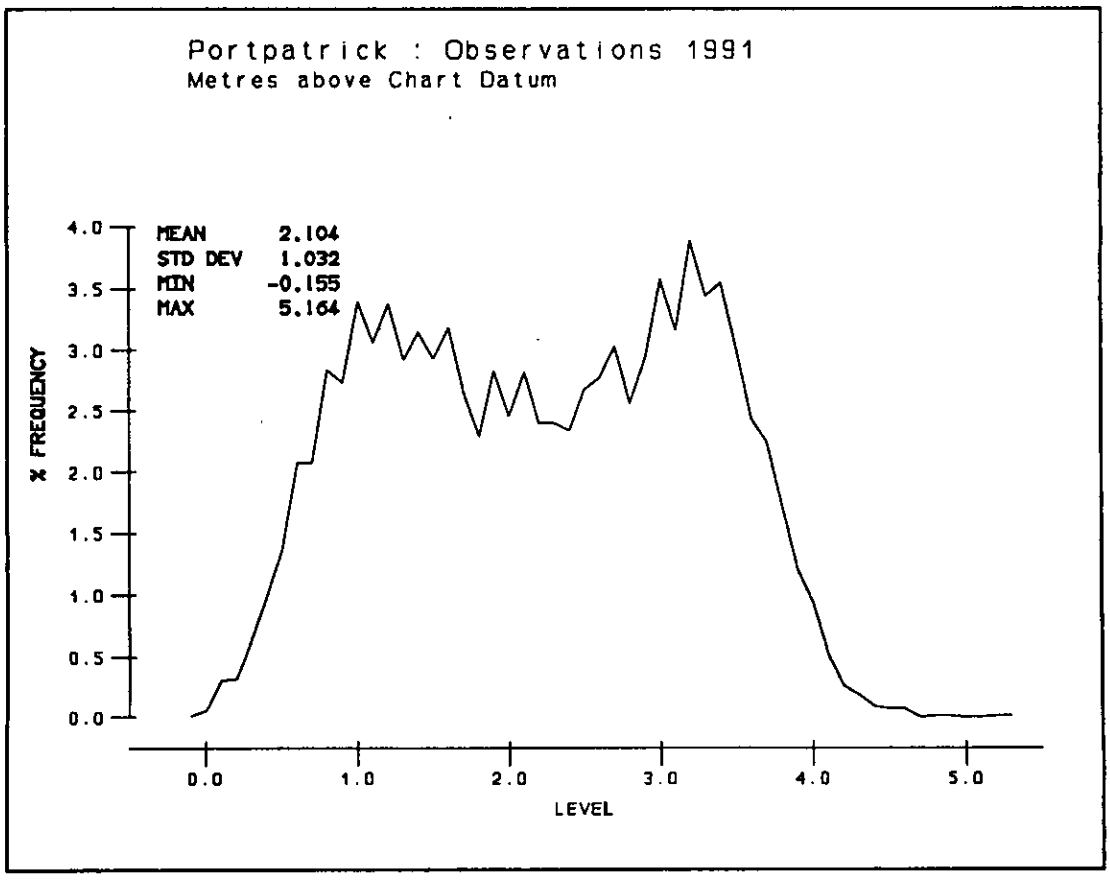
Both channels of data were processed for 1991 but detailed information is given for channel 2 only.

Isolated spurious and missing scans in the raw data from channel 2 were edited for the following dates in 1991:- 10,28 Jan; 12,22 Feb; 13,27 Mar; 11 Apr; 9,31 May; 19 Jun; 6,9,23,25 Jul; 7,21 Aug; 4,18(2) Sep; 3,15,25 Oct; 6,11,22,26 Nov; 5,18,31 Dec.

Scans integrated at 1 7/8 minute during visit by TGI 9 June were edited to 15 minute interval.

Gaps in final processed hourly levels from channel 2

22hrs. 20 May -	20hrs. 3 June	Faulty pressure transducer.



Harmonic Tidal Analysis.

Port: Scotland, West Coast - Portpatrick

Latitude: 54 50' 32.7" N
Longitude: 5 07' 08.0" W

Time Zone: GMT

Length: 350 Days

From: 1st January, 1991 To: 31st December, 1991

Units: Metres A0: 2.102

Hourly data from digiquartz sensor

Datum of Observations = ACD : 1.80 Metres below Ordnance Datum (Newlyn)

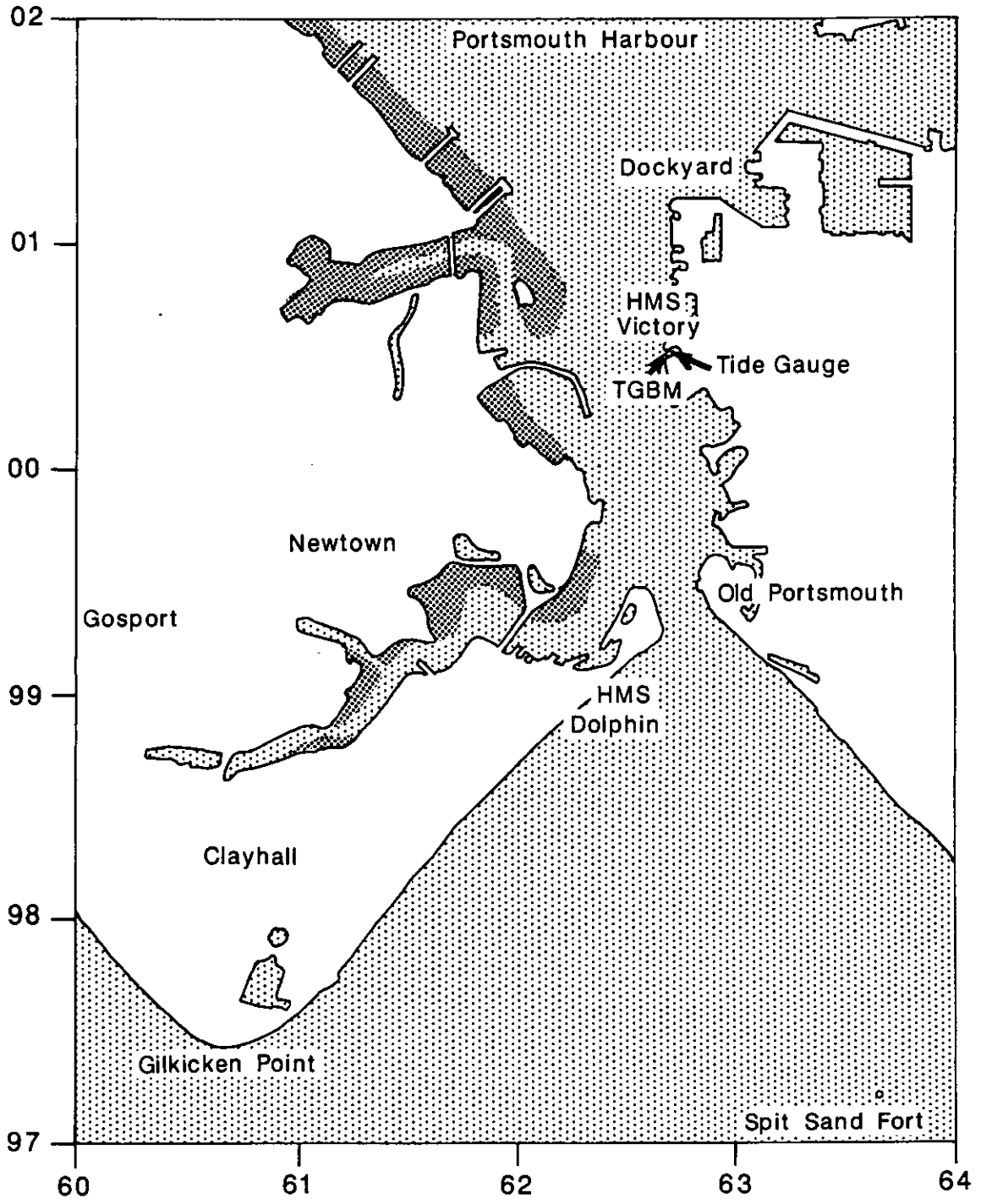
Observation Mean =	0.2105D+01	Residual Mean =	0.6357D-06
Std Dev =	0.1030D+01	Std Dev =	0.2034D+00

Constituent	h	g
Q1	0.027	346.31
O1	0.102	43.31
P1	0.036	178.07
K1	0.103	191.44
J1	0.001	77.64
2N2	0.049	297.53
N2	0.252	305.83
M2	1.341	332.51
S2	0.377	17.42
K2	0.112	15.18
M3	0.021	104.33
M4	0.004	17.39
MS4	0.009	81.81
M6	0.004	223.39

Portsmouth

Latitude 50 deg 48' 1.3"N Longitude 01 deg 06' 37.1"W
National Grid Reference SU 6269 0053

Recording zero = Chart Datum = 2.73m below Ordnance Datum Newlyn
Recording zero = 6.007m below Tide Gauge Bench Mark



Bench Mark	NG co-ords	Description
TGBM	SU 6269 0053	Bolt on concrete jetty by tide gauge building S angle.
Aux1	SZ 6330 9996	Gate Post N of side entrance to H.M.S.Vernon.

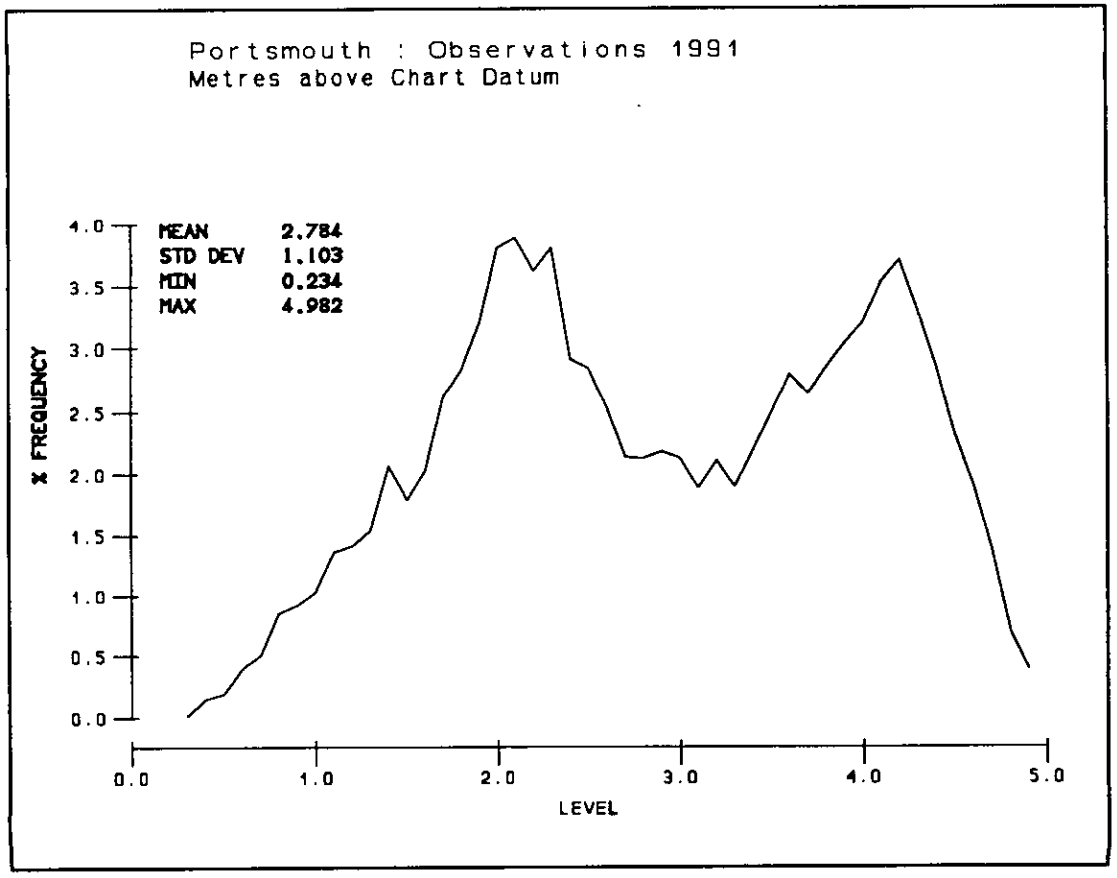
The tide gauge building housing a Lea gauge recorder with stilling well was completely refurbished to accommodate two pneumatic bubbler systems for Dataring in December 1990. It was fully operational by **29 January 1991**. Unfortunately a modem fault developed in early December and no further values were obtained for the year.

Isolated and missing scans in the raw values from channel 2 were edited for the following dates in the interim period :- 19 Feb; 27 Jul; 11,21(4),28 Aug; 4,10 Sep; 22 Nov.

Gaps in filtered hourly levels from channel 2

(Records begin 1600 GMT 29 January)

0400 GMT 8 December to end of year.	Modem fault.



Harmonic Tidal Analysis.

Port: England, South Coast - Portsmouth

Latitude: 50 48' 01.3" N
Longitude: 1 06' 37.1" W

Time Zone: GMT

Length: 177 Days

From: 30th January, 1991 To: 25th July, 1991

Units: Metres A0: 2.748

Hourly data from digiquartz sensor 2

Datum of Observations = ACD : 2.73 Metres below Ordnance Datum (Newlyn)

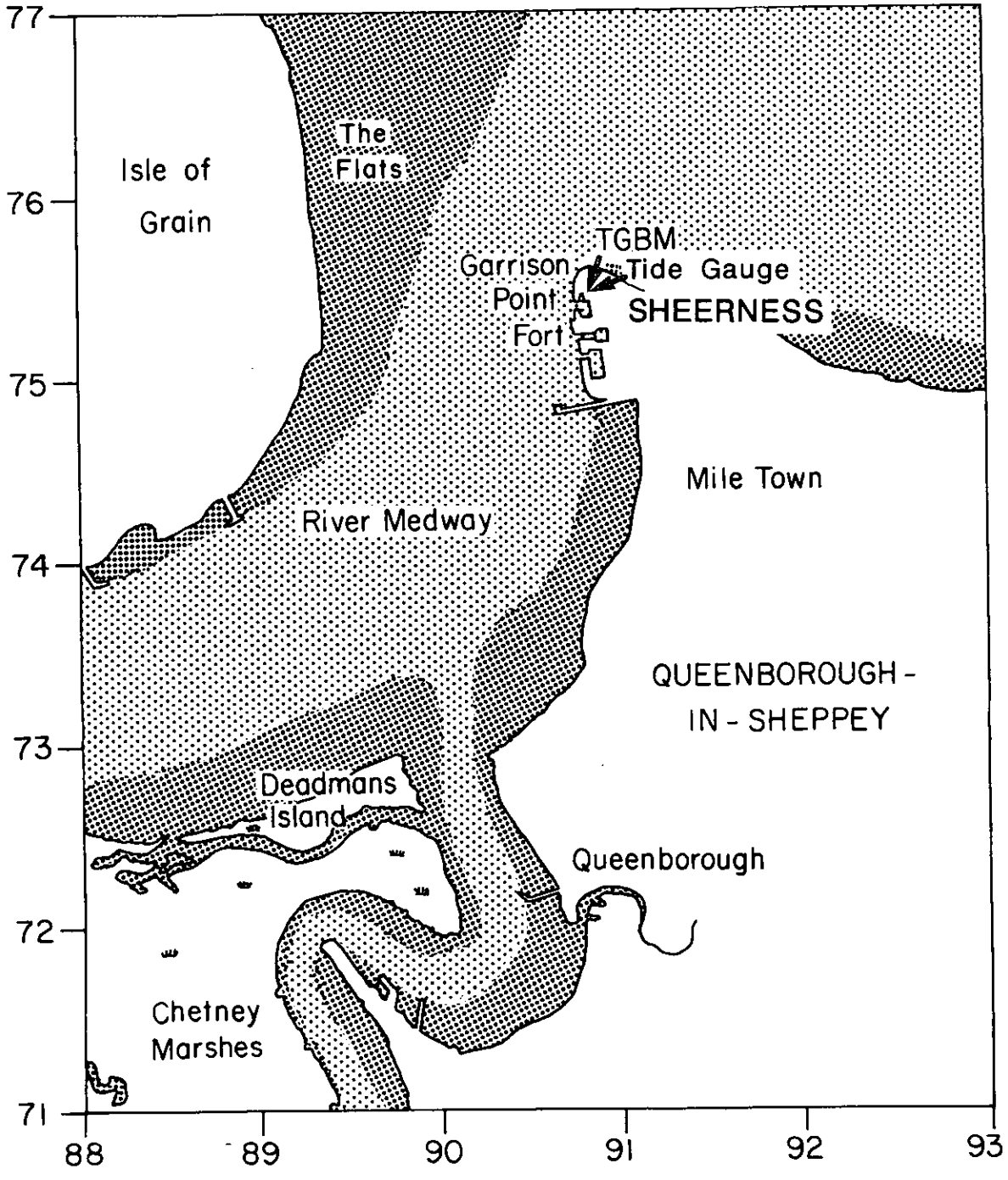
Observation Mean =	0.2745D+01	Residual Mean =	-0.2346D-05
Std Dev =	0.1099D+01	Std Dev =	0.1265D+00

Constituent	h	g
Q1	0.005	42.98
O1	0.029	345.18
P1	0.030	114.52
K1	0.091	106.61
J1	0.004	175.05
2N2	0.051	281.30
N2	0.275	303.68
M2	1.423	326.64
S2	0.439	12.70
K2	0.127	10.50
M3	0.005	139.34
M4	0.202	13.43
MS4	0.132	72.91
M6	0.113	147.22

Sheerness

Latitude 51 deg 26' 42.4"N Longitude 00 deg 44' 41.9"E
National Grid Reference TQ 9073 7542

Recording zero = Chart Datum = 2.9m below Ordnance Datum Newlyn
Recording zero = 7.532m below Tide Gauge Bench Mark



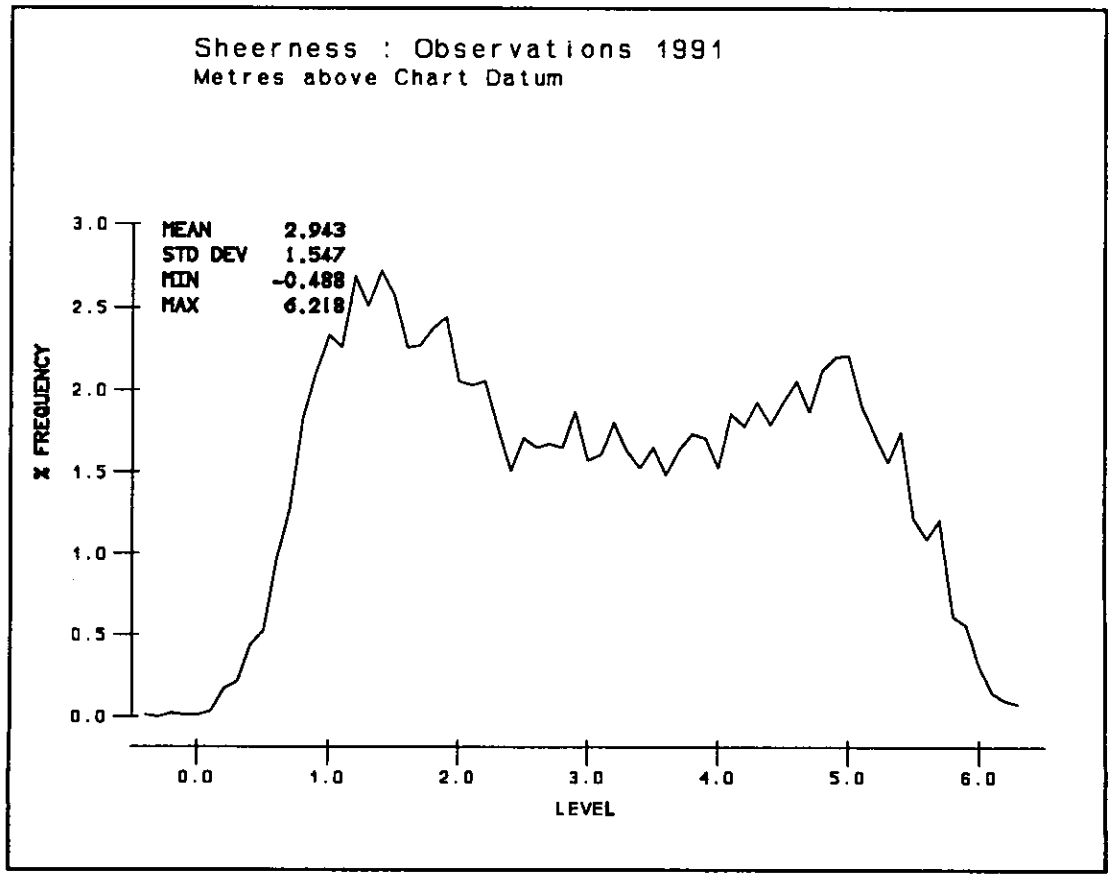
Bench Mark	NG co-ords	Description
TGBM	TQ 9080 7549	Flush Bracket 11859 Garrison Point Fort E. junction of flood gate.
Aux1	TQ 9133 7523	Flush Bracket G4790 Dockyard Cottages.

This site was modernised to accommodate Dataring in 1986 with two digiquartz transducers linked to pneumatic bubbler systems.

Isolated spurious and missing scans in the raw data from channel 2 were edited for the following dates in 1991: 14 Jan; 1,13 Feb; 13,19 Mar; 18 Apr; 31 May; 10 Jun; 10,18 Jul; 22 Aug; 16,25 Sep; 5,19 Dec.

Scans integrated at 1 7/8 minute interval over the TGI visit of 16 October were edited to 15 minute interval before filtering to hourly levels.

Ultimately there were **no gaps** in the filtered hourly levels from channel 2.



Harmonic Tidal Analysis.

Port: England, East Coast - Sheerness

Latitude: 51 26' 42.4" N
Longitude: 0 44' 41.9" E

Time Zone: GMT

Length: 365 Days

From: 1st January, 1991 To: 31st December, 1991

Units: Metres A0: 2.944

Hourly data from digiquartz sensor 2

Datum of Observations = ACD : 2.90 Metres below Ordnance Datum (Newlyn)

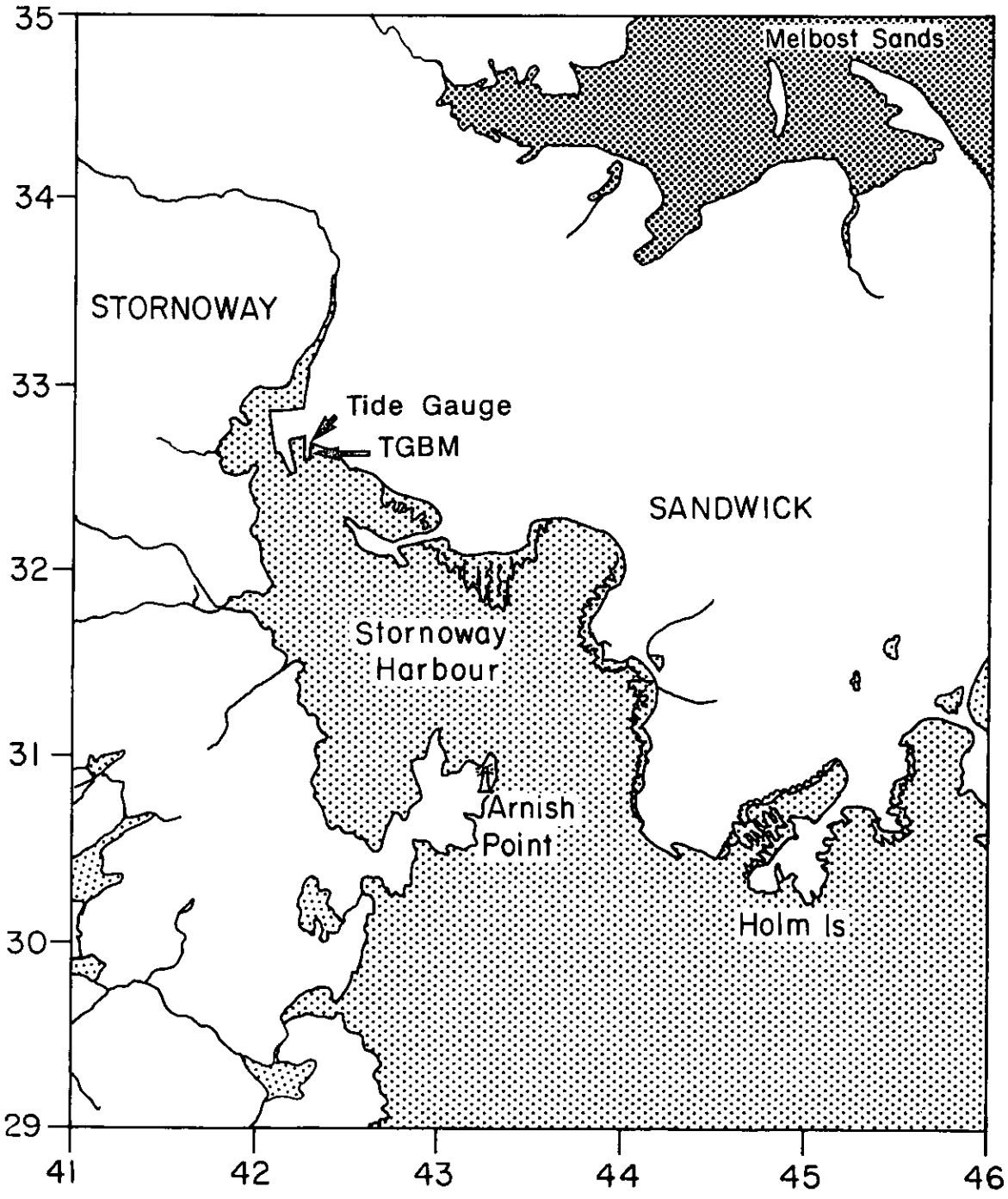
Observation Mean =	0.2944D+01	Residual Mean =	0.8961D-06
Std Dev =	0.1548D+01	Std Dev =	0.2251D+00

Constituent	h	g
Q1	0.042	124.17
O1	0.133	188.38
P1	0.034	337.84
K1	0.107	10.50
J1	0.010	27.57
2N2	0.093	309.91
N2	0.335	330.71
M2	2.036	354.43
S2	0.584	51.33
K2	0.173	52.73
M3	0.010	66.52
M4	0.113	12.16
MS4	0.048	85.75
M6	0.053	38.27

Stornoway

Latitude 58 deg 12' 28.6"N Longitude 06 deg 23' 17.5"W
National Grid Reference NB 4226 3271

Recording zero = Chart Datum = 2.71m below Ordnance Datum Local
Recording zero = 6.368m below Tide Gauge Bench Mark



Bench Mark	NG co-ords	Description
TGBM	NB 4228 3264	OSBM Bolt E. side No.2 Wharf.
Aux1	NB 4215 3271	OSBM Bolt on steps NE angle King Edward Wharf.

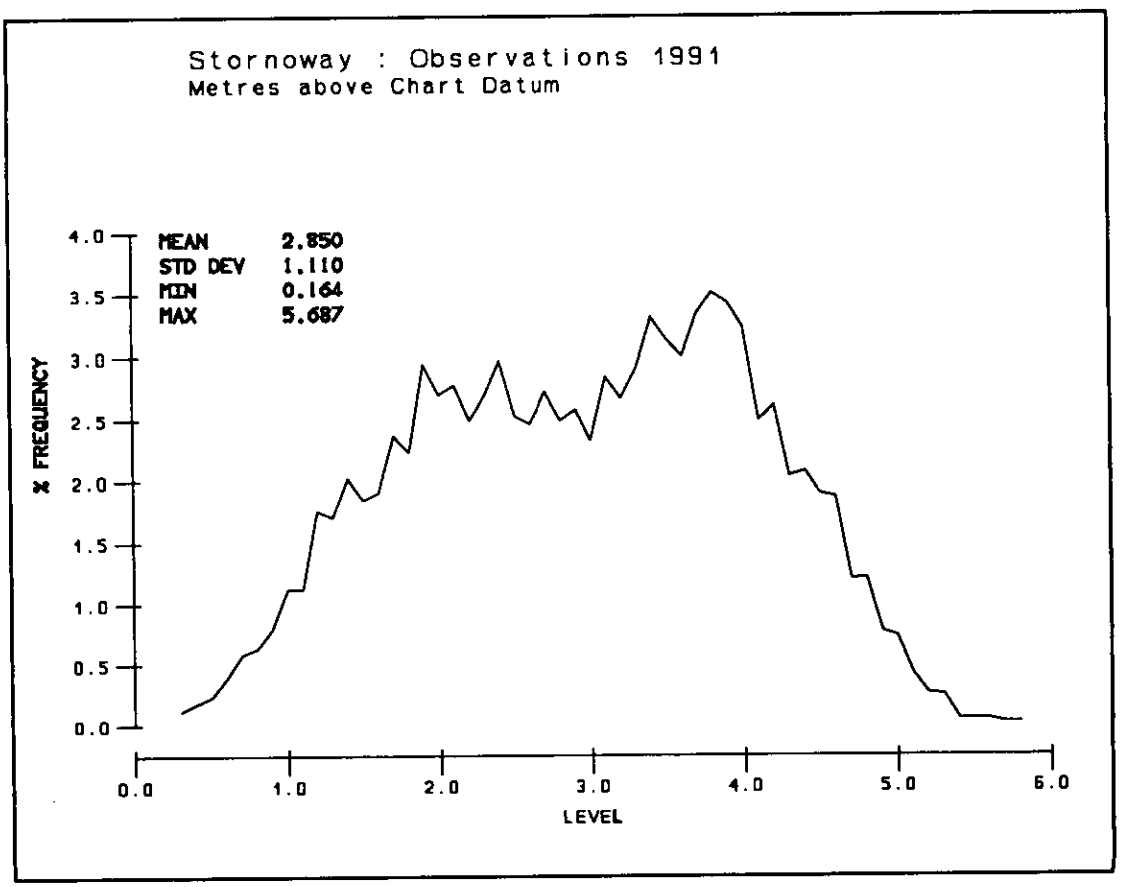
Hourly levels were filtered from the channel 2 digiquartz transducer linked to a pneumatic bubbler system.

Isolated spurious and missing values in the raw data were edited for the following dates in 1991: 9 Jan; 7, 12 Feb; 18, 23 Apr; 29 (3) Jun; 10 Nov; 12 Dec.

Scans integrated at 1 7/8 minute during TGI visit of 12-13 June were edited to 15 minute interval before filtering. Both channels were recalibrated on this visit.

Gaps in filtered hourly levels from channel 2

0200 GMT 3 April -	2000 GMT 13 May	Compressor switched off in error.
1200 GMT 12 June -	1100 GMT 13 June	TGI visit.



Harmonic Tidal Analysis.

Port: Scotland, West Coast - Stornoway

Latitude: 58 12' 28.6" N
Longitude: 6 23' 17.5" W

Time Zone: GMT

Length: 353 Days

From: 1st January, 1991 To: 31st January, 1992

Units: Metres A0: 2.831

Hourly data from digiquartz sensor

Datum of Observations = ACD : 2.71 Metres below Ordnance Datum (Local)

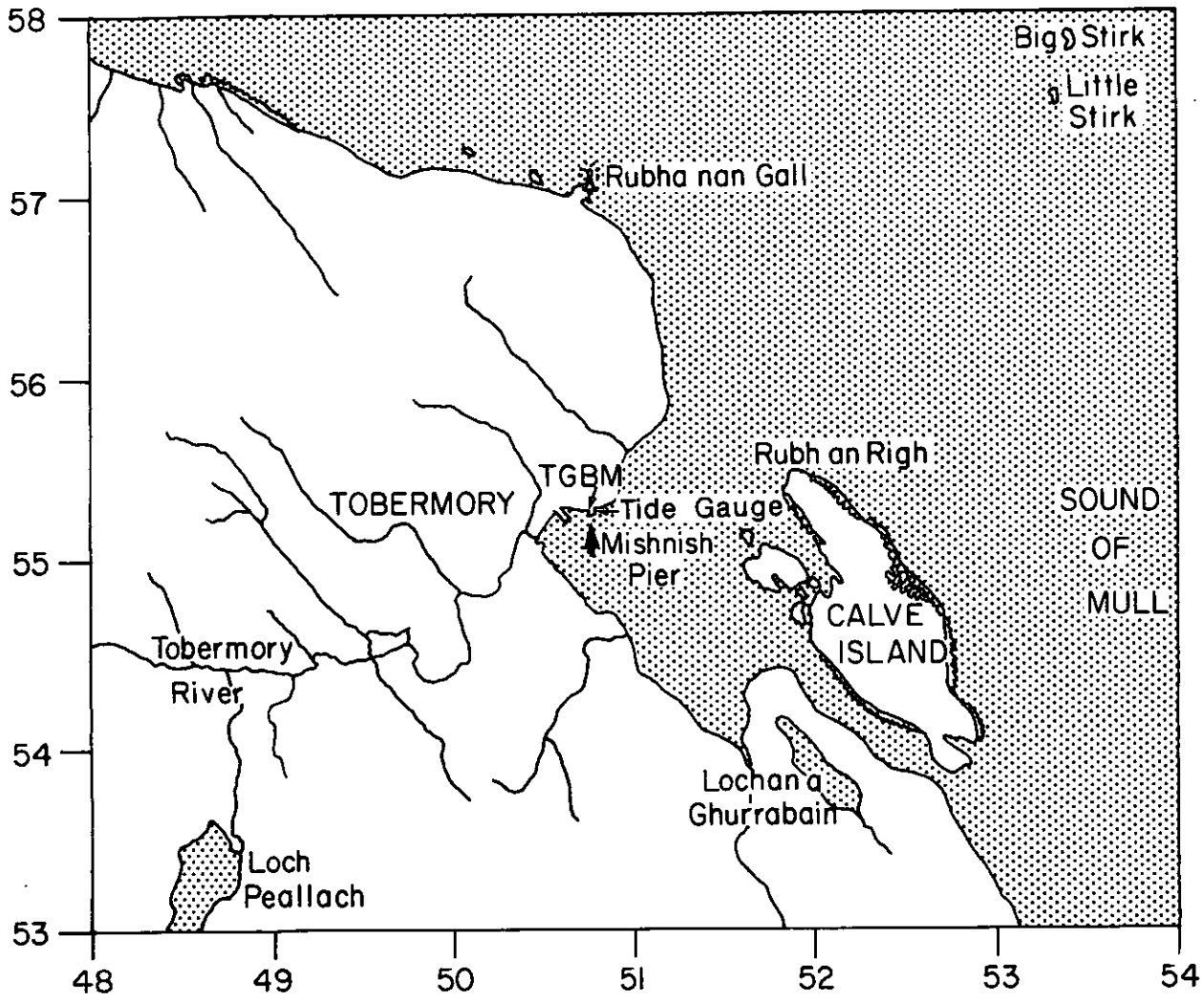
Observation Mean =	0.2850D+01	Residual Mean =	0.5864D-06
Std Dev =	0.1106D+01	Std Dev =	0.1817D+00

Constituent	h	g
Q1	0.029	298.31
O1	0.092	348.44
P1	0.037	123.33
K1	0.128	135.60
J1	0.010	157.82
2N2	0.034	159.64
N2	0.276	176.38
M2	1.390	197.86
S2	0.547	231.58
K2	0.156	228.93
M3	0.031	118.27
M4	0.061	221.29
MS4	0.073	295.73
M6	0.007	188.44

Tobermory

Latitude 56 deg 37' 23.3"N Longitude 06 deg 03' 46.1W
National Grid reference NM 5081 5529

Recording zero = Chart Datum = 2.39m below Ordnance Datum Newlyn
Recording zero = 6.856m below Tide Gauge Bench Mark



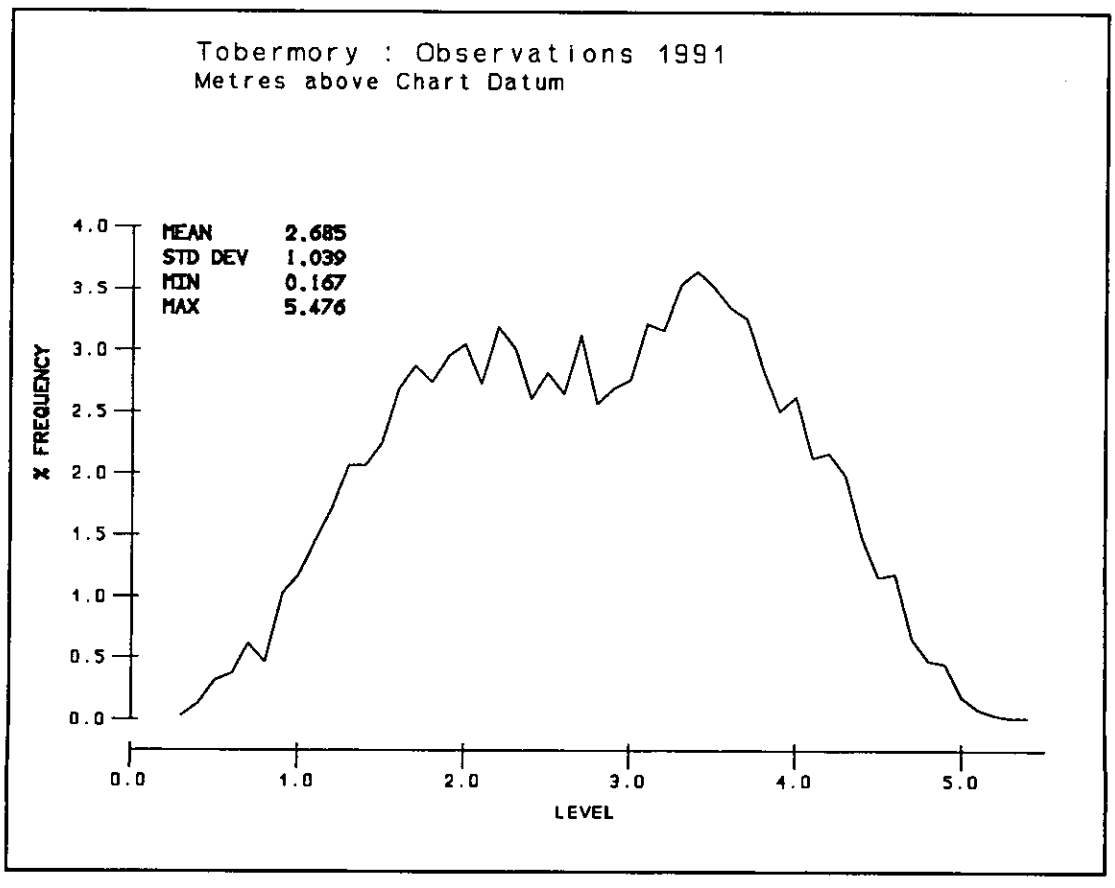
Bench Mark	NG co-ords	Description
TGBM	NM 5069 5530	Flush Bracket G5186 SW angle Royal Buildings.
Aux2	NM 5077 5529	NBM Rivet on sea wall Mishnish Pier.

Hourly levels were filtered from the channel 2 digiquartz transducer linked to a pneumatic bubbler system.

Isolated spurious and missing scans in the raw data from channel 2 were edited for the following dates in 1991 : 17 Jan; 15,19 Feb; 1,30(2) Apr; 28 Jul; 7,12,20 Aug; 25 Sep; 10 Oct; 17,23 Dec.

Scans integrated at 1 7/8 minute interval during the TGI visit of 11 June were edited to 15 minute interval before filtering. Both channels were recalibrated on this visit.

Ultimately there were **no gaps** in the filtered hourly levels for 1991.



Harmonic Tidal Analysis.

Port: Scotland, West Coast - Tobermory

Latitude: 56 37' 23.3" N
Longitude: 6 03' 46.1" W

Time Zone: GMT

Length: 365 Days

From: 1st January, 1991 To: 31st December, 1991

Units: Metres A0: 2.687

Hourly data from digiquartz sensor 2

Datum of Observations = ACD : 2.39 Metres below Ordnance Datum (Newlyn)

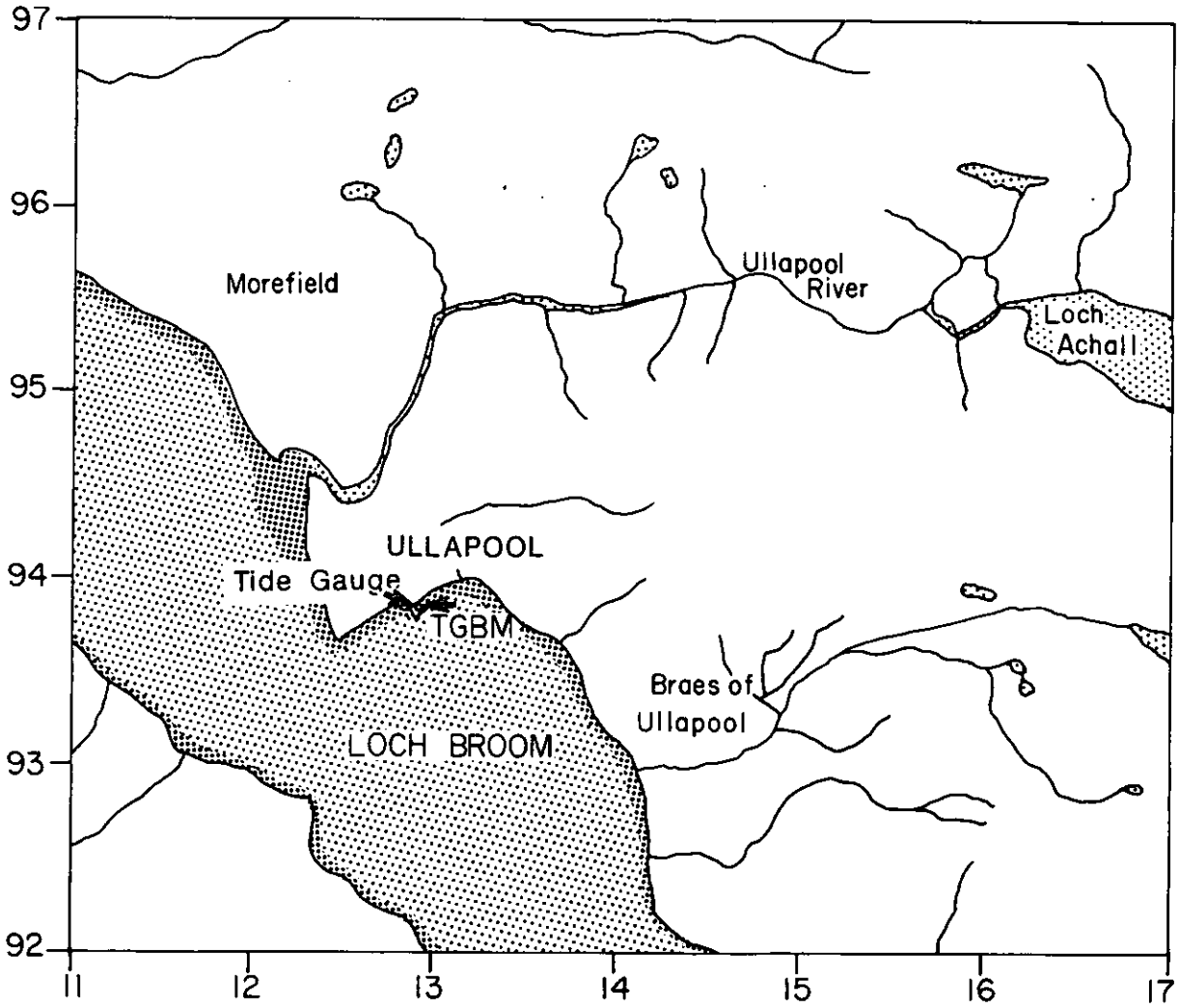
Observation Mean =	0.2686D+01	Residual Mean =	0.3816D-06
Std Dev =	0.1037D+01	Std Dev =	0.1999D+00

Constituent	h	g
Q1	0.024	325.27
O1	0.061	23.23
P1	0.018	153.50
K1	0.059	168.01
J1	0.003	156.71
2N2	0.032	126.20
N2	0.259	148.45
M2	1.299	168.59
S2	0.530	204.96
K2	0.152	201.95
M3	0.040	112.88
M4	0.045	182.51
MS4	0.037	288.52
M6	0.013	9.98

Ullapool .

Latitude 57 deg 53' 44.0"N Longitude 05 deg 09' 26.9"W
National Grid Reference NH 1288 9391

Recording zero = Chart Datum = 2.75m below Ordnance Datum Newlyn
Recording zero = 7.155m below Tide Gauge Bench Mark



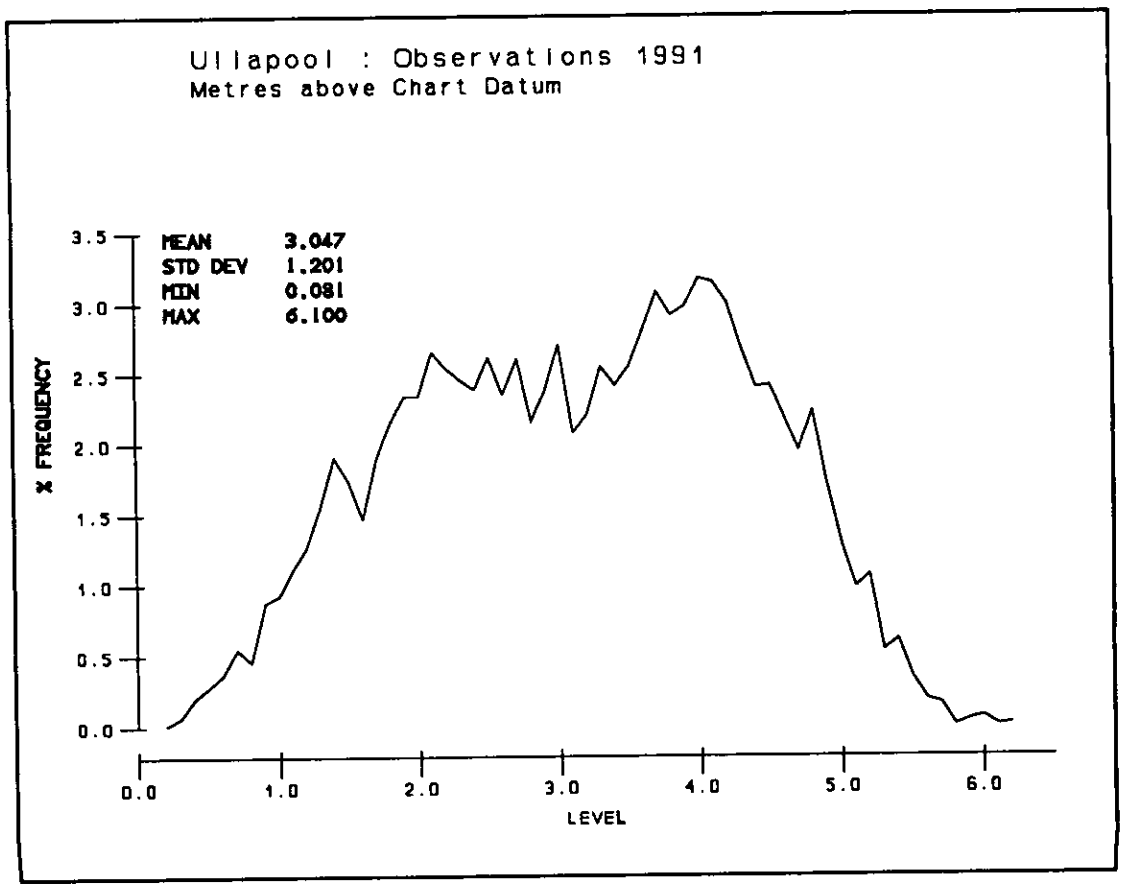
Bench Mark	NG co-ords	Description
TGBM	NH 1288 9391	OSBM on pier NW parapet 8.2m NE of steps.
Aux1	NH 1303 9425	PA Bolt on church SW side of road NE face N. angle.

This site was originally modernised to accommodate Dataring in May 1987 with a potentiometer attached to the Munro gauge (channel 1 back-up)and a digiquartz transducer linked to a pressure outlet (channel 2).

Interpolated values in the raw series for channel 2 in 1991 were on the following dates : 27 Feb; 10 May; 26 Sep; 6 Nov.
Scans integrated at 1 7/8 minute during the TGI visit of 14 June were edited to 15 minute interval. Both digiquartz channels were recalibrated during this visit. They also visited the site on 4 June to fit a new modem and change the compressor. Unfortunately, the mains cable and telephone line were cut during harbour works in June but were both quickly repaired.

Gaps in hourly filtered levels from channel 2

0100 GMT 5 March -	1600 GMT 18 March	System locked up.
0000 GMT 21 May -	2000 GMT 4 June	Modem fault.
0100 GMT 18 June -	2300 GMT 23 June	Mains power line and phone line cut.
0000 GMT 6 August -	2000 GMT 6 August	Modem fault.
0100 GMT 23 December -	0800 GMT 31 December	Modem fault.



Harmonic Tidal Analysis.

Port: Scotland, West Coast - Ullapool

Latitude: 57 53' 44.0" N
Longitude: 5 09' 26.9" W

Time Zone: GMT

Length: 351 Days

From: 1st January, 1991 To: 31st January, 1992

Units: Metres A0: 3.036

Hourly data from digiquartz sensor

Datum of Observations = ACD : 2.75 Metres below Ordnance Datum (Newlyn)

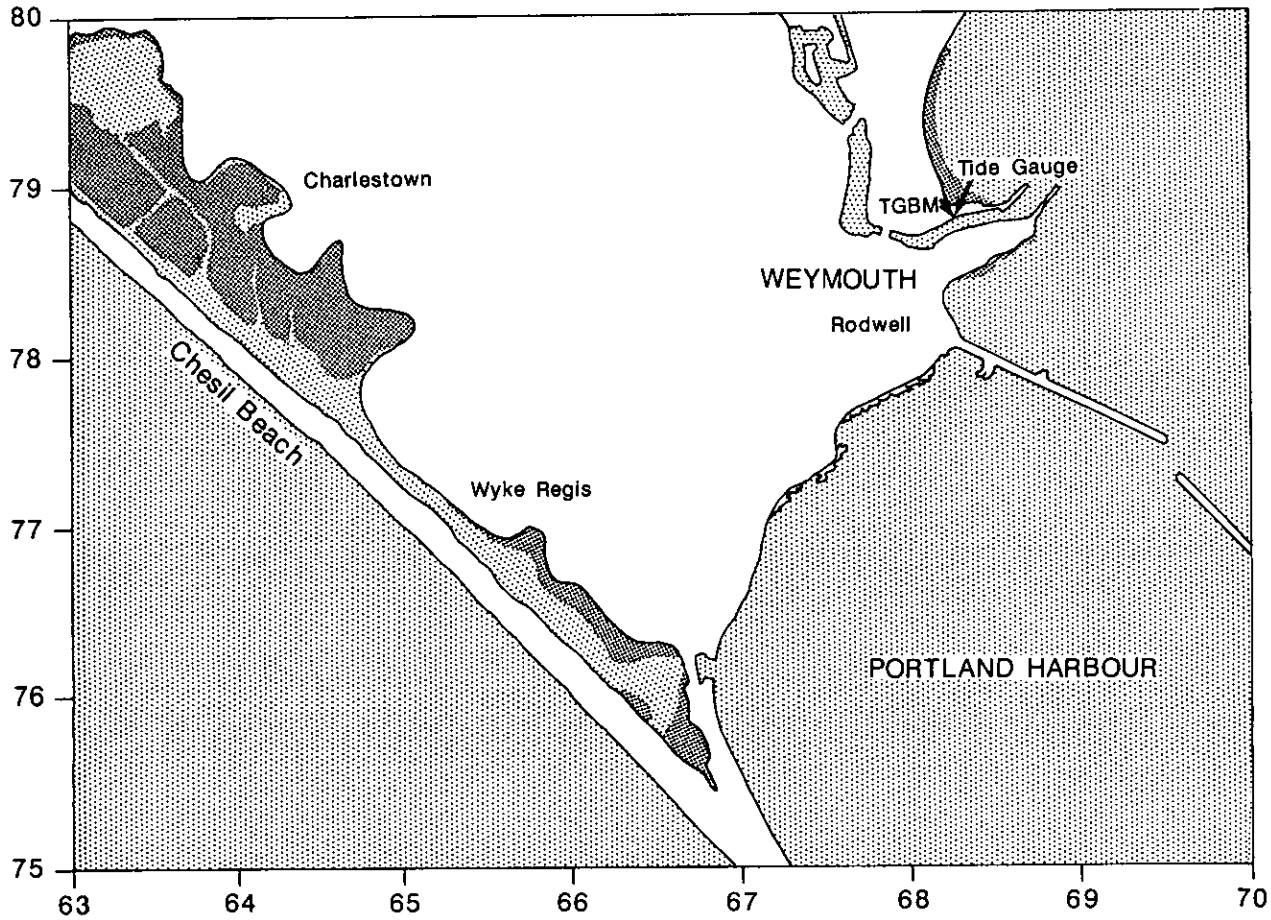
Observation Mean =	0.3049D+01	Residual Mean =	0.3359D-06
Std Dev =	0.1198D+01	Std Dev =	0.2008D+00

Constituent	h	g
Q1	0.026	302.83
O1	0.075	344.17
P1	0.031	116.93
K1	0.107	127.01
J1	0.009	146.38
2N2	0.037	164.32
N2	0.298	179.00
M2	1.503	200.86
S2	0.585	235.23
K2	0.169	232.58
M3	0.032	125.48
M4	0.066	231.00
MS4	0.077	303.81
M6	0.007	197.18

Weymouth

Latitude 50 deg 36' 27.8"N Longitude 02 deg 26' 55.0"W
National Grid Reference SY 6826 7883

Recording zero = Chart Datum = 1.02m below Ordnance Datum Newlyn
Recording zero = 4.334m below Tide Gauge Bench Mark

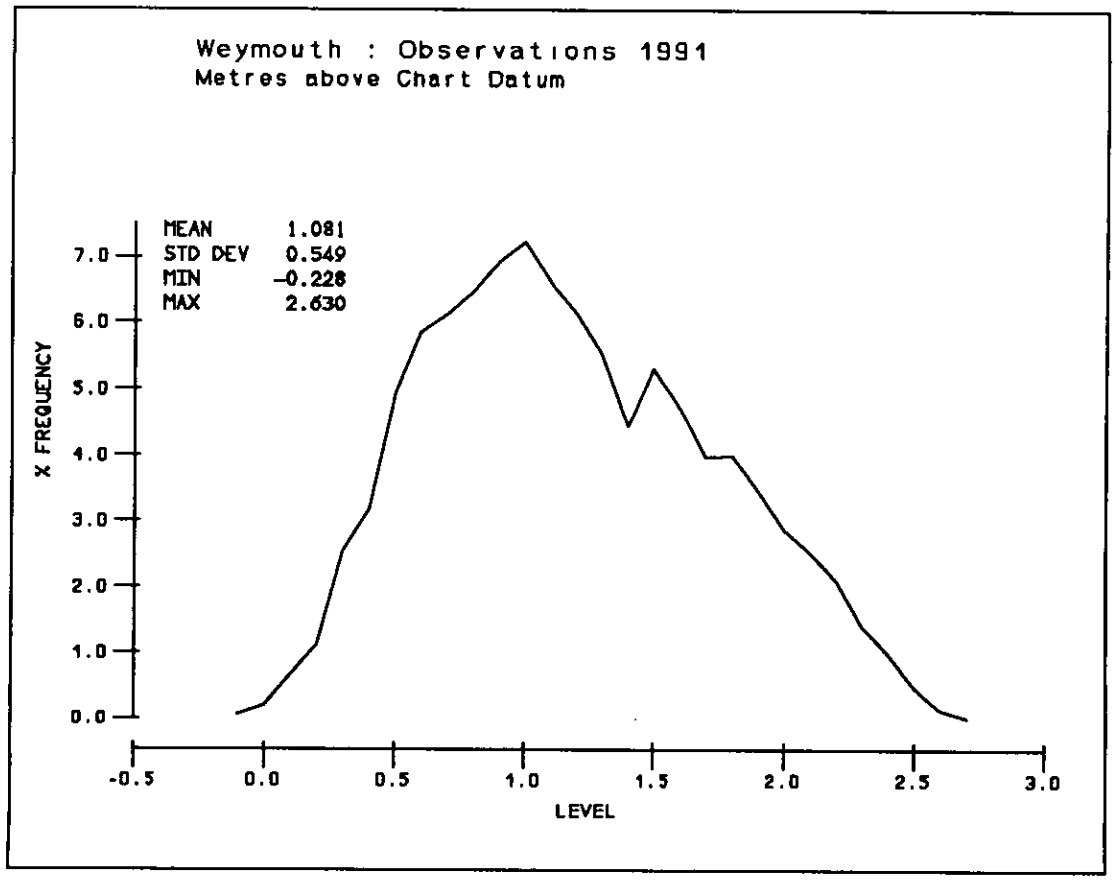


Bench Mark	NG co-ords	Description
TGBM	SY 6826 7882	Bolt on corner of quay wall NW side N angle.
Aux1	SY 6822 7886	Bolt on sea wall 5.5m W of steps.

This new site on the Class-A network, to replace the now dismantled Portland installation, was furnished with two pressure point outlets with digiquartz transducers and operational from **30 January 1991.**

Isolated missing and spurious values were edited for the following dates : 31(3) Jan; 2, 5, 12, 15, 16, 17, 18, 21, 22 Feb; 1, 6, 11, 22, 25, 26 Mar; 2, 10, 19, 28, 29(2) Apr; 2, 9, 13, 19, 21, 22, 23, 26, 27, 29(2), 30 May; 1, 2, 8, 9, 10, 12, 16, 17, 28(2) Jun; 2, 3, 6, 7, 10(2), 14, 16, 18, 19, 21, 22 Jul; 1(2), 5(3), 10, 13(3), 15(3), 16, 17, 19(2), 20, 21, 22, 23(2), 24(2), 25, 26, 27(3) Aug; 3, 4, 6, 10, 11, 15, 19, 26, 30 Sep; 6, 7, 8(2), 14, 15, 20, 25, 26, 31 Oct; 10, 11, 16, 18, 19, 22, 24, 26, 28(2), 29 Nov; 4(5), 10, 11, 12, 12, 15, 18, 20(4), 24 Dec.
In addition to all these there were many occasions through the year where spikes appeared in both channels of data which were also edited before the filtering process. These may have been caused by shipping close to the pressure point outlets.

Scans integrated at 1 7/8 minute interval during TGI visit of 14th March were edited to 15 minute interval. On this visit the clock and start-up boards were replaced creating a gap in the readings from 1630 to 1800 which were interpolated before filtering to hourly levels. Ultimately there were **no gaps** in data processed from the designated class-a channel 2 series for the year.



Harmonic Tidal Analysis.

Port: England, South Coast - Weymouth

Latitude: 50 36' 27.8" N
Longitude: 2 26' 55.0" W

Time Zone: GMT

Length: 366 Days

From: 31st January, 1991 To: 31st January, 1992

Units: Metres A0: 1.075

Hourly data from digiquartz sensor 2

Datum of Observations = ACD : 1.02 Metres below Ordnance Datum (Newlyn)

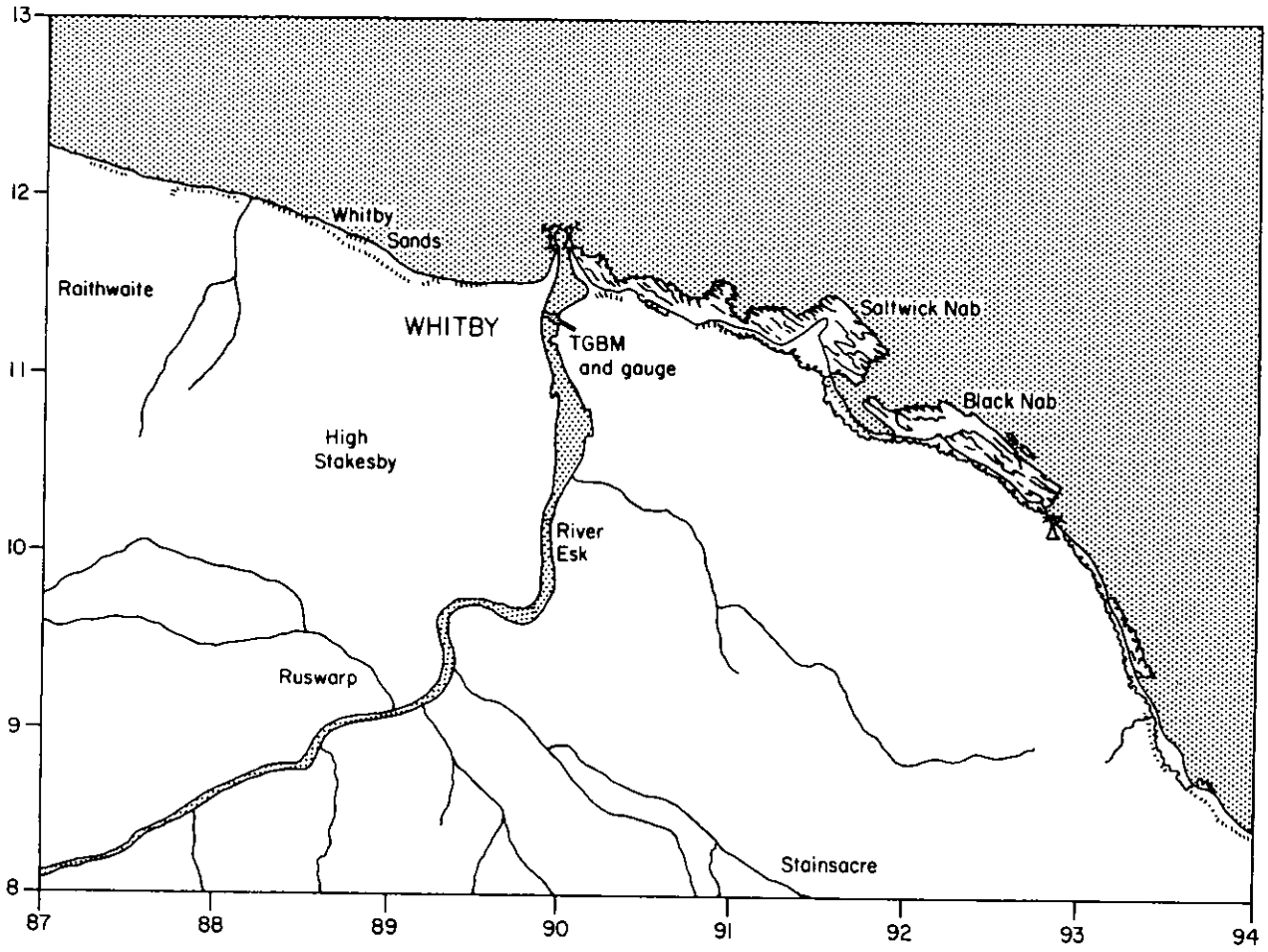
Observation Mean =	0.1075D+01	Residual Mean =	0.4587D-06
Std Dev =	0.5480D+00	Std Dev =	0.1195D+00

Constituent	h	g
Q1	0.007	333.89
O1	0.048	349.93
P1	0.033	107.60
K1	0.089	109.88
J1	0.005	137.25
2N2	0.025	108.07
N2	0.135	185.19
M2	0.605	191.00
S2	0.316	242.51
K2	0.090	237.44
M3	0.012	177.30
M4	0.149	26.00
MS4	0.091	82.52
M6	0.062	64.15

Whitby

Latitude 54 deg 29' 23.7"N Longitude 00 deg 36' 45.4"W
National Grid Reference NZ 8986 1141

Recording zero = Chart Datum = 3.00m below Ordnance Datum Newlyn
Recording zero = 9.107m below Tide Gauge Bench Mark



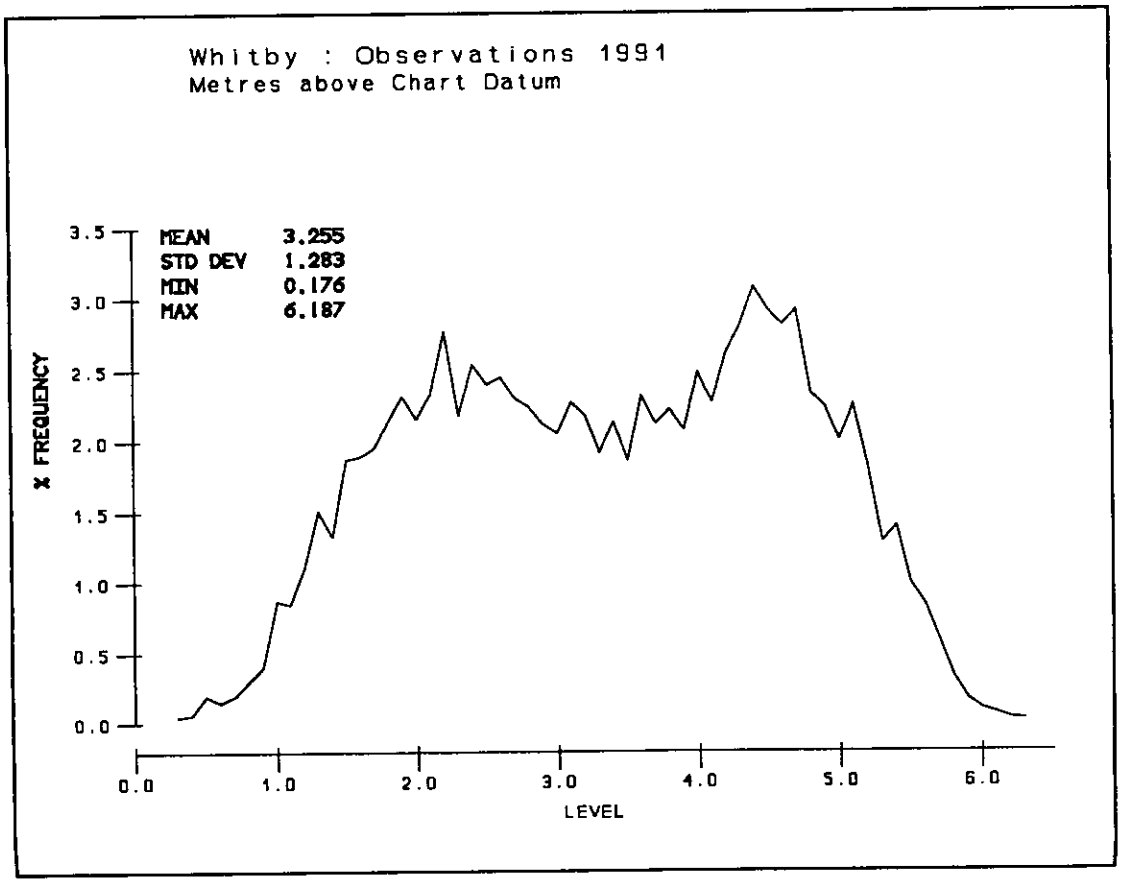
Bench Mark	NG co-ords	Description
TGBM	NZ 8986 1141	East side of Pier Road.
Aux1	NZ 8992 1105	Bolt on buttress of Whitby Bridge.
Aux2	NZ 8985 1134	Rivet on quayside SE side of Pier Road.

This site was originally furnished with an Aanderaa pressure gauge in 1980. It was upgraded to Dataring in April 1989 with a further pneumatic bubbler system installed.

Isolated missing and spurious scans in the raw data series from channel 2 were edited for the following dates in 1991 : 15,24 Feb; 11 Mar; 26 May; 5,10 Jun; 2 Jul; 16,22 Aug; 23 Sep; 22 Nov; 7 Dec.
Scans integrated at 1 7/8 minute during the TGI visits of 16 July and 8 October were edited to 15 minute interval prior to filtering to hourly levels.

On their visit of 16 July both digiquartz channels were recalibrated. On their visit of 8 October a fault on channel one (back-up) was traced to a partially blocked pneumatic tube.

Ultimately, there were **no gaps** in the filtered hourly series for 1991.



Harmonic Tidal Analysis.

Port: England, East Coast - Whitby

Latitude: 54 29' 23.7" N
Longitude: 0 36' 45.4" W

Time Zone: GMT

Length: 365 Days

From: 1st January, 1991 To: 31st December, 1991

Units: Metres A0: 3.257

Hourly data from digiquartz sensor 2

Datum of Observations = ACD : 3.00 Metres below Ordnance Datum (Newlyn)

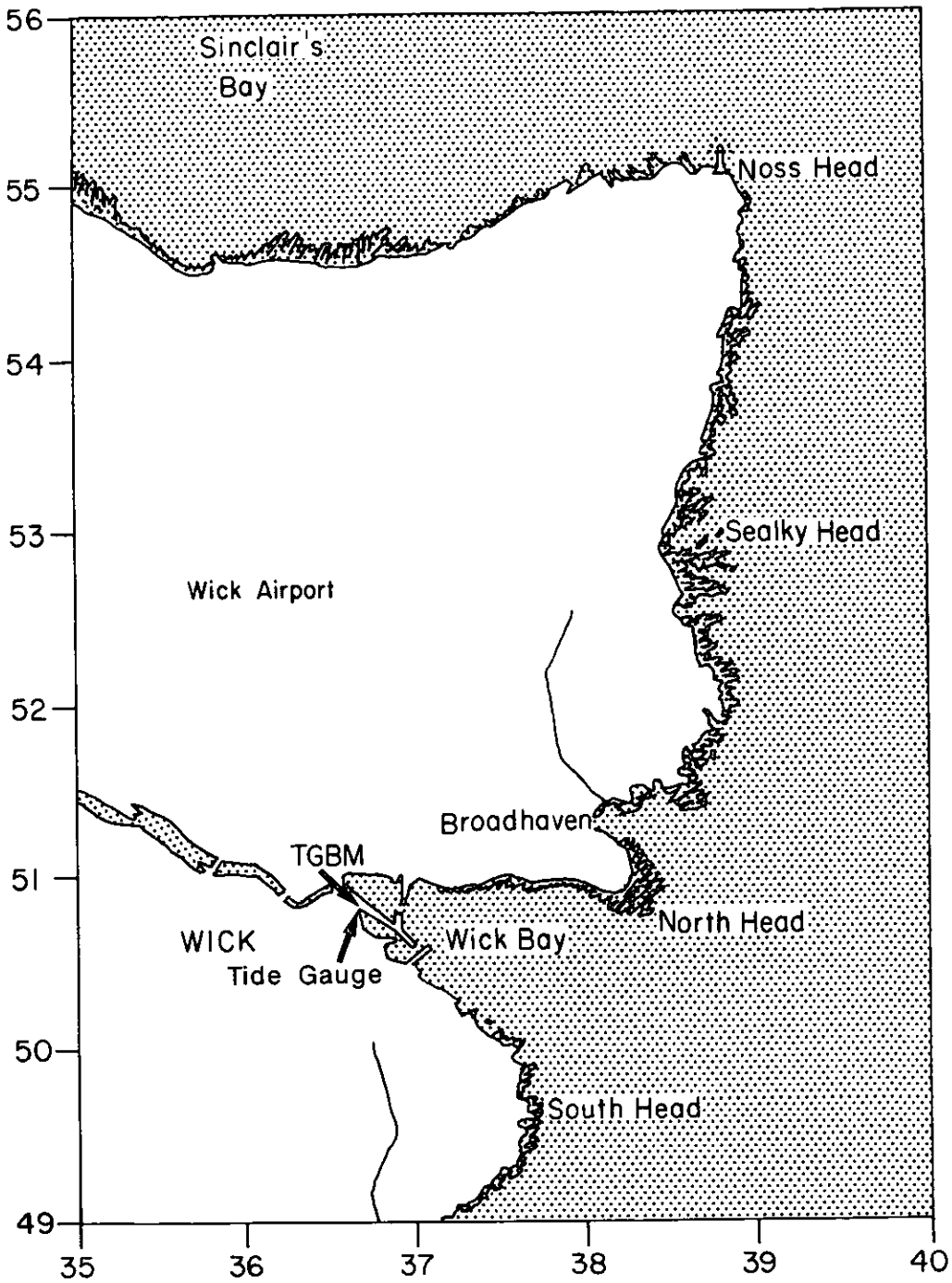
Observation Mean =	0.3256D+01	Residual Mean =	0.7184D-06
Std Dev =	0.1284D+01	Std Dev =	0.1750D+00

Constituent	h	g
Q1	0.044	33.45
O1	0.150	84.42
P1	0.035	229.74
K1	0.125	249.66
J1	0.014	271.57
2N2	0.052	66.59
N2	0.317	80.26
M2	1.664	104.22
S2	0.561	147.06
K2	0.161	144.59
M3	0.012	95.61
M4	0.029	72.87
MS4	0.033	100.02
M6	0.011	358.88

Wick

Latitude 58 deg 26' 28.5"N Longitude 03 deg 05' 5.7"W
National Grid reference ND 3667 5080

Recording zero = Chart Datum = 1.71m below Ordnance Datum Newlyn
Recording zero = 5.077m below Tide Gauge Bench Mark

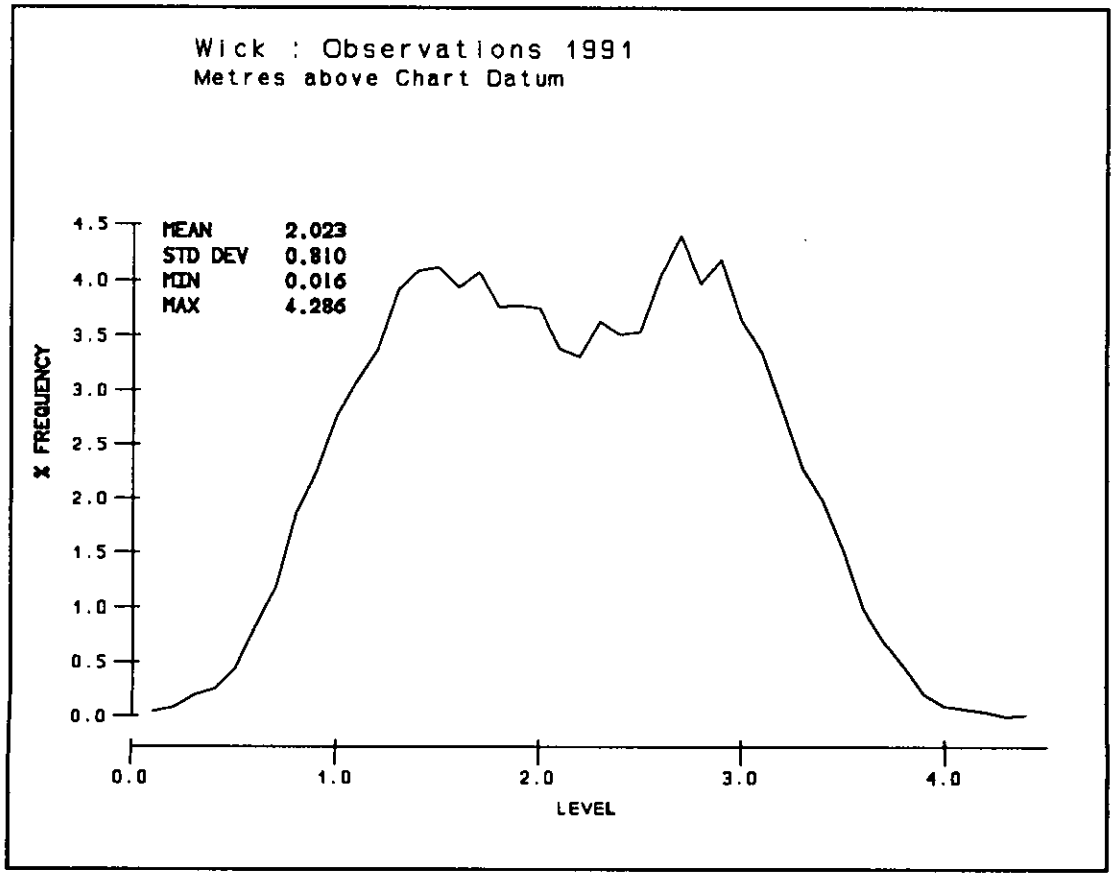


Bench Mark	NG co-ords	Description
TGBM	ND 3667 5081	OSBM Bolt in quay E angle of tide gauge building.
Aux1	ND 3670 5084	Rivet at base of wall 15.5m NE angle of building.

Hourly levels for 1991 were filtered from the channel 2 digiquartz.
Isolated spurious and missing scans in the raw data were edited for the following dates in 1991 : 27 Apr; 25, 27 May; 26 Jun; 9, 26 Jul; 23 Sep; 8 Oct; 4 Dec.

Scans integrated at 1 7/8 minute during the visit by TGI 20 November were edited to 15 minute interval before filtering to hourly levels.

Ultimately there were **no gaps** in the hourly series for 1991.



Harmonic Tidal Analysis.

Port: Scotland, East Coast - Wick

Latitude: 58 26' 28.5" N
Longitude: 3 05' 5.7" W

Time Zone: GMT

Length: 365 Days

From: 1st January, 1991 To: 31st December, 1991

Units: Metres A0: 2.025

Hourly data from digiquartz sensor

Datum of Observations = ACD : 1.71 Metres below Ordnance Datum (Newlyn)

Observation Mean =	0.2025D+01	Residual Mean =	0.5302D-06
Std Dev =	0.8079D+00	Std Dev =	0.1781D+00

Constituent	h	g
Q1	0.033	339.15
O1	0.117	25.41
P1	0.032	161.98
K1	0.108	175.11
J1	0.008	197.99
2N2	0.033	287.81
N2	0.199	302.41
M2	1.017	322.50
S2	0.350	0.49
K2	0.099	357.88
M3	0.013	240.32
M4	0.038	319.11
MS4	0.021	56.12
M6	0.006	228.62

3. Analysed data statistics

3.1 Extreme Level Statistics

Levels for the year are presented as values referenced to Chart Datum for each site in alphabetical order. Where long series exist some indication of the relative magnitude is indicated. It must be noted these comparisons are with hourly levels only. Records of turning points extracted over the years show levels of the order of centimetres higher. Two storms dominate the extreme levels recorded at a number of sites, that of 1/2 January and 23 December.

January 2

A deep depression centred between Hebrides and Iceland with strong south-westerly winds produced the highest level recorded at **Wick**, on the midday tide for 2 January, since records began in 1965. Observed levels were over 0.5m above predicted at this site from 0300GMT until 1800GMT. At 0800GMT, at **Ullapool,** the highest tide since 1979 was recorded and at **Stornoway** the lowest maximum since 1987. At many other sites further south, away from the strong winds, the lowest annual maximum since 1986 was recorded for the same date.

The A.M. tides at ports from **Cromer** south to **Dover** were the lowest annual minima recorded, with the level of 0.716m below Chart Datum at **Lowestoft** the lowest since 1982.

December 23

Elsewhere, gales on 23 December, although not of long term record proportions created annual maxima at **Aberdeen, Leith,North Shields,Liverpool** and **Barmouth** (limited length of record).

Aberdeen Extreme Levels to Chart Datum

Max	Hr	Mon	Day	Min	Hr	Mon	Day
5.006	14.	Jan	02	.024	20.	Jan	30
4.375	16.	Feb	19	**-.032**	21.	Feb	01
4.709	15.	Mar	19	.056	20.	Mar	01
4.423	03.	Apr	02	.228	19.	Apr	14
4.196	14.	May	15	.325	09.	May	17
4.567	14.	Jun	13	.401	09.	Jun	15
4.564	03.	Jul	14	.281	09.	Jul	14
4.674	02.	Aug	12	.200	09.	Aug	12
4.785	01.	Sep	25	.143	07.	Sep	08
4.666	01.	Oct	08	.472	08.	Oct	25
4.576	01.	Nov	07	.639	07.	Nov	06
5.032	02.	Dec	23	.059	22.	Dec	24

Avonmouth Extreme Levels to Chart Datum

Max	Hr	Mon	Day	Min	Hr	Mon	Day
14.293	20.	Jan	01	.486	15.	Jan	31
13.766	09.	Feb	01	.601	04.	Feb	02
13.856	08.	Mar	02	.632	03.	Mar	02
13.327	08.	Apr	16	**.431**	15.	Apr	16
13.193	20.	May	15	.723	03.	May	16
13.501	20.	Jun	13	1.091	03.	Jun	14
13.765	21.	Jul	14	.839	16.	Jul	14
14.028	21.	Aug	12	.663	15.	Aug	11
14.074	20.	Sep	09	.675	03.	Sep	10
13.671	07.	Oct	08	.906	02.	Oct	24
13.286	20.	Nov	23	1.149	02.	Nov	23
13.555	09.	Dec	24	.722	16.	Dec	24

Barmouth Extreme Levels to Chart Datum
(Records begin 10 October)

Max	Hr	Mon	Day	Min	Hr	Mon	Day
4.956	21.	Oct	25	.606	16.	Oct	24
5.357	10.	Nov	25	.655	02.	Nov	21
5.794	09.	Dec	23	**.476**	18.	Dec	24

Cromer Extreme Levels to Chart Datum

Max	Hr	Mon	Day	Min	Hr	Mon	Day
5.548	19.	Jan	02	**-.621**	02.	Jan	02
5.203	19.	Feb	15	-.070	01.	Feb	28
5.148	20.	Mar	19	-.254	03.	Mar	19
5.247	20.	Apr	16	.278	01.	Apr	15
5.049	19.	May	15	.369	16.	May	18
5.081	19.	Jun	13	.488	17.	Jun	17
5.347	08.	Jul	14	.288	16.	Jul	15
5.482	08.	Aug	12	.296	15.	Aug	12
5.583	07.	Sep	25	.216	14.	Sep	09
5.324	07.	Oct	09	.294	13.	Oct	07
5.342	05.	Nov	05	.392	03.	Nov	11
5.521	22.	Dec	26	.140	04.	Dec	25

Devonport Extreme Levels to Chart Datum
(Records begin 14 March)

Max	Hr	Mon	Day	Min	Hr	Mon	Day
5.825	06.	Mar	17	.422	12.	Mar	30
5.509	18.	Apr	29	.425	13.	Apr	16
5.393	19.	May	16	.455	01.	May	16
5.739	19.	Jun	14	.731	01.	Jun	14
5.807	19.	Jul	13	.569	01.	Jul	14
5.817	19.	Aug	11	**.336**	01.	Aug	12
5.857	08.	Sep	28	.467	00.	Sep	09
5.862	17.	Oct	07	.675	00.	Oct	24
5.788	08.	Nov	25	.785	00.	Nov	23
5.784	07.	Dec	23	.475	14.	Dec	24

Dover Extreme Levels to Chart Datum

Max	Hr	Mon	Day	Min	Hr	Mon	Day
7.439	00.	Jan	03	**.144**	07.	Jan	02
7.009	00.	Feb	16	.326	08.	Feb	01
6.921	01.	Mar	20	.224	08.	Mar	19
7.316	00.	Apr	17	.566	06.	Apr	15
6.894	00.	May	16	.610	07.	May	15
6.806	12.	Jun	14	.696	20.	Jun	14
7.081	13.	Jul	14	.538	20.	Jul	13
7.154	12.	Aug	12	.476	20.	Aug	12
7.208	13.	Sep	11	.451	19.	Sep	09
6.960	12.	Oct	09	.674	18.	Oct	07
7.097	10.	Nov	05	.757	17.	Nov	21
7.096	01.	Dec	24	.419	09.	Dec	25

Felixstowe Extreme Levels to Chart Datum

Max	Hr	Mon	Day	Min	Hr	Mon	Day
4.295	01.	Jan	03	**-.617**	06.	Jan	02
4.016	00.	Feb	16	-.310	05.	Feb	28
4.082	02.	Mar	20	-.289	07.	Mar	19
4.260	01.	Apr	17	.066	05.	Apr	15
3.920	00.	May	16	.172	21.	May	18
4.145	02.	Jun	16	.206	21.	Jun	17
4.056	01.	Jul	14	.107	19.	Jul	13
4.063	13.	Aug	12	.115	19.	Aug	12
4.164	00.	Sep	25	.089	18.	Sep	09
4.048	12.	Oct	09	.188	17.	Oct	07
4.381	14.	Nov	11	.118	17.	Nov	06
4.309	01.	Dec	24	-.086	08.	Dec	25

Fishguard Extreme Levels to Chart Datum

Max	Hr	Mon	Day	Min	Hr	Mon	Day
5.324	09.	Jan	03	**.289**	15.	Jan	31
5.065	09.	Feb	01	.463	16.	Feb	02
5.235	08.	Mar	02	.395	14.	Mar	30
4.821	09.	Apr	02	.367	03.	Apr	17
4.621	20.	May	15	.410	03.	May	16
4.969	21.	Jun	14	.649	03.	Jun	14
5.122	21.	Jul	14	.468	03.	Jul	14
5.137	21.	Aug	12	.297	03.	Aug	12
5.205	20.	Sep	09	.422	02.	Sep	09
4.870	18.	Oct	07	.640	02.	Oct	24
5.100	09.	Nov	25	.714	01.	Nov	22
5.201	08.	Dec	23	.362	16.	Dec	24

Heysham Extreme Levels to Chart Datum

Max	Hr	Mon	Day	Min	Hr	Mon	Day
10.640	00.	Jan	02	**.374**	19.	Jan	31
9.972	13.	Feb	01	.602	20.	Feb	02
10.327	13.	Mar	19	.562	18.	Mar	30
9.787	12.	Apr	01	.460	19.	Apr	16
9.487	00.	May	16	.649	07.	May	16
9.912	23.	Jun	12	.829	08.	Jun	15
10.020	01.	Jul	15	.703	07.	Jul	14
10.154	00.	Aug	12	.442	07.	Aug	12
10.176	00.	Sep	10	.494	06.	Sep	09
9.963	23.	Oct	07	.755	06.	Oct	09
9.868	23.	Nov	06	1.091	05.	Nov	05
10.435	12.	Dec	23	.552	20.	Dec	24

Hinkley Point Extreme Levels to Chart Datum

Max	Hr	Mon	Day	Min	Hr	Mon	Day
12.519	19.	Jan	01	.285	14.	Jan	31
12.291	08.	Feb	01	.309	02.	Feb	01
12.267	08.	Mar	02	.347	02.	Mar	02
11.683	08.	Apr	01	**.270**	13.	Apr	15
11.563	08.	May	16	.550	02.	May	16
11.894	20.	Jun	14	.814	14.	Jun	14
12.263	20.	Jul	13	.569	15.	Jul	14
12.268	20.	Aug	11	.300	02.	Aug	12
12.433	20.	Sep	10	.380	02.	Sep	10
12.264	19.	Oct	08	.699	01.	Oct	24
11.929	08.	Nov	24	.914	01.	Nov	23
12.369	08.	Dec	23	.548	15.	Dec	24

Holyhead Extreme Levels to Chart Datum

Max	Hr	Mon	Day	Min	Hr	Mon	Day
6.437	23.	Jan	01	**.111**	17.	Jan	31
5.918	12.	Feb	01	.227	18.	Feb	01
6.055	12.	Mar	19	.231	17.	Mar	01
5.744	12.	Apr	02	.245	17.	Apr	16
5.453	23.	May	15	.290	05.	May	16
5.870	22.	Jun	12	.401	07.	Jun	16
5.973	00.	Jul	15	.240	06.	Jul	14
5.959	23.	Aug	11	.167	05.	Aug	11
6.018	23.	Sep	09	.295	05.	Sep	10
5.878	21.	Oct	06	.601	03.	Oct	06

Ilfracombe Extreme Levels to Chart Datum

Max	Hr	Mon	Day	Min	Hr	Mon	Day
9.835	18.	Jan	01	**.349**	13.	Jan	31
9.647	07.	Feb	01	.358	01.	Feb	01
9.762	07.	Mar	02	.468	01.	Mar	02
9.473	19.	Sep	25	.839	01.	Sep	26
9.535	18.	Oct	08	.612	12.	Oct	08
9.320	07.	Nov	24	.788	00.	Nov	23
9.573	07.	Dec	23	.410	14.	Dec	24

Immingham Extreme Levels to Chart Datum

Max	Hr	Mon	Day	Min	Hr	Mon	Day
7.949	19.	Jan	02	**-.072**	01.	Jan	02
7.469	18.	Feb	15	.365	02.	Feb	02
7.609	20.	Mar	19	.157	02.	Mar	19
7.634	19.	Apr	16	.658	00.	Apr	15
7.287	19.	May	15	.799	14.	May	17
7.369	08.	Jun	15	.759	13.	Jun	14
7.373	09.	Jul	16	.588	13.	Jul	13
7.904	07.	Aug	12	.399	14.	Aug	12
7.922	06.	Sep	25	.434	13.	Sep	09
7.662	06.	Oct	09	.662	12.	Oct	07
7.456	06.	Nov	07	.791	12.	Nov	06
7.701	07.	Dec	23	.423	03.	Dec	25

Kinlochbervie Extreme Levels to Chart Datum
(Records begin 17 June)

Max	Hr	Mon	Day	Min	Hr	Mon	Day
4.489	21.	Jun	29	.838	06.	Jun	18
5.202	20.	Jul	13	.315	03.	Jul	14
5.276	20.	Aug	11	**.145**	03.	Aug	12
5.384	07.	Sep	24	.180	02.	Sep	09
5.346	19.	Oct	07	.370	02.	Oct	09
5.307	08.	Nov	24	.535	00.	Nov	05
4.621	08.	Dec	07	.960	01.	Dec	06

Leith Extreme Levels to Chart Datum

Max	Hr	Mon	Day	Min	Hr	Mon	Day
6.158	16.	Jan	02	**.007**	21.	Jan	30
5.609	16.	Feb	01	.025	22.	Feb	01
5.696	16.	Mar	18	.021	21.	Mar	01
5.634	04.	Apr	02	.255	20.	Apr	14
5.565	16.	May	16	.325	09.	May	15
5.889	15.	Jun	13	.504	10.	Jun	14
5.869	04.	Jul	14	.233	10.	Jul	13
5.978	04.	Aug	12	.078	10.	Aug	12
5.998	03.	Sep	25	.034	09.	Sep	09
5.899	02.	Oct	08	.475	09.	Oct	25
5.799	15.	Nov	07	.512	07.	Nov	21
6.407	03.	Dec	23	.079	23.	Dec	24

Lerwick Extreme Levels to Chart Datum

Max	Hr	Mon	Day	Min	Hr	Mon	Day
2.791	12.	Jan	02	**-.102**	18.	Jan	31
2.266	14.	Feb	19	-.092	19.	Feb	01
2.450	13.	Mar	19	-.065	17.	Mar	01
2.363	13.	Apr	02	-.012	06.	Apr	17
1.998	10.	May	13	.079	06.	May	16
2.317	11.	Jun	13	.207	08.	Jun	16
2.376	00.	Jul	14	.194	07.	Jul	15
2.406	00.	Aug	12	.123	06.	Aug	12
2.603	23.	Sep	24	.042	05.	Sep	09
2.376	22.	Oct	07	.227	05.	Oct	24
2.376	11.	Nov	07	.316	03.	Nov	20
2.662	00.	Dec	23	-.008	19.	Dec	24

Liverpool Extreme Levels to Chart Datum
(Records begin 23 May)

Max	Hr	Mon	Day	Min	Hr	Mon	Day
8.613	00.	May	30	1.437	17.	May	27
9.541	23.	Jun	12	.747	08.	Jun	15
9.720	01.	Jul	15	.601	08.	Jul	14
9.840	00.	Aug	12	.395	07.	Aug	12
9.770	00.	Sep	10	**.388**	06.	Sep	09
9.577	23.	Oct	07	.746	06.	Oct	09
9.541	12.	Nov	24	1.042	05.	Nov	05
10.250	12.	Dec	23	.492	20.	Dec	24

Lowestoft Extreme Levels to Chart Datum

Max	Hr	Mon	Day	Min	Hr	Mon	Day
3.329	22.	Jan	02	**-.716**	04.	Jan	02
2.951	22.	Feb	15	-.271	03.	Feb	28
2.804	23.	Mar	19	-.324	05.	Mar	19
3.122	22.	Apr	16	.197	04.	Apr	15
2.693	22.	May	15	.137	19.	May	18
2.656	12.	Jun	16	.242	20.	Jun	17
2.870	11.	Jul	14	.126	17.	Jul	13
2.968	10.	Aug	12	.119	15.	Aug	09
3.041	09.	Sep	25	.137	16.	Sep	09
3.143	05.	Oct	18	.147	15.	Oct	07
3.133	12.	Nov	11	.202	05.	Nov	11
3.380	07.	Dec	20	-.033	06.	Dec	25

Milford Haven Extreme Levels to Chart Datum
(Records begin 25 February)

Max	Hr	Mon	Day	Min	Hr	Mon	Day
7.058	06.	Feb	28	.519	12.	Feb	28
7.487	07.	Mar	02	.308	13.	Mar	01
7.016	07.	Apr	16	.279	01.	Apr	16
6.834	19.	May	15	.314	13.	May	15
7.159	20.	Jun	14	.595	01.	Jun	14
7.350	20.	Jul	14	.331	02.	Jul	14
7.390	19.	Aug	11	**.200**	02.	Aug	12
7.462	19.	Sep	09	.310	01.	Sep	10
7.277	06.	Oct	08	.554	01.	Oct	25
7.219	08.	Nov	25	.697	00.	Nov	22
7.406	07.	Dec	23	.348	15.	Dec	24

Millport Extreme Levels to Chart Datum

Max	Hr	Mon	Day	Min	Hr	Mon	Day
5.067	15.	Jan	05	-.122	18.	Jan	30
3.706	15.	Feb	03	.016	20.	Feb	02
3.901	03.	Mar	05	.034	17.	Mar	29
3.788	14.	Apr	02	**-.176**	08.	Apr	19
3.311	03.	May	18	.005	07.	May	16
3.633	00.	Jun	13	.051	08.	Jun	16
3.834	02.	Jul	15	.069	07.	Jul	14
3.704	02.	Aug	13	.017	07.	Aug	12
4.053	00.	Sep	24	.100	06.	Sep	09
3.988	23.	Oct	06	.192	06.	Oct	24
4.200	15.	Nov	12	.110	04.	Nov	20
4.001	13.	Dec	23	-.082	20.	Dec	24

Mumbles Extreme Levels to Chart Datum

Max	Hr	Mon	Day	Min	Hr	Mon	Day
10.274	19.	Jan	01	.507	13.	Jan	31
9.896	08.	Feb	01	.583	02.	Feb	02
10.003	07.	Mar	02	.571	01.	Mar	02
9.599	07.	Apr	16	.493	13.	Apr	16
9.381	19.	May	15	.639	13.	May	15
9.678	20.	Jun	14	.934	01.	Jun	14
9.892	20.	Jul	14	.672	02.	Jul	14
10.008	20.	Aug	12	**.452**	14.	Aug	12
10.081	19.	Sep	09	.548	01.	Sep	10
9.821	06.	Oct	08	.834	00.	Oct	24
9.621	08.	Nov	25	1.114	00.	Nov	22
8.799	07.	Dec	07	1.568	12.	Dec	06

Newhaven Extreme Levels to Chart Datum

Max	Hr	Mon	Day	Min	Hr	Mon	Day
7.269	00.	Jan	03	.273	18.	Jan	31
6.885	00.	Feb	16	**.221**	19.	Feb	01
6.821	00.	Mar	02	.279	18.	Mar	01
6.919	00.	Apr	17	.356	06.	Apr	16
6.777	00.	May	16	.436	06.	May	15
6.771	13.	Jun	15	.594	06.	Jun	14
6.963	13.	Jul	14	.413	06.	Jul	13
7.011	13.	Aug	12	.300	06.	Aug	11
7.034	13.	Sep	11	.397	06.	Sep	10
6.937	11.	Oct	08	.672	04.	Oct	07

Newlyn Extreme Levels to Chart Datum

Max	Hr	Mon	Day	Min	Hr	Mon	Day
5.914	06.	Jan	03	**.374**	12.	Jan	31
5.857	06.	Feb	01	.491	13.	Feb	01
5.857	05.	Mar	17	.438	11.	Mar	30
5.492	05.	Apr	16	.471	12.	Apr	16
5.361	18.	May	16	.417	00.	May	16
5.703	18.	Jun	14	.619	00.	Jun	14
5.762	18.	Jul	13	.477	01.	Jul	14
5.777	18.	Aug	12	.375	00.	Aug	11
5.893	17.	Sep	09	.494	00.	Sep	10
5.792	16.	Oct	07	.701	12.	Oct	25
5.697	06.	Nov	25	.746	12.	Nov	23
5.669	06.	Dec	23	.447	13.	Dec	24

North Shields Extreme Levels to Chart Datum

Max	Hr	Mon	Day	Min	Hr	Mon	Day
5.760	16.	Jan	02	**-.004**	22.	Jan	30
5.248	16.	Feb	15	.074	23.	Feb	01
5.359	17.	Mar	19	.097	22.	Mar	01
5.299	16.	Apr	16	.331	21.	Apr	14
5.117	16.	May	15	.379	12.	May	17
5.300	16.	Jun	13	.446	12.	Jun	15
5.398	05.	Jul	14	.259	11.	Jul	13
5.501	04.	Aug	12	.134	11.	Aug	12
5.555	04.	Sep	25	.088	10.	Sep	09
4.379	21.	Oct	01	1.123	03.	Oct	31
5.353	03.	Nov	07	.588	00.	Nov	26
5.836	04.	Dec	23	.124	00.	Dec	25

Port Ellen Extreme Levels to Chart Datum
(Records begin 13 June)

Max	Hr	Mon	Day	Min	Hr	Mon	Day
.800	18.	Jun	14	-.281	14.	Jun	16
.986	18.	Jul	12	-.256	13.	Jul	14
.904	18.	Aug	11	-.375	12.	Aug	12
1.200	02.	Sep	24	-.285	12.	Sep	11
1.328	08.	Oct	31	-.247	11.	Oct	09
1.543	17.	Nov	12	-.349	09.	Nov	19
1.231	06.	Dec	23	**-.474**	00.	Dec	24

Portpatrick Extreme Levels to Chart Datum

Max	Hr	Mon	Day	Min	Hr	Mon	Day
5.164	15.	Jan	05	-.132	18.	Jan	30
4.086	13.	Feb	01	.002	20.	Feb	02
4.267	13.	Mar	19	-.017	17.	Mar	29
4.058	13.	Apr	02	**-.155**	08.	Apr	19
3.689	02.	May	18	-.009	07.	May	16
4.056	23.	Jun	12	.032	08.	Jun	16
4.207	02.	Jul	15	.039	07.	Jul	14
4.095	01.	Aug	13	-.017	07.	Aug	12
4.237	23.	Sep	23	.065	05.	Sep	08
4.285	22.	Oct	06	.199	06.	Oct	24
4.524	15.	Nov	12	.174	04.	Nov	05
4.412	13.	Dec	23	-.094	20.	Dec	24

Portsmouth Extreme Levels to Chart Datum
(Records begin 29 January)

Max	Hr	Mon	Day	Min	Hr	Mon	Day
4.656	12.	Jan	31	.255	17.	Jan	30
4.872	00.	Feb	16	**.234**	19.	Feb	02
4.818	00.	Mar	17	.286	16.	Mar	29
4.685	00.	Apr	30	.261	06.	Apr	17
4.637	00.	May	16	.339	05.	May	15
4.793	01.	Jun	15	.610	08.	Jun	17
4.812	13.	Jul	14	.424	06.	Jul	14
4.846	13.	Aug	12	.271	05.	Aug	11
4.982	14.	Sep	28	.404	05.	Sep	09
4.884	11.	Oct	08	.534	17.	Oct	24
4.871	12.	Nov	07	.609	16.	Nov	21
4.310	10.	Dec	04	.817	17.	Dec	07

Sheerness Extreme Levels to Chart Datum

Max	Hr	Mon	Day	Min	Hr	Mon	Day
6.218	14.	Jan	03	**-.488**	08.	Jan	02
5.931	01.	Feb	16	-.153	07.	Feb	28
6.001	03.	Mar	20	-.255	09.	Mar	19
6.154	02.	Apr	17	.185	08.	Apr	01
5.842	01.	May	16	.282	22.	May	18
6.171	03.	Jun	16	.275	21.	Jun	15
6.077	02.	Jul	14	.108	20.	Jul	13
6.077	02.	Aug	12	.176	21.	Aug	12
6.203	14.	Sep	11	.254	19.	Sep	08
6.001	13.	Oct	09	.364	18.	Oct	07
6.155	15.	Nov	11	.158	19.	Nov	06
6.156	02.	Dec	24	.123	10.	Dec	25

Stornoway Extreme Levels to Chart Datum

Max	Hr	Mon	Day	Min	Hr	Mon	Day
5.687	08.	Jan	02	.212	14.	Jan	31
5.122	08.	Feb	01	.178	15.	Feb	01
5.232	08.	Mar	19	**.164**	13.	Mar	30
4.916	08.	Apr	01	.722	02.	Apr	01
4.511	07.	May	15	.293	14.	May	15
4.967	19.	Jun	13	.504	04.	Jun	16
5.206	20.	Jul	13	.393	03.	Jul	14
5.237	20.	Aug	11	.214	02.	Aug	12
5.197	19.	Sep	24	.209	01.	Sep	09
5.340	18.	Oct	07	.417	01.	Oct	24
5.187	08.	Nov	24	.623	00.	Nov	05
5.228	07.	Dec	22	.207	15.	Dec	24

Tobermory Extreme Levels to Chart Datum

Max	Hr	Mon	Day	Min	Hr	Mon	Day
5.476	07.	Jan	02	.294	00.	Jan	31
4.815	07.	Feb	01	.249	02.	Feb	02
5.171	08.	Mar	19	.377	00.	Mar	30
4.782	19.	Apr	01	**.167**	13.	Apr	16
4.323	05.	May	13	.335	13.	May	15
4.842	18.	Jun	12	.617	15.	Jun	16
4.933	19.	Jul	13	.426	14.	Jul	14
4.942	19.	Aug	11	.331	13.	Aug	12
4.987	06.	Sep	24	.310	13.	Sep	10
4.984	17.	Oct	07	.423	13.	Oct	09
4.969	07.	Nov	24	.659	11.	Nov	05
4.990	07.	Dec	23	.308	02.	Dec	24

Ullapool Extreme Levels to Chart Datum

Max	Hr	Mon	Day	Min	Hr	Mon	Day
6.100	08.	Jan	02	.223	14.	Jan	31
5.424	08.	Feb	01	.201	15.	Feb	01
5.634	09.	Mar	19	.227	14.	Mar	01
5.328	08.	Apr	01	**.081**	14.	Apr	16
4.882	07.	May	15	.324	14.	May	15
5.391	19.	Jun	12	.557	04.	Jun	16
5.559	20.	Jul	13	.429	03.	Jul	14
5.583	20.	Aug	11	.278	02.	Aug	12
5.647	07.	Sep	24	.264	01.	Sep	09
5.647	18.	Oct	07	.450	02.	Oct	10
5.580	08.	Nov	24	.651	00.	Nov	05
5.577	07.	Dec	22	.986	13.	Dec	21

Weymouth Extreme Levels to Chart Datum
(Records begin 30 January 1991)

Max	Hr	Mon	Day	Min	Hr	Mon	Day
2.308	08.	Jan	31	-.162	16.	Jan	31
2.430	08.	Feb	01	-.177	17.	Feb	02
2.519	07.	Mar	17	-.159	14.	Mar	29
2.275	20.	Apr	16	-.104	12.	Apr	15
2.112	20.	May	15	-.034	04.	May	16
2.349	20.	Jun	14	.123	04.	Jun	14
2.425	21.	Jul	14	-.056	04.	Jul	14
2.456	20.	Aug	11	**-.228**	03.	Aug	11
2.630	09.	Sep	28	-.082	03.	Sep	09
2.495	19.	Oct	07	.137	00.	Oct	25
2.421	09.	Nov	25	.106	22.	Nov	20
2.458	08.	Dec	23	-.143	18.	Dec	25

Whitby Extreme Levels to Chart Datum

Max	Hr	Mon	Day	Min	Hr	Mon	Day
6.187	17.	Jan	02	**.176**	23.	Jan	01
5.646	17.	Feb	15	.192	00.	Feb	02
5.834	18.	Mar	19	.236	23.	Mar	01
5.895	17.	Apr	16	.509	22.	Apr	14
5.531	17.	May	15	.608	12.	May	17
5.656	16.	Jun	13	.632	12.	Jun	15
5.826	05.	Jul	14	.433	11.	Jul	13
6.039	05.	Aug	12	.386	11.	Aug	11
6.088	04.	Sep	25	.374	10.	Sep	08
5.850	04.	Oct	09	.600	09.	Oct	07
5.823	04.	Nov	07	.736	09.	Nov	21
6.148	05.	Dec	23	.391	01.	Dec	25

Wick Extreme Levels to Chart Datum

Max	Hr	Mon	Day	Min	Hr	Mon	Day
4.286	12.	Jan	02	.040	17.	Jan	30
3.697	14.	Feb	19	.028	19.	Feb	01
3.982	13.	Mar	19	.083	16.	Mar	28
3.684	13.	Apr	02	.141	06.	Apr	17
3.312	12.	May	15	.271	07.	May	17
3.727	23.	Jun	12	.337	08.	Jun	16
3.772	01.	Jul	14	.286	07.	Jul	14
3.855	00.	Aug	12	.216	07.	Aug	12
3.994	23.	Sep	24	.162	05.	Sep	08
3.927	23.	Oct	07	.390	05.	Oct	24
3.786	13.	Nov	24	.506	03.	Nov	20
4.015	00.	Dec	23	**.016**	20.	Dec	24

3.2 Mean Sea Level Values

Monthly values to Chart Datum calculated using the Doodson x0 filter are presented for 1991 with suffixes denoting missing days in each month. In accordance with the rules of the Permanent Service for Mean Sea Level (PSMSL), publishers of figures worldwide and based at POL, no monthly mean value is given where the number of days missing exceeds 15 in any one month. Similarly no annual mean value is given where the number of days missing exceeds one month.

Plots of relative anomalies (monthly-annual) ordered geographically are shown for the three years 1989 to 1991 for ports where sufficient modernised data has been collated.

MEAN SEA LEVEL VALUES TO CHART DATUM
millimetres

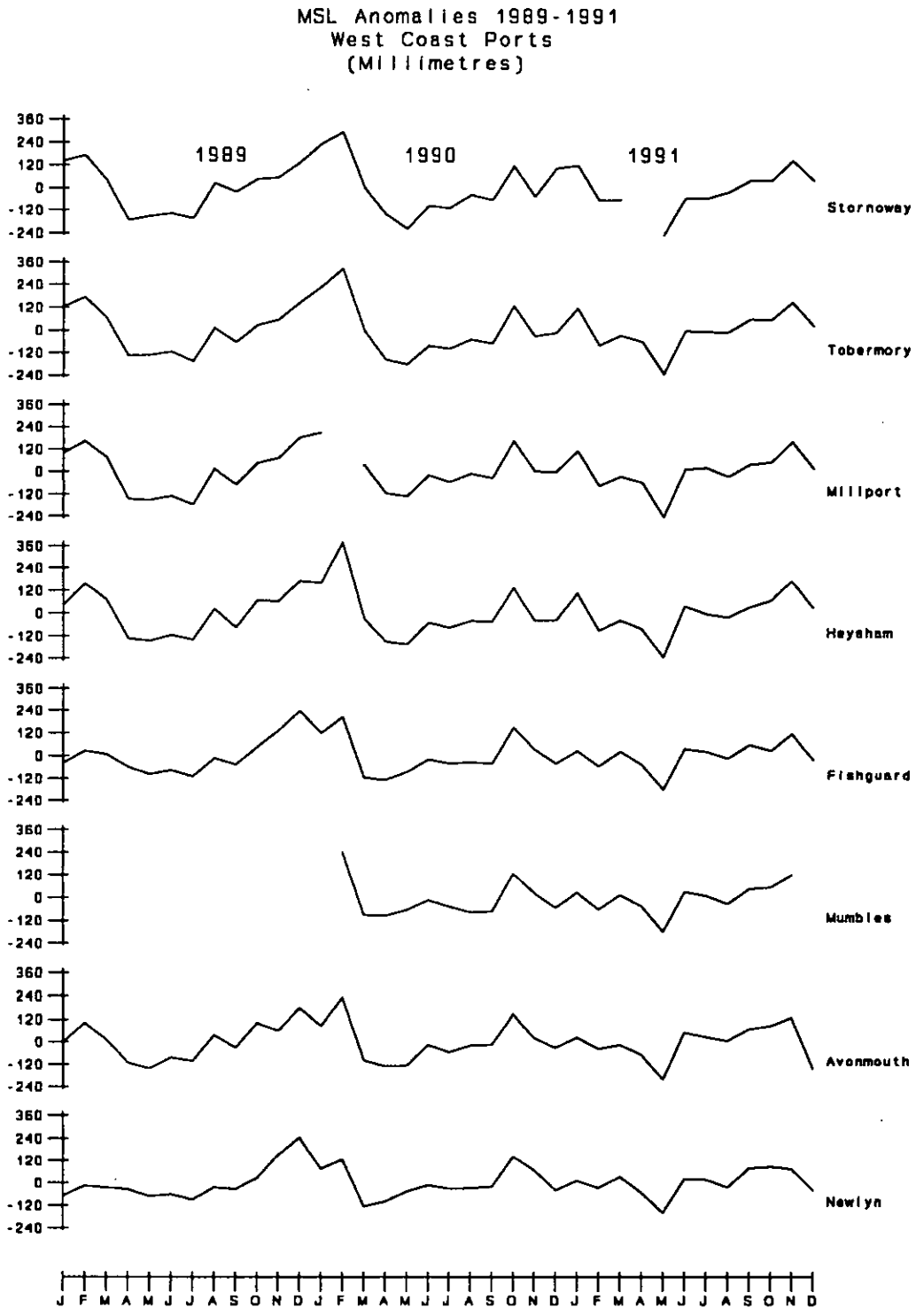
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
ABERDEEN	2553	2406	2429	2437	2341	2505	2463	2508	2570	2548	2650	2582	2500
AVONMOUTH	6915 05[1]	6854	6876	6826 14	6692	6943	6919	6899	6962	6981	7023	6749	6892
CROMER	2681	2595	2642	2707	2705	2779	2754	2785	2881	2846	2849	2843	2756
DEVONPORT	31	28	3320 14	3343	3235	3416	3403	3358	3456	3463	3483	3348	
DOVER	3653	3568	3626	3642	3609	3718	3686	3692	3780	3768	3789	3711	3687
FELIXSTOWE	1946 03	1882	1938	1971	1958	2022	1998	2035	2116	2080	2077	2059	2008
FISHGUARD	2648	2568	2647	2578	2442	2661	2646	2610	2683 11	2654	2739	2602	2622
HEYSHAM	5205	5008	5065	5019	4866	5139	5098	5079	5135	5170	5269	5129	5099
HINKLEY	6152 02	6034 03	6099	6054	5921	6144	6113 06	6082	6210	6260	6307	6152	6128
HOLYHEAD	3274	3153	3201	3142	2999	3243	3221	3191	3259	31	30	31	
IMMINGHAM	4120 03	4084	4093	4125	4080	4177	4124	4152	4235	4197	4219	4181	4149
LEITH	3147	3052	3073	3073	2981	3143	3109	3125	3182	3156	3238	3168	3121
LERWICK	1326	1149	1166	1174	1070	1235	1187	1245	1311	1292	1404	1324	1241

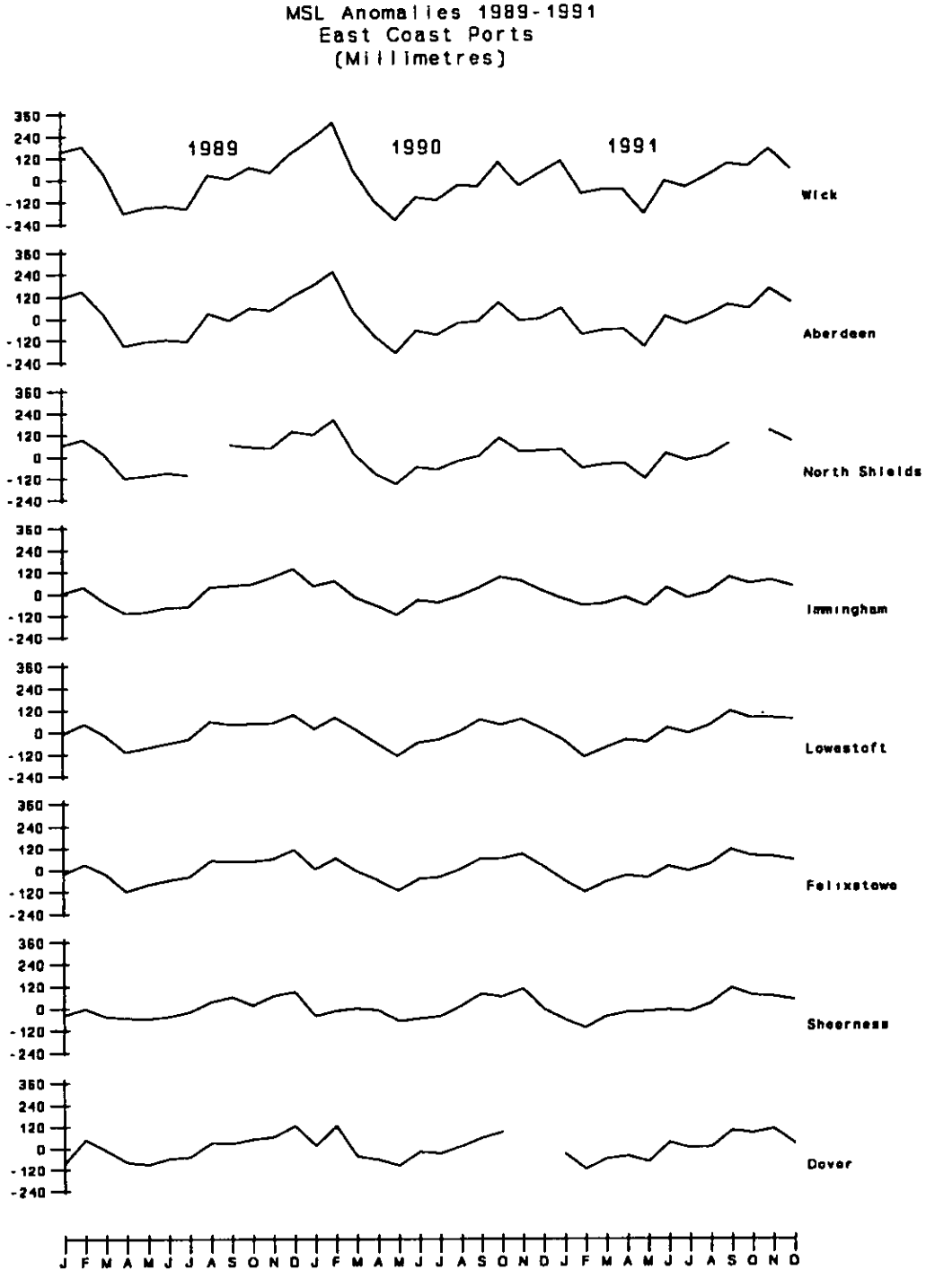
[1] Suffixes denote number of days missing in each month

MEAN SEA LEVEL VALUES TO CHART DATUM
millimetres

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
LIVERPOOL						5217	5175	5153	5215	5263	5331	5282	
	31[2]	28	31	30	31								
LOWESTOFT	1513	1426	1471	1515	1503	1579	1548	1590	1670	1632	1632	1625	1560
			02	01									
MILFORD HAVEN			3789	3715	3571	3800	3783	3739	3814	3819	3863	3723	
	31	28											
MILLPORT	2080	1890	1943	1908	1724	1980	1989	1943	2005	2019	2126	1981	1965
						10					11		
MUMBLES	5194	5105	5184	5125	4987	5198	5178	5138	5213	5223	5287		5167
												31	
NEWHAVEN	3521	3423	3492	3474	3399	3557	3528	3510	3597				
										31	30	31	
NEWLYN	3156	3116	3177	3092	2987	3165	3161	3120	3223	3232	3219	3104	3144
										04	05		
NORTH SHIELDS	2912	2812	2833	2836	2756	2893	2853	2879	2944		3016	2957	2880
										31			
PORTPATRICK	2198	2038	2088	2033	1849	2123	2102	2078	2139	2156	2247	2114	2105
					12	03							
PORTSMOUTH		2704	2774	2741	2653	2820	2798	2775	2866	2862	2889		
	31											31	
SHEERNESS	2878	2835	2895	2920	2924	2932	2923	2966	3051	3011	3003	2985	2944
TOBERMORY	2803	2611	2661	2627	2455	2686	2681	2680	2745	2743	2837	2713	2687
WEYMOUTH		1014	1087	1034	941	1119	1099	1067	1160	1161	1183	1046	1082
	31												
WHITBY	3244	3154	3175	3212	3144	3265	3229	3262	3343	3334	3381	3330	3256
WICK	2123	1943	1964	1965	1832	2007	1977	2036	2103	2089	2187	2074	2025

[2] Suffixes denote number of days missing in each month


MSL Anomalies 1989-1991
West Coast Ports
(Millimetres)
1989
1990
1991
360
240
120
0
-120
-240
Stornoway
Tobermory
Millport
Heysham
Fishguard
Mumbles
Avonmouth
Newlyn
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D


MSL Anomalies 1989-1991
East Coast Ports
(Millimetres)
1989
1990
1991
360
240
120
0
-120
-240
Wick
Aberdeen
North Shields
Immingham
Lowestoft
Felixstowe
Sheerness
Dover
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D

4. Storm Surge Residuals

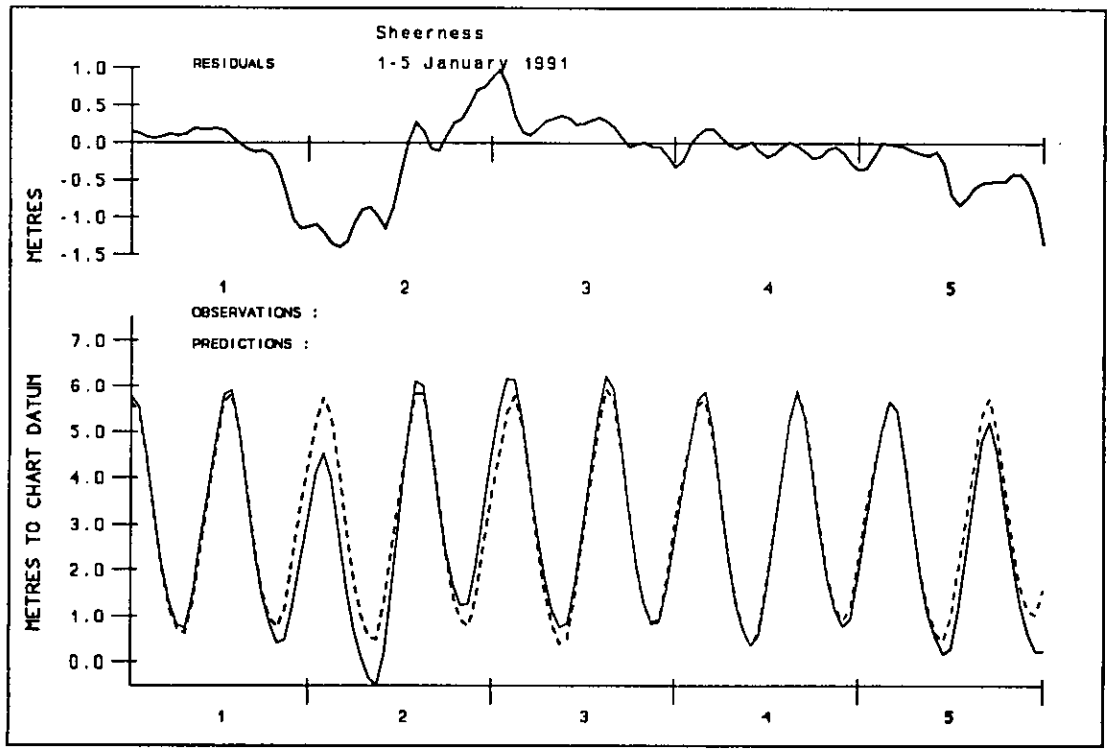
On the following pages, monthly plots of the differences between observed and predicted levels are presented for each of the west and east coasts and the south-west approaches with the English Channel ports for all ports where relevant data are available. West coast ports include Kinlochbervie in the north to Fishguard in the south including Scottish islands. The south-west approaches and English Channel include ports from Milford Haven in the west to Dover in the east. The remaining east coast port plots cover Lerwick in the north to Sheerness. Plots for each coast are displayed in monthly order.

Analytical problems reflected in the poor quality of the residuals for the Severn Estuary are very evident with Hinkley Point being the worst where the length of data available for analysis is insufficient to resolve the true astronomical tide. Values shown for Weymouth, where again the data series obtained is comparatively short, are from a comparison with predictions for Portland. As mentioned in section 2 (page 46) the resultant residuals depicted for Kinlochbervie show errors in timing which are associated with the recording difficulties encountered until mid-November.

The larger anomalies, of 1 metre or more above or below predicted levels, during 1991 were:-

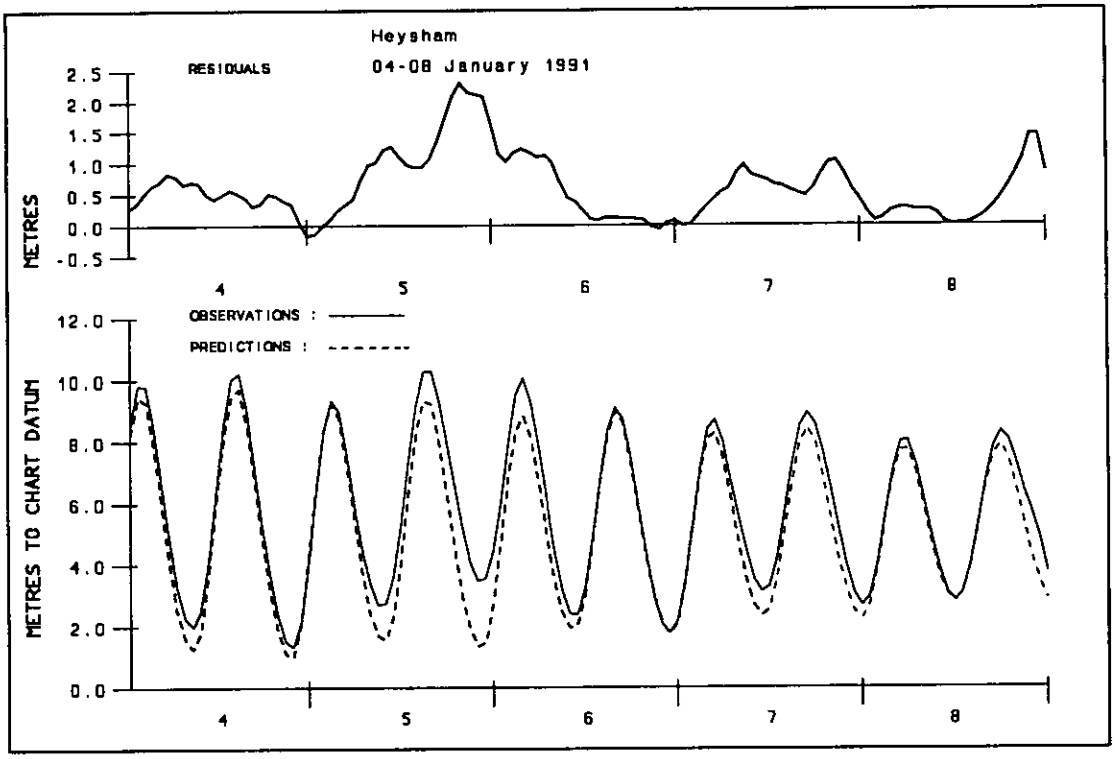
January 2
-1.4m at Sheerness
1.16m at Immingham

Levels at Sheerness remained over a metre below predicted levels from 2100GMT on the 1st. to 0500GMT on the 2nd.
Gusts up to 71 knots were reported at the Butt of Lewis. There are however no suitably sited instruments in the area to record the effect on water levels.



January 5
2.298m at Heysham
1.420m at Tobermory

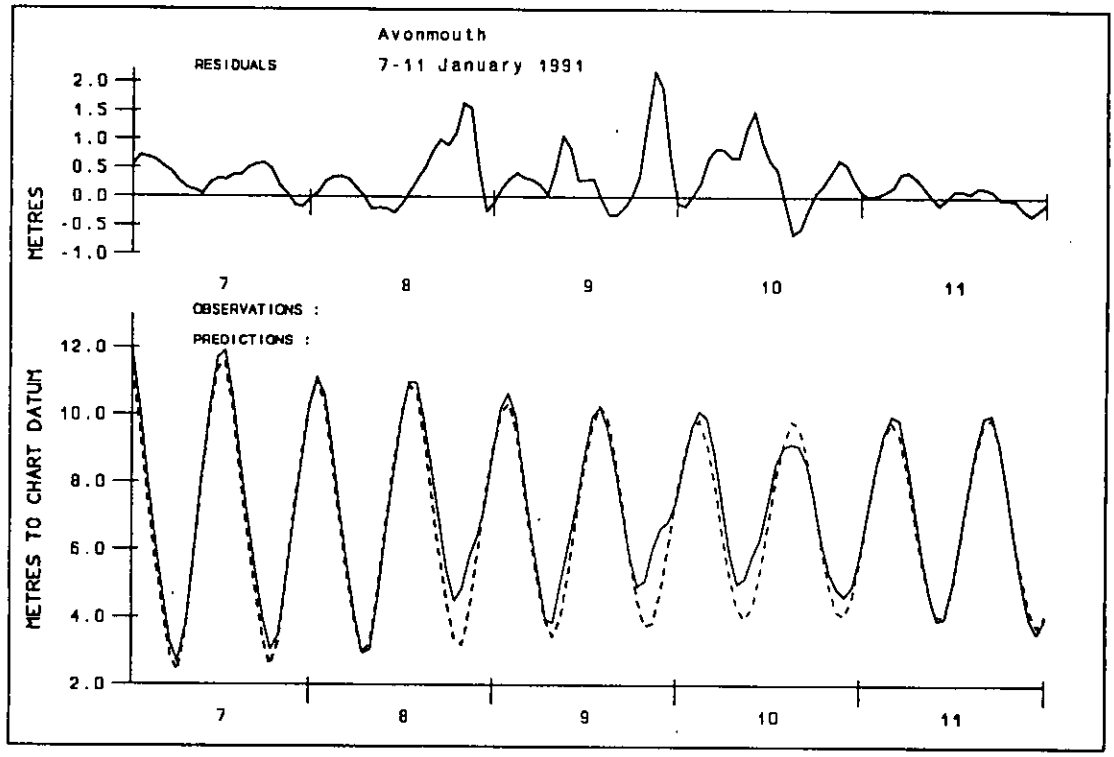
Gales and high tides caused considerable flooding and extensive damage especially in the west. Gusts up to 78kts were reported in Greenock.



January 6
1.25m at Avonmouth
-1.706m at Sheerness

Levels remained over a metre above predicted from midnight to 0500 GMT at Avonmouth and over a metre **below** predicted from 2300GMT 5th to 0700GMT 6th at Sheerness.

January 9
2.18m at Avonmouth
1.10m at Heysham



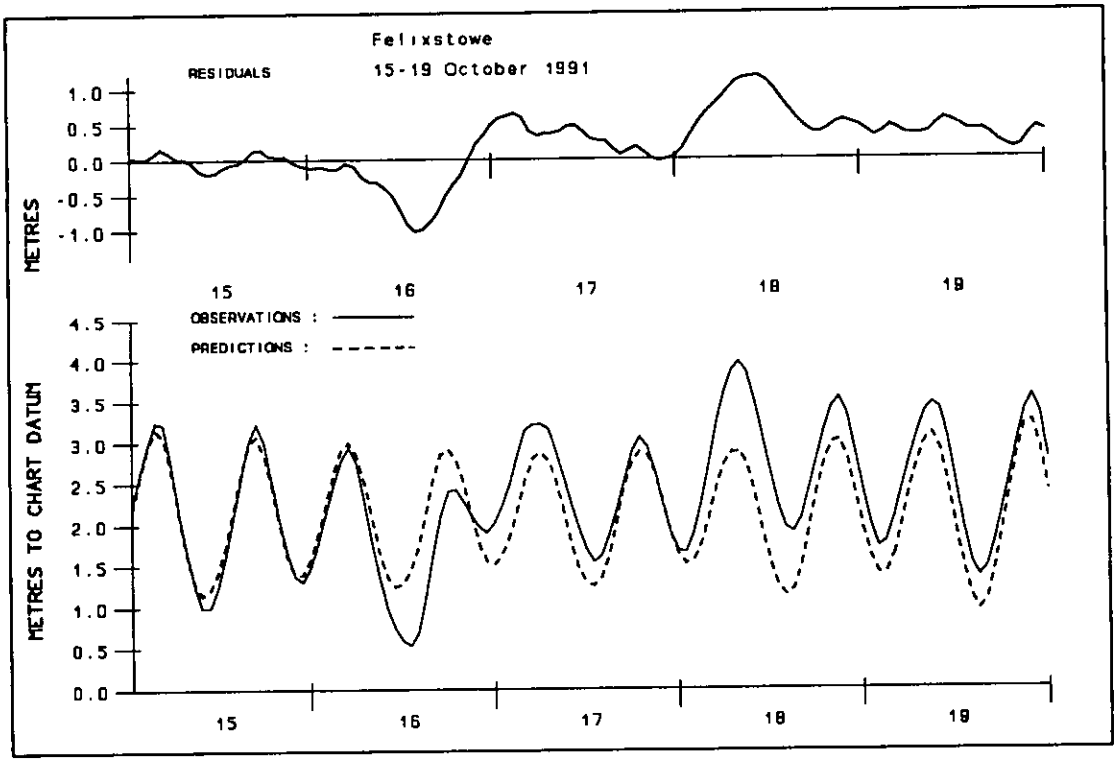
April 5
1.04m at Avonmouth
1.024m at Immingham

October 2
1.06m at Lowestoft
1.05m at Cromer

A depression, with strong northerly winds in its wake, crossed northern Britain to southern Norway overnight 1/2 October.

October 16/17
1.092m at Kinlochbervie
-1.335m at Sheerness

Effect evident on all recorded levels.



A slow moving Icelandic low tracked across northern Scotland during the 16th with severe west to north-westerly gales increasing to storm force. The centre of the depression was still only over southern Sweden by 1800GMT on the 18th.

October 18
1.229m at Lowestoft

Surge in excess of a metre at all sites from Cromer to Sheerness.

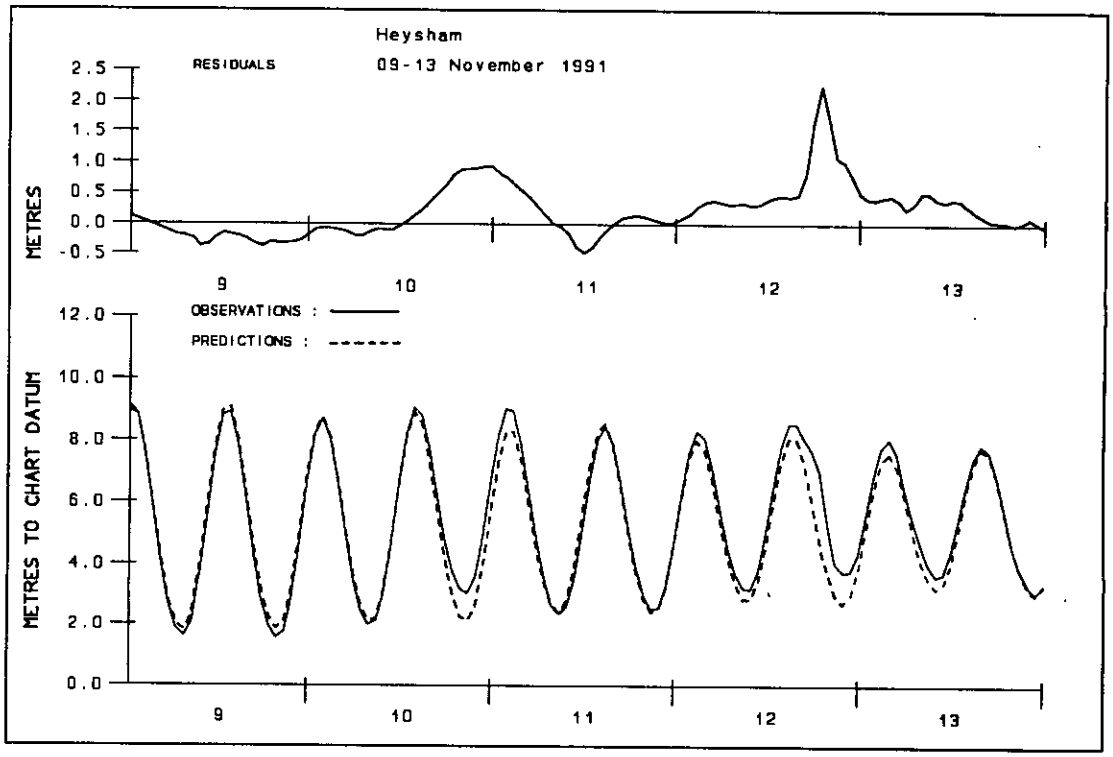
October 31
-1.232m at Cromer

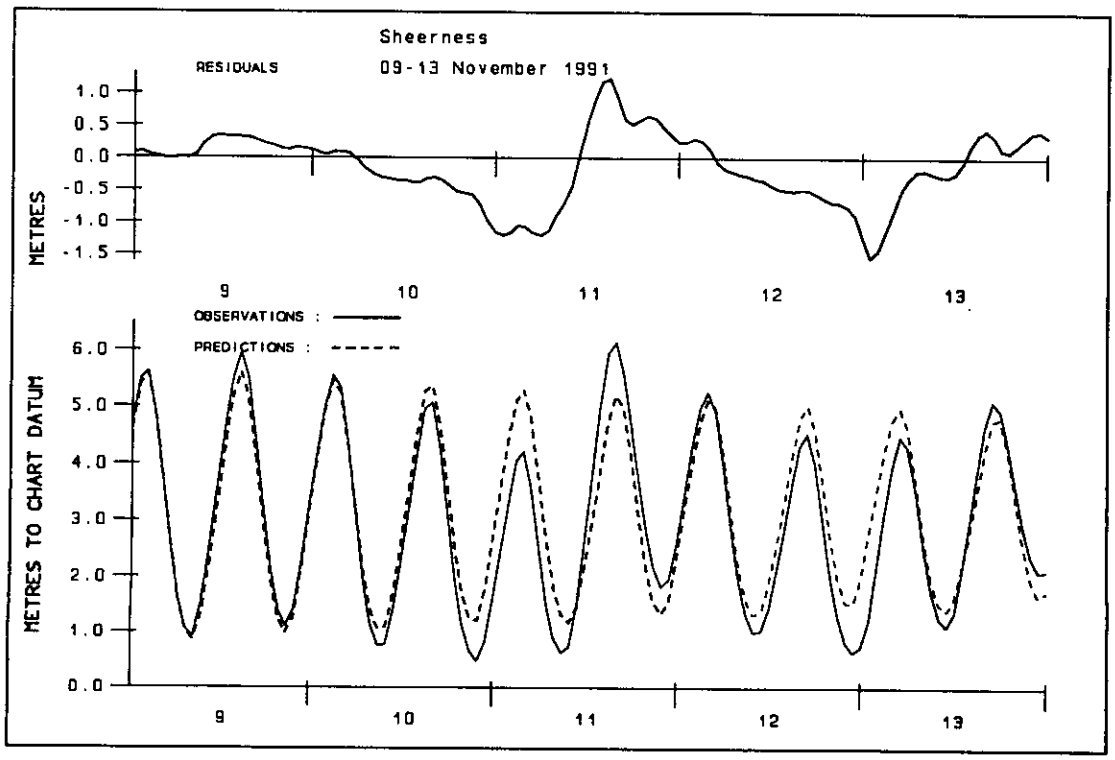
Positive surge evident on all west coast records.
Southerly gale force winds with gusts up to 67kts. at Tiree in the Hebrides.

November 10/11
-1.21m at Sheerness.
followed by 1.23m at Sheerness.

Levels at this site remained in excess of a metre below predicted from 2300GMT on the 10th to 0700GMT on the 11th. Other sites on the East coast were similarly though lesser affected.

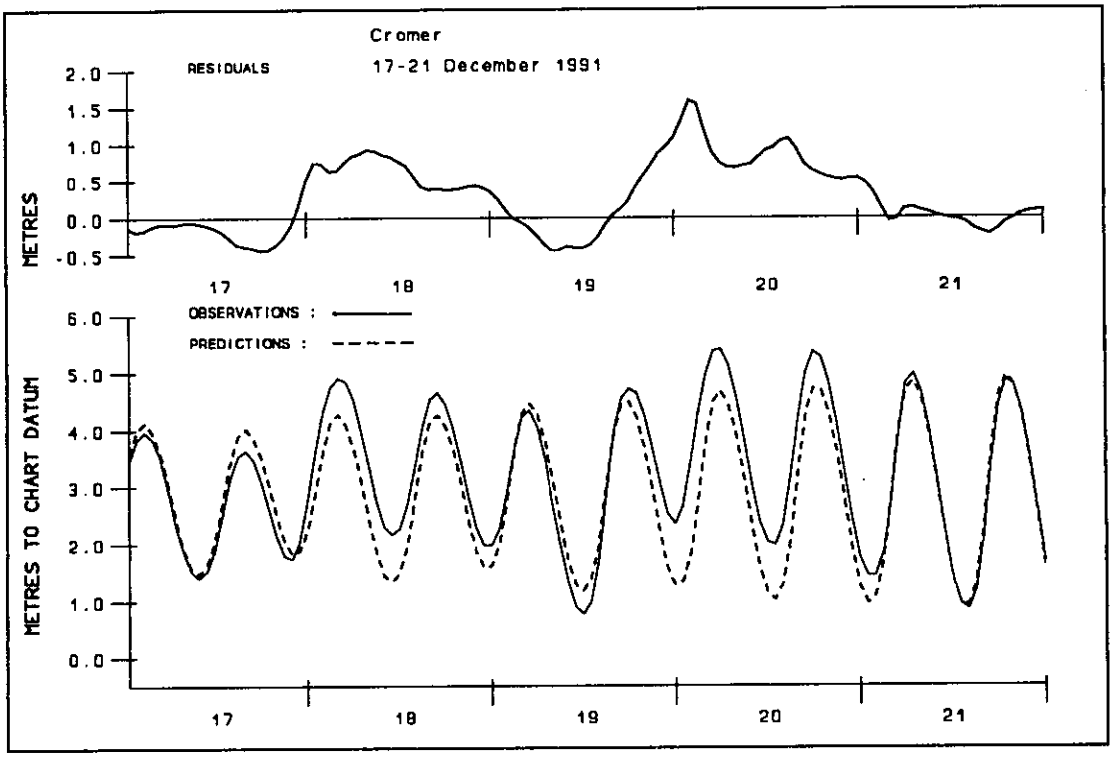
November 12/13
2.265m at Heysham.
-1.549m at Sheerness.



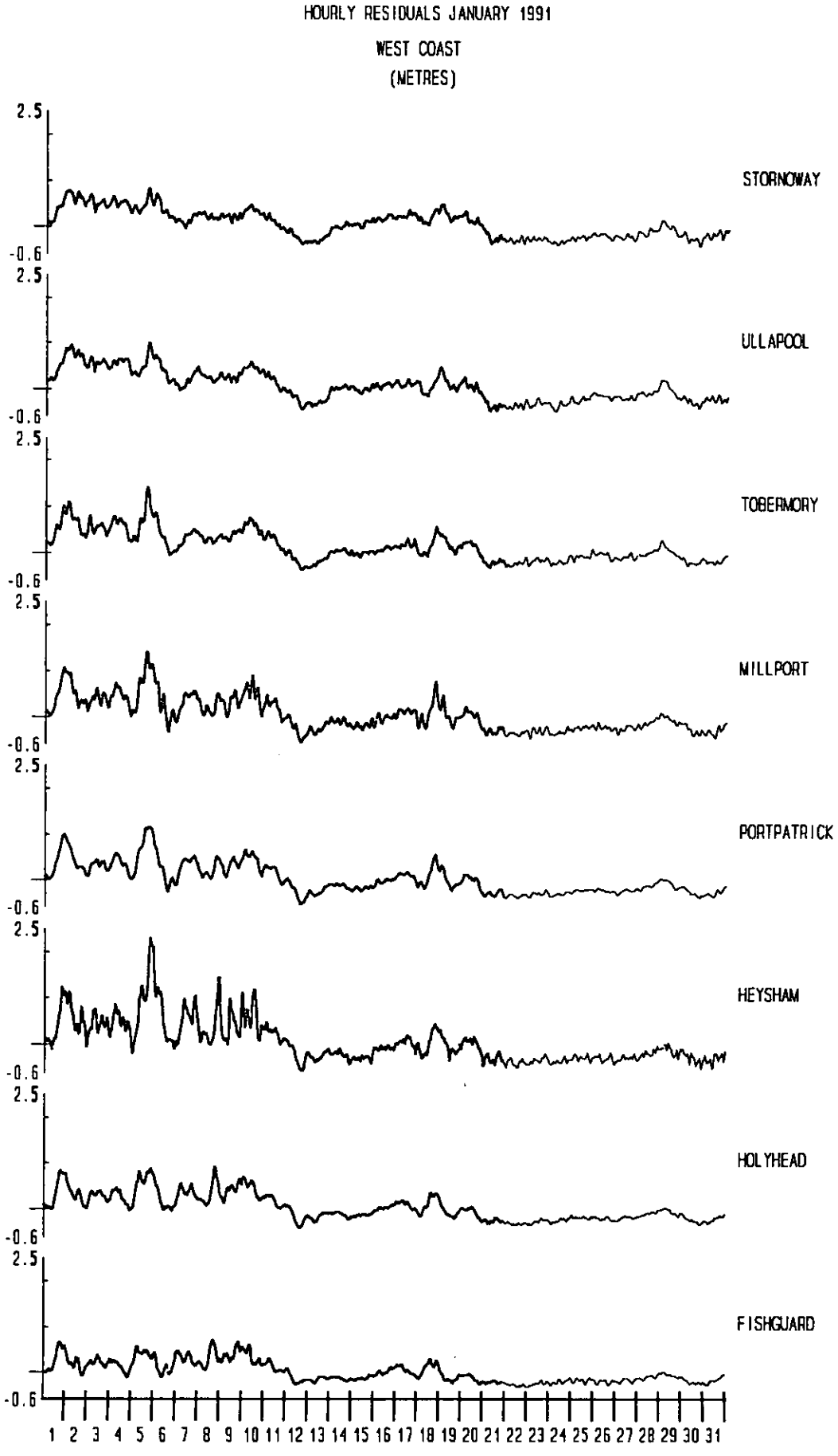


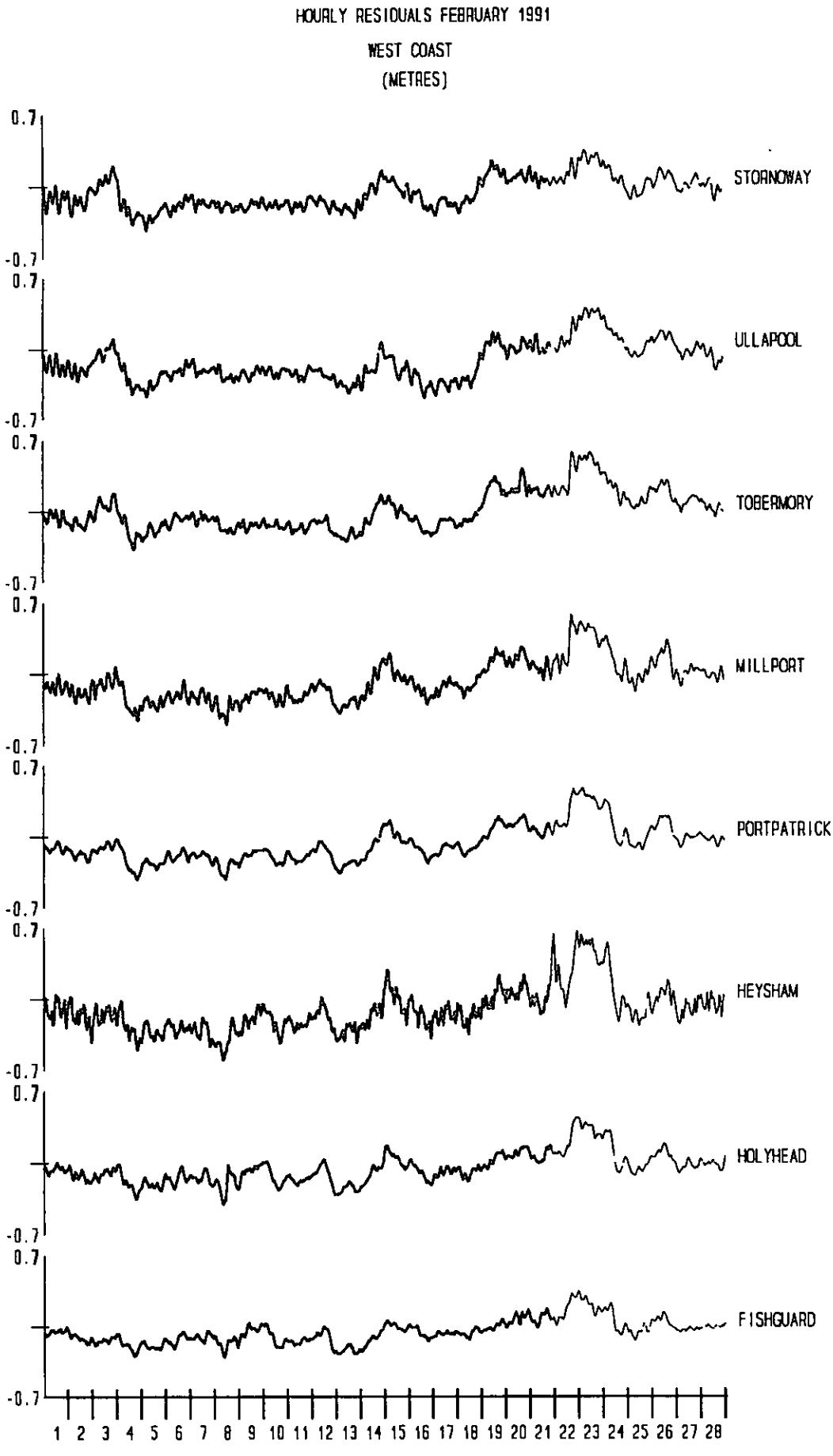
November 19
-1.056m at Avonmouth
Affect evident on other sites in the Severn Estuary including Milford Haven.

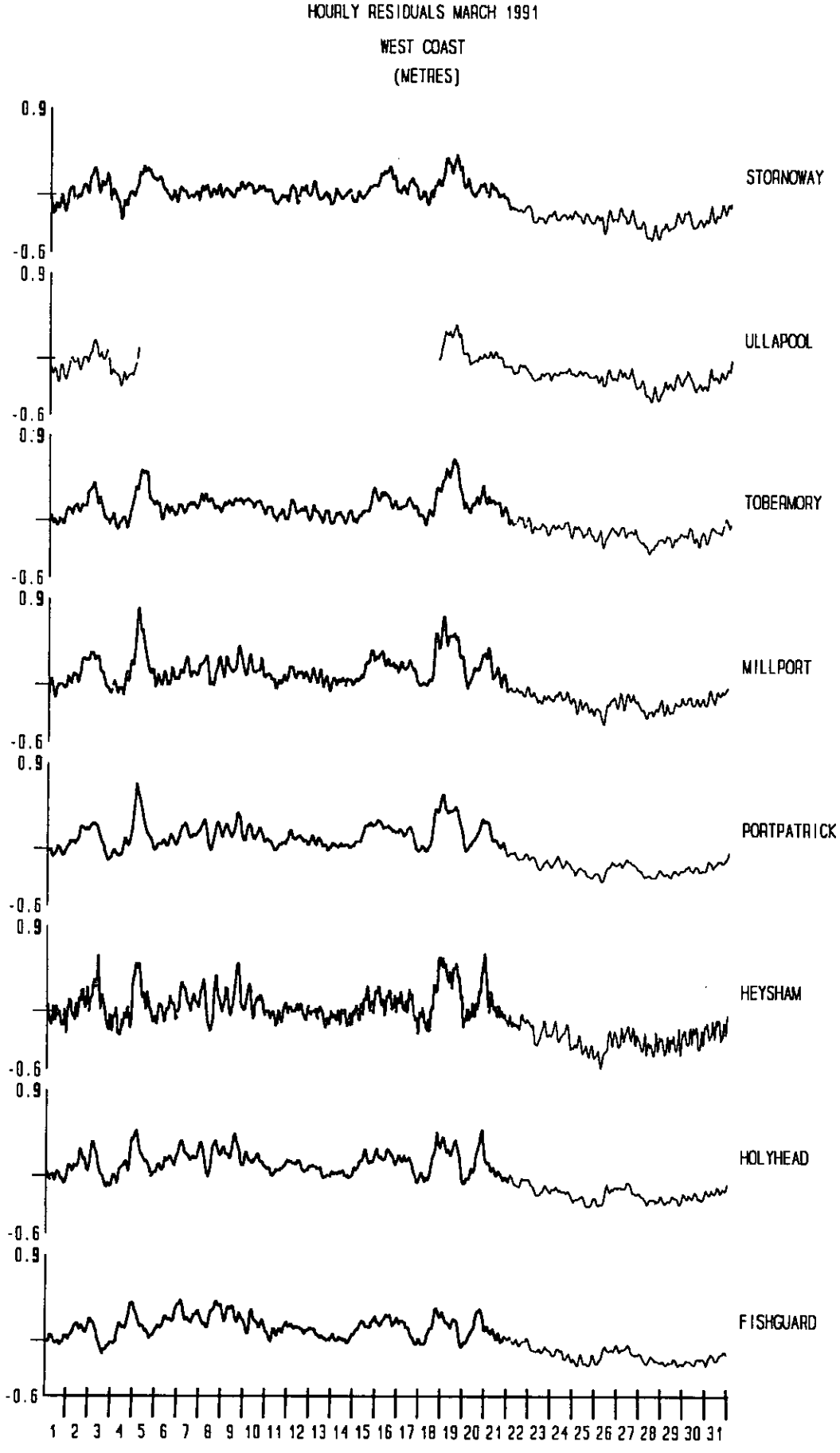
December 20
1.596m at Cromer
Records remained over a metre above predicted for seven hours at Lowestoft (0100GMT - 0700GMT). Effect of storm evident on all east coast records.

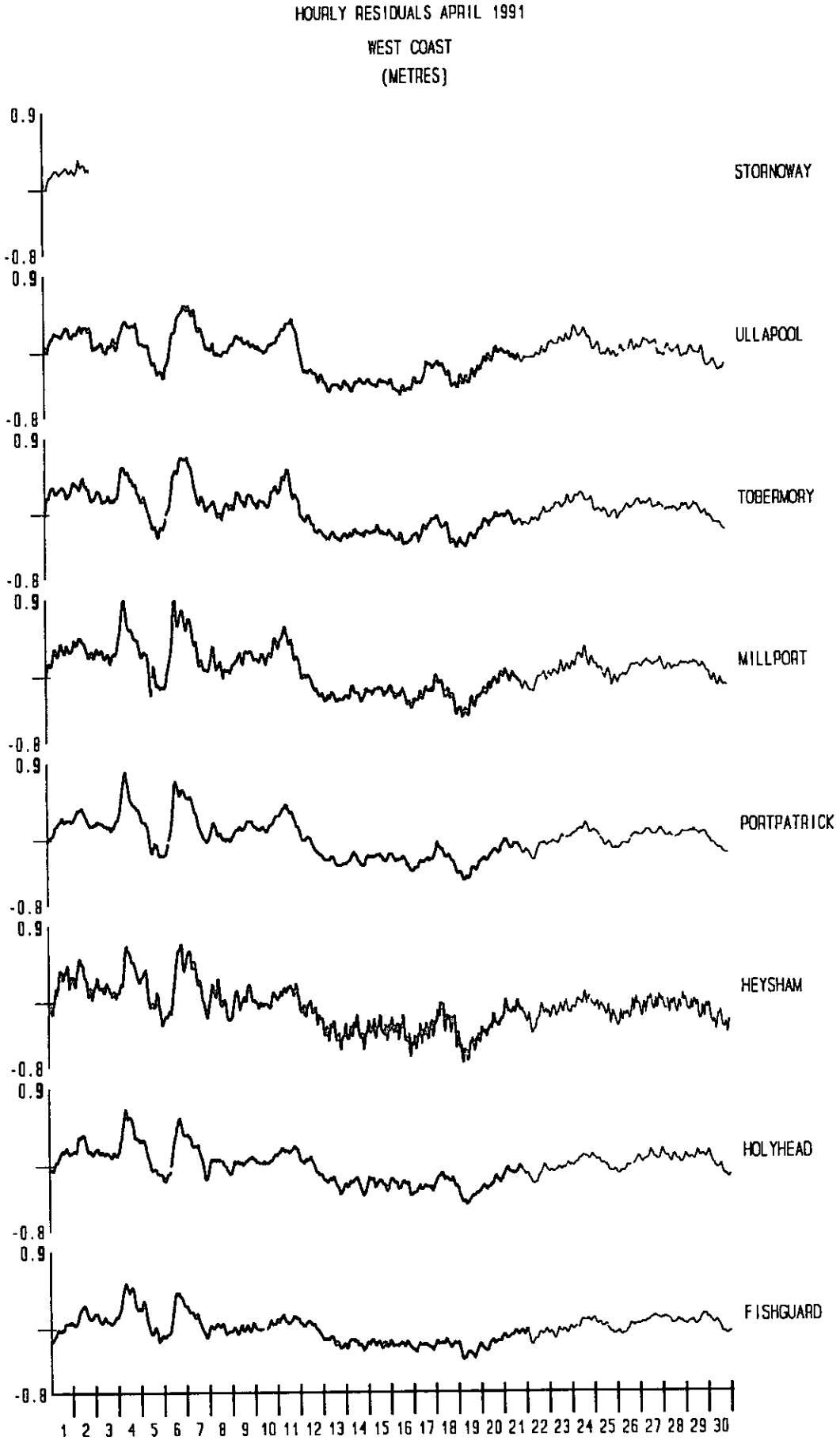


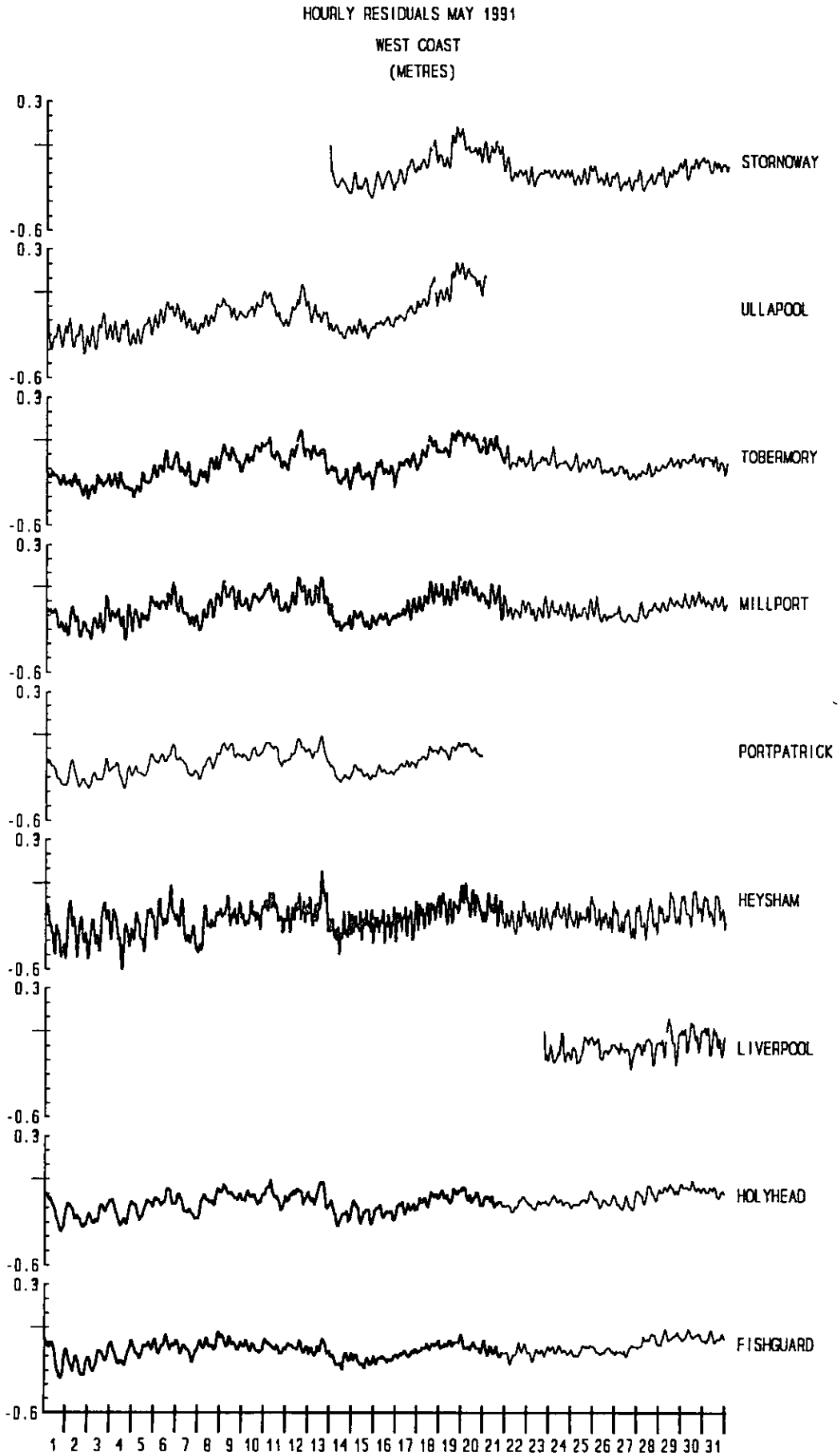
December 23
2.023m at Hinkley Point (poor quality predicted levels)
1.066m at Barmouth
No record available for Avonmouth or Mumbles.
Squally conditions in gale with winds veering NWly with passage of frontal trough.

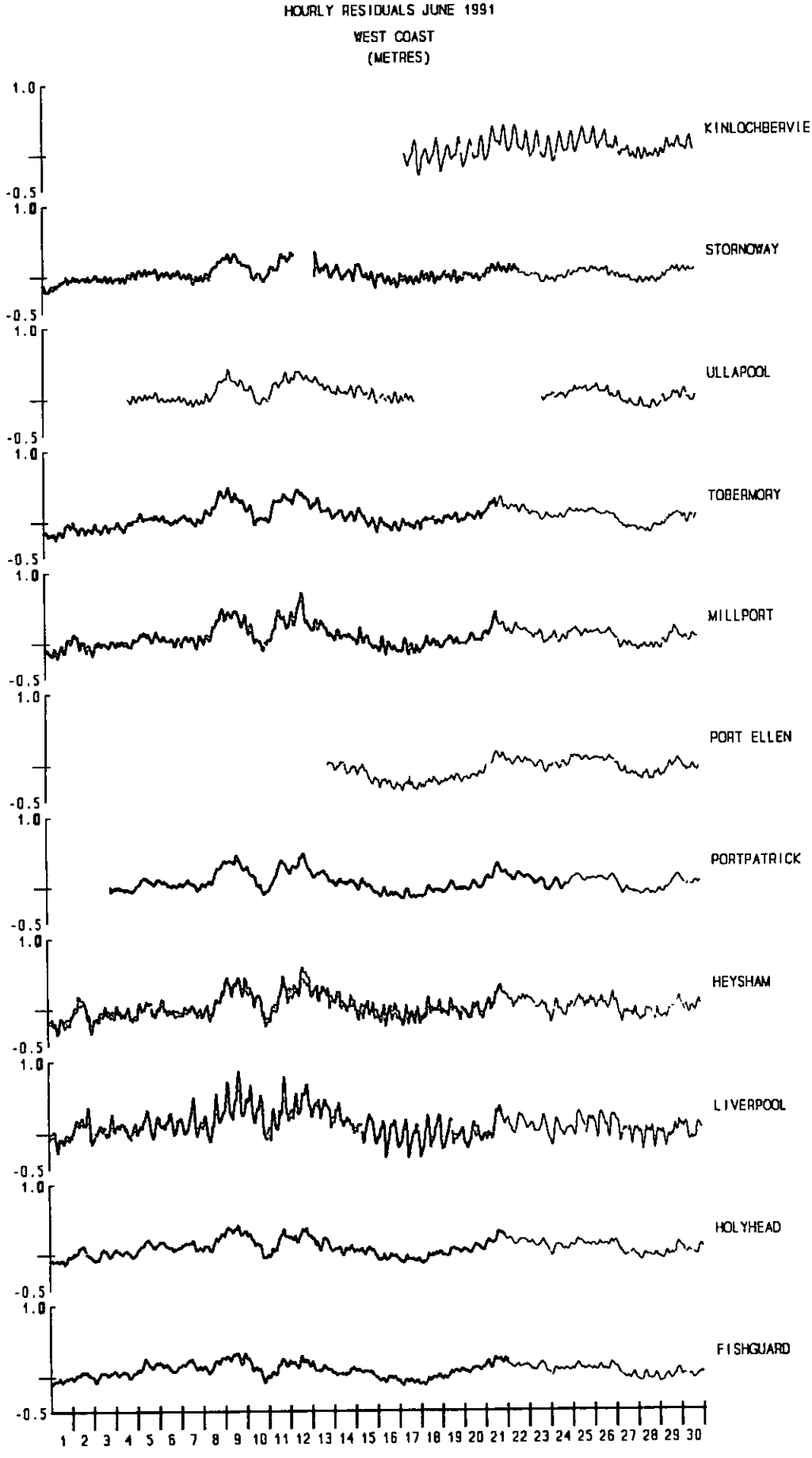

HOURLY RESIDUALS JANUARY 1991
WEST COAST
(METRES)
2.5
-0.6
STORNOWAY
ULLAPOOL
TOBERMORY
MILLPORT
PORTPATRICK
HEYSHAM
HOLYHEAD
FISHGUARD
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31

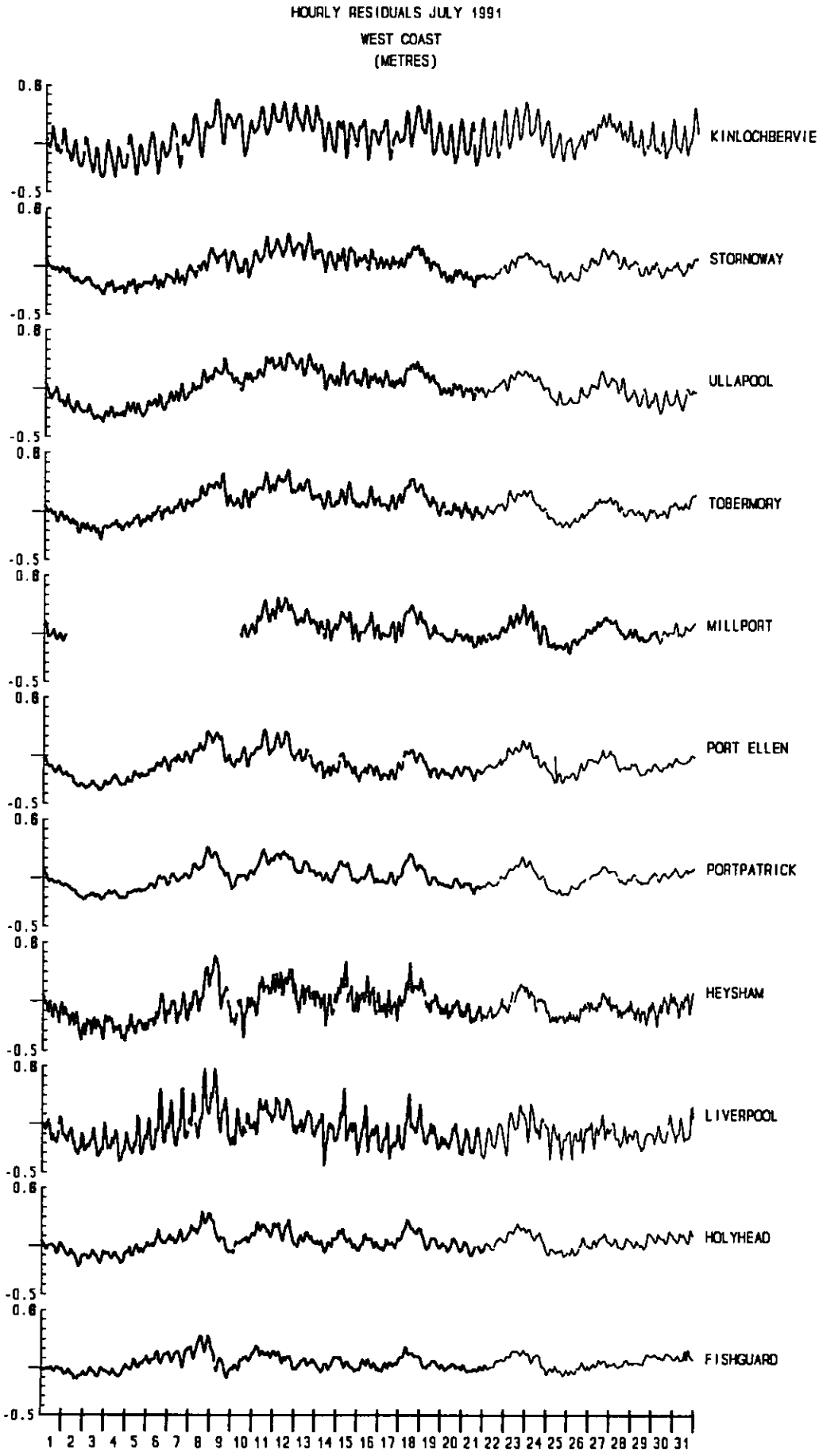

HOURLY RESIDUALS FEBRUARY 1991
WEST COAST
(METRES)
0.7
-0.7
STORNOWAY
ULLAPOOL
TOBERMORY
MILLPORT
PORTPATRICK
HEYSHAM
HOLYHEAD
FISHGUARD
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28

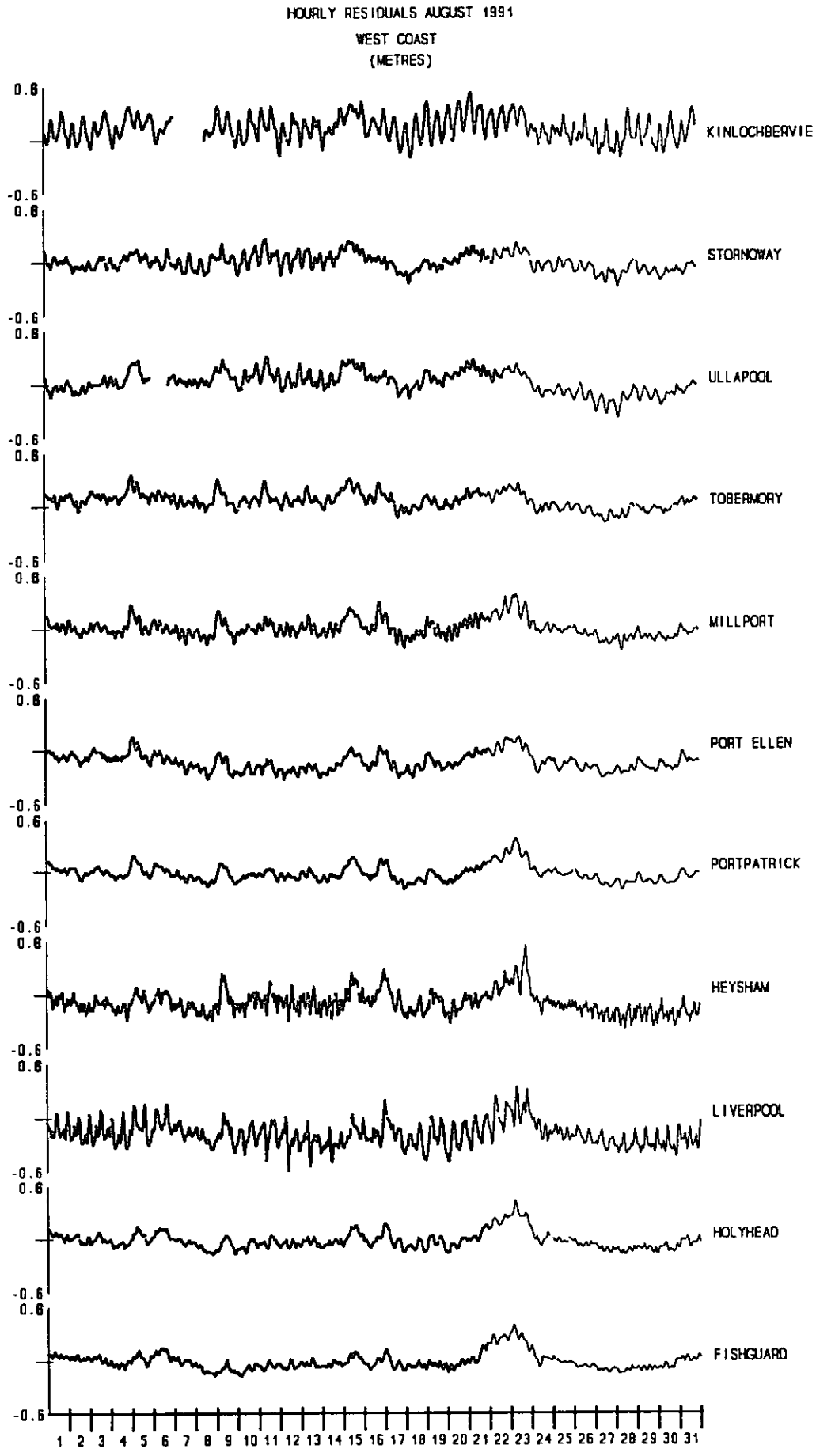

HOURLY RESIDUALS MARCH 1991
WEST COAST
(METRES)
0.9
-0.6
STORNOWAY
ULLAPOOL
TOBERMORY
MILLPORT
PORTPATRICK
HEYSHAM
HOLYHEAD
FISHGUARD
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31

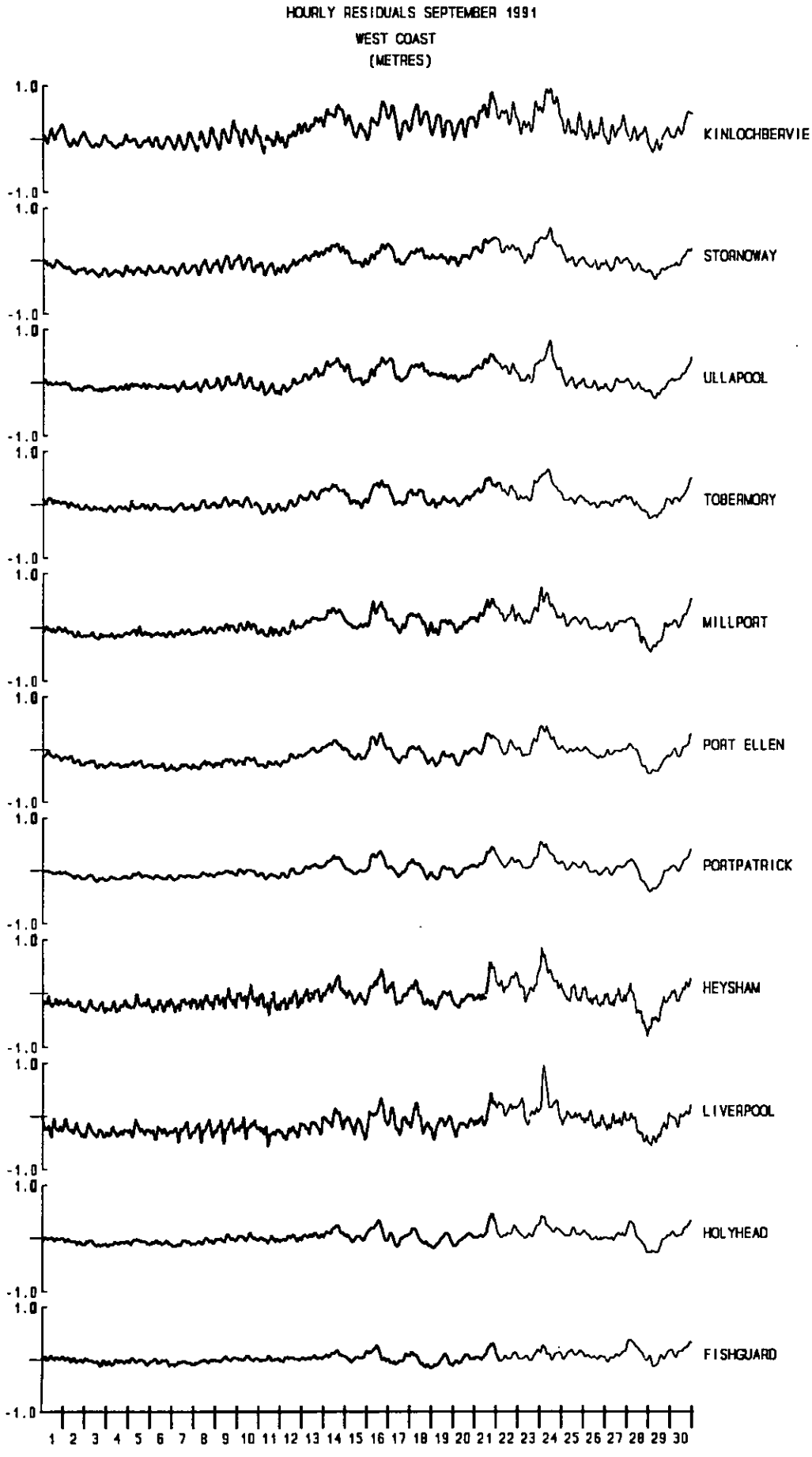

HOURLY RESIDUALS APRIL 1991
WEST COAST
(METRES)
0.9
-0.8
STORNOWAY
ULLAPOOL
TOBERMORY
MILLPORT
PORTPATRICK
HEYSHAM
HOLYHEAD
FISHGUARD
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30

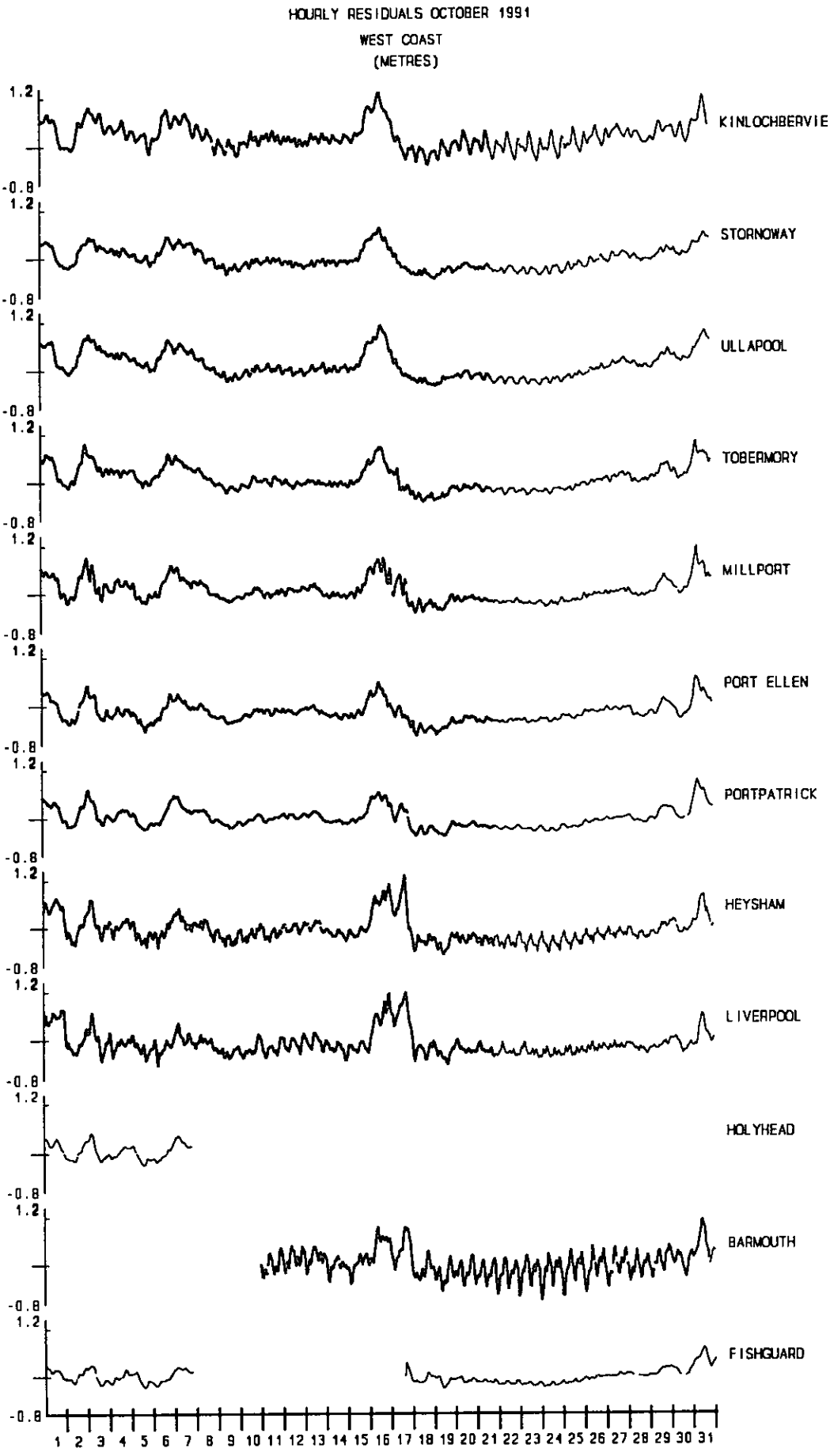

HOURLY RESIDUALS MAY 1991
WEST COAST
(METRES)
0.3
-0.6
STORNOWAY
ULLAPOOL
TOBERMORY
MILLPORT
PORTPATRICK
HEYSHAM
LIVERPOOL
HOLYHEAD
FISHGUARD
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31

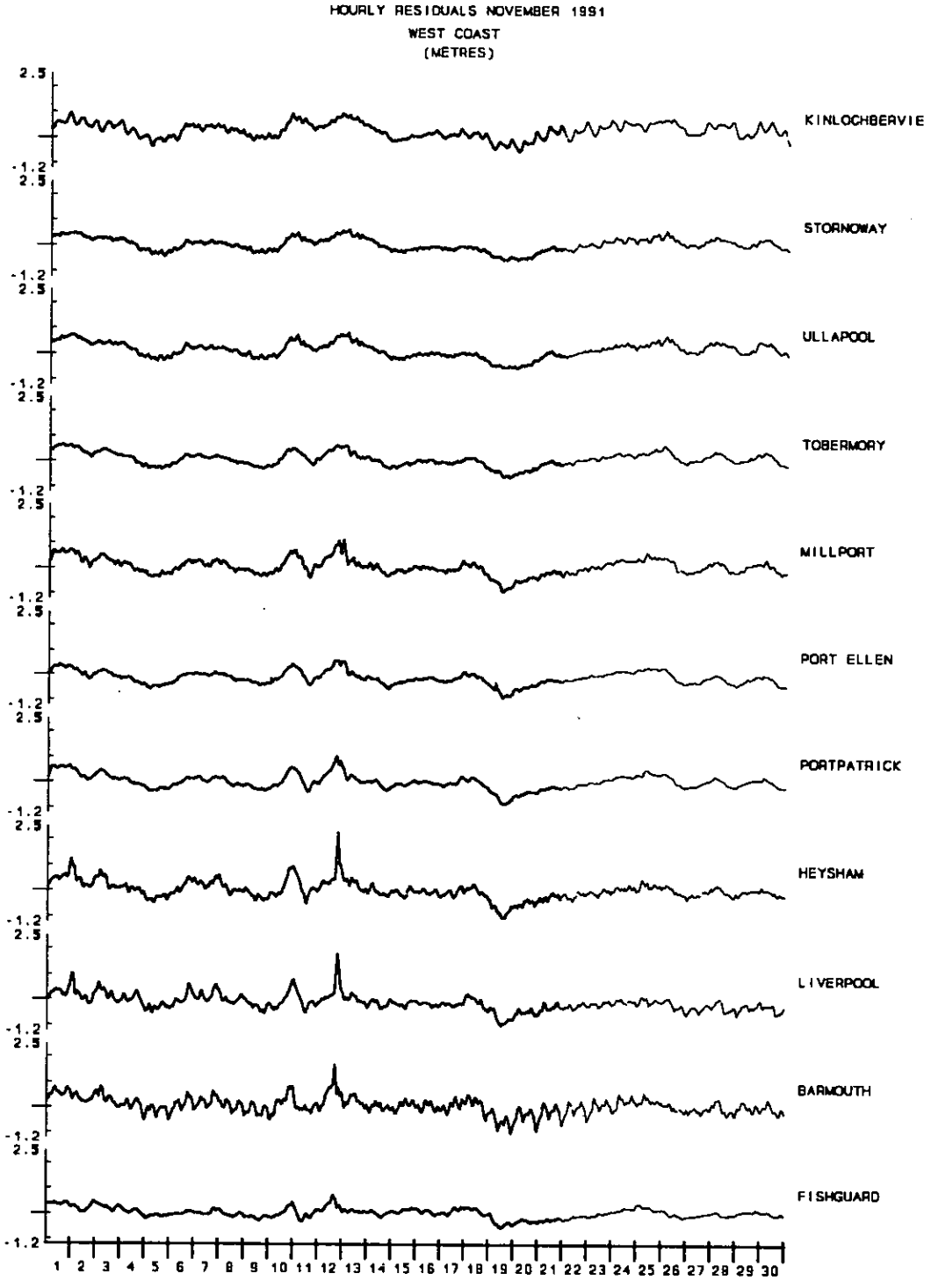

HOURLY RESIDUALS JUNE 1991
WEST COAST
(METRES)
KINLOCHBERVIE
STORNOWAY
ULLAPOOL
TOBERMORY
MILLPORT
PORT ELLEN
PORTPATRICK
HEYSHAM
LIVERPOOL
HOLYHEAD
FISHGUARD
1.0
-0.5
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30

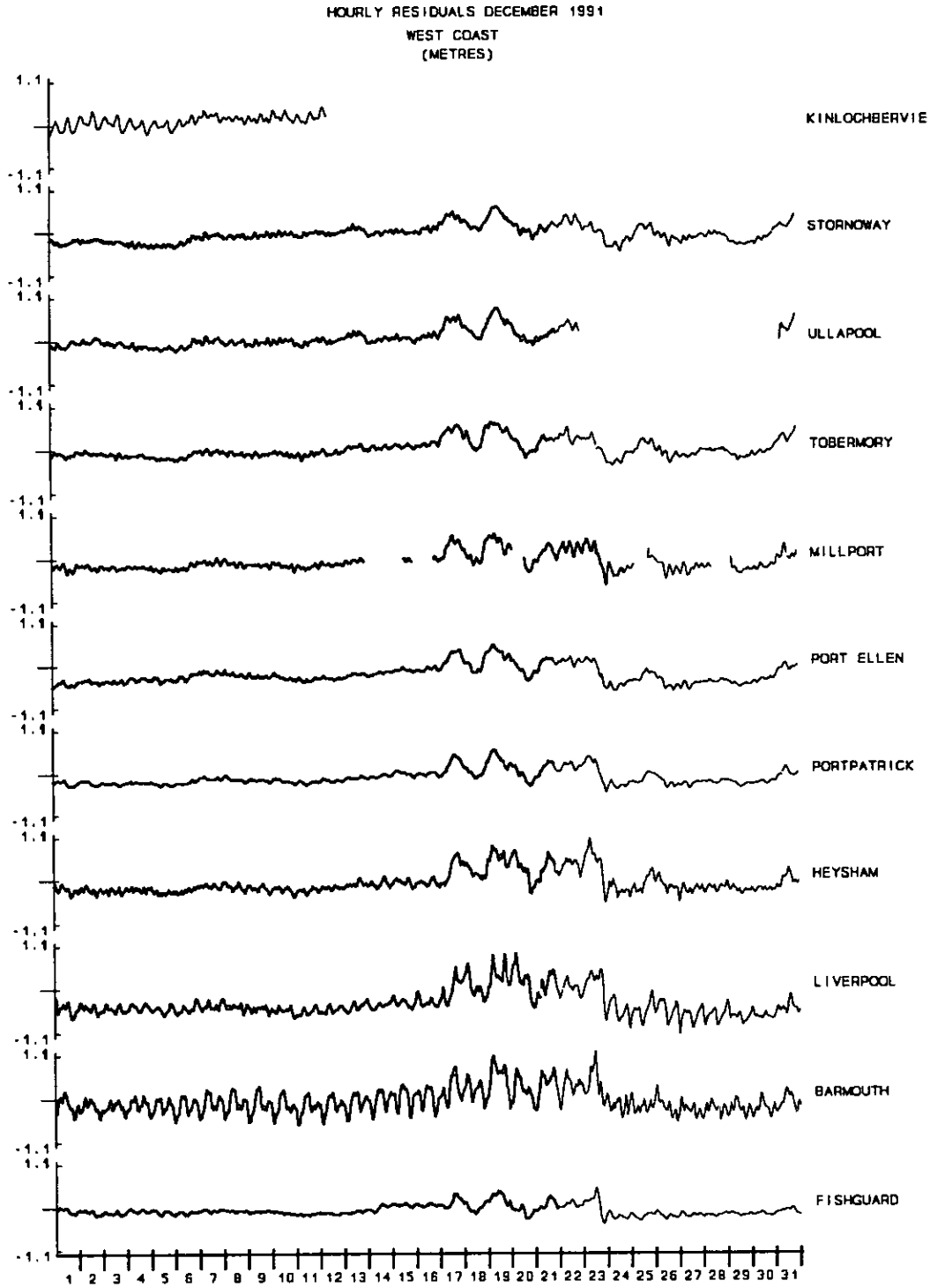

HOURLY RESIDUALS JULY 1991
WEST COAST
(METRES)
KINLOCHBERVIE
STORNOWAY
ULLAPOOL
TOBERMORY
MILLPORT
PORT ELLEN
PORTPATRICK
HEYSHAM
LIVERPOOL
HOLYHEAD
FISHGUARD
0.8
-0.5
0.6
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31


HOURLY RESIDUALS AUGUST 1991
WEST COAST
(METRES)
0.6
-0.6
KINLOCHBERVIE
STORNOWAY
ULLAPOOL
TOBERMORY
MILLPORT
PORT ELLEN
PORTPATRICK
HEYSHAM
LIVERPOOL
HOLYHEAD
FISHGUARD
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

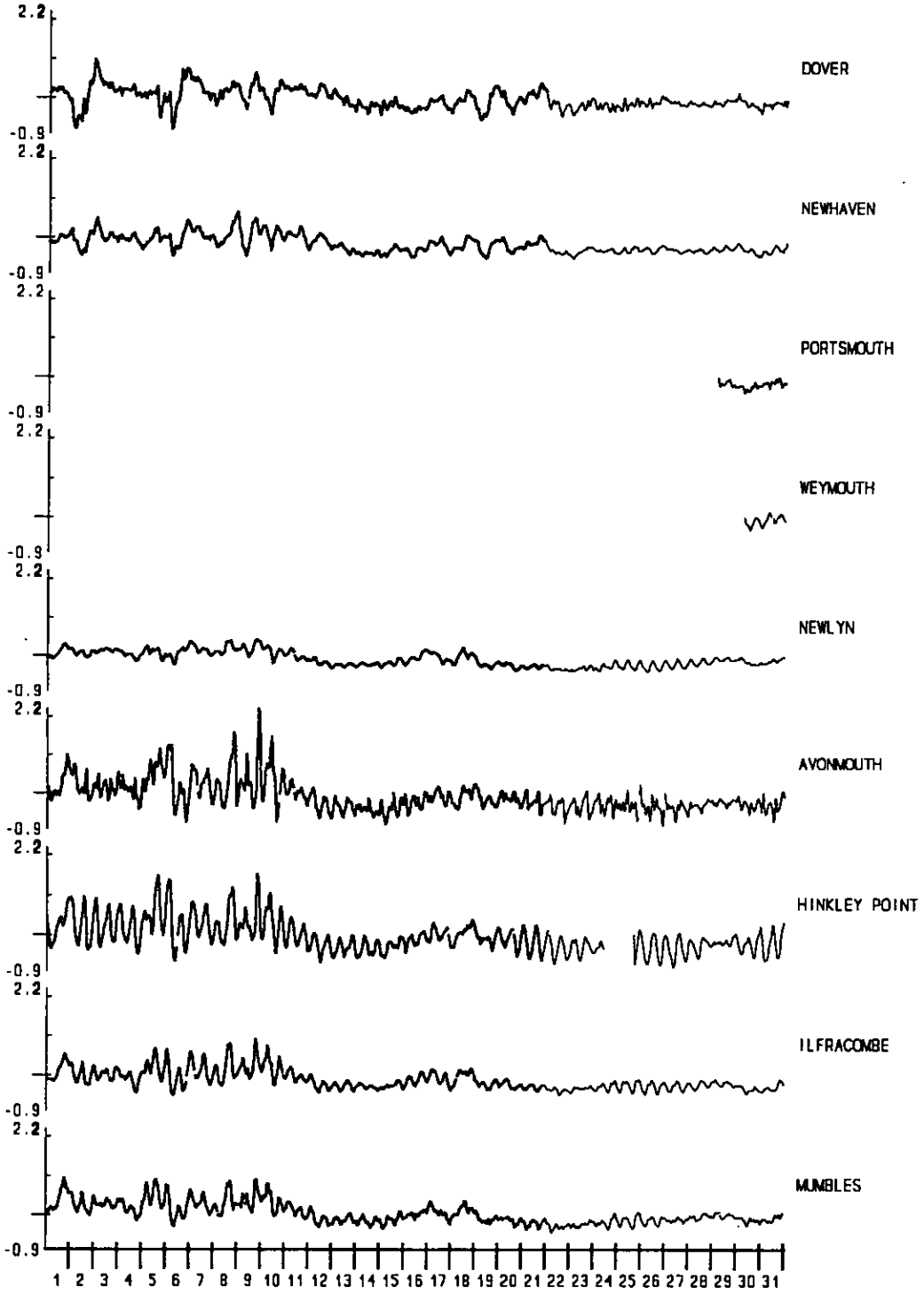

HOURLY RESIDUALS SEPTEMBER 1991
WEST COAST
(METRES)
KINLOCHBERVIE
STORNOWAY
ULLAPOOL
TOBERMORY
MILLPORT
PORT ELLEN
PORTPATRICK
HEYSHAM
LIVERPOOL
HOLYHEAD
FISHGUARD
1.0
-1.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30

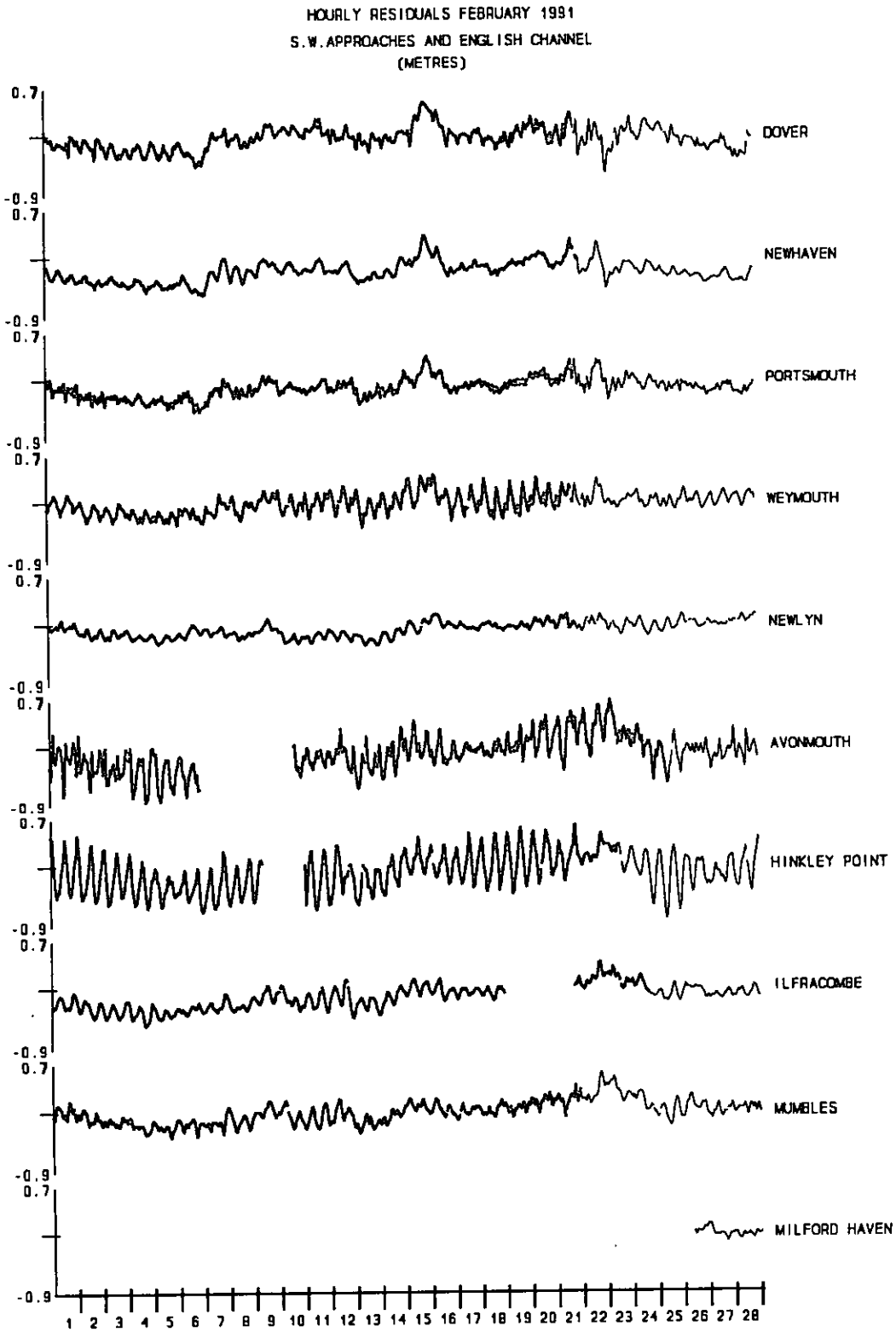

HOURLY RESIDUALS OCTOBER 1991
WEST COAST
(METRES)
1.2
-0.8
KINLOCHBERVIE
STORNOWAY
ULLAPOOL
TOBERMORY
MILLPORT
PORT ELLEN
PORTPATRICK
HEYSHAM
LIVERPOOL
HOLYHEAD
BARMOUTH
FISHGUARD
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31

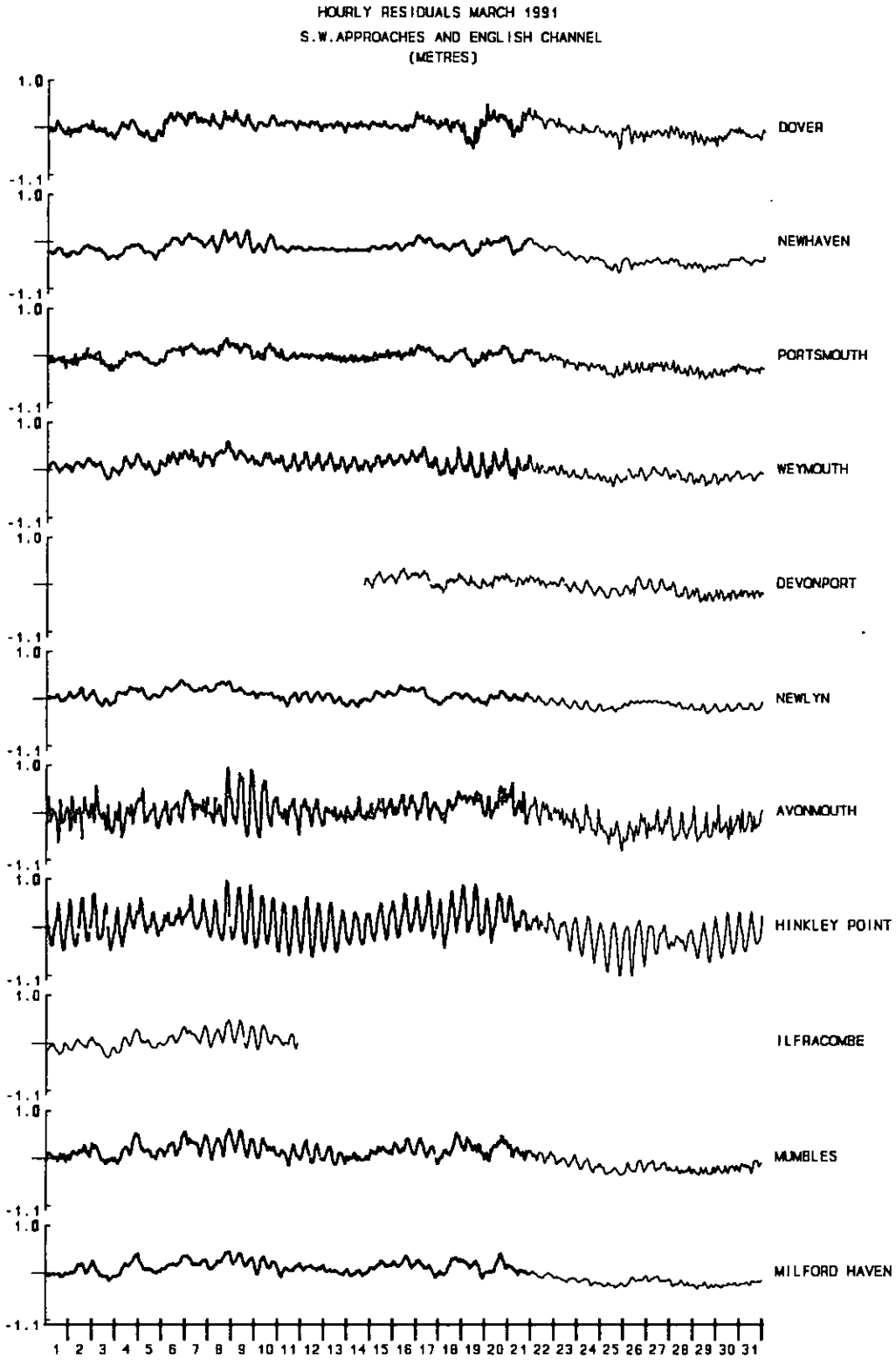

HOURLY RESIDUALS NOVEMBER 1991
WEST COAST
(METRES)
2.5
-1.2
KINLOCHBERVIE
STORNOWAY
ULLAPOOL
TOBERMORY
MILLPORT
PORT ELLEN
PORTPATRICK
HEYSHAM
LIVERPOOL
BARMOUTH
FISHGUARD
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30

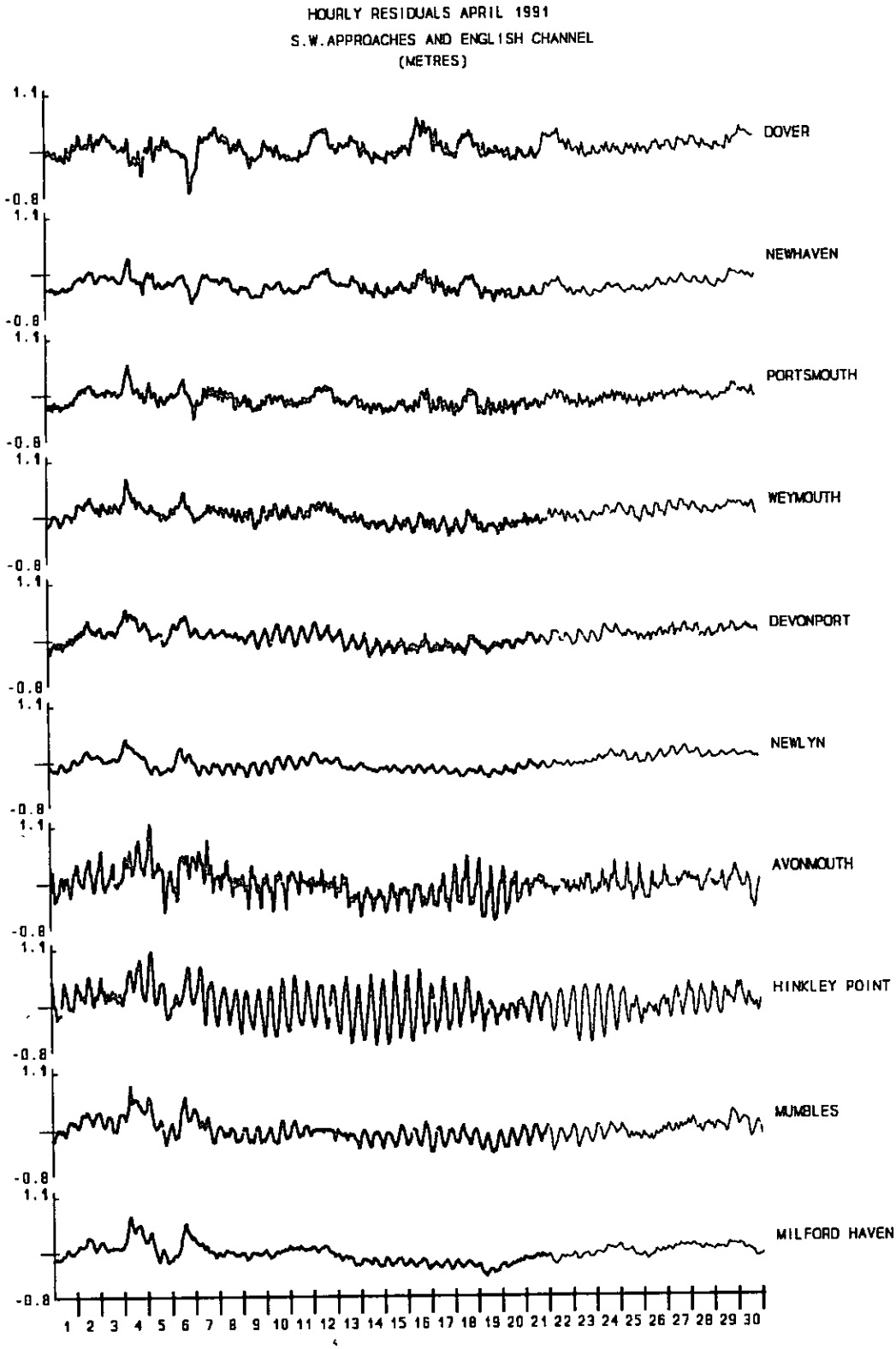

HOURLY RESIDUALS DECEMBER 1991
WEST COAST
(METRES)
1.1
-1.1
KINLOCHBERVIE
STORNOWAY
ULLAPOOL
TOBERMORY
MILLPORT
PORT ELLEN
PORTPATRICK
HEYSHAM
LIVERPOOL
BARMOUTH
FISHGUARD
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31

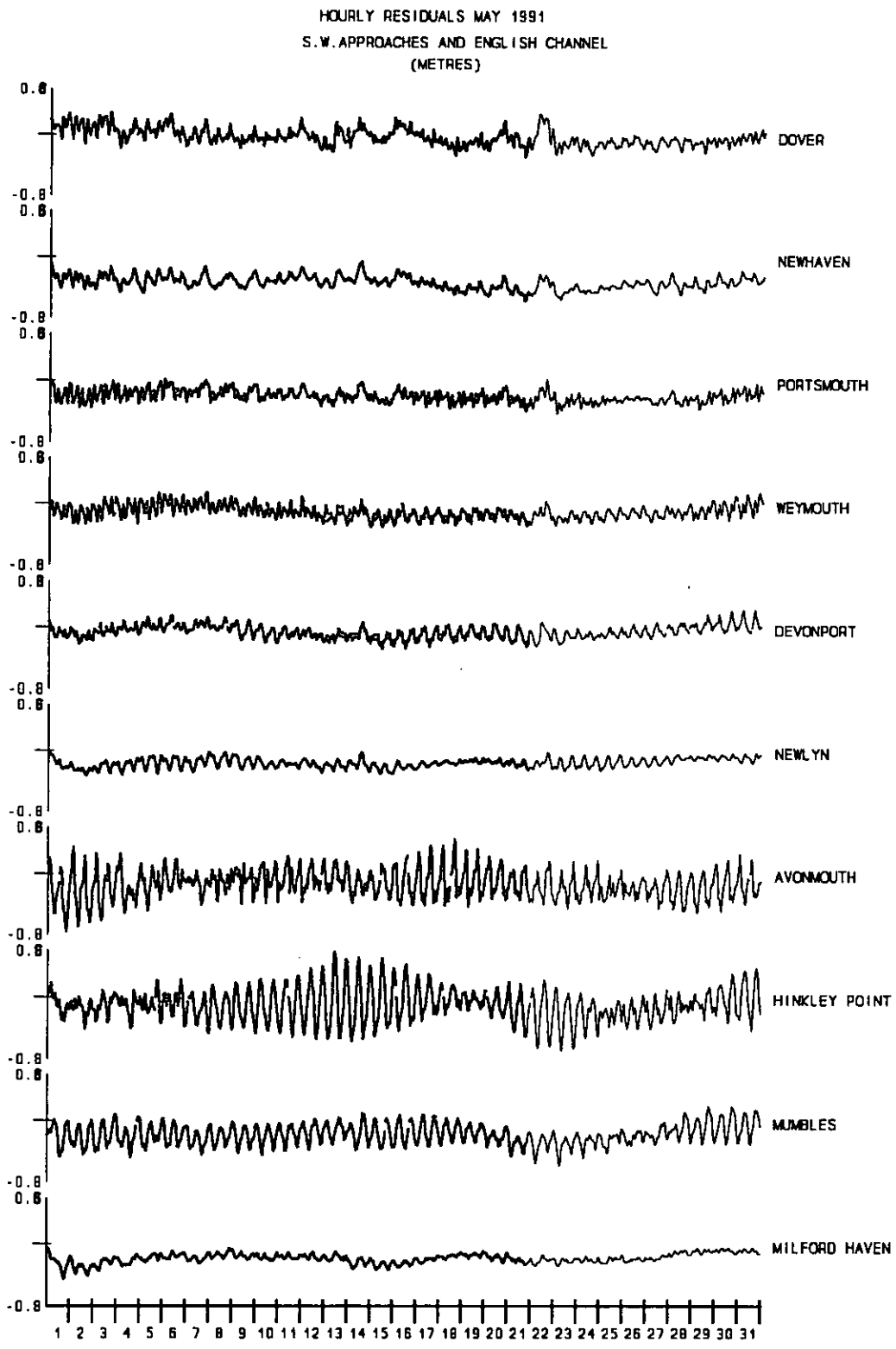
HOURLY RESIDUALS JANUARY 1991
S.W.APPROACHES AND ENGLISH CHANNEL
(METRES)

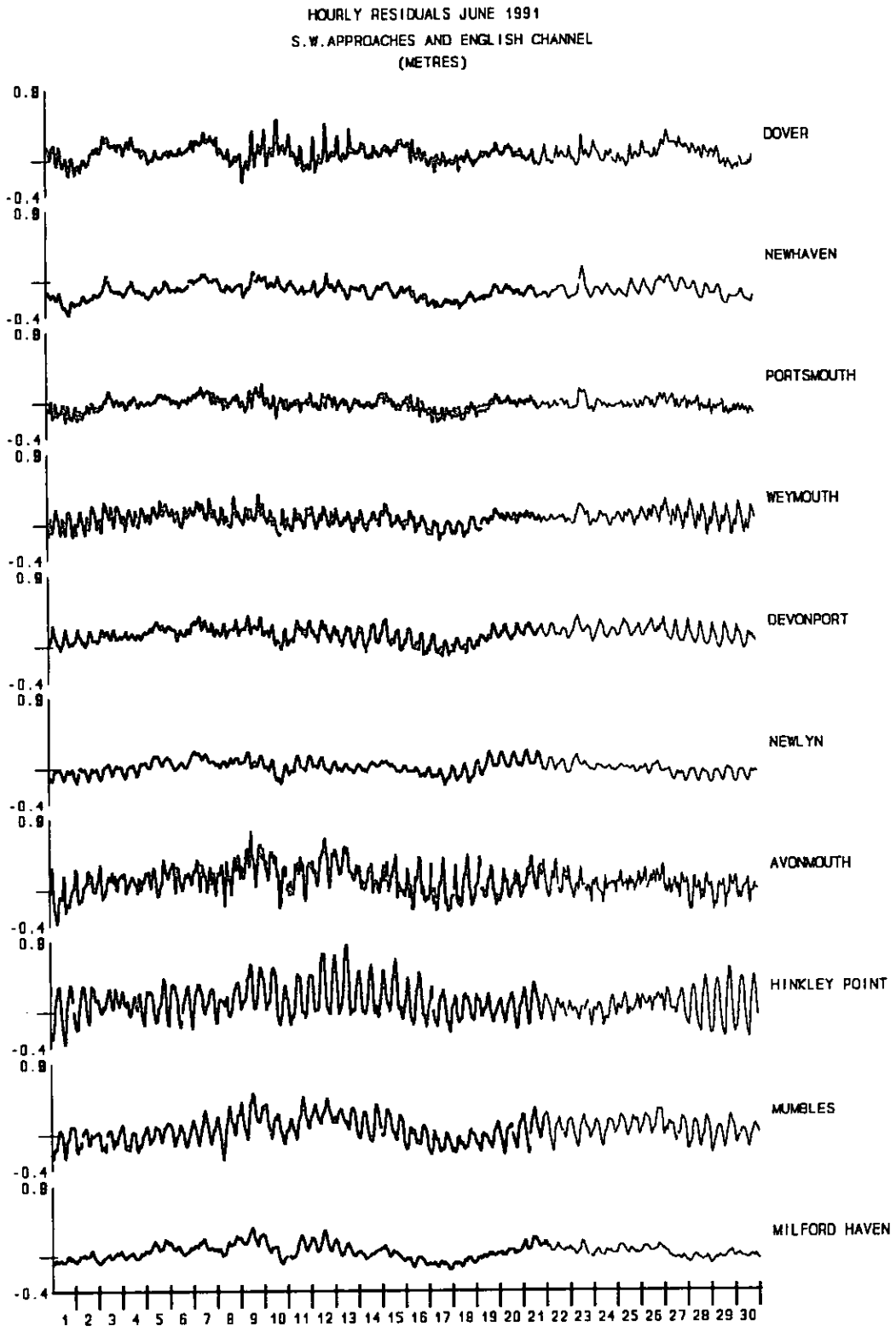


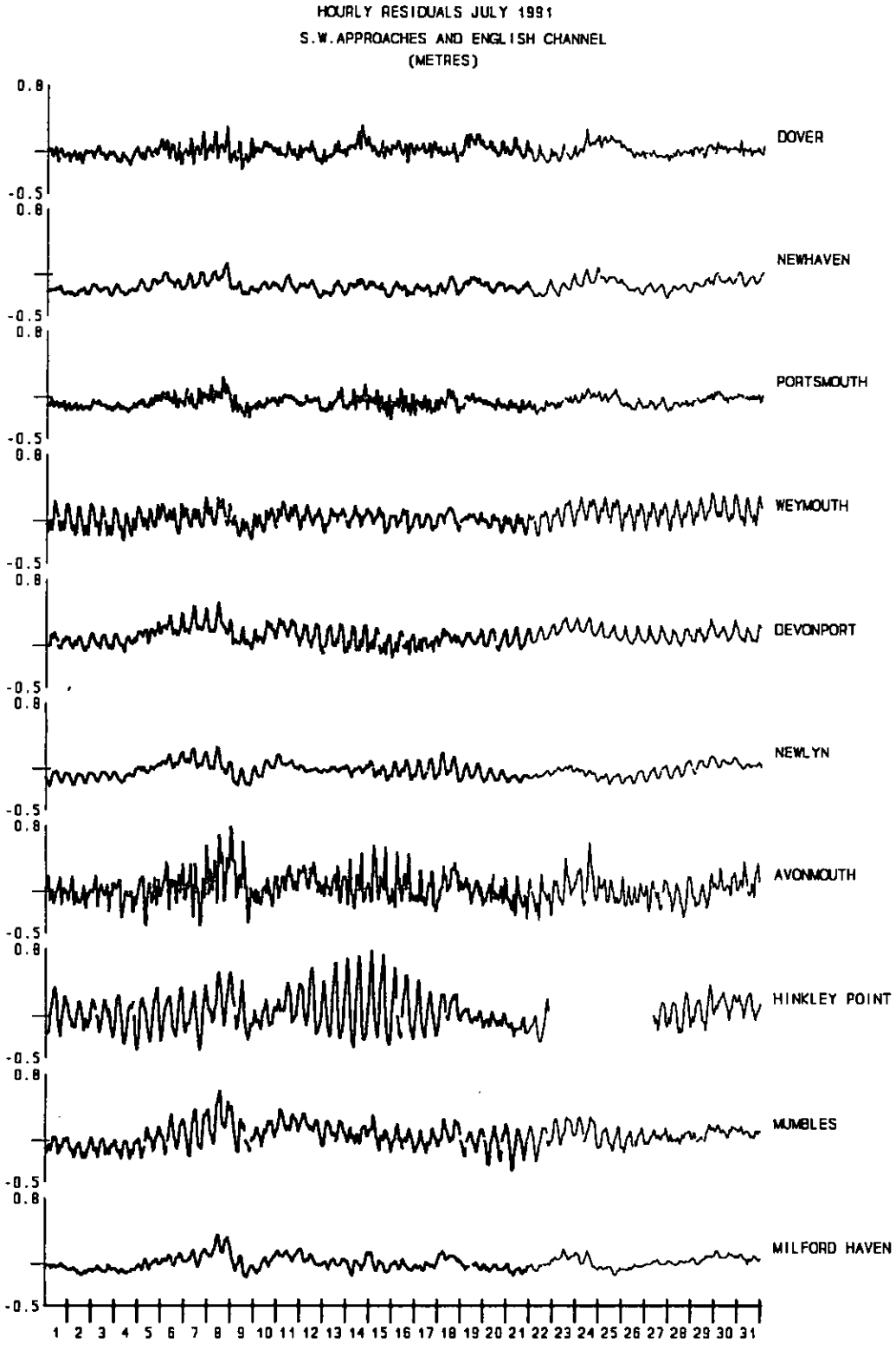

HOURLY RESIDUALS FEBRUARY 1991
S.W.APPROACHES AND ENGLISH CHANNEL
(METRES)
0.7
-0.9
DOVER
NEWHAVEN
PORTSMOUTH
WEYMOUTH
NEWLYN
AVONMOUTH
HINKLEY POINT
ILFRACOMBE
MUMBLES
MILFORD HAVEN
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28

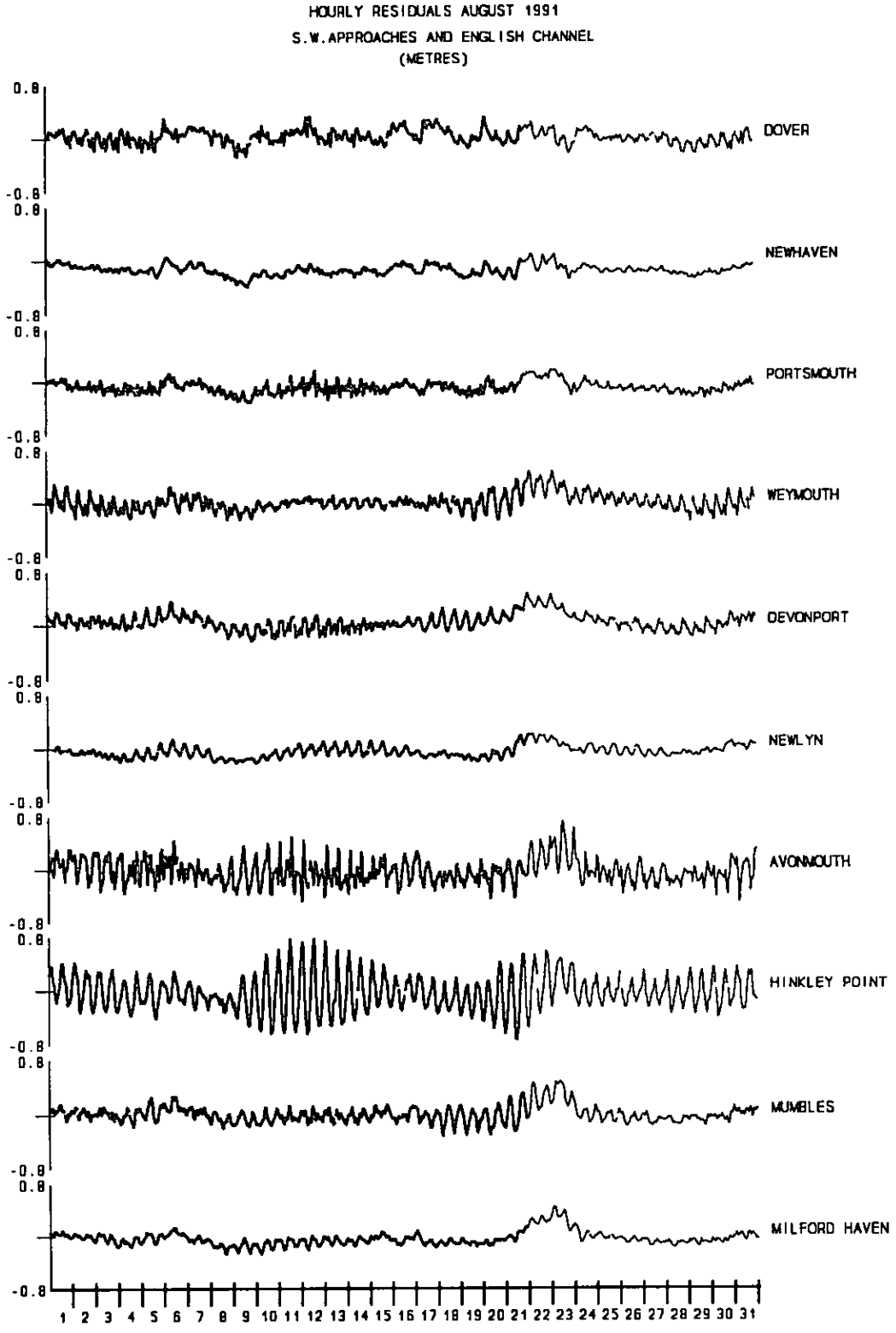

HOURLY RESIDUALS MARCH 1991
S.W.APPROACHES AND ENGLISH CHANNEL
(METRES)
1.0
-1.1
DOVER
NEWHAVEN
PORTSMOUTH
WEYMOUTH
DEVONPORT
NEWLYN
AVONMOUTH
HINKLEY POINT
ILFRACOMBE
MUMBLES
MILFORD HAVEN
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31

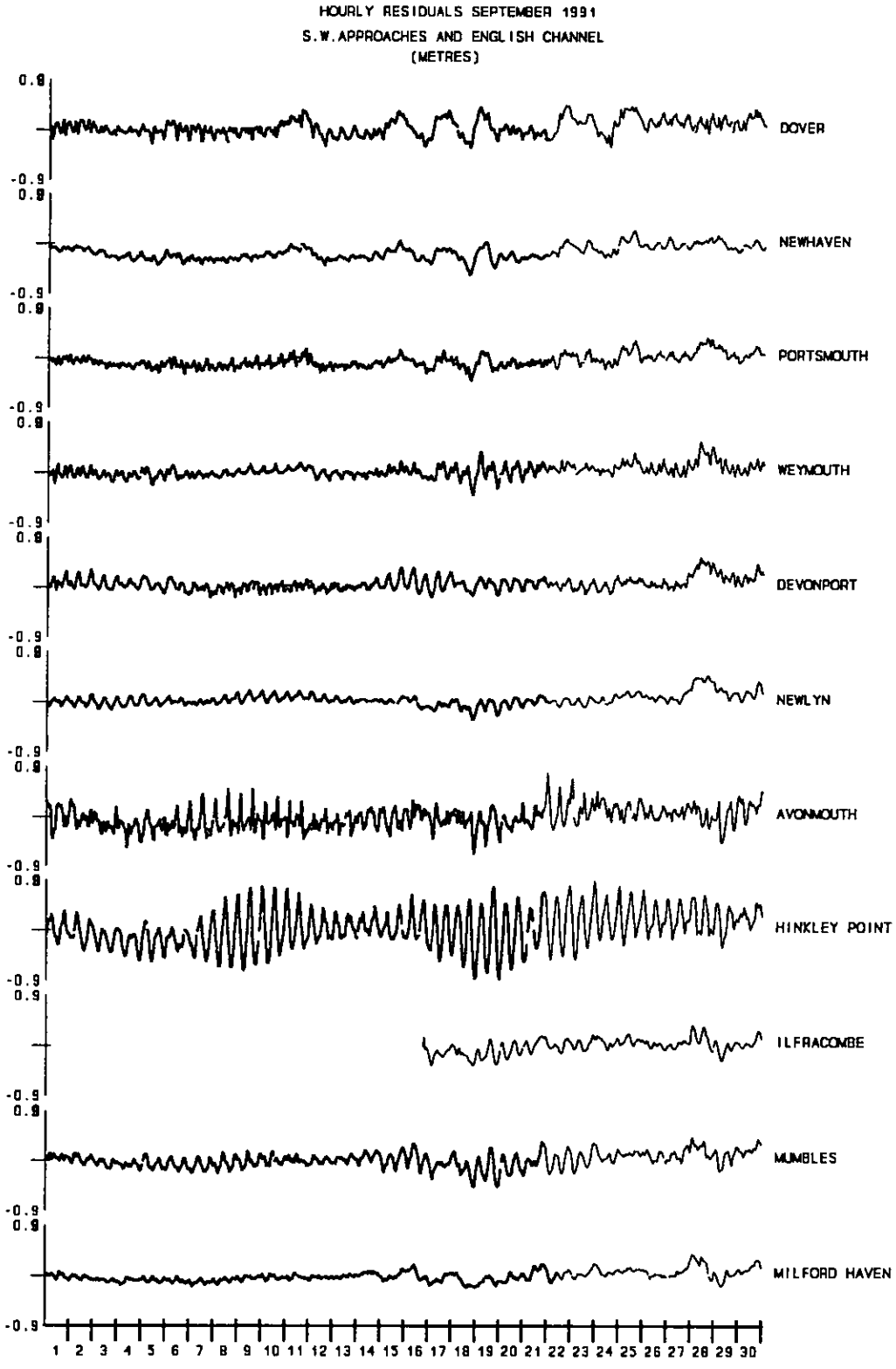

HOURLY RESIDUALS APRIL 1991
S.W. APPROACHES AND ENGLISH CHANNEL
(METRES)
1.1
-0.8
DOVER
NEWHAVEN
PORTSMOUTH
WEYMOUTH
DEVONPORT
NEWLYN
AVONMOUTH
HINKLEY POINT
MUMBLES
MILFORD HAVEN
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30

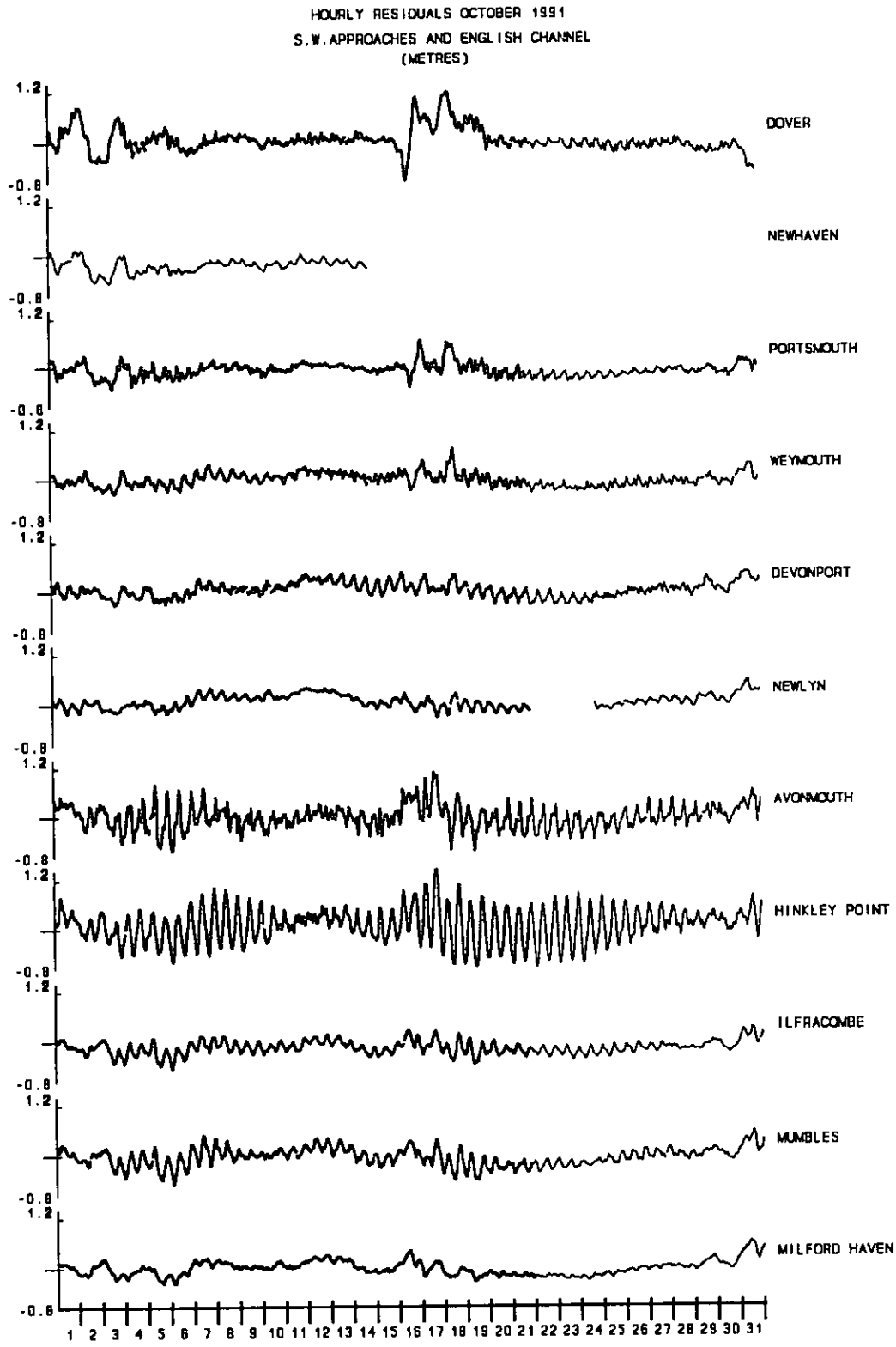

HOURLY RESIDUALS MAY 1991
S.W.APPROACHES AND ENGLISH CHANNEL
(METRES)
0.8
-0.8
DOVER
NEWHAVEN
PORTSMOUTH
WEYMOUTH
DEVONPORT
NEWLYN
AVONMOUTH
HINKLEY POINT
MUMBLES
MILFORD HAVEN
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31

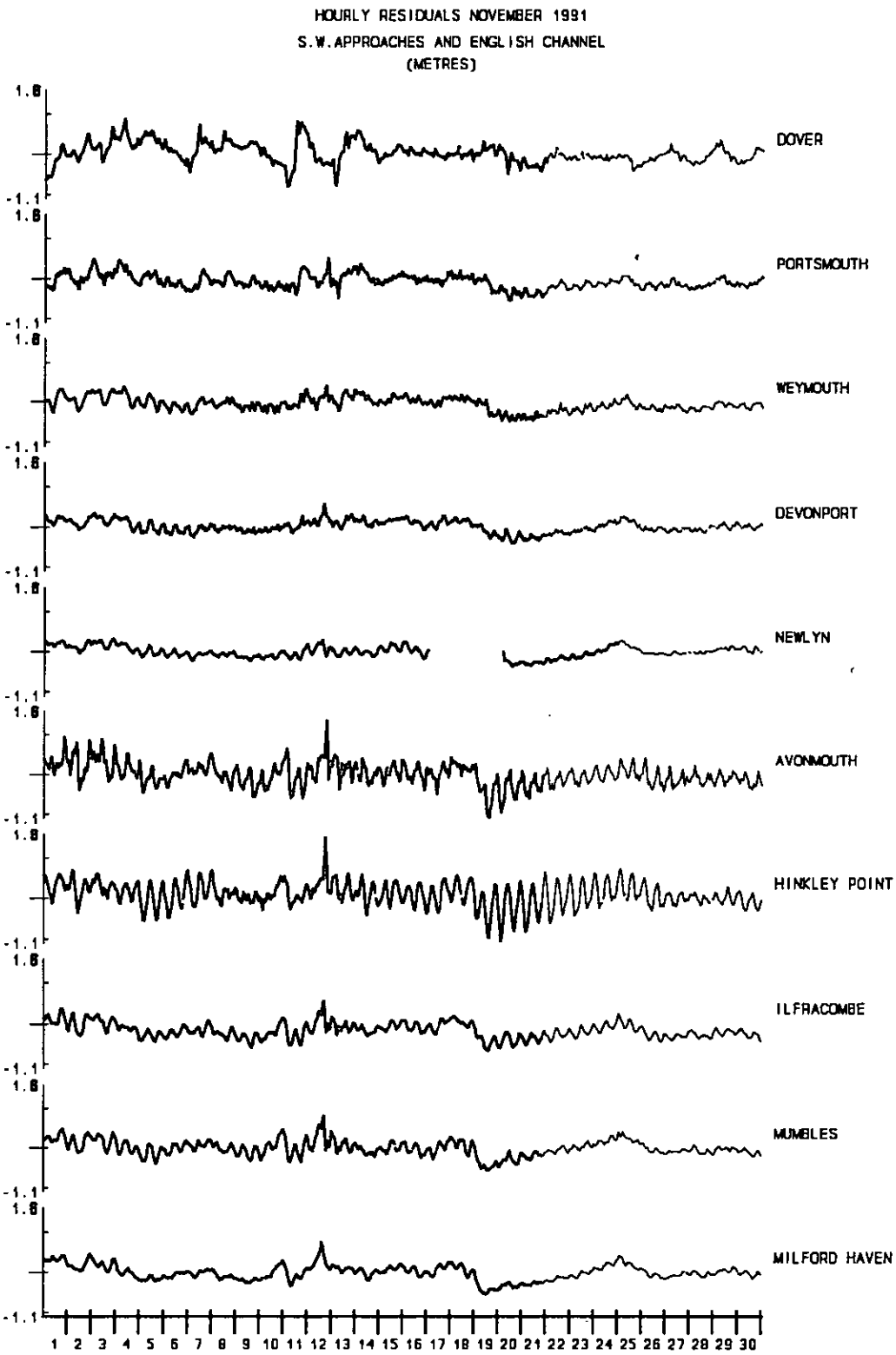

HOURLY RESIDUALS JUNE 1991
S.W. APPROACHES AND ENGLISH CHANNEL
(METRES)
0.8
-0.4
DOVER
NEWHAVEN
PORTSMOUTH
WEYMOUTH
DEVONPORT
NEWLYN
AVONMOUTH
HINKLEY POINT
MUMBLES
MILFORD HAVEN
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30

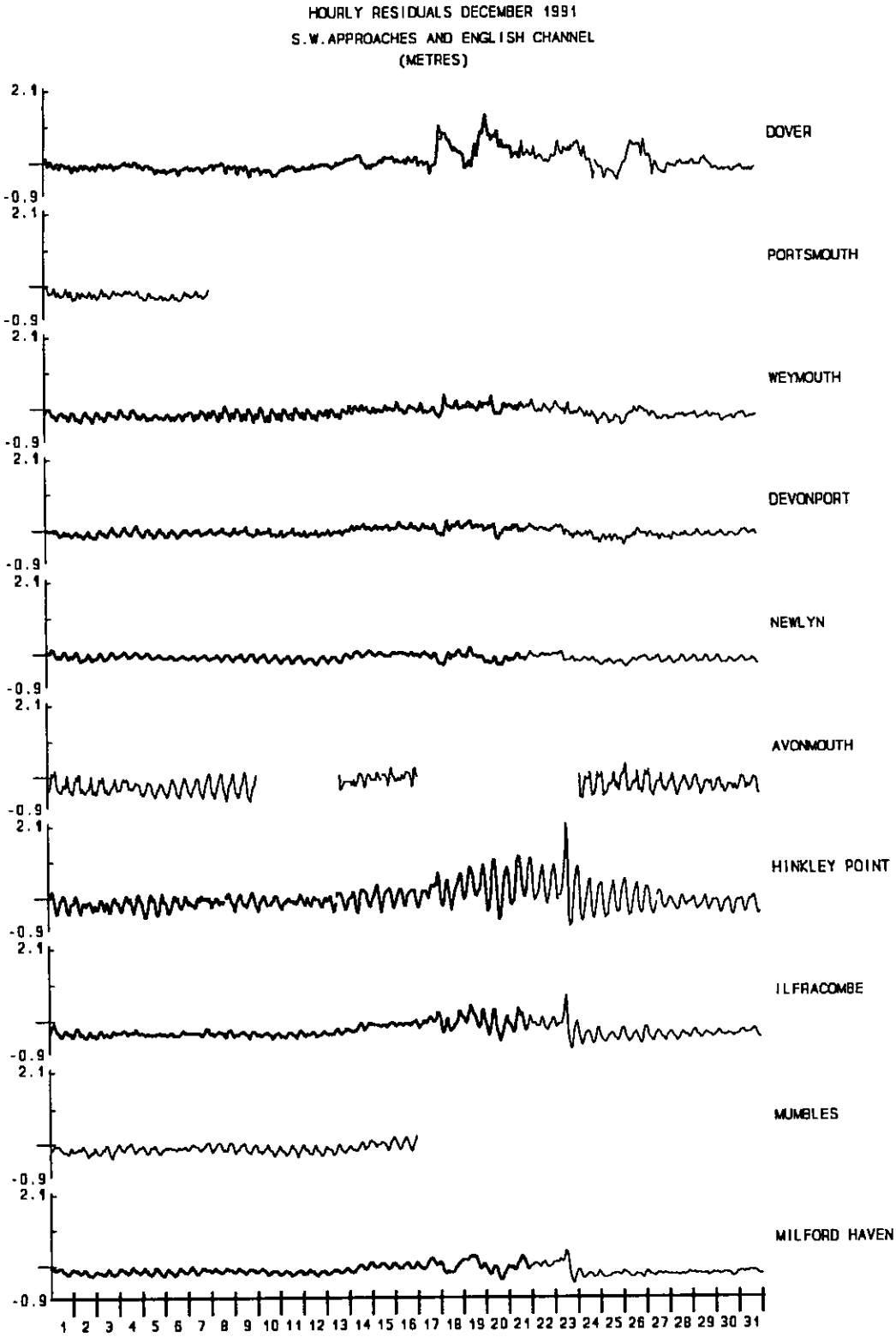

HOURLY RESIDUALS JULY 1991
S.W. APPROACHES AND ENGLISH CHANNEL
(METRES)
0.8
-0.5
DOVER
NEWHAVEN
PORTSMOUTH
WEYMOUTH
DEVONPORT
NEWLYN
AVONMOUTH
HINKLEY POINT
MUMBLES
MILFORD HAVEN
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31

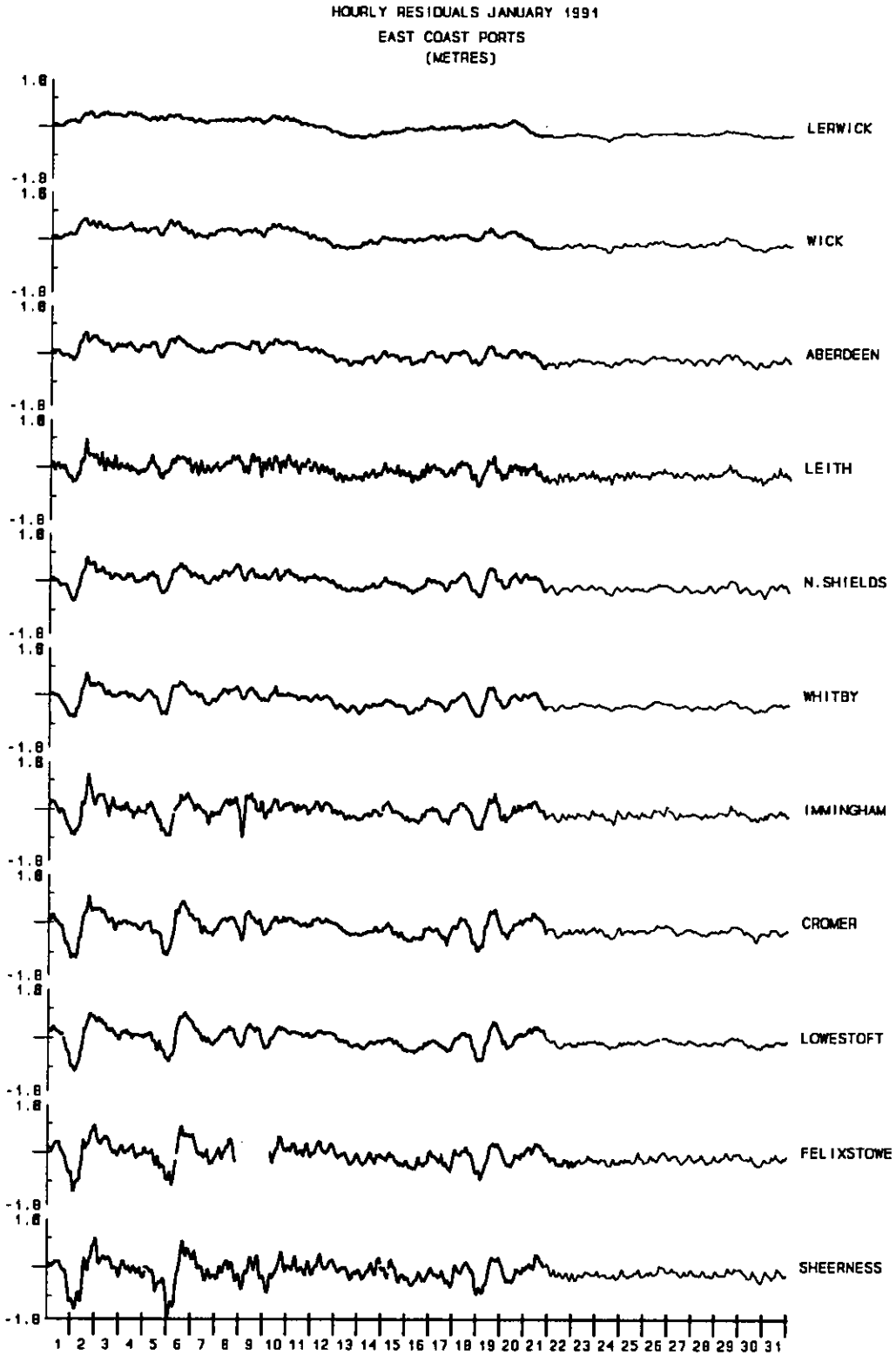

HOURLY RESIDUALS AUGUST 1991
S.W.APPROACHES AND ENGLISH CHANNEL
(METRES)
0.8
-0.8
DOVER
NEWHAVEN
PORTSMOUTH
WEYMOUTH
DEVONPORT
NEWLYN
AVONMOUTH
HINKLEY POINT
MUMBLES
MILFORD HAVEN
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31

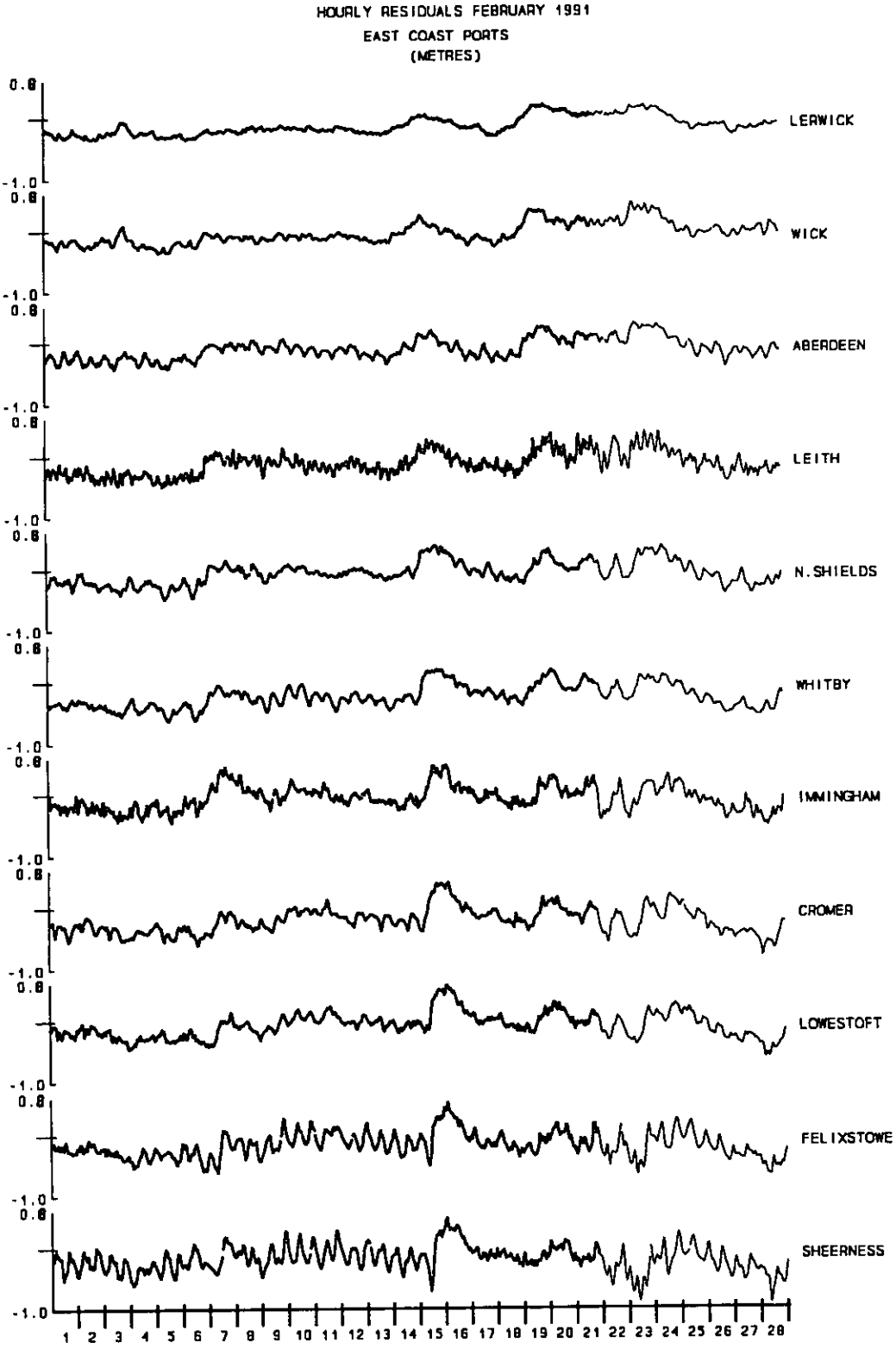

HOURLY RESIDUALS SEPTEMBER 1991
S.W.APPROACHES AND ENGLISH CHANNEL
(METRES)
0.9
-0.9
DOVER
NEWHAVEN
PORTSMOUTH
WEYMOUTH
DEVONPORT
NEWLYN
AVONMOUTH
HINKLEY POINT
ILFRACOMBE
MUMBLES
MILFORD HAVEN
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30

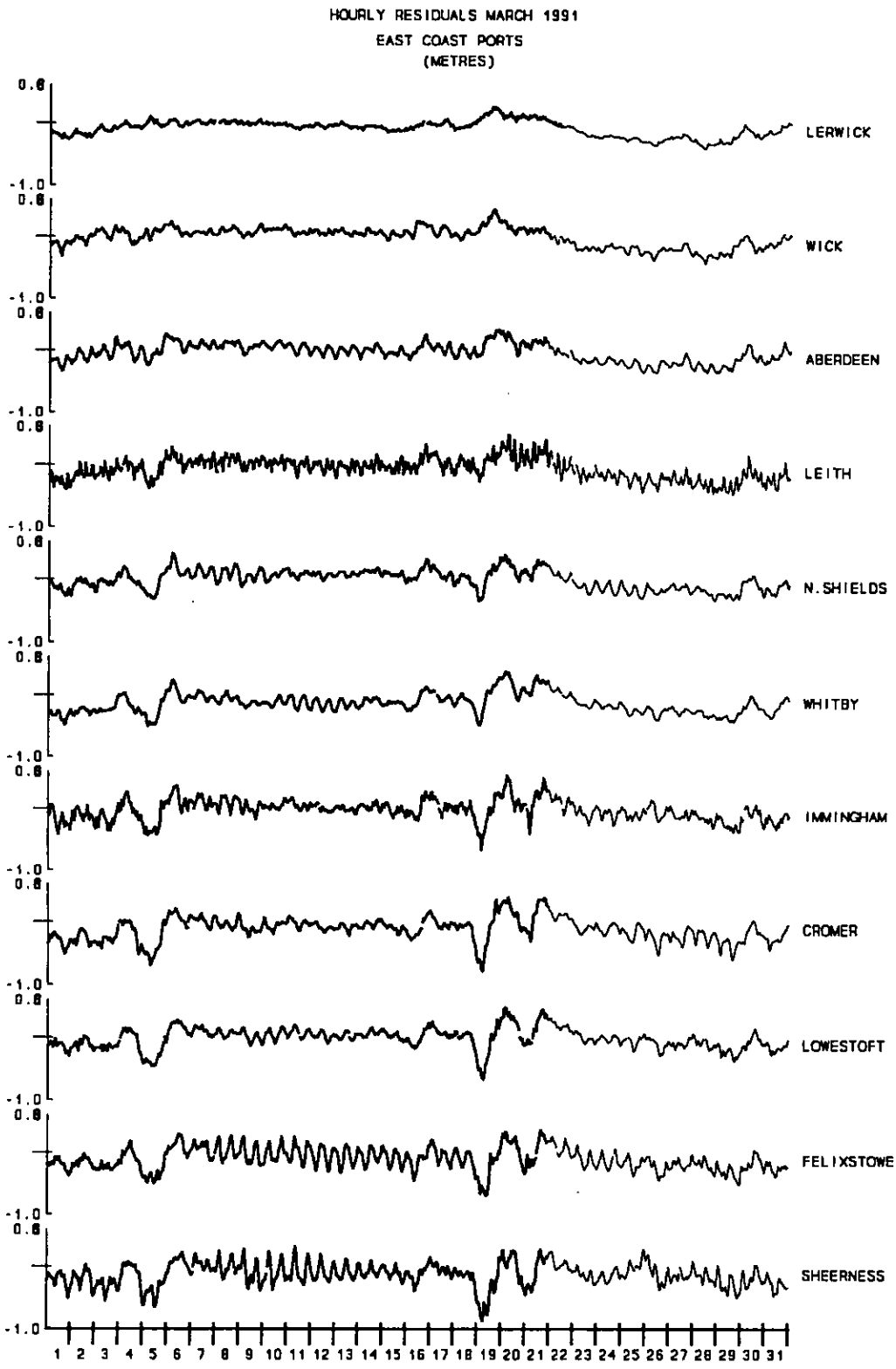

HOURLY RESIDUALS OCTOBER 1991
S.W. APPROACHES AND ENGLISH CHANNEL
(METRES)
1.2
-0.8
DOVER
NEWHAVEN
PORTSMOUTH
WEYMOUTH
DEVONPORT
NEWLYN
AVONMOUTH
HINKLEY POINT
ILFRACOMBE
MUMBLES
MILFORD HAVEN
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31

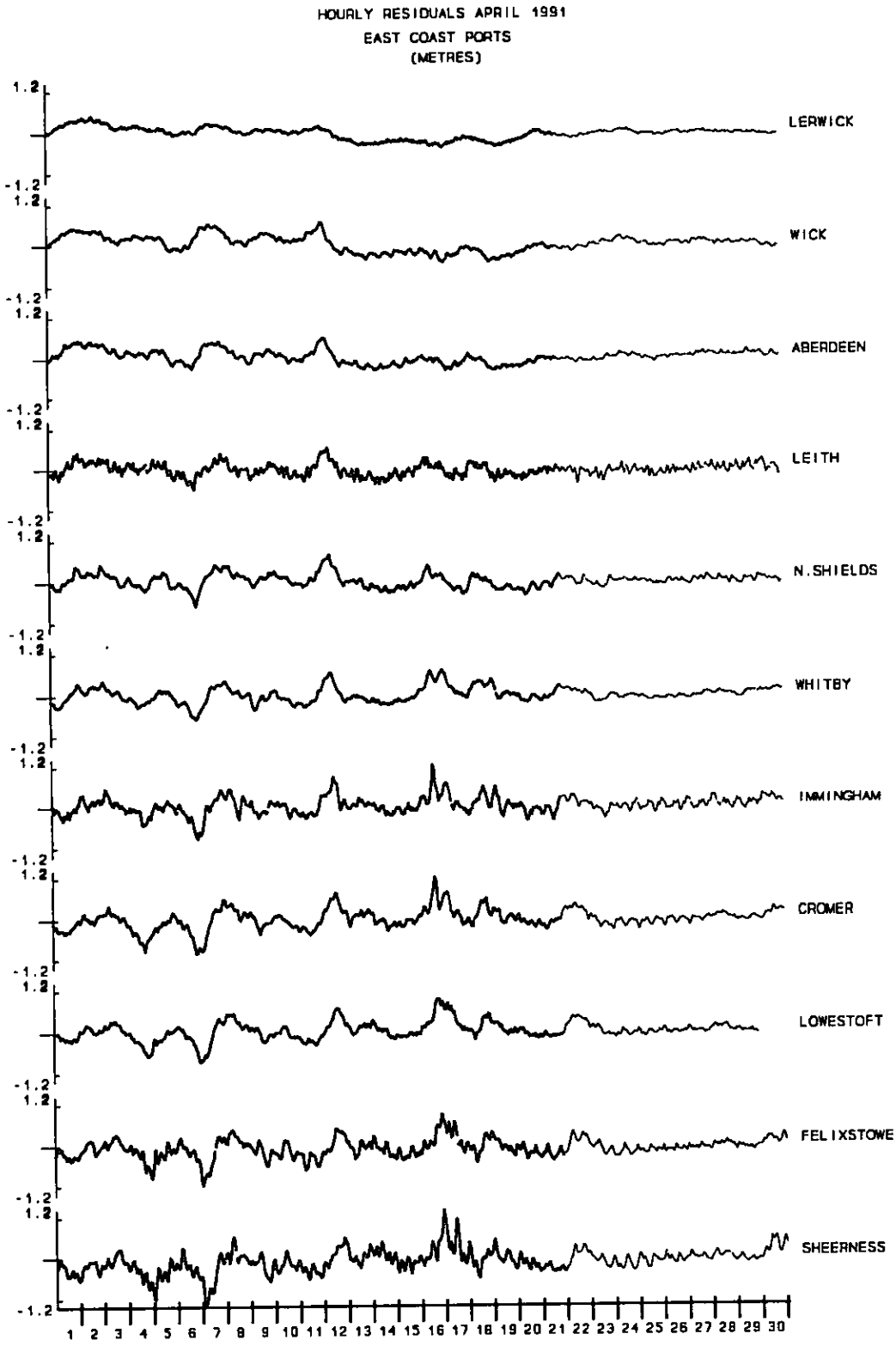

HOURLY RESIDUALS NOVEMBER 1991
S.W.APPROACHES AND ENGLISH CHANNEL
(METRES)
1.6
-1.1
DOVER
PORTSMOUTH
WEYMOUTH
DEVONPORT
NEWLYN
AVONMOUTH
HINKLEY POINT
ILFRACOMBE
MUMBLES
MILFORD HAVEN
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30

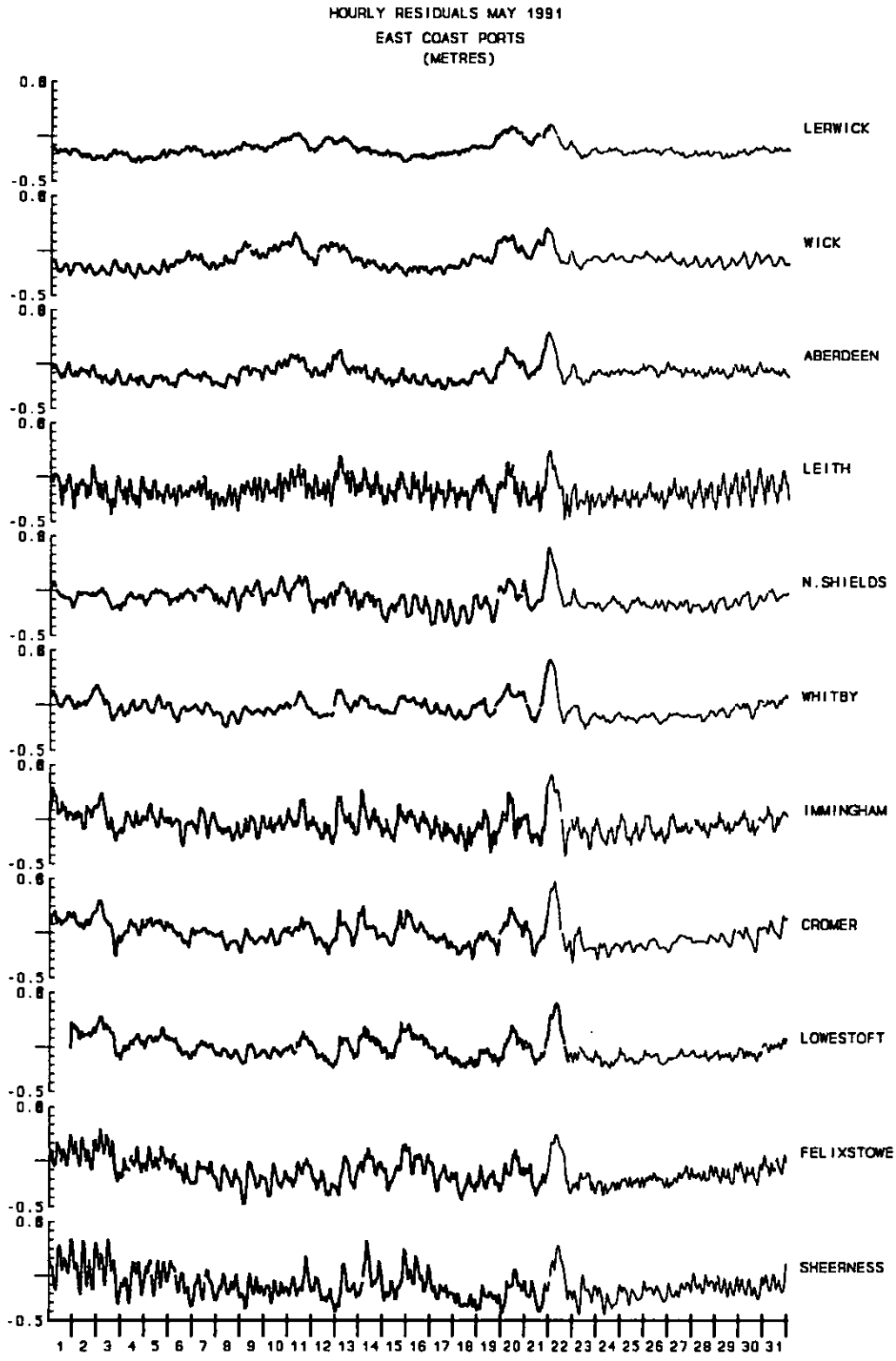

HOURLY RESIDUALS DECEMBER 1991
S.W.APPROACHES AND ENGLISH CHANNEL
(METRES)
2.1
-0.9
DOVER
PORTSMOUTH
WEYMOUTH
DEVONPORT
NEWLYN
AVONMOUTH
HINKLEY POINT
ILFRACOMBE
MUMBLES
MILFORD HAVEN
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31

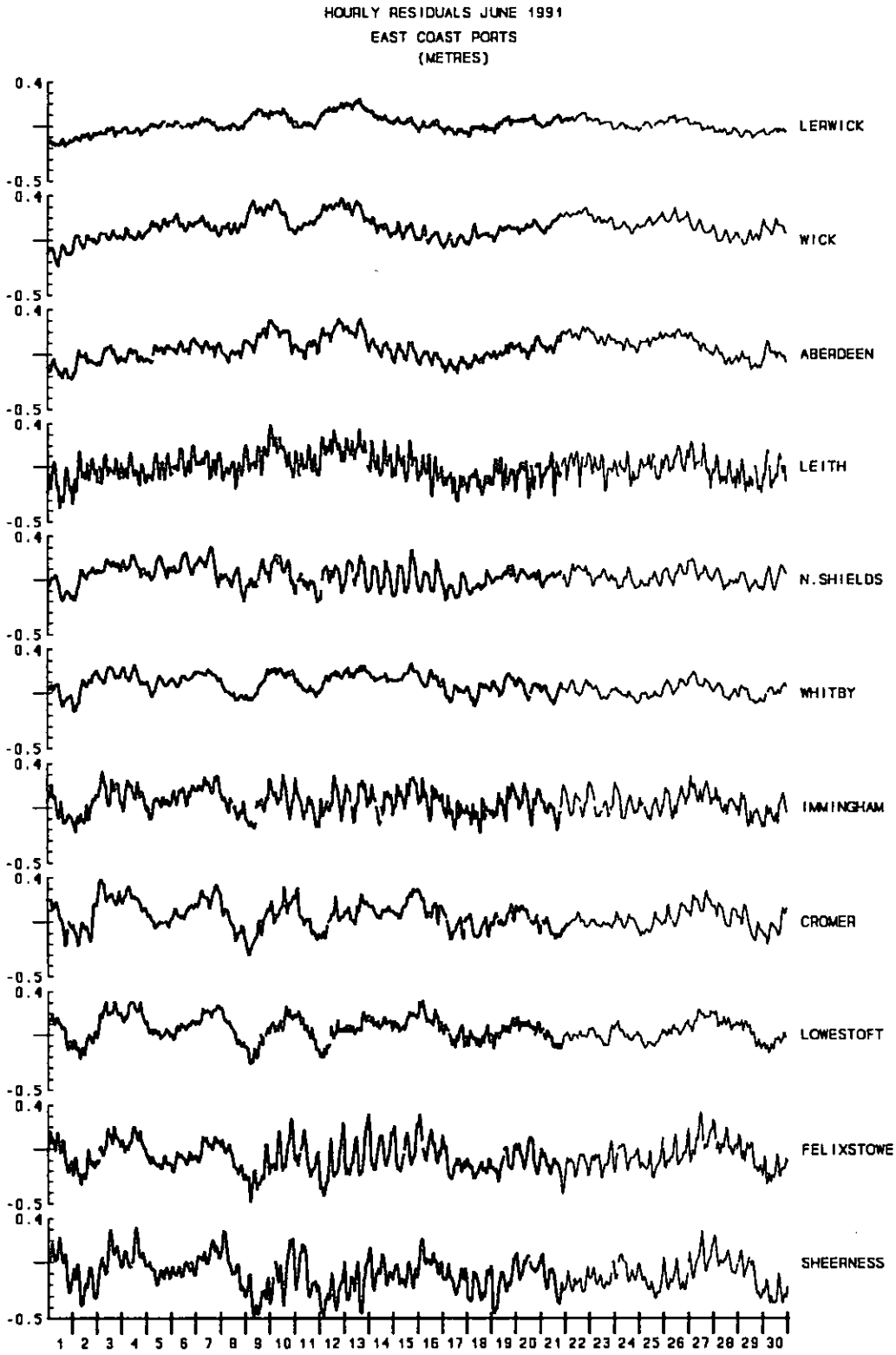

HOURLY RESIDUALS JANUARY 1991
EAST COAST PORTS
(METRES)
1.0
-1.0
LERWICK
WICK
ABERDEEN
LEITH
N.SHIELDS
WHITBY
IMMINGHAM
CROMER
LOWESTOFT
FELIXSTOWE
SHEERNESS
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31

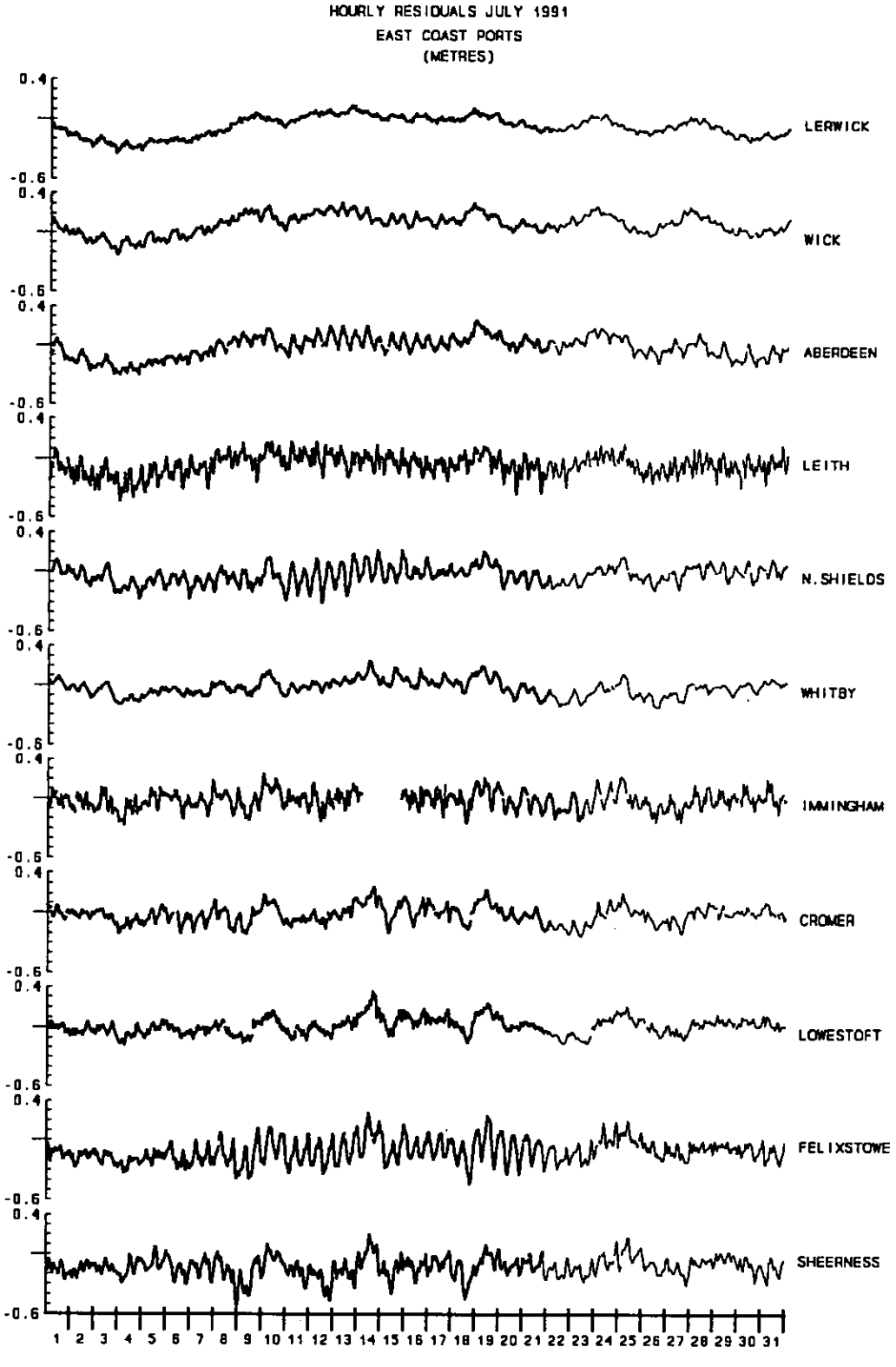

HOURLY RESIDUALS FEBRUARY 1991
EAST COAST PORTS
(METRES)
0.8
-1.0
LERWICK
WICK
ABERDEEN
LEITH
N.SHIELDS
WHITBY
IMMINGHAM
CROMER
LOWESTOFT
FELIXSTOWE
SHEERNESS
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28

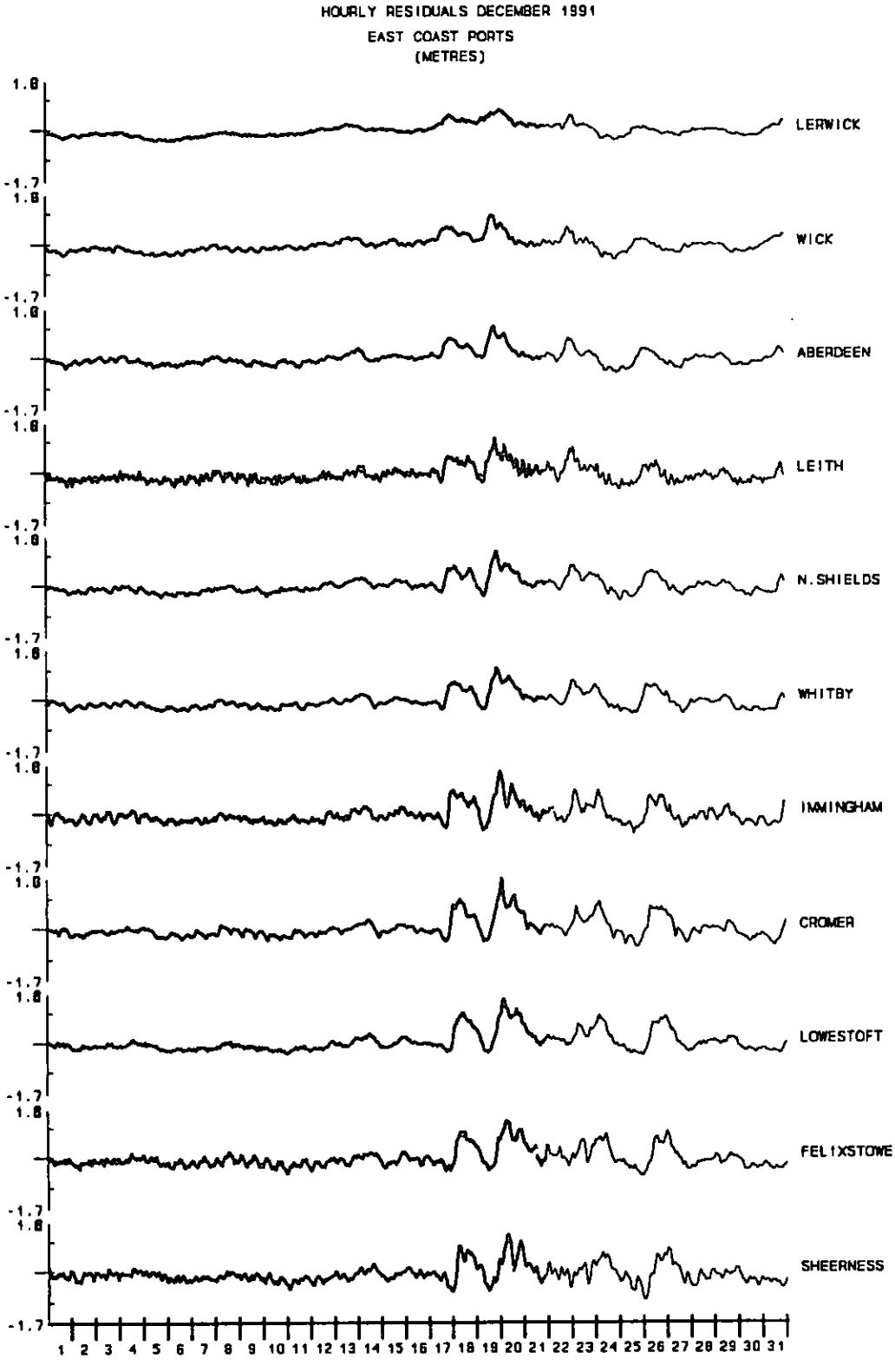

HOURLY RESIDUALS MARCH 1991
EAST COAST PORTS
(METRES)
0.8
-1.0
LERWICK
WICK
ABERDEEN
LEITH
N.SHIELDS
WHITBY
IMMINGHAM
CROMER
LOWESTOFT
FELIXSTOWE
SHEERNESS
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31


HOURLY RESIDUALS APRIL 1991
EAST COAST PORTS
(METRES)
1.2
-1.2
LERWICK
WICK
ABERDEEN
LEITH
N.SHIELDS
WHITBY
IMMINGHAM
CROMER
LOWESTOFT
FELIXSTOWE
SHEERNESS
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


HOURLY RESIDUALS MAY 1991
EAST COAST PORTS
(METRES)
0.8
-0.5
LERWICK
WICK
ABERDEEN
LEITH
N.SHIELDS
WHITBY
IMMINGHAM
CROMER
LOWESTOFT
FELIXSTOWE
SHEERNESS
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


HOURLY RESIDUALS JUNE 1991
EAST COAST PORTS
(METRES)
0.4
-0.5
LERWICK
WICK
ABERDEEN
LEITH
N.SHIELDS
WHITBY
IMMINGHAM
CROMER
LOWESTOFT
FELIXSTOWE
SHEERNESS
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


HOURLY RESIDUALS JULY 1991
EAST COAST PORTS
(METRES)
0.4
-0.6
LERWICK
WICK
ABERDEEN
LEITH
N.SHIELDS
WHITBY
IMMINGHAM
CROMER
LOWESTOFT
FELIXSTOWE
SHEERNESS
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


HOURLY RESIDUALS DECEMBER 1991
EAST COAST PORTS
(METRES)
1.8
-1.7
LERWICK
WICK
ABERDEEN
LEITH
N.SHIELDS
WHITBY
IMMINGHAM
CROMER
LOWESTOFT
FELIXSTOWE
SHEERNESS
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

MAXIMUM RESIDUALS 1991

WEST COAST PORTS

PORT	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
KINLOCHBERVIE						.400	.448	.523	.948	1.092	.952	.412	1.092
STORNOWAY	.828	.343	.426	.375	.129	.328	.345	.255	.623	.614	.621	.578	.828
ULLAPOOL	.992	.391	.374	.577	.209	.416	.368	.305	.801	.909	.816	.754	.992
TOBERMORY	1.420	.574	.658	.707	.074	.484	.430	.355	.665	.808	.712	.623	1.420
MILLPORT	1.402	.582	.803	.942	.082	.691	.374	.383	.748	.960	1.137	.564	1.402
PORT ELLEN						.157	.269	.158	.450	.563	.624	.500	.624
PORTPATRICK	1.156	.476	.681	.835	.000	.470	.307	.380	.539	.749	1.035	.544	1.156
HEYSHAM	2.298	.668	.615	.723	.077	.578	.461	.540	.838	1.068	2.265	.948	2.298
LIVERPOOL					.092	.852	.572	.344	.935	.965	1.777	.795	1.777
HOLYHEAD	.907	.447	.479	.691	-.013	.412	.348	.426	.454	.430			.907
BARMOUTH										.909	1.679	1.066	1.679
FISHGUARD	.706	.354	.420	.558	-.007	.320	.332	.404	.372	.566	.726	.452	.726

MINIMUM RESIDUALS 1991

WEST COAST PORTS

KINLOCHBERVIE						-.301	-.344	-.222	-.250	-.403	-.501	-.243	-.501
STORNOWAY	-.407	-.434	-.463	.000	-.370	-.215	-.283	-.287	-.337	-.436	-.534	-.457	-.534
ULLAPOOL	-.469	-.490	-.450	-.536	-.432	-.174	-.338	-.392	-.304	-.346	-.507	-.241	-.536
TOBERMORY	-.345	-.381	-.345	-.427	-.414	-.244	-.281	-.203	-.261	-.417	-.577	-.368	-.577
MILLPORT	-.537	-.495	-.406	-.522	-.370	-.202	-.192	-.254	-.456	-.410	-.877	-.619	-.877
PORT ELLEN						-.381	-.360	-.328	-.466	-.630	-.861	-.635	-.861
PORTPATRICK	-.531	-.411	-.342	-.509	-.380	-.384	-.225	-.217	-.404	-.395	-.799	-.488	-.799
HEYSHAM	-.543	-.605	-.579	-.758	-.600	-.330	-.404	-.399	-.797	-.560	-1.014	-.537	-1.014
LIVERPOOL					-.256	-.355	-.422	-.592	-.551	-.516	-.955	-1.057	-1.057
HOLYHEAD	-.395	-.403	-.311	-.492	-.360	-.137	-.208	-.179	-.285	-.238			-.492
BARMOUTH										-.742	-.980	-.601	-.980
FISHGUARD	-.329	-.302	-.269	-.387	-.354	-.126	-.115	-.161	-.163	-.273	-.511	-.388	-.511

MAXIMUM RESIDUALS 1991

S.W APPROACHES AND ENGLISH CHANNEL PORTS

PORT	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
MILFORD HAVEN		.122	.452	.649	-.038	.356	.351	.442	.398	.488	.745	.389	.745
MUMBLES	.942	.552	.602	.778	.186	.518	.600	.477	.436	.447	.818	.176	.942
HINKLEY POINT	1.521	.576	.960	.959	.580	.841	.783	.784	.892	1.166	1.516	2.023	2.023
AVONMOUTH	2.180	.658	.935	1.040	.446	.743	.781	.730	.794	.895	1.369	.300	2.180
ILFRACOMBE	.922	.345	.483						.376	.243	.549	.617	.617
DOVER	.971	.486	.511	.550	.294	.510	.324	.317	.462	.975	.869	1.267	1.267
PORTSMOUTH		.325	.371	.536	.016	.233	.244	.172	.384	.526	.513		.536
NEWHAVEN	.651	.310	.243	.277	-.055	.160	.139	.089	.265	.113			.651
WEYMOUTH	.147	.388	.602	.688	.150	.369	.354	.468	.576	.598	.408	.328	.688
DEVONPORT			.347	.540	.240	.385	.519	.476	.570	.374	.578	.232	.578
NEWLYN	.442	.127	.405	.409	.003	.220	.255	.210	.505	.457	.314	.128	.505

MINIMUM RESIDUALS 1991

S.W APPROACHES AND ENGLISH CHANNEL PORTS

PORT	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
MILFORD HAVEN		-.157	-.339	-.426	-.441	-.184	-.147	-.265	-.204	-.305	-.525	-.521	-.525
MUMBLES	-.446	-.371	-.357	-.417	-.576	-.310	-.352	-.324	-.452	-.559	-.545	-.387	-.576
HINKLEY POINT	-.806	-.827	-1.025	-.705	-.688	-.400	-.396	-.730	-.862	-.798	-1.030	-.848	-1.030
AVONMOUTH	-.825	-.855	-.817	-.682	-.760	-.420	-.405	-.505	-.657	-.705	-1.056	-.737	-1.056
ILFRACOMBE	-.502	-.562	-.296						-.353	-.529	-.633	-.829	-.829
DOVER	-.783	-.591	-.418	-.734	-.266	-.284	-.205	-.268	-.292	-.780	-.797	-.549	-.797
PORTSMOUTH		-.485	-.470	-.420	-.428	-.262	-.247	-.314	-.384	-.430	-.535		-.535
NEWHAVEN	-.527	-.564	-.640	-.534	-.561	-.420	-.271	-.403	-.526	-.547			-.640
WEYMOUTH	-.308	-.400	-.344	-.355	-.293	-.216	-.221	-.288	-.378	-.313	-.456	-.538	-.538
DEVONPORT			-.352	-.325	-.278	-.143	-.130	-.234	-.170	-.296	-.394	-.483	-.483
NEWLYN	-.403	-.332	-.298	-.300	-.326	-.212	-.200	-.217	-.301	-.257	-.337	-.434	-.434

MAXIMUM RESIDUALS 1991

EAST COAST PORTS

PORT	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
LERWICK	.490	.192	.257	.422	.135	.236	.140	.136	.395	.514	.483	.628	.628
WICK	.750	.431	.453	.560	.248	.369	.307	.351	.639	.705	.575	.910	.910
ABERDEEN	.697	.296	.342	.475	.364	.310	.255	.298	.531	.573	.642	1.037	1.037
LEITH	.963	.364	.473	.522	.295	.379	.174	.208	.491	.457	.646	1.085	1.085
NORTH SHIELDS	.805	.368	.407	.649	.474	.302	.219	.171	.608	.399	.723	1.112	1.112
WHITBY	.746	.195	.382	.572	.504	.265	.252	.252	.636	.852	.870	1.032	1.032
IMMINGHAM	1.158	.476	.532	1.024	.491	.316	.247	.345	.799	.877	.826	1.361	1.361
CROMER	.879	.406	.389	1.000	.568	.381	.261	.344	.793	1.214	1.105	1.596	1.596
LOWESTOFT	.862	.562	.478	.771	.483	.307	.350	.347	.742	1.229	.966	1.411	1.411
FELIXSTOWE	.917	.507	.362	.738	.339	.326	.275	.351	.564	1.163	1.113	1.196	1.196
SHEERNESS	.977	.484	.325	1.156	.392	.305	.195	.220	.682	1.002	1.231	1.196	1.231

MINIMUM RESIDUALS 1991

EAST COAST PORTS

PORT	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
LERWICK	-.434	-.347	-.407	-.394	-.291	-.176	-.336	-.285	-.280	-.345	-.417	-.363	-.434
WICK	-.407	-.354	-.408	-.435	-.296	-.232	-.221	-.153	-.281	-.327	-.500	-.553	-.553
ABERDEEN	-.479	-.418	-.365	-.354	-.269	-.217	-.305	-.328	-.291	-.363	-.413	-.509	-.509
LEITH	.583	-.498	-.494	-.485	-.468	-.370	-.434	-.428	-.376	-.595	-.731	-.645	-.731
NORTH SHIELDS	-.666	-.474	-.341	-.578	-.382	-.207	-.300	-.452	-.322	-.510	-.569	-.535	-.666
WHITBY	-.742	-.627	-.507	-.574	-.266	-.164	-.224	-.297	-.303	-.599	-.652	-.513	-.742
IMMINGHAM	-.953	-.545	-.658	-.754	-.397	-.234	-.261	-.502	-.417	-.833	-1.064	-.687	-1.064
CROMER	-1.193	-.813	-.780	-.830	-.334	-.305	-.233	-.332	-.481	-1.232	-1.079	-.664	-1.232
LOWESTOFT	-1.123	-.626	-.661	-.715	-.232	-.259	-.171	-.216	-.314	-1.008	-1.031	-.480	-1.123
FELIXSTOWE	-1.325	-.668	-.691	-.966	-.469	-.476	-.427	-.524	-.650	-1.018	-1.260	-.639	-1.325
SHEERNESS	-1.706	-.933	-.863	-1.187	-.440	-.490	-.507	-.564	-.868	-1.335	-1.549	-.956	-1.706

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