



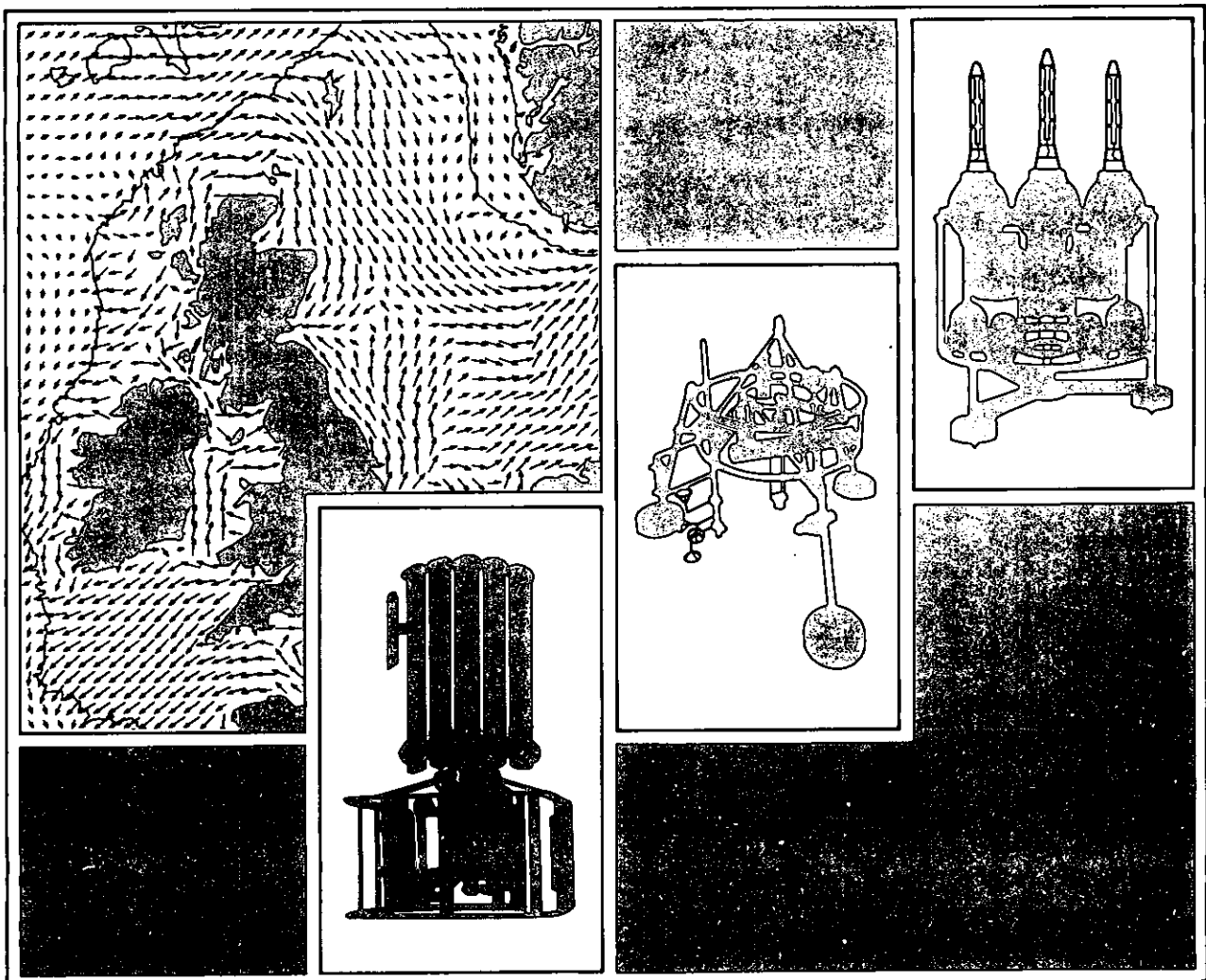
Proudman
Oceanographic
Laboratory

Class A Network Dataring gauges

1990 data processing and analysis

SM Shaw

Report No 23 1992



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PROUDMAN OCEANOGRAPHIC LABORATORY
REPORT No.23

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S.M.Shaw

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1.Introduction

This report is the third 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 27 Class-A sites were modernised by the end of 1990 (Figure 1). Four sites modernised in 1989 are introduced in this report for 1990 :- Mumbles and Milford Haven (Hakin) in south Wales, Lerwick in Shetland and Whitby, North Yorkshire.

Other sites which were modernised during 1990 include Portpatrick in Galloway, Newhaven, Sussex and a completely new installation at Hinkley Point in Devon.

Maps showing the instrument sites and bench mark information for the seven new installations are included in this report with statistical and analytical results for 1990 for all twenty-seven where sufficient data have been obtained.

During the year, much attention was paid to the storm events of the 1989-1990 winter, and their effects on coastal areas particularly in North Wales and in the south west. To improve forecasting capabilities, sites have been very recently modernised at both Weymouth and Portsmouth on the south coast with plans in hand for more gauges in North Wales.

Extreme, mean sea level and surge diagrams and statistics from the modernised sites are included in this report.

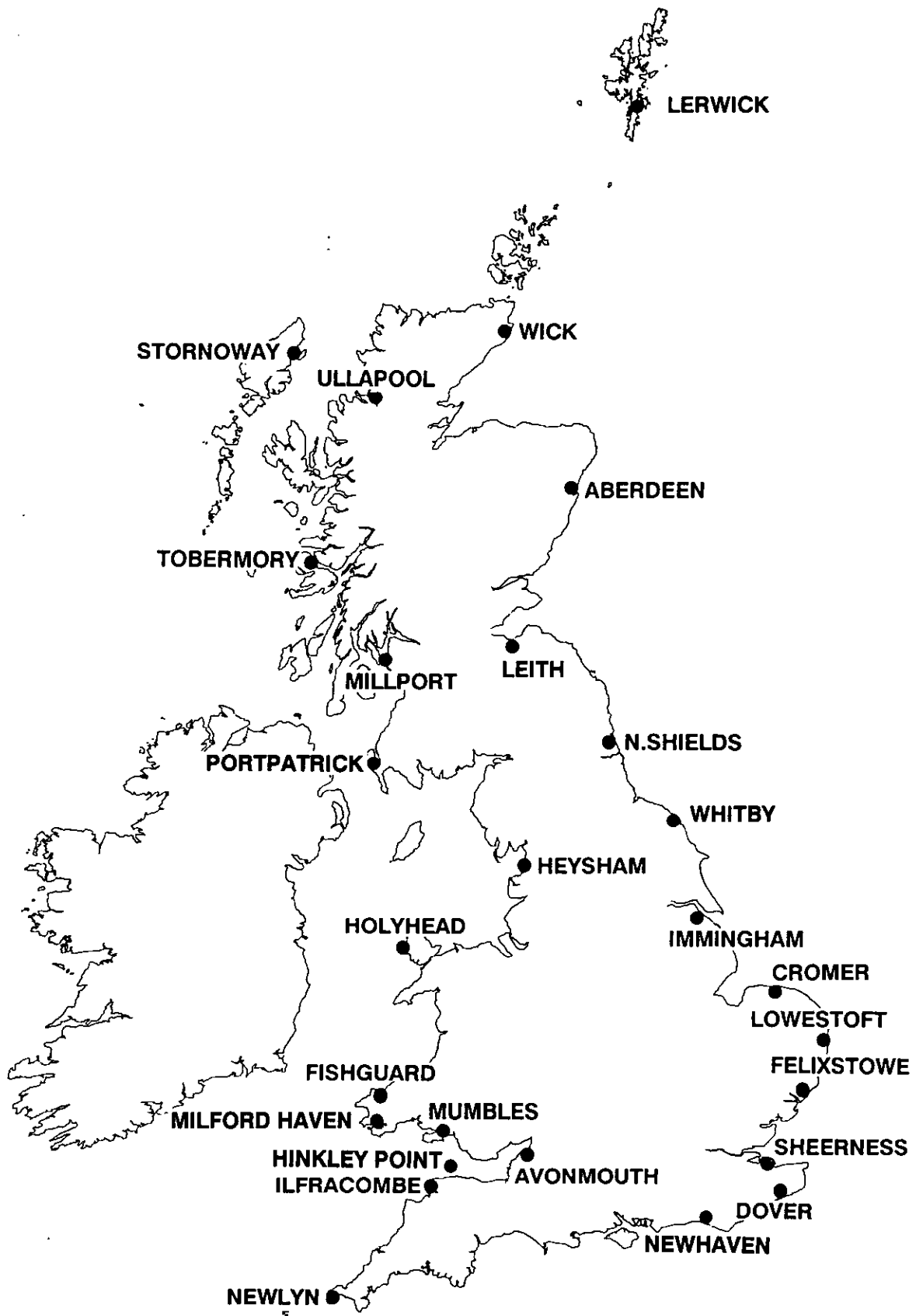


Figure 1. Class A Tide Gauge sites operational in 1990.

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.

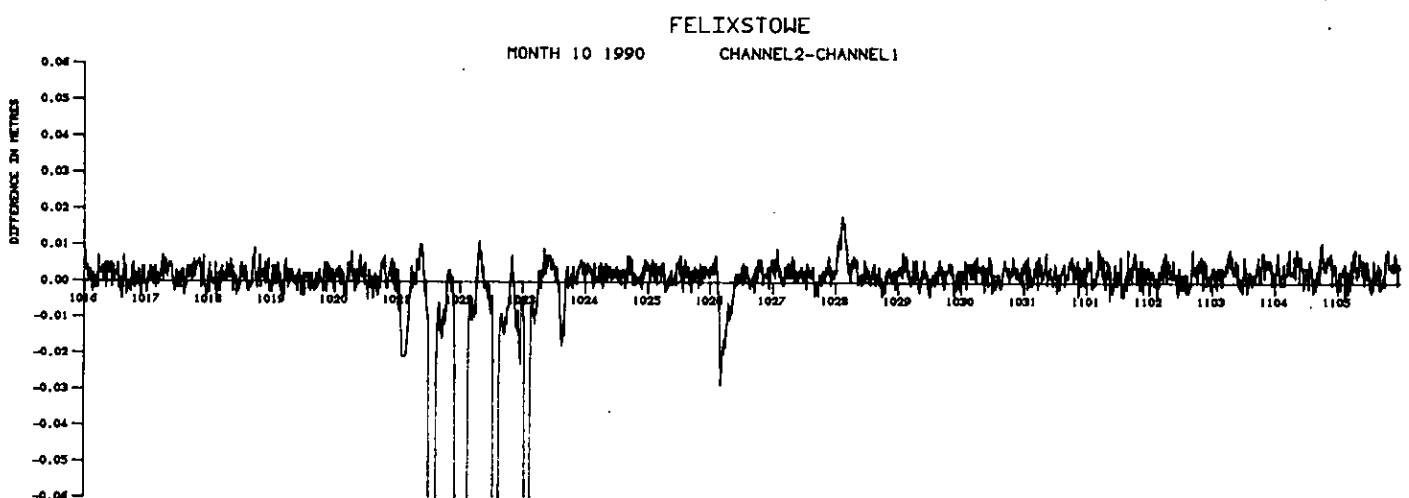
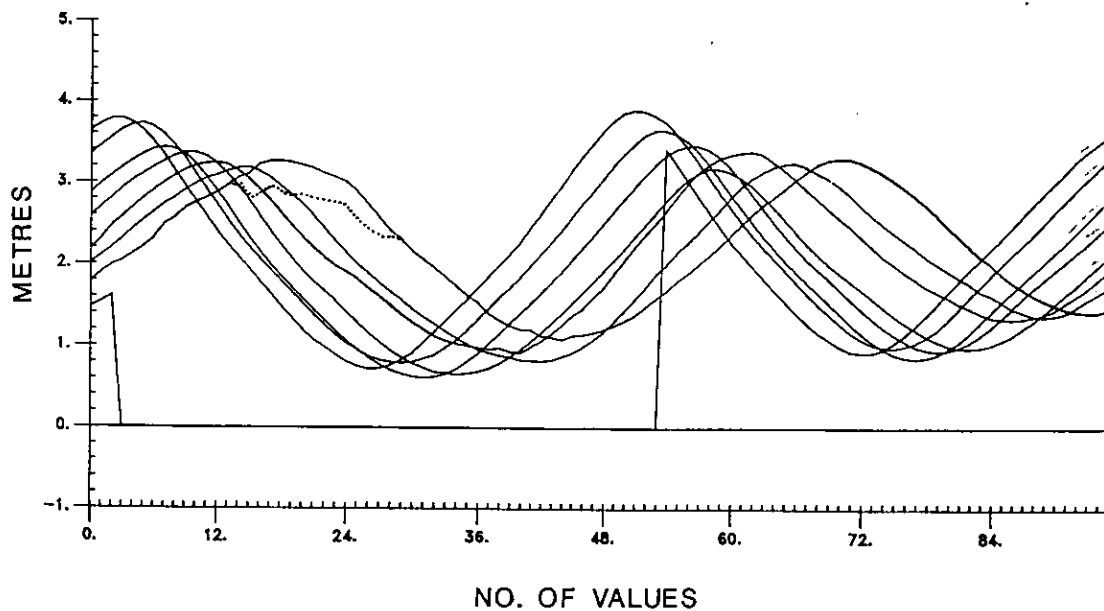


Figure 2. Typical plots of a) Raw Dataring values covering a period of a week, and b) The differences between recording channels at a site with two digiquartz sensors.

Aberdeen

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

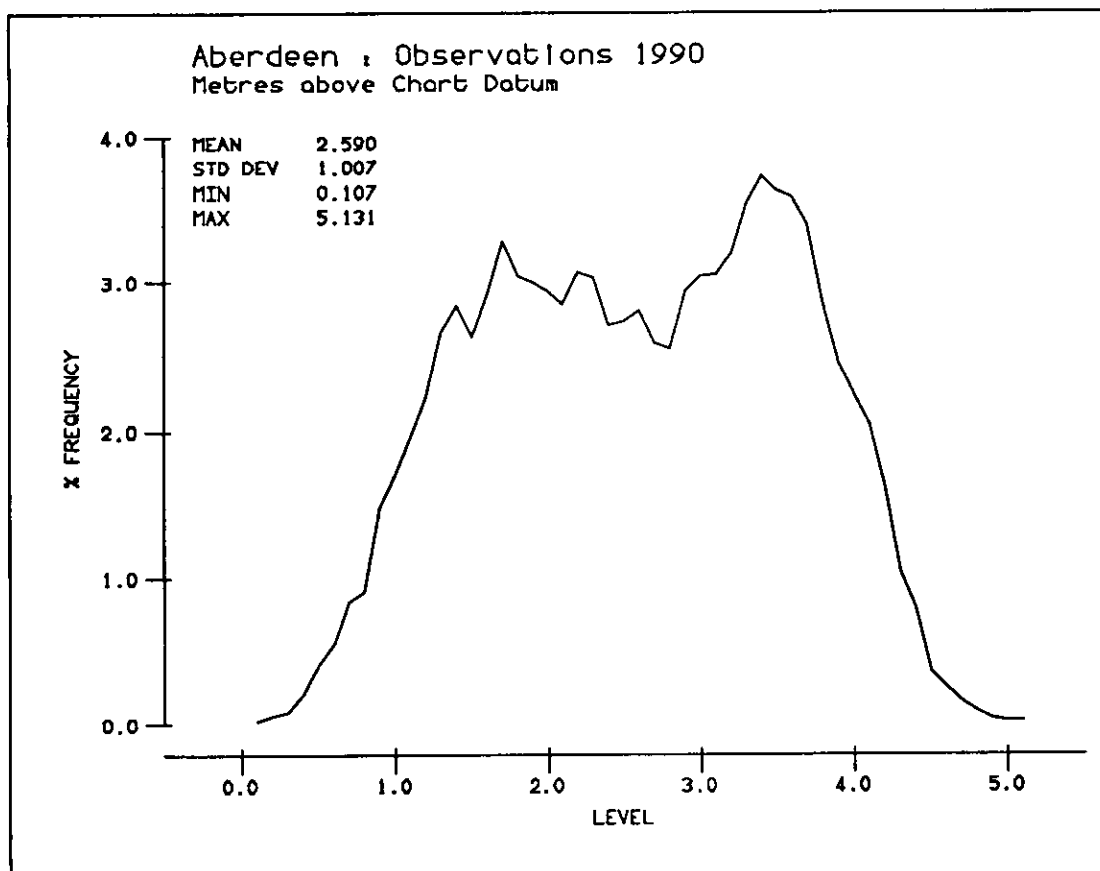
Recording zero = Chart Datum = 2.25m below Ordnance Datum Newlyn
Recording zero = 6.091m below Tide Gauge Bench Mark

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.

A complete series of hourly levels was collated from the digiquartz channel for 1990, which is the designated Class-A channel of data.

The Tide Gauge Inspectorate (TGI) visited the site 14 December. Values integrated at 1 7/8 minutes over the period were edited.

Isolated missing scans were edited on the following dates: 8 Jan; 15 Feb; 13,22 Mar; 12 Apr; 15 May; 14,26 Jun; 20 Jul; 8,31 Aug; 17,26(2) Sep; 7,23,25 Oct; 26,29 Nov.



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, 1990

To: 31st December, 1990

Units: Metres

A0: 2.592

Hourly data from digiquartz sensor

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

Observation Mean =	0.2592D+01	Residual Mean =	0.1075D-05
Std Dev =	0.1004D+01	Std Dev =	0.1600D+00

Constituent	h	g
Q1	0.035	7.16
O1	0.132	50.61
P1	0.033	197.37
K1	0.110	205.38
J1	0.009	278.69
2N2	0.043	331.67
N2	0.257	1.86
M2	1.301	24.22
S2	0.440	62.55
K2	0.127	60.15
M3	0.009	315.52
M4	0.032	163.35
MS4	0.030	240.07
M6	0.007	108.38

Avonmouth

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

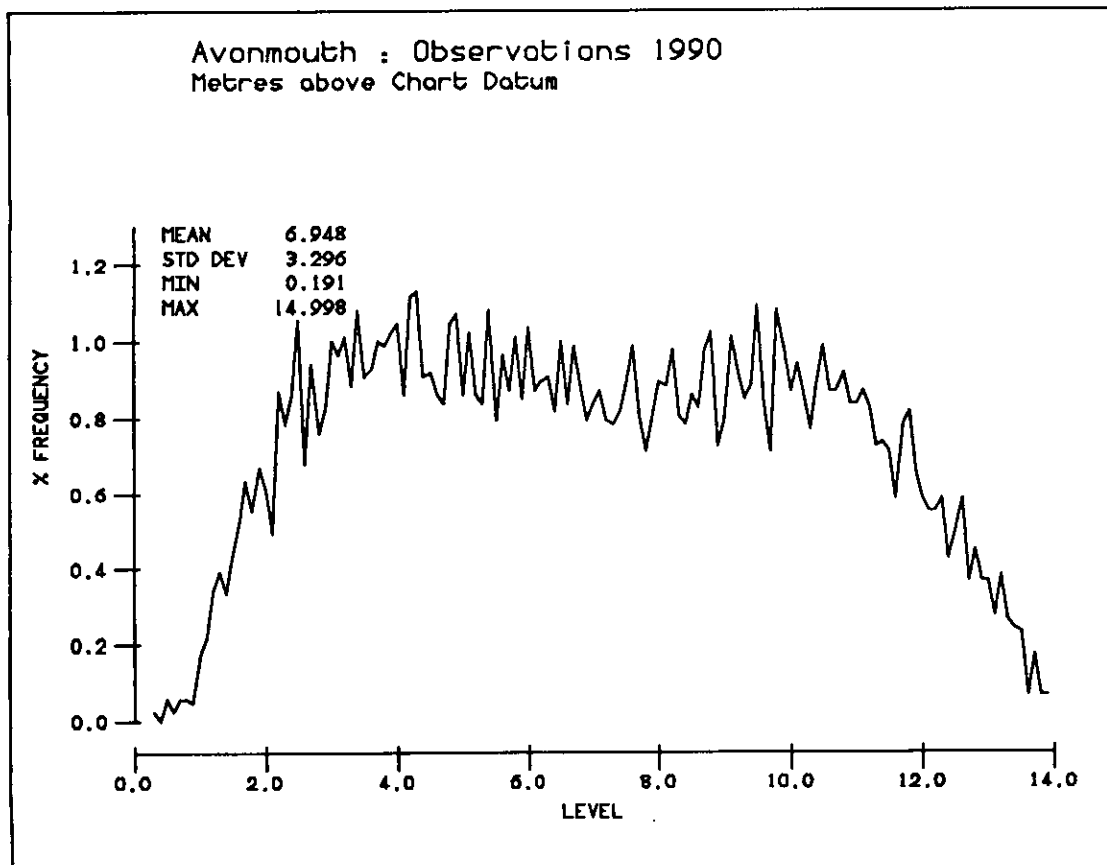
Recording zero = Chart Datum = 6.5m below Ordnance Datum Newlyn
Recording zero = 15.711m below Tide Gauge Bench Mark

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

A fault developed in the on-site modem creating a gap in hourly levels processed for 1990 from 00hrs GMT 3 April to 01hrs GMT 5 April.

Spurious values and missing scans were edited at the raw stage for the following dates:
5,20,22 Jan; 3,4,9,12,16,17 Feb; 1,4,5,6,8,14,29 Mar; 9,16,17,18 Apr; 1,18,20,28 May;
1,3(2),7,9,14,30 Jun; 7,10,20,27(2),29 Jul; 10,17,22,28,30 Aug; 13,26 Sep; 4,7,9,12,15 Oct;
1,24,25 Nov; 3,16,19,27(2) Dec.

The TGI visited the site 20 May.



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: 365 Days

From: 1st January, 1990

To: 31st December, 1990

Units: Metres

A0: 6.949

Hourly data from digiquartz sensor 1

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

Observation Mean =	0.6950D+01	Residual Mean =	0.9021D-06
Std Dev =	0.3298D+01	Std Dev =	0.2278D+00

Constituent	h	g
Q1	0.028	337.78
O1	0.077	2.10
P1	0.036	132.96
K1	0.068	148.03
J1	0.009	178.42
2N2	0.104	166.51
N2	0.789	186.32
M2	4.297	200.01
S2	1.537	258.75
K2	0.446	253.64
M3	0.052	212.54
M4	0.264	346.16
MS4	0.239	19.73
M6	0.123	271.56

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

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

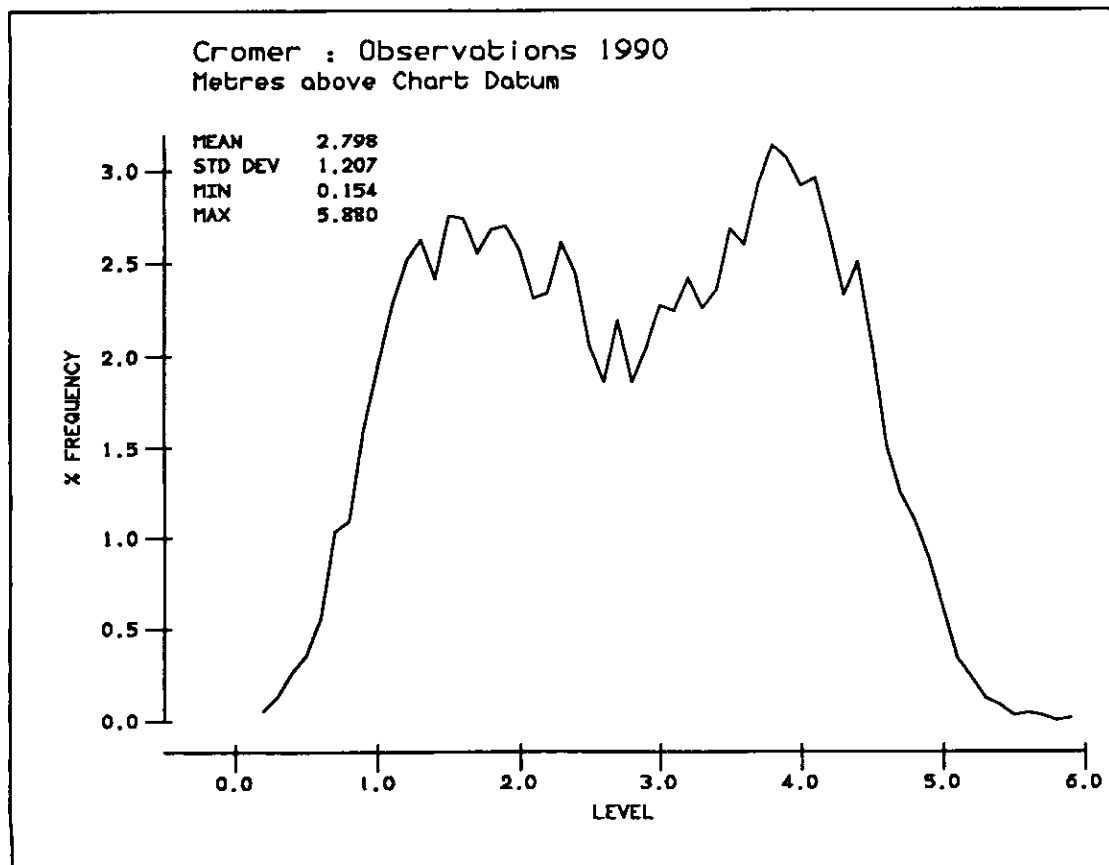
A modem failure at Cromer on 5 February was finally repaired by TGI on 2 April. Unfortunately a back-up Aanderaa tape ran out on 14 March preventing a complete retrieval of the gap in recording.

Spurious values and missing scans were edited at the raw stage for the following dates: 3 Jan; 24 Apr; 20,27 Jul; 9 Oct; 29 Nov; 10,25,28 Dec.

24 September. Routine maintenance visit by TGI. Values integrated at 1 7/8 minute were edited.

Gaps in hourly filtered levels (Channel 2 digiquartz)

20hrs. 5 February - 23hrs. 2 April Modem failure.



Harmonic Tidal Analysis.

Port: England, East Coast - Cromer

Latitude: 52 56' 01.9" N

Longitude: 1 18' 12.5" E

Time Zone: GMT

Length: 393 Days

From: 3rd April, 1990

To: 30th April, 1991

Units: Metres

A0: 2.759

Hourly data from digiquartz sensor 2

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

Observation Mean =	0.2755D+01	Residual Mean =	0.7293D-05
Std Dev =	0.1217D+01	Std Dev =	0.2092D+00

Constituent	h	g
Q1	0.049	90.16
O1	0.160	134.18
P1	0.038	292.88
K1	0.142	302.29
J1	0.010	348.24
2N2	0.055	130.66
N2	0.300	165.56
M2	1.567	188.34
S2	0.534	234.30
K2	0.152	231.73
M3	0.005	197.31
M4	0.088	281.88
MS4	0.072	326.75
M6	0.025	37.86

Dover

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

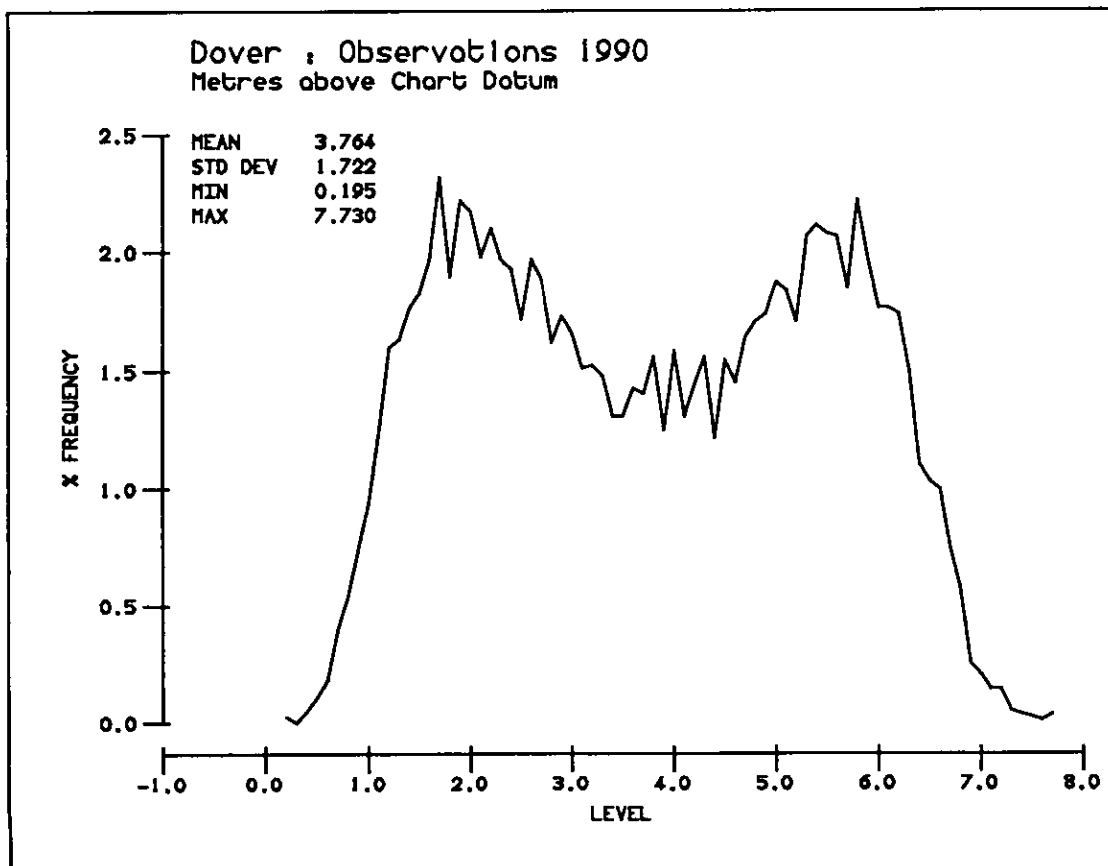
Recording zero = Chart Datum = 3.67m below Ordnance Datum Newlyn
Recording zero = 10.491m below Tide Gauge Bench Mark

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

The Tide Gauge Inspectorate visited the site on 5 February for routine maintenance. A memory board failure occurred on 12 November causing the TGI to revisit on 15 - 16 November and again on the 28 November when all memory boards were replaced. The period of lost hourly levels ultimately extended from 20hrs GMT 12 November to 14hrs GMT 30 November.

Spurious and missing values were interpolated at the raw stage for the following dates: 8,9,18,23 Jan; 4,5,24 Feb; 16,19,22,27 Mar; 1(3),9,21(2),25,26,28,30 Apr; 3,4,14,15,17,20,22,24 May; 19 Jun; 6,9,16(2),17,20,21,25,30 Jul; 8,13,22 Aug; 6,7,8,9,12,13(2),14(4),23,26,28 Sep; 1,4,14,15,16 Oct; 5 Nov; 27 Dec.

There were steps in the recording from mid March to April which were also edited.



Harmonic Tidal Analysis.

Port: England, South Coast - Dover

Latitude: 51 06' 59.7" N

Longitude: 1 19' 05.4" E

Time Zone: GMT

Length: 347 Days

From: 1st January, 1990

To: 31st December, 1990

Units: Metres

A0: 3.768

Hourly data from potentiometer sensor 2

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

Observation Mean =	0.3766D+01	Residual Mean =	0.8089D-06
Std Dev =	0.1723D+01	Std Dev =	0.1973D+00

Constituent	h	g
Q1	0.012	153.12
O1	0.067	178.69
P1	0.027	40.94
K1	0.059	48.97
J1	0.005	139.10
2N2	0.055	282.91
N2	0.418	309.72
M2	2.263	331.63
S2	0.720	23.37
K2	0.205	21.86
M3	0.017	26.13
M4	0.262	220.18
MS4	0.177	272.97
M6	0.065	102.15

Felixstowe

Latitude 51 deg 57' 22.8"N Longitude 01 deg 21' 0.0"E
National Grid reference TM 3015 3400

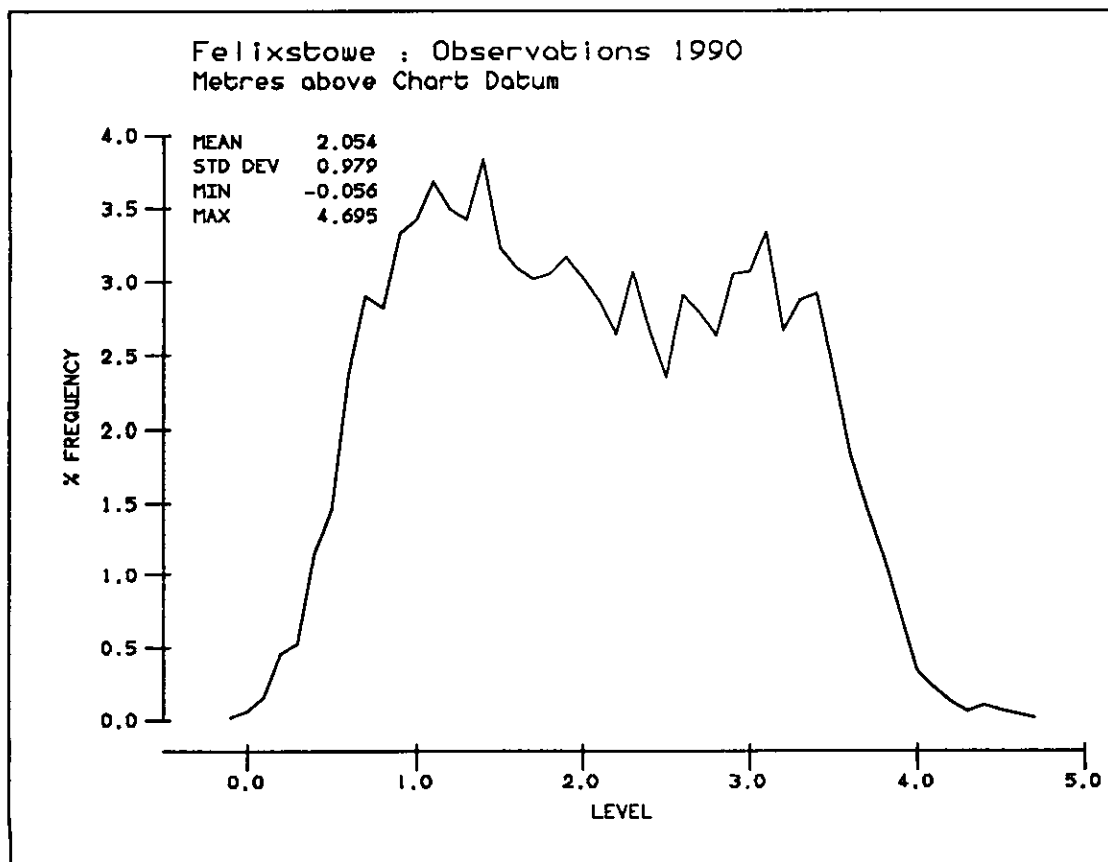
Recording zero = Chart Datum = 1.95m below Ordnance Datum Newlyn
Recording zero = 5.690m below Tide Gauge Bench Mark

This installation, furnished with two pressure gauge systems was modernised in September 1988.

Spurious and missing scans were interpolated at the raw stage for the following dates: 12,14 Jan; 8,13 Feb; 12 Apr; 30 May; 19,29 Jun; 3,14,29 Jul; 8 Aug; 27 Sep; 24 Dec.

Scans integrated at 1 7/8 minute during a maintenance visit by TGI, 26 September were also edited.

Problems thought to be caused by water in the tubing created flats over high waters on the Class-A channel 2 channel of data. There being little difference between recordings, figures from channel 1 have been substituted for the periods 21 to 23 October and 00hrs. to 1015hrs. 26 November to maintain a complete series for 1990.



Harmonic Tidal Analysis.

Port: England, East Coast - Felixstowe

Latitude: 51 57' 22.8" N

Longitude: 1 21' 00.0" E

Time Zone: GMT

Length: 365 Days

From: 1st January, 1990

To: 31st December, 1990

Units: Metres

A0: 2.056

Hourly data from digiquartz sensor 2

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

Observation Mean =	0.2056D+01	Residual Mean =	0.2827D-06
Std Dev =	0.9776D+00	Std Dev =	0.2323D+00

Constituent	h	g
Q1	0.033	137.73
O1	0.138	172.84
P1	0.043	351.73
K1	0.110	356.77
J1	0.010	62.85
2N2	0.055	236.11
N2	0.216	298.36
M2	1.264	321.63
S2	0.352	13.77
K2	0.101	13.85
M3	0.006	295.38
M4	0.076	320.75
MS4	0.055	31.31
M6	0.052	266.87

Fishguard

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

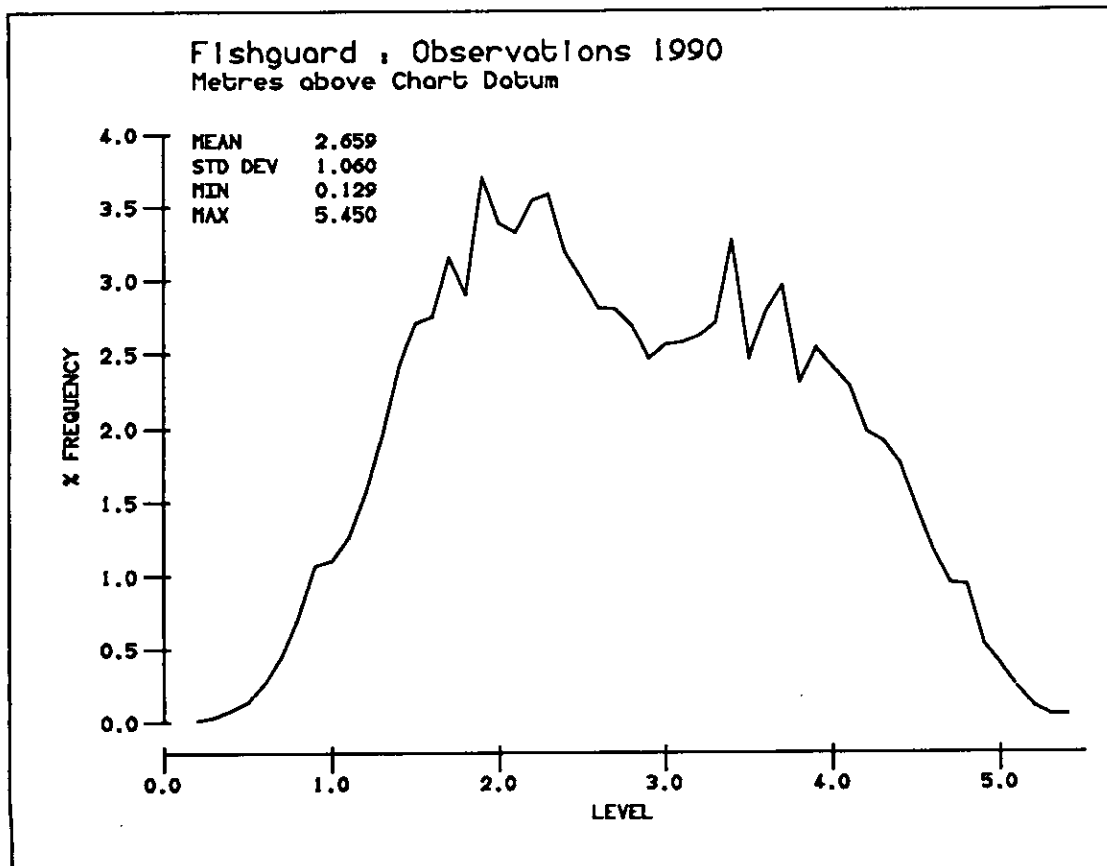
Recording zero = Chart Datum = 2.44m below Ordnance Datum Newlyn
Recording zero = 7.88m below Tide Gauge Bench Mark

This site was completely refurbished in June 1988 with two digiquartz sensors attached to pressure point systems. Values from the 2nd channel of data were treated as Class-A.

Spurious and missing scans were interpolated at the raw stage for the following dates:
8,23(2),25,26,31 Jan; 21 Feb; 5 Mar; 8 Apr; 8,11,15,24 May; 15,20 Jun; 3,6(2),22 Jul; 1,6,31
Aug; 28 Sep; 4,15(3),17,21,25 Oct; 5,19,28(2) Nov; 28 Dec.

Scans integrated at 1 7/8minute over a TGI maintenance visit on 2 August were also edited.

There were ultimately no gaps in the 1990 filtered hourly series of levels.



Harmonic Tidal Analysis.

Port: Wales - Fishguard

Latitude: 52 00' 46.2" N

Longitude: 4 58' 57.5" W

Time Zone: GMT

Length: 365 Days

From: 1st January, 1990

To: 31st December, 1990

Units: Metres

A0: 2.661

Hourly data from digiquartz sensor 2

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

Observation Mean =	0.2661D+01	Residual Mean =	0.2026D-05
Std Dev =	0.1059D+01	Std Dev =	0.1467D+00

Constituent	h	g
Q1	0.025	331.13
O1	0.082	10.20
P1	0.028	40.80
K1	0.080	155.76
J1	0.003	142.62
2N2	0.040	168.66
N2	0.278	188.17
M2	1.357	207.18
S2	0.534	248.15
K2	0.152	245.76
M3	0.013	189.65
M4	0.114	19.25
MS4	0.056	66.14

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

Compressor and modem problems at this site prevented any recordings of the severe surge effects accompanying the storm of 25-26 January. However, repairs were made by TGI on 13 February, in time to record the even larger storm of 26 February.

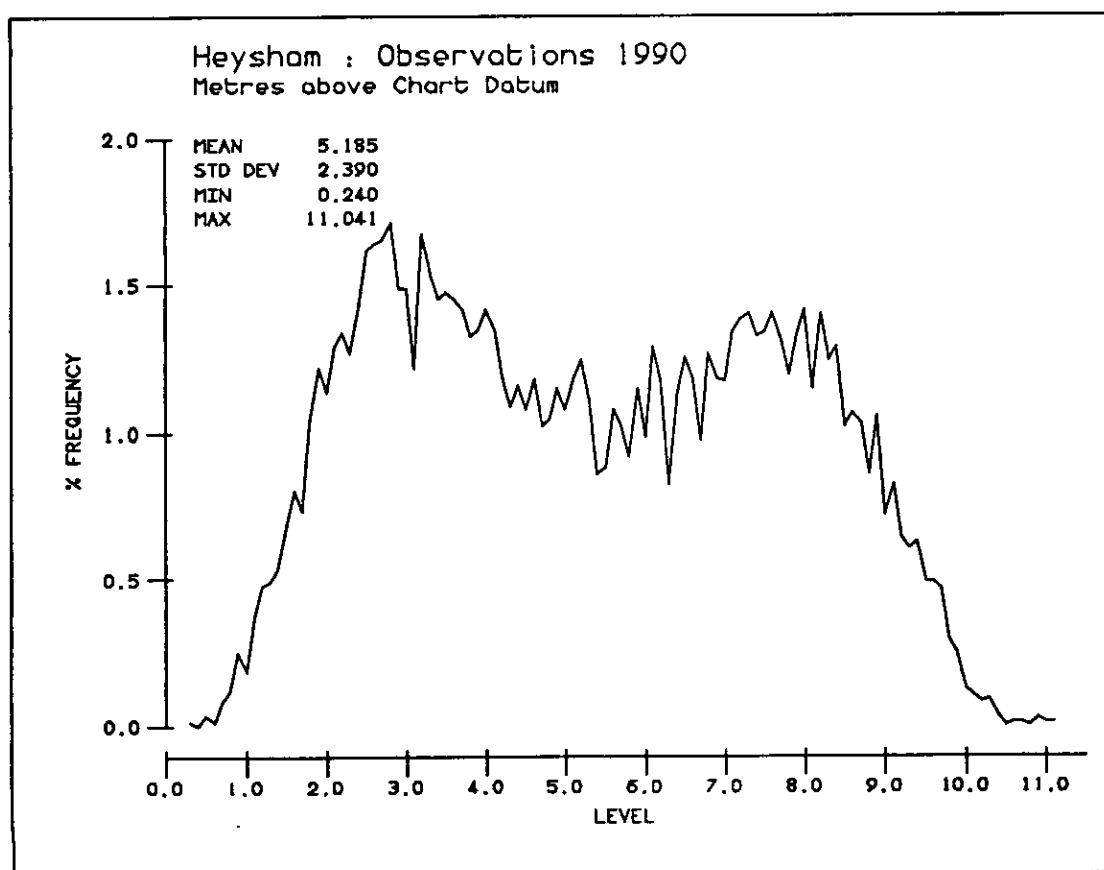
Spurious values and missing scans in the raw data were interpolated for the following dates:
15 Jan; 6 Feb; 14 Jun; 2,31 Aug; 11 Dec.

Scans integrated at 1 7/8 minutes during the TGI visit of 13 February were also edited at the raw stage.

Gaps in hourly filtered levels (Channel 2 digiquartz)

00hrs 23 January - 20hrs 29 January

The TGI visited the site both on the 24 January and 13 February.



Harmonic Tidal Analysis.

Port: England, West Coast - Heysham

Latitude: 54 02' 0.3" N

Longitude: 2 54' 41.7" W

Time Zone: GMT

Length: 359 Days

From: 1st January, 1990

To: 31st December, 1990

Units: Metres

A0: 5.188

Hourly data from digiquartz sensor 2

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

Observation Mean =	0.5187D+01	Residual Mean =	0.2721D-06
Std Dev =	0.2392D+01	Std Dev =	0.2304D+00

Constituent	h	g
Q1	0.037	359.81
O1	0.118	40.55
P1	0.040	183.76
K1	0.133	191.62
J1	0.004	187.32
2N2	0.083	276.26
N2	0.607	302.03
M2	3.176	325.75
S2	1.037	8.70
K2	0.293	6.78
M3	0.032	314.51
M4	0.206	247.35
MS4	0.122	299.22
M6	0.010	62.18

Hinkley Point

This new site to the network of gauges 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.(Figure 3).

Neither harmonic constants nor residual statistics for 1990 are presented as there are insufficient data for meaningful analysis. Extreme and mean sea levels have however been computed (Section 3).

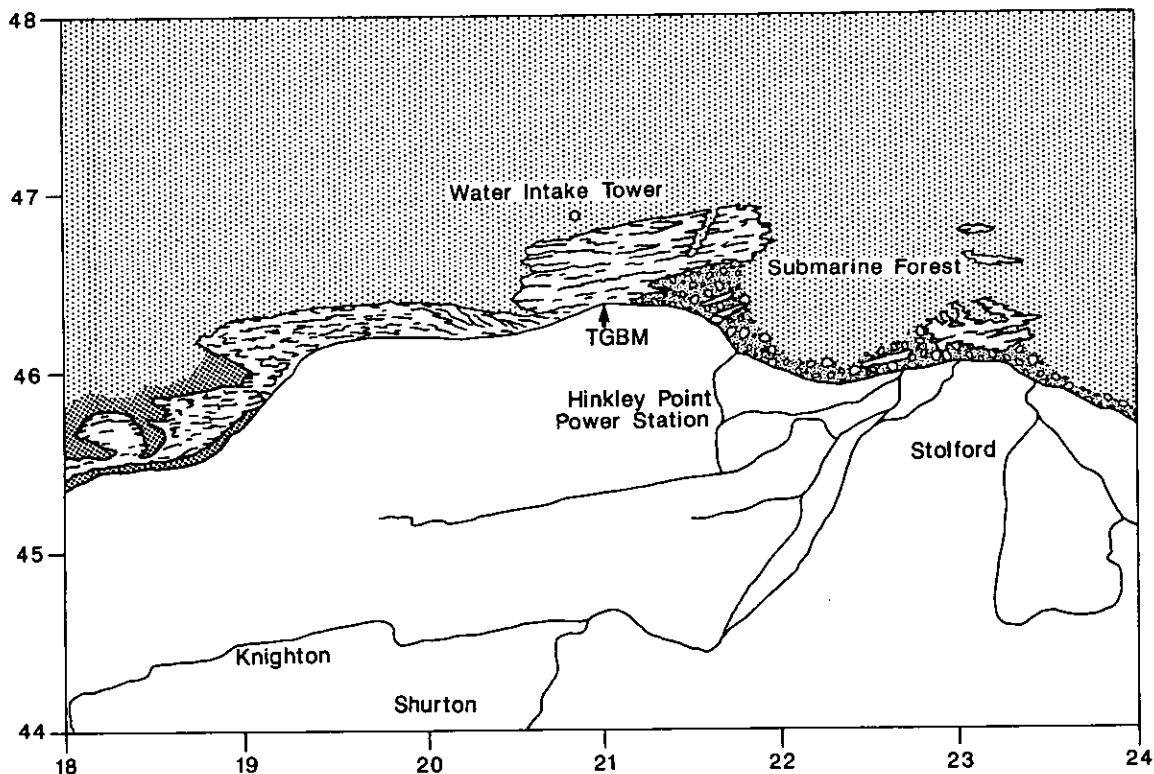
Geographic and reference details

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.

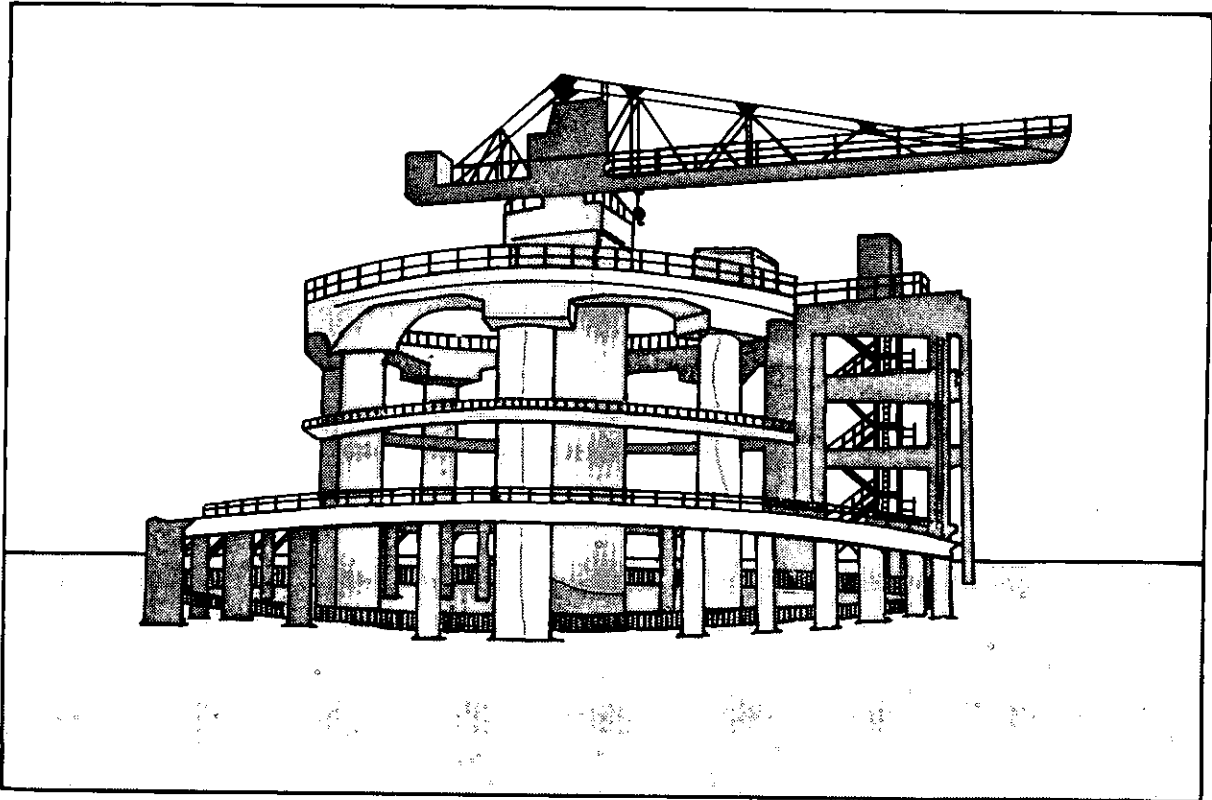
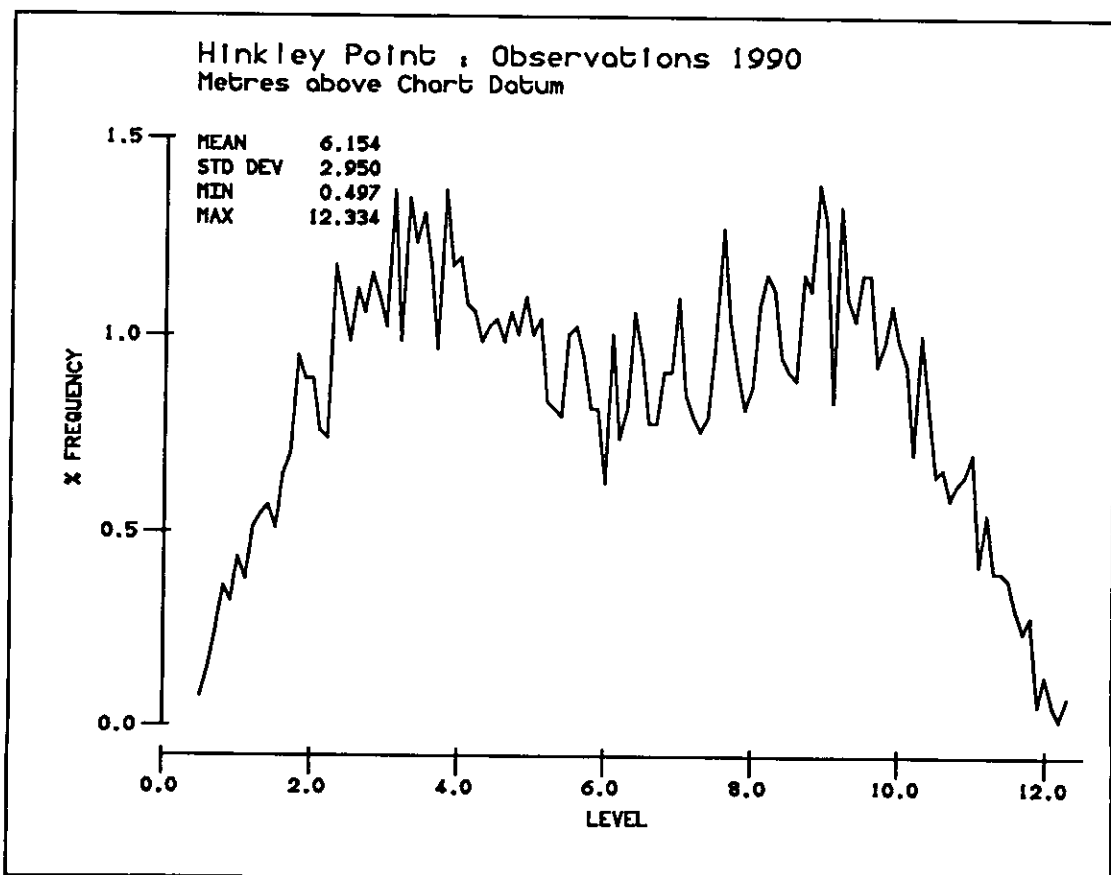


Figure 3. The cooling water intake tower at Hinkley Point.



Holyhead

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

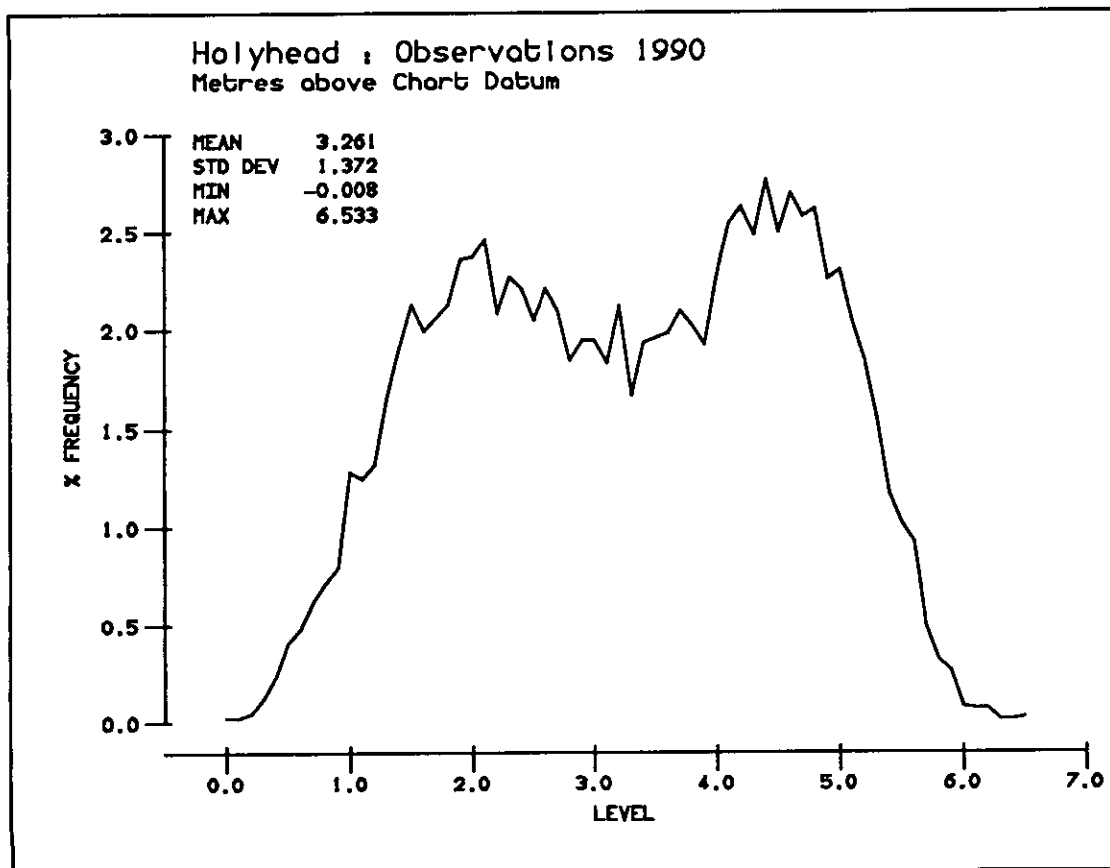
Recording zero = Chart Datum = 3.05m below Ordnance Datum Newlyn
Recording zero = 7.447m below Tide Gauge Bench Mark

Spurious and missing scans in the raw values from channel 2 digiquartz were edited on the following dates: 10 Jan (TGI visit); 22 Mar; 3 Apr; 9 May (TGI visit); 19,27 Jun (TGI visits); 17 Jul; 8,14 Aug (TGI visits); 28 Oct; 8 Dec.
The datum of the channel 2 pressure point was 0.8m high until 10 January, and corrected in the reduction process.

Gaps in hourly filtered levels (Channel 2 digiquartz)

07hrs. 8 March to 04hrs. 9 March

On-site memory loss.



Harmonic Tidal Analysis.

Port: Wales - Holyhead

Latitude: 53 18' 49.3" N

Longitude: 4 37' 9.4" W

Time Zone: GMT

Length: 364 Days

From: 1st January, 1990

To: 31st December, 1990

Units: Metres

A0: 3.262

Hourly data from digiquartz sensor

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

Observation Mean=	0.3263D+01	Residual Mean =	0.1982D-05
Std Dev =	0.1373D+01	Std Dev =	0.1695D+00

Constituent	h	g
Q1	0.033	347.26
O1	0.105	28.93
P1	0.038	166.24
K1	0.112	178.95
J1	0.005	185.39
2N2	0.050	243.12
N2	0.358	267.48
M2	1.810	291.93
S2	0.595	328.81
K2	0.169	327.08
M3	0.017	246.04
M4	0.033	27.87
MS4	0.012	52.31
M6	0.020	223.72

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.

The Class-A channel 2 (digiquartz) had been beset by scaling problems since 30 January. Some values were retrieved from the back-up channel when TGI visited the site 2 March. The compressor for channel 2 pressure gauge failed 6 March and remained unserviceable until 5 April.

Values from the back-up potentiometer, although retained have not been used to fill the gap. Therefore no statistics are published for February or March for this site.

Power lines were brought down at this site during the February storms and the pier suffered some damage.

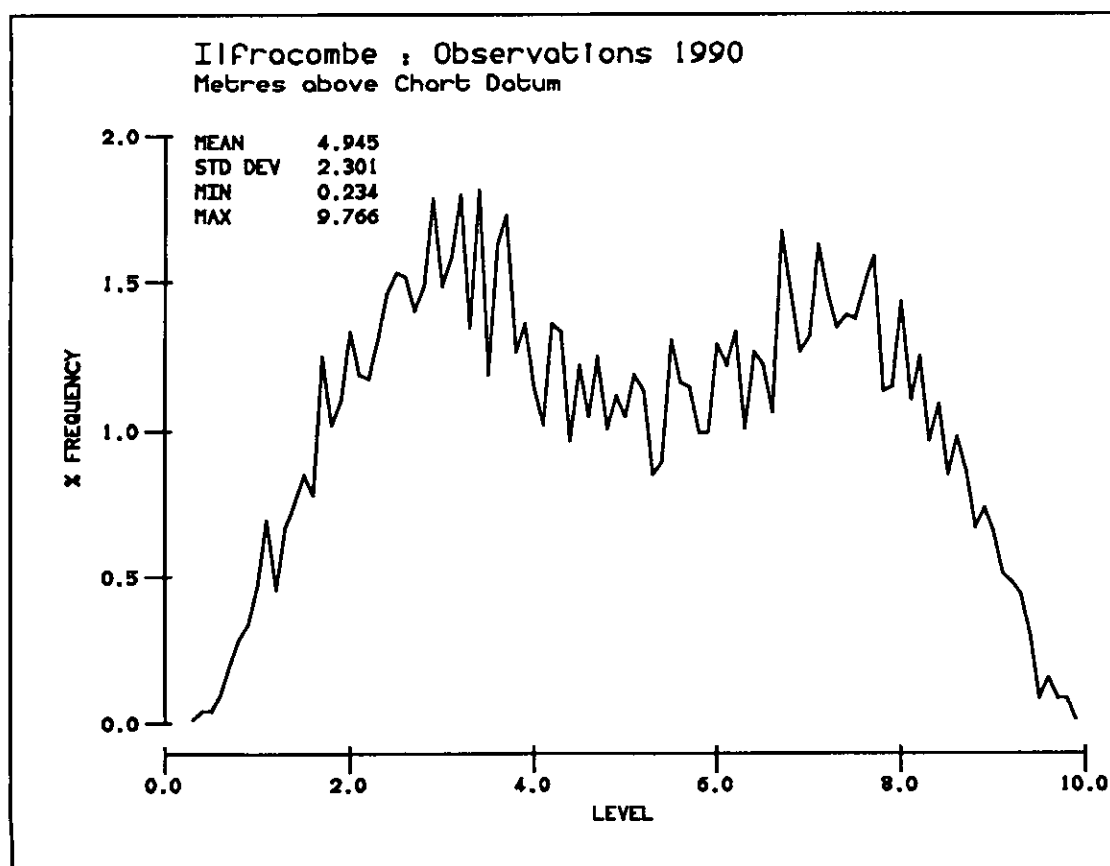
Spurious and missing scans were interpolated at the raw stage for the following dates: 15,30 Jan; 6,8 Feb; 24 Mar; 4,30 Apr; 25 Jun; 24,31 Jul; 8 Aug; 1,6,17 Sep; 28 Oct; 3 Dec.

Scans integrated at 1 7/8 minute during TGI visit of 21 May were edited.

Gaps in final filtered hourly levels for Channel 2

10hrs. 30 January - 04hrs. 6 April

17hrs. 04 July - 19hrs. 9 July



Harmonic Tidal Analysis.

Port: England, West Coast - Ilfracombe

Latitude: 51 12' 39.0" N

Longitude: 4 06' 36.3" W

Time Zone: GMT

Length: 362 Days

From: 1st January, 1990

To: 11th March, 1991

Units: Metres

A0: 4.934

Hourly data from digiquartz sensor

Datum of Observations = ACD : 4.80 Metres below Ordnance Datum (Newlyn)

Observation Mean =	0.4941D+01	Residual Mean =	0.6589D-06
Std Dev =	0.2312D+01	Std Dev =	0.1552D+00

Constituent	h	g
Q1	0.022	302.52
O1	0.068	349.49
P1	0.023	114.42
K1	0.065	124.38
J1	0.005	113.69
2N2	0.074	126.99
N2	0.579	143.78
M2	3.050	161.83
S2	1.117	208.89
K2	0.323	206.14
M3	0.032	123.66
M4	0.110	350.36
MS4	0.064	52.79
M6	0.020	335.88

Immingham

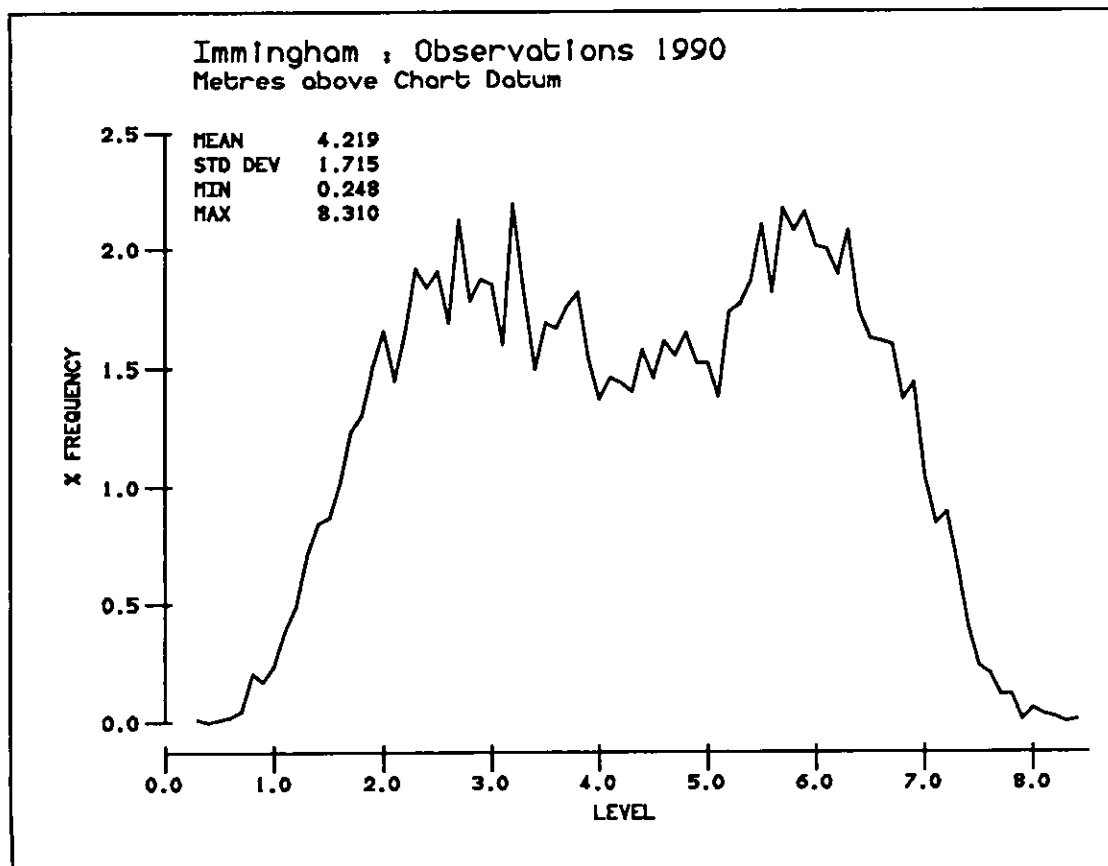
Latitude 53 deg 37' 58.9"N Longitude 00 deg 11' 13.0"W
National Grid reference TA 1987 1672

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

Spurious and missing values in the raw data from Channel 2 (Class-A) digiquartz were interpolated on the following dates: 2 Jan; 5 Mar; 2,23 May; 3,24,25 Jul; 8,21,31 Aug; 1 Sep; 6,15 Oct; 6 Nov.

Scans integrated over 1 7/8 minute during a visit by TGI for routine maintenance on 26 September were edited.

There were no gaps in the final hourly 1990 series of elevations processed.



Harmonic Tidal Analysis.

Port: England, East Coast - Immingham

Latitude: 53 37' 58.9" N

Longitude: 0 11' 13.0" W

Time Zone: GMT

Length: 365 Days

From: 1st January, 1990

To: 31st December, 1990

Units: Metres

A0: 4.222

Hourly data from digiquartz sensor 2

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

Observation Mean =	0.4221D+01	Residual Mean =	0.2072D-06
Std Dev =	0.1717D+01	Std Dev =	0.2057D+00

Constituent	h	g
Q1	0.045	76.40
O1	0.179	113.79
P1	0.048	277.97
K1	0.152	287.06
J1	0.018	358.13
2N2	0.057	117.56
N2	0.429	141.83
M2	2.262	161.84
S2	0.746	211.99
K2	0.215	209.26
M3	0.007	193.98
M4	0.022	179.51
MS4	0.032	246.47
M6	0.016	159.32

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

During the summer the TGI completely refurbished the Leith installation, only to have gales on 19 September rip it out. It was reinstated by 18 October.

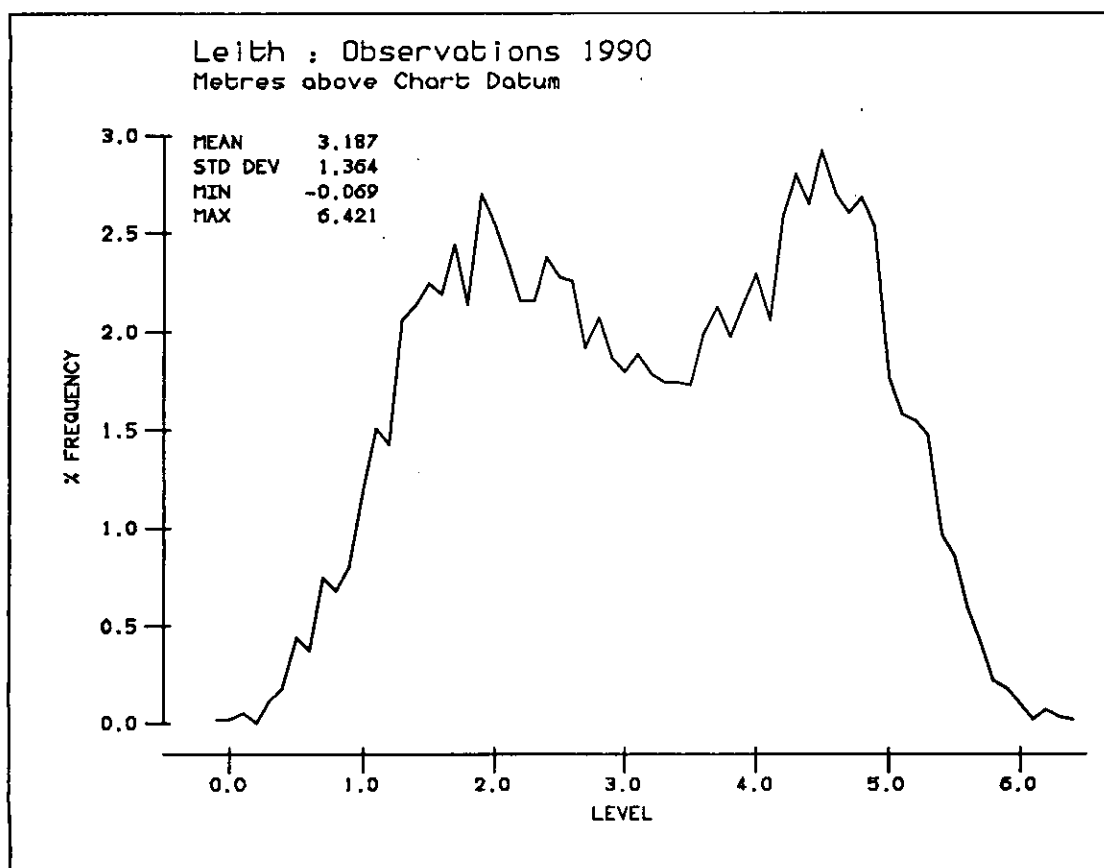
Spurious and missing values in the raw data from the Channel 2 potentiometer on the well-head unit were interpolated on the following dates: 17 Jan; 19 Mar; 11,26 Apr; 9,23 May; 13,22 Jun; 26 Nov.

Scans integrated at 1 7/8 minute over the TGI visit of 5 March were edited.

Because of all the gaps in this series, no Harmonic Constants are presented for 1990.

Gaps in final processed hourly levels

00hrs GMT	1 January -	18hrs GMT	1 January	
21hrs GMT	5 February -	19hrs GMT	18 February	On-site modem failure
12hrs GMT	30 June -	23hrs GMT	12 September	Equipment removed for refurbishment.
22hrs GMT	18 September -	22hrs GMT	18 October	Equipment failure caused by gales.
17hrs GMT	30 December -	23hrs GMT	31 December	



Lerwick

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 pressure outlet.

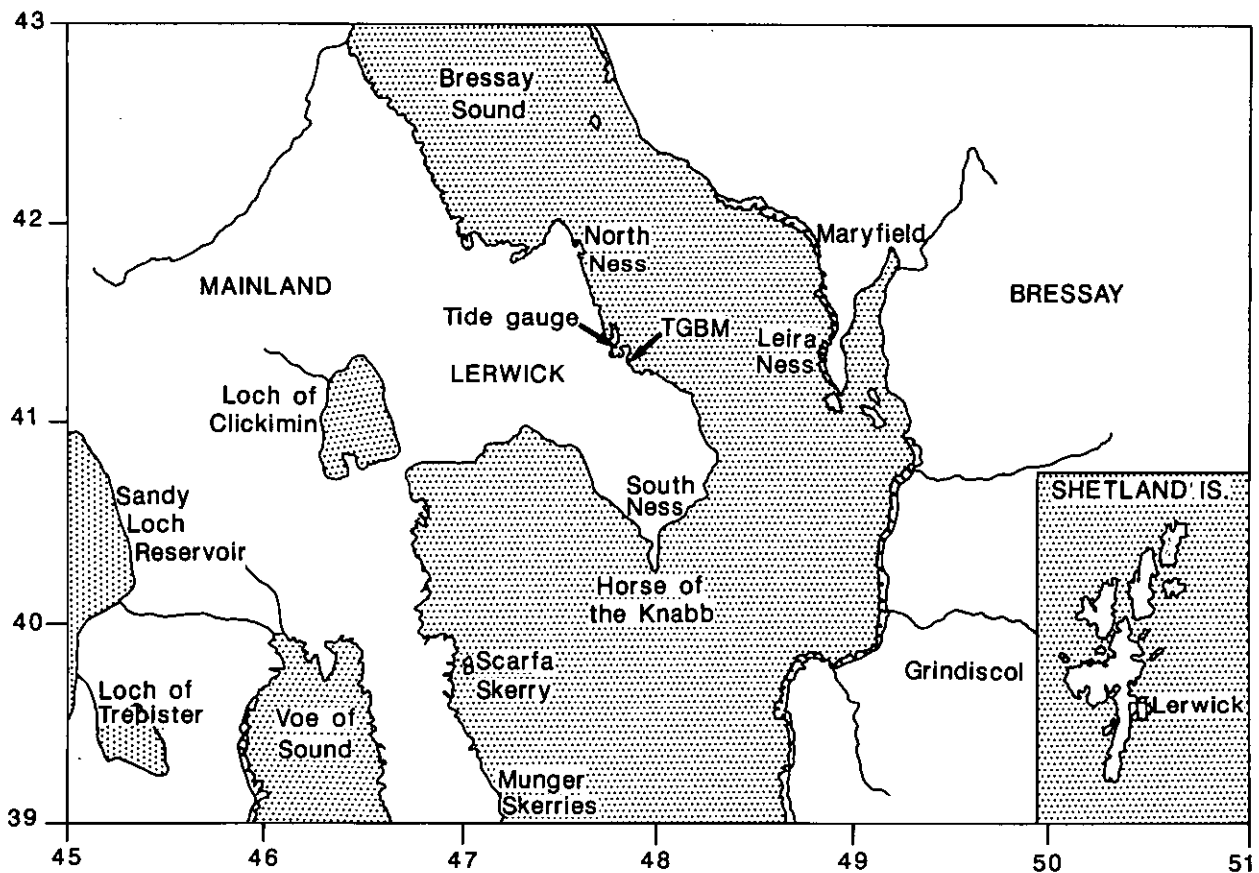
Geographic and reference details

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	HU4783 4129	OSBM bolt on breakwater wall.
Aux1	HU4784 4125	Queen's Hotel 7.5m SW face south angle.
Aux2	HU4777 4110	Lerwick Parish Church North face NW angle.

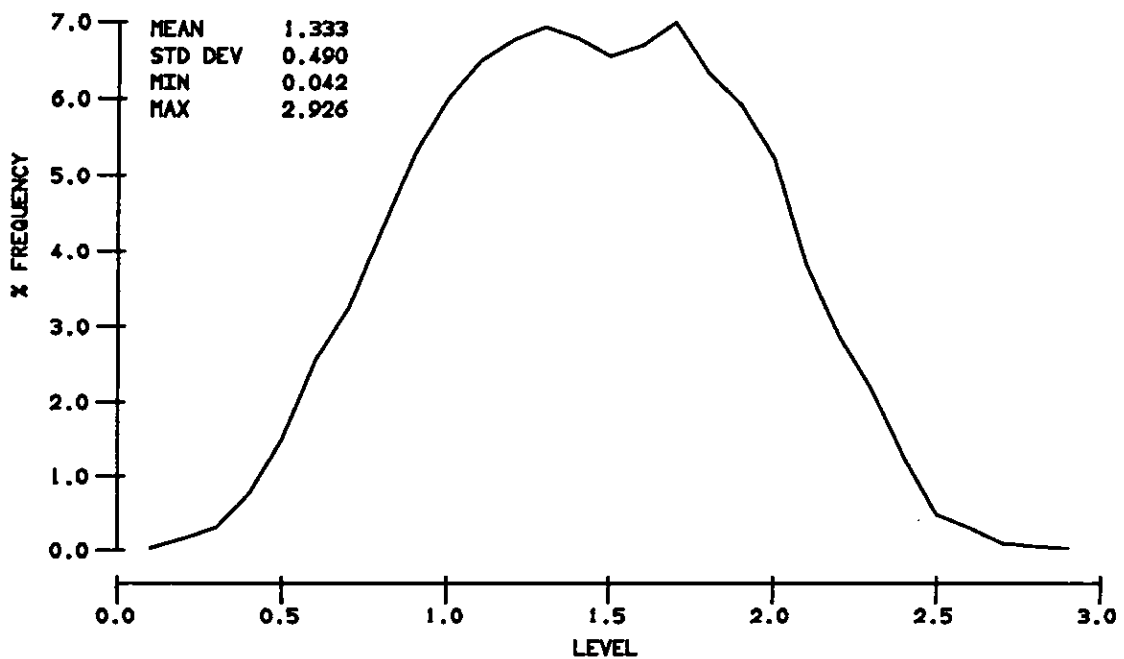
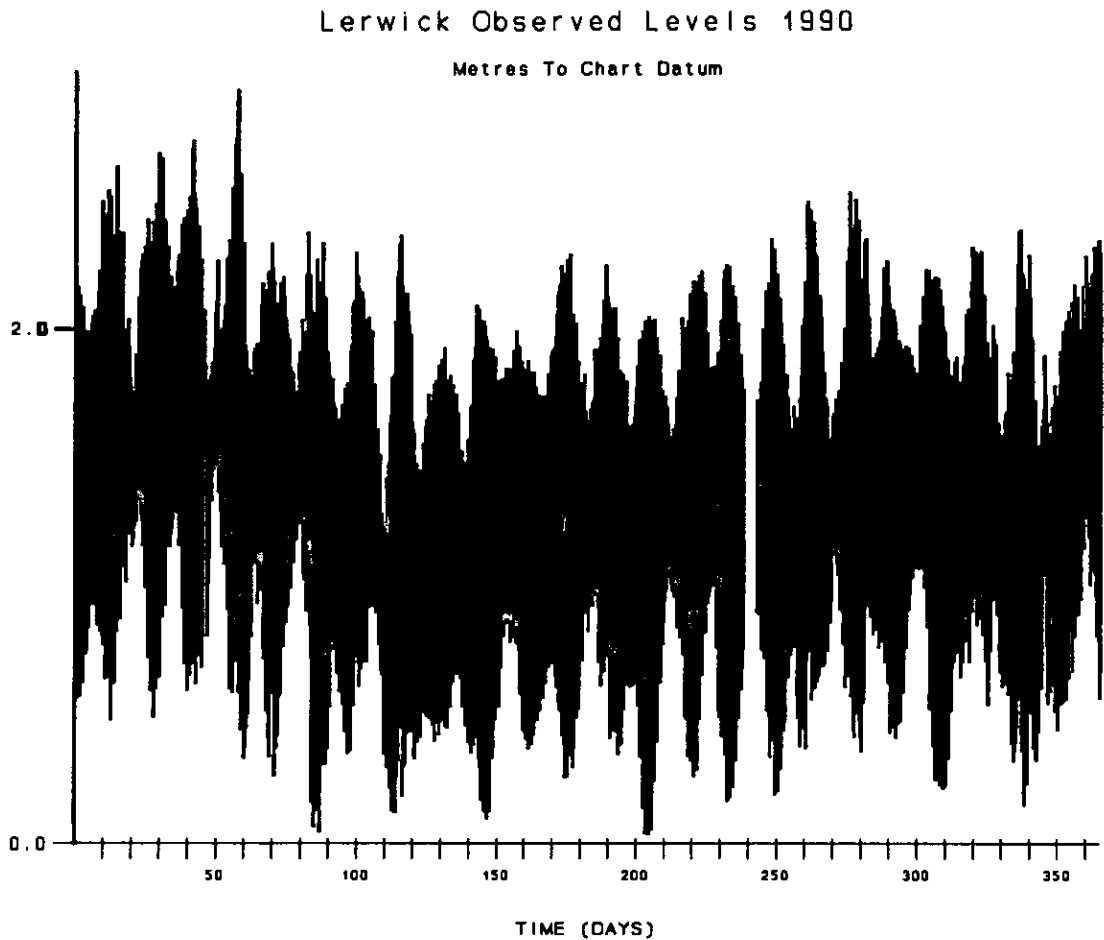
Missing and spurious values in the raw data from Channel 2 digiquartz were edited for the following dates: 6,28 Feb; 3 Mar; 4 Apr; 27 Aug; 29,30 Oct; 27 Nov.

Scans integrated at 1 7/8 minute over a visit by TGI on 11 December were edited.

Gaps in final processed hourly levels

04hrs 27 August - 14hrs 31 August

Spurious values - deleted.



Harmonic Tidal Analysis.

Port: Shetland Islands - Lerwick

Latitude: 60 09' 13.8" N

Longitude: 1 08' 18.2" W

Time Zone: GMT

Length: 360 Days

From: 1st January, 1990

To: 31st December, 1990

Units: Metres

A0: 1.335

Hourly data from digiquartz sensor

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

Observation Mean =	0.1335D+01	Residual Mean =	0.1137D-06
Std Dev =	0.4893D+00	Std Dev =	0.1420D+00

Constituent	h	g
Q1	0.024	349.40
O1	0.082	31.13
P1	0.021	148.43
K1	0.075	164.84
J1	0.006	208.20
2N2	0.017	272.80
N2	0.120	292.26
M2	0.580	312.00
S2	0.210	346.67
K2	0.059	342.41
M3	0.006	200.32
M4	0.016	272.05
MS4	0.013	1.87
M6	0.012	223.21

Lowestoft

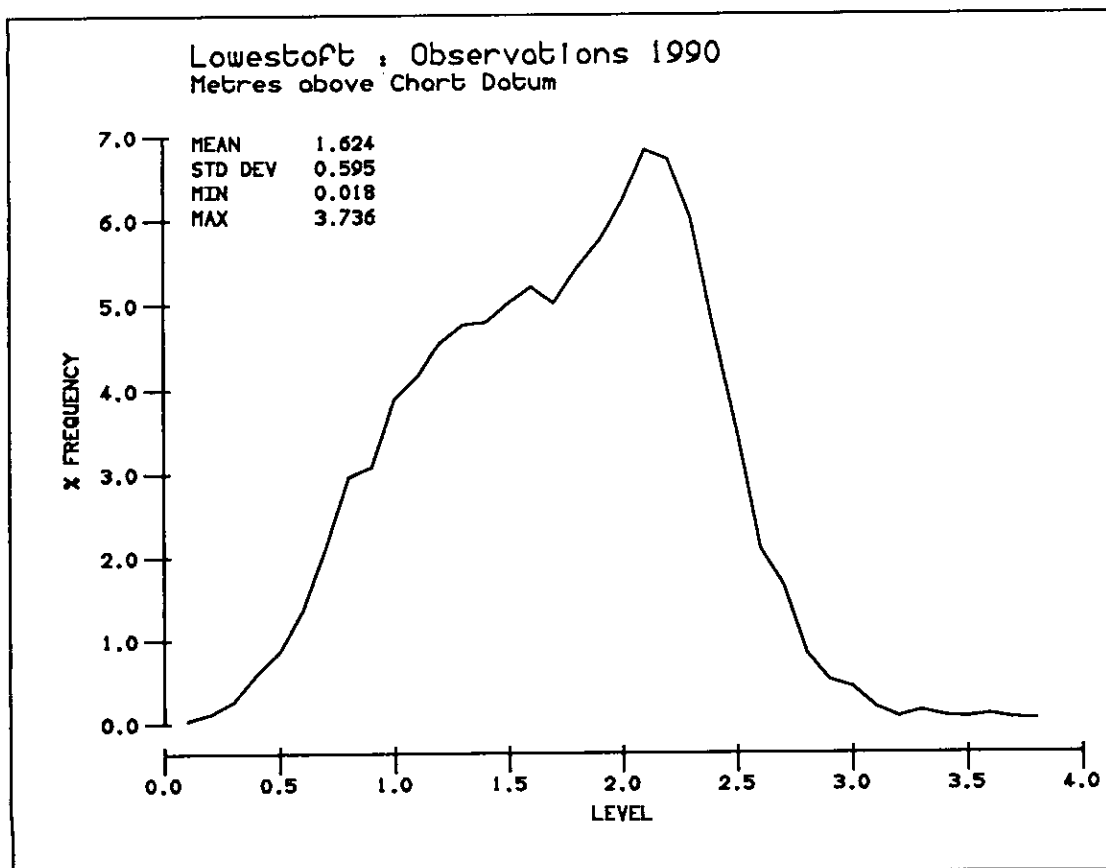
Latitude 52 deg 28' 20.9"N Longitude 01 deg 45' 6.4"E
National Grid reference TM 5477 9272

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

Missing and spurious values in the raw values from the designated Class-A channel 2 were interpolated for the following dates: 13,23,31 Jan; 5,25,30 Mar; 29 Apr; 15 May; 1,19,30 Jun; 5,20,29 Jul; 8,21 Aug; 13 Sep; 25 Oct.

Scans integrated at 1 7/8 minute, during attendance by TGI for routine maintenance from 25 to 27 September, were edited.

There were no gaps in the final filtered hourly processed data for 1990.



Harmonic Tidal Analysis.

Port: England, East Coast - Lowestoft

Latitude: 52 28' 20.9"N

Longitude: 1 45' 6.4"E

Time Zone: GMT

Length: 365 Days

From: 1st January, 1990

To: 31st December, 1990

Units: Metres

A0: 1.626

Hourly data from potentiometer sensor 2

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

Observation Mean =	0.1625D+01	Residual Mean =	0.5059D-06
Std Dev =	0.5929D+00	Std Dev =	0.2344D+00

Constituent	h	g
Q1	0.035	123.04
O1	0.145	159.62
P1	0.043	332.29
K1	0.120	336.24
J1	0.012	41.53
2N2	0.034	195.27
N2	0.131	232.24
M2	0.693	259.70
S2	0.207	298.57
K2	0.057	298.41
M3	0.006	246.40
M4	0.049	335.03
MS4	0.042	25.09
M6	0.039	114.64

Milford Haven

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 pressure gauge systems. Unfortunately, for much of 1990 the channel 2 system was unserviceable, therefore statistics presented in this report stem from channel 1.

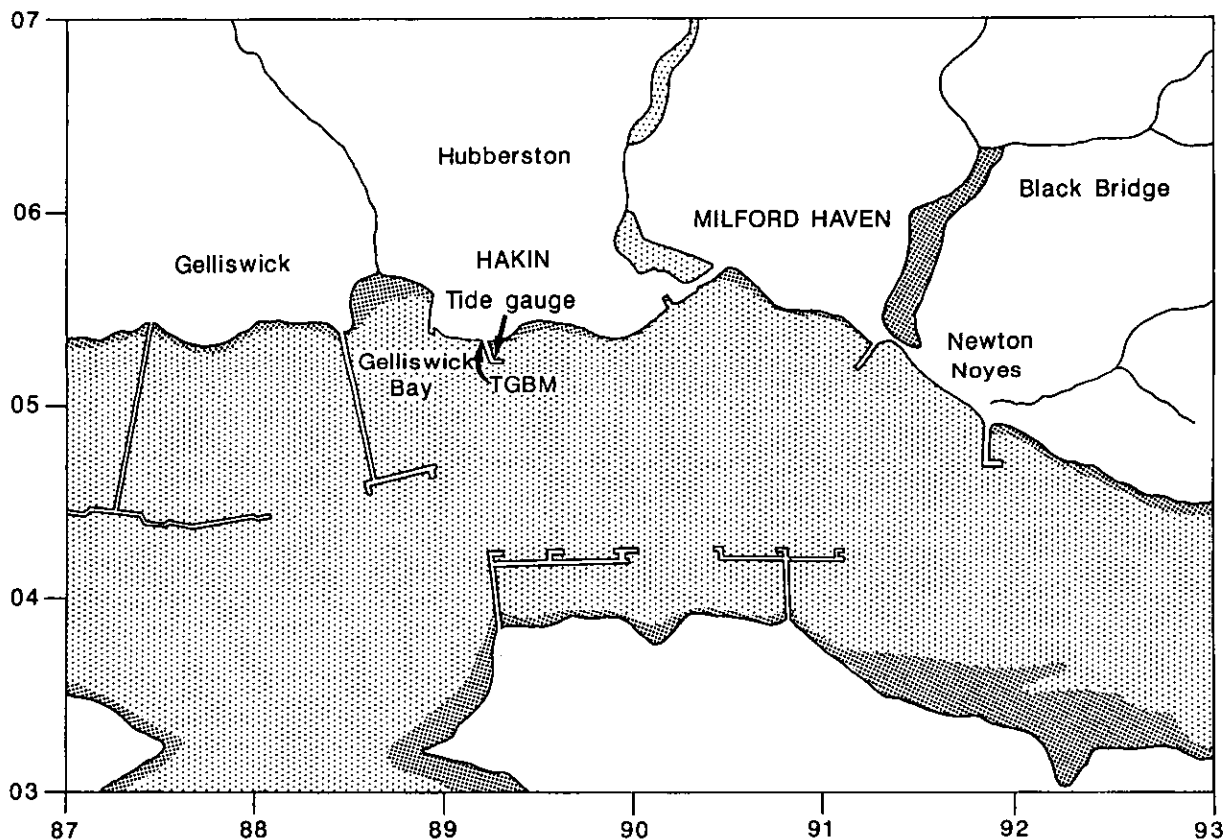
Geographic and reference details

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

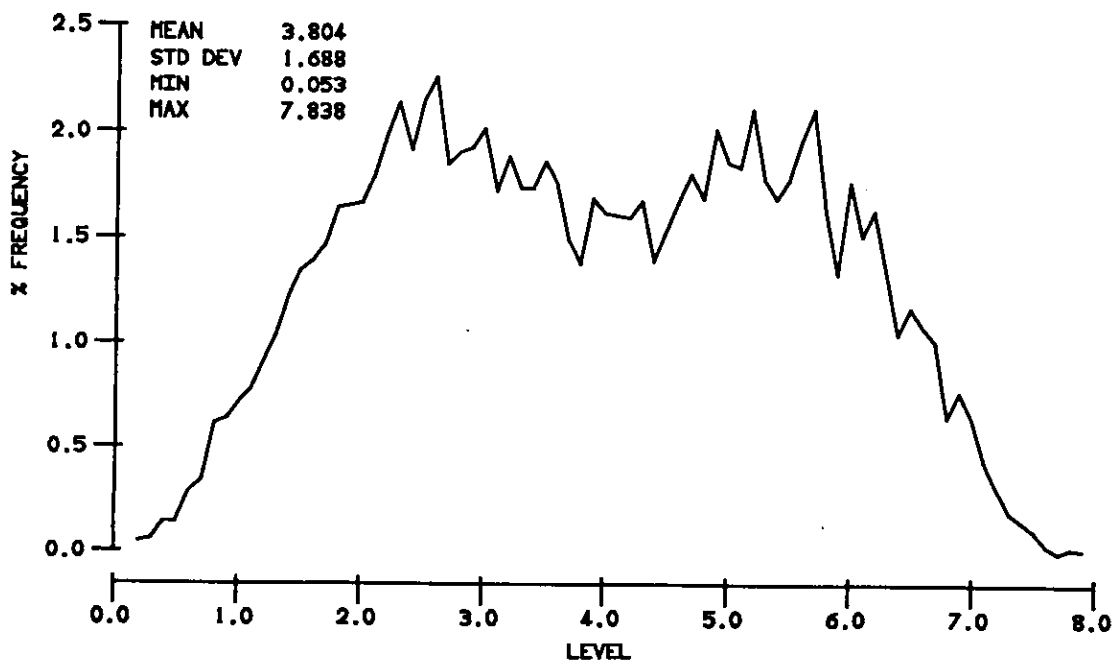
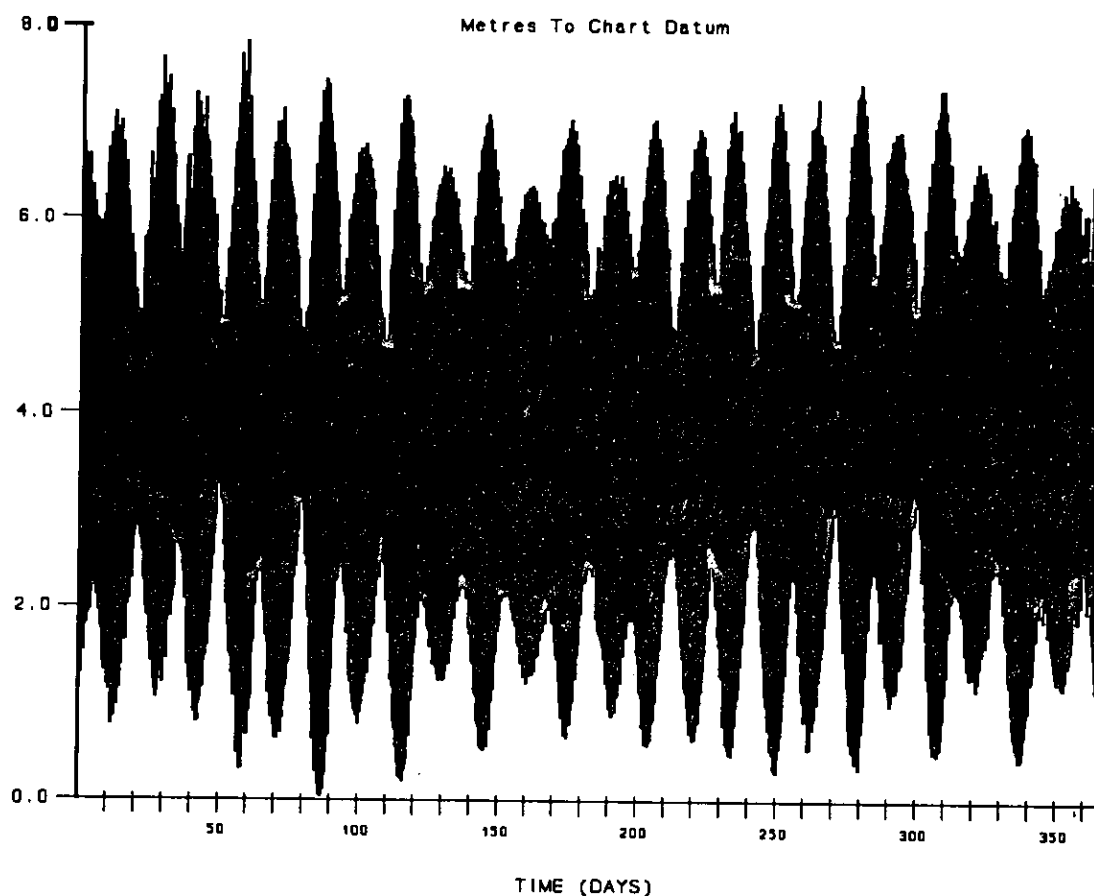


Bench Mark	NG co-ords	Description
TGBM	SM8921 0536	OSBM bolt on wall West side of entrance to jetty.
Aux1	SM8918 0541	Flush Bracket G4977 office building, SW face, NW angle.

Isolated spurious and missing values from the channel 1 digiquartz raw data were interpolated for the following dates: 6,12,16,17,19,23(2),24,25(2),27 Jan; 3,6,9,10,12(2),15,23,24,27,28(3) Feb; 1,13(2),18,19,21,25,26,31 Mar; 3,4,7,8,13,14(2),20,24,26 Apr; 16(3) May; 1(3),6,7(2),8,19,20,22,23(2),29,30 Jun; 4,5,10,12(2),13,17(2),18,28,30,31 Jul; 16,17(2),27,30 Aug; 1,2,5,7,15,23 Sep; 1,12,13,16,27 Oct; 11,13,14,20,24 Nov; 6,18,19 Dec. Scans integrated at 1 7/8 minute, during TGI visit of 2 August, were edited.

There were no gaps in the final filtered hourly values for 1990.

Milford Haven Observed Levels 1990



Harmonic Tidal Analysis.

Port: Wales - Milford Haven

Latitude: 51 42' 21.5" N

Longitude: 5 03' 2.1" W

Time Zone: GMT

Length: 365 Days

From: 1st January, 1990

To: 31st December, 1990

Units: Metres

A0: 3.806

Hourly data from digiquartz sensor 1

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

Observation Mean =	0.3806D+01	Residual Mean =	0.2020D-05
Std Dev =	0.1691D+01	Std Dev =	0.1510D+00

Constituent	h	g
Q1	0.021	316.69
O1	0.068	355.76
P1	0.024	117.74
K1	0.066	135.39
J1	0.003	99.88
2N2	0.060	132.63
N2	0.431	153.16
M2	2.221	172.55
S2	0.813	217.15
K2	0.232	215.00
M3	0.017	123.15
M4	0.065	306.77
MS4	0.033	358.75
M6	0.015	150.50

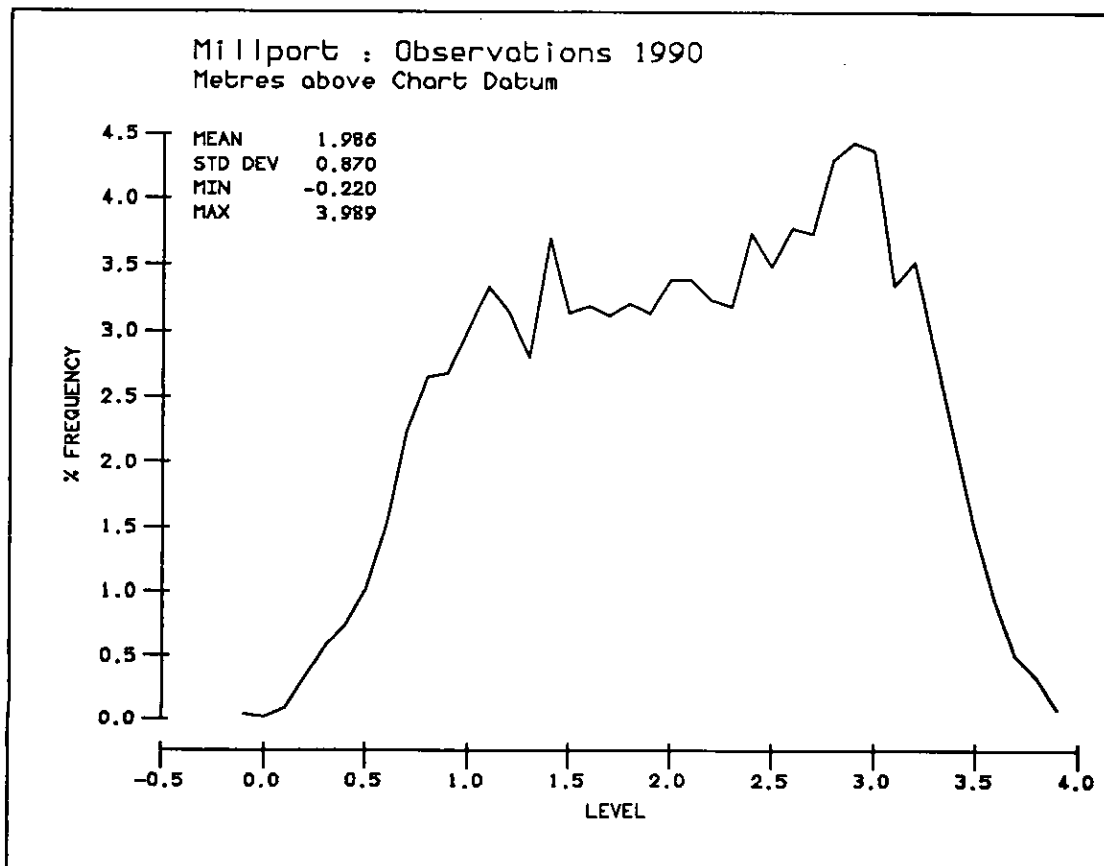
Millport

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.

Channel 2 with a digiquartz sensor is the designated Class-A channel of data at this site.
Isolated missing and spurious values in the raw data were interpolated for the following dates:
13,25,26 Mar; 8 Jun; 8,18 Jul; 7,22 Sep; 22 Oct.

The central processing unit failed at this site on 24 January and was replaced by TGI on 7 March. The gap in the final processed data extended from 22hrs GMT 23 January to 19hrs GMT 7 March.



Harmonic Tidal Analysis.

Port: Scotland, West Coast - Millport

Latitude: 55 44' 58.2" N

Longitude: 4 54' 17.9" W

Time Zone: GMT

Length: 364 Days

From: 8th March, 1990

To: 7th March, 1991

Units: Metres

A0: 2.021

Hourly data from digiquartz sensor

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

Observation Mean =	0.2022D+01	Residual Mean =	0.5247D-06
Std Dev =	0.8594D+00	Std Dev =	0.2035D+00

Constituent	h	g
Q1	0.033	348.67
O1	0.104	43.03
P1	0.037	192.07
K1	0.110	192.55
J1	0.005	246.54
2N2	0.028	289.29
N2	0.212	316.87
M2	1.127	342.94
S2	0.303	35.63
K2	0.088	34.93
M3	0.049	113.67
M4	0.093	90.15
MS4	0.086	115.86
M6	0.024	303.71

Mumbles

Mumbles is a new site to the network intended to replace Swansea, as briefly mentioned in the 1989 report. It has two differential pressure gauges linked to digiquartz transducers. Since installation in January 1989, it has suffered rather a chequered history in terms of both data quantity and quality.

Originally furnished with an Aanderaa pressure gauge system in November 1988, this site was upgraded to Dataring in January 1989. However, the installation was beset with problems with very little data retrieved in 1989. In 1990, the installation was damaged during the storm of 25 February and remained unserviceable until reinstated by the Tide Gauge Inspectorate (TGI) in August.

Graphs of the observed levels (overleaf) and statistics for the first seven months of 1990, presented in this report are from the back-up Aanderaa pressure recorder.

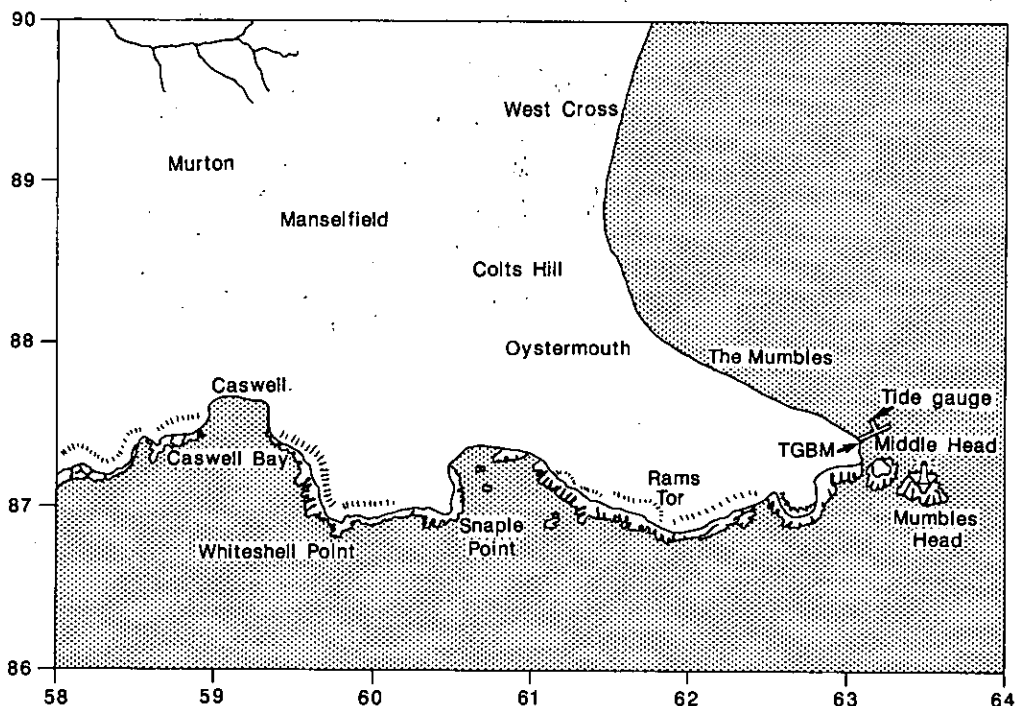
Geographic and reference details

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



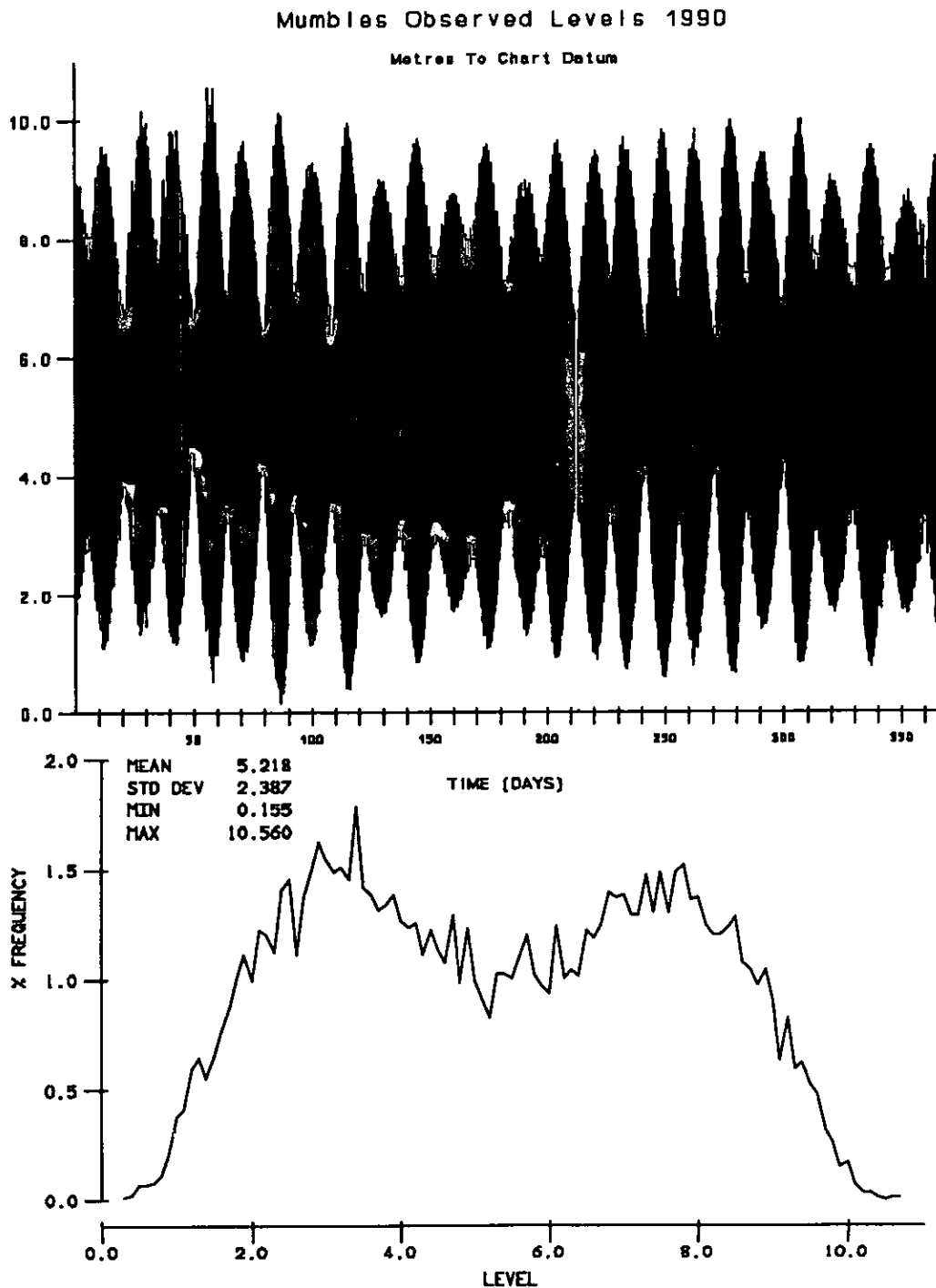
Bench Mark	NG co-ords	Description
TGBM	SS6298 8743	OSBM bolt Living Rock South side of road.
Aux1	SS6317 8752	OSBM bolt Lifeboat Station Mumbles Pier.
Aux2	SS6284 8750	OSBM bolt on concrete base of bollard, Lifeboat Cottage.

Full details of elevations obtained from the channel 2 digiquartz for 1990 are as follows:- Isolated spurious and missing scans were interpolated on the following dates: 7,8,18,25(4),26,27,28,29(2),31 Jan; 6,11(5),12,13(6) Feb; 29 Aug; 1,19,27 Nov; 19,21(2) Dec.

Gaps in final processed hourly levels

04hrs. 23 January	- 06hrs. 24 January	Error in data store.
05hrs. 02 February	- 12hrs. 03 February	Data lost from store.
12hrs. 05 February	- 03hrs. 06 February	Data lost from store.
21hrs. 11 February	- 10hrs. 12 February	Data lost from store.
17hrs. 19 February	- 11hrs. 07 March	Data lost from store, then storm damage.
07hrs. 13 March	- 20hrs. 01 August	Installation awaiting repair.

In view of all the gaps and poor quality of the data retrieved from dataring until August, the back-up Aanderaa recording was processed for the period January to July.



Newhaven

This site was upgraded to Dataring in November 1990 with two pressure gauge sensors to replace an Aanderaa pressure system which remains as a back-up recording.

Operational from 14 November, isolated spurious and missing scans in the raw data were interpolated for the following dates: 20 Nov.

However, the recordings seem to drift up to 5cms. in error by the 17 November and there were many other spikes and anomalous values throughout the series such that processing was abandoned for 1990.

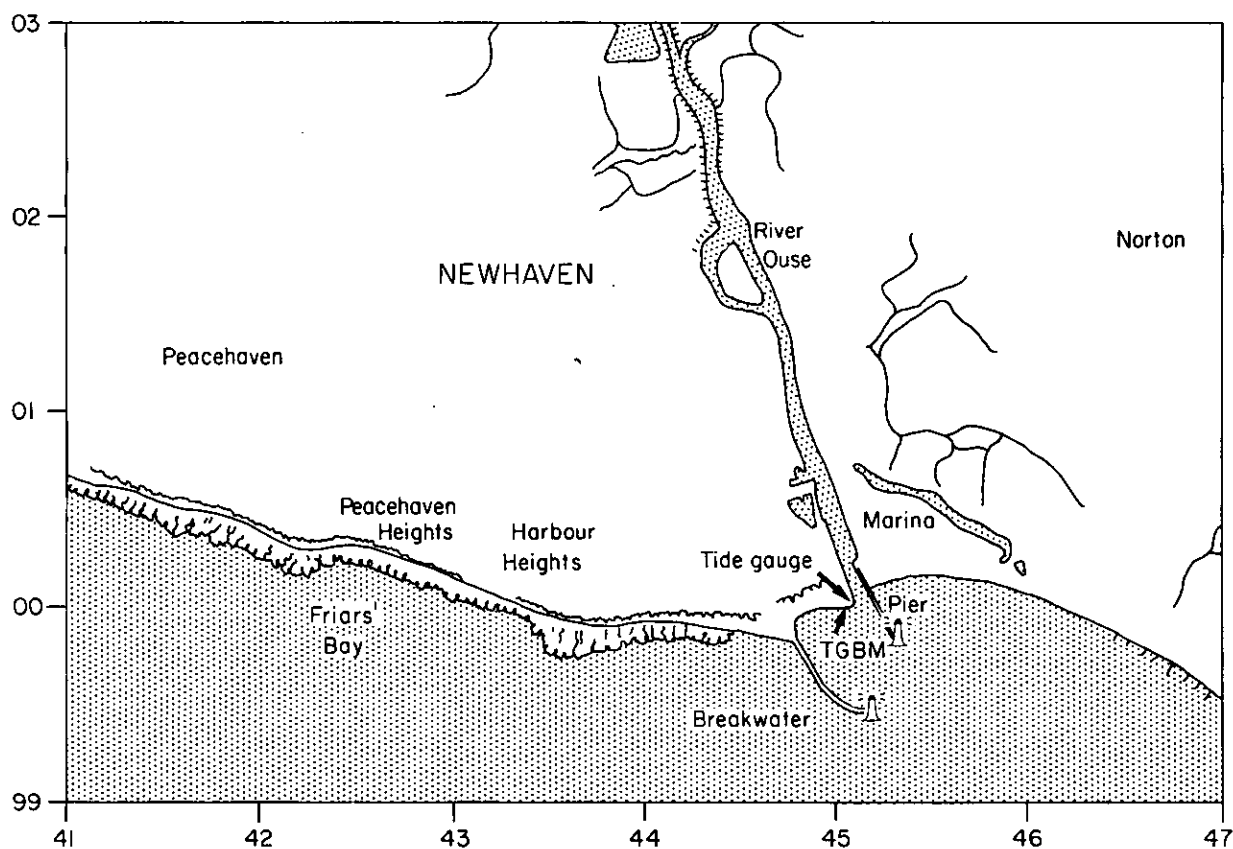
Geographic and reference details

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	N.G. co-ords	Description
TGBM	TQ4510 0003	OSBM bolt on concrete surround 7.4m SW of SW angle of tower.
Aux1	TQ4495 0001	OSBM bolt on concrete sea wall 154.3m SW of tower.

Newlyn

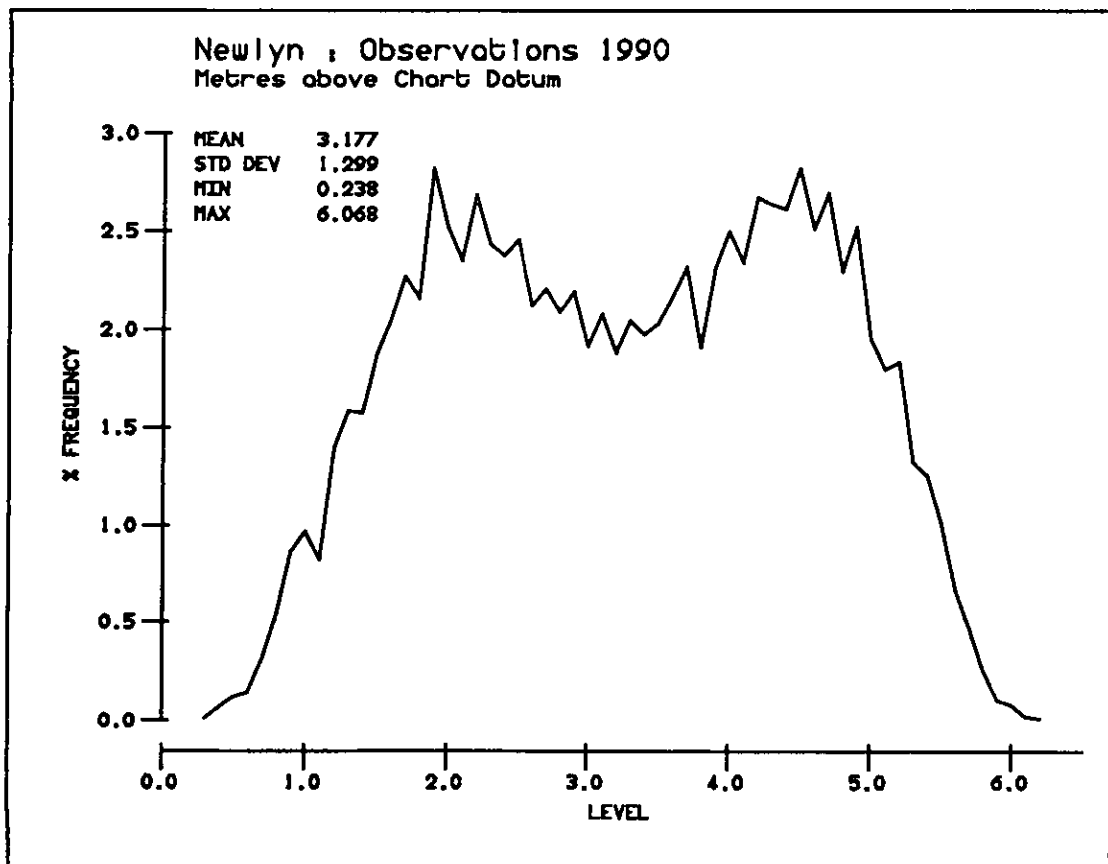
Latitude 50 deg 06' 8.4"N Longitude 05 deg 32' 30.6"W
National Grid Reference SW 4676 2855

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

Isolated spurious and missing scans in the raw data from the Channel 2 digiquartz were interpolated for the following dates : 9,16 Jan; 1,19,20 Feb; 8,15,26,30 Mar; 7,25 Apr; 3,5,14,22 Jun; 26 Jul; 4,7 Oct; 8 Nov; 15,17 Dec.

Scans integrated at 1 7/8 minute were edited for the 23 May over the period of a visit by TGI.

Despite many problems with the back-up potentiometer channel of data at this site, there were ultimately no gaps in the series of hourly data from channel 2 digiquartz for 1990.



Harmonic Tidal Analysis.

Port: England, South Coast - Newlyn

Latitude: 50 06' 08.7" N

Longitude: 5 32' 30.0" W

Time Zone: GMT

Length: 365 Days

From: 1st January, 1990

To: 31st December, 1990

Units: Metres

A0: 3.180

Hourly data from digiquartz sensor 2

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

Observation Mean =	0.3179D+01	Residual Mean =	0.1505D-05
Std Dev =	0.1300D+01	Std Dev =	0.1187D+00

Constituent	h	g
Q1	0.016	305.85
O1	0.055	341.34
P1	0.021	101.80
K1	0.065	112.25
J1	0.003	152.12
2N2	0.046	69.43
N2	0.331	113.67
M2	1.720	133.09
S2	0.579	177.50
K2	0.165	174.66
M3	0.010	15.69
M4	0.115	165.22
MS4	0.077	217.38
M6	0.009	325.64

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

Prior to filtering to hourly heights, missing and spurious values in the Class A channel 2 data were interpolated for the following dates : 10 Jan; 3,30 Mar; 25 Apr; 23,31 May; 3,26 Jul; 9,24 Aug; 26 Sep.

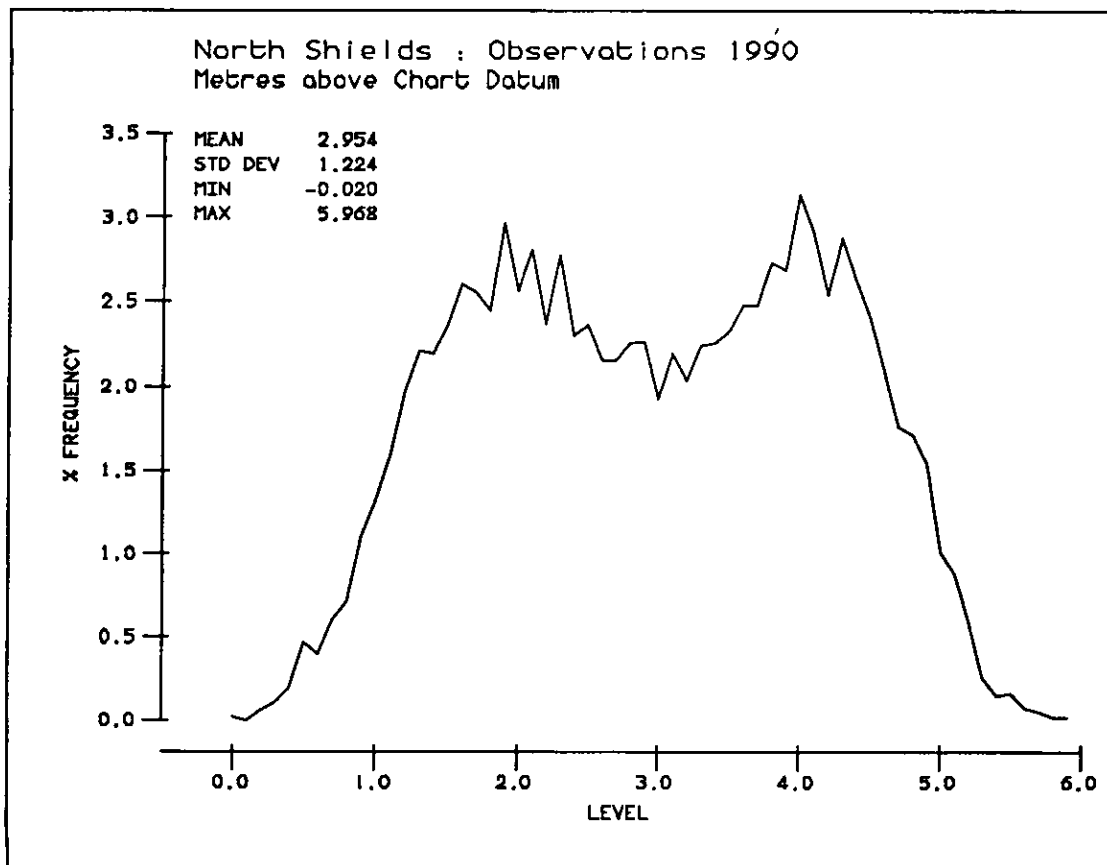
Scans integrated at 1 7/8 minute over the TGI visit of 4 March were edited.

Gaps in final processed hourly levels

17hrs 18 October - 15hrs 6 November Modem fault.

The TGI visited the site 6 November and fitted new processor and power boards.

From 6 November to the end of the year, duplicate values were recorded on both channels of data. These were removed as part of the processing procedure.



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: 366 Days

From: 1st January, 1990

To: 20th January, 1991

Units: Metres

A0: 2.954

Hourly data from potentiometer sensor 2

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

Observation Mean =	0.2959D+01	Residual Mean =	-0.7965D-04
Std Dev =	0.1226D+01	Std Dev =	0.1779D+00

Constituent	h	g
Q1	0.038	43.10
O1	0.146	80.60
P1	0.032	229.04
K1	0.115	244.08
J1	0.012	313.37
2N2	0.051	33.29
N2	0.312	65.94
M2	1.604	88.91
S2	0.539	130.92
K2	0.156	128.92
M3	0.009	62.13
M4	0.024	108.37
MS4	0.017	87.55
M6	0.007	7.80

Portpatrick

Upgraded to Dataring and operational from *July with a potentiometer sensor linked to the stilling well (Channel 1) and digiquartz on a pressure gauge system. The Lea gauge which had been in use since 1968 was removed in October 1989.

*Dataring was installed at this site on 1 June 1990, but was beset with clock problems until a new clock board was fitted by TGI 9 July. Isolated missing and spurious scans were interpolated at the raw stage for the following dates : 25,31 Jul; 10,22,31 Aug; 13(2),26 Sep; 15,25 Oct; 5,13,28 Nov; 12,17,23 Dec.

There were no gaps in the final series of filtered hourly values for 1990, which started at 1500hrs. GMT 9 July.

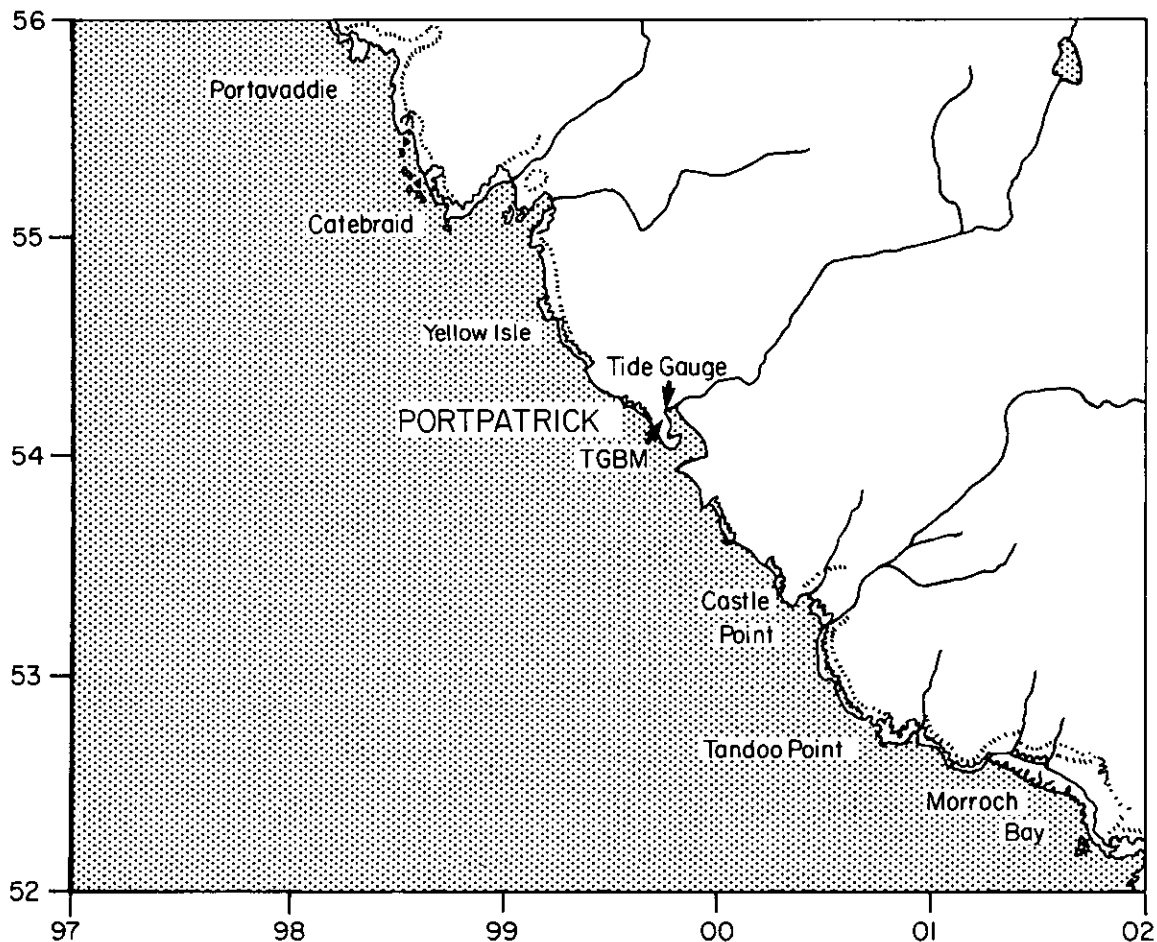
Geographic and reference details

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	N.G. co-ords	Description
TGBM	NW9976 5421	Bolt on harbour wall 13.84m NE angle of building.
Aux1	NW9977 5411	Rivet on E side of jetty wall 16.6m SE angle of Life Boat headquarters
Aux2	NW9995 5412	Rivet S angle of No.53 Main St.

Sheerness

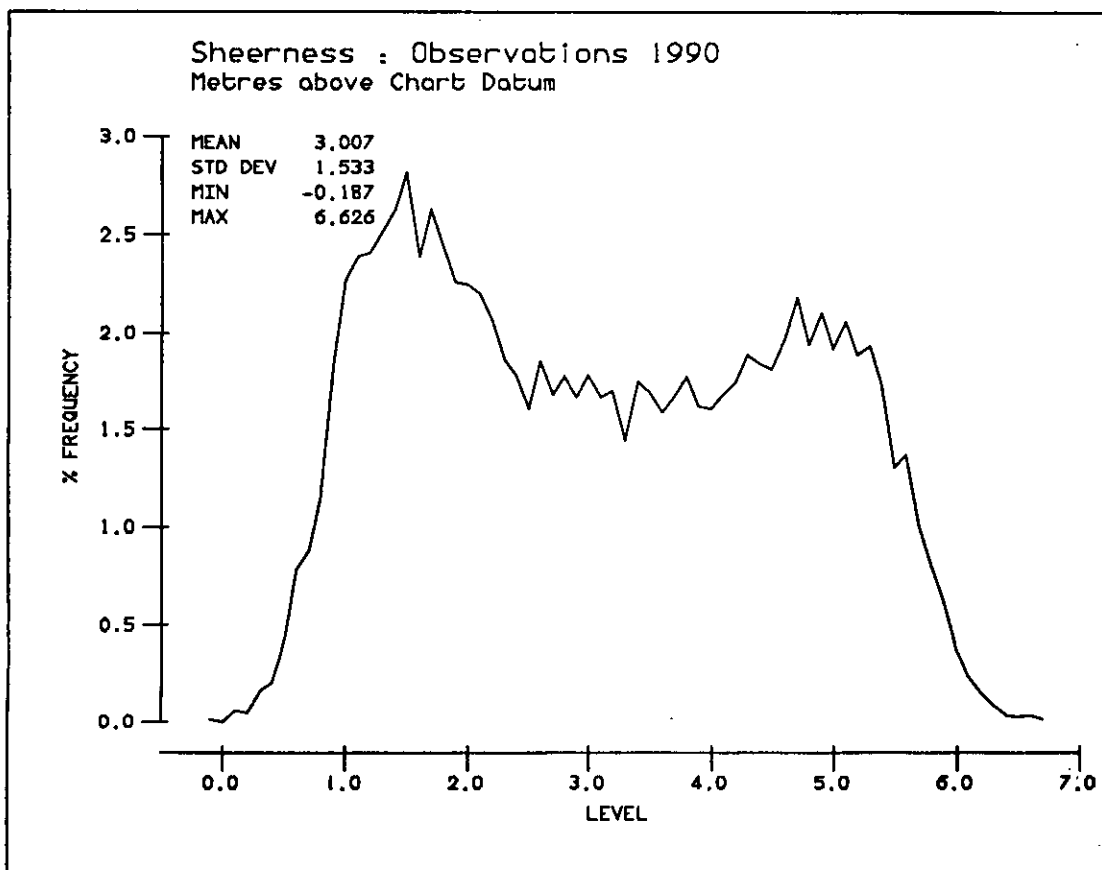
Latitude 51 deg 26' 42.4"N Longitude 00 deg 44' 41.9"E
National Grid Reference TQ 9073 7542

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

The channel 2 digiquartz connected to a pressure point was treated as the Class-A channel of data. Isolated and missing values in the raw data were interpolated for the following dates: 23 Jan; 13,20,28 Feb; 6,19 Mar(2); 2,20 May; 13,19 Jun; 26 Jul; 21 Aug; 2,27 Sep; 14,25 Oct; 29 Nov; 27 Dec.

Scans integrated at 1 7/8 minute over the TGI visit of 27 November were edited.

Ultimately there were no gaps in processed data from Channel 2 digiquartz for 1990. The pressure point tubing was replaced in August after a split in one tube was discovered.



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, 1990

To: 31st December, 1990

Units: Metres

A0: 3.009

Hourly data from digiquartz sensor 2

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

Observation Mean =	0.3009D+01	Residual Mean =	-0.4522D-06
Std Dev =	0.1534D+01	Std Dev =	0.2521D+00

Constituent	h	g
Q1	0.033	153.60
O1	0.140	189.30
P1	0.048	9.80
K1	0.117	18.57
J1	0.010	82.74
2N2	0.079	260.27
N2	0.348	332.32
M2	2.030	353.76
S2	0.584	50.48
K2	0.171	49.57
M3	0.009	12.84
M4	0.115	7.03
MS4	0.052	79.69
M6	0.053	34.06

Stornoway

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

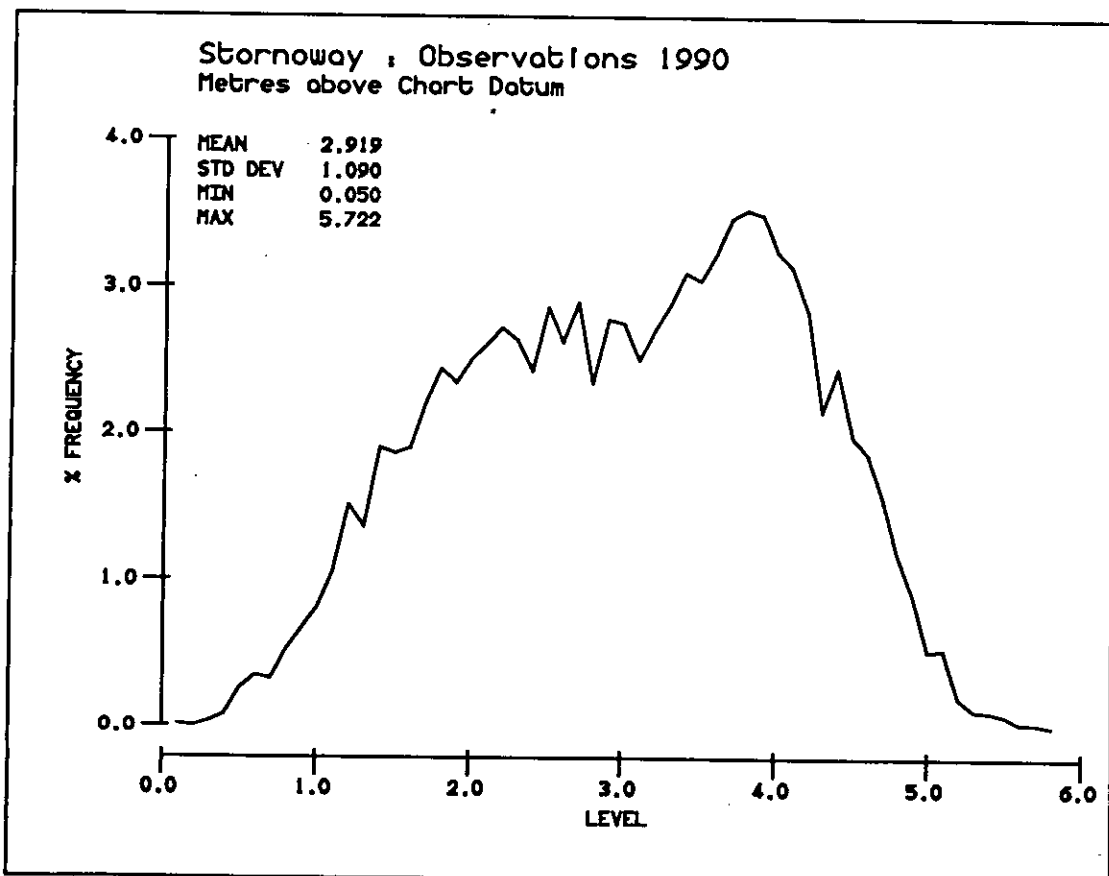
Recording zero = Chart Datum = 2.71m below Ordnance Datum Local
Recording zero = 6.368m below Tide Gauge Bench Mark

Isolated missing and spurious scans in the raw data from channel 2 digiquartz were interpolated for the following dates: 15 Feb; 17,21 Mar; 21 May; 4 Jun; 3,9(4) Jul; 30 Oct; 30 Nov; 2 Dec; 14 Dec.

Scans integrated at 1 7/8 minute, during the visit by TGI on 3 and 4 October to implement 'g' corrections, were also edited at the raw stage.

The equipment was damaged in the gales of 4 December.

The gap in final filtered data was from 00hrs GMT 4 December to 02hrs 14 December.



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, 1990

To: 31st December, 1990

Units: Metres

A0: 2.922

Hourly data from digiquartz sensor 2

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

Observation Mean =	0.2920D+01	Residual Mean =	0.8366D-06
Std Dev =	0.1090D+01	Std Dev =	0.1599D+00

Constituent	h	g
Q1	0.027	306.59
O1	0.095	350.20
P1	0.038	127.18
K1	0.132	136.12
J1	0.012	171.31
2N2	0.040	161.32
N2	0.279	176.45
M2	1.384	197.71
S2	0.544	231.43
K2	0.154	228.57
M3	0.030	118.70
M4	0.060	222.06
MS4	0.073	294.90
M6	0.007	190.43

Tobermory

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

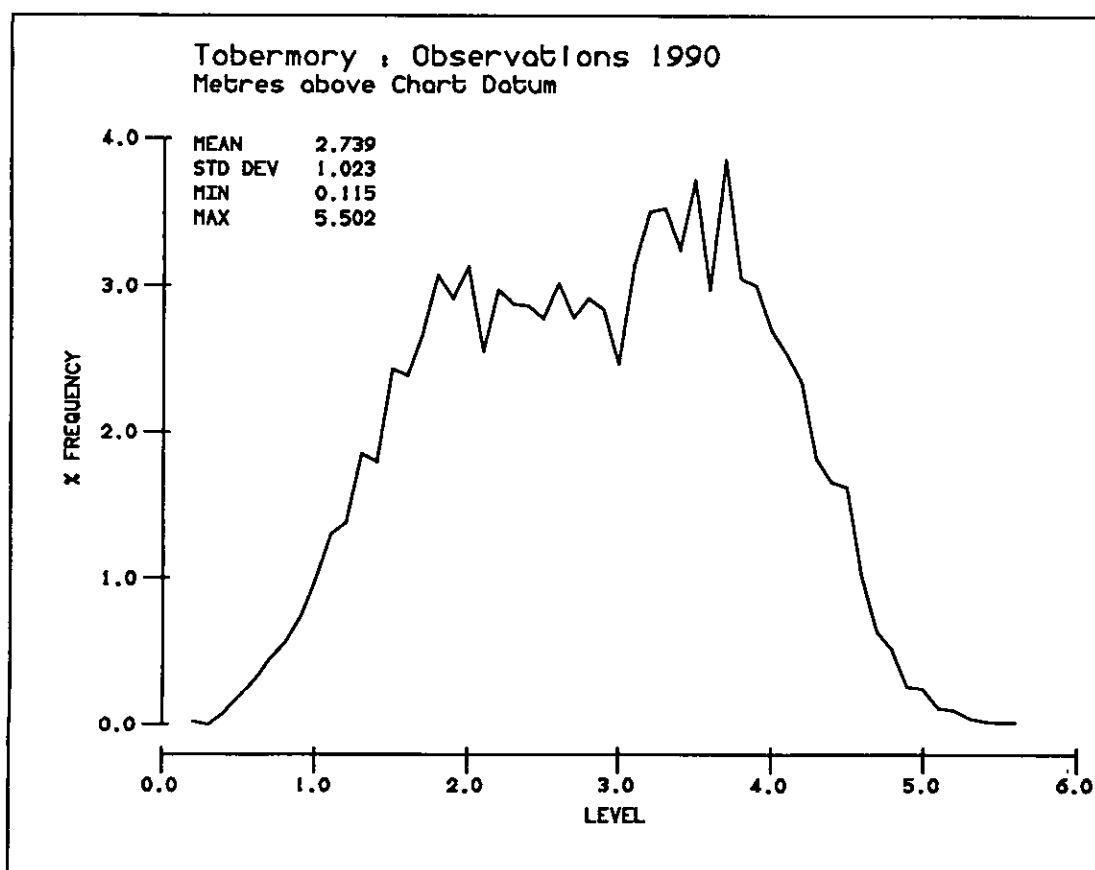
Recording zero = Chart Datum = 2.39m below Ordnance Datum Newlyn
Recording zero = 6.856m below Tide Gauge Bench Mark

After interpolation of isolated missing and spurious values in the raw data for the dates as listed below, hourly levels were filtered from the channel 2 digiquartz recordings.

12(4) Jan; 6 Feb; 8 Mar; 14 Mar; 4,11,24 Apr; 19 Jun; 22 Aug; 22,28 Sep; 8,19 Nov; 28:Dec.
Scans integrated at 1 7/8 minute during the TGI visit of 5 October were also edited at the raw stage.

TGI visited the site 5 October for routine maintenance and to apply gravitational corrections to the digiquartz sensor calibrations.

There were no gaps in the final filtered hourly values for 1990.



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, 1990 To: 31st December, 1990

Units: Metres A0: 2.741

Hourly data from digiquartz sensor 2

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

Observation Mean =	0.2740D+01	Residual Mean =	0.1851D-05
Std Dev =	0.1021D+01	Std Dev =	0.1859D+00

Constituent	h	g
Q1	0.024	335.43
O1	0.062	22.71
P1	0.016	158.49
K1	0.064	167.33
J1	0.008	156.01
2N2	0.033	130.98
N2	0.261	148.60
M2	1.290	168.59
S2	0.525	204.91
K2	0.150	202.23
M3	0.038	116.10
M4	0.043	182.93
MS4	0.036	286.63
M6	0.013	5.63

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

After interpolation of isolated missing and spurious scans in the raw data for the dates listed below, hourly levels were filtered from the channel 2 digiquartz.

4 Feb; 13 Feb; 8 Aug; 1 Oct.

Scans integrated at 1 7/8 minute during the visit by TGI on 2 and 3 October were also edited at the raw stage.

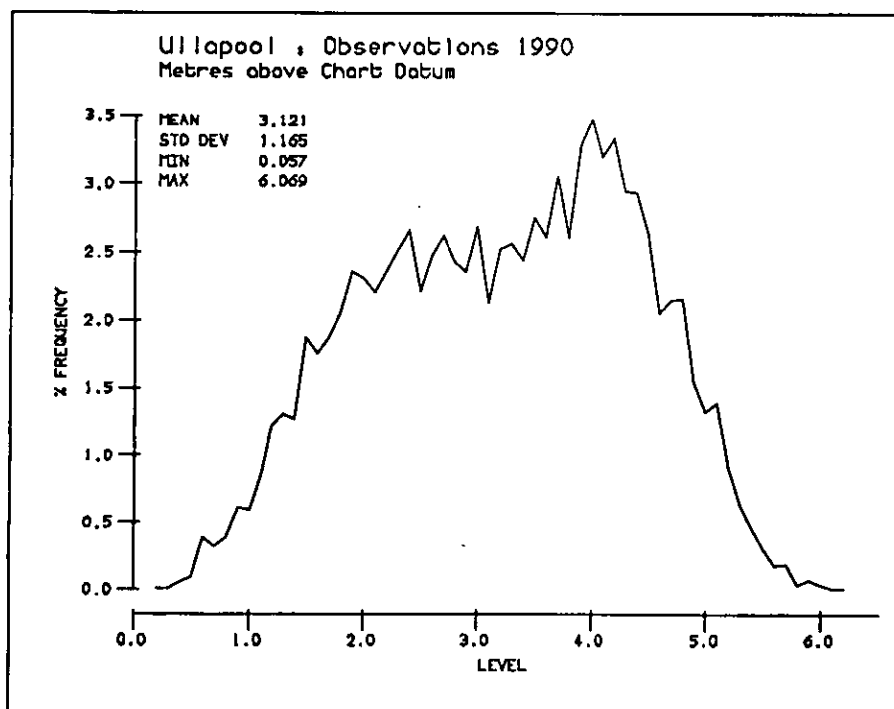
Problems with the clock appeared to begin towards the end of March with erratic timing. This was controlled to some extent from the central processor. By mid-April however, corrections had to be applied as part of the reduction process of the hourly levels.

Values were treated as being 4 minutes fast from 1200GMT 11 April until 1200GMT 17 April. From 1300GMT 17 April until 1300GMT 27 September they were treated as 7 minutes fast. The TGI visited the site to make repairs and fit a new clock 3 October.

The residual values (differences between observed and predicted) show a phase lag in May and June which indicates the conclusions reached about the clock error may be slightly in error but they represent a 'best-fit' scenario from evidence to hand. (See diagrams of residuals in Section 5)

Gaps in hourly filtered data

06hrs 10 August	0300GMT 15 August	Values lost from on-site memory after system locked up.
01hrs 12 September	1500GMT 19 September	" " "
11hrs 31 October	1300GMT 5 November	" " "



Harmonic Tidal Analysis.

Port: Scotland, West Coast - Ullapool

Latitude: 57 53' 44.0" N

Longitude: 5 09' 26.9" W

Time Zone: GMT

Length: 391 Days

From: 1st January, 1990

To: 11th February, 1991

Units: Metres

A0: 3.104

Hourly data from digiquartz sensor 2

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

Observation Mean =	0.3119D+01	Residual Mean =	0.8606D-06
Std Dev =	0.1169D+01	Std Dev =	0.2141D+00

Constituent	h	g
Q1	0.024	309.54
O1	0.079	346.82
P1	0.031	119.24
K1	0.111	129.65
J1	0.011	177.08
2N2	0.044	164.18
N2	0.301	179.31
M2	1.496	200.85
S2	0.581	234.85
K2	0.163	230.28
M3	0.030	127.40
M4	0.066	231.67
MS4	0.075	301.92
M6	0.007	196.63

Whitby

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

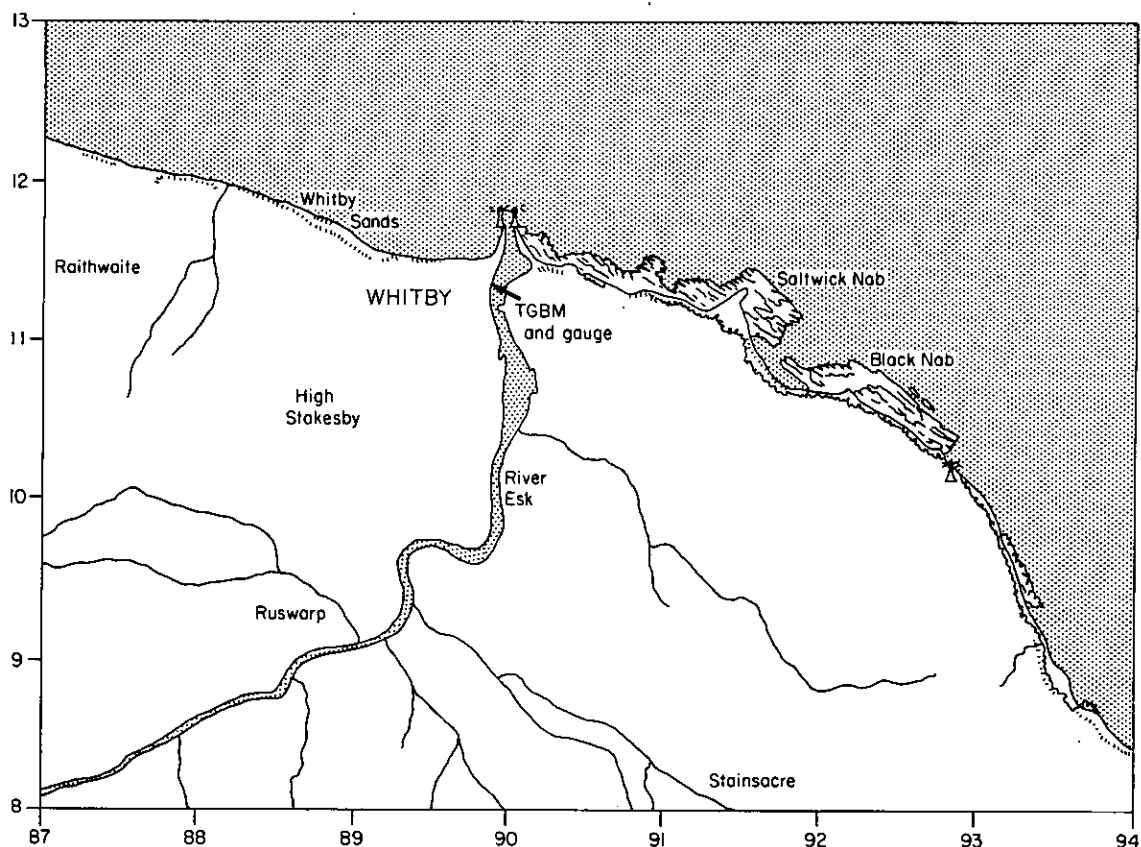
Geographic and reference details

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

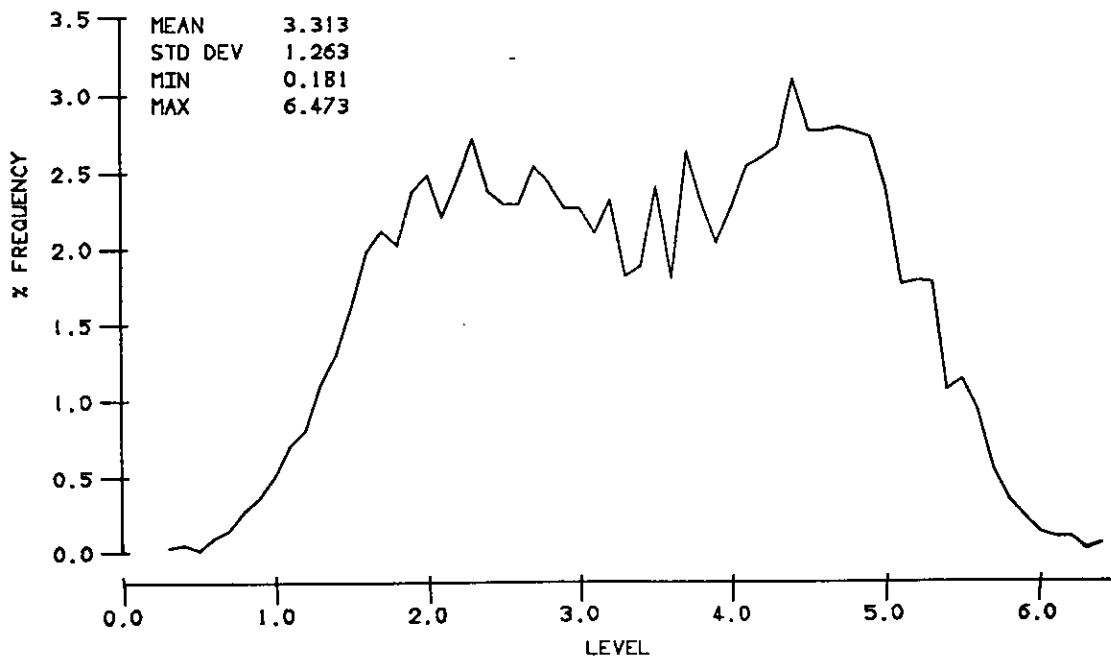
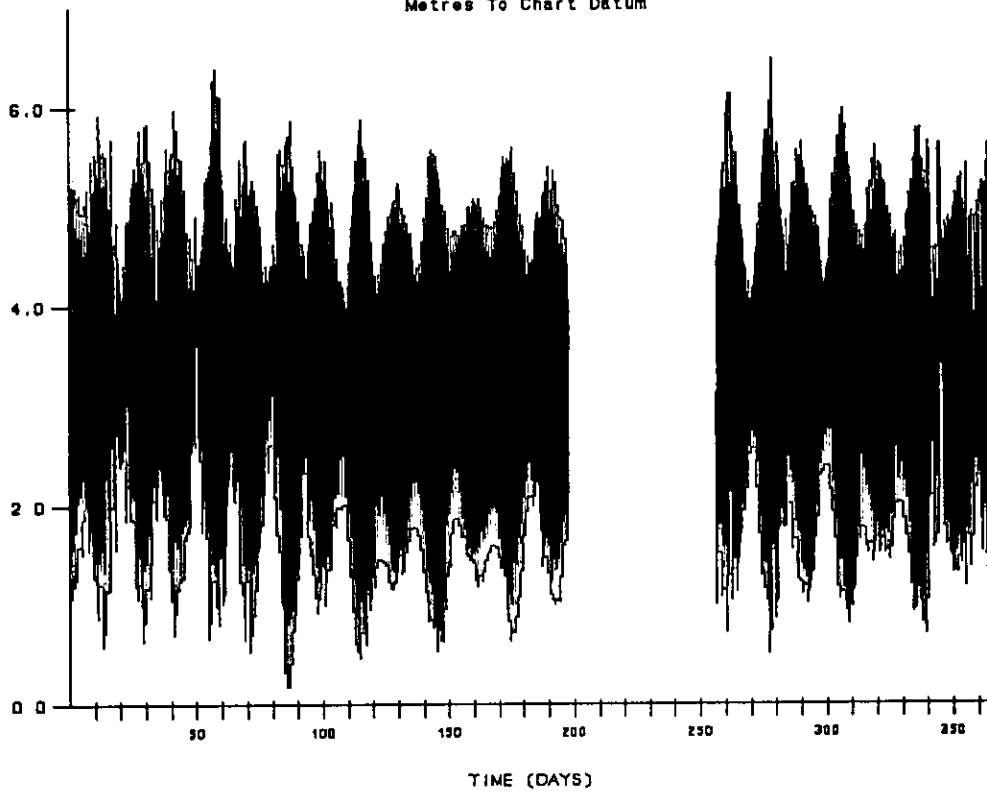


Bench Mark	N.G. co-ords	Description
TGBM	NZ8986 1141	East side of Pier Road.
Aux1	NZ8992 1105	Bolt on buttress of Whitby Bridge.
Aux2	NZ8985 1134	Rivet on quayside SE side of Pier Road.

Evidence of both pressure points becoming blocked began on 18 July. Initially visited by TGI 23 July, new pipes were fitted by them on 14 September. The gap in the final processed data extended from 01hrs.GMT 18 July to 15hrs.GMT 14 September. Faulty and missing scans at the raw stage were edited on the following dates: 20,28 Feb; 14,30 Mar; 29 Jun; 14 Jul; 14 Sep (over TGI visit) 26,27 Sep; 26 Dec.

Whitby Observed Levels 1990

Metres To Chart Datum



Harmonic Tidal Analysis.

Port: England, East Coast - Whitby

Latitude: 54 29' 23.7" N

Longitude: 00 36' 45.4" W

Time Zone: GMT

Length: 382 Days

From: 1st July, 1989

To: 17th July, 1990

Units: Metres

A0: 3.307

Hourly data from digiquartz sensor 2

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

Observation Mean = 0.3304D+01 Residual Mean = 0.7245D-07
 Std Dev = 0.1266D+01 Std Dev = 0.1633D+00

Constituent	h	g
Q1	0.045	44.62
O1	0.151	86.86
P1	0.036	247.11
K1	0.134	253.13
J1	0.016	321.33
2N2	0.044	38.89
N2	0.327	80.71
M2	1.661	103.94
S2	0.561	146.90
K2	0.160	144.49
M3	0.010	81.46
M4	0.028	71.51
MS4	0.030	99.22
M6	0.011	350.34

Wick

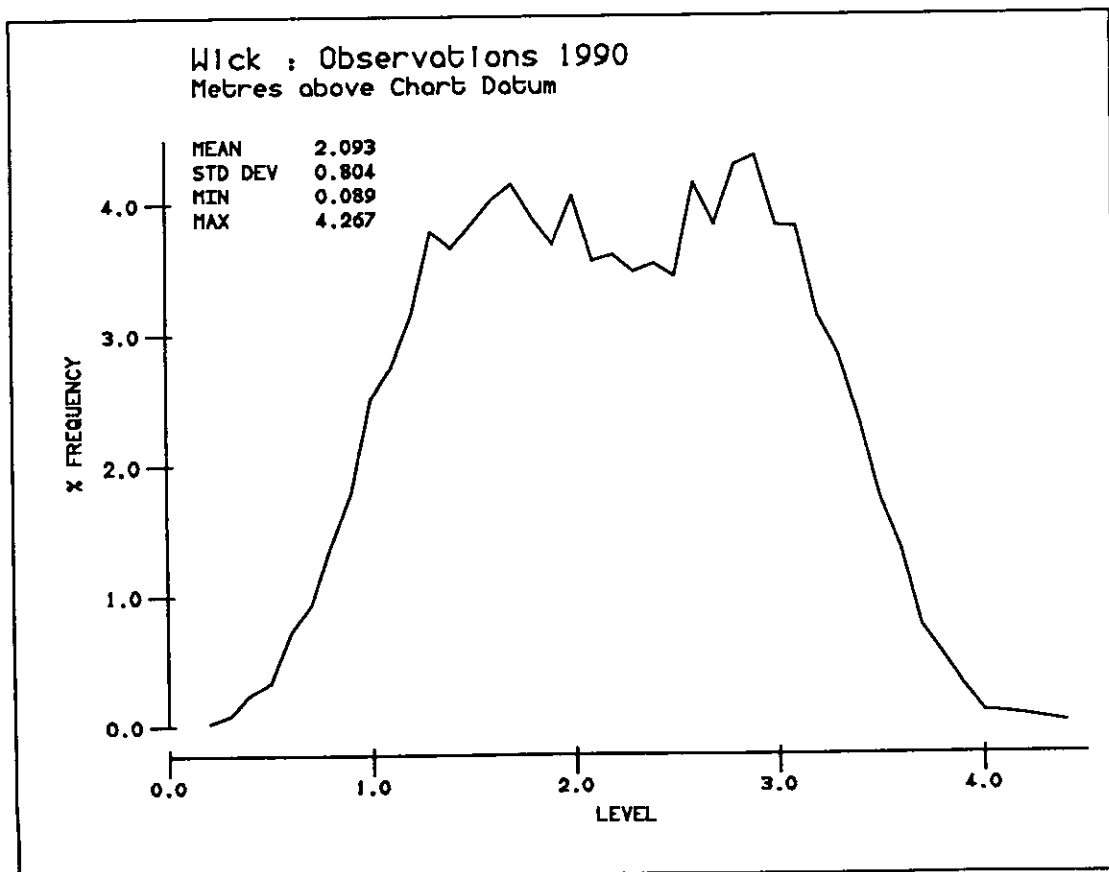
Latitude 58 deg 26' 28.5"N Longitude 03 deg 05' 5.7"W
 National Grid reference ND 3667 5080

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

Hourly levels were filtered from the channel 2 digiquartz; spurious and missing scans having been edited on the following dates: 11 Jun; 1,31 Jul; 24,31 Aug; 15,23 Sep; 15 Oct; 6 Nov and 14 Dec.

Gaps in processed data

0100GMT 4 December - 1900GMT 5 December Memory loss at site
 1000GMT 13 December - 0300GMT 14 December TGI visit



Harmonic Tidal Analysis.

Port: Scotland, East Coast - Wick

Latitude: 58 26' 28.5" N

Longitude: 3 05' 5.7" W

Time Zone: GMT

Length: 362 Days

From: 1st January, 1990

To: 31st December, 1990

Units: Metres

A0: 2.095

Hourly data from digiquartz sensor

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

Observation Mean =	0.2095D+01	Residual Mean =	0.8970D-06
Std Dev =	0.8016D+00	Std Dev =	0.1651D+00

Constituent	h	g
Q1	0.032	342.79
O1	0.118	27.09
P1	0.032	167.26
K1	0.109	176.36
J1	0.008	240.49
2N2	0.030	271.62
N2	0.203	303.19
M2	1.014	322.40
S2	0.348	0.11
K2	0.097	356.89
M3	0.011	235.49
M4	0.036	316.67
MS4	0.020	51.27
M6	0.006	227.07

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 26/27 February and 7 October.

26 and 27 February

At **Aberdeen** levels on 27 February were the highest recorded (Based on an incomplete series held dating from 1930).

At **Avonmouth** levels on 26 February were the highest ever (data series from 1924) as they also were at **Holyhead** (data series from 1964).

On 27 February, records were broken at **Lerwick** (records from 1959) and at **Wick** where levels equalled that recorded in 1981 (incomplete statistics from 1965).

At **North Shields** on the East coast the 27 February 1990 level was only exceeded in 1953 and 1969. (Incomplete records from 1953).

7 October

In terms of extremes, this storm may be a little deceptive in so far as sites displaying this as a record have only very short series. The site with the longest record involved and therefore probably giving the most realistic picture is **Dover** where the 1990 level was exceeded in 1953, 1961 and 1983 (based on an incomplete series dating from 1924). At **Whitby** the level of 6.473m above Chart Datum was the highest since records began in 1980 and at **Cromer** the 1990 level was also a record but based on a very short series dating from 1985.

Aberdeen Extreme Levels to Chart Datum

Max	Hr	Mon	Day	Min	Hr	Mon	Day
4.812	16.	Jan	31	.503	21.	Jan	13
5.132	15.	Feb	27	.626	21.	Feb	28
4.716	16.	Mar	01	.108	20.	Mar	28
4.636	14.	Apr	26	.374	18.	Apr	24
4.332	13.	May	24	.328	08.	May	26
4.357	03.	Jun	26	.479	08.	Jun	24
4.248	03.	Jul	25	.175	08.	Jul	23
4.475	02.	Aug	22	.313	08.	Aug	21
4.695	01.	Sep	19	.361	08.	Sep	07
4.825	02.	Oct	06	.473	07.	Oct	05
4.491	01.	Nov	03	.479	21.	Nov	05
4.602	01.	Dec	03	.371	21.	Dec	04

Avonmouth Extreme Levels to Chart Datum

Max	Hr	Mon	Day	Min	Hr	Mon	Day
13.823	09.	Jan	29	1.047	03.	Jan	13
14.998	08.	Feb	26	.582	04.	Feb	28
14.117	08.	Mar	28	.192	15.	Mar	28
13.886	08.	Apr	26	.356	03.	Apr	27
13.409	20.	May	25	.791	02.	May	25
13.252	20.	Jun	24	1.216	04.	Jun	26
13.388	21.	Jul	24	1.000	15.	Jul	23
13.588	20.	Aug	21	.963	15.	Aug	22
13.781	20.	Sep	06	.833	04.	Sep	08
14.004	08.	Oct	06	.954	16.	Oct	07
13.926	20.	Nov	04	.894	03.	Nov	05
13.371	20.	Dec	03	.868	03.	Dec	04

Cromer Extreme Levels to Chart Datum

Max	Hr	Mon	Day	Min	Hr	Mon	Day
5.350	22.	Jan	17	.174	03.	Jan	30
4.582	00.	Feb	04	.641	06.	Feb	02
5.387	19.	Apr	26	.318	01.	Apr	25
5.110	18.	May	24	.335	14.	May	26
5.021	09.	Jun	26	.467	14.	Jun	24
4.956	08.	Jul	24	.290	15.	Jul	24
5.287	07.	Aug	21	.376	15.	Aug	23
5.679	07.	Sep	21	.332	13.	Sep	18
5.880	08.	Oct	07	.154	14.	Oct	05
5.363	06.	Nov	03	.574	03.	Nov	06
5.332	20.	Dec	04	.413	04.	Dec	06

Dover Extreme Levels to Chart Datum

Max	Hr	Mon	Day	Min	Hr	Mon	Day
7.109	00.	Jan	29	.682	09.	Jan	31
7.726	00.	Feb	27	.726	06.	Feb	25
7.473	02.	Mar	02	.195	08.	Mar	29
7.122	00.	Apr	27	.420	07.	Apr	26
6.985	23.	May	24	.610	20.	May	26
6.756	12.	Jun	24	.751	20.	Jun	24
6.725	13.	Jul	25	.604	20.	Jul	24
7.046	11.	Aug	21	.663	20.	Aug	23
7.495	12.	Sep	21	.742	18.	Sep	18
7.730	12.	Oct	07	.501	19.	Oct	05
7.248	11.	Nov	03	.776	20.	Nov	05
7.022	01.	Dec	05	.746	09.	Dec	06

Felixstowe Extreme Levels to Chart Datum

Max	Hr	Mon	Day	Min	Hr	Mon	Day
4.110	01.	Jan	29	-.041	17.	Jan	25
4.601	01.	Feb	28	.027	06.	Feb	26
4.538	02.	Mar	01	-.056	06.	Mar	28
4.054	00.	Apr	11	.115	05.	Apr	25
3.909	11.	May	24	.115	20.	May	28
3.931	02.	Jun	26	.170	19.	Jun	24
3.798	01.	Jul	24	.077	19.	Jul	24
4.068	00.	Aug	21	.166	19.	Aug	23
4.577	00.	Sep	20	.184	17.	Sep	18
4.695	13.	Oct	07	.061	18.	Oct	05
4.171	23.	Nov	02	.380	08.	Nov	07
4.601	20.	Dec	12	.191	08.	Dec	06

Fishguard Extreme Levels to Chart Datum

Max	Hr	Mon	Day	Min	Hr	Mon	Day
5.414	09.	Jan	29	.706	15.	Jan	12
5.450	08.	Feb	26	.459	15.	Feb	27
5.031	08.	Mar	28	.129	15.	Mar	28
4.940	08.	Apr	26	.260	03.	Apr	27
4.828	20.	May	25	.590	02.	May	25
4.941	20.	Jun	24	.722	03.	Jun	25
4.877	21.	Jul	24	.622	03.	Jul	24
4.956	20.	Aug	21	.572	03.	Aug	23
5.110	20.	Sep	20	.418	03.	Sep	07
5.106	08.	Oct	06	.464	15.	Oct	07
5.094	19.	Nov	03	.607	01.	Nov	03
4.798	08.	Dec	04	.501	15.	Dec	04

Heysham Extreme Levels to Chart Datum

Max	Hr	Mon	Day	Min	Hr	Mon	Day
10.265	13.	Jan	30	1.013	19.	Jan	12
11.041	12.	Feb	26	.940	07.	Feb	28
10.189	13.	Mar	29	.240	19.	Mar	28
10.141	12.	Apr	26	.434	07.	Apr	27
9.666	00.	May	26	.768	06.	May	25
9.757	00.	Jun	25	.999	07.	Jun	25
9.690	01.	Jul	25	.780	07.	Jul	24
9.899	00.	Aug	22	.832	06.	Aug	21
10.246	00.	Sep	21	.678	07.	Sep	07
10.588	12.	Oct	06	.688	07.	Oct	07
10.007	00.	Nov	05	.757	06.	Nov	04
9.721	23.	Dec	02	.685	19.	Dec	04

Hinkley Point Extreme Levels to Chart Datum

Max	Hr	Mon	Day	Min	Hr	Mon	Day
11.789	20.	May	26	.655	14.	May	26
11.841	20.	Jun	24	.963	02.	Jun	25
11.739	20.	Jul	23	.663	02.	Jul	24
11.847	20.	Aug	22	.497	14.	Aug	22
12.076	20.	Sep	06	.506	14.	Sep	07
12.328	20.	Oct	06	.589	01.	Oct	05
12.334	19.	Nov	03	.567	01.	Nov	04
11.778	07.	Dec	03	.618	02.	Dec	04

Holyhead Extreme Levels to Chart Datum

Max	Hr	Mon	Day	Min	Hr	Mon	Day
6.432	12.	Jan	29	.549	17.	Jan	12
6.533	11.	Feb	26	.451	18.	Feb	27
5.916	13.	Mar	01	-.008	05.	Mar	28
5.859	11.	Apr	26	.119	05.	Apr	27
5.667	23.	May	25	.407	05.	May	26
5.840	23.	Jun	24	.468	06.	Jun	25
5.737	00.	Jul	25	.447	05.	Jul	23
5.835	23.	Aug	21	.452	05.	Aug	22
6.063	23.	Sep	20	.333	06.	Sep	08
6.180	11.	Oct	06	.389	18.	Oct	07
5.902	22.	Nov	03	.460	17.	Nov	04
5.775	10.	Dec	31	.366	18.	Dec	04

Ifracombe Extreme Levels to Chart Datum

Max	Hr	Mon	Day	Min	Hr	Mon	Day
9.727	08.	Jan	29	.878	01.	Jan	13
9.534	06.	Apr	26	.234	01.	Apr	27
9.304	06.	May	25	.633	12.	May	25
9.346	19.	Jun	24	.931	01.	Jun	25
9.349	19.	Jul	23	.778	01.	Jul	24
9.344	19.	Aug	21	.537	13.	Aug	22
9.568	19.	Sep	06	.411	13.	Sep	07
9.690	19.	Oct	06	.523	01.	Oct	07
9.766	18.	Nov	03	.570	00.	Nov	04
9.285	07.	Dec	04	.654	01.	Dec	04

Immingham Extreme Levels to Chart Datum

Max	Hr	Mon	Day	Min	Hr	Mon	Day
7.697	19.	Jan	12	.661	02.	Jan	30
8.130	19.	Feb	27	.675	00.	Feb	25
7.974	21.	Mar	01	.248	01.	Mar	28
7.674	19.	Apr	26	.664	00.	Apr	25
7.352	17.	May	24	.755	13.	May	26
7.385	08.	Jun	26	.842	13.	Jun	24
7.304	07.	Jul	24	.603	14.	Jul	24
7.550	06.	Aug	21	.667	13.	Aug	21
7.933	07.	Sep	21	.662	13.	Sep	06
8.310	07.	Oct	07	.582	13.	Oct	05
7.731	06.	Nov	04	.966	02.	Nov	06
7.540	19.	Dec	04	.876	03.	Dec	06

Leith Extreme Levels to Chart Datum

Max	Hr	Mon	Day	Min	Hr	Mon	Day
5.986	17.	Jan	30	.532	22.	Jan	13
6.421	16.	Feb	27	.501	23.	Feb	28
6.230	17.	Mar	01	-.069	21.	Mar	27
5.956	15.	Apr	26	.296	20.	Apr	24
5.678	14.	May	24	.361	10.	May	26
5.708	14.	Jun	22	.509	10.	Jun	25
5.327	02.	Sep	18	.531	08.	Sep	18
5.502	03.	Oct	19	.910	09.	Oct	20
5.868	03.	Nov	04	.524	22.	Nov	05
5.823	15.	Dec	03	.468	23.	Dec	05
Max	Hr	Mon	Day	Min	Hr	Mon	Day

Lerwick Extreme Levels to Chart Datum

Max	Hr	Mon	Day	Min	Hr	Mon	Day
2.681	13.	Jan	30	.494	19.	Jan	13
2.926	12.	Feb	27	.459	19.	Feb	28
2.368	09.	Mar	24	.051	18.	Mar	28
2.354	11.	Apr	26	.136	16.	Apr	24
2.086	09.	May	23	.112	07.	May	27
2.286	01.	Jun	26	.270	06.	Jun	24
2.243	23.	Jul	08	.042	06.	Jul	24
2.243	23.	Aug	20	.182	05.	Aug	21
2.487	23.	Sep	18	.204	06.	Sep	07
2.521	22.	Oct	03	.372	19.	Oct	07
2.310	10.	Nov	16	.228	18.	Nov	05
2.375	11.	Dec	03	.168	18.	Dec	04

Lowestoft Extreme Levels to Chart Datum

Max	Hr	Mon	Day	Min	Hr	Mon	Day
3.328	01.	Jan	18	.024	06.	Jan	31
3.637	22.	Feb	26	.175	05.	Feb	12
3.363	00.	Mar	02	.018	04.	Mar	28
2.811	10.	Apr	11	.210	03.	Apr	25
2.712	21.	May	24	.140	19.	May	28
2.617	12.	Jun	26	.231	17.	Jun	24
2.747	10.	Jul	10	.134	18.	Jul	25
2.953	09.	Aug	21	.243	15.	Aug	19
3.476	10.	Sep	21	.167	15.	Sep	18
3.675	10.	Oct	07	.077	16.	Oct	05
3.011	09.	Nov	03	.418	06.	Nov	07
3.736	19.	Dec	12	.174	23.	Dec	28

Milford Haven Extreme Levels to Chart Datum

Max	Hr	Mon	Day	Min	Hr	Mon	Day
7.666	08.	Jan	29	.795	13.	Jan	12
7.838	08.	Feb	28	.325	14.	Feb	27
7.440	07.	Mar	28	.053	13.	Mar	28
7.273	07.	Apr	26	.205	01.	Apr	27
7.083	19.	May	25	.530	01.	May	26
7.046	19.	Jun	24	.672	02.	Jun	25
7.040	20.	Jul	24	.588	02.	Jul	24
7.135	19.	Aug	21	.480	02.	Aug	23
7.259	19.	Sep	20	.300	02.	Sep	08
7.411	07.	Oct	06	.340	14.	Oct	07
7.363	18.	Nov	03	.485	13.	Nov	04
6.989	07.	Dec	04	.430	13.	Dec	03

Millport Extreme Levels to Chart Datum

Max	Hr	Mon	Day	Min	Hr	Mon	Day
3.989	16.	Jan	16	.395	19.	Jan	12
3.825	12.	Mar	11	-.168	17.	Mar	25
3.556	04.	Apr	02	-.010	07.	Apr	27
3.493	03.	May	29	.072	08.	May	28
3.671	01.	Jun	25	.173	08.	Jun	26
3.565	03.	Jul	27	.063	07.	Jul	24
3.597	03.	Aug	11	.126	07.	Aug	23
3.837	00.	Sep	19	-.032	07.	Sep	07
3.676	23.	Oct	02	-.032	07.	Oct	07
3.694	15.	Nov	23	.066	05.	Nov	03
3.873	18.	Dec	26	-.220	23.	Dec	08

Mumbles Extreme Levels to Chart Datum

Max	Hr	Mon	Day	Min	Hr	Mon	Day
10.159	08.	Jan	29	1.114	01.	Jan	13
10.560	07.	Feb	26	.538	02.	Feb	28
10.128	07.	Mar	28	.155	13.	Mar	28
9.944	07.	Apr	26	.401	01.	Apr	27
9.692	19.	May	25	.855	01.	May	26
9.596	19.	Jun	24	1.098	01.	Jun	24
9.647	20.	Jul	24	.937	13.	Jul	23
9.697	19.	Aug	21	.729	13.	Aug	22
9.847	19.	Sep	20	.589	02.	Sep	08
9.984	07.	Oct	06	.682	14.	Oct	07
9.993	19.	Nov	04	.838	00.	Nov	04
9.542	07.	Dec	04	.773	01.	Dec	04

Newlyn Extreme Levels to Chart Datum

Max	Hr	Mon	Day	Min	Hr	Mon	Day
6.068	06.	Jan	29	.737	12.	Jan	12
5.977	06.	Feb	27	.394	13.	Feb	27
5.753	05.	Mar	28	.238	12.	Mar	28
5.625	05.	Apr	26	.323	00.	Apr	27
5.630	17.	May	25	.600	00.	May	26
5.618	18.	Jun	24	.713	01.	Jun	25
5.599	18.	Jul	24	.714	01.	Jul	25
5.609	17.	Aug	21	.568	00.	Aug	22
5.677	17.	Sep	05	.518	00.	Sep	07
5.764	18.	Oct	06	.516	00.	Oct	06
5.812	05.	Nov	04	.673	12.	Nov	04
5.503	06.	Dec	04	.589	12.	Dec	04

North Shields Extreme Levels to Chart Datum

Max	Hr	Mon	Day	Min	Hr	Mon	Day
5.501	16.	Jan	12	.491	00.	Jan	30
5.968	17.	Feb	27	.576	21.	Feb	24
5.730	18.	Mar	01	-.020	23.	Mar	28
5.525	16.	Apr	26	.269	21.	Apr	24
5.224	15.	May	24	.379	11.	May	26
5.133	15.	Jun	22	.490	12.	Jun	26
5.061	05.	Jul	25	.217	11.	Jul	24
5.285	04.	Aug	22	.265	10.	Aug	21
5.599	04.	Sep	20	.353	11.	Sep	07
5.862	05.	Oct	07	.335	10.	Oct	05
5.207	03.	Nov	17	.665	00.	Nov	07
5.302	16.	Dec	03	.392	00.	Dec	06

Portpatrick Extreme Levels to Chart Datum

Max	Hr	Mon	Day	Min	Hr	Mon	Day
3.964	02.	Jul	26	.073	06.	Jul	23
4.017	00.	Aug	22	.115	07.	Aug	23
4.256	23.	Sep	18	-.003	07.	Sep	07
4.147	22.	Oct	02	-.022	07.	Oct	07
3.976	15.	Nov	23	.090	05.	Nov	03
4.129	20.	Dec	28	-.019	23.	Dec	08

Sheerness Extreme Levels to Chart Datum

Max	Hr	Mon	Day	Min	Hr	Mon	Day
6.060	02.	Jan	29	-.038	18.	Jan	25
6.458	02.	Feb	28	-.187	08.	Feb	26
6.523	03.	Mar	01	.102	08.	Mar	28
6.056	13.	Apr	26	.202	07.	Apr	26
5.913	12.	May	24	.283	20.	May	26
5.919	03.	Jun	26	.232	20.	Jun	24
5.789	02.	Jul	24	.257	21.	Jul	24
5.953	01.	Aug	21	.321	21.	Aug	09
6.471	01.	Sep	20	.324	19.	Sep	18
6.626	14.	Oct	07	.056	20.	Oct	06
6.172	00.	Nov	03	.643	09.	Nov	06
6.038	21.	Dec	12	.355	09.	Dec	06

Stornoway Extreme Levels to Chart Datum

Max	Hr	Mon	Day	Min	Hr	Mon	Day
5.617	09.	Jan	30	.785	15.	Jan	13
5.722	08.	Feb	27	.487	03.	Feb	28
5.298	07.	Mar	27	.050	14.	Mar	28
5.129	07.	Apr	26	.272	02.	Apr	27
4.711	05.	May	23	.407	02.	May	26
4.995	20.	Jun	24	.621	02.	Jun	24
4.831	20.	Jul	23	.391	02.	Jul	23
5.048	19.	Aug	21	.436	03.	Aug	23
5.290	19.	Sep	05	.237	02.	Sep	07
5.409	19.	Oct	05	.362	02.	Oct	07
4.954	18.	Nov	02	.289	01.	Nov	04
4.985	06.	Dec	31	.650	14.	Dec	03

Tobermory Extreme Levels to Chart Datum

Max	Hr	Mon	Day	Min	Hr	Mon	Day
5.393	08.	Jan	30	.655	01.	Jan	13
5.502	06.	Feb	26	.439	02.	Feb	28
4.920	06.	Mar	27	.115	13.	Mar	28
4.741	06.	Apr	26	.252	01.	Apr	27
4.472	19.	May	26	.479	00.	May	25
4.857	19.	Jun	24	.743	14.	Jun	25
4.538	19.	Jul	23	.487	13.	Jul	23
4.690	19.	Aug	21	.439	13.	Aug	22
4.987	18.	Sep	05	.388	13.	Sep	07
5.203	18.	Oct	05	.288	14.	Oct	07
4.711	18.	Nov	03	.435	12.	Nov	03
4.679	17.	Dec	30	.477	01.	Dec	04

Ullapool Extreme Levels to Chart Datum

Max	Hr	Mon	Day	Min	Hr	Mon	Day
5.946	09.	Jan	30	.796	15.	Jan	13
6.069	08.	Feb	27	.509	03.	Feb	28
5.640	07.	Mar	27	.057	14.	Mar	28
5.466	07.	Apr	26	.323	14.	Apr	26
5.021	07.	May	25	.431	02.	May	26
5.360	20.	Jun	24	.653	02.	Jun	24
5.140	20.	Jul	23	.394	02.	Jul	23
5.349	19.	Aug	21	.474	03.	Aug	23
5.608	19.	Sep	05	.293	02.	Sep	07
5.777	19.	Oct	05	.375	15.	Oct	07
5.069	07.	Nov	18	.521	14.	Nov	05
5.319	06.	Dec	31	.486	14.	Dec	04

Whitby Extreme Levels to Chart Datum

Max	Hr	Mon	Day	Min	Hr	Mon	Day
5.916	17.	Jan	12	.587	00.	Jan	14
6.388	17.	Feb	27	.666	22.	Feb	24
6.100	18.	Mar	01	.181	23.	Mar	27
5.866	17.	Apr	26	.470	22.	Apr	25
5.559	15.	May	24	.529	11.	May	26
5.590	06.	Jun	26	.641	11.	Jun	24
5.391	05.	Jul	10	1.001	13.	Jul	12
6.122	04.	Sep	20	.716	10.	Sep	18
6.473	05.	Oct	07	.509	10.	Oct	05
5.963	04.	Nov	04	.801	00.	Nov	06
5.766	17.	Dec	04	.699	00.	Dec	06

Wick Extreme Levels to Chart Datum

Max	Hr	Mon	Day	Min	Hr	Mon	Day
4.178	14.	Jan	31	.501	19.	Jan	13
4.267	13.	Feb	27	.536	19.	Feb	28
3.799	13.	Mar	29	.089	18.	Mar	28
3.720	12.	Apr	26	.306	16.	Apr	24
3.461	10.	May	23	.267	06.	May	26
3.594	01.	Jun	26	.422	06.	Jun	24
3.520	00.	Jul	09	.097	06.	Jul	23
3.668	00.	Aug	22	.284	06.	Aug	21
3.963	23.	Sep	18	.242	06.	Sep	07
3.927	00.	Oct	06	.422	19.	Oct	07
3.572	00.	Nov	05	.414	05.	Nov	04
3.765	23.	Dec	02	.507	18.	Dec	03

4.2 Mean Sea Level Values

Monthly values to Chart Datum calculated using the Doodson x0 filter are presented for 1990 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.

As previously mentioned, the monthly mean values for January to July at Mumbles stem from the levels collected from the Aanderaa back-up recorder and adjusted for datum.

Plots of relative anomalies (monthly-annual) ordered geographically are shown for the three years 1988 to 1990 for ports where sufficient modernised data has been collated.

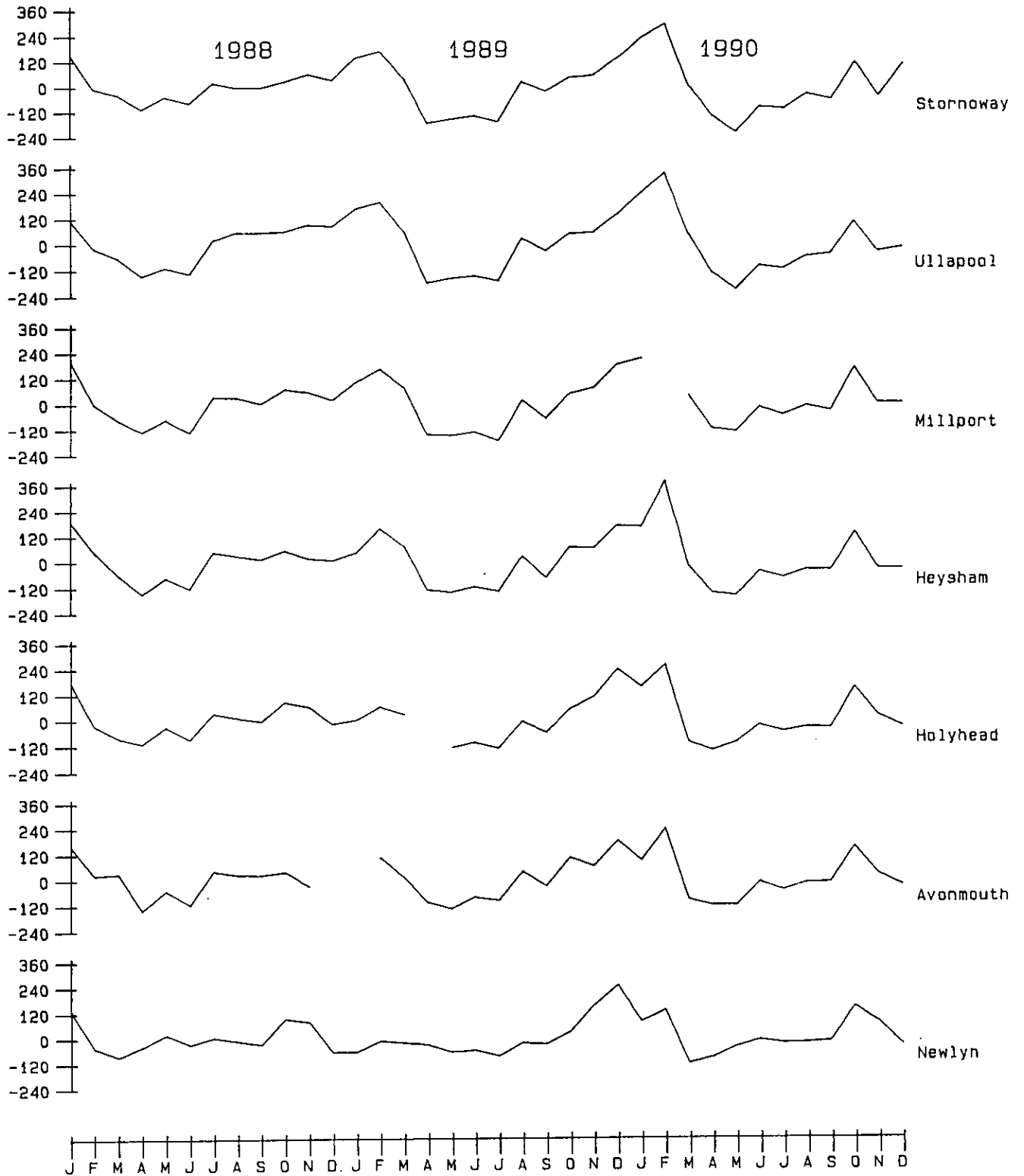
MEAN SEA LEVEL VALUES TO CHART DATUM
(MILLIMETRES)

NAME	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
ABERDEEN	2765	2843	2625	2490	2400	2520	2499	2566	2574	2677	2577	2586	2592
AVONMOUTH	7038	7184	6851	6823	6824	6935	6896	6932	6935	7099	6970	6919	6950
CROMER	2826			2741	2687	2761	2761	2818	2871	2857	2882	2795	
DOVER	3779	28 3885	31 3719	03 3700	3666	3744	3734	3774	3819	3852		3743	3766
FELIXSTOWE	2057	2119	2049	1999	1939	2004	2013	2058	2115	2114	30 2140	2072	2056
FISHGUARD	2781	2865	2547	2534	2577	2644	2621	2627	2622	2811	2699	2623	2661
HEYSHAM	5347	5563	5158 07	5035	5022	5137	5107	5146	5141	5319	5148	5147	5184
HINKLEY						6141	6105	6122	6128	6278	6195	6130	
HOLYHEAD	31 3417	28 3517	31 3155	30 3116	31 3154	3235	3204	3225	3221	3412	3279	3227	3263
ILFRACOMBE	5033 02	28 4292	31 4203	06 4826	4878	4933	4906 06	4917	4917	5099	4996	4915	
IMMINGHAM	4262	4292	4203	4157	4102	4185	4172	4209	4253	4310	4290	4235	4222
LEITH	3342 01	3403 14	3176	3089	3028	3114					3214	3201	
LERWICK	1546	1622	1369	1228	1118	1250	1228	1297	1305	1420	1311	1339	1335
LOWESTOFT	1639	1706	1638	1566	1499	1569	1583	1628	1691	06 1663	1695	1641	1626

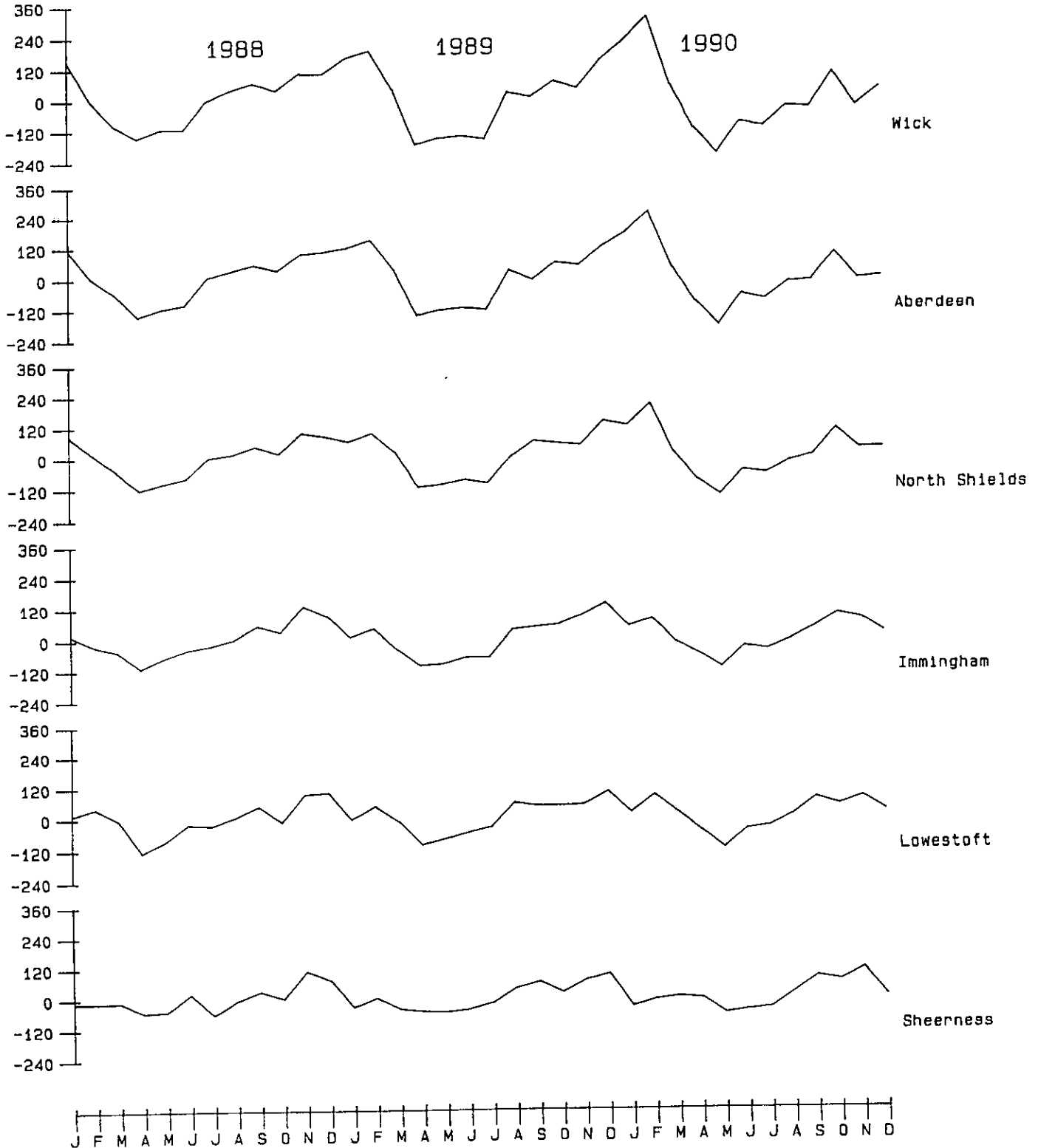
MEAN SEA LEVEL VALUES TO CHART DATUM
(MILLIMETRES)

NAME	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
MILFORD HAVEN	3976	4042	3734	3723	3748	3775	3726	3748	3735	3932	3821	3736	3807
MILLPORT	2198 09	28	2025 07	1871	1856	1969	1933	1977	1954	2151	1989	1987	1986
MUMBLES	5351	5461	5128	5126	5155	5209	5173	5145	5148	5347 01	5245 01	5169	5220
NEWLYN	3254	3307	3054	3083	3133	3166	3148	3152	3159	3323	3248	3141	3180
NORTH SHIELDS	3074	3156	2967	2861	2801	2895	2883	2930	2954	3054 14	2981 06	2983	2956
PORTPATRICK							2039 09	2114	2093	2294	2144	2123	
SHEERNESS	31 2968	28 2994	31 3006	30 2997	31 2938	30 2952	2962	3022	3084	3067	3112	3005	3009
STORNOWAY	3154	3217	2926	2779	2703	2825	2814	2887	2860	3037	2876	3027 12	2921
TOBERMORY	2971	3067	2742	2586	2560	2662	2645	2695	2672	2869	2712	2731	2741
WHITBY	3386	3451	3299	3205	3143	3239			3389	3408	3359	3355	
WICK	2315	2404	2142	1973	1876	1997	31 1980	31 2058	14 2052	2186	2057	2125 05	2095

MSL Anomalies 1988-1990
West Coast Ports
(Millimetres)



MSL Anomalies 1988-1990
 East Coast Ports
 (Millimetres)



4. Storm Surge Residuals

The larger anomalies, between the astronomically predicted level and the observed level, during 1990 were:-

(Figures 4-9 follow the text)

January 17-18

1.409m at Sheerness. (Figure 4)

Surges in excess of 1m occurred at all sites from North Shields southwards to Sheerness.

January 25

2.711m at Avonmouth. (Figure 5)

Surges of over a metre occurred at all sites from Ilfracombe northward to Heysham. Negative surges of 1.509m below predicted and 1.094m below predicted at Sheerness and Felixstowe, respectively.

The centre of the depression crossed Ireland during the morning and continued to deepen as it tracked east into southern Scotland and northern England, falling to a minimum of about 948mb when the storm was over the central North Sea. Mean wind speeds of 40kts occurred widely with speeds up to 50kts in some parts of Wales and southern England. Gusts of 90kts were reported.

February 26

2.662m at Heysham. (Figure 6)

Excessive damage was caused at Towyn in North Wales when the sea wall was breached, and flooding was extensive in parts of Devon, Cornwall, Somerset, south and west Wales, Northern Ireland and the west of Scotland.

Surge levels at Heysham remained over a metre above predicted levels for 11 hours, so although the maximum coincided with low tide, the effect at high tide was devastating.

February 28

1.995m at Avonmouth

Floods again occurred in the south west and along the English Channel.

March 24

1.198m at Sheerness

Surge levels over a metre above predicted at Immingham (Figure 7) and Lowestoft. No record available for Cromer.

September 21

1.372m at Sheerness

Surge levels were over a metre above predicted at all sites from Immingham southwards to Dover.

October 6 and 7

1.372m at Sheerness on 7th.

Surge levels of over a metre above predicted were observed at all ports Whitby to Sheerness. (Figure 8). A surge of 1.046m occurred at Heysham on the west coast on the 6th.

October 28
 1.751m at Avonmouth
 Above a metre at Heysham.

December 12
 2.039m at Sheerness
 Levels over 2m above predicted at Cromer and Lowestoft (Figure 9); over a metre at all ports
 North Shields southward to Dover.

December 25
 Negative surge of -2.060m at Sheerness.
 Lesser effects on all records from Immingham southward to Dover.

December 26
 1.641m at Avonmouth
 Levels remained over a metre above predicted at this site for 5 hours.

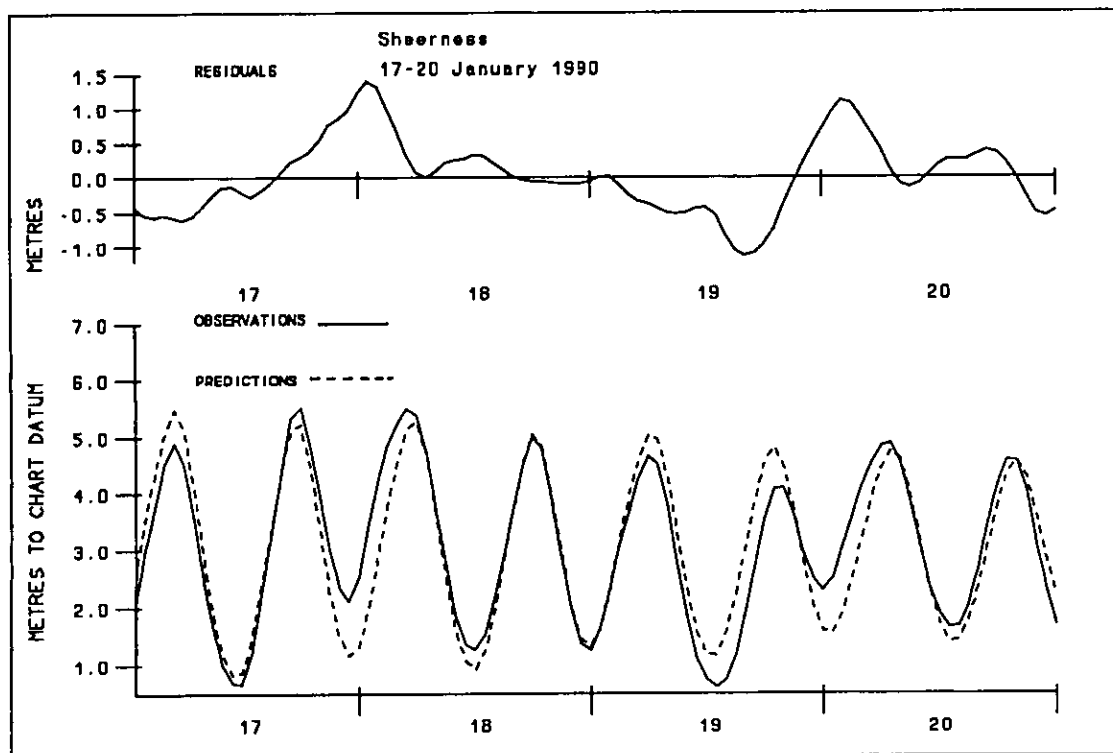


Figure 4. Hourly still water levels and residual surge, Sheerness 18 January

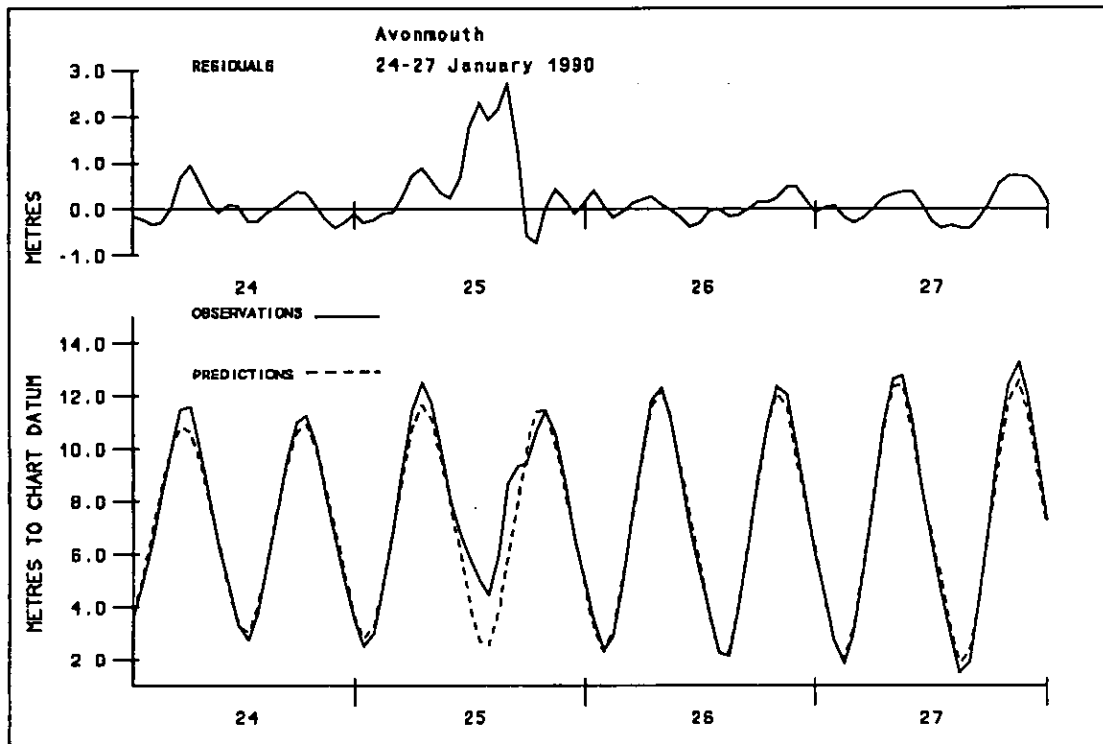


Figure 5. Hourly still water levels and residual surge Avonmouth 25 January.

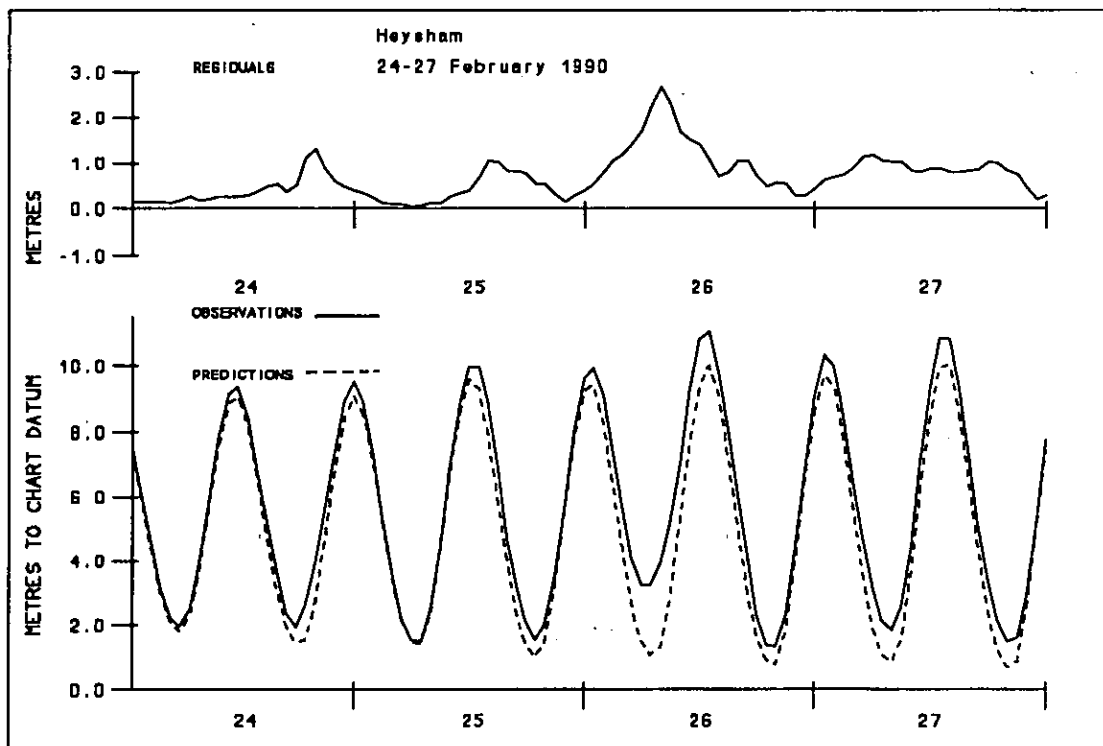


Figure 6. Hourly still water levels and residual surge Heysham 26 February.

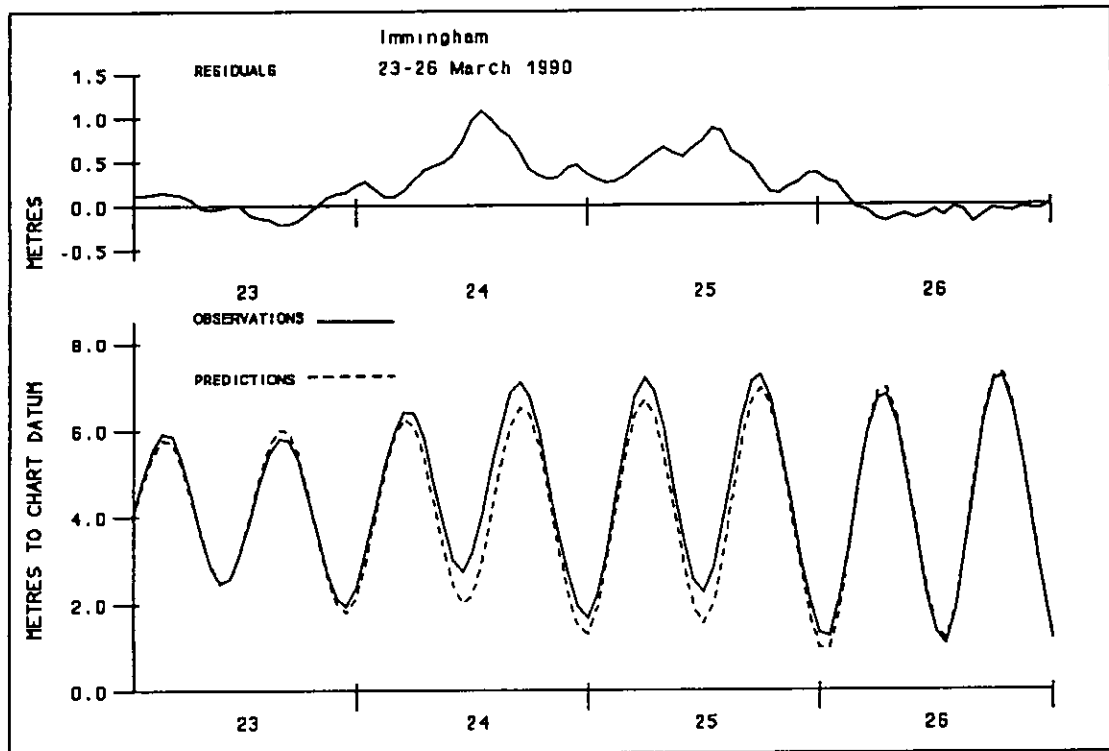


Figure 7. Hourly still water levels and residual surge Immingham 24 March.

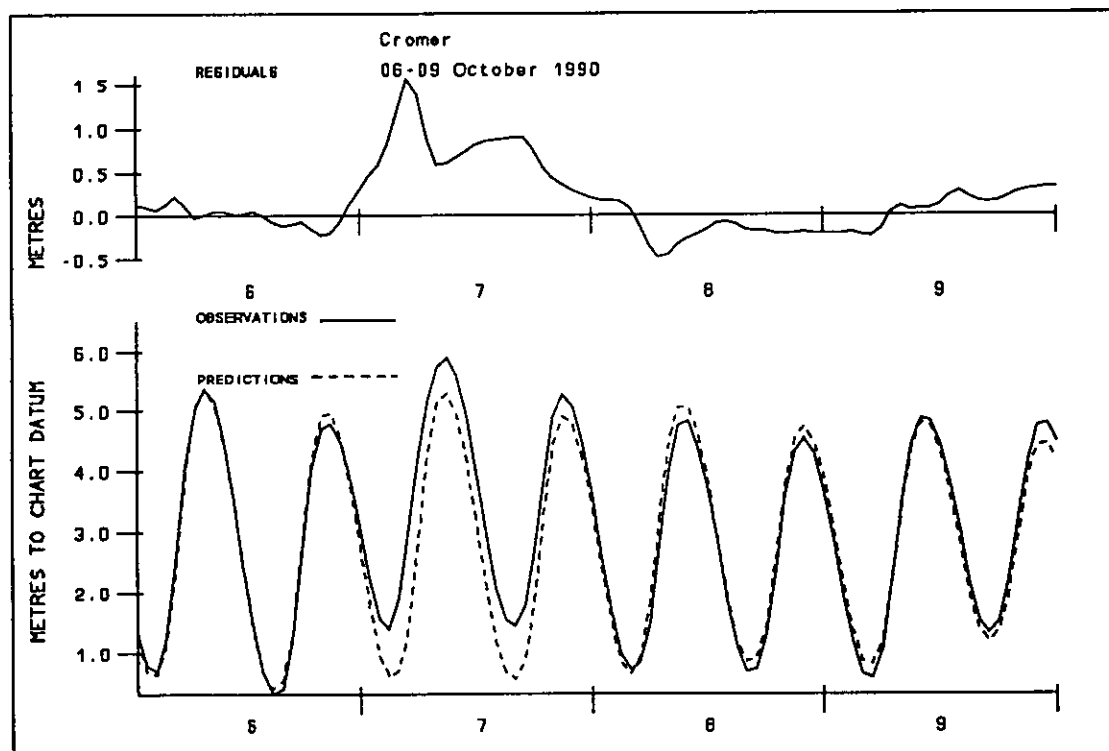


Figure 8. Hourly still water levels and residual surge Cromer 7 October.

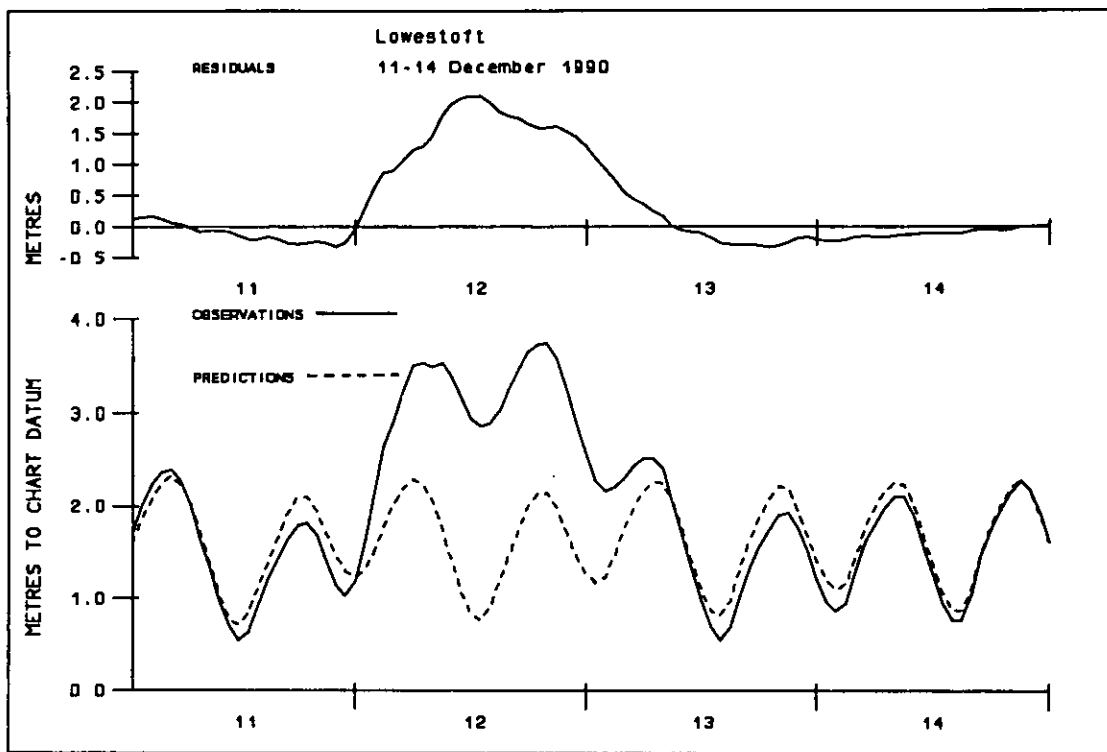


Figure 9. Hourly still water levels and residual surge Lowestoft 12 December.

On the following pages, monthly plots of storm surge residuals are presented for west and east coasts for all ports where relevant data are available. For example, no values are given for Hinkley Point or Mumbles as there is insufficient data for a meaningful analysis. Early studies of results have revealed an analytical problem similar to those found for Ilfracombe and Avonmouth in the Bristol Channel (Figure 10) and to a lesser degree, Leith in the Firth of Forth. At all these sites, the 'residuals' have a tidal semi-diurnal pattern which is to be further investigated.

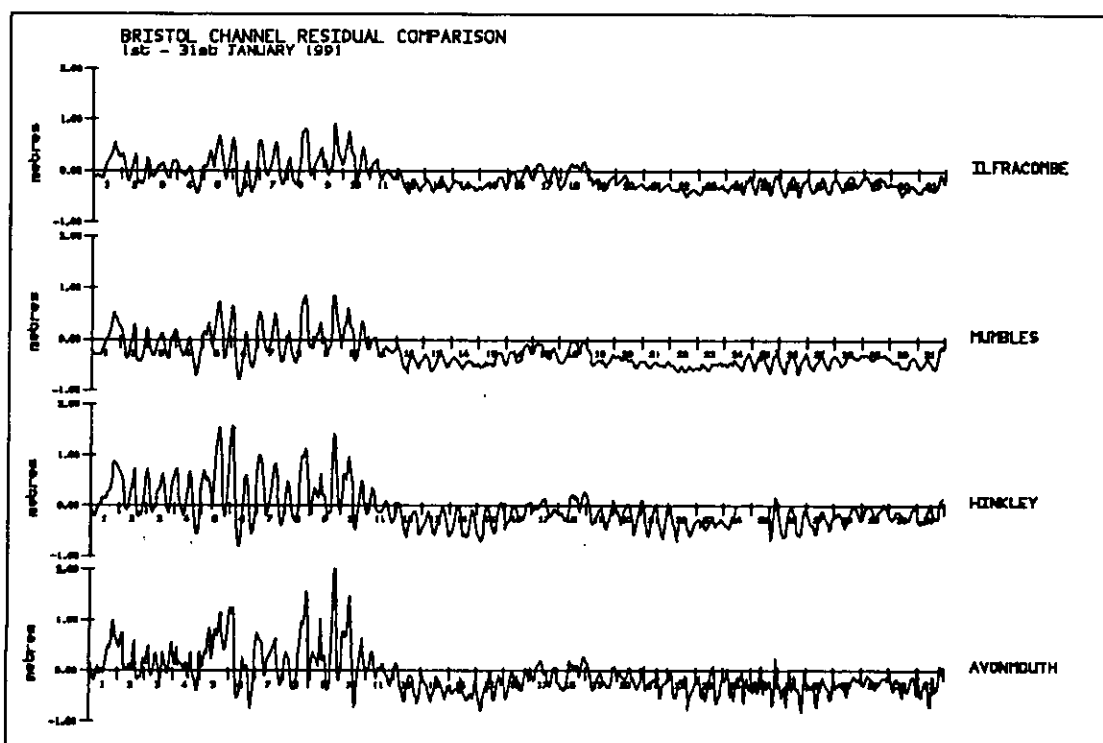
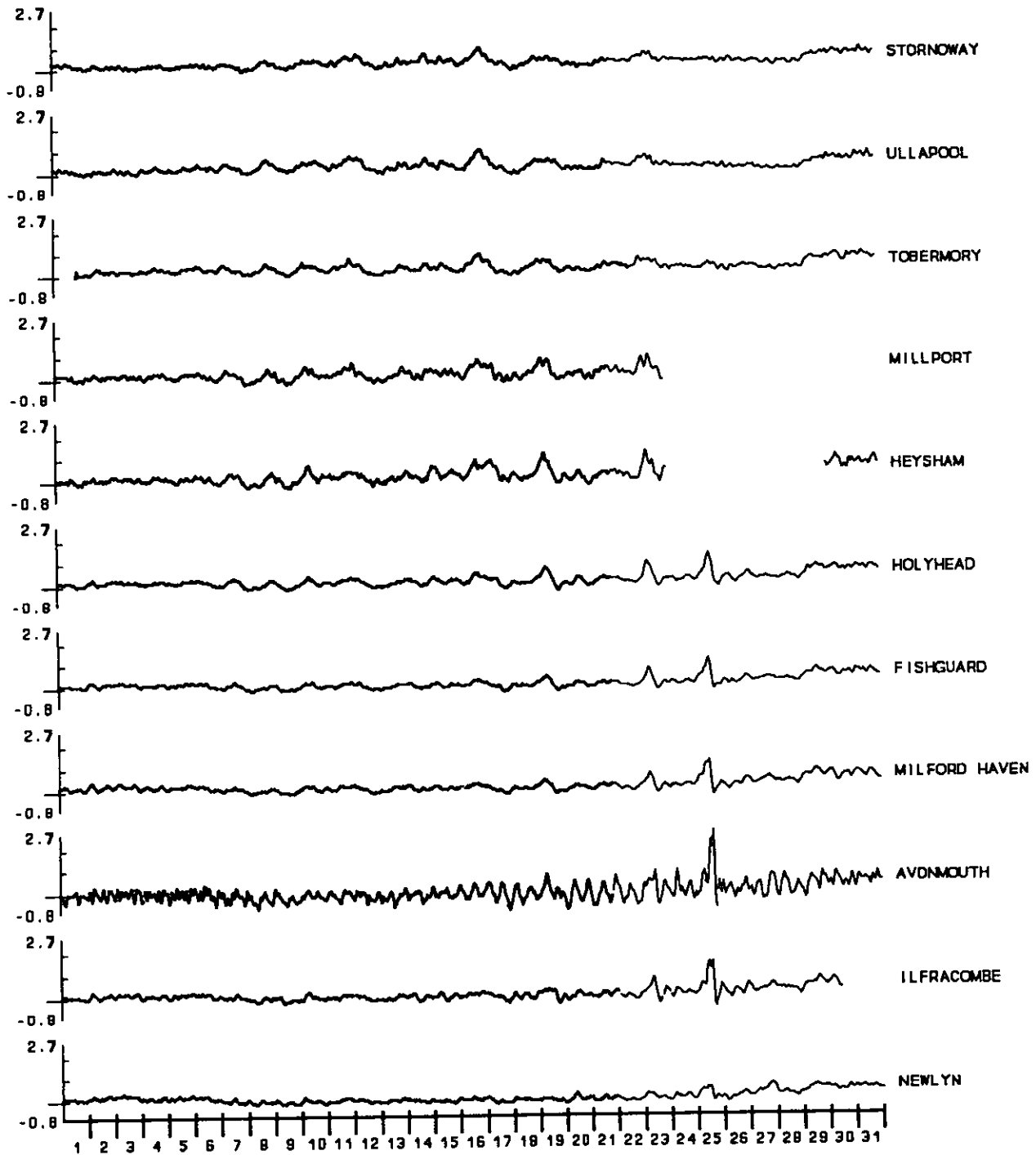
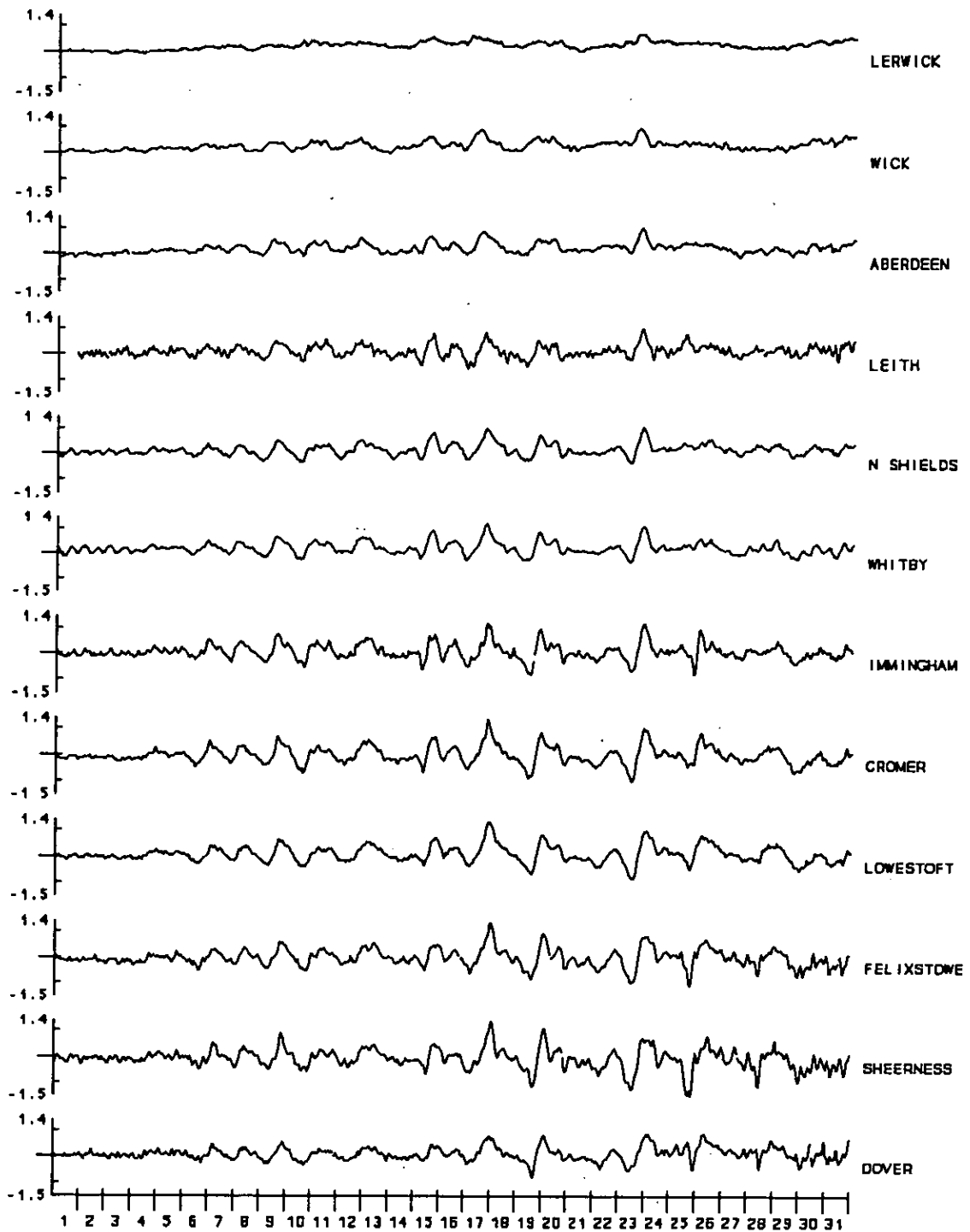


Figure 10.

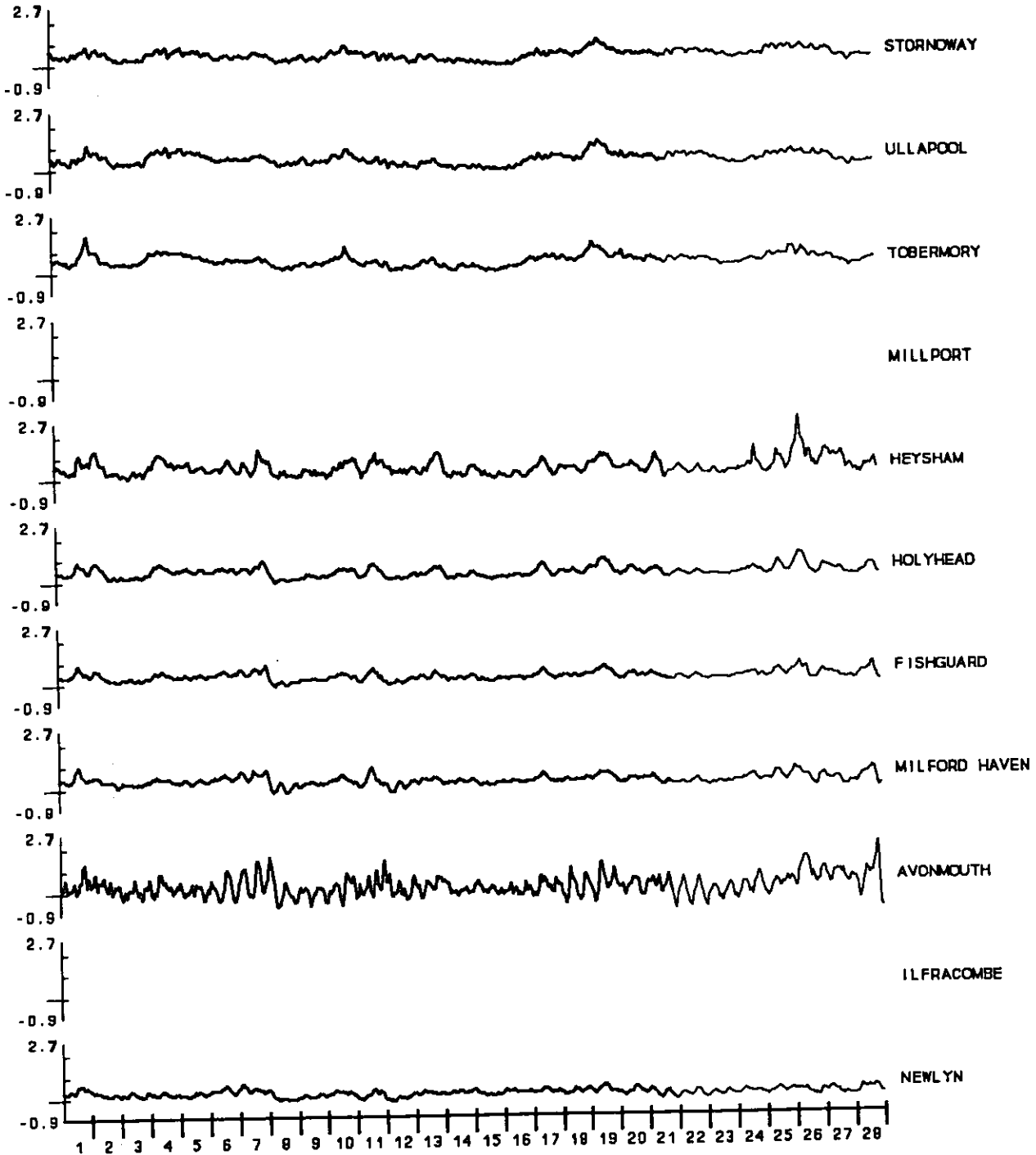
HOURLY RESIDUALS JANUARY 1990
WEST COAST PORTS
(METRES)



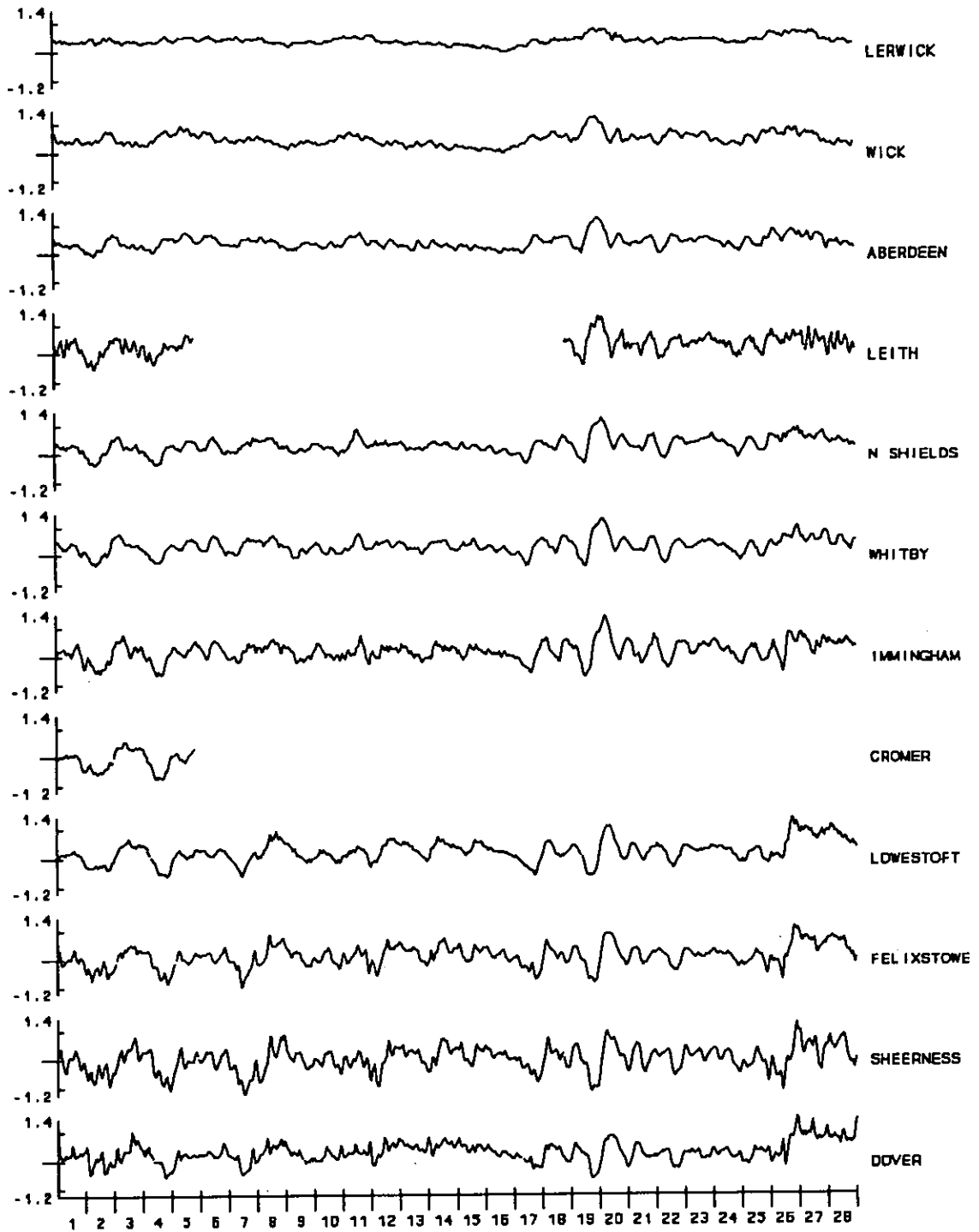
HOURLY RESIDUALS JANUARY 1990
EAST COAST PORTS
(METRES)



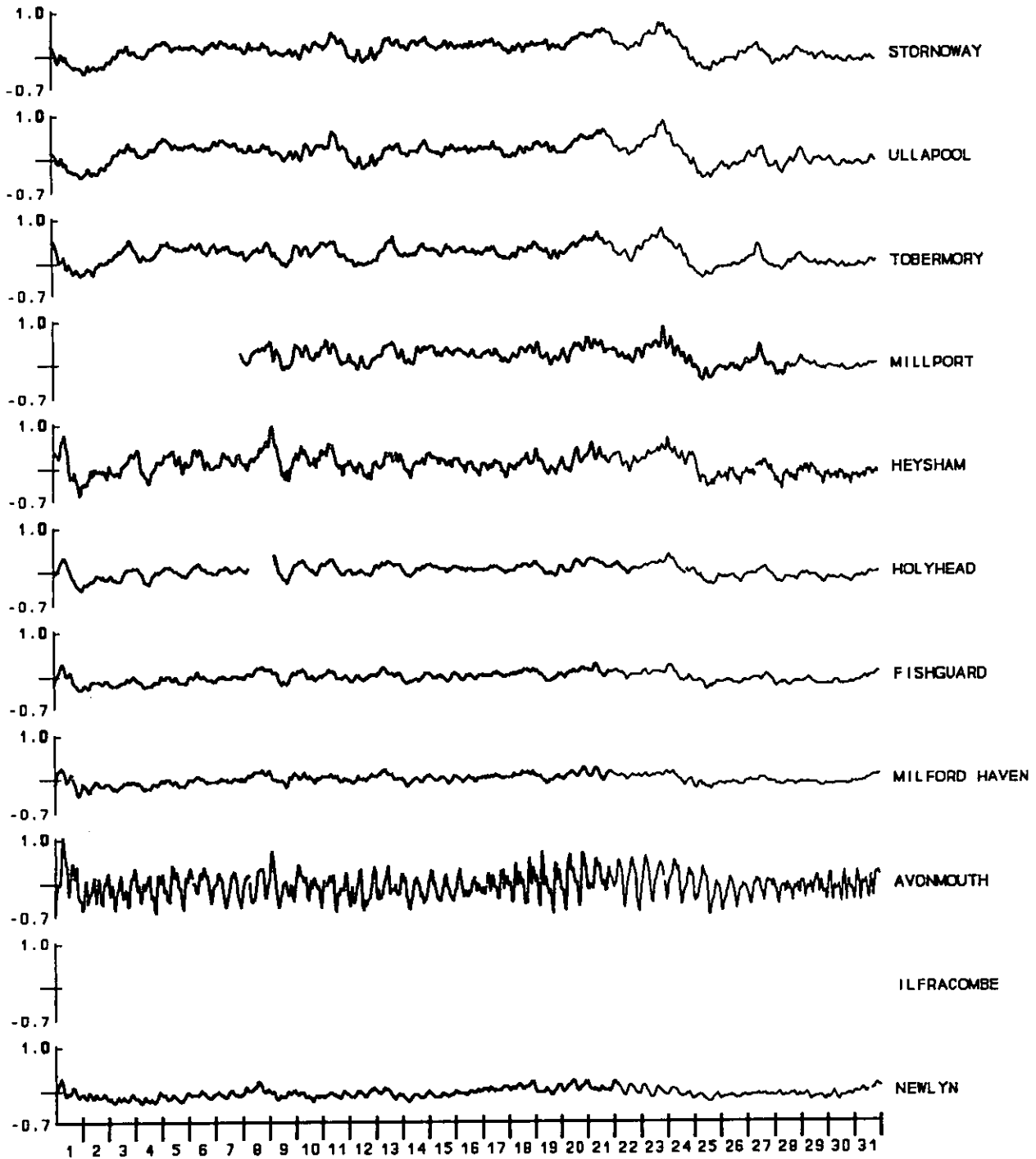
HOURLY RESIDUALS FEBRUARY 1990
WEST COAST PORTS
(METRES)



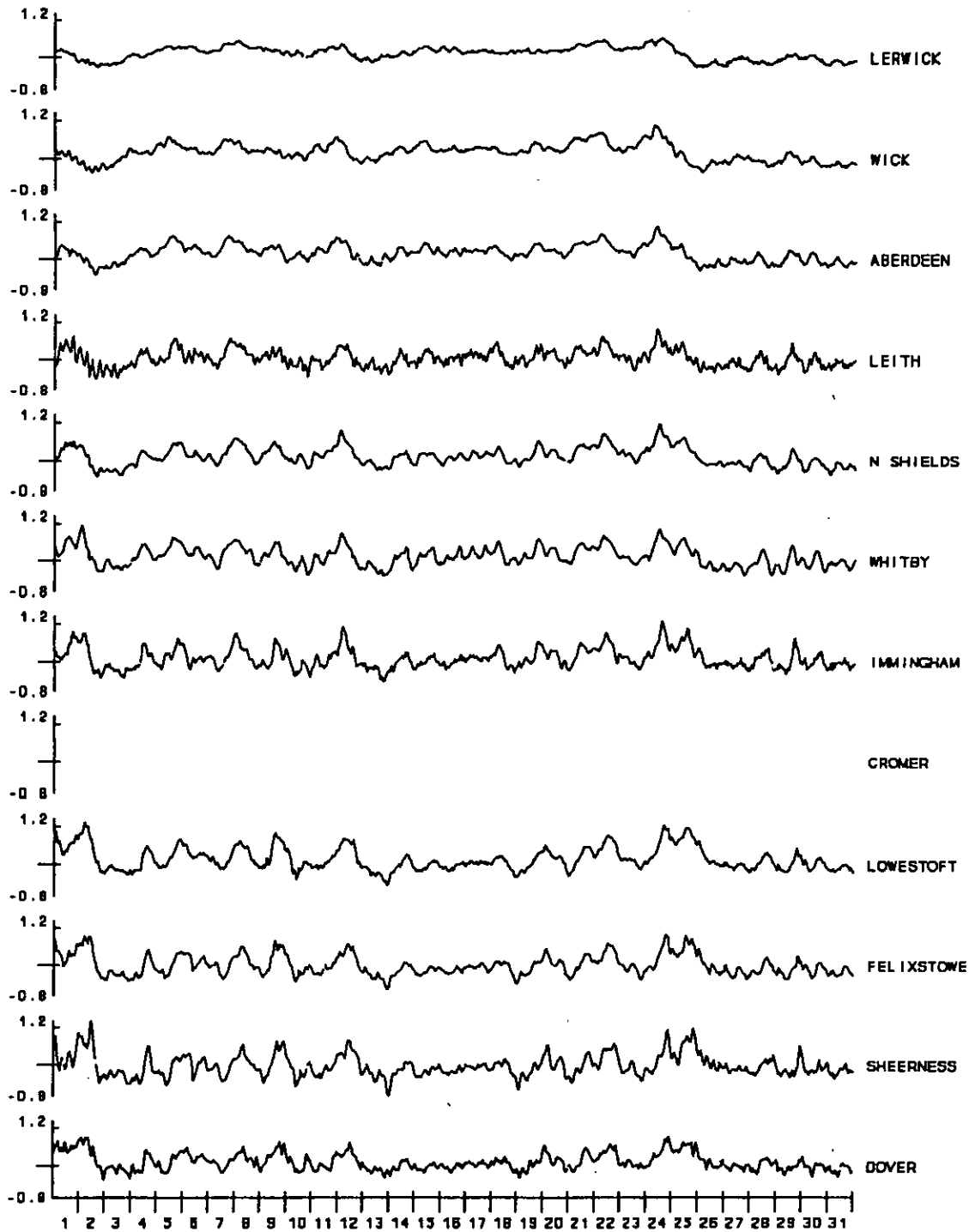
HOURLY RESIDUALS FEBRUARY 1990
EAST COAST PORTS.
(METRES)



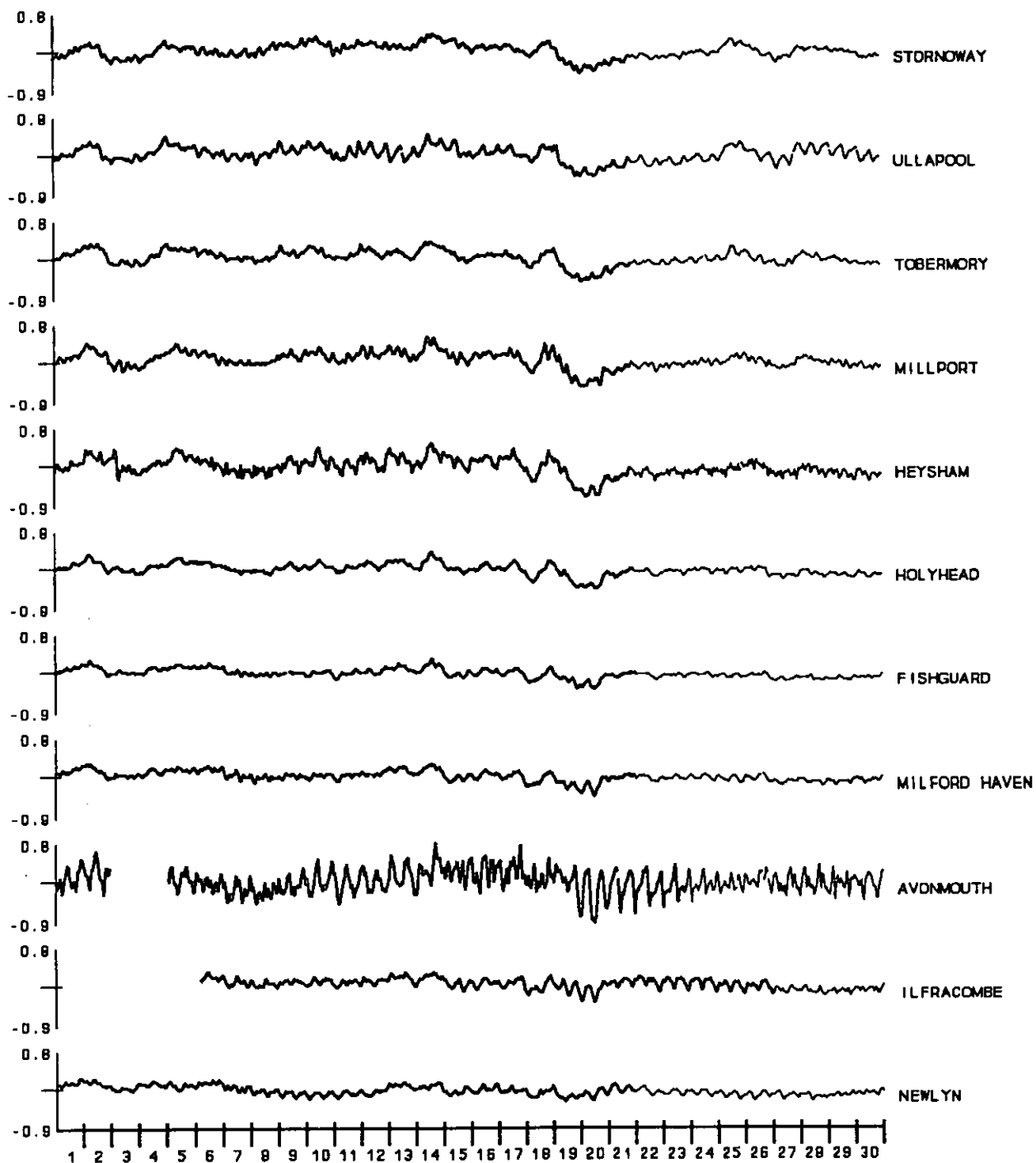
HOURLY RESIDUALS MARCH 1990
WEST COAST PORTS
(METRES)



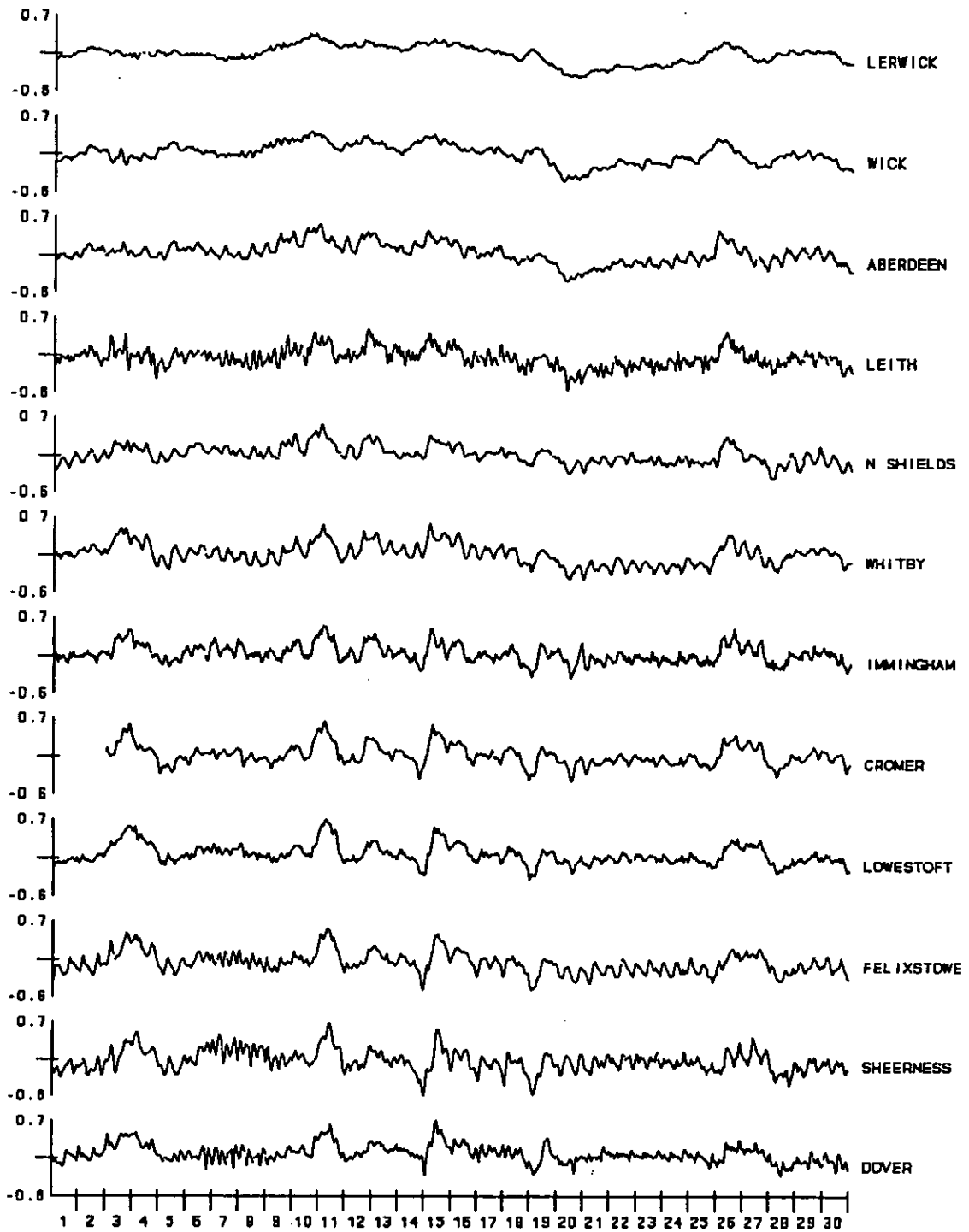
HOURLY RESIDUALS MARCH 1990
EAST COAST PORTS
(METRES)



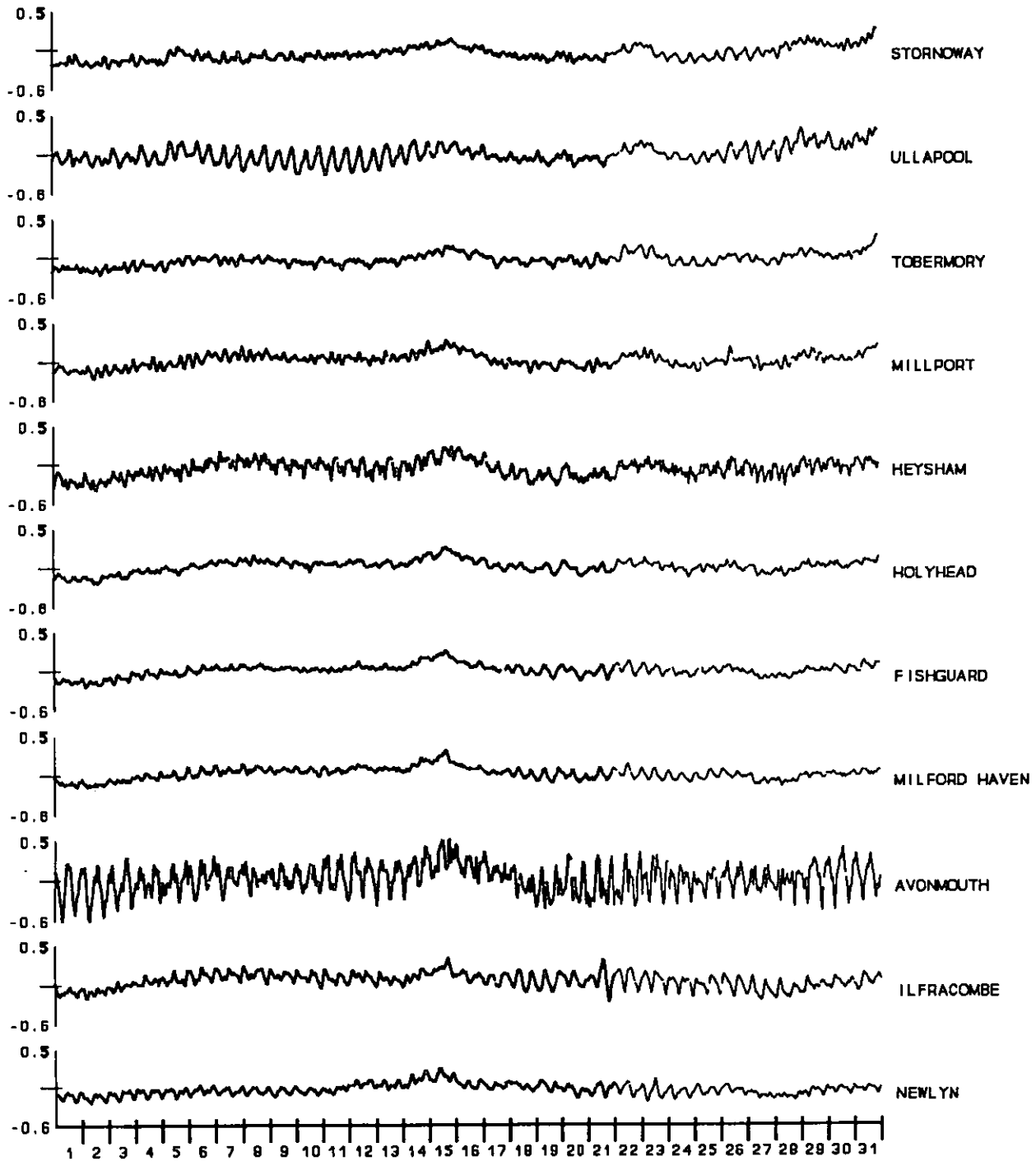
HOURLY RESIDUALS APRIL 1990
WEST COAST PORTS
(METRES)



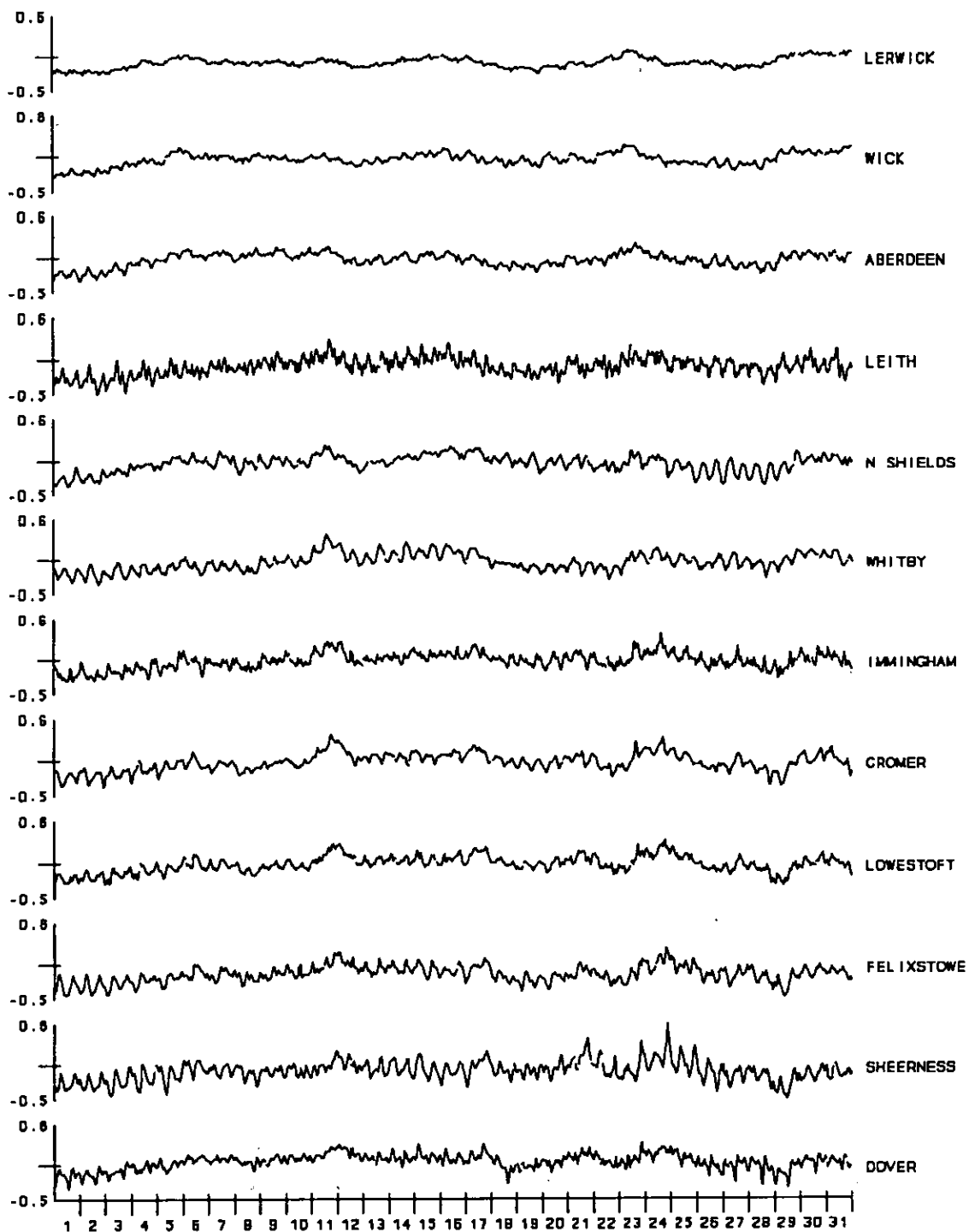
HOURLY RESIDUALS APRIL 1990
EAST COAST PORTS
(METRES)



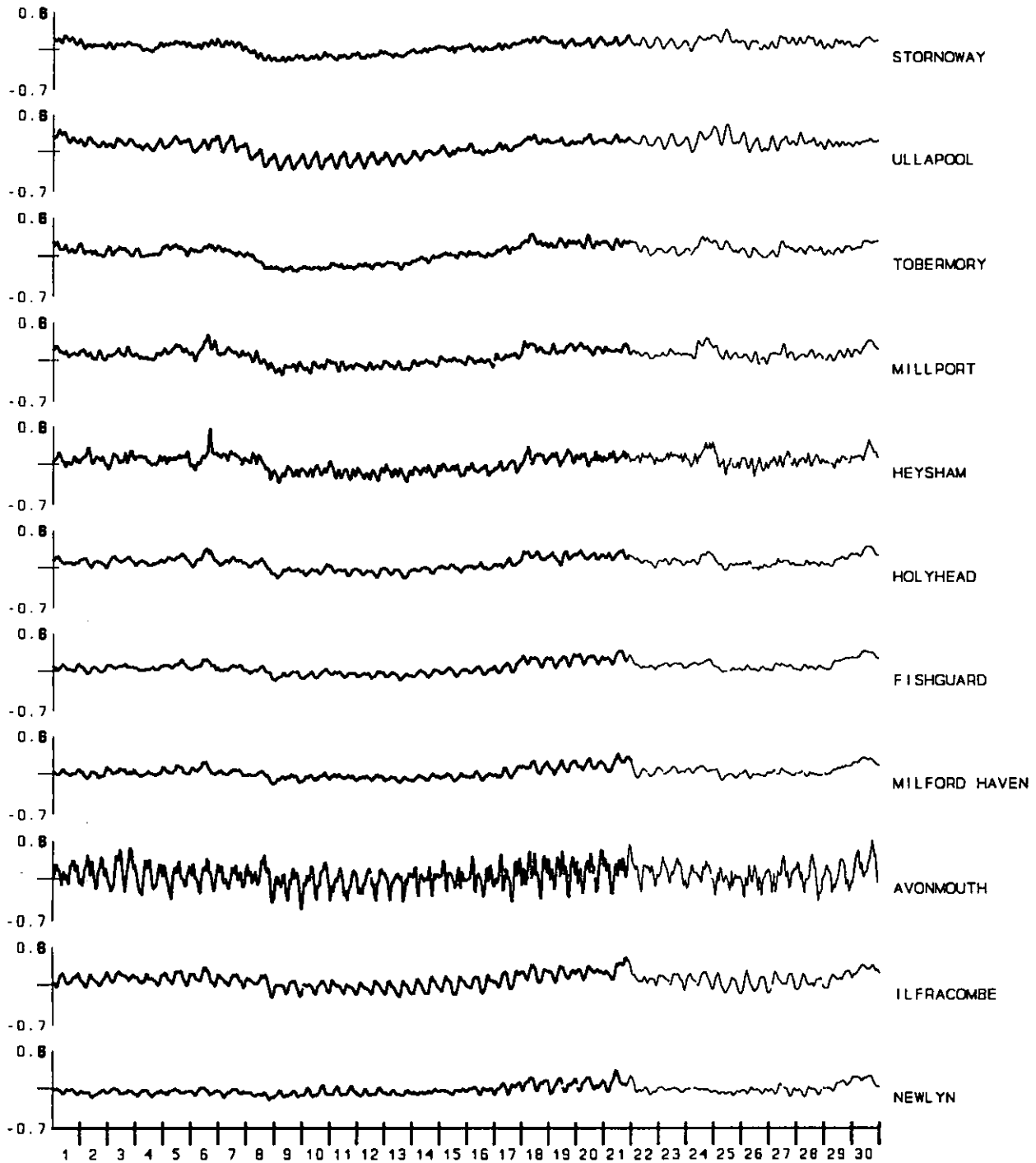
HOURLY RESIDUALS MAY 1990
WEST COAST PORTS
(METRES)



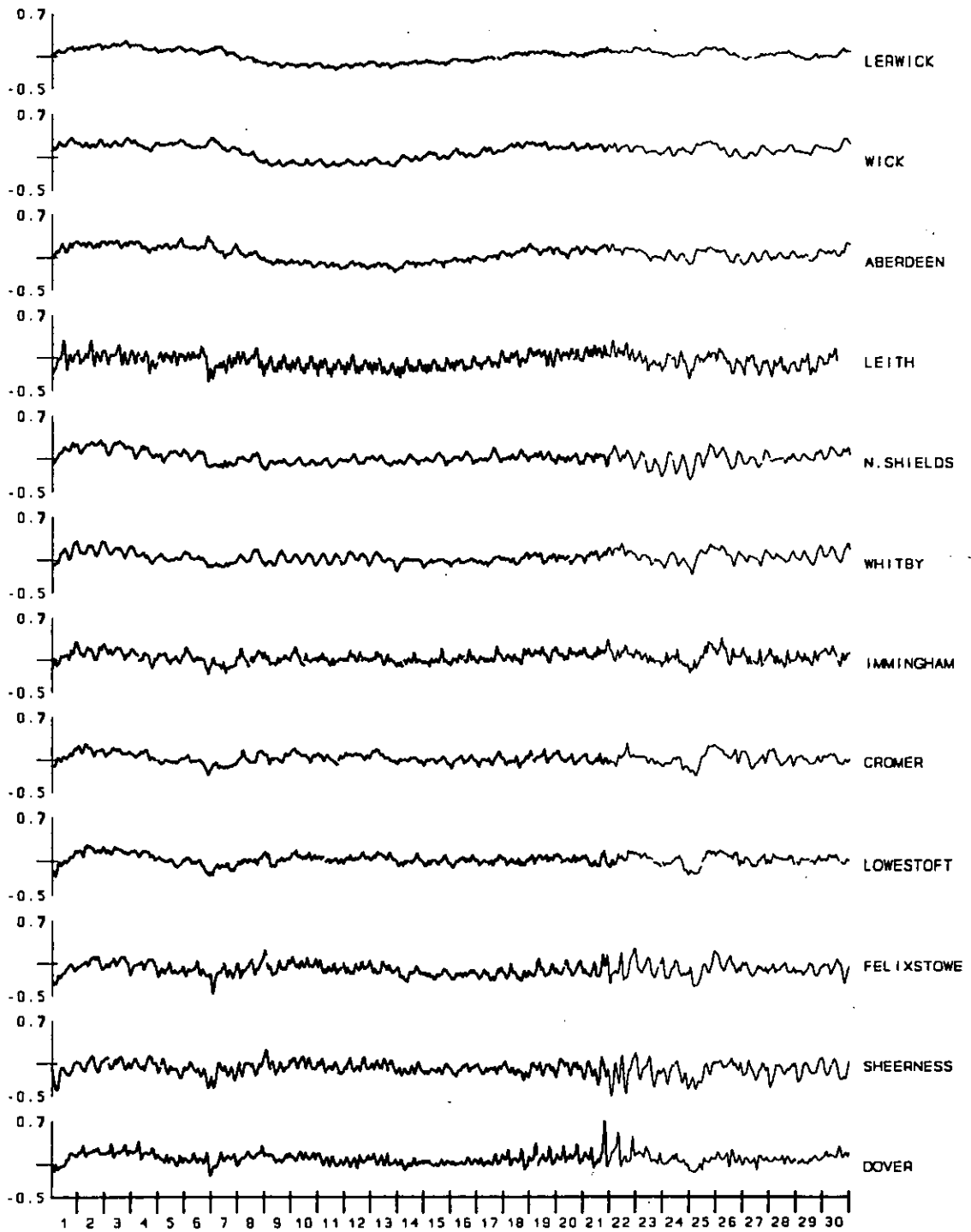
HOURLY RESIDUALS MAY 1990
EAST COAST PORTS
(METRES)



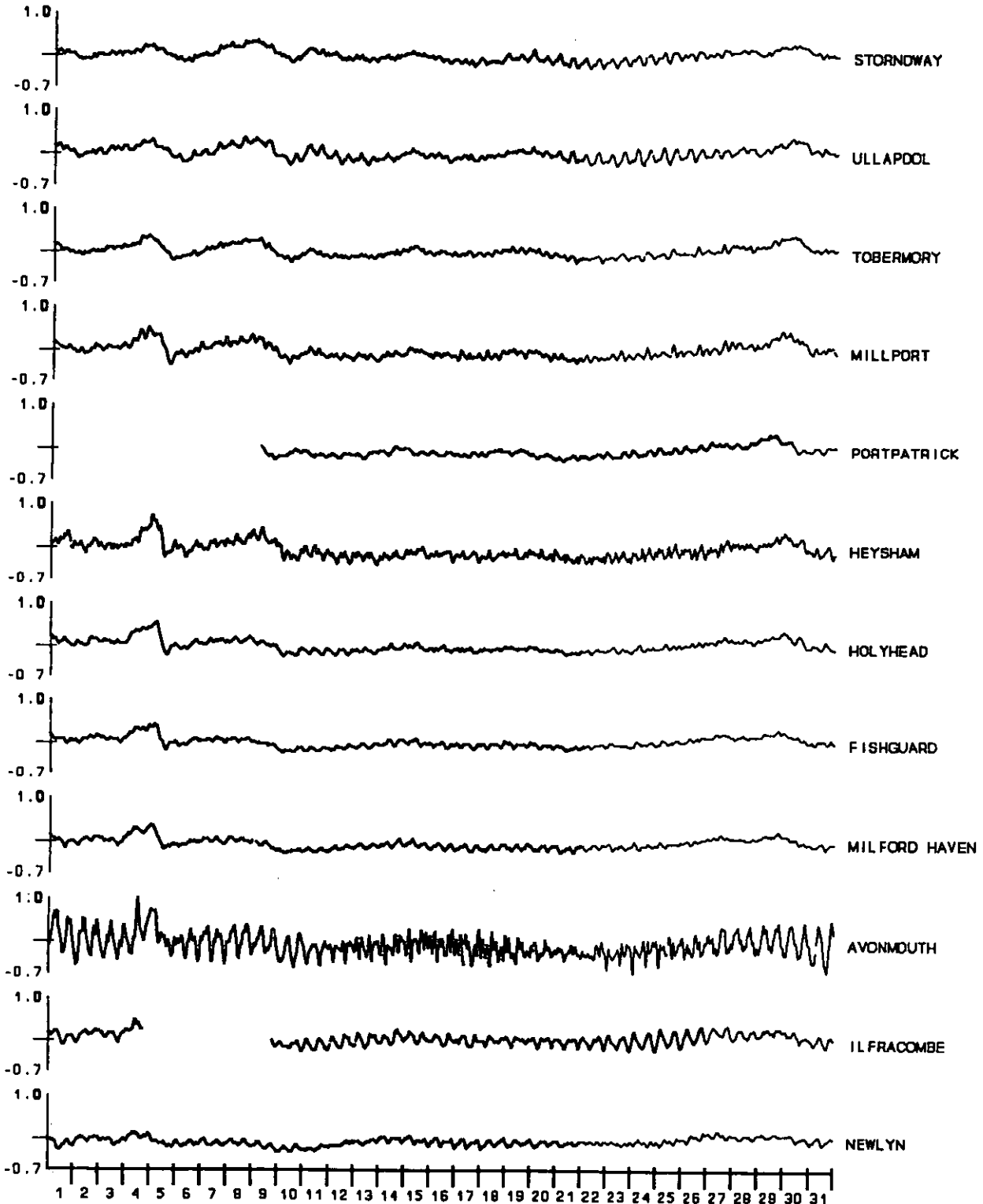
HOURLY RESIDUALS JUNE 1990
WEST COAST PORTS
(METRES)



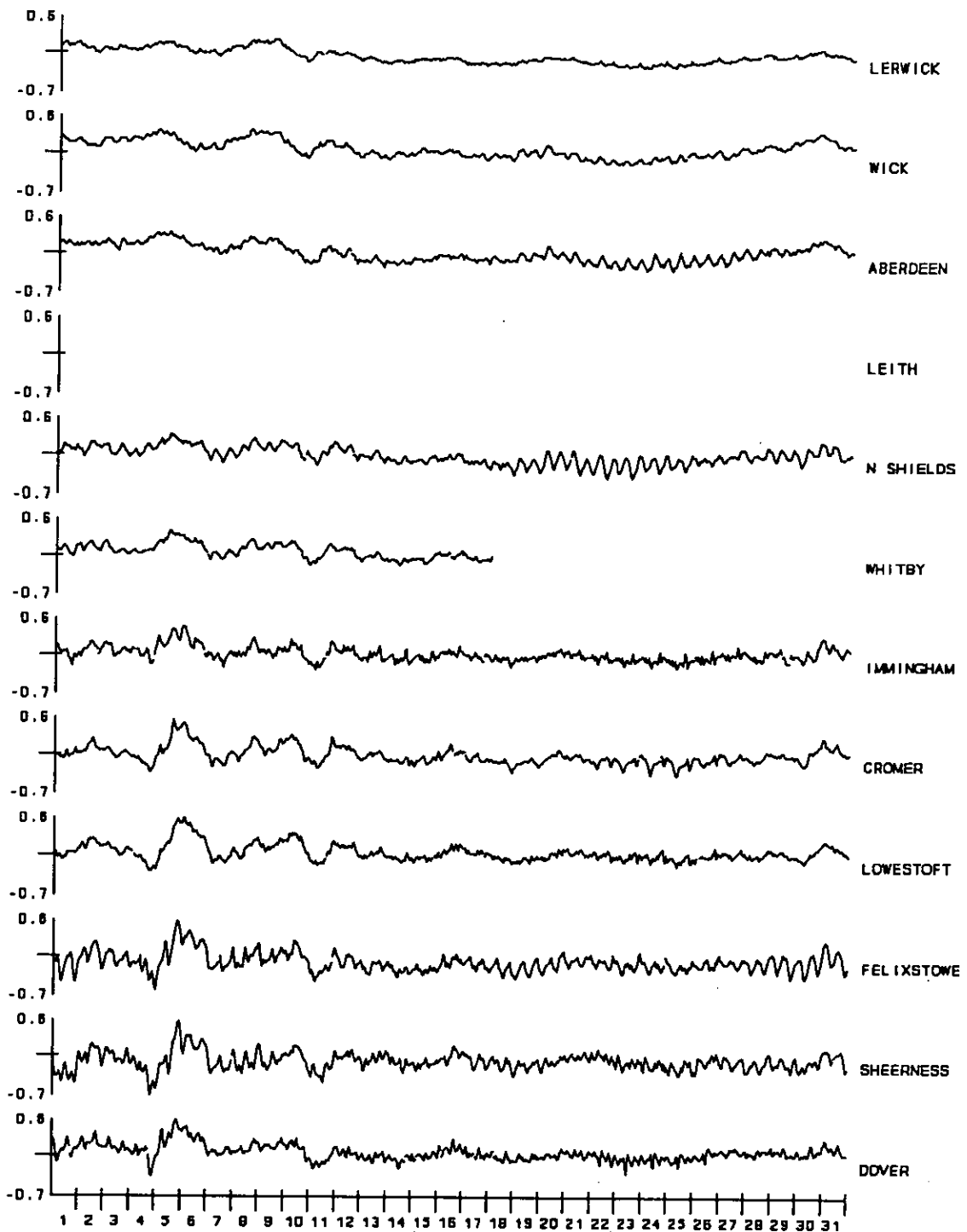
HOURLY RESIDUALS JUNE 1990
EAST COAST PORTS
(METRES)



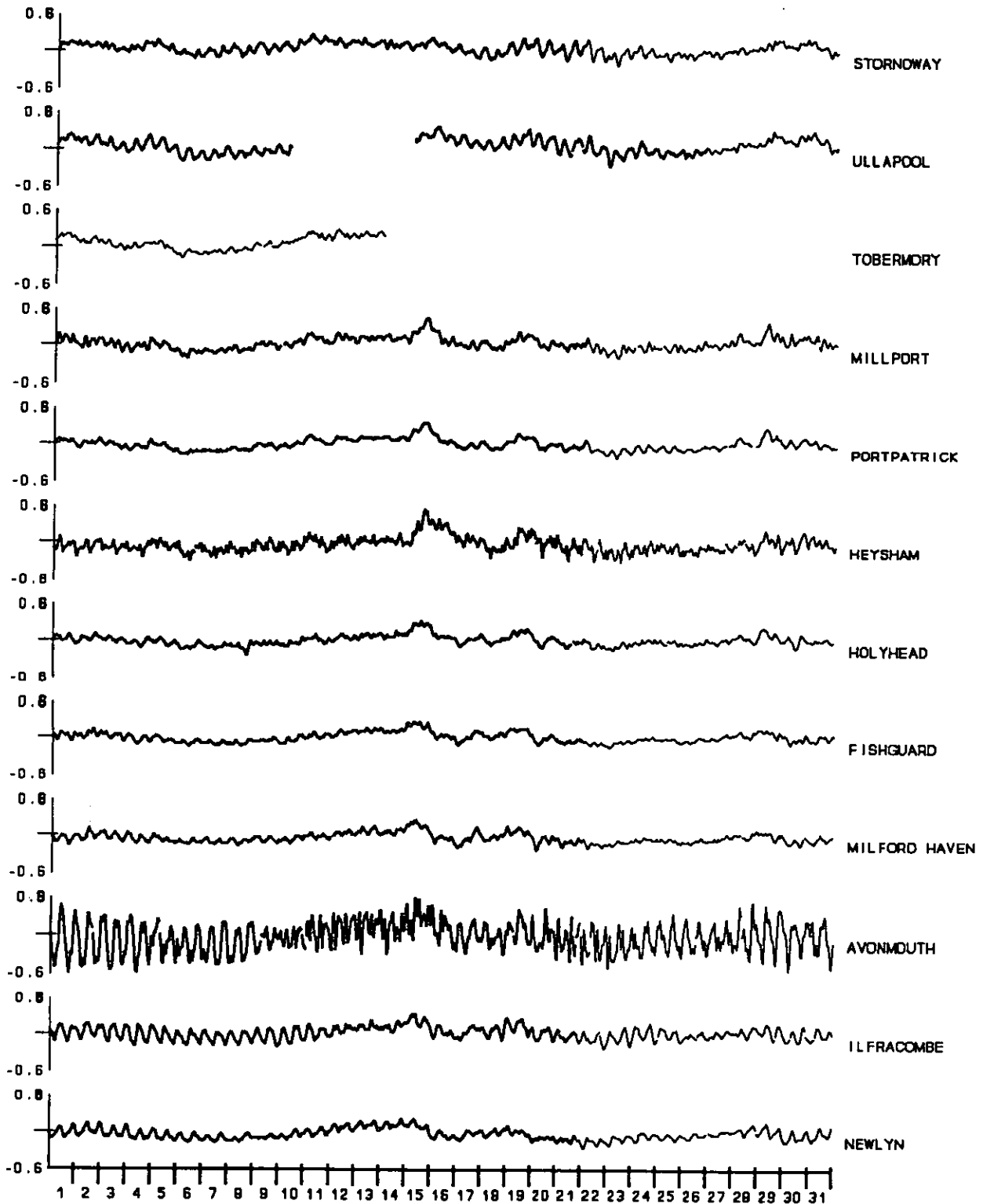
HOURLY RESIDUALS JULY 1890
WEST COAST PORTS
(METRES)



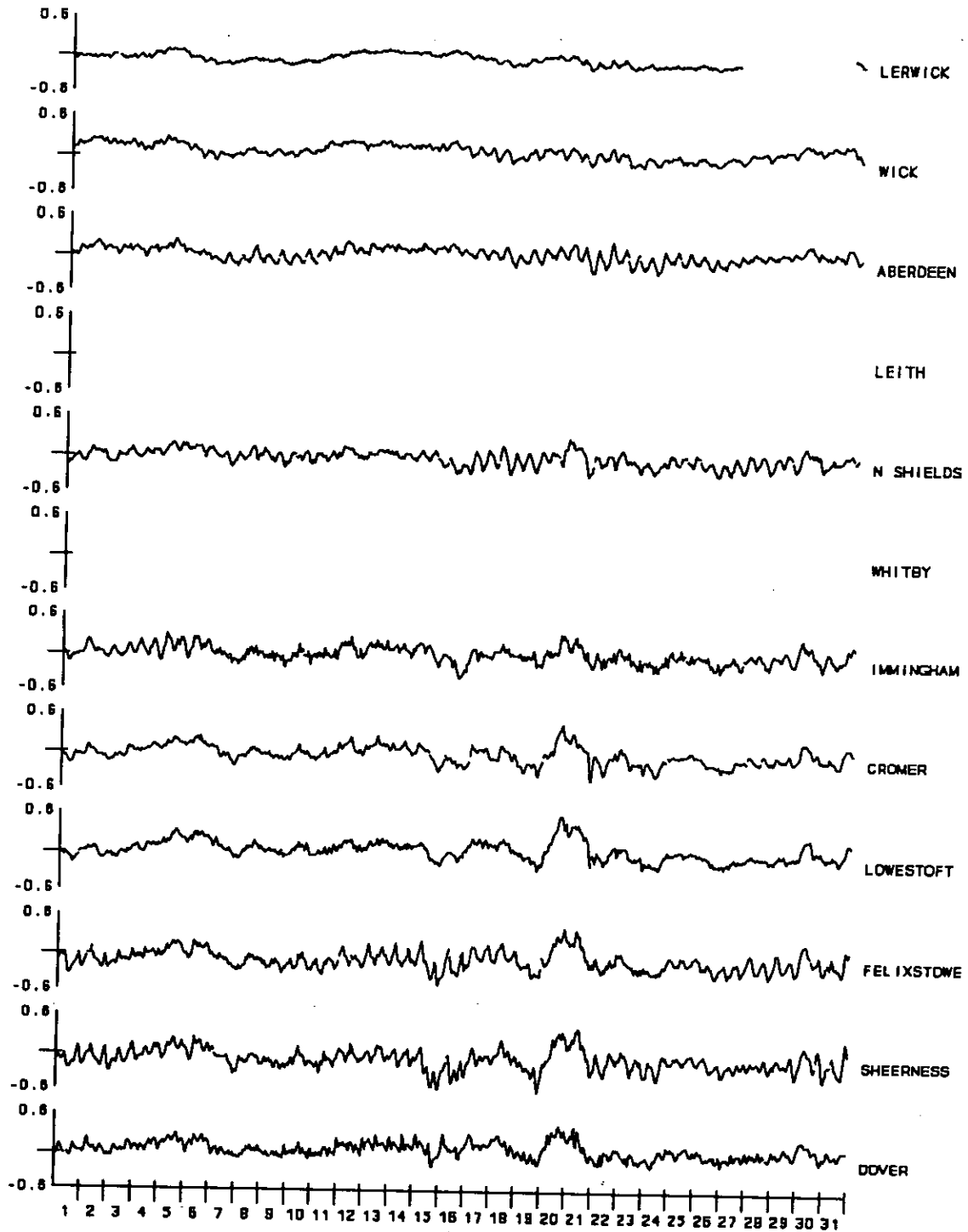
HOURLY RESIDUALS JULY 1990
EAST COAST PORTS
(METRES)



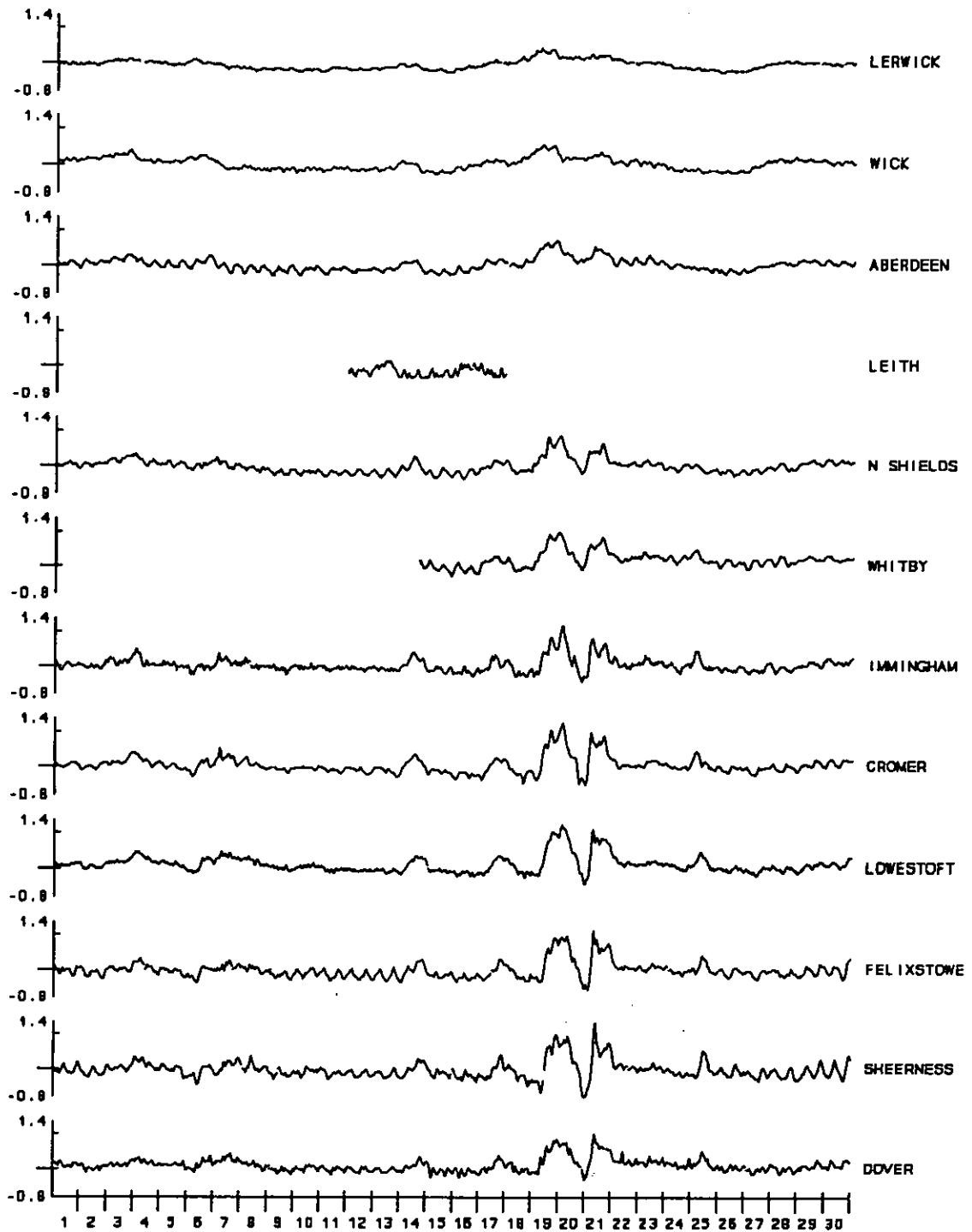
HOURLY RESIDUALS AUGUST 1990
WEST COAST PORTS
(METRES)



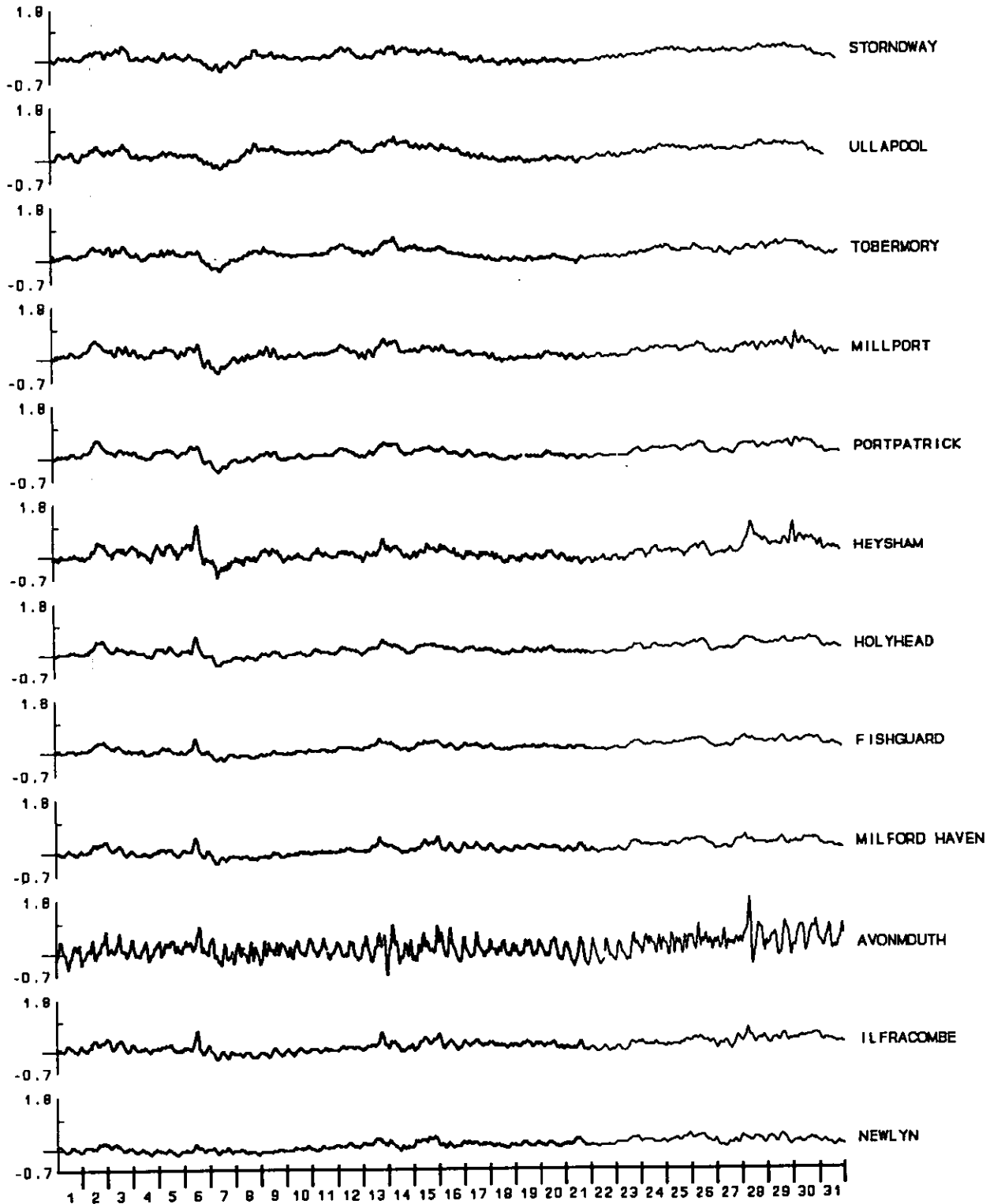
HOURLY RESIDUALS AUGUST 1990
EAST COAST PORTS
(METRES)



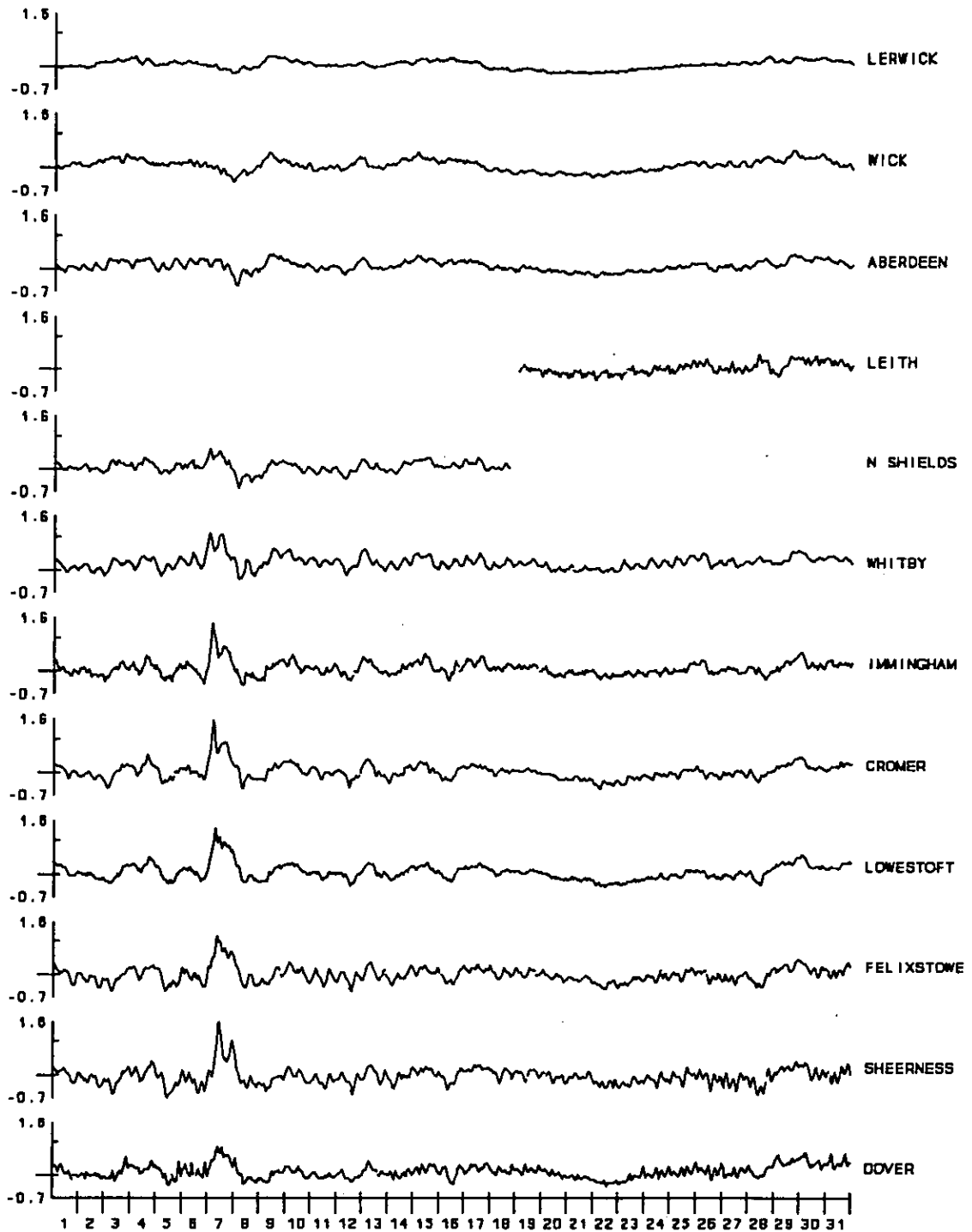
HOURLY RESIDUALS SEPTEMBER 1990
EAST COAST PORTS
(METRES)



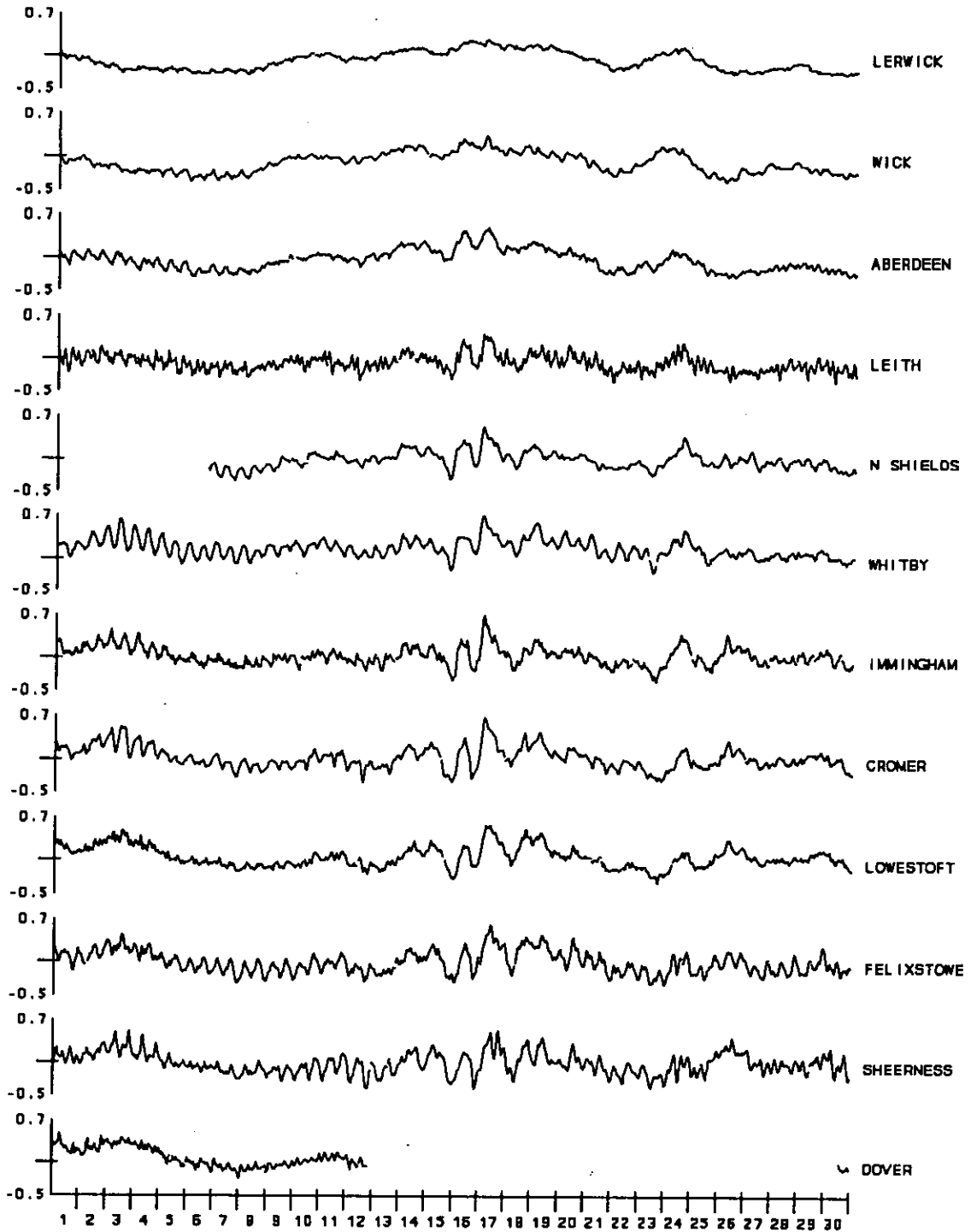
HOURLY RESIDUALS OCTOBER 1990
WEST COAST PORTS
(METRES)



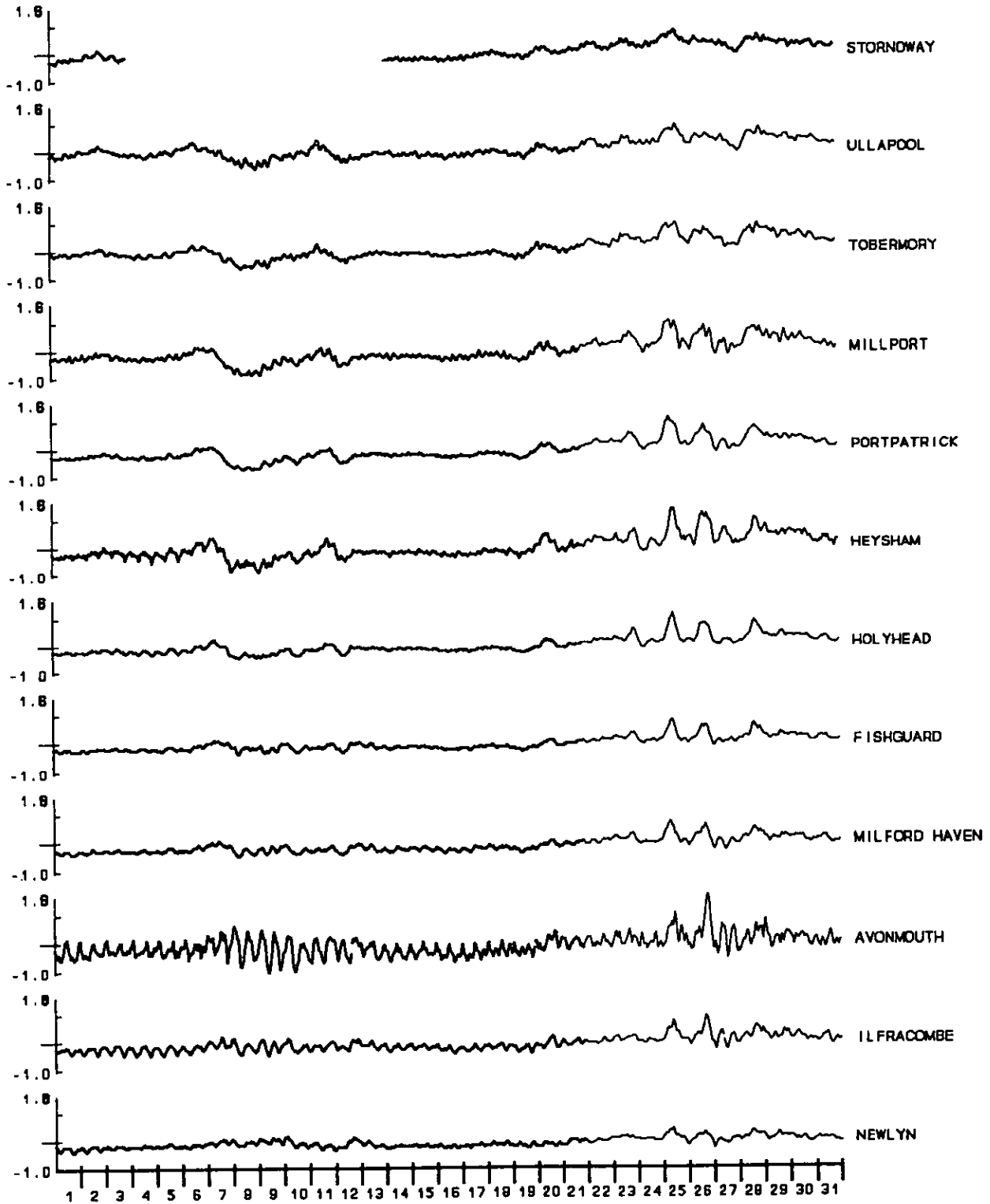
HOURLY RESIDUALS OCTOBER 1990
EAST COAST PORTS
(METRES)



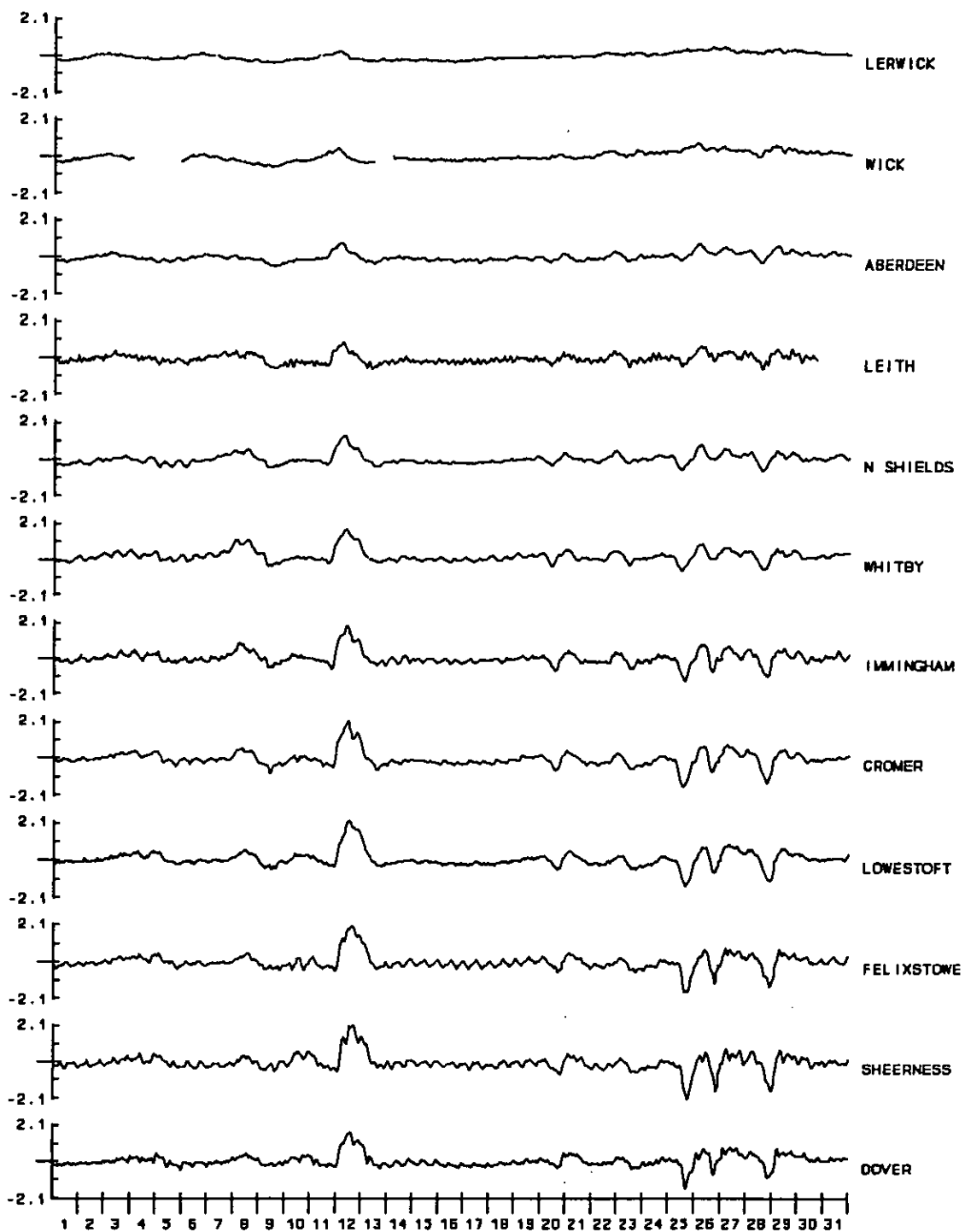
HOURLY RESIDUALS NOVEMBER 1990
 EAST COAST PORTS
 (METRES)



HOURLY RESIDUALS DECEMBER 1990
 WEST COAST PORTS
 (METRES)



HOURLY RESIDUALS DECEMBER 1990
 EAST COAST PORTS
 (METRES)



MAXIMUM RESIDUALS 1990
WEST COAST PORTS
(METRES)

PORT	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
STORNOWAY	.894	.995	.665	.336	.249	.321	.336	.267	.530	.487	.414	.746	.995
ULLAPOOL	.967	1.142	.800	.406	.308	.459	.372	.366	.366	.680	.470	.876	1.142
TOBERMORY	.937	1.680	.726	.330	.274	.343	.380	.384	.549	.672	.380	.903	1.680
MILLPORT	.949		.814	.520	.258	.421	.488	.461	.607	.766	.504	.995	.995
PORTPATRICK							.341	.353	.410	.599	.448	1.048	1.048
HEYSHAM	1.245	2.662	.962	.468	.221	.601	.712	.538	.703	1.046	.671	1.321	2.662
HOLYHEAD	1.286	1.037	.361	.341	.264	.364	.526	.328	.449	.573	.391	1.080	1.286
FISHGUARD	1.161	.881	.263	.251	.251	.334	.427	.279	.355	.484	.322	.754	1.161
MILFORD HAVEN	1.229	1.022	.249	.268	.315	.316	.352	.248	.192	.464	.335	.682	1.229
AVONMOUTH	2.711	1.995	1.043	.809	.532	.646	.969	.594	.702	1.751	.606	1.641	2.711
ILFRACOMBE	1.490			.300	.336	.459	.474	.341	.319	.704	.376	.880	1.490
NEWLYN	.627	.652	.253	.234	.254	.300	.195	.218	.248	.424	.271	.369	.652

MAXIMUM RESIDUALS 1990
EAST COAST PORTS
(METRES)

PORT	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
LERWICK	.635	.708	.521	.338	.065	.252	.252	.153	.400	.285	.273	.482	.708
WICK	.910	1.178	.875	.386	.145	.330	.412	.297	.548	.505	.352	.721	1.178
ABERDEEN	.977	1.183	.893	.548	.183	.352	.366	.265	.729	.453	.487	.731	1.183
LEITH	.980	1.230	.825	.472	.266	.305			.143	.453	.420	.815	1.230
NORTH SHIELDS	1.008	1.158	.960	.539	.208	.310	.362	.333	.856	.587	.520	1.280	1.280
WHITBY	1.169	1.213	.921	.551	.357	.307	.427		.992	1.093	.759	1.684	1.684
IMMINGHAM	1.141	1.338	1.065	.518	.369	.365	.514	.377	1.191	1.419	.707	1.808	1.808
CROMER	1.376	.549		.623	.359	.282	.604	.515	1.237	1.554	.692	2.013	2.013
LOWESTOFT	1.334	1.332	1.056	.657	.302	.259	.631	.642	1.229	1.353	.591	2.108	2.108
FELIXSTOWE	1.350	1.095	.830	.539	.221	.260	.617	.475	1.149	1.146	.620	1.920	1.920
SHEERNESS	1.409	1.194	1.198	.636	.579	.230	.613	.458	1.372	1.584	.534	2.039	2.039
DOVER	.872	1.448	.765	.672	.293	.707	.644	.486	1.007	.844	.479	1.574	1.574

MINIMUM RESIDUALS 1990
WEST COAST PORTS
(METRES)

PORT	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
STORNOWAY	-.095	-.111	-.428	-.531	-.252	-.216	-.279	-.224	-.316	-.373	-.367	-.351	-.531
ULLAPOOL	-.128	-.153	-.509	-.507	-.302	-.315	-.259	-.268	-.297	-.315	-.337	-.616	-.616
TOBERMORY	-.065	-.053	-.390	-.554	-.233	-.275	-.233	-.199	-.236	-.365	-.330	-.636	-.636
MILLPORT	-.270		-.424	-.561	-.249	-.247	-.322	-.214	-.286	-.489	-.388	-.911	-.911
PORTPATRICK							-.252	-.210	-.276	-.486	-.317	-.751	-.751
HEYSHAM	-.288	-.148	-.610	-.713	-.362	-.318	-.360	-.319	-.461	-.713	-.496	-.917	-.917
HOLYHEAD	-.293	-.056	-.422	-.460	-.216	-.195	-.235	-.242	-.295	-.393	-.271	-.485	-.485
FISHGUARD	-.273	-.140	-.351	-.412	-.218	-.167	-.233	-.151	-.240	-.261	-.242	-.378	-.412
MILFORD HAVEN	-.297	-.230	-.366	-.427	-.180	-.168	-.255	-.227	-.266	-.354	-.323	-.481	-.481
AVONMOUTH	-.831	-.935	-.750	-.898	-.549	-.500	-.684	-.633	-.571	-.749	-.568	-1.038	-1.038
ILFRACOMBE	-.502			-.380	-.236	-.214	-.214	-.242	-.236	-.281	-.316	-.484	-.502
NEWLYN	-.246	-.233	-.291	-.318	-.219	-.196	-.273	-.285	-.247	-.216	-.310	-.401	-.401

MINIMUM RESIDUALS 1990
EAST COAST PORTS
(METRES)

PORT	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
LERWICK	-0.081	-0.046	-0.226	-0.394	-0.244	-0.200	-0.223	-0.151	-0.280	-0.235	-0.313	-0.400	-0.400
WICK	-0.025	-0.051	-0.360	-0.447	-0.279	-0.153	-0.165	-0.099	-0.288	-0.417	-0.417	-0.592	-0.592
ABERDEEN	-0.160	-0.093	-0.422	-0.444	-0.321	-0.207	-0.279	-0.229	-0.315	-0.494	-0.319	-0.529	-0.529
LEITH	-0.540	-0.544	-0.502	-0.592	-0.468	-0.367			-0.349	-0.325	-0.360	-0.631	-0.631
NORTH SHIELDS	-0.353	-0.395	-0.415	-0.403	-0.365	-0.321	-0.401	-0.257	-0.359	-0.537	-0.368	-0.632	-0.632
WHITBY	-0.337	-0.442	-0.401	-0.403	-0.343	-0.219	-0.172		-0.258	-0.263	-0.216	-0.645	-0.645
IMMINGHAM	-0.794	-0.780	-0.561	-0.364	-0.289	-0.218	-0.264	-0.336	-0.437	-0.411	-0.373	-1.289	-1.289
CROMER	-0.989	-0.729		-0.415	-0.347	-0.261	-0.372	-0.383	-0.506	-0.482	-0.385	-1.585	-1.585
LOWESTOFT	-0.840	-0.645	-0.511	-0.348	-0.307	-0.231	-0.286	-0.214	-0.428	-0.369	-0.326	-1.439	-1.439
FELIXSTOWE	-1.094	-0.974	-0.655	-0.532	-0.465	-0.479	-0.605	-0.462	-0.571	-0.518	-0.345	-1.719	-1.719
SHEERNESS	-1.509	-1.207	-0.815	-0.641	-0.474	-0.539	-0.697	-0.557	-0.795	-0.668	-0.418	-2.060	-2.060
DOVER	-0.782	-0.679	-0.341	-0.270	-0.335	-0.174	-0.352	-0.167	-0.288	-0.302	-0.261	-1.508	-1.508

5. Acknowledgements

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