Moorings deployed for Resuspension Experiments (Challenger 44, 52 and 60)

The major objective of the resuspension experiments was to make time series observations of physical, sedimentological and biological properties of the sediment, suspended particulate material and water at two sites in the North Sea. A variety of moored instruments were deployed as part of these experiments at two sites.

The two sites are: Northern site 54°35'N 04°50'E, water depth 45m, muddy sand, seasonally stratified water column, Magnetic variation 2.9 degrees west.

Southern site 52°40'N 03°40'E, water depth 27m, sand, permanently well mixed water column, Magnetic variation 3.0 degrees west.

The moorings used for these experiments are given below, together with the cruise and rig numbers (i.e. 44319 = Challenger 44, rig 319) for which they were deployed:

Rig 1: A U-shaped mooring comprising three Aanderaa current meters 5m, 10m and 30m above the sea bed and three SeaTech transmissometers 5m, 10m and 30m above the sea bed. The marker buoy was attached to the anchor by wire, the anchor was attached by a ground line to a further anchor, this was attached to a sub-surface buoy (a 0.8m diameter steel sphere); the current meters and transmissometers were attached to this line. (44319, 52351, 60410).

Rig 2: Containing near surface InterOcean S4 current meters 37m and 31m above the sea bed. An Aanderaa RCM was included 20m above the sea bed on the rig deployed on Challenger 44. (44320, 52352, 60411).

An ETA rig with two InterOcean S4 current meters 40m and 35m above the sea bed. (44321, 52353, 60412).

A POL current meter/tide gauge mounted on a frame positioned on the sea bed. (44322, 52354, 60413).

STABLE (Sediment Transport and Boundary Layer Equipment). (44323,52355,60414).

A POL 250kHz Acoustic Doppler Current Profiler (ADCP) and an IOS acoustic release mounted on a low profile frame positioned on the sea bed. The instrument was located 0.8m above the sea floor. On recovery the release was triggered by sending acoustic signals from the ship so that the frame separated from the ballast weight. The frame, under its own buoyancy (glass spheres), then rose to the surface ready for picking up. (44326, 52358, 52359, 60417, 60419).

Waverider buoy. (44325, 52357, 60416).

POL Met. buoy. Note: All met. data recorded were compared with output from the Meteorological Office model. Sea surface temperature data were recalibrated against CTD measurements: $T_{ctd} = 2.25 + T_{buoy} * 0.792$ ($r^2 = 99.6\%$). (44324, 52356, 60415).

Thermistor chain. (52360, 60418).

CM/TR: A U-shaped mooring containing three current meters 5m, 10m and 21m above the sea bed and three transmissometers 4m, 9m and 30m above the sea bed. The marker buoy was attached to the anchor by wire, the anchor was attached by a ground line to a further anchor, this was attached to a sub-surface buoy (a 0.8m diameter steel sphere); the current meters and transmissometers were attached to this line. (44xxx, 52352, 60420).

SMBA rig containing two InterOcean S4 current meters. (52SMBA).

InterOcean Systems Model S4 Current Meter

The InterOcean Systems Model S4 electromagnetic current meter is a self-contained 0.25m diameter sphere, with no protruding sensors. It measures current by creating a magnetic field and sensing the voltage induced in two orthogonal directions, by the movement of the sea water, an electrical conductor, through the field. This information is combined with instrument orientation, sensed by a flux-gate compass, and the north and east components of current computed. The S4s were used in vector average mode throughout the survey. They sampled every 0.5 seconds and averaged the vectors over a 10 minute recording interval.

S4 specification

	Range	Accuracy
Speed	0 to 350 cm/s	+/- 2 cm/s
Direction	0 to 360 degrees	+/- 2 degrees

Aanderaa RCM7 and RCM4 Current Meters

The Aanderaa RCM7 and RCM4 current meters are self-recording current meters. Temperature is measured by a thermistor fitted into a stud extending into the water. A vane is attached to the meter in order to align the compass with current flow and keep the meter in an upright position. The RCM4 measures current speed with a savonius rotor situated on top of the meter and magnetically coupled to an electronic counter. The number of revolutions over the sampling interval of 10 minutes gives the average speed over the interval.

The RCM7 measures current speed with a half shrouded paddle wheel situated on top of the meter. During the selected recording interval of 10 minutes the number of rotor revolutions and the direction of the compass are sampled every 12 seconds and broken up into north-south and east-west components. When the 10 minute recording interval has elapsed, the resultant average vector and its angle is calculated and recorded.

RCM4 and RCM7 specification

	Range	Accuracy
Speed	2 to 250 cm/s	+/- 2 cm/s
Direction	0 to 360 degrees	+/- 5 degrees
Temperature	-2.46 to 21.4 degC	+/- 0.05 degC

Acoustic Doppler Current Profiler (POL 250kHz version)

The ADCP (POL 250kHz version) sends out short acoustic pulses, typically lasting a few thousandths of a second, at a fixed frequency. The acoustic pulses are transmitted in two narrow beams at right angles to each other and 30 degrees to the vertical and are reflected back to the ADCP by small particles, such as plankton, which move with the water. The frequency of the reflected signal is changed by a small amount proportional to the current speed, the Doppler shift. By measuring the frequency change along the two beams the speed and direction of the currents are determined. The currents at different heights through the water are obtained by chopping the return signal into segments by time.

The 250KHz ADCP has a range of 100m and can measure up to 24 bins. However the technique has some limitations which reduce the amount of good data return. The closest bins to the transducers can give erroneous data due to the time taken for transients to decay and the far end bins can be affected by interference from side lobes reflected from the sea surface. Hence the good data return bins are usually between 25% of the depth from the surface and 10% of depth from the bottom.

ADCP specification

	Range	Accuracy
Speed	2 to 350 cm/s	+/- 4 cm/s
Direction	see below - ADCP angle correction	
Tilt	Two tilts measured at 90 degrees to each other (these were not used in processing)	

ADCP set up details

Sample period	10 minutes
No. of bins (cells)	8
First bin height	7.9m
Bin separation	4.5m
Bin heights (1-8)	7.9m, 12.4m, 16.9m, 21.3m, 25.8m, 30.2m, 34.7m, 39.2m

ADCP angle correction

The compass, manufactured by Digicourse (no longer in production), measures the angle between magnetic north and the frame. The two beams can be converted into east and north components by using the angle obtained by the compass and trigonometry. During the North Sea Project the compass showed a tendency to return arbitrary zero directions thus giving directions of flow different from those predicted by tidal models and previous current meter records. Also the frame moved on the sea floor during some storm events. A correction was then required to the frame angle for each deployment.

The ADCP data were first processed through the software. The statistical analysis gave the angle of maximum variance, which was taken to represent the M_2 major axis tidal ellipse angle. The compass, although giving incorrect readings of frame angle, was recording direction to an unknown fixed position. The frame angle was adjusted by adding a correction angle.

The correction angle was calculated from the difference between the M_2 major axis tidal ellipse angle from a model and the angle of maximum variance calculated from the initial raw data analysis. The model gave a depth average value, so the angle of maximum variance obtained from the data bin closest to this depth was needed. The bin used was found by taking the bin nearest to a value z=0.4D, where D is the total depth of water and z is the height from the bottom (Prandle, 1982). There is an 180 degree ambiguity in the calculation of the angle of maximum variance which was resolved by study of the M_2 tidal phase given by the model and by other observations.

UCNW transmissometers

Optical transmittance was measured using logging 25cm transmissometers, designed by UCNW. These were calibrated against the SeaTech red light (661nm) transmissometer on the CTD, both before and after deployment.

STABLE

The following sensors were included on the STABLE rig: four open (toroidal) electromagnetic current meters (EMCMs) were mounted in two pairs at 30cm and 70cm above the anticipated sea-bed level, to provide three dimensional turbulent current information; two optical back-scatter (OBS) sensors were mounted at the same heights, to provide concurrent suspended sediment concentration data; a Digiquartz pressure sensor was included, to provide wave-induced pressure information. Nine data channels (6 EMCM, 2 OBS and 1 pressure) were recorded in bursts, at 4Hz for 18 minutes every three hours on to a digital cassette data logger. A camera was used to provide photographs, to quantify bedload sediment transport rates resulting from the tidal current flows.

The logger also recorded spot readings at one minute intervals, from instruments measuring parameters which were likely to change only slowly during the course of the experiments. The pressure transducer (above) was interrogated in this way, to provide tidal depth information. To provide current data, an Aanderaa rotor measured flow rate, with a vane measuring direction. A compass was used to orientate the rig, relative to North, and pitch and roll sensors mounted in the logger measured rig attitude (thus, corrections to horizontal and vertical EMCM data can be applied if necessary). A thermistor was fitted to provide sea temperature. These seven 'mean' data channels were logged throughout the experiments (including through the 'bursts'). A transmissometer was also mounted on the rig.

In the table below each instrument is identified by a mooring code (comprising the cruise number, rig number), together with an instrument identifier (e.g. A indicates Aanderaa RCM, S - InterOcean S4, D - ADCP, TR - transmissometer, TC - thermistor chain) and instrument number. The data file name is also given.

Please note: these data have not yet been fully quality controlled by BODC.

Mooring/ Meter No.	Start Date dd-Mon-yy	Record Length (days)	Comment
44319/A3277	16-Jan-89	5.7	Good record obtained (NJAN8930.AA).
44319/TRtop	16-Jan-89	5.7	Good record obtained (NJAN8930.TR).
44319/A3559	16-Jan-89	5.7	Good record obtained (NJAN8910.AA).
44319/TRmiddle	16-Jan-89	5.7	Good record obtained (NJAN8910.TR).
44319/TRbottom	16-Jan-89	0.0	Meter damaged, no data return.
44320/S0716	17-Jan-89	4.7	Good record obtained (NJAN8937.S4).
44320/S0714	17-Jan-89	4.7	Good record obtained (NJAN8931.S4).
44320/A6974	17-Jan-89	0.0	Calibration problems, no data obtained.
44321/S1195	17-Jan-89	4.9	Good record obtained (NJAN8935.S4).
44321/S1196	17-Jan-89	0.0	Instrument failure, no data recorded.
44322/CMTG	16-Jan-89	6.8	Good record obtained from pressure sensor. (NJAN8901.PR)
44323/STABLE	17-Jan-89	5.0	Good record obtained from transmissometer only (NJAN8901.TR).

44324/Met. buoy	16-Jan-89	7.0	Good record obtained for barometric pressure, wind speed and direction. Sea surface temperature record was approx. 0.6 degC cool, although the relative values look correct. Recalibrated against CTD. Relative humidity values are 10 below those given by Met. model output, relative values look correct. Air temperature is incorrect by approx. 1 degC and relative values appear incorrect (odd step function with changes of 1 degC). Air temperature channel deleted. (NJAN8945.MT)
44325/Waverider	16-Jan-89	6.0	Good record obtained (NJAN8945.WV).
44326/D0003	18-Jan-89	5.0	Good record obtained (NJAN8901.DP).
44xxx/Atop	19-Jan-89	4.5	Good record obtained although the rig was snared by a trawler (SJAN8920.AA).
44xxx/TRtop	19-Jan-89	4.5	Good record obtained although the rig was snared by a trawler (SJAN8920.TR).
44xxx/Amiddle	19-Jan-89	4.5	Good record obtained although the rig was snared by a trawler (SJAN8910.AA).
44xxx/TRmiddle	19-Jan-89	4.5	Good record obtained although the rig was snared by a trawler (SJAN8920.TR).
44xxx/Abottom	19-Jan-89	4.5	Good record obtained although the rig was snared by a trawler (SJAN8906.AA).
44xxx/TRbottom	19-Jan-89	4.5	Good record obtained although the rig was snared by a trawler (SJAN8905.TR).
52351/TR852	12-May-89	0.0	No data returned.
52351/S714	12-May-89	9.5	Good record obtained (SMAY8917.S4).
52351/Valeport	12-May-89		
52351/S715	12-May-89	9.5	Good record obtained (SMAY8911.S4).
52351/A9652	12-May-89	9.5	Good record obtained (SMAY8909.AS).
52351/A9680	12-May-89	9.5	Good record obtained (SMAY8906.AS).
52351/TR853	12-May-89	0.0	No data returned.
52352/A9634	14-May-89	5.8	Good record obtained (NMAY8922.AS).
52352/TR834	14-May-89	0.0	No data returned.
52352/A9650	14-May-89	5.8	Good record obtained (NMAY8911.AS).
52352/TR487	14-May-89	5.8	Good record obtained (NMAY8909.TR).
52352/A9643	14-May-89	5.8	Good record obtained (NMAY8906.AS).
52352/TR561	14-May-89	5.8	Good record obtained (NMAY8904.TR).
52353/S1195	12-May-89	0.0	No data returned.
52353/S1258	12-May-89	0.0	Instrument set up incorrectly, no usable data.
52354/CMTG1750	13-May-89		
52355/STABLE	12-May-89	6.0	Good one minute 'mean' speed and pressure record obtained (SMAY8901.SM).
		10.0	Good record obtained from transmissometer (SMAY8901.TR).

52356/Met. buoy	12-May-89	9.4	Good record obtained for atmospheric pressure, wind speed and direction. Relative humidity record looks reasonable, but frequently deviates from model output. Sea surface temperature record has been recalibrated against the CTD. The air temperature data compare reasonably well with the model, but should be used with care. (SMAY8930.MT)
52357/Waverider	12-May-89	9.5	Good record obtained (SMAY8930.WV).
52358/D0004	13-May-89	0.0	An experimental set up was used to try and get more cells in the shallow water depth (28-30m). Unfortunately, the backscatter return with the 2 m/sec transit pulse used was not enough and no useful data were obtained.
52359/D0009	14-May-89	0.0	This was a new instrument on a test deployment which suffered a transmission failure; no data were obtained.
52360/TC1146	14-May-89		
52SMBA/M957	16-May-89	0.0	Data not available.
52SMBA/M858	16-May-89	0.0	Data not available.
60410/A9634	07-Sep-89	9.7	Good record obtained (NSEP8930.AS).
60410/TR3	07-Sep-89	9.7	Good record obtained (NSEP8929.TR).
60410/A9680	07-Sep-89	9.7	Good record obtained (NSEP8910.AS).
60410/TR2	07-Sep-89	9.7	Good record obtained (NSEP8909.TR).
60410/A9652	07-Sep-89	9.7	Good record obtained (NSEP8905.AS).
60410/TR1	07-Sep-89	0.0	Instrument leaked and returned no data.
60411/S1258	08-Sep-89	8.2	Good record obtained (NSEP8936.S4).
60411/S1306	08-Sep-89	8.2	Good record obtained (NSEP8930.S4).
60412/S1308	08-Sep-89	0.0	No data recorded.
60412/S1195	08-Sep-89	5.8	Good record obtained (NSEP8935.S4).
60413/CMTG1750	08-Sep-89		
60414/STABLE	07-Sep-89	10.0	Good record obtained from transmissometer only (NSEP8901.TR).
60415/Met. buoy	07-Sep-89	8.0	Good record obtained for atmospheric pressure, wind speed and direction. Warning: Although relative humidity values look reasonable relative to each other, some are greater than 100. Sea surface temperature recalibrated against CTD. Air temperature data 5degC different from Met. model, channel deleted. (NSEP8945.MT)

60416/Waverider	08-Sep-89	13.0	Good record obtained (NSEP8945.WV).
60417/D0004	08-Sep-89	8.1	Top bin deleted as noise outweighs signal. Phase is doubtful from tidal analysis; suggests timing error although this is not obvious from the time channel. (NSEP8901.DP).
60418/TC1146	07-Sep-89		
60419/D0007	10-Sep-89	4.8	Good record obtained for bottom four bins. Top four bins deleted as they are not in the water (SSEP8901.DP).
60420/A9631	10-Sep-89	5.2	Good record obtained (SSEP8921.AS).
60420/TR6	10-Sep-89	5.2	Good record obtained (SSEP8920.TR).
60420/A9643	10-Sep-89	5.2	Good record obtained (SSEP8910.AS).
60420/TR5	10-Sep-89	5.2	Good record obtained (SSEP8909.TR).
60420/A9650	10-Sep-89	5.2	Good record obtained (SSEP8905.AS).
60420/TR3	10-Sep-89	5.2	Good record obtained (SSEP8904.TR).

References

Howarth, M.J. 1990. Atlas of tidal elevations and currents around the British Isles. Department of Energy, Offshore Technology Report, OTH 89 293, 16pp

Prandle, D. 1982. The vertical structure of tidal currents and other oscillatory flows. Continental Shelf Research, 1(2), 191-207