Shipborne Acoustic Doppler Current Profiler (ADCP) measurements

A vessel mounted ADCP was operated continuously on the North Sea Project survey cruises and also on some process study cruises. The data included in this data set are from the following cruises: Challenger 28 (CH28), CH33, CH35, CH37, CH39, CH41, CH45, CH47, CH49, CH51, CH52, CH53, CH55, CH57, CH59, CH60, CH61, CH66B, CH72A, and CH72C. Data were also collected on CH43 and CH44 but the ship's velocity as determined by the ADCP in bottom tracking mode was erroneously not recorded. The data from these two cruises are useful for investigations of shear only and are described elsewhere.

The cruise track for the survey cruises visited a wide variety of tidal conditions, from very energetic regions with mean spring amplitudes in excess of 1.2m/s (off the Humber estuary, off Great Yarmouth and the Dover Strait) to much more sluggish regions, where the mean spring amplitude barely reached 0.2m/s (off the Danish coast). Along the cruise track the variance of the tidal currents varied by more than a factor of 100. The water column was well-mixed in the tidally energetic, shallow southern region but was thermally stratified in summer in the tidally weaker, deeper regions to the east and west of the Dogger Bank and exhibited saline stratification in the German Bight and locally offshore at most of the estuaries.

Instrumentation

The 150kHz RD Instruments ADCP on RRS Challenger was operated throughout each cruise, sampling in 4m slices in the vertical, with the top bin at 10m, and averaged over 10 minutes - equivalent to at most 3km horizontally at the ship's cruising speed of 10 knots. Exceptions to this are CH52, CH66B and CH72C. During CH52, in addition to recording 107 profiles at 4m bin intervals (10 minute averaging), 2m depth bins were used, with the top bin at 8m. A 5 minute averaging period was used at this time, which covers 3264 profiles. Data collected during CH66B used an averaging period of 4 minutes throughout the cruise. On CH72C the first 233 profiles were collected with a 10 minute averaging period and 4m depth bins, with the top bin at 10m. After that the averaging period was set to 4 minutes for the remainder of the cruise. For profiles 234 to 304 the depth bins were 2m, with the top bin at 8m; this was then reset to 4m for the remainder of the cruise, with the top bin at 9m (profiles 305-1368) or 10m (profiles 1369 to the end).

The ship's position was determined via Decca main chain every 2 minutes and interpolated to 30 second values, which were recorded on the ship. The navigation has been taken from the surface underway data files and merged with the ADCP profile data using date and time as the link. The ship's velocity was determined by the ADCP in 'bottom track' mode. This is achieved by emitting a bottom echo pulse (longer than the water sampling pulse) which is used to reference the ship's speed over the bottom. This enables the calculation of accurate current profile velocities.

The ADCP system has three components, the ADCP itself, the ship as a (pitching and rolling) sensor platform for the ADCP and measurement of the ship's velocity. With the configuration outlined above the ADCP itself has a nominal accuracy of 0.01m/s. The upper bound on the accuracy of the ADCP fitted to the ship was obtained from shear measurements, since the North Sea is well-mixed, particularly in winter when thermal stratification is absent. The shear was estimated by averaging the standard deviation of the speed for each profile over a cruise. The minimum value, 0.03m/s occurred in March.

The ratio of true to ADCP ship's speed varied sinusoidally between a maximum of 1.014 in September to a minimum of 0.989 in March - matching the effect of changes in the speed of sound in water caused by the seasonal changes in temperature, since a constant value for the speed of sound was used in the ADCP in the computation of velocities. The direction differences varied in blocks of cruises,

presumably as corrections were applied to the gyro compass by the ship's officers, between 2.4 and -1.8 degrees.

The parameters recorded by the ADCP include: two horizontal velocity components, per cent good data, error velocity, amplitude (of the back-scattered signal) and vertical velocity.

The ADCP records a consistency check for each velocity measurement (the error velocity) by taking the difference between vertical speeds calculated from the fore and aft transducers and the port and starboard transducers. It should, of course, be zero. During most of the stormy weather, inspection of the observed currents showed that the accuracy of the system was seriously degraded, and this was well correlated with large error velocities. This may be due in part to the entrainment of bubbles under the ship's hull, from breaking waves in rough weather.

The depth range covered by the measurements is from 10m below the surface of the water to, on average, 65% of the water depth. The percentage of data coverage lost near the sea bed appeared to be related to water depth, being greater in shallow water.

Data processing

The data included in the data set is as follows:

A header record containing the date and time, latitude, longitude, depth averaged north and east components of current (generated from averaging all the values flagged 'G'), bathymetric depth, depth of the deepest bin, north and east components of ship's speed.

The data file includes the bin depth, absolute north and east components of current speed (current speed after ship speed has been subtracted), amplitude and quality control flags. A description of the conversion of the per cent good and error velocity measurements to quality flags is given below.

The quality control flags are as follows:

G = good data
S = data from surface (top) depth cell. This has been used to distinguish data from the top depth cell, as these differ from the data recorded at other depths.
B = suspect data, used if any of the following criteria are met:

per cent good < 85%
absolute current speed > 2.5m/s
absolute value of error velocity > 0.09m/s

The table below summarises the number of data cycles with each quality flag on a cruise by cruise basis and also indicates the number of profiles for each cruise.

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

Cruise No.	Start Date	No. of datacycles with flag 'S'	'G'	'B'	Total	No. of Profiles	Comments
CH28	29-Apr-88	1755	9954	1531	13260	2015	
CH33	04-Aug-88	1124	6402	2942	10468	1567	18 hours missing at the start, plus 4 days lost in the middle, failed gyro input.

CH35	03-Sep-88	1010	7194	4365	12569	1671	Data noisy over last 3 days.
CH37	02-Oct-88	1192	6356	4773	12321	1524	Cruise track affected by storm; data noisy between days 5 and 8.
CH39	01-Nov-88	1472	7958	1949	11379	1682	
CH41	01-Dec-88	1400	7089	3737	12226	1625	Cruise track affected by storm.
CH45	28-Jan-89	1466	6667	3753	11886	1744	Data noisy between days 7 and 9.
CH47	27-Feb-89	1424	6915	2872	11211	1777	Noisy data at the start of day 4 and on day 11.
CH49	29-Mar-89	1382	6488	3541	11411	1655	Data noisy between days 4 and 7.
CH51	27-Apr-89	1140	6347	842	8329	1273	3 days missing at start.
CH52	11-May-89	1782	23752	12513	38047	3371	
CH53	26-May-89	1420	6736	1483	9639	1542	Noisy at start of day 6 and on last day.
CH55	24-Jun-89	1318	5998	1348	8664	1401	Two days missing at start.
CH57	24-Jul-89	1552	7364	1631	10547	1667	One day in dry dock in the middle whilst the ship docked for repair to bow thruster. End of 7th and start 8th day noisy, also last day noisy.
CH59	23-Aug-89	1389	6533	1741	9663	1539	Data noisy between days 6 and 7, also between days 11 and 12.
CH60	06-Sep-89	1440	5883	2124	9447	1748	Occasional noisy patches.
CH61	21-Sep-89	1318	6643	1532	9493	1575	17 hours missing from the middle of the record for visit to Den Helder. Noisy at end of record.
CH66B	03-Jun-90	4849	16660	47359	68898	5003	
CH72A	20-Sep-90	442	3522	7942	11906	890	
CH72C	06-Oct-90	1781	3447	3382	8610	2321	

References

Howarth, M.J. and Proctor, R. 1992 Ship ADCP measurements and tidal models of the North Sea. Continental Shelf Research, Vol 12, No. 5/6 pp 601-623