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Dataset of ADCP current measurements at the Panarea test site

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Submitted (Author(s))	Dino Viezzoli, OGS	2013-04-22
Verified (WP-leader)	Edwin Foekema, IMARES	2013-10-09
Approved (Coordinator)	First name Last name, short org. name	yyyy-mm-dd

Authors		
Name	**Organisation**	**E-mail**
Dino Viezzoli	OGS	dviezzoli@inogs.it
Massimo Pacciaroni	OGS	mpacciaroni@inogs.it

Abstract

In the multidisciplinary study at the Panarea natural test site, where geological CO_2 is leaking in the seawater from the sea floor, physical issues have been considered, with particular consideration for dynamics (*Task 2.2.3 Physical monitoring at the Panarea test site*) and integrated within the *Work package 2.2 – Field observations (Sapienza to lead) –,* to flank the chemical (*Task 2.2.1*) and biological measurements (*Task 2.2.2*). This report describes the technological characteristics of the Acoustic Doppler Current Profilers employed, the consequent limitations, the experimental strategy adopted for measuring the current close to CO2 emissions, the setup and mooring of two ADCP 600 kHz, in the contest of the overall logistics and field activities, during four seasonal campaigns, the methods used to process and validate current data and the quality of the data set obtained.

During the first campaign the new TRDI-ADCP, purchased on RISCS project funds, did not work at all after deployment at station "NE1" on October 21st 2010. That malfunctioning was due to a bug in the latest firmware version. In this deliverable are reported: a preliminary analysis of current measurements, depth (calculated from pressure) and temperature signals at the sea floor; the methods adopted for validating current data.

The basic statistics of entire records obtained in the four campaigns allow to discern a first characterization of the circulation regime around the emission. The single vertical profiles simultaneous to the CTD casts and bottle samplings, rendered in this report, need to sustain the interpretation of the overall results of WP 2.2 and to feed the planned modelling activities aimed at further helping in interpretation.

For completing information about the RISCS PANAREA ADCP DATASET, the several file formats employed are described till and up the details.

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1 INTRODUCTION

In the multidisciplinary study at the Panarea natural test site, where geological CO2 is leaking in the seawater from the sea floor, physical issues (*Task 2.2.3 Physical monitoring at the Panarea test site*) have been considered and integrated within the *Work package 2.2 Field observations* , to flank the chemical (*Task 2.2.1*) and biological measurements (*Task 2.2.2*). This report describes the experimental strategy adopted for measuring the current close to CO2 emissions, the setup and mooring of two Acoustic Doppler Current Profilers (ADCP) 600 kHz, the field activities during four seasonal campaigns, the methods used to process, correct and validate ADCP data and the quality of the data set. ADCPs were already used for characterizing the dynamics around a vent in the same area (Aliani *et al.*, 2010). In this study two ADCPs allow to compare simultaneous vertical profiles of current at different distances from the emissions.

1.1 Site description

A number of fumarolic fields are active 2.5 km west of Panarea Island (fig. 1.1a) on a plateau, 30m maximum depth, edged by a circular pattern of islets (Dattilo, Panarelli, Lisca Bianca, Bottaro, Lisca Nera) and submerged rocks (Secca di Panarelli, Secca di Lisca Nera) about 1 km wide (Fig 1.1b); the seafloor of the inner shallow sea, partly covered by Posidonia mats, consists of sands and conglomerates that are mainly derived from the erosion of the emerging islets (Tassi *et al.* 2009). In the middle of the plateau the Point 21, shown in fig. 1.1.b, denotes a major gas exhaling field already reported by Italiano and Nuccio (1991), before the gas burst 2002.

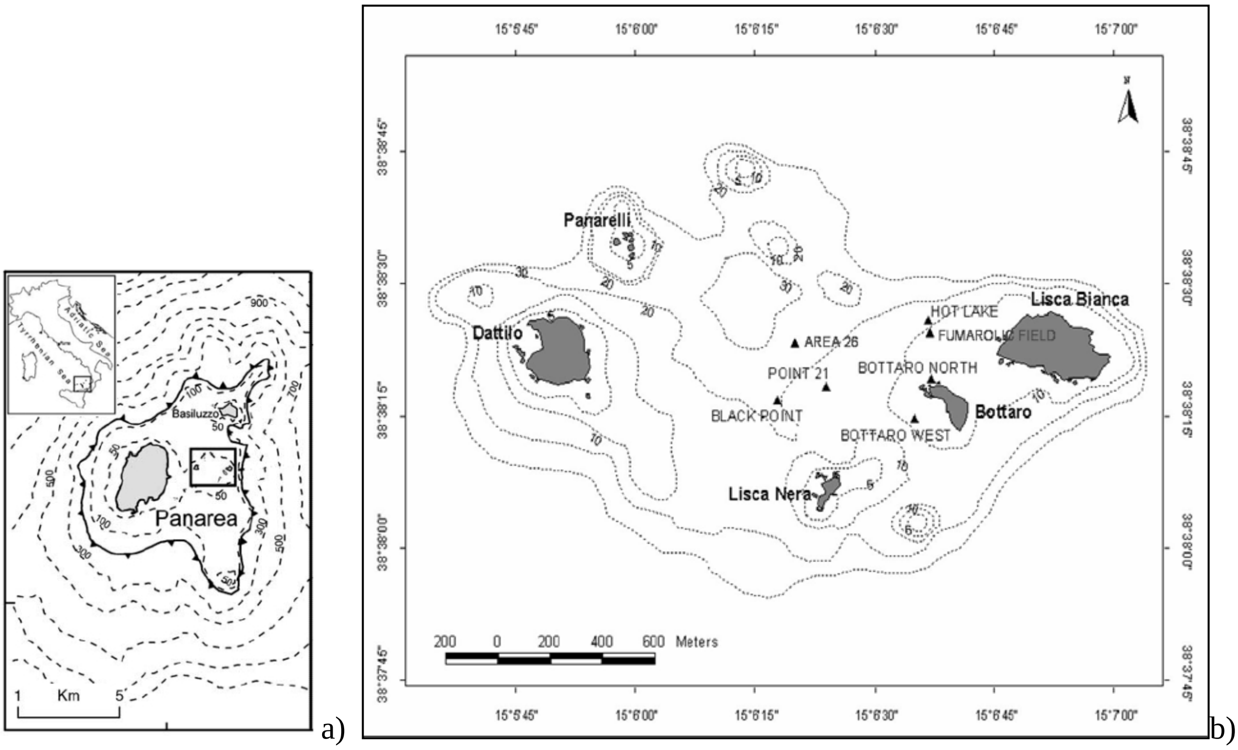


Figure 1.1 a) Map showing Panarea Island and its islets; modified after Esposito et al. (2006). b) Map of rectangular area outlined in a), showing the islets and main emissions. Modified after Rohland 2007 and Steinbrückner, 2009.

2 METHODS

2.1 ADCP monitoring close to a bubble plume.

An Acoustic Doppler Current Profiler (ADCP) exploits the Doppler effect to directly measure the radial components – that is the projection - of the current vector along each acoustic beam. The Teledyne RDI Instruments WH 600kHz mounts four TX acoustic transducers. Each beam's axis forms an angle of 20° with the axis of the instrument. In this way radial components are remotely measured on the edges of an truncated pyramid, whose vertex coincides with the instrument. The ADCP computes depth cell locations by assuming a constant sound speed over the water column: the sound speed is calculated using the temperature measured by a sensor, at instrument depth and a constant user defined salinity. Since the current is a three dimensional vector and ADCP performs four scalar measurements then a redundancy exist that allow a double determination of vertical velocity. In an undisturbed vertically homogeneous current field the two determination would be identical. In a non homogeneous current field or in a disturbed environment the two vertical velocities are systematically different: the difference of the two determinations is named *error velocity* (RD Instruments, 1996). Bubble plumes acting as a shield, inhibit the transmission of sound: sometimes bubbles reduce profiling range, and in extreme cases, block the signal completely (RD Instruments, 1996). For this reason it is better to deploy an ADCP close, but not too close to a bubble source. Furthermore at the margin of a bubble plume a strongly non uniform current field and, as a consequence, a large *error velocity* is expected, but those current estimates may be significant anyhow. For this reason data with large error velocity, close to a bubble plume, must be conserved.

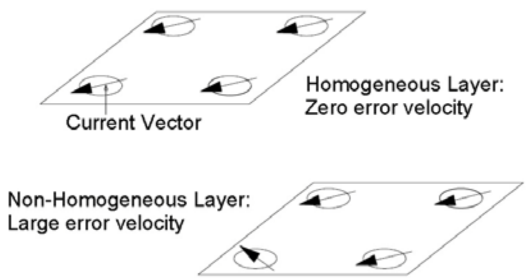


Figure 2.1 (after RD Instruments,1996)

In both ADCPs used at Panarea pressure sensors (standard 200 Bar) and a temperature sensor (a thermistor embedded in the transducer head) are installed measuring at about 40cm from the sea bottom. Two tilt sensor provide pitch and roll angles. A flux-gate compass provides heading that is corrected by the internal software on the basis of fixed value of magnetic declination opportunely calculated.

Side lobe contamination (RD Instruments, 1996) affects the profile for no less than 6% of the depth below the sea surface: in the case of our ADCPs that 6% corresponds to 1.1m on 18m depth. Furthermore due to ringing of tranducers the first valid cell is available at 1.60m from the bottom. The calculated water velocity at a particular depth is obtained using a method called *depth cell mapping*: cells that are at the same depth when the instrument is tilted are used to compute velocity referred to earth. Depth cell mapping was implemented for BroadBand firmware versions 5.0 and later.

2.2 Preparing and setting the ADCPs.

The hardware was always prepared strictly following rules and suggestions of the user's guide (Teledyne RD Instruments, 2007) and on the basis of previous experiences at OGS (Arena, 2006).

Using the Teledyne RDI Instruments program named WinSC (Teledyne RD Instruments, 2007), the same configuration was chosen and used for setting up both current meters during all four seasonal campaigns: bottom mounted, upward looking ADCPs, a sampling time (or *ping*) = 1s, averaging time interval (or *ensemble*) = 300s, and vertical resolution (bin height) = 0.5m (the same value adopted for pre-processing CTD data). It is important to point out that, due to side lobe contamination at the sea-air interface, pitch, roll and sea level variation at least a couple of upper cells close to sea-air interface (corresponding to a vertical extent of ~ 1-2 m) are not reliable, non continuous and not considered valid. Before each campaign, for correcting the heading we did input an estimated magnetic declination value obtained from the Magnetic Field Calculators at the NOAA site http://www.ngdc.noaa.gov/geomagmodels/struts/calcDeclination/ , now moved at http://www.ngdc.noaa.gov/geomag-web/ .

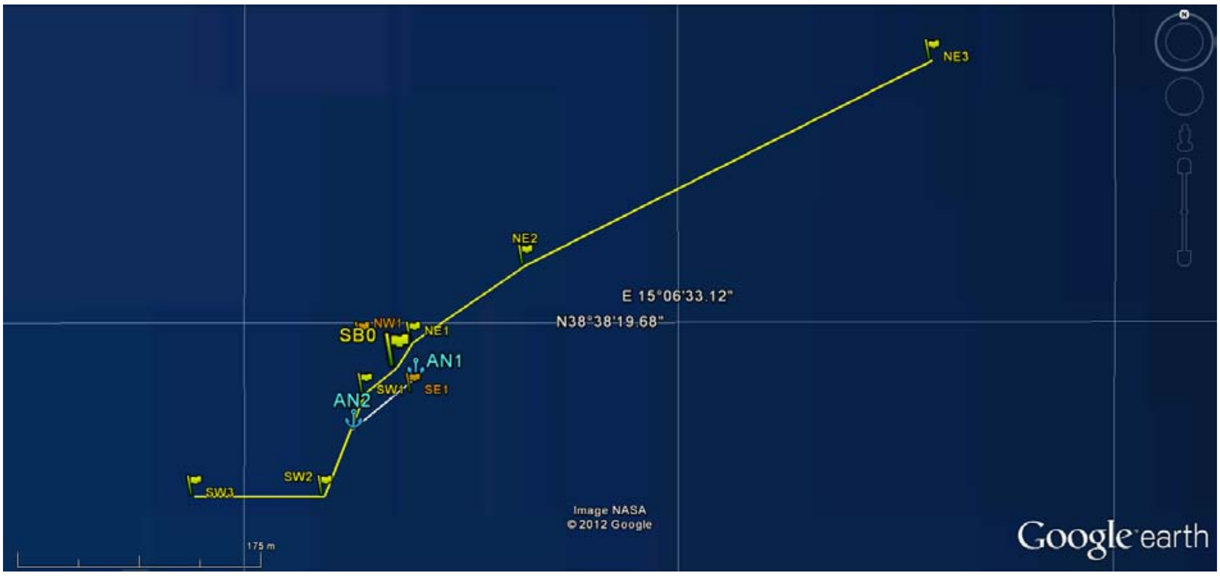
2.3 Current monitoring strategy.

Two of the three originally proposed monitoring stations were performed. This decision was taken to reduce scuba divers time dedicated to ADCPs in order to favour multidisciplinary field activities of all participants, particularly due to the need to concentrate the work performed because of frequently adverse sea conditions and/or problematic logistics that limited the access time to the site. Nevertheless current monitoring using two simultaneously-deployed ADCPs offers some advantage: 1) a synoptic spatial description; 2) a more robust statistics on current in the area; 3) an improved possibility to characterise the physical impact of the CO2 bubble plume on water circulation around the vent by means of comparative time-series analysis of current data gathered at two different points.

3 DESCRIPTION OF WORK

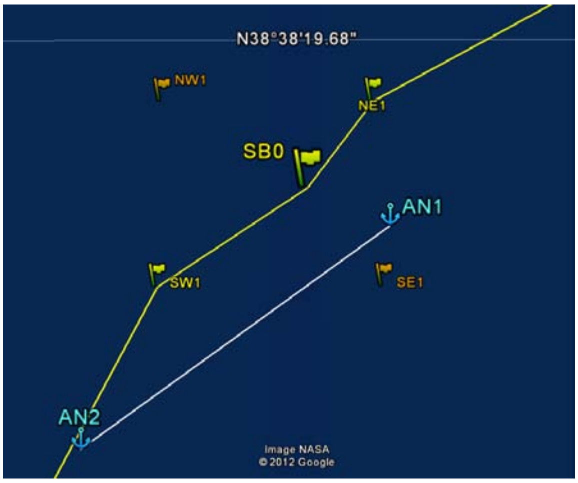
3.1 Multidisciplinary surveys at Panarea.

As originally outlined in the RISCS proposal, a total of 4 field campaigns were performed for chemical, biological and physical surveys, with one survey each for the four seasons. Due to occasional inclement weather and sea conditions the small, 8m long boats used for this sampling work was logistically difficult and plans had to be kept flexible to ensure the safety and physical well-being of the field staff. Despite these difficulties, almost all planned work was conducted.



a)

Figure 3.1 a) Map of the CTD stations(SW3, SW2, SW1, SB0, NE1, NE2, NE3) and of the ADCP stations (NE1 and SW1, during the 1st campaign; AN1, AN2, during the 2nd,3rd and 4th campaigns.



b) zoom of large map in *a).*

3.1.1 1st Campaign (fall, 2010)

Work was performed during the period of October 19 to 25, 2010. The field base was situated on Lipari Island, which necessitated a travel time of about 1 hour in the morning and the evening each day, which limited the number of working hours. Conditions were moderately rough the first couple of days, with the sea calming in the latter half of the study period. The ADCP current meters were deployed at stations NE1 and SW1 shown in fig. 3.1.*a*,*b*.

The transect was performed over two days from a fibreglass boat. During the first Panarea campaign the new TRDI-ADCP, purchased on RISCS project funds, did not work at all after deployment at station "NE1" on 21 October 2010. That is malfunctioning was due to a bug in the latest firmware version (50.38). The possible effects of such a bug, occurring when a typical but, in this case, critical sequence of commands is used, was highlighted by the manufacturer on 29 Oct 2010. Unfortunately that alert reached us a few days after return from the field, and thus too late to avoid loss of data. The other TRDI-ADCP, property of OGS, programmed with the same procedure adopted for the other instrument; was deployed at station SW1 and worked perfectly, thanks to an older and bug-free firmware version.
The central day of the monitoring period was one day before maximum tide in the 1st campaign

3.1.2 2nd Campaign (summer, 2011)

A proposal was written by members of this research item (together with other partners) to the EU infrastructure project EuroFleets entitled: "The Panarea natural CO_2 seeps: fate and impact of the leaking gas (PaCO2)". This proposal for 5 ship days on the research vessel Urania was successful, thus giving the partnership access to a large ship for this one campaign. As EuroFleets only provides ship time, it had to be clearly stated in the proposal that research was linked with other projects that would cover costs related to personnel, analyses, and data interpretation. As both EU projects RISCS and ECO2 have research scheduled at Panarea, work within PaCO2 was conducted within the framework of these other two projects. As Urania has difficulty, however, manoeuvring in the shallow waters amongst the islets, it was decided to conduct primarily deep-water work with the ship for the ECO2 project and to use smaller boats to continue monitoring the RISCS sites. Although direct sampling from Urania was not conducted, the ship was used as the field base (greatly simplifying logistics and reducing costs) and some analyses were conducted directly on board rather than transporting the samples back to the laboratory (e.g. dissolved gas analyses). Unfortunately, due to limited space on the ship, the researchers conducting the current measurements, authors of the present report, had to re-establish their base at Lipari Island. Work was performed over the period from July 27 to August 1, 2011. Seas were calm to weakly agitated. Work on the transect and benthic chambers were performed as per the first campaign. During the 2nd campaign a different strategy was adopted for the current monitoring: a first ADCP was deployed at station AN1 more close to the bubble plume and the second, more far than in the first campaign, at station AN2. This choice was useful also to prevent any accidents with the rope deployed between the two units. Due to the high season for the tourism and many requests of boats for scuba diving it was impossible for us obtain from scuba a shift further of the day for recovering ADCPs, in order to overlap current monitoring and last three CTD casts postponed by inclement weather conditions.
Both units functioned correctly during this campaign, however for reasons not yet explained, the currentmeter deployed at station AN1 suspended recording at 2011/07/28 22:15:00 and restarted at 2011/07/28 22:56:17 without causing bad consequences on the comparison with results of other tasks. The central day of the monitoring period was two days before maximum tide during the 2nd campaign.

3.1.3 3rd Campaign (winter, 2012)

Work was performed over the period from January 27 to 31, 2012, using Panarea Island as a base. Although a smaller settlement, which has restricted vehicle access, this location greatly

reduced travel time to the site thereby increasing working hours, simplifying logistics, and increasing safety.
Although the sea was calm to weakly agitated during the study period, the research had to be cut short due to the arrival of a large storm. The transect was conducted over two days. Only the vent site could be monitored with the benthic chamber, whereas the background site could not be studied due to the bad weather. Both ADCPs current meters were deployed and functioned properly at stations AN1 and AN2 (the same than in the 2nd campaign).
The central day of the monitoring period was two days before minimum tide during the 3nd campaign.

3.1.4 4th Campaign (spring, 2012)

Work was performed over the period from March 27 to April 3, 2012. Weather was good and the sea was primarily calm. Panarea Island was once again used as a base. Due to the longer daylight hours, closer proximity, and calm weather, the entire transect was performed in one day. Both benthic chamber sites were monitored in one day for each site. The ADCP current meters were deployed over the period of March 28 to April 1. Both ADCP current meters were deployed and functioned properly at stations AN1 and AN2 (the same than in the 2nd and 3rd campaigns).
Five additional CTD casts were performed on April, 1st 2012, at the central station SB0 and for enclosing it in a box with stations SW1, NE1 and the new stations NW1, SE1 (see fig. 3.1.*a,b*)
The central day of the monitoring period was exactly at the minimum tide during the 4th campaign.

3.2 Current monitoring

Two 600 kHz, Acoustic Doppler Current Profilers (ADCP) have been used at Panarea during each seasonal campaign instead of the single current meter as originally described in the project Description of Work (Task 2.2.3 - Physical monitoring at the Panarea test site).
Two dismountable frames were designed and built at OGS using non-magnetic stainless steel plates, tubes, bars, bolts, nuts and clamps appropriate for use in corrosive environments; no soldering were used to connect parts. Cathodic protection was granted by zinc anodes. Four extendable tubes were used to increase stability of the system (Figure 3.2.a).
The combined frame and current meters were quick to assemble and easy to deploy and recover by hand from the Zodiac boats.
The ADCPs were always prepared and set up in "sleeping mode" at the OGS laboratories, using the RDI Instruments program named WinSC, before of departure. Then the two ADCPs were ready to be deployed in the planned day without the need to open the instruments or connecting it to the computer at Panarea before deployment. Only mechanical assembling of ADCPs and dismountable frame components (see fig.3.2.a) was required at the arrival at Panarea, so avoiding a loss of time.

a) b)

Figure 3.2. ADCP unit mounted on stainless steel support prior to deployment; note the yellow cap protecting the upward-facing lenses (a) and complete equipment for current monitoring before last deployment.

Field activities, regarding physical monitoring, were planned and coordinated with other activities on the transect described above to get ADCP-measured current data that was contemporaneous with the multiparametric CTD cast and bottle sampling on the transect.
A handheld marine GPS, a GARMIN GPSMAP® 78s, was used for positioning during mooring and recovery of the ADCPs. The accuracy of position estimated by the instrument itself was about 10m. Unfortunately the more accurate EGNOS Data Access Service (EDAS) (Directorate-General for Enterprise and Industry, 2012) is available only from 30th July 2012,that is three months after the last campaign. A test on EGNOS modality activated in the GPSMAP® 78s carried out aboard a car running in the neighbourhood of Trieste, gave an internally estimated error of 4m. This accuracy was confirmed by an analysis, made by means of Google Earth: the car's trajectory, recorded by our GPSMAP® 78s in EGNOS mode, never resulted off road.

During the four seasonal campaigns the two ADCPs were deployed on the seafloor in positions 15m - 55m away from the selected CO2 emission located at station SB0 (see fig. 3.1) to assess mean conditions and variability of 3D circulation around the studied vent.
Before the first campaign we assumed that both the average current and the tidal component were oriented in the NW-SE direction along the deepest channel among the islets shown in fig. 1.1.b. Since we aimed at gathering information on the reciprocal influence of a bubble plume induced dynamics and ambient current, we determined to deploy ADCPs at stations SW1 and NE1, 60m apart, linked by a line on sea floor, and symmetrical with respect to central station SB0, on the same transect adopted for CTD casts (see fig. 3.1.*a,b*). In this way a change in direction of current would cause a swap of roles of the two currentmeters allowing to gather upstream and downstream current profiles with respect to the bubble plume.
Analysis of velocity records of the first campaign, evidenced large variability of both current intensity and direction. Furthermore some marine evaluation aimed at preventing entanglement, as happened in the first cruise, between the line linking the ADCP moorings and the anchor of the boats used for CTD casting and bottle sampling, suggested us to move the deployment positions to AN1 and AN2 shown in fig. 3.1.*a,b*.
Then during the 2nd , 3rd and 4th campaigns the different strategy was adopted: a first ADCP was deployed at station AN1, located 30m to the east-southeast from station “SB0”, more close to the bubble plume and the second, more far from it then in the 1st campaign, at station AN2 at 40m far from the emission. Since the two moorings were linked by a cord 60m long, the second ADCP was deployed at station “AN2”, located exactly 60 m to the southwest of station “AN1” and 40m far from the emission.

4 RESULTS

4.1 Preliminary analysis of current measurements

The preliminary results of the current monitoring are rendered in figures from 4.1.1 to 4.1.4 obtained using the program WinADCP (Teledyne RD Instruments, 2009) starting from raw binary data input, also included in the RISCS PANAREA ADCP DATASET(see §5.1).
A summary of metadata related to ADCP monitoring is reported in Table 4.1. Metadata are: campaign number, season, station name, coordinates, average bottom depth, no. of bins, average heading pitch and roll, date and time of first and last valid data, total number of valid ensambles (period of averaging 5'long of pinging with an interval of 1s) and prefix of file names used. A set of notes completes the description.

Table 4.1 Summary of the ADCP current meter deployments and processing

Campaign	Season	Station name	Geographical coordinates Avg. Bottom depth	Heading Pitch Roll (1)	Number of cells (5)	First valid record's Date UTC hour ensamble #	Last valid record's Date UTC hour ensamble #	Total # of valid ensmbles	Prefix of file names	Notes
1	fall	NE1	38° 38.317'N 15° 06.420'E ~18m	-	-	- - -	- - -	0	-	(2)
		SW 1	38° 38.295'N 15° 06.396'E 17.99m	064°N 9.2° 1.8°	28	2010/10/21 10:55:00 60	2010/10/23 13:20:00 665	606	P1SW1_	OK (6)
2	summer	AN1	38° 38.308'N 15° 06.421'E 17.83m	325°N -0.5° 5.1°	30	2011/07/27 13:40:00 45	2011/07/28 22:15:00 436	392	P2AN1a	(3) (6)
			= = 17.76m	325°N -0.5° 5.1°	29	2011/07/28 22:56:17 1	2011/07/29 07:46:17 107	107	P2AN1b	
		AN2	38° 38.286'N 15° 06.390'E 18.32m	053°N 3,2° -1.3°	31	2011/07/27 13:38:22 44	2011/07/29 07:53:22 551	508	P2AN2_	OK (6)
			= = 18.34m	053°N 3.2° -1.3°		2011/07/27 13:38:22 44	2011/07/28 22:13:22 435	392	P2AN2a	(4) (6)
			= = 18.27m	053°N 3.2° -1.3°		2011/07/28 22:53:22 443	2011/07/29 07:53:22 549	107	P2AN2b	
3	winter	AN1	38° 38.308'N 15° 06.421'E 18.43m	179°N 1.7° -6.0°	31	2012/01/28 10:55:00 36	2012/01/31 10:20:00 893	858	P3AN1_	OK (6)
		AN2	38° 38.286'N 15° 06.390'E 17.26m	007°N -1.3° 3.5°	29	2012/01/28 10:53:22 35	2012/01/31 10:18:22 892	858	P3AN2_	
4	spring	AN1	38° 38.308'N 15° 06.421'E 18.27m	221°N 0.8° 0.8°	30	2012/03/28 14:30:00 91	2012/04/01 14:50:00 1247	1157	P4AN1_	OK (6)
		AN2	38° 38.286'N 15° 06.390'E 15.92m	162°N -1.4° 1.4°	26	2012/03/28 14:28:22 90	2012/04/01 14:48:22 1246	1157	P4AN2_	

1) Heading is the orientation of ADCPs' "bow" that is the acoustic transducer number 3 (Teledyne RD Instruments, 1996) with respect to the geographic north; pitch and roll are defined with respect the same bow.
2) No recording due to firmware problems.
3) Recording split by instrumentation into two files separated by gap 41 minutes long.
4) Cutting P2AN2_ as close as possible to times of start and end P2AN1a and P2AN1b, the records P2AN2a and P2AN2b have been obtained. This trick facilitates comparative analysis between stations.
5) The value indicates the number of cells good along the entire record: it is influenced by sea level variations during the deployment; or by quite large pitch and/or roll values inducing an increase of interference at sea water interface.
6) Central days of the four monitoring periods were one day before maximum tide in Fall; two days before maximum tide in Summer; two days before minimum tide in Winter and zero days from the minimum tide in Spring.

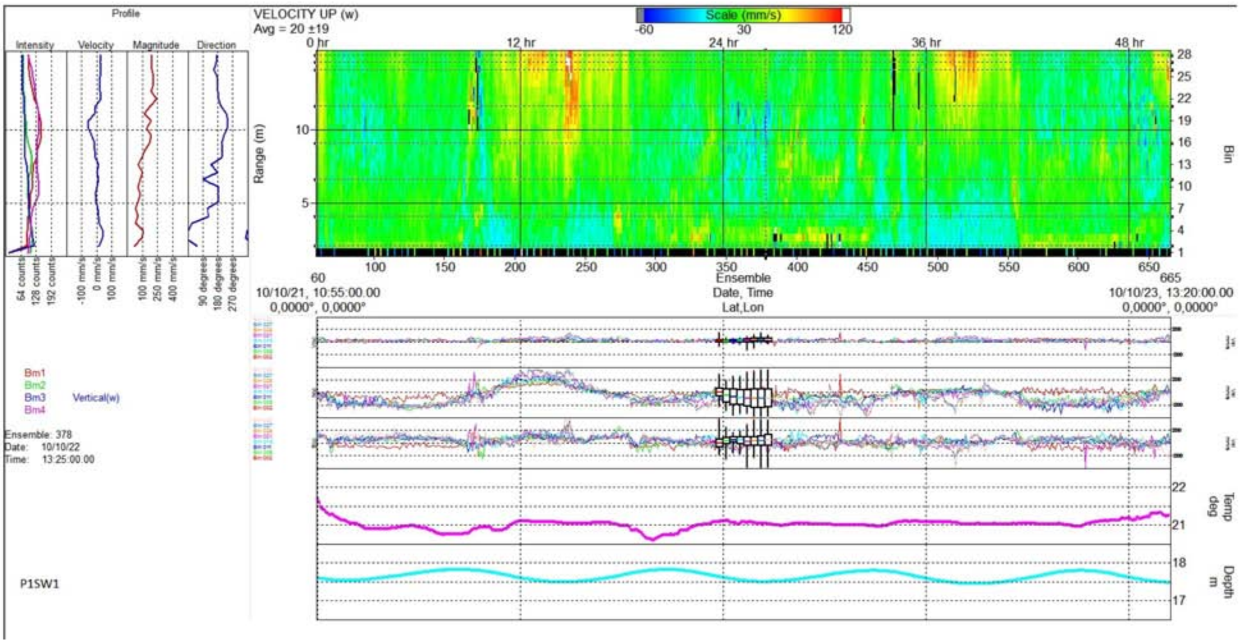


Figure 4.1.1 First campaign, station SW1. The profile chart, located on the left side of the figure, displays four single vertical profiles at a generic time: acoustic echo intensities relative to each of the four beams, vertical velocity (W), magnitude and direction (°N) of the horizontal component of the current velocity. In the upper right-hand portion of the figure the time evolution of the vertical velocity (positive up) is shown. The lower left-hand portion of the figure shows time series of vertical, north and east components of current velocity at a selected subset of cells. The pink line describes the time evolution of temperature at the sea bottom. The light-blue line displays the bottom depth evolution calculated using pressure data

During the 1st first campaign of late, October 2010, data from the ADCP deployed at station "NE1" were lost for the reasons described above. Good results were instead obtained by the ADCP deployed in the station named "SW1" (fig. 4.1.1).

During the 2nd campaign of summer, July 2011, at station AN1 the same ADCP, funded by the project, and set-up adopting a non critical sequence of commands, for reasons not yet explained, stopped acquisition over 41' from 22:15 to 22:56 UTC of July 28th 201 and then restarted: The two splitted subrecords obtained are shown in Figures 4.1.2.1.a and 4.1.2.1.b. During the 2nd campaign, in July 2001, it is easy to note some dissimilarity on data at station AN1, close to CO_2 emission. "Black holes" are a feature visible which indicate non-valid data on the vertical velocity signal (Figure 4.1.2.1.a) or a bad correlation, likely a symptom of scattering of acoustic energy caused by the CO_2 bubble plume (§2.1). This feature is observed, but much less intense, at the other station (Figure 4.1.2.2) in the same campaign.
No "black holes" were observed during the 3rd campaign of winter, January 2012 (fig. 4.1.3.1 & 2), and during the 4th campaign of spring, March 2012, (fig. 4.1.4.1 & 2).
During the 3rd campaign of winter and the 4th of spring vertical velocities recorded were lower than in the previous campaigns and those vertical velocities were larger at AN2 than at AN1 (fig. 4.1.3.1, 4.1.3.2, 4.1.4.1, 4.1.4.2). This feature is confirmed also by statistics rendered in §4.4 below.

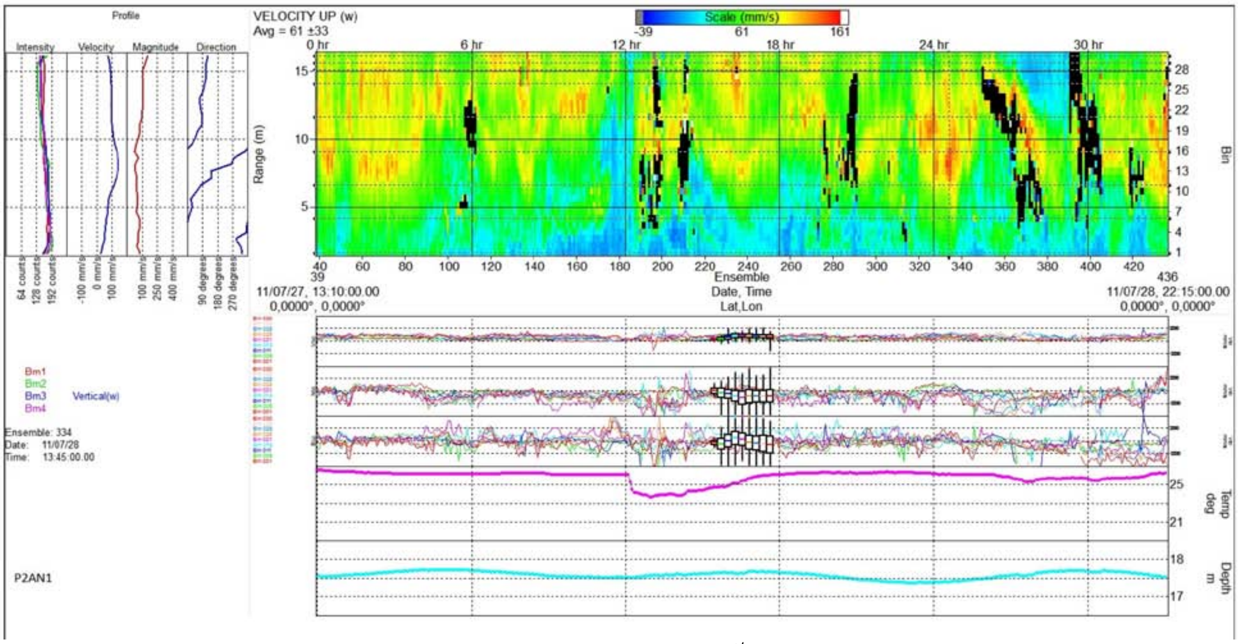


Figure 4.1.2.1.a. Second campaign, station AN1, 1st subrecord. See caption of Figure 4.1.1 for details.

In the contour map showing measured vertical velocity a number of black holes denote the situation in which the bubble plume(s) crossed one or more beams of the ADCP causing a quality of measurement judged bad by the RDI's software.

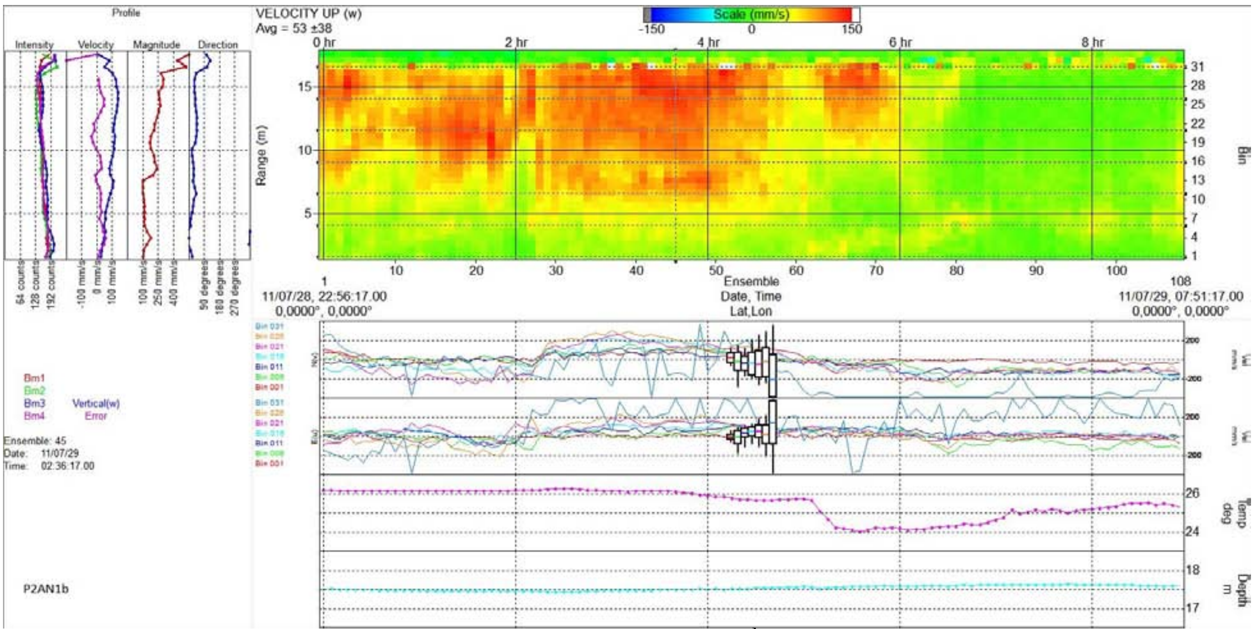


Figure 4.1.2.1.b. Second campaign, station AN1, 2nd subrecord. See caption of Figure 4.1.1 for details.

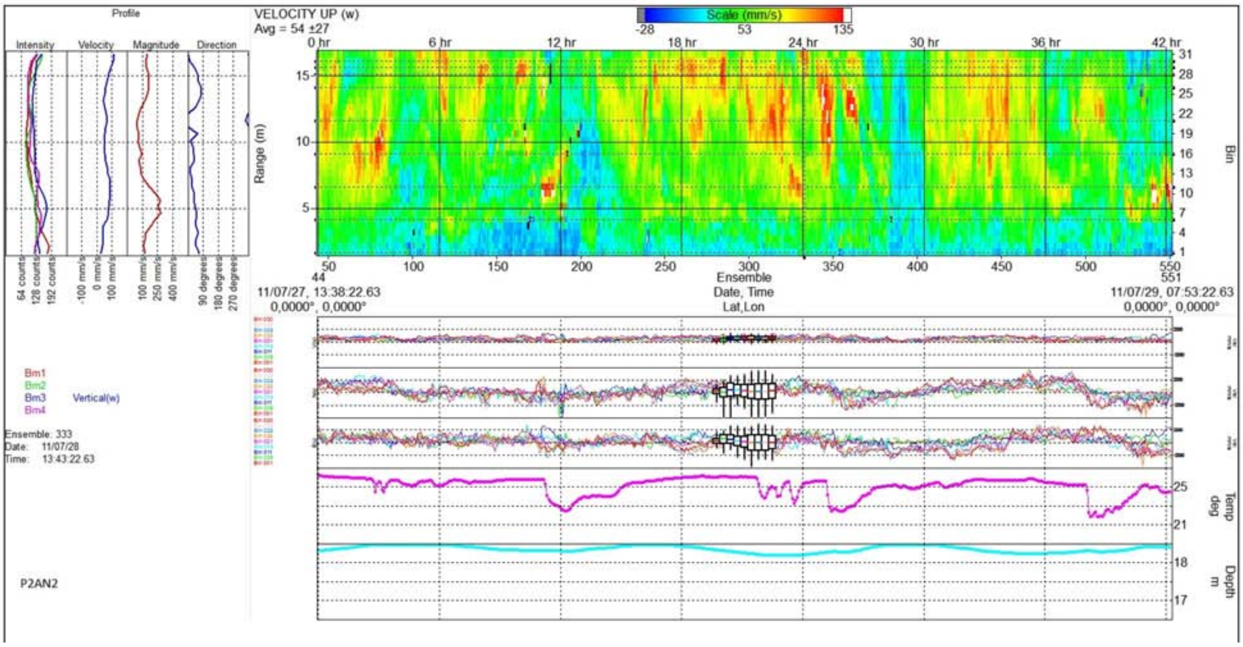


Figure 4.1.2.2. Second campaign, station AN2. See caption of fig. 4.1.1 for details.

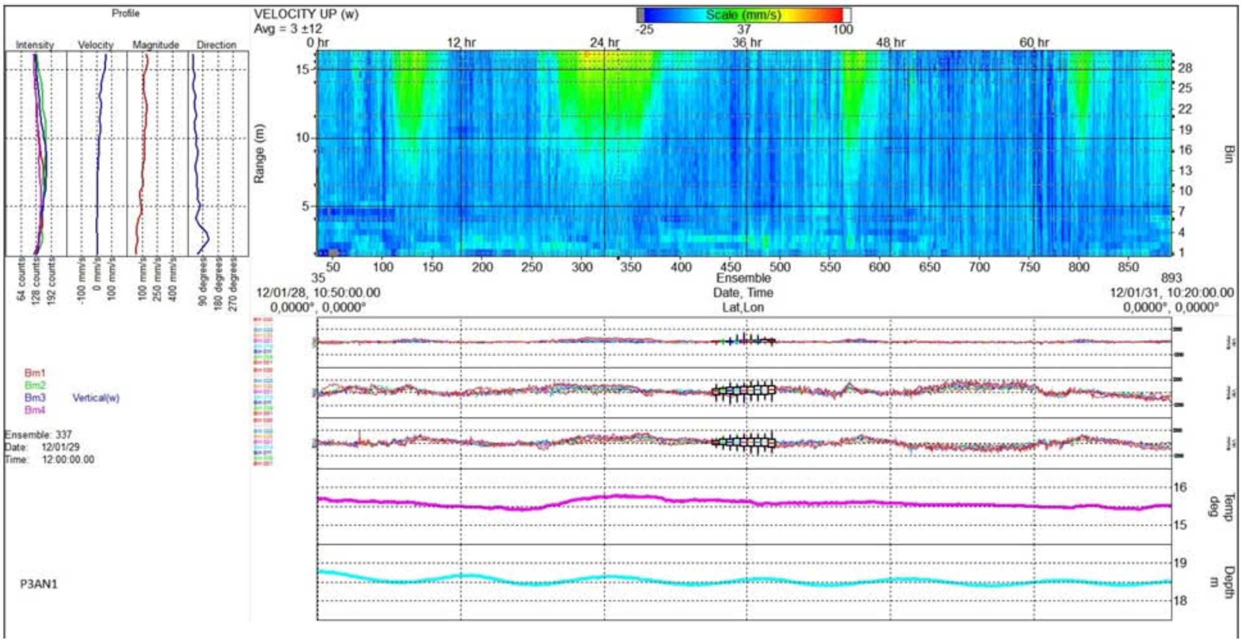


Figure 4.1.3.1. Third campaign, station AN1. See caption of 4.1.1 for details.

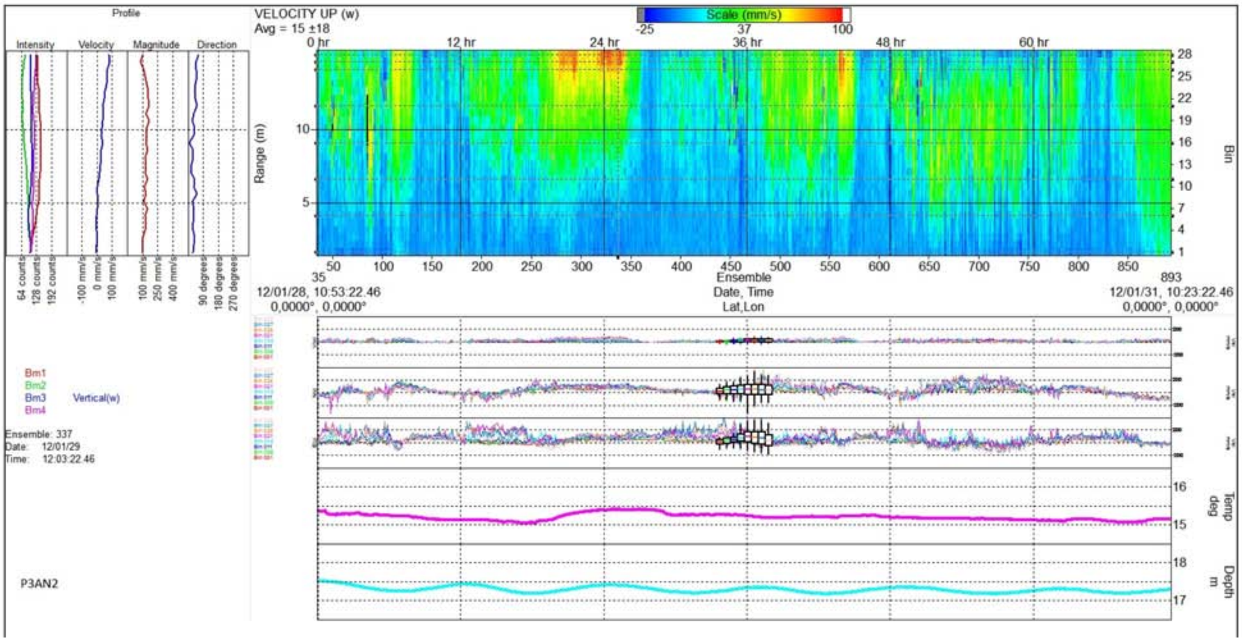


Figure 4.1.3.2. Third campaign, station AN2. See caption of fig. 4.1.1 for details.

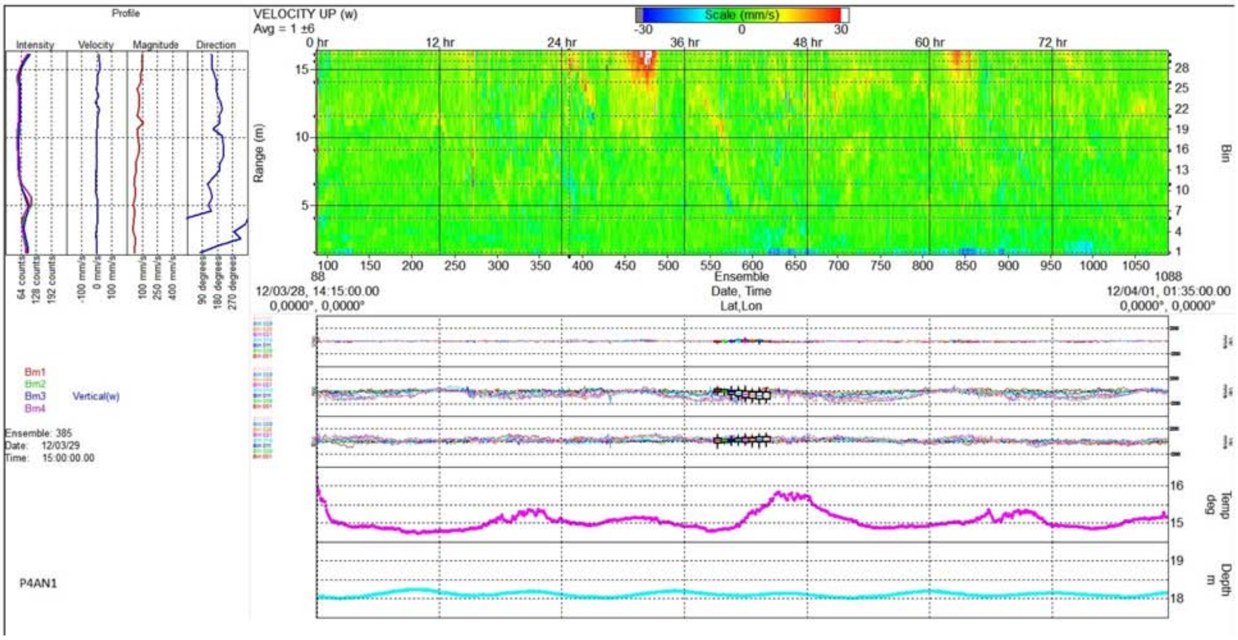


Figure 4.1.4.1. Fourth campaign, station AN1. See caption of Figure 4.1.1 for details.

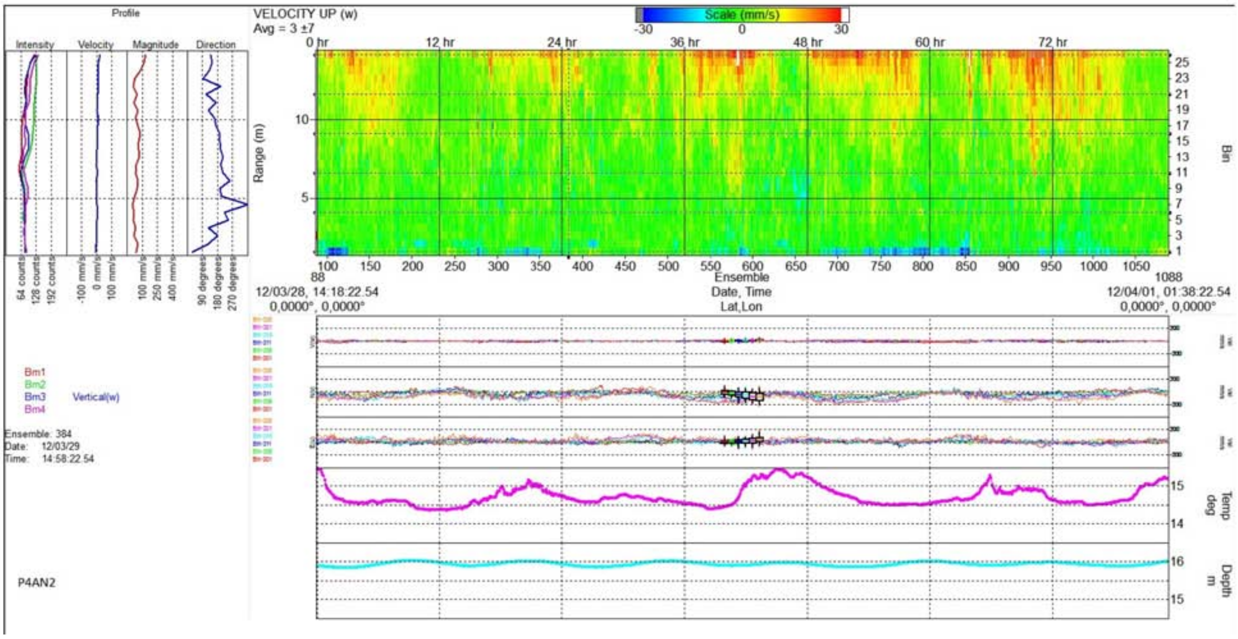


Figure 4.1.4.2 Fourth campaign, station AN2. See caption of Figure 4.1.1 for details.

4.2 Ancillary data

Ancillary data acquired by the ADCPS are pitch, roll, heading, temperature and pressure acquired at the level of the instrument. We analyzed the evolution of pitch, roll, heading and pressure to determine the date, time and ensamble number of first and last valid records. Pressure is transformed in depth using a density calculated from measured temperature and a constant user defined salinity. Table 4.2 reports average, standard deviation, minima and maxima of valid ancillary data that is with ADCPs deployed on the sea bottom. We performed a correction of depth signal adding the constant height of pressure meter above sea floor of 0.40m; and applying a time dependent linear correction to depth based on reading in air just before and just after deployment to eliminate drifts of pressure sensors: the results are time series of corrected bottom depth (BD). Basic statistics, minima and maxima of ancillary data, are shown in table 4.2.. Statistics and extrema of pitch, roll and heading indicate that ADCPs were always still and stable during each campaign in the limits of the accuracy of the sensors.
Complete time series of all (valid and not) ancillary data are available in text format (see §5.2). Valid ancillary time series and their statistics are available in text format (§5.3, §5.5 respectively). Time series of corrected bottom depth and temperature are rendered in §4.2.1.

Table 4.2

FILE NAME=	P1SW1_ATS.dat				
FIRST ENS.=	60	LAST ENS.=	665	# OF ENS.=	606
PARAMETER	**AVG**	**STD**	**MIN**	**MAX**	**NGOOD**
Pitch	9.2	0.1	9.1	9.4	606
Roll	1.8	0.0	1.6	1.9	606
Heading	63.6	0.1	63.1	63.7	606
Temperature	21.02	0.13	20.60	21.70	606
Bottom Depth	17.67	0.12	17.47	17.85	606
Corrected BD	17.99	0.12	17.79	18.17	606
Calc.bins#	34.11				
FILE NAME=	P2AN1aATS.dat				
FIRST ENS.=	45	LAST ENS.=	436	# OF ENS.=	392
PARAMETER	**AVG**	**STD**	**MIN**	**MAX**	**NGOOD**
Pitch	-0.5	0.0	-0.6	-0.4	392
Roll	5.1	0.0	5.0	5.2	392
Heading	324.7	0.1	324.6	324.8	392
Temperature	25.95	0.68	23.74	26.60	392
Bottom Depth	17.61	0.10	17.39	17.76	392
Corrected BD	17.83	0.10	17.61	17.98	392
Calc.bins#	33.71				
FILE NAME=	P2AN1bATS.dat				
FIRST ENS.=	1	LAST ENS.=	107	# OF ENS.=	107
PARAMETER	**AVG**	**STD**	**MIN**	**MAX**	**NGOOD**
Pitch	-0.5	0.0	-0.6	-0.5	107
Roll	5.1	0.0	5.1	5.2	107
Heading	324.6	0.0	324.5	324.7	107
Temperature	25.52	0.75	24.02	26.29	107
Bottom Depth	17.54	0.07	17.44	17.64	107
Corrected BD	17.76	0.07	17.66	17.86	107
Calc.bins#	33.48				
FILE NAME=	P2AN2_ATS.dat				
FIRST ENS.=	44	LAST ENS.=	551	# OF ENS.=	508
PARAMETER	**AVG**	**STD**	**MIN**	**MAX**	**NGOOD**
Pitch	3.2	0.0	3.1	3.3	508
Roll	-1.3	0.0	-1.4	-1.3	508
Heading	52.9	0.1	52.7	53.1	508
Temperature	25.13	1.06	21.86	26.34	508
Bottom Depth	18.39	0.09	18.22	18.55	508

Corrected BD	18.32	0.09	18.15	18.48	508
Calc.bins#	34.71				
FILE NAME=	P2AN2aATS.dat				
FIRST ENS.=	44	LAST ENS.=	435	# OF ENS.=	392
PARAMETER	**AVG**	**STD**	**MIN**	**MAX**	**NGOOD**
Pitch	3.2	0.0	3.2	3.3	392
Roll	-1.3	0.0	-1.4	-1.3	392
Heading	52.9	0.1	52.7	53.1	392
Temperature	25.23	0.97	22.46	26.34	392
Bottom Depth	18.41	0.09	18.22	18.55	392
Corrected BD	18.34	0.09	18.15	18.48	392
Calc.bins#	34.71				
FILE NAME=	P2AN2bATS.dat				
FIRST ENS.=	443	LAST ENS.=	549	# OF ENS.=	107
PARAMETER	**AVG**	**STD**	**MIN**	**MAX**	**NGOOD**
Pitch	3.2	0.0	3.1	3.3	107
Roll	-1.3	0.0	-1.4	-1.3	107
Heading	52.9	0.1	52.7	53.0	107
Temperature	24.73	1.29	21.86	25.96	107
Bottom Depth	18.33	0.06	18.27	18.46	107
Corrected BD	18.27	0.06	18.20	18.39	107
Calc.bins#	34.54				
FILE NAME=	P3AN1_ATS.dat				
FIRST ENS.=	36	LAST ENS.=	893	# OF ENS.=	858
PARAMETER	**AVG**	**STD**	**MIN**	**MAX**	**NGOOD**
Pitch	1.7	0.0	1.7	1.7	858
Roll	-6.0	0.0	-6.0	-5.9	858
Heading	179.5	0.1	179.4	179.7	858
Temperature	15.59	0.09	15.42	15.81	858
Bottom Depth	18.54	0.08	18.42	18.80	858
Corrected BD	18.43	0.08	18.31	18.69	858
Calc.bins#	35.15				
FILE NAME=	P3AN2_ATS.dat				
FIRST ENS.=	35	LAST ENS.=	892	# OF ENS.=	858
PARAMETER	**AVG**	**STD**	**MIN**	**MAX**	**NGOOD**
Pitch	-1.3	0.0	-1.3	-1.2	858
Roll	3.5	0.0	3.4	3.6	858
Heading	7.3	0.1	7.1	7.4	858
Temperature	15.22	0.09	15.05	15.43	858
Bottom Depth	17.31	0.08	17.19	17.54	858
Corrected BD	17.26	0.08	17.15	17.50	858
Calc.bins#	32.76				
FILE NAME=	P4AN1_ATS.dat				
FIRST ENS.=	91	LAST ENS.=	1247	# OF ENS.=	1157
PARAMETER	**AVG**	**STD**	**MIN**	**MAX**	**NGOOD**
Pitch	0.8	0.1	0.7	1.0	1157
Roll	0.8	0.1	0.5	0.9	1157
Heading	220.9	0.4	219.2	221.3	1157
Temperature	15.08	0.23	14.73	15.87	1157
Bottom Depth	18.12	0.05	18.01	18.26	1157
Corrected BD	18.27	0.05	18.16	18.41	1157
Calc.bins#	34.57				
FILE NAME=	P4AN2_ATS.dat				
FIRST ENS.=	90	LAST ENS.=	1246	# OF ENS.=	1157
PARAMETER	**AVG**	**STD**	**MIN**	**MAX**	**NGOOD**
Pitch	-1.4	0.0	-1.4	-1.1	1157
Roll	1.4	0.0	1.1	1.5	1157
Heading	161.5	0.3	161.3	162.7	1157
Temperature	14.77	0.27	14.37	15.69	1157
Bottom Depth	15.97	0.05	15.86	16.08	1157
Corrected BD	15.92	0.05	15.81	16.03	1157
Calc.bins#	29.81				

4.2.1 Sea level and sea bottom temperature

Depth and temperature data of the 2nd campaign of Summer are shown for the two subrecords obtained at station AN1 and the subrecords obtained cutting the entire record at AN2 in the same way (see notes 3 and 4 of Table 4.1).

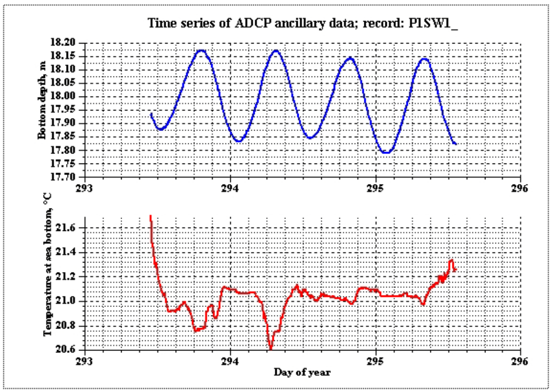


Figure 4.2.1.1

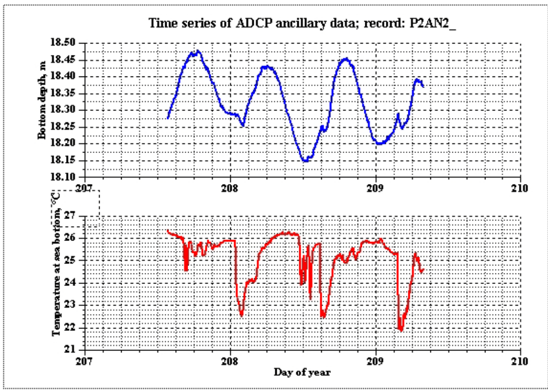


Figure 4.2.2.2

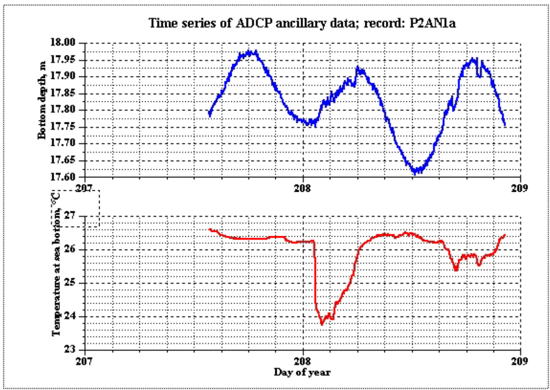


Figure 4.2.2.1.a

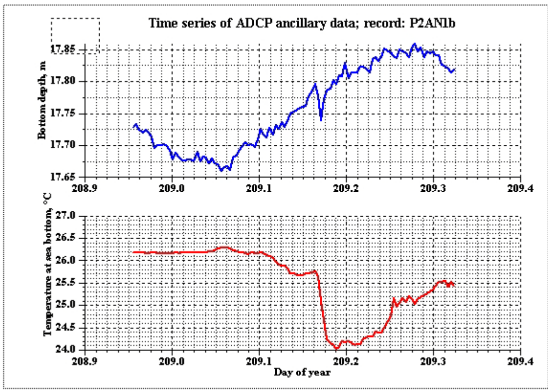


Figure 4.2.2.1.b

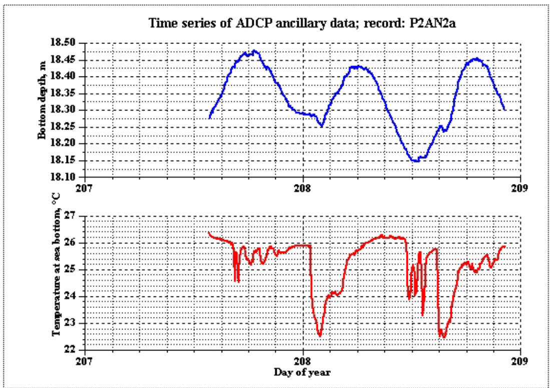


Figure 4.2.2.2.a

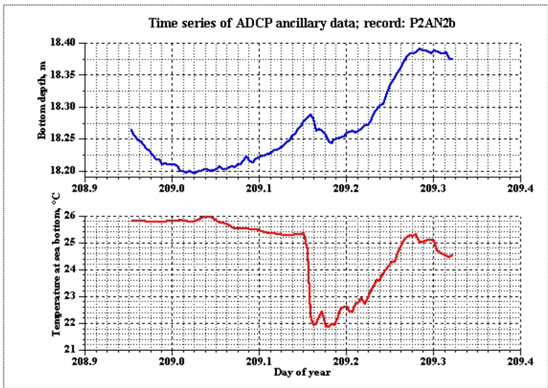


Figure 4.2.2.2.b

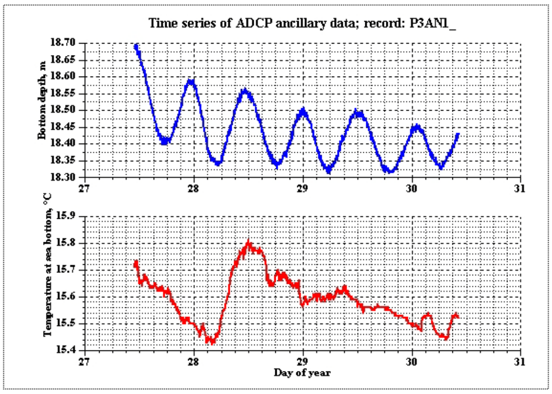


Figure 4.2.3.1

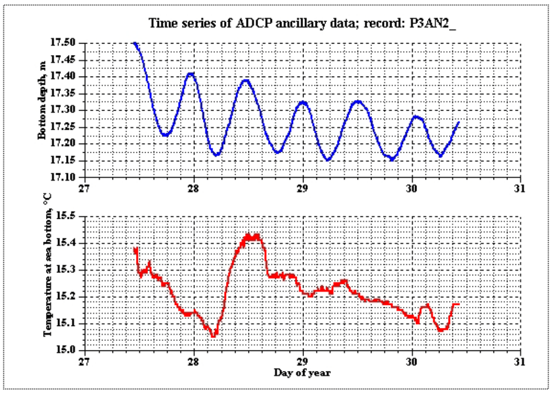


Figure 4.2.3.2

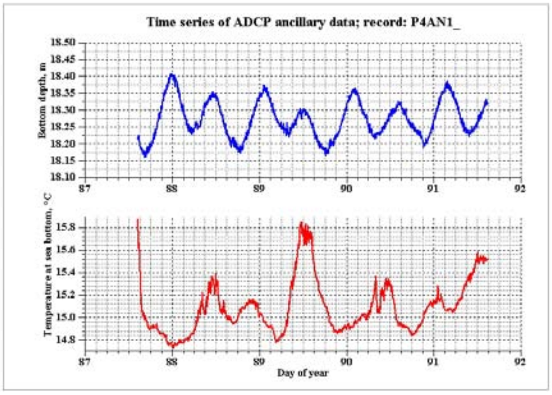


Figure 4.2.4.1

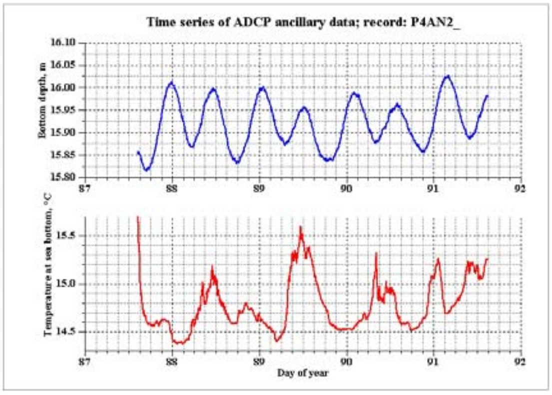


Figure 4.2.4.2

4.3 Validation of current data

For the reasons given in §2.1, current estimates affected by a large error velocity may be significant close to a bubble plume, and so a large threshold of 0.5m/s for error velocity was adopted to discard data and produce valid time series. A lower threshold of 0.05m/s was, for instance, chosen to validate ADCP data in the more deep and homogeneous environment of Otranto Channel at ~600m depth by Manca *et al.*(2002). The threshold of 0.5m/s adopted here allows some spike to remain, as in the case of time series shown in fig. 4.3.1. Tightening the threshold would eliminate those spikes, but at the same time would discard data with a fair continuity visible elsewhere, but associated to large error velocities (yellow line). Continuity of current estimates is good also in the other two examples of figures 4.3.2 and 4.3.3, although large values and variability of error velocity occur.

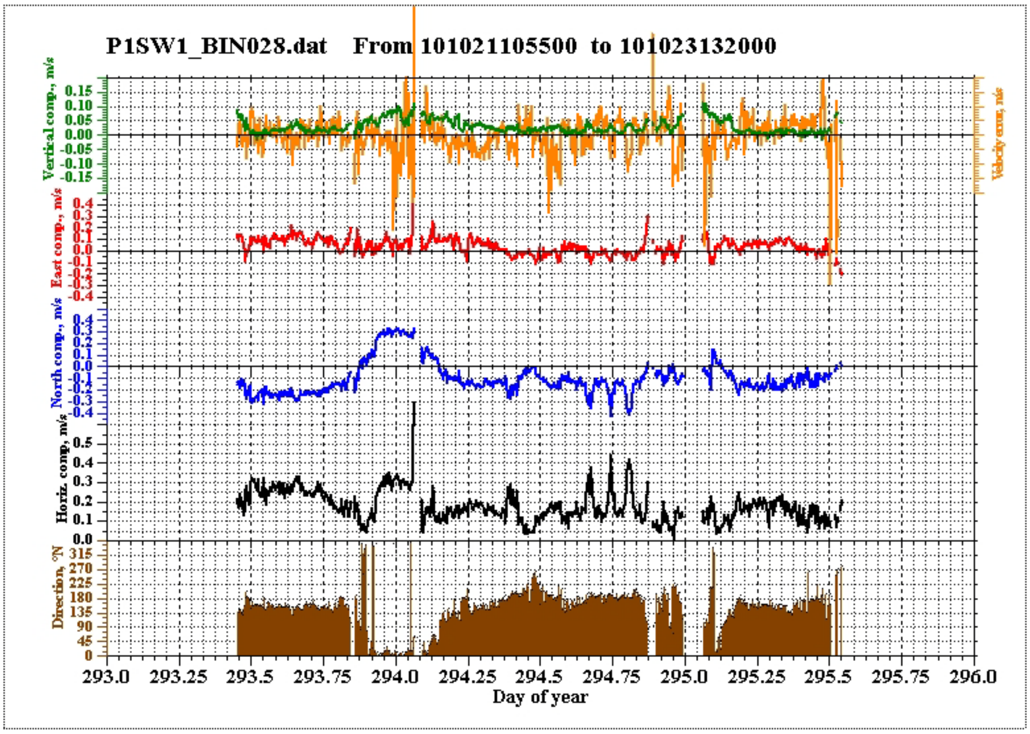


Figure 4.3.1 Time series of current data at a fixed range of 15.6m from the ADCP recorded during the 1st campaign. From top to bottom: error velocity (yellow), vertical component (green), , east component (red), north component (blue), horizontal component (black), direction °N (brown).

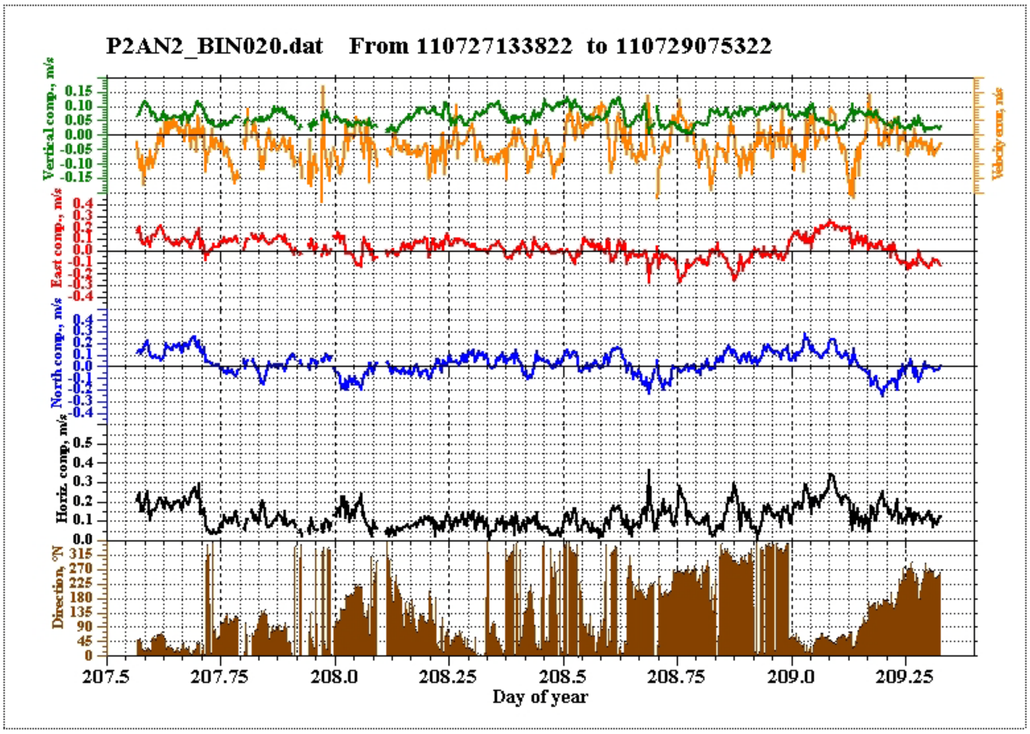


Figure 4.3.2. See fig 4.3.1 for details.

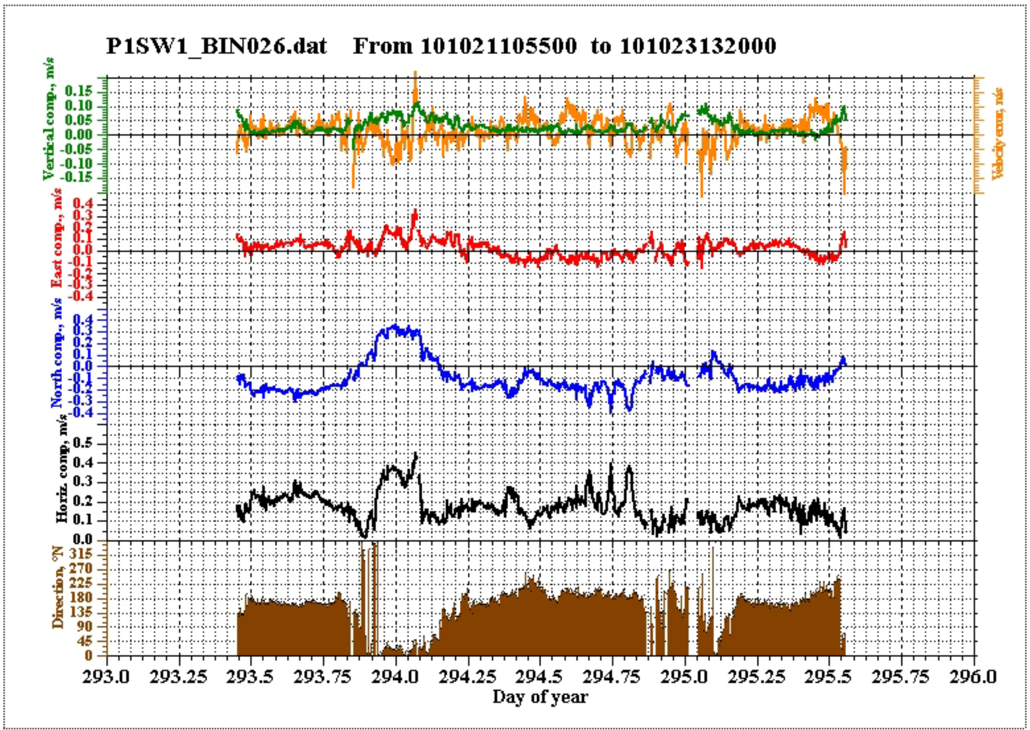


Figure 4.3.3. See fig 4.3.1 for details

In fig. 4.3.4 four scatter plots are shown of error velocity versus east, north, horizontal and vertical components. The criterion adopted to discard data has resulted in at least 20 spikes remaining in the entire four ADCP dataset.
Time series rendered in the figures of this section are available in text format (see §5.6).

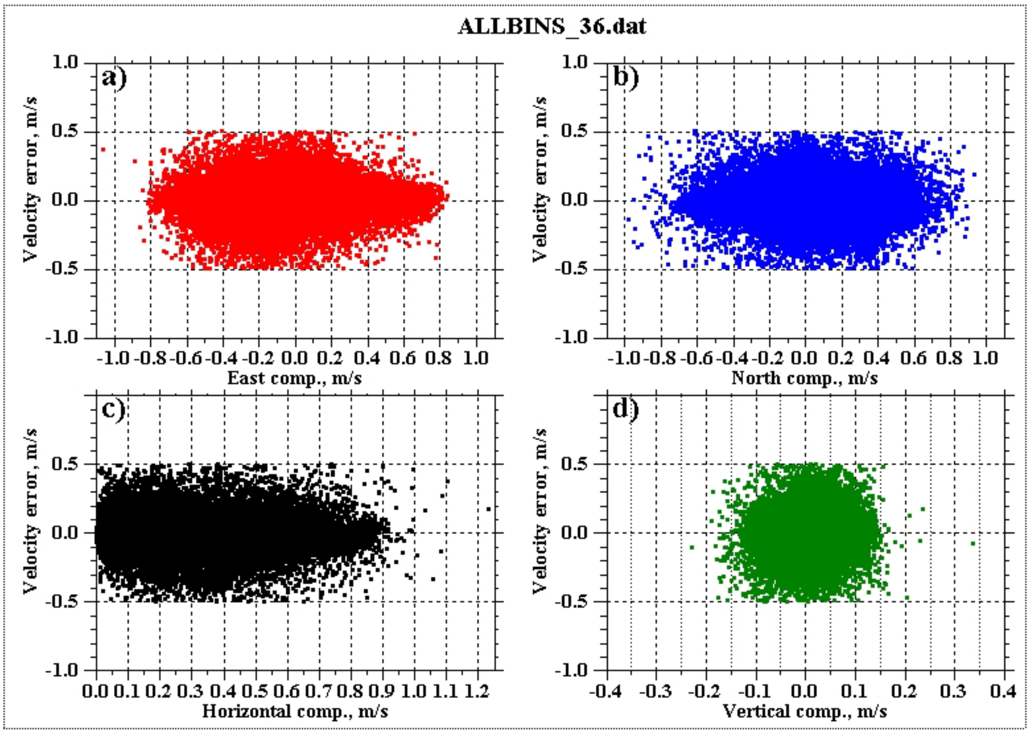


Figure 4.3.4 scatter plots are shown of error velocity versus east (a), north (b), horizontal (c) and vertical components (d).

4.4 Statistics of valid ADCP velocity records

Complete statistics of current data is shown here: the top value of average components is affected by side lobe contamination (see §2.1): top values are shown anyhow for keeping under control the manual procedure adopted to flag out bad bin data: pink crosses on the right side denote bins not good enough for time series analysis. The light blue dashed line denote percentage of good data with respect to all data in the record: 0% and 100% are at the left and right sides respectively. Statistics rendered in the figures of this section are available in text format (see 5.5).
For identifying campaign and station in the following figures, please refer to table 4.1 (§4.1) where attribution of names is listed in the column entitled *Prefix of file names*.

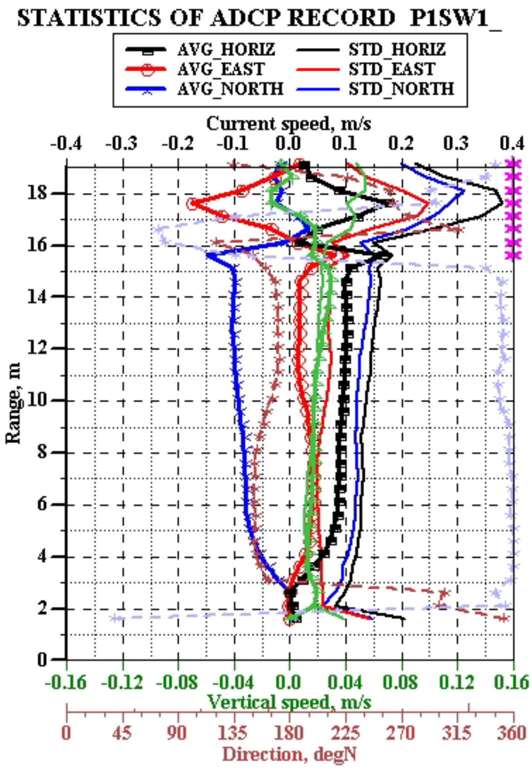


Figure 4.4.1.1

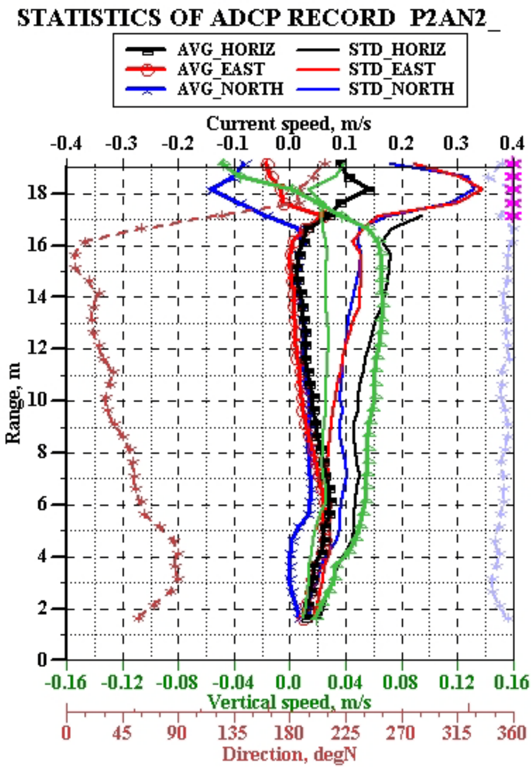


Figure 4.4.2.2

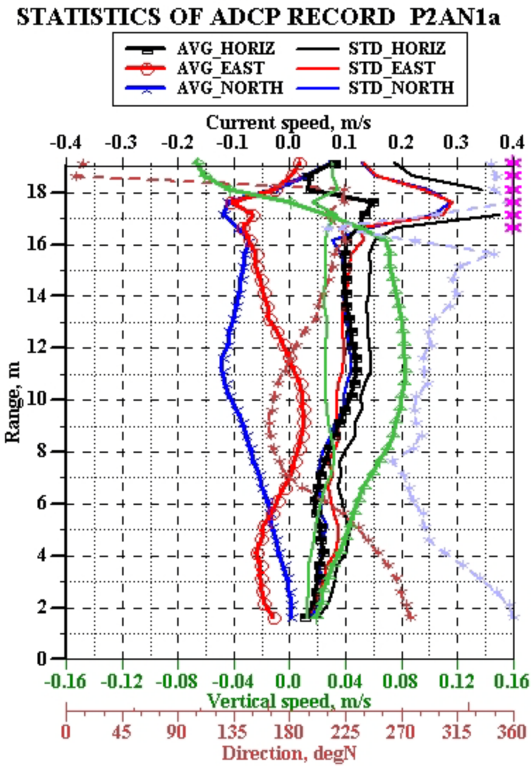


Figure 4.4.2.1.a

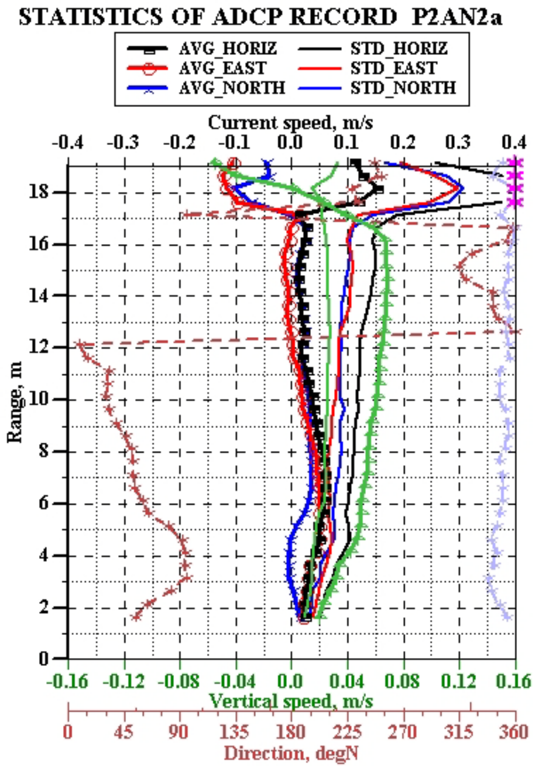


Figure 4.4.2.2.a

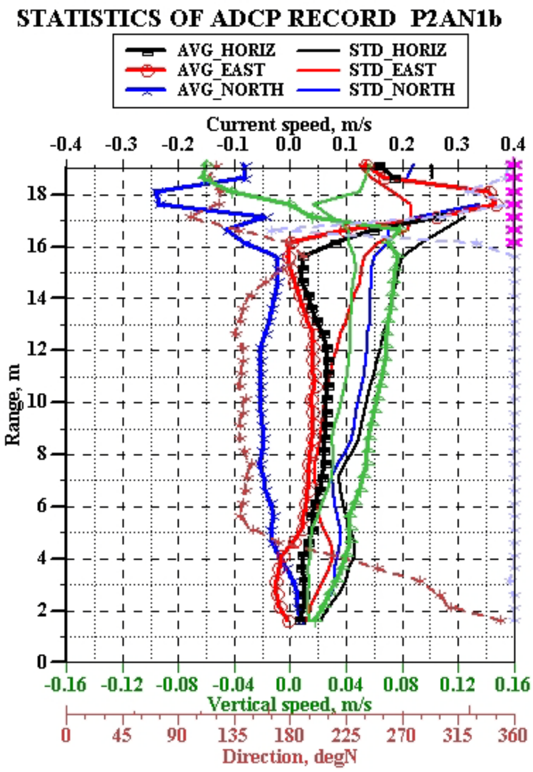


Figure 4.4.2.1.b

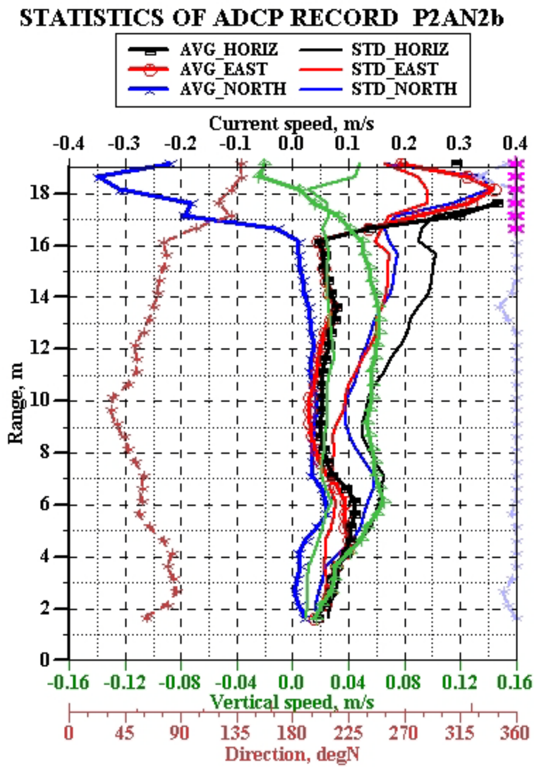


Figure 4.4.2.2.b

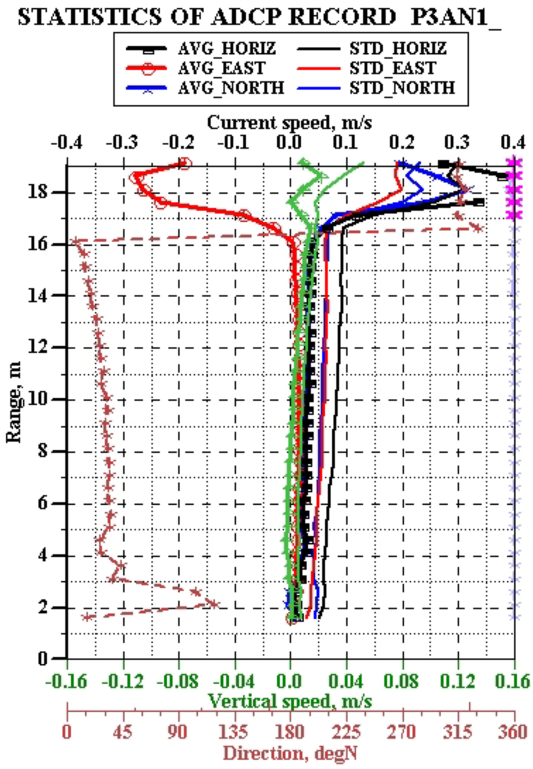


Figure 4.4.3.1

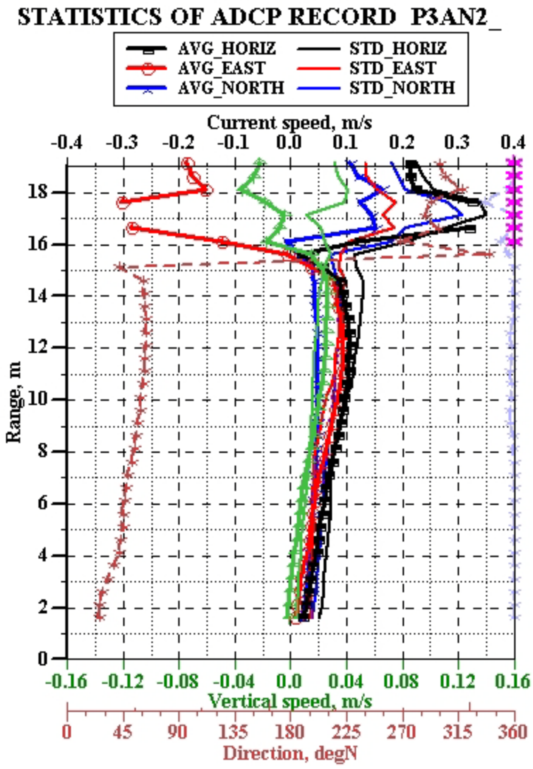


Figure 4.4.3.2

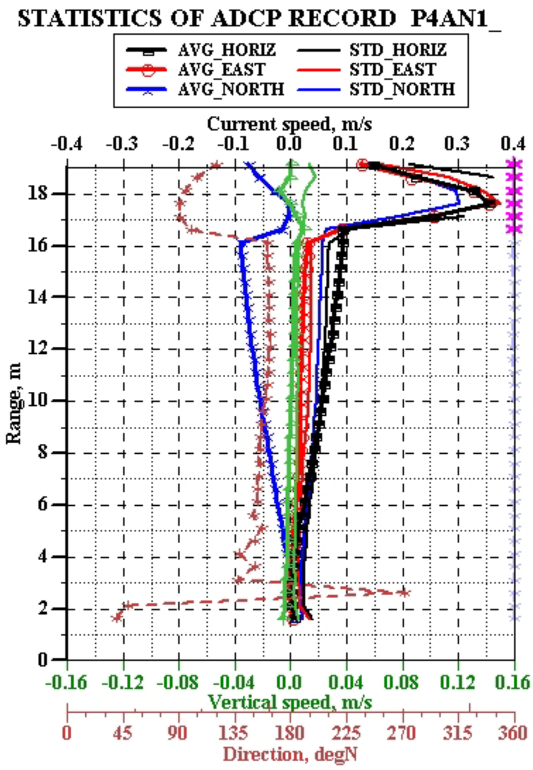


Figure 4.4.4.1

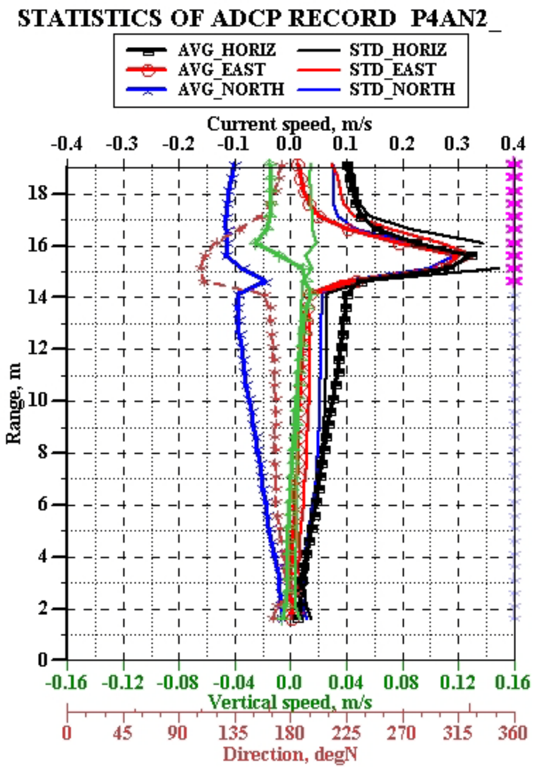


Figure 4.4.4.2

4.5 ADCP profiles synchronous with CTD casts

As a support to interpretation with the CTD casts and bottle results of Task 2.2.1, we produce in separated figures (§4.5.1÷4.5.2) and text files (see §5.7) the single ADCP vertical profiles synchronous with CTD casts. Table 4.5 depicts the work of a procedure, (a *Fortran* routine), for extracting ADCP profiles as close in time as possible to the CTD cast times. The CTD original time has been converted into UTC time taking into account legal hour, when active in Italy, time error in the PC used for CTD data acquisition and half the duration of each CTD downcast.
The time difference between CTD cast's UTC time at mid downcast, reported in the last column of table 4.5, and start time of ADCP profile never exceeds 2.5', that is the half the duration of an ADCP ensamble (see §2.2)
.

Table 4.5

Camp1ign	CTD cast's station name	CTD cast 's date and legal time	CTD cast's legal hour + local to UTC correction	CTD cast's local date and UTC time	CTD PC time correction (min)	Half duration of CTD downcast (s)	CTD cast's date an UTC time at mid downcast
1	1SW1	Oct 22 2010 11:28:10	-2	Oct 22 2010 09:28:10	-14	59	2010/10/22 09:15:09
1	1SB0	Oct 22 2010 14:00:13	-2	Oct 22 2010 12:00:13	-14	59	2010/10/22 11:47:12
1	1NE1	Oct 22 2010 15:30:16	-2	Oct 22 2010 13:30:16	-14	43	2010/10/22 13:16:59
1	1SW3	Oct 23 2010 09:15:40	-2	Oct 23 2010 07:15:40	-14	48	2010/10/23 07:02:28
1	1NE3	Oct 23 2010 10:59:47	-2	Oct 23 2010 08:59:47	-14	51	2010/10/23 08:46:38
1	1SW2	Oct 23 2010 12:19:05	-2	Oct 23 2010 10:19:05	-14	54	2010/10/23 10:05:59
1	1NE2	Oct 23 2010 14:01:39	-2	Oct 23 2010 12:01:39	-14	66	2010/10/23 11:48:45
2	2SB0	Jul 28 2011 09:01:02	-2	Jul 28 2011 07:01:02	0	84	2011/07/28 07:02:26
2	2NE1	Jul 28 2011 10:55:47	-2	Jul 28 2011 08:55:47	0	68	2011/07/28 08:56:55
2	2NE2	Jul 28 2011 12:17:24	-2	Jul 28 2011 10:17:24	0	49	2011/07/28 10:18:13
2	2NE3	Jul 28 2011 13:40:18	-2	Jul 28 2011 11:40:18	0	68	2011/07/28 11:41:26
2	2SW1	Jul 30 2011 10:09:24	-2	Jul 30 2011 08:09:24	0	58	2011/07/30 08:10:22
2	2SW2	Jul 30 2011 11:48:58	-2	Jul 30 2011 09:48:58	0	59	2011/07/30 09:49:57
2	2SW3	Jul 30 2011 12:55:26	-2	Jul 30 2011 10:55:26	0	67	2011/07/30 10:56:33
3	3SB0	Jan 28 2012 11:31:03	-1	Jan 28 2012 10:31:03	0	52	2012/01/28 10:31:55
3	3SW1	Jan 28 2012 13:03:34	-1	Jan 28 2012 12:03:34	0	40	2012/01/28 12:04:14
3	SW2	Jan 28 2012 14:06:48	-1	Jan 28 2012 13:06:48	0	37	2012/01/28 13:07:25
3	SW3	Jan 29 2012 09:39:13	-1	Jan 29 2012 08:39:13	0	65	2012/01/29 08:40:18
3	3NE1	Jan 29 2012	-1	Jan 29 2012	0	42	2012/01/29

		10:40:06		09:40:06			09:40:48
3	3NE2	Jan 29 2012 11:40:54	-1	Jan 29 2012 10:40:54	0	35	2012/01/29 10:41:29
3	3NE3	Jan 29 2012 12:35:14	-1	Jan 29 2012 11:35:14	0	32	2012/01/29 11:35:46
4	4SW3	Mar 30 2012 11:47:07	-2	Mar 30 2012 09:47:07	0	50	2012/03/30 09:47:57
4	4SW2	Mar 30 2012 10:50:36	-2	Mar 30 2012 08:50:36	0	49	2012/03/30 08:51:25
4	4SW1	Mar 30 2012 09:30:18	-2	Mar 30 2012 07:30:18	0	108	2012/03/30 07:32:06
4	4SB0	Mar 30 2012 12:42:16	-2	Mar 30 2012 10:42:16	0	52	2012/03/30 10:43:08
4	4NE1	Mar 30 2012 14:36:21	-2	Mar 30 2012 12:36:21	0	51	2012/03/30 12:37:12
4	4NE2	Mar 30 2012 15:35:57	-2	Mar 30 2012 13:35:57	0	52	2012/03/30 13:36:49
4	4NE3	Mar 30 2012 16:28:49	-2	Mar 30 2012 14:28:49	0	43	2012/03/30 14:29:32
4	5SW1	Apr 01 2012 11:13:15	-2	Apr 01 2012 09:13:15	0	54	2012/04/01 09:14:09
4	5SB0	Apr 01 2012 11:21:44	-2	Apr 01 2012 09:21:44	0	53	2012/04/01 09:22:37
4	5NE1	Apr 01 2012 11:29:10	-2	Apr 01 2012 09:29:10	0	54	2012/04/01 09:30:04
4	5NW1	Apr 01 2012 11:37:01	-2	Apr 01 2012 09:37:01	0	57	2012/04/01 09:37:58
4	5SE1	Apr 01 2012 11:44:09	-2	Apr 01 2012 09:44:09	0	58	2012/04/01 09:45:07

In the figures of §4.5.1÷§4.5.5 horizontal, north and east component profiles are referred to the upper abscissa labelled *Current speed*. Absolute value of error velocity is plotted with respect the same upper abscissa but assuming a zero at the left side. Profiles of direction and vertical component are referred to two lower abscissas. In order to facilitate comparison between ADCP profiles, CTD casts and bottle data, the ordinate is now expressed in distance from sea surface (*Depth=0m*) calculated on the basis of the range (distance from the bottom) and of the corrected bottom depth (see §4.2.1) instant value in order to align all data with respect to the same reference at the (moving) surface. A pink rhombus in low and central position denotes sea bottom that is at 2m from the lower current sample (1.60m is the distance of first bin from ADCP + 0.40m is its height above sea floor). Station name, date and time of the ADCP profile are reported in the first line of left upper part of each figure. The second line reports station name date and time of the synchronous CTD cast.

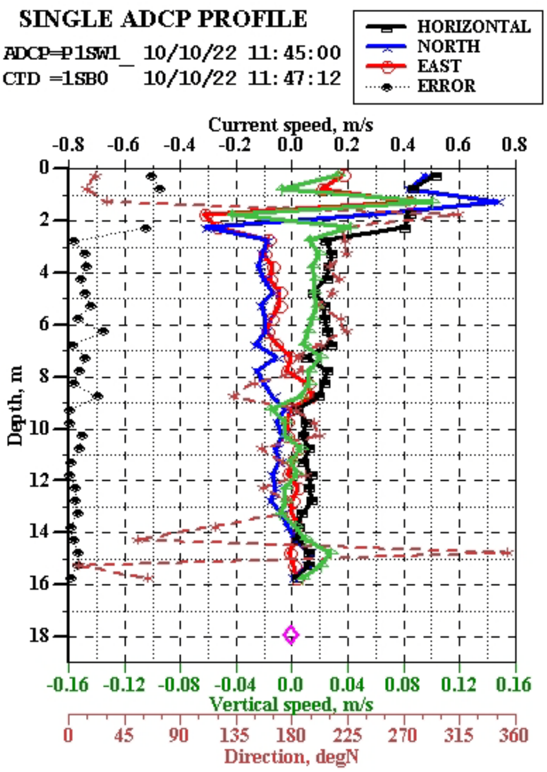
Quality of profiles synchronous with CTD casts is good except for the ones acquired at ADCP station AN1, during the second, campaign of July, 28th 2011, synchronous with CTD stations:

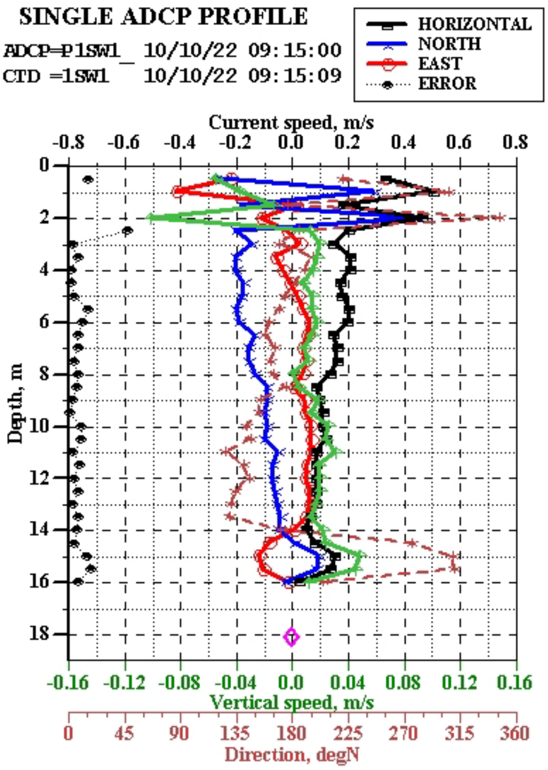
- 2NE1 (08:56 UTC): bad correlation at depths 6÷8.5m and 11.5m.
- 2NE2 (10:18 UTC): error velocity >0.5m at depths ~4÷14m
- 2NE3 (11:41 UTC): error velocity >0.5m at depths ~4÷13.5m

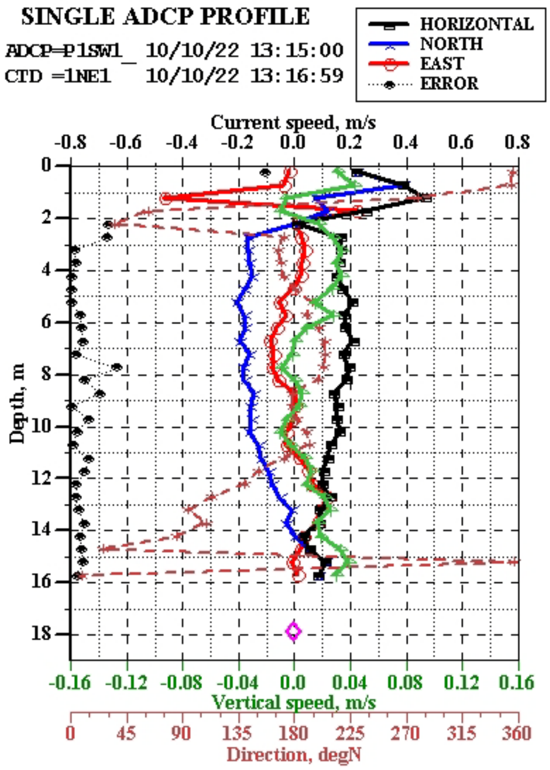
due to bad correlation of acoustic signal, likely caused by a shift of bubble plume toward the beams of ADCP deployed there. In these cases current measured at station AN2 is more representative of the current field at all CTD stations.

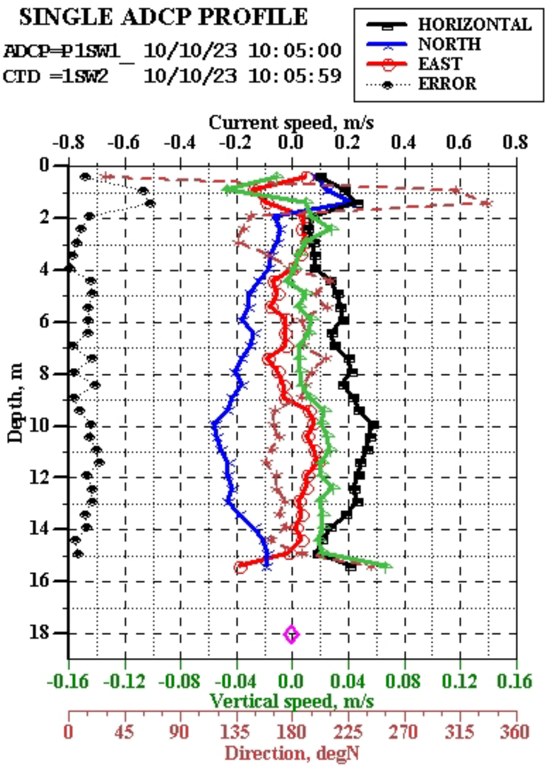
During the 3rd and 4th campaigns error velocities of single ADCP profiles are, with few exceptions, much lower than those of previous campaigns.

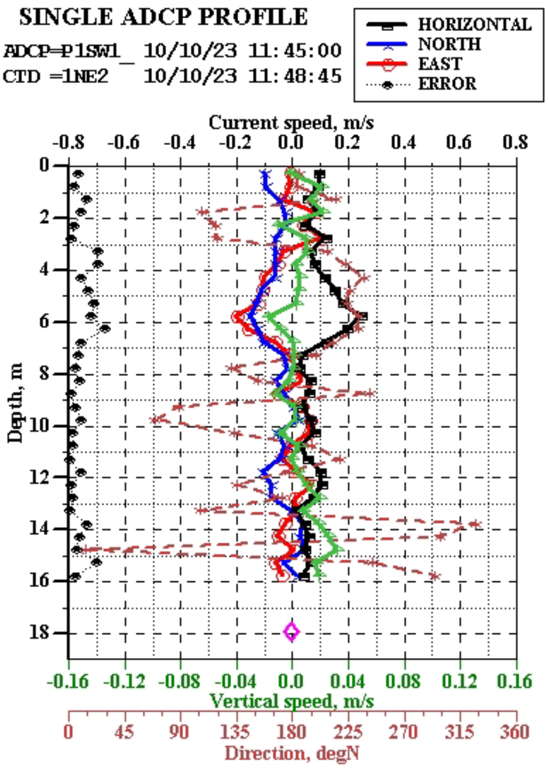
4.5.1 ADCP profiles synchronous with CTD casts - 1st campaign

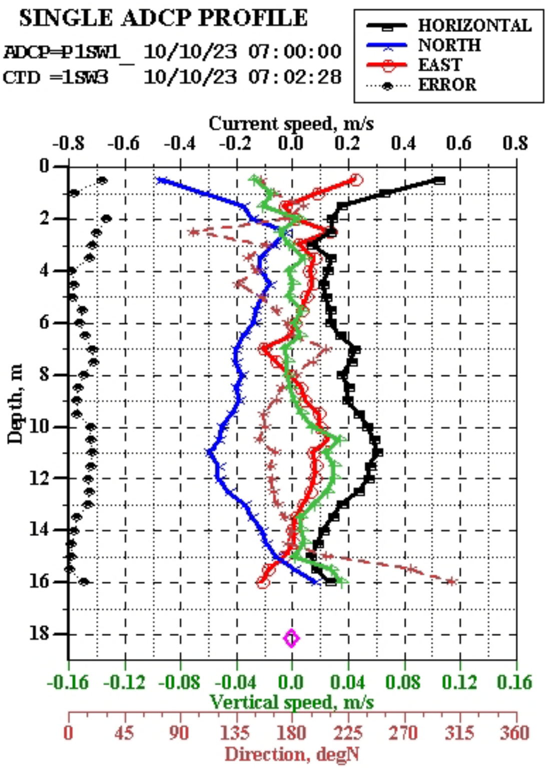


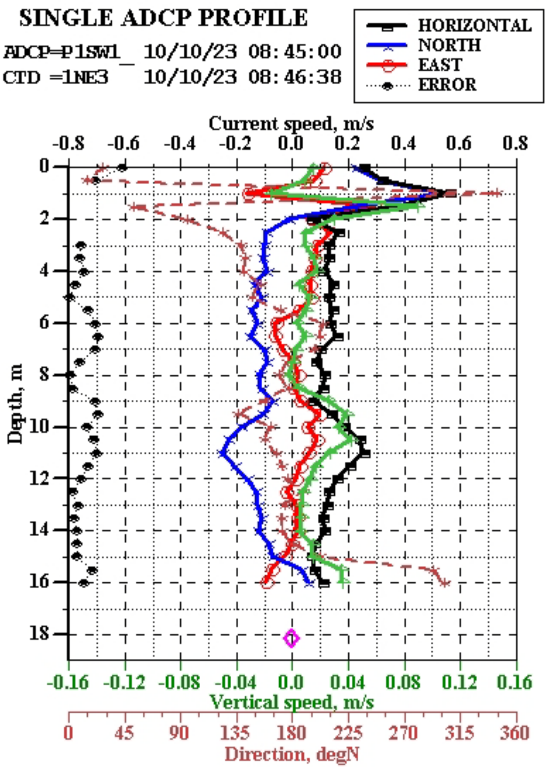




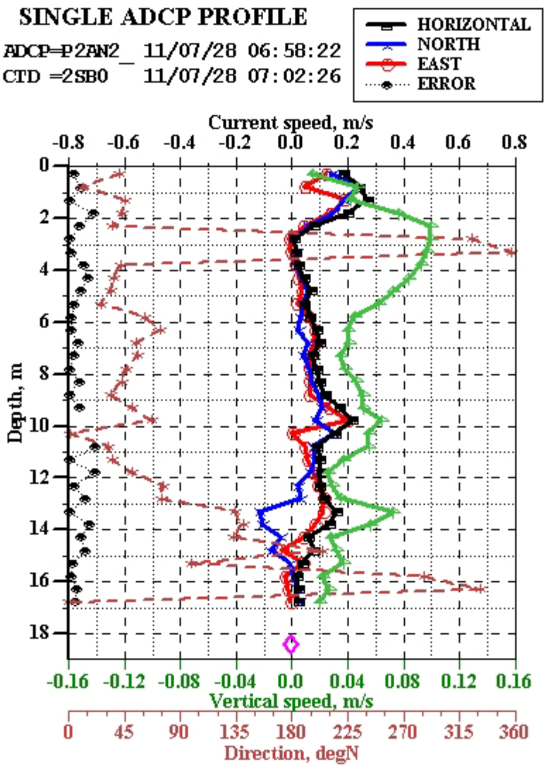

SINGLE ADCP PROFILE
ADCP=P1SW1_ 10/10/23 10:05:00
CTD =1SW2 10/10/23 10:05:59
HORIZONTAL
NORTH
EAST
ERROR
Current speed, m/s
-0.8 -0.6 -0.4 -0.2 0.0 0.2 0.4 0.6 0.8
Depth, m
0 2 4 6 8 10 12 14 16 18
-0.16 -0.12 -0.08 -0.04 0.0 0.04 0.08 0.12 0.16
Vertical speed, m/s
0 45 90 135 180 225 270 315 360
Direction, degN

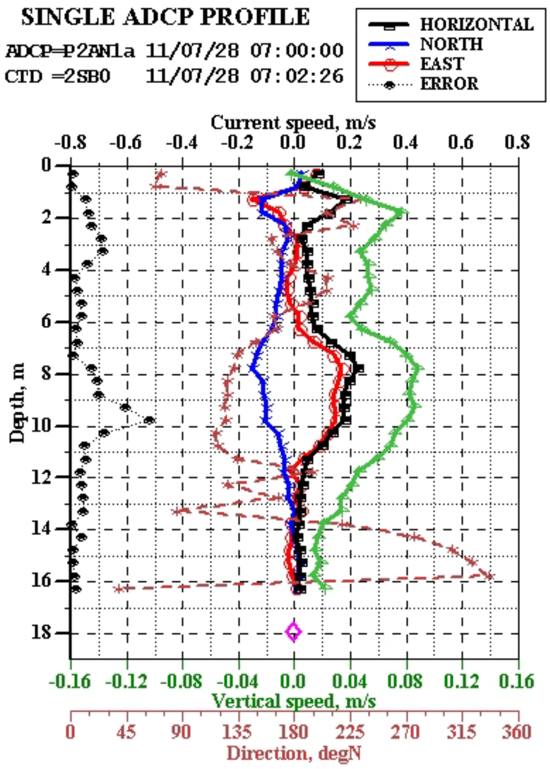

SINGLE ADCP PROFILE
ADCP=P1SW1_ 10/10/23 11:45:00
CTD =1NE2 10/10/23 11:48:45
HORIZONTAL
NORTH
EAST
ERROR
Current speed, m/s
-0.8 -0.6 -0.4 -0.2 0.0 0.2 0.4 0.6 0.8
Depth, m
0 2 4 6 8 10 12 14 16 18
-0.16 -0.12 -0.08 -0.04 0.0 0.04 0.08 0.12 0.16
Vertical speed, m/s
0 45 90 135 180 225 270 315 360
Direction, degN

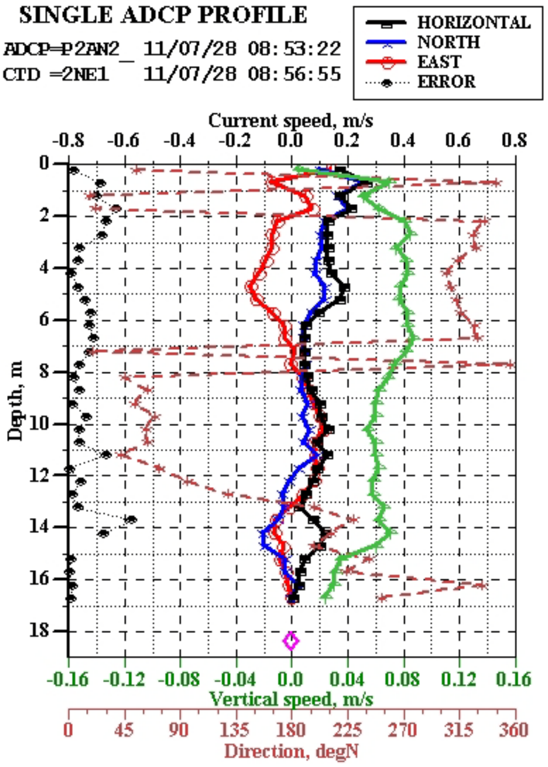

SINGLE ADCP PROFILE
ADCP=P1SW1_ 10/10/23 07:00:00
CTD =1SW3 10/10/23 07:02:28
HORIZONTAL
NORTH
EAST
ERROR
Current speed, m/s
-0.8 -0.6 -0.4 -0.2 0.0 0.2 0.4 0.6 0.8
Depth, m
0 2 4 6 8 10 12 14 16 18
-0.16 -0.12 -0.08 -0.04 0.0 0.04 0.08 0.12 0.16
Vertical speed, m/s
0 45 90 135 180 225 270 315 360
Direction, degN

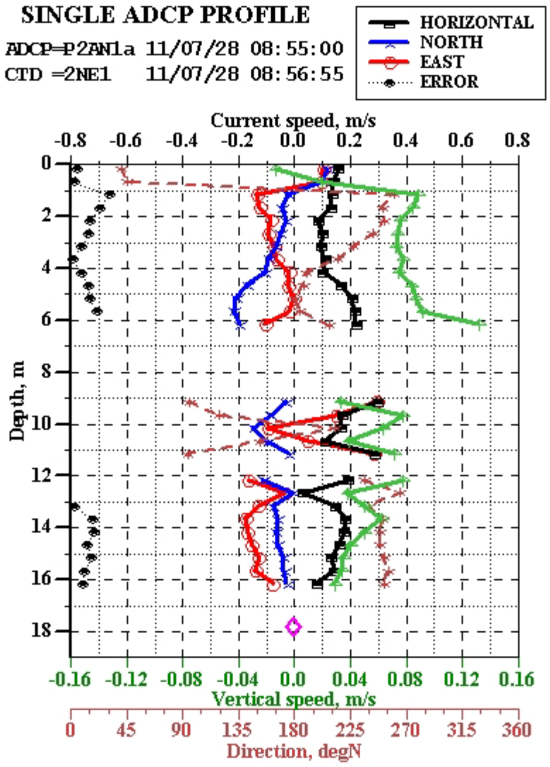

SINGLE ADCP PROFILE
ADCP=P1SW1_ 10/10/23 08:45:00
CTD =1NE3 10/10/23 08:46:38
HORIZONTAL
NORTH
EAST
ERROR
Current speed, m/s
-0.8 -0.6 -0.4 -0.2 0.0 0.2 0.4 0.6 0.8
Depth, m
0 2 4 6 8 10 12 14 16 18
-0.16 -0.12 -0.08 -0.04 0.0 0.04 0.08 0.12 0.16
Vertical speed, m/s
0 45 90 135 180 225 270 315 360
Direction, degN

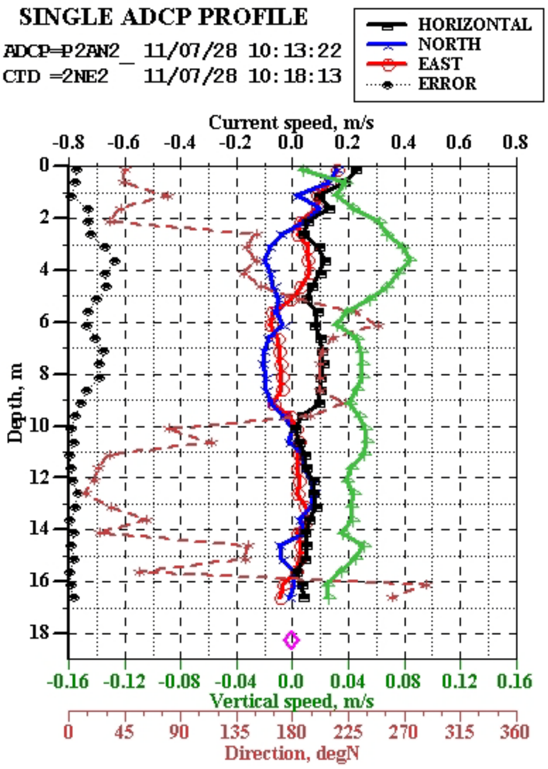
4.5.2 ADCP profiles synchronous with CTD casts - 2nd campaign

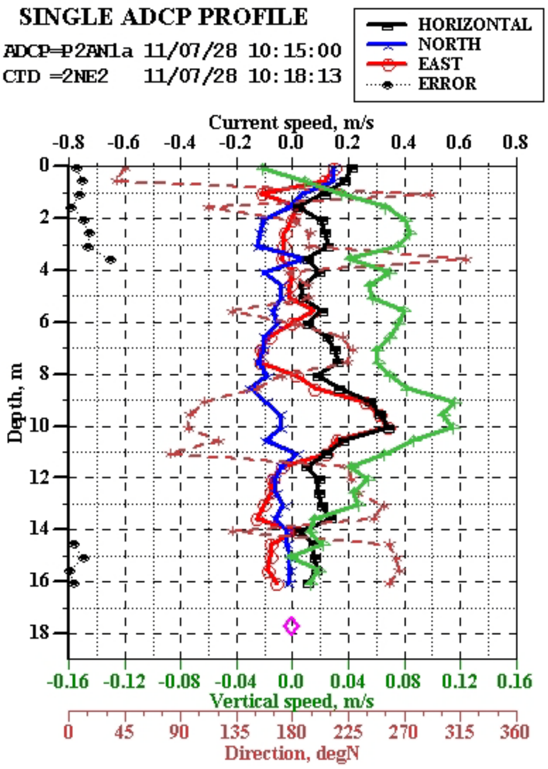


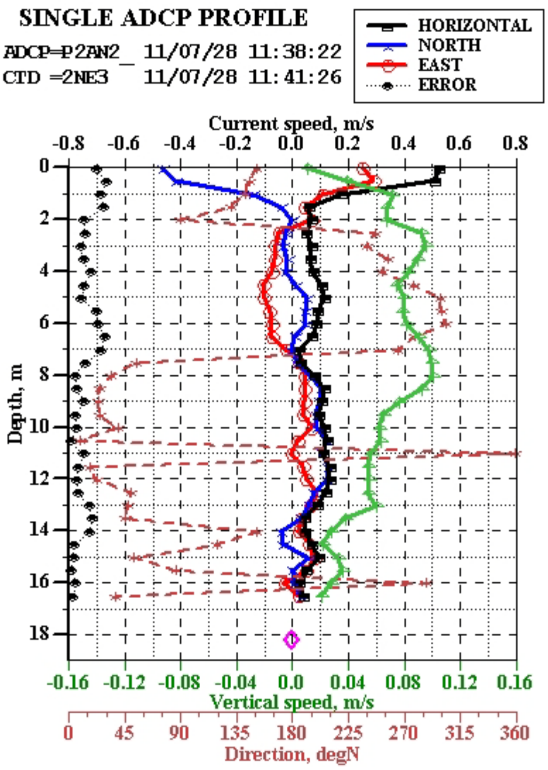


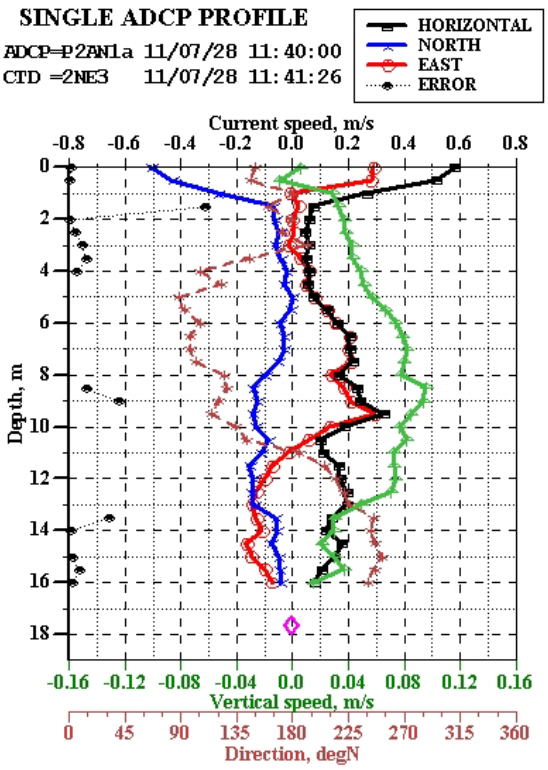




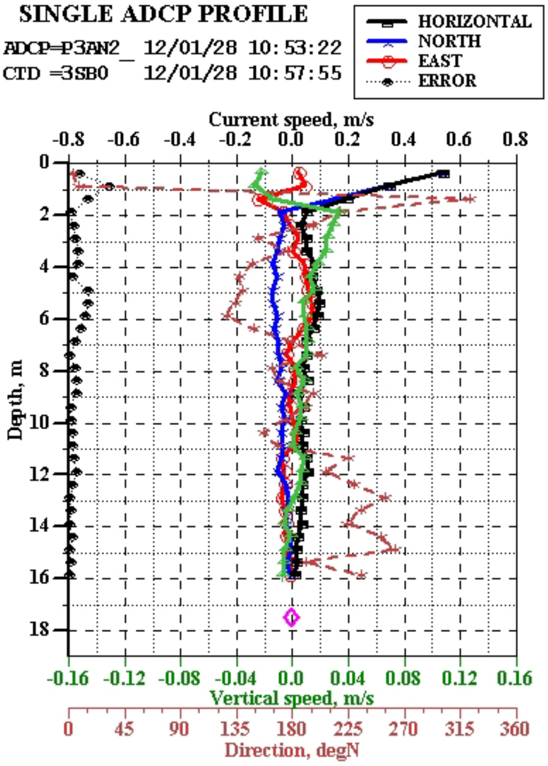

SINGLE ADCP PROFILE
ADCP=P2AN2_ 11/07/28 10:13:22
CTD =2NE2 11/07/28 10:18:13
HORIZONTAL
NORTH
EAST
ERROR
Current speed, m/s
Depth, m
Vertical speed, m/s
Direction, degN

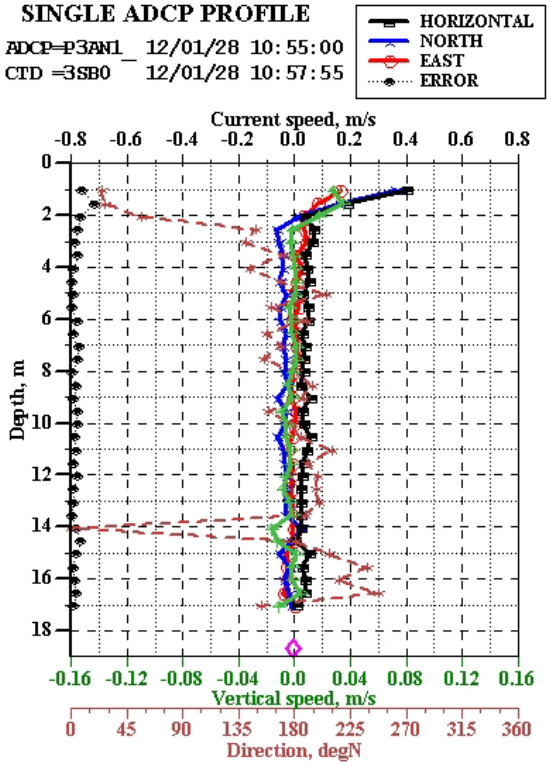

SINGLE ADCP PROFILE
ADCP=P2AN1a 11/07/28 10:15:00
CTD =2NE2 11/07/28 10:18:13
HORIZONTAL
NORTH
EAST
ERROR
Current speed, m/s
Depth, m
Vertical speed, m/s
Direction, degN

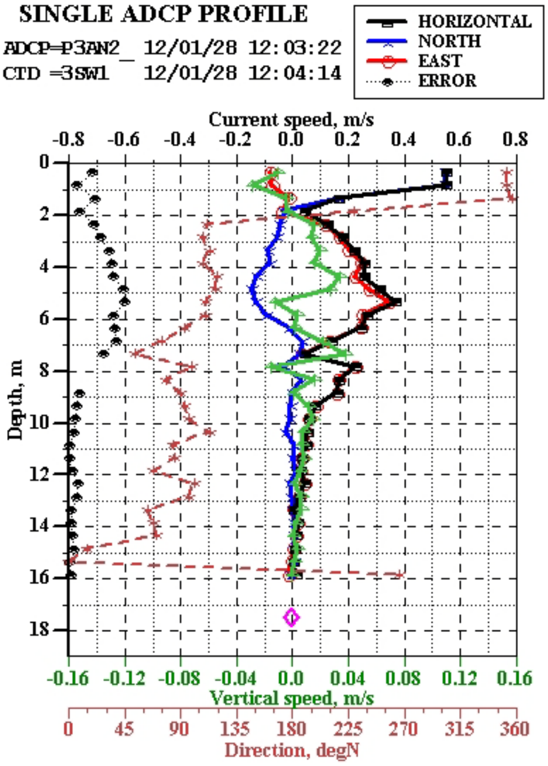

SINGLE ADCP PROFILE
ADCP=P2AN2_ 11/07/28 11:38:22
CTD =2NE3 11/07/28 11:41:26
HORIZONTAL
NORTH
EAST
ERROR
Current speed, m/s
Depth, m
Vertical speed, m/s
Direction, degN

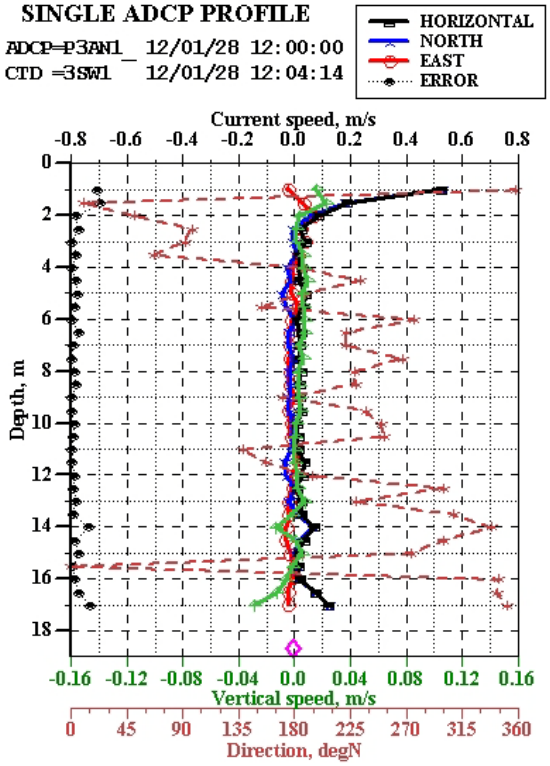

SINGLE ADCP PROFILE
ADCP=P2AN1a 11/07/28 11:40:00
CTD =2NE3 11/07/28 11:41:26
HORIZONTAL
NORTH
EAST
ERROR
Current speed, m/s
Depth, m
Vertical speed, m/s
Direction, degN

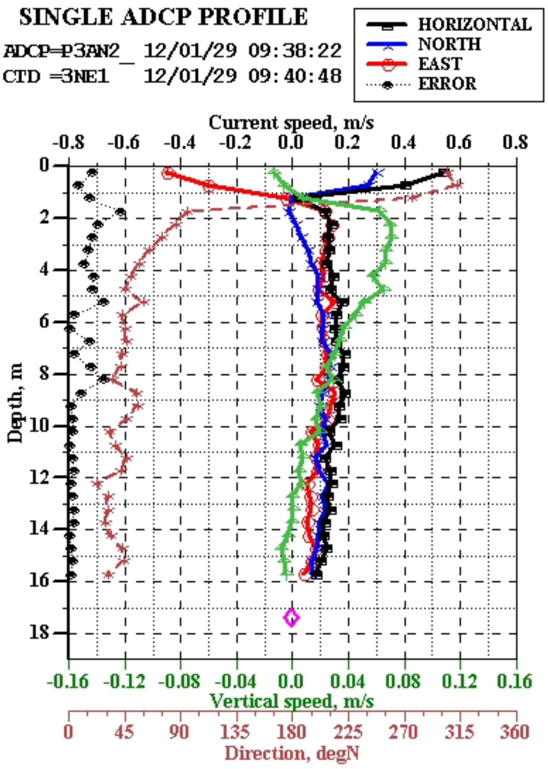
4.5.3 ADCP profiles synchronous with CTD casts - 3rd campaign

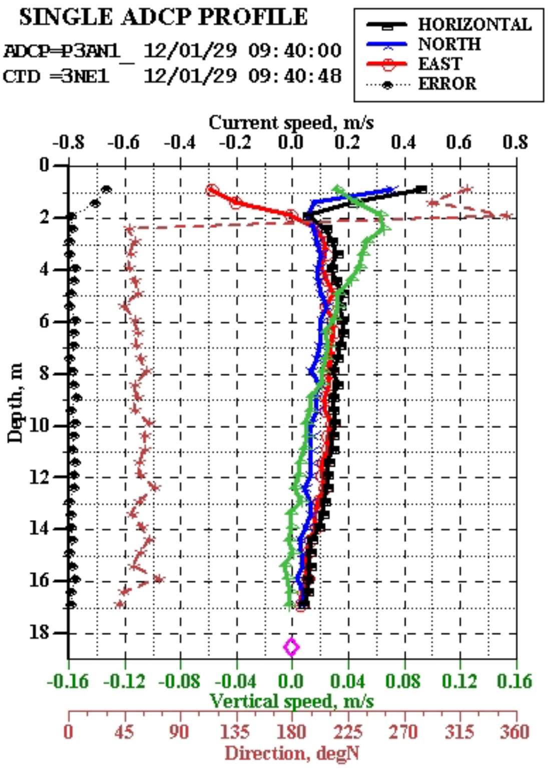


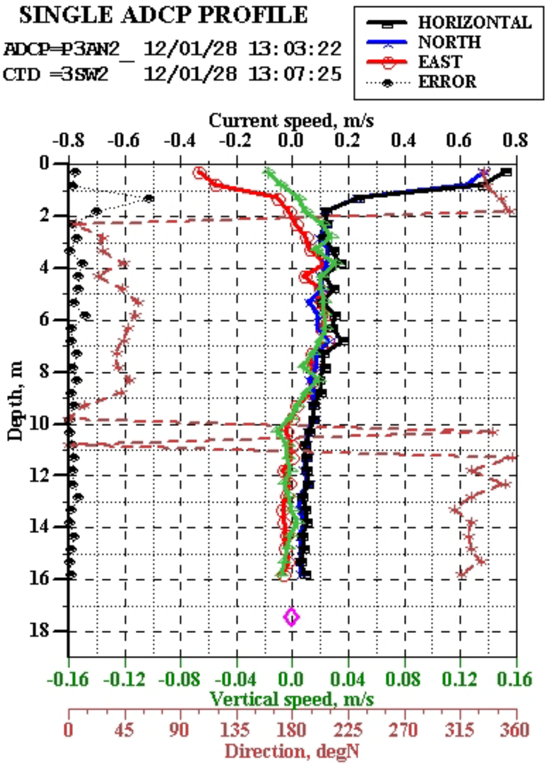


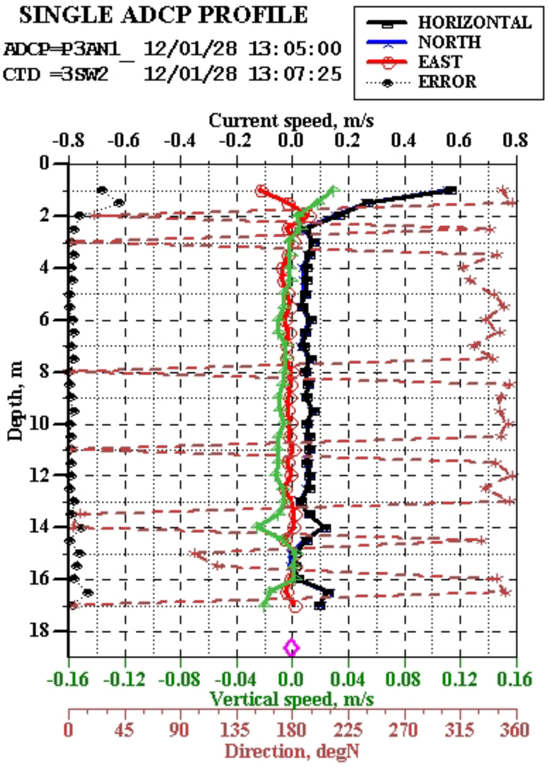


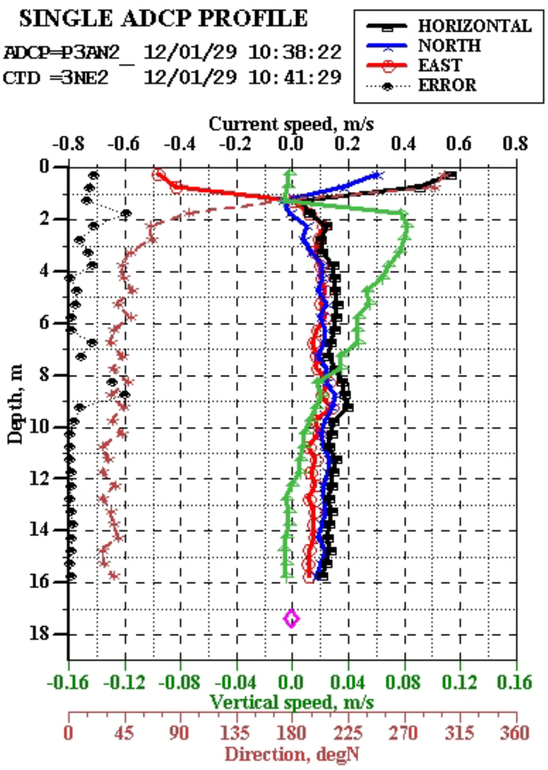


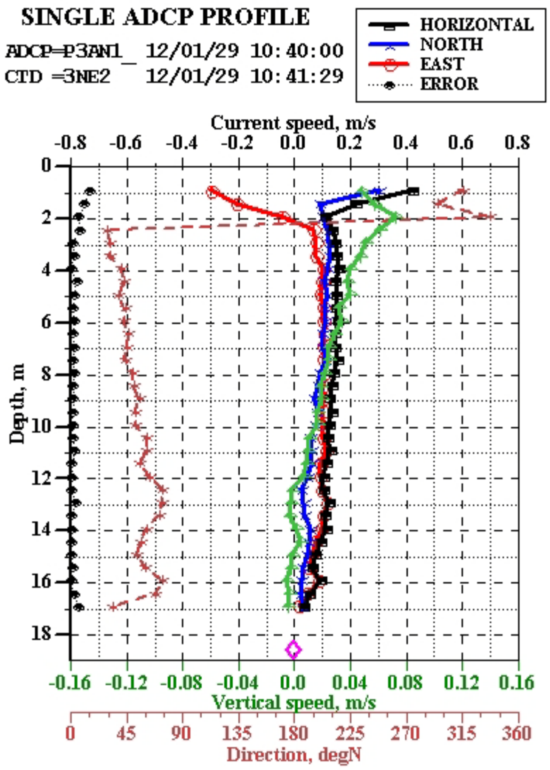

SINGLE ADCP PROFILE
ADCP=P3AN2_ 12/01/29 09:38:22
CTD =3NE1 12/01/29 09:40:48
HORIZONTAL
NORTH
EAST
ERROR
Current speed, m/s
Depth, m
Vertical speed, m/s
Direction, degN

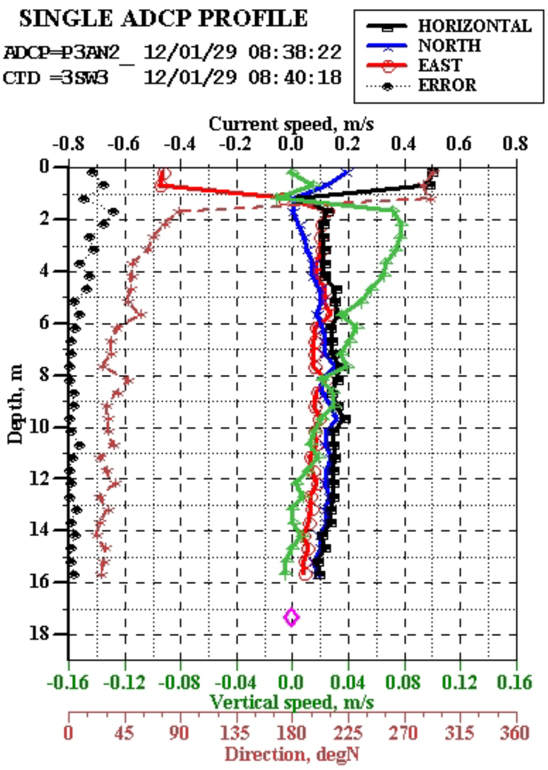

SINGLE ADCP PROFILE
ADCP=P3AN1_ 12/01/29 09:40:00
CTD =3NE1 12/01/29 09:40:48
HORIZONTAL
NORTH
EAST
ERROR
Current speed, m/s
Depth, m
Vertical speed, m/s
Direction, degN

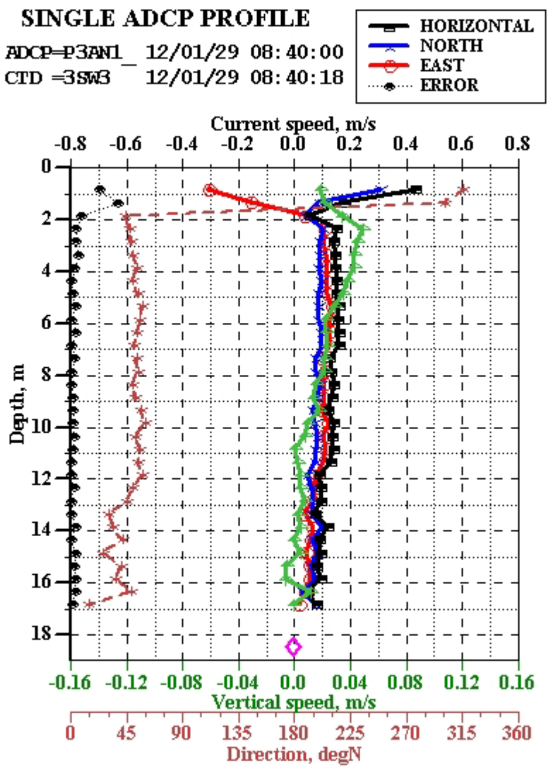

SINGLE ADCP PROFILE
ADCP=P3AN2_ 12/01/28 13:03:22
CTD =3SW2 12/01/28 13:07:25
HORIZONTAL
NORTH
EAST
ERROR
Current speed, m/s
Depth, m
Vertical speed, m/s
Direction, degN

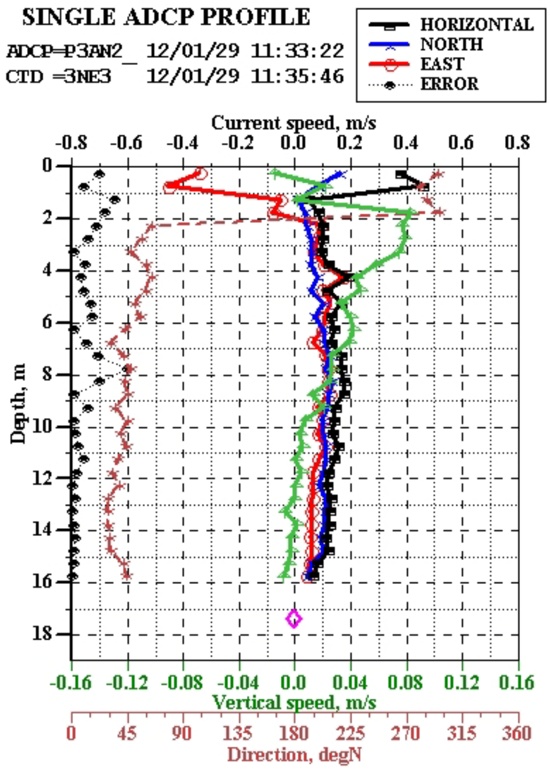

SINGLE ADCP PROFILE
ADCP=P3AN1_ 12/01/28 13:05:00
CTD =3SW2 12/01/28 13:07:25
HORIZONTAL
NORTH
EAST
ERROR
Current speed, m/s
Depth, m
Vertical speed, m/s
Direction, degN

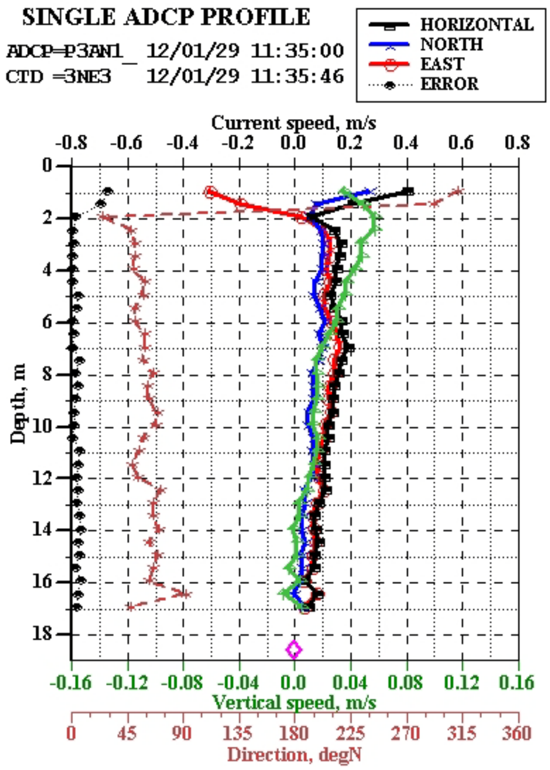

SINGLE ADCP PROFILE
ADCP=P3AN2_ 12/01/29 10:38:22
CTD =3NE2 12/01/29 10:41:29
HORIZONTAL
NORTH
EAST
ERROR
Current speed, m/s
Depth, m
Vertical speed, m/s
Direction, degN

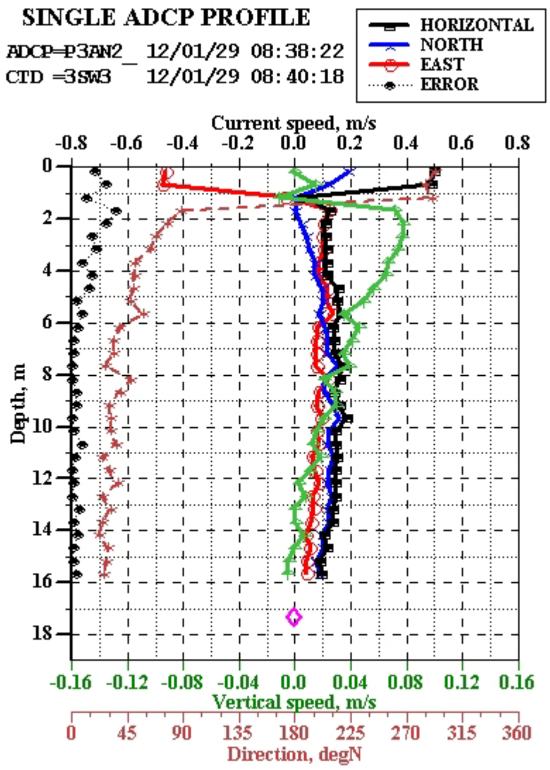

SINGLE ADCP PROFILE
ADCP=P3AN1_ 12/01/29 10:40:00
CTD =3NE2 12/01/29 10:41:29
HORIZONTAL
NORTH
EAST
ERROR
Current speed, m/s
Depth, m
Vertical speed, m/s
Direction, degN

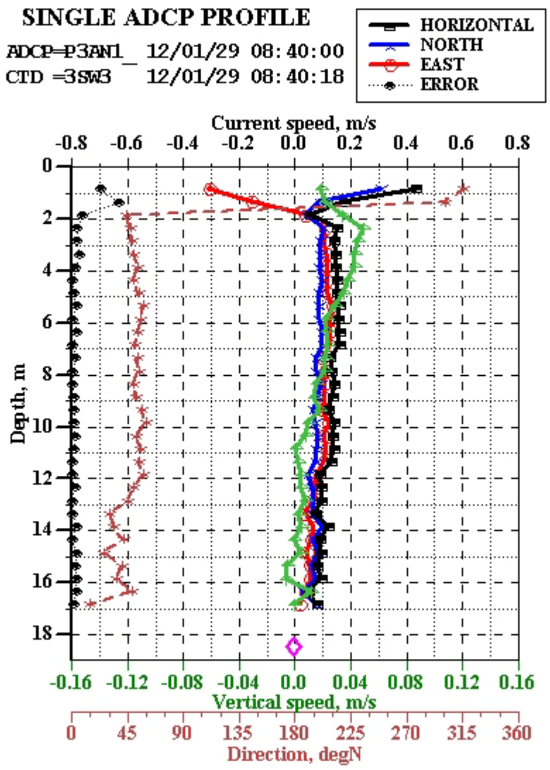

SINGLE ADCP PROFILE
ADCP=P3AN2_ 12/01/29 08:38:22
CTD =3SW3 12/01/29 08:40:18
HORIZONTAL
NORTH
EAST
ERROR
Current speed, m/s
Depth, m
Vertical speed, m/s
Direction, degN


SINGLE ADCP PROFILE
ADCP=P3AN1_ 12/01/29 08:40:00
CTD =3SW3 12/01/29 08:40:18
HORIZONTAL
NORTH
EAST
ERROR
Current speed, m/s
Depth, m
Vertical speed, m/s
Direction, degN

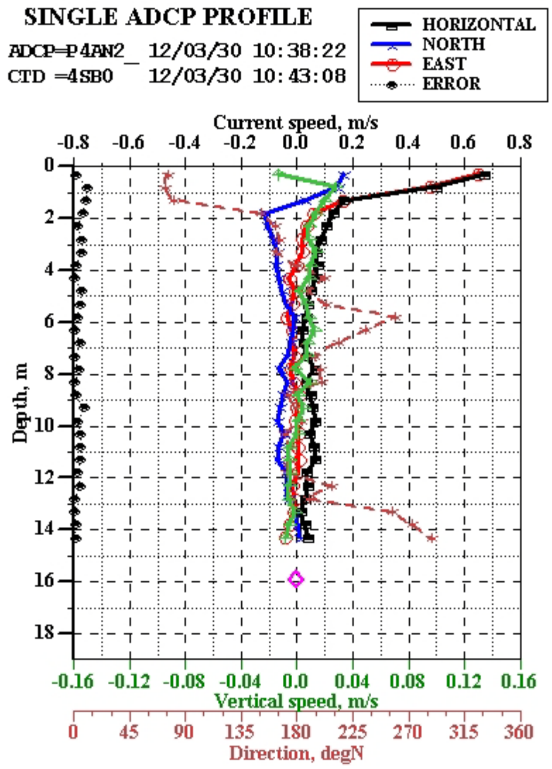

SINGLE ADCP PROFILE
ADCP=P3AN2_ 12/01/29 11:33:22
CTD =3NE3 12/01/29 11:35:46
HORIZONTAL
NORTH
EAST
ERROR
Current speed, m/s
-0.8 -0.6 -0.4 -0.2 0.0 0.2 0.4 0.6 0.8
Depth, m
0 2 4 6 8 10 12 14 16 18
-0.16 -0.12 -0.08 -0.04 0.0 0.04 0.08 0.12 0.16
Vertical speed, m/s
0 45 90 135 180 225 270 315 360
Direction, degN

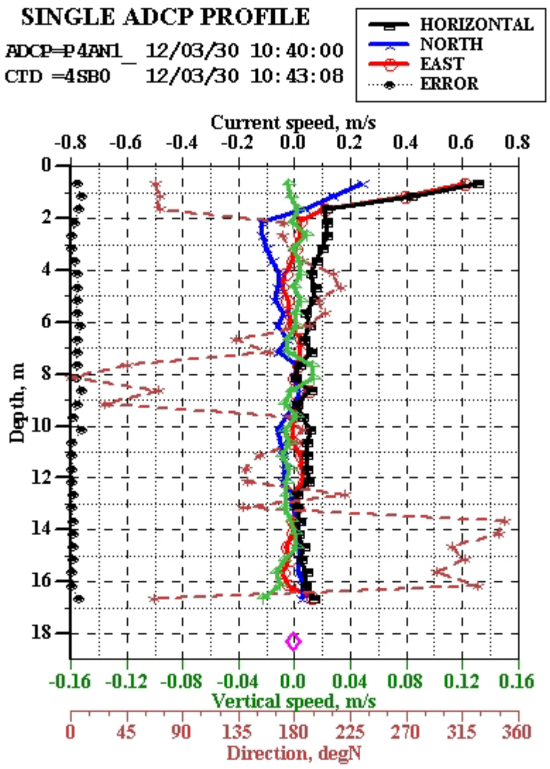

SINGLE ADCP PROFILE
ADCP=P3AN1_ 12/01/29 11:35:00
CTD =3NE3 12/01/29 11:35:46
HORIZONTAL
NORTH
EAST
ERROR
Current speed, m/s
-0.8 -0.6 -0.4 -0.2 0.0 0.2 0.4 0.6 0.8
Depth, m
0 2 4 6 8 10 12 14 16 18
-0.16 -0.12 -0.08 -0.04 0.0 0.04 0.08 0.12 0.16
Vertical speed, m/s
0 45 90 135 180 225 270 315 360
Direction, degN

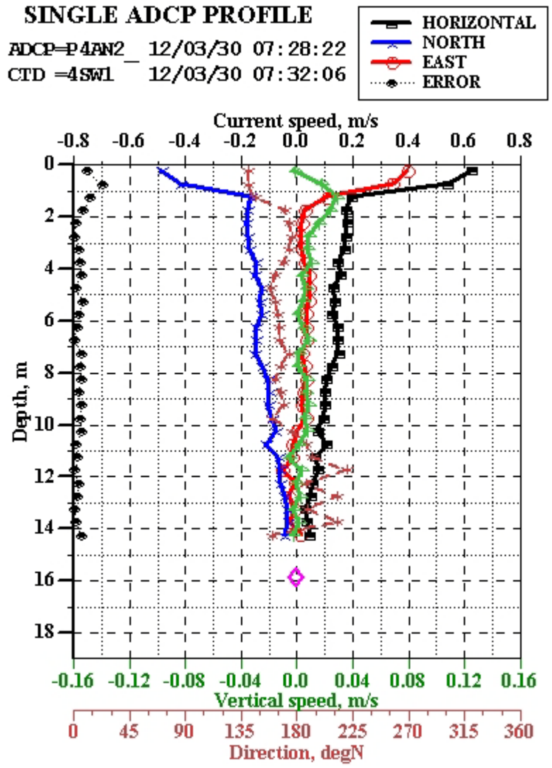

SINGLE ADCP PROFILE
ADCP=P3AN2_ 12/01/29 08:38:22
CTD =3SW3 12/01/29 08:40:18
HORIZONTAL
NORTH
EAST
ERROR
Current speed, m/s
-0.8 -0.6 -0.4 -0.2 0.0 0.2 0.4 0.6 0.8
Depth, m
0 2 4 6 8 10 12 14 16 18
-0.16 -0.12 -0.08 -0.04 0.0 0.04 0.08 0.12 0.16
Vertical speed, m/s
0 45 90 135 180 225 270 315 360
Direction, degN

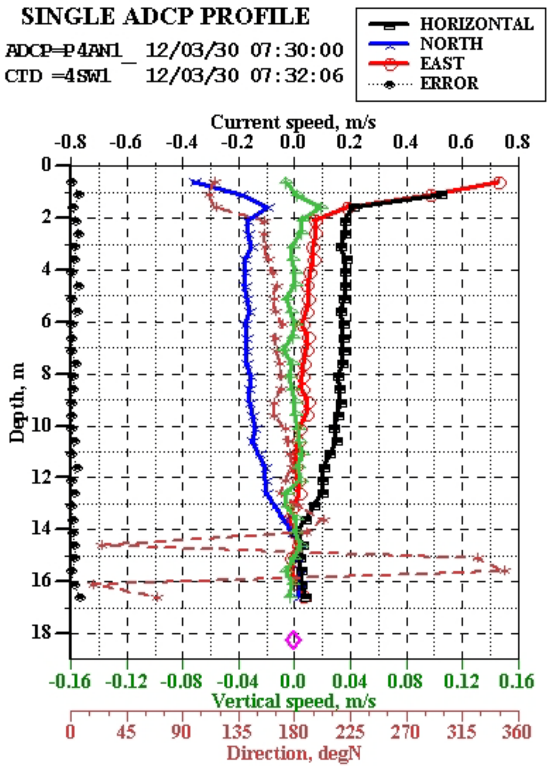

SINGLE ADCP PROFILE
ADCP=P3AN1_ 12/01/29 08:40:00
CTD =3SW3 12/01/29 08:40:18
HORIZONTAL
NORTH
EAST
ERROR
Current speed, m/s
-0.8 -0.6 -0.4 -0.2 0.0 0.2 0.4 0.6 0.8
Depth, m
0 2 4 6 8 10 12 14 16 18
-0.16 -0.12 -0.08 -0.04 0.0 0.04 0.08 0.12 0.16
Vertical speed, m/s
0 45 90 135 180 225 270 315 360
Direction, degN

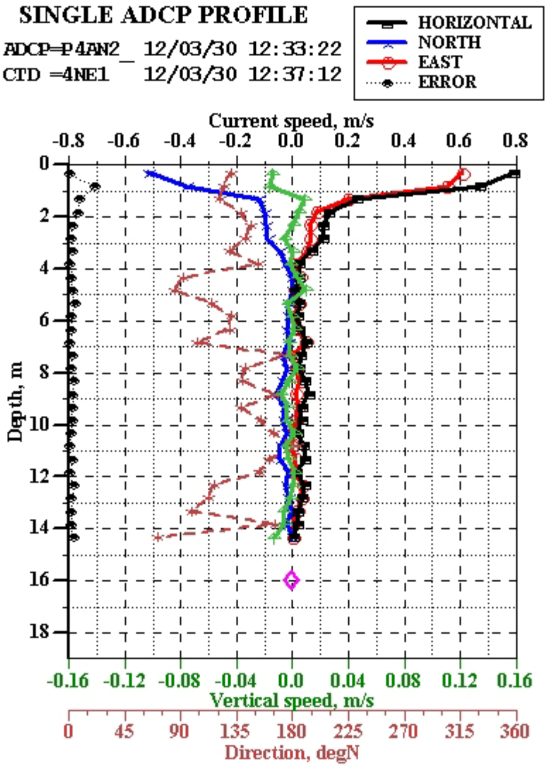
4.5.4 ADCP profiles synchronous with CTD casts – 4th campaign

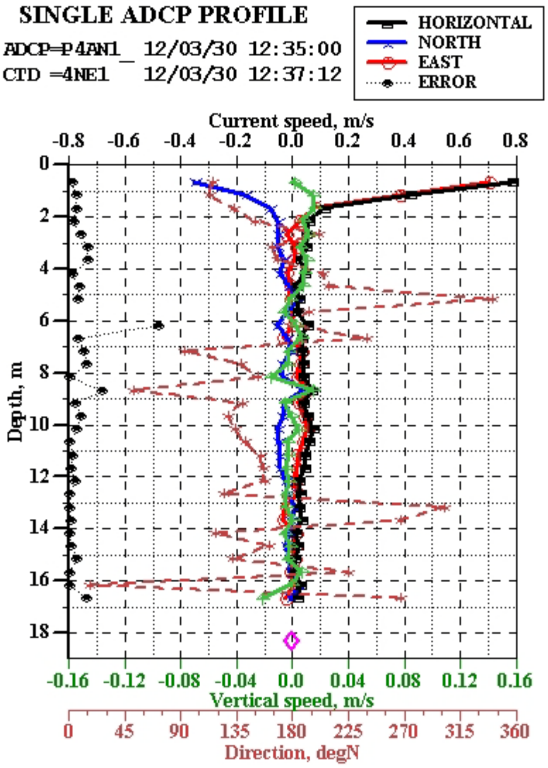


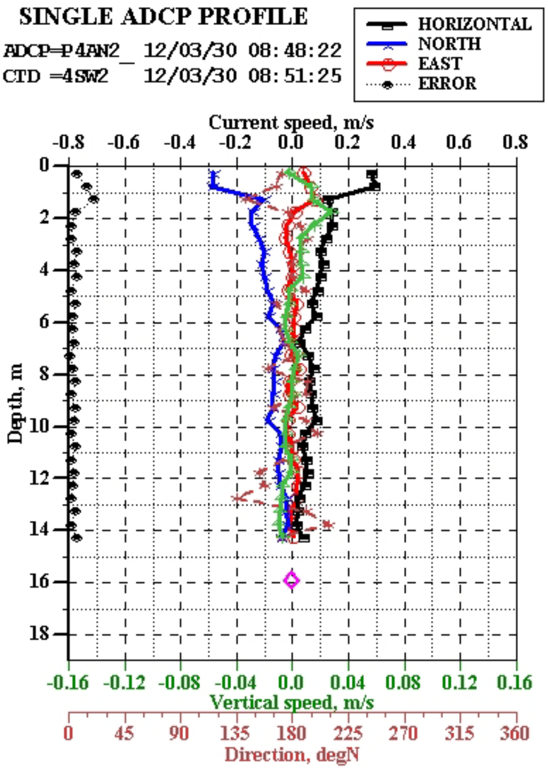


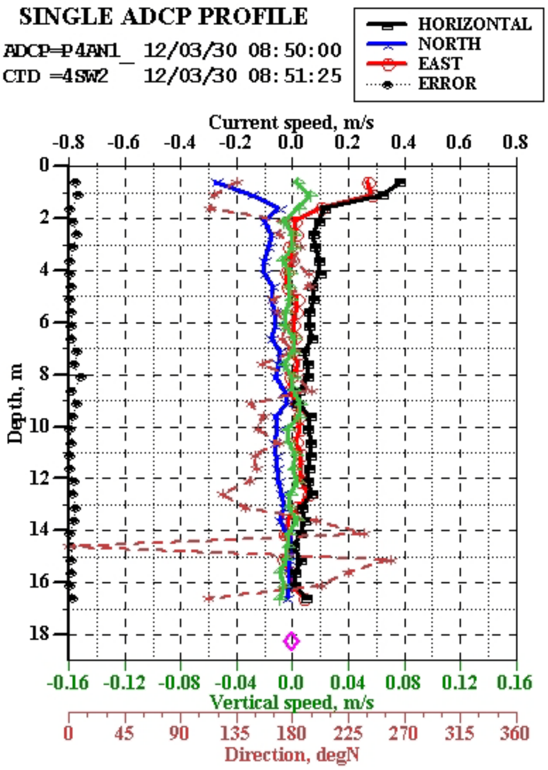


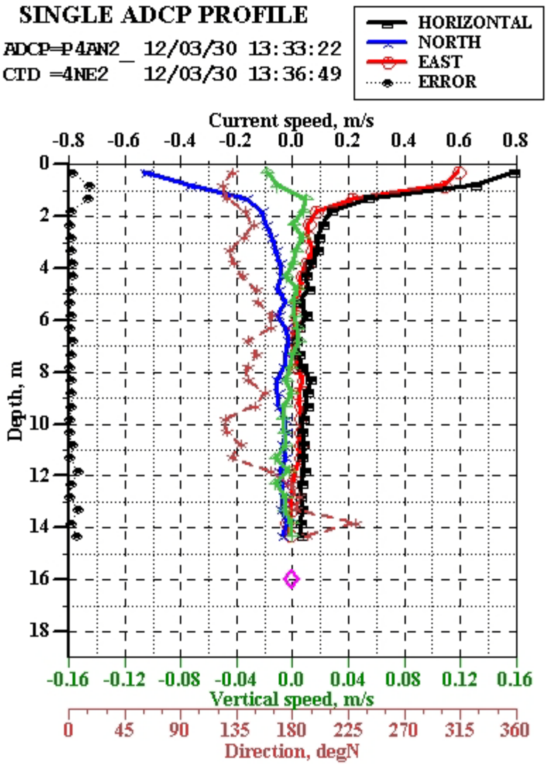


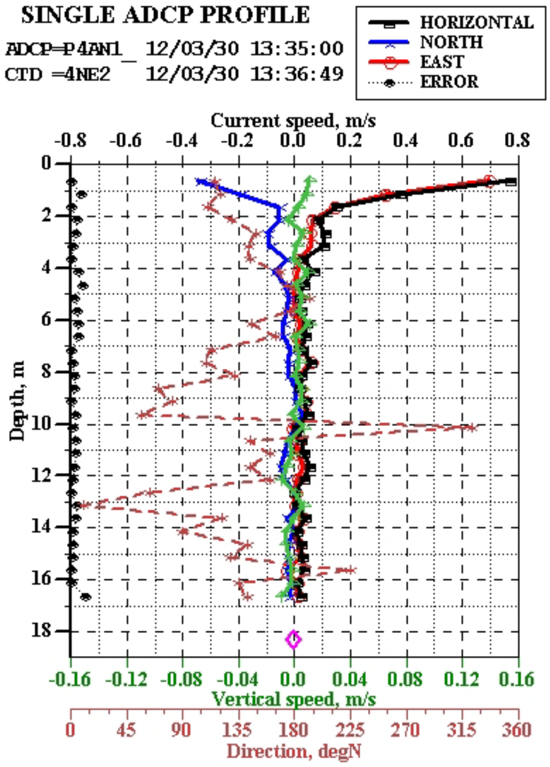

SINGLE ADCP PROFILE
ADCP=P4AN2_ 12/03/30 12:33:22
CTD =4NE1 12/03/30 12:37:12
HORIZONTAL
NORTH
EAST
ERROR
Current speed, m/s
Depth, m
Vertical speed, m/s
Direction, degN

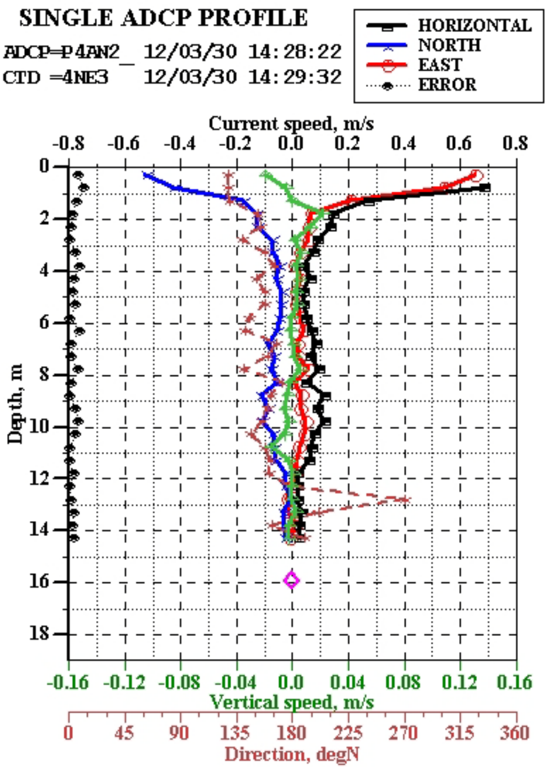

SINGLE ADCP PROFILE
ADCP=P4AN1_ 12/03/30 12:35:00
CTD =4NE1 12/03/30 12:37:12
HORIZONTAL
NORTH
EAST
ERROR
Current speed, m/s
Depth, m
Vertical speed, m/s
Direction, degN

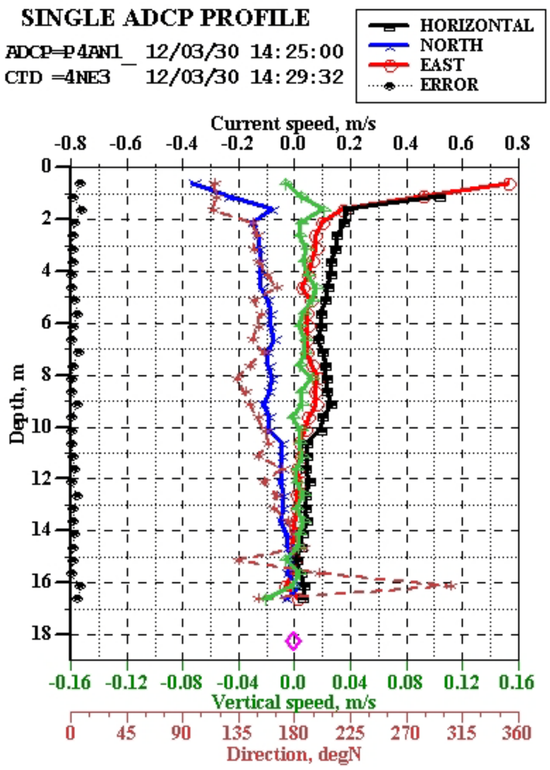

SINGLE ADCP PROFILE
ADCP=P4AN2_ 12/03/30 08:48:22
CTD =4SW2 12/03/30 08:51:25
HORIZONTAL
NORTH
EAST
ERROR
Current speed, m/s
Depth, m
Vertical speed, m/s
Direction, degN


SINGLE ADCP PROFILE
ADCP=P4AN1_ 12/03/30 08:50:00
CTD =4SW2 12/03/30 08:51:25
HORIZONTAL
NORTH
EAST
ERROR
Current speed, m/s
Depth, m
Vertical speed, m/s
Direction, degN

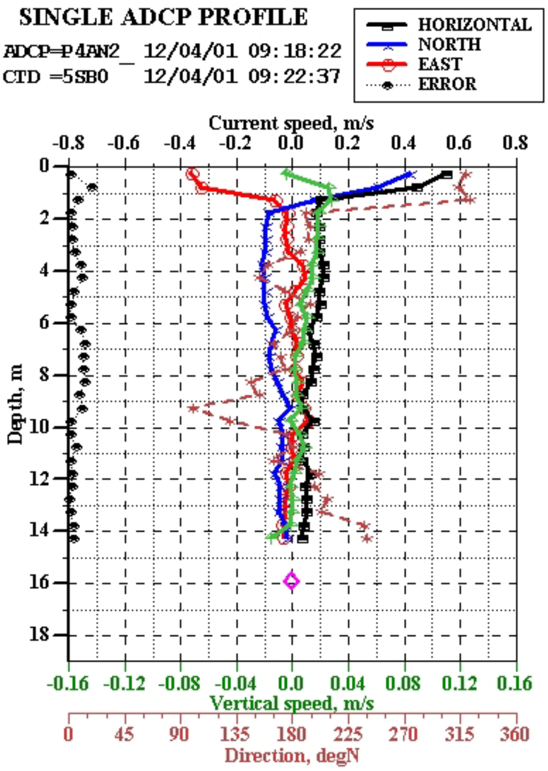

SINGLE ADCP PROFILE
ADCP=P4AN2_ 12/03/30 13:33:22
CTD =4NE2 12/03/30 13:36:49
HORIZONTAL
NORTH
EAST
ERROR
Current speed, m/s
Depth, m
Vertical speed, m/s
Direction, degN

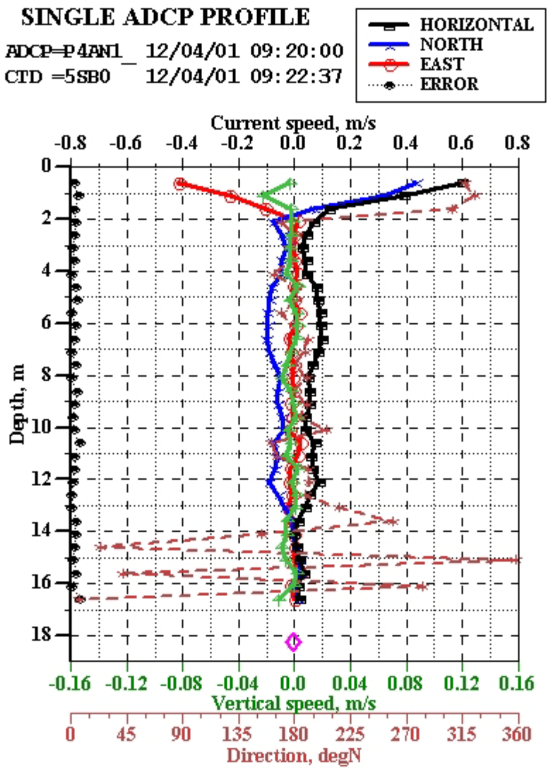

SINGLE ADCP PROFILE
ADCP=P4AN1_ 12/03/30 13:35:00
CTD =4NE2 12/03/30 13:36:49
HORIZONTAL
NORTH
EAST
ERROR
Current speed, m/s
Depth, m
Vertical speed, m/s
Direction, degN

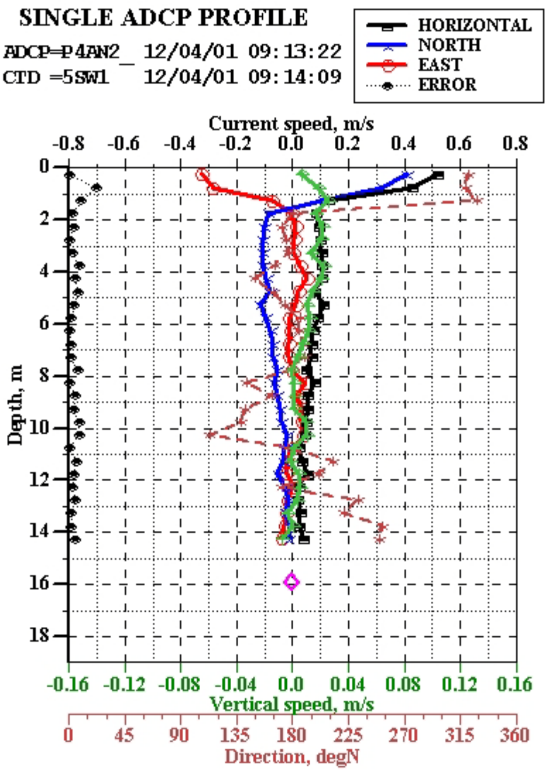

SINGLE ADCP PROFILE
ADCP=P4AN2_ 12/03/30 14:28:22
CTD =4NE3 12/03/30 14:29:32
HORIZONTAL
NORTH
EAST
ERROR
Current speed, m/s
Depth, m
Vertical speed, m/s
Direction, degN

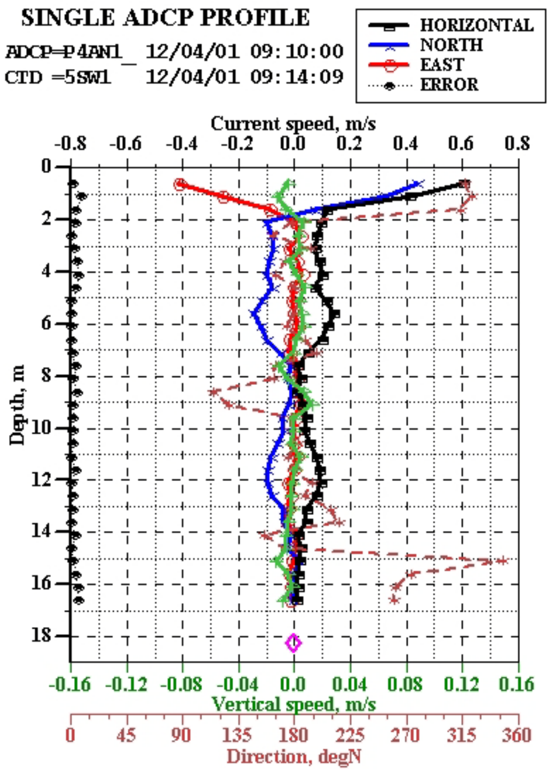

SINGLE ADCP PROFILE
ADCP=P4AN1_ 12/03/30 14:25:00
CTD =4NE3 12/03/30 14:29:32
HORIZONTAL
NORTH
EAST
ERROR
Current speed, m/s
Depth, m
Vertical speed, m/s
Direction, degN

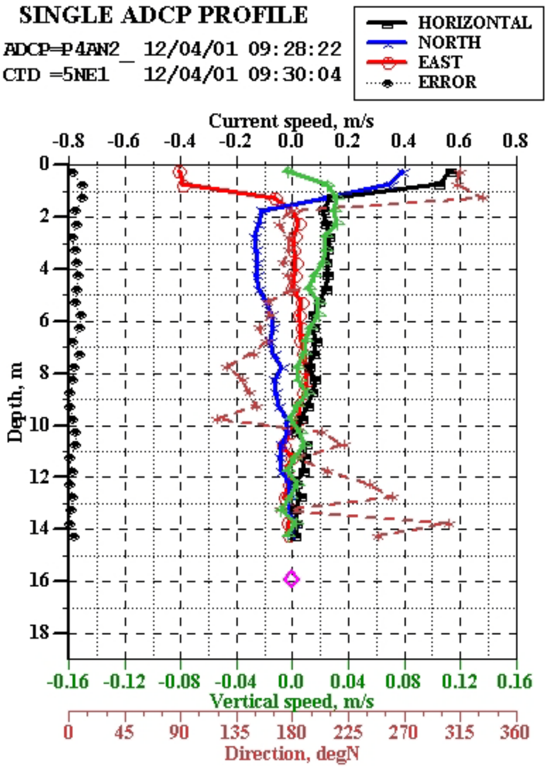
4.5.5 ADCP profiles synchronous with additional CTD casts – 4th campaign

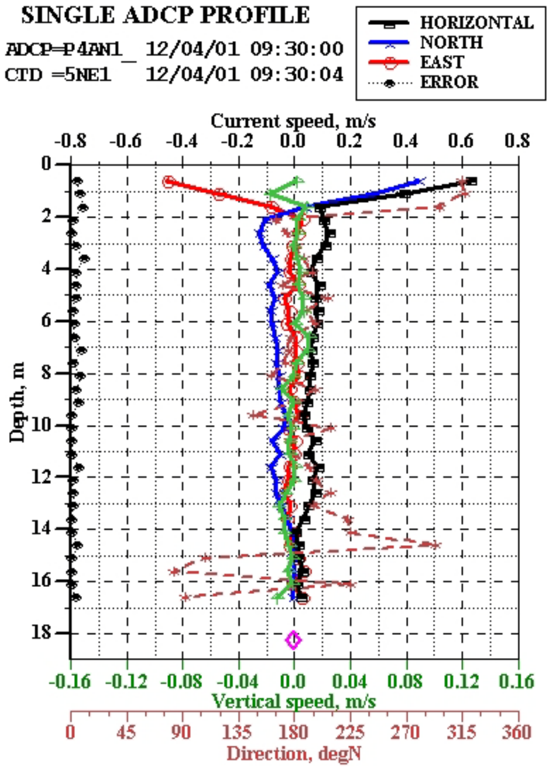


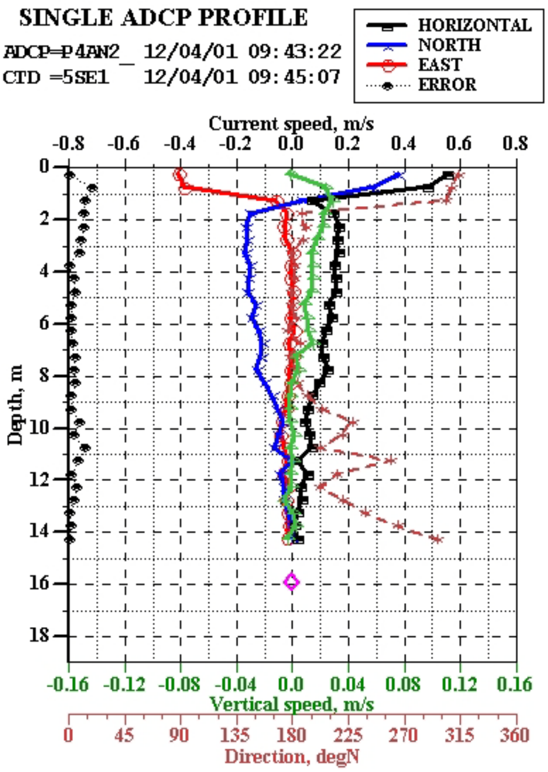


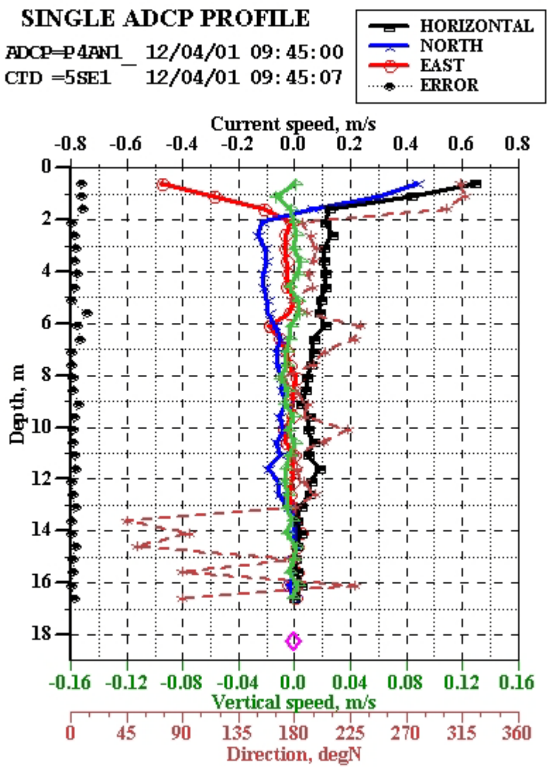


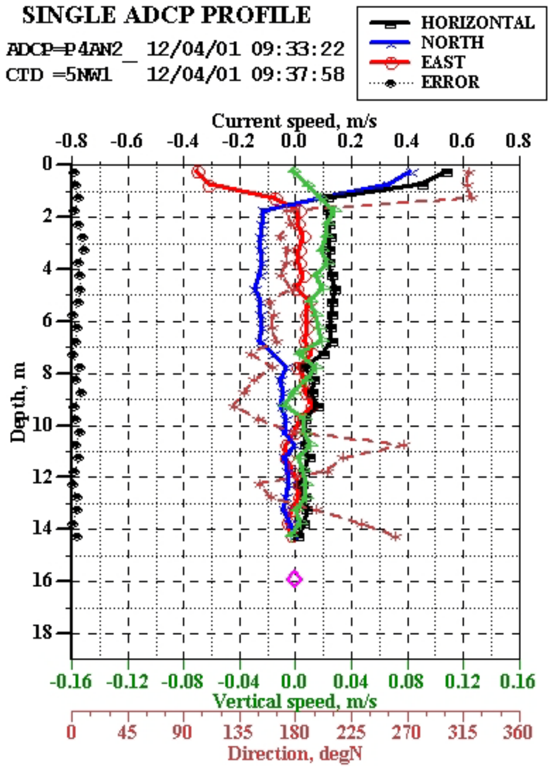


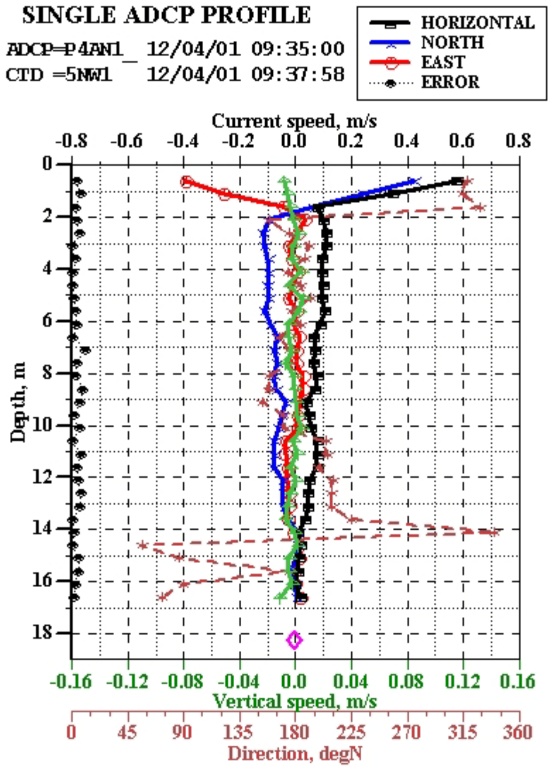

SINGLE ADCP PROFILE
ADCP=P4AN2_ 12/04/01 09:28:22
CTD =5NE1 12/04/01 09:30:04
HORIZONTAL
NORTH
EAST
ERROR
Current speed, m/s
Depth, m
Vertical speed, m/s
Direction, degN


SINGLE ADCP PROFILE
ADCP=P4AN1_ 12/04/01 09:30:00
CTD =5NE1 12/04/01 09:30:04
HORIZONTAL
NORTH
EAST
ERROR
Current speed, m/s
Depth, m
Vertical speed, m/s
Direction, degN


SINGLE ADCP PROFILE
ADCP=P4AN2_ 12/04/01 09:43:22
CTD =5SE1 12/04/01 09:45:07
HORIZONTAL
NORTH
EAST
ERROR
Current speed, m/s
Depth, m
Vertical speed, m/s
Direction, degN


SINGLE ADCP PROFILE
ADCP=P4AN1_ 12/04/01 09:45:00
CTD =5SE1 12/04/01 09:45:07
HORIZONTAL
NORTH
EAST
ERROR
Current speed, m/s
Depth, m
Vertical speed, m/s
Direction, degN


SINGLE ADCP PROFILE
ADCP=P4AN2_ 12/04/01 09:33:22
CTD =5NW1 12/04/01 09:37:58
HORIZONTAL
NORTH
EAST
ERROR
Current speed, m/s
Depth, m
Vertical speed, m/s
Direction, degN


SINGLE ADCP PROFILE
ADCP=P4AN1_ 12/04/01 09:35:00
CTD =5NW1 12/04/01 09:37:58
HORIZONTAL
NORTH
EAST
ERROR
Current speed, m/s
Depth, m
Vertical speed, m/s
Direction, degN

5 DESCRIPTION AND FILE FORMATS OF RISCS PANAREA ADCP DATASET

Refer to column ***Prefix of file names*** and note 4) of table 4.1 of § for decrypting file names.

5.1 Raw data files

The subdirectory containing the raw data files **.000* is named *"RAW"*. Those are binary data files discharged from the memory of the ADCP using TRDI software. They comprise also measurements made before and after the mooring. During the second campaign the ADCP moored at station AN1 acquired two separated files P2AN1000.000 and P2AN1001.000. The recording gap is 41' long.

Campaign	File name
1st, fall 2010	P1SW1000.000
2nd, summer 2011	P2AN1000.000
	P2AN1001.000
	P2AN2000.000
3rd, winter 2012	P3AN1000.000
	P3AN2000.000
4th, spring 2012	P4AN1000.000
	P4AN2000.000

5.2 Ancillary data files – WinADCP format

The subdirectory containing **ANC.txt* files is named *"ANC"*. The *ANC.txt* ASCII files were obtained using the TRDI software named WinADCP. Cutting P2AN2_ as close as possible to times of start and end P2AN1a and P2AN1b, the records P2AN2a and P2AN2b have been obtained; this expedient facilitates comparative analysis between the two stations' data.

Campaign	File name
1st, fall 2010	P1SW1_ANC.txt
2nd, summer 2011	P2AN1aANC.txt
	P2AN1bANC.txt
	P2AN2_ANC.txt
	P2AN2aANC.txt
	P2AN2bANC.txt
3rd, winter 2012	P3AN1_ANC.txt
	P3AN2_ANC.txt
4th, spring 2012	P4AN1_ANC.txt
	P4AN2_ANC.txt

FORMAT DESCRIPTION:
the first 10 lines contain self describing metadata on acquisition parameters. At line 13 the header specify the contents of the time series: *Ens* is the ensamble number; *YR*, *M*, *DA*, *HH*, *MM*, *SS*, *HH* are year, month, day, hour, minutes and second respectively; *"Pit"*, *"Rol"*, *"Hea"*, *"Tem"*, are pitch(°), roll(°), heading (°N) and temperature (°C) respectively.
NOTE: the analysis of pitch, roll and heading information, regarding the entire acquisition (also data gathered from instrument not moored) has been useful for determining the first and last valid ensamble numbers.

5.3 Ancillary data files – Gsharp format

The subdirectory containing **ATS.txt* files is named *"ATS"*.(acronym for *ancillary time series*). The **ATS.dat* ASCII files were obtained using the OGS Fortran code named *extradcp36.f* that converts the **ANC.txt* files into a simpler format compatible with the *AVS/Gsharp* data visualization software.

Campaign	File name
1st, fall 2010	P1SW1_ATS.dat
2nd, summer 2011	P2AN1aATS.dat
	P2AN1bATS.dat
	P2AN2_ATS.dat
	P2AN2aATS.dat
	P2AN2bATS.dat
3rd, winter 2012	P3AN1_ATS.dat
	P3AN2_ATS.dat
4th, spring 2012	P4AN1_ATS.dat
	P4AN2_ATS.dat

FORMAT DESCRIPTION:
Ens is the ensamble number, *YDaya* is the day of the year in floating format, *YYMMDDHHMNSSa* is the date and time in compact format 6I2; *Temp* is temperature (°C); *BDepth* is bottom depth computed by pressure measurements taking into account measured temperature and user imposed salinity; *BDeptC* is the bottom depth corrected for pressure sensor bias and drift and sensor height above sea level; *Pitch*, *Rol*, *Head* are pitch(°), roll(°), heading (°N) respectively.

NOTE1: These files contains only data acquired by moored (still) instruments.
NOTE2: Cutting P2AN2_as close as possible to times of start and end P2AN1a and P2AN1b, the records P2AN2a and P2AN2b have been obtained; this expedient facilitates comparative analysis between the two stations' data.

5.4 Converted data files

The subdirectory containing **DOK.txt* files is named *"C36"*. The **DOK.dat* ASCII files were obtained using the TRDI software named *BBLIST.exe*, applying a user defined format.
FORMAT DESCRIPTION:
the format description is available in the **.RPT* associated metadata files.
NOTE:during the first two campaigns a wrong magnetic variation was imposed; those mistakes were corrected when producing the converted files.

Campaign	File name of data file	File name of metadata file
1st, fall 2010	P1SW1_DOK.txt	P1SW1_DOK.RPT
2nd, summer 2011	P2AN1aDOK.txt	P2AN1aDOK.RPT
	P2AN2bDOK.txt	P2AN2bDOK.RPT
	P2AN2_DOK.txt	P2AN2_DOK.RPT
	P2AN2aDOK.txt	P2AN2_DOK.RPT
	P2AN2bDOK.txt	P2AN2_DOK.RPT
3rd, winter 2012	P3AN1_DOK.txt	P3AN1_DOK.RPT
	P3AN2_DOK.txt	P3AN2_DOK.RPT
4th, spring 2012	P4AN1_DOK.txt	P4AN1_DOK.RPT
	P4AN2_DOK.txt	P4AN2_DOK.RPT

5.5 Current data statistics and ancillary data statistics; the files

The subdirectory containing those **STA.dat* files is named *"STA"*. The **STA.dat* ASCII files were obtained using the OGS Fortran code named *extradcp36.f* and contains statistics of current data.
FORMAT DESCRIPTION:
The label used for bin number is *NB* at a fixed *Range* (m) from the bottom; *Fla* is a flag (0 for valid bins, 1 for discarded bins); *ND* is the total number of data of which *Ngv* is the number of valid data. The other columns are *MagAve DirAve EasAve NorAve VerAve EasStd NorStd VerStd MagMax EasMin EasMax NorMin NorMax VerMin VerMax*, where: *Mag stands for* magnitude of horizontal velocity (m/s), *Dir* for direction (°N), *Eas* for east component, *Nor* for north component, *Ver* for vertical component; *Ave, Std, Min, Max* stand for average, standard deviation, minimum, maximum values respectively.
NOTE: the file *ANCI_STA.dat* contains statistics of ancillary data in a self-describing format.

Campaign	File name	Contents
1st, fall 2010	P1SW1_STA.dat	Statistics of current data
2nd, summer 2011	P2AN1aSTA.dat	Statistics of current data
	P2AN1bSTA.dat	Statistics of current data
	P2AN2_STA.dat	Statistics of current data
	P2AN2aSTA.dat	Statistics of current data
	P2AN2bSTA.dat	Statistics of current data
3rd, winter 2012	P3AN1_STA.dat	Statistics of current data
	P3AN2_STA.dat	Statistics of current data
4th, spring 2012	P4AN1_STA.dat	Statistics of current data
	P4AN2_STA.dat	Statistics of current data
All campaigns	ALLBINS_STA.dat	Stat. of all current. data
All campaigns	ANCI_STA.dat	Stat. of all ancillary data

5.6 Time series of current data; the files

The subdirectory containing those **BINxyz.dat* files is named *"VTS"* (acronym for *velocity time series).*
The **BINxyz.dat* ASCII files (where *xyz*=001,002,003,…) were obtained using the OGS Fortran code named *extradcp36.f* and contain time series of current data. Each file contains only data belonging to a

Campaign	File name
1st, fall 2010	P1SW1_BIN*xyz*.dat
2nd, summer 2011	P2AN1aBIN*xyz*.dat
	P2AN1bBIN*xyz*.dat
	P2AN2_BIN*xyz*.dat
	P2AN2aBIN*xyz*.dat
	P2AN2bBIN*xyz*.dat
3rd, winter 2012	P3AN1_BIN*xyz*.dat
	P3AN2_BIN*xyz*.dat
4th, spring 2012	P4AN1_BIN*xyz*.dat
	P4AN2_BIN*xyz*.dat

fixed bin or cell - # 001, 002, 003, … - at a fixed range from the bottom.
NOTE1: The number of files corresponding to different campaigns and different stations is different.
NOTE2: The number of files is always 36 for each deployment, but the files with high *xyz* number may contain bad data, that is corresponding to ranges too large (echoes from above the sea surface) or too close to the sea surface and, for this reason, affected by side lobe contamination (RD Instruments, 1996).

FORMAT DESCRIPTION:

Line	Field	Description	Example
1	1	File name	P3AN1_BIN020.dat
2	1	Latitude (float)	38.638466 15.107017 0.000 11.120 0.000 300.000 0
	2	Longitude (float)	
	3	field not used	
	4	range(m)	
	5	field not used	
	6	# of s per ensamble	
	7	field not used	
3		Void	
4	1	Labels	YDay YYMMDDHHMNSS Eas Nor Ver Err Mag Dir Iflad
5 and following	1	day of the year (float)	27.454861 120128105500 0.014 -0.030 0.002 -0.023 0.033 155.000 0
	2	date & time format 6I2: YYMMDDHHMNSS	
	3	East comp. (m/s)	
	4	North comp. (m/s)	
	5	Vertical comp. (m/s)	
	6	Error velocity (m/s)	
	7	Magnitude of horizontal comp (m/s)	
	8	Direction (°N)	
	9	Flag to characterize samples	

5.7 ADCP single profile data synchronous with CTD casts; the files

The subdirectory containing those **PRO.dat* files is named *"PRO"* (acronym of *profile*). The **PRO.dat* ASCII files were obtained using the OGS Fortran code named *extradcp36.f* and contains single ADCP vertical profiles synchronous, that is sampled at the same time, with the CTD casts

FORMAT DESCRIPTION: The label *DeptC* refer to the corrected depth (distance from the surface). *BDeptC* refers to the corrected bottom depth. The correction of depth signal is described in §4.2.

Campaign	File name
1st, fall 2010	P1SW1_1NE1_PRO.dat
	P1SW1_1NE2_PRO.dat
	P1SW1_1NE3_PRO.dat
	P1SW1_1SB0_PRO.dat
	P1SW1_1SW1_PRO.dat
	P1SW1_1SW2_PRO.dat
	P1SW1_1SW3_PRO.dat
2nd, summer 2011	P2AN1a2NE1_PRO.dat
	P2AN1a2NE2_PRO.dat
	P2AN1a2NE3_PRO.dat
	P2AN1a2SB0_PRO.dat
	P2AN2a2NE1_PRO.dat
	P2AN2a2NE2_PRO.dat
	P2AN2a2NE3_PRO.dat
	P2AN2a2SB0_PRO.dat
	P2AN2_2NE1_PRO.dat
	P2AN2_2NE2_PRO.dat
	P2AN2_2NE3_PRO.dat
	P2AN2_2SB0_PRO.dat
3rd, winter 2012	P3AN1_3NE1_PRO.dat
	P3AN1_3NE2_PRO.dat
	P3AN1_3NE3_PRO.dat
	P3AN1_3SB0_PRO.dat
	P3AN1_3SW1_PRO.dat
	P3AN1_3SW2_PRO.dat
	P3AN1_3SW3_PRO.dat
	P3AN2_3NE1_PRO.dat
	P3AN2_3NE2_PRO.dat
	P3AN2_3NE3_PRO.dat
	P3AN2_3SB0_PRO.dat
	P3AN2_3SW1_PRO.dat
	P3AN2_3SW2_PRO.dat
	P3AN2_3SW3_PRO.dat
4th, spring 2012	P4AN1_4NE1_PRO.dat
	P4AN1_4NE2_PRO.dat
	P4AN1_4NE3_PRO.dat
	P4AN1_4SB0_PRO.dat
	P4AN1_4SW1_PRO.dat
	P4AN1_4SW2_PRO.dat
	P4AN1_4SW3_PRO.dat
	P4AN1_5NE1_PRO.dat
	P4AN1_5NW1_PRO.dat
	P4AN1_5SB0_PRO.dat
	P4AN1_5SE1_PRO.dat
	P4AN1_5SW1_PRO.dat
	P4AN2_4NE1_PRO.dat
	P4AN2_4NE2_PRO.dat
	P4AN2_4NE3_PRO.dat
	P4AN2_4SB0_PRO.dat
	P4AN2_4SW1_PRO.dat
	P4AN2_4SW2_PRO.dat
	P4AN2_4SW3_PRO.dat
4th, spring 2012 corresponding to additional x CTD profiles	P4AN2_5NE1_PRO.dat
	P4AN2_5NW1_PRO.dat
	P4AN2_5SB0_PRO.dat
	P4AN2_5SE1_PRO.dat
	P4AN2_5SW1_PRO.dat
All four campaigns	ALL_PRO.dat

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