APPENDIX H5.5

Additional oceanographic data collected in 2010

BMT WBM

Point Lowly Instrument Deployment Preliminary Data

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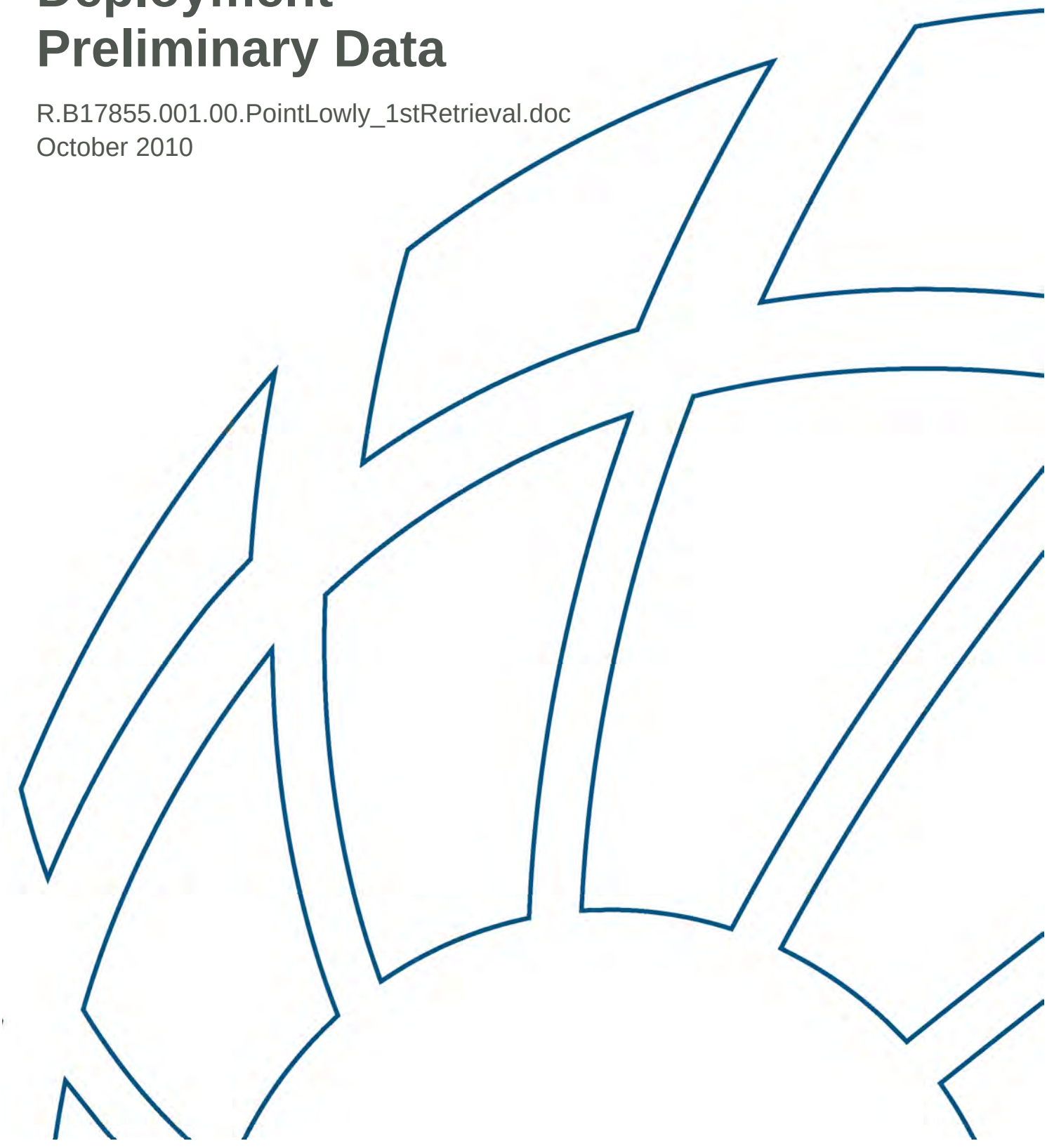
October 2010



Point Lowly Instrument Deployment Preliminary Data Retrieval Report

Prepared For:	BHP Billiton
Prepared By:	BMT WBM Pty Ltd (Member of the BMT group of companies)

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DOCUMENT CONTROL SHEET

BMT WBM Pty Ltd

BMT WBM Pty Ltd
Level 11, 490 Upper Edward Street
Brisbane 4000
Queensland Australia
PO Box 203 Spring Hill 4004

Tel: +61 7 3831 6744
Fax: + 61 7 3832 3627

ABN 54 010 830 421

www.wbmpl.com.au

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Project Manager :	Michael Barry
Client :	BHP Billiton
Client Contact:	David Wiltshire
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Author :	Daniel Botelho
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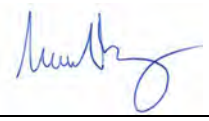
0	22/10/2010	Michael Barry		Daniel Botelho	

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CONTENTS

1 INTRODUCTION

BHP Billiton commissioned BMT WBM to collect oceanographic data at Point Lowly (Whyalla), South Australia as part of the ongoing marine environmental assessment works for the Olympic Dam Expansion and its associated proposed desalination plant discharge. Point Lowly is located in the Northern Spencer Gulf at approximately latitude 33^{o} 0.0' S, and longitude 137^{o} 47.3' (Figure 1-1). This report describes the data collection program and instrument deployments, and presents the data retrieved to date. Additional reports are to be issued when more data is retrieved.

Title:

Northern Spencer Gulf Locality
Rectangle shows the detail presented in Figure 2-1

Figure: **1-1**

Rev: **A**

N

0 5 10km

Approx. Scale

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2 DEPLOYMENTS AND INSTRUMENTATION

One ADCP (Acoustic Doppler Current Profiler) and several CTD (Conductivity, Temperature, Depth) sensors were deployed at different times during the data collection program. The deployments and associated instrumentation used in the data collection program are described in detail below and summarised at the end of the Section in Table 2-1.

2.1 Deployments

The ADCP and CTD instruments were deployed at four locations as presented in Figure 2-1. For ease of reference the deployments are named as follows:

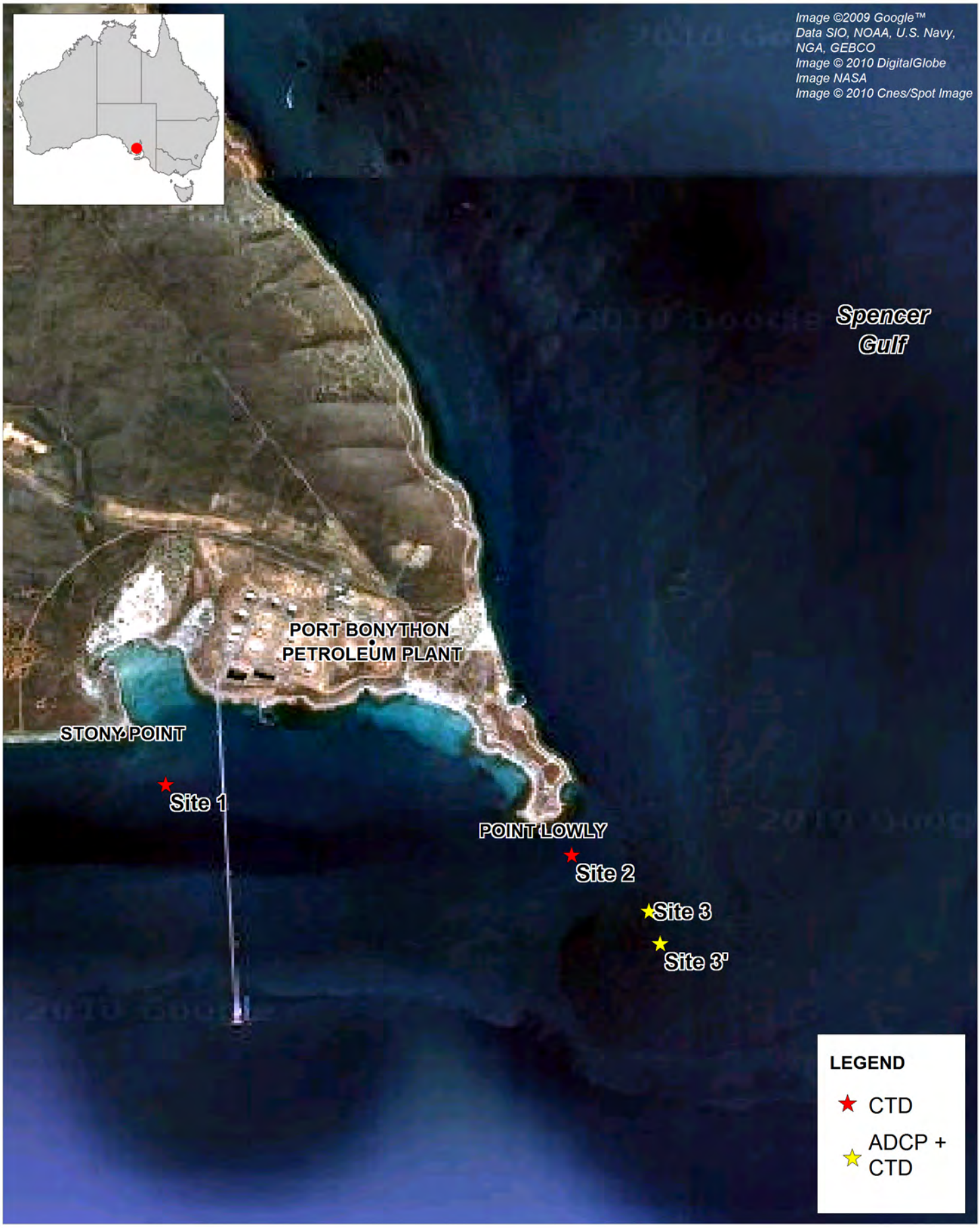
- Deployment 1: instruments were deployed on 22 March 2010 and data retrieval was performed on 23-24 June 2010;
- Deployment 2: instruments were re-deployed on 27 June 2010 and data retrieval was performed on 2 October 2010; and
- Deployment 3: instruments were re-deployed on 6 March 2010 and data retrieval is yet to be performed.

During Deployment 1, instruments were installed at Sites 1, 2, and 3 (Figure 2-1). On retrieval, the instruments at Site 3 were found approximately 100 m from the initial deployment location and it is believed that they were accidentally moved by a third party. In order to avoid similar problems, Site 3 was re-located to Site 3' (Figure 2-1) in Deployments 2 and 3. The ADCP at Site 3 was replaced with a similar model for subsequent deployments at Site 3'. It is noted that the retrieved ADCP was not faulty when examined at the BMT WBM workshop.

Subsequently to each of the deployments, the CTD instruments batteries were replaced, and the CTDs were re-calibrated. In Deployments 2 and 3, additional CTDs were added to the instruments' arrangements with the objective of testing the new equipment and obtaining replicate time series. Installation of this additional equipment was beyond scope, at BMT WBM cost, to ensure high quality data could be obtained.

Future data retrievals are scheduled on an approximately three month basis, commensurate with instruments battery lifetime.

Conditions for deployments and data retrieval events were calm.



Title:

Location of Deployments

Figure: 2-1

Rev: A

BMT WBM endeavours to ensure that the information provided in this map is correct at the time of publication. BMT WBM does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.

N

0 0.5 1km

Approx. Scale

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2.2 Instrumentation

The ADCP instruments were Workhorse Sentinel 600kHz unit (manufactured by RD Instruments (http://www.rdinstruments.com/) and were mounted on the seafloor bolted to a seaspider frame arrangement. Deployment was conducted by professional divers from Whyalla Diving Services under supervision of BMT WBM staff.

The ADCP was programmed to collect measurements through the water column at regular 0.5 metre bins above the instrument. Samples were collected at 6-minute intervals through the deployment period, and each measurement consisted of an ensemble of 100 'pings', which were averaged to provide a single representative current speed and direction measurement within each vertical bin at each time.

For all deployments, the CTDs consisted of *Tyco Greenspan* CTD3100 Multi-parameter Sensor probes (hereafter Greenspan). For Deployments 2 and 3, CTD sensors consisting of *RDI Teledyne Instruments* CITADEL CT-NH (hereafter Citadel) were added to the instrument arrangements. These latter CTD sensors are less susceptible to bio-fouling.

CTDs were either housed in custom-built steel plates (heavily ballasted to avoid motion) or on the seaspider frame housing the ADCP (Figure 2-2). All CTDs sampled at six minute intervals.

2.3 Supplementary Data

In order to supplement the above measurements, meteorological data at Whyalla Airport (Figure 1-1) was sourced from the Bureau of Meteorology web site (www.bom.gov.au). Air temperature and wind data were available at 9:00 AM and 3:00 PM for each day of the record. Additionally, daily maximum and minimum temperatures, and maximum wind gust speed, direction, and time were available.

Figure 2-2 Typical instrument arrangement in the "spider" frame. ADCP housed in the centre and additional probe and retrieval systems attached to the frame as required.

Table 2-1 Equipment deployment location and data type

Instrument Type	Station	Location		Measurement Interval	Measured Variables
		Longitude	Latitude		
Deployment 1 Vertical Velocity Profile (ADCP)	Site 3 (~28 m depth)	137° 47.45' E	33° 00.31' S	22/03/2010 to 13/05/2010*	Current speed and direction, wave height, wave period, wave direction and water depth)
Deployments 2 and 3 Vertical Velocity Profile (ADCP)	Site 3' (~27-28 m depth)	137° 47.49' E	33° 00.43' S	28/06/2010 to 02/10/2010*	
Deployments 1, 2, and 3 Greenspan Conductivity Temperature and Depth (CTD)	Site 1 (~7.0 m depth)	137° 45.62' E	32° 59.83' S	22/03/2010 to 02/10/2010	Temperature, conductivity, and pressure (salinity and depth derived)
	Site 2 (~7.5 m depth)	137° 47.14' E	33° 00.09' S		
	Site 3 (~28-28 m depth)	137° 47.45' E	33° 00.31' S		
	Site 3' (~27 m depth)	137° 47.49' E	33° 00.43' S	28/06/2010 to 02/10/2010	
Deployments 2, and 3 Citadel Conductivity Temperature and Depth (CTD)	Site 1 (~7.0 m depth)	137° 45.62' E	32° 59.83' S	28/06/2010 to 02/10/2010	Temperature, conductivity, and depth (salinity derived)
	Site 2 (~7.5 m depth)	137° 47.14' E	33° 00.09' S		
	Site 3' (~27 m depth)	137° 47.49' E	33° 00.43' S		
Meteorological Data	Whyalla Aero BoM Station 018120	137° 31.23' E	33° 03.23' S	01/03/2010 to 30/06/2010	Wind speed, wind direction, air temperature, and mean sea level pressure (at 9am and 3pm daily)

* Data corrupted between 13/05/2010 to 24/06/2010

3 DATA

3.1 Air Temperature and Wind Data

Figure 3-1 and Figure 3-2 summarise the temperature and wind observations for the period concurrent with Deployment 1 (22 March to 24 June 2010) and Deployment 2 (27 June 2010 to 03 October 2010), respectively. The initial period reflects a period of seasonal cooling, while the second reflects a period of seasonal warming.

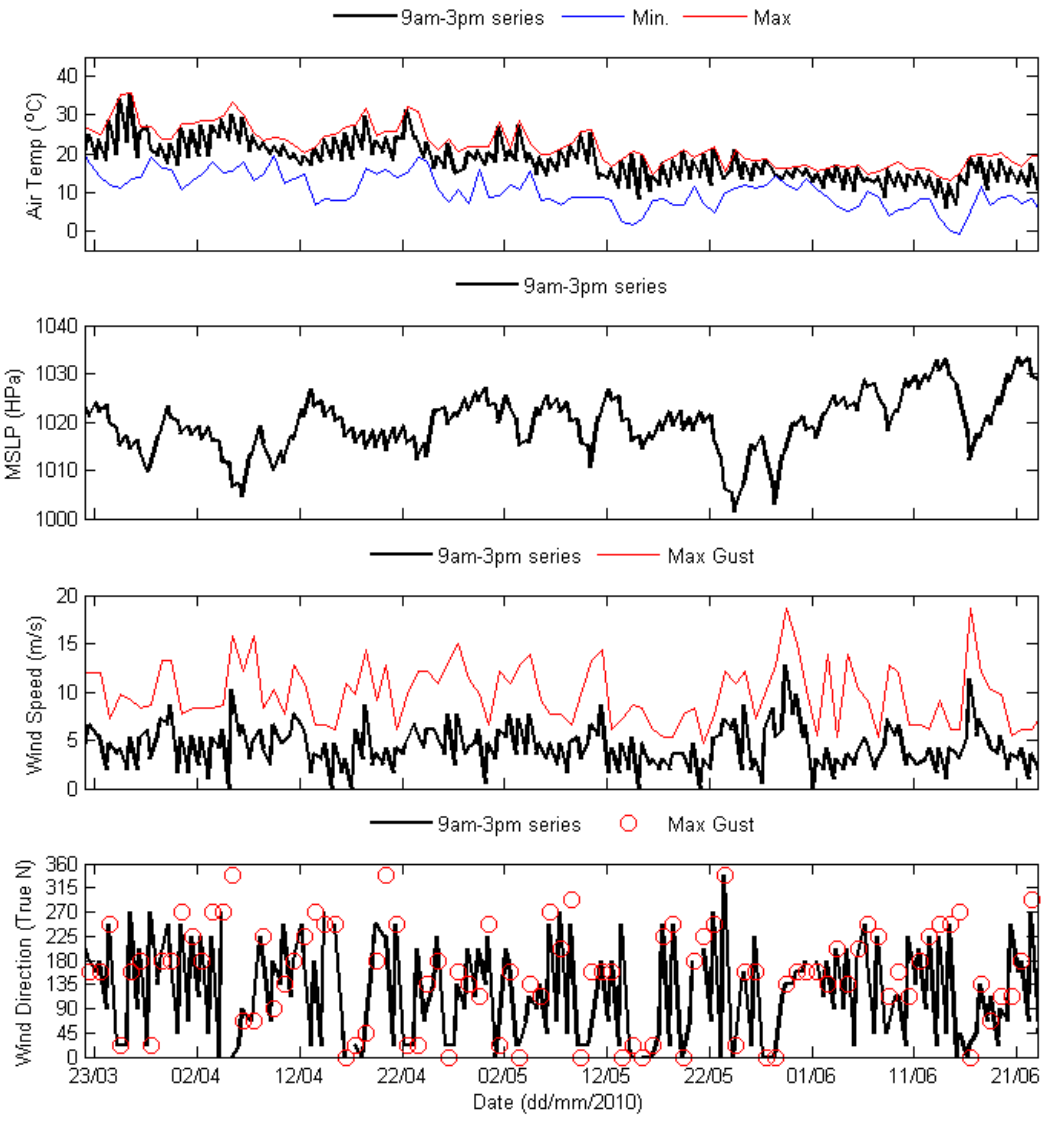


Figure 3-1 Air temperature, mean sea level pressure (MSLP) and wind data for the measurement period at Whyalla Aero concurrent with deployment 1

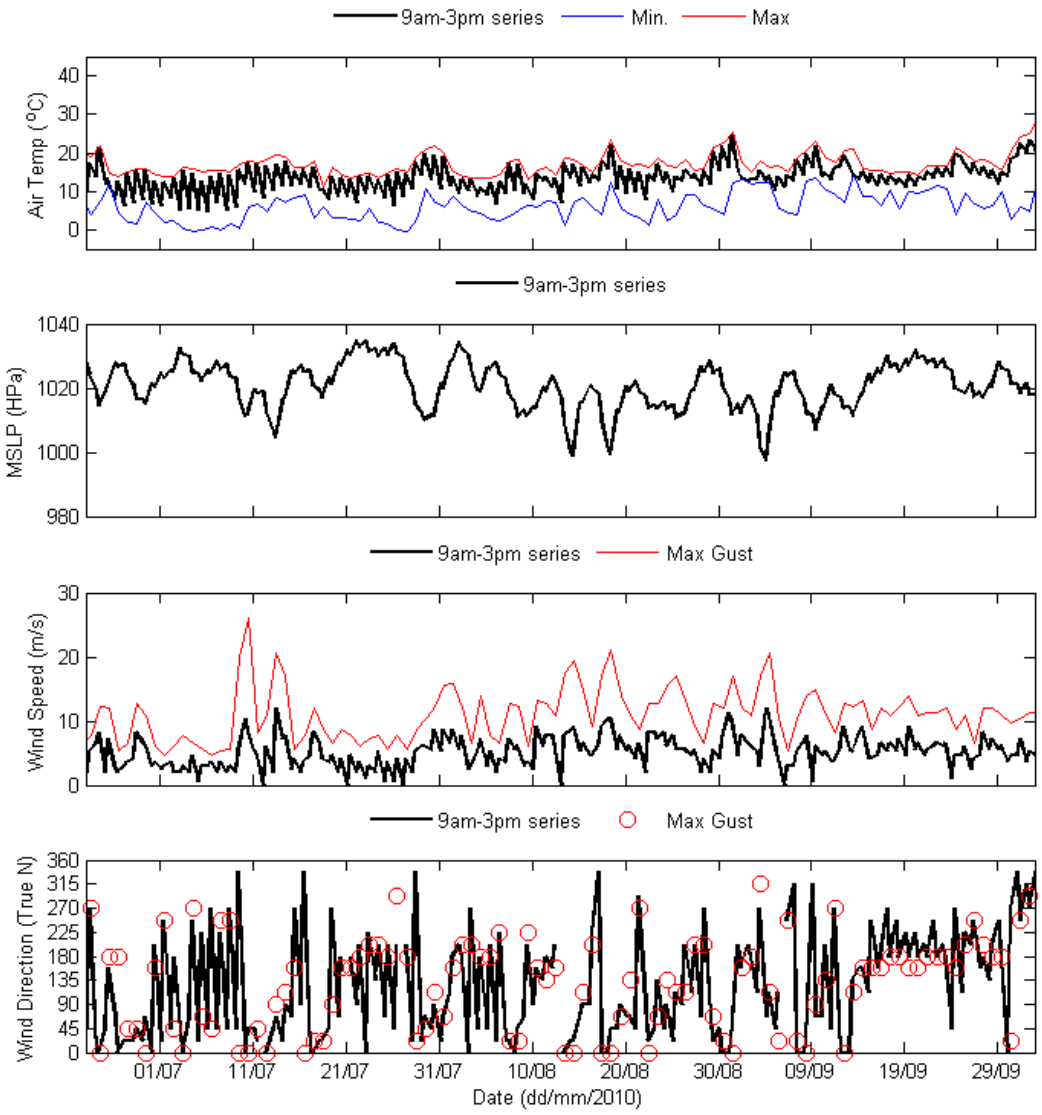


Figure 3-2 Air temperature, mean sea level pressure (MSLP) and wind data for the measurement period at Whyalla Aero concurrent with deployment 2

3.2 ADCP Measurements

3.2.1 Deployment 1

Time series of the ADCP measurements for Deployment 1 at Site 3 are shown in Figure 3-3. In the upper two panels on the left hand side, the horizontal and vertical axes represent time and height above seabed, respectively. Associated current speeds and directions are given by the colour scale. The blue lines in these two upper panels in Figure 3-3 show the water surface elevation above the instrument. The lower panel in Figure 3-3 presents the percentile distributions of the current speeds, with numerical statistics presented on the right hand side of the figure. Appendix A presents the same data zoomed in at 15 day intervals.

Data collected on 27 March between 8:00 AM and 10:00 PM were corrupted and therefore discarded from Figure 3-3 and from further analysis. The water surface elevation data in Figure 3-3 indicates that the instrument was moved to a deeper site during this period (~29.2 m mean depth), consistent with potential movement by a third party. Data recording proceeded until 13 May 8:54 AM and thereon bad readings were recorded. These "upturned" readings were also discarded from the analysis. The available data after 27 March 10:00 PM is nonetheless consistent with previous measurements at the site (see e.g. BMT WBM 2010a).

The measurement period covered at least 3 complete spring and neap cycles (Figure 3-3). Mean and maximum current speeds were 0.55 m/s and 1.54 m/s, respectively.

Bottom currents as measured by the lowest ADCP bin in the water column (at 1.6 m above seabed) were interrogated and are presented with respective current magnitude statistics in Figure 3-4. Mean and maximum bottom current magnitudes were 0.40 m/s and 1.11 m/s, respectively. Appendix B presents the same data zoomed in at 15 day intervals.

3.2.2 Deployment 2

Time series of the ADCP measurements for the subsequent deployment at Site 3' are shown in Figure 3-5. The data was consistent throughout the record and was used in its entirety in the analysis. The measurement period covered at least 6 complete spring and neap cycles and two incomplete neap cycles (Figure 3-5). Mean and maximum current speeds were 0.51 m/s and 1.57 m/s, respectively. Zoomed in plots at 15-day intervals for this deployment are also presented in Appendix A.

Bottom currents as measured by the lowest ADCP bin in the water column (at 1.6 m above seabed) were interrogated and are presented with respective current magnitude statistics in Figure 3-6. Mean and maximum bottom current magnitudes were 0.32 m/s and 0.83 m/s, respectively. The zoomed in data at 15-day intervals for this deployment are also presented in Appendix B.

3.2.3 Deployments 1 and 2 Combined Data

Data from both deployments were combined and are presented in Figure 3-7 and Figure 3-8. Data over the water column were very similar and were within 5 cm/s for all percentiles across individual and combined data sets. Data near the seabed were considerably larger for Deployment 1, particularly for the higher percentiles (i.e. above 80%).

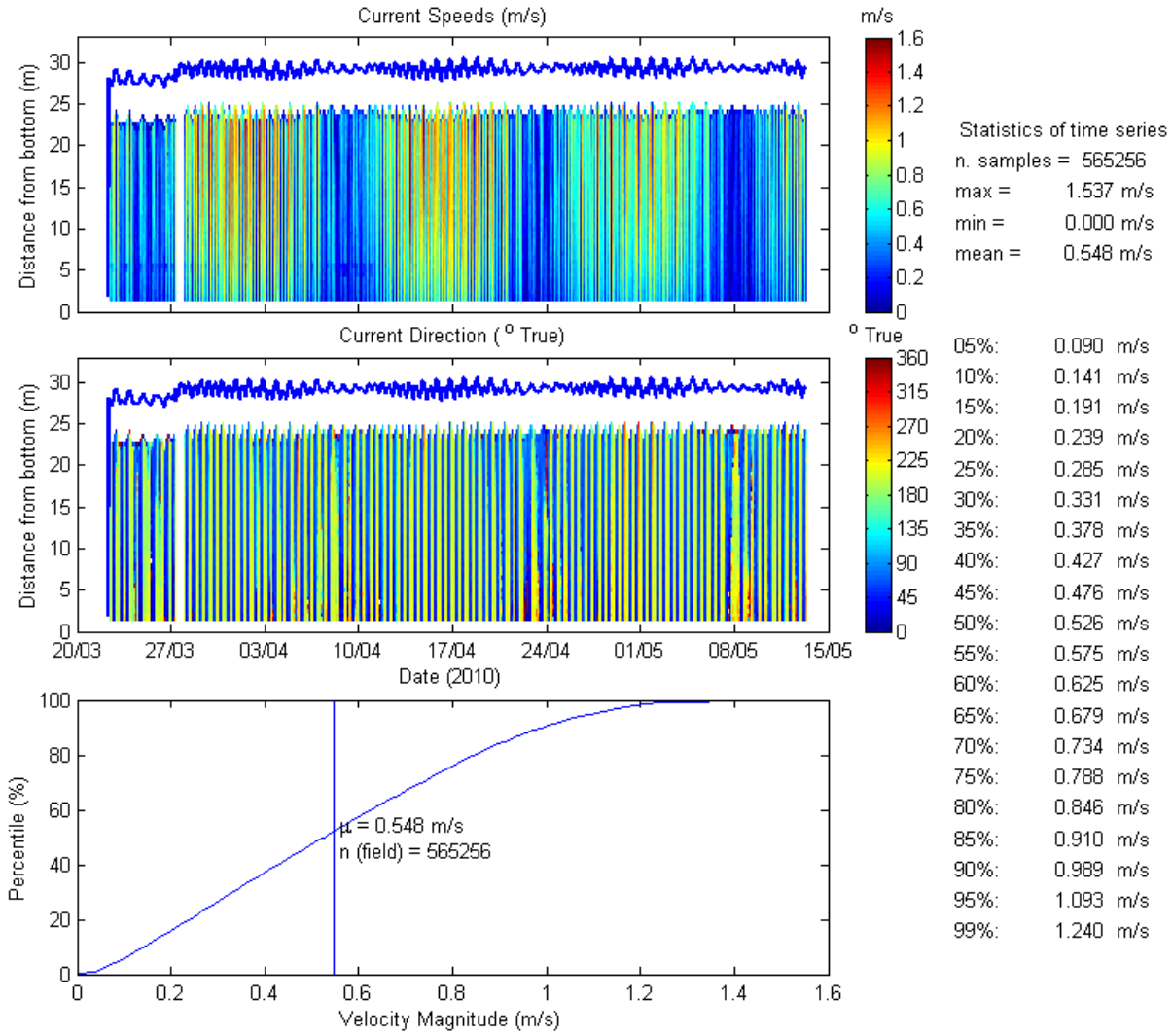


Figure 3-3 ADCP data from first data retrieval at site 3

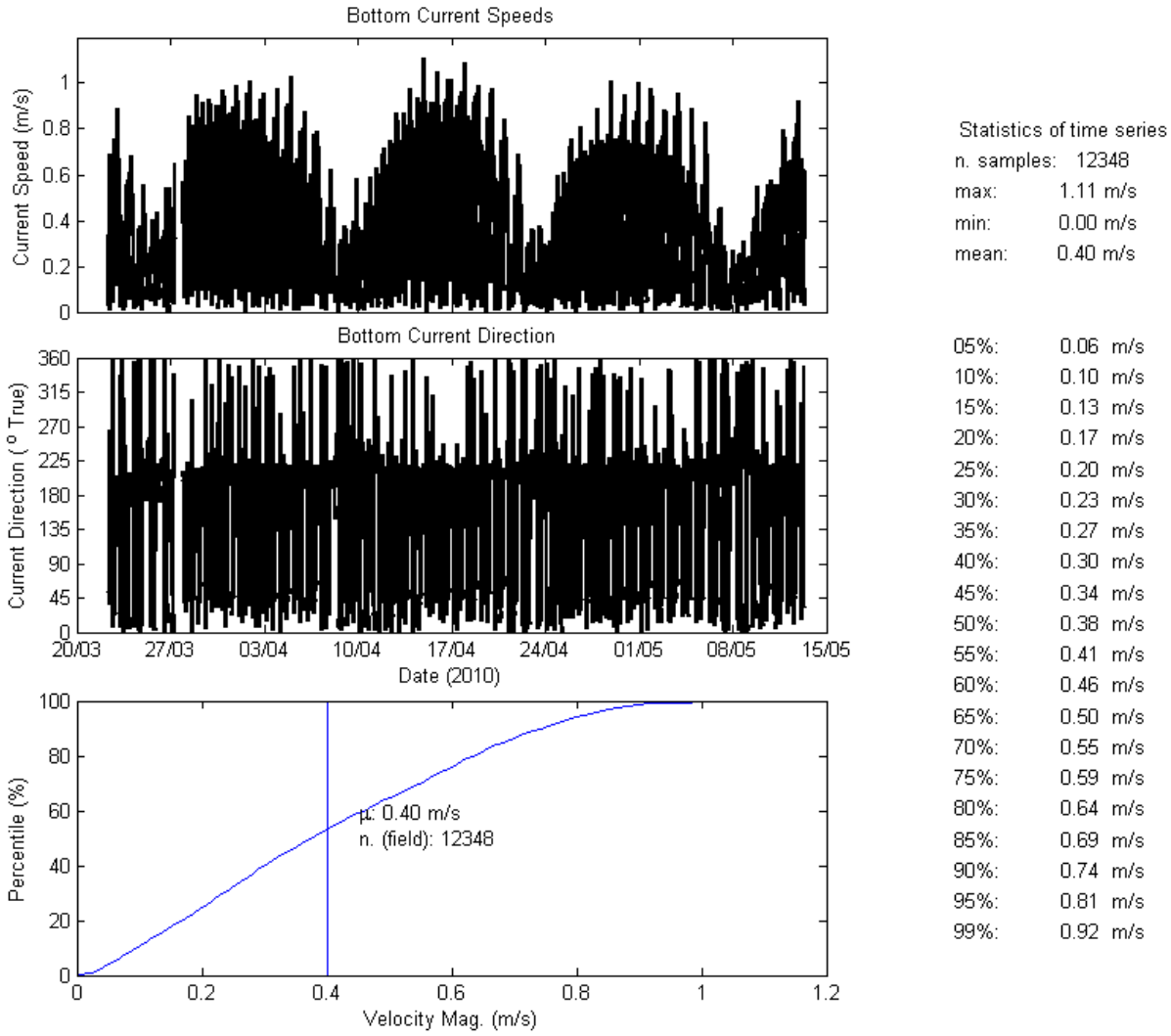


Figure 3-4 Bottom current measurements from first data retrieval at site 3

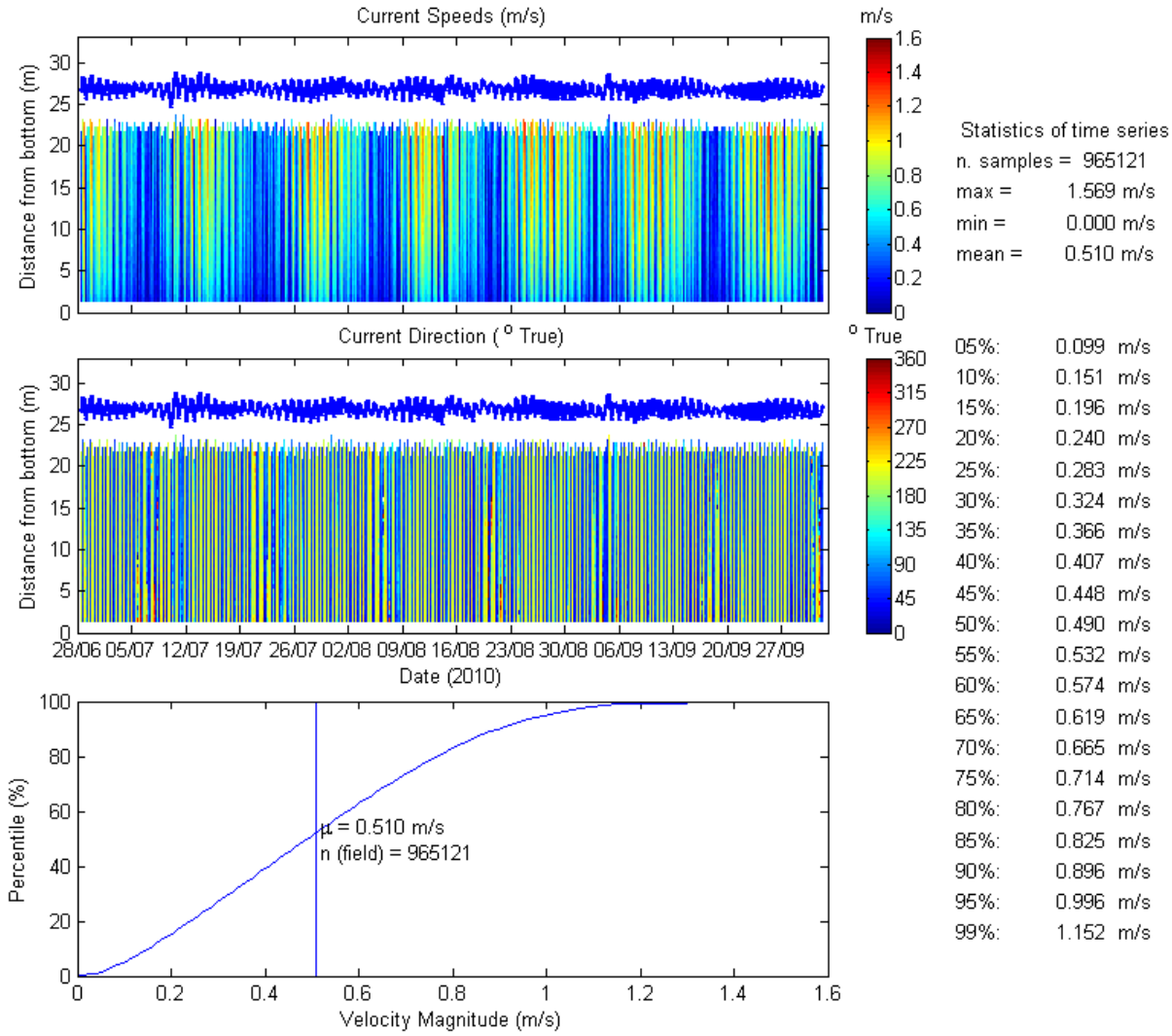


Figure 3-5 ADCP data from second data retrieval at site 3'

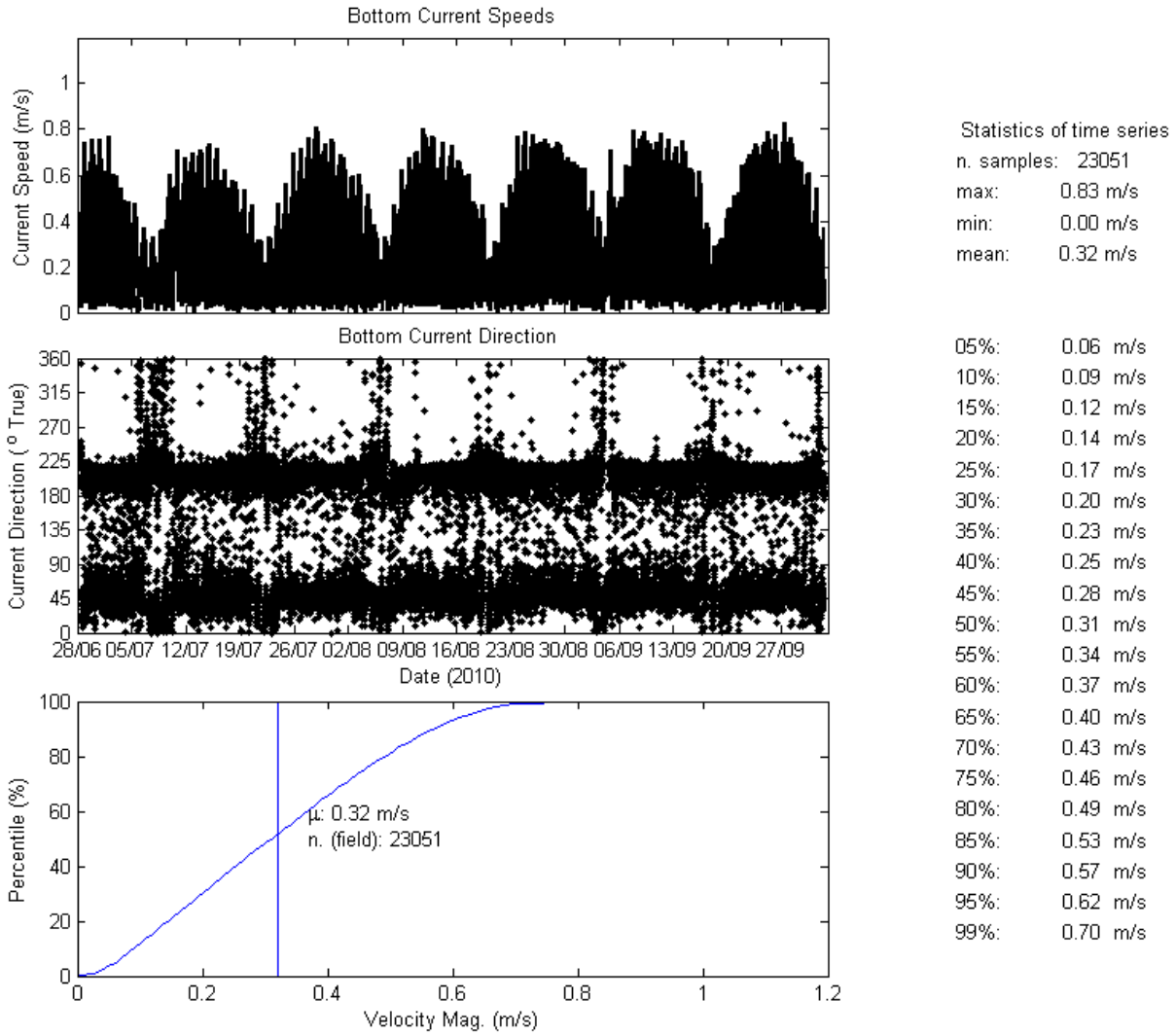


Figure 3-6 Bottom current measurements from second data retrieval at site 3'

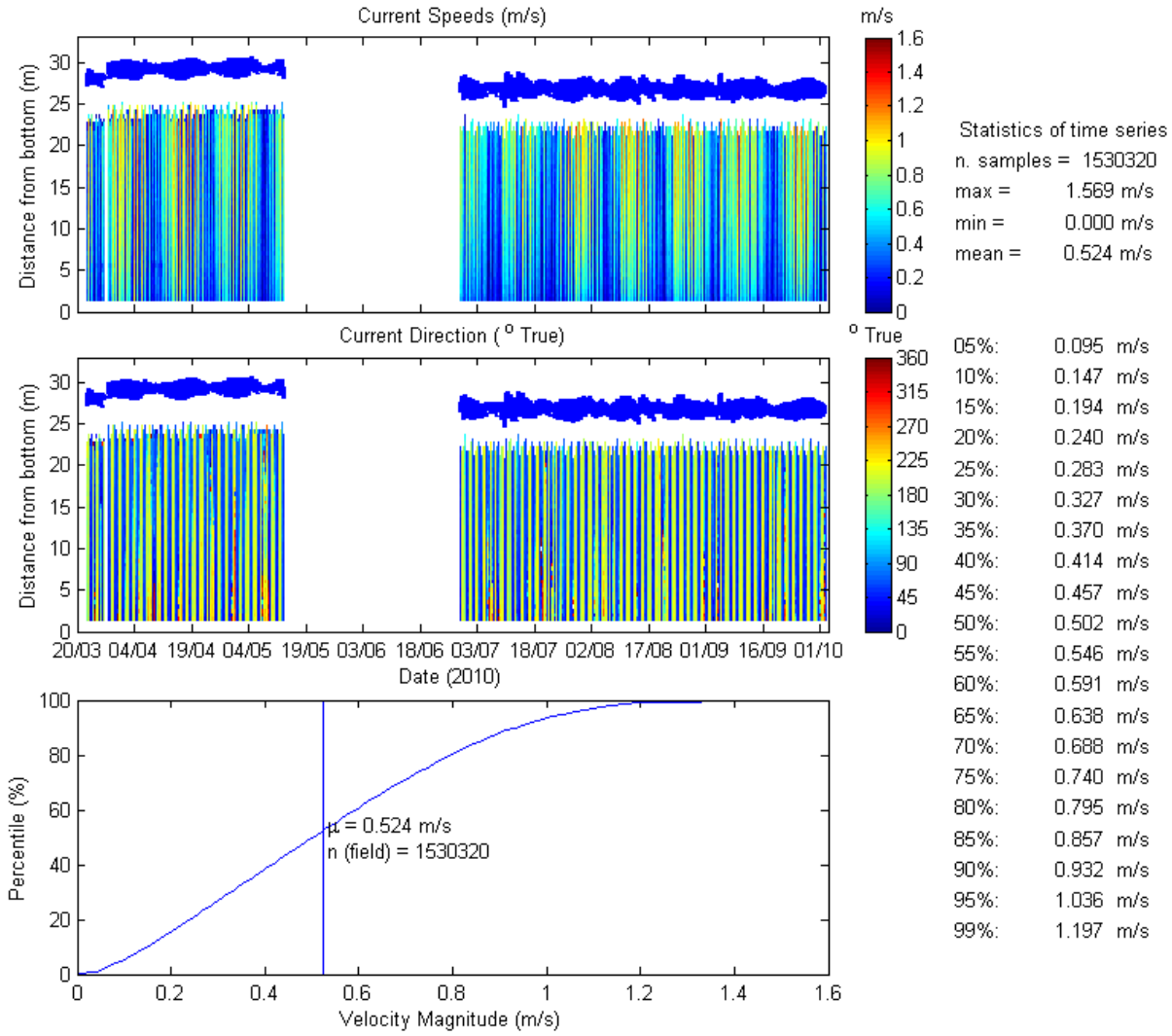


Figure 3-7 ADCP data combined from first and second data retrieval at sites 3 and 3'

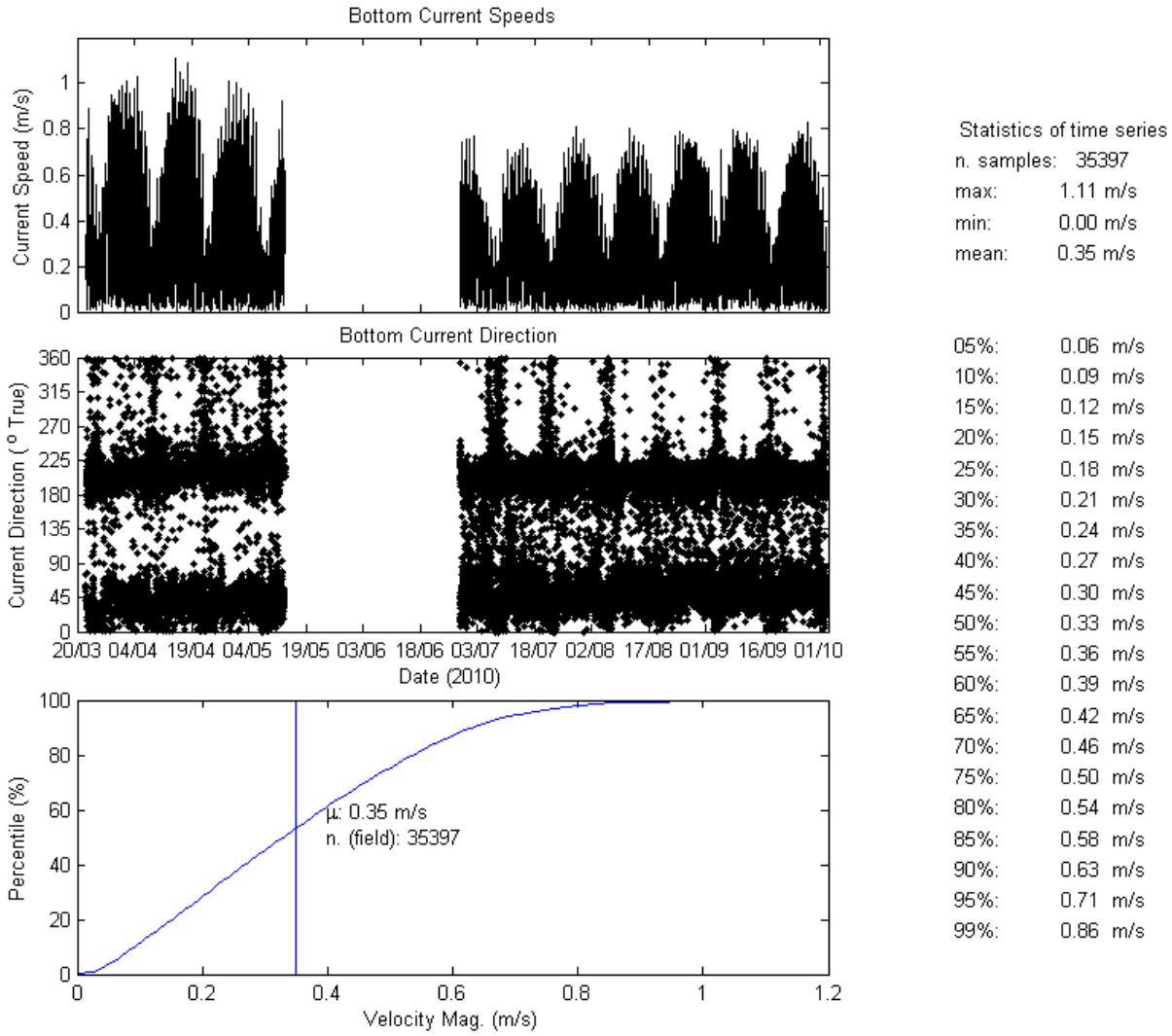


Figure 3-8 Bottom current measurements combined from first and second data retrieval at sites 3 and 3'

3.3 CTD Measurements

3.3.1 Water Depth

Water depth was derived by assuming the CTD pressure measurements and the mean sea level pressure given by the BoM measurements. The depth is only approximate given the time resolution of mean sea level pressure measurements (twice a day).

3.3.1.1 Deployment 1

Time series of water depths for Deployment 1 are presented in Figure 3-9. Similarly to the ADCP data, the accidental (third party) movement of the instrument at Site 3 was rather evident. However, unlike the ADCP data, water depth data did not present data corruption. In general, water depth variations were relatively similar at all sites, as expected (Figure 3-9).

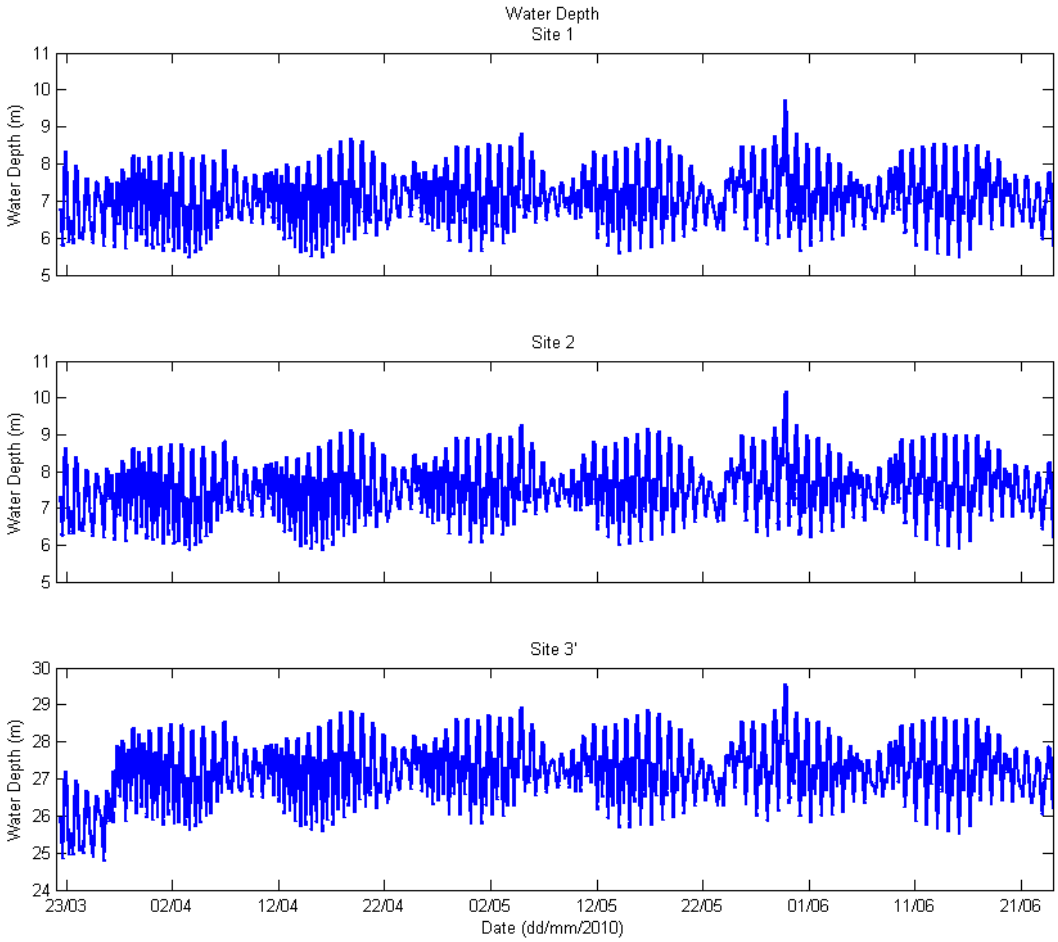


Figure 3-9 Water depth measurements for deployment 1

3.3.1.2 Deployment 2

Time series of water depths for Deployment 2 are presented for both Greenspan and Citadel CTDs in Figure 3-10. It is noted that download of Citadel data for Site 2 failed. The recovered instrument presented problems in its electronics circuitry and was sent to the manufacturer for further investigation. It is expected that part of the data is available in the instrument logger and will be retrieved by the manufacturer.

Differences between instruments were very small and water depth variations were relatively similar at all sites, as expected (Figure 3-10).

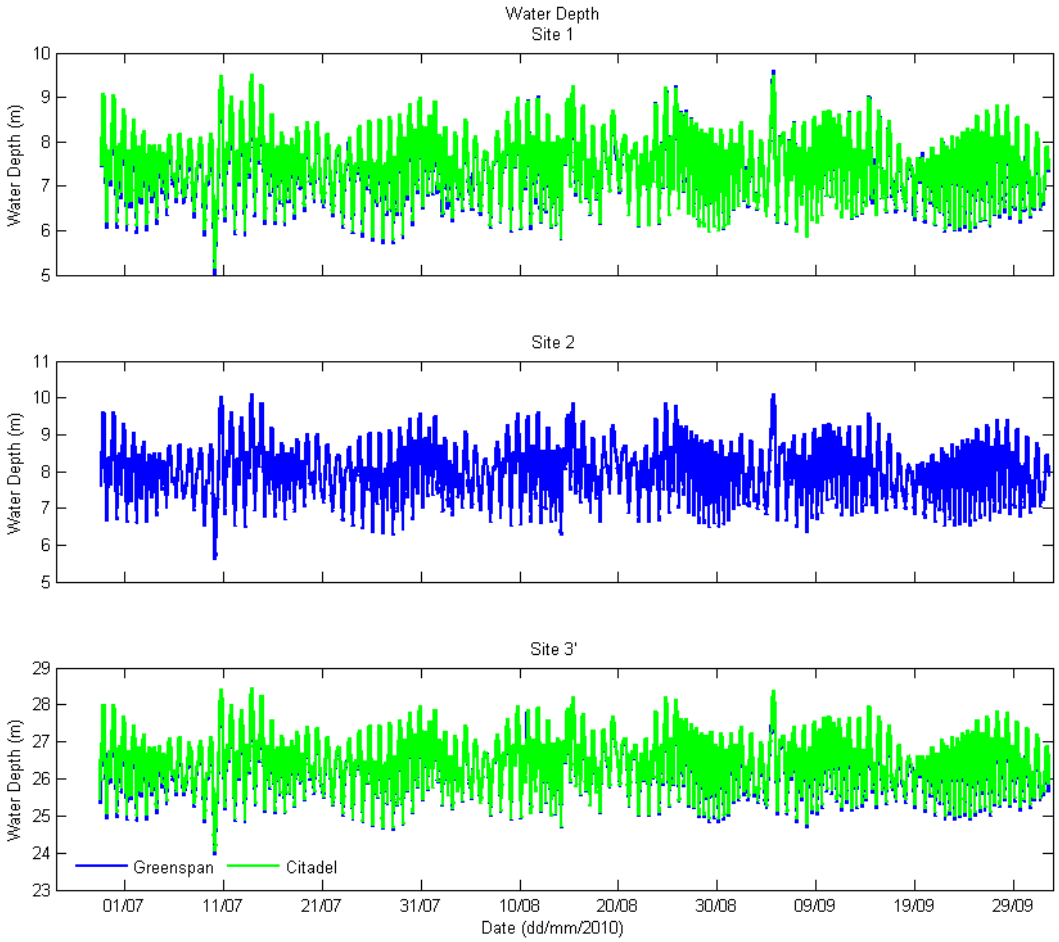


Figure 3-10 Water depth measurements for deployment 2

3.3.2 Temperature

3.3.2.1 Deployment 1

Time series of temperature for Deployment 1 are presented in Figure 3-11. Similarly to water depth data, the problems associated with third party movement of the instrument at Site 3 was not apparent. Temperatures at Site 3 did not present the diurnal variations experienced at the other sites because it was located at larger depth and less susceptible to the atmospheric influence. Nonetheless the seasonal trend was reflected similarly across all sites (Figure 3-11)

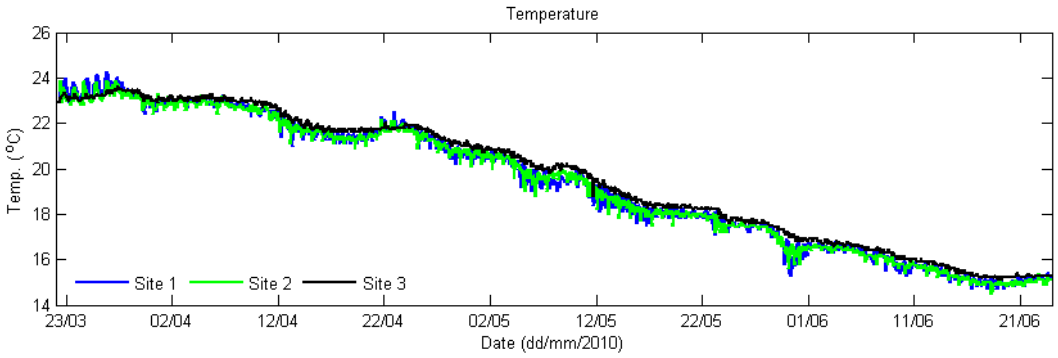


Figure 3-11 Temperature measurements for deployment 1

3.3.2.2 Deployment 2

Time series of temperature for Deployment 2 are presented in Figure 3-12. Similarly to Deployment 1, temperatures at Site 3' did not present the diurnal variations experienced at the other sites. The seasonal trend was reflected similarly across all sites, and showed the reversal from cooling to warming during Deployment 2 (Figure 3-12)

The Citadel temperature measurements were generally lower than the Greenspan at Sites 1 and 3' (Figure 3-12). Although not readily evident at the scale of these graphs in Figure 3-12, Citadel measurements presented higher resolution, as expected from its nominal sensor's characteristics in relation to the Greenspan's (Site 3' shows it more clearly).

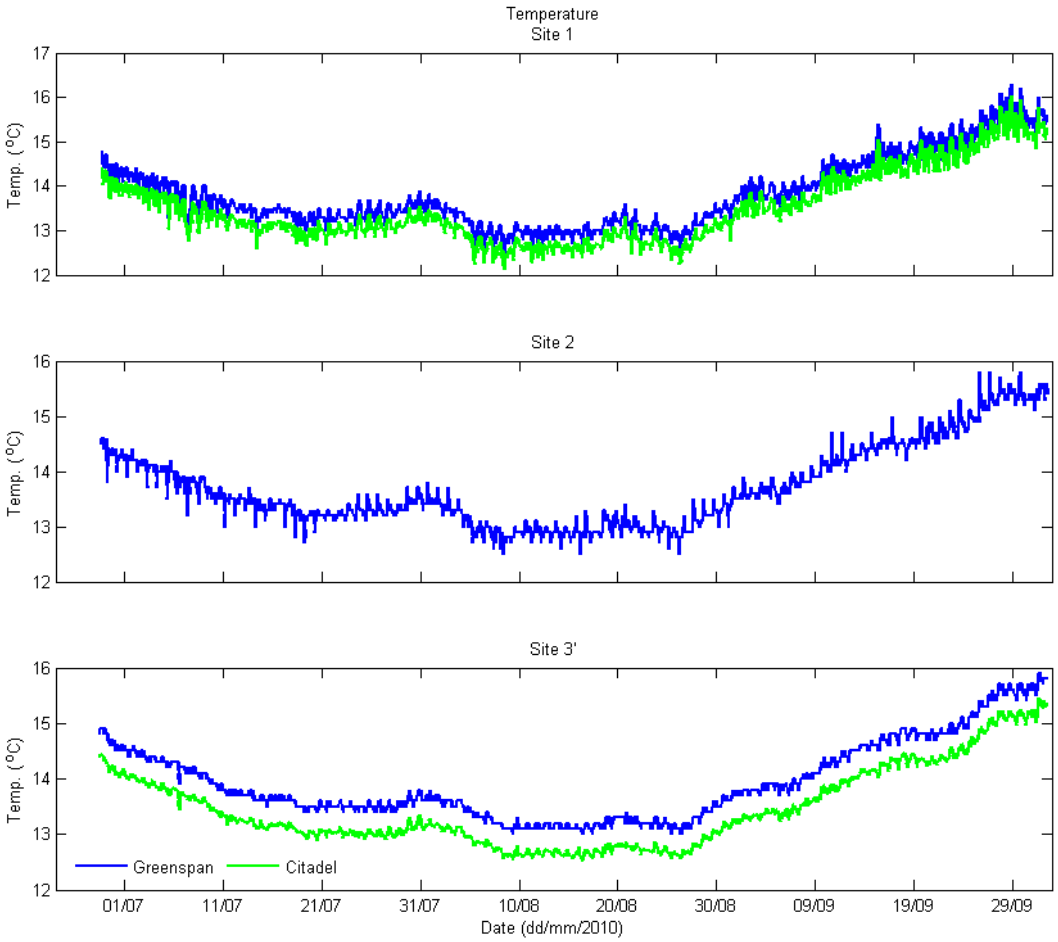


Figure 3-12 Temperature measurements for deployment 2

3.3.3 Salinity

Salinity data was obtained according to UNESCO (1983) taking into account conductivity, pressure, and temperature. The salinity data was then adjusted following the methodology described in BMT WBM (2010a). To this end, an important aspect of the data collection program was the provision of CTD sensor cleaning, and collection of water samples for posterior laboratory analysis. These procedures were required to minimise the effects of bio-fouling and provide suitable adjustment for salinity data.

Assuming the hand samples were a true representation of the field salinity, the following procedure was applied for the correction of the CTD measurements:

1 Hand samples salinities were converted to electrical conductivities according to UNESCO (1983), assuming the depth and pressure measured by the CTD;

2 An average of the replicate hand samples conductivities was calculated;

3 Looping through each hand sample measurement:

(a) an offset was computed between the hand sample electrical conductivity and the CTD electrical conductivity measurement in the time the hand sample was taken;

(b) an offset rate was calculated as a linear variation between 0 and the offset over the time between the time in which the CTD sensor was cleaned and the previous hand sample time (or from the first CTD measurement if the first hand sample);

(c) the offset rate was then used to calculate electrical conductivity offsets for all CTD samples on times between the time in which the CTD sensor was cleaned and the previous hand sample time (or from the first CTD measurement if the first hand sample);

(d) the offsets were then added to the CTD samples;

4 The adjusted CTD salinities were then computed using UNESCO (1983), using the adjusted CTD electrical conductivities and the same CTD pressure and temperature.

Given the importance of these data and the desire to collect the highest quality data possible, BMT WBM acquired and deployed at no extra cost, three additional Citadel CTD sensors for Deployment 2 and subsequent deployments. This data was then used for comparative purposes and to supplement the data obtained from the Greenspan CTDs. Salinity data collected to date are described below. The data quality could be further improved by executing a maintenance program as discussed previously with BHP Billiton.

3.3.3.1 Deployment 1

Time series of salinity for Deployment 1 are presented in Figure 3-13 and values for CTD salinities (prior to adjustment) and hand samples for salinity adjustment are presented in Table 3-1. The second set of hand samples (24 June 2010) was used to adjust the salinity time series. It is noted that the hand samples were only collected at (or near) the time of instrument deployment and retrieval, which impacted on the salinity adjustment process (see below). The first set of measurements (22 March 2010) show that the accuracy of the CTD salinity measurements was the order of 0.2 to 0.4. Hand sample salinities replicates varied between 0.00 and 0.05 (Table 3-1).

Figure 3-13 presents the salinities resulting from the adjustment process. Salinities at Site 3 were discarded because the sensor failed after 5 May 2010 (most likely due to third party damage), such that an adjustment with reference to 24 June 2010 could not be made.

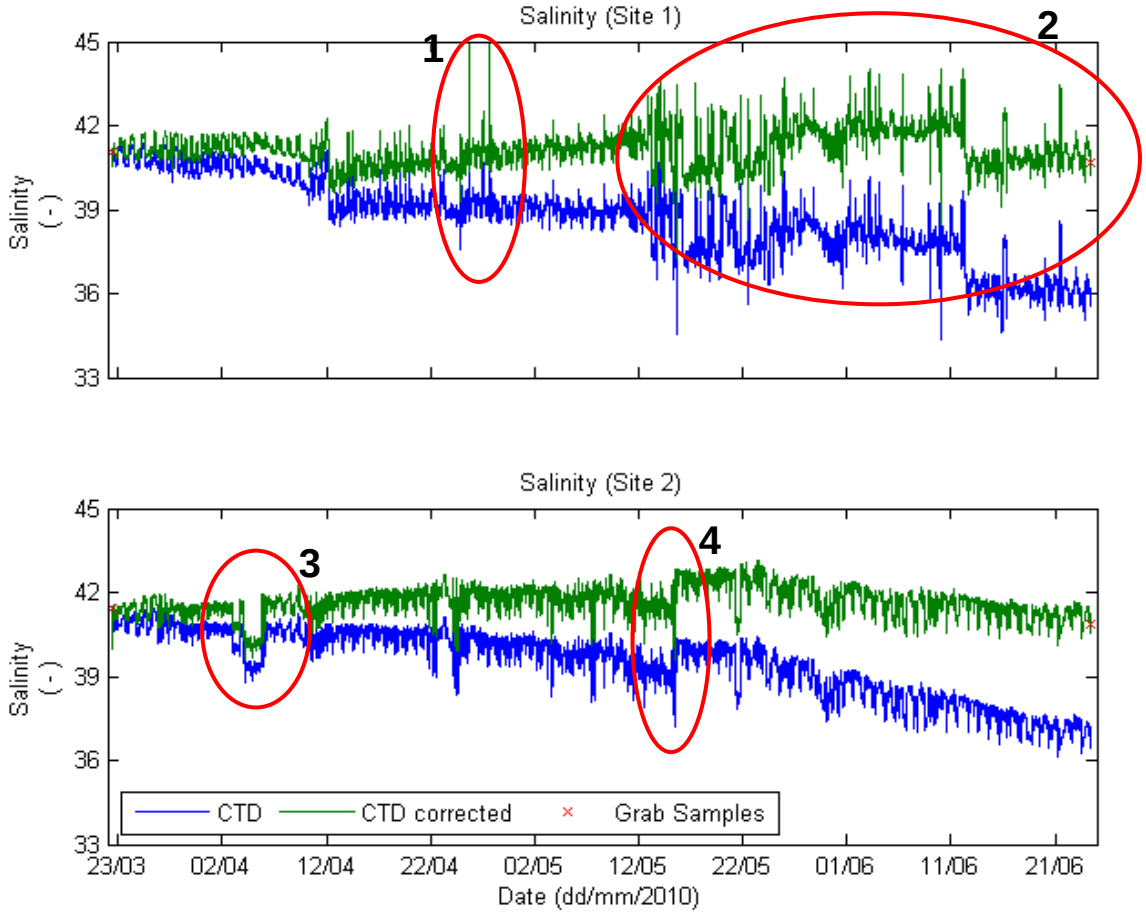


Figure 3-13 Hand-samples, non adjusted salinities, and adjusted CTD salinities. numbers indicate the data issues of concern raised in the text and highlighted within the ellipses

Table 3-1 Salinity measurements verification – June 2010 data retrieval

Site	Date	Salinity			
		CTD	Hand Sample A	Hand Sample B	Hand Sample C
1	22-Mar-2010 11:42	40.85	41.06	41.11	41.07
	24-Jun-2010 09:16	35.58	40.68	40.66	-
2	22-Mar-2010 11:10	41.06	41.45	41.46	41.46
	24-Jun-2010 11:00	36.75	40.89	40.84	-
3	22-Mar-2010 09:40	41.51	41.66	41.66	41.66
	24-Jun-2010 10:00	26.52*	41.13	41.11	-

*Last record sampled on 23-Jun-2010 22:42

Although adjusted salinities at Sites 1 and 2 reproduced salinities generally within the expected range, data issues were identified and some of these issues are of concern for data reliability. These issues are listed below as highlighted by the ellipses in Figure 3-13:

1 Abnormal salinity spikes within subsequent samples at Site 1. These spikes occur over one sample and do not present an issue in terms of overall data reliability. These data were discarded before further analysis and should not be used for future model comparisons;

2 Sudden increase of high-frequency signal amplitude at Site 1. The increase of amplitude occurred after 12 May 2010 and was not observed at the other Sites (Figure 3-13). Of particular relevance are sudden decreases of salinity, such that resulting values after adjustment were significant lower than 40, and therefore outside the expected range. These measurements were deemed not reliable unless replicate data can be used to 'ground-truth' these results. The adjustment based on hand samples collected at the end of the record was therefore likely inadequate.

3 Abnormal temporary salinity decrease at Site 2. The sudden decrease of salinity was not repeated at the other Sites and cannot be deemed reliable. It is unclear what caused these changes, however it is believed they do not present an issue in terms of overall data reliability. In the absence of replicate data, these data were discarded before further analysis and should not be used for future model comparisons;

4 Sudden reduction and successive increase of salinity at Site 2. This characteristic is not realistic as it produced a change of 3 units over two successive samples. Although the sensor presented consistent amplitude of the high-frequency signal, the adjustment based on the hand samples collected at the end of the record is likely inadequate.

In general terms, the results above highlight the requirement of regular sensor maintenance and collection of reference (hand samples) salinities at shorter intervals. BMT WBM's installation of the new Citadel sensors is assisting with the collection of good quality data, however a maintenance program is crucial for successful completion of the program.

Given the above, statistical distributions were performed only for the three first weeks of the adjusted data, as during this period, the sensor problems were considered of a lesser influence. Data associated with issues 1 and 3 above were discarded from the analysis. In the case of spikes, these were eliminated when a salinity variation of more than 0.5 between consecutive samples was found. This time series and respective distribution data are presented in Figure 3-14. The numerical values of the cumulative distribution are presented in Table 3-2.

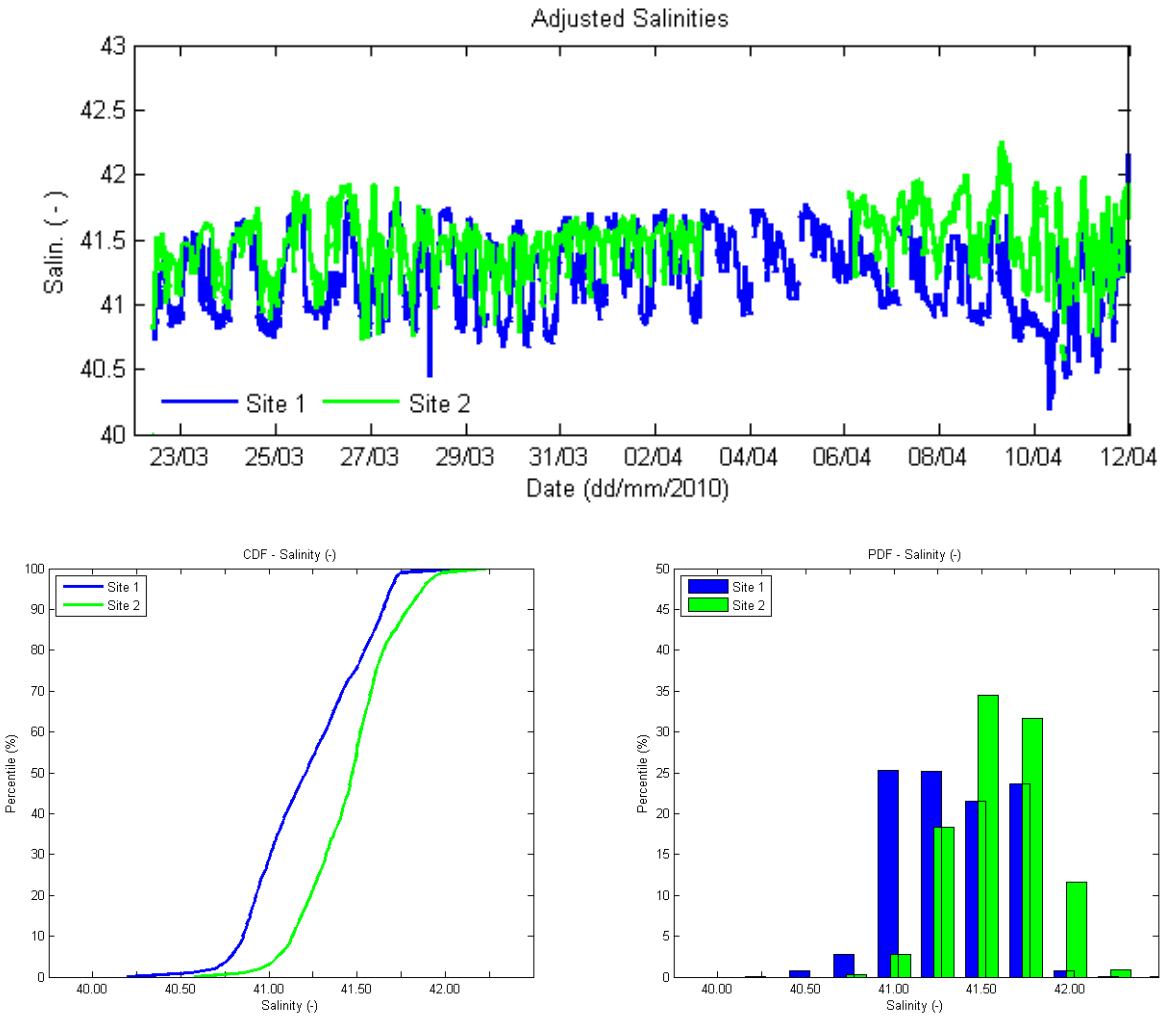


Figure 3-14 Adjusted salinity measurements for deployment 1. Upper panel: Time-series, Lower left panel: Cumulative distribution. Lower right panel: Probability density distribution.

Table 3-2 Cumulative distribution of deployment 1,adjusted salinity measurements

Salinity Distribution		
%ile	Site 1	Site 2
0	40.19	40.58
5	40.79	41.05
10	40.85	41.13
15	40.89	41.17
20	40.93	41.24
25	40.97	41.28
30	41.01	41.32
35	41.05	41.37
40	41.10	41.41
45	41.15	41.45
50	41.21	41.48
55	41.26	41.50
60	41.32	41.52
65	41.37	41.55
70	41.42	41.58
75	41.49	41.61
80	41.54	41.65
85	41.60	41.72
90	41.65	41.79
95	41.69	41.87
100	42.15	42.26

3.3.3.2 Deployment 2

3.3.3.2.1 Greenspan CTD

Time series of adjusted salinity derived from the Greenspan CTD for Deployment 2 are presented in Figure 3-15. The values for CTD salinities (prior to adjustment) and hand samples for salinity adjustments are presented in Table 3-3. It is noted that the hand samples were collected at (or near) the time of instrument deployment and retrieval, and on another occasion ten days prior instrument retrieval. As before, the interval between visits was longer than required and impacted on the adjustment process (see below).

All Greenspan salinity measurements presented a relatively large initial offset in relation to the hand samples (Figure 3-15 and Table 3-3). Contrastingly, the time series at different sites evolved somewhat differently from each other. Site 1 and Site 2 Greenspan measurements presented some spikes, similar to the ones indentified in Deployment 1. Measurements at Site 1 presented significant salinity reduction, particularly towards the end of the records. Measurements at Site 3' presented a sudden reduction on the signal (22 Aug 2010) followed by sudden increase in signal amplitude variation. Salinities at Site 2 presented considerably less drifting at the end of the record in comparison to the other sites.

The result of adjustment on the Greenspan salinities is also presented in Figure 3-15. The sudden reduction of Greenspan measurements at Site 3' was eliminated by assuming the same conductivities before and after the sudden salinity change. The spikes were also eliminated from the Greenspan measurements. The adjusted Greenspan salinities for Sites 1 and 3 differed significantly from the Citadel measurements (see below) and presented a seasonal trend of increasing salinities, which did not conform with known winter and spring months trends (Figure 3-15).

3.3.3.2.2 Citadel CTD

Citadel salinity measurements did not present large initial offsets in relation to the hand samples and no spikes were present in the signals (Figure 3-16 and Table 3-3). Citadel salinity measurements at Site 1 presented significantly more drifting than Site 3', which was however minimised after sensor cleaning on 22 September 2010. Final salinity measurements were very close to the hand sample salinities (Figure 3-16 and Table 3-3).

3.3.3.2.3 Combined CTD Data

Given the results above, Citadel measurements were used to produce statistical distributions for Sites 1 and 3', while Greenspan measurements were used for Site 2 (Citadel measurements are pending). These results illustrate the value added by the Citadel sensor, as they were less susceptible by bio-fouling and more amenable to the adjustments. The adjusted time series and respective distributions are presented in Figure 3-17. Significant salinity variations across the sites were observed, with a generally lower seasonal reduction of salinity at Site 3'. Numerical values of the cumulative distributions are presented in Table 3-4 and the zoomed-in data at 10 day intervals are presented in Appendix C.

Table 3-3 Salinity measurements verification – October 2010 data retrieval

Site	Date	Salinity			
		Greenspan	Citadel	Hand Sample A	Hand Sample B
1	28-Jun-2010 15:00	39.31	40.71	40.70	40.71
	22-Sep-2010 14:00*	39.28	35.59	40.10	40.10
	02-Oct-2010 13:00	39.45	33.78	39.53	39.52
2	28-Jun-2010 13:30	39.72	-	40.82	40.82
	22-Sep-2010 14:30*	38.97	-	40.28	40.27
	02-Oct-2010 13:24	37.89	-	39.60	39.61
3	28-Jun-2010 12:30	40.00	41.01	40.91	-
	02-Oct-2010 12:18	36.55	40.42	40.33	40.38

*Precise times to be confirmed

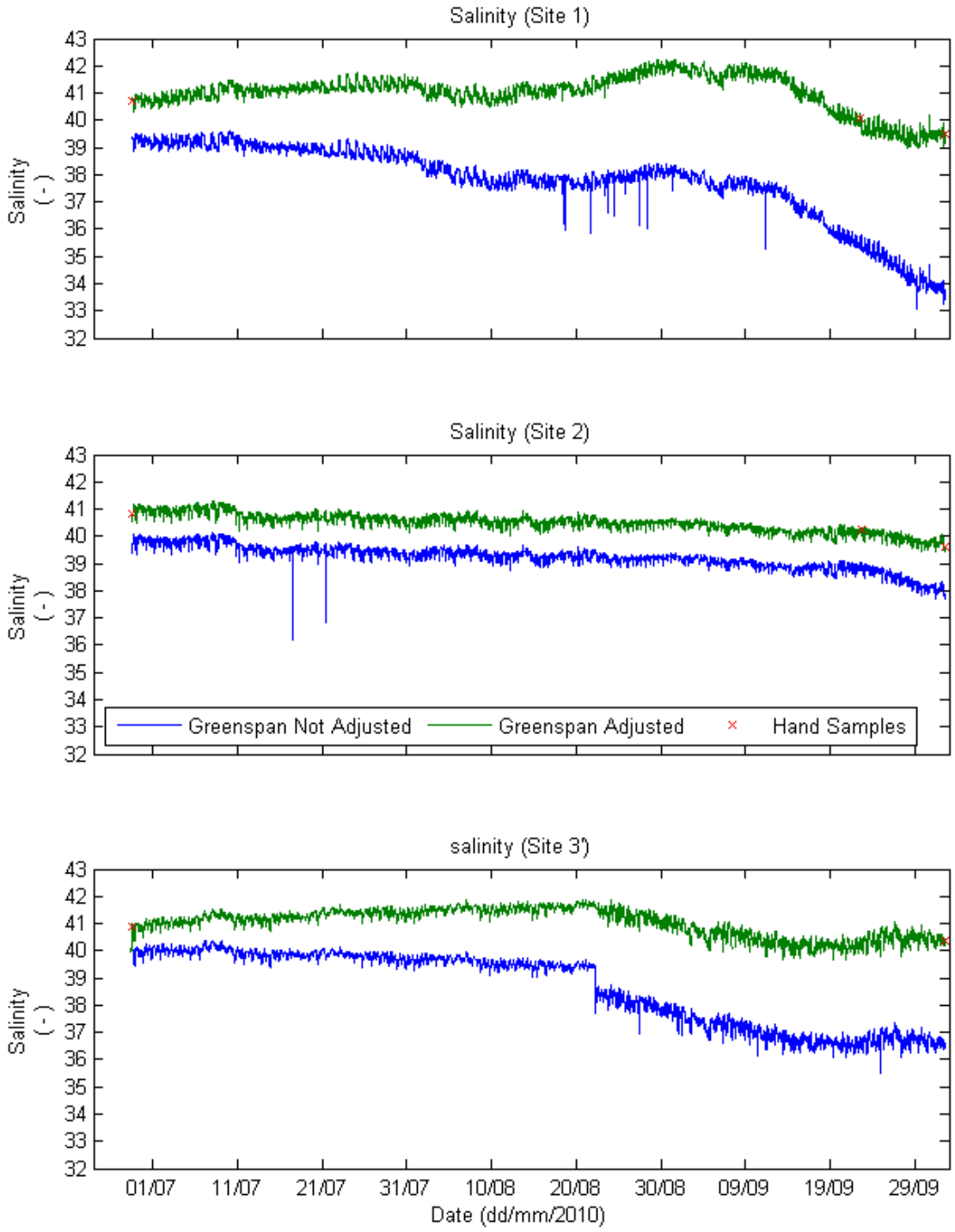


Figure 3-15 Greenspan salinity measurements

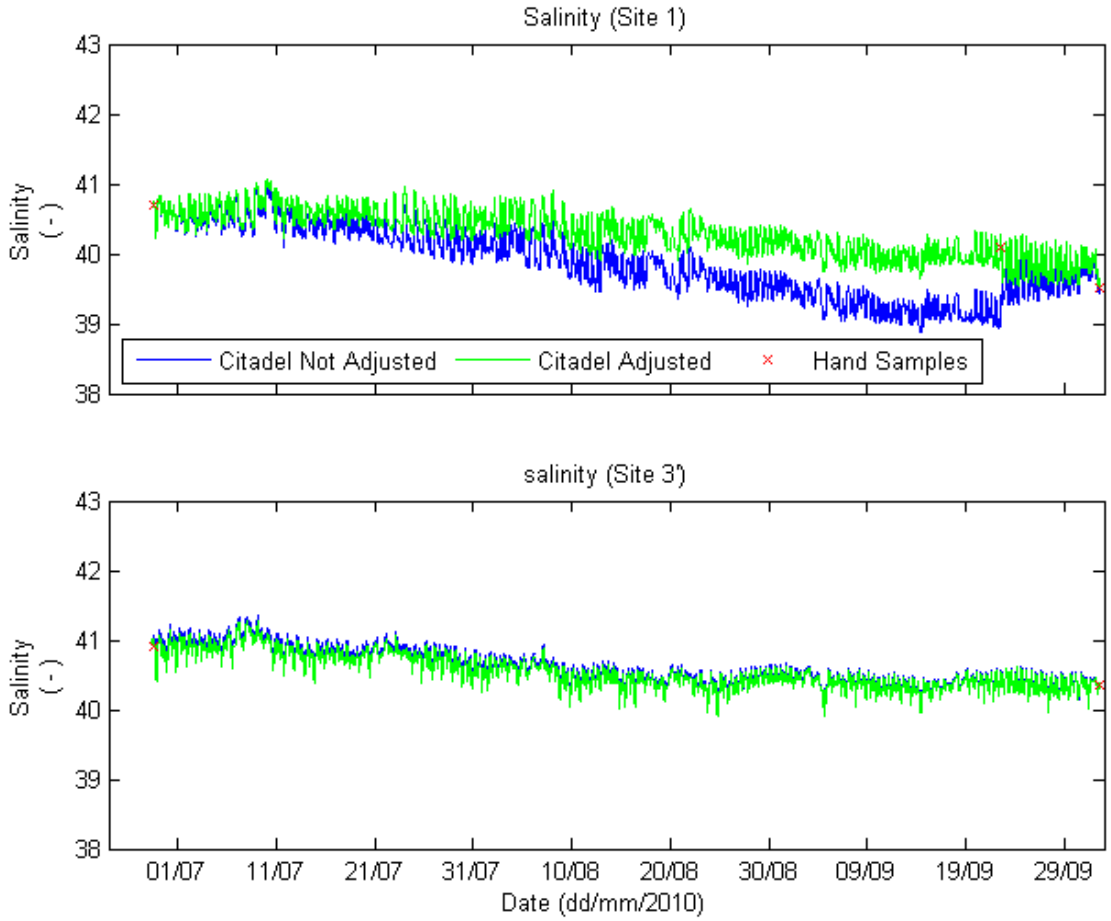


Figure 3-16 Citadel salinity measurements

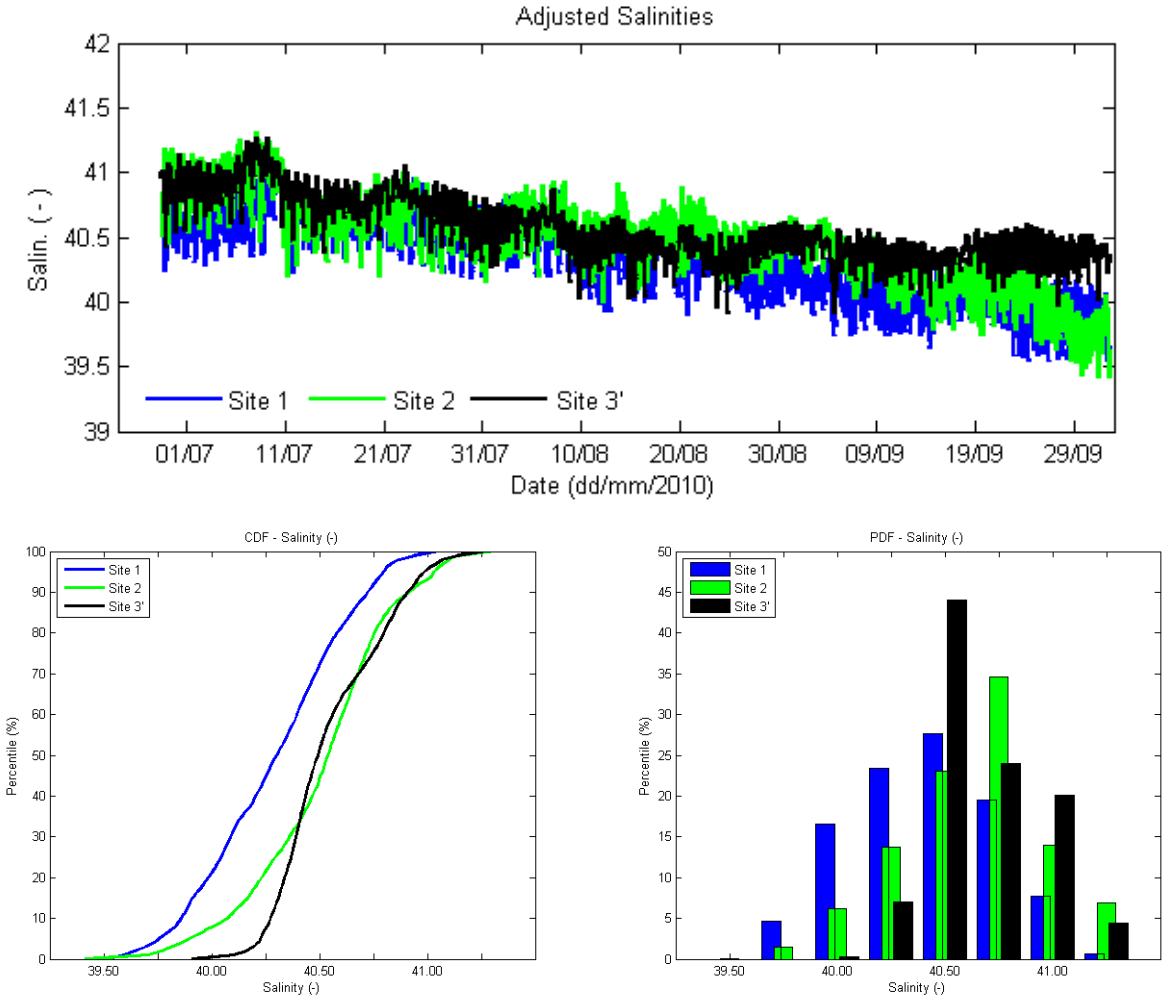


Figure 3-17 Adjusted salinity measurements for deployment 2. Upper panel: time-series, lower left panel: cumulative distribution, lower right panel: probability density distribution.

Table 3-4 Cumulative distribution of adjusted salinity measurements

Salinity Distribution			
%ile	Site 1	Site 2	Site 3'
0	39.52	39.41	39.91
5	39.76	39.9	40.23
10	39.86	40.07	40.27
15	39.91	40.17	40.31
20	39.99	40.23	40.34
25	40.05	40.3	40.37
30	40.09	40.36	40.39
35	40.14	40.42	40.41
40	40.21	40.47	40.44
45	40.25	40.5	40.46
50	40.3	40.54	40.49
55	40.35	40.57	40.52
60	40.4	40.61	40.56
65	40.44	40.64	40.61
70	40.48	40.68	40.68
75	40.53	40.71	40.75
80	40.58	40.75	40.8
85	40.65	40.82	40.85
90	40.72	40.92	40.91
95	40.8	41.03	40.99
100	41.05	41.31	41.27

4 SUMMARY

ADCP measurements were generally consistent with previous observations in Point Lowly. Some external problems occurred for data during Deployment 1. Deployment 2 data did not present any abnormalities.

CTD water depth and temperature measurements were consistent between all sites.

CTD salinity measurements for Deployment 1 were deemed unsuitable to the intended purposes of the data sets (i.e. background conditions, model validation). This highlights the need for suitable sensor maintenance regime as per BMT WBM (2009). Additionally, data (hand samples) for ground truth of measurements and further salinity data adjustment was not collected on a suitable time interval. Only the first three weeks of data were used for additional analysis.

Greenspan CTD salinity measurements of Deployment 2 presented problems for Site 1 and Site 3' and were deemed unsuitable to the intended purposes of the data sets. Citadel salinity measurements for Site 2 were not available at the time of finalisation of this report.

However, Citadel salinity measurements presented considerably less drifting and were therefore considered more robust than the Greenspan. Citadel salinity measurements for Sites 1 and 3' were amenable to adjustment using hand-sample data as references, compensating for the lack of sensor maintenance. Greenspan CTD salinity measurements for Site 2 did not present excessive drifting and was consistent with the Citadel measurements, therefore they were deemed reliable. Despite better performance, Citadel sensors also require maintenance (see Site 1 for example) and a more periodic schedule of reference data collection. Periodic maintenance will be particularly important in the warming period where effects of bio-fouling of sensors are expected to increase.

A schedule of CTD sensor cleaning and reference sample collection is required on a regular basis if data is to be used for its intended purposes. A cleaning interval from 2 to 3 weeks and monthly replicate salinity samples are suggested for reliable data adjustment. BMT WBM is happy to discuss this further as required.

5 REFERENCES

BMT WBM 2010a. *Hydrodynamic and Water Quality Modelling of Spencer Gulf: Model Validation Report.* Technical Report R.B17415.003 Prepared for BHP Billiton.

BMT WBM 2010b. *Spencer Gulf Modelling Assessments. Final Report.* Technical Report R.B17994.006 Prepared for BHP Billiton.

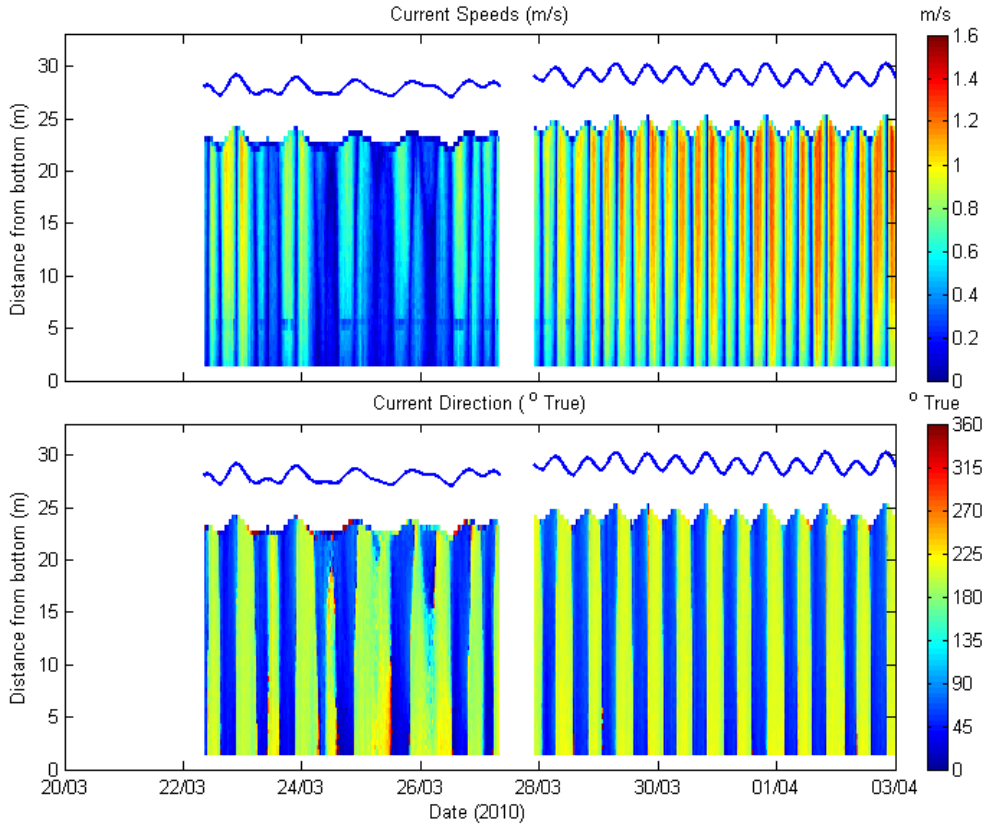
BMT WBM 2010c. *Additional Analyses of Spencer Gulf ADCP and Salinity Data Collected in 2009.* Memorandum M.B17415.019 Prepared for BHP Billiton.

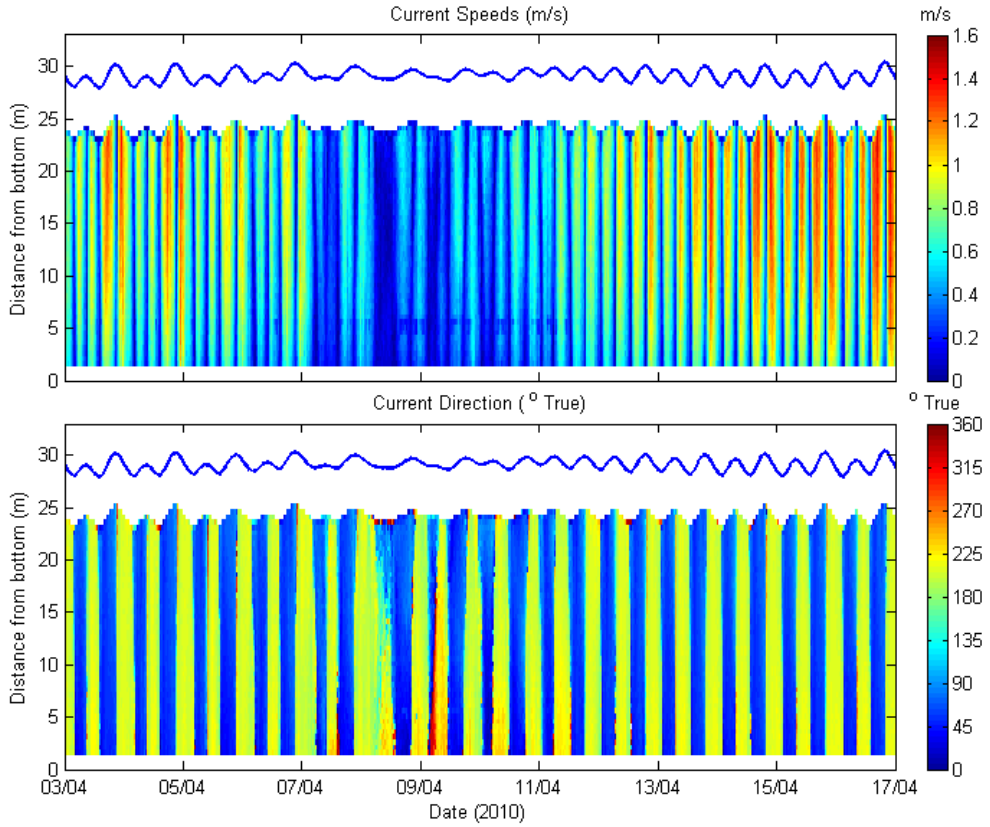
BMT WBM 2007 *Hydrodynamic and water quality modelling at Port Bonython: modelling assessments*. Technical report R.B15583.005. Prepared for BHP Billiton/Arup.

UNESCO 1983. Algorithms for computation of fundamental properties of seawater. *Technical papers in marine science no. 44.*

UNESCO 1985. The International System of Units (SI) in oceanography. *Technical papers in marine science no. 45.*

APPENDIX A: ADCP DATA

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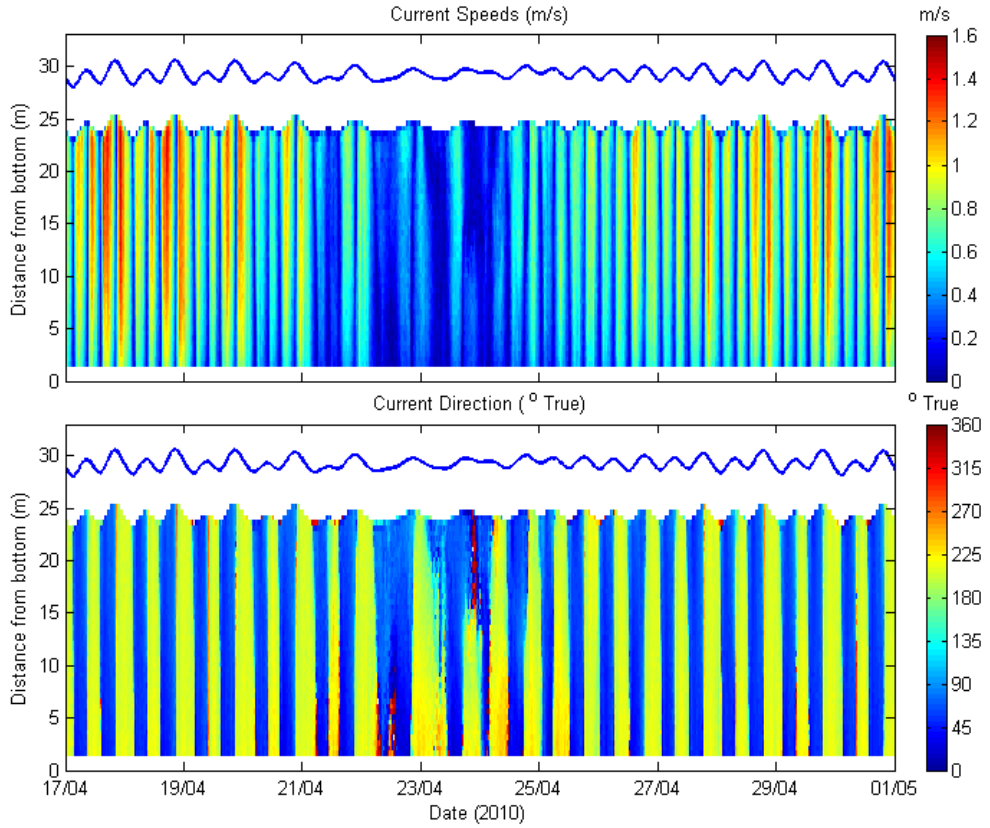
09/04
11/04
13/04
15/04
17/04
Date (2010)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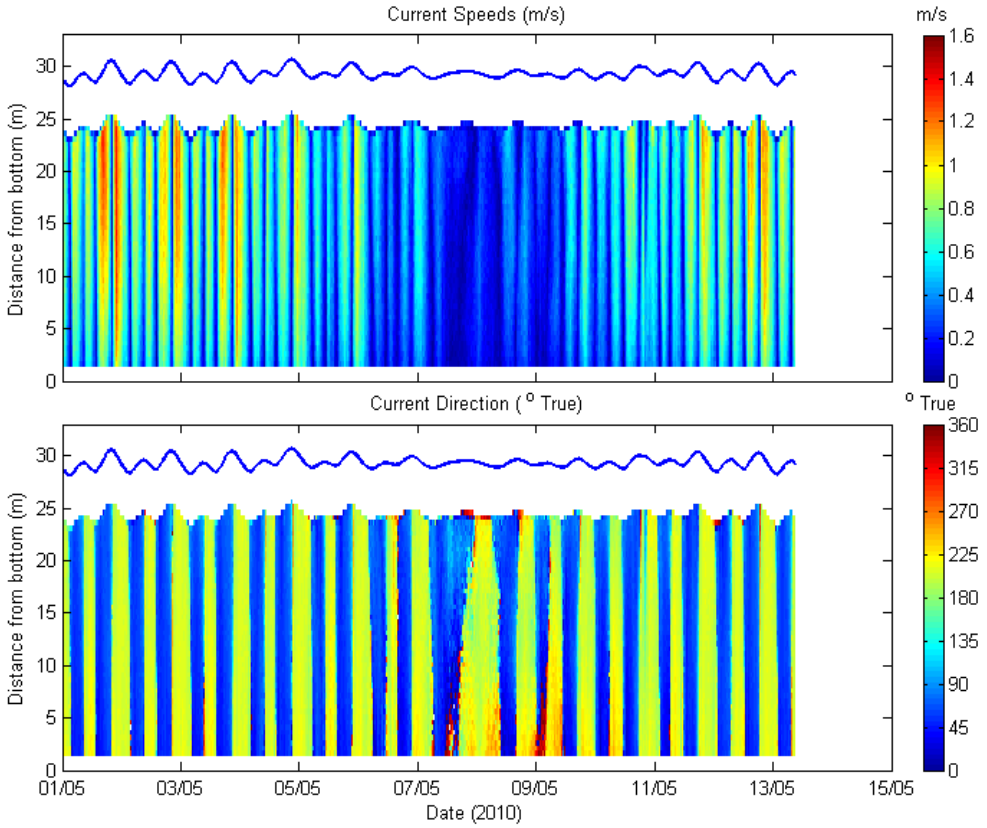
Date (2010)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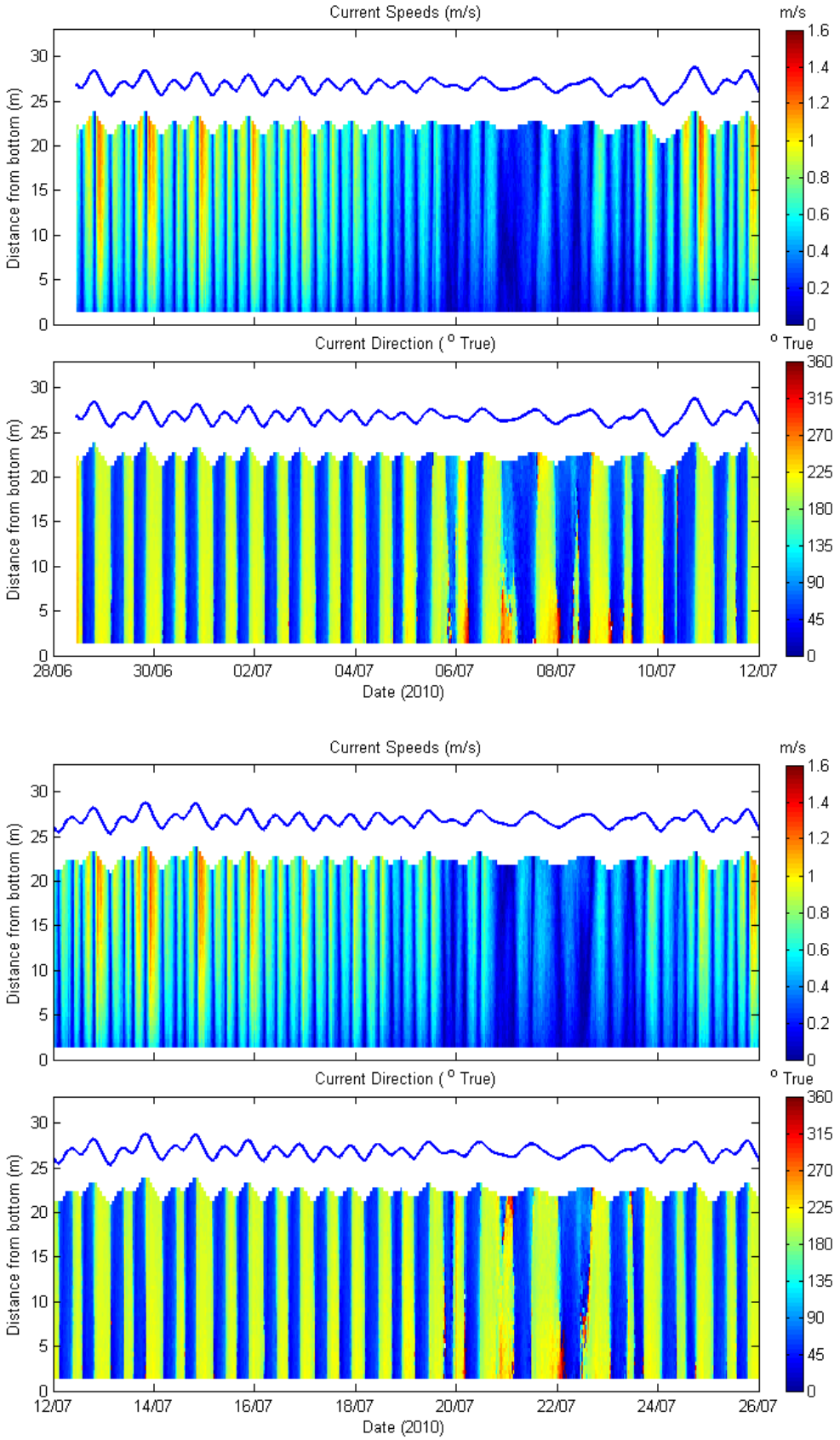
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Date (2010)
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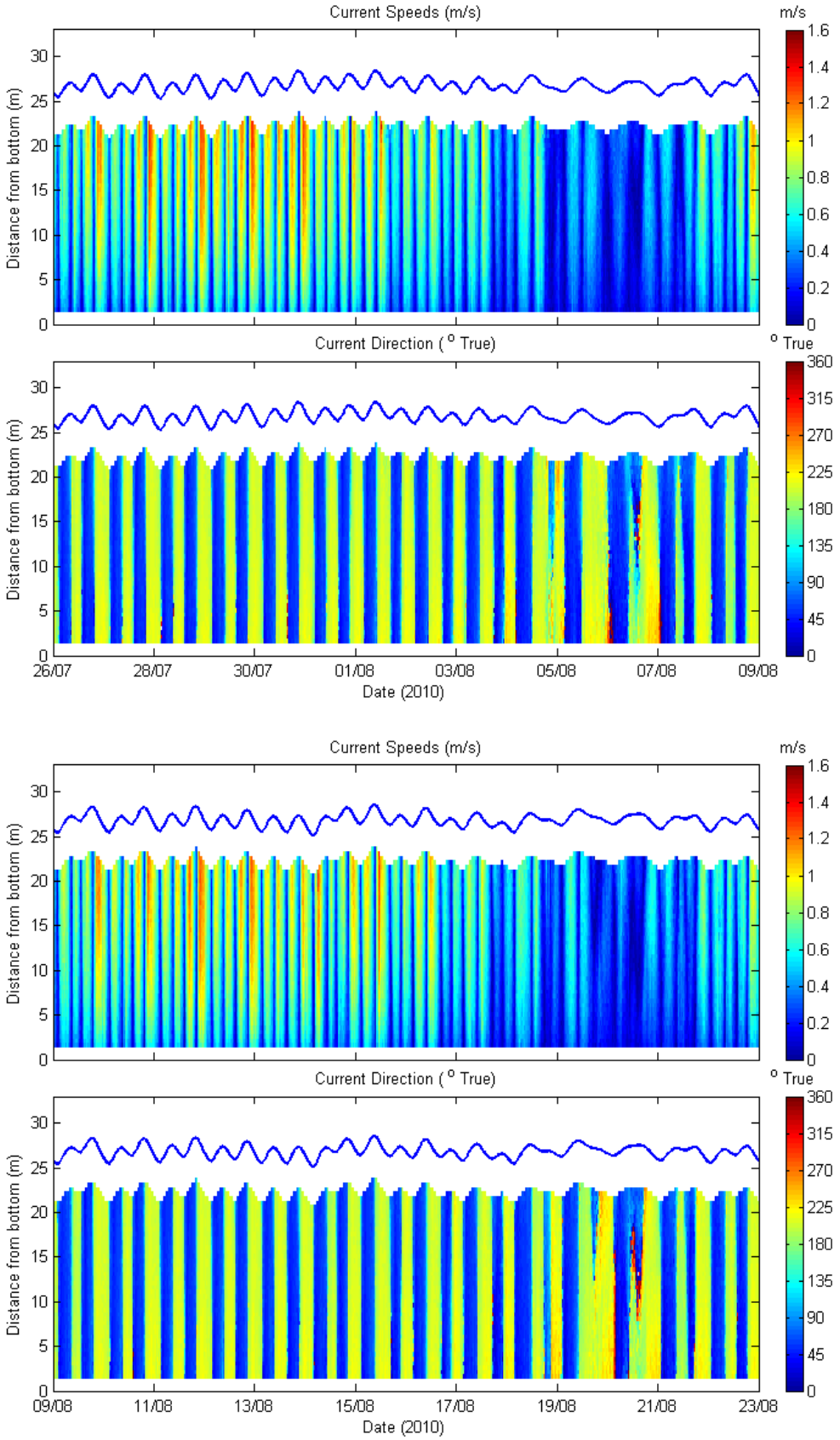
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Distance from bottom (m)
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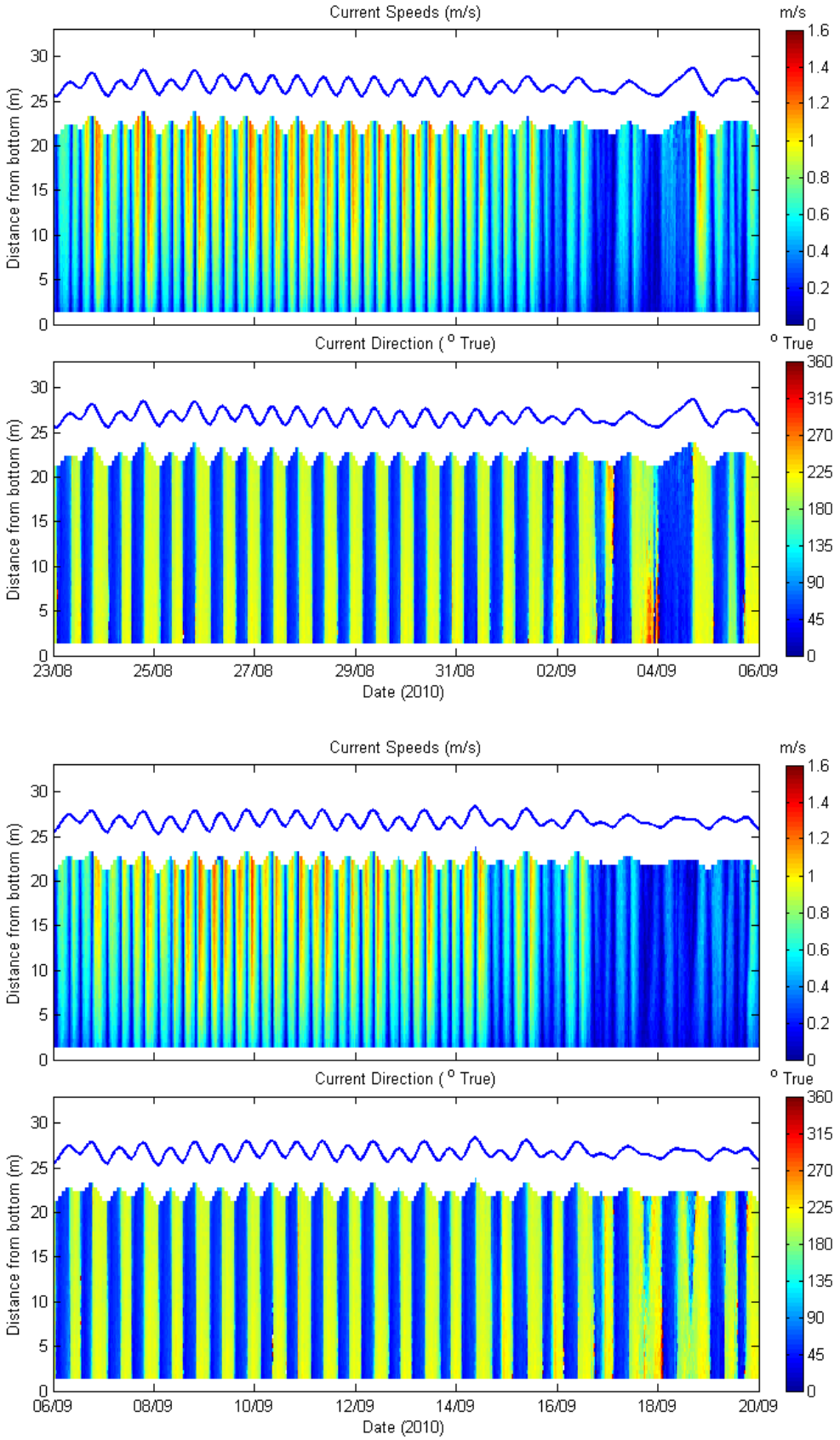
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29/08
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m/s
Distance from bottom (m)
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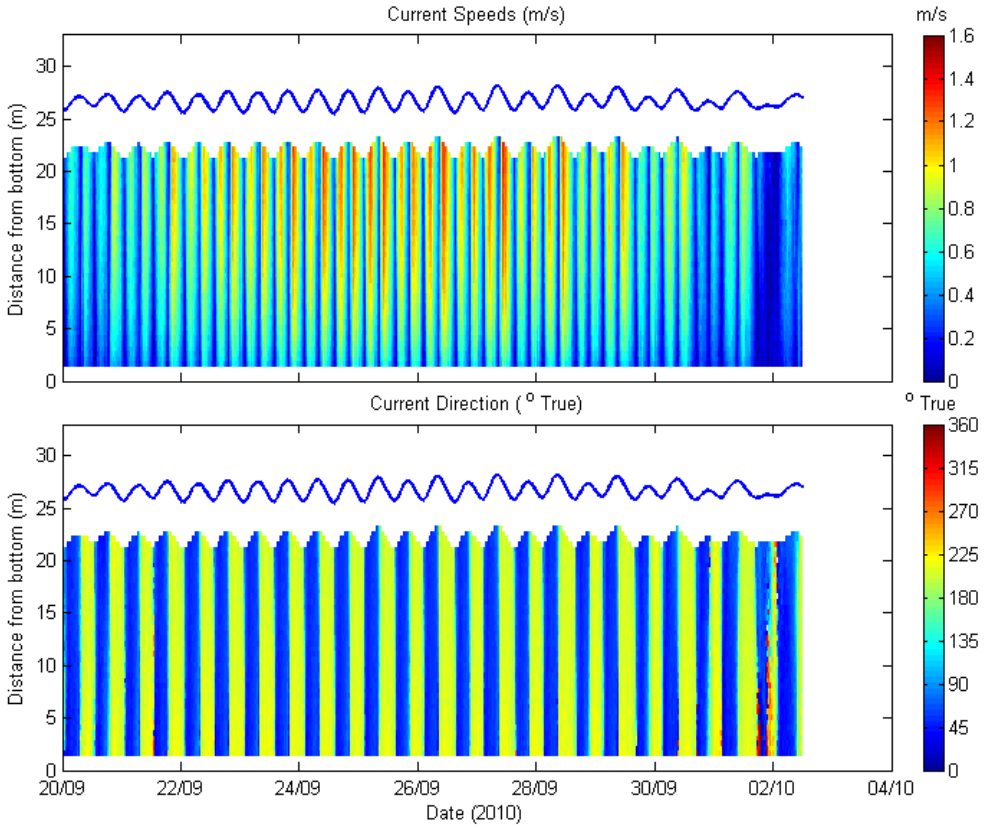
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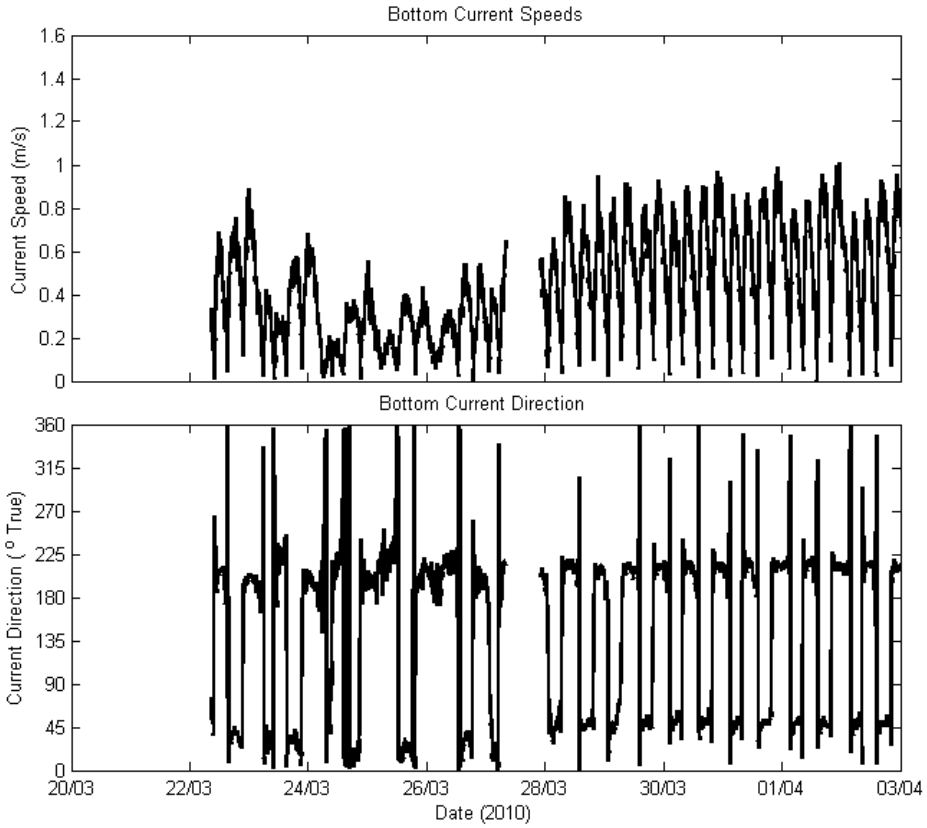
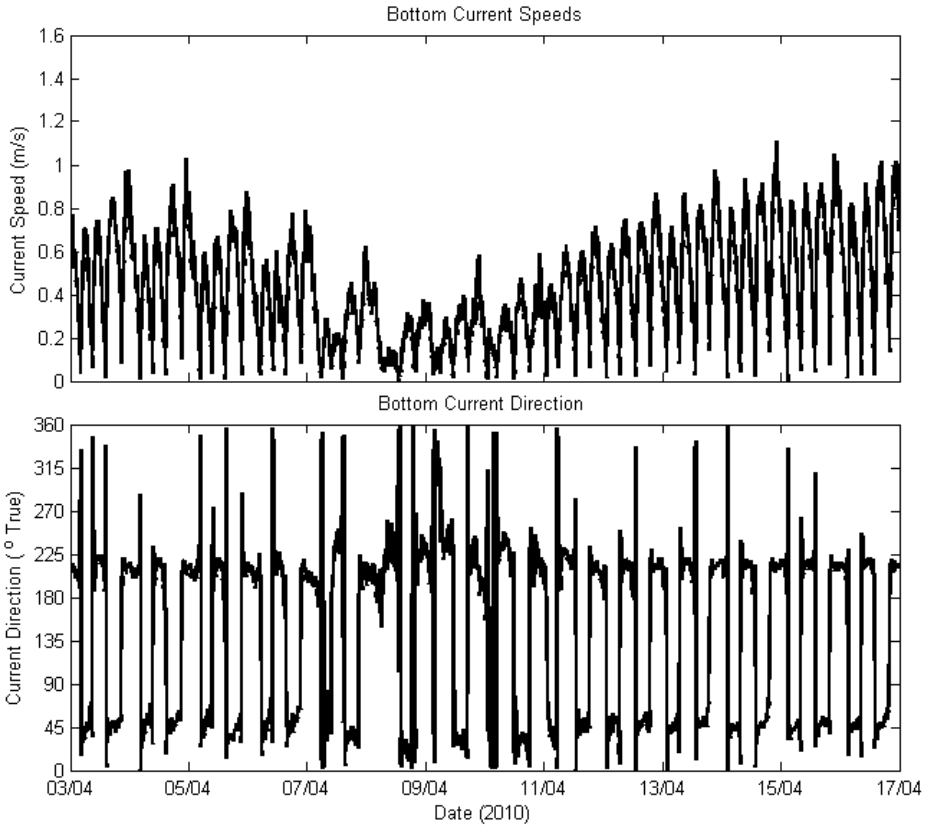
APPENDIX B: NEAR SEABED ADCP DATA

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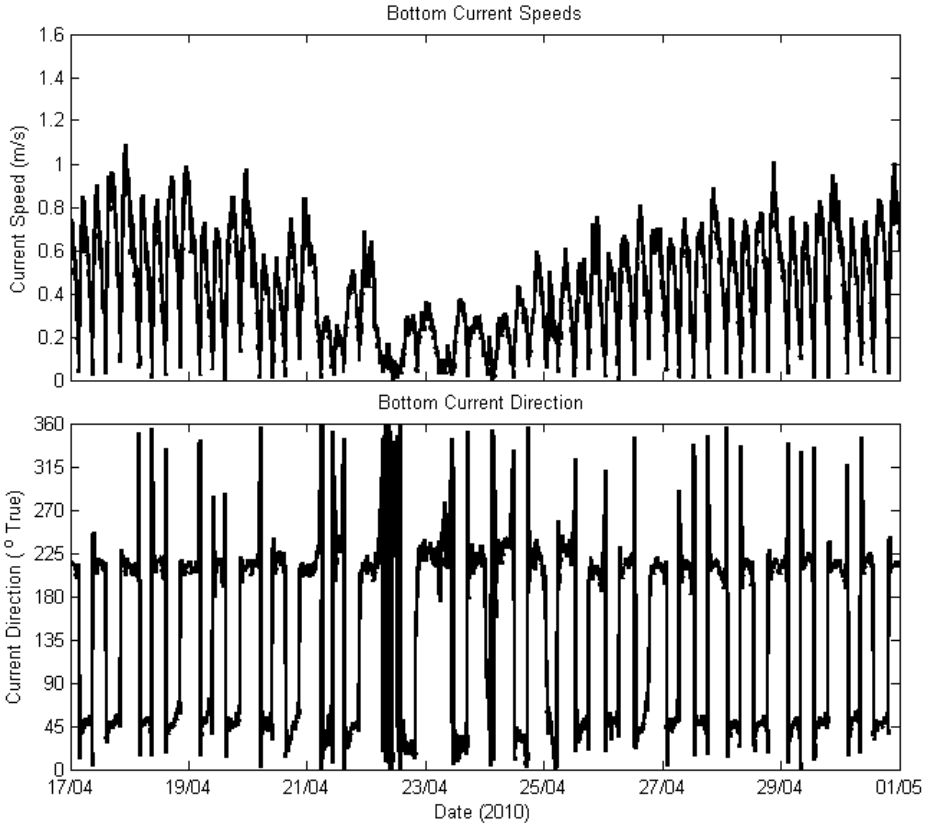
13/04
15/04
17/04
Date (2010)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Current Direction (° True)
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25/04
27/04
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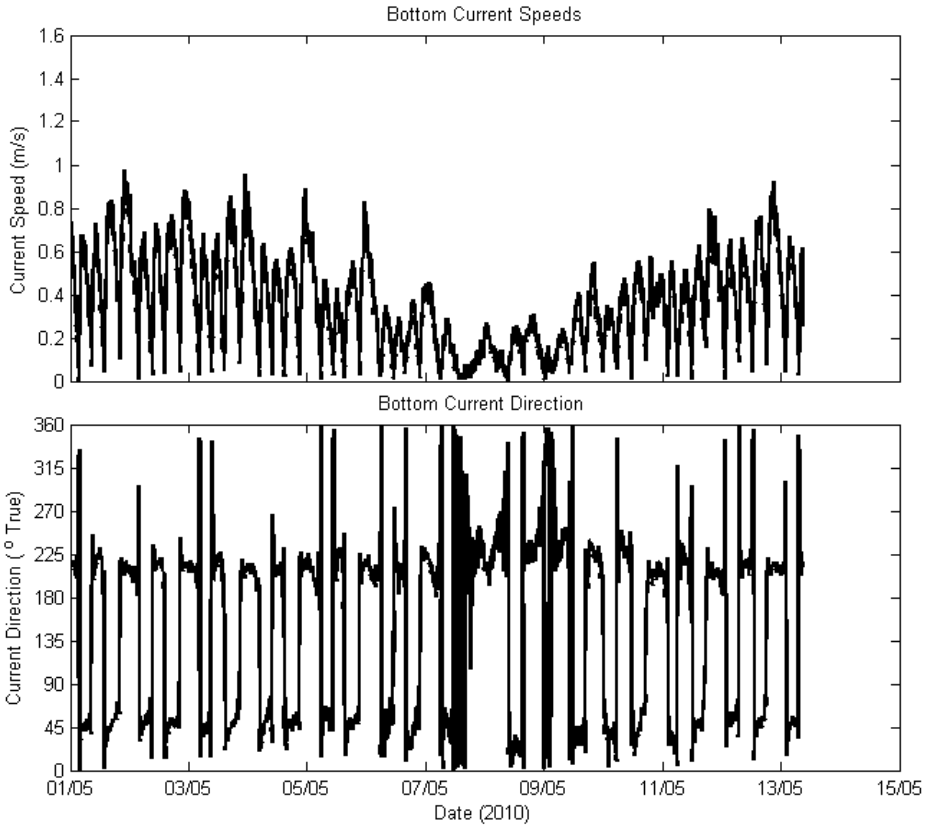
01/05
Date (2010)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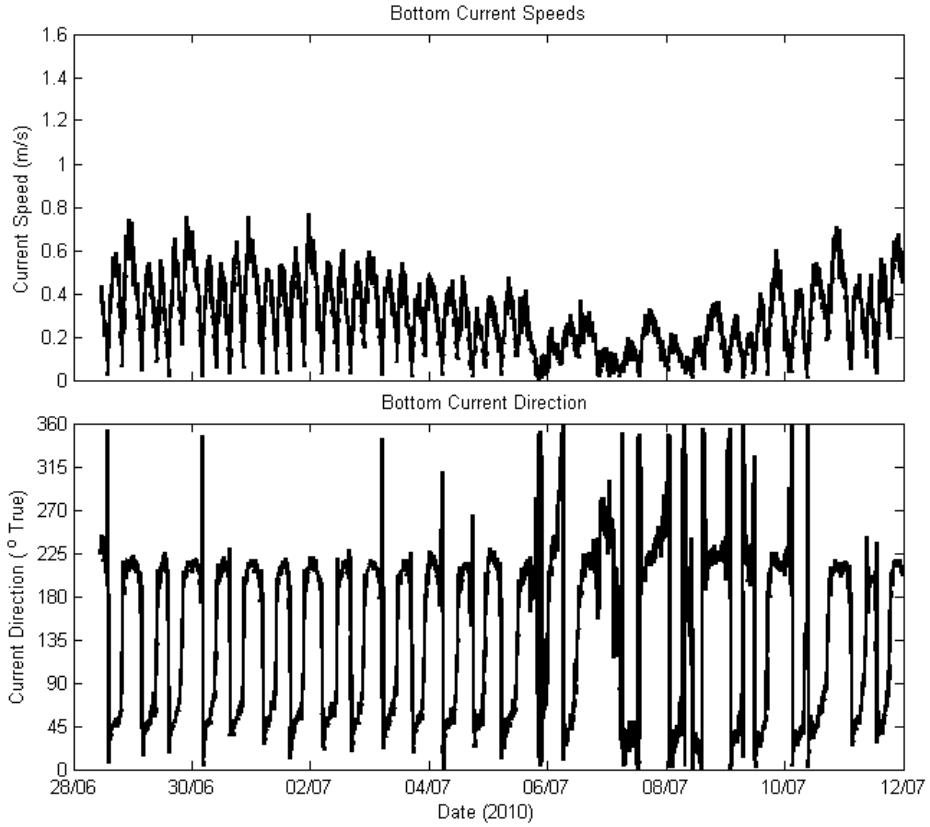
Date (2010)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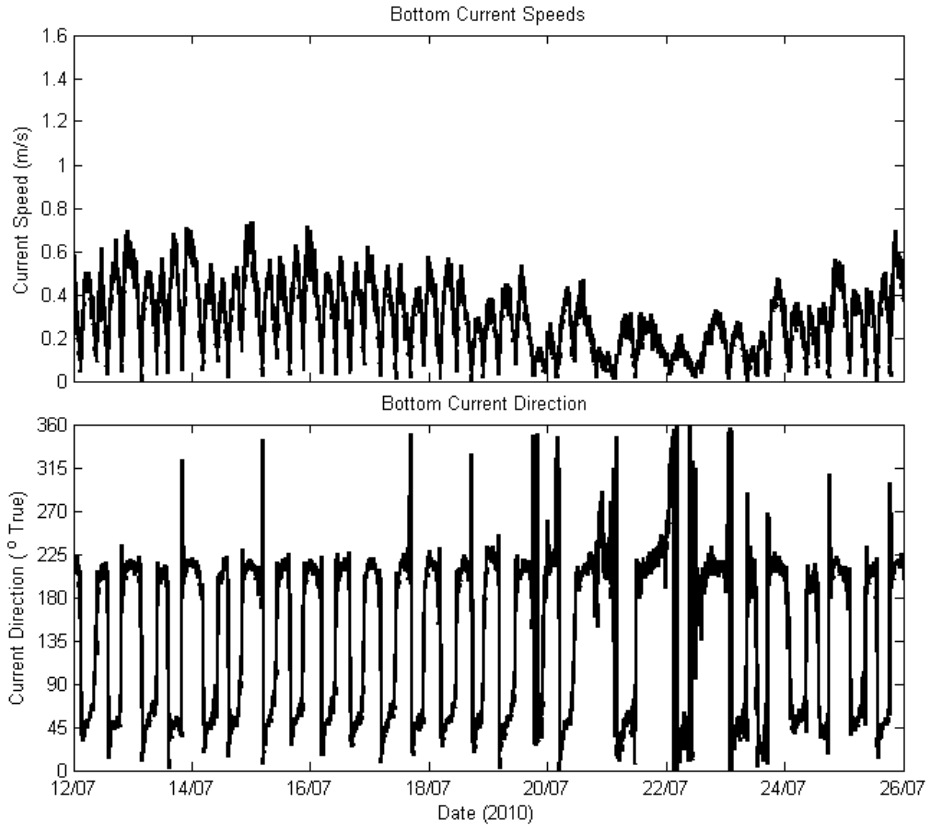
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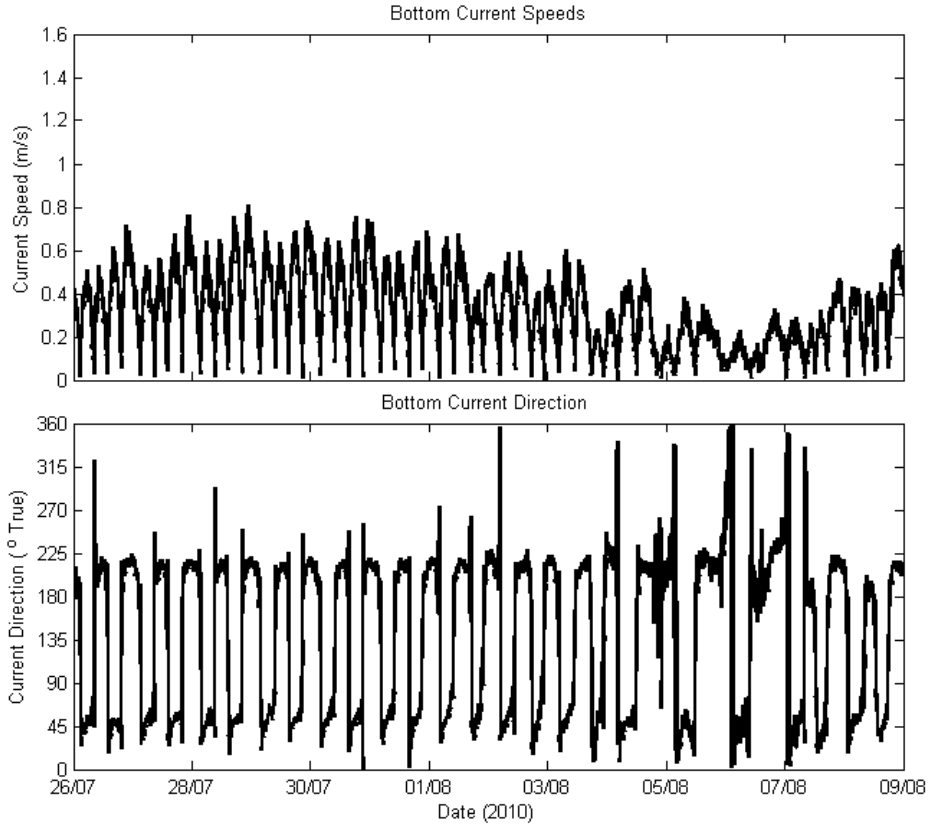
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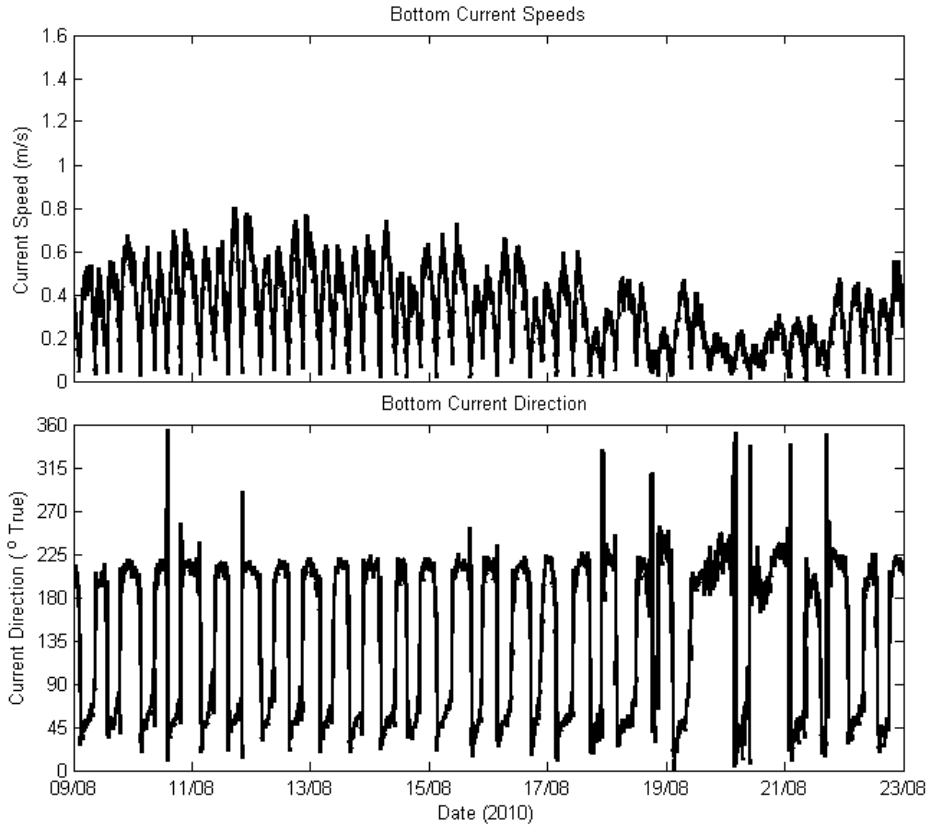
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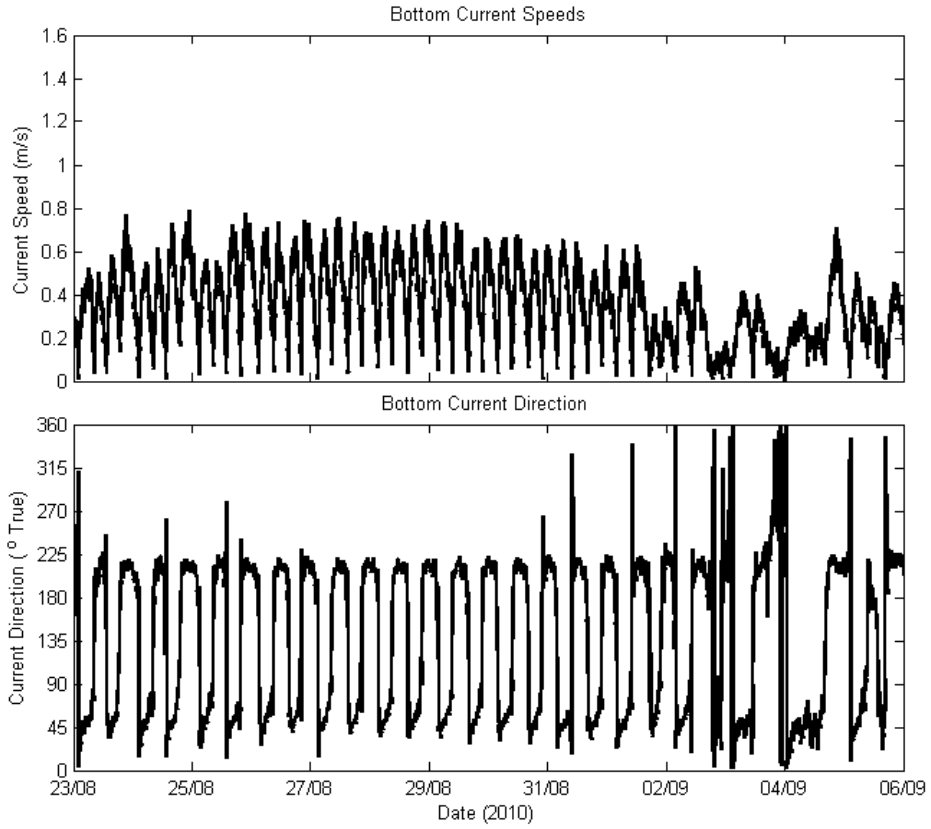
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Current Direction (° True)
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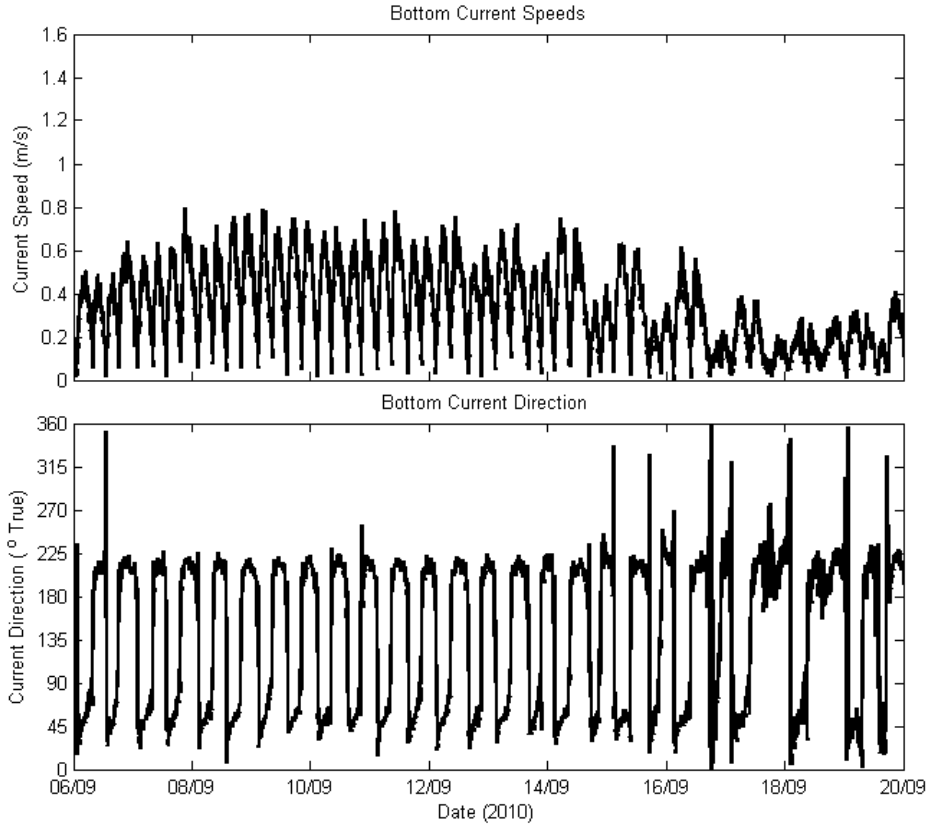
04/09
06/09
Date (2010)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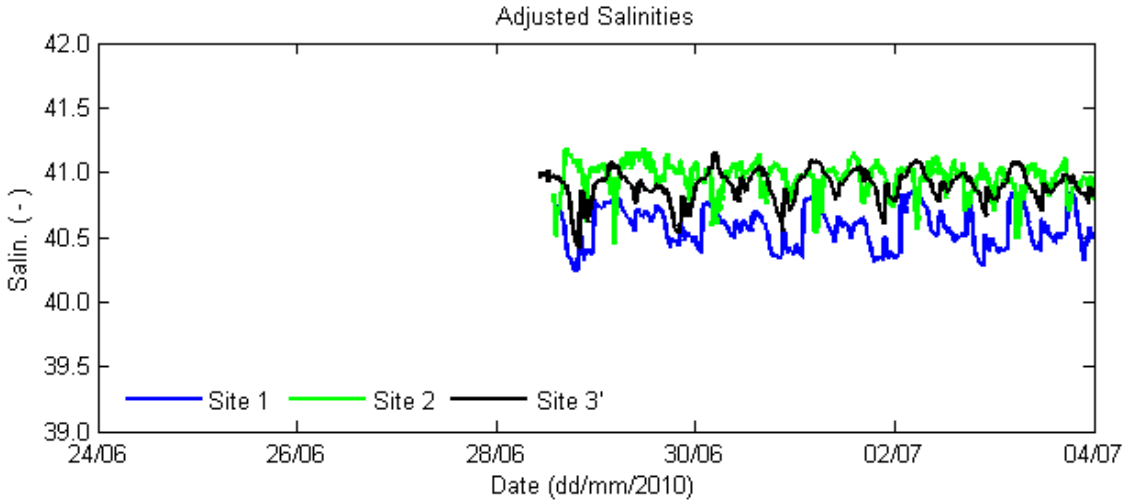
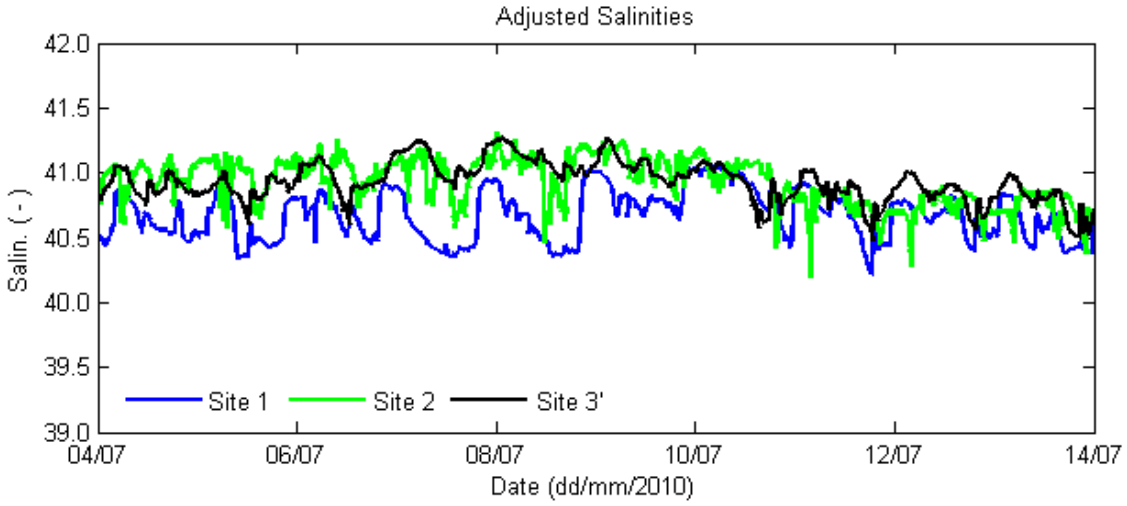
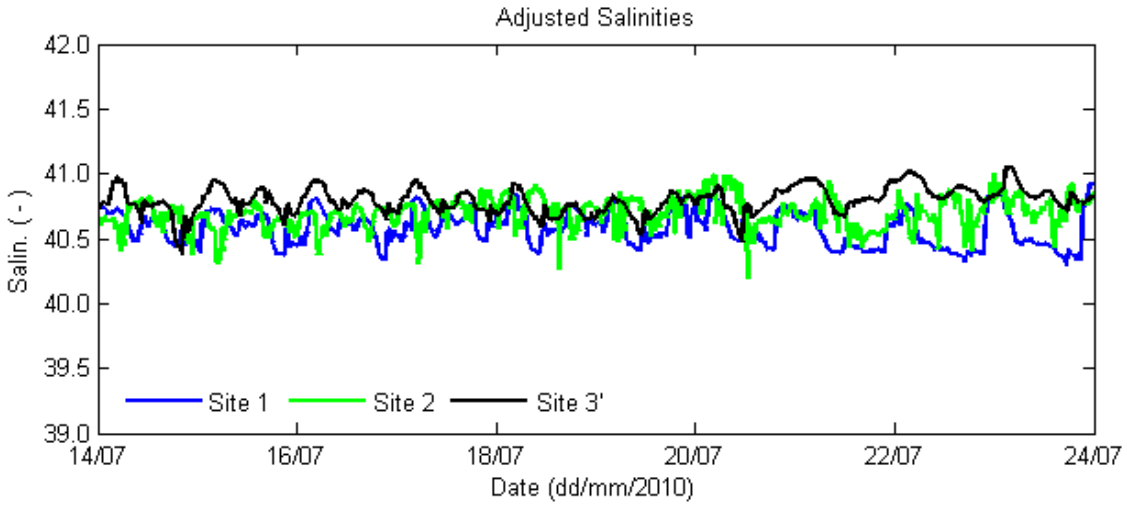
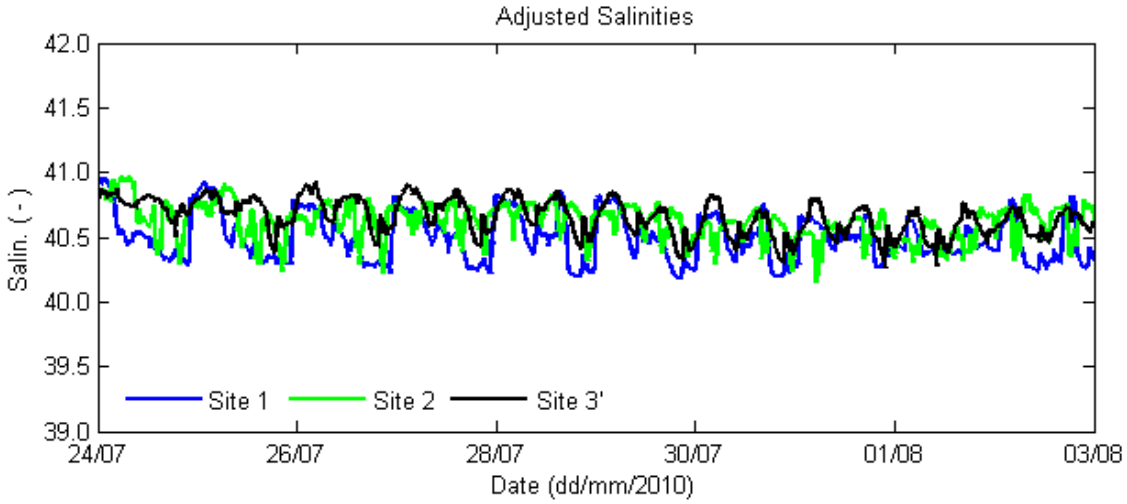
20/09
Date (2010)

APPENDIX C: CTD DATA





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Salin. (-)
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41.0
40.5
40.0
39.5
39.0
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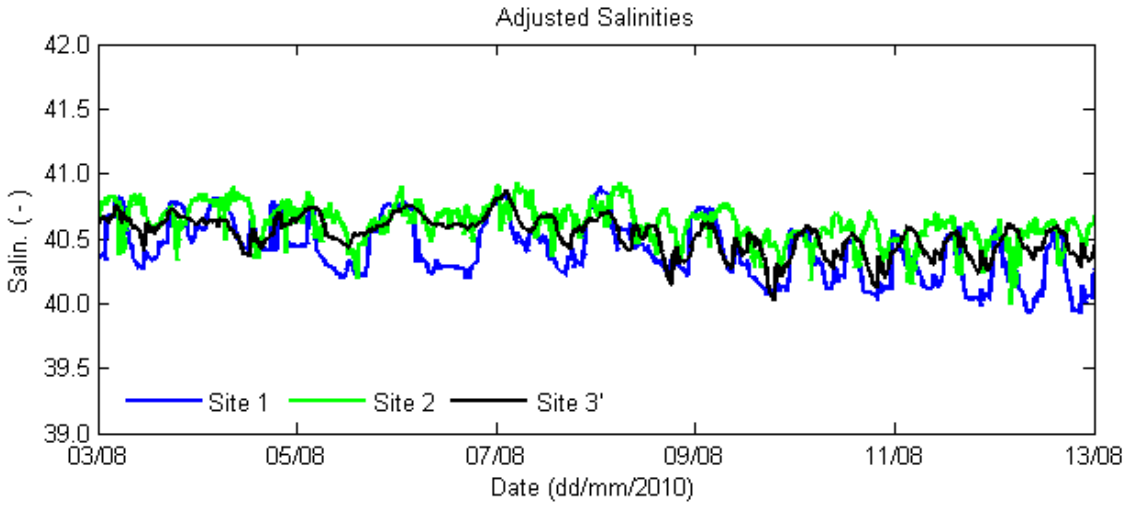
Site 2
Site 3'
24/07
26/07
28/07
30/07
01/08
03/08
Date (dd/mm/2010)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Site 2
Site 3'
03/08
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07/08
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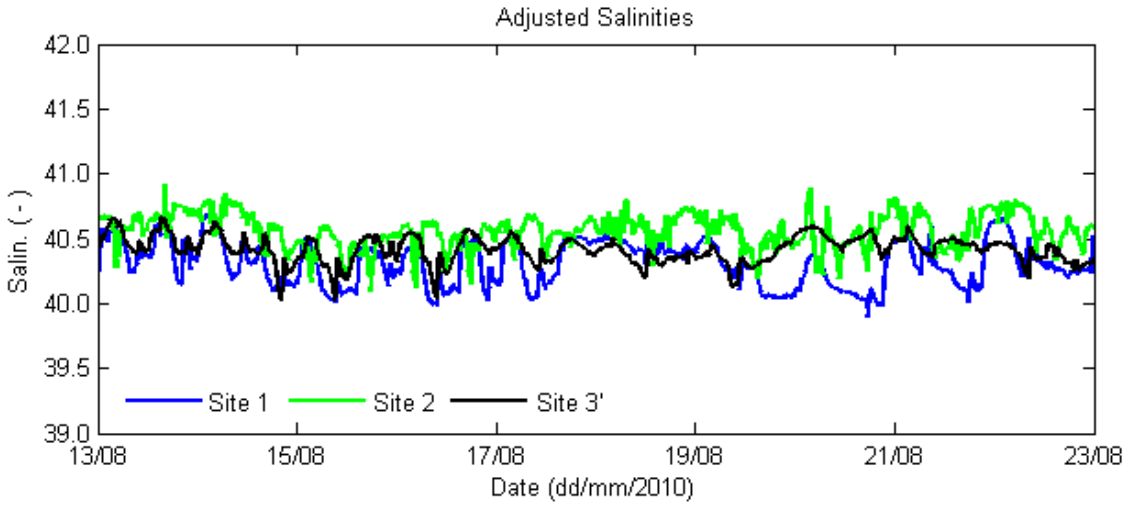
11/08
13/08
Date (dd/mm/2010)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Site 2
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15/08
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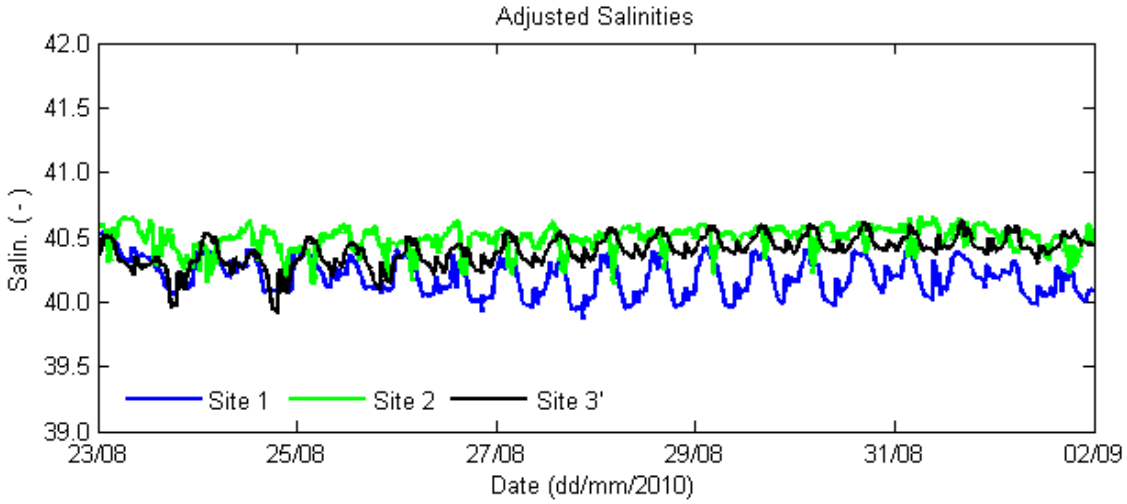
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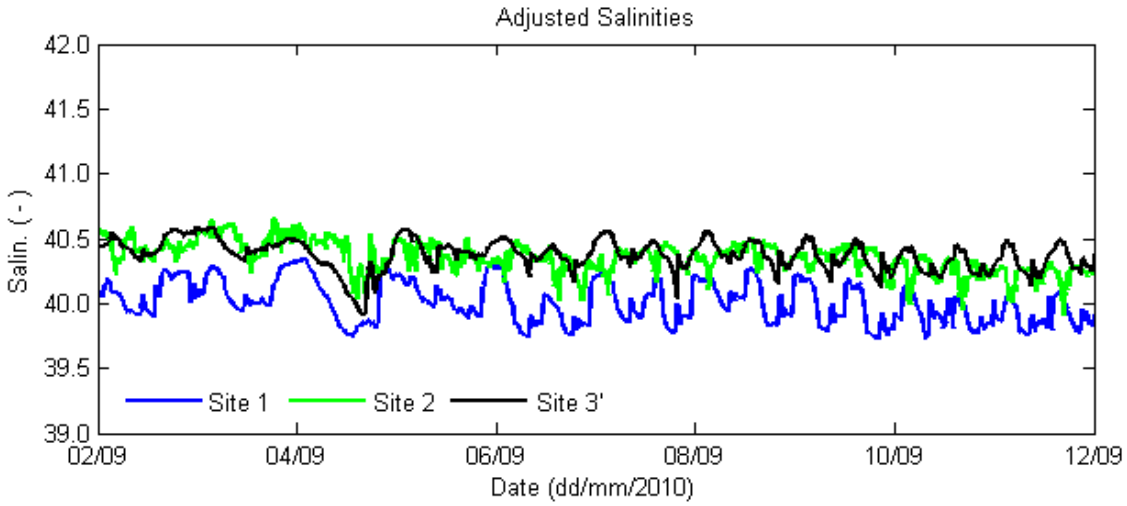
Site 2
Site 3'
23/08
25/08
27/08
29/08
31/08
02/09
Date (dd/mm/2010)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Site 1
Site 2
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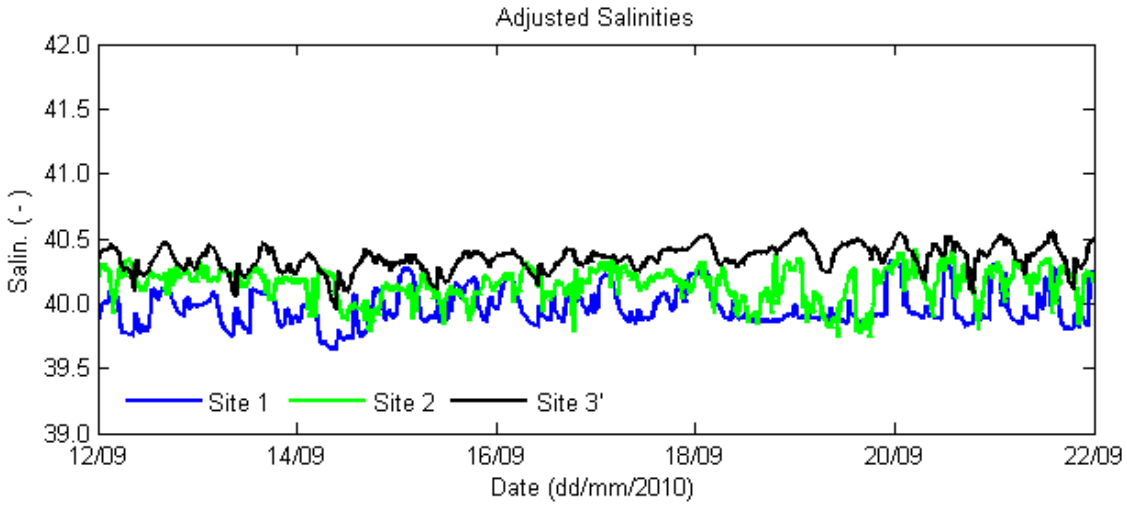
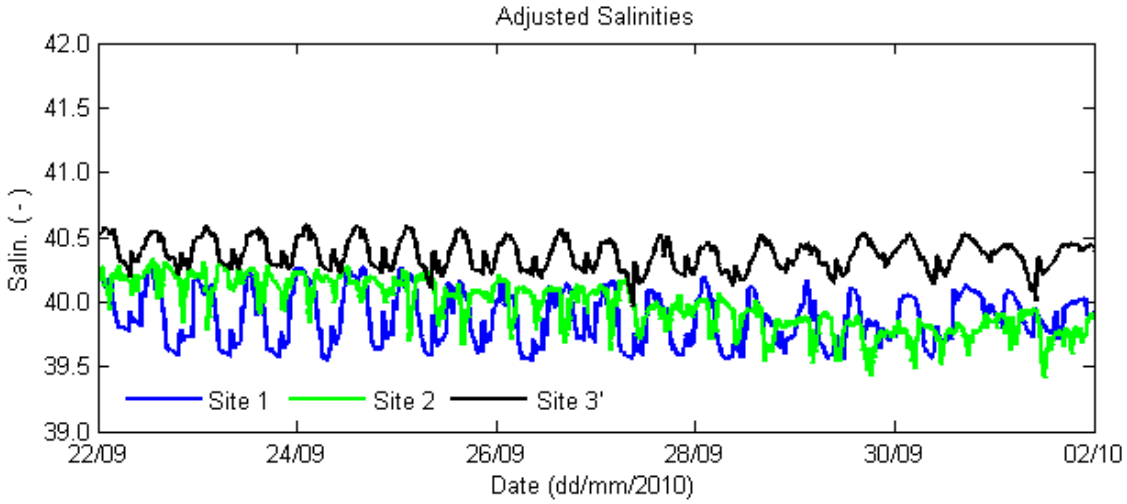
02/09
04/09
06/09
08/09
10/09
12/09
Date (dd/mm/2010)


Adjusted Salinities
Salin. (-)
42.0
41.5
41.0
40.5
40.0
39.5
39.0
Site 1
Site 2
Site 3'
12/09
14/09
16/09
18/09
20/09
22/09
Date (dd/mm/2010)


Adjusted Salinities
Salin. (-)
42.0
41.5
41.0
40.5
40.0
39.5
39.0
Site 1
Site 2
Site 3'
22/09
24/09
26/09
28/09
30/09
02/10
Date (dd/mm/2010)

BMT WBM Brisbane
Level 11, 490 Upper Edward Street Brisbane 4000
PO Box 203 Spring Hill QLD 4004
Tel +61 7 3831 6744 Fax +61 7 3832 3627
Email wbm@wbmpl.com.au
Web www.wbmpl.com.au

BMT WBM Denver
14 Inverness Drive East, #B132
Englewood Denver Colorado 80112 USA
Tel +1 303 792 9814 Fax +1 303 792 9742
Email wbmdenver@wbmpl.com.au
Web www.wbmpl.com.au

BMT WBM Mackay
Suite 1, 138 Wood Street Mackay 4740
PO Box 4447 Mackay QLD 4740
Tel +61 7 4953 5144 Fax +61 7 4953 5132
Email wbmmackay@wbmpl.com.au
Web www.wbmpl.com.au

BMT WBM Melbourne
Level 5, 99 King Street Melbourne 3000
PO Box 604 Collins Street West VIC 8007
Tel +61 3 8620 6100 Fax +61 3 8620 6105
Email wbmmelbourne@wbmpl.com.au
Web www.wbmpl.com.au

BMT WBM Newcastle
126 Belford Street Broadmeadow 2292
PO Box 266 Broadmeadow NSW 2292
Tel +61 2 4940 8882 Fax +61 2 4940 8887
Email wbmnewcastle@wbmpl.com.au
Web www.wbmpl.com.au

BMT WBM Perth
1 Brodie Hall Drive Technology Park Bentley 6102
Tel +61 8 9328 2029 Fax +61 8 9486 7588
Email wbmperth@wbmpl.com.au
Web www.wbmpl.com.au

BMT WBM Sydney
Level 1, 256-258 Norton Street Leichhardt 2040
PO Box 194 Leichhardt NSW 2040
Tel +61 2 9713 4836 Fax +61 2 9713 4890
Email wbmsydney@wbmpl.com.au
Web www.wbmpl.com.au

BMT WBM Vancouver
1190 Melville Street #700 Vancouver
British Columbia V6E 3W1 Canada
Tel +1 604 683 5777 Fax +1 604 608 3232
Email wbmvancouver@wbmpl.com.au
Web www.wbmpl.com.au