



ADCP Deployment Report

South Bute, Isle of Bute

Data Collected Across 3 Deployments

Deployment 1 - 04/10/2017 to 19/11/2017

Deployment 2 - 10/01/2018 to 22/02/2018 Deployment

3 - 22/02/2018 to 23/03/2018

Report Drafted 06/12/2018

Prepared By

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1. Introduction

Dawnfresh Farming Ltd. is preparing this report in order to present the findings of the recent hydrographic survey carried out at South Bute. The report will consider the method of collection of hydrographic data in order to ascertain whether it is suitably robust for use in autoDepomod modelling.

2. Site Description

The proposed site lies off the south east coast of the Island of Bute, the current meter was positioned within 150m of the centre of the proposed cage group. On recovery data was downloaded and the meter redeployed with all effort made to return the meter to the same location. The same location was kept as close as possible due to a request from the NLB in the interests of safe navigation. The proposed South Bute site will consist of 10 x 120m circumference pens arranged in a 5 x 2, 75m x 75m grid matrix. The biomass being applied for is 2,500T at a Stocking Density of 13.6kg/m³.

3. Survey Details

Dawnfresh Farming engaged the environmental consultant AMS Ltd. to deploy a current meter at the South Bute site in order to gather current data in support of a CAR licence application. After 46 days deployment the current meter was recovered, data was downloaded on recovery. Unfortunately once the data was downloaded it was apparent that on the 27th October 2017 something dragged the meter moving the meter off position restricting the valid data to 23 days. A further deployment was undertaken at the site on the 10th January 2018 which was recovered on 22nd February 2018 on recovering the data it was discovered that after 18 days the meter developed a compass offset. The 24.5 days data after this point may be suitable for future use with further processing but only the first 18 days are considered in this Hydrographic Report. Once the data was downloaded the meter was redeployed on the 22nd February 2018 until 23rd March 2018, the meter recorded 29 days data. Over the three deployments a 70 day data set has been recovered, this Hydrographic report considers the full data set as collected and identifies a single 15 days data set between 8th March 2018 and the 23rd March 2018 which is representative of median conditions at the site.

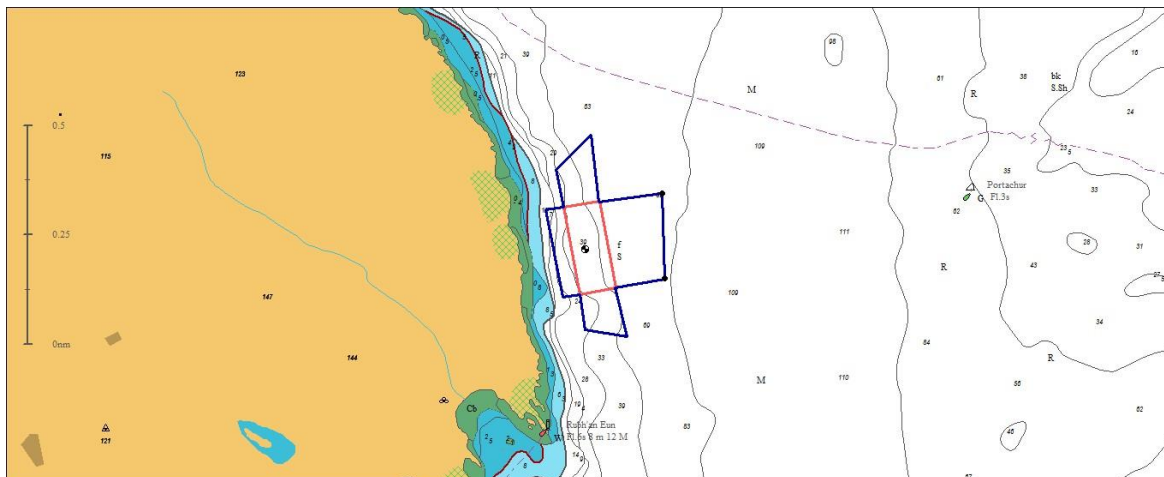


Figure 3.1: South Bute current meter deployment location and proposed site (Red)

4. Materials and Methods

Dawnfresh Farming Ltd. used an RD instruments Sentinel V 100 ADCP which is a 300kHz acoustic Doppler current profiler for deployment 1 and an RD instruments Sentinel Workhorse ADCP which is also a 300kHz acoustic Doppler current profiler for deployments 2 and 3. Due to the prediction of strong currents at this location, in discussion with our consultant it was decided the most appropriate method of anchoring the meter to the seabed would be using an inline frame. The frame was used with a J mooring consisting of a 10kg anchor to 8m of 19mm chain then 40m ground rope to a 25kg clump weight below the frame. The frame is then suspended 0.5m above the seabed supported by 2 trawl floats. Prior to deployment Dawnfresh Farming Ltd. applied to marine Scotland for an exemption to deploy a current meter and navigation was a key consideration, this resulted a deployment position being agreed and this position was maintained throughout the deployment period. The mooring was marked by a surface marker buoy of 0.5m diameter at the request of the, Northern Lighthouse Board, to aid navigation. Further information can be found on the Sentinel V 100 and the Sentinel Workhorse ADCPs at:

<http://www.teledynemarine.com/>

All deployed ADCPs were positioned at 55 45.223'N, 004 53.842'W [218270.163E, 654952.937N] which was within 150m of the proposed cage group centre. The meters were programmed prior to deployment based on chart depth at the proposed deployment location. The cell size was set to 1m and the number of cells was 59. Using the mooring configuration outlined above the transducer head was positioned 0.5m above the seabed. For deployment 1 the Sentinel V 100 the blanking distance and cell size chosen, the bottom cell was automatically set at 2.4m which gave a total distance from the seabed of 2.9m which is within the SEPA requirements. For deployments 2 and 3 with the Sentinel Workhorse the head was positioned 0.5m above the seabed. Due to the blanking distance and cell size chosen the bottom cell was set at 3.2m which gave a total distance from the seabed of 3.7m which is out with the SEPA guidance. In order to address this issue the Dyer Logarithmic Profile (Dyer 1979) was used to artificially reduce the bottom cell height by 0.8m in order to accommodate this reduction the bottom cell speed was reduced by 3%. This reduction was undertaken prior to modelling the extracted 15 days of data and applied to all bottom cell readings across the 15 days. The reduction in cell height resulted in a corrected cell height of 2.9m which is within the SEPA requirements and maintains consistency with deployment 1. Data was automatically stored to the internal memory and downloaded on recovery.

Sentinel V

20 m, 50 m, 100 m Profiling ADCP



TECHNICAL SPECIFICATIONS

Depth Cell Size ¹	V20 (1000 kHz)		V50 (500 kHz)		V100 (300 kHz)		
	Depth Cell Size ¹	Range (m) ^{2,3} Wide/Narrow	Std Dev (cm/s) ^{5,4} Wide/Narrow	Range (m) ^{2,3} Wide/Narrow	Std Dev (cm/s) ^{5,4} Wide/Narrow	Range (m) ^{2,3} Wide/Narrow	Std Dev (cm/s) ^{5,4} Wide/Narrow
	0.25 m	18.0/22.6	19.2/36.5				
	0.3 m	19.3/24.0	11.1/20.8				
	0.5 m	20.2/24.9	7.1/13.4	44.1/57.6	19.2/36.5		
	1.0 m	22.1/26.9	3.6/6.7	50.5/64.6	7.1/13.5	94.5/120.6	10.9/20.6
	2.0 m	24.5/29.4	1.7/3.2	56.0/70.6	3.6/6.7	103.5/130.4	5.5/10.3
	4.0 m	26.9/32.0	0.8/1.6	63.1/78.2	1.7/3.2	114.6/142.3	2.7/5.2
	6.0 m			67.4/82.8	1.1/2.1	121.7/151.5	1.8/3.3
Self-Contained (SC) Communications and Recording	Wireless/Ethernet Internal memory			802.11 b/g/n / TCP/IP One 16 GB Micro SD Card included			
Real-Time (RT) Communications	Serial/Ethernet			RS232 and RS422 / TCP/IP (setup) UDP (output)			
Profile Parameters	Velocity accuracy Velocity resolution Velocity range Ping rate			V20/V50: 0.3% of the water velocity relative to the ADCP ± 0.3 cm/s V100: 0.5% of the water velocity relative to the ADCP ± 0.5 cm/s 0.1 cm/s ± 5m/s (default); ± 20m/s (maximum) Up to 4 Hz (SC); Up to 16 Hz (RT)			
Echo Intensity Profile	Vertical resolution Dynamic range Precision			Depth cell size 80 dB ±1.5 dB			
Transducer and Hardware	Beam angle Configuration Depth rating Materials			25° 4-beam, convex; 5th beam vertical 200 m Transducer, housing, and end cap: plastic Connector: metal shell			
Standard Sensors	Temperature (mounted on transducer) Compass (magneto-inductive sensor) Tilt (MEMS accelerometers) Pressure sensor (mounted on transducer) Recorder			Range -5° to 45°C, precision ± 0.4°C, resolution 0.1° Accuracy 2° RMS, resolution 0.1°, max. dip angle 85° Pitch range ± 90°, roll range ± 180°, accuracy 2° RMS, precision 0.05° RMS, resolution 0.1° Range 300m, accuracy 0.1% FS 16GB Micro SD Card			
Power	External DC input Internal battery voltage Battery capacity; over-the-counter @ 0°C Battery pack @ 5°C			12–20 VDC 18 VDC new 100 watt hours (typical) 510 watt hours			
Software	Included Teledyne RDI Software Optional Teledyne RDI Software (recommended)			ReadyV (SC)—Pre-deployment (testing, planning, and data recovery) ⁵ PLAN (RT)—Pre-deployment (testing and planning) ⁶ VMDAS (RT)—Real-Time (deploy and data processing) ⁶ Velocity (SC/RT)—Post-processing (data handling, display, and export) ⁶			
Environmental	Standard depth rating Operating temperature Storage temperature (without batteries)			200 m -5° to 45°C -30° to 60°C			
Available Options—Hardware Available Options—Firmware/Software	Straight or right-angle metal shell connector • AC/DC power converter and cable • External battery case Waves (SC) / Bottom Track (RT)						
Dimensions and Weights	Special configuration drawing available upon request						

1. User's choice of depth cell not limited to the typical values specified.

2. Ranges specified are typical at temperature of 5°C and salinity of 35 psu; longer ranges are possible.

3. User selects the bandwidth mode; wide = 25% or narrow = 6%.

4. Standard deviations (Std Dev) are typical values for single ping data.

5. Resident in ADCP accessed via a web browser.


6. Windows™ based software program.

Figure 4.1: Specification sheet for Sentinel V 100 ADCP

Figure 4.1.1: Specification sheet for Sentinel V 100 ADCP

Workhorse Monitor

Direct Reading 1200, 600, 300 kHz ADCP



TECHNICAL SPECIFICATIONS

Water Profiling	Depth Cell Size ¹	Typical Range ² 12m 1200kHz		Typical Range ² 50m 600kHz		Typical Range ² 110m 300kHz	
	Vertical Resolution	Range ³	Std. Dev. ⁴	Range ³	Std. Dev. ⁴	Range ³	Std. Dev. ⁴
	0.25m	11m	14.0cm/s				
	0.5m	12m	7.0cm/s	38m	14.0cm/s	see note ¹	
	1m	13m	3.6cm/s	42m	7.0cm/s	83m	14.0cm/s
	2m	15m ²	1.8cm/s	46m	3.6cm/s	93m	7.0cm/s
	4m	see note ¹		51m ²	1.8cm/s	103m	3.6cm/s
	8m					116m ²	1.8cm/s
Long Range Mode	2m	19m	3.4m/s				
	4m			66m	3.6cm/s		
	8m					154m	3.7cm/s
Profile Parameters	Velocity Accuracy	0.3% of water velocity relative to ADCP ±0.3cm/s		0.3% of water velocity relative to ADCP ±0.3cm/s		0.5% of water velocity relative to ADCP ±0.5cm/s	
	Velocity resolution	0.1cm/s		0.1cm/s		0.1cm/s	
	Velocity range	±5m/s default, ±20m/s max		±5m/s default, ±20m/s max		±5m/s default, ±20m/s max	
	Number of depth cells	1–255		1–255		1–255	
	Ping rate	2Hz (typical)		2Hz (typical)		2Hz (typical)	
Echo Intensity Profile	Vertical resolution			Depth cell size, user configurable			
	Dynamic range			80dB			
	Precision			±1.5dB			
Transducer and Hardware	Beam angle			20°			
Transducer and Hardware	Beam angle			20°			
	Configuration			4-beam, convex			
	Internal memory			Two PCMCIA card slots; no memory card included			
	Communications			Serial port selectable by switch for RS-232 or RS-422. ASCII or binary output at 1200-115,200 baud			
Environmental	Standard depth rating			200m; optional to 500m, 1000m, 6000m			
	Operating temperature			-5° to 45°C			
	Storage temperature (without batteries)			-30° to 60°C			
	Weight in air			7.0kg			
	Weight in water			3.0kg			
Software	TRDI's Windows™-based software included: WinSC —Data Acquisition System; WinADCP —Data Display and Export;						
Power	Input Power			20–50VDC			
Standard Sensors	Temperatures (mounted on transducer)			Range -5° to 45°C, Precision ±0.4°C, Resolution 0.01°			
	Tilt			Range ±15°, Accuracy ±0.5°, Precision ±0.5°, Resolution 0.01°			
	Compass (fluxgate type, includes built-in field calibration feature)			Accuracy ±2°, Precision ±0.5°, Resolution 0.01°, Maximum tilt ±15°			
Available Options	<ul style="list-style-type: none">• Memory: 2 PCMCIA slots; total 4GB• Pressure sensor• External battery case• High-resolution water-profiling modes• Bottom tracking• AC/DC power converter, 48VDC output• Conversion kit for internal power supply and memory• Directional Waves Array• Velocity—Data Display, Processing, and Export software						
Dimensions	228.0mm wide x 201.5mm long (line drawings available upon request)						

Figure 4.2: Specification sheet for Sentinel Workhorse ADCP

Table 4.1: Deployment 1 ADCP Settings

Deployment Log		
	First Deployment	
Site Name	South Bute	
Position	55 44.214, 005 00.075	Meter was dragged out of position by a fishing boat who reported the movement to DFF. Movement occurred on 27th October.
	211671.782, 653359.783	
ADCP Type	Sentinel V	
Serial Number	19968	
Frequency	307	
Number of Cells	59	
Cell Size	1	
First Cell Range	2.42	
Number of Pings	200	
Ping Interval	1	
Start Date + Time	04/10/2017 @ 08:03	
Deployment Date + Time	04/10/2017 @ 10:00	
Recovery Date + Time	19/11/2017 @09:20	
End/Turned off Date + Time	19/11/2017 @09:23	
Minimum Depth Recorded	45.95m	
First Cell	43.03 @ 2.42m from profiler	+ 0.5m profiler height
Bottom Cell Depth	43.03	m
Surface Cell Depth	5.53 @ 40.42m from profiler	
Middle Cell Depth	16.53 @ 29.42m from profiler	Net Depth 16m

Table 4.2: Deployment 2 ADCP Settings

Deployment Log	
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	Second Deployment	
Site Name	South Bute	
Position	55 44.214, 005 00.075	Meter was recovered and repositioned as close to original point as possible
	211671.782, 653359.783	
ADCP Type	Workhorse	
Serial Number	23318	
Frequency	307	
Number of Cells	59	
Cell Size	1	
First Cell Range	3.2	
Number of Pings	50	
Ping Interval	24	
Start Date + Time	10/01/2018 @ 11:46	Meter experienced an event that resulted in a small compass offset on all data after 28th January 2018. Data presented is from 10th to 28th January
Deployment Date + Time	10/01/2018 @ 11:55	
Recovery Date + Time	22/02/2018 @ 10:00	
End/Turned off Date + Time	22/02/2018 @ 10:06	
Minimum Depth Recorded	39.37	+ 0.5m profiler height
Bottom Cell Depth	1 @ 2.4m from profiler	Rreduced from 3.2m using Dyer Log profile
Surface Cell Depth	21 @ 23.2m from profiler	
Middle Cell Depth	32 @ 34.2m from profiler	
Net Depth	16m	

Table 4.3: Deployment 3 ADCP Settings

Deployment Log		
Site Name	South Bute	
Position	55 44.214, 005 00.075	

	211671.782, 653359.783	Meter was repositioned as close to the original location as possible
ADCP Type	Workhorse	
Serial Number	23318	
Frequency	307	
Number of Cells	59	
Cell Size	1	
First Cell Range	3.2	
Number of Pings	50	
Ping Interval	24	
Start Date + Time	22/02/2018 @12:18	
Deployment Date + Time	22/02/2018 @12:50	
Recovery Date + Time	23/03/2018 @10:35	
End/Turned off Date + Time	23/03/2018 @10:40	
Minimum Depth Recorded	40.89	
Bottom Cell Depth	38.49 @ 2.4m	bottom height has been reduced by 3% to allow a reduction in bottom height of 0.8m using Dyers Log Profile
Surface Cell Depth	5.69 @ 35.2m from profile	
Middle Cell Depth	16.69 @ 24.2m from profiler	

5. Magnetic Variation

No magnetic variation correction was applied to the ADCP during the deployment. The magnetic variation was applied to the downloaded data during post processing. The magnetic variation for this deployment was 2.9°W which has been calculated using the World Magnetic Calculator: - http://www.geomag.bgs.ac.uk/data_service/models_compass/wmm_calc.html

6. Depth Survey

In order to map the bathymetry of the site depths were collected close to the time of deployment. A Simrad NSS7 evo2 echo sounder was used which logs depth, position and time directly to the laptop at 1 second intervals. Transducer depth was set at 0.4m below the surface and automatically corrected into depth data output. Prior to beginning the survey the system was manually checked against a Plastimo II hand held echo sounder and found to be accurate over three readings. There is

no GPS offset required as the echo sounder transducer and gps antennae were positioned close together. The Belfield Software Tide Plotter (<http://www.chartsandtides.co.uk/tideplotter>) was used to correct raw depth soundings to Chart Datum and the depth offset was given as 2.02m at 08:54 GMT on the 4th October 2017 for the Millport tidal port.

Following the collection and correction of soundings the results were used as bathymetry files in autoDepomod. The process involves converting the depth readings to Eastings and Northings and creating a CSV file which generates a contour map.

7. Meteorological Data

Weather History Graph
March 8, 2018 - March 15, 2018

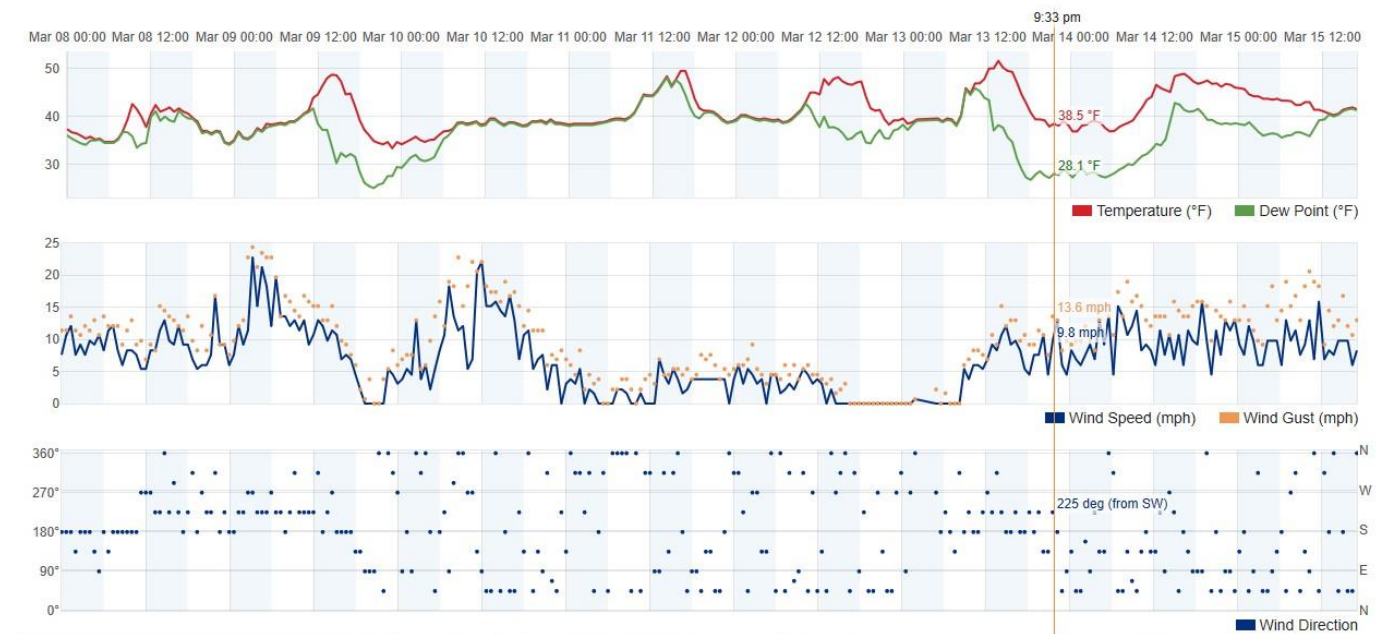


Figure 7.1: Weather data 29/10/17 to 05/11/17

Weather History Graph
March 16, 2018 - March 23, 2018

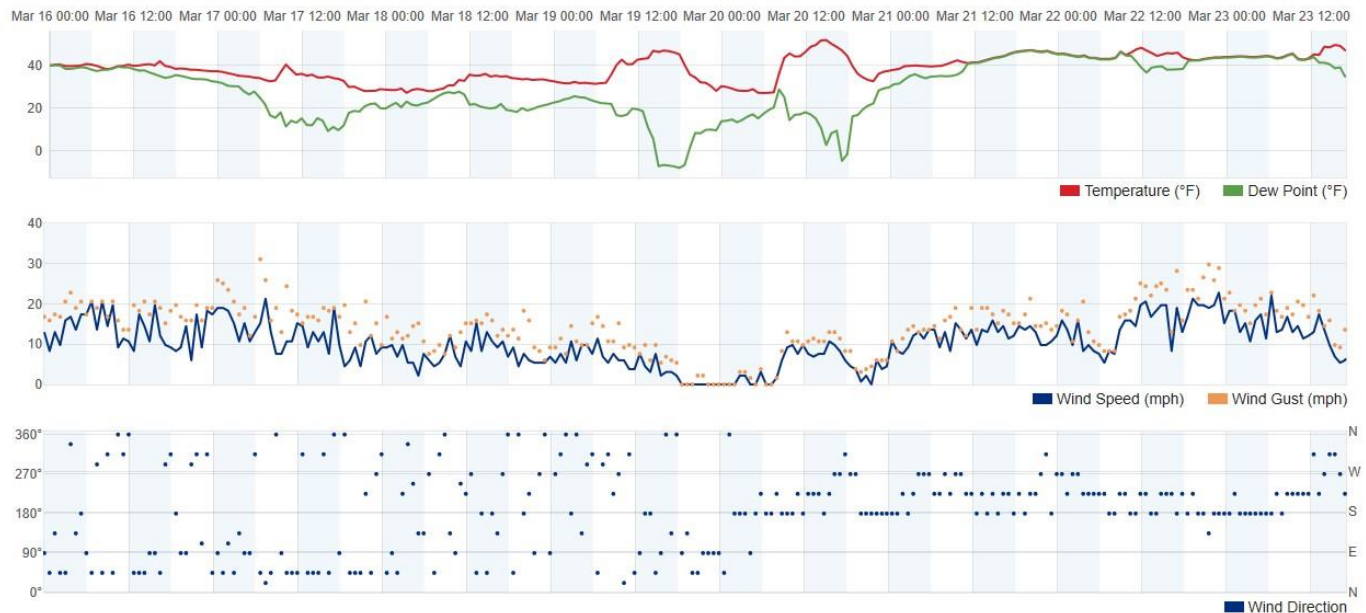


Figure 7.2: Weather Data 06/11/17 to 13/11/17

Weather data was recovered from the Wunderground website, data was taken from a weather station situated in the nearby coastal town of Inverkip at the position: 55 54.000'N, -004 52.140'W, 220724.671E, 671152.413N, Figure 7.3 shows the location in relation to the proposed South Bute farm. The data showed that there was at least 3 days of consecutive wind speed below 22 mph which equates to just under 10 m/s, the data is therefore considered to be suitable to allow the current data of this period to be used for modelling. Full data can be viewed at the link below: <https://www.wunderground.com/personal-weatherstation/dashboard?ID=IINVERCL2#history/s20180316/e20180323/mweek>

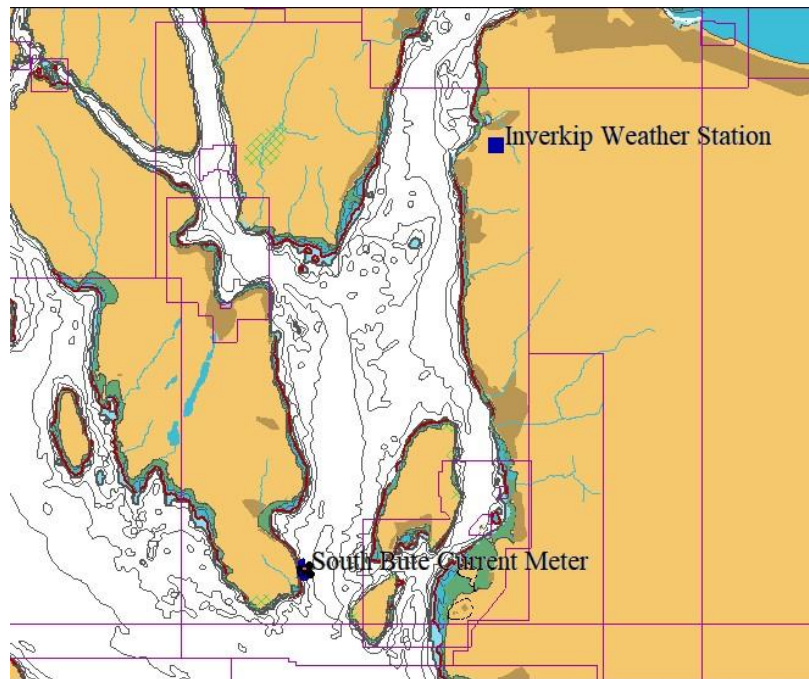


Figure 7.3: Location of Inverkip weather station in relation to proposed South Bute farm

8. Results and Discussion

All data was inputted to the HG analysis spreadsheets to allow consideration of the full deployments. Once the full range of data were identified a median data set was extracted and processed as a 15 day data set for use in autoDepomod modelling. Figures 8.1 – 8.14 and tables 8.1 – 8.10 show the analysis of the full deployment periods of the two deployments. Figures 8.16 – 8.22 and tables 8.11 – 8.13 show the analysis of the 15 days data for use in autoDepomod modelling.

*note depths in figures 8.1 – 8.14 have not been corrected for transducer depth (0.5m) but Tables 8.1 – 8.10 have been

Deployment 1

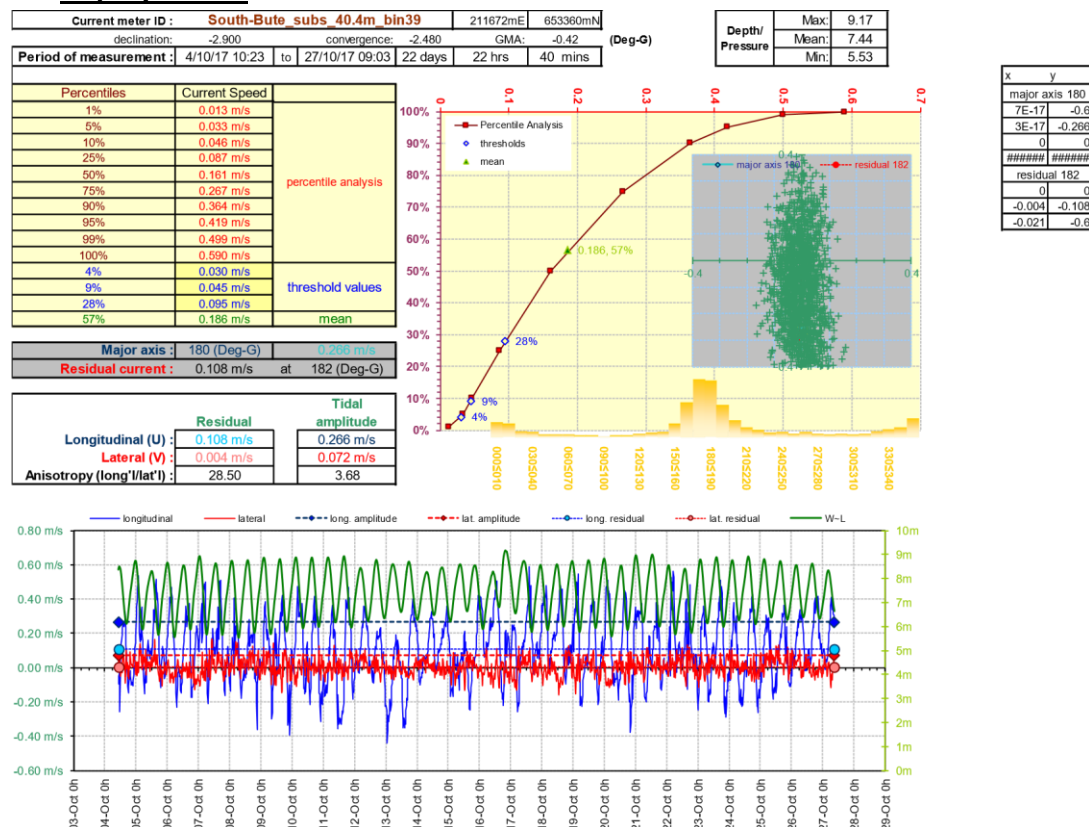


Figure 8.1: HG analysis sheet summary Deployment 1 - Surface

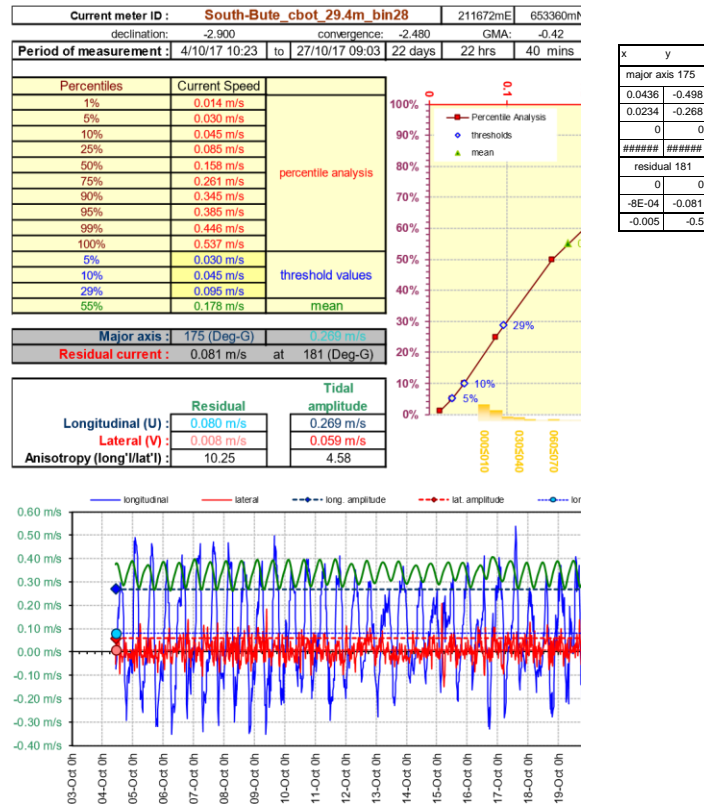


Figure 8.2: HG analysis sheet summary Deployment 1 - Net bottom

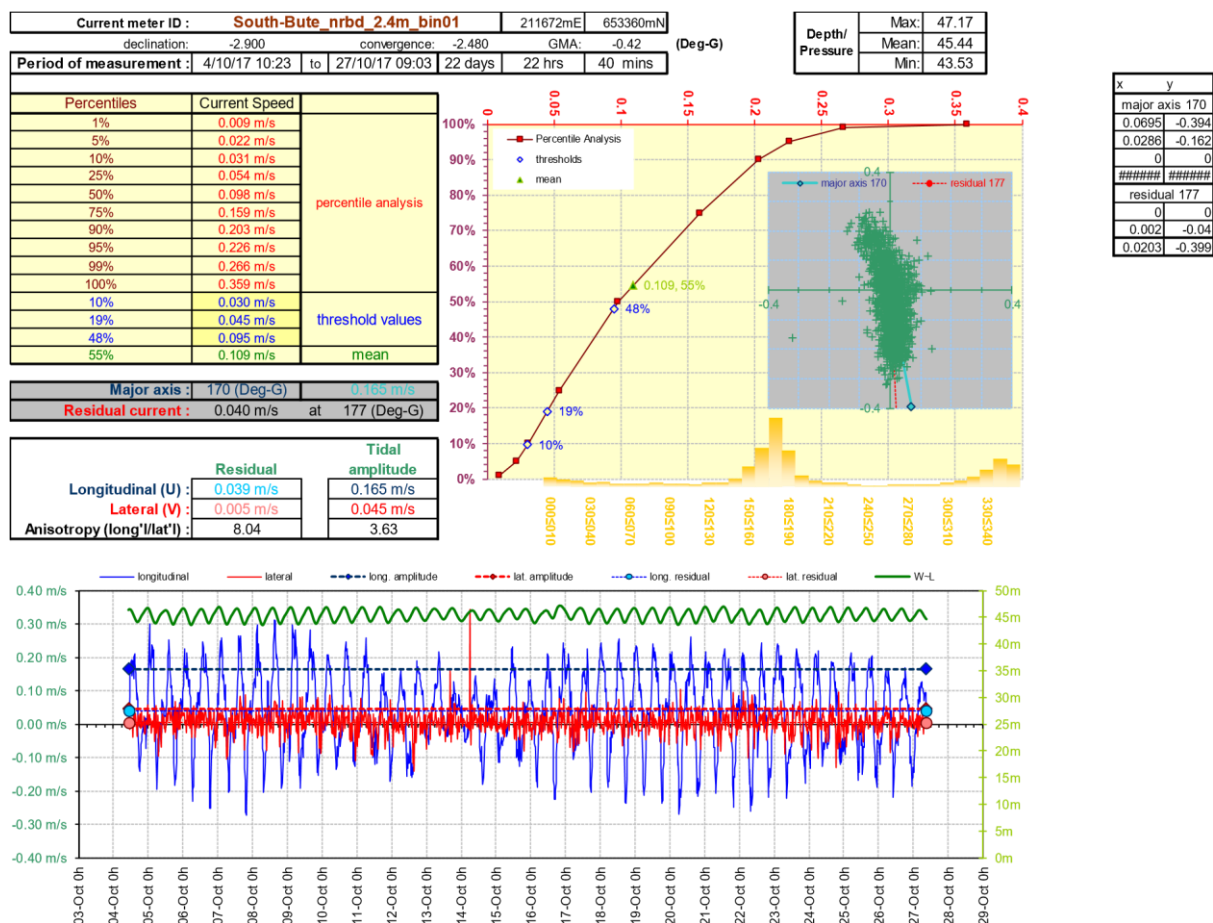


Figure 8.3: HG analysis sheet summary Deployment 1 – Bottom

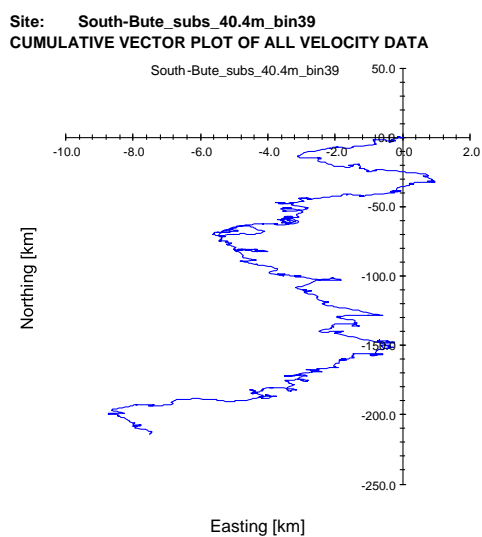


Figure 8.4

Naviga: Cumulative vector plot
Deployment 1 - surface

Site: **South-Bute_cbot_29.4m_bin28**
CUMULATIVE VECTOR PLOT OF ALL VELOCITY DATA

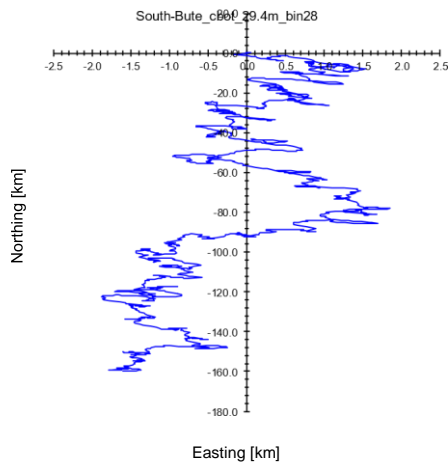


Figure 8.5: Cumulative vector plot Deployment 1 - net bottom

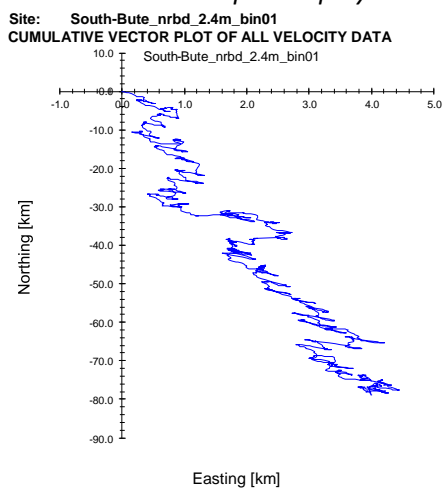


Figure 8.6: Cumulative vector plot bottom

Table 8.1: Recorded depths over deployment period

	Date	Height (m)
Highest Depth Recorded	16/10/2017	49.59
Lowest Depth Recorded	17/10/2017	45.95
Tidal Range Recorded	-	3.64

Table 8.2: Predicted Tidal data at nearest tidal port to monitoring site

Nearest tidal port	Tidal state	High water (GMT)	Height (m)	Low Water (GMT)	Height (m)
Millport	Spring	08/10/2017 02:24	3.57	08/10/2017 07:59	0.18
	Neap	14/10/2017 08:09	2.78	14/10/2017 14:08	1.08

Table 8.3: Summary of current speeds during the deployment period

Cell	Cell Height from Seabed (m)	Depth Below Surface (m)	Mean Speed (cm/s)	Ranked Percentile for mean speed (%)
Surface	40.9	5.53	18.6	57
Net bottom	29.9	16.53	17.8	55
Bottom	2.9	43.53	10.9	55

Table 8.4: Ranked percentiles for current speeds

Cell	Ranked Percentiles			Major Axis (Deg)
	≤3cm/s (%)	≥4.5cm/s (%)	≥9.5cm/s (%)	
Surface	4	91	72	180
Net bottom	5	90	71	175
Bottom	10	81	52	170

Table 8.5: Mean and residual currents over deployment period

	Mean Speed (m/s)	Residual Speed (m/s)	Residual Parallel (m/s)	Residual Normal (m/s)	Tidal Amplitude Parallel (m/s)	Tidal Amplitude Normal (m/s)
Surface	0.186	0.108	0.108	0.004	0.266	0.072
Net Bottom	0.178	0.081	-	-	-	-
Bottom	0.109	0.040	-	-	-	-

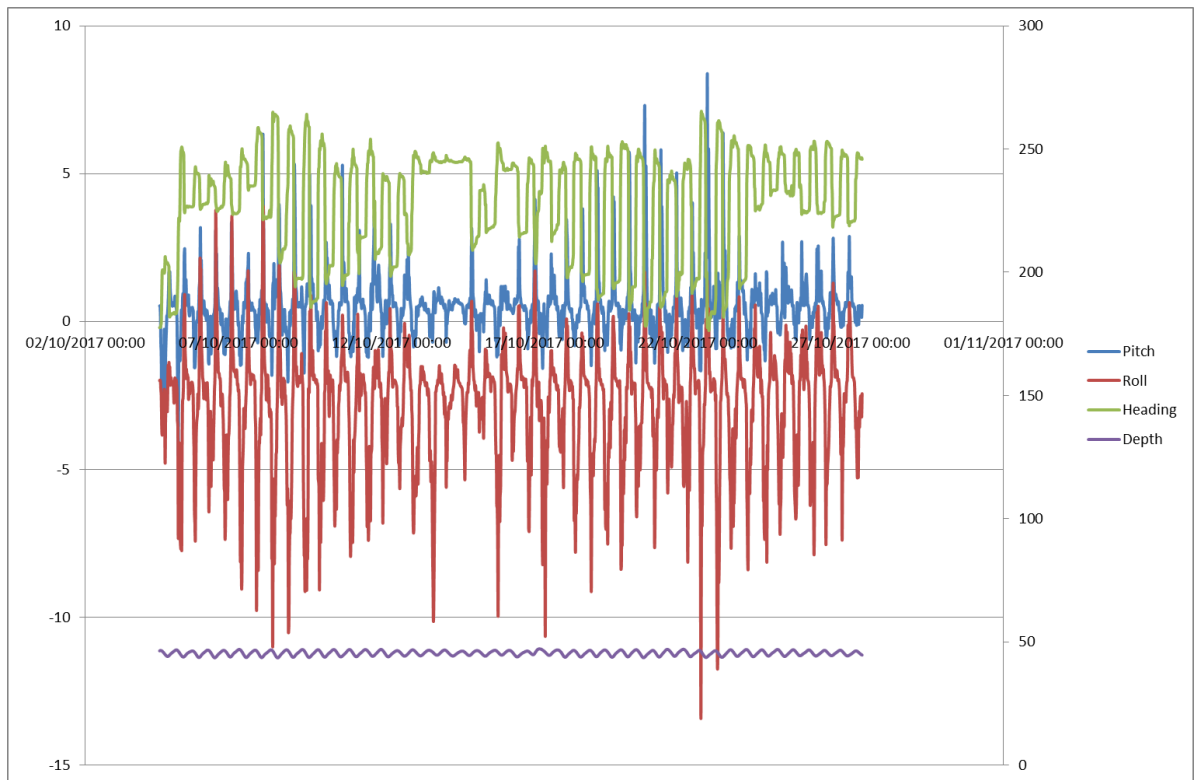


Figure 8.7: Graph of heading, pitch, roll and depth during Deployment 1

Deployment 2

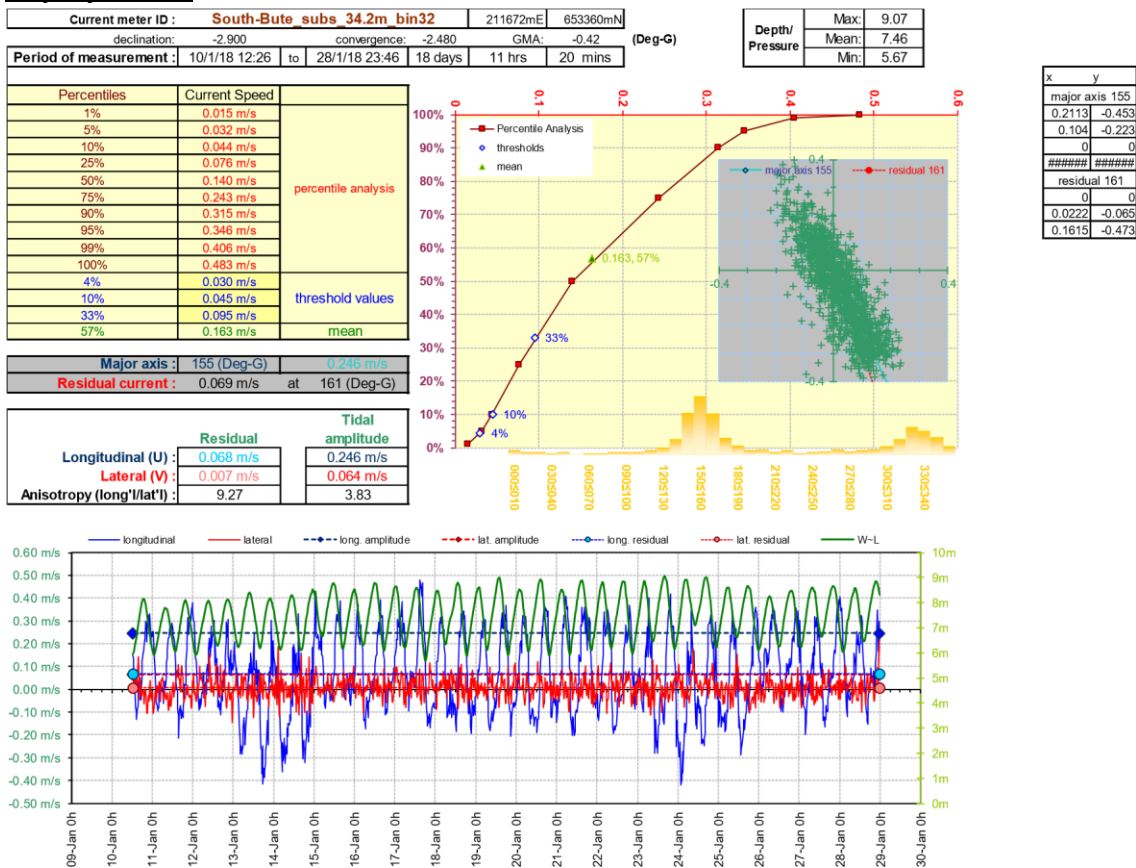


Figure 8.8: HG analysis sheet summary Deployment 2 - Surface

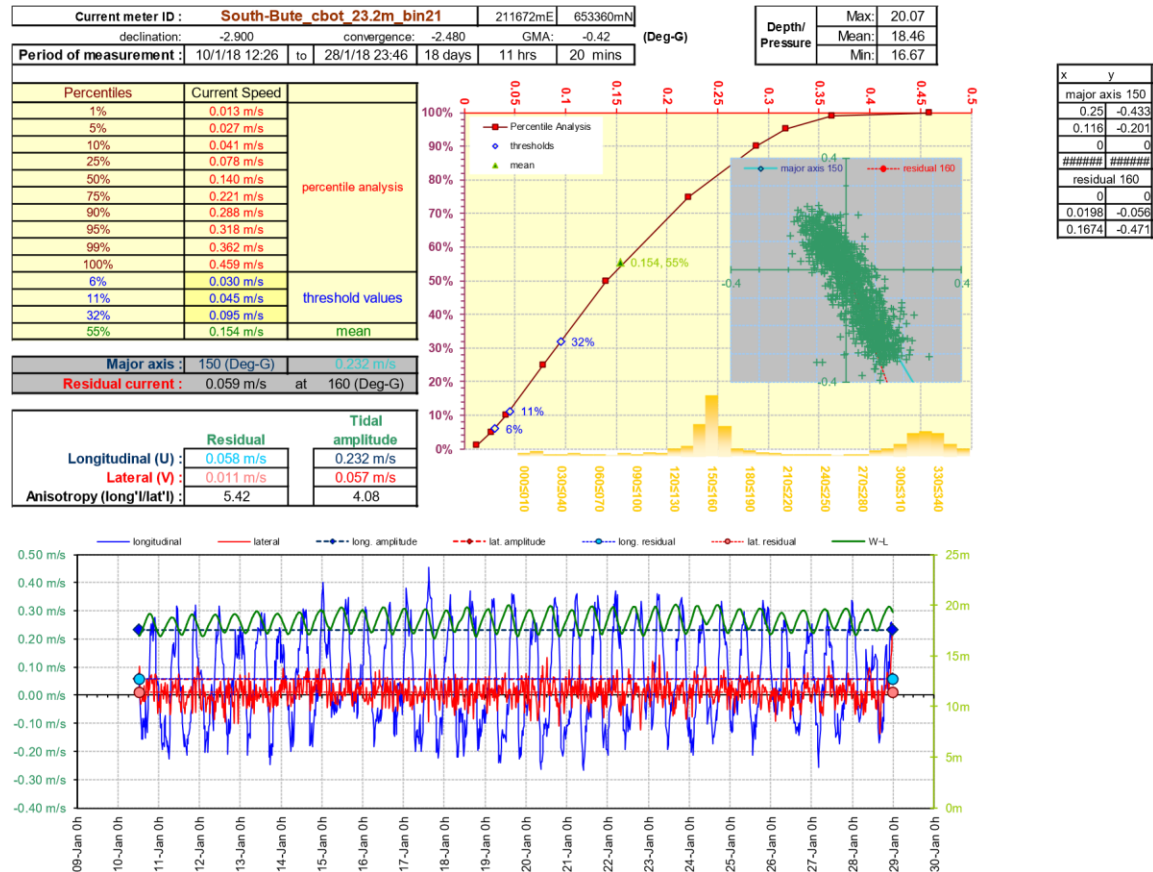


Figure 8.9: HG analysis sheet summary Deployment 2 - Net bottom

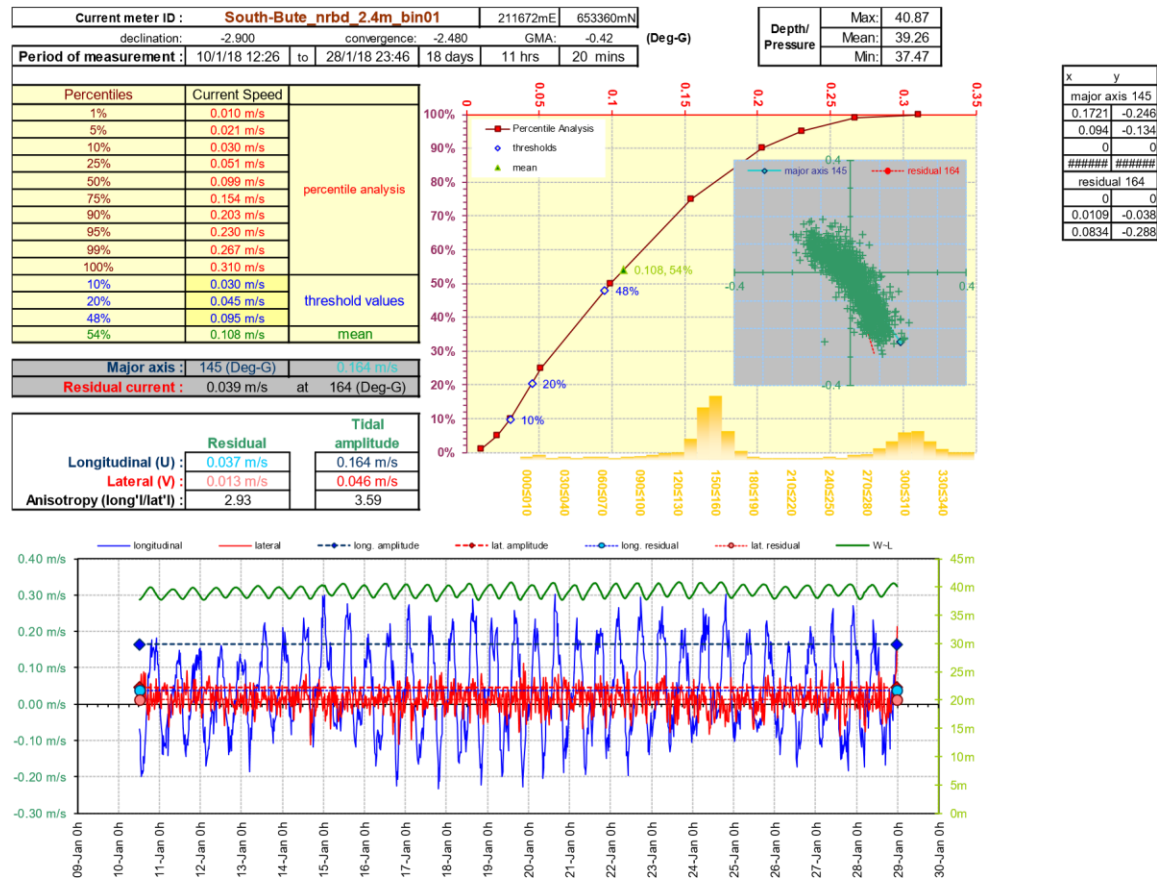


Figure 8.10: HG analysis sheet summary Deployment 2 – Bottom

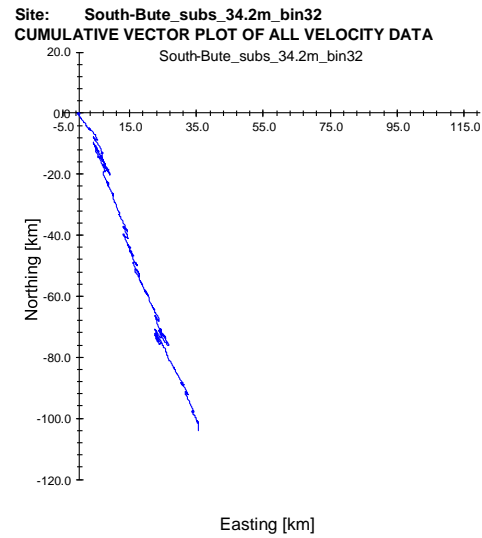


Figure 8.11: Cumulative vector plot Deployment 2 - surface

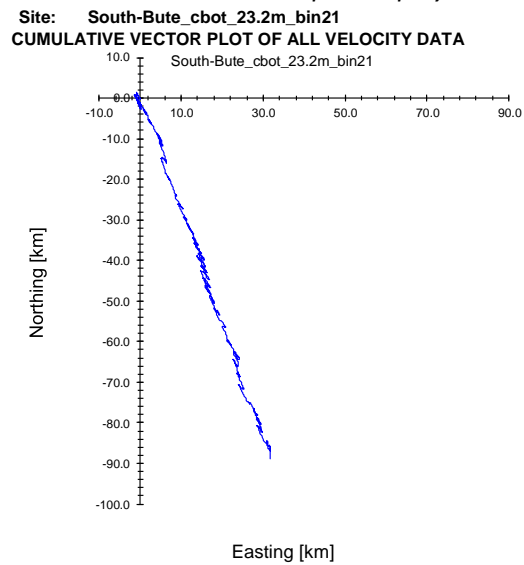


Figure 8.12: Cumulative vector plot Deployment 2 - net bottom

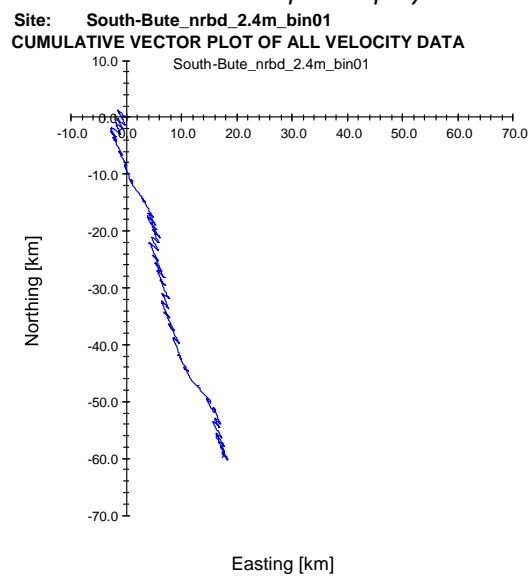


Figure 8.13: Cumulative vector plot Deployment 2 - bottom Table 8.6: Recorded depths over deployment period

	Date	Height (m)
Highest Depth Recorded	23/01/2018	43.27
Lowest Depth Recorded	17/01/2018	39.87
Tidal Range Recorded	-	3.40

Table 8.7: Predicted Tidal data at nearest tidal port to monitoring site - Millport

Nearest tidal port	Tidal state	High water (GMT)	Height (m)	Low Water (GMT)	Height (m)
Millport	Spring	23/01/2018 16:04	3.27	23/01/2018 22:00	0.54
	Neap	26/01/2018 06:22	2.99	26/01/2018 12:18	1.02

Table 8.8: Summary of current speeds during the deployment period

Cell	Cell Height from Seabed (m)	Depth Below Surface (m)	Mean Speed (cm/s)	Ranked Percentile for mean speed (%)
Surface	34.7	5.67	16.3	57
Net bottom	23.7	16.67	15.4	55
Bottom	2.9	37.47	10.8	54

Table 8.9: Ranked percentiles for current speeds

Cell	Ranked Percentiles			Major Axis (Deg)
	≤3cm/s (%)	≥4.5cm/s (%)	≥9.5cm/s (%)	
Surface	4	90	67	155
Net bottom	6	89	68	150
Bottom	10	80	52	145

Table 8.10: Mean and residual currents over deployment period

	Mean Speed (m/s)	Residual Speed (m/s)	Residual Parallel (m/s)	Residual Normal (m/s)	Tidal Amplitude Parallel (m/s)	Tidal Amplitude Normal (m/s)
Surface	0.163	0.069	0.068	0.007	0.246	0.064
Net Bottom	0.154	0.059	-	-	-	-

Bottom	0.108	0.039	-	-	-	-
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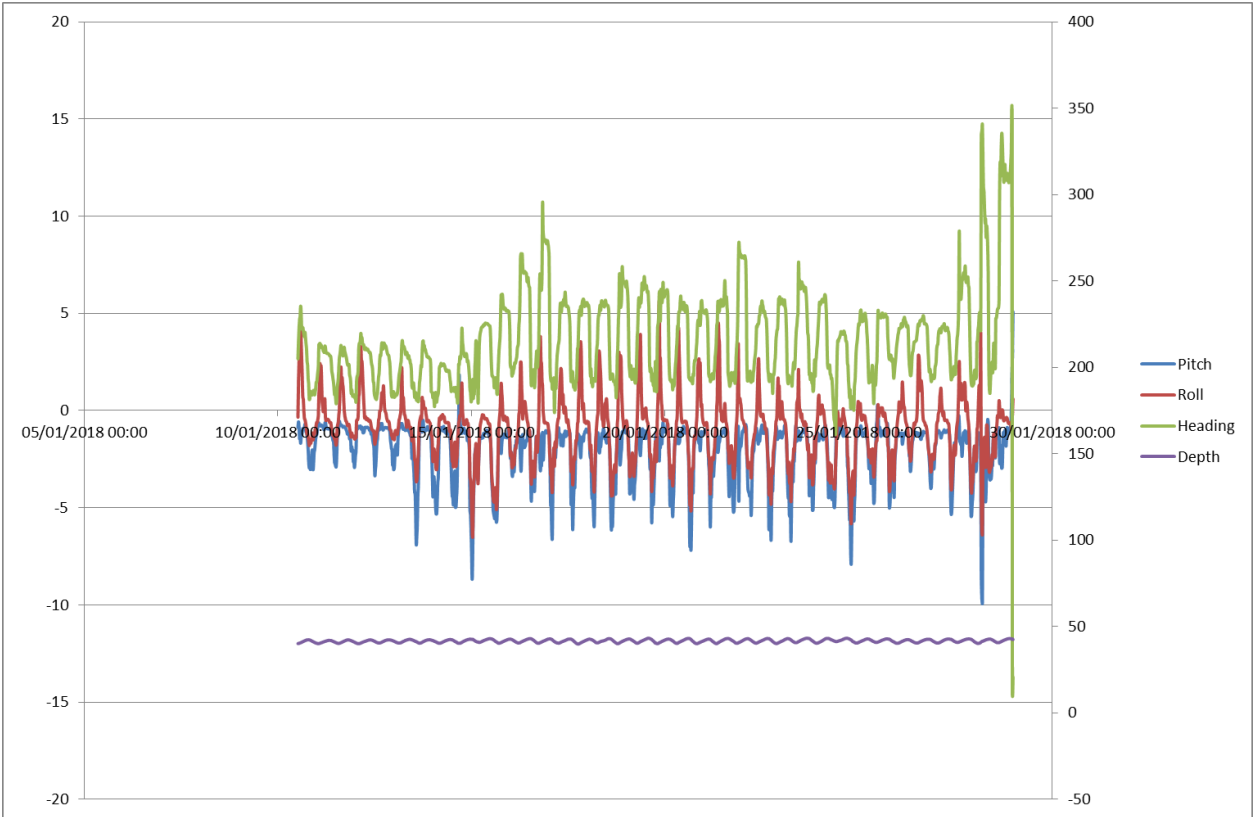


Figure 8.14: Graph of heading, pitch, roll and depth during Deployment 2

Deployment 3

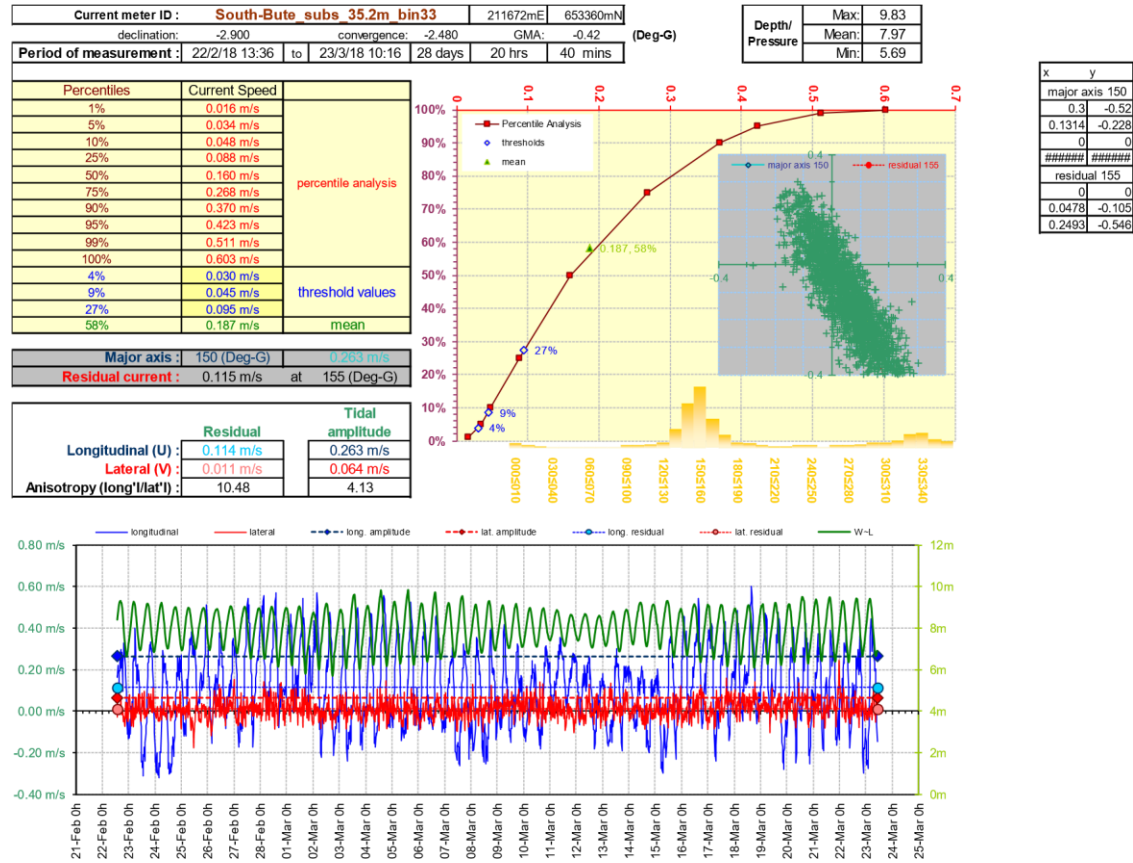


Figure 8.15: HG analysis sheet summary Deployment 3 - Surface

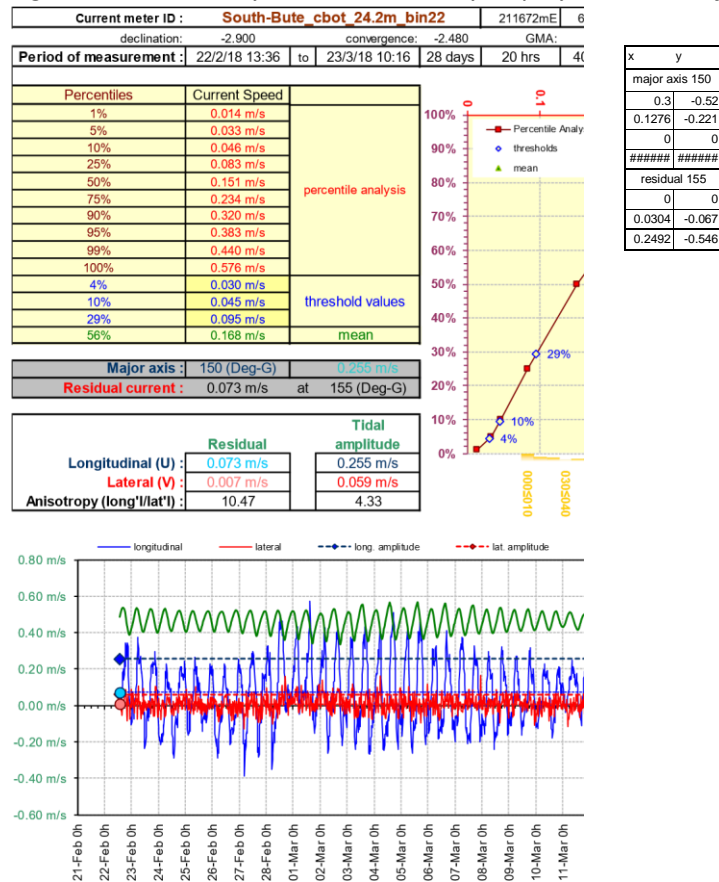


Figure 8.16: HG analysis sheet summary Deployment 3- Net bottom

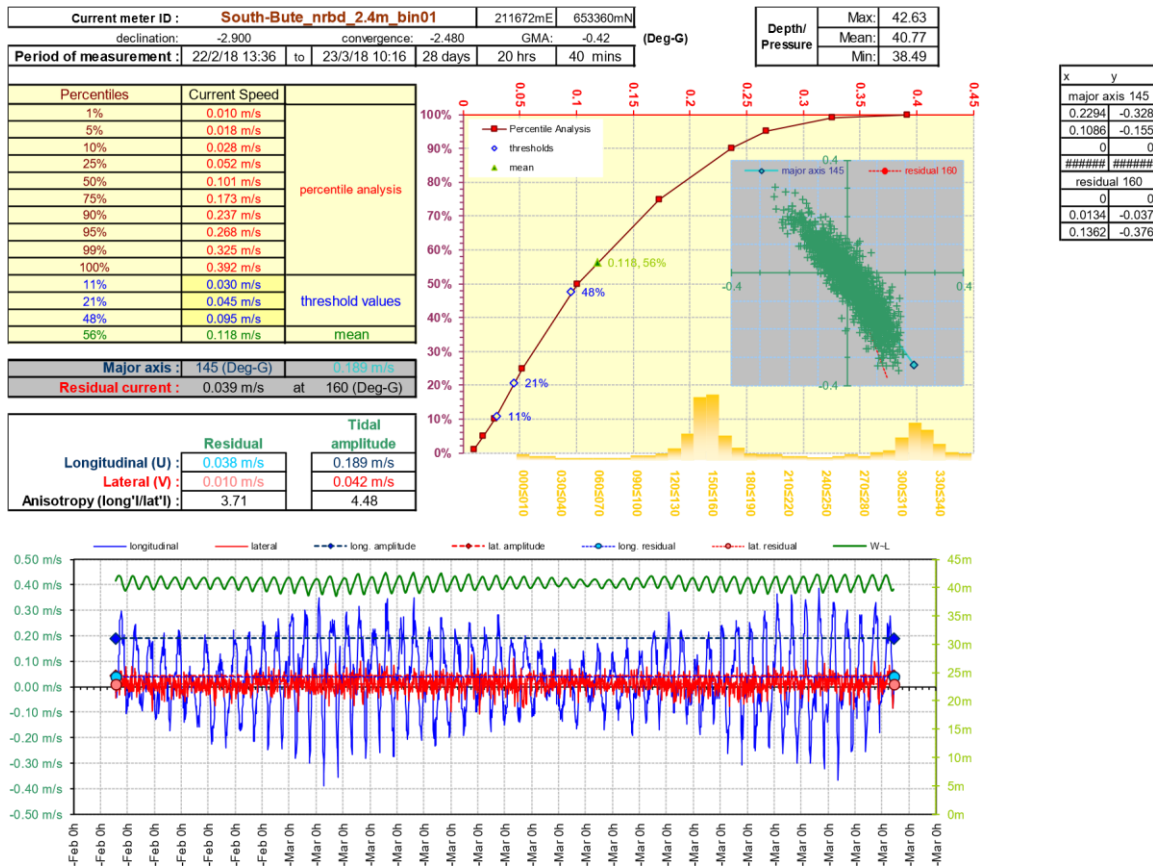


Figure 8.17: HG analysis sheet summary Deployment 3 – Bottom

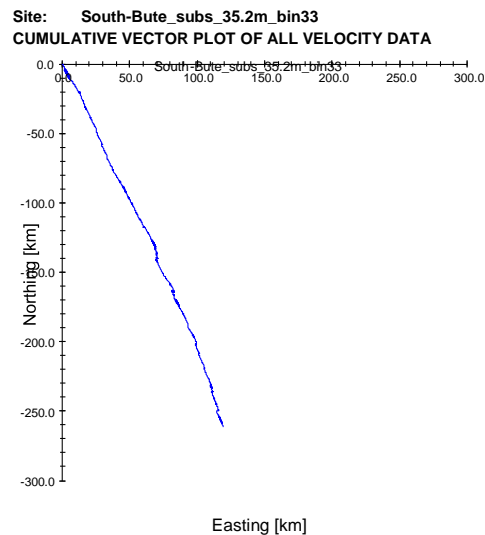


Figure 8.18: Cumulative vector plot Deployment 3 - surface

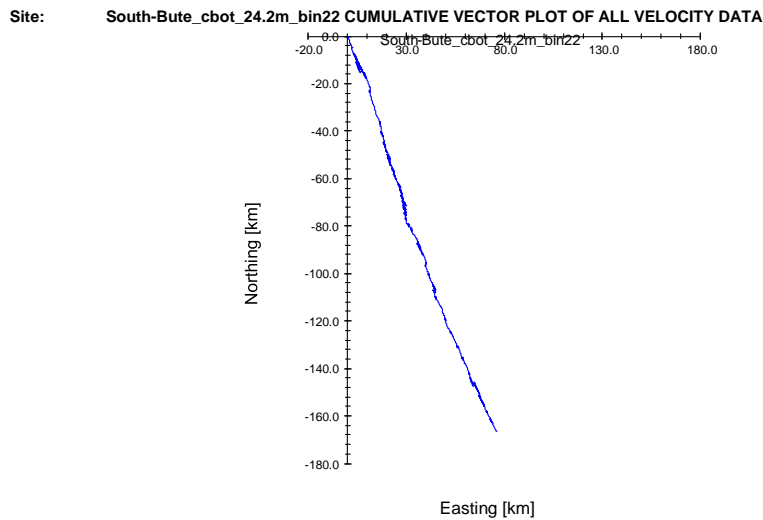


Figure 8.19: Cumulative vector plot Deployment 3 - net bottom

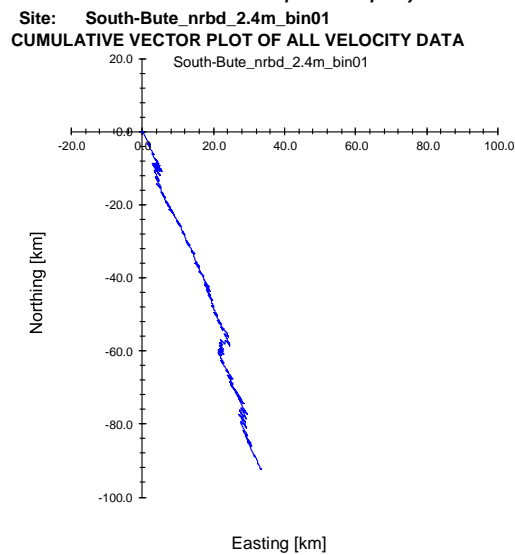


Figure 8.20: Cumulative vector plot Deployment 3 - bottom

Table 8.11: Recorded depths over deployment period

	Date	Height (m)
Highest Depth Recorded	05/03/2018	45.03
Lowest Depth Recorded	02/03/2018	40.89
Tidal Range Recorded	-	4.14

Table 8.12: Predicted Tidal data at nearest tidal port to monitoring site

Nearest tidal port	Tidal state	High water (GMT)	Height (m)	Low Water (GMT)	Height (m)
Millport	Spring	20/03/2018 14:06	3.33	20/03/2018 19:41	0.14
	Neap	11/03/2018 19:04	2.75	11/03/2018 00:31	1.36

Table 8.13: Summary of current speeds during the deployment period

Cell	Cell Height from Seabed (m)	Depth Below Surface (m)	Mean Speed (cm/s)	Ranked Percentile for mean speed (%)
Surface	35.7	5.69	18.7	58
Net bottom	24.2	16.69	16.8	56
Bottom	2.9	38.49	11.8	56

Table 8.14: Ranked percentiles for current speeds

Cell	Ranked Percentiles			Major Axis (Deg)
	≤3cm/s (%)	≥4.5cm/s (%)	≥9.5cm/s (%)	
Surface	4	91	73	150
Net bottom	4	90	71	150
Bottom	11	79	52	145

Table 8.15: Mean and residual currents over deployment period

	Mean Speed (m/s)	Residual Speed (m/s)	Residual Parallel (m/s)	Residual Normal (m/s)	Tidal Amplitude Parallel (m/s)	Tidal Amplitude Normal (m/s)
Surface	0.187	0.115	0.114	0.011	0.263	0.064
Net Bottom	0.168	0.073	-	-	-	-
Bottom	0.118	0.039	-	-	-	-

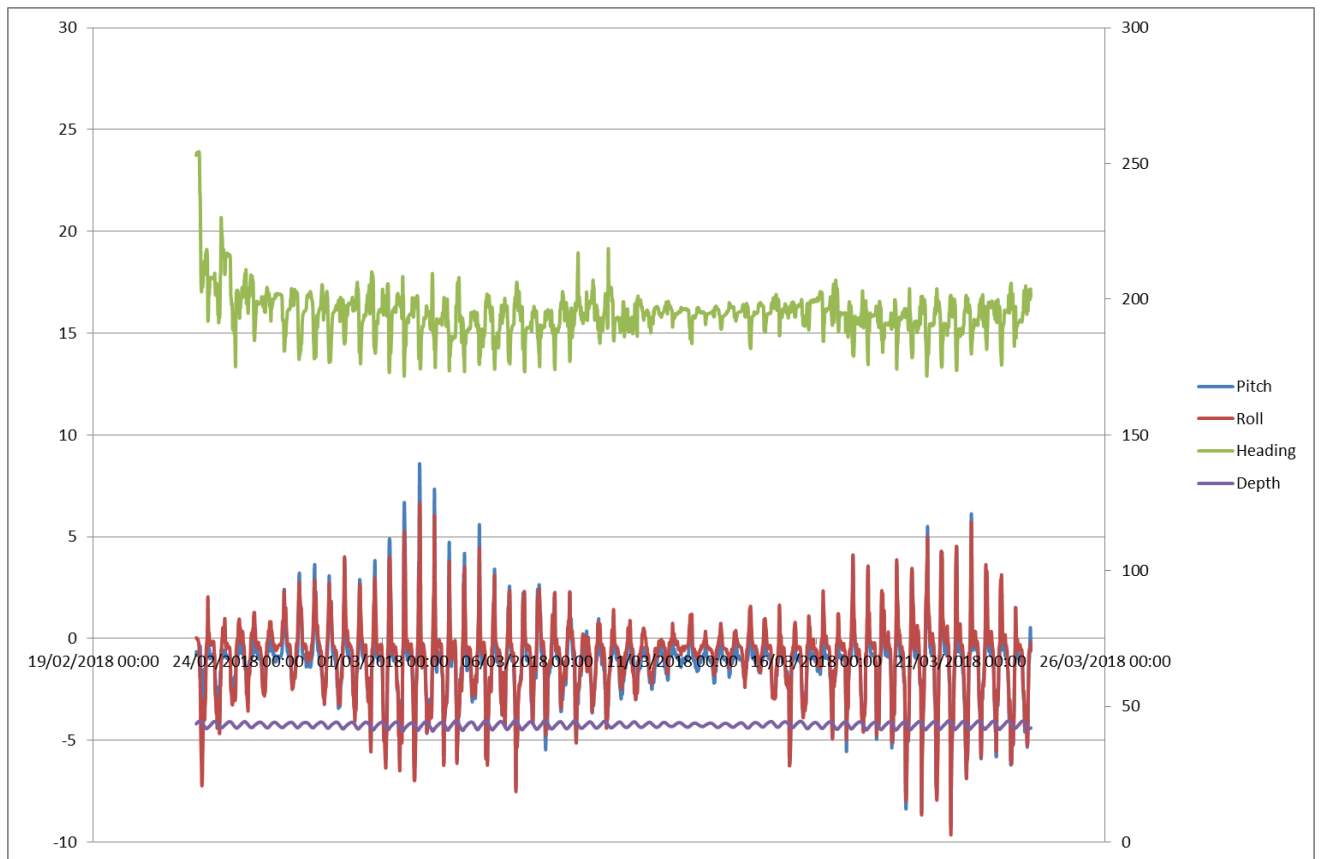


Figure 8.21: Graph of heading, pitch, roll and depth during Deployment 3

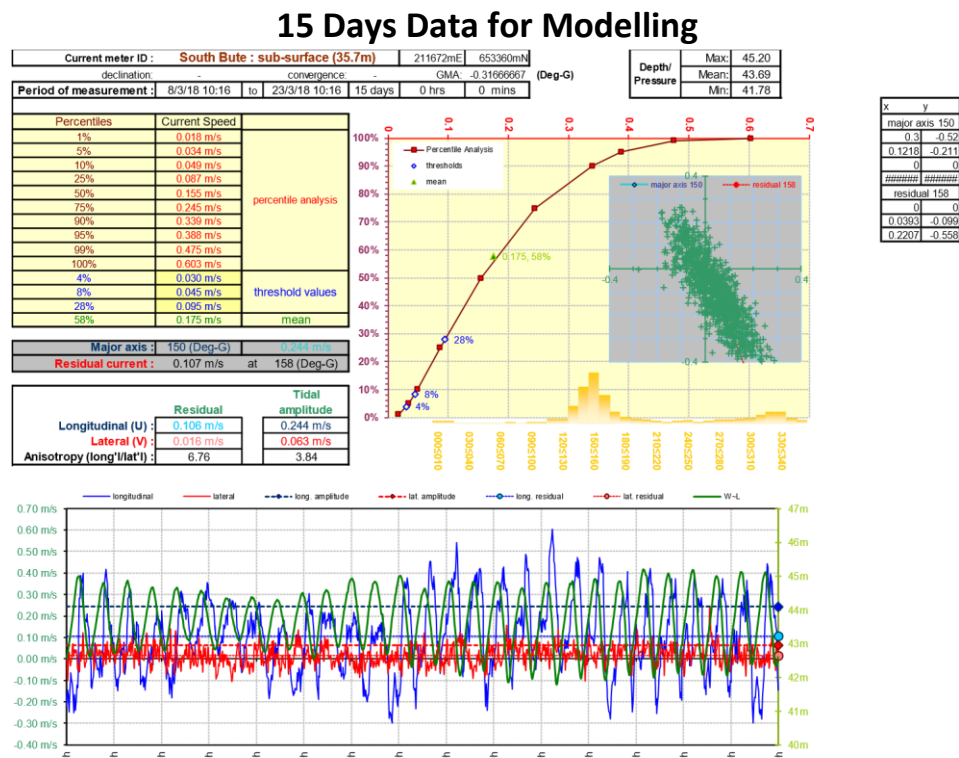


Figure 8.22: 15 days data, 29/10/17 09:47 to 13/11/17 09:47 – Surface

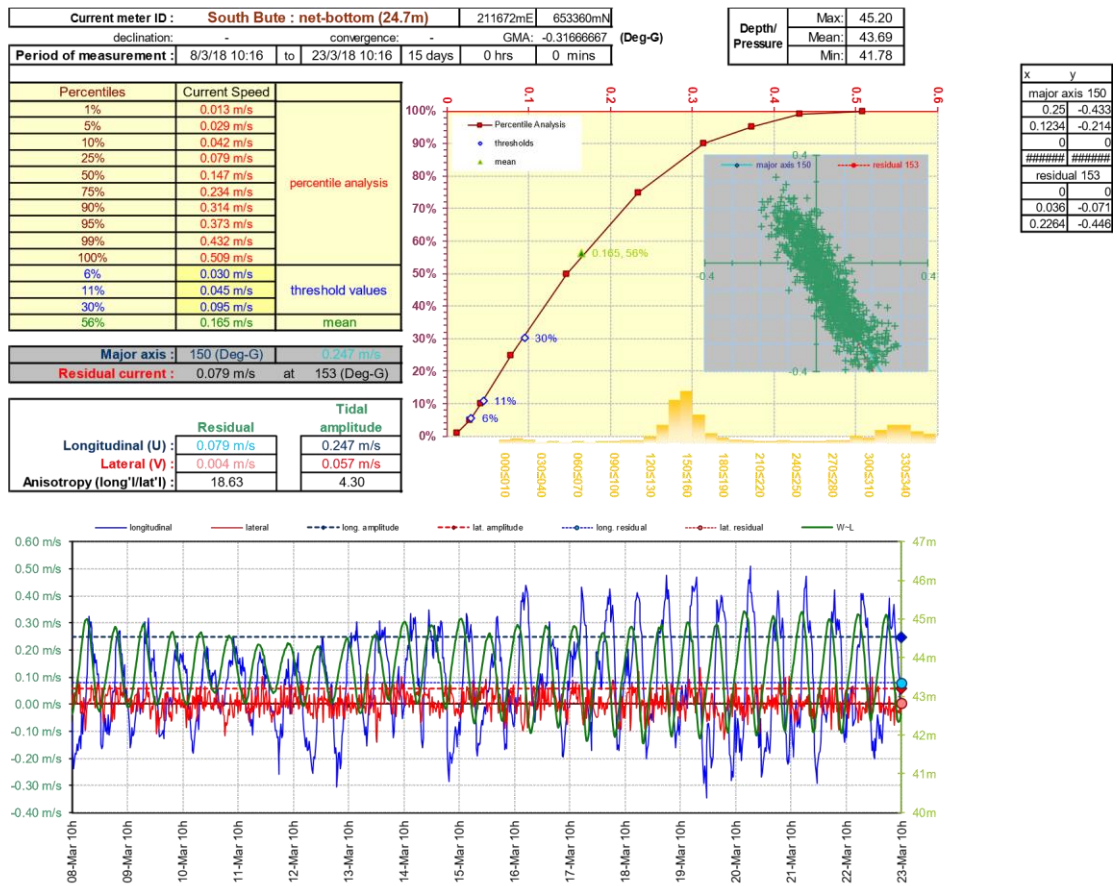


Figure 8.23: 15 days data, 29/10/17 09:47 to 13/11/17 09:47 – Middle

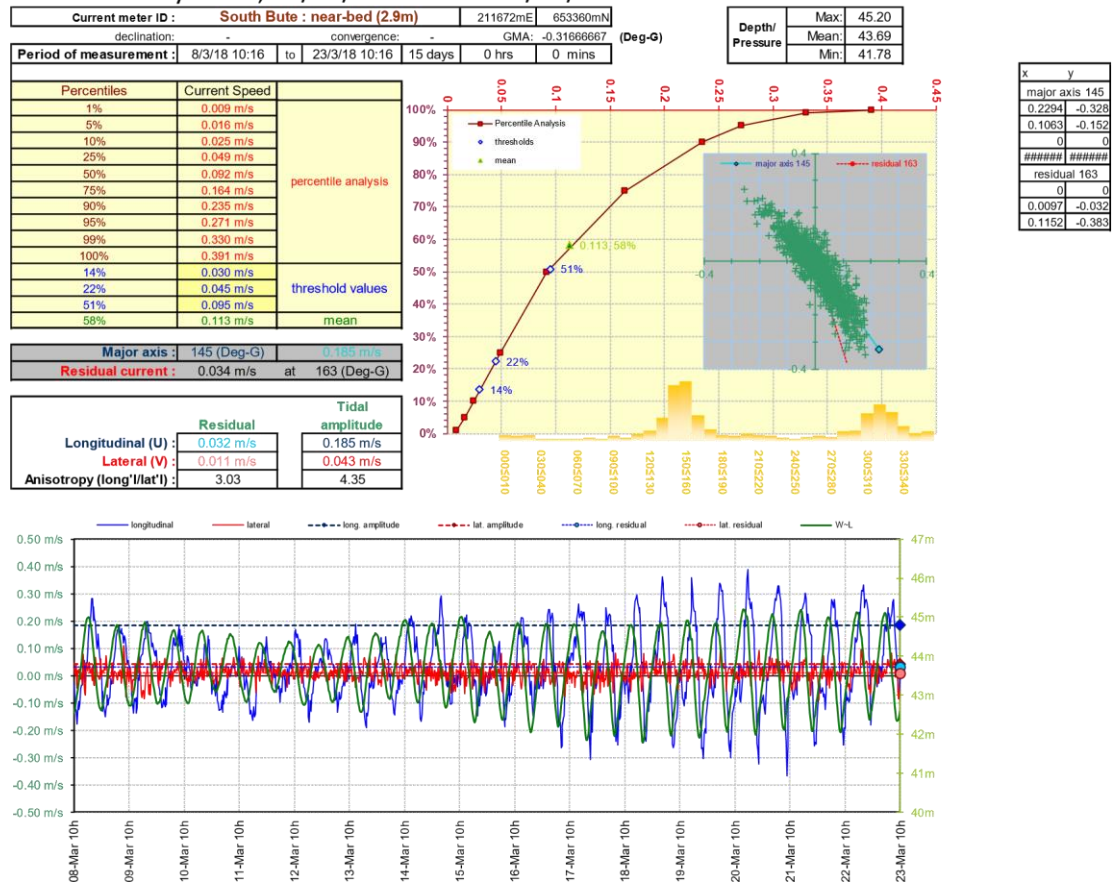


Figure 8.24: 15 days data, 29/10/17 09:47 to 13/11/17 09:47 – Bottom

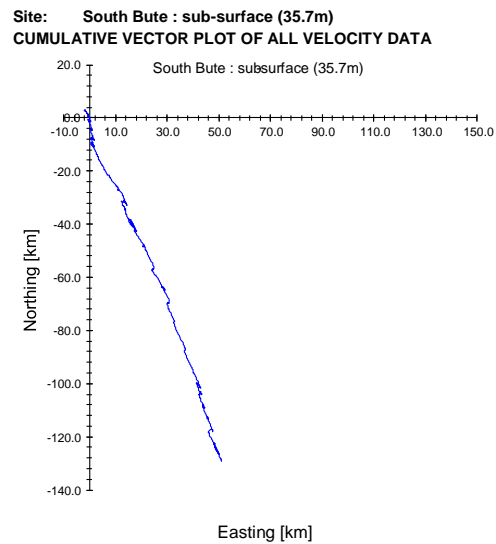


Figure 8.25: 15 days current data Cumulative Vector Plot – Surface

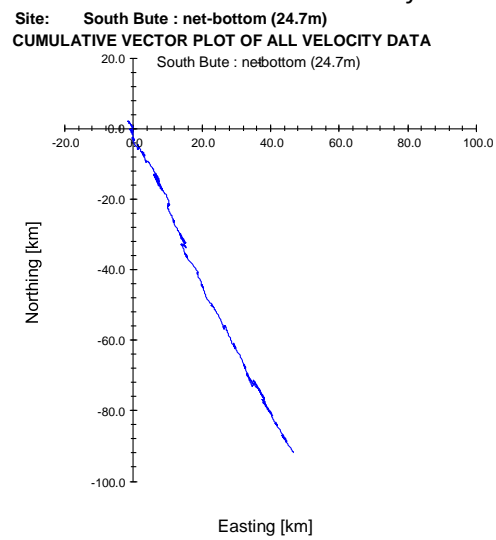


Figure 8.26: 15 days current data Cumulative Vector Plot – Middle

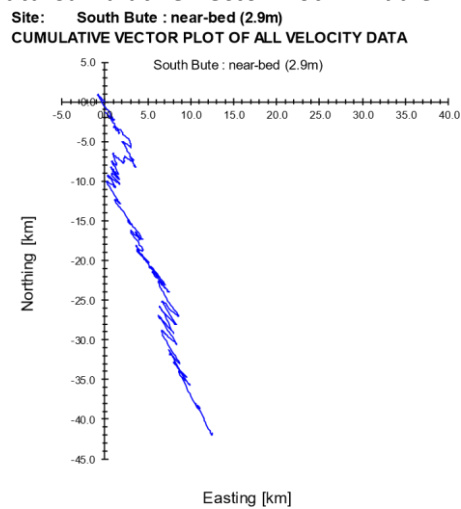


Figure 8.27: 15 days current data Cumulative Vector Plot – Bottom

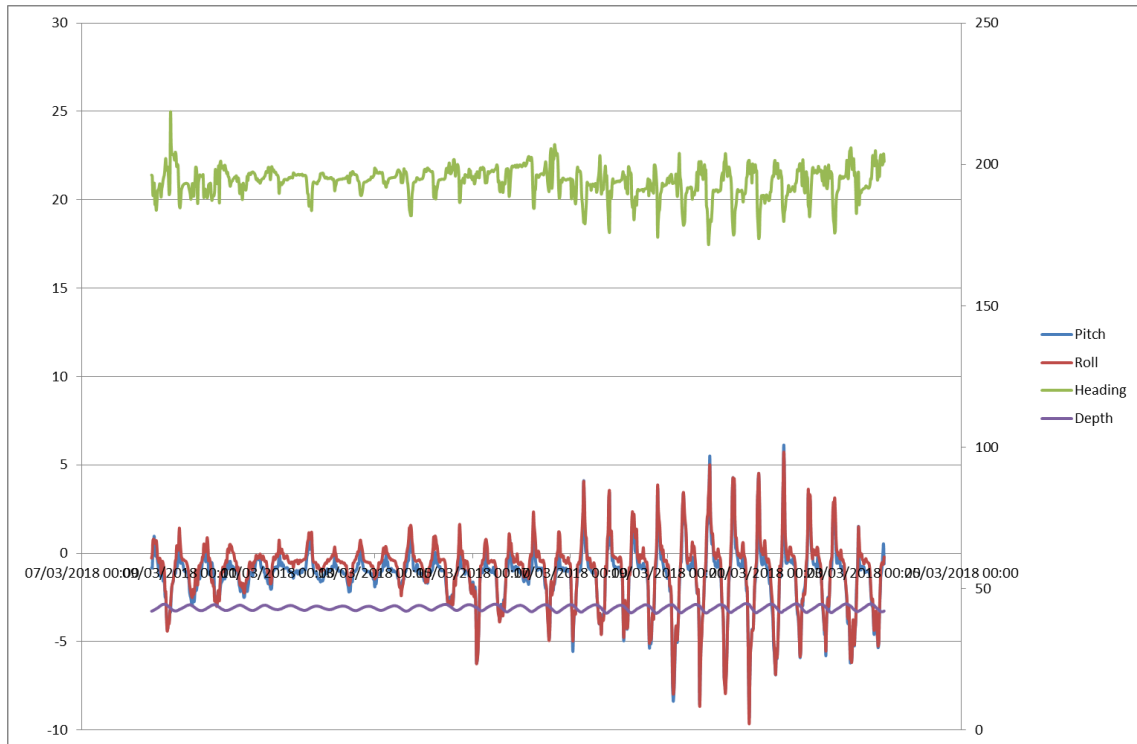


Figure 8.28: Heading, Depth, Pitch and Roll over the 15 days analysed

Table 8.16: Summary of current speeds during the deployment period

Cell	Cell Height from Seabed (m)	Depth Below Surface (m)	Mean Speed (cm/s)	Ranked Percentile for mean speed (%)
Surface	35.7	6.08	17.5	58
Net bottom	24.7	17.08	16.5	56
Bottom	2.9	38.88	11.3	58

Table 8.17: Ranked percentiles for current speeds

Cell	Ranked Percentiles			Major Axis (Deg)
	≤3cm/s (%)	≥4.5cm/s (%)	≥9.5cm/s (%)	
Surface	4	92	72	150
Net bottom	6	89	70	150
Bottom	14	78	49	145

Table 8.18: Mean and residual currents over deployment period

	Mean Speed (m/s)	Residual Speed (m/s)	Residual Parallel (m/s)	Residual Normal (m/s)	Tidal Amplitude Parallel (m/s)	Tidal Amplitude Normal (m/s)
Surface	0.175	0.107	0.106	0.016	0.244	0.063

Net Bottom	0.165	0.079	-	-	-	-
Bottom	0.113	0.034	-	-	-	-

9. Depth Survey Results

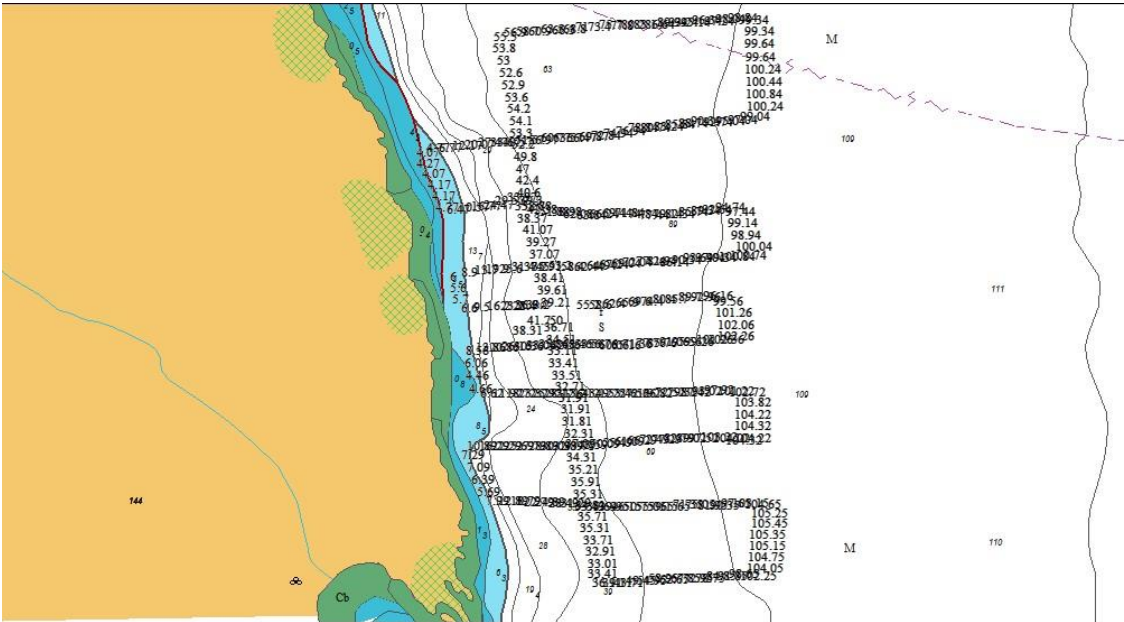


Figure 9.1: South Bute depth survey results plotted on Seapro

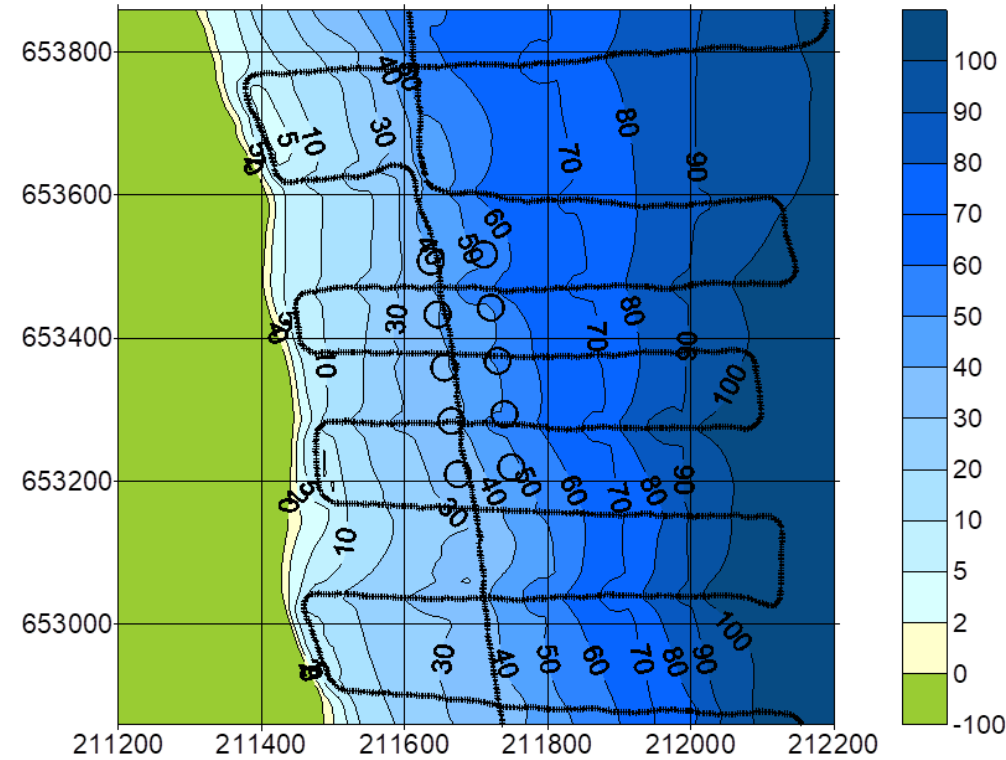


Figure 9.2: Contour map created from depth survey and charted depths

Table 9.1: Extract from full South Bute depth survey 4th October 2017

					OSGB E	OSGB N	04-Oct-17	UTC		Measured D	Correction	chart datum
55	44.350	5 W	0.129	211630.7	653619.7			08:54:11		40.9	2.02	38.88
55	44.349	5 W	0.129	211630.7	653617.8			08:54:12		41.2	2.02	39.18
55	44.349	5 W	0.128	211631.7	653617.8			08:54:13		41.4	2.02	39.38
55	44.348	5 W	0.127	211632.7	653615.9			08:54:14		41.6	2.02	39.58
55	44.348	5 W	0.126	211633.7	653615.8			08:54:15		42	2.02	39.98
55	44.347	5 W	0.125	211634.7	653613.9			08:54:16		42	2.02	39.98
55	44.347	5 W	0.124	211635.7	653613.9			08:54:17		42.3	2.02	40.28
55	44.346	5 W	0.123	211636.7	653612			08:54:18		42.5	2.02	40.48
55	44.346	5 W	0.121	211638.8	653611.9			08:54:19		43.2	2.02	41.18
55	44.345	5 W	0.118	211641.8	653609.9			08:54:20		43.6	2.02	41.58
55	44.345	5 W	0.116	211643.9	653609.8			08:54:21		44.4	2.02	42.38
55	44.344	5 W	0.113	211647	653607.8			08:54:22		45.2	2.02	43.18
55	44.344	5 W	0.111	211649.1	653607.7			08:54:23		45.8	2.02	43.78
55	44.343	5 W	0.108	211652.1	653605.7			08:54:24		47	2.02	44.98
55	44.343	5 W	0.105	211655.3	653605.6			08:54:25		47.7	2.02	45.68
55	44.343	5 W	0.103	211657.4	653605.5			08:54:26		48.7	2.02	46.68
55	44.342	5 W	0.100	211660.4	653603.5			08:54:27		50.2	2.02	48.18
55	44.342	5 W	0.097	211663.6	653603.4			08:54:28		51.2	2.02	49.18
55	44.342	5 W	0.094	211666.7	653603.2			08:54:29		52	2.02	49.98
55	44.342	5 W	0.091	211669.8	653603.1			08:54:30		52.8	2.02	50.78
55	44.342	5 W	0.088	211673	653603			08:54:31		53.9	2.02	51.88
55	44.342	5 W	0.085	211676.1	653602.8			08:54:32		54.8	2.02	52.78
55	44.342	5 W	0.082	211679.3	653602.7			08:54:33		55.7	2.02	53.68

55	44.342	5 W	0.079	211682.4	653602.6		08:54:34		56.5	2.02	54.48
55	44.343	5 W	0.077	211684.6	653604.3		08:54:35		57.2	2.02	55.18
55	44.343	5 W	0.074	211687.7	653604.2		08:54:36		58.2	2.02	56.18
55	44.343	5 W	0.071	211690.8	653604.1		08:54:37		58.9	2.02	56.88
55	44.343	5 W	0.068	211694	653603.9		08:54:38		59.3	2.02	57.28
55	44.343	5 W	0.065	211697.1	653603.8		08:54:39		59.9	2.02	57.88

**Full depth survey was comprised of 3,007 readings and will therefore be appended to the final submission*

10. Conclusions

The pitch and roll of the transducer was influenced by the state of tide, it was apparent that during spring tides the meter displayed higher readings of pitch and roll. The high energy nature of the site did make data collection challenging but for the majority of the deployment period the meter remained within the operable tolerances of the instrumentation used with only isolate peaks close to those tolerances. The variations in heading through the 3 deployments were larger but such variations in heading are due to the use of an inline frame which was used as the location was predicted to be a high energy location particularly suited to the use of an inline frame. The Sentinel V 100 and the Sentinel Workhorse corrects the direction of current against the heading reading for each ping therefore the data is largely unaffected by the movement in heading even mid reading.

Measured depths during the depth survey correspond to those recorded by the pressure sensor during deployment. A full depth survey was used to generate the contour map for use with autoDepomod and this was generally consistent with charted depths.

Average daily wind speed was below 10 m/s for a period greater than 3 consecutive days

The 15 days current data is considered to be representative of the likely average conditions at the proposed South Bute location. The analysis of the 15 days of data is consistent with the analysis of the full data sets and gives confidence that the data is acceptable for autoDepomod modelling. The site and hydrographic survey reported in this document is considered to comply with the requirements of Attachment VIII and the current speed and direction are considered to be representative of the proposed South Bute location.