ADCP Deployment Report

Little Cumbrae, Firth of Clyde

Data Collected Across 3 Deployments

Deployment 1 - 04/10/2017 to 23/11/2017

Deployment 2 - 23/11/2017 to 08/01/2018

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 Little Cumbrae. 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 north west coast of the Island of Little Cumbrae, south west from Sheanawally Point. 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 proposed Little Cumbrae fish farm site will consist of 10 x 120m circumference pens arranged in a 5 x 2, 80m x 75m grid matrix. The biomass being applied for is 2,243.8T at a Stocking Density of 14.0kg/m^3.

3. Survey Details

Dawnfresh Farming engaged the environmental consultant AMS Ltd. to deploy a current meter at the Little Cumbrae site in order to gather 90 days of current data. After 46 days deployment the current meter was recovered, data was downloaded and the meter was redeployed in as close to the same location as practicable. The meter was subsequently recovered after a further 46 days to complete the 90 days data collection. Data was collected between 4th October 2017 – 19th November 2018 and 19th November 2018 - 8th January 2018. The current meter was deployed on the 4th October and recovered on the 19th of November, after redeployment the meter was dragged slightly shoreward on the 23rd November which cause the depth record to deviate by 2-3m. Due to this movement the data sets have been separated on the 23rd November to take account of this movement. This Hydrographic report considers the full data set and identifies a single 15 days data set between 12th October 2017 and the 27th October 2017 which is representative of median conditions at the site.

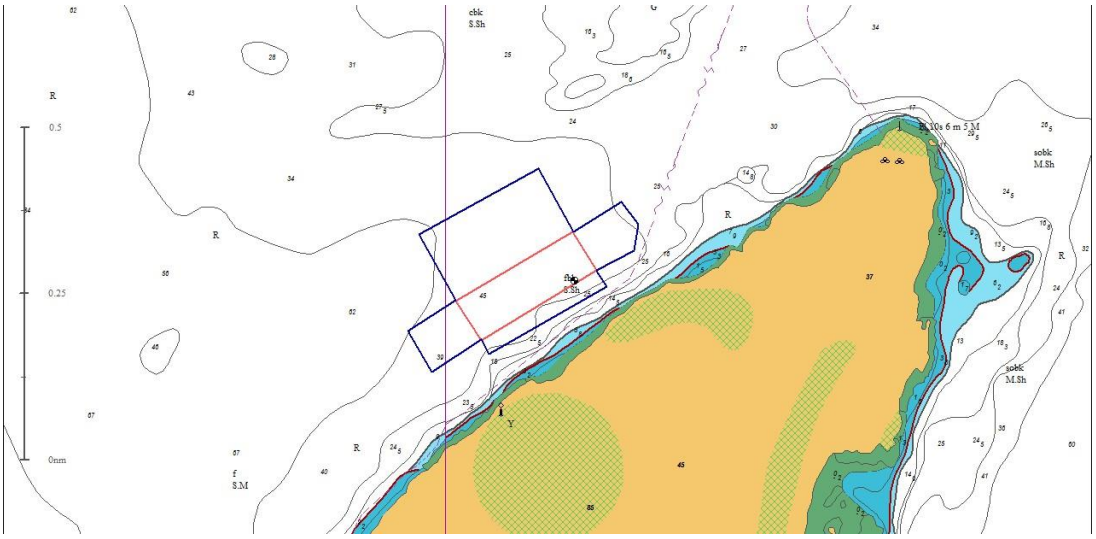


*Figure 3.1: Location map of the Little Cumbrae current meter deployment location and proposed site (**Red**)*

4. Materials and Methods

Dawnfresh Farming Ltd. used an RD instruments Sentinel V 100 ADCP which is a 300kHz acoustic Doppler current profiler. 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 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 ADCP at:

http://www.teledynemarine.com/sentinel-v-adcp?ProductLineID=12

The Sentinel V 100 ADCP was positioned at 55 43.902'N, 004 57.226'W [214627.273E, 652653.207N] which was within 150m of the proposed cage group centre. The meter was 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. Due to 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. Data was automatically stored to the internal memory and downloaded via Bluetooth on recovery.

Sentinel V

20 m, 50 m, 100 m Profiling ADCP

TECHNICAL SPECIFICATIONS

Depth Cell Size[1]

Depth Cell Size[1]	V20 (1000 kHz) Range (m)[2,3] Wide/Narrow	V20 (1000 kHz) Std Dev (cm/s)[3,4] Wide/Narrow	V50 (500 kHz) Range (m)[2,3] Wide/Narrow	V50 (500 kHz) Std Dev (cm/s)[3,4] Wide/Narrow	V100 (300 kHz) Range (m)[2,3] Wide/Narrow	V100 (300 kHz) Std Dev (cm/s)[3,4] 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 / TCPIP One 16 GB Micro SD Card included
Real-Time (RT) Communications	Serial/Ethernet	RS232 and RS422 / TCPIP (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	25° 4-beam, convex; 5th beam vertical 200 m

	Materials	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	Straight or right-angle metal shell connector • AC/DC power converter and cable • External battery case	
Available Options—Firmware/Software	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

Table 4.1: Deployment 1 ADCP Settings

Site Name	Little Cumbrae
Meter Position	55 43.902'N, 004 57.226'W
	214627.273'E, 652653.207'N
ADCP Type	Sentinel V
Serial Number	17469
Frequency	307
Number of Cells	59
Cell Size	1
First Cell Range	2.41
Number of Pings	200
Ping Interval	1
Start Date + Time	04/10/2017 @ 07:59
Deployment Date + Time	04/10/2017 @ 11:00
Recovery Date + Time	19/11/2017 @10:45
End/Turned off Date + Time	19/11/2017 @10:59
Minimum Depth Recorded	31.51
Bottom Cell Depth	1 @ 2.4m
Surface Cell Depth	12 @ 13.4m from profiler
Middle Cell Depth	23 @ 24.4m from profiler
Minimum Depth Corrected (CD)	
Net Depth	16

Table 4.2: Deployment 2 ADCP Settings

Summary and Deployment Log		Notes
	Second Deployment	
Site Name	Little Cumbrae	
ADCP Type	Sentinel V	
Serial Number	17469	
Frequency	307	
Number of Cells	59	
Cell Size	1	
First Cell Range	2.41	
Number of Pings	200	Meter was redeployed on 19th November 2017, 4 days into the deployment the depth record takes a 3m jump and it is believed the meter was dragged to a slightly shallower location. Pitch and Roll remain relatively stable during this time therefore it is likely this was moved by the current flow. The position was taken on recovery which confirmed the meter had moved in an easterly direction along a similar transect as the residual current flow.
Ping Interval	1	
Deployment Position	55 43.902'N, 004 57.226'W	
	214627.273'E, 652653.207'N	
Start Date + Time	19/11/2017 @11:31	
Deployment Date + Time	19/11/2017 @11:32	

Meter Dragged	23/11/2017 @ between 13:11 - 14:11	
New Position	55 43.889, 004 57.209	
	214644.030, 652628.346	
Recovery Date + Time	08/01/2018 @ 12:15	
End/Turned off Date + Time	08/01/2018 @ 12:31	
		This dataset only includes data from the new position after 14:11 on the 23rd
Minimum Depth Recorded	28.36	
Bottom Cell Depth	1 @ 2.4m from profiler	
Surface Cell Depth	22 @ 23.4m from profiler	
Middle Cell Depth	11 @ 12.4m from profiler	
Net Depth	16m	

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^{O}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 1.31m at 08:12 GMT on the 5th 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

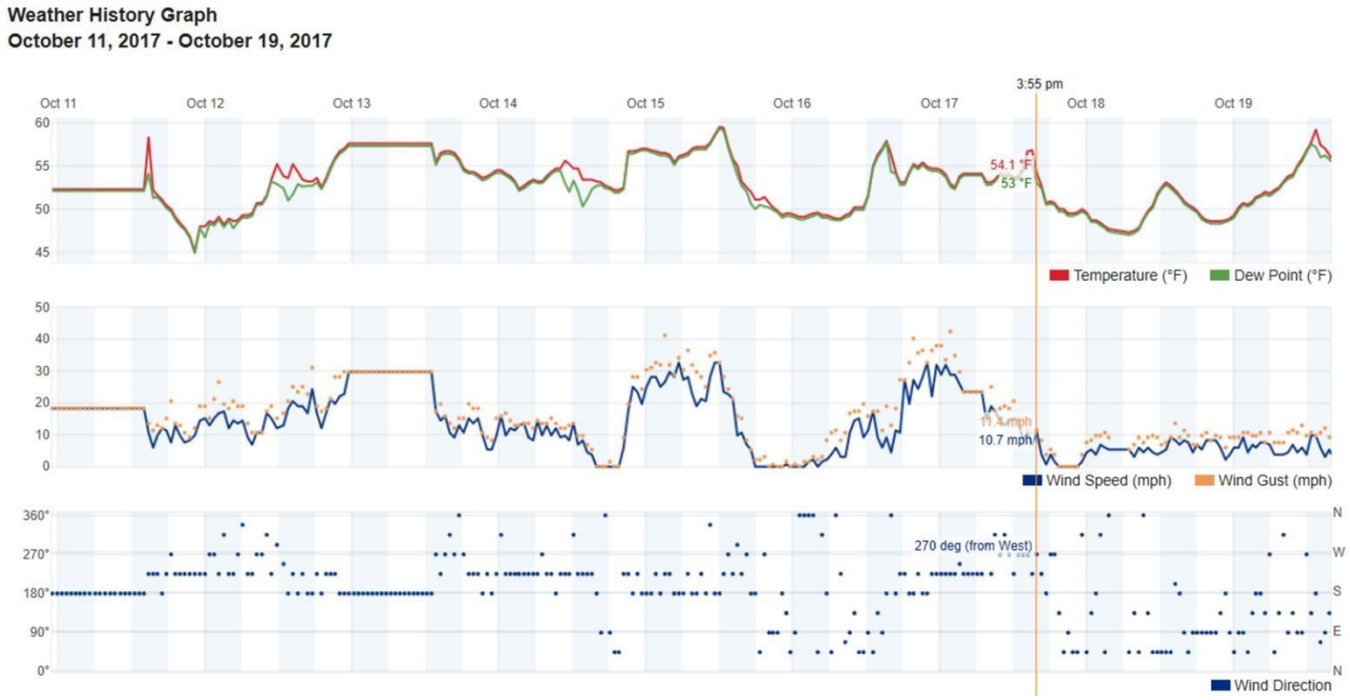


Figure 7.1: Weather data 29/10/17 to 05/11/17

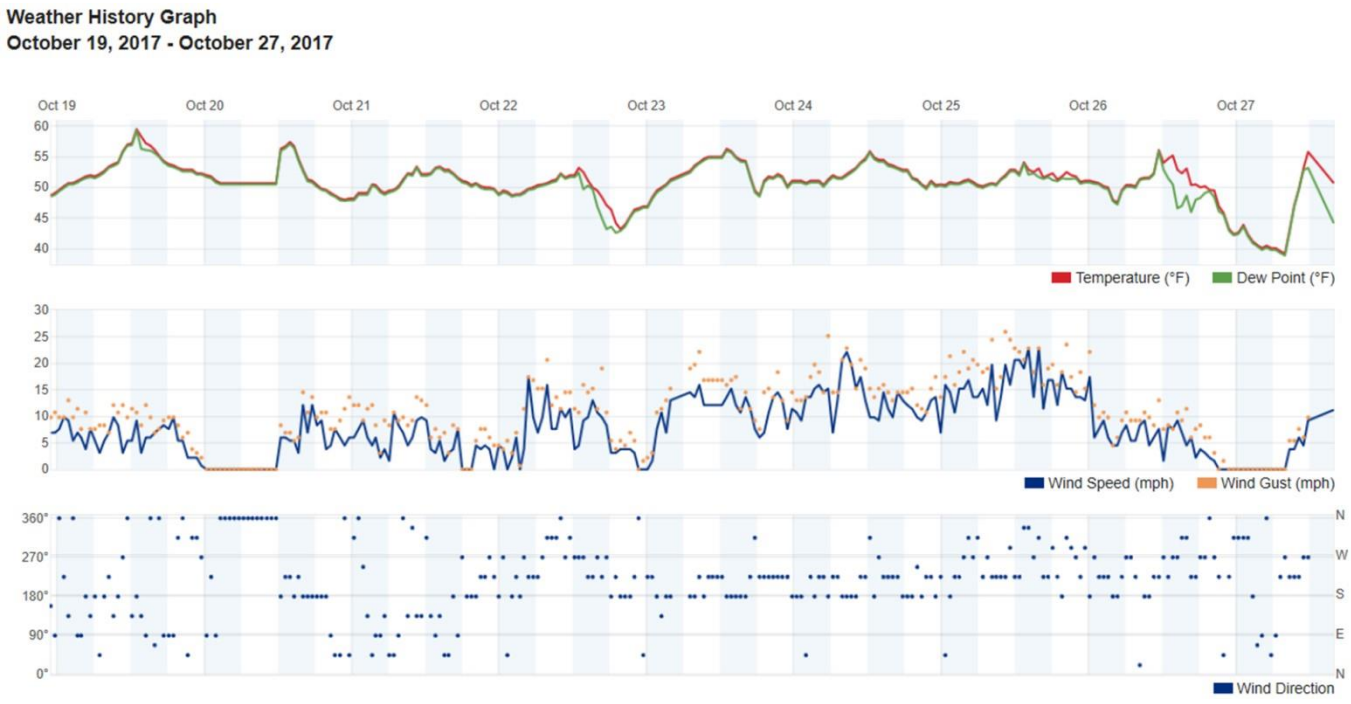


Figure 7.2: Weather Data 06/11/17 to 13/11/17

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 Little Cumbrae farm. The data showed that there was at least 3 days of consecutive wind speed below 22 mph which equates to less than 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/s20171019/e20171027/mweek

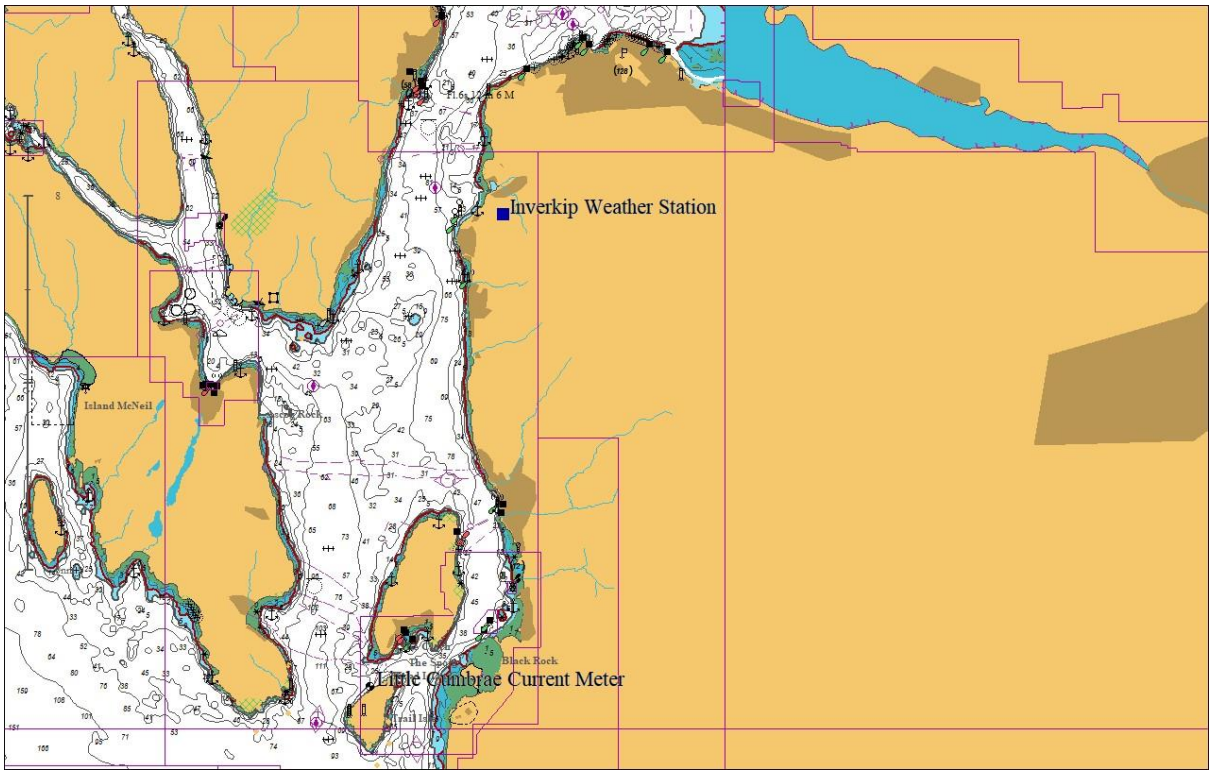
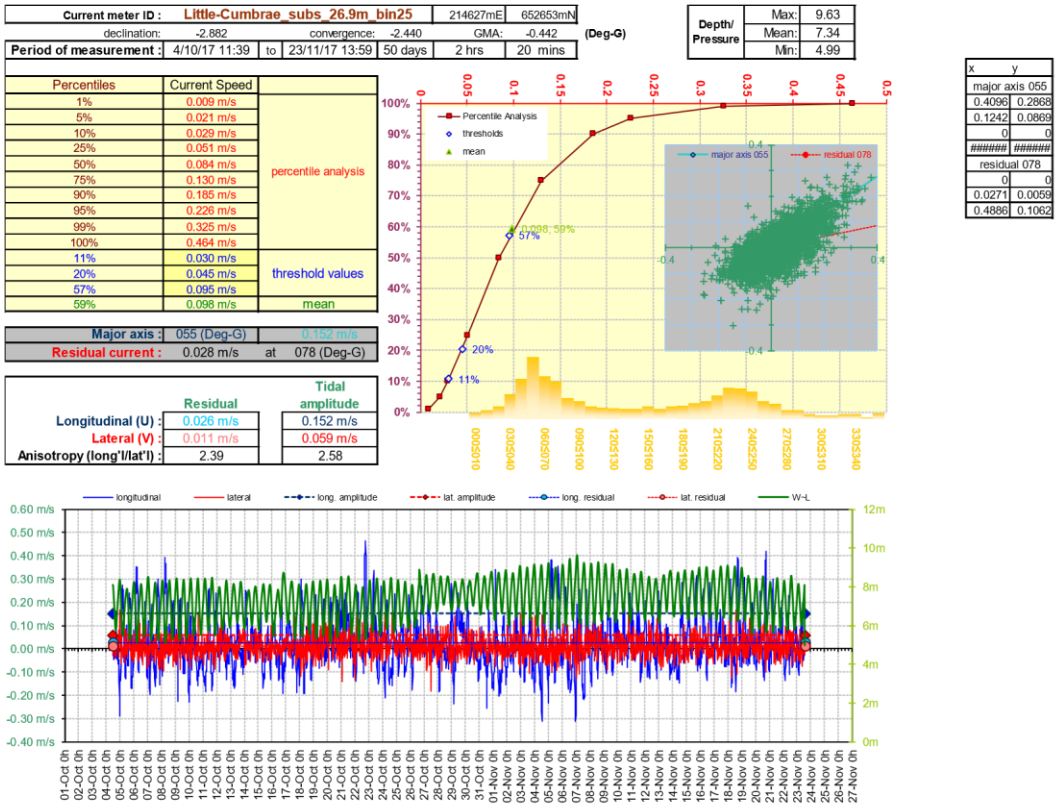


Figure 7.3: Location of Inverkip weather station in relation to proposed Little Cumbrae farm

8. Results and Discussion

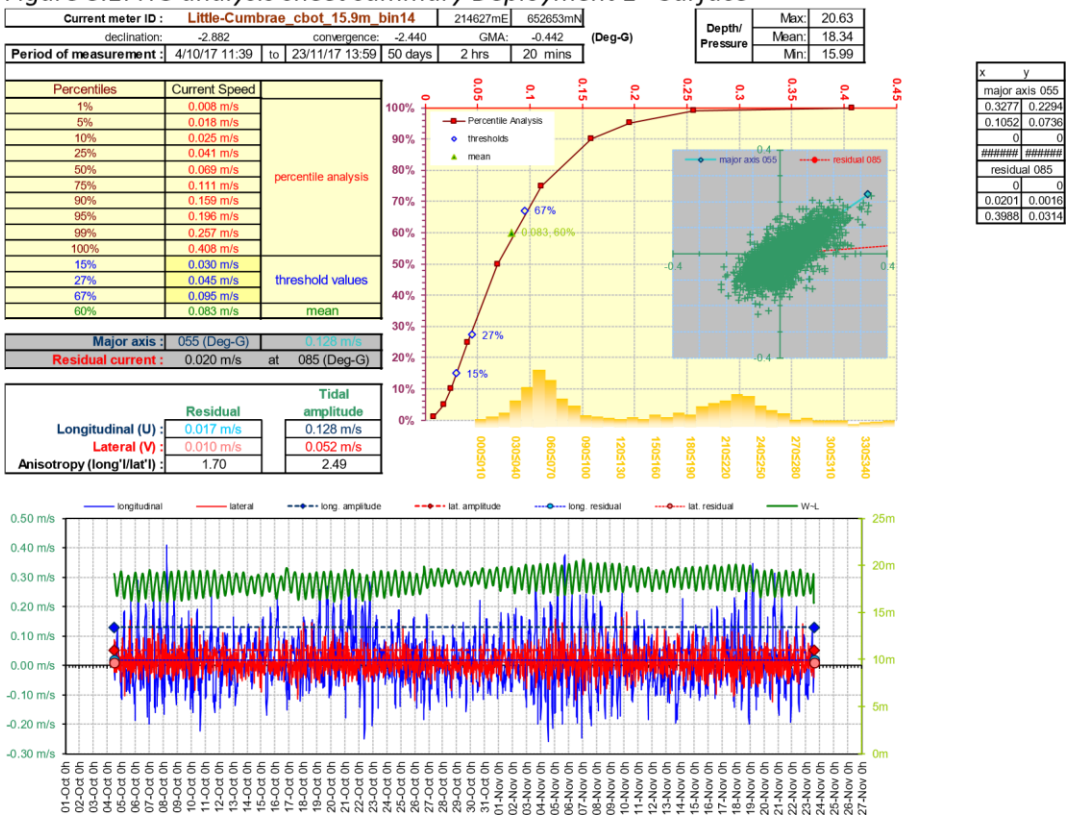
All data was inputted to the HG analysis spreadsheets to allow consideration of the full deployments. Once the full range of data were identified a median data set was extracted and processed as a 15 day data set for use in autoDepomod modelling. Figures 8.1 – 8.14 and tables 8.1 – 8.10 show the analysis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

Deployment 1



x	y
major axis 055	
0.4096	0.2868
0.1242	0.0869
0	0
#######	#######
residual 078	
0	0
0.0271	0.0059
0.4886	0.1062

Figure 8.1: HG analysis sheet summary Deployment 1 - Surface



x	y
major axis 055	
0.3277	0.2294
0.1052	0.0736
0	0
#######	#######
residual 085	
0	0
0.0201	0.0016
0.3988	0.0314

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

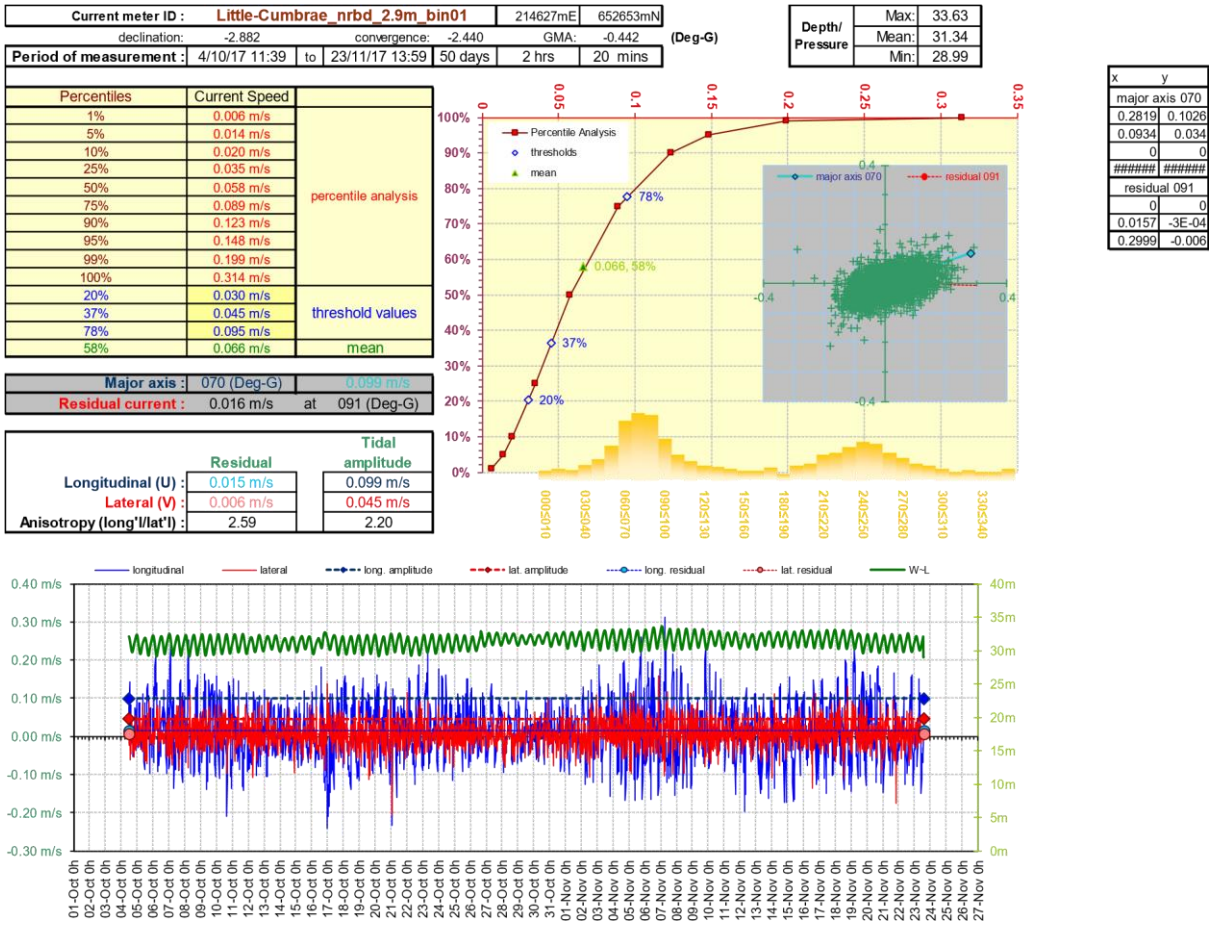


Figure 8.3: HG analysis sheet summary Deployment 1 – Bottom

Site: Little-Cumbrae_subs_26.9m_bin25
CUMULATIVE VECTOR PLOT OF ALL VELOCITY DATA

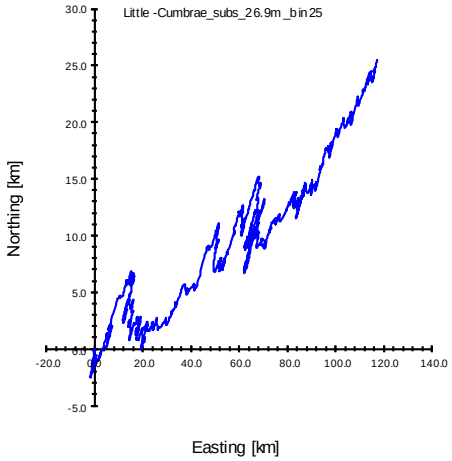


Figure 8.4: Cumulative vector plot Deployment 1 - surface

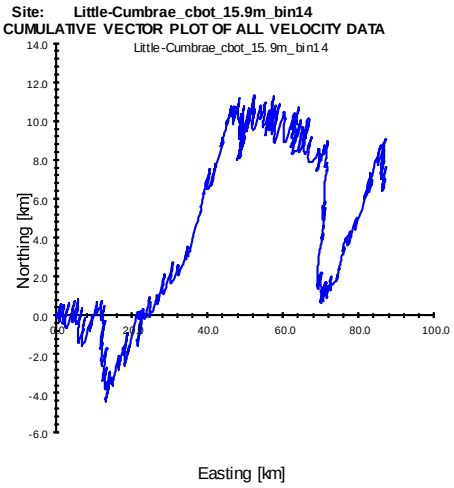


Figure 8.5: Cumulative vector plot Deployment 1 - net bottom

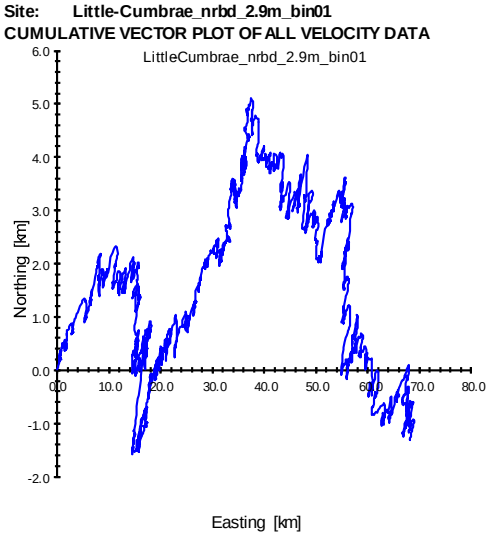


Figure 8.6: Cumulative vector plot bottom

Table 8.1: Recorded depths over deployment period

	Date	Height (m)
Highest Depth Recorded	07/11/2017	36.05
Lowest Depth Recorded	23/11/2017	31.41
Tidal Range Recorded	-	4.64

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	26.9	4.99	9.8	59
Net bottom	15.9	15.99	8.3	60
Bottom	2.9	28.99	6.6	58

Table 8.4: Ranked percentiles for current speeds

Cell	Ranked Percentiles			Major Axis (Deg)
	≤3cm/s (%)	≥4.5cm/s (%)	≥9.5cm/s (%)	
Surface	11	80	43	55
Net bottom	15	73	33	55
Bottom	20	63	22	70

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	0.098	0.028	0.026	0.011	0.152	0.059
Net Bottom	0.083	0.020	-	-	-	-
Bottom	0.066	0.016	-	-	-	-

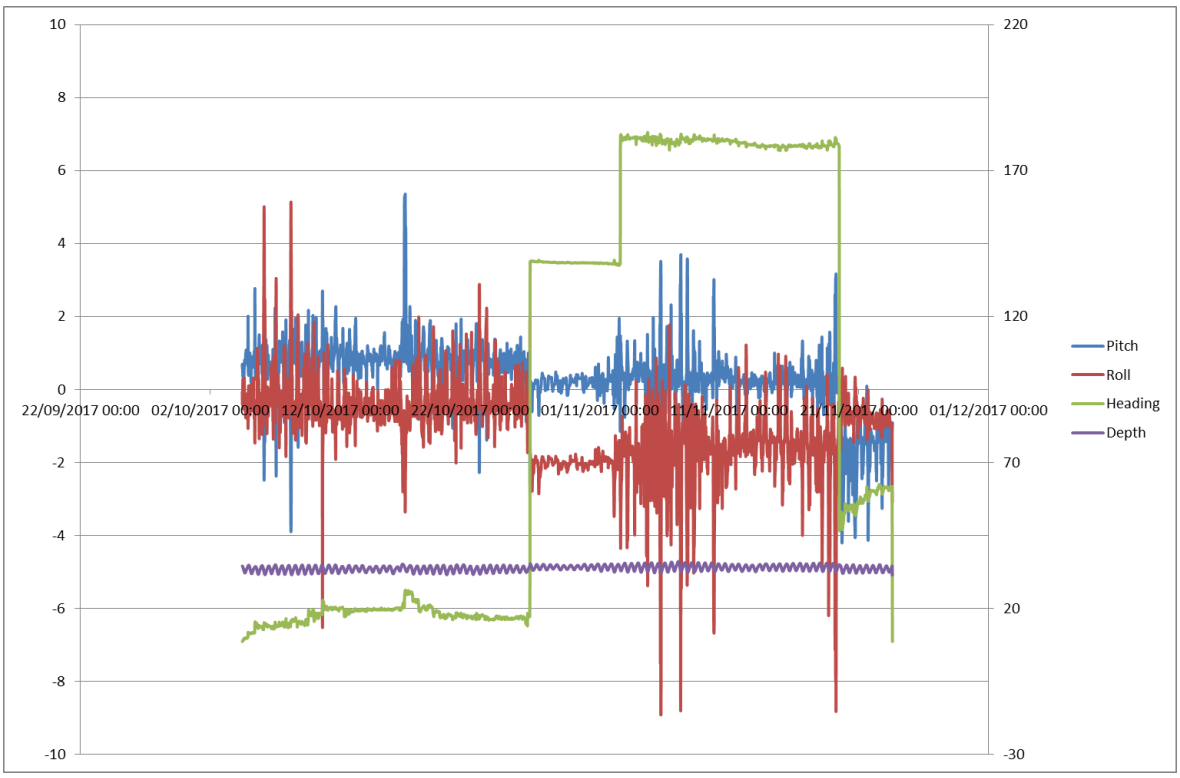


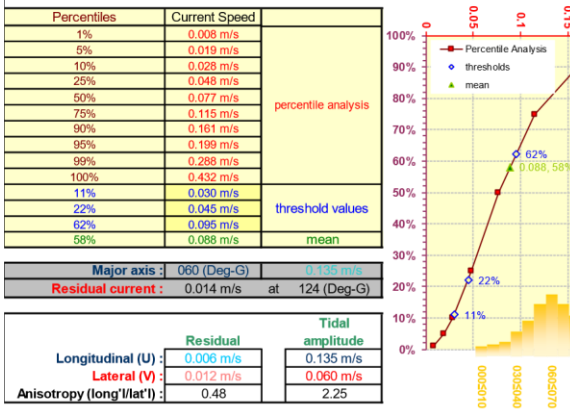
Figure 8.7: Graph of heading, pitch, roll and depth during Deployment 1 **Deployment 2**

Current meter ID :	Little-Cumbrae_subs_23.9m_bin22			214644mE	652628m	
declination:	-2.900		convergence:	-2.440	GMA:	-0.46
Period of measurement :	23/11/17 14:31	to	8/1/18 12:11	45 days	21 hrs	40 mins

Percentiles	Current Speed	
1%	0.008 m/s	percentile analysis
5%	0.019 m/s	
10%	0.028 m/s	
25%	0.048 m/s	
50%	0.077 m/s	
75%	0.115 m/s	
90%	0.161 m/s	
95%	0.199 m/s	
99%	0.288 m/s	
100%	0.432 m/s	
11%	0.030 m/s	threshold values
22%	0.045 m/s	
62%	0.095 m/s	
58%	0.088 m/s	mean

Major axis :	060 (Deg-G)		0.135 m/s
Residual current :	0.014 m/s	at	124 (Deg-G)

	Residual	Tidal amplitude
Longitudinal (U) :	0.006 m/s	0.135 m/s
Lateral (V) :	0.012 m/s	0.060 m/s
Anisotropy (long'l/lat'l) :	0.48	2.25



x	y
major axis 060	
0.3464	0.2
0.1167	0.0674
0	0
########	########
residual 124	
0	0
0.0114	-0.009
0.3307	-0.225

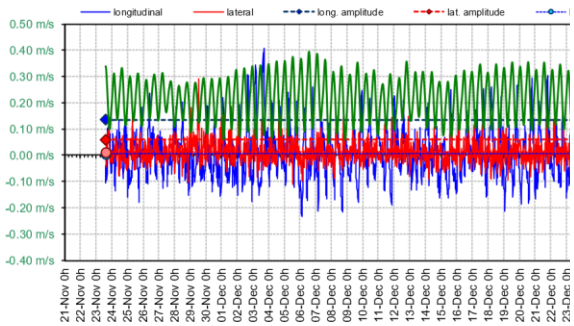
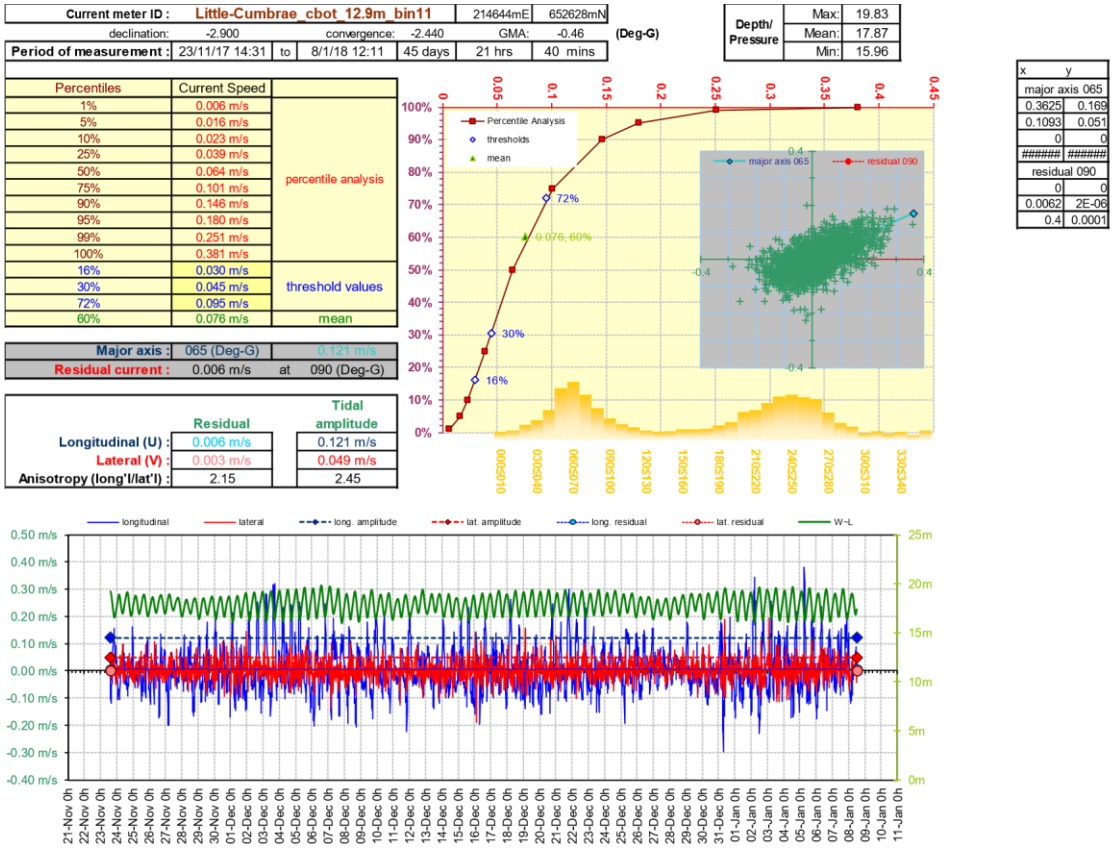


Figure 8.8: HG analysis sheet summary Deployment 2 - Surface



Current meter ID :	Little-Cumbrae_cbot_12.9m_bin11		214644mE	652628mN
declination:	-2.900	convergence:	-2.440	GMA: -0.46 (Deg-G)
Period of measurement :	23/11/17 14:31	to 8/1/18 12:11	45 days	21 hrs 40 mins

Depth/ Pressure	
Max:	19.83
Mean:	17.87
Min:	15.96

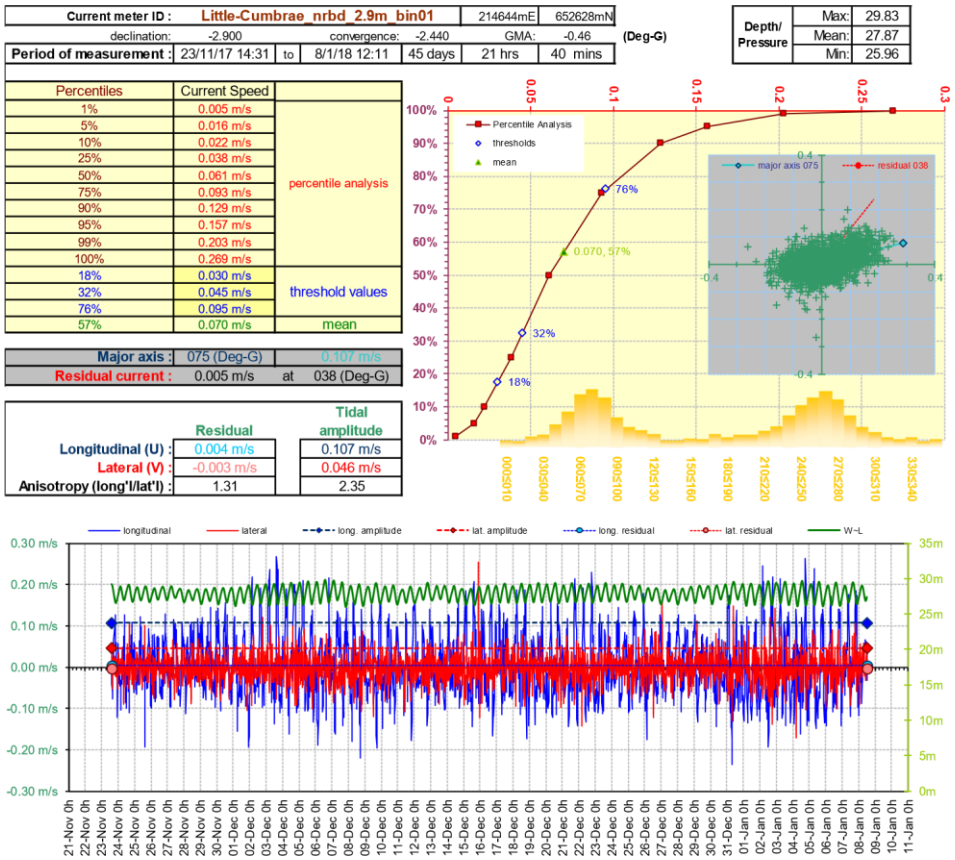
Percentiles	Current Speed	
1%	0.006 m/s	percentile analysis
5%	0.016 m/s	
10%	0.023 m/s	
25%	0.039 m/s	
50%	0.064 m/s	
75%	0.101 m/s	
90%	0.146 m/s	
95%	0.180 m/s	
99%	0.251 m/s	
100%	0.381 m/s	
16%	0.030 m/s	threshold values
30%	0.045 m/s	
72%	0.095 m/s	
60%	0.076 m/s	mean

Major axis :	065 (Deg-G)	0.121 m/s
Residual current :	0.006 m/s	at 090 (Deg-G)

	Residual	Tidal amplitude
Longitudinal (U) :	0.006 m/s	0.121 m/s
Lateral (V) :	0.003 m/s	0.049 m/s
Anisotropy (long'l/lat'l) :	2.15	2.45

x	y
major axis 065	
0.3625	0.169
0.1093	0.051
0	0
#######	#######
residual 090	
0	0
0.0062	2E-06
0.4	0.0001

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



Current meter ID :	Little-Cumbrae_nrbd_2.9m_bin01		214644mE	652628mN
declination:	-2.900	convergence:	-2.440	GMA: -0.46 (Deg-G)
Period of measurement :	23/11/17 14:31	to 8/1/18 12:11	45 days	21 hrs 40 mins

Depth/ Pressure	
Max:	29.83
Mean:	27.87
Min:	25.96

Percentiles	Current Speed	
1%	0.005 m/s	percentile analysis
5%	0.016 m/s	
10%	0.022 m/s	
25%	0.038 m/s	
50%	0.061 m/s	
75%	0.093 m/s	
90%	0.129 m/s	
95%	0.157 m/s	
99%	0.203 m/s	
100%	0.269 m/s	
18%	0.030 m/s	threshold values
32%	0.045 m/s	
76%	0.095 m/s	
57%	0.070 m/s	mean

Major axis :	075 (Deg-G)	0.107 m/s
Residual current :	0.005 m/s	at 038 (Deg-G)

	Residual	Tidal amplitude
Longitudinal (U) :	0.004 m/s	0.107 m/s
Lateral (V) :	-0.003 m/s	0.046 m/s
Anisotropy (long'l/lat'l) :	1.31	2.35

x	y
major axis 075	
0.2898	0.0776
0.1034	0.0277
0	0
#######	#######
residual 038	
0	0
0.003	0.004
0.1829	0.2378

Figure 8.10: HG analysis sheet summary Deployment 2 – Bottom

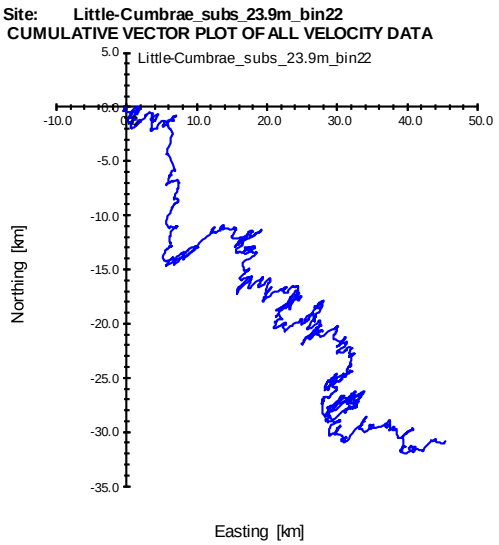


Figure 8.11: Cumulative vector plot Deployment 2 - surface

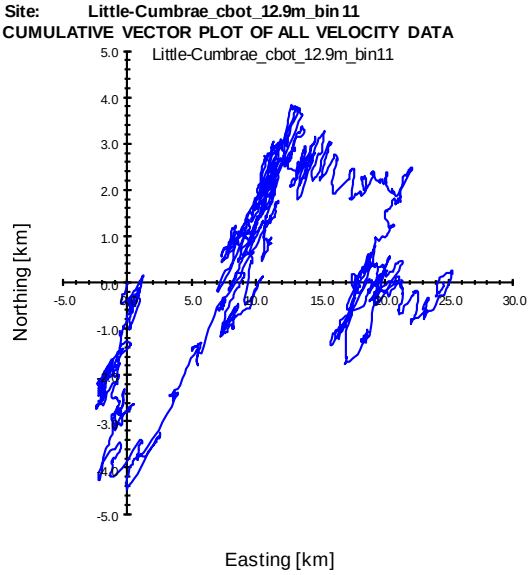
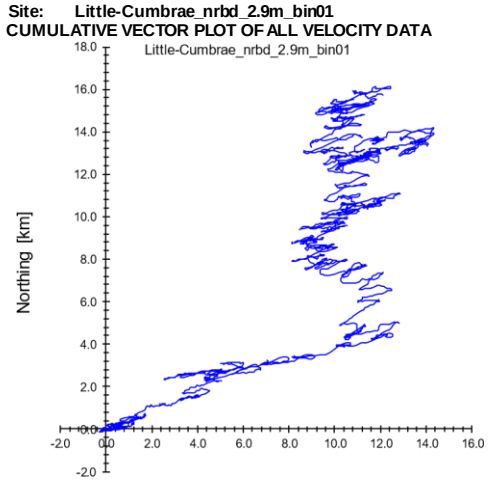


Figure 8.12: Cumulative vector plot Deployment 2 - net bottom



Easting [km]

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

	Date	Height (m)
Highest Depth Recorded	06/12/2017	32.23
Lowest Depth Recorded	07/12/2017	28.36
Tidal Range Recorded	-	3.87

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	04/01/2018 13:37	3.81	04/01/2018 19:18	-0.26
	Neap	27/12/2017 18:10	3.11	27/12/2017 11:53	1.16

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	23.9	5.0	8.8	58
Net bottom	12.9	16.0	7.6	60
Bottom	2.9	26.0	7.0	57

Table 8.9: Ranked percentiles for current speeds

Cell	Ranked Percentiles			Major Axis (Deg)
	≤3cm/s (%)	≥4.5cm/s (%)	≥9.5cm/s (%)	
Surface	11	78	38	60
Net bottom	16	70	28	65
Bottom	18	68	24	75

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	0.088	0.014	0.006	0.012	0.135	0.060
Net Bottom	0.076	0.006	-	-	-	-

Bottom	0.070	0.005	-	-	-	-

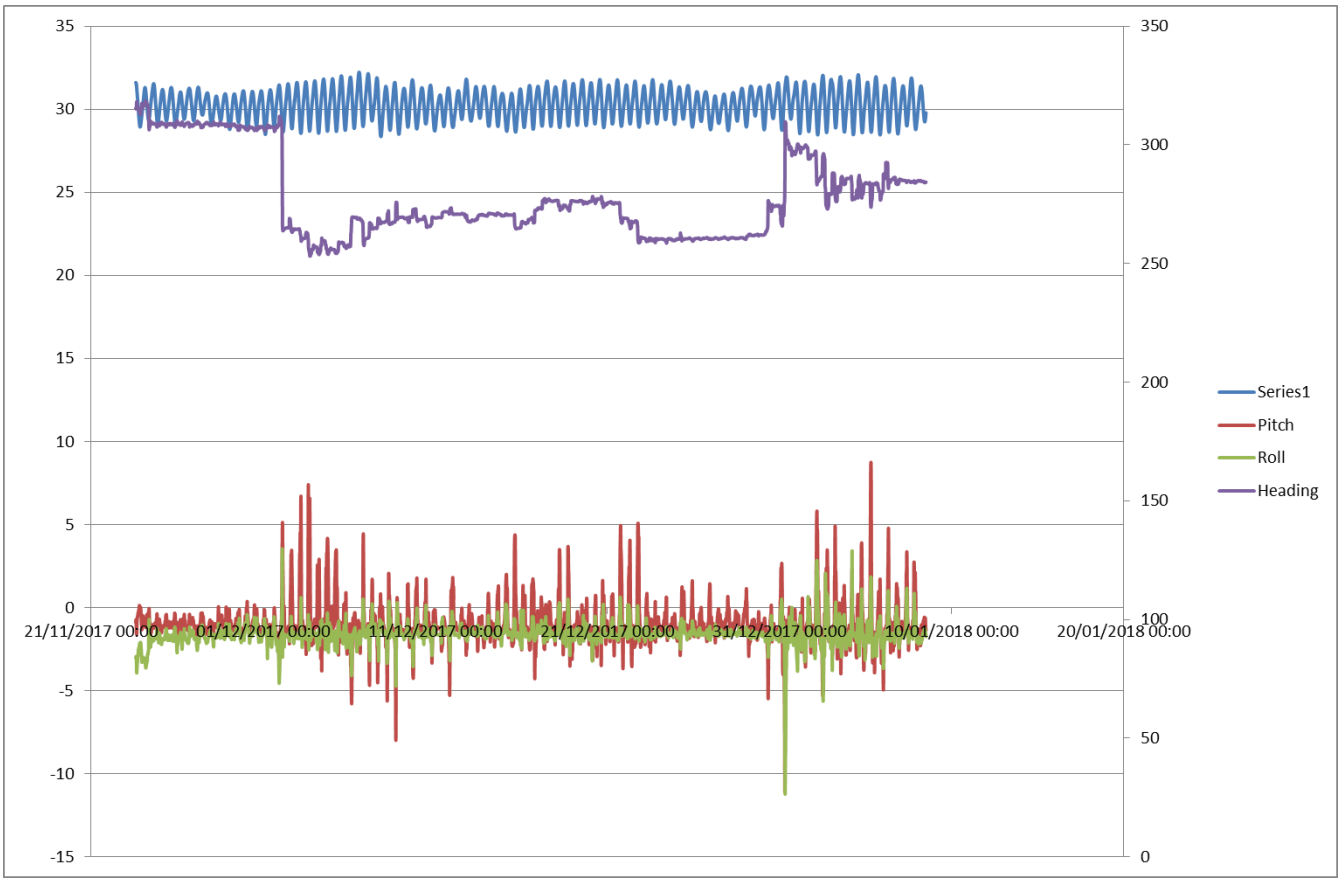


Figure 8.14: Graph of heading, pitch, roll and depth during Deployment 2

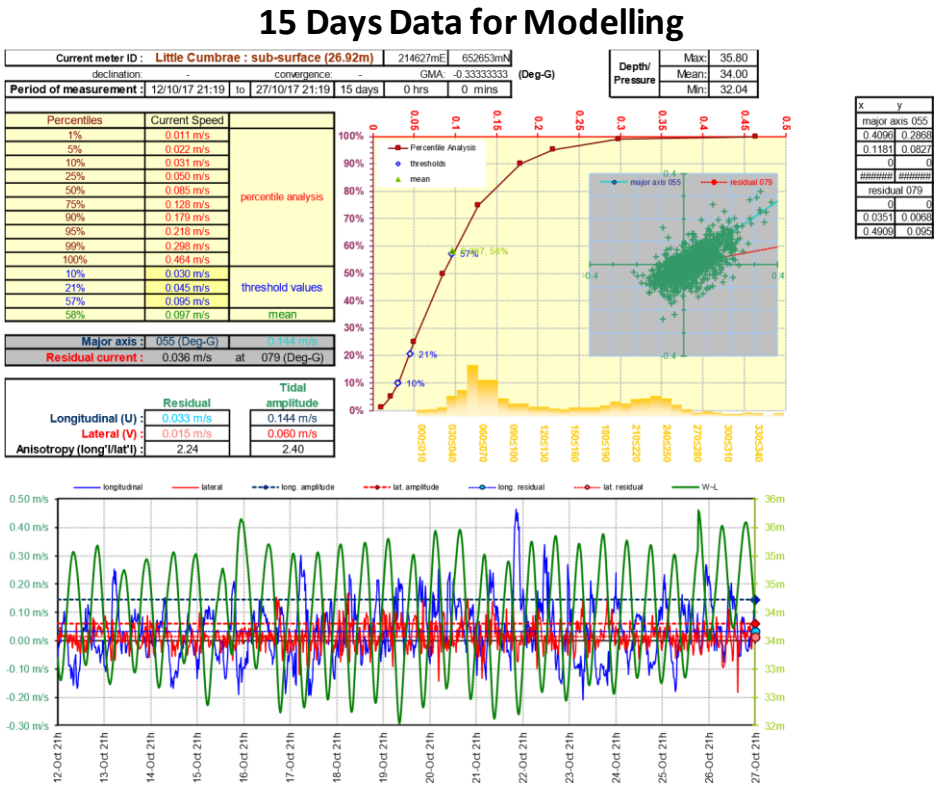


Figure 8.22: 15 days data, 29/10/17 09:47 to 13/11/17 09:47 – Surface

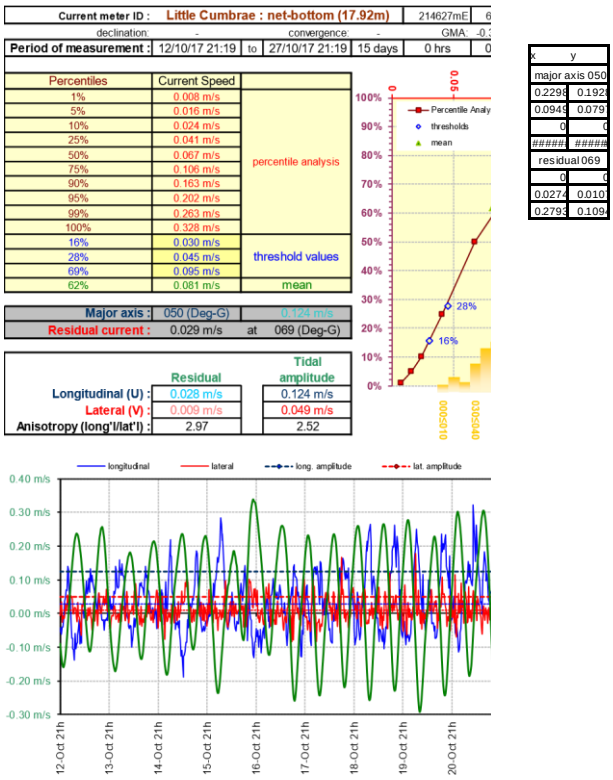


Figure 8.23: 15 days data, 29/10/17 09:47 to 13/11/17 09:47 – Middle

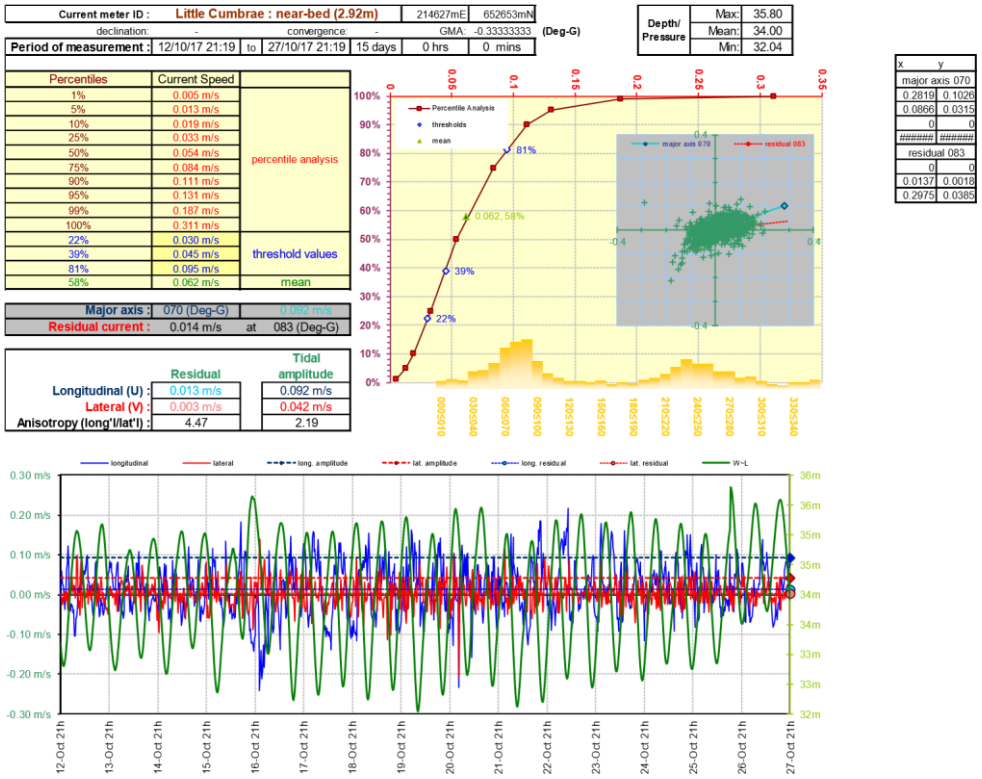


Figure 8.24: 15 days data, 29/10/17 09:47 to 13/11/17 09:47 – Bottom

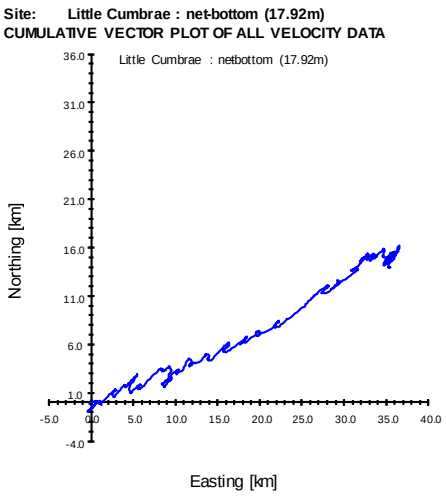


Figure 8.25: 15 days current data Cumulative Vector Plot – Surface

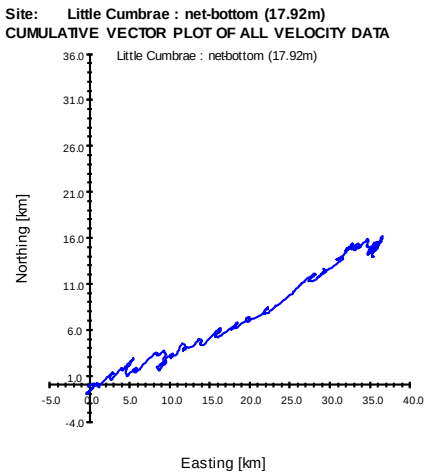


Figure 8.26: 15 days current data Cumulative Vector Plot – Middle

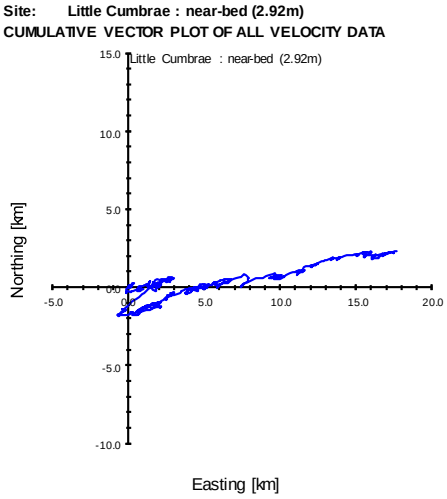


Figure 8.27: 15 days current data Cumulative Vector Plot – Bottom

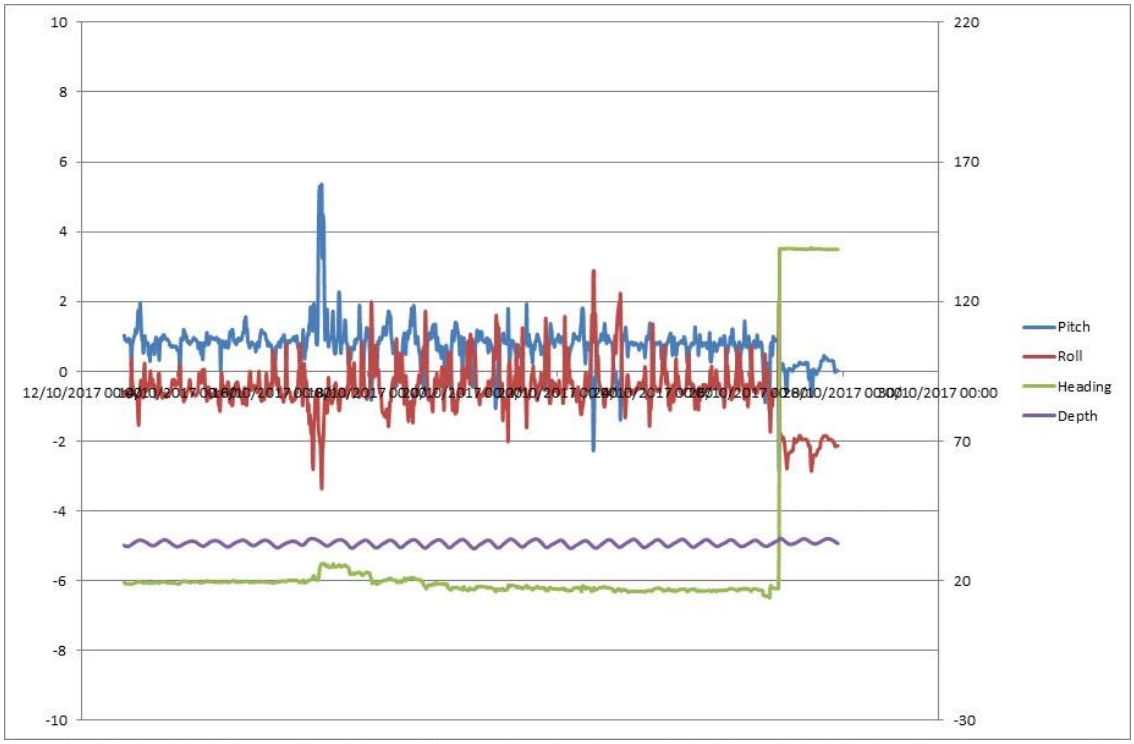


Figure 8.28: Heading, Depth, Pitch and Roll over the 15 days analysed

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	26.92	5.12	9.7	58
Net bottom	17.92	14.12	8.1	62
Bottom	2.92	29.12	6.2	58

Table 8.17: Ranked percentiles for current speeds

Cell	Ranked Percentiles			Major Axis (Deg)
	≤3cm/s (%)	≥4.5cm/s (%)	≥9.5cm/s (%)	
Surface	10	79	43	55
Net bottom	16	72	31	50
Bottom	22	61	19	70

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	0.097	0.036	0.033	0.015	0.144	0.060
Net Bottom	0.081	0.029	-	-	-	-

Bottom	0.062	0.014	-	-	-	-

9. Depth Survey Results

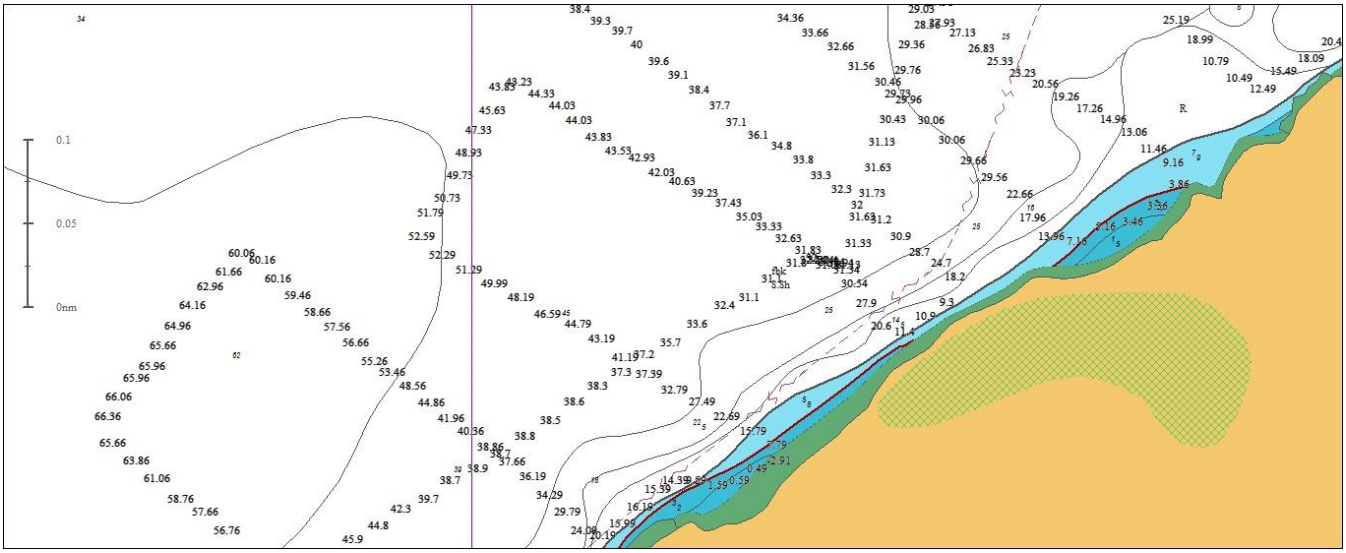


Figure 9.1: Little Cumbrae depth survey results, 1 in 10 plotted on Seapro

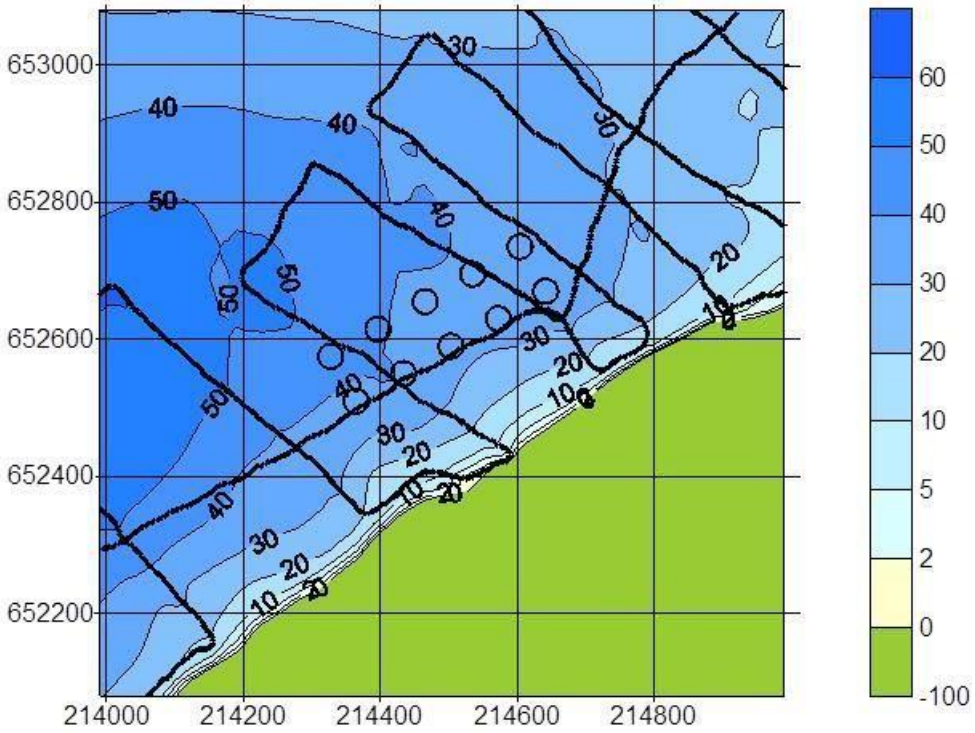


Figure 9.2: Contour map created from depth survey and charted depths

Table 9.1: Extract from full Little Cumbrae depth survey

					OSGB E	OSGB N	04-Oct-17	UTC	Measured Depth	Correction	chart datum
55	43.893	4	W	57.228	214628.9	652641.9		10:19:03	35.2	2.66	32.54
55	43.893	4	W	57.227	214629.9	652641.9		10:19:04	35.2	2.66	32.54
55	43.893	4	W	57.226	214631	652641.8		10:19:05	35.1	2.66	32.44
55	43.893	4	W	57.225	214632	652641.8		10:19:06	35.2	2.66	32.54
55	43.893	4	W	57.224	214633.1	652641.8		10:19:07	35	2.66	32.34
55	43.893	4	W	57.224	214633.1	652641.8		10:19:08	35	2.66	32.34
55	43.893	4	W	57.223	214634.1	652641.7		10:19:09	34.9	2.66	32.24
55	43.893	4	W	57.222	214635.2	652641.7		10:19:10	34.8	2.66	32.14
55	43.893	4	W	57.221	214636.2	652641.6		10:19:11	34.9	2.66	32.24
55	43.893	4	W	57.220	214637.3	652641.6		10:19:12	34.9	2.66	32.24
55	43.893	4	W	57.219	214638.3	652641.5		10:19:13	34.8	2.66	32.14
55	43.892	4	W	57.218	214639.3	652639.6		10:19:14	34.7	2.66	32.04
55	43.892	4	W	57.218	214639.3	652639.6		10:19:15	34.8	2.66	32.14
55	43.892	4	W	57.216	214641.4	652639.5		10:19:16	34.8	2.66	32.14
55	43.892	4	W	57.215	214642.4	652639.5		10:19:17	34.9	2.66	32.24
55	43.892	4	W	57.214	214643.5	652639.4		10:19:18	34.5	2.66	31.84
55	43.892	4	W	57.213	214644.5	652639.4		10:19:19	34.5	2.66	31.84
55	43.892	4	W	57.212	214645.6	652639.4		10:19:20	34.5	2.66	31.84
55	43.892	4	W	57.211	214646.6	652639.3		10:19:21	34.5	2.66	31.84
55	43.892	4	W	57.209	214648.7	652639.2		10:19:22	34.5	2.66	31.84
55	43.892	4	W	57.208	214649.7	652639.2		10:19:23	34.5	2.66	31.84
55	43.892	4	W	57.208	214649.7	652639.2		10:19:24	34.5	2.66	31.84
55	43.892	4	W	57.207	214650.8	652639.1		10:19:25	34.5	2.66	31.84
55	43.892	4	W	57.206	214651.8	652639.1		10:19:26	34.4	2.66	31.74
55	43.892	4	W	57.205	214652.9	652639		10:19:27	34.4	2.66	31.74
55	43.891	4	W	57.205	214652.8	652637.2		10:19:28	34.3	2.66	31.64

55	43.891	4	W	57.203	2146549	6526371		10:19:29	34.3	2.66	31.64
55	43.891	4	W	57.203	2146549	6526371		10:19:30	34.4	2.66	31.74
55	43.891	4	W	57.202	2146559	6526371		10:19:31	34.6	2.66	31.94

**Full depth survey was comprised of 3,033 readings and will therefore be appended to the final submission*

10. Conclusions

The pitch and roll of the transducer was relatively stable over the valid data contained within the two deployments although there was a clear relationship between greater pitch and roll readings and the occurrence of spring tides. The high energy nature of the site did make data collection challenging but for the majority of the deployment period the meter remained comfortably within the operable tolerances of the instrumentation used with only a single isolated peak out with those tolerances. The variations in heading through the 2 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 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. The movements recorded do not appear to have undermined the quality of data collected.

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 windspeed 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 Little Cumbrae 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 Little Cumbrae location.