SCOTTISH SEA FARMS LTD.
BRING HEAD, SCAPA FLOW
CAR/L/1015854

MODELLING DATA COLLECTION REPORT

Report To	Scottish Environment Protection Agency
Deployment IDs	BNGHD, BH04
Status	V1
Date	11 March 2022

Scottish Sea Farms Ltd
South Shian
Benderloch
Argyll & Bute
[redacted]

Contents

1 Introduction

This report presents the survey work undertaken by Scottish Sea Farms Ltd. at the existing Bring Head fish farm located in Scapa Flow, Orkney (CAR/L/1015854). Two current meter deployments from 2018 and 2021 are reported which have been conducted to collect the hydrographic data used to assess the proposed expansion at Bring Head. Data collection and analysis follow guidance from the Scottish Environment Protection Agency (SEPA) (SEPA 2019a, SEPA 2019b, SEPA 2022).

2 Site description

The survey area is located adjacent to the existing fish farm in Hoy Sound on the western side of Scapa Flow, positioned approximately 490 m from the shore (Figure 2.1). This is a location which is influenced by the tidal streams associated with the western entrance to Scapa Flow, and is exposed to a moderate fetch from ENE through SE. The survey area is located at the transition between a region of relatively uniform depth at 36-41m and the gradually shoaling seabed towards the cliffs along the NE coast of Hoy. Immediately to the NE are the Bring Deeps, the deepest part of Scapa Flow with depths in excess of 60m of water.

The proposed expansion at Bring Head includes a relocation of the site centre 198m ENE. Details of the existing and proposed infrastructure are found in Table 2.1.

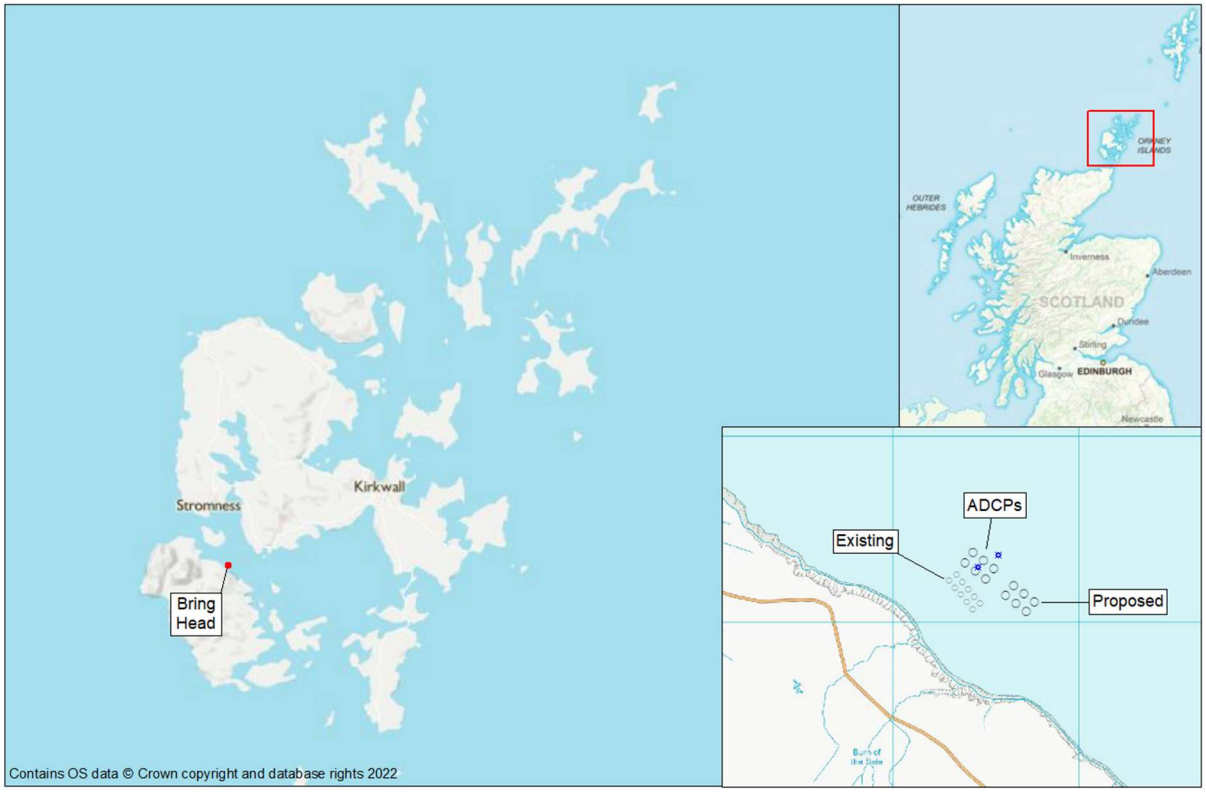

Figure 2.1 Location of the Bring Head marine fish farm, existing and proposed, and ADCP deployment locations.

Table 2.1 Bring Head site infrastructure.

	Existing	Proposed
Site centre	327382E, 1002164N	327573E, 1002216N
Number of pens	10	12
Pen circumference	80 m	120 m
Pen net depth	10 m	12 m
Mooring grid spacing	50 m	70 m
Layout	2 x 5	2no. 2 x 3

3 Scope

To establish the environmentally appropriate biomass and medicine consent limits for the proposal, an assessment is undertaken using NewDEPOMOD configured according to the "standard default" approach as outlined in SEPA 2019b. This requires the collection of at least 90 days of hydrographic data from the location which in this case are formed from two shorter subsets. Individually these data also support the development of a hydrodynamic model.

Historically a hydrographic survey in 2008 at a location inshore of the existing site was used to support the licencing requirements here using AutoDEPOMOD. However, at 316 m from the centre of the proposal these data are not suitable to represent conditions at the latter. A bathymetric survey of the area was undertaken by the UK Hydrographic Office (UKHO) in 2009 (UKHO 2019).

4 Methods

4.1 Instrument deployment

An Acoustic Doppler Current Profiler (ADCP) was deployed at Bring Head on both occasions (Table 4.1).

Table 4.1 Deployment details.

Identifier	BNGDH	BH04
Deployment date	24/09/2018	01/11/2021
Data acquisition period	24/09/2018 14:01 to 09/12/2018 21:21 (76.31 days)	02/11/2021 18:30 to 23/11/2021 09:30 (20.63 days)
Instrument	Teledyne RDI Workhorse Sentinel	Teledyne RDI Sentinel V50

Instruments were mounted in a gimballed frame and deployed on the seabed at the target positions. An 80m ground rope attached to the frame ran to a clump weight marked with a surface buoy to allow recovery. Each ADCP specification and deployment configuration is given in Section 6. Position fixes were obtained using a Garmin GPSMAP 76S in WGS84. The GPS position accuracy was compared against a known location and checked for consistency at the end of each survey. The depth at each deployment location was obtained using a Plastimo Echotest II hand-held depth sounder. Readings were later corrected to Chart Datum using predicted tidal heights for the secondary port Stromness obtained from Admiralty TotalTide software.

4.2 Data processing

Following retrieval of the ADCP the raw data file was downloaded from the instrument and imported into Teledyne's *Velocity* software, automatically averaging the raw ping data using the default screening parameters and generating the corresponding **.pdv* file used for data processing (screenshots are presented at Appendices A-D). These are given an initial inspection (e.g. orientation, pitch, roll, heading, pressure) to check that the meter has remained undisturbed and that there are no obvious breaks in the data. Side-lobe interference was removed and the data for the valid bins was exported in ASCII format. These were compiled into a Microsoft Excel workbook and evaluated according to Teledyne's *QA/QC Parameter for Acoustic Doppler Current Profilers* application.

The standard deviation (SD) for each ensemble at each bin is calculated according to:

$$bin\ SD = \frac{single\ ping\ SD}{\sqrt{\frac{(PG1 + PG4)}{100} * no.of\ pings}}$$

Where the single ping SD is specific to the instrument for a given bin size, PG1 (percent good 1) and PG4 are the percentages of 3 and 4 beam solutions respectively (i.e. valid pings) and the number of pings is that per ensemble programmed for each deployment.

Three depth bins were selected as outlined by SEPA guidance and these data were analysed using the SEPA tool *HGdata_analysis_v7.11.xls* (SEPA 2019b & SEPA 2022). All bearings were corrected from magnetic north to grid north using a Grid Magnetic Angle derived from the declination obtained for the survey position and date from the World Magnetic Model 2020 Calculator (BGS 2021), and from a grid convergence angle calculated from the deployment National Grid Reference by the HGdata_analysis spreadsheet. Deployment specific values are given in Table 4.2.

Table 4.2 Heading correction parameters.

Identifier	BHGHD	BH04
Grid Magnetic Angle	1.40°W	0.68°W
Declination (date)	2.48°W (01/11/2018)	1.76°W (12/11/2021)
Grid Convergence Angle	1.08°W	1.08°W

4.3 Data repair

An interference event occurred during the BNGHD deployment affecting the intensity of all four beams for four hours on 20/11/2018 between 14:41 and 19:01. This resulted in an atypical spike in current velocity. These data were repaired using an appropriate patch from the preceding tide with details provided on the 'dataRepair' tab of *BNGHD000_ADCP_Extracts.xlsx*.

No data repair was required for the second deployment, BH04.

4.4 Harmonic analysis

For each deployment the astronomic tidal component was derived using harmonic analysis to remove the influence of meteorological effects using the UTide toolbox in MATLAB. This reduces the flow to its harmonic constituents from which the tide only speed and direction are reproduced.

4.5 Data combination

The TotalTide prediction for Stromness and lunar phase information were used to align both data sets, with the full moon on the 19/11/2021 considered to be equivalent to that on the 25/9/2018. Water level, velocity and direction data for each of the selected bins are plotted to assess and fine tune an appropriate point to join the data with the best fit identified at 19/11/2021 04:10:00 to

25/09/2018 04:41:00 (Table 4.3). The joint is flagged in each CurrentMeterData_BringHead_'layer'90d _v2.xlsx spreadsheet.

The artificial timestamp for the 90-day timeseries was cast backwards from the first date of the longer 2018 BNGHD data.

Table 4.3 Data combination tide and lunar phase details from TotalTide, secondary port 0280 Stromness.

Identifier	Part	Start	Tide height	Tide timing	End	Tide height	Tide timing
BH04	1	02/11/2021 18:30:00	3.3m	50 min before HW	19/11/2021 04:10:00	1.3m	1.5 hrs after LW
		02/11/2021 Time / Height High: 07:16 3.2 m; 19:20 3.5 m Low: 00:49 0.9 m; 13:01 1.2 m 04/11/2021 21:13 11/11/2021 12:45 19/11/2021 08:56 27/11/2021 12:26 17 days until full moon 4 days before spring tide				19/11/2021 Time / Height High: 08:55 3.5 m; 21:05 3.4 m Low: 02:37 0.9 m; 14:53 1.0 m 19/11/2021 08:56 27/11/2021 12:26 04/12/2021 07:42 11/12/2021 01:34 Full Moon 2 days before spring tide		
BNGHD	2	25/09/2018 04:41:00	1.1m	1.7 hrs after LW	07/12/2018 18:41:00	2.5m	2.5 hrs before HW
		25/09/2018 Time / Height High: 09:13 3.4 m; 21:16 3.7 m Low: 03:01 0.7 m; 15:08 0.8 m 25/09/2018 02:51 02/10/2018 09:44 09/10/2018 03:46 16/10/2018 18:00 29 days until full moon 2 days before spring tide				07/12/2018 Time / Height High: 08:53 3.6 m; 21:11 3.5 m Low: 02:37 0.9 m; 14:58 0.9 m 07/12/2018 07:19 15/12/2018 11:48 22/12/2018 17:47 29/12/2018 09:33 15 days until full moon 2 days before spring tide		

5 Flow data

5.1 Deployment position

The deployment positions are given in Table 5.1 and illustrated at Figure 5.1. BNGHD was deployed at a location 150m NW of the proposed site centre among the proposed pens, while BH04 was deployed 147m north of the proposed site centre, 81m from the nearest pen centre. The raw depth sounding was converted to chart datum using the predicted tidal height for Stromness (secondary port ID 0280) obtained from Admiralty TotalTide software. The weighted average ADCP position and depth was determined following SEPA guidance (SEPA 2022).

Table 5.1 ADCP deployment positions for Bring Head.

Identifier	Date & time (UT)	Easting	Northing	Raw depth (m)	Tide (m)	Depth (mCD)
BNGHD	24/09/2018 14:01	327444	1002295	37.8	1.0	36.8
BH04	01/11/2021 18:25	327567	1002363	43.1	3.2	39.9
Weighted average	-	327467	1002307	-	-	37.4

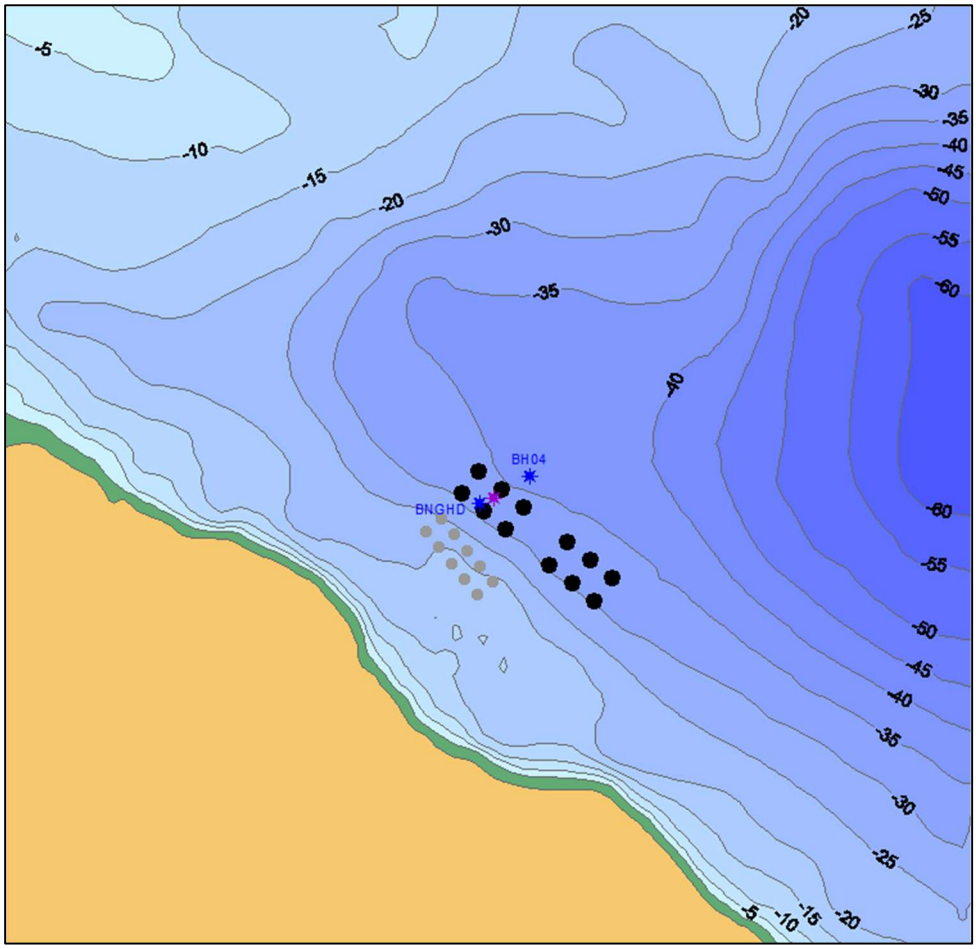

Figure 5.1 Location of the Bring Head marine fish farm illustrating the ADCP deployments and the weighted average position (purple) relative to the proposed and existing pens (black and grey respectively). Bathymetry derived from Admiralty Chart ref. 35-0.

5.2 Description – BNGHD, 2018

5.2.1 Quality

A total of 5,495 valid ensembles were processed from the BNGHD deployment. With a 20-minute interval between ensembles this equates to 76.3 days. Heading, pitch and roll sensor data show minor variation during the deployment (Appendix B). The recorded pressure was compared with the estimated tidal heights for Stromness which shows that both range and timing are consistent with those predicted. The mean depth during the deployment, including the height of the frame, was 38.98m and the minimum depth was 36.93mCD. This corresponds well with the deployment depth of 36.8mCD.

The mean SD for all 5,495 ensembles for bins 1 to 31 is 0.0035 m s^{-1} and is therefore below the SEPA guideline threshold for horizontal precision by not exceeding 10% of the mean velocity recorded (0.153 m s^{-1}, bins 1-31).

5.2.2 Depth bin selection

Bins 1, 25 and 30 were selected to represent near-bed, pen-bottom and sub-surface conditions respectively, detailed in Table 5.2. The near-bed bin is at a depth within 3 m above the seabed. The pen-bottom bin was selected from a depth corresponding to the bottom of the pens at the mean depth observed during the deployment period. The sub-surface bin was selected from a depth to be within 5 m of the lowest observed tide during the deployment, while being below potential effects from wave breaking or side-lobe interference.

Table 5.2 Depth bin selection (BNGHD).

	Position of bin centre (metres)			
Bin number	From sensor head	From seabed	From the mean tidal level	From lowest observed tide
1	2.10	**2.90**	36.08	34.04
25	26.10	26.90	**12.08**	10.04
30	31.10	31.90	7.08	**5.04**

5.2.3 Analysis

The summary statistics for ensembles 14 to 5,508 equivalent to the period from 24/09/2018 14:01:00 to 09/12/2018 21:21:00 (76.31 days) of each bin selected are given in Table 5.3.

Table 5.3 BNGHD summary statistics.

	Near-bed	Pen-bottom	Sub-surface
Mean velocity (m s^{-1})	0.135	0.154	0.156
Min velocity (m s^{-1})	0.001	0.004	0.001
Max velocity (m s^{-1})	0.488	0.557	0.563
Ranked percentage 0.095 m s^{-1}	30.7%	27.5%	27.1%
Major axis (°G)	315	315	315
Amplitude anisotropy	2.63	3.01	2.88
Residual velocity (m s^{-1})	0.051	0.044	0.037
Residual direction (°G)	318.4	300.9	305.6
Parallel Residual (m s^{-1})	0.050	0.043	0.036
Normal Residual (m s^{-1})	0.003	-0.011	-0.006
Parallel tidal amplitude (m s^{-1})	0.189	0.231	0.235
Normal tidal amplitude (m s^{-1})	0.072	0.077	0.082
	Min	**Max**	**Range**
Depth (m)	36.9	40.8	3.9

BNGHD_nrbd_2.9m_bin01

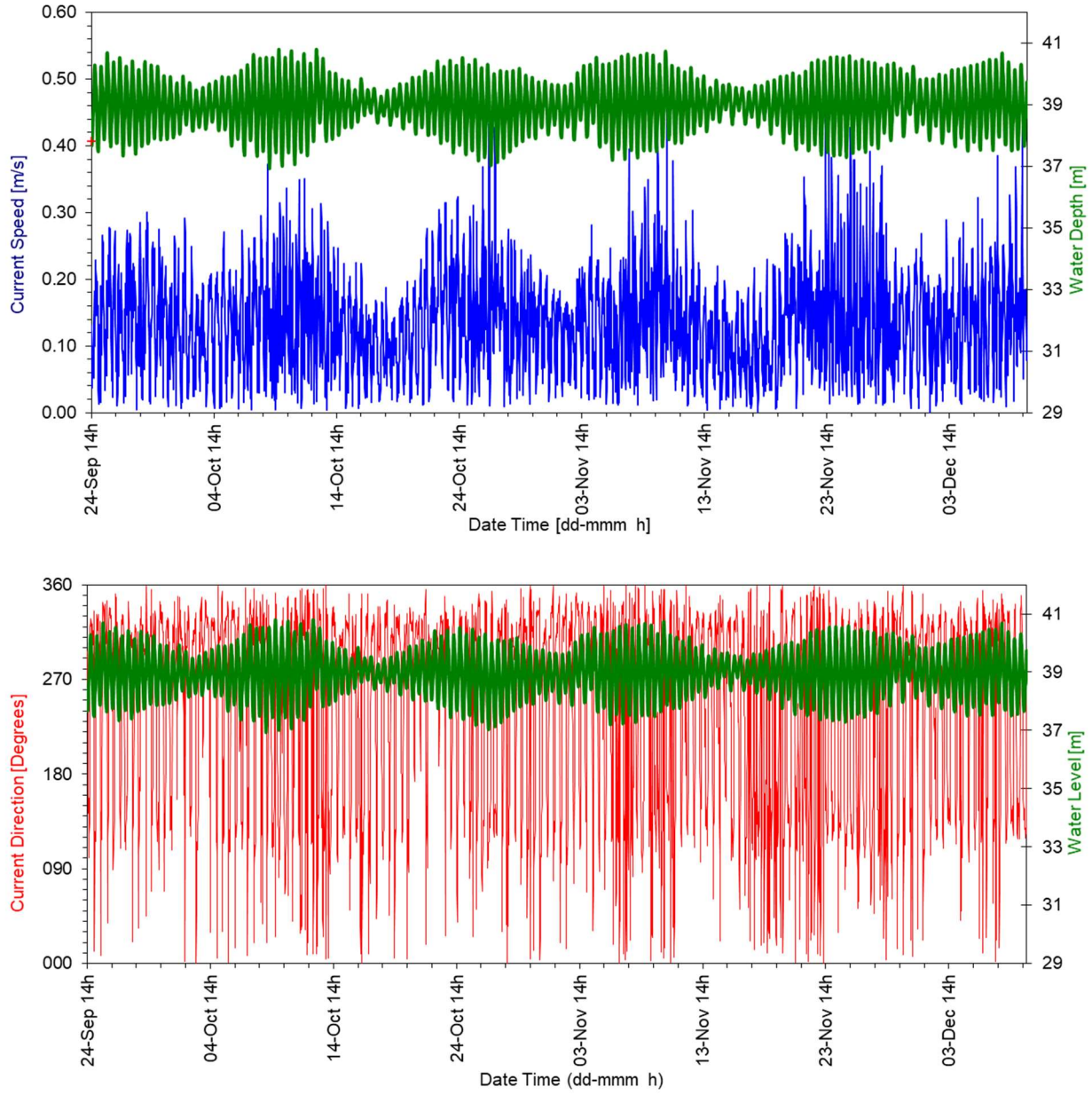

Figure 5.2 Near-bed time series plots for current speed and direction against water level.

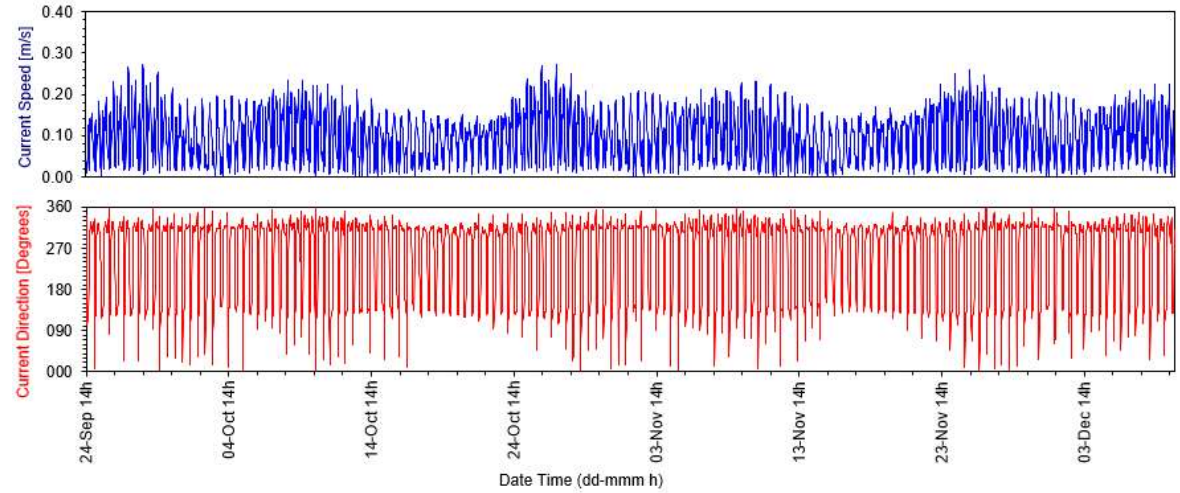

Figure 5.3 Near-bed time series plots for harmonic reproduction of speed and direction.

BNGHD_cbot_26.9m_bin25

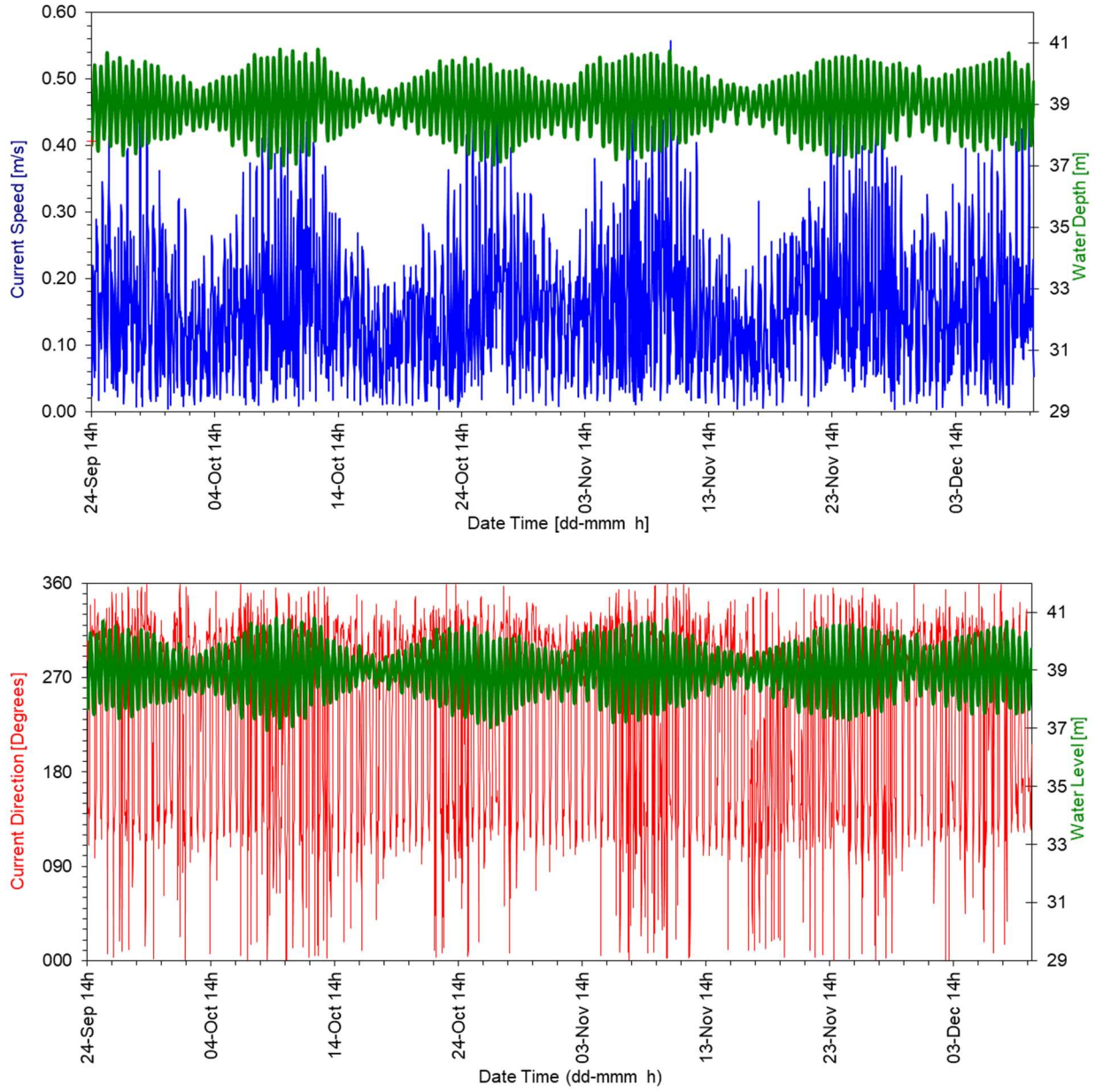

Figure 5.4 Pen-bottom time series plots for current speed and direction against water level.

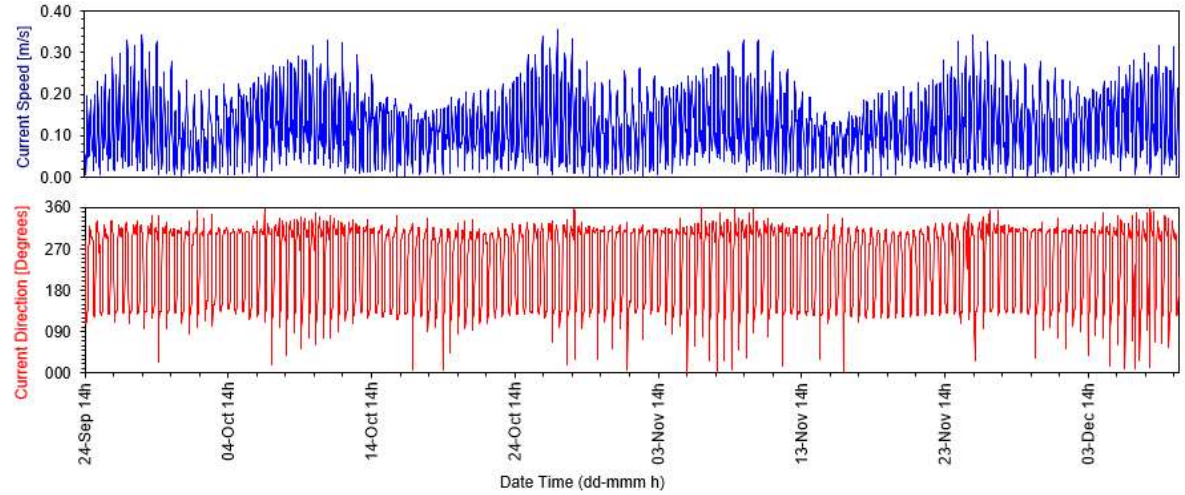

Figure 5.5 Pen-bottom time series plots for harmonic reproduction of speed and direction.

BNGHD_subs_31.9m_bin30

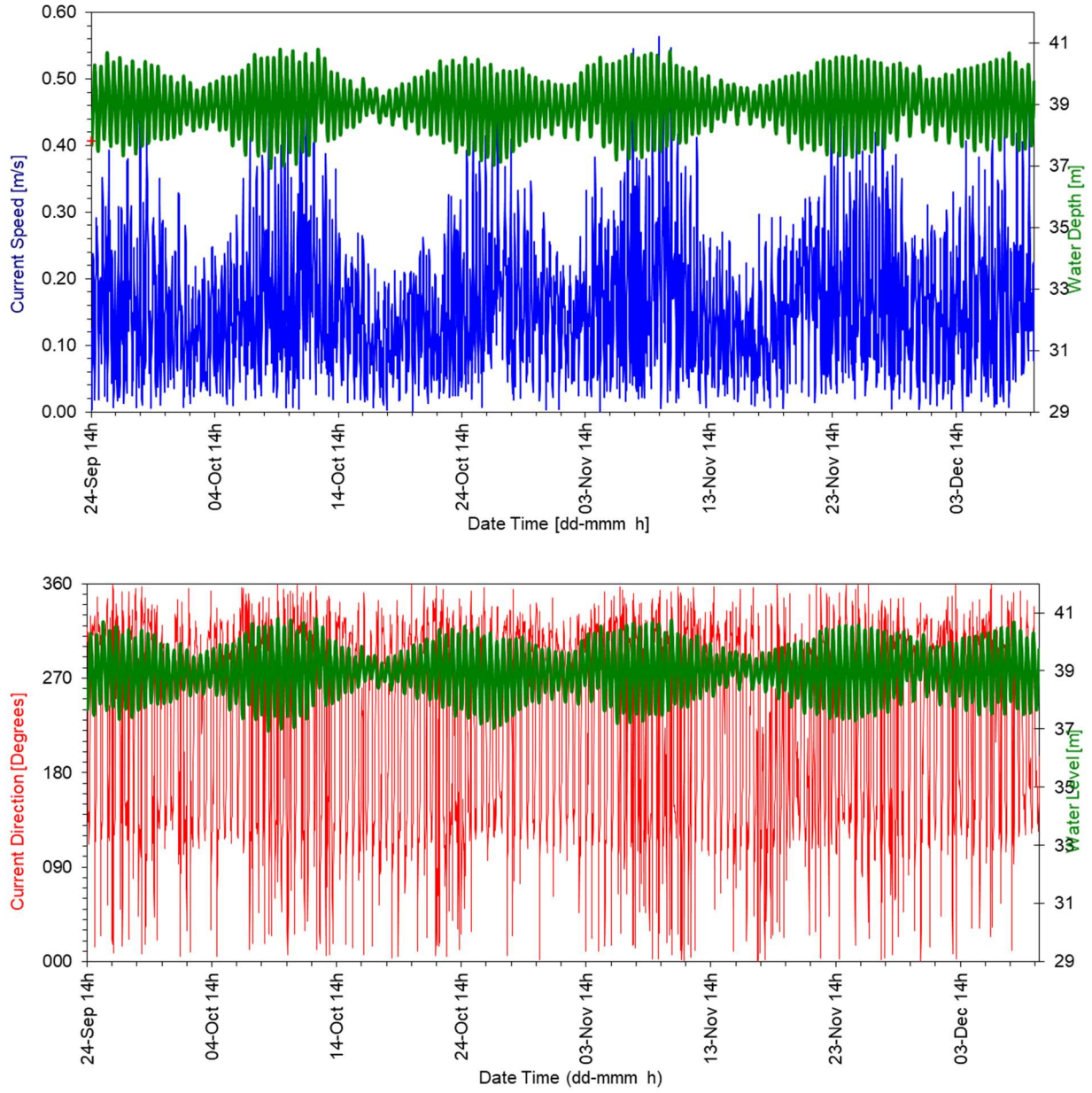

Figure 5.6 Sub-surface time series plots for current speed and direction against water level

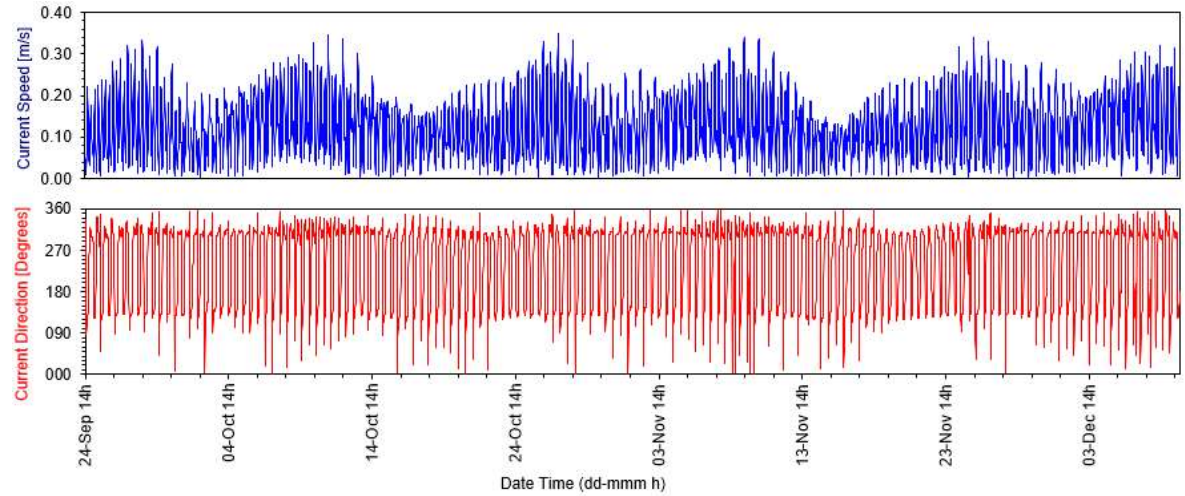

Figure 5.7 Sub-surface time series plots for harmonic reproduction of speed and direction.

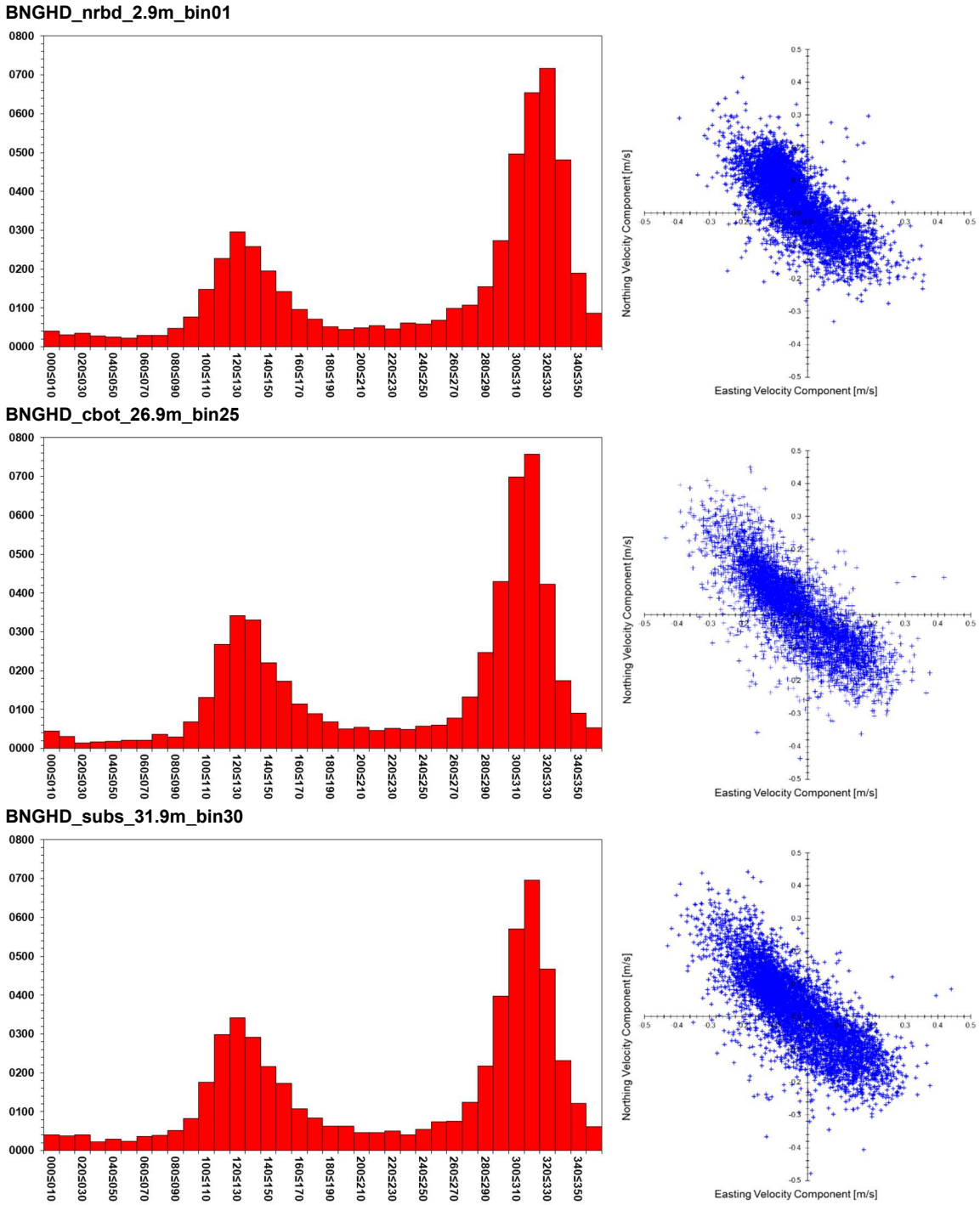

Figure 5.8 Current direction frequency plots and easting and northing velocity component scatter plots for the Near-bed, pen-bottom and near-surface bins

5.3 Description – BH04, 2021

5.3.1 Quality

A total of 1,486 valid ensembles were processed from the BH04 deployment. With a 20-minute interval between ensembles this equates to 20.6 days. Heading, pitch and roll sensor data show minor variation during the deployment (Appendix D). The recorded pressure was compared with the estimated tidal heights for Stromness which shows that, as with to BNGHD, range and timing are consistent with those predicted. The mean depth during the deployment including the height of the

frame, was 42.25m and the minimum depth was 40.24mCD. This corresponds well with the deployment depth of 39.94mCD.

The mean SD for all 1,486 ensembles for bins 1 to 34 is 0.0035 m s^{-1} and is therefore below the SEPA guideline threshold for horizontal precision by not exceeding 10% of the mean velocity recorded (0.150 m s^{-1}, bins 1-34).

5.3.2 Depth bin selection

Bins 1, 29 and 34 were selected to represent near-bed, pen-bottom and sub-surface conditions respectively, detailed in Table 5.4. The near-bed bin is at a depth within 3m above the seabed. The pen-bottom bin was selected from a depth corresponding to the bottom of the pens at the mean depth observed during the deployment period. The sub-surface bin was selected from a depth to be within 5m of the lowest observed tide during the deployment, while being below potential effects from wave breaking or side-lobe interference.

Table 5.4 Depth bin selection (BH04).

	Position of bin centre (metres)			
Bin number	From sensor head	From seabed	From the mean tidal level	From lowest observed tide
1	2.22	**2.72**	39.53	37.52
29	30.22	30.72	**11.53**	9.52
34	35.22	35.72	6.53	**4.52**

5.3.3 Analysis

The summary statistics for ensembles 2-1487 equivalent to the period from 02/11/2021 18:30 to 23/11/2021 09:30 (20.6 days) of each bin are given in Table 5.5.

Table 5.5 BH04 summary statistics.

	Near-bed	**Pen-bottom**	**Sub-surface**
Mean velocity (m s^{-1})	0.147	0.146	0.147
Min velocity (m s^{-1})	0.002	0.005	0.003
Max velocity (m s^{-1})	0.507	0.470	0.456
Ranked percentage 0.095 m s^{-1}	27.9%	30.6%	30.1%
Major axis (°G)	325	315	130
Amplitude anisotropy	2.15	2.50	2.43
Residual velocity (m s^{-1})	0.059	0.013	0.004
Residual direction (°G)	305.9	279.0	93.8
Parallel Residual (m s^{-1})	0.055	0.010	0.003
Normal Residual (m s^{-1})	-0.019	-0.007	-0.002
Parallel tidal amplitude (m s^{-1})	0.198	0.219	0.221
Normal tidal amplitude (m s^{-1})	0.092	0.088	0.091
	Min	**Max**	**Range**
Depth (m)	40.24	44.28	4.04

BH04_nrbd_2.72m_bin01

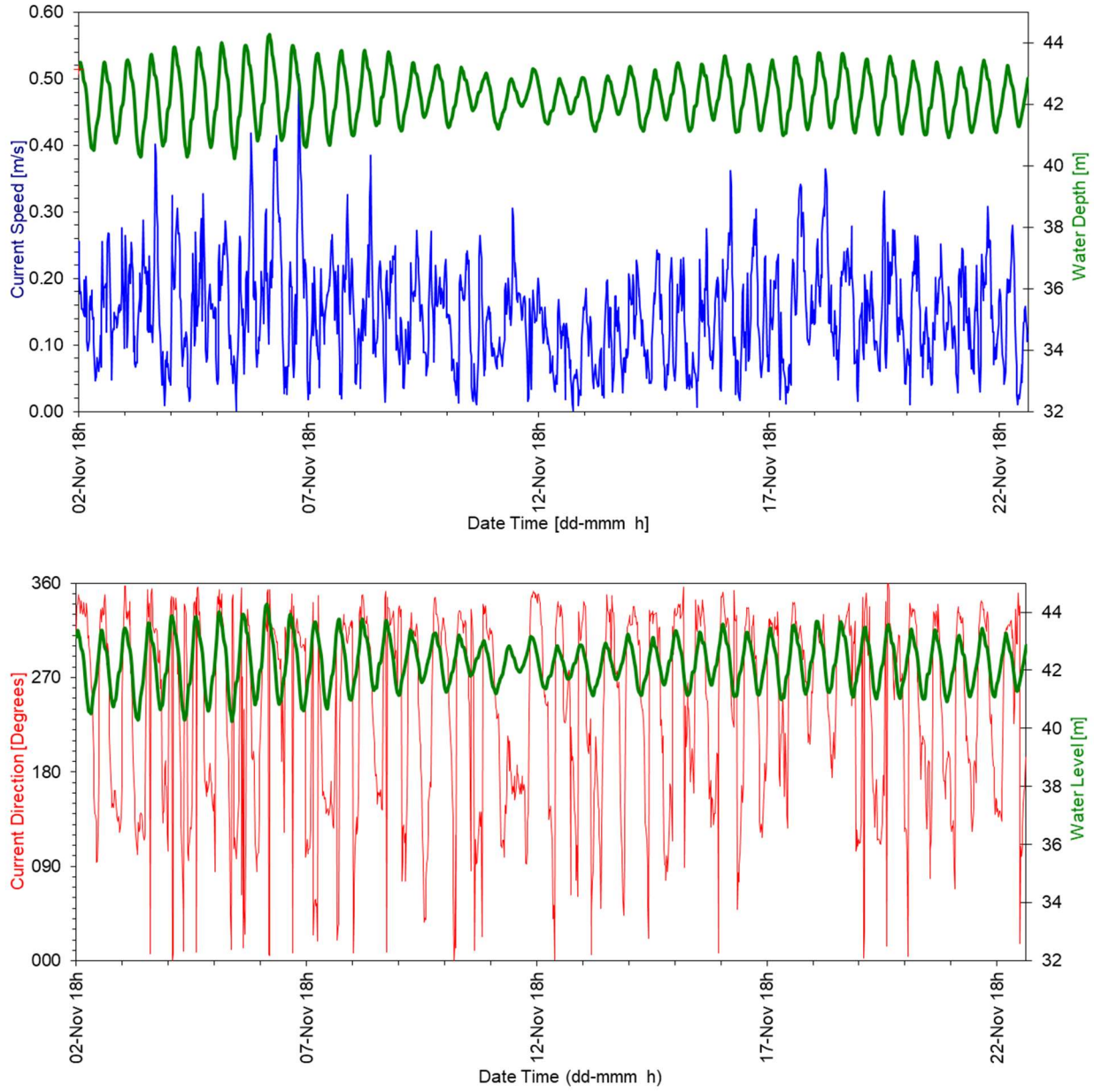

Figure 5.9 Near-bed time series plots for current speed and direction against water level.

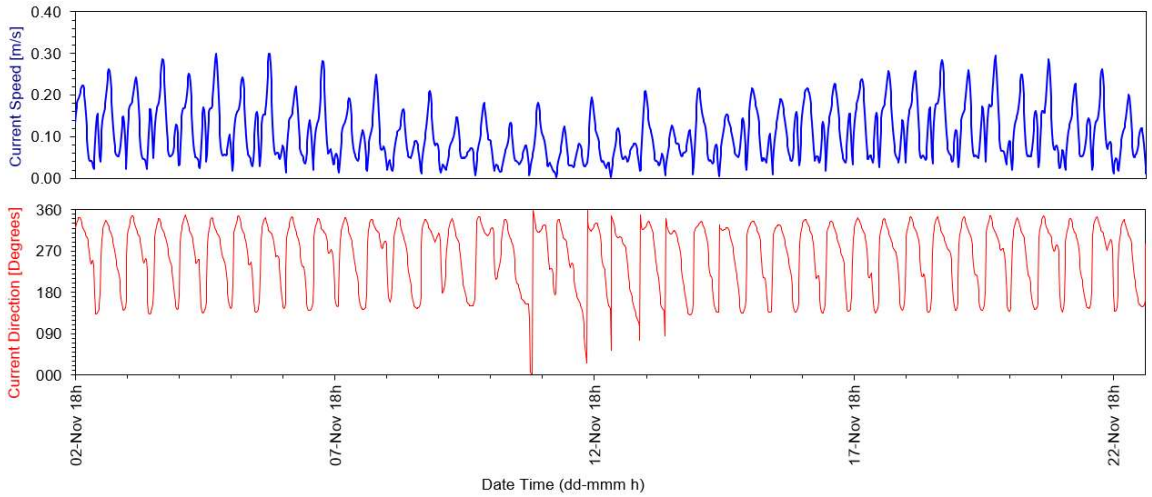

Figure 5.10 Near-bed time series plots for harmonic reproduction of speed and direction.

BH04_cbot_30.72m_bin29

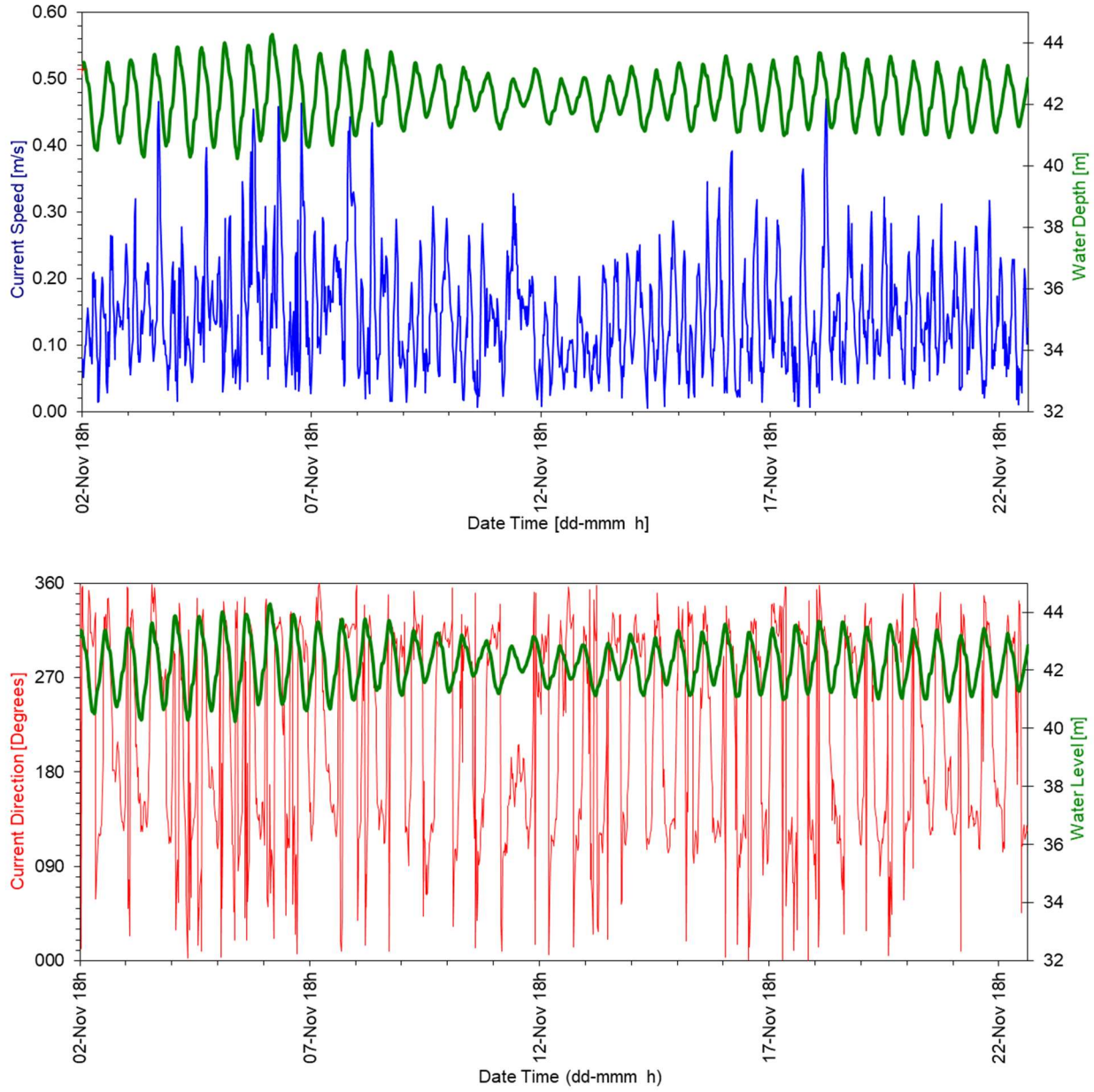

Figure 5.11 Pen-bottom time series plots for current speed and direction against water level.

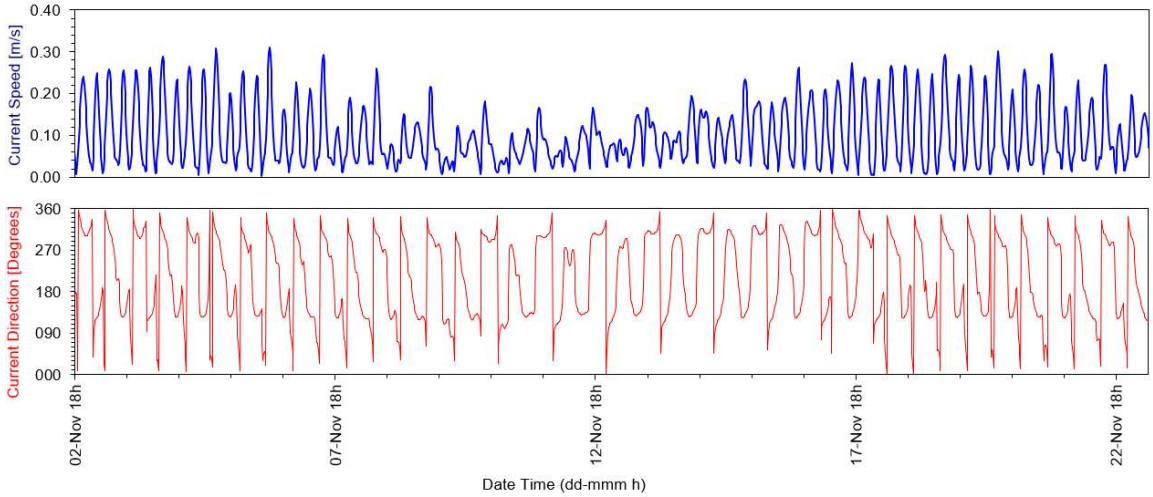

Figure 5.12 Pen-bottom time series plots for harmonic reproduction of speed and direction.

BH04_subs_35.72m_bin34

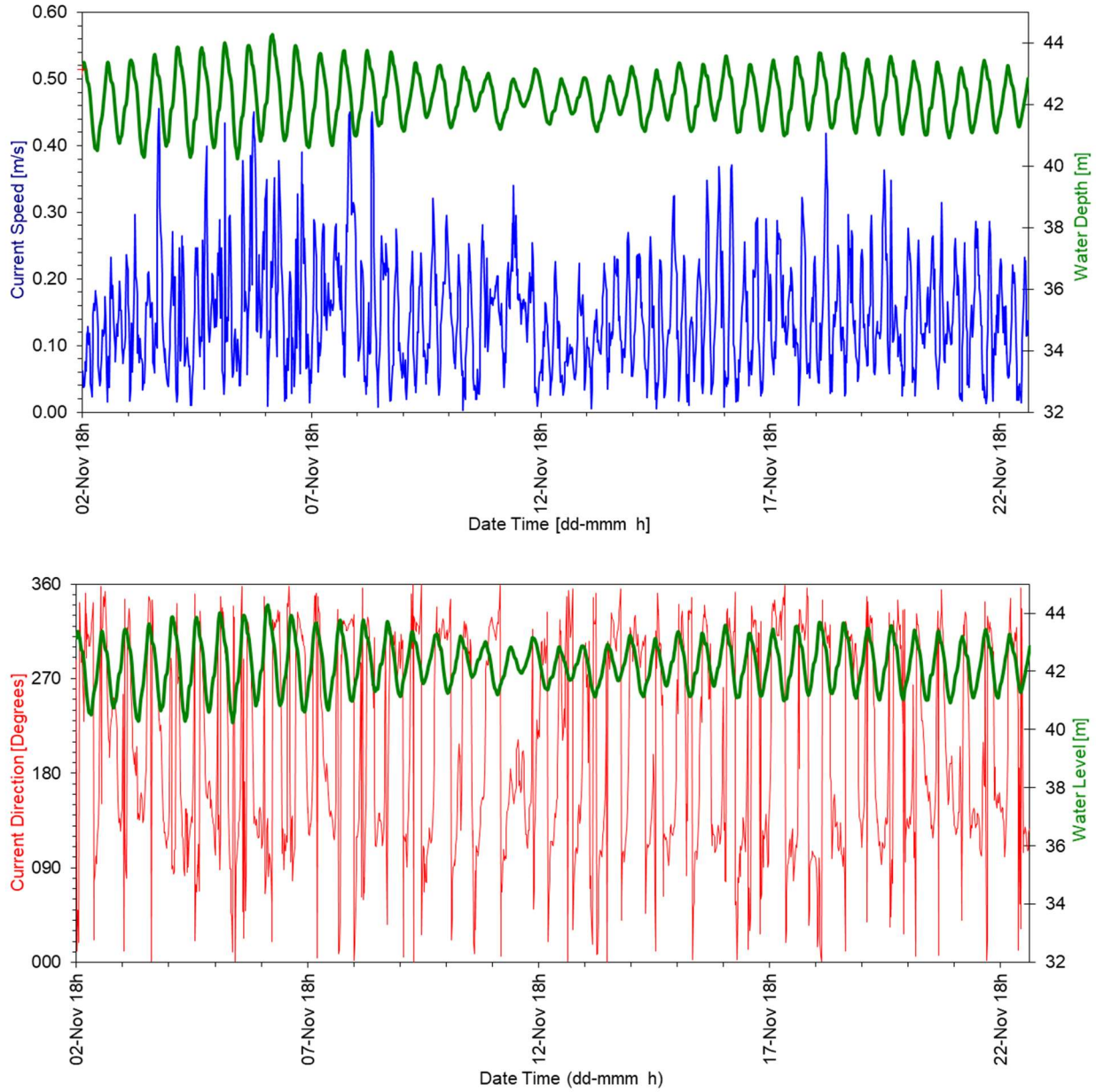

Figure 5.13 Sub-surface time series plots for current speed and direction against water level

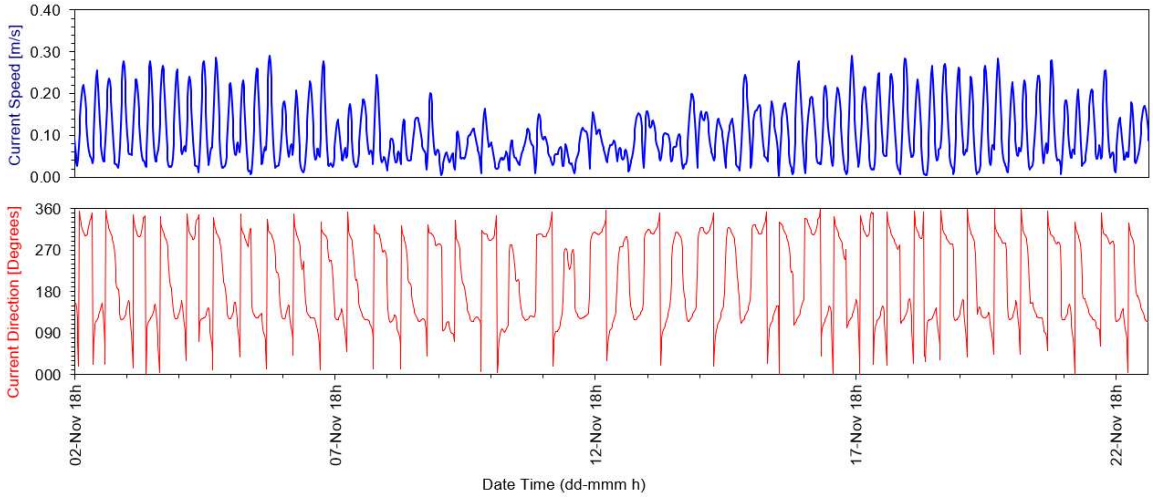

Figure 5.14 Sub-surface time series plots for harmonic reproduction of speed and direction.

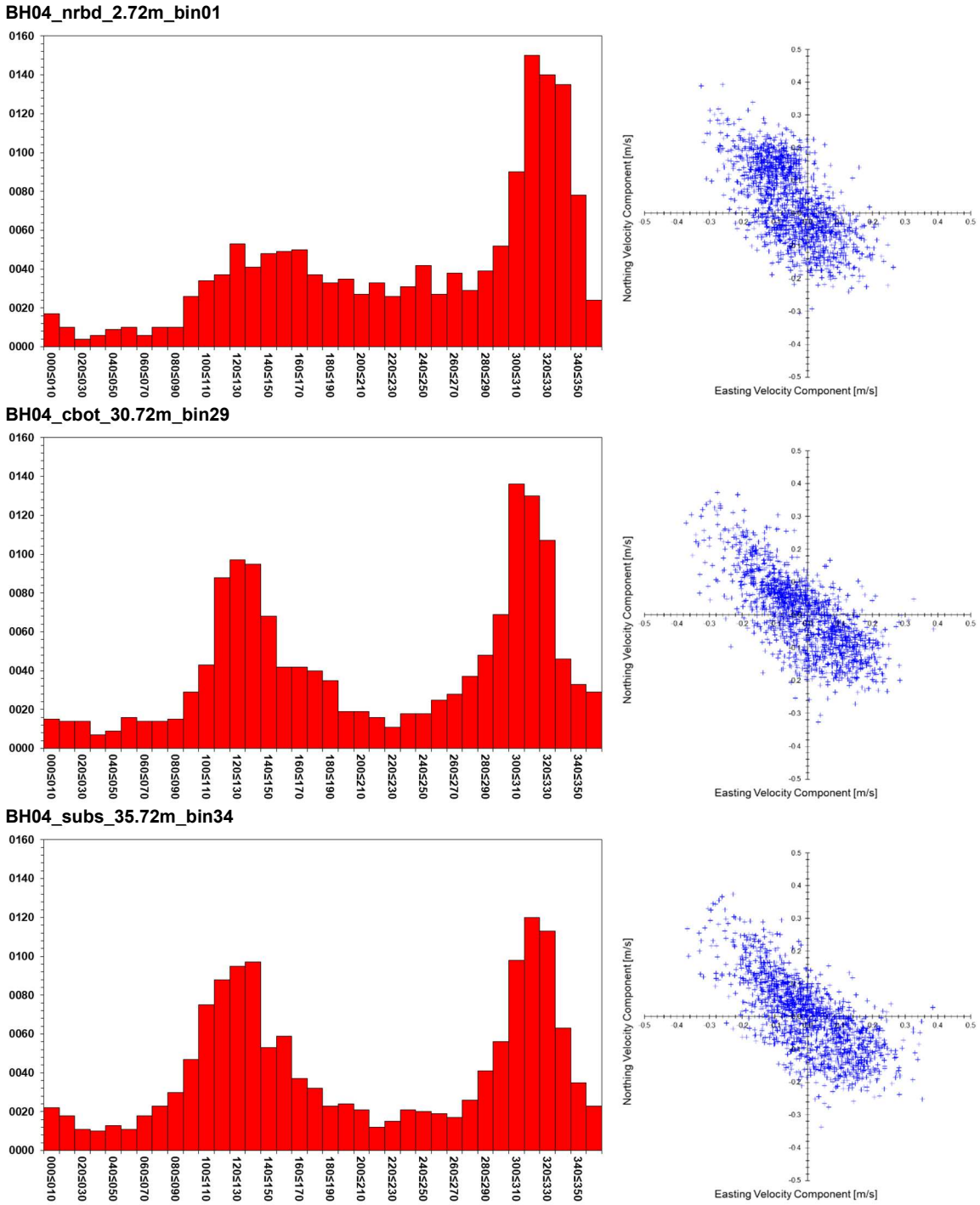

Figure 5.15 Current direction frequency plots and easting and northing velocity component scatter plots for the Near-bed, pen-bottom and near-surface bins

5.4 Description – Composite 90-day data

5.4.1 Analysis

The composite data comprise 16.4 days of BH04 followed by 73.6 days of BNGHD. Weighted averaging was used to calculate appropriate heights above seabed for the selected bins following stitching as per SEPA 2022. The summary statistics for the 90-day composite data for these bins are given in Table 5.6 below.

Table 5.6 Composite 90-day data summary statistics.

	Near-bed	Pen-bottom	Sub-surface
Weighted average bin height (m)	2.87	27.60	32.60
Mean velocity (m s^{-1})	0.136	0.153	0.154
Min velocity (m s^{-1})	0.001	0.004	0.001
Max velocity (m s^{-1})	0.507	0.557	0.563
Ranked percentage 0.095 m s^{-1}	30.7%	28.6%	28.0%
Major axis (°G)	315	315	310
Amplitude anisotropy	2.46	2.89	2.78
Residual velocity (m s^{-1})	0.053	0.040	0.031
Residual direction (°G)	316.2	301.3	309.1
Residual to mean velocity ratio	38.6%	26.0%	20.2%
Parallel Residual (m s^{-1})	0.053	0.038	0.031
Normal Residual (m s^{-1})	0.001	-0.009	0.000
Parallel tidal amplitude (m s^{-1})	0.189	0.229	0.233
Normal tidal amplitude (m s^{-1})	0.077	0.079	0.084

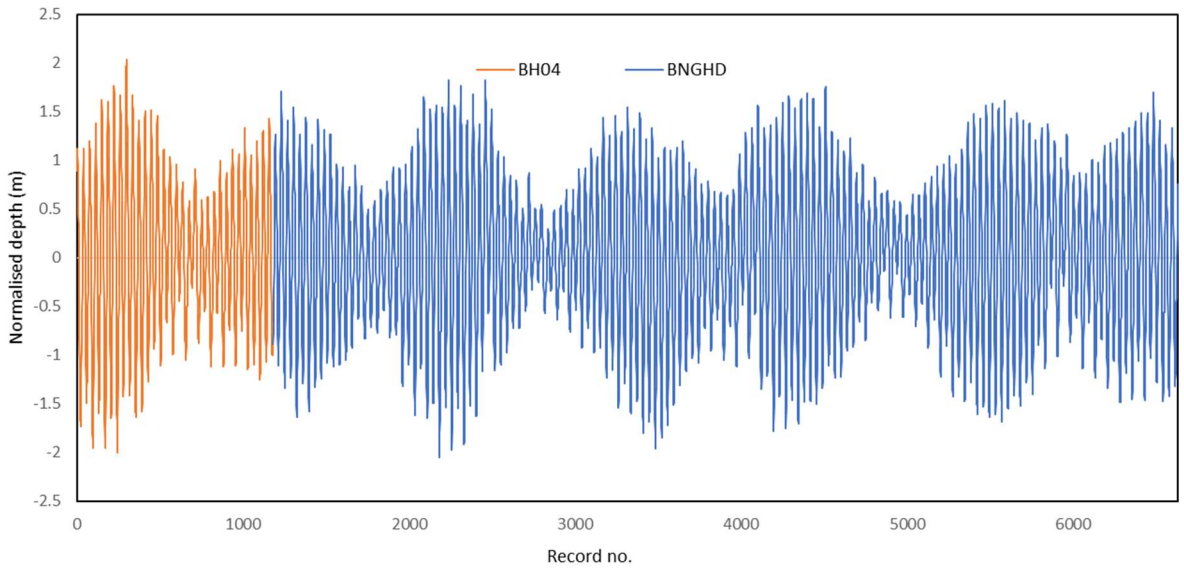

Figure 5.16 Time series of composite 90-day normalised water level indicating the stitch point between BH04 and BNGHD.

BH90d_nrbd_2.87m

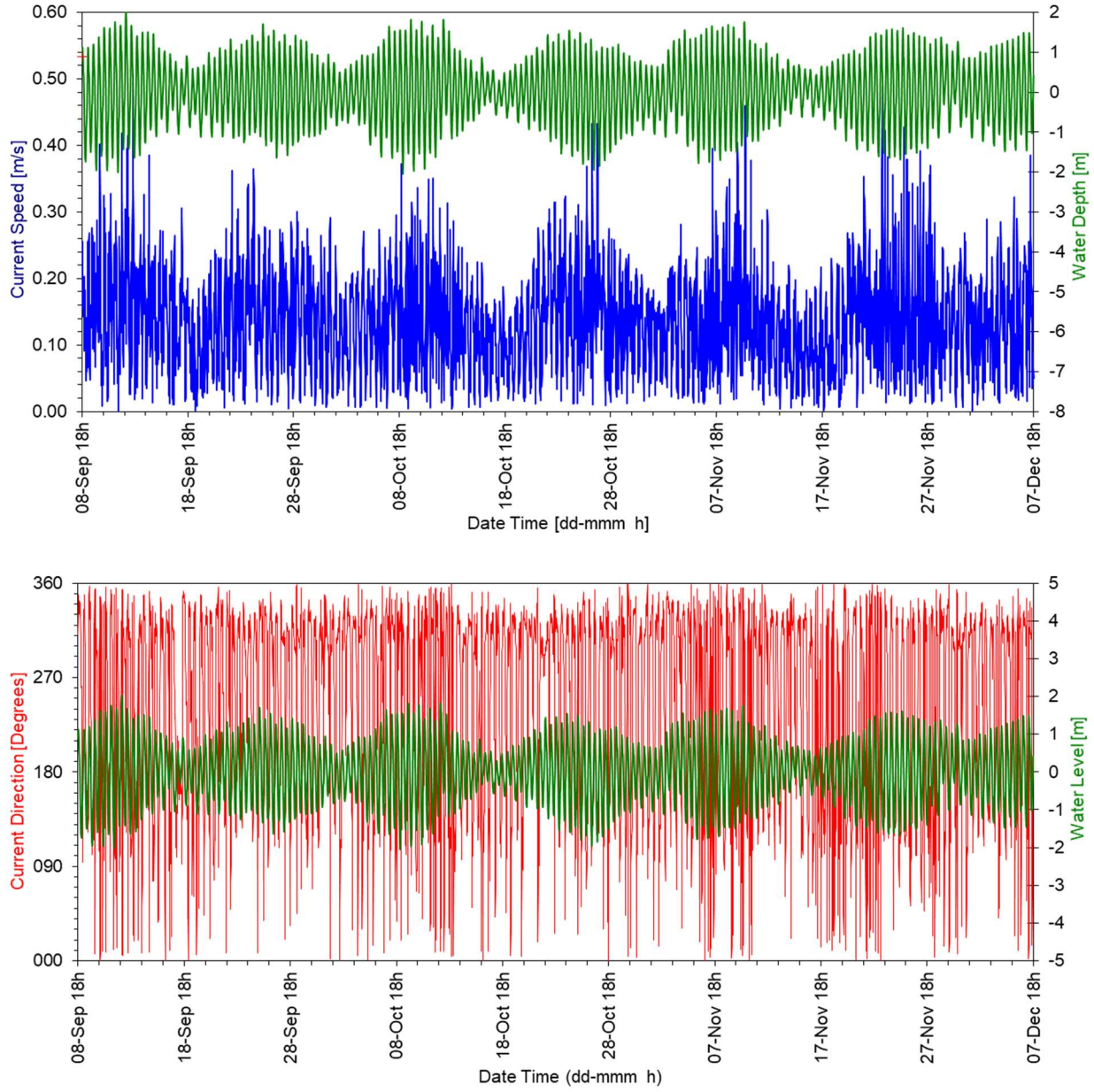

Figure 5.17 Near-bed time series of composite 90-day for current speed and direction against water level

BH90d_cbot_27.60m

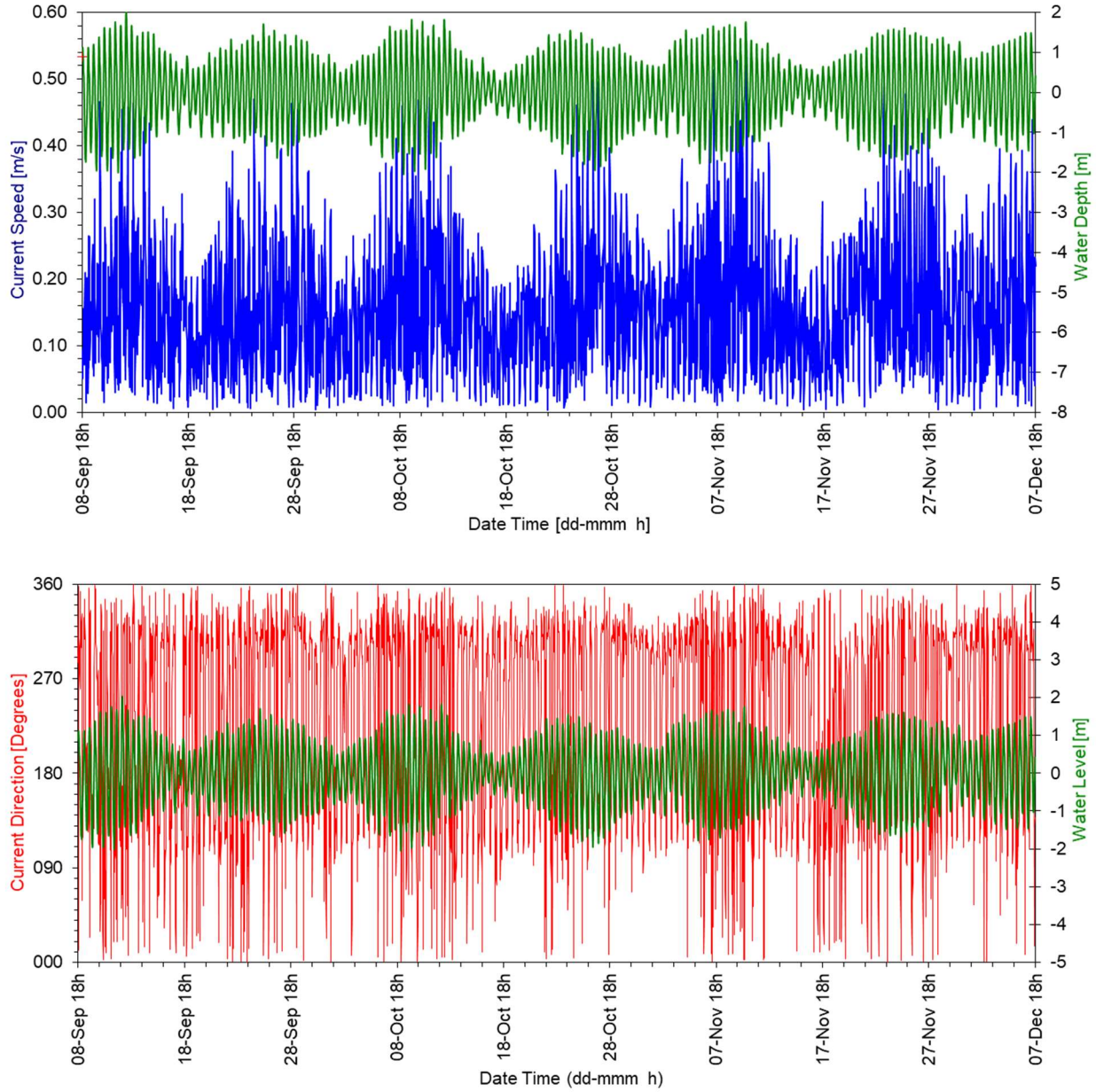

Figure 5.18 Pen-bottom time series of composite 90-day current speed and direction against water level

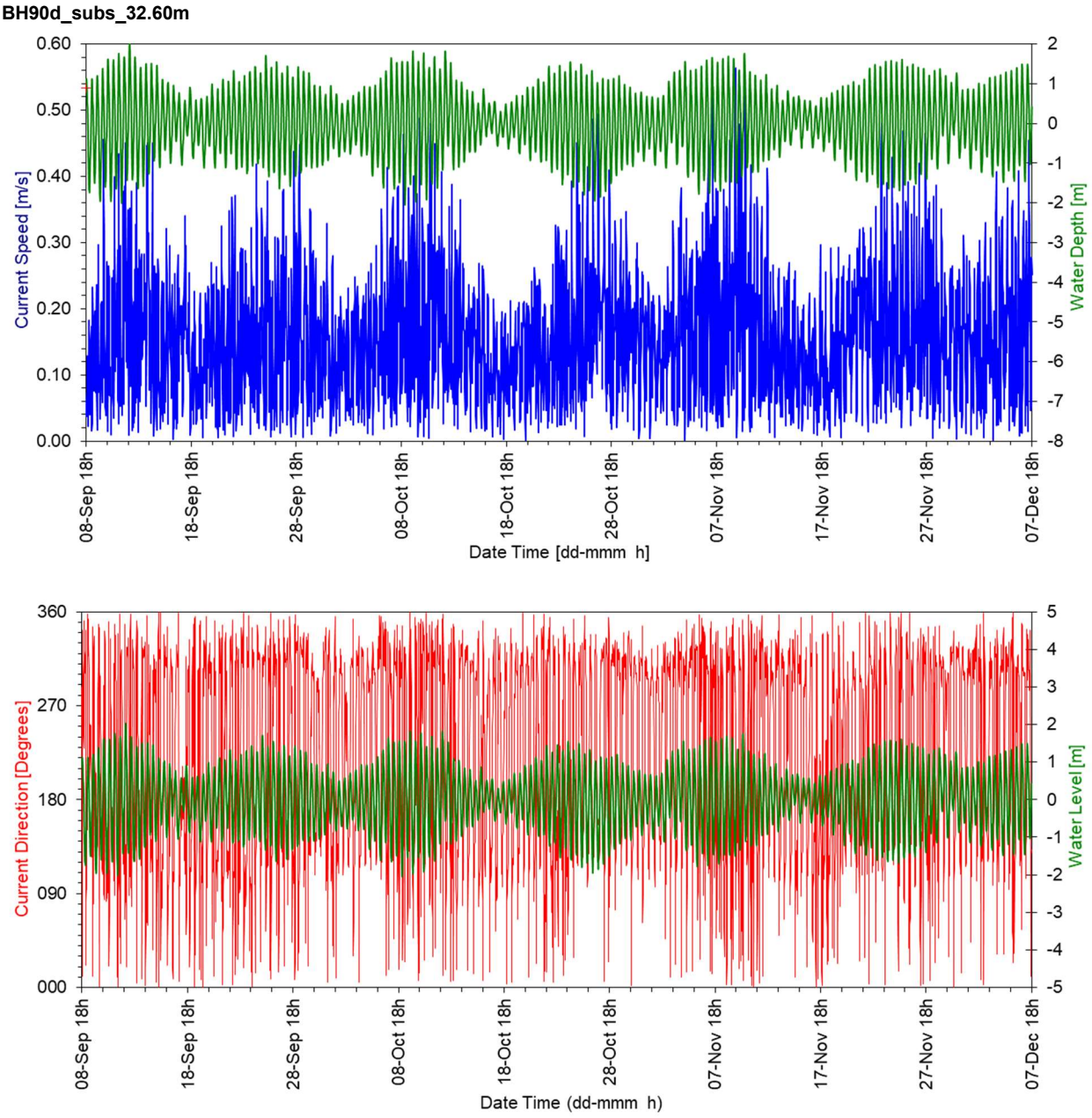

Figure 5.19 Sub-surface time series of composite 90-day current speed and direction against water level

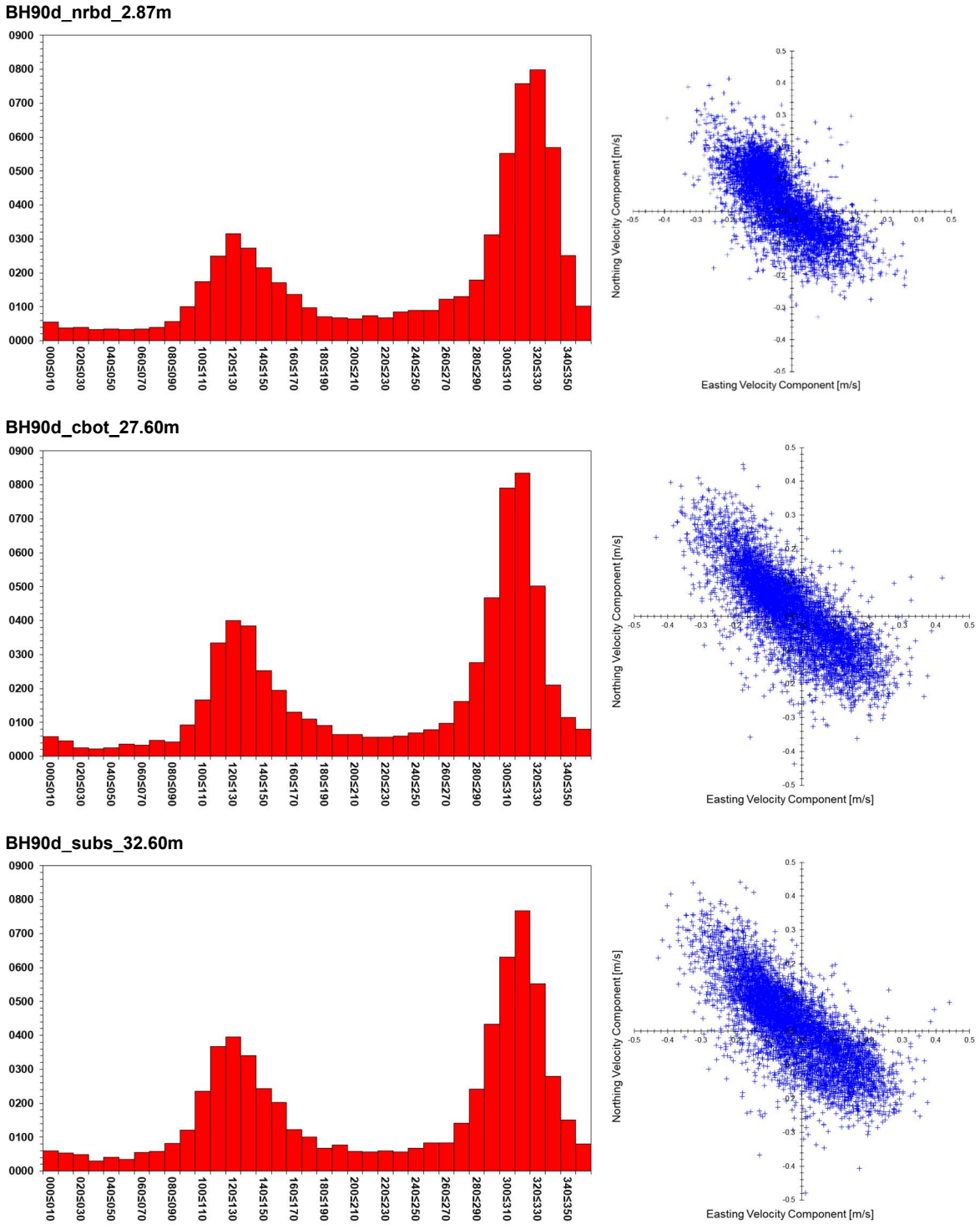

Figure 5.15 Current direction frequency plots and easting and northing velocity component scatter plots for the Near-bed, pen-bottom and near-surface bins

5.5 Summary

The data are indicative of a strongly flushed site with a dominant tidal signature. Currents are relatively homogenous, aligned along a NW-SE axis parallel to the Hoy shoreline. Peak speeds are observed during the NW ebb tide, and it is apparent that the transition to this direction from the SE flood occurs in the latter part of this tide while water levels are still rising, potentially indicating that a counter current forms in this part of the sound.

Data combination is successful with commonality observed between the two data sets, separated by approximately three years. The data are considered representative of conditions at the site and suitable for use in modelling. The magnitude of the near-seabed residual currents exceeds 35% of the mean velocity requiring that NewDEPOMOD is forced with flowmetry where the residual current has been removed.

6 Equipment set-up parameters and specifications

Table 6.1 ADCP configurations

Deployment name	BNGHD	BH04
Instrument	Teledyne RDI Workhorse Sentinel ADCP	Teledyne RDI Sentinel V50 ADCP
Serial number	19584	115
Frequency (kHz)	614	492
First viable ensemble (no.)	14	2
Last viable ensemble (no.)	5,508	1487
Bin size (m)	1.0	1.0
Blanking distance (m)	0.88	1.0
No. of bins	41	42
First bin range (m)	2.10	2.22
Ensemble interval (s)	1,200	1,200
Number of pings	400	450
Ping interval (s)	3	1
Ambiguity velocity (m s^{-1})	1.75	1.75
Bandwidth (%)	25	25
Theoretical standard deviation (m s^{-1})	0.0035	0.0035

		1200 kHz		600 kHz		300 kHz	
Water Profiling	Depth Cell Size[1]	Typical Range[2] 12 m		Typical Range[2] 50 m		Typical Range[2] 110 m	
	Vertical Resolution	Range[3]	Std. Dev.[4]	Range[3]	Std. Dev.[4]	Range[3]	Std. Dev.[4]
	0.25 m	11 m	14.0 cm/s				
	0.5 m	12 m	7.0 cm/s	38 m	14.0 cm/s	see note[1]	
	1 m	13 m	3.6 cm/s	42 m	7.0 cm/s	83 m	14.0 cm/s
	2 m	15 m[2]	1.8 cm/s	46 m	3.6 cm/s	93 m	7.0 cm/s
	4 m	see note[1]		51 m[2]	1.8 cm/s	103 m	3.6 cm/s
	8 m					116 m[2]	1.8 cm/s
Long Range Mode	2 m	19 m	3.4 cm/s				
	4 m			66 m	3.6 cm/s		
	8 m					154 m	3.7 cm/s
Profile Parameters	Velocity accuracy	0.3% of water velocity relative to ADCP ±0.3 cm/s		0.3% of water velocity relative to ADCP ±0.3 cm/s		0.5% of water velocity relative to ADCP ±0.5 cm/s	
	Velocity resolution	0.1 cm/s		0.1 cm/s		0.1 cm/s	
	Velocity range	±5 m/s default, ±20 m/s max		±5 m/s default, ±20 m/s max		±5 m/s default, ±20 m/s max	
	Number of depth cells	1–255		1–255		1–255	
	Ping rate	Typical 4 Hz, Max. 10 Hz		Typical 2 Hz, Max. 10 Hz		Typical 1 Hz, Max. 10 Hz	
Echo Intensity Profile	Vertical resolution	Depth cell size, user configurable					
	Dynamic range	80 dB					
	Precision	±1.5 dB					
Transducer and Hardware	Beam angle	20°					
	Configuration	4-beam, convex					
	Internal memory	Two PCMCIA card slots; one memory card included					
	Communications	RS-232 or RS-422; ASCII or binary output at 1200-115,200 baud					
Standard Sensors	Temperature (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°[5], Precision ±0.5°[5], Resolution 0.01°, Maximum tilt ±15°					

Figure 6.1 Teledyne RDI Workhorse Sentinel technical specifications

		V20 (1000 kHz)		V50 (500 kHz)		V100 (300 kHz)	
Depth Cell Size[1]	Depth Cell Size[1]	Range (m)[2,3] Wide/Narrow	Std Dev (cm/s)[3,4] Wide/Narrow	Range (m)[2,3] Wide/Narrow	Std Dev (cm/s)[3,4] Wide/Narrow	Range (m)[2,3] Wide/Narrow	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	11.1/20.8	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) Commss and Recording	Wireless/Ethernet[7], Internal memory			802.11 b/g/n / TCPIP; One 16 GB micro SD card included			
Real-Time (RT) Communications	Serial/Ethernet[7]			RS422 / TCPIP (setup) UDP (output)			
Profile Parameters	Center Frequency			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			
	Velocity resolution			0.1 cm/s			
	Velocity range			± 5m/s (default); ± 20m/s (maximum)			
	Ping rate			Up to 4 Hz (SC); Up to 16 Hz (RT)			
Echo Intensity Profile	Vertical resolution			Depth cell size			
	Dynamic range			80 dB			
	Precision			±1.5 dB			
Transducer and Hardware	Beam angle			25°			
	Configuration			4-beam, convex; 5th beam vertical			
	Depth rating			200 m			
	Materials			Transducer, housing, and end cap: plastic; Connector: metal shell			
Standard Sensors	Temperature (mounted on transducer)			Range -5° to 45°C, precision ± 0.4°C, resolution 0.1°			
	Compass (magneto-inductive sensor)			Accuracy 2° RMS, resolution 0.1°, max. dip angle 85°			
	Tilt (MEMS accelerometers)			Pitch range ± 90°, roll range ± 180°, accuracy 2° RMS, precision 0.05° RMS, resolution 0.1°			
	Pressure sensor (mounted on transducer)			Range 300m, accuracy 0.1% FS			
	Recorder			16GB Micro SD Card			

Figure 6.2 Teledyne RDI Sentinel V50 technical specifications

7 List of data files

BNGHD	
Raw current meter data	*BNGHD000.000*
Processed data, *Velocity* format	*BNGHD000.000.pdv*
Raw current meter data ASCII exports, compiled	*BNGHD000_ADCP_Extracts.xlsx*
Processed HG data and summary statistics.	*CurrentMeterData_BNGHD_Surface2018.xlsx* *CurrentMeterData_BNGHD_Middle2018.xlsx* *CurrentMeterData_BNGHD_Bottom2018.xlsx*
SEPA HG Data Analysis workbooks	*BNGHD_NS_HGdata_analysis_v7.xls* *BNGHD_CB_HGdata_analysis_v7.xls* *BNGHD_NB_HGdata_analysis_v7.xls*
BH04	
Averaged current meter data (from raw data *BH04 20211028T135411.pd0*)	*BH04.averaged.pdv*
Raw current meter data ASCII exports, compiled	*BH04_ADCP_Extracts.xlsx*
Processed HG data and summary statistics.	*CurrentMeterData_BH04_Surface2021.xlsx* *CurrentMeterData_BH04_Middle2021.xlsx* *CurrentMeterData_BH04_Bottom2021.xlsx*
SEPA HG Data Analysis workbooks	*BH04_NS_HGdata_analysis_v7.xls* *BH04_CB_HGdata_analysis_v7.xls* *BH04_NB_HGdata_analysis_v7.xls*
90-day composite data	
Detailed velocity and water level plots	*BH_Composite90d_ver2_Plots.xlsx*
Processed HG data and summary statistics.	*CurrentMeterData_BringHead_Surface90d_v2.xlsx* *CurrentMeterData_BringHead_Middle90d_v2.xlsx* *CurrentMeterData_BringHead_Bottom90d_v2.xlsx*
SEPA HG Data Analysis workbooks	*BH90d_ver2_NS_HGdata_analysis_v7.xls* *BH90d_ver2_CB_HGdata_analysis_v7.xls* *BH90d_ver2_NB_HGdata_analysis_v7.xls*

8 References

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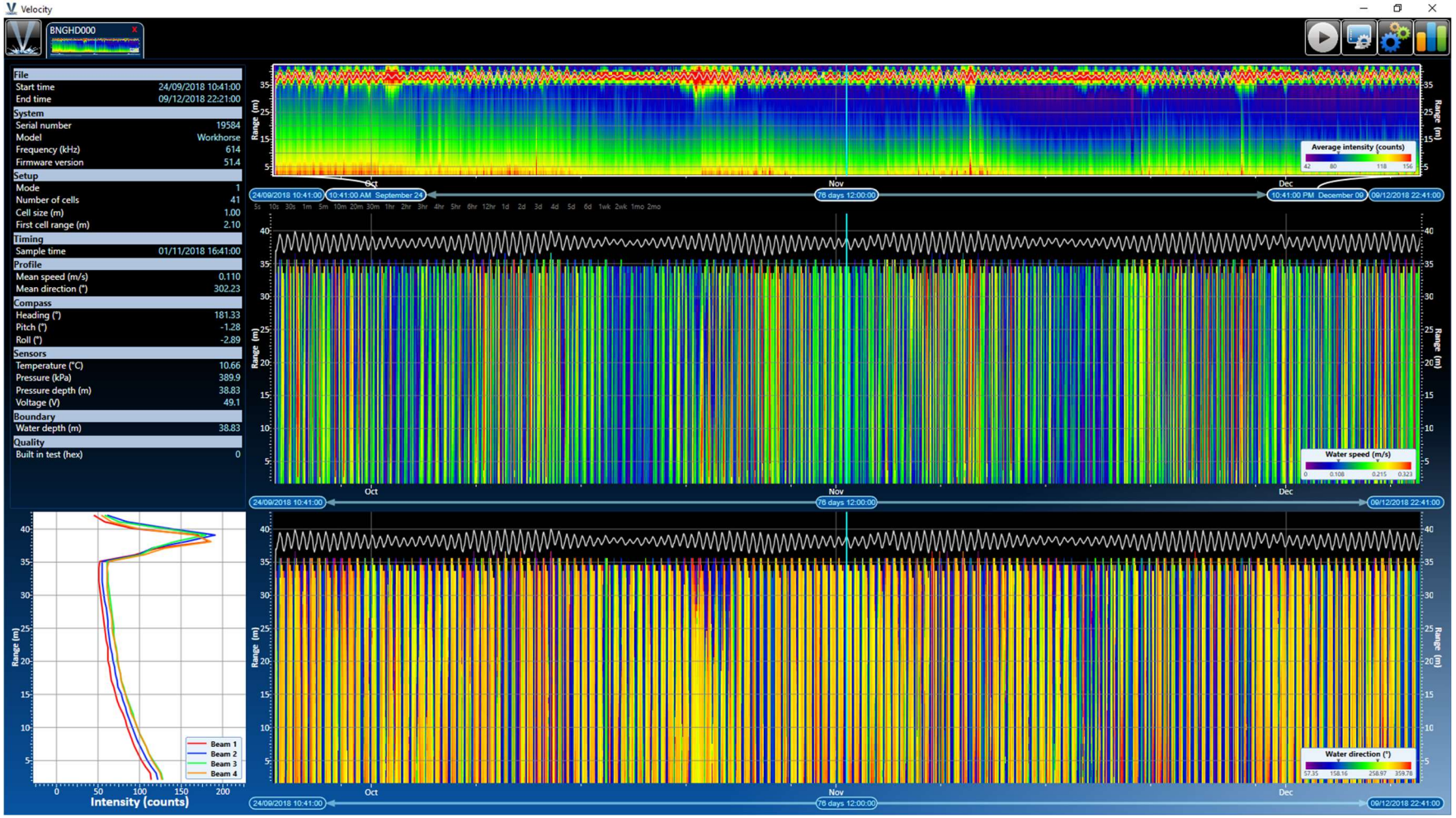
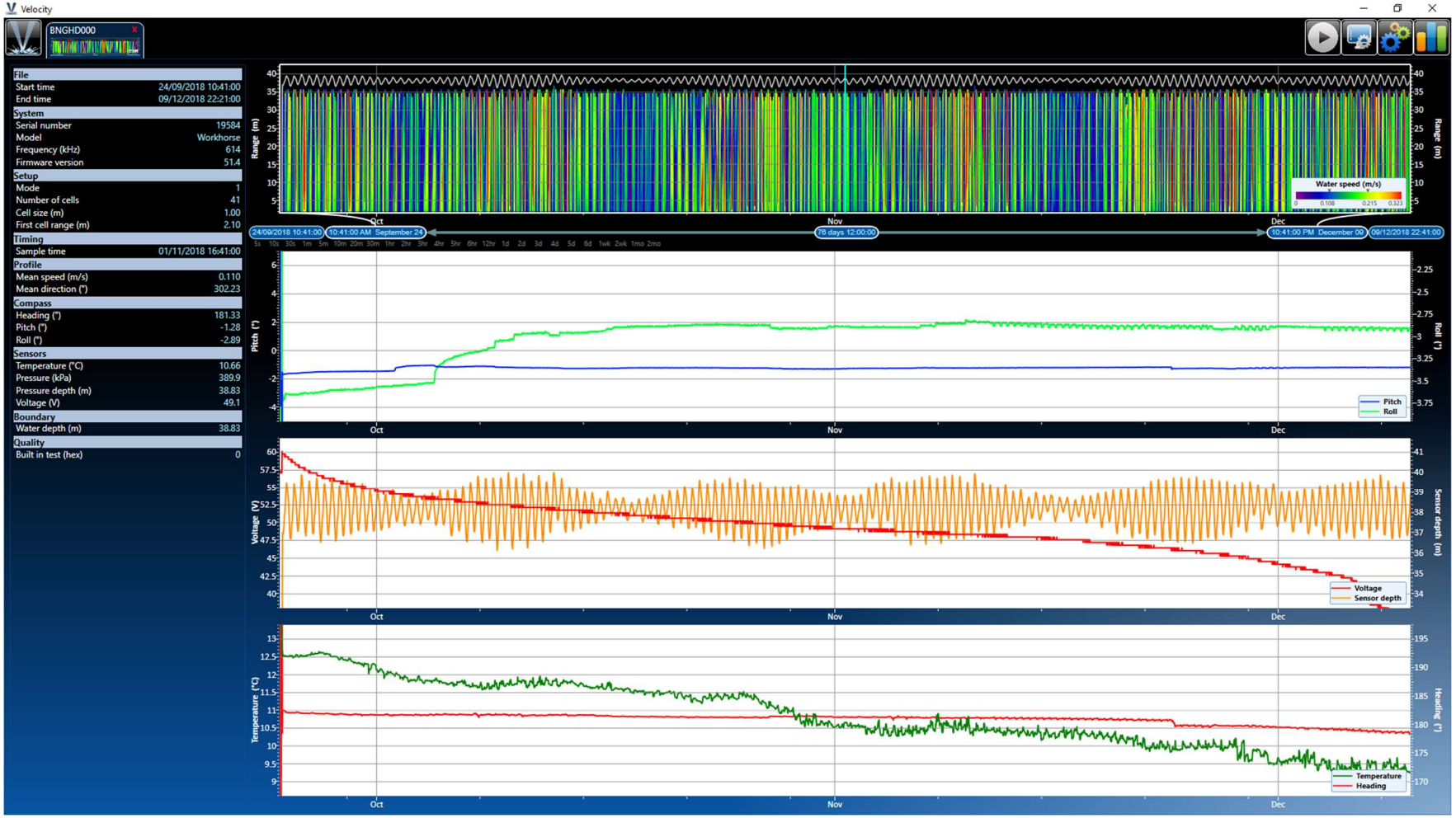
9 Appendices

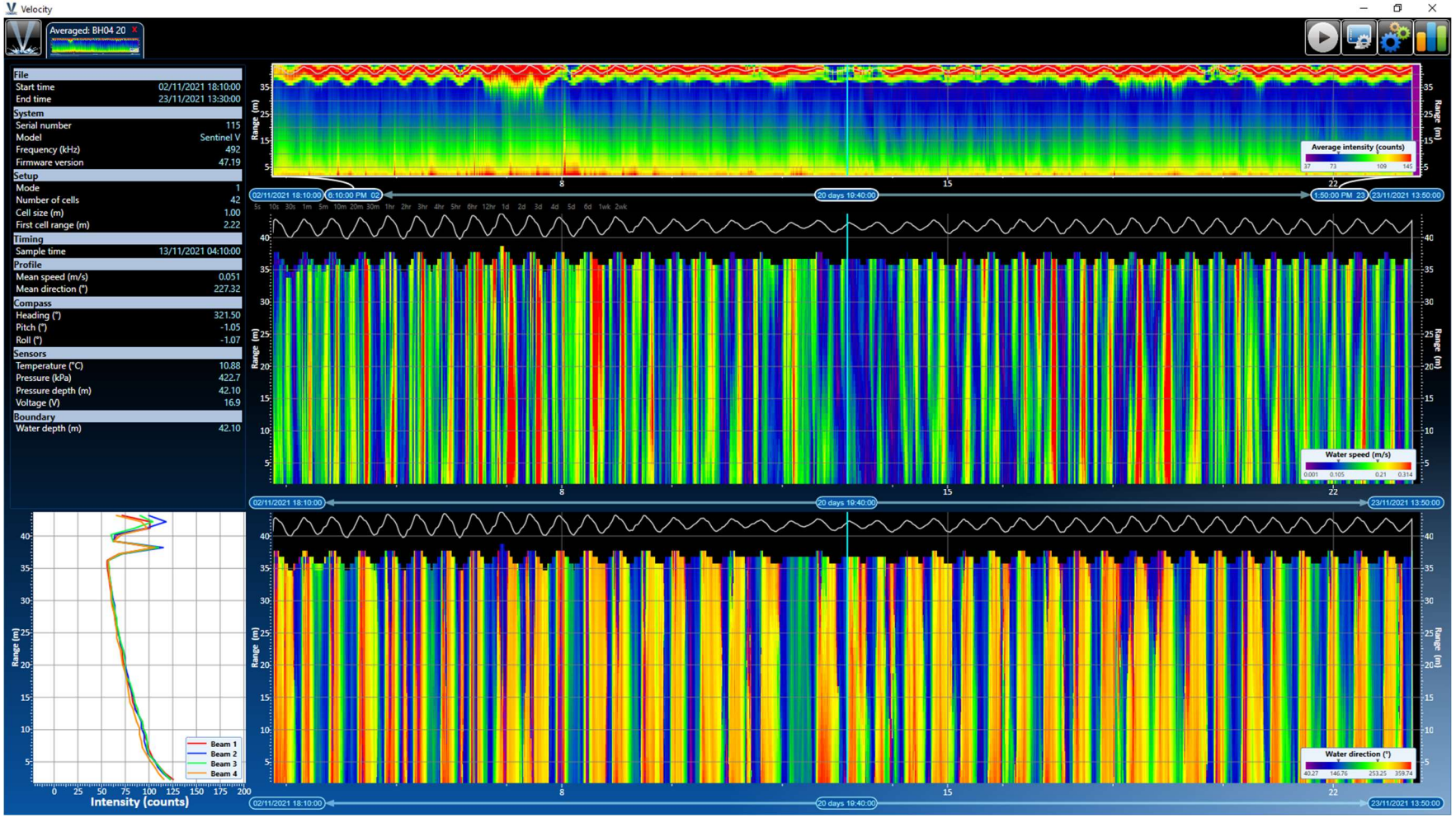
Appendix A Screenshot of *BNGHD000.000.pdv* from Teledyne's *Velocity* data processing software.



Appendix B Plots of BNGHD heading, pitch, roll, sensor depth, temperature and current velocity captured from *Velocity* data processing software.



Appendix C Screenshot of *BH04 20211028T135411.averaged.pdv* from Teledyne's *Velocity* data processing software.



Appendix D Plots of BH04 heading, pitch, roll, sensor depth, temperature and current velocity captured from *Velocity* data processing software.