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Alternative measures for beach nourishment maintenance

Monitoring of a pilot experiment at Mariakerke
Measuring campaign November – December 2013

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Alternative measures for beach nourishment maintenance

Monitoring of a pilot experiment at Mariakerke,
Measuring campaign November – December 2013

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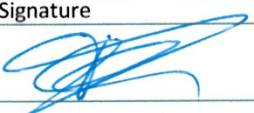
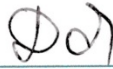
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Abstract

This report presents the field campaign of water and sediment measurements carried out in the nearshore area of Mariakerke in November and December 2013. Section 1 gives an overview of the context and goals of the campaign. Section 2 describes the deployment of the multi-array sensor frames and measuring conditions during the field campaign. Results of the measurements for each frame are reported in Section 3.

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1 Introduction

1.1 Description of the project

In the agenda of the implementation of the Integrated Masterplan for Coastal Safety of the Flemish Government, a pilot experiment to evaluate the suitability of underwater nourishments as a measure to reduce beach nourishment maintenance costs is ongoing. The experiment is undertaken in Mariakerke where a monitoring program is currently ongoing in the framework of the ARGONAUTS project (*ARGus and in-situ mONitoring of beAch and shoreface NoUrishment for Sustainable coastal safety*). Specifically, the project consists of the monitoring of both hydrodynamics and morphological evolution of the beach and shoreface at a location which is nourished on the beach only and a site where both the beach and shoreface has been nourished. The goal of the project is to compare the evolution of the beach only nourishment with the evolution of the combined beach and shoreface nourishment and identify the effect of the underwater nourishment on both short and mid-term coastal safety levels.

1.2 Objectives

One of the main objectives of this project is to assess the evolution and impact of pilot nourishments in terms of hydrodynamics, sediment dynamics and morphology through a monitoring program.

Thus, a series of field campaigns are planned to assess the hydrodynamics and sediment dynamics on the coastal zone subject of the artificial sand nourishment. The first campaign took place in August - September 2013 (Dan et al., 2014). From November to December 2013, a six-weeks in-situ measuring campaign was carried out. During this campaign, different hydrodynamic parameters were measured, resulting in a number of high resolution and high quality datasets with information about waves, currents and sediment dynamics.

1.3 Team

The field campaign design and execution was made by the following team: Sebastian Dan, Rosalia Delgado, Hans Vereecken, Erwin De Backer, Anne-Lise Montreuil, all from Flanders Hydraulics Research Antwerp.

An important support was provided by the Zeetijger ship's crew led by captain Karl T'Jaecx who deployed and retrieved the instruments and the navigational buoys. The metallic frames carrying the instruments were checked and connected to the buoys by the divers from the company DECO.

1.4 Convention

All the coordinates used in the bellow described field campaigns are geographical, WGS84. The hour was set as local time (CET).

The report is composed of three sections. An introduction and a description of the goals of the campaign are presented in Section 1. Section 2 describes the deployment and measuring conditions of all the measured parameters. Section 3 is devoted to present all the measurement results which are displayed in the Appendices.

2 Deployment and measuring conditions

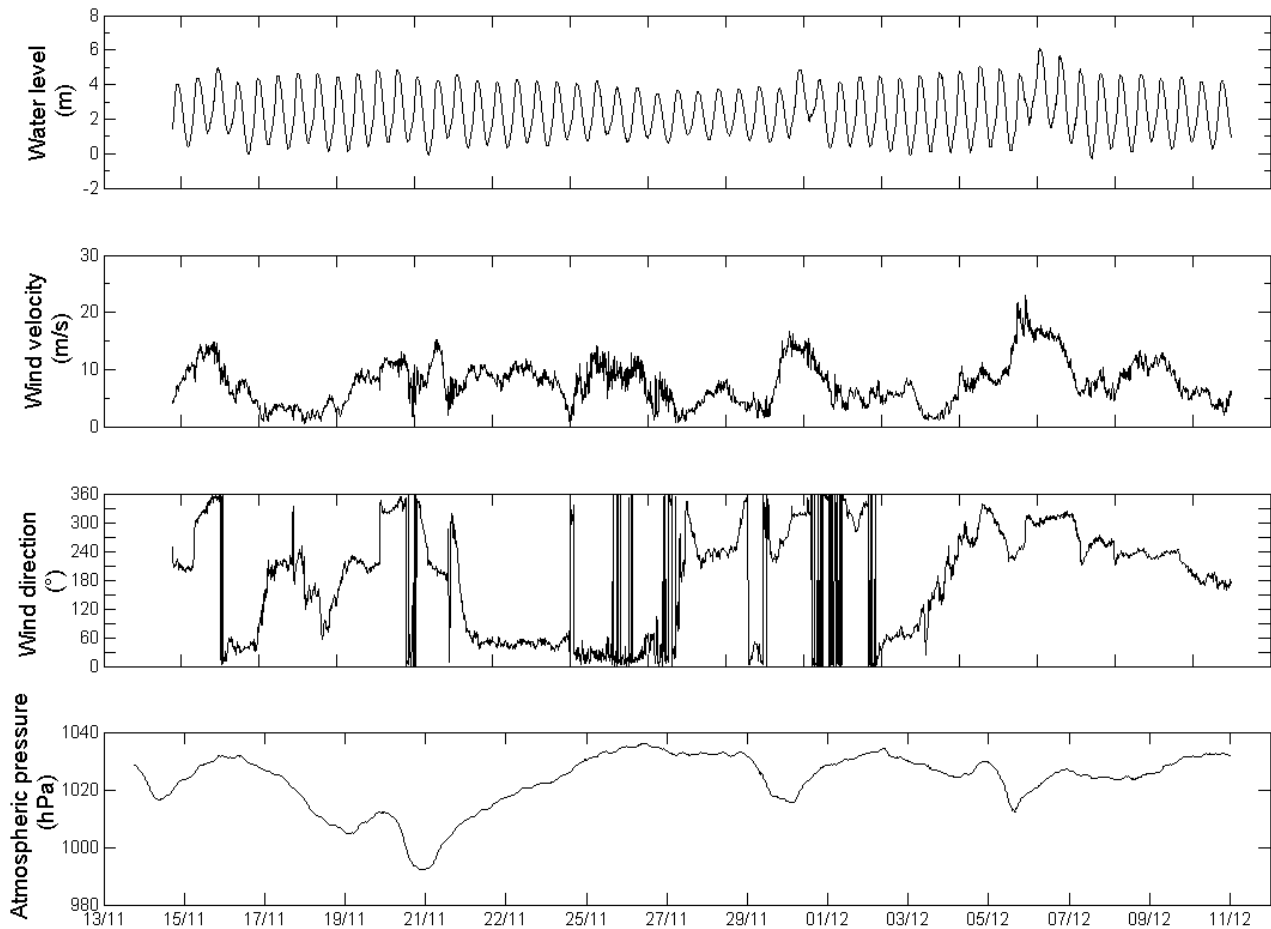
2.1 Description of the meteo-marine conditions during the campaigns

Meteo- and marine conditions were recorded from stations nearby the study area (Figure 1). The water level ranged from -0.3m to +6.07m TAW over the field campaign from 13th November- 11th December 2013 (Figure 2). The average of wind speed was 7.7m/s, but a maximum value of 23m/s was recorded on 5th December. There was a high variability of wind direction but southwest winds (200°-220°) prevailed. The atmospheric pressure was also variable with a clear drop of 993hPa on 21st November 2013. A storm surge occurred on 5th-6th December 2014 when the water level exceeded 6.19m high in Ostende harbour.

Figure 1 – Location of the meteo-marine weather stations. Profile 104 is the referenced transect for the study.



Figure 2 – Time series of water levels, wind (velocity and direction) and atmospheric pressure nearby the study area.



Source: weather station from the study site available from Meetnet website.

2.2 Description of the deployment campaign

During the campaign, two metallic frames-Hercules and Hylas III were deployed at the depths of -6.5m and -3.5m TAW respectively (Figure 3 and Table 1). The frames were designed at Flanders Hydraulics Research, each of them is weighting approximately one ton. They are able to carry wide range of instruments measuring hydrodynamics and sediment circulation (Dan et. al, 2014). Figures 4 and 5 show the frames after the retrieval.

Figure 3 – Bathymetric map in 2013 and location of the instruments during the field campaign.

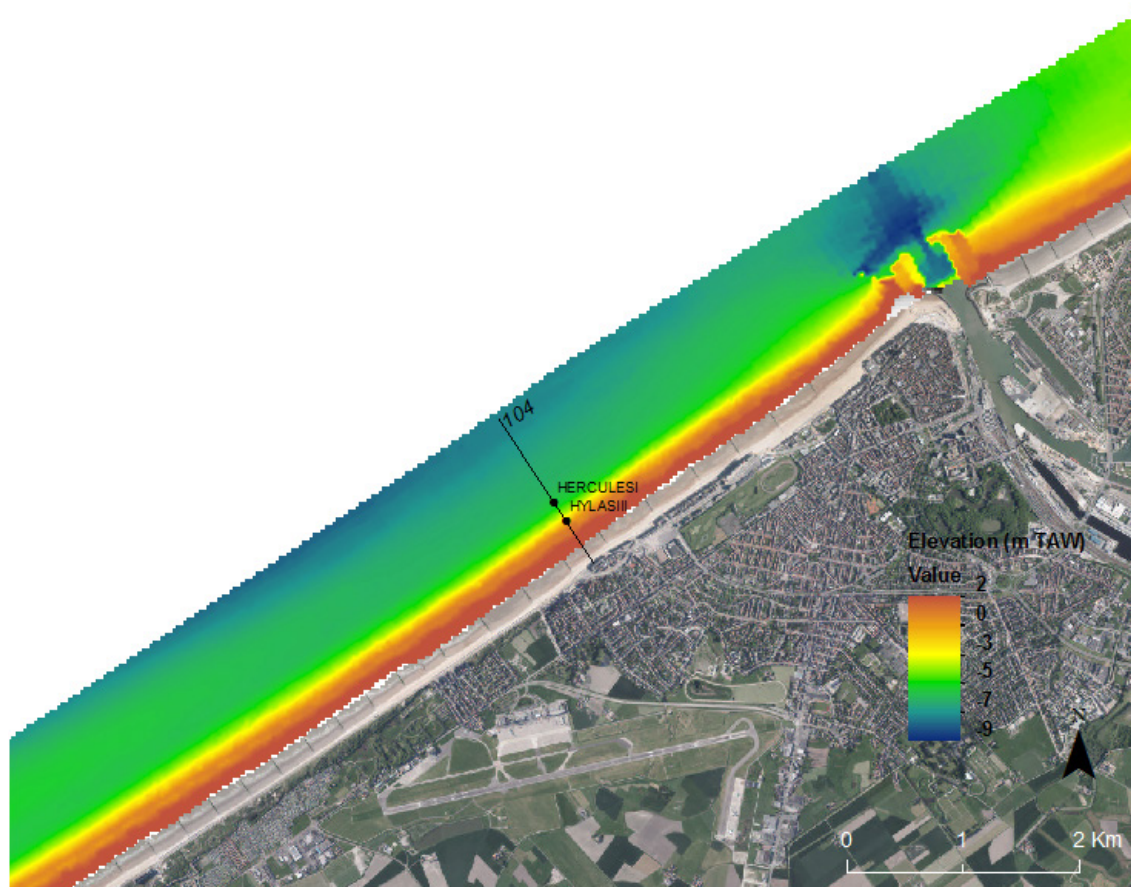


Table 1 – Description of the location and deployment of the instrument frames.

Instrument/Position		Geographical coordinates (WGS84)		Date (local hour)	Depth (m TAW)
		Longitude	Latitude		
Hercules/M1	Deployment	2°52'22.8"E	51°13'15"N	13/11/2013 18:20	-6.5 m
	Retrieval	2°52'21.1"E	51°13'14.4"N	11/12/2013 13:20	
Hylas III /M3	Deployment	2°52'28.2"E	51°13'10.2"N	13/11/2013 18:20	-3.5 m
	Retrieval	2°52'32"E	51°13'09.9"N	11/12/2013 12:50	

The frames were deployed on 13 November, and the measurements started at 18:20 and finished on the 11th December 00:00, so the total duration of the campaign was of 27.3 days. The deployment took place without any incident.

Figure 4 – Hercules frame after the retrieval.

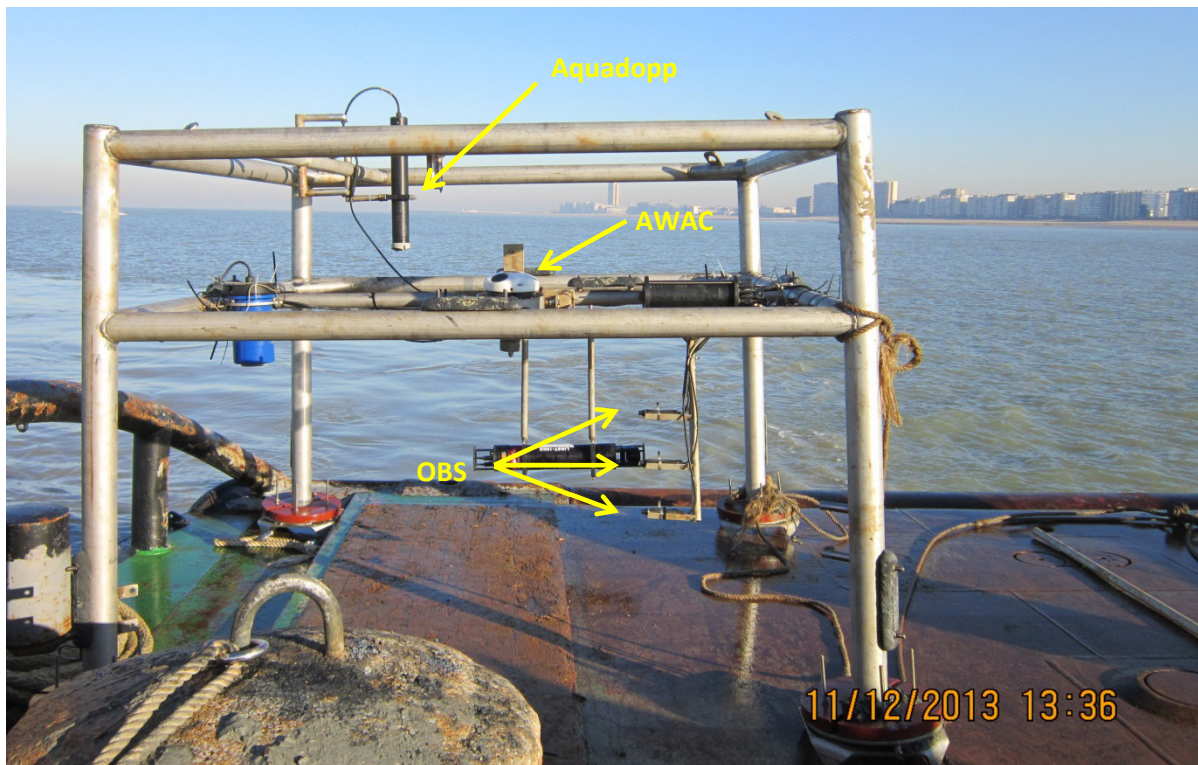
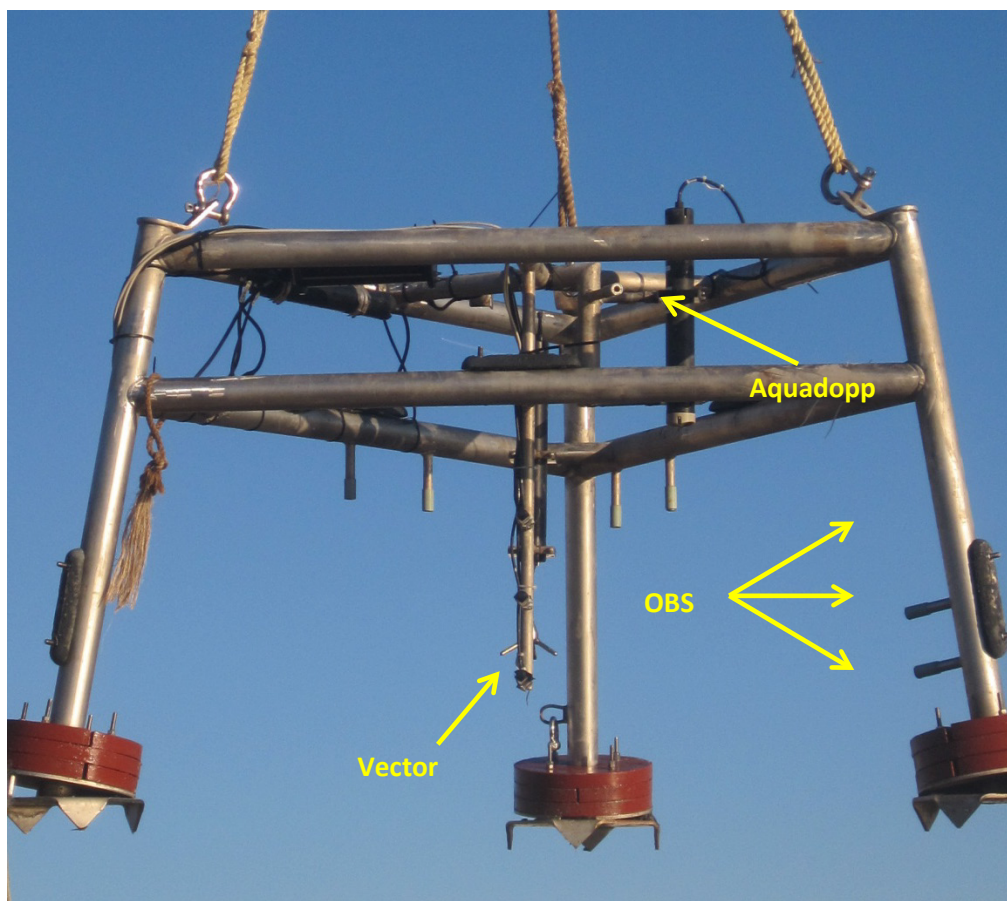


Figure 5 – Hylas III frame after the retrieval.



2.3 Instruments and measuring techniques

2.3.1 Waves

Description: Waves were measured using an Acoustic Wave and Current meter (AWAC-W). This sensor is composed to three beams and one central AST beam. It uses the Doppler effect by transmitting a short pulse of sound and then by listening to its echo; and also by measuring the change in pitch or frequency of the echo. Sound does not reflect from the water itself, but rather from particles suspended in the water. In addition, its wave performance depends on the optional Acoustic Surface Tracking (AST) which is echo-ranging to the surface with the vertically oriented transducer. This method circumvents the depth limits imposed by bottom mounted pressure and velocity measurements.

Principle of operation: An AWAC was deployed on the Hercules frame located around -6.5m TAW. Appendix 1 presents the setting of the instrument for each frame. The head of the AWAC containing the sensor was situated at the top of the frame around 1.37 m distance from the sea bottom and orientated up-looking. The instrument was installed on a gyroscopic mechanism (designed and manufactured at Flanders Hydraulic Research) which ensured that the AWAC stayed horizontal when submerged. The instrument was calibrated before delivery by Nortek. The only calibration necessary to be made was the compass calibration. The compass calibration is designed to adjust for magnetic materials that may be present in the deployment frame or mooring structure. As a consequence, calibration of the compass took place after the AWAC was mounted on the frame using the AWAC-AST software.

Sampling rate: The sampling rate was 2Hz of 20min records per hour (Table 3). The average interval was 10min.

Related software and output files: The data retrieved from the AWAC contained information about wave parameters. Combined with the AST system, the AWAC delivered time series of wave height, period, direction, spectrum. Data processing was carried out with Storm software from Nortek. The output files are presented in .wap format (more details in Appendix 2).

2.3.2 Near-bed flow velocity

Description: A vector velocimeter was used to measure near-bed flow velocity at a single-point. Its principle is to use the Doppler effect technology previously described for the AWAC. The vector transmits through a central beam and receives through three received beams displaced off to the side. This instrument measures velocity components parallel to its three beams, reporting to East, North and Vertical coordinates.

Principle of operation: A vector was deployed on Hylas III frame located around -3.5m TAW. Appendix 1 presents the setting of the instrument for each frame. The vector was vertically placed at a distance of 0.42 m from the seafloor (Table 2). The instrument was calibrated before delivery by Nortek. The only calibration necessary was for the compass which was carried out after mounting the instrument on the frame. Then, the calibration procedure was done using the Vec software. The vector data were information about marine currents as velocities on the horizontal directions (eastward [u], northward [v]) and vertical direction [w] at a fixed point.

Sampling rate: The sampling rate was 16Hz of 10minutes of records per hour (Table 3).

Related software and output files: Data were exported into readable ASCII format files using Vector software (more details in Appendix 1). Then they were processed to remove spike noise using Goring and Nikora (2002) approach which considers first and second derivatives of time series signal. This was carried out with Matlab. The files of the final processed data are in .txt format.

2.3.3 Velocity profiles

Description: An AWAC and two Aquadopp profiles were used to measure the current velocity in the upper and lower water column respectively. They measured flow velocities in the three directions eastward, northward and vertical.

Principle of operation: The AWAC deployed on Hercules frame was used to measure the current velocity (AWAC-C). Appendix 1 presents the setting of the instrument for each frame. It measured the current in a set of cells along each beam to obtain the current profiles. The blanking is the distance between the instrument transducers and the closest control volume (layer) within which no measurement takes place was around 0.9m. The function of the blanking zone is to allow for a Doppler shift of the signal travelling until the closest layer. The distance between cells was of 0.5m.

An Aquadopp profiler was placed on each frame to measure the bottom current profile using the acoustic Doppler effect technology. This sensor uses large transducers composed of three acoustic beams pointing in different directions which measure current velocity parallel to them. The blanking window was 0.2m and the distance between cells was 0.1m. The Aquadopps were mounted at 1.36m and 0.98m for Hercules and Hylas III frame respectively; and they were orientated down-looking (Table 2). Before being delivered by Nortek, the Aquadopps were calibrated. However, their compass were calibrated after the deployment on the frame. This was done using the AquaPro software. In addition, the aquadopp sensors were set-up in HR mode. It corresponds pulse to pulse coherent doppler measurement and could be only used when the maximum horizontal velocity is between 0.6 and 0.8m/s. However, the current velocity is much higher at the study site (>1m/s). The setting must had been in Normal mode. Therefore, the aquadopp data must be post-processed for higher speeds before being further analyzed in the future.

Sampling rate: The AWAC measured the currents during two times of the hour for 10-min with a resolution of 2Hz (Table 3). Each Aquadopp was set to record at 2 Hz resolution for 10minutes per hour.

Related software and output files: The data from the AWAC were processed using Storm software. The data output files are presented in Appendix I. For the Aquadopp, the data retrieved from the Aquadopp current profilers contain information about marine currents as velocities on the two horizontal and vertical directions. Data were converted to readable ASCII profile using AquaPro (more details in Appendix 2).

2.3.4 Suspended sediment concentration

Description, principle of the operation and sampling rate: Water samples were collected nearby the field site (coordinates: 51°13'12.49"N, 2°52'25.66"E) on Zeetijger ship using a pump. The instruments mounted on the frames were measuring at the same time. The samples were analyzed in the sediment laboratory at WL. in order to get the suspended sediment concentration (SSC), specific conductivity and the grain size distribution. The sampling took place at a location between the frames and at a distance of approximately 100m from the frames; and collected at an elevation of 1m above the sea floor. This was carried out on the 11th December 2013 at noon.

2.3.5 Pressure

Principle of operation: The AWAC, aquadopp and vector sensors recorded pressure (dBar) during the campaign period.

Sampling rate: Depending on the sensor, the sampling rate was an averaged value per hour.

Related software and output files: The data are located in .sen file.

2.3.6 Temperature

Principle of operation: The AWAC, aquadopp and vector sensors recorded temperature (degree C) during the campaign period.

Sampling rate: Depending on the sensor, the sampling rate was an averaged value per hour.

Related software and output files: The data are located in .sen file.

Table 2 – Description of instrument settings. The detailed settings are presented in the Appendix I.

Frame	Instrument	Serial number	Type of record	Resolution (Hz)	Orientation	Distance sensor-sea floor (m)
Hercules /M1	AWAC	WPR2022	Currents Waves	2	Vertical and up-looking	1.370
	Aquadopp-HR	AQD8481	Currents	2	Vertical and down-looking	1.360
	OBS	T8852	SSC	4	Horizontal	0.735
	OBS	T8853	SSC	4	Horizontal	0.575
	OBS	T8859	SSC	4	Horizontal	0.345
HylasIII /M3	Aquadopp HR	AQD6161	Currents	2	Vertical and down-looking	0.980
	Vector	VEC8210	Near-bed currents	16	Vertical and down-looking	0.420
	OBS	T8854	SSC	4-Low range	Horizontal	0.705
	OBS	T8855	SSC	4-Low range	Horizontal	0.505
	OBS	T8858	SSC	4-High range	Horizontal	0.305

Table 3 – Measurement scheme.

Instrument	Measurement duration											
	1 st hour						2 nd hour					
AWAC Currents (2Hz)	10 min				10 min		10 min		10 min		10 min	
AWAC Waves (2Hz) [averaged 10-min]		20 min						20 min				
Aquadopp HR (2Hz)			10 min									
Vector (16Hz)			10 min						10 min			
OBS (4Hz)			10 min						10 min			
Time Interval	2 hours											

Figures 6 and 7 present the connections between instruments for Hercules and Hylas III respectively.

Figure 6 – Instruments connections for the frame Hercules.

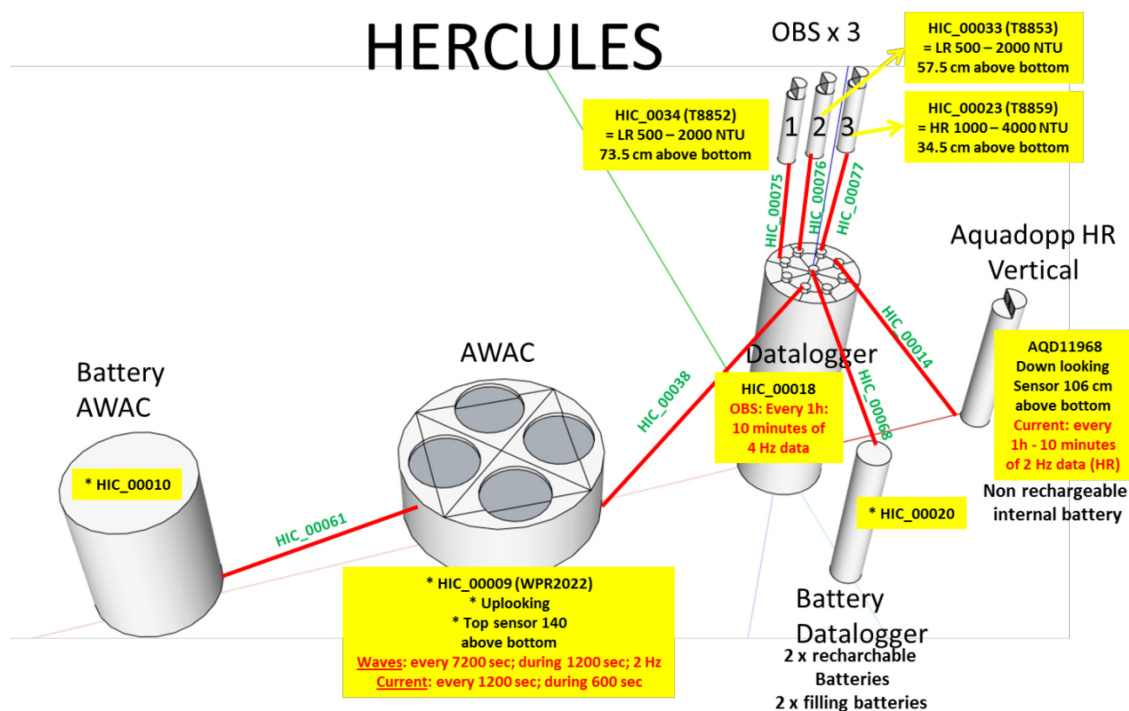
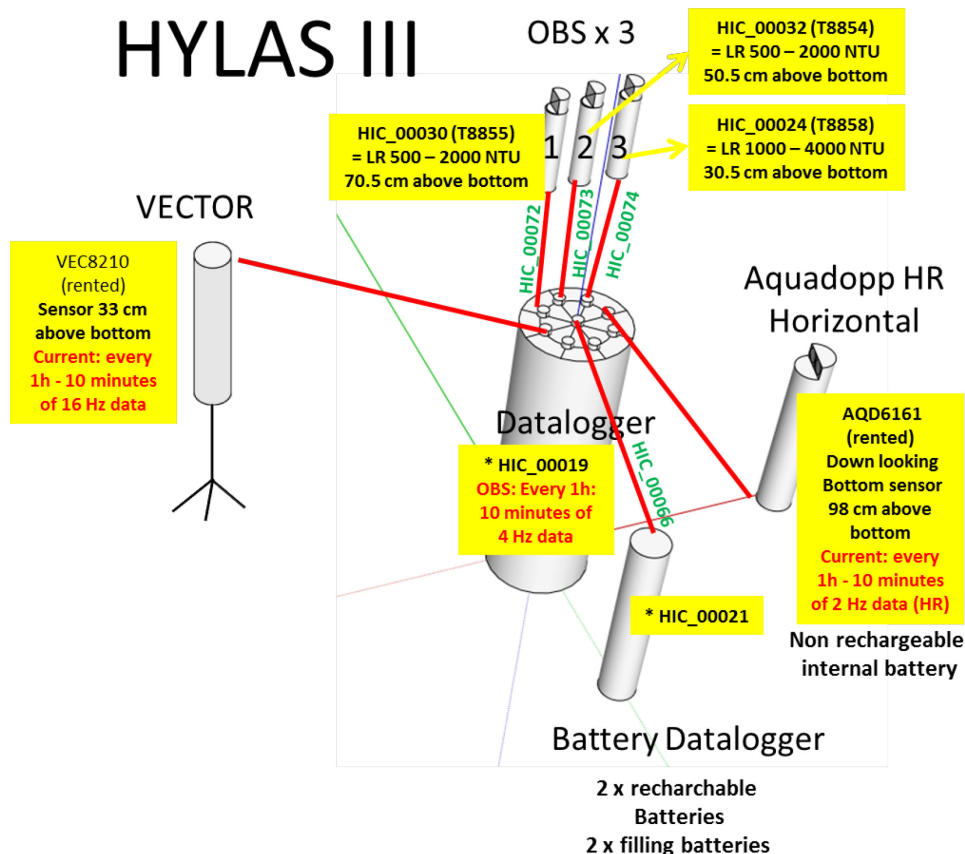


Figure 7 – Instruments connections for the frame Hylas III.



3 Measurement results

Records of all the parameters measured are presented in Appendix from 2 to 8.

3.1 Waves

The AWAC mounted on Hercules frame (-6.5m TAW) was relatively stable with limited heading, pitch and roll motions of less than 3° which is acceptable (see in Appendix 3.1.). The complete time serie of significant wave height (Hm0), maximum wave height (Hmax), peak period (Tp) and mean wave direction (MeanDir) are displayed in Appendix 4. Statistical analyses of the wave parameters are presented as well.

3.2 Near-bed flow velocity

Time serie of the vector orientation is displayed in Appendix 2.2. The motion of the heading, pitch and roll together were less than 1° for most of the time. Short sporadic motions of the sensor of a few degrees were also recorded on 11th November, 14th November, 22nd November, 30th November, 2nd December, 6th December and 11th December, and consequently, the record values were out of range over these periods.

Appendix 5.1. presents the time serie of the records without any processing to remove spikes or noise not related to the flow characteristics. The time serie of the processed records of the three velocity components is, however, presented in Appendix 5.2. Statistical analyses of the three components are also presented.

3.3 Velocity profiles

The motions of the Aquadopps sensor mounted on Hercules frame were in acceptable range of less than 5°(see Appendix 3.3. Specifically, the motion of the sensor was generally less than 1.5° for the pitch and the roll, and 2° for the heading.

Time series of the total records of flow velocity from every Aquadopps and AWAC cells in three directions eastward, northward and vertical are given in Appendices 6.1.-6.3. Apart of showing the quality of the data, these plots allow the identification of the variation of the three velocity components. Plots are ordered from the closer to the further cells from the sensor.

Time series of depth-averaged of each velocity component recorded from the AWAC, and from the Aquadopps on Hercules and Hylas III frames are displayed in Appendix 6.4.1, 6.5.1 and 6.6.1 respectively. Also, time series of velocity norm, $V = \sqrt{u^2 + v^2 + w^2}$, showing the current velocity profile above the sensors are presented in Appendix 6.4.2, 6.5.2 and 6.6.2.

3.4 Suspended sediment profiles

Sediment concentration are presented in Appendix 7.

3.5 Pressure

Time series of pressure data measured from every sensors are shown in Appendix 8.

3.6 Temperature

Time series of temperature data measured from every sensors are shown in Appendix 9.

3.7 Data

All the raw and processing data are saved in :

P:\00_128-VooroevGeulSu\3_Uitvoering\Data\Campaigns\20131113_20131211

4 References

Dan, S., Vereecken, H., Delgado, R., De Backer, E., Levy, Y., Verzhbitskiy, L., Verwaest, T., Mostaert, F. (2014) Measuring campaigns of hydrodynamics and sand dynamics at Mariakerke: Campaigns August-September 2013. Version 2_0 WL Rapporten, 00_128. Flanders Hydraulics Research, Antwerp, Belgium.

Goring D., and Nikora V., 2002. Despiking Acoustic Doppler Velocimeter Data. Journal of Hydraulic Eng., 128(1), 117-126.

Appendix 1. Instrument settings

Detailed settings for the instruments on the Hercules frame:

AWAC

=====

Deployment : W2022

Current time : 06/11/2013 17:21:00

Start at : 13/11/2013 18:00:00

Comment:

Profile interval (s) : 1200

Number of cells : 30

Cell size (m) : 0.50

Average interval (s) : 600

Blanking distance (m) : 0.40

Measurement load (%) : 25

Power level : HIGH

Number of wave samples : 2400

Wave interval (s) : 3600

Wave sampling rate (Hz) : 2

Wave AST Ice mode : DISABLED

Wave AST SUV mode : DISABLED

Compass upd. rate (s) : 600

Coordinate System : ENU

Speed of sound (m/s) : MEASURED

Salinity (ppt) : 35

Analog input 1 : NONE

Analog input 2 : NONE

Analog input power out : DISABLED

File wrapping : OFF

TellTale : OFF

Acoustic modem : OFF

Serial output : OFF

Baud rate : 9600

Onboard wave processing : DISABLED

Assumed duration (days) : 25.0
Battery utilization (%) : 48.0
Battery level (V) : 12.8
Recorder size (MB) : 185
Recorder free space (MB) : 184.971
Memory required (MB) : 33.9
Vertical vel. prec (cm/s) : 0.6
Horizon. vel. prec (cm/s) : 1.7

Instrument ID : WPR 2022
Head ID : WAV 6606
Firmware version : 3.37 AST

AWAC AST Version 1.46.04
Copyright (C) Nortek AS
=====

Detailed settings for the instruments on the Hercules frame:

Aquadopp

=====

Deployment : A8481
Current time : 06/11/2013 17:40:09
Start at : 13/11/2013 18:20:00

Measurement interval (s) : 3600
Cell size (mm) : 100
Orientation : DOWNLOOKING
Distance to bottom (m) : 1.05
Pulse distance (m) : 1.15
Profile range (m) : 0.90
Horiz. vel. range (m/s) : 0.80
Vert. vel. range (m/s) : 0.34

Number of cells : 9
Average interval (s) : 1
Blanking distance (m) : 0.100
Measurement load (%) : 40
Samples per burst : 1200
Sampling rate (Hz) : 2
Compass upd. rate (s) : 1
Coordinate System : ENU
Speed of sound (m/s) : MEASURED
Salinity (ppt) : 35
Analog input 1 : NONE
Analog input 2 : NONE
Analog input power out : DISABLED
File wrapping : OFF
TellTale : OFF
Acoustic modem : OFF
Serial output : OFF
Baud rate : 9600

Assumed duration (days) : 25.0
Battery utilization (%) : 59.0
Battery level (V) : 11.4
Recorder size (MB) : 185
Recorder free space (MB) : 184.973
Memory required (MB) : 112.6

Instrument ID : AQD 8481
Head ID : AQP 5385
Firmware version : 3.14 HR

AquaProHR Version 1.10.10
Copyright (C) Nortek AS

Detailed settings for the instruments on the Hylas III frame:

Aquaodopp

=====

Deployment : A6161

Current time : 06/11/2013 15:36:47

Start at : 13/11/2013 18:20:00

Measurement interval (s) : 3600

Cell size (mm) : 100

Orientation : DOWNLOOKING

Distance to bottom (m) : 1.05

Pulse distance (m) : 1.15

Profile range (m) : 0.90

Horiz. vel. range (m/s) : 0.80

Vert. vel. range (m/s) : 0.34

Number of cells : 9

Average interval (s) : 1

Blanking distance (m) : 0.100

Measurement load (%) : 40

Samples per burst : 1200

Sampling rate (Hz) : 2

Compass upd. rate (s) : 1

Coordinate System : ENU

Speed of sound (m/s) : MEASURED

Salinity (ppt) : 35

Analog input 1 : NONE

Analog input 2 : NONE

Analog input power out : DISABLED

File wrapping : OFF

TellTale : OFF

Acoustic modem : OFF

Serial output : OFF

Baud rate : 9600

Assumed duration (days) : 25.0

Battery utilization (%) : 59.0
Battery level (V) : 11.3
Recorder size (MB) : 185
Recorder free space (MB) : 184.973
Memory required (MB) : 112.6

Instrument ID : AQD 6161
Head ID : AQP 2639
Firmware version : 3.11 HR

AquaProHR Version 1.10.10
Copyright (C) Nortek AS
=====

Detailed settings for the instruments on the Hylas III frame:

Vector

=====

Deployment : V8210
Current time : 06/11/2013 15:52:41
Start at : 13/11/2013 18:20:00

Sampling rate (Hz) : 16
Nominal vel. range (m/s) : 2.00
Burst interval (s) : 3600
Samples per burst : 9600
Sampling volume (mm) : 14.9
Transmit length (mm) : 4.0
Measurement load (%) : 36
Power level : HIGH
Output sync : VECTOR
Start on sync : DISABLED
Sample on sync : DISABLED
INS Sensor : DISABLED
INS Data type : AHRSCC
Compass upd. rate (s) : 1

Coordinate System : ENU
Speed of sound (m/s) : MEASURED
Salinity (ppt) : 35
Analog output : DISABLED
Analog output range : N/A
Analog input 1 : NONE
Analog input 2 : NONE
Analog input power out : DISABLED
File wrapping : OFF
TellTale : OFF
Acoustic modem : OFF
Serial output : OFF
Baud rate : 19200

Assumed duration (days) : 25.0
Battery utilization (%) : 51.0
Battery level (V) : 11.3
Recorder size (MB) : 361
Recorder free space (MB) : 360.973
Memory required (MB) : 142.5
Vertical vel. range (m/s) : 1.0
Horizon. vel. range (m/s) : 3.5

Instrument ID : VEC 8210
Head ID : VEC 4965
Firmware version : 3.36

Vector Version 1.37.01
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Appendix 2. Output data files

2.1. AWAC output files

Wave records averaged for 10min.

Current records averaged for 1min

.a1	Amplitude data for cell 1
.a2	Amplitude data for cell 2
.a3	Amplitude data for cell 3
.csv	All the data in csv format
.dat	Data file
.hdr	Parameter settings
.prf	Data in access file
.sen	Sensor data
.v1	Velocity data for cell 1
.v2	Velocity data for cell 2
.v3	Velocity data for cell 3
.wpb	Description of processed wave data
.wap	Processed wave data

2.2. Aquadopp output files

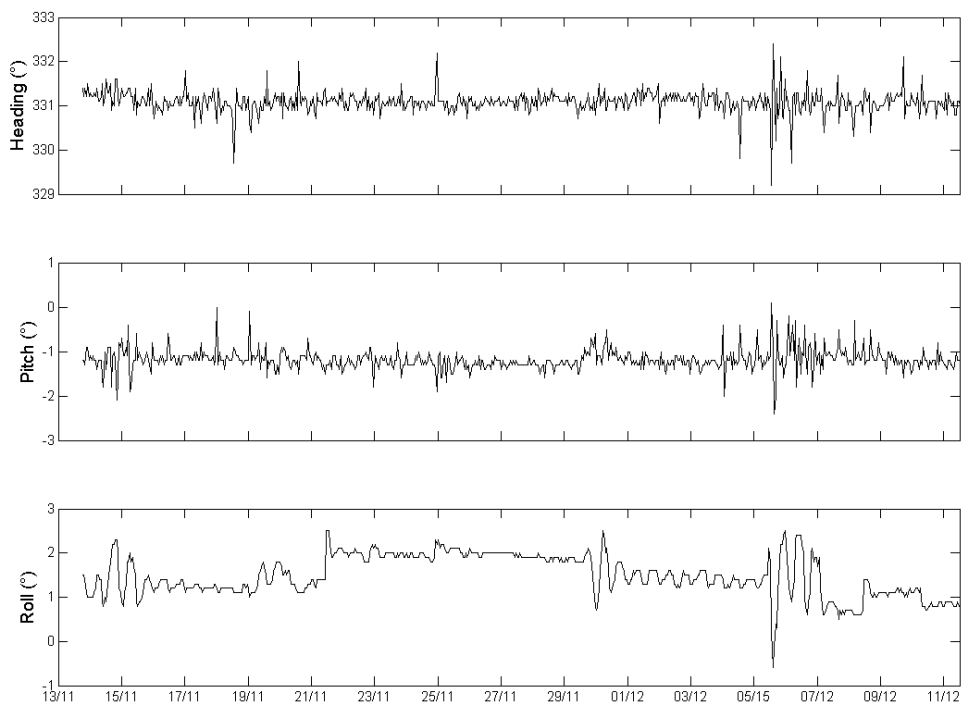
.a1	Amplitude data for cell 1
.a2	Amplitude data for cell 2
.a3	Amplitude data for cell 3
.csv	Profile data in csv format
.dat	Profile velocity data
.hdr	Parameter settings
.v1	Velocity data for cell 1
.v2	Velocity data for cell 2
.v3	Velocity data for cell 3
.sen	Sensor data

2.3. Vector output files

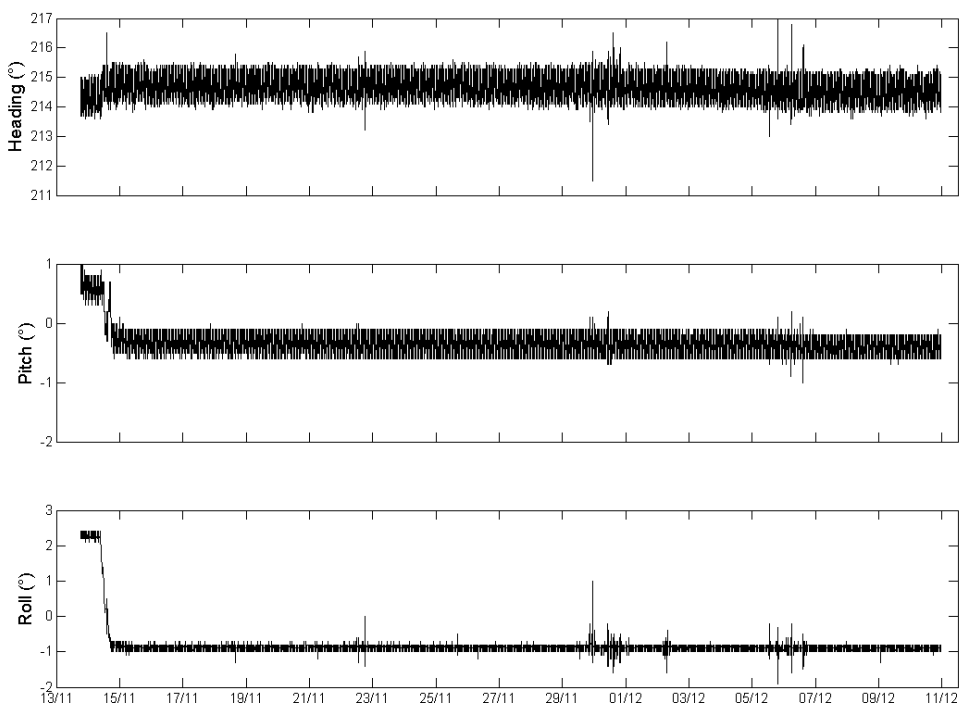
.dat	Velocity data
.hdr	Parameter settings
.pck	Probed check data
.sen	Sensor data
.vhd	Velocity header data

Appendix 3. Instrument orientation

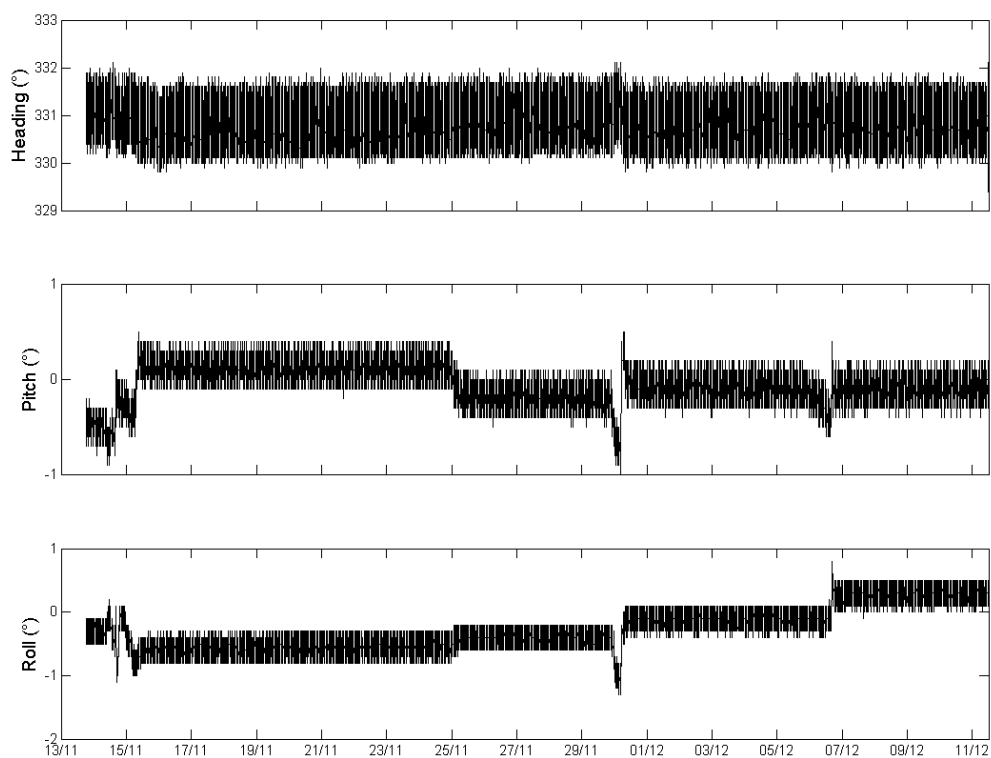
3.1. Time series of the AWAC orientation (Hercules frame)



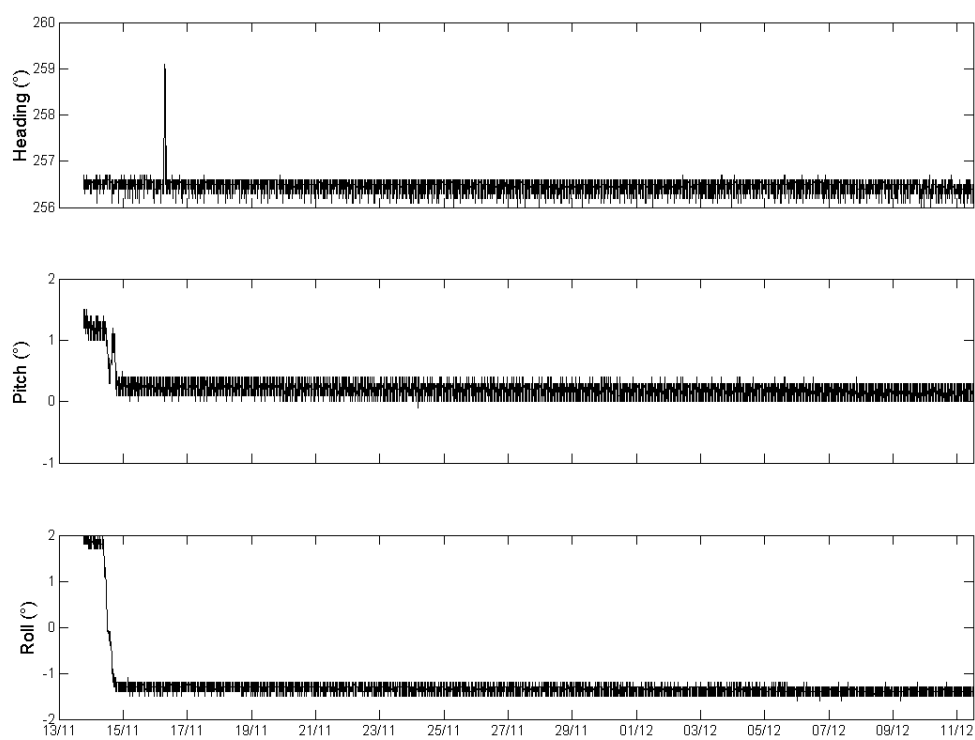
3.2. Time series of the vector orientation (Hylas III frame)



3.3. Time series of the Aquadopp orientation (Hercules frame)



3.4. Time series of the Aquadopp orientation (Hylas III frame)

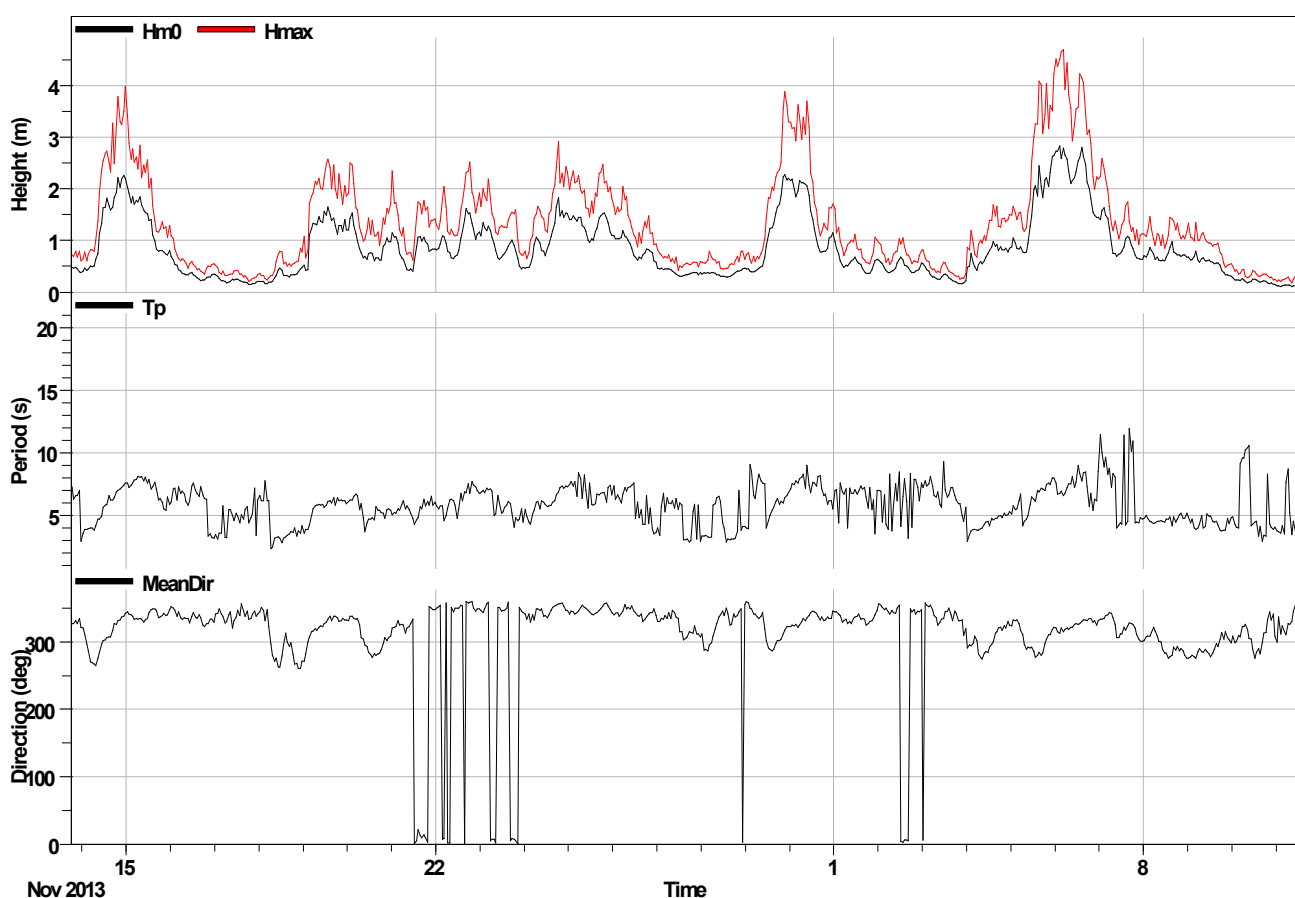


Appendix 4. Time series of waves

4.1. Waves recorded from the AWAC on Hercules frame (-6.5m TAW)

Description of parameters

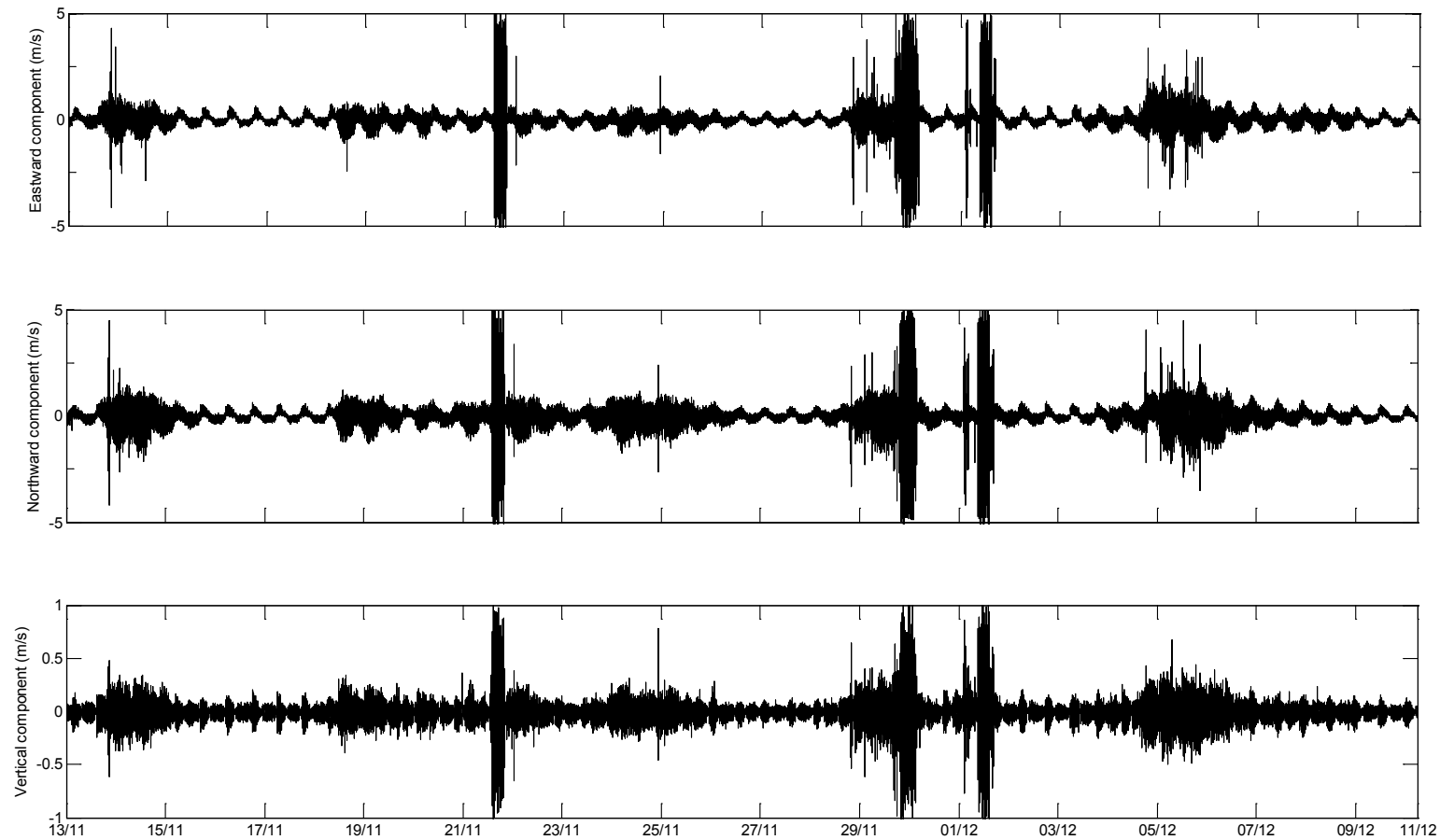
Hm0	Significant wave height (m)
Hmax	Maximum wave height (m)
Tp	Peak period (s)
MeanDir	Mean direction of the waves (°)



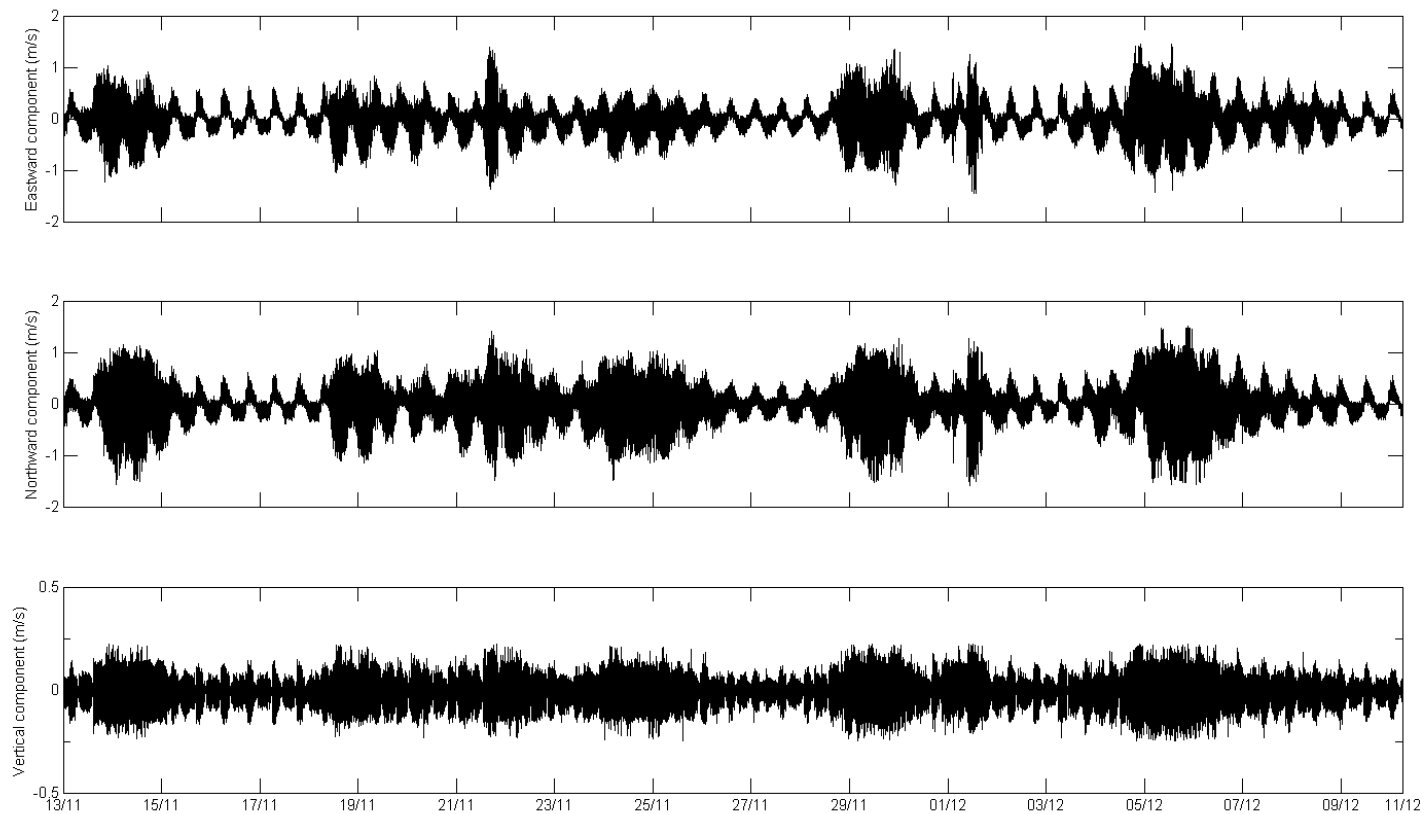
	Unit	Mean	Standard deviation	Kurtosis	Skewness	Max	Min	Range
Hm0	m	0.86	0.59	3.87	1.17	2.83	0.14	2.69
Hmax	m	1.36	0.92	4.28	1.25	4.70	0.21	4.49
Tp	s	5.85	1.58	3.22	0.34	11.99	2.37	9.62
Dir	°	310.55	69.50	16.49	-3.70	360	0.15	359.85

Appendix 5. Time series of near-bed flow velocity

5.1. No-processed data from the vector on Hylas III (-3.5m TAW)



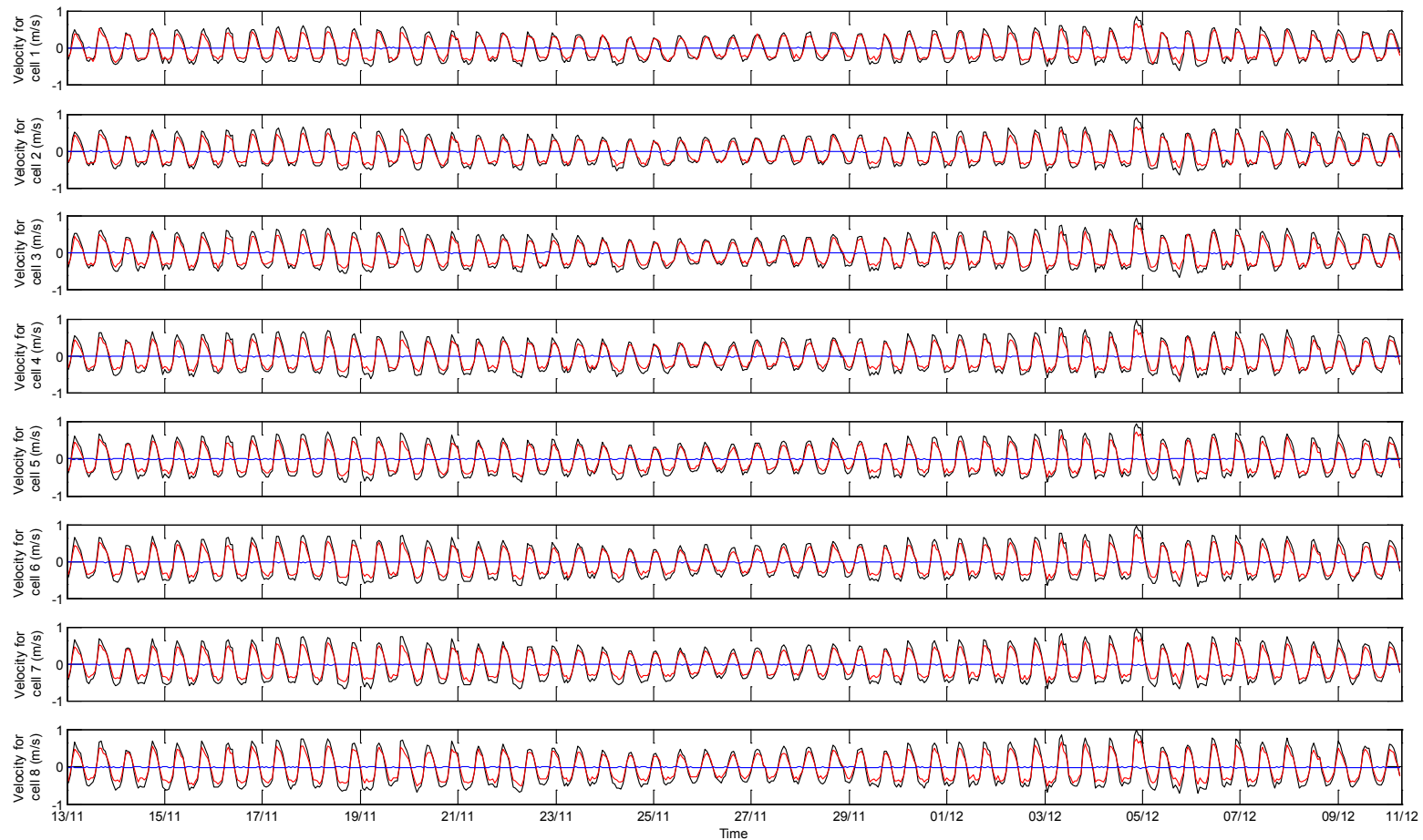
5.2. Processed data from the vector on Hylas III (-3.5m TAW)



Component	Mean	Standard deviation	Kurtosis	Skewness	Max	Min	Range
Eastward	-0.01	0.23	3.86	0.11	1.46	-1.45	2.91
Northward	-0.01	0.24	5.07	-0.16	1.51	-1.59	3.10
Vertical	-0.01	0.03	6.07	-0.08	0.23	-0.25	0.47

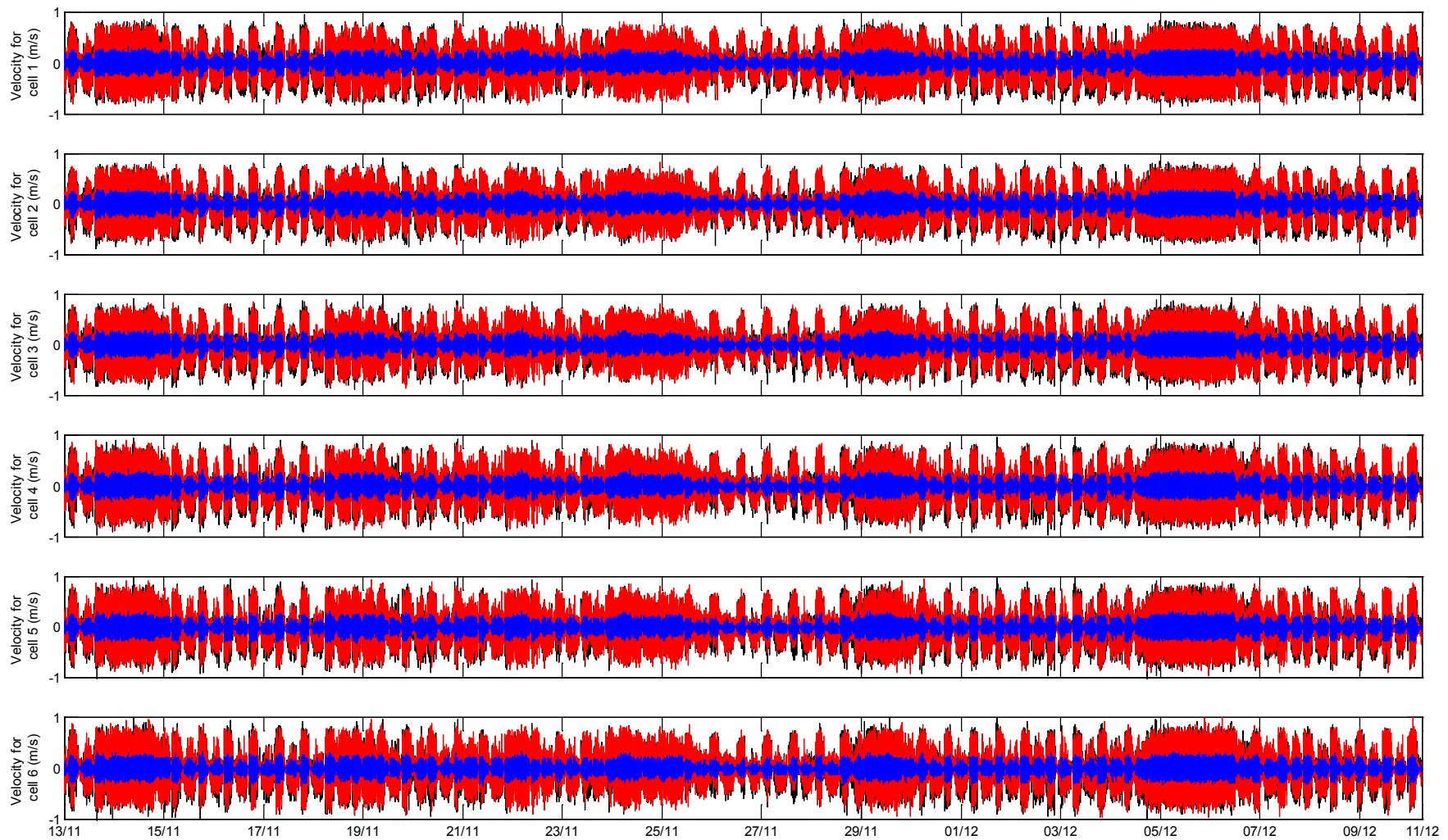
Appendix 6. Current profiles

6.1. Currents recorded from the AWAC on Hercules frame (-6.5m TAW).

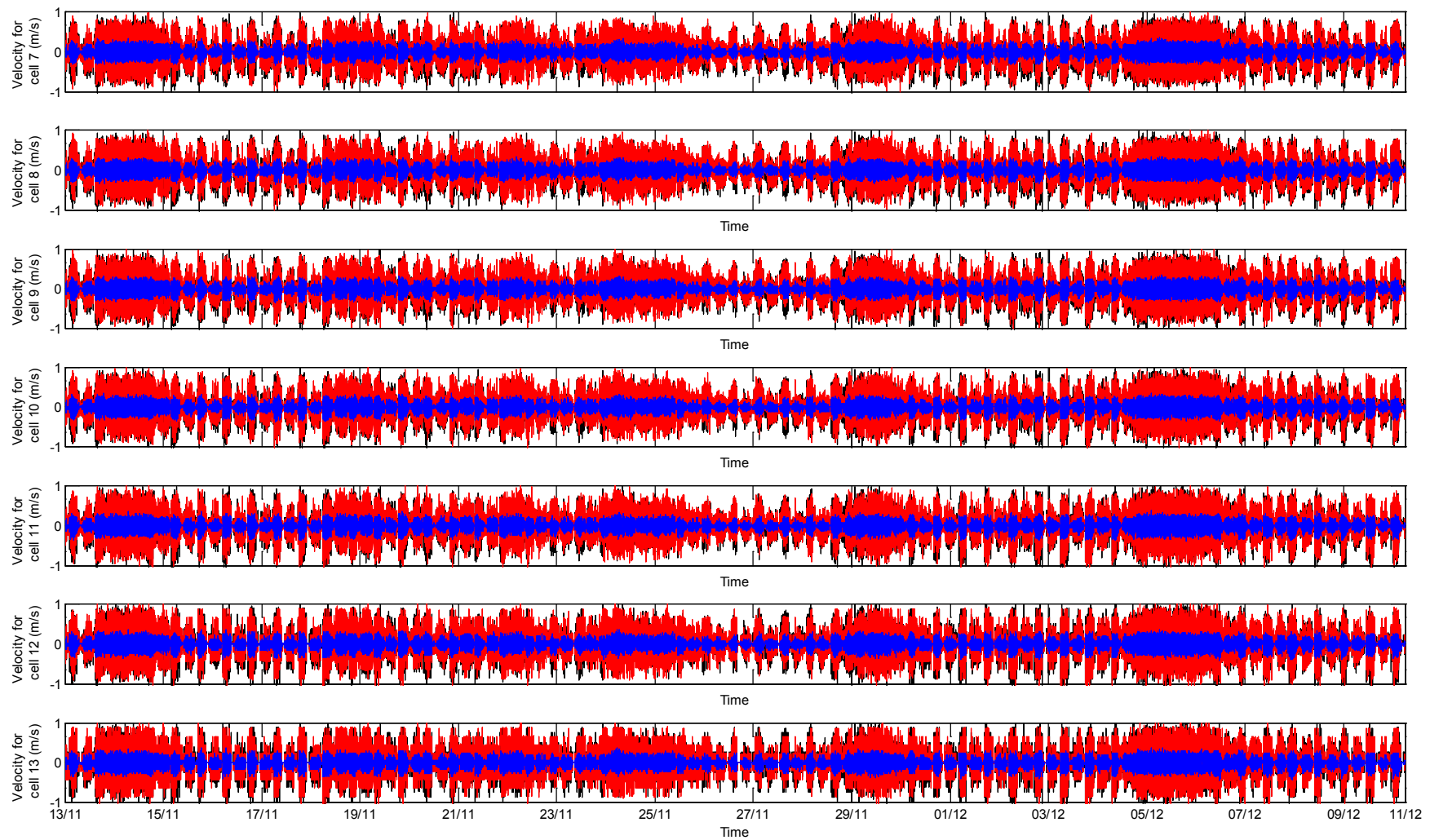


The black, red and blue lines correspond to eastward, northward and vertical components respectively.

6.2. Currents recorded from the Aquadopp on Hercules frame (-6.5m TAW).

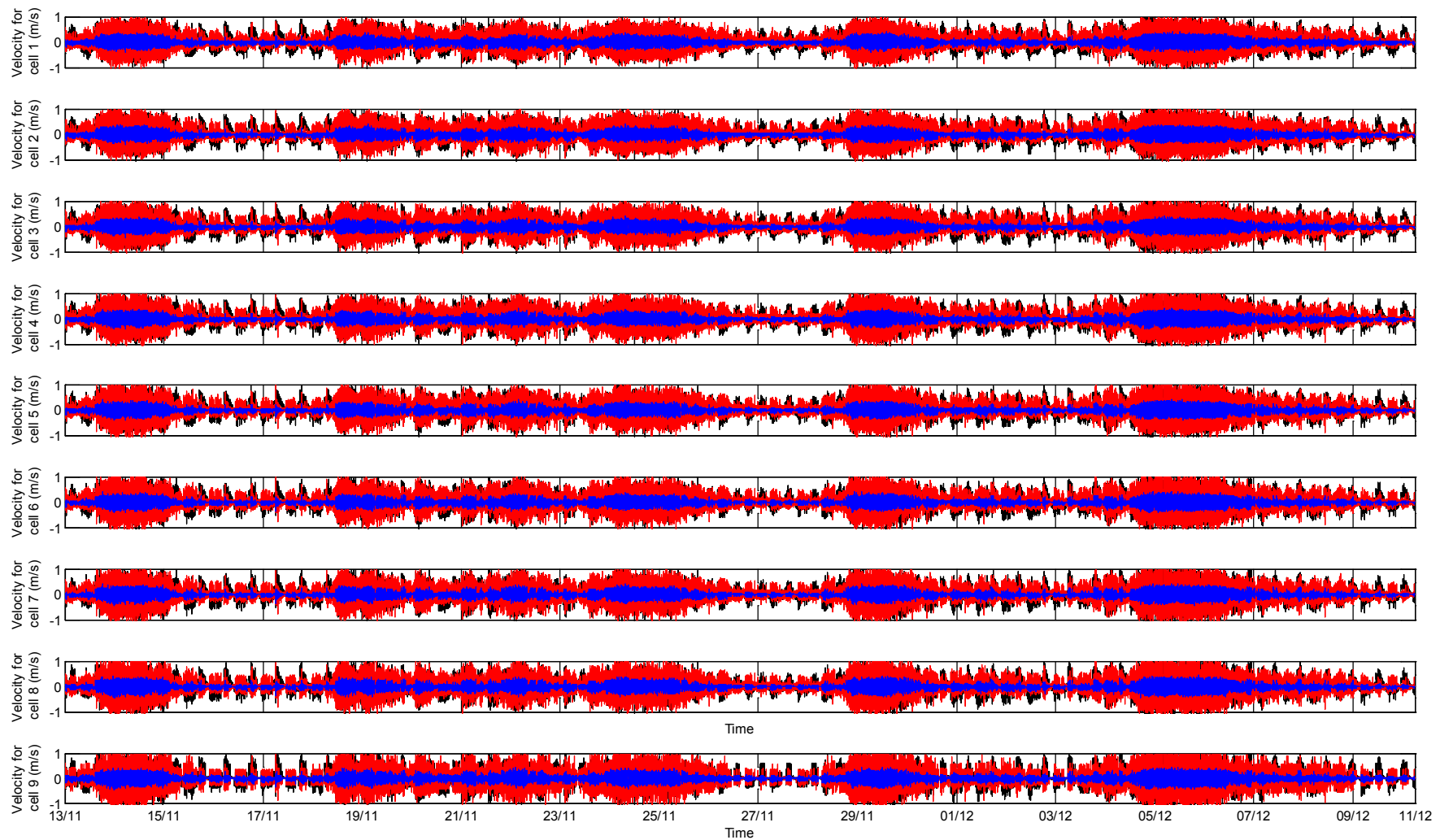


The black, red and blue lines correspond to eastward, northward and vertical components respectively.



The black, red and blue lines correspond to eastward, northward and vertical components respectively.

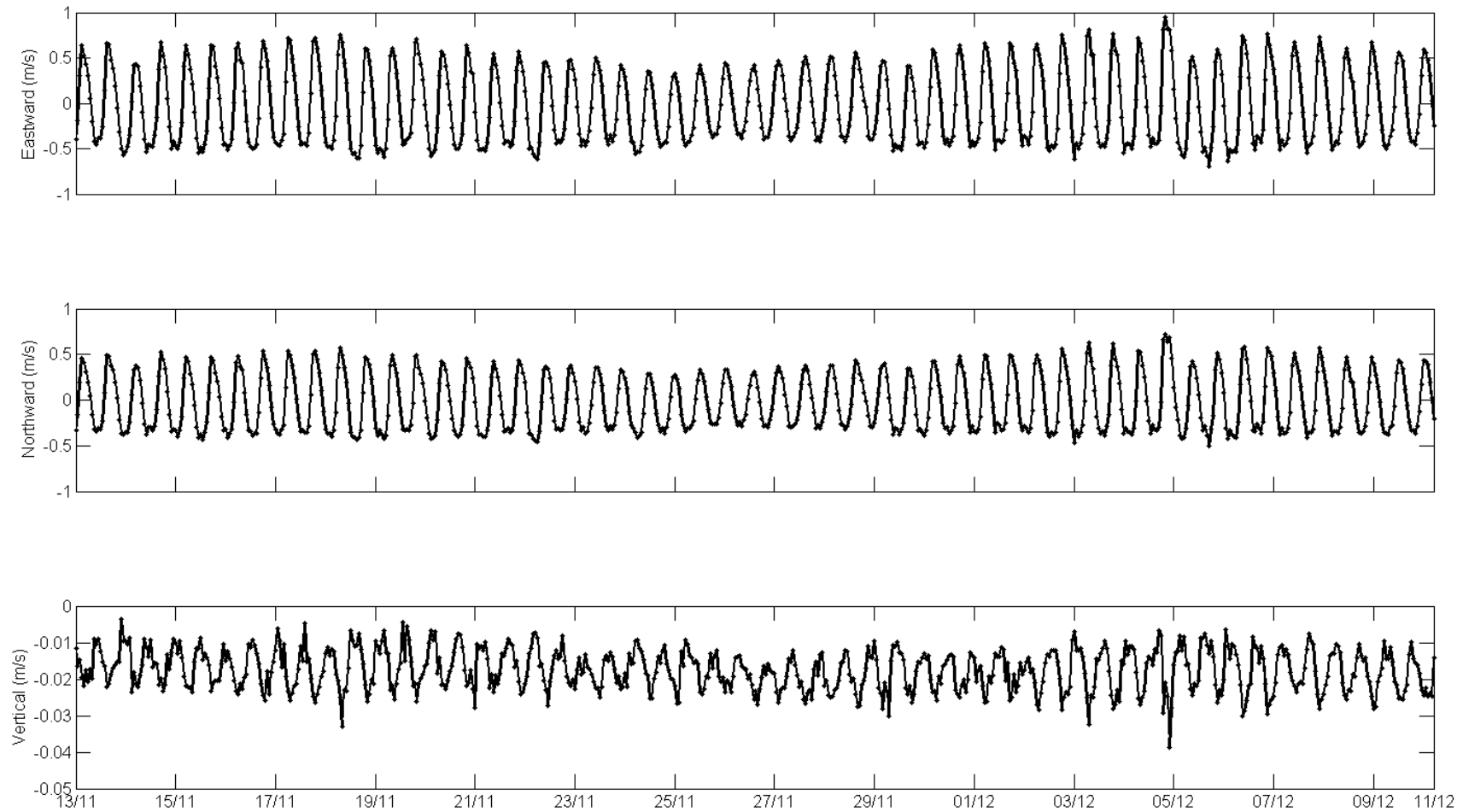
6.3. Currents recorded from the Aquadopp on Hylas III frame (-3.5m TAW)



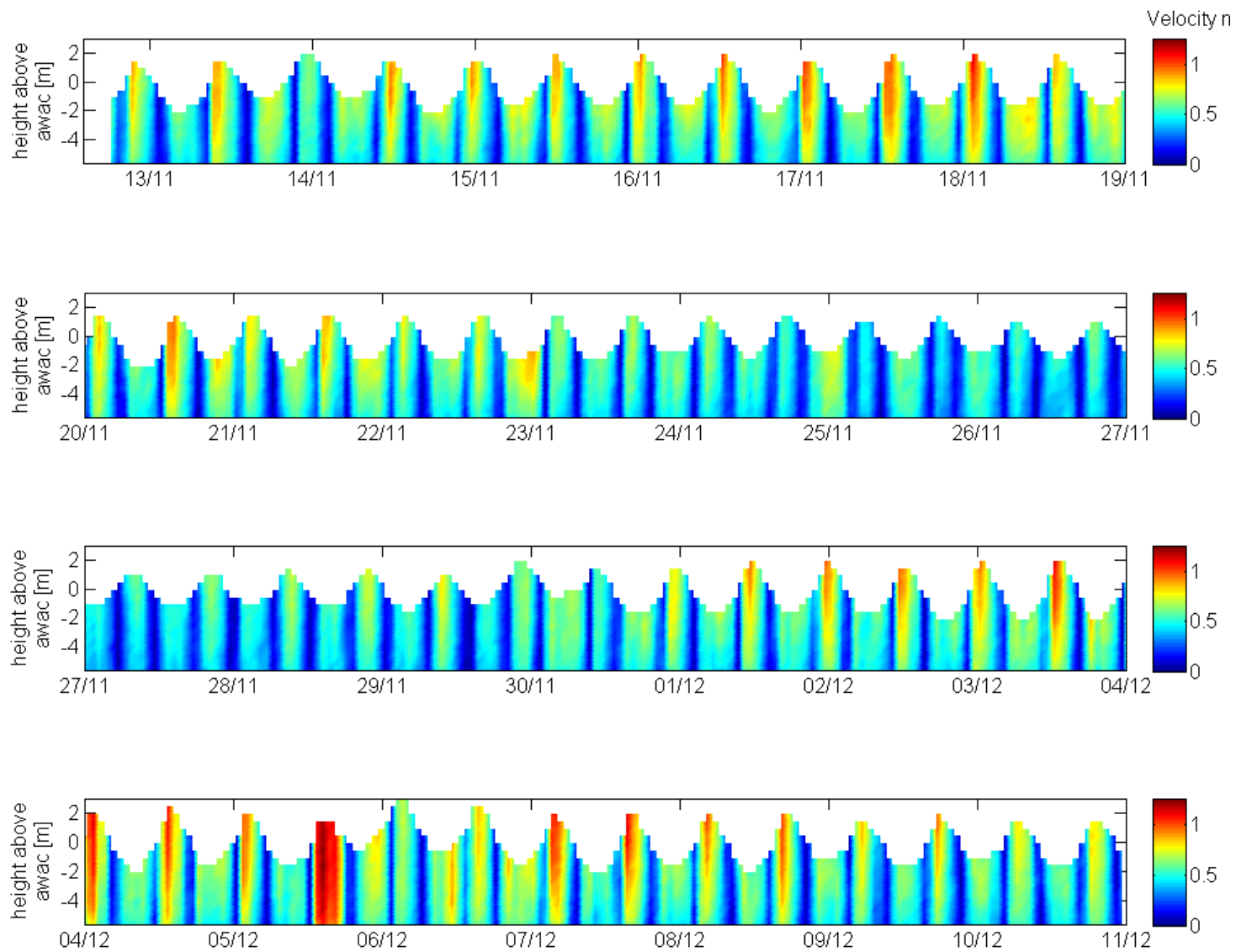
The black, red and blue lines correspond to eastward, northward and vertical components respectively.

6.4. Velocity profiles recorded from the AWAC on Hercules frame

6.4.1. Depth-averaged velocity

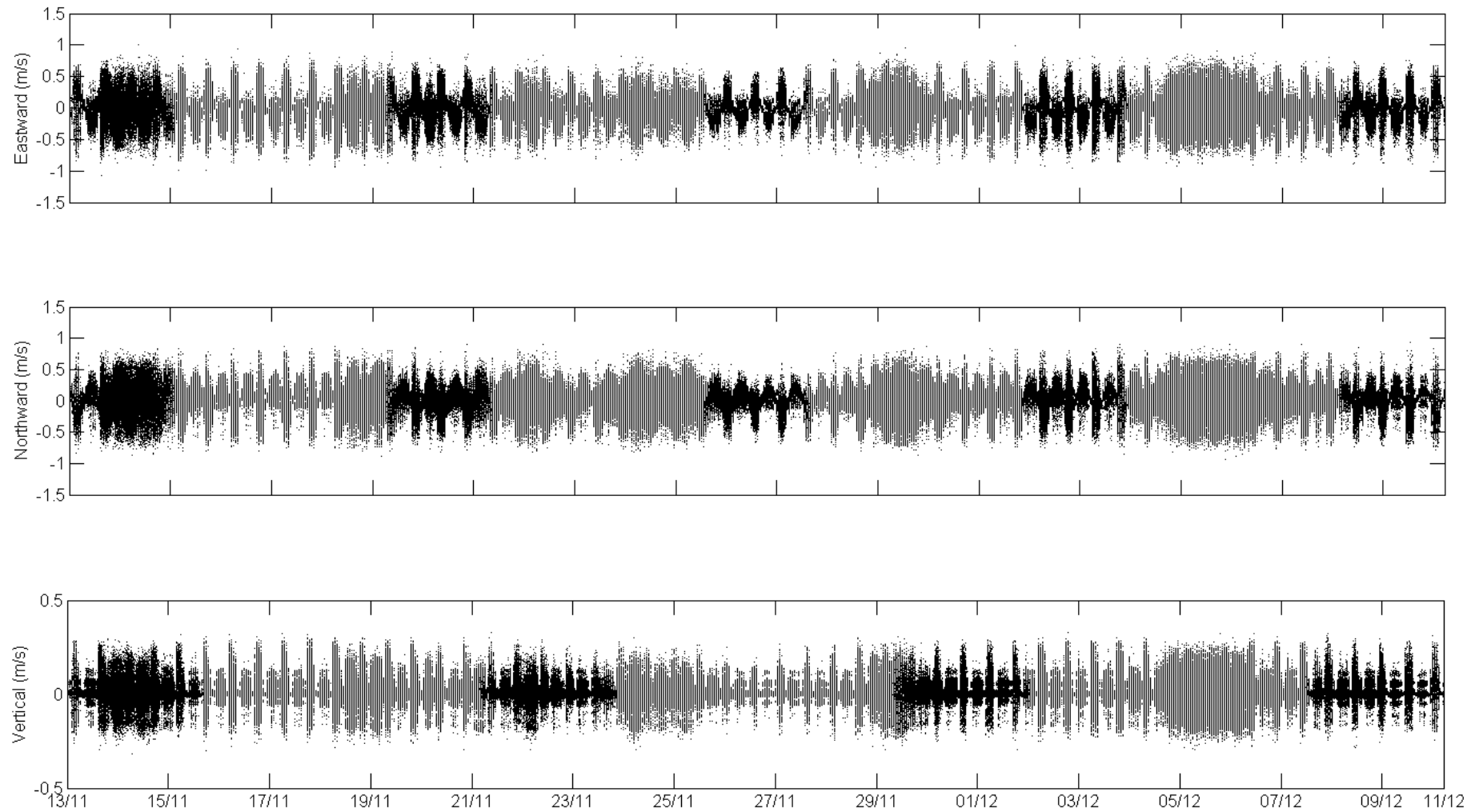


6.4.2. Velocity norm

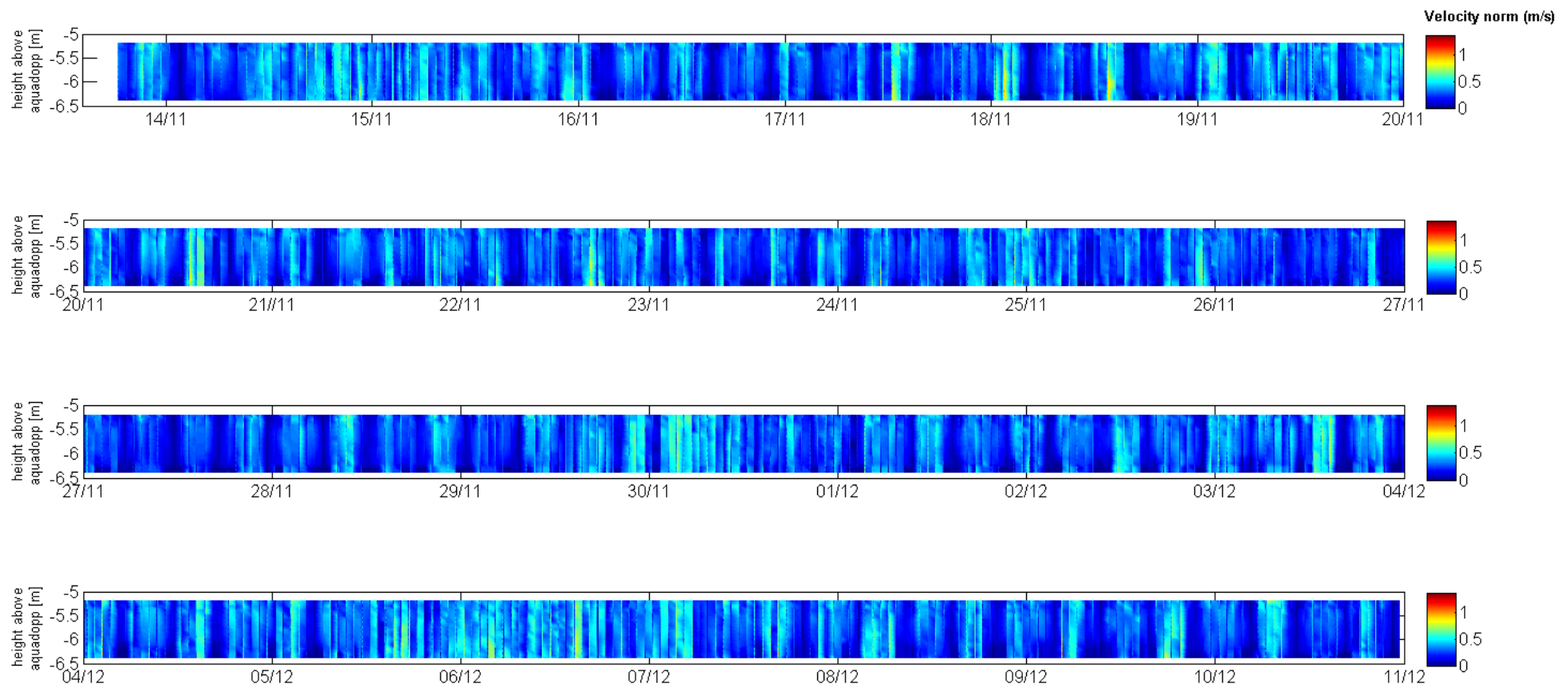


6.5. Velocity profiles for the bottom water column recorded from the Aquadopp on Hercules frame (-6.5m TAW)

6.5.1. Depth-averaged velocity

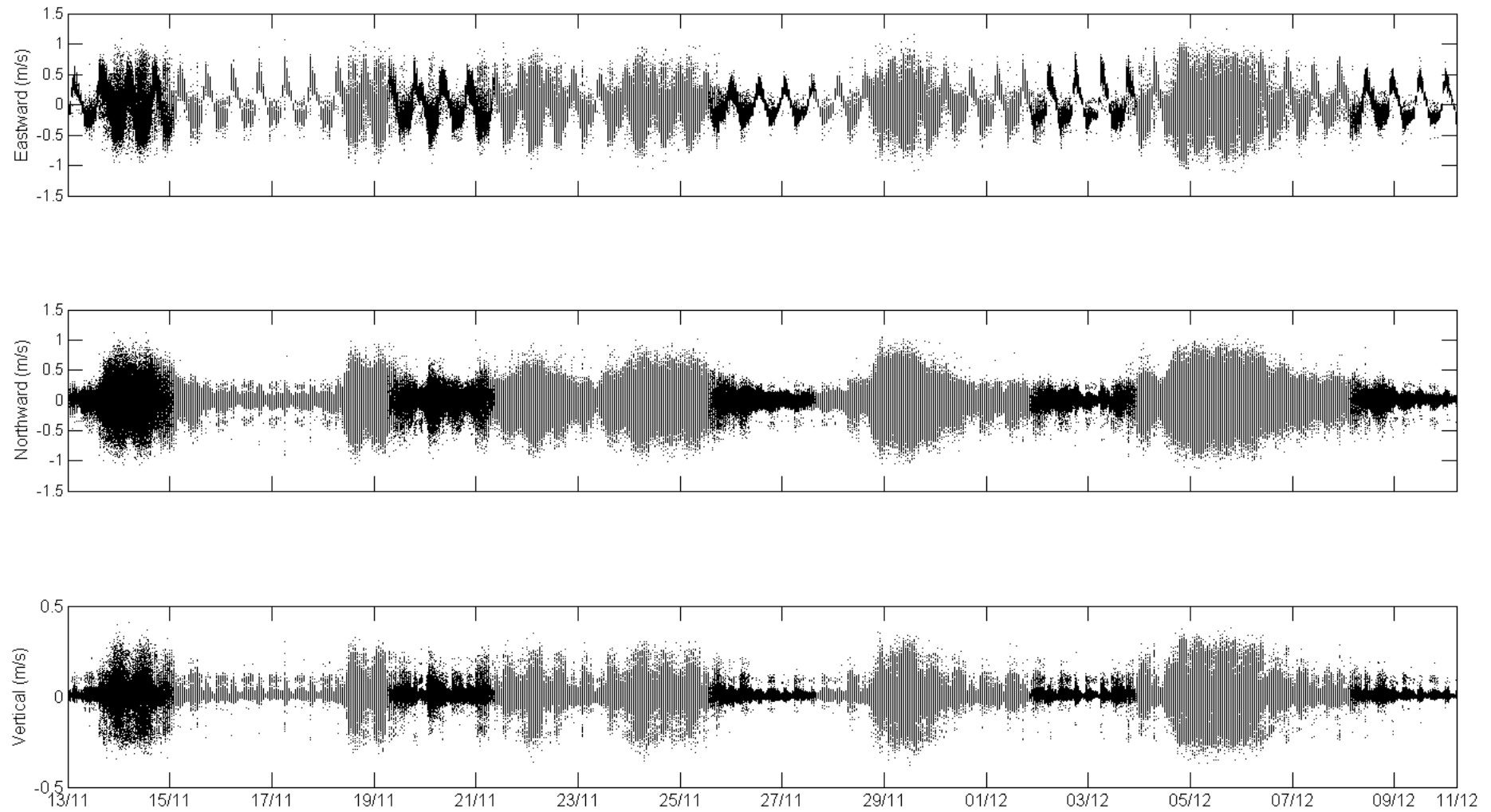


6.5.2. Velocity norm

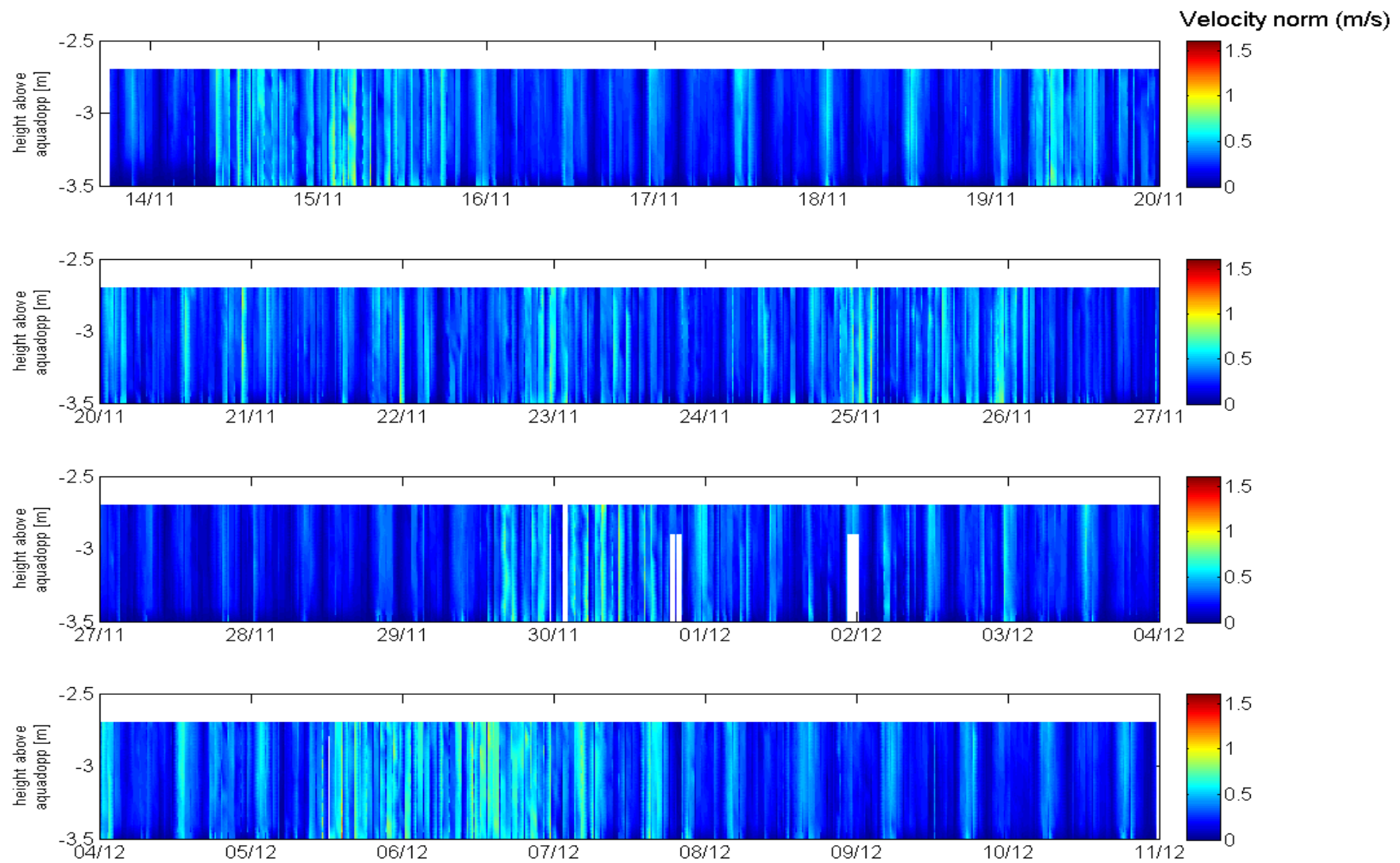


6.6. Velocity profiles for the bottom water column recorded from the Aquadopp on Hylas III frame

6.6.1. Depth-averaged velocity



6.6.2. Velocity norm



Note : The blanks do not correspond to missing records, but they are generated due to the interpolation processing.

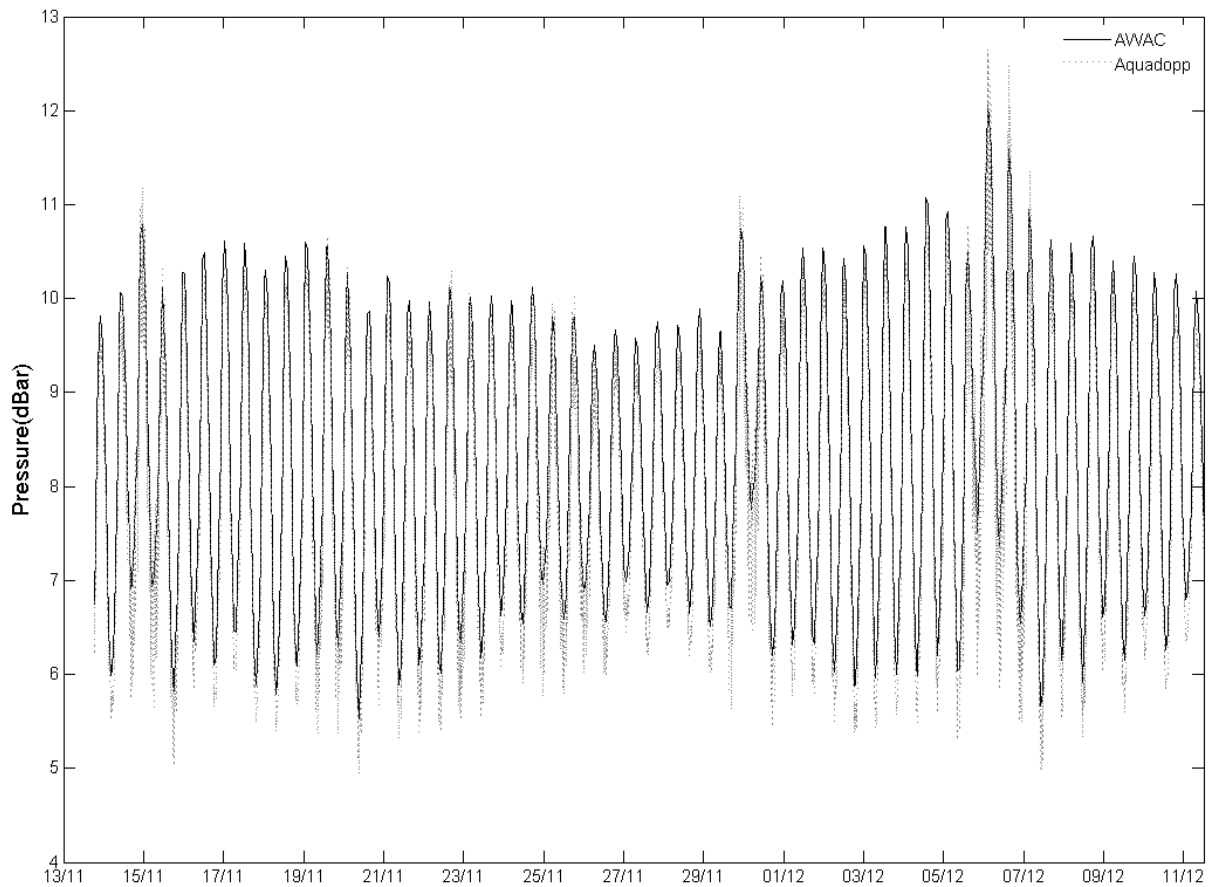
Appendix 7. Suspended sediments

No. sample				Water depth (m TAW)			Results			
laboratory	field	Surface to sensor	Water level	Absolute	Instantaneous	Elevation above seafloor (m)	SSC (mg/l)	Conductivity (μ S/cm)	Temperature (°C)	Specific conductivity (μ S/cm for 25°C)
SC2013020617	1081	4.5	0.5	5	5.5	1	86	40613	20.17	44679
SC2013020618	1082	4.5	0.5	5	5.5	1	89	38969	20.42	42669
SC2013020619	1083	4.5	0.5	5	5.5	1	96	40718	20.48	44600
SC2013020620	1084	4.5	0.5	5	5.5	1	75	35146	20.49	38470
SC2013020621	1085	4.5	0.5	5	5.5	1	71	38160	20.41	41819
SC2013020622	1086	4.5	0.5	5	5.5	1	70	40824	20.22	44920
SC2013020623	1087	4.5	0.5	5	5.5	1	71	39720	20.36	43567
SC2013020624	1088	4.5	0.5	5	5.5	1	82	38799	20.33	43652
SC2013020625	1089	4.5	0.5	5	5.5	1	70	39406	20.44	43160
SC2013020626	1090	4.5	0.5	5	5.5	1	74	40624	20.39	44547

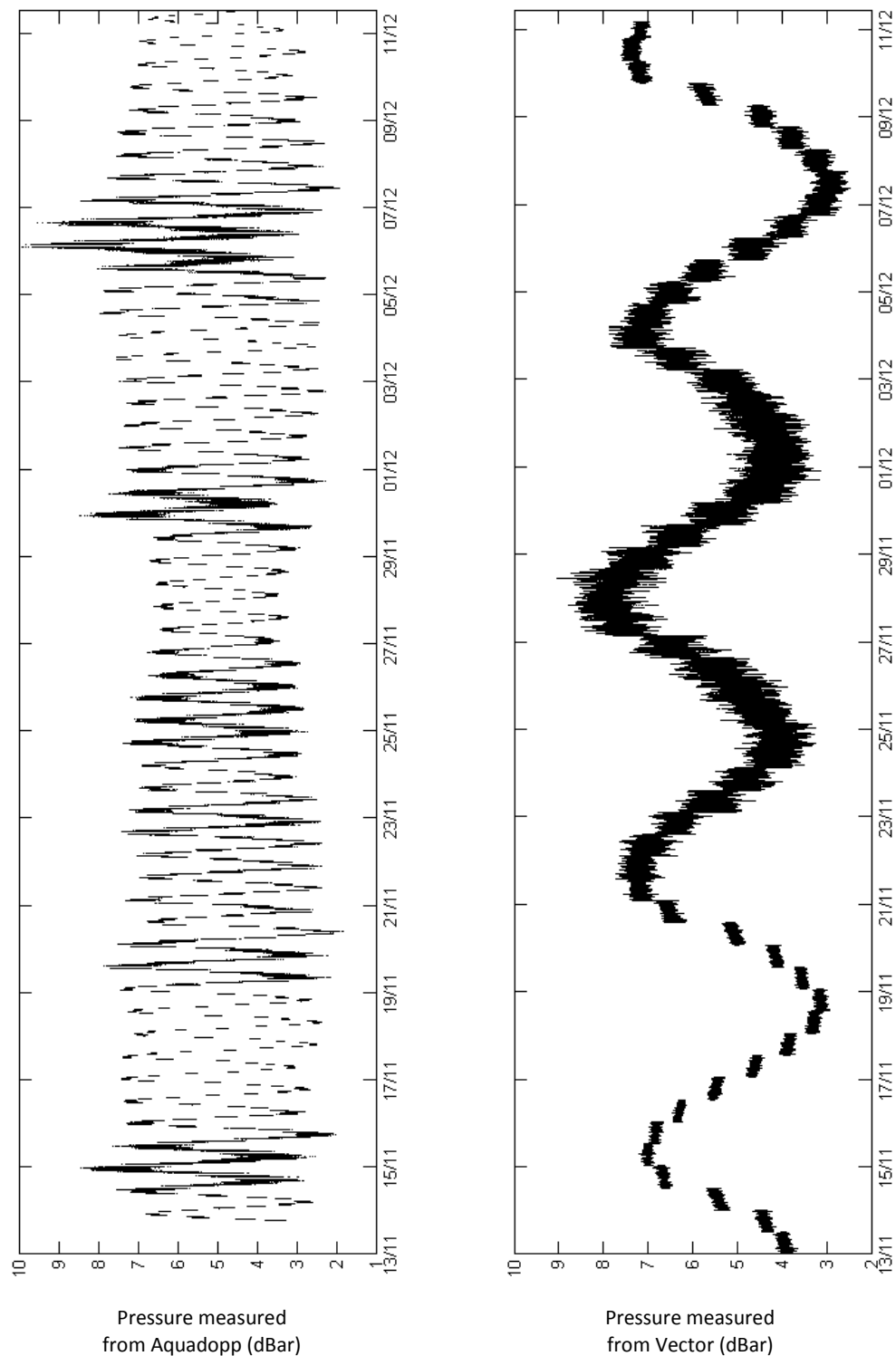
Results grain size						
Below 2.000 μ m	2.00 μ m-63.00 μ m	63.00 μ m-125.00 μ m	125.00 μ m-250.00 μ m	250.00 μ m-500.00 μ m	500.00 μ m-1000.00 μ m	Above 1000.000 μ m
8.62	90.47	0.87	0.05	0.000	0.000	0.000
8.22	90.70	0.10	0.08	0.000	0.000	0.000
8.47	90.62	0.91	0.01	0.000	0.000	0.000
9.06	89.11	1.74	0.09	0.000	0.000	0.000
10.74	88.17	1.08	0.01	0.000	0.000	0.000
11.04	87.25	1.69	0.03	0.000	0.000	0.000
10.78	87.21	1.98	0.03	0.000	0.000	0.000
8.52	90.43	1.05	0.00	0.000	0.000	0.000
10.71	87.24	2.02	0.03	0.000	0.000	0.000
8.61	90.23	1.16	0.01	0.000	0.000	0.000

Appendix 8. Pressure

8.1. Time serie of pressure recorded from Hercules frame

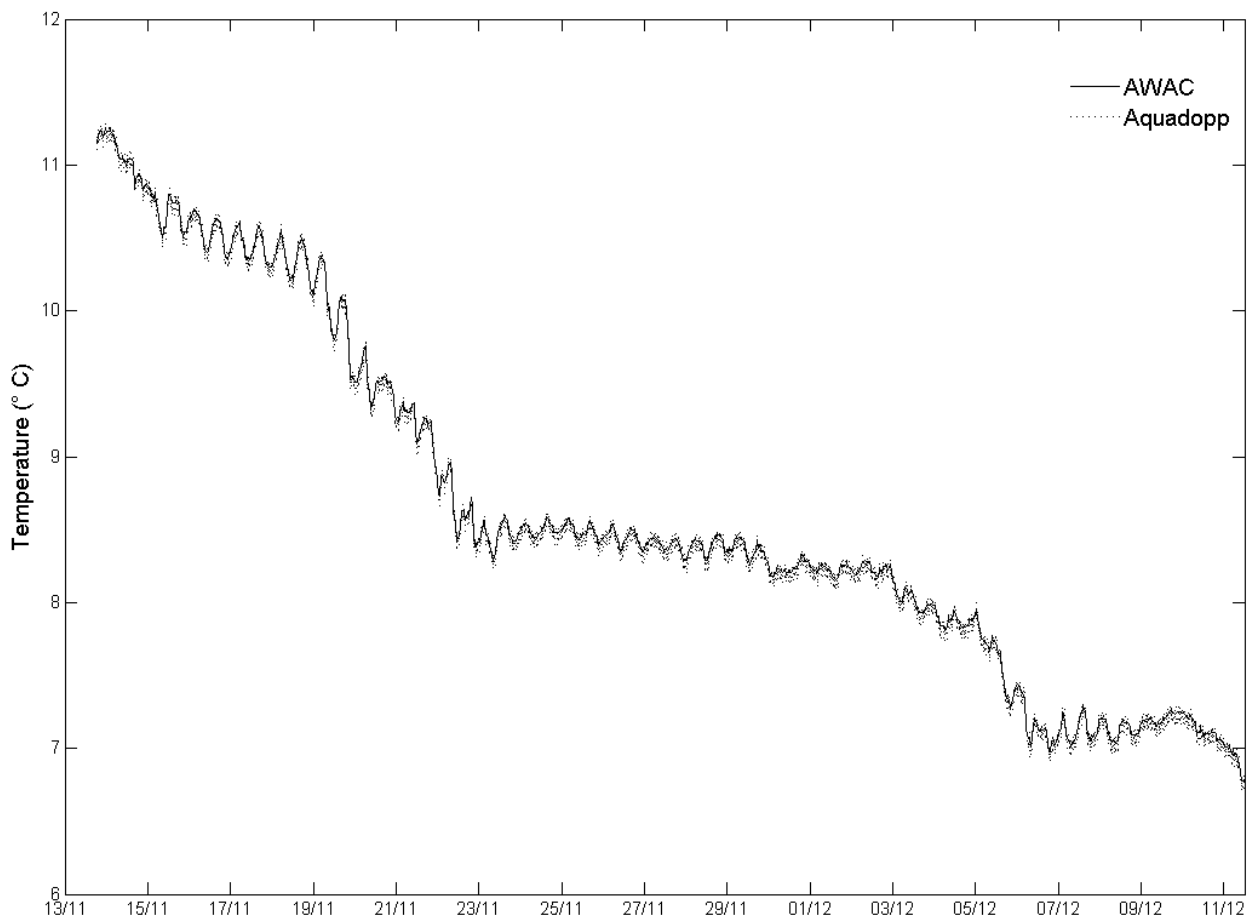


8.1.2. Time series of pressure recorded from HylasIII frame

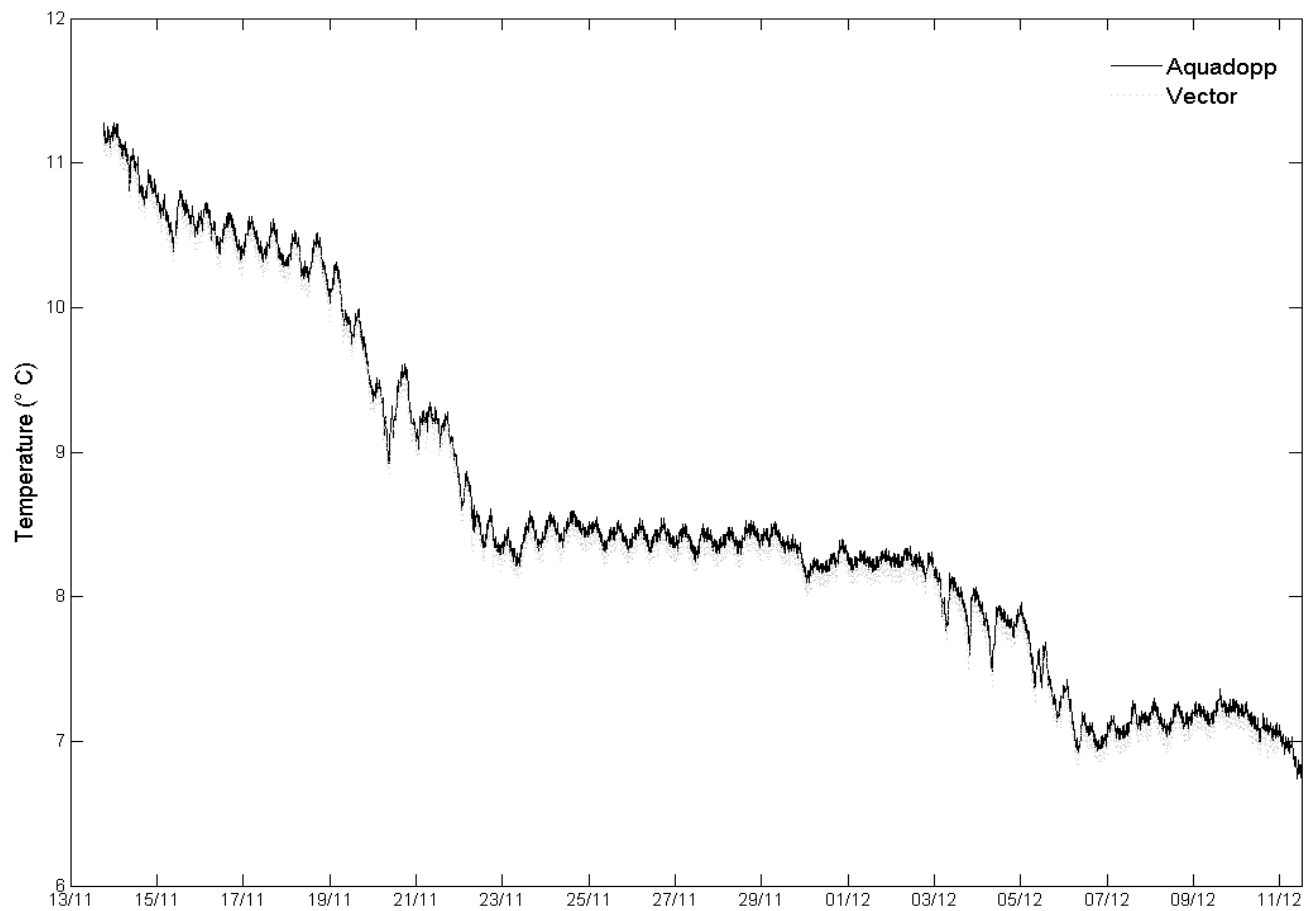


Appendix 9. Temperature

9.1. Time serie of temperature recorded from Hercules frame



9.2. Time serie of temperature recorded from HylasIII frame



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