



Flanders
State of
the Art

00_128_6
FHR reports

Alternative measures for beach nourishment maintenance

Monitoring of a pilot experiment at Mariakerke
Measuring campaign February – April 2014

DEPARTMENT
**MOBILITY &
PUBLIC
WORKS**

www.flandershydraulicsresearch.be

Alternative measures for beach nourishment maintenance

Monitoring of a pilot experiment at Mariakerke,
Measuring campaign February – April 2014

Montreuil, A-L.; Dan, S.; Vereecken, H.; De Backer, E.; Claeys, S.; Verwaest, T.; Mostaert, F.

Legal notice

Flanders Hydraulics Research is of the opinion that the information and positions in this report are substantiated by the available data and knowledge at the time of writing.

The positions taken in this report are those of Flanders Hydraulics Research and do not reflect necessarily the opinion of the Government of Flanders or any of its institutions.

Flanders Hydraulics Research nor any person or company acting on behalf of Flanders Hydraulics Research is responsible for any loss or damage arising from the use of the information in this report.

Copyright and citation

© The Government of Flanders, Department of Mobility and Public Works, Flanders Hydraulics Research 2017
D/2017/3241/94

This publication should be cited as follows:

Montreuil, A-L.; Dan, S.; Vereecken, H.; De Backer, E.; Claeys, S.; Verwaest, T.; Mostaert, F. (2017). Alternative measures for beach nourishment maintenance: Monitoring of a pilot experiment at Mariakerke, Measuring campaign February – April 2014. Version 4.0. FHR Reports, 00_128_6. Flanders Hydraulics Research: Antwerp.

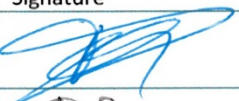
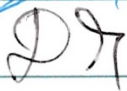
Reproduction of and reference to this publication is authorised provided the source is acknowledged correctly.

Document identification

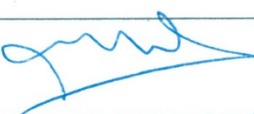
Customer:	Agentschap Maritieme Dienstverlening en Kust - Afdeling Kust	Ref.:	WL2017R00_128_6
Keywords (3-5):	In-situ measurements, waves, currents, sediment		
Text (p.):	14	Appendices (p.):	39
Confidentiality:	☒ No	☒ Available online	

Author(s):	Montreuil, A-L. ; Dan, S.
------------	---------------------------

Control

	Name	Signature
Reviser(s):	Vereecken, H.	
Project leader:	Dan, S.	

Approval

Coordinator research group:	Verwaest, T.	
Head of Division:	Mostaert, F.	

Abstract

This reports aims to present the field campaign of water and sediment measurements carried out in the nearshore area of Mariakerke from February to April 2014. Section 1 presents the context and goals of the campaign. Then, Section 2 describes the deployment of the multi-array sensor frames and measuring conditions during the field campaign. Results of the records of each parameters measured from every frame are reported in Section 3.

Contents

Abstract	III
Contents	V
List of tables.....	IX
List of figures	X
1 Introduction.....	1
1.1 Description of the project.....	1
1.2 Objectives	1
1.3 Team	1
1.4 Conventions.....	1
2 Deployment and measuring conditions	2
2.1 Description of the meteo-marine conditions during the campaigns	2
2.2 Description of the deployment campaign.....	3
2.3 Instruments / measuring techniques	7
2.3.1 Waves	7
2.3.2 Near-bed flow velocity	7
2.3.3 Velocity profiles	8
2.3.4 Suspended sediment profiles	8
2.3.5 Pressure	9
2.3.6 Temperature.....	9
3 Measurement results	13
3.1 Waves	13
3.2 Near-bed flow velocity	13
3.3 Velocity profiles	13
3.4 Suspended sediment profiles	13
3.5 Pressure	13
3.6 Temperature.....	13
3.7 Data	13
4 References.....	14
Appendix 1 Output data files.....	A1
1.1 AWAC output files	A1
1.2. Aquadopp output files	A1

1.3 Vector output files	A1
Appendix 2 Instrument orientation.....	A2
Hercules frame	A2
2.1. Awac-time serie	A2
2.2. Aquadopp-time serie	A2
2.3. Vector-time serie	A3
Hylas I frame	A3
2.4. AWAC-time serie	A3
2.5. Aquadopp-time serie	A4
2.6. Vector-time serie	A4
Hylas II frame	A5
2.7. Aquadopp-time serie	A5
Hylas III frame	A5
2.8. Aquadopp-time serie	A5
Appendix 3 Time serie of waves.....	A6
Hercules (-6.5m TAW)	A6
Hylas I (-3.5m TAW)	A7
Appendix 4 Time serie of near-bed flow velocity.....	A8
Near-bed currents recorded from the vector on Hercules frame (-6.5m TAW)	A8
No processed data	A8
Processed data	A9
Near-bed currents recorded from the vector on Hylas I frame (-3.5m TAW)	A10
No processed data	A10
Processed data	A11
Appendix 5. Current profiles from Hercules frame (-6.5m TAW).....	A12
5.1. Currents recorded from the AWAC	A12
5.1.1. Current records from every beams.	A12
5.1.2. Depth-averaged velocity	A13
5.2. Currents recorded from the aquadopp	A14
5.2.1. Current records from every beams	A14
Appendix 6. Current profiles from Hylas I frame (-3.5m TAW)	A17
6.1. Currents recorded from the AWAC	A17
6.1.1. Current records from every beams	A17
6.1.2. Depth-averaged velocity	A18
6.2. Currents recorded from the aquadopp	A19
6.2.1. Current records from every beams	A19

6.2.2. Depth-averaged velocity	A20
Appendix 7. Current profiles from Hylas II frame (-6.5m TAW)	A21
7.1. Currents recorded from the aquadopp	A21
7.1.1. Current records from every beams	A21
7.1.2. Depth-averaged velocity	A23
Appendix 8. Current profiles from Hylas III frame (-3.5m TAW)	A24
8.1. Currents recorded from the aquadopp	A24
8.1.1. Current records from every beams	A24
8.1.2. Depth-averaged velocity	A25
Appendix 9. Suspended sediment concentrantion and grain size distribution.....	A26
Appendix 10. Pressure.....	A27
10.1. Pressure recorded from the sensors on Hercules frame (-6.5m TAW)	A27
10.1.1. Records from the AWAC.....	A27
10.1.2. Records from the aquadopp.....	A27
10.2. Pressure recorded from the sensors on Hylas I frame (-3.5m TAW).....	A28
10.2.1. Records from the pressure sensor	A28
10.2.2. Records from the AWAC.....	A28
10.2.3. Records from the aquadopp.....	A29
10.3. Pressure recorded from the sensors on Hylas II frame (-6.5m TAW).....	A29
10.3.1. Records from the aquadopp.....	A29
10.4. Pressure recorded from the sensors on Hylas III frame (-3.5m TAW).....	A30
10.4.1. Records from the pressure sensor	A30
10.4.2. Records from the aquadopp.....	A30
Appendix 11. Temperature.....	A31
11.1. Hercules frame	A31
11.1.1.AWAC.....	A31
11.1.2. Aquadopp	A31
11.1.3. Vector	A32
11.2. Hylas I frame.....	A32
11.2.1. AWAC.....	A32
11.2.2. Aquadopp	A33
11.2.3.	A33
11.3. Hylas II frame.....	A34
11.3.1. Aquadopp	A34
11.4. Hylas III frame.....	A34
11.4.1. Aquadopp	A34

Appendix 12. Detailed settings of the instruments..... A35

 Aquadopp A35

 AWAC..... A36

 Vector A38

 Pressure sensor A39

List of tables

Table 1 – Description of the location and deployment of the instrument frames.	4
Table 2 – Description of the sampling conditions.	9
Table 3 – Description of instrument settings.	10
Table 4 – Measurement scheme.	11

List of figures

Figure 1 – Location of the meteo-marine weather stations. Profile 104 is the referenced transect for the study.	2
Figure 2 – Time series of water levels, wind (velocity and direction) and atmospheric pressure nearby the study area.	3
Figure 3 – Bathymetric map in 2013 and location of the instruments.	4
Figure 4 – Hercules frame before deployment.	5
Figure 5 – Hylas I frame before deployment.	5
Figure 6 – Hylas II frame before deployment.	6
Figure 7 – Hylas III frame before deployment.	6
Figure 8 – Connection between instruments for the frame Hercules.	11
Figure 9 – Connection between instruments for the frame Hylas I	12
Figure 10 – Connection between instruments for the frame Hylas II	12
Figure 11 – Connection between instruments for the frame Hylas III	12

1 Introduction

1.1 Description of the project

In the framework 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 the 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) and the second one from November-December 2013 (Montreuil et al., 2015). From February to April 2014, another 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 Conventions

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

The field measurement campaign started on 07/03/2014 (instrument deployed from 26th February 2014) and ended on 13th April 2014 (instrument retrieved on 13th and 23rd April 2014). The campaign lasted 37 days in total. No incidences were recorded over the campaign.

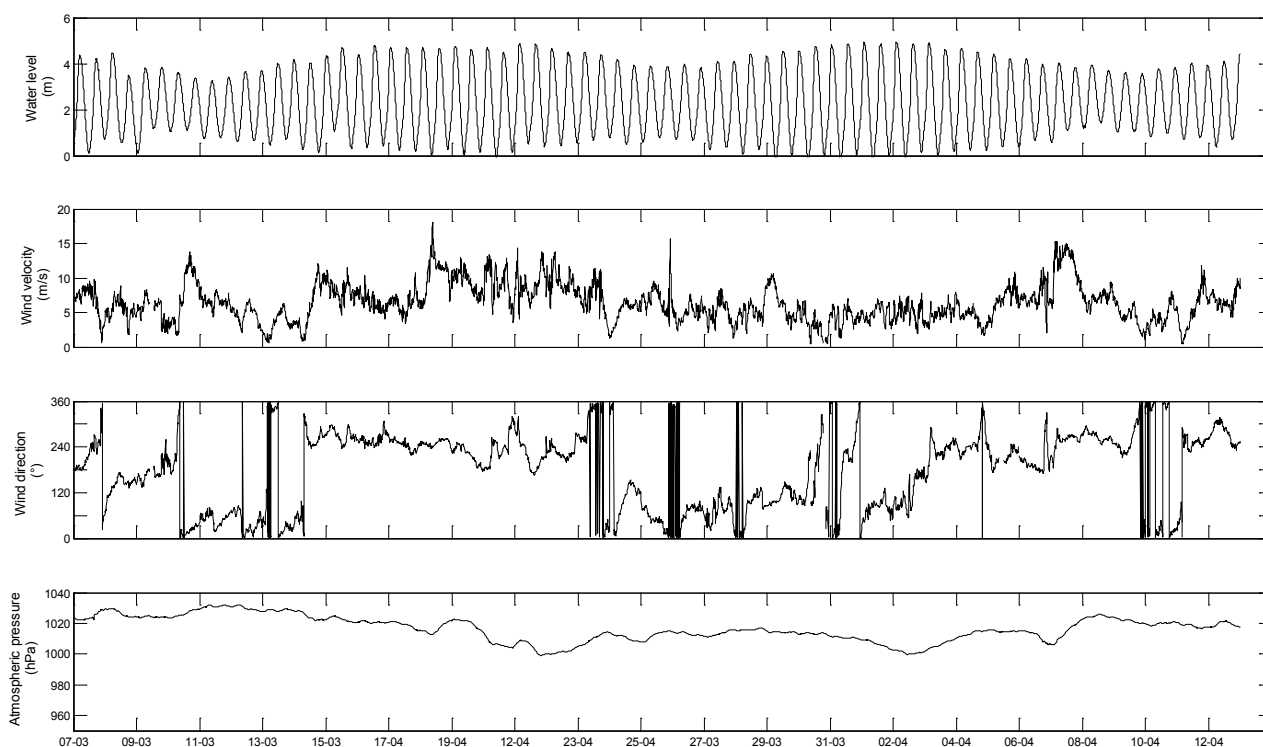
2.1 Description of the meteo-marine conditions during the campaigns

Meteo- and marine conditions were recorded from stations nearby the study area (Figure 1). The maximum water level was of 4.96m TAW, recorded on 2nd April 2014. The field campaign covers two complete lunar tidal cycles. The average of wind speed was 6.4m/s and it reached a maximum value of 18m/s. Most of the time, wind came from SSW-NE. The atmospheric pressure ranged between 999hPa and 1030hPa, but it was most of the time (80%) above 1010hPa.

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.



2.2 Description of the deployment campaign

During the campaign, four metallic frames - Hercules, Hylas I, Hylas II and Hylas III - were deployed at the depths of -6.5m TAW and -3.5m TAW (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 a 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.

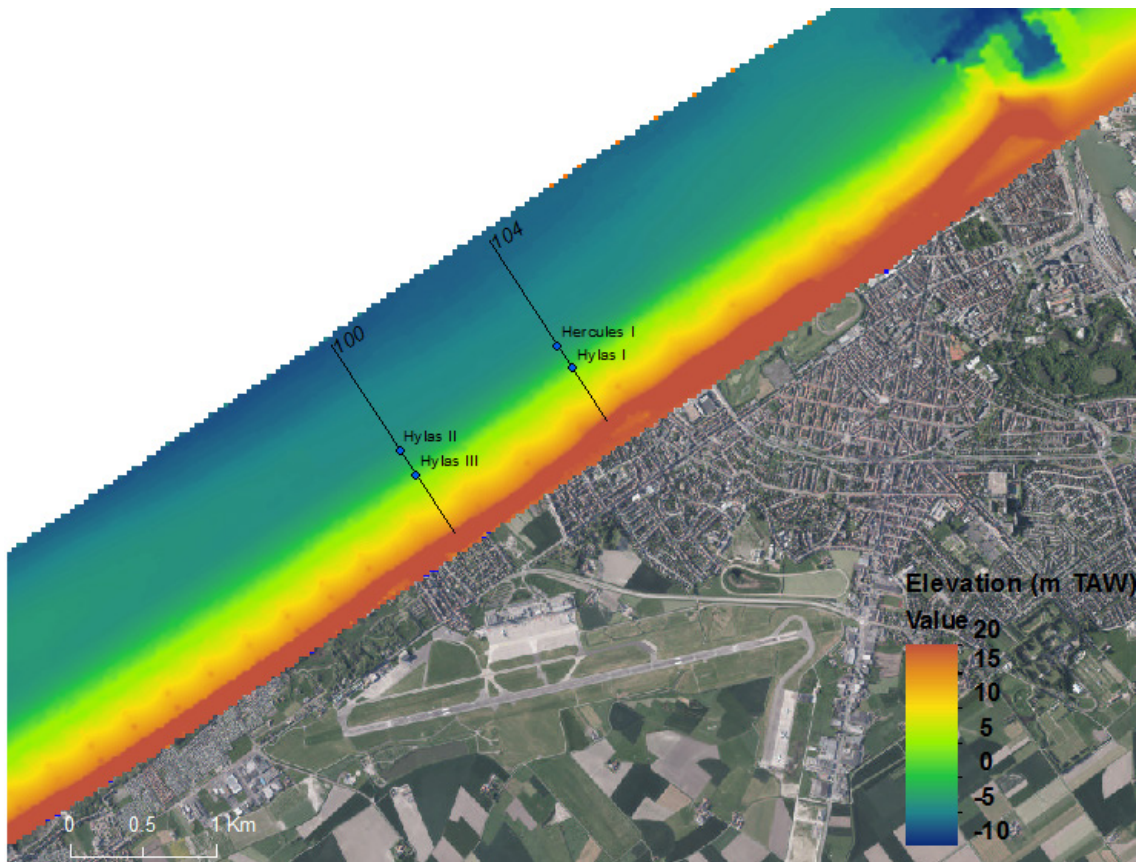


Table 1 – Description of the location and deployment of the instrument frames.

Instrument/Position		Geographical coordinates (WGS84)		Date	Depth (m TAW)
		Longitude	Latitude		
Hercules / M1	Deployment	2°52'23.94"E	51°13'15"N	26/02/2014	-6.5 m
	Retrieval	2°52'23.94"E	51°13'15"N	13/04/2014	-6.5 m
Hylas I / M3	Deployment	2°52'12.48"E	51°13'12.24"N	26/02/2014	-3.5 m
	Re-positioning	2°52'30.96"E	51°13'13.08"N	06/04/2014	-3.5 m
	Retrieval	2°52'28.92"E	51°13'17.94"N	13/04/2014	-3.5 m
Hylas II / M2	Deployment	2°51'27.3"E	51°12'51.18"N	26/02/2014	-6.5 m
	Retrieval	2°51'27.3"E	51°12'51.18"N	23/04/2014	-6.5 m
Hylas III / M4	Deployment	2°51'34.92"E	51°12'46.32"N	26/02/2014	-3.5 m
	Retrieval	2°51'34.92"E	51°12'46.32"N	23/04/2014	-3.5 m

Figure 4 – Hercules frame before deployment.

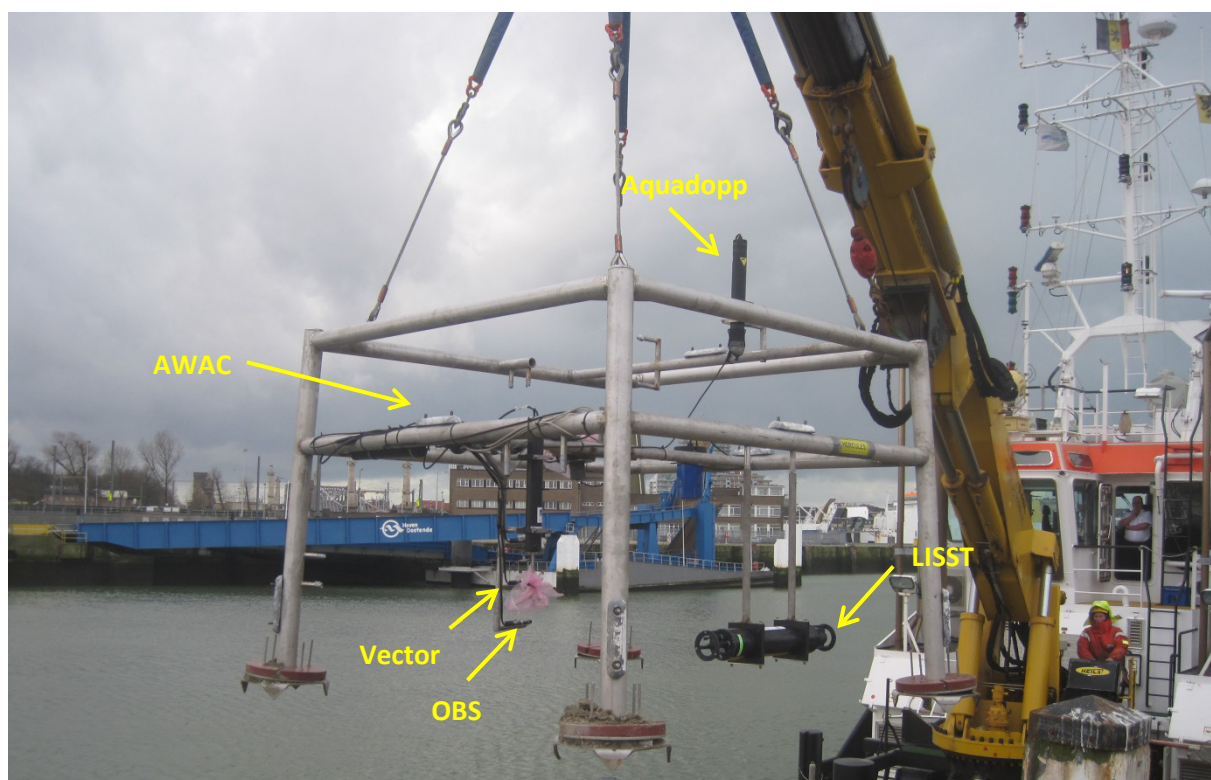


Figure 5 – Hylas I frame before deployment.

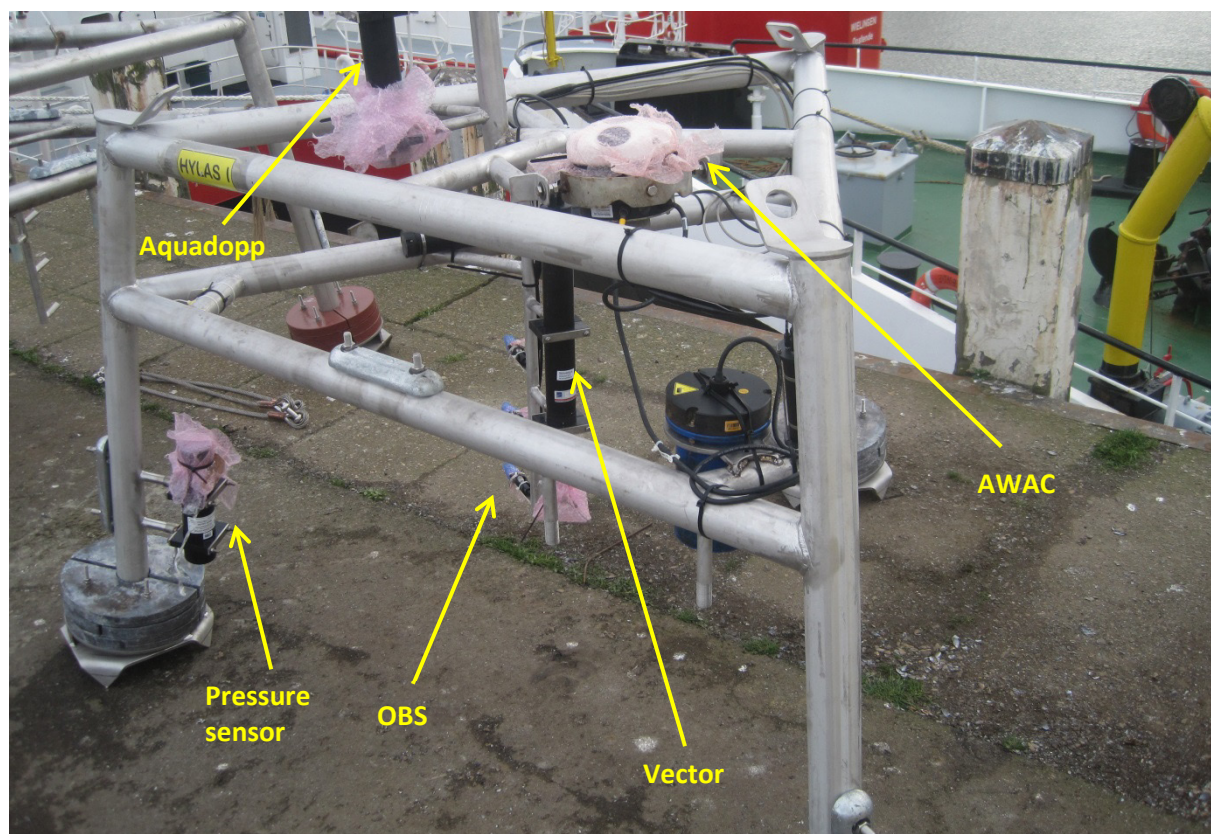


Figure 6 – Hylas II frame before deployment.

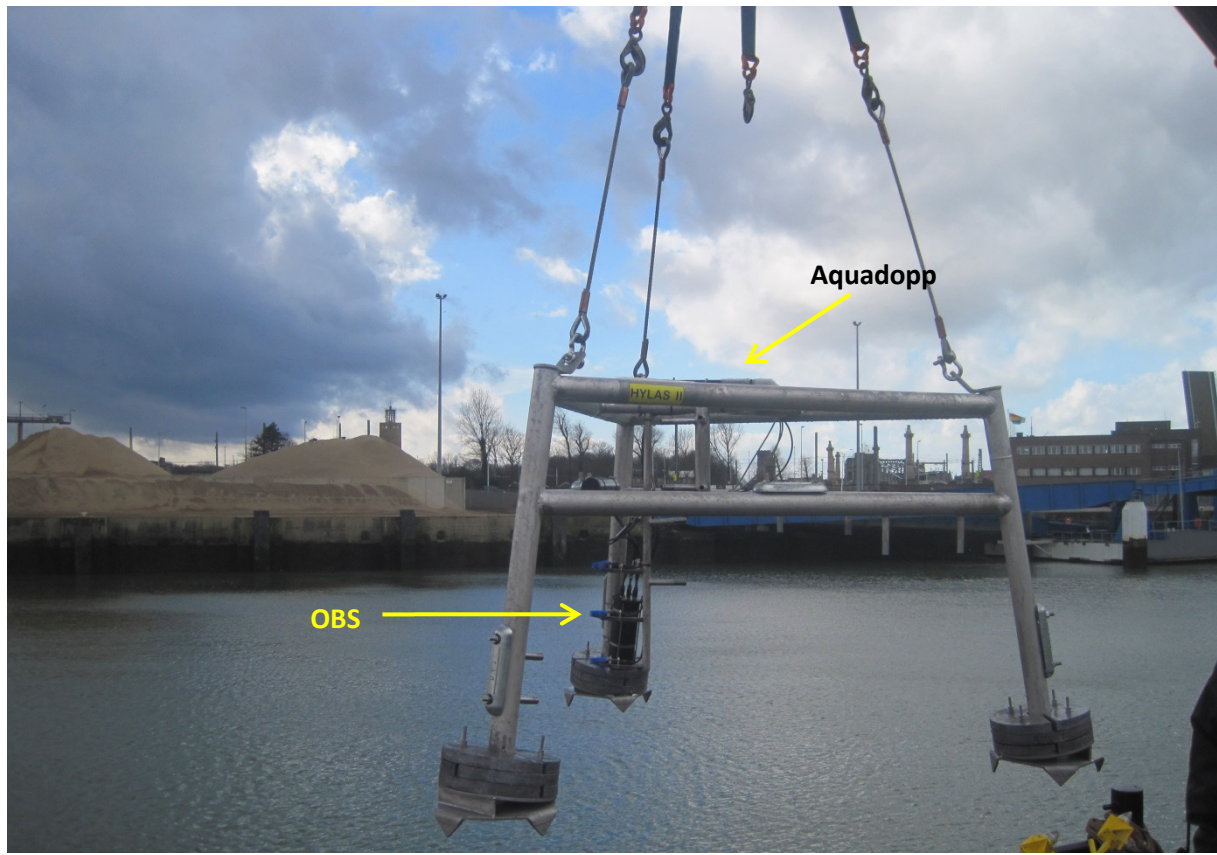
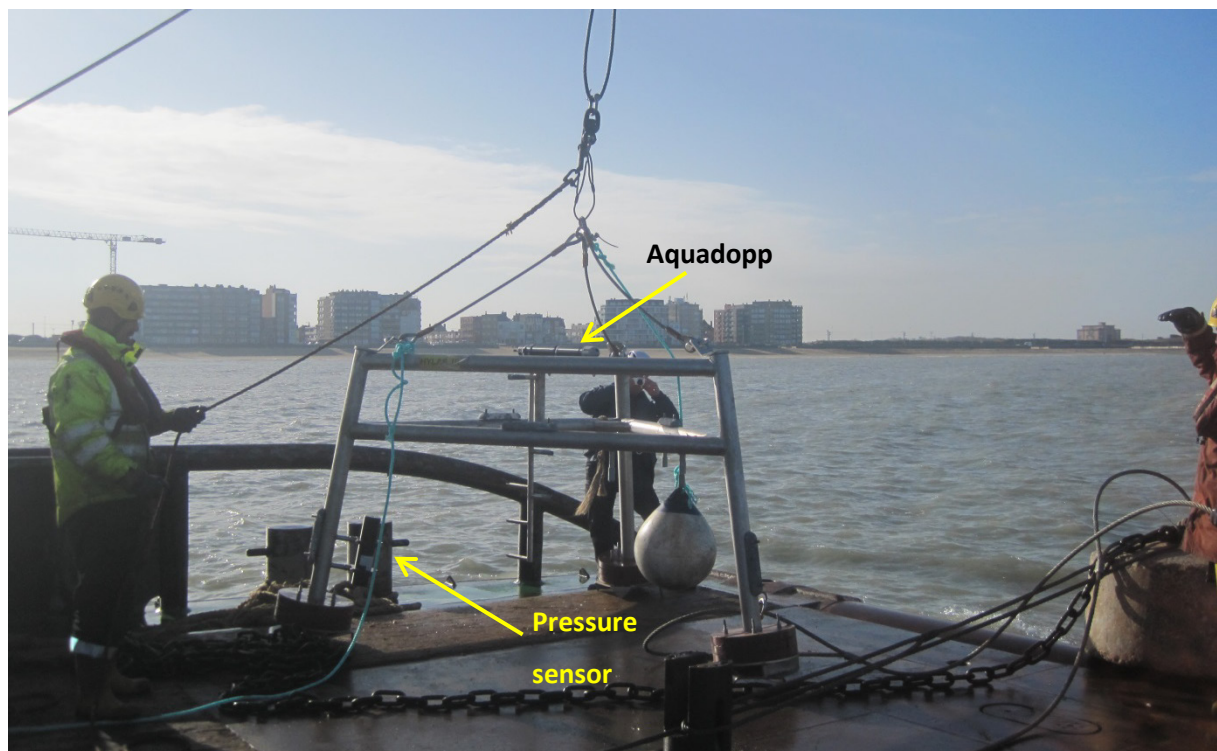


Figure 7 – Hylas III frame before deployment.



2.3 Instruments / 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 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 and Hylas I located around -6.5m TAW and -3.5m TAW respectively. The settings of the AWAC of the Hercules frame were so that there head containing the sensor was situated at the top of the frame around 1.37 m distance from the sea bottom and orientated up-looking, while the heads of the AWAC for the Hylas I frame were around 1.53m from the sea bottom. The instrument was installed in 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 1).

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 Hercules and Hylas I frames located around -6.5m TAW and -3.5m TAW respectively. The vector on Hercules was vertically placed at a distance of 0.51 m from the seafloor and the one on Hylas I frame around 0.42m (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 (u, v) and vertical direction (w) at a fix 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 Aquadopps profilers 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 and Hylas I frames were used to measure the current velocity (AWAC-C). 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 1.76m for Hercules frame, at 1.41m for Hylas I frame, at 1.48m for Hylas II frame and at 1.45m for Hylas III frame, and all 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 1. 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 in Appendix 1).

2.3.4 Suspended sediment profiles

Description, principle of the operation and sampling rate: water samples were collected using a pump after the deployment of the frames. The samples were taken in the vicinity of the frames (as close as navigation safety rules allow) from the Zeetijger ship. The details about sampling conditions are presented in Table 2. Samples were analyzed in the sediment laboratory at WL to determine the suspended sediment concentration and the grain size distribution.

Related software and output files: samples_frames.xlsx. The data files are in .xlsx format.

Table 2 – Description of the sampling conditions.

No. sample	Sample volume (l)	Date	Hour	Latitude (N)	Longitude (E)	Depth (m)	Water level (m)	Absolute (m)	Elevation (m)
SC2014 005709	1	6/03/2014	15:01:00	51°13'17.94"	2°52'28.92"	10.4	3.4	7	1
SC2014 005710	1	6/03/2014	15:01:10	51°13'17.94"	2°52'28.92"	10.4	3.4	7	1
SC2014 005711	1	6/03/2014	15:01:20	51°13'17.94"	2°52'28.92"	10.4	3.4	7	1
SC2014 005712	1	6/03/2014	15:01:30	51°13'17.94"	2°52'28.92"	10.4	3.4	7	1
SC2014 005713	1	6/03/2014	15:01:40	51°13'17.94"	2°52'28.92"	10.4	3.4	7	1
SC2014 005714	1	6/03/2014	15:01:50	51°13'17.94"	2°52'28.92"	10.4	3.4	7	1
SC2014 005715	1	6/03/2014	15:02:00	51°13'17.94"	2°52'28.92"	10.4	3.4	7	1
SC2014 005716	1	6/03/2014	15:02:10	51°13'17.94"	2°52'28.92"	10.4	3.4	7	1
SC2014 005717	1	6/03/2014	15:02:20	51°13'17.94"	2°52'28.92"	10.4	3.4	7	1
SC2014 005718	1	6/03/2014	15:02:30	51°13'17.94"	2°52'28.92"	10.4	3.4	7	1

(the settings as recorded by the instruments are detailed in Appendix 12. Detailed settings of the instruments)

2.3.5 Pressure

Principle of operation: The AWAC and aquadopp sensors measured the pressure (dBar) during the campaign period. Also, pressure sensors were mounted on Hylas I and Hylas II around 0.60m and 0.59m from the seafloor respectively (both frames were located around -3.5m TAW). Pressure sensors, measuring in bar, were deployed in order to convert the records to wave height and wave period (not presented here)

Sampling rate: For the AWAC, aquadopp, and vector sensors, the sampling rate was an averaged value per hour. However, the resolution of each pressure sensor was 5Hz measuring continuously (Table 3).

Related software and output files: The data are located in .sen file for the AWAC, aquadopp and vector sensors. For the pressure sensors, the data are in .sen format.

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 3 – Description of instrument settings.

Frame	Instrument	Serial number	Position	Distance sensor - sea floor (m)
Hercules / M1	AWAC	WPR2022	Up-looking	1.37
	AQUADOPP-HR	AQD 8481	vertical down-looking	1.76
	VECTOR	VEC 8170	vertical down-looking	0.51
	Data Logger	HIC_00018		
	OBS	T8852		0.73
	OBS	T8853		0.55
	OBS	T8859		0.34
	LISST			0.31
Hylas I / M3	AWAC	WPR2004	Up-looking	1.53
	AQUADOPP-HR dolooking	AQD 8471	vertical down-looking	1.41
	VECTOR	VEC 8185	vertical down-looking	0.42
	Data Logger	HIC_00019		
	OBS	T8854		0.70
	OBS	T8855		0.50
	OBS	T8858		0.30
	Pressure sensor	HIC_00113		0.60
Hylas II / M2	AQUADOPP-HR	AQD8479	horizontal downlooking	1.48
	Data Logger	HIC_00017		
	OBS	T8856		0.52
	OBS	T8857		0.32
	OBS	T8860		0.12
Hylas III / M4	AQUADOPP-HR	AQD11842	horizontal downlooking	1.45
	Pressure sensor	HIC_00112		0.59

Table 4 – Measurement scheme.

Instrument	Measurement duration											
	1 st hour						2 nd hour					
AWAC Currents (2Hz)	10 min						10 min		10 min		10 min	
AWAC Waves (2Hz)		20 min										
Aquadop HR (2Hz)			8 min						8 min			
Vector (16Hz)			10 min						10 min			
OBS (4Hz)			10 min						10 min			
Pressure sensor (5Hz)		20 min					20 min					
Time Interval	2 hours											

Figure 8 – Connection between instruments for the frame Hercules

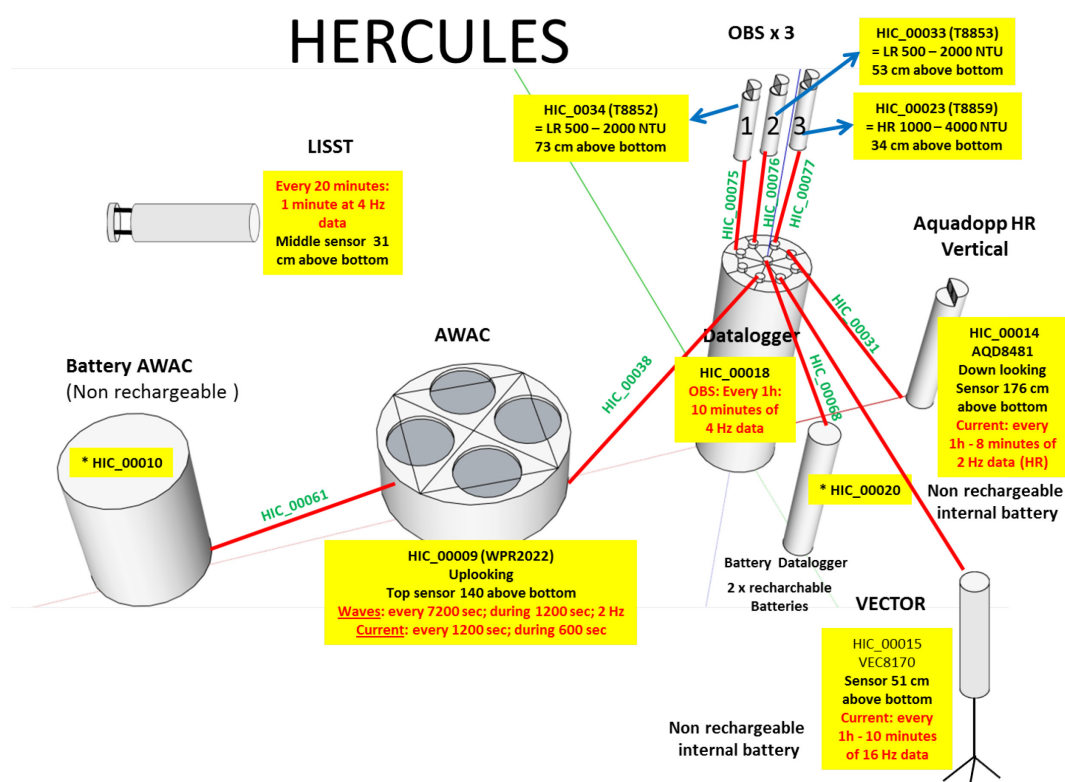


Figure 9 – Connection between instruments for the frame Hylas I

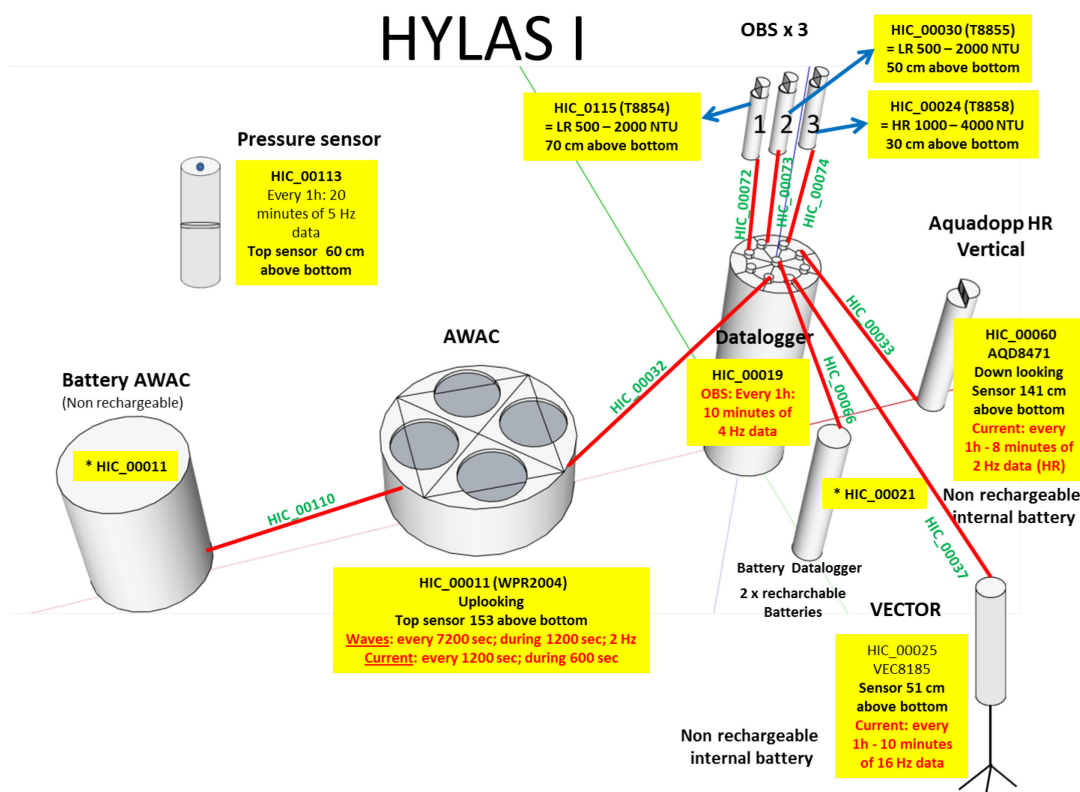
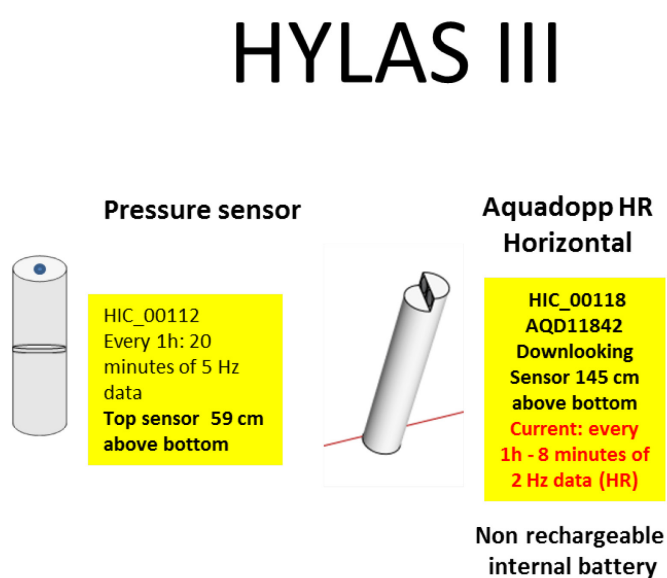
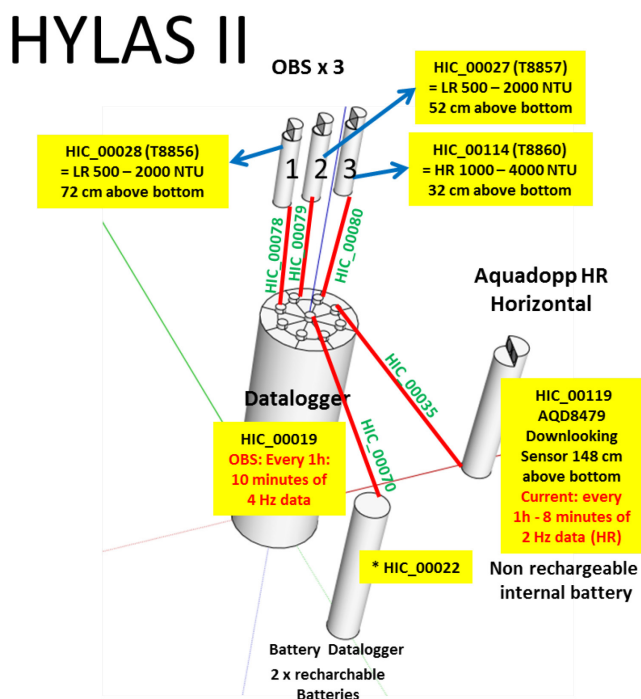


Figure 10 – Connection between instruments for the frame Hylas II

Figure 11 – Connection between instruments for the frame Hylas III



3 Measurement results

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

3.1 Waves

The AWAC sensors mounted on Hercules frame (-6.5m TAW), Hylas I frame (-3.5m TAW), were relatively stable with limited heading, pitch and roll motions of less than 4° which are acceptable (see in Appendices 2.1. and 2.4.). The complete time series of significant wave height (Hm0), maximum wave height (Hmax), peak period (Tp) and mean wave direction (MeanDir) are displayed in Appendix 3. Statistical analyses of the wave parameters are presented too.

3.2 Near-bed flow velocity

Time series of the vector orientation on Hercules and Hylas I frames are displayed in Appendices 2.3. and 2.6. The motion of the heading, pitch and roll together were less than 3° for most of the time. Appendix 4 presents the time series of the records. Statistical analyses were also carried out.

3.3 Velocity profiles

The motions of each Aquadopp sensor mounted on the four frames were in acceptable range of less than 5° (see Appendices 2.2, 2.5, 2.7 and 2.8).

Time series of the total records of flow velocity from every AWAC and aquadopp cells in three directions eastward, northward and vertical are presented respectively in Appendices 5.1.1, 5.2.1 (for Hercules); 6.1.1, 6.2.1 (Hylas I); 7.1.1 (Hylas II) and 8.1.1 (Hylas III). 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 either the AWAC and the Aquadopp or only Aquadopp sensors are displayed in the second part of these appendices just mentioned above.

3.4 Suspended sediment profiles

The sediment concentration and grain size distribution are presented in Appendix 9.

3.5 Pressure

Time series of pressure data measured from every sensors are shown in Appendix 10.

3.6 Temperature

Time series of temperature data measured from every sensors are shown in Appendix 11.

3.7 Data

All the raw and processing data are saved in :

P:\00_128-VooroevGeulSu\3_Uitvoering\Data\Campaigns\20140307_20140412

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.

Montreuil, A-L., Dan, S., Vereecken, H., De Backer, E., Claeys, S., Verwaest, T., Mostaert, F. (2017) Alternative measures for beach nourishment maintenance: Monitoring of a pilot experiment at Mariakerke, Measuring campaign November-December 2013 Version 1.4. FHR, 00_128_6. Flanders Hydraulics Research: Antwerp.

Appendix 1 Output data files.

1.1 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 data
.wap	Processed data

1.2. 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

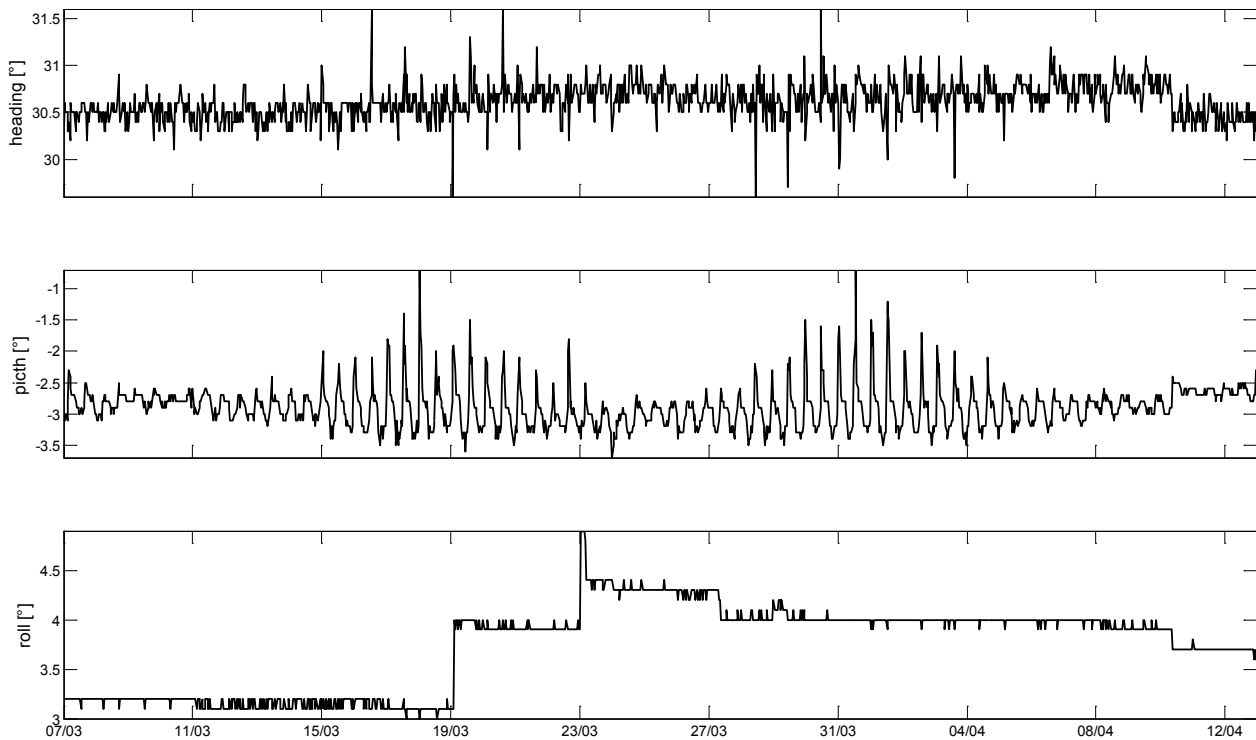
1.3 Vector output files

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

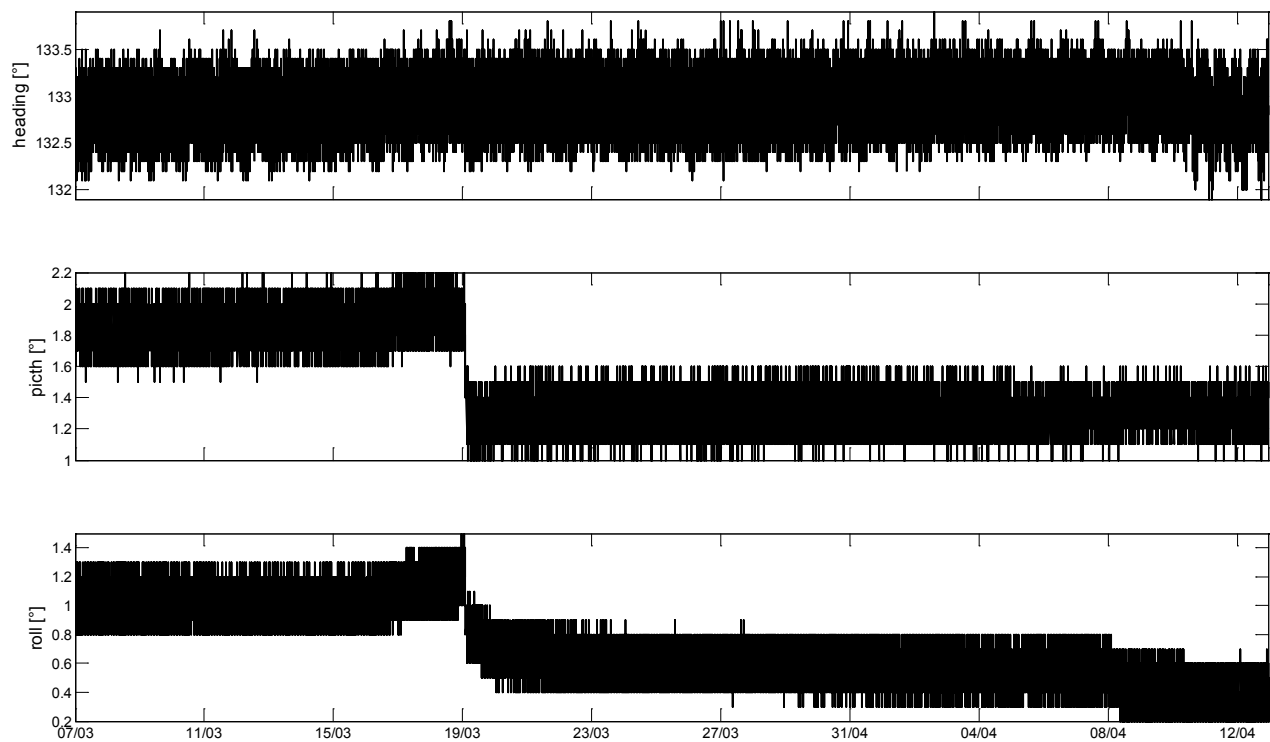
Appendix 2 Instrument orientation.

Hercules frame

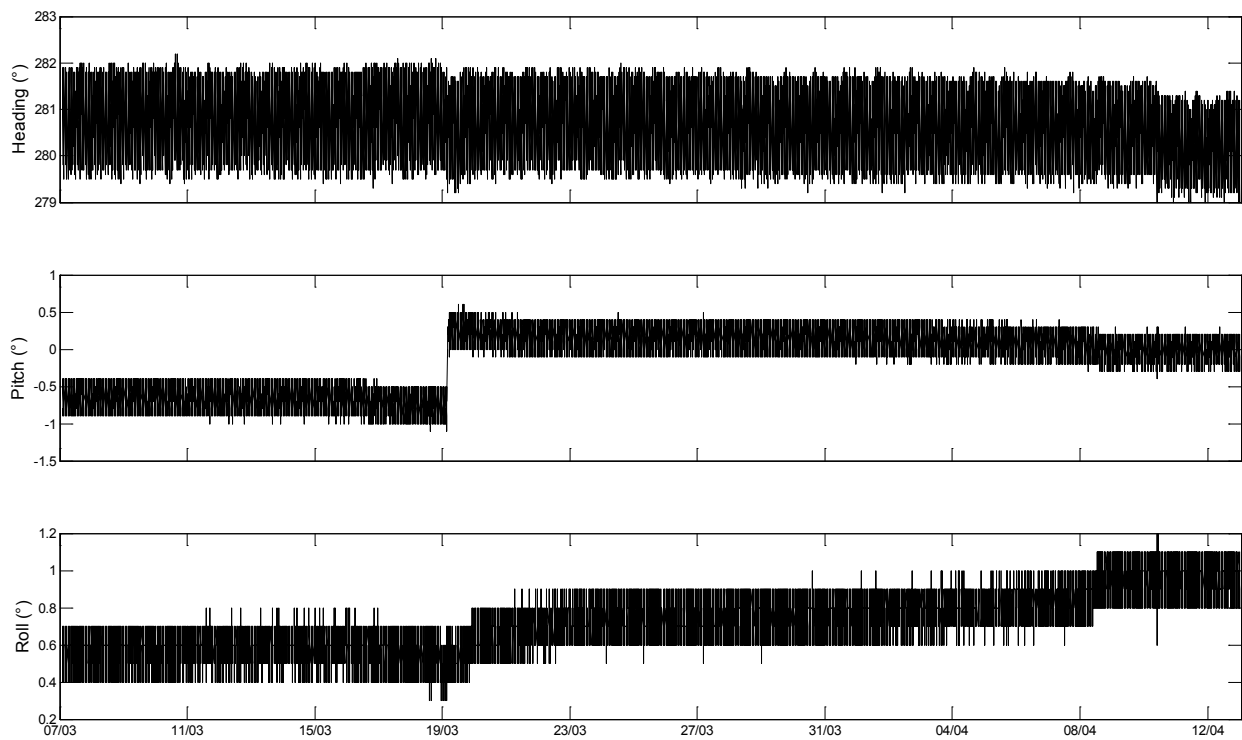
2.1. Awac-time serie



2.2. Aquadopp-time serie

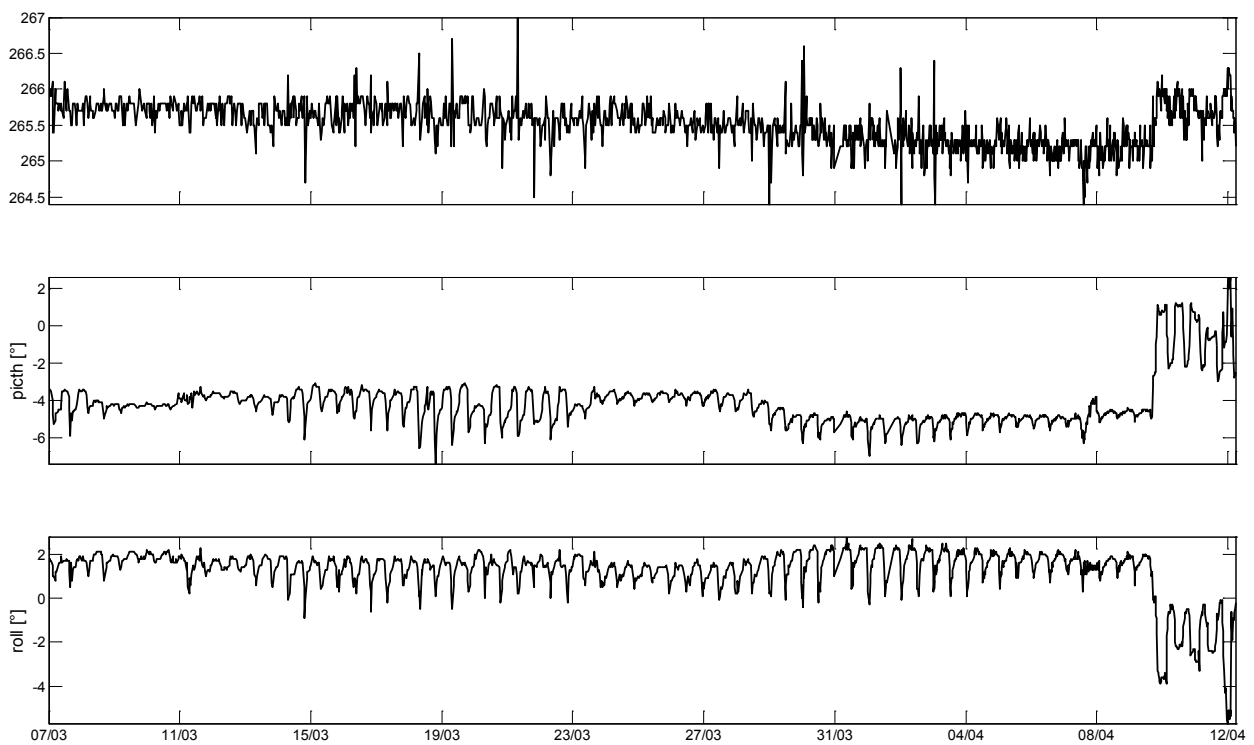


2.3. Vector-time serie

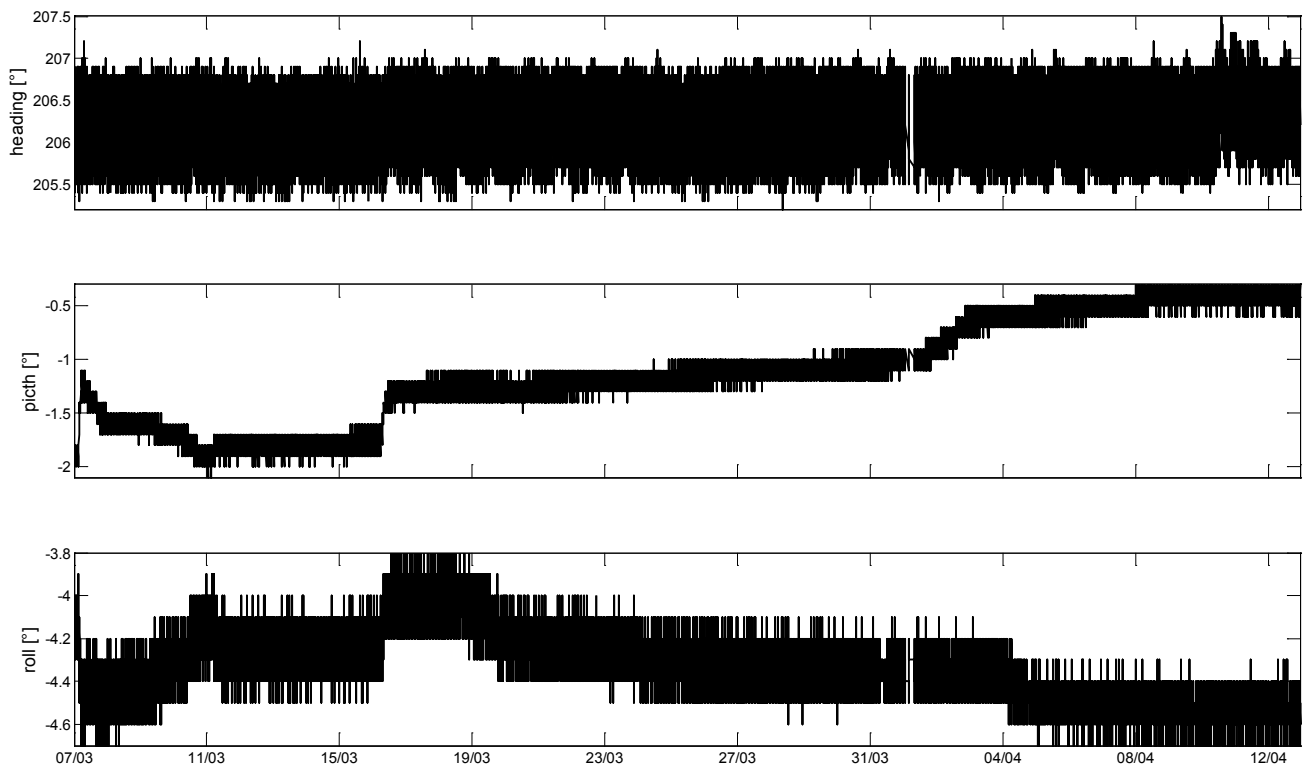


Hylas I frame

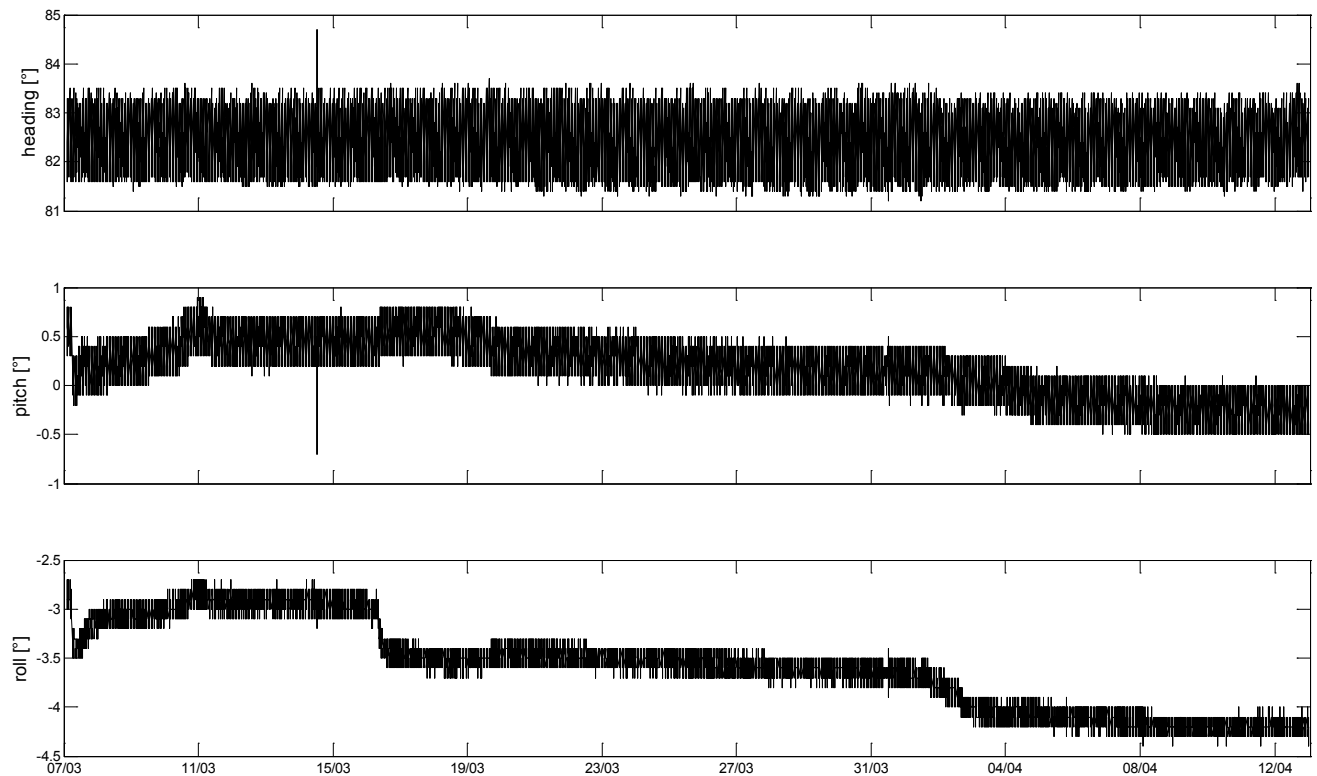
2.4. AWAC-time serie



2.5. Aquadopp-time serie

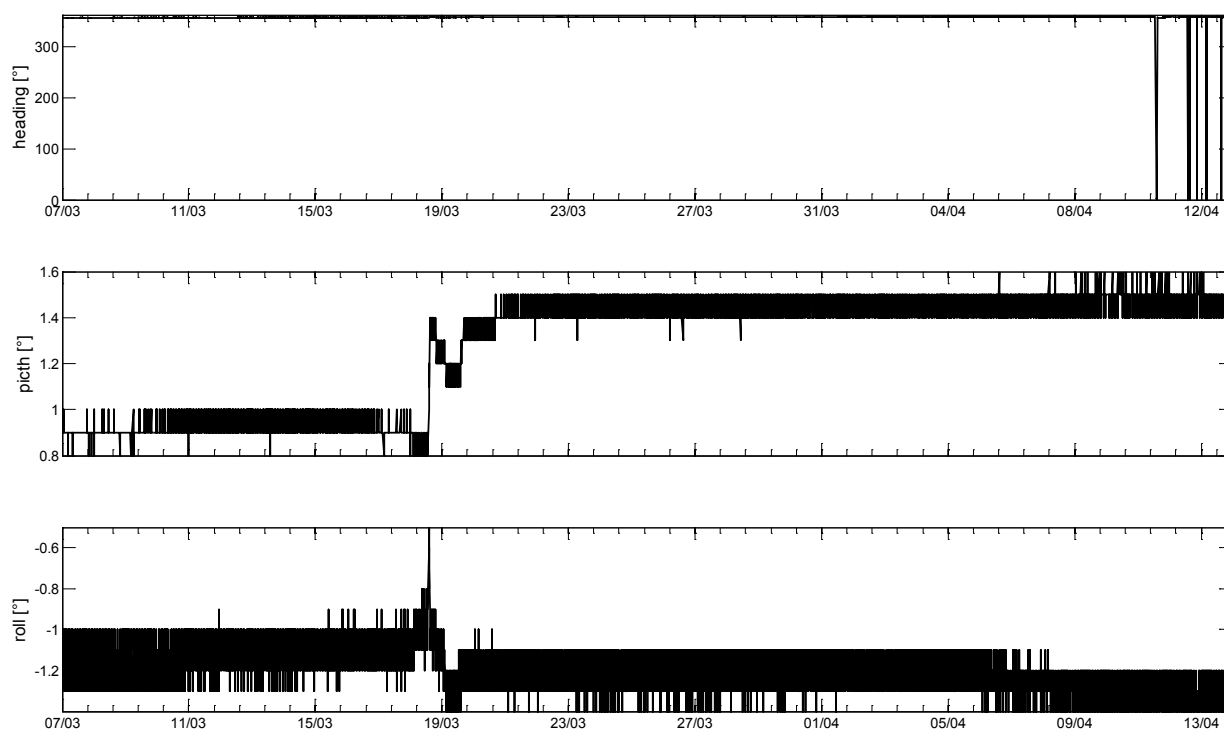


2.6. Vector-time serie



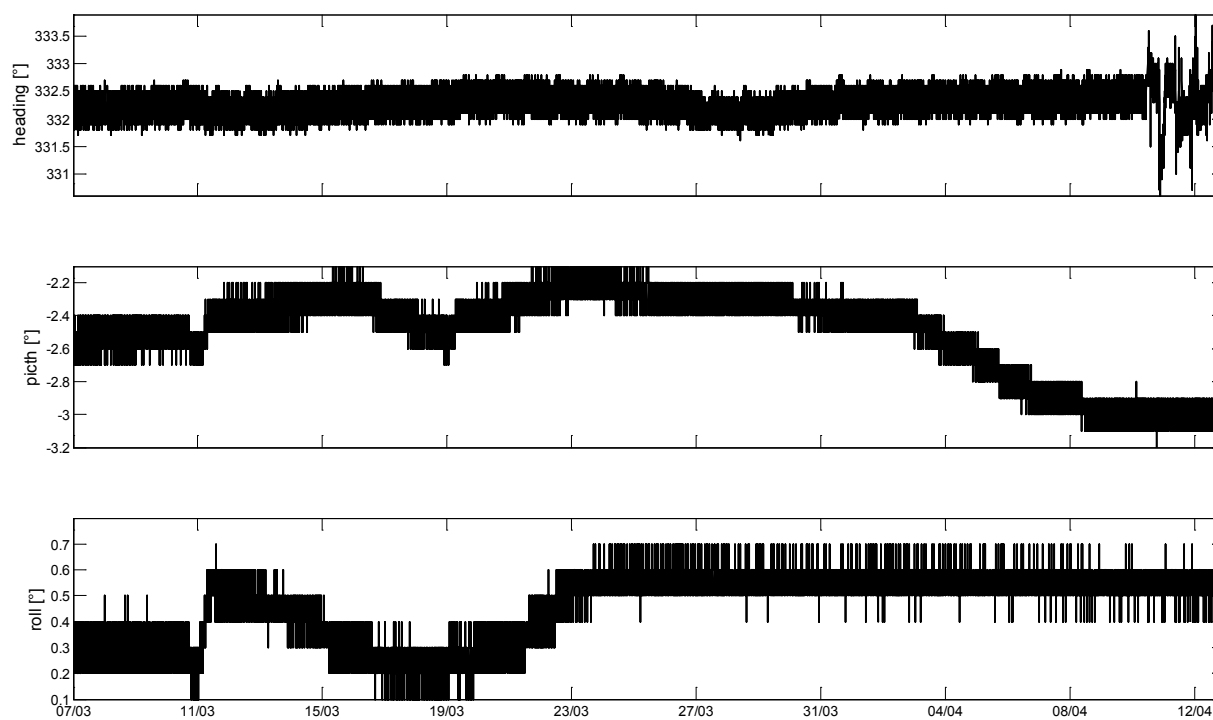
Hylas II frame

2.7. Aquadopp-time serie



Hylas III frame

2.8. Aquadopp-time serie



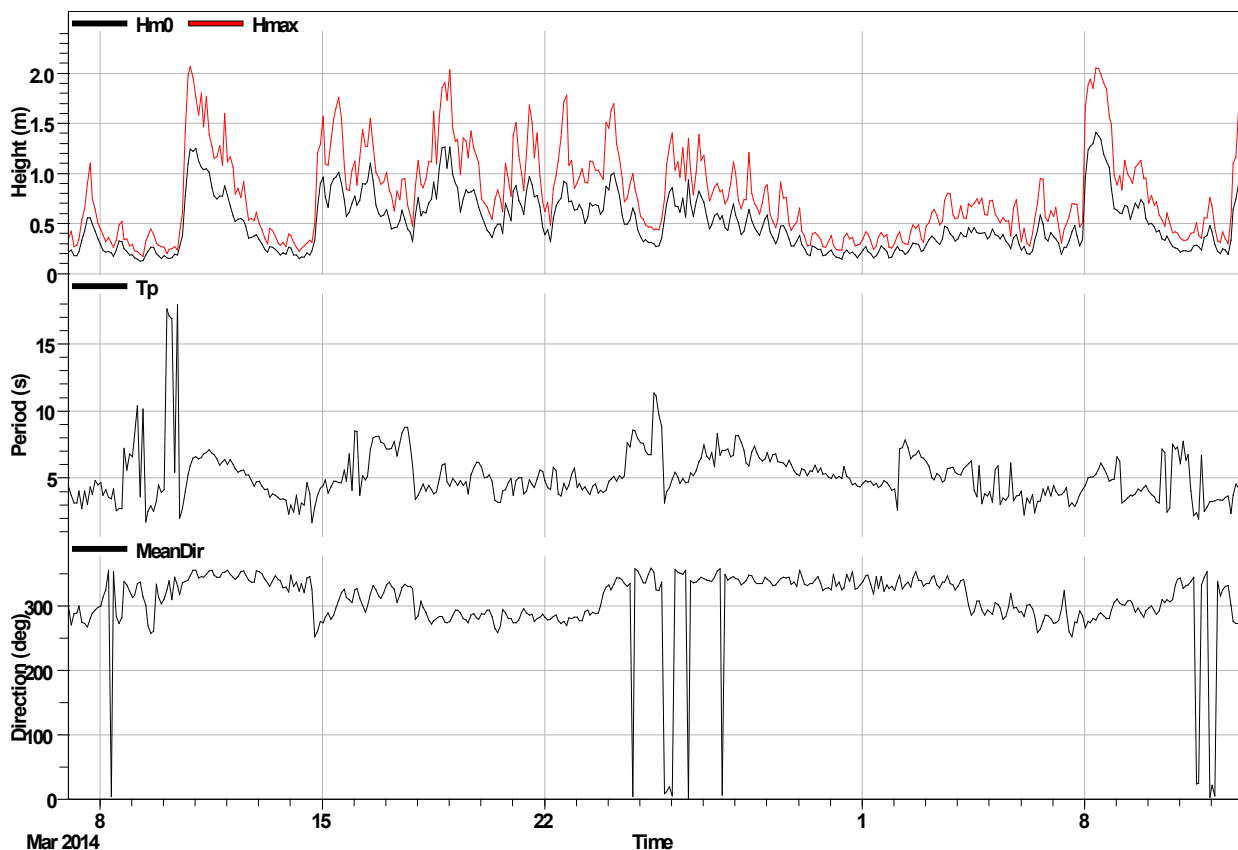
Appendix 3 Time serie of waves.

Waves recorded from the AWAC sensors

Description of parameters

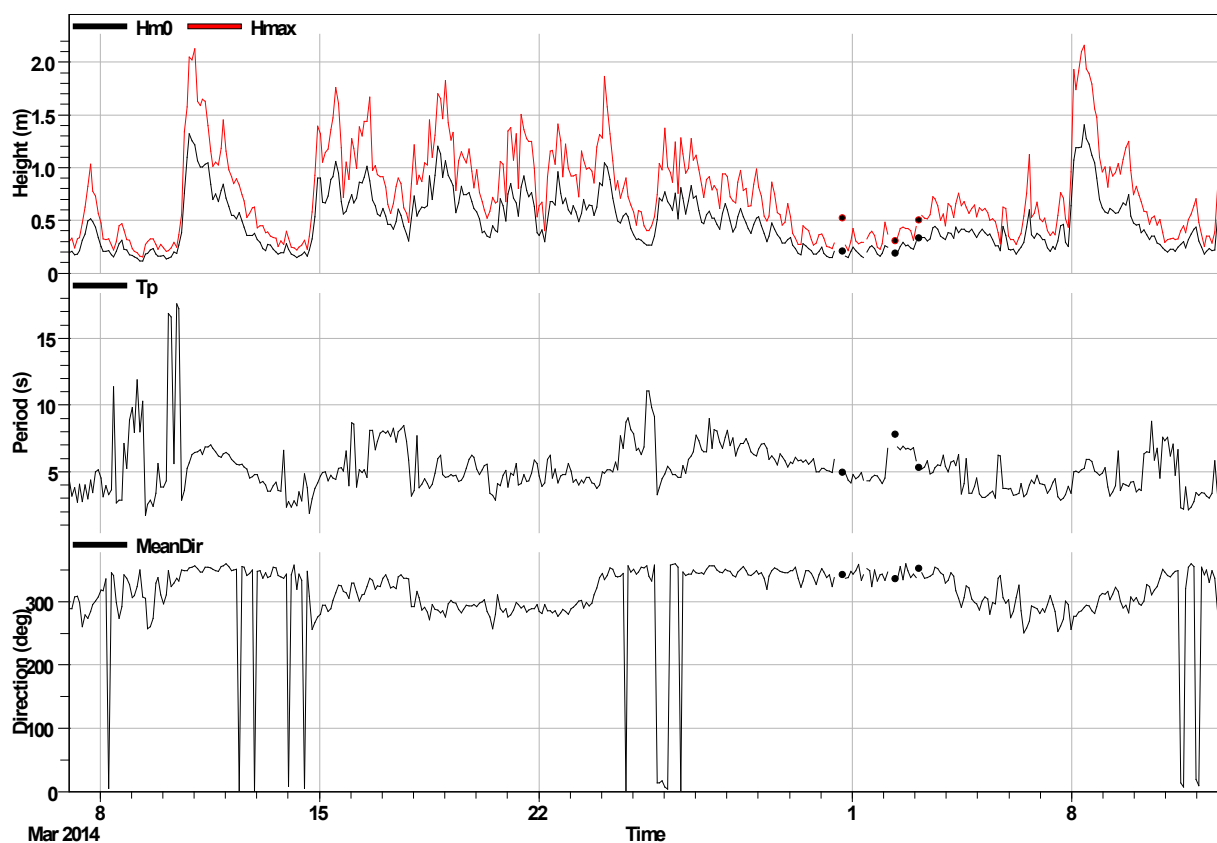
Hm0	Significant wave height (m)
Hmax	Maximum wave height (m)
Tp	Peak period (s)
MeanDir	Mean direction of the waves (°)

Hercules (-6.5m TAW)



	Unit	Mean	Standard deviation	Kurtosis	Skewness	Max	Min	Range
Hm0	m	0.50	0.28	3.28	0.91	1.41	0.13	1.28
Hmax	m	0.78	0.44	3.15	0.89	2.07	0.17	1.90
Tp	s	5.17	1.97	14.99	2.41	17.92	1.68	16.24
Dir	°	305.83	58.16	19.78	-3.78	358.56	1.26	357.3

Hylas I (-3.5m TAW)

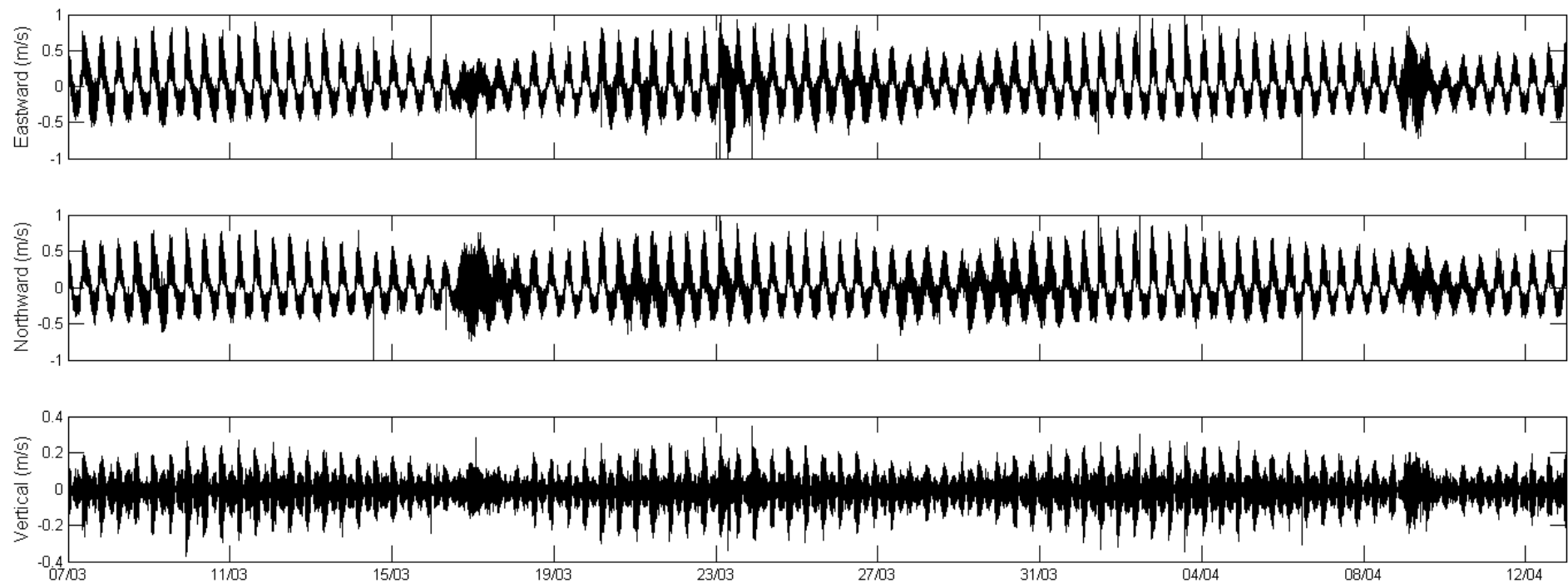


	Unit	Mean	Standard deviation	Kurtosis	Skewness	Max	Min	Range
Hm0	m	0.48	0.26	3.35	0.91	1.4	0.12	1.28
Hmax	m	0.76	0.42	3.41	0.90	2.16	0.15	2.01
Tp	s	5.28	1.99	12.93	2.23	17.58	1.74	15.84
Dir	°	308.72	64.68	17.2	-3.6	359.97	0.17	359.80

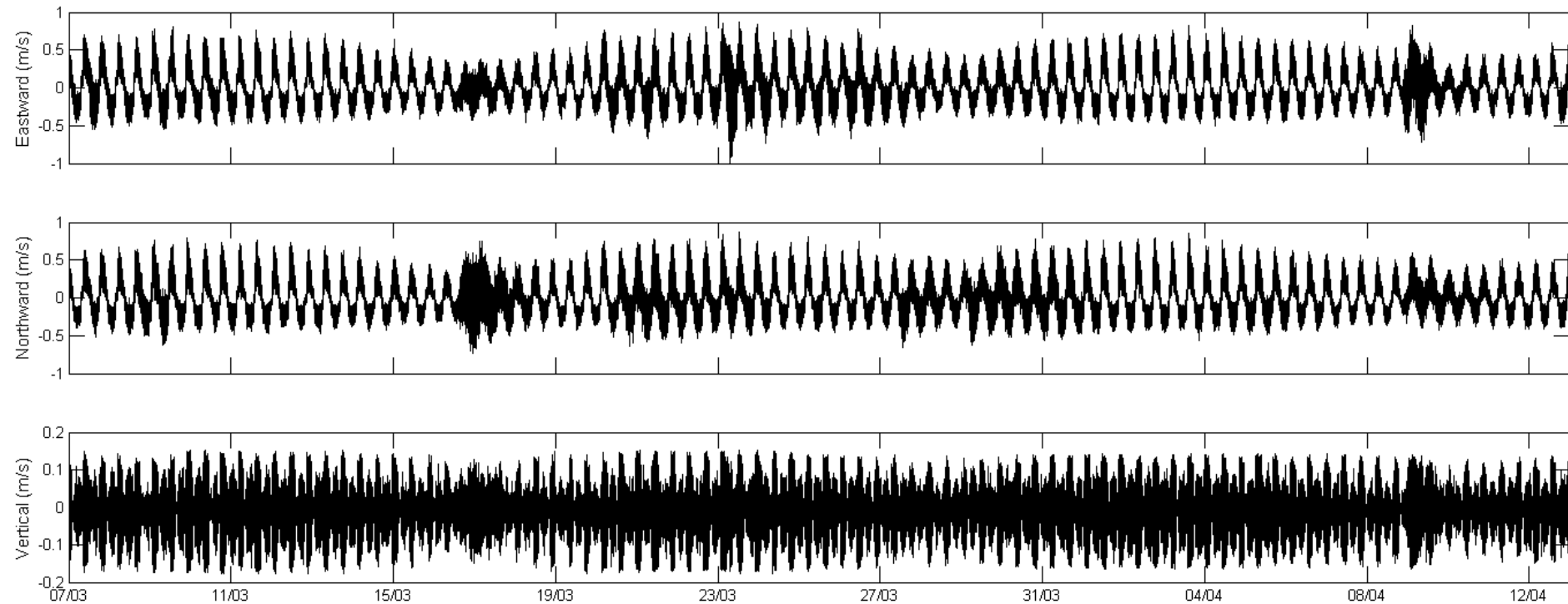
Appendix 4 Time serie of near-bed flow velocity.

Near-bed currents recorded from the vector on Hercules frame (-6.5m TAW)

No processed data



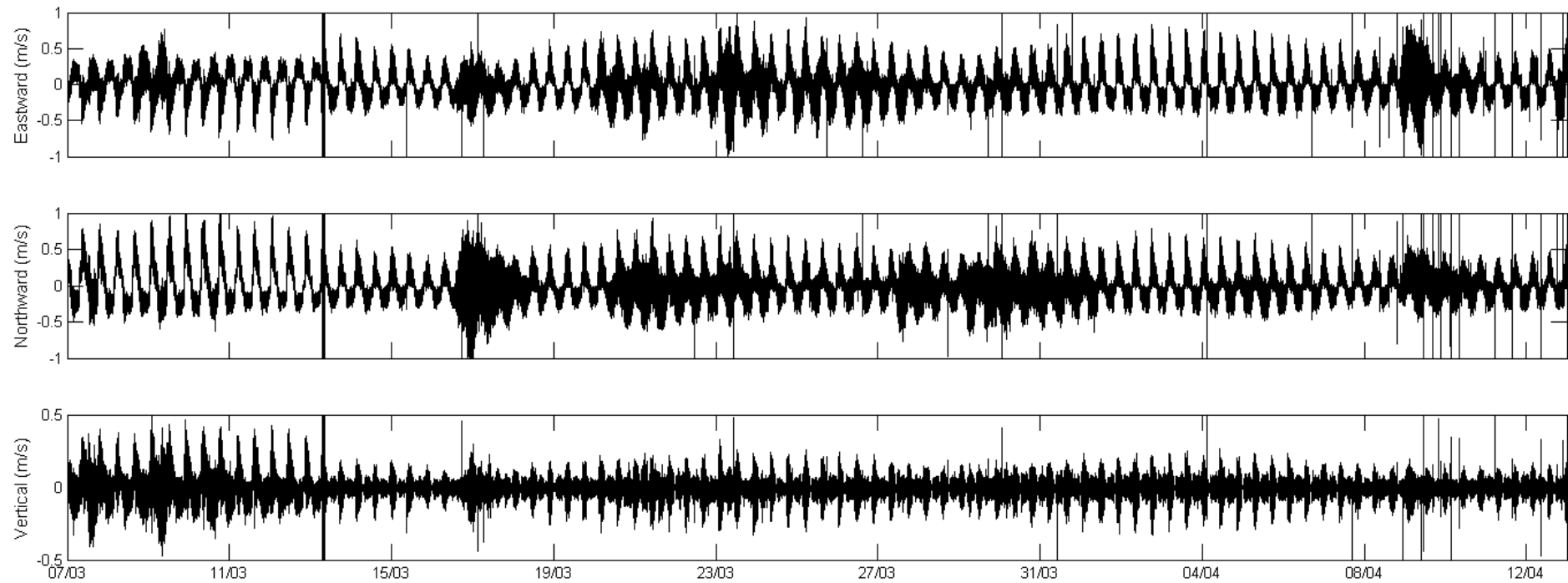
Processed data



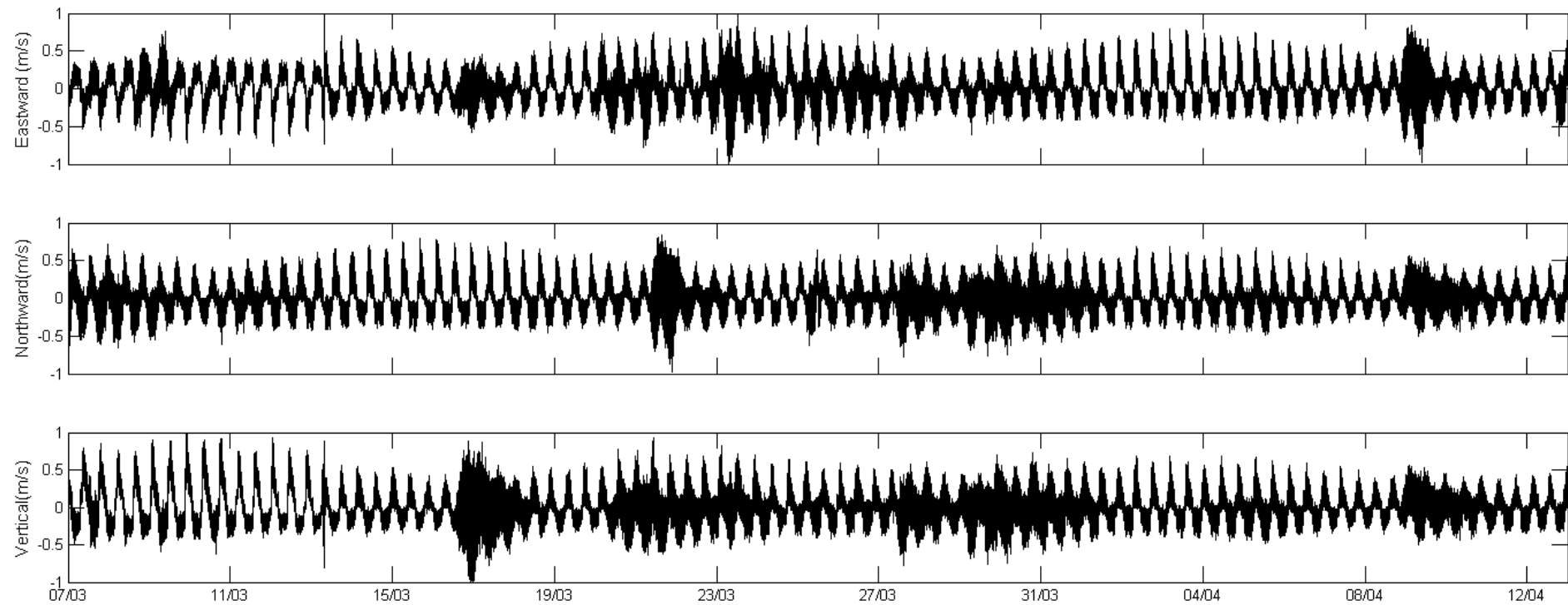
Component	Unit	Mean	Standard deviation	Kurtosis	Skewness	Max	Min	Range
Eastward	m/s	0.01	0.22	2.11	0.36	0.87	-0.99	1.86
Northward	m/s	-0.002	0.21	2.19	0.41	0.88	-0.74	1.62
Vertical	m/s	-0.01	0.03	5.61	0.03	0.15	-0.18	0.33

Near-bed currents recorded from the vector on Hylas I frame (-3.5m TAW)

No processed data



Processed data

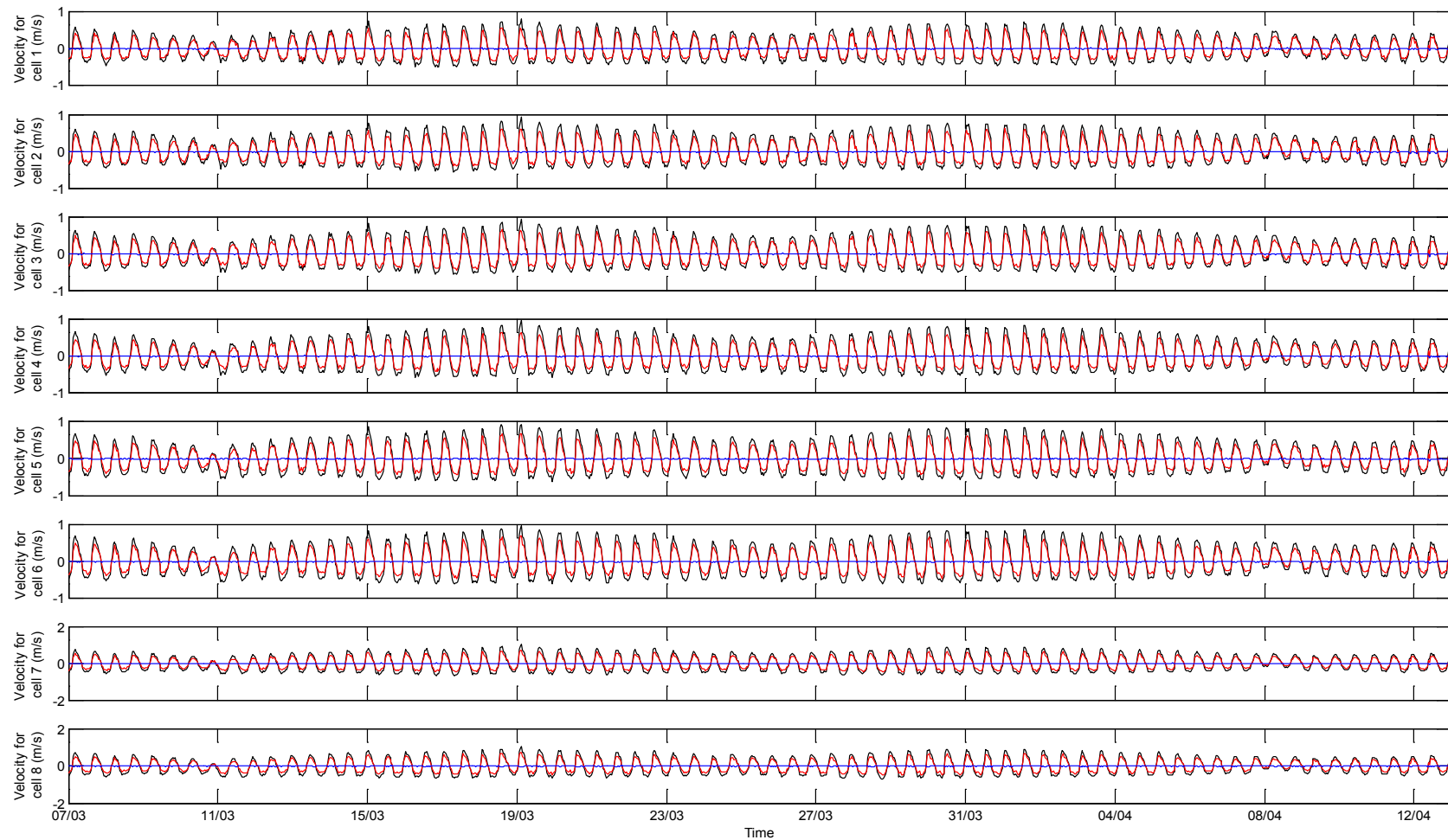


Component	Unit	Mean	Standard deviation	Kurtosis	Skewness	Max	Min	Range
Eastward	m/s	0	0.19	2.44	0.19	1.05	-0.99	2.04
Northward	m/s	0	0.17	2.48	0.34	0.84	-0.97	1.81
Vertical	m/s	0	0.19	3.55	0.67	1.02	-1.16	2.18

Appendix 5. Current profiles from Hercules frame (-6.5m TAW)

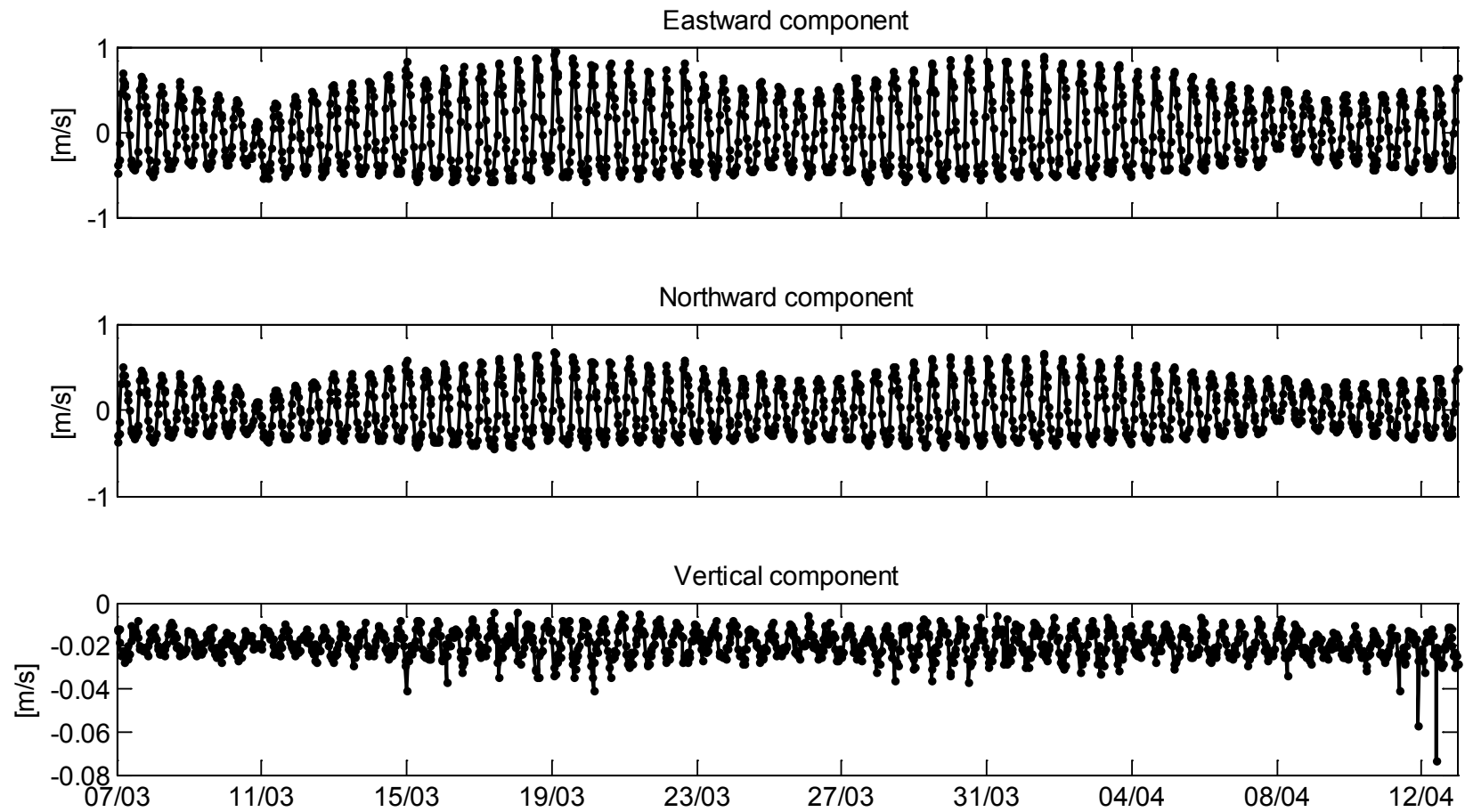
5.1. Currents recorded from the AWAC

5.1.1. Current records from every beams.



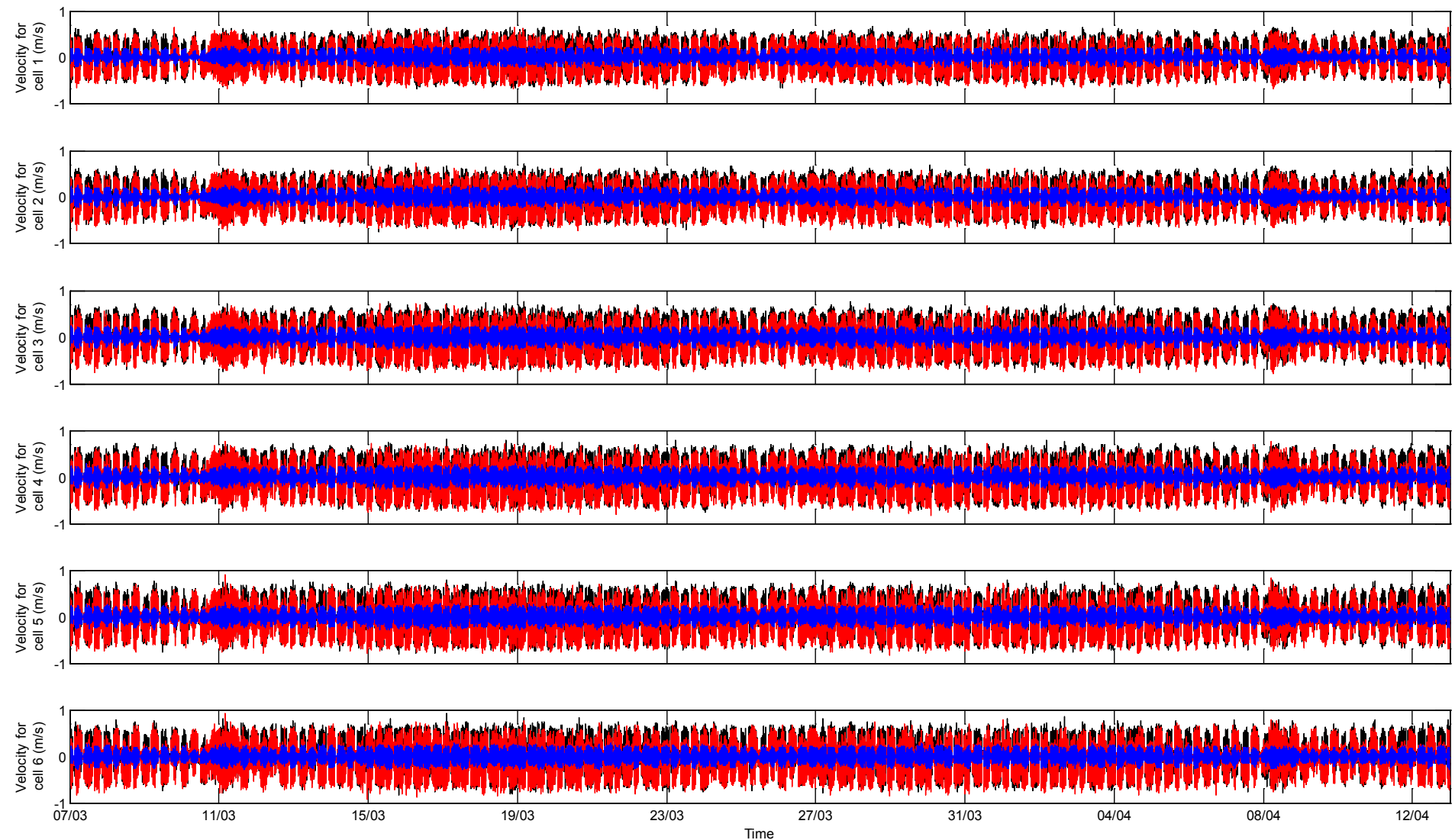
Black, red and blue colours correspond to the u-, v- and w-velocity components

5.1.2. Depth-averaged velocity

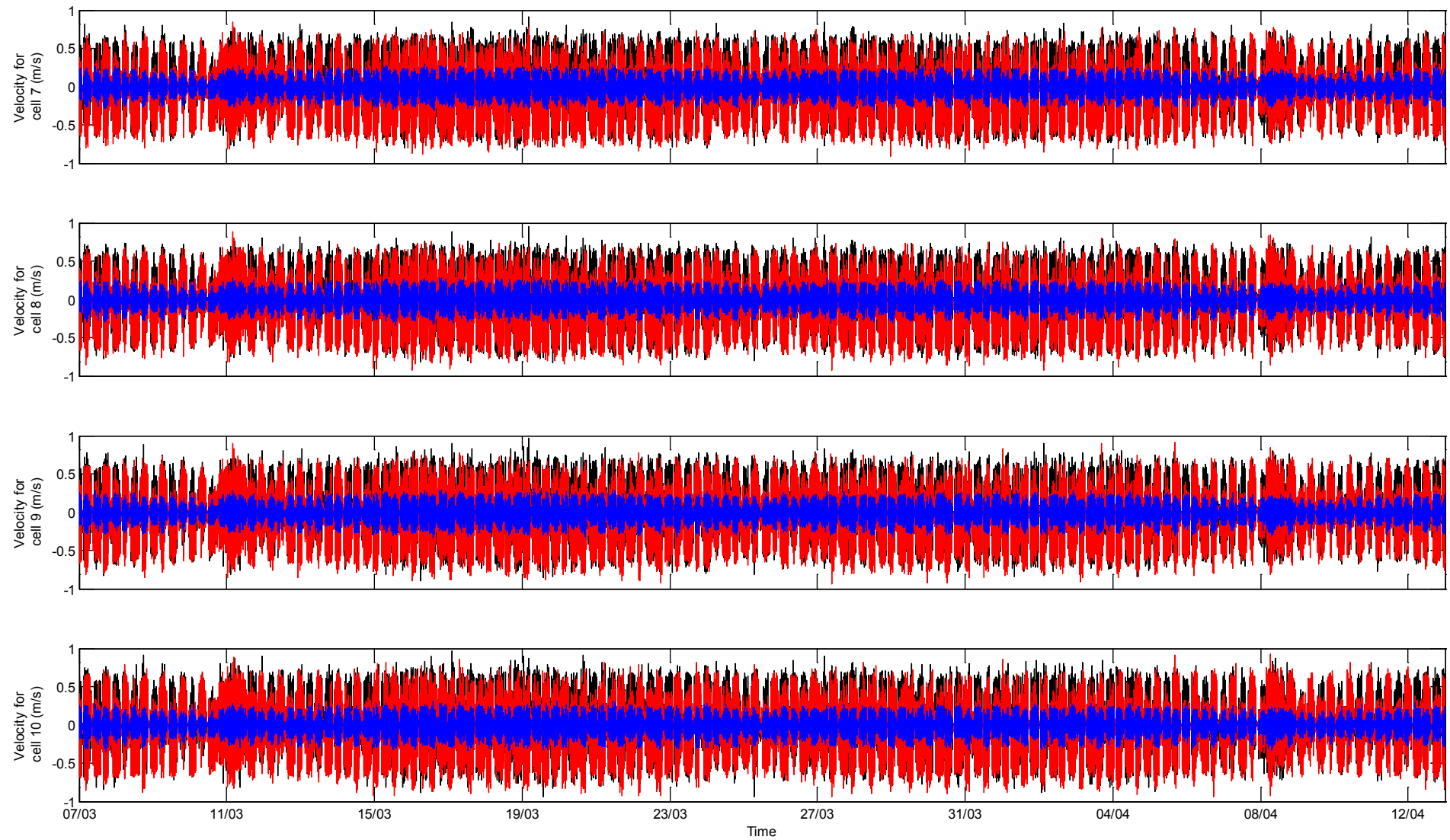


5.2. Currents recorded from the aquadopp

5.2.1. Current records from every beams

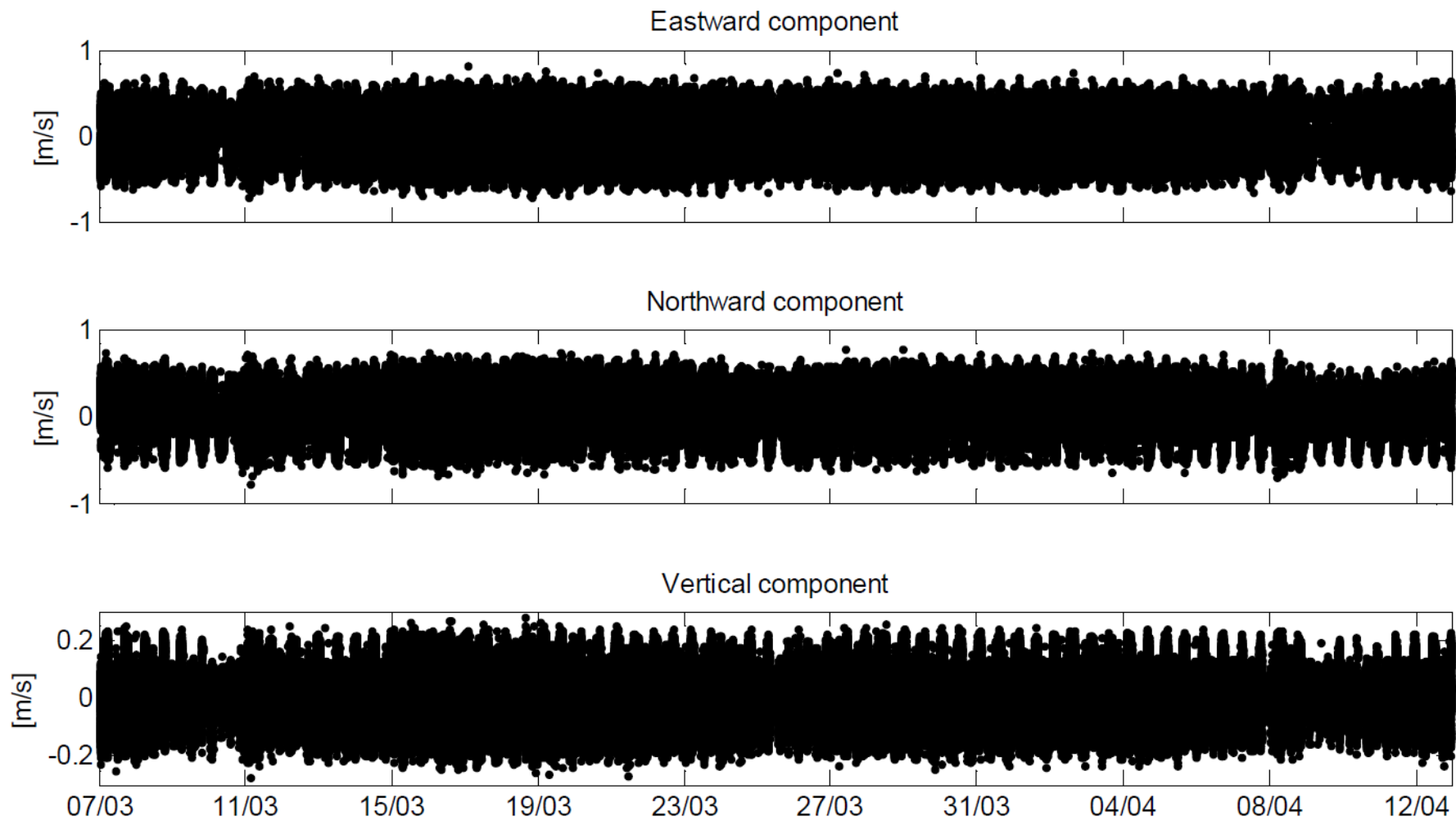


Black, red and blue colours correspond to the u-, v- and w-velocity components



Black, red and blue colours correspond to the u-, v- and w-velocity components

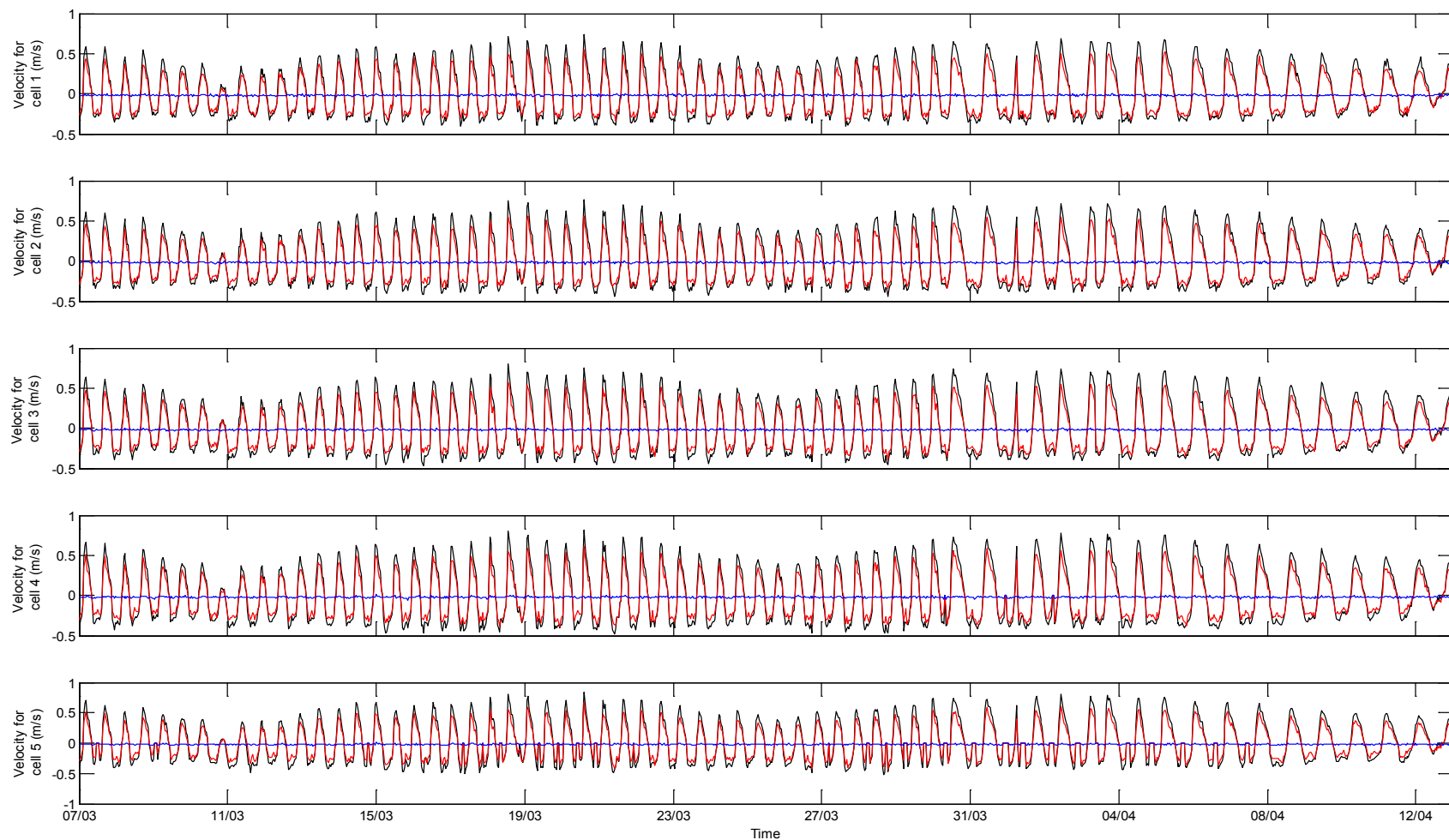
5.2.2. Depth-averaged velocity



Appendix 6. Current profiles from Hylas I frame (-3.5m TAW)

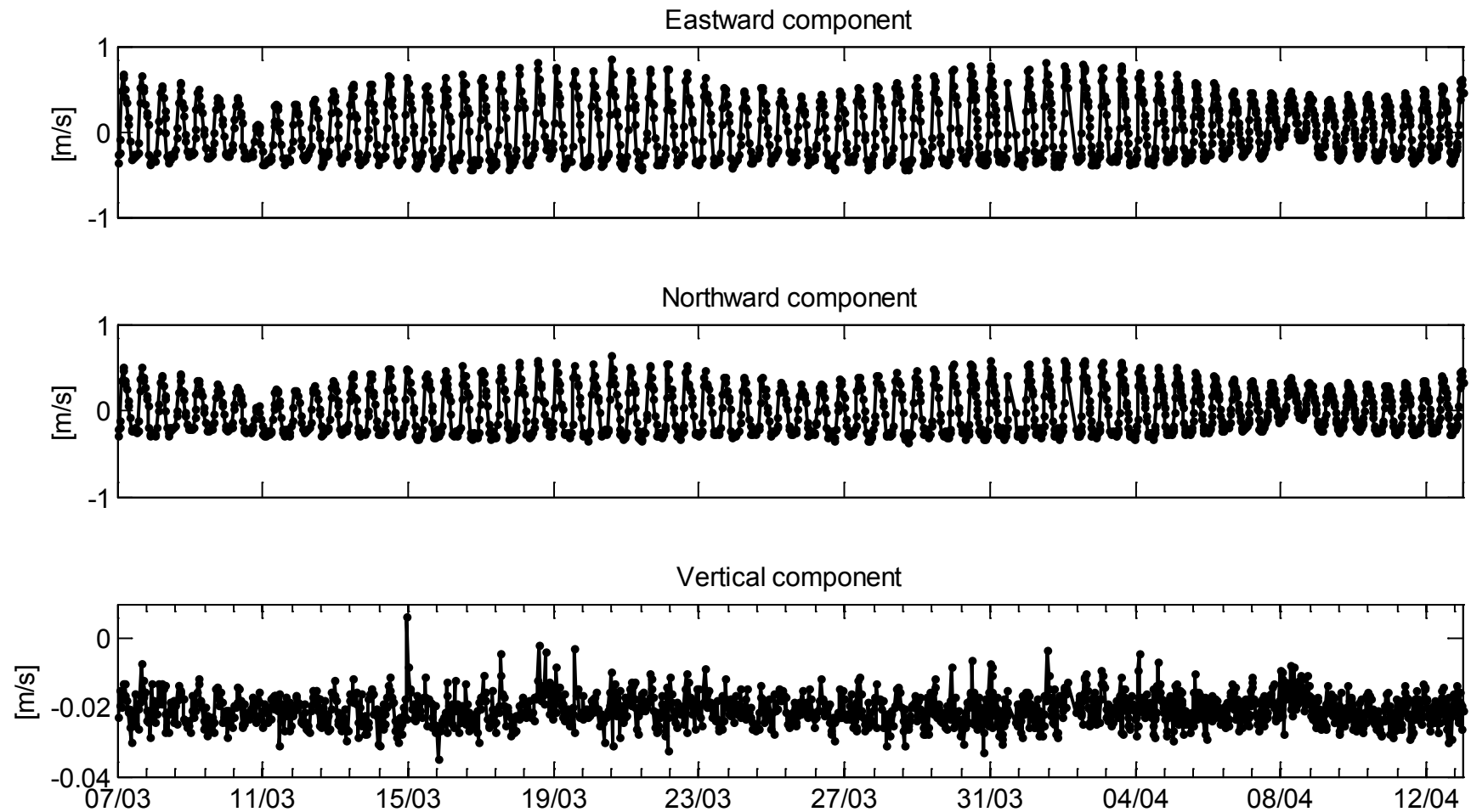
6.1. Currents recorded from the AWAC

6.1.1. Current records from every beams



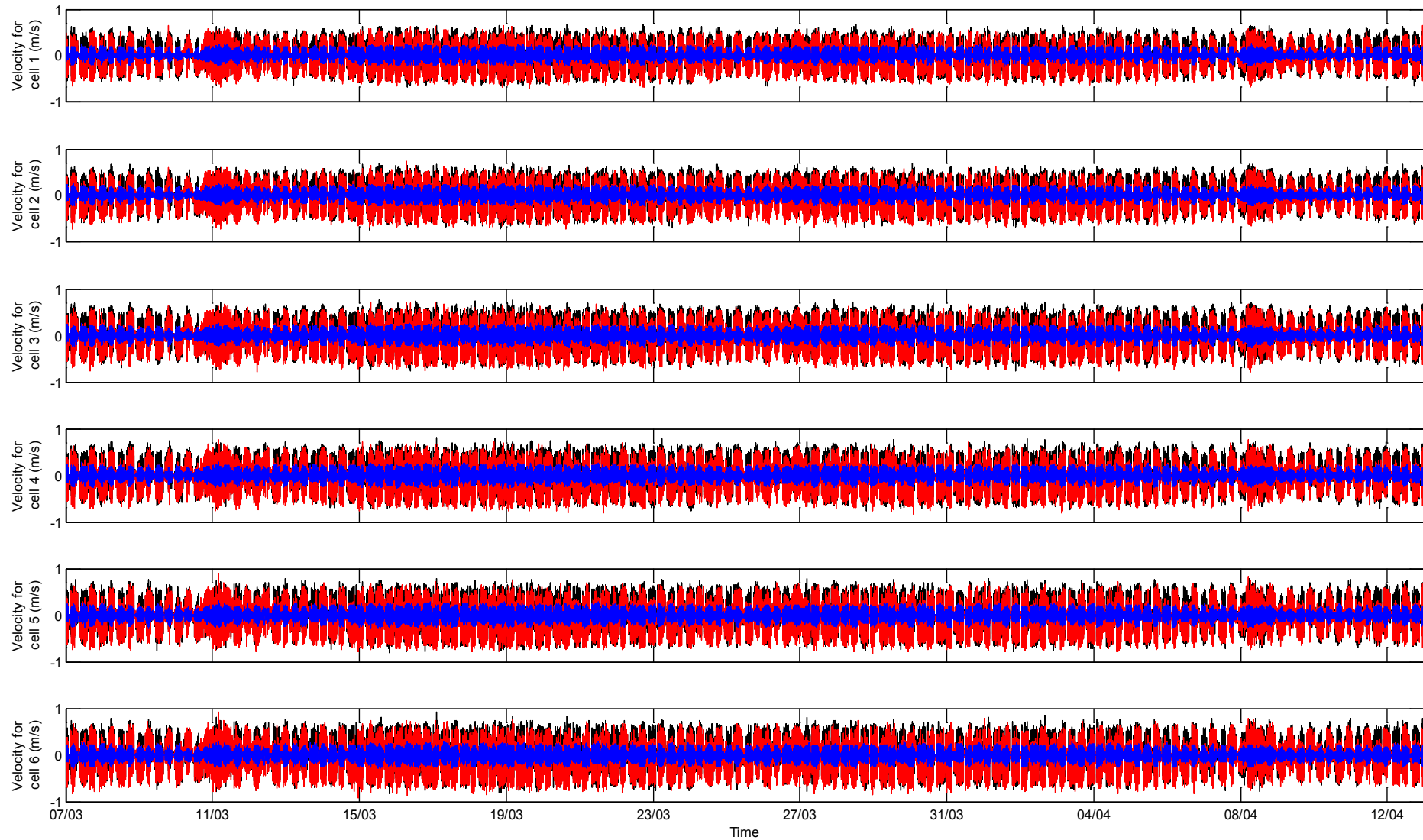
Black, red and blue colours correspond to the u-, v- and w-velocity components

6.1.2. Depth-averaged velocity



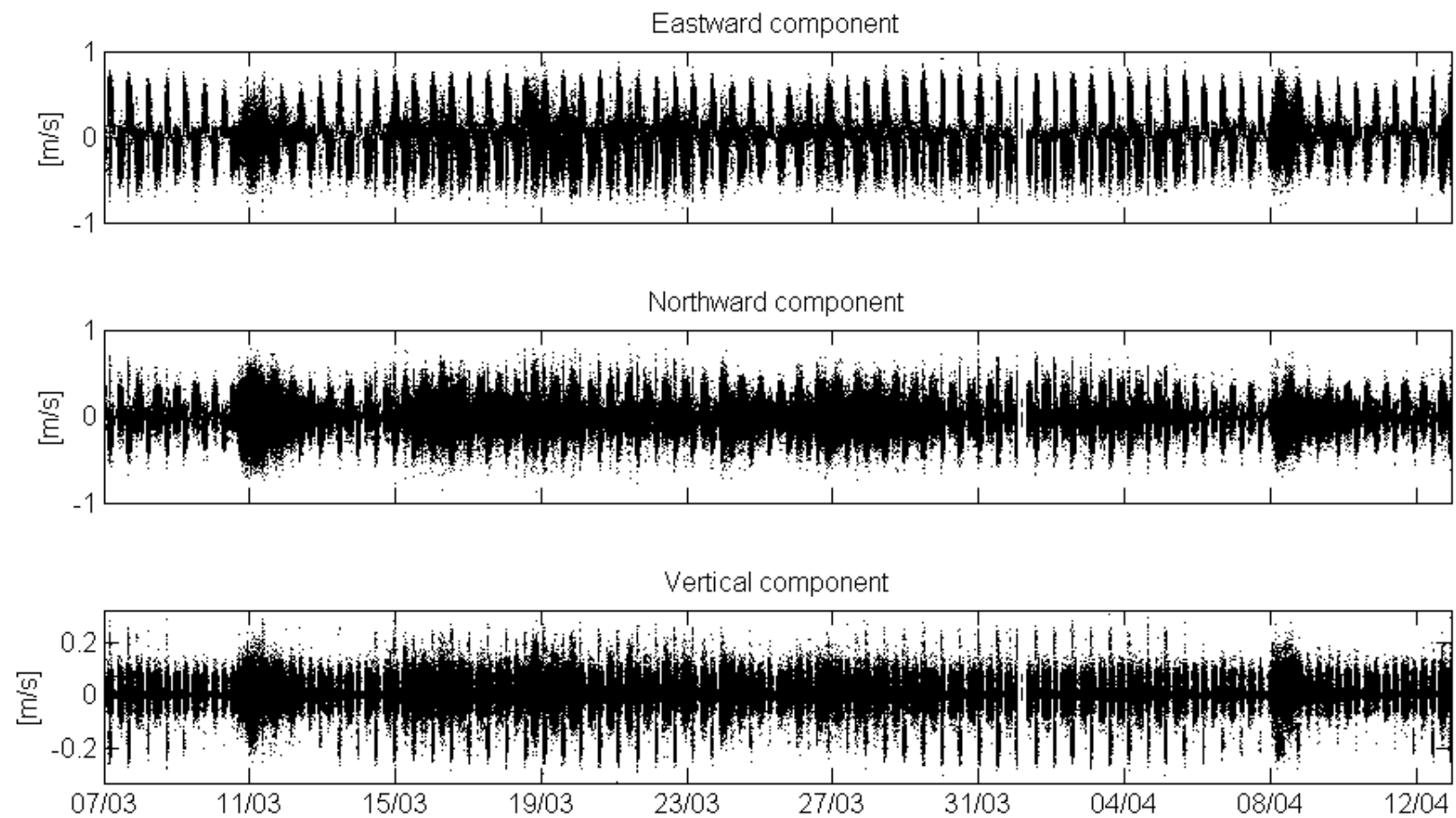
6.2. Currents recorded from the aquadopp

6.2.1. Current records from every beams



Black, red and blue colours correspond to the u-, v- and w-velocity components

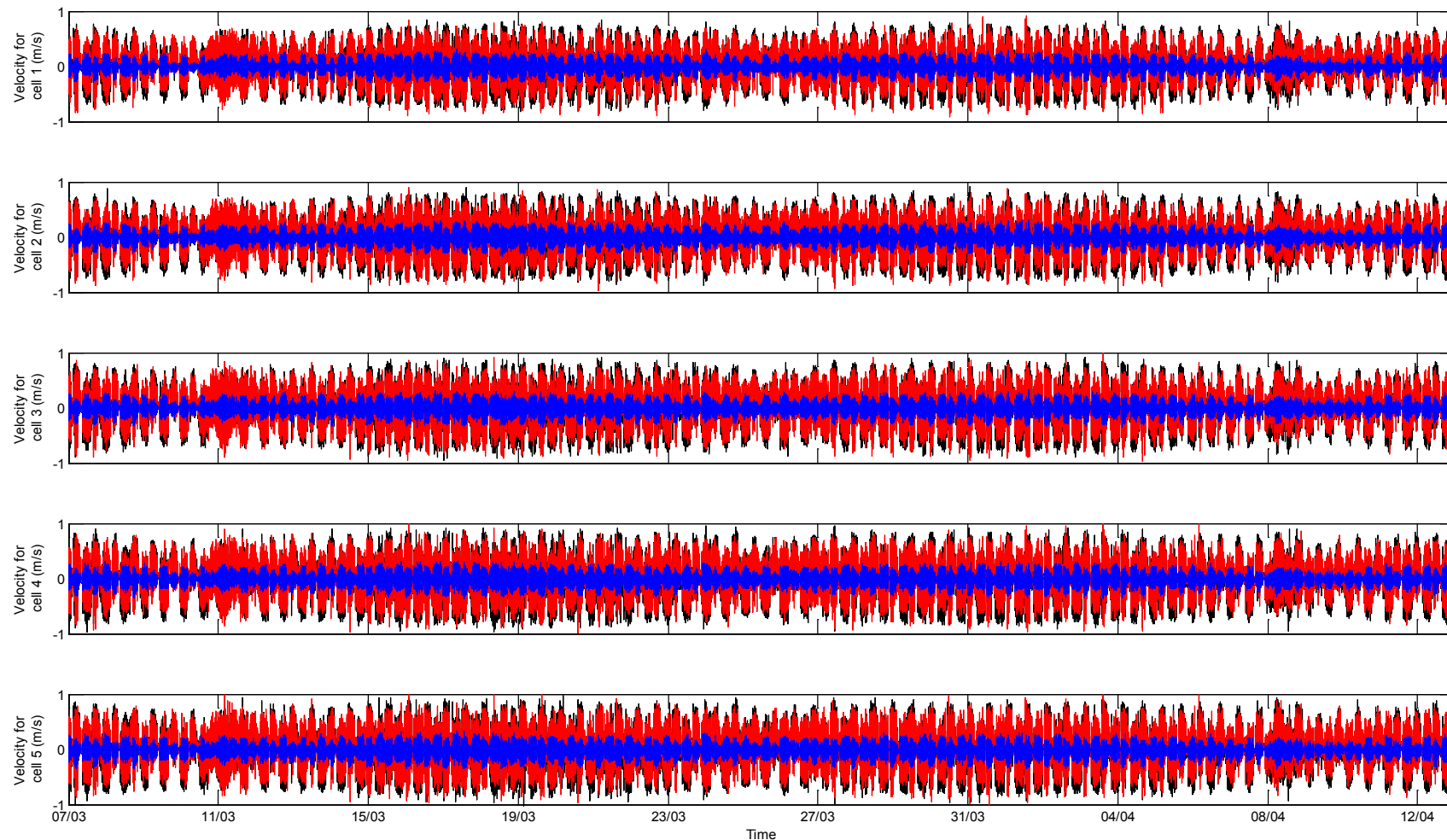
6.2.2. Depth-averaged velocity



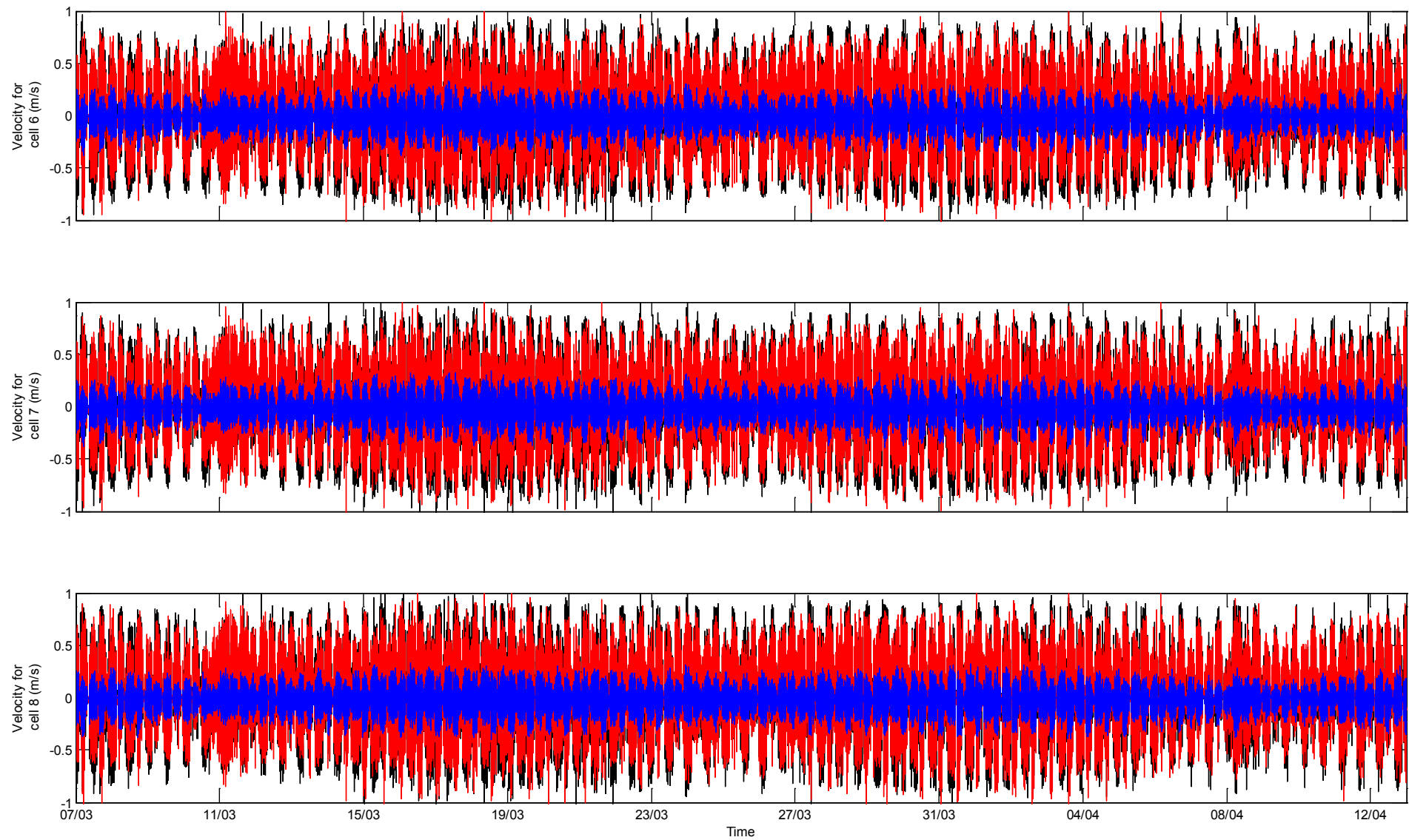
Appendix 7. Current profiles from Hylas II frame (-6.5m TAW)

7.1. Currents recorded from the aquadopp

7.1.1. Current records from every beams

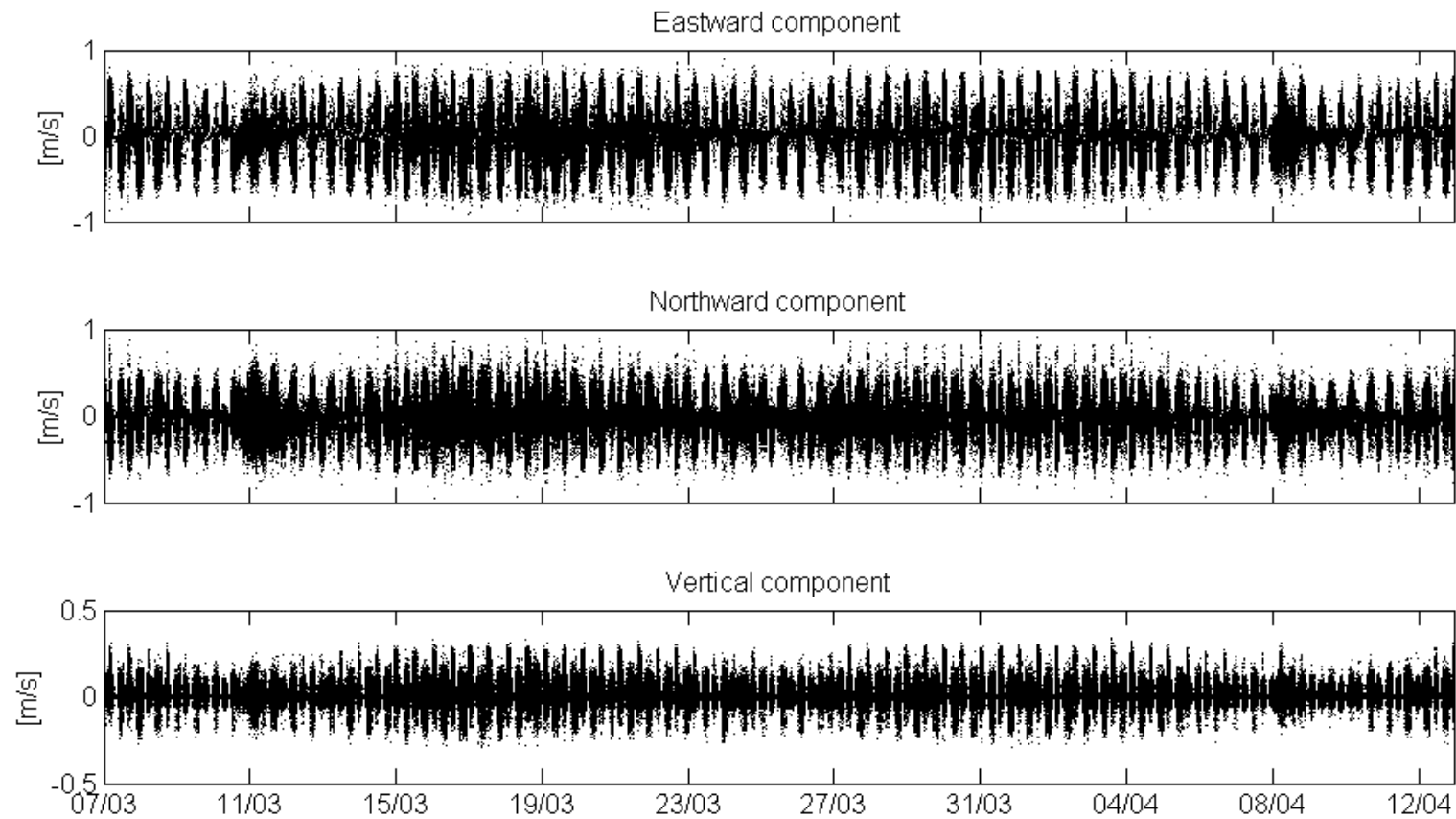


Black, red and blue colours correspond to the u-, v- and w-velocity components



Black, red and blue colours correspond to the u-, v- and w-velocity components

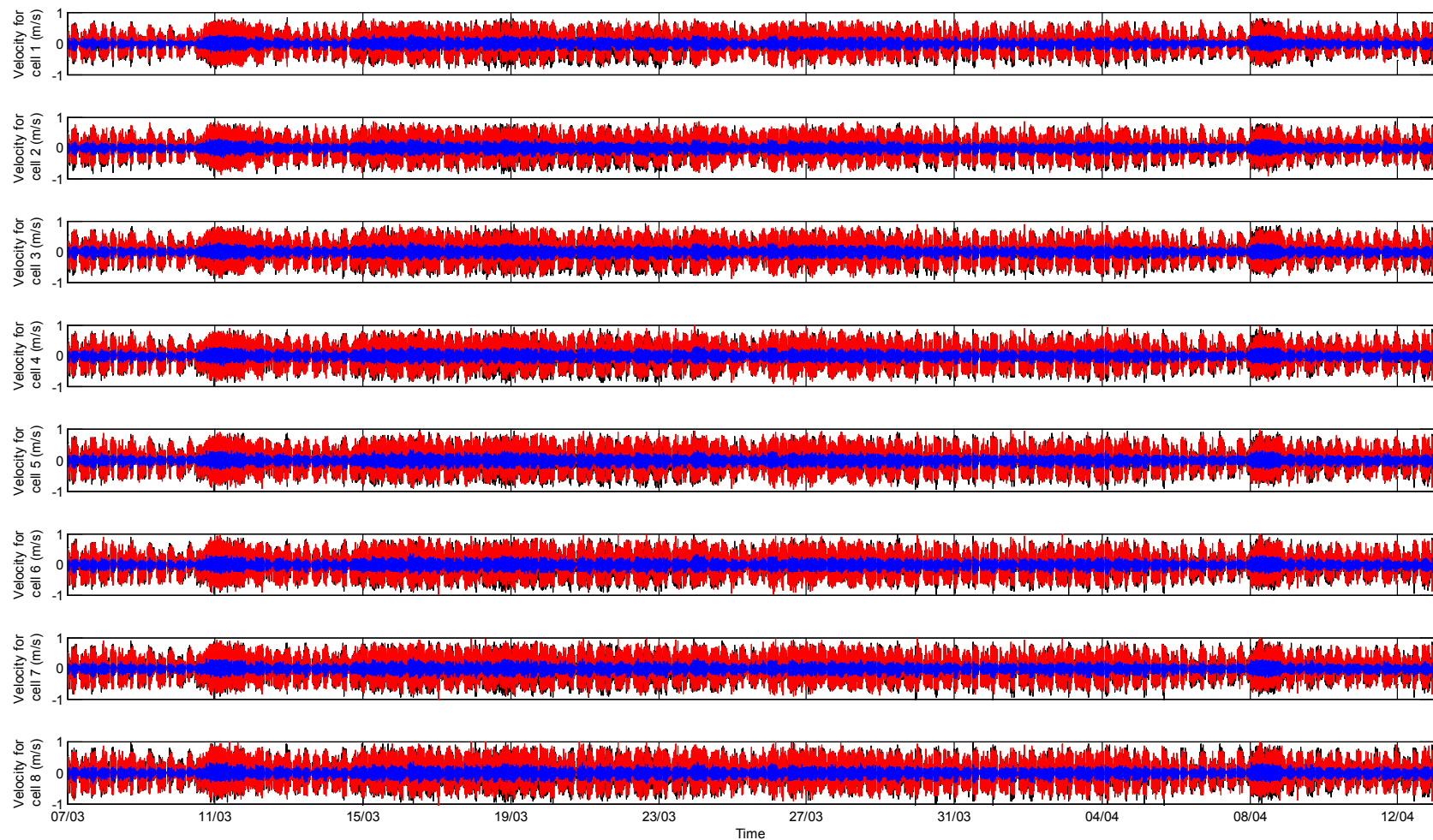
7.1.2. Depth-averaged velocity



Appendix 8. Current profiles from Hylas III frame (-3.5m TAW)

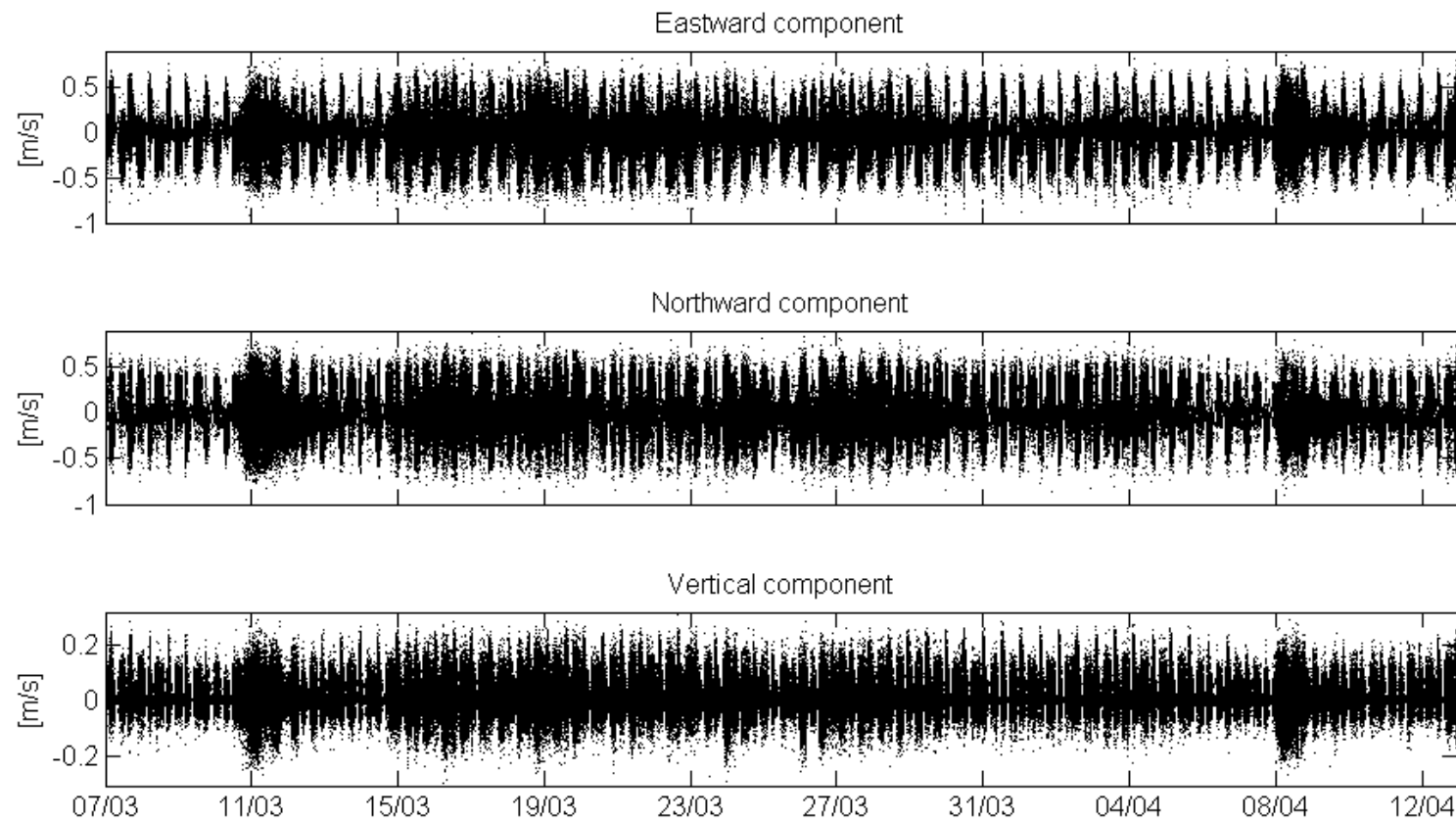
8.1. Currents recorded from the aquadopp

8.1.1. Current records from every beams



Black, red and blue colours correspond to the u-, v- and w-velocity components

8.1.2. Depth-averaged velocity



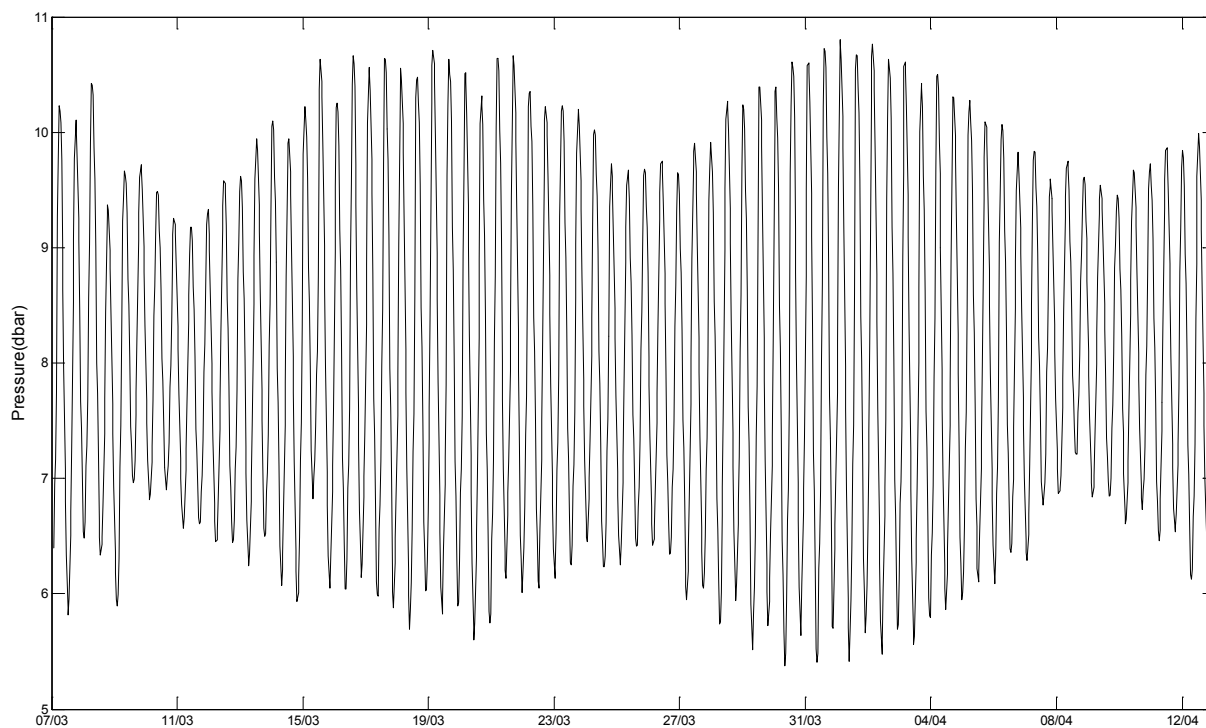
Appendix 9. Suspended sediment concentrantion and grain size distribution.

No. sample	SSC (mg/l)	Below 2.000 µm	2.00-63.00 µm	63.00-125.00 µm	125.00-250.00 µm	250.00-500.00 µm	500.00-1000.00 µm	Above 1000.000 µm
SC2014005709	57	8.766	88.150	2.281	0.594	0.209	0.000	0.000
SC2014005710	45	10.557	83.181	3.085	2.491	0.687	0.000	0.000
SC2014005711	45	7.952	89.022	2.316	0.675	0.035	0.000	0.000
SC2014005712	42	10.746	85.520	2.966	0.733	0.034	0.000	0.000
SC2014005713	53	10.350	85.086	3.233	1.306	0.024	0.000	0.000
SC2014005714	58	10.252	85.634	3.193	0.905	0.015	0.000	0.000
SC2014005715	70	10.135	85.514	3.308	0.915	0.128	0.000	0.000
SC2014005716	70	10.054	85.748	3.221	0.866	0.111	0.000	0.000
SC2014005717	66	8.267	88.990	2.190	0.514	0.038	0.000	0.000
SC2014005718	54	7.241	89.712	2.538	0.355	0.154	0.000	0.000

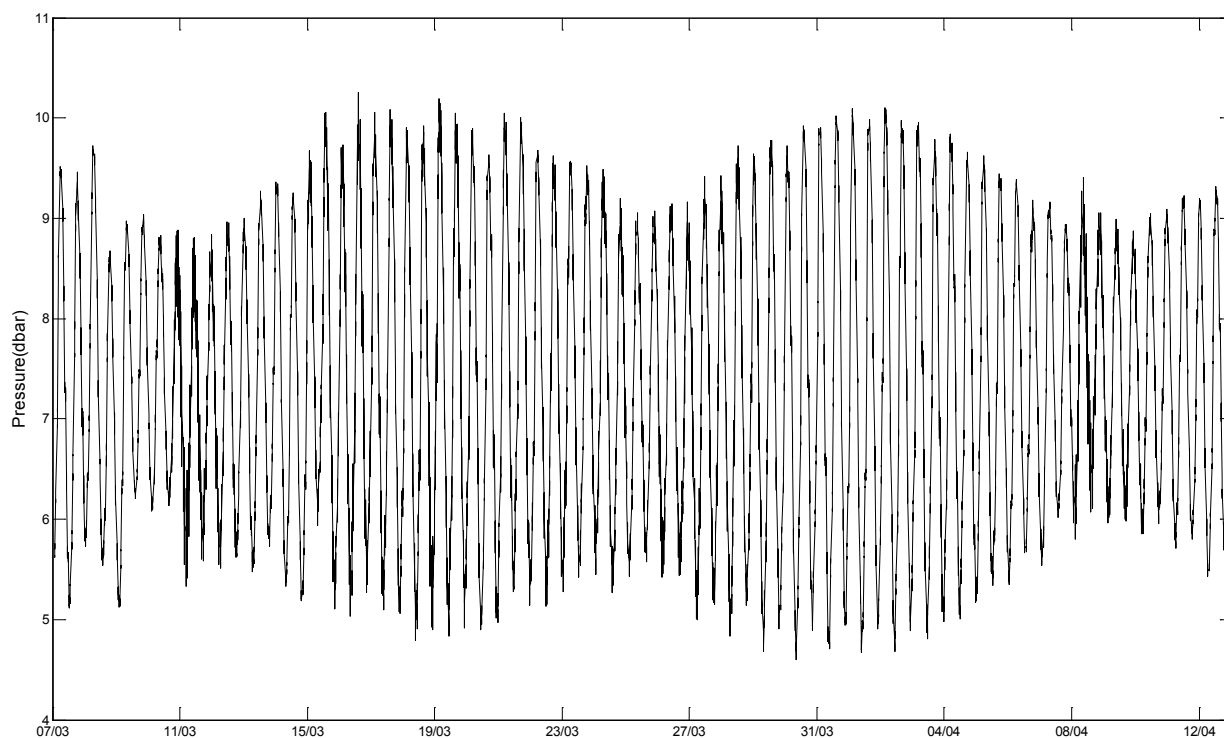
Appendix 10. Pressure.

10.1. Pressure recorded from the sensors on Hercules frame (-6.5m TAW)

10.1.1. Records from the AWAC

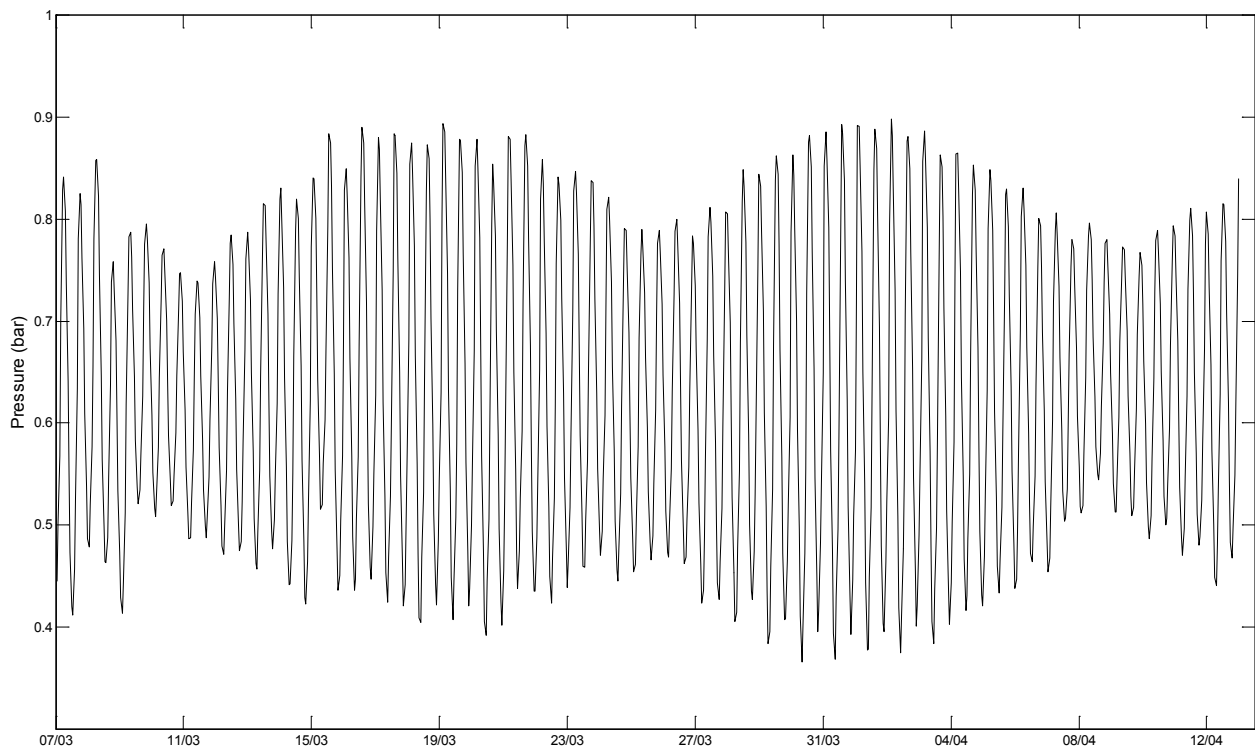


10.1.2. Records from the aquadopp

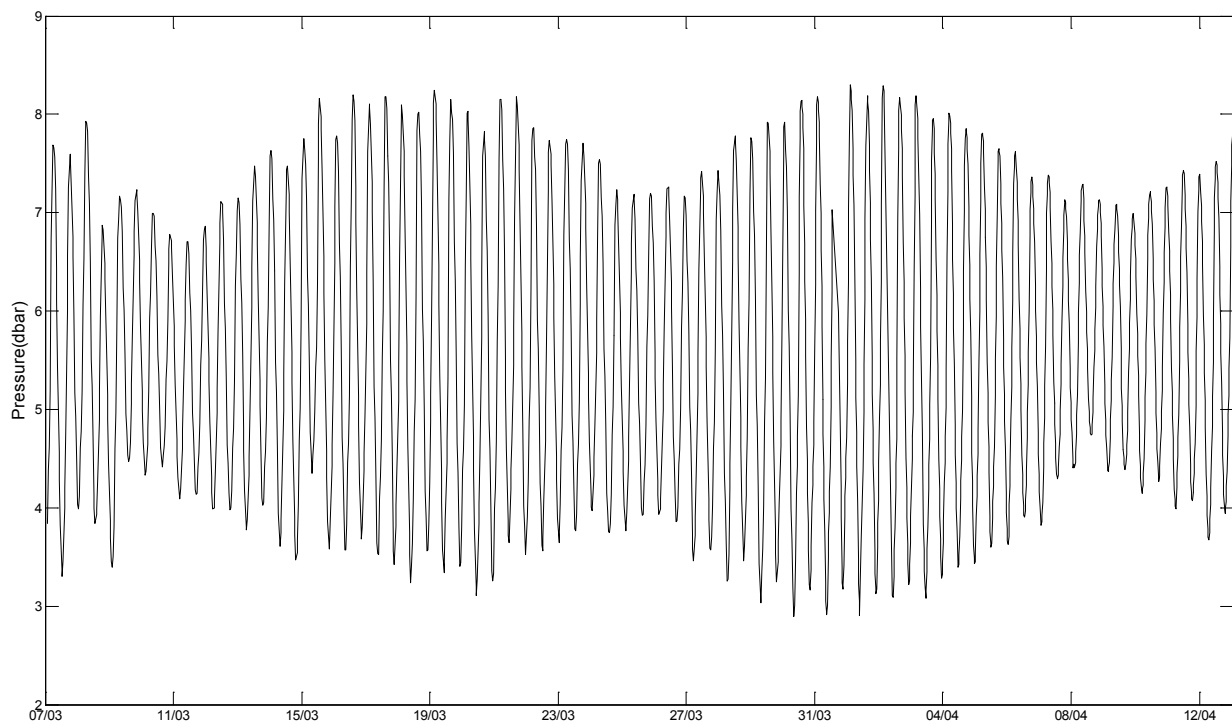


10.2. Pressure recorded from the sensors on Hylas I frame (-3.5m TAW)

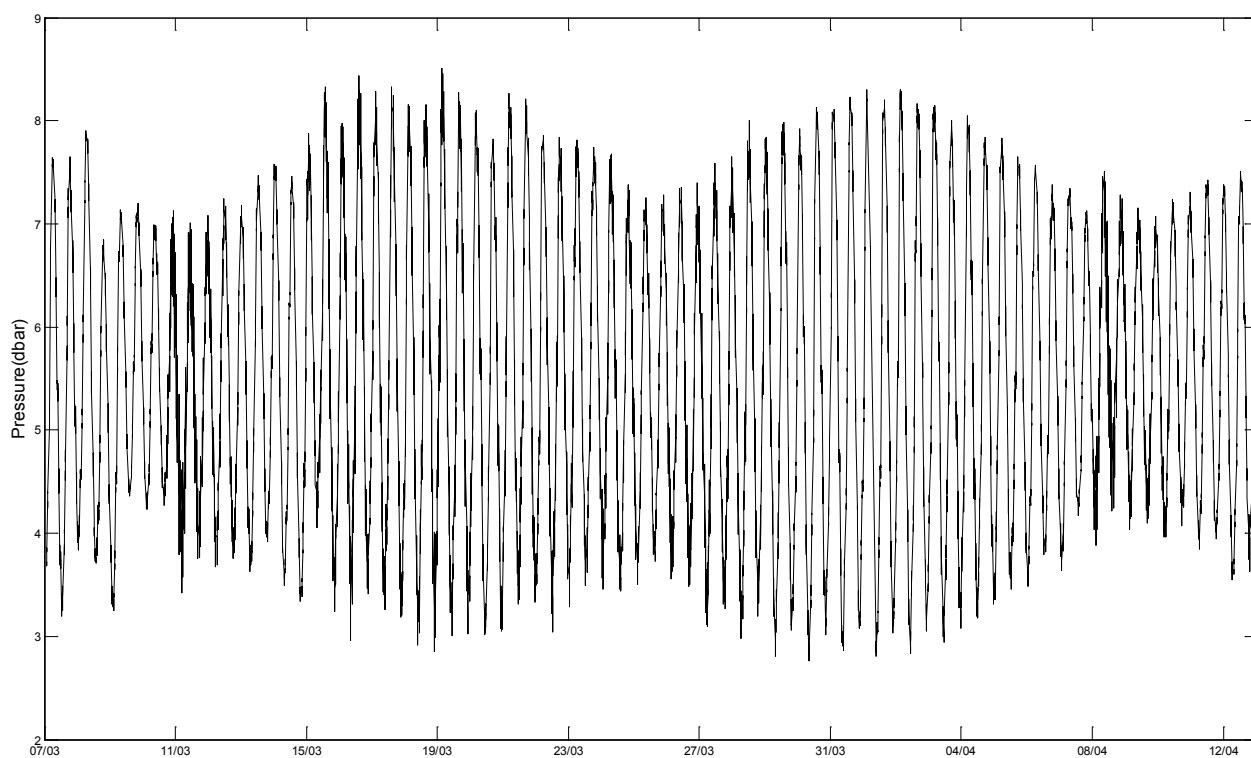
10.2.1. Records from the pressure sensor



10.2.2. Records from the AWAC

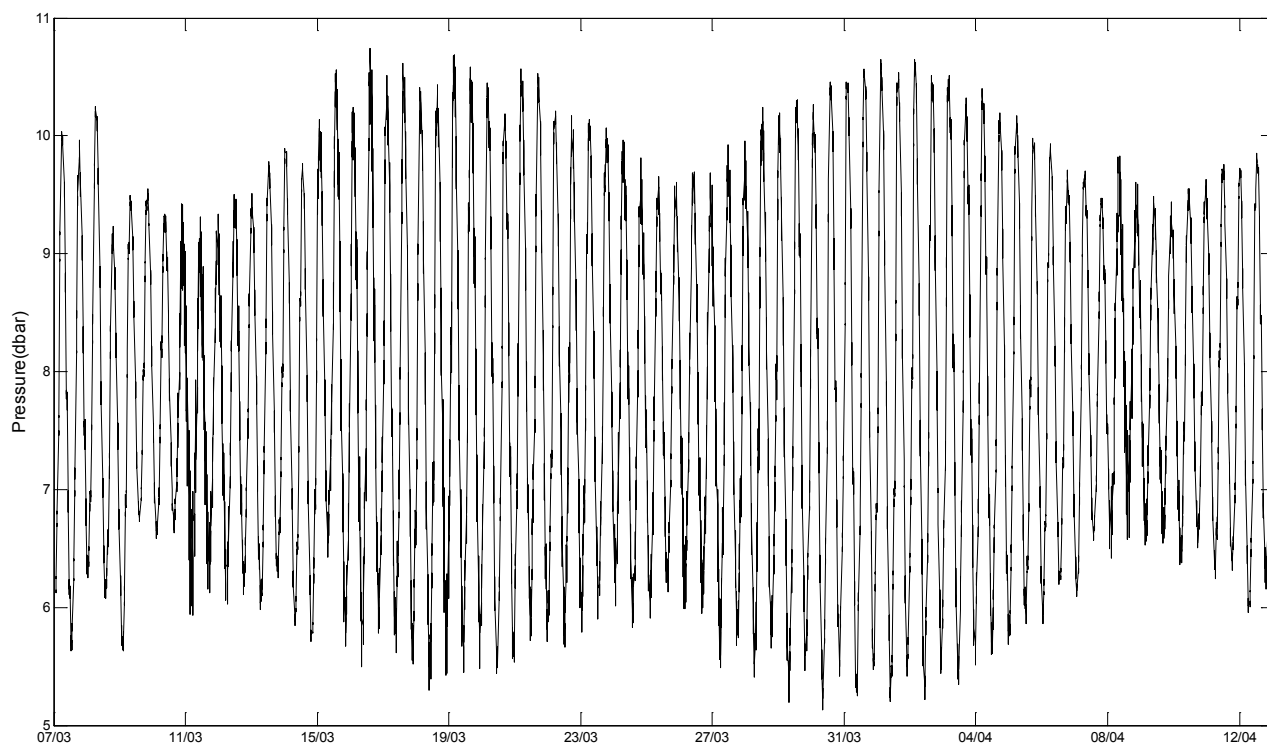


10.2.3. Records from the aquadopp



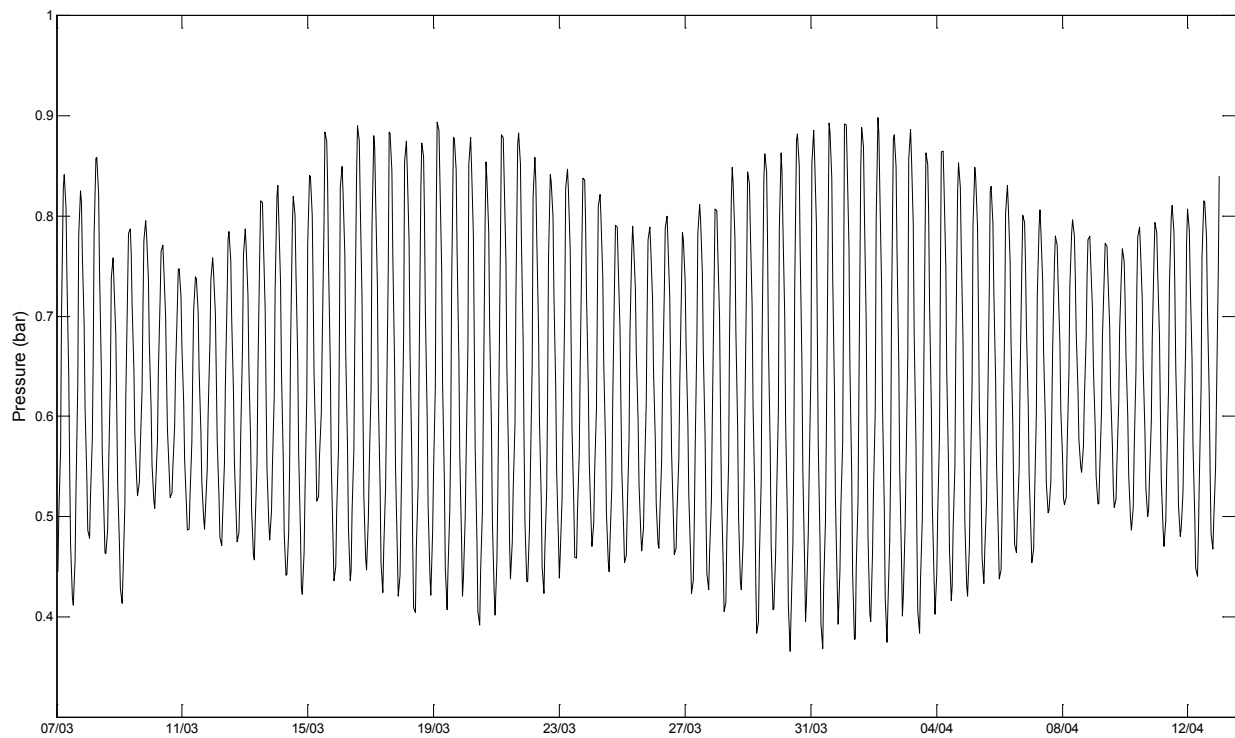
10.3. Pressure recorded from the sensors on Hylas II frame (-6.5m TAW)

10.3.1. Records from the aquadopp

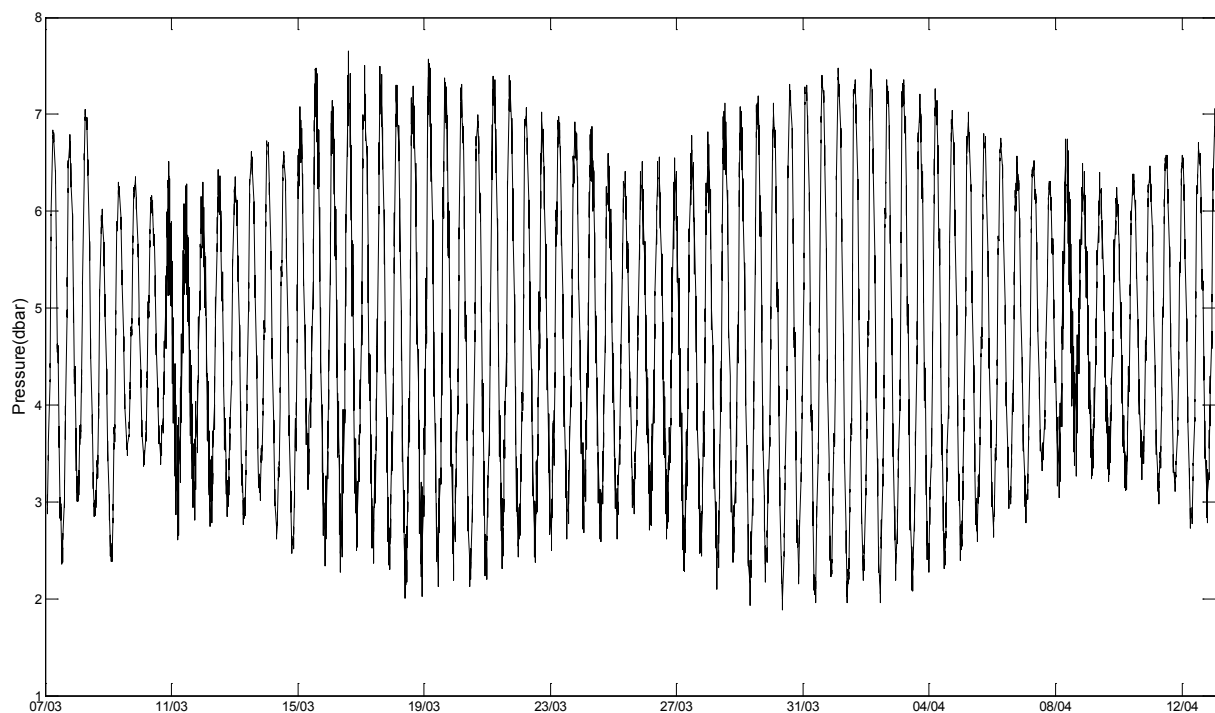


10.4. Pressure recorded from the sensors on Hylas III frame (-3.5m TAW)

10.4.1. Records from the pressure sensor



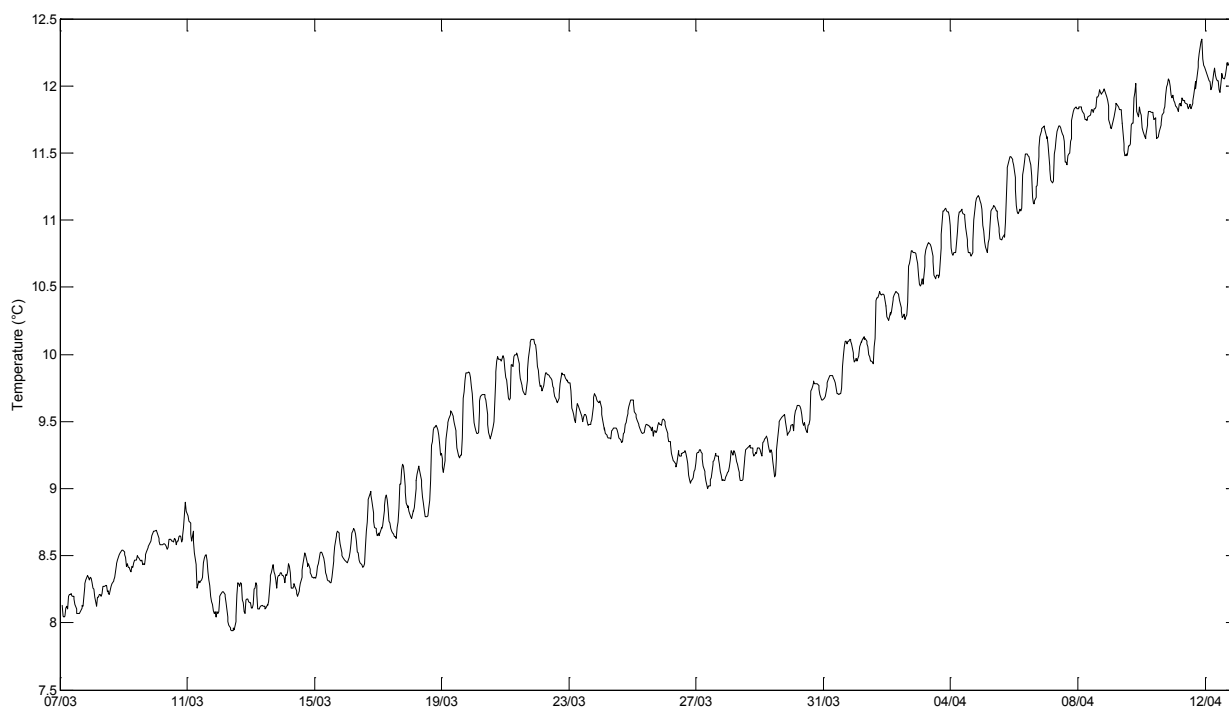
10.4.2. Records from the aquadopp



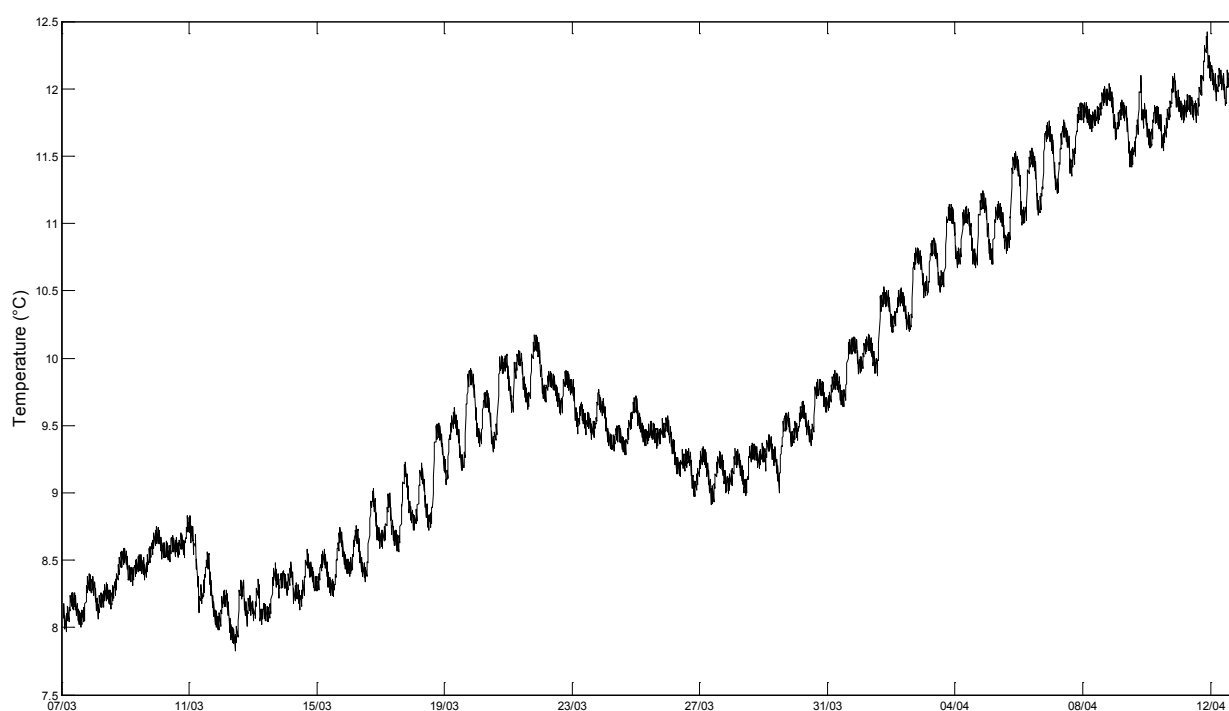
Appendix 11. Temperature.

11.1. Hercules frame

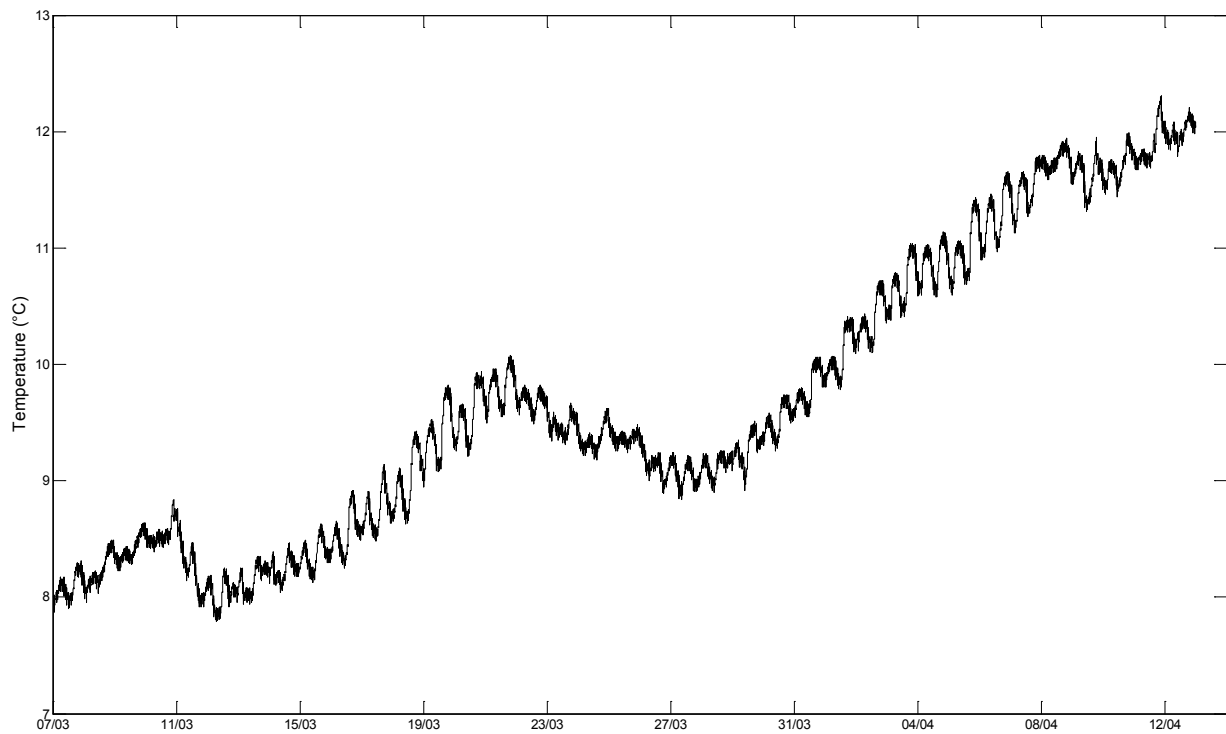
11.1.1.AWAC



11.1.2. Aquadopp

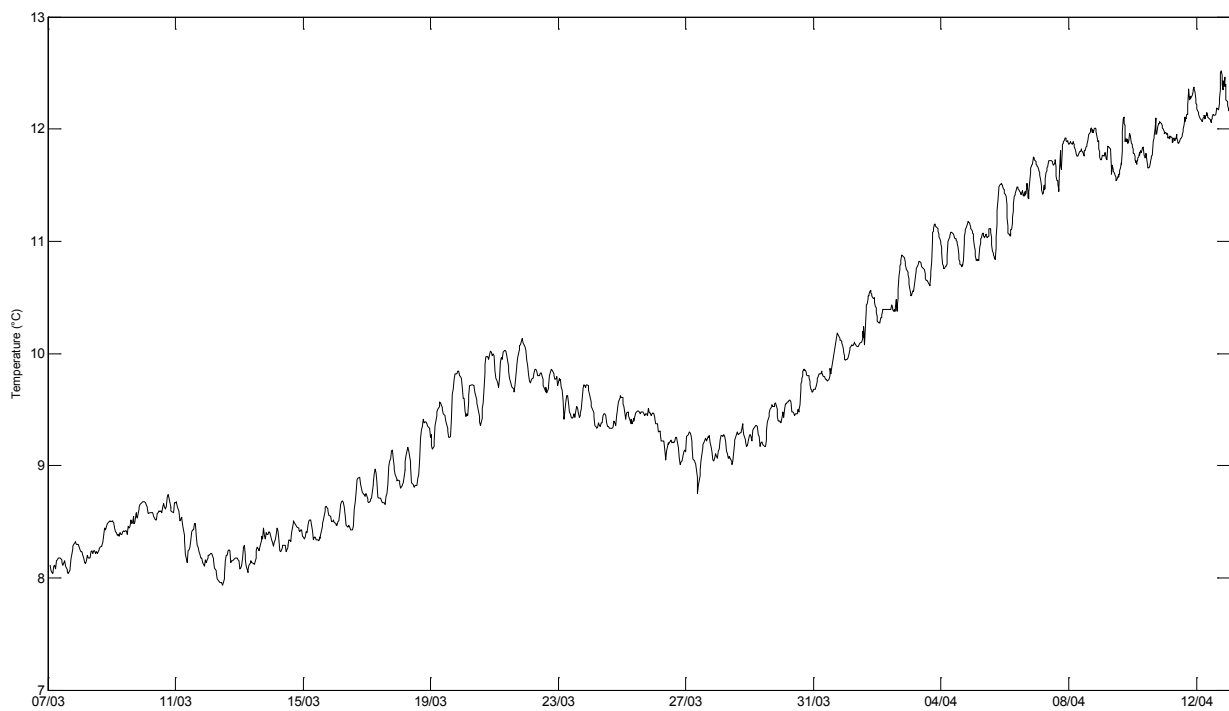


11.1.3. Vector

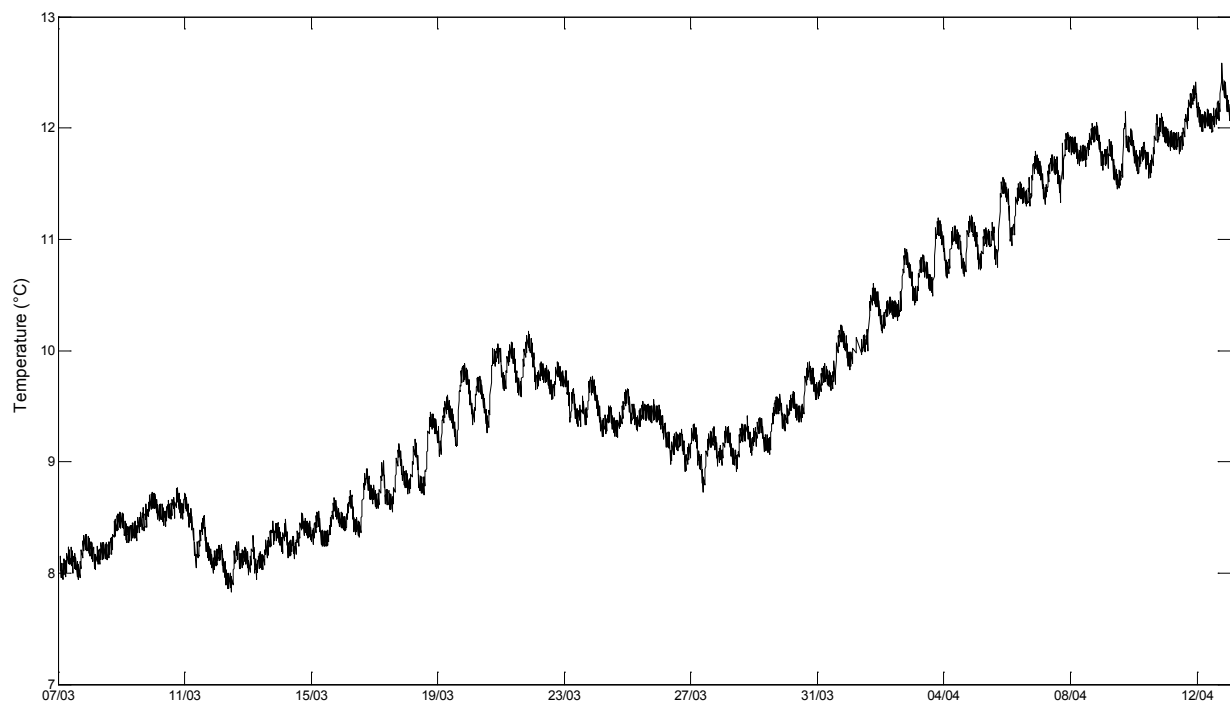


11.2. Hylas I frame

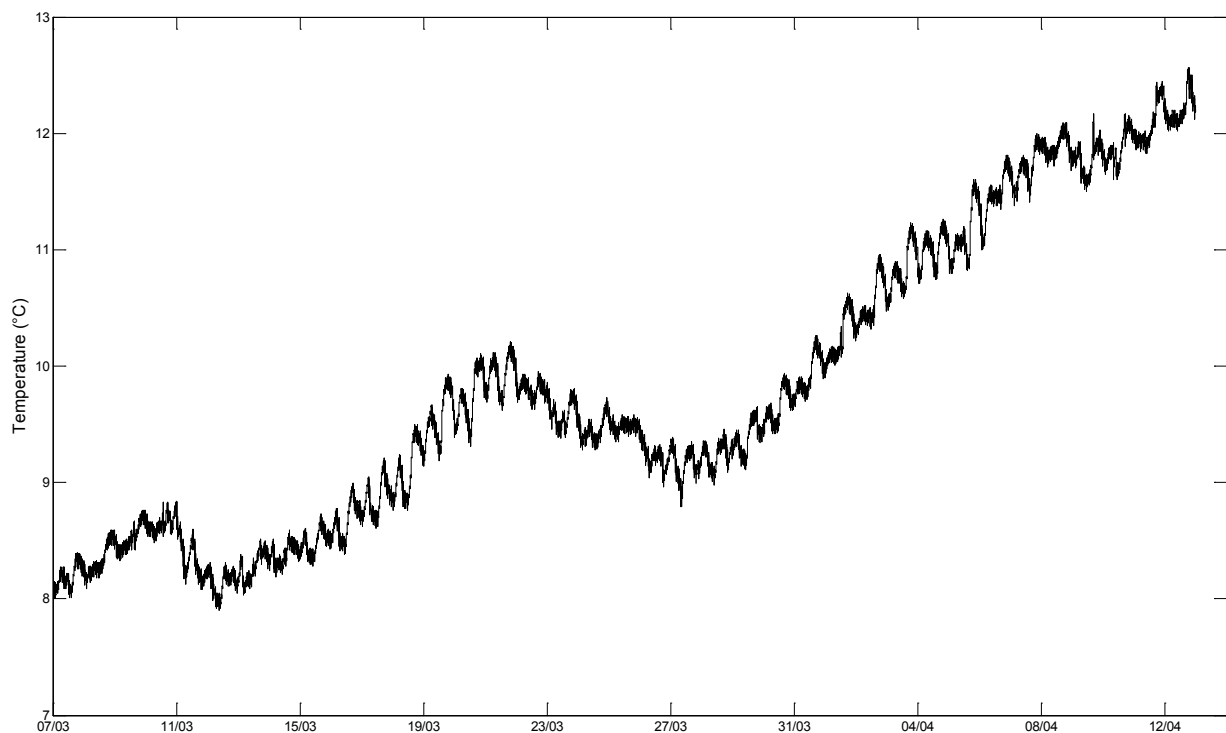
11.2.1. AWAC



11.2.2. Aquadopp

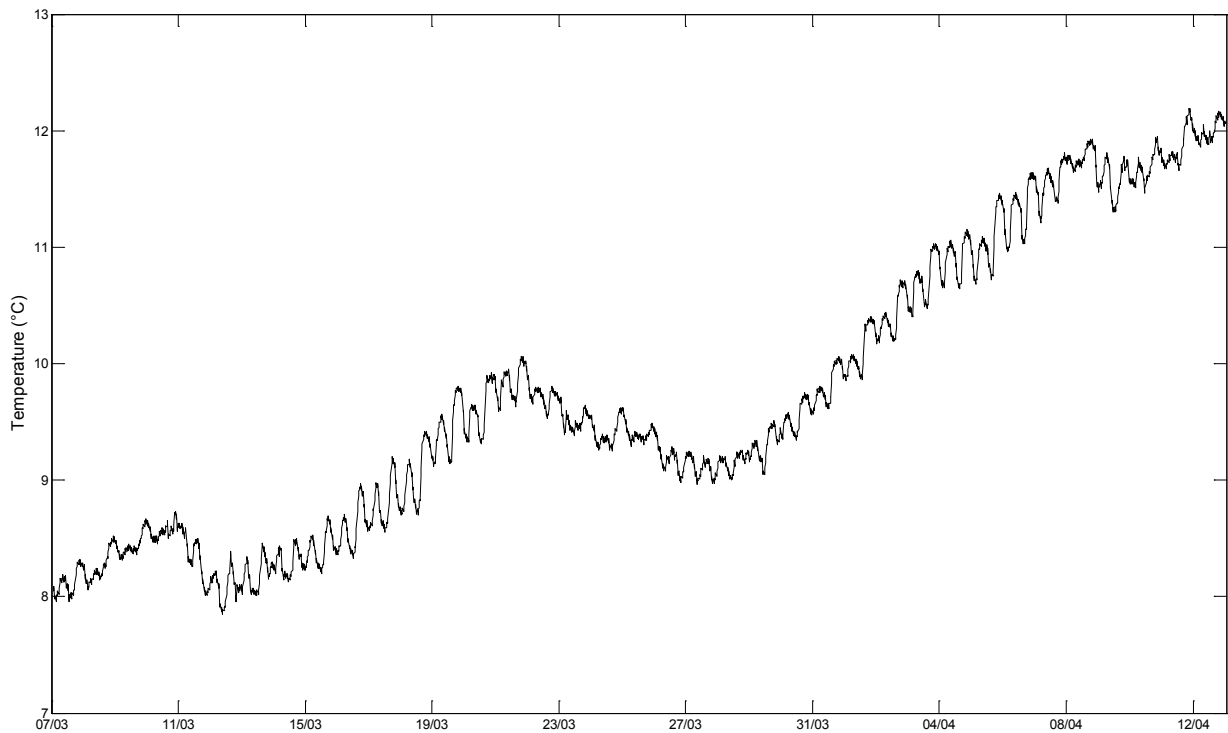


11.2.3.



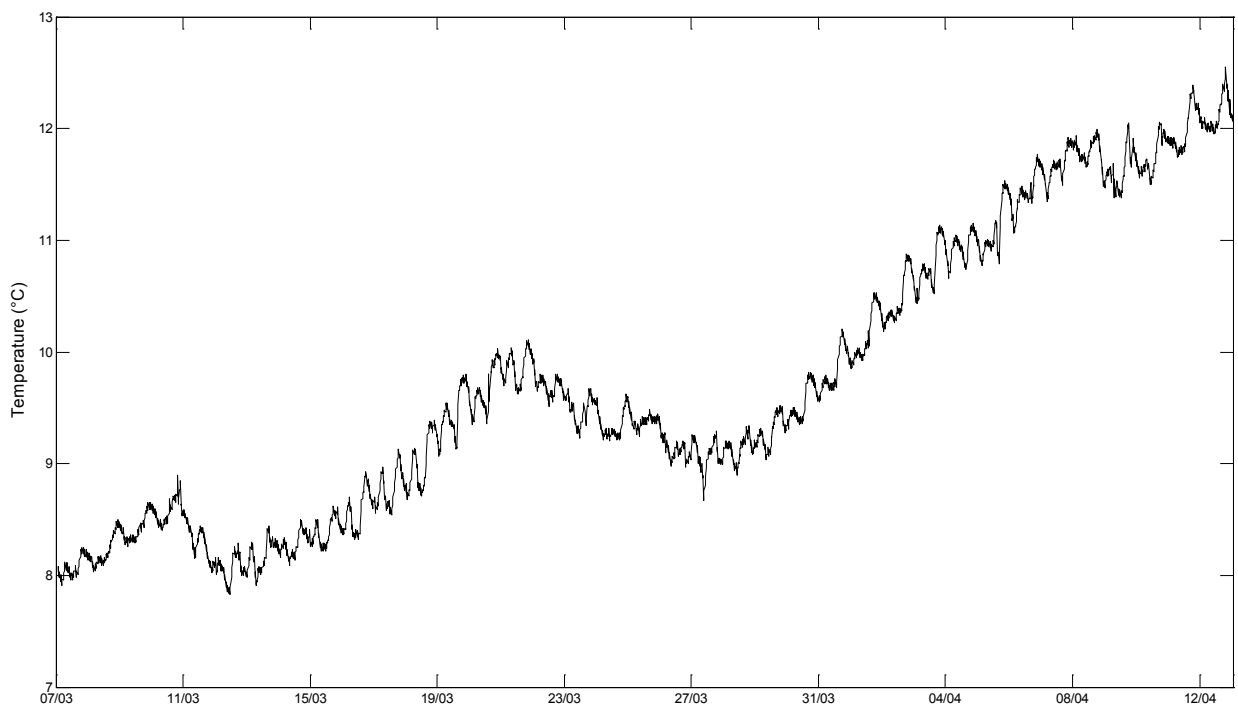
11.3. Hylas II frame

11.3.1. Aquadopp



11.4. Hylas III frame

11.4.1. Aquadopp



Appendix 12. Detailed settings of the instruments.

Aquadopp

Deployment : aqd014

Current time : 25/02/2014 9:21:31

Start at : 27/02/2014 0:20:00

Comment:

Measurement interval (s) : 3600

Cell size (mm) : 150

Orientation : DOWNLOOKING

Distance to bottom (m) : 1.75

Pulse distance (m) : 1.85

Profile range (m) : 1.50

Horiz. vel. range (m/s) : 0.49

Vert. vel. range (m/s) : 0.21

Number of cells : 10

Average interval (s) : 1

Blanking distance (m) : 0.104

Measurement load (%) : 35

Samples per burst : 960

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 : 19200

Assumed duration (days) : 45.0

Battery utilization (%) : 92.0

Battery level (V) : 11.4

Recorder size (MB) : 185

Recorder free space (MB) : 183.973

Memory required (MB) : 174.0

Instrument ID : AQD 8481

Head ID : AQP 5385

Firmware version : 3.14 HR

AquaProHR Version 1.10.10

Copyright (C) Nortek AS

=====

AWAC

=====

Deployment : AWAC09

Current time : 25/02/2014 11:51:18

Start at : 27/02/2014

Comment:

Profile interval (s) : 1200

Number of cells : 26

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) : 7200
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

Onboard wave processing : DISABLED

Assumed duration (days) : 45.0
Battery utilization (%) : 52.0
Battery level (V) : 13.7
Recorder size (MB) : 185
Recorder free space (MB) : 184.973
Memory required (MB) : 30.9
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 1.44
Copyright (C) Nortek AS

Vector

=====

Deployment : VEC015

Current time : 24/02/2014 16:28:54

Start at : 27/02/2014 0:20:00

Comment:

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

Instrument ID : VEC 8170
Head ID : VEC 5025
Firmware version : 3.36

Pressure sensor

0A,03,00,00,00,00,00,05,14,3C,01,35,47,13,00,24,02,14,09,00,27,02,14,00,00,00,00,00,00,00,00,00,0
0,00,00,00,00,00,00,22,22,B6

DEPARTMENT **MOBILITY & PUBLIC WORKS**
Flanders hydraulics Research

Berchemlei 115, 2140 Antwerp

T +32 (0)3 224 60 35

F +32 (0)3 224 60 36

waterbouwkundiglabo@vlaanderen.be

www.flandershydraulicsresearch.be