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Measuring campaigns of hydrodynamics and sand dynamics in Blankenberge

Sub report 3
Data report 2012 and 2013

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Measuring campaigns of hydrodynamics and sand dynamics in Blankenberge

Sub report 4 – Data report 2012 and 2013

Dan, S.; Levy, Y.; Vereecken, H.; Verwaest, T.; Mostaert, F.

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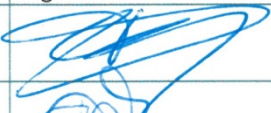
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	Name	Signature
Reviser(s):	Vereecken, H.	
Project leader:	Dan, S.	

Approval

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

Abstract

In the vicinity of the Blankenberge area the marine currents, waves and sediment transport have specific patterns and their investigation could lead to better management of the area. In order to measure these parameters two field campaigns were carried out by the Flanders Hydraulic Research in 2012 and 2013, both in early summer.

A series of instruments were deployed on the field for periods ranging between one day and four weeks. For measuring the marine currents Aquadopp and AWAC instruments were used along with drifters. The wave parameters were measured using AWAC instruments and pressure sensors, while for measuring the sediment fluxes OBS instruments were used along with in situ water sampling.

This report presents the data collected in these two campaigns concerning marine currents (speed and direction – profile averaged values), wave data (height, period, direction, water level variation) and sediment concentration (OBS measurements, in situ measured concentrations). The meteo-marina data during the campaign are also presented as recorded at A2 buoy.

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1 Introduction

The present report describes the data gathered during two field campaigns carried out in 2012 and 2013 in the vicinity of the Blankenberge harbour in the framework of the WL R&D project 00_064 “Meetcampagne hydro- en zanddynamica haven van Blankenberge” (Delgado et al., 2012).

The main objective of the project was to collect data regarding the hydrodynamics and sediment dynamics in the area of Blankenberge harbour.

The research objective of this project was to gather reliable information about hydrodynamics at the study area and data that can be used for the calibration and validation of high resolution numerical tools. Processes such as water and structures interaction, general hydrodynamic patterns, fluxes of suspended sediment and currents and wave transformation can be better understood using the collected data.

The data regarding the hydrodynamics and the sediment concentration have been collected in two campaigns in 2012 and 2013. The hydrodynamics was measured using subaqueous buoy and two current profilers deployed for three or four weeks (AWAC and Aquadopp) as well as drifters and pressure sensors deployed during one day campaigns. Sediment concentrations were measured during the three weeks deployment by means of an optical instrument deployment (OBS) and by analysing water samples of the sea water taken during deployment and retrieval of the instruments. Detailed description of the instruments and methods was made in a previous report (Dan et al., 2013).

2 Location and type of instruments

For the first campaign, in 2012, a number of 13 instruments were deployed south-west from Blankenberge harbor for different periods (Figure 1). Aquadopp, OBS and AWAC were deployed for 23 days while pressure sensors and drifters were deployed several hours during two different days. The exact dates and locations are shown in Table 1.

For the second campaign, in 2013, a number of 7 instruments were deployed in front and north-east of the Blankenberge harbor for different periods (Figure 1). Aquadopp, OBS and AWAC were deployed for 16 days while pressure sensors and drifters were deployed several hours during one day. The exact dates and locations are shown in Table 2.

Figure 1 – Location of the instruments used for measurements in 2012 and 2013.



The yellow and orange rectangles show the areas where the drifters have been deployed on the 11th of June 2012 and 27th of June 2013, respectively.

Table 1 – The exact location of the instruments deployment for Campaign 2012.

Instrument	Latitude	Longitude	Depth (relative to TAW)	Period of deployment	Distance sensor - sea floor
Aquadopp 1	51°18'46.37"N	3° 5'54.06"E	-4.0 m	5/06 – 28/06/2012	2.6 m
OBS 1	51°18'46.37"N	3° 5'54.06"E	-3.5 m	5/06 – 28/06/2012	1.0 m
Aquadopp 2	51°18'50.40"N	3° 6'5.97"E	-4.0 m	5/06 – 28/06/2012	2.8 m
OBS 2	51°18'50.40"N	3° 6'5.97"E	-3.0 m	5/06 – 28/06/2012	1.0 m
Pressure sensor P1	51°18'44.06"N	3° 5'56.48"E	0.0 m	11/06/2012	0.1 m
Pressure sensor P1	51°19'0.26"N	3° 7'12.36"E	0.0 m	15/06/2012	0.1 m
Pressure sensor P2	51°18'42.73"N	3° 5'57.28"E	-1.0 m	11/06/2012	0.1 m
Pressure sensor P2	51°19'2.57"N	3° 7'11.50"E	-1.0 m	15/06/2012	0.1 m
Pressure sensor P3	51°18'40.81"N	3° 5'59.16"E	-2.0 m	11/06/2012	0.1 m
Pressure sensor P3	51°19'4.80"N	3°7'11.53"E	-2.0 m	15/06/2012	0.1 m
Pressure sensor P4	51°18'38.71"N	3° 5'59.16"E	-3.0 m	11/06/2012	0.1 m
Pressure sensor P4	51°19'7.20"N	3° 7'8.94"E	-3.0 m	15/06/2012	0.1 m
Drifters	Area 2012		-1.0 m	11/06/2012	variable
Water samples	51°18'48.61"N	3° 6'0.57"E	-4.0 m	5/06 and 26/06/20112	+1.0 and +2.0 m
Water samples	51°18'50.53"N	3° 6'12.13"E	-4.0 m	5/06 and 26/06/20112	+1.0 and +2.0 m

Table 2 – The exact location of the instruments deployment for Campaign 2013.

Instrument	Latitude	Longitude	Depth (relative to TAW)	Period of deployment	Distance sensor - sea floor
AWAC WC_0	51°19'5.4"N	3°06'11.4' E	-5.1 m	19/06 – 4/07/2013	0.5 m
AWAC harbor	51°18'43.06"N	3°06'47.44"E	- 1.2 m	20/06 – 5/07/2013	0.3 m
Aquadopp WC_E	51°19'09"N	3° 7'5.74"E	-4.5 m	19/06 – 4/07/2013	0.3 m
Pressure sensor P5	51°18'45.11"N	3°06'44.39"E	-2.0 m	29/06/2013	0.1
Pressure sensor P6	51°18'48.92"N	3°06'37.04"E	-3.0 m	29/06/2013	0.1
Pressure sensor P7	51°19'04.04"N	3°07'09.66'E	-3.0 m	27/06/2013	0.1
Drifters	Area 2013		-1.0 m	27/06/2013	variable

3 Campaign 2012

3.1 Aquadopp and OBS data

Two Aquadopp instruments have been deployed and the data collected are shown in this sub-chapter. The data have been checked for and corrected for the tilt effects, echo spikes velocity variations, low signal and sidelobe rejection using the software Storm Ver. 1.14 from Nortek.

Aquadopp 1 recorded valid data between 5/06/2012 18:00:00 and 19/06/2012 0:00:00 while Aquadopp 2 recorded valid data between 5/06/2012 18:00:00 and 26/06/2012 0:00:00. The main settings are presented in Table 3 while the detailed settings can be seen in Dan et al., 2013.

Aquadopp and OBS data location:

P:\00_064-hydrodynamica\Data field campaigns

Blankenberge_Mariakerke_2012_2013\Blankenberge\2012\Aquadopp

Table 3 – The main settings of the instruments deployed in the Campaign 2012.

Instrument	Aquadopp 1	Aquadopp 1
Orientation	Looking downwards	Looking downwards
Current profile interval	300 sec	300 sec
Number of cells	20	20
Cell size	0.1 m	0.1 m
Average interval	60 sec	60 sec
Blanking distance	0.1 m	0.1 m
Wave – Interval	1200 sec	No
Wave – Number of samples	1024	No
Wave – Sampling rate	2 Hz	No
Wave – Cell size	0.5 m	No
Analog input	OBS	OBS
Coordinate system	XYZ	XYZ

The marine currents velocity and direction averaged for the total profile towards the bottom are presented in Figure 2 and Figure 7 while for each directional component in Figure 3 and Figure 8. Figure 4 shows other parameters recorded by the instrument, those related to the in situ conditions (temperature, pressure) and those related to the position on the sensor (heading, pitch and roll). Figure 5 shows the main wave parameters (significant height, period and direction) as processed by the Storm software using as main input the water pressure variation and the current data. The OBS data are shown in Figure 6 and Figure 10. The data are presented as measured, in counts, which are ranging from 0 (no sediments) – to 65 000 (saturation) representing a voltage from 0 – 5 V.

Figure 2 – Processed current data (speed and direction) for the Aquadopp 1, 2012.

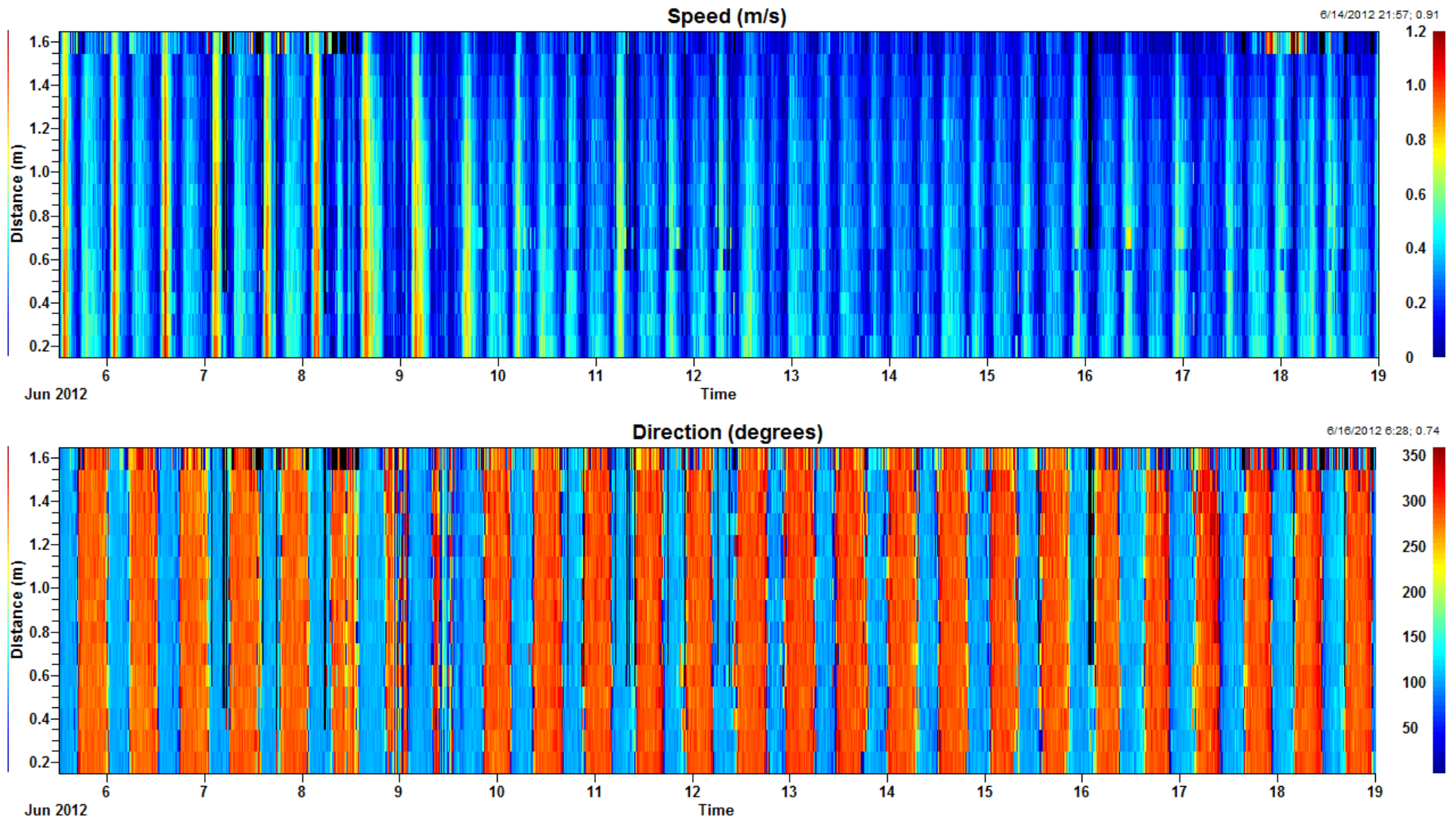


Figure 3 – Current velocities on the three spatial components for the Aquadopp 1, 2012. Note the different scales

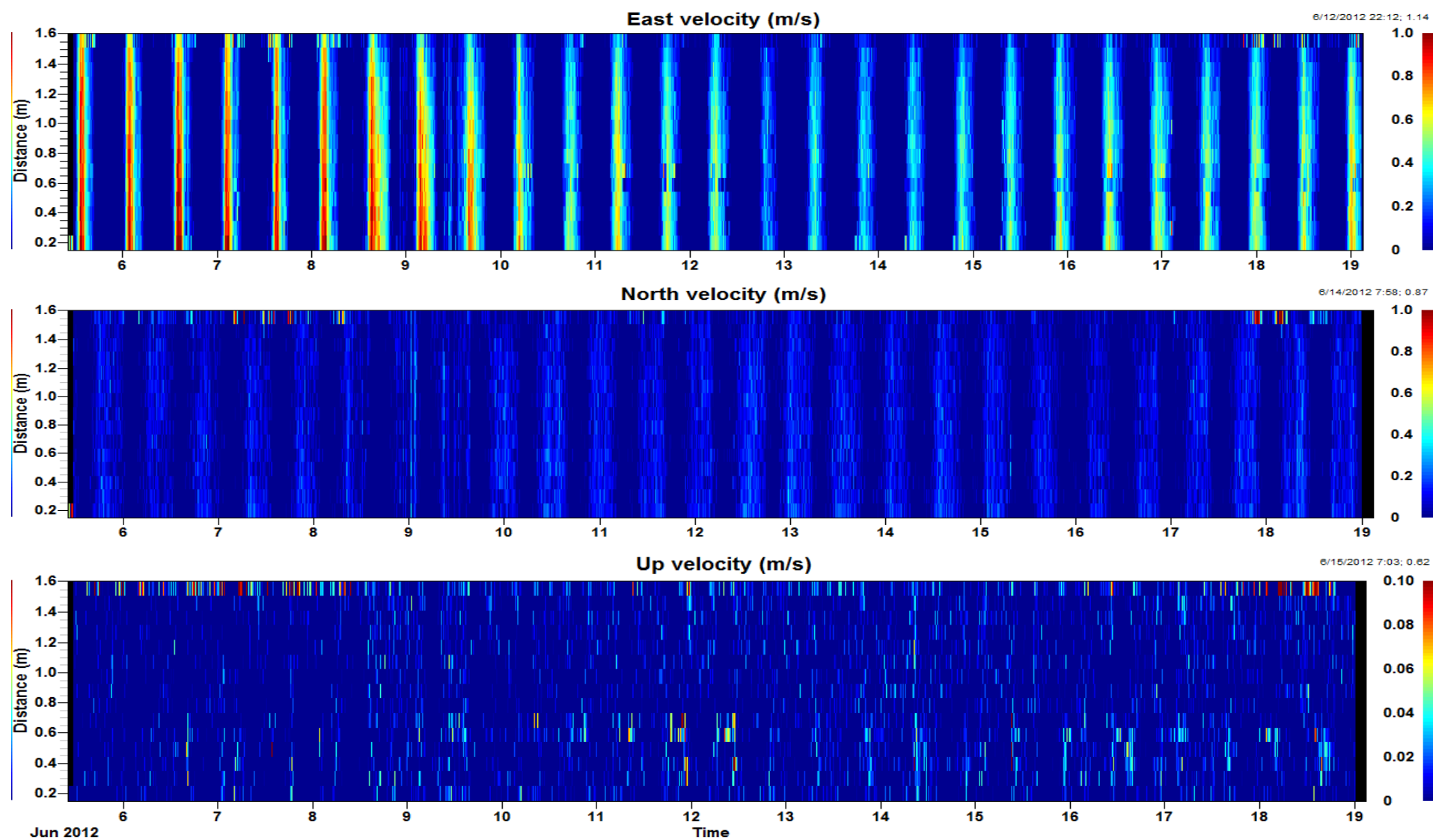


Figure 4 – Temperature, pressure and data regarding positioning recorded by Aquadopp 1, 2012.

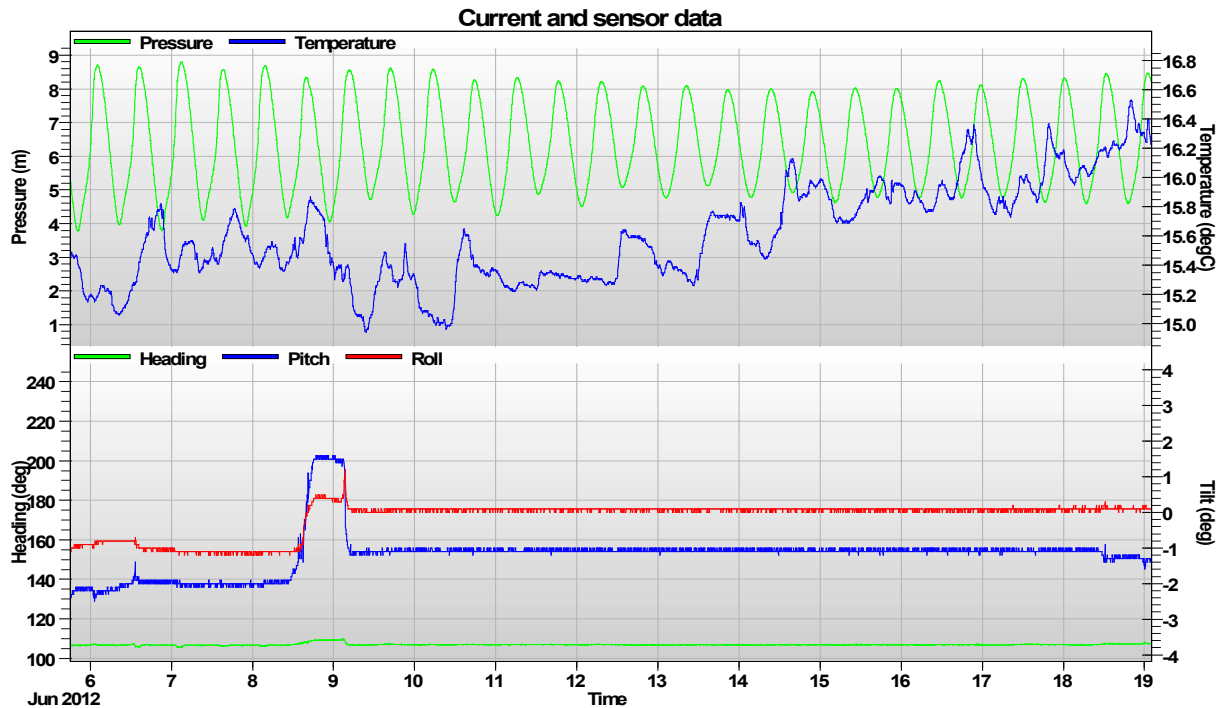


Figure 5 – Processed wave data from Aquadopp 1, 2012.

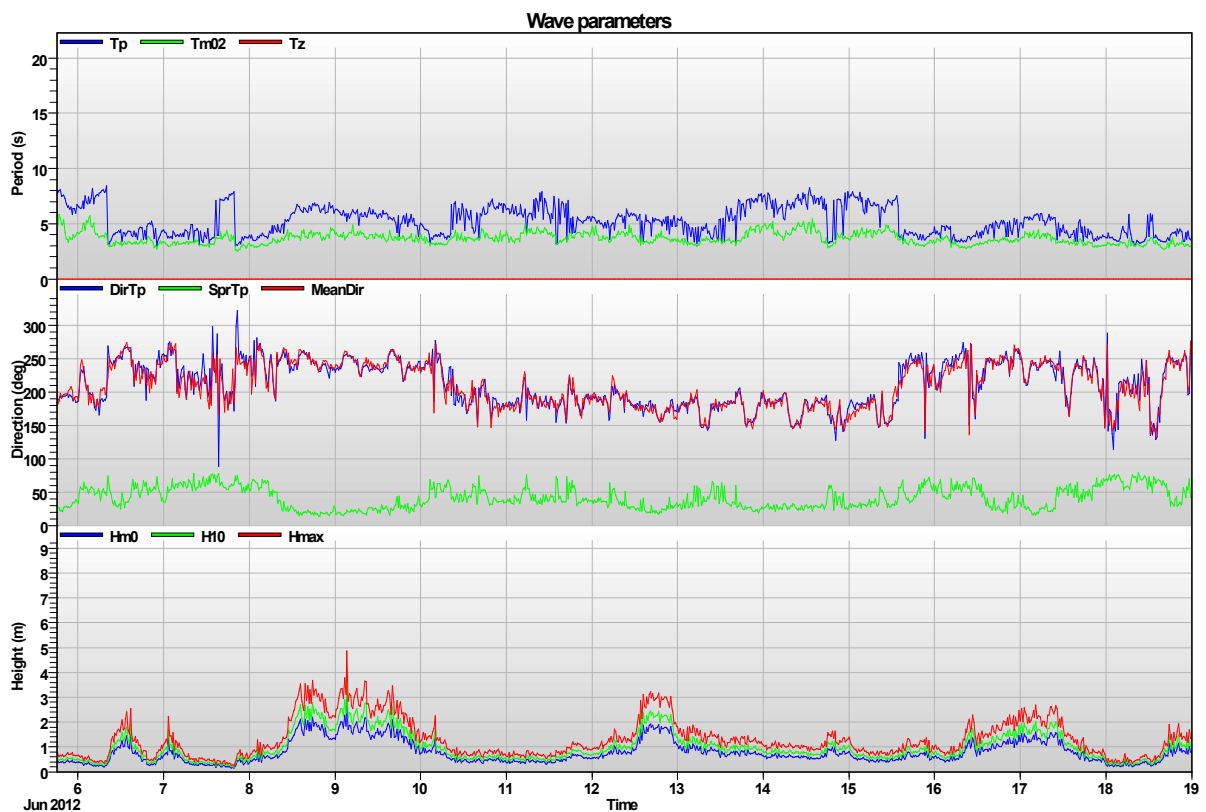
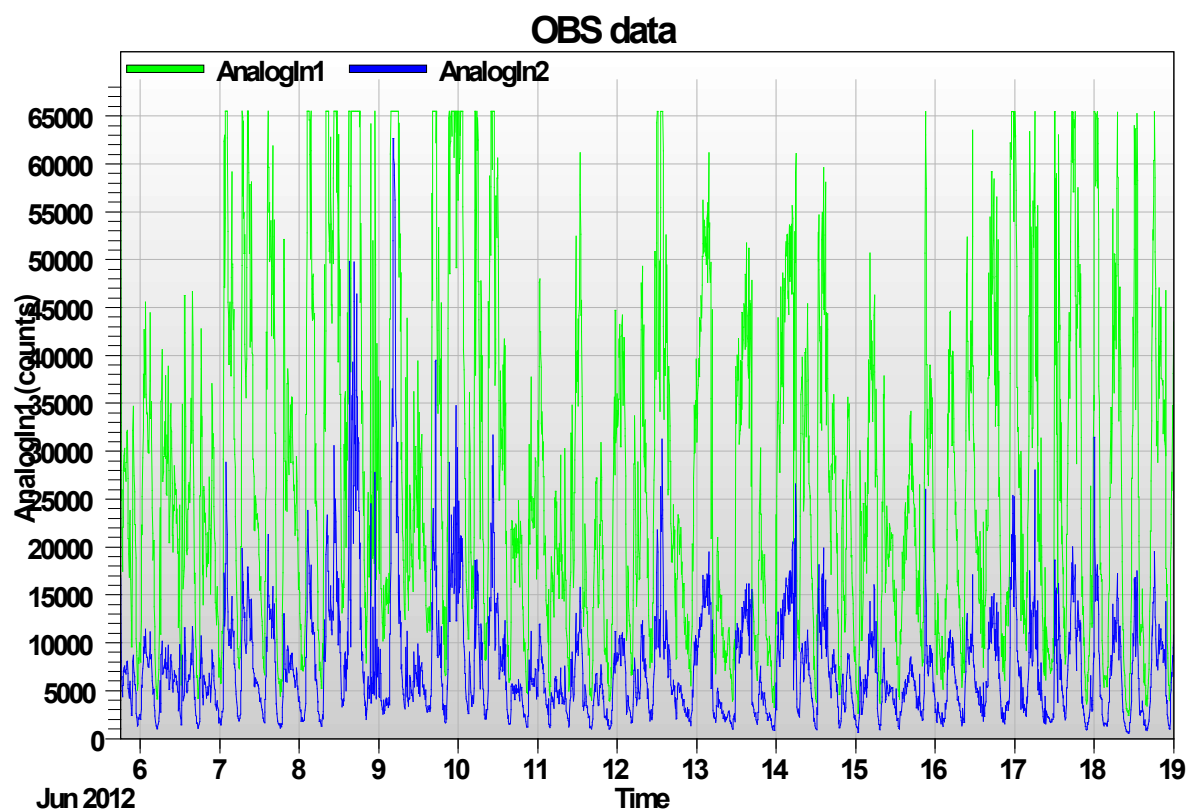


Figure 6 – OBS data from Aquadopp 1, 2012.



The green line (AnalogIn 1) displays the low range measurements and blue line (AnalogIn 2) displays the high range measurements.

Figure 7 – Processed current data (speed and direction) for the Aquadopp 2, 2012.

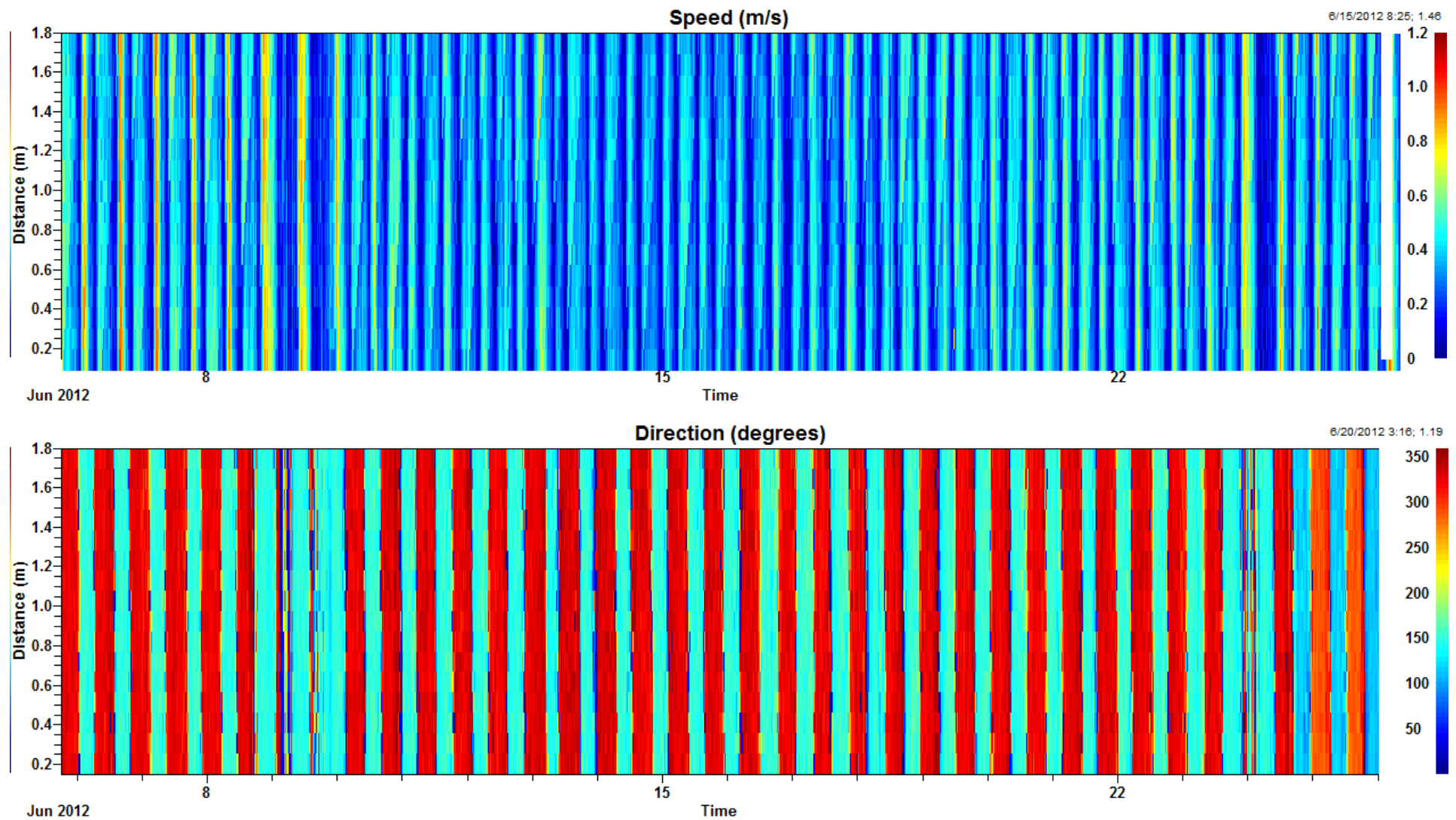


Figure 8 – Current velocities on the three spatial components for the Aquadopp 2, 2012. Note the different scales.

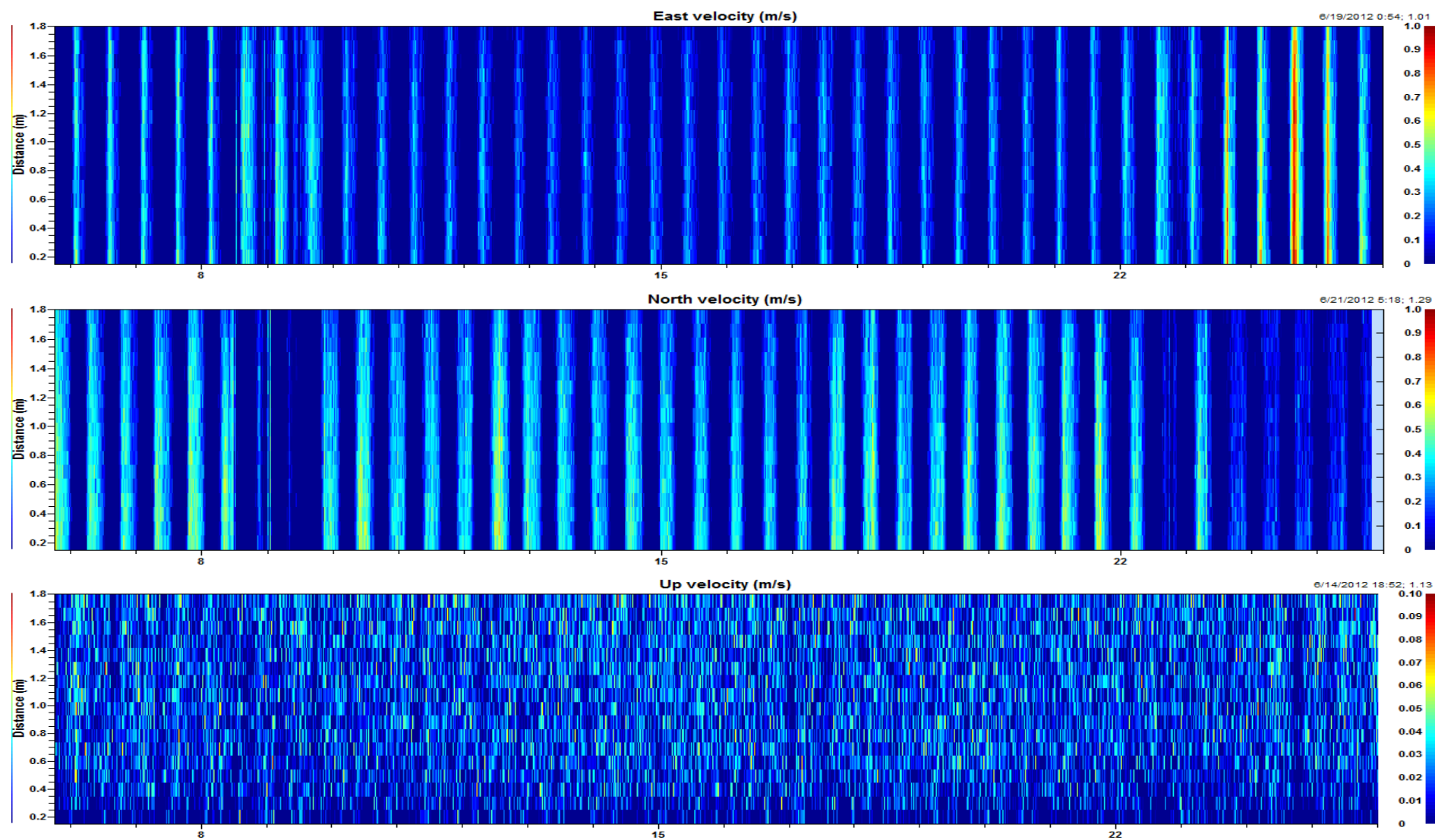
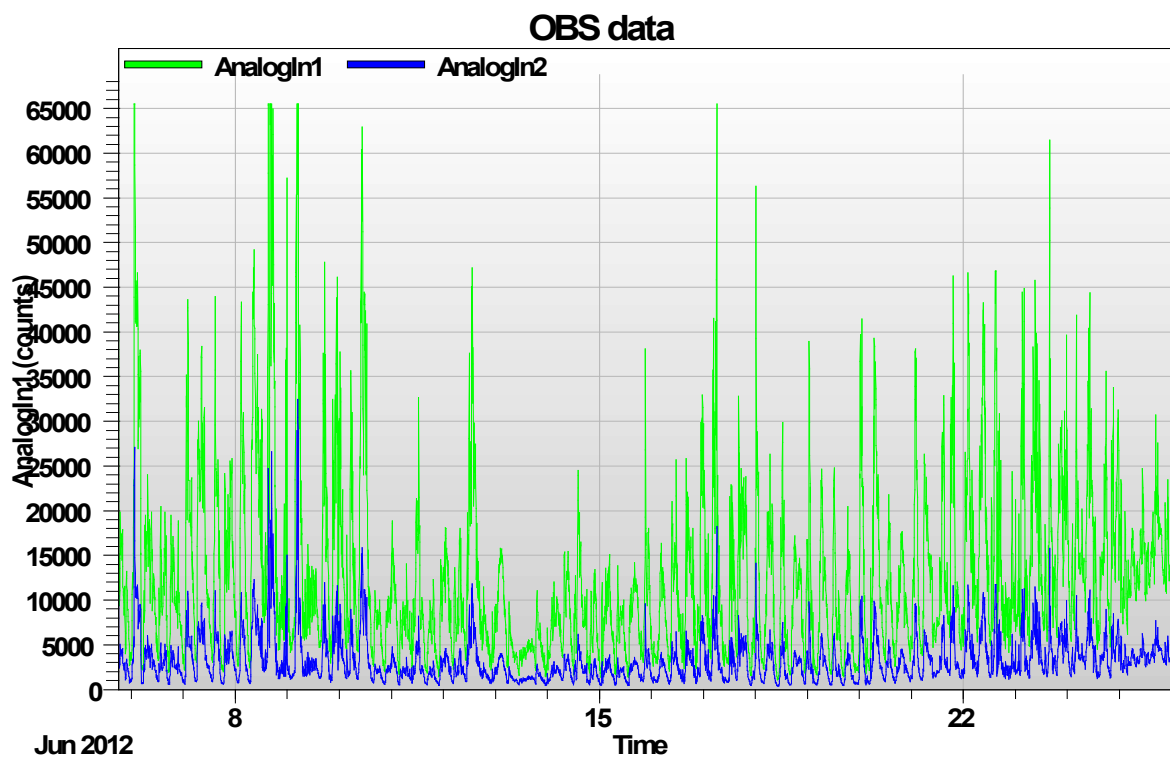


Figure 9 – Temperature, pressure and data regarding positioning recorded by Aquadopp 2, 2012.



Figure 10 – OBS data from Aquadopp 2, 2012.



The green line (AnalogIn 1) display the low range measurements and blue line (AnalogIn 2) display the high range measurements.

3.2 Pressure data

The water pressure variation was measured at different locations (Figure 1) and in different days (Table 1). Figure 11, Figure 12, Figure 13, Figure 14, Figure 15, Figure 16, Figure 17, Figure 18 display the measurements in mH₂O.

Pressure data location:

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Blankenberge_Mariakerke_2012_2013\Blankenberge\2012\Pressure sensors

Figure 11 – Pressure sensor 1, 11/06/2012.

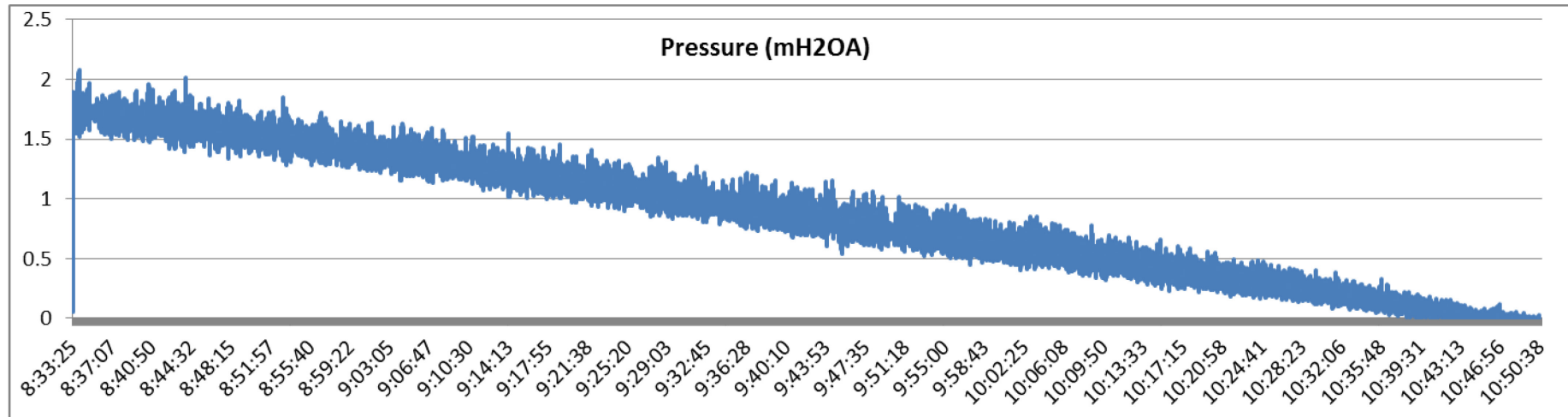


Figure 12 – Pressure sensor 2, 11/06/2012.

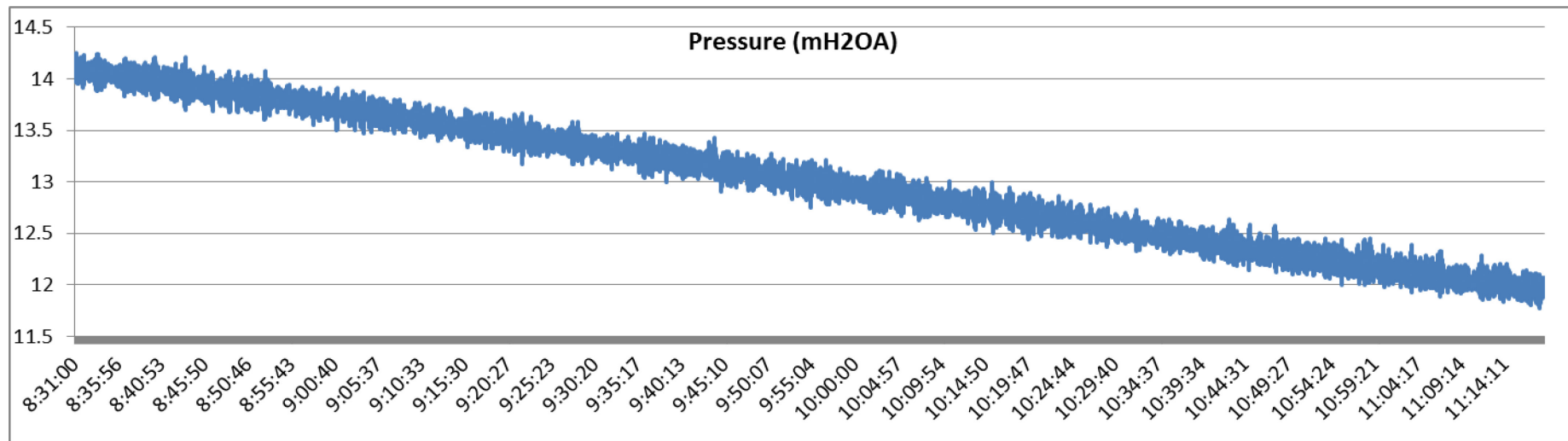


Figure 13 – Pressure sensor 3, 11/06/2012.

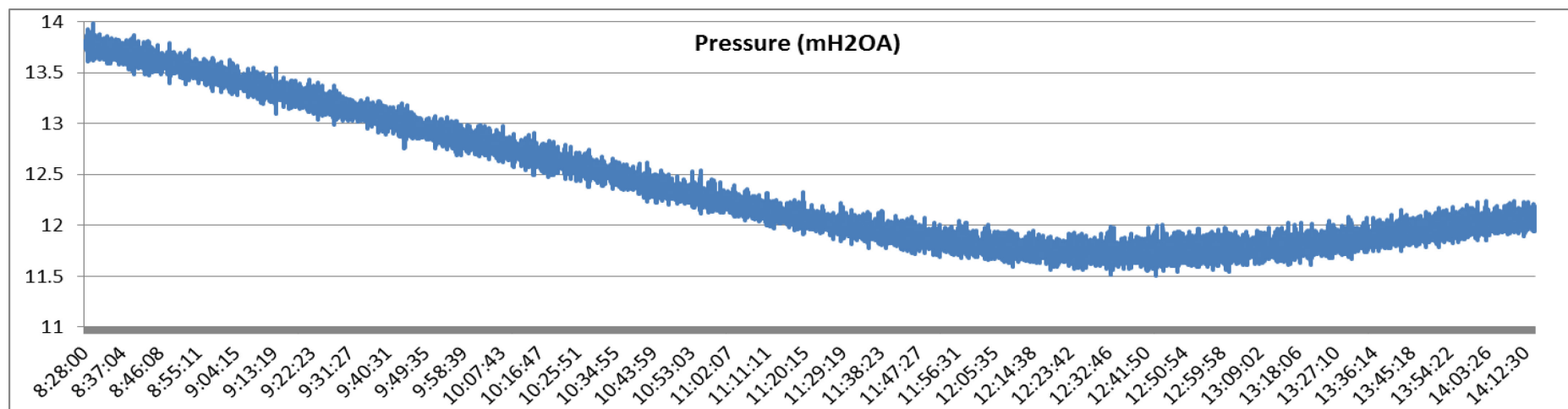


Figure 14 – Pressure sensor 4, 11/06/2012.

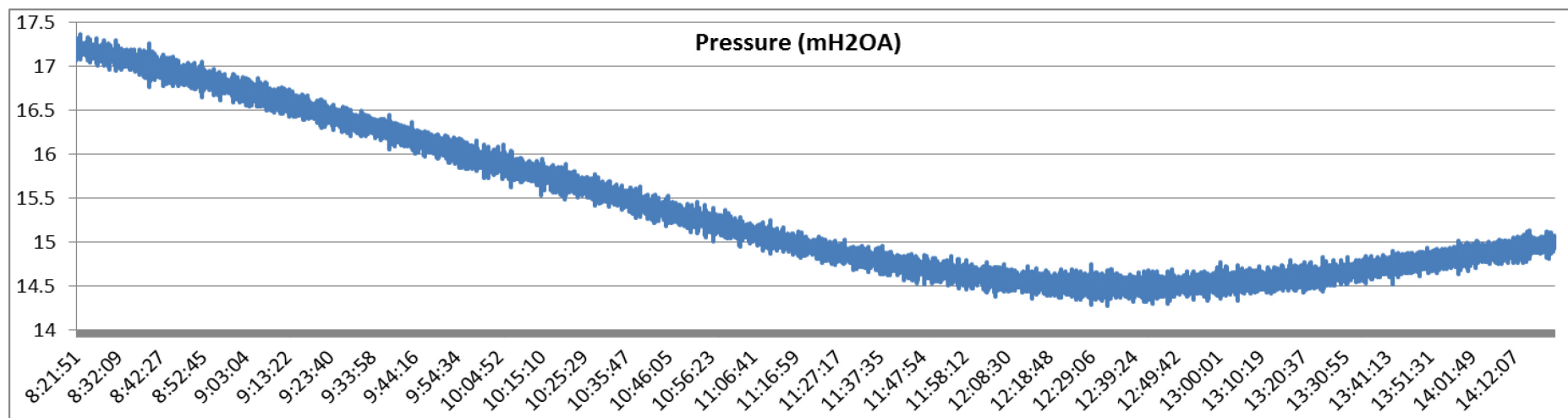


Figure 15 – Pressure sensor 1, 15/06/2012.

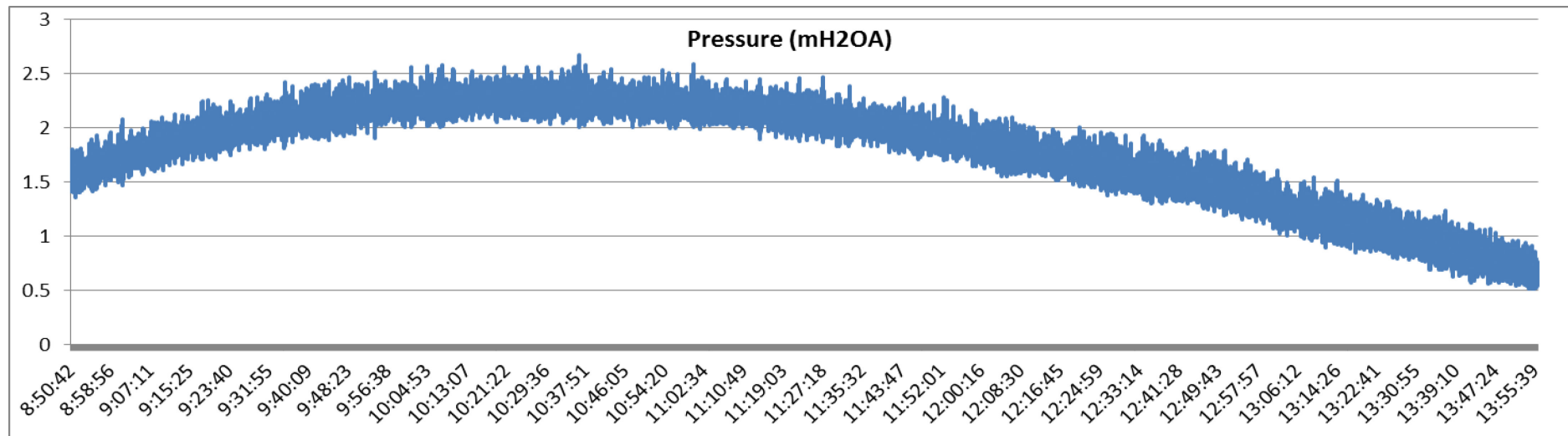


Figure 16 – Pressure sensor 2, 15/06/2012.

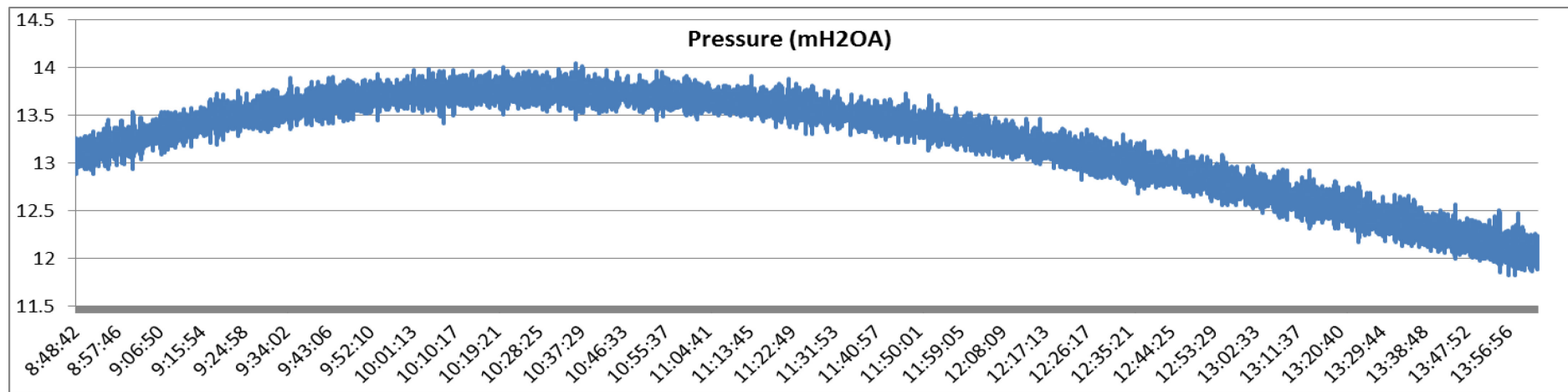


Figure 17 – Pressure sensor 3, 15/06/2012.

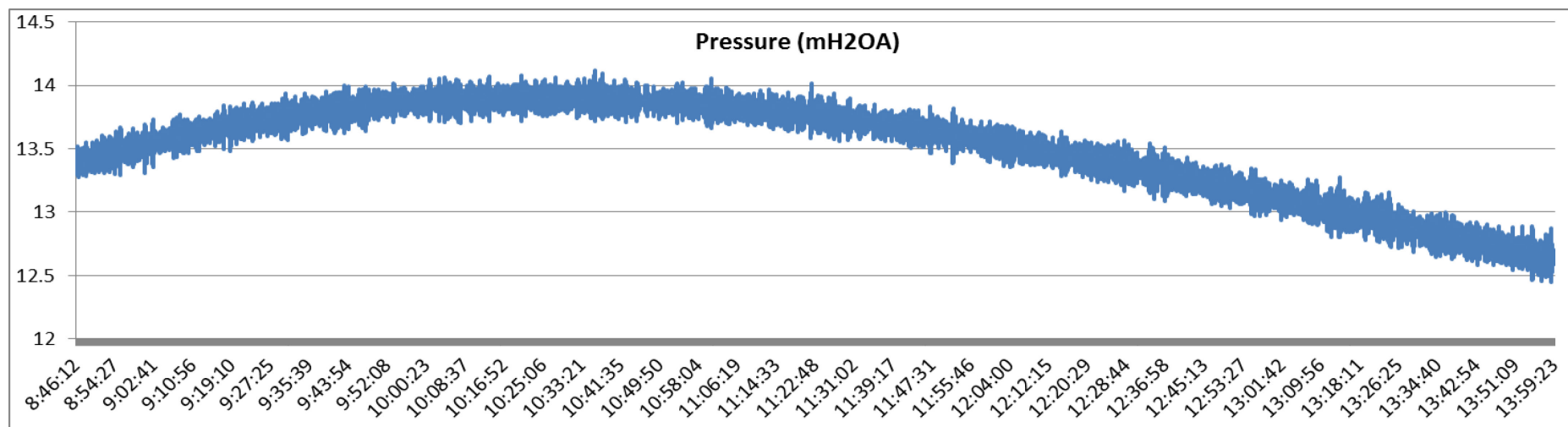
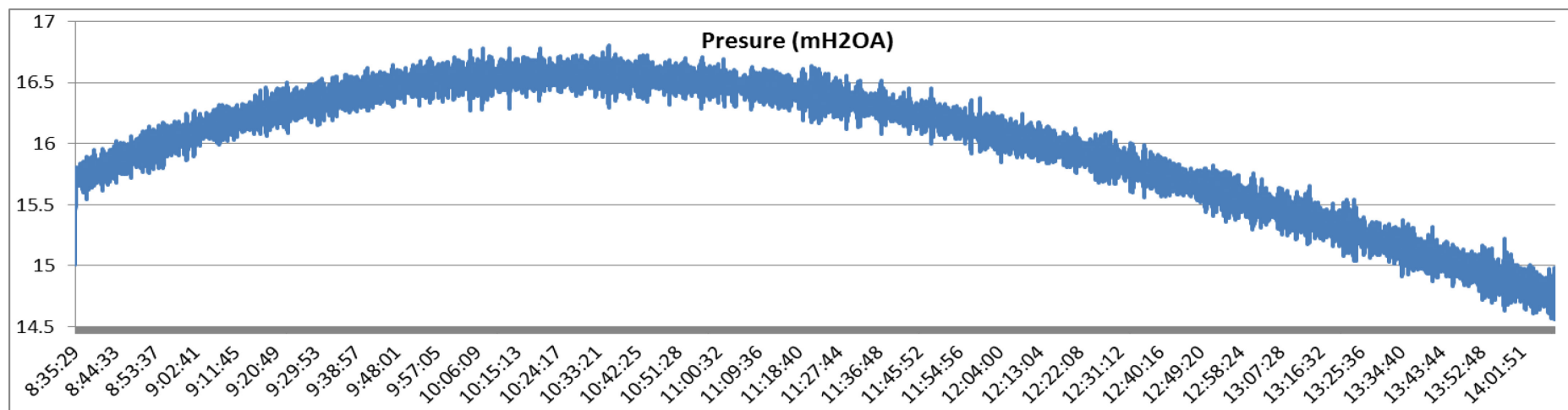


Figure 18 – Pressure sensor 4, 15/06/2012.



3.3 Drifters

A number of 6 drifters were used to measure the marine currents on the 11th of June 2012 at a depth of approximately -1 below water level. Inside of each drifter a GPS instrument was fitted making possible the recording of their trajectory. A detailed description of the drifters was made in Dan et al. 2013. A series of maps were built to determine their movement (Appendix A). The method employed for building the maps is presented in Dan et al. 2014.

Drifters data location:

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Blankenberge_Mariakerke_2012_2013\Blankenberge\2012\Drifters

3.4 Water samples

A number of 20 water samples were taken in the vicinity of the measuring instruments. The suspended sediment concentration (mg/l) was measured for all of them while the conductivity was measured just for 9 of the samples. The exact location and date of the sampling as well as the results of the laboratory analysis are presented in the Table 4.

Water sample data location:

P:\00_064-hydrodynamica\Data field campaigns
Blankenberge_Mariakerke_2012_2013\Blankenberge\2012\water samples

Table 4 – Water samples Campaign 2012.

Sample no.	Date and hour (CET)	Location		Elevation above the sea floor	Suspended sediment concentration (mg/l)	Conductivity at 25°C (mS)
SC2012010126/1046	05/06/12 13:21	51°18'48.61"N	3° 6'0.57"E	2	39	
SC2012010127/1047	05/06/12 13:21	51°18'48.61"N	3° 6'0.57"E	2	95	46.8
SC2012010128/1048	05/06/12 13:21	51°18'48.61"N	3° 6'0.57"E	2	40	
SC2012010129/1049	05/06/12 13:21	51°18'48.61"N	3° 6'0.57"E	2	22	46.7
SC2012010130/1050	05/06/12 13:21	51°18'48.61"N	3° 6'0.57"E	2	30	
SC2012010131/1031	05/06/12 13:29	51°18'50.53"N	3° 6'12.13"E	1	353	
SC2012010132/1032	05/06/12 13:29	51°18'50.53"N	3° 6'12.13"E	1	337	46.6
SC2012010133/1033	05/06/12 13:29	51°18'50.53"N	3° 6'12.13"E	1	314	
SC2012010134/1034	05/06/12 13:29	51°18'50.53"N	3° 6'12.13"E	1	371	46.7
SC2012010135/1035	05/06/12 13:29	51°18'50.53"N	3° 6'12.13"E	1	368	
SC2012010136/1036	05/06/12 13:31	51°18'50.53"N	3° 6'12.13"E	2	41	
SC2012010137/1037	05/06/12 13:31	51°18'50.53"N	3° 6'12.13"E	2	52	46.6
SC2012010138/1038	05/06/12 13:31	51°18'50.53"N	3° 6'12.13"E	2	42	
SC2012010139/1039	05/06/12 13:31	51°18'50.53"N	3° 6'12.13"E	2	35	46.6
SC2012010140/1040	05/06/12 13:31	51°18'50.53"N	3° 6'12.13"E	2	111	

Sample no.	Date and hour (CET)	Location		Elevation above the sea floor	Suspended sediment concentration (mg/l)	Conductivity at 25°C (mS)
SC2012010141/1041	05/06/12 13:20	51°18'48.61"N	3° 6'0.57"E	1	412	
SC2012010142/1042	05/06/12 13:20	51°18'48.61"N	3° 6'0.57"E	1	341	46.8
SC2012010143/1043	05/06/12 13:20	51°18'48.61"N	3° 6'0.57"E	1	269	
SC2012010144/1044	05/06/12 13:20	51°18'48.61"N	3° 6'0.57"E	1	169	46.7
SC2012010145/1045	05/06/12 13:20	51°18'48.61"N	3° 6'0.57"E	1	245	
SC2012011231/1171	26/06/12 8:13	51°18'48.61"N	3° 6'0.57"E	1	71	
SC2012011232/1172	26/06/12 8:13	51°18'48.61"N	3° 6'0.57"E	1	65	45.4
SC2012011233/1173	26/06/12 8:13	51°18'48.61"N	3° 6'0.57"E	1	75	
SC2012011234/1174	26/06/12 8:13	51°18'48.61"N	3° 6'0.57"E	1	66	45.5
SC2012011235/1175	26/06/12 8:13	51°18'48.61"N	3° 6'0.57"E	1	69	
SC2012011236/1176	26/06/12 8:15	51°18'48.61"N	3° 6'0.57"E	2	28	
SC2012011237/1177	26/06/12 8:15	51°18'48.61"N	3° 6'0.57"E	2	86	45.2
SC2012011238/1178	26/06/12 8:15	51°18'48.61"N	3° 6'0.57"E	2	30	
SC2012011239/1179	26/06/12 8:15	51°18'48.61"N	3° 6'0.57"E	2	30	45.1
SC2012011240/1180	26/06/12 8:15	51°18'48.61"N	3° 6'0.57"E	2	37	
SC2012011241/1181	26/06/12 8:24	51°18'50.53"N	3° 6'12.13"E	1	60	
SC2012011242/1182	26/06/12 8: 24	51°18'50.53"N	3° 6'12.13"E	1	55	45.4
SC2012011243/1183	26/06/12 8: 24	51°18'50.53"N	3° 6'12.13"E	1	61	
SC2012011244/1184	26/06/12 8: 24	51°18'50.53"N	3° 6'12.13"E	1	52	45.3
SC2012011245/1185	26/06/12 8: 24	51°18'50.53"N	3° 6'12.13"E	1	56	
SC2012011246/1186	26/06/12 8:26	51°18'50.53"N	3° 6'12.13"E	2	31	
SC2012011247/1187	26/06/12 8: 26	51°18'50.53"N	3° 6'12.13"E	2	24	45.4
SC2012011248/1188	26/06/12 8: 26	51°18'50.53"N	3° 6'12.13"E	2	29	
SC2012011249/1189	26/06/12 8: 26	51°18'50.53"N	3° 6'12.13"E	2	29	45.1
SC2012011250/1190	26/06/12 8: 26	51°18'50.53"N	3° 6'12.13"E	2	28	

3.5 Meteo-marine data

The meteo-marine conditions are important to understand the context during the measurements. The tide variation is presented in the Figure 19, the significant wave height in Figure 20 and the wave period in Figure 21. All the parameters were recorded at the buoy A2 (Source of the data: <http://www.meetnetvlaamsebanken.be/Default.aspx?Page=Measurements&L=nl>) .

Figure 19 – The tide recorded at buoy A2 every 5 minutes between 5/06 and 26/06/2012 (in cm).

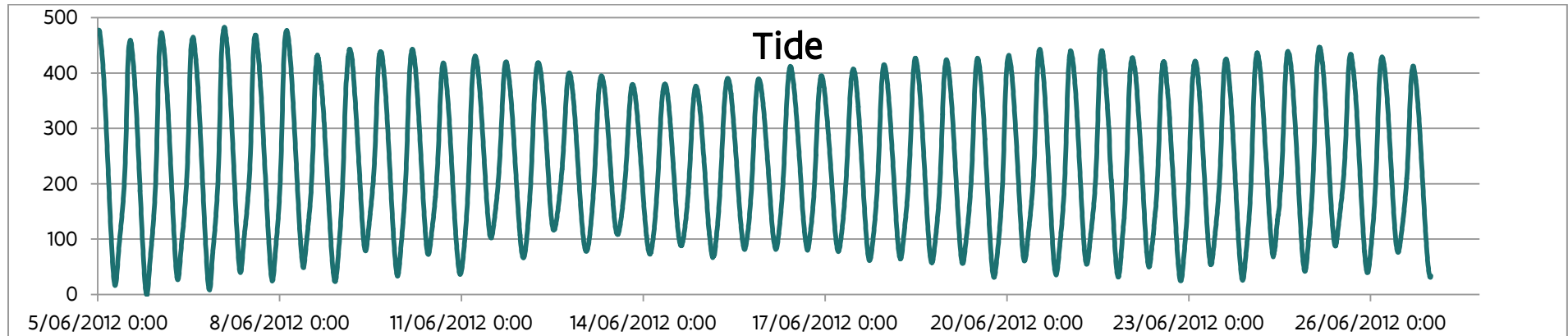


Figure 20 – The significant wave height recorded at buoy A2 every 5 minutes between 5/06 and 26/06/2012 (in cm).

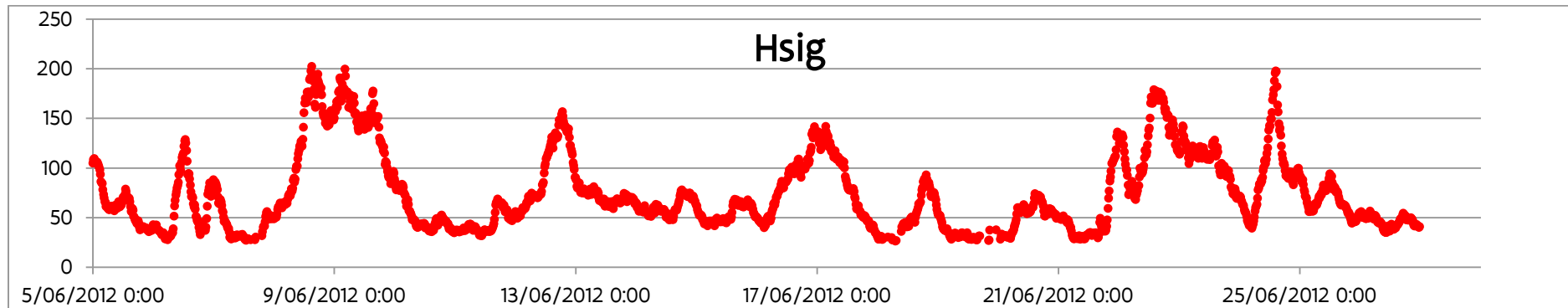
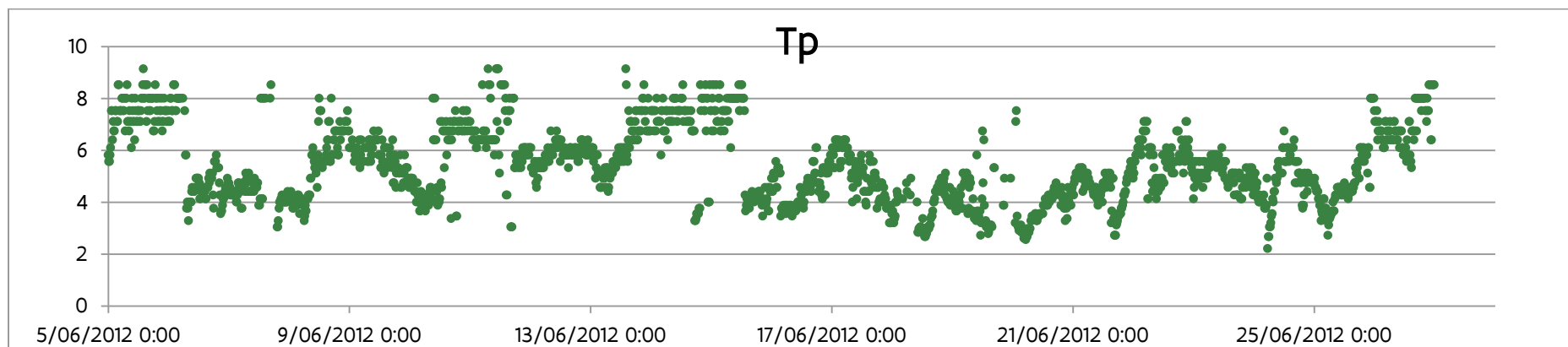


Figure 21 – The peak period of the waves recorded at buoy A2 every 5 minutes between 5/06 and 26/06/2012 (in seconds).



4 Campaign 2013

4.1 AWAC and Aquadopp data

Two AWAC and one Aquadopp instruments have been deployed and the data collected are shown in this sub-chapter. The data have been checked for and corrected for the tilt effects, echo spikes velocity variations, low signal and sidelobe rejection using the software Storm Ver. 1.14 from Nortek.

AWAC WC_0 recorded valid data between 19/06/2013 12:00:00 till 4/07/2013 12:00:00, AWAC harbor recorded valid data between 20/06/2013 12:00:00 till 5/07/2013 12:00:00 and Aquadopp WC_E recorded valid data between 19/06/2013 12:00:00 till 4/07/2013 12:00:00. The main settings are presented in Table 3 while the detailed settings can be seen in Dan et al., 2013.

AWAC and Aquadopp data location:

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Table 5 – The main settings of the instruments deployed in the Campaign 2013.

Instrument	AWAC WC_0	AWAC harbor	Aquadopp WC_E
Orientation	Looking upwards	Looking upwards	Looking upwards
Current profile interval	300 sec	300 sec	300 sec
Number of cells	22	14	20
Cell size	0.5 m	0.5 m	0.5 m
Average interval	60 sec	60 sec	60 sec
Blanking distance	0.2 m	0.2 m	0.2 m
Wave - Interval	3600 sec	3600 sec	3600 sec
Wave - Number of samples	2400	2400	2400
Wave - Sampling rate	2 Hz	2 Hz	2 Hz
Wave - Cell size	0.5 m	0.5 m	0.5 m
Analog input	no	no	no
Coordinate system	ENU	ENU	ENU

The velocity and direction of the currents averaged over the total waterdepth are presented in Figure 22, Figure 26 and Figure 30 while for each directional component in Figure 23, Figure 27 and Figure 31. Figure 25, Figure 29 and Figure 33 show the main wave parameters (significant height, period and direction) as processes by the Storm software using as main input the water pressure variation and the current data. Figure 24, Figure 28 and Figure 32 show other parameters recorded by the instrument, those related to the in situ conditions (temperature, pressure) and those related to the position on the sensor (heading, pitch and roll).

Figure 22 – Processed current data (speed and direction) for the AWAC harbor, 2013.

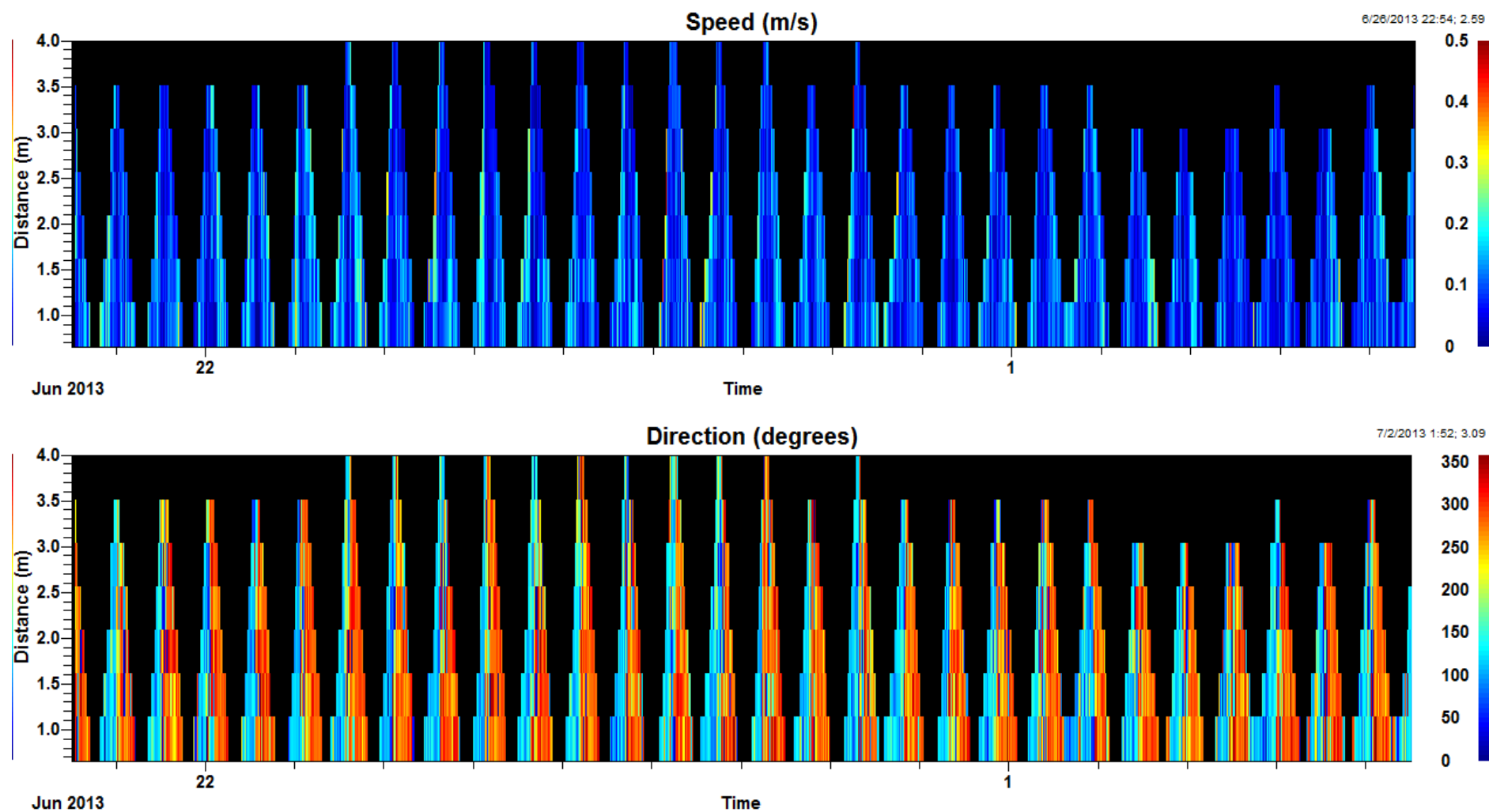


Figure 23 – Current velocities on the three spatial components for the AWAC harbor, 2013. Note the different scales.

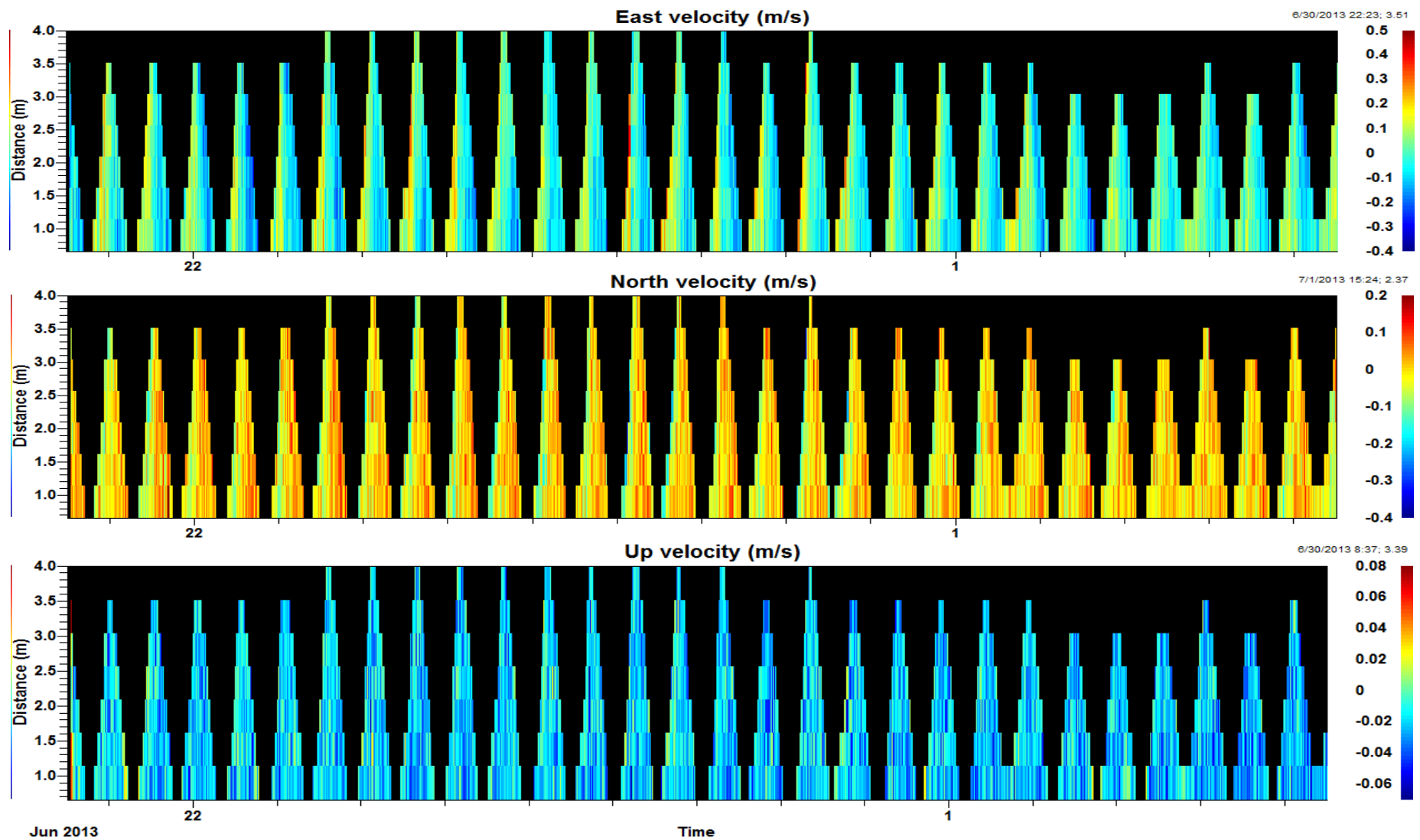


Figure 24 – Temperature, pressure and data regarding positioning recorded by AWAC harbor, 2013.

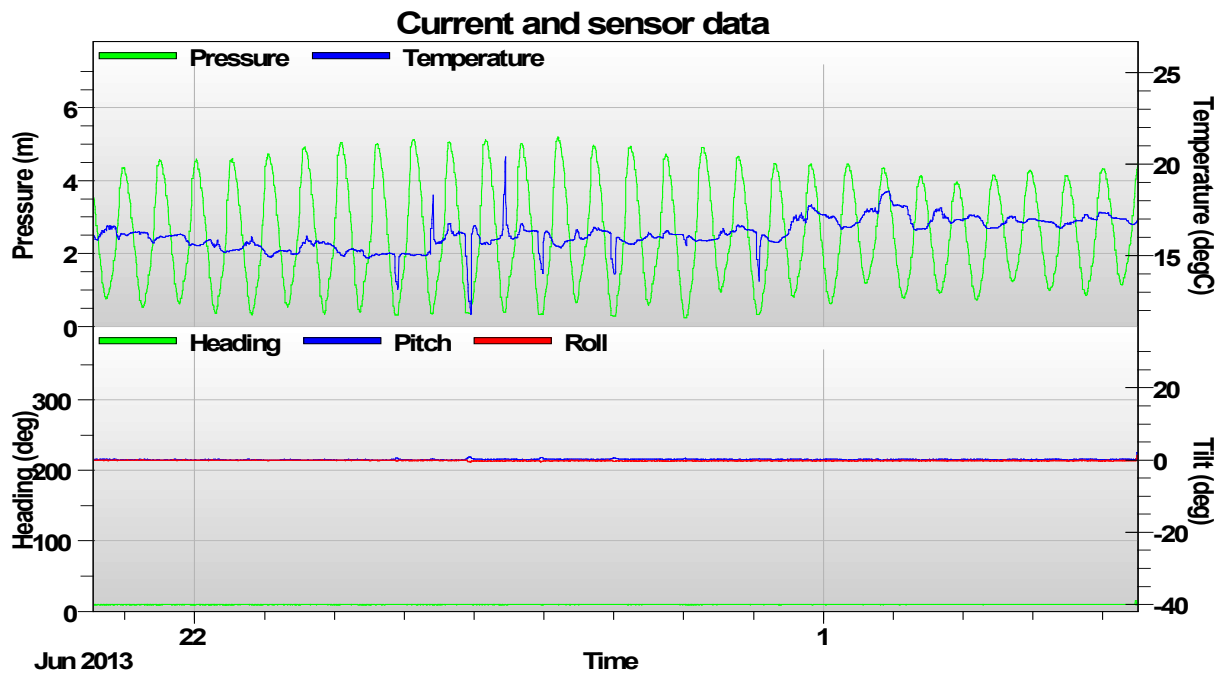


Figure 25 – Processed wave data from AWAC harbor, 2013.

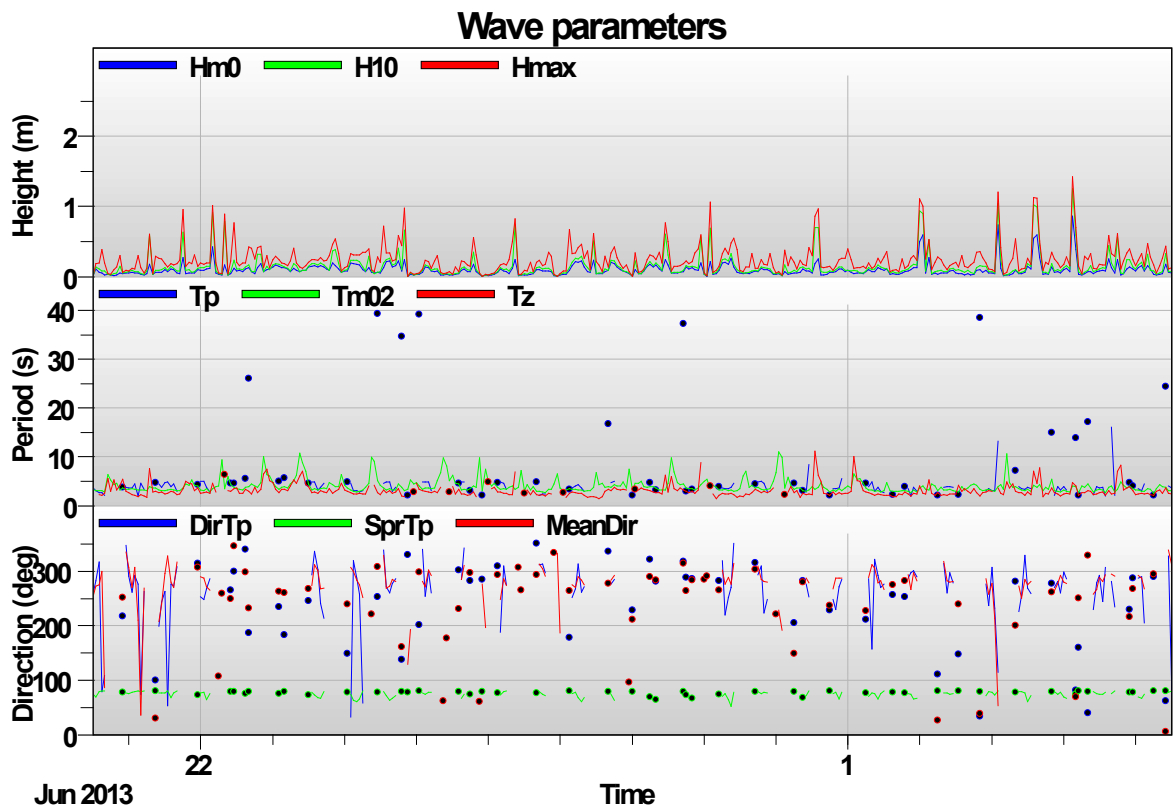


Figure 26 – Processed current data (speed and direction) for the AWAC WC_0, 2013.

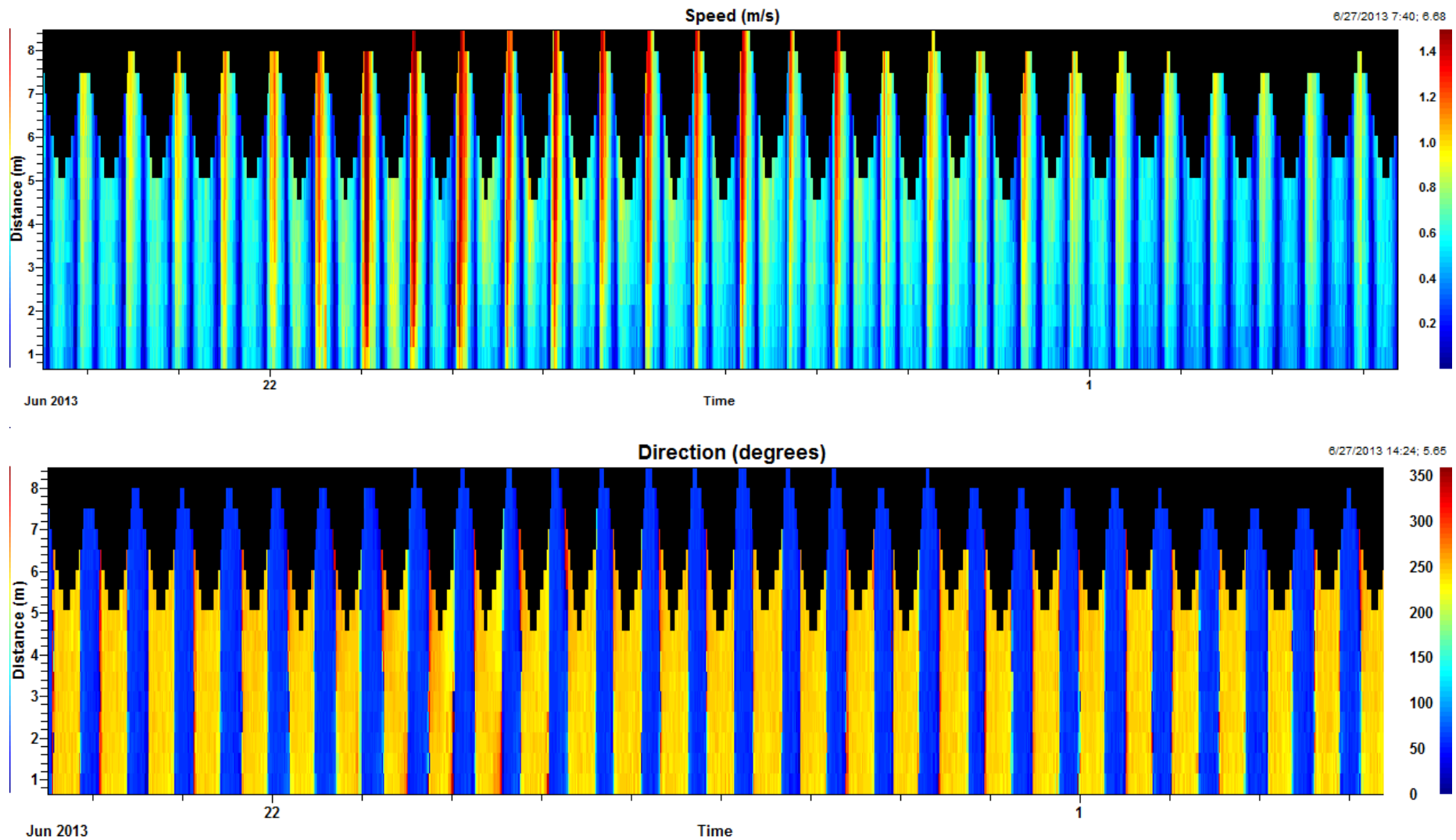


Figure 27 – Current velocities on the three spatial components for the AWAC harbor, 2013. Note the different scales.

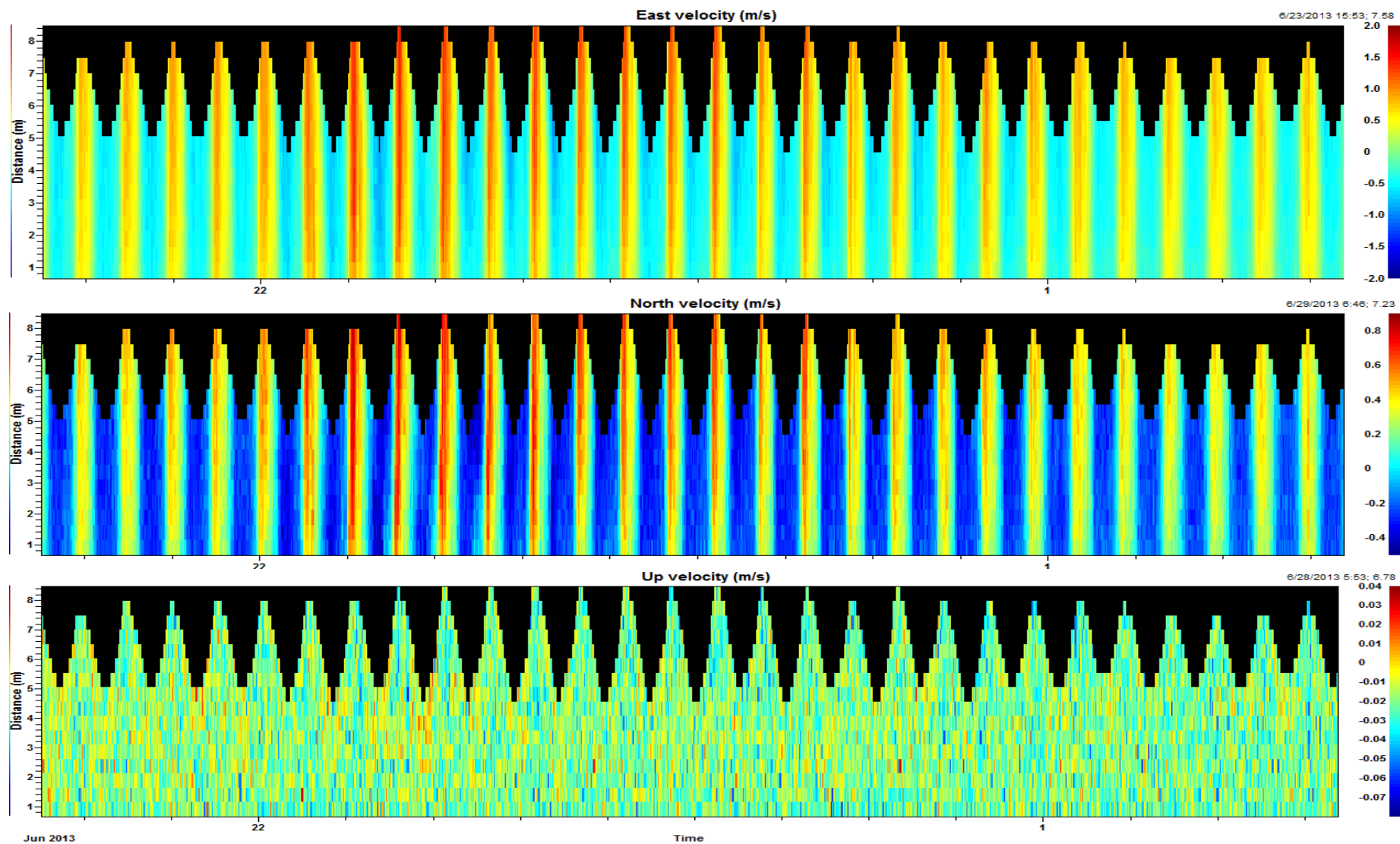


Figure 28 – Temperature, pressure and data regarding positioning recorded by AWAC WC_0, 2013.

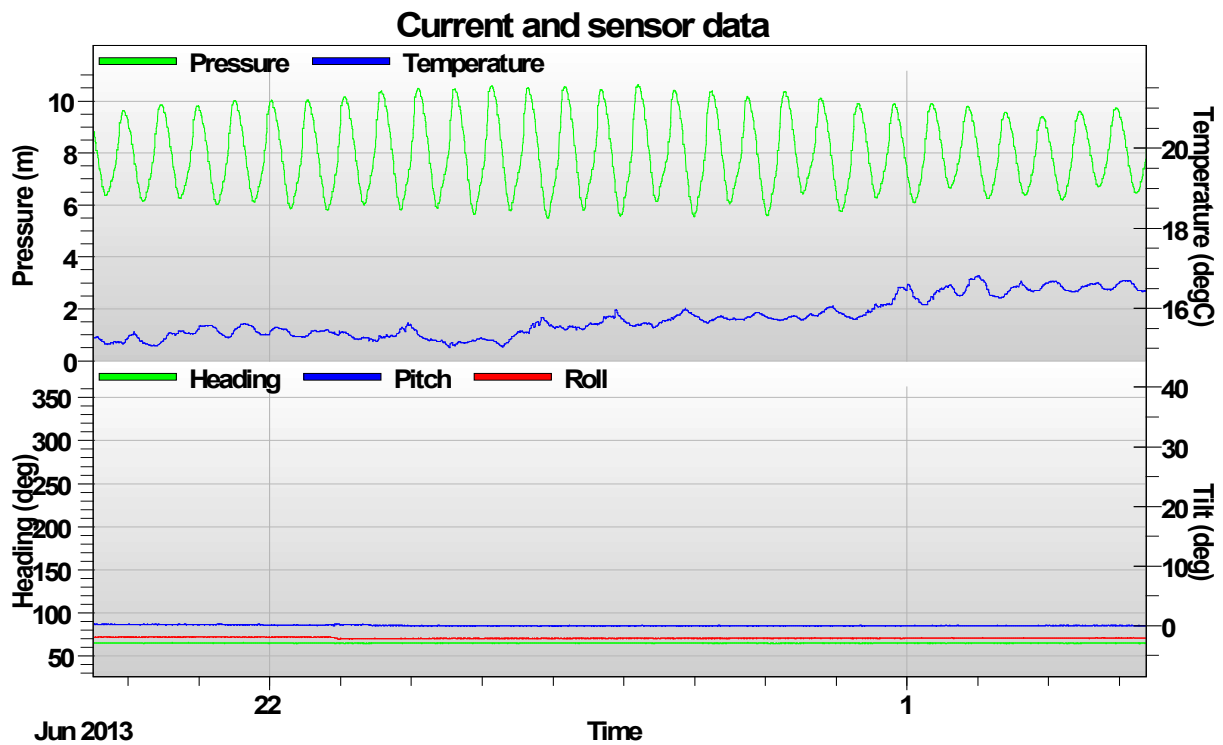


Figure 29 – Processed wave data from AWAC WC_0, 2013.

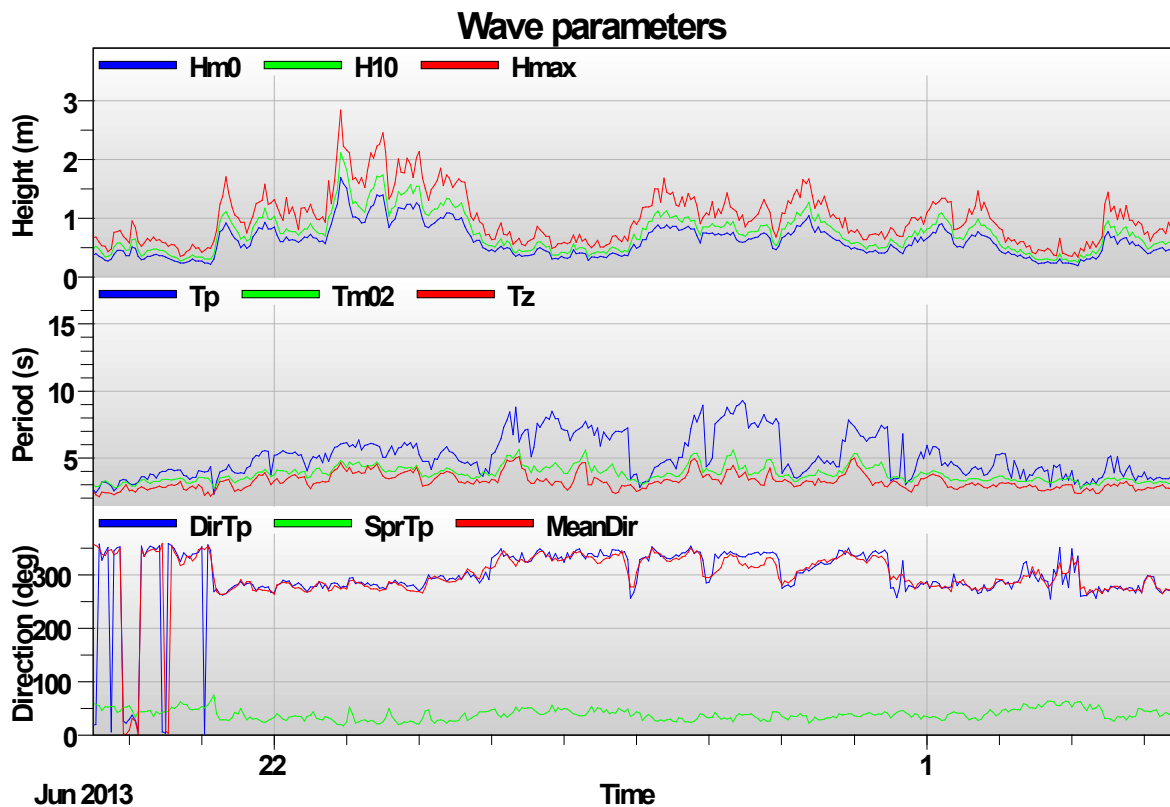


Figure 30 – Processed current data (speed and direction) for the Aquadopp WC_E, 2013.

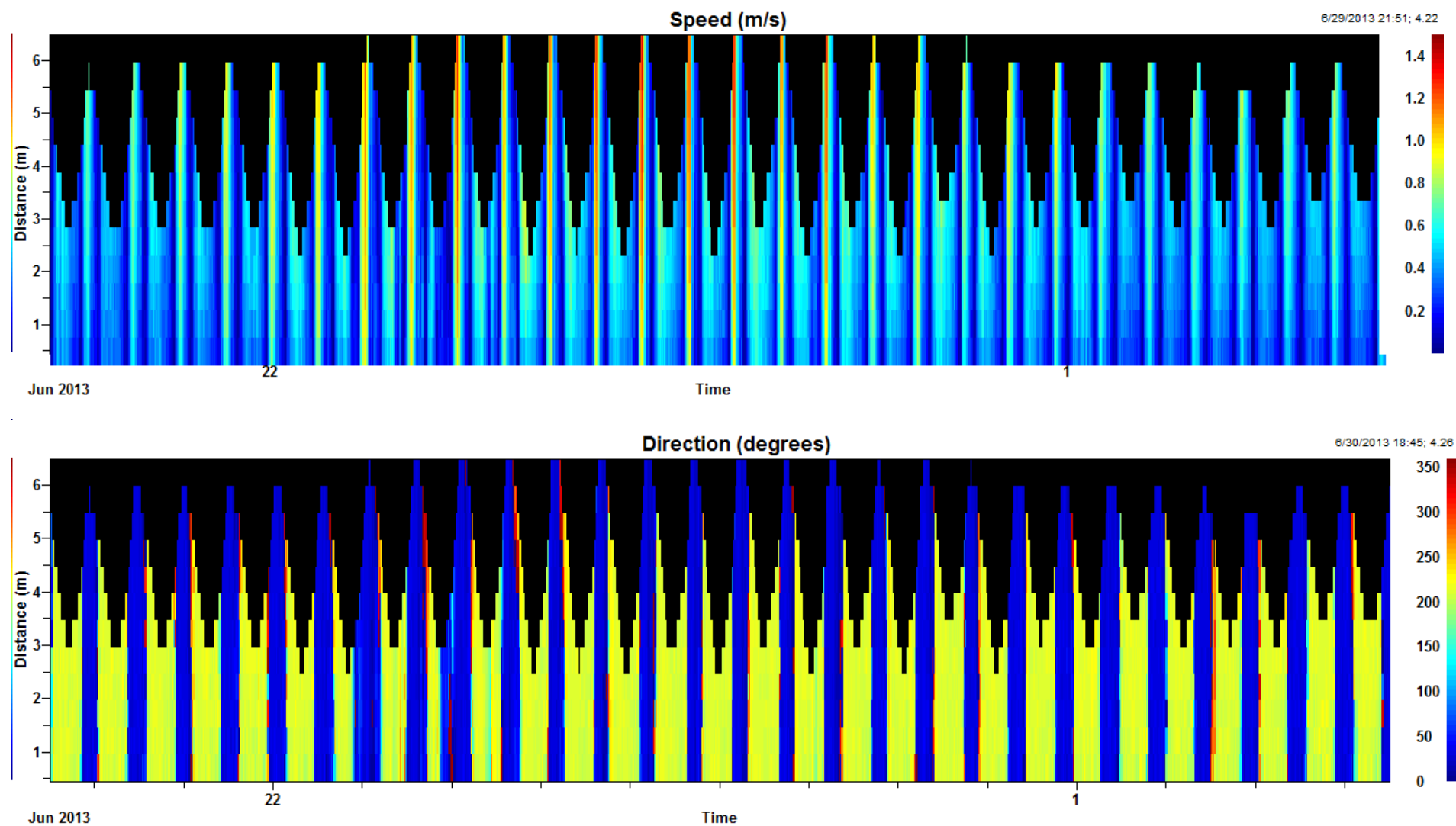


Figure 31 – Current velocities on the three spatial components for the AWAC harbor, 2013. Note the different scales.

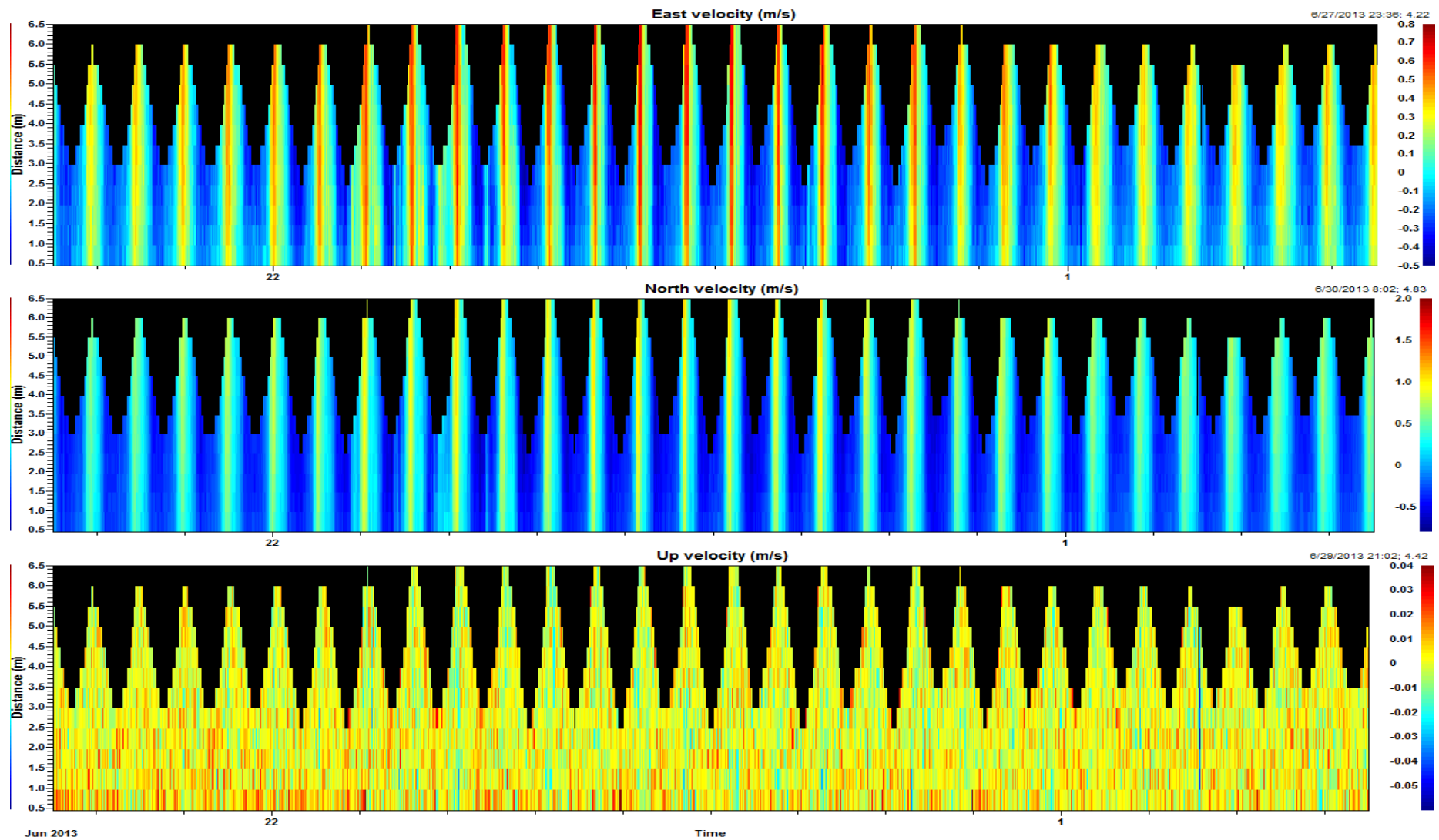


Figure 32 – Temperature, pressure and data regarding positioning recorded by Aquadopp WC_E, 2013.

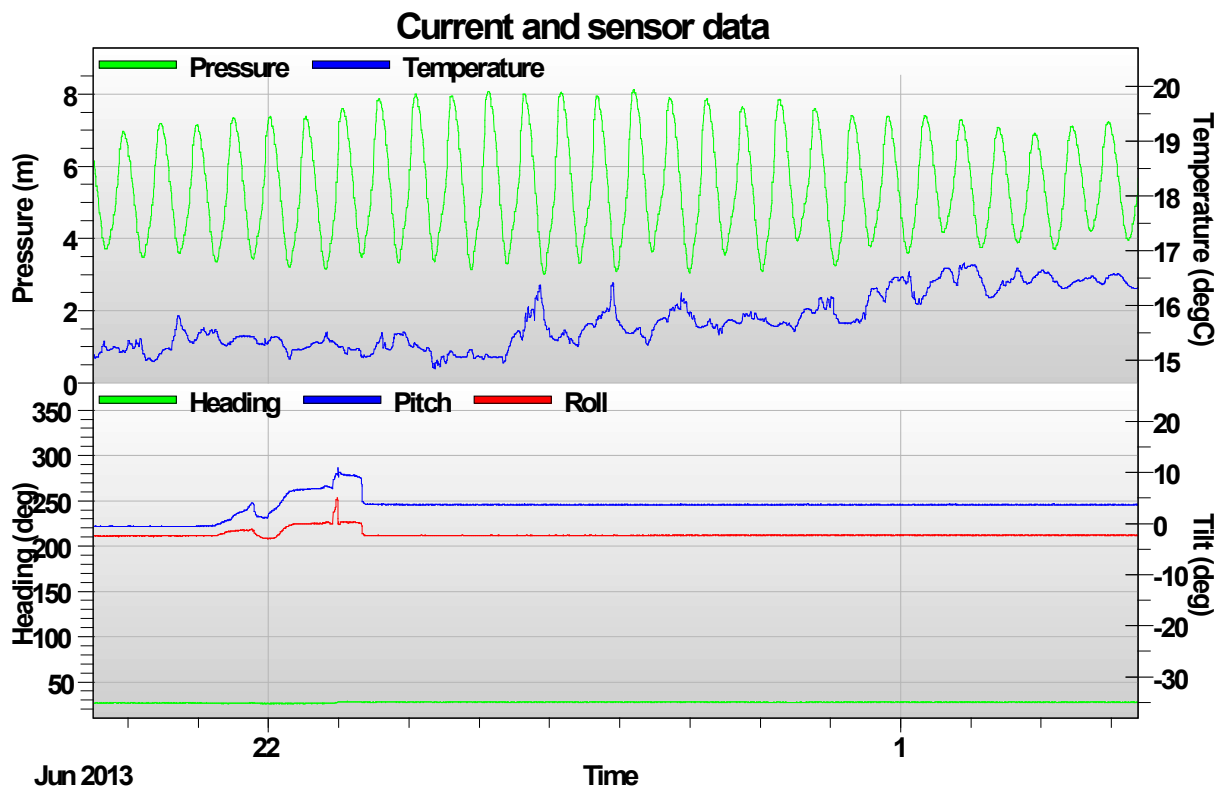
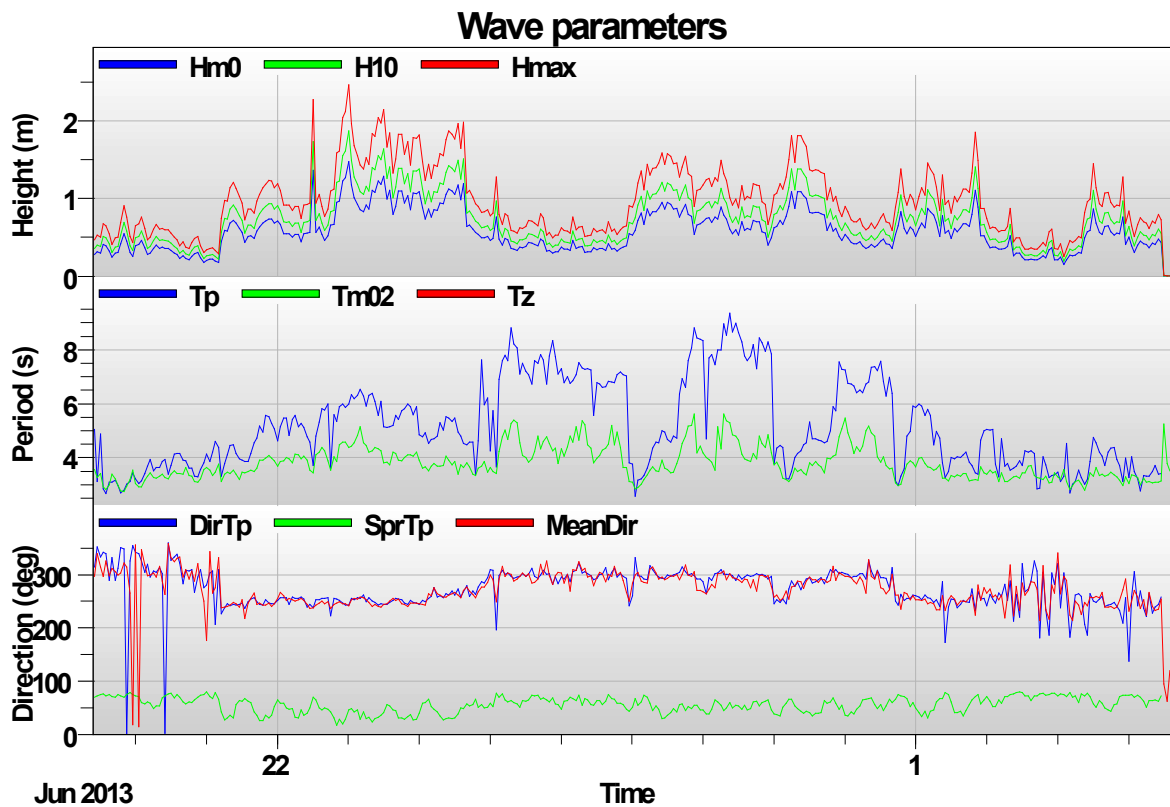


Figure 33 – Processed wave data from Aquadopp WC_E, 2013.



4.2 Pressure data

The water pressure variation was measured at different locations (Figure 1) and in different days (Table 2 The exact location of the instruments deployment for Campaign 2013.). Figure 34, Figure 35 and Figure 36 display the measurements in mH₂O.

Pressure data location:

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Figure 34 – Pressure sensor P5, 27/06/2013.

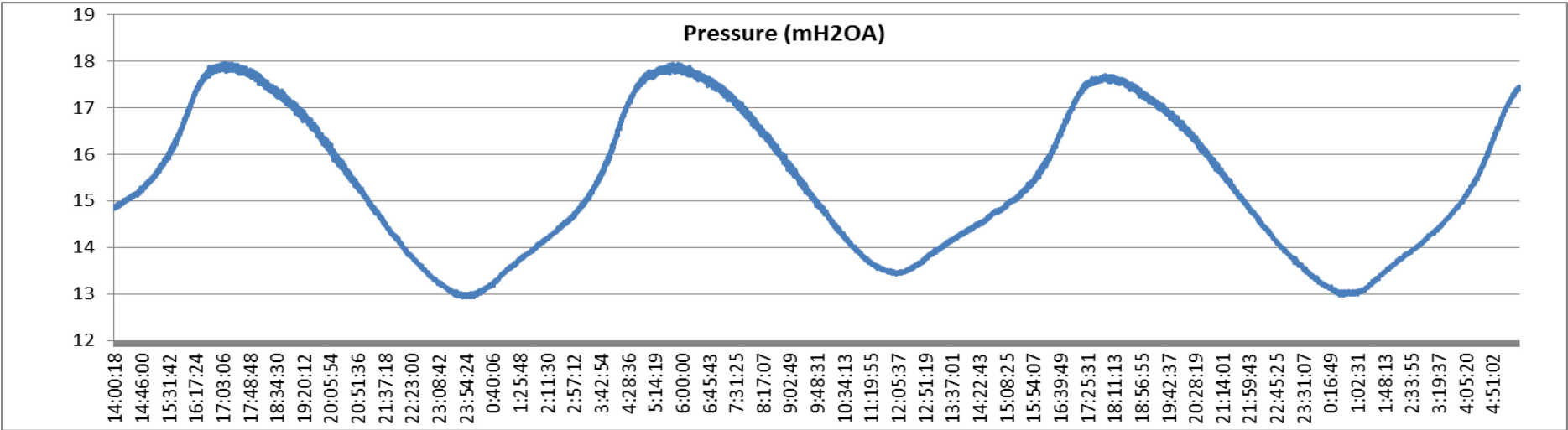


Figure 35 – Pressure sensor P6, 29/06/2013.

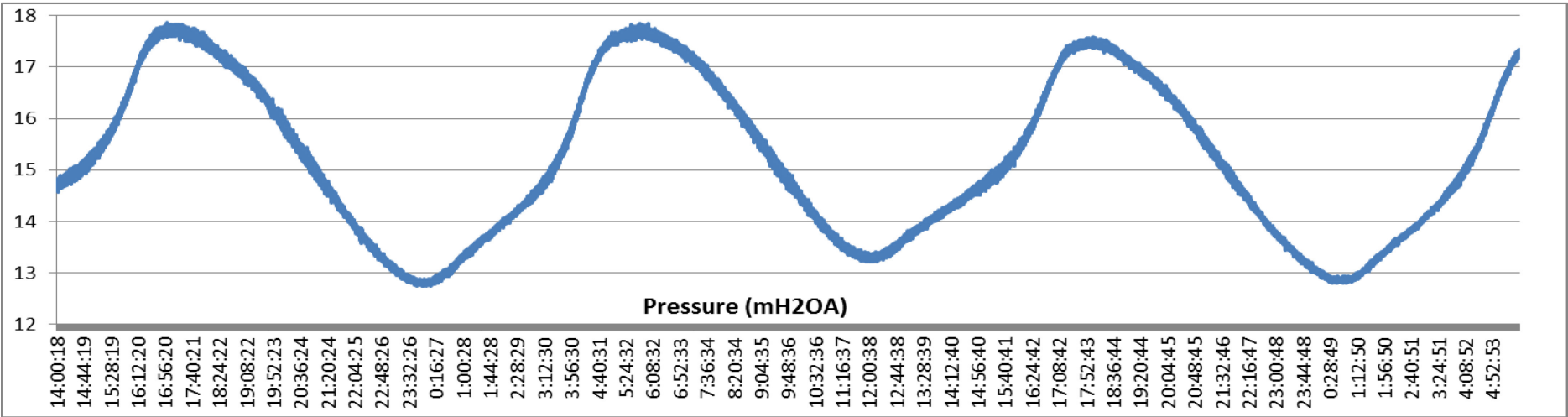
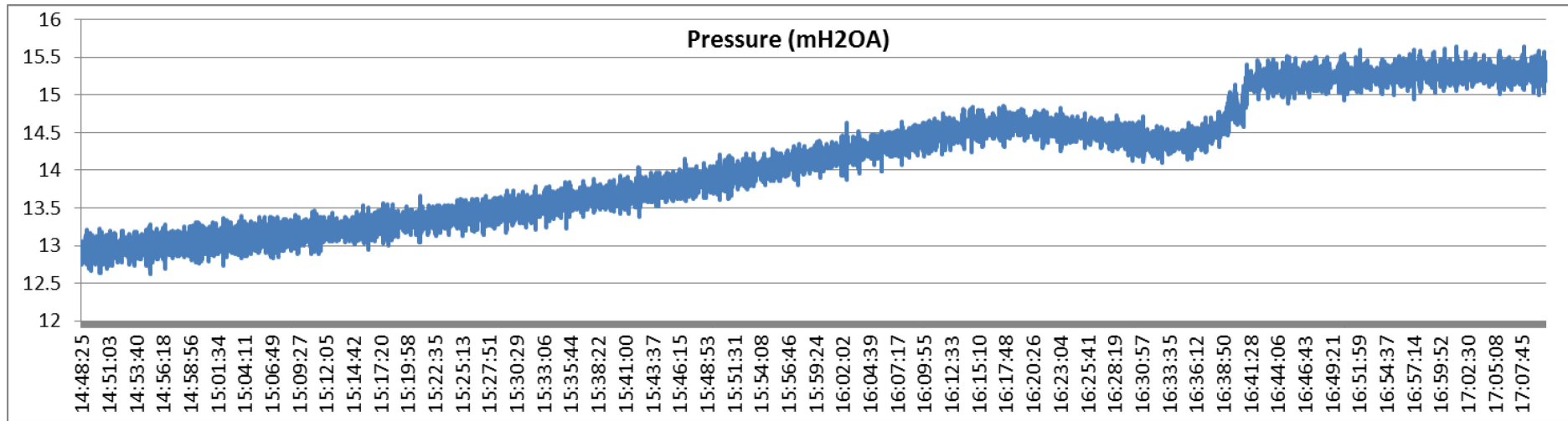


Figure 36 – Pressure sensor, 27/06/2013.



4.3 Drifters

A number of 6 drifters were used to measure the marine currents on the 27th of June 2013 at a depth of approximately -1 below water level. Inside of each drifter a GPS instrument was fitted making possible the recording of their trajectory. A detailed description of the drifters was made in Dan et al. 2013. A series of maps were built to determine their movement (Appendix A). The method employed for building the maps is presented in Dan et al. 2014.

Drifters data location:

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Blankenberge_Mariakerke_2012_2013\Blankenberge\2013\Drifters

4.4 Meteo-marine data

The tide variation is presented in Figure 37, the significant wave height in Figure 38. All the wave parameters were recorded at the buoy A2 (Source of the data:

<http://www.meetnetvlaamsebanken.be/Default.aspx?Page=Measurements&L=nl>).

Figure 37 – The tide recorded at buoy A2 every 5 minutes between 19/06 and 4/07/2013 (in cm).

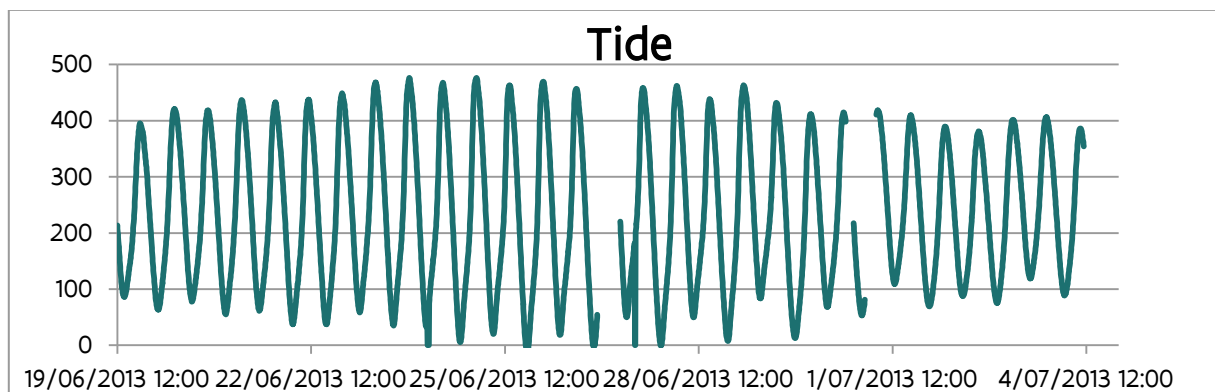
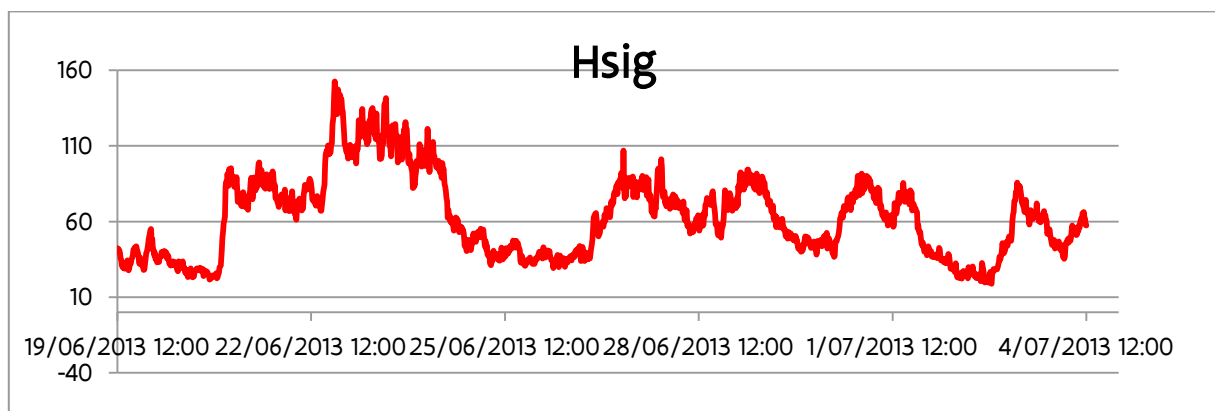


Figure 38 – The significant wave height recorded at buoy A2 every 15 minutes between 19/06 and 4/07/2013 (in cm).



5 References

Dan, S.; Delgado, R.; Vereecken H.; Levy, Y.; De Backer E.; Verzhbitskiy, L.; Kamminga, S.; Verwaest, T; Mostaert, F. (2013). Measuring campaigns of hydrodynamics and sand dynamics in Blankenberge: Campaign June 2012. Version 2_0. WL Rapporten, 00_064. Flanders Hydraulics Research, Antwerp, Belgium.

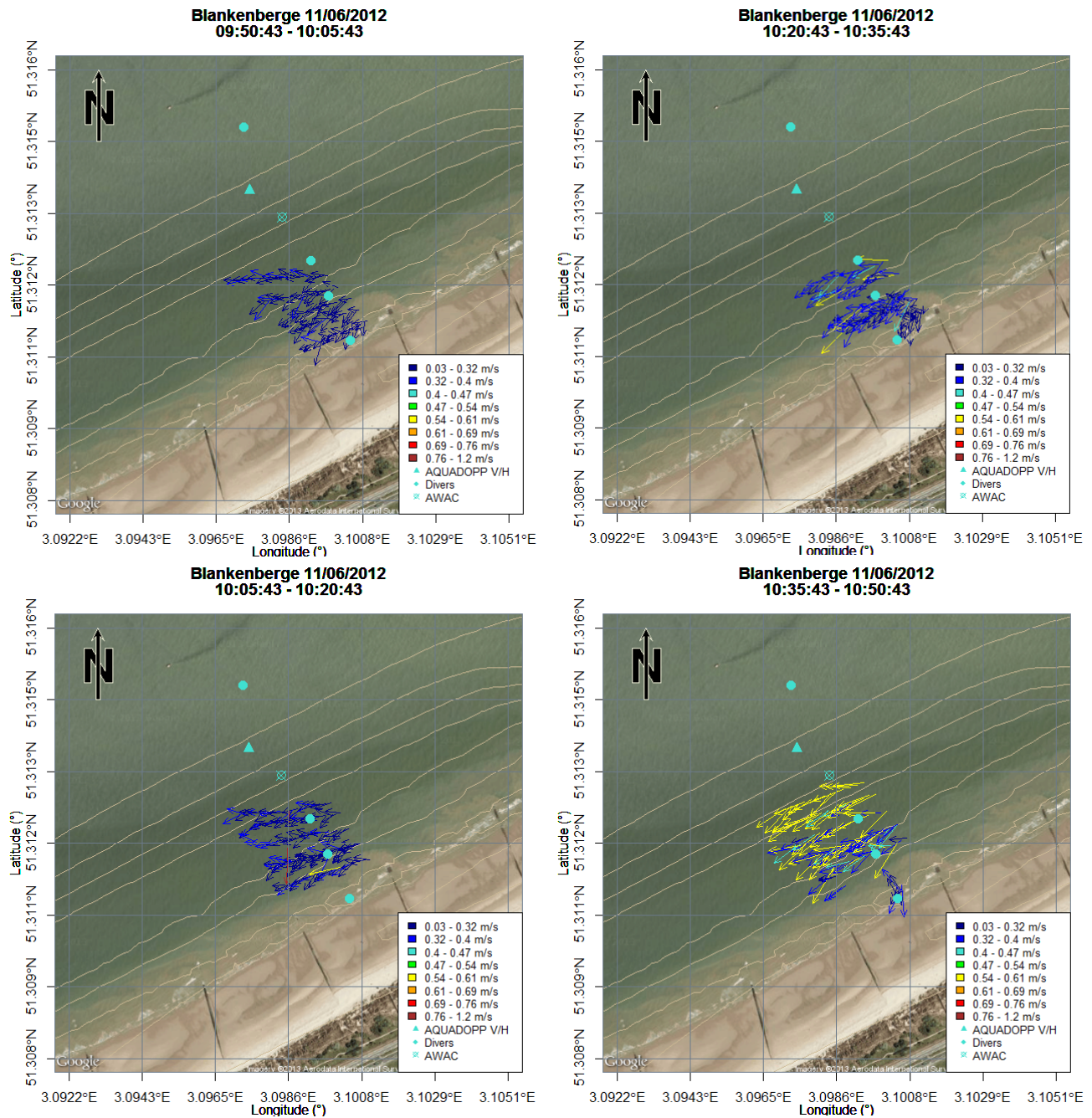
Dan, S.; Vereecken H.; Levy, Y.; Delgado, R.; De Backer E.; Mostaert, F. (2014). Measuring campaigns of hydrodynamics and sand dynamics in Blankenberge: Sub report 4 – Data report 2012 and 2013. Version 2_0. WL Rapporten, 00_064. Flanders Hydraulics Research, Antwerp, Belgium.

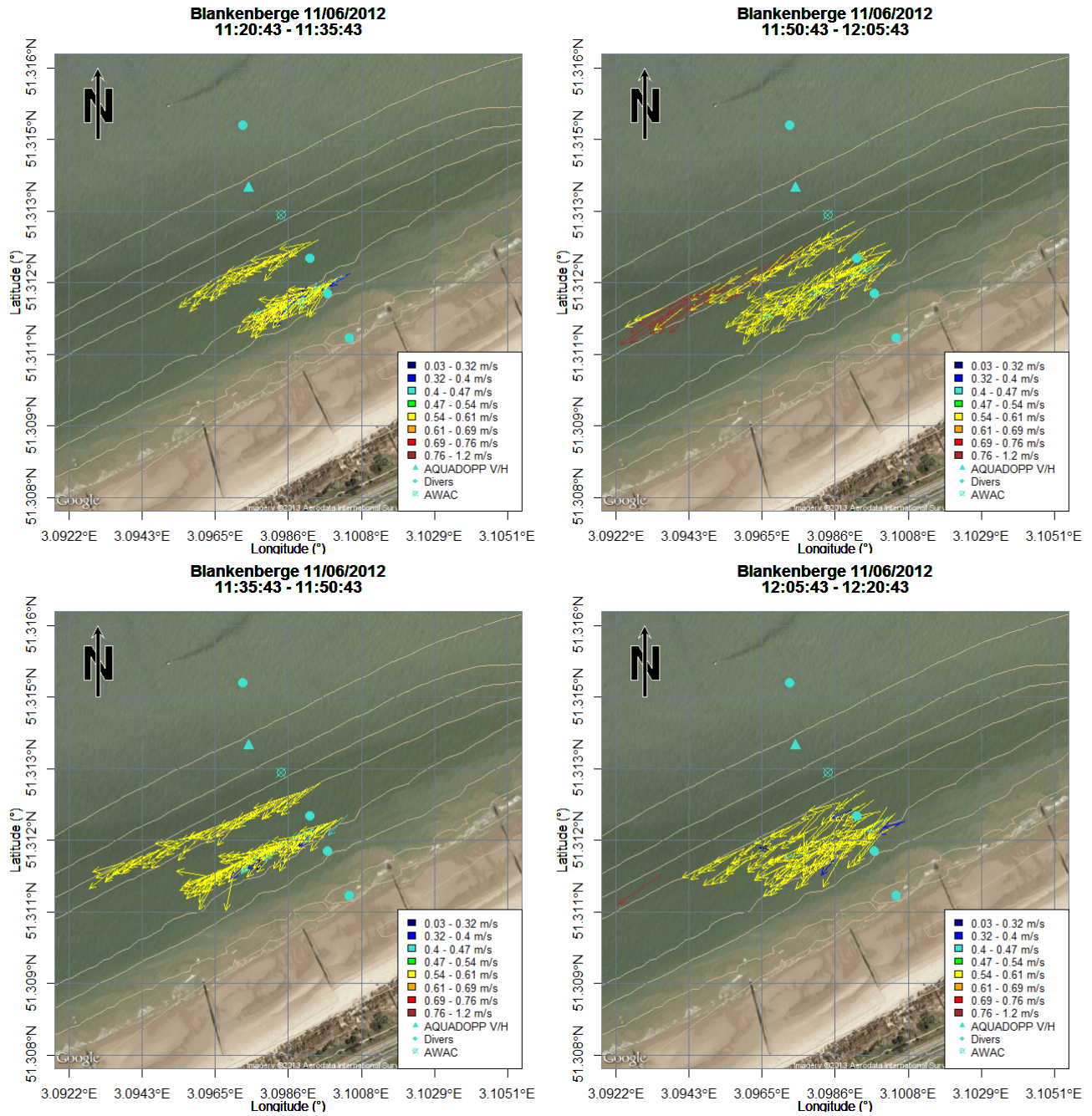
Delgado, R. Measuring campaigns of hydrodynamics and sand dynamics in Blankenberge (2012), WL2012_000_089 Project plan.

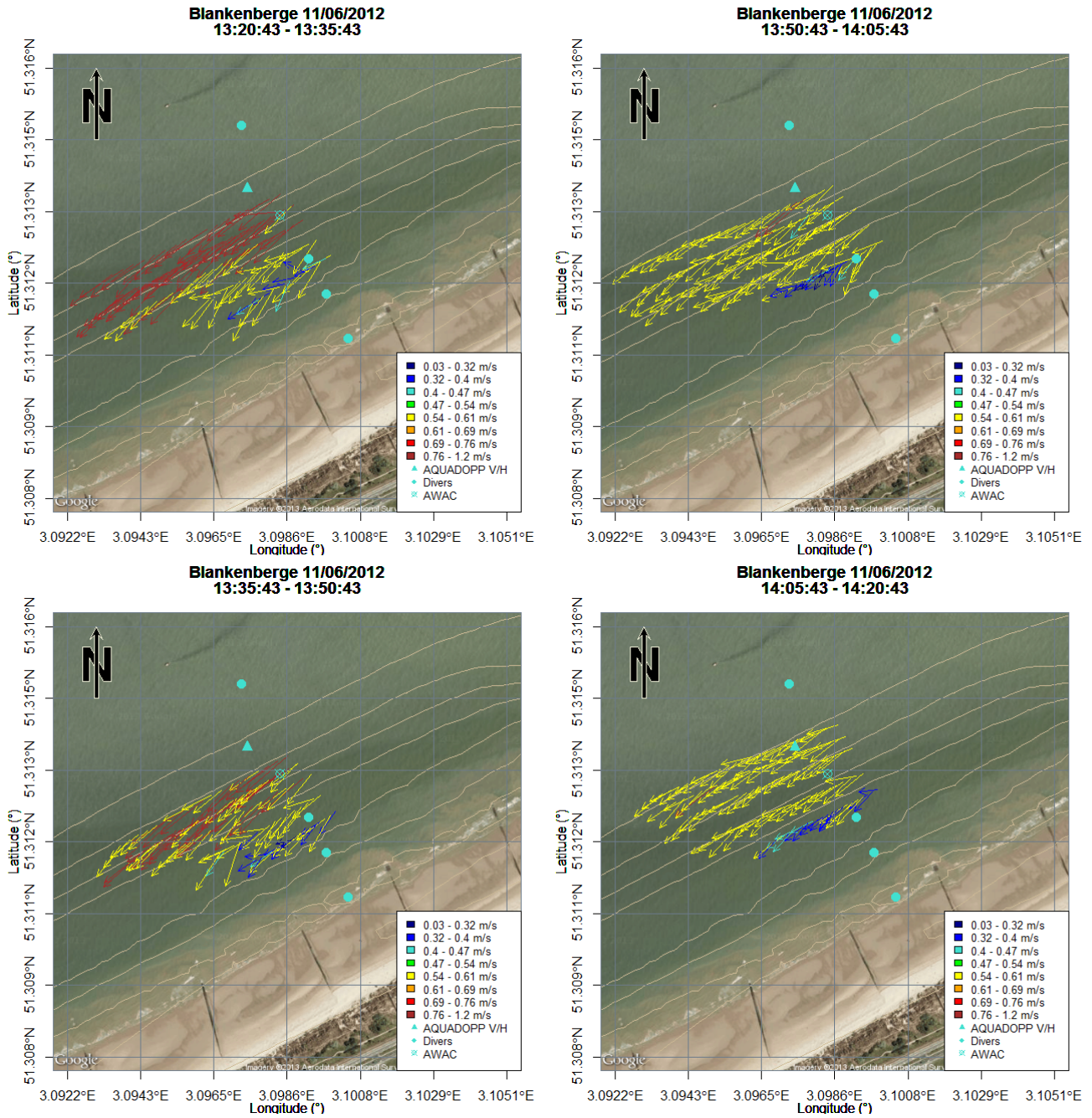
Annexe A – Drifter MAPS

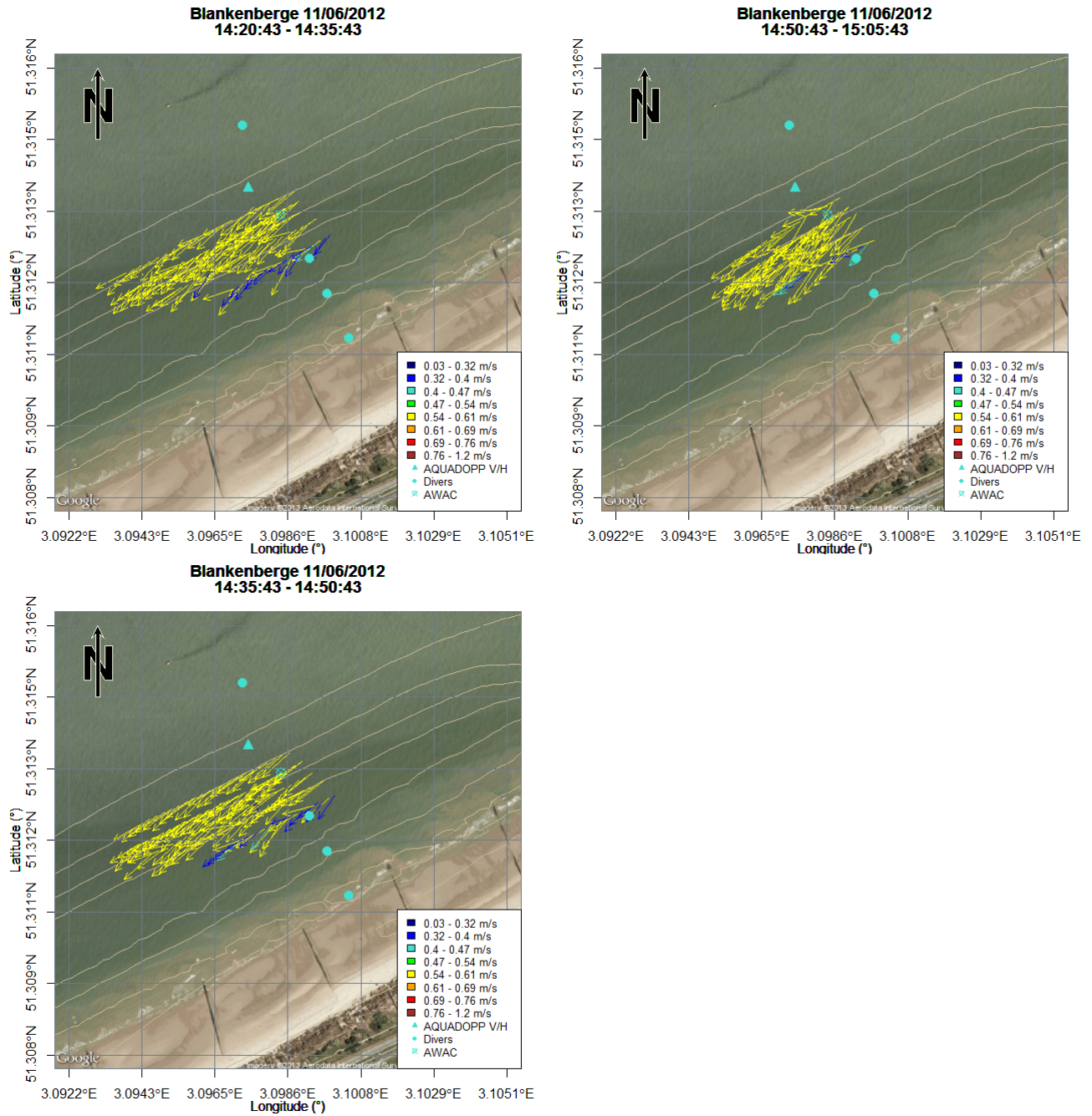
11/06/2012 & 27/06/2013

11th of June 2012

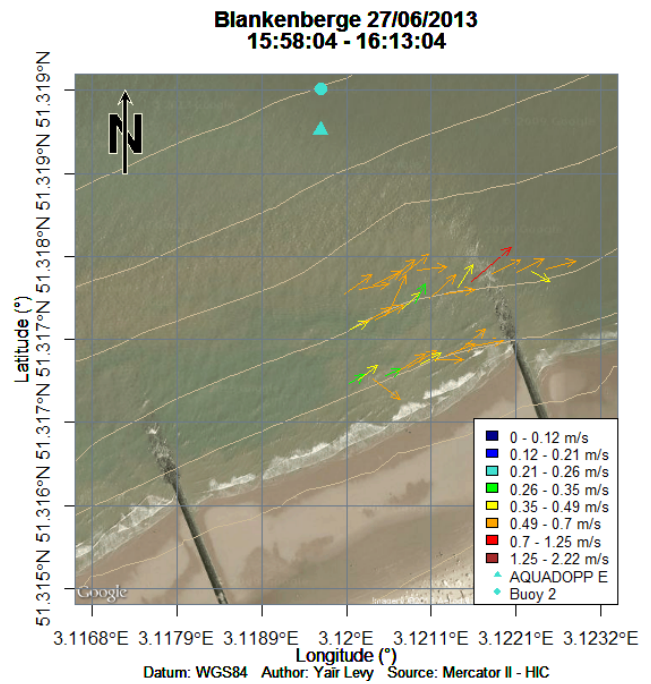
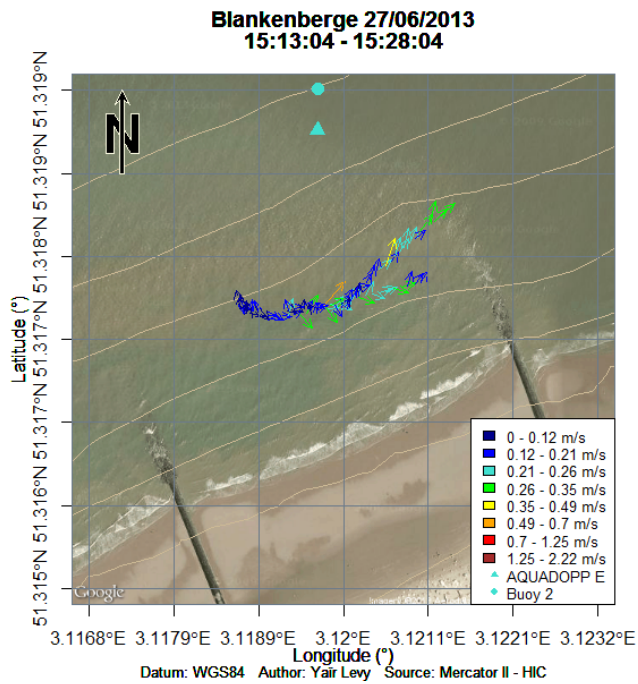
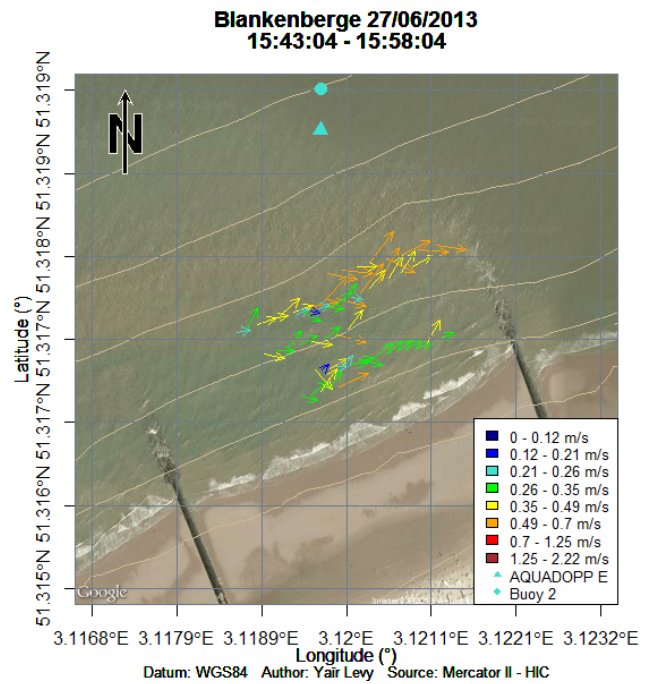
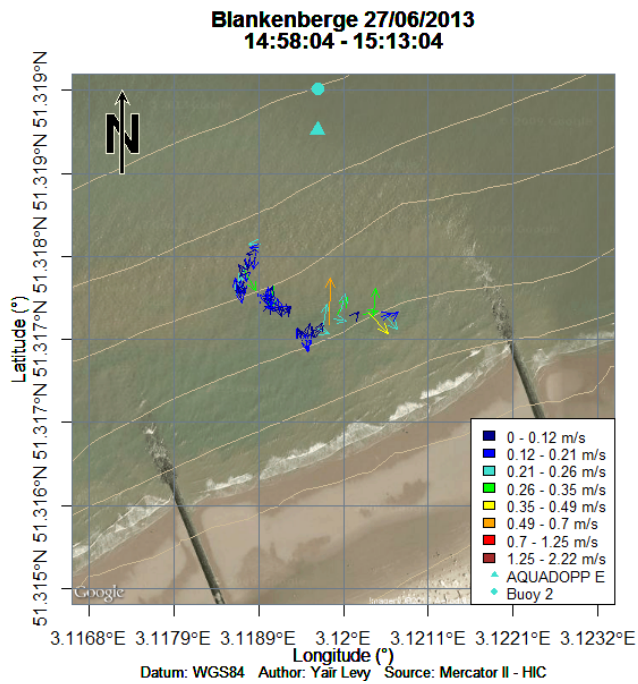


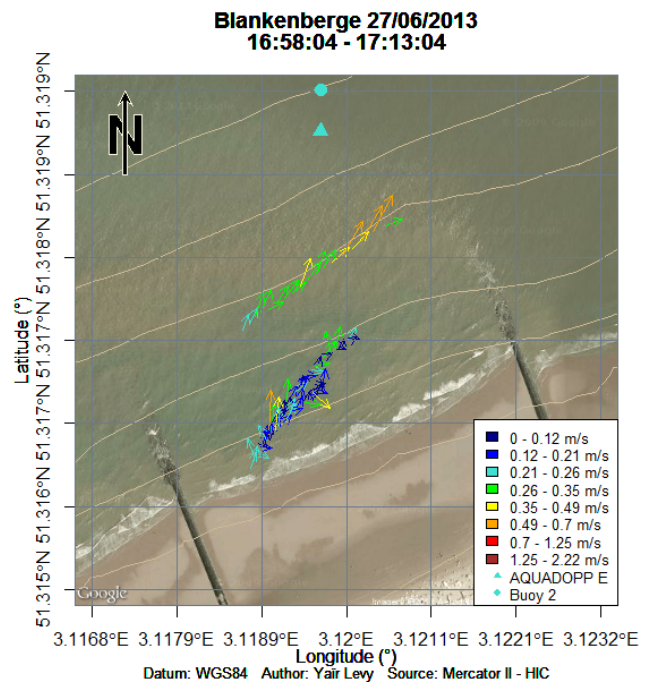
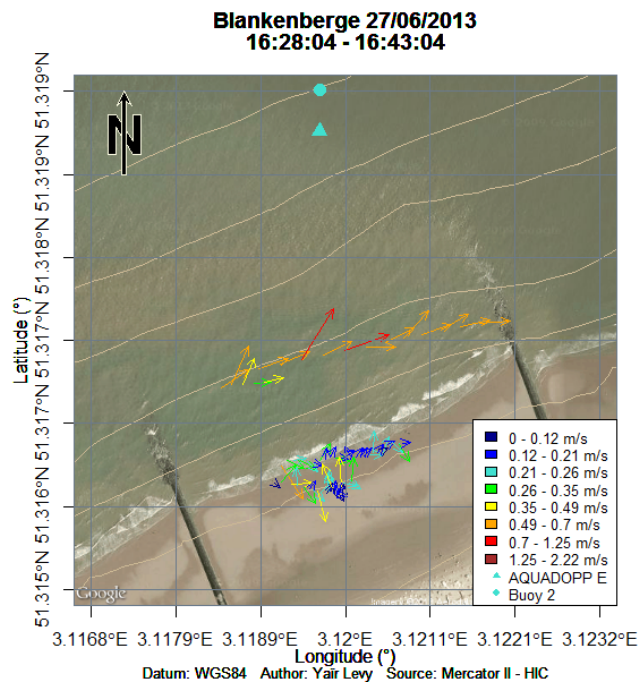
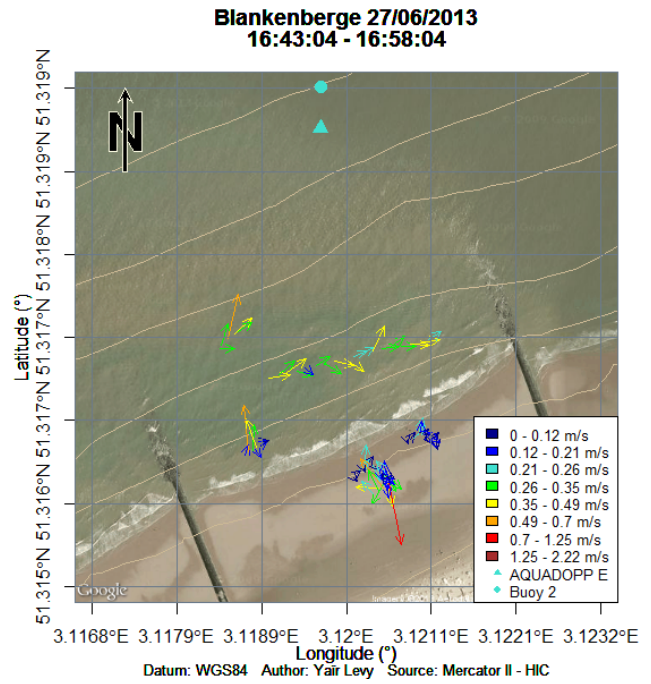
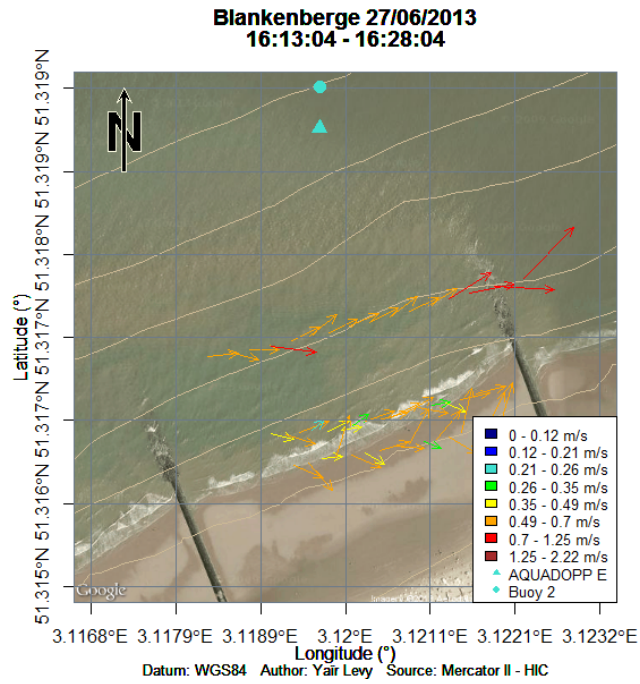


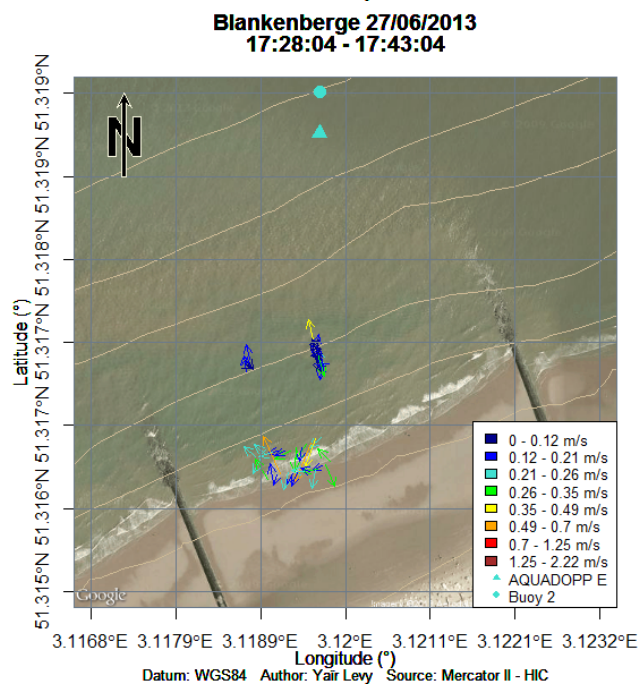
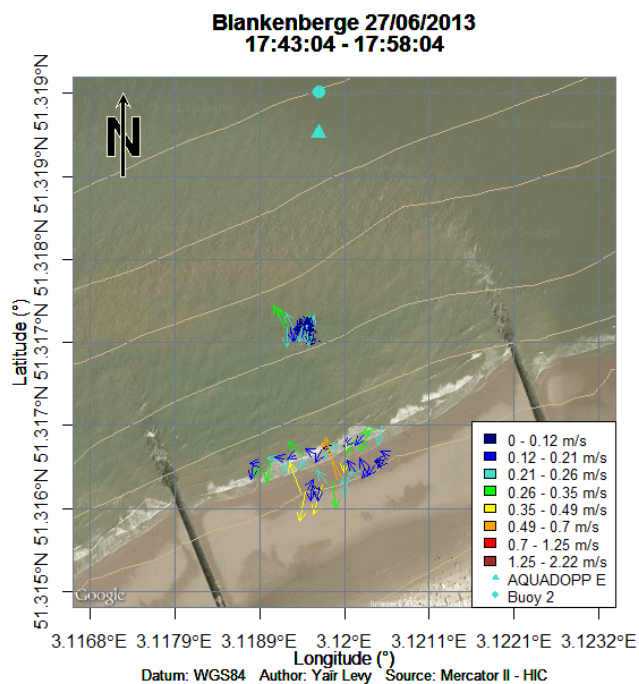
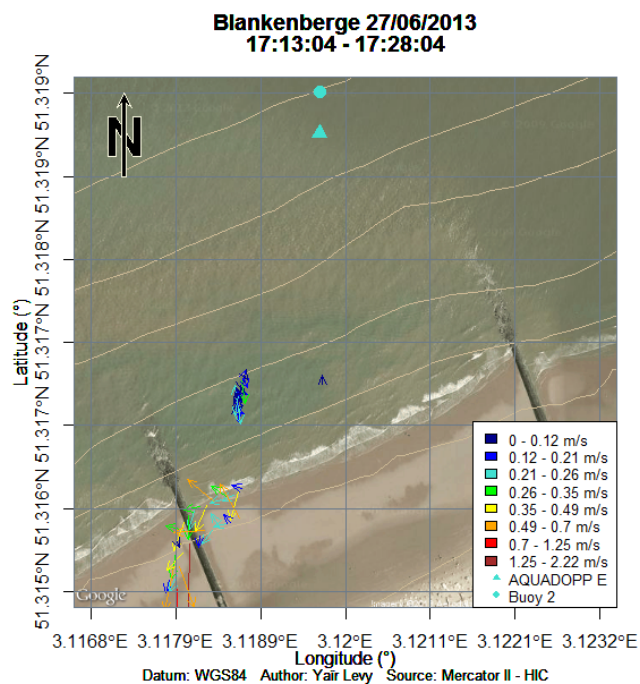




27th of June 2013







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