

REPORT

**Vlaamse Overheid - Departement
Mobiliteit en Openbare Werken**

Afdeling Maritieme Toegang

**Evaluation of the external effects on
the siltation in Deurganckdok**

Report 2.6: Through tide measurements: Eddy
Currents during spring tide at DGD - Autumn 2011

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0. SUMMARY

This report presents the factual data of a through tide measurement to determine the flow pattern at the entrance of Deurganckdok during a complete tidal cycle on the 29th of September 2011. The measurement was focused on eddy current patterns which were formed at the entrance of the dock depending on the water levels inside and outside the dock and the flow on the river Scheldt. The eddy currents were measured by using Acoustic Doppler Current Profiler (ADCP). To indicate a spatial pattern of the suspended sediment concentrations (SSC) at the entrance the ADCP backscatter was calibrated with some water samples.

The measurement took place after completing a current deflecting wall (CDW) in August 2011 near the northern entrance of Deurganckdok. This report will help us to evaluate the effect of a current deflecting wall on the flow pattern at the entrance and to gain insight in the mechanisms causing siltation in Deurganckdok.

1. INTRODUCTION

1.1 THE ASSIGNMENT

This report is part of a set of reports (IMDC, 2010 a-b, 2011 a-d, 2012, a-f) concerning the project 'Evaluation of the external effects on the siltation in Deurganckdok'. The terms of reference were prepared by 'Departement Mobiliteit en Openbare Werken van de Vlaamse Overheid, Afdeling Maritieme Toegang (16EF/2009/14). The study was awarded to International Marine and Dredging Consultants NV in association with Deltares and Gems International on 8 December 2009.

This study is a follow-up study on the study 'Opvolging aanslibbing Deurganckdok' that ran from January 2006 till March 2009 (IMDC, 2006 a-q, 2007 a-w, 2008 a-aa, 2009 a-o).

Waterbouwkundig Laboratorium– Cel Hydrometrie Schelde provided data on discharge, tide, salinity and turbidity along the river Scheldt and provided survey vessels for the long term and through tide measurements. Afdeling Maritieme Toegang provided maintenance dredging data. Agentschap voor Maritieme Dienstverlening en Kust – Afdeling Kust provided depth sounding measurements.

1.2 PURPOSE OF THE STUDY

The purpose of this study entails evaluating the external effects on the siltation in the Deurganckdok. External effects are those effects caused by recent or near-future human operations near Deurganckdok:

- The construction of the Current Deflecting Wall downstream of the entrance of the Deurganckdok.
- The deepening and widening of the navigational channel in the Lower Sea Scheldt between the entrance of the Deurganckdok and the access channels to the locks of Zandvliet-Berendrecht.
- The deepening of the entrance to the Deurganckdok by removing the sill at the entrance.

1.3 OVERVIEW OF THE STUDY

This study constitutes of 3 parts:

- Reporting and analysis of existing documents and measurement data
- Execution of specific measurement campaigns to map the siltation and its environmental factors.
- Support in numerical modelling efforts

Reports of the project 'Evaluation of the external effects on the siltation in the Deurganckdok' are summarized in Table 1-1.

This report 2.6, is one of a set of reports that gains insight in sediment and water transport between Deurganckdok and the river Scheldt, which belongs to the second part of this project.

• Table 1-1: Overview of the External Effects Deurganckdok Reports

Report	Description
I.	Reporting
I.1	Annual Sediment Balance: Bathymetry surveys, Density measurements, Maintenance and construction dredging activities
1.1	Annual Sediment Balance: year 1: 1/4/2009-31/3/2010 (I/RA/11354/10.067/NZI)
1.2	Annual Sediment Balance: year 2: 1/4/2010-31/3/2011 (I/RA/11354/10.100/MBO/ANF)
1.3	Annual Sediment Balance: year 3: 1/4/2011-31/3/2012 (I/RA/11354/10.101/MBO/ANF)
I.2	Boundary Conditions: Upriver Discharge, Salt concentration Scheldt, Bathymetric evolution in access channels, dredging activities in Lower Sea Scheldt and access channels
1.4	Boundary Conditions year 1: 01/04/2009 – 31/3/2010 (I/RA/11354/10.102/MBO/ANF)
1.5	Boundary Conditions year 2: 01/04/2010 – 31/3/2011 (I/RA/11354/10.103/MBO/ANF)
1.6	Boundary Conditions year 3: 01/04/2011 – 31/3/2012 (I/RA/11354/10.104/MBO/ANF)
I.3	Synthesis of CDW research
1.7	Synthesis report of research on Current Deflecting Wall (I/RA/11354/10.063/MBO)
I.4	Analysis: evaluation of external effects on siltation in Deurganckdok
1.8	Analysis of external effects on siltation processes and factors (I/RA/11354/10.105/MBO/ANF)
II.	Measurement campaigns: Factors contributing to salt and sediment distribution in Deurganckdok: Salt-Silt (OBS3A) & Frame measurements, Through tide measurements (SiltProfiling & ADCP) & Calibrations
II.1	Through tide measurements fixed transects
2.1	Through tide Sediview measurement: Entrance DGD during spring tide Autumn 2011 (I/RA/11354/10.106/MBO/ANF)
2.2	Through tide Sediview measurement: Entrance DGD during neap tide Autumn 2011 (I/RA/11354/10.107/MBO/ANF)
2.3	Through tide Sediview measurement: Entrance DGD during spring tide Spring 2012 (I/RA/11354/10.108/MBO/ANF)
2.4	Through tide Sediview measurement: Entrance DGD during neap tide Spring 2012 (I/RA/11354/10.109/MBO/ANF)
II.2	Through tide measurements eddy currents
2.5 ²	Through tide measurements: Eddy Currents DGD 02/03/2010 (I/RA/11283/10.051/MSA)
2.6	Through tide measurements: Eddy Currents DGD Autumn I/RA/11354/10.110/MBO/ANF)
2.7	Through tide measurements: Eddy Currents DGD Spring 2012 (I/RA/11354/10.111/MBO/ANF)
II.3	Salt Silt Distribution entrance Deurganckdok
2.8 ³	Salt-Silt distribution Deurganckdok 1/4/2009-31/3/2010 (I/RA/11354/10.068/NZI)
2.9	Sal-Silt distribution Deurganckdok 1/6/2011-31/03/2012 (I/RA/11354/10.112/MBO/ANF)
II.4	Current Salt Silt Distribution CDW Deurganckdok
2.10	Salt Silt & Current Distribution entrance Deurganckdok: frame measurements and throughtide measurements: Autumn 2011 (I/RA/11354/11.131/BQU)
2.11	Salt Silt & Current Distribution entrance Deurganckdok: frame measurements and throughtide measurements: Spring 2012 (I/RA/11354/10.114/MBO/ANF)

Report Description	
II.5 Quality Control instruments	
2.12	Calibration stationary & mobile equipment 16/03/2011 (I/RA/11354/10.113/MBO/ANF)
2.13	Calibration stationary equipment 2012 (I/RA/11354/12.011/JCA)

²: this report is part of the project Siltation Deurganckdok (11283)

³: this report contains report 2.35 of project Siltation Deurganckdok (I/RA/11283/09.085/MSA)

2. THE MEASUREMENT CAMPAIGN

2.1 OVERVIEW OF THE PARAMETERS

The first part of the study aims at determining a sediment balance of Deurganckdok and the net influx of sediment. The sediment balance comprises a number of sediment transport modes: deposition, influx from capital dredging works, internal replacement and removal of sediments due to maintenance dredging (Figure 2-1).

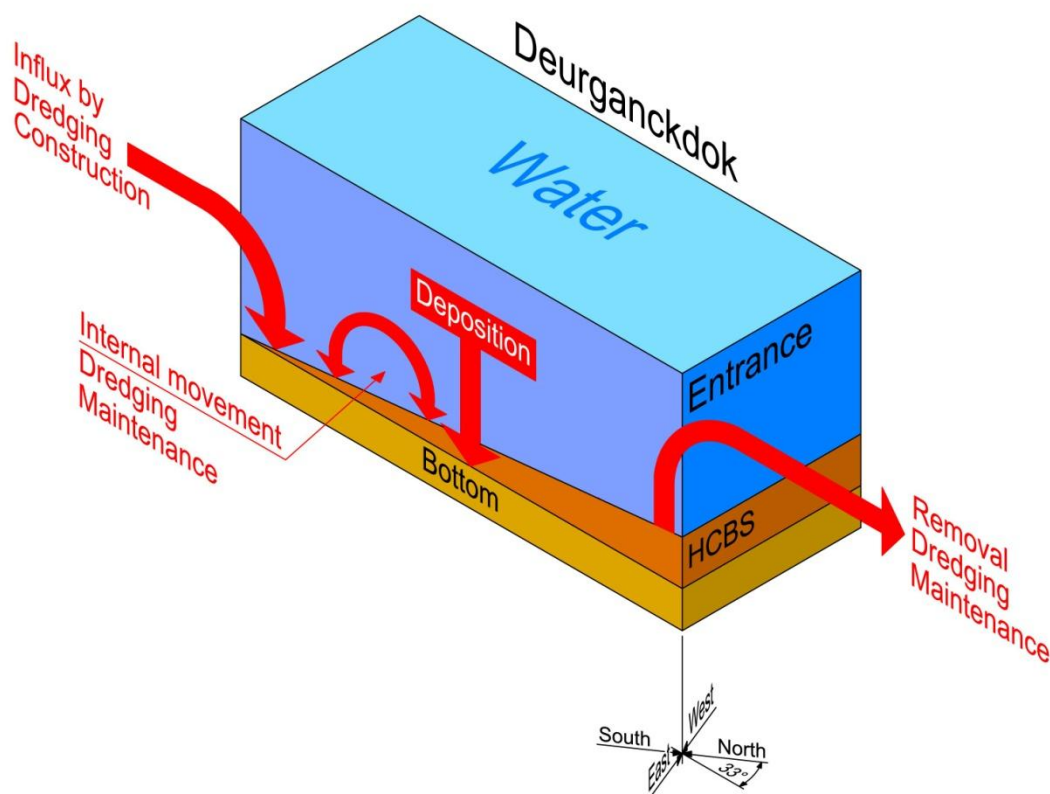


Figure 2-1: Elements of the sediment balance

A net deposition can be calculated from a comparison with a chosen initial condition t_0 (Figure 2-2). The mass of deposited sediment is determined from the integration of bed density profiles recorded at grid points covering the dock. Subtracting bed sediment mass at t_0 leads to the change in mass of sediments present in the dock (mass growth). Adding cumulated dry matter mass of dredged material removed since t_0 and subtracting any sediment influx due to capital dredging works leads to the total cumulated mass entered from the Scheldt river since t_0 .

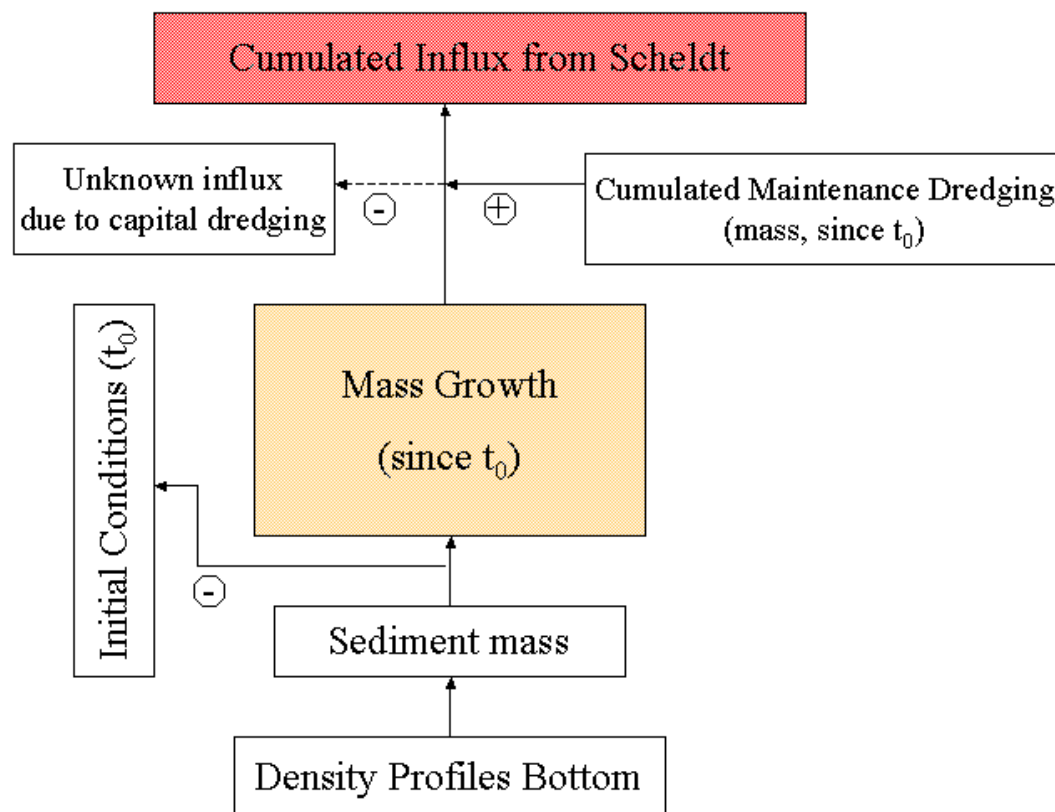


Figure 2-2: Determining a sediment balance

The main purpose of the second part of the study is to gain insight in the mechanisms causing siltation in Deurganckdok. The following mechanisms will be aimed at in this part of the study:

- Tidal prism, i.e. the extra volume in a water body due to high tide
- Vortex patterns due to passing tidal current
- Density currents due to salt gradient between the Scheldt river and the dock
- Density currents due to highly concentrated benthic suspensions

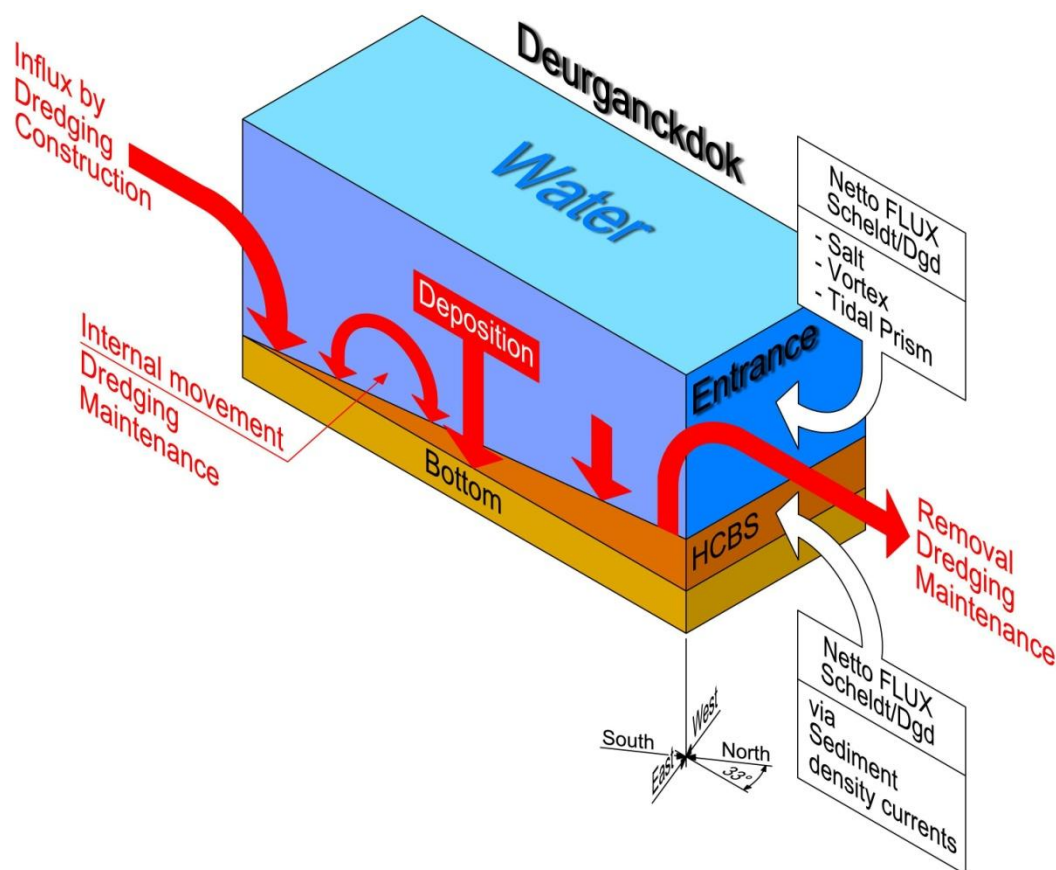


Figure 2-3: Transport mechanisms

These aspects of hydrodynamics and sediment transport have been landmark in determining the parameters to be measured during the project. Measurements will be focussed on three types of timescales: one tidal cycle, one neap-spring cycle and seasonal variation within one year.

Following data are being collected to understand these mechanisms:

- Monitoring the freshwater input (discharge) from the tributaries into the river Scheldt.
- Monitoring salinity and sediment concentration in the Lower Sea Scheldt at permanent measurement locations at Oosterweel, up- and downstream of the Deurganckdok.
- Long term measurement of salinity and suspended sediment distribution in Deurganckdok.
- Monitoring near-bed processes (current velocity, turbidity, and bed elevation variations) in the central trench in the dock, near the entrance as well as near the current deflecting wall location.
- Dynamic measurements of flow pattern, salinity and sediment transport at the entrance of Deurganckdok.
- Through tide measurements of vertical sediment concentration profiles -including near bed high concentrated benthic suspensions.
- Monitoring dredging activities at the entrance channels towards the Kallo, Zandvliet and Berendrecht locks as well as dredging and dumping activities in the Lower Sea Scheldt and Deurganckdok in particular.

In situ calibrations were conducted on several dates to calibrate all turbidity and conductivity sensors.

2.2.2 Measurement procedure

Flow velocity and direction measurements were conducted on the 29th of September 2011 from 6h04 MET until 18h50 MET. Four transects were sailed throughout 13 hours to cover a complete tidal cycle (Table 2-1).

To reduce the time in between 2 cycles, 2 ships were deployed to conduct each 2 transects. From the survey vessel Nele 36 a measurement cycle, consisting of consecutively measuring transects 1 & 3, was completed approximately every 20 minutes. At a same pace, measurements on transects 2 & 4 were conducted from the vessel Parel II. Both vessels were mounted with an ADCP and on regular times CTD-turbidity profiles and water samples were gathered to calibrate the ADCP transects. The samples and turbidity values were used to calibrate the ADCP for suspended sediment concentrations (SSC).

Table 2-1: Transect of the Flow Measurements on 29th of September 2011 (UTM31 WGS84)

Measurement location	Left Bank Easting	Left Bank Northing	Right Bank Easting	Right Bank Northing	Length [m]	Course [degr.]
Transect 1	588 744	5 684 634	588 160	5 683 670	1 100	32
Transect 2	588 797	5 684 553	588 236	5 683 626	1 100	32
Transect 3	588 851	5 684 471	588 312	5 683 581	1 000	32
Transect 4	588 904	5 684 389	588 388	5 683 536	997	32

2.3 THE EQUIPMENT ON BOTH VESSELS

2.3.1 ADCP

The current measurements were conducted using a RD Instruments ADCP 600 kHz Workhorse on the Nele 36 and 1200 kHz Workhorse on the Parel II both with beam angle of 20°. For positioning, the GPS onboard the vessels were used. For the measurement of the heading a gyrocompass was installed.

At the side of each vessel a ADCP systems was mounted on a steel pole. The transducer set of an ADCP was looking vertically downwards to the bottom. Transceiver unit and computer system were connected to peripherals such as the differential GPS-receiver, the ADCP and the gyrocompass.

During the measurements the acquisition software of Winriver was used. The main settings are given in Table 2-2.

Table 2-2: Main Configuration Settings of ADCP

Main configuration settings of ADCP 600 - 1200kHz Workhorse:
Cell depth: 0.5 m
Number of cells: 50
Number of Water pings per ensemble: 2
Number of Bottom Track pings per ensemble: 2
Time between ensembles: 0
Averaging: None
Speed of Sound: Fixed 1500 m/s
3-beam solution: enabled
Beam angle: 20°

2.3.2 CTD-OBS3A

A D&A type OBS 3A was used to measure absolute pressure (m), temperature (°C) and turbidity (NTU) while the conductivity (mS/cm) was extracted from the CTD-diver.

The technical details on the OBS 3A and CTD-diver are given in the winter calibration Report of the HCBS 1 measurement campaign. (IMDC, 2006a)

2.3.3 Water sampler

A Van Dorn water sampler of Wildco was attached nearby the turbidity sensor taking water samples. Samples were collected in 1 liter sampling bottles.

3. DESCRIPTION OF THE MEASUREMENTS

3.1 MEASUREMENT PERIODS

At Deurganckdok four different ADCP transects were sailed about every 20 to 25 minutes for 13 hours. In total 40 sets of four transects were measured.

Annex A gives the start and end points of the tracks, the sailed length and the course.

3.2 HYDRO-METEOROLOGICAL CONDITIONS DURING THE MEASUREMENT CAMPAIGN

3.2.1 Vertical tide during the measurements

The vertical tide was measured at the Liefkenshoek tidal gauge. Graphs of the tide at Liefkenshoek on the 29th of September 2011 can be found in Annex B. Table 3-1 gives the most important characteristics (high and low tide) of the tide at this gauge on the 29th of September 2011.

Table 3-1: High and low tide at Liefkenshoek on 29/09/2011

Liefkenshoek Tidal Gauge		
29 September 2011		
	Time [MET]	Water level [m TAW]
HW (1)	4:00	5.88
LW (2)	11:10	-0.22
HW (3)	16:30	5.85

In Table 3-2 the tidal characteristics of the tide on the 29th of September 2011 are compared to the average tide over the decade 1991-2000 (AMT, 2003).

Table 3-2: Comparison of the tidal characteristics of 29/09/2011 with the average tide, the average neap tide and the average spring tide over the decade 1991-2000 for Liefkenshoek.

	Neap tide (1991 - 2000)	Avg Tide (1991 - 2000)	Spring Tide (1991 - 2000)	Tide 29/09/2011
Water level [m TAW]				
HW (1)	4.63	5.19	5.63	5.88
LW (2)	0.39	0.05	-0.18	-0.22
HW (3)	-	-	-	5.85
Tidal difference [m]				
Falling (1 to 2)	4.24	5.14	5.81	6.10
Rising (2 to 3)	4.24	5.14	5.81	6.07
Duration [hh:mm]				
Falling (1 to 2)	6:40	6:50	7:02	7:10
Rising (2 to 3)	5:59	5:34	5:16	5:20
Tide (1 to 3)	12:39	12:24	12:18	12:30
Tidal coefficient				
Falling (1 to 2)	0.82	1.00	1.13	1.19
Rising (2 to 3)	0.82	1.00	1.13	1.18

The tidal coefficients from 1.18 up to 1.19 for the measured tide of the 29th of September 2011 indicate that this tide is larger than the spring tide for the decade of 1991-2000, and therefore can be classified as a strong spring tide.

3.2.2 Meteorological data

Meteorological data at Woensdrecht (NL) was obtained from the Weather Underground website (Wunderground, 2011).

The weather on the 29th of September 2011 was dry. The wind blew all day from the east at an average velocity of 6 km/h. The air temperature varied between 18 and 26°C. The sky was slightly cloudy without precipitation. It was foggy during the morning and the evening time.

3.3 NAVIGATION INFORMATION

An overview of the relevant navigation at the measurement location is given in Annex C.

3.4 REMARKS ON DATA

There were no significant problems during the measurements on board of the Nele 36.

On board of the Parel II the pc was not working properly and was replaced by a spare one at 16h25. Therefore file 4072T2 was aborted early and there is no data between 16h05 and 16h33. At 18h15 the GPS signal was lost, therefore file 4083T2 was aborted early.

Shipwakes were removed from the data where possible and are also given in Annex C.

4. PROCESSING OF DATASETS

4.1 METHODOLOGY OF PROCESSING OF THE ADCP DATA WITH SEDIVIEW

DRL Software's Sediview was used to process the ADCP data. Sediview is designed to derive estimates of SSC throughout the water column using acoustic backscatter data obtained by ADCP's manufactured by RD Instruments of San Diego, California. Sediview is also used to correct the ADCP depths to calculate the sound velocity based on the CTD-profiles.

4.1.1 Acoustic backscatter theory

The acoustic theory governing backscatter from particles suspended in the water column is complex, but the following simplified formula serves to introduce the main factors that are relevant:

$$E = SL + SV + Constant - 20\log(R) - 2\alpha_w R$$

Where:

E = echo intensity,
 SL = transmitted power,
 SV = backscatter intensity due to the particles suspended in the water column,
 α_w = a coefficient describing the absorption of energy by the water,
 R = the distance from the transducer to the measurement bin.

The term $20\log(R)$ is a simple geometric function that accounts for the spherical spreading of the beam. The constant is required because each ADCP has specific performance characteristics.

In order to measure the suspended sediment concentration in the water column it is necessary to relate the backscattered sound intensity to the mass concentration in the water. For the purposes of measuring solids concentration on site, it can be shown that the relationship is as follows (derived from Thorne and Campbell, 1992 and Hay, 1991 in DRL (2003)):

$$\log_{10} M_r = \{dB + 2r(\alpha_w + \alpha_s) - K_s\} S^{-1}$$

Where:

$M(r)$ = mass concentration per unit volume at range, r
 S = relative backscatter coefficient
 K_s = site and instrument constant
 dB = the measured relative backscatter intensity (corrected for beam spreading)
 α_w = water attenuation coefficient
 α_s = sediment attenuation coefficient, which is a function of the effective particle size

In this expression there are four unknowns: S , K_s , α_w and α_s . These parameters are to be determined within Sediview.

4.1.2 Water sampling and transect sailing

To calibrate Sediview for SSC, every 2 hours each vessel takes two water samples per profile. Both samples are taken within the range of reliable data of the ADCP. For the near-surface sample this means in bin 3 or 4, for the near-bed sample this means at about one or two meter above the sidelobe. 12 samples were taken by Nele 36 and 12 by Parel II during whole the campaign. This set of water samples gains insight of the spatial variation of SSC in the water column during the measurement campaign.

Water sampling is done together with CTD-OBS measurement in order to have two independent SSC measurements for each sample. OBS measurements were compared to the water samples

and calibrated with water samples. The water samples were used for Sediview calibration, while cross-calibrated OBS measurements were used as a backup check. The salinity and temperature was used to compute the acoustic water absorption (water attenuation coefficient). Calibration for suspended sediment concentration within Sediview.

4.1.2.1 Calibration workset

The calibration workset consists of ADCP-files, sampling times, sampling depths, SSC obtained from water samples and SSC, temperature and salinity obtained from CTD-OBS readings.

The suspended sediment concentration of the water samples was determined. One-litre samples were filtered over a preweighed desiccated 0.45 micron filter, after which the filter is dried in an oven at 105°C, cooled and weighted (NEN 6484).

4.1.2.2 SSC calibration per ensemble pair

In the Sediview calibration process the following parameters must be defined: the site and instrument constant (Ks), the relative backscatter coefficient (S) and the effective particle size per ensemble-pair (near-surface sample and near-bed sample) in order to fit the Sediview-estimate with the suspended sediment concentration of the water samples. These parameter sets may not differ too much from the previous parameter sets, as the environmental conditions will not change that much over a small time interval. To obtain a smooth progress in time of Ks, S and effective particle size an iterative approach is used. The result of the Sediview calibration can be seen in Figure 4-1 and Figure 4-2.

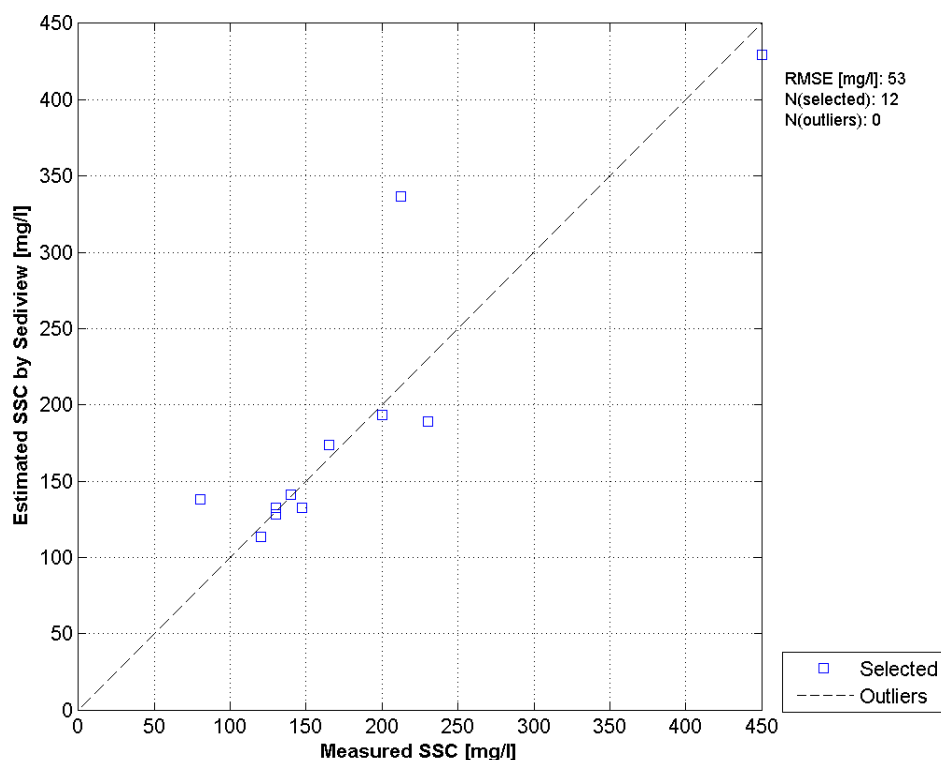


Figure 4-1: Calibration in Sediview for 29/09/2011 data (Nele 36)

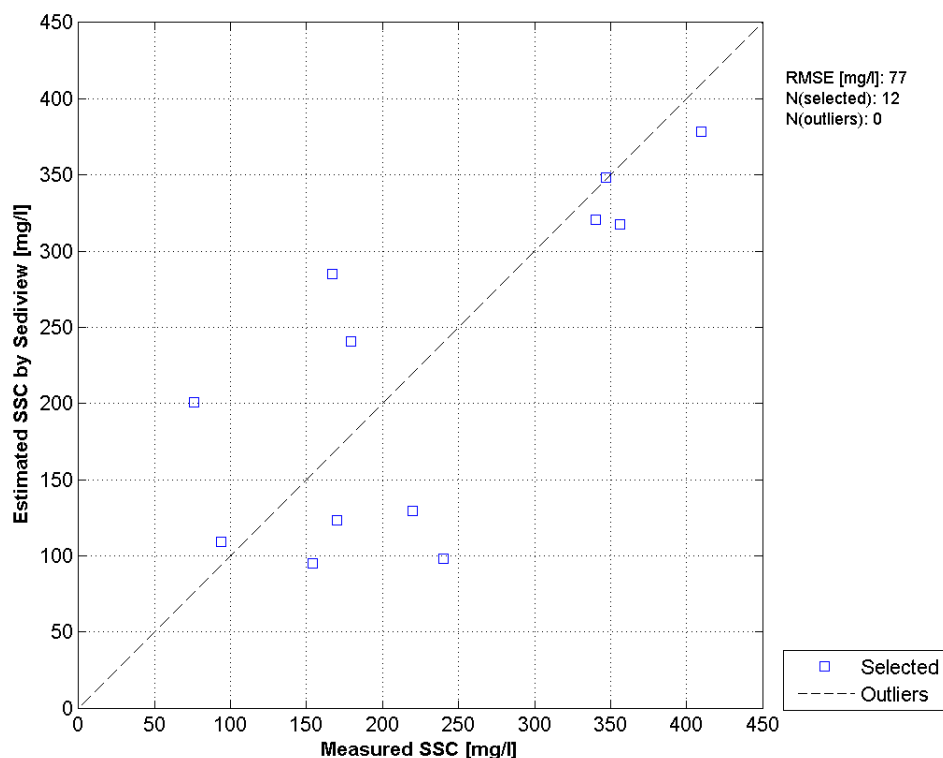


Figure 4-2: Calibration in Sediview for 29/09/2011 data (Parel II)

4.2 OUTPUT

General transect information containing start-stop coordinates of each sailed transect with stop time, track length and heading is given in Annex A.

Contour plots with currents and SSC are plotted in Annex E. All plots are plotted as such that the river side of the dock is plotted on the left side of the figure and the land side of DGD is plotted on the right. The parallel velocities are defined positive when current direction is inwards the dock, negative when the current direction is faced outwards the dock to the river Scheldt.

In Annex F, the measured depth averaged velocities (above and below -7.6mTAW of the water column) are plotted. Each map shows the velocity fields of the four consecutively recorded transects 1, 2, 3 & 4.

4.2.1 Depth averaging methodology and maps

Depth average velocities are calculated for the water column above -7.6 mTAW and below -7.6 mTAW. -7.6 mTAW is the highest point of the table of the current deflecting wall, which is to be built at Deurganckdok to reduce sedimentation in the dock.

Maps were made of the measured depth averaged (above and below -7.6mTAW of the water column) velocity fields by plotting a velocity vector at the recorded location of the measurements, together with a map of the Deurganckdok and the river Scheldt.

Depth-averaged velocities were calculated with the following methodology. For the area between the highest measurement bin and the free surface, the velocity data were extrapolated for each ensemble assuming a constant velocity equal to the velocity in the highest measurement bin of that ensemble.

The velocity for the bottom water layer is estimated by using the power method. Chen (1991) discusses the theory of power laws for flow resistance. Simpson and Oltmann (1990) discuss Chen's power law equivalent of Manning's formula for open channels (with $b=1/6$) (RD Instruments, 2003).

$$u/u^* = 9.5(z/z_0)^b$$

Where:

z = Distance to the channel bed [m]
 u = Velocity at distance z from bed [m/s]
 u^* = Shear velocity [m/s]
 z_0 = Bottom roughness height [m]
 b = Exponent (1/6)

In the horizontal plane, a moving average including three vectors along the transect was calculated and only one out of three of these averaged vectors were plotted, because otherwise the vectors would be too closely spaced to obtain a clear view.

4.2.2 Contour plots of the transects

All contour plots show parallel projected values on the straightened sailed transects together with contourplots of SSC to visualise the flux in and out of the Deurganckdok. The eddy currents are visualised in vector plots which are described below in Chapter 5: Preliminary Analysis of the Data. The heading of the straightened sailed transect is defined by picking 2 points in the straight part of the line after having corrected the heading of the ADCP compass. The compass offset is derived from a comparison of the ADCP's bottom track with the external GPS data.

5. PRELIMINARY ANALYSIS OF THE DATA

5.1 PREVIOUS INVESTIGATIONS

Similar vector plots of the current measured using an ADCP at the entrance of the Dock are presented in previous studies (IMDC 2006m and IMDC 2006q). In these investigations, IMDC 2006m correspond to spring tide conditions (a tidal coefficient of 1.09 to 1.11), which is very similar to this measurement. A 3-d numeric simulation of these cases has been made (WL|Delft Hydraulics and IMDC, 2006), and it was found that the numerical results agreed well with the measurements. Therefore, we will compare the results of the present mainly with the depth-averaged results of the 3-d model simulation. Further descriptions of the processes that occur at a harbour mouth can be found in PIANC (2008).

5.2 OCTOBER 1ST 2008 SURVEY (IMDC, 2008Y)

As Deurganckdok is situated along the part of the Scheldt River, which is under tidal influence, it is subject to complex current fields near its entrance. In (IMDC, 2008y), measurements were performed along different transects at the entrance of the Deurganckdok in order to obtain more insight in the occurring flow field at this location. These transects started well into the Scheldt river and extended some 500 meters into the Deurganckdok, which is a distance that is approximately equal to the width of the Deurganckdok.

In these measurements, it can be seen that on the River Scheldt tidal flow occurs, with a westward flow during ebb. The flow parallel to the dock's entrance decreases strongly when approaching the dock. Perpendicular to the dock entrance, the flow is directed outwards (i.e. the dock is emptying). The flow at the Scheldt shows a maximum ebb velocity around 4 to 5 hours after high water. It is interesting to note that no clear eddy pattern is visible during the ebb flow in the depth-averaged data, even though sometimes a very weak eddy appears (at 4h16 and 5h07 after HW to be precise). This compares rather well with model simulation, which show in the depth-averaged data (which is in that report defined over the complete water depth, and here over the upper 12 m) rather weak eddies during ebb.

Approximately one hour after low water, slack water occurs on the river, and afterwards the flood current, which is here in easterly direction, starts to increase. At this moment the flow inside the dock is directed southward (i.e. the flow is directed into the dock), but this flow is rather weak. After this moment an eddy starts to form in the dock entrance, and the flow inside the dock has a direction opposite to the flow in the river. This eddy starts to become particularly strong at around 2.30 to 1.00 hours before high water. At this instant in time, the flow at the inflowing side of the eddy is stronger than in the outflowing side. This pattern is also clearly visible in the model simulations (WL|Delft Hydraulics and IMDC, 2006) during flood. Similar flow patterns were observed in laboratory measurements of the eddy in a tidal harbour (Langendoen 1992 and references therein), especially the fact that the eddy is stronger during flood than during ebb.

After this, the flow at the river decreases, and when this happens, the strength of the eddy decreases as well, even though it still remains visible for some time after the flow has decreased. After the eddy has decayed, there is mainly outflow. This is a difference with the results from (WL|Delft Hydraulics and IMDC, 2006), where the depth-averaged eddy although it decreases in the strength, remains visible until up to an hour after HW.

5.3 MARCH 2ND 2010 SURVEY

Compared to previous survey of 1st October 2008, the tidal coefficients are larger with an average tidal coefficient of 1.24. The maximal salinity gradient measured during the campaign and in the dock is +/- 4.0 ppt.

The present measurements started approximately three hours after high water during ebb conditions. The flow parallel to the dock's entrance decreases strongly when approaching the dock. The tidal flow in the Scheldt shows a maximum ebb velocity around 4 to 5 hours after high water with a notable difference between the surface and the bottom velocity pattern.

It is interesting to note that there is no clear eddy pattern during the ebb flow in the data and that there are important differences between bottom and top velocities. In the upper part of the water column a counter clockwise eddy can be seen during maximum ebb velocity. In the lower part of the water column no ebb eddy current can be noticed.

There is a bottom flow outwards during the end of the ebb phase (starting 1.5 hr before low water), lasting till 3 hours after low water. This is a density driven current with top water flowing in and saltier dock water flowing out near the bottom.

About one hour after slack water (2 hours after LW), a clockwise eddy starts to form in the upper part of the water column in the dock entrance. This eddy is visible over the complete water column from around 2:30 to 1:00 hours before high water. This pattern is also clearly visible in the model simulations (WL|Delft Hydraulics and IMDC, 2006) during flood. Similar flow patterns were observed in laboratory measurements of the eddy in a tidal harbour (Langendoen 1992 and references therein), especially the fact that the eddy is stronger during flood than during ebb. Around slack water (1 hour after high water) the flood eddy is still visible, but only in the lower half of the water column.

After the eddy has decayed around slack water, there is outflow at the top of the water column and an inflow at the bottom. This is the density driven flow, because the dock water has a lower salinity than the river water. This density current last from high water till about 3 hours after high water.

The suspended sediment concentrations in Deurganckdok are in general low during LW and start to increase near the bed during flood. Around high water maximum concentrations (+300mg/l) occur in the dock. Concentrations in Deurganckdock stay high until 2 hours after high water.

5.4 SEPTEMBER 29TH 2011 SURVEY

In August 2011 the current deflecting wall (CDW) is built north of Deurganckdok and the sill at the entrance is dredged. The purpose of this measurement campaign is to compare the eddy current pattern before and after the CDW. Compared to previous surveys, the tidal coefficients of 1.18 and maximal salinity gradient of +/-3.5 ppt are slightly smaller.

The present measurements started approximately 2 hours after high water during ebb conditions. At this moment the dock is emptying above the -7.5mTAW while the flow below the -7.5mTAW is incoming. This is the density driven flow, because the dock water has a lower salinity than the river water. The stratification in salinity can be seen in SS concentrations where the concentrations of the incoming river water are higher than the outgoing dock water. Approximately 3.5 hours after HW the bottom flow is changing from incoming to outgoing at the south side of the dock which suggests an influence of a weak counter clockwise eddy. At this moment, the tidal flow in the Scheldt shows a maximum ebb velocity. The density current take completely over about LW. The more turbid river water is flowing in near the surface, the saltier and less turbid dock water is flowing out near the bottom.

Approximately 1 hour after low water, slack water occurs on the river, and afterwards the flood current, which is southerly, starts to increase. About 3.5 hours before HW, an eddy starts to form in the dock entrance, and the flow inside the dock has a direction opposite to the flow in the river. This eddy starts to become particularly strong at around 2 to 1 hour before high water and the flow in Scheldt shows a maximum flood velocity. This eddy is clockwise but more pronounced than the ebb eddy.

The current deflecting wall (CDW) construction is supposed to influence the current pattern around the entrance and the intensity of horizontal eddy during flood. It's working principle is of diverting the more turbid waters in the lower half of the water column towards the deeper channel in the river and the less turbid waters in the upper half of the water column towards the dock entrance. No significant difference in current pattern is determined between with and without CDW (e.g. Figure 5-1). The intensity depends of the boundary conditions like tidal coefficient and salinity gradient between dock and river which makes it difficult to determine the effect of CDW. An extensive analysis will be covered in the analysis report.

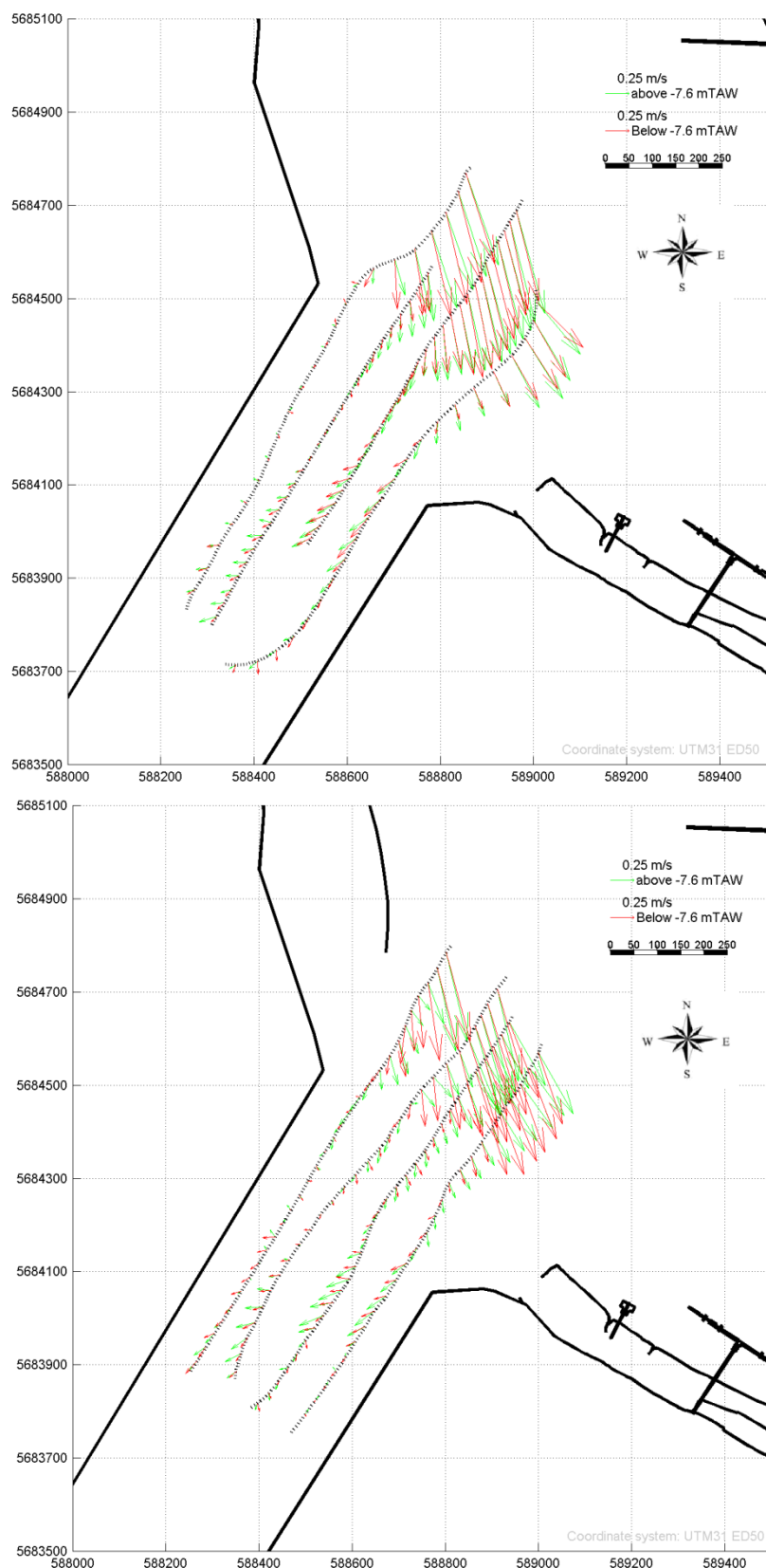


Figure 5-1: Results of eddy current measurements at 1 hour before HW during spring tide. Top: measurement on 2/03/2010 without CDW and with sill (tidal coefficient: 1.24 and maximal salinity gradient: 4.0 ppt); Below: measurement on 29/09/2011 with CDW and without sill (tidal coefficient: 1.18 and maximal salinity gradient: 3.5 ppt).

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IMDC (2009c) Langdurige metingen Deurganckdok: Opvolging en analyse aanslibbing. Deelrapport 2.34: Calibration stationary & mobile equipment autumn 2008 (I/RA/11283/08.095/MSA)

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IMDC (2009h) Langdurige metingen Deurganckdok: Opvolging en analyse aanslibbing. Deelrapport 1.24: Annual Sediment Balance (I/RA/11283/08.080/MSA)

IMDC (2009i) Langdurige metingen Deurganckdok: Opvolging en analyse aanslibbing. Deelrapport 2.26: Through tide measurement Sediview during neap tide Winter 2009 (I/RA/11283/08.087/MSA)

IMDC (2009j) Langdurige metingen Deurganckdok: Opvolging en analyse aanslibbing. Deelrapport 2.30: Through tide measurement SiltProfiler winter 2009 (I/RA/11283/08.091/MSA)

IMDC (2009k) Langdurige metingen Deurganckdok: Opvolging en analyse aanslibbing. Deelrapport 2.31: Through tide measurement Salinity Profiling winter 2009 (I/RA/11283/08.092/MSA)

IMDC (2009l) Langdurige metingen Deurganckdok: Opvolging en analyse aanslibbing. Deelrapport 2.33: Salt-Silt distribution Deurganckdok: six monthly report 1/10/2008 – 31/3/2009 (I/RA/11283/08.094/MSA)

IMDC (2009m) Langdurige metingen Deurganckdok: Opvolging en analyse aanslibbing. Deelrapport 3.21: Boundary conditions: Six monthly report 1/10/2008 – 31/03/2009 (I/RA/11283/08.097/MSA)

IMDC (2009n) Langdurige metingen Deurganckdok: Opvolging en analyse aanslibbing. Deelrapport 2.27: Through tide measurement Sediview during spring tide Winter 2009 (I/RA/11283/08.088/MSA)

IMDC (2009o) Langdurige metingen Deurganckdok: Opvolging en analyse aanslibbing. Deelrapport 4.20: Analysis of siltation Processes and Factors (I/RA/11283/08.098/MSA)

IMDC (2010a) Evaluatie externe effecten aanslibbing Deurganckdok. Deelrapport 2.5 Through Tide measurement: eddy currents DGD 02/03/2010 (I/RA/11283/10.051/MSA)

IMDC (2010b) Evaluatie externe effecten aanslibbing Deurganckdok. Deelrapport 2.8 Sal-Silt distribution Deurganckdok 01/04/2009 – 31/03/2010 (I/RA/11354/10.068/NZI)

IMDC (2011a) Evaluatie externe effecten aanslibbing Deurganckdok. Deelrapport 1.1 Annual Sediment Balance year 1: 1/04/2009 – 31/03/2010 (I/RA/11354/10.067/NZI)

IMDC (2011b) Evaluatie externe effecten aanslibbing Deurganckdok. Deelrapport 1.2 Annual Sediment Balance year 2: 1/04/2009 – 31/03/2010 (I/RA/11354/10.100/MBO/ANF)

IMDC (2011c) Evaluatie externe effecten aanslibbing Deurganckdok. Deelrapport 1.4 Boundary Conditions year 1: 01/04/2009 – 31/03/2010 (I/RA/11354/10.102/MBO/ANF)

IMDC (2011d) Evaluatie externe effecten aanslibbing Deurganckdok. Deelrapport 1.7 Synthesis report of research on Current Deflecting Wall (I/RA/11354/10.063/MBO)

IMDC (2012a) Evaluatie externe effecten aanslibbing Deurganckdok. Deelrapport 2.1 Through Tide Sediview measurement: entrance DGD during spring tide in Autumn 2011 (I/RA/11354/10.106/MBO/ANF)

IMDC (2012b) Evaluatie externe effecten aanslibbing Deurganckdok. Deelrapport 2.1 Through Tide Sediview measurement: entrance DGD during neap tide in Autumn 2011 (I/RA/11354/10.107/MBO/ANF)

IMDC (2012c) Evaluatie externe effecten aanslibbing Deurganckdok. Deelrapport 2.5 Through Tide measurement: eddy currents DGD Autumn 2011 (I/RA/11354/10.110/MBO/ANF)

IMDC (2012d) Evaluatie externe effecten aanslibbing Deurganckdok. Deelrapport 2.10 Salt-Silt & Current Distribution entrance Deurganckdok: Frame measurements and through tide measurements: Autumn 2011 (I/RA/11354/11.131/BQU)

IMDC (2012e) Evaluatie externe effecten aanslibbing Deurganckdok. Deelrapport 2.12 Calibration stationary & mobile equipment 16/03/2011 (I/RA/11354/11.113/MBO/ANF)

IMDC (2012f) Evaluatie externe effecten aanslibbing Deurganckdok. Deelrapport 1.5 Boundary conditions year 2: 01/04/2010 – 31/03/2011 (I/RA/11354/11.103/MBO/ANF)

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RD Instruments (October 2003). Winriver User's Guide International Version

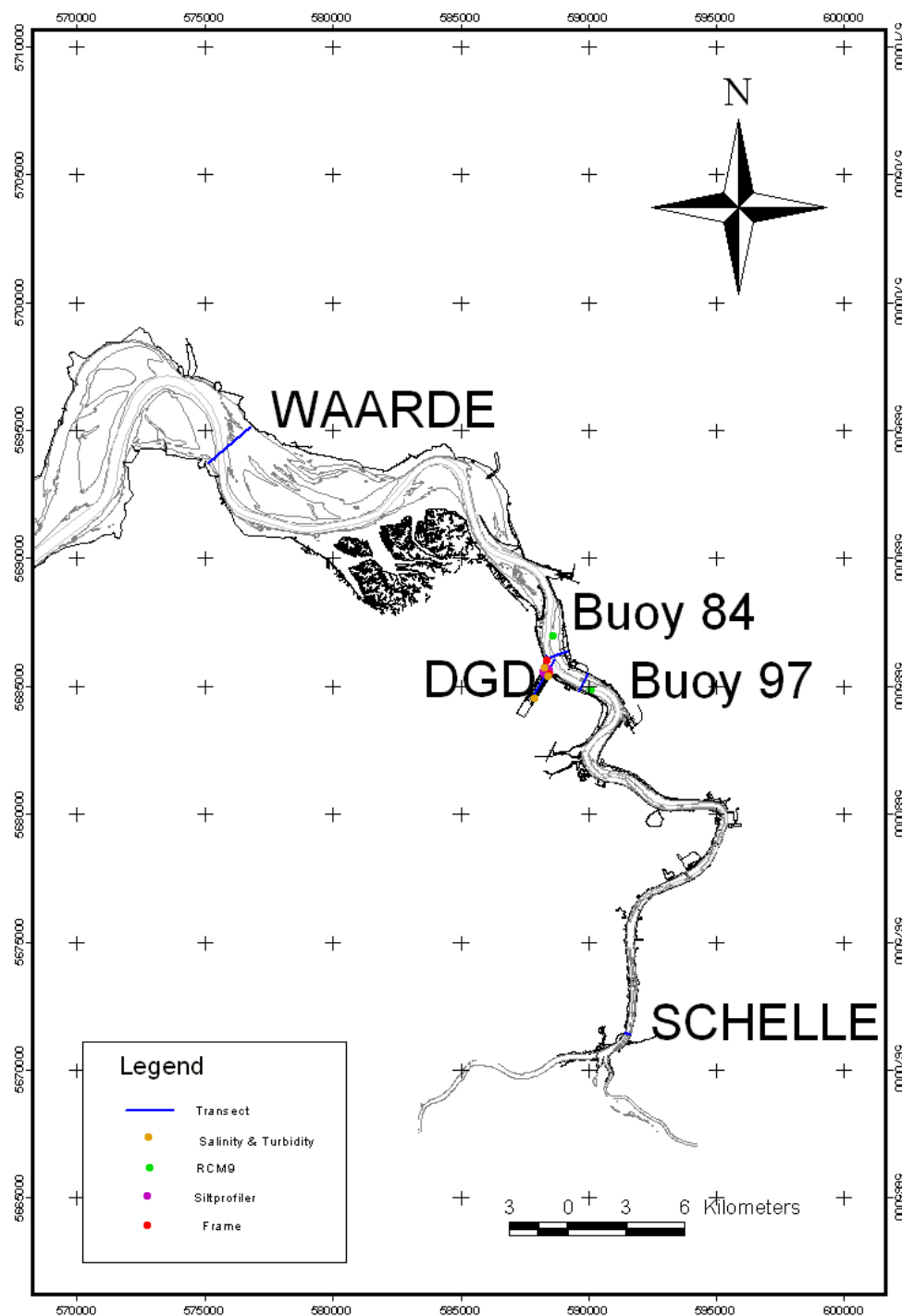
Unesco (1983). Algorithms for computation of fundamental properties of seawater, UNESCO Technical Papers in Marine Science, 44. UNESCO, France.

WL|Delft Hydraulics and IMDC (2006), 3D silttransport model Zeeschelde, Scenario 6: Validatie hydrodynamica 3D siltmodel nabij het Deurganckdok, Versie 2.0, April 2006, Z3824.40, Notitie 8f

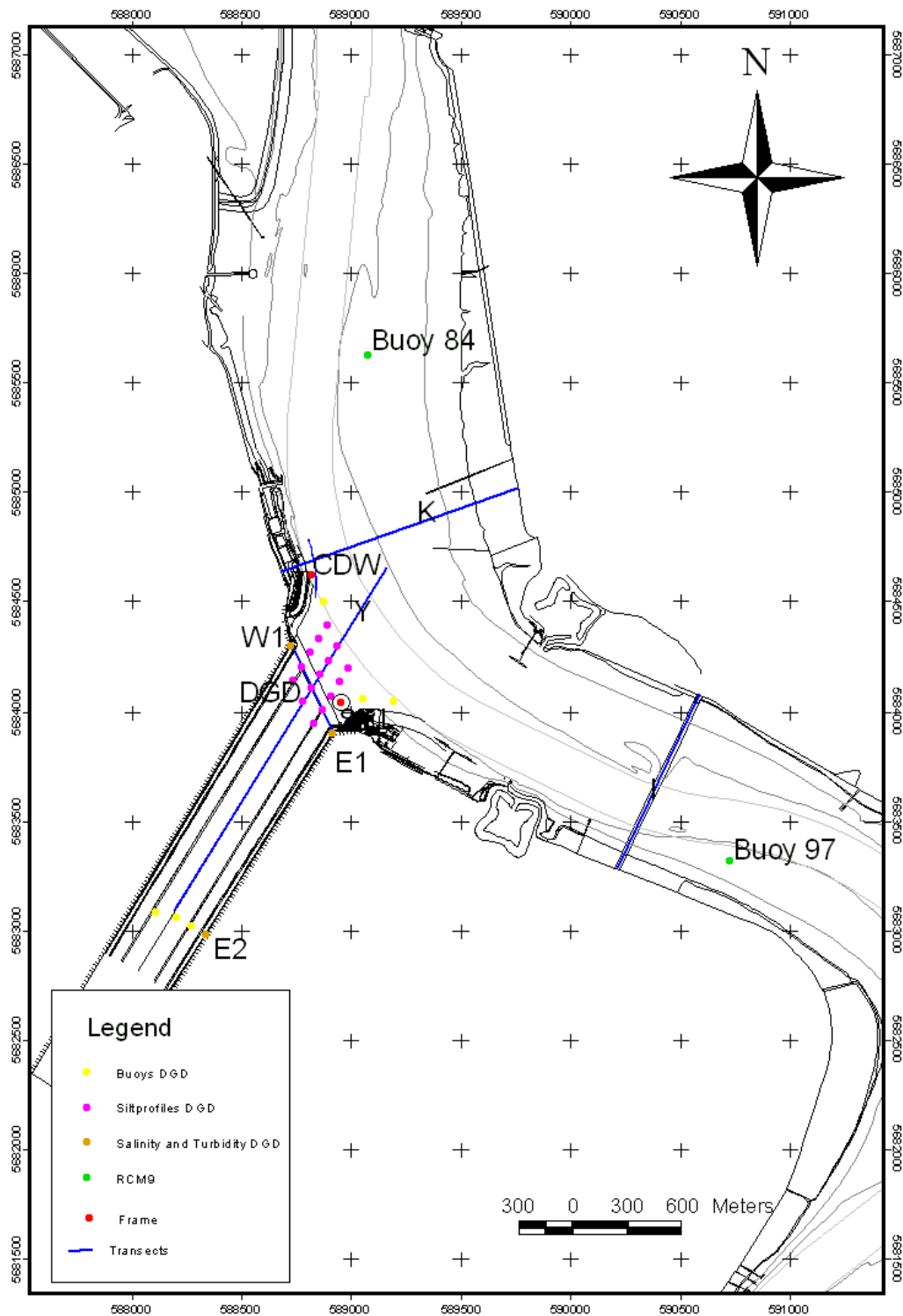
Wunderground (2011). Weather Underground: www.wunderground.com

Annex A Overview of measurement

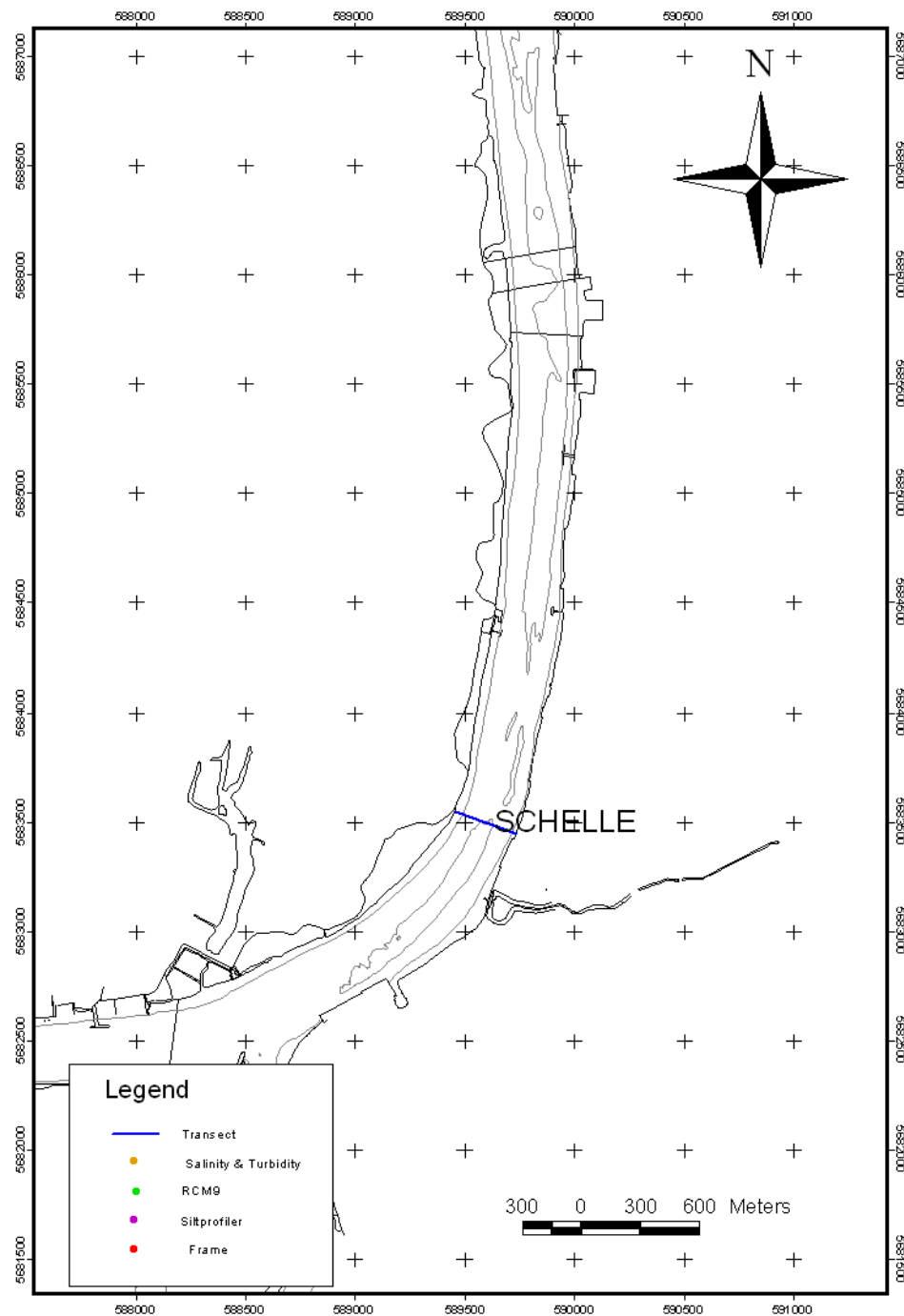
A.1 Overview of the measurement locations for the whole HCBS2 and Deurganckdok measurement campaigns



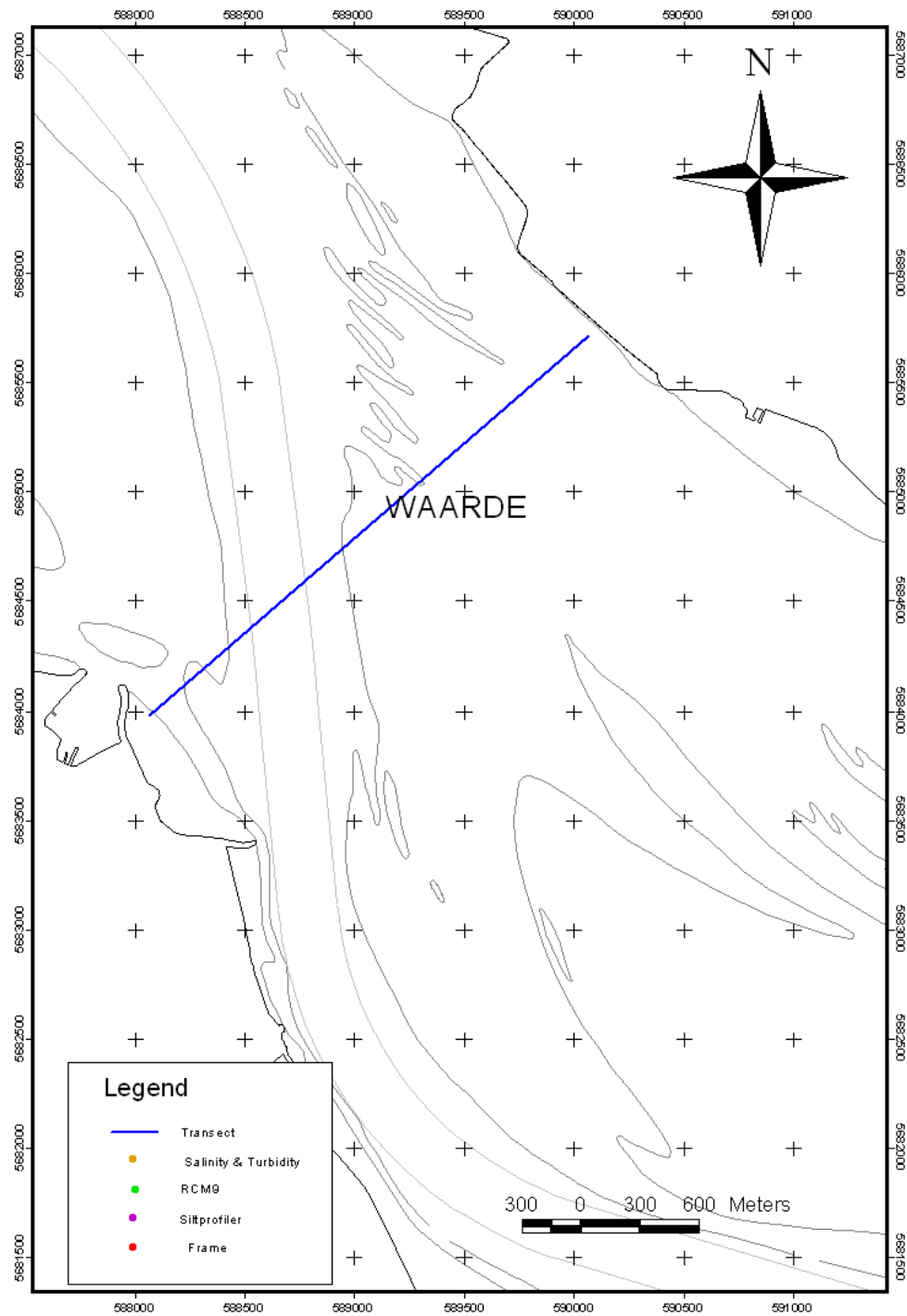
Annex Figure A-1: Overview of the measurement locations



Annex Figure A-2: Overview of the measurement locations at Deurganckdok during previous campaigns



Annex Figure A-3: Transect S in Schelle



Annex Figure A-4: Transect W in Waarde

A.2 Overview of all measurement locations HCBS and Deurganckdok measurement campaigns

Annex Table A-1: coordinates of theoretical transects

Transect	Start Easting	Start Northing	End Easting	End Northing
I	590318	5683302	590771	5684257
K	588484	5684924	589775	5685384
SCHELLE	592645	5665794	592952	5665682
DGD	588765	5684056	588541	5684527
Transect X	588878	5684866	588314	5683955
Transect Y	588934	5684748	588371	5683837
Transect Z	588991	5684630	588427	5683719
Transect 1	588838	5684844	588254	5683880
Transect 2	588891	5684763	588330	5683836
Transect 3	588945	5684681	588406	5683791
Transect 4	588998	5684599	588482	5683746
WAARDE	573541	5696848	571318	5694933

Annex Table A-2: coordinates of SiltProfiler gauging locations

SP	EASTING	NORTHING
1	588737	5684638
2	588690	5684562
3	588643	5684486
4	588596	5684411
5	588549	5684335
6	588606	5684217
7	588653	5684293
8	588700	5684368
9	588747	5684444
10	588793	5684520
11	588850	5684402
12	588803	5684326
13	588756	5684250
14	588709	5684174
15	588662	5684099

A.3 Measurement overview at DGD on 29/09/2011

<i>FileName</i>	<i>End time [hh:mm UTC]</i>	<i>Time after HW [hh:mm]</i>	<i>Easting Left (UTM31 WGS84)</i>	<i>Northing Left (UTM31 WGS84)</i>	<i>Easting Right (UTM31 WGS84)</i>	<i>Northing Right (UTM31 WGS84)</i>	<i>Sailed Transect length [m]</i>	<i>Sailed Transect heading [°]</i>
Raai 1								
3002t1_sub.csv	5:19	2:19	588735	5684591	588175	5683668	1079	31
3004t1_sub.csv	5:34	2:34	588741	5684635	588199	5683697	1083	30
3006t1_sub.csv	5:50	2:50	588728	5684619	588173	5683664	1105	30
3009t1_sub.csv	6:15	3:15	588721	5684648	588164	5683685	1112	30
3012t1_sub.csv	6:37	3:37	588704	5684613	588186	5683670	1077	29
3014t1_sub.csv	6:55	3:55	588641	5684555	588164	5683669	1006	28
4016T1uit_sub.csv	7:16	4:16	588730	5684642	588168	5683668	1124	30
3017t1_sub.csv	7:35	4:35	588750	5684592	588173	5683663	1094	32
3019t1_sub.csv	7:51	4:51	588746	5684627	588169	5683667	1120	31
3022t1_sub.csv	8:19	5:19	588689	5684587	588175	5683696	1029	30
3024t1_sub.csv	8:35	5:35	588716	5684617	588161	5683687	1083	31
3027t1_sub.csv	9:13	6:13	588712	5684653	588159	5683673	1125	29
3029t1_sub.csv	9:29	6:29	588708	5684577	588159	5683678	1053	31
3031t1_sub.csv	9:47	6:47	588700	5684634	588161	5683673	1102	29
3033t1_sub.csv	10:05	7:05	588700	5684590	588159	5683671	1067	30
3036t1_sub.csv	10:32	-4:57	588663	5684474	588167	5683668	946	32
3038t1_sub.csv	10:50	-4:39	588686	5684609	588163	5683686	1062	30
3041t1_sub.csv	11:23	-4:06	588767	5684619	588172	5683669	1121	32
3043t1_sub.csv	11:40	-3:49	588770	5684608	588169	5683665	1118	32
3045t1_sub.csv	11:55	-3:34	588785	5684583	588173	5683665	1104	34
3048t1_sub.csv	12:18	-3:11	588758	5684591	588170	5683677	1087	33
3050t1_sub.csv	12:34	-2:55	588704	5684583	588178	5683661	1061	30
3052t1_sub.csv	12:50	-2:39	588685	5684586	588158	5683675	1052	30
3055t1_sub.csv	13:23	-2:06	588668	5684533	588156	5683674	1000	31
3057t1_sub.csv	13:39	-1:50	588721	5684598	588163	5683693	1063	32
3059t1_sub.csv	13:55	-1:34	588723	5684604	588155	5683676	1088	31
3061t1_sub.csv	14:11	-1:18	588736	5684623	588159	5683673	1112	31
3063t1_sub.csv	14:27	-1:02	588717	5684588	588157	5683673	1073	31
3065t1_sub.csv	14:43	-0:46	588741	5684612	588174	5683686	1086	31
3068t1_sub.csv	15:12	-0:17	588690	5684537	588150	5683676	1016	32

<i>FileName</i>	<i>End time [hh:mm UTC]</i>	<i>Time after HW [hh:mm]</i>	<i>Easting Left (UTM31 WGS84)</i>	<i>Northing Left (UTM31 WGS84)</i>	<i>Easting Right (UTM31 WGS84)</i>	<i>Northing Right (UTM31 WGS84)</i>	<i>Sailed Transect length [m]</i>	<i>Sailed Transect heading [°]</i>
3071t1_sub.csv	15:38	0:08	588759	5684618	588169	5683665	1120	32
3073t1_sub.csv	15:54	0:24	588689	5684559	588167	5683667	1033	30
3075t1_sub.csv	16:10	0:40	588748	5684631	588156	5683675	1124	32
3077t1_sub.csv	16:26	0:56	588732	5684587	588169	5683672	1075	32
3079t1_sub.csv	16:41	1:11	588732	5684622	588180	5683683	1089	30
3081t1_sub.csv	16:55	1:25	588629	5684473	588161	5683671	928	30
3084t1_sub.csv	17:33	2:03	588748	5684558	588189	5683705	1020	33
3086t1_sub.csv	17:48	2:18	588707	5684565	588209	5683715	985	30
Raai 2								
4001T2uit_sub.csv	5:19	2:19	588794	5684555	588224	5683643	1075	32
4004T2uit_sub.csv	5:34	2:34	588788	5684557	588218	5683640	1079	32
4006T2uit_sub.csv	5:51	2:51	588798	5684549	588228	5683644	1070	32
3010t2_sub.csv	6:21	3:21	588770	5684566	588202	5683652	1076	32
4010T2uit_sub.csv	6:30	3:30	588759	5684573	588228	5683638	1075	30
4012T2uit_sub.csv	6:44	3:44	588778	5684557	588221	5683636	1076	31
4014T2uit_sub.csv	7:00	4:00	588764	5684560	588234	5683627	1073	30
4018T2uit_sub.csv	7:32	4:32	588748	5684558	588231	5683644	1050	30
4020T2uit_sub.csv	7:47	4:47	588748	5684576	588228	5683664	1050	30
4022T2in_sub.csv	8:12	5:12	588764	5684529	588233	5683630	1044	31
4024T2in_sub.csv	8:25	5:25	588776	5684564	588232	5683632	1079	30
4026T2in_sub.csv	8:39	5:39	588764	5684526	588232	5683630	1042	31
4028T2in_sub.csv	8:52	5:52	588766	5684568	588233	5683631	1078	30
4031T2uit_sub.csv	9:13	6:13	588802	5684549	588234	5683631	1079	32
4033T2uit_sub.csv	9:28	6:28	588808	5684543	588203	5683649	1079	34
4035T2uit_sub.csv	9:43	6:43	588832	5684528	588247	5683689	1023	35
4037T2uit_sub.csv	9:57	6:57	588762	5684498	588204	5683648	1017	33
4039T2in_sub.csv	10:23	-5:06	588780	5684549	588250	5683619	1070	30
4041T2in_sub.csv	10:39	-4:50	588782	5684562	588238	5683628	1080	30
4043T2in_sub.csv	10:59	-4:30	588812	5684542	588241	5683626	1079	32
4045T2in_sub.csv	11:16	-4:13	588809	5684540	588218	5683638	1078	33
4047T2in_sub.csv	11:32	-3:57	588794	5684509	588223	5683642	1038	33
4049T2in_sub.csv	11:49	-3:40	588818	5684538	588240	5683629	1078	32

<i>FileName</i>	<i>End time [hh:mm UTC]</i>	<i>Time after HW [hh:mm]</i>	<i>Easting Left (UTM31 WGS84)</i>	<i>Northing Left (UTM31 WGS84)</i>	<i>Easting Right (UTM31 WGS84)</i>	<i>Northing Right (UTM31 WGS84)</i>	<i>Sailed Transect length [m]</i>	<i>Sailed Transect heading [°]</i>
3047t2_sub.csv	12:09	-3:20	588784	5684536	588253	5683616	1062	30
4053T2uit_sub.csv	12:40	-2:49	588815	5684540	588220	5683636	1082	33
4055T2uit_sub.csv	12:59	-2:30	588808	5684540	588235	5683631	1075	32
4057T2uit_sub.csv	13:20	-2:09	588804	5684548	588229	5683631	1082	32
4059T2uit_sub.csv	13:35	-1:54	588815	5684536	588240	5683624	1078	32
4061T2uit_sub.csv	13:48	-1:41	588817	5684540	588246	5683622	1081	32
4064T2uit_sub.csv	14:14	-1:15	588816	5684540	588239	5683625	1082	32
4066T2uit_sub.csv	14:28	-1:01	588837	5684521	588255	5683660	1040	34
4068T2uit_sub.csv	14:40	-0:49	588864	5684512	588269	5683738	976	38
4070T2uit_sub.csv	14:54	-0:35	588820	5684528	588236	5683627	1074	33
4072T2uit_sub.csv	15:05	-0:24	588270	5683642	588434	5683989	384	25
3070t2_sub.csv	15:30	0:00	588816	5684541	588259	5683623	1074	31
4074T2in_sub.csv	15:45	0:15	588765	5684487	588223	5683635	1010	32
4077T2in_sub.csv	16:19	0:49	588782	5684547	588236	5683647	1052	31
4079T2in_sub.csv	16:39	1:09	588803	5684546	588191	5683654	1082	34
4081T2in_sub.csv	16:57	1:27	588802	5684548	588229	5683640	1073	32
4083T2in_sub.csv	17:15	1:45	588732	5684426	588456	5684019	491	34
4084T2in_sub.csv	17:26	1:56	588776	5684565	588257	5683661	1042	30
4086T2in_sub.csv	17:42	2:12	588780	5684550	588247	5683655	1042	31
Raai 3								
3001t3_sub.csv	5:13	2:13	588852	5684433	588303	5683591	1005	33
3003t3_sub.csv	5:27	2:27	588835	5684479	588330	5683653	968	31
3005t3_sub.csv	5:43	2:43	588814	5684460	588325	5683614	977	30
3007t3_sub.csv	5:58	2:58	588827	5684463	588298	5683589	1021	31
3011t3_sub.csv	6:28	3:28	588830	5684476	588326	5683642	974	31
3013t3_sub.csv	6:46	3:46	588831	5684480	588311	5683585	1036	30
4015T3in_sub.csv	7:08	4:08	588822	5684486	588341	5683570	1035	28
3016t3_sub.csv	7:28	4:28	588792	5684409	588302	5683613	934	32
3018t3_sub.csv	7:43	4:43	588819	5684459	588296	5683592	1012	31
3021t3_sub.csv	8:11	5:11	588840	5684475	588315	5683584	1033	31
3023t3_sub.csv	8:27	5:27	588848	5684452	588315	5683607	999	32
3025t3_sub.csv	8:44	5:44	588851	5684463	588301	5683605	1019	33

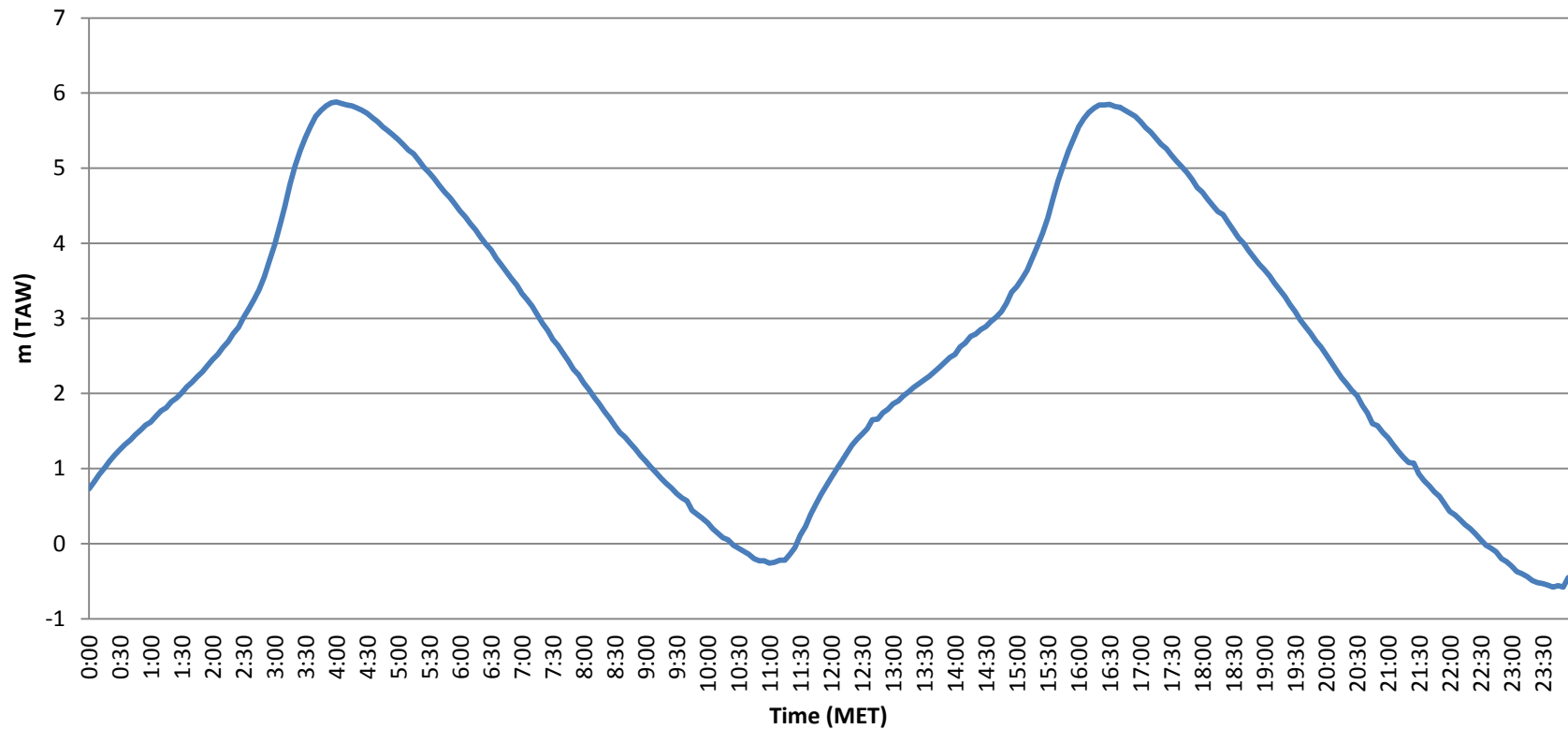
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4030T3in_sub.csv	9:05	6:05	588848	5684446	588318	5683584	1013	32
3028t3_sub.csv	9:21	6:21	588854	5684462	588298	5683592	1033	33
3030t3_sub.csv	9:37	6:37	588788	5684381	588303	5683586	931	31
3032t3_sub.csv	9:56	6:56	588819	5684435	588304	5683587	991	31
3035t3_sub.csv	10:24	-5:05	588837	5684478	588321	5683579	1037	30
3037t3_sub.csv	10:41	-4:48	588797	5684440	588314	5683583	984	29
3040t3_sub.csv	11:14	-4:15	588826	5684439	588305	5683602	986	32
3042t3_sub.csv	11:31	-3:58	588856	5684468	588300	5683591	1038	32
3044t3_sub.csv	11:48	-3:41	588921	5684426	588293	5683611	1028	38
3046t3_sub.csv	12:02	-3:27	588840	5684476	588312	5683619	1007	32
3049t3_sub.csv	12:25	-3:04	588856	5684449	588281	5683600	1025	34
3051t3_sub.csv	12:42	-2:47	588859	5684465	588285	5683601	1037	34
3053t3_sub.csv	12:57	-2:32	588858	5684465	588258	5683614	1041	35
3056t3_sub.csv	13:31	-1:58	588853	5684468	588314	5683603	1019	32
3058t3_sub.csv	13:46	-1:43	588860	5684465	588299	5683589	1040	33
3060t3_sub.csv	14:02	-1:27	588848	5684450	588296	5683592	1020	33
3062t3_sub.csv	14:19	-1:10	588849	5684437	588290	5683598	1008	34
3064t3_sub.csv	14:35	-0:54	588872	5684454	588305	5683591	1032	33
3066t3_sub.csv	14:51	-0:38	588843	5684445	588313	5683581	1013	32
3069t3_sub.csv	15:20	-0:09	588848	5684470	588292	5683596	1036	32
3072t3_sub.csv	15:48	0:18	588837	5684479	588295	5683603	1031	32
3074t3_sub.csv	16:03	0:33	588819	5684427	588300	5683593	983	32
3076t3_sub.csv	16:19	0:49	588847	5684472	588340	5683607	1002	30
3078t3_sub.csv	16:34	1:04	588850	5684471	588291	5683596	1038	33
3080t3_sub.csv	16:50	1:20	588811	5684450	588320	5683579	1000	29
3083t3_sub.csv	17:27	1:57	588825	5684461	588293	5683594	1017	32
3085t3_sub.csv	17:41	2:11	588907	5684435	588309	5683628	1004	37
Raai 4								
4000T4in_sub.csv	5:13	2:13	588923	5684372	588372	5683549	989	34
4002T4in_sub.csv	5:27	2:27	588879	5684404	588391	5683536	996	29
4005T4in_sub.csv	5:42	2:42	588885	5684400	588395	5683533	996	29
3008t4_sub.csv	6:04	3:04	588887	5684381	588375	5683557	969	32

FileName	End time [hh:mm UTC]	Time after HW [hh:mm]	Easting Left (UTM31 WGS84)	Northing Left (UTM31 WGS84)	Easting Right (UTM31 WGS84)	Northing Right (UTM31 WGS84)	Sailed Transect length [m]	Sailed Transect heading [°]
4009T4in_sub.csv	6:23	3:23	588872	5684406	588377	5683543	995	30
4011T4in_sub.csv	6:38	3:38	588866	5684407	588385	5683538	993	29
4013T4in_sub.csv	6:53	3:53	588882	5684397	588402	5683529	992	29
4017T4in_sub.csv	7:25	4:25	588860	5684414	588371	5683547	995	29
4019T4in_sub.csv	7:40	4:40	588878	5684401	588379	5683542	994	30
3020t4_sub.csv	7:59	4:59	588876	5684403	588379	5683545	992	30
4023T4uit_sub.csv	8:18	5:18	588883	5684398	588363	5683576	972	32
4025T4uit_sub.csv	8:31	5:31	588890	5684383	588376	5683545	983	32
4027T4uit_sub.csv	8:46	5:46	588895	5684387	588374	5683546	989	32
4029T4uit_sub.csv	8:59	5:59	588898	5684383	588388	5683543	984	31
4032T4in_sub.csv	9:20	6:20	588884	5684396	588378	5683544	991	31
4034T4in_sub.csv	9:36	6:36	588883	5684395	588394	5683534	990	30
4036T4in_sub.csv	9:49	6:49	588891	5684396	588383	5683539	996	31
3034t4_sub.csv	10:16	-5:13	588895	5684393	588379	5683543	995	31
4040T4uit_sub.csv	10:32	-4:57	588927	5684375	588363	5683556	994	35
4042T4uit_sub.csv	10:50	-4:39	588905	5684387	588384	5683539	995	32
4044T4uit_sub.csv	11:08	-4:21	588912	5684351	588372	5683548	968	34
4046T4uit_sub.csv	11:24	-4:05	588916	5684376	588396	5683535	989	32
4048T4uit_sub.csv	11:40	-3:49	588903	5684388	588382	5683556	981	32
4050T4uit_sub.csv	11:57	-3:32	588926	5684375	588378	5683545	994	33
4052T4in_sub.csv	12:23	-3:06	588911	5684351	588430	5683512	966	30
4054T4in_sub.csv	12:48	-2:41	588909	5684386	588384	5683539	996	32
4056T4in_sub.csv	13:11	-2:18	588936	5684369	588411	5683524	995	32
4058T4in_sub.csv	13:27	-2:02	588906	5684380	588384	5683546	984	32
4060T4in_sub.csv	13:41	-1:48	588900	5684356	588394	5683539	961	32
4063T4in_sub.csv	14:07	-1:22	588895	5684394	588369	5683555	990	32
4065T4in_sub.csv	14:21	-1:08	588911	5684377	588374	5683544	991	33
4067T4in_sub.csv	14:34	-0:55	588931	5684371	588377	5683550	990	34
4069T4in_sub.csv	14:47	-0:42	588940	5684364	588385	5683539	994	34
4071T4in_sub.csv	15:01	-0:28	588929	5684371	588377	5683546	993	34
4073T4uit_sub.csv	15:38	0:08	588910	5684385	588386	5683541	994	32
4075T4uit_sub.csv	15:51	0:21	588924	5684375	588370	5683550	994	34

FileName	End time [hh:mm UTC]	Time after HW [hh:mm]	Easting Left (UTM31 WGS84)	Northing Left (UTM31 WGS84)	Easting Right (UTM31 WGS84)	Northing Right (UTM31 WGS84)	Sailed Transect length [m]	Sailed Transect heading [°]
4078T4uit_sub.csv	16:26	0:56	588902	5684389	588370	5683550	993	32
4080T4uit_sub.csv	16:47	1:17	588897	5684392	588375	5683545	996	32
4082T4uit_sub.csv	17:05	1:35	588906	5684383	588383	5683541	992	32
4085T4uit_sub.csv	17:33	2:03	588887	5684383	588409	5683597	921	31
4087T4uit_sub.csv	17:48	2:18	588881	5684399	588359	5683557	991	32

Annex B Tidal data

11354 – Autumn 2011 SURVEY



Measured tide on 29/09/2011 at Liefkenshoek

Location:
River Scheldt

Date:
29/09/2011

Data processed by:

In association with:



&

I/RA/11354/10.110/MB0/ANF

Annex C Navigation information as recorded on site

Ship:		Nele 36 & Parel II
Location:		Deurganckdok (transect DGD)
Transect	Remarks	
3005t3	Schroefwater: binnenschip uit	
3009t1	Schroefwater: binnenschip in	
3012t1	Schroefwater: binnenschip in/uit	
3013t3	Schroefwater: binnenschip uit	
3014t1	Schroefwater: binnenschip in/uit	
3016t3	Schroefwater: binnenschip uit	
3018t3	Schroefwater: parel 2	
3021t3	Schroefwater: binnenschip uit	
3051t3	Schroefwater: containerschip uit	
4014T2uit	Schroefwater: binnenschip uit	
4022T2in	Schroefwater: 2 binnenschepen uit	
4033T2uit	Schroefwater: binnenschip door raai	
4049T2in	Schroefwater: binnenschip uit	

Annex D Unesco PPs-78 formula for calculating salinity

Practical Salinity Scale (PPS 78) Salinity in the range of 2 to 42

Constants from the 19th Edition of Standard Methods

R cond.ratio	0.0117	$R = \frac{C}{42.914 \text{ mS/cm}}$							
C Cond at t	0.5	Input conductivity in mS/cm of sample							
t deg. C	22.00	Input temperature of sample solution							
P dBar	20	Input pressure at which sample is measured in decibars							
R _p	1.0020845	$R_p = 1 + \frac{p(e_1 + e_2 p + e_3 p^2)}{1 + d_1 t + d_2 t^2 + (d_3 + d_4 t)R}$							
r _t	1.1641102	$r_t = c_0 + c_1 t + c_2 t^2 + c_3 t^3 + c_4 t^4$							
R _t	0.0099879	$R_t = \frac{R}{R_p \times r_t}$							
Delta S	-0.0010	$\Delta S = \frac{(t-15)}{1+k(t-15)} (b_0 + b_1 R_t^{1/2} + b_2 R_t^{3/2} + b_3 R_t^{5/2} + b_4 R_t^2 + b_5 R_t^{5/2})$							
S = Salinity	0.257	$S = a_0 + a_1 R_t^{1/2} + a_2 R_t^{3/2} + a_3 R_t^2 + a_4 R_t^{5/2} + a_5 R_t^2 + \Delta S$							
a0	0.0080	b0	0.0005	c0	0.6766097	d1	3.426E-02	e1	2.070E-04
a1	-0.1692	b1	-0.0056	c1	2.00564E-02	d2	4.464E-04	e2	-6.370E-08
a2	25.3851	b2	-0.0066	c2	1.104259E-04	d3	4.215E-01	e3	3.989E-12
a3	14.0941	b3	-0.0375	c3	-6.9698E-07	d4	-3.107E-03		
a4	-7.0261	b4	0.0636	c4	1.0031E-09				
a5	2.7081	b5	-0.0144						
		k	0.0162						

R = ratio of measured conductivity to the conductivity of the Standard Seawater Solution

Conductivity Ratio R is a function of salinity, temperature, and hydraulic pressure. So that we can factor R into three parts i.e.

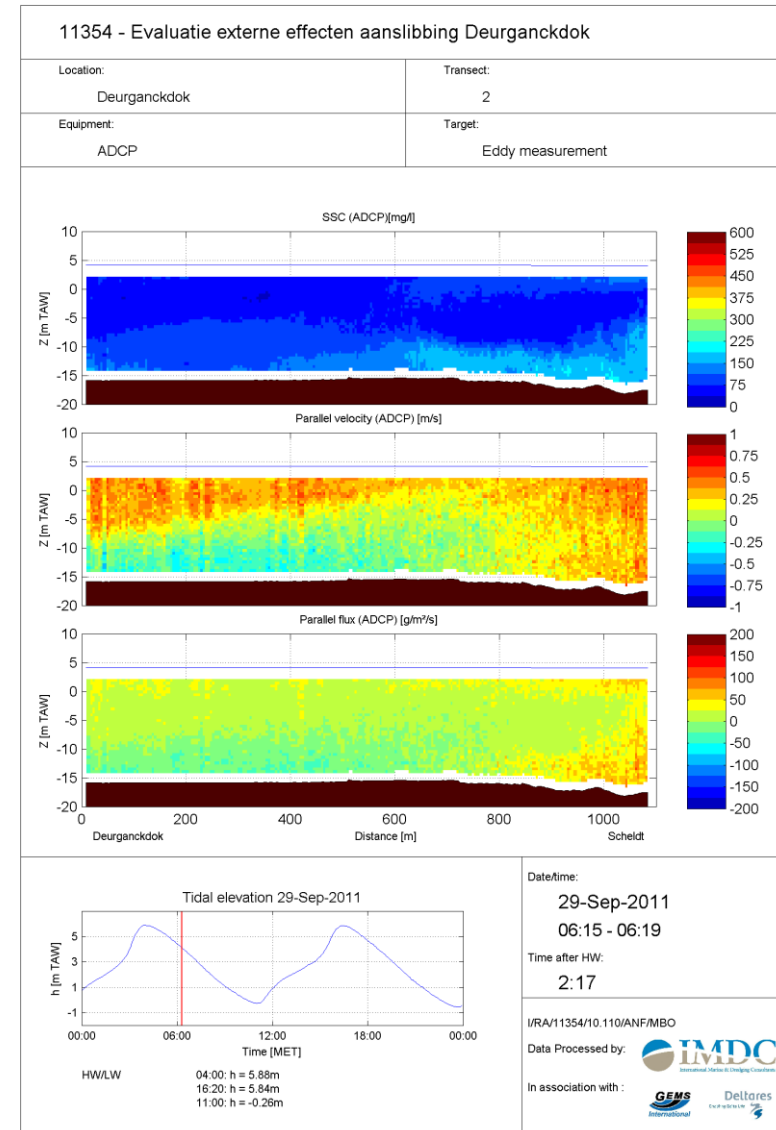
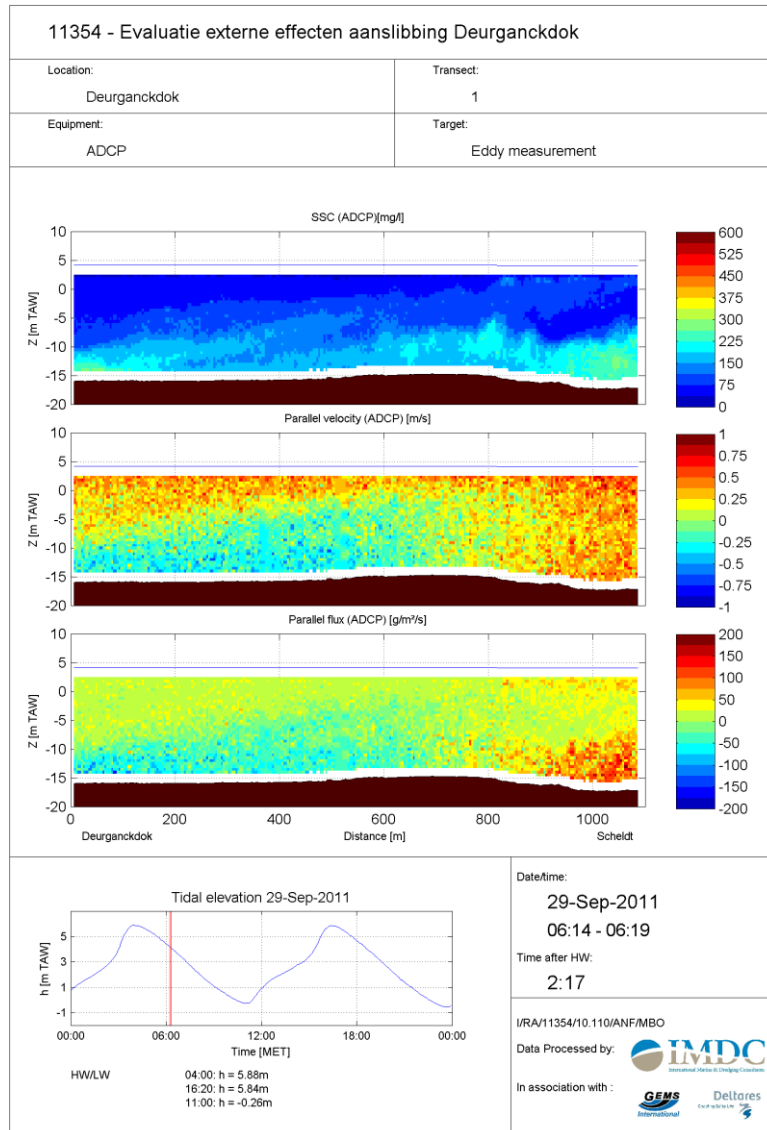
$$R = R_t \times R_p \times r_t$$

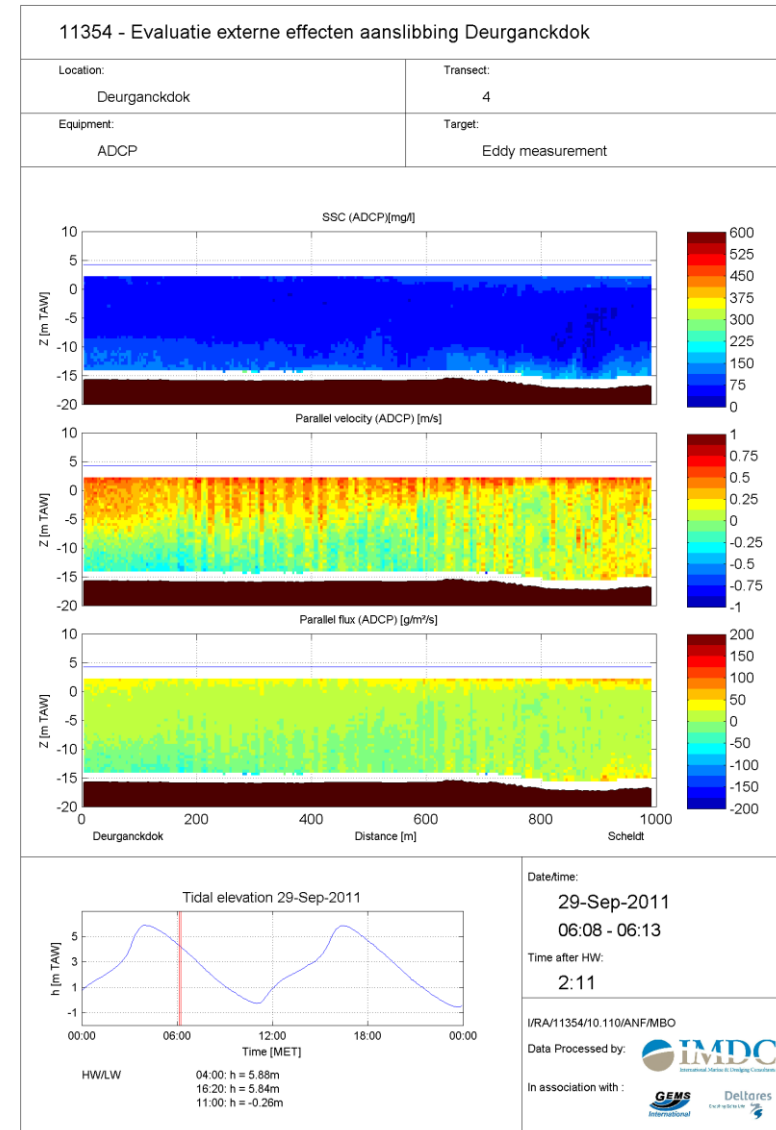
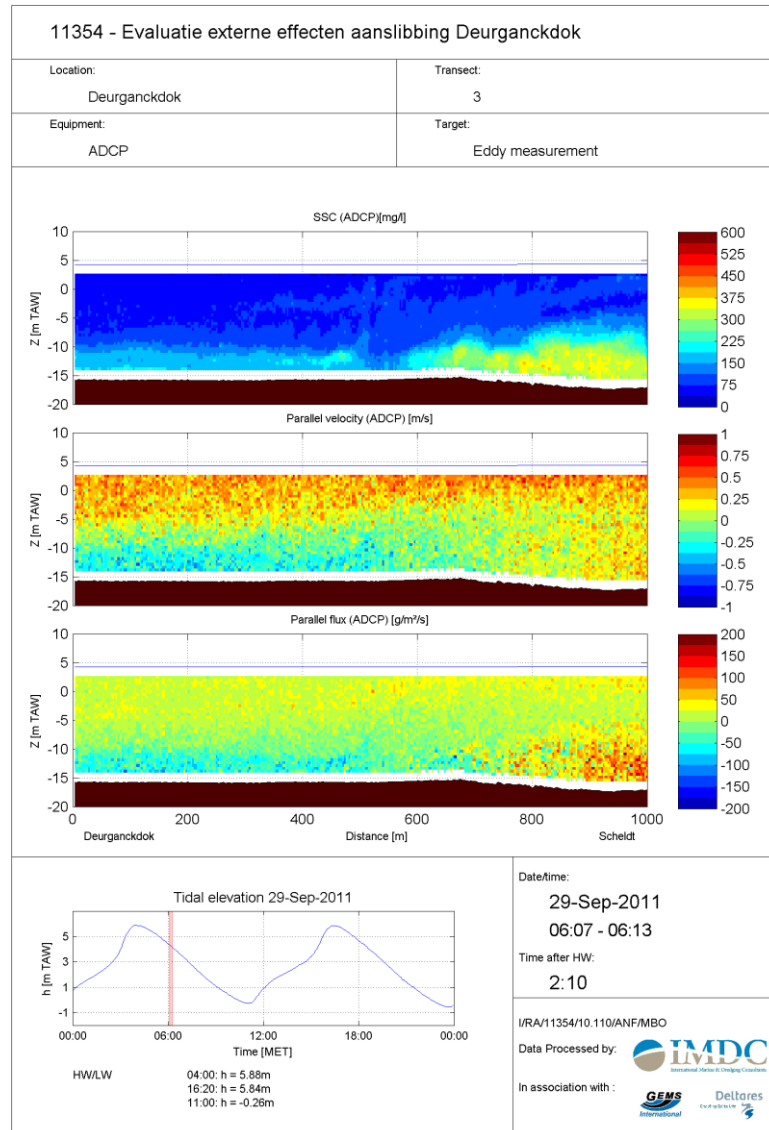
$$R = C(S, t, p) / C(35, 15, 0)$$

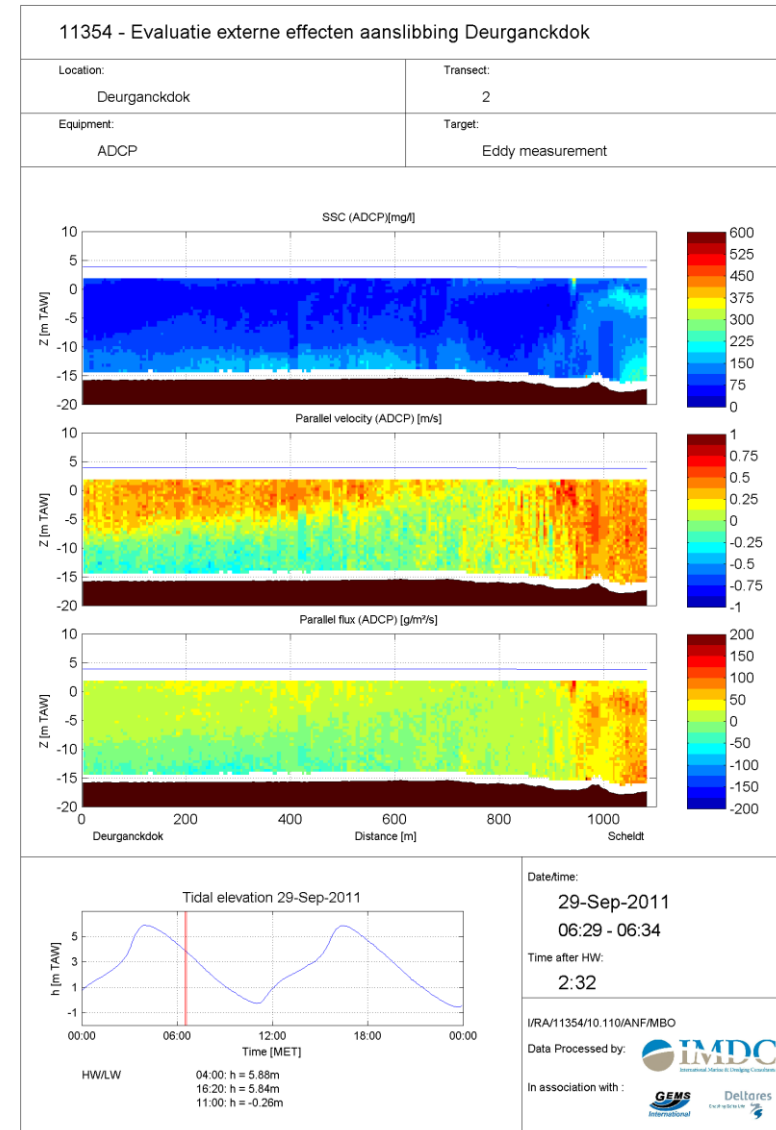
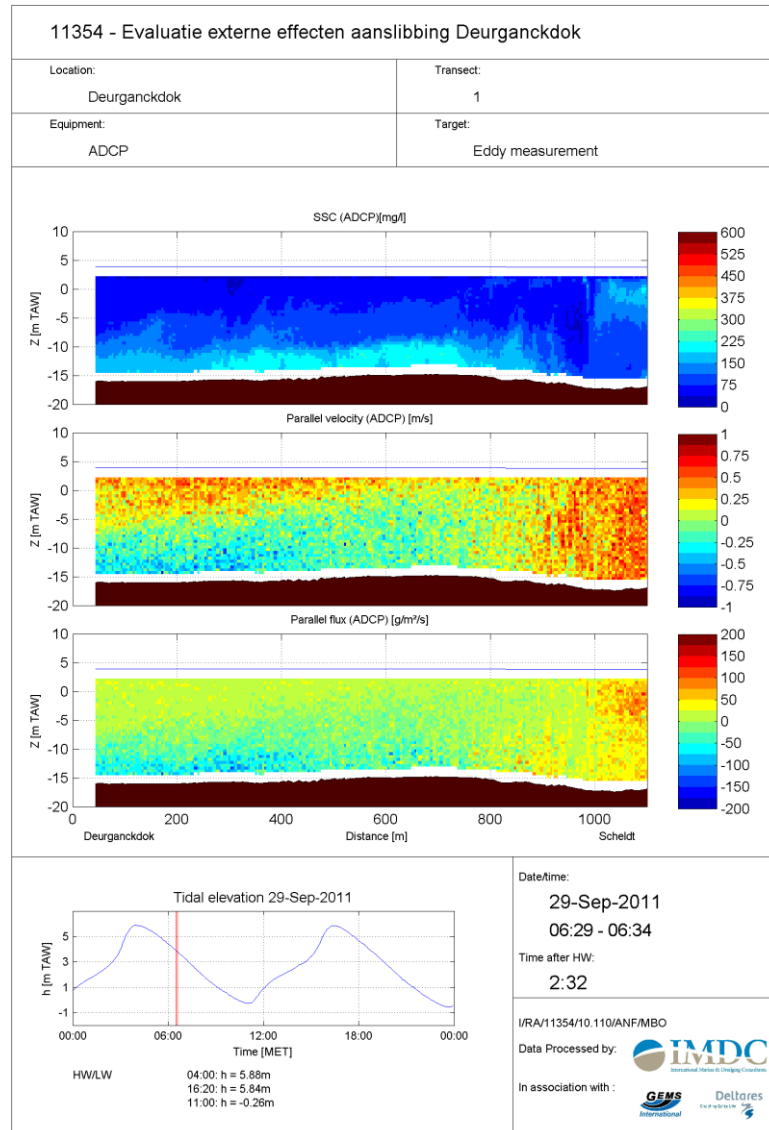
C = 42.914 mS/cm at 15 deg C and 0 dbar pressure ie C(35,15,0) where 35 is the salinity

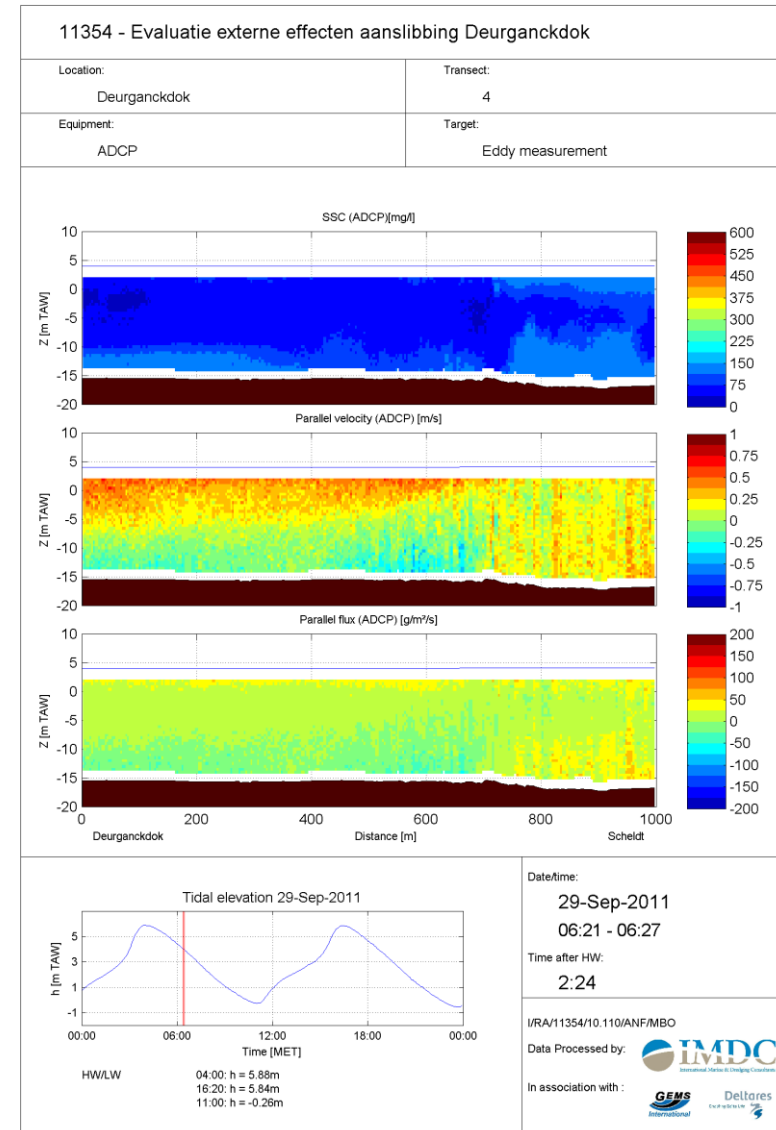
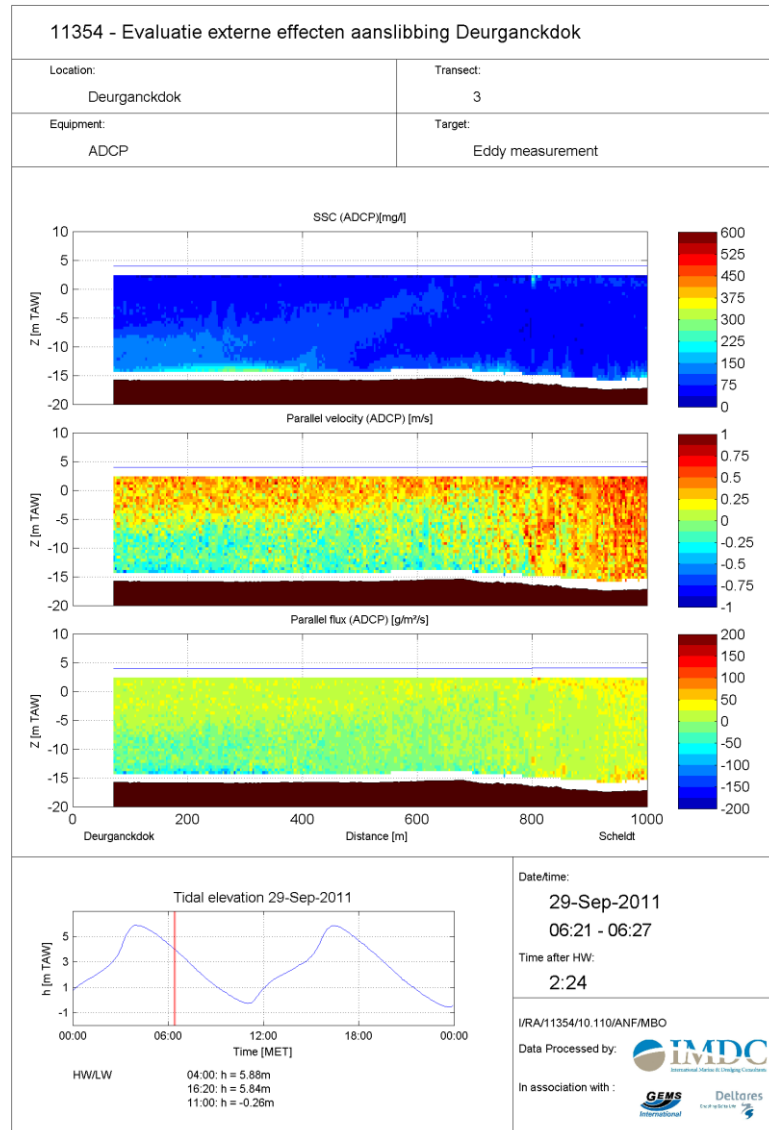
Ocean pressure is usually measured in decibars. 1 dbar = 10⁻¹ bar = 10⁵ dyne/cm² = 10⁴ Pascal.

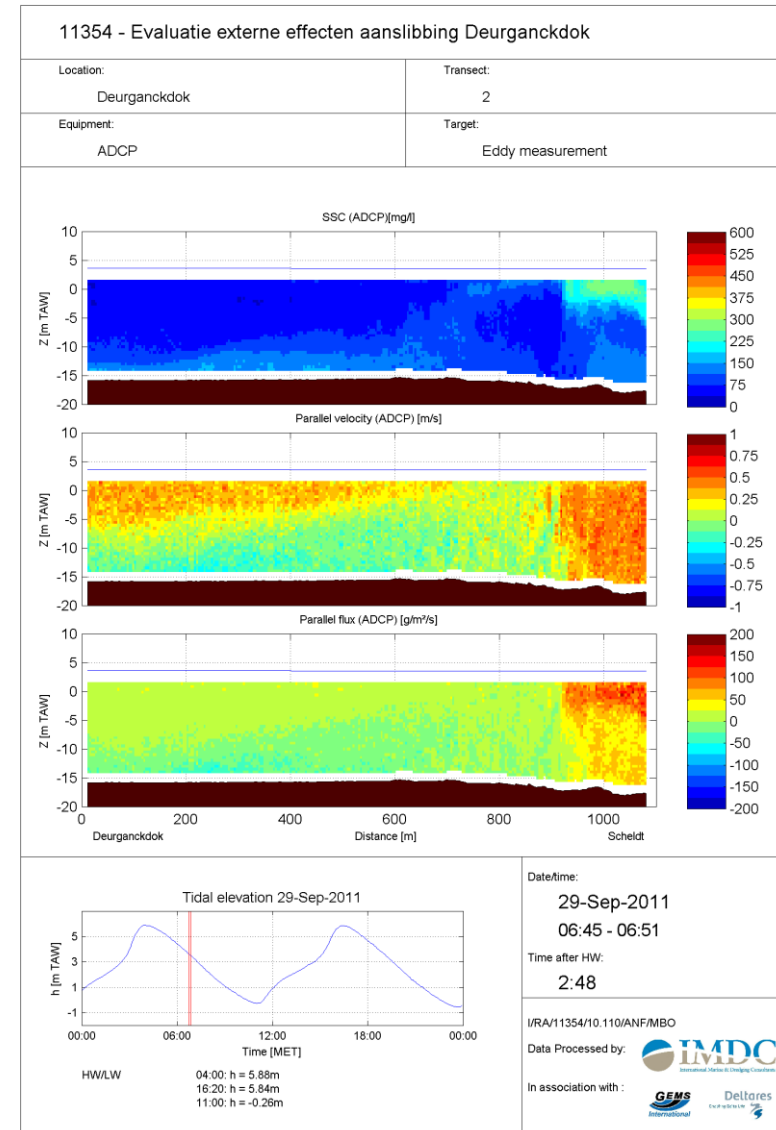
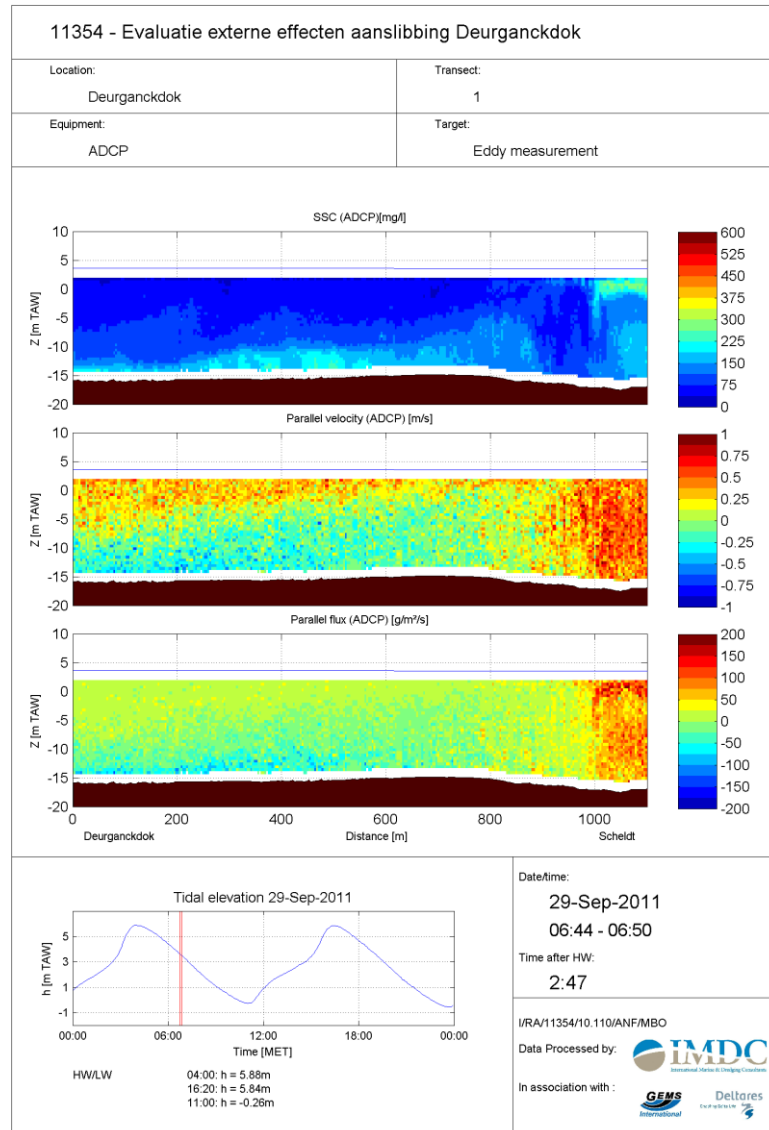
Annex E Contourplots of flow velocities and concentration per sailed transect

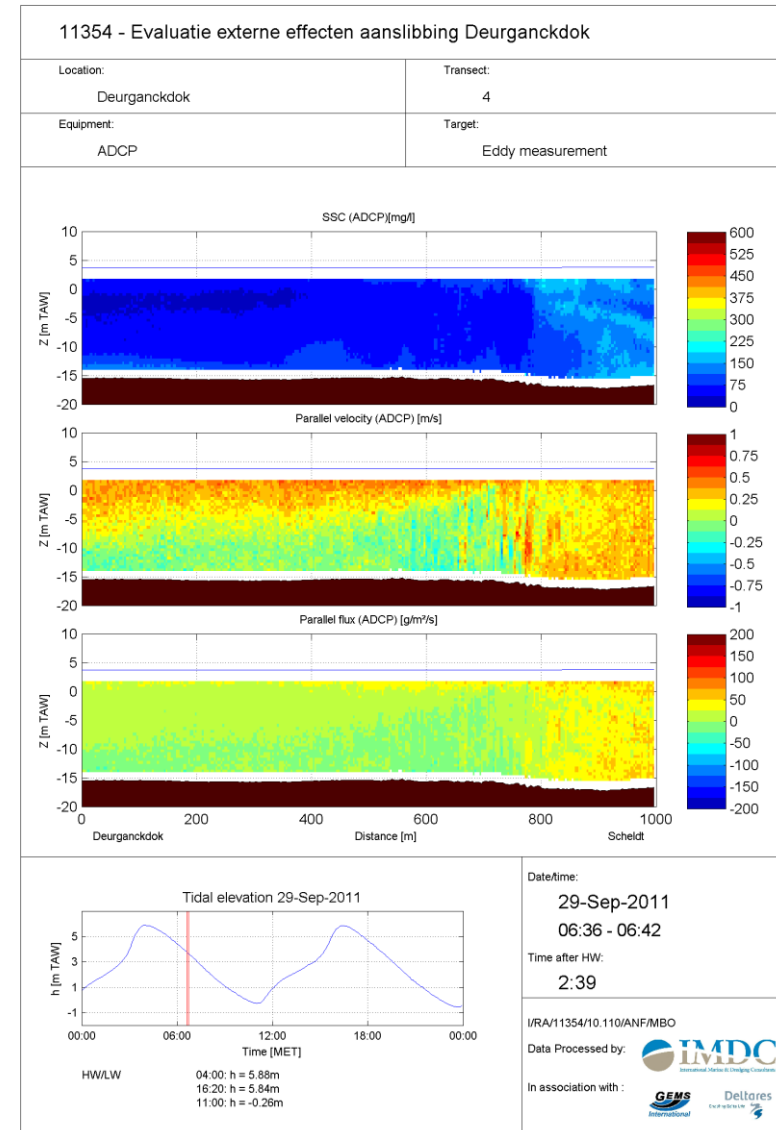
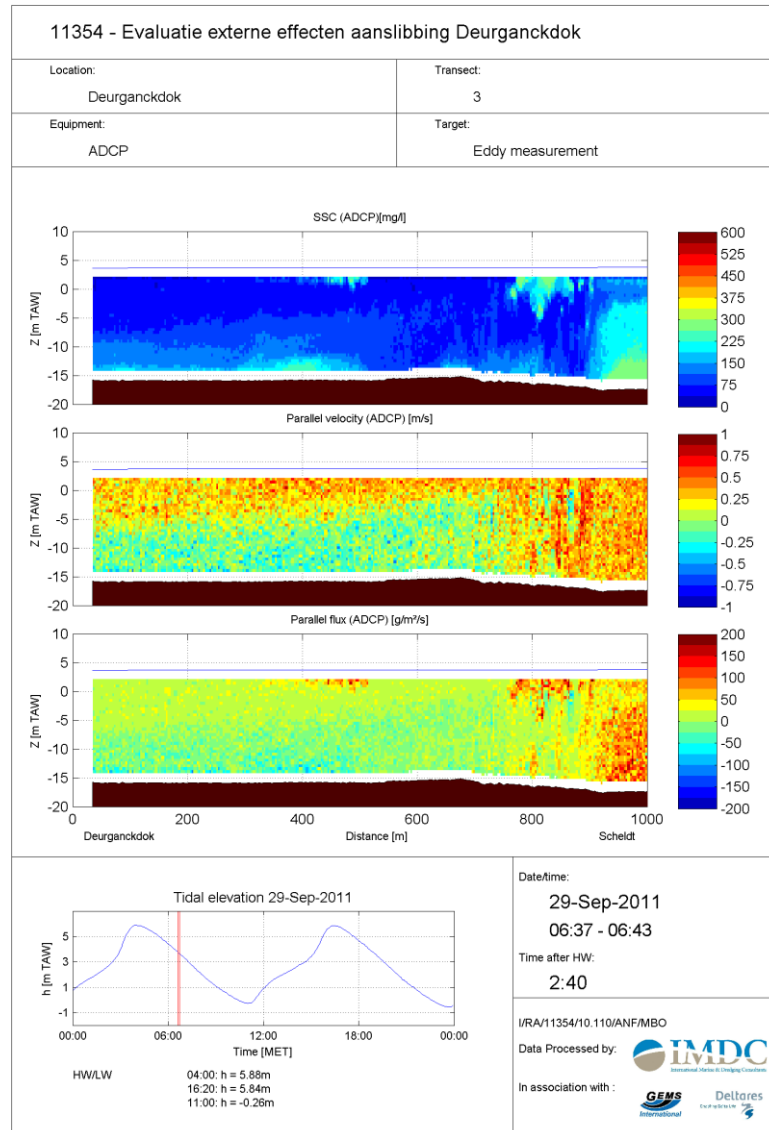


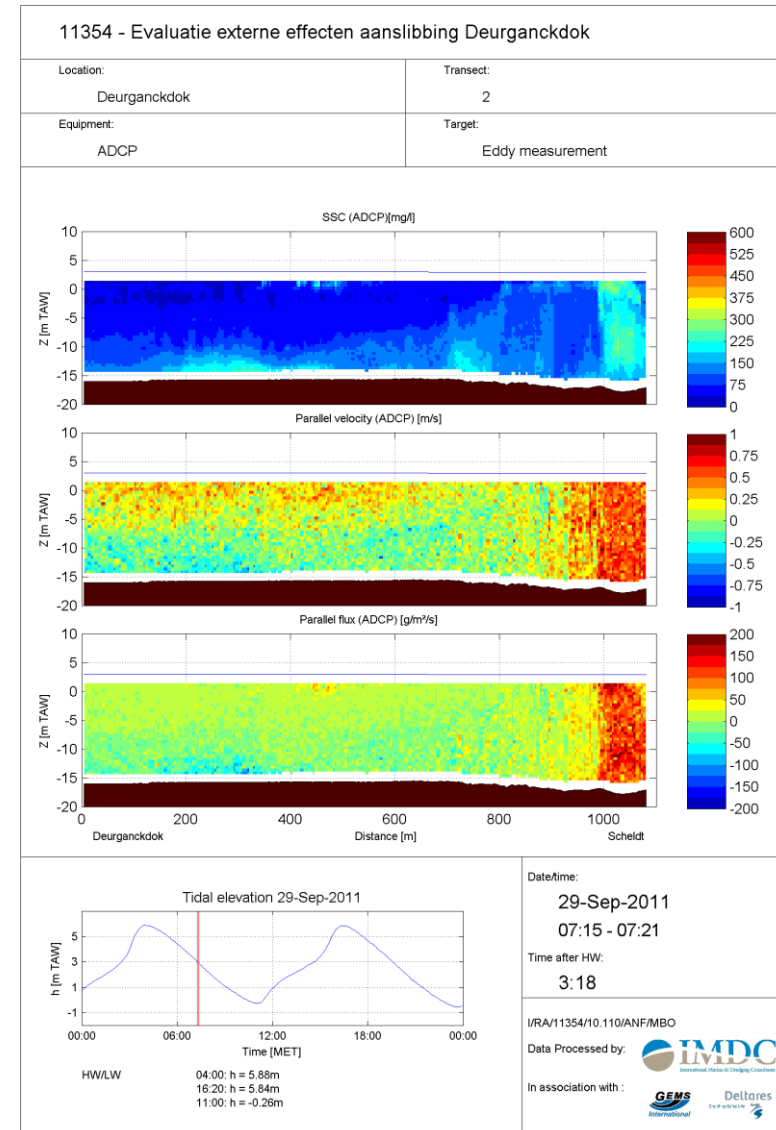
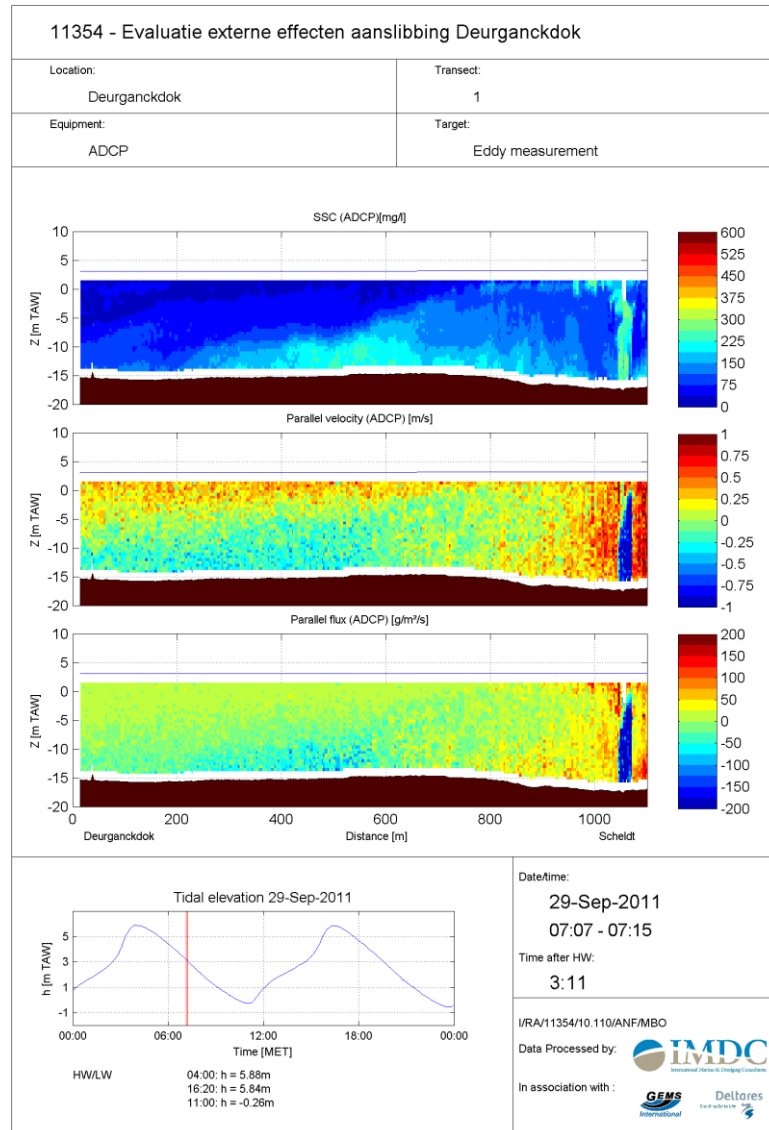


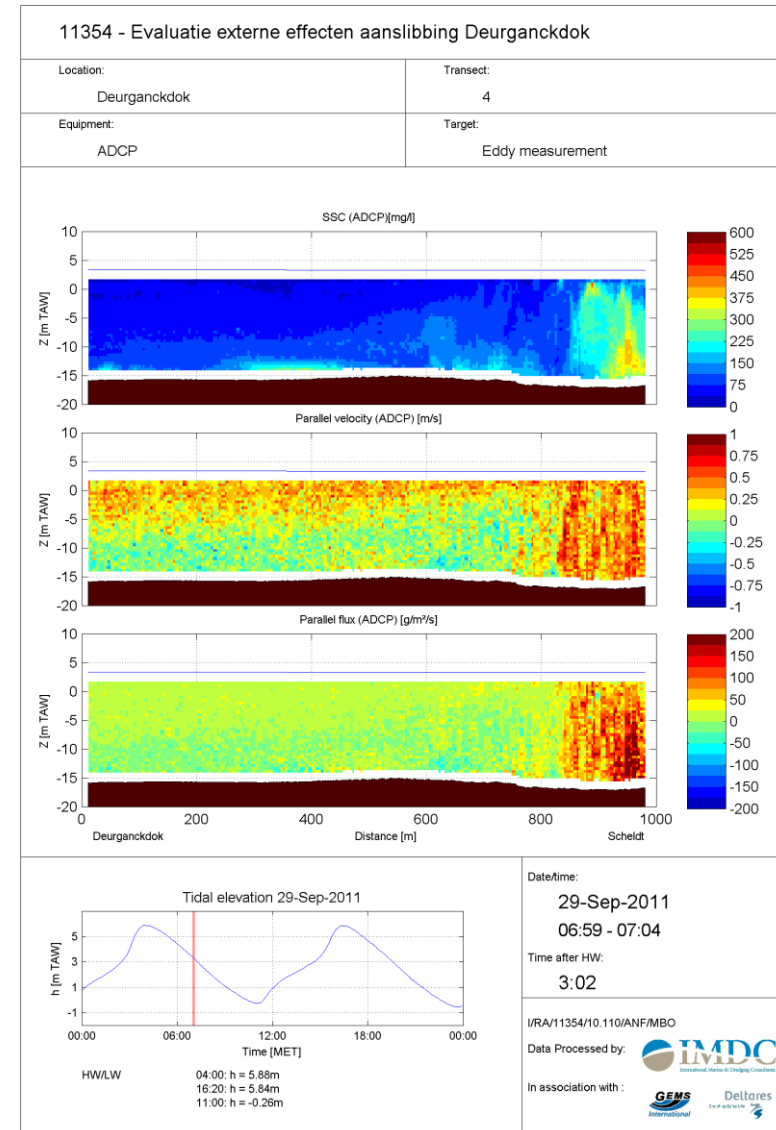
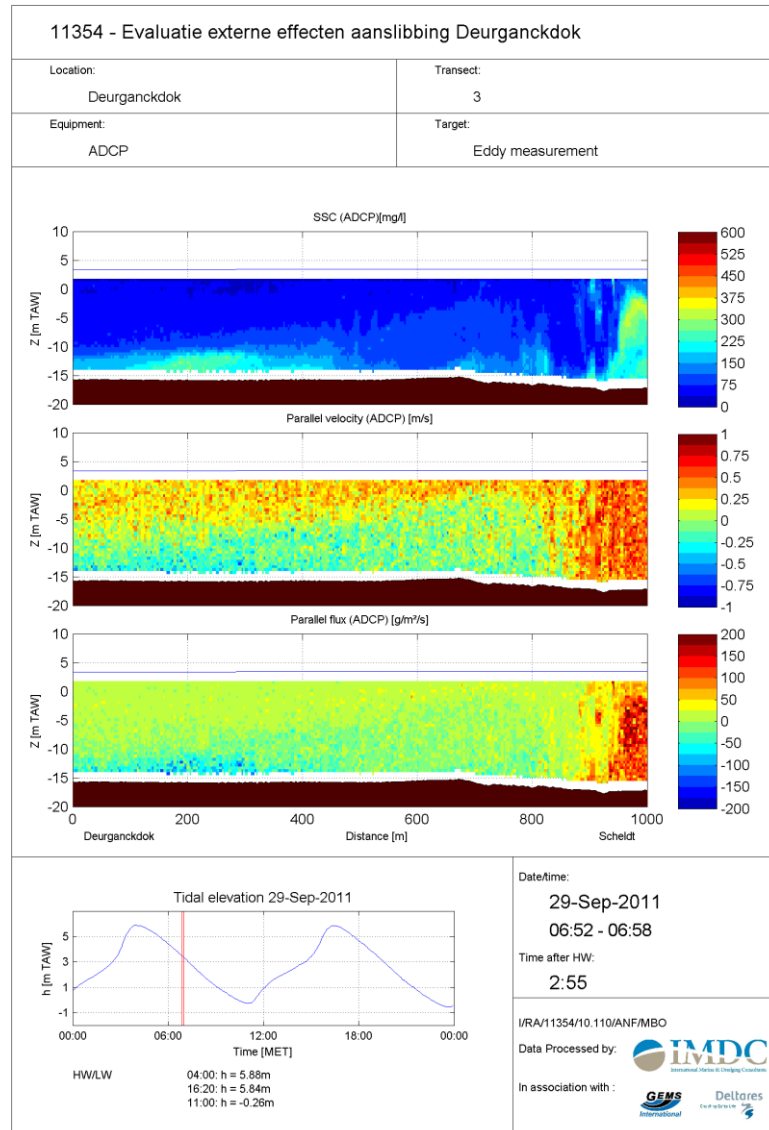


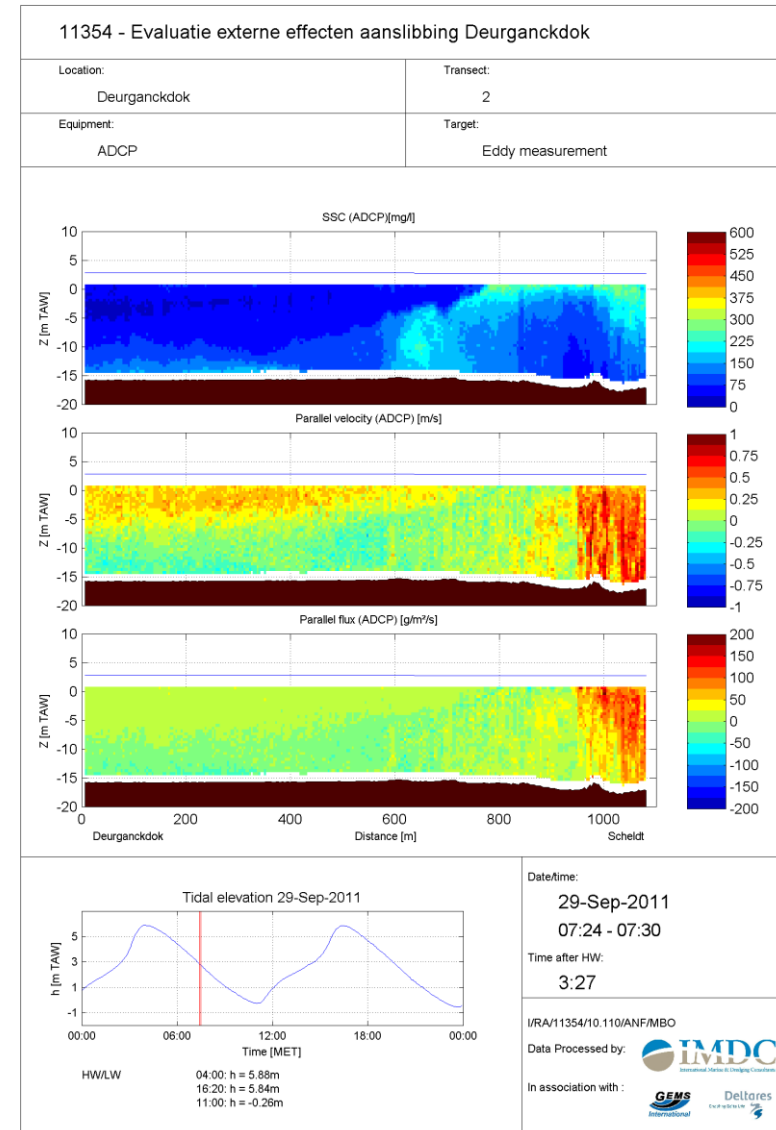
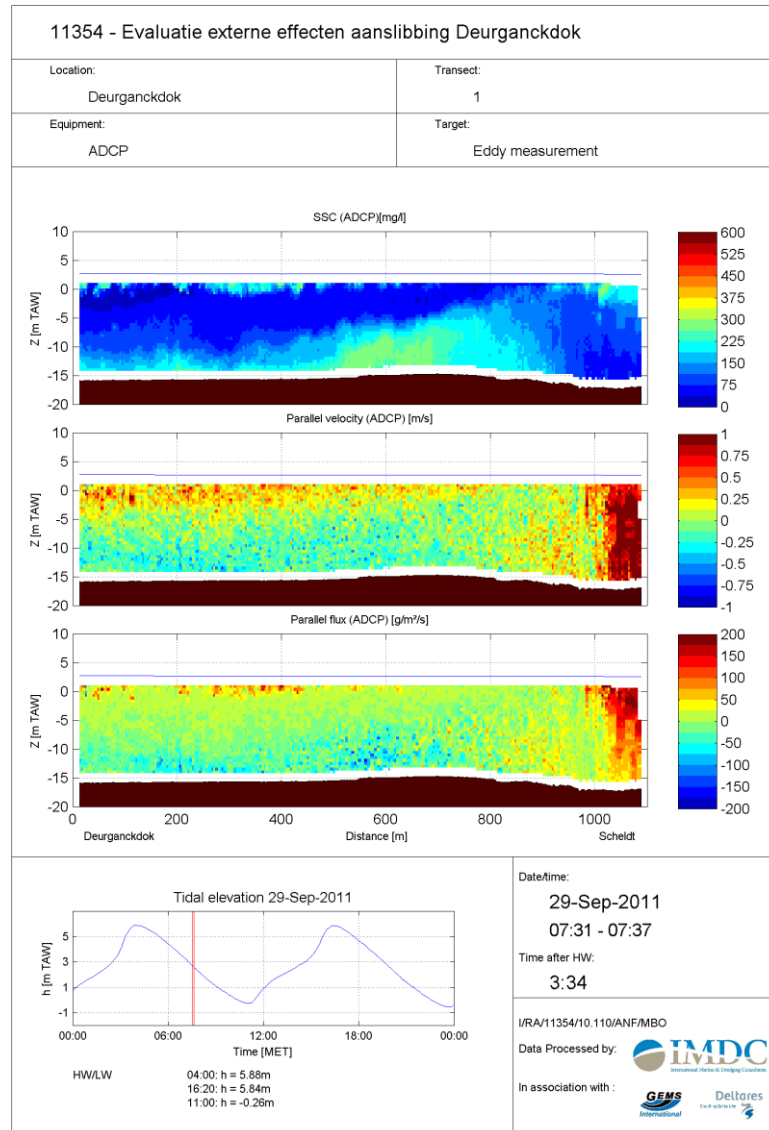


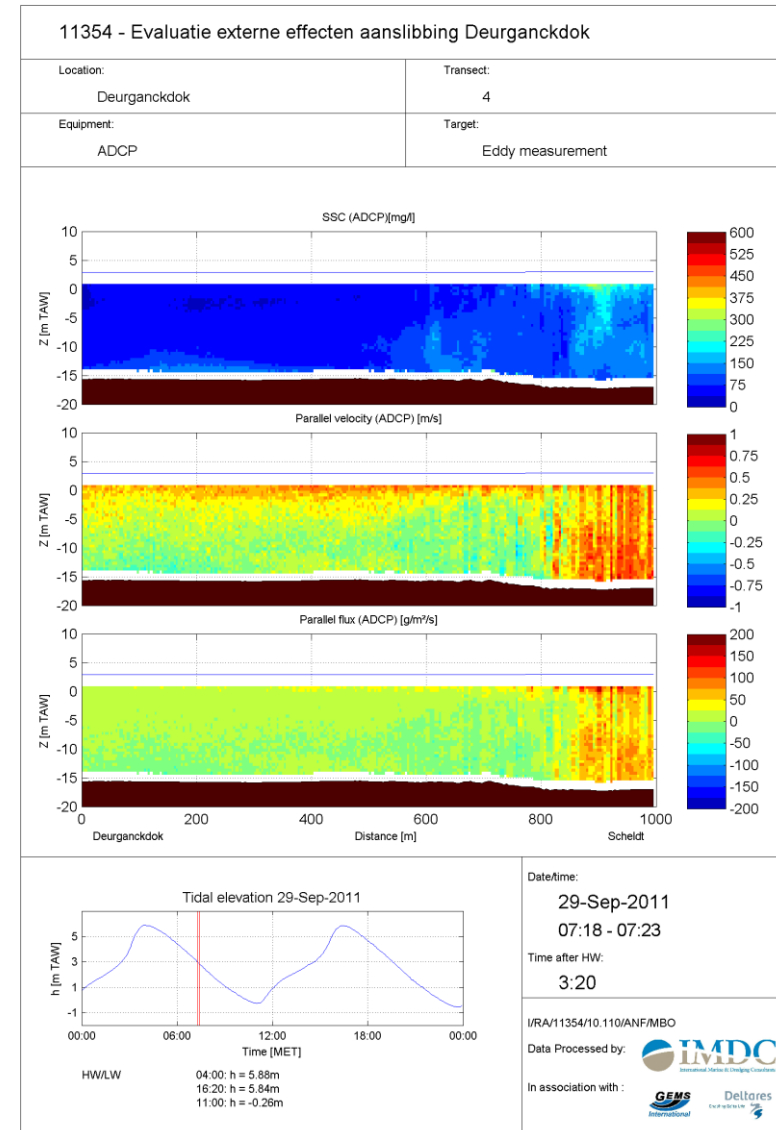
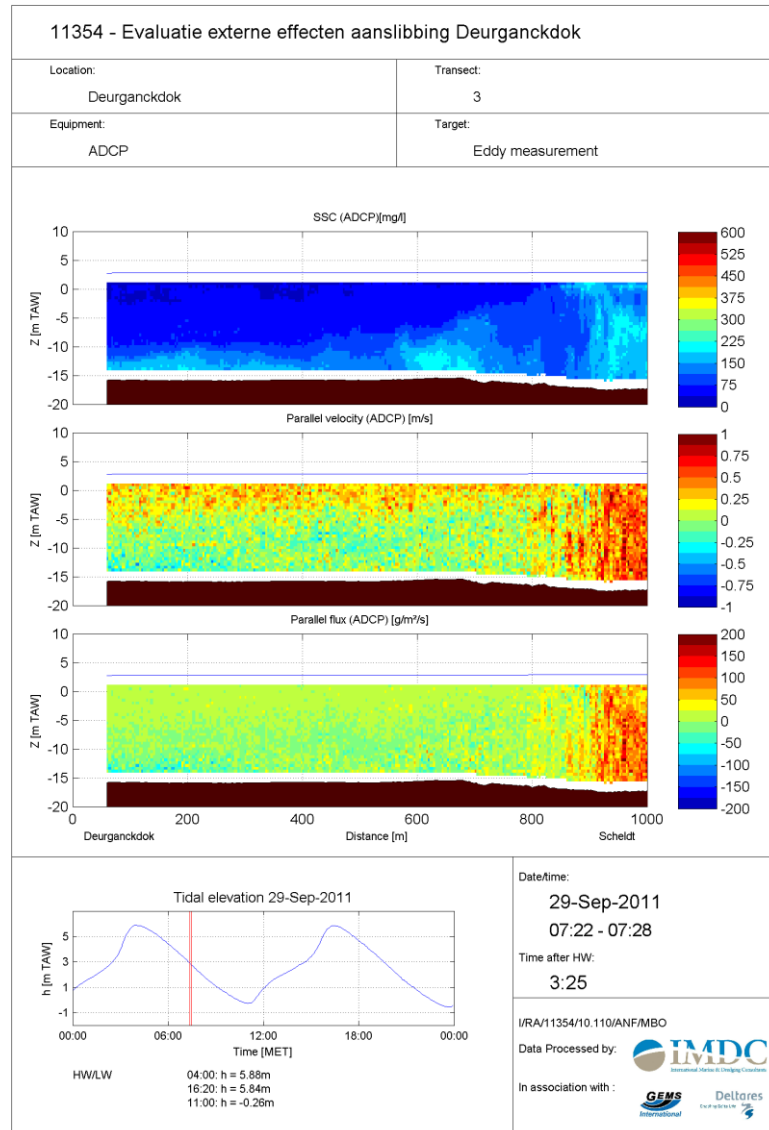


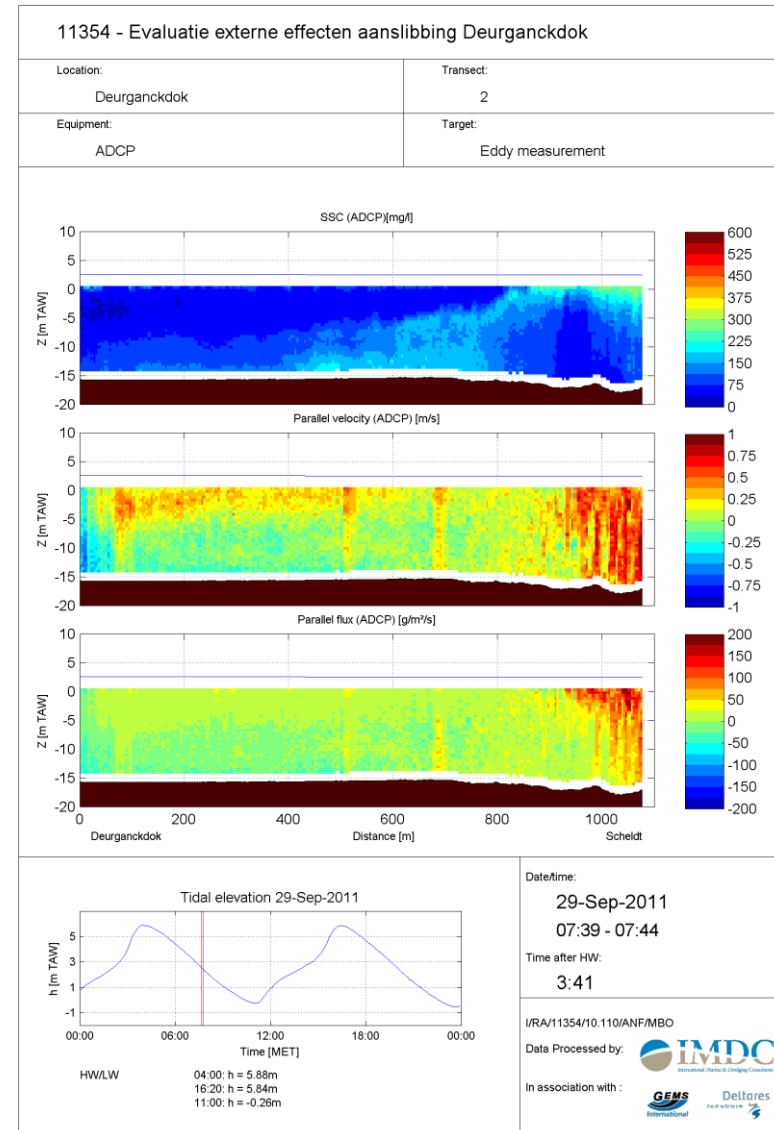


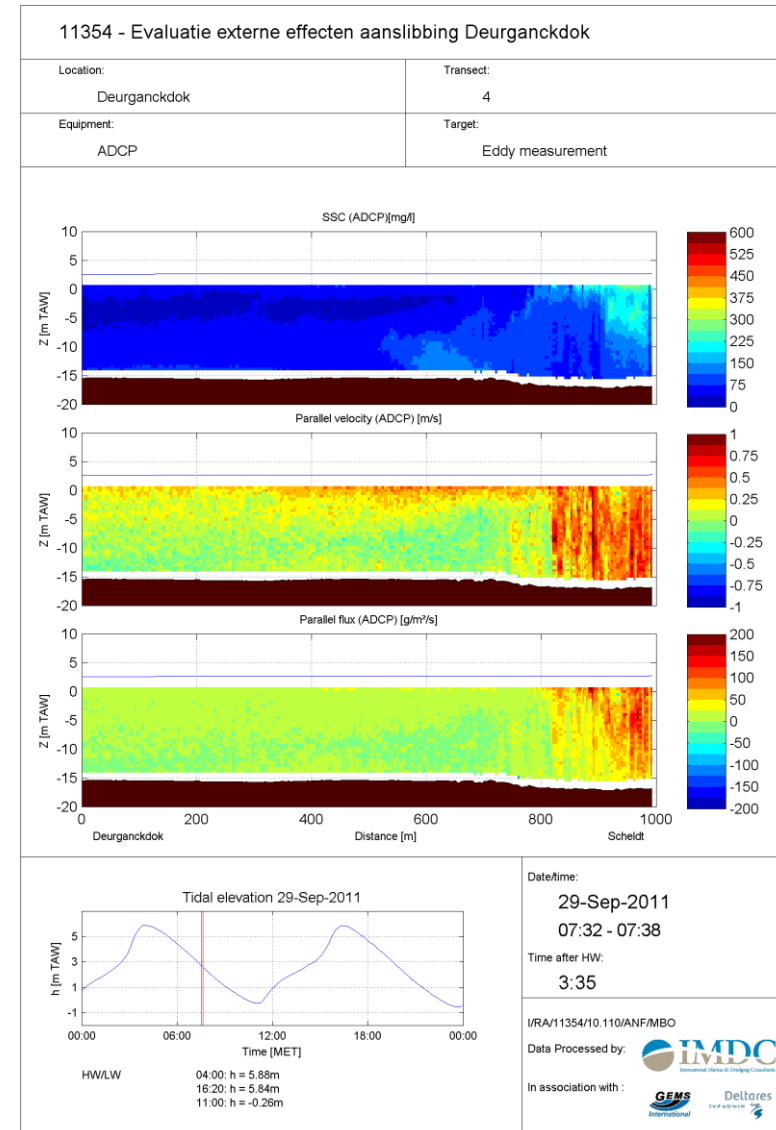
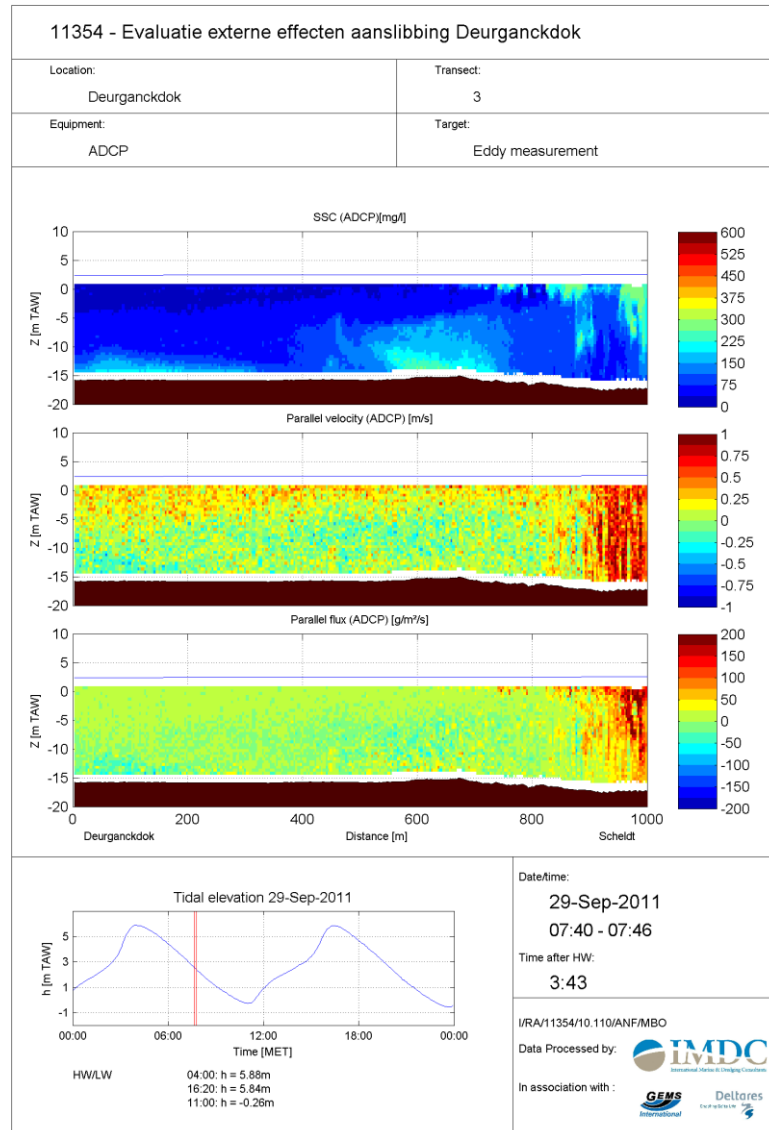


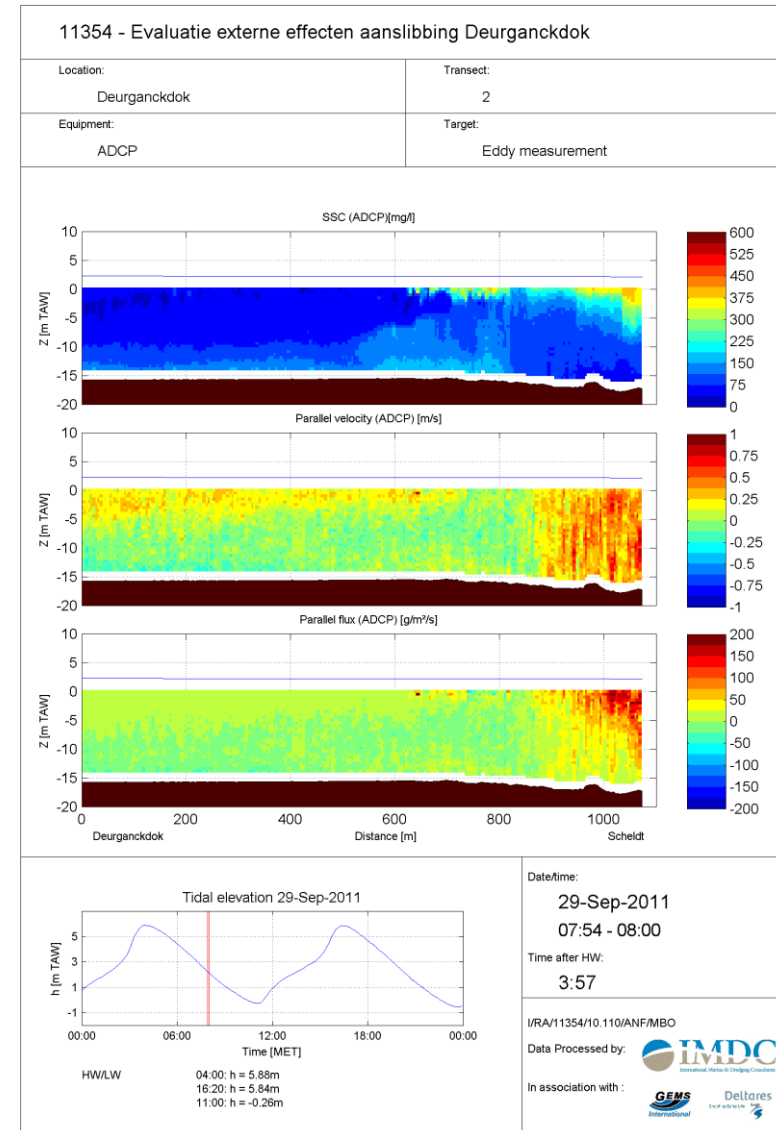
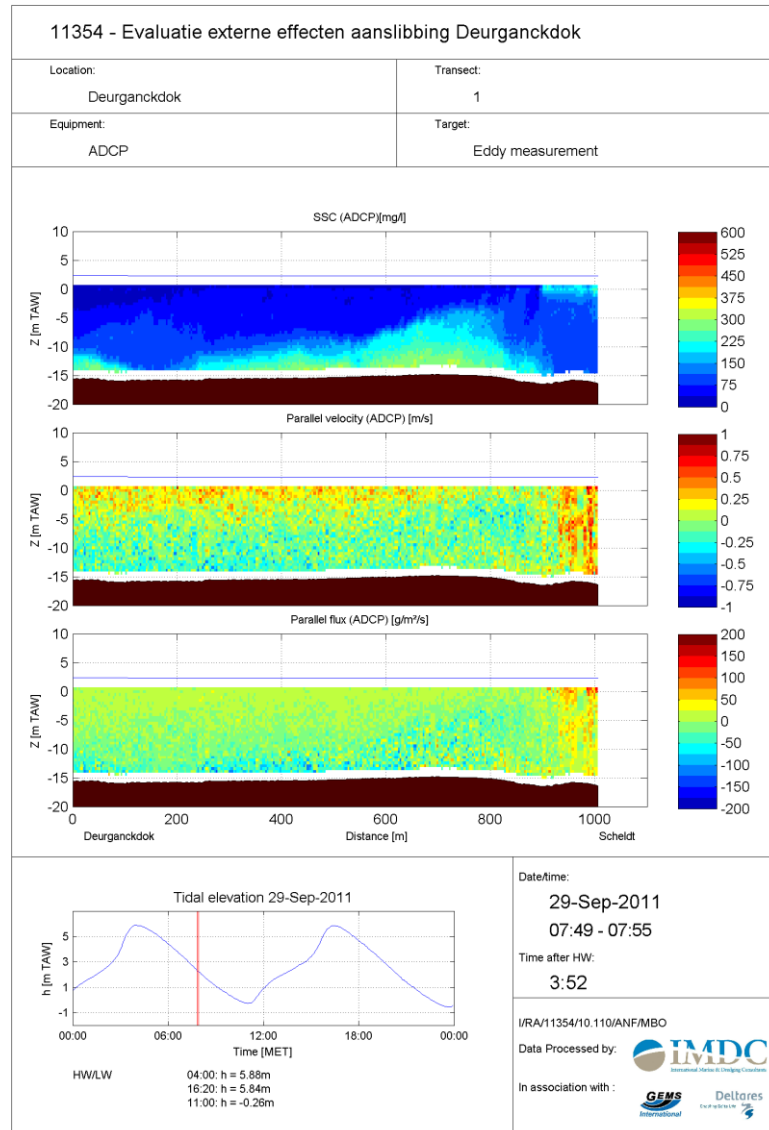


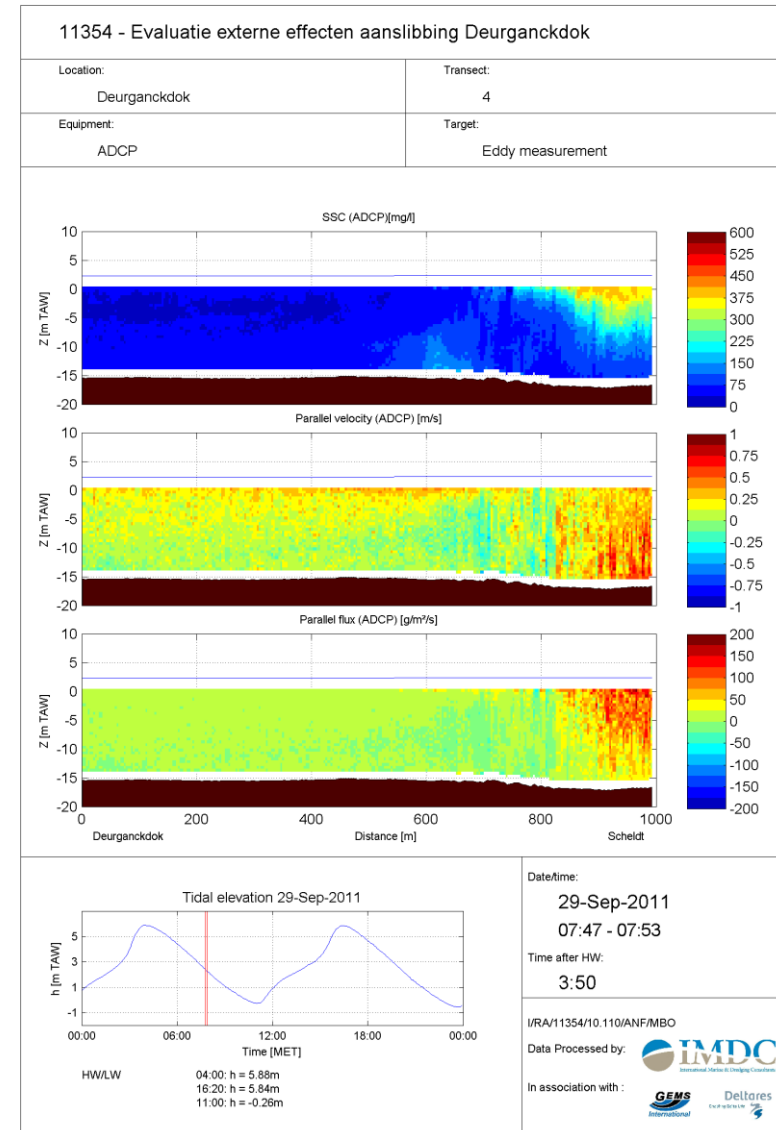
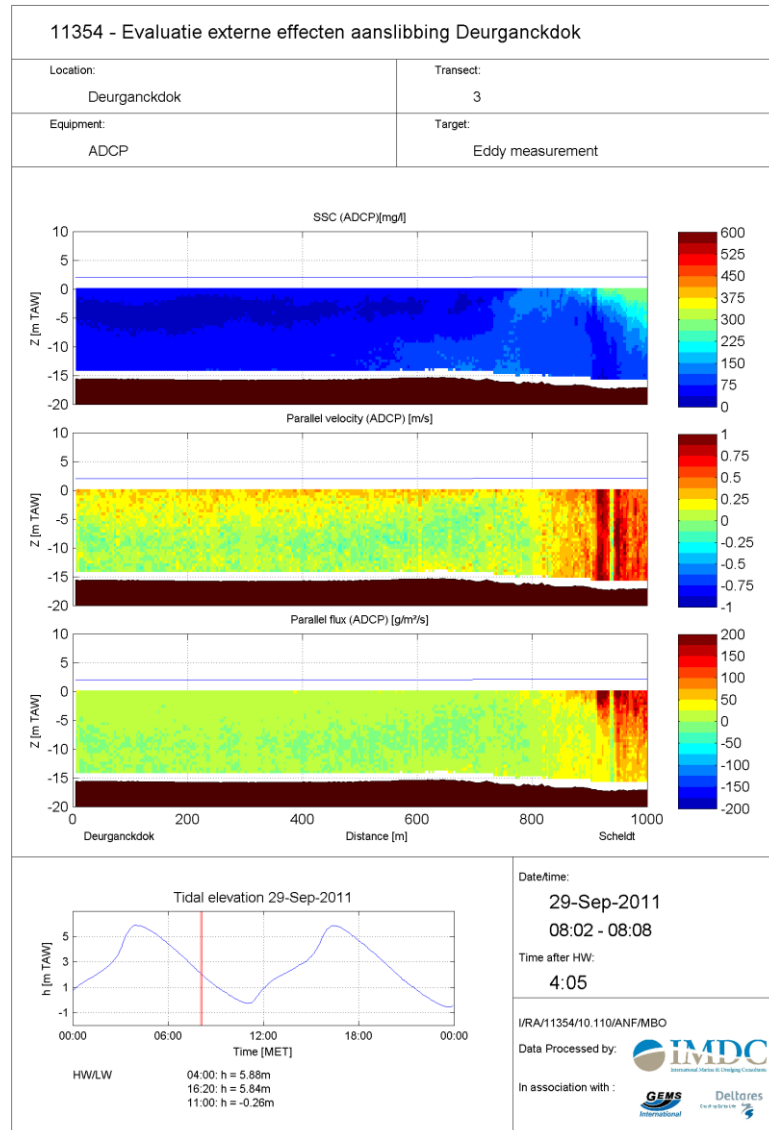


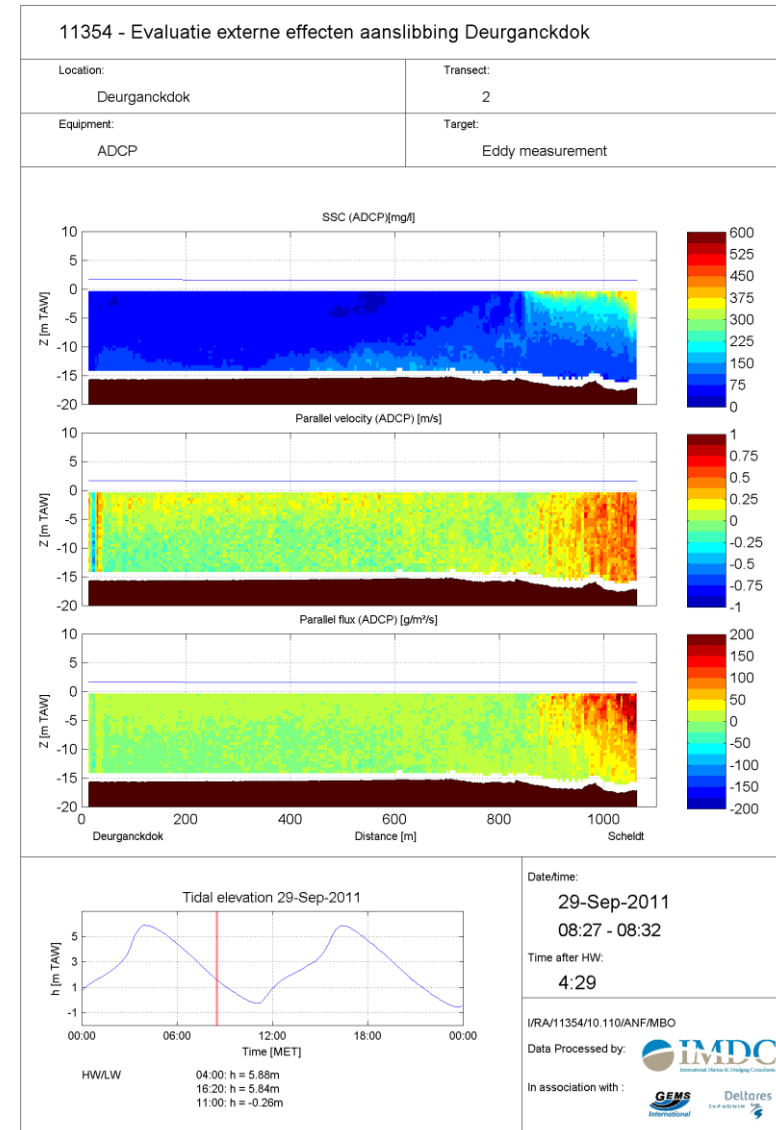
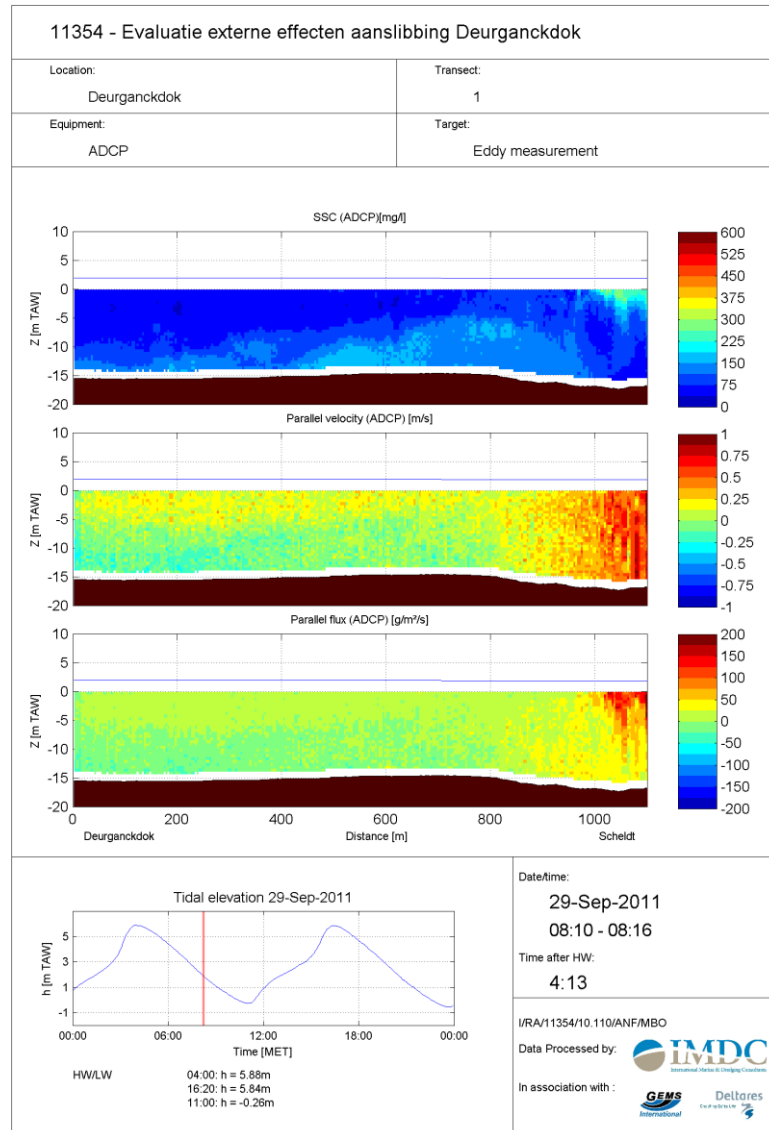


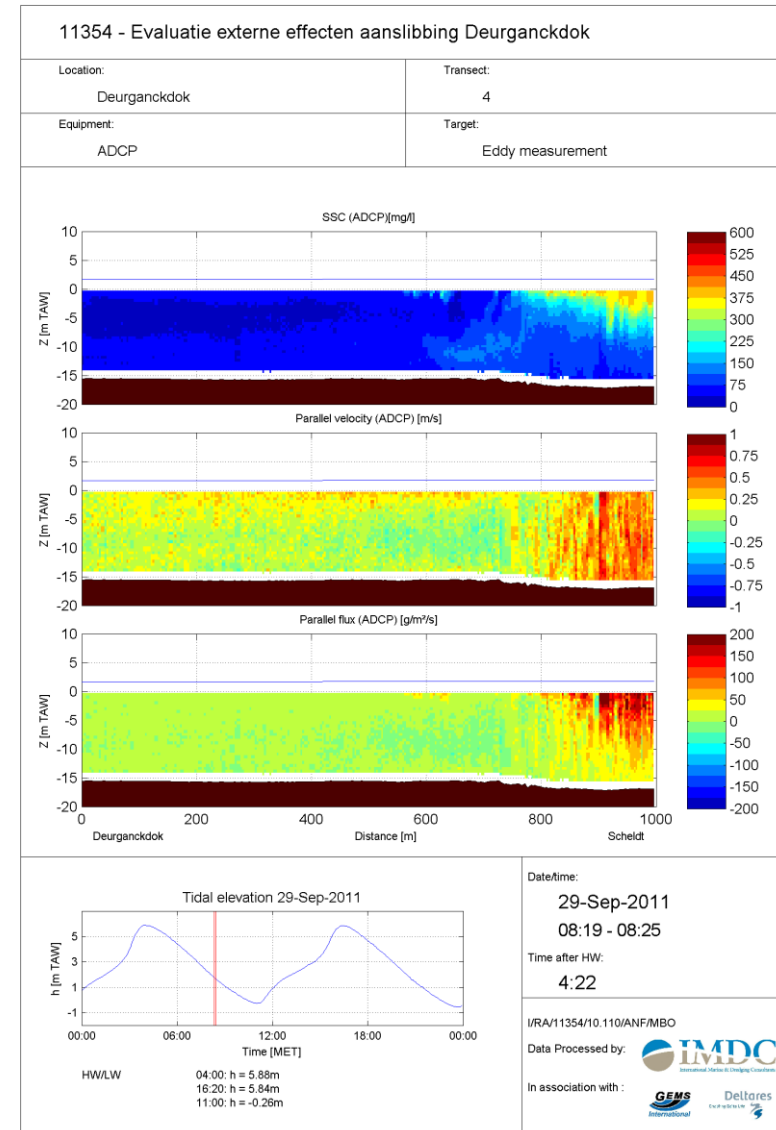
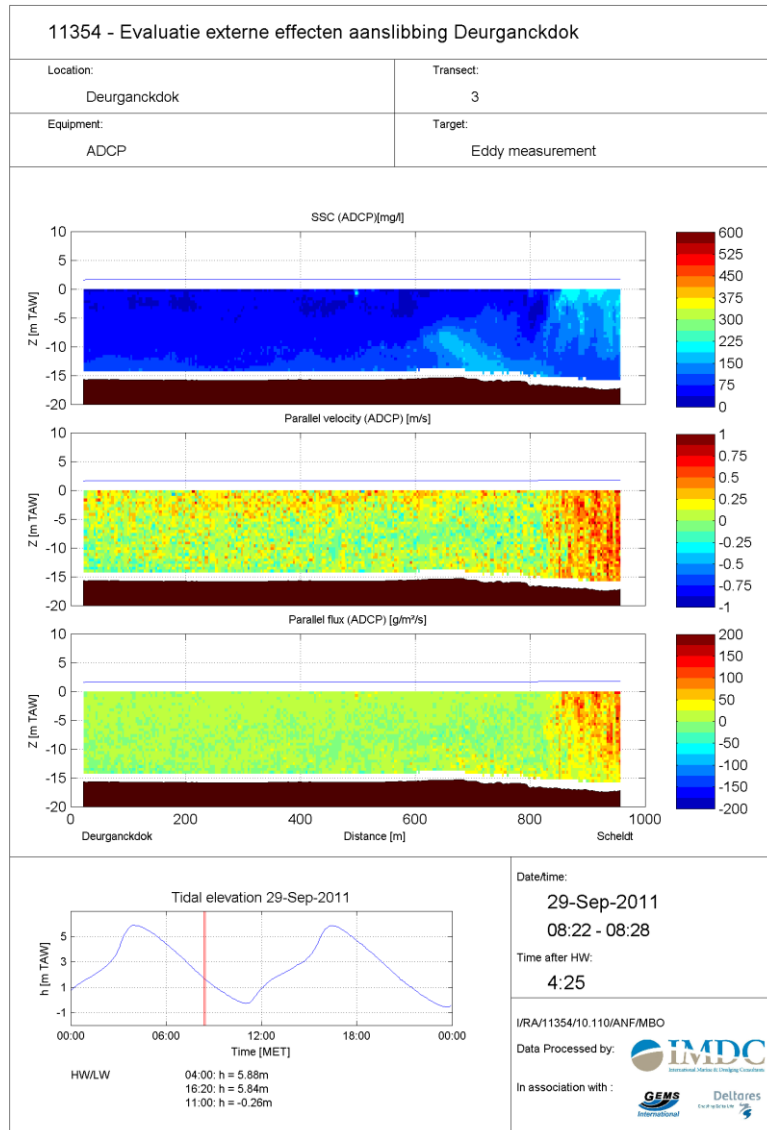


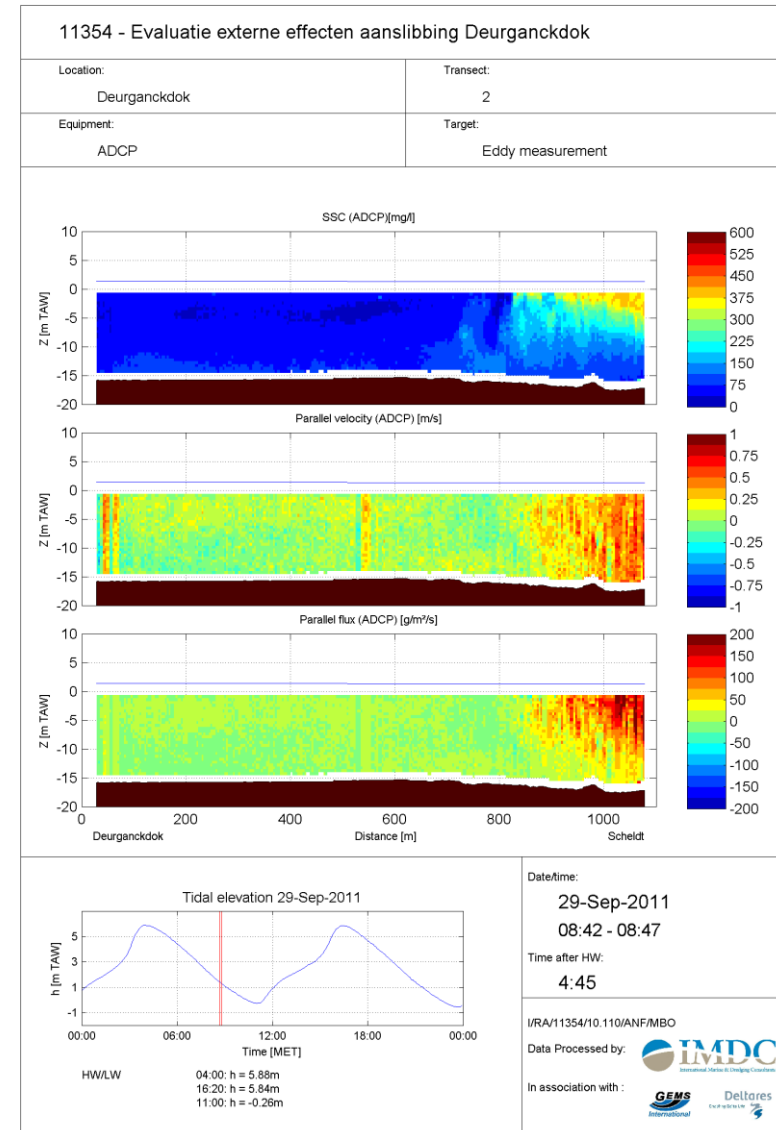
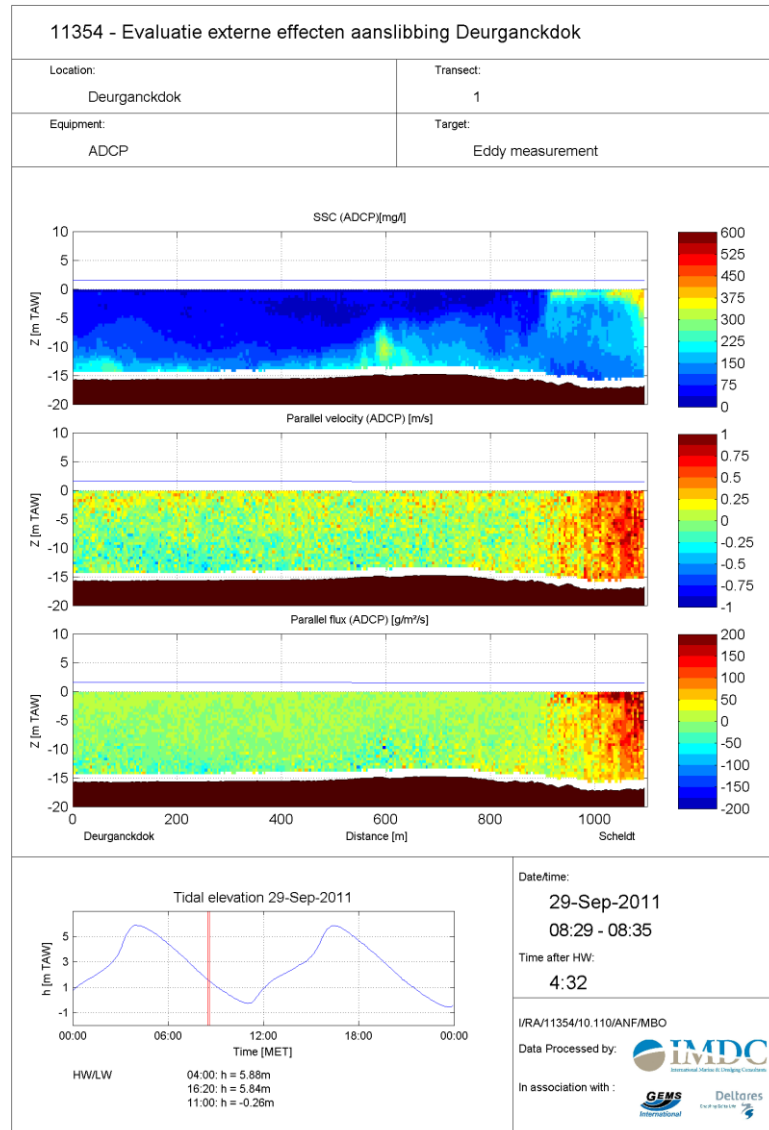


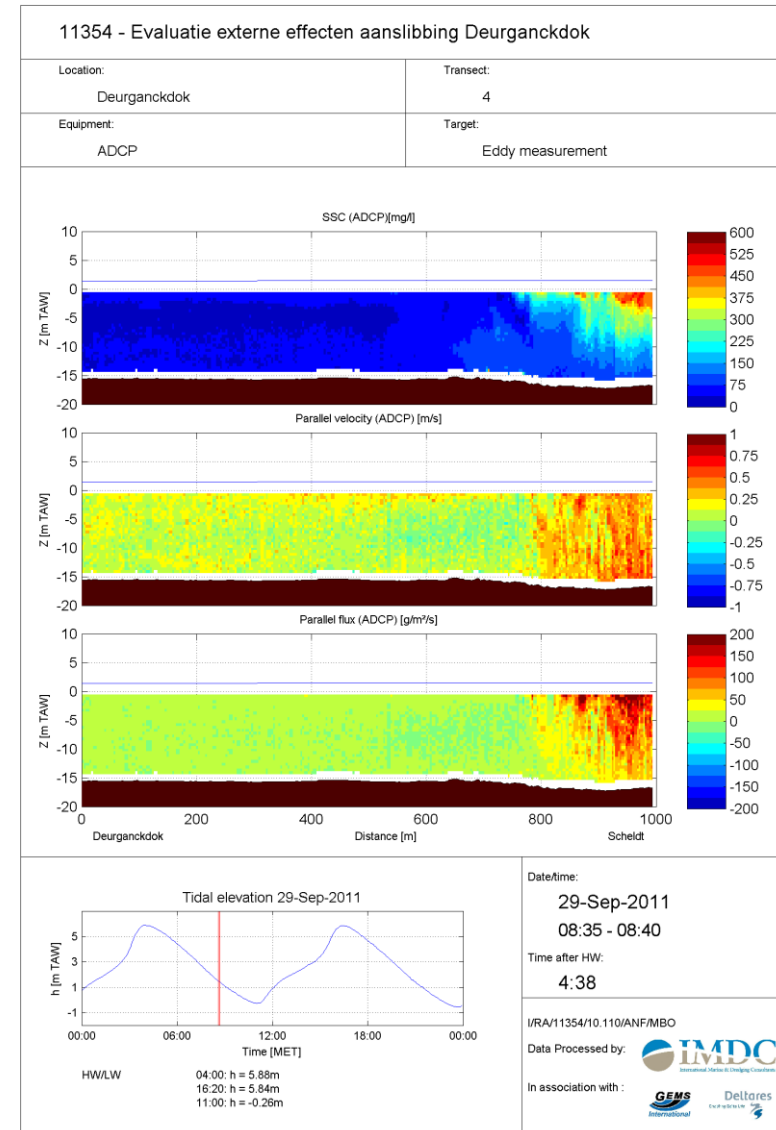
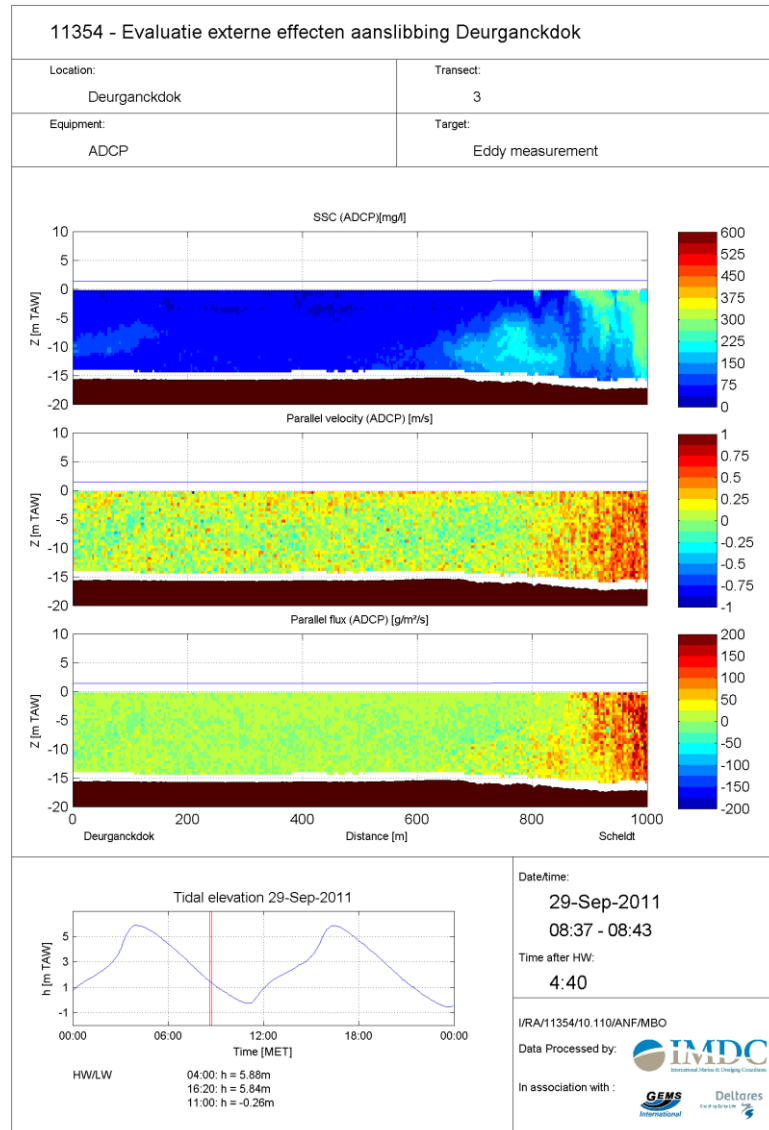


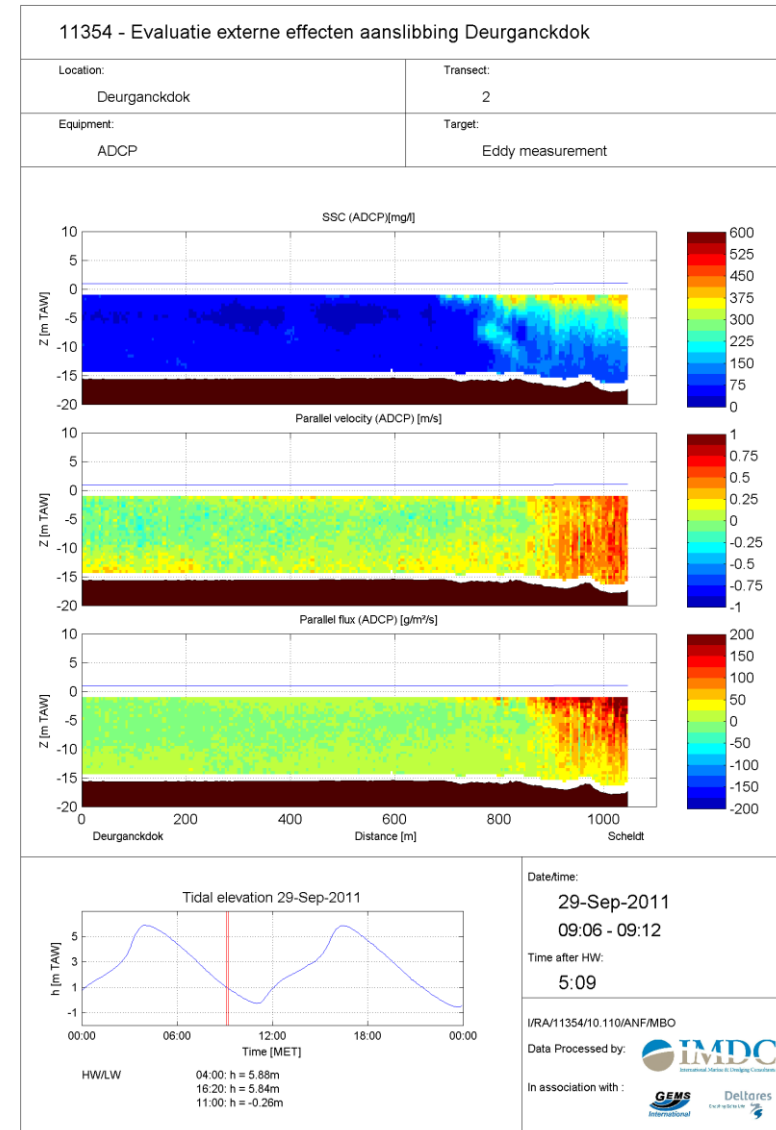
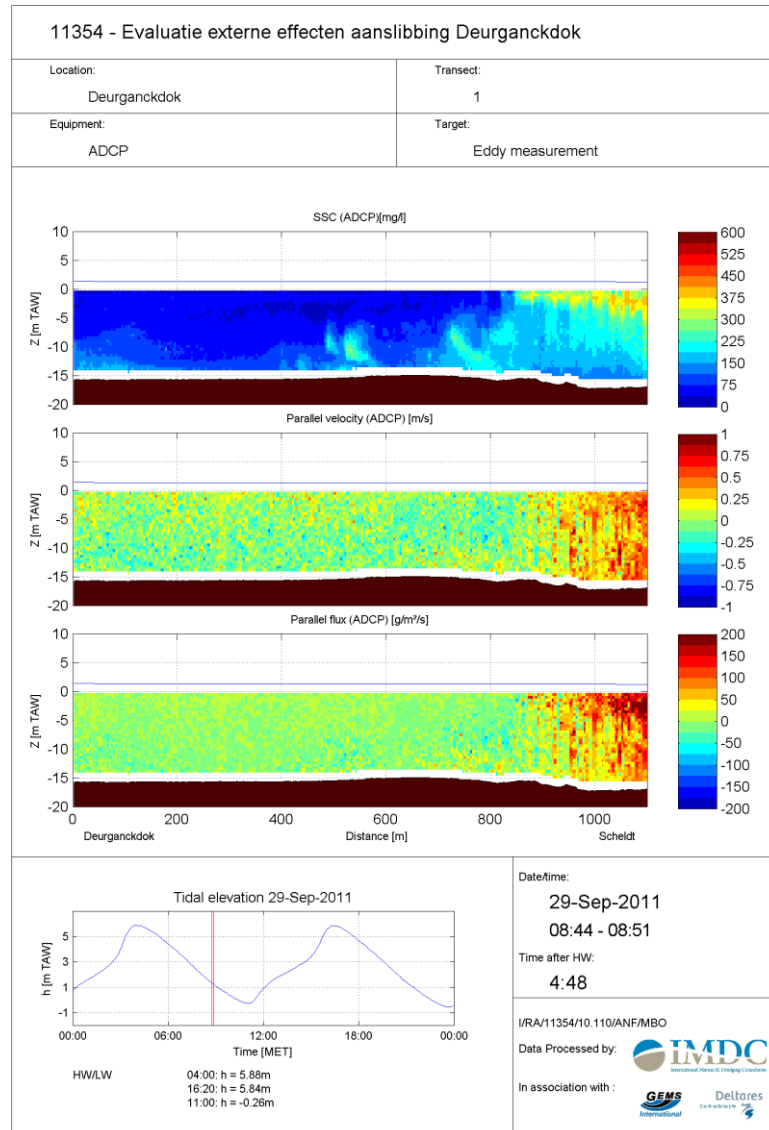


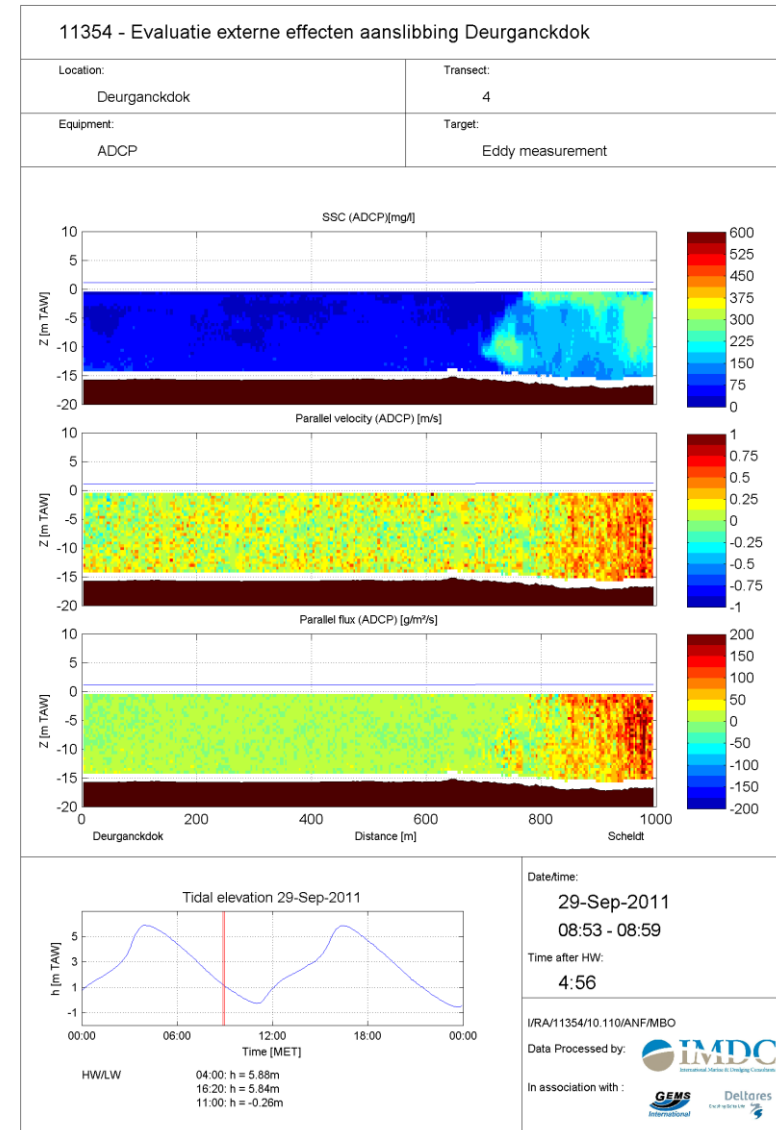
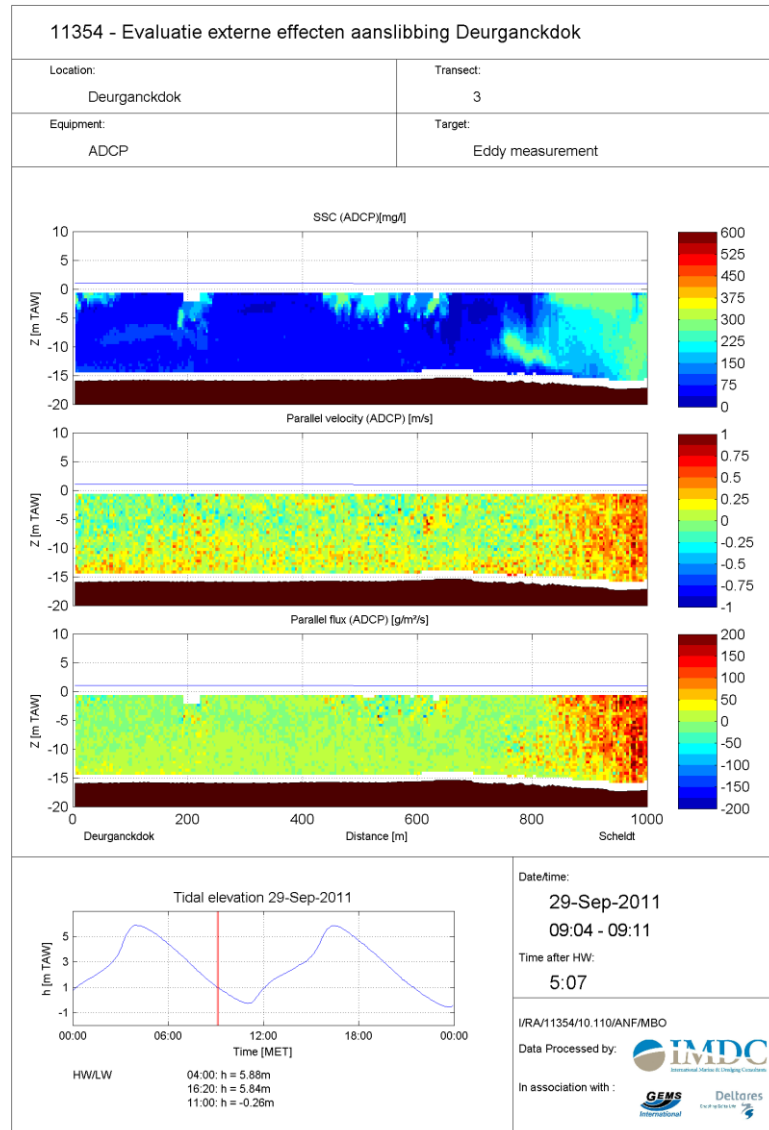


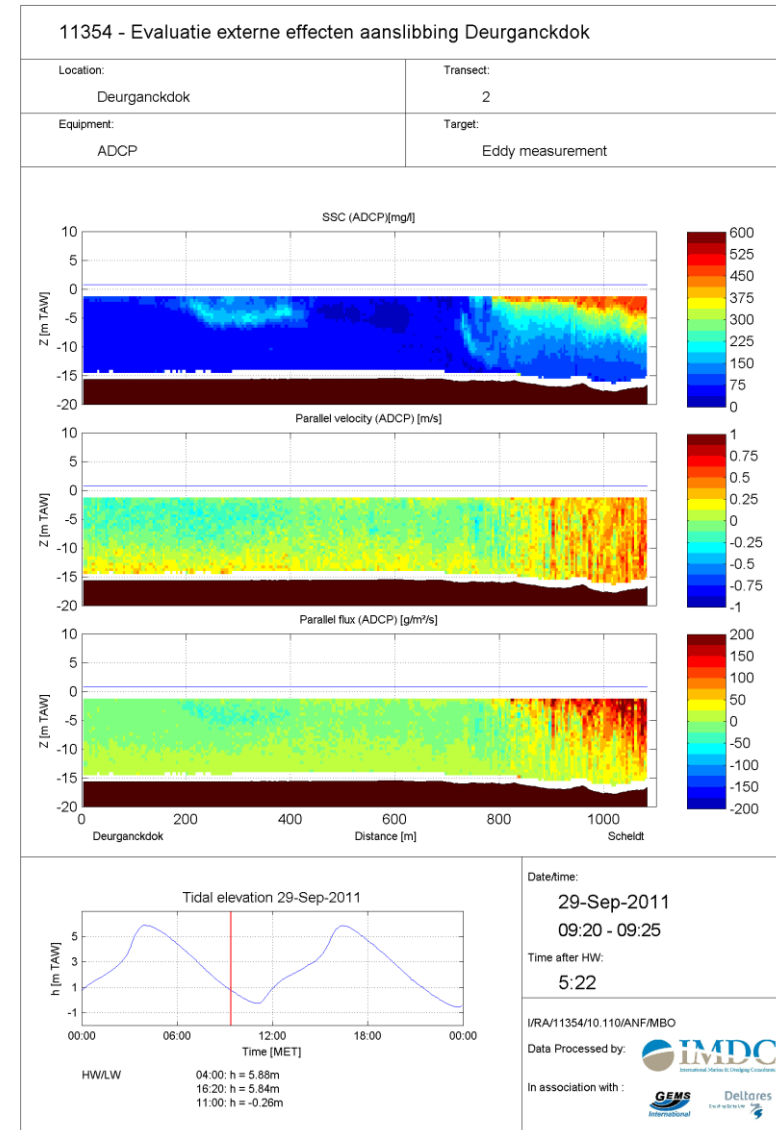
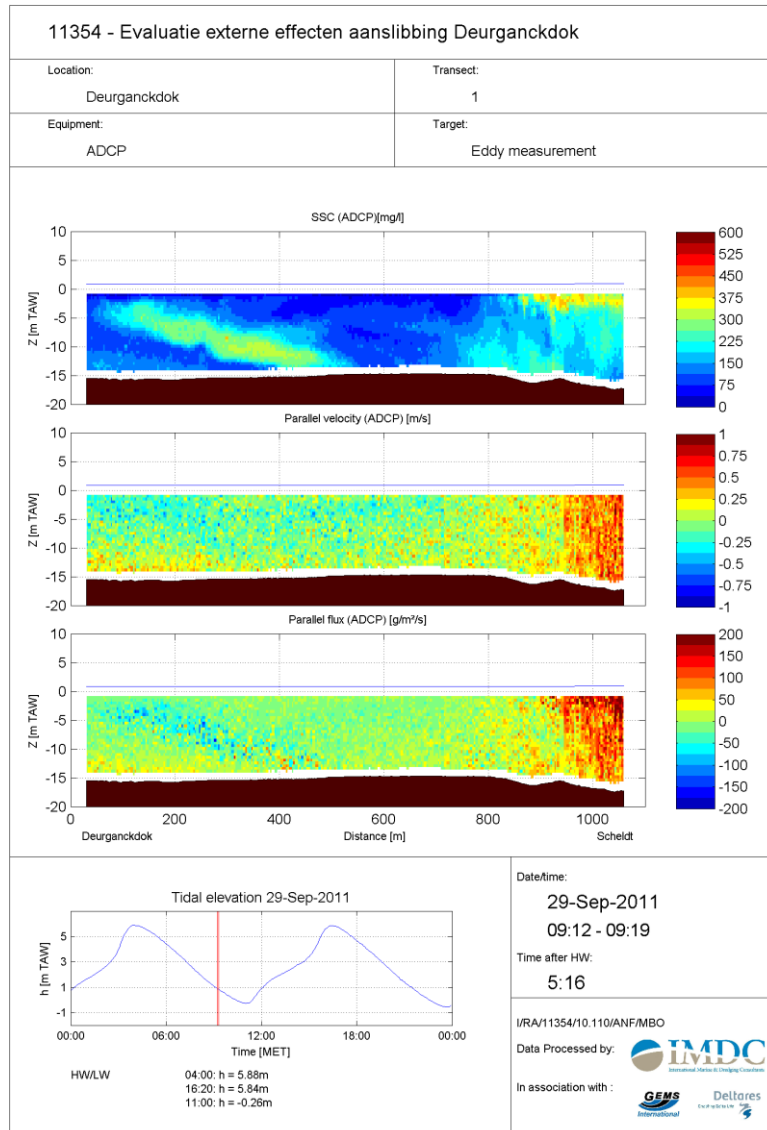


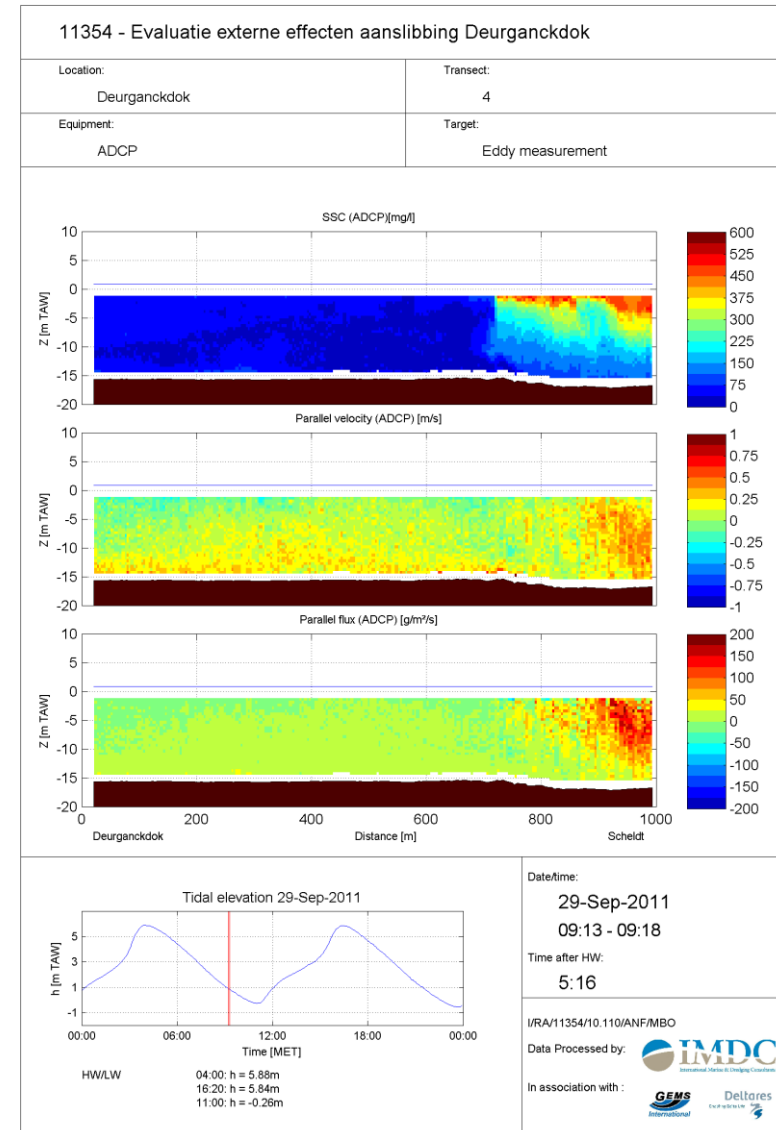
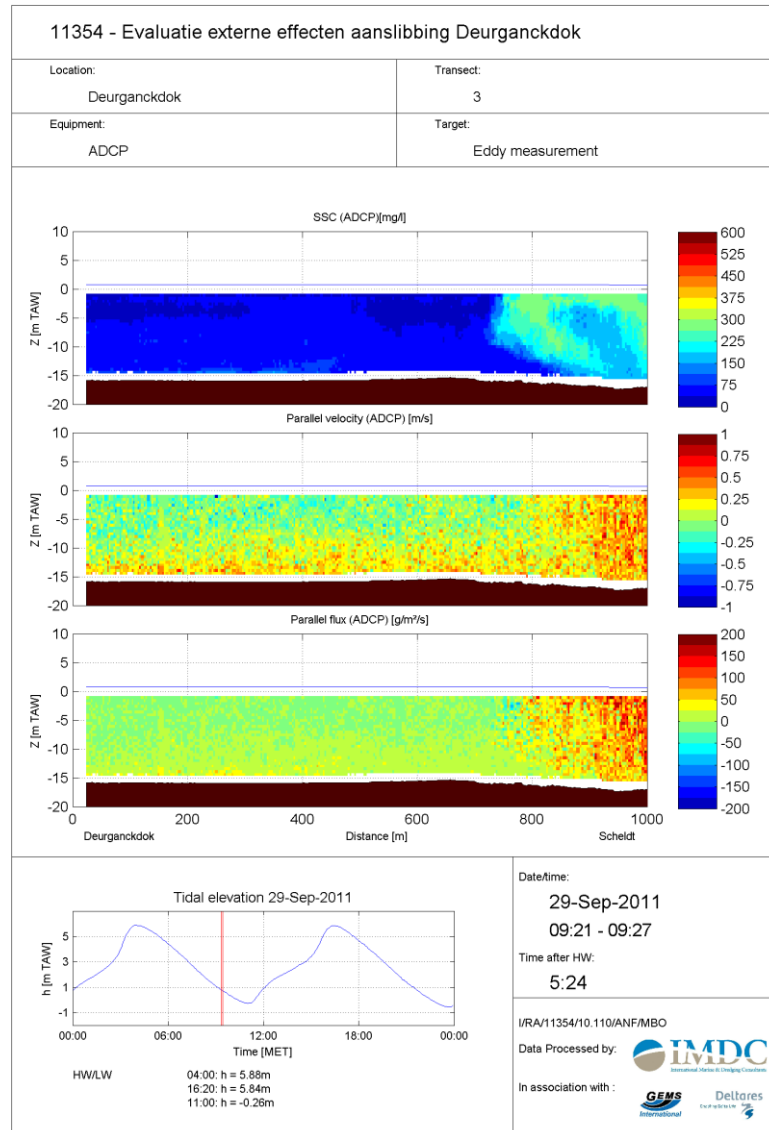


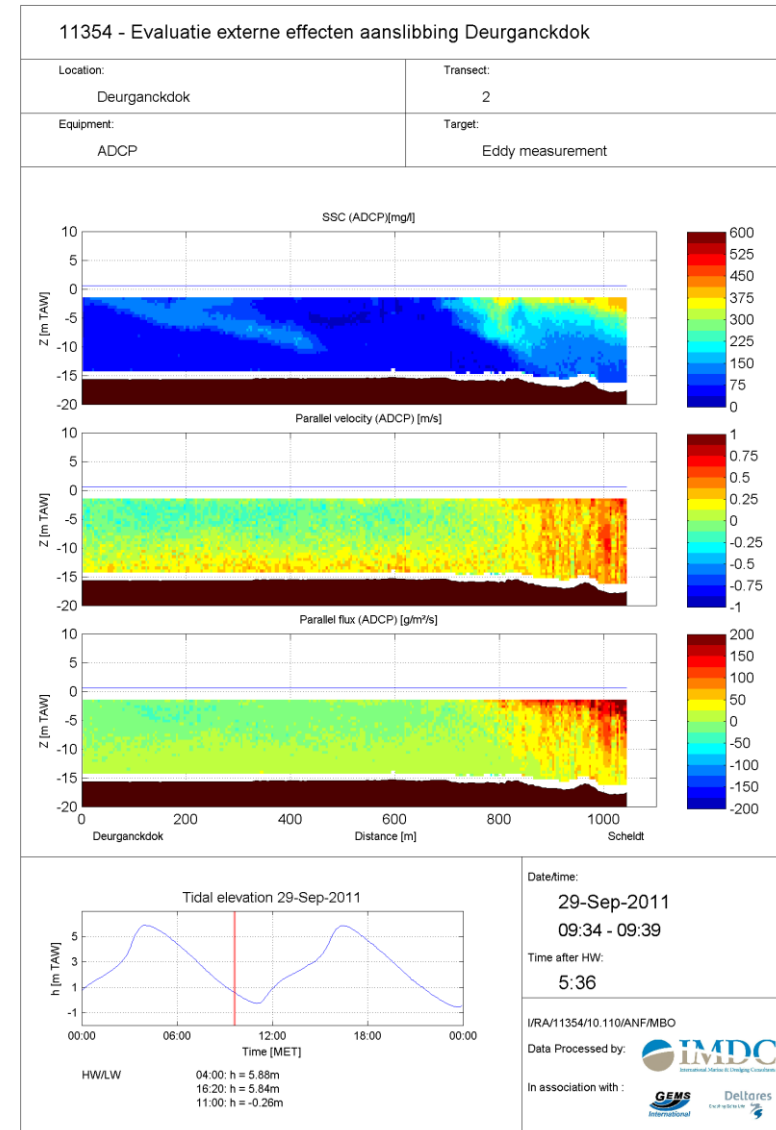
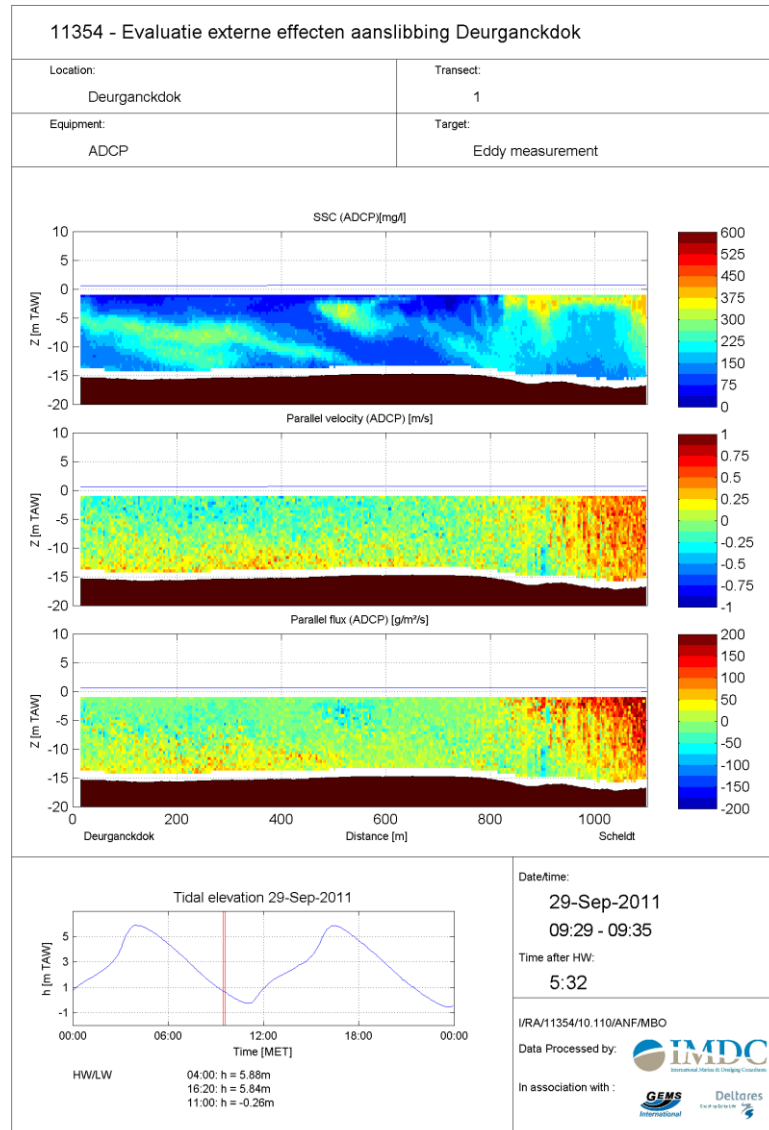


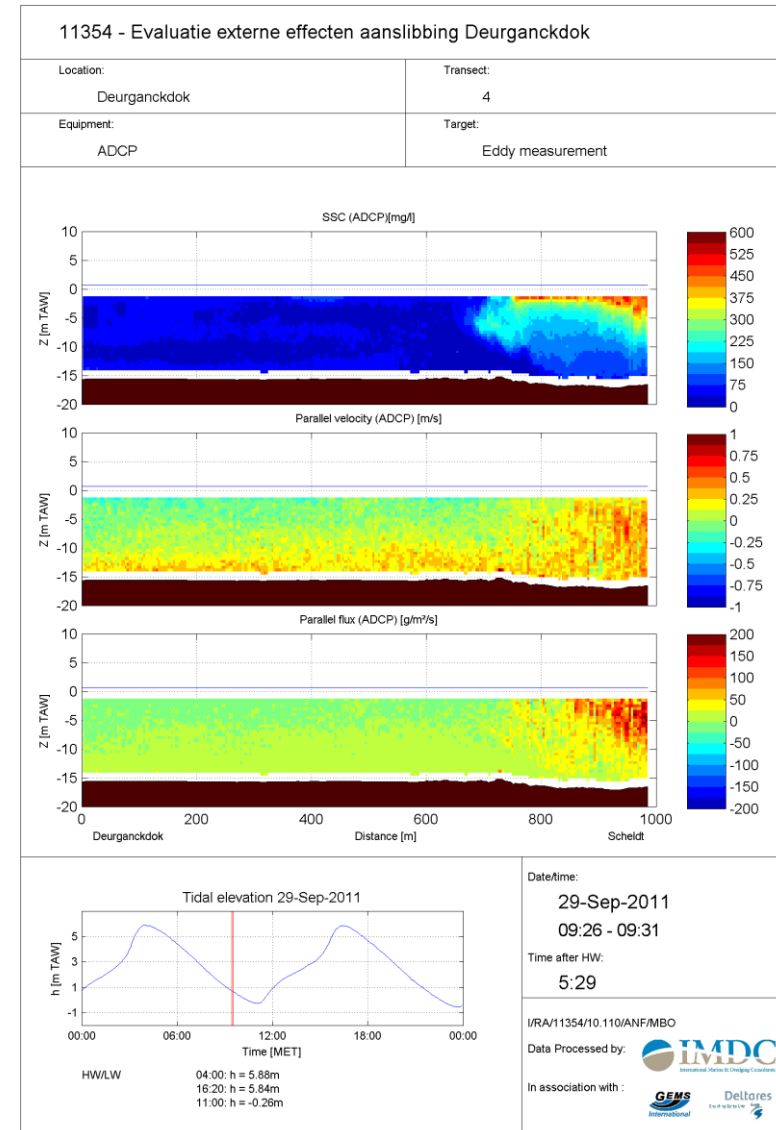


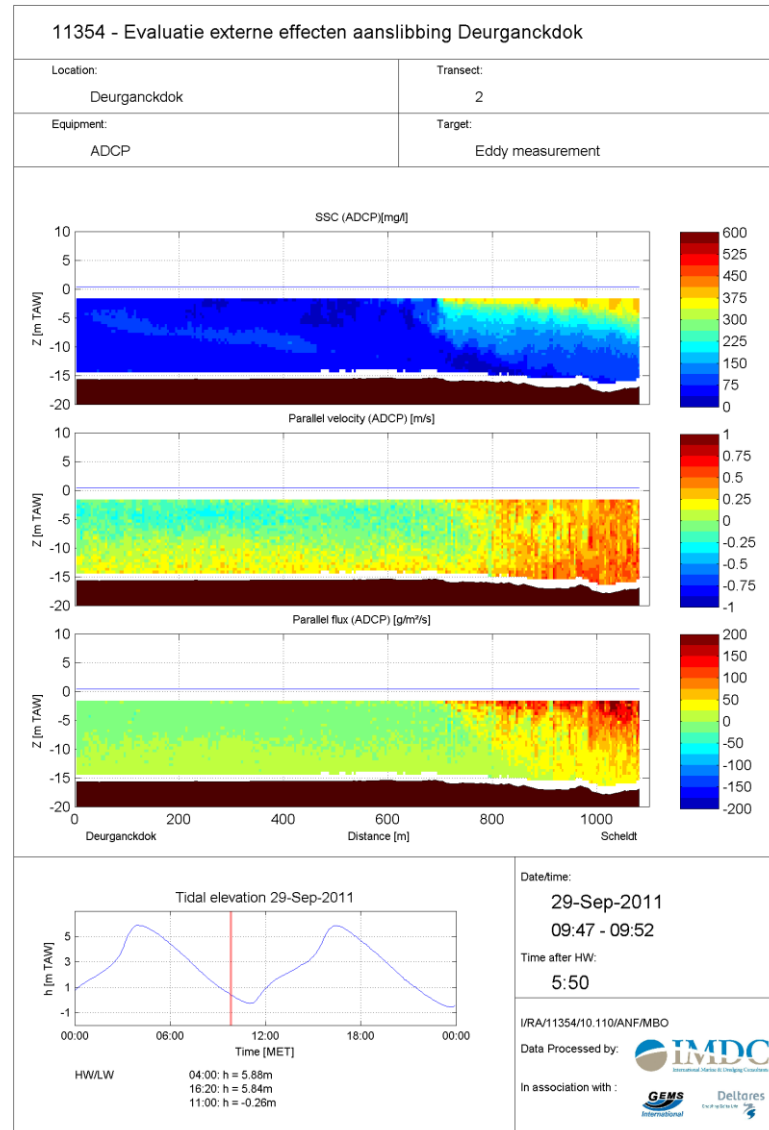


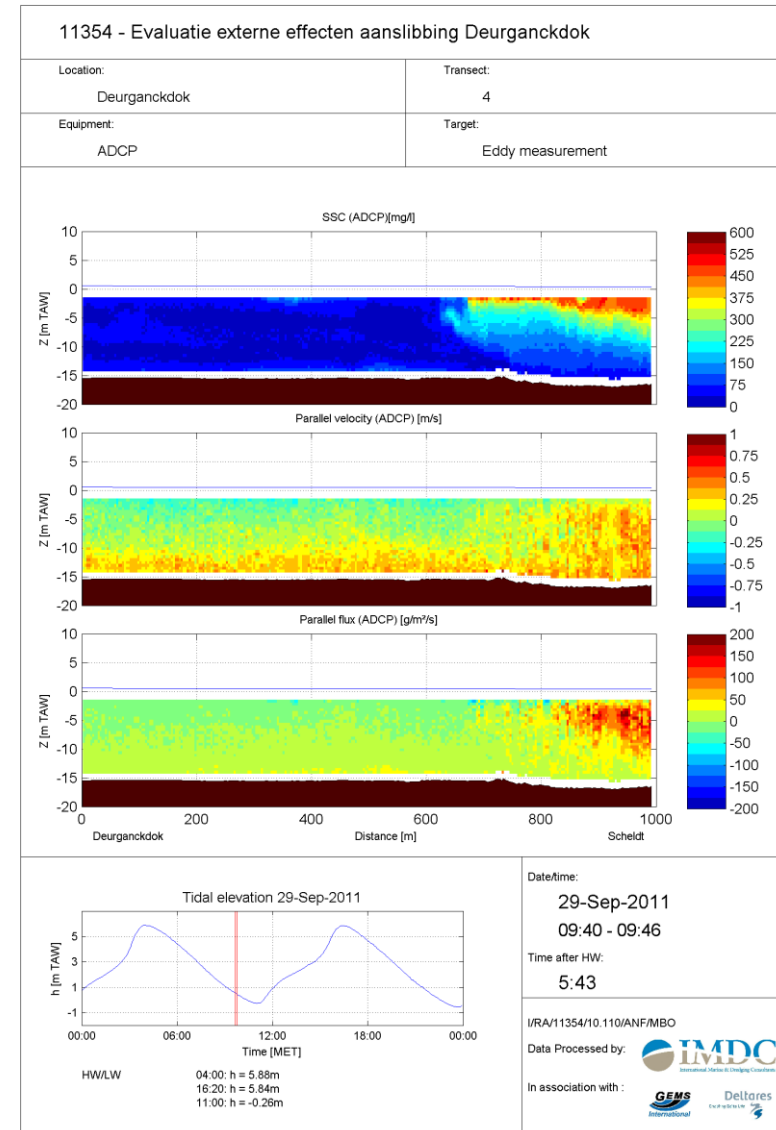
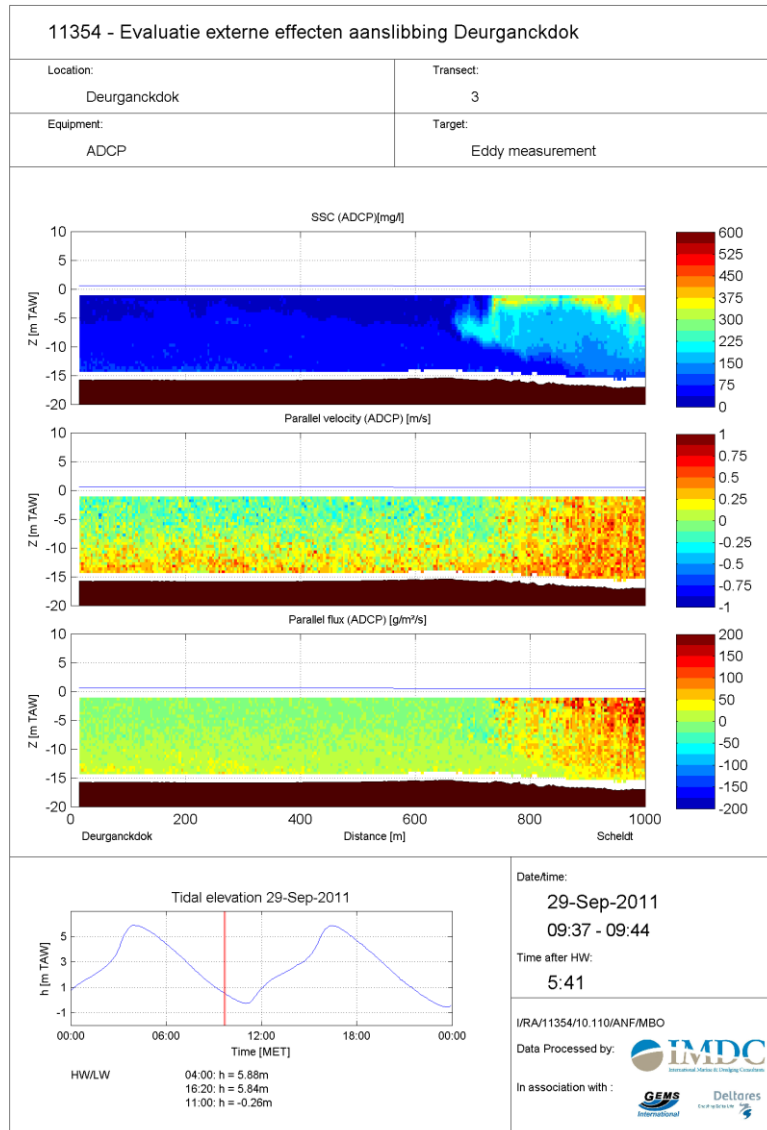


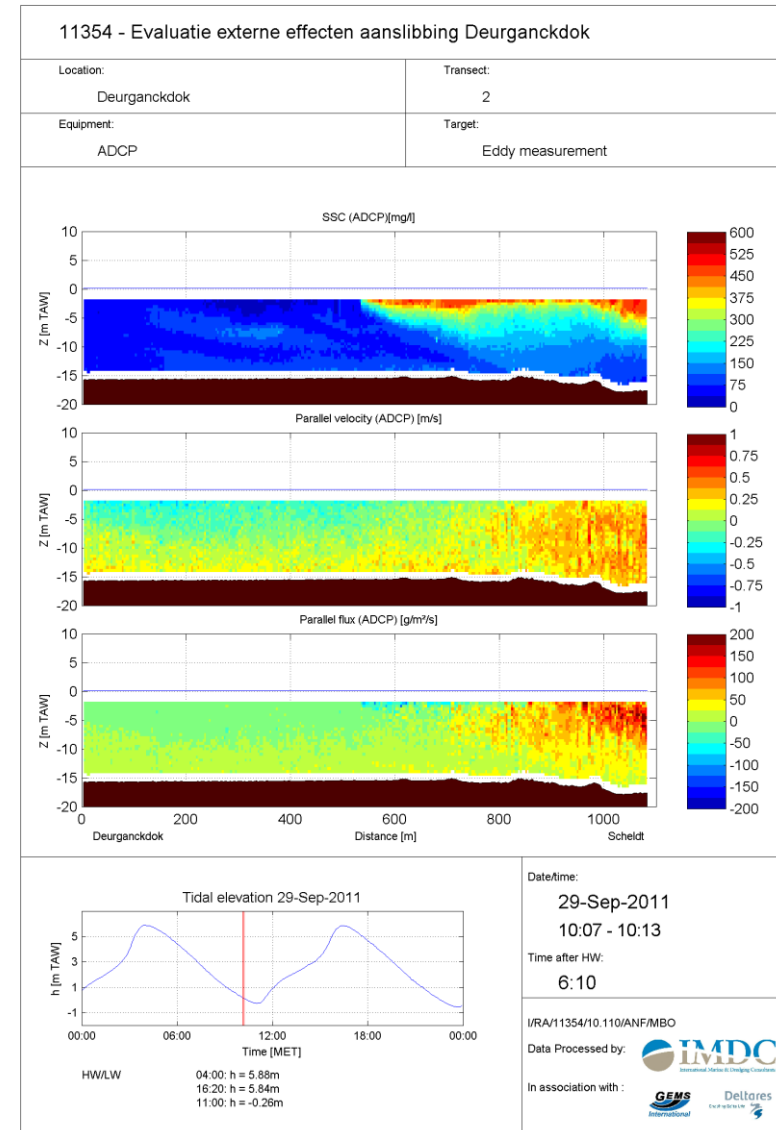
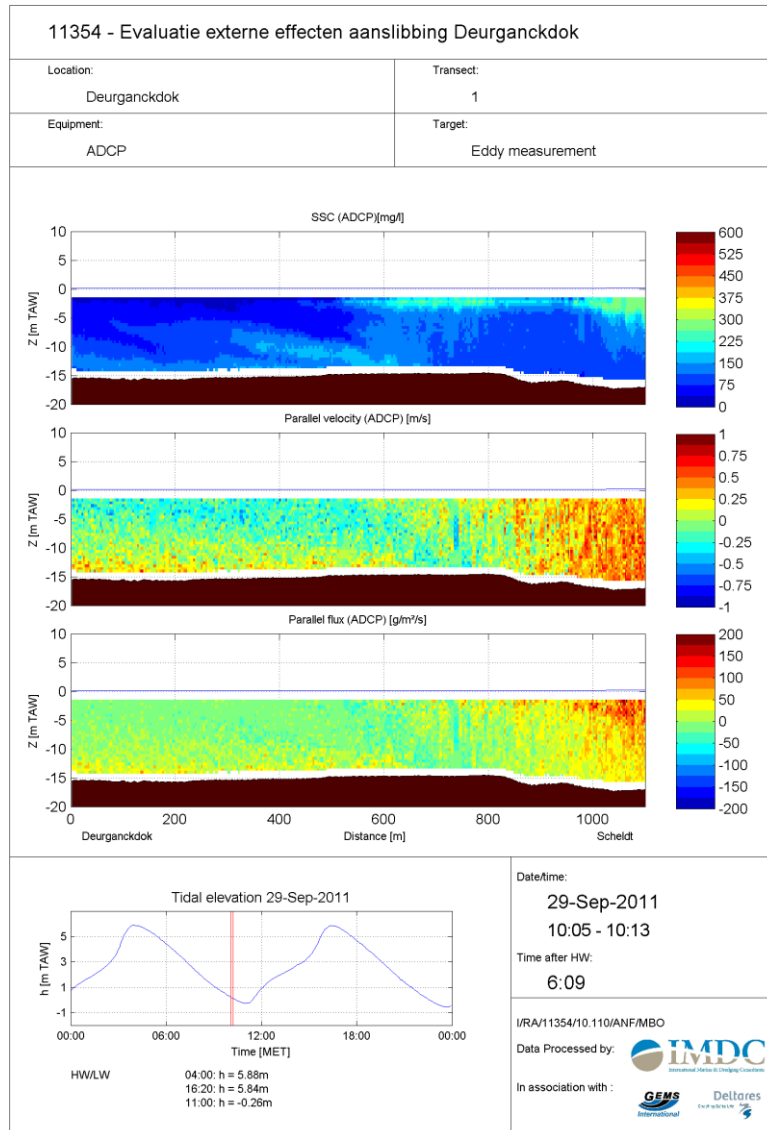


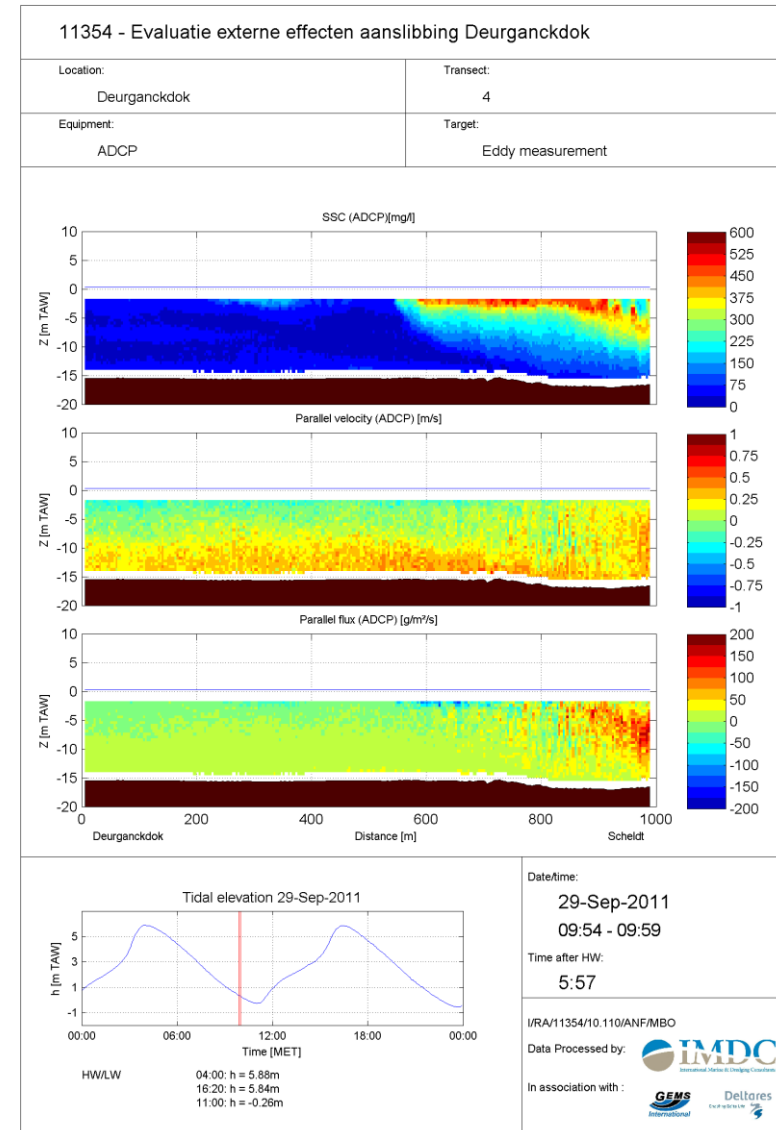
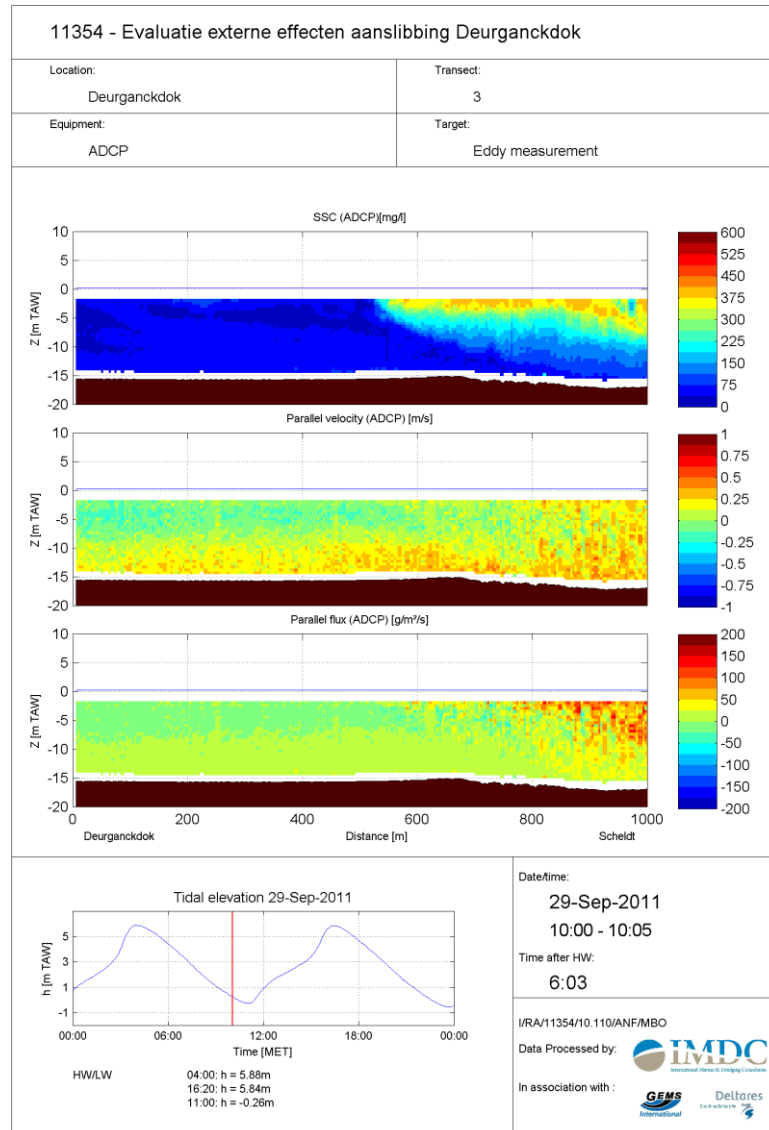


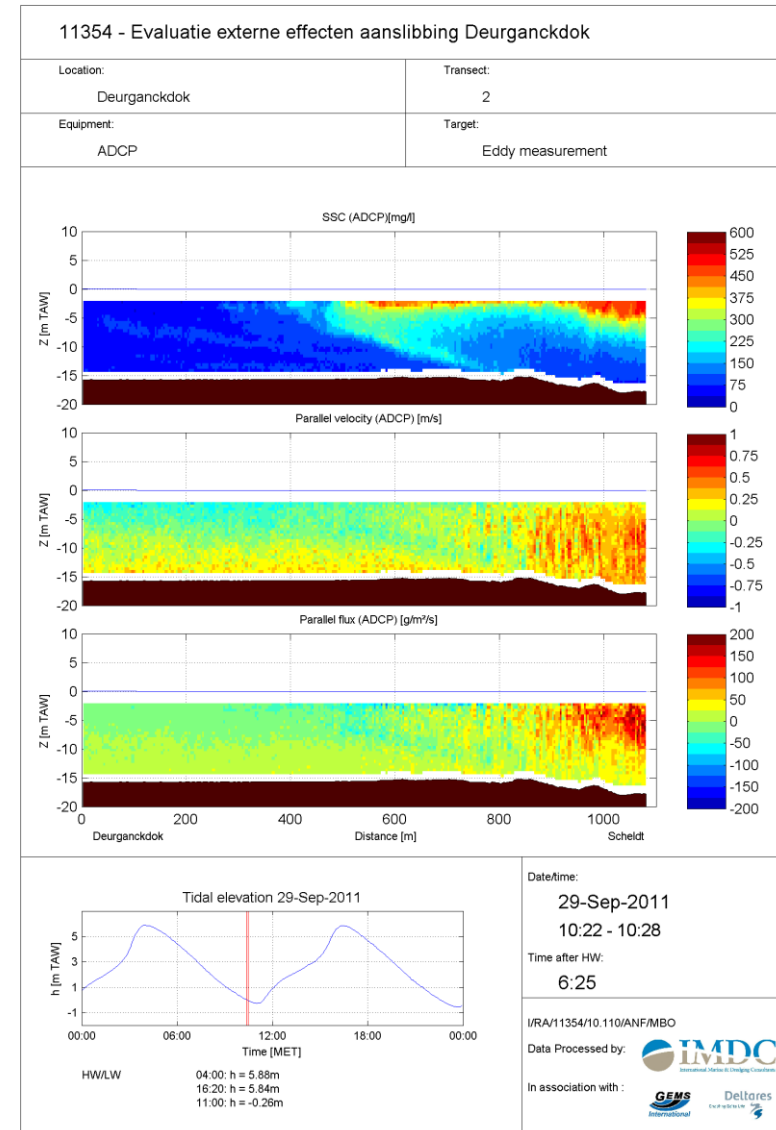
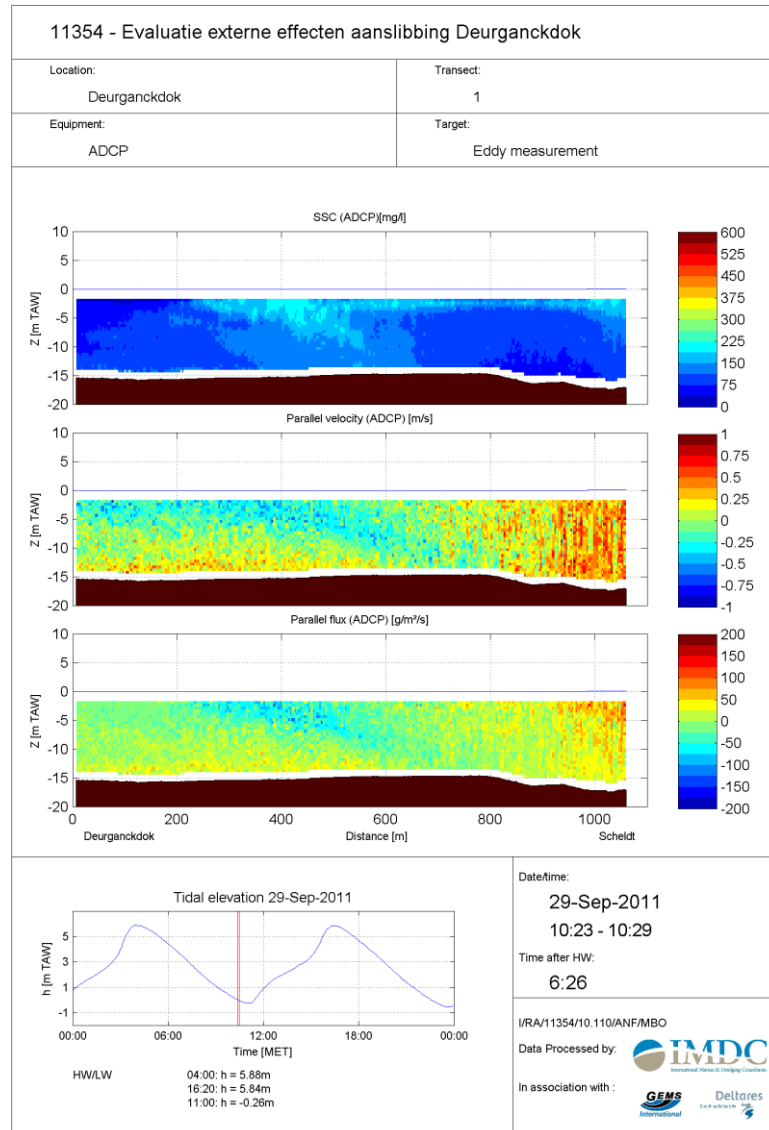


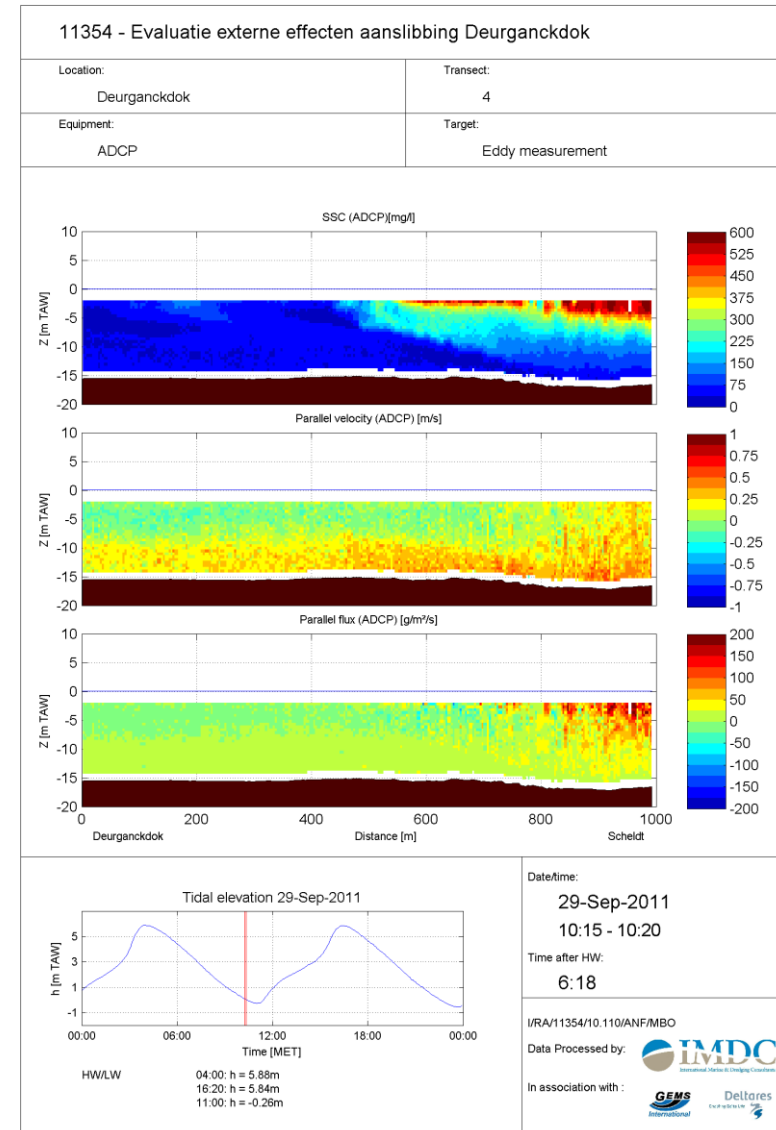
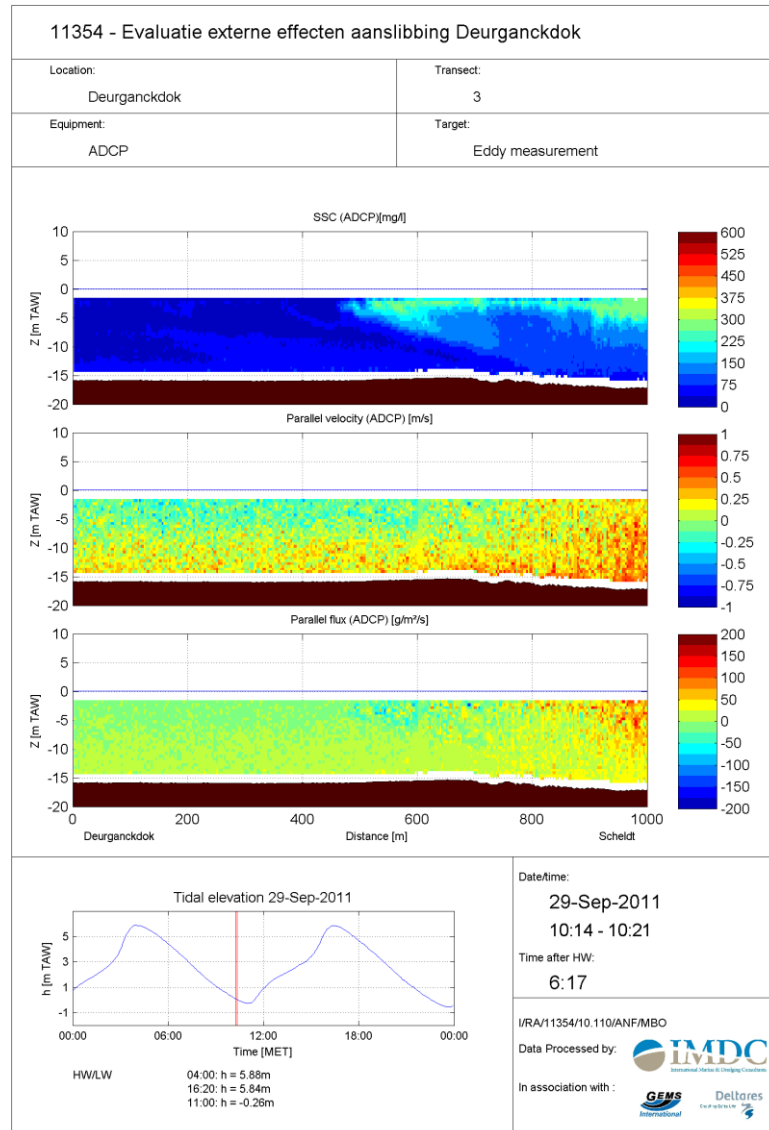


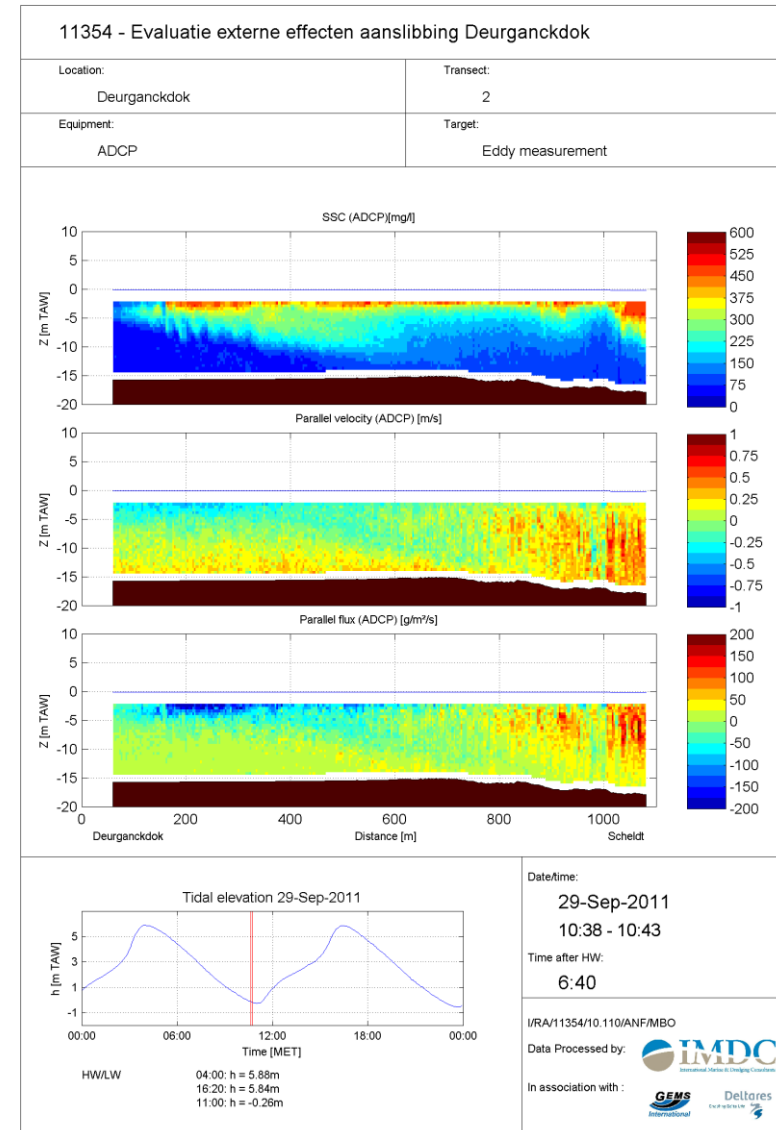
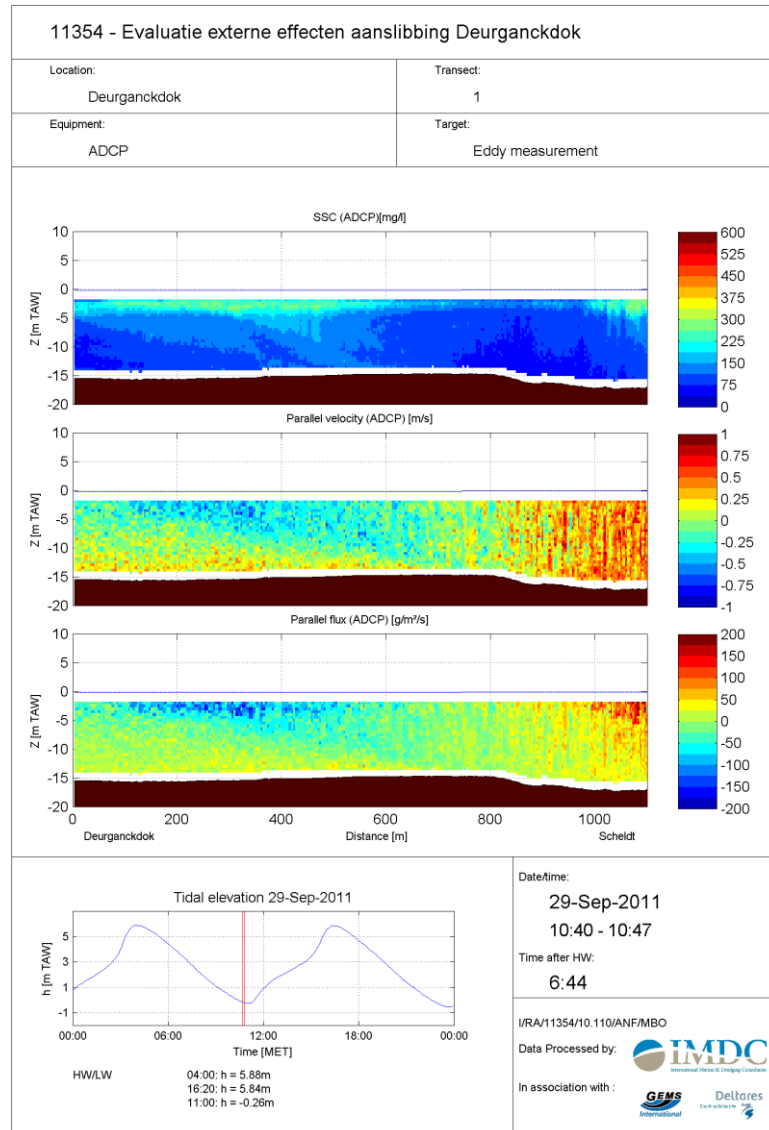


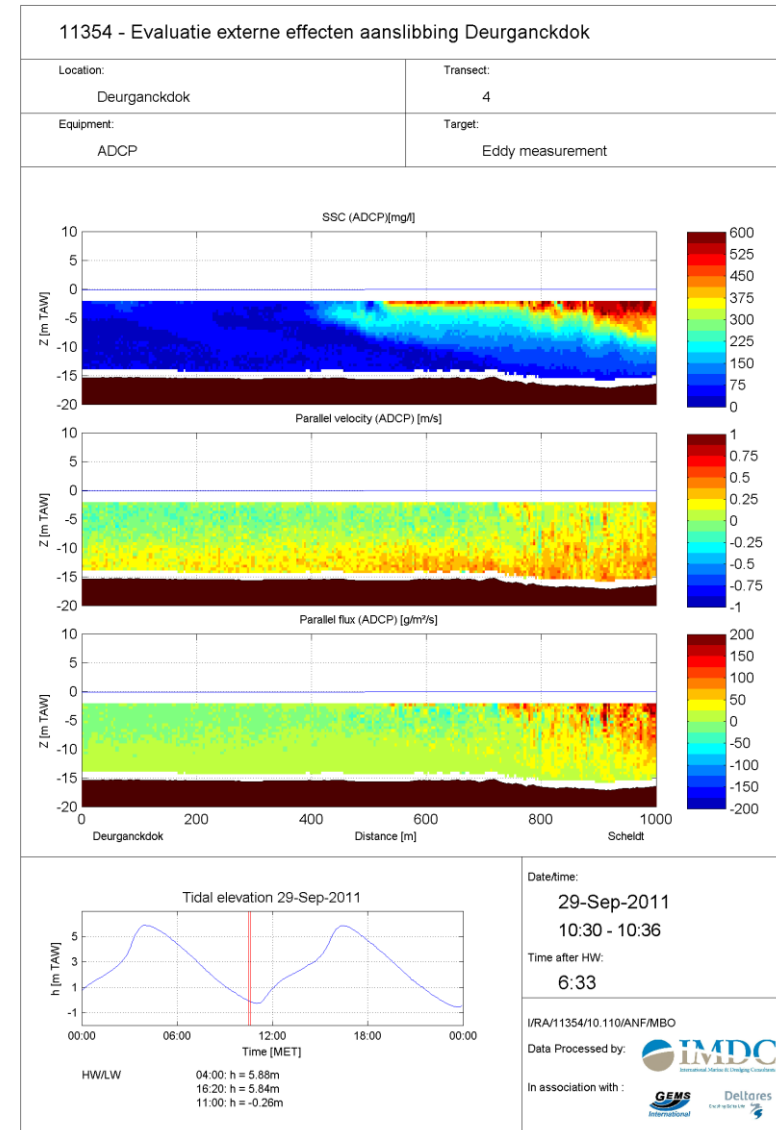
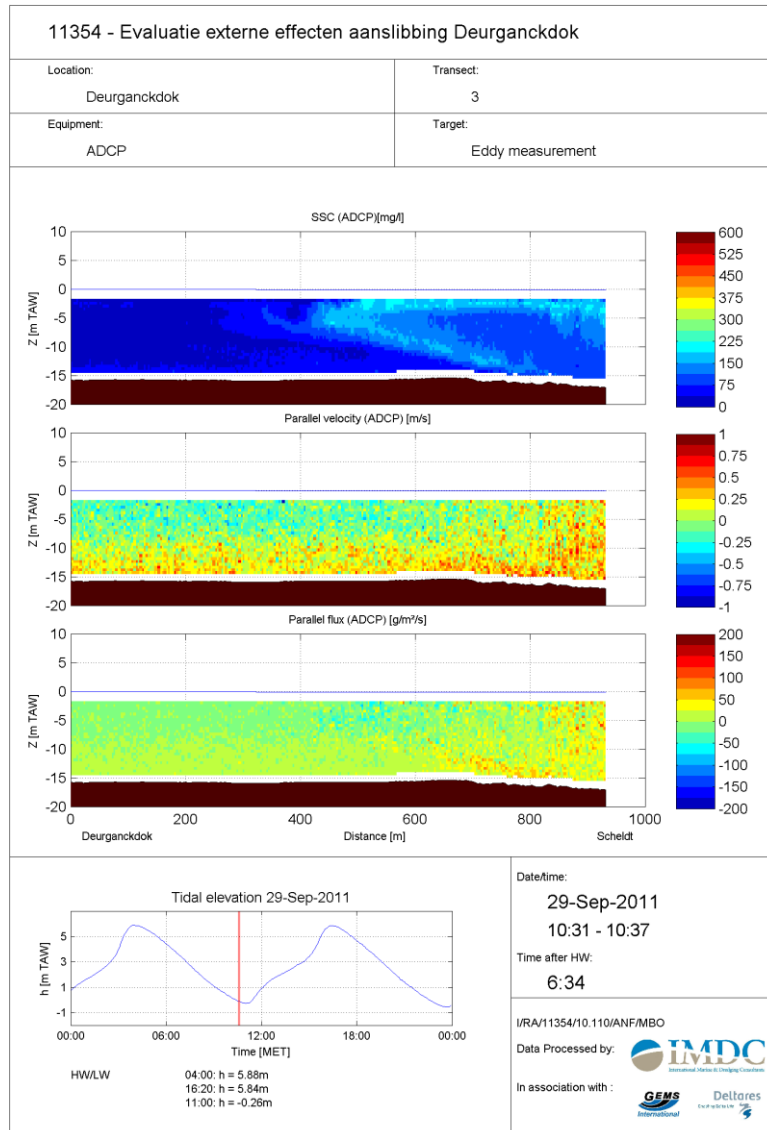


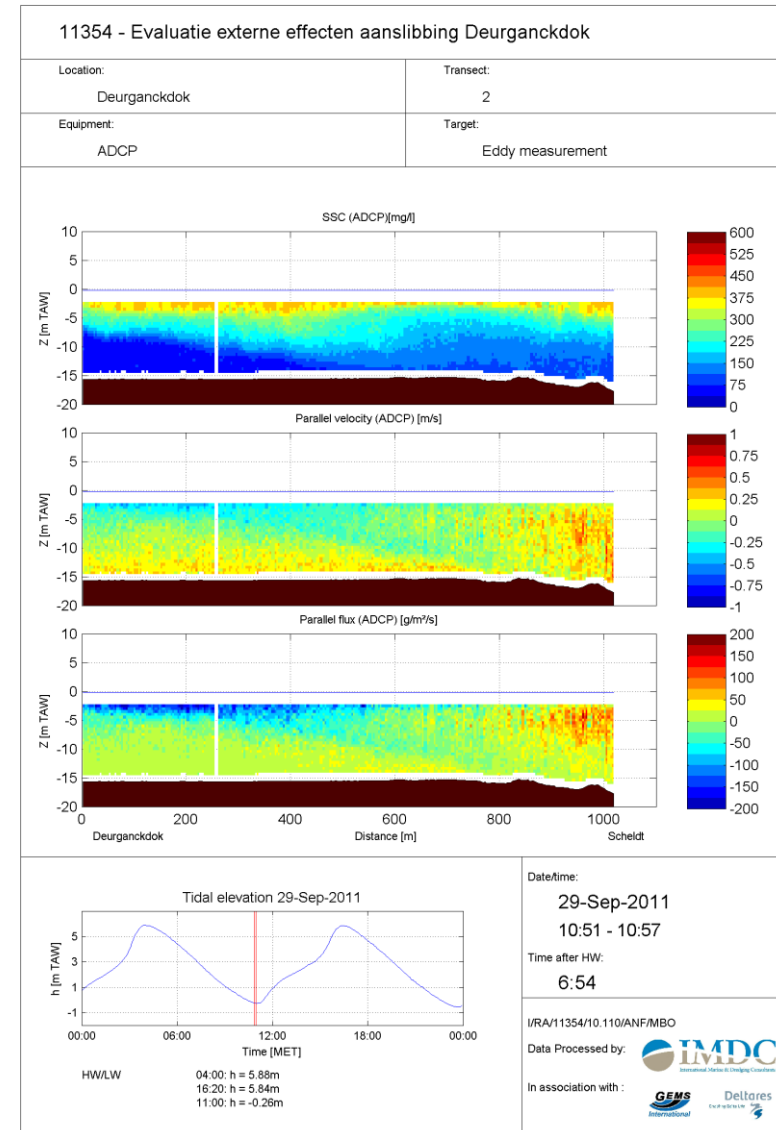
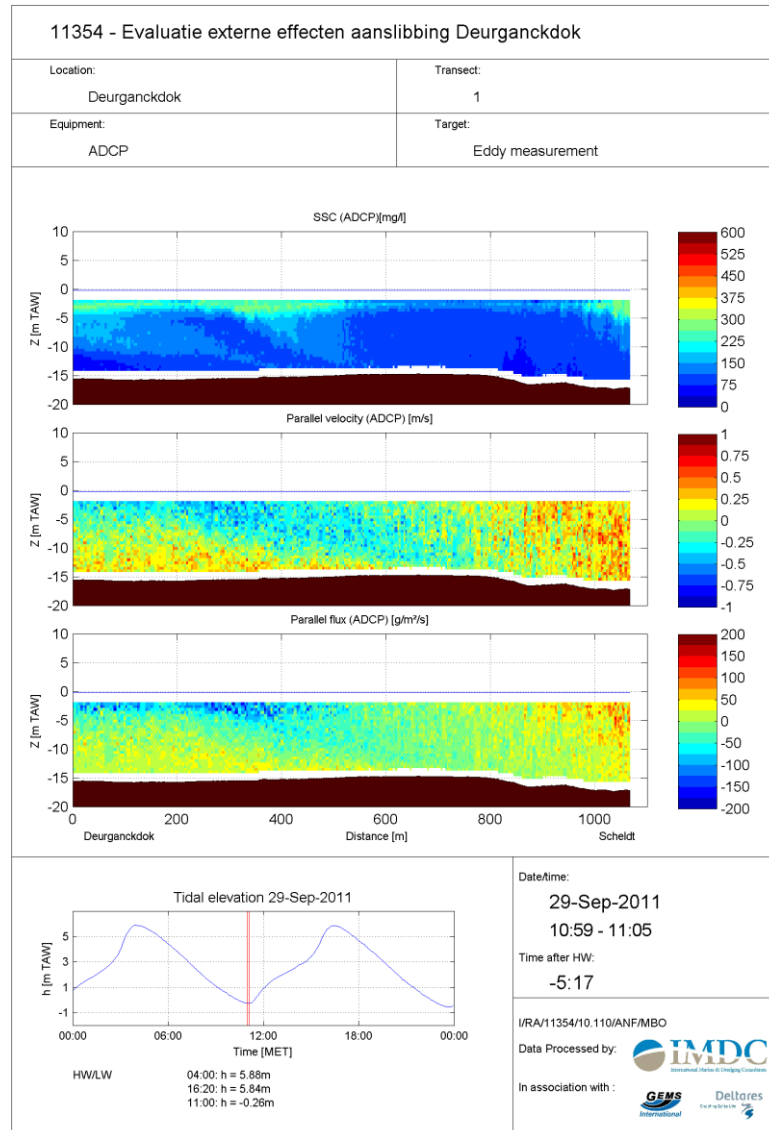


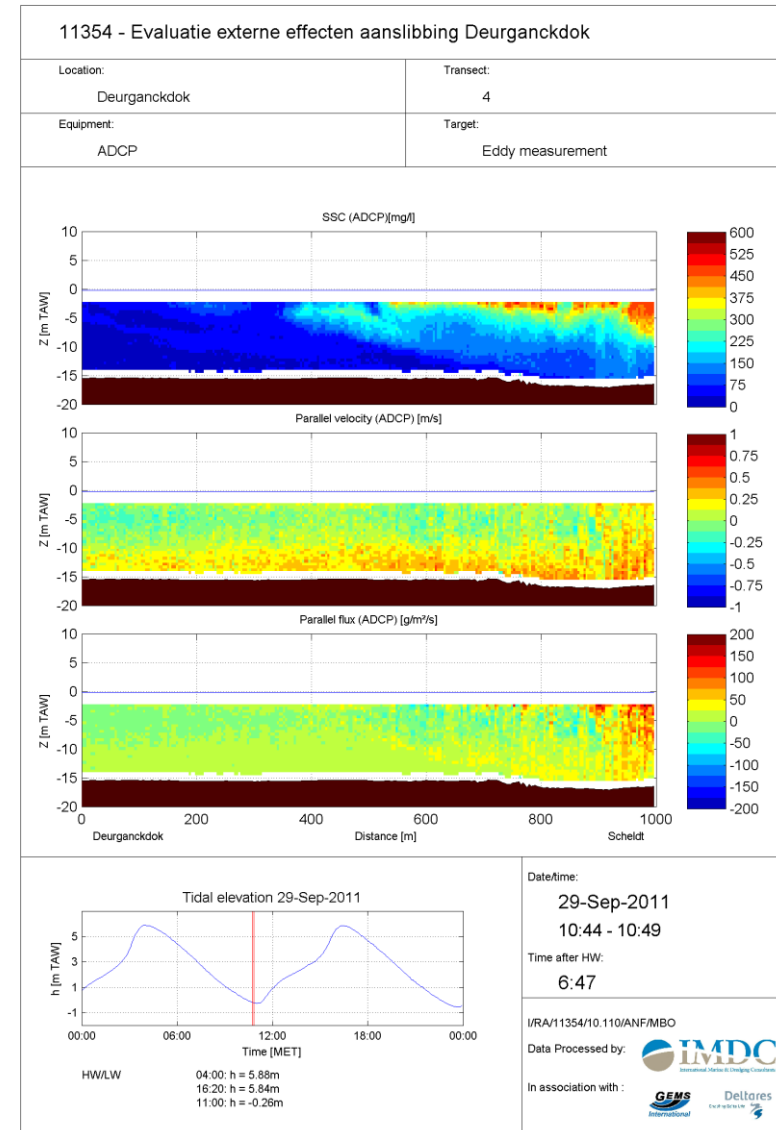
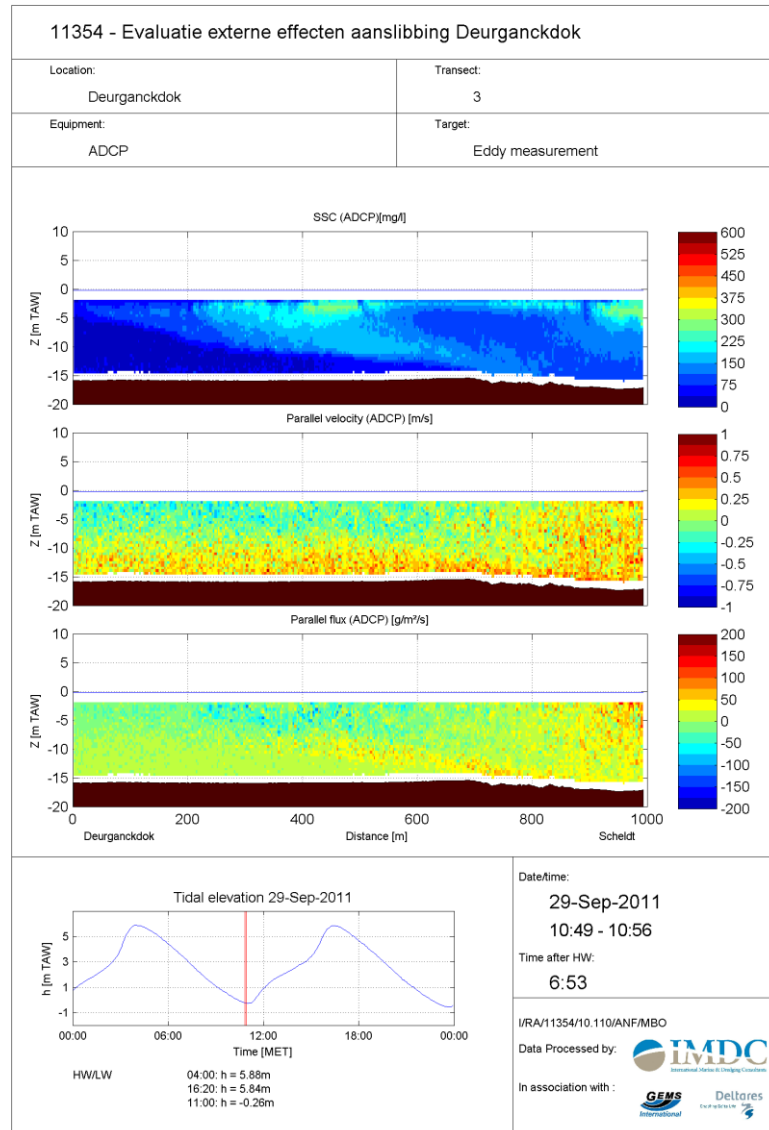


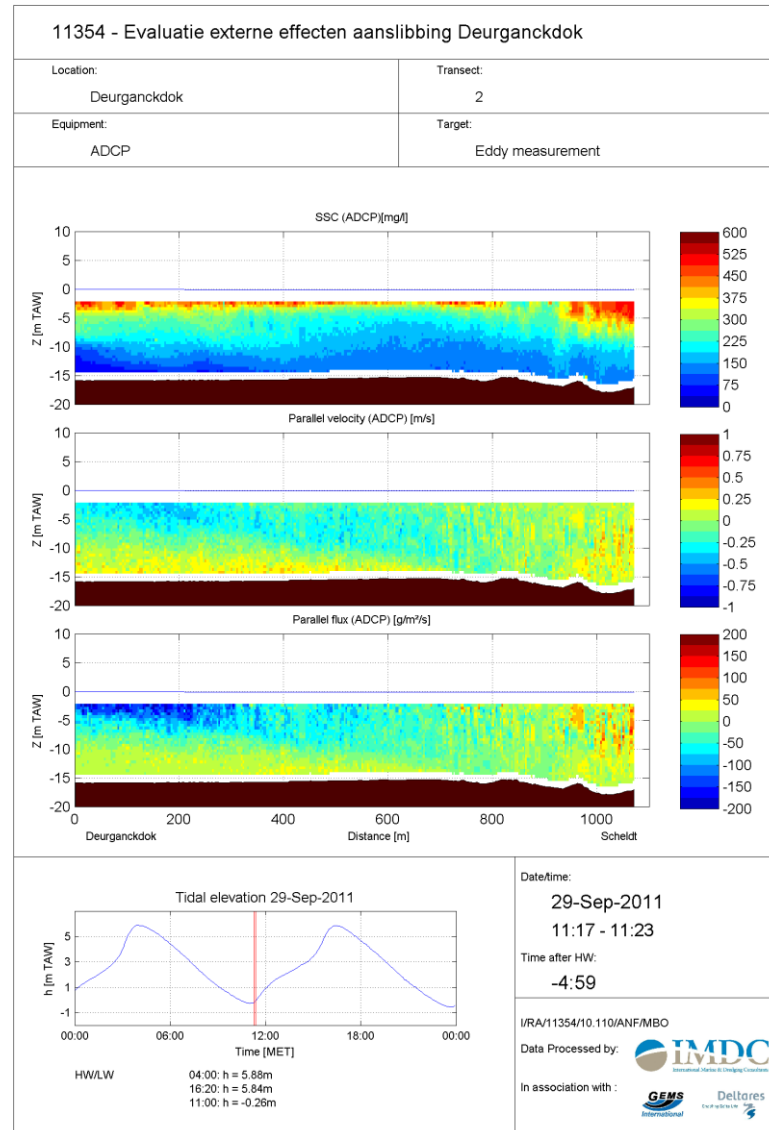


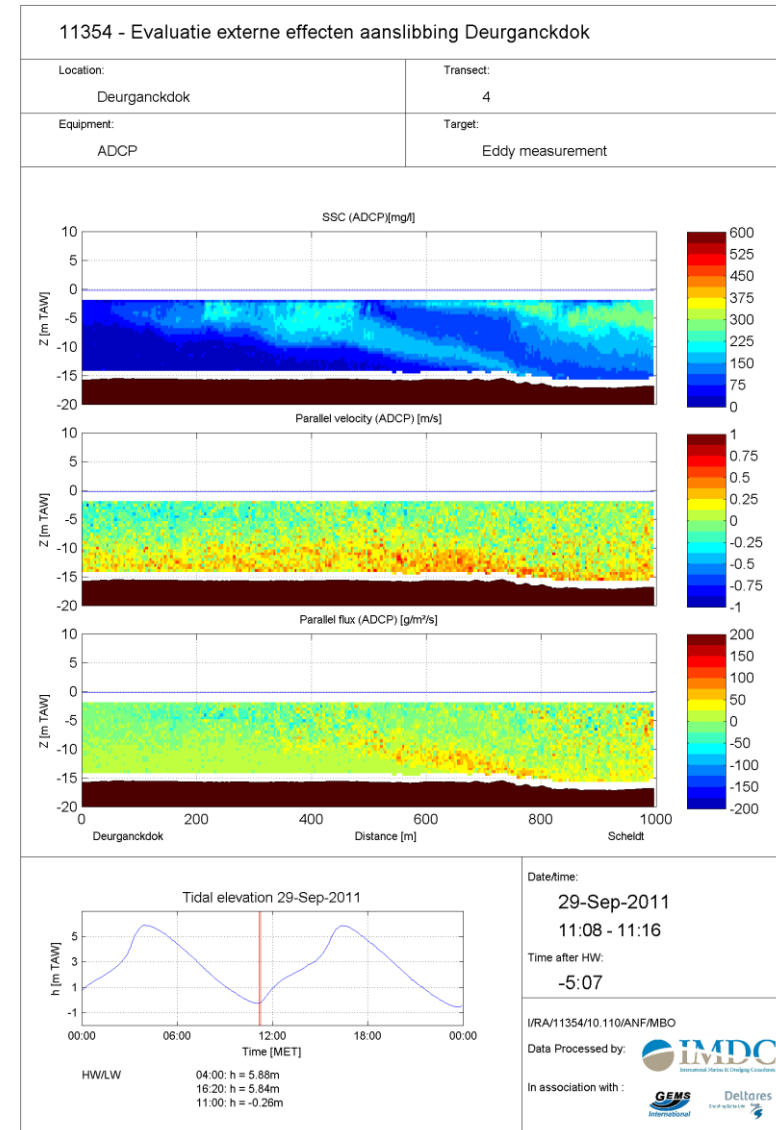
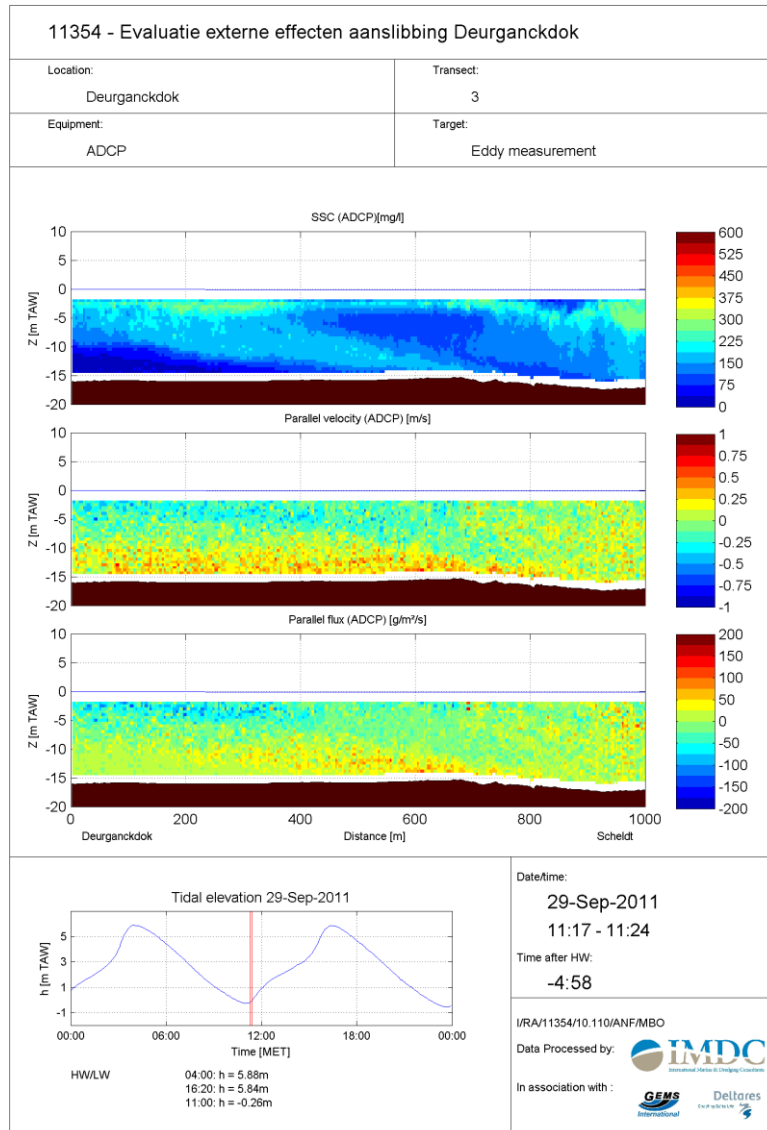


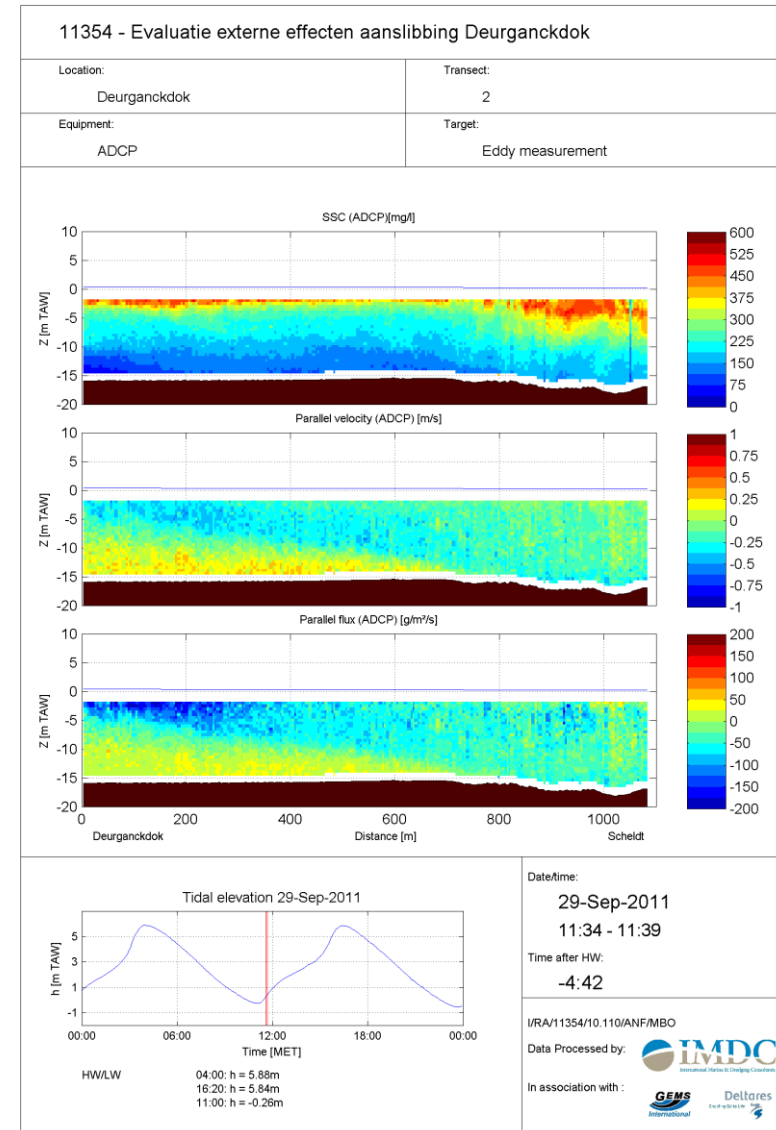
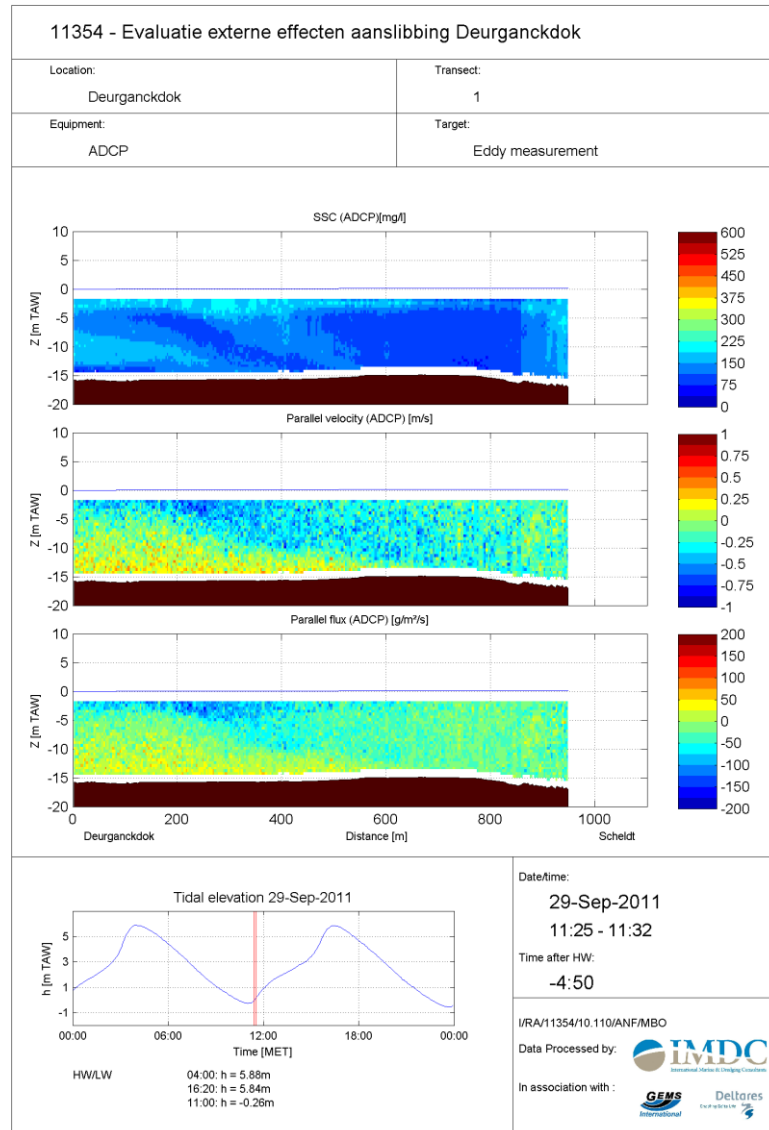


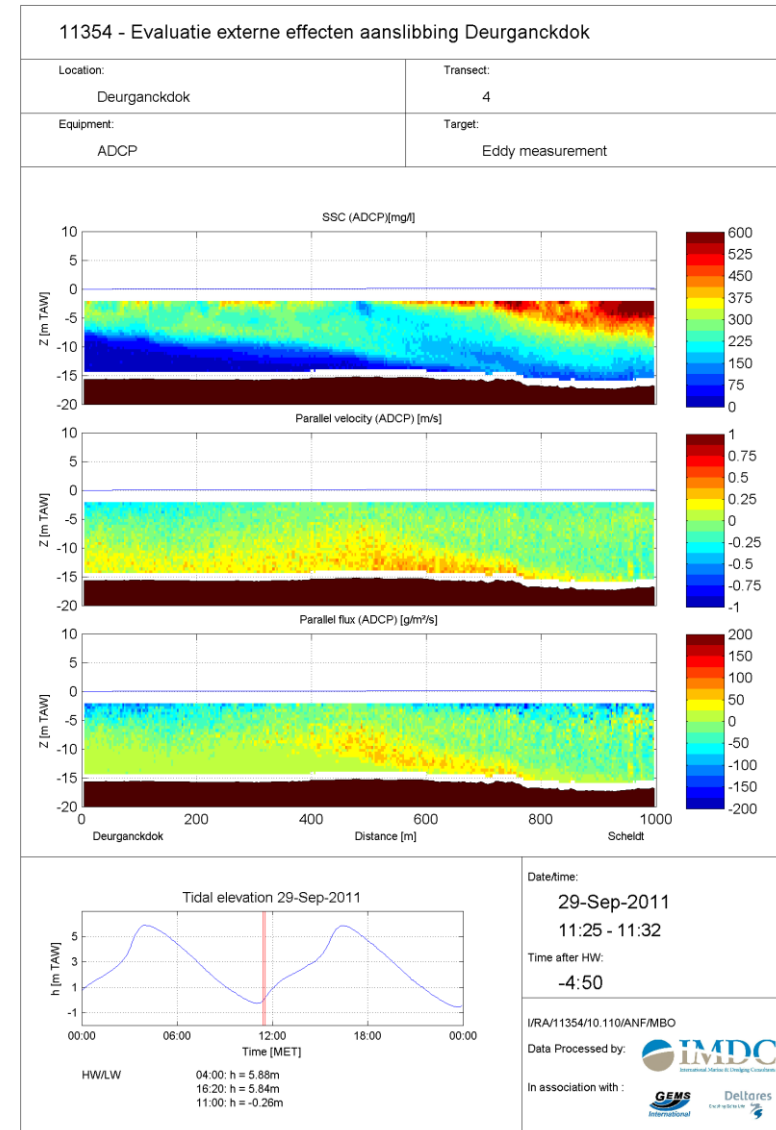
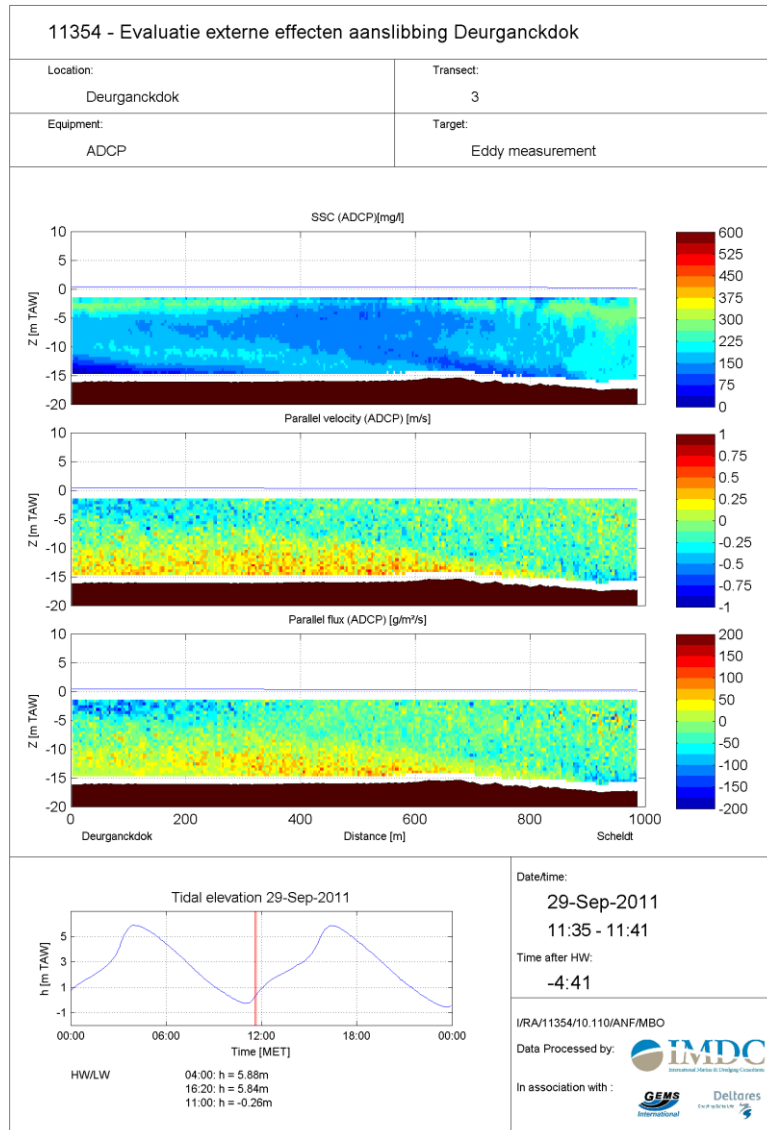


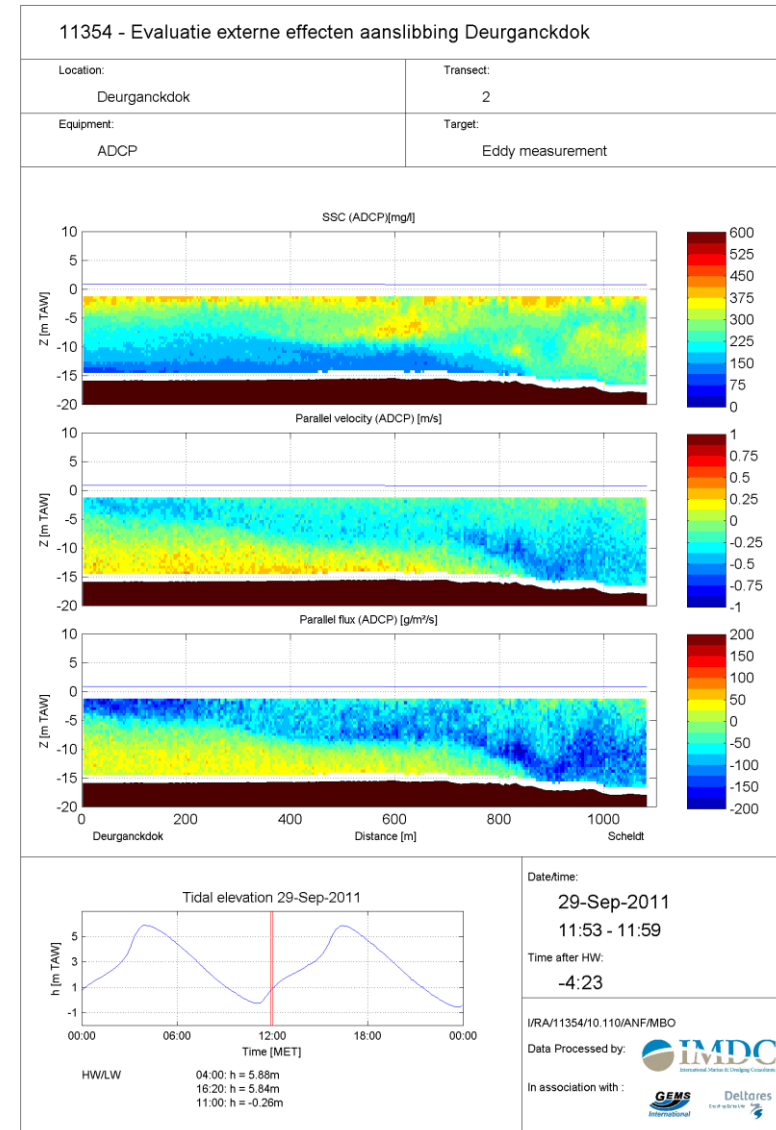
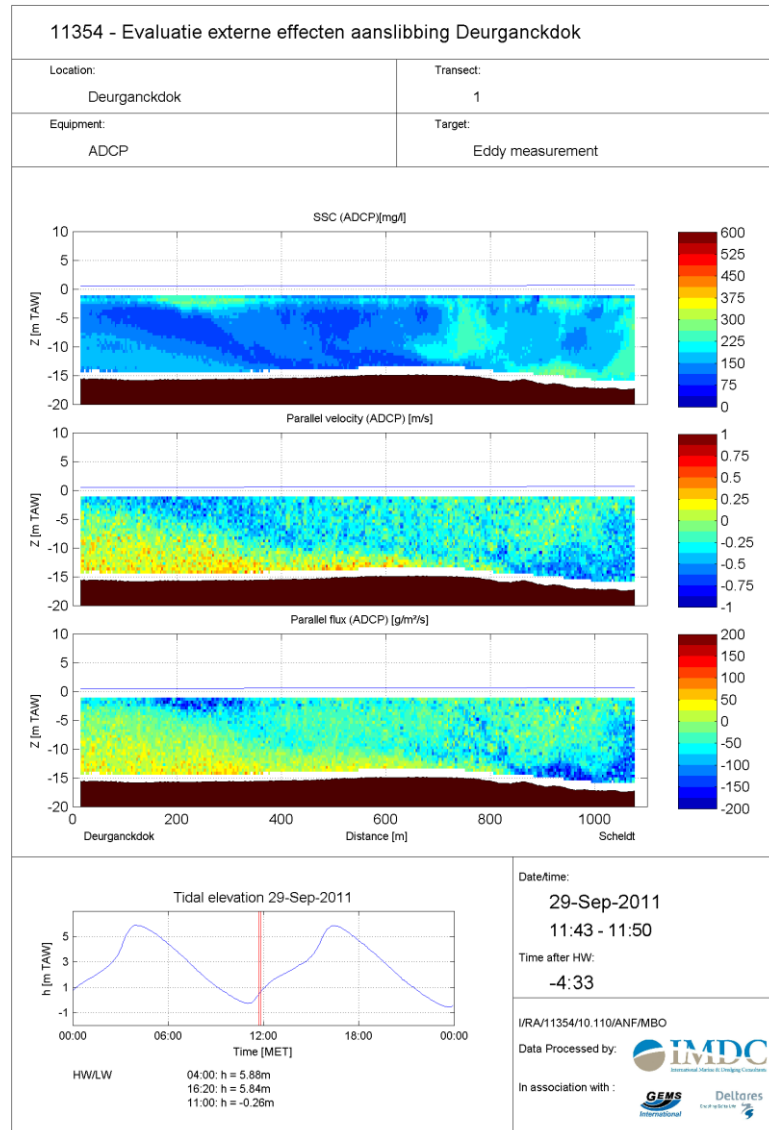


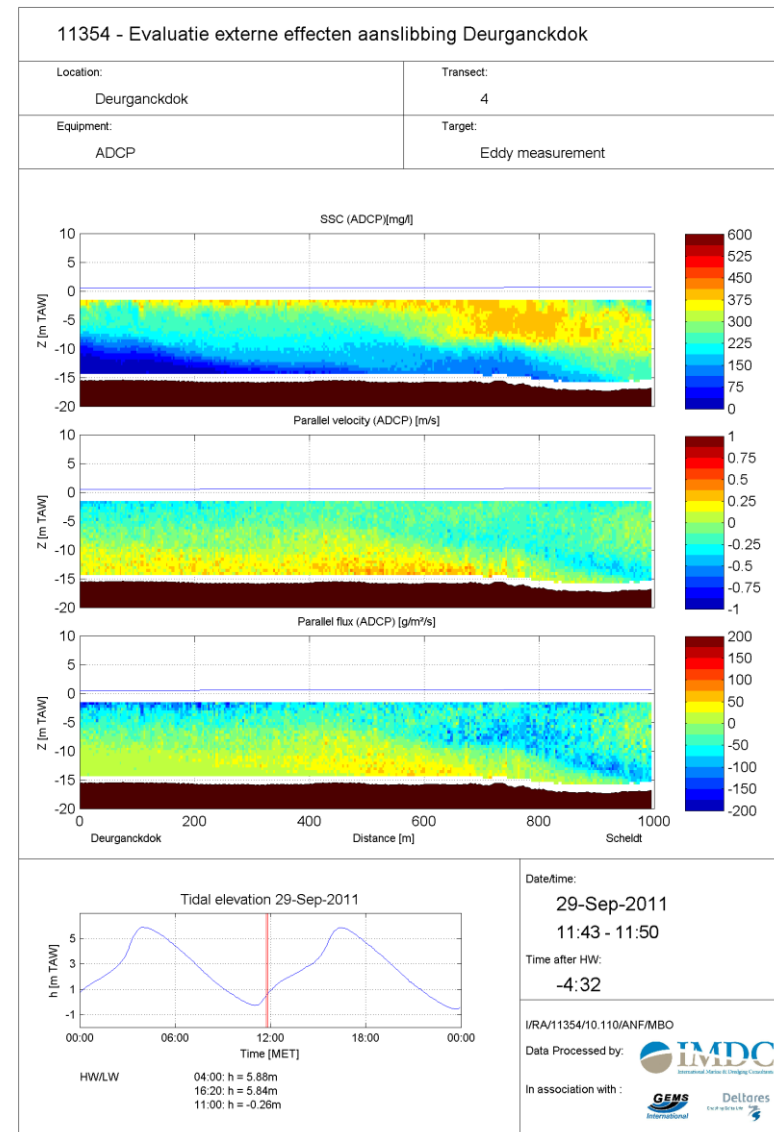


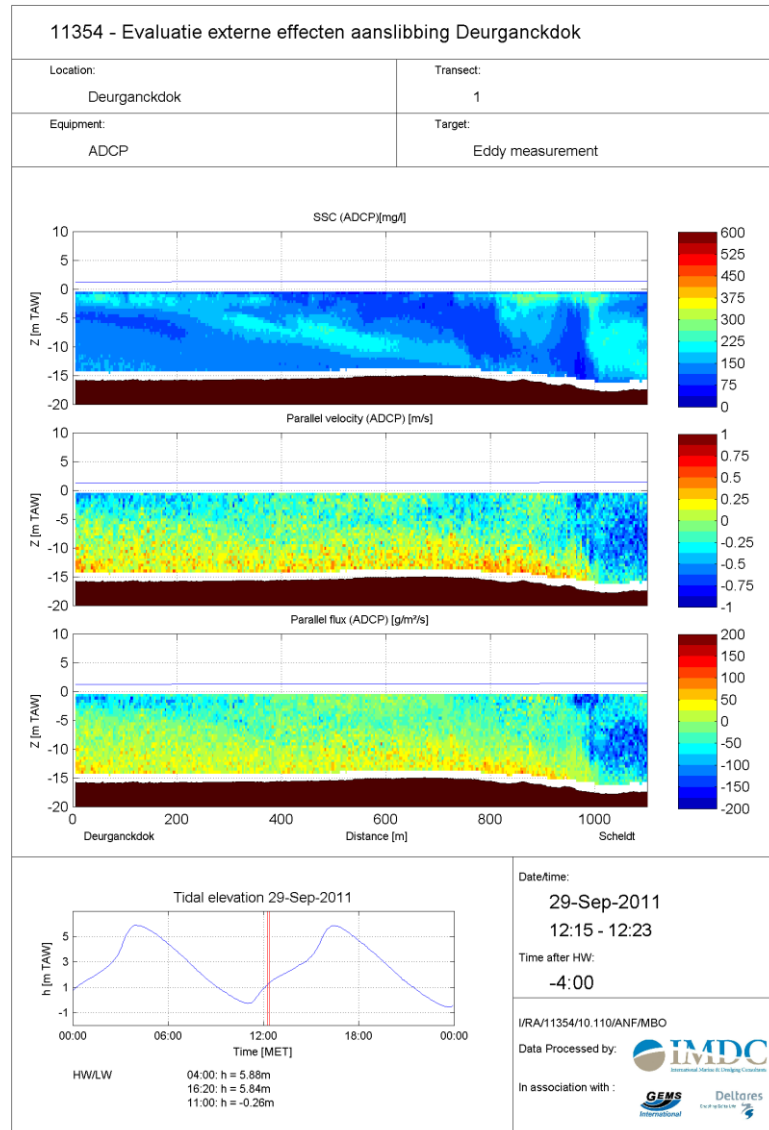




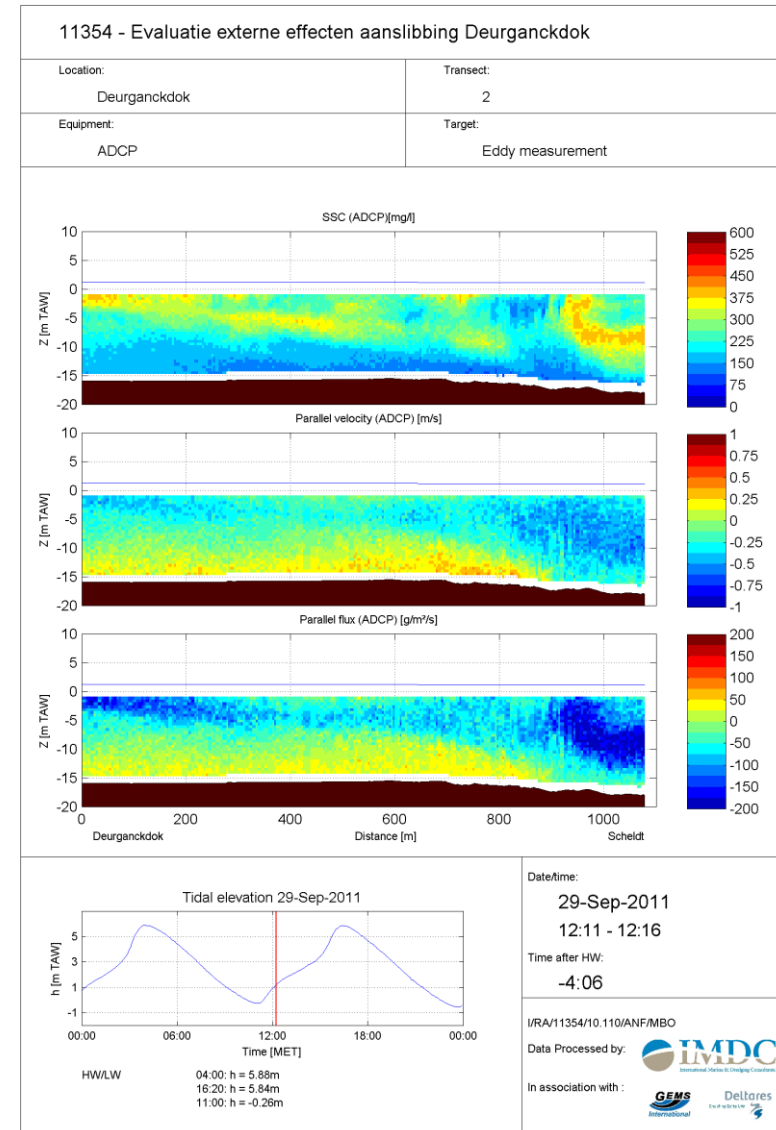




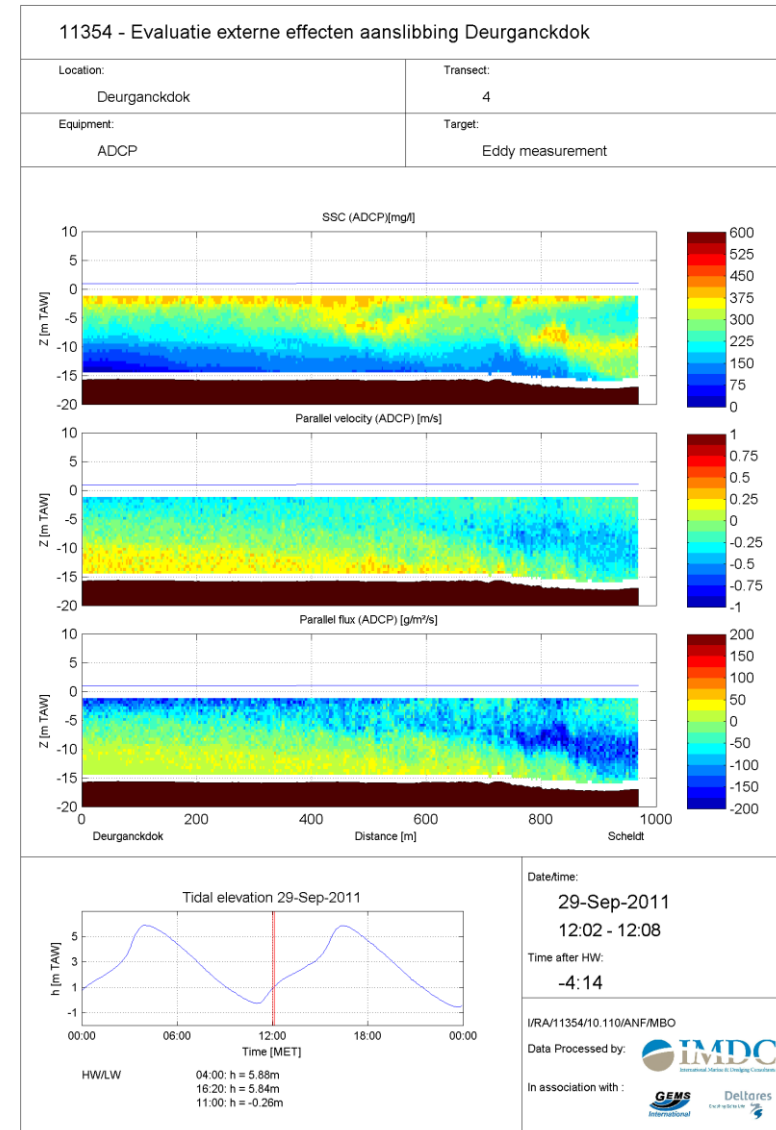
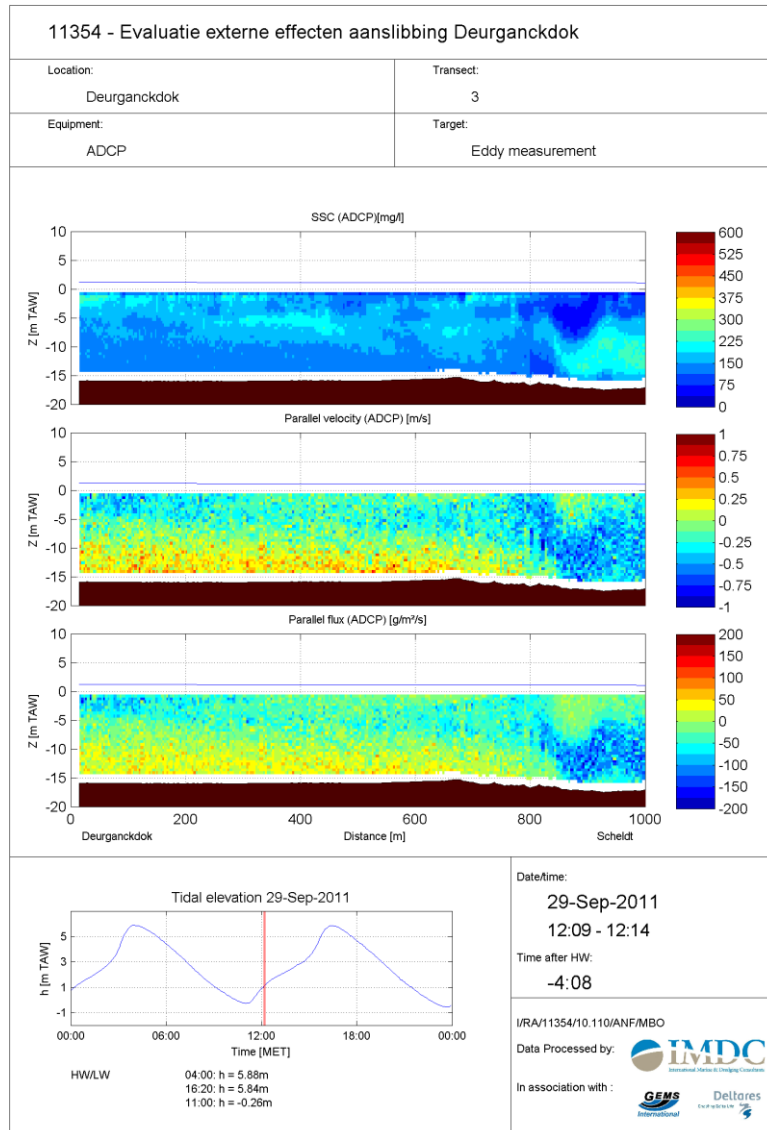


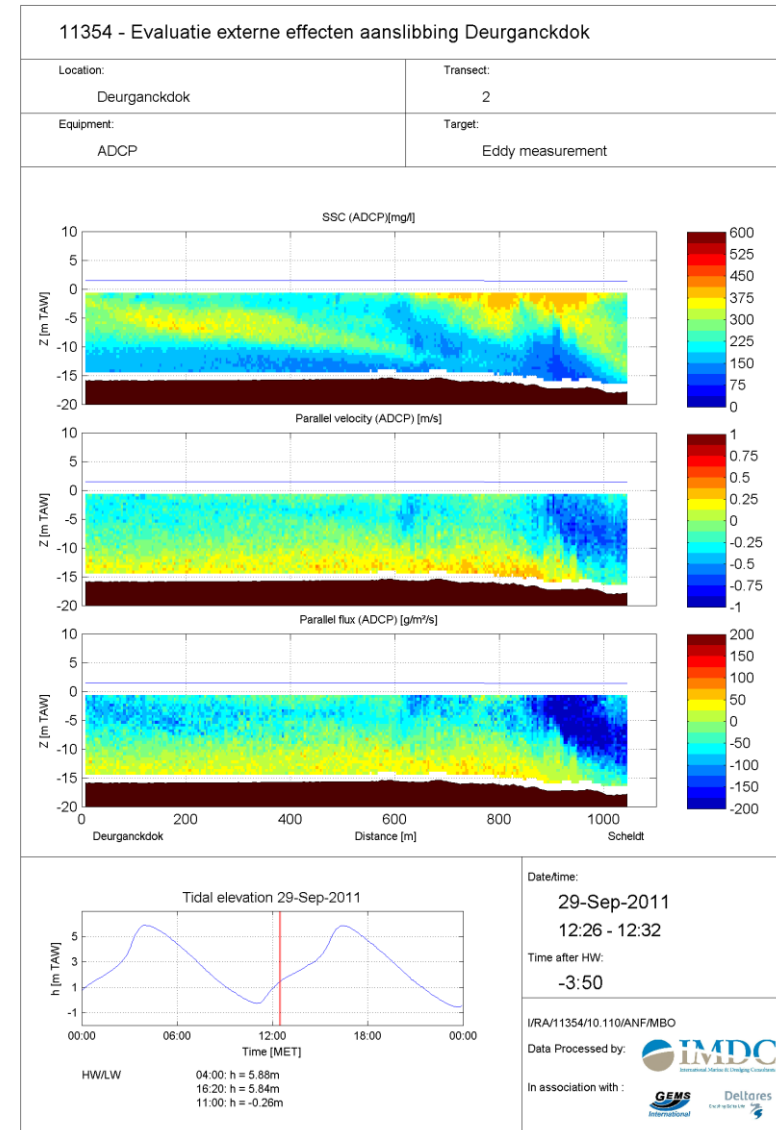


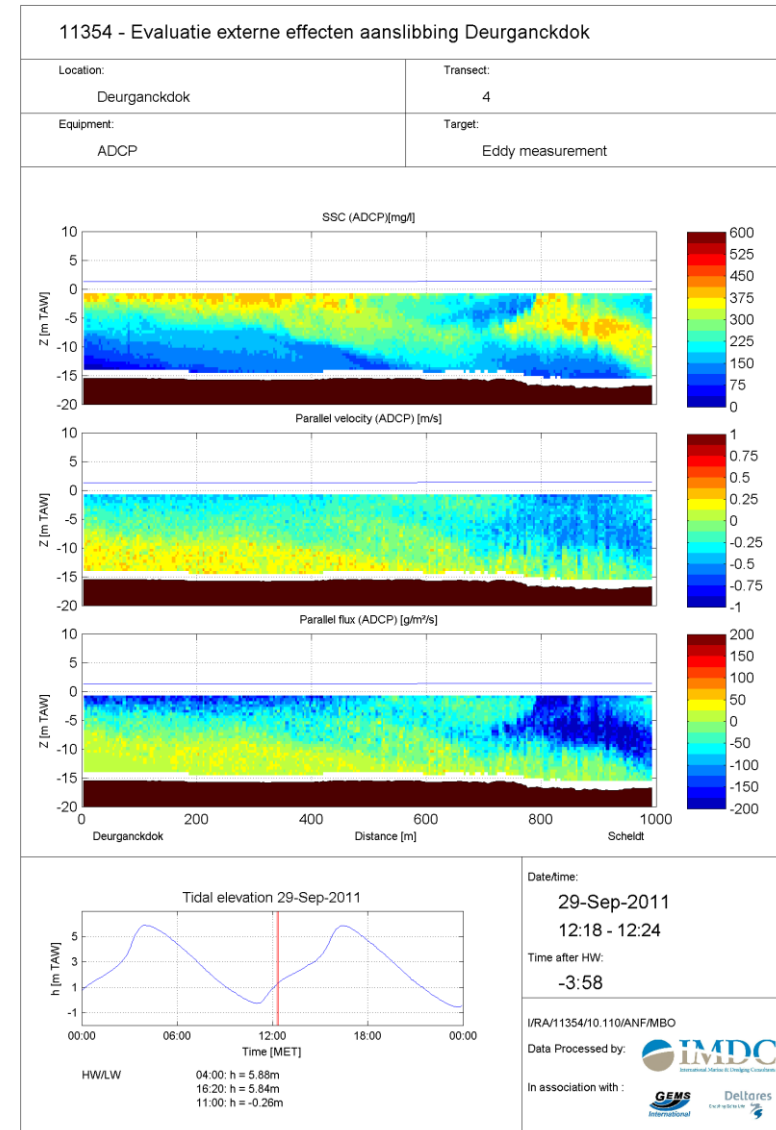
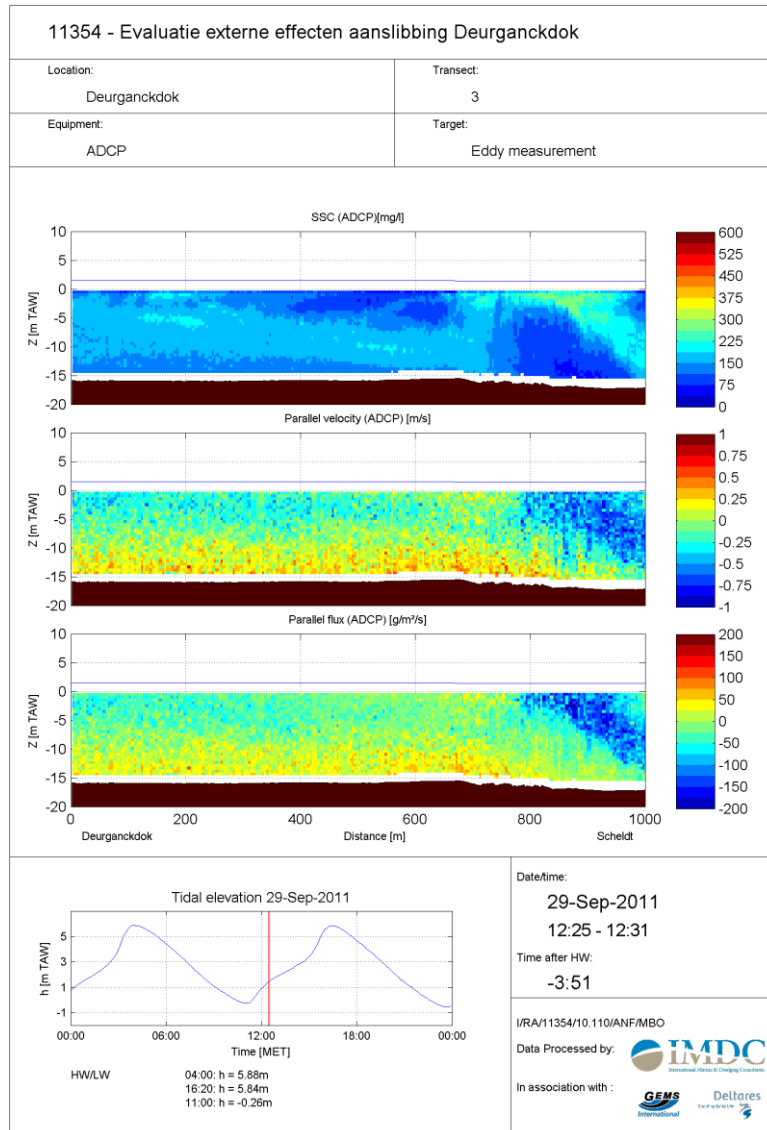
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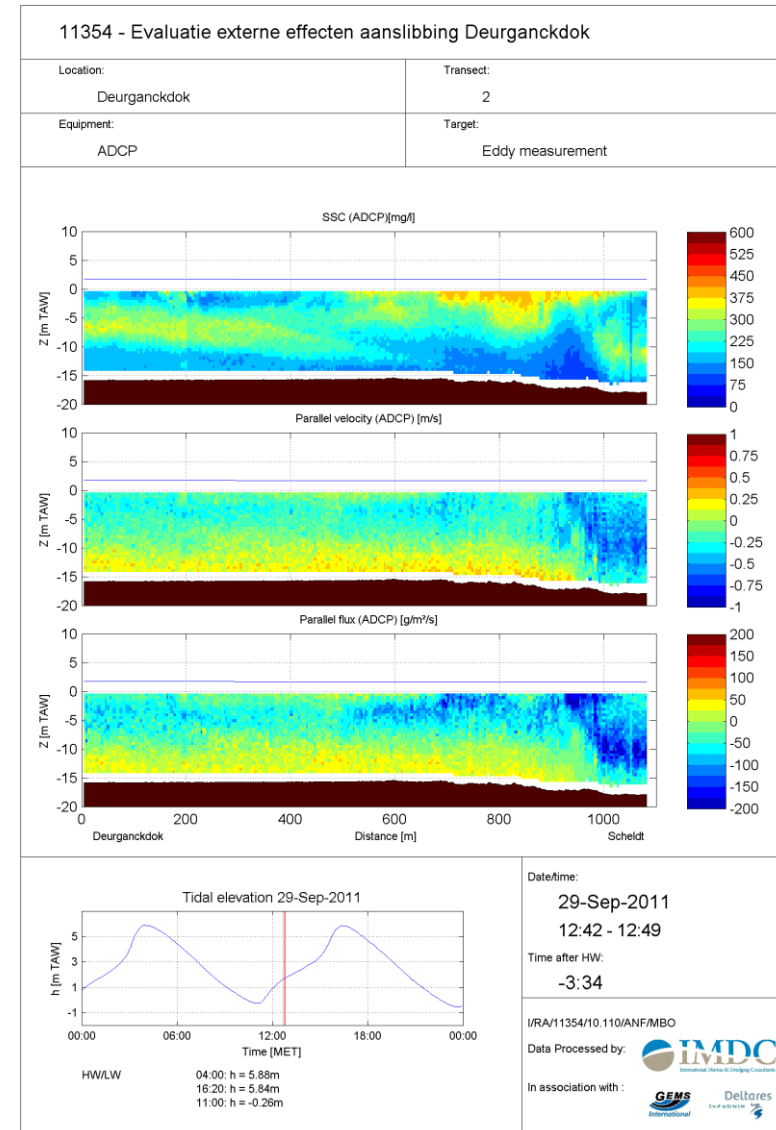
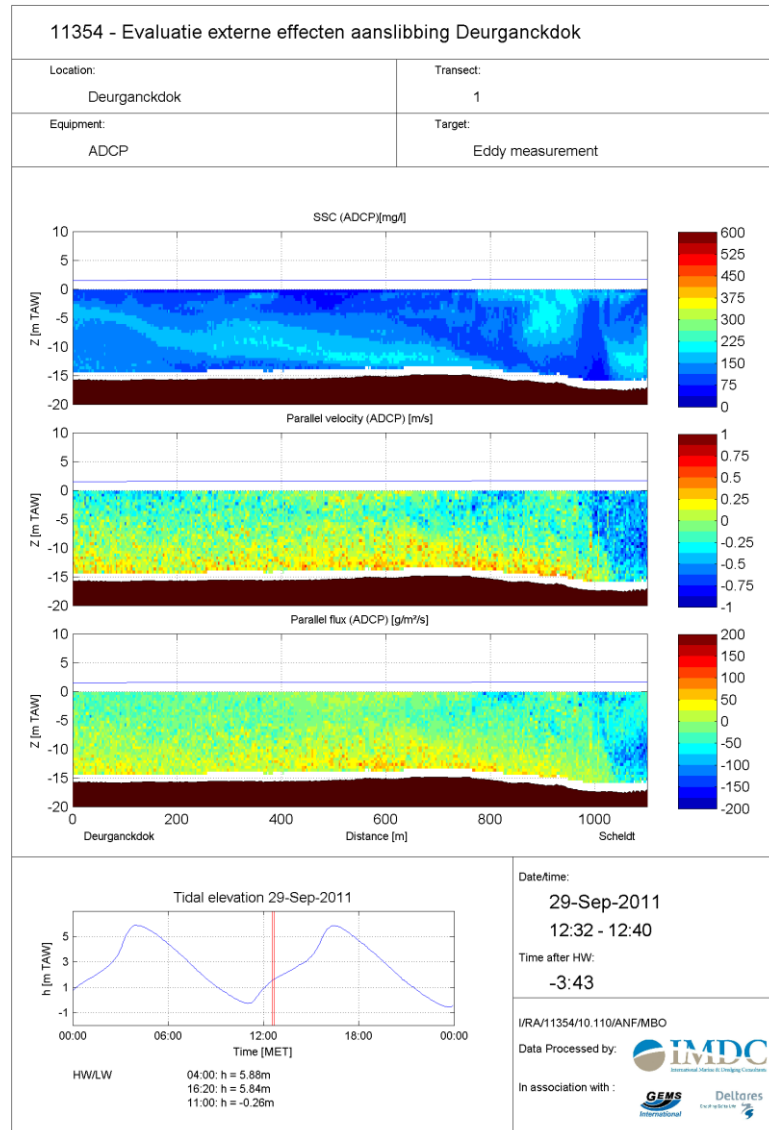


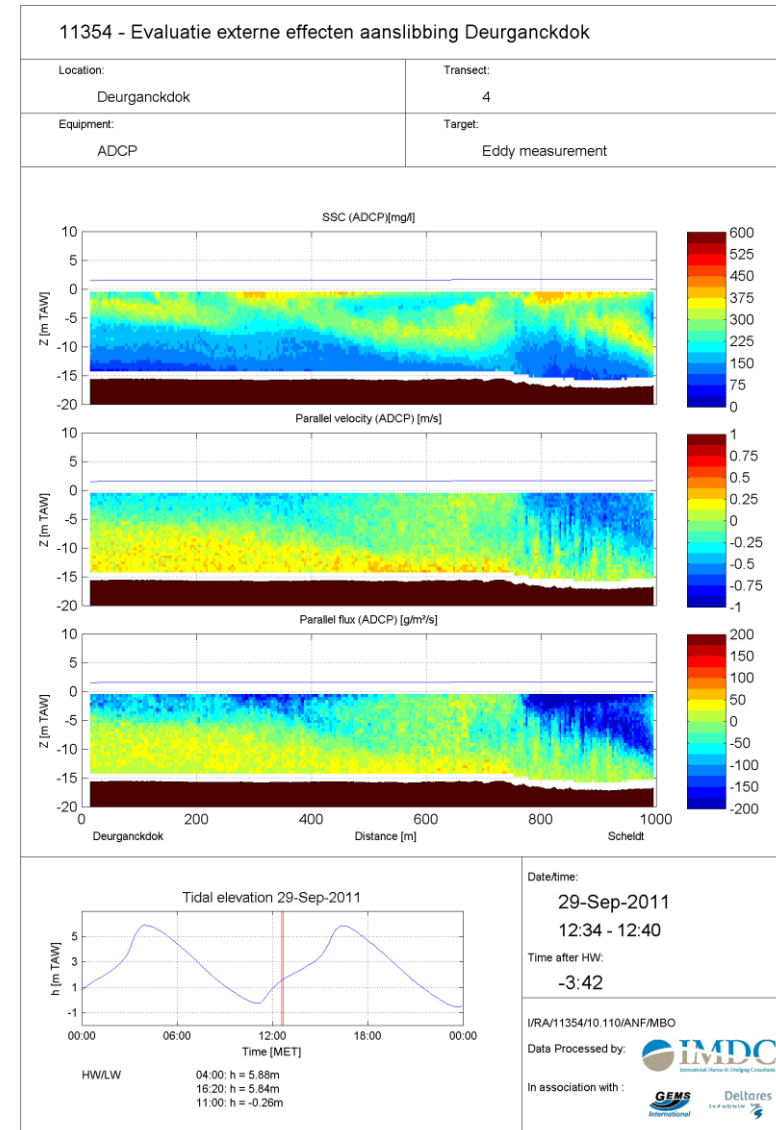
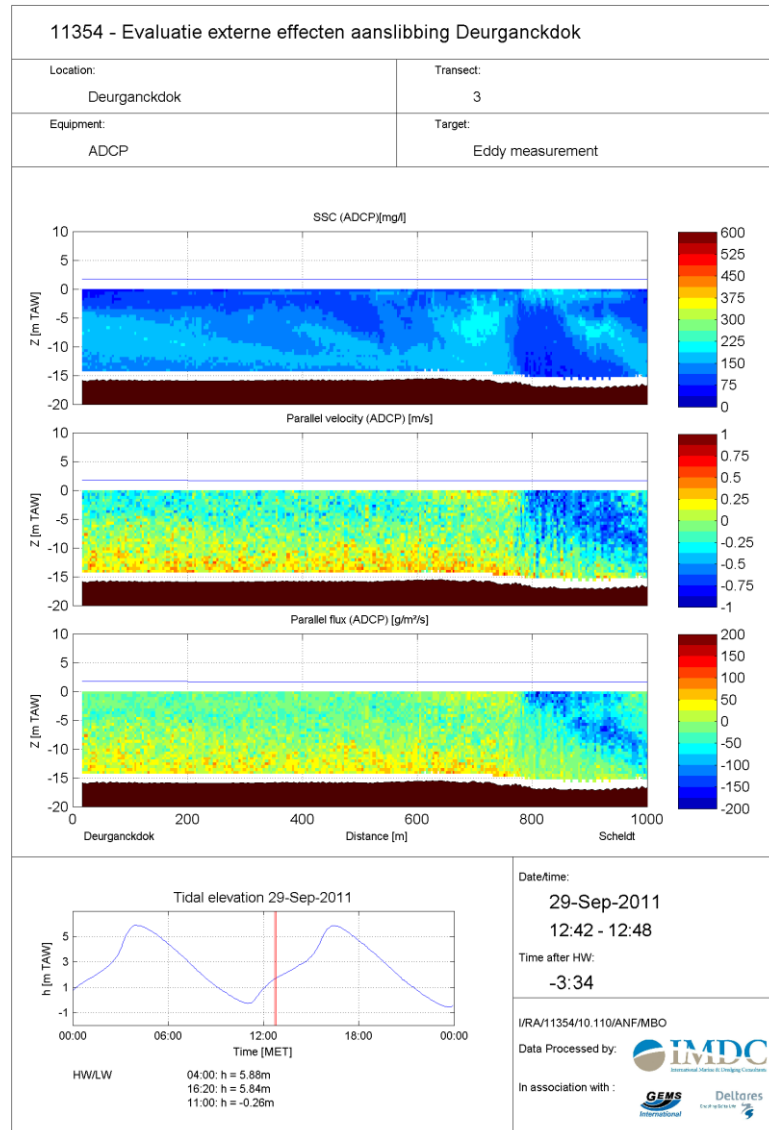
version 2.0 - 15/10/2012

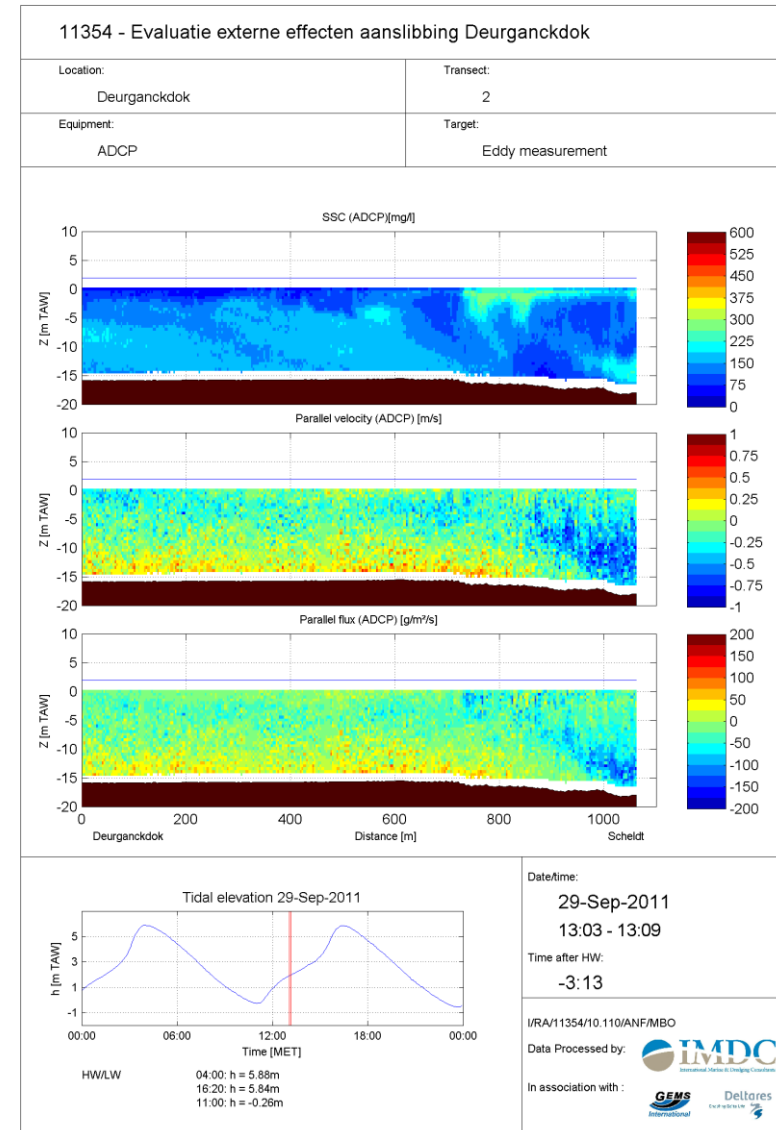
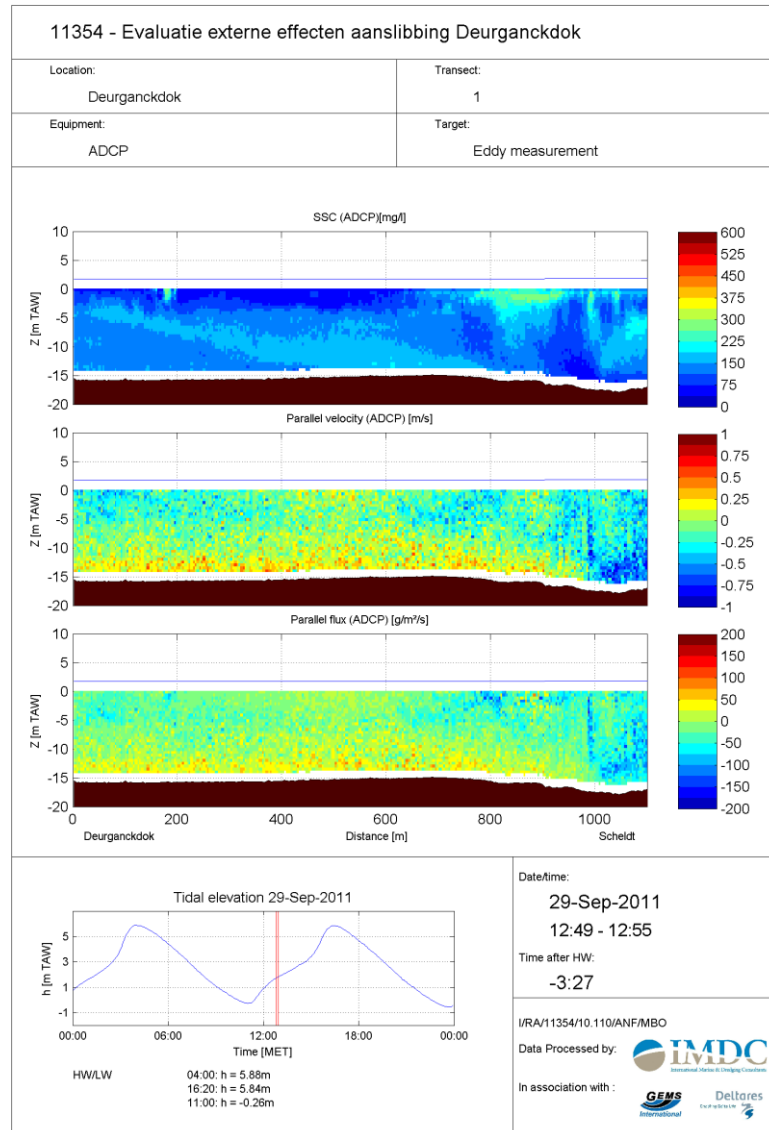


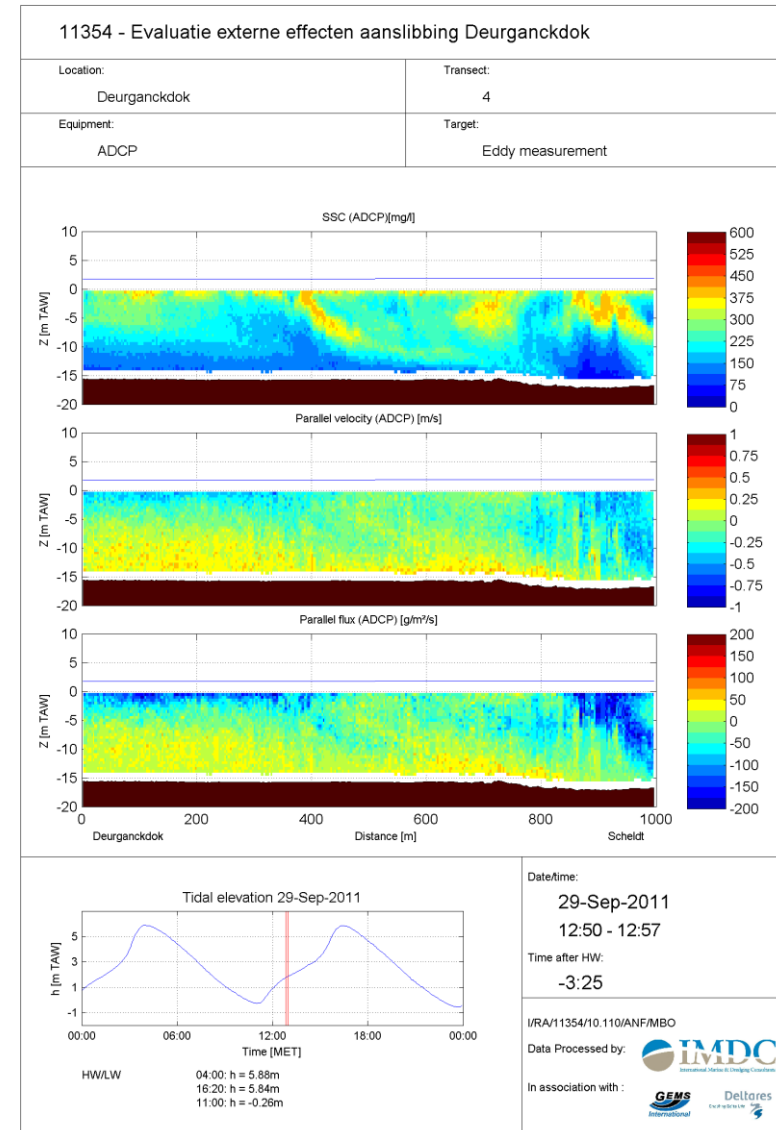
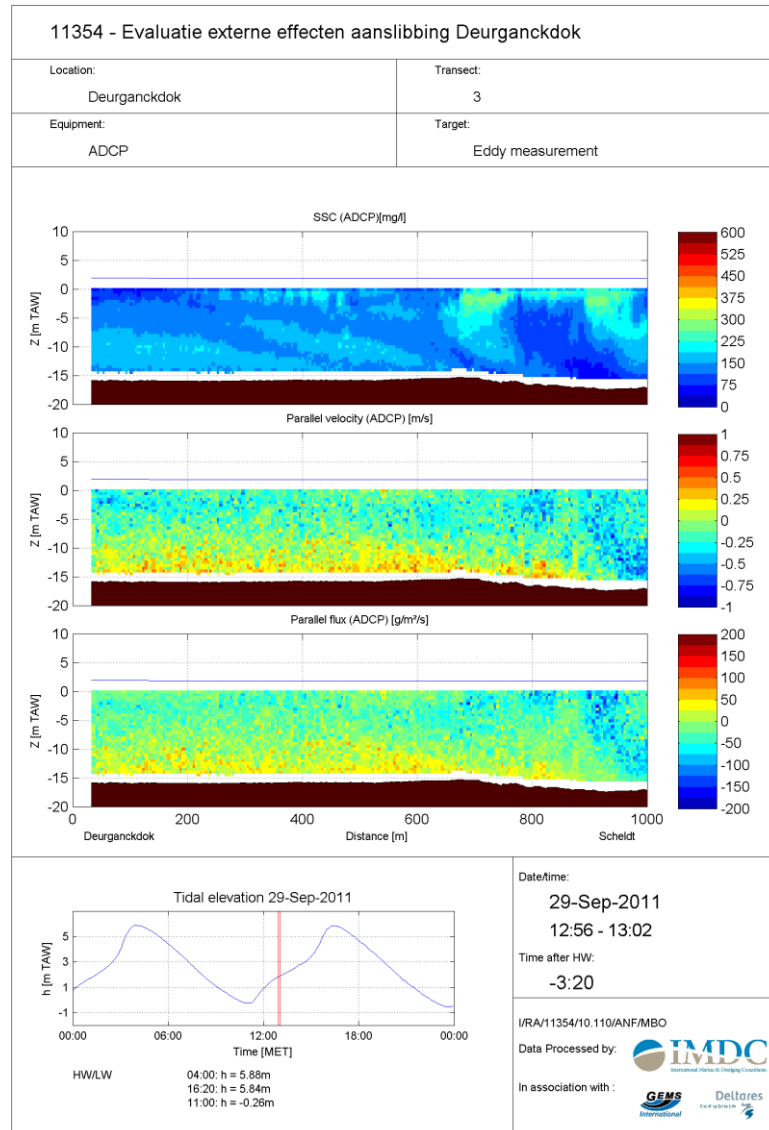


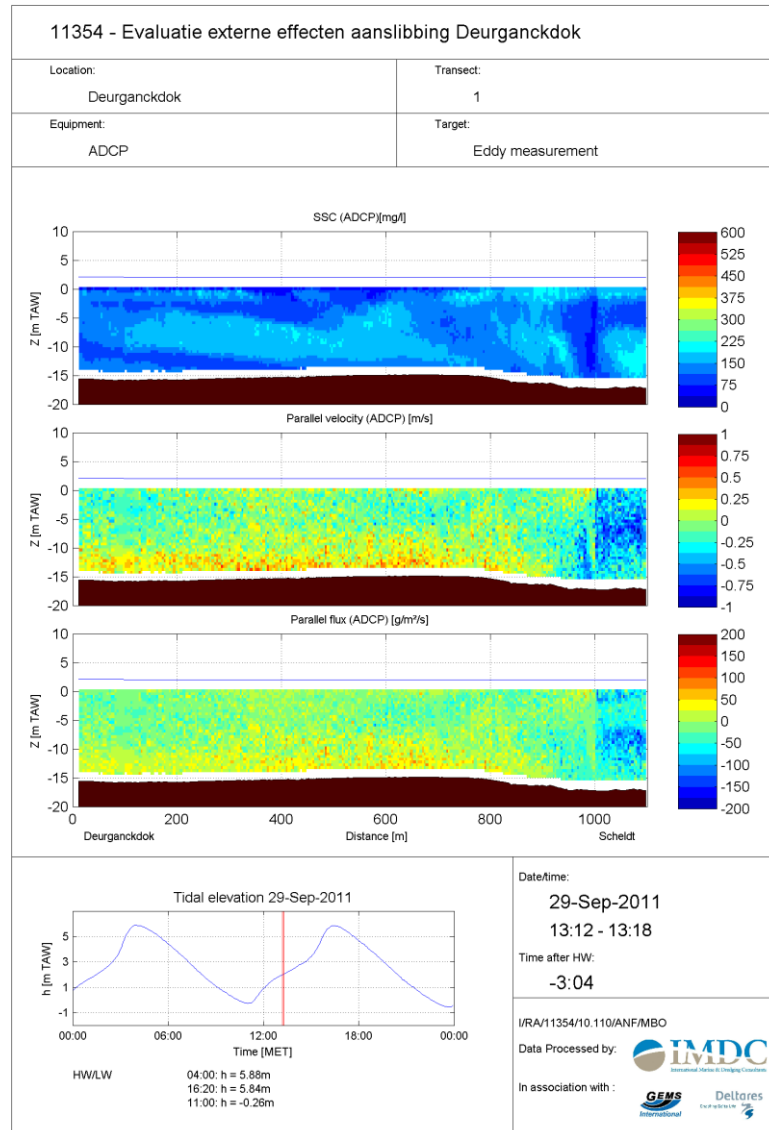


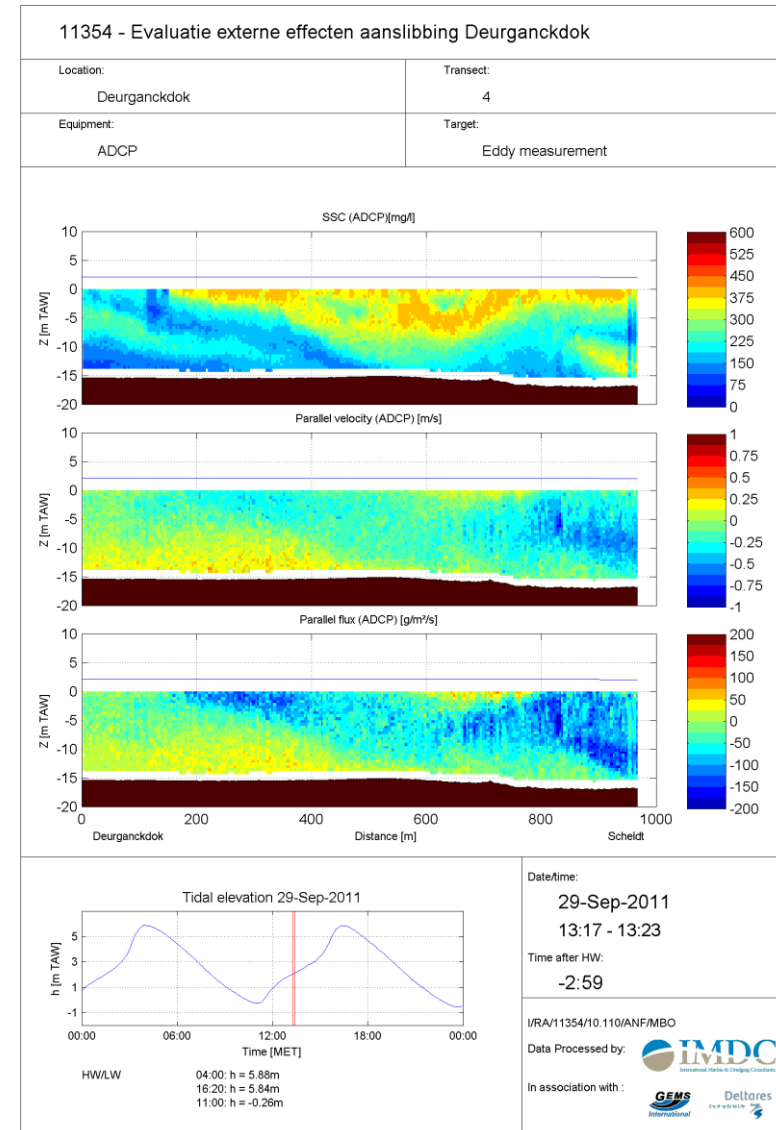
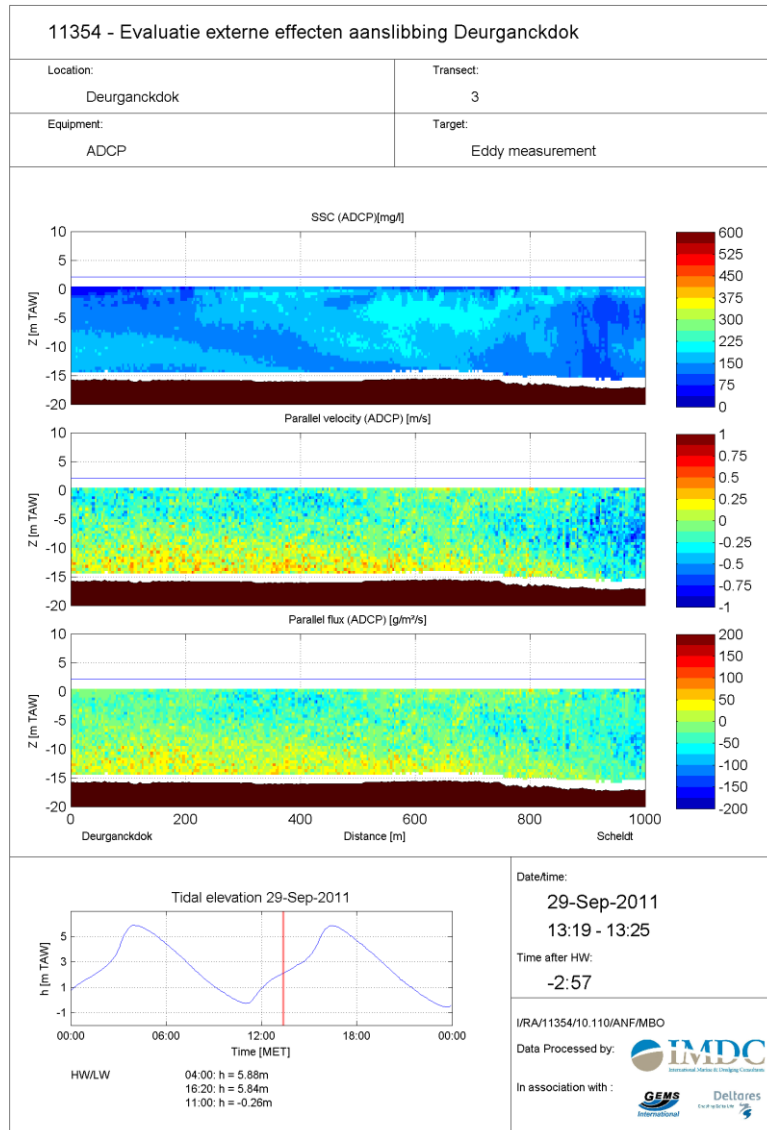


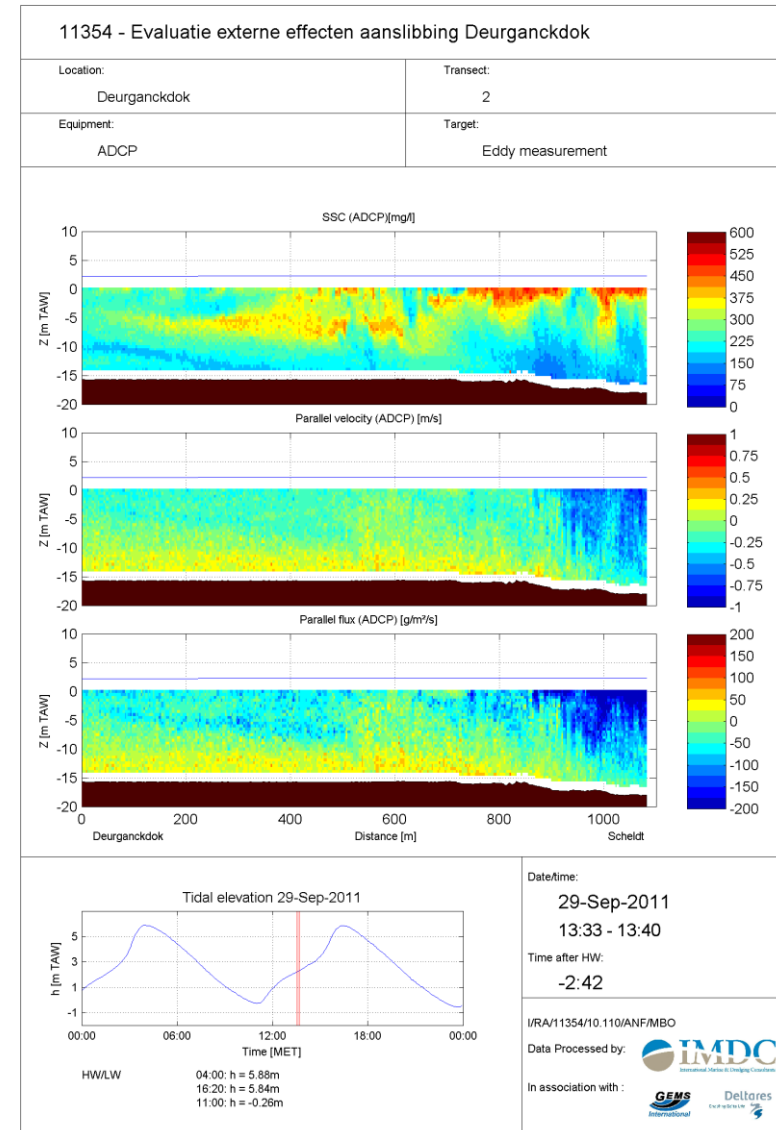
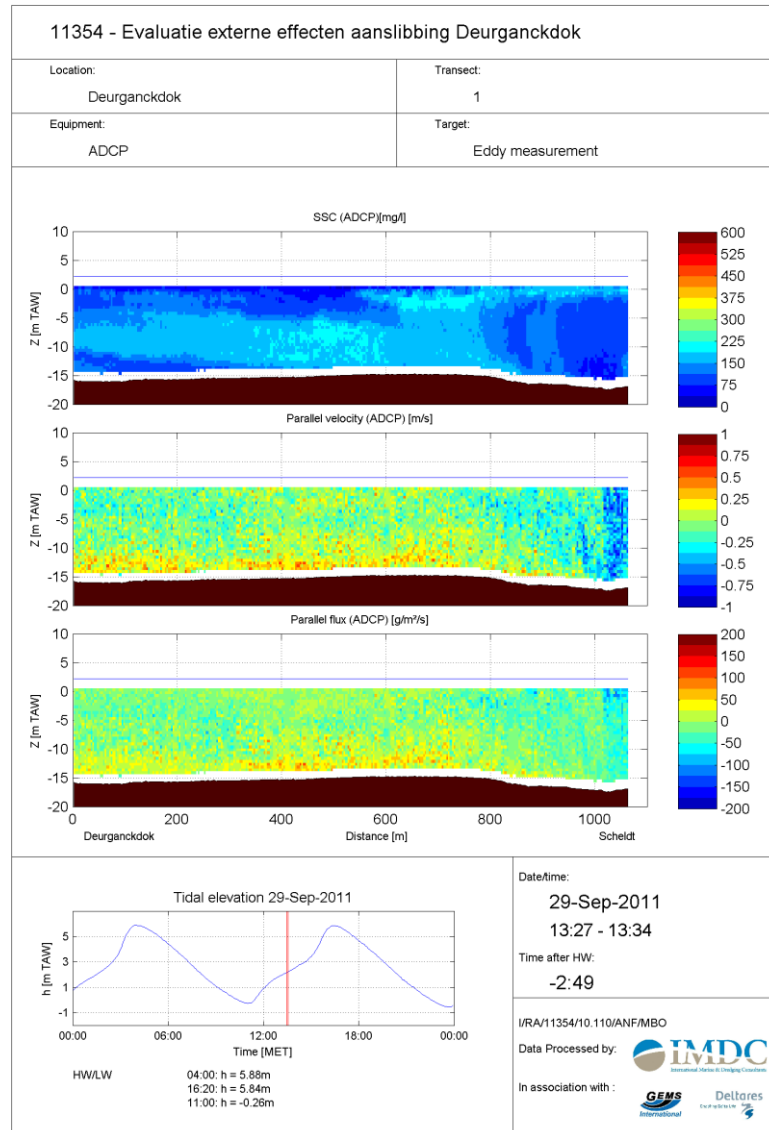


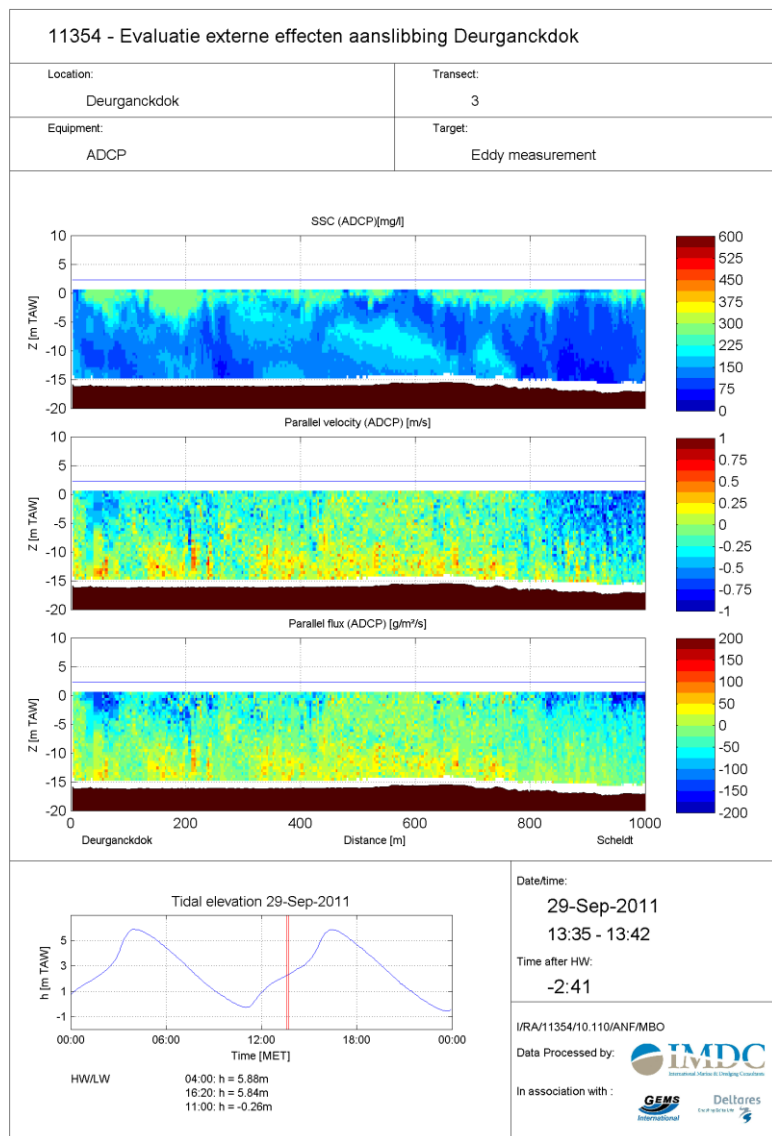


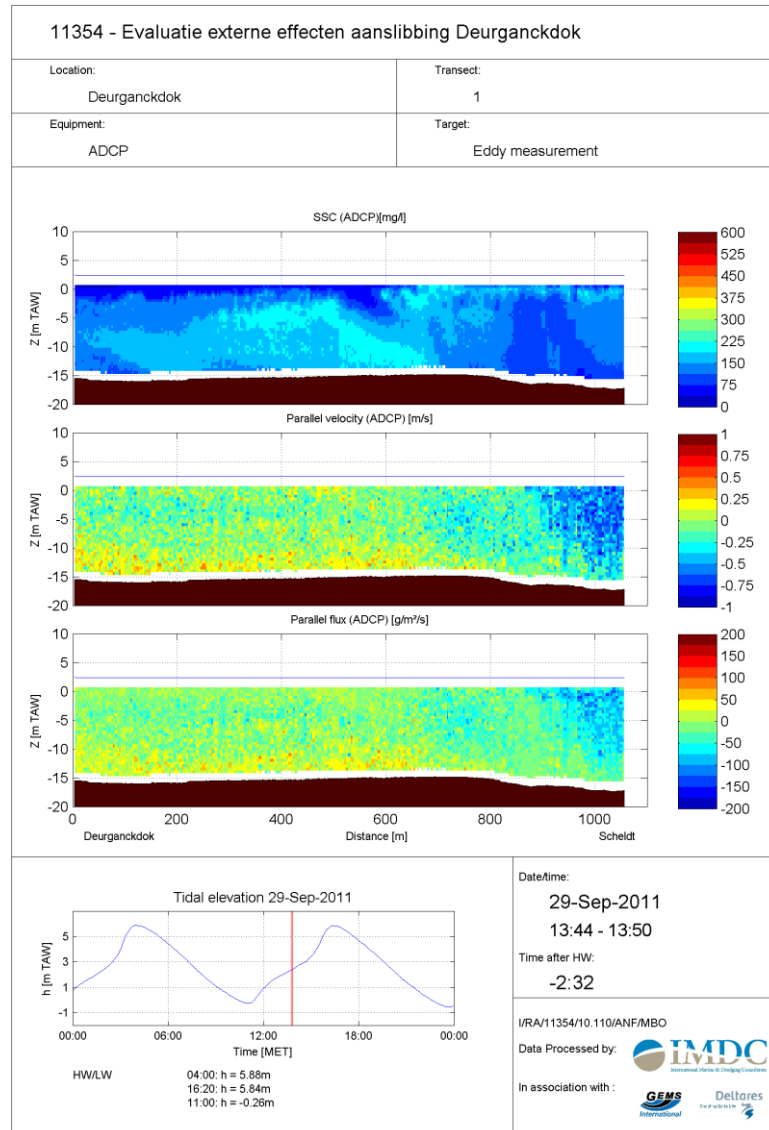




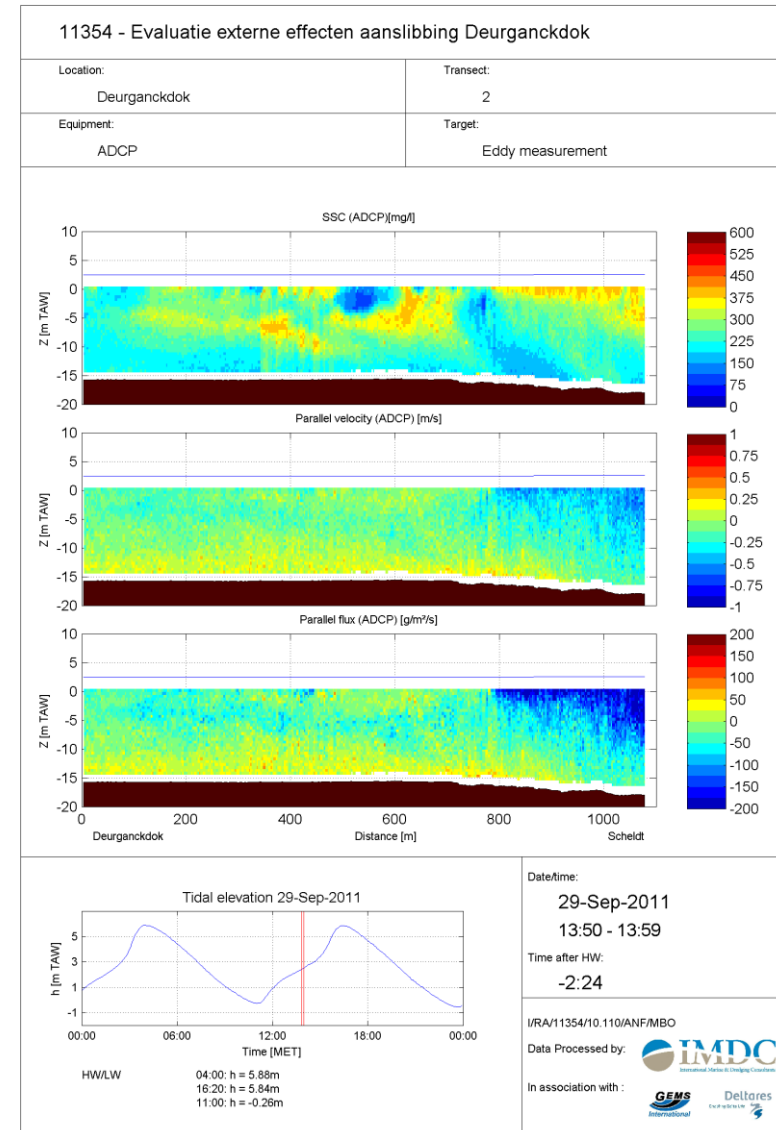






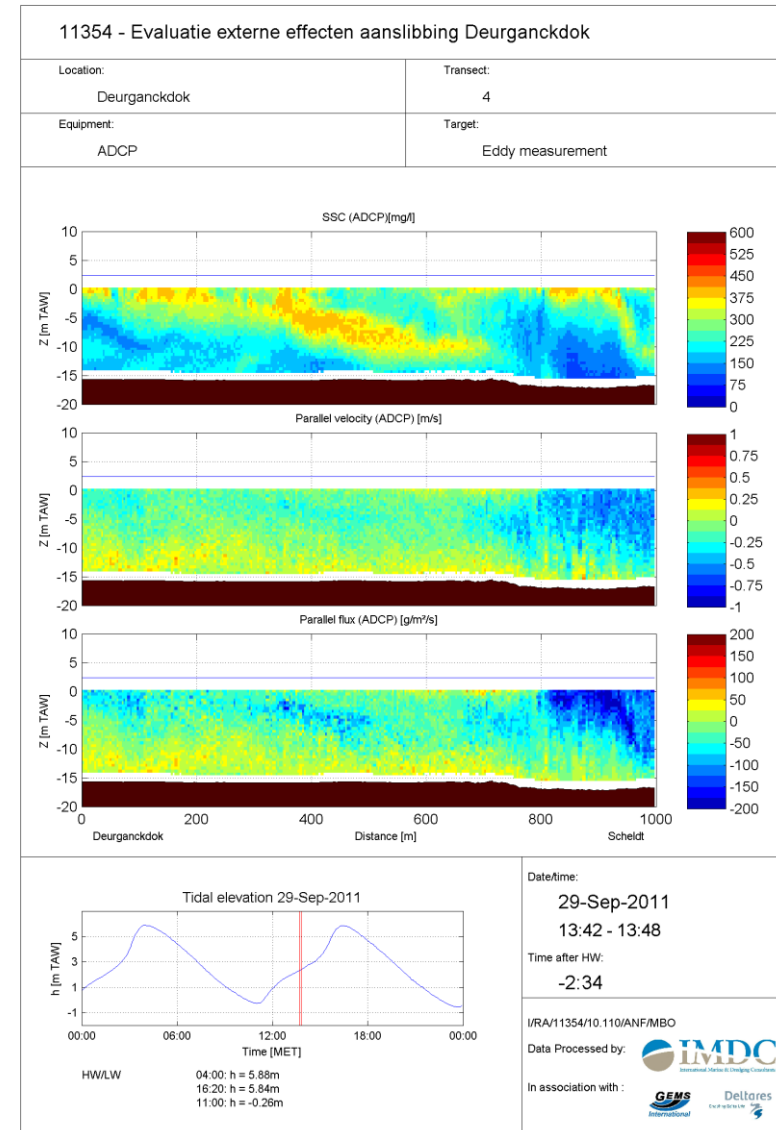
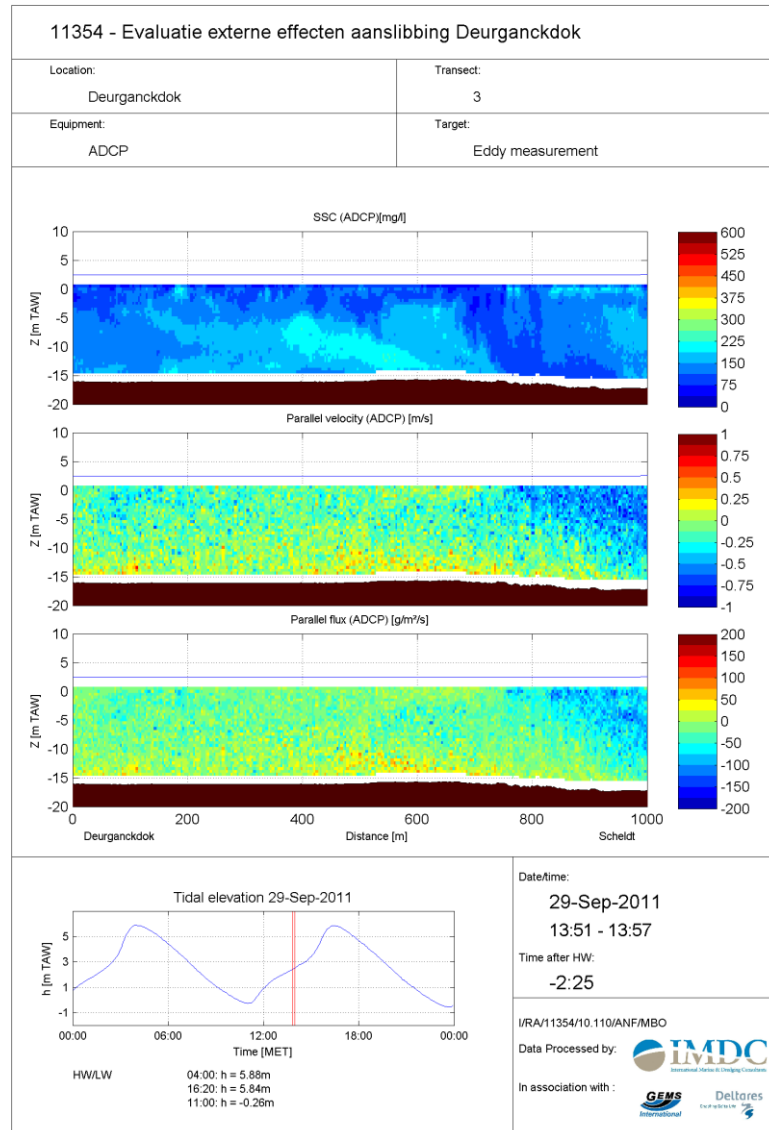


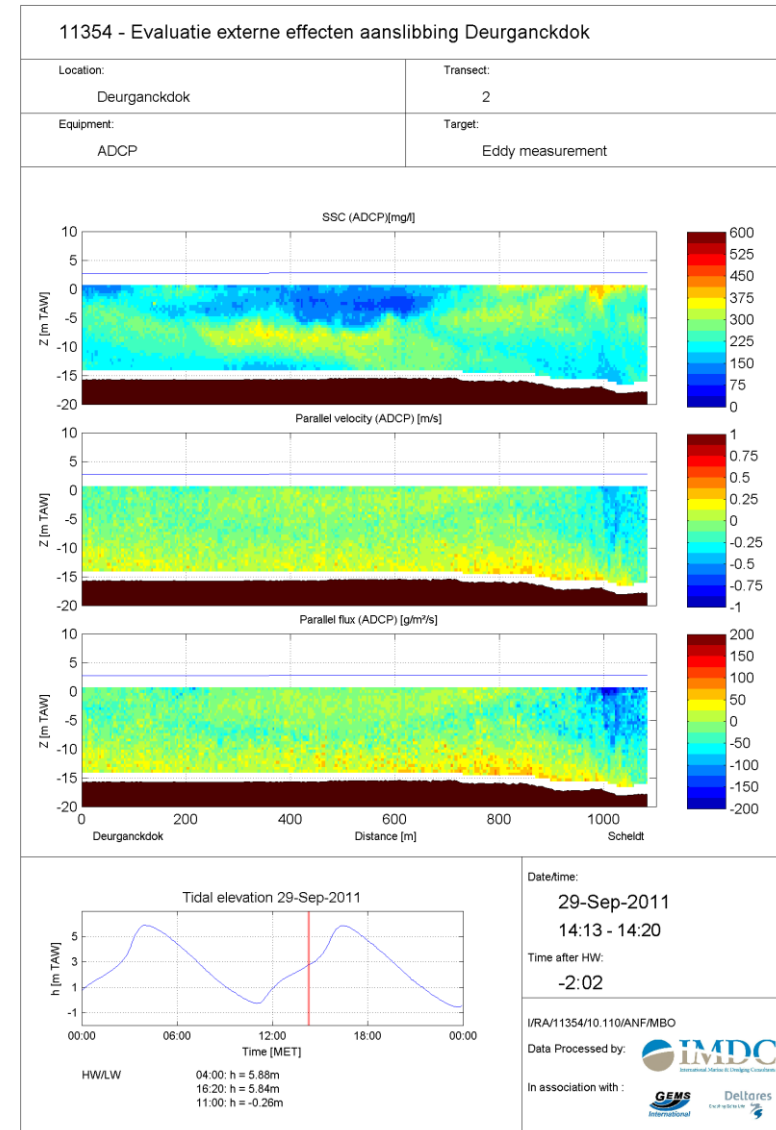
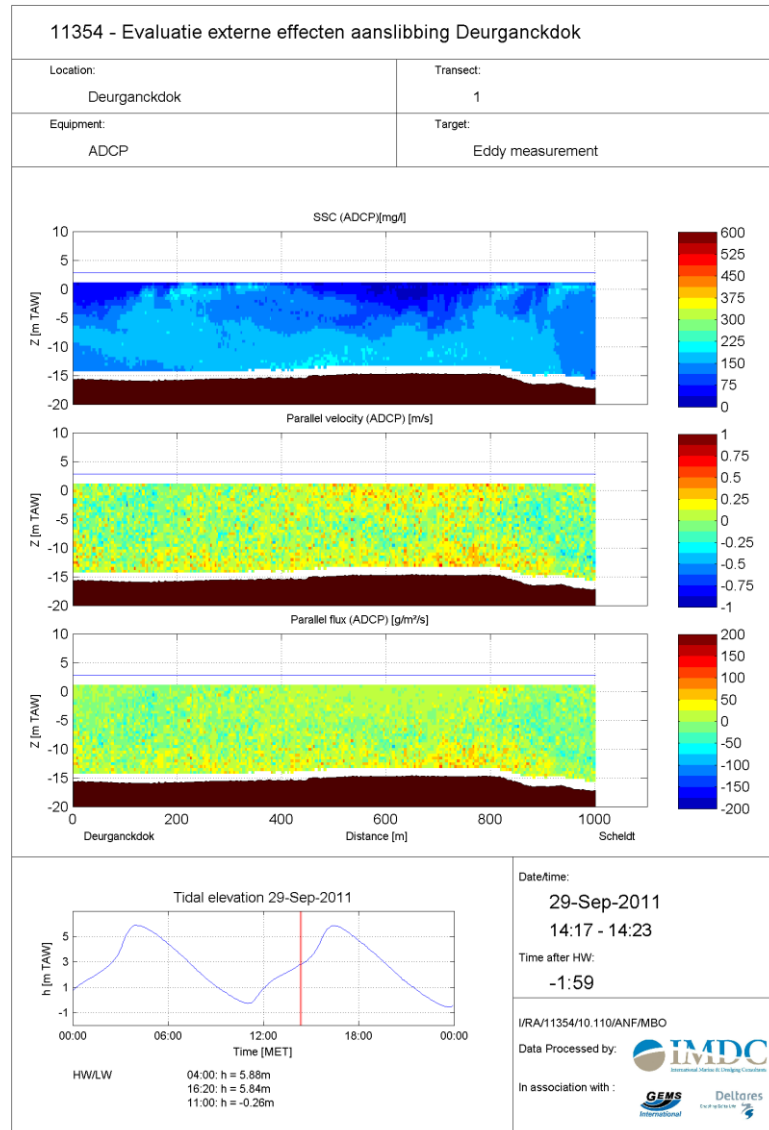
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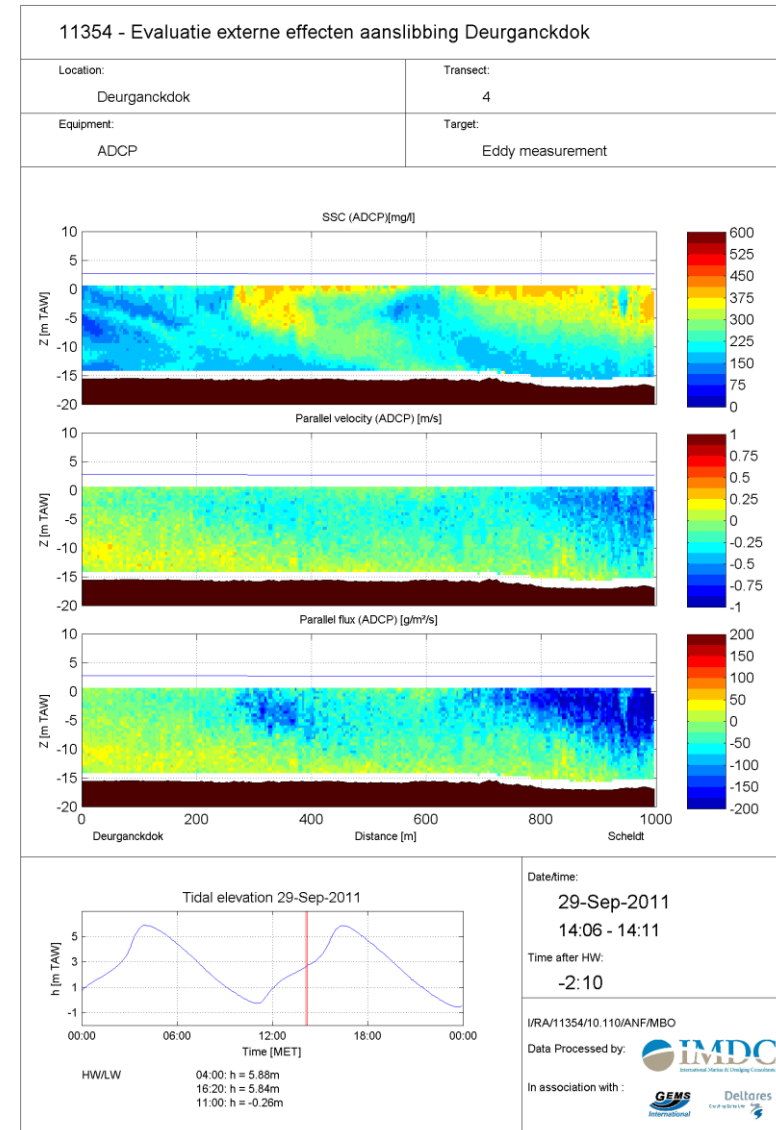


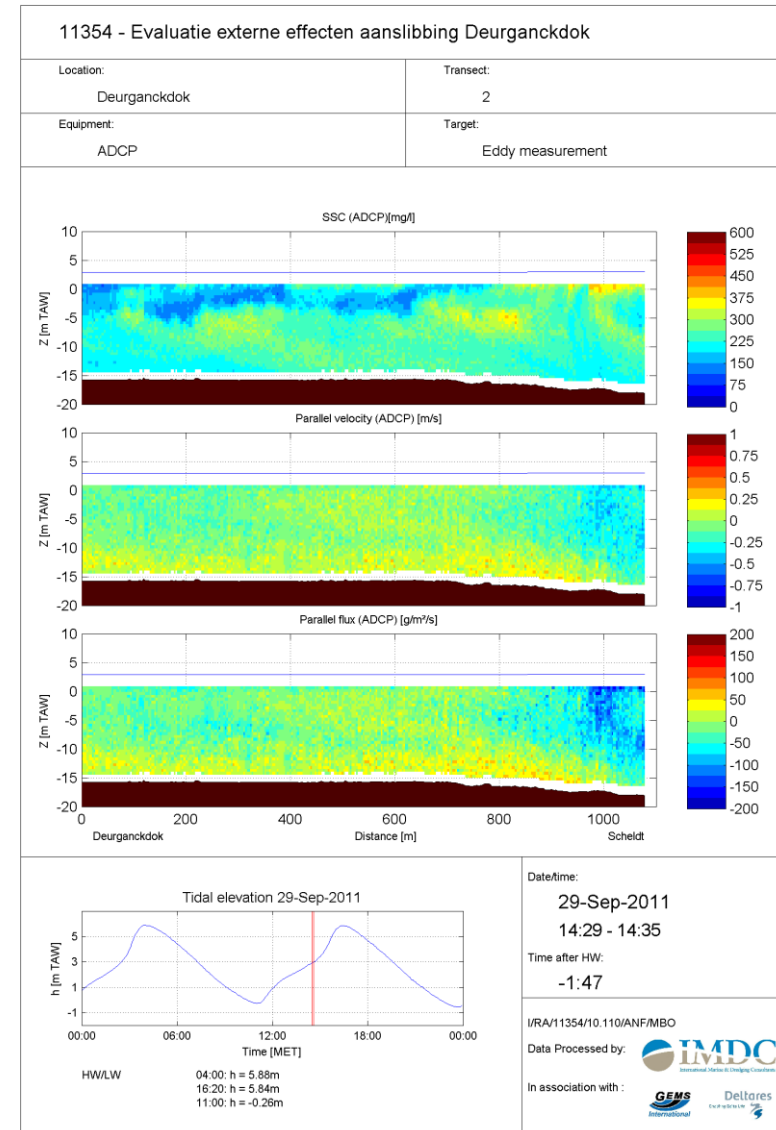
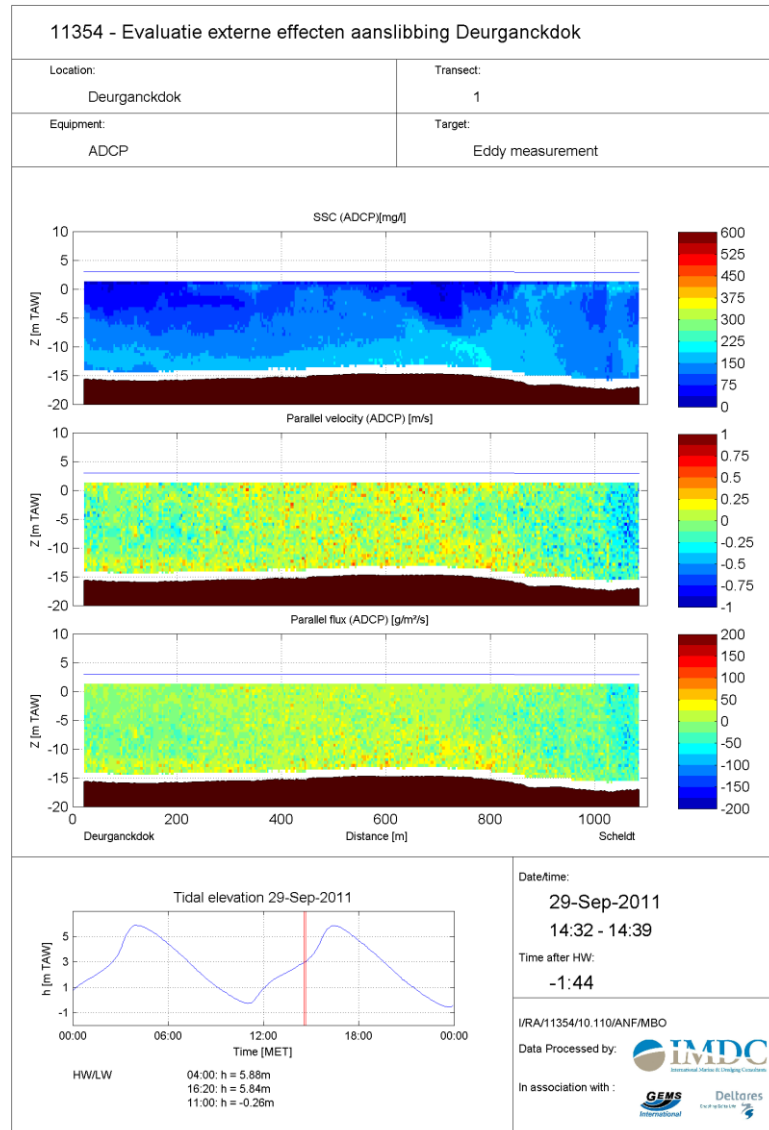
page 100

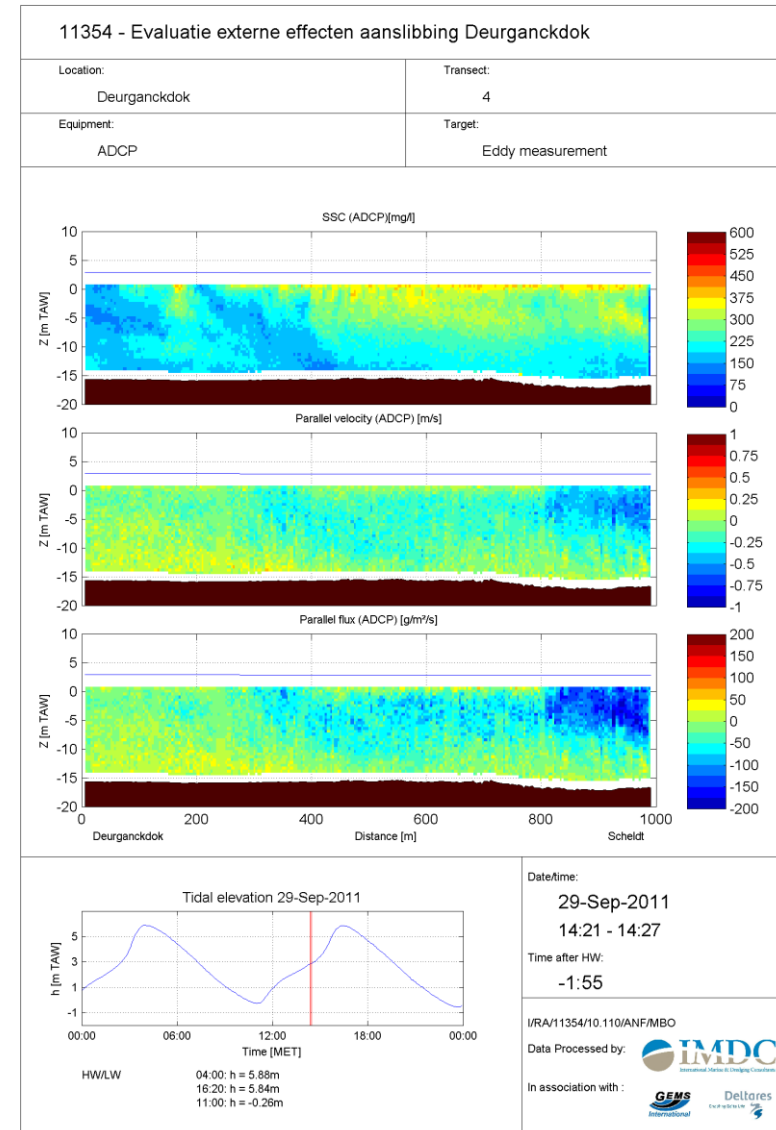
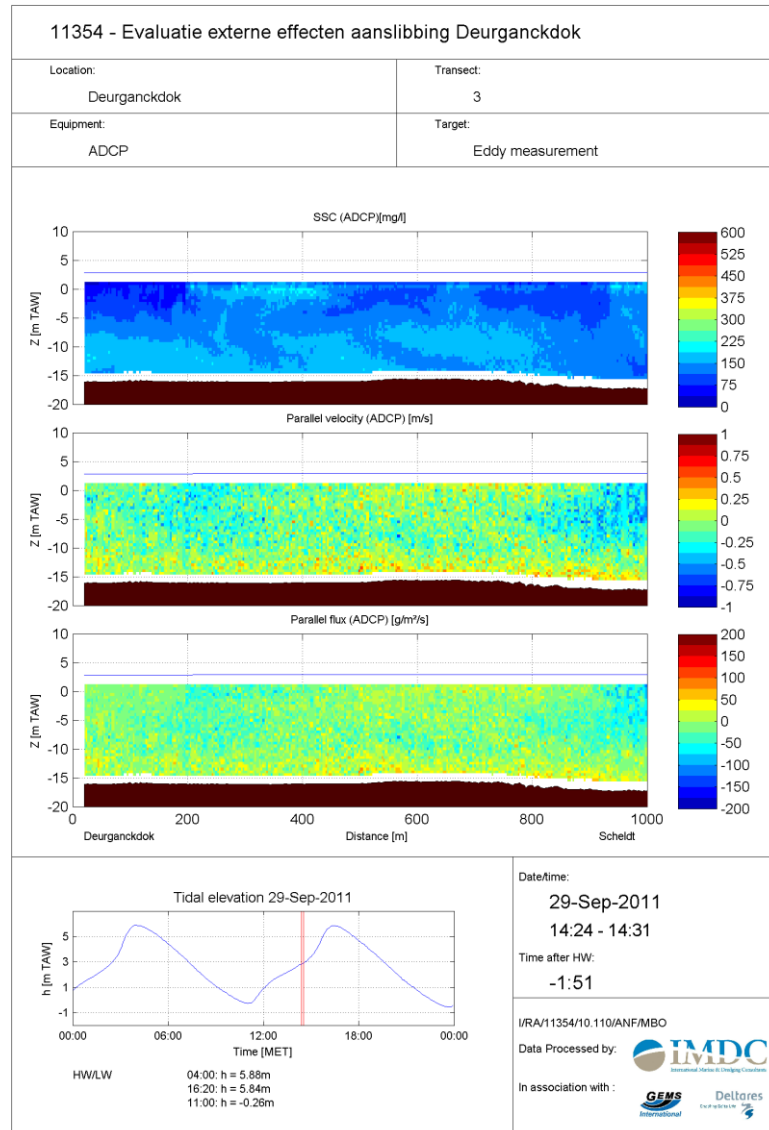
version 2.0 - 15/10/2012

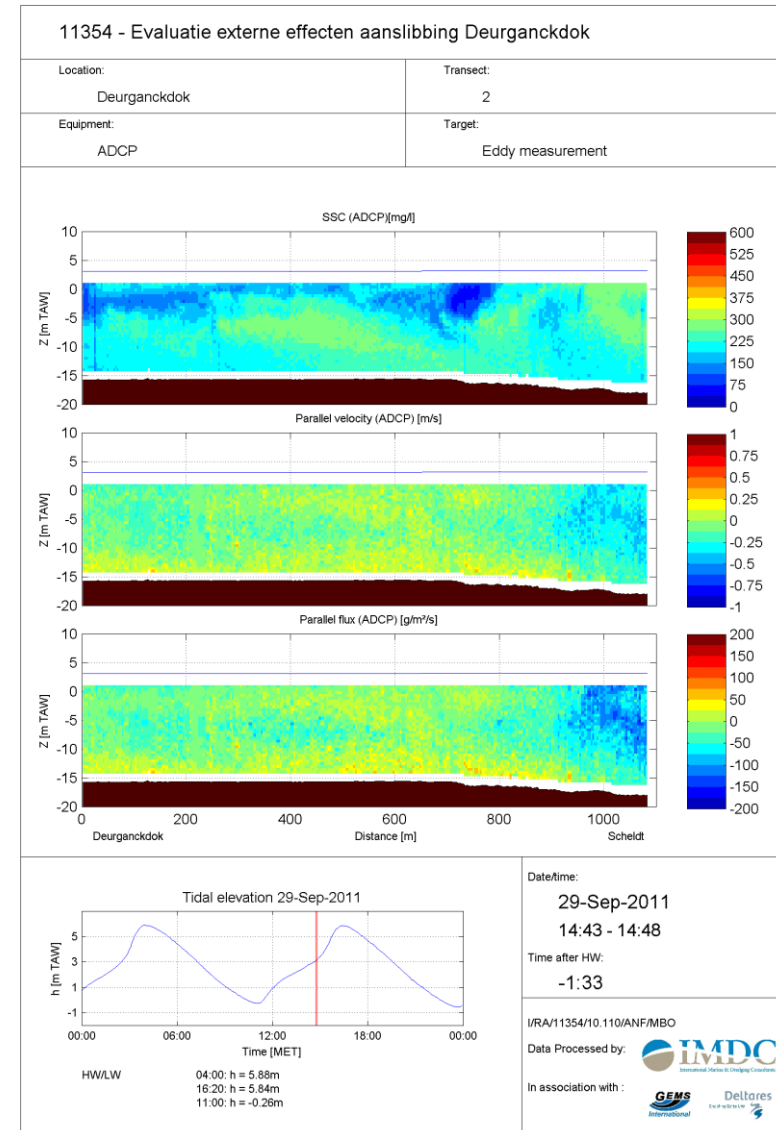
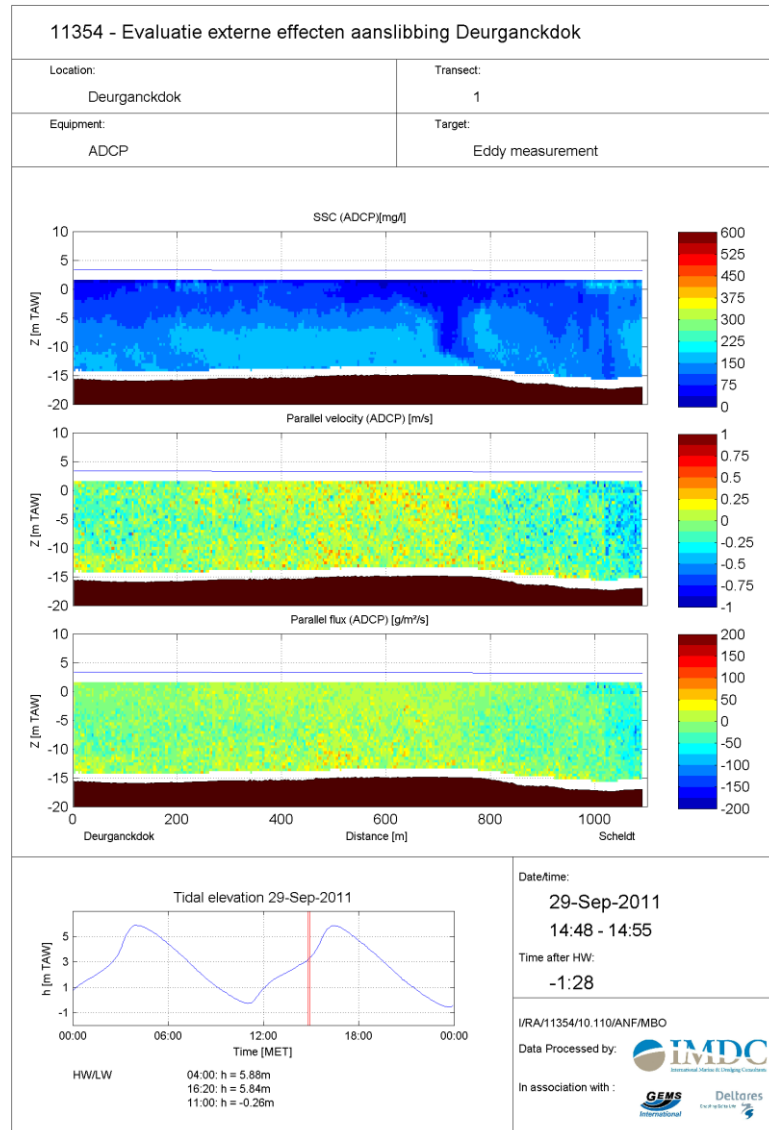


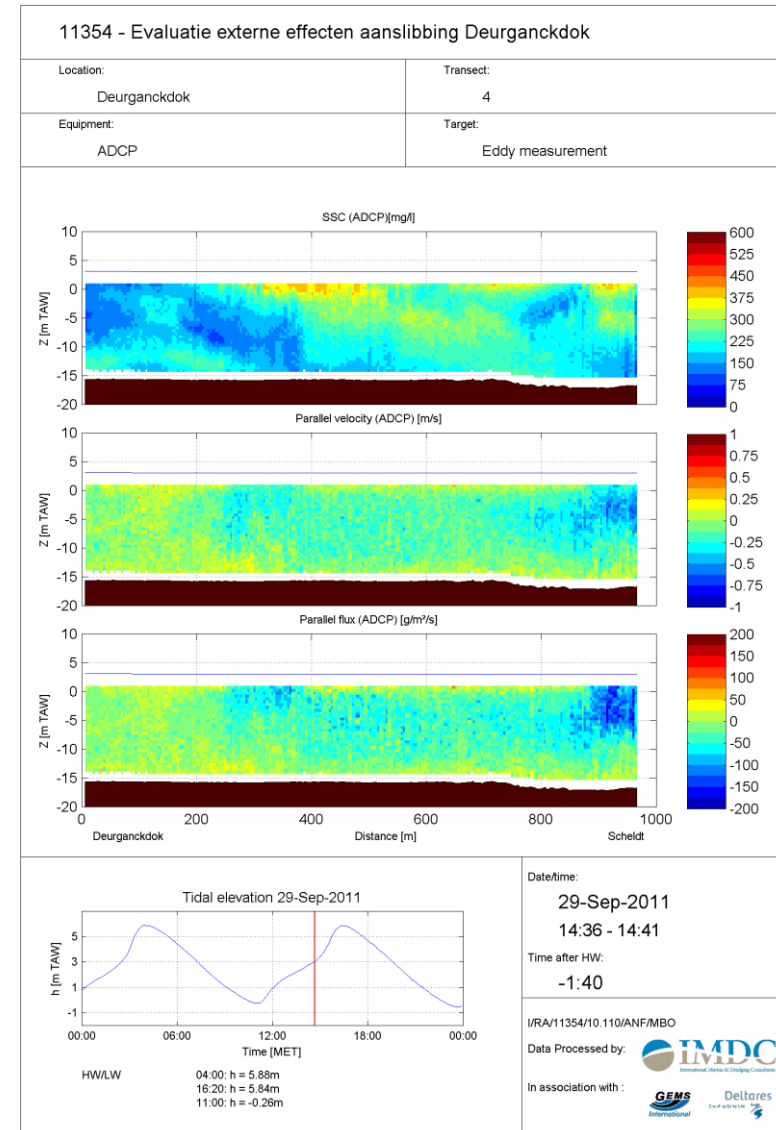
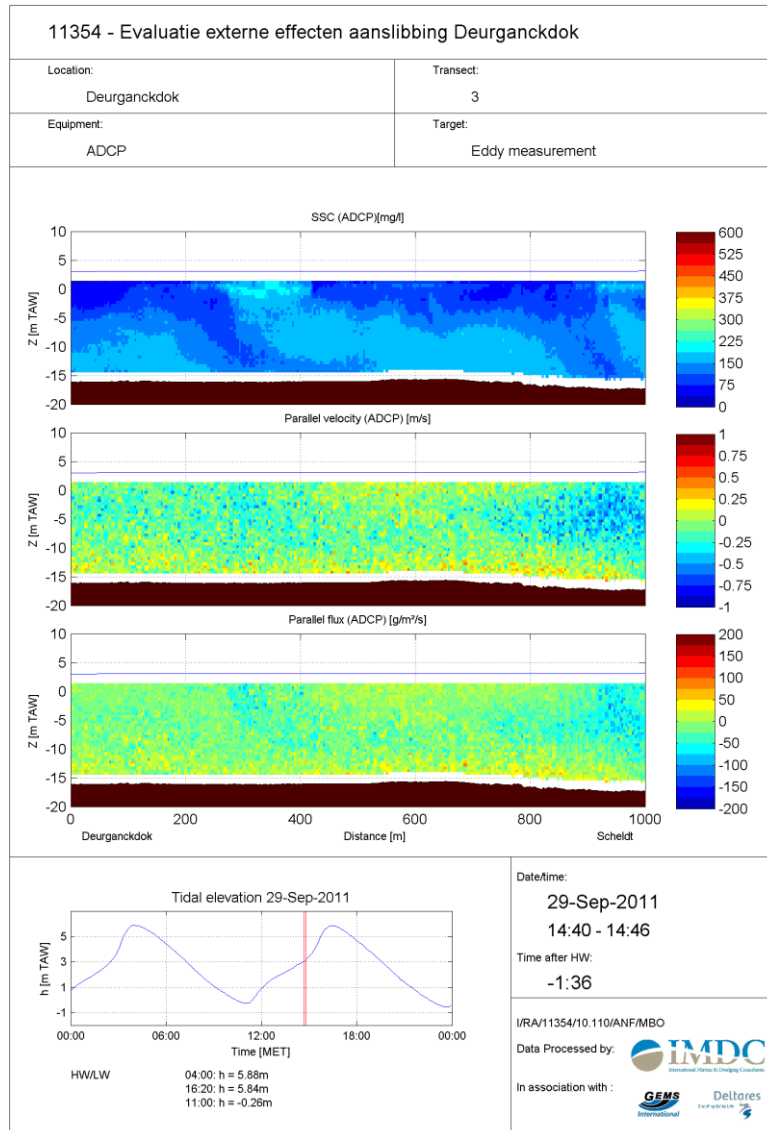


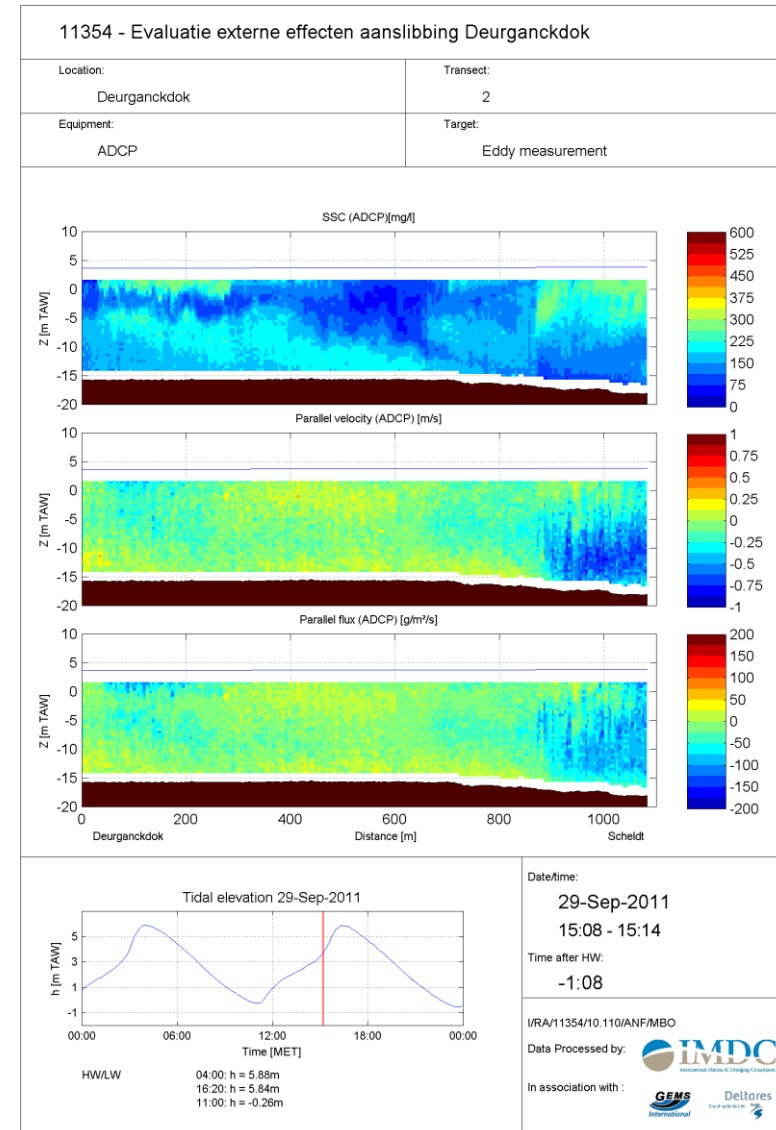
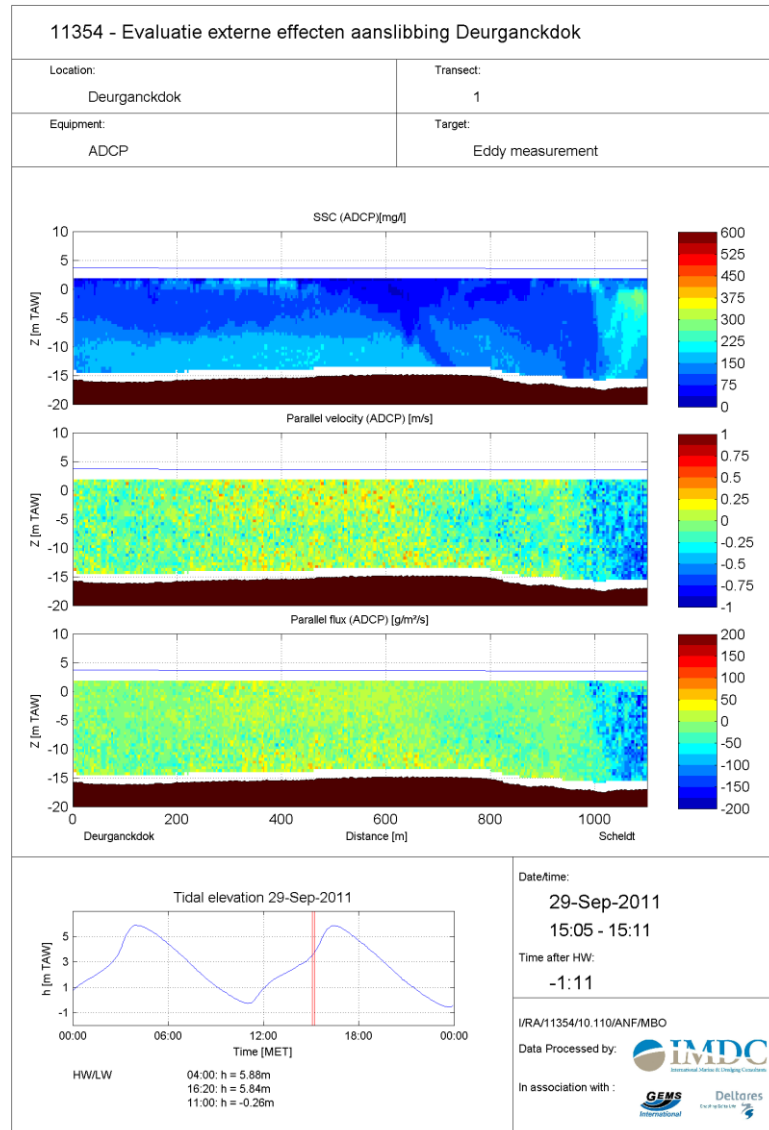


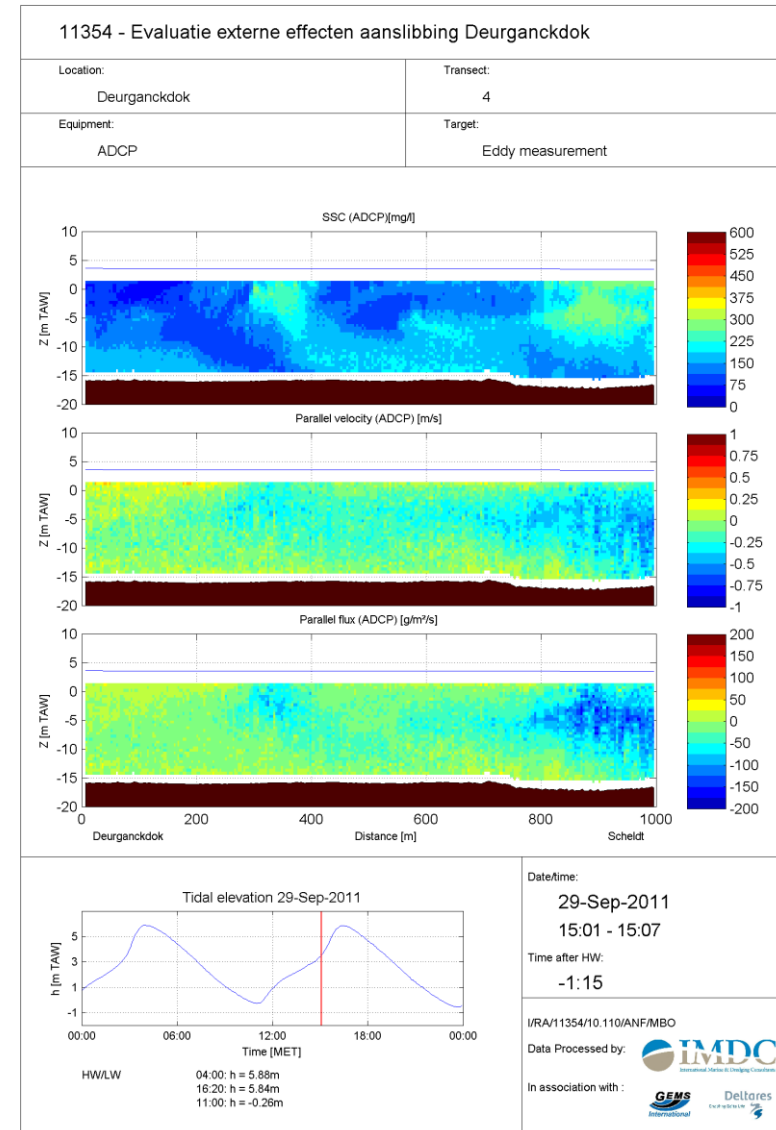
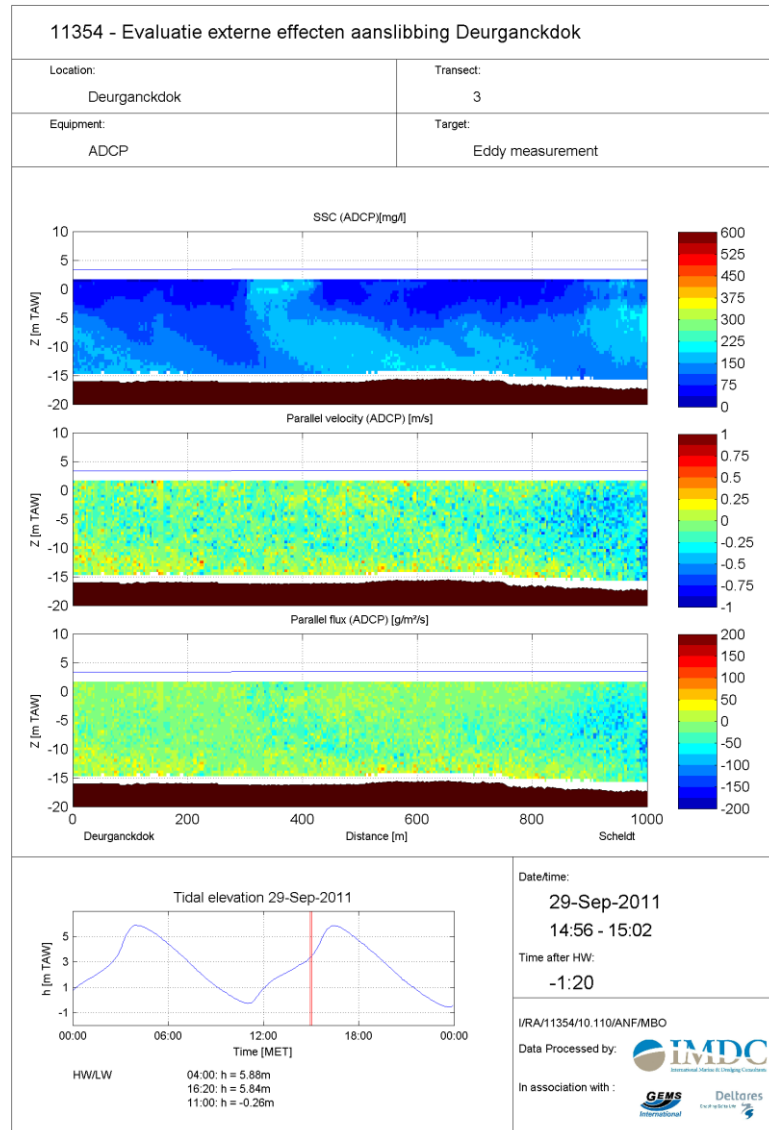


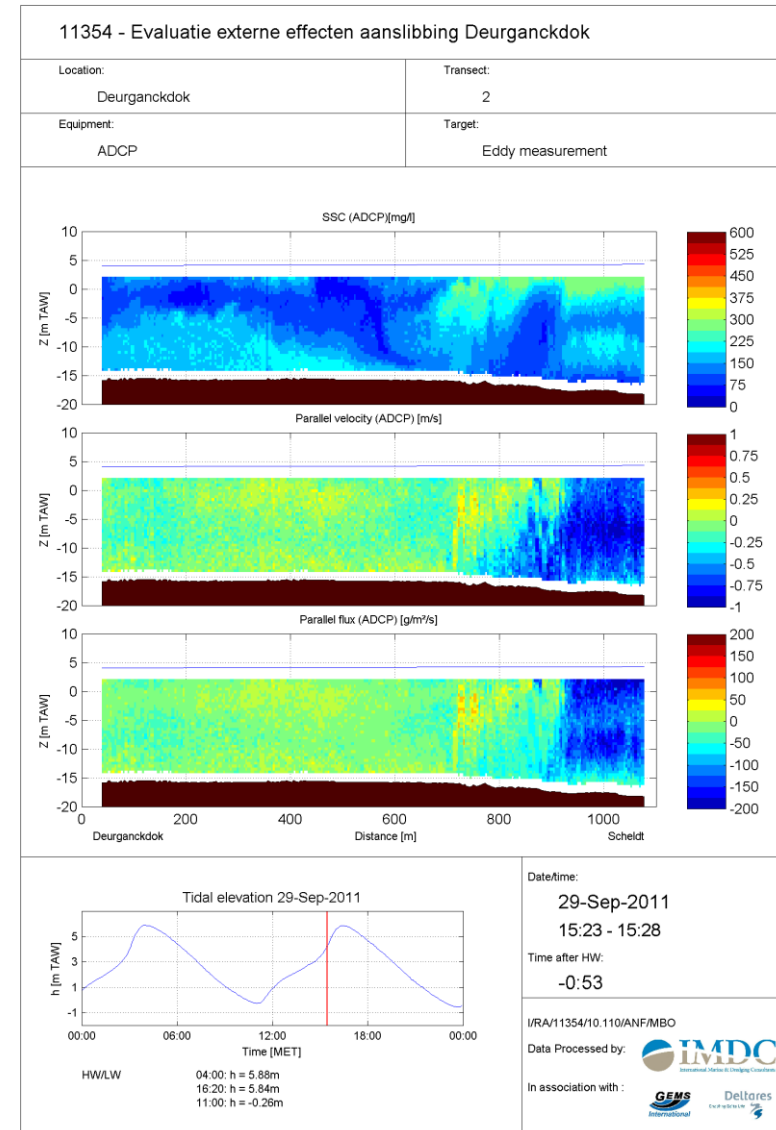
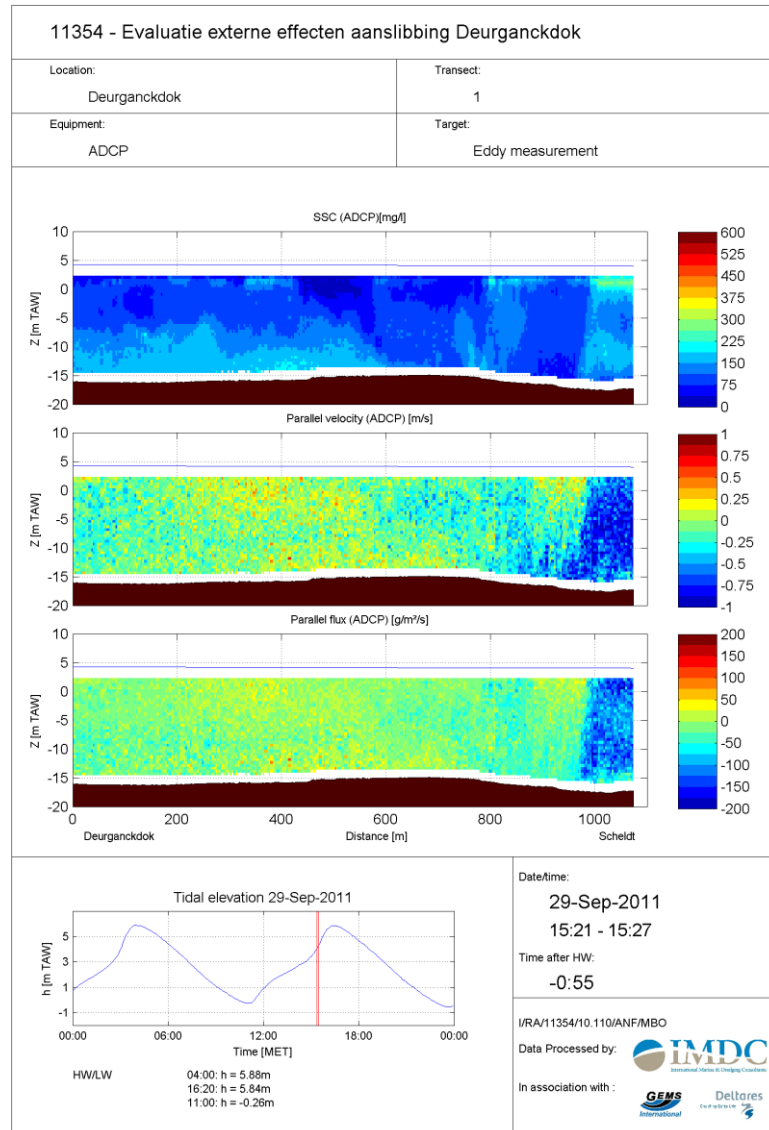


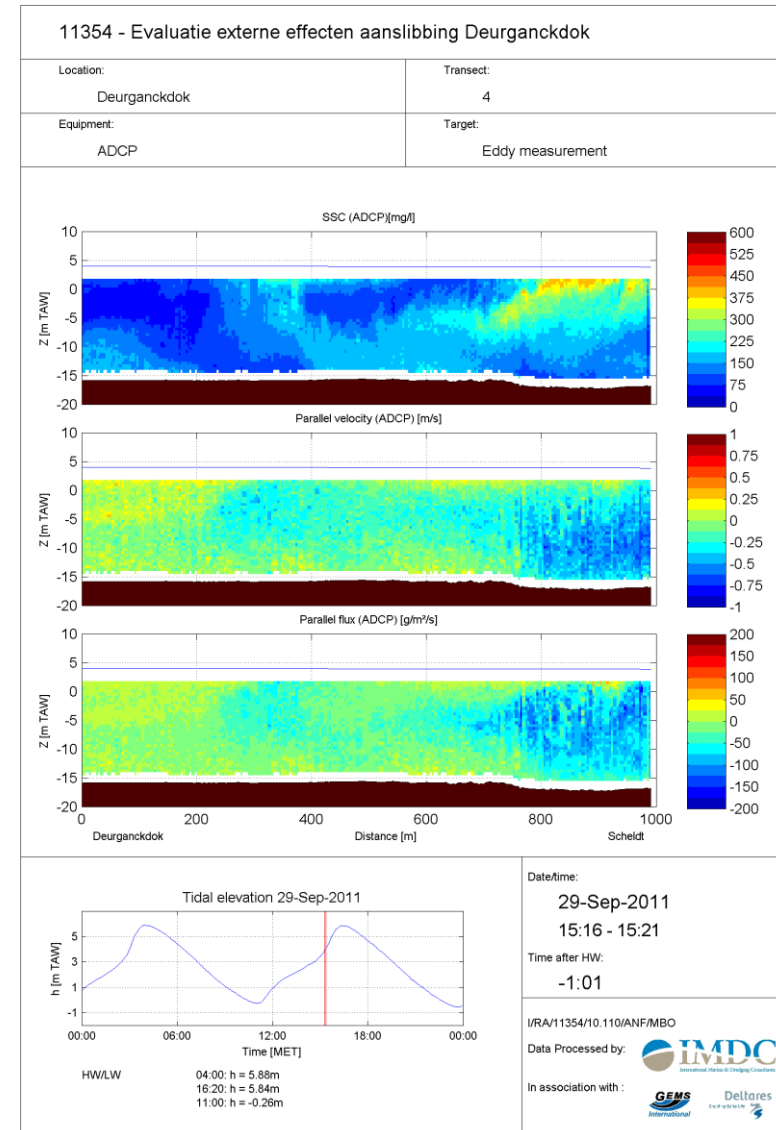
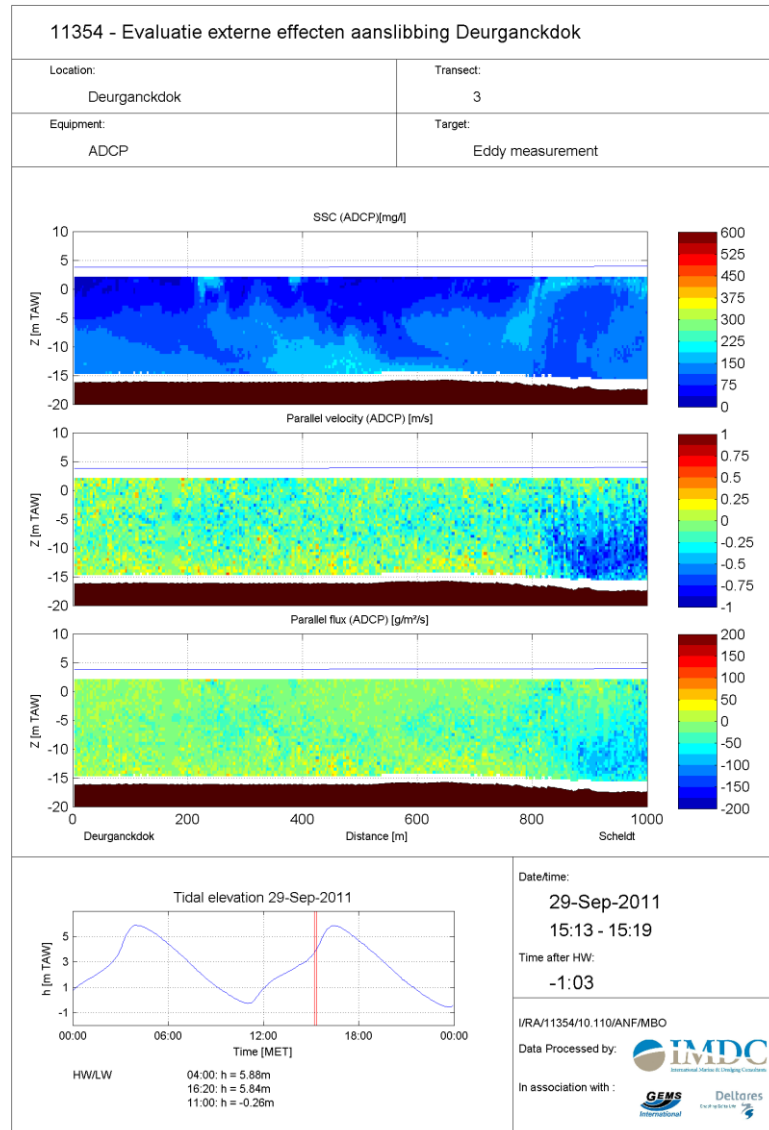


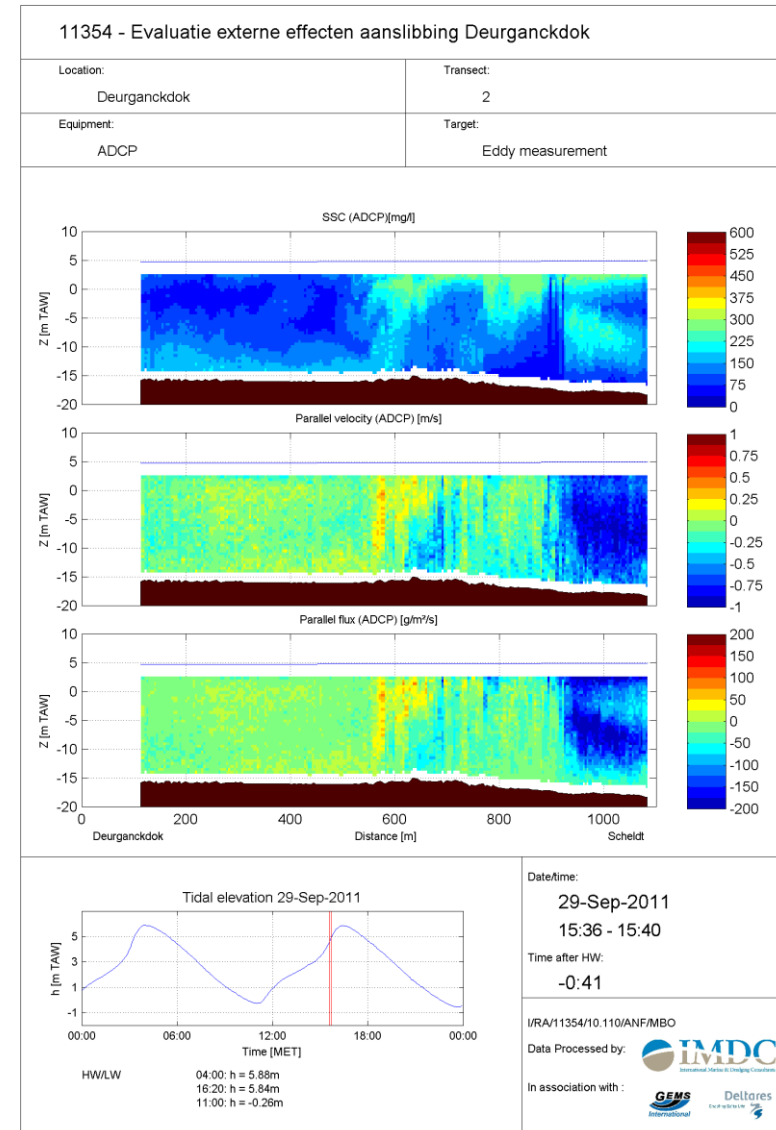
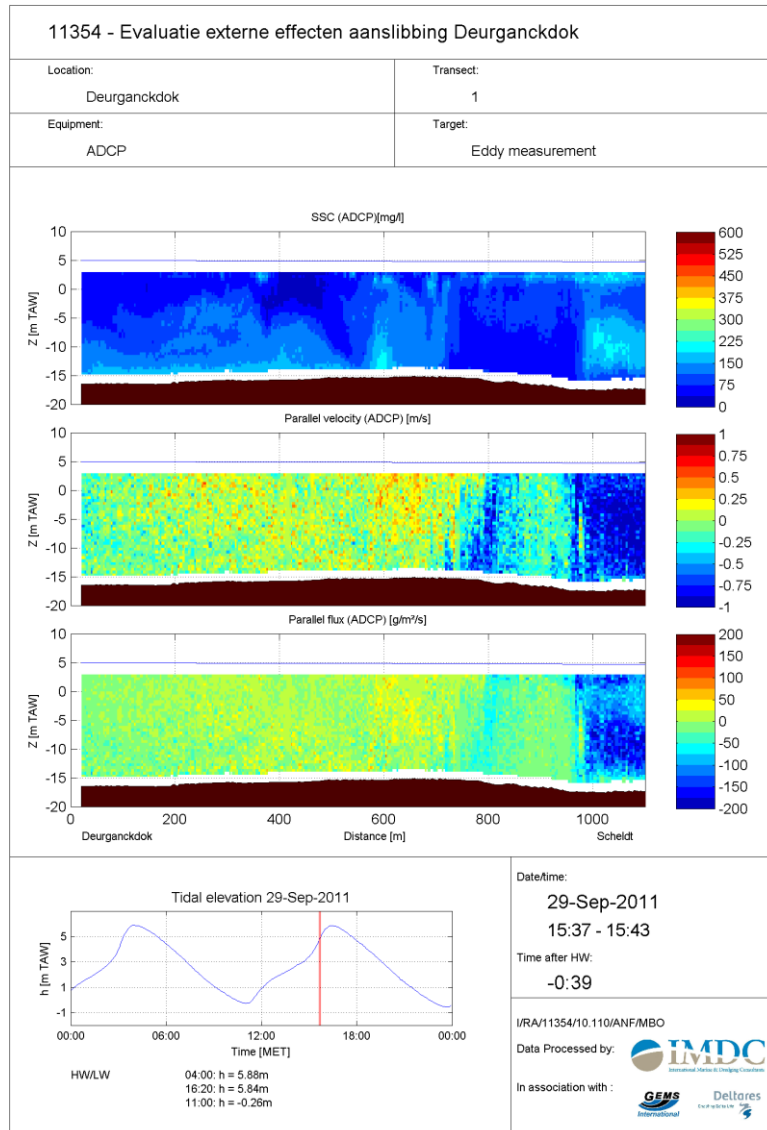


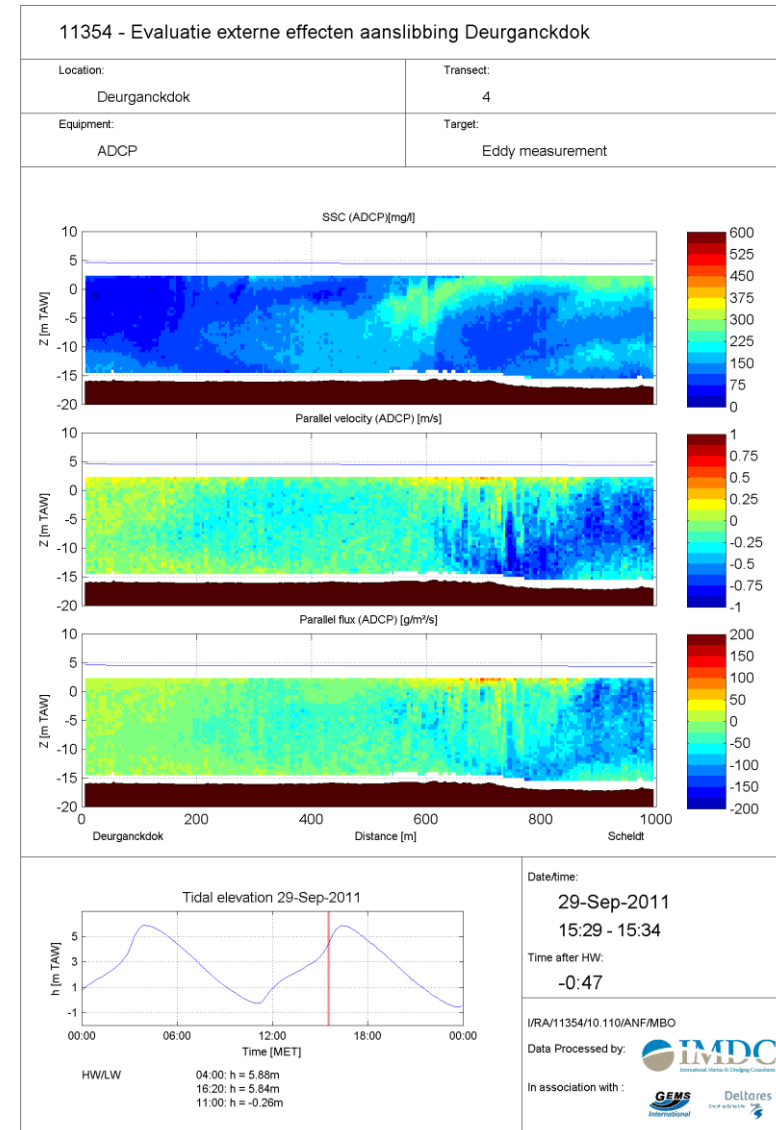
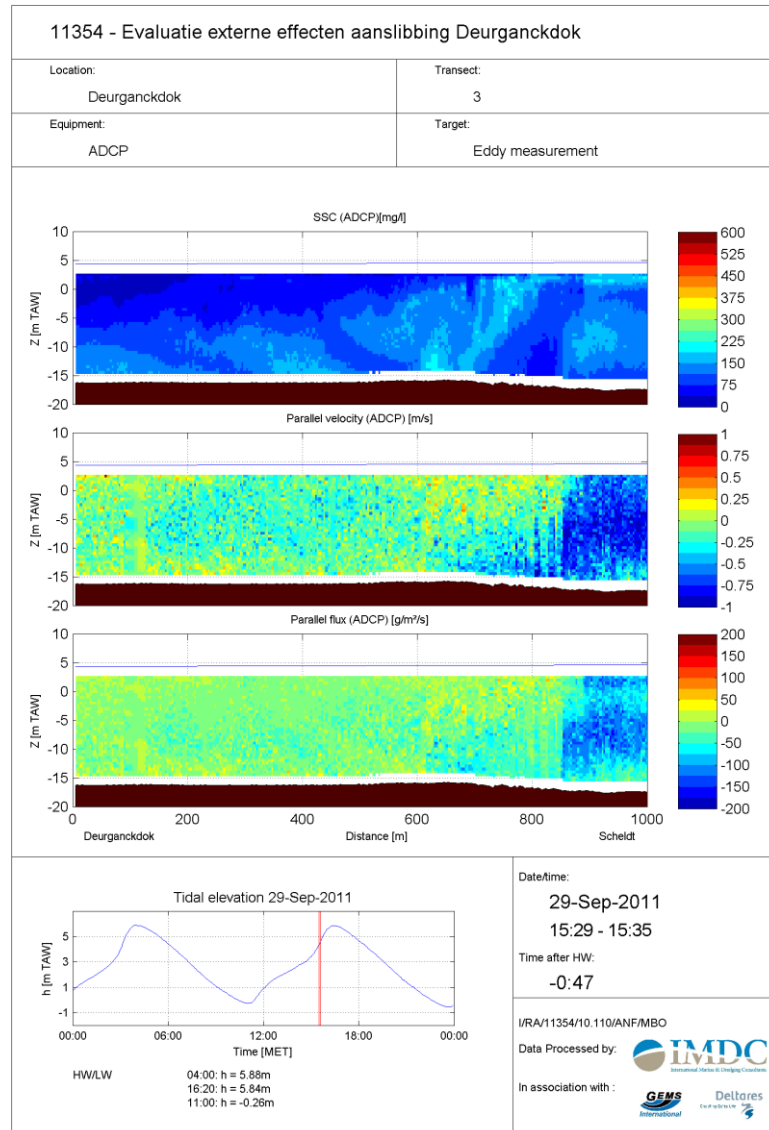


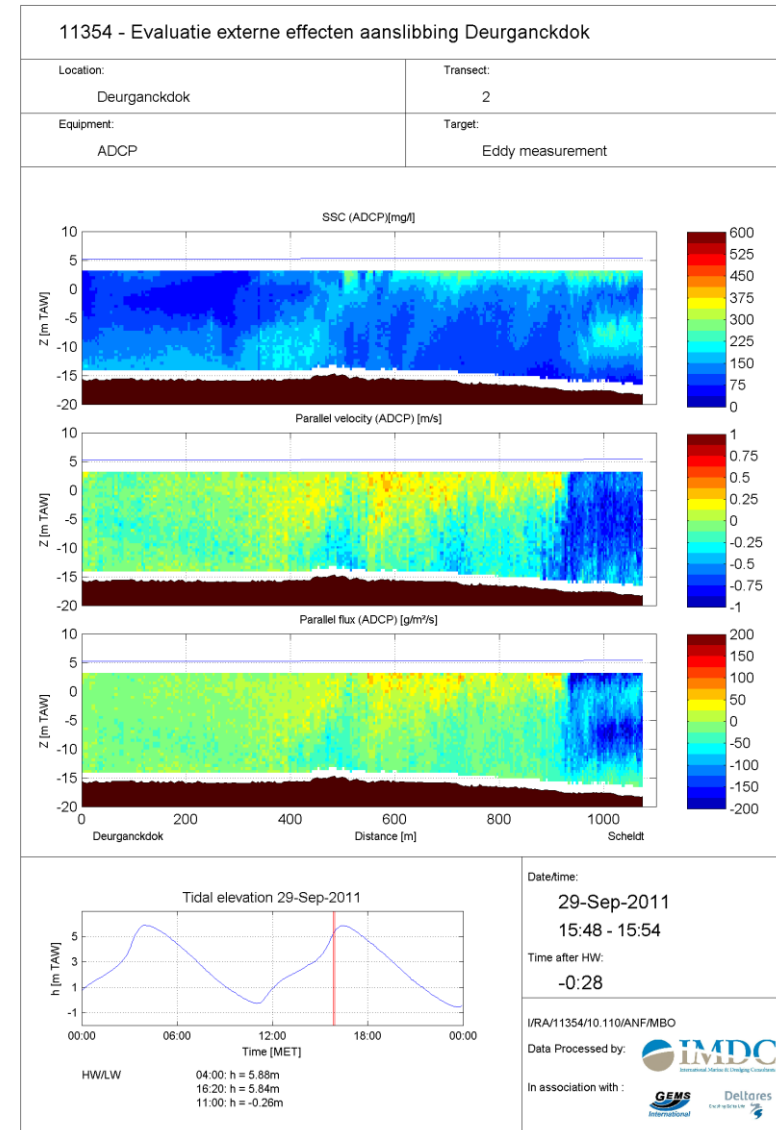


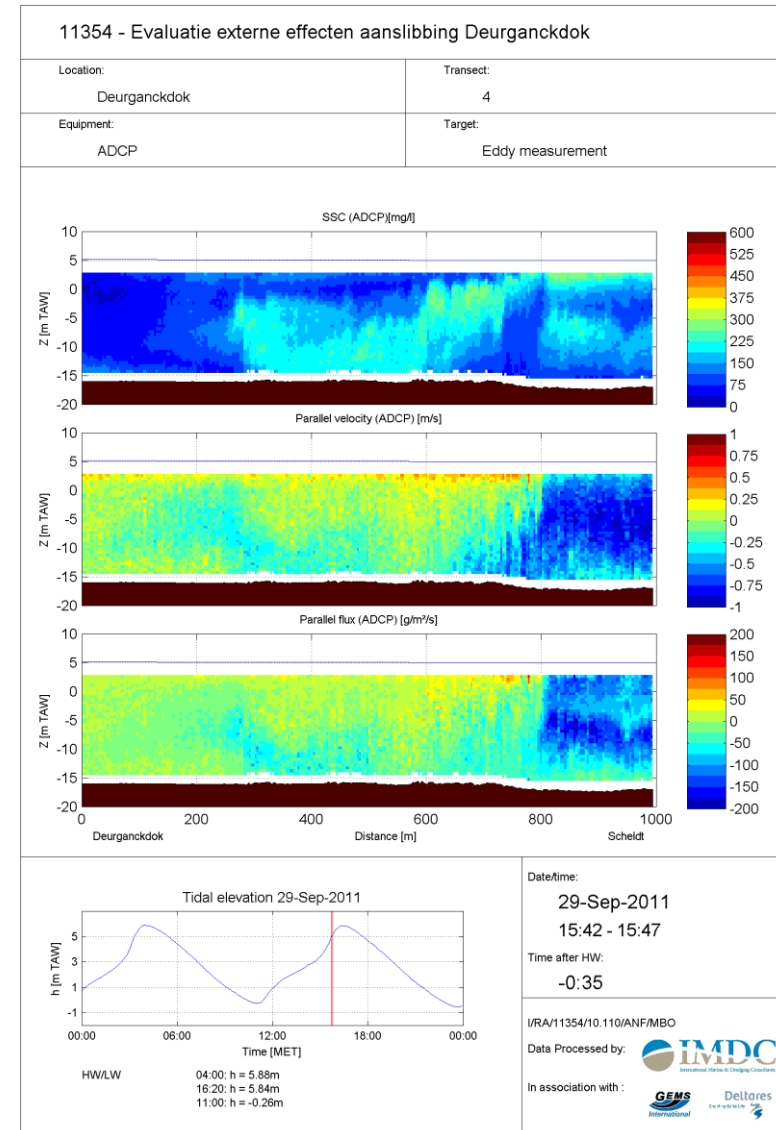
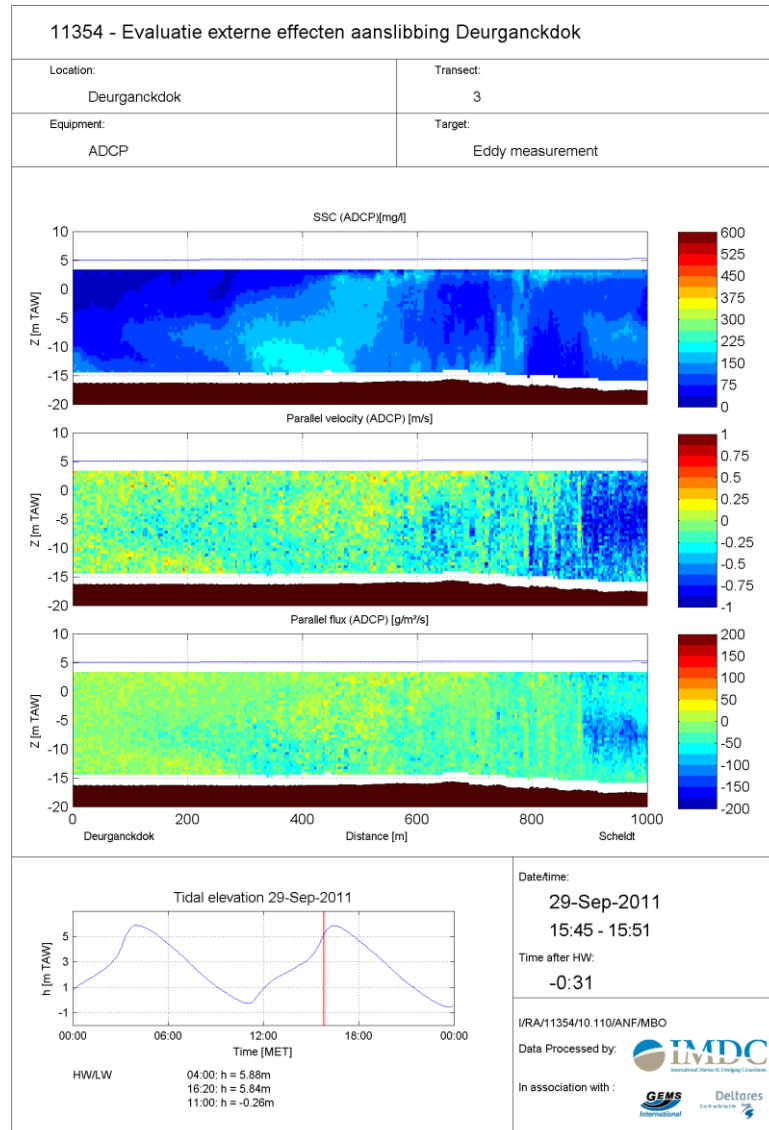


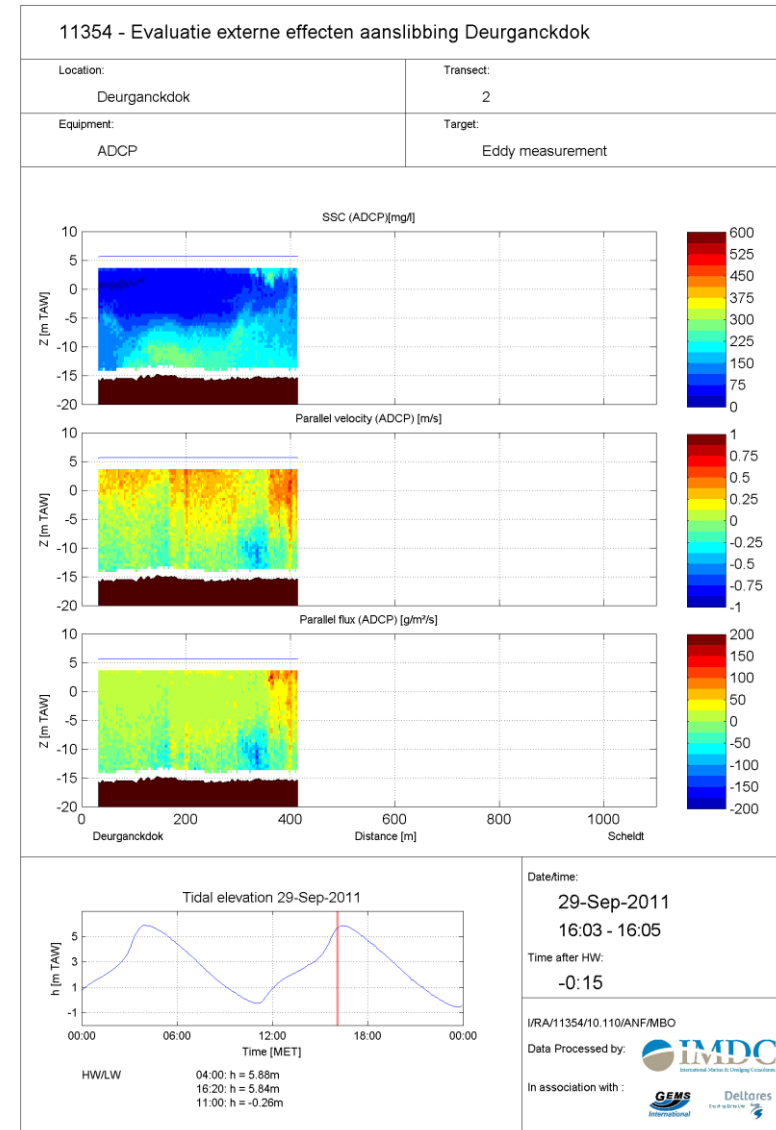
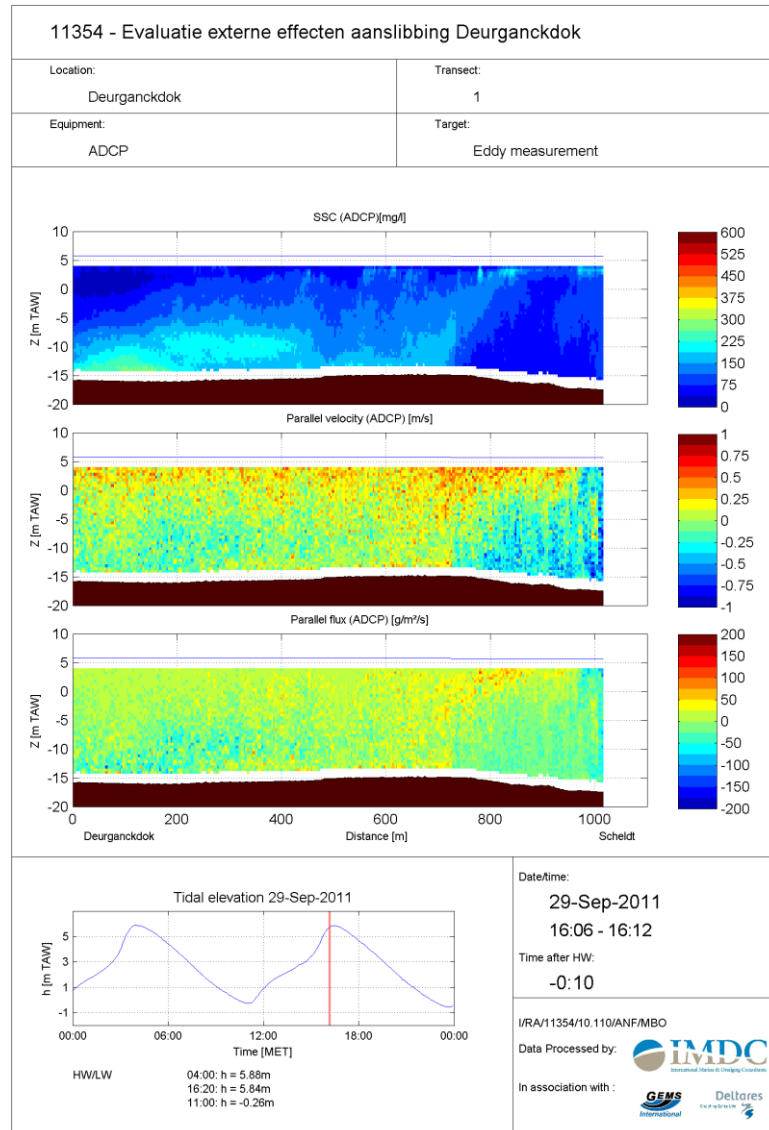


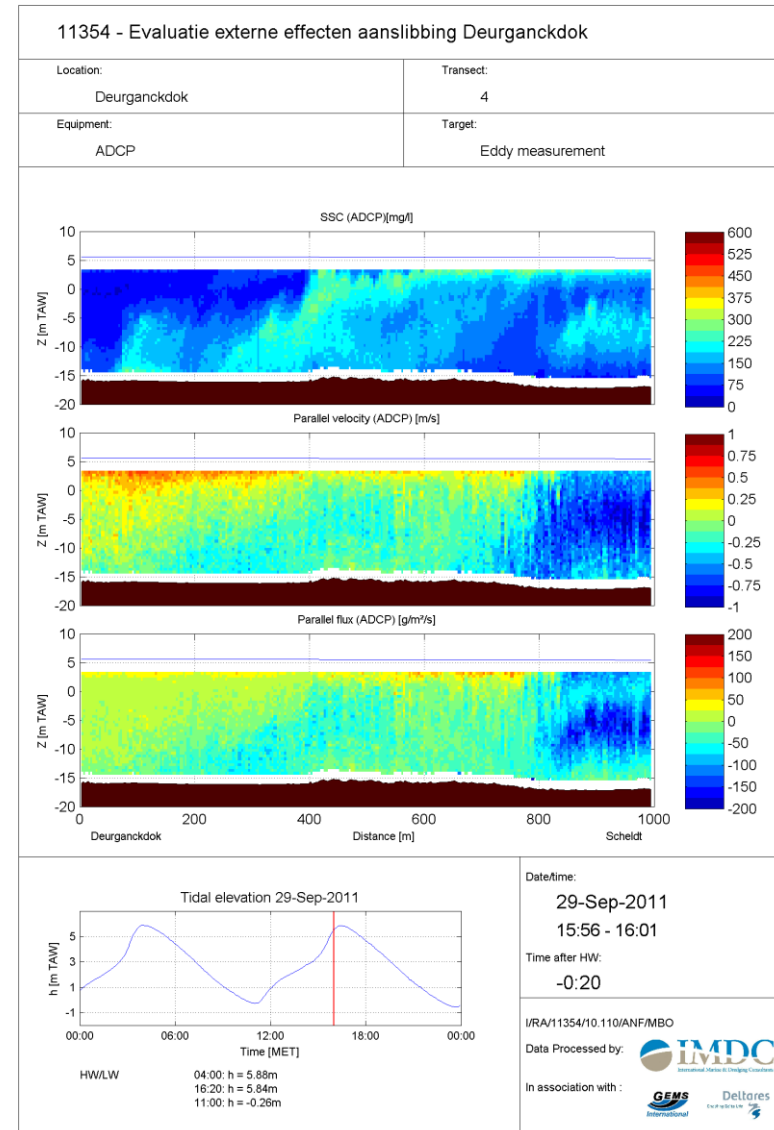


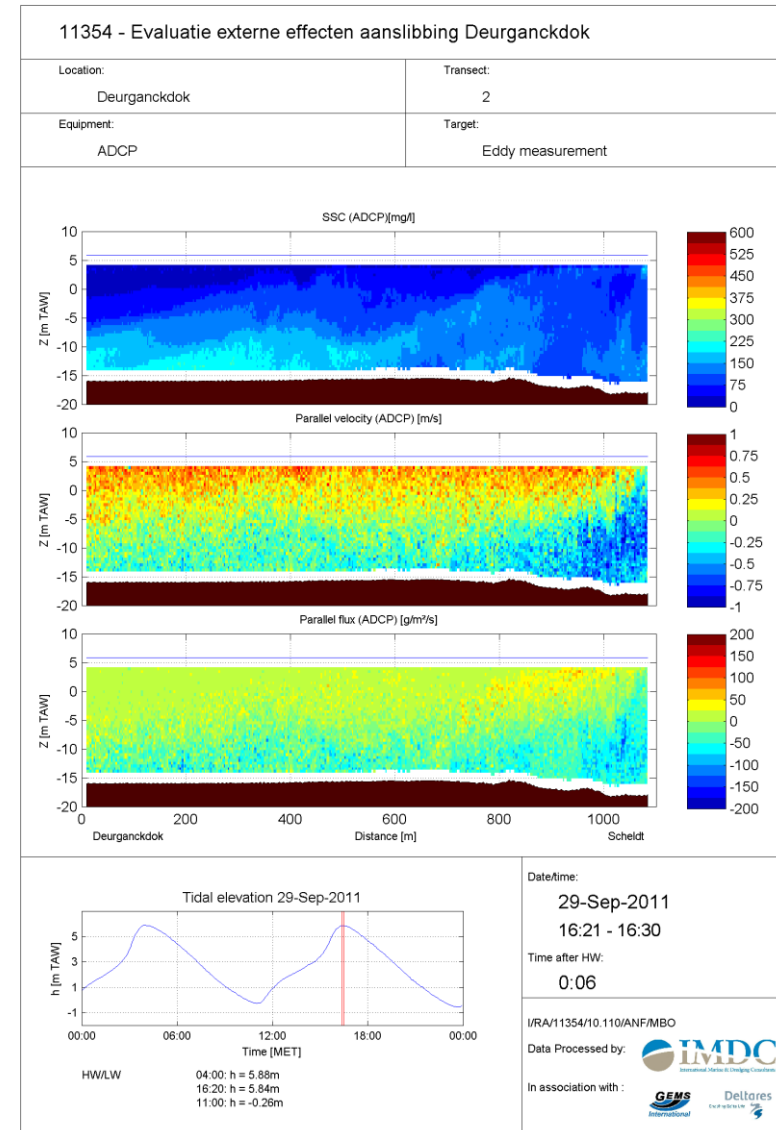
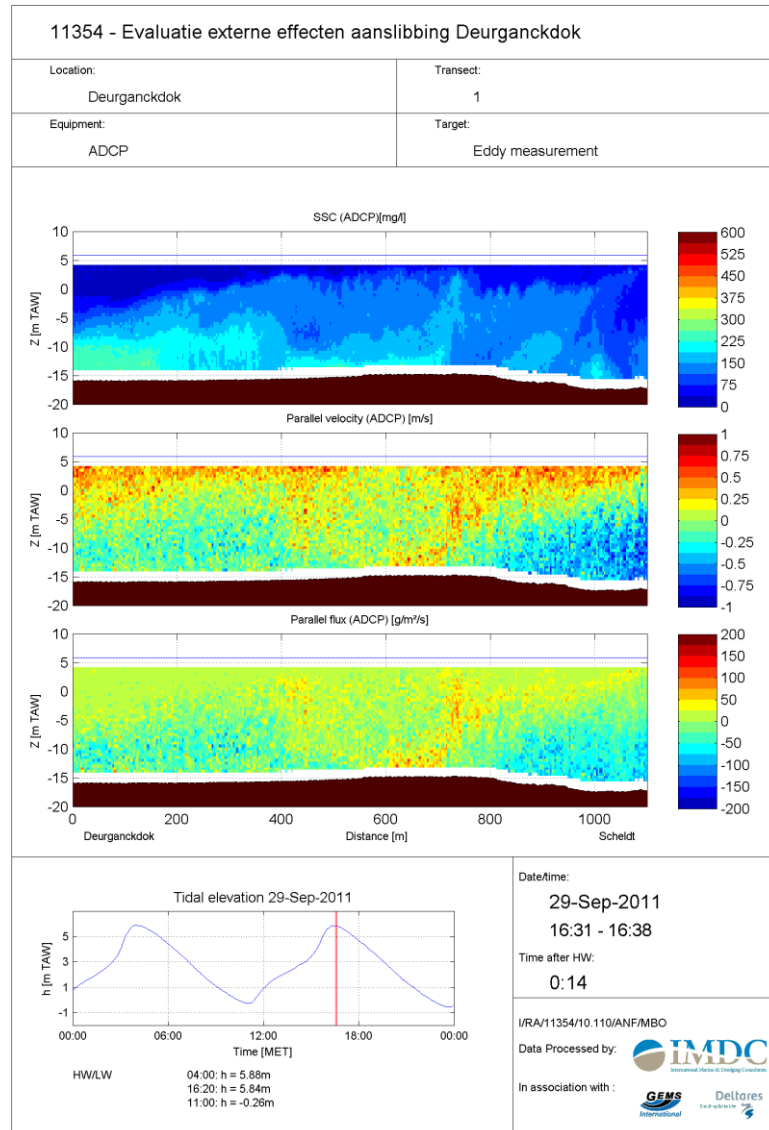


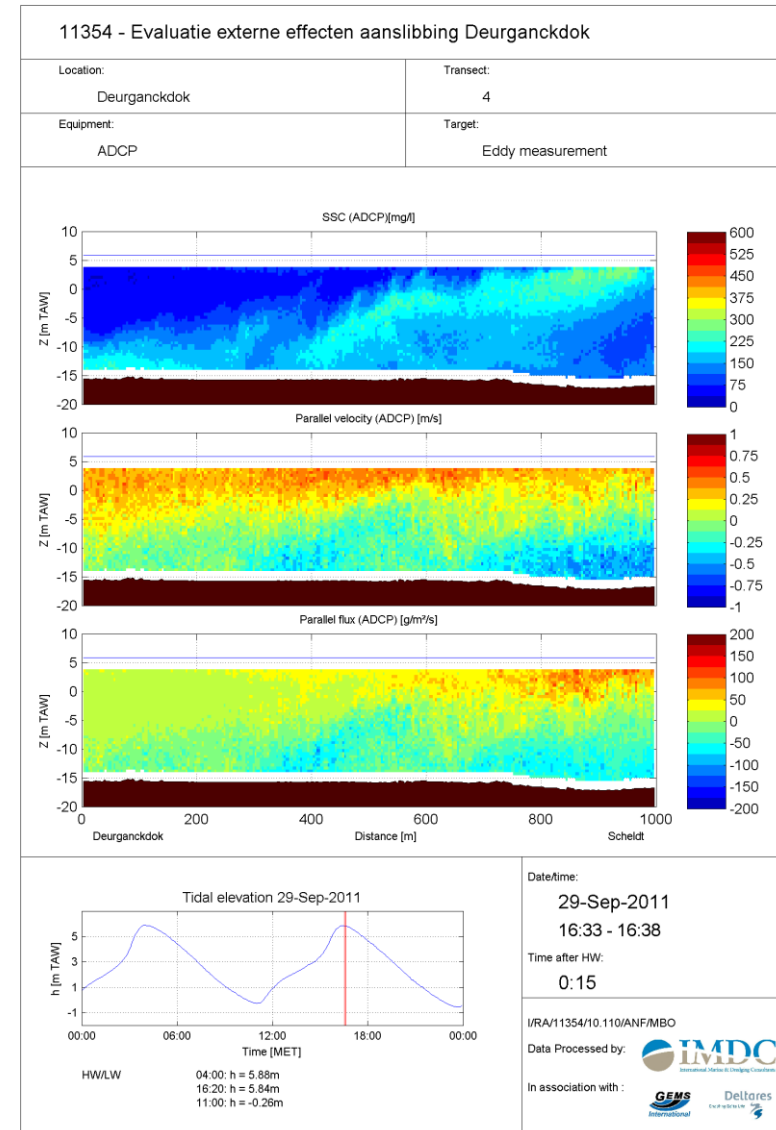
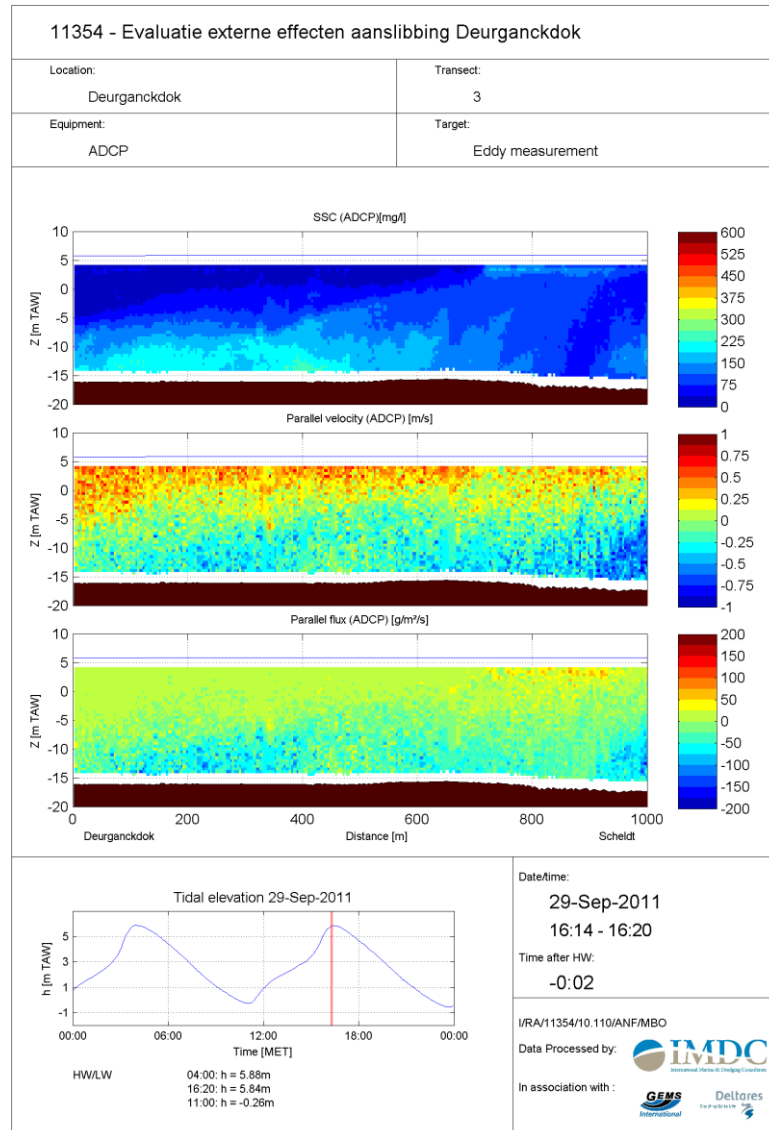


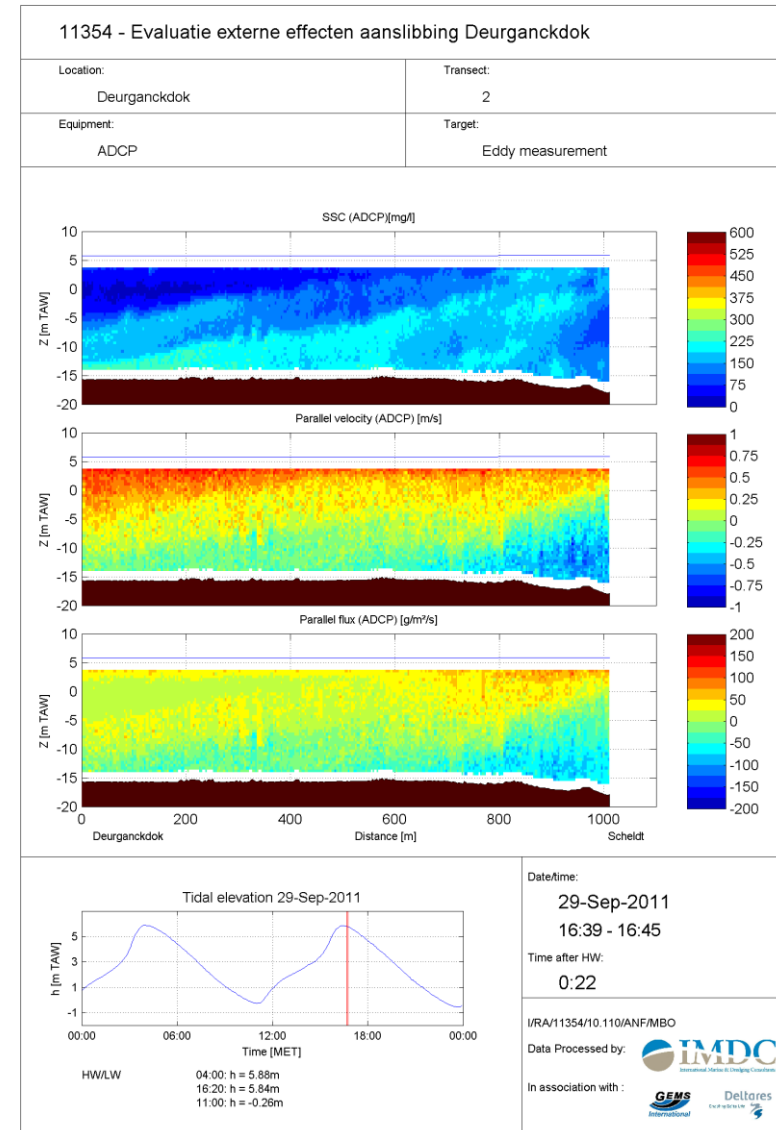
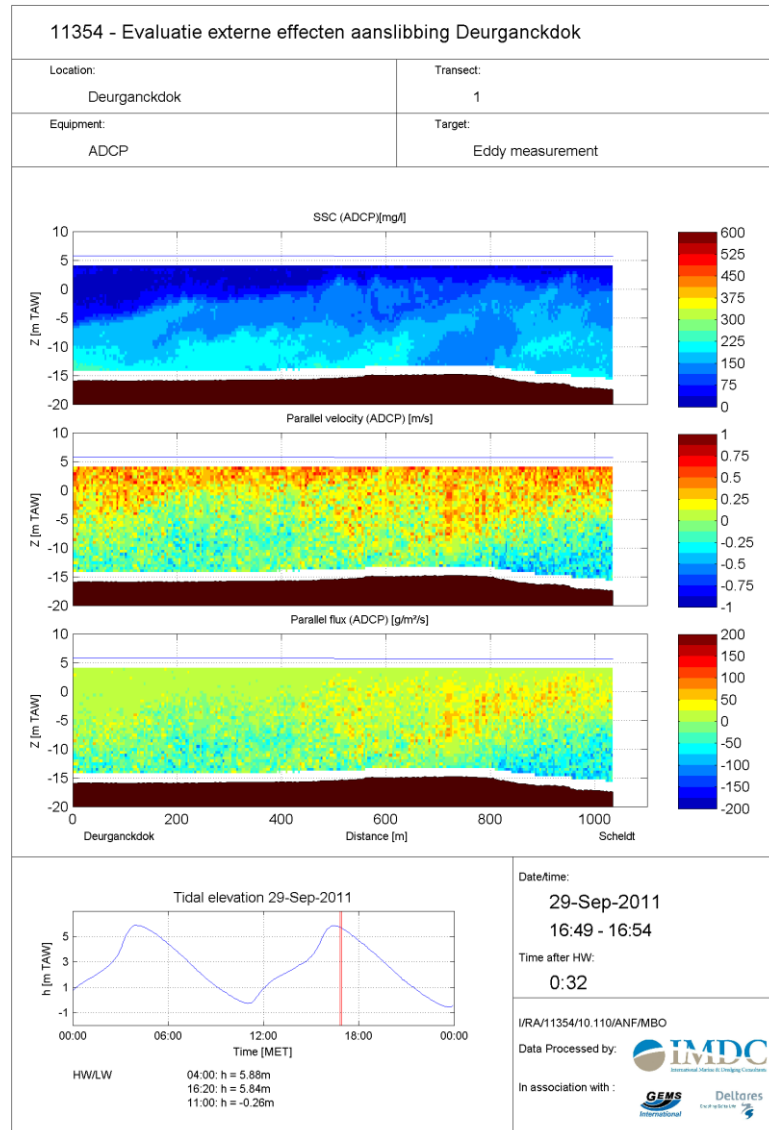


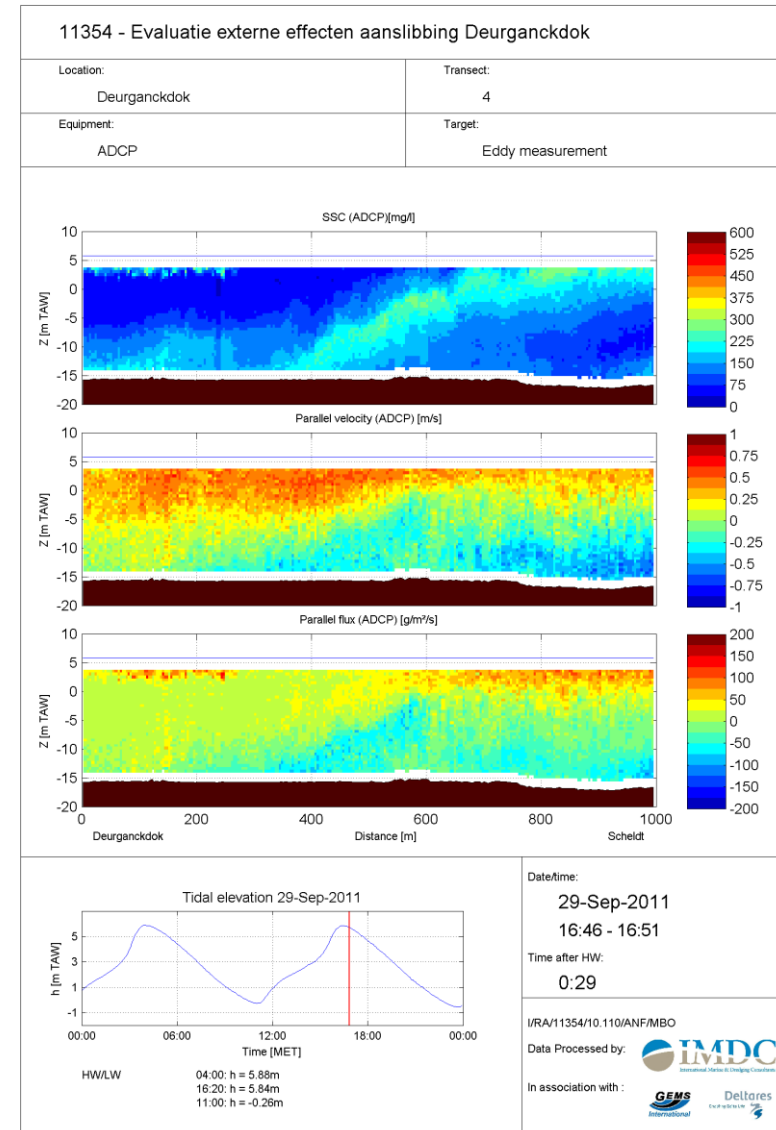
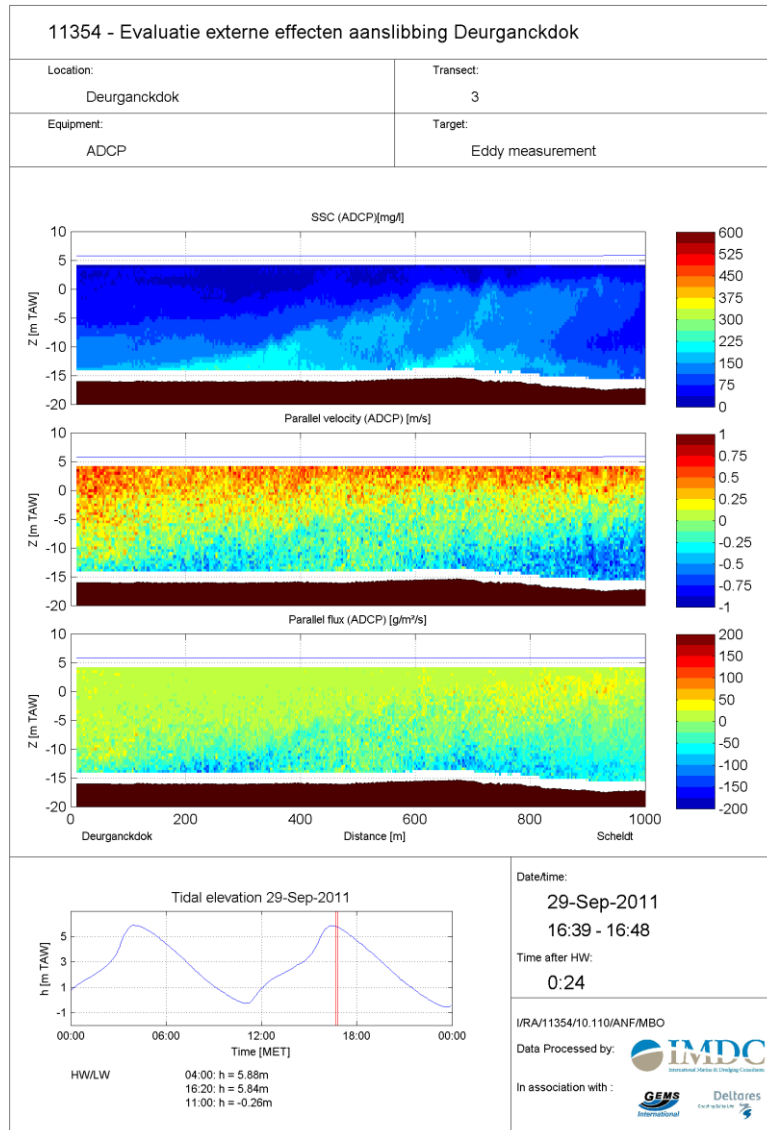


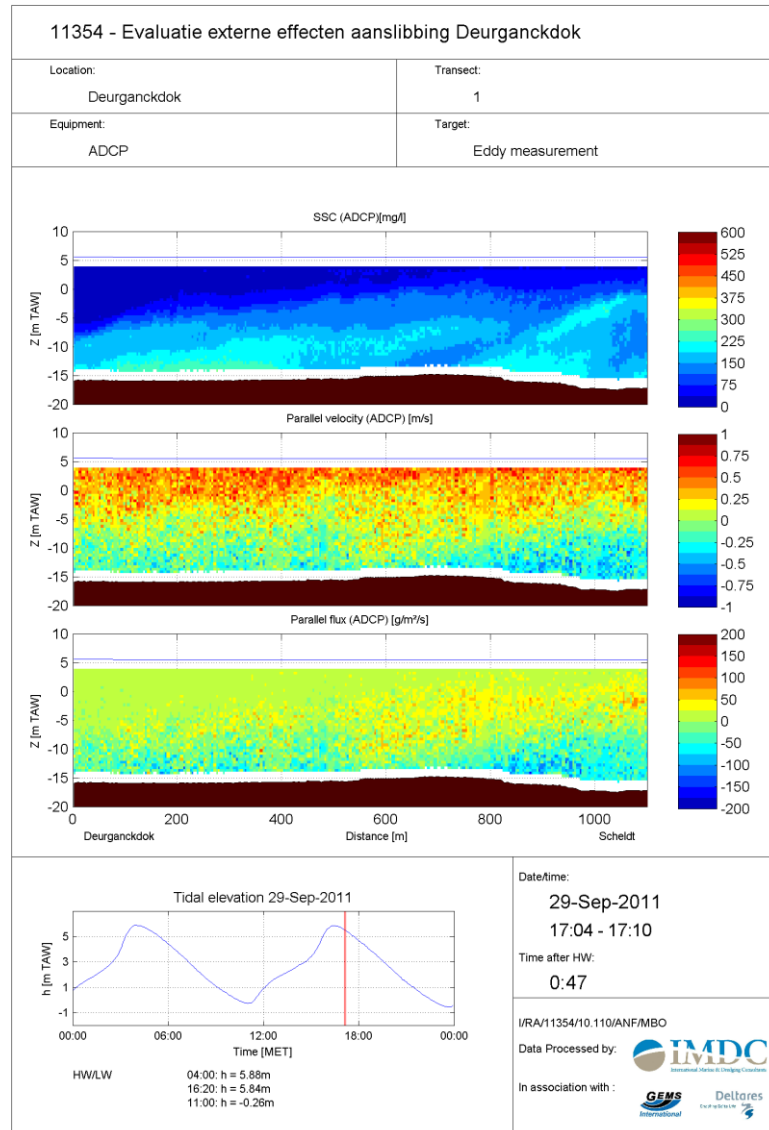


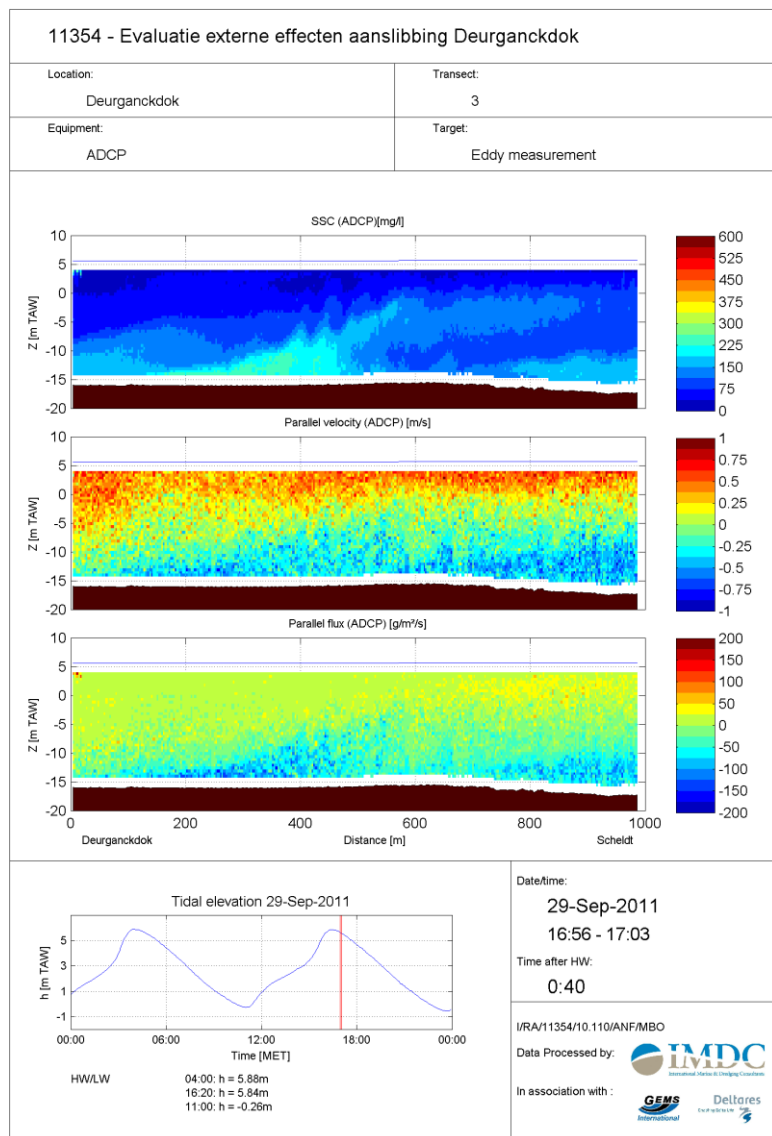


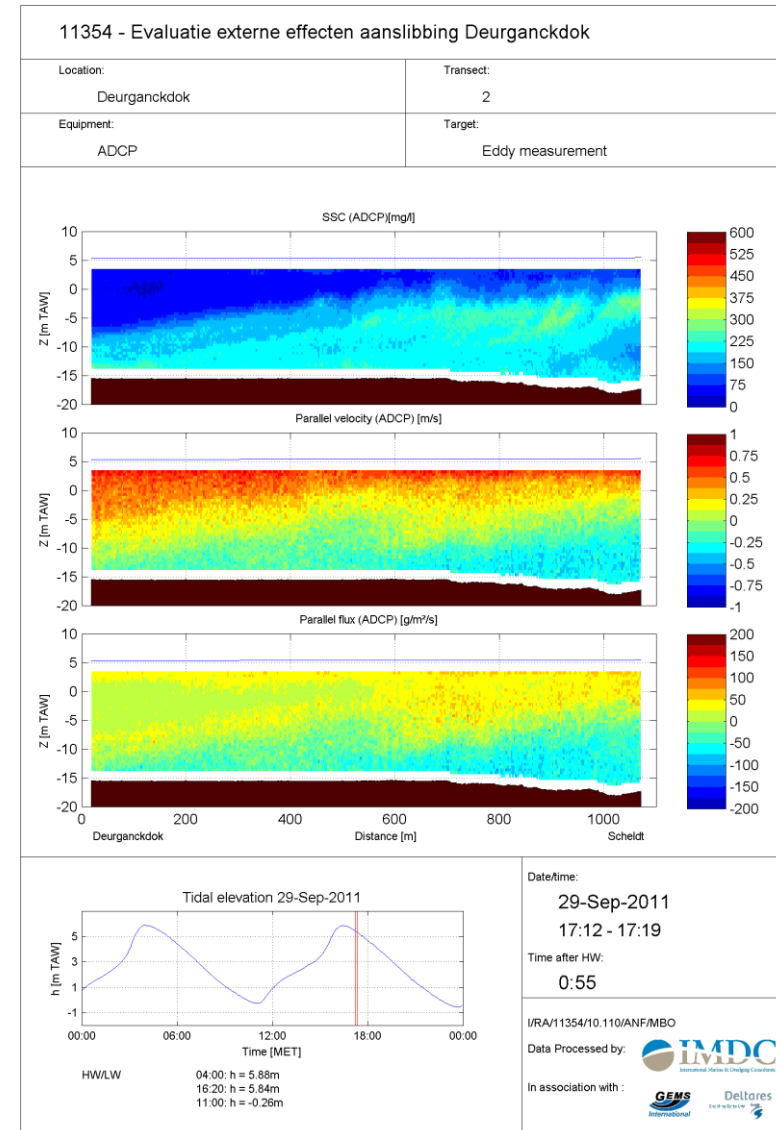
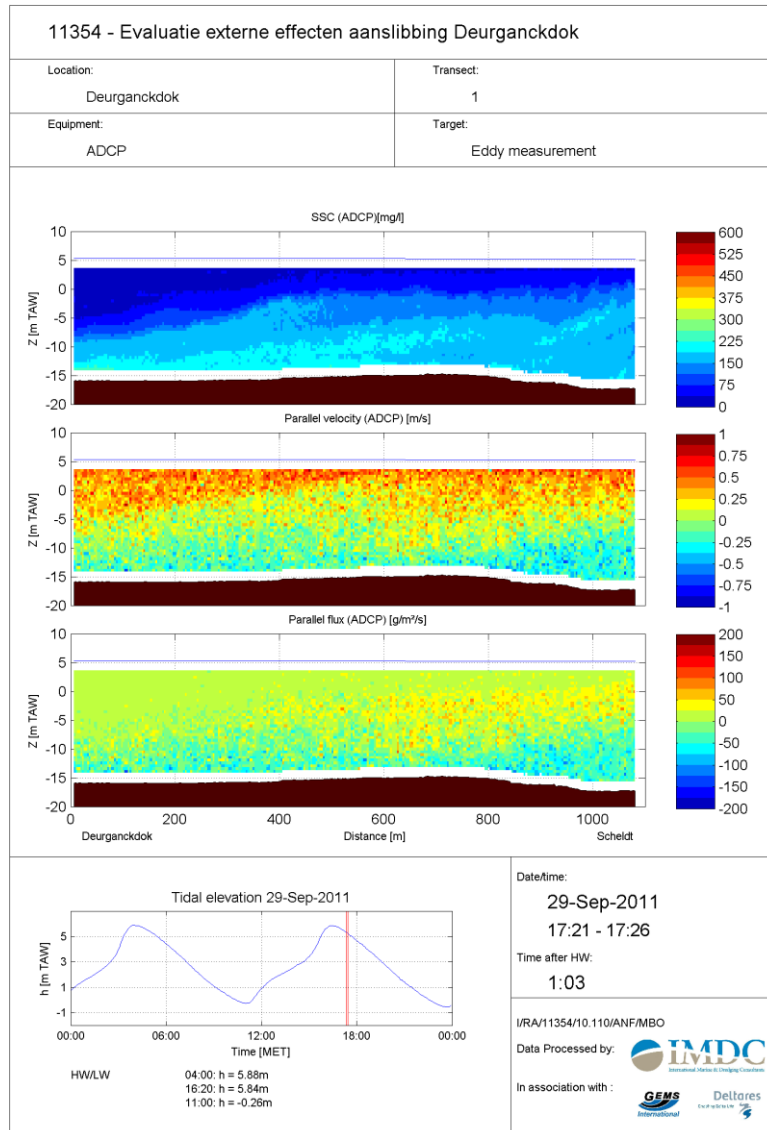


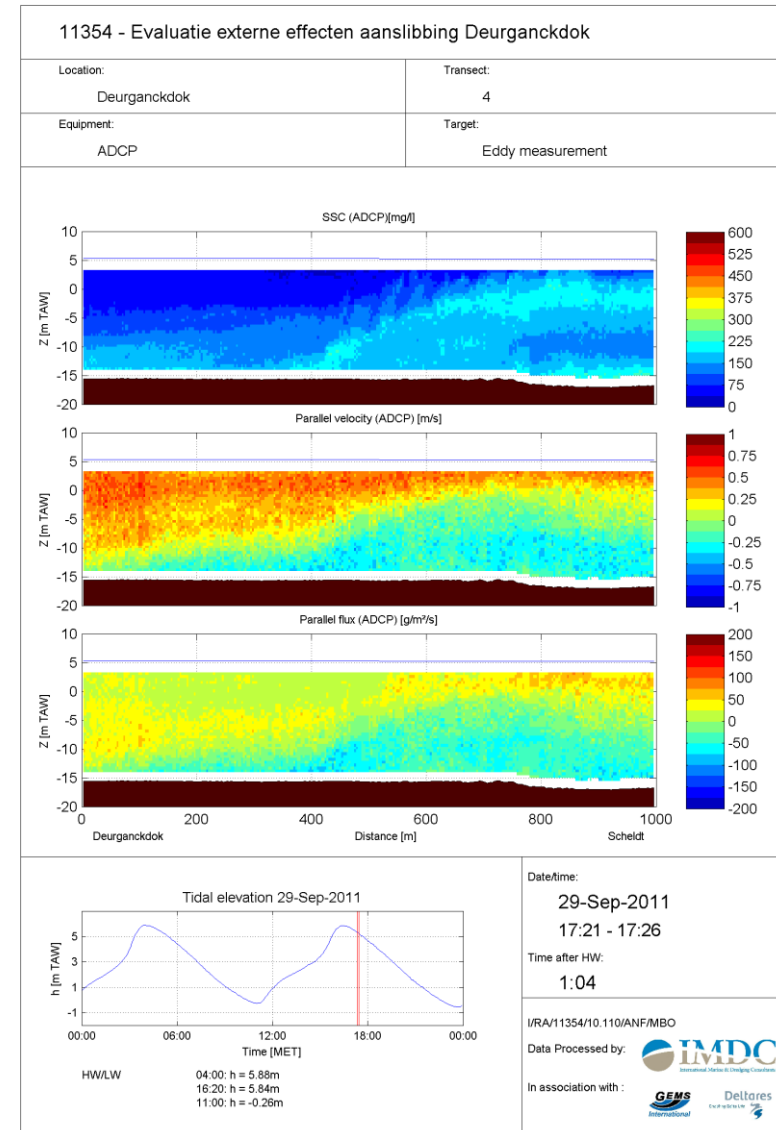
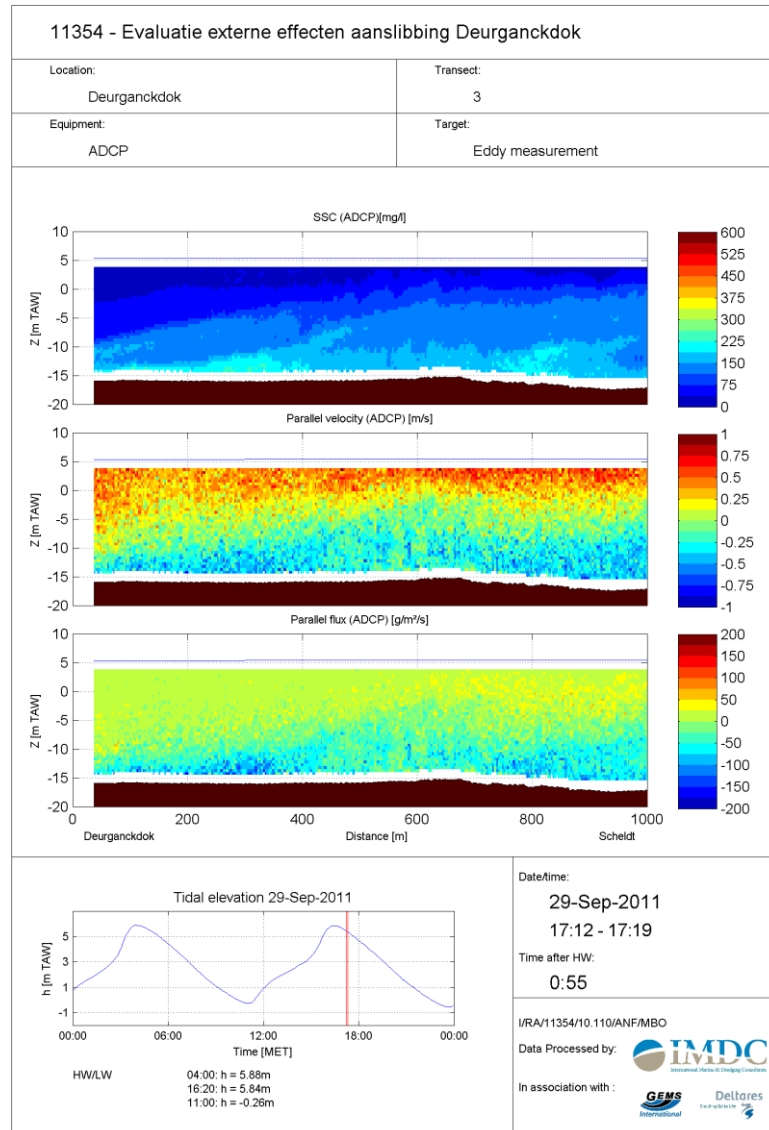


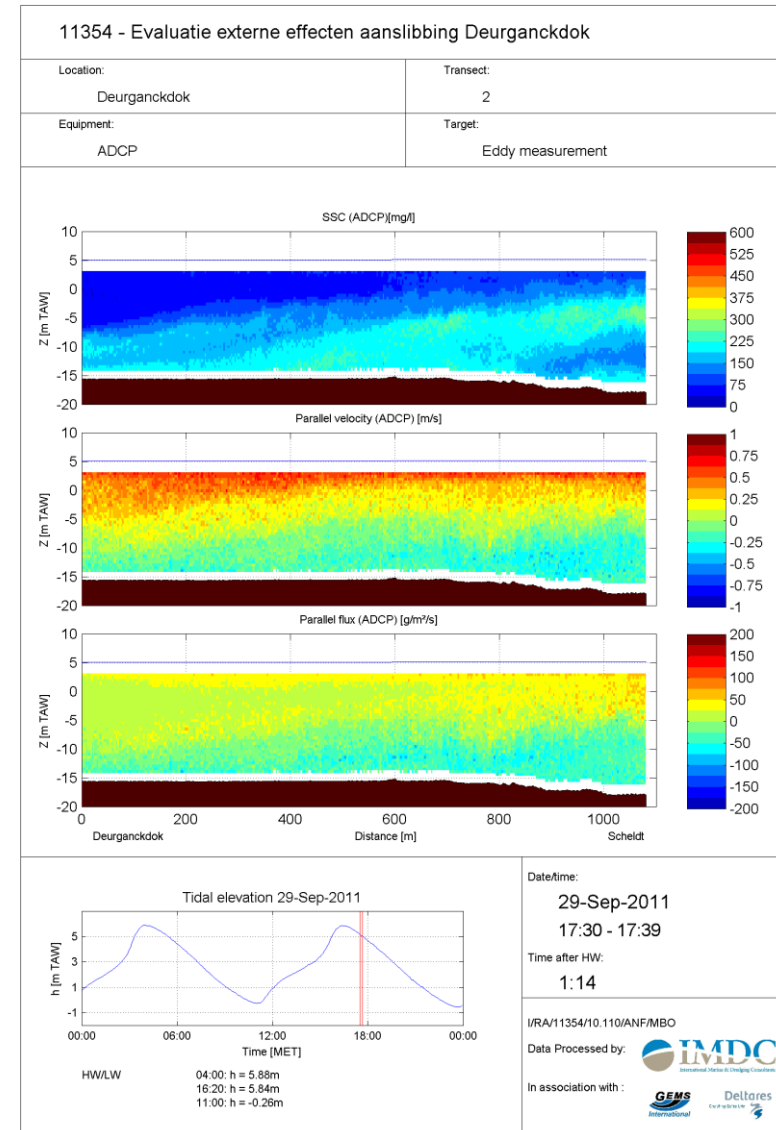
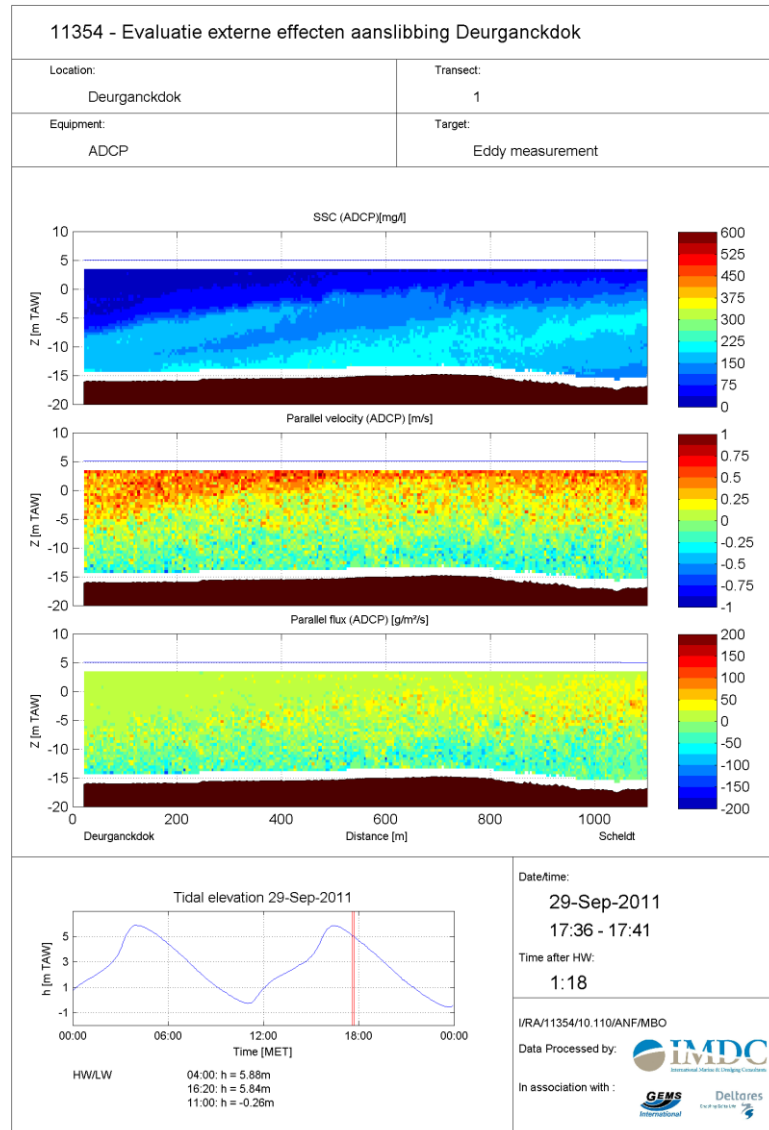


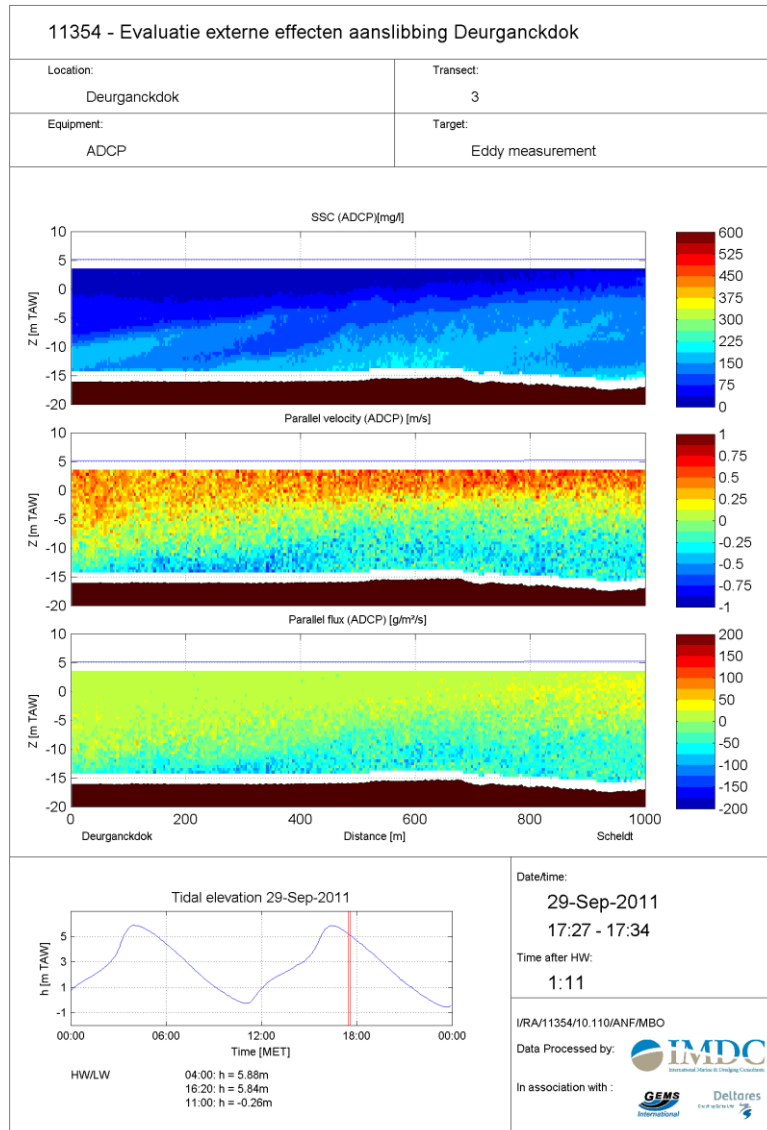


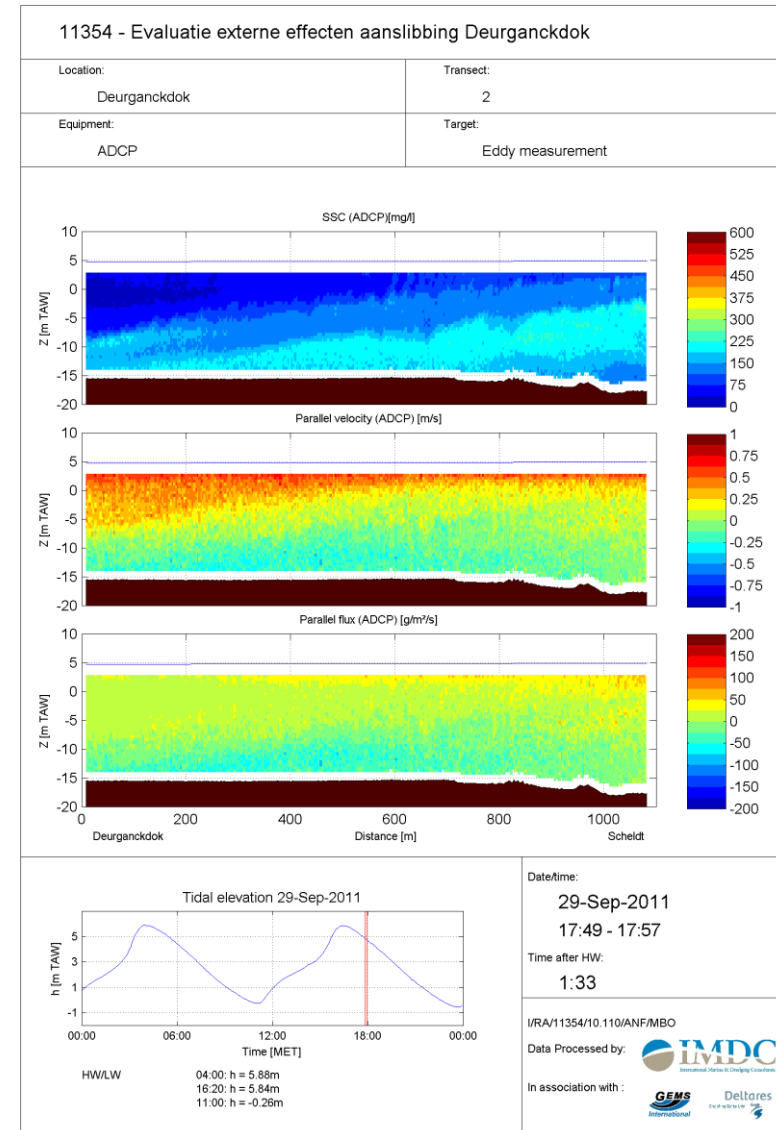
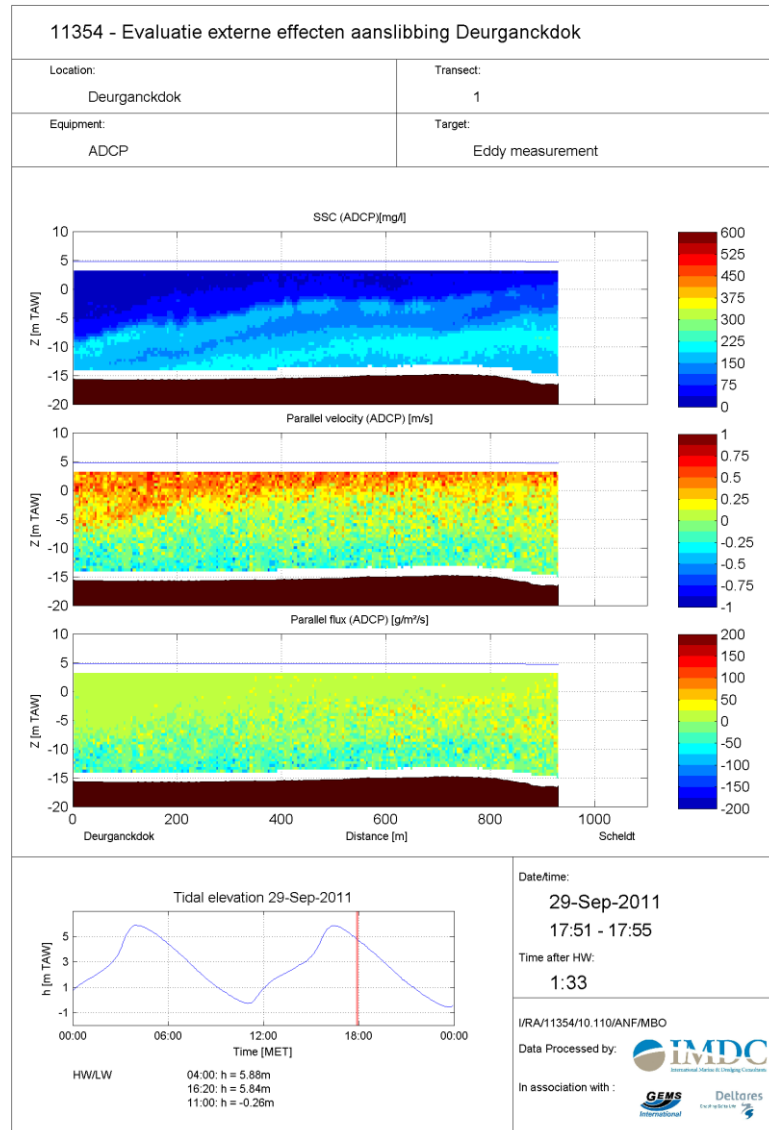


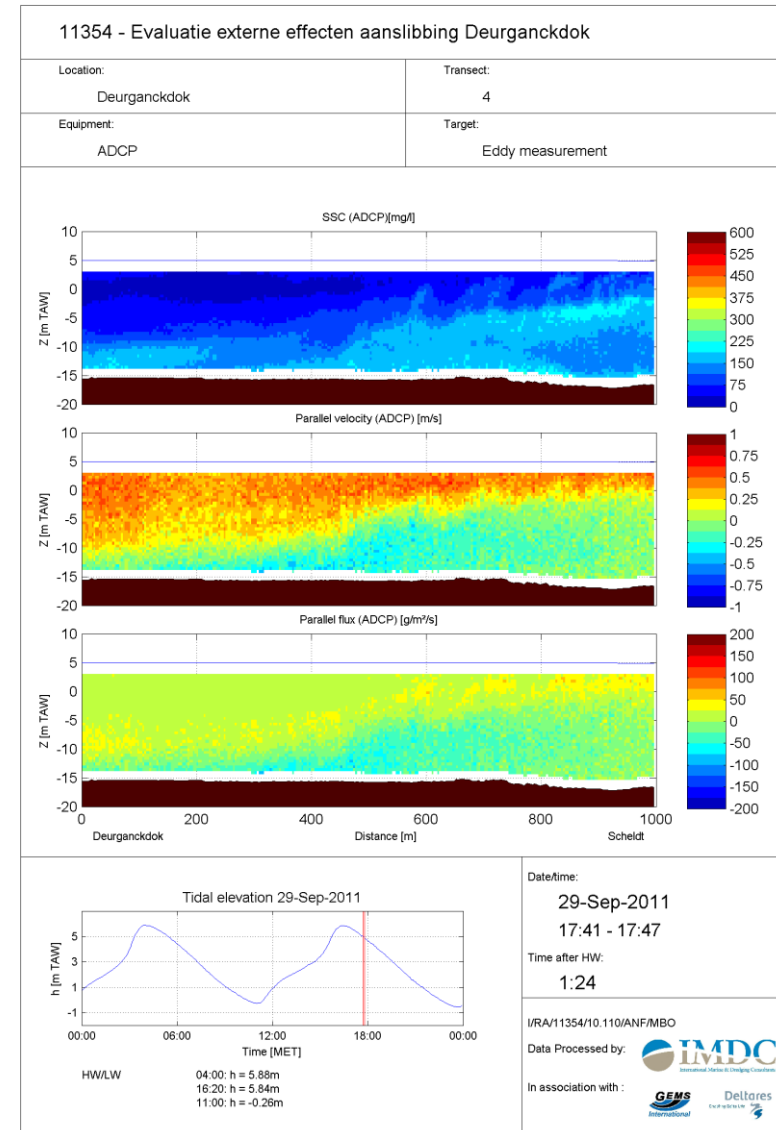
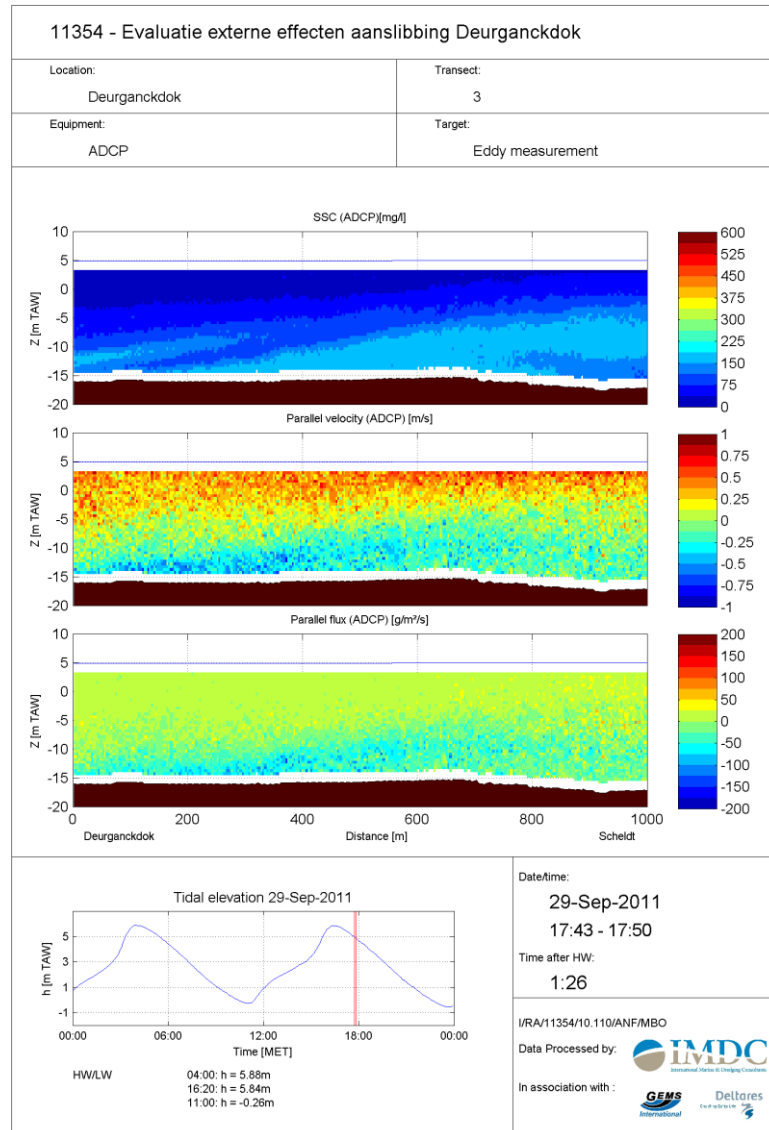


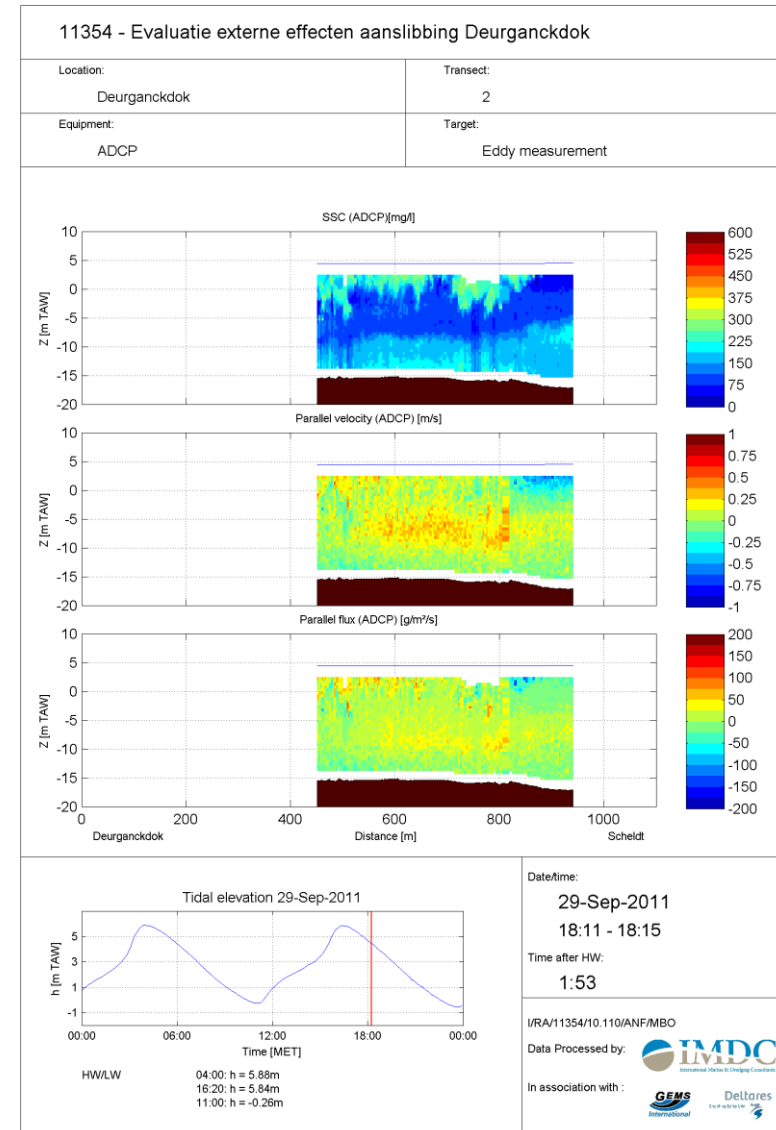


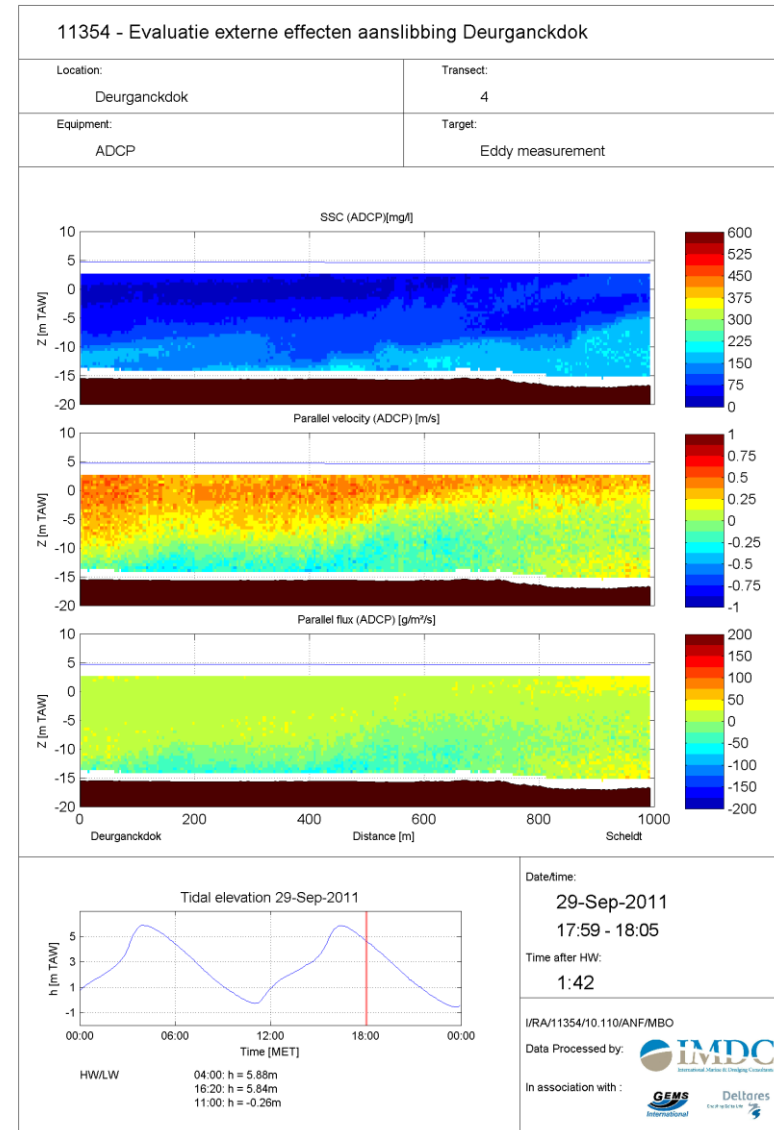


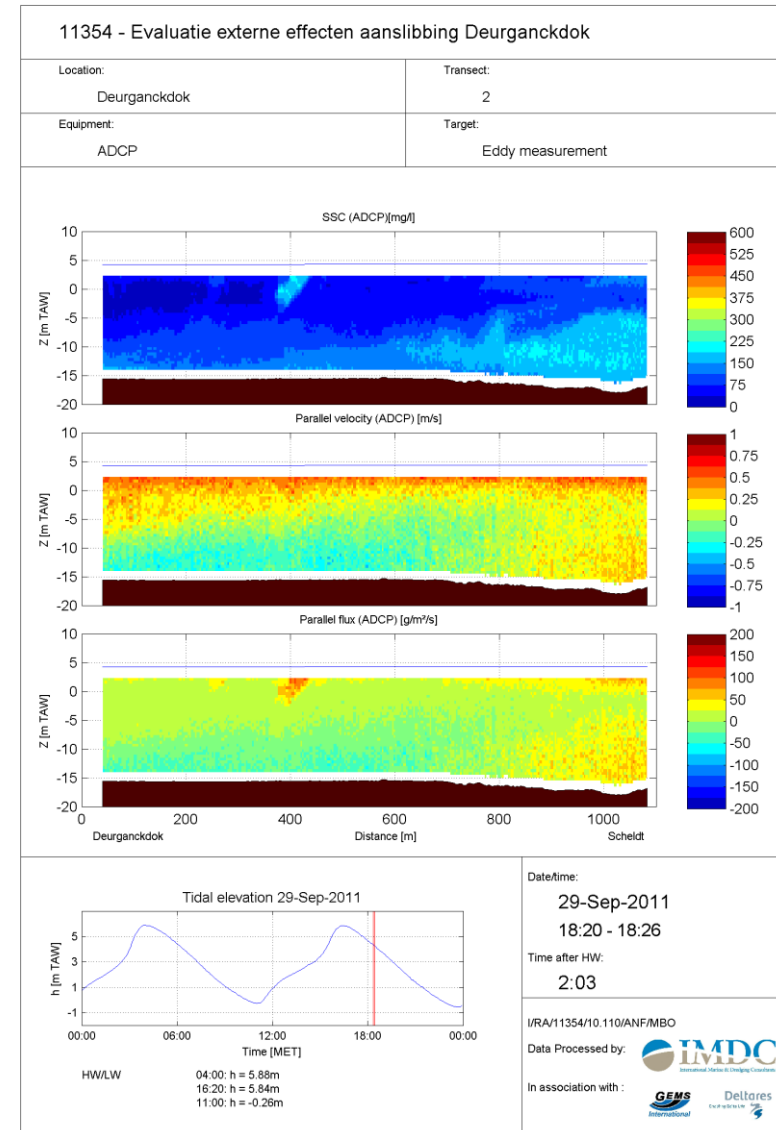
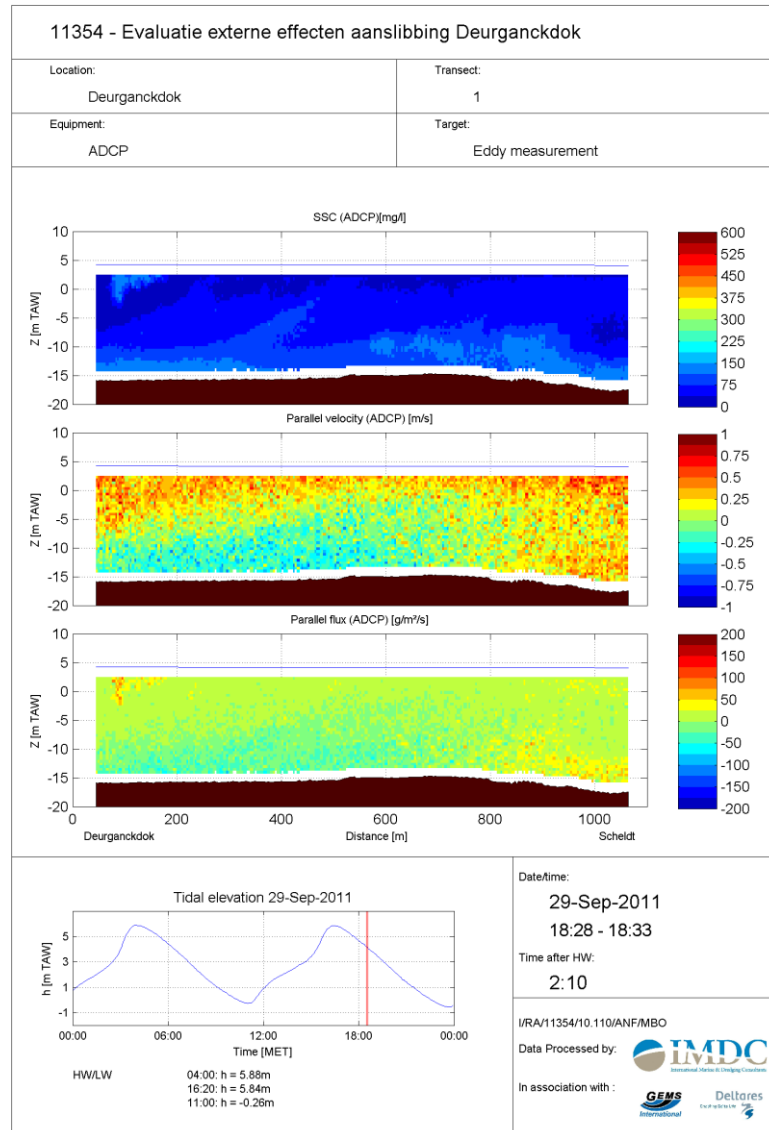


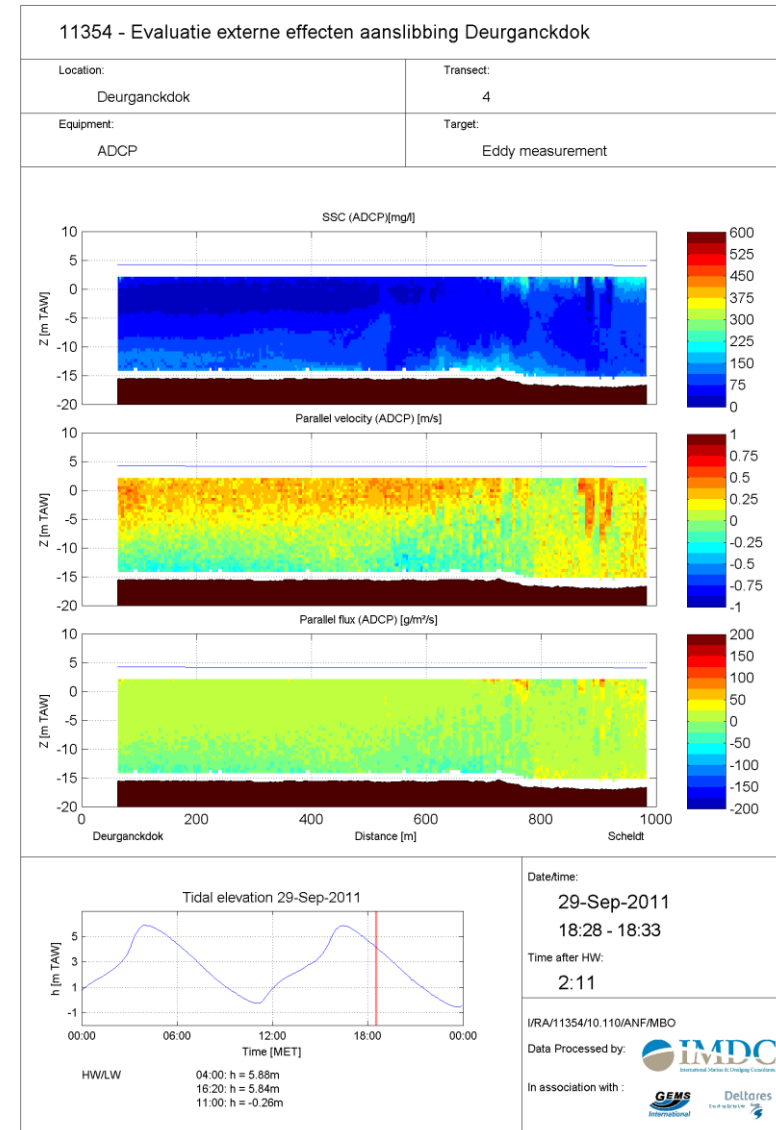
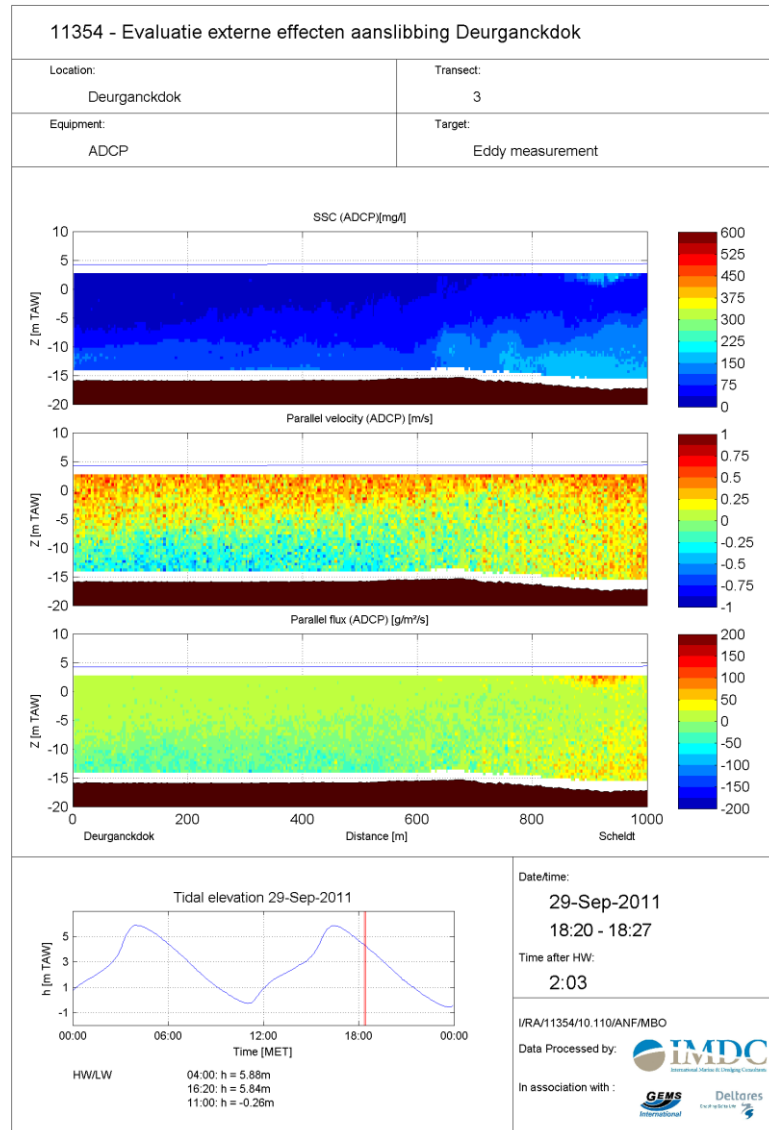


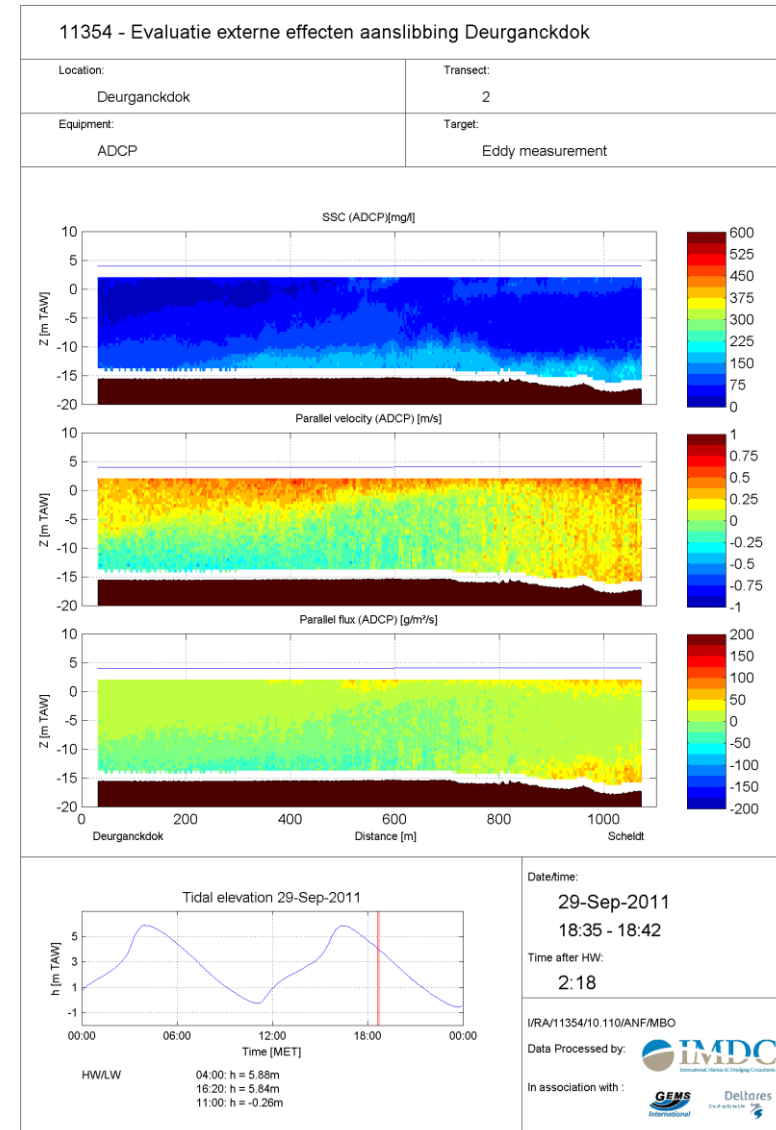
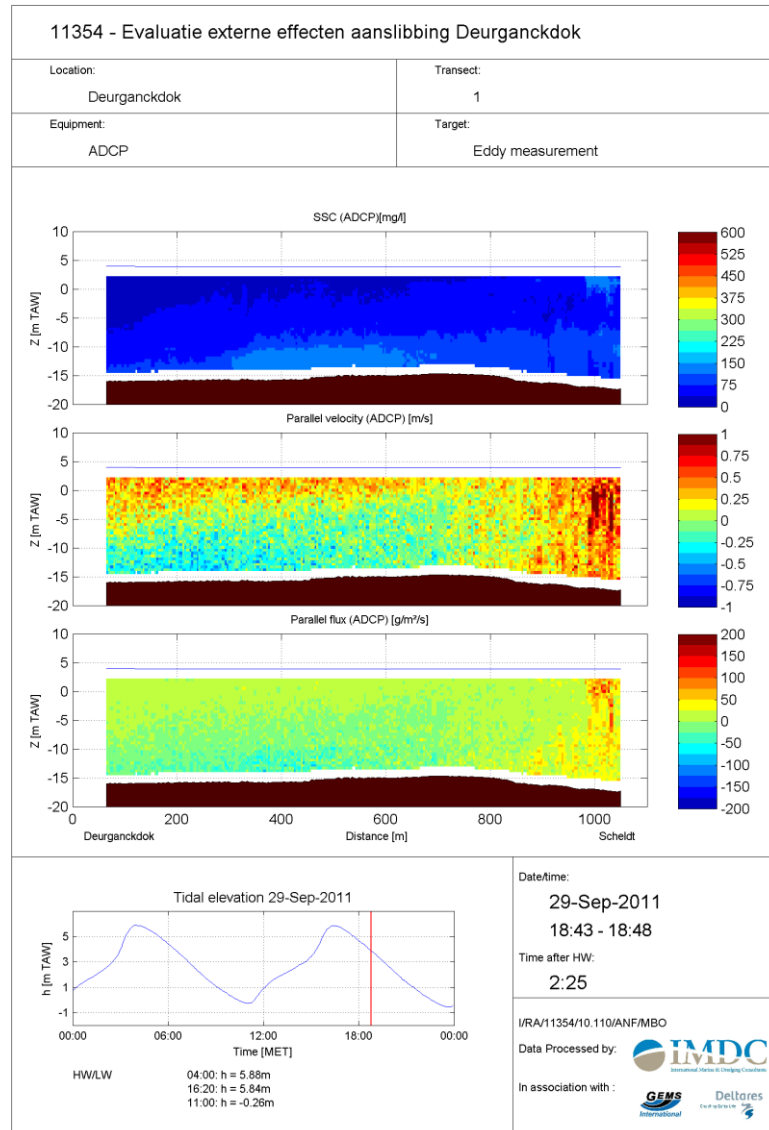


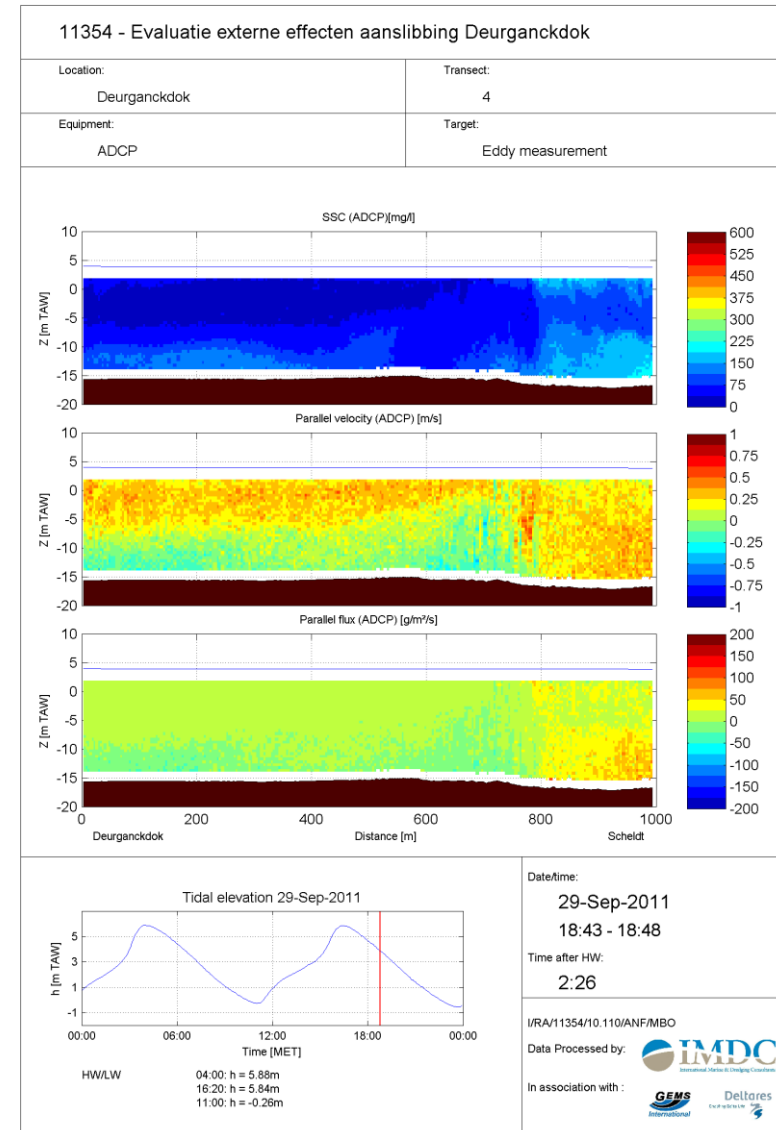
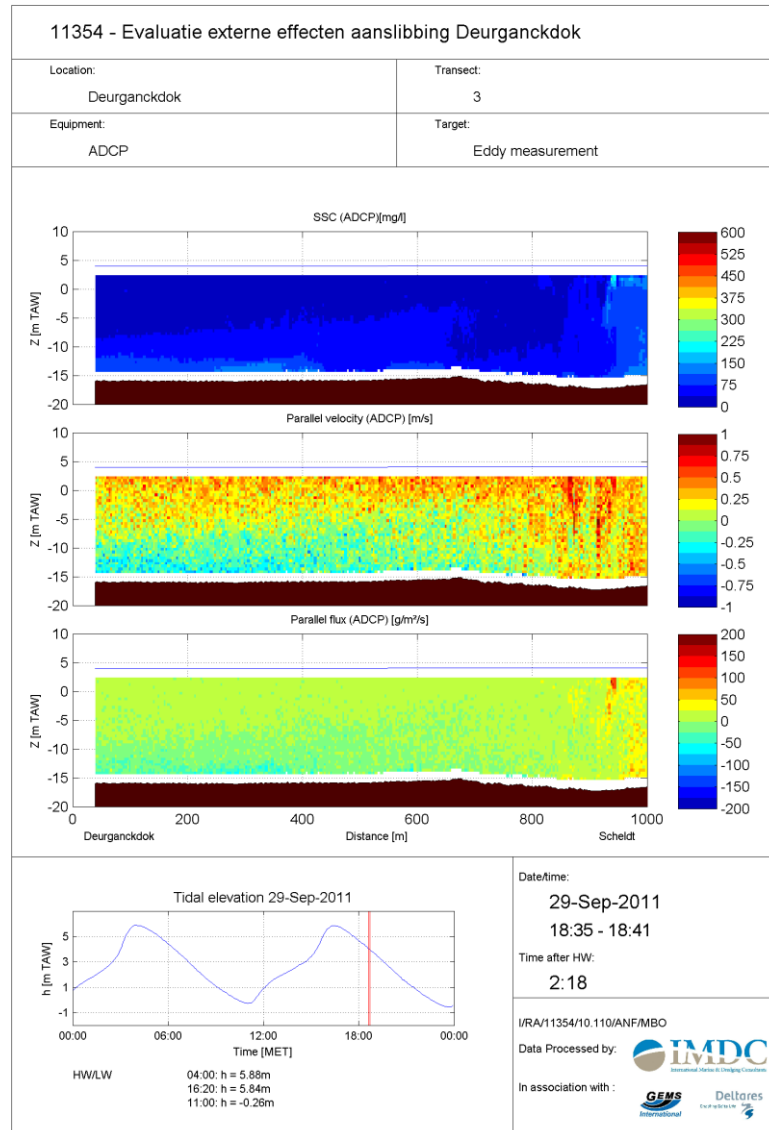












Annex F Maps of the measured depth averaged velocity fields

11354 Evaluatie externe effecten aanslibbing DGD

Equipment(s):

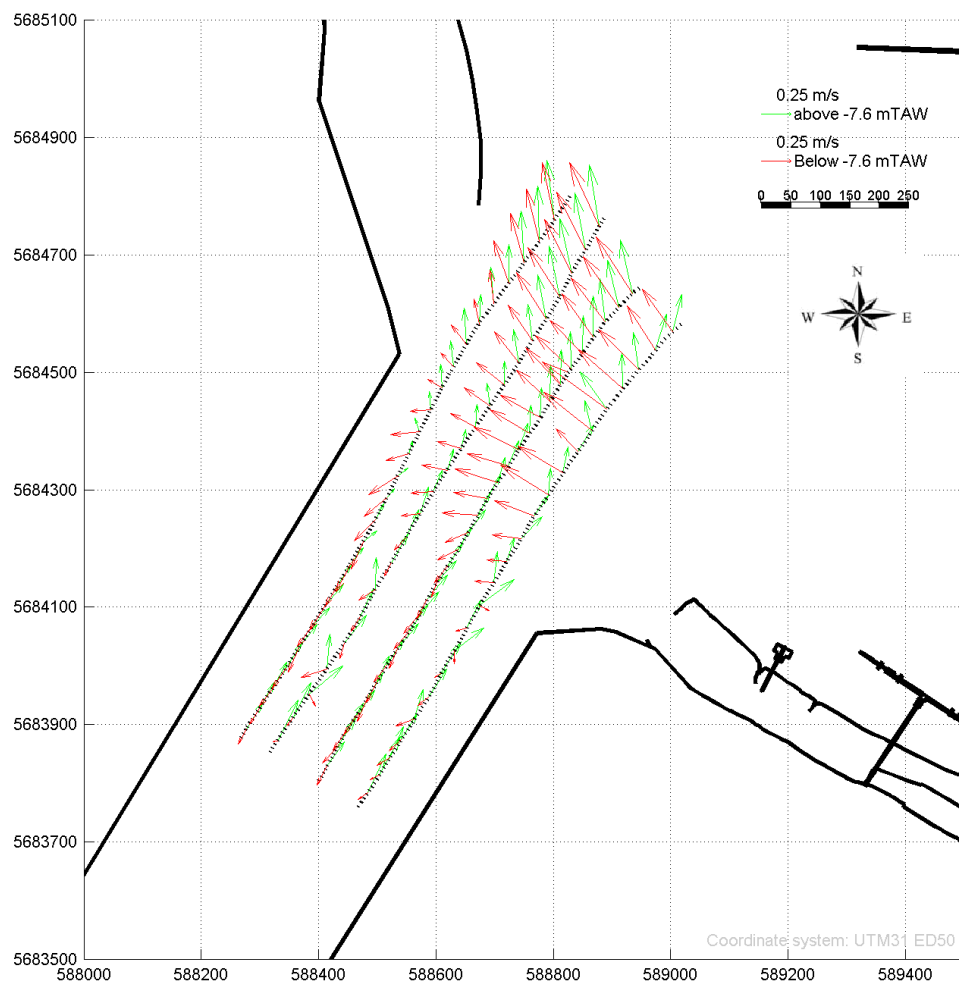
ADCP

Sourcefile:

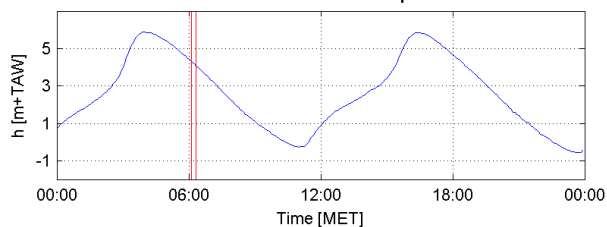
3002t1_sub,4001T2uit_sub,
3001t3_sub,4000T4in_sub

Location:

Deurganckdok



Tidal Elevation 29-Sep-2011



Slack water
Liefkenshoek:
04:00: h = 5.88 m+TAW
16:30: h = 5.85 m+TAW
11:00: h = -0.26 m+TAW

Date / Time [MET] :

29-Sep-2011

06:07 - 06:19

Time after HW Liefkenshoek [HH:MM]

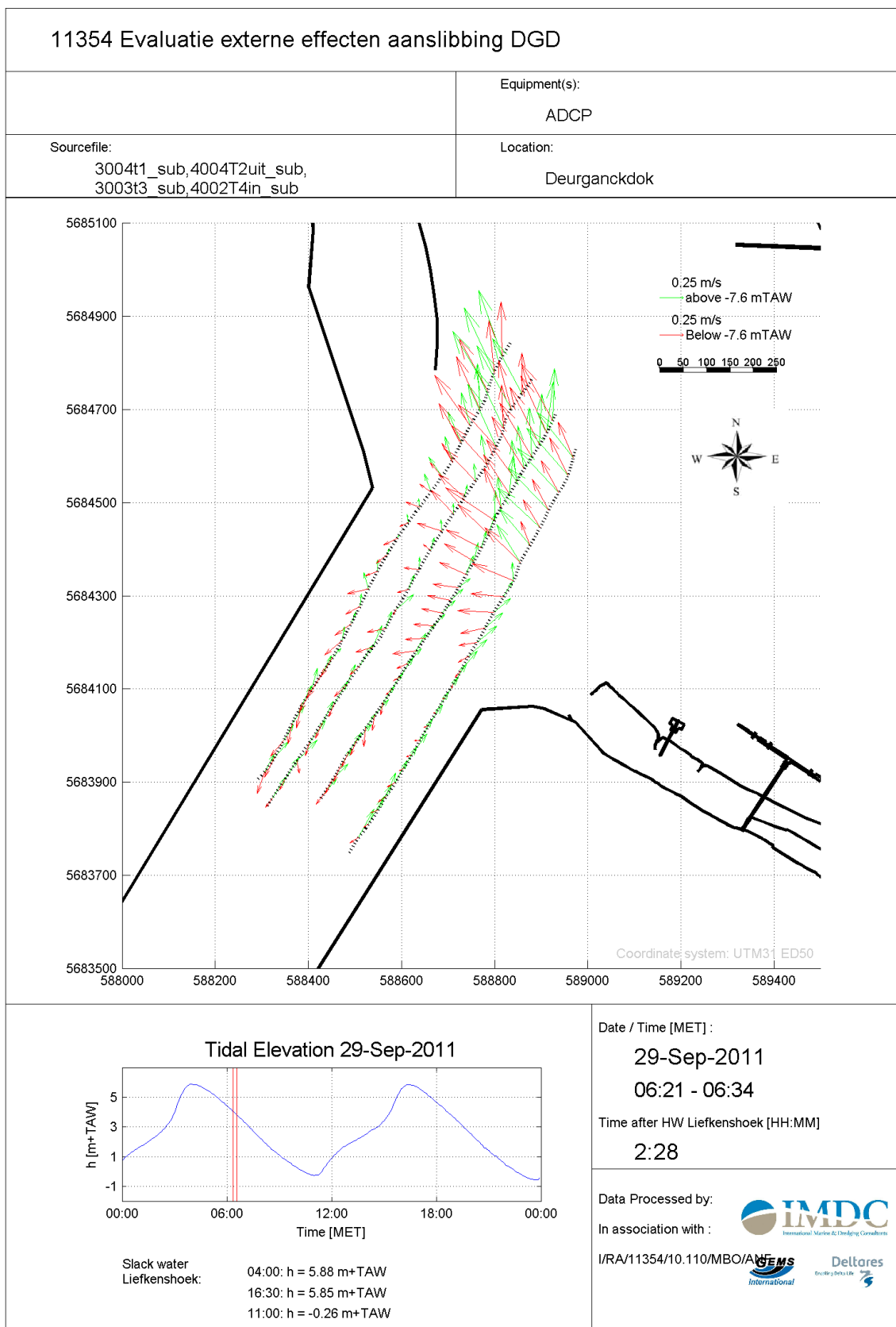
2:13

Data Processed by:

In association with :

I/RA/11354/10.110/MBO/ANF





11354 Evaluatie externe effecten aanslibbing DGD

Equipment(s):

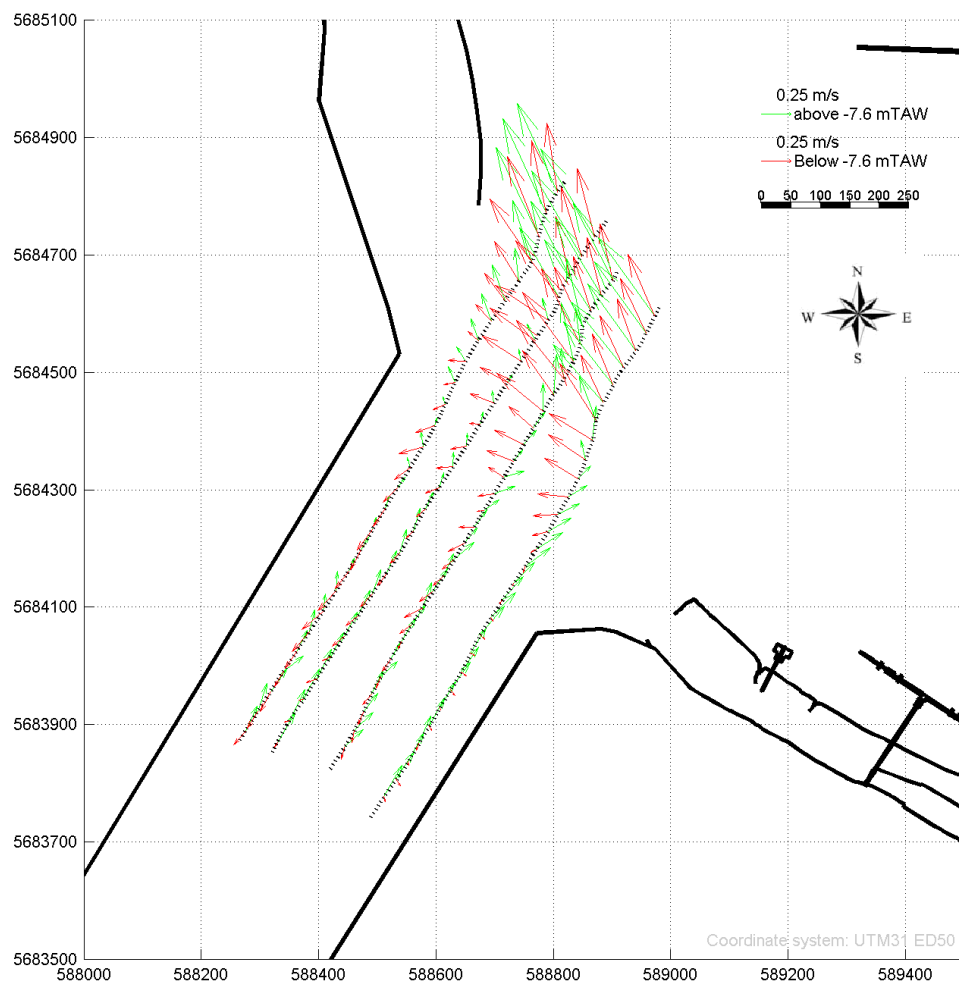
ADCP

Sourcefile:

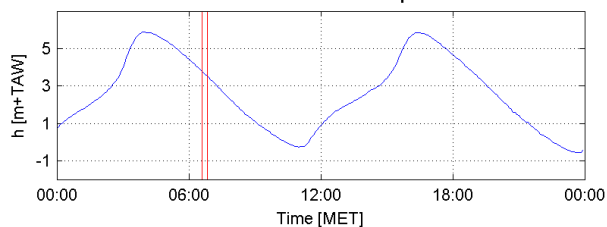
3006t1_sub,4006T2uit_sub,
3005t3_sub,4005T4in_sub

Location:

Deurganckdok



Tidal Elevation 29-Sep-2011



Slack water
Liefkenshoek:
04:00: h = 5.88 m+TAW
16:30: h = 5.85 m+TAW
11:00: h = -0.26 m+TAW

Date / Time [MET] :

29-Sep-2011

06:36 - 06:50

Time after HW Liefkenshoek [HH:MM]

2:43

Data Processed by:

In association with :

I/RA/11354/10.110/MBO/ANF



11354 Evaluatie externe effecten aanslibbing DGD

Equipment(s):

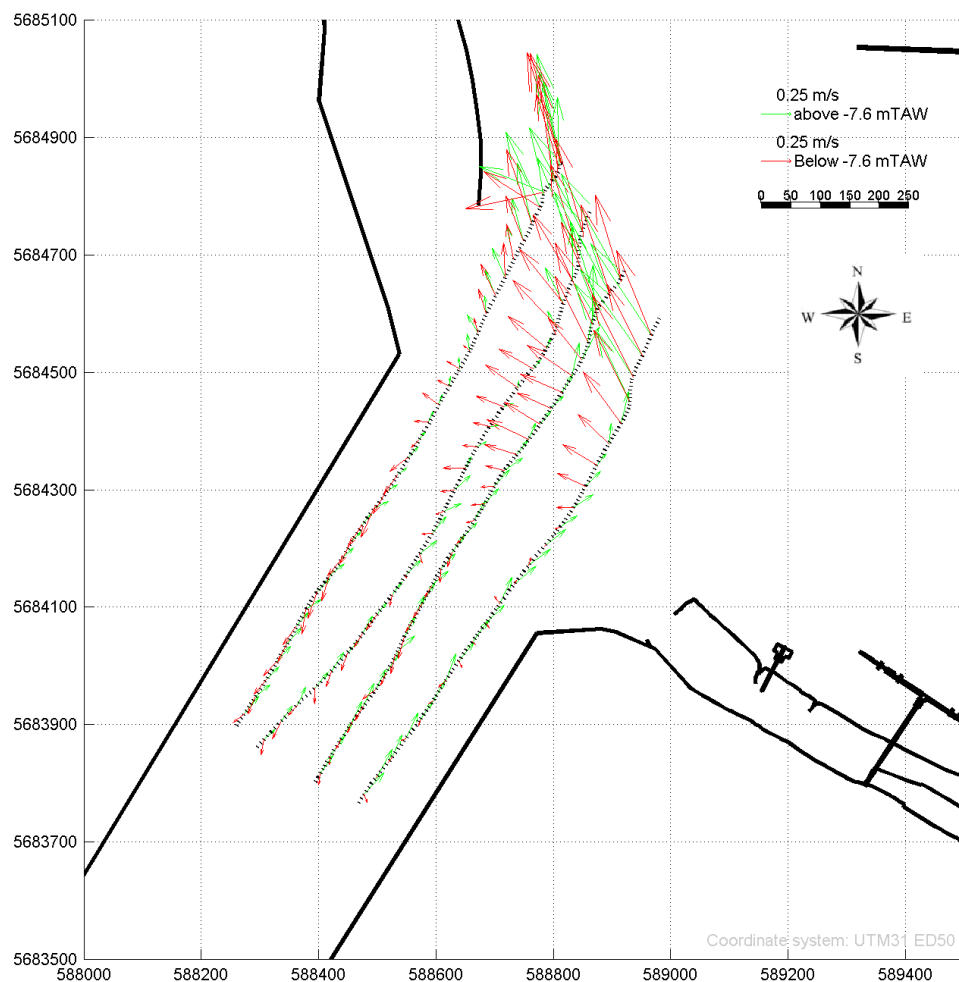
ADCP

Sourcefile:

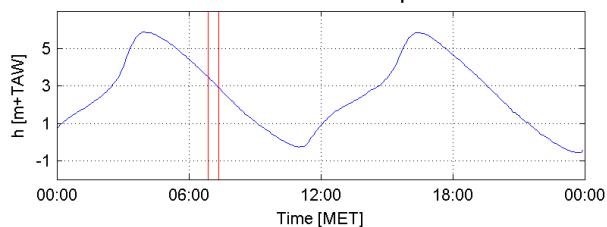
3009t1_sub,3010t2_sub,3007t3_sub,
3008t4_sub

Location:

Deurganckdok



Tidal Elevation 29-Sep-2011



Slack water
Liefkenshoek:
04:00: h = 5.88 m+TAW
16:30: h = 5.85 m+TAW
11:00: h = -0.26 m+TAW

Date / Time [MET] :

29-Sep-2011

06:52 - 07:21

Time after HW Liefkenshoek [HH:MM]

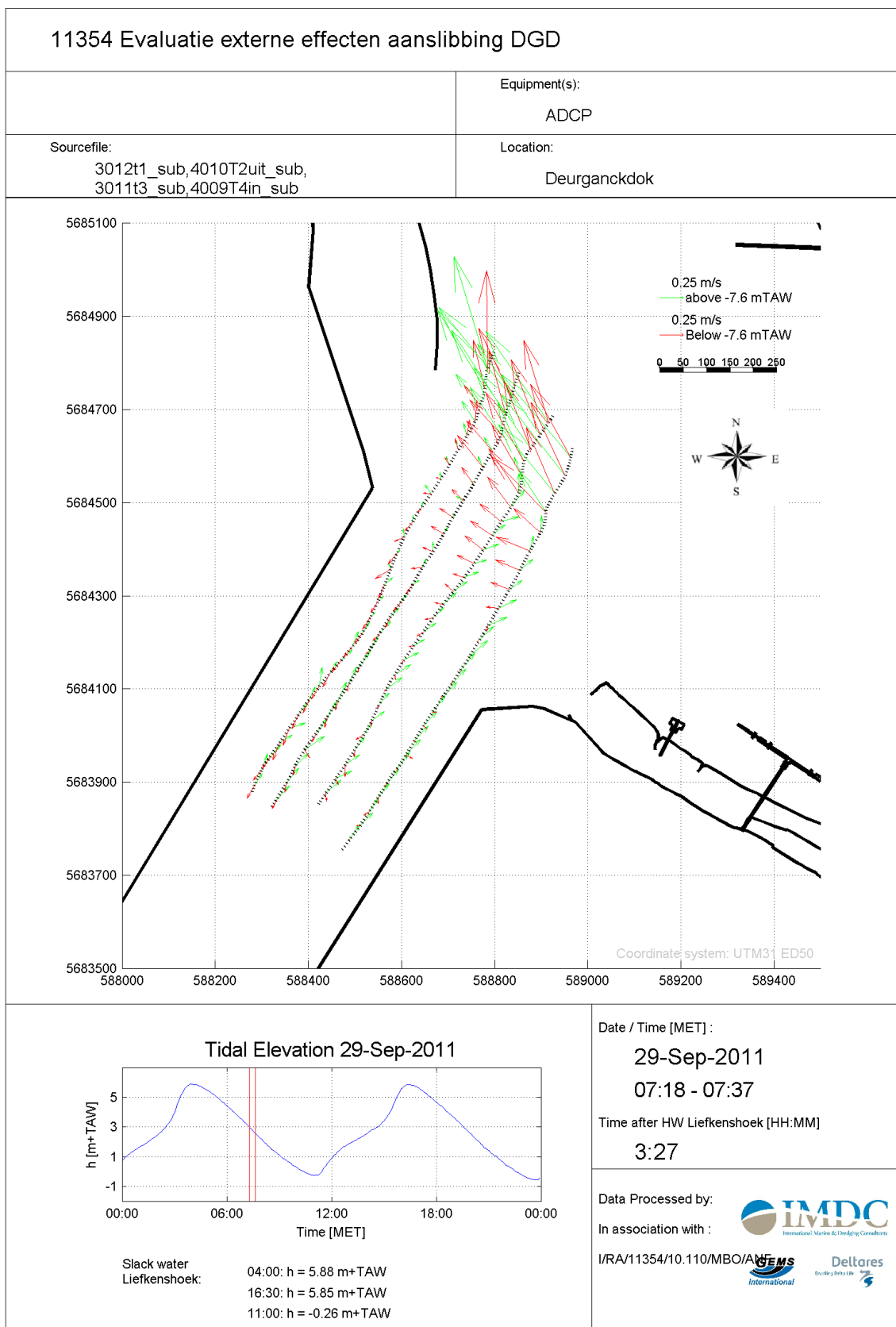
3:06

Data Processed by:

In association with :

I/RA/11354/10.110/MBO/ANF





11354 Evaluatie externe effecten aanslibbing DGD

Equipment(s):

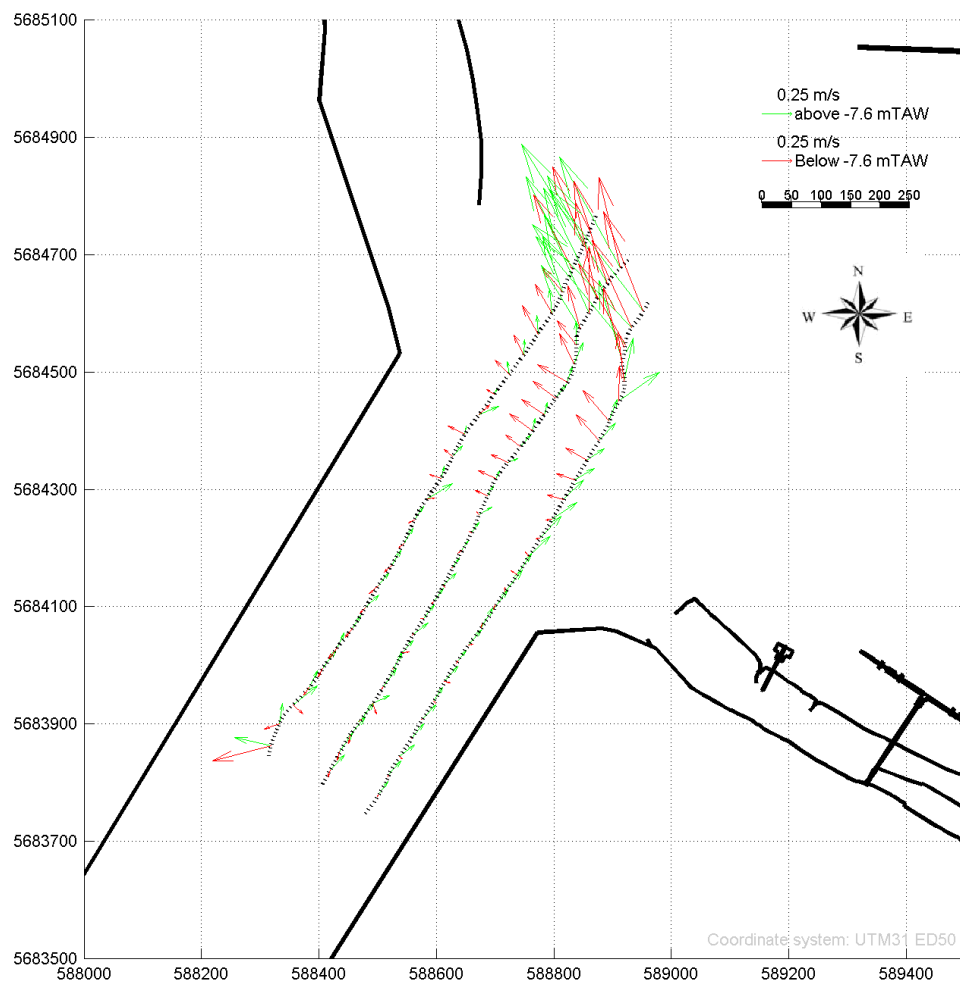
ADCP

Sourcefile:

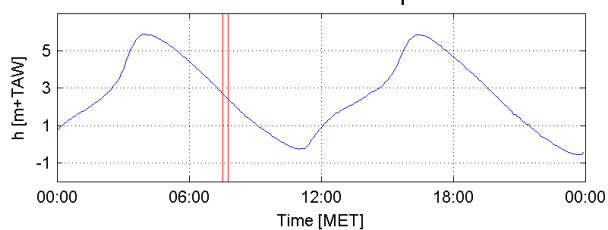
4012T2uit_sub,4012T2uit_sub,
3013t3_sub,4011T4in_sub

Location:

Deurganckdok



Tidal Elevation 29-Sep-2011



Slack water
Liefkenshoek:
04:00: h = 5.88 m+TAW
16:30: h = 5.85 m+TAW
11:00: h = -0.26 m+TAW

Date / Time [MET] :

29-Sep-2011

07:32 - 07:46

Time after HW Liefkenshoek [HH:MM]

3:39

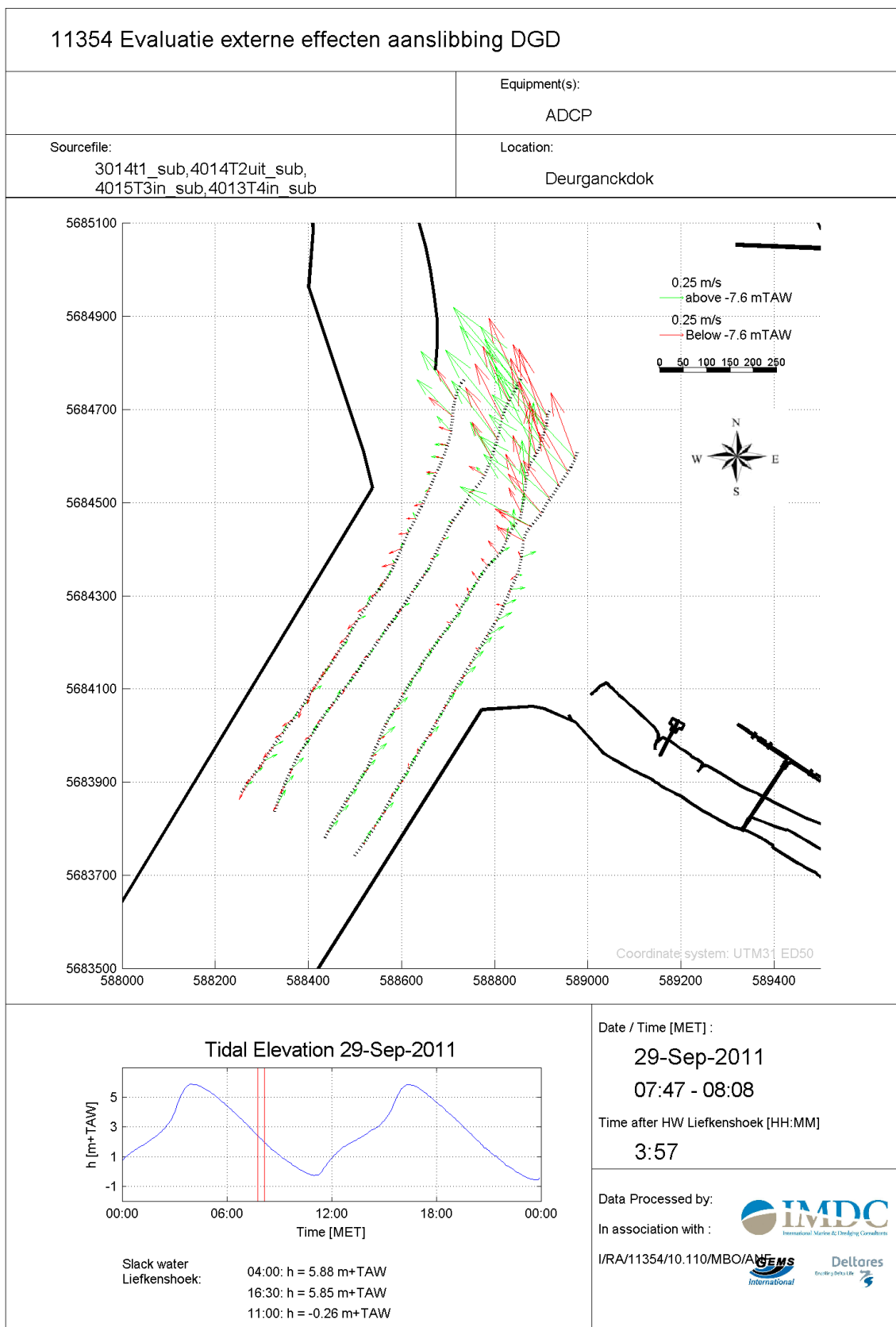
Data Processed by:



In association with :

I/RA/11354/10.110/MBO/ANF





11354 Evaluatie externe effecten aanslibbing DGD

Equipment(s):

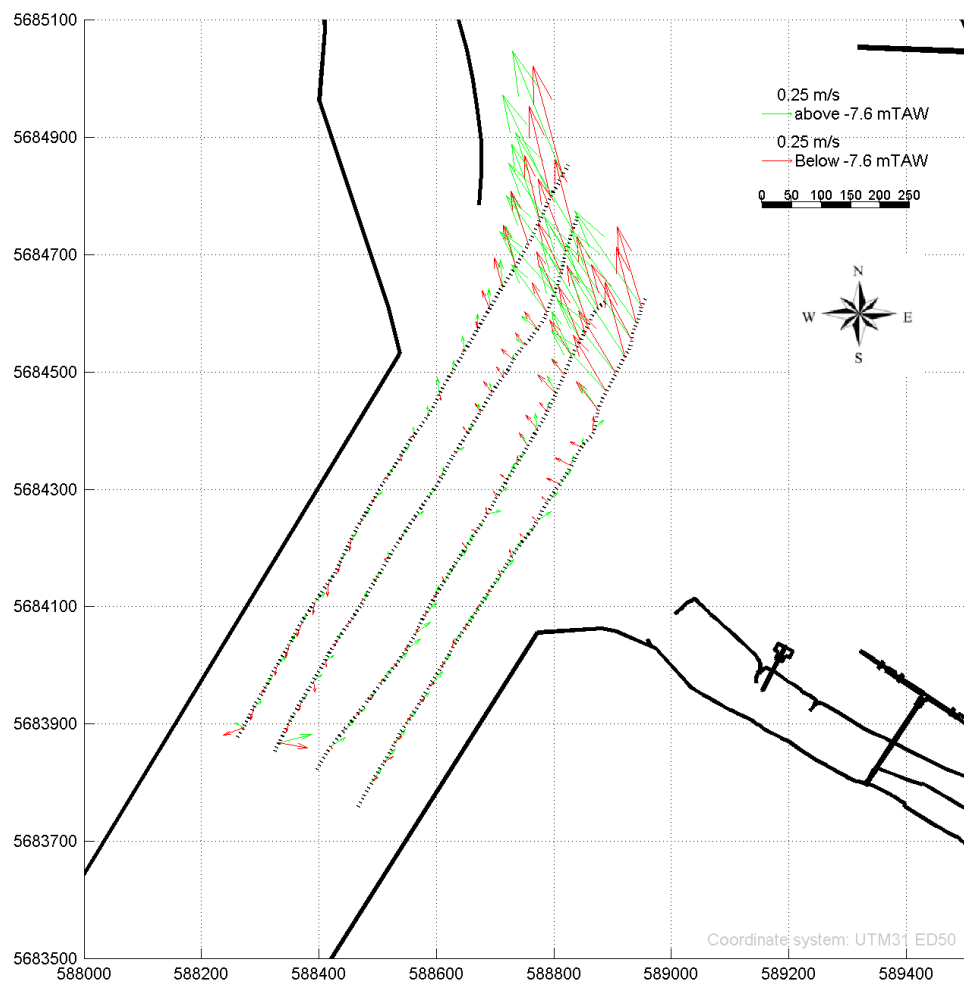
ADCP

Sourcefile:

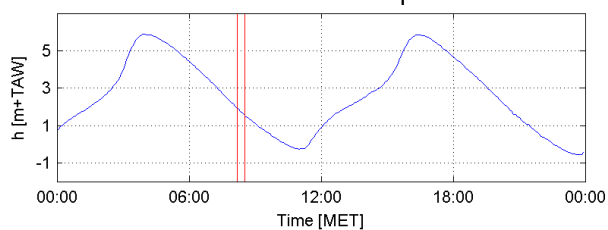
4016T1uit_sub,4018T2uit_sub,
3016t3_sub,4017T4in_sub

Location:

Deurganckdok



Tidal Elevation 29-Sep-2011



Slack water
Liefkenshoek:
04:00: h = 5.88 m+TAW
16:30: h = 5.85 m+TAW
11:00: h = -0.26 m+TAW

Date / Time [MET] :

29-Sep-2011

08:10 - 08:32

Time after HW Liefkenshoek [HH:MM]

4:21

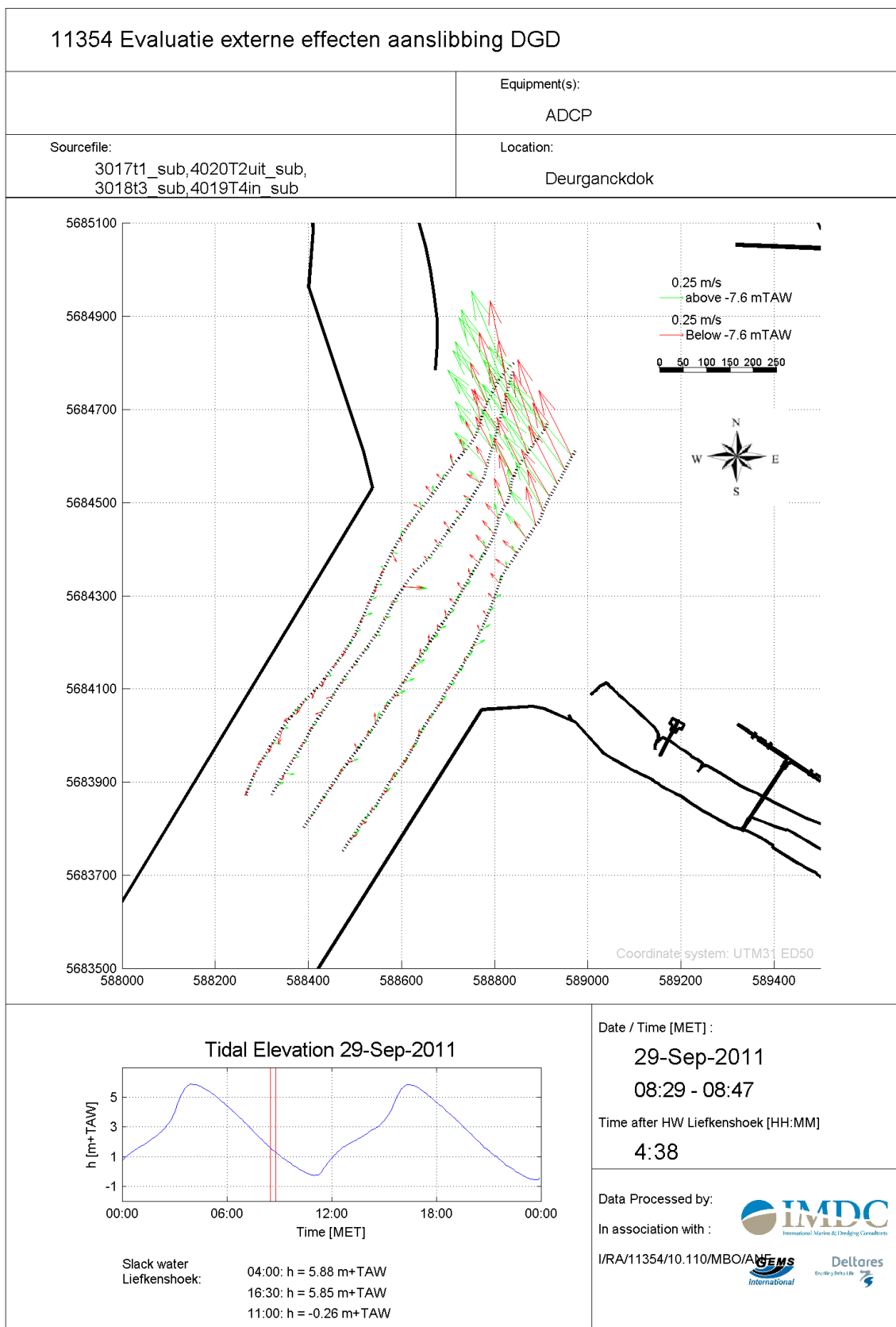
Data Processed by:

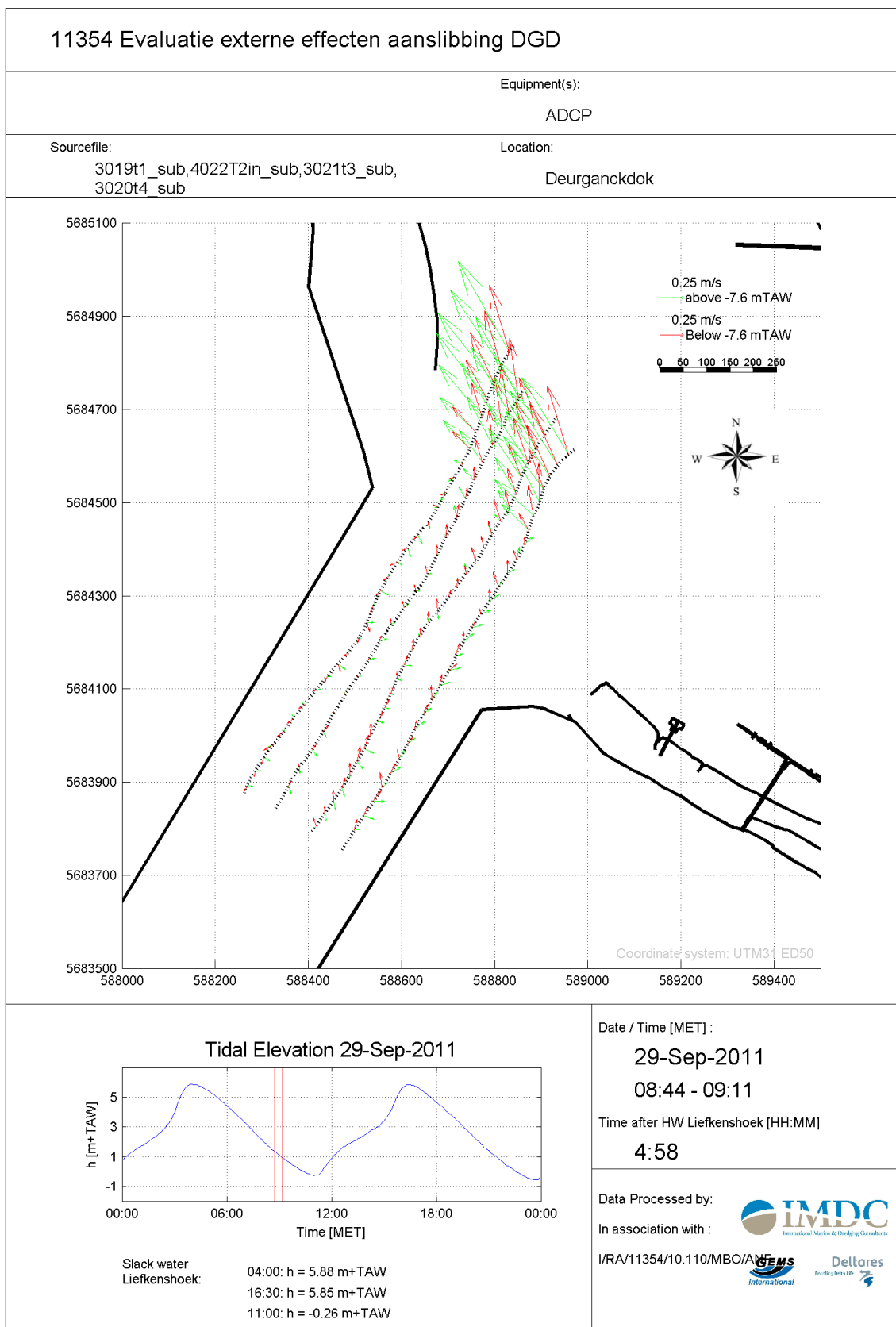


In association with :

I/RA/11354/10.110/MBO/ANF







11354 Evaluatie externe effecten aanslibbing DGD

Equipment(s):

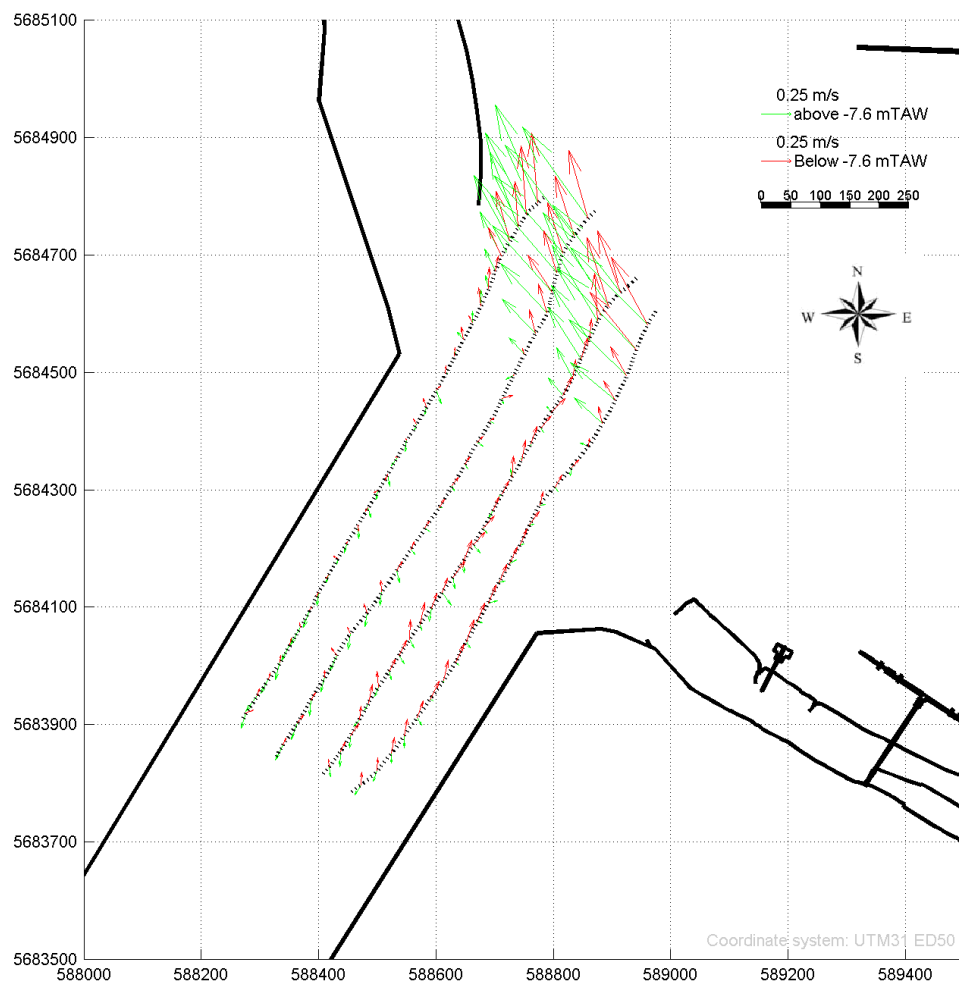
ADCP

Sourcefile:

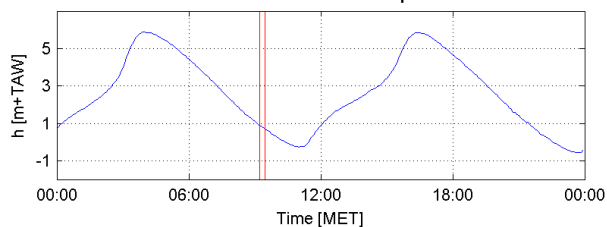
3022t1_sub,4024T2in_sub,3023t3_sub,
4023T4uit_sub

Location:

Deurganckdok



Tidal Elevation 29-Sep-2011



Slack water
Liefkenshoek:
04:00: h = 5.88 m+TAW
16:30: h = 5.85 m+TAW
11:00: h = -0.26 m+TAW

Date / Time [MET] :

29-Sep-2011

09:12 - 09:27

Time after HW Liefkenshoek [HH:MM]

5:20

Data Processed by:

In association with :

I/RA/11354/10.110/MBO/ANF



11354 Evaluatie externe effecten aanslibbing DGD

Equipment(s):

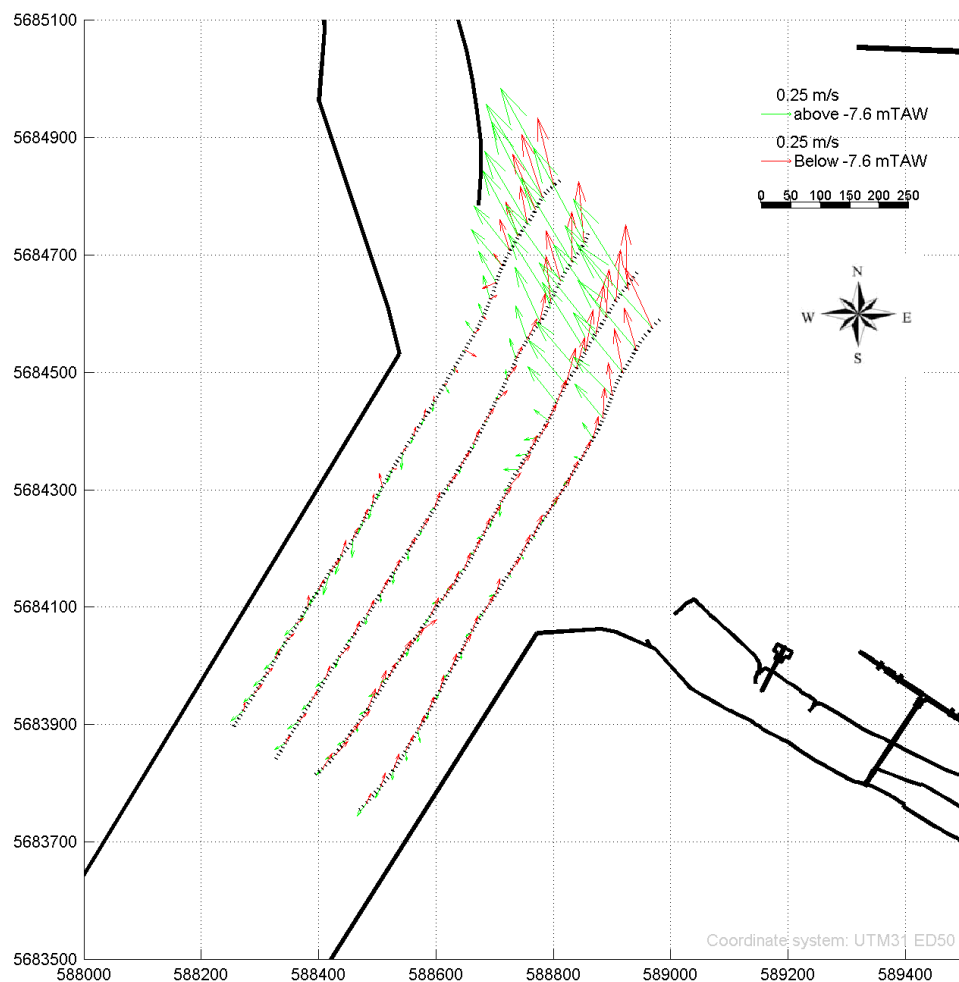
ADCP

Sourcefile:

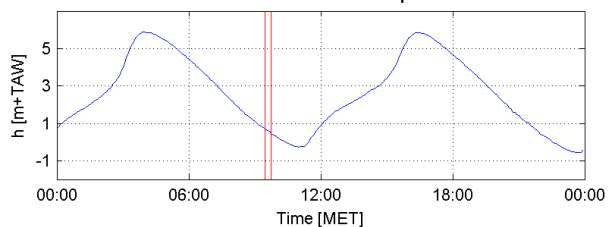
3024t1_sub,4026T2in_sub,3025t3_sub,
4025T4uit_sub

Location:

Deurganckdok



Tidal Elevation 29-Sep-2011



Slack water
Liefkenshoek: 04:00: h = 5.88 m+TAW
16:30: h = 5.85 m+TAW
11:00: h = -0.26 m+TAW

Date / Time [MET] :

29-Sep-2011

09:26 - 09:44

Time after HW Liefkenshoek [HH:MM]

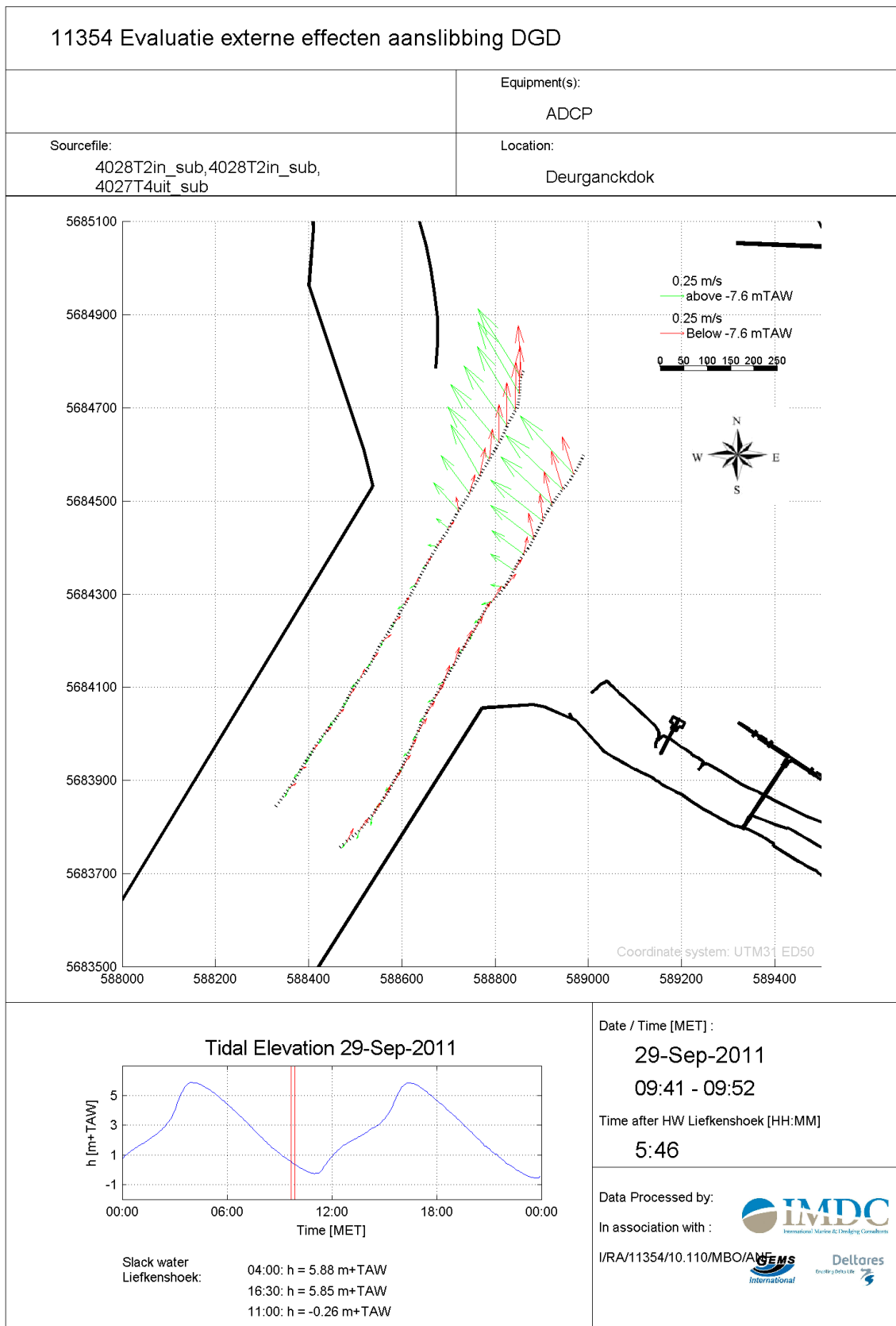
5:35

Data Processed by:

In association with :

I/RA/11354/10.110/MBO/ANF





11354 Evaluatie externe effecten aanslibbing DGD

Equipment(s):

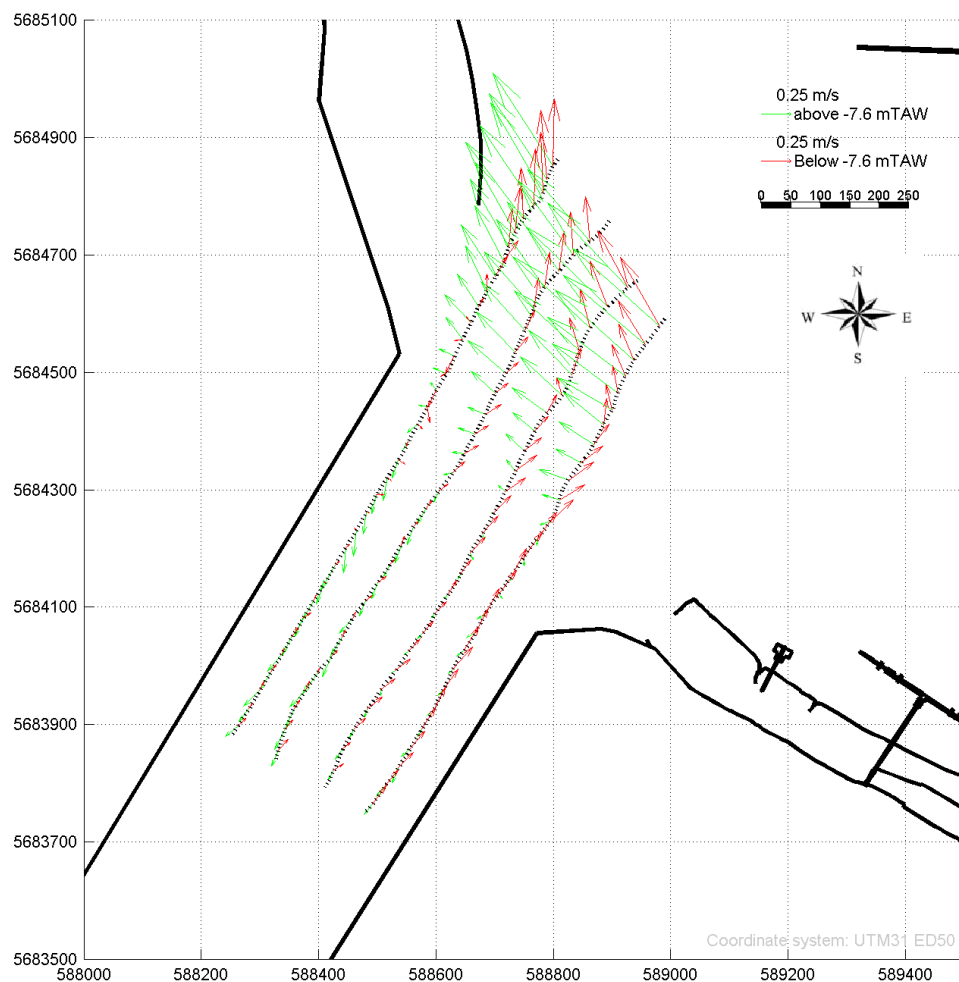
ADCP

Sourcefile:

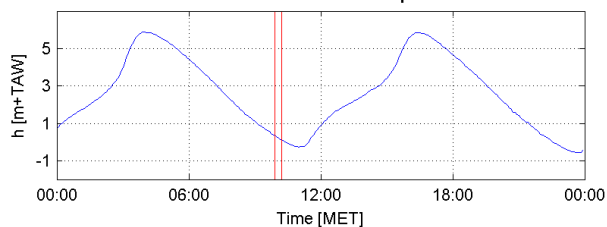
3027t1_sub,4031T2uit_sub,
4030T3in_sub,4029T4uit_sub

Location:

Deurganckdok



Tidal Elevation 29-Sep-2011



Slack water
Liefkenshoek:

04:00:	h = 5.88 m+TAW
16:30:	h = 5.85 m+TAW
11:00:	h = -0.26 m+TAW

Date / Time [MET] :

29-Sep-2011

09:54 - 10:12

Time after HW Liefkenshoek [HH:MM]

6:03

Data Processed by:

In association with :

I/RA/11354/10.110/MBO/ANF



11354 Evaluatie externe effecten aanslibbing DGD

Equipment(s):

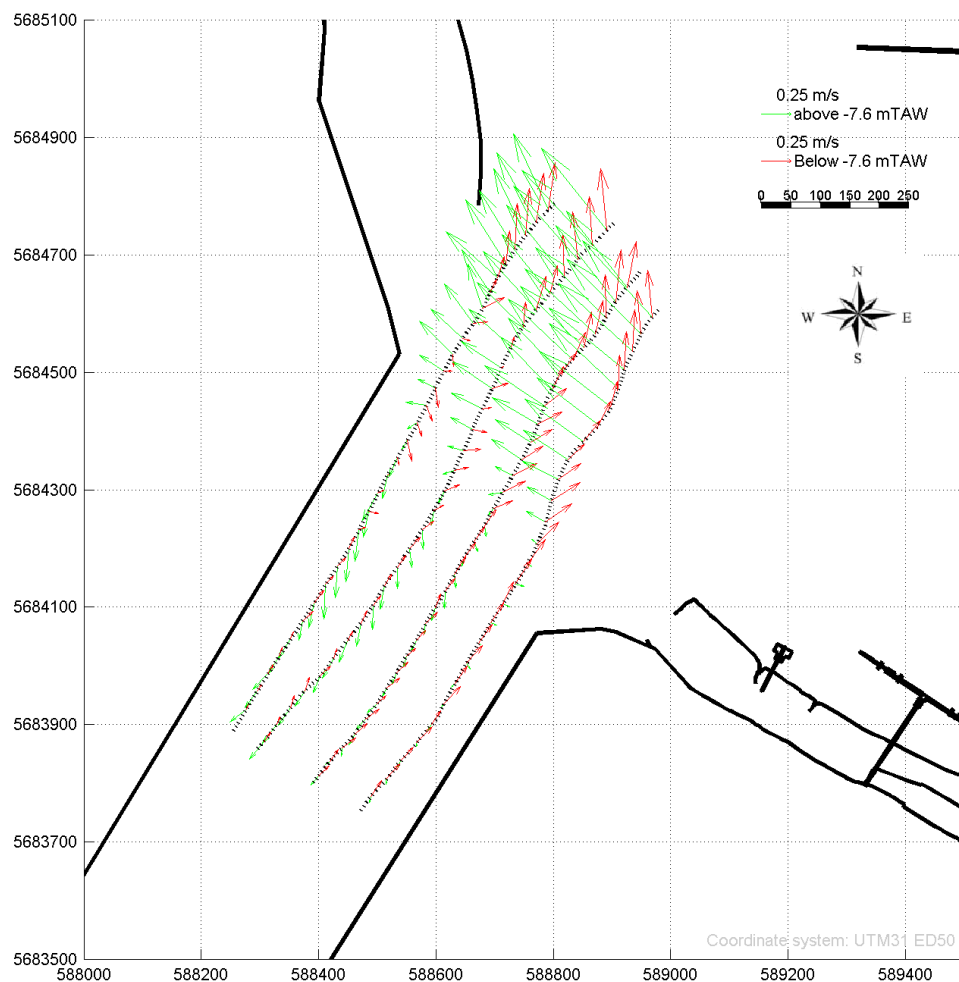
ADCP

Sourcefile:

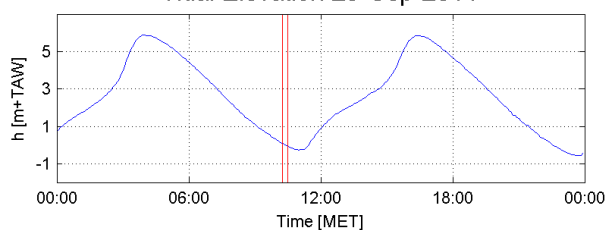
3029t1_sub,4033T2uit_sub,
3028t3_sub,4032T4in_sub

Location:

Deurganckdok



Tidal Elevation 29-Sep-2011



Slack water
Liefkenshoek:
04:00: h = 5.88 m+TAW
16:30: h = 5.85 m+TAW
11:00: h = -0.26 m+TAW

Date / Time [MET] :

29-Sep-2011

10:14 - 10:29

Time after HW Liefkenshoek [HH:MM]

6:22

Data Processed by:

In association with :

I/RA/11354/10.110/MBO/ANF



11354 Evaluatie externe effecten aanslibbing DGD

Equipment(s):

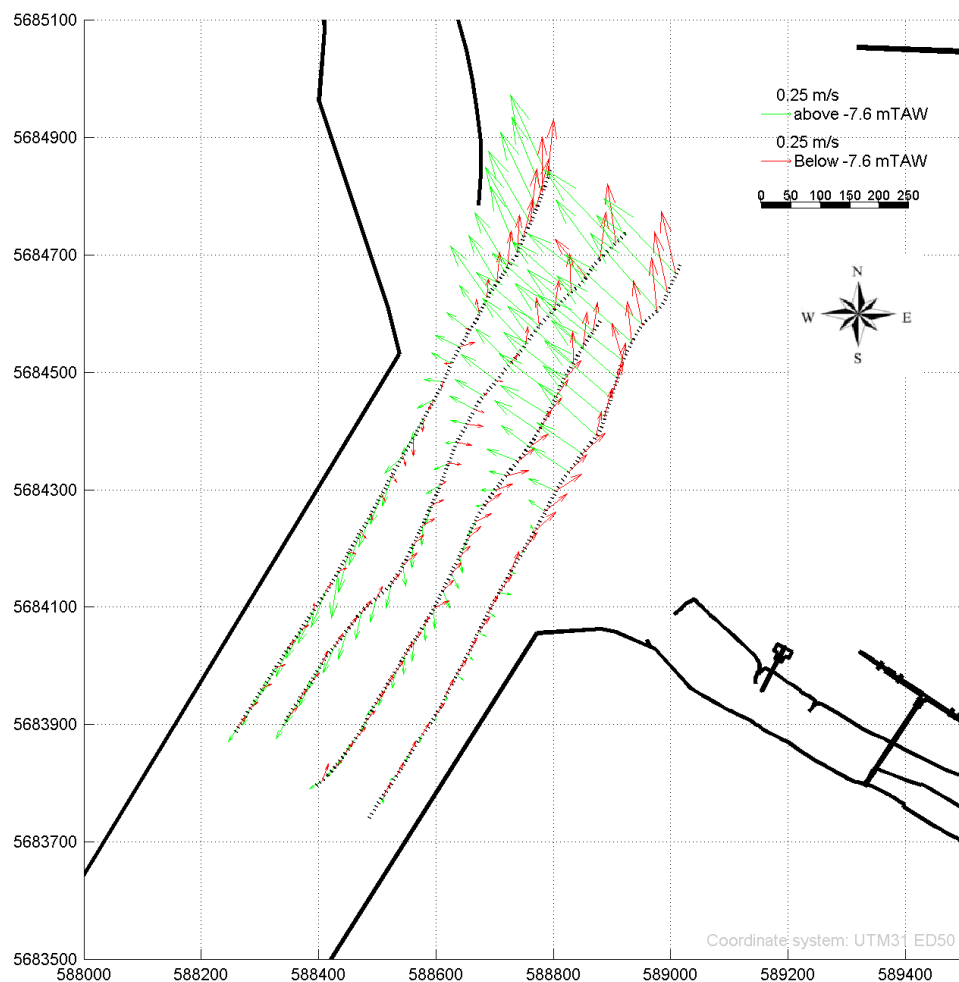
ADCP

Sourcefile:

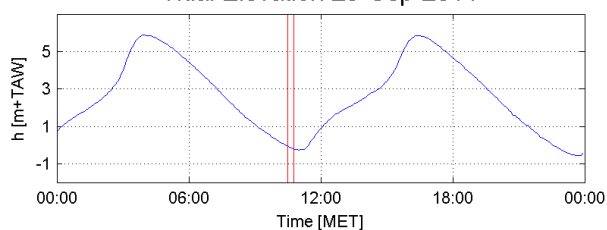
3031t1_sub,4035T2uit_sub,
3030t3_sub,4034T4in_sub

Location:

Deurganckdok



Tidal Elevation 29-Sep-2011



Slack water
Liefkenshoek:

04:00:	h = 5.88 m+TAW
16:30:	h = 5.85 m+TAW
11:00:	h = -0.26 m+TAW

Date / Time [MET] :

29-Sep-2011

10:30 - 10:47

Time after HW Liefkenshoek [HH:MM]

6:38

Data Processed by:

In association with :

I/RA/11354/10.110/MBO/ANF



11354 Evaluatie externe effecten aanslibbing DGD

Equipment(s):

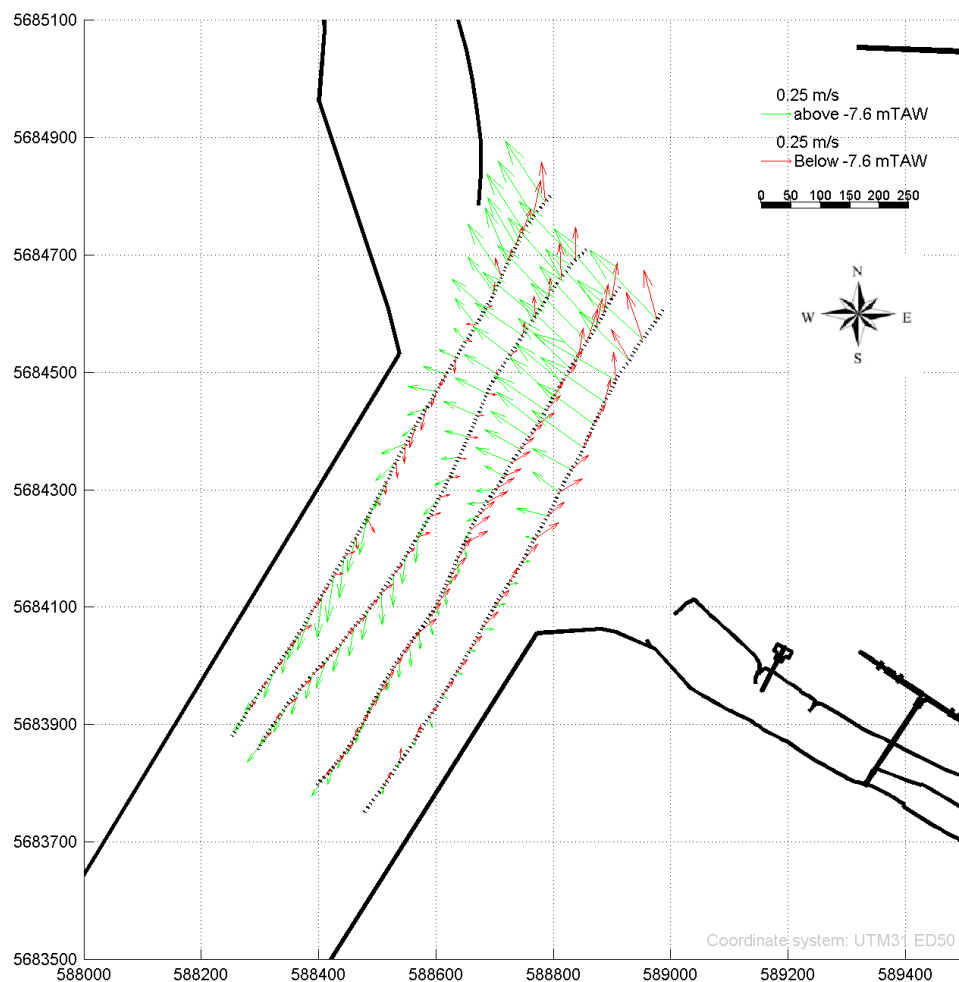
ADCP

Sourcefile:

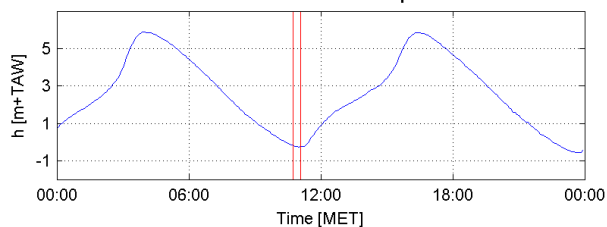
3033t1_sub,4037T2uit_sub,
3032t3_sub,4036T4in_sub

Location:

Deurganckdok



Tidal Elevation 29-Sep-2011



Slack water
Liefkenshoek:

04:00: h = 5.88 m+TAW
16:30: h = 5.85 m+TAW
11:00: h = -0.26 m+TAW

Date / Time [MET] :

29-Sep-2011

10:45 - 11:05

Time after HW Liefkenshoek [HH:MM]

6:55

Data Processed by:

In association with :

I/RA/11354/10.110/MBO/ANF



11354 Evaluatie externe effecten aanslibbing DGD

Equipment(s):

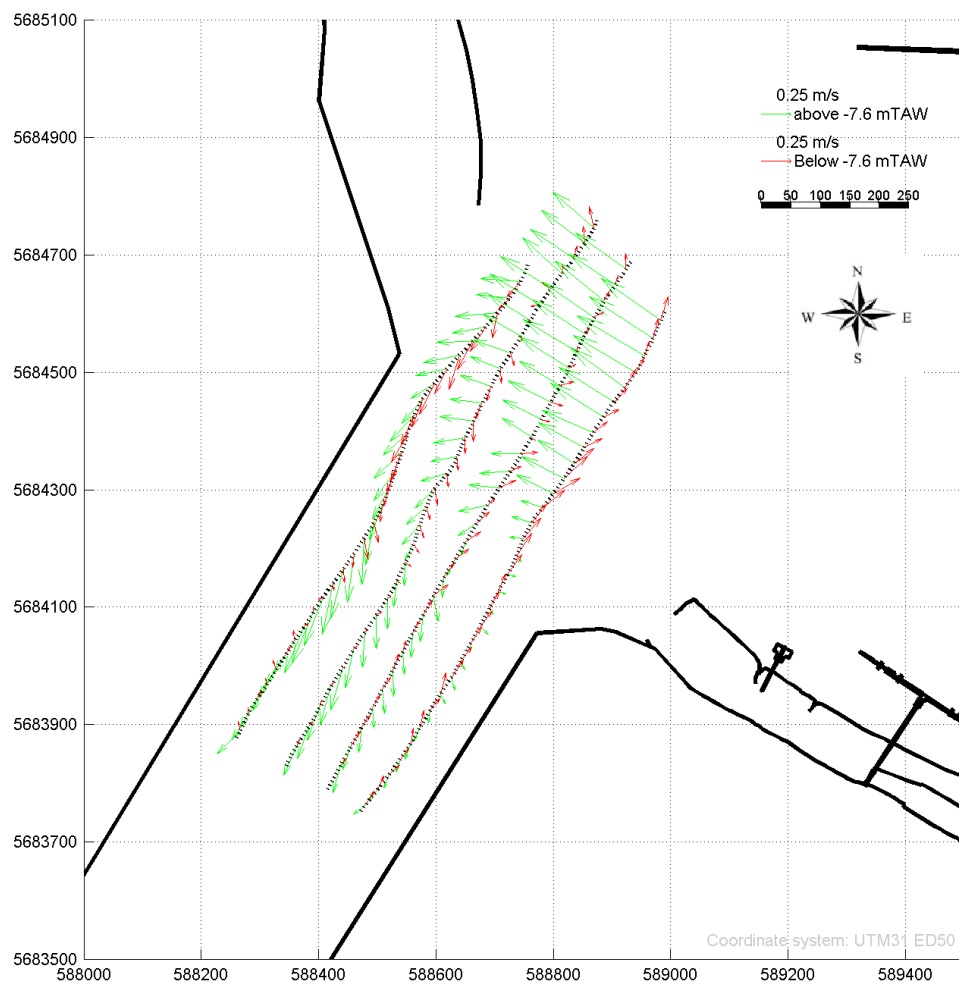
ADCP

Sourcefile:

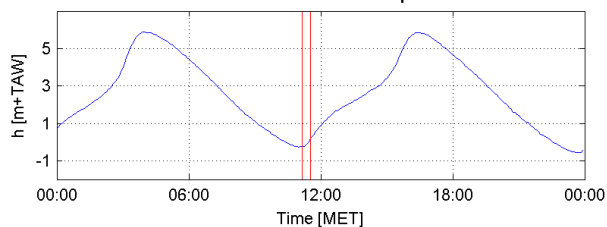
3036t1_sub,4039T2in_sub,3035t3_sub,
3034t4_sub

Location:

Deurganckdok



Tidal Elevation 29-Sep-2011



Slack water
Liefkenshoek:

04:00: h = 5.88 m+TAW
16:30: h = 5.85 m+TAW
11:00: h = -0.26 m+TAW

Date / Time [MET] :

29-Sep-2011

11:09 - 11:32

Time after HW Liefkenshoek [HH:MM]

-5:09

Data Processed by:

In association with :

I/RA/11354/10.110/MBO/ANF



11354 Evaluatie externe effecten aanslibbing DGD

Equipment(s):

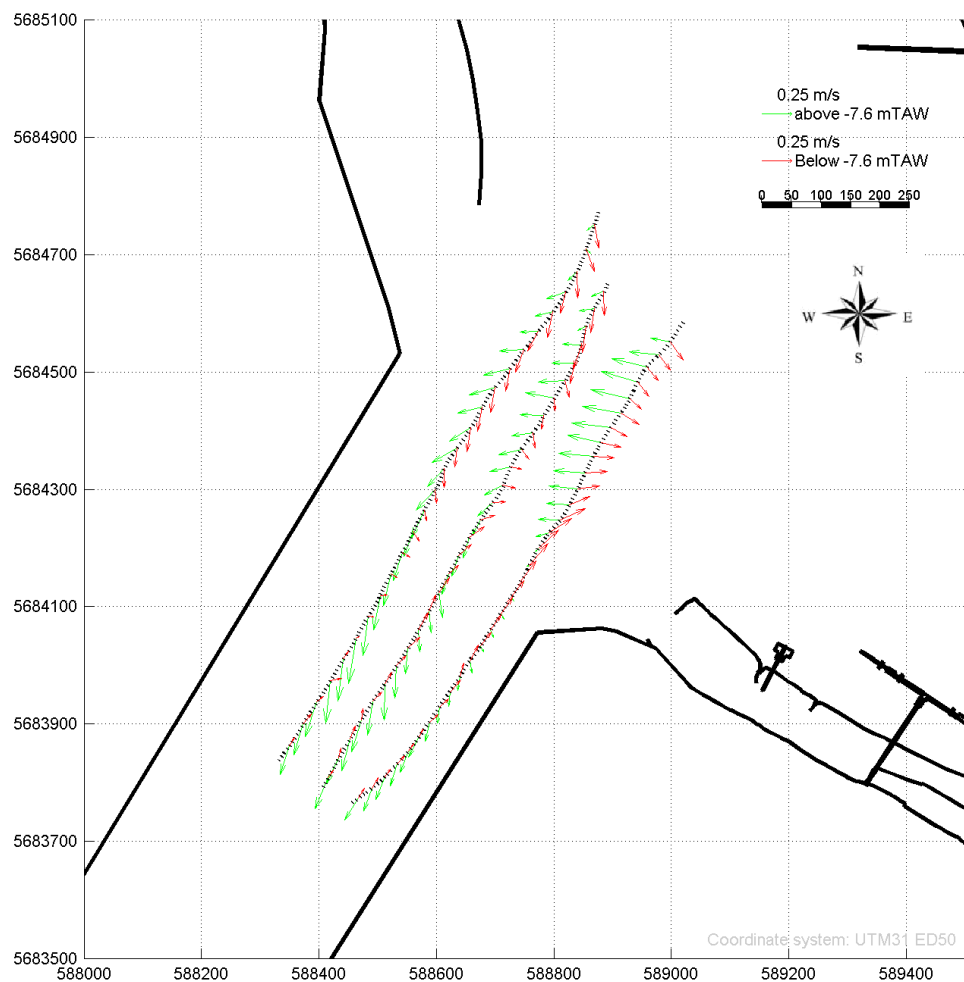
ADCP

Sourcefile:

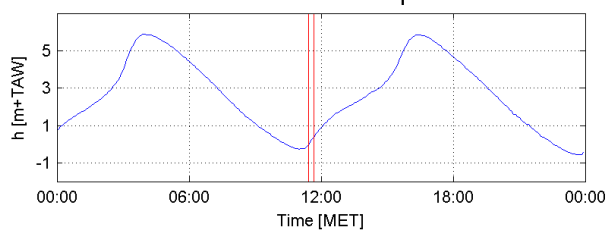
4041T2in_sub,4041T2in_sub,
3037t3_sub,4040T4uit_sub

Location:

Deurganckdok



Tidal Elevation 29-Sep-2011



Slack water
Liefkenshoek:
04:00: h = 5.88 m+TAW
16:30: h = 5.85 m+TAW
11:00: h = -0.26 m+TAW

Date / Time [MET] :

29-Sep-2011

11:26 - 11:40

Time after HW Liefkenshoek [HH:MM]

-4:56

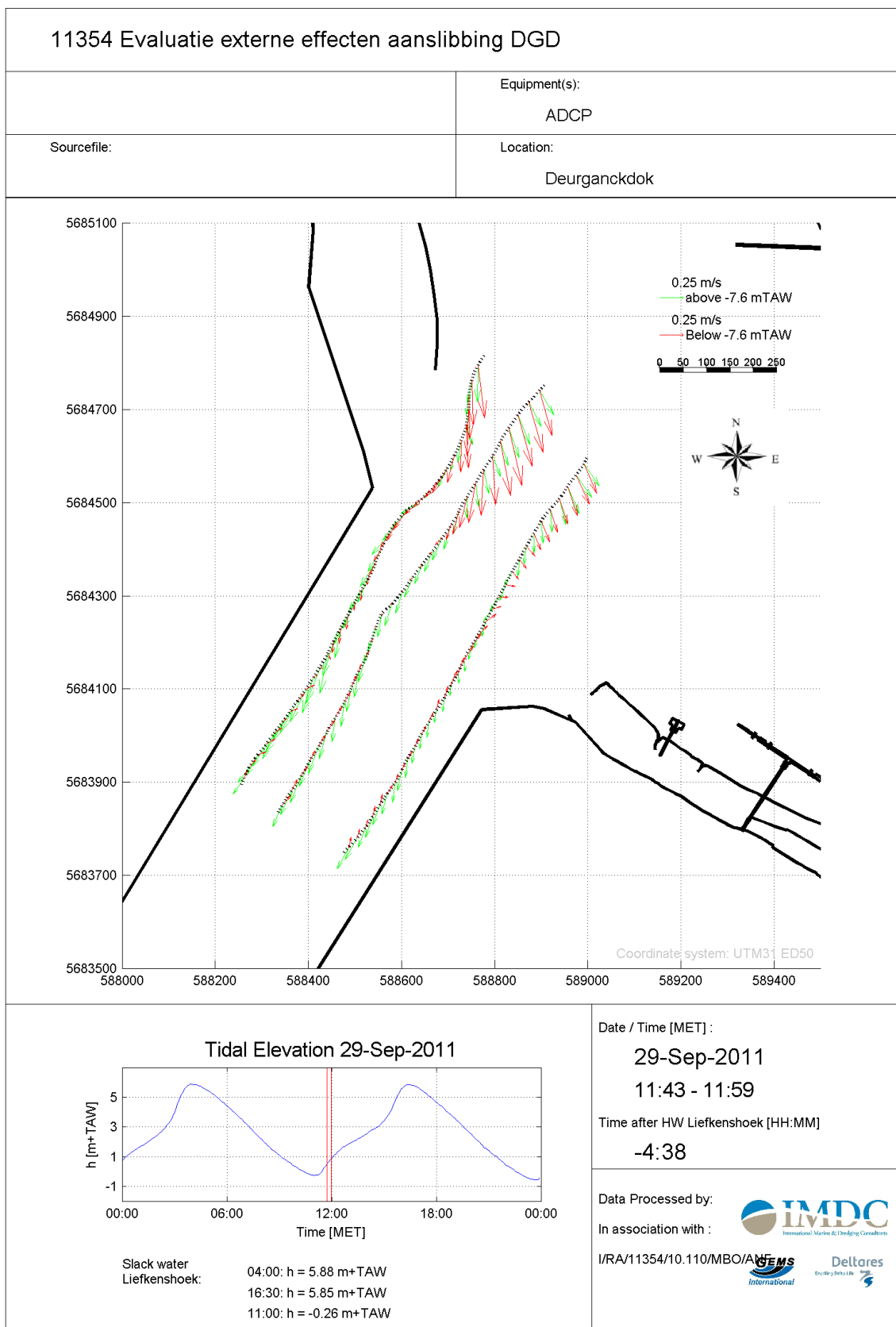
Data Processed by:

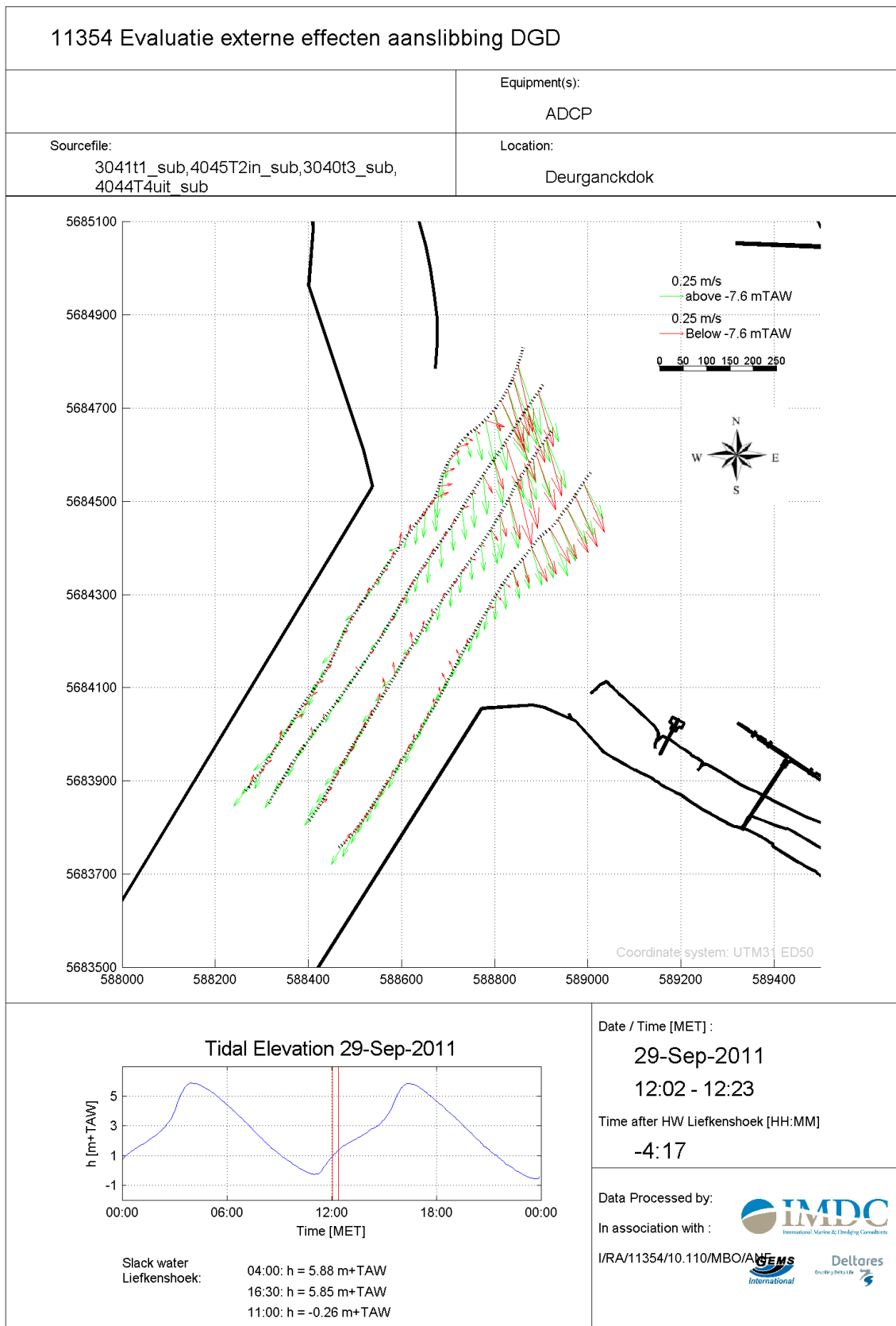


In association with :

I/RA/11354/10.110/MBO/ANF







11354 Evaluatie externe effecten aanslibbing DGD

Equipment(s):

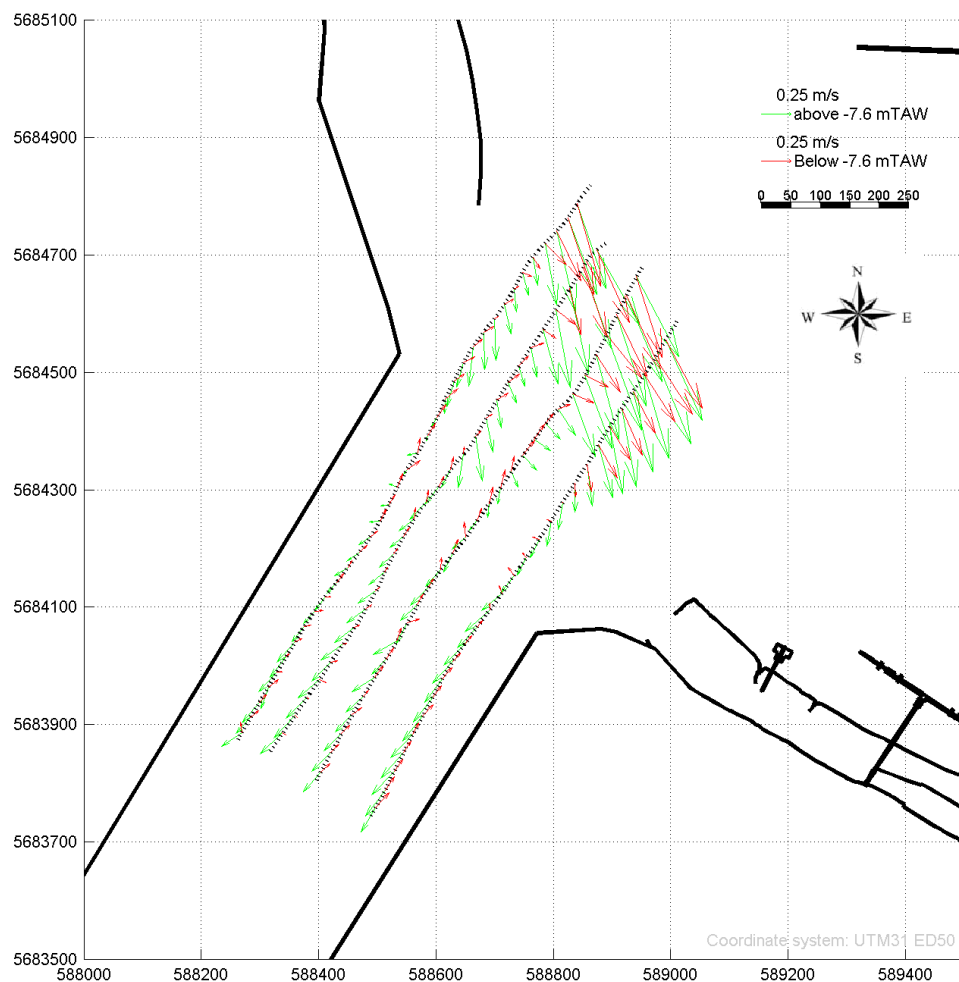
ADCP

Sourcefile:

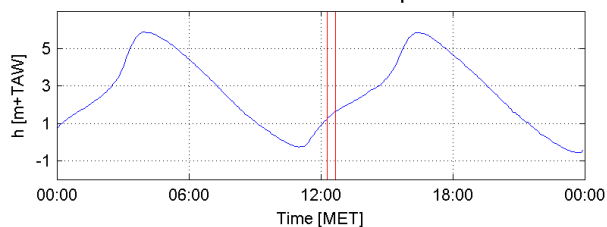
3043t1_sub,4047T2in_sub,3042t3_sub,
4046T4uit_sub

Location:

Deurganckdok



Tidal Elevation 29-Sep-2011



Slack water
Liefkenshoek:
04:00: h = 5.88 m+TAW
16:30: h = 5.85 m+TAW
11:00: h = -0.26 m+TAW

Date / Time [MET] :

29-Sep-2011

12:18 - 12:40

Time after HW Liefkenshoek [HH:MM]

-4:00

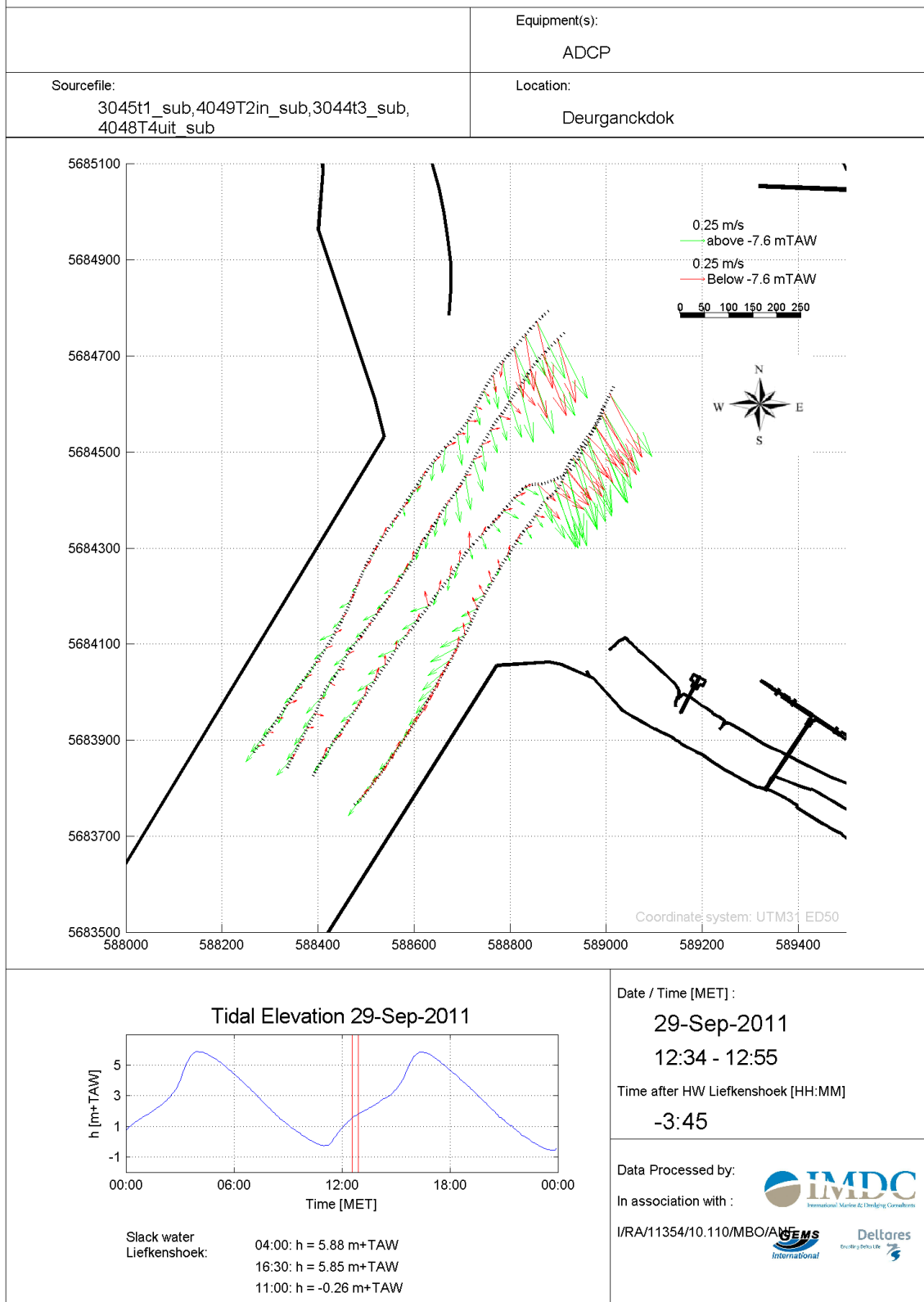
Data Processed by:

In association with :

I/RA/11354/10.110/MBO/ANF



11354 Evaluatie externe effecten aanslibbing DGD



11354 Evaluatie externe effecten aanslibbing DGD

Equipment(s):

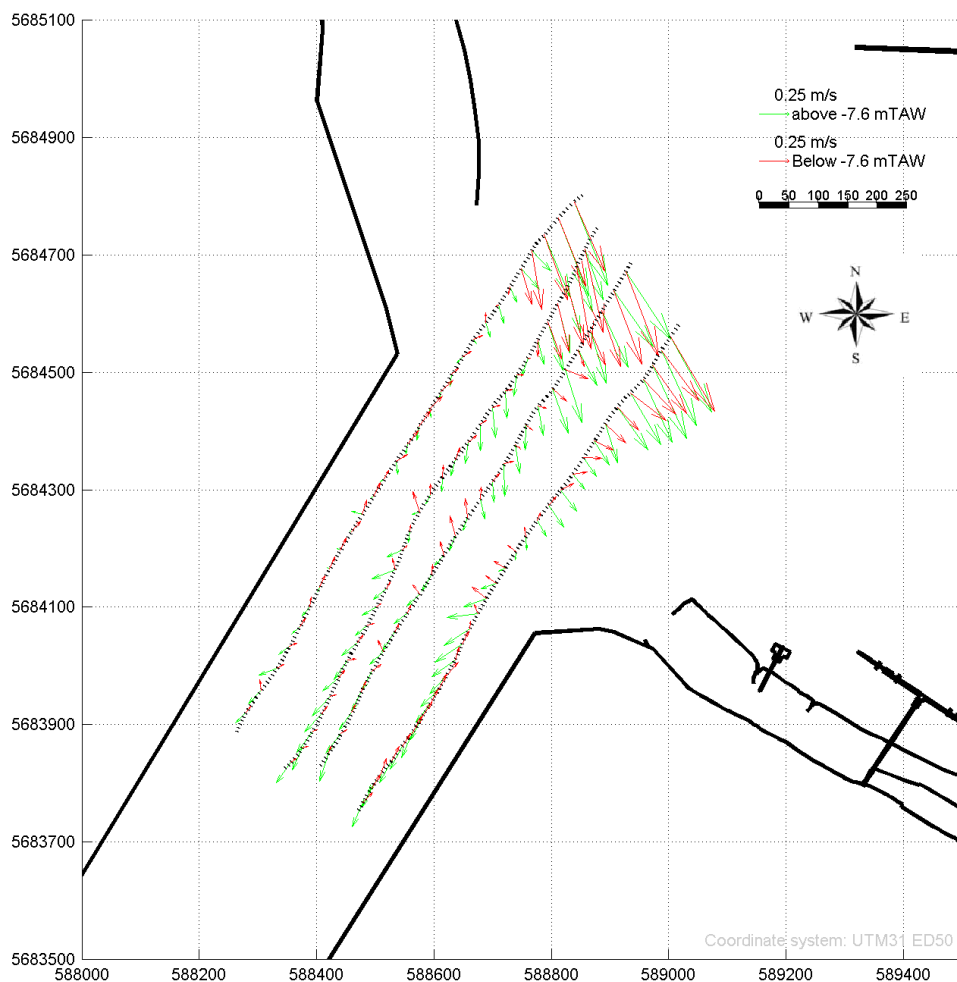
ADCP

Sourcefile:

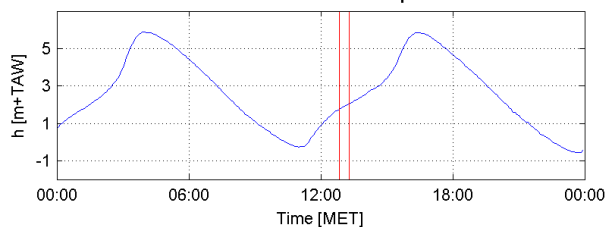
3048t1_sub,3047t2_sub,3046t3_sub,
4050T4uit_sub

Location:

Deurganckdok



Tidal Elevation 29-Sep-2011



Slack water
Liefkenshoek:

04:00:	h = 5.88 m+TAW
16:30:	h = 5.85 m+TAW
11:00:	h = -0.26 m+TAW

Date / Time [MET] :

29-Sep-2011

12:51 - 13:18

Time after HW Liefkenshoek [HH:MM]

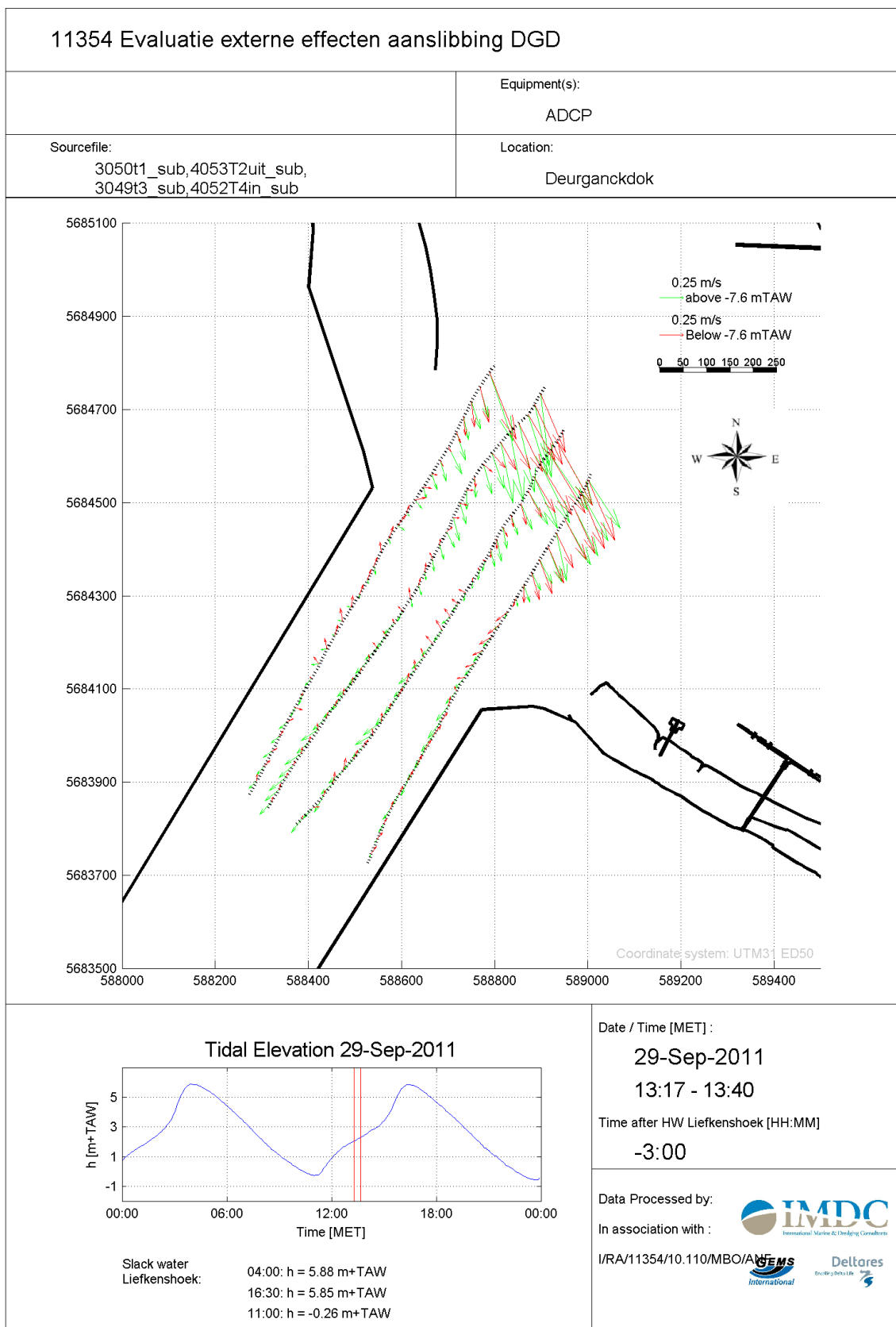
-3:25

Data Processed by:

In association with :

I/RA/11354/10.110/MBO/ANF





11354 Evaluatie externe effecten aanslibbing DGD

Equipment(s):

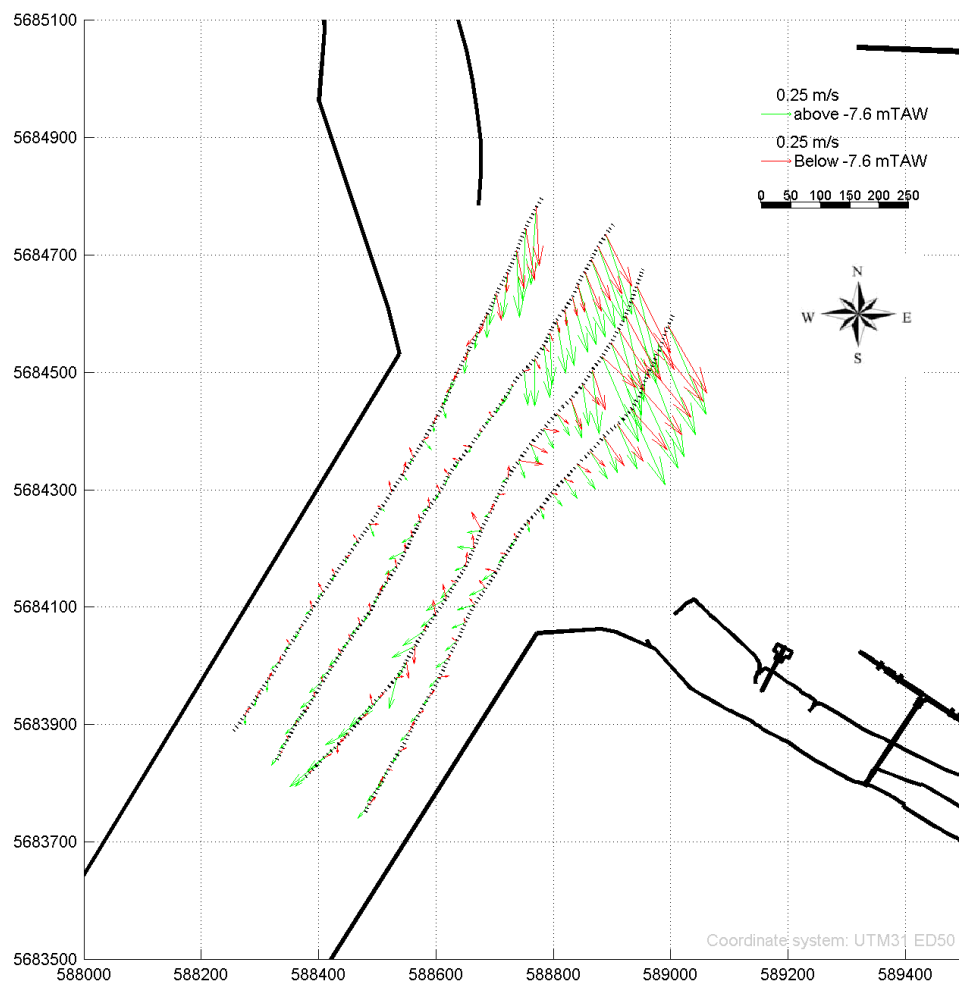
ADCP

Sourcefile:

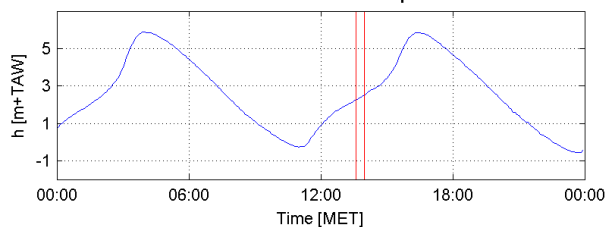
3052t1_sub,4055T2uit_sub,
3051t3_sub,4054T4in_sub

Location:

Deurganckdok



Tidal Elevation 29-Sep-2011



Slack water
Liefkenshoek:
04:00: h = 5.88 m+TAW
16:30: h = 5.85 m+TAW
11:00: h = -0.26 m+TAW

Date / Time [MET] :

29-Sep-2011

13:35 - 13:59

Time after HW Liefkenshoek [HH:MM]

-2:42

Data Processed by:

In association with :

I/RA/11354/10.110/MBO/ANF



11354 Evaluatie externe effecten aanslibbing DGD

Equipment(s):

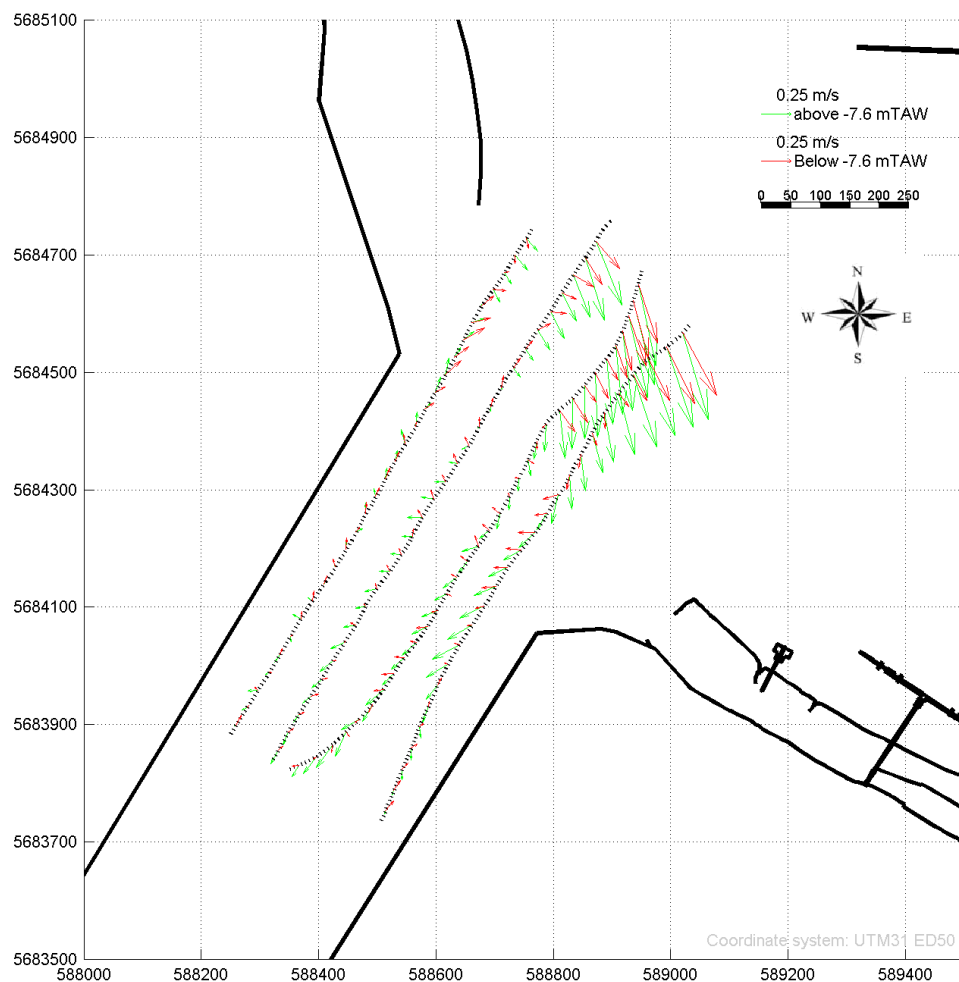
ADCP

Sourcefile:

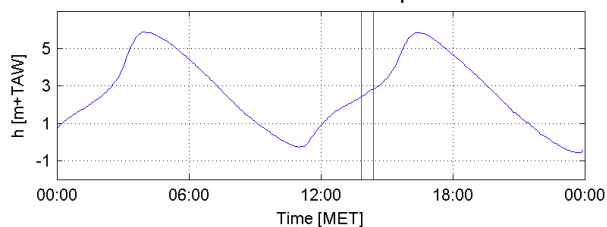
3055t1_sub,4057T2uit_sub,
3053t3_sub,4056T4in_sub

Location:

Deurganckdok



Tidal Elevation 29-Sep-2011



Slack water
Liefkenshoek:

04:00: h = 5.88 m+TAW
16:30: h = 5.85 m+TAW
11:00: h = -0.26 m+TAW

Date / Time [MET] :

29-Sep-2011

13:51 - 14:23

Time after HW Liefkenshoek [HH:MM]

-2:22

Data Processed by:

In association with :

I/RA/11354/10.110/MBO/ANF



11354 Evaluatie externe effecten aanslibbing DGD

Equipment(s):

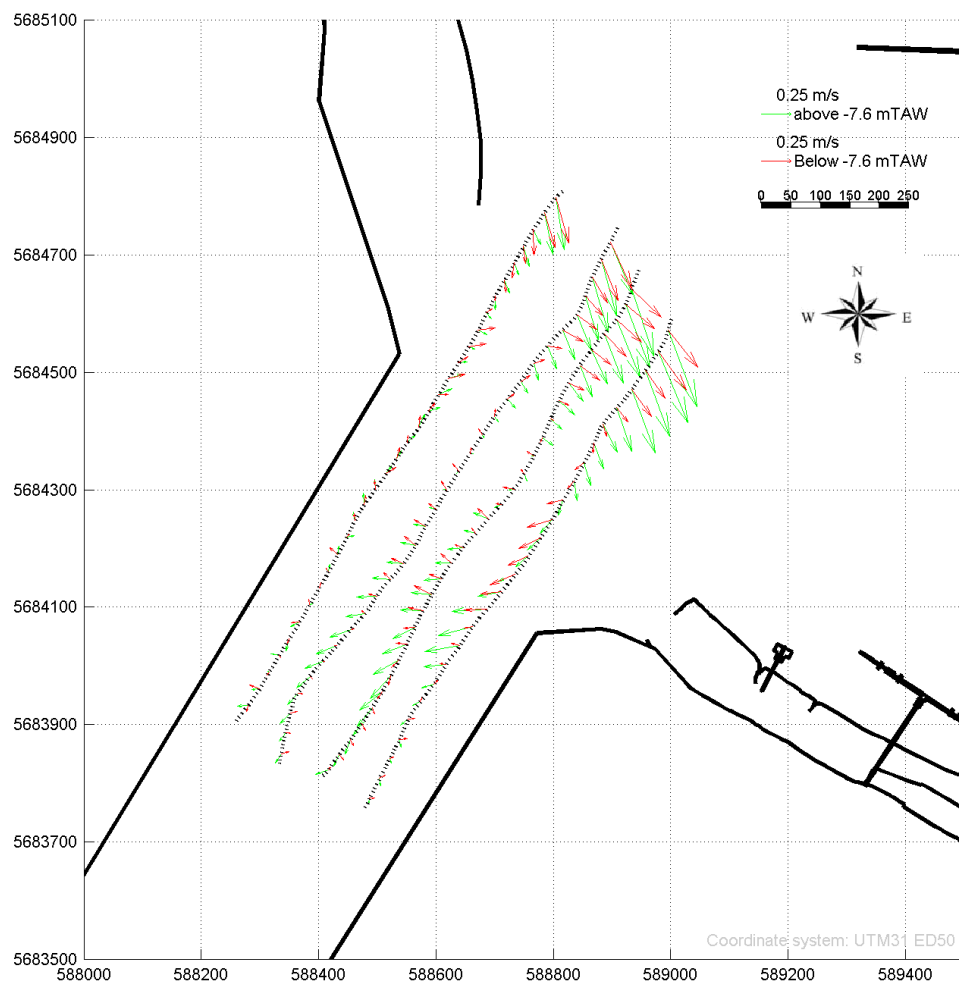
ADCP

Sourcefile:

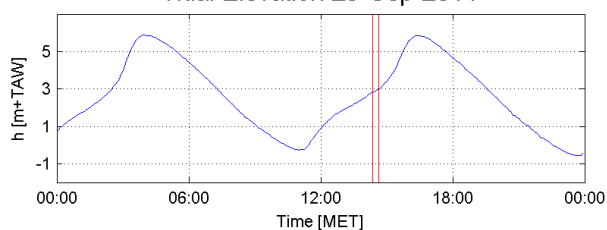
3057t1_sub,4059T2uit_sub,
3056t3_sub,4058T4in_sub

Location:

Deurganckdok



Tidal Elevation 29-Sep-2011



Slack water
Liefkenshoek:

04:00: h = 5.88 m+TAW
16:30: h = 5.85 m+TAW
11:00: h = -0.26 m+TAW

Date / Time [MET] :

29-Sep-2011

14:22 - 14:39

Time after HW Liefkenshoek [HH:MM]

-1:59

Data Processed by:

In association with :

I/RA/11354/10.110/MBO/ANF



11354 Evaluatie externe effecten aanslibbing DGD

Equipment(s):

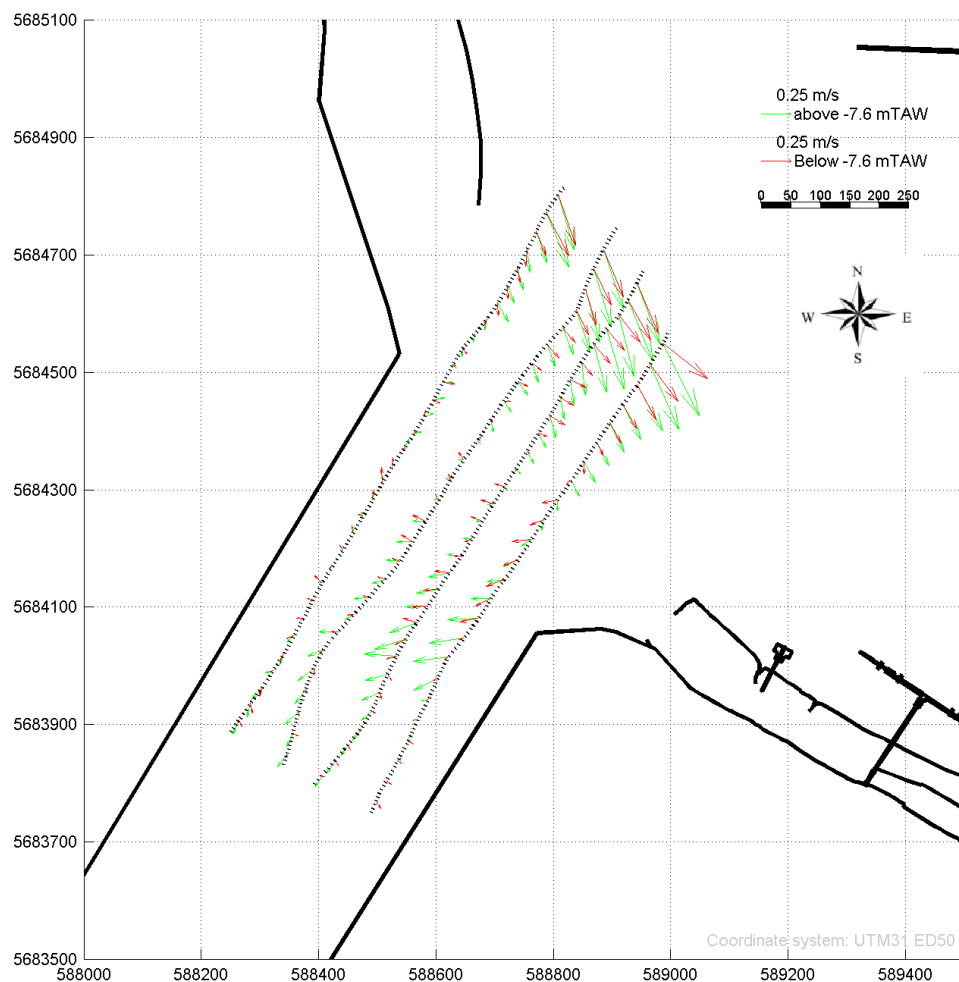
ADCP

Sourcefile:

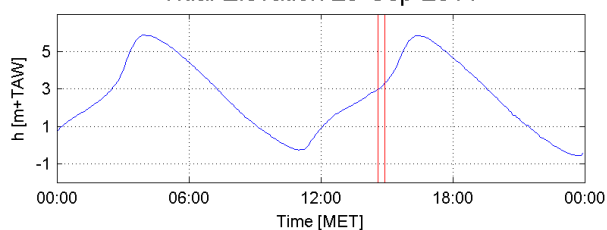
3059t1_sub,4061T2uit_sub,
3058t3_sub,4060T4in_sub

Location:

Deurganckdok



Tidal Elevation 29-Sep-2011



Slack water
Liefkenshoek:
04:00: h = 5.88 m+TAW
16:30: h = 5.85 m+TAW
11:00: h = -0.26 m+TAW

Date / Time [MET] :

29-Sep-2011

14:36 - 14:55

Time after HW Liefkenshoek [HH:MM]

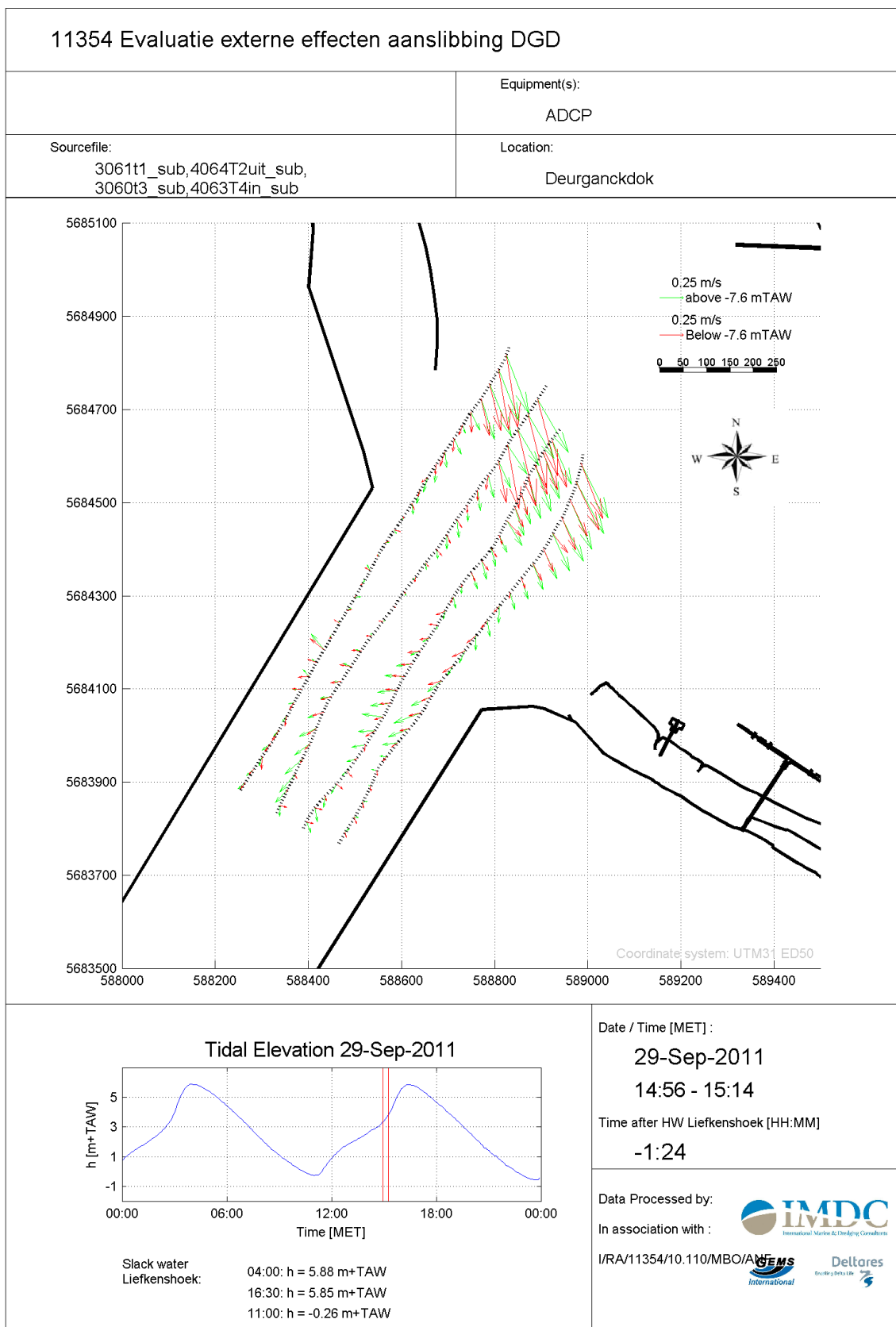
-1:44

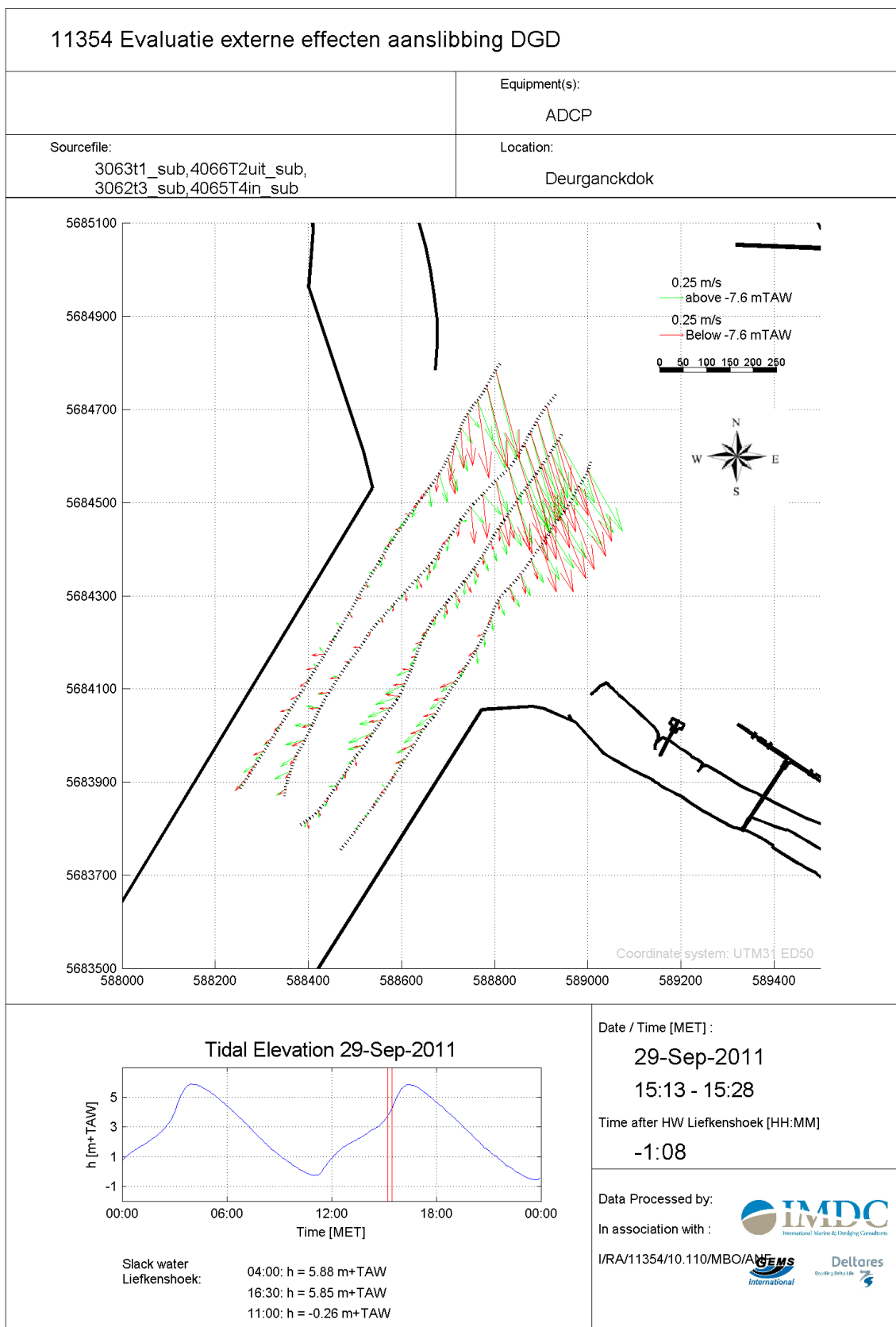
Data Processed by:

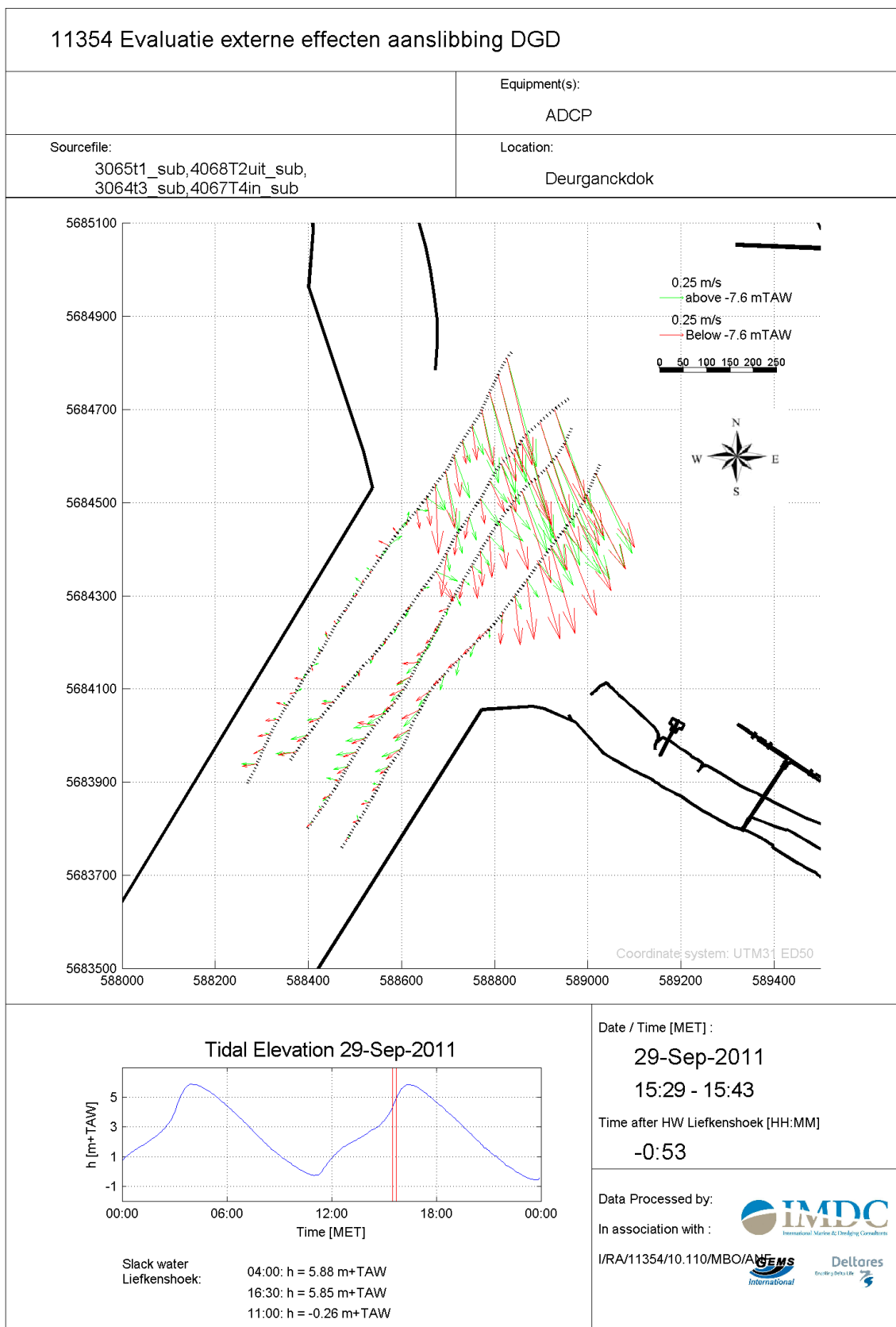
In association with :

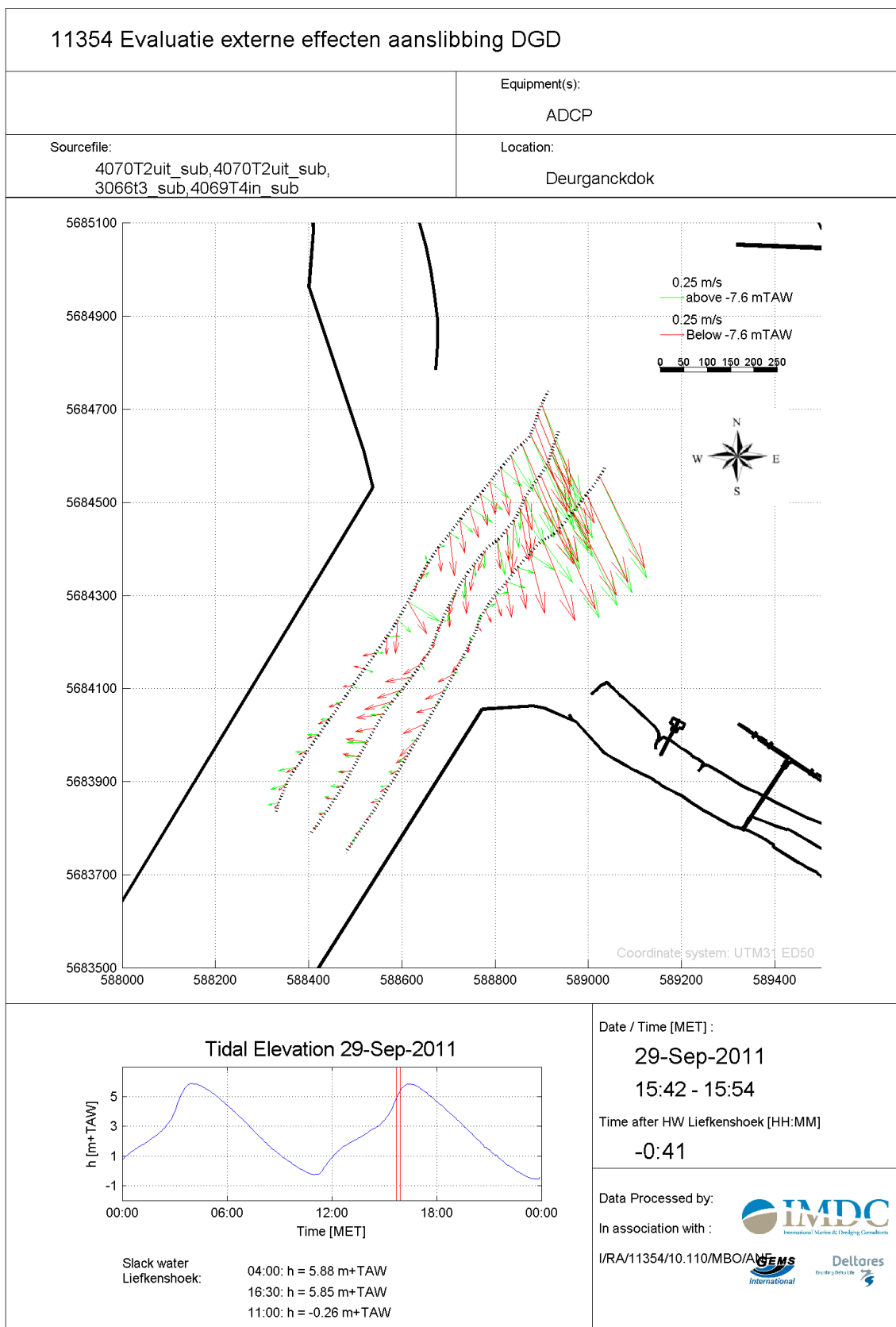
I/RA/11354/10.110/MBO/ANF











11354 Evaluatie externe effecten aanslibbing DGD

Equipment(s):

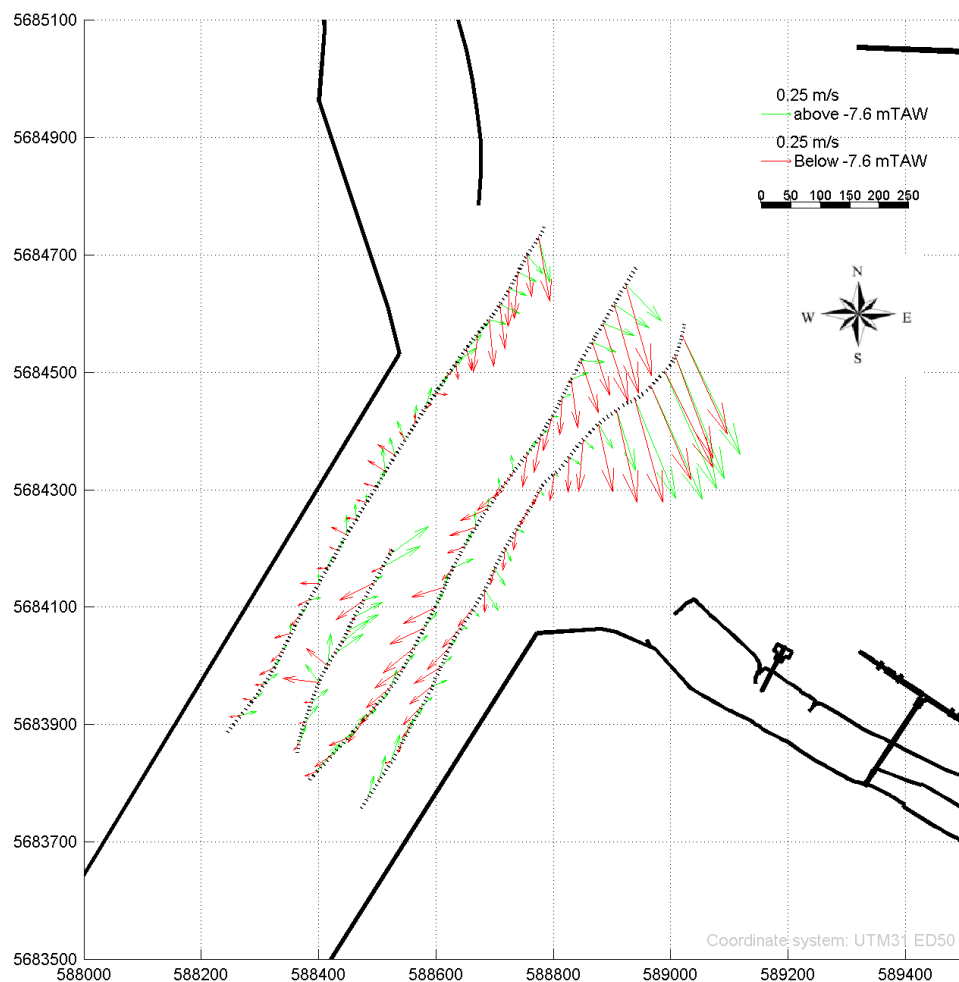
ADCP

Sourcefile:

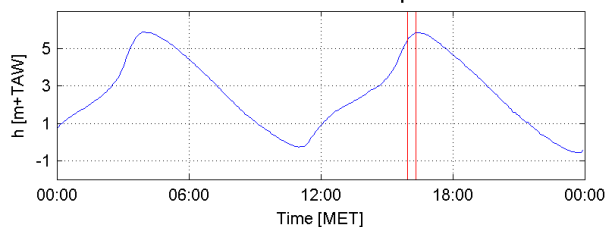
3068t1_sub,4072T2uit_sub,
3069t3_sub,4071T4in_sub

Location:

Deurganckdok



Tidal Elevation 29-Sep-2011



Slack water
Liefkenshoek:

04:00: h = 5.88 m+TAW
16:30: h = 5.85 m+TAW
11:00: h = -0.26 m+TAW

Date / Time [MET] :

29-Sep-2011

15:56 - 16:20

Time after HW Liefkenshoek [HH:MM]

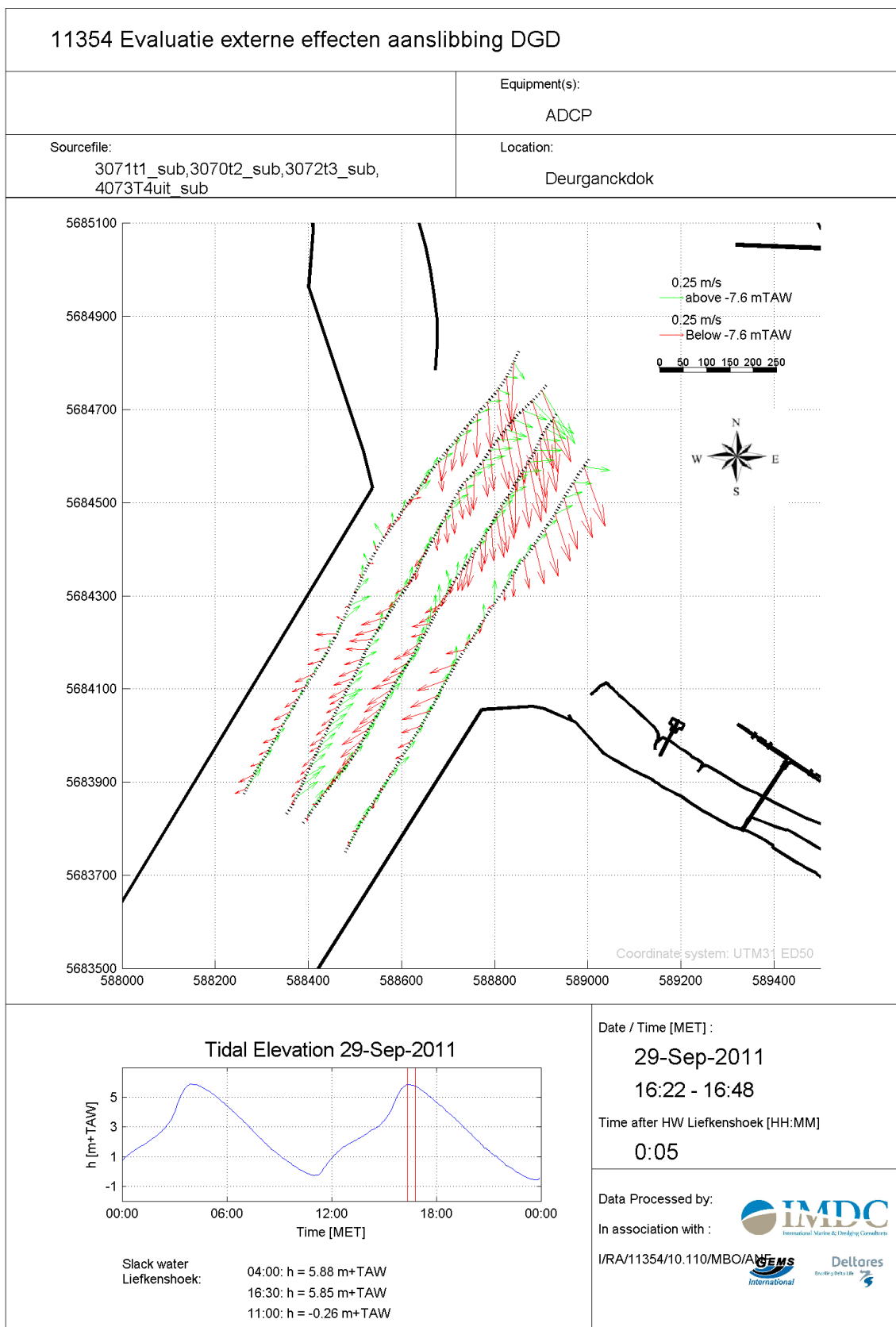
-0:21

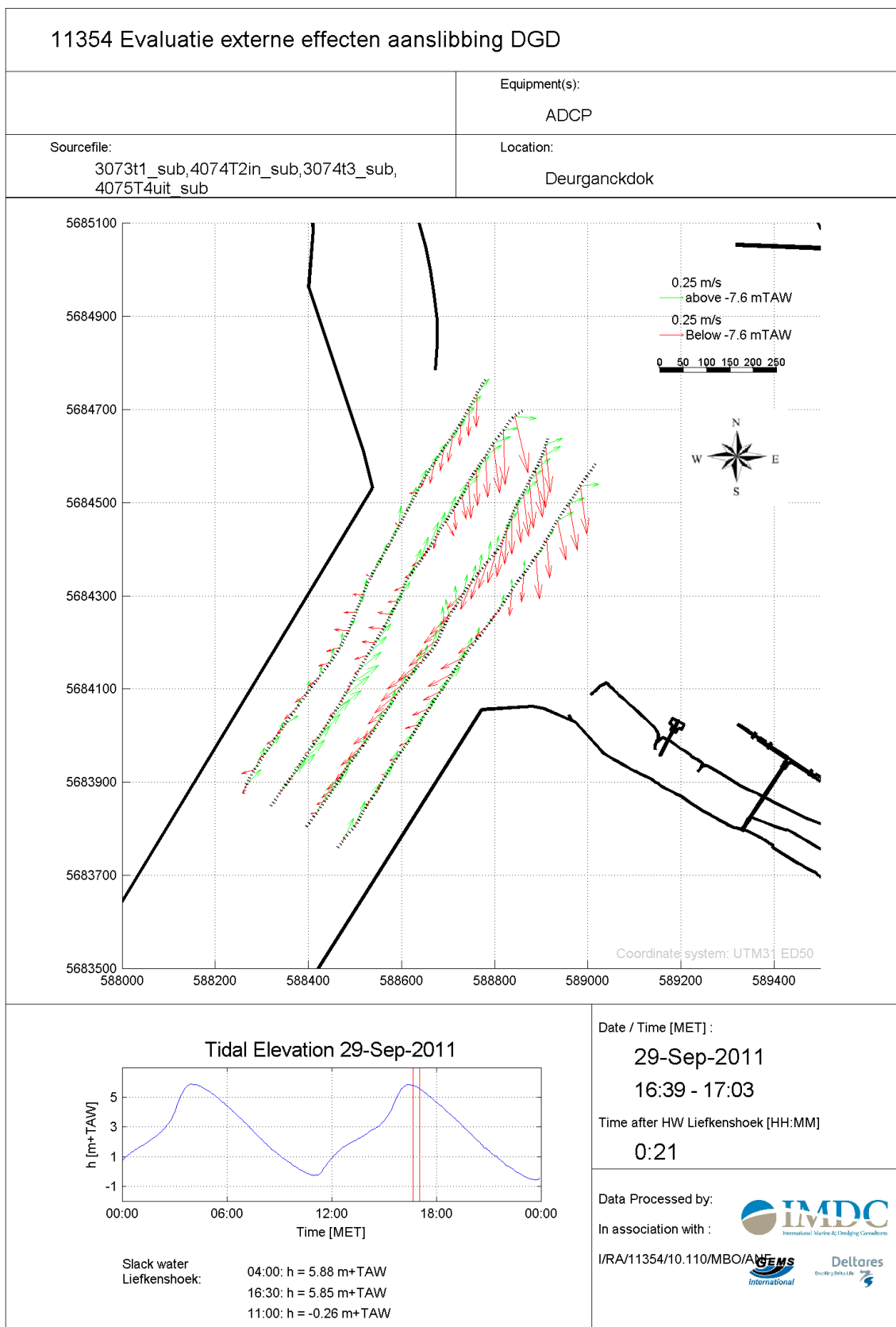
Data Processed by:

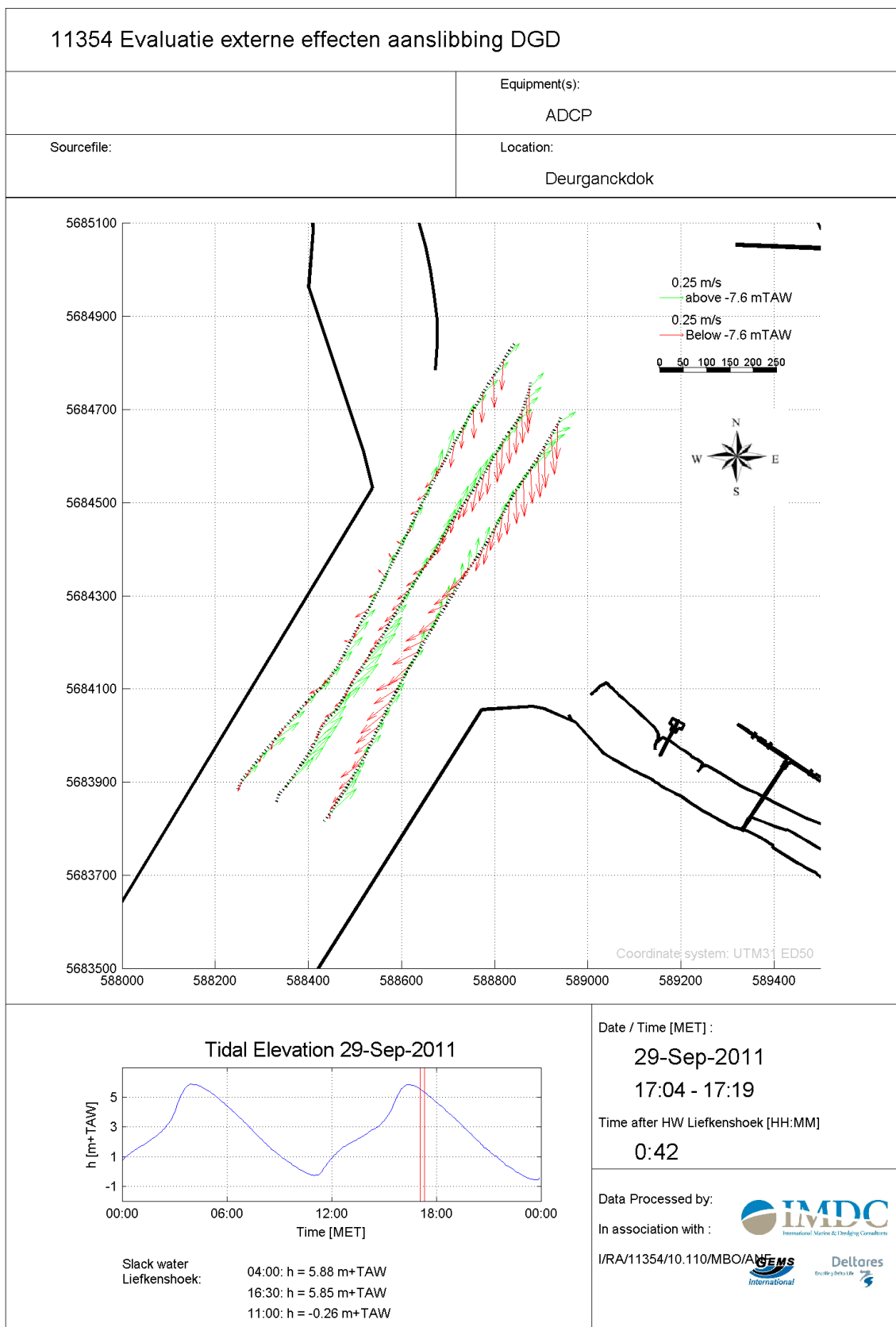
In association with :

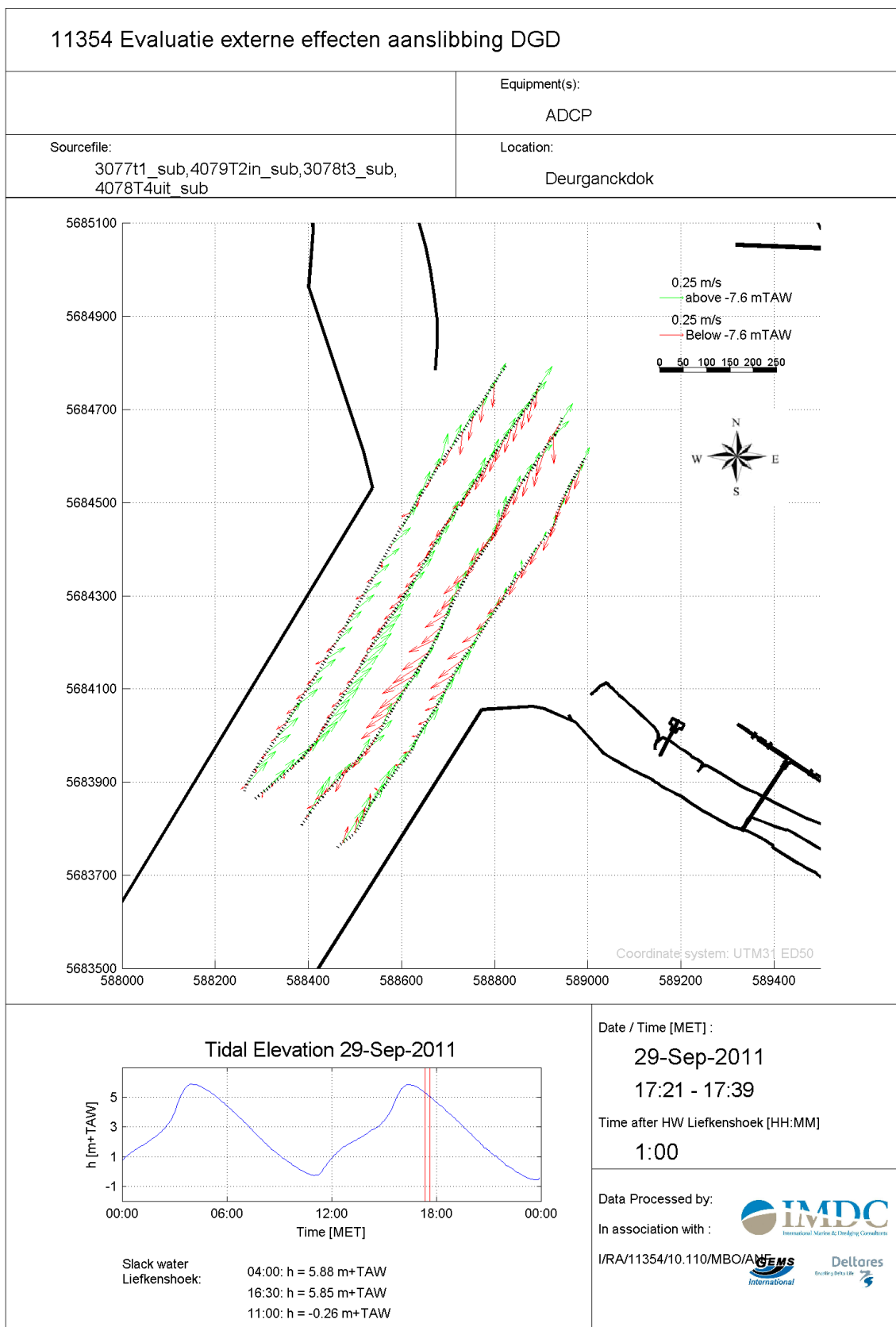
I/RA/11354/10.110/MBO/ANF











11354 Evaluatie externe effecten aanslibbing DGD

Equipment(s):

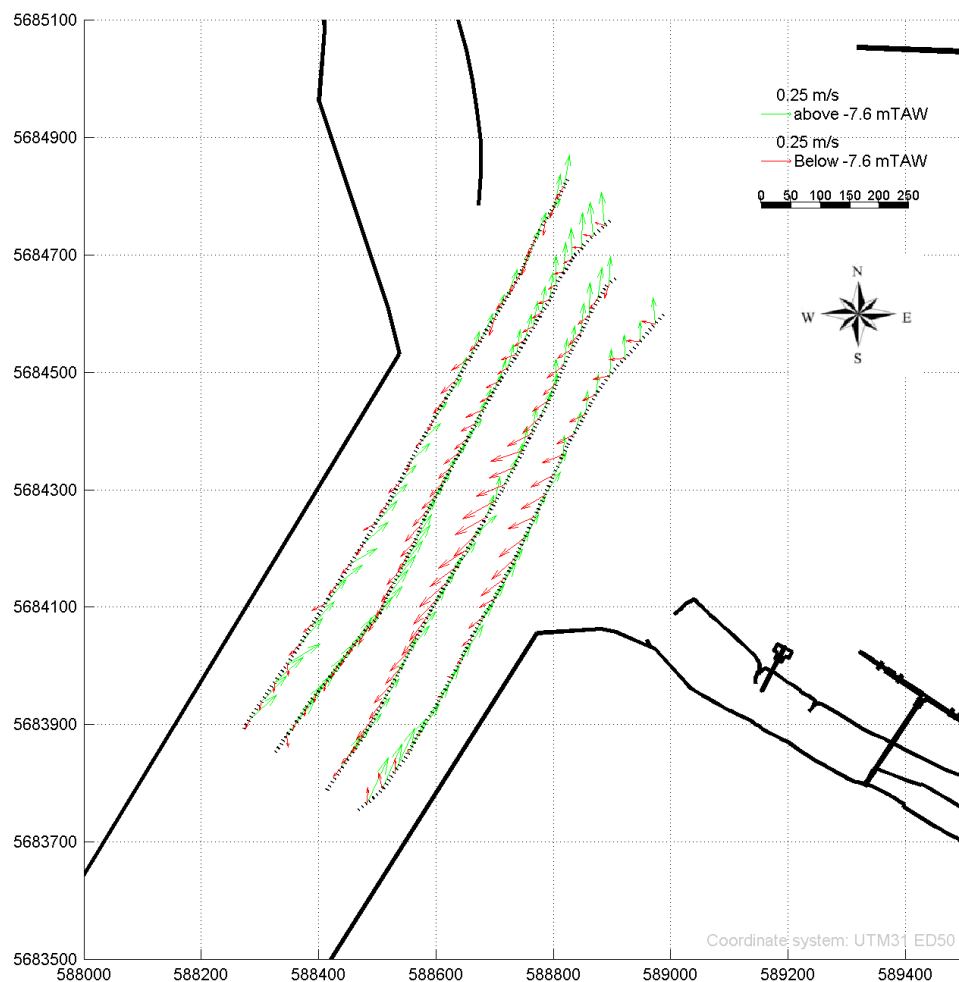
ADCP

Sourcefile:

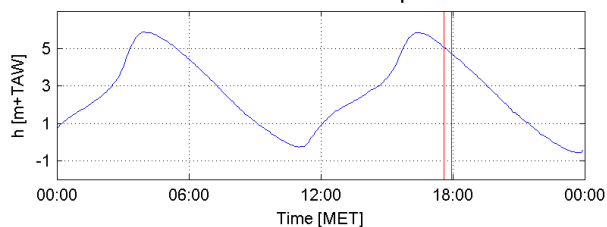
3079t1_sub,4081T2in_sub,3080t3_sub,
4080T4uit_sub

Location:

Deurganckdok



Tidal Elevation 29-Sep-2011



Slack water
Liefkenshoek:

04:00:	h = 5.88 m+TAW
16:30:	h = 5.85 m+TAW
11:00:	h = -0.26 m+TAW

Date / Time [MET] :

29-Sep-2011

17:36 - 17:57

Time after HW Liefkenshoek [HH:MM]

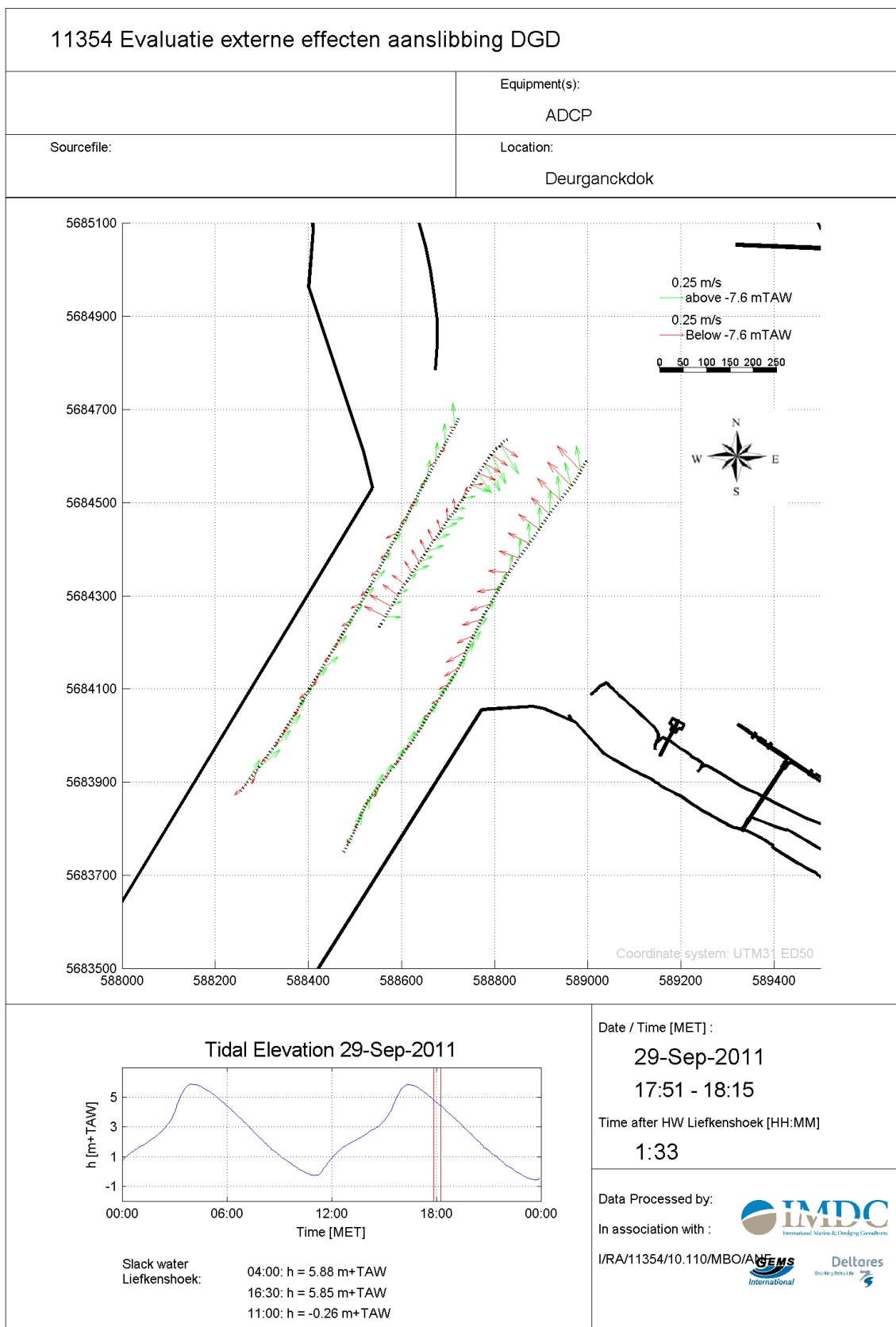
1:16

Data Processed by:

In association with :



I/RA/11354/10.110/MBO/ANF



11354 Evaluatie externe effecten aanslibbing DGD

Equipment(s):

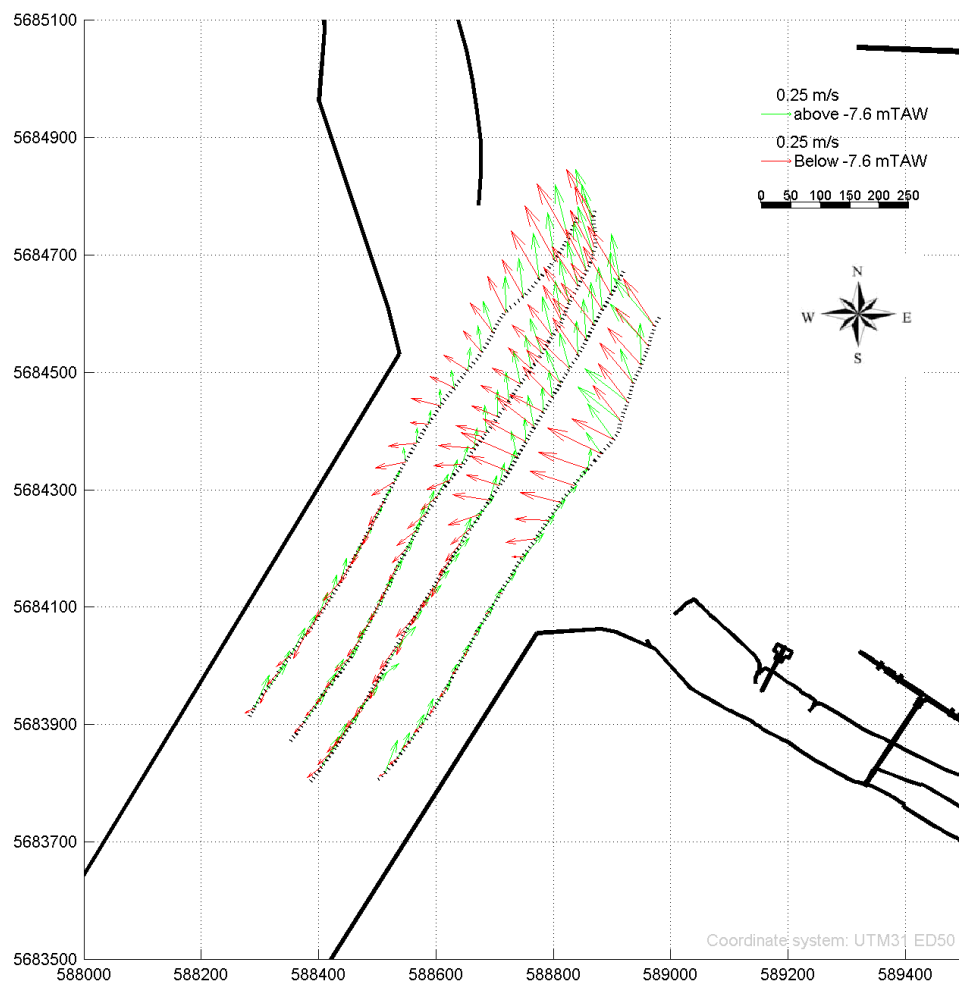
ADCP

Sourcefile:

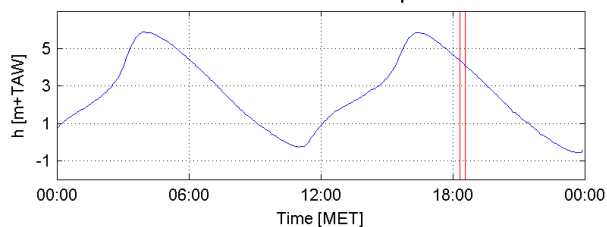
3084t1_sub,4084T2in_sub,3083t3_sub,
4085T4uit_sub

Location:

Deurganckdok



Tidal Elevation 29-Sep-2011



Slack water
Liefkenshoek:

04:00: h = 5.88 m+TAW
16:30: h = 5.85 m+TAW
11:00: h = -0.26 m+TAW

Date / Time [MET] :

29-Sep-2011

18:20 - 18:33

Time after HW Liefkenshoek [HH:MM]

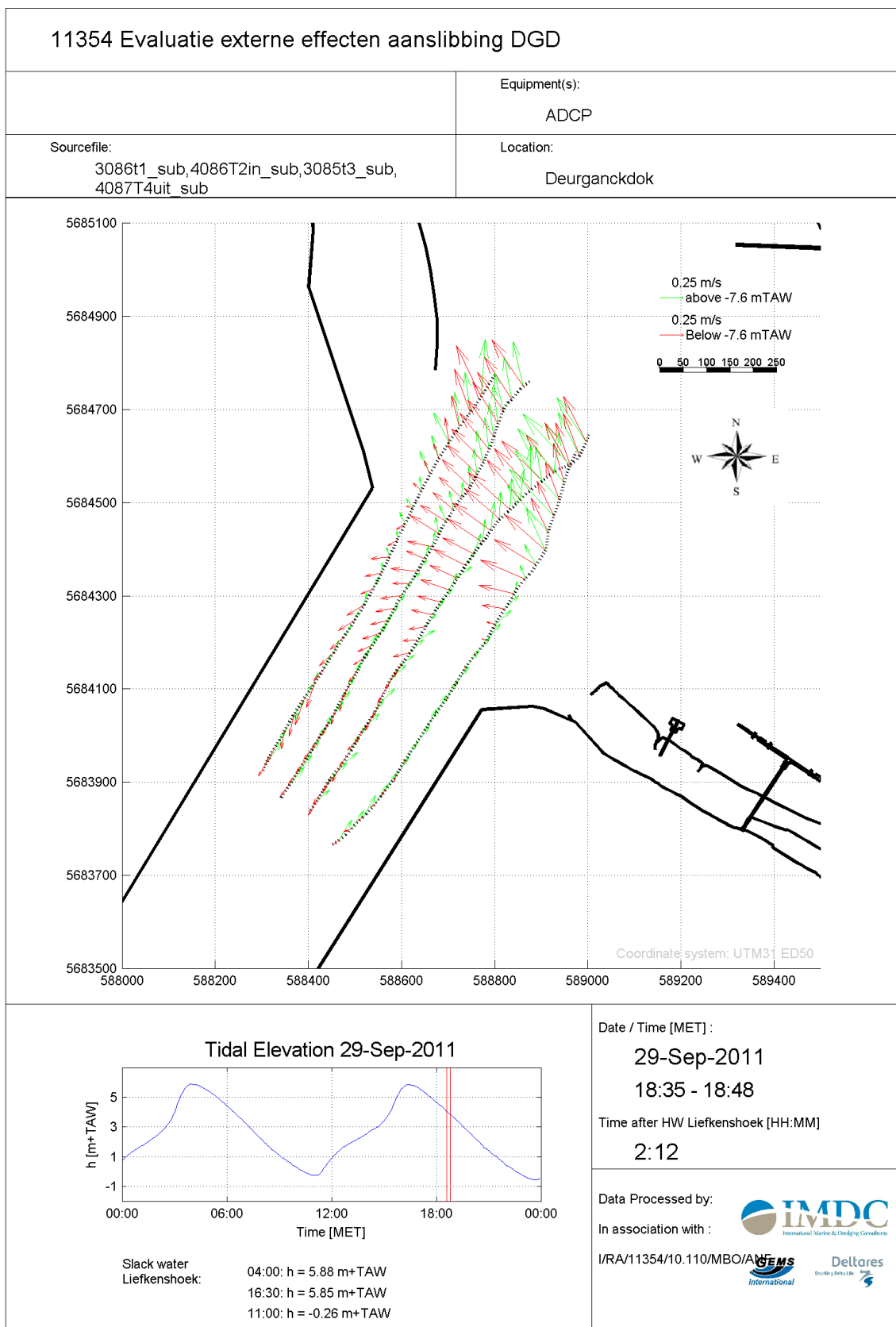
1:56

Data Processed by:

In association with :

I/RA/11354/10.110/MBO/ANF





Annex G Overview of HCBS2 and aanslibbing Deurganckdok reports

Report	Description of HCBS2
Ambient Conditions Lower Sea Scheldt	
5.3	Overview of ambient conditions in the river Scheldt – January-June 2006 (I/RA/11291/06.088/MSA)
5.4	Overview of ambient conditions in the river Scheldt – July-December 2006 (I/RA/11291/06.089/MSA)
5.5	Overview of ambient conditions in the river Scheldt : RCM-9 buoy 84 & 97 (1/1/2007 -31/3/2007) (I/RA/11291/06.090/MSA)
5.6	Analysis of ambient conditions during 2006 (I/RA/11291/06.091/MSA)
Calibration	
6.1	Winter Calibration (I/RA/11291/06.092/MSA)
6.2	Summer Calibration and Final Report (I/RA/11291/06.093/MSA)
Through tide Measurements Winter 2006	
7.1	21/3 Scheldewacht – Deurganckdok – Salinity Distribution (I/RA/11291/06.094/MSA)
7.2	22/3 Parel 2 – Deurganckdok (I/RA/11291/06.095/MSA)
7.3	22/3 Laure Marie – Liefkenshoek (I/RA/11291/06.096/MSA)
7.4	23/3 Parel 2 – Schelle (I/RA/11291/06.097/MSA)
7.5	23/3 Laure Marie – Deurganckdok (I/RA/11291/06.098/MSA)
7.6	23/3 Veremans Waarde (I/RA/11291/06.099/MSA)
HCBS Near bed continuous monitoring (Frames)	
8.1	Near bed continuous monitoring winter 2006 (I/RA/11291/06.100/MSA)
INSSEV	
9	Settling Velocity - INSSEV summer 2006 (I/RA/11291/06.102/MSA)
Cohesive Sediment	
10	Cohesive sediment properties summer 2006 (I/RA/11291/06.103/MSA)
Through tide Measurements Summer 2006	
11.1	Through Tide Measurement Sediview and Siltprofiler 27/9 Stream - Liefkenshoek (I/RA/11291/06.104/MSA)
11.2	Through Tide Measurement Sediview 27/9 Veremans - Raai K (I/RA/11291/06.105/MSA)
11.3	Through Tide Measurement Sediview and Siltprofiler 28/9 Stream - Raai K (I/RA/11291/06.106/MSA)
11.4	Through Tide Measurement Sediview 28/9 Veremans - Waarde(I/RA/11291/06.107/MSA)
11.5	Through Tide Measurements Sediview 28/9 Parel 2 - Schelle (I/RA/11291/06.108/MSA)
11.6	Through Tide measurement 26/9 Scheldewacht – Deurganckdok – Salinity

	Distribution (I/RA/11291/06.161/MSA)
Analysis	
12	Report concerning the presence of HCBS layers in the Scheldt river (I/RA/11291/06.109/MSA)

Report Description of Opvolging aanslibbing Deurganckdok between April 2006 till March 2008	
Sediment Balance: Bathymetry surveys, Density measurements, Maintenance and construction dredging activities	
1.1	Sediment Balance: Three monthly report 1/4/2006 – 30/06/2006 (I/RA/11283/06.113/MSA)
1.2	Sediment Balance: Three monthly report 1/7/2006 – 30/09/2006 (I/RA/11283/06.114/MSA)
1.3	Sediment Balance: Three monthly report 1/10/2006 – 31/12/2006 (I/RA/11283/06.115/MSA)
1.4	Sediment Balance: Three monthly report 1/1/2007 – 31/03/2007 (I/RA/11283/06.116/MSA)
1.5	Annual Sediment Balance (I/RA/11283/06.117/MSA)
1.6	Sediment balance Bathymetry: 2005 – 3/2006 (I/RA/11283/06.118/MSA)
1.10	Sediment Balance: Three monthly report 1/4/2007 - 30/06/2007 (I/RA/11283/07.081/MSA)
1.11	Sediment Balance: Three monthly report 1/7/2007 – 30/09/2007 (I/RA/11283/07.082/MSA)
1.12	Sediment Balance: Three monthly report 1/10/2007 – 31/12/2007 (I/RA/11283/07.083/MSA)
1.13	Sediment Balance: Three monthly report 1/1/2007 – 31/03/2007 (I/RA/11283/07.084/MSA)
1.14	Annual Sediment Balance (I/RA/11283/07.085/MSA)
Factors contributing to salt and sediment distribution in Deurganckdok: Salt-Silt (OBS3A) & Frame measurements, Through tide measurements (SiltProfiling & ADCP)	
2.1	Through tide measurement Siltprofiler 21/03/2006 Laure Marie (I/RA/11283/06.087/WGO)
2.2	Through tide measurement Siltprofiler 26/09/2006 Stream (I/RA/11283/06.068/MSA)
2.3	Through tide measurement Sediview spring tide 22/03/2006 Veremans (I/RA/11283/06.110/BDC)
2.4	Through tide measurement Sediview spring tide 27/09/2006 Parel 2 (I/RA/11283/06.119/MSA)
2.5	Through tide measurement Sediview average tide 24/10/2007 Parel 2 (I/RA/11283/06.120/MSA)
2.6	Salinity-Silt distribution & Frame Measurements Deurganckdok 13/3/2006 – 31/05/2006 (I/RA/11283/06.121/MSA)
2.7	Salinity -Silt distribution & Frame Measurements Deurganckdok 15/07/2006 – 31/10/2006 (I/RA/11283/06.122/MSA)
2.8	Salinity-Silt distribution & Frame Measurements Deurganckdok 12/02/2007 – 18/04/2007 (I/RA/11283/06.123/MSA)
2.9	Calibration stationary equipment autumn (I/RA/11283/07.095/MSA)
2.10	Through tide measurement Siltprofiler 23 October 2007 (I/RA/11283/07.086/MSA)
2.11	Through tide measurement Salinity Profiling winter (I/RA/11283/07.087/MSA)
2.12	Through tide measurement Sediview winter 11 March 2008 Transect I (I/RA/11283/07.088/MSA)

Report Description of Opvolging aanslibbing Deurganckdok between April 2006 till March 2008	
2.13	Through tide measurement Sediview winter 11 March 2008 Transect K (I/RA/11283/07.089/MSA)
2.14	Through tide measurement Sediview winter 11 March 2008 Transect DGD (I/RA/11283/07.090/MSA)
2.15	Through tide measurement Siltprofiler 12 March 2008 (I/RA/11283/07.091/MSA)
2.16	Salinity-Silt distribution Deurganckdok summer (21/6/2007 – 30/07/2007) (I/RA/11283/07.092/MSA)
2.17	Salinity-Silt distribution & Frame Measurements Deurganckdok autumn (17/09/2007 - 10/12/2007) (I/RA/11283/07.093/MSA)
2.18	Salinity-Silt distribution & Frame Measurements Deurganckdok winter (18/02/2008 - 31/3/2008) (I/RA/11283/07.094/MSA)
2.19	Calibration stationary & mobile equipment winter (I/RA/11283/07.096/MSA)
Boundary Conditions: Upriver Discharge, Salt concentration Scheldt, Bathymetric evolution in access channels, dredging activities in Lower Sea Scheldt and access channels	
3.1	Boundary conditions: Three monthly report 1/1/2007 – 31/03/2007 (I/RA/11283/06.127/MSA) including HCBS 2 report 5.5
3.2	Boundary conditions: Annual report (I/RA/11283/06.128/MSA)¹
3.10	Boundary conditions: Three monthly report 1/4/2007 – 30/06/2007 (I/RA/11283/07.097/MSA)
3.11	Boundary conditions: Three monthly report 1/7/2007 – 30/09/2007 (I/RA/11283/07.098/MSA)
3.12	Boundary conditions: Three monthly report 1/10/2007 – 31/12/2007 (I/RA/11283/07.099/MSA)
3.13	Boundary conditions: Three monthly report 1/1/2008 – 31/03/2008 (I/RA/11283/07.100/MSA)
3.14	Boundary conditions: Annual report (I/RA/11283/07.101/MSA)
Analysis	
4.1	Analysis of Siltation Processes and Factors, 4/06 – 3/07 (I/RA/11283/06.129/MSA)
4.10	Analysis of Siltation Processes and Factors, 4/07 – 3/08 (I/RA/11283/07.102/MSA)

¹ considered in report 5.6 'Analysis of ambient conditions during 2006' (I/RA/11291/06.091/MSA) in the framework of the study 'Extension of the study about density currents in the Beneden Zeeschelde'

Report Description of Opvolging aanslibbing Deurganckdok between April 2008 till March 2010	
Sediment Balance: Bathymetry surveys, Density measurements, Maintenance and construction dredging activities	
1.20	Sediment Balance: Three monthly report 1/4/2008 - 30/6/2008 (I/RA/11283/08.076/MSA)
1.21	Sediment Balance: Three monthly report 1/7/2008 – 30/9/2008 (I/RA/11283/08.077/MSA)
1.22	Sediment Balance: Three monthly report 1/10/2008 – 31/12/2008 (I/RA/11283/08.078/MSA)
1.23	Sediment Balance: Three monthly report 1/1/2009 – 31/03/2009 (I/RA/11283/08.079/MSA)
1.24	Annual Sediment Balance (I/RA/11283/08.080/MSA)
Factors contributing to salt and sediment distribution in Deurganckdok: Salt-Silt (OBS3A) & Frame measurements, Through tide measurements (SiltProfiling & ADCP) & Calibrations	
2.20	Through tide measurement Sediview DGD during average tide Spring 2008 – 19 June 2008 (I/RA/11283/08.081/MSA)
2.21	Through tide measurement Sediview DGD during average tide Spring 2008 – 26 June 2008 (I/RA/11283/08.082/MSA)
2.22	Through tide measurement Sediview DGD during neap tide Summer 2008 – 24 September 2008 (I/RA/11283/08.083/MSA)
2.23	Through tide measurement Sediview DGD during spring tide Summer 2008 – 30 September 2008 (I/RA/11283/08.084/MSA)
2.24	Through tide measurement Sediview DGD during neap tide Autumn 2008 – 02 December 2008 (I/RA/11283/08.085/MSA)
2.25	Through tide measurement Sediview DGD during spring tide Autumn 2008 – 10 December 2008 (I/RA/11283/08.086/MSA)
2.26	Through tide measurement Sediview DGD during neap tide Winter 2009 – 06 March 2009 (I/RA/11283/08.087/MSA)
2.27	Through tide measurement Sediview DGD during spring tide Winter 2009 – 12 March 2009 (I/RA/11283/08.088/MSA)
2.28	Through tide measurement ADCP eddy DGD Summer 2008 – 1 October 2008 (I/RA/11283/08.089/MSA)
2.29	Through tide measurement Siltprofiler DGD Summer 2008 – 29 September 2008 (I/RA/11283/08.090/MSA)
2.30	Through tide measurement Siltprofiler DGD Winter 2009 – 13 March 2009 (I/RA/11283/08.091/MSA)
2.31	Through tide measurement Salinity Profiling DGD Winter 2009 – 11 March 2009 (I/RA/11283/08.092/MSA)
2.32	Salt-Silt distribution Deurganckdok: Six monthly report 1/4/2008 - 30/9/2008 (I/RA/11283/08.093/MSA)
2.33	Salt-Silt distribution Deurganckdok: Six monthly report 1/10/2008 – 31/3/2009 (I/RA/11283/08.094/MSA)
2.34	Calibration stationary & mobile equipment Autumn 2008 – 27 & 28 October 2008 (I/RA/11283/08.095/MSA)

Report Description of Opvolging aanslibbing Deurganckdok between April 2008 till March 2010	
Boundary Conditions: Upriver Discharge, Salt concentration Scheldt, Bathymetric evolution in access channels, dredging activities in Lower Sea Scheldt and access channels	
3.20	Boundary conditions: Six monthly report 1/4/2008 – 30/09/2008 (I/RA/11283/08.097/MSA)
3.21	Boundary conditions: Six monthly report 1/10/2008 – 31/03/2009 (I/RA/11283/08.097/MSA)
Analysis	
4.20	Analysis of Siltation Processes and Factors (I/RA/11283/08.098/MSA)