

REPORT

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

Afdeling Maritieme Toegang

Evaluation of the external effects on the siltation in Deurganckdok

Report 2.7: Through tide measurements: Eddy
Currents during spring tide at DGD - Winter 2012

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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 12th of March 2012. 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. The results presented in this report will be used 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 2.7, 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 – 30/5/2012 (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 Winter 2012 (I/RA/11354/10.108/MBO/ANF)
2.4	Through tide Sediview measurement: Entrance DGD during neap tide Winter 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 Winter 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 through tide measurements: Autumn 2011 (I/RA/11354/11.131/BQU)

Report	Description
2.11	Salt Silt & Current Distribution entrance Deurganckdok: frame measurements and through tide measurements: Winter 2012 (I/RA/11354/10.114/MBO/ANF)
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).

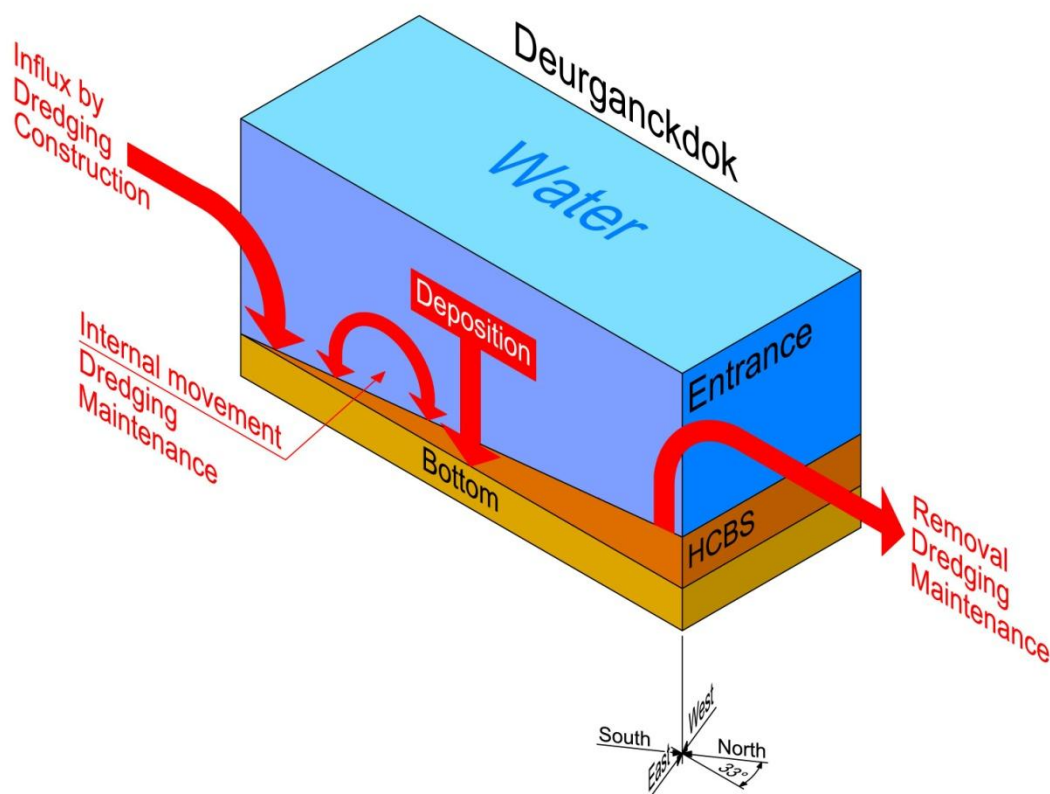


Figure 2-1: Elements of the sediment balance

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 .

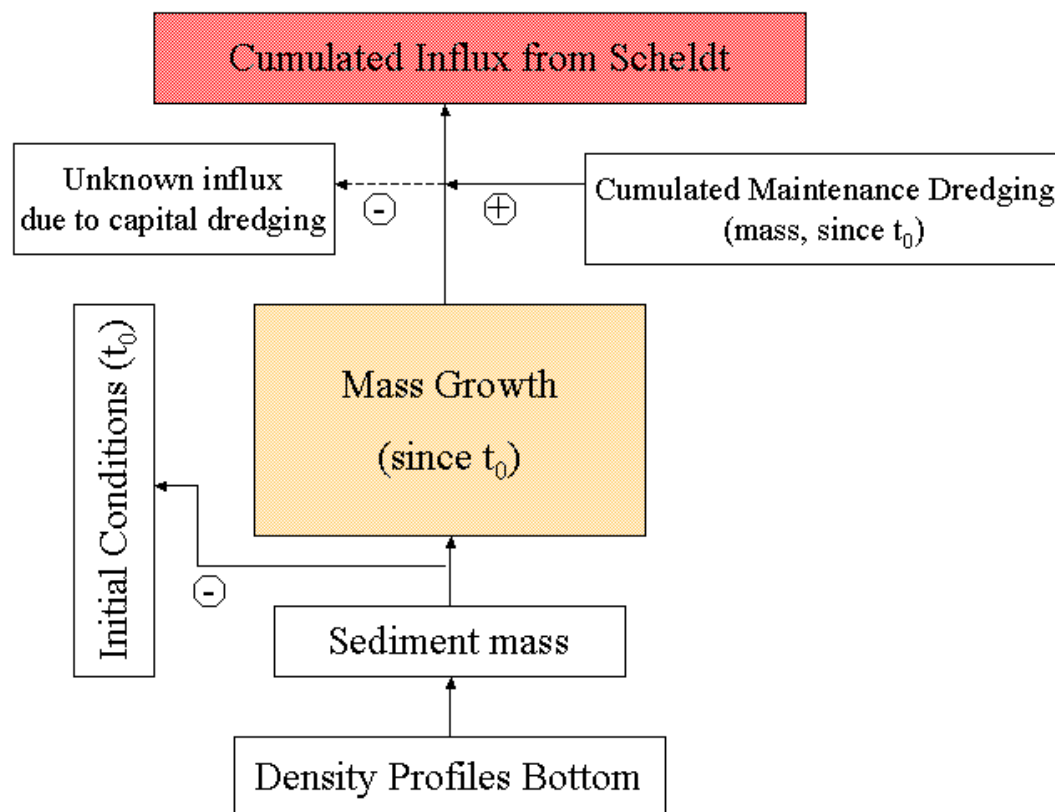


Figure 2-2: Determining a sediment balance

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

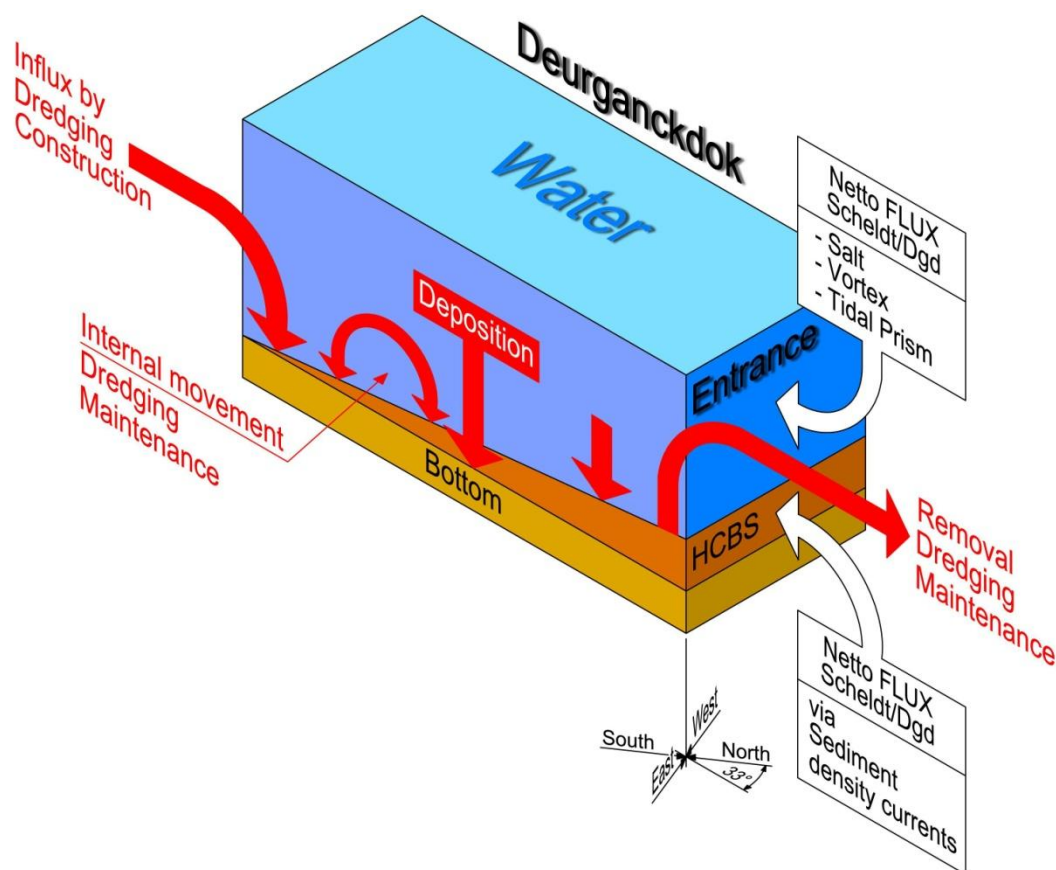


Figure 2-3: Transport mechanisms

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 12th of March 2012 from 7h13 MET until 20h06 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 Parel II 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 Scheldewacht II. Both vessels were mounted with an ADCP and every 2 hours 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 12th of March 2012 (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 Scheldewacht II 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.

The ADCP system of the Scheldewacht II was mounted on a steel pole underneath the central axis of the vessel. The ADCP system of the Parel II was mounted on a steel pole at the portside of the vessel. The transducer sets of both vessels were 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 Pump sampler

A water sampler was attached nearby the turbidity sensor taking water samples. Samples were collected in 1 liter sampling bottles. The pumping speed of the water sampler was tested at the start of the measurement campaign on board. Dye was used to time the duration between the intake of the dye and exit at the sampling end of the sampler on board. The duration between intake and exit at the end was 26 seconds for the pump aboard Parel II and 19 seconds for the pump aboard Scheldewacht II.

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 37 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 12th of March 2012 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 12th of March 2012.

Table 3-1: High and low tide at Liefkenshoek on 12/03/2012

Liefkenshoek Tidal Gauge		
12 March 2012		
	Time [MET]	Water level [m TAW]
HW (1)	5:55	5.73
LW (2)	13:00	-0.57
HW (3)	18:15	5.60

In Table 3-2 the tidal characteristics of the tide on the 12th of March 2012 are compared to the average tide over the decade 1991-2000 (AMT, 2003).

Table 3-2: Comparison of the tidal characteristics of 12/03/2012 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 12/03/2012
Water level [m TAW]				
HW (1)	4.63	5.19	5.63	5.73
LW (2)	0.39	0.05	-0.18	-0.57
HW (3)	-	-	-	5.60
Tidal difference [m]				
Falling (1 to 2)	4.24	5.14	5.81	6.30
Rising (2 to 3)	4.24	5.14	5.81	6.17
Duration [hh:mm]				
Falling (1 to 2)	6:40	6:50	7:02	7:05
Rising (2 to 3)	5:59	5:34	5:16	5:15
Tide (1 to 3)	12:39	12:24	12:18	12:20
Tidal coefficient				
Falling (1 to 2)	0.82	1.00	1.13	1.23
Rising (2 to 3)	0.82	1.00	1.13	1.20

The tidal coefficients from 1.20 up to 1.23 for the measured tide of the 12th of March 2012 indicate that this tide is larger than the average 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, 2012).

The weather on the 12th of March 2012 was dry. The wind direction before noon was WSW and changed to the N in the late afternoon/evening. The average wind speed was 7 km/h. The maximum wind speed was 14.8 km/h at 15:20. The air temperature varied between 0.5°C at night and reached a maximum of 15°C at 15:15. 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

In the report of annual sediment balance 2011-2012 (IMDC, 2012m) has observed that the natural sedimentation rates during this measurement period have increased and are twice as high as expected. The cause is most likely the deeper dredging during the dredging campaign of January 2012 where the bed level is reduced by about 1.0m. After the dredging campaign the system returns faster to the equilibrium and the sedimentation rates will be increase. As result the sludge layer will be thicker and more unstable.

In combination to lot of traffic in the dock on the 12th of March, the ADCP has some problems to detect the bottom (track). The detection problems resulted in affected velocity measurements. The traffic and bottom lost reached its peak between 17:00 and 18:40 i.e. +/-1 hour before and after HW. Bad velocity and flux data has been removed. 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 one 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. 5 samples were taken by Scheldewacht II and 6 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 could differ very much from the previous parameter sets, as the environmental conditions will change that much over 2 hours. Due to the few water samples every 2 hours the estimated SSC of some transects are less accurate and gives more an idea of the distribution. The result of the Sediview calibration can be seen in Figure 4-1 and Figure 4-2. In this case the

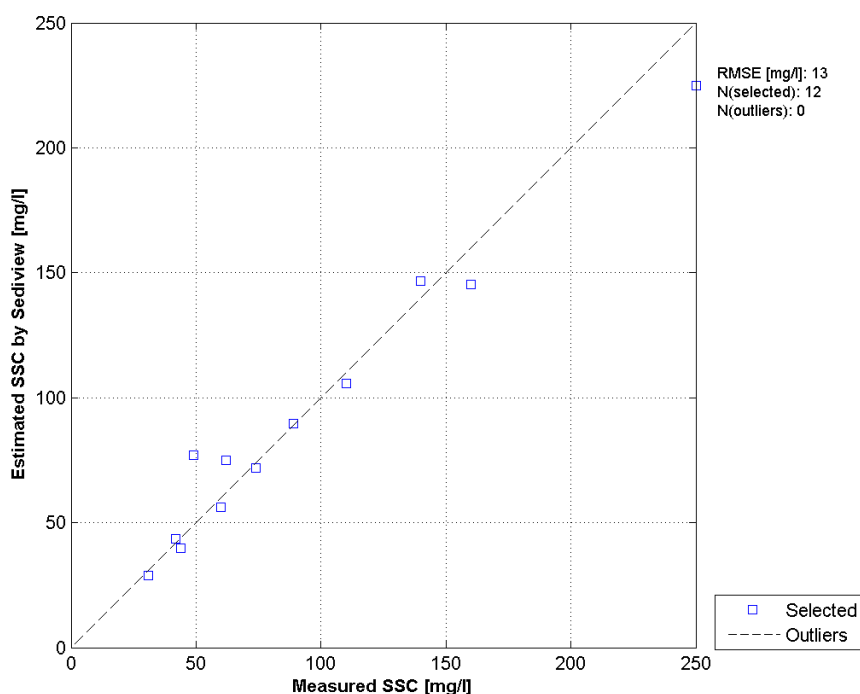


Figure 4-1: Calibration in Sediview for 12/03/2012 data (Parel II)

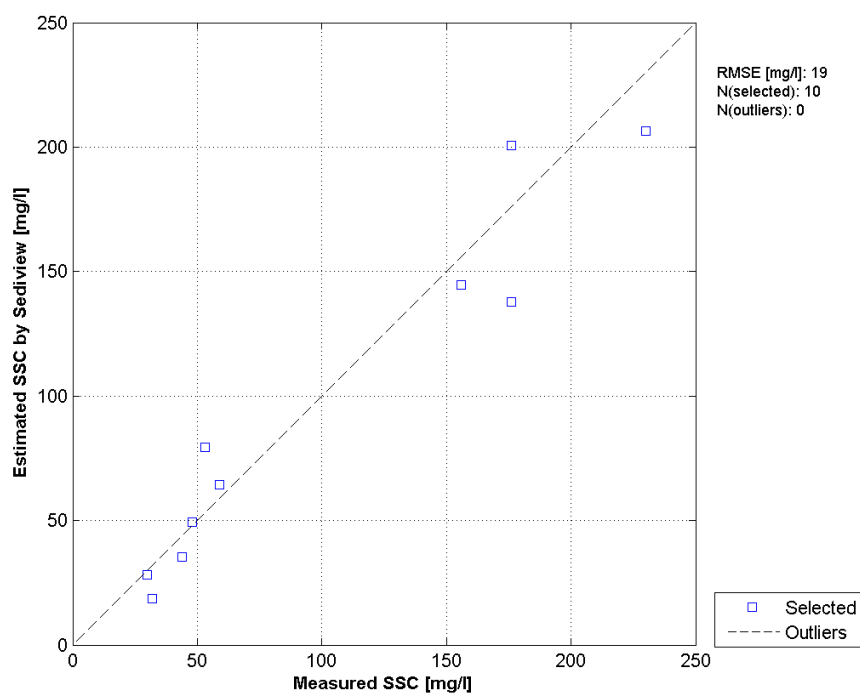


Figure 4-2: Calibration in Sediview for 12/03/2012 data (Scheldewacht II)

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 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 PRE-CDW SURVEYS

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 reports IMDC (2008y & 2010a), 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 before the construction of a CDW. These measurements were conducted on October 1st 2008 and March 2nd 2010. The 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.

Average tidal coefficients during the surveys of October 1st 2008 and March 2nd 2010 were 1.09 and 1.24 respectively. The maximal salinity gradient measured during the campaign and in the dock is +/- 4.0 ppt for March 2nd 2010.

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. 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.

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.

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 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.

5.3 POST-CDW SURVEYS

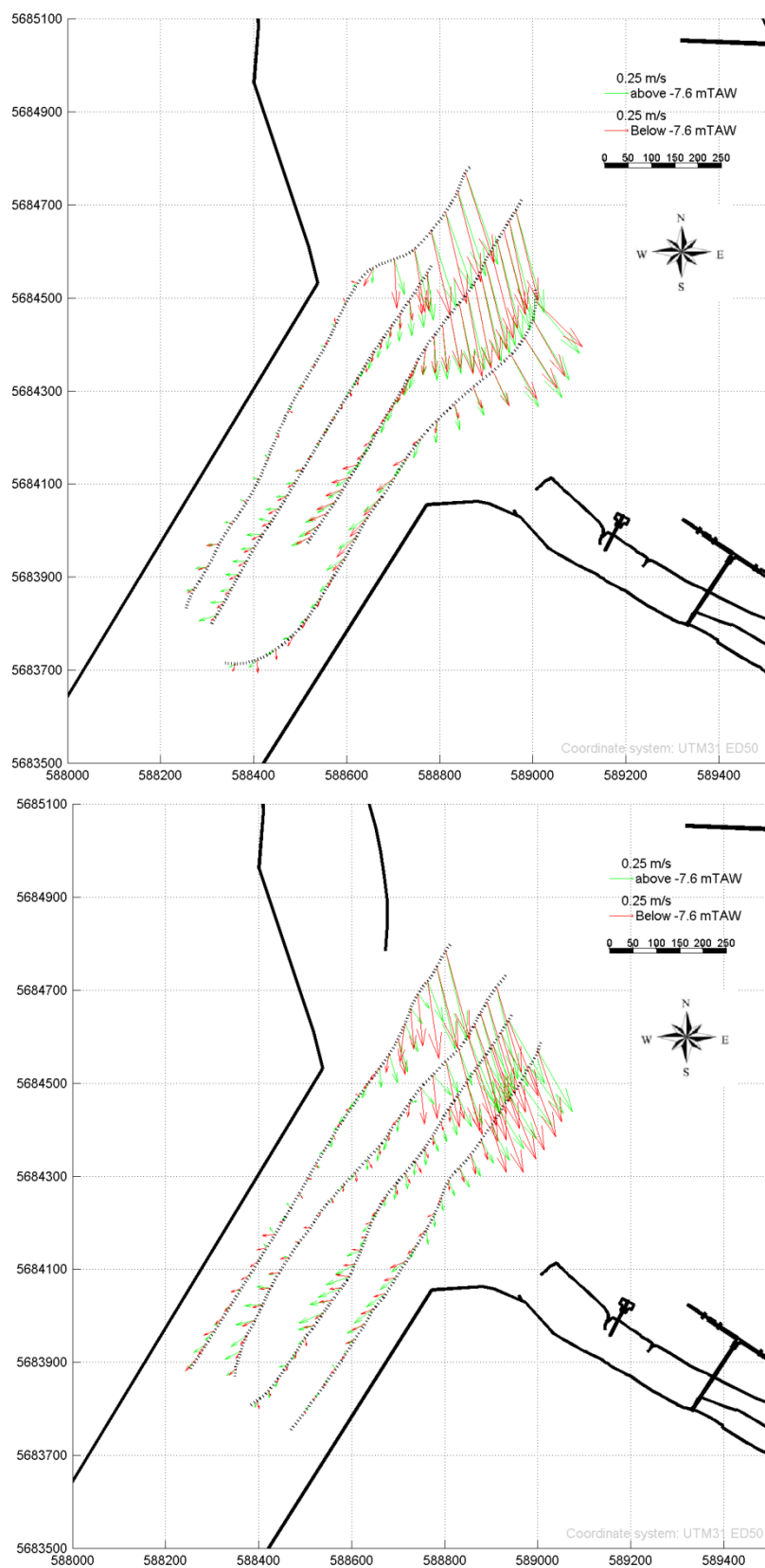
In August 2011 the current deflecting wall (CDW) is built north of Deurganckdok and the sill at the entrance is dredged. The purpose of this measurement campaign is to compare the eddy current pattern before and after the CDW.

Two surveys were conducted after the construction of the CDW. One on September 29th 2011 and one on March 12th 2012. The averaged tidal coefficients for both surveys were 1.18 and 1.21 respectively. The maximal salinity gradients were +/-3.5 ppt and +/-3.2 ppt respectively.

Both surveys started during ebb conditions. At this moment the dock is emptying above the -7.6mTAW while the flow below the -7.6mTAW 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 around 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. During the survey on March 12th 2012, the eddy was less outspoken than during previous surveys.

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.



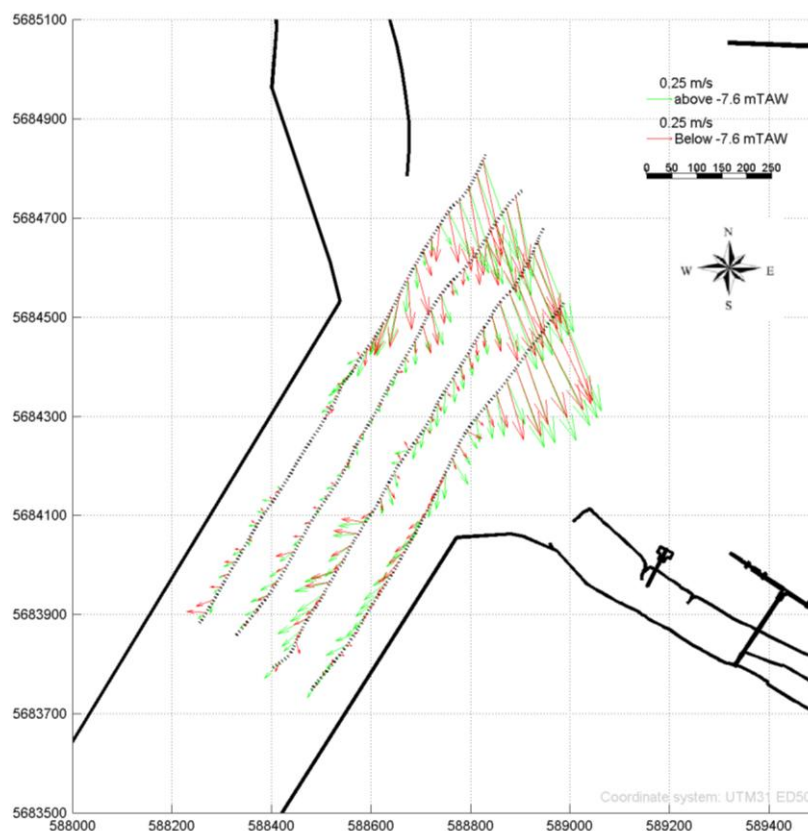


Figure 5-1: Results of eddy current measurements at 1 hour before HW during spring tide. Top: measurement on 2/03/2010 without CDW and with sill (tidal coefficient: 1.24 and maximal salinity gradient: 4.0 ppt); Mid: measurement on 29/09/2011 with CDW and without sill (tidal coefficient: 1.18 and maximal salinity gradient: 3.5 ppt Below: measurement on 12/03/2012 with CDW and without sill (tidal coefficient: 1.23 and maximal salinity gradient: 3.2 ppt)).

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2.2 Through tide measurement SiltProfiler 26/09/2006 Stream (I/RA/11283/06.068/MSA)

IMDC (2007o) Langdurige metingen Deurganckdok: Opvolging en analyse aanslibbing. Deelrapport
2.7 Salt-Silt distribution & Frame Measurements Deurganckdok 15/07/2006 – 31/10/2006
(I/RA/11283/06.122/MSA)

IMDC (2007p) Langdurige metingen Deurganckdok: Opvolging en analyse aanslibbing. Deelrapport
2.8 Salt-Silt distribution & Frame Measurements Deurganckdok 15/01/2007 – 15/03/2007
(I/RA/11283/06.123/MSA)

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4.1: Analysis of siltation Processes and Factors (I/RA/11283/06.129/MSA)

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1.14: Annual Sediment Balance. (I/RA/11283/07.085/MSA)

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2.09: Calibration stationary equipment autumn (I/RA/11283/07.095/MSA)

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2.10: Through tide measurement SiltProfiler 23 October 2007 (I/RA/11283/07.086/MSA)

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IMDC (2008i) Langdurige metingen Deurganckdok: Opvolging en analyse aanslibbing. Deelrapport 2.12: Through tide measurement Sediview winter 11 March 2008 – Transect I (I/RA/11283/07.088/MSA)

IMDC (2008j) Langdurige metingen Deurganckdok: Opvolging en analyse aanslibbing. Deelrapport 2.13: Through tide measurement Sediview winter 11 March 2008 – Transect K (I/RA/11283/07.089/MSA)

IMDC (2008k) Langdurige metingen Deurganckdok: Opvolging en analyse aanslibbing. Deelrapport 2.14: Through tide measurement Sediview winter 11 March 2008 – Transect DGD (I/RA/11283/07.090/MSA)

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IMDC (2008m) Langdurige metingen Deurganckdok: Opvolging en analyse aanslibbing. Deelrapport 2.17: Salt-Silt distribution & Frame Measurements Deurganckdok autumn (17/9/2007-10/12/2007) (I/RA/11283/07.093/MSA)

IMDC (2008n) Langdurige metingen Deurganckdok: Opvolging en analyse aanslibbing. Deelrapport 2.18: Salt-Silt distribution & Frame Measurements Deurganckdok winter (18/02/2007-31/03/2008) (I/RA/11283/07.094/MSA)

IMDC (2008o) Langdurige metingen Deurganckdok: Opvolging en analyse aanslibbing. Deelrapport 2.19: Calibration stationary & mobile equipment winter (I/RA/11283/07.096/MSA)

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IMDC (2008u) Langdurige metingen Deurganckdok: Opvolging en analyse aanslibbing. Deelrapport 2.20: Through tide measurement Sediview during average tide Spring 2008 – 19 June 2008 (I/RA/11283/08.081/MSA)

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IMDC (2008x) Langdurige metingen Deurganckdok: Opvolging en analyse aanslibbing. Deelrapport 2.22: Through tide measurement Sediview during neap tide Summer 2008 – 24 September 2008 (I/RA/11283/08.083/MSA)

IMDC (2008y) Langdurige metingen Deurganckdok: Opvolging en analyse aanslibbing. Deelrapport 2.28: Through tide measurement ADCP eddy Summer 2008 – 1 October 2008 (I/RA/11283/08.089/MSA)

IMDC (2008z) Langdurige metingen Deurganckdok: Opvolging en analyse aanslibbing. Deelrapport 2.32: Salt-Silt distribution Deurganckdok: six monthly report 1/4/2008 – 30/9/2008 (I/RA/11283/08.093/MSA)

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IMDC (2009d) Langdurige metingen Deurganckdok: Opvolging en analyse aanslibbing. Deelrapport 1.22: Sediment Balance: Three monthly report 1/10/2008 – 31/12/2008 (I/RA/11283/08.078/MSA)

IMDC (2009e) Langdurige metingen Deurganckdok: Opvolging en analyse aanslibbing. Deelrapport 2.24: Through tide measurement Sediview during neap tide Autumn 2008 (I/RA/11283/08.085/MSA)

IMDC (2009f) Langdurige metingen Deurganckdok: Opvolging en analyse aanslibbing. Deelrapport 2.25: Through tide measurement Sediview during spring tide Autumn 2008 (I/RA/11283/08.086/MSA)

IMDC (2009g) Langdurige metingen Deurganckdok: Opvolging en analyse aanslibbing. Deelrapport 1.23: Sediment Balance: Three monthly report 1/01/2009 – 31/03/2009 (I/RA/11283/08.079/MSA)

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)

IMDC (2012g) Evaluatie externe effecten aanslibbing Deurganckdok. Deelrapport 2.3 Through Tide Sediview measurement: entrance DGD during spring tide in Winter 2012 (I/RA/11354/10.108/MBO/ANF)

IMDC (2012h) Evaluatie externe effecten aanslibbing Deurganckdok. Deelrapport 2.4 Through Tide Sediview measurement: entrance DGD during neap tide in Winter 2012 (I/RA/11354/10.109/MBO/ANF)

IMDC (2012k) Evaluatie externe effecten aanslibbing Deurganckdok. Deelrapport 2.7 Through Tide measurement: eddy currents DGD Winter 2012 (I/RA/11354/10.111/MBO/ANF)

IMDC (2012l) Evaluatie externe effecten aanslibbing Deurganckdok Deelrapport 2.11 Salt-Silt & Current Distribution entrance Deurganckdok: Frame measurements and through tide measurements: Winter 2012 (I/RA/11354/11.114/MBO/ANF)

IMDC (2012m) Evaluatie externe effecten aanslibbing Deurganckdok. Deelrapport 1.3 Annual Sediment Balance year 3: 1/04/2011 – 31/03/2012 (I/RA/11354/10.101/MBO/ANF)

IMDC (2012n) Evaluatie externe effecten aanslibbing Deurganckdok. Deelrapport 2.9 Sal-Silt distribution Deurganckdok 01/04/2009 – 31/05/2010 (I/RA/11354/10.112/MBO/ANF)

IMDC (2012o) Evaluatie externe effecten aanslibbing Deurganckdok. Deelrapport 2.13 Calibration stationary & mobile equipment 01/06/2012 (I/RA/11354/12.011/JCA)

IMDC (2012p) Evaluatie externe effecten aanslibbing Deurganckdok. Deelrapport 1.6 Boundary conditions year 3: 01/04/2011 – 31/03/2012 (I/RA/11354/11.104/MBO/ANF)

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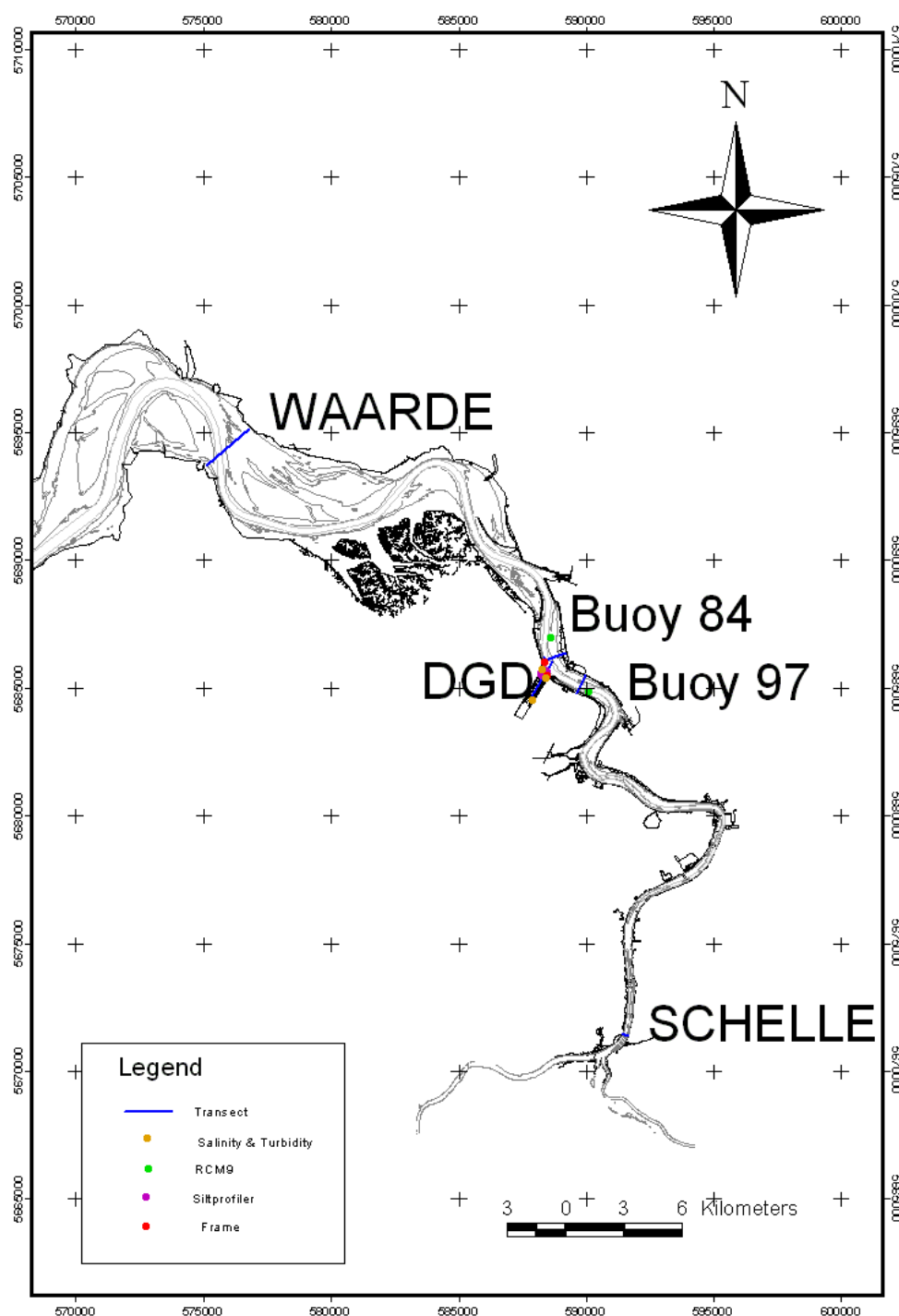
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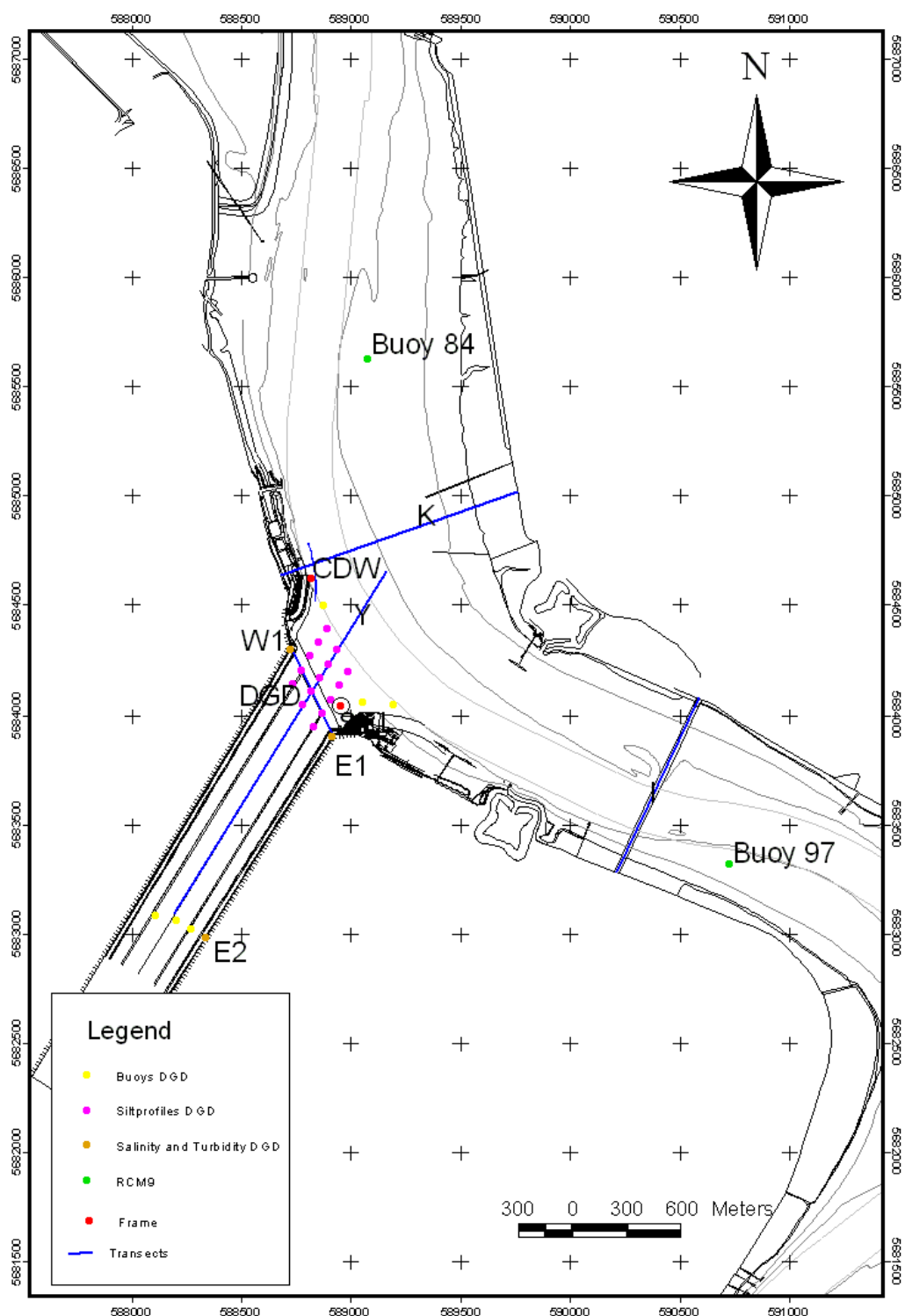
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Annex A Overview of measurement

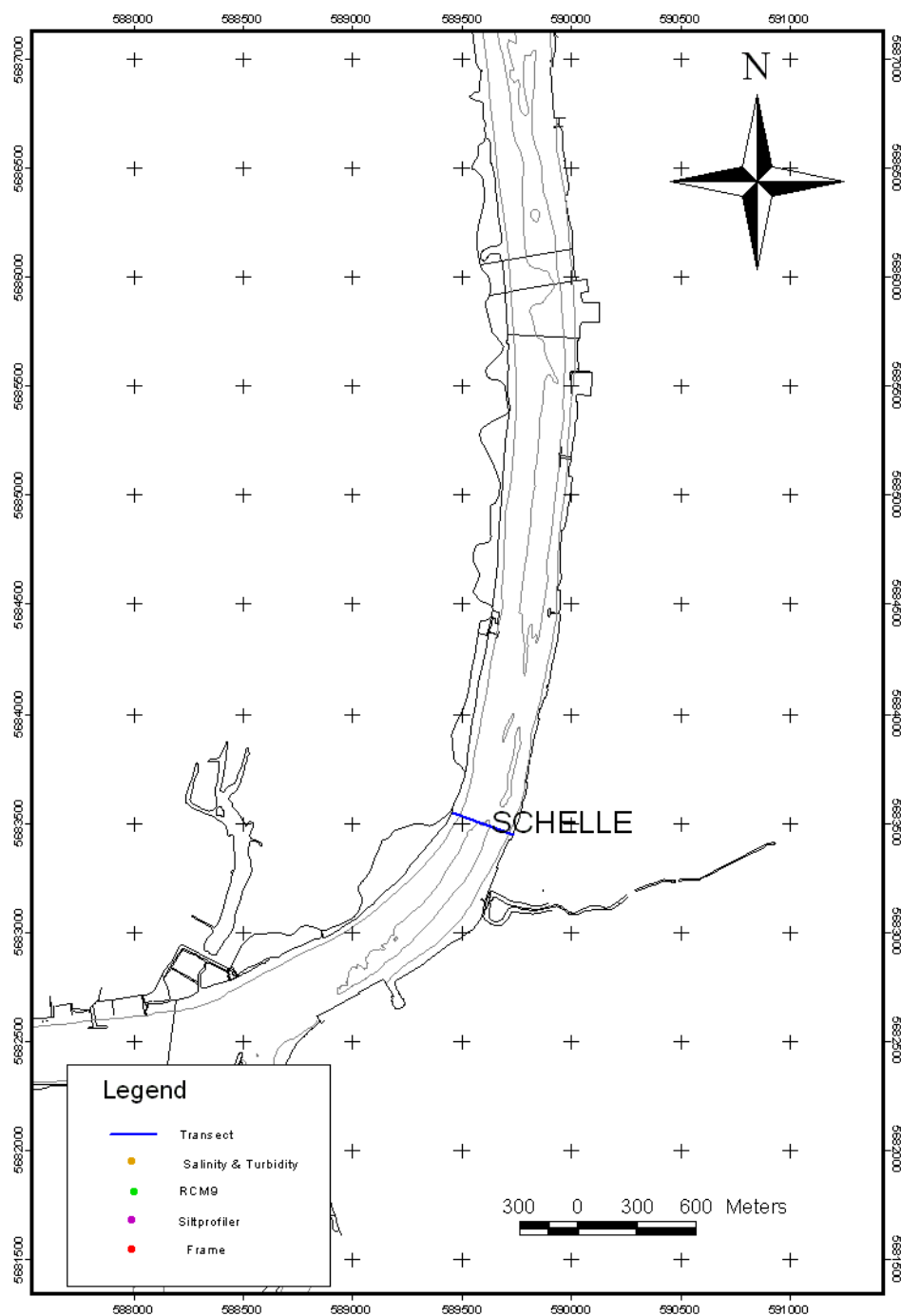
A.1 Overview of the measurement locations for the whole HCBS2 and Deurganckdok measurement campaigns



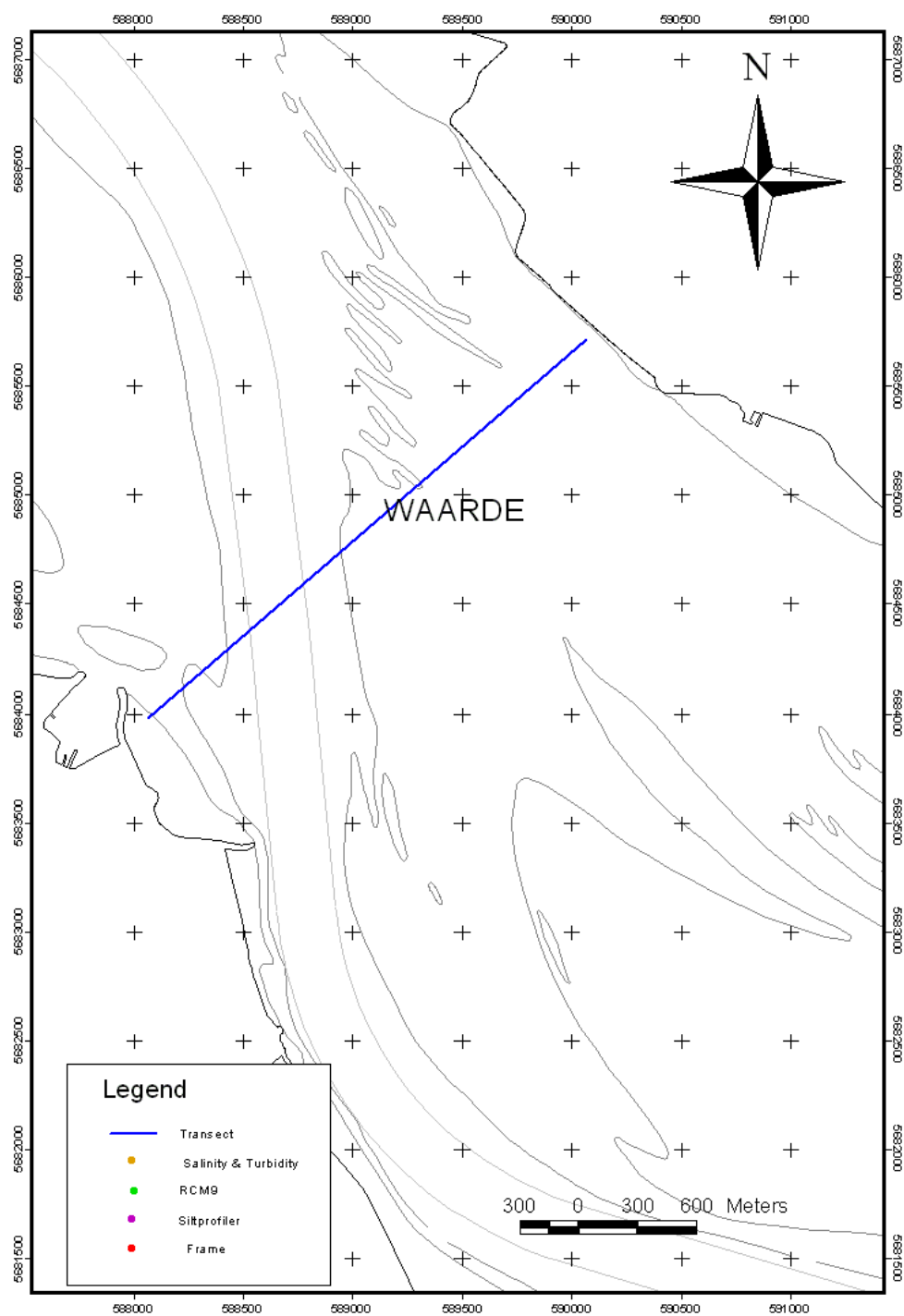
Annex Figure A-1: Overview of the measurement locations



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 12/03/2012

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 [°]
Transect 1								
8502T1.csv	06:23	0:28	588722	5684612	588172	5683672	1089	30
8001T1.csv	06:31	0:36	588744	5684629	588174	5683662	1123	31
8003T1.csv	06:53	0:58	588744	5684633	588178	5683659	1126	30
8005T1.csv	07:11	1:16	588744	5684631	588164	5683676	1118	31
8007T1.csv	07:32	1:37	588747	5684632	588169	5683677	1116	31
8009T1.csv	07:51	1:56	588743	5684630	588161	5683671	1122	31
8012T1.csv	08:39	2:44	588739	5684631	588162	5683673	1119	31
8014T1.csv	08:58	3:03	588741	5684617	588161	5683671	1110	32
8016T1.csv	09:16	3:21	588729	5684640	588165	5683672	1121	30
8018T1.csv	09:39	3:44	588742	5684632	588168	5683681	1111	31
8020T1.csv	09:58	4:03	588744	5684629	588161	5683670	1123	31
8024T1.csv	10:46	4:51	588731	5684641	588163	5683669	1126	30
8026T1.csv	11:05	5:10	588733	5684639	588156	5683673	1125	31
8028T1.csv	11:24	5:29	588735	5684639	588155	5683680	1121	31
8030T1.csv	11:43	5:48	588728	5684610	588160	5683674	1095	31
8033T1.csv	12:10	6:15	588750	5684629	588154	5683675	1124	32
8035T1.csv	12:31	6:36	588743	5684633	588160	5683675	1122	31
8038T1.csv	13:11	-5:03	588739	5684620	588157	5683677	1108	32
8040T1.csv	13:36	-4:38	588751	5684628	588161	5683671	1125	32
8042T1.csv	13:56	-4:18	588743	5684633	588154	5683675	1126	32
8044T1.csv	14:18	-3:56	588699	5684555	588158	5683673	1034	32
8046T1.csv	14:48	-3:26	588742	5684632	588162	5683671	1122	31
8048T1.csv	15:12	-3:02	588739	5684624	588163	5683668	1115	31
8051T1.csv	15:42	-2:32	588743	5684633	588162	5683671	1124	31
8053T1.csv	16:02	-2:12	588738	5684635	588159	5683673	1123	31
8055T1.csv	16:24	-1:50	588736	5684618	588160	5683672	1106	31
8057T1.csv	16:52	-1:22	588741	5684630	588161	5683670	1122	31
8059T1.csv	17:11	-1:03	588738	5684636	588159	5683671	1126	31
8061T1.csv	17:32	-0:42	588740	5684635	588160	5683673	1124	31

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 [°]
8570T1.csv	17:57	-0:17	588750	5684630	588159	5683672	1126	32
8572T1.csv	18:16	0:01	588737	5684636	588161	5683677	1119	31
8574T1.csv	18:34	0:19	588737	5684636	588174	5683713	1081	31
8576T1.csv	18:50	0:35	588779	5684597	588186	5683716	1062	34
Transect 2								
8501T2.csv	06:17	0:22	588787	5684554	588239	5683625	1079	31
8503T2.csv	06:29	0:34	588774	5684564	588231	5683633	1078	30
8505T2.csv	06:44	0:49	588801	5684548	588233	5683630	1079	32
8507T2.csv	07:04	1:09	588748	5684500	588224	5683634	1013	31
8510T2.csv	07:26	1:31	588775	5684566	588231	5683633	1080	30
8512T2.csv	07:45	1:50	588765	5684569	588227	5683635	1078	30
8514T2.csv	08:04	2:09	588788	5684558	588237	5683626	1083	31
8516T2.csv	08:26	2:31	588765	5684571	588249	5683620	1082	28
8518T2.csv	08:45	2:50	588765	5684572	588273	5683667	1030	29
8520T2.csv	09:03	3:08	588793	5684554	588297	5683736	956	31
8523T2.csv	09:31	3:36	588776	5684564	588299	5683729	961	30
8525T2.csv	09:48	3:53	588776	5684563	588304	5683765	928	31
8527T2.csv	10:06	4:11	588761	5684573	588252	5683639	1064	29
8530T2.csv	10:54	4:59	588756	5684571	588256	5683661	1039	29
8532T2.csv	11:13	5:18	588773	5684565	588264	5683670	1030	30
8534T2.csv	11:39	5:44	588812	5684541	588292	5683732	962	33
8536T2.csv	11:57	6:02	588835	5684529	588313	5683745	942	34
8538T2.csv	12:14	6:19	588836	5684529	588323	5683758	927	34
8540T2.csv	12:32	6:37	588819	5684540	588326	5683768	915	33
8543T2.csv	13:11	-5:03	588802	5684547	588237	5683656	1055	32
8545T2.csv	13:35	-4:39	588839	5684526	588252	5683642	1061	34
8547T2.csv	13:55	-4:19	588756	5684485	588224	5683634	1004	32
8549T2.csv	14:14	-4:00	588764	5684571	588270	5683680	1019	29
8551T2.csv	14:35	-3:39	588788	5684558	588258	5683689	1018	31
8553T2.csv	15:10	-3:04	588760	5684572	588264	5683694	1009	29
8555T2.csv	15:38	-2:36	588774	5684550	588248	5683621	1067	29

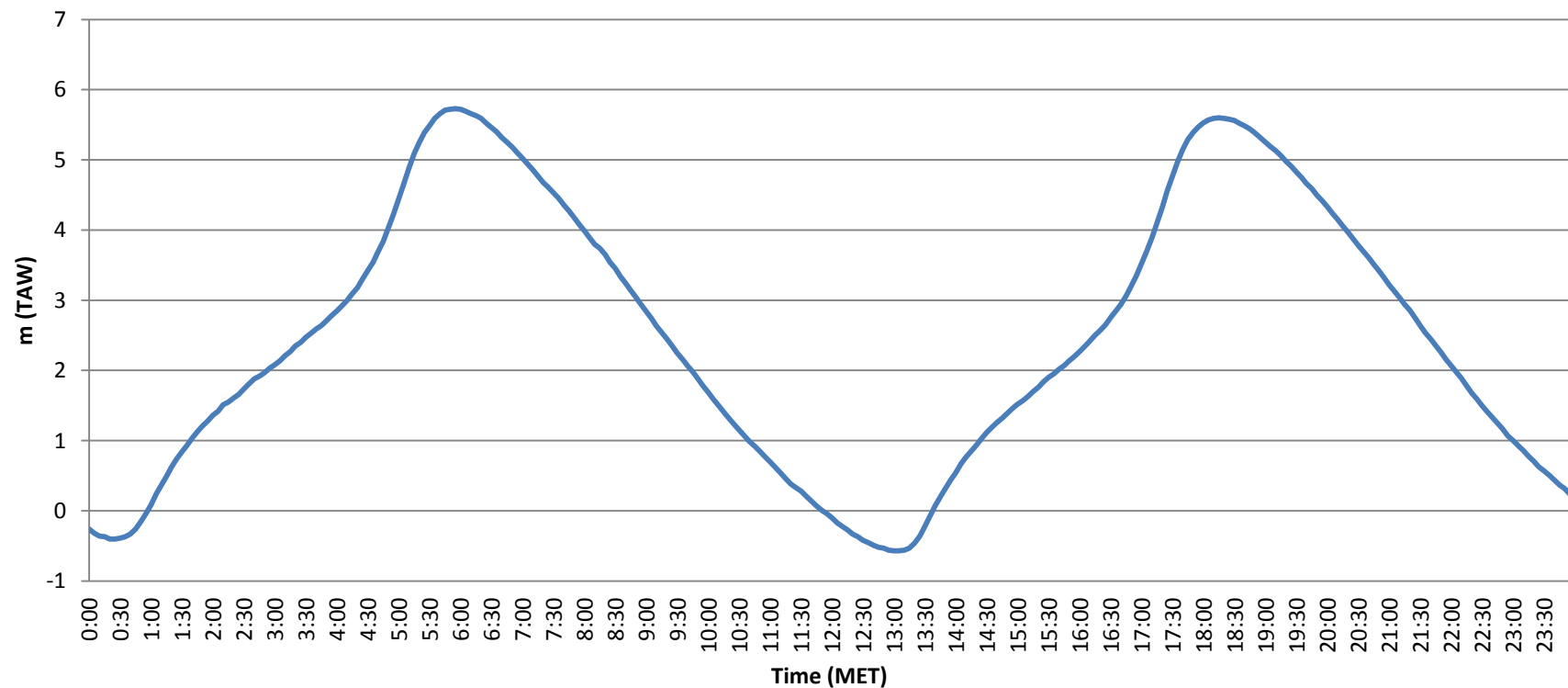
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8557T2.csv	15:57	-2:17	588784	5684558	588247	5683647	1057	30
8559T2.csv	16:14	-2:00	588808	5684544	588232	5683645	1068	33
8561T2.csv	16:32	-1:42	588818	5684525	588259	5683662	1028	33
8563T2.csv	16:52	-1:22	588731	5684541	588272	5683690	968	28
8565T2.csv	17:10	-1:04	588759	5684563	588279	5683721	969	30
8567T2.csv	17:31	-0:43	588739	5684583	588288	5683700	992	27
8063T2.csv	17:52	-0:22	588796	5684553	588235	5683627	1083	31
8066T2.csv	18:27	0:12	588797	5684552	588235	5683629	1081	31
8068T2.csv	18:47	0:32	588782	5684531	588229	5683630	1057	32
8070T2.csv	19:06	0:51	588793	5684553	588236	5683630	1078	31
Transect 3								
8002T3.csv	06:42	0:47	588857	5684463	588311	5683583	1036	32
8004T3.csv	07:03	1:08	588851	5684469	588310	5683586	1036	31
8006T3.csv	07:23	1:28	588843	5684474	588311	5683589	1032	31
8008T3.csv	07:42	1:47	588839	5684461	588308	5683587	1023	31
8010T3.csv	08:02	2:07	588827	5684448	588309	5683585	1006	31
8013T3.csv	08:50	2:55	588836	5684463	588308	5683590	1021	31
8015T3.csv	09:08	3:13	588843	5684465	588311	5683583	1030	31
8017T3.csv	09:30	3:35	588852	5684470	588311	5683583	1039	31
8019T3.csv	09:49	3:54	588842	5684475	588312	5683587	1035	31
8022T3.csv	10:18	4:23	588844	5684474	588317	5683584	1034	31
8023T3.csv	10:36	4:41	588847	5684472	588318	5683582	1035	31
8025T3.csv	10:55	5:00	588851	5684470	588318	5683580	1038	31
8027T3.csv	11:15	5:20	588849	5684471	588321	5683579	1037	31
8029T3.csv	11:34	5:39	588843	5684474	588320	5683578	1038	30
8031T3.csv	11:52	5:57	588855	5684469	588316	5683582	1038	31
8034T3.csv	12:22	6:27	588855	5684468	588318	5683577	1040	31
8036T3.csv	12:42	6:47	588855	5684466	588318	5683578	1037	31
8039T3.csv	13:22	-4:52	588855	5684468	588321	5683578	1038	31
8041T3.csv	13:46	-4:28	588860	5684465	588318	5683579	1039	31
8043T3.csv	14:09	-4:05	588848	5684468	588317	5683579	1035	31

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 [°]
8045T3.csv	14:38	-3:36	588857	5684466	588311	5683583	1039	32
8047T3.csv	15:00	-3:14	588863	5684461	588311	5683582	1038	32
8050T3.csv	15:32	-2:42	588863	5684463	588321	5683577	1039	31
8052T3.csv	15:52	-2:22	588856	5684467	588315	5683579	1039	31
8054T3.csv	16:13	-2:01	588852	5684469	588310	5683584	1038	32
8058T3.csv	17:00	-1:14	588858	5684466	588315	5683584	1036	32
8060T3.csv	17:21	-0:53	588855	5684468	588321	5683577	1039	31
8569T3.csv	17:47	-0:27	588844	5684473	588348	5683559	1040	29
8571T3.csv	18:06	-0:08	588829	5684466	588341	5683567	1023	28
8067T3.csv	18:35	0:20	588857	5684466	588322	5683579	1036	31
8069T3.csv	18:55	0:40	588852	5684468	588325	5683575	1037	31
Transect 4								
8504T4.csv	06:36	0:41	588908	5684378	588396	5683540	982	31
8506T4.csv	06:52	0:57	588909	5684384	588403	5683529	993	31
8508T4.csv	07:12	1:17	588916	5684377	588393	5683537	990	32
8511T4.csv	07:35	1:40	588890	5684397	588397	5683533	995	30
8513T4.csv	07:54	1:59	588908	5684373	588394	5683533	985	31
8515T4.csv	08:16	2:21	588878	5684320	588435	5683552	887	30
8517T4.csv	08:36	2:41	588828	5684283	588397	5683532	867	30
8519T4.csv	08:55	3:00	588885	5684359	588405	5683526	962	30
8522T4.csv	09:21	3:26	588828	5684310	588393	5683537	888	29
8524T4.csv	09:39	3:44	588863	5684222	588399	5683530	833	34
8526T4.csv	09:57	4:02	588831	5684303	588384	5683541	883	30
8528T4.csv	10:19	4:24	588958	5684355	588412	5683623	914	37
8531T4.csv	11:03	5:08	588891	5684349	588394	5683535	953	31
8533T4.csv	11:31	5:36	588868	5684320	588394	5683535	917	31
8535T4.csv	11:49	5:54	588862	5684298	588393	5683533	897	31
8537T4.csv	12:06	6:11	588840	5684284	588394	5683536	871	31
8539T4.csv	12:24	6:29	588862	5684291	588389	5683537	891	32
8541T4.csv	12:42	6:47	588915	5684371	588390	5683537	985	32
8544T4.csv	13:20	-4:54	588898	5684362	588400	5683532	968	31

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 [°]
8546T4.csv	13:45	-4:29	588897	5684385	588392	5683538	987	31
8548T4.csv	14:05	-4:09	588910	5684385	588390	5683540	992	32
8550T4.csv	14:26	-3:48	588924	5684376	588391	5683538	993	32
8552T4.csv	14:49	-3:25	588776	5684281	588389	5683537	839	28
8554T4.csv	15:25	-2:49	588867	5684294	588401	5683528	896	31
8556T4.csv	15:48	-2:26	588919	5684377	588388	5683539	992	32
8558T4.csv	16:06	-2:08	588912	5684362	588393	5683537	974	32
8560T4.csv	16:24	-1:50	588894	5684320	588387	5683538	932	33
8562T4.csv	16:41	-1:33	588886	5684292	588397	5683532	904	33
8564T4.csv	17:01	-1:13	588839	5684273	588392	5683536	862	31
8566T4.csv	17:18	-0:56	588836	5684260	588406	5683528	849	30
8062T4.csv	17:40	-0:34	588901	5684388	588393	5683533	994	31
8065T4.csv	18:15	0:00	588910	5684385	588394	5683534	995	31
8573T4.csv	18:24	0:09	588890	5684365	588408	5683529	965	30
8575T4.csv	18:42	0:27	588880	5684386	588400	5683529	982	29
8577T4.csv	18:57	0:42	588839	5684302	588403	5683529	887	29

Annex B Tidal data

11354 – Spring 2012 SURVEY



Measured tide on 12/03/2012 at Liefkenshoek

Location:
River Scheldt

Date:
12/03/2012

Data processed by:

In association with:



I/RA/11354/10.111/MBO/ANF

Annex C Navigation information as recorded on site

Ship:		Scheldewacht II & Parel II
Location:		Deurganckdok (transect DGD)
Transect	Remarks	
8013t3	Schroefwater: binnenschip	
8023t3	Schroefwater: containerschip	
8043t3	Schroefwater: binnenschip	
8067t3	Schroefwater: binnenschip	
8501t2	Schroefwater: binnenschip	
8505t2	Schroefwater: binnenschip	
8513t4	Schroefwater: binnenschip	
8515t4	Schroefwater: binnenschip	
8517t4	Schroefwater: binnenschip	
8522t4	Schroefwater: binnenschip	
8523t2	Schroefwater: binnenschip	
8524t4	Schroefwater: binnenschip	
8528t4	Schroefwater: containerschip	
8533t4	Schroefwater: binnenschip	
8550t4	Schroefwater: sleepboot	
8553t2	Schroefwater: sleepboot	
8556t2	Schroefwater: binnenschip	
8558t4	Schroefwater: binnenschip	
8574t1	Schroefwater: binnenschip	
8575t4	Schroefwater: binnenschip	

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	0.5	Input conductivity in mS/cm of sample							
Cond at t	22.00	Input temperature of sample solution							
t deg. C	20	Input pressure at which sample is measured in decibars							
P dBar									
Rp	1.0020845	R_p = $1 + \frac{p(e_1 + e_2p + e_3p^2)}{1 + d_1t + d_2t^2 + (d_3 + d_4t)R}$							
rt	1.1641102	r_t = $c_0 + c_1t + c_2t^2 + c_3t^3 + c_4t^4$							
Rt	0.0099879	R_t = $\frac{R}{R_p \times r_t}$							
Delta S	-0.0010	Delta S = $\frac{(t-15)}{1+k(t-15)} (b_0 + b_1R_t^{1/2} + b_2R_t^{3/2} + b_3R_t^{5/2} + b_4R_t^2 + b_5R_t^{5/2})$							
S = Salinity	0.257	S = $a_0 + a_1R_t^{1/2} + a_2R_t^{3/2} + a_3R_t^2 + a_4R_t^{5/2} + a_5R_t^2 + \text{delta S}$							
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.

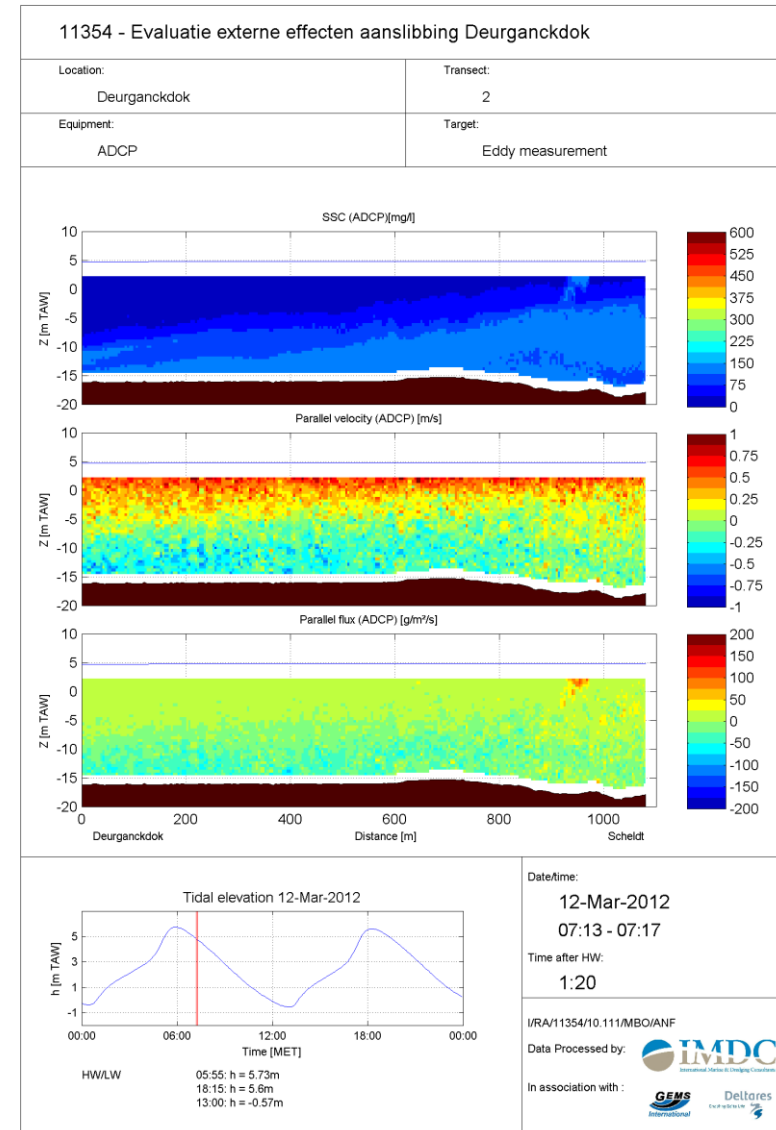
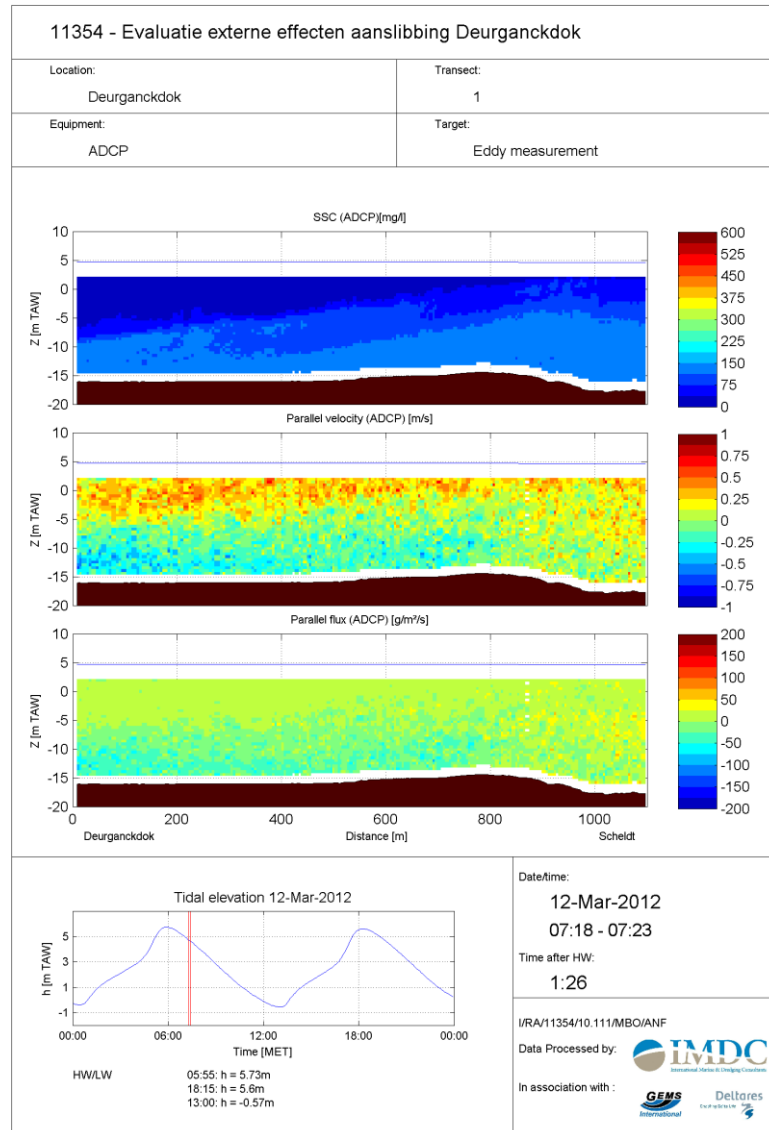
$$R = R_t \times R_p \times r_t$$

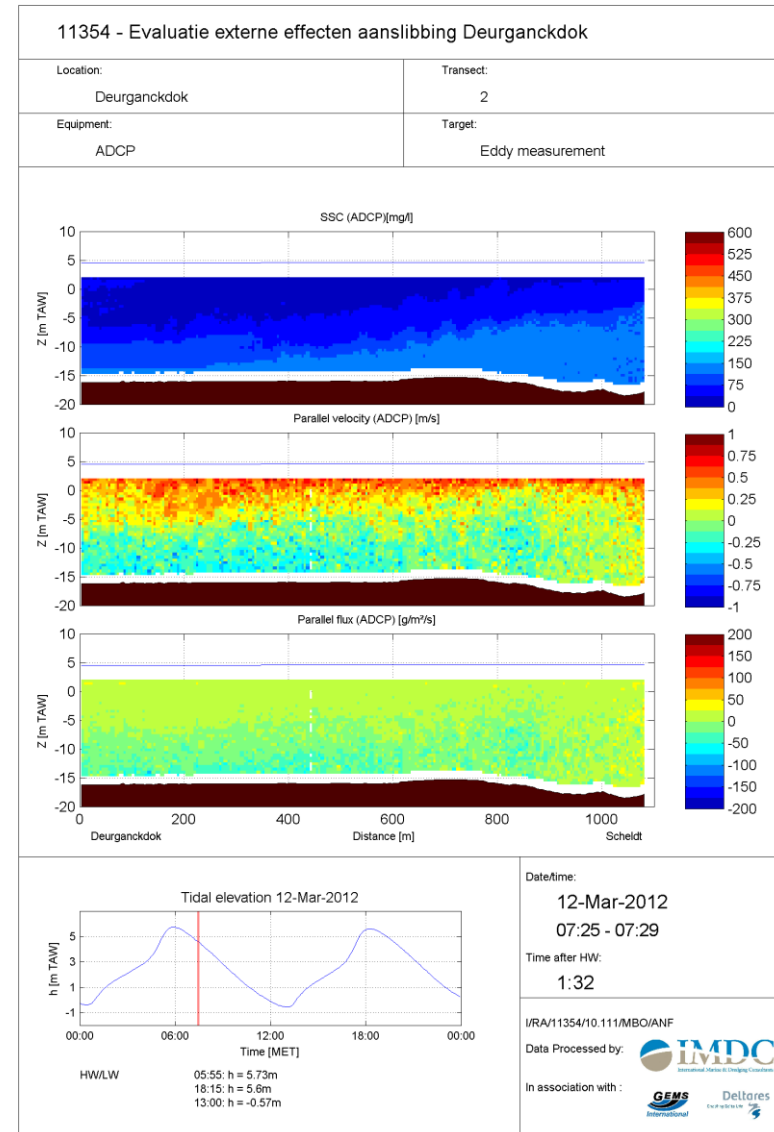
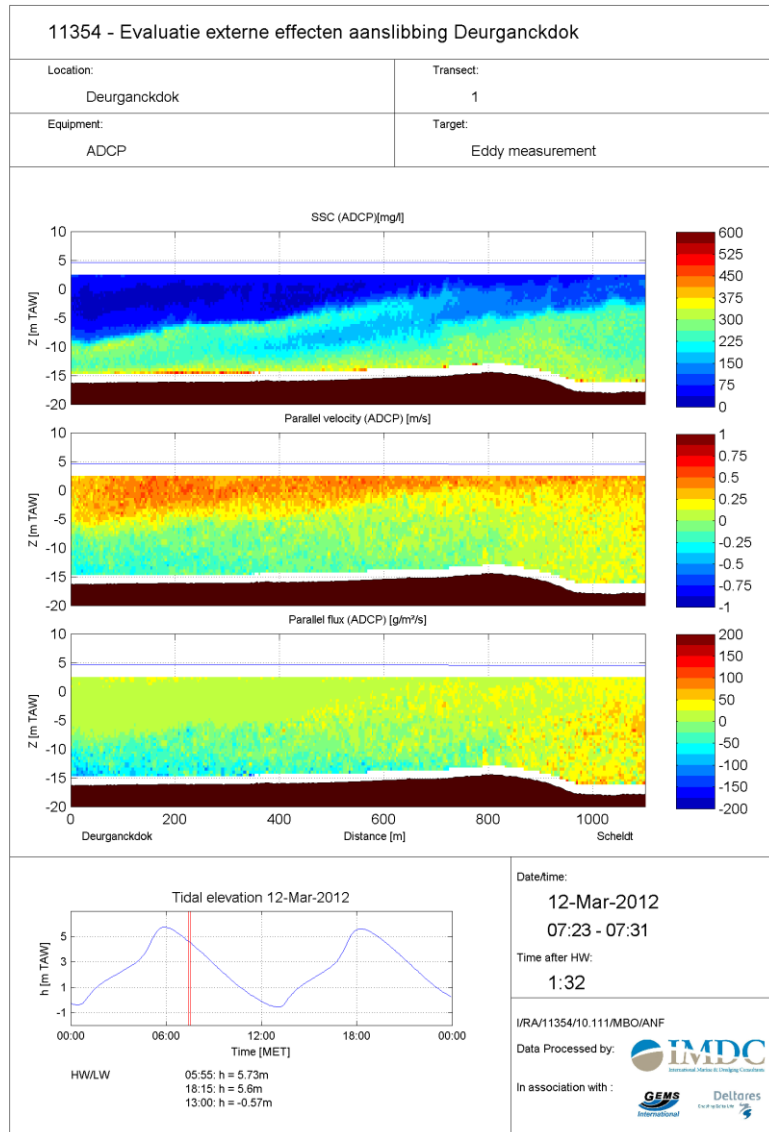
$$R = C(S, t, p) / C(35, 15, 0)$$

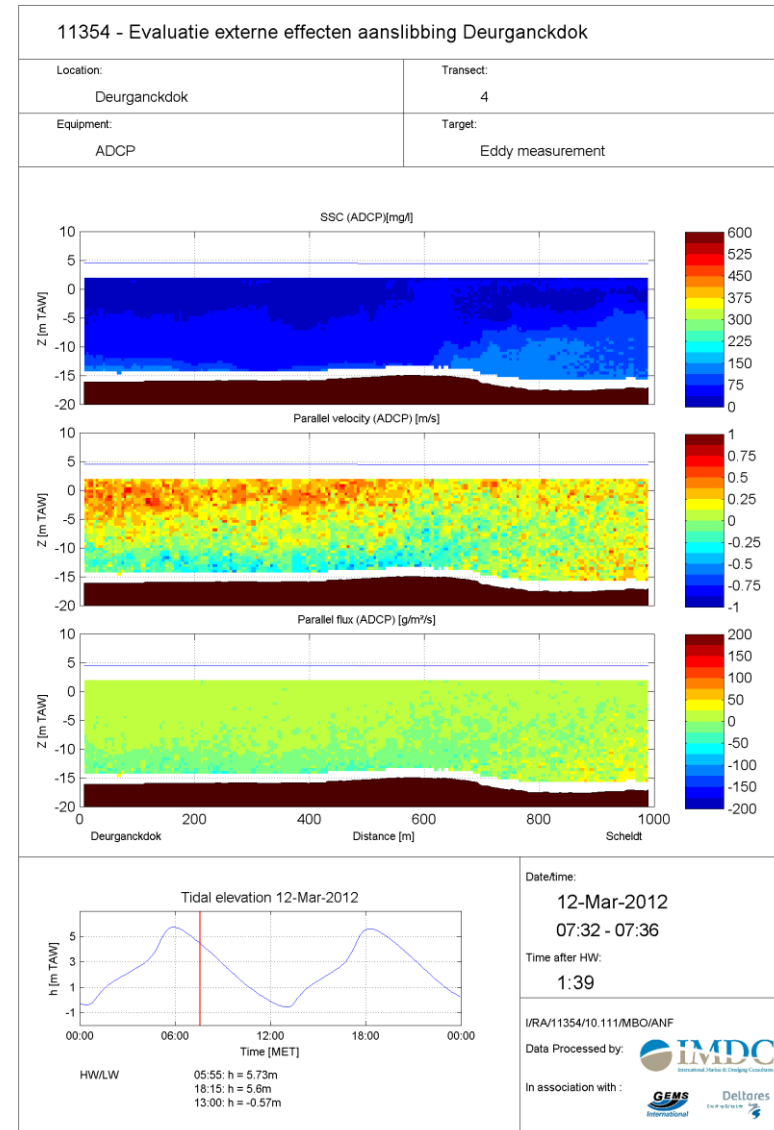
C = 42.914 mS/cm at 15 deg C and 0 dbar pressure ie C(35,15,0) where 35 is the salinity

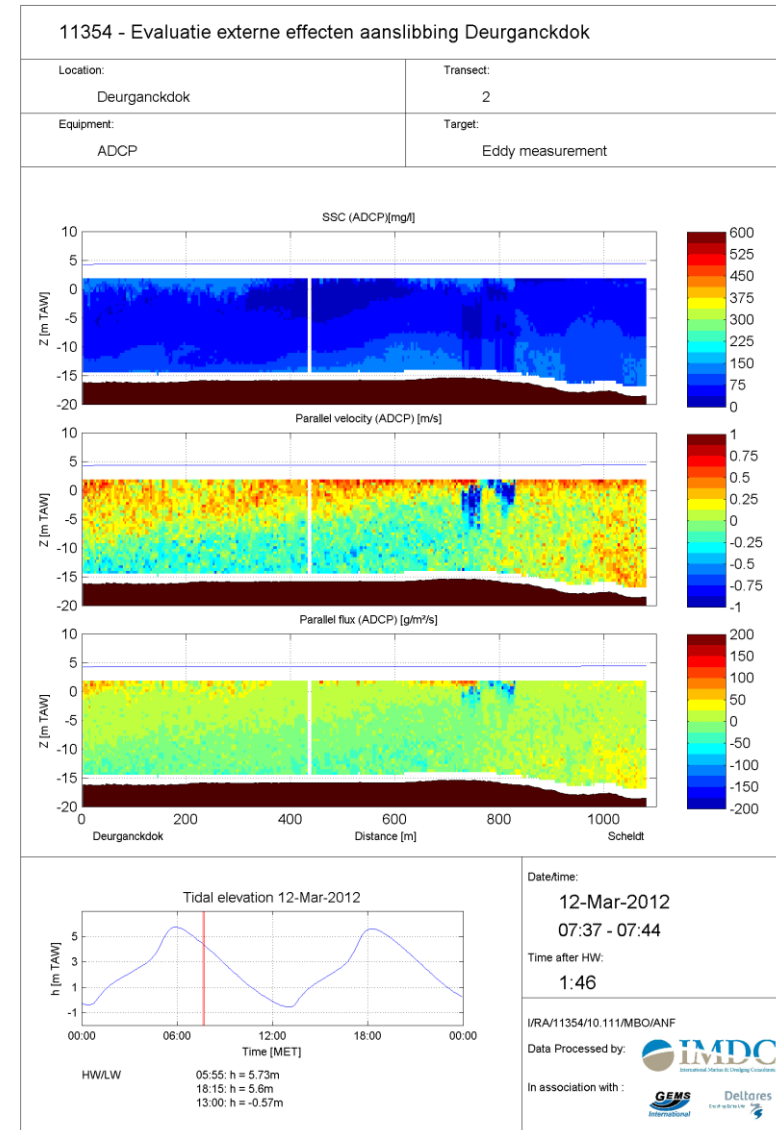
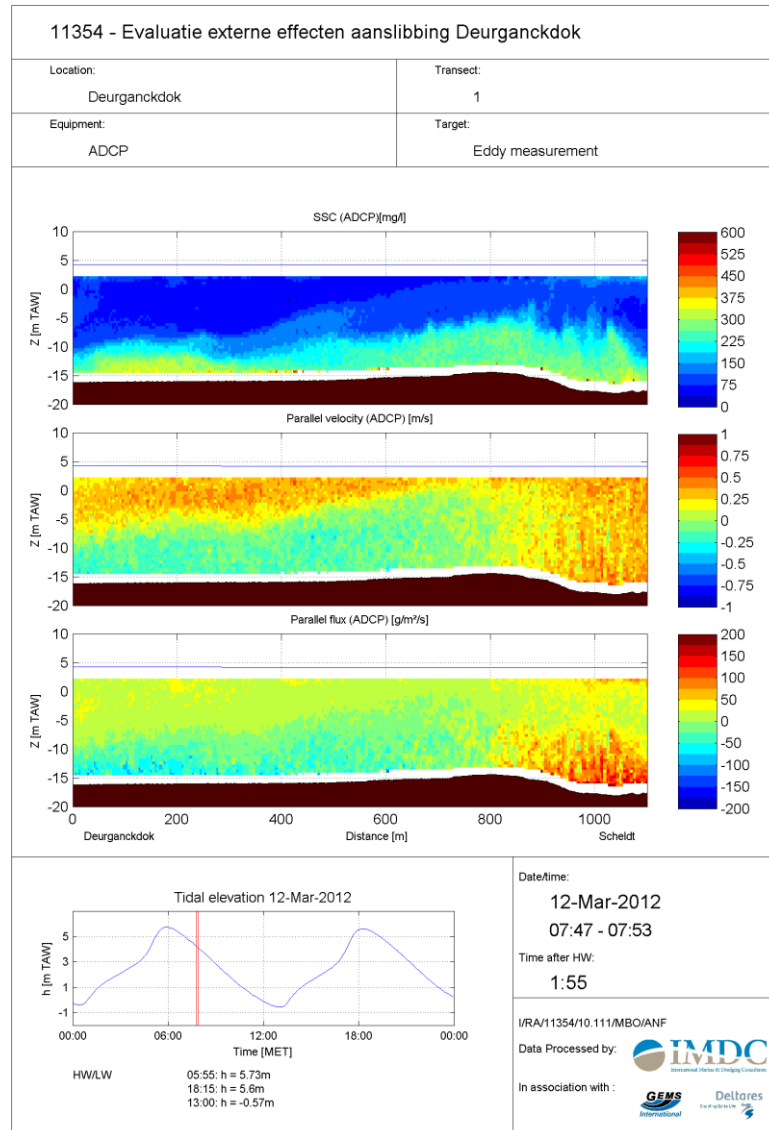
Ocean pressure is usually measured in decibars. 1 dbar = 10⁻¹ bar = 10⁵ dyne/cm² = 10⁴ Pascal.

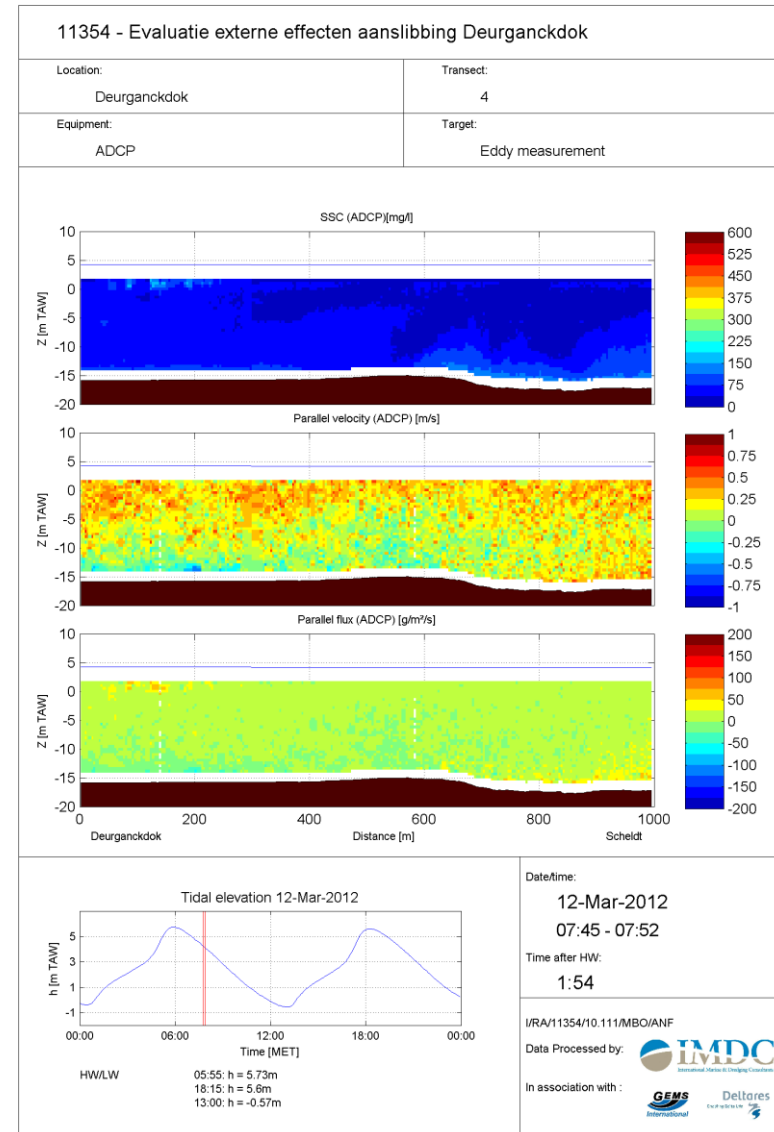
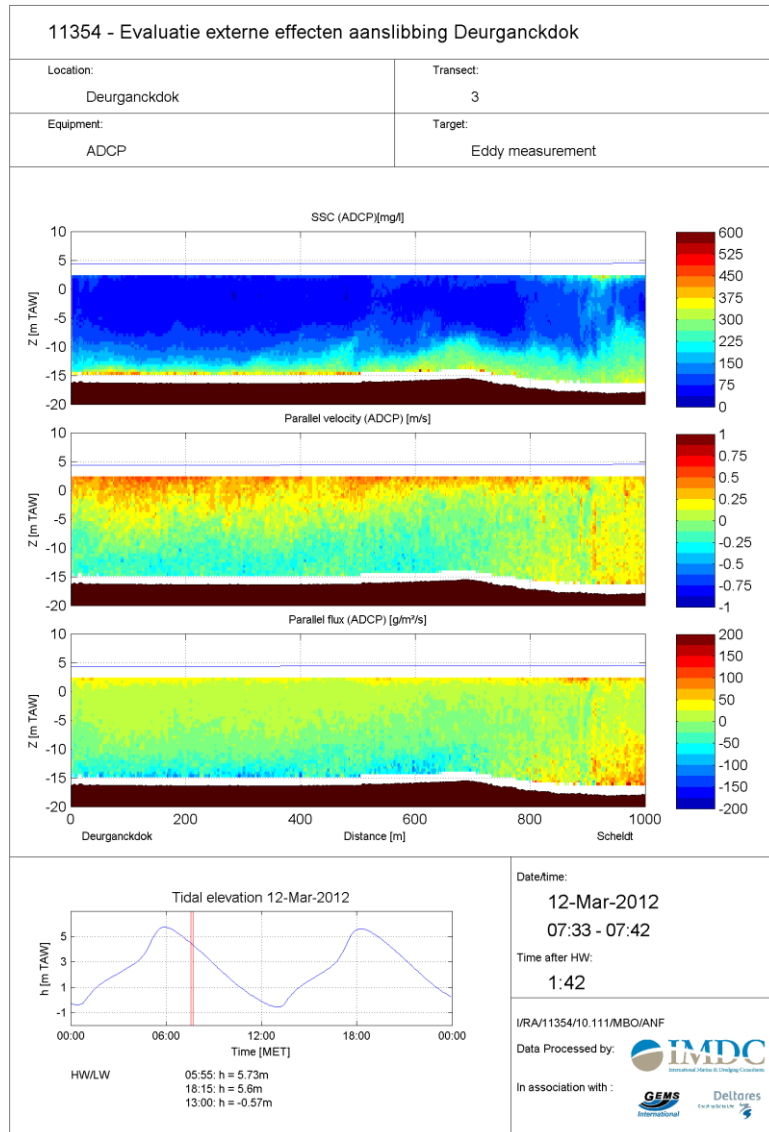
Annex E Contourplots of flow velocities and concentration per sailed transect

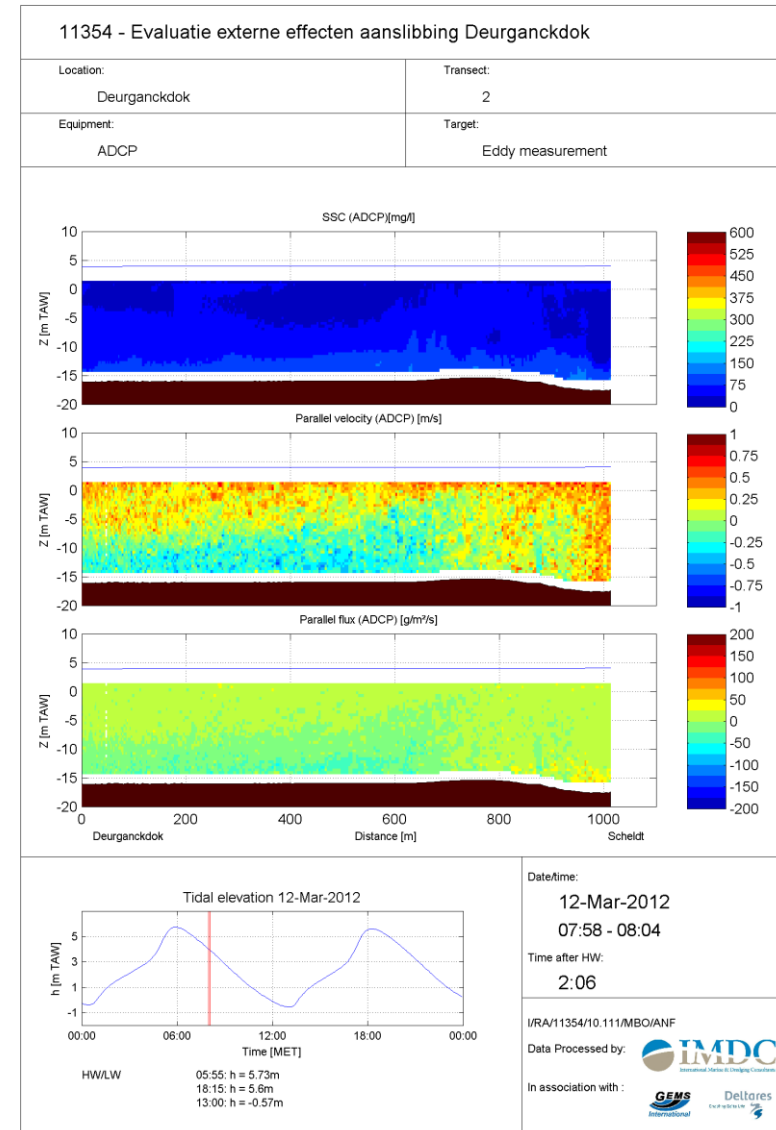
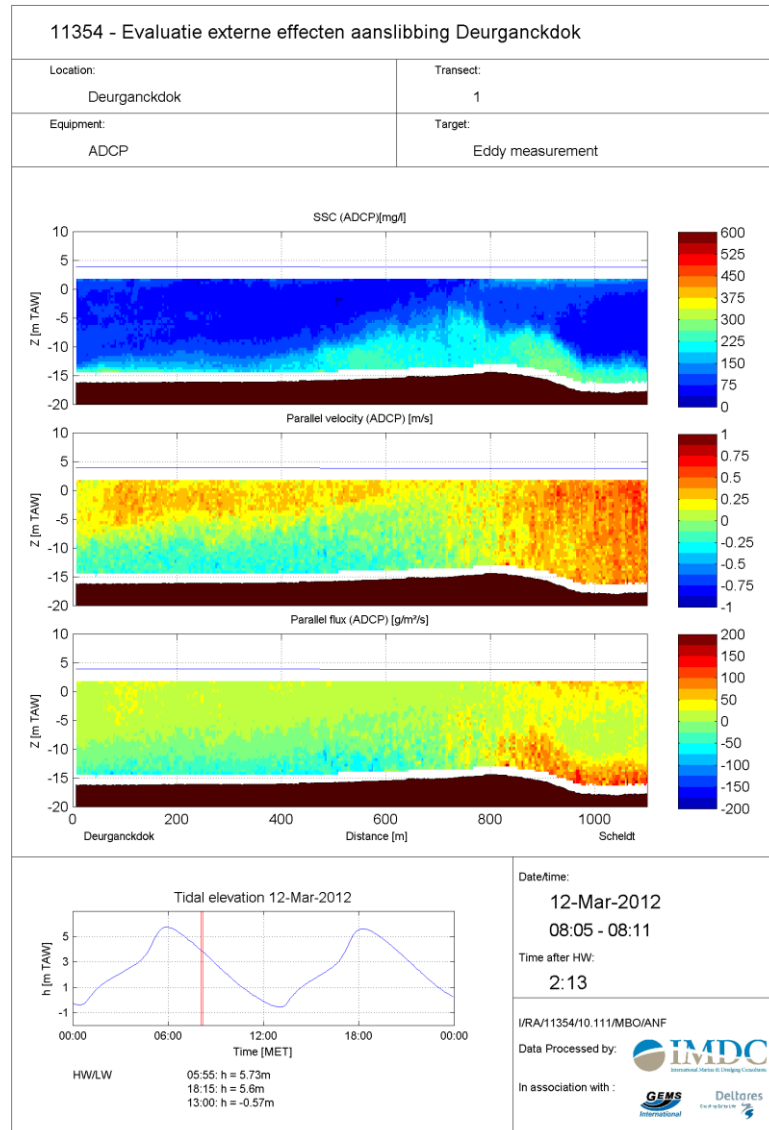


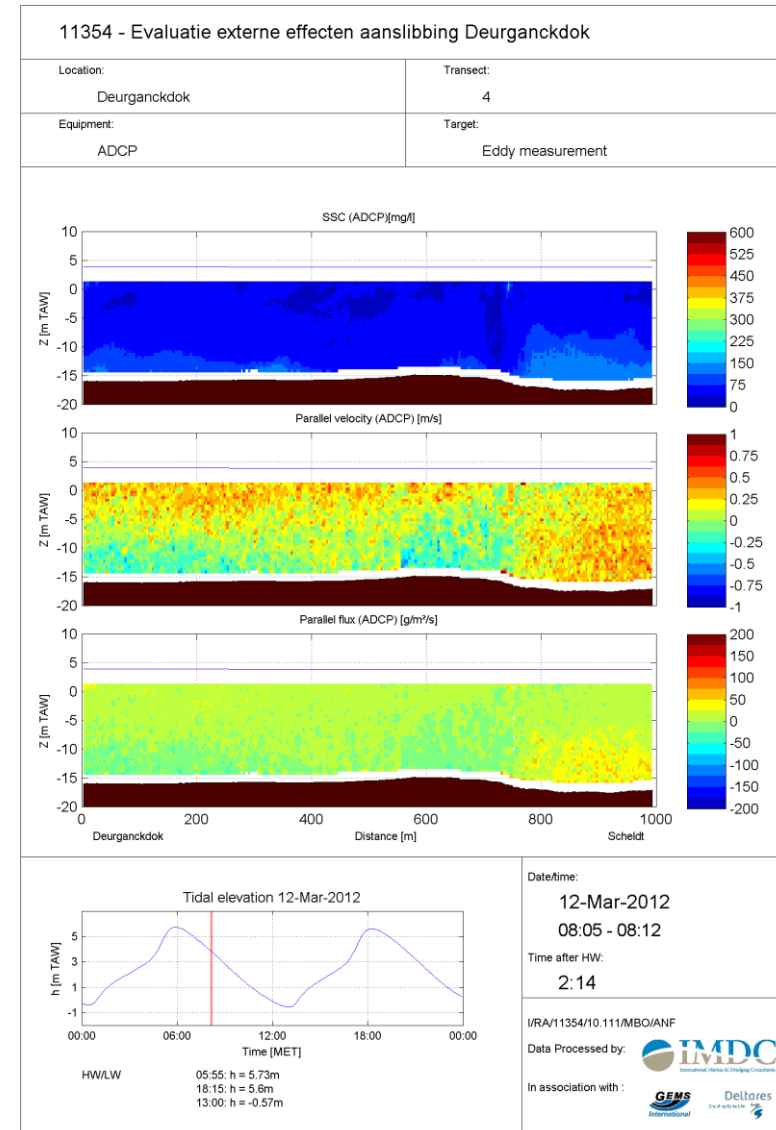
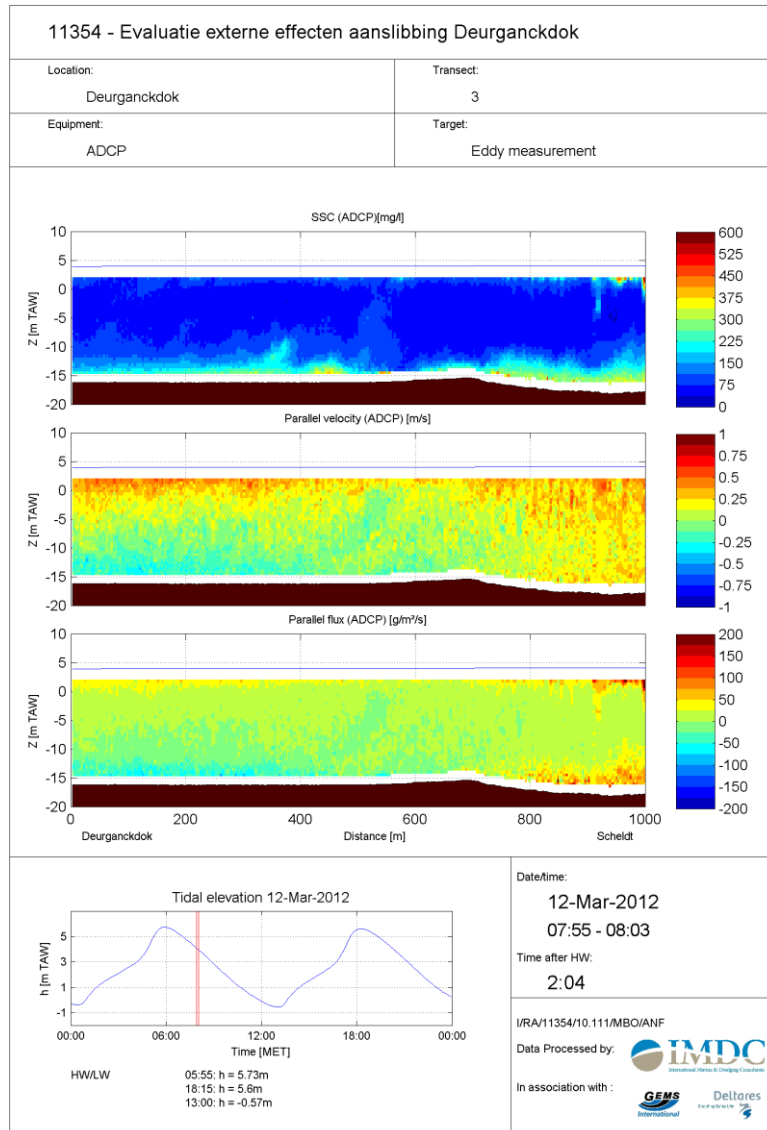


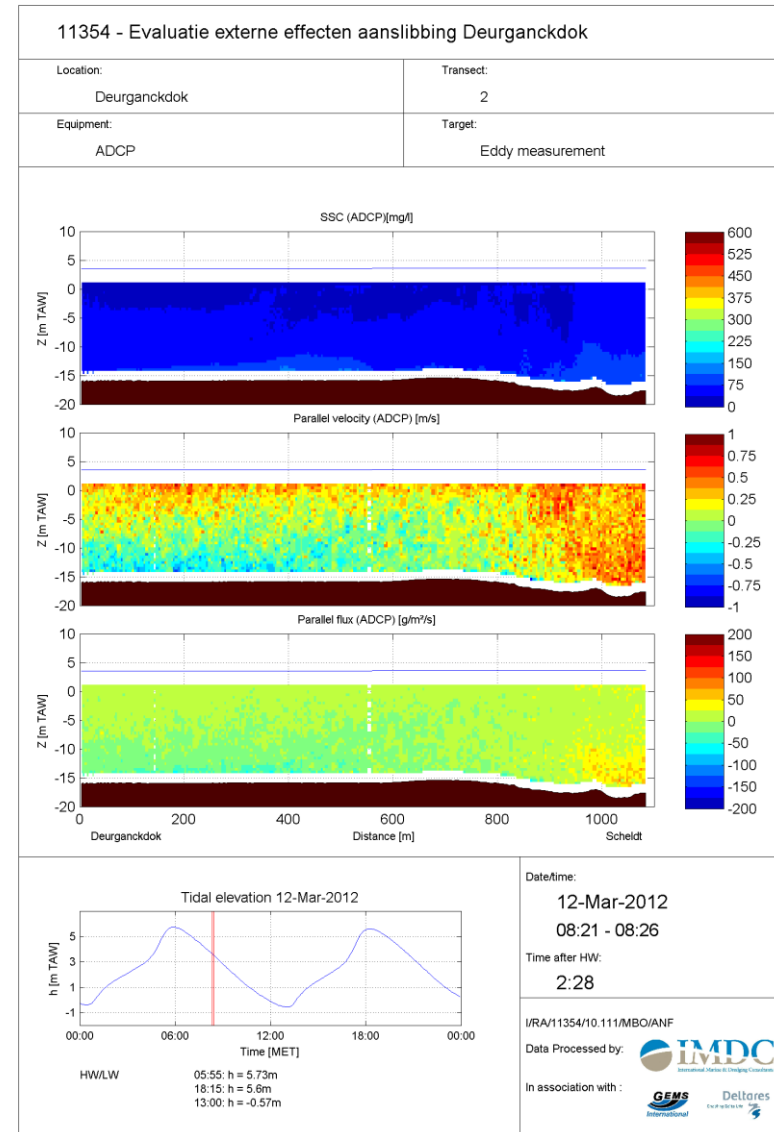
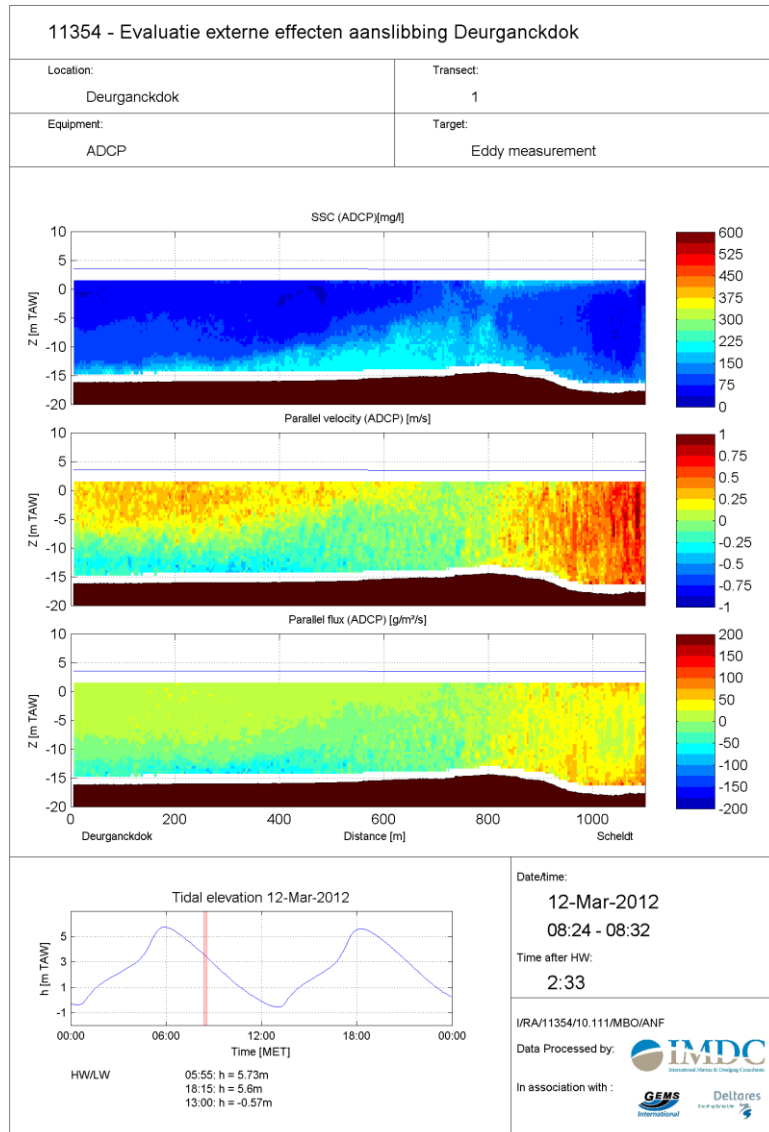


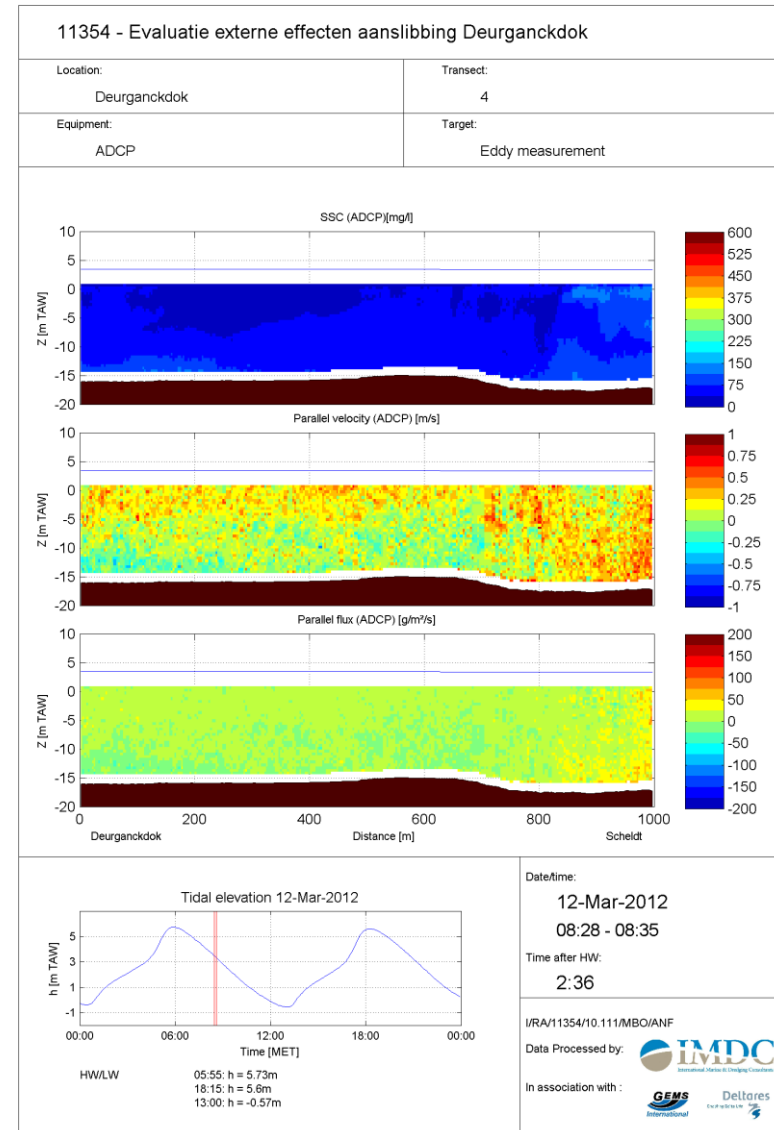
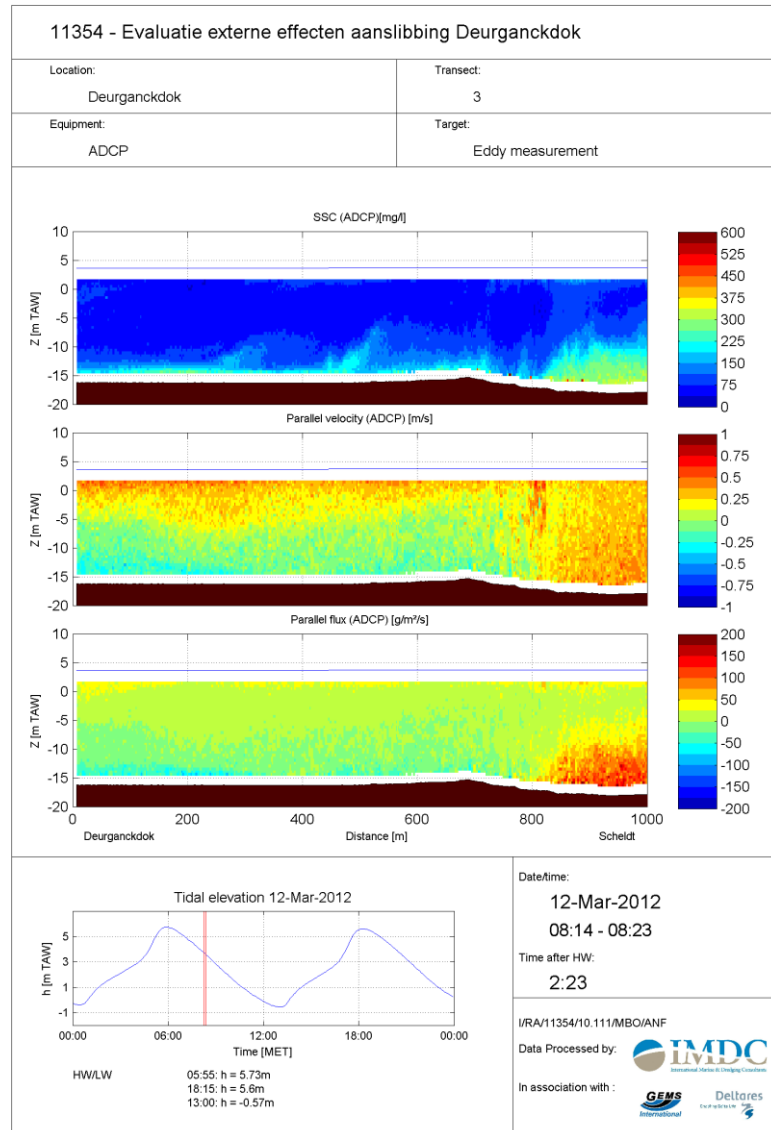


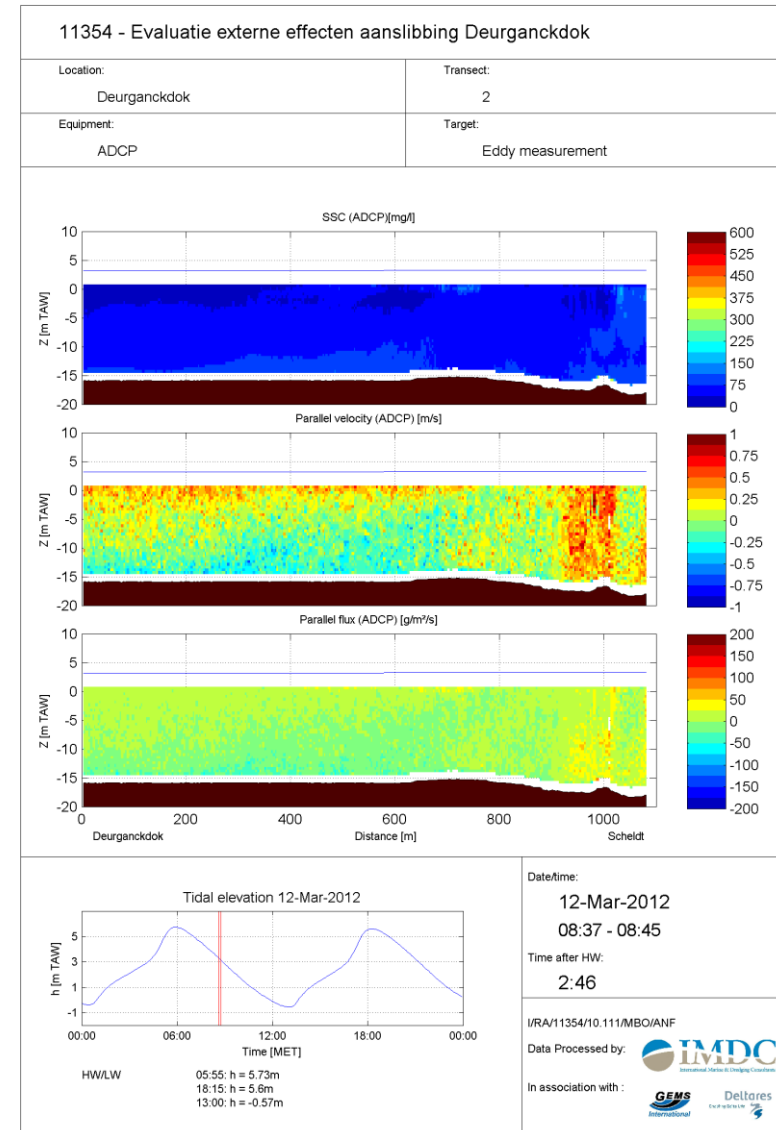
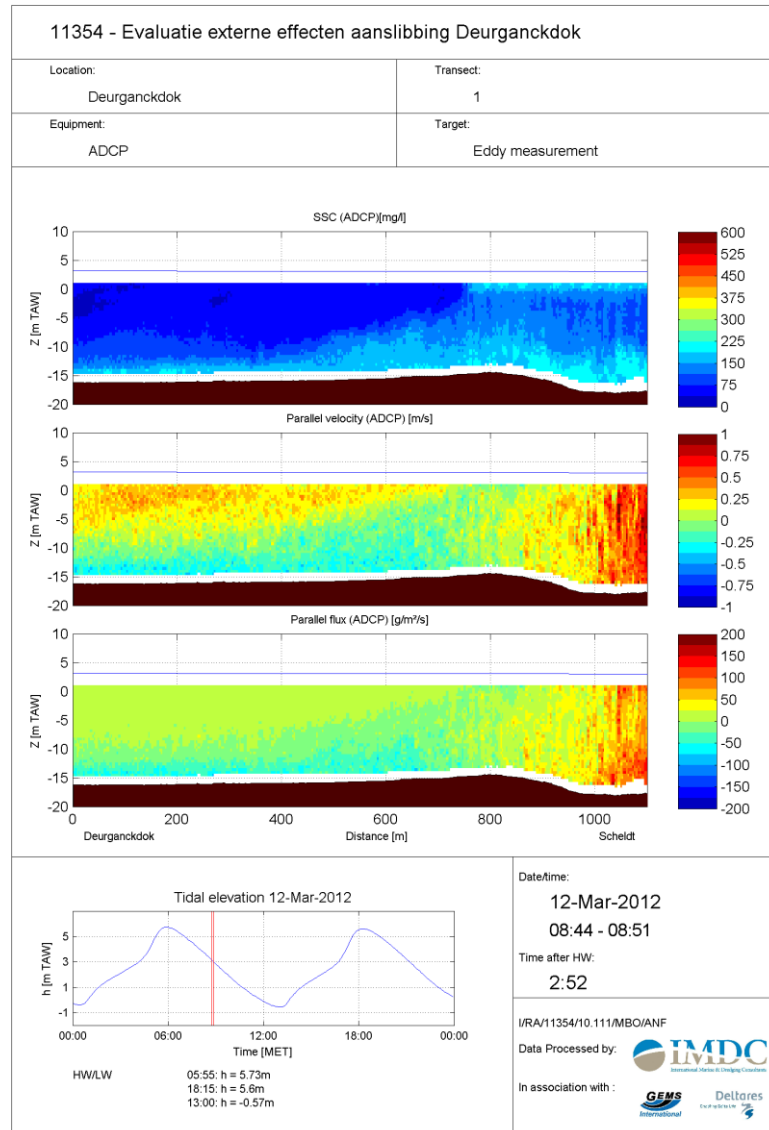


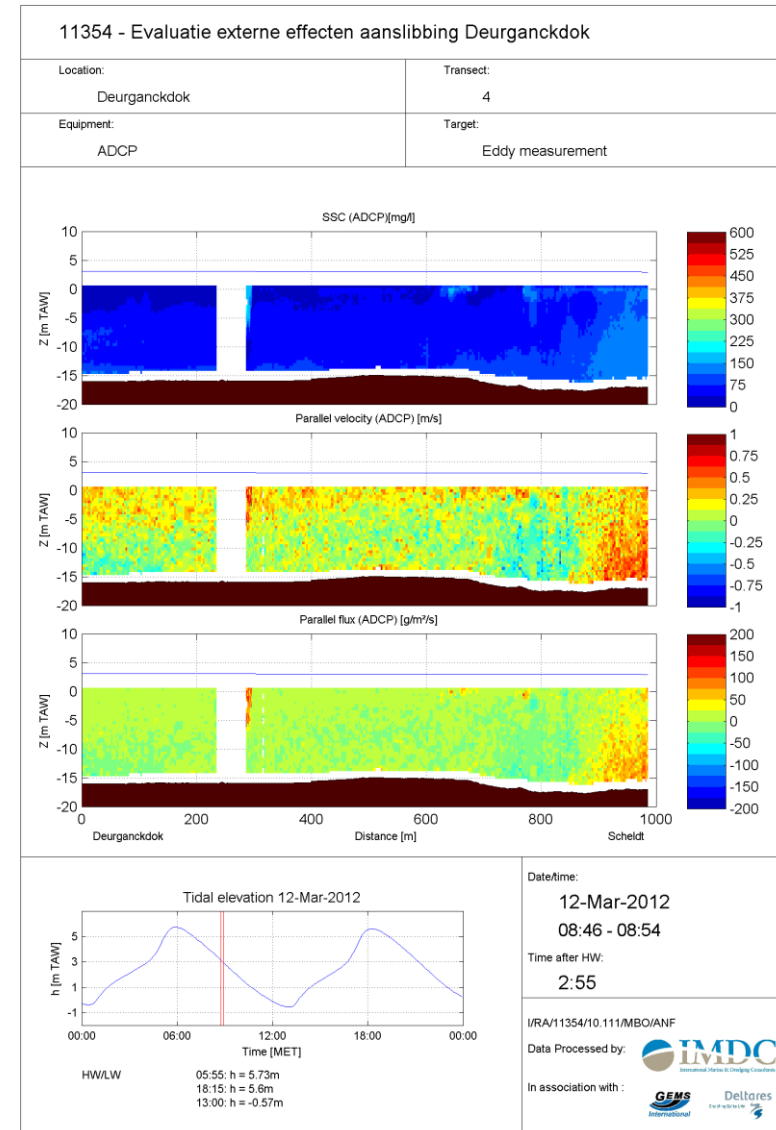
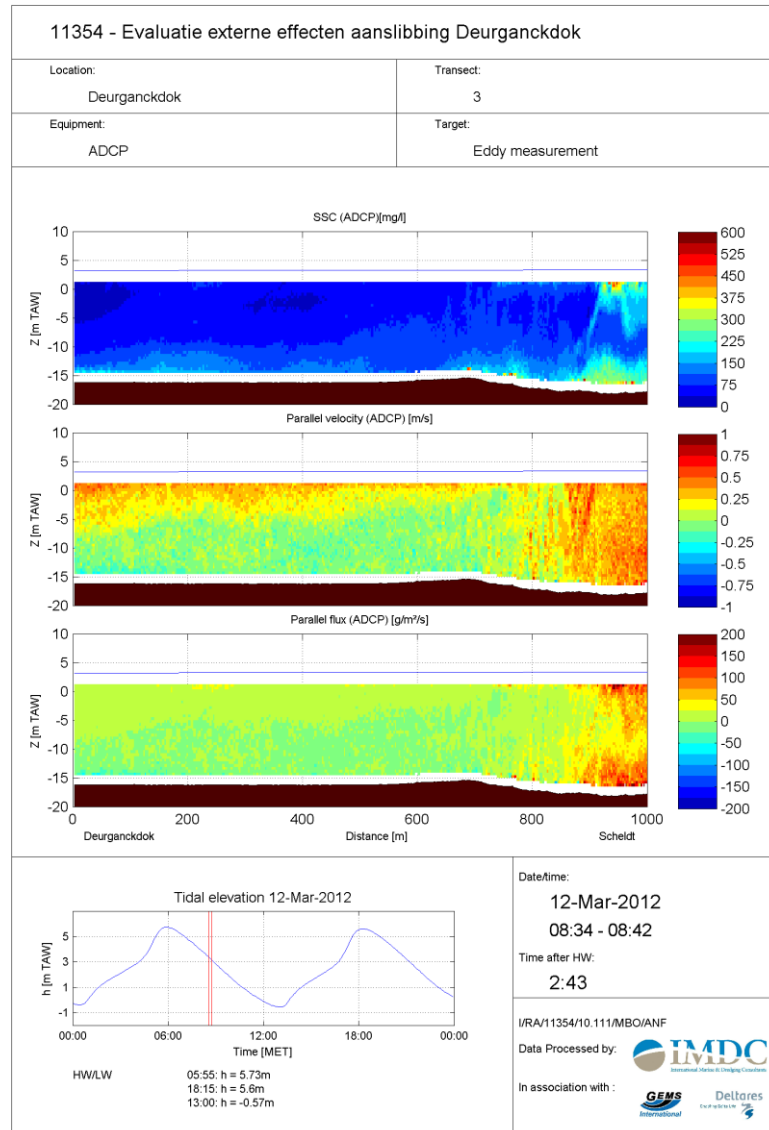


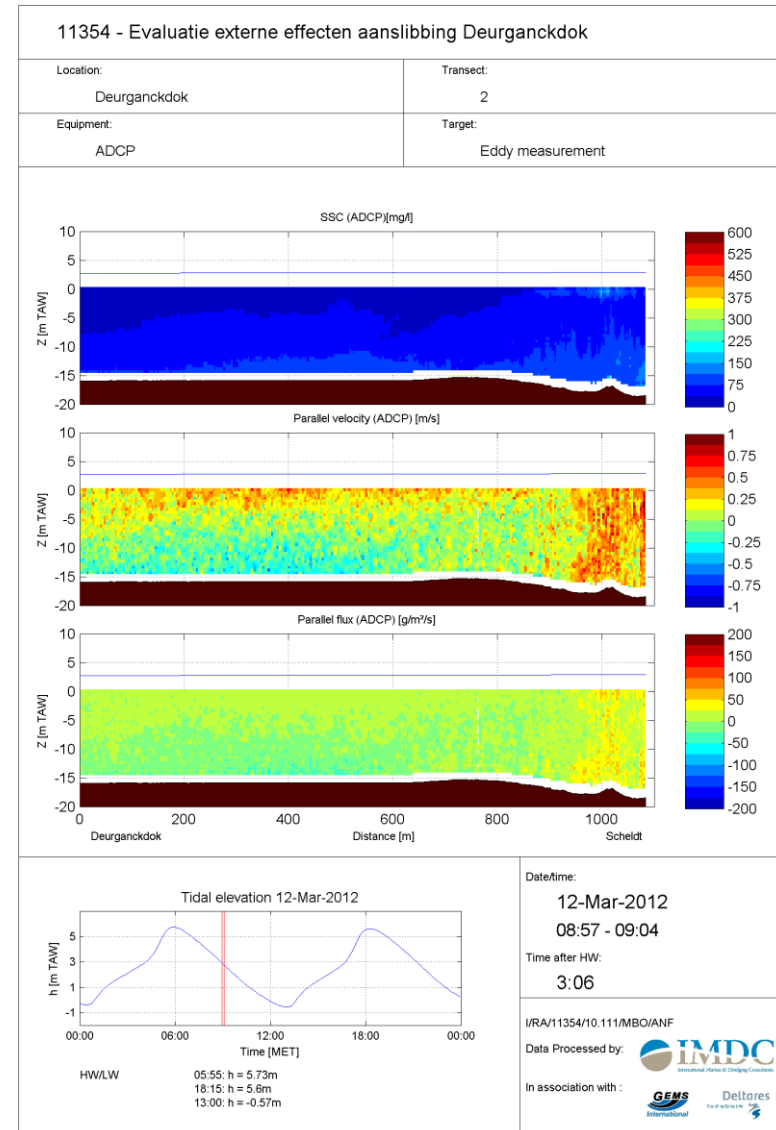


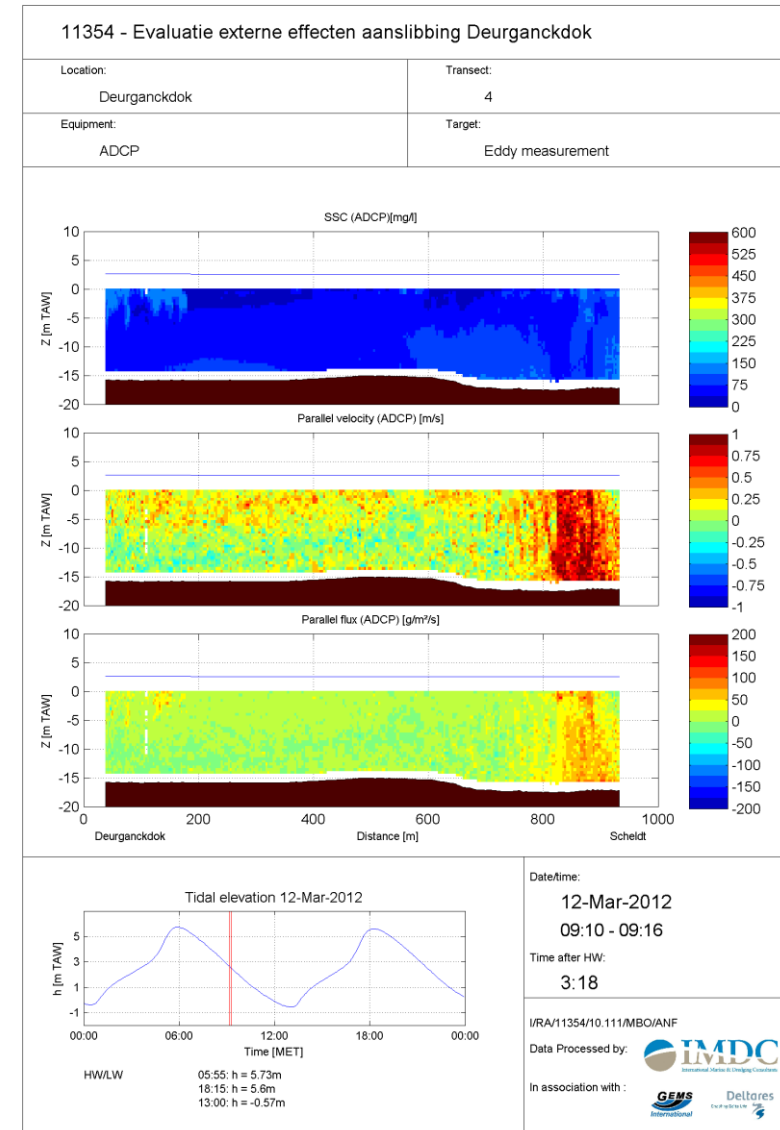
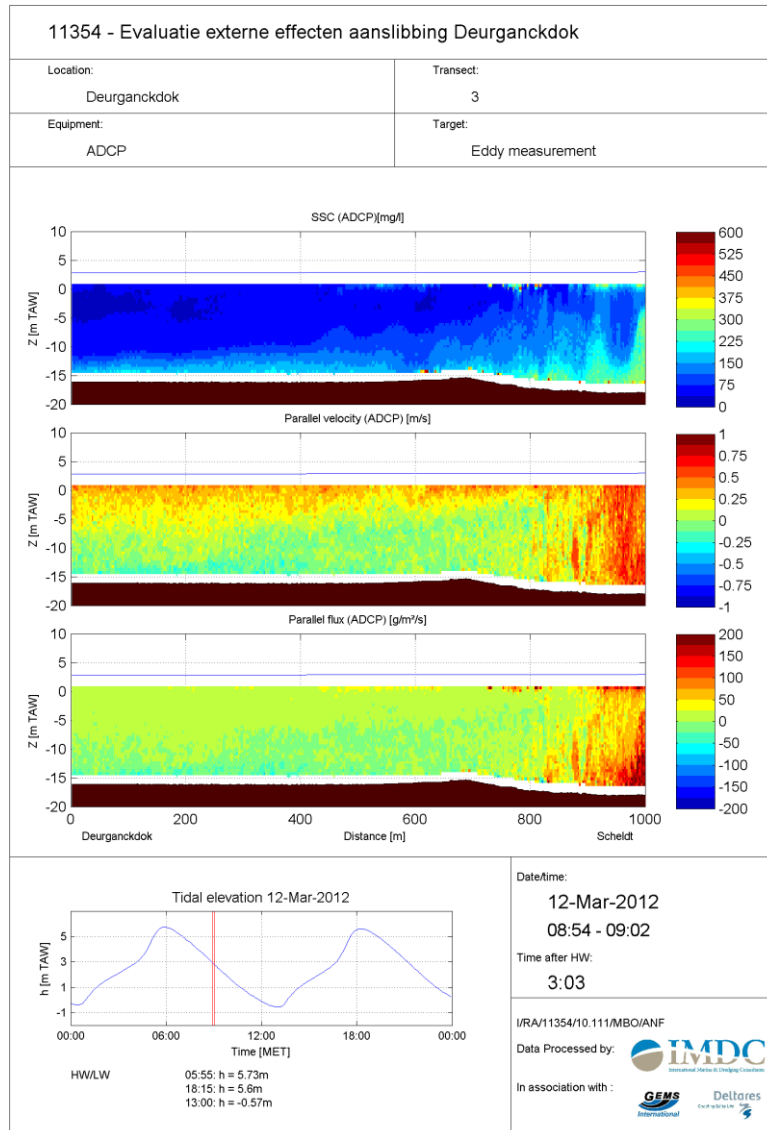


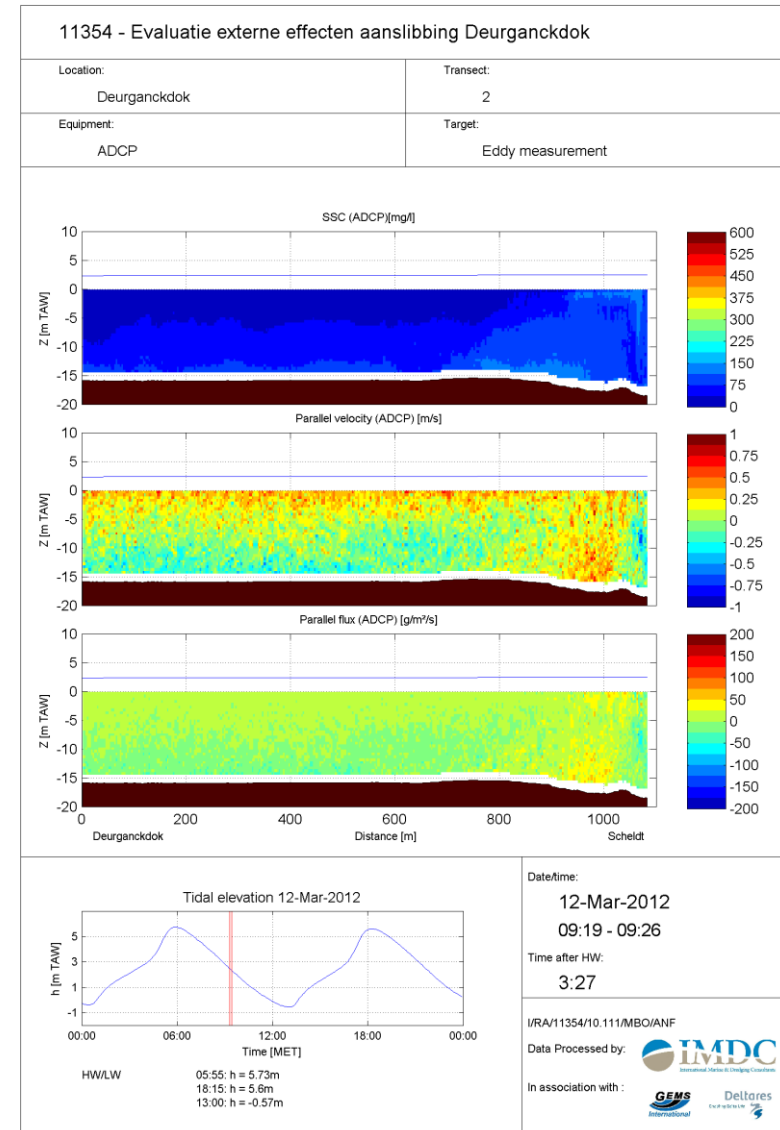
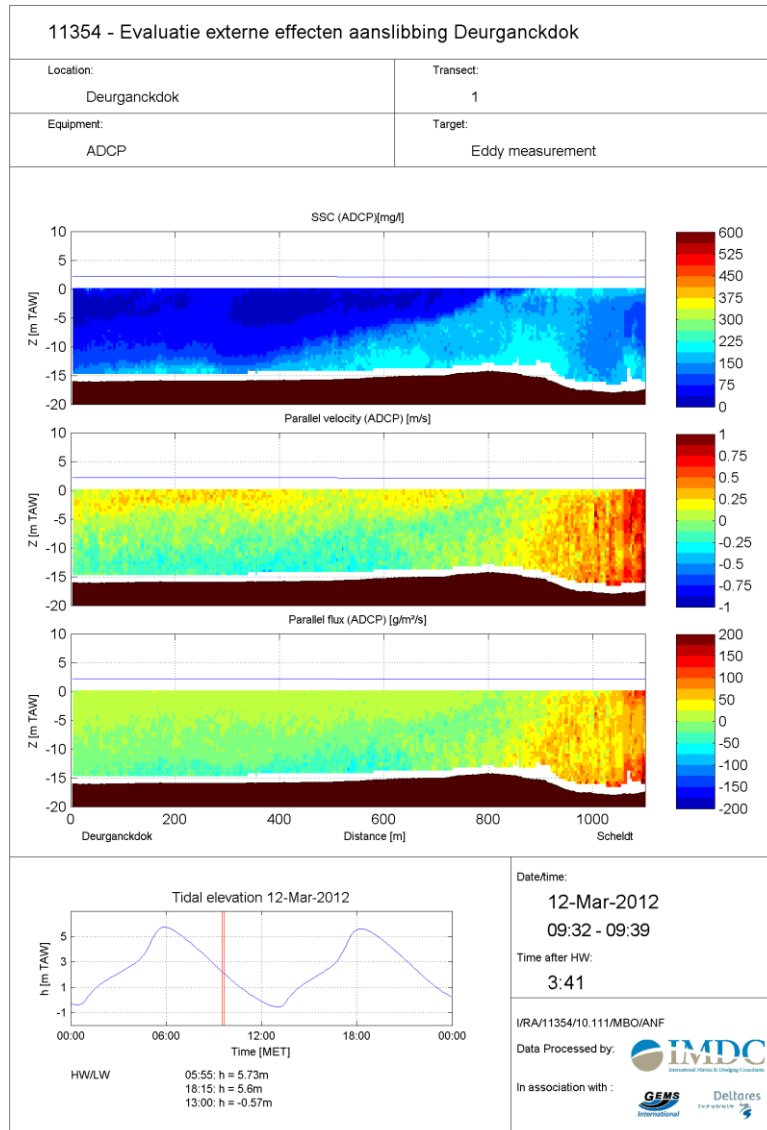


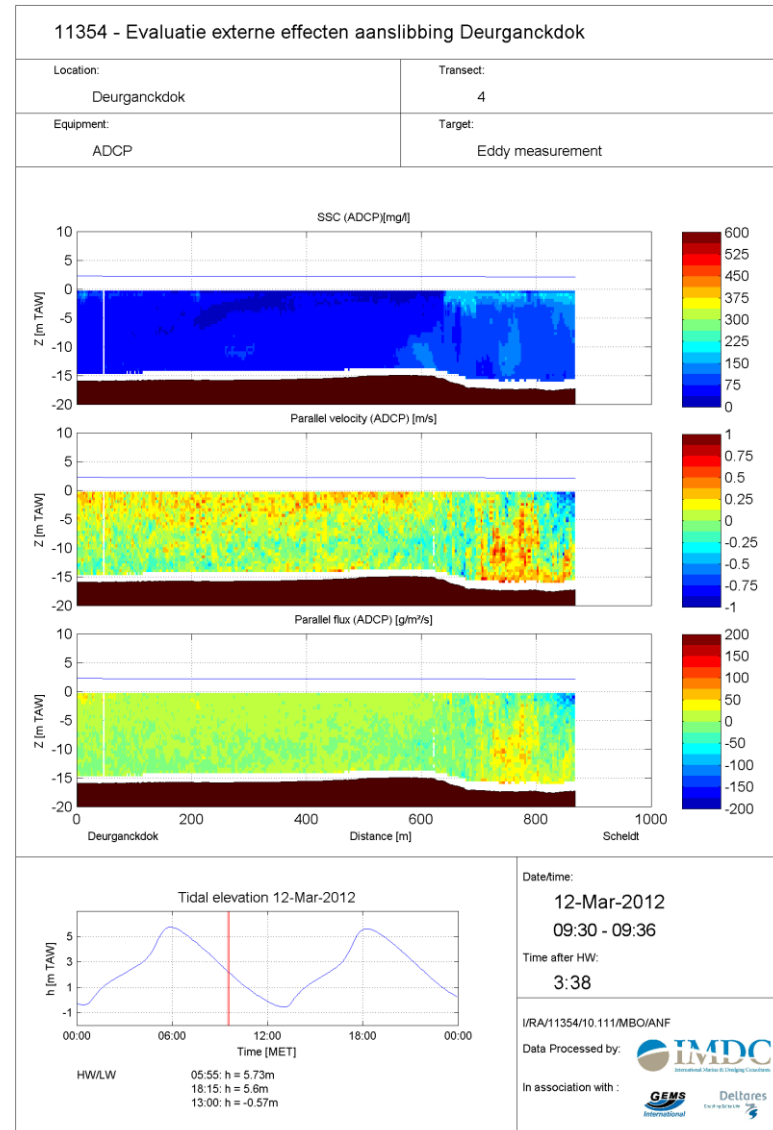


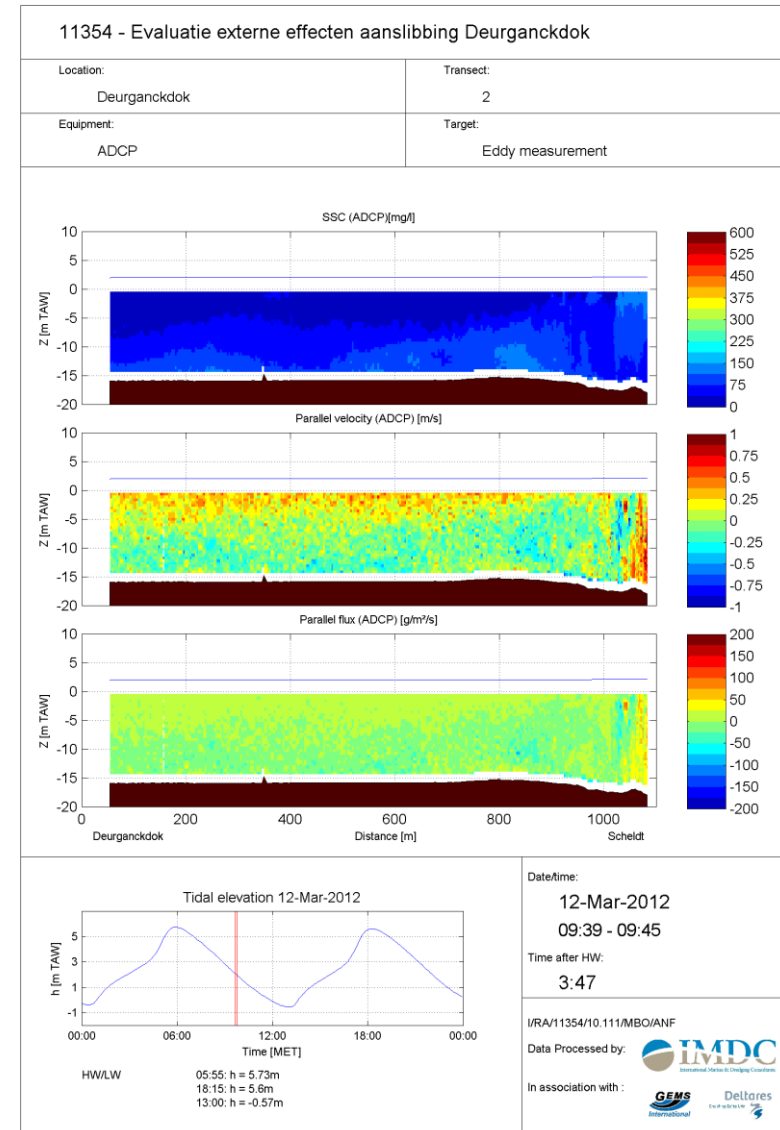
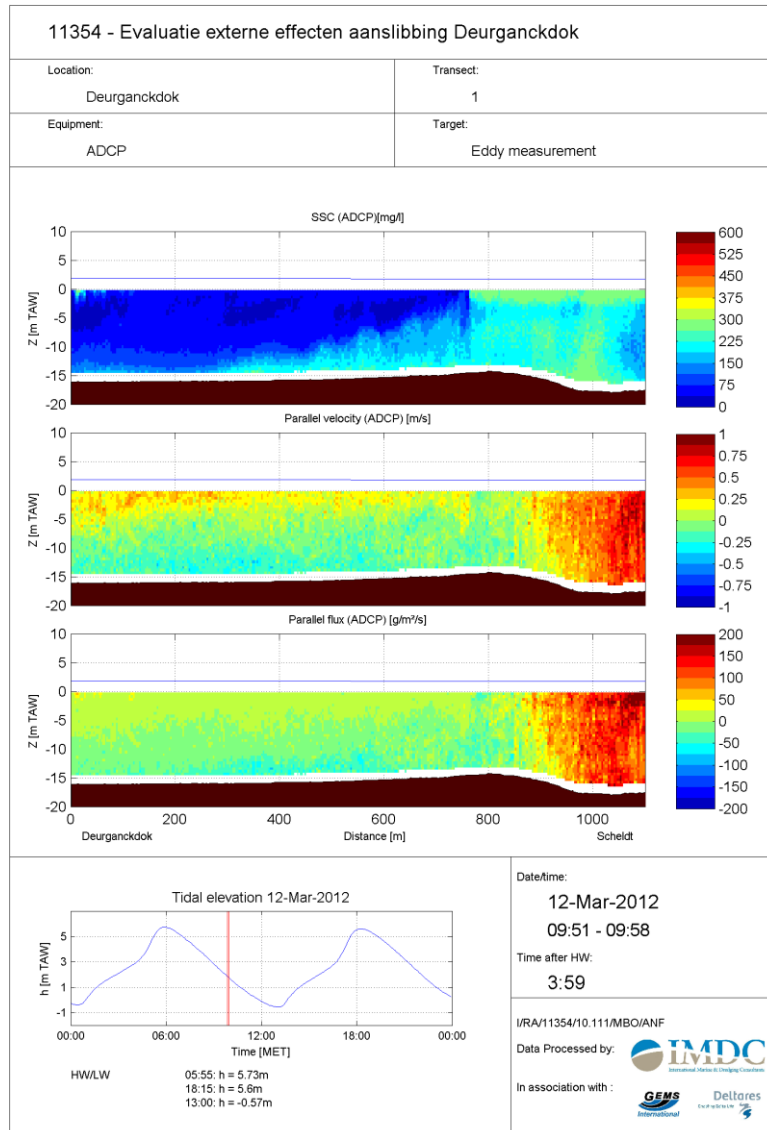


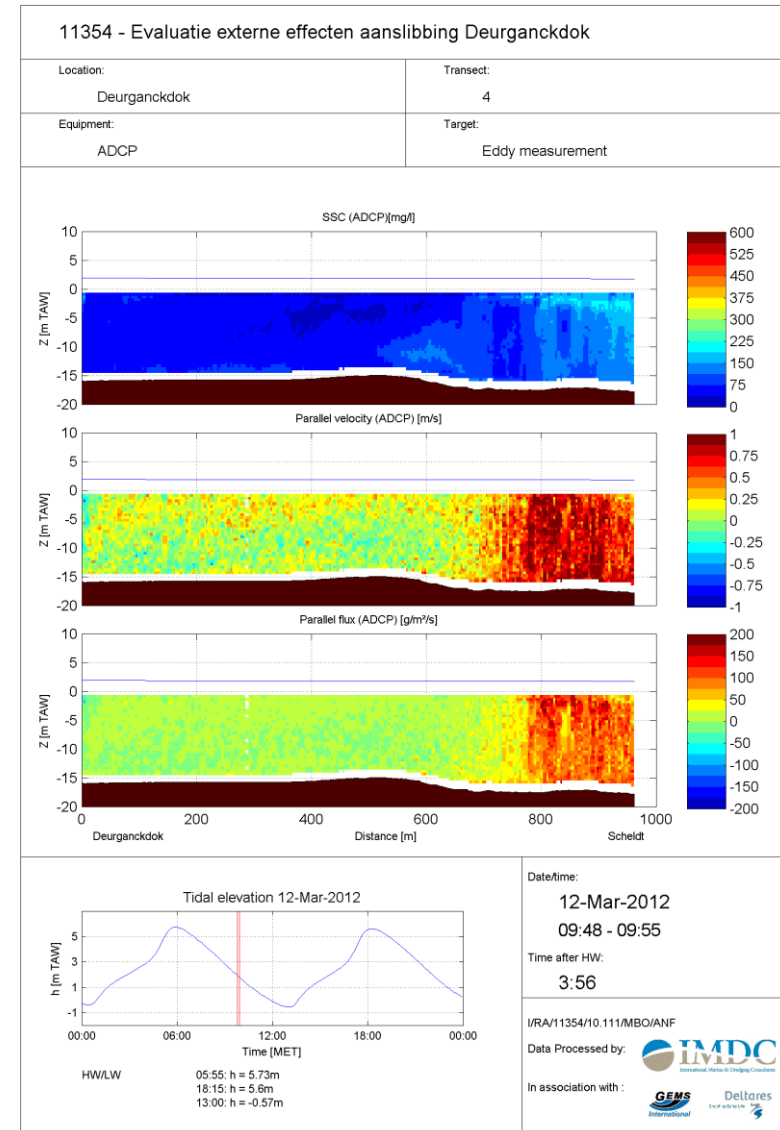
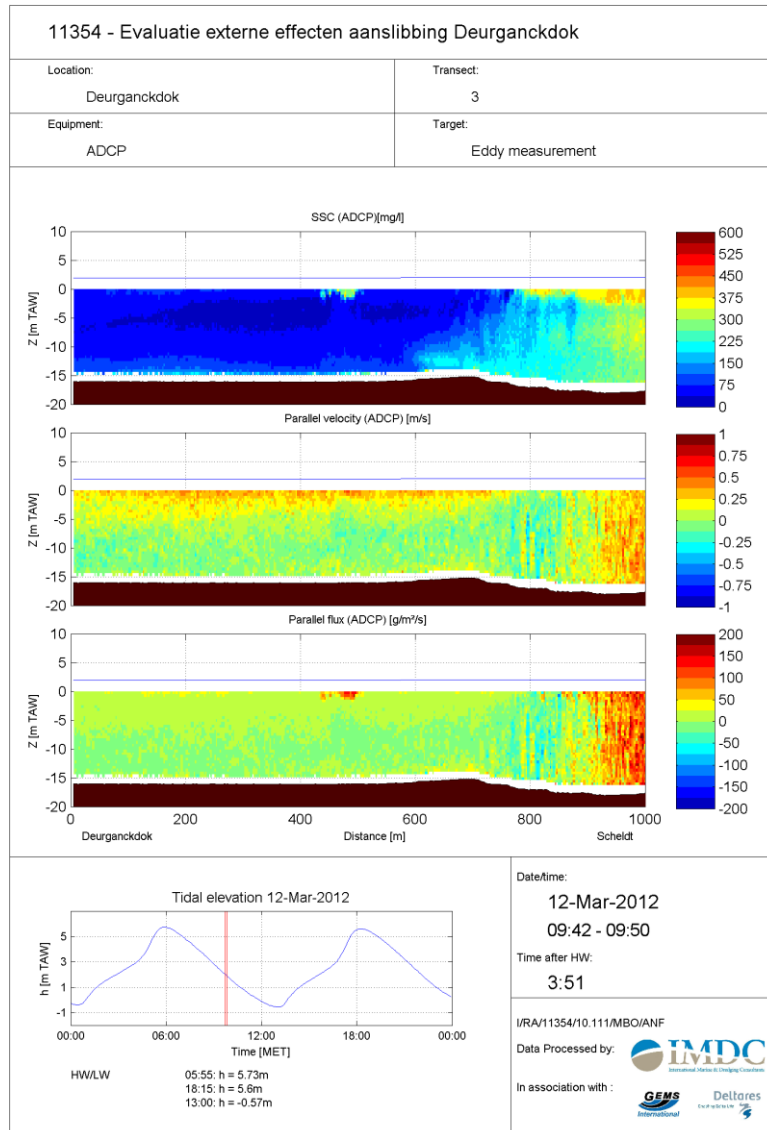


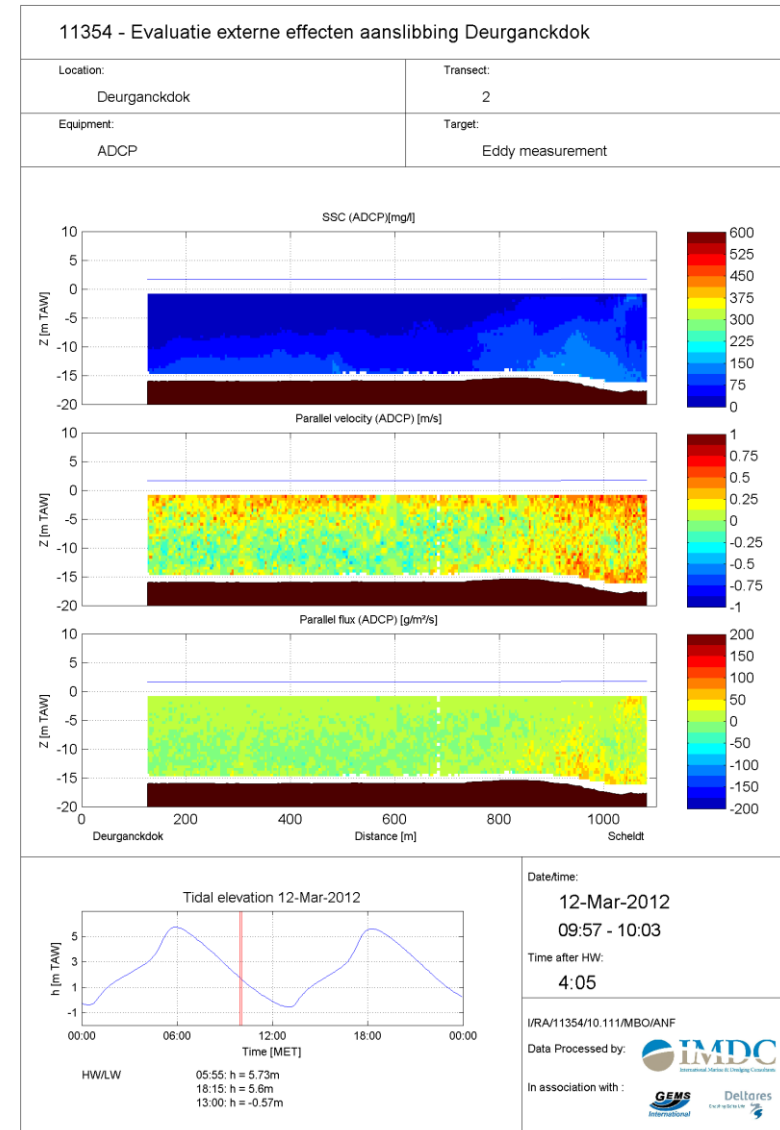
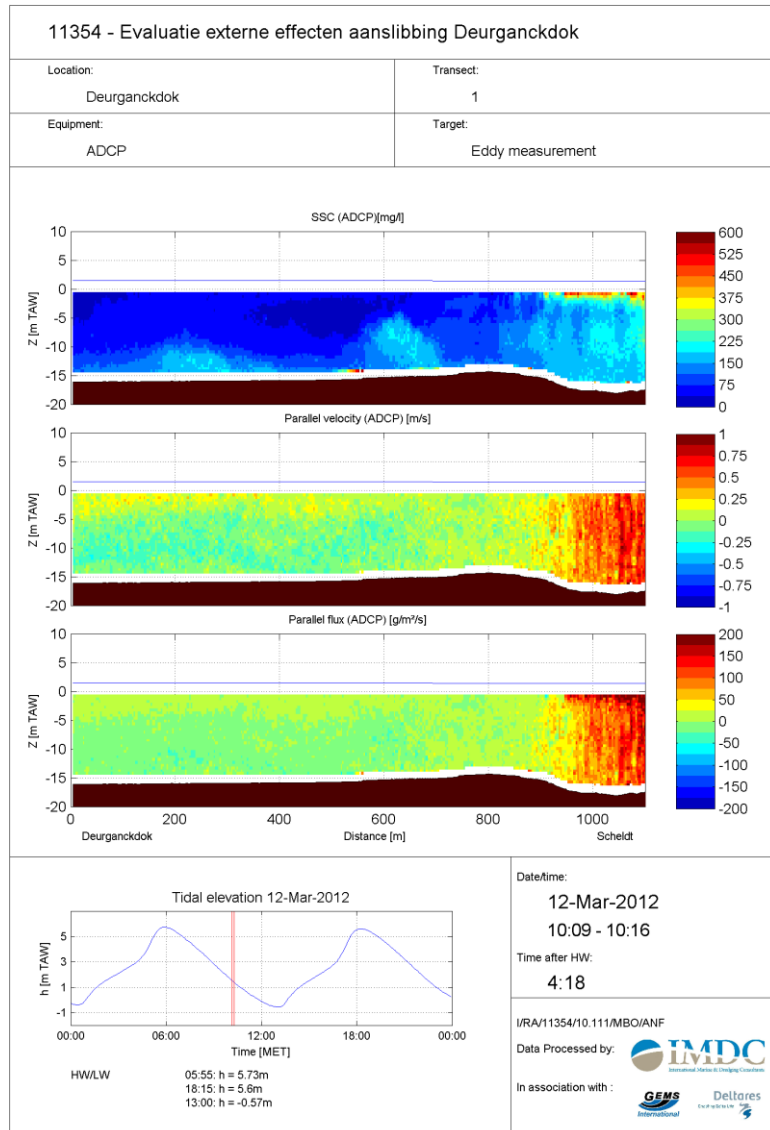


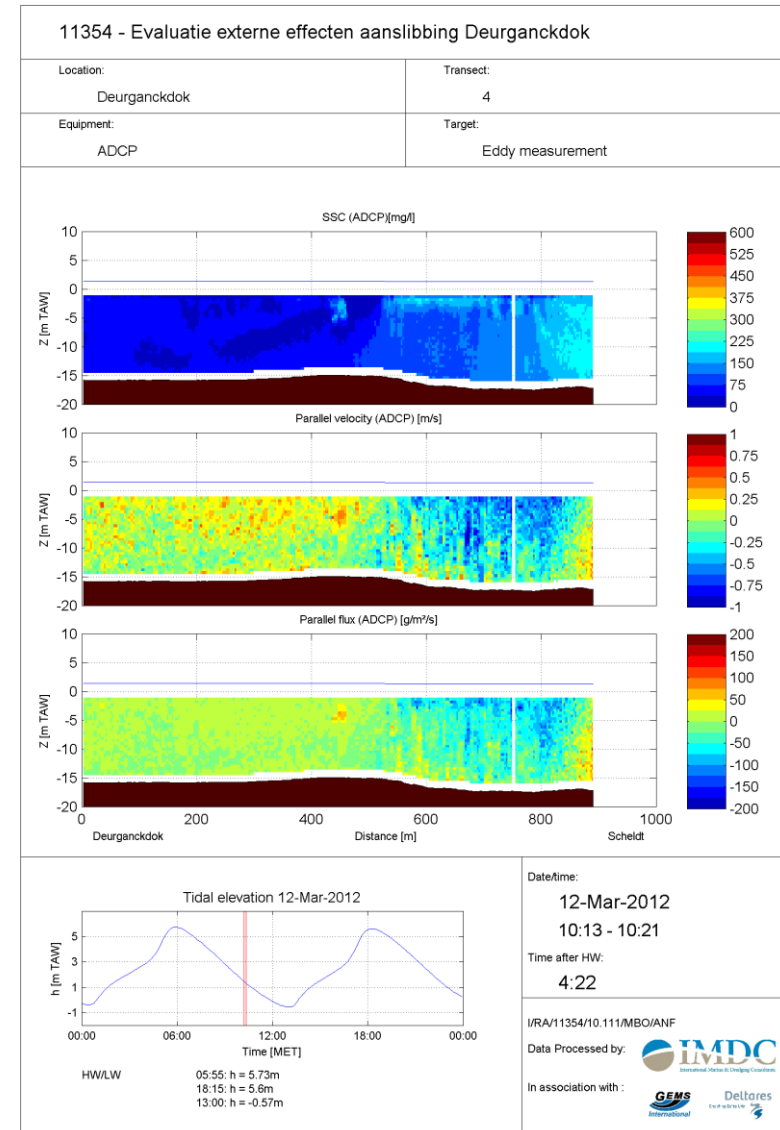
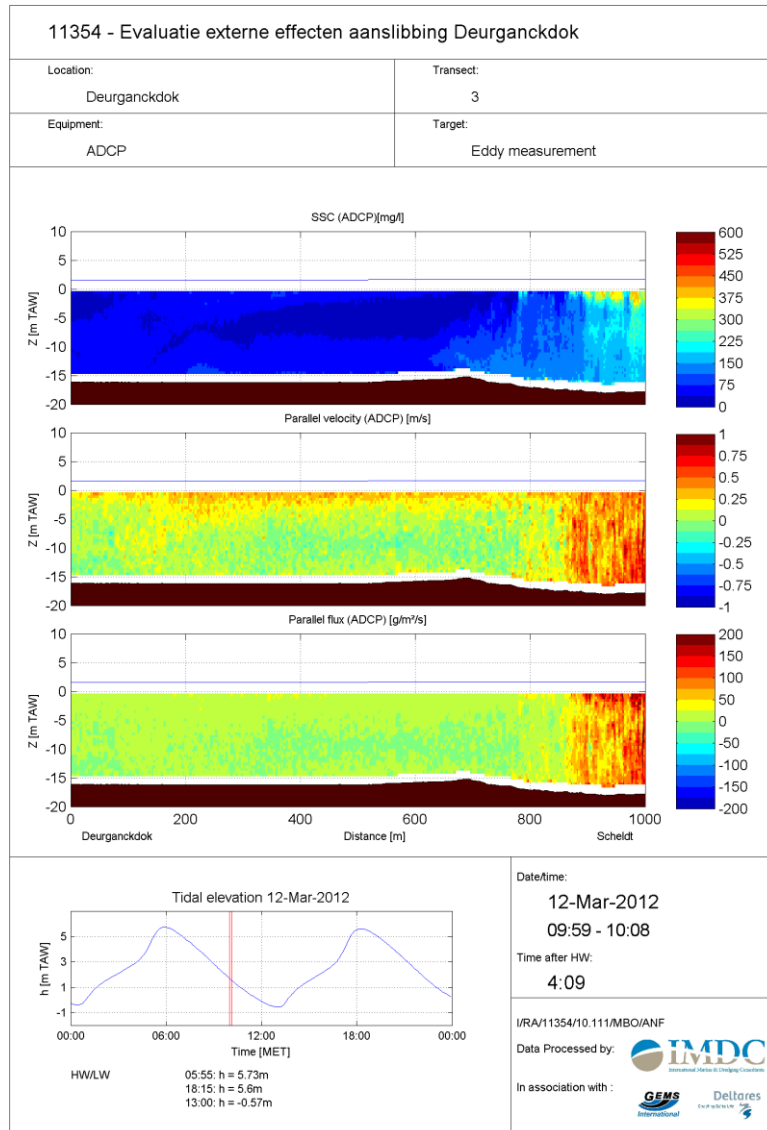


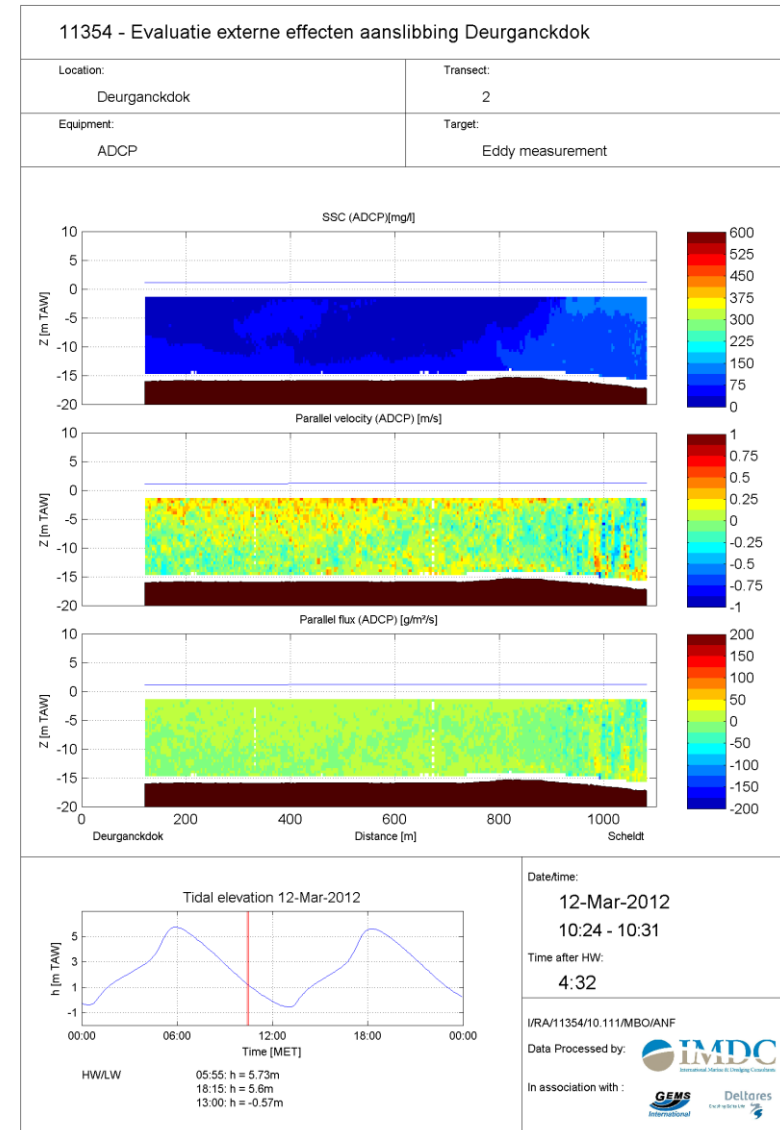
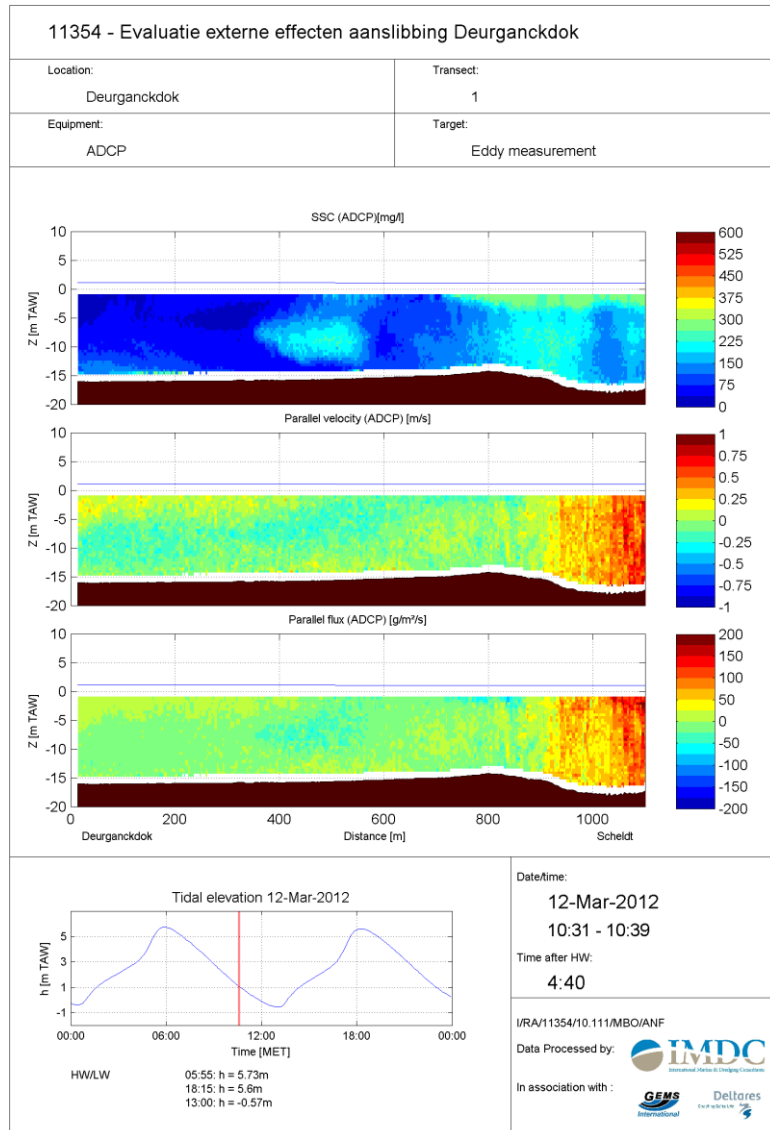


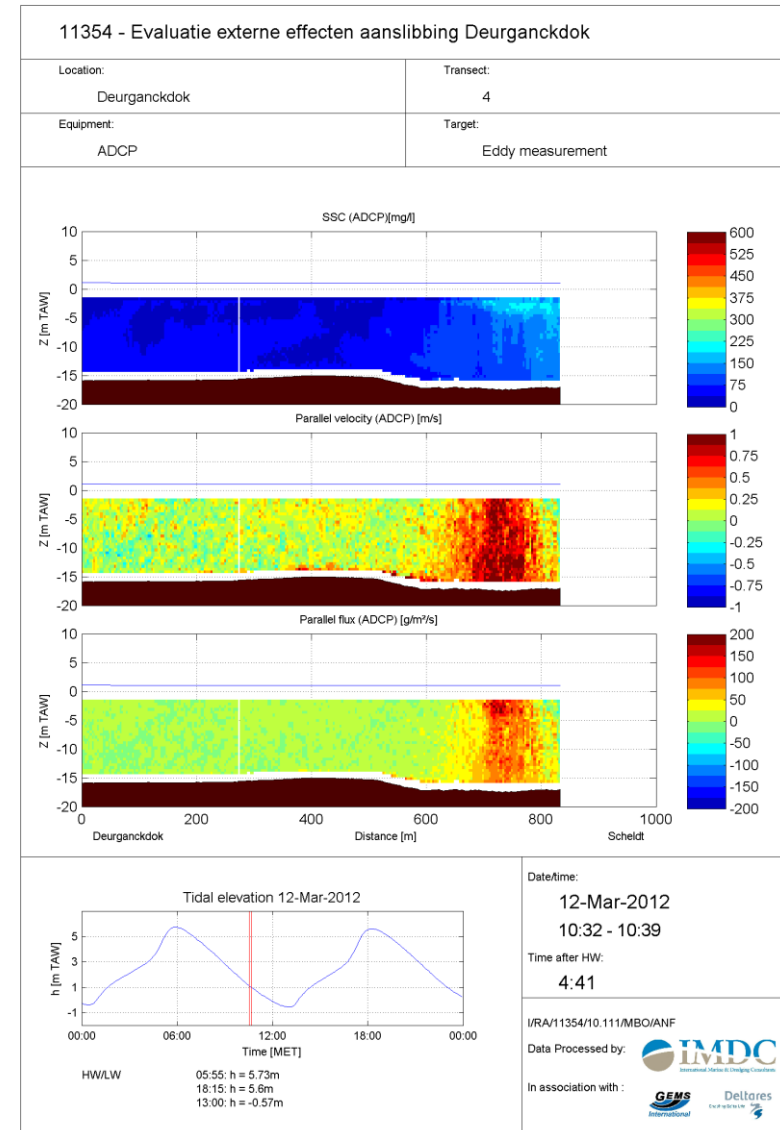
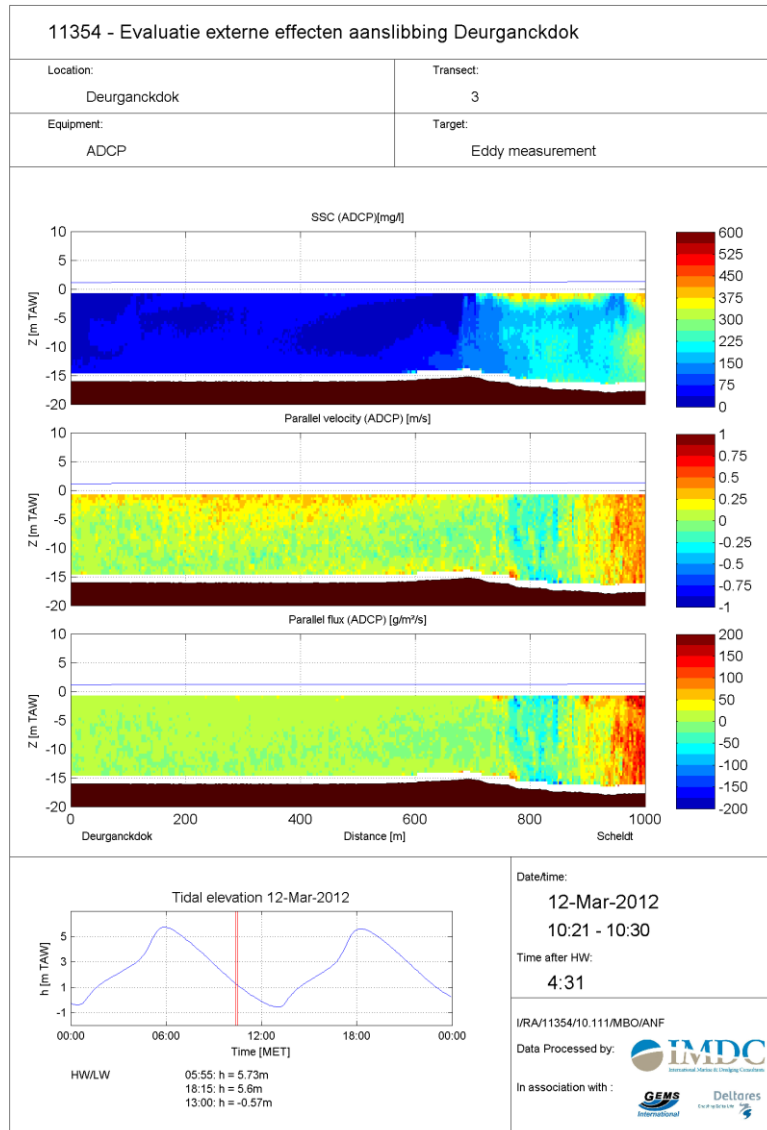


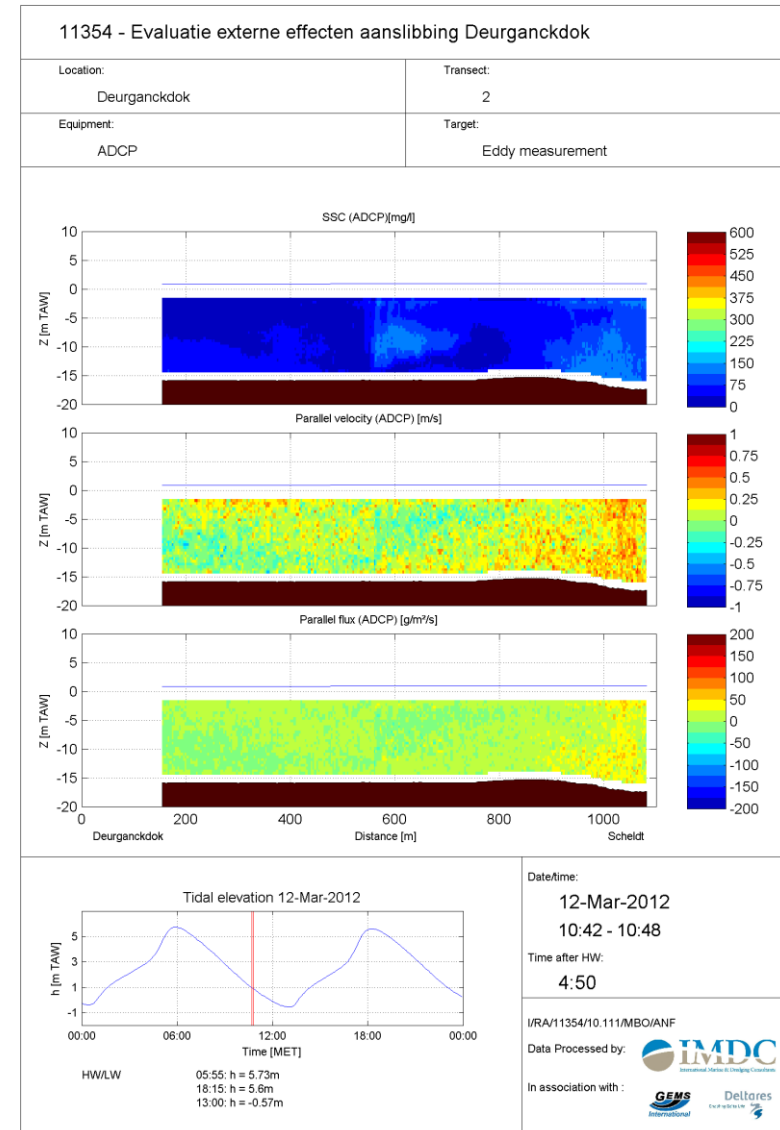
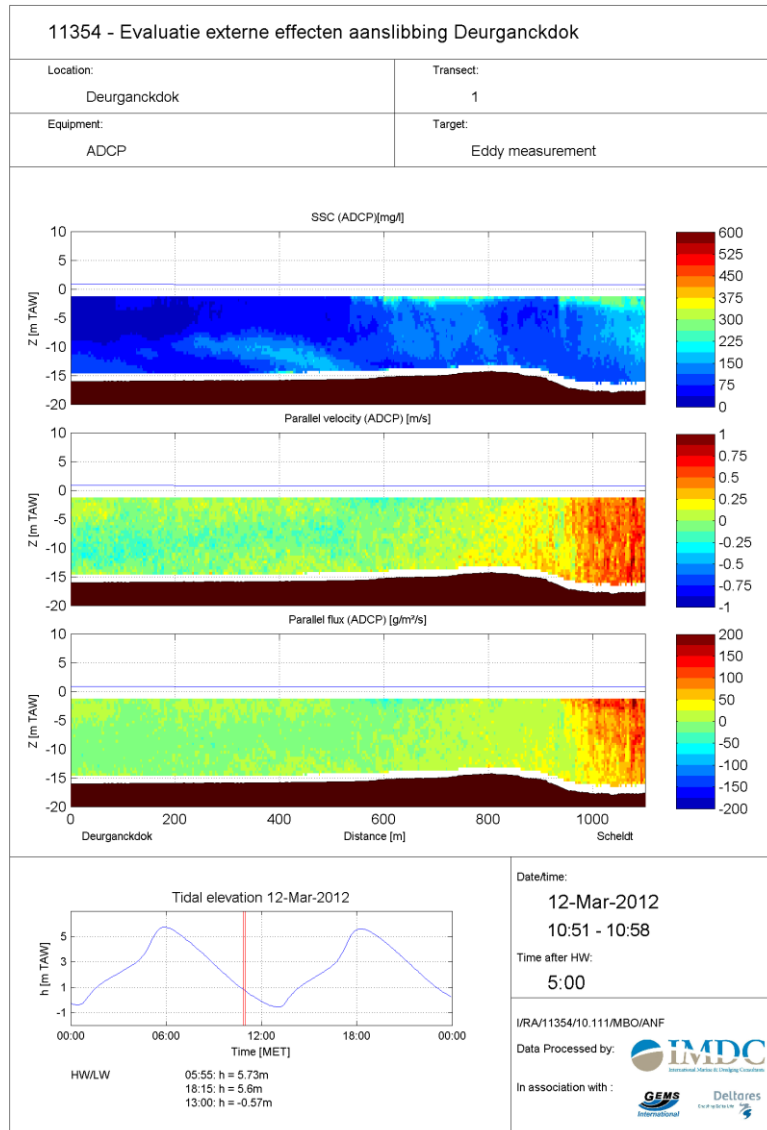


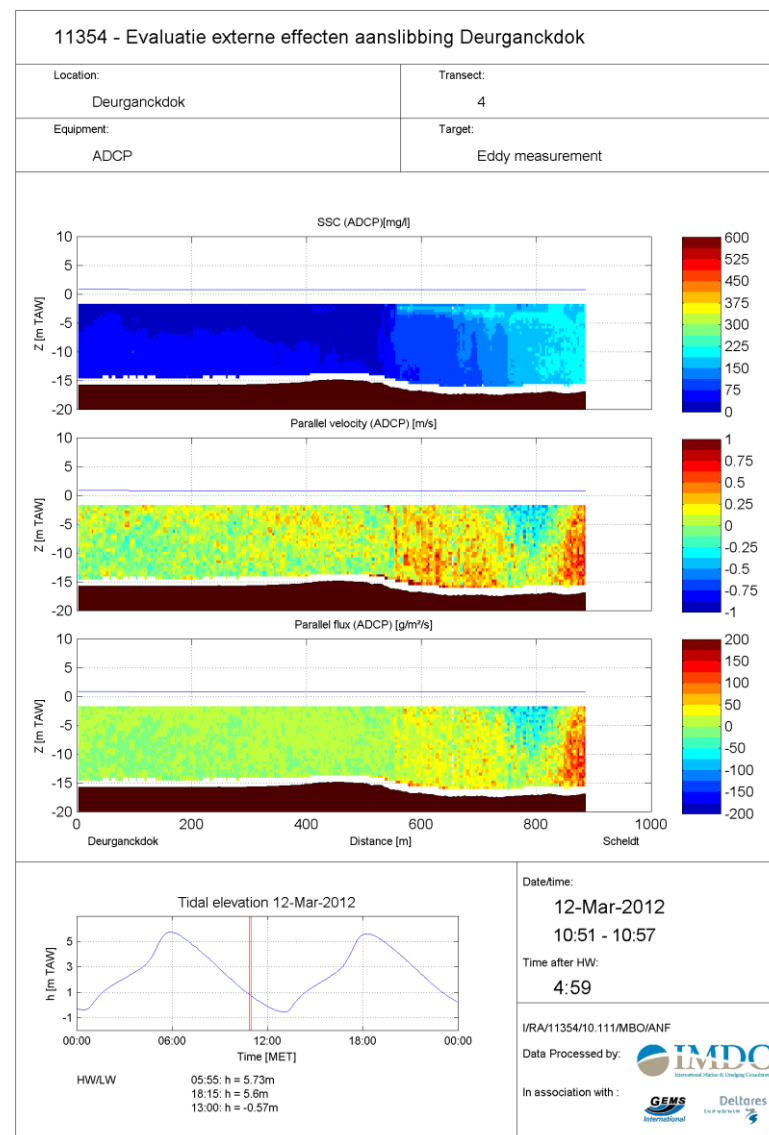
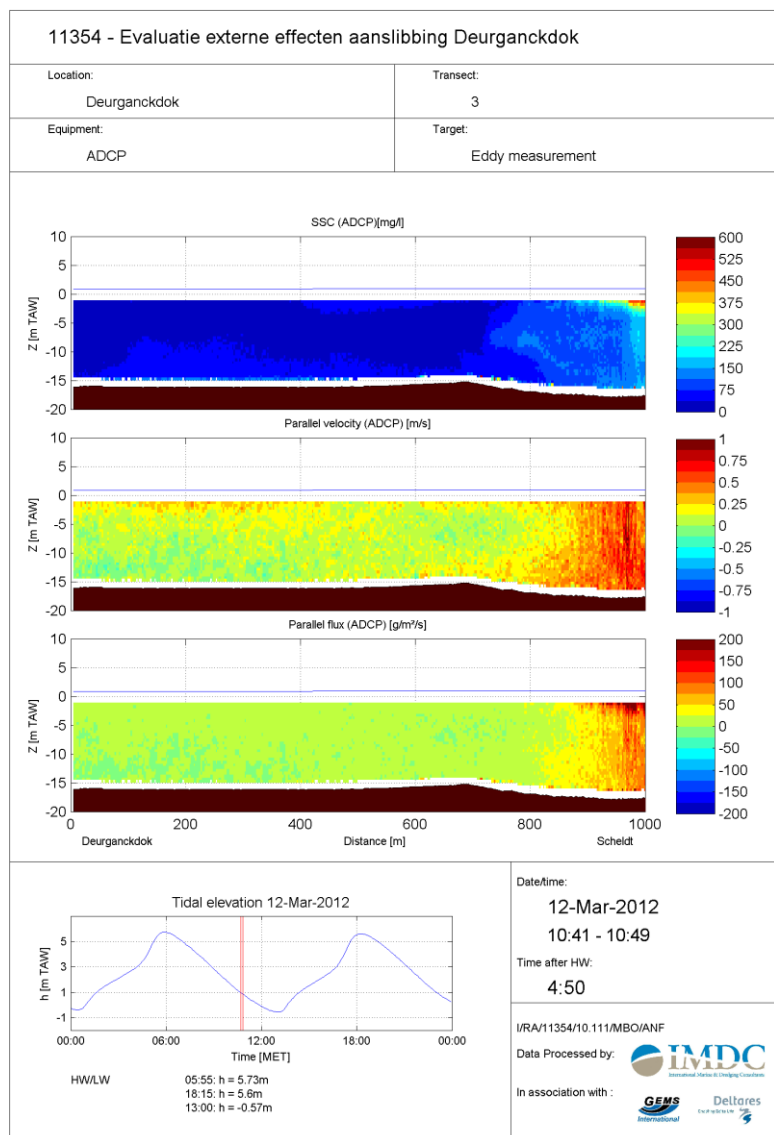


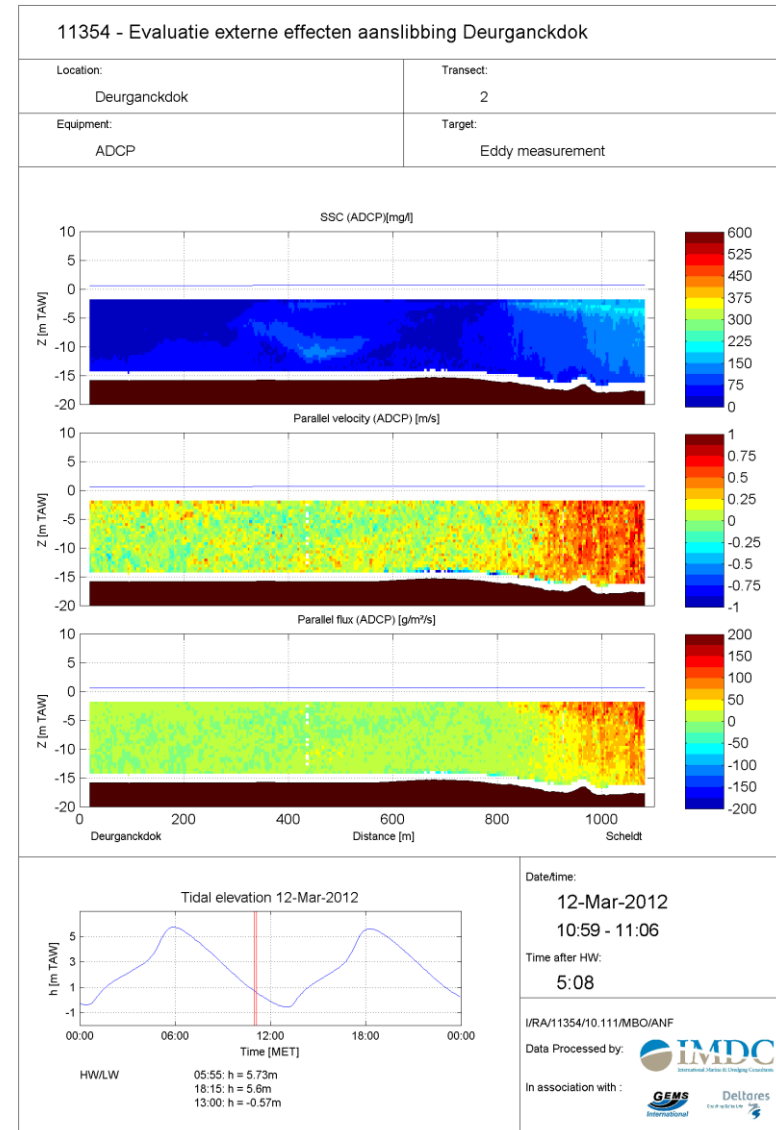


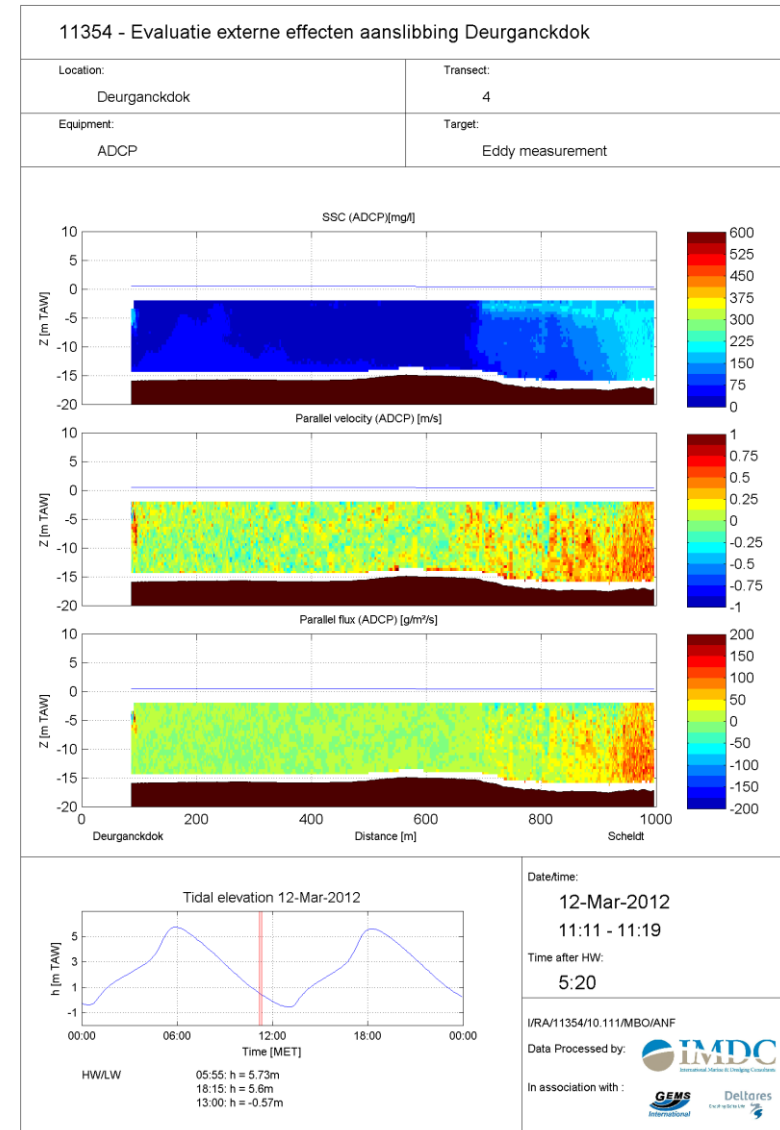
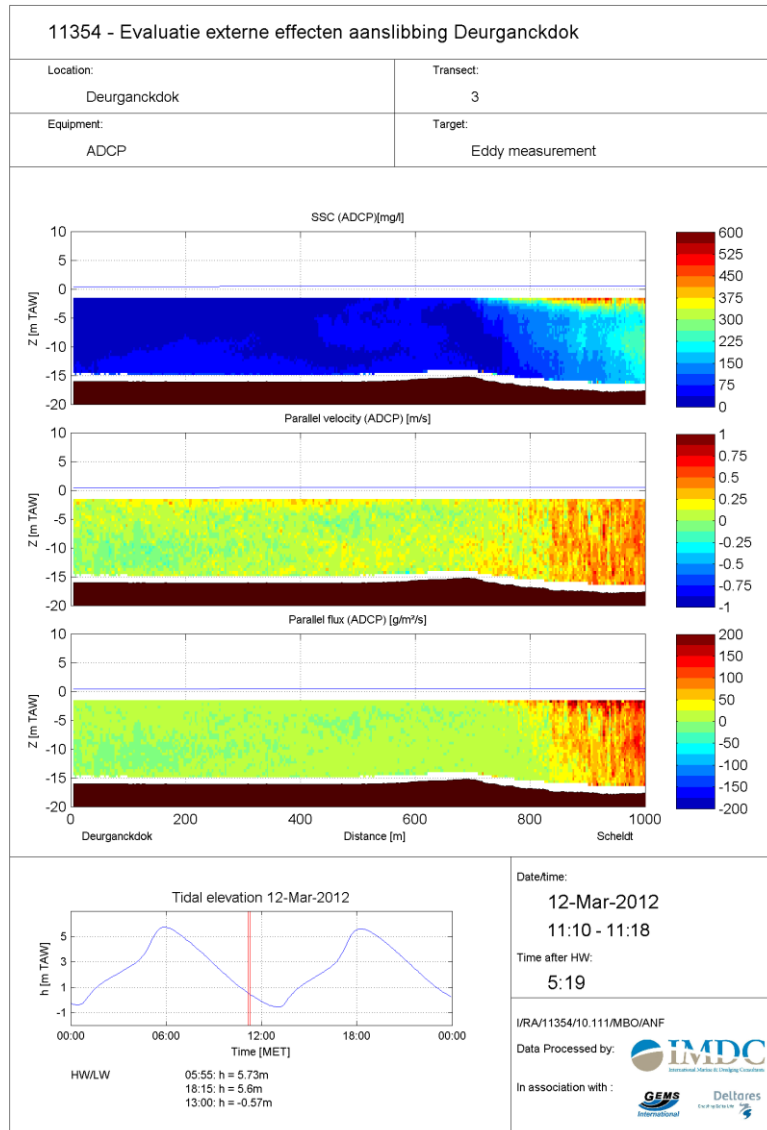


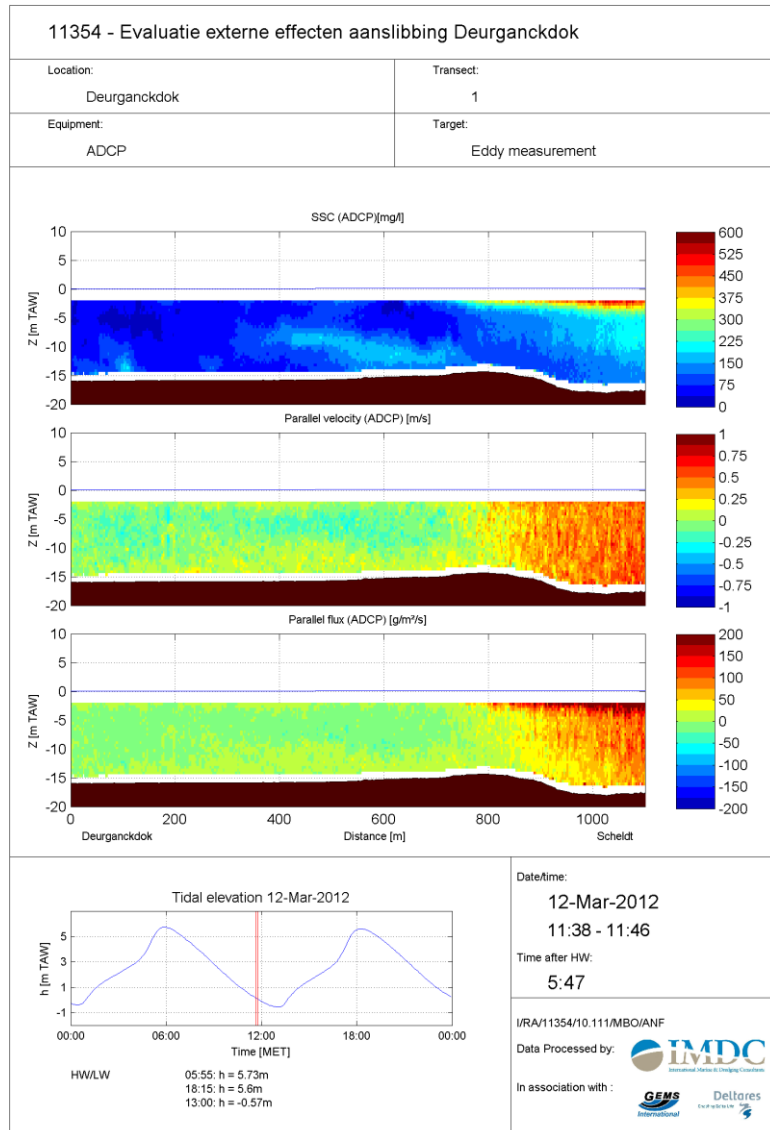


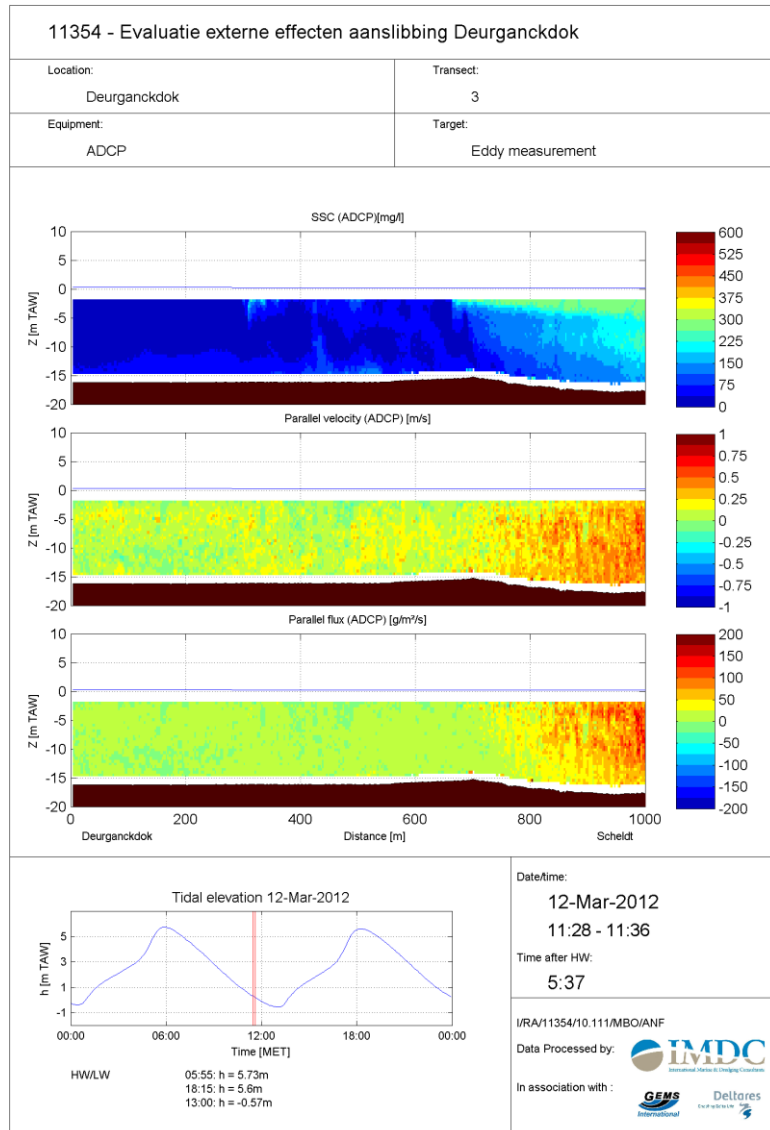


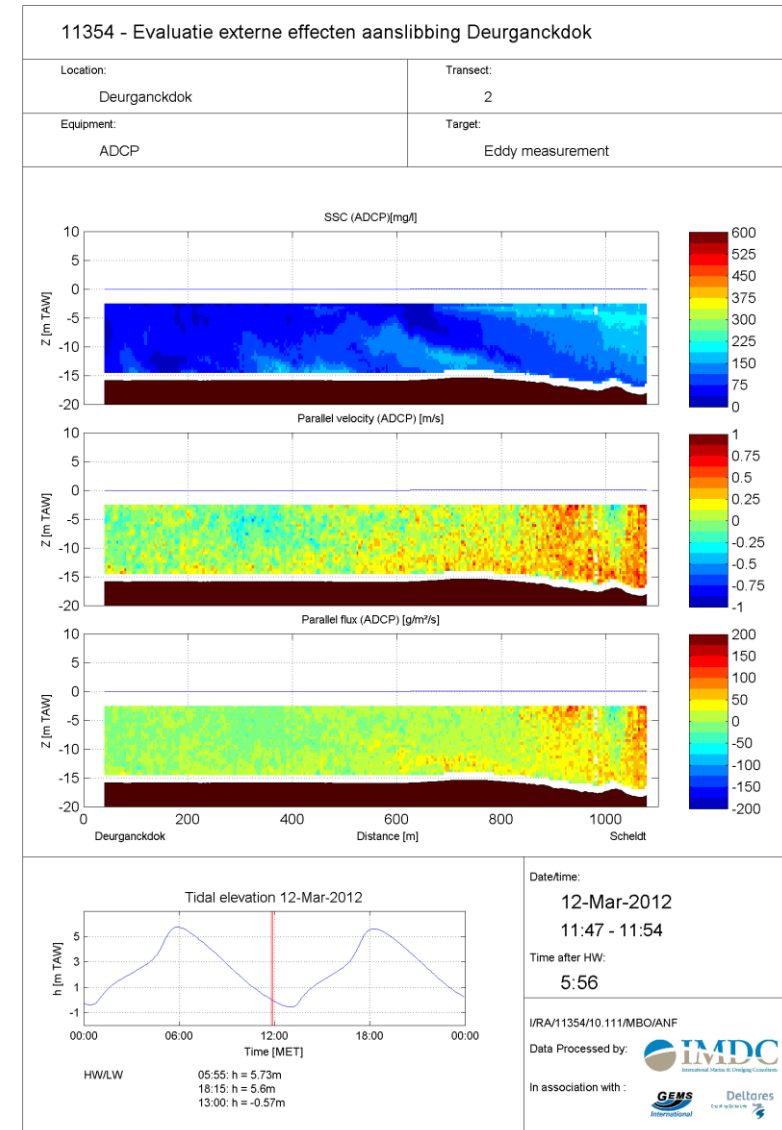
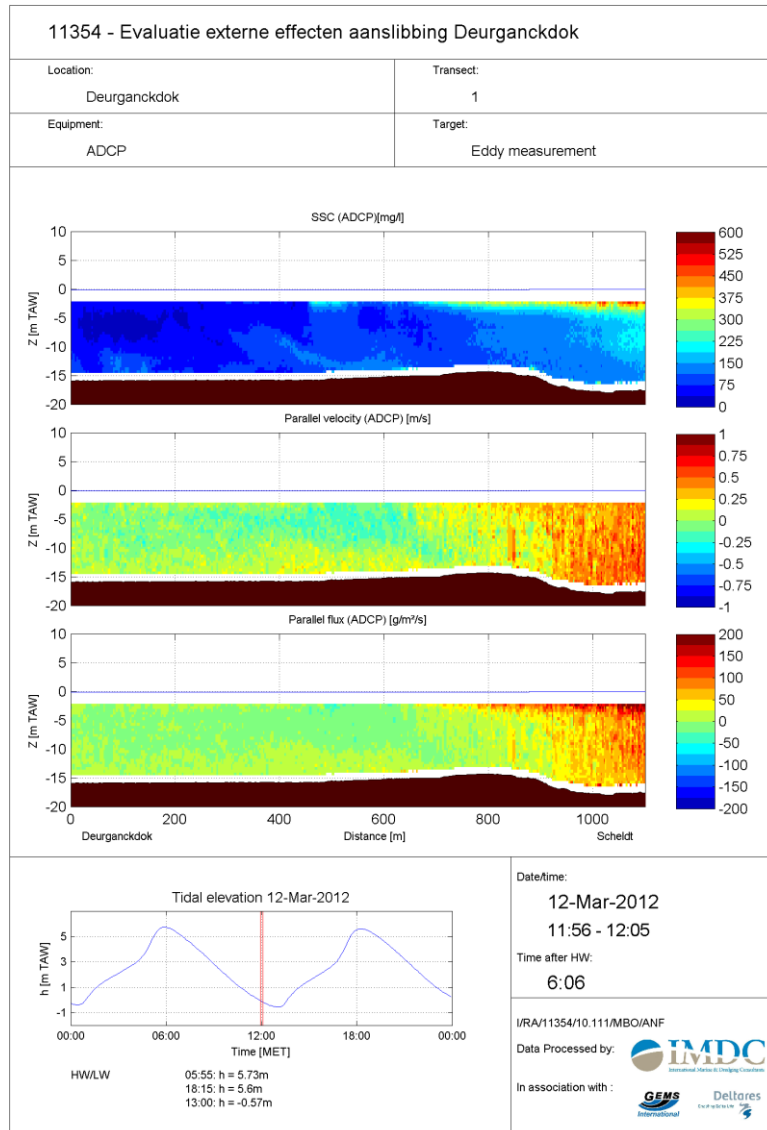


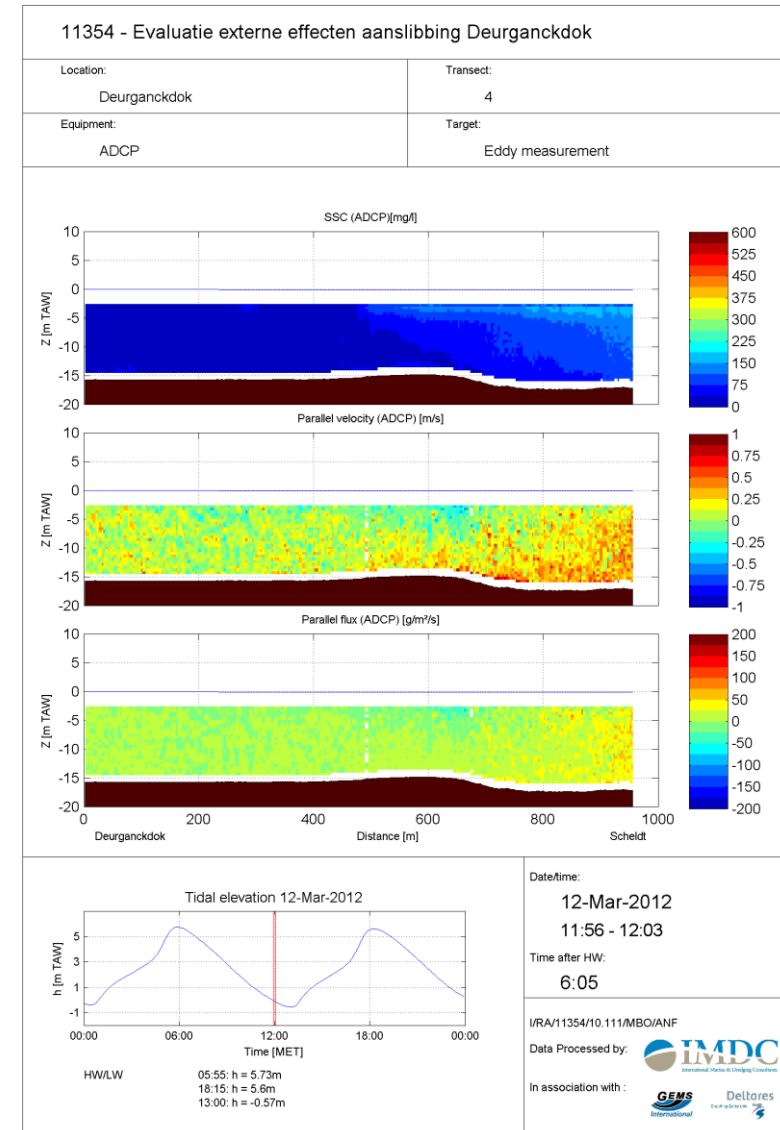
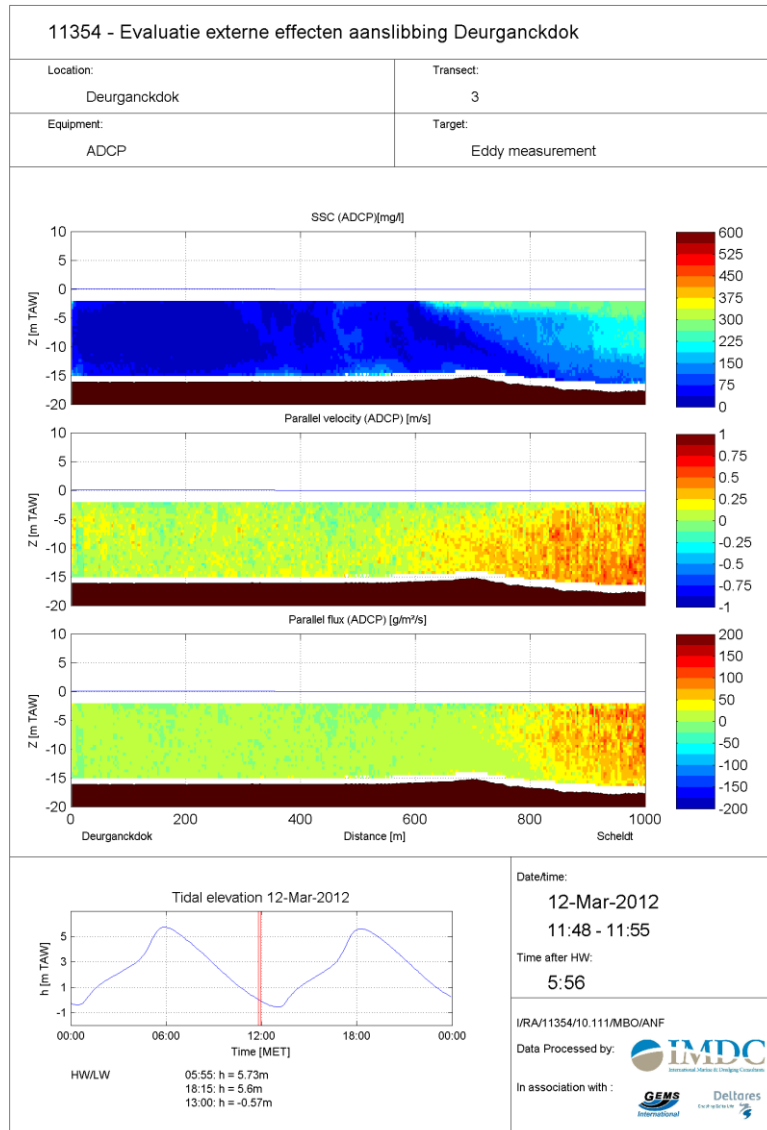


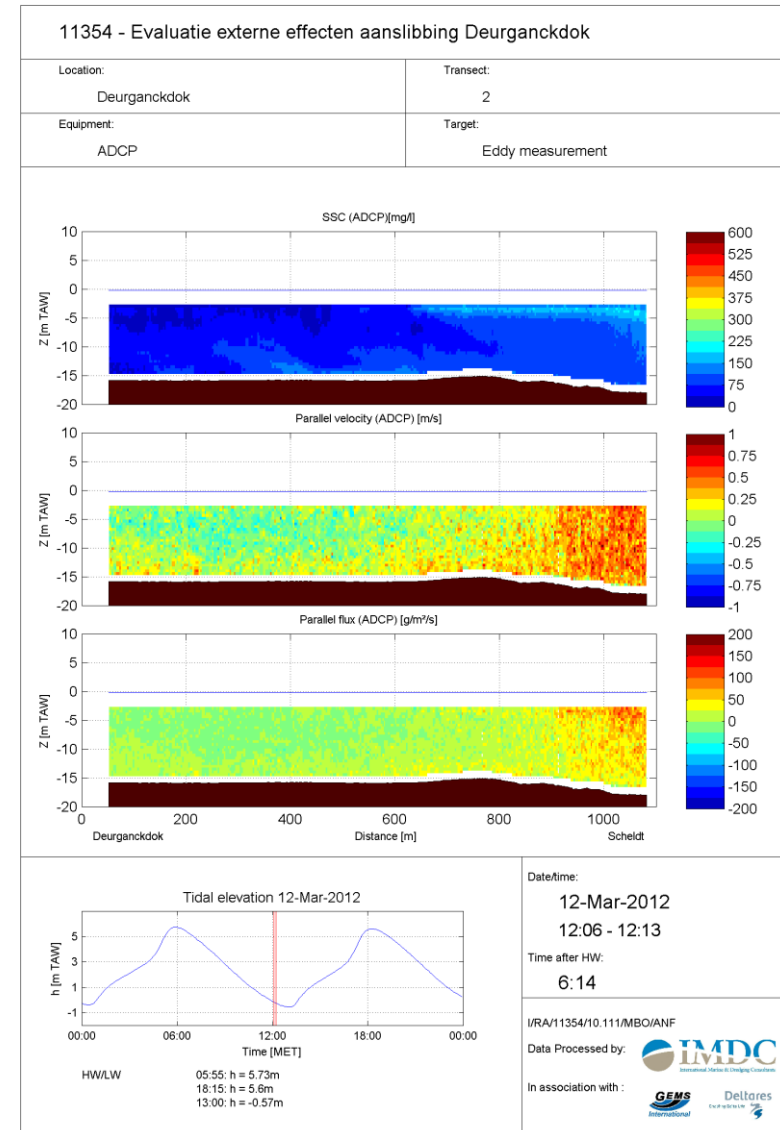
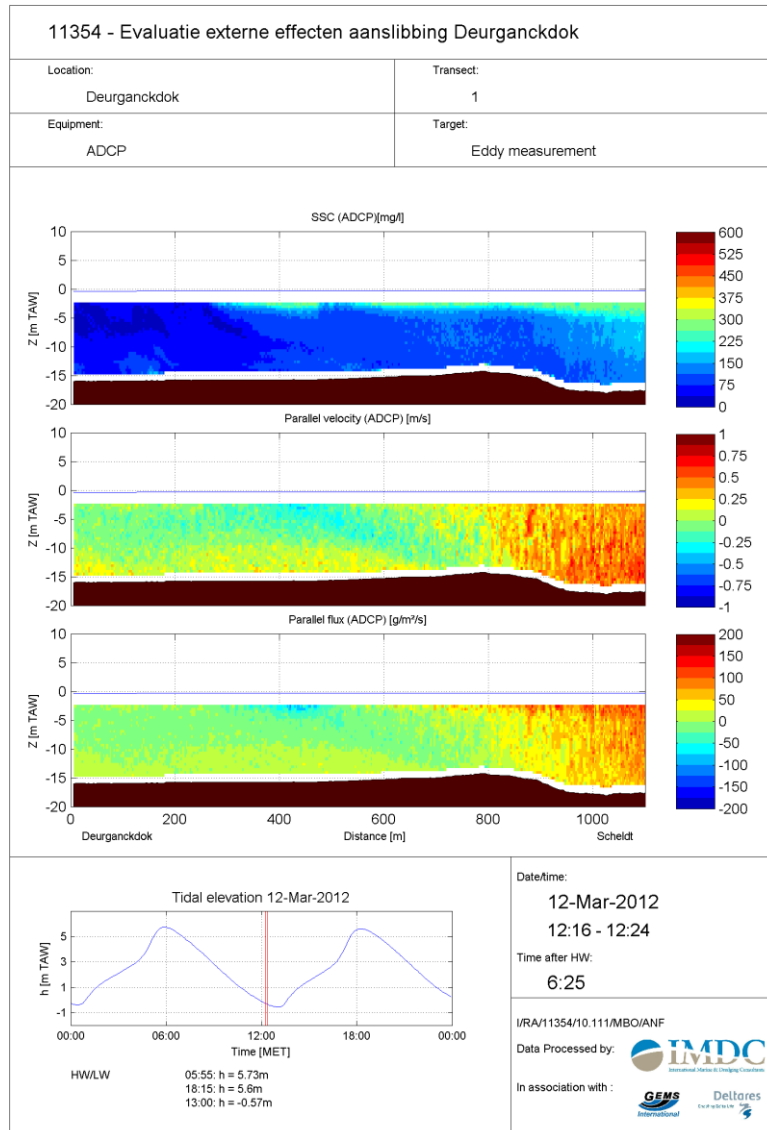


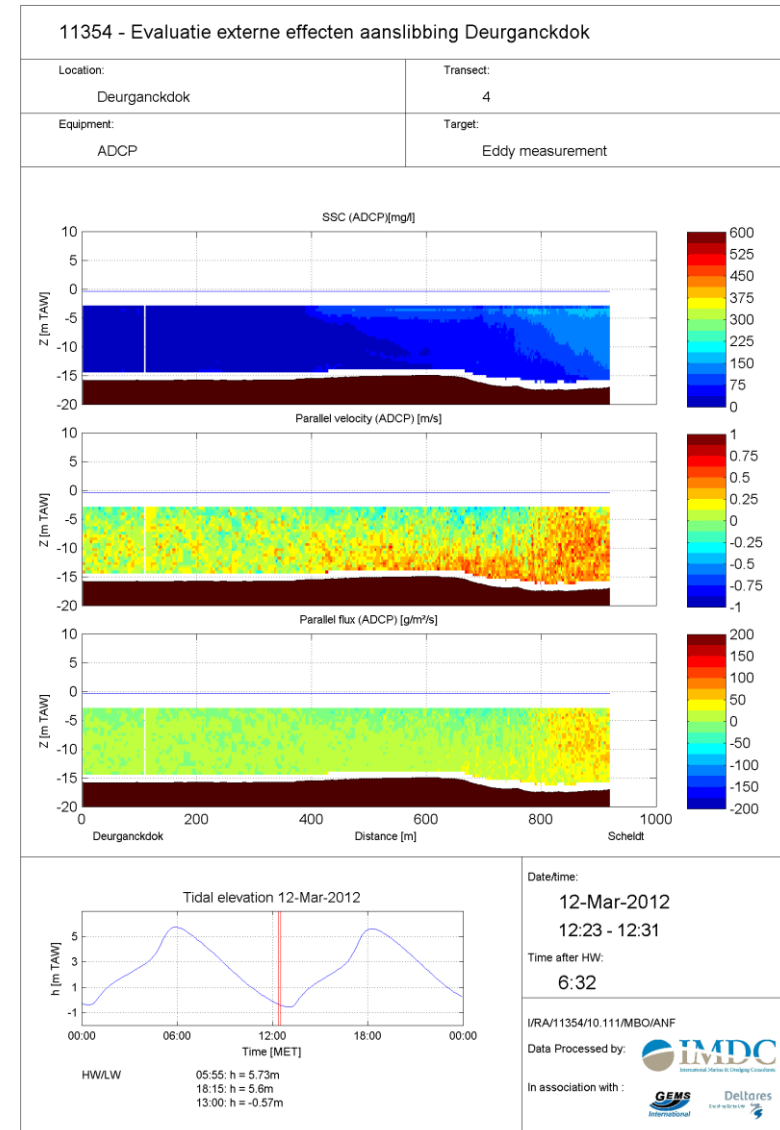
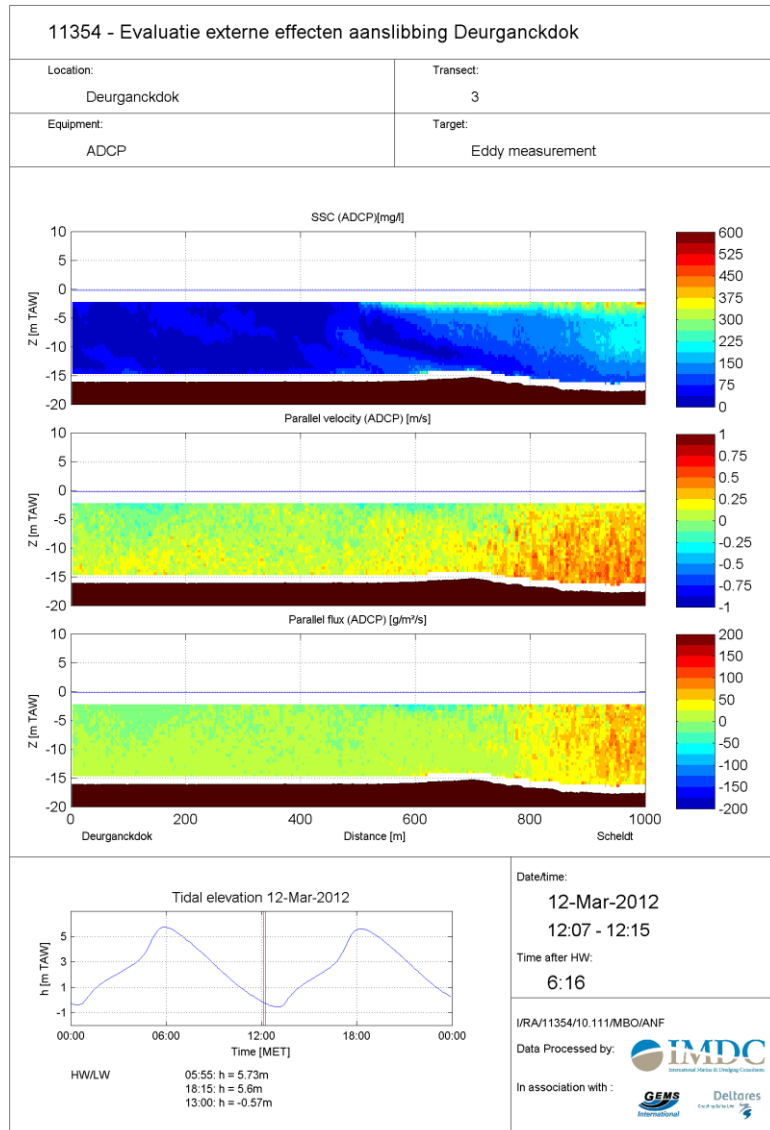


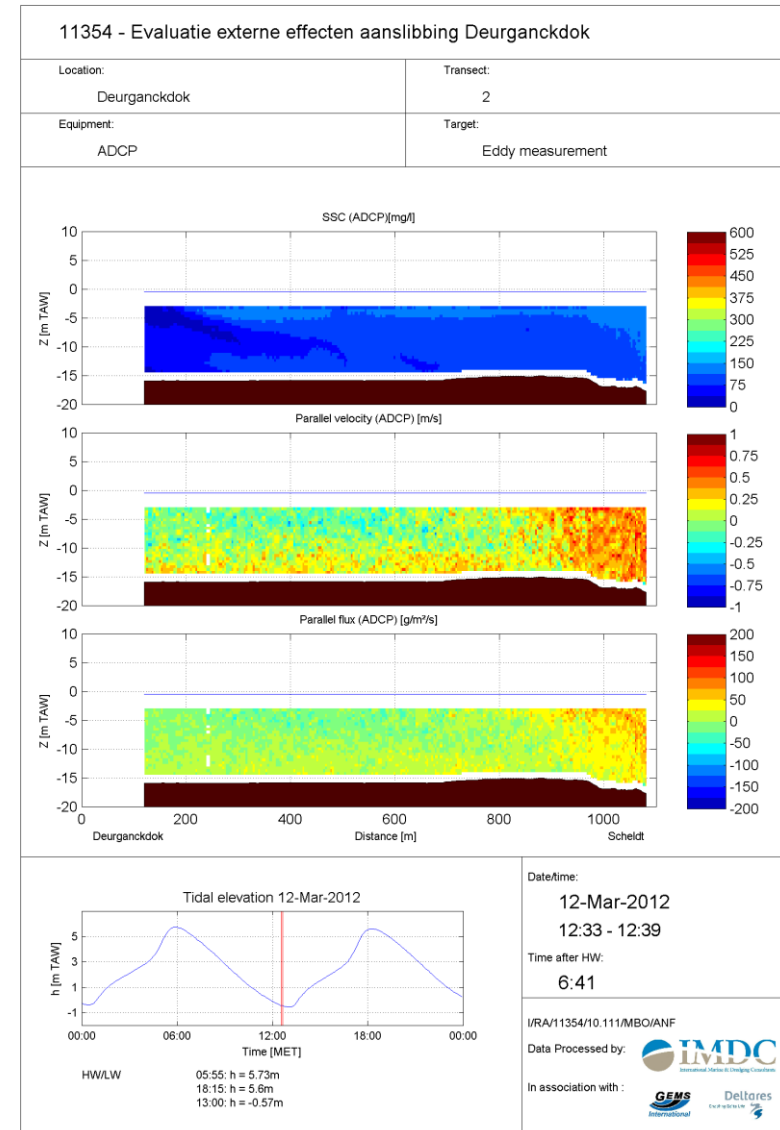
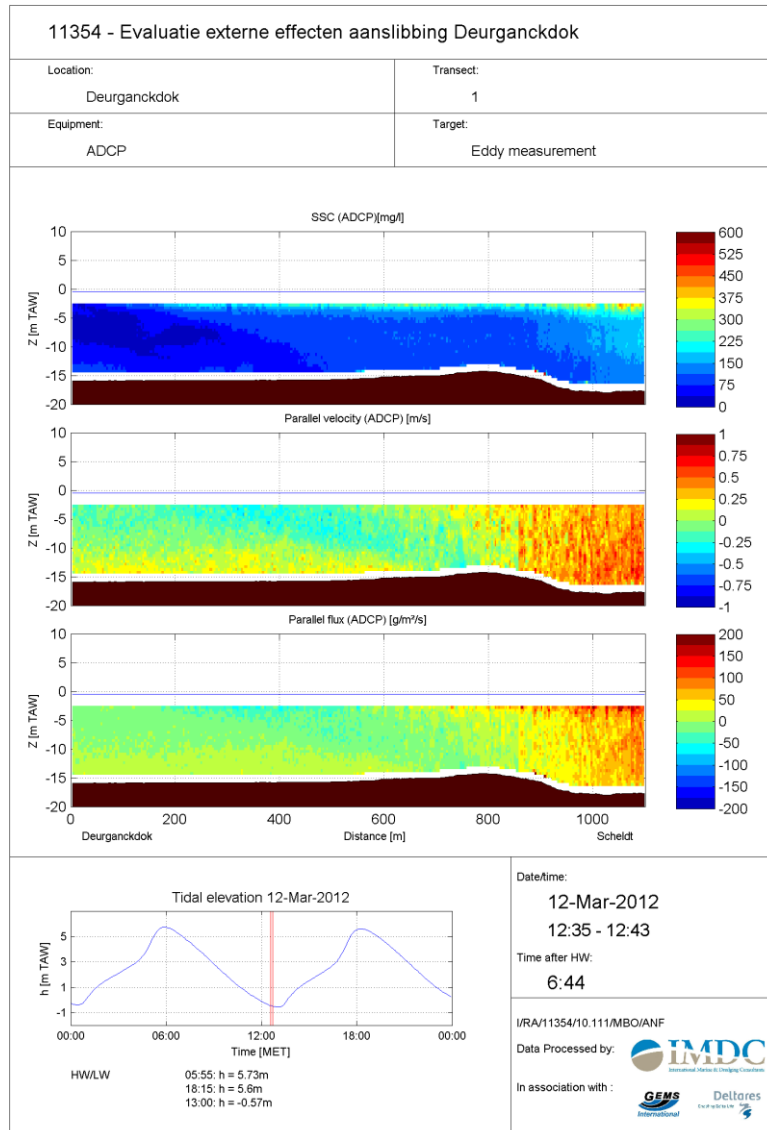


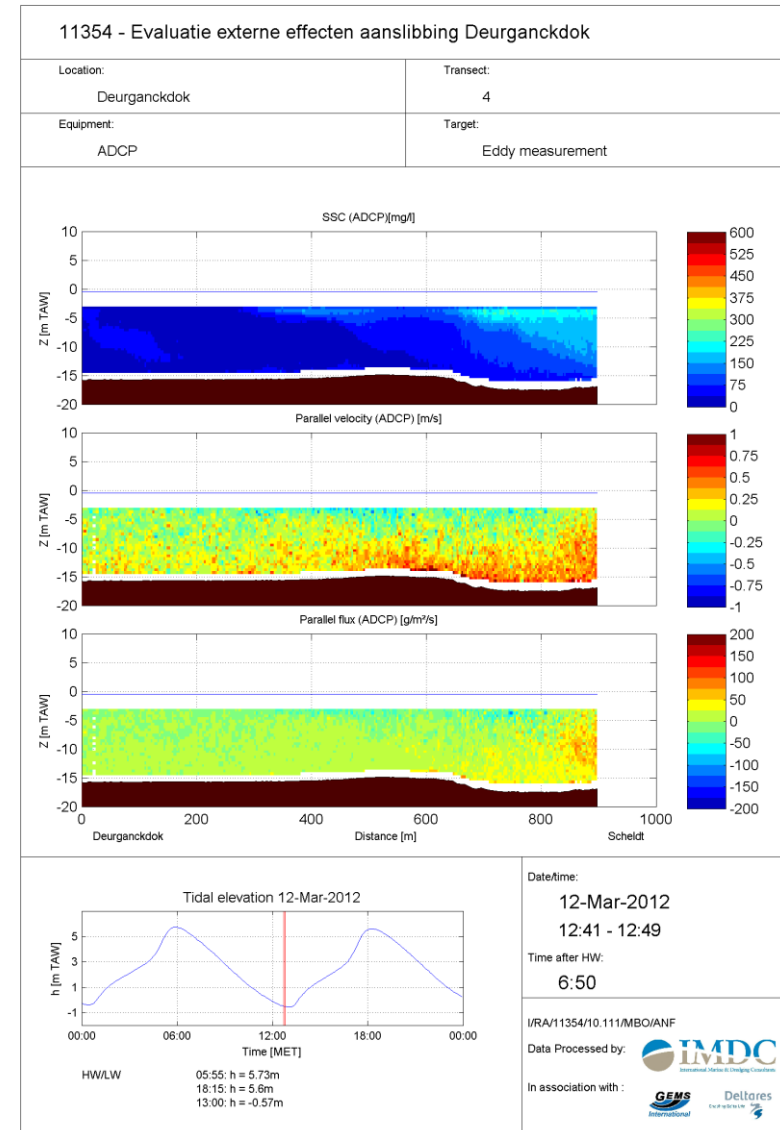
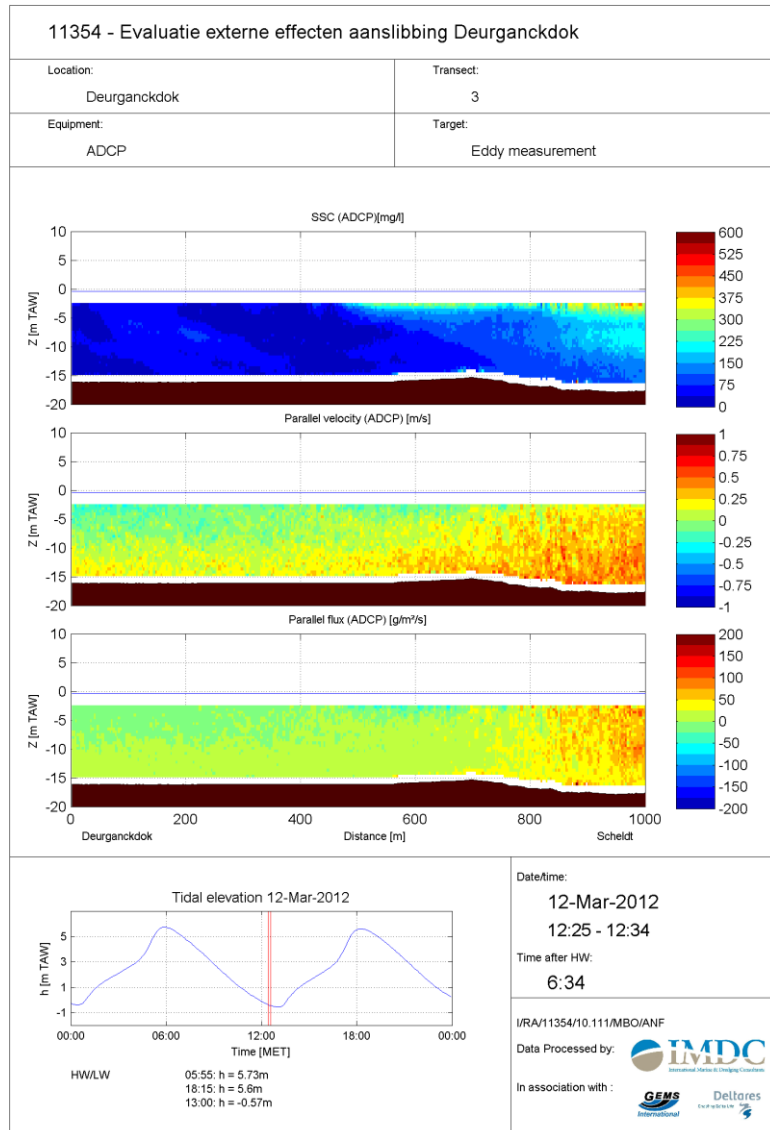


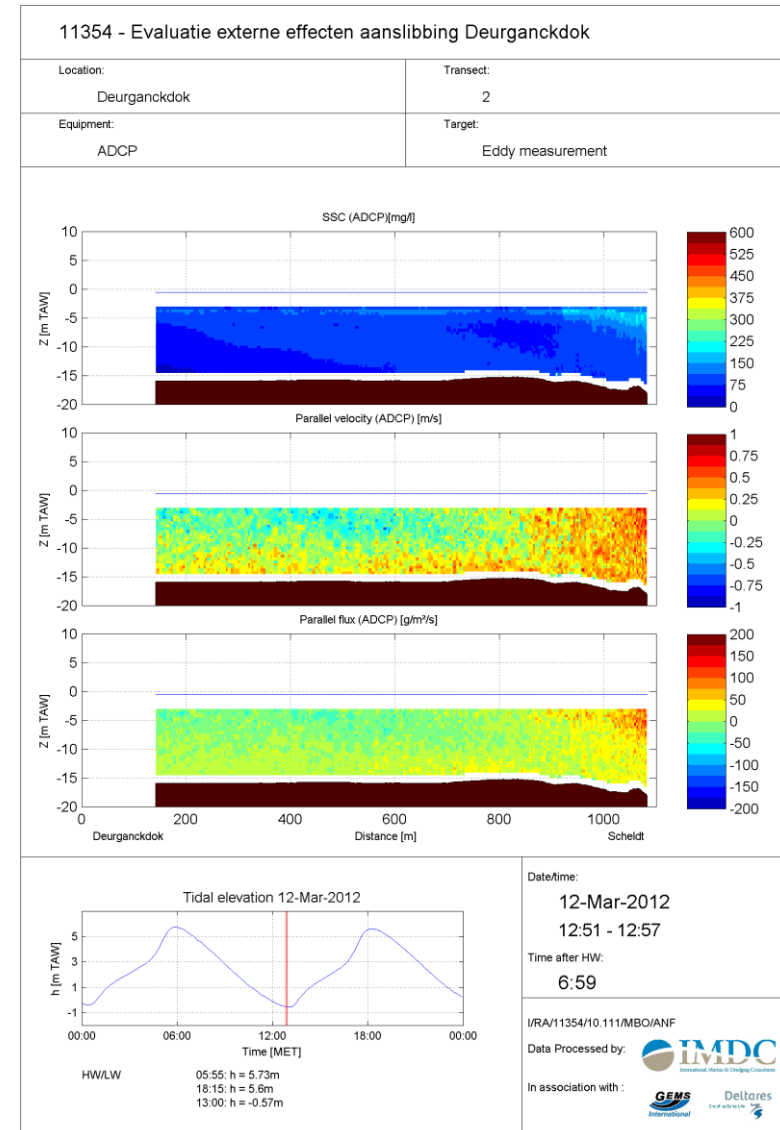
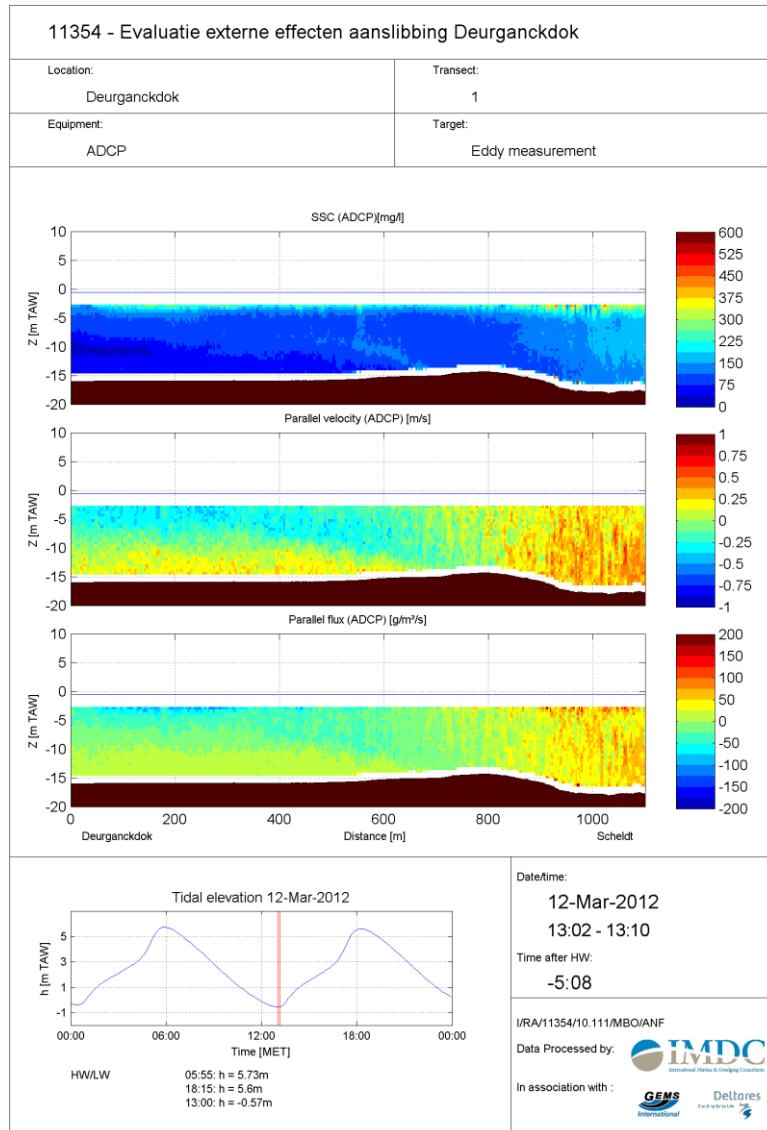


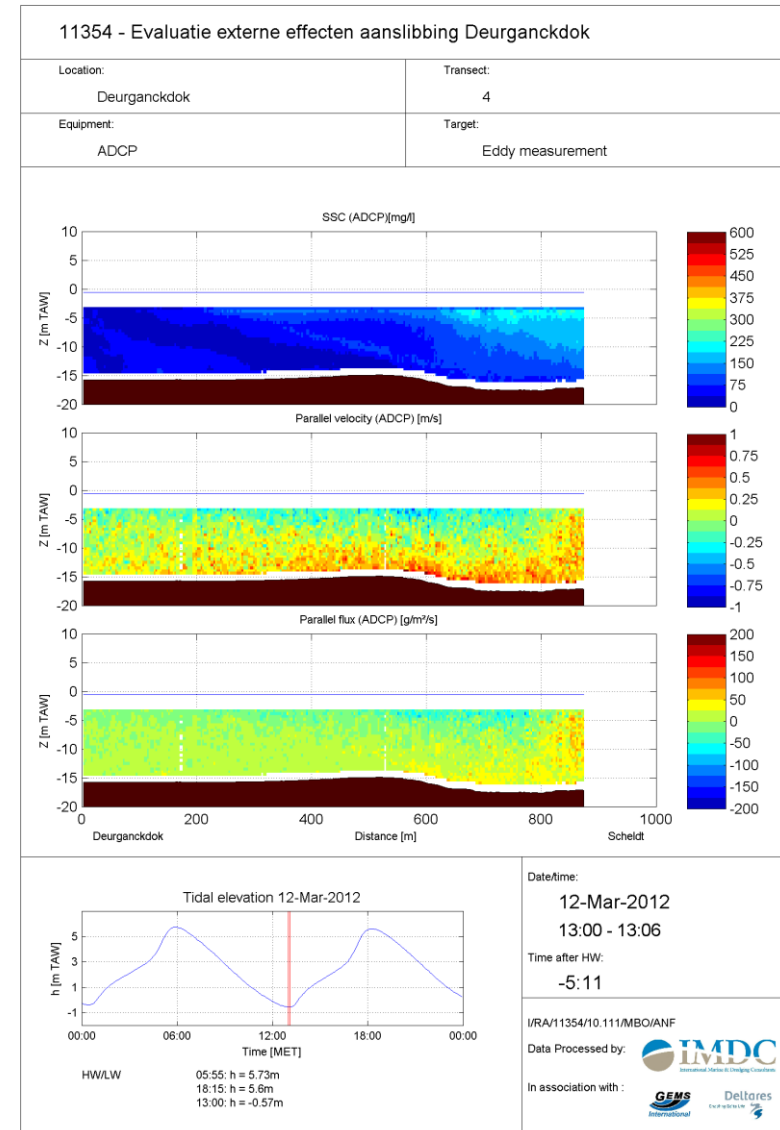
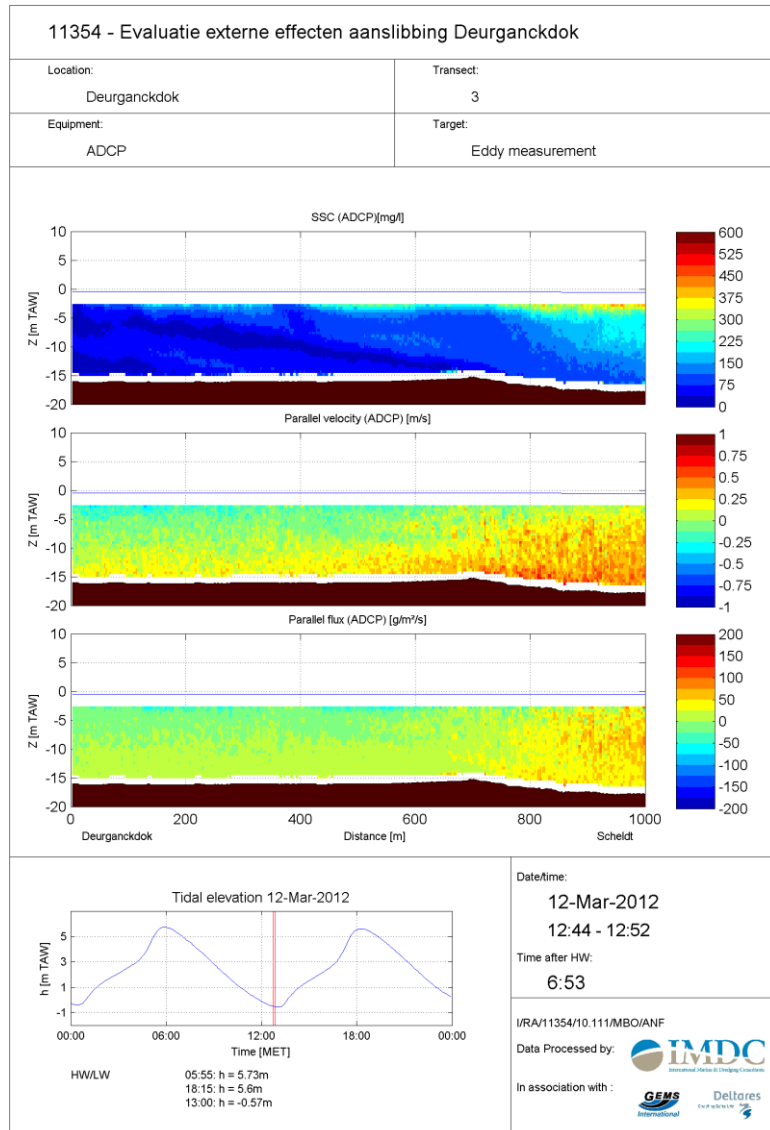


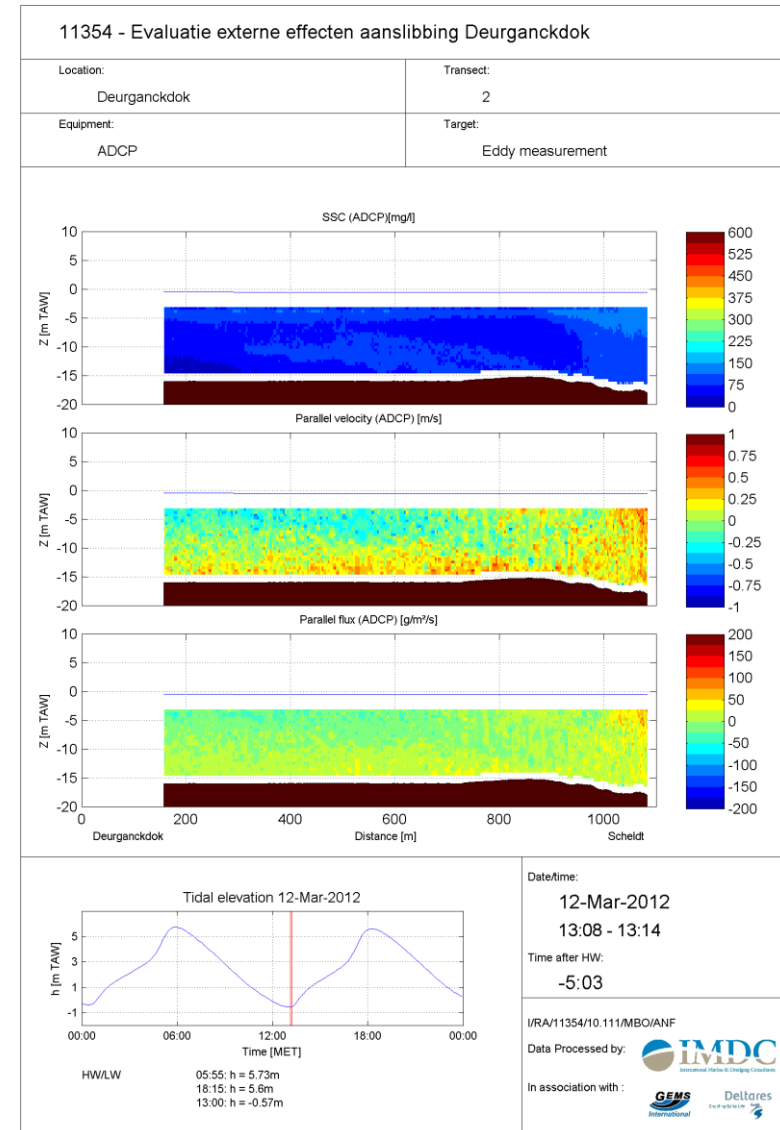
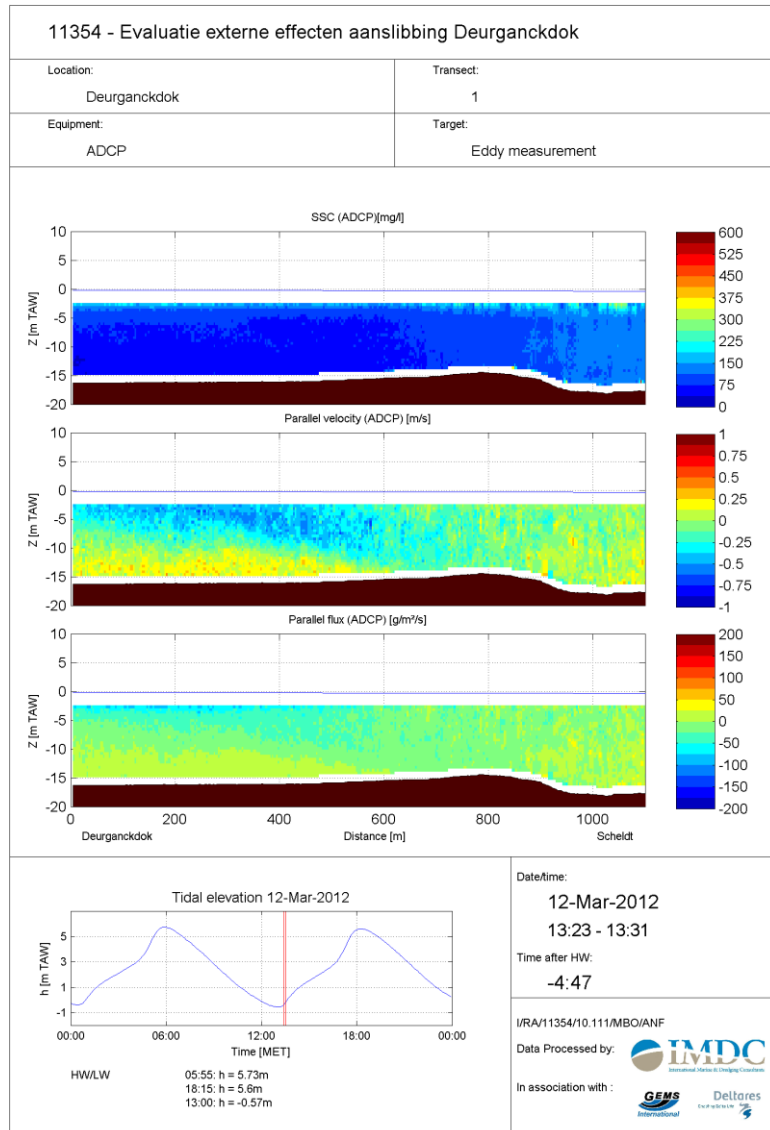


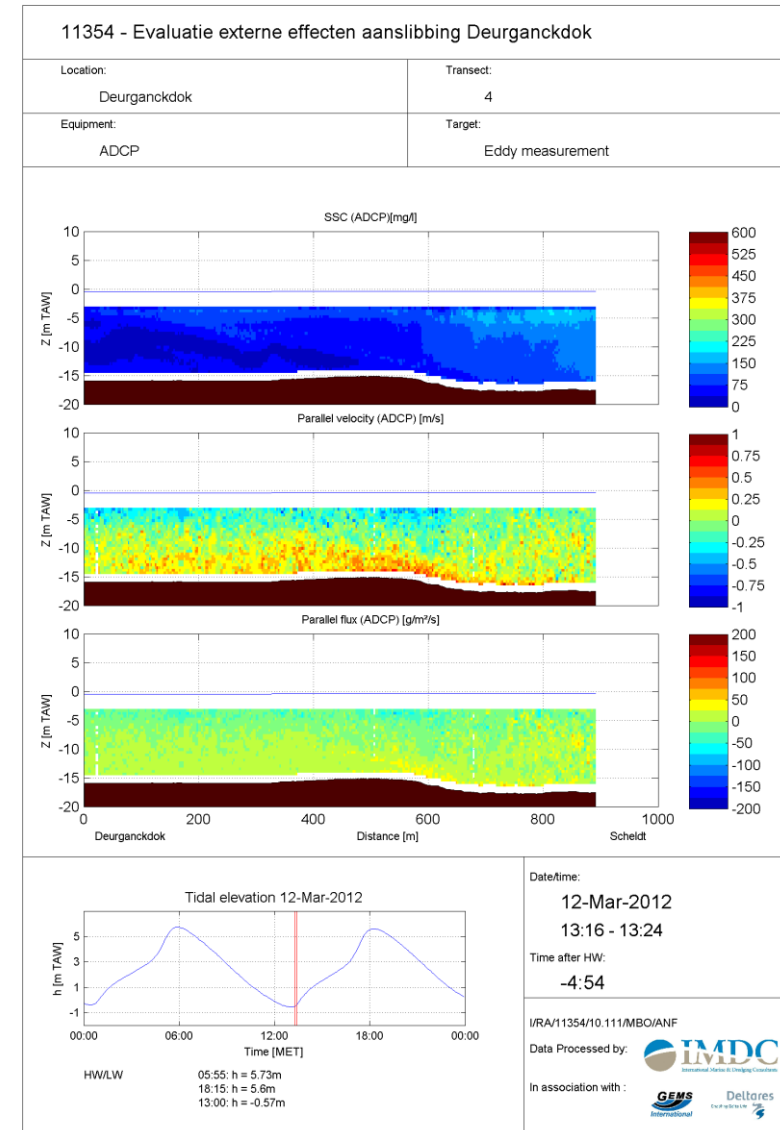
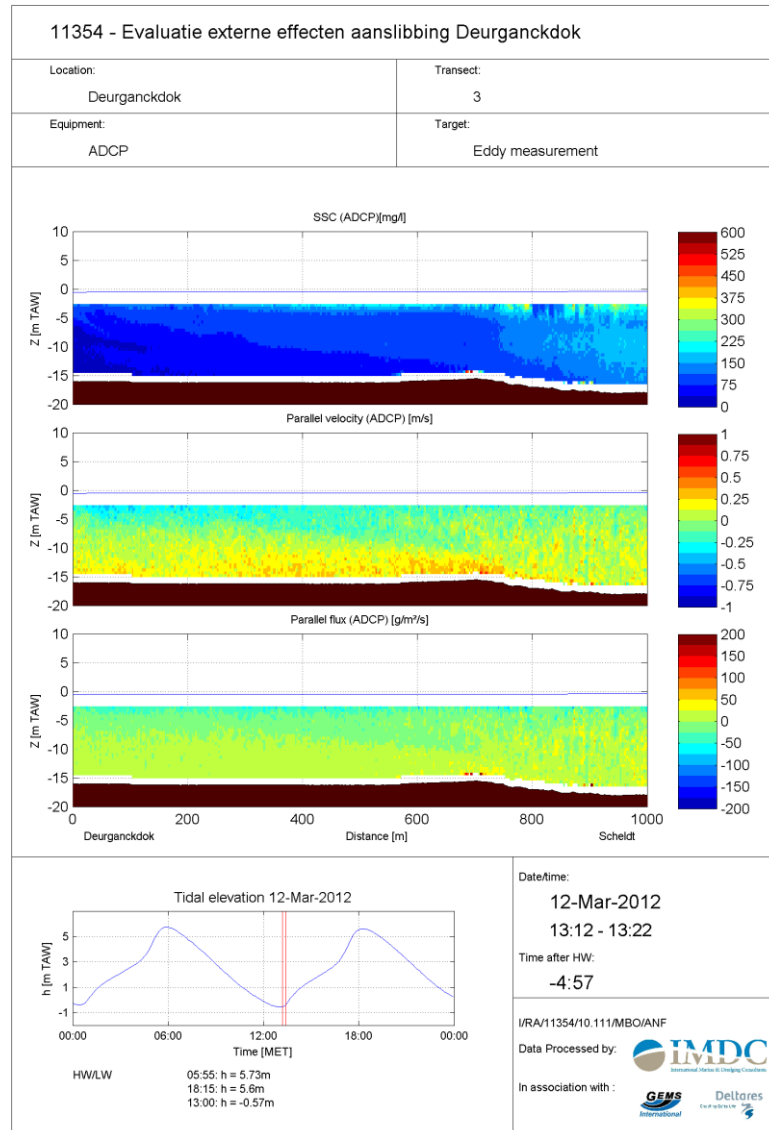


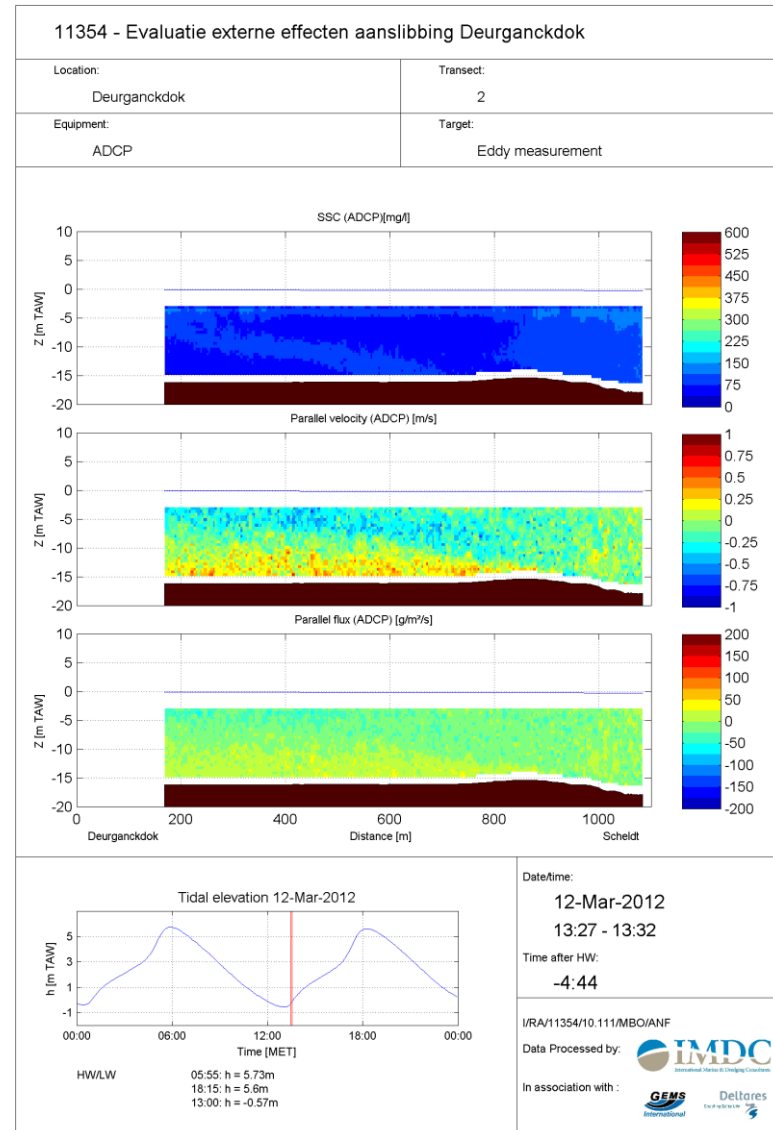


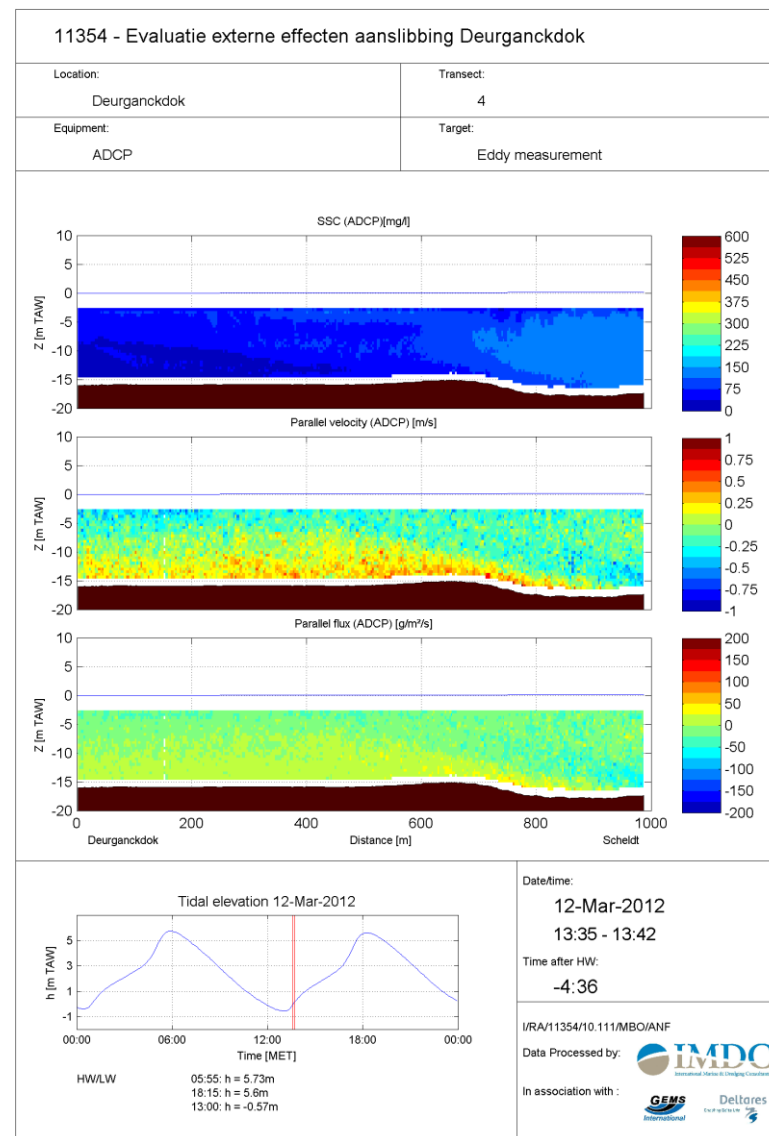
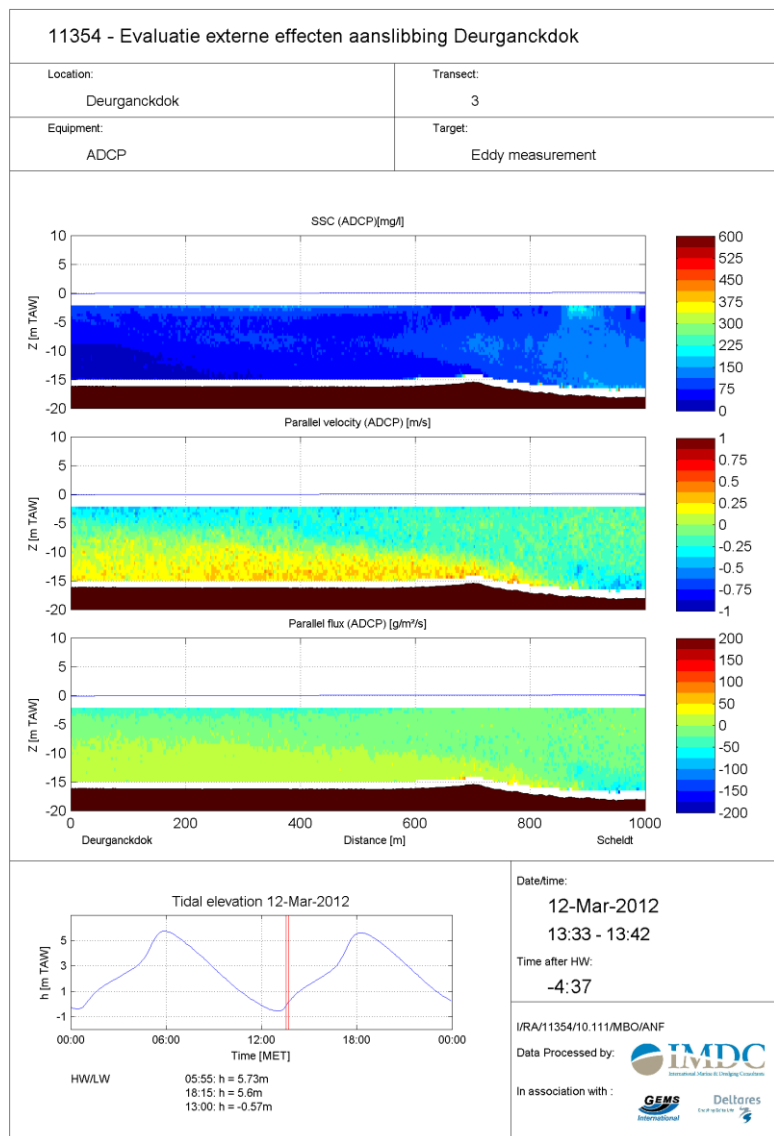


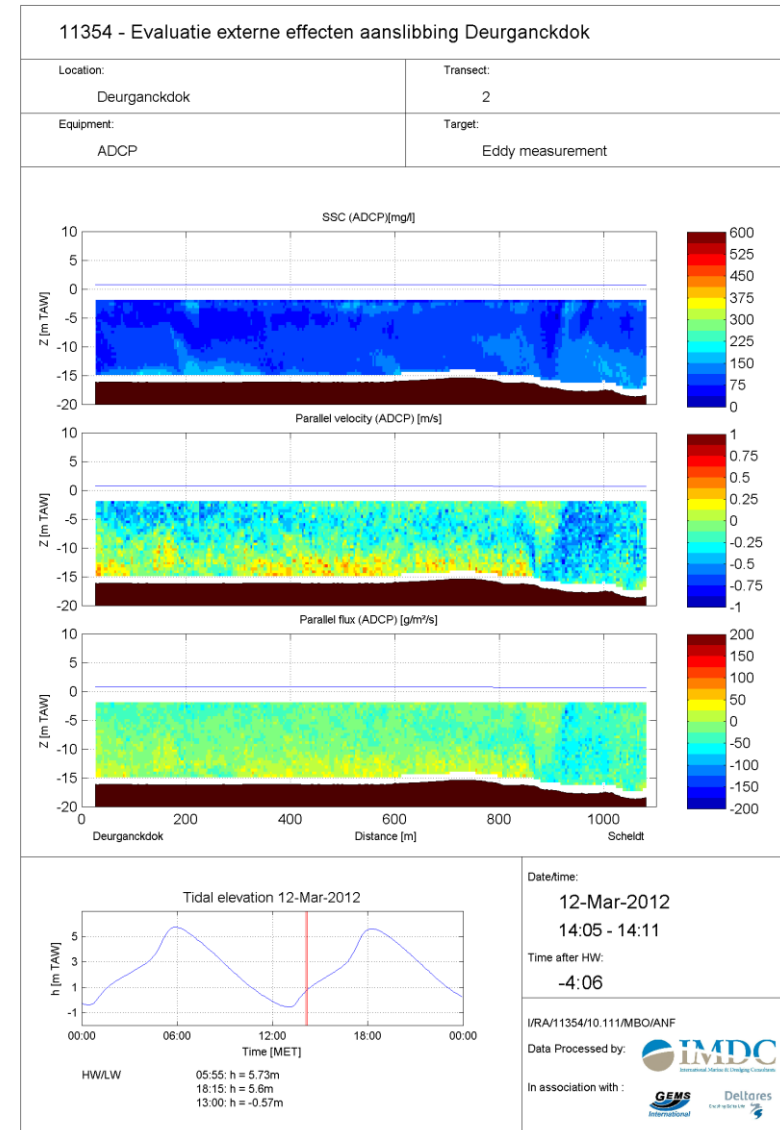
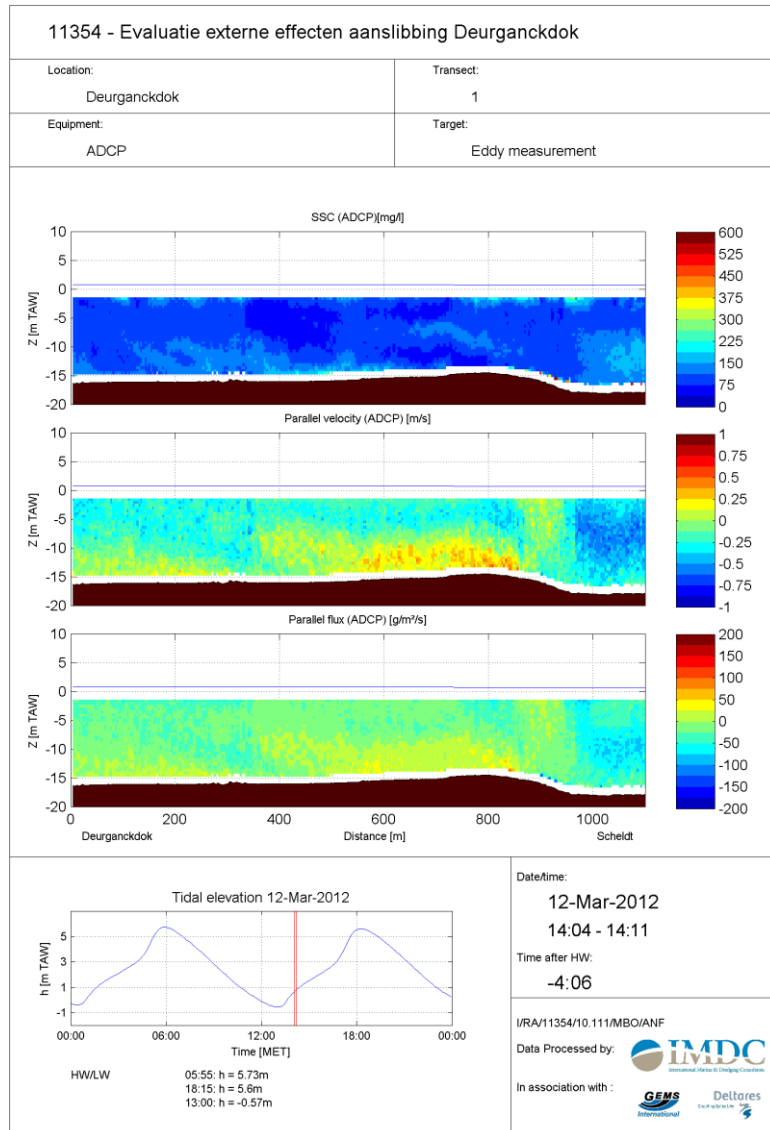


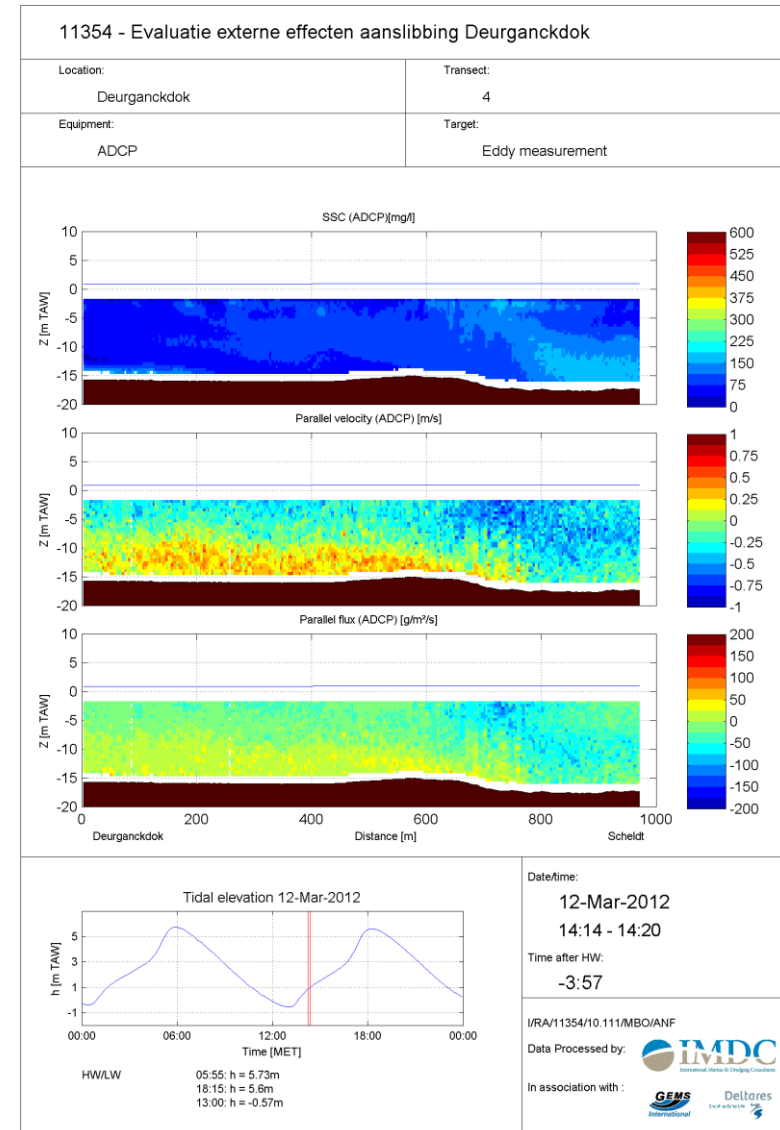
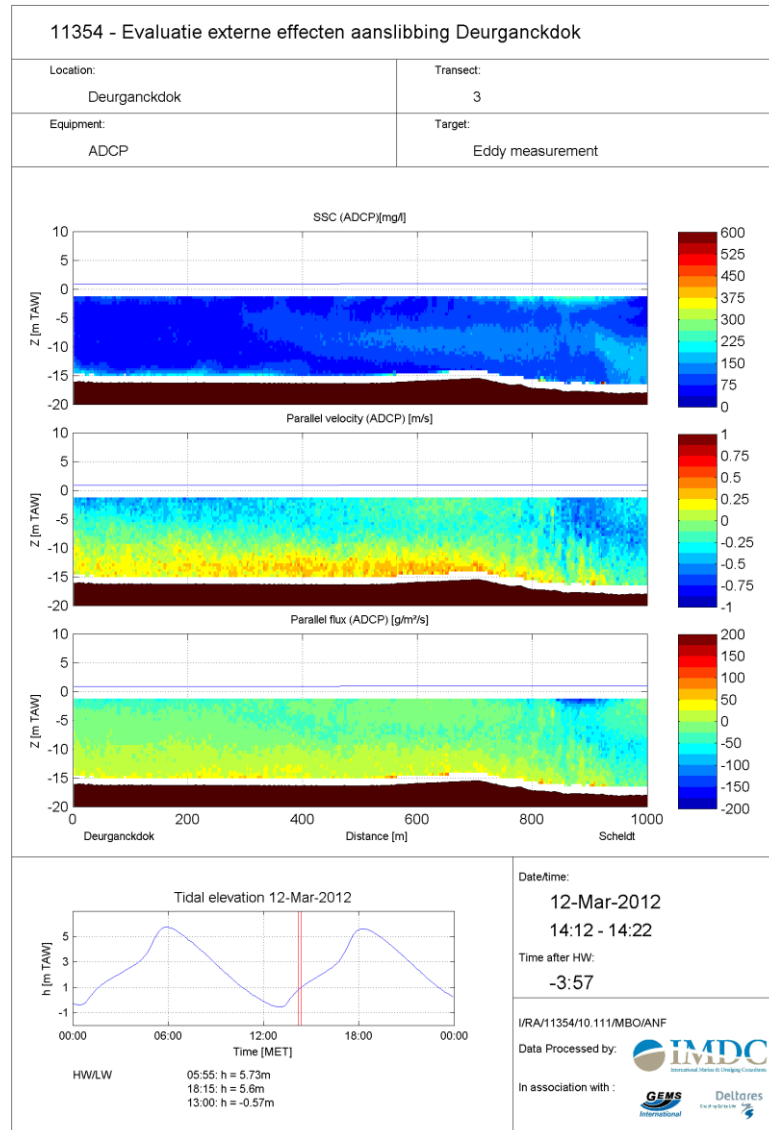


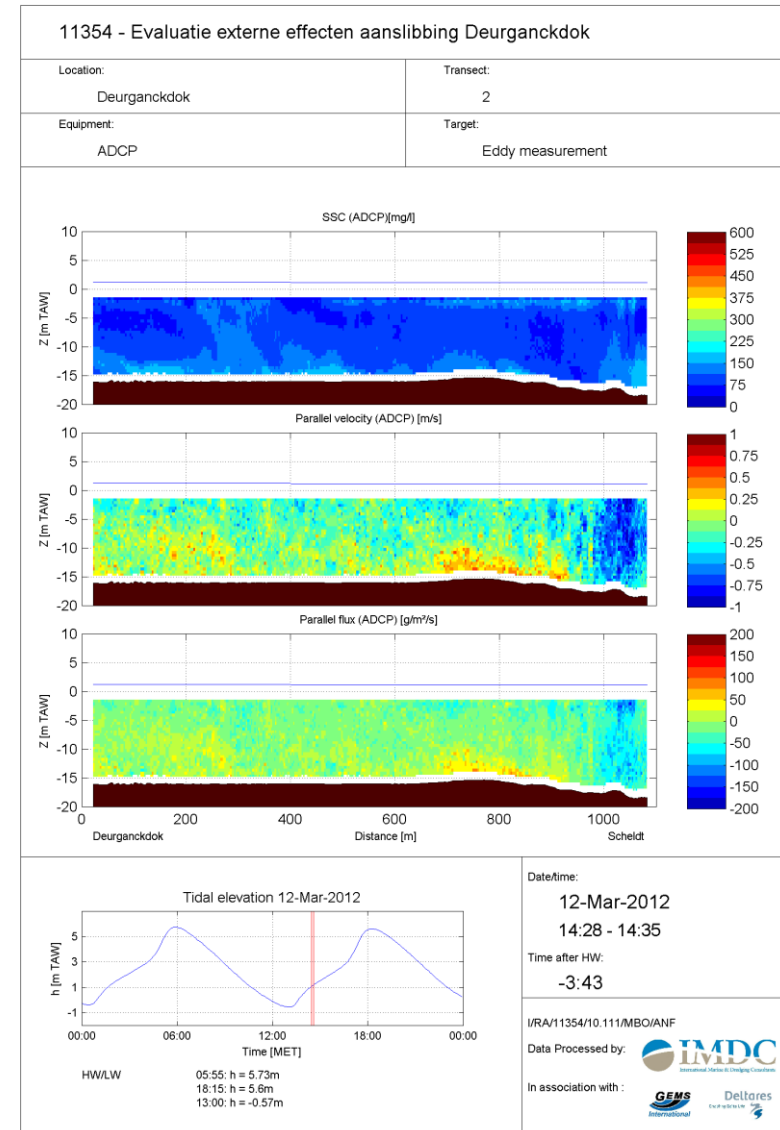
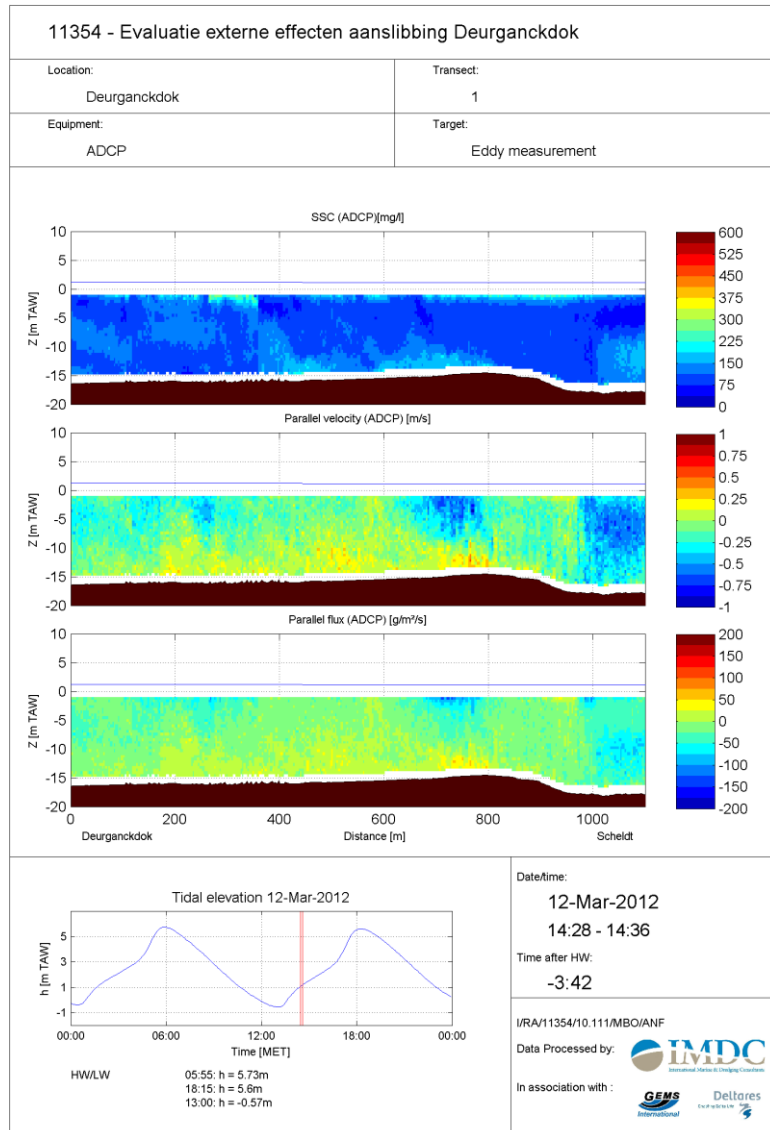


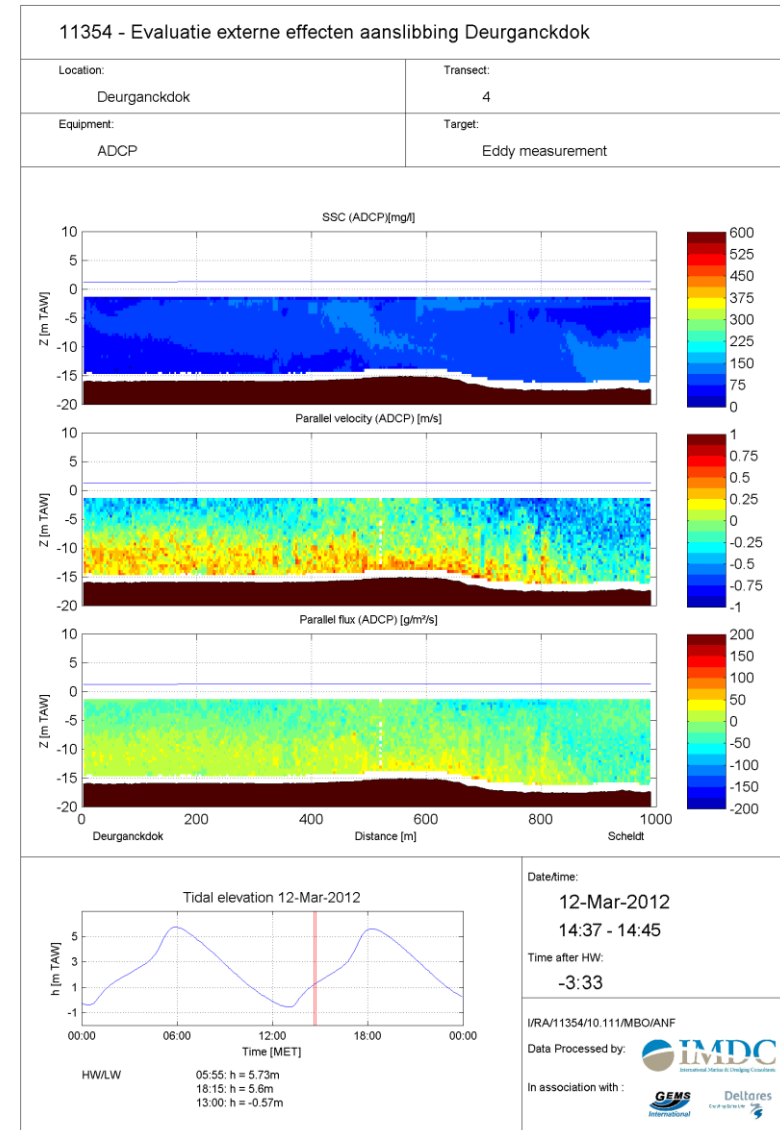
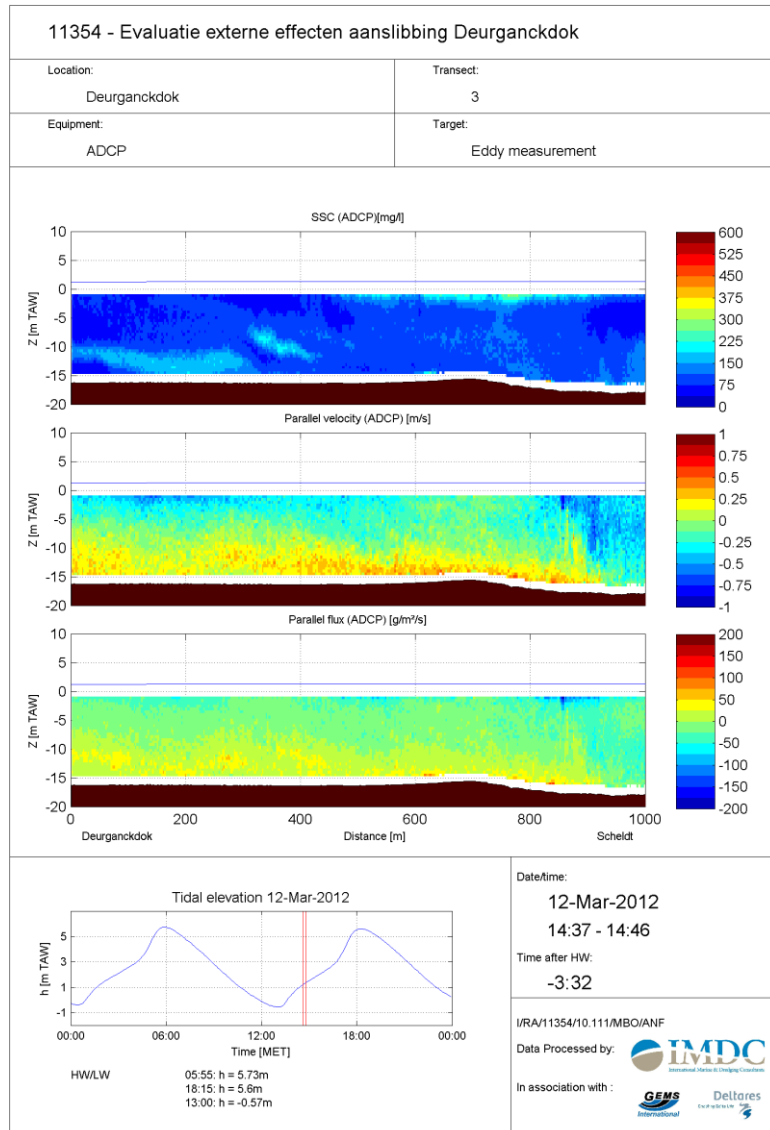


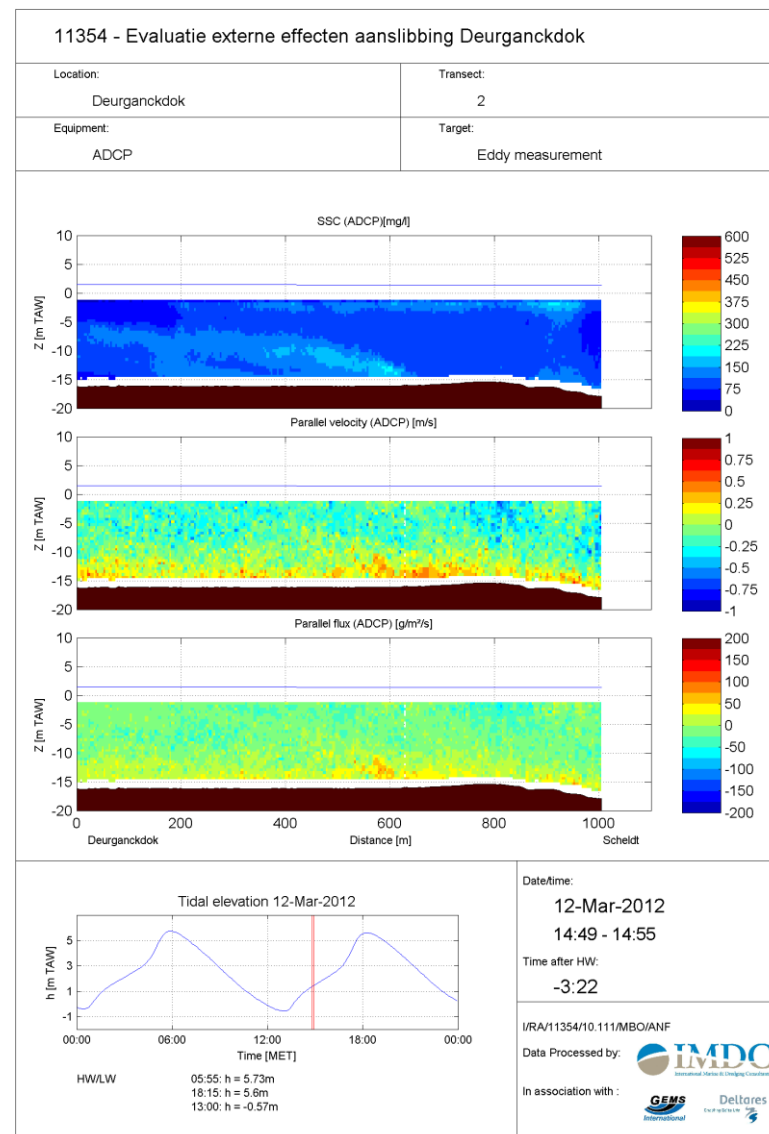
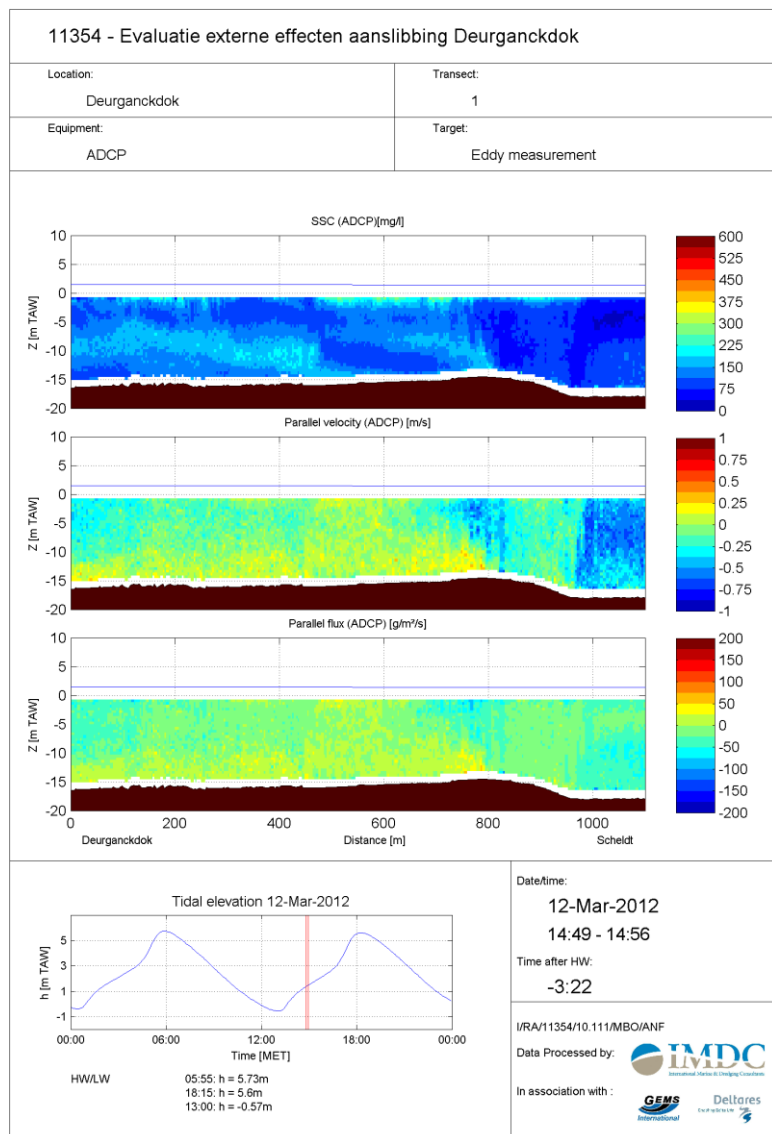


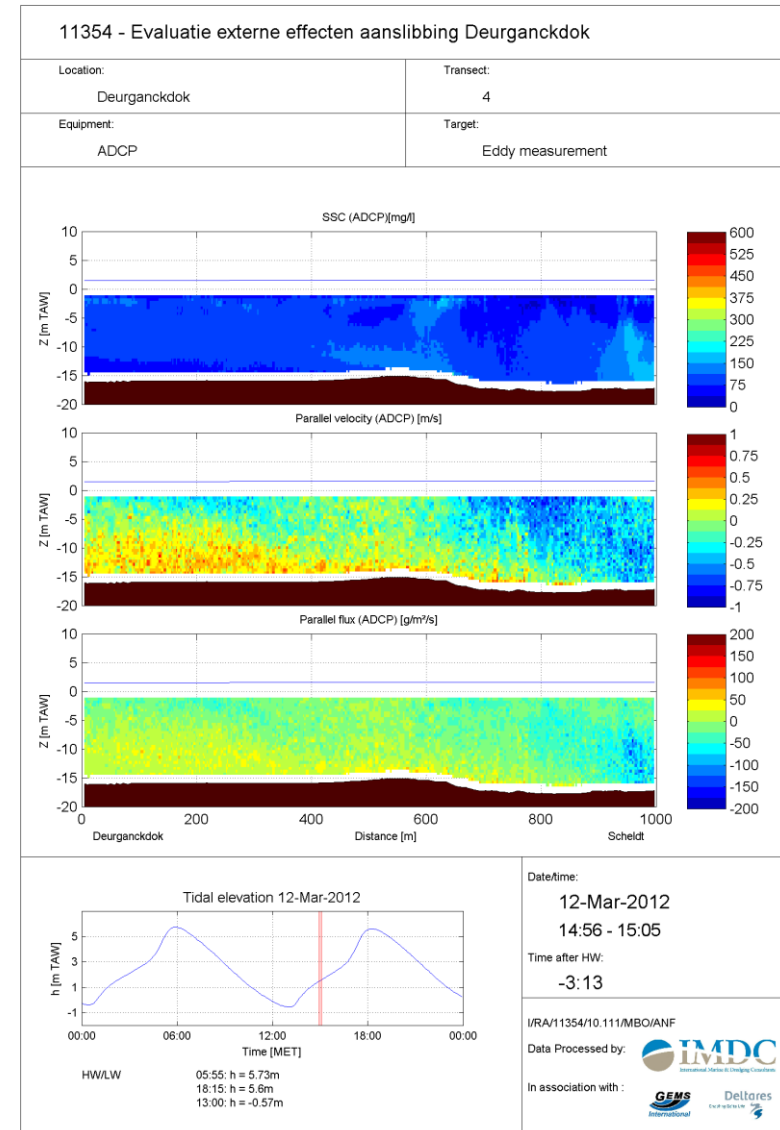
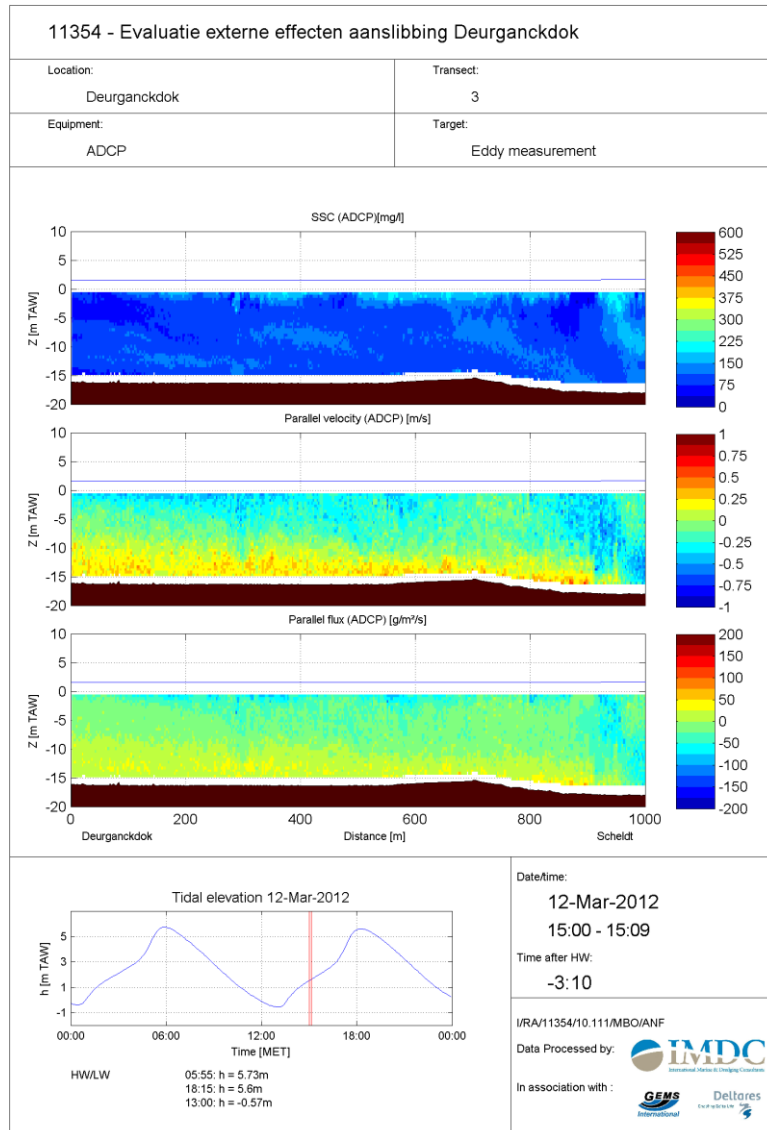


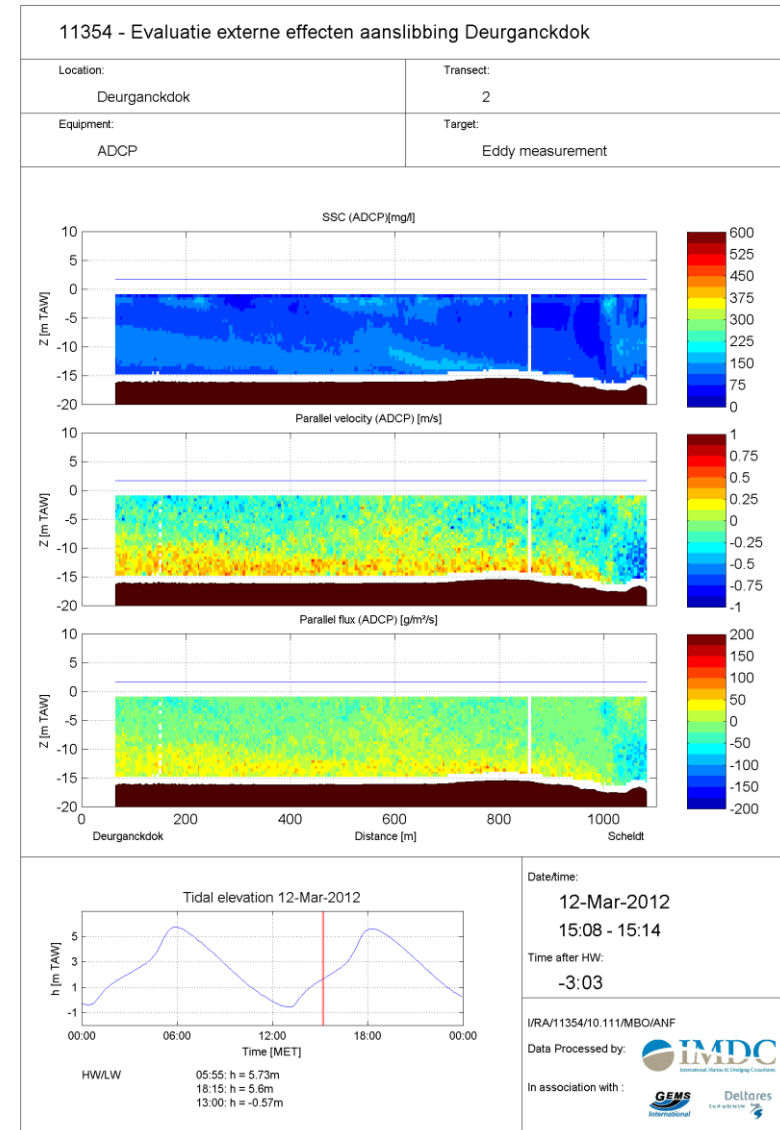
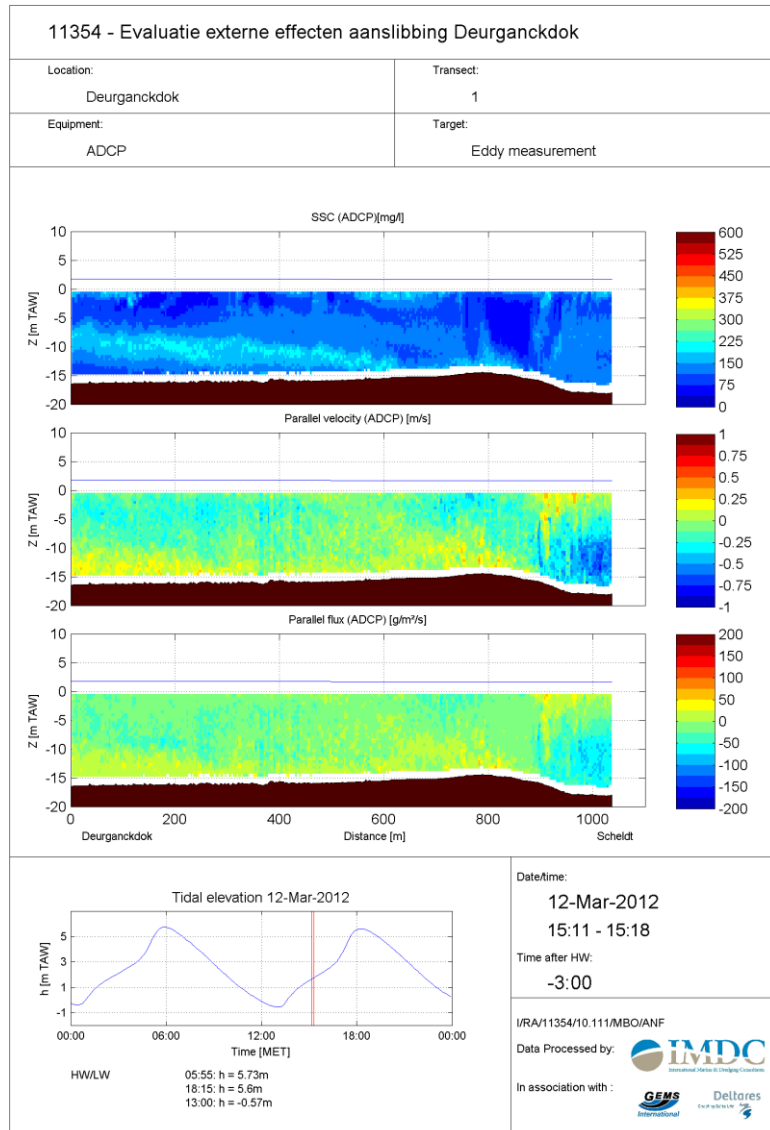


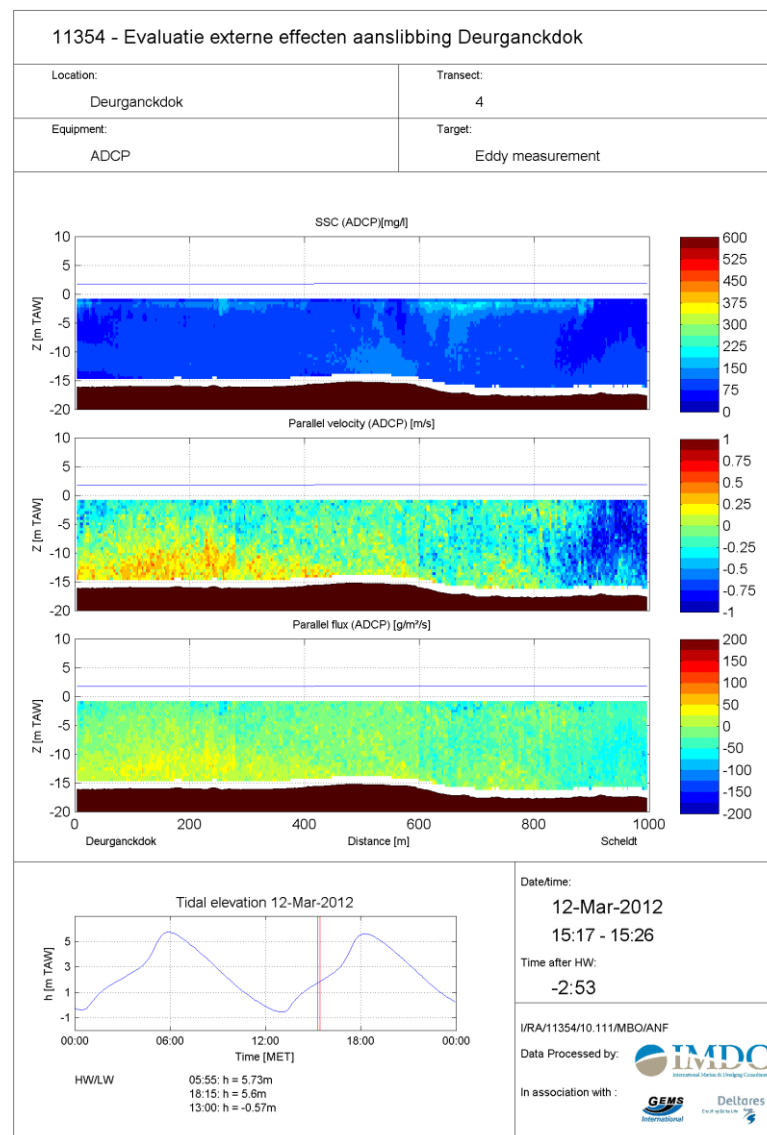


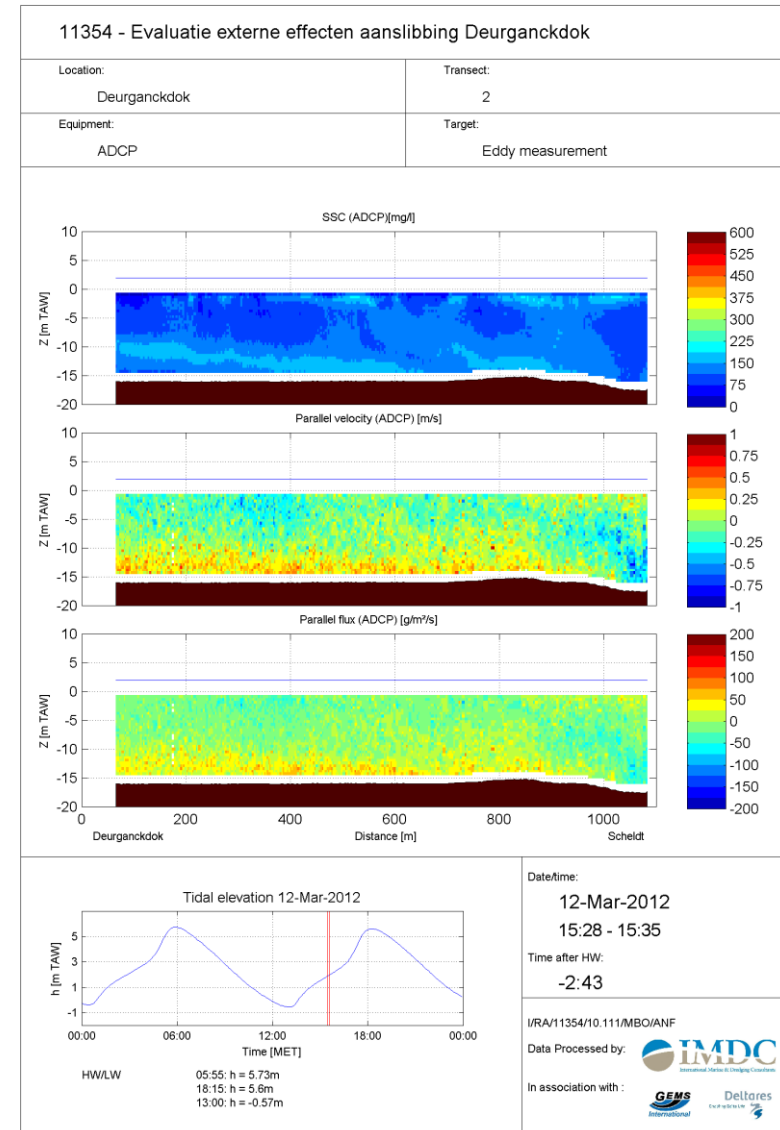
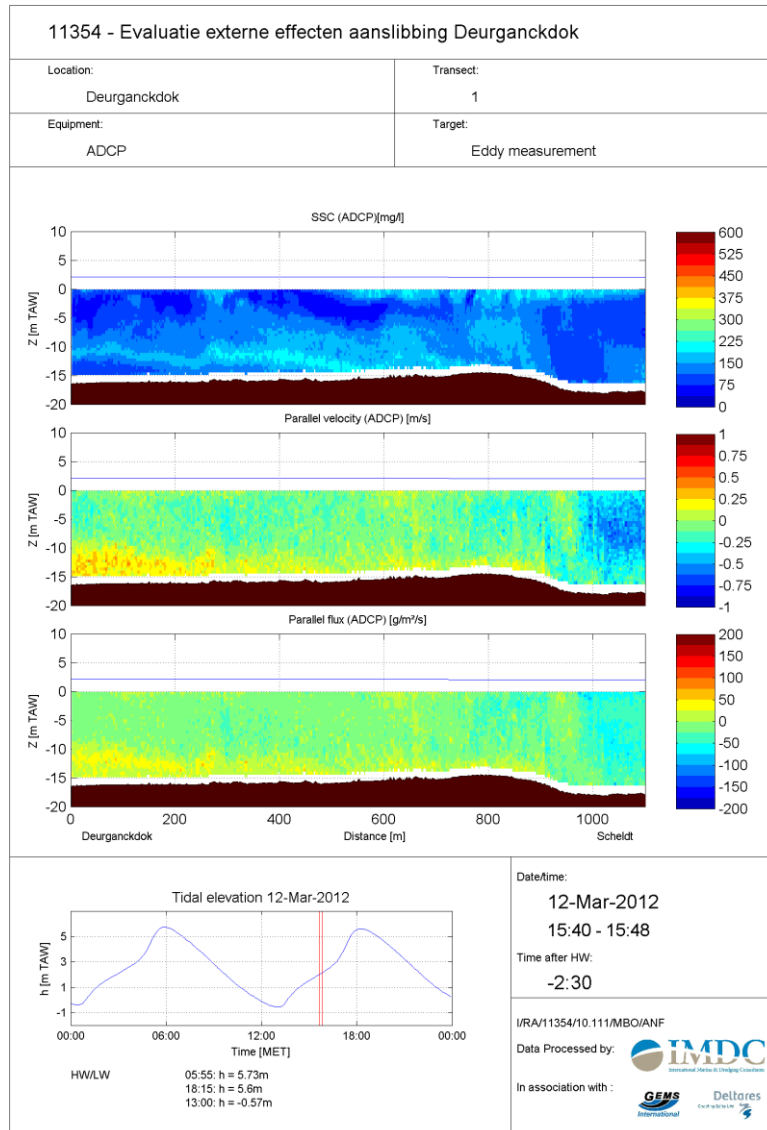


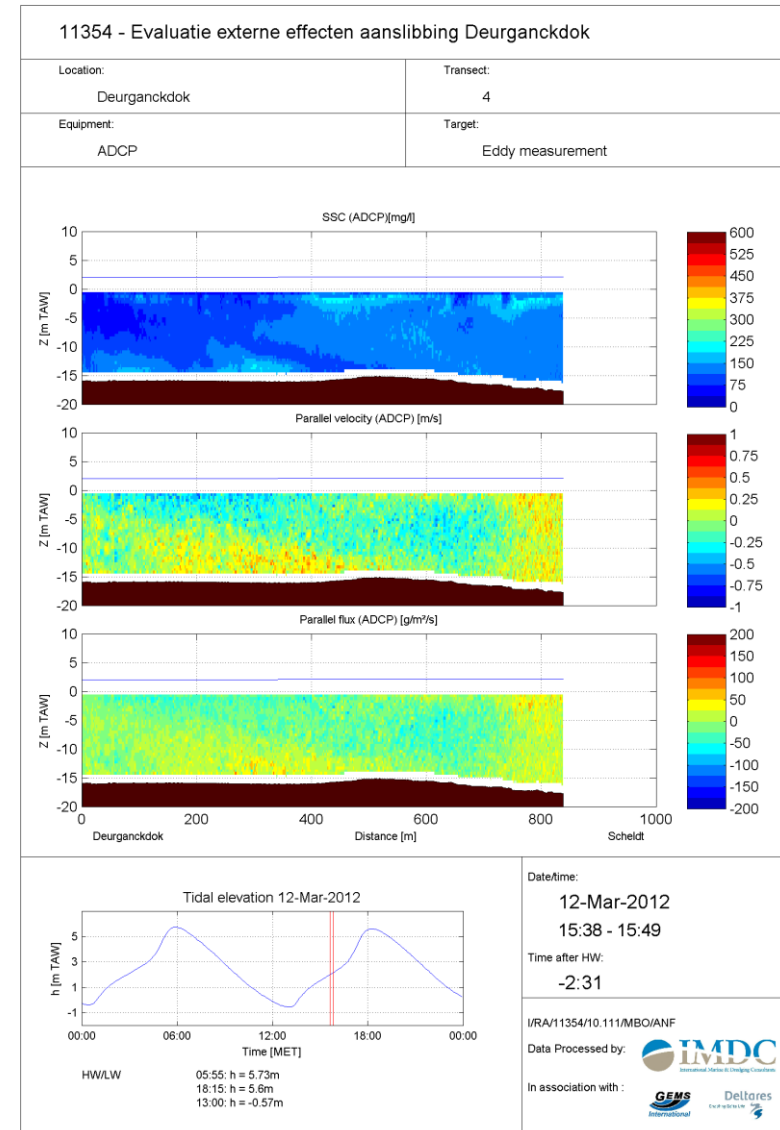
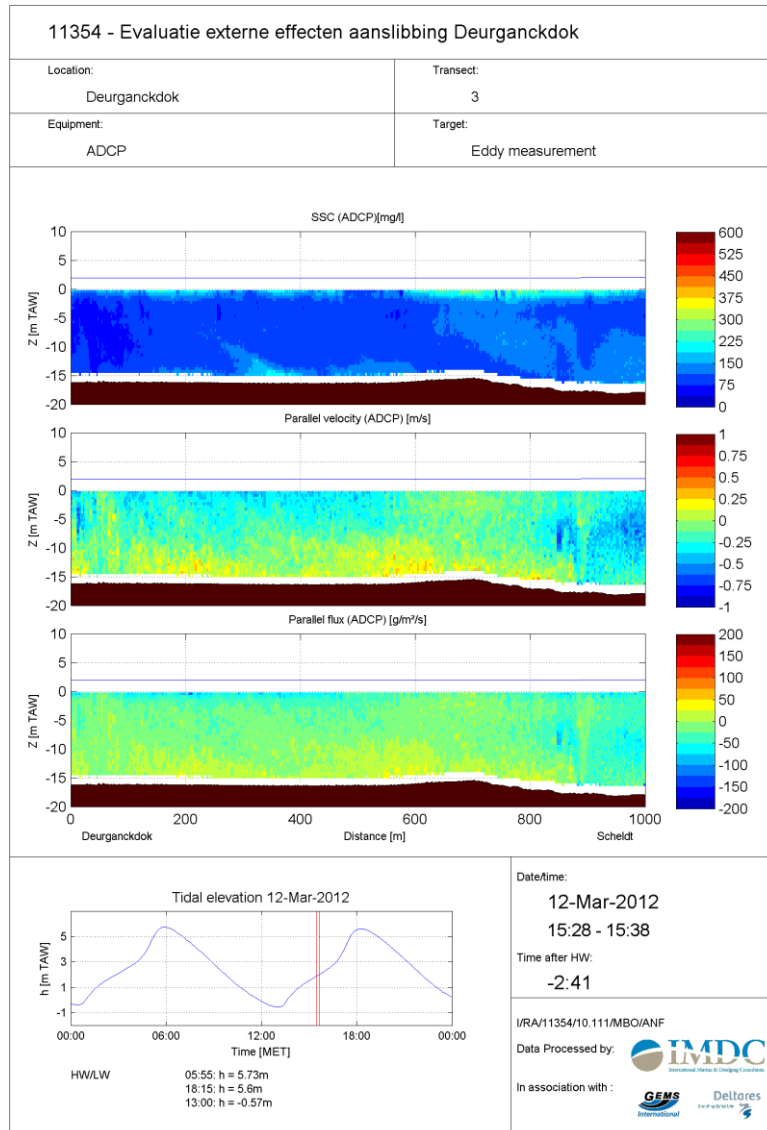


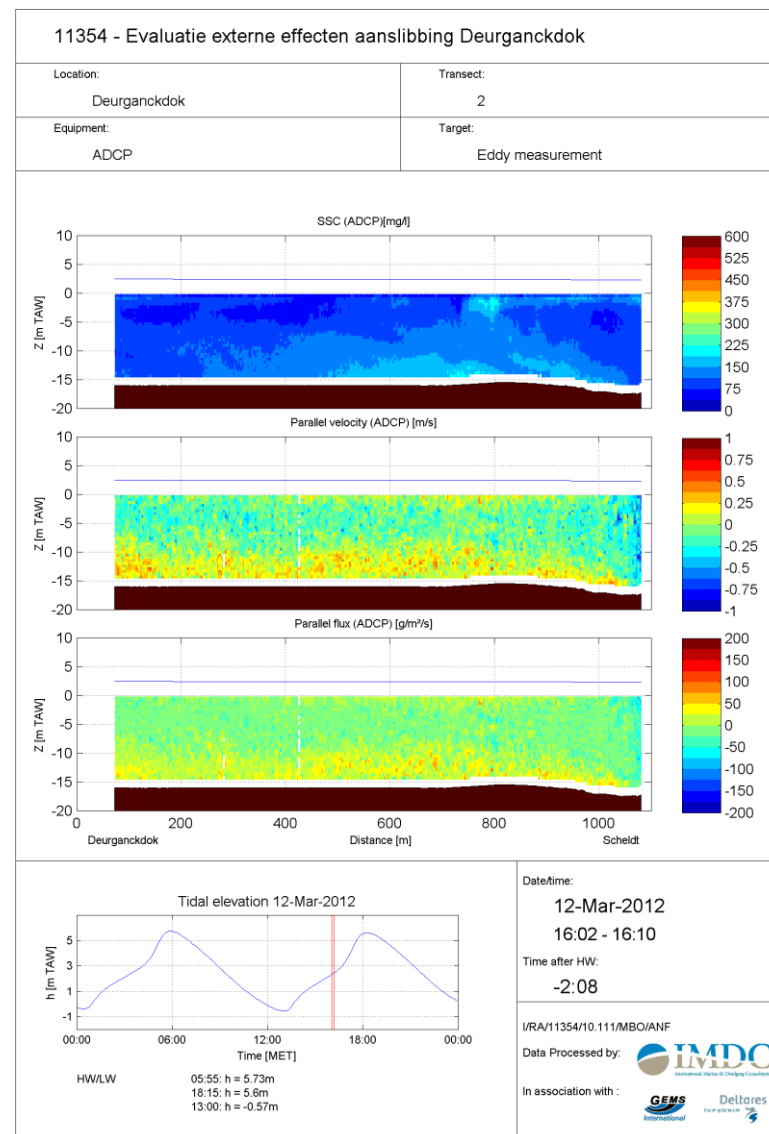
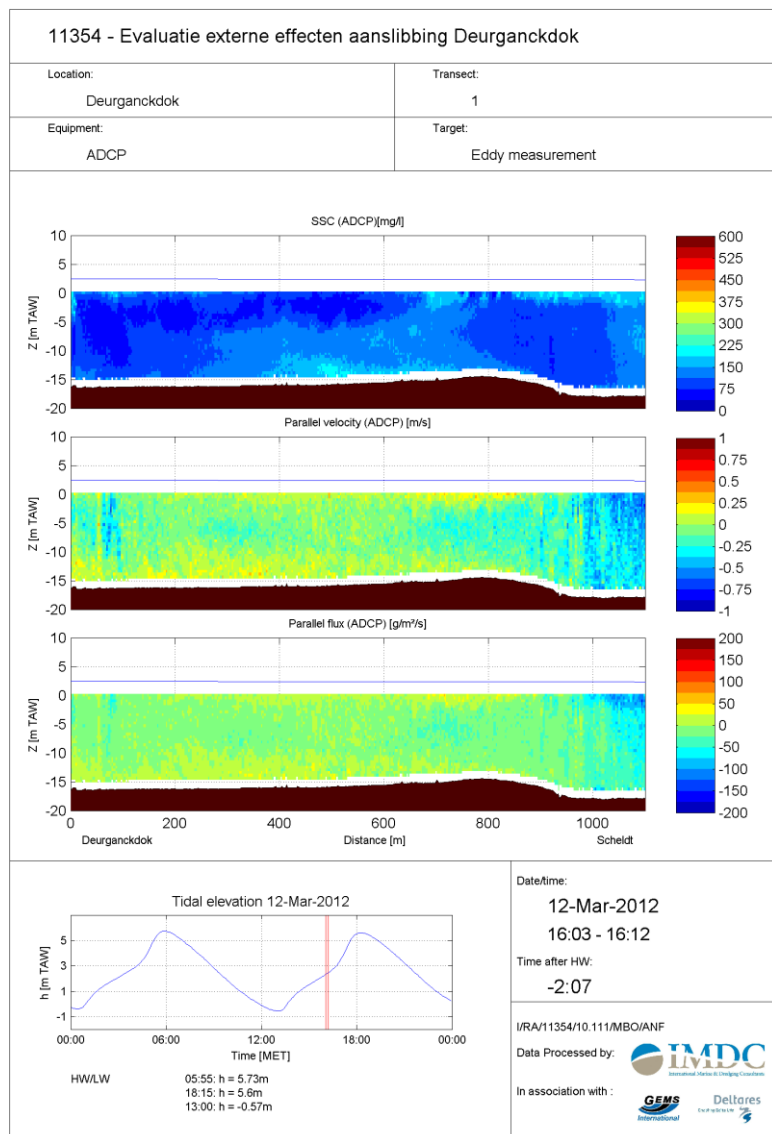


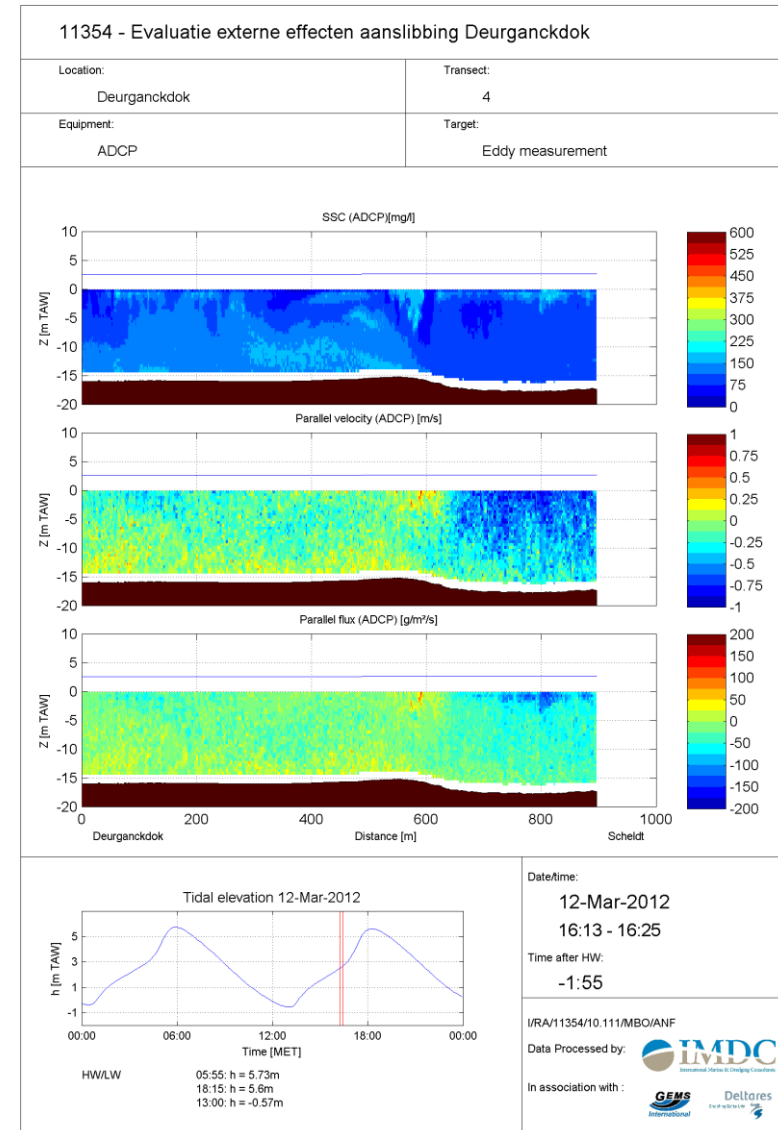
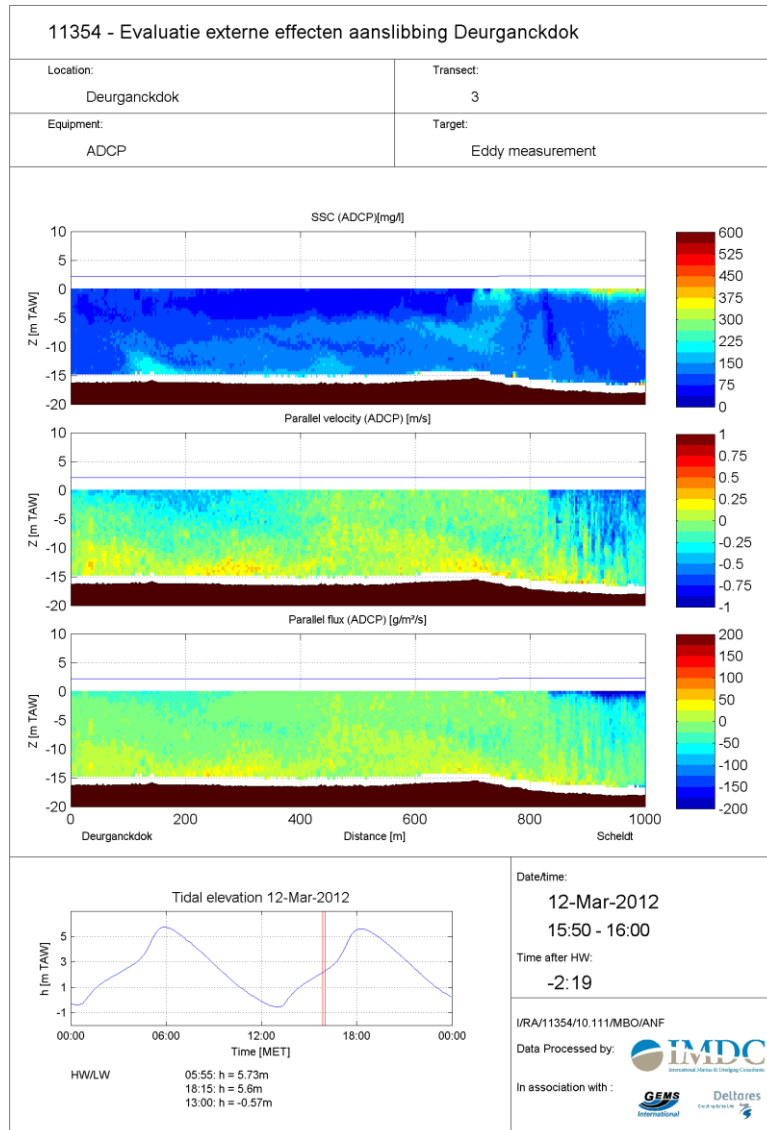


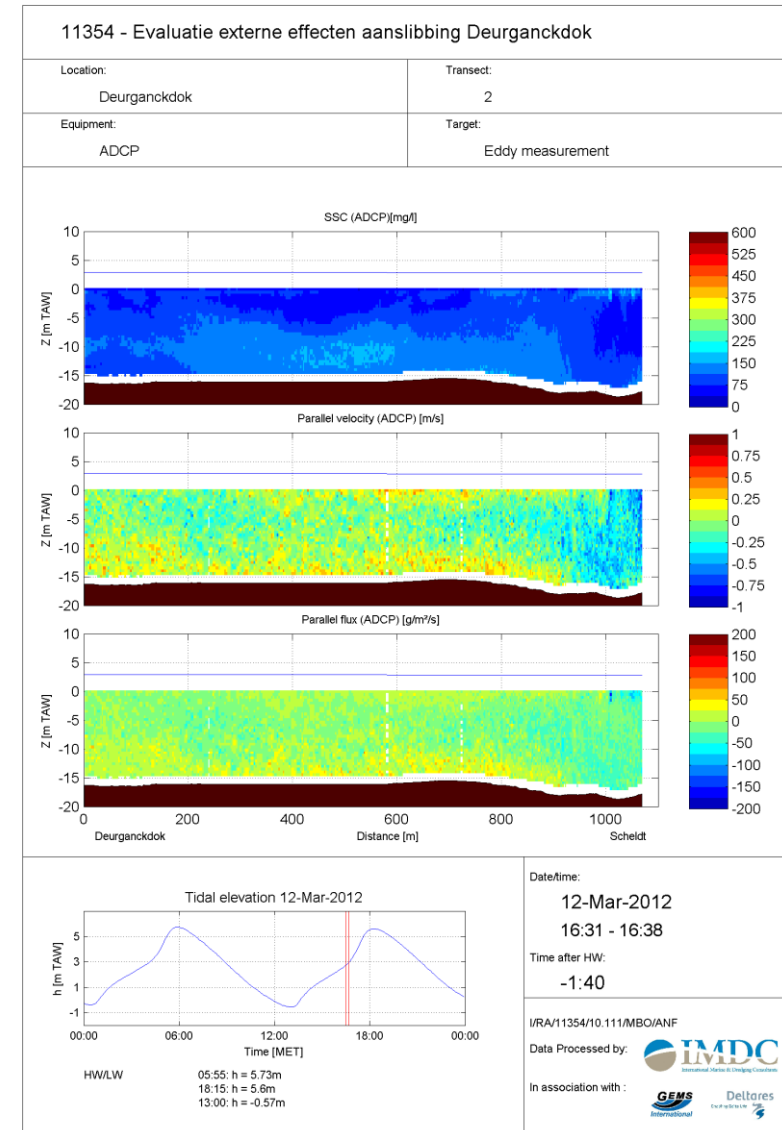
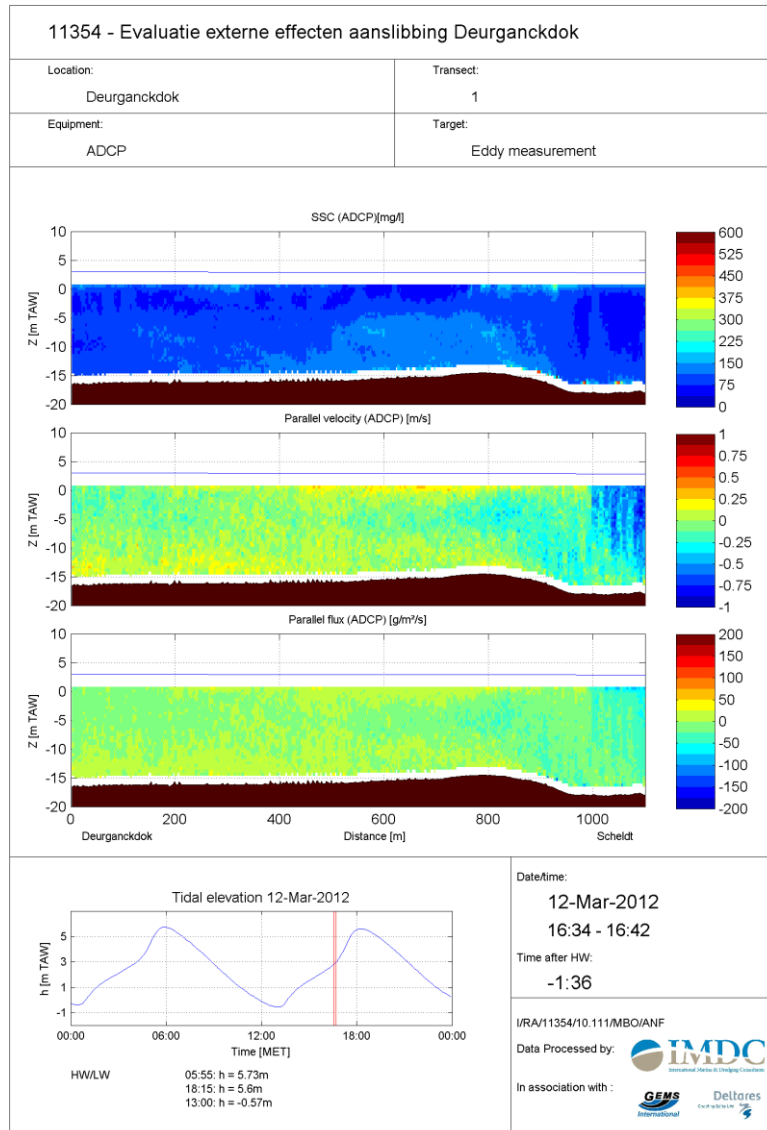


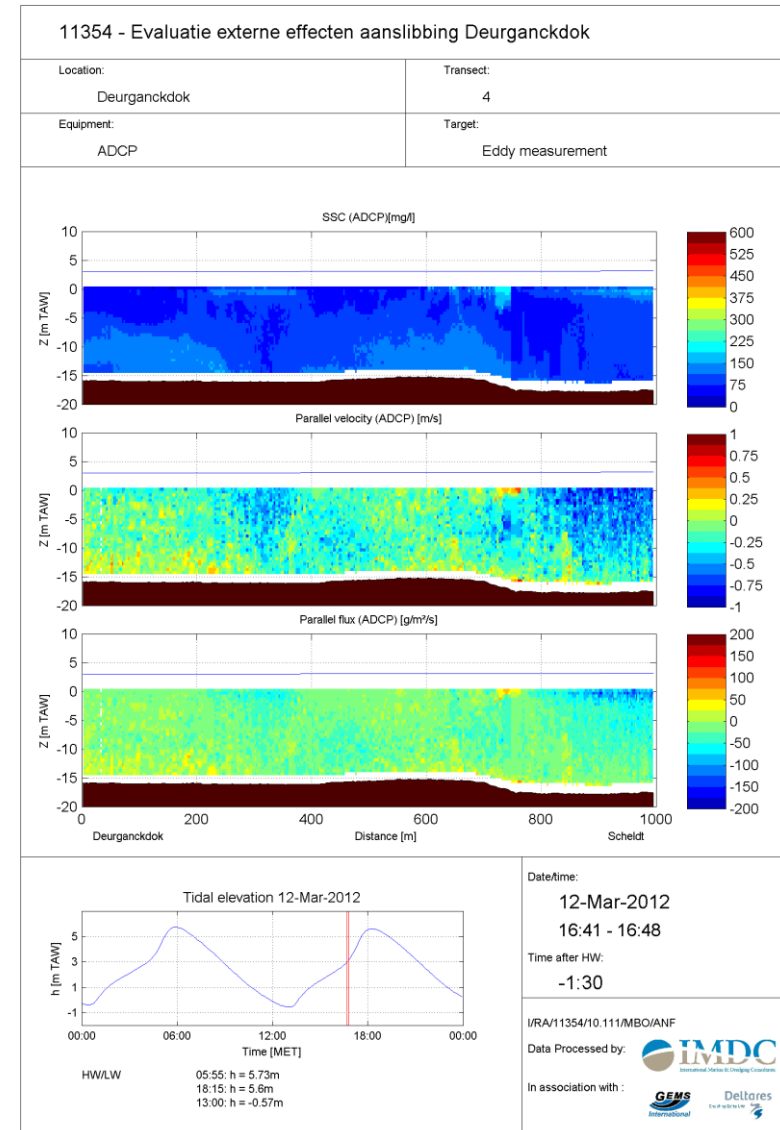
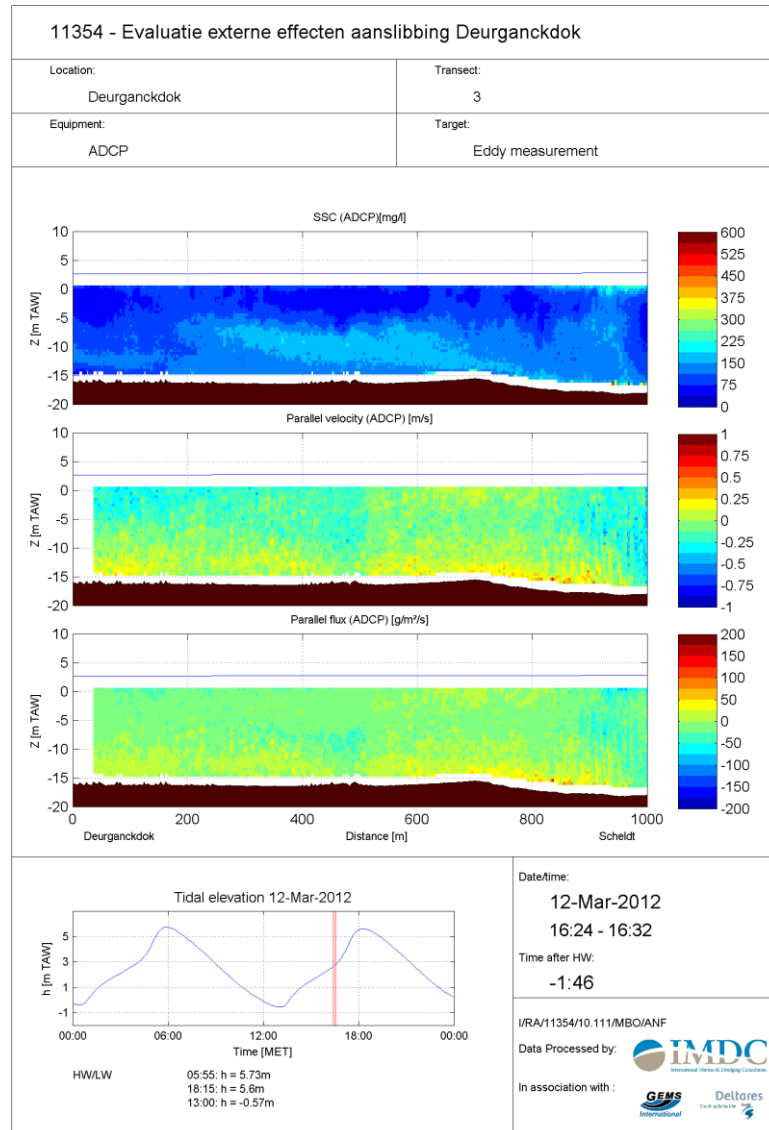


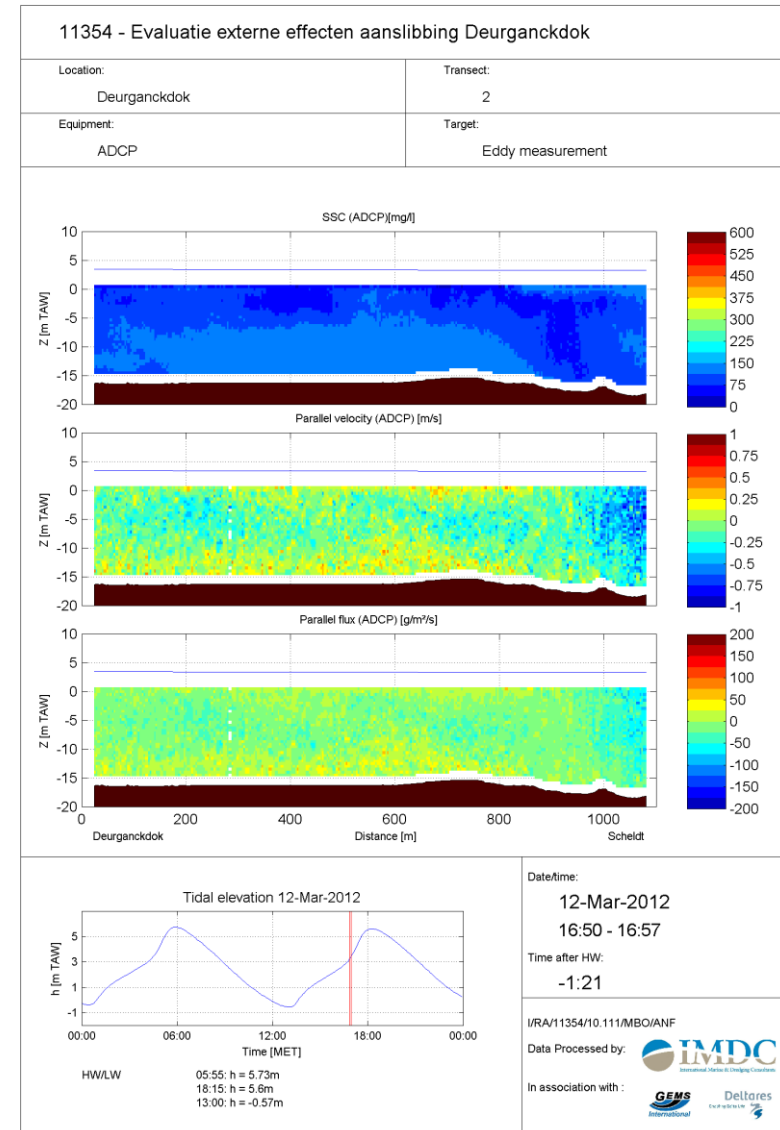
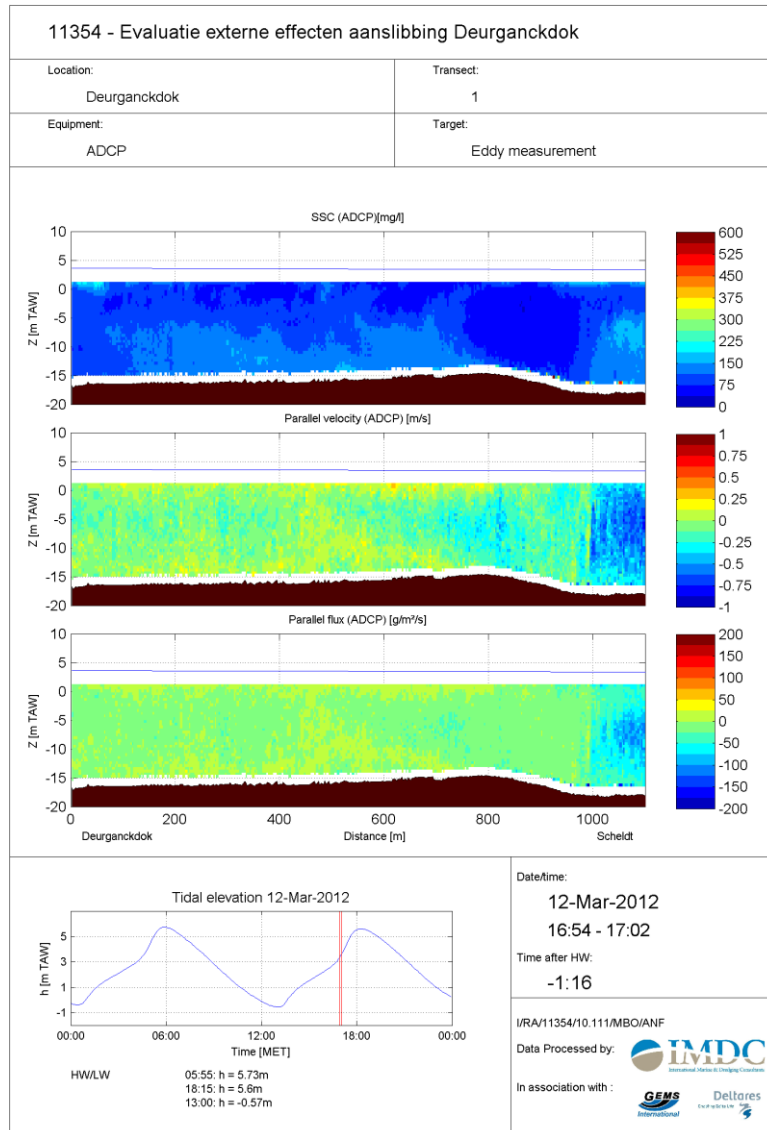


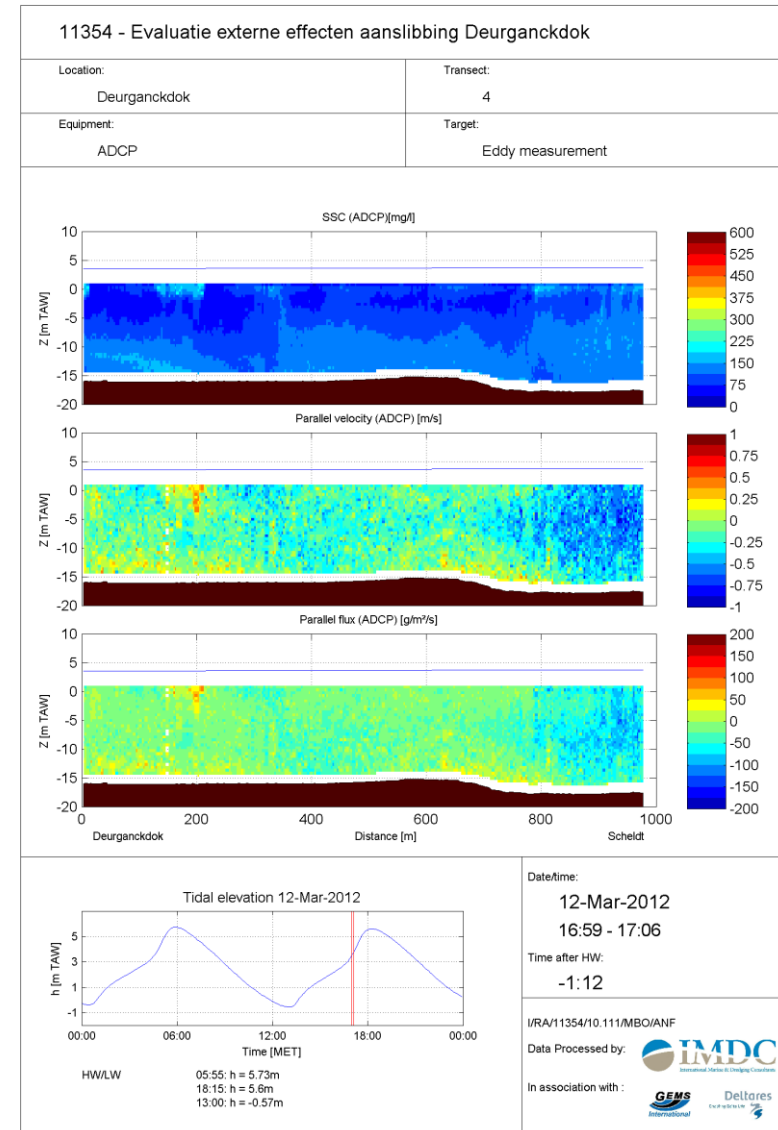
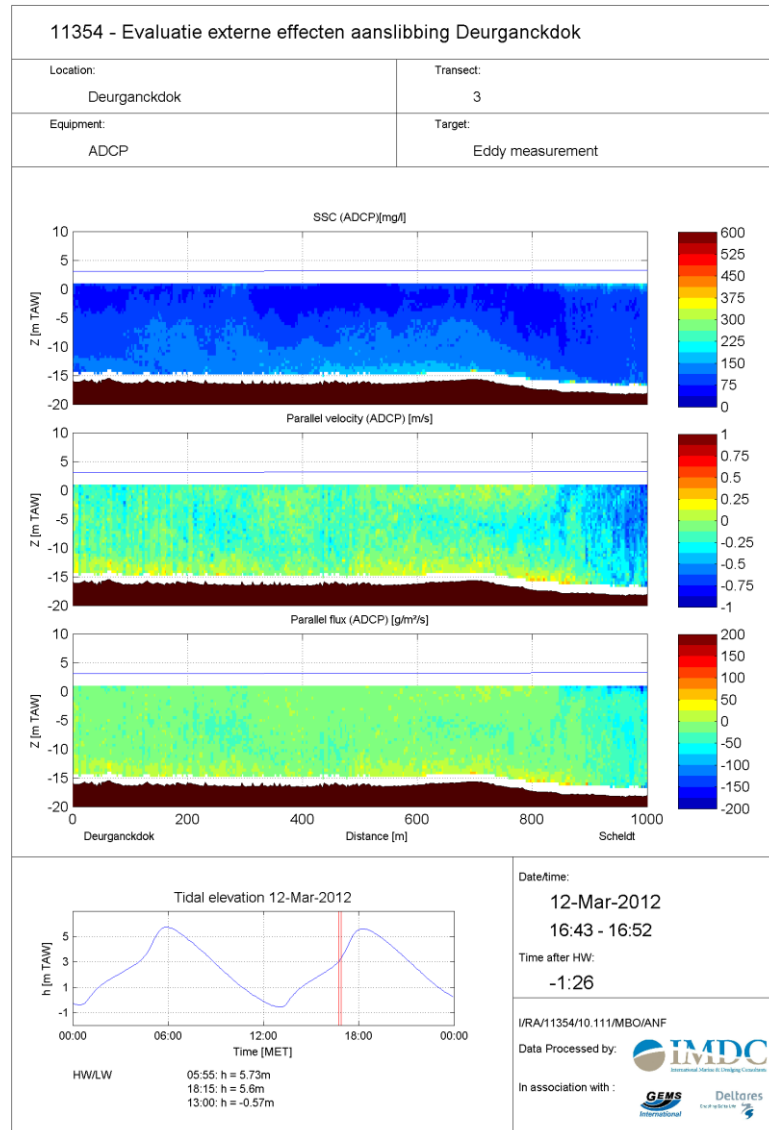


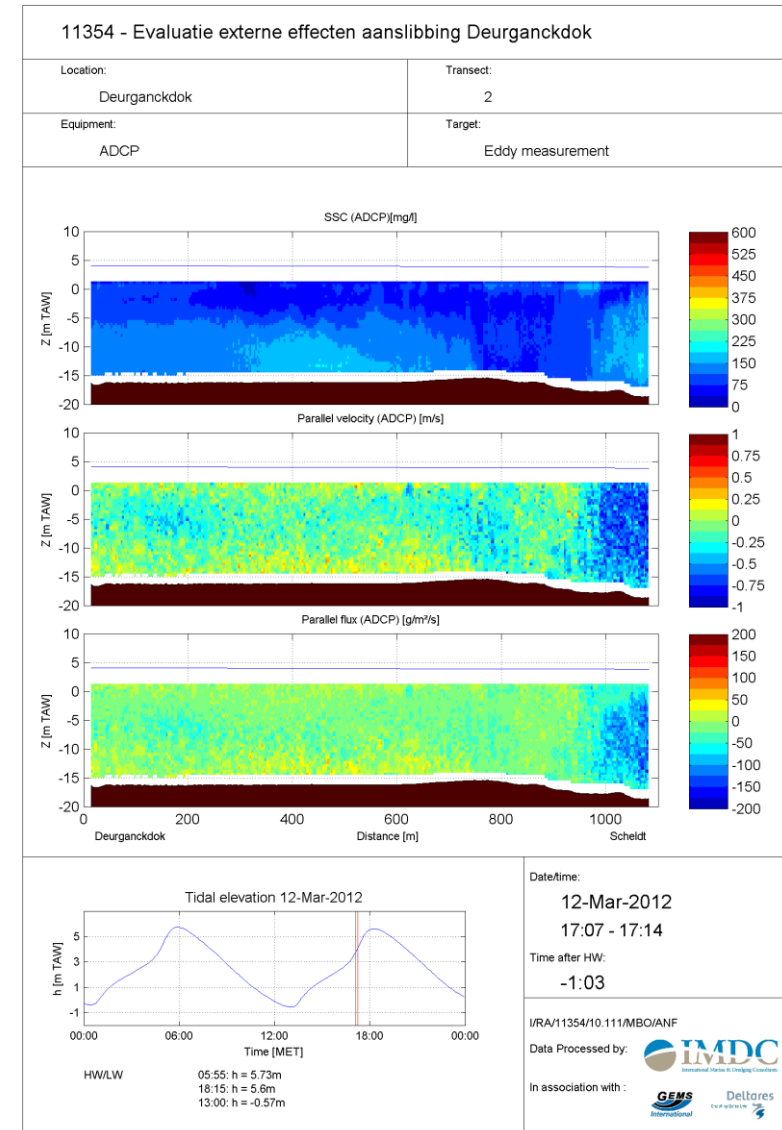
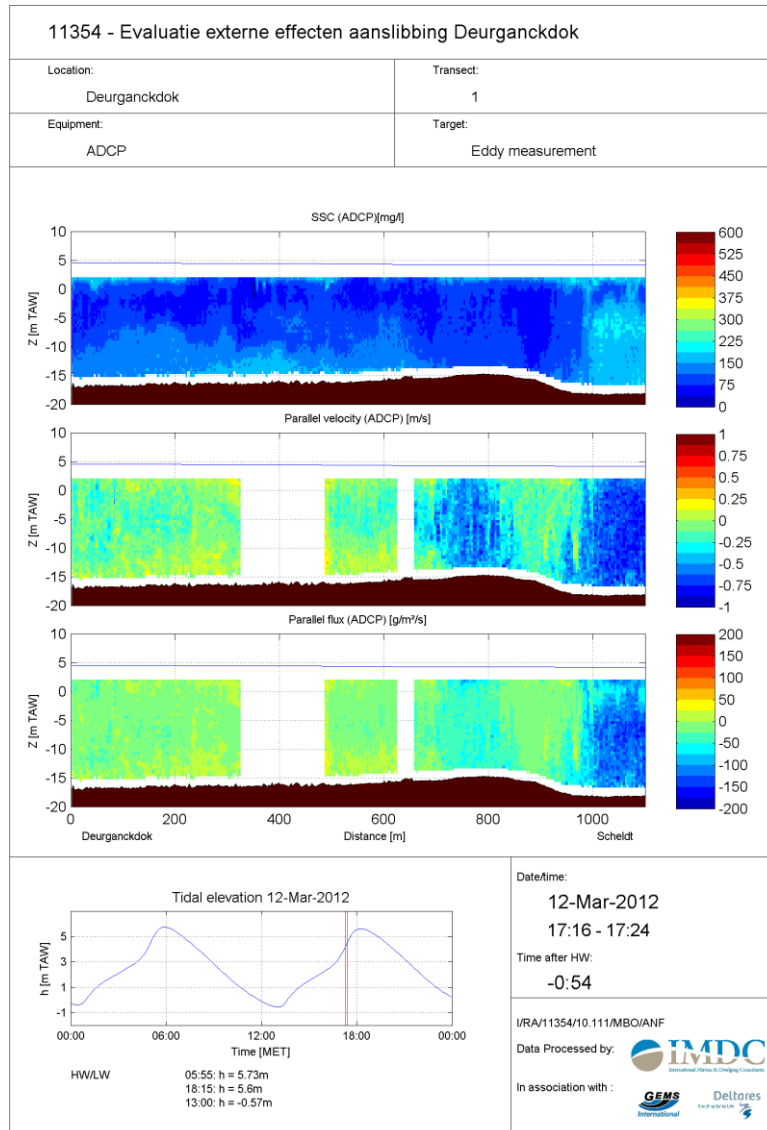


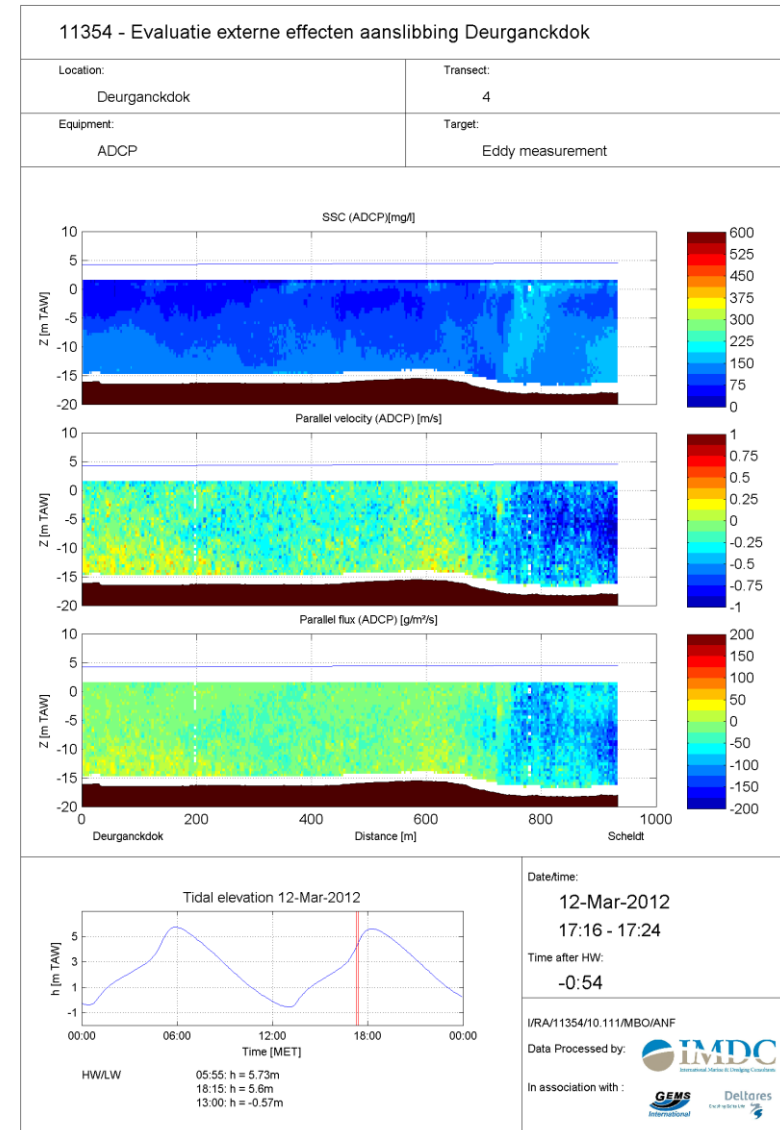
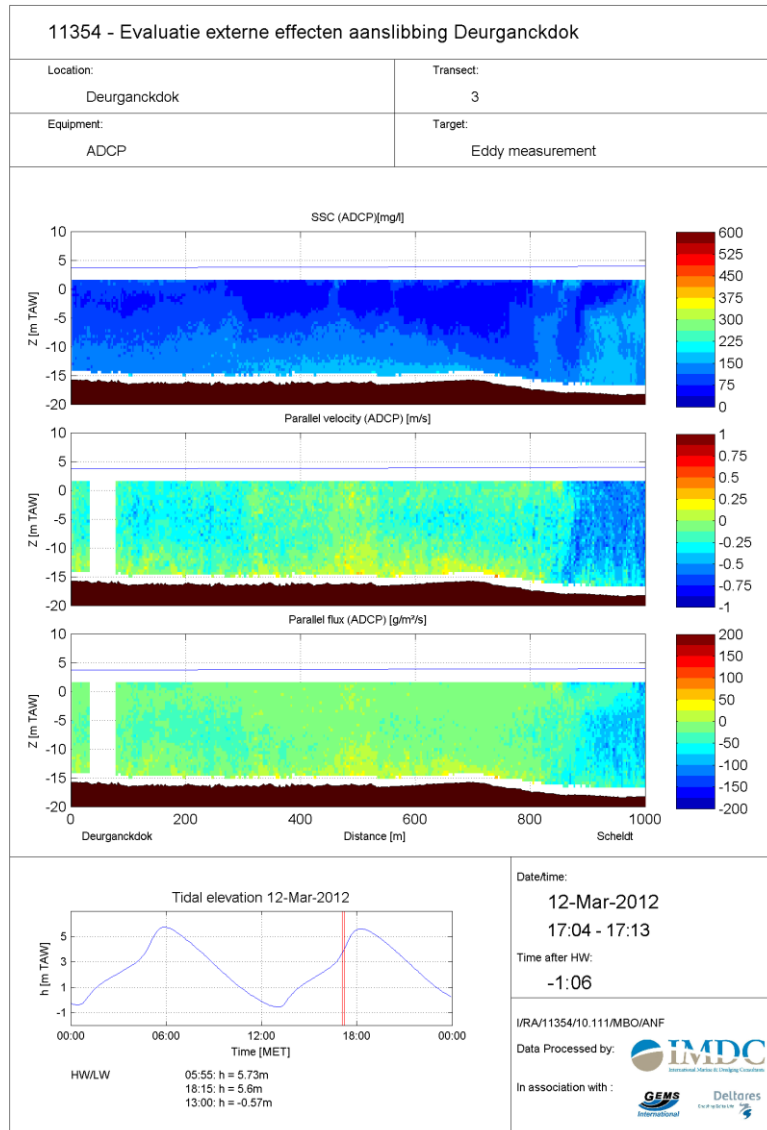


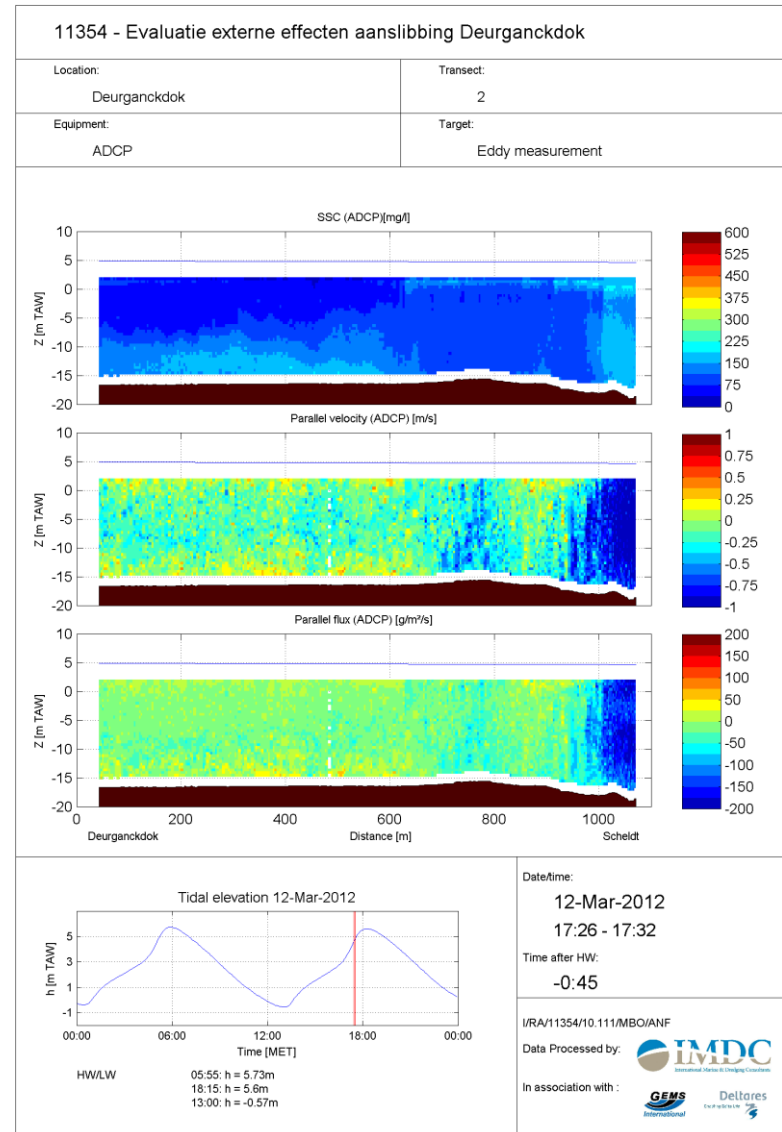


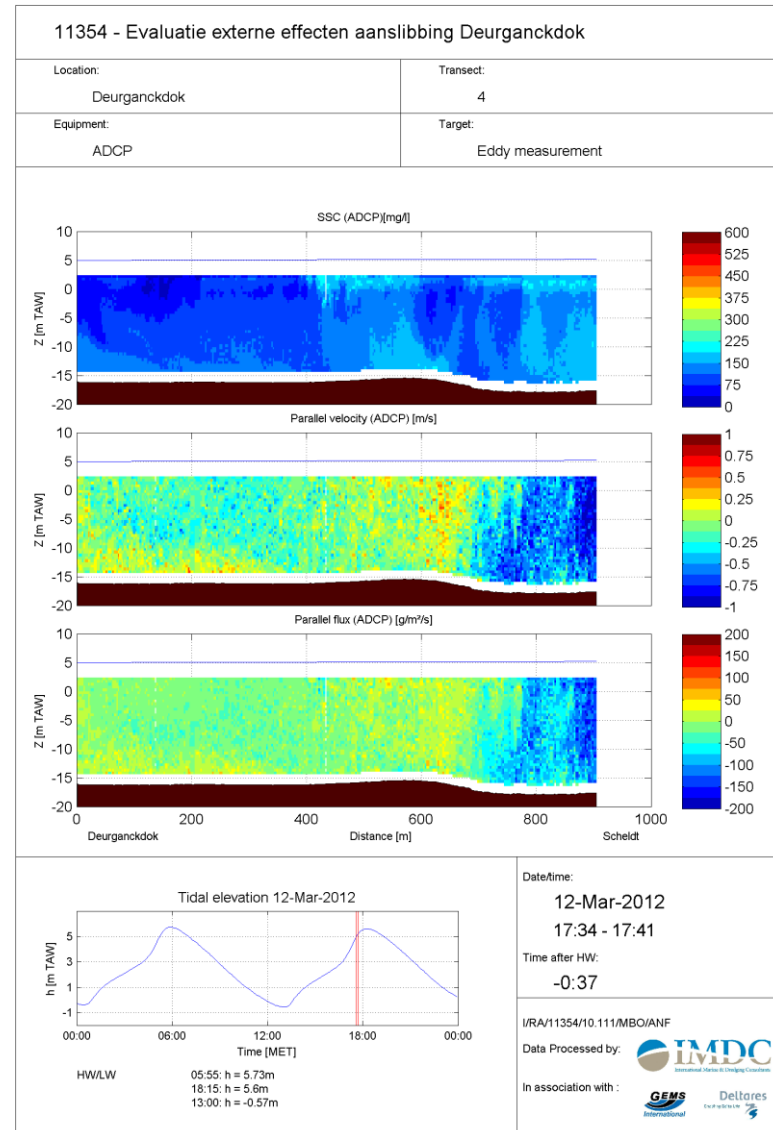


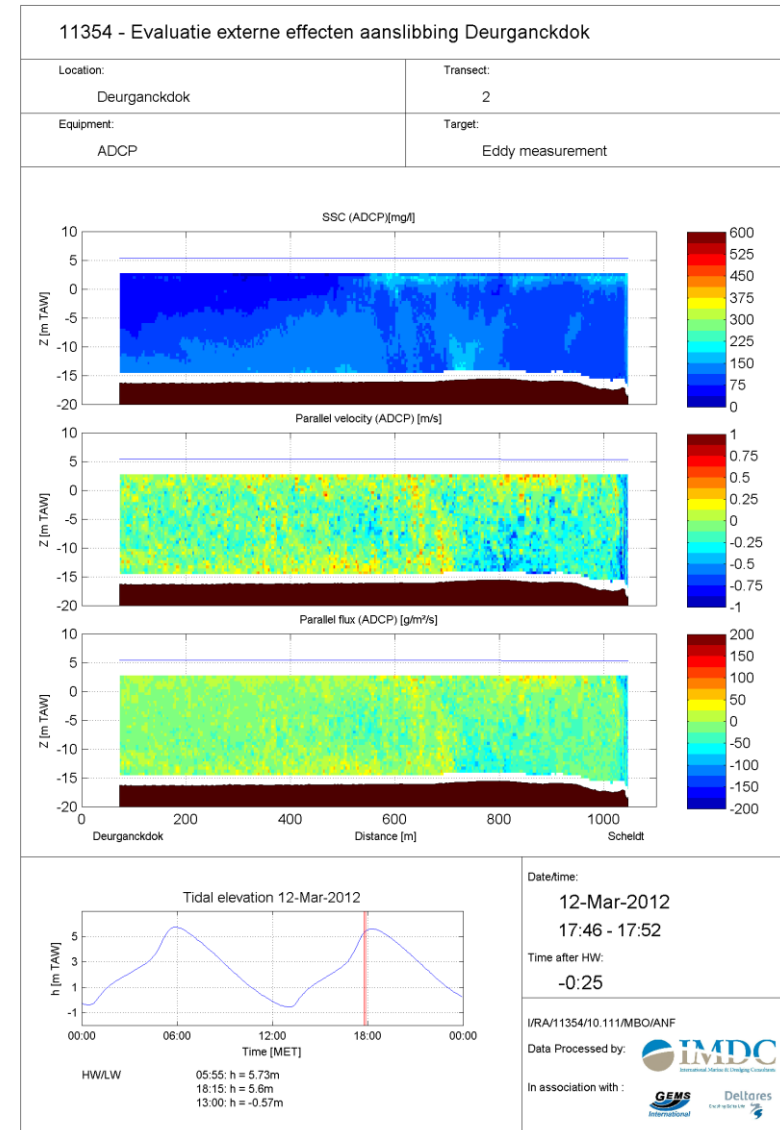
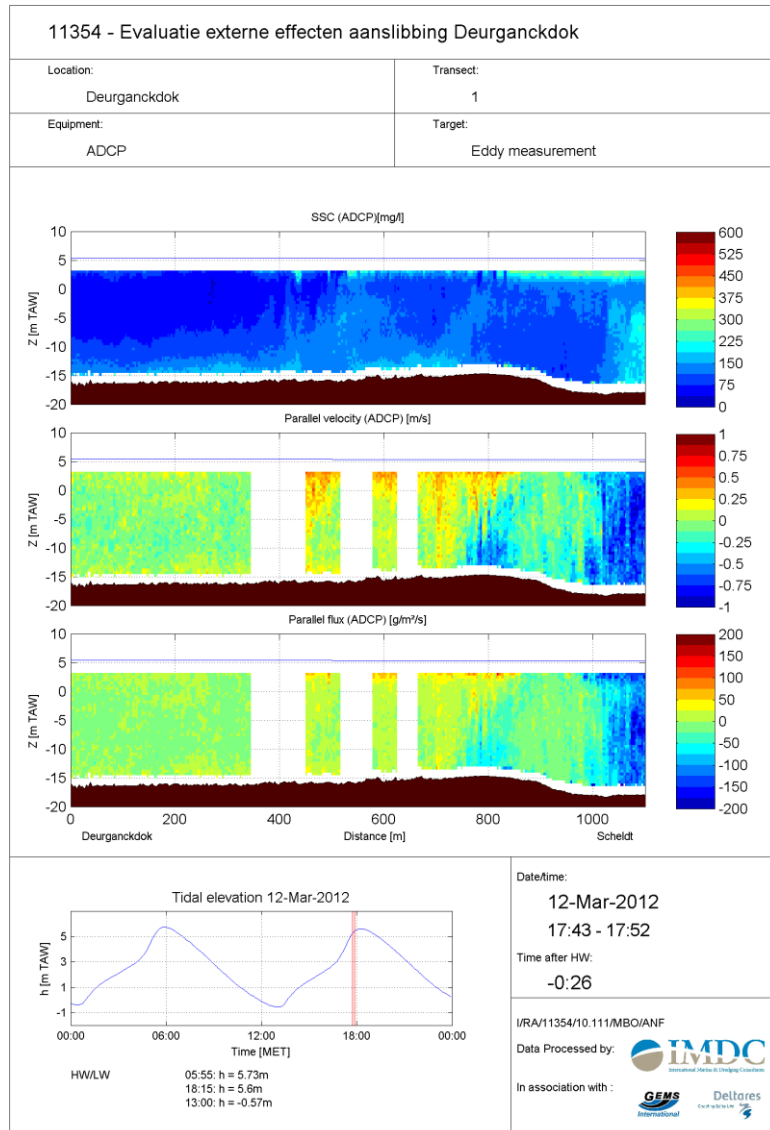


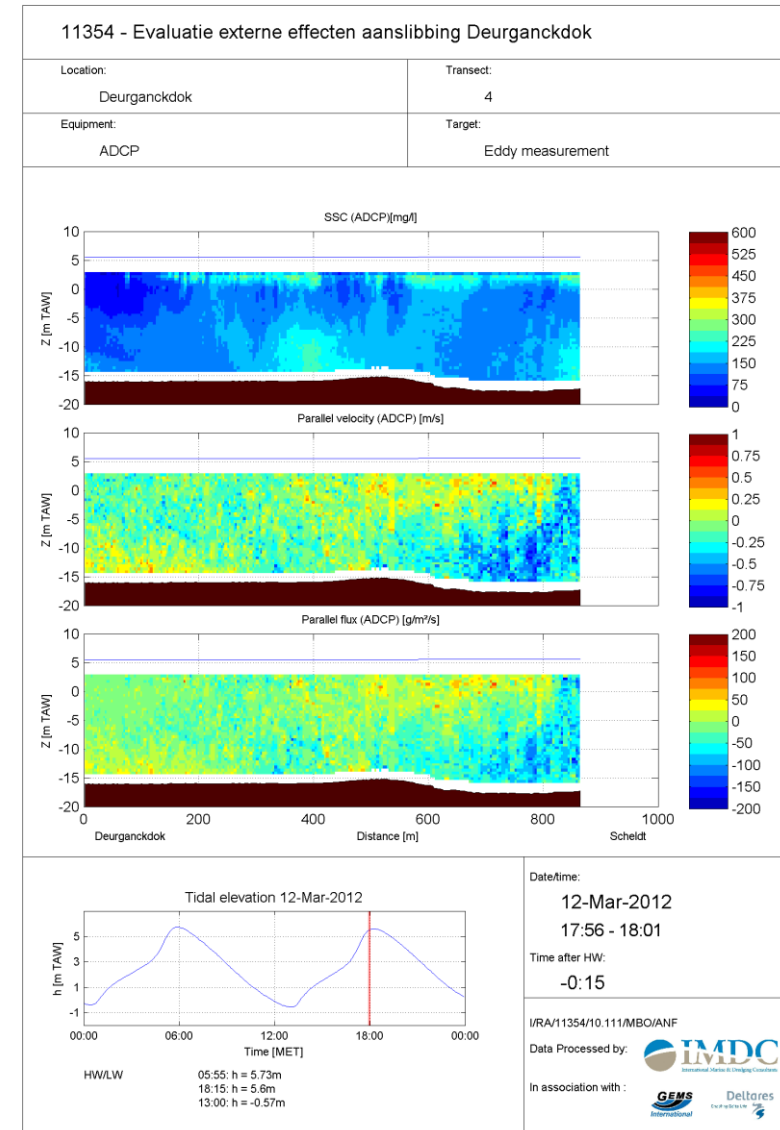
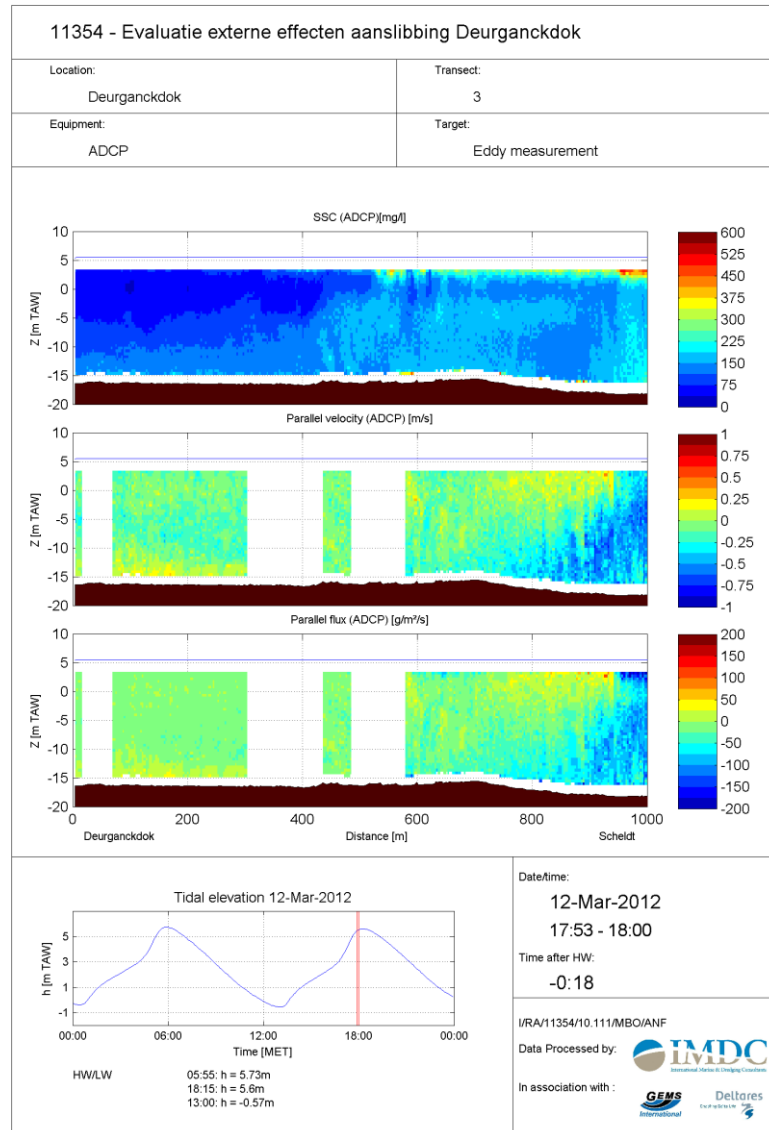


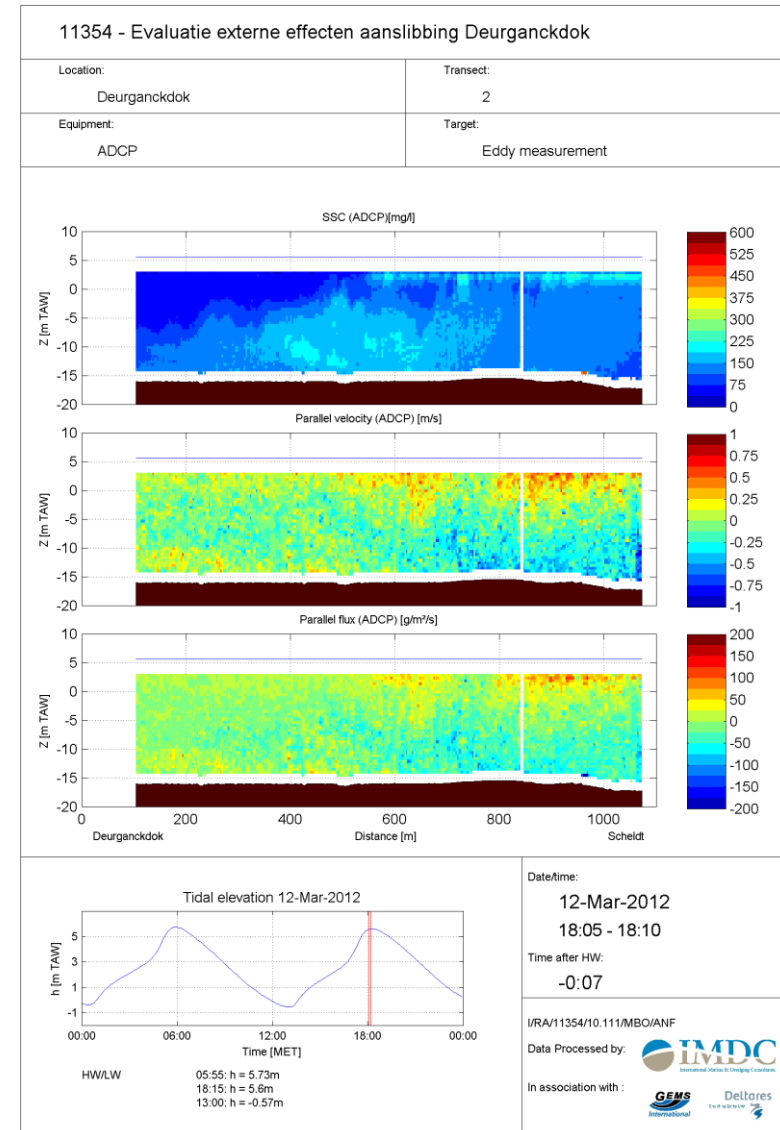
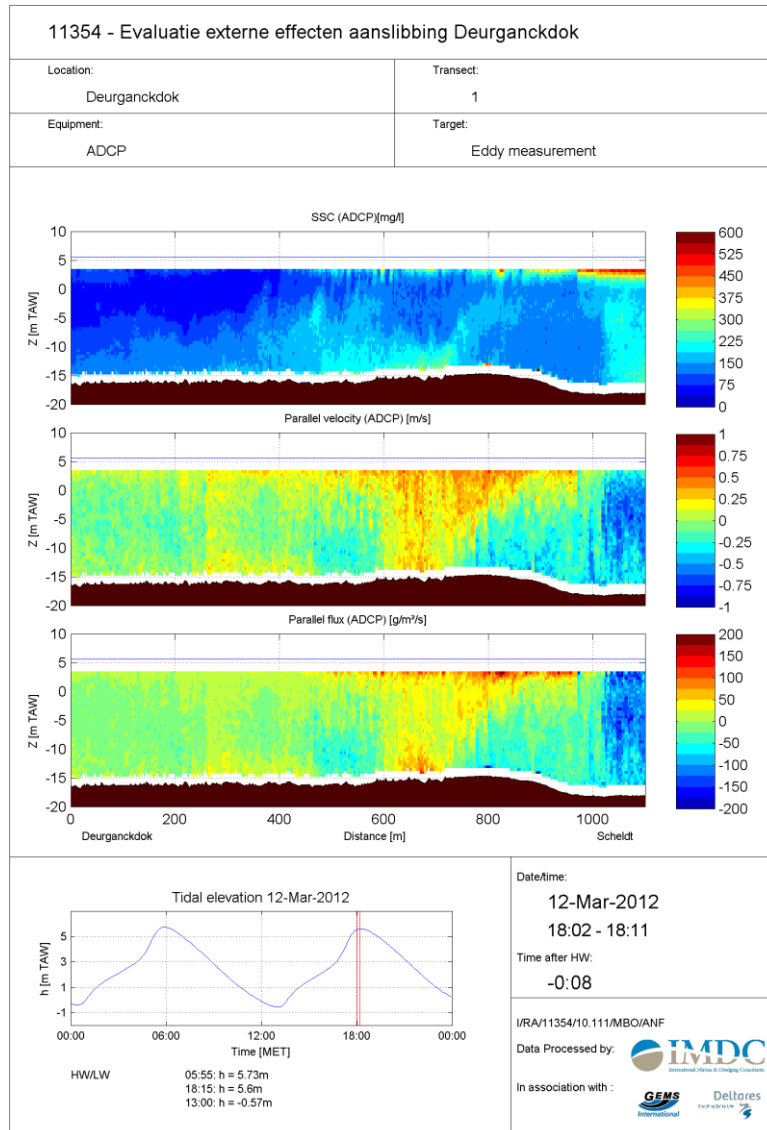


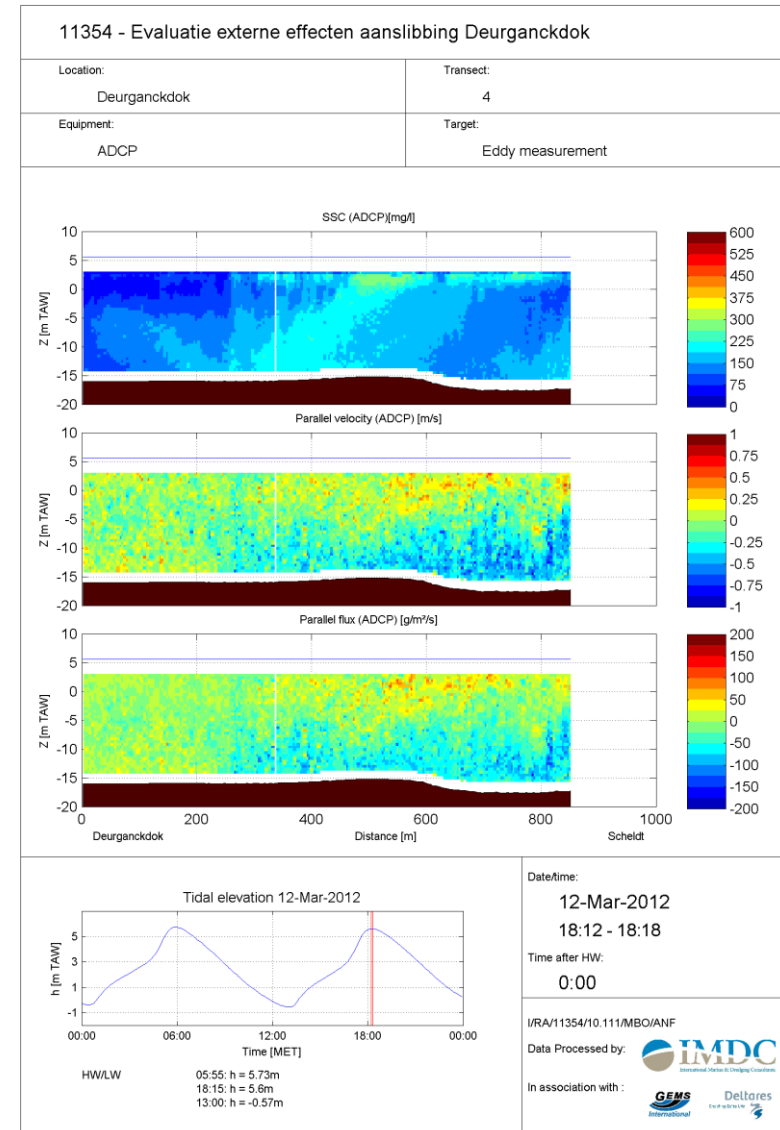
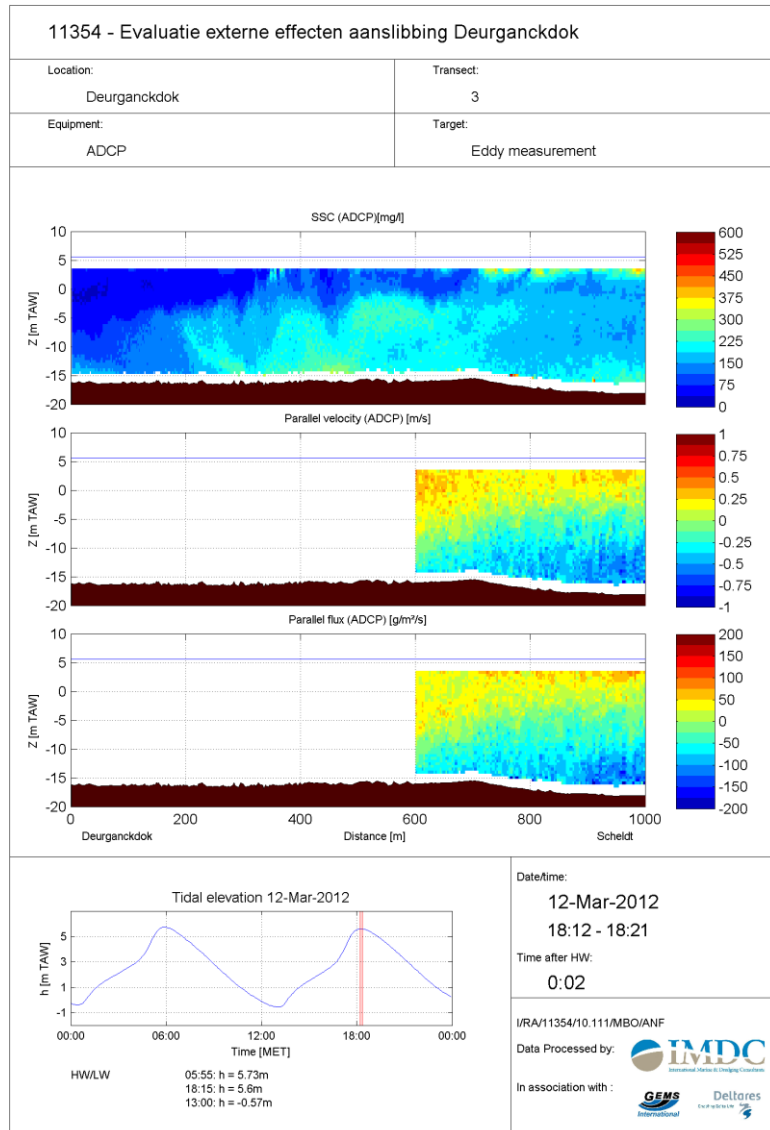


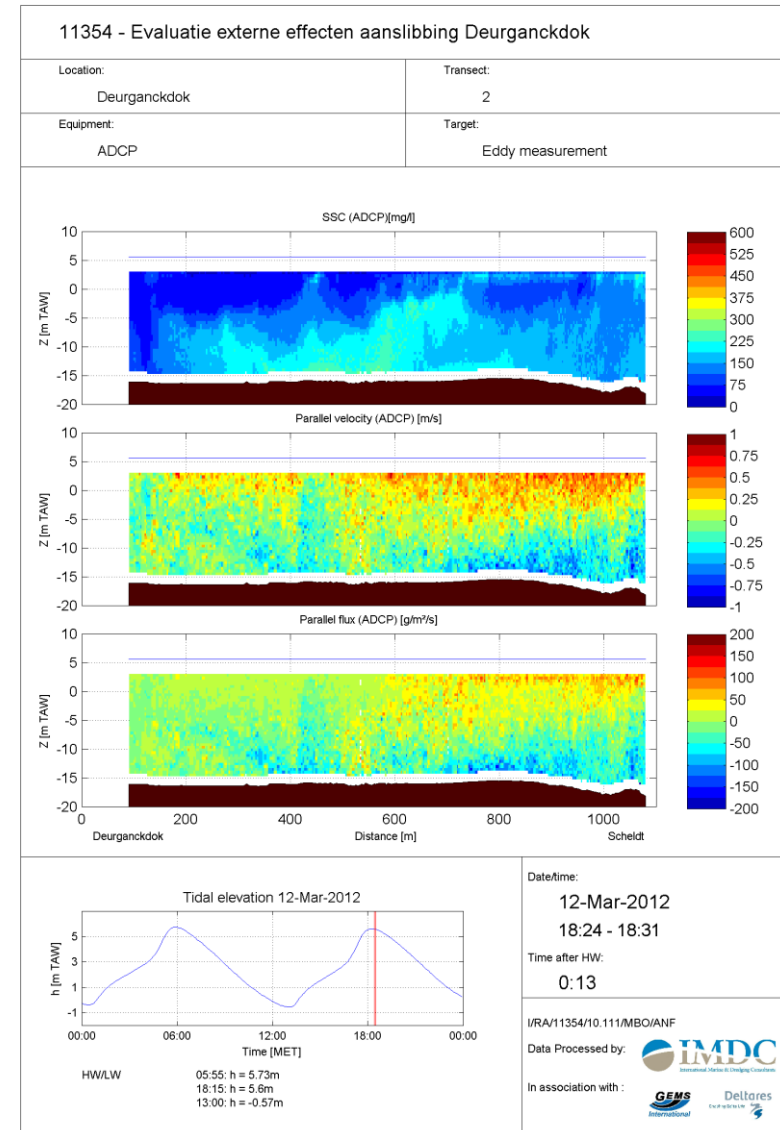
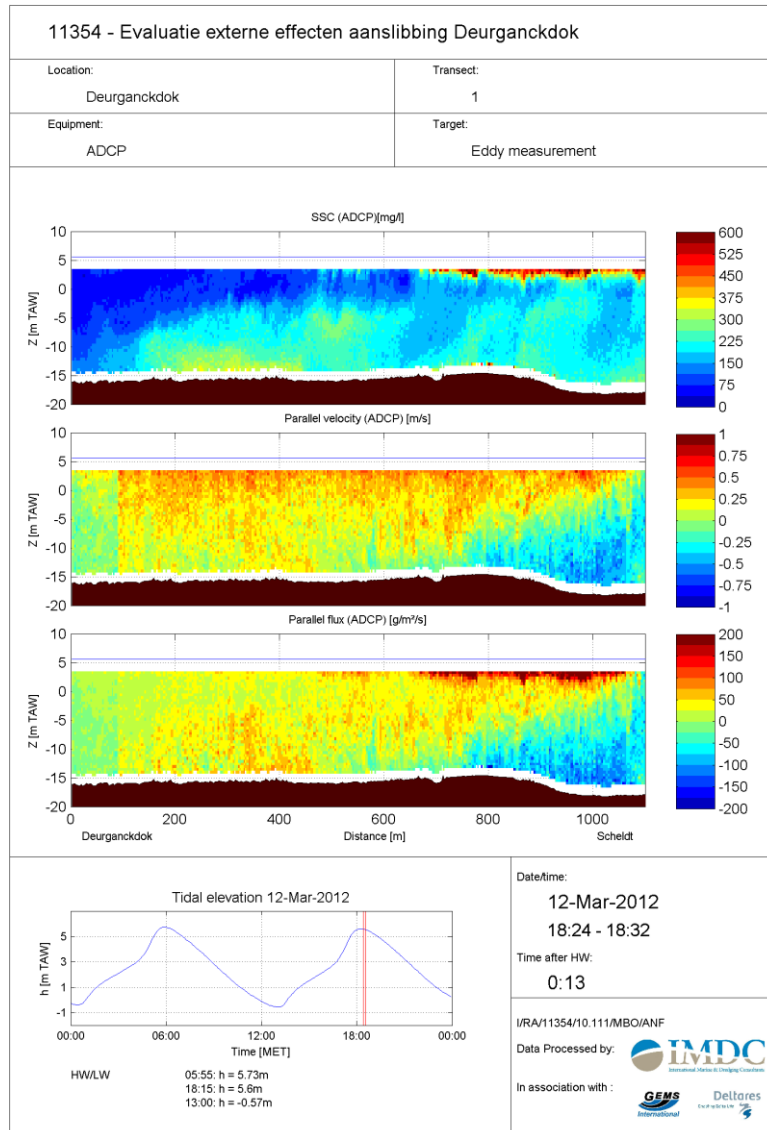


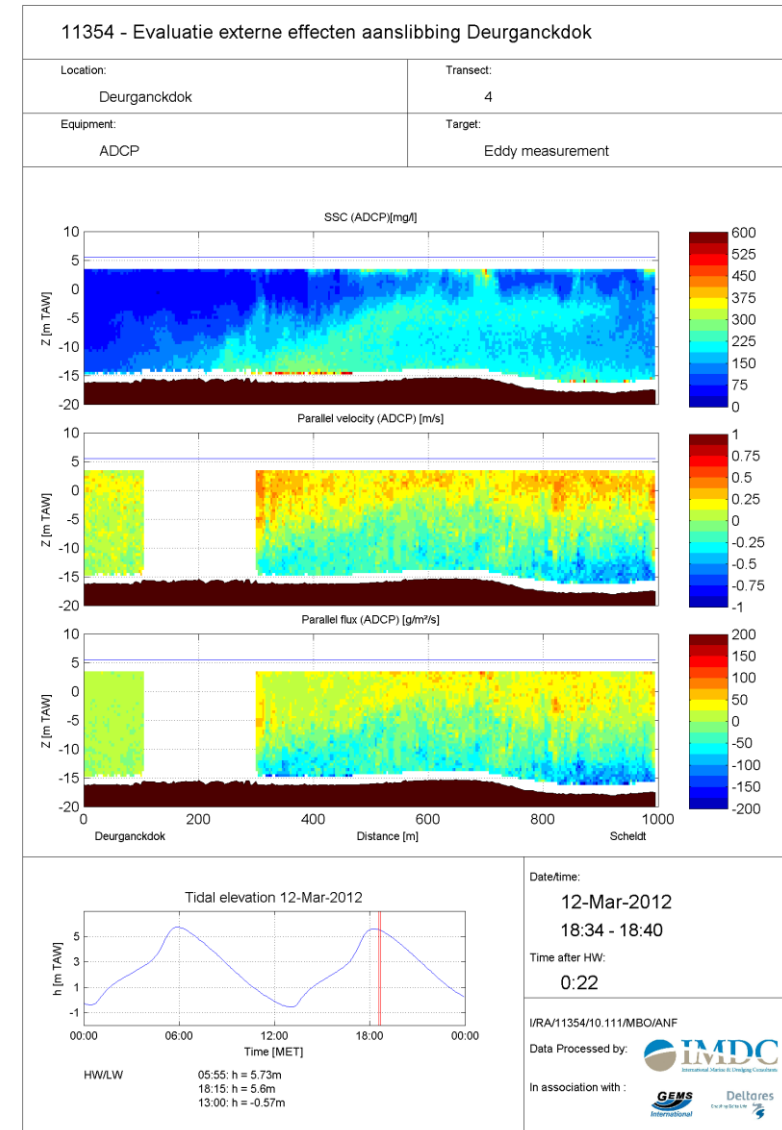
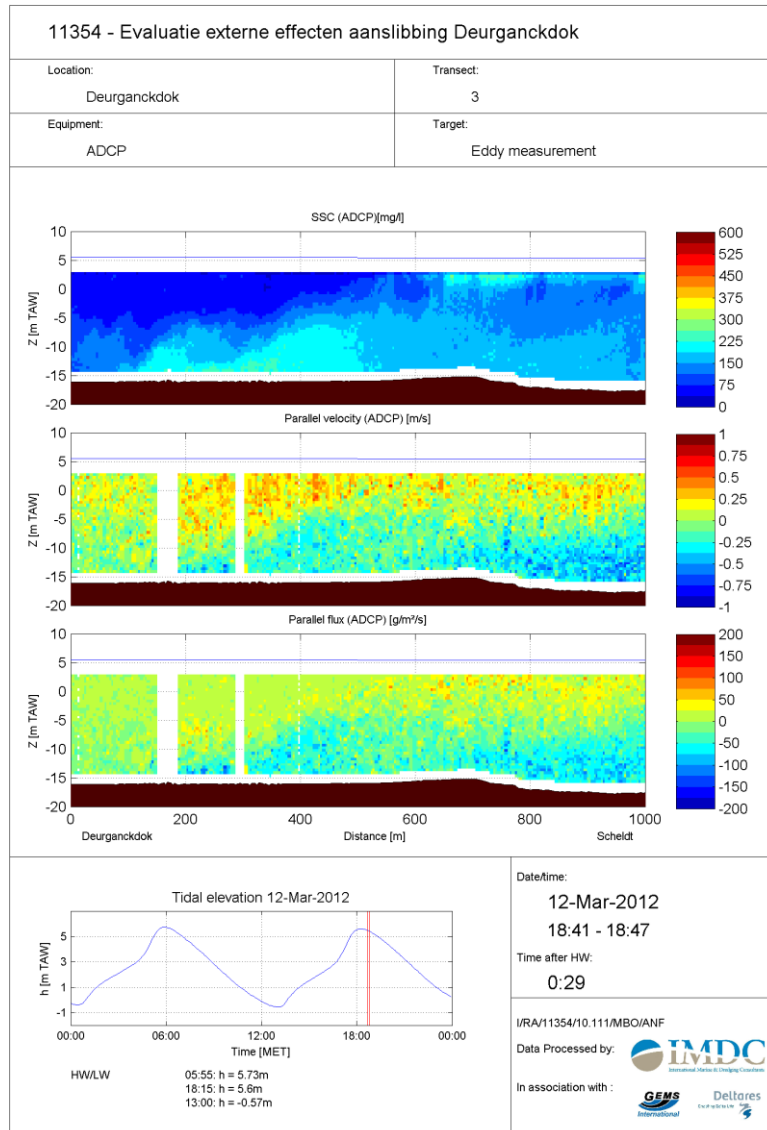


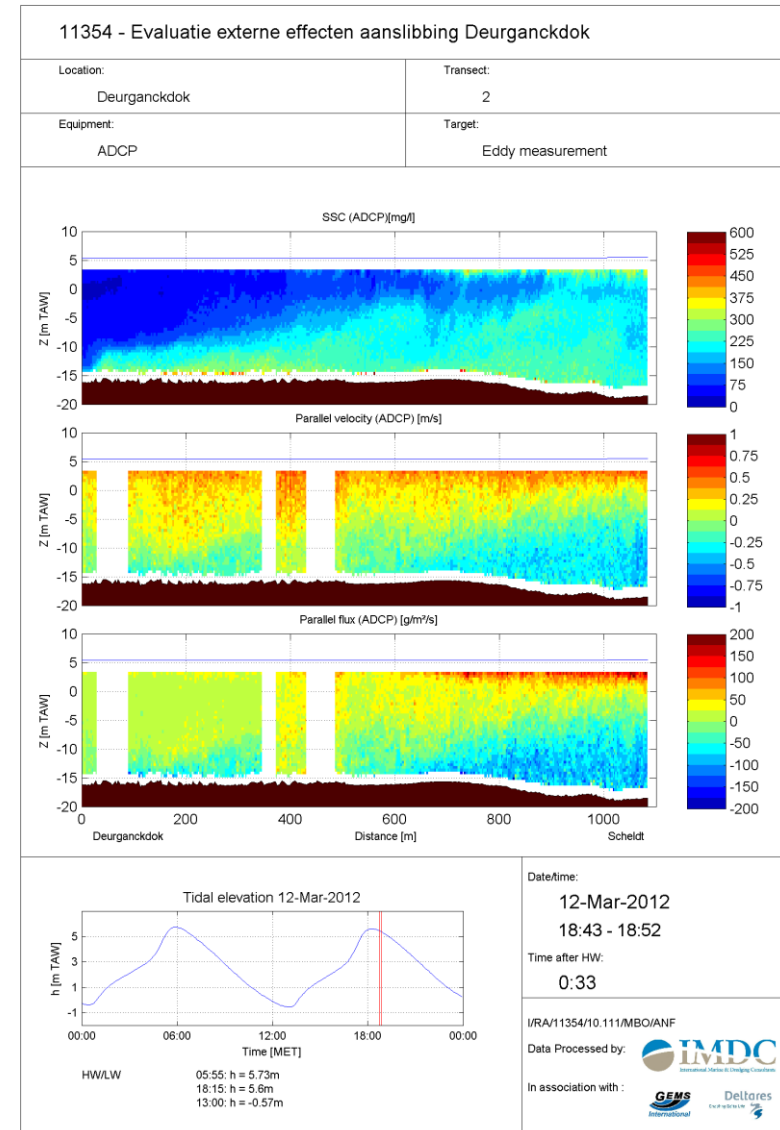
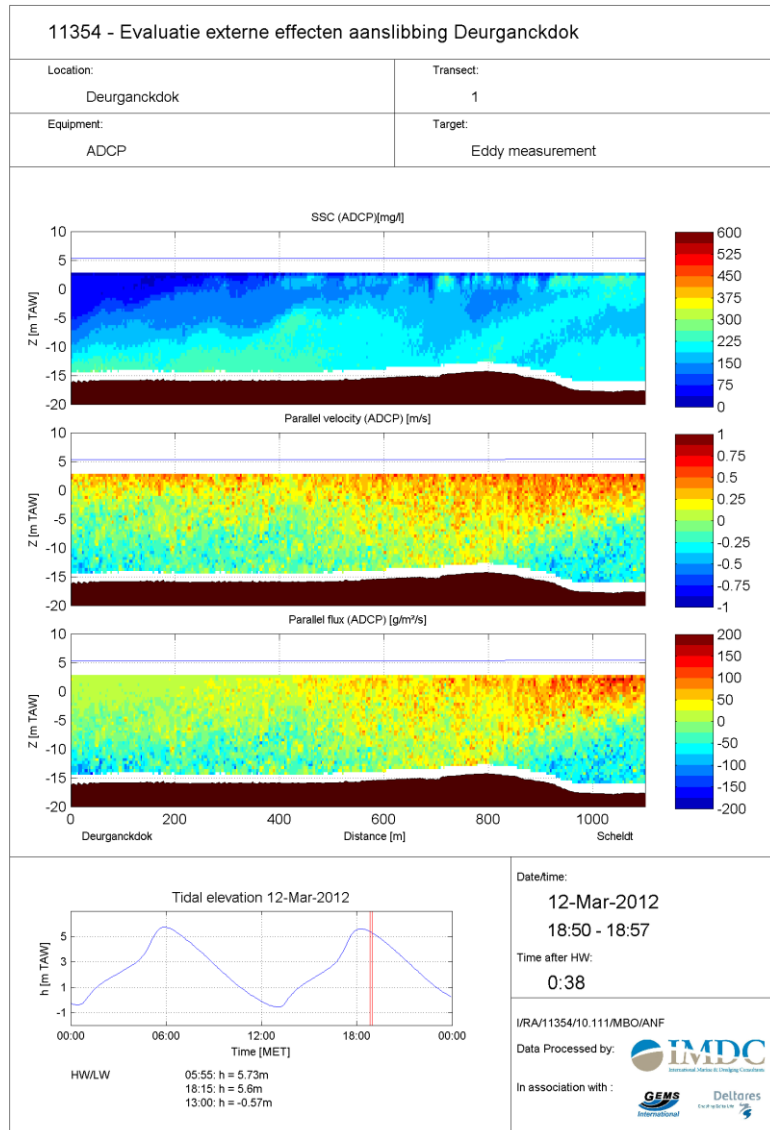


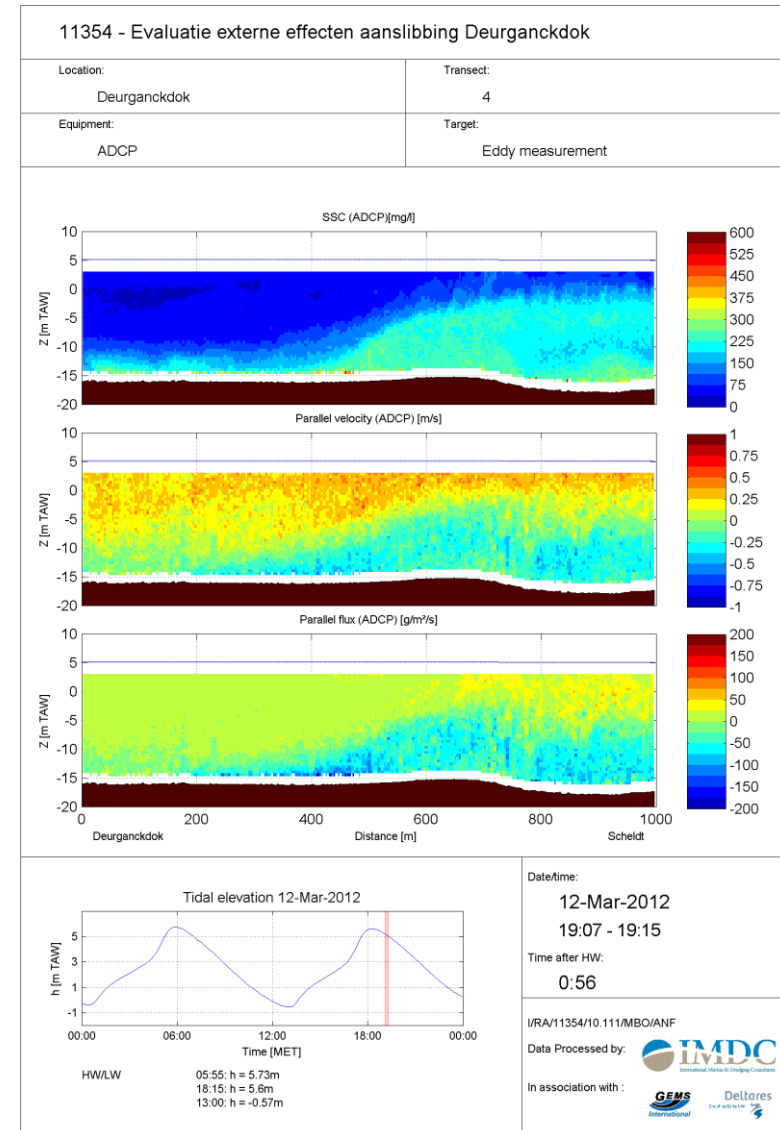
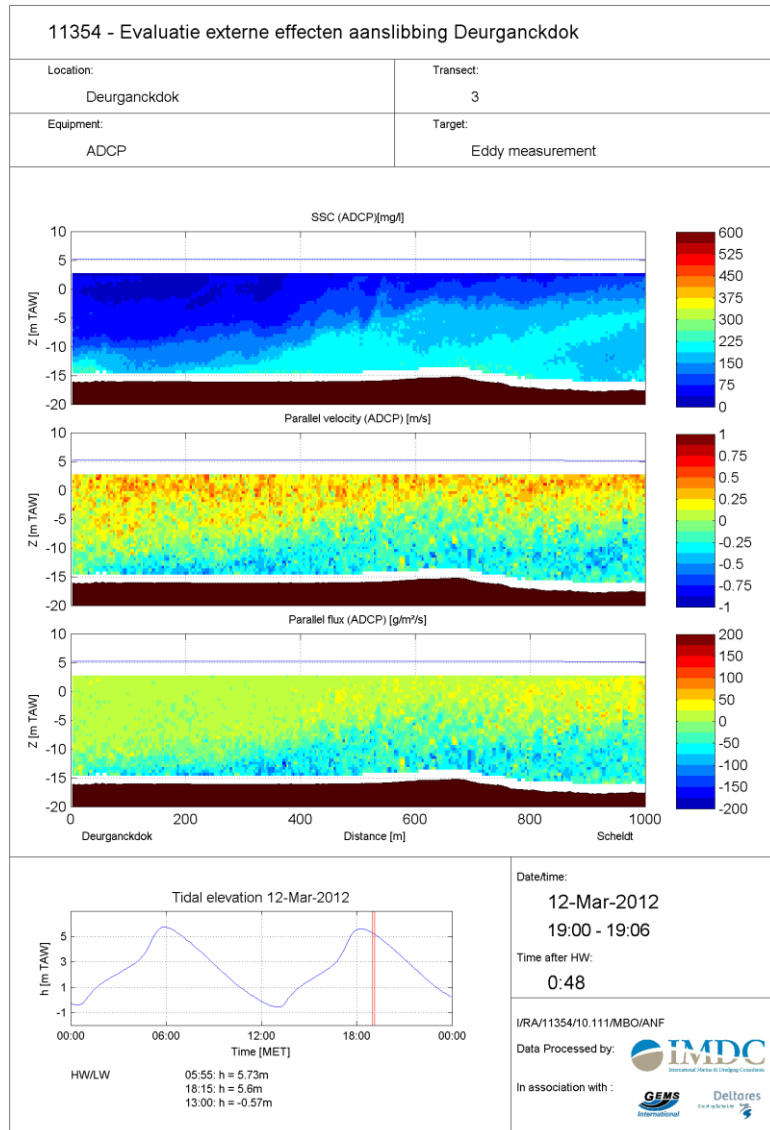


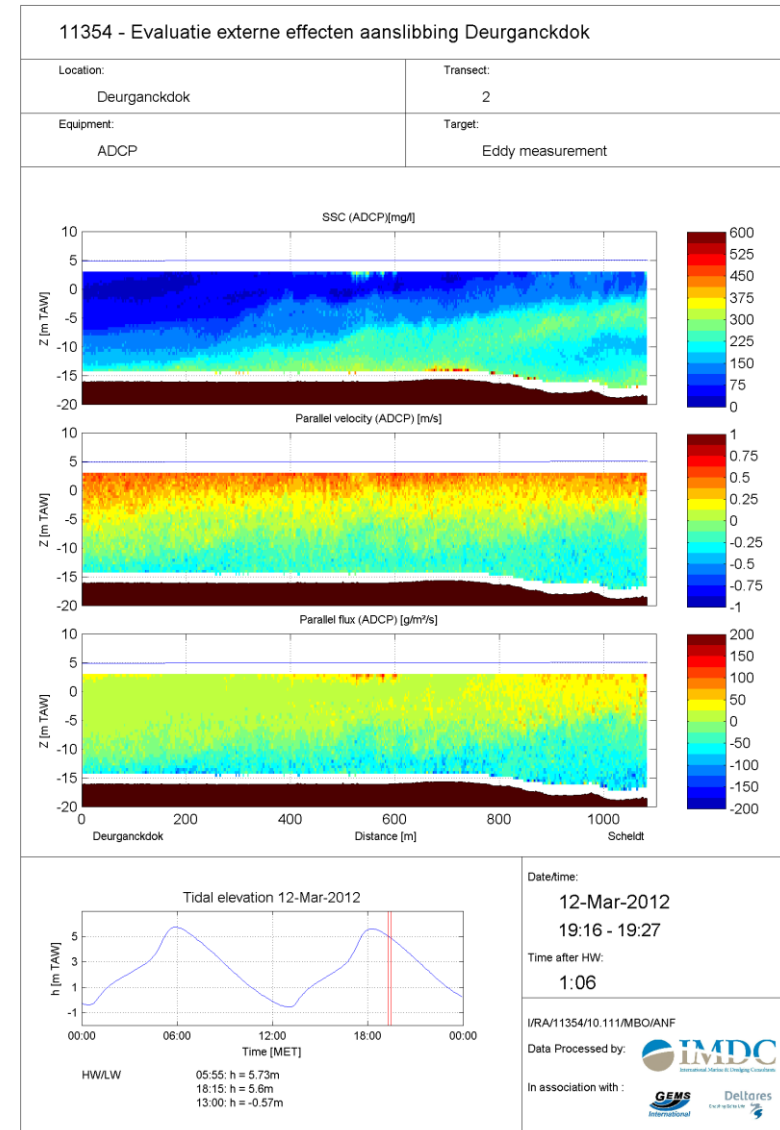
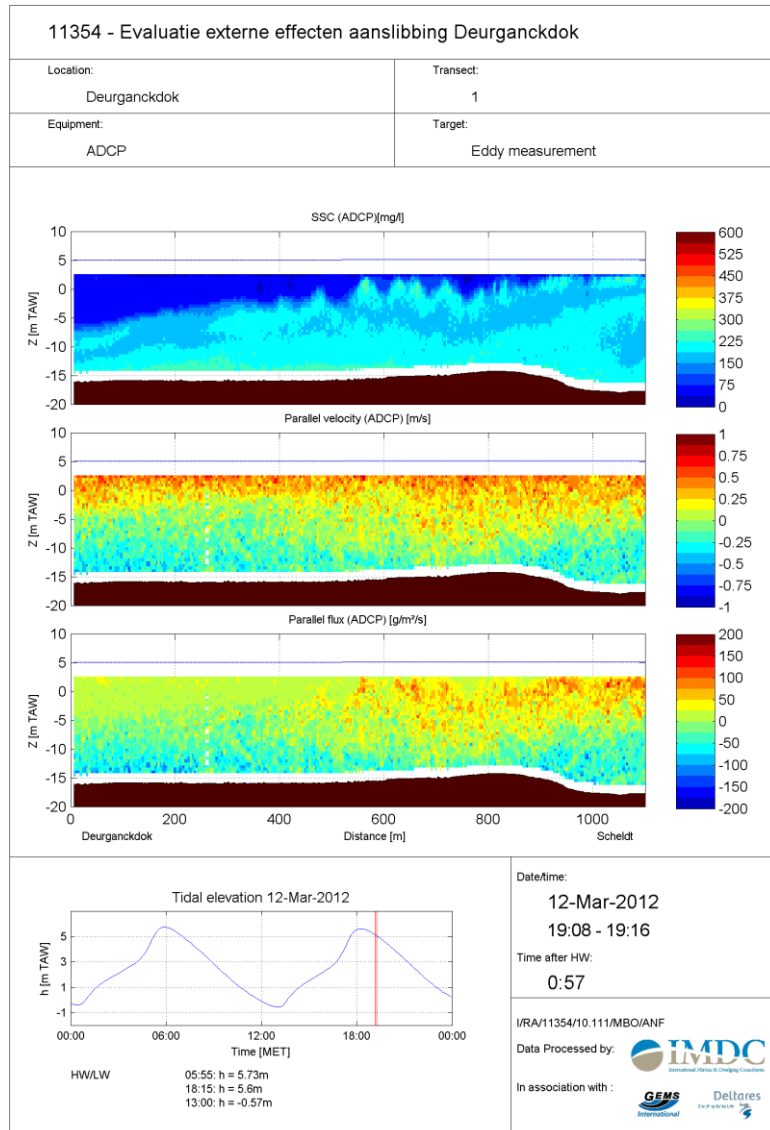


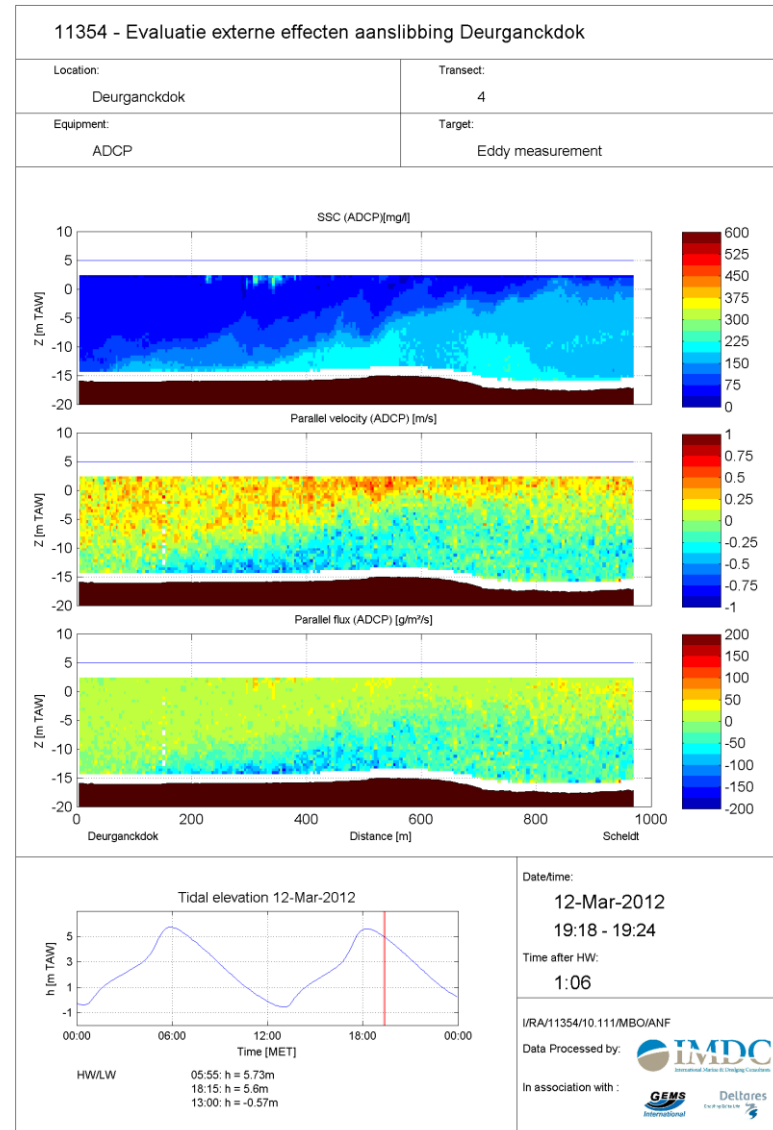


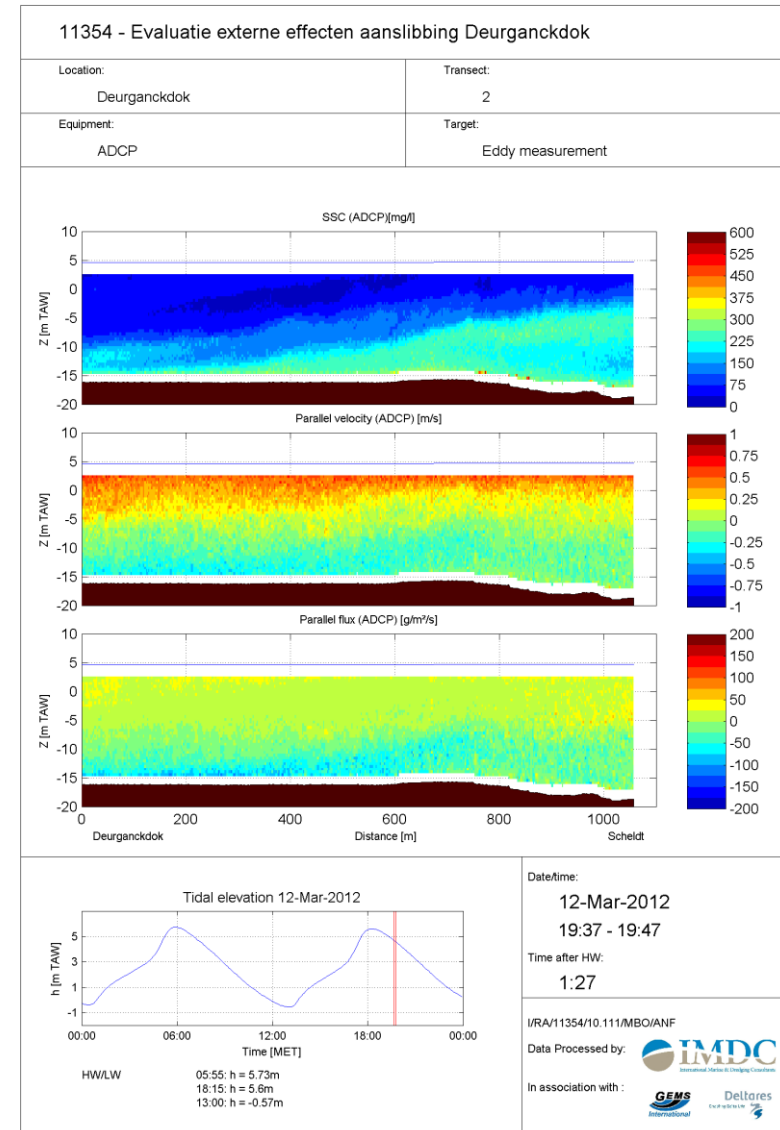
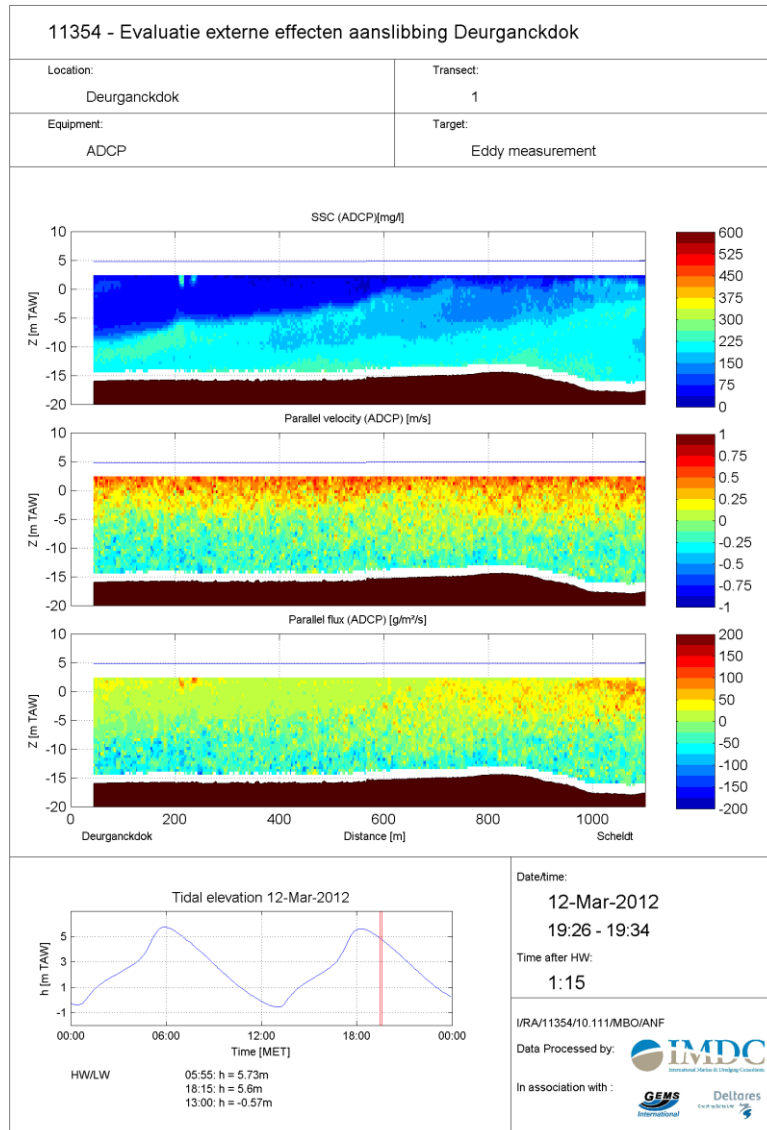


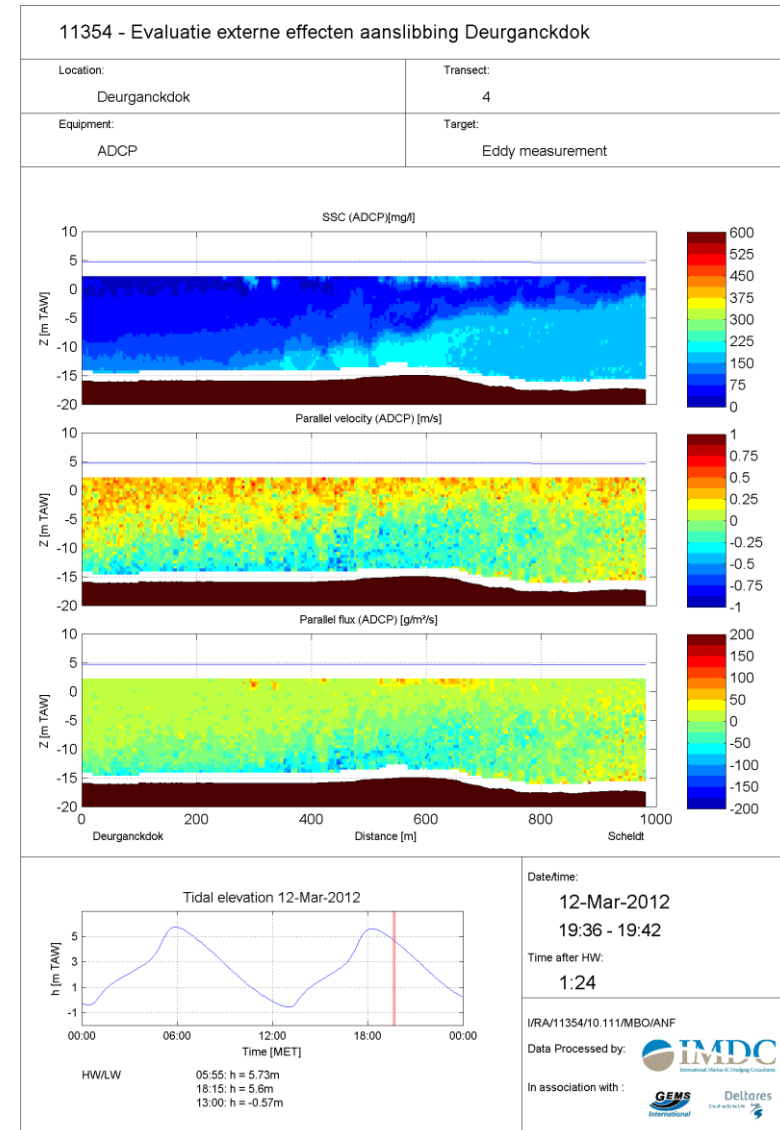
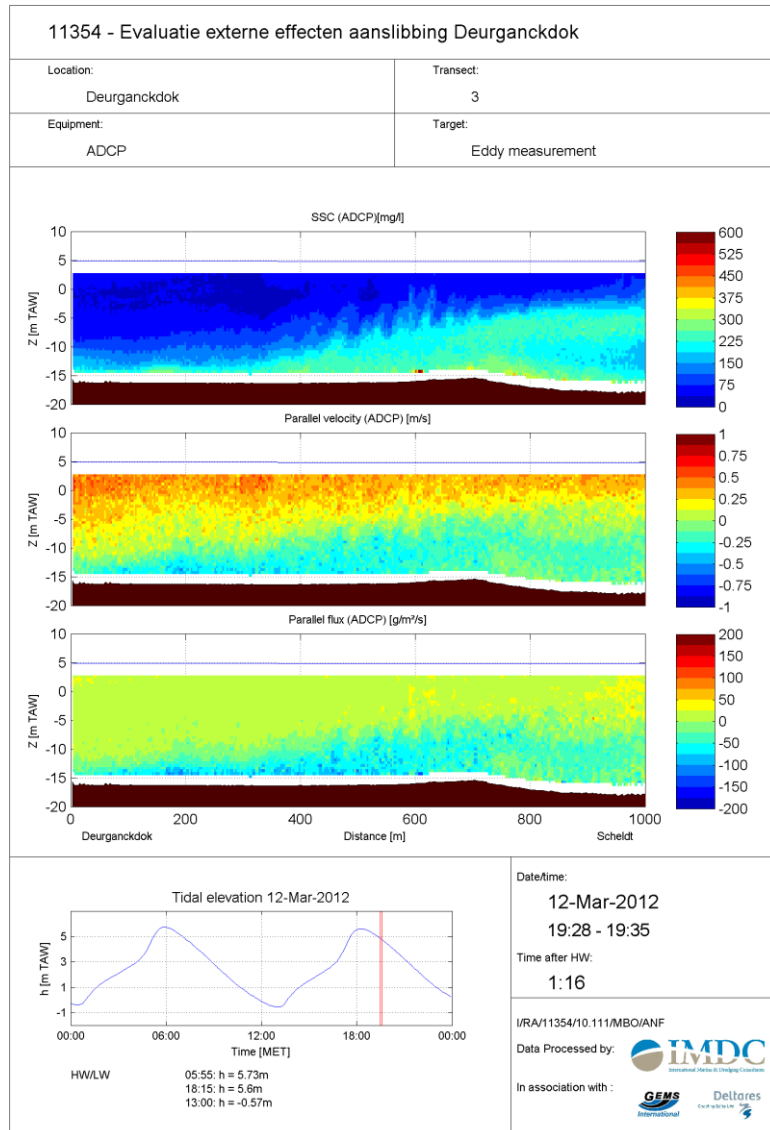


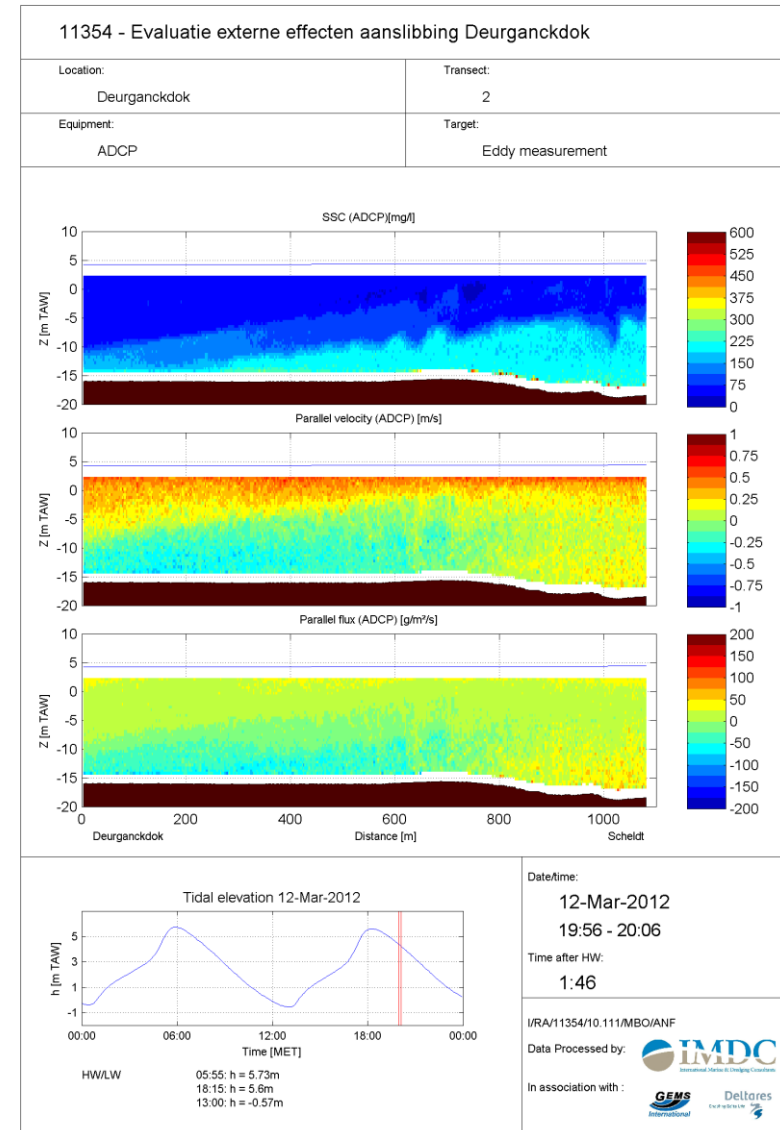
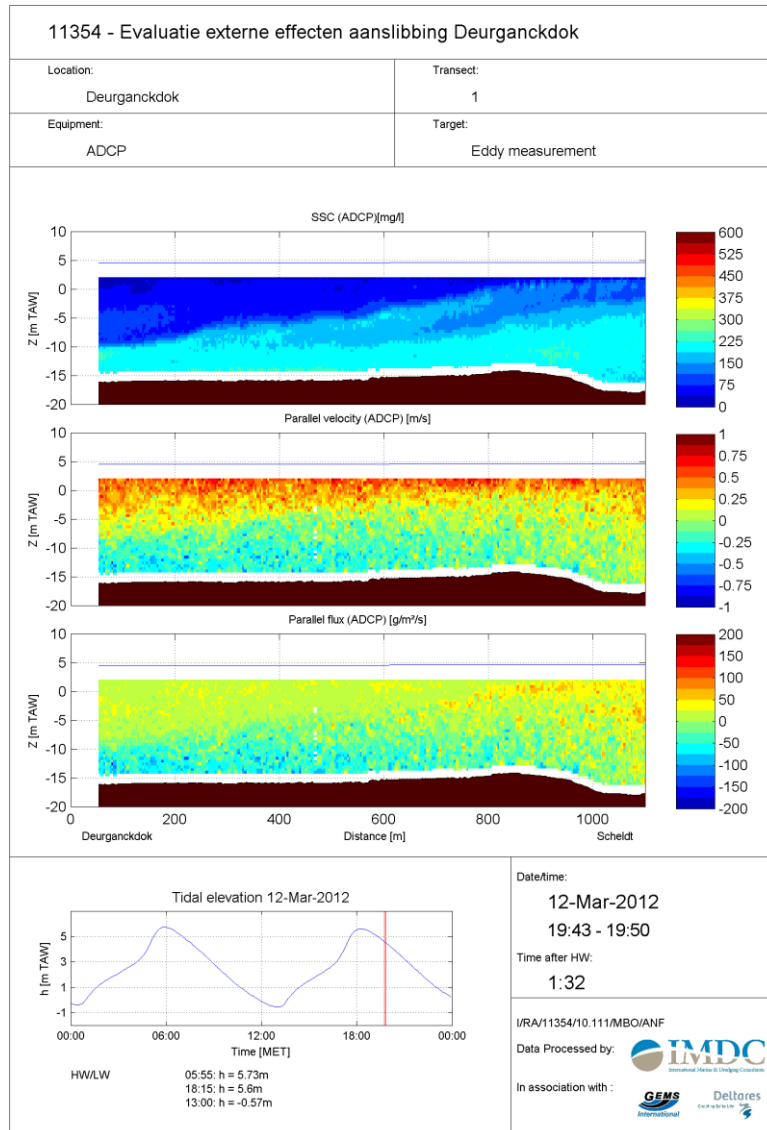


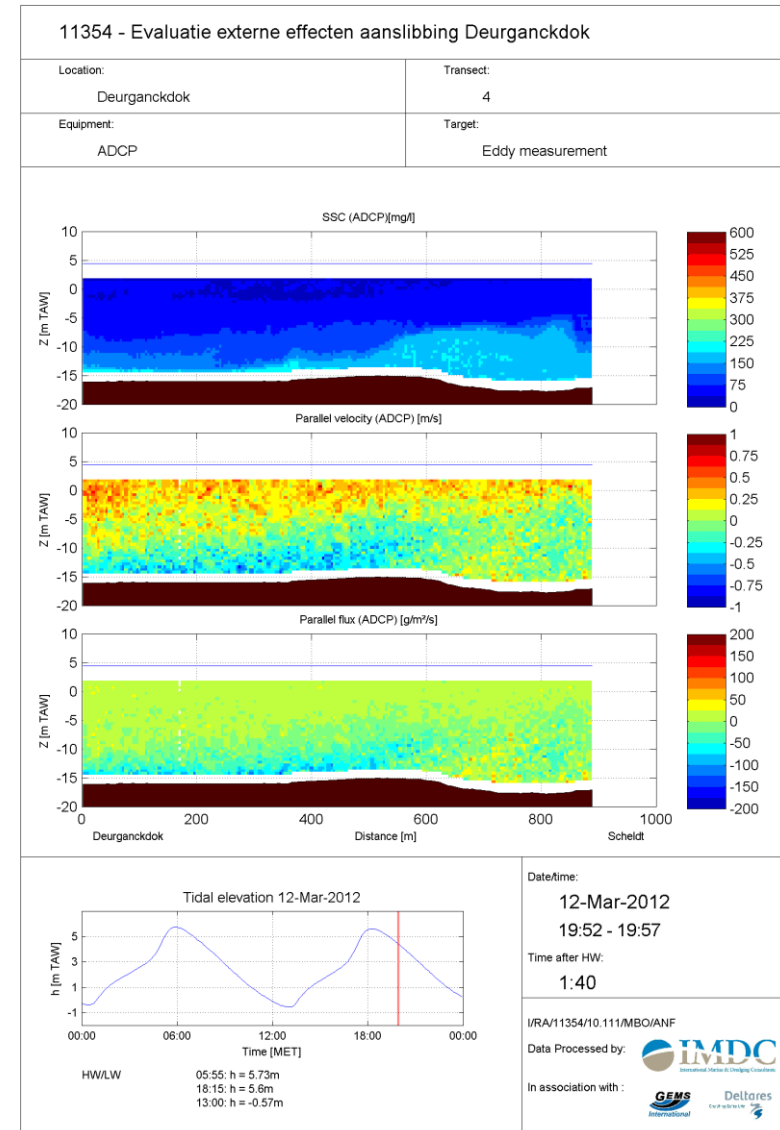
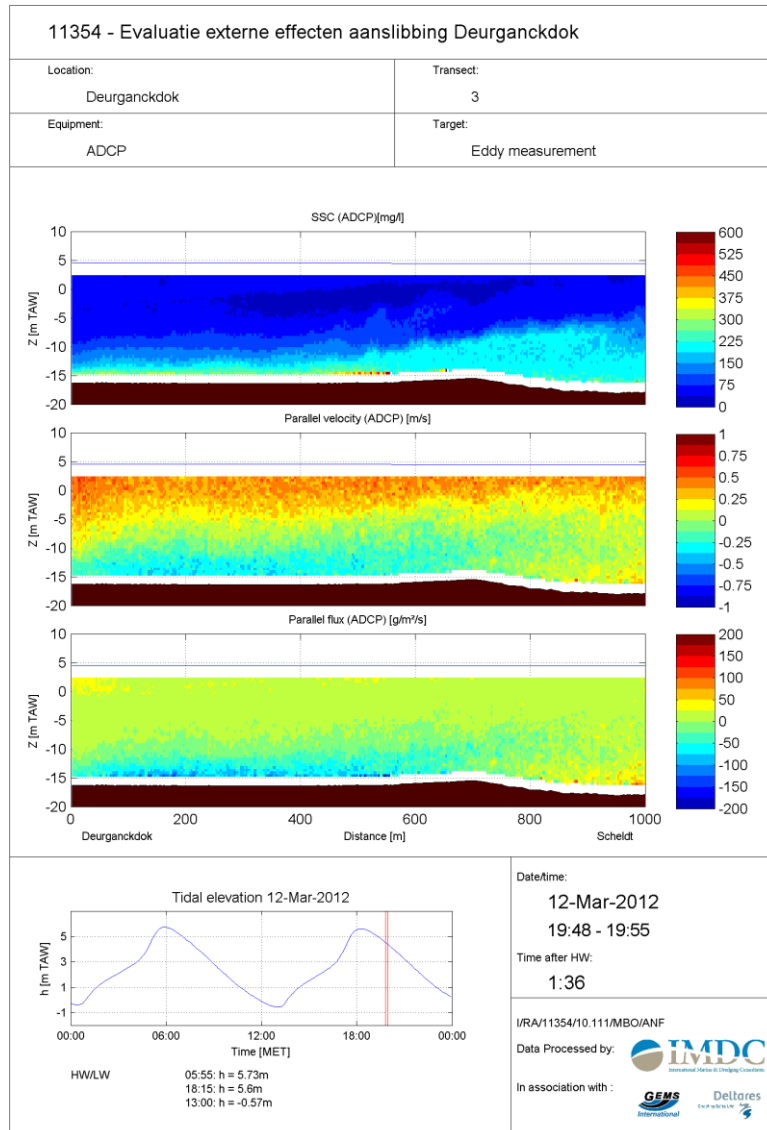




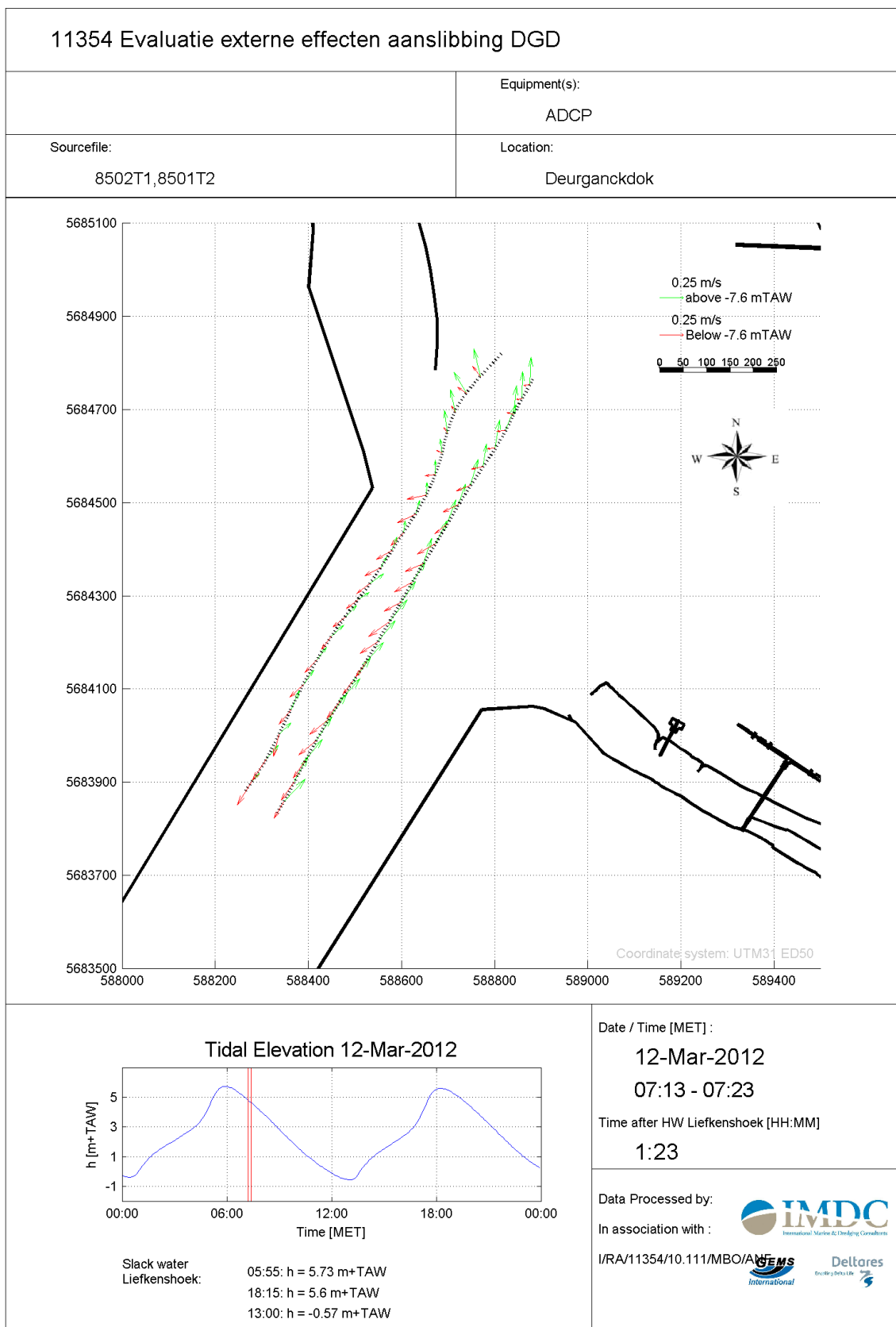






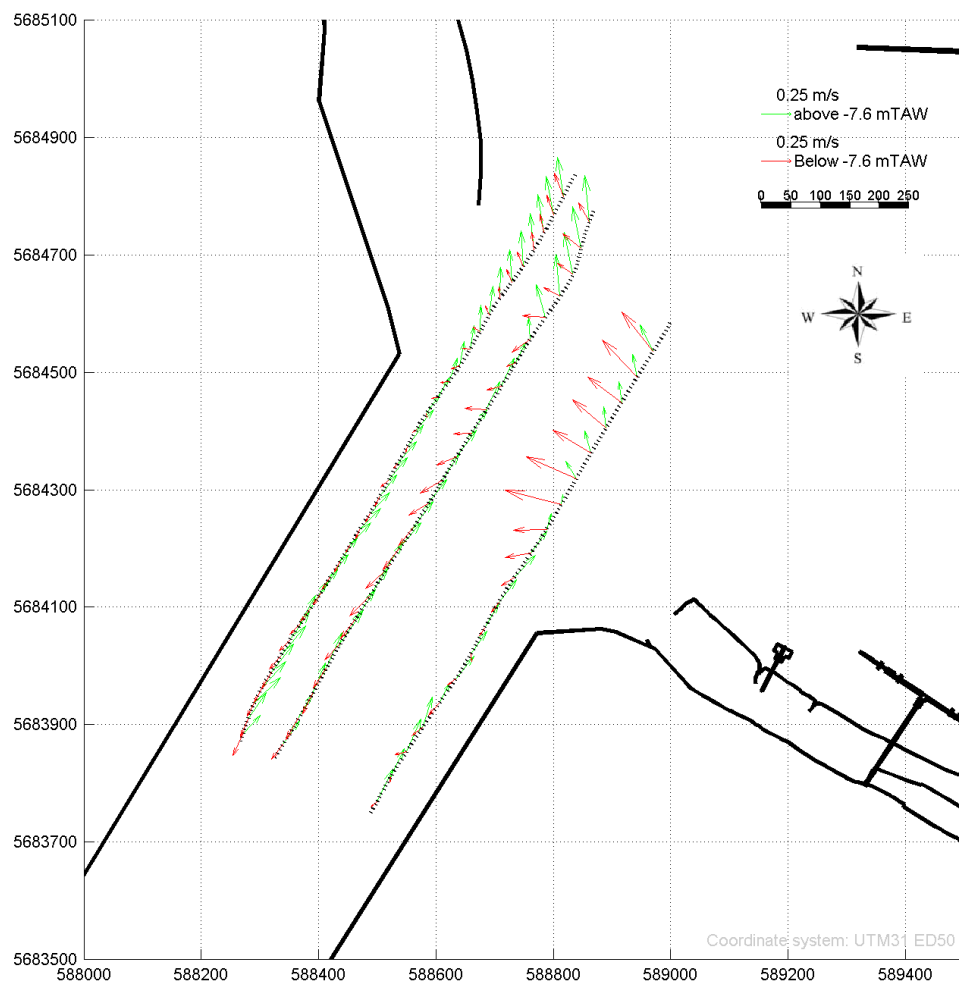


Annex F Maps of the measured depth averaged velocity fields

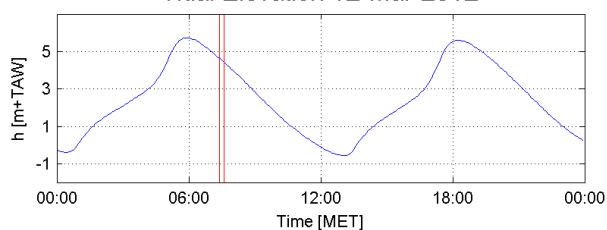


11354 Evaluatie externe effecten aanslibbing DGD

	Equipment(s): ADCP
Sourcefile: 8001T1,8503T2,8504T4	Location: Deurganckdok



Tidal Elevation 12-Mar-2012



Slack water
Liefkenshoek:

05:55:	$h = 5.73 \text{ m+TAW}$
18:15:	$h = 5.6 \text{ m+TAW}$
13:00:	$h = -0.57 \text{ m+TAW}$

Date / Time [MET] :

12-Mar-2012

07:23 - 07:36

Time after HW Liefkenshoek [HH:MM]

1:35

Data Processed by:

In association with :

I/RA/11354/10.111/MBO/ANF



11354 Evaluatie externe effecten aanslibbing DGD

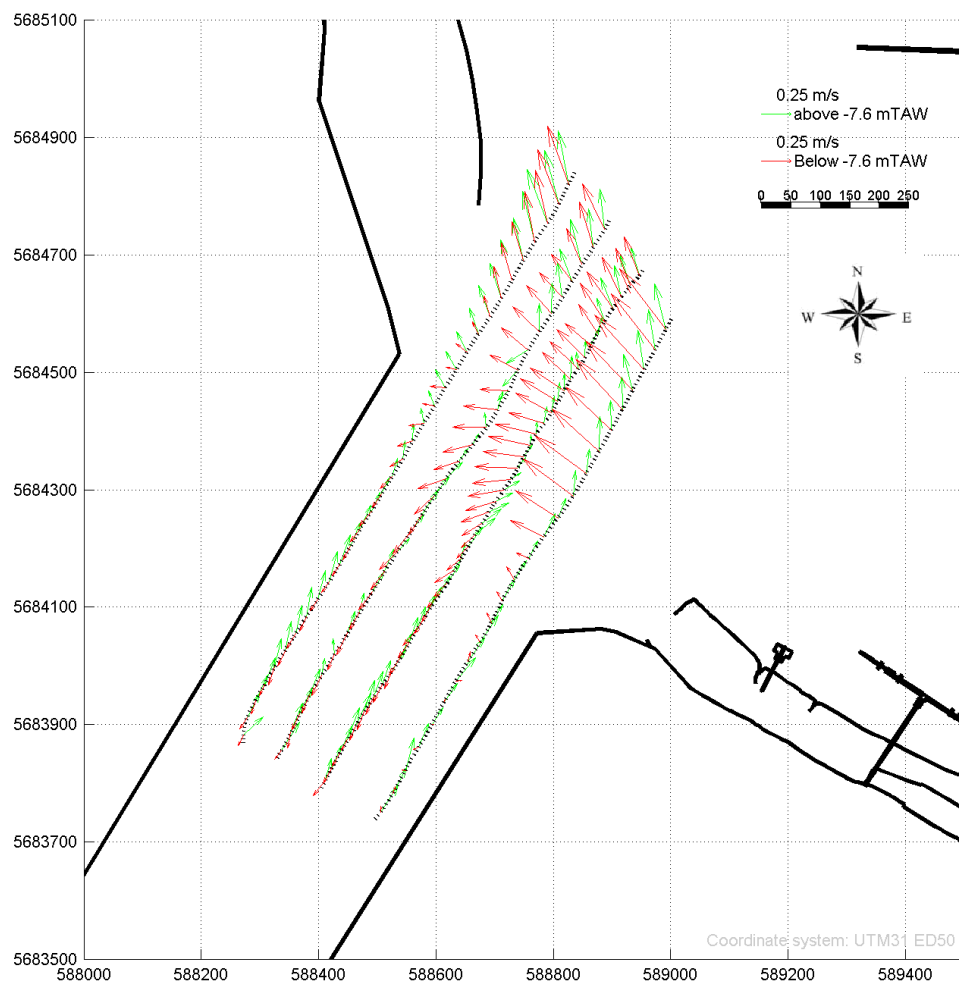
Equipment(s):

ADCP

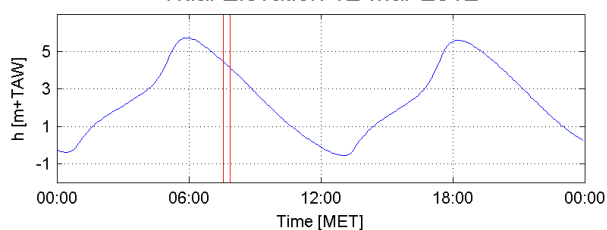
Sourcefile:

Location:

Deurganckdok



Tidal Elevation 12-Mar-2012



Slack water
Liefkenshoek:
05:55: h = 5.73 m+TAW
18:15: h = 5.6 m+TAW
13:00: h = -0.57 m+TAW

Date / Time [MET] :

12-Mar-2012

07:33 - 07:53

Time after HW Liefkenshoek [HH:MM]

1:48

Data Processed by:

In association with :

I/RA/11354/10.111/MBO/ANF



11354 Evaluatie externe effecten aanslibbing DGD

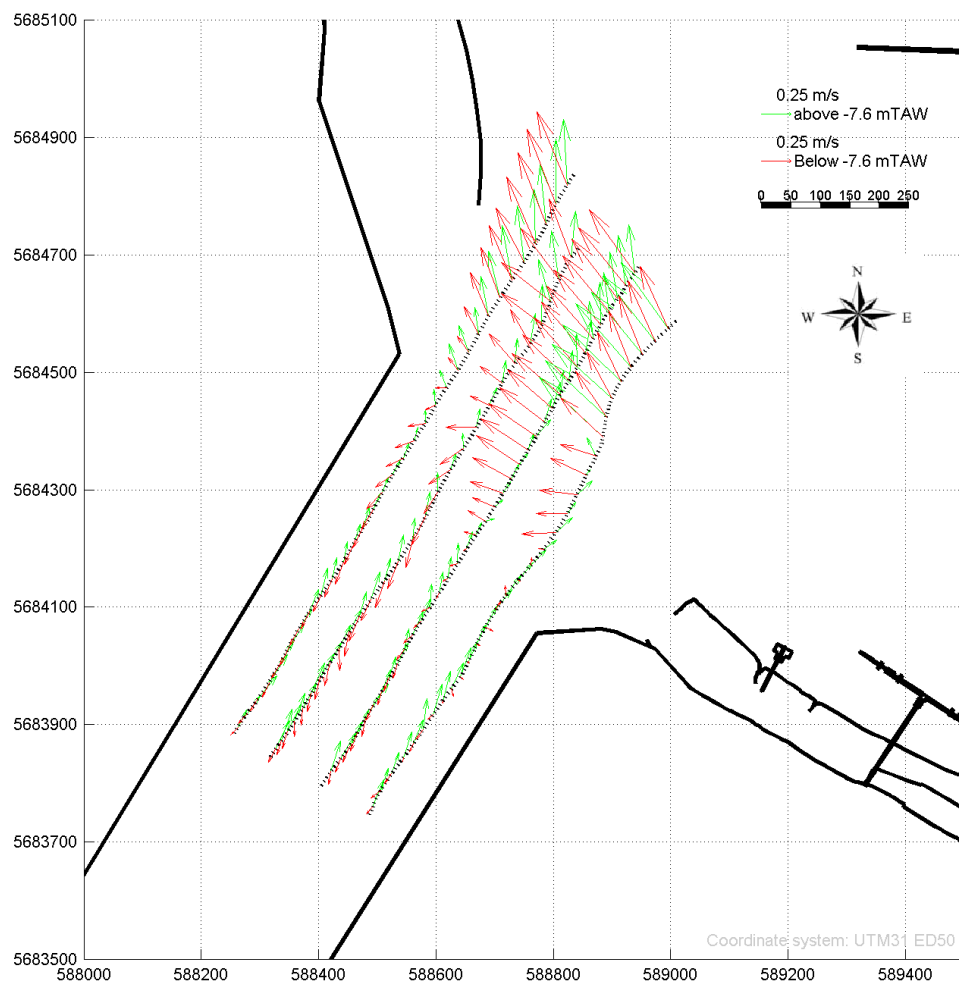
Equipment(s):

ADCP

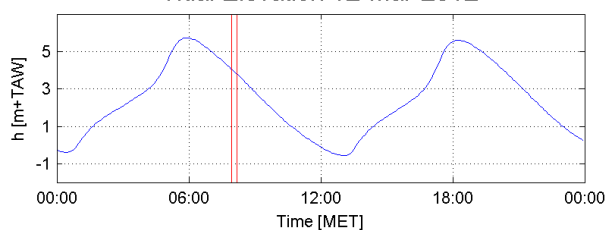
Sourcefile:

Location:

Deurganckdok



Tidal Elevation 12-Mar-2012



Slack water
Liefkenshoek:
05:55: h = 5.73 m+TAW
18:15: h = 5.6 m+TAW
13:00: h = -0.57 m+TAW

Date / Time [MET] :

12-Mar-2012

07:55 - 08:12

Time after HW Liefkenshoek [HH:MM]

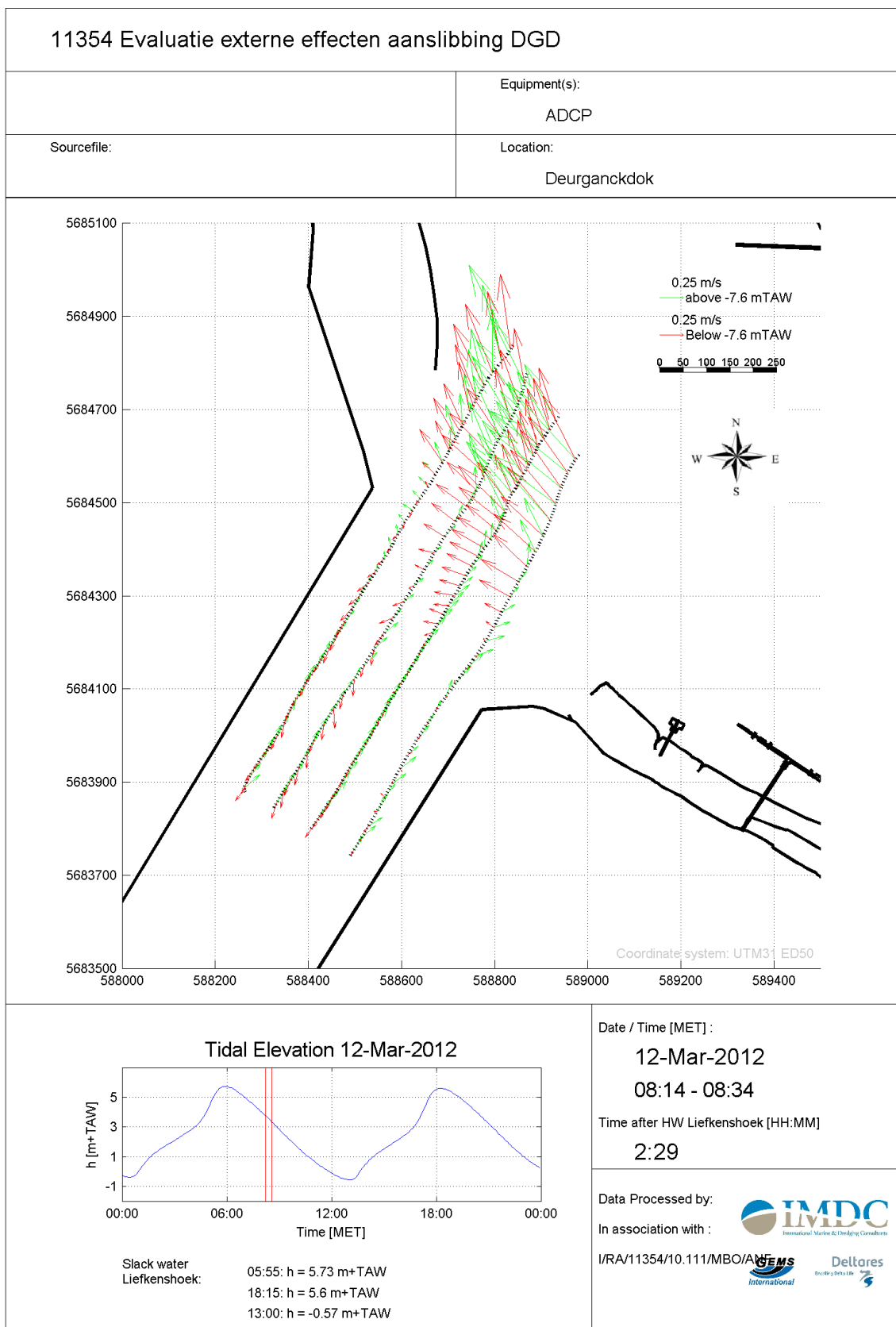
2:09

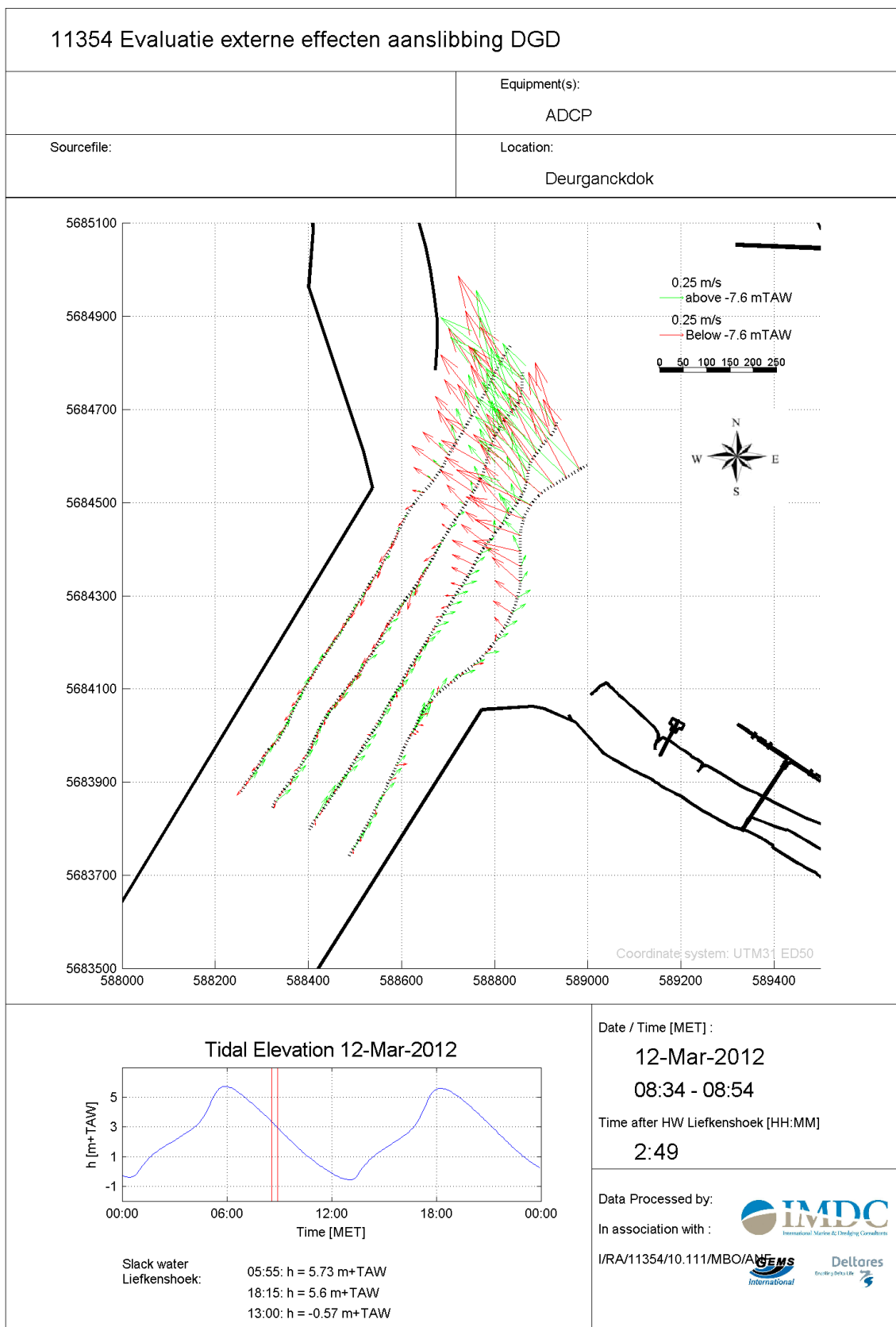
Data Processed by:

In association with :

I/RA/11354/10.111/MBO/ANF







11354 Evaluatie externe effecten aanslibbing DGD

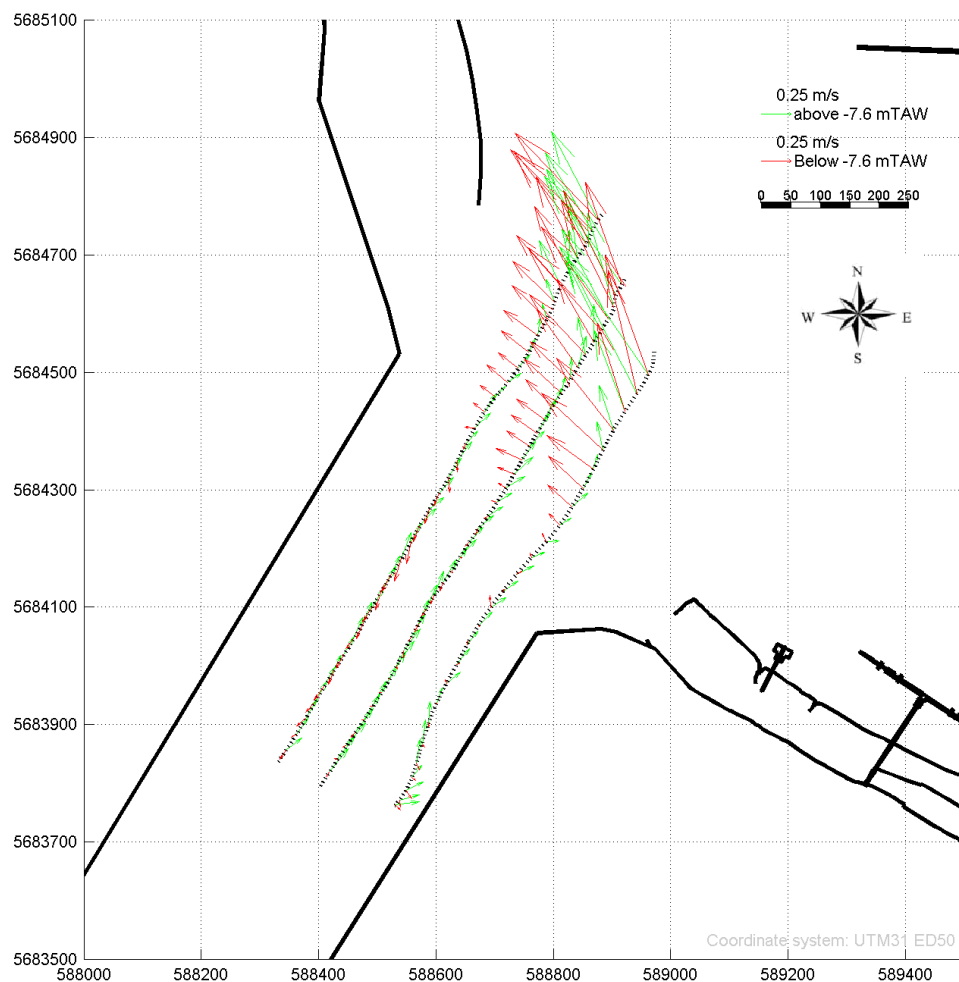
Equipment(s):

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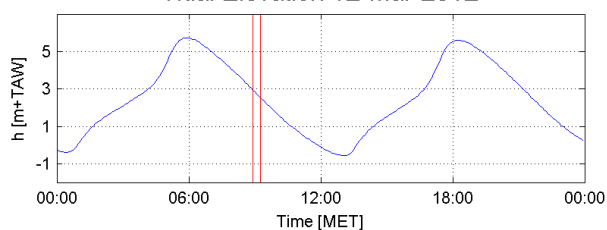
Sourcefile:

Location:

Deurganckdok



Tidal Elevation 12-Mar-2012



Slack water
Liefkenshoek:
05:55: h = 5.73 m+TAW
18:15: h = 5.6 m+TAW
13:00: h = -0.57 m+TAW

Date / Time [MET] :

12-Mar-2012

08:54 - 09:16

Time after HW Liefkenshoek [HH:MM]

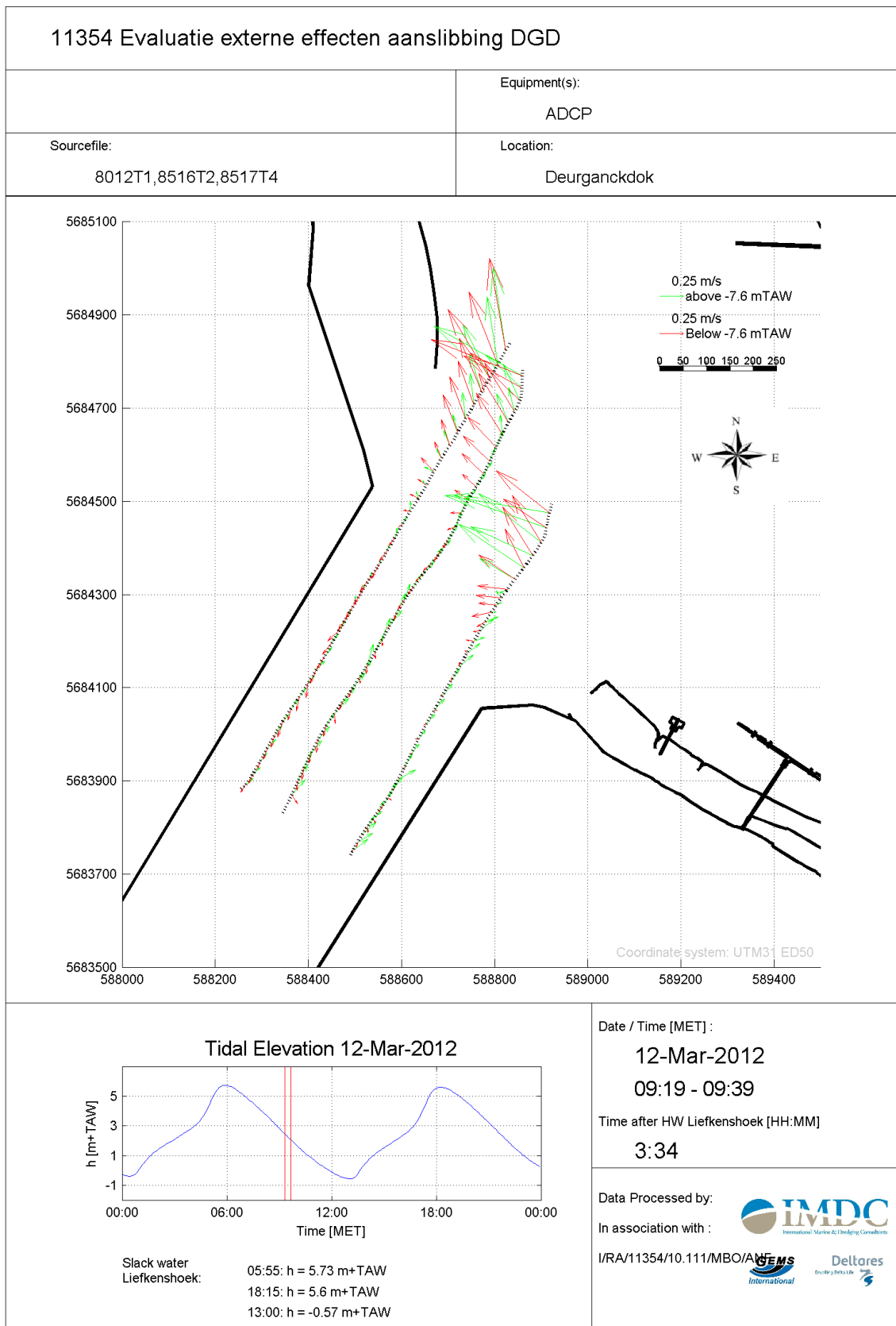
3:10

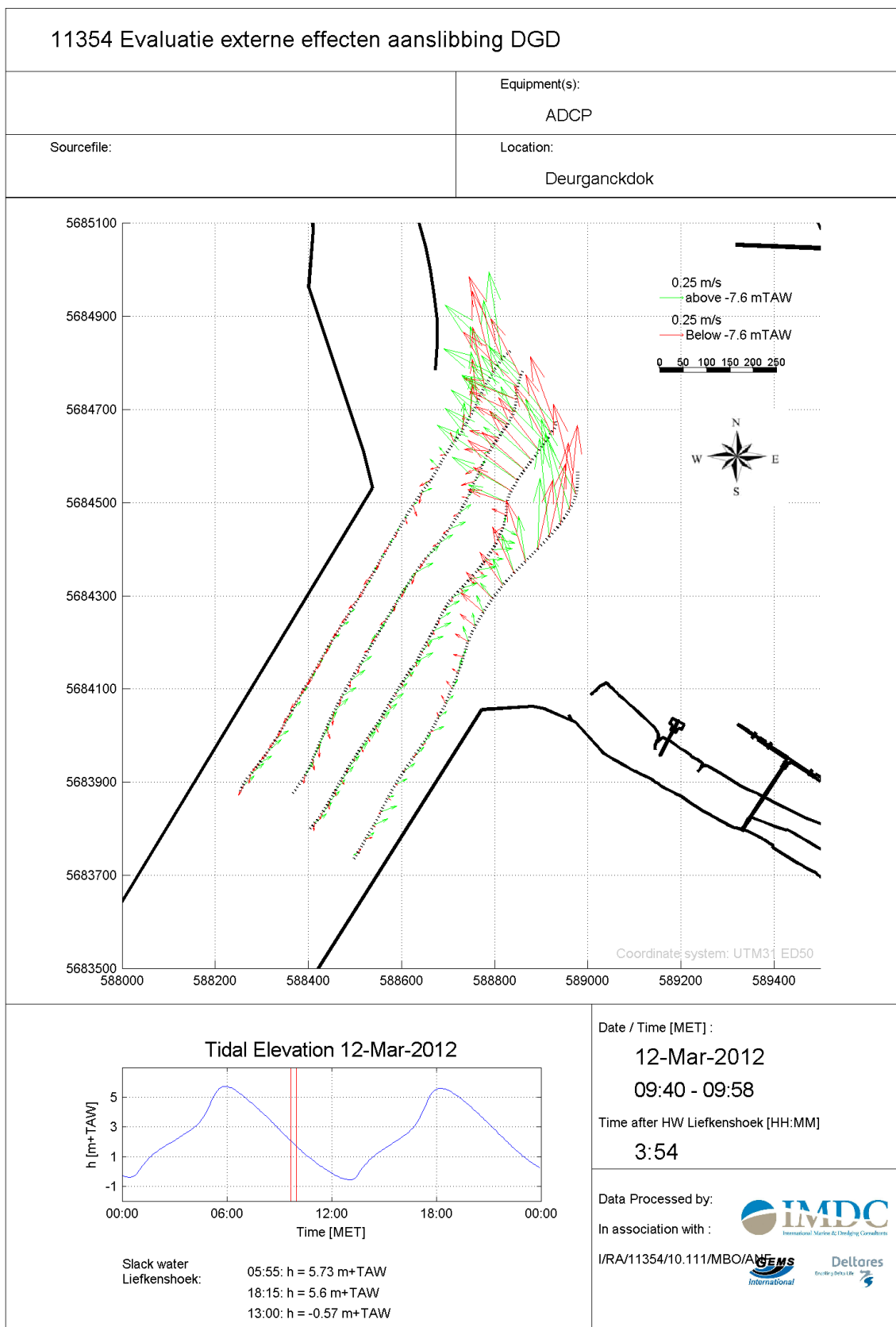
Data Processed by:

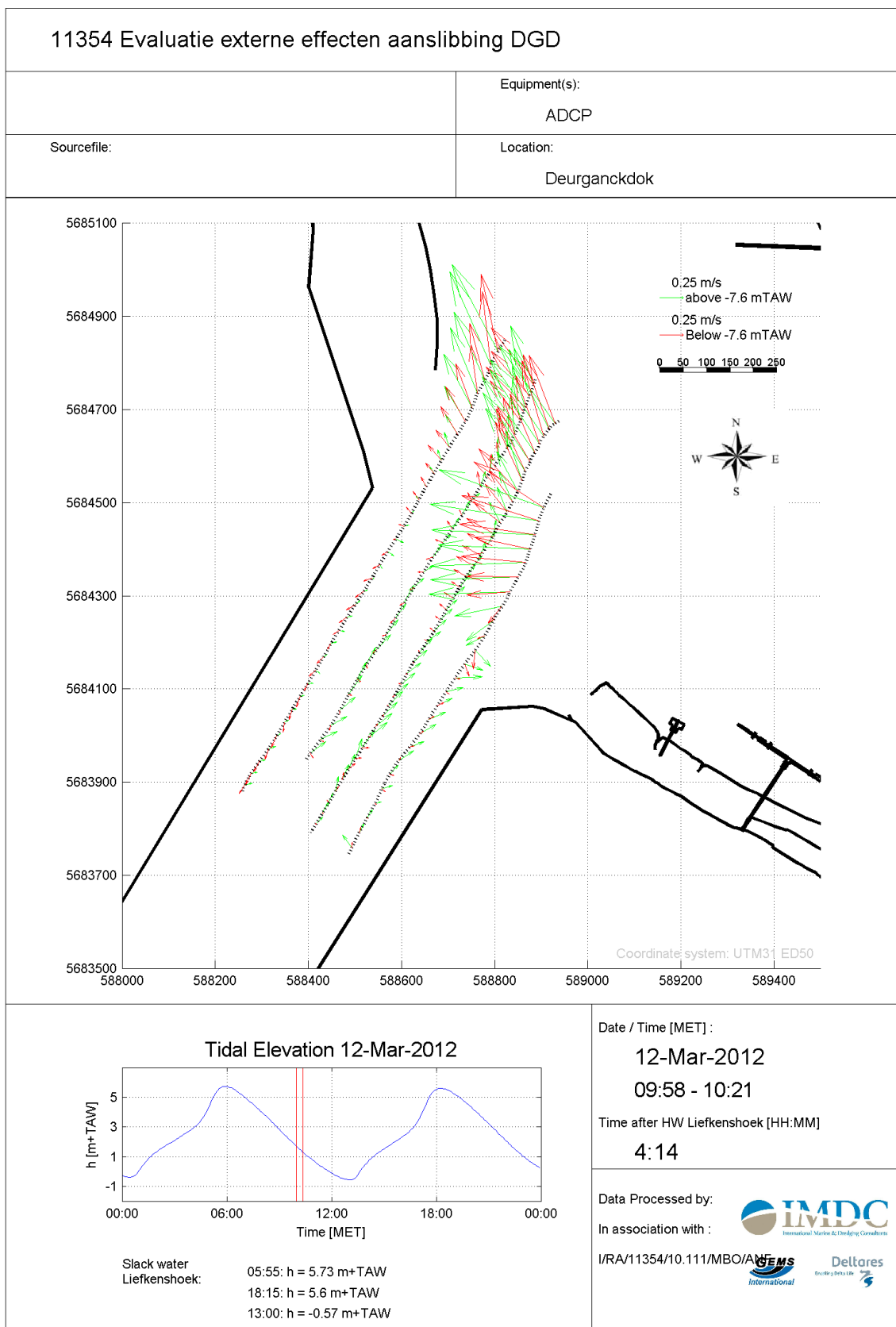
In association with :

I/RA/11354/10.111/MBO/ANF









11354 Evaluatie externe effecten aanslibbing DGD

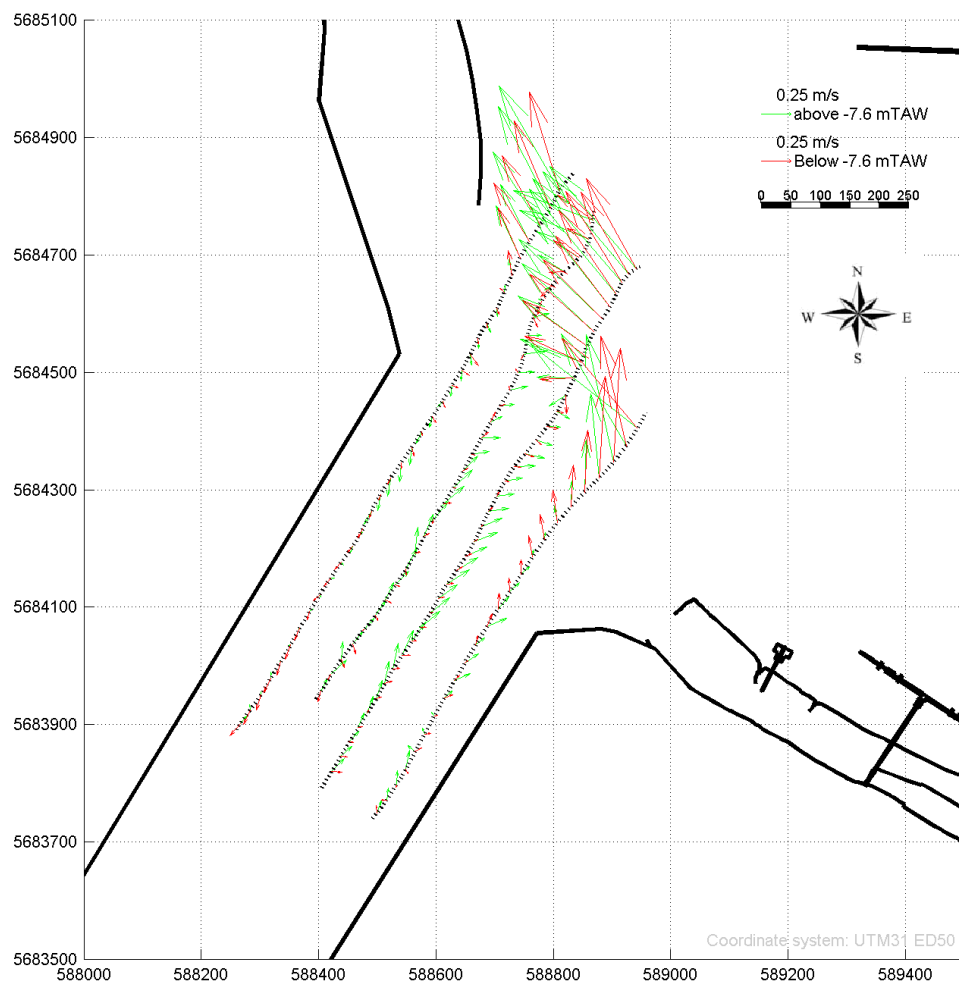
Equipment(s):

ADCP

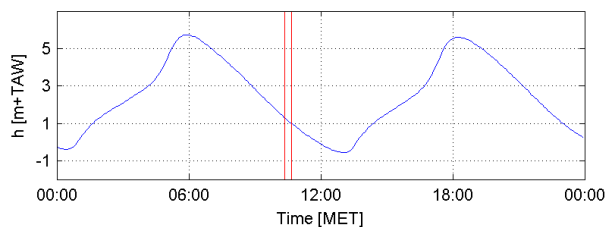
Sourcefile:

Location:

Deurganckdok



Tidal Elevation 12-Mar-2012



Slack water
Liefkenshoek:
05:55: h = 5.73 m+TAW
18:15: h = 5.6 m+TAW
13:00: h = -0.57 m+TAW

Date / Time [MET] :

12-Mar-2012

10:22 - 10:39

Time after HW Liefkenshoek [HH:MM]

4:35

Data Processed by:

In association with :

I/RA/11354/10.111/MBO/ANF



11354 Evaluatie externe effecten aanslibbing DGD

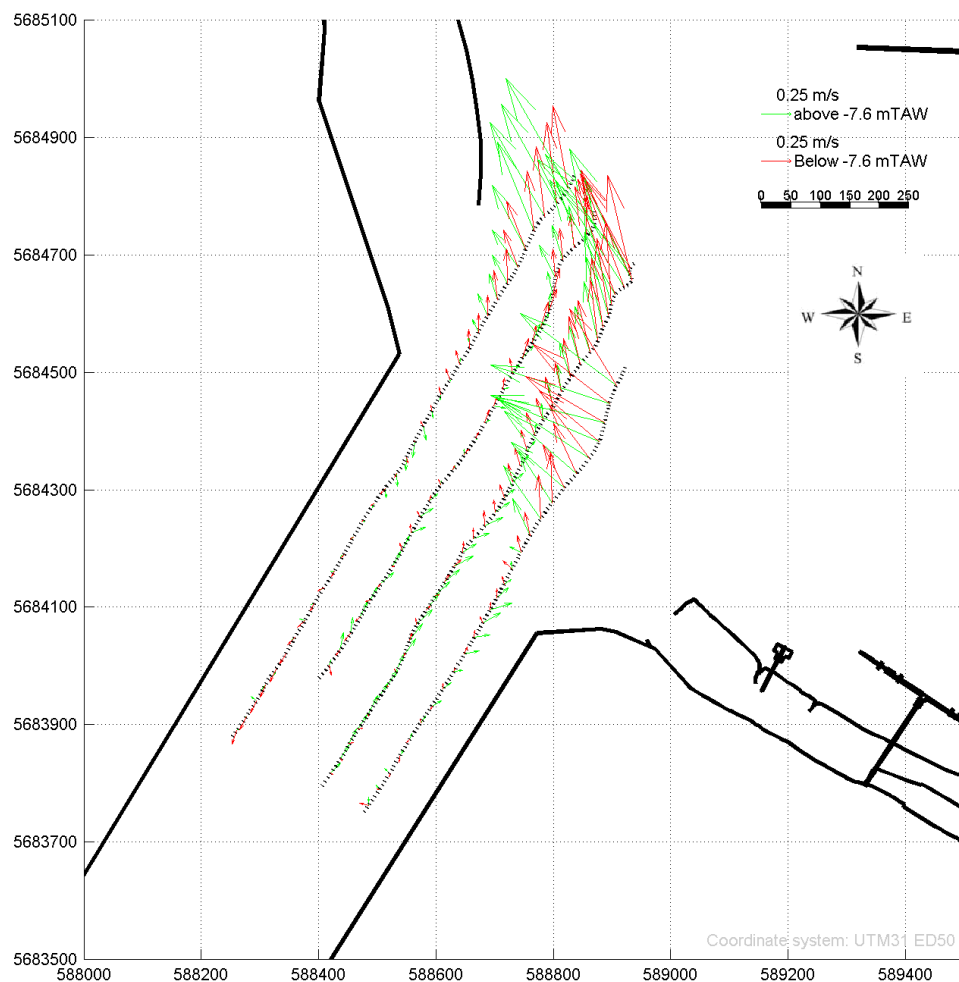
Equipment(s):

ADCP

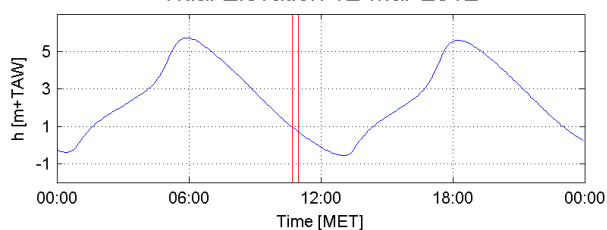
Sourcefile:

Location:

Deurganckdok



Tidal Elevation 12-Mar-2012



Slack water
Liefkenshoek:
05:55: h = 5.73 m+TAW
18:15: h = 5.6 m+TAW
13:00: h = -0.57 m+TAW

Date / Time [MET] :

12-Mar-2012

10:41 - 10:58

Time after HW Liefkenshoek [HH:MM]

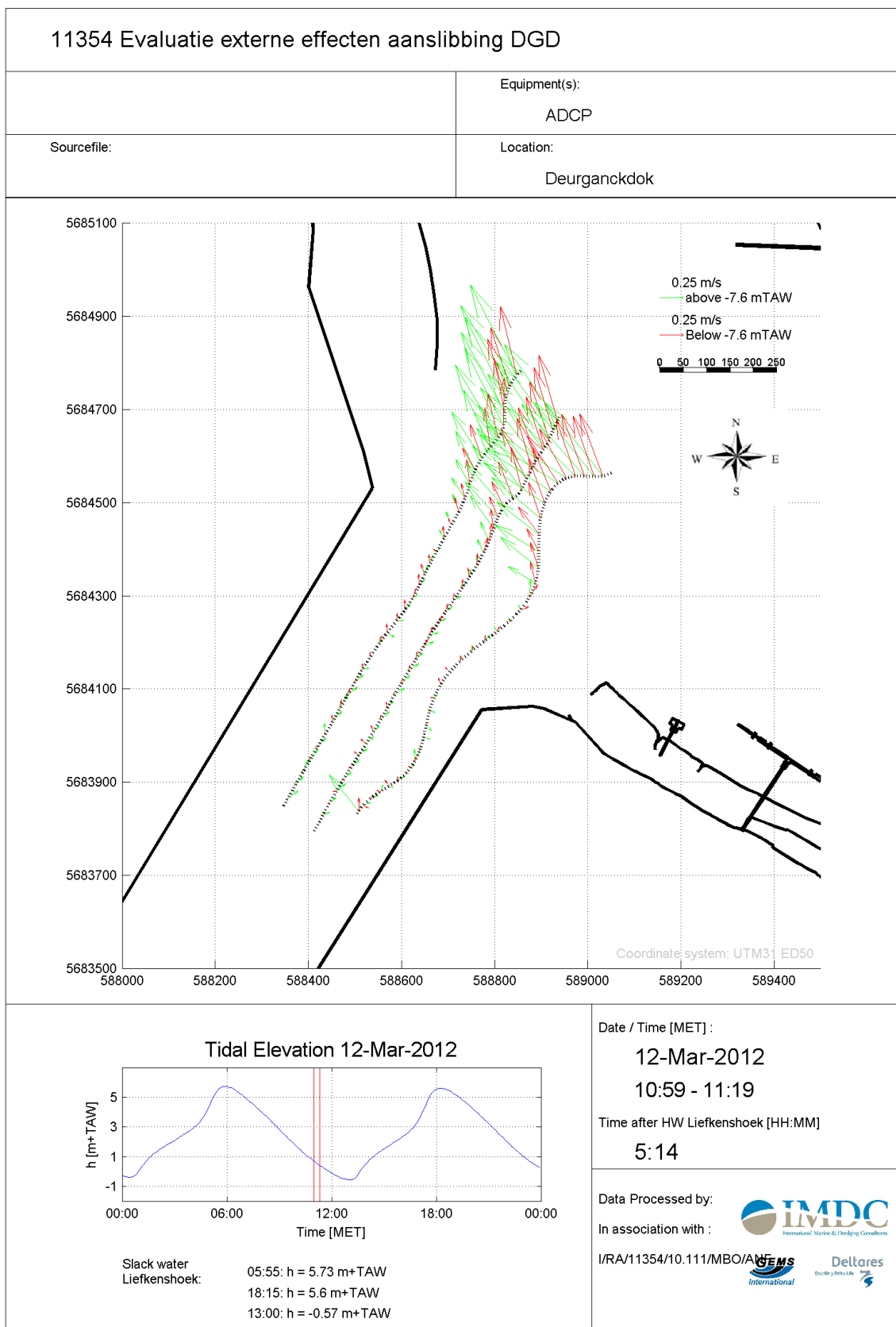
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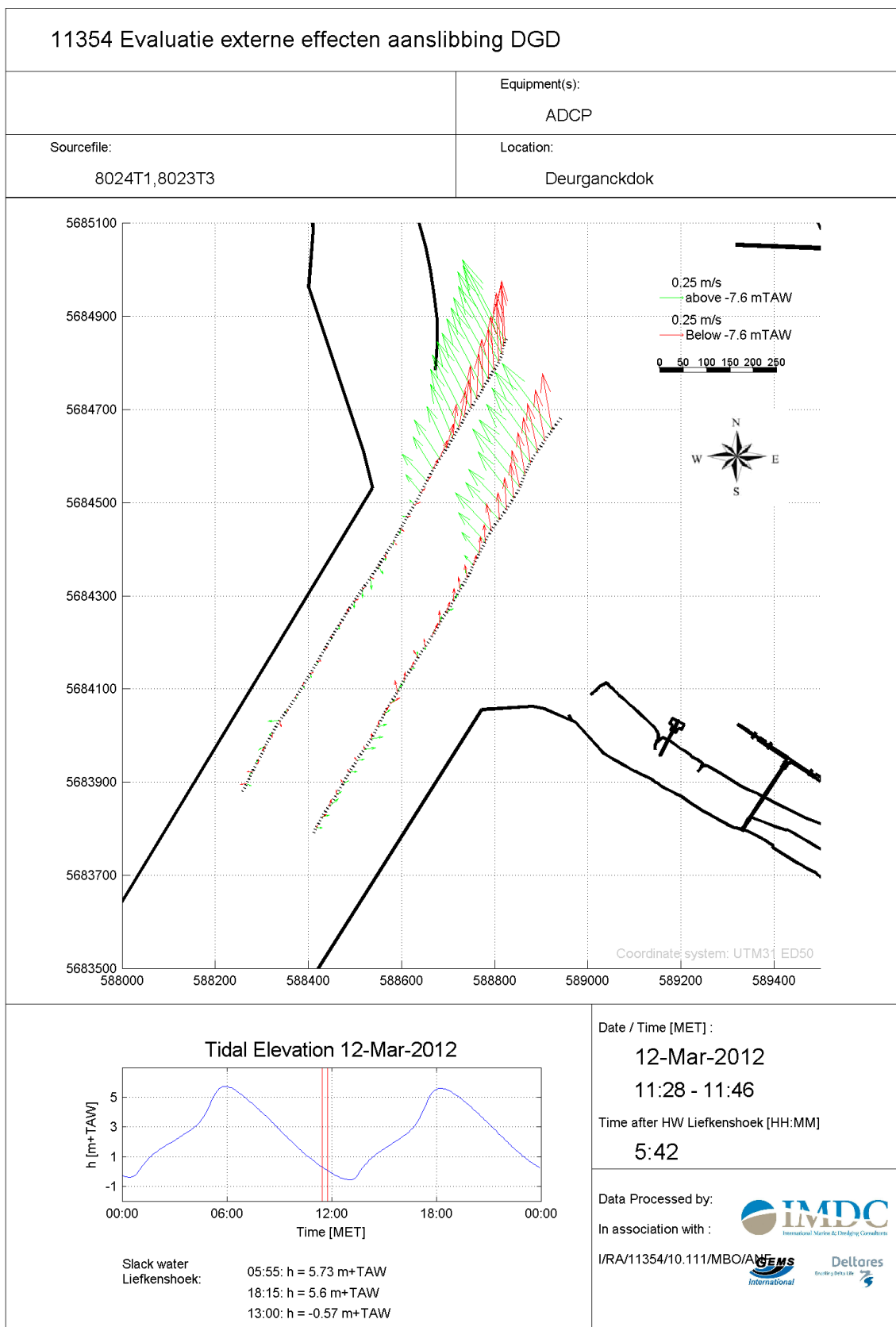
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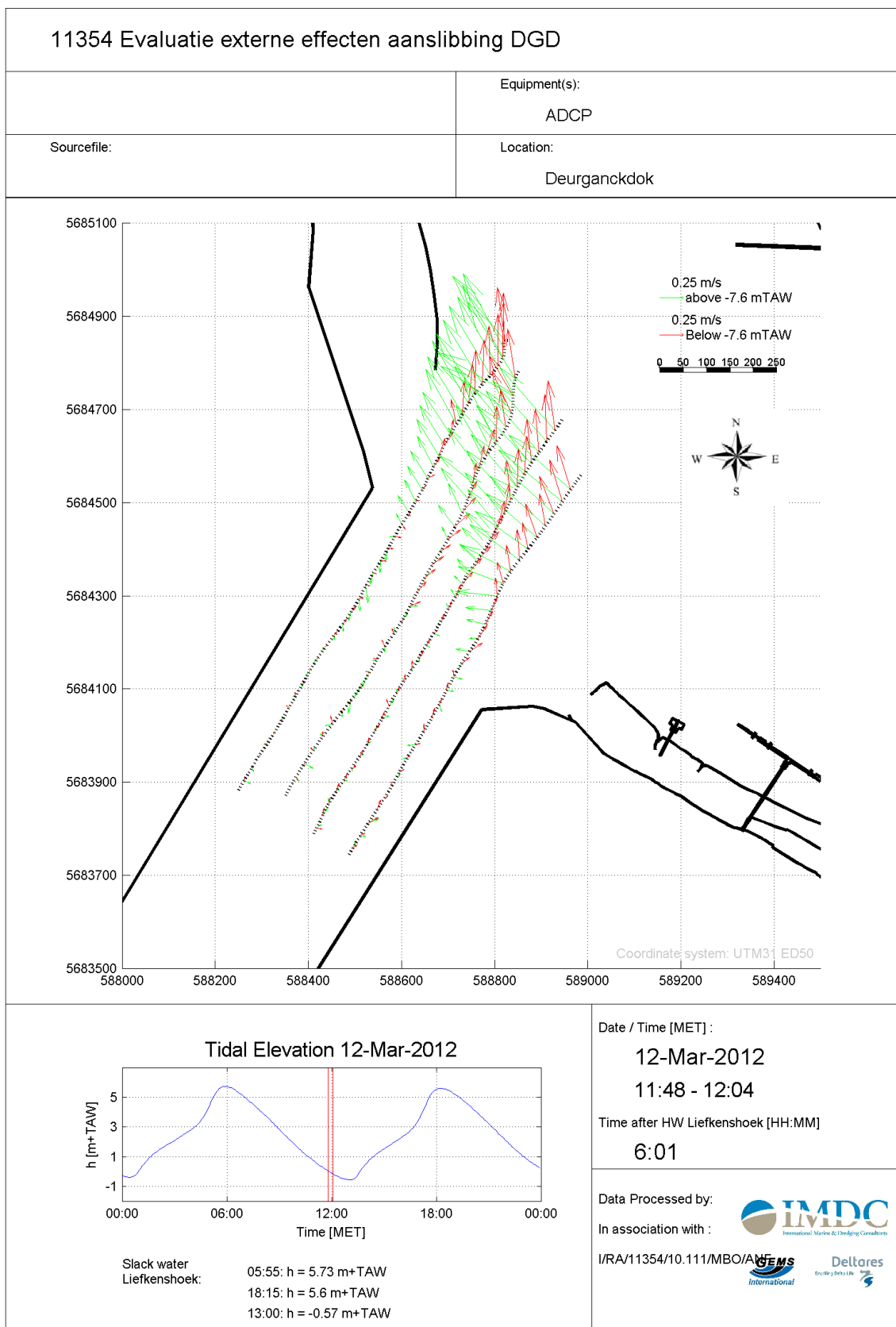
In association with :

I/RA/11354/10.111/MBO/ANF









11354 Evaluatie externe effecten aanslibbing DGD

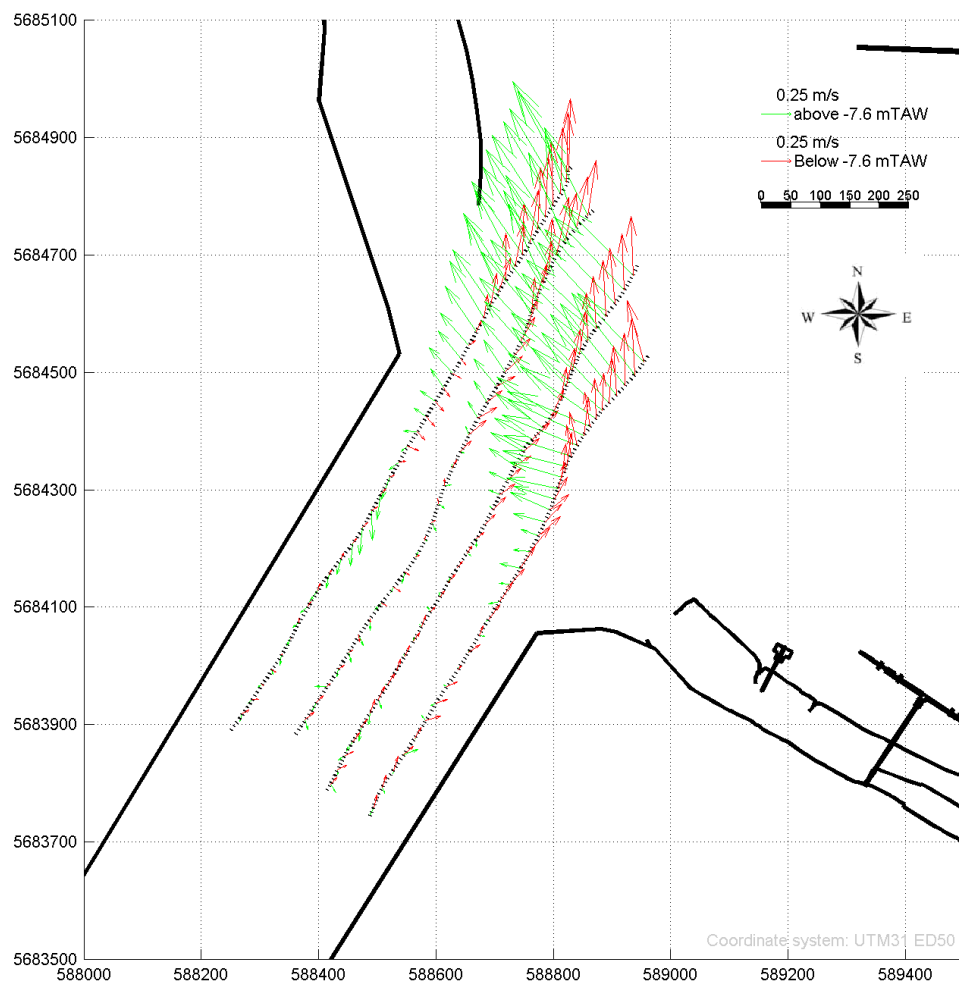
Equipment(s):

ADCP

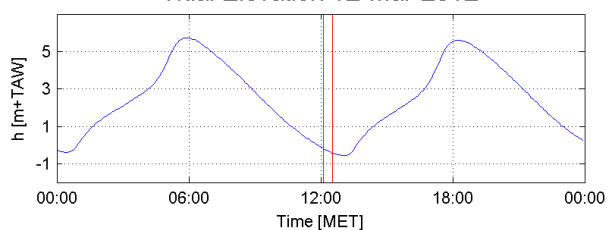
Sourcefile:

Location:

Deurganckdok



Tidal Elevation 12-Mar-2012



Slack water
Liefkenshoek:

05:55: h = 5.73 m+TAW
18:15: h = 5.6 m+TAW
13:00: h = -0.57 m+TAW

Date / Time [MET] :

12-Mar-2012

12:06 - 12:31

Time after HW Liefkenshoek [HH:MM]

6:24

Data Processed by:

In association with :

I/RA/11354/10.111/MBO/ANF



11354 Evaluatie externe effecten aanslibbing DGD

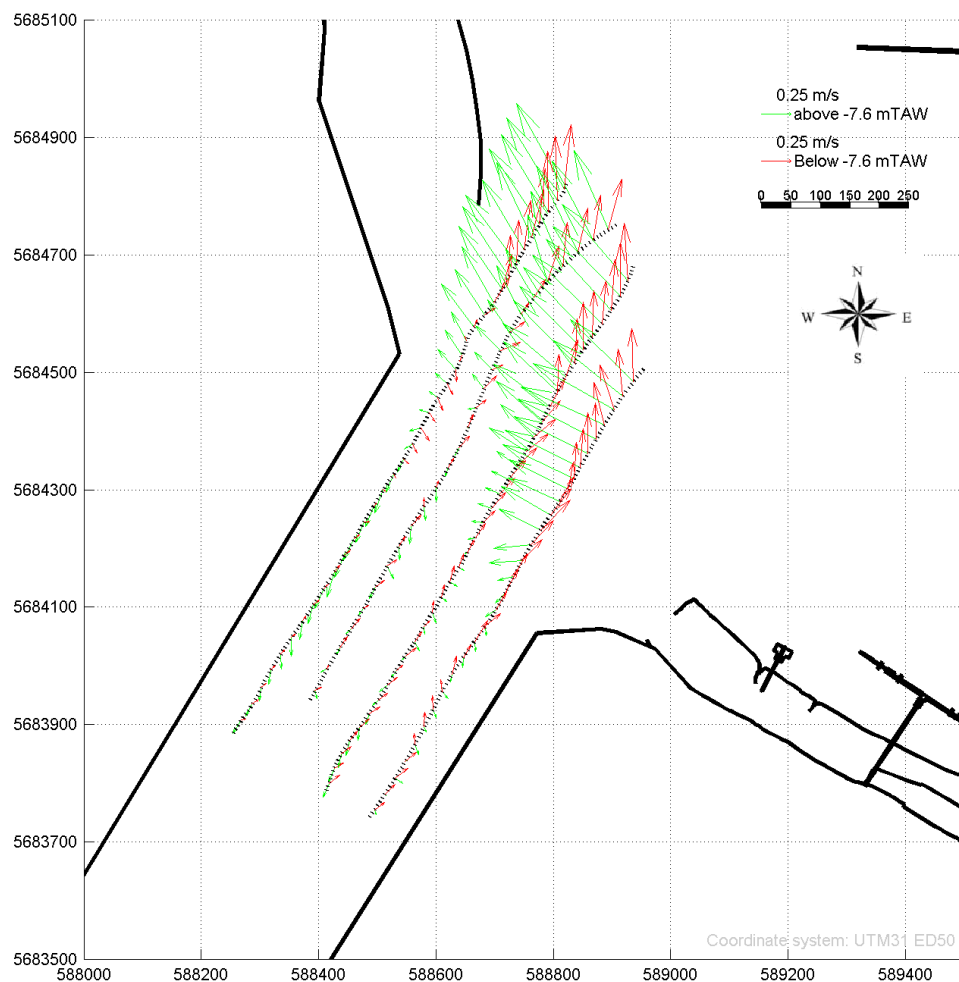
Equipment(s):

ADCP

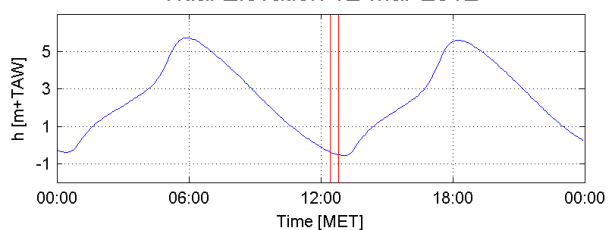
Sourcefile:

Location:

Deurganckdok



Tidal Elevation 12-Mar-2012



Slack water
Liefkenshoek:
05:55: $h = 5.73 \text{ m+TAW}$
18:15: $h = 5.6 \text{ m+TAW}$
13:00: $h = -0.57 \text{ m+TAW}$

Date / Time [MET] :

12-Mar-2012

12:26 - 12:49

Time after HW Liefkenshoek [HH:MM]

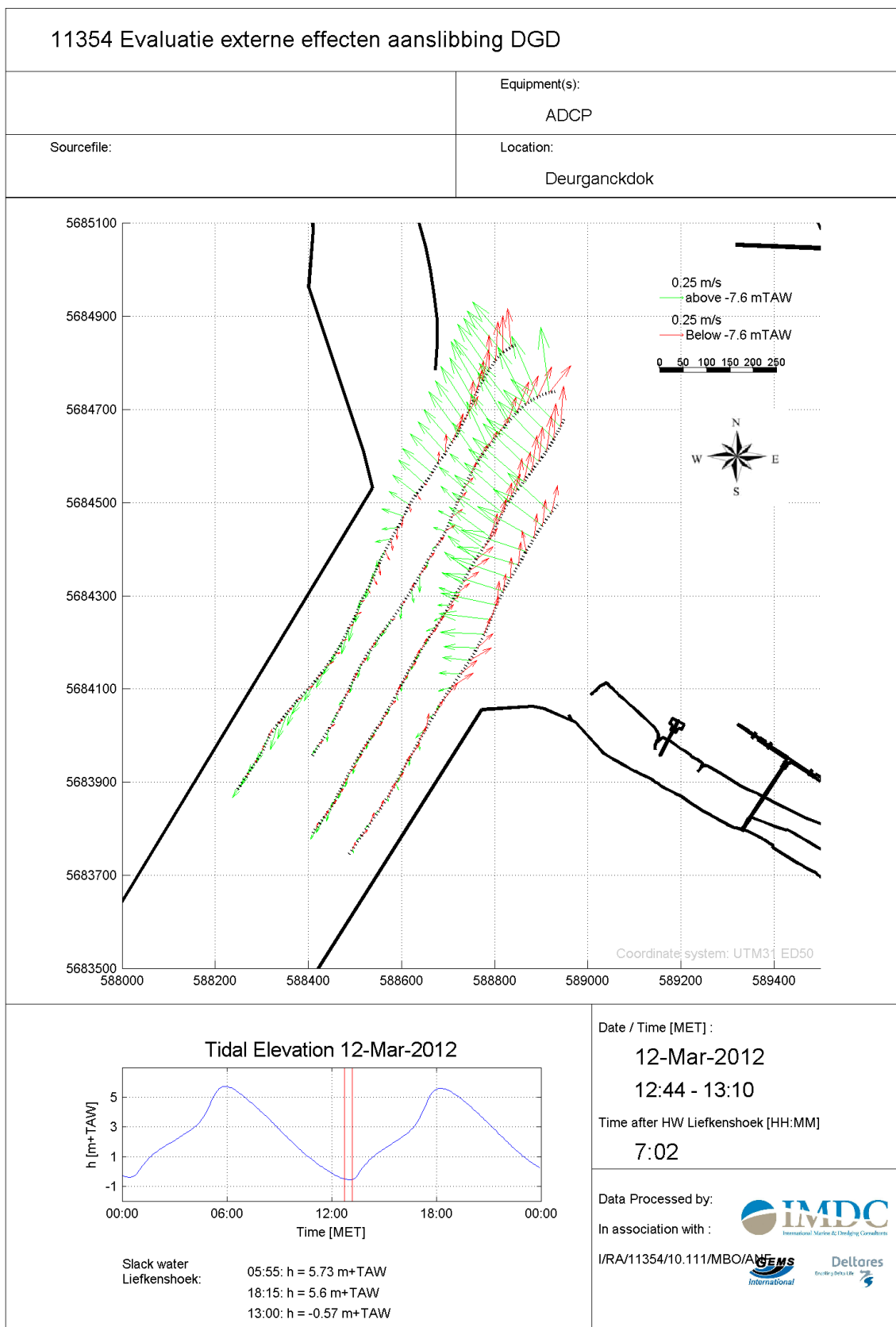
6:42

Data Processed by:

In association with :

I/RA/11354/10.111/MBO/ANF





11354 Evaluatie externe effecten aanslibbing DGD

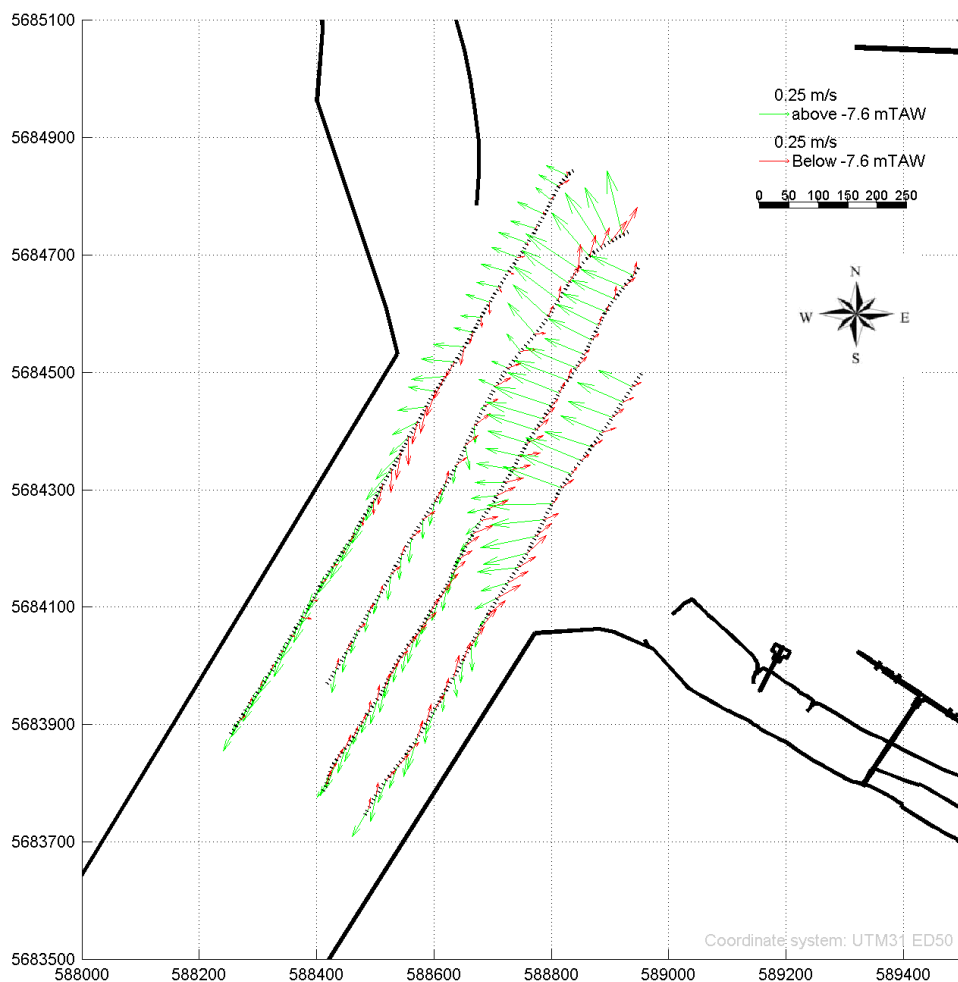
Equipment(s):

ADCP

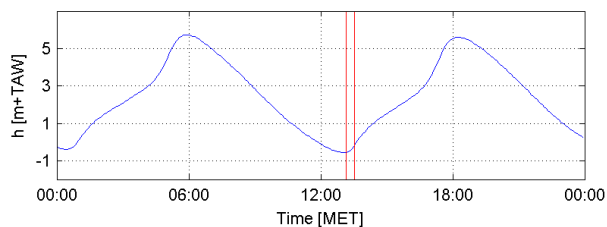
Sourcefile:

Location:

Deurganckdok



Tidal Elevation 12-Mar-2012



Slack water
Liefkenshoek:
05:55: h = 5.73 m+TAW
18:15: h = 5.6 m+TAW
13:00: h = -0.57 m+TAW

Date / Time [MET] :

12-Mar-2012

13:09 - 13:31

Time after HW Liefkenshoek [HH:MM]

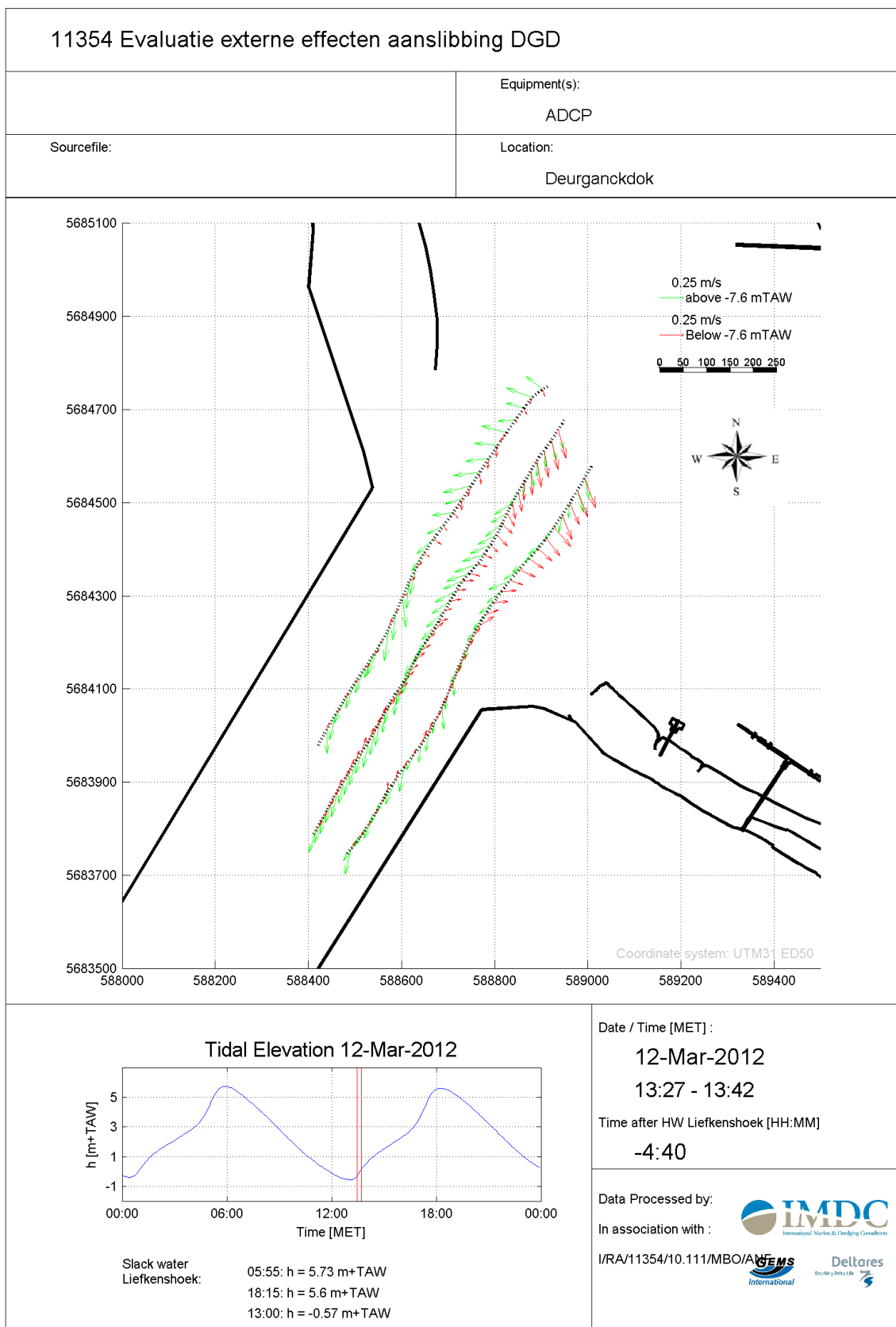
-4:54

Data Processed by:

In association with :

I/RA/11354/10.111/MBO/ANF





11354 Evaluatie externe effecten aanslibbing DGD

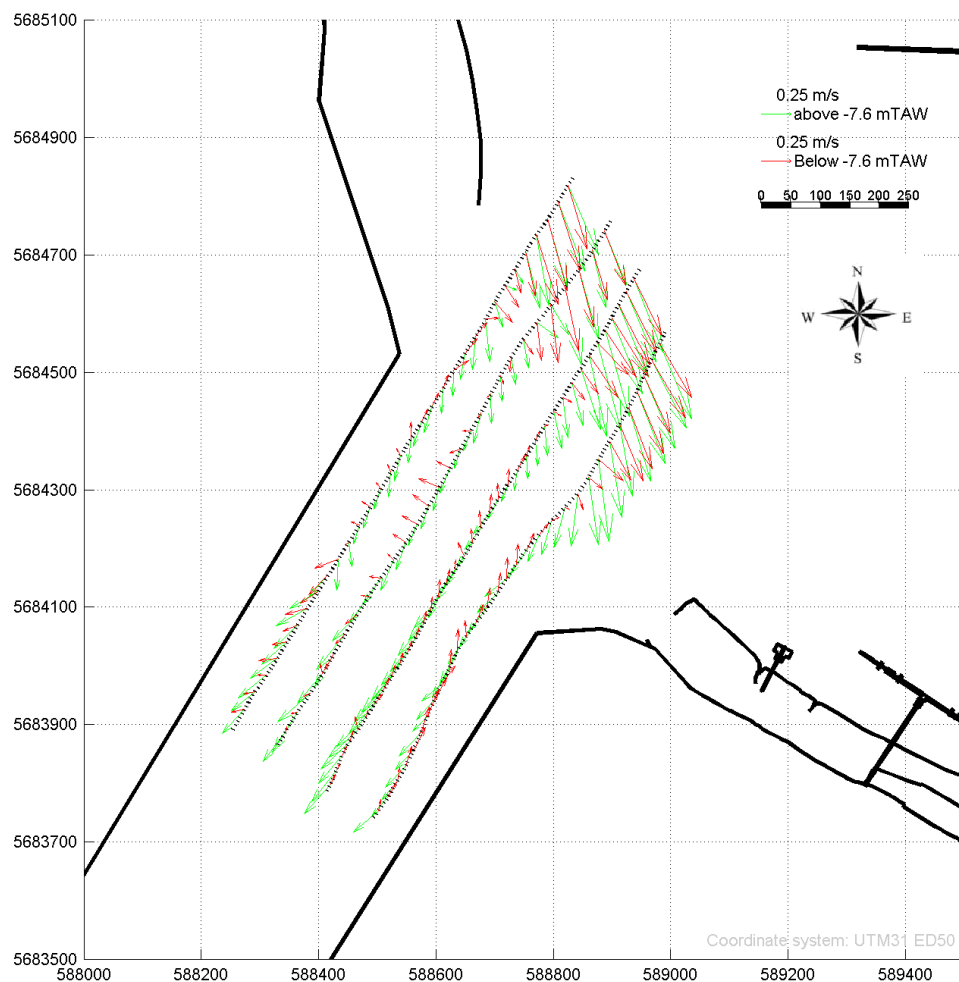
Equipment(s):

ADCP

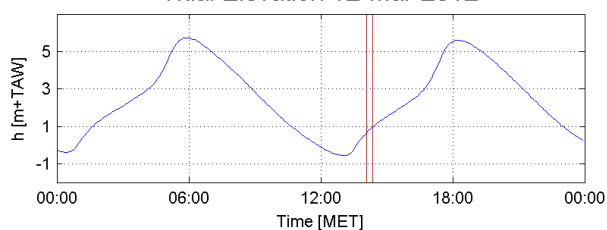
Sourcefile:

Location:

Deurganckdok



Tidal Elevation 12-Mar-2012



Slack water
Liefkenshoek:
05:55: $h = 5.73 \text{ m+TAW}$
18:15: $h = 5.6 \text{ m+TAW}$
13:00: $h = -0.57 \text{ m+TAW}$

Date / Time [MET]:

12-Mar-2012

14:04 - 14:21

Time after HW Liefkenshoek [HH:MM]

-4:01

Data Processed by:

In association with:

I/RA/11354/10.111/MBO/ANF



11354 Evaluatie externe effecten aanslibbing DGD

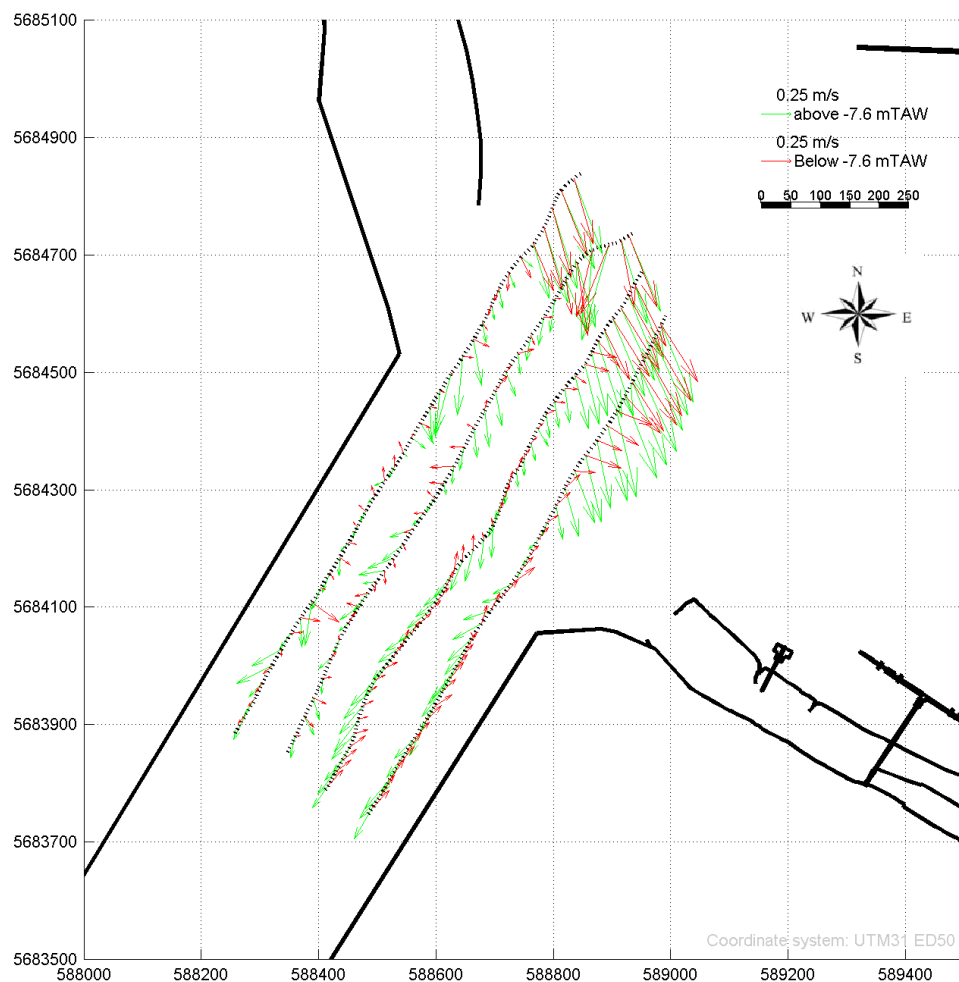
Equipment(s):

ADCP

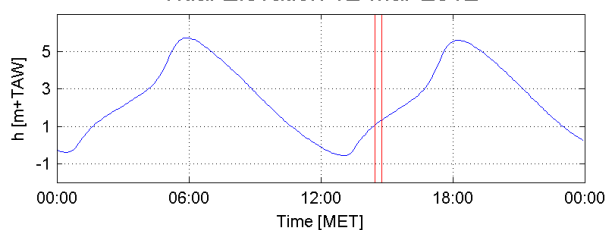
Sourcefile:

Location:

Deurganckdok



Tidal Elevation 12-Mar-2012



Slack water
Liefkenshoek:

05:55: h = 5.73 m+TAW
18:15: h = 5.6 m+TAW
13:00: h = -0.57 m+TAW

Date / Time [MET] :

12-Mar-2012

14:28 - 14:46

Time after HW Liefkenshoek [HH:MM]

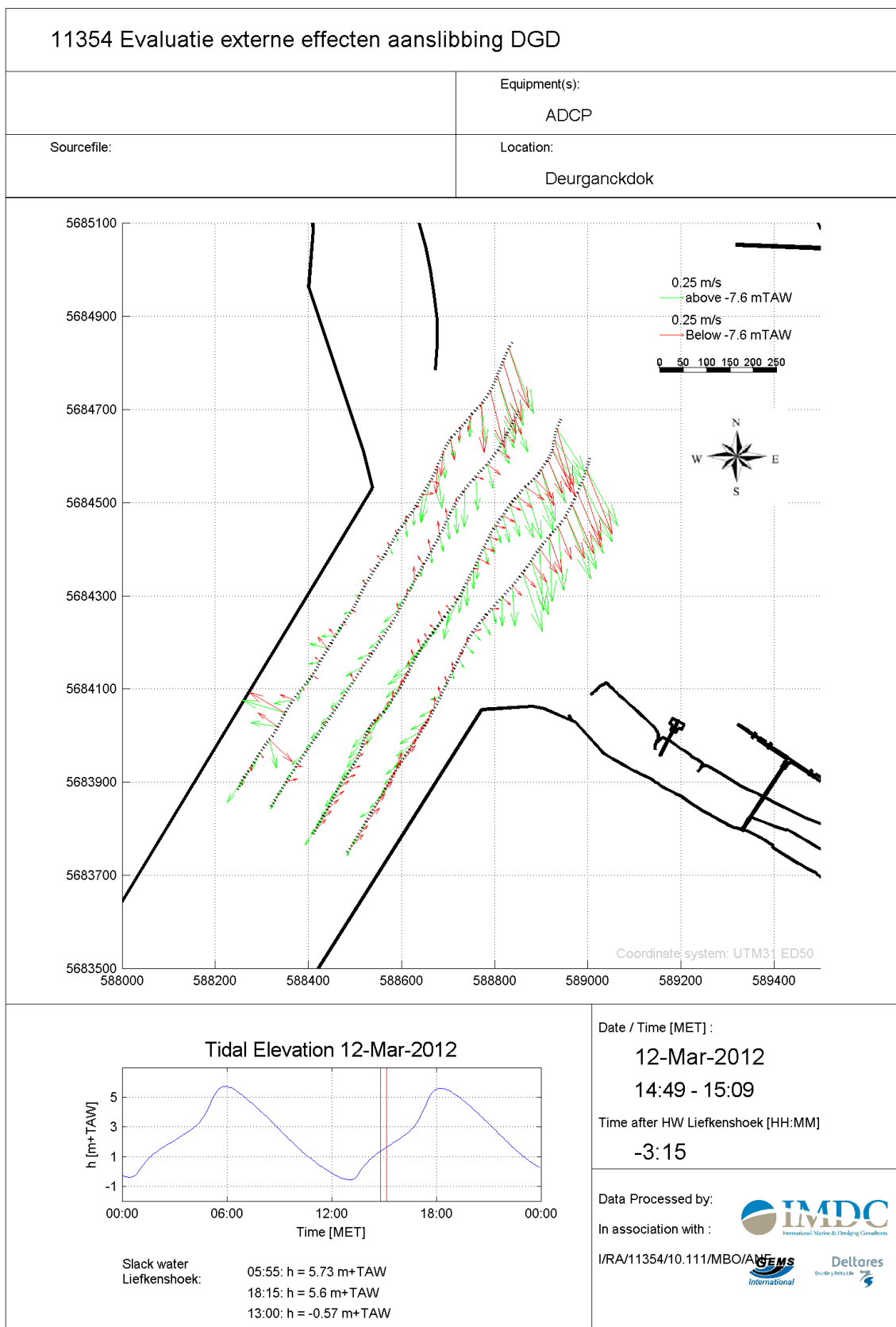
-3:37

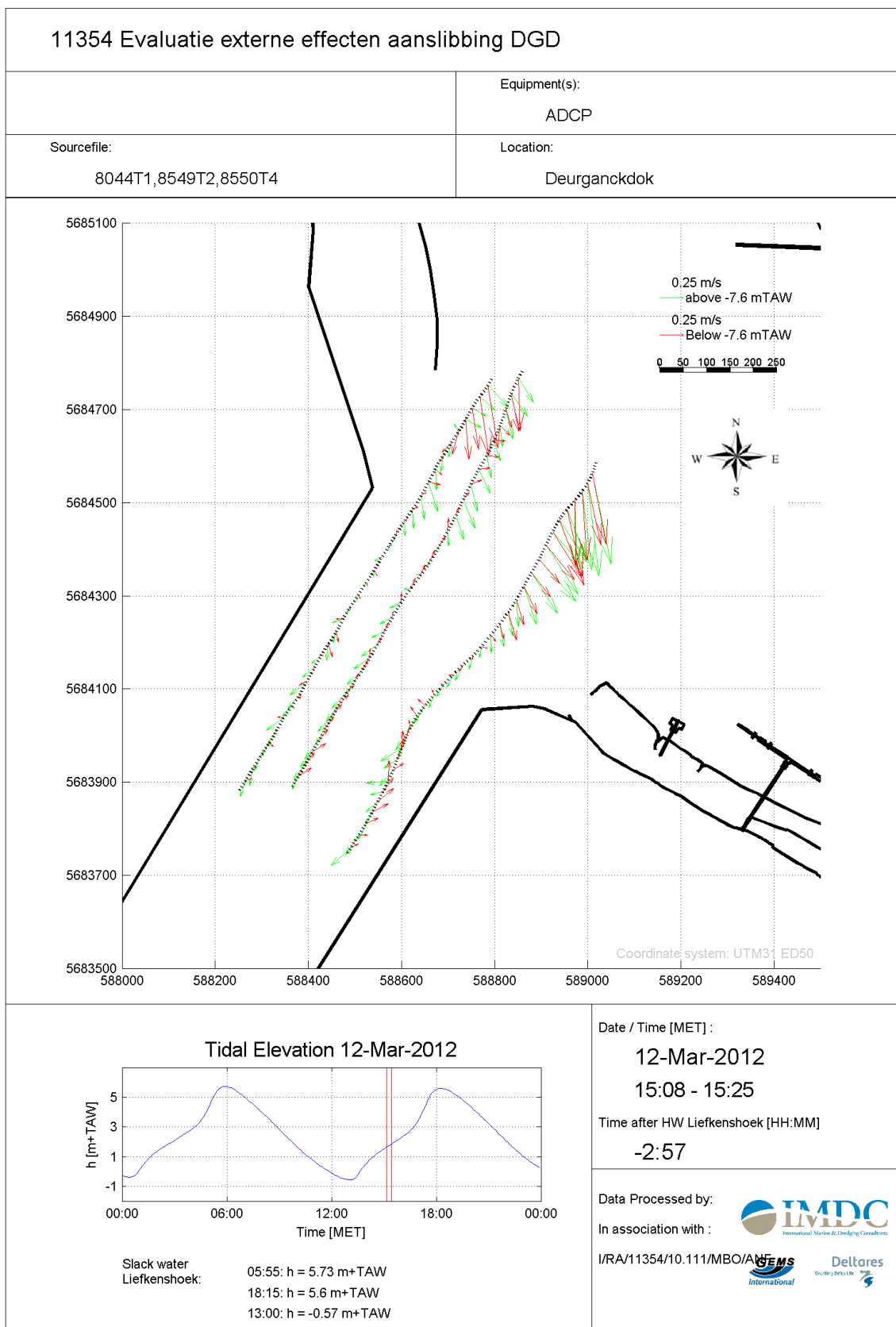
Data Processed by:

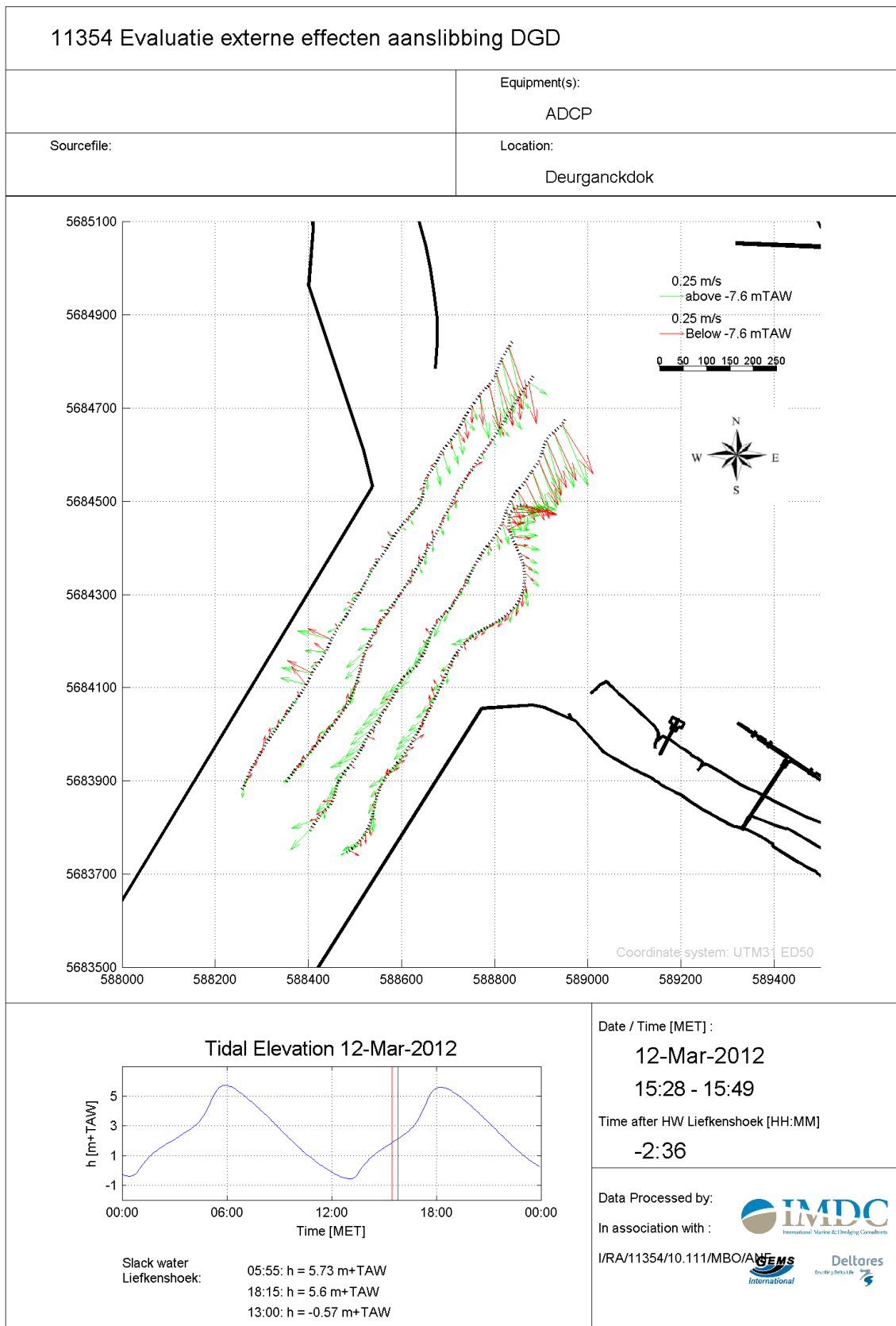
In association with :

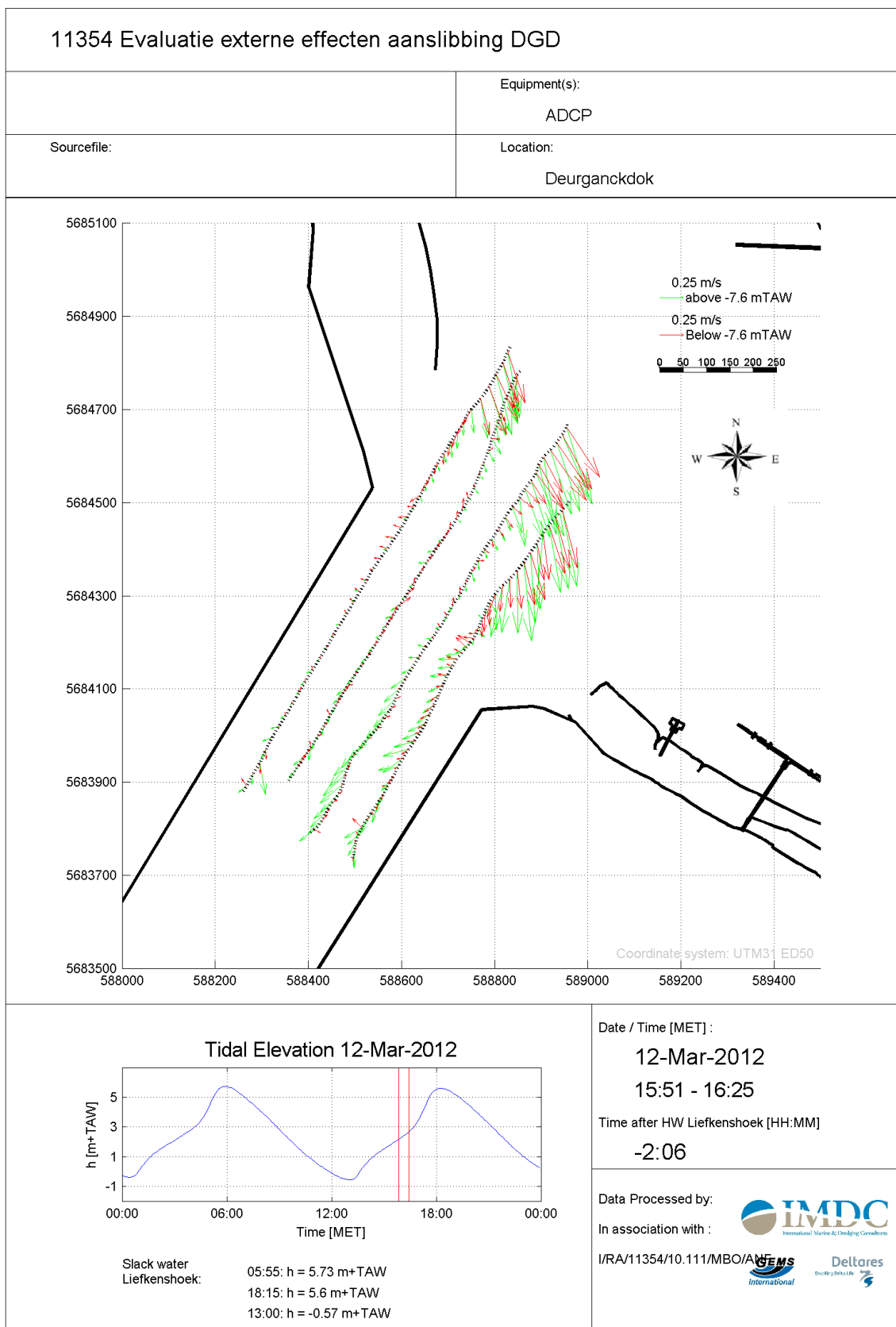
I/RA/11354/10.111/MBO/ANF











11354 Evaluatie externe effecten aanslibbing DGD

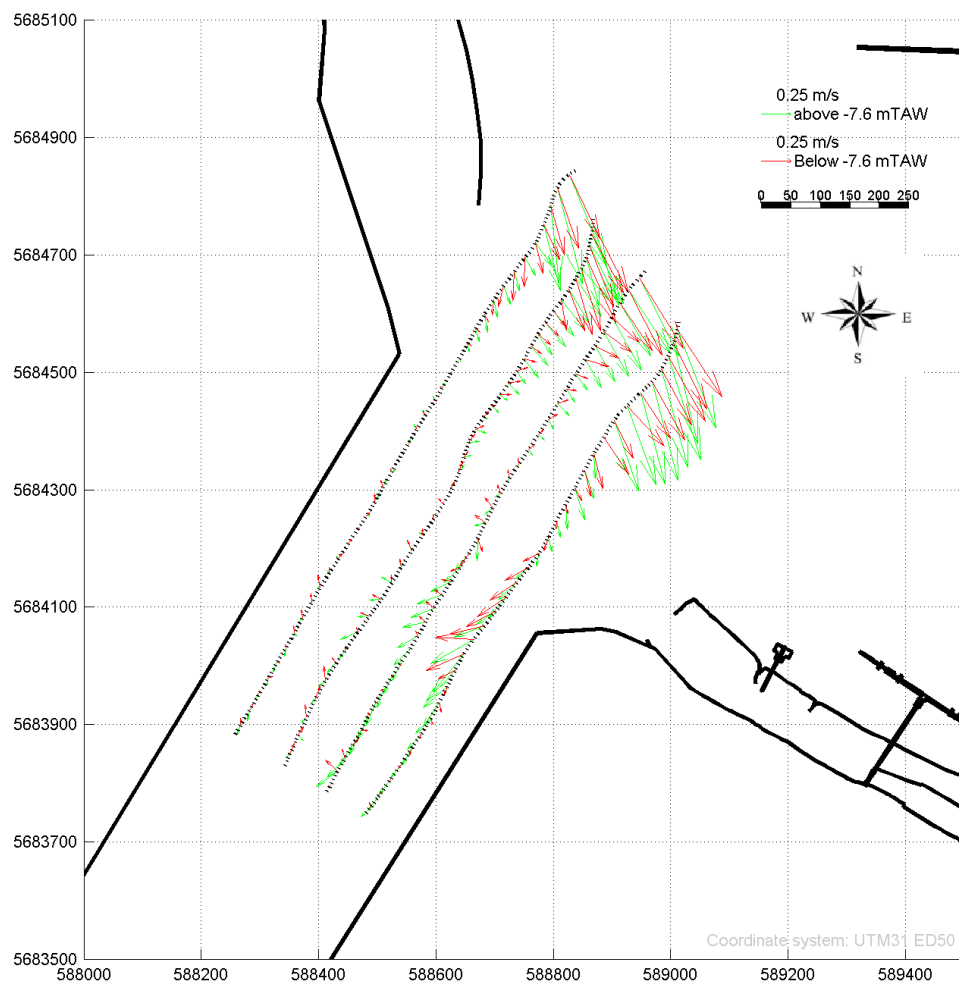
Equipment(s):

ADCP

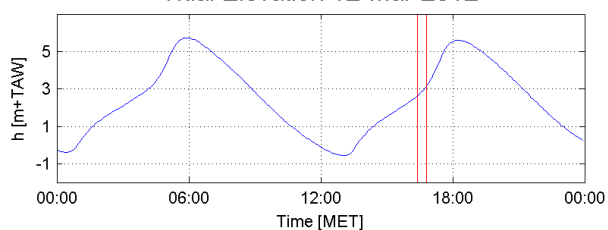
Sourcefile:

Location:

Deurganckdok



Tidal Elevation 12-Mar-2012



Slack water
Liefkenshoek:

05:55: h = 5.73 m+TAW
18:15: h = 5.6 m+TAW
13:00: h = -0.57 m+TAW

Date / Time [MET] :

12-Mar-2012

16:24 - 16:48

Time after HW Liefkenshoek [HH:MM]

-1:38

Data Processed by:

In association with :

I/RA/11354/10.111/MBO/ANF



11354 Evaluatie externe effecten aanslibbing DGD

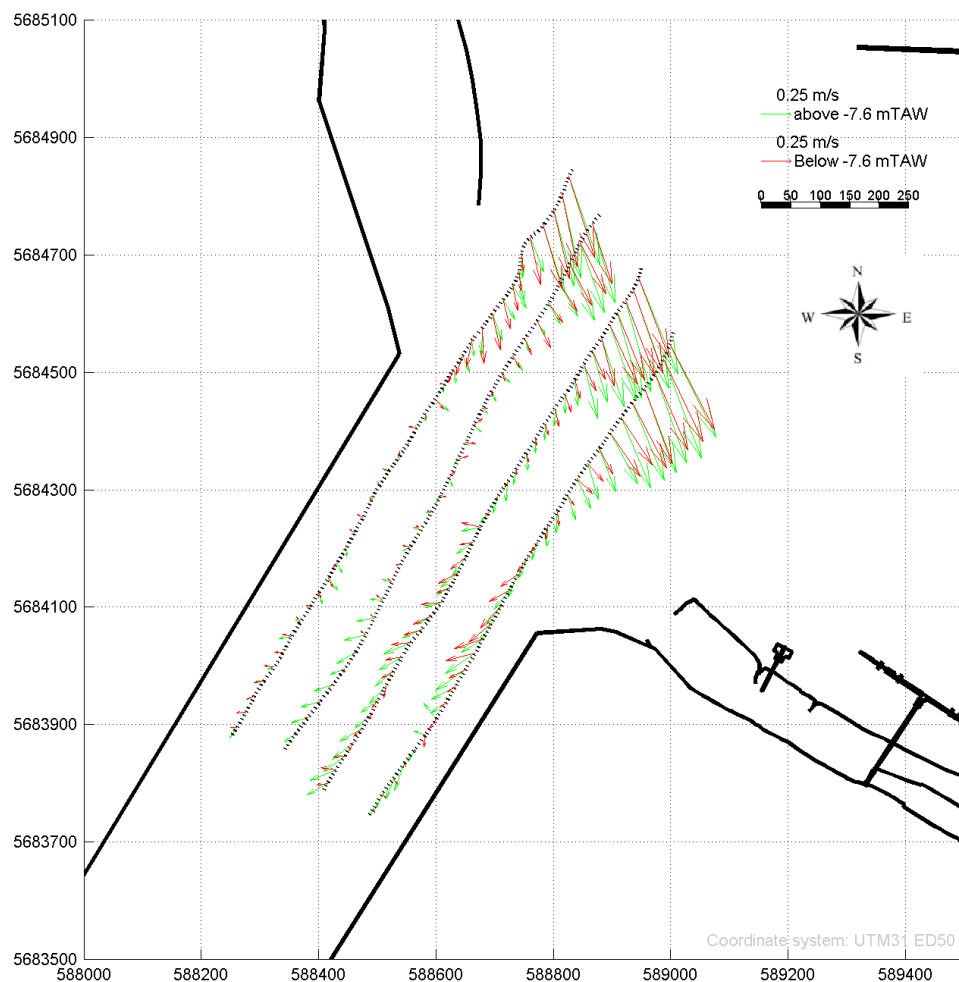
Equipment(s):

ADCP

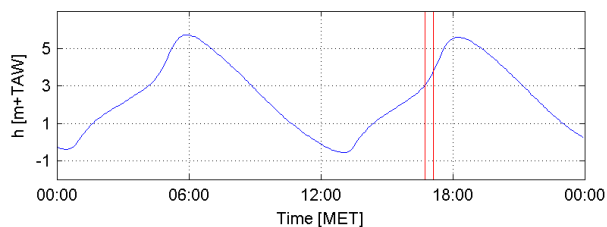
Sourcefile:

Location:

Deurganckdok



Tidal Elevation 12-Mar-2012



Slack water
Liefkenshoek:

05:55: h = 5.73 m+TAW
18:15: h = 5.6 m+TAW
13:00: h = -0.57 m+TAW

Date / Time [MET] :

12-Mar-2012

16:44 - 17:06

Time after HW Liefkenshoek [HH:MM]

-1:19

Data Processed by:

In association with :

I/RA/11354/10.111/MBO/ANF



11354 Evaluatie externe effecten aanslibbing DGD

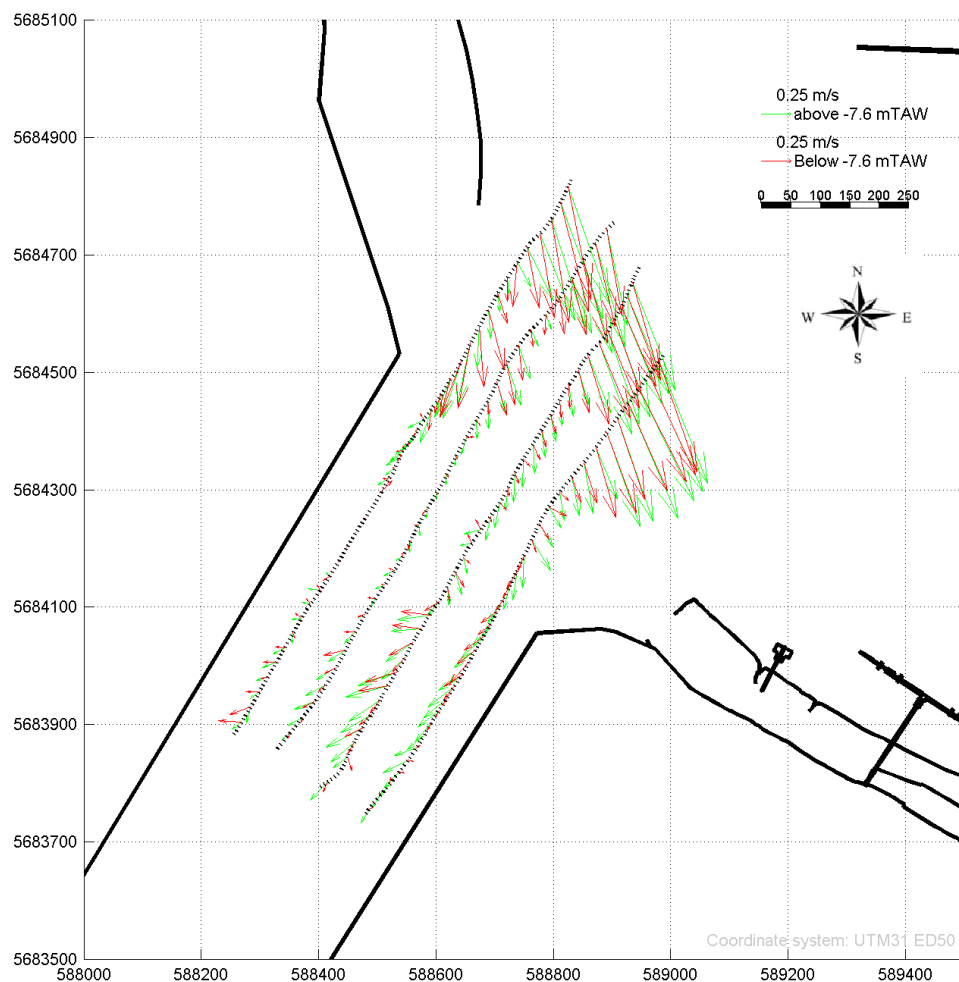
Equipment(s):

ADCP

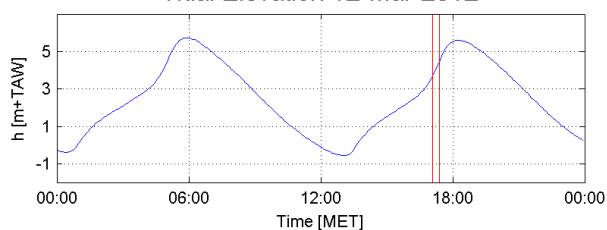
Sourcefile:

Location:

Deurganckdok



Tidal Elevation 12-Mar-2012



Slack water
Liefkenshoek:

05:55: h = 5.73 m+TAW
18:15: h = 5.6 m+TAW
13:00: h = -0.57 m+TAW

Date / Time [MET] :

12-Mar-2012

17:04 - 17:24

Time after HW Liefkenshoek [HH:MM]

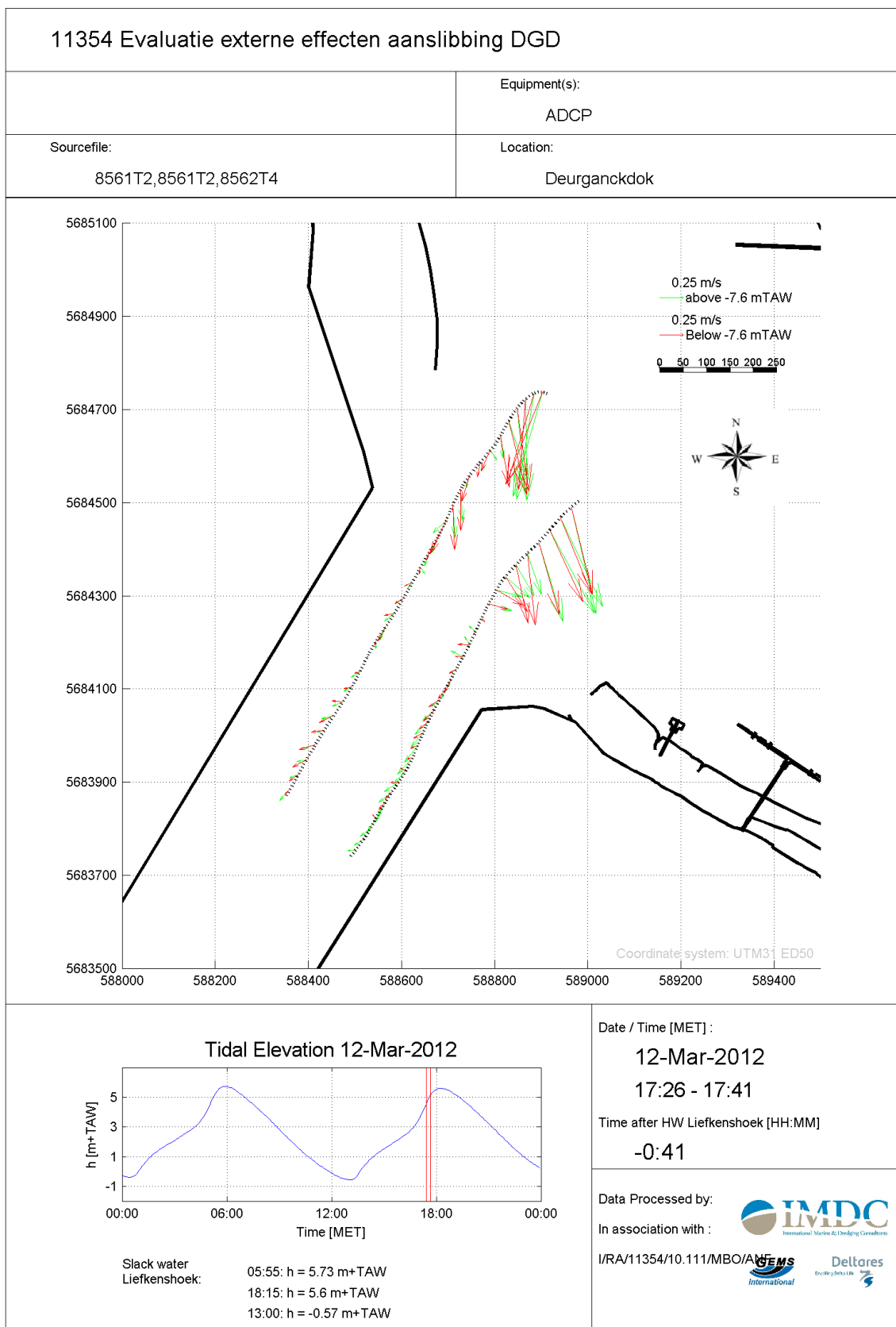
-1:00

Data Processed by:

In association with :

I/RA/11354/10.111/MBO/ANF





11354 Evaluatie externe effecten aanslibbing DGD

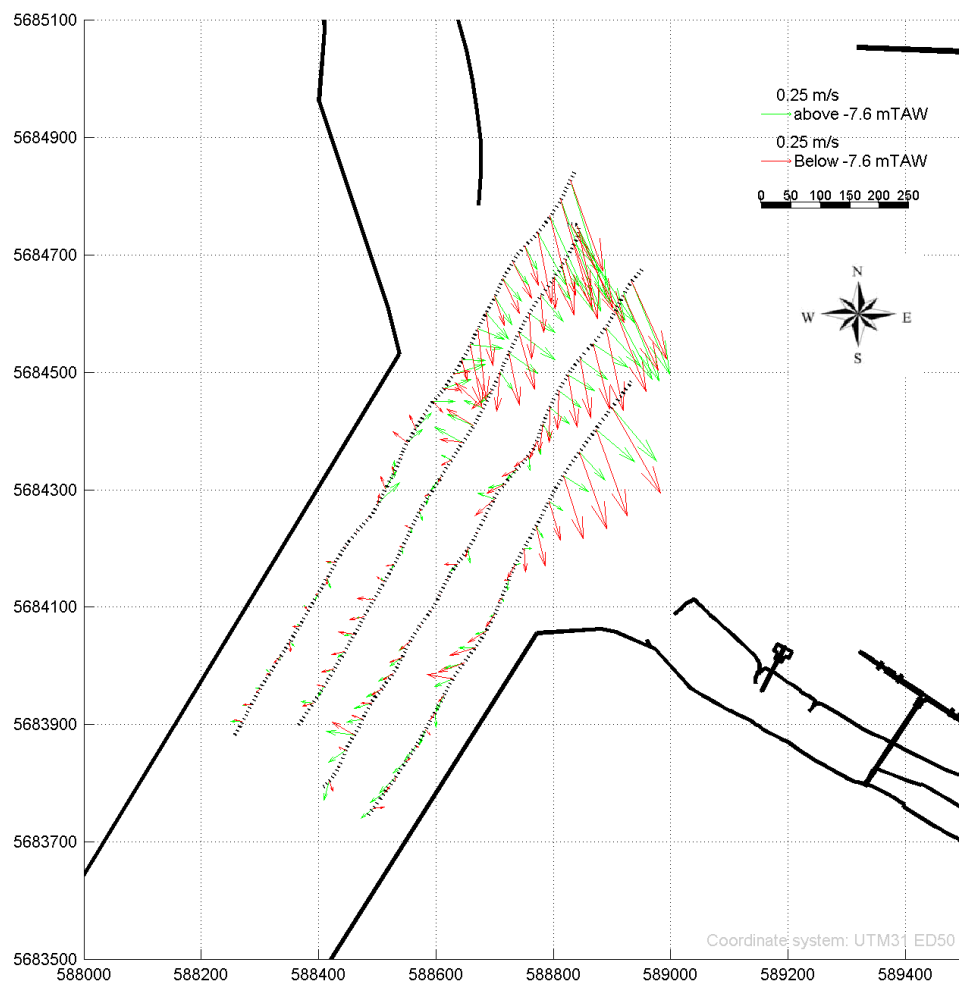
Equipment(s):

ADCP

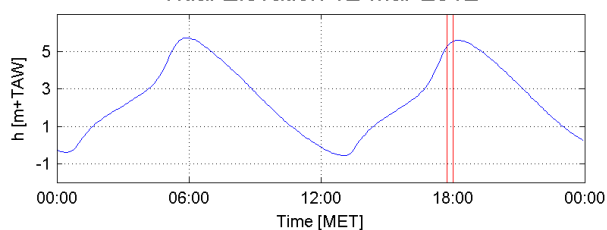
Sourcefile:

Location:

Deurganckdok



Tidal Elevation 12-Mar-2012



Slack water
Liefkenshoek:
05:55: h = 5.73 m+TAW
18:15: h = 5.6 m+TAW
13:00: h = -0.57 m+TAW

Date / Time [MET] :

12-Mar-2012

17:44 - 18:01

Time after HW Liefkenshoek [HH:MM]

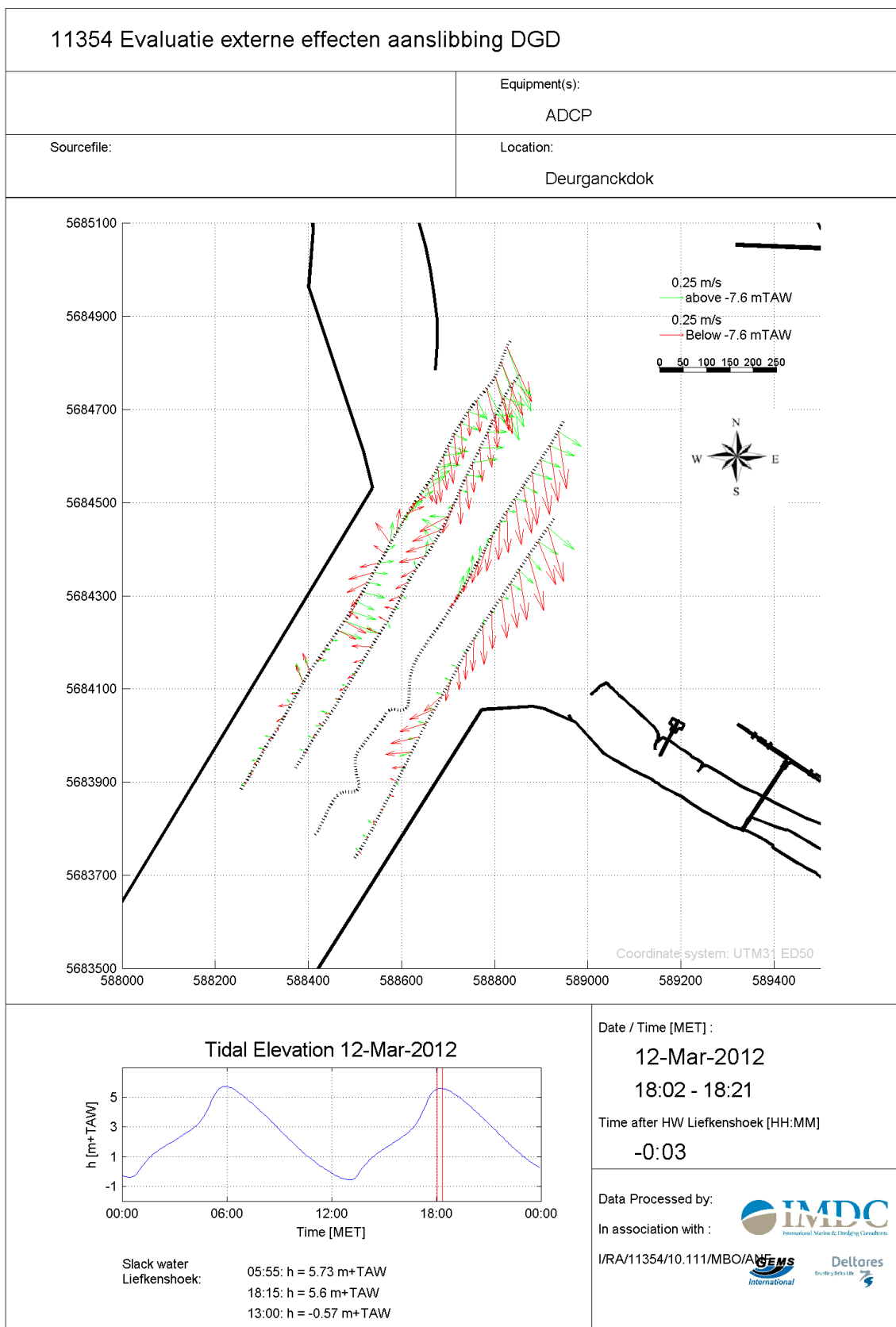
-0:21

Data Processed by:

In association with :

I/RA/11354/10.111/MBO/ANF





11354 Evaluatie externe effecten aanslibbing DGD

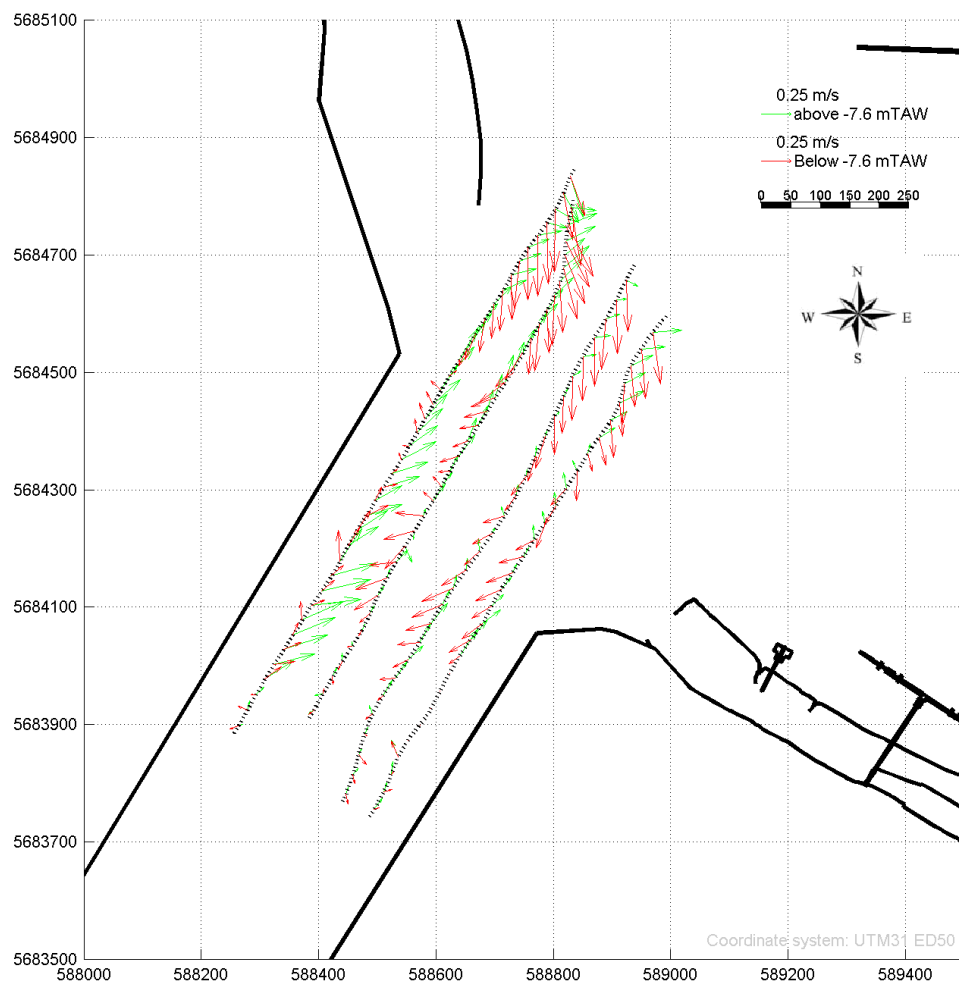
Equipment(s):

ADCP

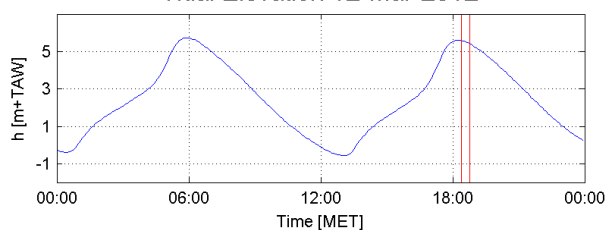
Sourcefile:

Location:

Deurganckdok



Tidal Elevation 12-Mar-2012



Slack water
Liefkenshoek:
05:55: h = 5.73 m+TAW
18:15: h = 5.6 m+TAW
13:00: h = -0.57 m+TAW

Date / Time [MET] :

12-Mar-2012

18:24 - 18:47

Time after HW Liefkenshoek [HH:MM]

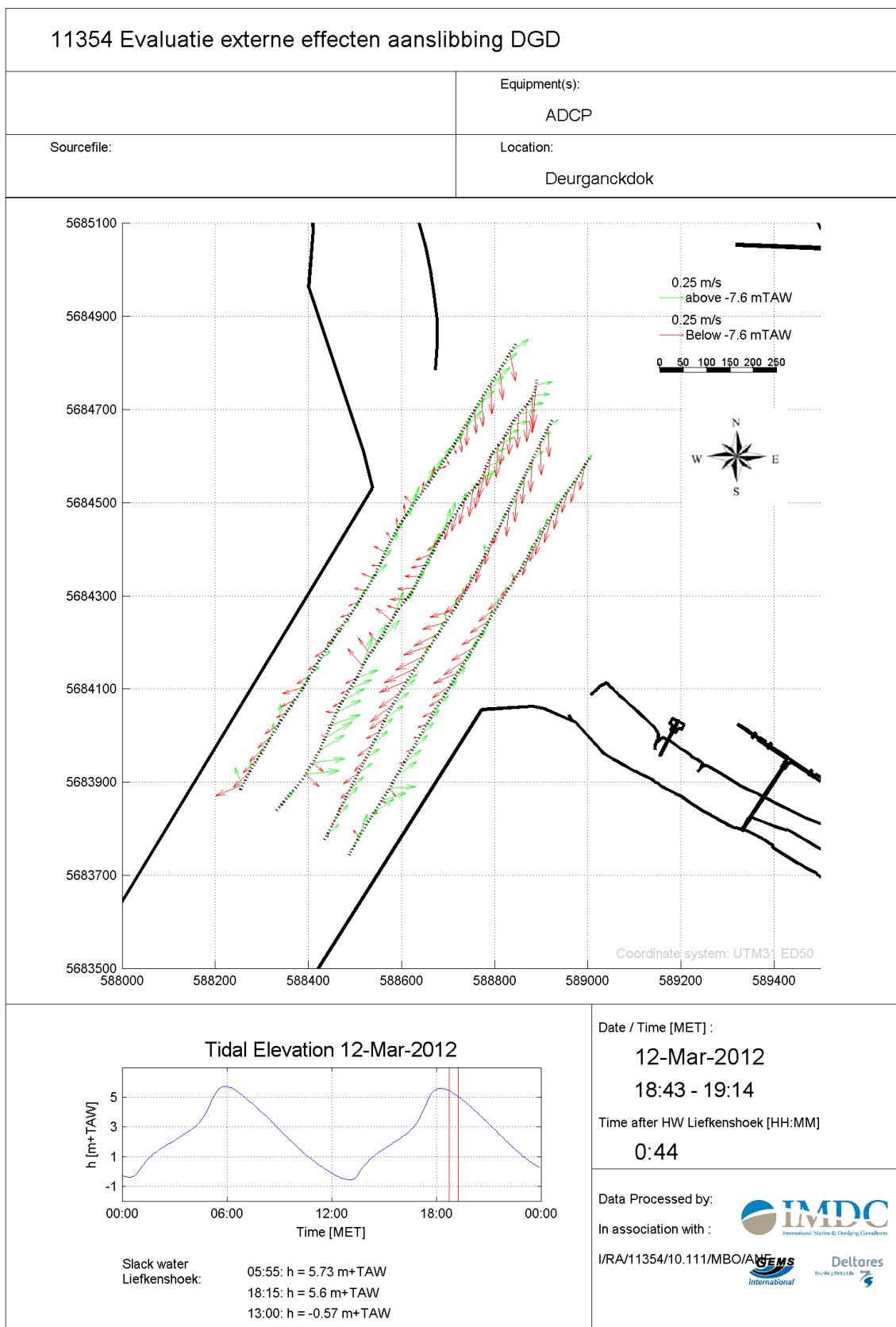
0:20

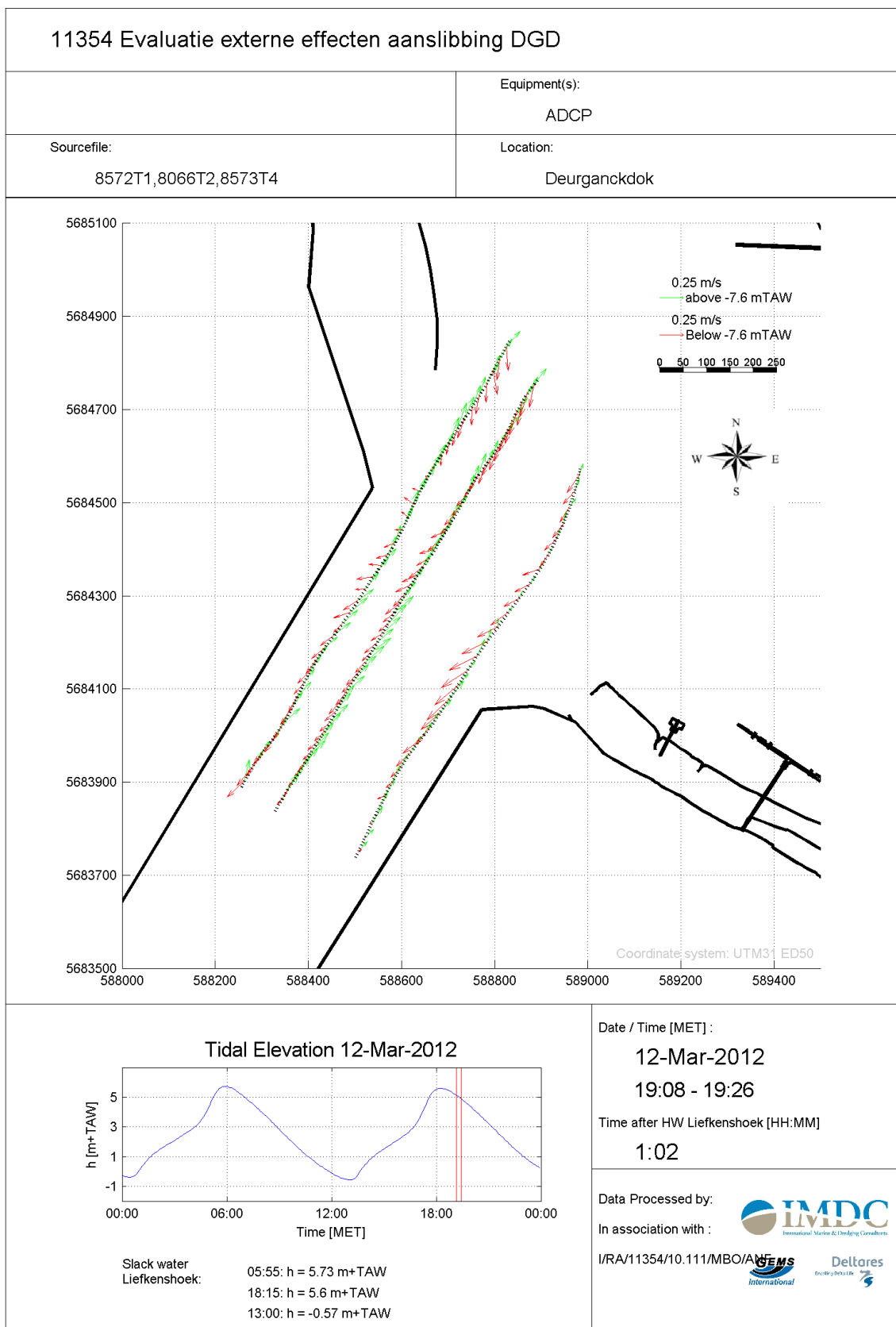
Data Processed by:

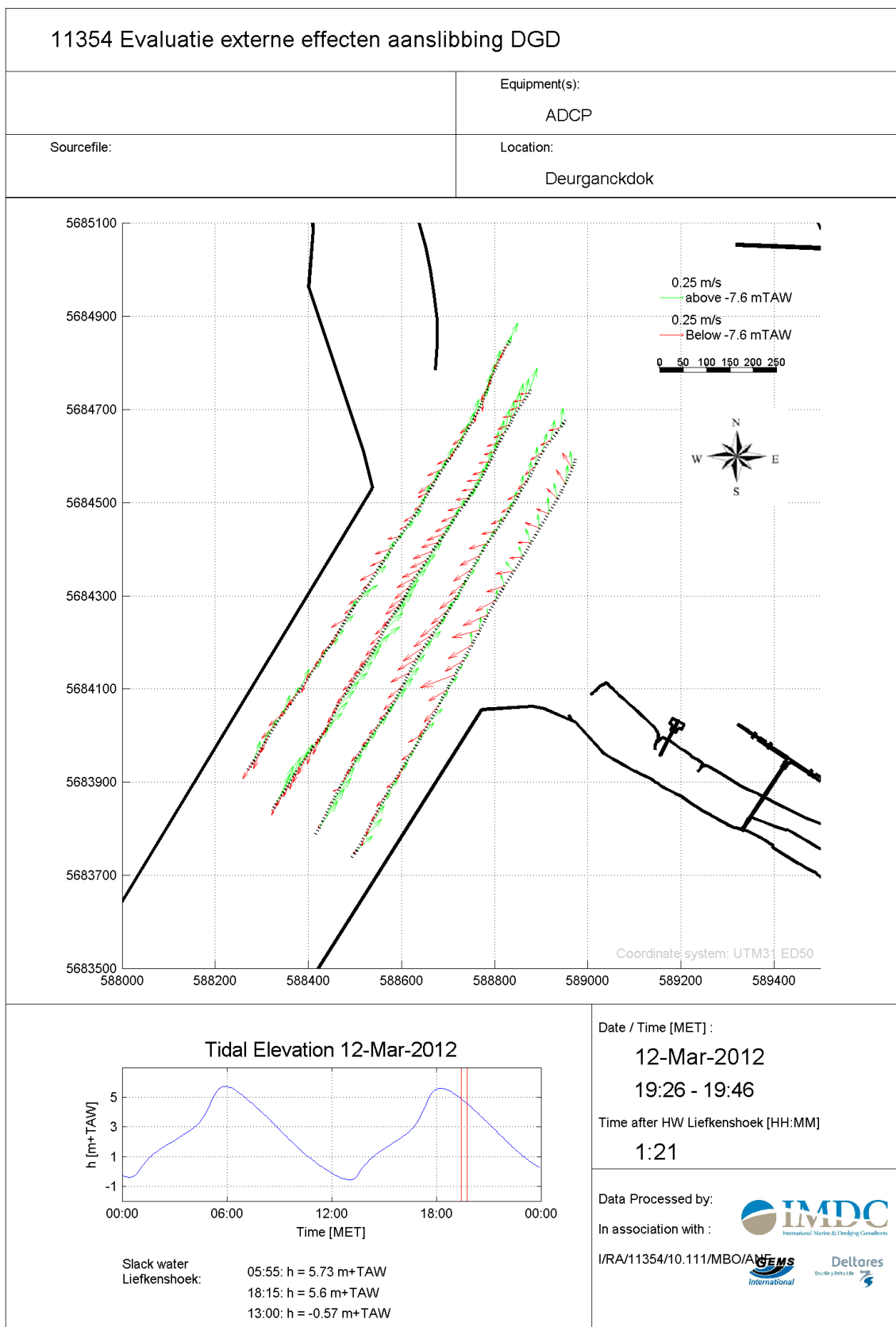
In association with :

I/RA/11354/10.111/MBO/ANF









11354 Evaluatie externe effecten aanslibbing DGD

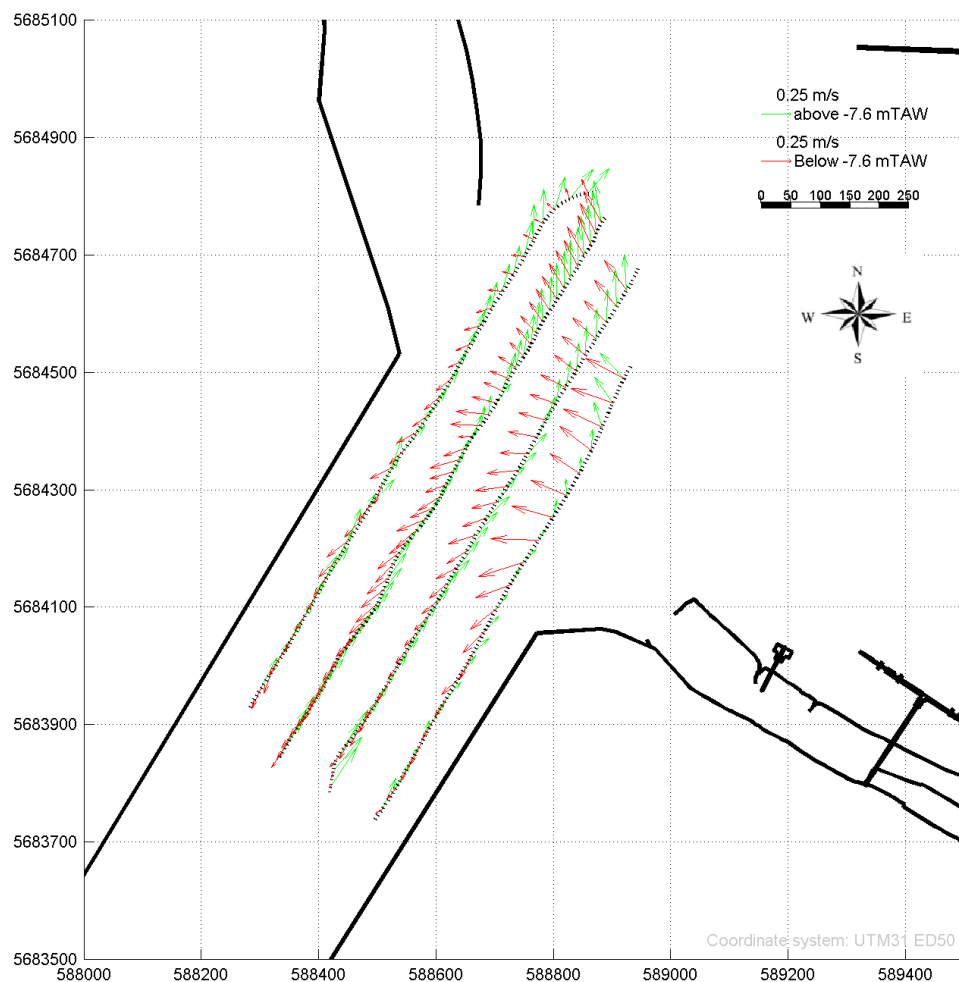
Equipment(s):

ADCP

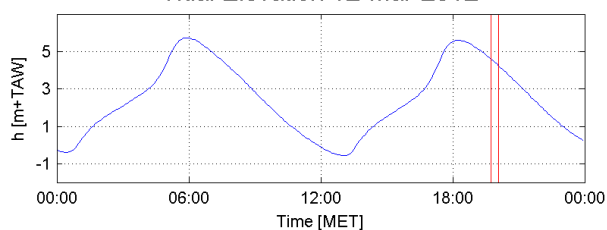
Sourcefile:

Location:

Deurganckdok



Tidal Elevation 12-Mar-2012



Slack water
Liefkenshoek:
05:55: h = 5.73 m+TAW
18:15: h = 5.6 m+TAW
13:00: h = -0.57 m+TAW

Date / Time [MET] :

12-Mar-2012

19:43 - 20:06

Time after HW Liefkenshoek [HH:MM]

1:40

Data Processed by:

In association with :

I/RA/11354/10.111/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)

Report Description of Opvolging aanslibbing Deurganckdok between April 2006 till March 2008	
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)
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)

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 2006 till March 2008
4.10	Analysis of Siltation Processes and Factors, 4/'07 – 3/'08 (I/RA/11283/07.102/MSA)

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)