

REPORT

**Vlaamse Overheid Departement
Mobiliteit en Openbare werken**

Afdeling Maritieme Toegang

Evaluation of the external effects on the siltation in Deurganckdok

Report 2.9: Salt-Silt distribution Deurganckdok
1/6/2011-30/05/2012

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International Marine & Dredging Consultants

in collaboration with

Deltares

Enabling Delta Life



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Table of Contents

1. INTRODUCTION.....	4
1.1 THE ASSIGNMENT	4
1.2 AIM OF THE STUDY	4
1.3 OVERVIEW OF THE STUDY	4
1.4 STRUCTURE OF THE REPORT	4
2. SEDIMENTATION IN DEURGANCKDOK	7
2.1 PROJECT AREA: DEURGANCKDOK	7
2.2 OVERVIEW OF THE STUDIED PARAMETERS.....	7
2.3 MEASUREMENT OBJECTIVES OF THE LONG TERM MEASUREMENTS NEAR THE QUAY WALLS.....	10
3. SUSPENDEDSEDIMENT-SALINITY MEASUREMENT CAMPAIGN 21/05/2011 – 10/06/2012	11
3.1 MEASUREMENT LOCATION.....	11
3.2 THE EQUIPMENT	12
3.2.1 Quay frame set up	12
3.2.2 Campbell Scientific OBS3A	13
3.2.3 Van Essen CTD-Diver	13
3.3 COURSE OF THE MEASUREMENTS.....	13
4. PROCESSING OF DATASETS.....	18
4.1 CALIBRATION OF THE SENSORS	18
4.1.1 Turbidity	18
4.1.2 Conductivity	18
4.2 LONG TERM MEASUREMENTS NEAR QUAY WALL	19
4.2.1 Factual data: week series.....	19
4.2.2 Average tidal cycle of local parameters.....	19
4.2.3 Average tidal cycle of gradients.....	20
5. PRELIMINARY ANALYSIS OF THE LONG TERM SALINITY MEASUREMENTS (20/05/2011 – 30/05/2012)	21
5.1 WEEK SERIES	21
5.1.1 N-entrance	21
5.1.2 S-entrance	21
5.1.3 Comparison IMDC-ANTEA.....	21
5.2 AVERAGE TIDAL CYCLES.....	22
5.2.1 Local parameters.....	22
5.2.2 Gradients	22
5.3 COMPARISON WITH PREVIOUS MEASUREMENTS.....	22
6. REFERENCES.....	24

Annexes

ANNEX A	OVERVIEW OF MEASUREMENTS	31
A.1	OVERVIEW OF THE MEASUREMENT LOCATIONS FOR THE WHOLE HCBS AND DEURGANCKDOK MEASUREMENTS CAMPAIGN (CHARTS).....	32
A.2	MEASUREMENT OVERVIEW AT DEURGANCKDOK	33
ANNEX B	WEEKSERIES SALINITY – SILT MEASUREMENTS DGD	34
B.1	N-ENTRANCE (PSA).....	35
B.2	S-ENTRANCE (DPW).....	91
ANNEX C	AVERAGE TIDAL CYCLES	147
C.1	LOCAL PARAMETERS	148
C.2	CROSS DOCK AND VERTICAL GRADIENTS.....	157
ANNEX D	COMPARISON ANTEA AND IMDC DATA.....	162
D.1	TIMESERIES	163
D.1.1	N-entrance (PSA)	163
D.1.2	S-entrance (DPW)	166
D.2	SCATTERPLOTS.....	169

List of Tables

TABLE 1-1: OVERVIEW OF THE EXTERNAL EFFECTS DEURGANCKDOK REPORTS.....	5
TABLE 3-1: MEASUREMENT LOCATIONS IN UTM31 WGS84	11
TABLE 3-2: DEPLOYMENT DEPTHS OF ALL INSTRUMENTS FOR THE MEASUREMENT PERIOD.....	11
TABLE 3-3: OVERVIEW OF MEASUREMENT PERIOD, SENSORS AND DATA GAPS	14
TABLE 4-1: LINEAR TURBIDITY CALIBRATION COEFFICIENT MAY 2011 – JUNE 2012 (SSC=A*TURBIDITEIT+B)	18

List of Figures

FIGURE 2-1: OVERVIEW OF DEURGANCKDOK	7
FIGURE 2-2: ELEMENTS OF THE SEDIMENT BALANCE.....	8
FIGURE 2-3: DETERMINING A SEDIMENT BALANCE.....	9
FIGURE 2-4: TRANSPORT MECHANISMS	10
FIGURE 3-1: MAP OF THE UPDATED MEASUREMENT LOCATIONS FOR LONG TERM SALT-SILT MEASUREMENTS IN DEURGANCKDOK	11
FIGURE 3-2: FRAME DESIGN.....	12
FIGURE 4-1: CATEGORISATION OF TIDAL TIDAL CYCLES	20

1. INTRODUCTION

1.1 THE ASSIGNMENT

This report is part of a set of reports (IMDC, 2010 a-b, 2011 a-d, 2012, a-p) 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 AIM 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 human operations near Deurganckdok:

- The construction of the Current Deflecting Wall (CDW) 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 silt 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

1.4 STRUCTURE OF THE REPORT

This report is the factual data report for the Long term salinity/silt measurements in Deurganckdok from 21 May 2011 – 30 May 2012. The first chapter comprises an introduction. The second chapter describes the project. Chapter 3 describes the measurement campaign, equipment and the course of the actual measurements. The measurement results and processed data are presented in Chapter 4, whereas chapter 5 gives a preliminary analysis of the data.

This report covers measurements of salt and silt distribution at the entrance of Deurganckdok from May 2011 until May 2012 (measurement years 5 and 6) and is part of the project 'Evaluation of the external effects on the siltation in the Deurganckdok', summarized in Table 1-1.

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

Report Description	
1. Reporting	
I.1 Annual Sediment Balance: Bathymetry surveys, Density measurements, Maintenance and construction dredging activities	
1.1	Annual Sediment Balance: year 1: 1/4/2009-31/3/2010 (I/RA/11354/10.067/NZI)
1.2	Annual Sediment Balance: year 2: 1/4/2010-31/3/2011 (I/RA/11354/10.100/MBO/ANF)
1.3	Annual Sediment Balance: year 3: 1/4/2011-31/3/2012 (I/RA/11354/10.101/MBO/ANF)
I.2 Boundary Conditions: Upriver Discharge, Salt concentration Scheldt, Bathymetric evolution in access channels, dredging activities in Lower Sea Scheldt and access channels	
1.4	Boundary Conditions year 1: 01/04/2009 – 31/3/2010 (I/RA/11354/10.102/MBO/ANF)
1.5	Boundary Conditions year 2: 01/04/2010 – 31/3/2011 (I/RA/11354/10.103/MBO/ANF)
1.6	Boundary Conditions year 3: 01/04/2011 – 31/3/2012 (I/RA/11354/10.104/MBO/ANF)
I.3 Synthesis of CDW research	
1.7	Synthesis report of research on Current Deflecting Wall (I/RA/11354/10.063/MBO)
I.4 Analysis: evaluation of external effects on siltation in Deurganckdok	
1.8	Analysis of external effects on siltation processes and factors (I/RA/11354/10.105/MBO/ANF)
2. Measurement campaigns: Factors contributing to salt and sediment distribution in Deurganckdok: Salt-Silt (OBS3A) & Frame measurements, Through tide measurements (Silt Profiling & 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 Spring 2012 (I/RA/11354/10.111/MBO/ANF)
II.3 Salt Silt Distribution entrance Deurganckdok	
2.8 ³	Salt-Silt distribution Deurganckdok 1/4/2009-31/3/2010 (I/RA/11354/10.068/NZI)
2.9	Sal-Silt distribution Deurganckdok 1/6/2011-30/05/2012 (I/RA/11354/10.112/MBO/ANF)

Report Description	
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)
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. SEDIMENTATION IN DEURGANCKDOK

2.1 PROJECT AREA: DEURGANCKDOK

Deurganckdok is a tidal dock situated at the left bank in the Lower Sea Scheldt, between Liefkenshoek and Doel. Deurganckdok has the following characteristics:

1. the dock has a total length of 2750 m and is 450 m wide at the Scheldt end and 400 m wide at the inward end of the dock
2. The bottom of Deurganckdok is provided at a depth of -17m TAW in the transition zones between the quay walls and the central trench and of -19m TAW in the central trench.
3. the quay walls reach up to $+9\text{m TAW}$

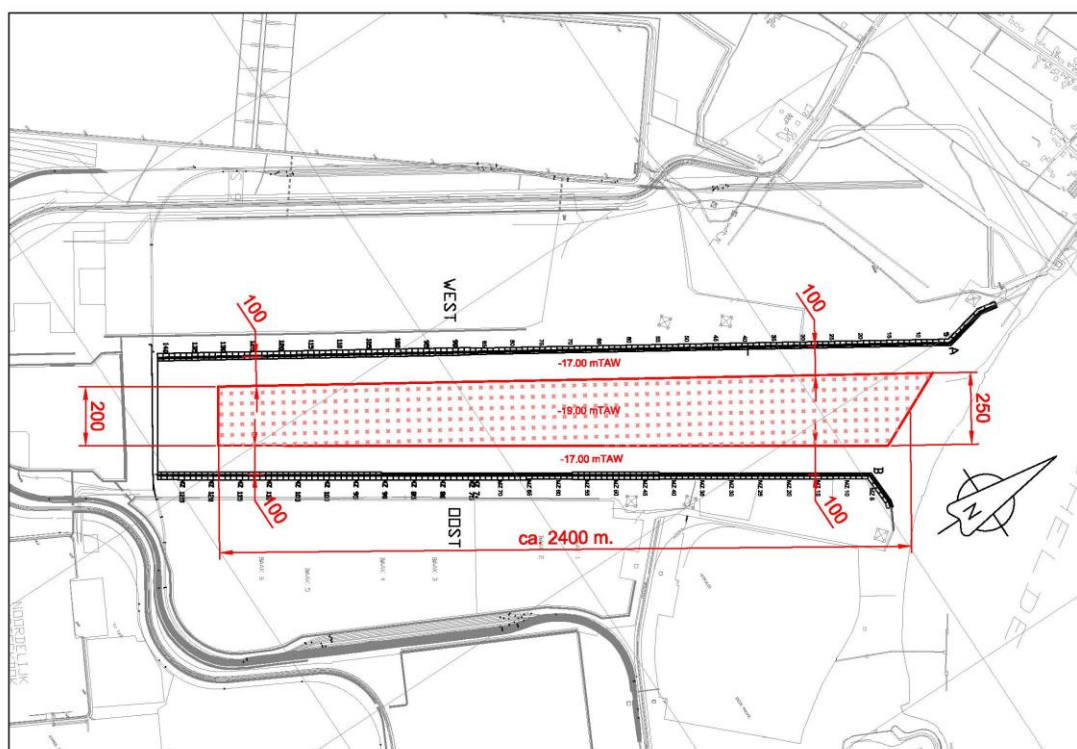


Figure 2-1: Overview of Deurganckdok

The dredging of the dock is performed in 3 phases. On 18 February 2005 the dike between the Scheldt and the Deurganckdok was breached. On 6 July 2005 Deurganckdok was officially opened. The second dredging phase was finalized a few weeks later. The first terminal operations have started since.

2.2 OVERVIEW OF THE STUDIED 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 2-2 & Figure 2-1).

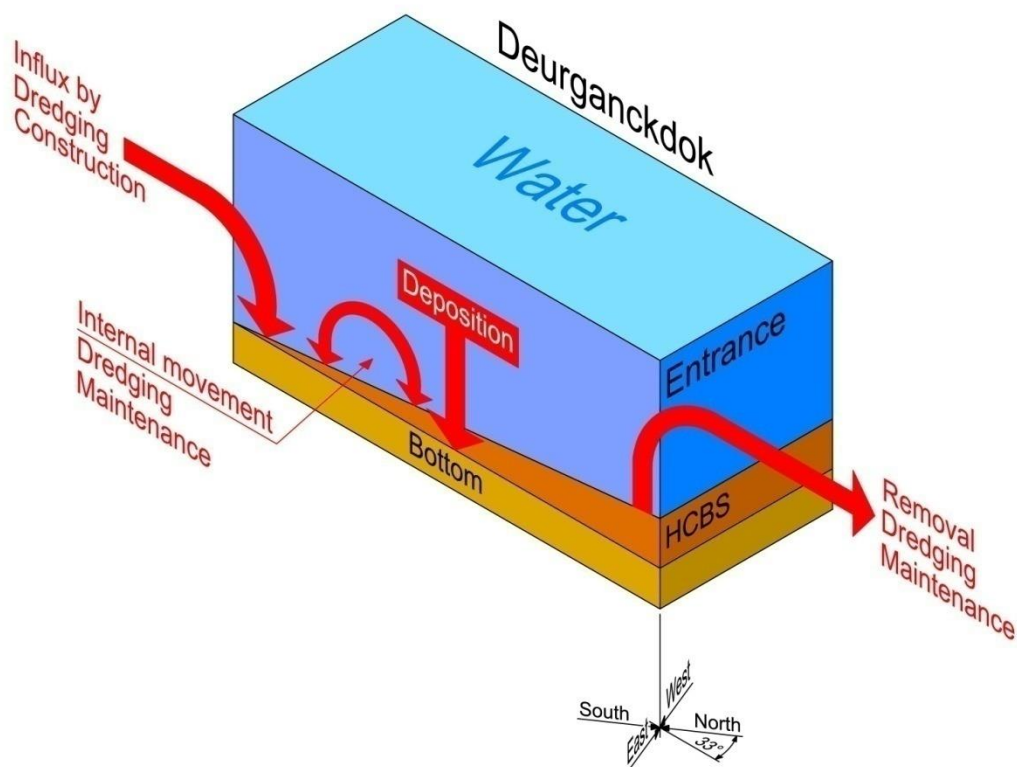


Figure 2-2: Elements of the sediment balance

A net deposition can be calculated from a comparison with a chosen initial condition t_0 (Figure 2-3). 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 river Scheldt since t_0 .

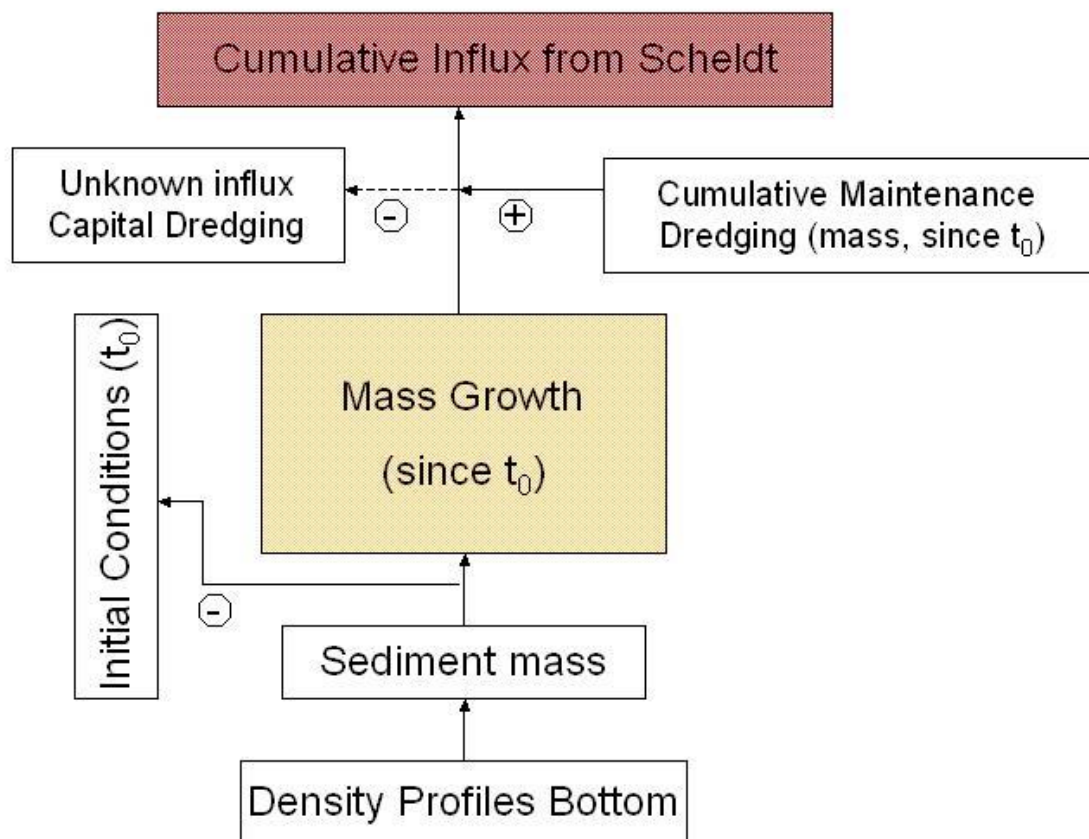


Figure 2-3: Determining a sediment balance

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 salinity gradient between the Scheldt river and the dock
- Density currents due to highly concentrated benthic suspensions

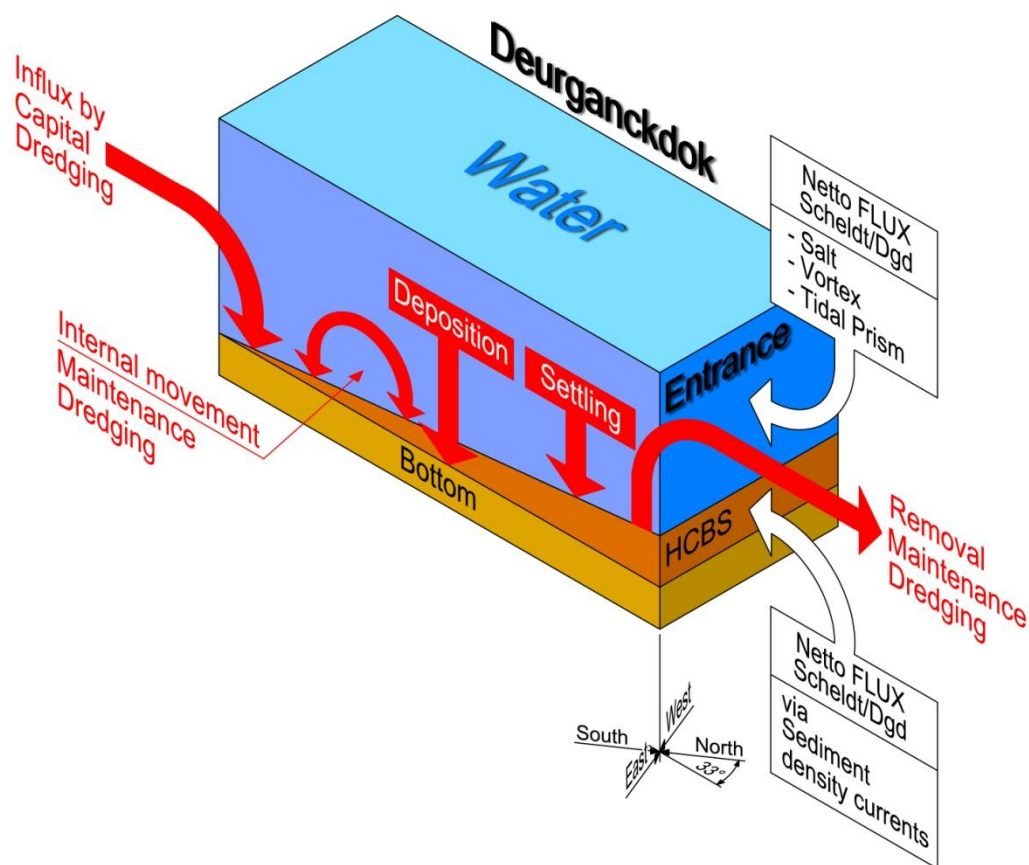


Figure 2-4: Transport mechanisms

These aspects of hydrodynamics and sediment transport have been landmark in determining the parameters to be measured during the project. Measurements will be focused 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 upstream discharge in 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 current, 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 entrance channels towards the Kallo, Zandvliet and Berendrecht locks as well as dredging and dumping activities in the Lower Sea Scheldt.
- In situ calibrations were conducted on several dates to calibrate all turbidity and conductivity sensors.

2.3 MEASUREMENT OBJECTIVES OF THE LONG TERM MEASUREMENTS NEAR THE QUAY WALLS

The goal of the survey is to monitor the spatial distribution of salinity and silt in the Deurganckdok. Vertical and horizontal (from north to south quay) distribution is surveyed in this set up. The entrance of the dock is a favoured location because of the dynamics caused by the river-dock interaction.

3. SUSPENDED SEDIMENT-SALINITY MEASUREMENT CAMPAIGN 21/05/2011 – 10/06/2012

3.1 MEASUREMENT LOCATION

During the period from 21/05/2011 till 10/06/2012, 4 multi parameter probes were placed on 2 fixed locations: PSA and DP World. At each location, a CTD-Diver and OBS-3A were hanging from the quay wall in Deurganckdok at 2 depths. The CTD-Diver was logging the temperature and conductivity, and OBS-3A the turbidity.

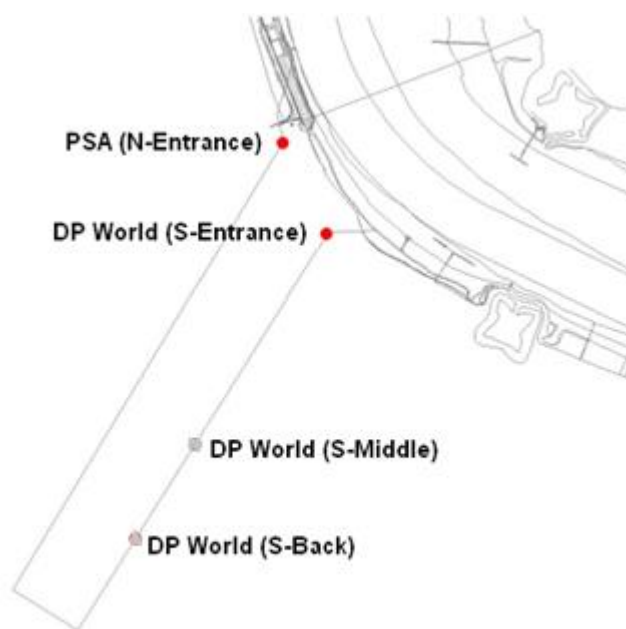


Figure 3-1: Map of the updated measurement locations for long term salt-silt measurements in Deurganckdok

Table 3-1: Measurement locations in UTM31 WGS84

Location	EASTING	NORTHING	Boulder	Operator
N entrance – Top (PSA)	588442	5684313	Moot 101	PSA-HNN
N entrance – Bottom (PSA)	588442	5684313	Moot 72	PSA-HNN
S entrance – Top (DPW)	588673	5683835	Moot 7	DP World
S entrance – Bottom (DPW)	588673	5683835	Moot 5 (boulder 286)	DP World

Table 3-2: Deployment depths of all instruments for the measurement period

Salinity Silt Measurements Deurganckdok				
Location	Easting (UTM31 WGS84)	Northing (UTM31 WGS84)	Instrument Height	Period
			[m TAW]	
N entrance – Top (CTD-OBS)	588442	5684313	-2.5	20/05/2011 – 30/05/2012
N entrance – Bottom (CTD-OBS)	588442	5684313	-12.2	20/05/2011_ 29/05/2012
S entrance – Top (CTD-OBS)	588673	5863835	-2.3	20/05/2011 – 30/05/2012
S entrance – Bottom (CTD-OBS)	588673	5863835	-13.0	20/05/2011 – 30/05/2012

3.2 THE EQUIPMENT

3.2.1 Quay frame set up

A simple rectangular measurement frame was conceived for suspending the instruments from the quay wall down into the Deurganckdok. Two frames rest against the dock wall and are suspended by stainless steel cables hanging from a rawlplug, secured on top of the quay wall.

Using a guiding system and a winch, it was possible to recover these instruments without the help of a survey vessel.



Figure 3-2: Frame design

3.2.2 Campbell Scientific OBS3A

The Campbell Scientific OBS 3A is a multiparameter instrument that consists of a CTD probe and a turbidity sensor. The instrument was set up to measure every ten minutes for a minute at a frequency of 1 Hz and output the average. Based on the calibration reports (see section 4.1.2), the salinity measurements of the OBS-3A are not reliable and is replaced by a CTD-Diver.

3.2.3 Van Essen CTD-Diver

Van Essen CTD-Diver were used and measured every 5 minutes following parameters by:

- temperature (°C),
- conductivity (mS/cm)
- absolute depth (m)

From these parameters the salinity is calculated.

IMDC (2008a) gives more details on the CTD-Diver datalogger.

3.3 COURSE OF THE MEASUREMENTS

The instruments were recovered, cleaned and read out every two weeks. Table 3-3 lists the measurement periods and data quality issues during the period covered by this report, from 20/05/2011 till 30/05/2012. Only OBS 3A and CTD-Diver instruments were deployed during this measurement period. The CTD diver instrument was only used to measure the conductivity and temperature.

Table 3-3: Overview of measurement period, sensors and data gaps

N-entrance top (PSA_CTD-OBS): -2m TAW						
Period			Sn CTD-OBS	No data	Faulty data	Comment
20/05/2011	-	10/06/2011	221		x	Anomalous salinity data removed at 06/06/2011. No CTD data
10/06/2011	-	27/06/2011	Z060/221			CTD instrument installed
27/06/2011	-	20/07/2011	Z060/221			
20/07/2011	-	02/08/2011	Z060/221			
02/08/2011	-	17/08/2011	Z060/221			
17/08/2011	-	08/09/2011	Z060/221		x	Anomalous (CTD) Temperature data removed at 21/08/2011.
08/09/2011	-	16/09/2011	Z060/221			
16/09/2011	-	04/10/2011	Z060/221			
04/10/2011	-	20/10/2011	Z060/221			
20/10/2011	-	3/11/2011	Z254/221			CTD Instrument replaced
3/11/2011	-	24/11/2011	Z061/221			CTD instrument replaced
24/11/2011	-	12/12/2011	Z061/221			
12/12/2011	-	04/01/2012	Z061/221			
04/01/2012	-	27/01/2012	Z061/221			
27/01/2012	-	16/02/2012	Z061/221			
16/02/2012	-	08/03/2012	Z061/221			
08/03/2012	-	27/03/2012	Z061/221			
27/03/2012	-	20/04/2012	Z061/221			
20/04/2012	-	21/05/2012	Z061/221		x	Anomalous (CTD) Temperature data removed at 24/04/2012 Anomalous (OBS) SSC data removed from 12/05/2012 till 21/05/2012 due to fouling on the turbidity sensor
21/05/2012	-	30/05/2012	Z061/221			

N-entrance bottom (PSA_CTD-OBS): -12m TAW						
Period			Sn CTD-OBS	No data	Faulty data	Comment
20/05/2011	-	10/06/2011	307		x	Anomalous salinity data removed from 20/05/2011 till 10/06/2011 No CTD data
10/06/2011	-	27/06/2011	Z065/307		x	CTD diver installed
27/06/2011	-	20/07/2011	Z065/307			
20/07/2011	-	02/08/2011	Z065/261			OBS Instrument replaced
02/08/2011	-	17/08/2011	Z065/261			
17/08/2011	-	08/09/2011	Z065/261			
08/09/2011	-	16/09/2011	Z065/261			
16/09/2011	-	04/10/2011	Z065/261		x	Anomalous SSC removed from 19/09/2011 till 04/10/2011 due to broken sensor
04/10/2011	-	20/10/2011	Z065/223			OBS replaced.
20/10/2011	-	3/11/2011	Z065/223			
3/11/2011	-	24/11/2011	Z065/224			OBS replaced.
24/11/2011	-	12/12/2011	Z065/224			
12/12/2011	-	04/01/2012	Z065/224			
04/01/2012	-	27/01/2012	Z065/224			
27/01/2012	-	16/02/2012	Z065/224		x	Anomalous salinity data removed from 02/02/2012 till 16/02/2012 due to broken wire. (CTD instrument on the seafloor) Anomalous SSC data removed from 14/02/2012 till 16/02/2012 due to broken wire (OBS instrument on the floor)
16/02/2012	-	08/03/2012	Z065/224			No data measured for Salinity, SSC and Temperature from 16/02/2012 due to problem with downloading from the instruments
08/03/2012	-	27/03/2012	Z065/224			
27/03/2012	-	20/04/2012	Z065/224			
20/04/2012	-	21/05/2012	Z065/224			
21/05/2012	-	30/05/2012	Z065/224			

S-entrance top (DP world CTD-OBS): -2m TAW						
Period			Sn	No data	Faulty data	Comment
20/05/2011	-	10/06/2011	224		x	Anomalous salinity data removed at 30/05/2011, 01/06/2011, 03/06/2011 and 06/06/2011. No CTD data
10/06/2011	-	27/06/2011	Z055/224			
27/06/2011	-	20/07/2011	Z275/224		x	Anomalous SSC data removed from 05/07/2011 till 21/07/2011 due to fouling Anomalous salinity removed at 15/07/2011.
20/07/2011	-	02/08/2011	Z259/224			
02/08/2011	-	17/08/2011	Z259/221			OBS replaced
17/08/2011	-	08/09/2011	221	x		No OBS data due to connection problems
08/09/2011	-	16/09/2011	Z059/221		x	
16/09/2011	-	04/10/2011	Z059/221			
04/10/2011	-	20/10/2011	Z059/221		x	
20/10/2011	-	3/11/2011	Z059/221		x	Anomalous Turbidity and SSC data removed at 26/10/2011
3/11/2011	-	24/11/2011	Z059/221			Instrument replaced.
24/11/2011	-	12/12/2011	Z059/222			
12/12/2011	-	04/01/2012	Z059/222			
04/01/2012	-	27/01/2012	Z059/222			
27/01/2012	-	16/02/2012	Z059/222			
16/02/2012	-	08/03/2012	Z059/222			
08/03/2012	-	27/03/2012	Z059/222			
27/03/2012	-	20/04/2012	Z059/222			
20/04/2012	-	21/05/2012	Z059/222			Anomalous SSC data removed from 10/05/2012 till 21/05/2012 due to fouling
21/05/2012	-	30/05/2012	Z059/222			

S-entrance bottom (DP world_OBS-CTD): -12m TAW						
Period			Sn	No data	Faulty data	Comment
20/05/2011	-	10/06/2011	Z059/225			
10/06/2011	-	27/06/2011	Z059/225			
27/06/2011	-	20/07/2011	Z258/225			
20/07/2011	-	02/08/2011	Z258/225			
02/08/2011	-	17/08/2011	Z258/225			
17/08/2011	-	08/09/2011	Z258/225	x		No OBS data due to connection problems
08/09/2011	-	16/09/2011	Z258/225			
16/09/2011	-	04/10/2011	Z258/224		x	OBS Instrument replaced Anomalous Temperature and SSC removed from 23/09/2011 till 02/10/2011 due to broken wire
04/10/2011	-	20/10/2011	Z258/224			
20/10/2011	-	3/11/2011	Z258/224			
3/11/2011	-	24/11/2011	Z258/224			
24/11/2011	-	12/12/2011	Z258/224			
12/12/2011	-	04/01/2012	Z258/224			
04/01/2012	-	27/01/2012	Z258/224			
27/01/2012	-	16/02/2012	Z258/224			
16/02/2012	-	08/03/2012	Z258/224			
08/03/2012	-	27/03/2012	Z258/224			Anomalous salinity data removed at 11/03/2011
27/03/2012	-	20/04/2012	Z258/224			
20/04/2012	-	21/05/2012	Z258/224			Anomalous SSC data removed from 4/05/2012 till 21/05/2012 due to fouling
21/05/2012	-	30/05/2012	Z258/225		x	Instrument replaced

4. PROCESSING OF DATASETS

4.1 CALIBRATION OF THE SENSORS

A crucial aspect of the accuracy and reliability of the data concerns the calibration of the instruments before the measurement campaign. The calibration procedures and results are described in 'Report 2.12 : Calibration of mobile and stationary instruments on March 16, 2011 (IMDC, 2012e).and 2.13 : Calibration of the stationary instruments on June 1, 2012 (IMDC, 2012o).

4.1.1 Turbidity

The turbidity calibration used in the present report is derived from the calibration data of 16 March 2011 (IMDC, 2012e) and 1 June 2012 (IMDC, 2012o) by taking an averaged calibration curve.. The new calibration coefficients are presented in Table 4-1 and are representative for whole the measurement period.

Table 4-1: Linear turbidity calibration coefficient May 2011 – June 2012 ($SSC=a*turbidity+b$)

Serial number OBS3A	a	b
221	1.64	-2.09
222	1.61	-2.09
223	1.77	-4.17
224	1.47	-2.09
225	1.53	-2.09
261	1.85	-4.17
307	1.56	-2.09

4.1.2 Conductivity

The conductivity of most sensors has also been checked on 1 June 2012 (IMDC, 2012o). The conductivity comparison of the CTD-Divers and RBR are showing similar trends, the range of values during each measurement is about 0.5mS/cm. The conductivity and temperature of the OBS3A instruments and RCM 9 instruments have a much higher variation than the comparison of the CTD-divers with RBR and will therefore not be used for salinity measurements.

4.2 LONG TERM MEASUREMENTS NEAR QUAY WALL

The long term measurements executed at two depths (on average -2 m TAW and -12 m TAW) at two locations on the quay walls of Deurganckdok lasted from May 21st 2011 until May 31st 2012. Depth, temperature, salinity and suspended sediment concentration have been logged. All gathered time series have been converted to appropriate engineering units and combined to form series covering the complete period. During validation erroneous data due to midterm recovery, sensor malfunction and buried equipment has been removed. In this form the data is ready for processing.

4.2.1 Factual data: week series

Measurements are visualized per instrument, location and per week in **Annex B**

- The title shows the week number followed by the year,
- The first graph shows the suspended sediment concentration.
- The second graph shows the temperature,
- The third graph shows the salinity,
- The last graph show the water level at the nearest tidal gauge,

Faulty data is omitted from these graphs.

4.2.2 Average tidal cycle of local parameters

For all parameters measured at one location data has been organised in separate series per tidal cycle (low water to next low water). High water moments were placed on a fixed position in the series, low water moments differ in time relative to high water due to variation in flood and ebb length with neap-spring phases. In this way a time series with time relative to high water is produced for each tide. When tidal elevation data showed substantial gaps data from pressure gauges was used to divide the long series into tidal series.

By defining average tidal amplitude A for neap, average and spring tides, it becomes possible to classify tidal cycles in three categories in the following way:

$$Neap : A \leq \alpha(A_{neap} + A_{aver})$$

$$Spring : A \geq \alpha(A_{spring} + A_{aver})$$

$$Average : \alpha(A_{neap} + A_{aver}) < A < \alpha(A_{spring} + A_{aver})$$

where: A_{neap} , A_{aver} and A_{spring} are average amplitudes

α is a factor to decide where to distinguish between categories (here taken as 0.5)

Using such categorisation the tidal series can be grouped in neap, average and spring tides. Within these groups an average is made per parameter per tidal phase relative to high water (Figure 4-1). In this way an average neap tidal cycle, an average middle tidal cycle and an average spring tidal cycle is obtained for all parameters.

The same exercise is repeated for relative values, which are the measured values divided by the tidal average (the average parameter value for that particular tidal cycle). All three types are shown in one plot with a plot for salinity, sediment concentration and temperature per page in **Error!**
Reference source not found..

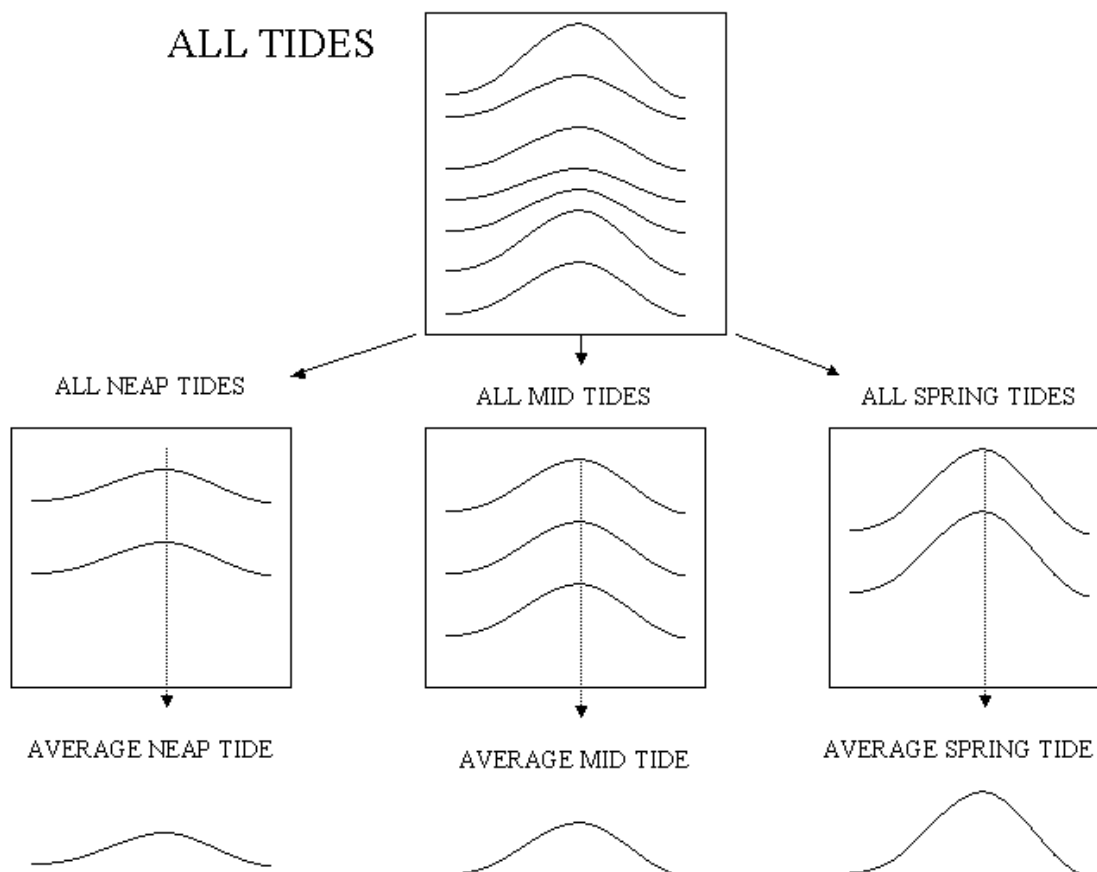


Figure 4-1: Categorisation of tidal tidal cycles

4.2.3 Average tidal cycle of gradients

For each of the three parameters being processed, two horizontal gradients (cross dock at two depths) and two vertical gradients (one per location) have been calculated. The gradient across Deurganckdok was calculated as the difference between locations S-ENTRANCE and N-ENTRANCE; the distance between these locations measured 530.89 m. For each of the locations a vertical gradient has been calculated from the difference between the measurements at approximately -2 m TAW and the measurements at approximately -12 m TAW (-12 m data minus -2 m data).

The time series of gradients obtained as such have then been processed following exactly the same tidal separation technique as for the local parameters (described in §4.2.2). The results are shown in **Error! Reference source not found..**

5. PRELIMINARY ANALYSIS OF THE LONG TERM SALINITY MEASUREMENTS (20/05/2011 – 30/05/2012)

For each of the two locations salinity, sediment concentration and temperature have been logged at two depths. Apart from week series of every parameter, average tidal cycles have been determined for each parameter. This was done for absolute and relative values, for horizontal gradients across the dock and vertical gradients (Annex C). All of these results are discussed below.

5.1 WEEK SERIES

5.1.1 N-entrance

The water temperature shows a seasonal variability. It lies around 17°C at the end of May, increases up to 21 °C during the summer, drops quickly starting from the end of October until a lowest value of 2 °C in February. The temperature at the top and the bottom is similar.

The salinity shows a seasonal variability. It increases from 10 ppt end of May up to 15 ppt end of November, then decreases quickly starting from the beginning of December to reach 2 ppt beginning of January. The salinity at the top and the bottom are similar, sensors occasionally show some drifting leading to a temporary salinity difference.

The salinity also often shows a regular variation within a tidal cycle. It is lowest around low water and highest around high water. Except during the summer where the tidal variation is less regular, it shows a sharp 3 ppt decrease at the end of ebb and 1 ppt increase at the end of flood. There is no obvious variation of salinity over a neap-spring tidal cycle, the intra-tidal variation may be slightly more pronounced during spring tide.

The SSC often shows a regular variation within a tidal cycle. The background suspended sediment concentration (SSC) lies around 50 to 100 mg/l both at the top and the bottom. The SSC is maximum during flood and there is no SSC peak during ebb. Peaks are around 500 to 1000 mg/l high at the bottom, approximately half at the top. There is no obvious variation of SSC over a neap-spring tidal cycle, high peaks may be more frequent during spring tide.

5.1.2 S-entrance

The water temperature is similar to the North dock entrance (see § 5.1.1).

The salinity shows a similar evolution to the North dock entrance (see § 5.1.1). It increases from 12ppt at the end of May to 17 ppt at the end of November. The bottom sensor salinity lies 1 to 2 ppt higher than the top sensor salinity at the end of the year. The intra-tidal variation of the salinity is as regular as at the North dock entrance, but much less pronounced (< 1 ppt).

The SSC evolution is similar to the North dock entrance (see § 5.1.1), however SSC flood peaks are less pronounced but still around 500-1000 mg/l at the bottom and approximately half at the top.

5.1.3 Comparison IMDC-ANTEA

At the N-entrance turbidity, salinity and temperature were also measured by ANTEA during the period 17th to 31st of May and at the S-entrance from 12th to 31st of May. The data measured by IMDC and ANTEA at N-entrance (PSA) and S-entrance (DPW) are represented in timeseries and scatterplots in Annex D. The plotted data of IMDC and ANTEA shows in general a similar trend. In comparison of the IMDC instruments, the Antea instruments are placed 1 à 2 metres deeper in the water column. At PSA bottom, the instruments are placed 2.2 metres deeper resulting in higher salinity and sediment concentration values registered by the Antea instruments. The sediment concentrations are also higher as a result of the use of another calibration curves. At location DPW

bottom, the salinity amplitude measured by IMDC are slightly higher compared to Antea salinity measurements.

5.2 AVERAGE TIDAL CYCLES

Plots of averaged tidal cycles can be found in Annex C.

5.2.1 Local parameters

The temperature remains in average constant over a tidal cycle.

The SSC is at both locations higher around high water than during the rest of the tidal cycle, approximately twice as high, and particularly pronounced at the bottom sensor of N-entrance. As noticed on the week series, the SSC is higher at the North dock entrance and is also in average slightly higher during spring tide and lower during neap tide.

The Salinity on most locations increased throughout the summer to maxima of 10ppt and with variation over the tide. The salinity shows a 1 ppt increase after low water at all of the four sensors. Only for S-entrance top the salinity shows a small decrease of the salinity. There is little to no variation of salinity within a neap-spring tidal cycle.

5.2.2 Gradients

The cross-dock gradients show a higher SSC at the North dock entrance around high water, in accordance with observations from average tidal cycle parameters. It also shows a negative salinity gradient (salinity in the South is higher than the salinity in the North) around low water, that reduces or reverses around high water. The salinity near the bottom and top increased 1-2 hours after ebb. The horizontal gradient show a higher temperature at the top than at the bottom for the whole tidal cycle

The vertical gradients show a positive temperature gradient at the South dock and a negative temperature gradient at the North dock. At both the North and South entrances, the bottom salinity is slightly lower than the top salinity. Around low water the salinity is 1-2 ppt higher at the bottom at both locations.

Around high water the bottom SSC is 200 mg/l higher than at the top at the North entrance and only 100 mg/l higher at the South-entrance.

5.3 COMPARISON WITH PREVIOUS MEASUREMENTS

Because this report comprises a full year of measurements, results can be compared to those of all previous reports.

The evolution of the measured parameters is very similar. The same seasonal variability of temperature and salinity is found. The same tidal variation of the SSC is found: SSC peaks occur mainly during flood and the background SSC lies around 50 to 100 mg/l. Values are generally comparable, although the measured salinity was much higher in 2006 (25 ppt). All campaigns found a noticeable but relatively weak variation of the parameters during a neap-spring tidal cycle.

Spatially the same observations can be made again. The salinity is slightly higher at the South entrance and the SSC higher at the North entrance. Cross-dock gradients are low and present the same tidal evolution. The salinity gradient is negative (salinity in the South is higher than the salinity in the North) around low water and positive around flood.

Year-through measurements like in 2008, 2009, 2012 and 2011 as opposed to measurements during periods of 6 to 12 weeks in the past, have two advantages. They make it easier to trace back erroneous data by looking at the connection between successive datasets, and they improve the

outcome of the data-assimilation model used for the analysis of all measurements. It allowed for instance to determine that a salinity sensor could drift up or down by 5 to 10 ppt within a couple of days, which has to be compared to the local salinity of 10 ppt.

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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)

IMDC (2008v) Langdurige metingen Deurganckdok: Opvolging en analyse aanslibbing. Deelrapport 2.21: Through tide measurement Sediview during average tide Spring 2008 – 26 June 2008 (I/RA/11283/08.082/MSA)

IMDC (2008w) Langdurige metingen Deurganckdok: Opvolging en analyse aanslibbing. Deelrapport 1.21: Sediment Balance: Three monthly report 1/7/2008 – 30/09/2008 (I/RA/11283/08.077/MSA)

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)

IMDC (2008aa) Langdurige metingen Deurganckdok: Opvolging en analyse aanslibbing. Deelrapport 3.20: Boundary conditions: Six monthly report 1/4/2008 – 30/09/2008 (I/RA/11283/08.096/MSA)

IMDC (2009a) Langdurige metingen Deurganckdok: Opvolging en analyse aanslibbing. Deelrapport 2.23: Through tide measurement Sediview during spring tide Summer 2008 – 30 September 2008 (I/RA/11283/08.084/MSA)

IMDC (2009b) Langdurige metingen Deurganckdok: Opvolging en analyse aanslibbing. Deelrapport 2.29: Through tide measurement SiltProfiler summer 2008 – 29 September 2008 (I/RA/11283/07.090/MSA)

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

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 (2009p) Langdurige metingen Deurganckdok: Opvolging en analyse aanslibbing. Deelrapport 2.35: Salt-Silt distribution Deurganckdok: nine monthly report 1/04/2009 – 31/12/2009 (I/RA/11283/09.085/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)

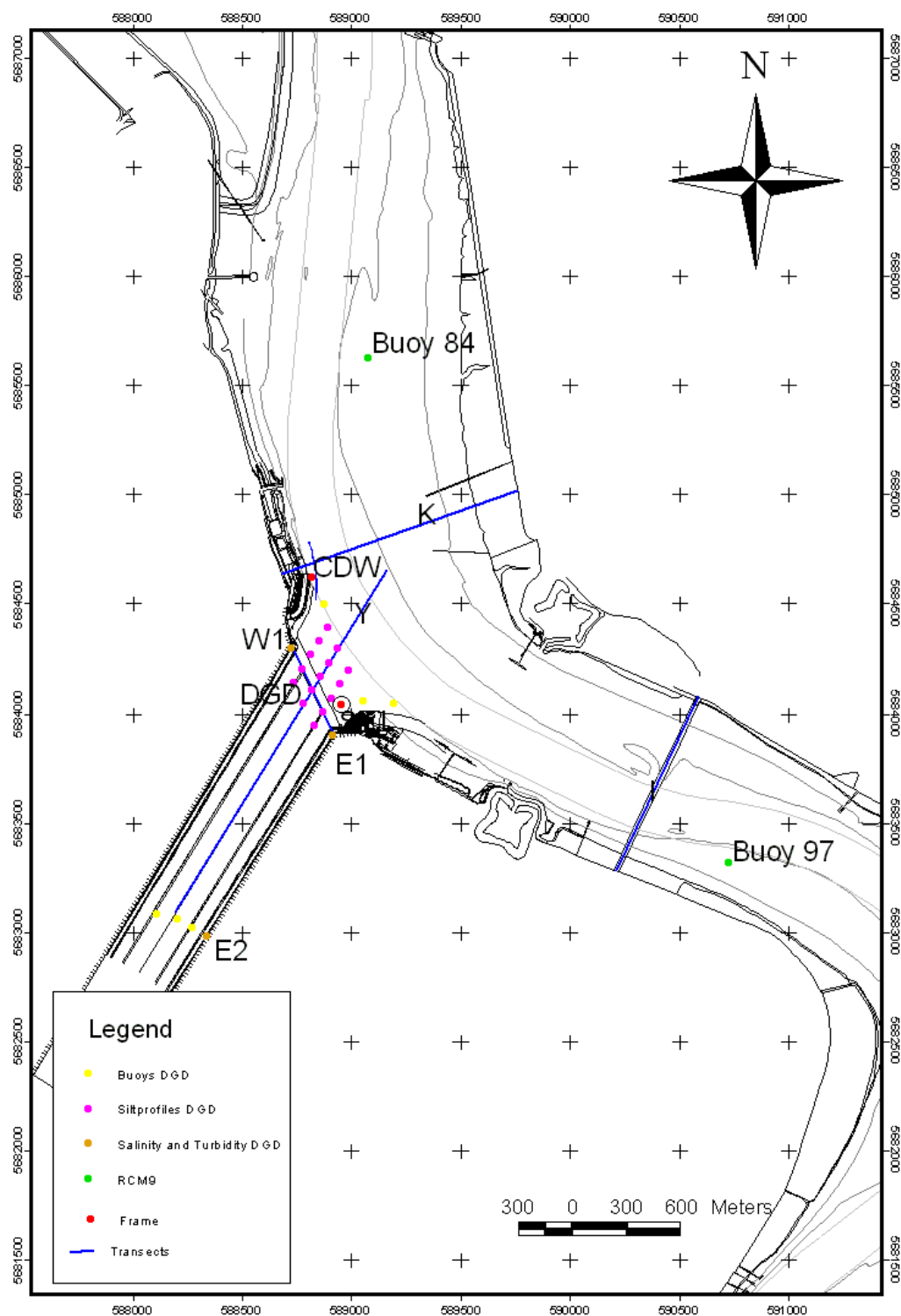
IMDC (2012o) Evaluatie externe effecten aanslibbing Deurganckdok. Deelrapport 2.13 Calibration stationary & mobile equipment 01/06/2012 (I/RA/11354/12.011/JCA)

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)

Annex A

Overview of measurements

A.1 Overview of the measurement locations for the whole HCBS and Deurganckdok measurements campaign (charts)



A.2 Measurement overview at Deurganckdok

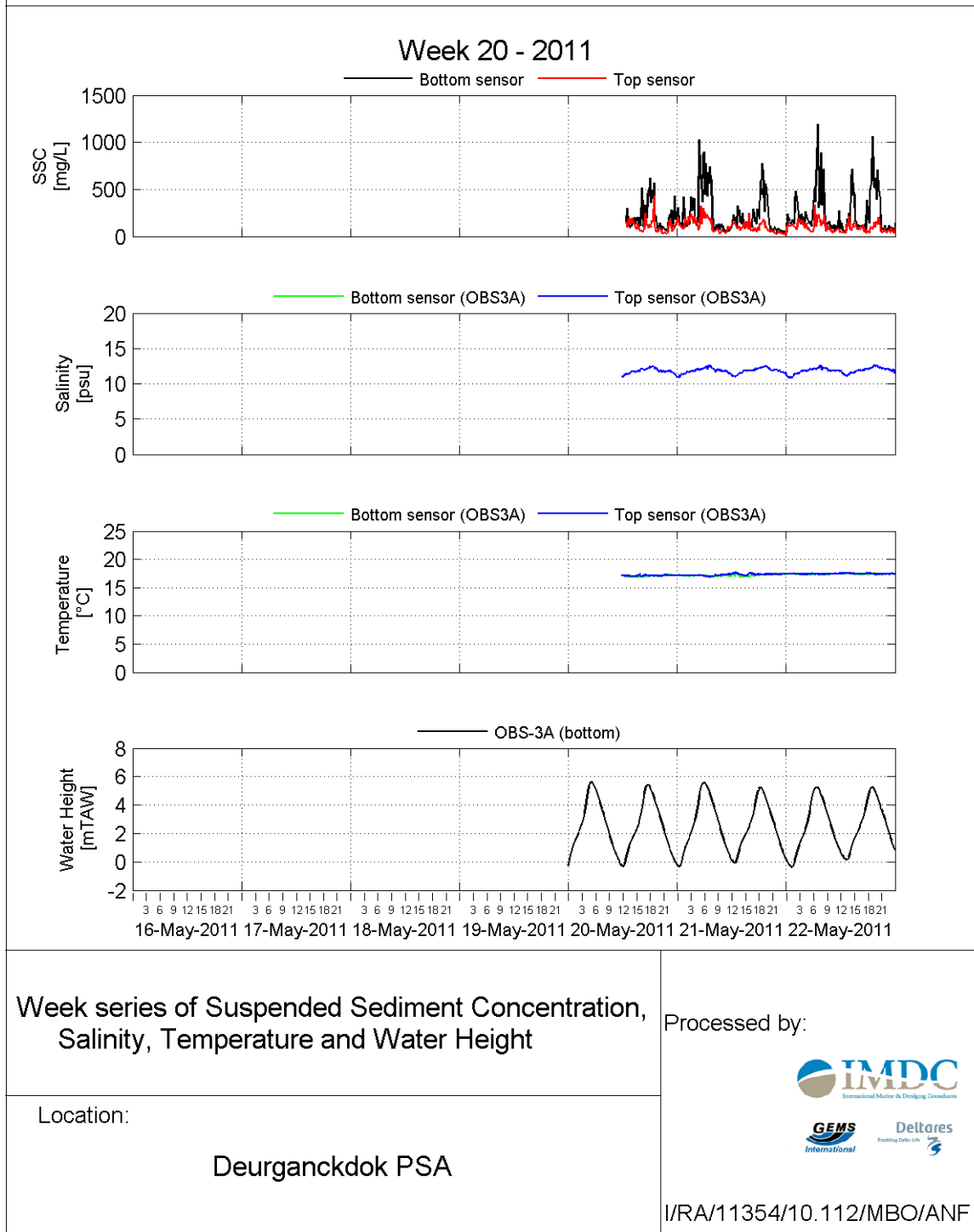
Salinity – Silt measurements Deurganckdok			
Location	<i>Easting (UTM31, WGS84)</i>	<i>Northing (UTM31, WGS84)</i>	<i>Period</i>
DP World (S-entrance-Top)	5886733	5683835	20/05/2011- 30/05/2012
PSA (N-entrance-Top)	588442	5684313	20/05/2011- 30/05/2012
DP World (S-entrance- Bottom)	588673	5683835	20/05/2011- 30/05/2012
PSA (N-entrance-Bottom)	588442	5684313	20/05/2011- 30/05/2012

Annex B

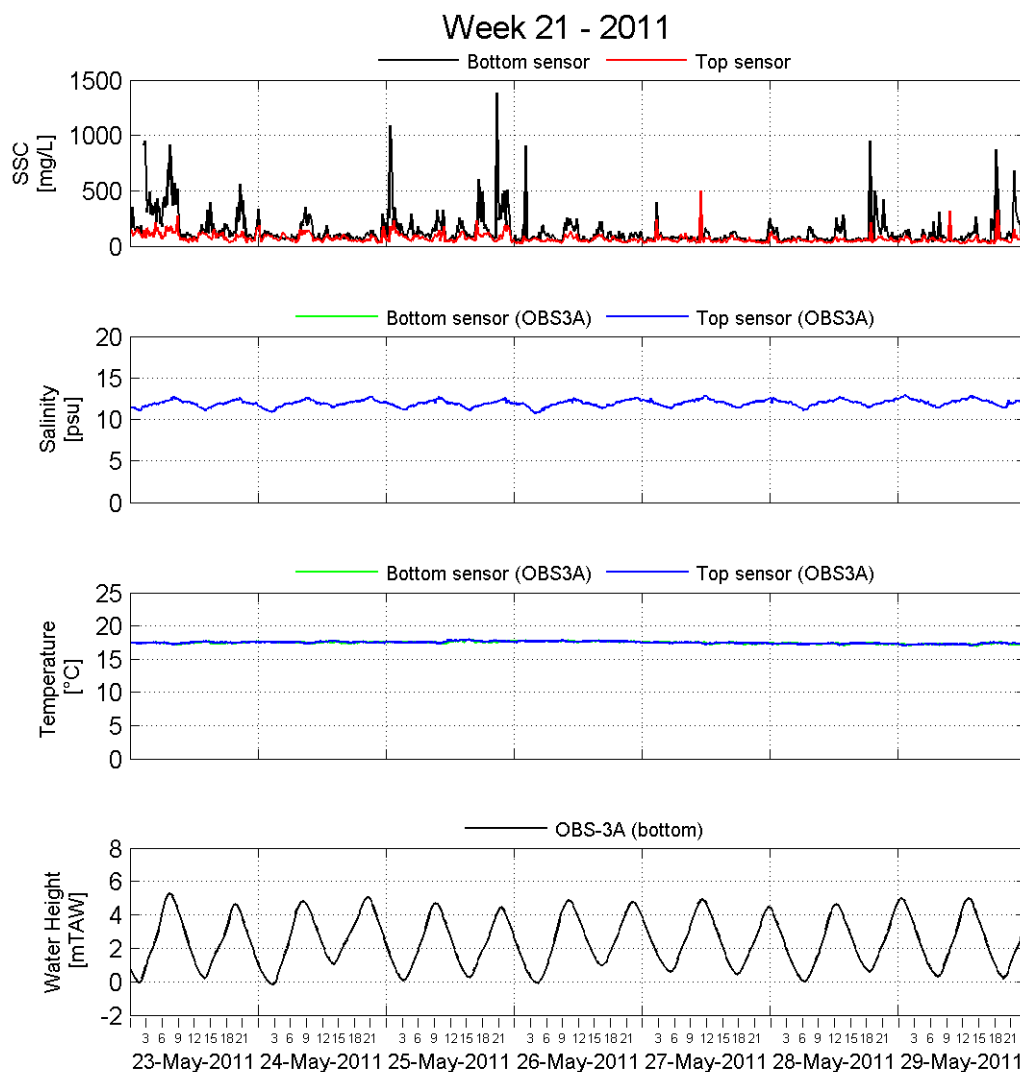
WEEKSERIES SALINITY – SILT MEASUREMENTS DGD

B.1 ***N-Entrance (PSA)***

11354 - Evaluation external effects Deurganckdok



11354 - Evaluation external effects Deurganckdok



Week series of Suspended Sediment Concentration,
Salinity, Temperature and Water Height

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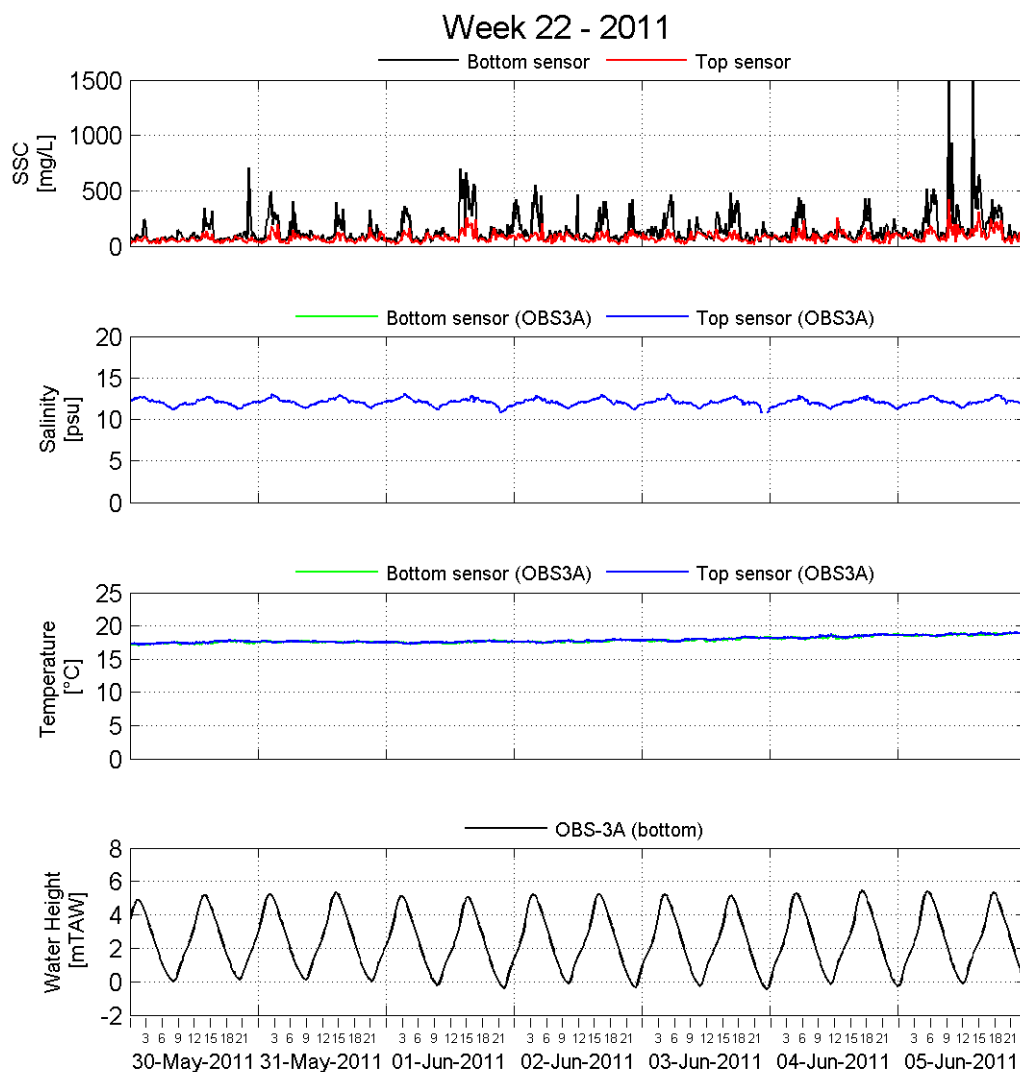
Deurganckdok PSA

Processed by:



I/RA/11354/10.112/MBO/ANF

11354 - Evaluation external effects Deurganckdok



Week series of Suspended Sediment Concentration,
Salinity, Temperature and Water Height

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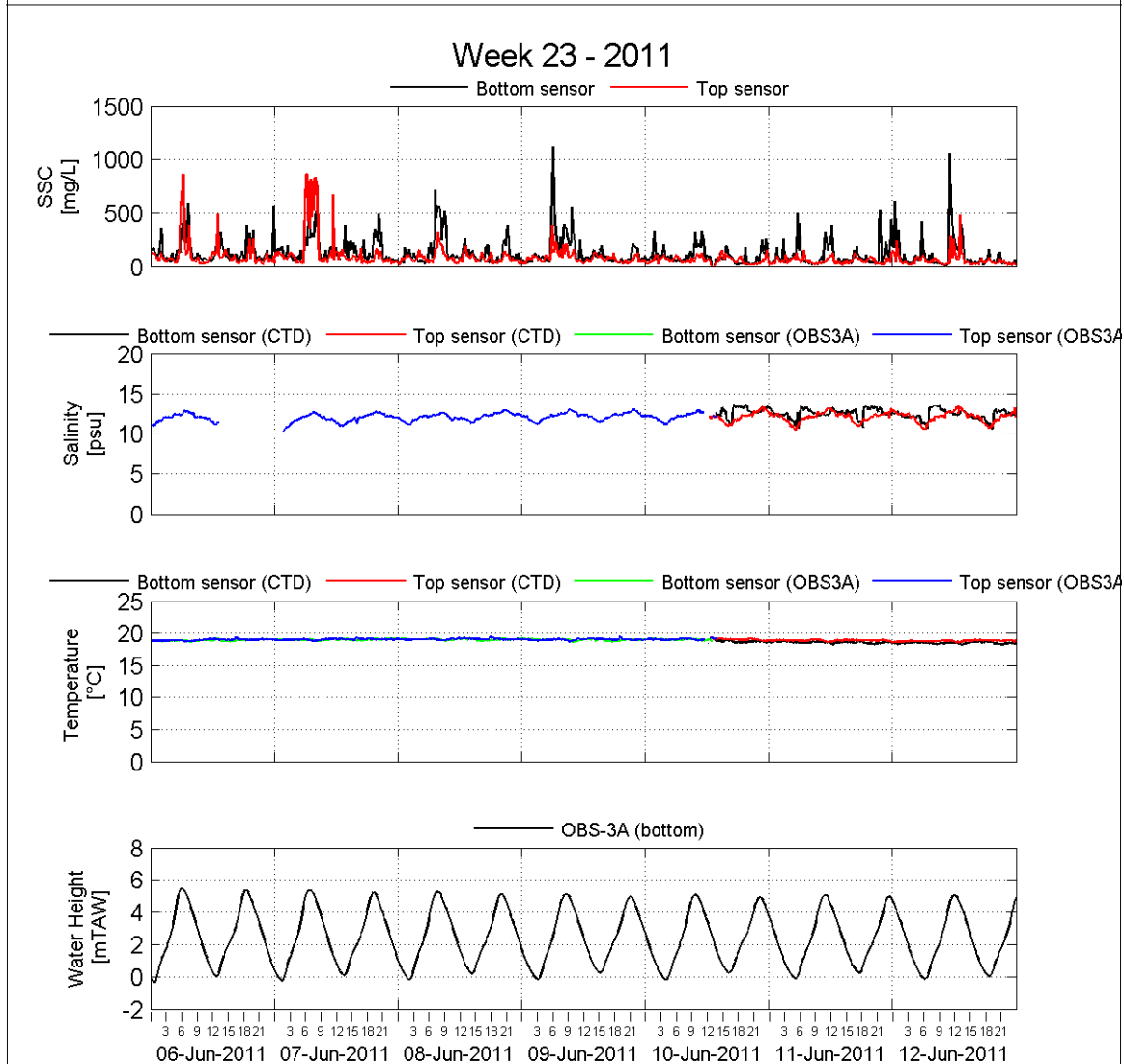
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11354 - Evaluation external effects Deurganckdok



Week series of Suspended Sediment Concentration,
Salinity, Temperature and Water Height

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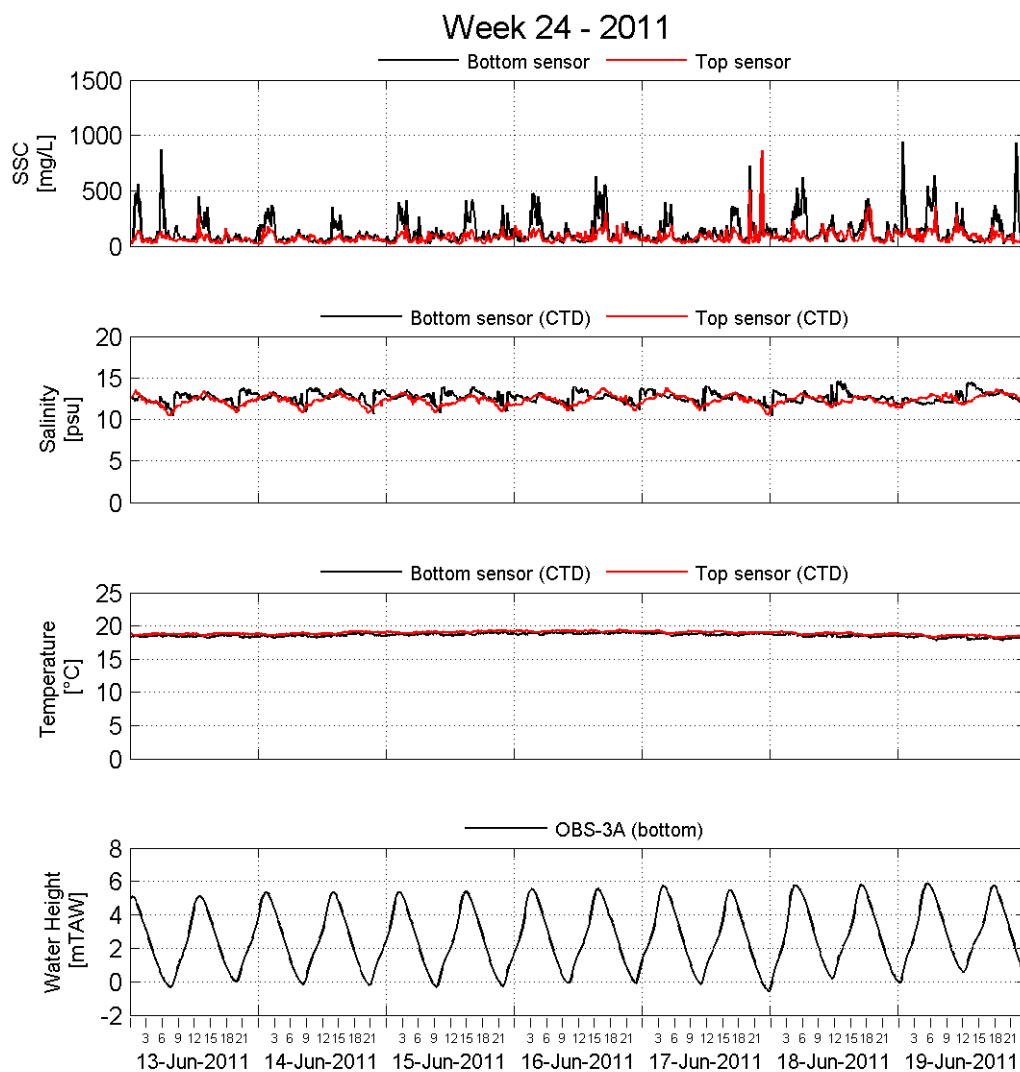
Deurganckdok PSA

Processed by:



I/RA/11354/10.112/MBO/ANF

11354 - Evaluation external effects Deurganckdok



Week series of Suspended Sediment Concentration,
Salinity, Temperature and Water Height

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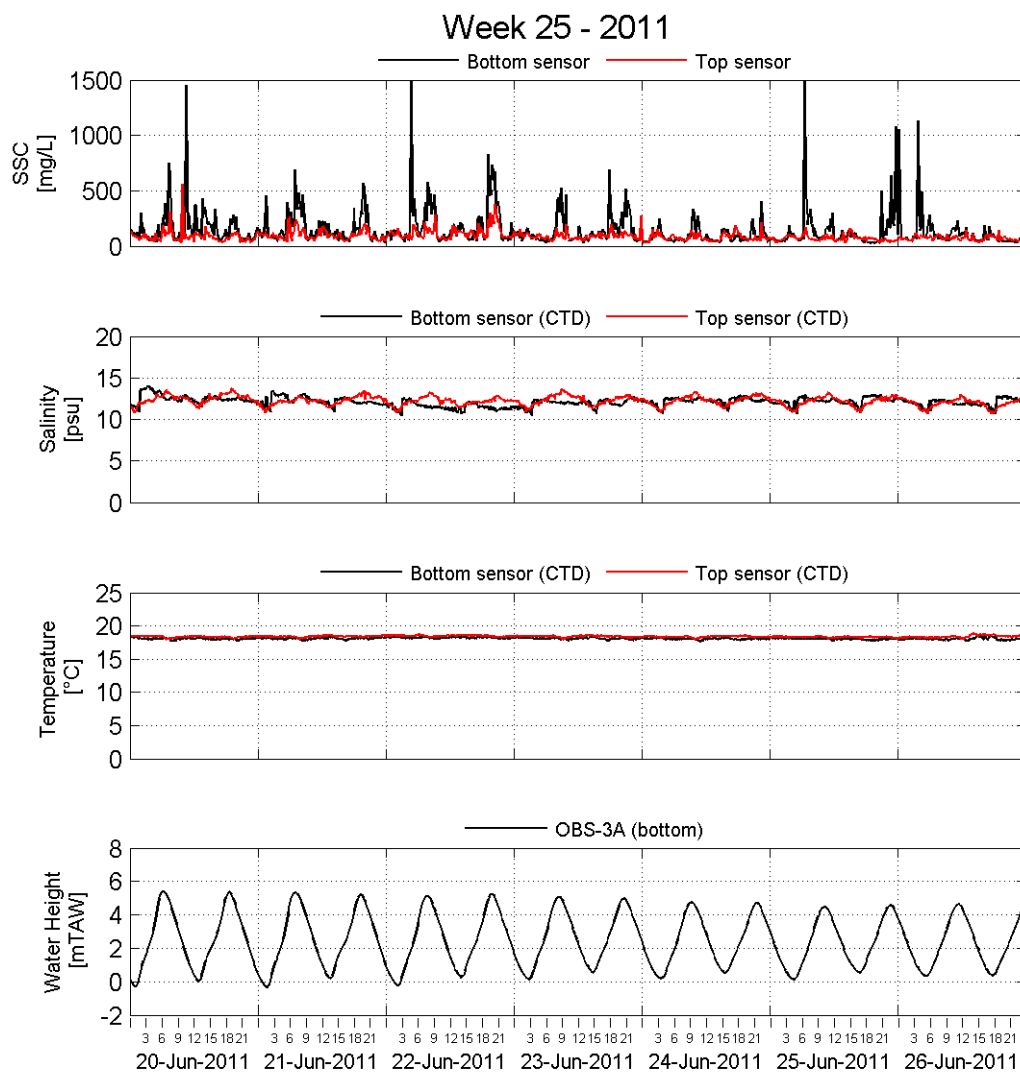


Location:

Deurganckdok PSA

I/RA/11354/10.112/MBO/ANF

11354 - Evaluation external effects Deurganckdok



Week series of Suspended Sediment Concentration,
Salinity, Temperature and Water Height

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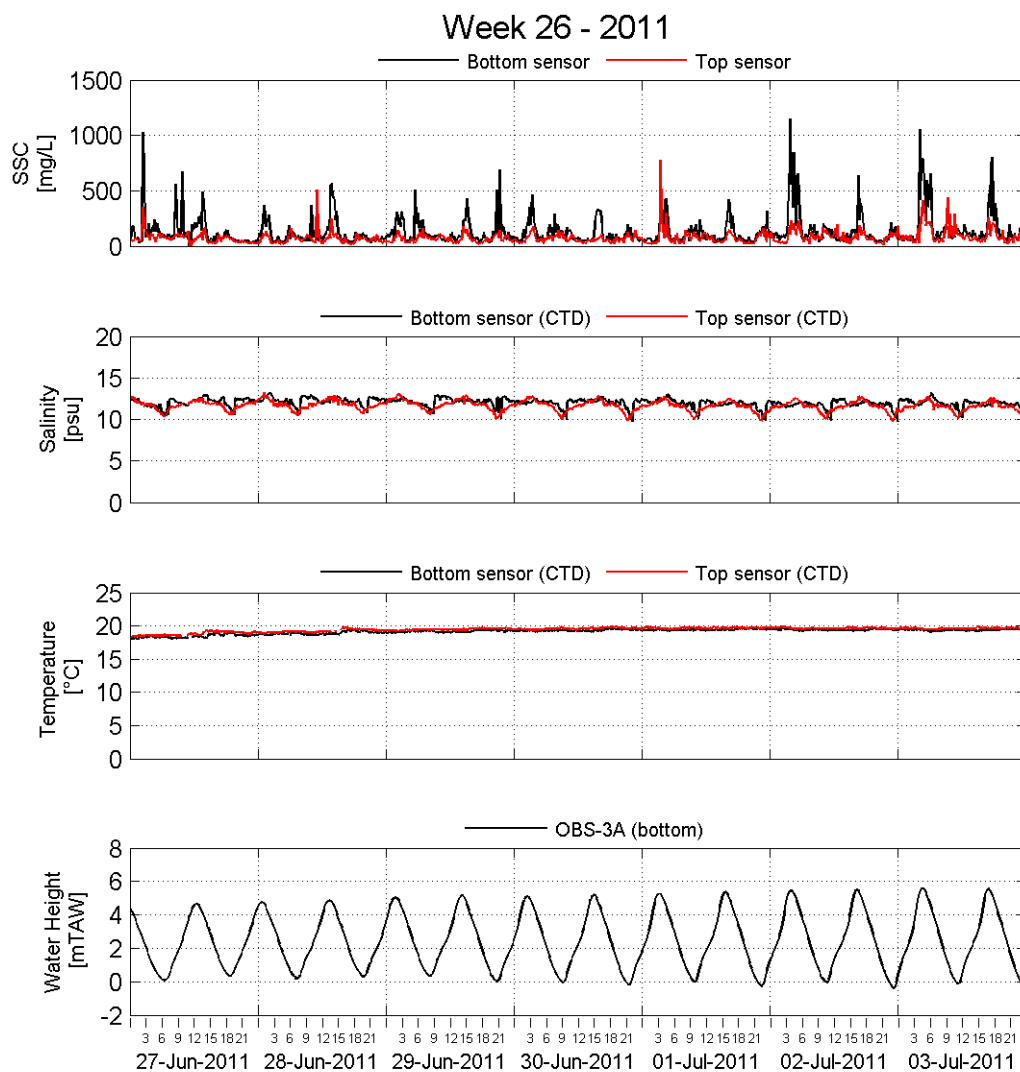
Deurganckdok PSA

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I/RA/11354/10.112/MBO/ANF

11354 - Evaluation external effects Deurganckdok



Week series of Suspended Sediment Concentration,
Salinity, Temperature and Water Height

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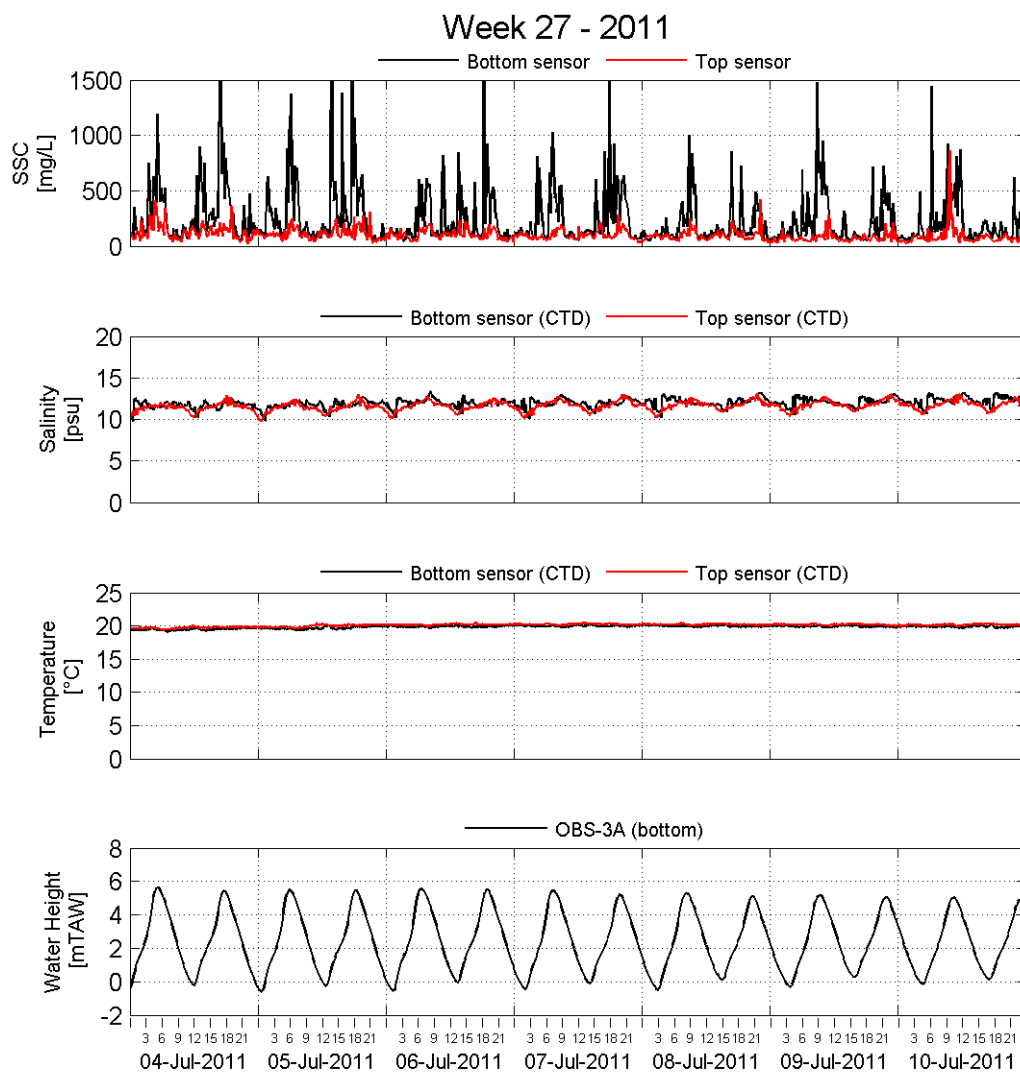
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I/RA/11354/10.112/MBO/ANF

11354 - Evaluation external effects Deurganckdok



Week series of Suspended Sediment Concentration,
Salinity, Temperature and Water Height

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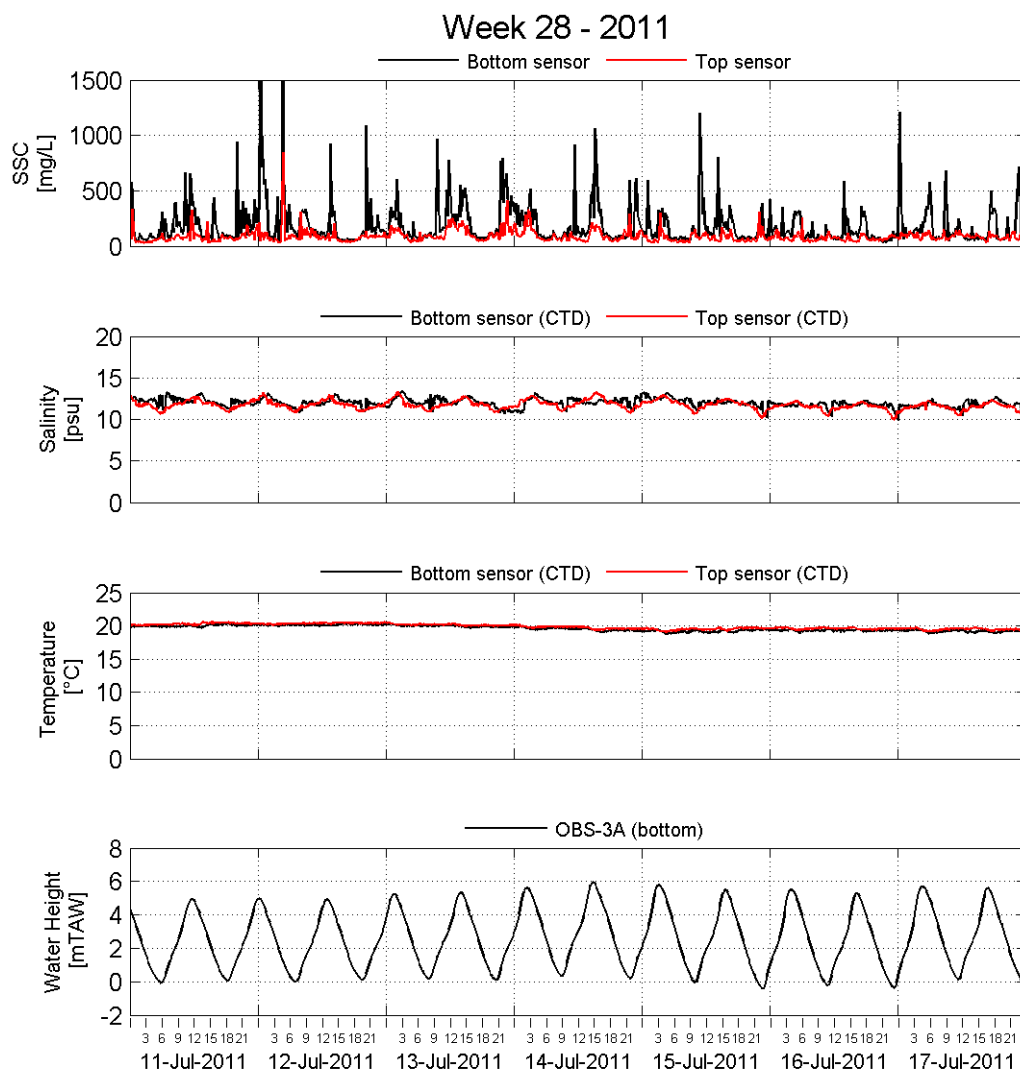
Deurganckdok PSA

Processed by:



I/RA/11354/10.112/MBO/ANF

11354 - Evaluation external effects Deurganckdok



Week series of Suspended Sediment Concentration,
Salinity, Temperature and Water Height

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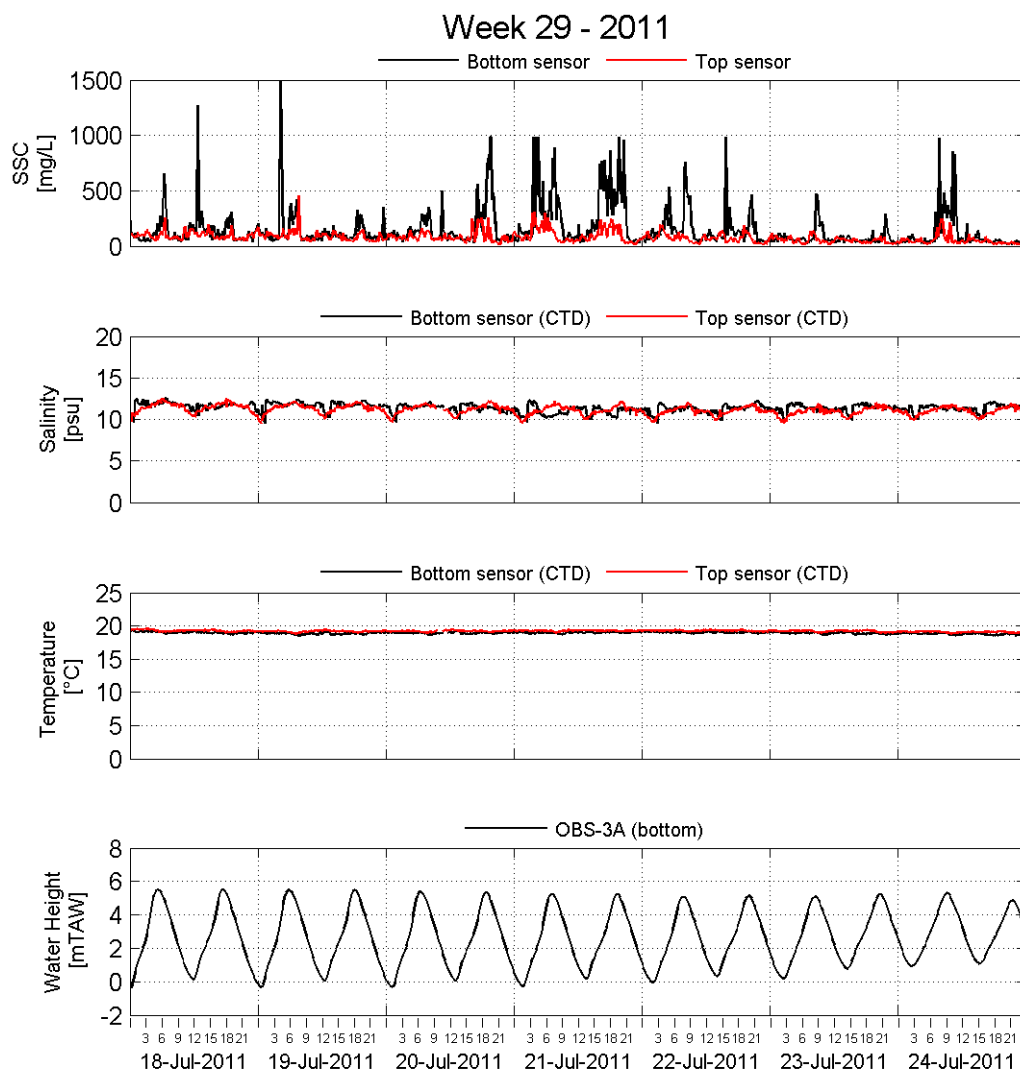
Deurganckdok PSA

Processed by:



I/RA/11354/10.112/MBO/ANF

11354 - Evaluation external effects Deurganckdok



Week series of Suspended Sediment Concentration,
Salinity, Temperature and Water Height

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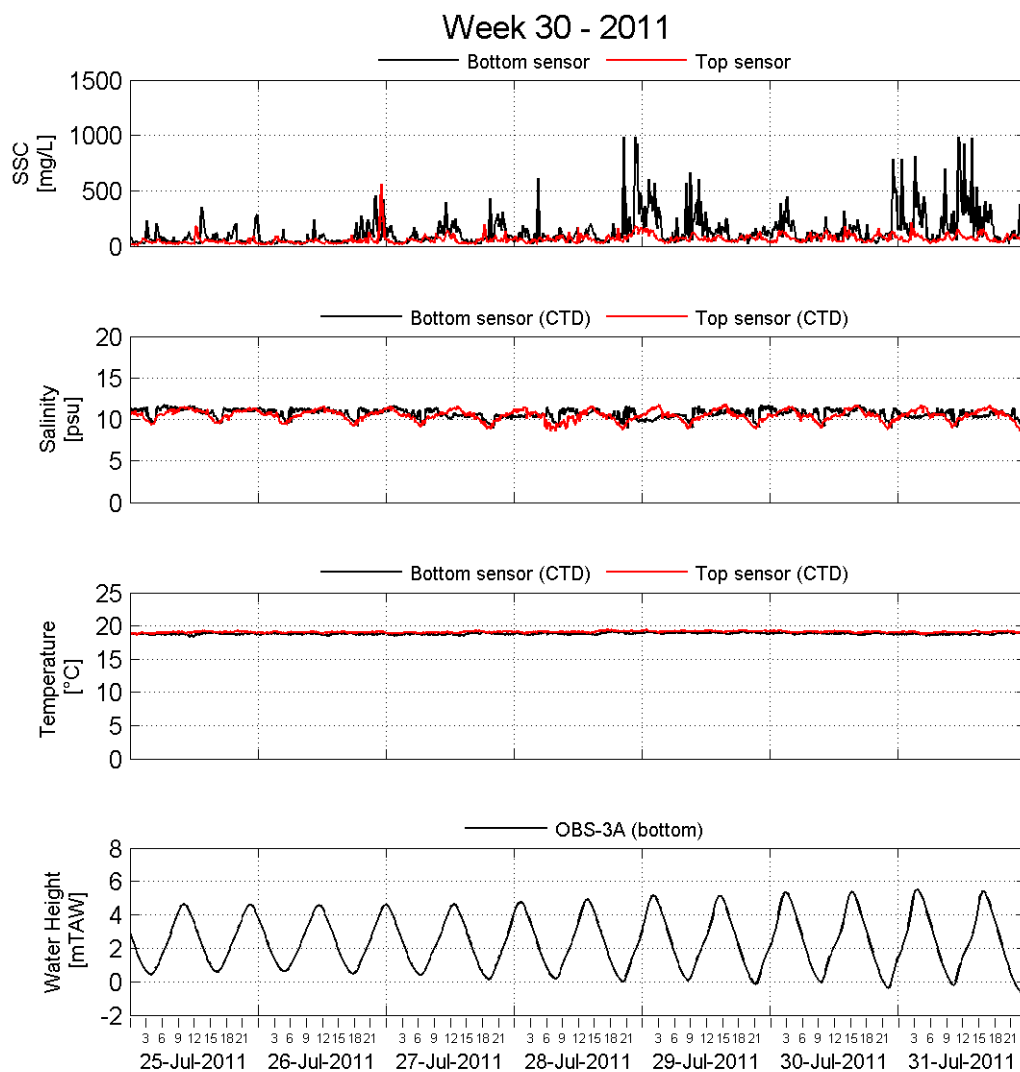
Deurganckdok PSA

Processed by:



I/RA/11354/10.112/MBO/ANF

11354 - Evaluation external effects Deurganckdok



Week series of Suspended Sediment Concentration,
Salinity, Temperature and Water Height

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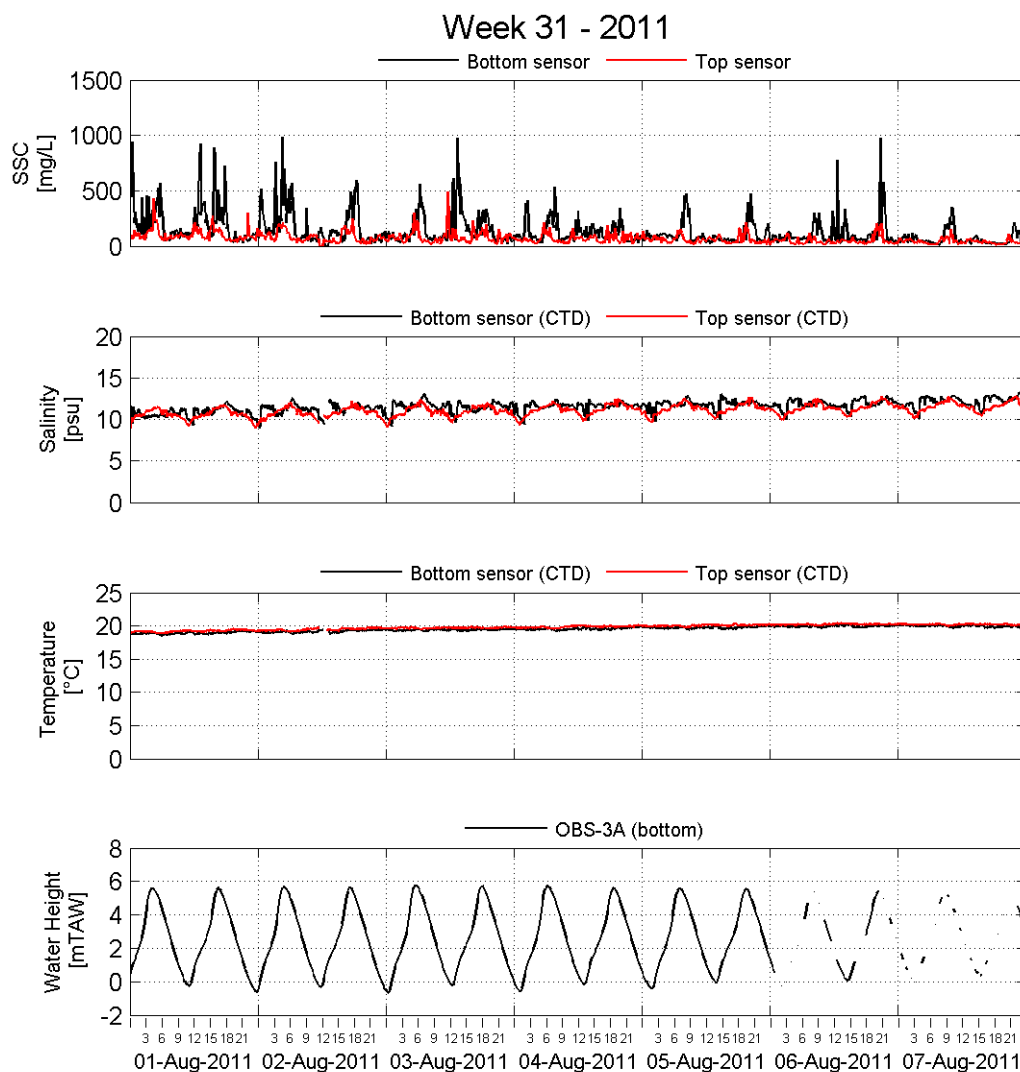
Deurganckdok PSA

Processed by:



I/RA/11354/10.112/MBO/ANF

11354 - Evaluation external effects Deurganckdok



Week series of Suspended Sediment Concentration,
Salinity, Temperature and Water Height

Location:

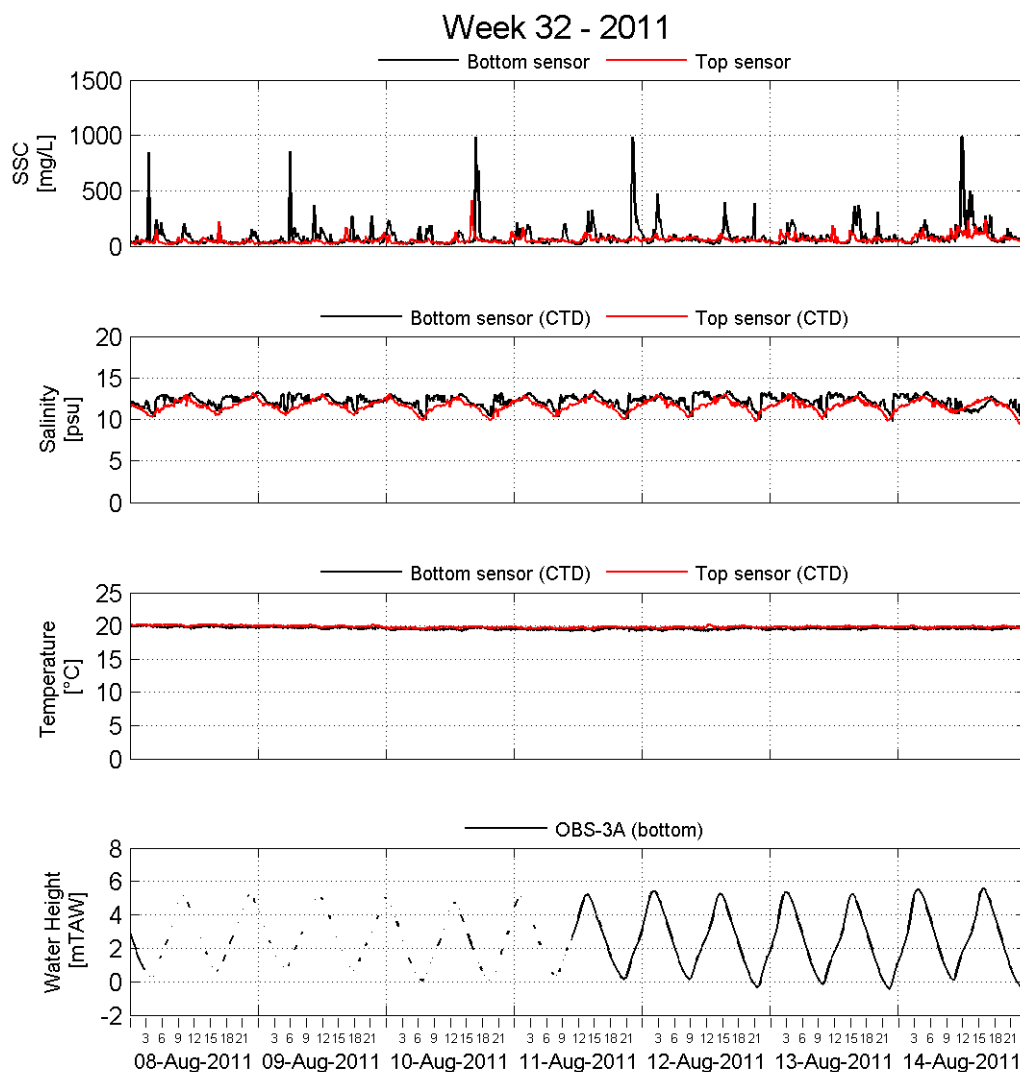
Deurganckdok PSA

Processed by:



I/RA/11354/10.112/MBO/ANF

11354 - Evaluation external effects Deurganckdok



Week series of Suspended Sediment Concentration,
Salinity, Temperature and Water Height

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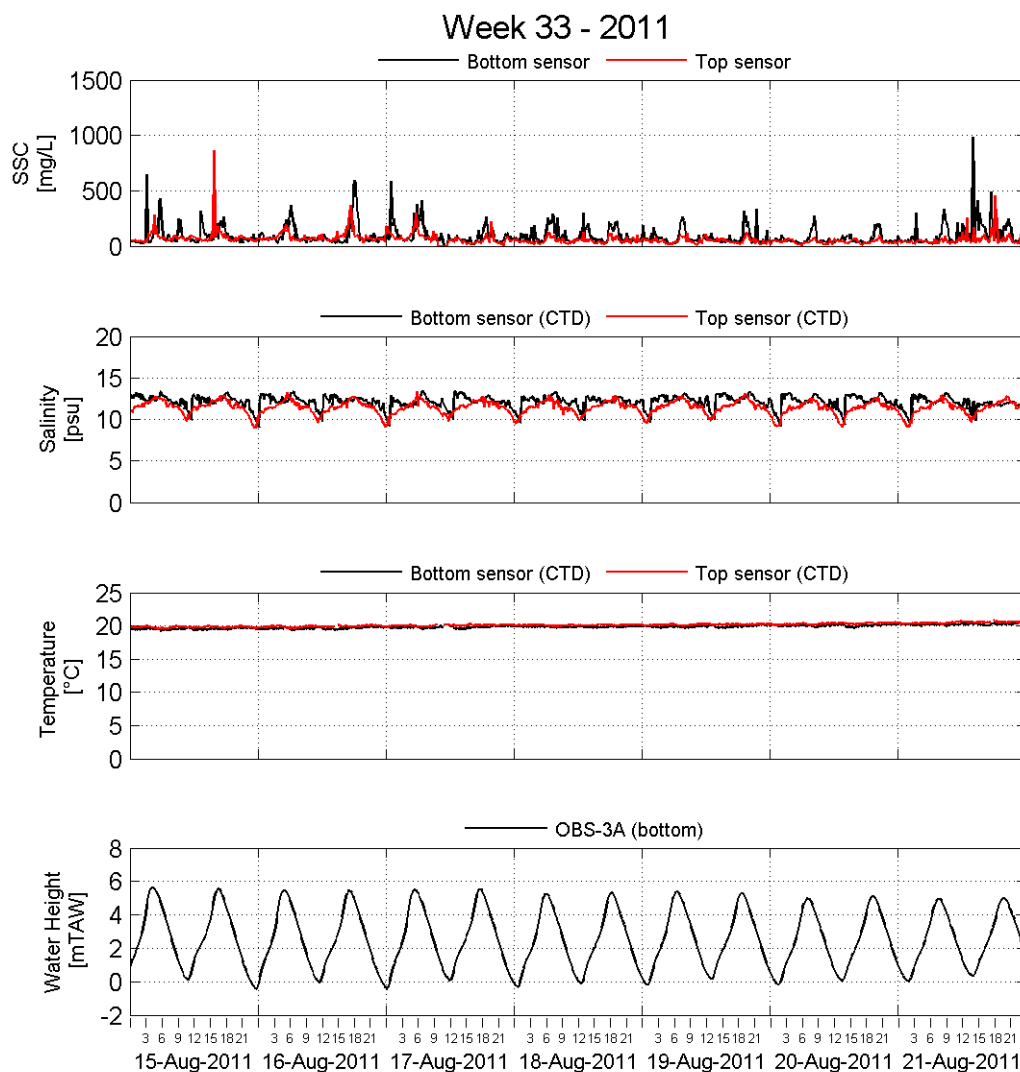
Deurganckdok PSA

Processed by:



I/RA/11354/10.112/MBO/ANF

11354 - Evaluation external effects Deurganckdok



Week series of Suspended Sediment Concentration,
Salinity, Temperature and Water Height

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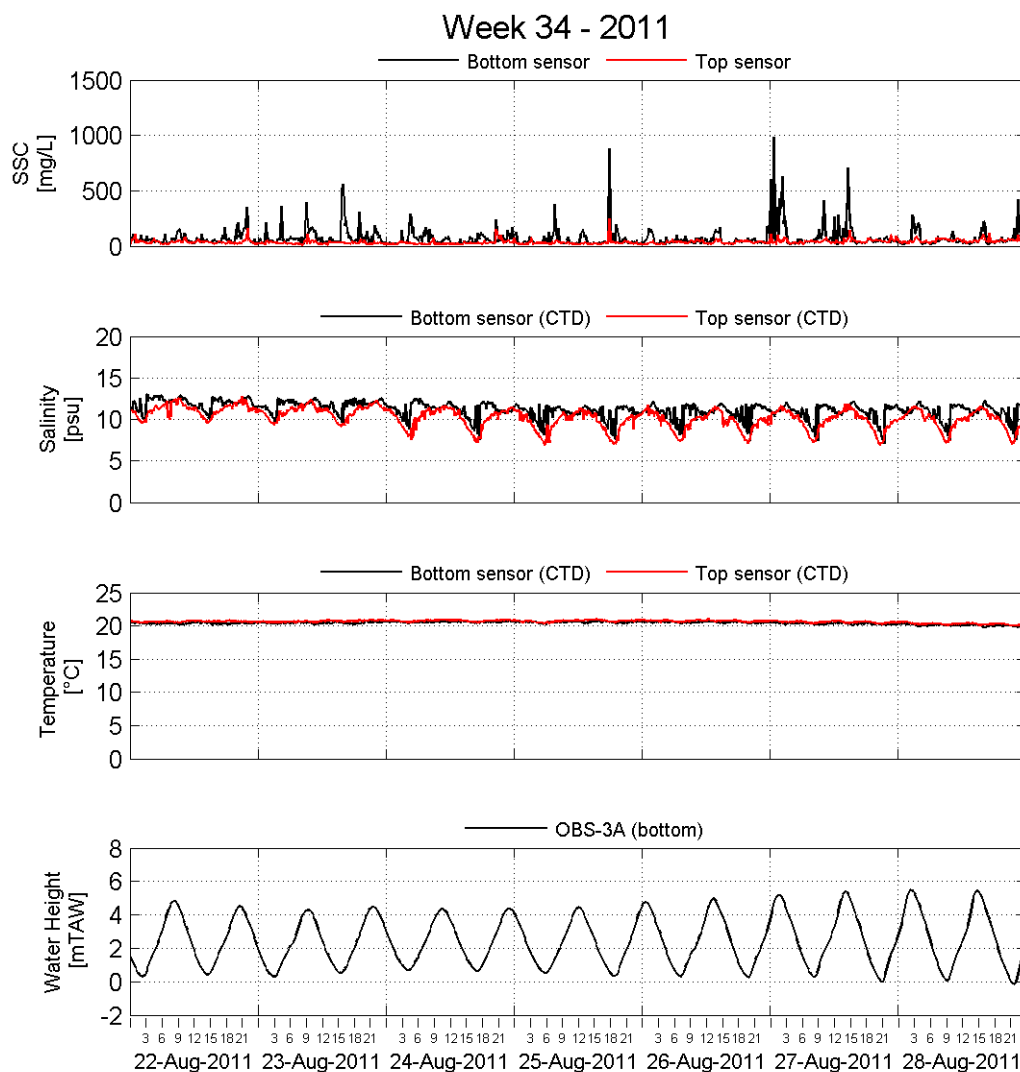
Deurganckdok PSA

Processed by:



I/RA/11354/10.112/MBO/ANF

11354 - Evaluation external effects Deurganckdok



Week series of Suspended Sediment Concentration,
Salinity, Temperature and Water Height

Location:

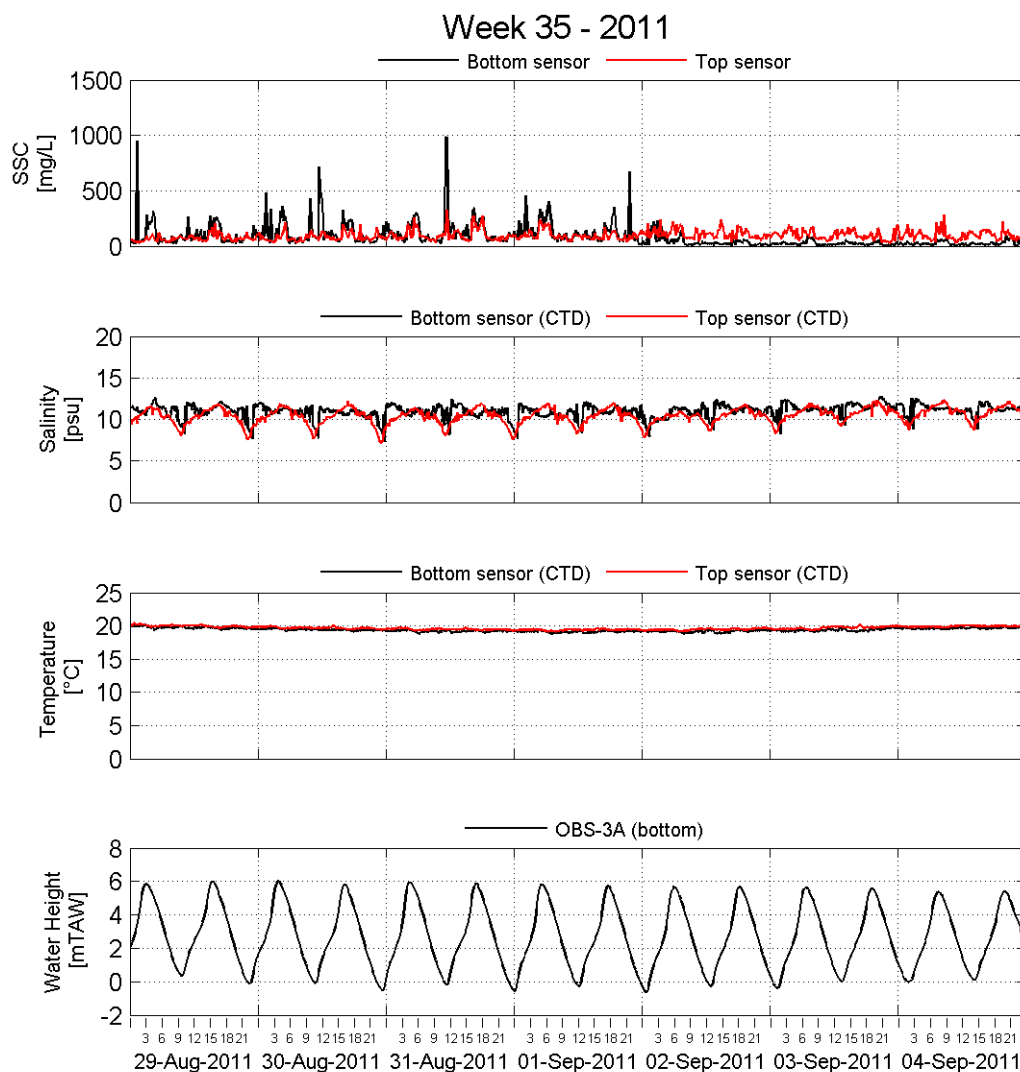
Deurganckdok PSA

Processed by:



I/RA/11354/10.112/MBO/ANF

11354 - Evaluation external effects Deurganckdok



Week series of Suspended Sediment Concentration,
Salinity, Temperature and Water Height

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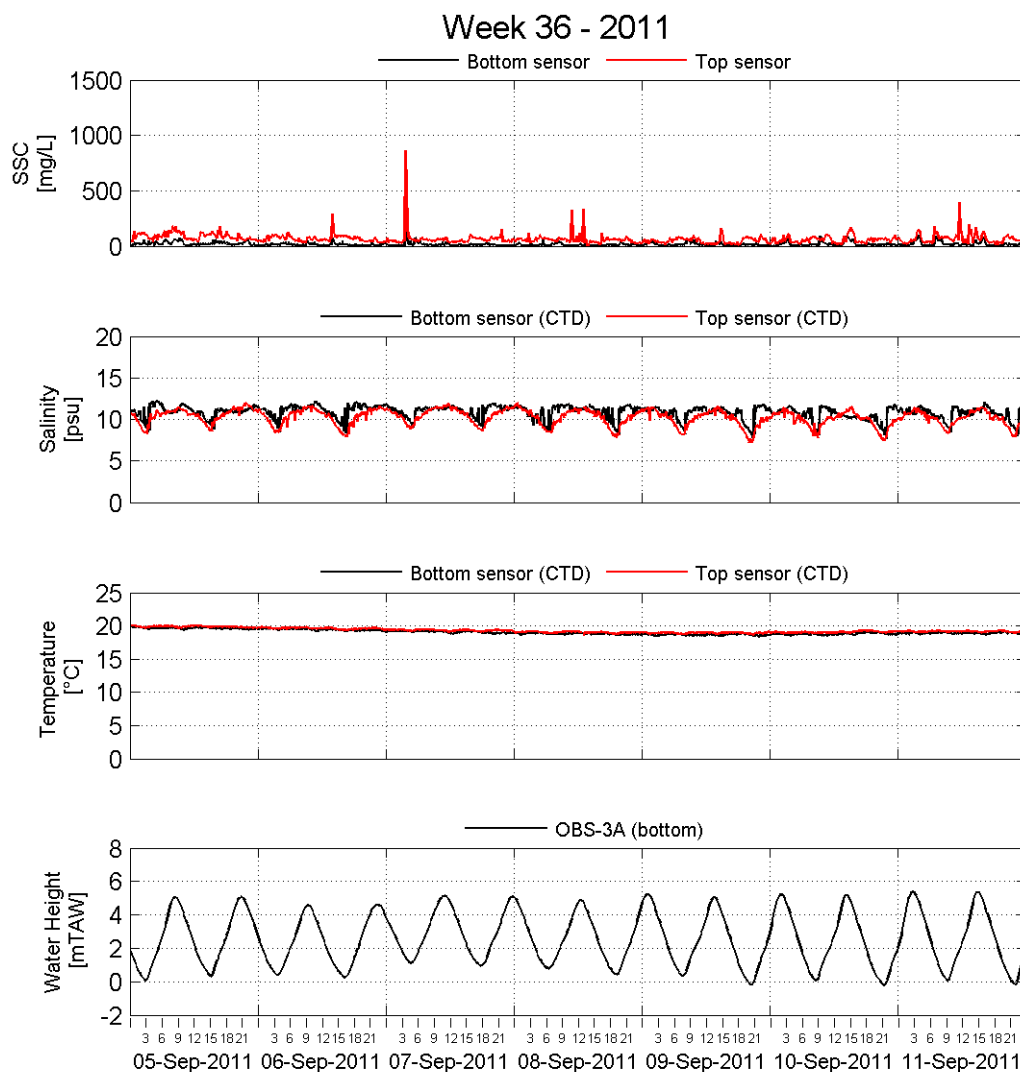
Deurganckdok PSA

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I/RA/11354/10.112/MBO/ANF

11354 - Evaluation external effects Deurganckdok



Week series of Suspended Sediment Concentration,
Salinity, Temperature and Water Height

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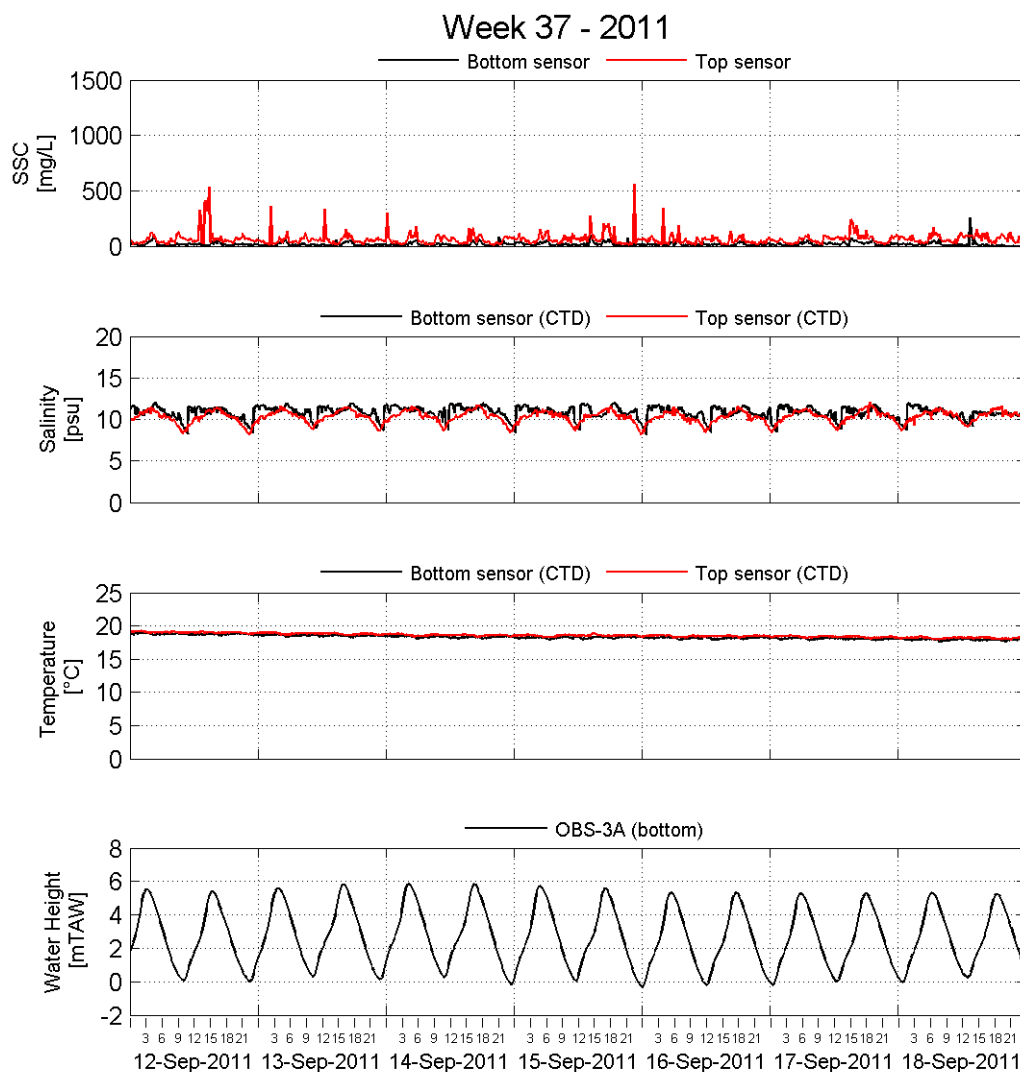
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Processed by:



I/RA/11354/10.112/MBO/ANF

11354 - Evaluation external effects Deurganckdok



Week series of Suspended Sediment Concentration,
Salinity, Temperature and Water Height

Location:

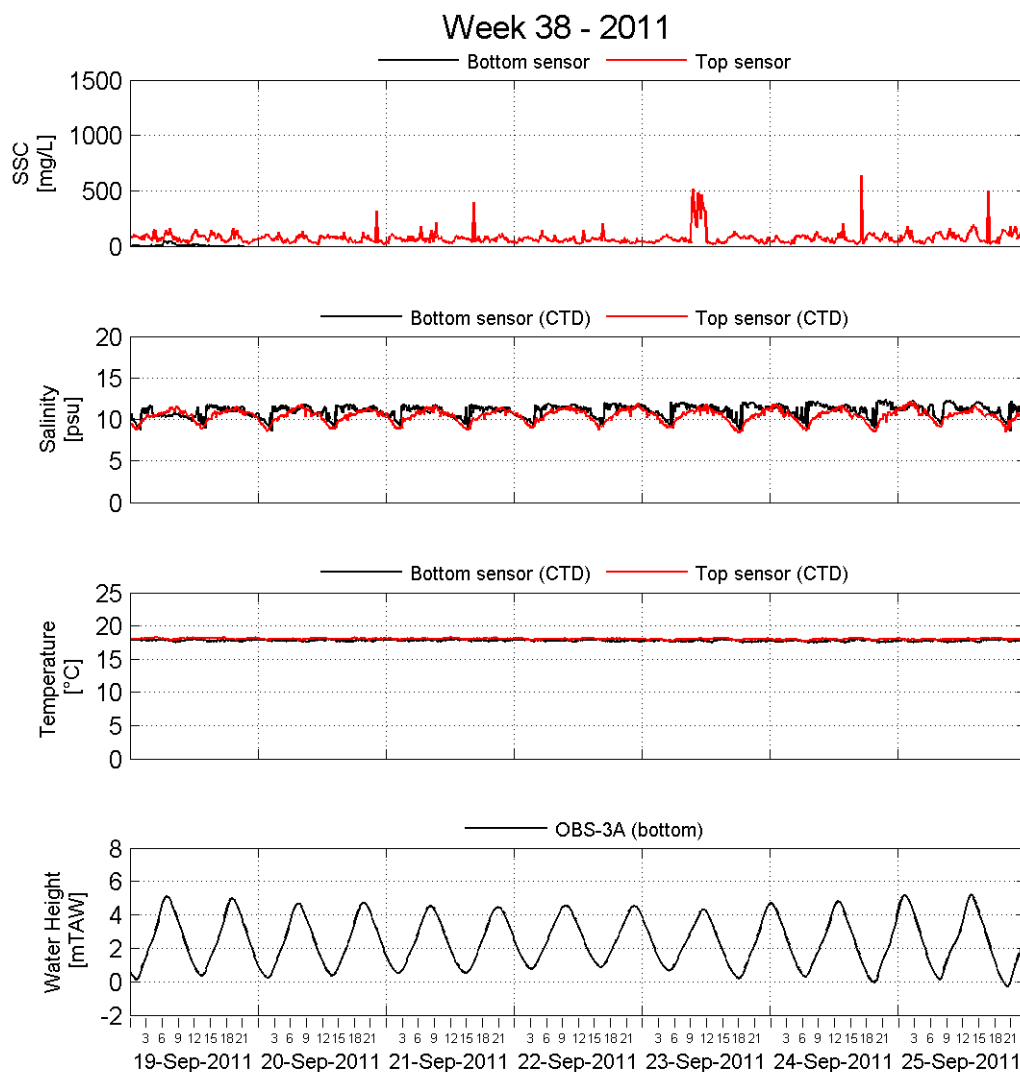
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Processed by:



I/RA/11354/10.112/MBO/ANF

11354 - Evaluation external effects Deurganckdok



Week series of Suspended Sediment Concentration,
Salinity, Temperature and Water Height

Location:

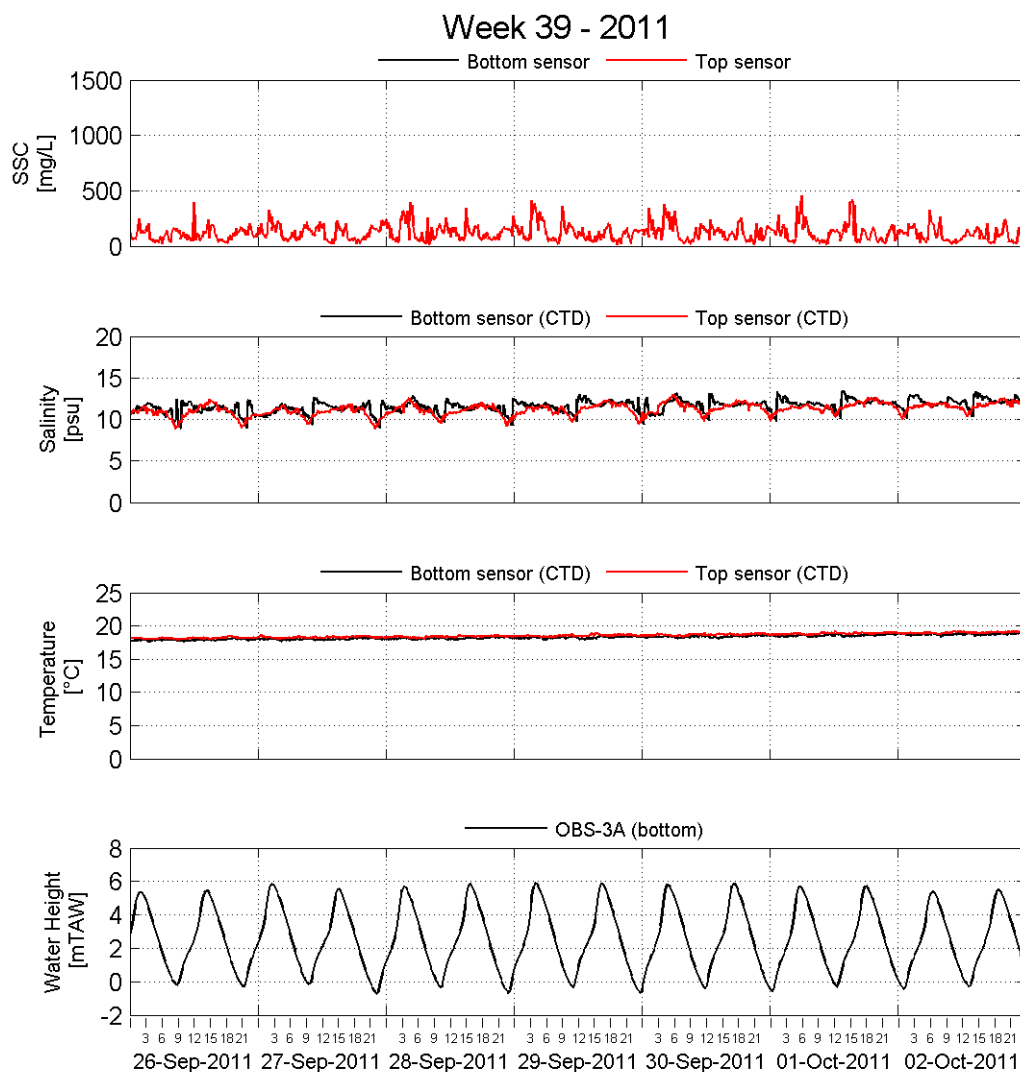
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Processed by:



I/RA/11354/10.112/MBO/ANF

11354 - Evaluation external effects Deurganckdok



Week series of Suspended Sediment Concentration,
Salinity, Temperature and Water Height

Location:

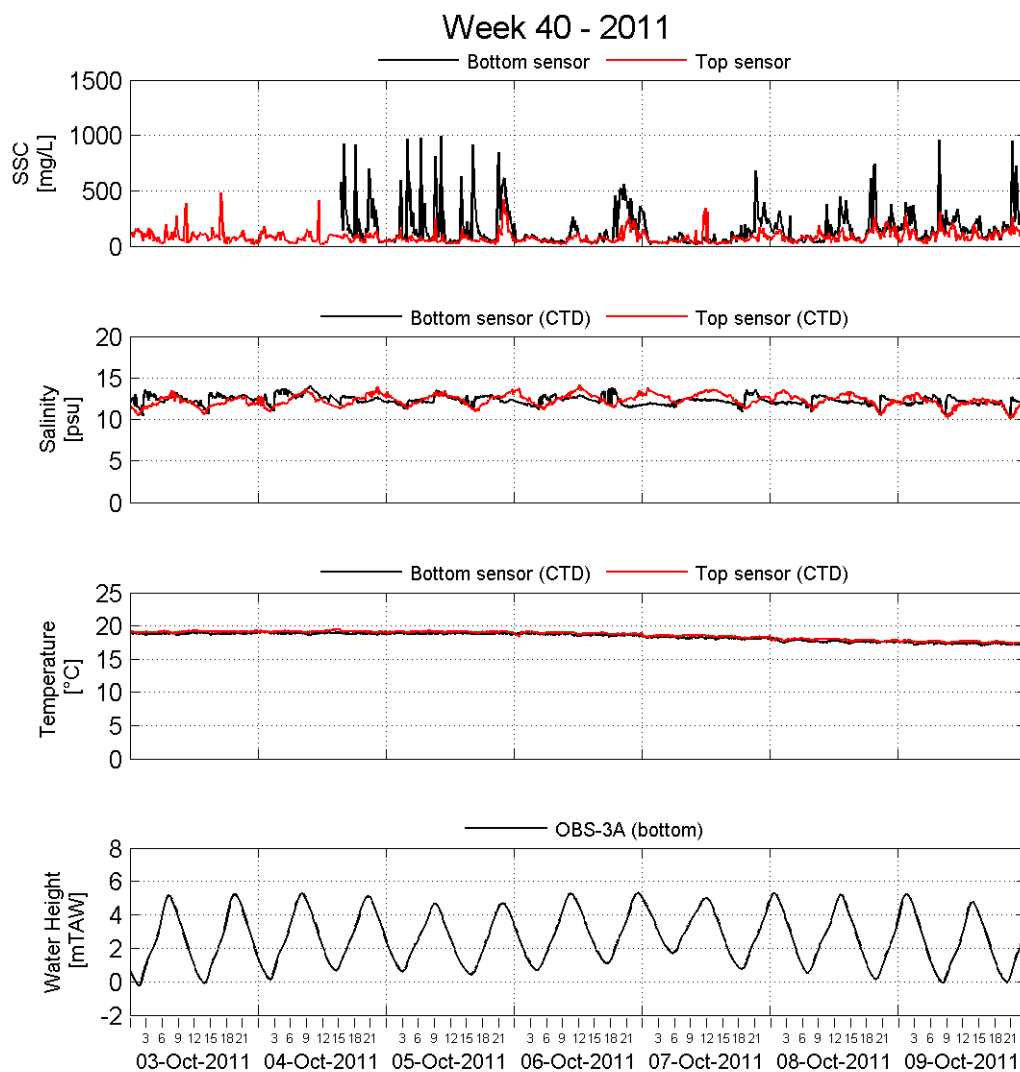
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Processed by:



I/RA/11354/10.112/MBO/ANF

11354 - Evaluation external effects Deurganckdok



Week series of Suspended Sediment Concentration,
Salinity, Temperature and Water Height

Location:

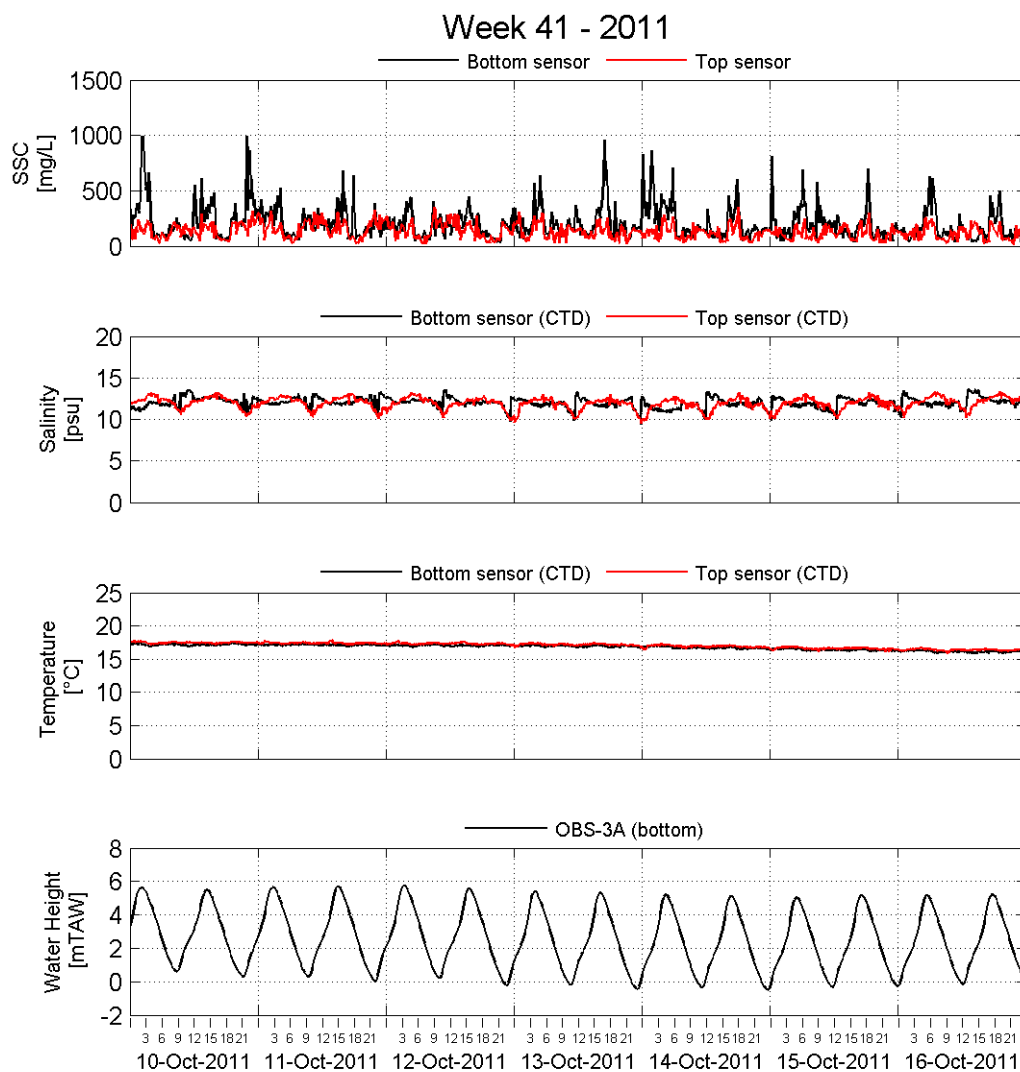
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I/RA/11354/10.112/MBO/ANF

11354 - Evaluation external effects Deurganckdok



Week series of Suspended Sediment Concentration,
Salinity, Temperature and Water Height

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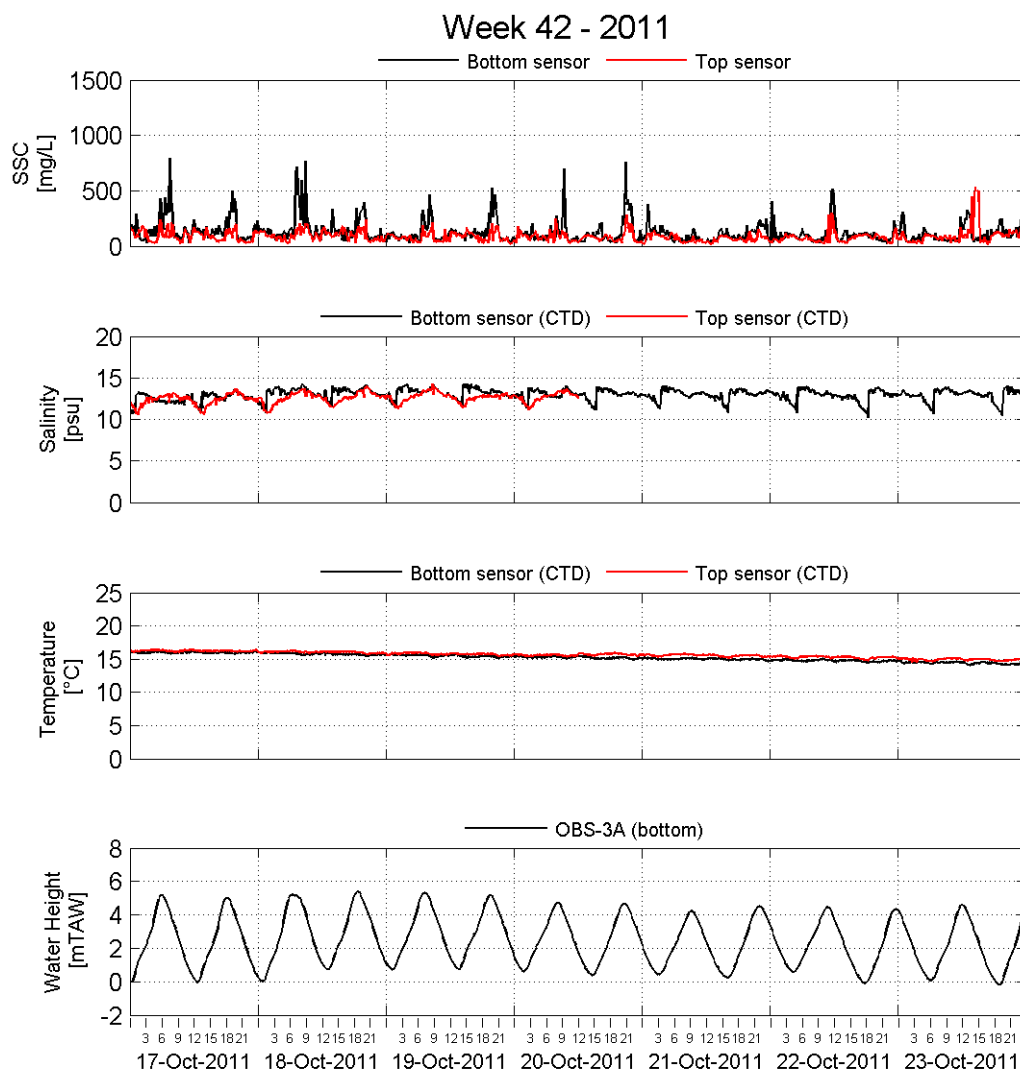
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11354 - Evaluation external effects Deurganckdok



Week series of Suspended Sediment Concentration,
Salinity, Temperature and Water Height

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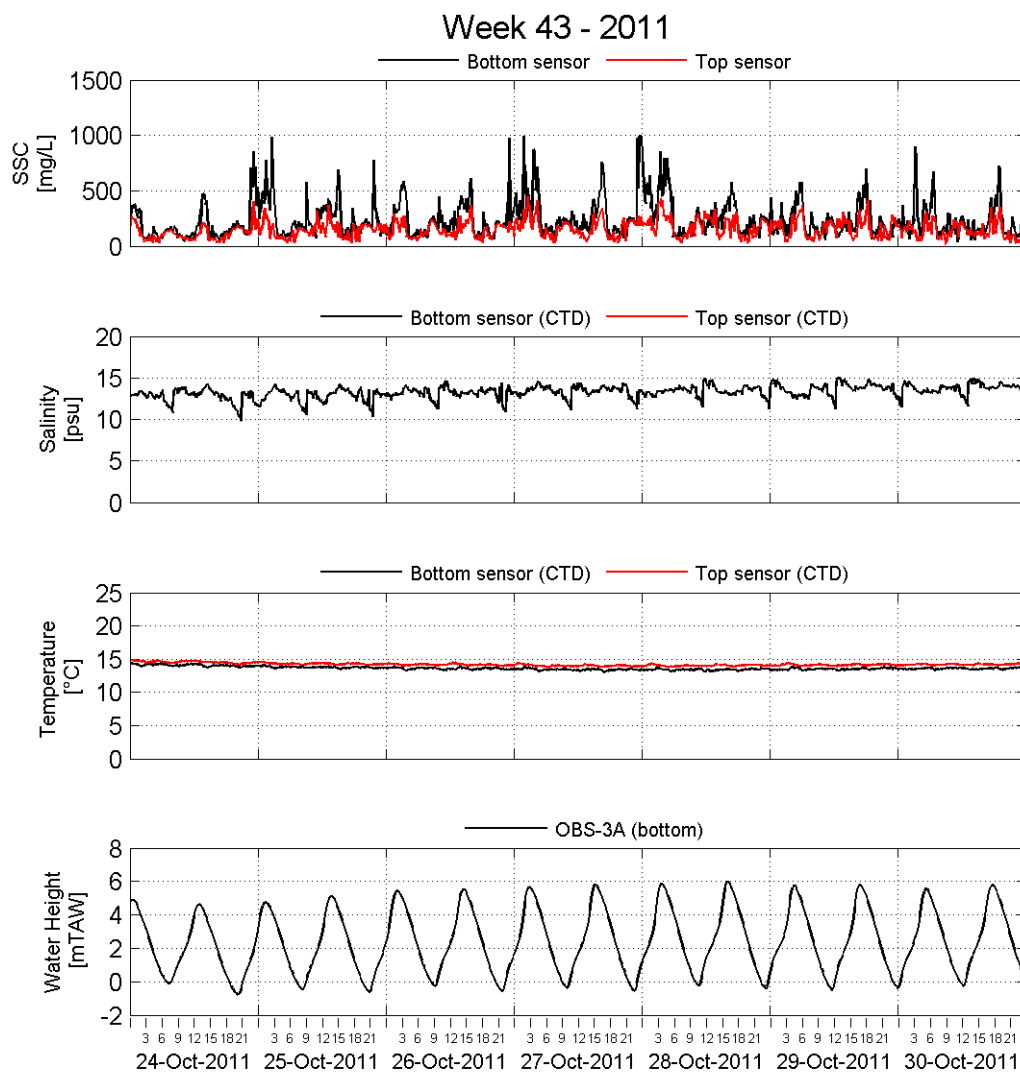
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11354 - Evaluation external effects Deurganckdok



Week series of Suspended Sediment Concentration,
Salinity, Temperature and Water Height

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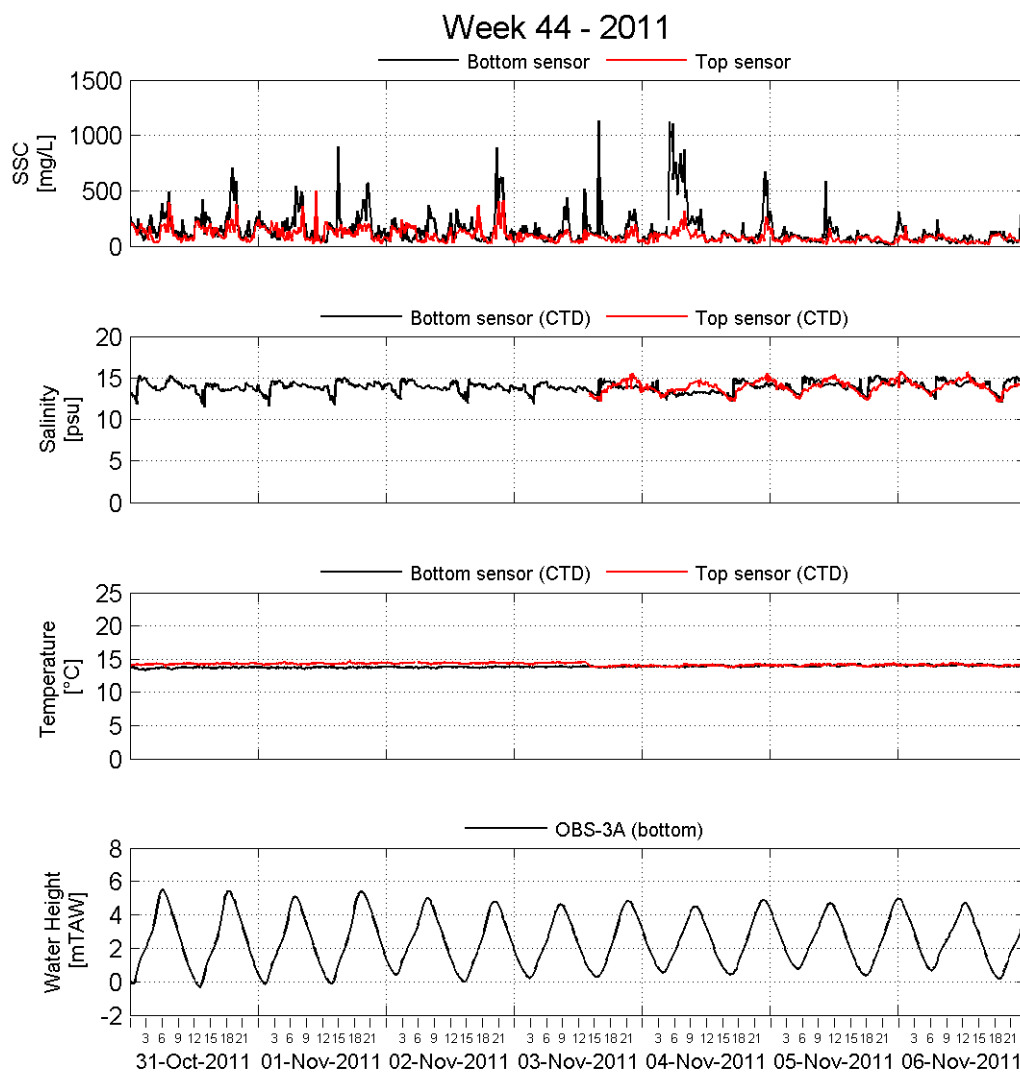
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11354 - Evaluation external effects Deurganckdok



Week series of Suspended Sediment Concentration,
Salinity, Temperature and Water Height

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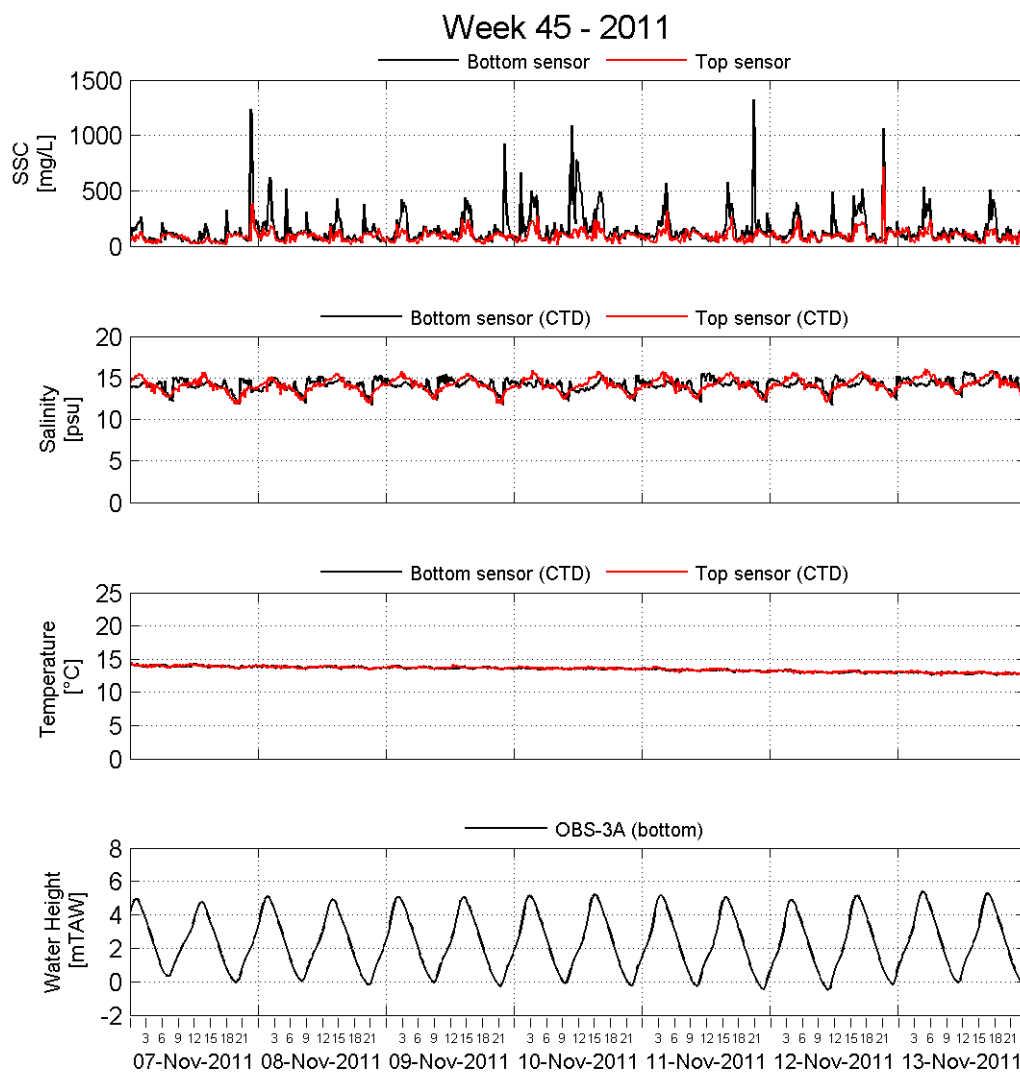
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I/RA/11354/10.112/MBO/ANF

11354 - Evaluation external effects Deurganckdok



Week series of Suspended Sediment Concentration,
Salinity, Temperature and Water Height

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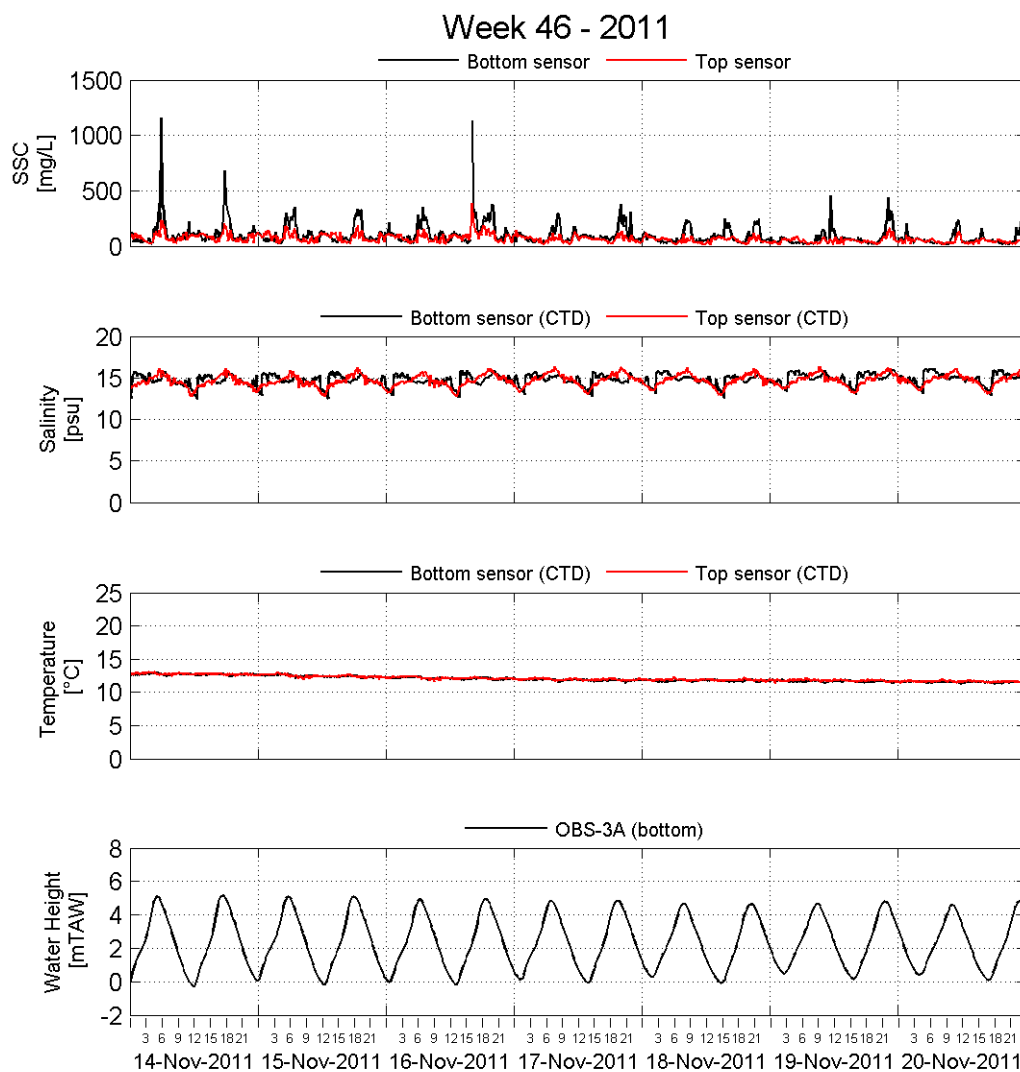
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I/RA/11354/10.112/MBO/ANF

11354 - Evaluation external effects Deurganckdok



Week series of Suspended Sediment Concentration,
Salinity, Temperature and Water Height

Location:

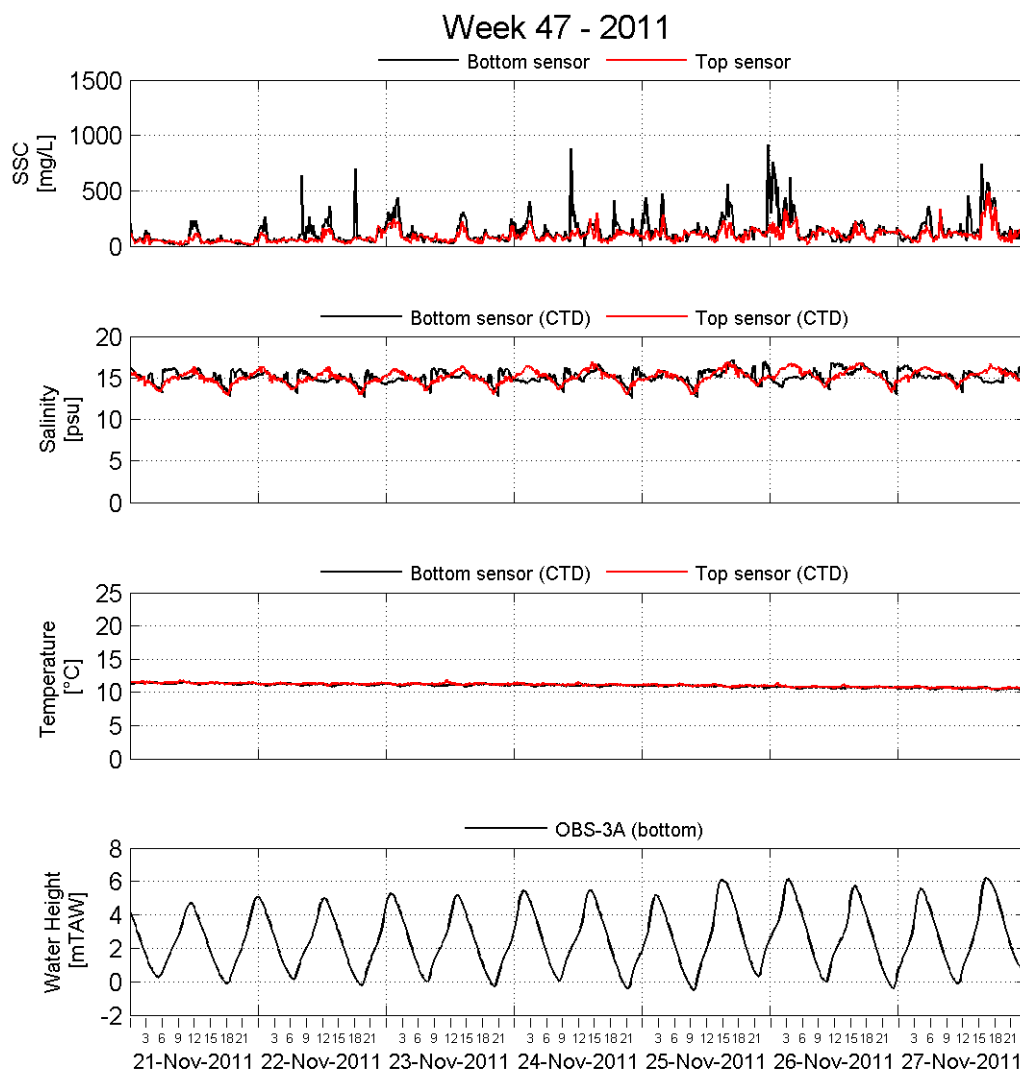
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I/RA/11354/10.112/MBO/ANF

11354 - Evaluation external effects Deurganckdok



Week series of Suspended Sediment Concentration,
Salinity, Temperature and Water Height

Location:

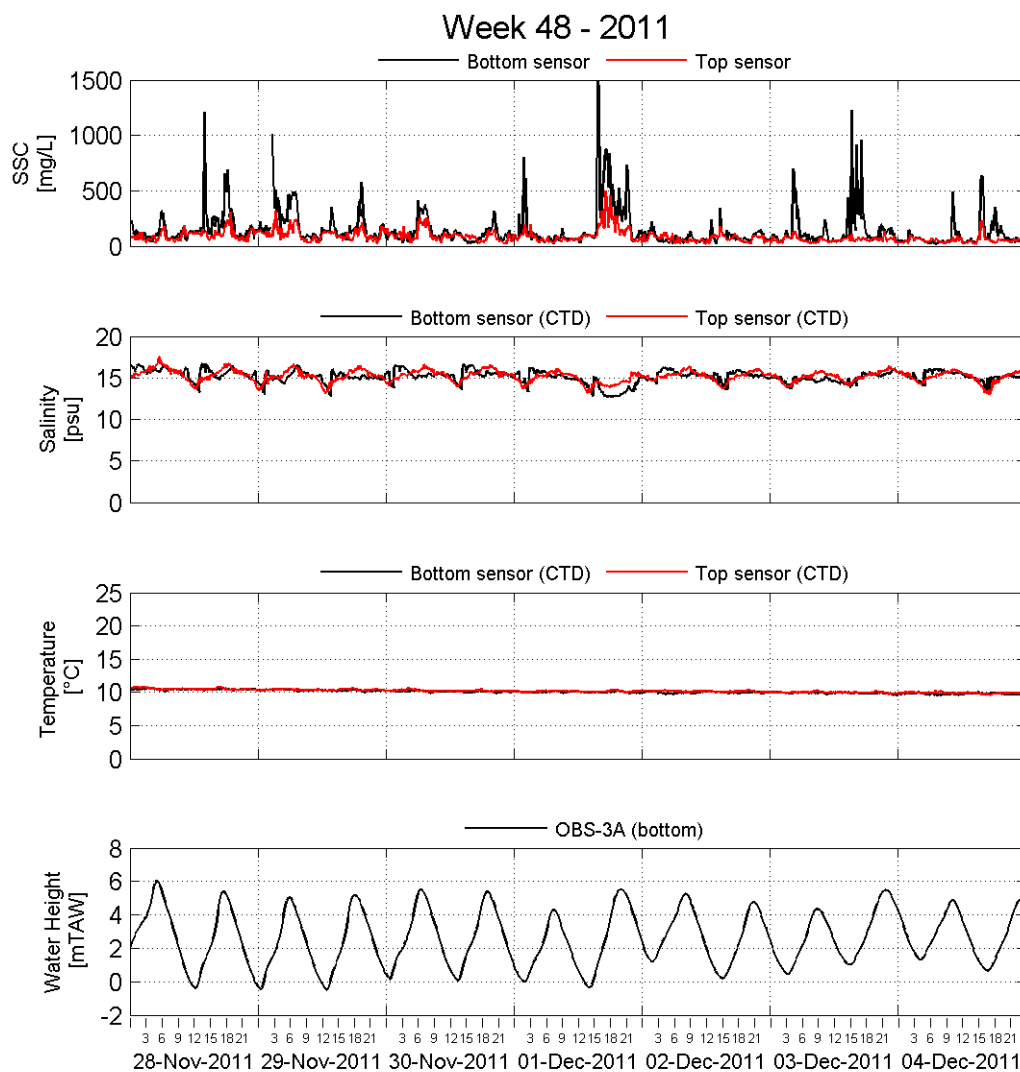
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11354 - Evaluation external effects Deurganckdok



Week series of Suspended Sediment Concentration,
Salinity, Temperature and Water Height

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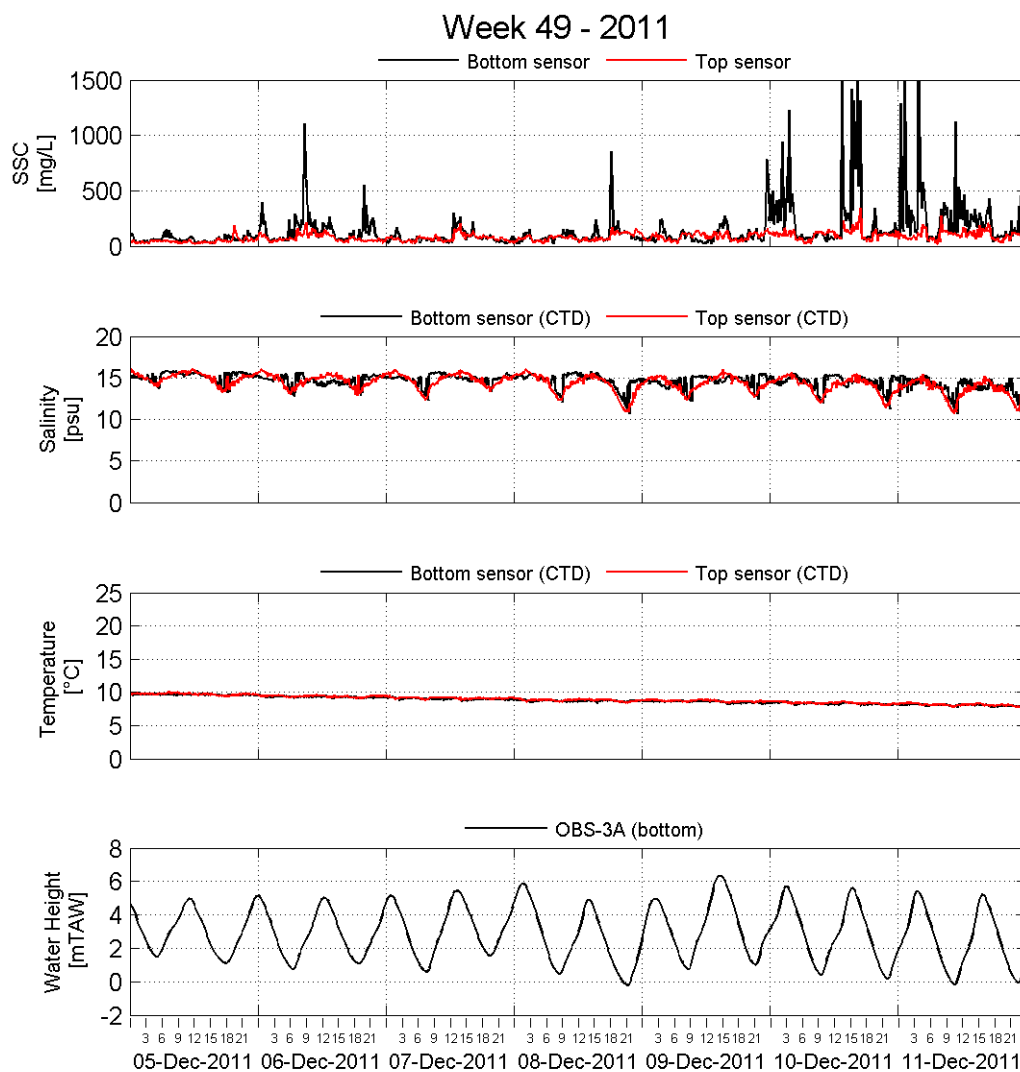
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11354 - Evaluation external effects Deurganckdok



Week series of Suspended Sediment Concentration,
Salinity, Temperature and Water Height

Location:

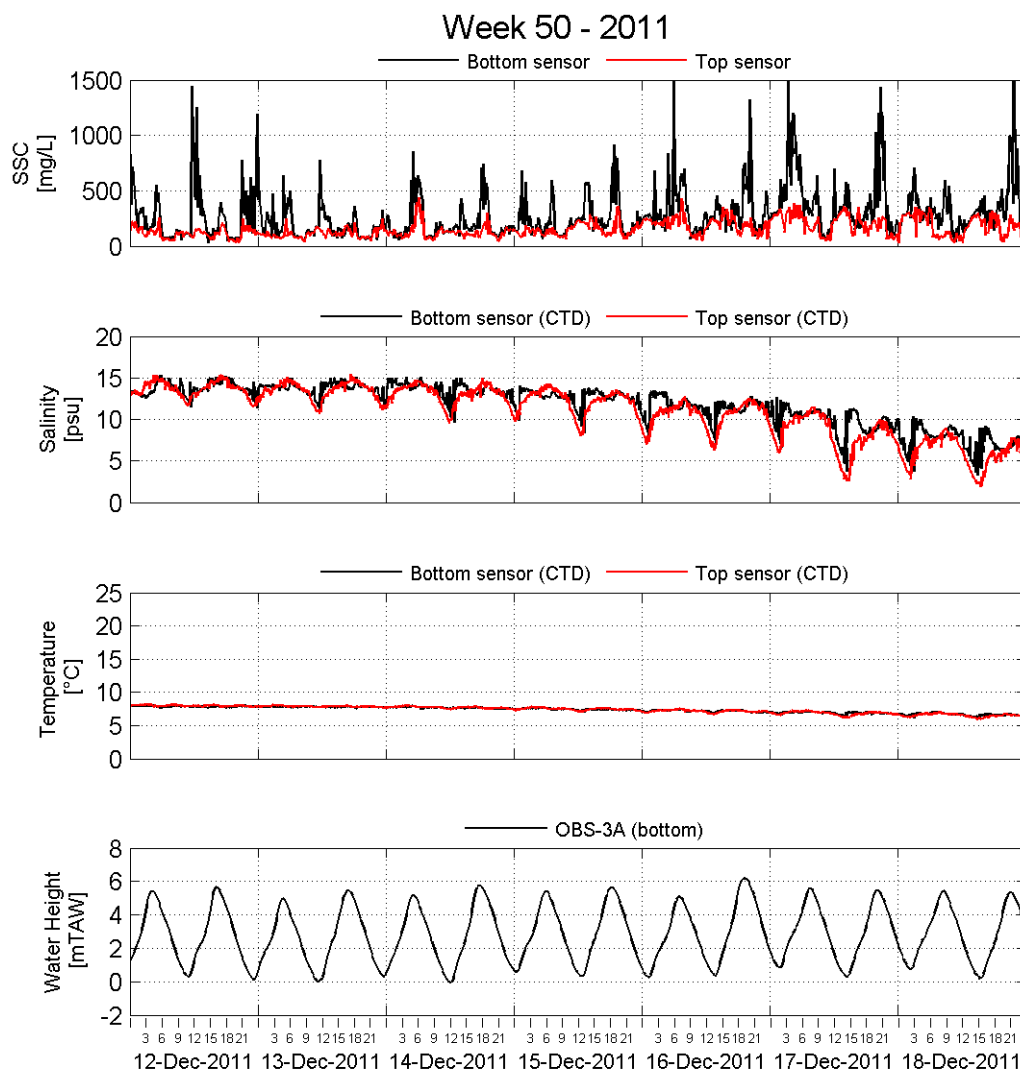
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I/RA/11354/10.112/MBO/ANF

11354 - Evaluation external effects Deurganckdok



Week series of Suspended Sediment Concentration,
Salinity, Temperature and Water Height

Location:

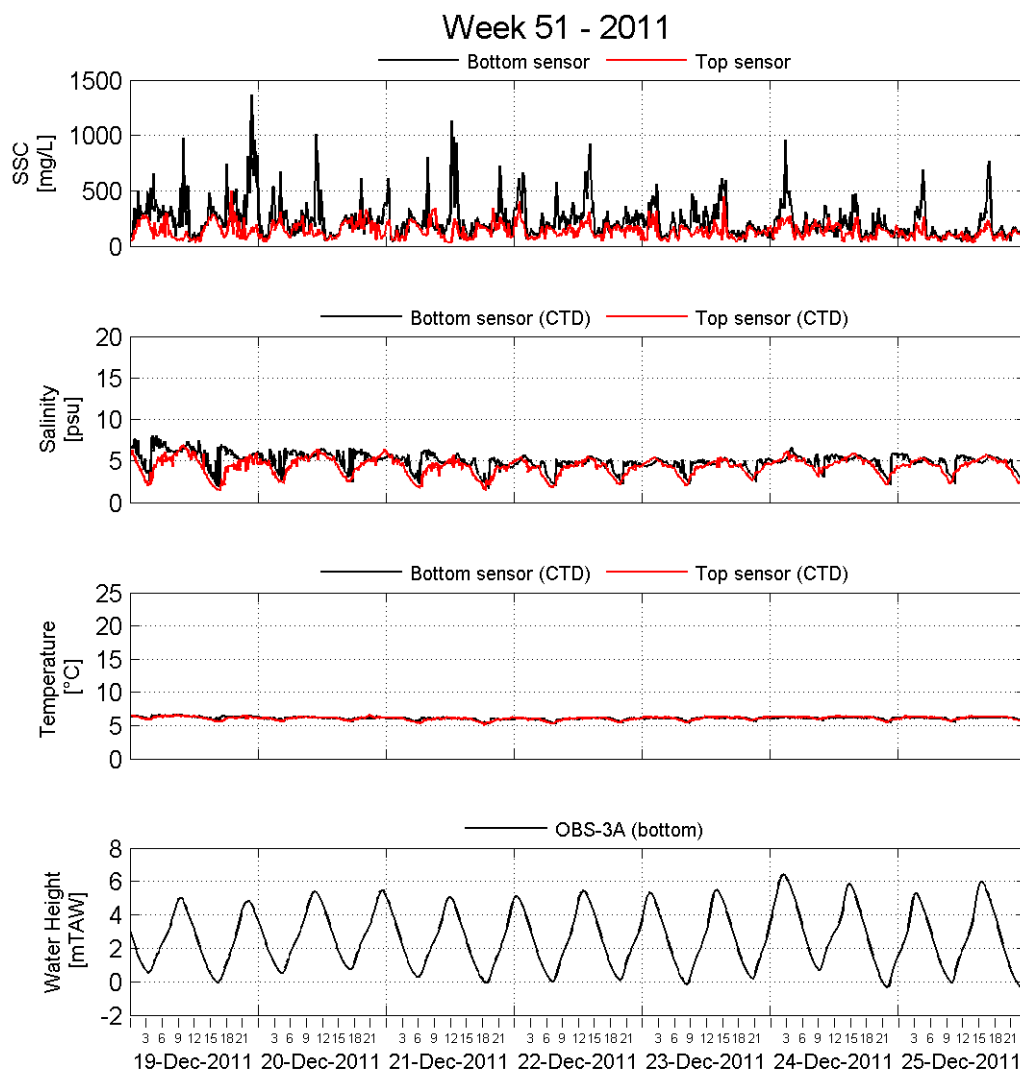
Deurganckdok PSA

Processed by:



I/RA/11354/10.112/MBO/ANF

11354 - Evaluation external effects Deurganckdok



Week series of Suspended Sediment Concentration,
Salinity, Temperature and Water Height

Location:

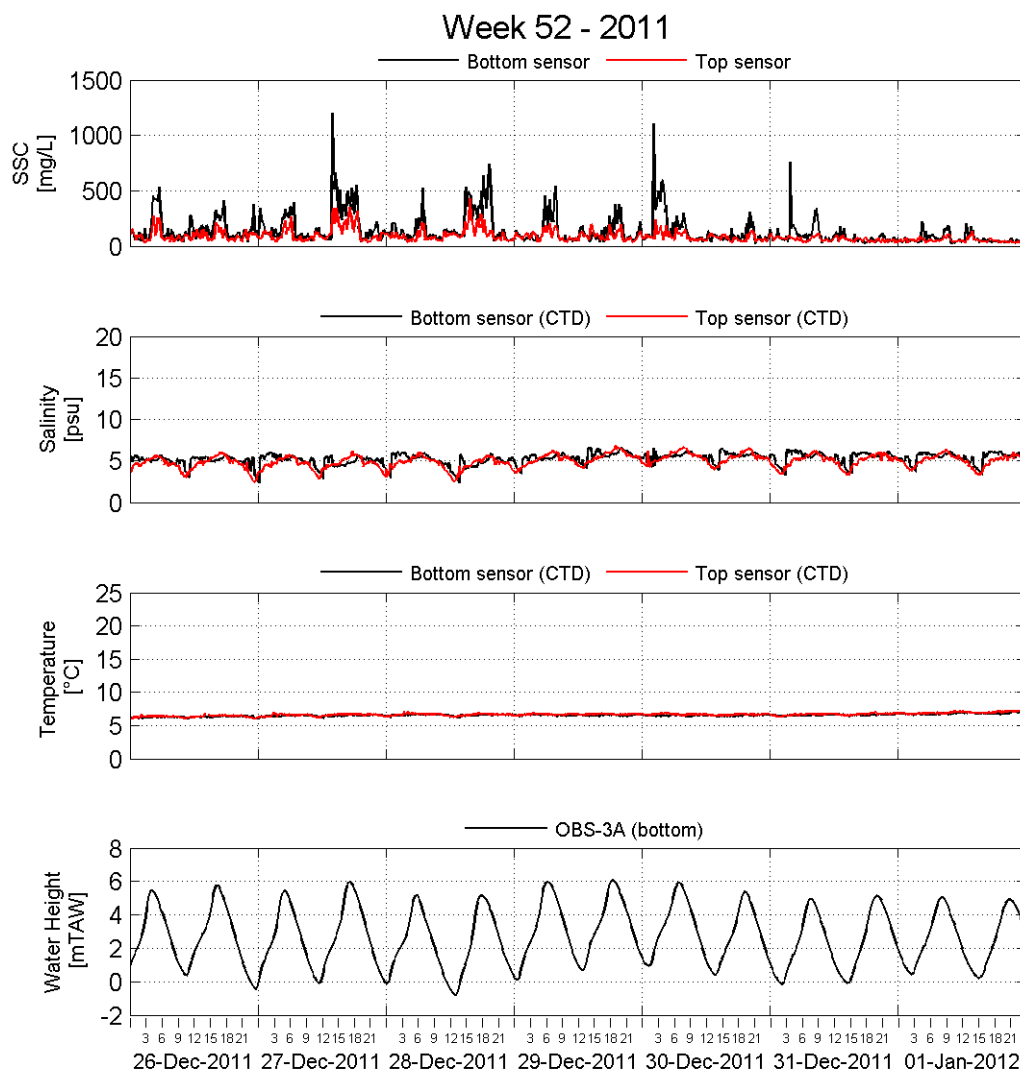
Deurganckdok PSA

Processed by:



I/RA/11354/10.112/MBO/ANF

11354 - Evaluation external effects Deurganckdok



Week series of Suspended Sediment Concentration,
Salinity, Temperature and Water Height

Location:

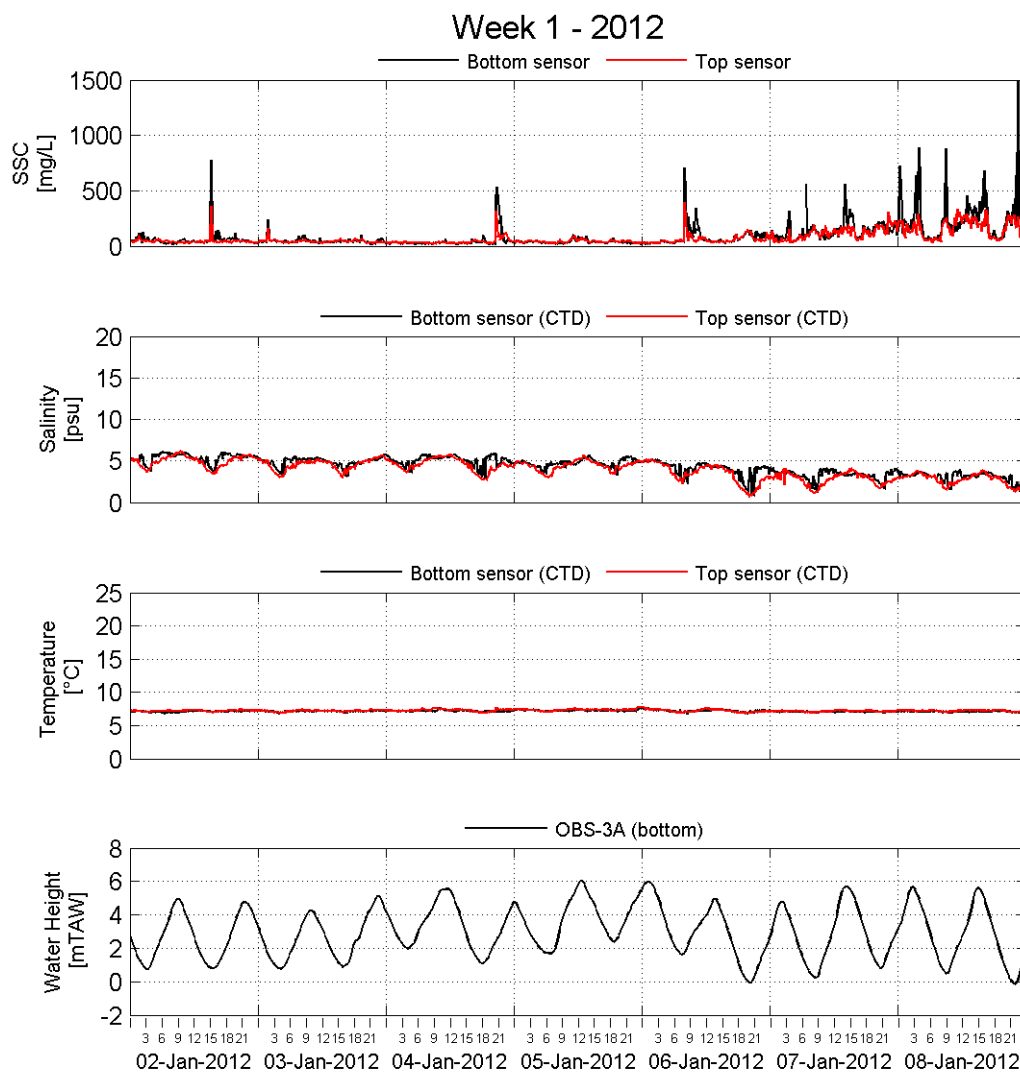
Deurganckdok PSA

Processed by:



I/RA/11354/10.112/MBO/ANF

11354 - Evaluation external effects Deurganckdok



Week series of Suspended Sediment Concentration,
Salinity, Temperature and Water Height

Location:

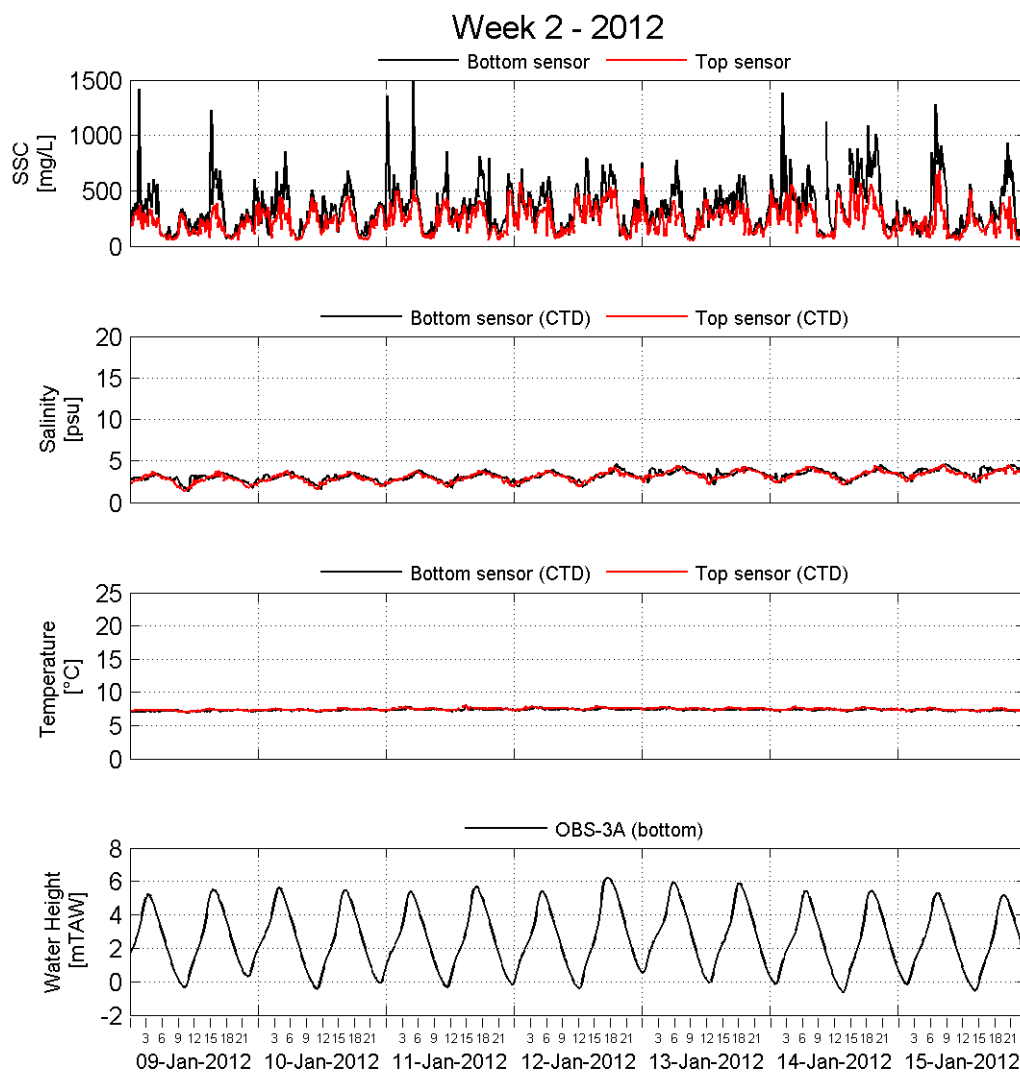
Deurganckdok PSA

Processed by:



I/RA/11354/10.112/MBO/ANF

11354 - Evaluation external effects Deurganckdok



Week series of Suspended Sediment Concentration,
Salinity, Temperature and Water Height

Location:

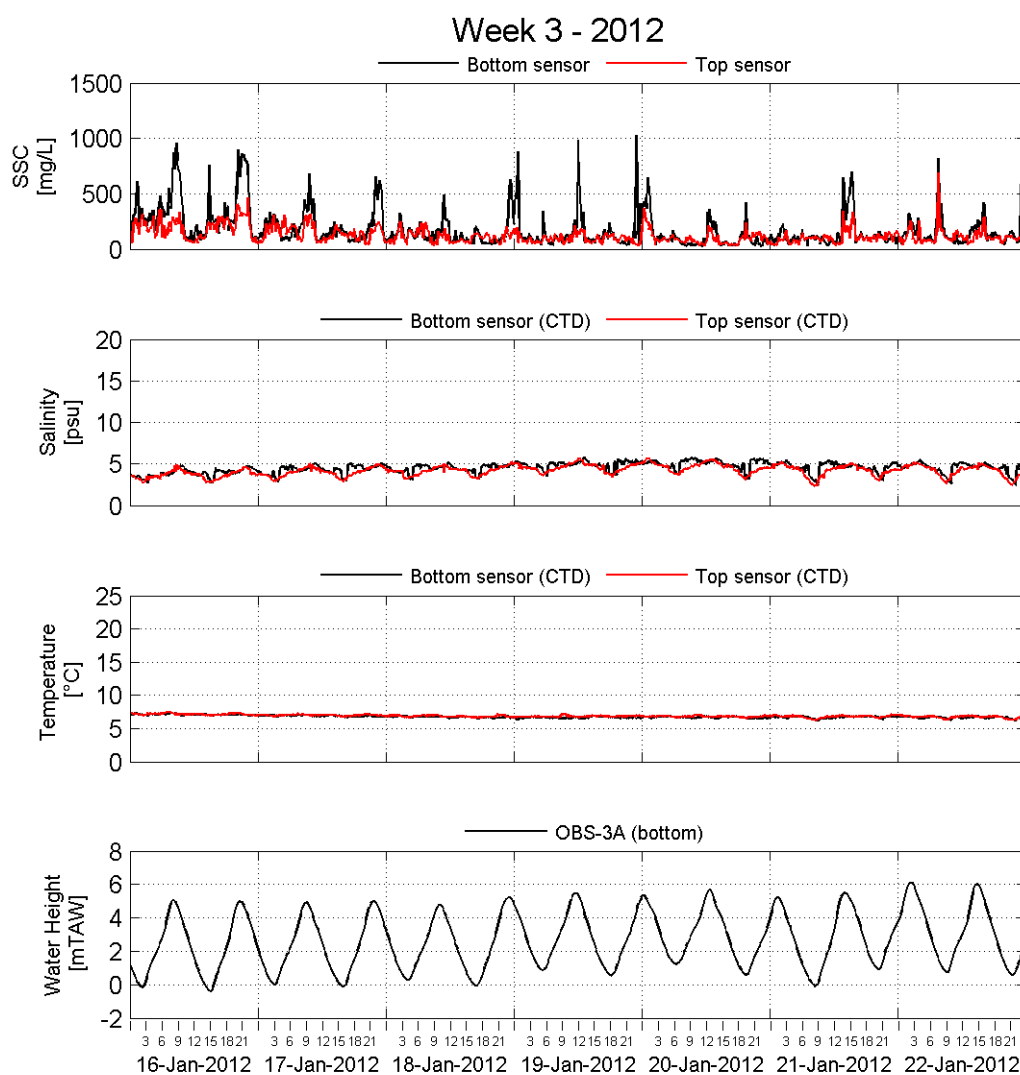
Deurganckdok PSA

Processed by:



I/RA/11354/10.112/MBO/ANF

11354 - Evaluation external effects Deurganckdok



Week series of Suspended Sediment Concentration,
Salinity, Temperature and Water Height

Processed by:

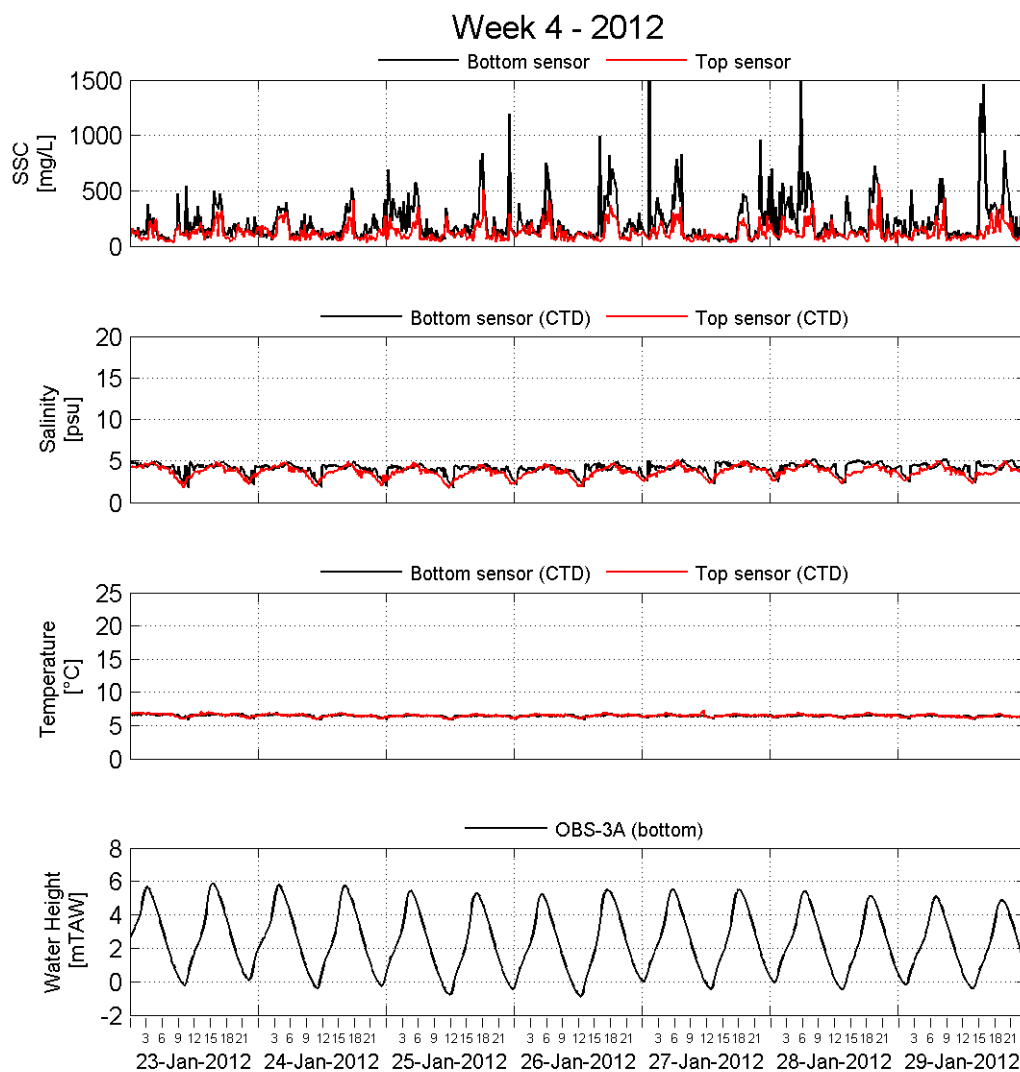


Location:

Deurganckdok PSA

I/RA/11354/10.112/MBO/ANF

11354 - Evaluation external effects Deurganckdok



Week series of Suspended Sediment Concentration,
Salinity, Temperature and Water Height

Location:

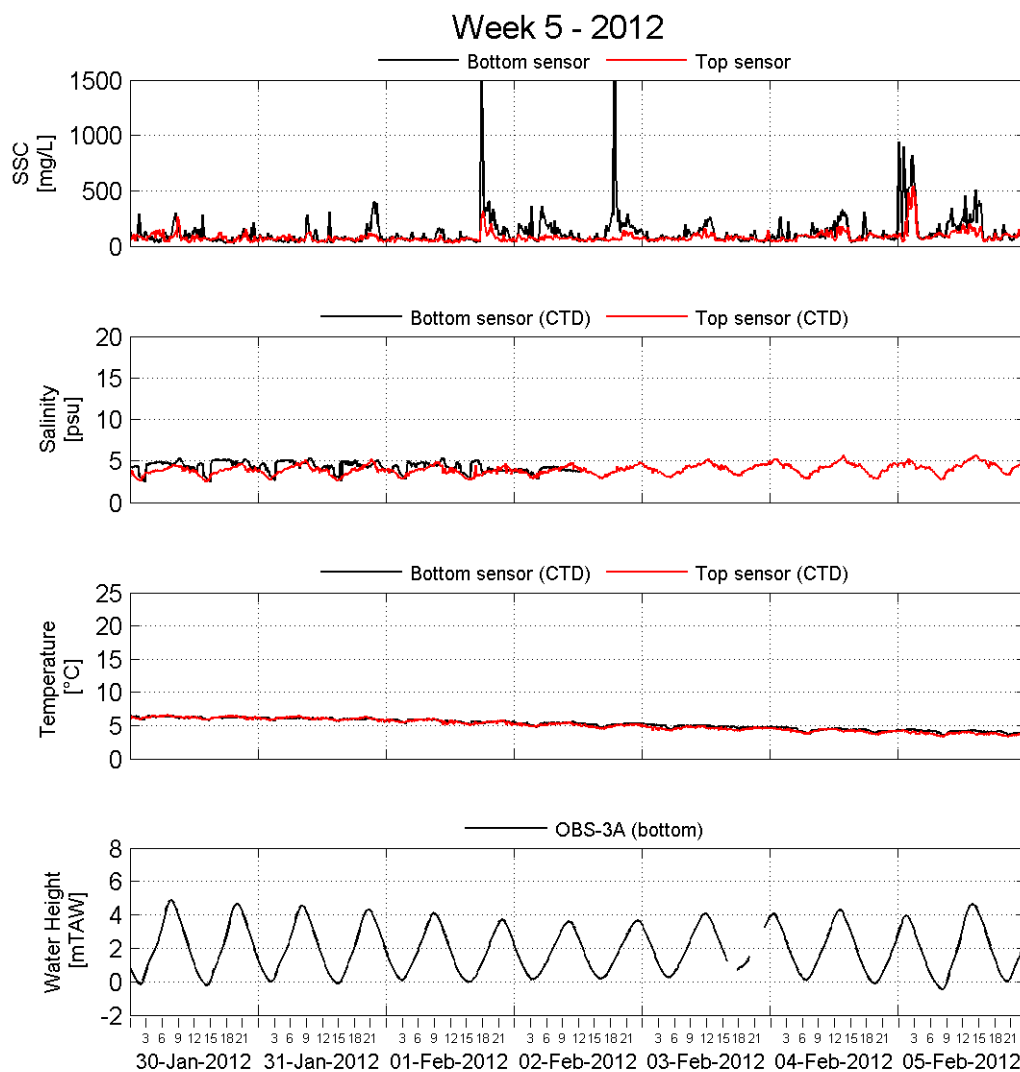
Deurganckdok PSA

Processed by:



I/RA/11354/10.112/MBO/ANF

11354 - Evaluation external effects Deurganckdok



Week series of Suspended Sediment Concentration,
Salinity, Temperature and Water Height

Location:

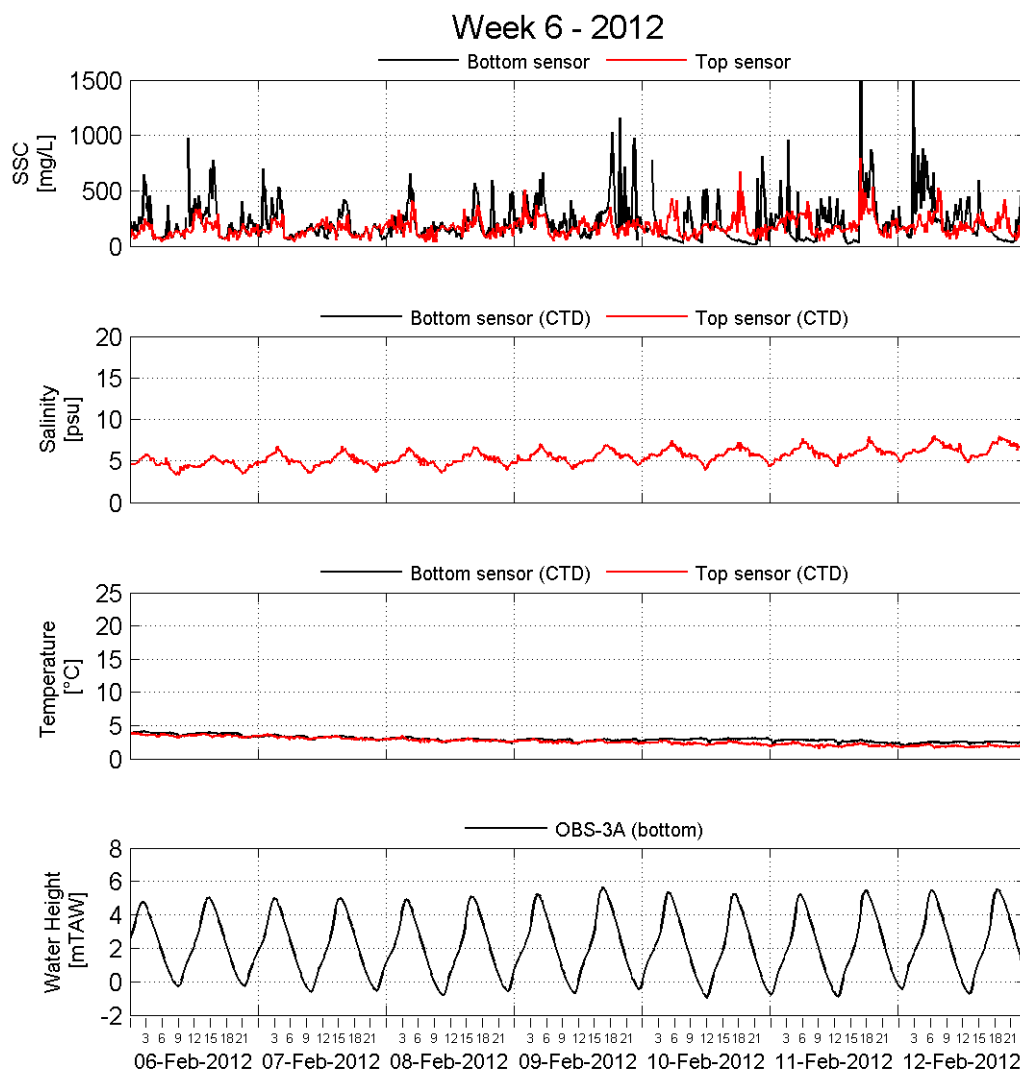
Deurganckdok PSA

Processed by:



I/RA/11354/10.112/MBO/ANF

11354 - Evaluation external effects Deurganckdok



Week series of Suspended Sediment Concentration,
Salinity, Temperature and Water Height

Location:

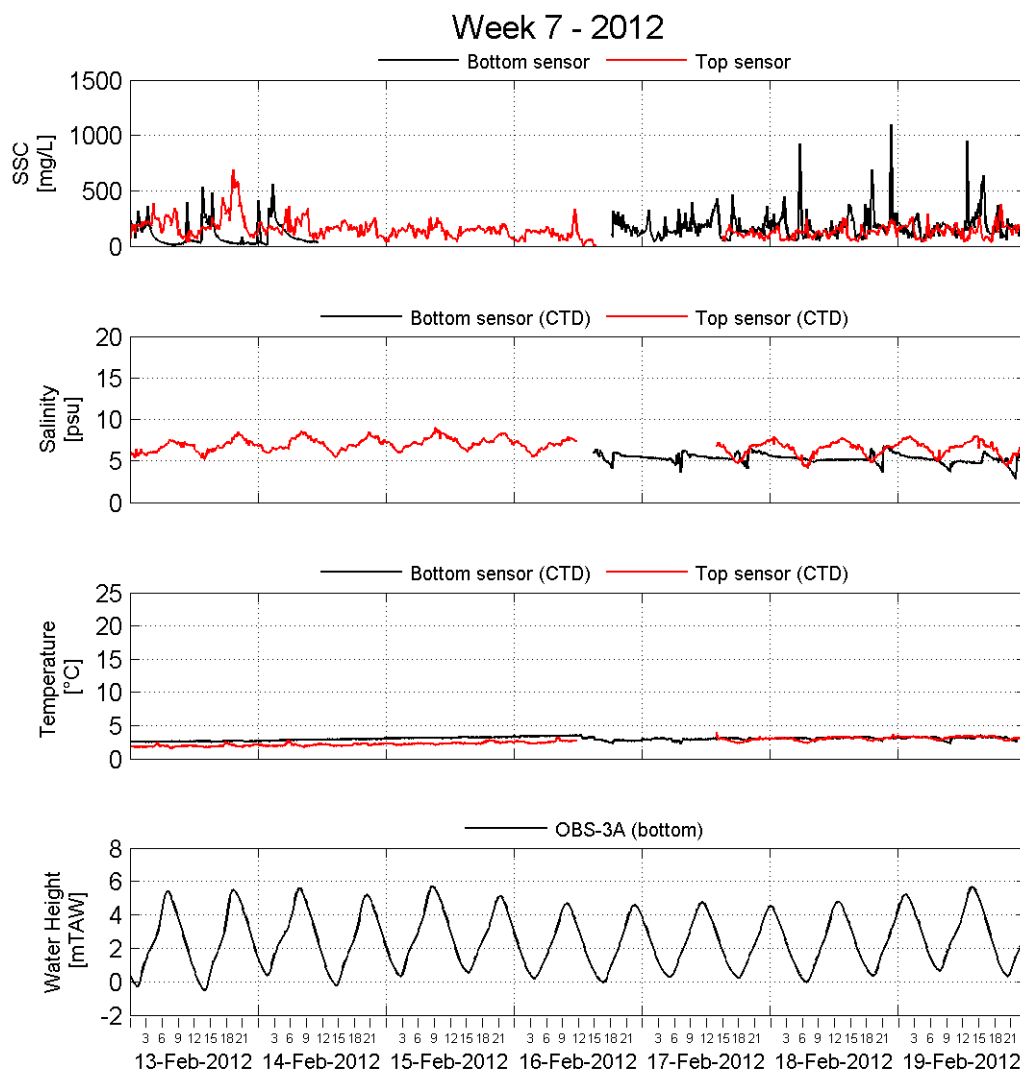
Deurganckdok PSA

Processed by:



I/RA/11354/10.112/MBO/ANF

11354 - Evaluation external effects Deurganckdok



Week series of Suspended Sediment Concentration,
Salinity, Temperature and Water Height

Location:

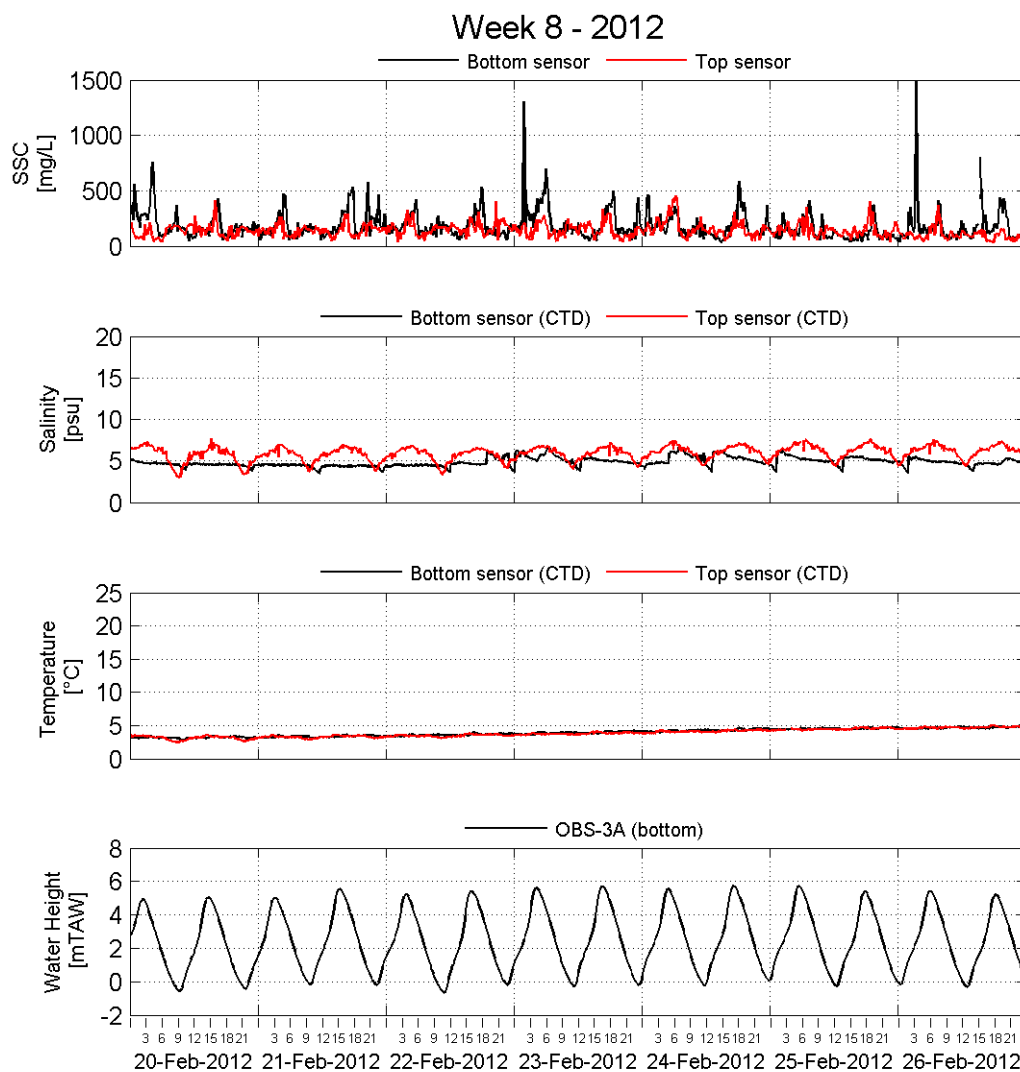
Deurganckdok PSA

Processed by:



I/RA/11354/10.112/MBO/ANF

11354 - Evaluation external effects Deurganckdok



Week series of Suspended Sediment Concentration,
Salinity, Temperature and Water Height

Location:

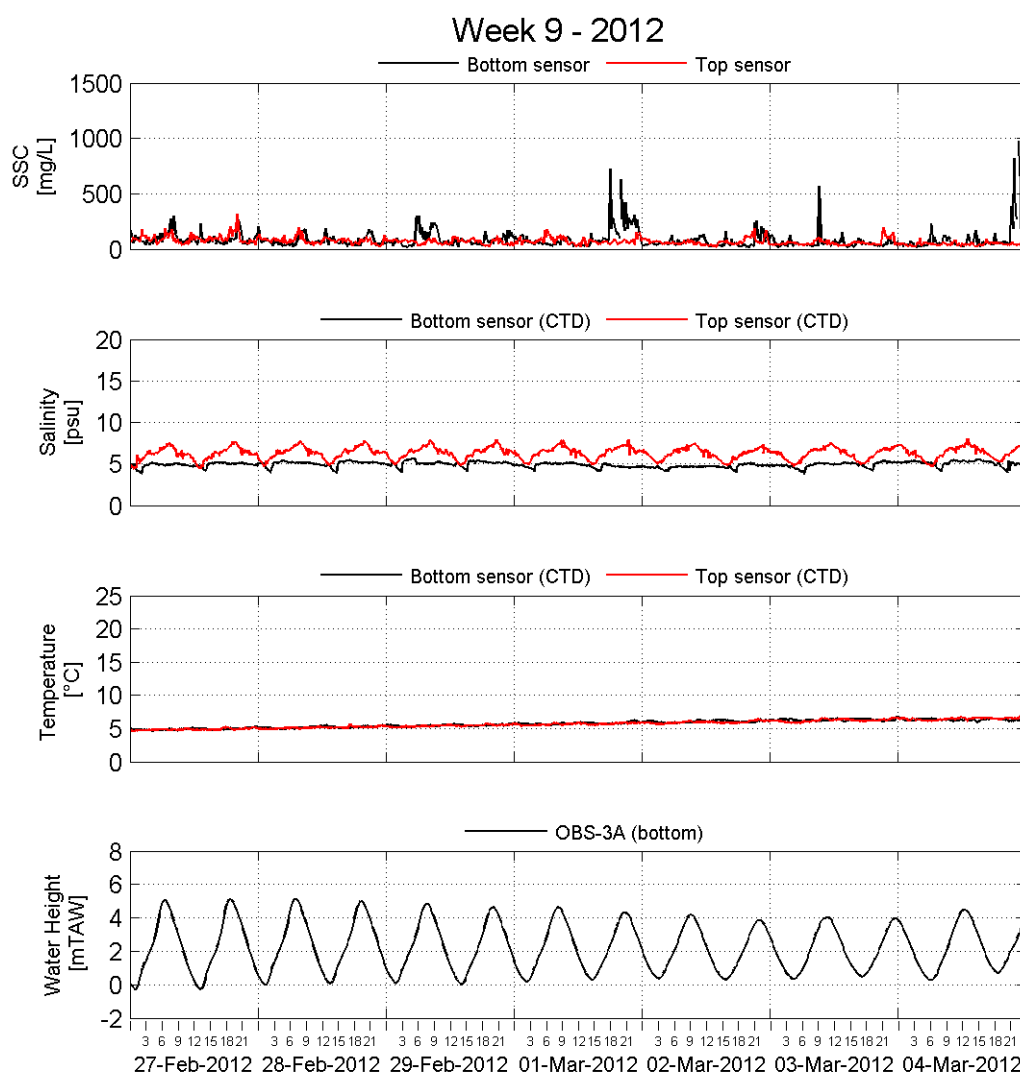
Deurganckdok PSA

Processed by:



I/RA/11354/10.112/MBO/ANF

11354 - Evaluation external effects Deurganckdok



Week series of Suspended Sediment Concentration,
Salinity, Temperature and Water Height

Location:

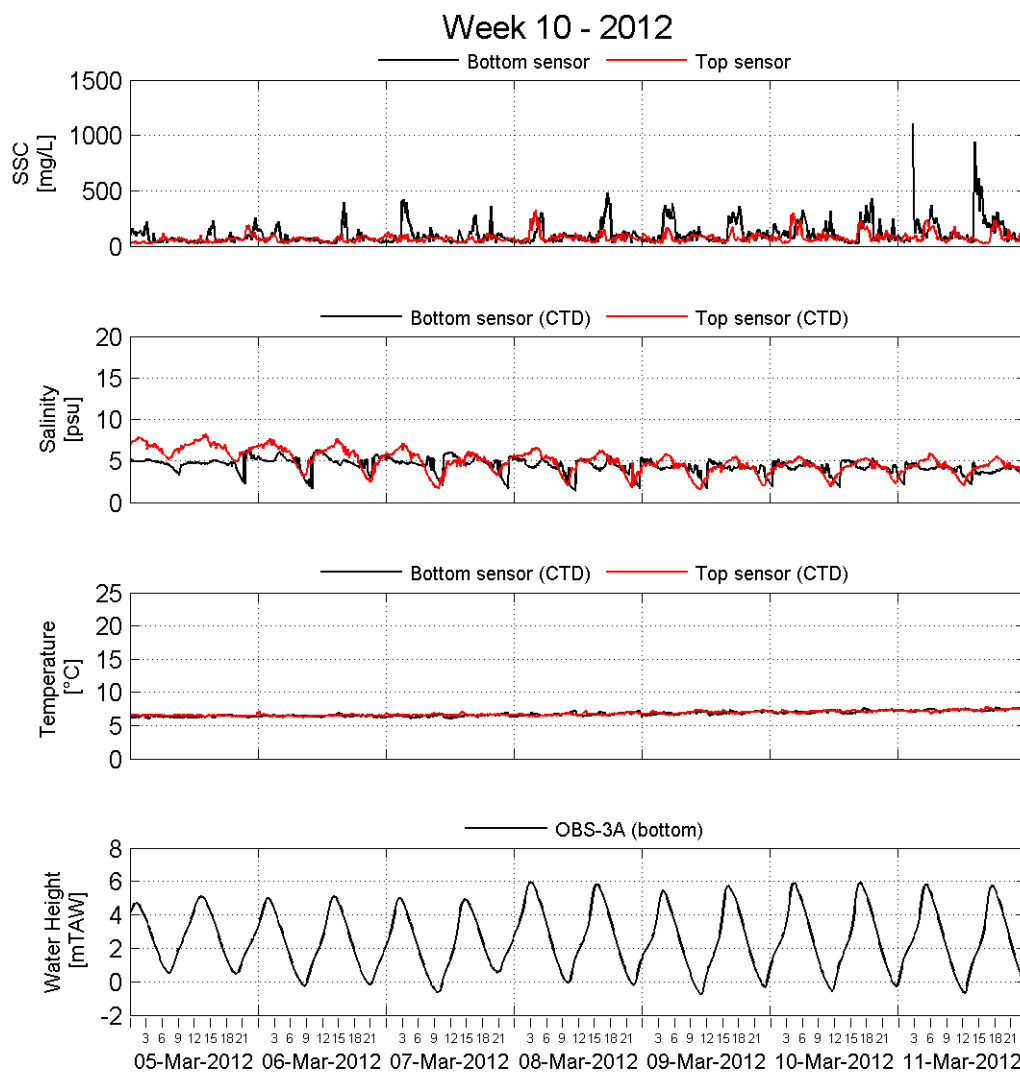
Deurganckdok PSA

Processed by:



I/RA/11354/10.112/MBO/ANF

11354 - Evaluation external effects Deurganckdok



Week series of Suspended Sediment Concentration,
Salinity, Temperature and Water Height

Location:

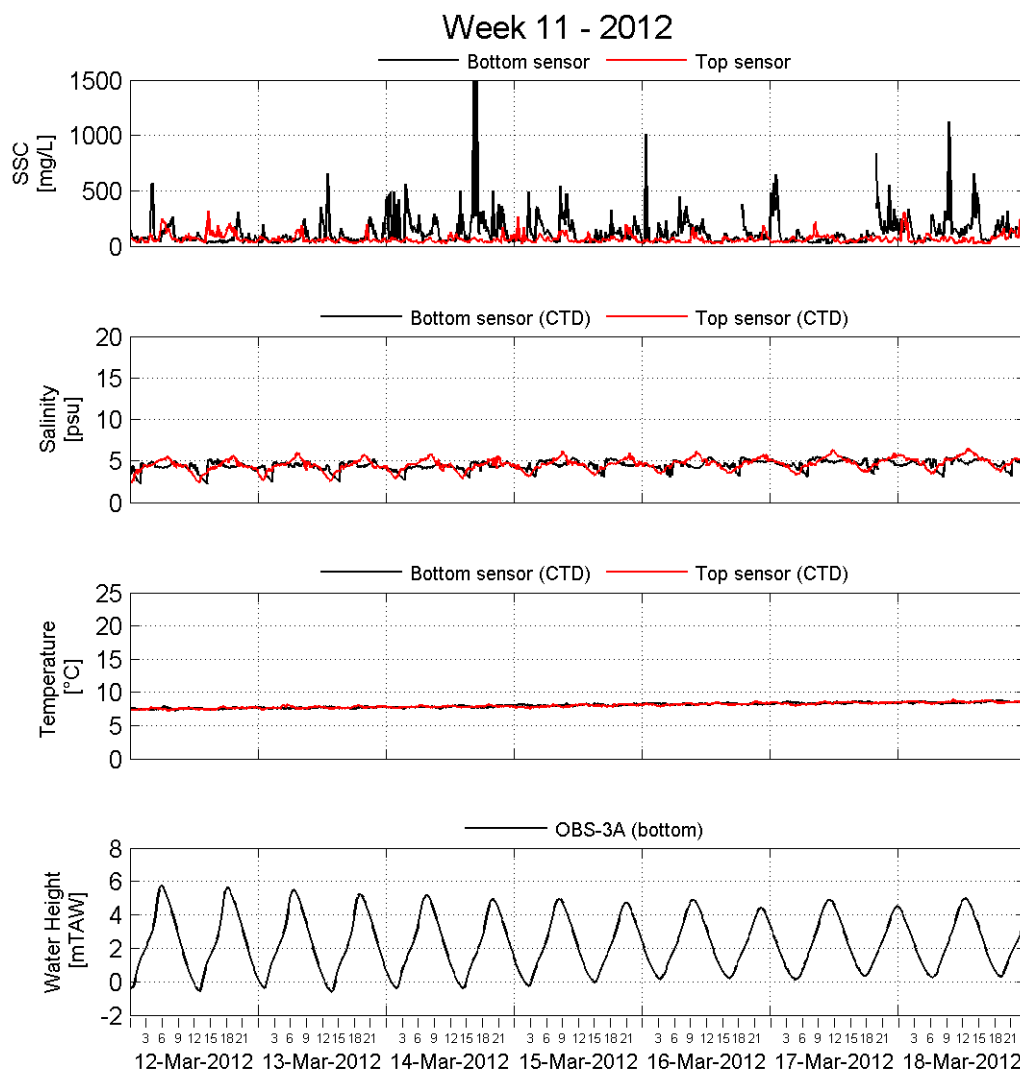
Deurganckdok PSA

Processed by:



I/RA/11354/10.112/MBO/ANF

11354 - Evaluation external effects Deurganckdok



Week series of Suspended Sediment Concentration,
Salinity, Temperature and Water Height

Location:

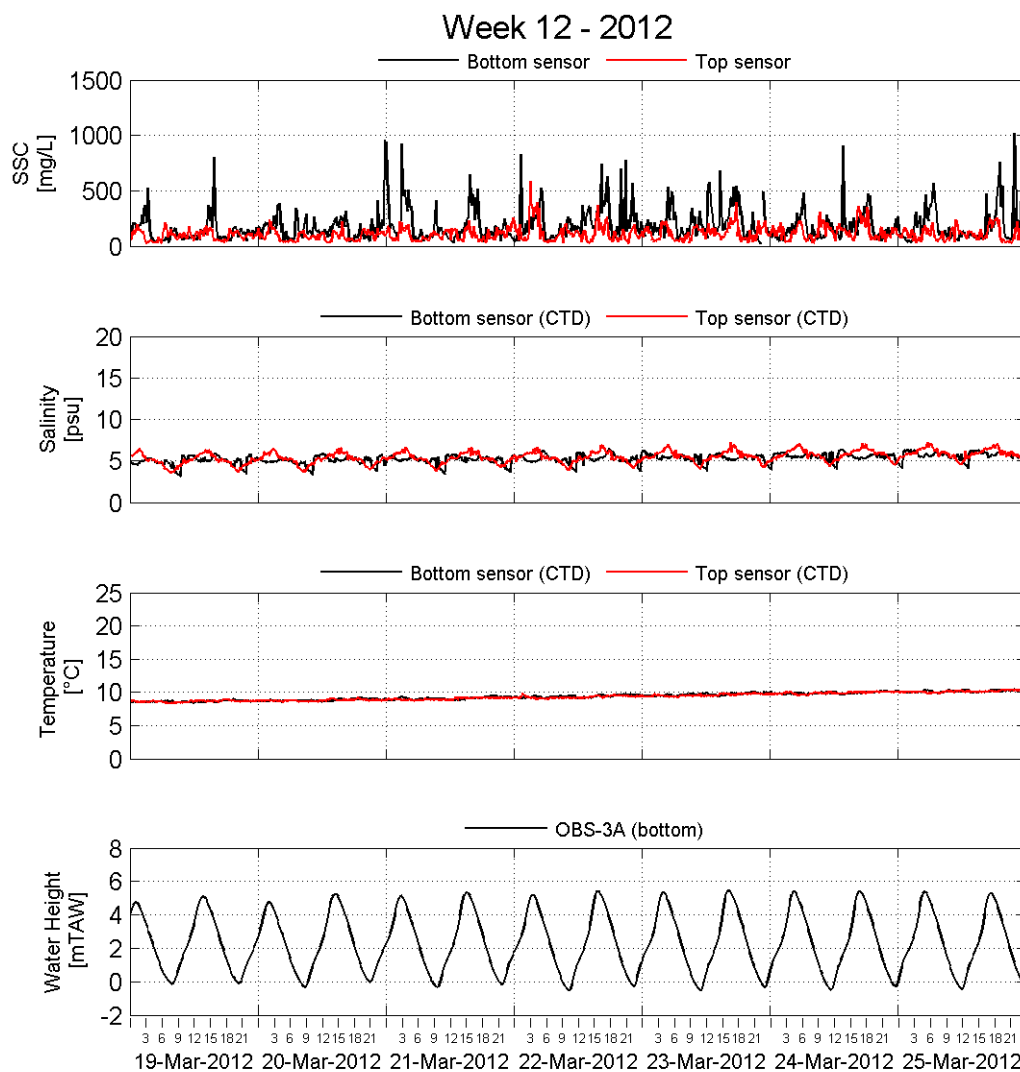
Deurganckdok PSA

Processed by:



I/RA/11354/10.112/MBO/ANF

11354 - Evaluation external effects Deurganckdok



Week series of Suspended Sediment Concentration,
Salinity, Temperature and Water Height

Location:

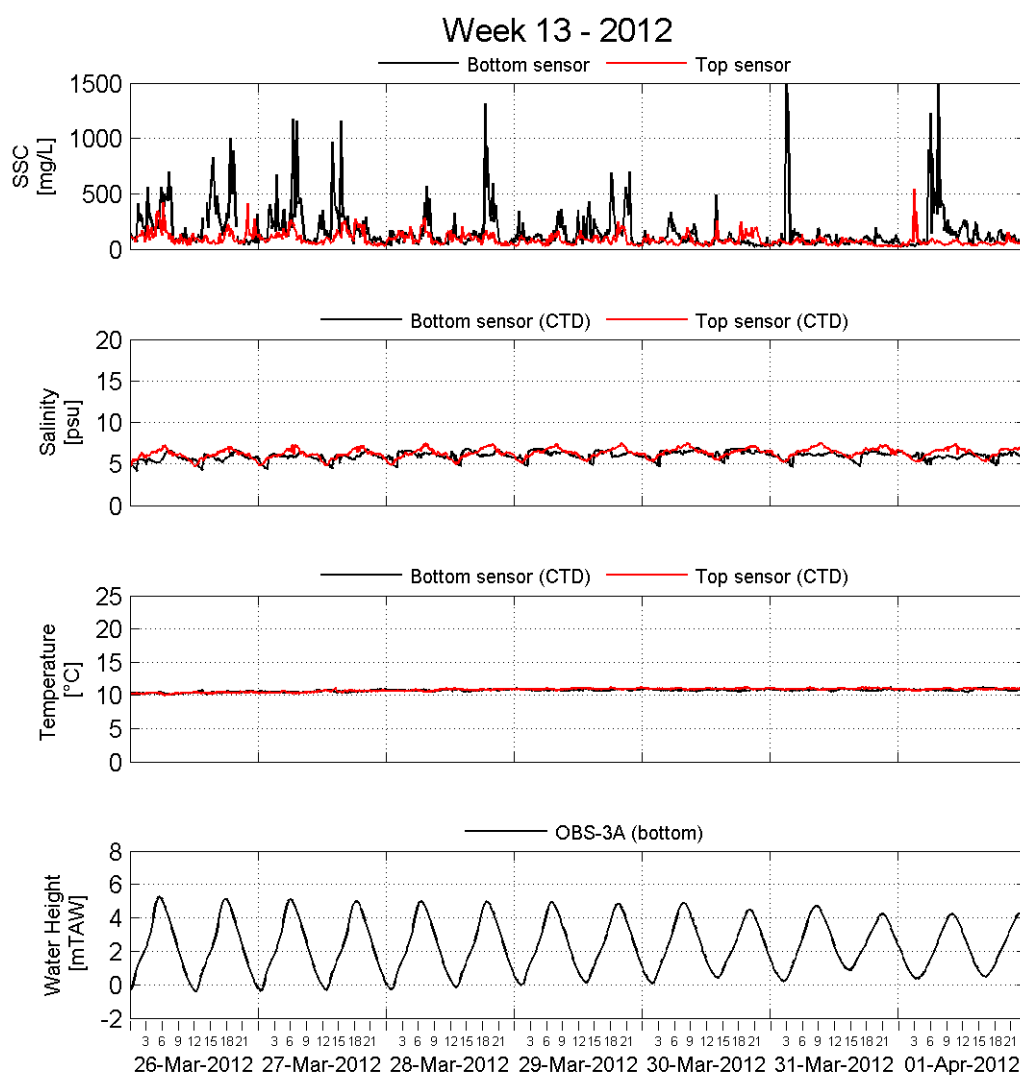
Deurganckdok PSA

Processed by:



I/RA/11354/10.112/MBO/ANF

11354 - Evaluation external effects Deurganckdok



Week series of Suspended Sediment Concentration,
Salinity, Temperature and Water Height

Location:

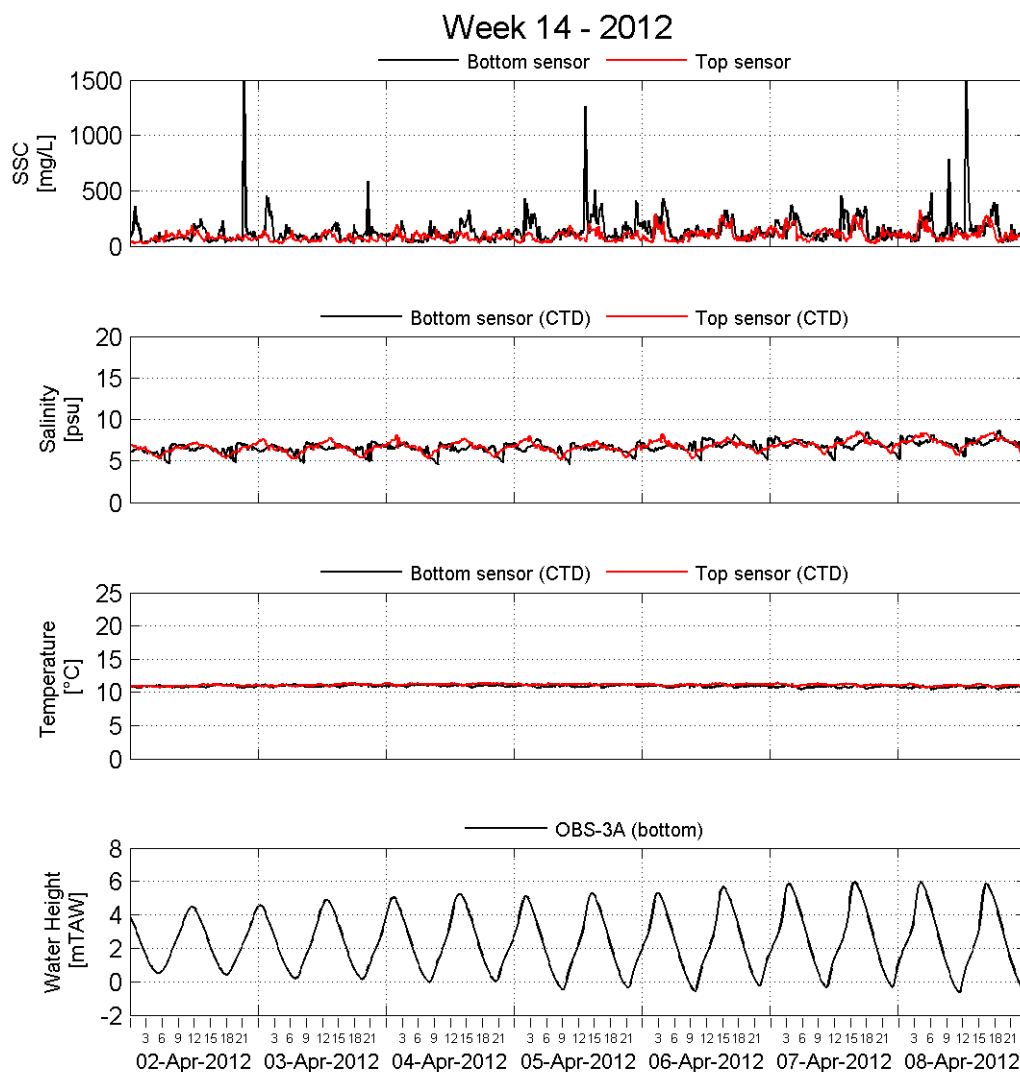
Deurganckdok PSA

Processed by:



I/RA/11354/10.112/MBO/ANF

11354 - Evaluation external effects Deurganckdok



Week series of Suspended Sediment Concentration,
Salinity, Temperature and Water Height

Location:

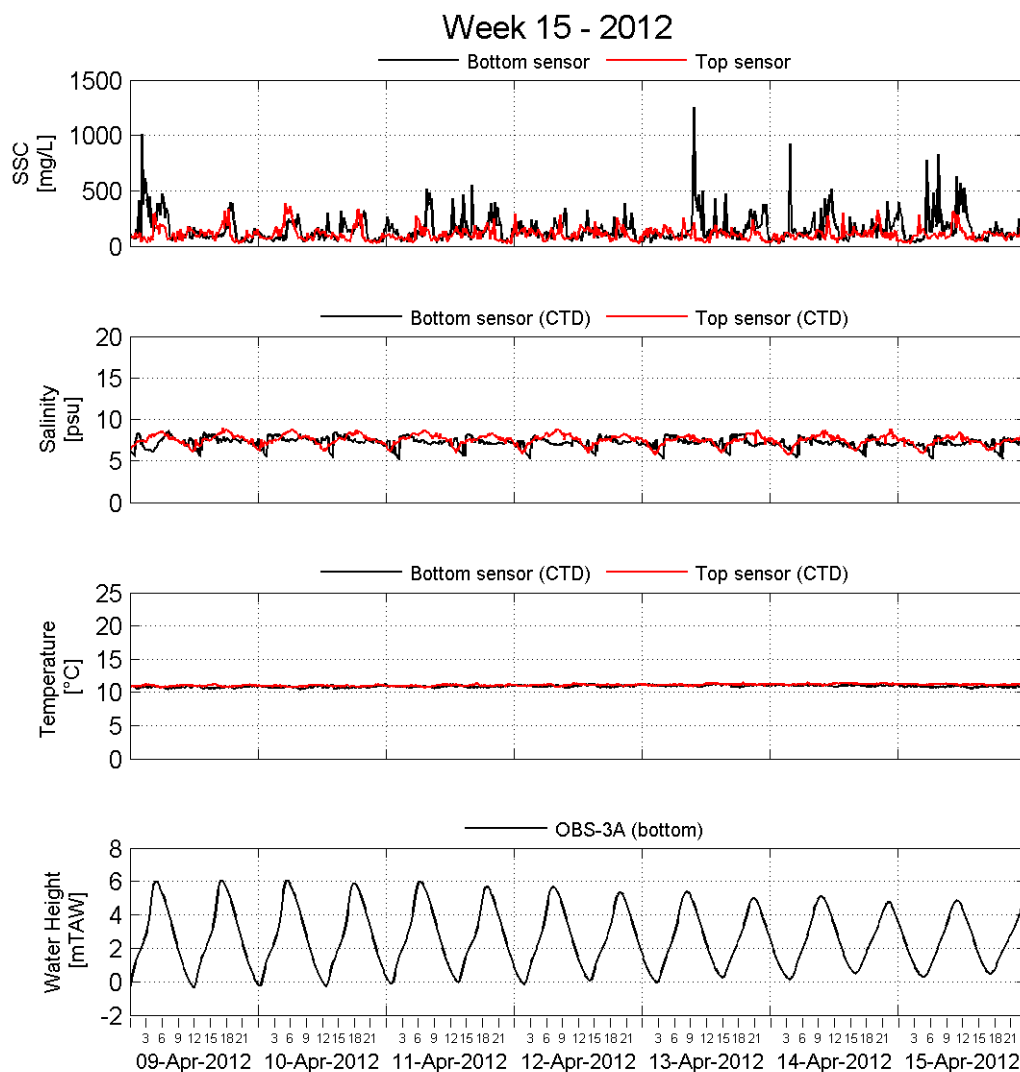
Deurganckdok PSA

Processed by:



I/RA/11354/10.112/MBO/ANF

11354 - Evaluation external effects Deurganckdok



Week series of Suspended Sediment Concentration,
Salinity, Temperature and Water Height

Location:

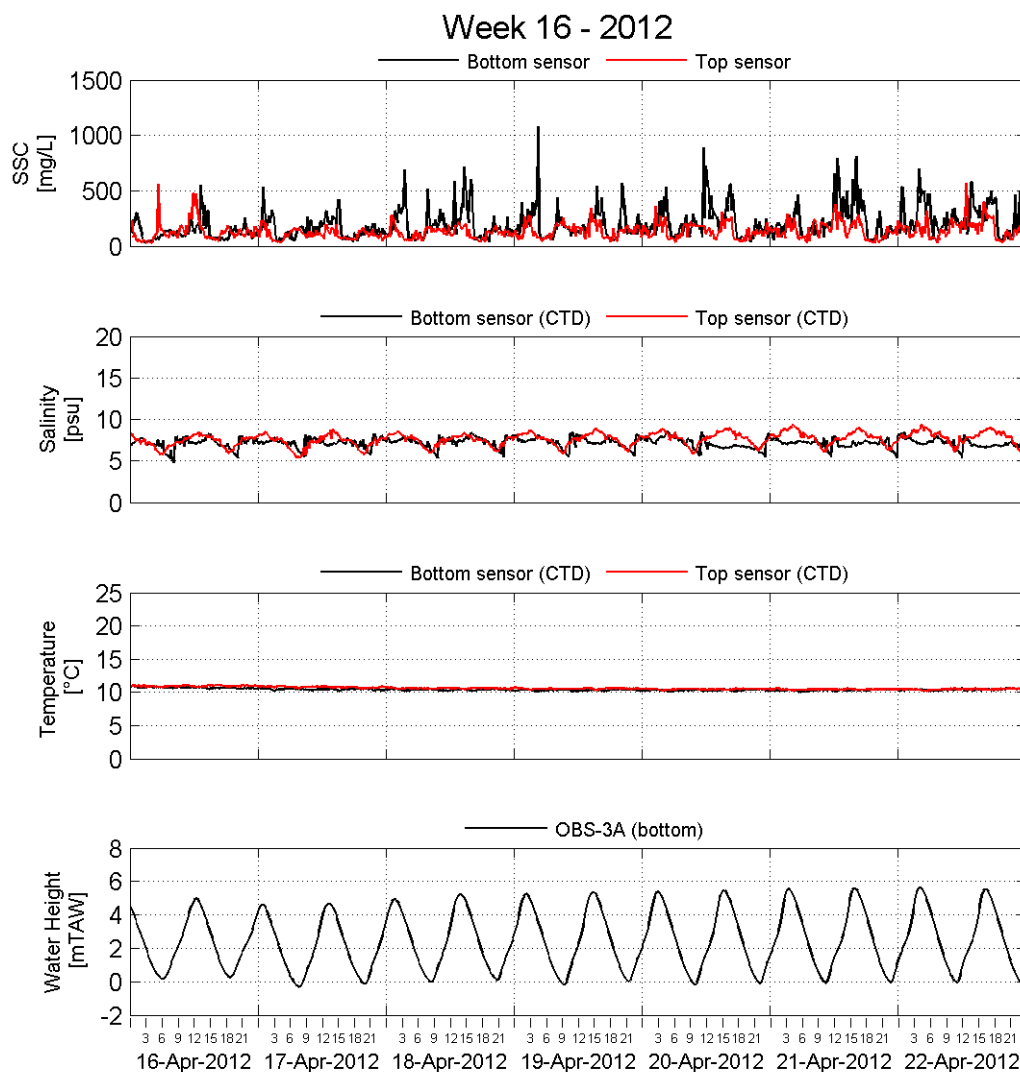
Deurganckdok PSA

Processed by:



I/RA/11354/10.112/MBO/ANF

11354 - Evaluation external effects Deurganckdok



Week series of Suspended Sediment Concentration,
Salinity, Temperature and Water Height

Location:

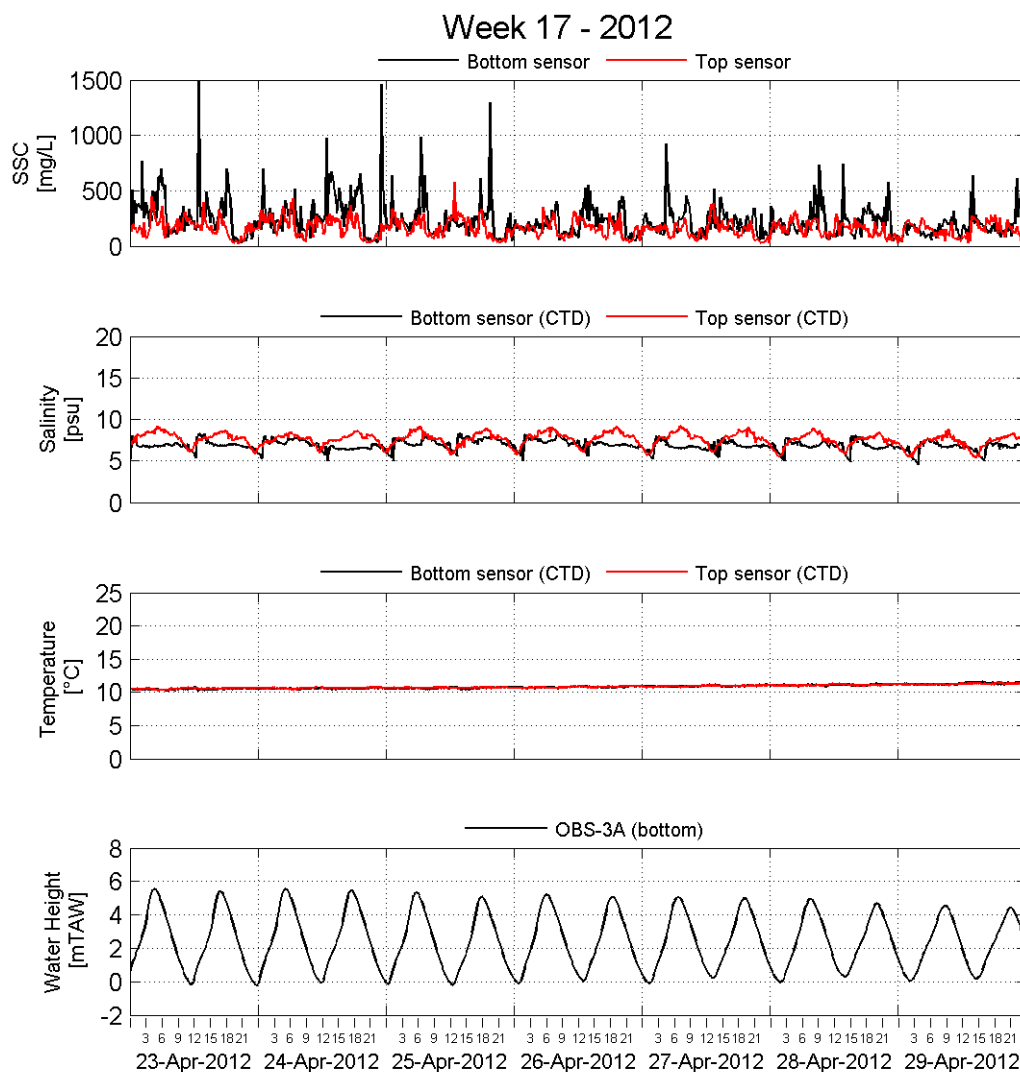
Deurganckdok PSA

Processed by:



I/RA/11354/10.112/MBO/ANF

11354 - Evaluation external effects Deurganckdok



Week series of Suspended Sediment Concentration,
Salinity, Temperature and Water Height

Location:

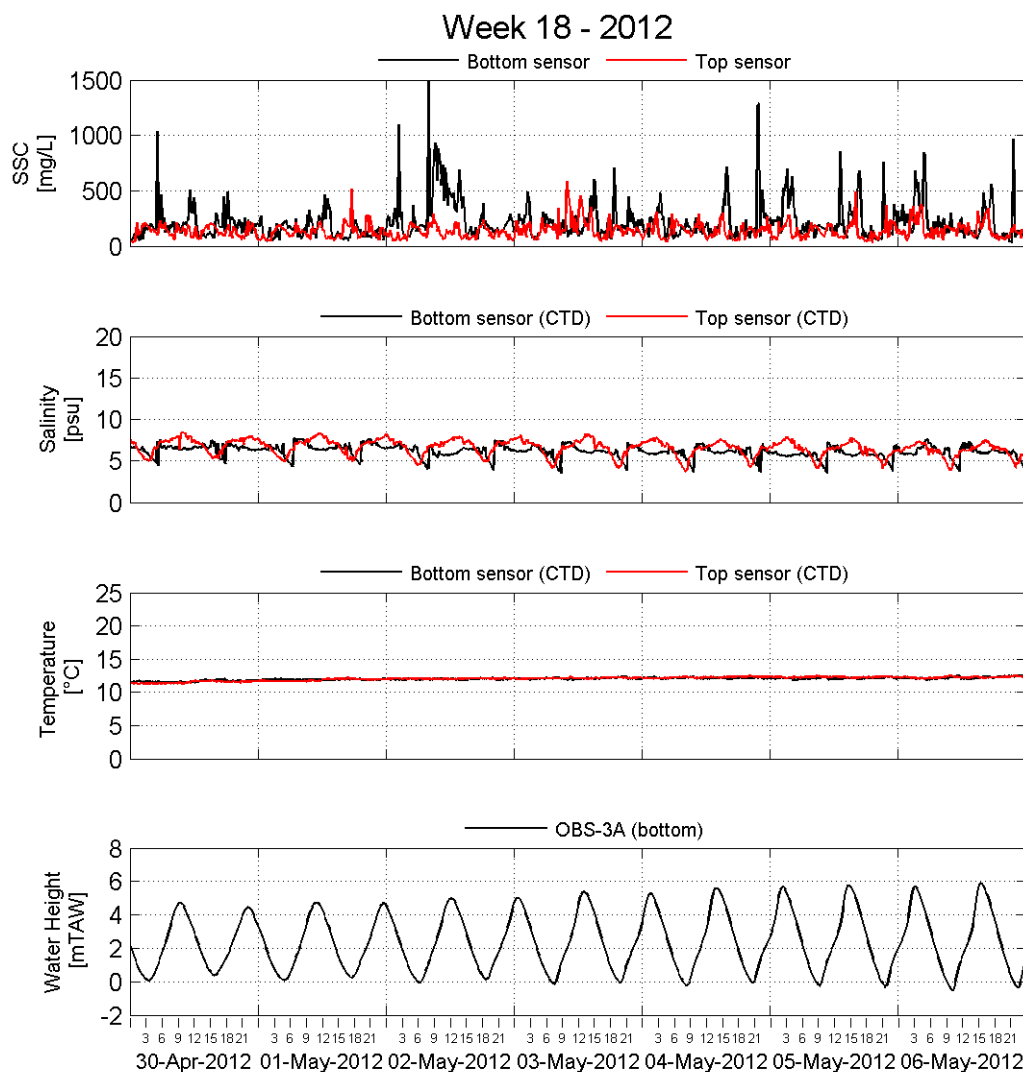
Deurganckdok PSA

Processed by:



I/RA/11354/10.112/MBO/ANF

11354 - Evaluation external effects Deurganckdok



Week series of Suspended Sediment Concentration,
Salinity, Temperature and Water Height

Location:

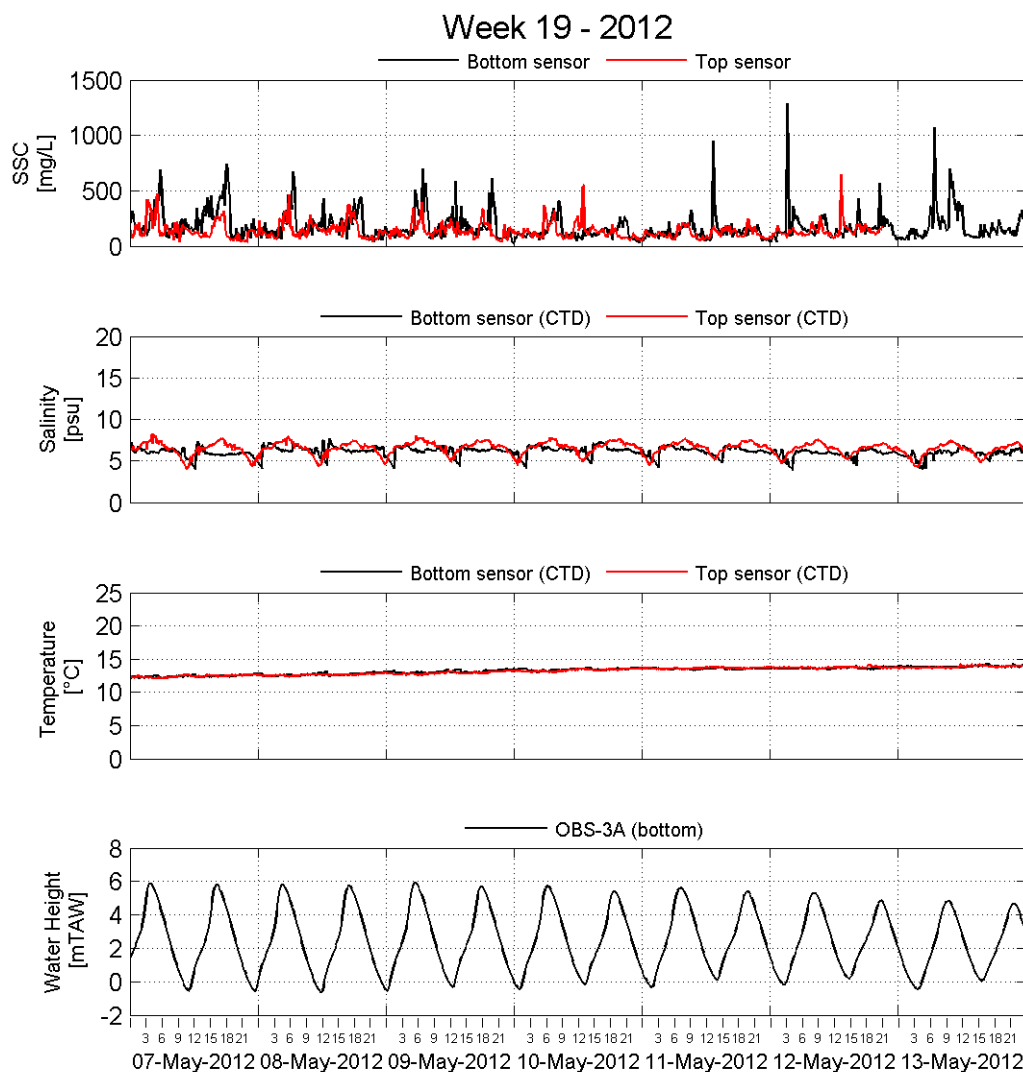
Deurganckdok PSA

Processed by:



I/RA/11354/10.112/MBO/ANF

11354 - Evaluation external effects Deurganckdok



Week series of Suspended Sediment Concentration,
Salinity, Temperature and Water Height

Location:

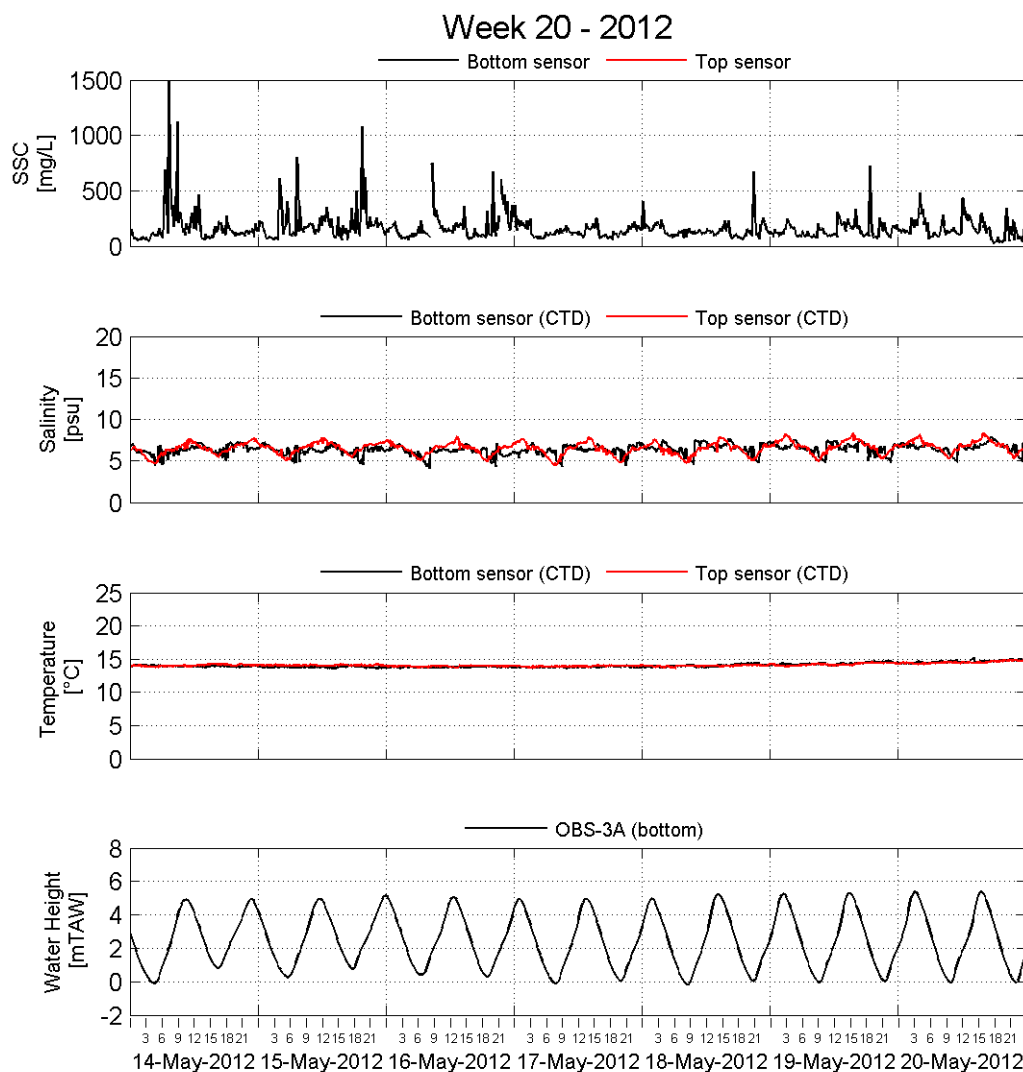
Deurganckdok PSA

Processed by:



I/RA/11354/10.112/MBO/ANF

11354 - Evaluation external effects Deurganckdok



Week series of Suspended Sediment Concentration,
Salinity, Temperature and Water Height

Location:

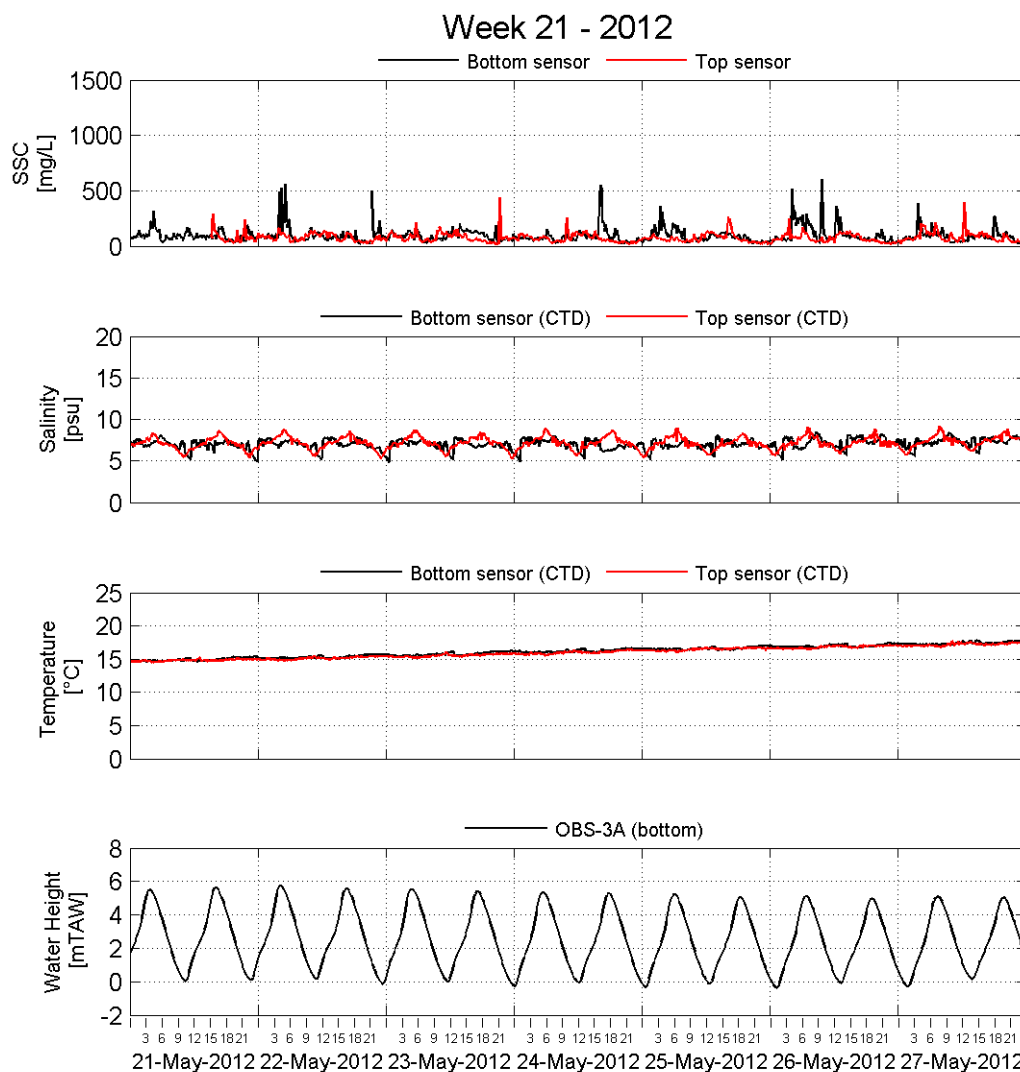
Deurganckdok PSA

Processed by:



I/RA/11354/10.112/MBO/ANF

11354 - Evaluation external effects Deurganckdok



Week series of Suspended Sediment Concentration,
Salinity, Temperature and Water Height

Location:

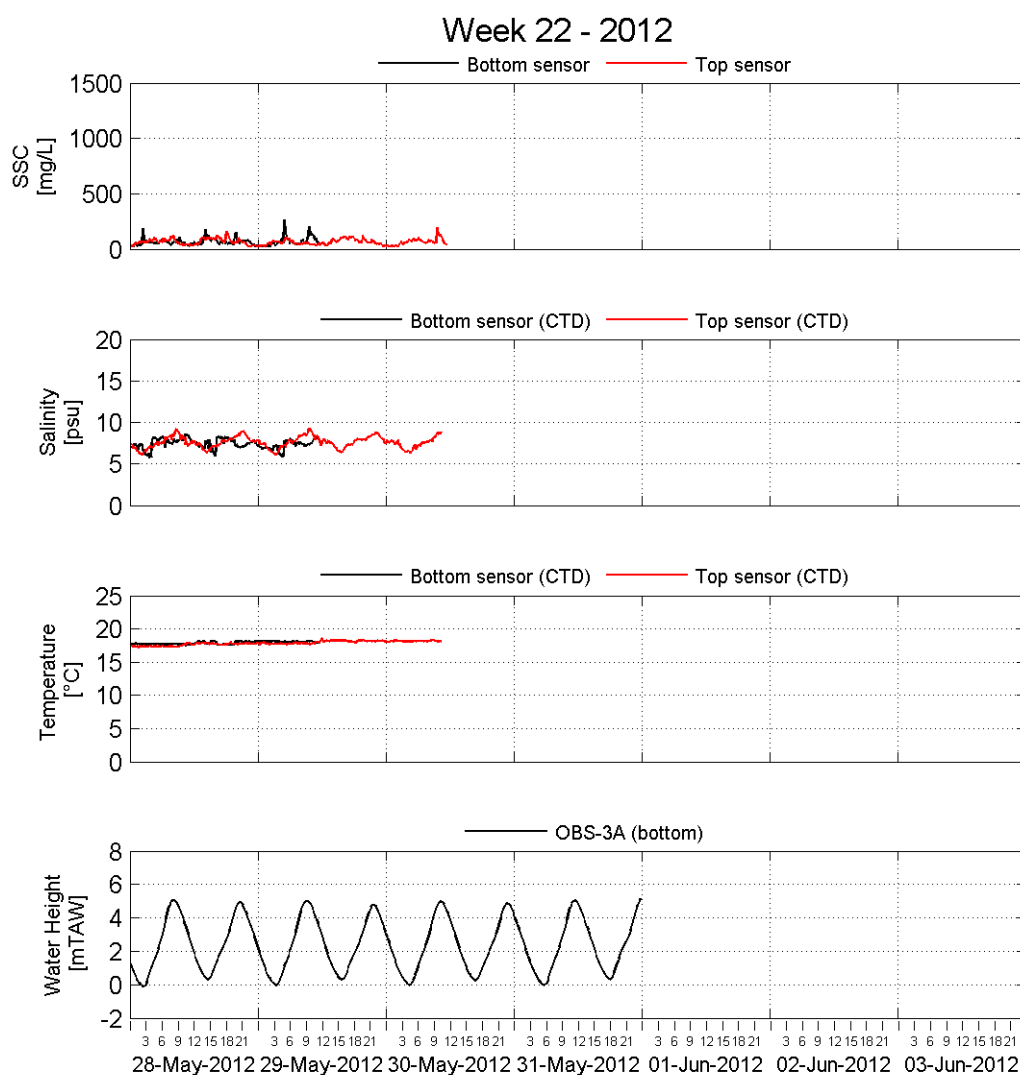
Deurganckdok PSA

Processed by:



I/RA/11354/10.112/MBO/ANF

11354 - Evaluation external effects Deurganckdok



Week series of Suspended Sediment Concentration,
Salinity, Temperature and Water Height

Location:

Deurganckdok PSA

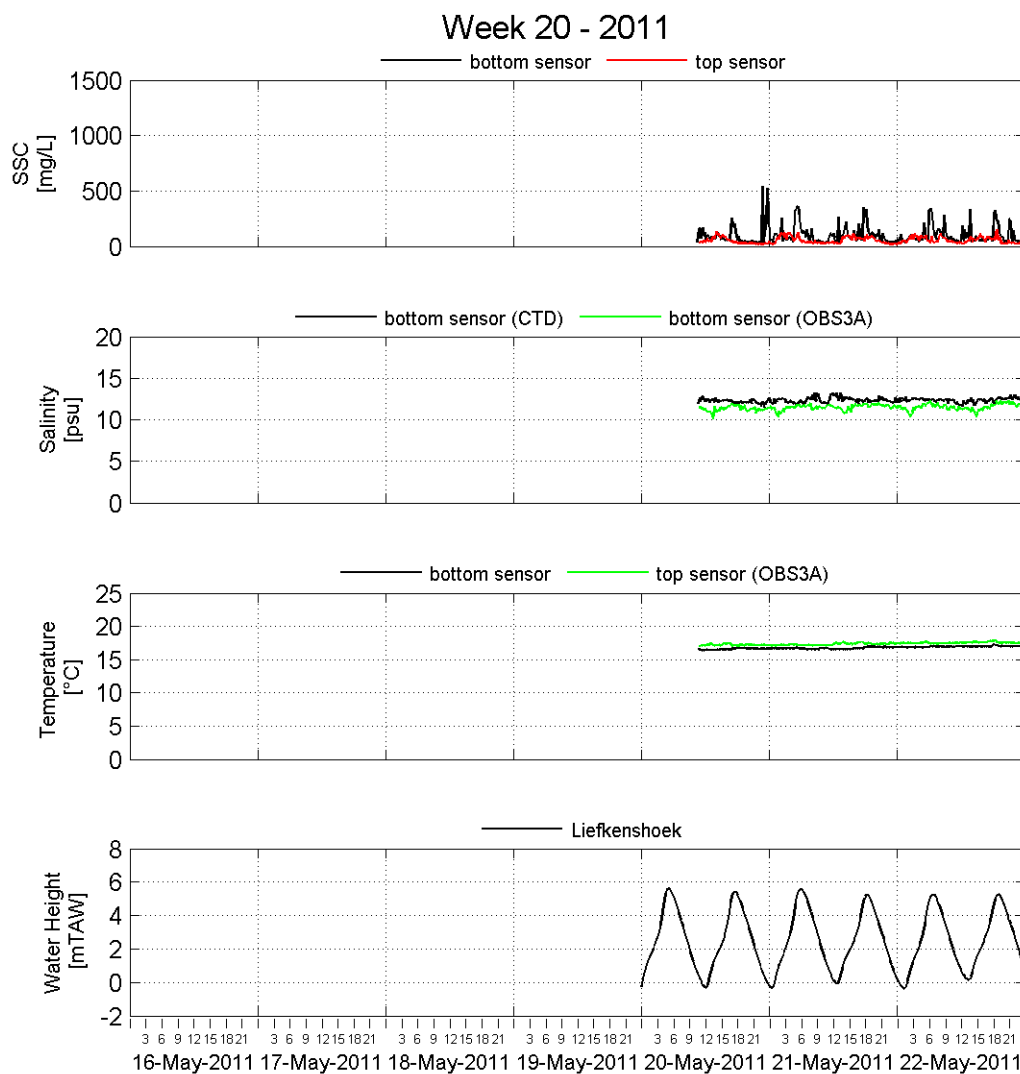
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I/RA/11354/10.112/MBO/ANF

B.2 S-Entrance (DPW)

11354 - Evaluation external effects Deurganckdok



Week series of Suspended Sediment Concentration,
Salinity, Temperature and Water Level

Processed by:



In Association with:

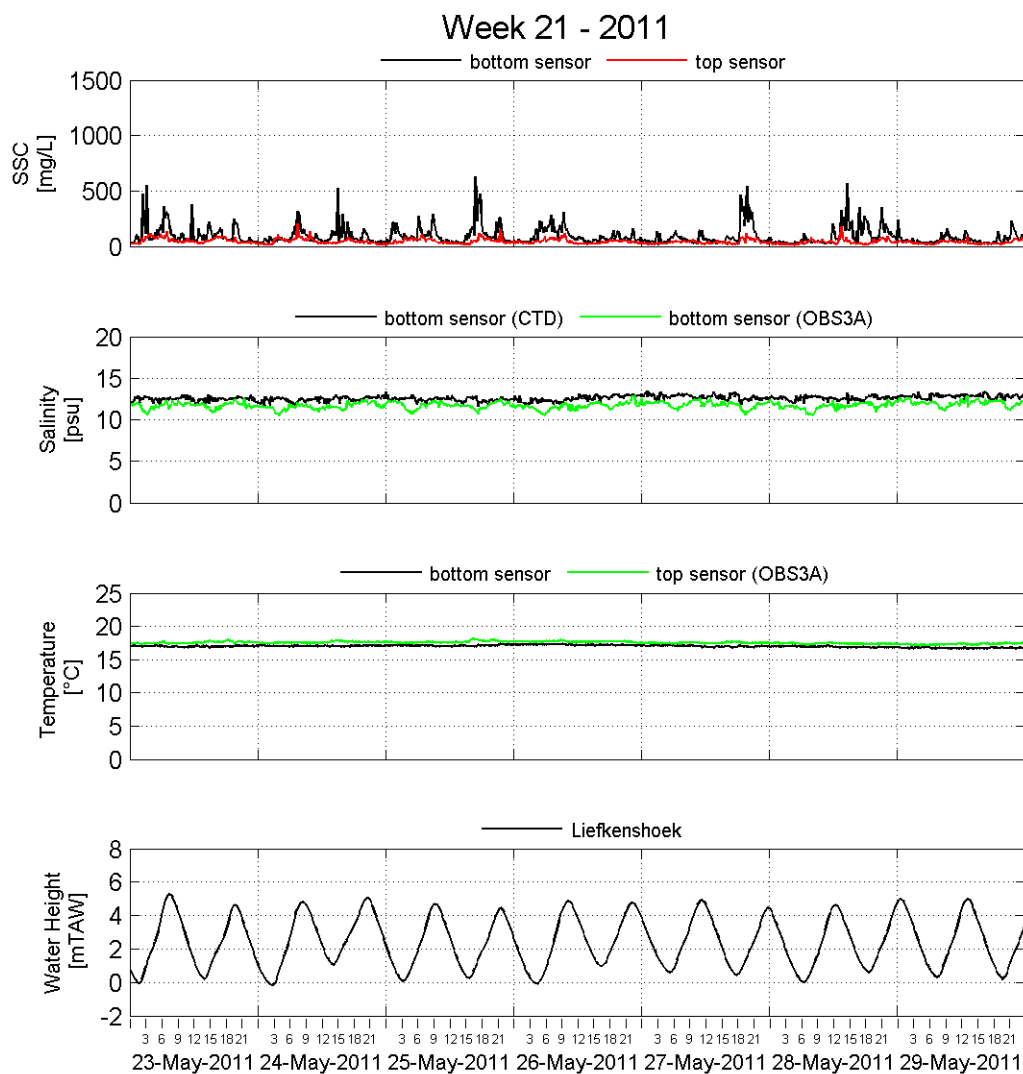


Location:

Deurganckdok DPW

I/RA/11354/10.112/MBO/ANF

11354 - Evaluation external effects Deurganckdok



Week series of Suspended Sediment Concentration,
Salinity, Temperature and Water Level

Location:

Deurganckdok DPW

Processed by:

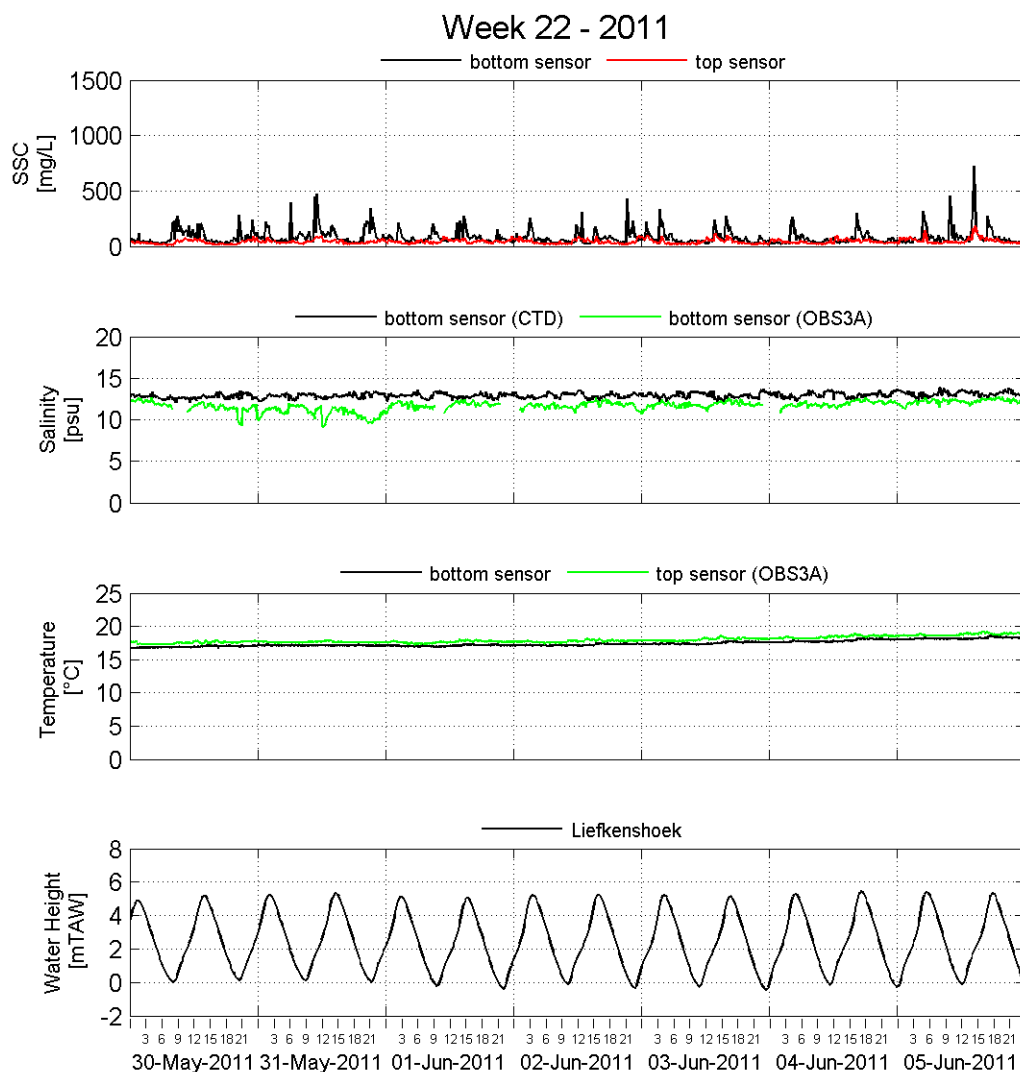


In Association with:



I/RA/11354/10.112/MBO/ANF

11354 - Evaluation external effects Deurganckdok



Week series of Suspended Sediment Concentration,
Salinity, Temperature and Water Level

Location:

Deurganckdok DPW

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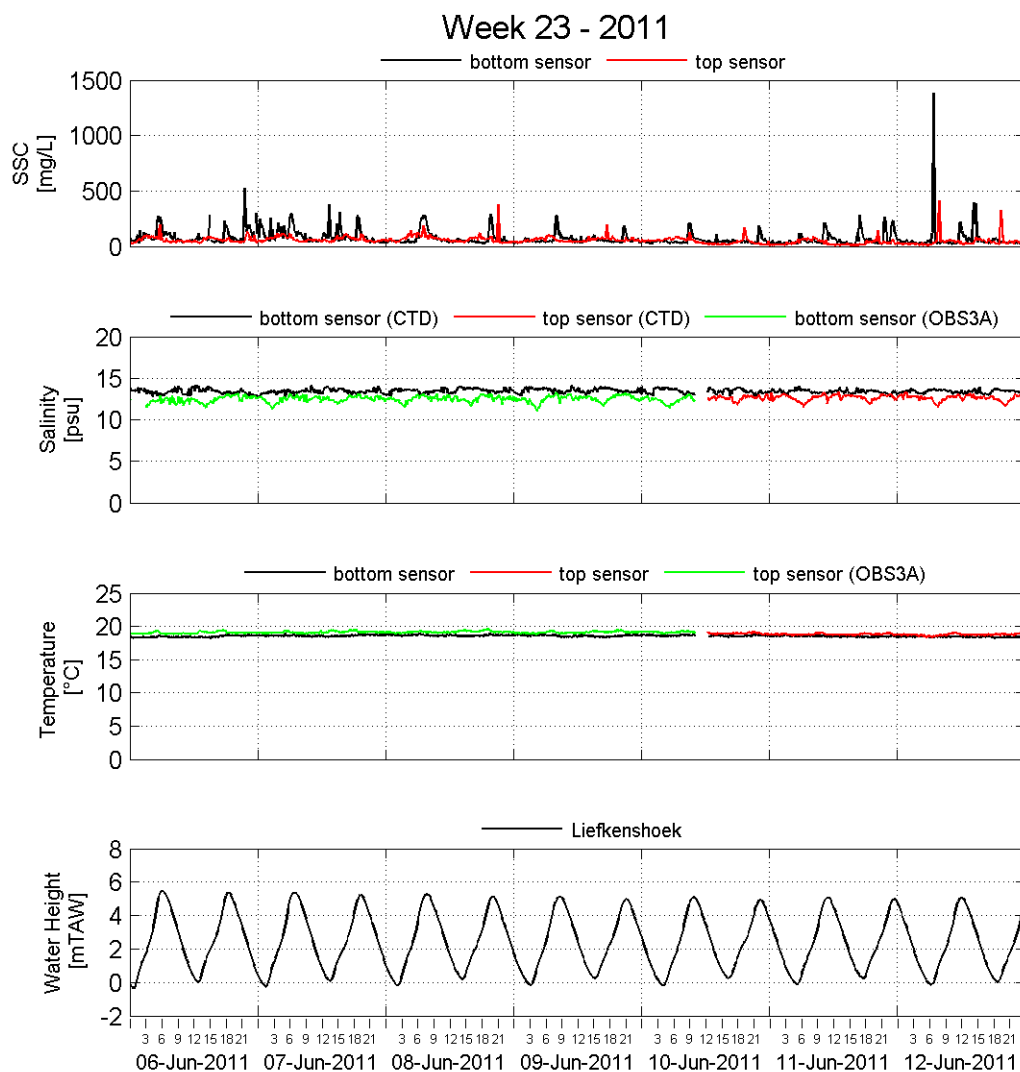


In Association with:



I/RA/11354/10.112/MBO/ANF

11354 - Evaluation external effects Deurganckdok



Week series of Suspended Sediment Concentration,
Salinity, Temperature and Water Level

Location:

Deurganckdok DPW

Processed by:

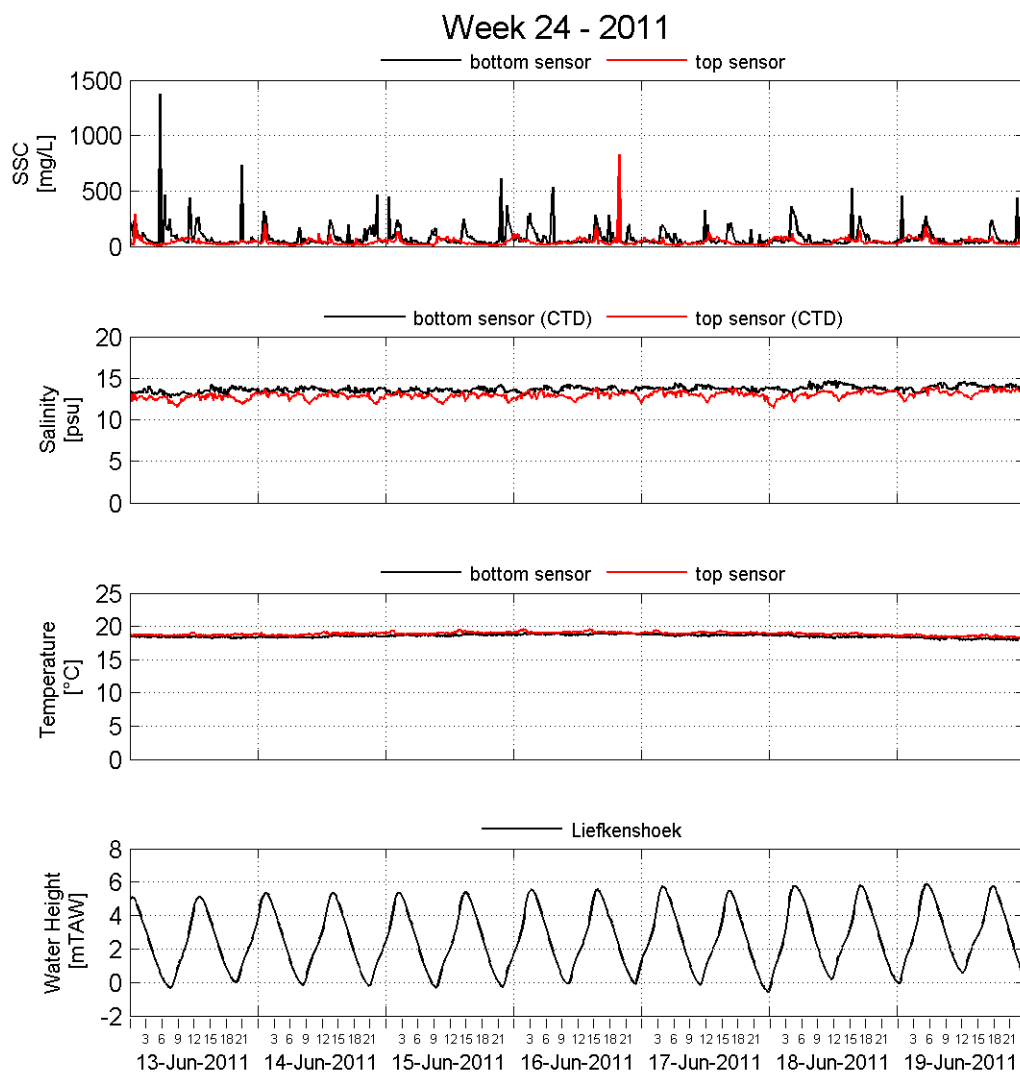


In Association with:



I/RA/11354/10.112/MBO/ANF

11354 - Evaluation external effects Deurganckdok



Week series of Suspended Sediment Concentration,
Salinity, Temperature and Water Level

Location:

Deurganckdok DPW

Processed by:

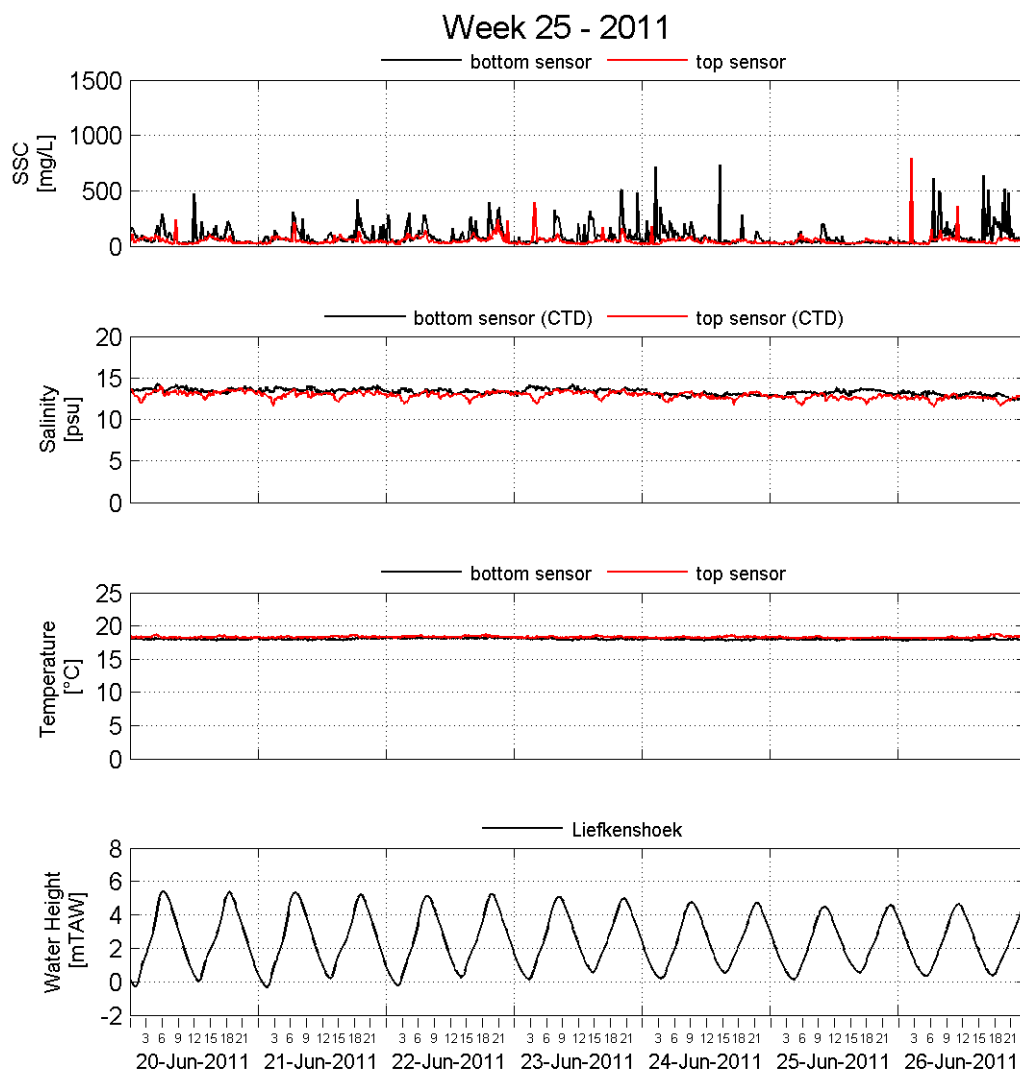


In Association with:



I/RA/11354/10.112/MBO/ANF

11354 - Evaluation external effects Deurganckdok



Week series of Suspended Sediment Concentration,
Salinity, Temperature and Water Level

Location:

Deurganckdok DPW

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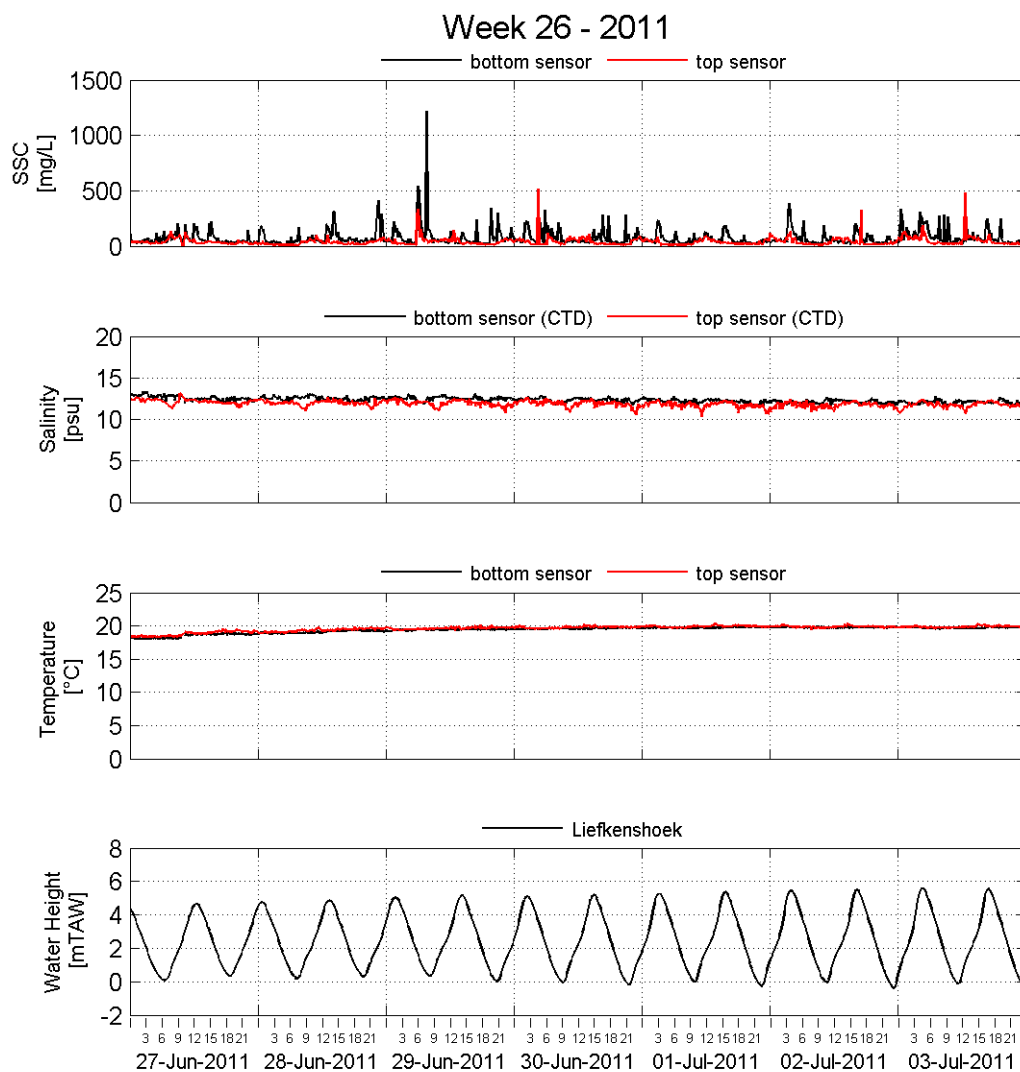


In Association with:



I/RA/11354/10.112/MBO/ANF

11354 - Evaluation external effects Deurganckdok



Week series of Suspended Sediment Concentration,
Salinity, Temperature and Water Level

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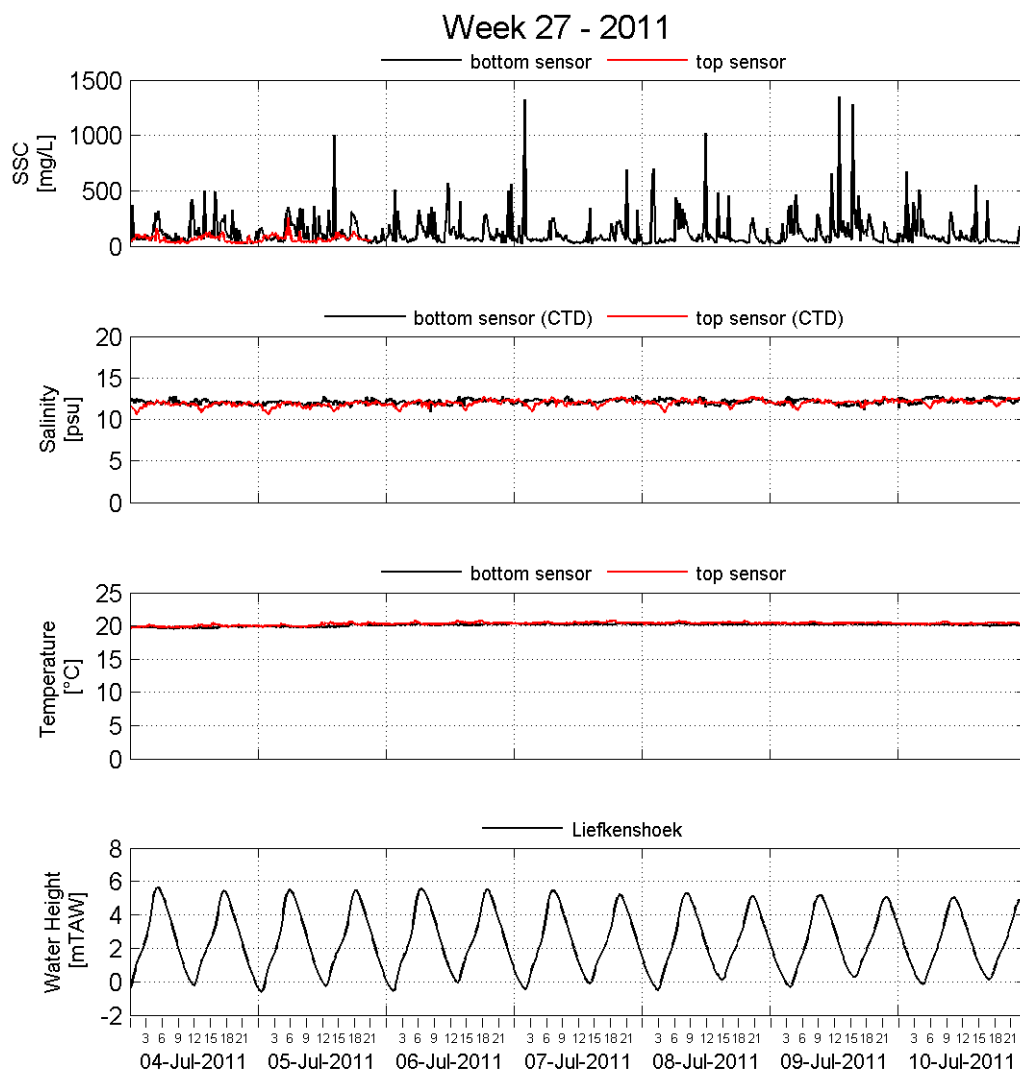


Location:

Deurganckdok DPW

I/RA/11354/10.112/MBO/ANF

11354 - Evaluation external effects Deurganckdok



Week series of Suspended Sediment Concentration,
Salinity, Temperature and Water Level

Location:

Deurganckdok DPW

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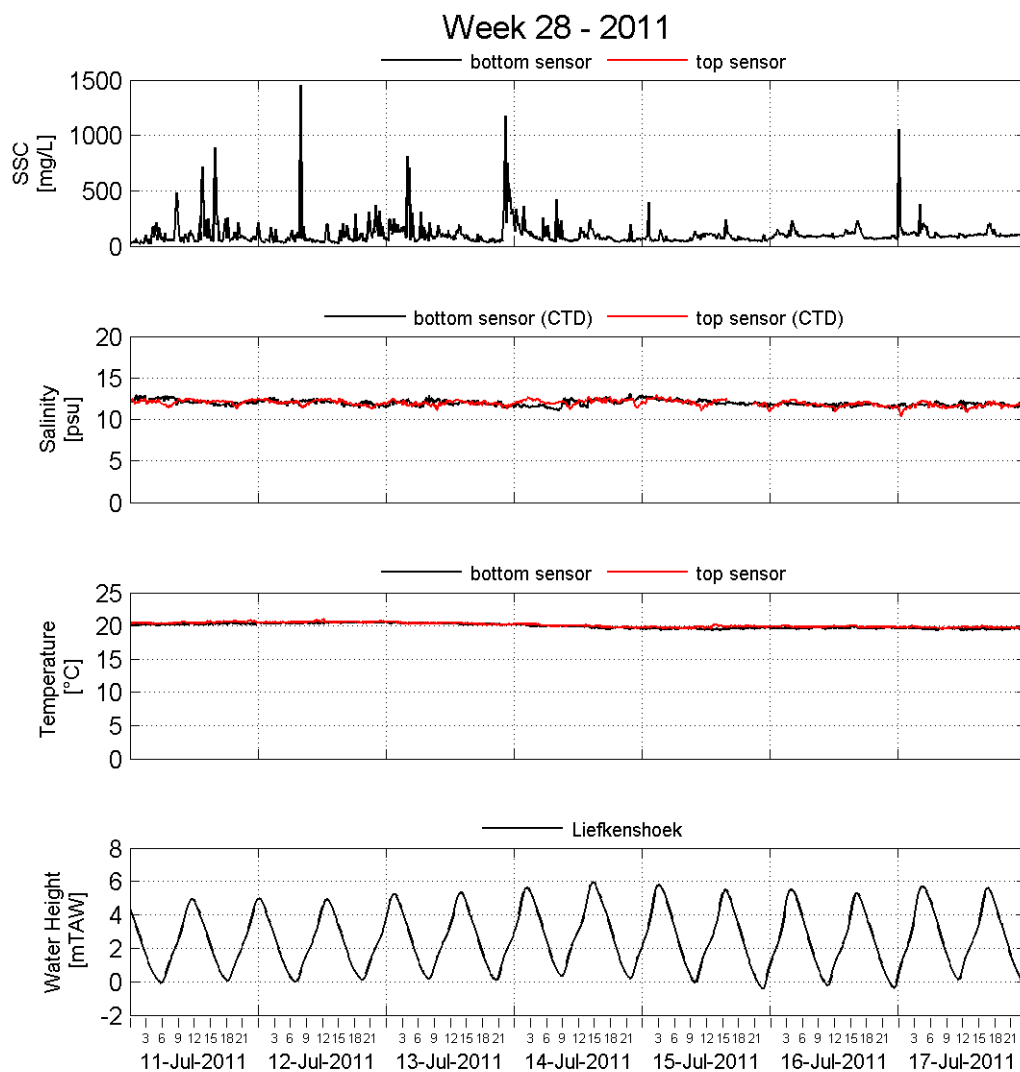


In Association with:



I/RA/11354/10.112/MBO/ANF

11354 - Evaluation external effects Deurganckdok



Week series of Suspended Sediment Concentration,
Salinity, Temperature and Water Level

Processed by:



In Association with:

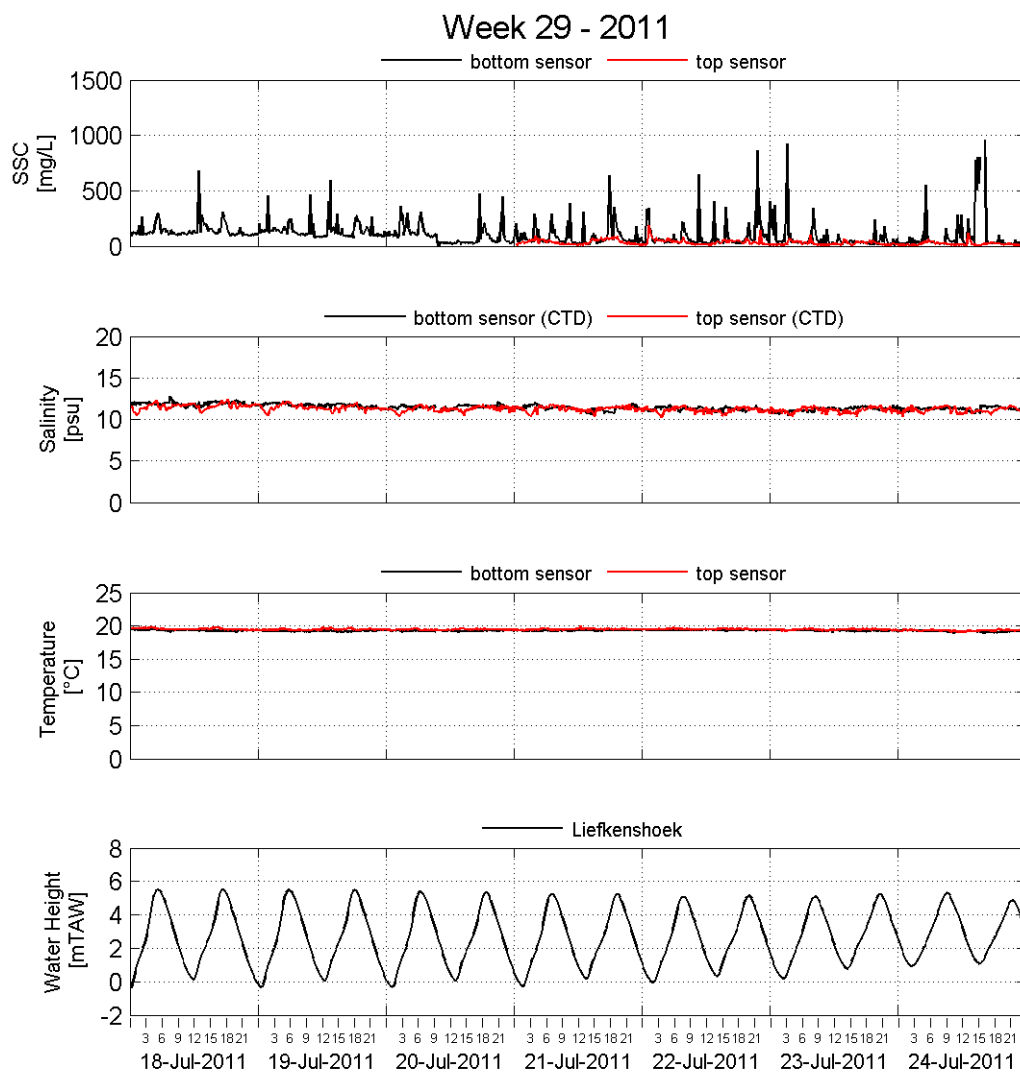


Location:

Deurganckdok DPW

I/RA/11354/10.112/MBO/ANF

11354 - Evaluation external effects Deurganckdok



Week series of Suspended Sediment Concentration,
Salinity, Temperature and Water Level

Processed by:



In Association with:

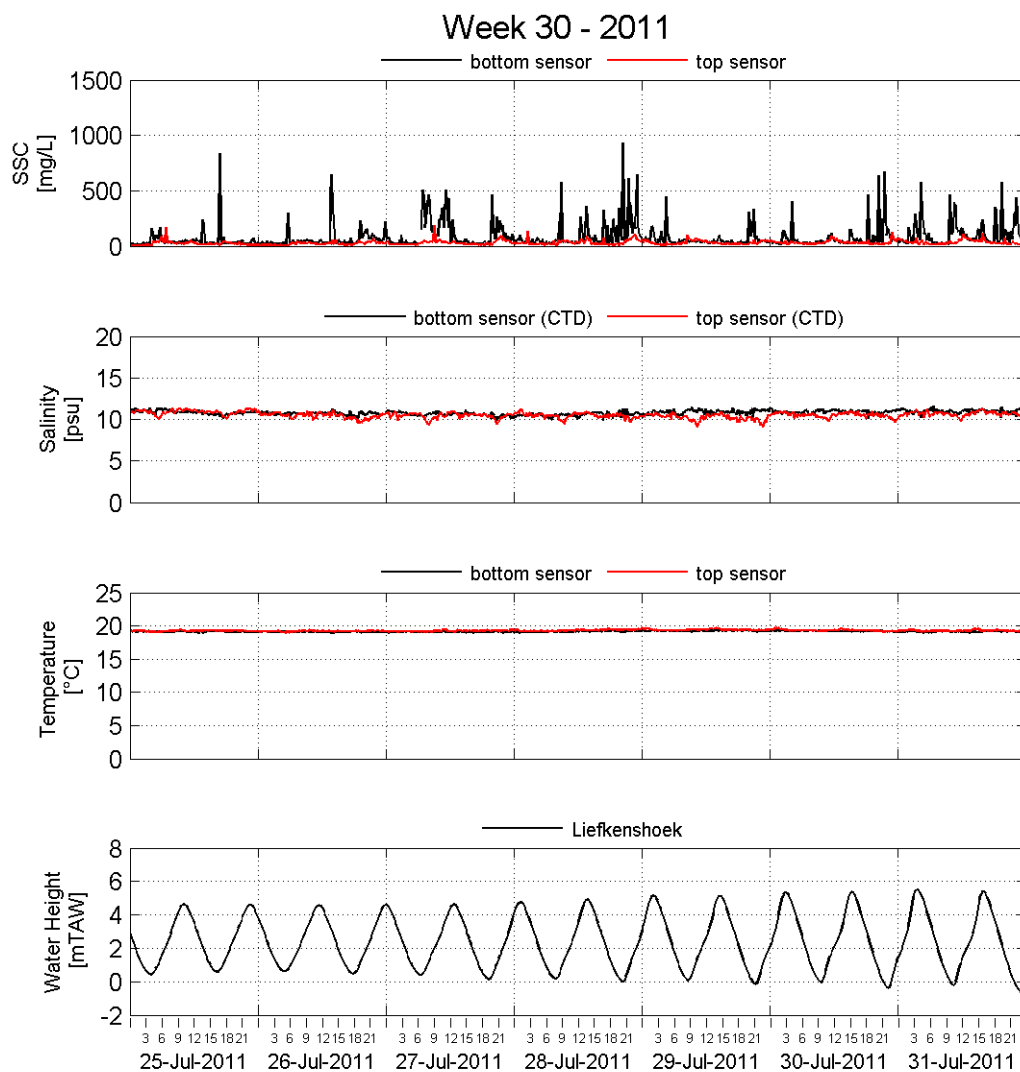


Location:

Deurganckdok DPW

I/RA/11354/10.112/MBO/ANF

11354 - Evaluation external effects Deurganckdok



Week series of Suspended Sediment Concentration,
Salinity, Temperature and Water Level

Processed by:



In Association with:

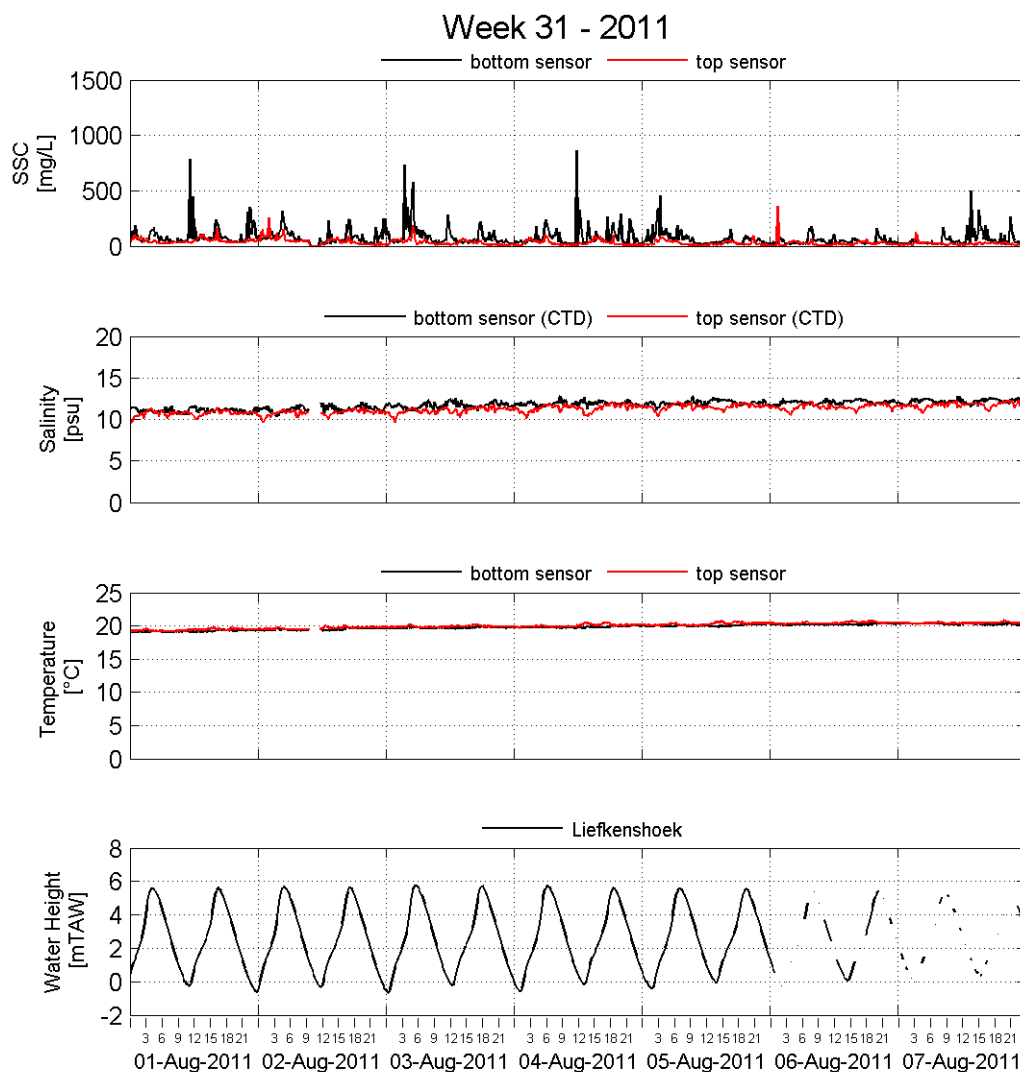


Location:

Deurganckdok DPW

I/RA/11354/10.112/MBO/ANF

11354 - Evaluation external effects Deurganckdok



Week series of Suspended Sediment Concentration,
Salinity, Temperature and Water Level

Location:

Deurganckdok DPW

Processed by:

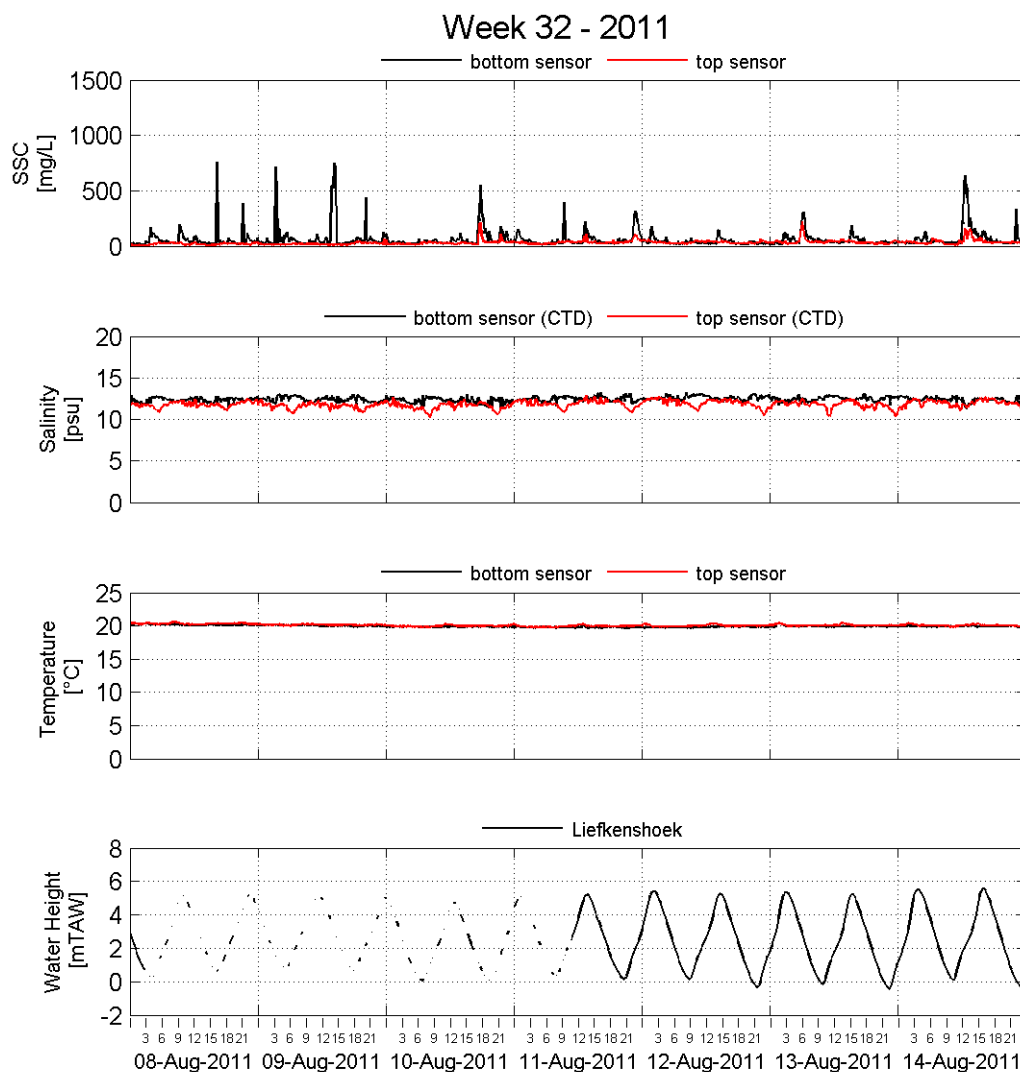


In Association with:



I/RA/11354/10.112/MBO/ANF

11354 - Evaluation external effects Deurganckdok



Week series of Suspended Sediment Concentration,
Salinity, Temperature and Water Level

Processed by:



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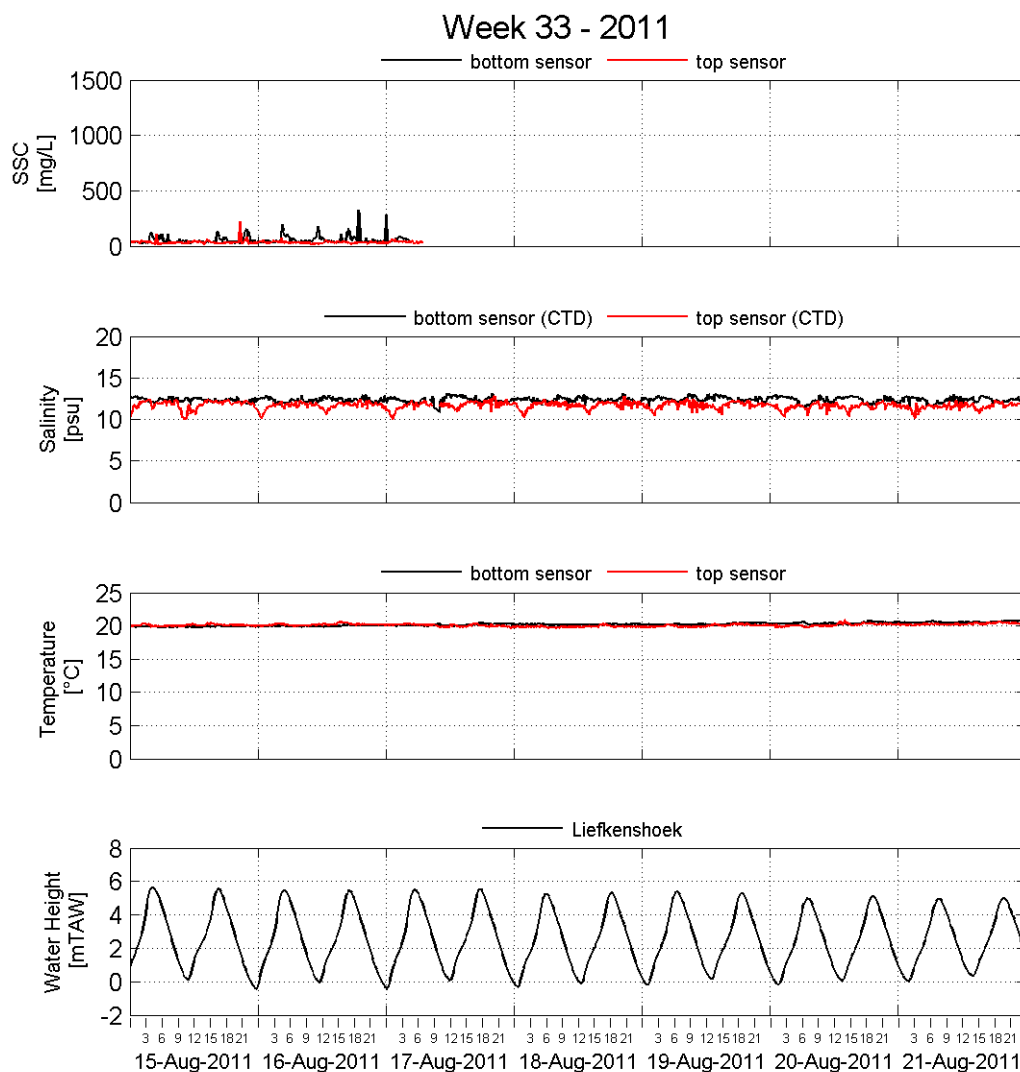


Location:

Deurganckdok DPW

I/RA/11354/10.112/MBO/ANF

11354 - Evaluation external effects Deurganckdok



Week series of Suspended Sediment Concentration,
Salinity, Temperature and Water Level

Location:

Deurganckdok DPW

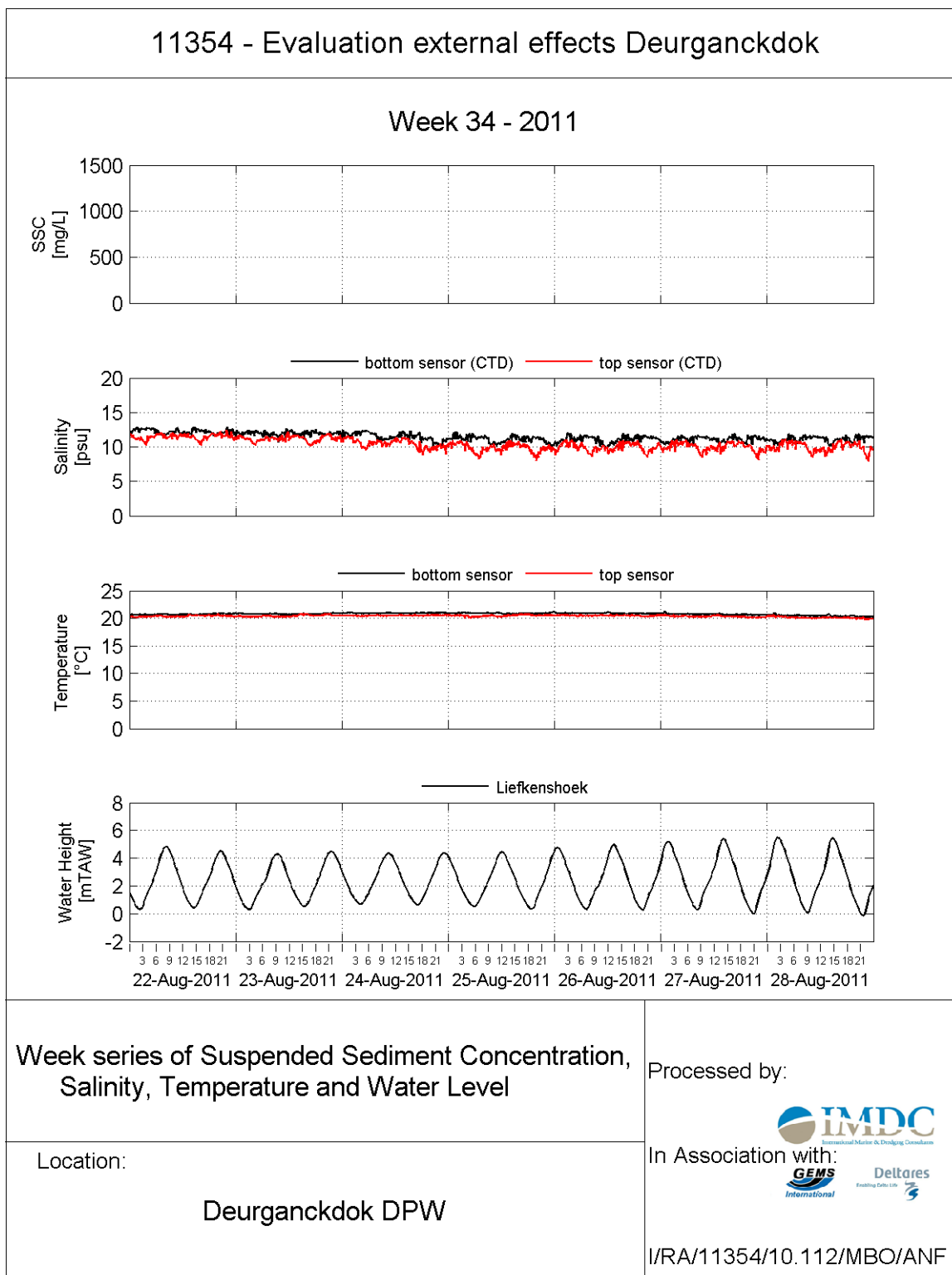
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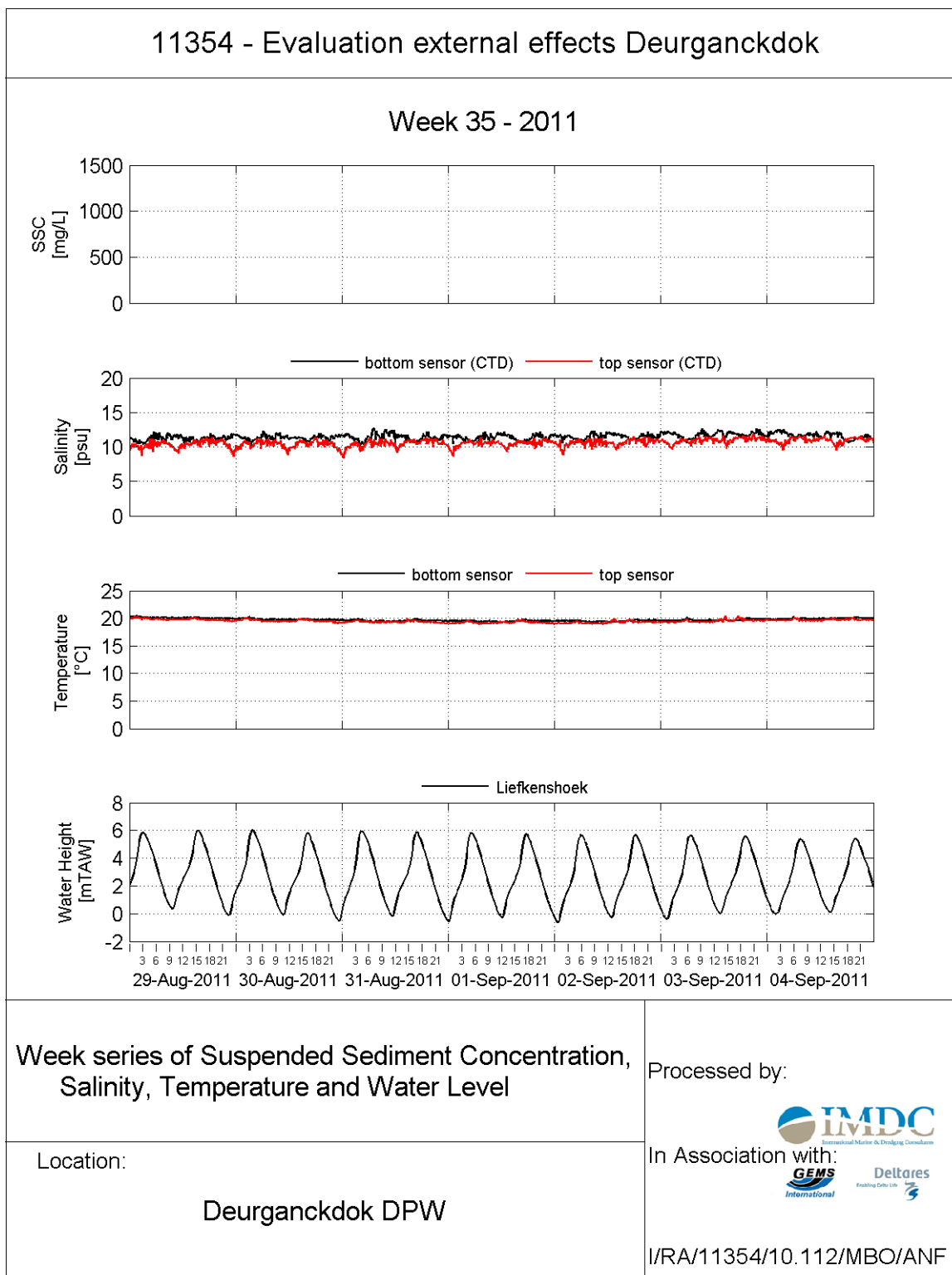


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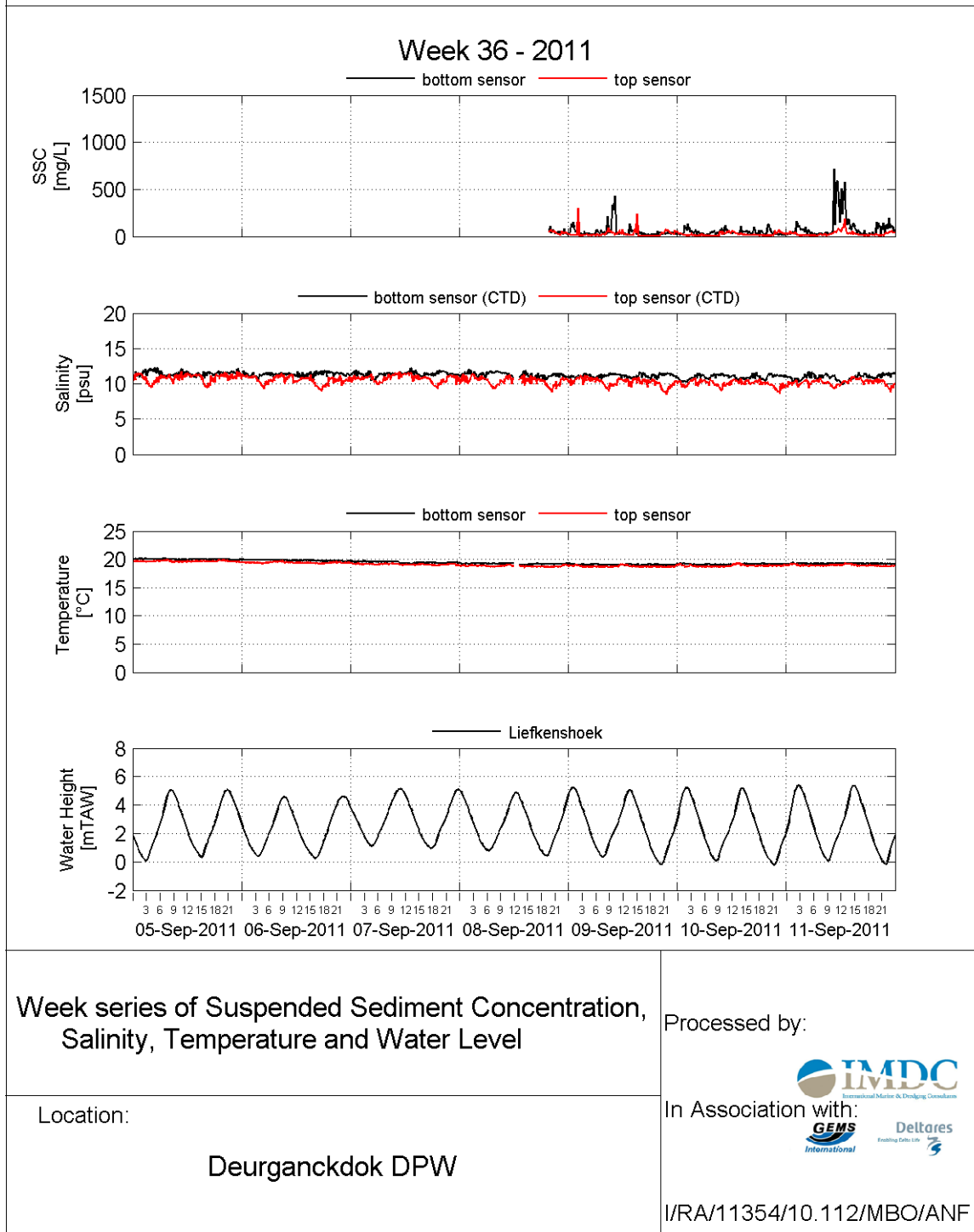


I/RA/11354/10.112/MBO/ANF

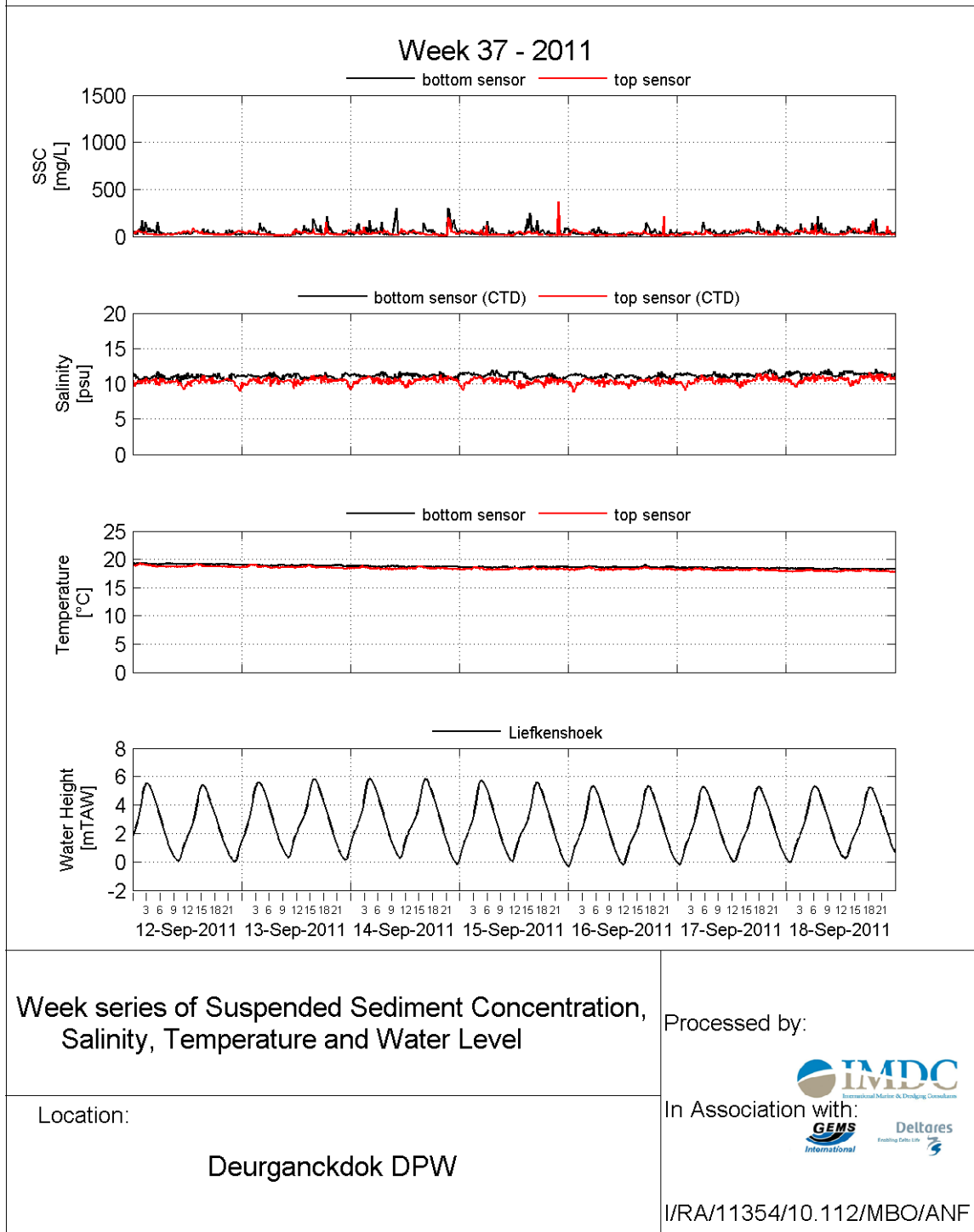




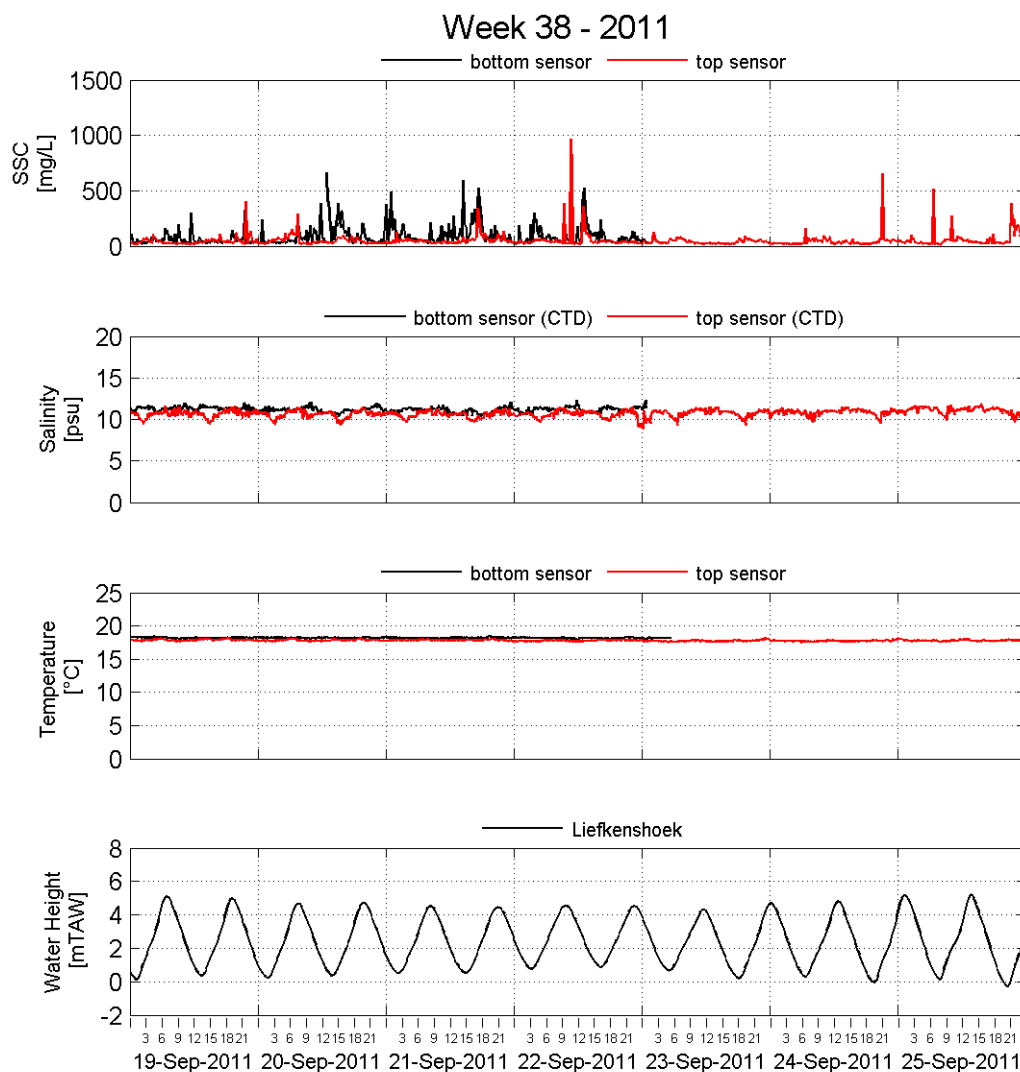
11354 - Evaluation external effects Deurganckdok



11354 - Evaluation external effects Deurganckdok



11354 - Evaluation external effects Deurganckdok



Week series of Suspended Sediment Concentration,
Salinity, Temperature and Water Level

Processed by:



In Association with:

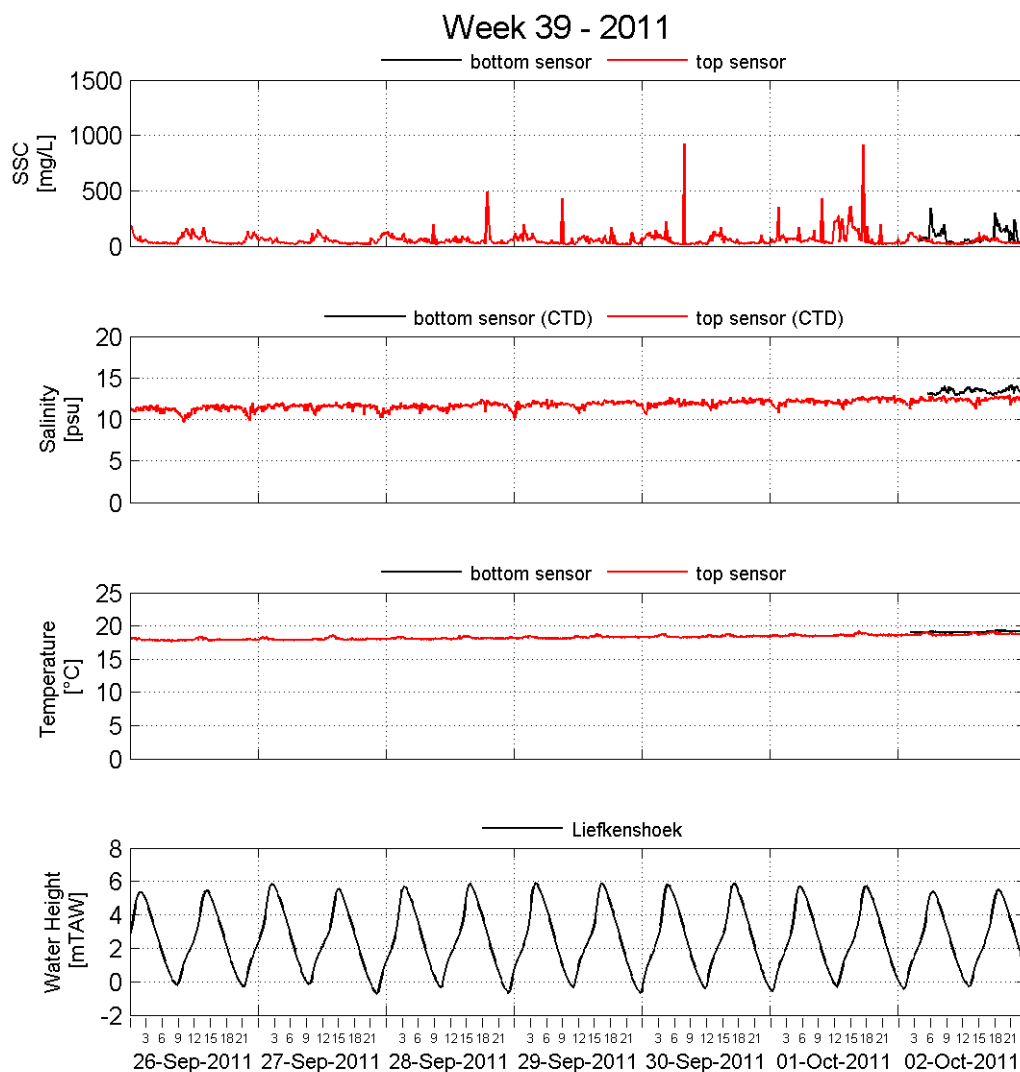


Location:

Deurganckdok DPW

I/RA/11354/10.112/MBO/ANF

11354 - Evaluation external effects Deurganckdok



Week series of Suspended Sediment Concentration,
Salinity, Temperature and Water Level

Processed by:



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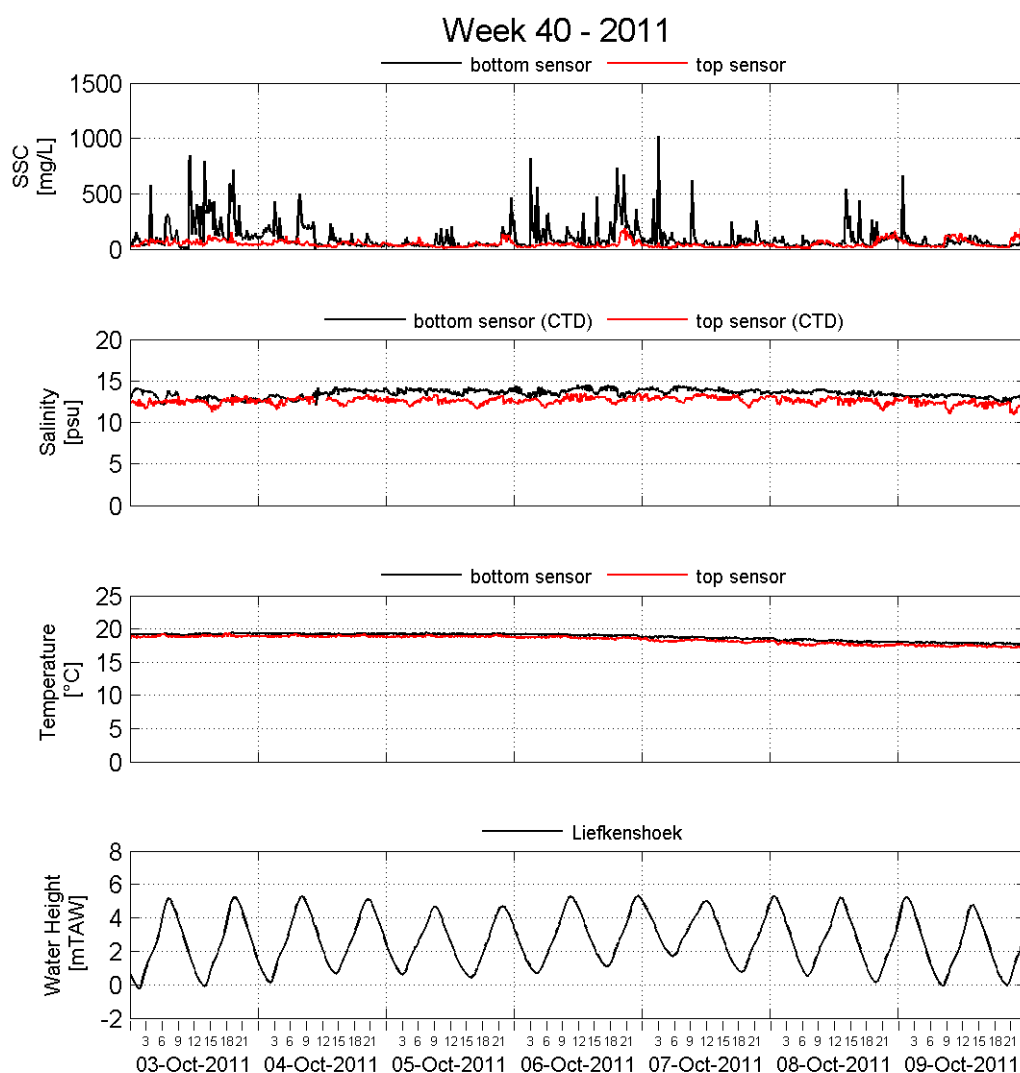


Location:

Deurganckdok DPW

I/RA/11354/10.112/MBO/ANF

11354 - Evaluation external effects Deurganckdok



Week series of Suspended Sediment Concentration,
Salinity, Temperature and Water Level

Location:

Deurganckdok DPW

Processed by:

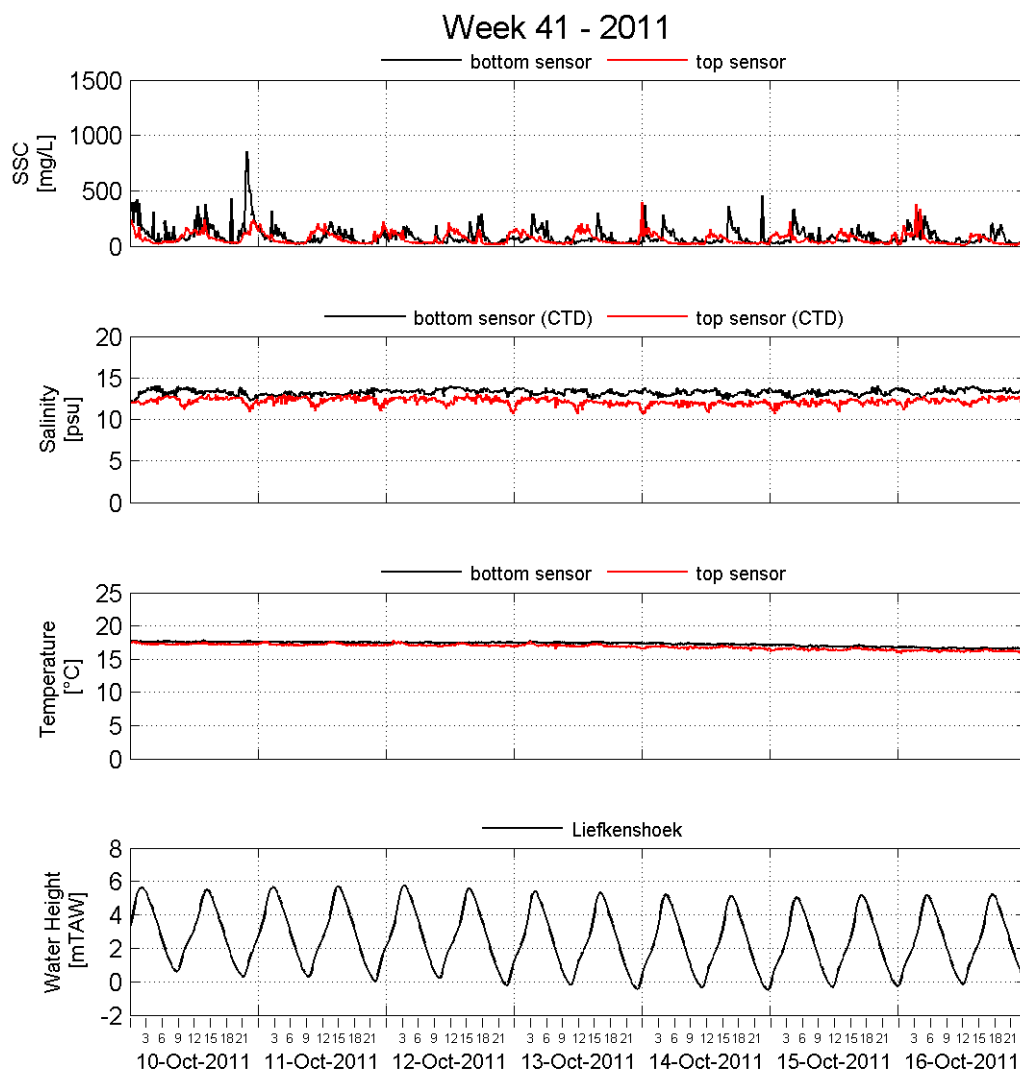


In Association with:



I/RA/11354/10.112/MBO/ANF

11354 - Evaluation external effects Deurganckdok



Week series of Suspended Sediment Concentration,
Salinity, Temperature and Water Level

Processed by:



In Association with:

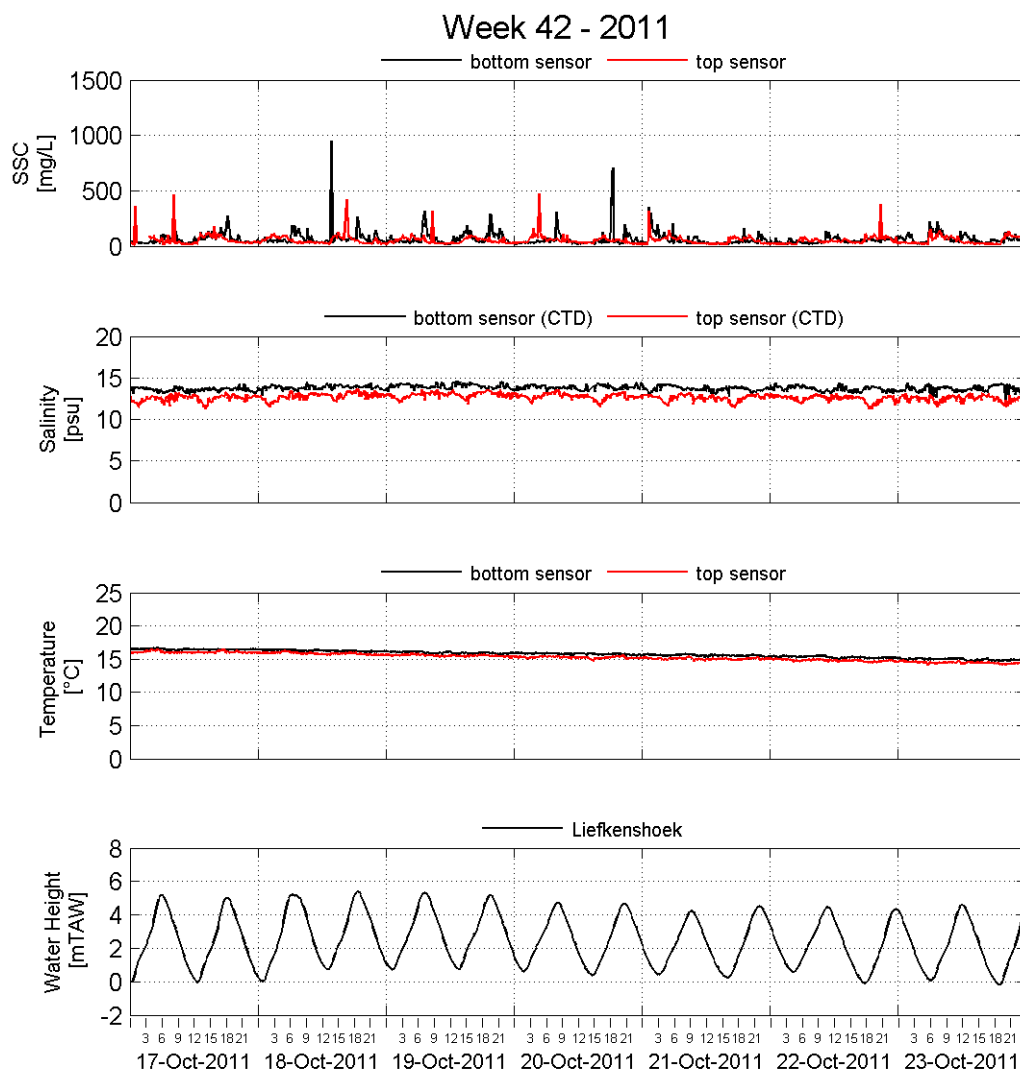


Location:

Deurganckdok DPW

I/RA/11354/10.112/MBO/ANF

11354 - Evaluation external effects Deurganckdok



Week series of Suspended Sediment Concentration,
Salinity, Temperature and Water Level

Processed by:



In Association with:

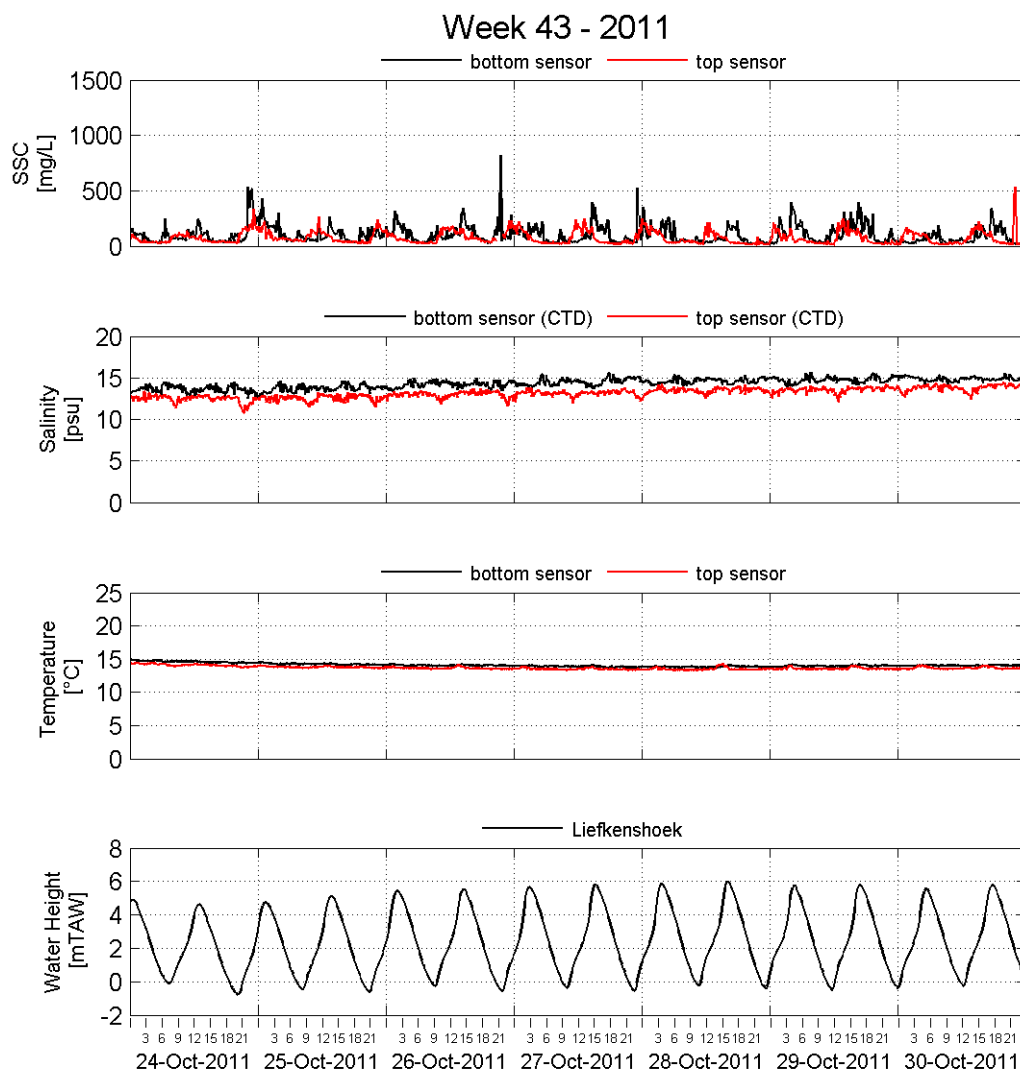


Location:

Deurganckdok DPW

I/RA/11354/10.112/MBO/ANF

11354 - Evaluation external effects Deurganckdok



Week series of Suspended Sediment Concentration,
Salinity, Temperature and Water Level

Processed by:



In Association with:

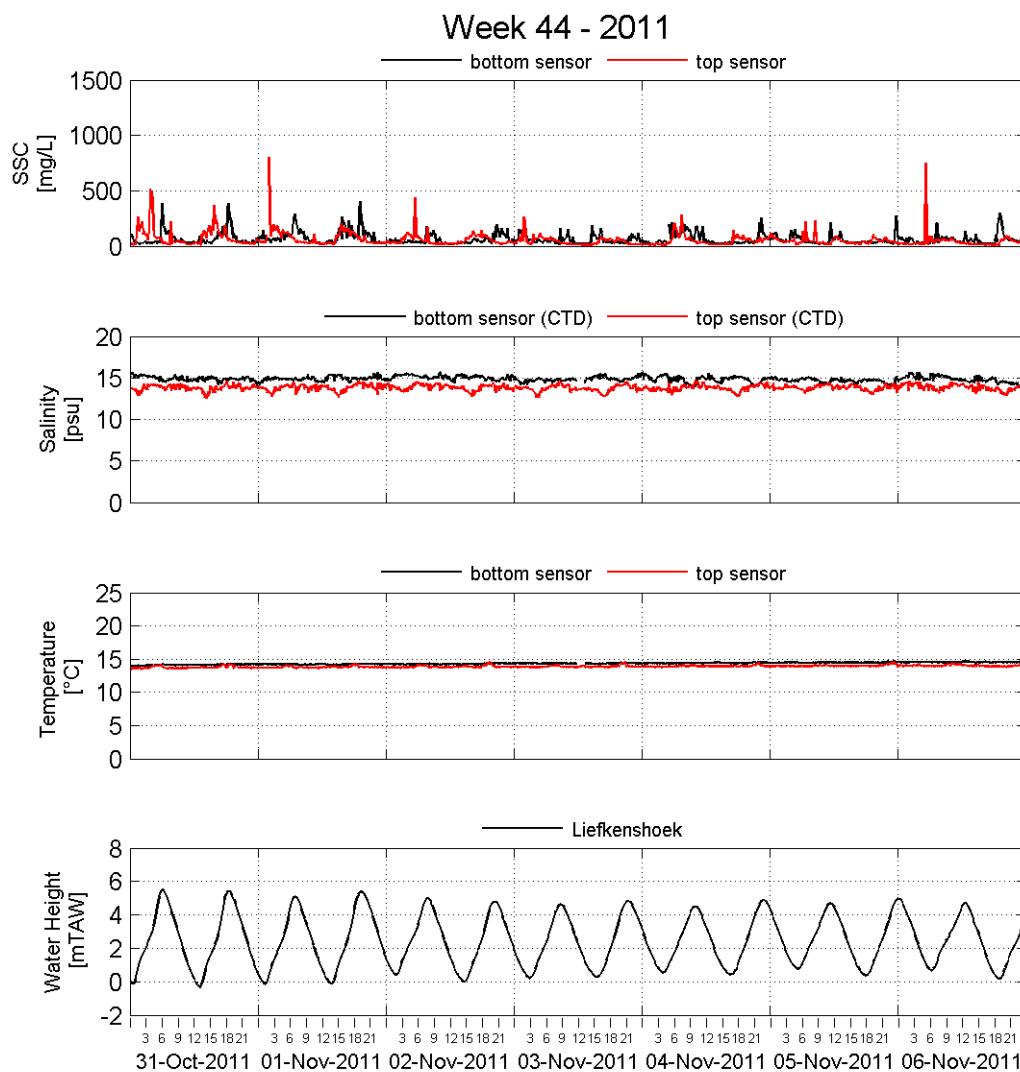


Location:

Deurganckdok DPW

I/RA/11354/10.112/MBO/ANF

11354 - Evaluation external effects Deurganckdok



Week series of Suspended Sediment Concentration,
Salinity, Temperature and Water Level

Location:

Deurganckdok DPW

Processed by:

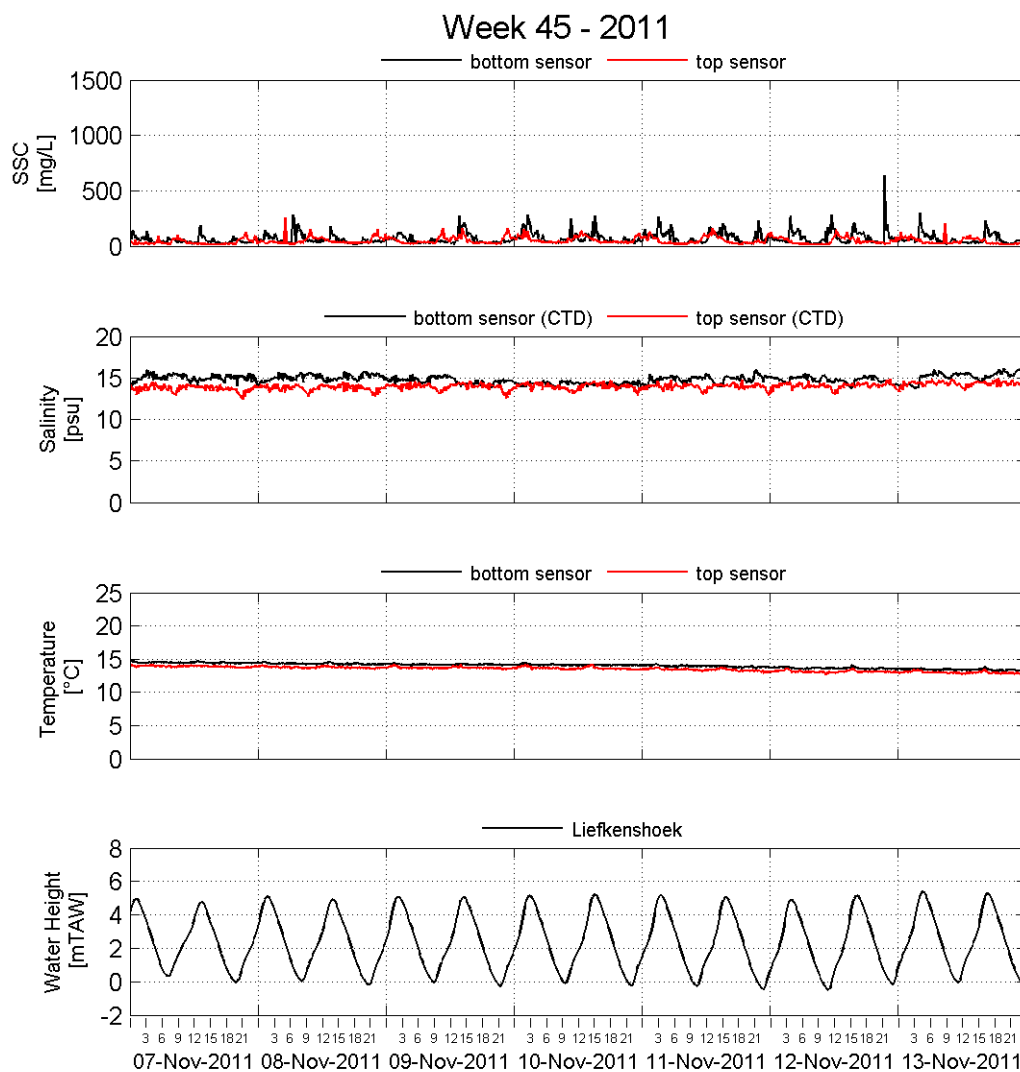


In Association with:



I/RA/11354/10.112/MBO/ANF

11354 - Evaluation external effects Deurganckdok



Week series of Suspended Sediment Concentration,
Salinity, Temperature and Water Level

Location:

Deurganckdok DPW

Processed by:

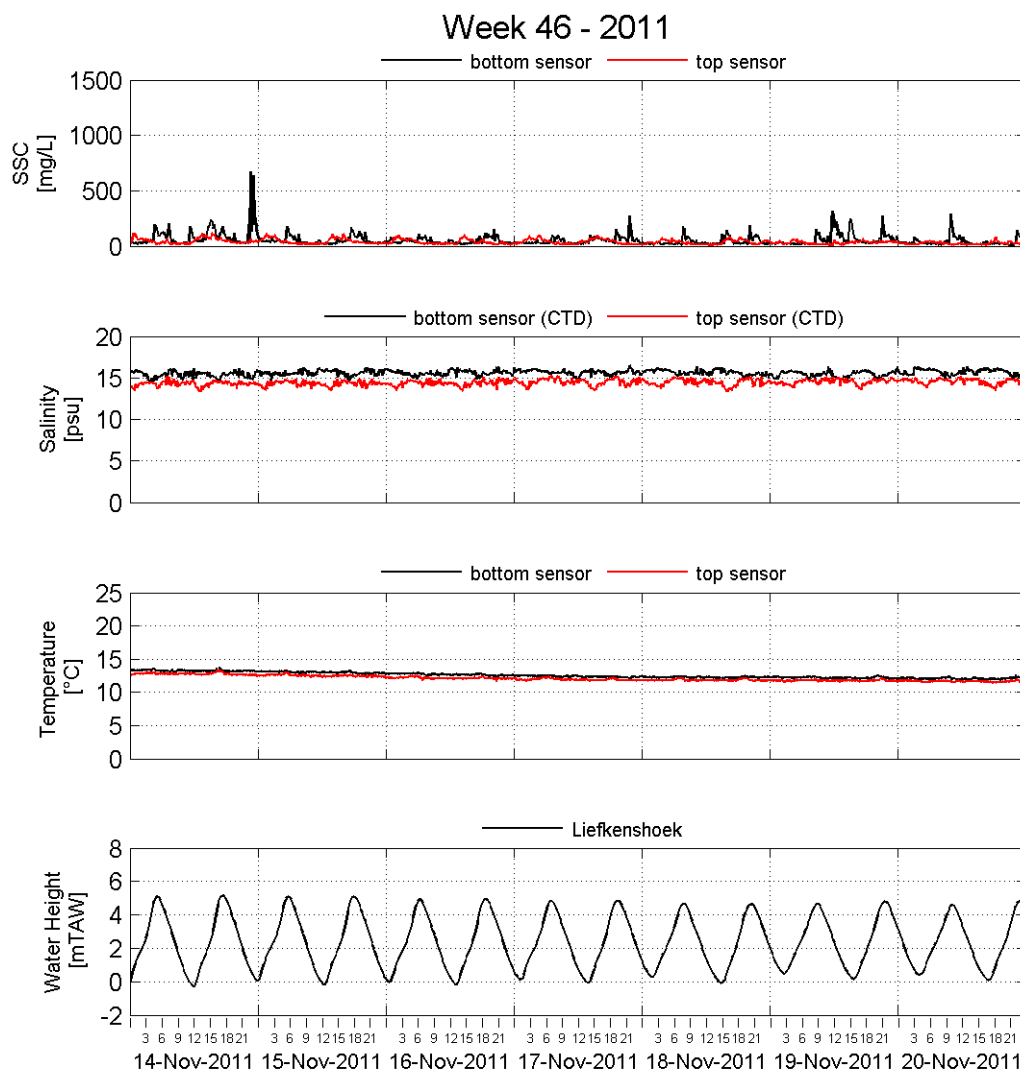


In Association with:



I/RA/11354/10.112/MBO/ANF

11354 - Evaluation external effects Deurganckdok



Week series of Suspended Sediment Concentration,
Salinity, Temperature and Water Level

Processed by:



In Association with:

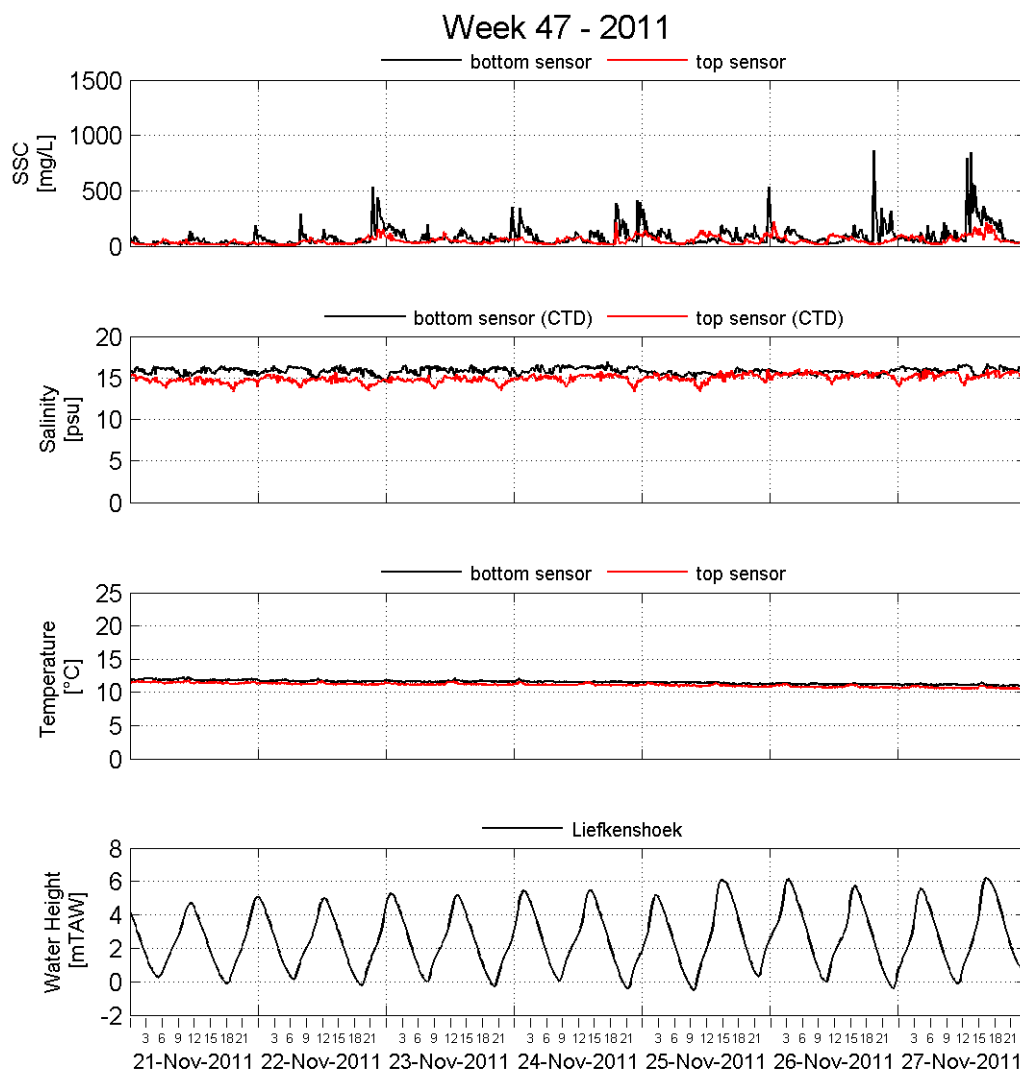


Location:

Deurganckdok DPW

I/RA/11354/10.112/MBO/ANF

11354 - Evaluation external effects Deurganckdok



Week series of Suspended Sediment Concentration,
Salinity, Temperature and Water Level

Location:

Deurganckdok DPW

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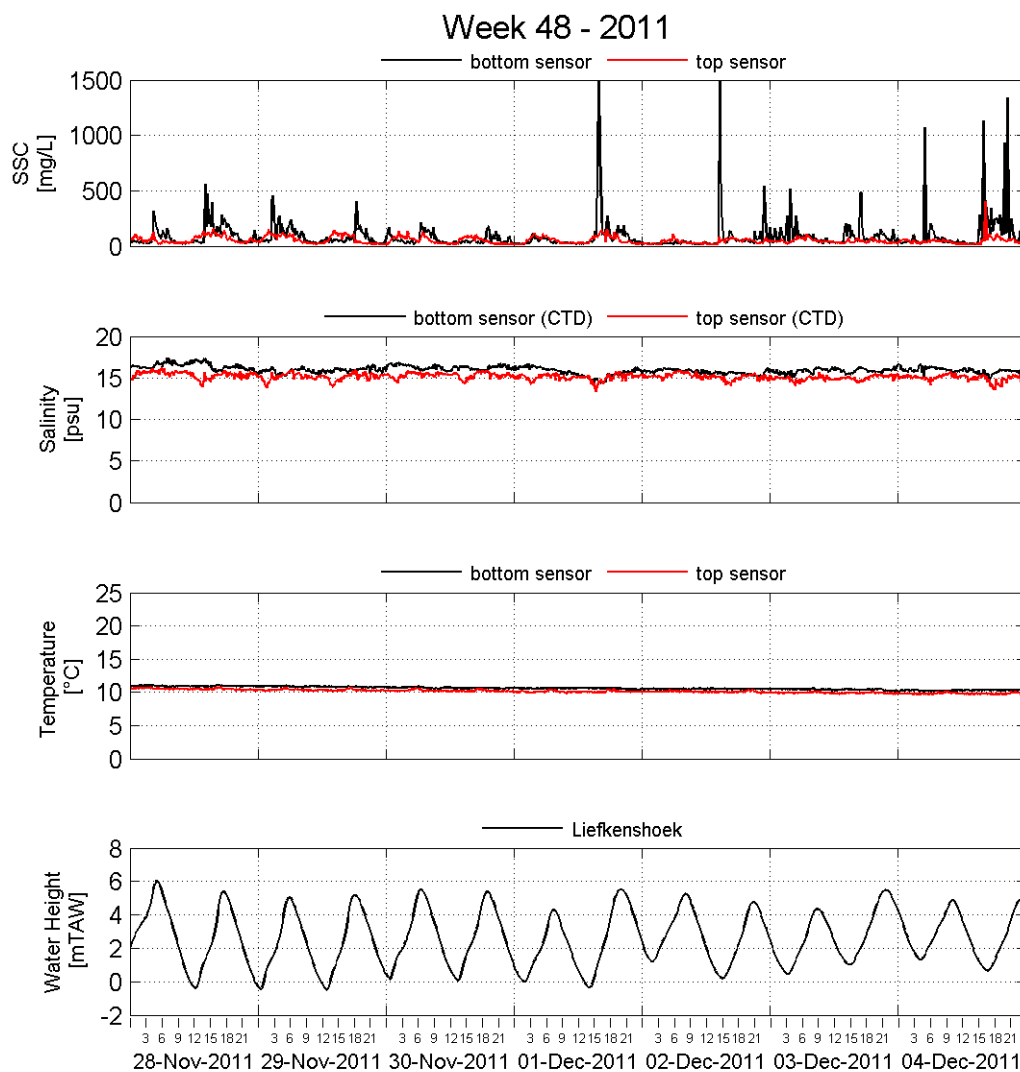


In Association with:



I/RA/11354/10.112/MBO/ANF

11354 - Evaluation external effects Deurganckdok



Week series of Suspended Sediment Concentration,
Salinity, Temperature and Water Level

Location:

Deurganckdok DPW

Processed by:

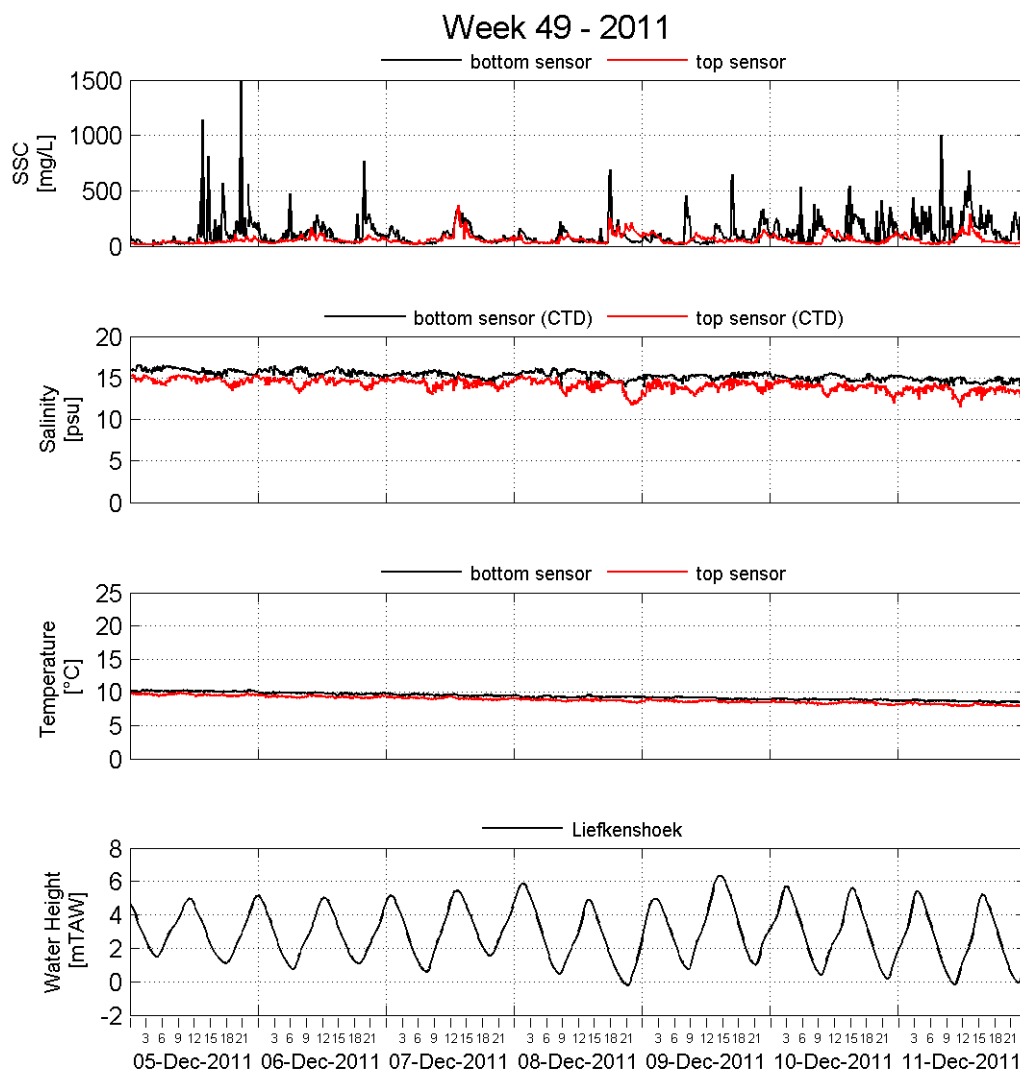


In Association with:



I/RA/11354/10.112/MBO/ANF

11354 - Evaluation external effects Deurganckdok



Week series of Suspended Sediment Concentration,
Salinity, Temperature and Water Level

Location:

Deurganckdok DPW

Processed by:

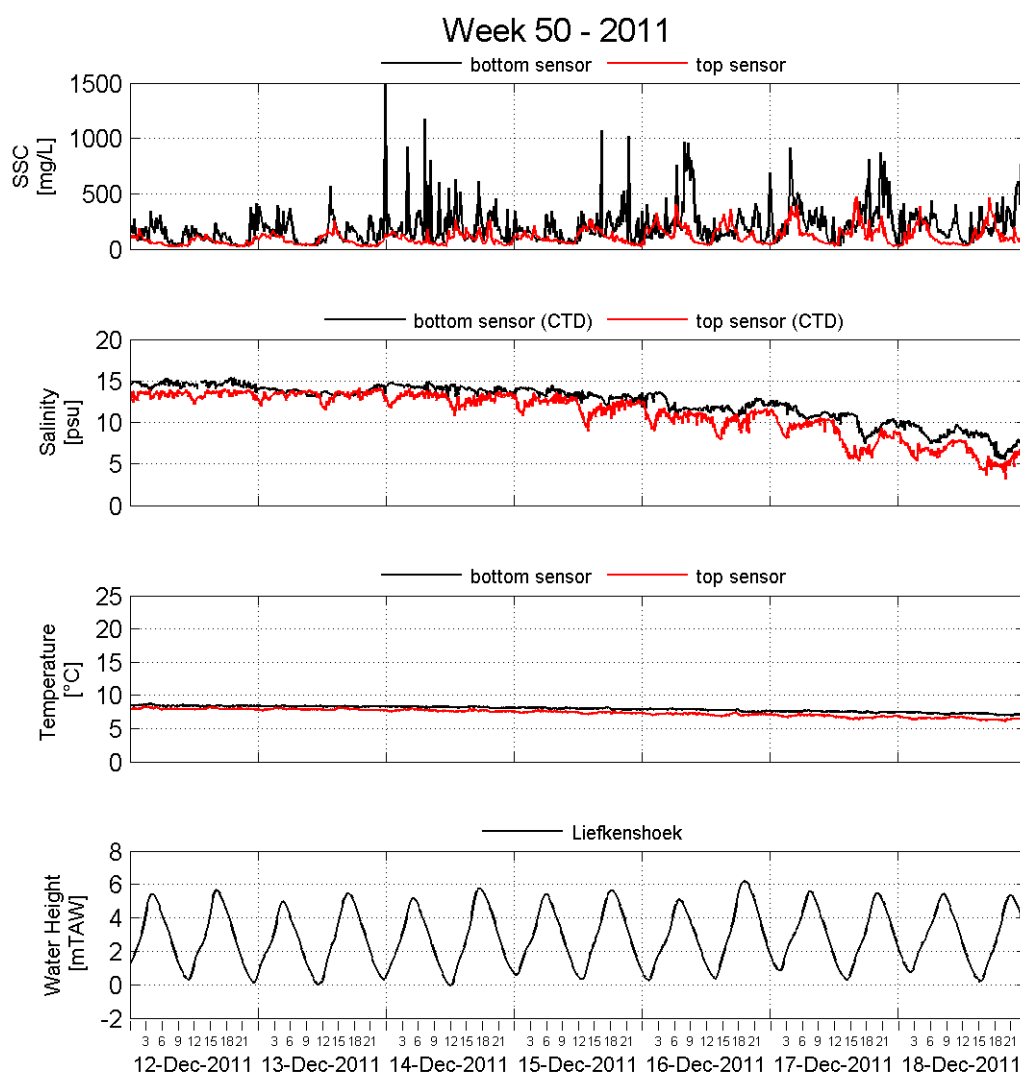


In Association with:



I/RA/11354/10.112/MBO/ANF

11354 - Evaluation external effects Deurganckdok



Week series of Suspended Sediment Concentration,
Salinity, Temperature and Water Level

Processed by:



In Association with:

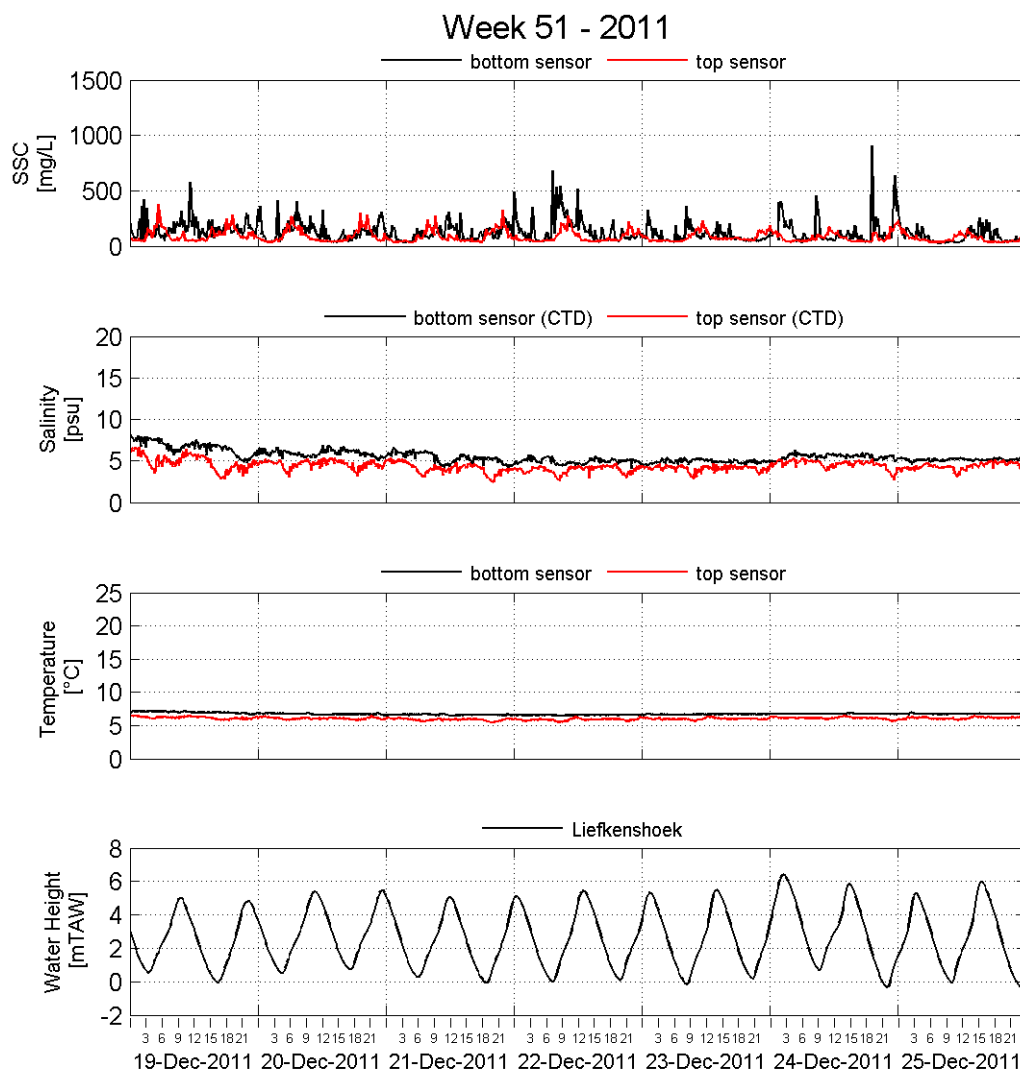


Location:

Deurganckdok DPW

I/RA/11354/10.112/MBO/ANF

11354 - Evaluation external effects Deurganckdok



Week series of Suspended Sediment Concentration,
Salinity, Temperature and Water Level

Location:

Deurganckdok DPW

Processed by:

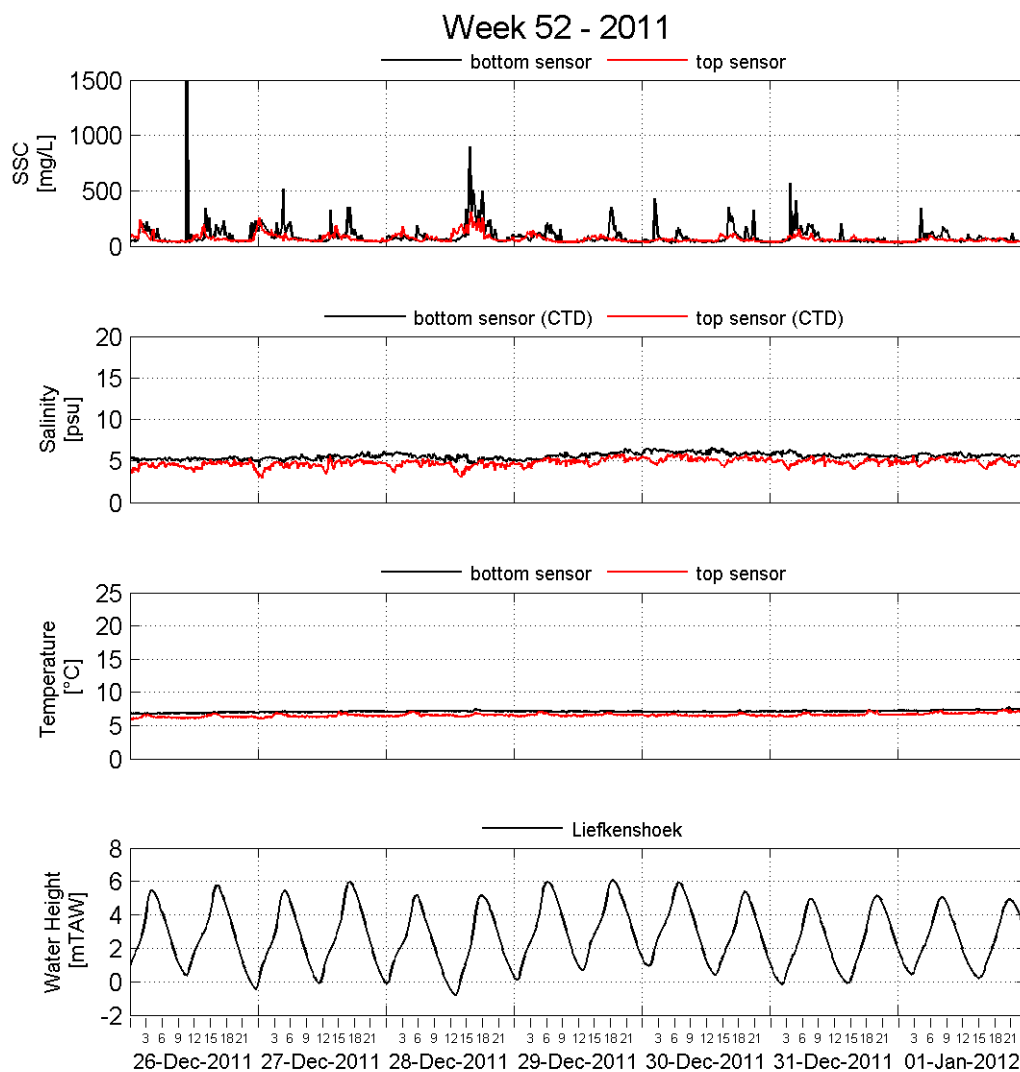


In Association with:



I/RA/11354/10.112/MBO/ANF

11354 - Evaluation external effects Deurganckdok



Week series of Suspended Sediment Concentration,
Salinity, Temperature and Water Level

Location:

Deurganckdok DPW

Processed by:

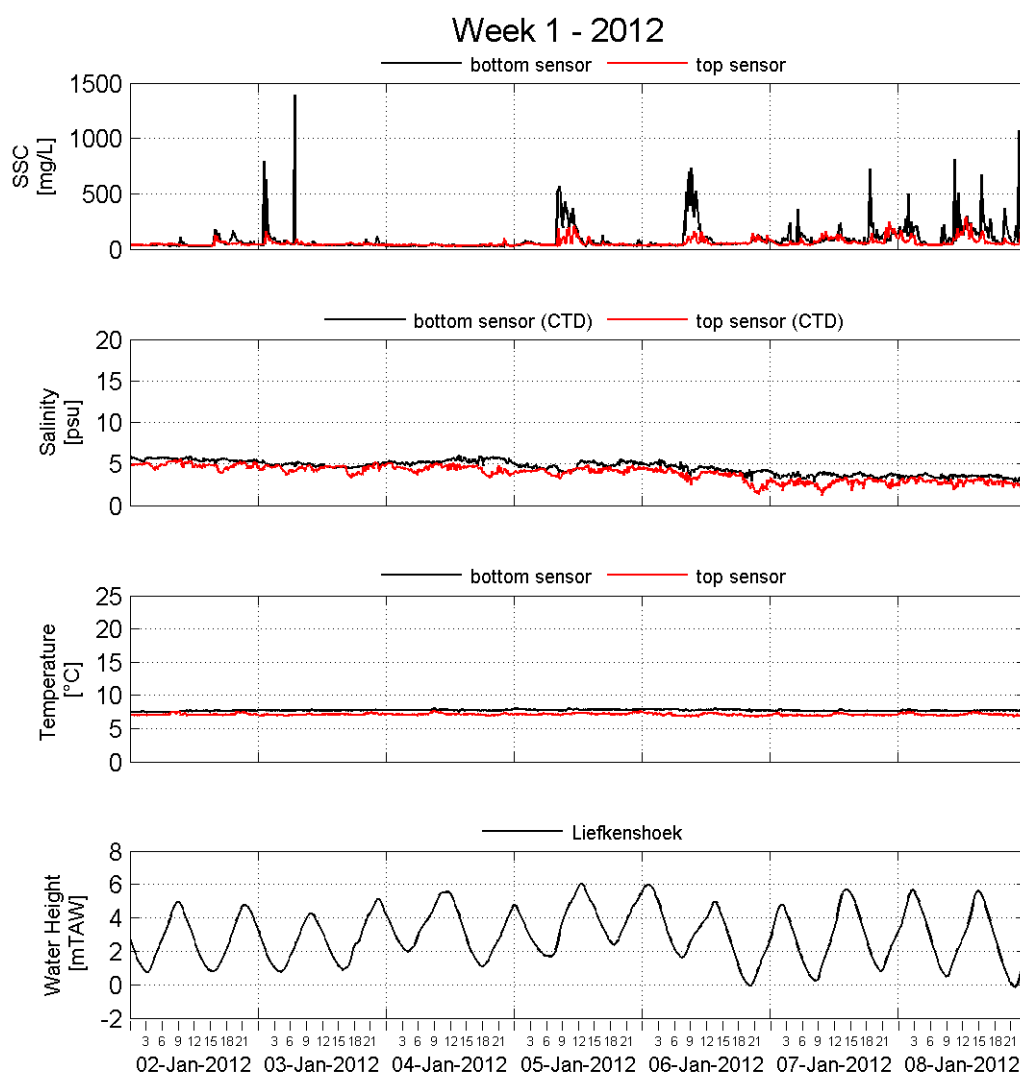


In Association with:



I/RA/11354/10.112/MBO/ANF

11354 - Evaluation external effects Deurganckdok



Week series of Suspended Sediment Concentration,
Salinity, Temperature and Water Level

Processed by:



In Association with:

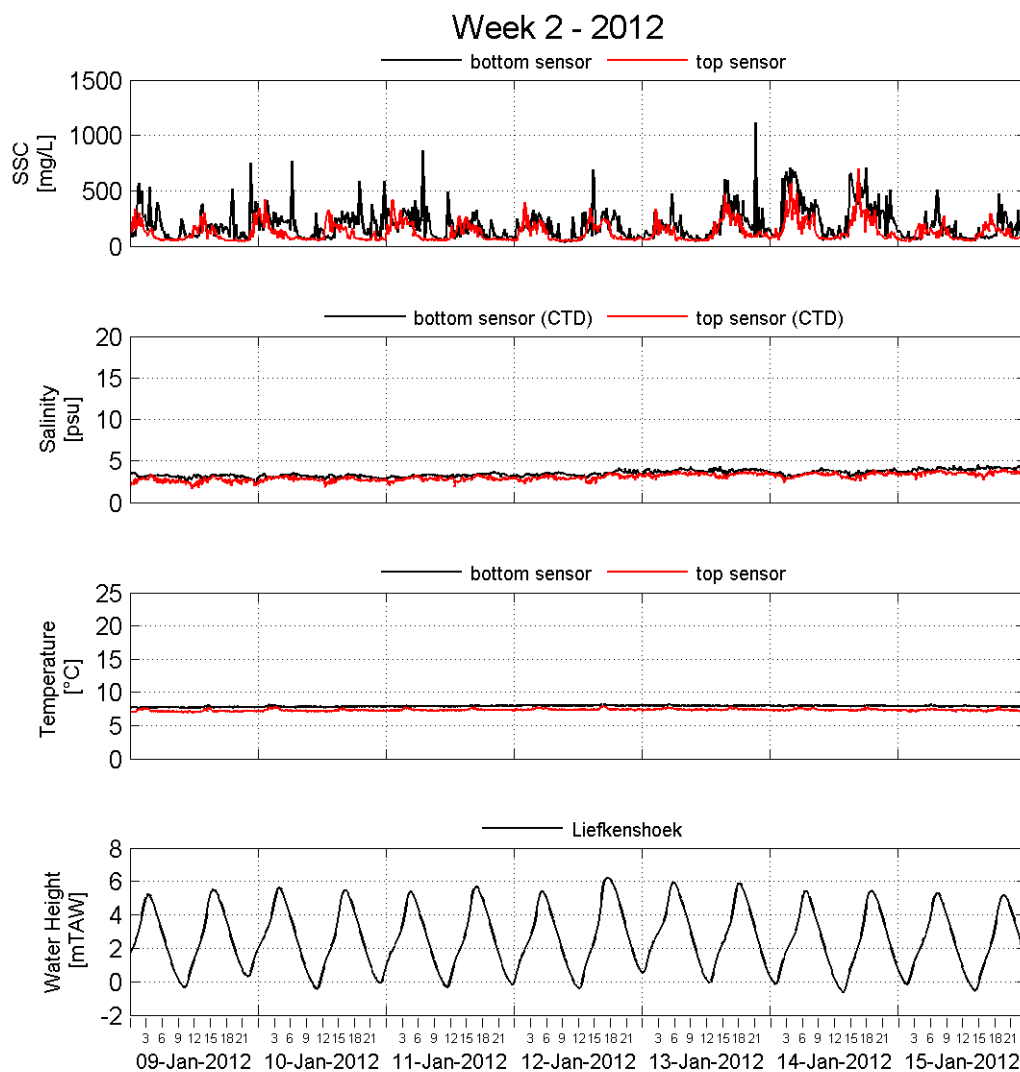


Location:

Deurganckdok DPW

I/RA/11354/10.112/MBO/ANF

11354 - Evaluation external effects Deurganckdok



Week series of Suspended Sediment Concentration,
Salinity, Temperature and Water Level

Location:

Deurganckdok DPW

Processed by:

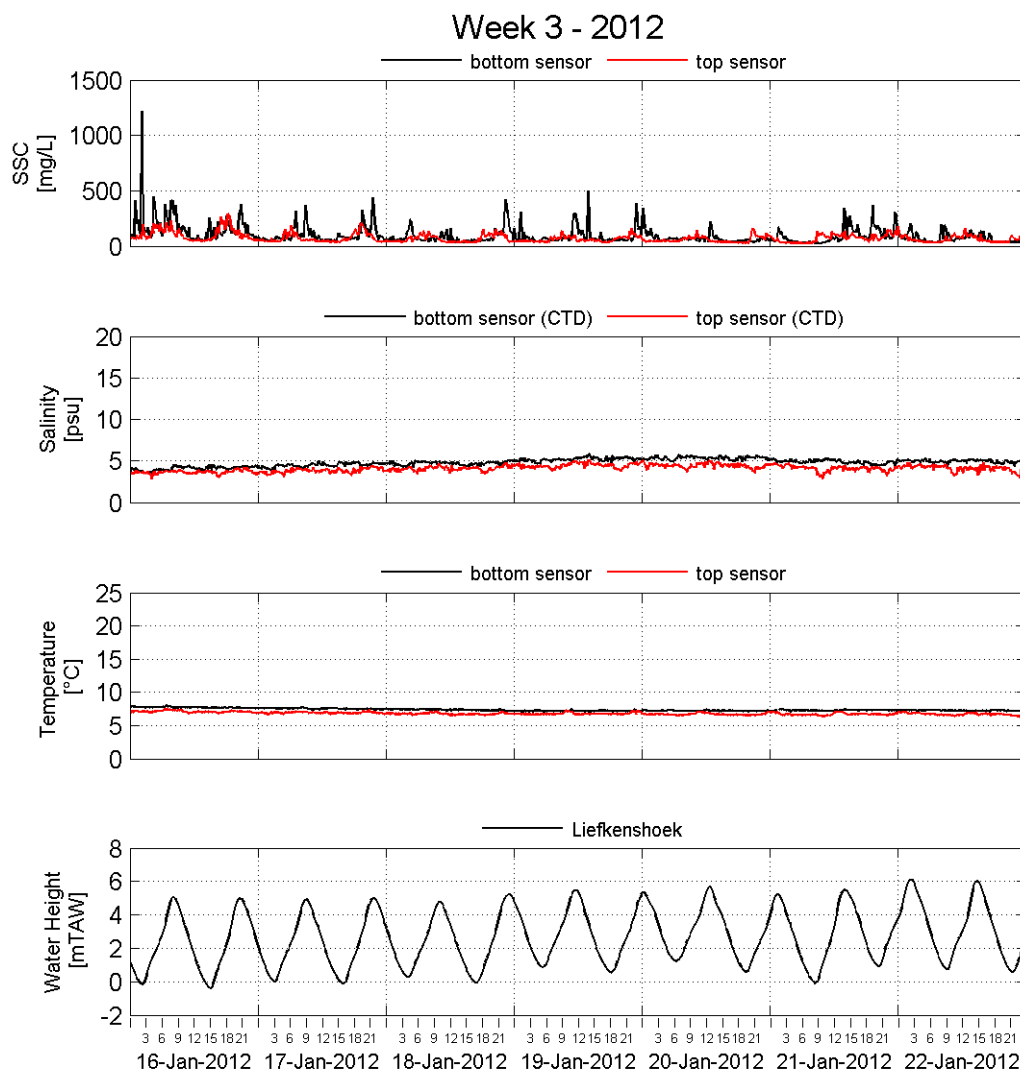


In Association with:



I/RA/11354/10.112/MBO/ANF

11354 - Evaluation external effects Deurganckdok



Week series of Suspended Sediment Concentration,
Salinity, Temperature and Water Level

Location:

Deurganckdok DPW

Processed by:

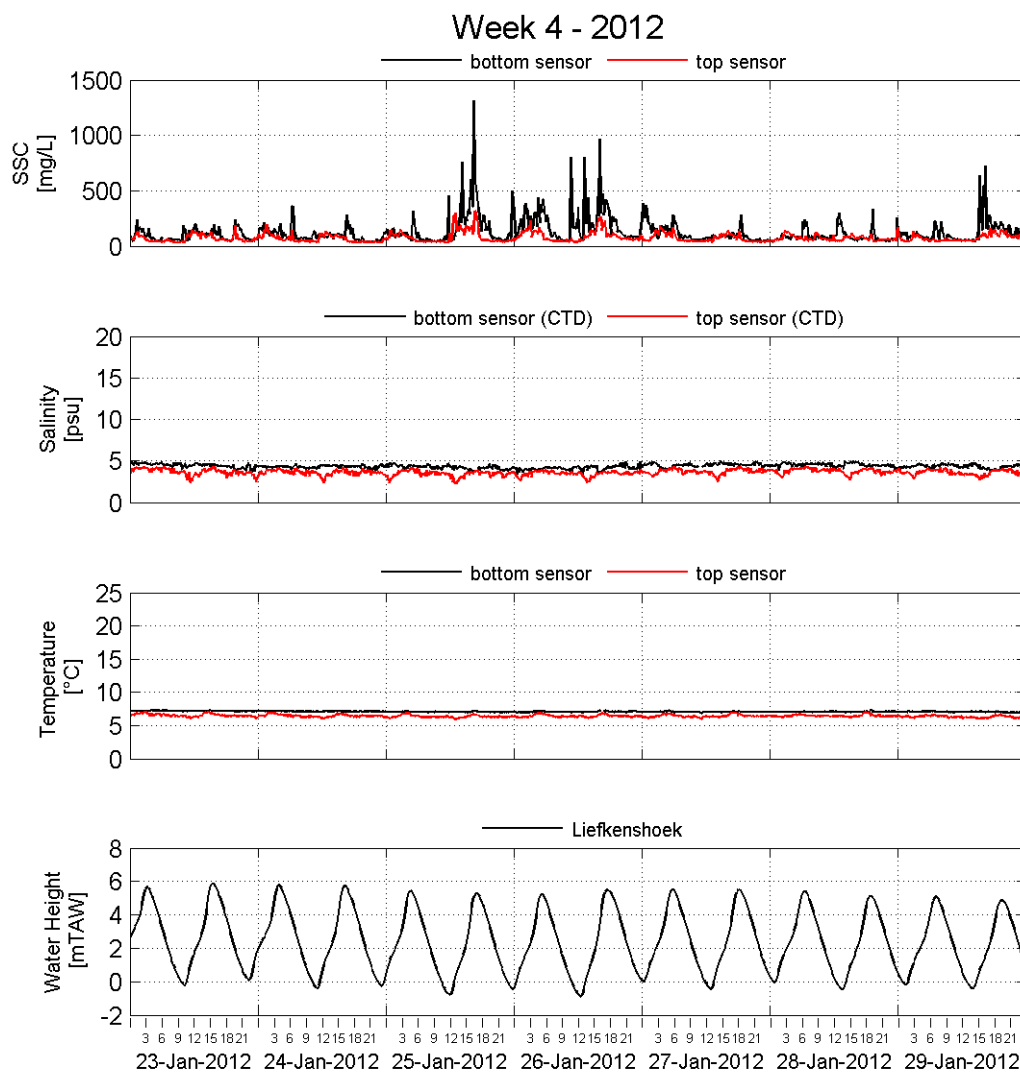


In Association with:



I/RA/11354/10.112/MBO/ANF

11354 - Evaluation external effects Deurganckdok



Week series of Suspended Sediment Concentration,
Salinity, Temperature and Water Level

Location:

Deurganckdok DPW

Processed by:

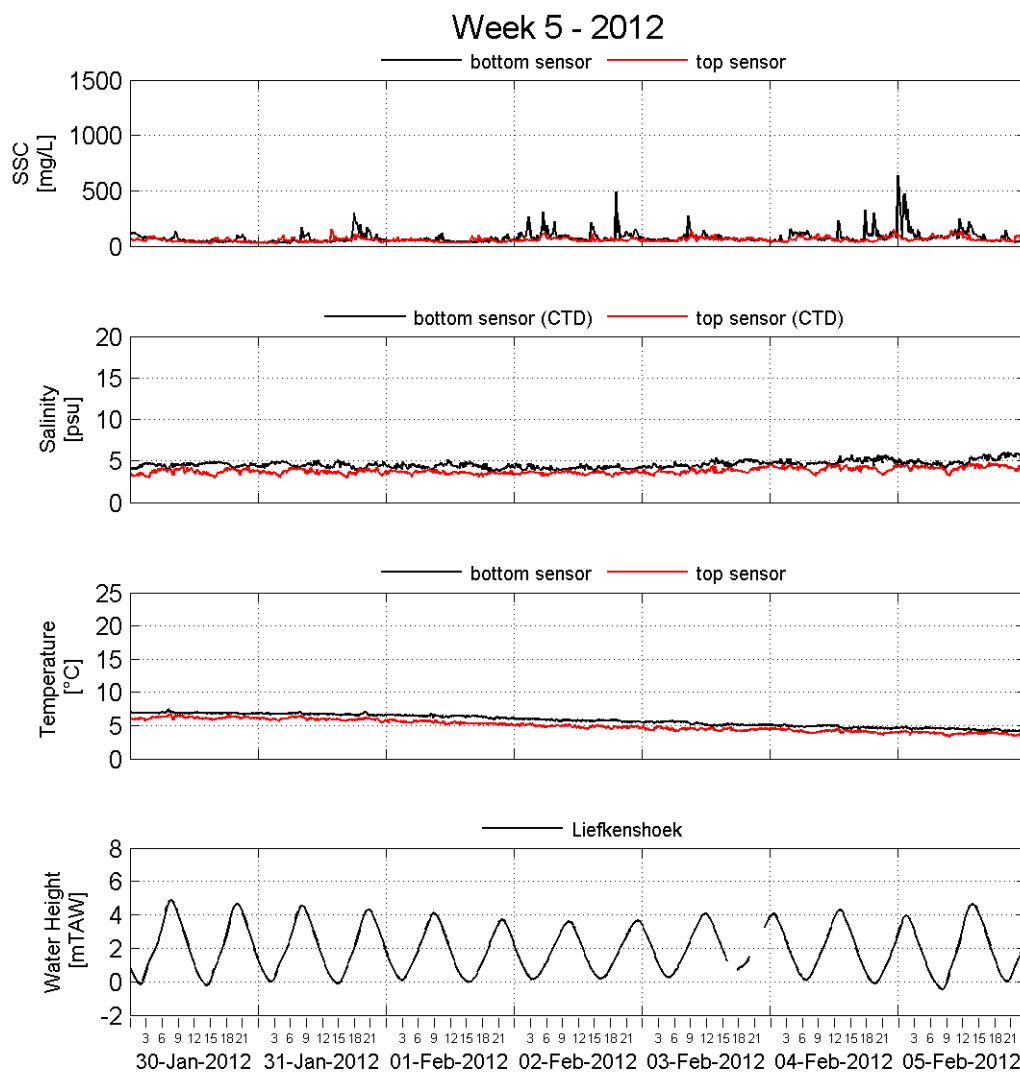


In Association with:



I/RA/11354/10.112/MBO/ANF

11354 - Evaluation external effects Deurganckdok



Week series of Suspended Sediment Concentration,
Salinity, Temperature and Water Level

Location:

Deurganckdok DPW

Processed by:

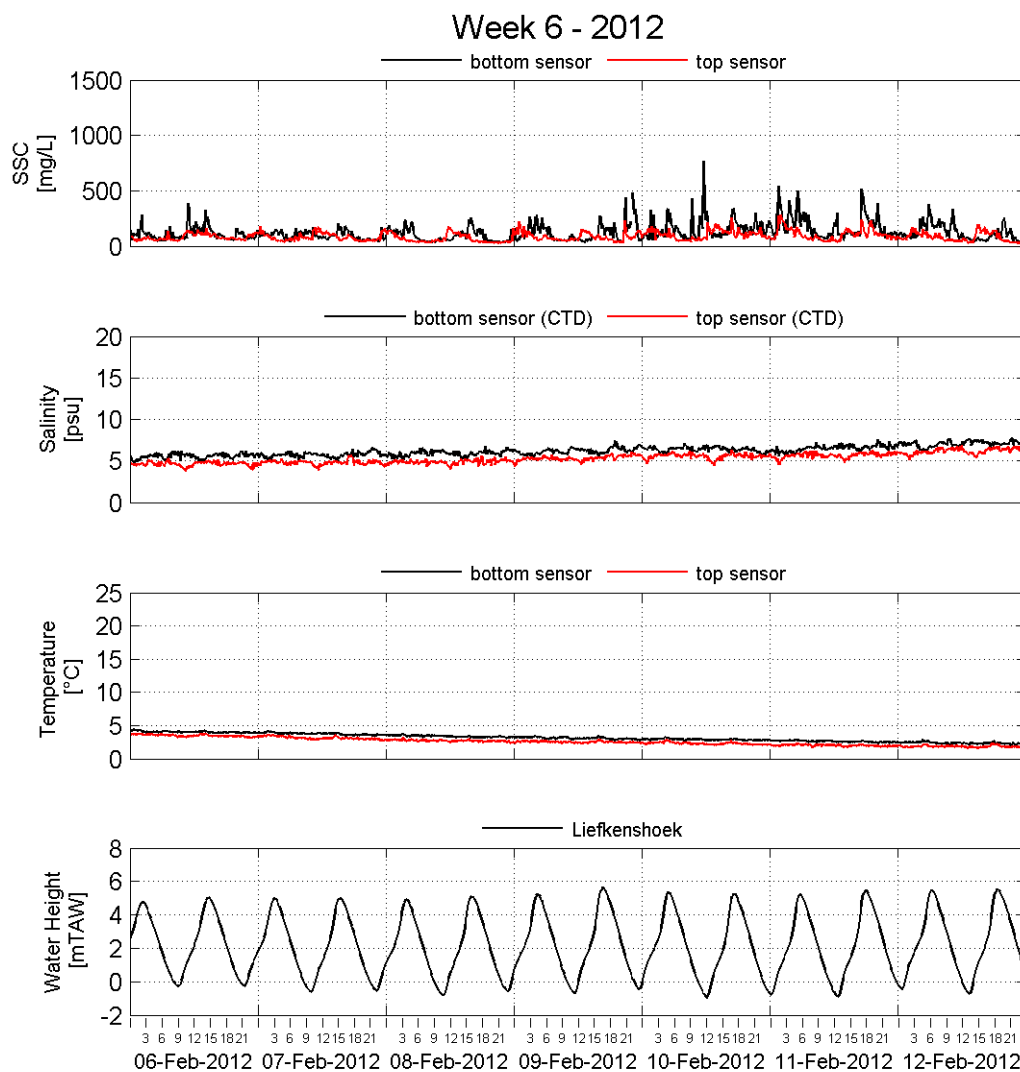


In Association with:



I/RA/11354/10.112/MBO/ANF

11354 - Evaluation external effects Deurganckdok



Week series of Suspended Sediment Concentration,
Salinity, Temperature and Water Level

Processed by:



In Association with:

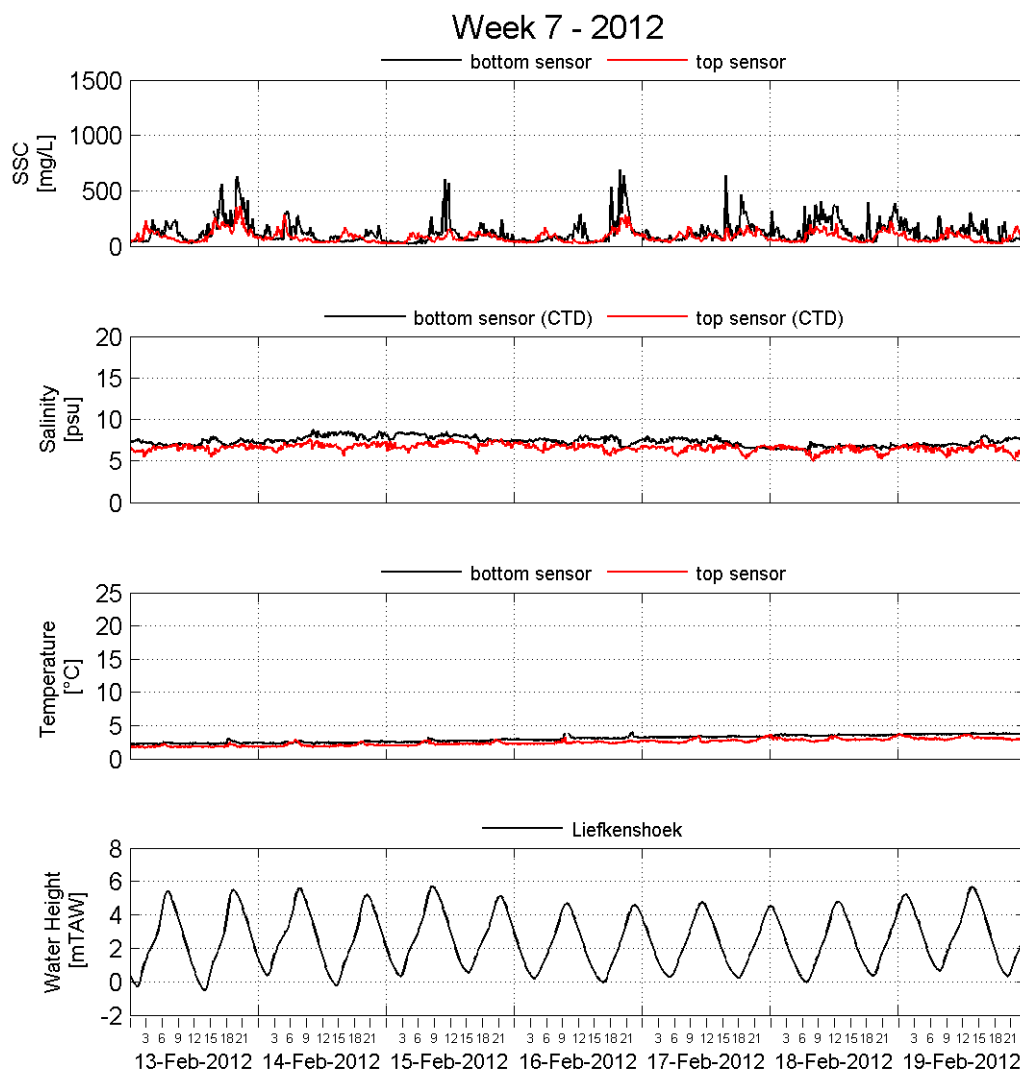


Location:

Deurganckdok DPW

I/RA/11354/10.112/MBO/ANF

11354 - Evaluation external effects Deurganckdok



Week series of Suspended Sediment Concentration,
Salinity, Temperature and Water Level

Location:

Deurganckdok DPW

Processed by:

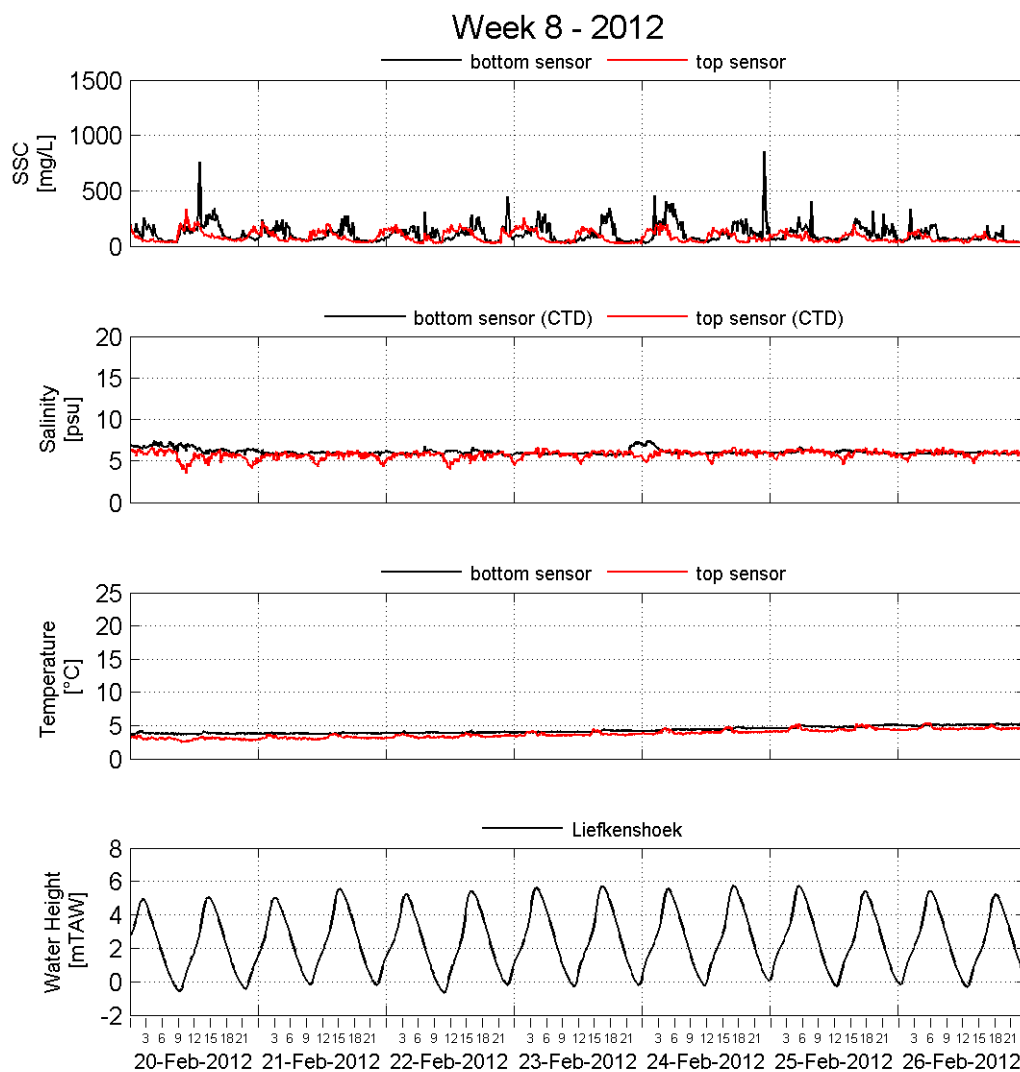


In Association with:



I/RA/11354/10.112/MBO/ANF

11354 - Evaluation external effects Deurganckdok



Week series of Suspended Sediment Concentration,
Salinity, Temperature and Water Level

Processed by:



In Association with:

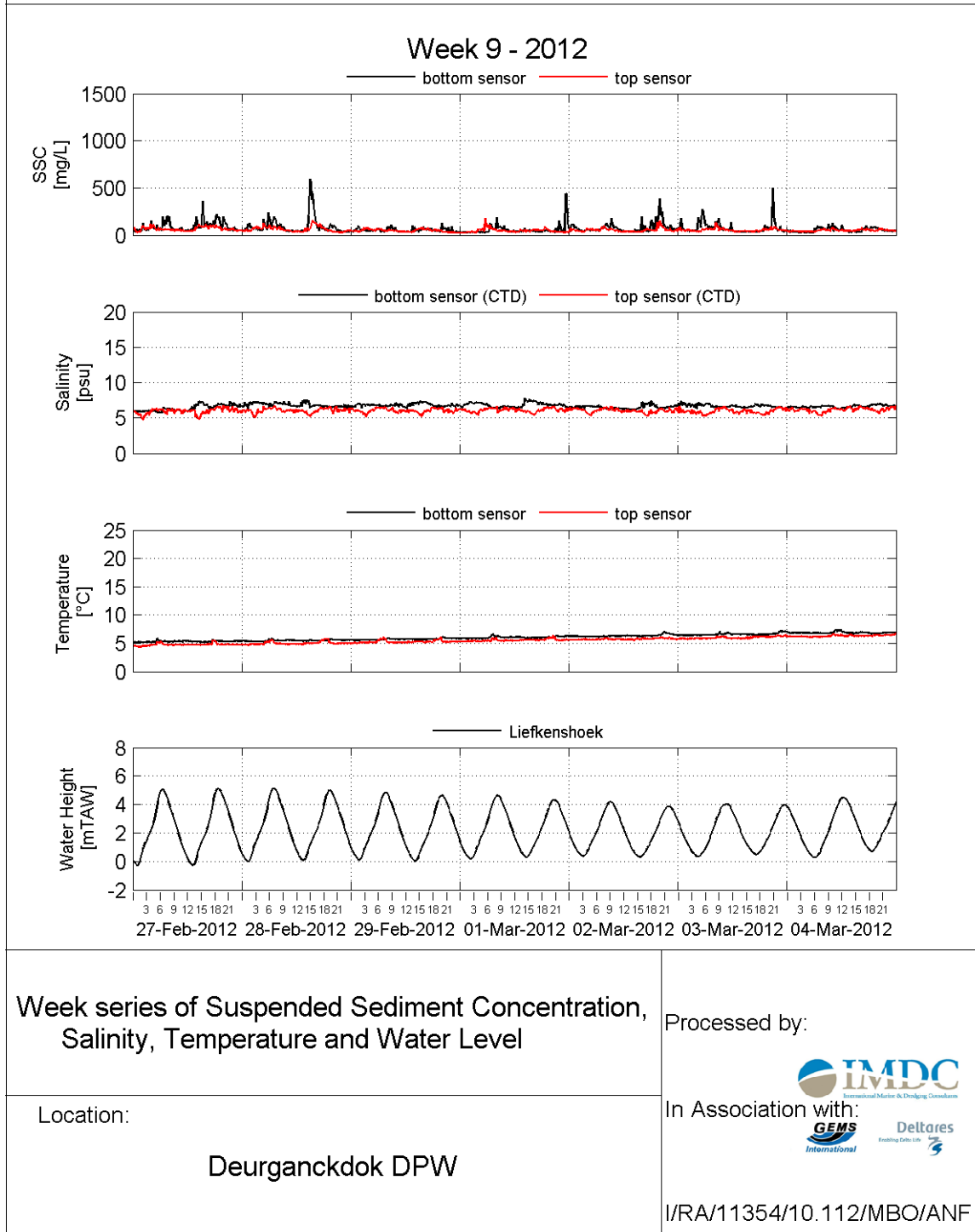


Location:

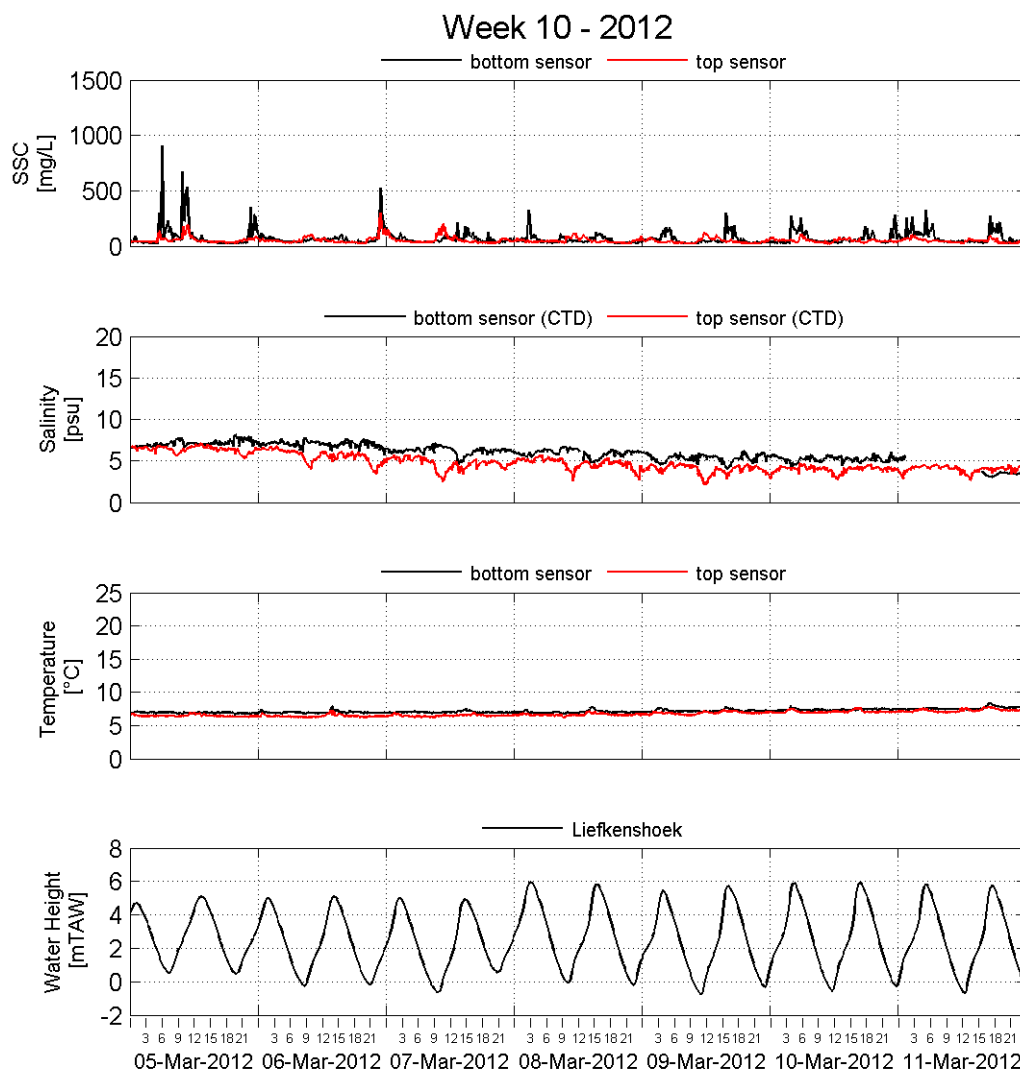
Deurganckdok DPW

I/RA/11354/10.112/MBO/ANF

11354 - Evaluation external effects Deurganckdok



11354 - Evaluation external effects Deurganckdok



Week series of Suspended Sediment Concentration,
Salinity, Temperature and Water Level

Location:

Deurganckdok DPW

Processed by:

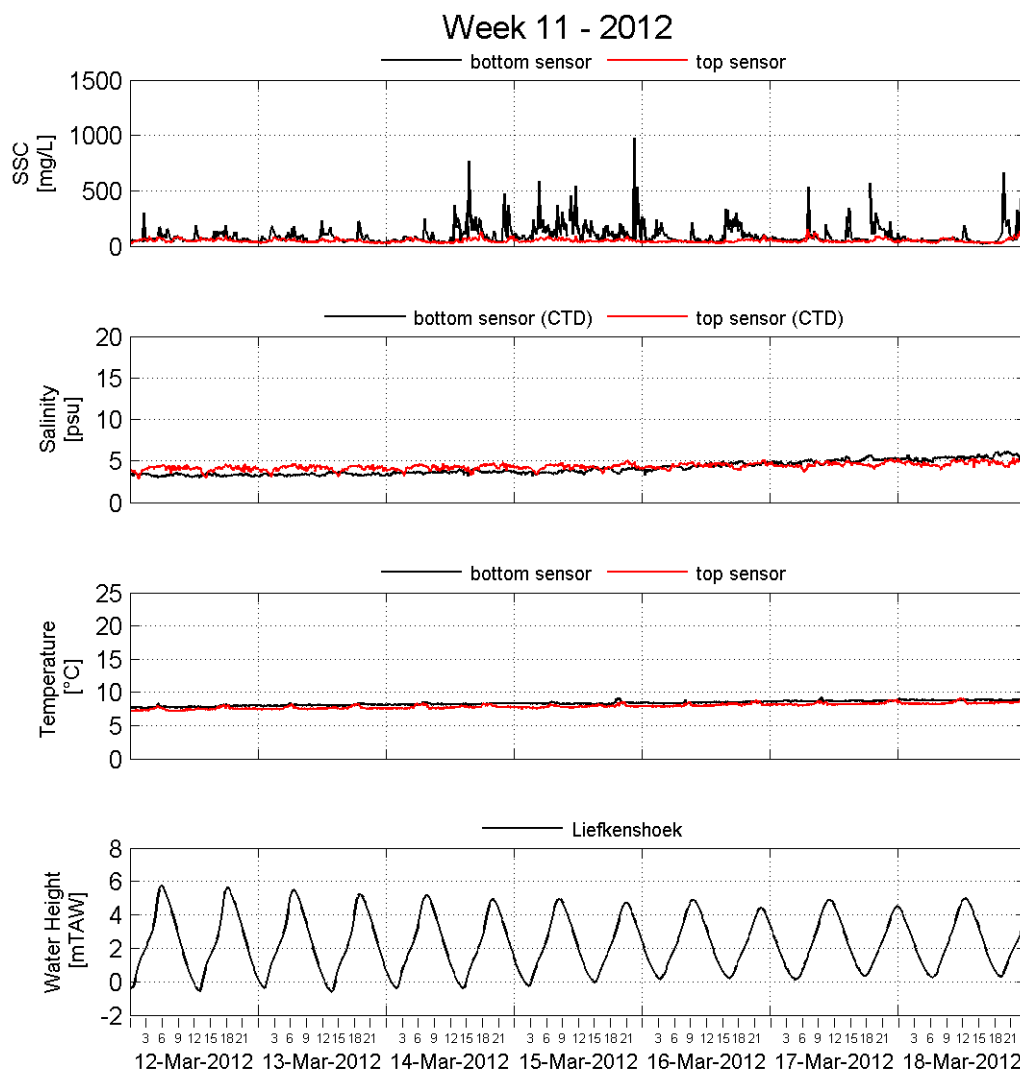


In Association with:



I/RA/11354/10.112/MBO/ANF

11354 - Evaluation external effects Deurganckdok



Week series of Suspended Sediment Concentration,
Salinity, Temperature and Water Level

Location:

Deurganckdok DPW

Processed by:

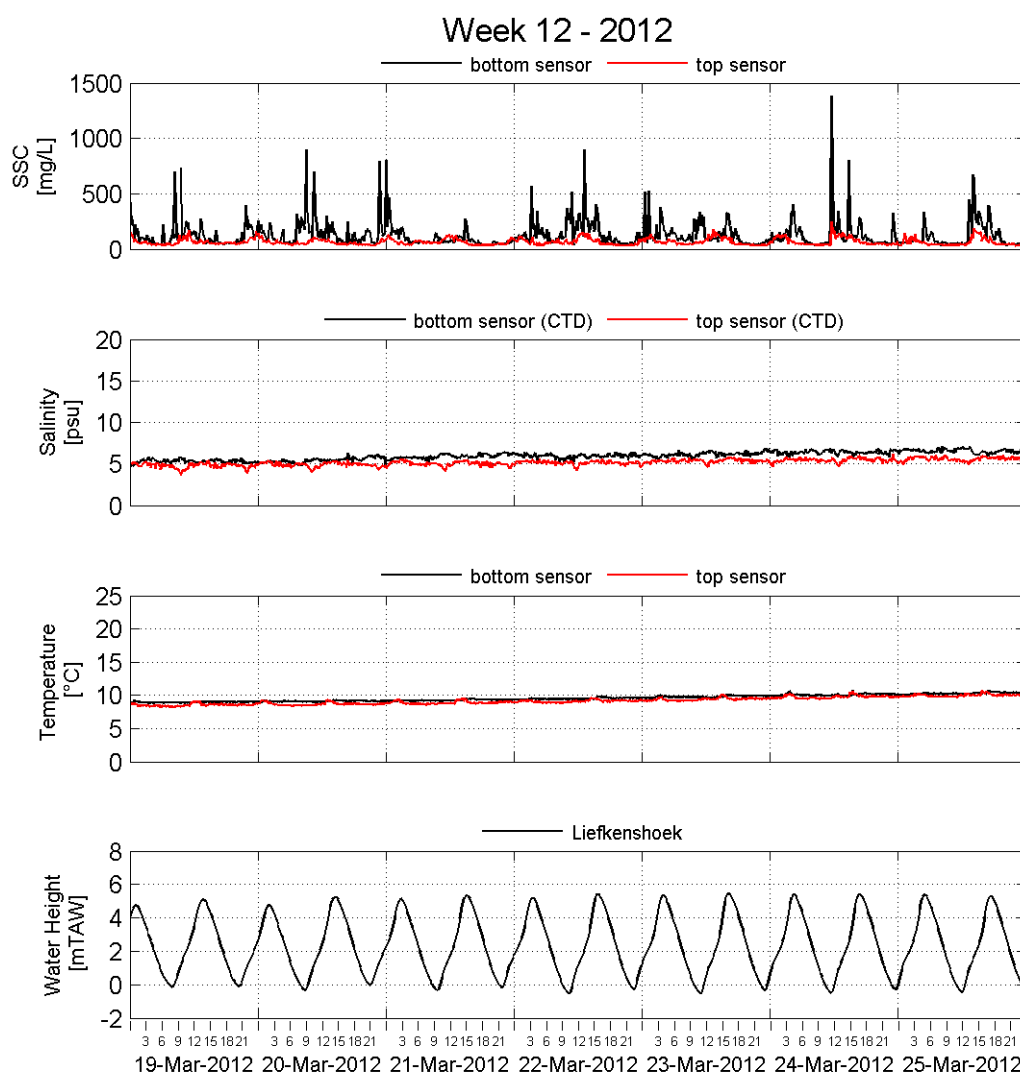


In Association with:



I/RA/11354/10.112/MBO/ANF

11354 - Evaluation external effects Deurganckdok



Week series of Suspended Sediment Concentration,
Salinity, Temperature and Water Level

Processed by:



In Association with:

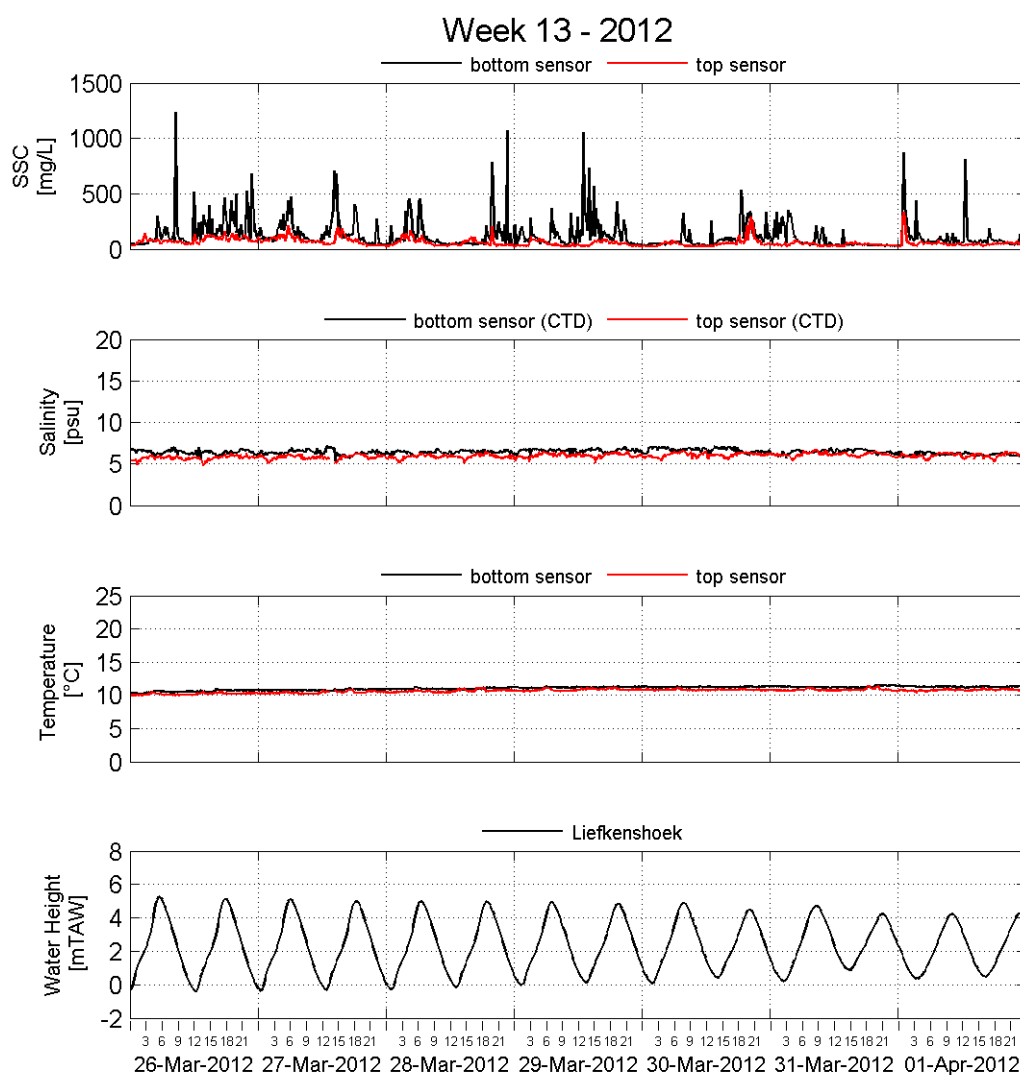


Location:

Deurganckdok DPW

I/RA/11354/10.112/MBO/ANF

11354 - Evaluation external effects Deurganckdok



Week series of Suspended Sediment Concentration,
Salinity, Temperature and Water Level

Location:

Deurganckdok DPW

Processed by:

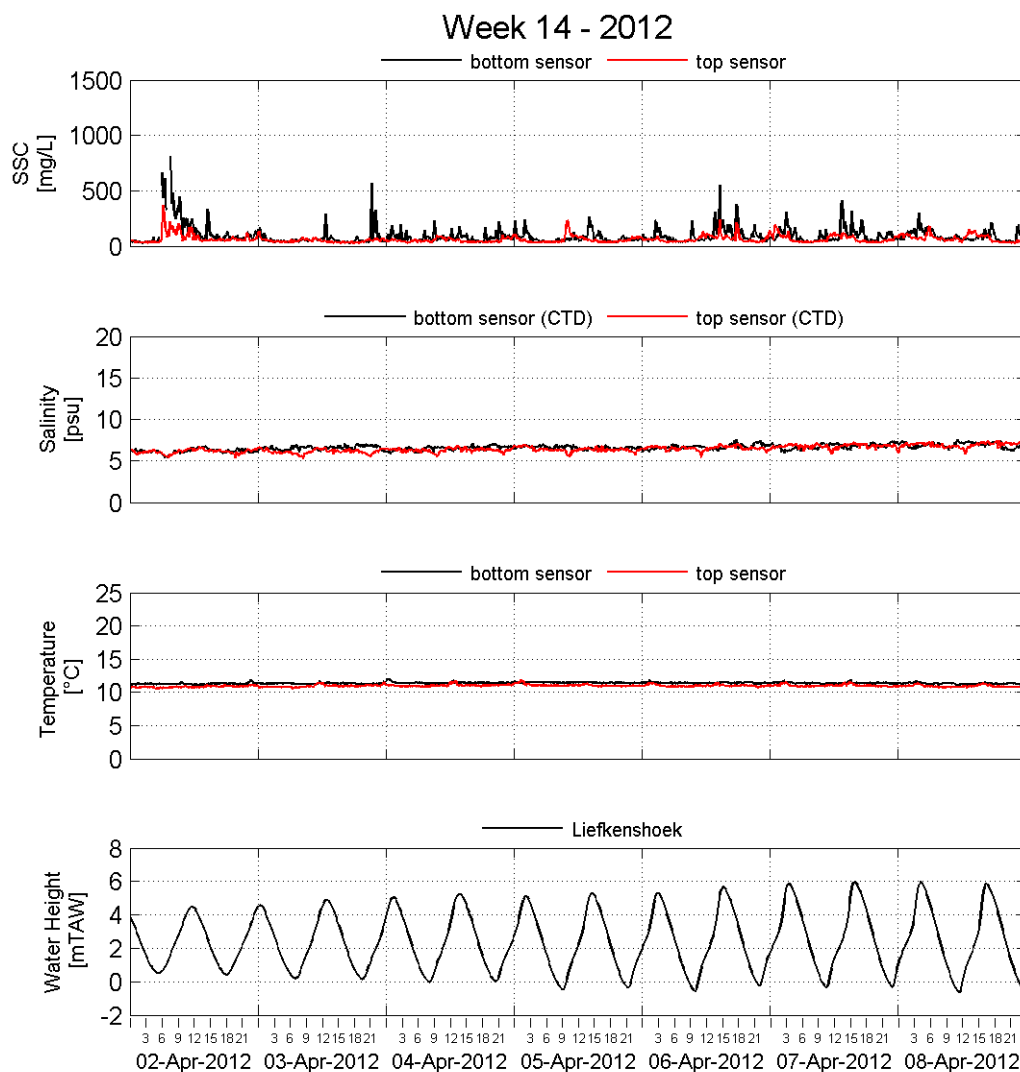


In Association with:



I/RA/11354/10.112/MBO/ANF

11354 - Evaluation external effects Deurganckdok



Week series of Suspended Sediment Concentration,
Salinity, Temperature and Water Level

Location:

Deurganckdok DPW

Processed by:

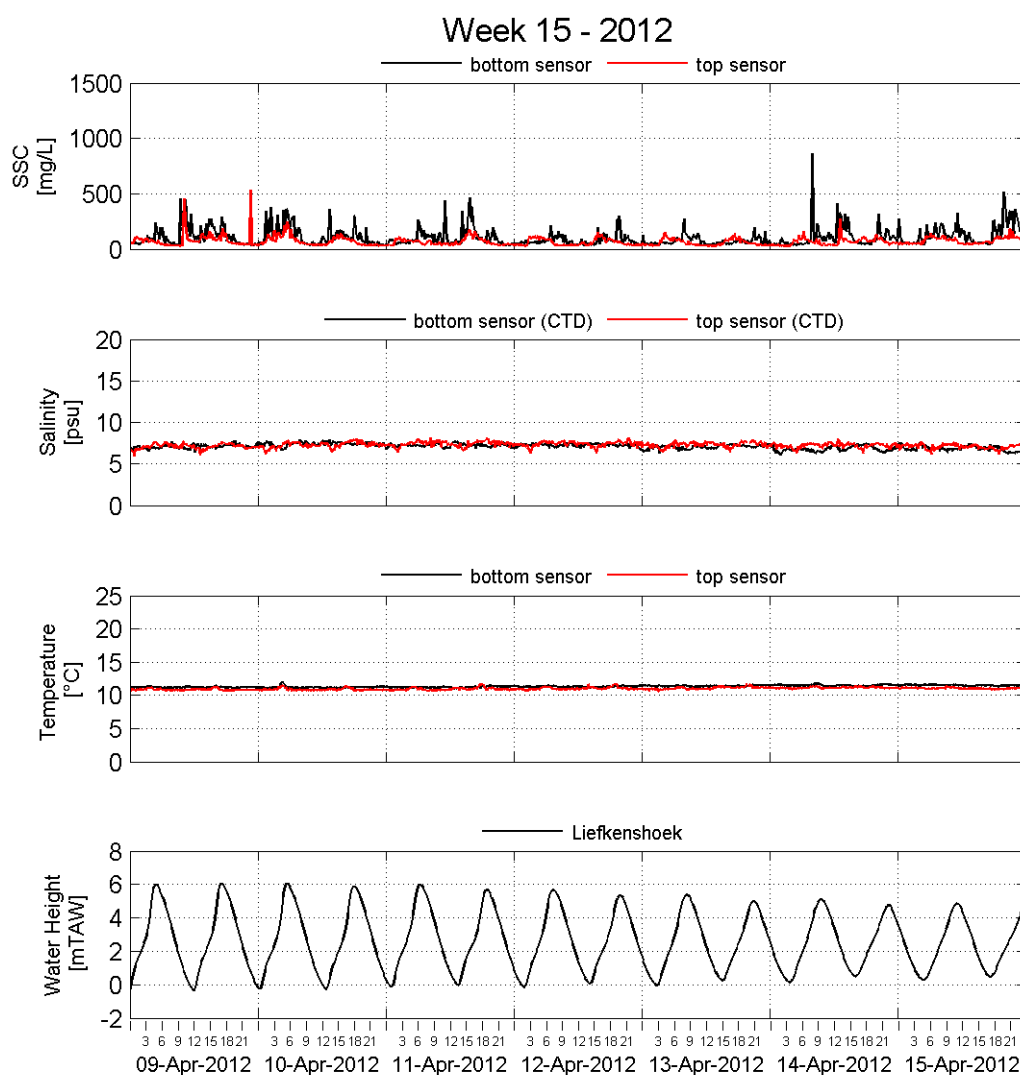


In Association with:



I/RA/11354/10.112/MBO/ANF

11354 - Evaluation external effects Deurganckdok



Week series of Suspended Sediment Concentration,
Salinity, Temperature and Water Level

Location:

Deurganckdok DPW

Processed by:

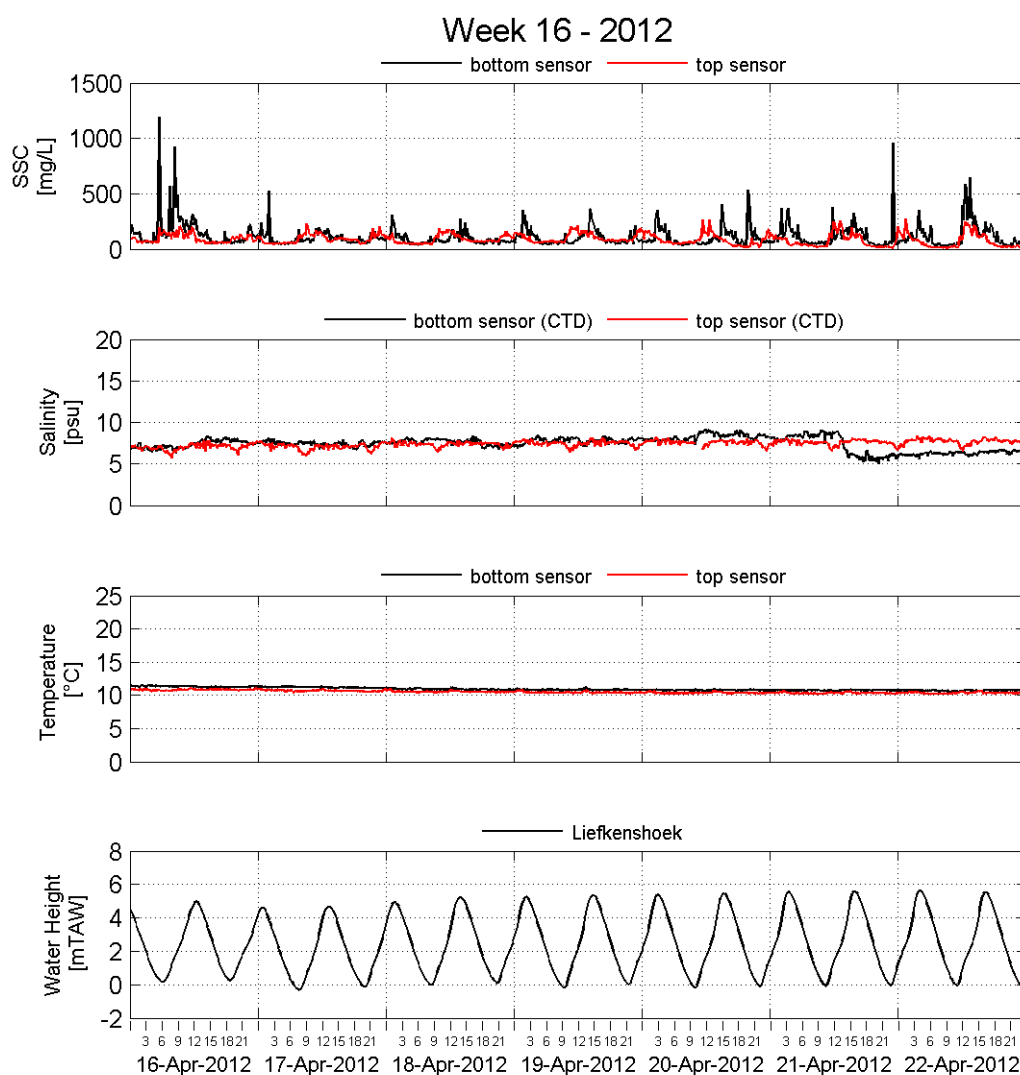


In Association with:



I/RA/11354/10.112/MBO/ANF

11354 - Evaluation external effects Deurganckdok



Week series of Suspended Sediment Concentration,
Salinity, Temperature and Water Level

Location:

Deurganckdok DPW

Processed by:

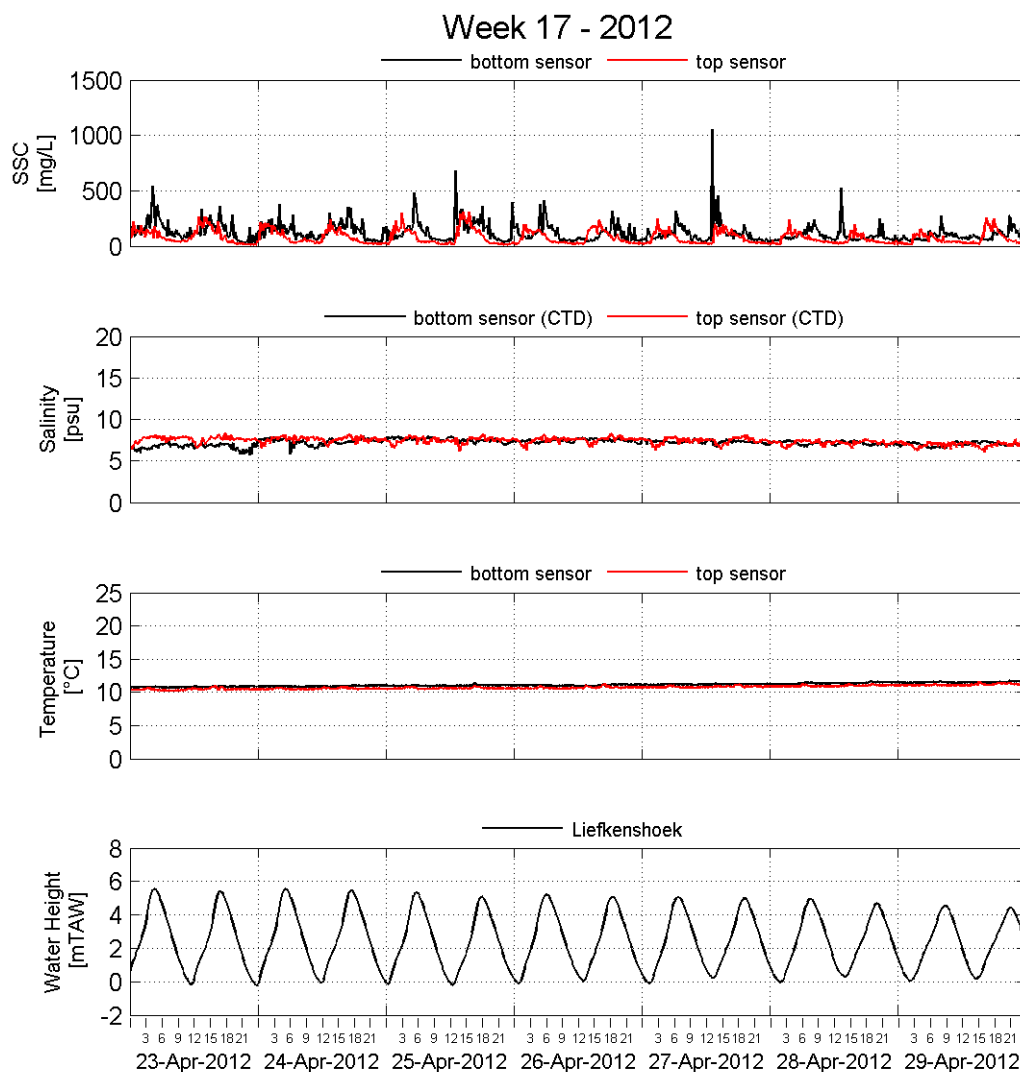


In Association with:



I/RA/11354/10.112/MBO/ANF

11354 - Evaluation external effects Deurganckdok



Week series of Suspended Sediment Concentration,
Salinity, Temperature and Water Level

Processed by:



In Association with:

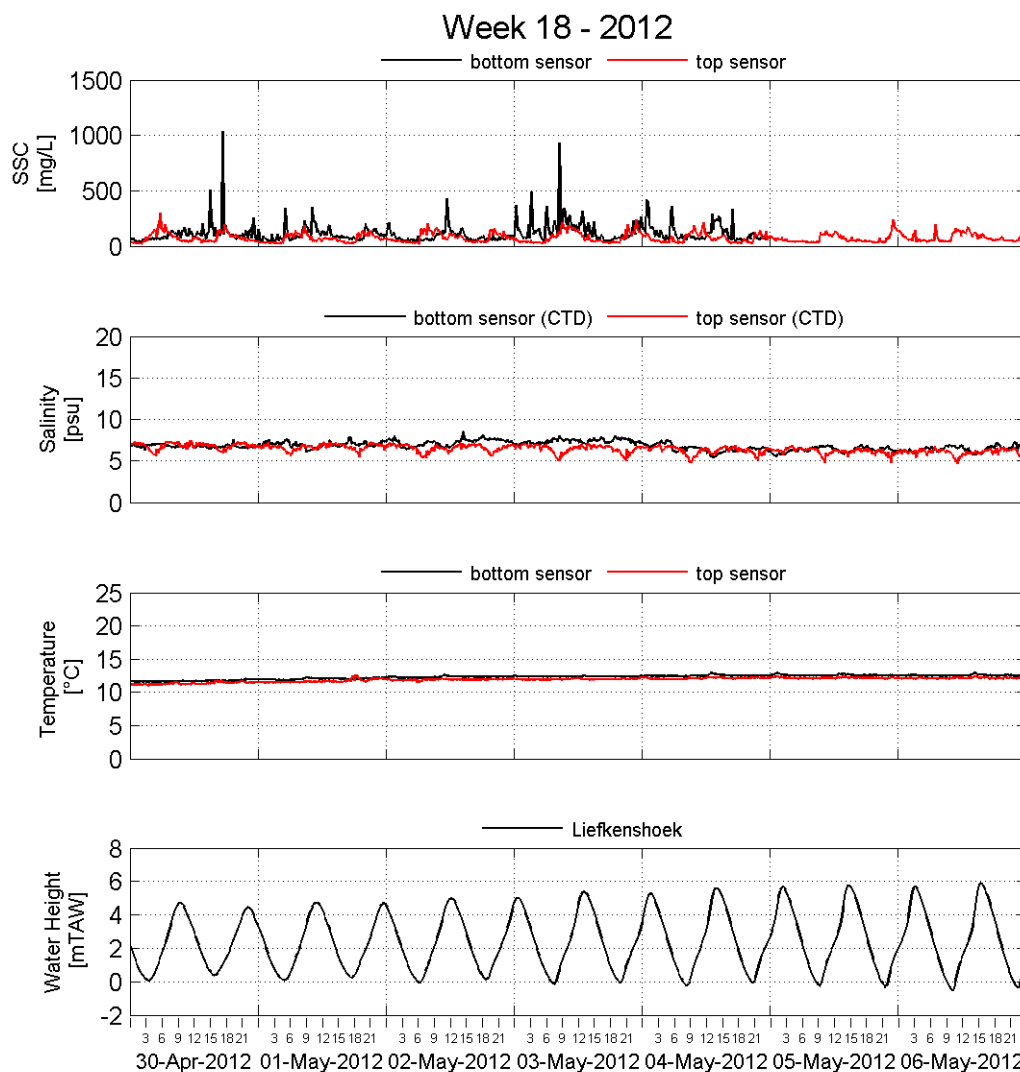


Location:

Deurganckdok DPW

I/RA/11354/10.112/MBO/ANF

11354 - Evaluation external effects Deurganckdok



Week series of Suspended Sediment Concentration,
Salinity, Temperature and Water Level

Location:

Deurganckdok DPW

Processed by:

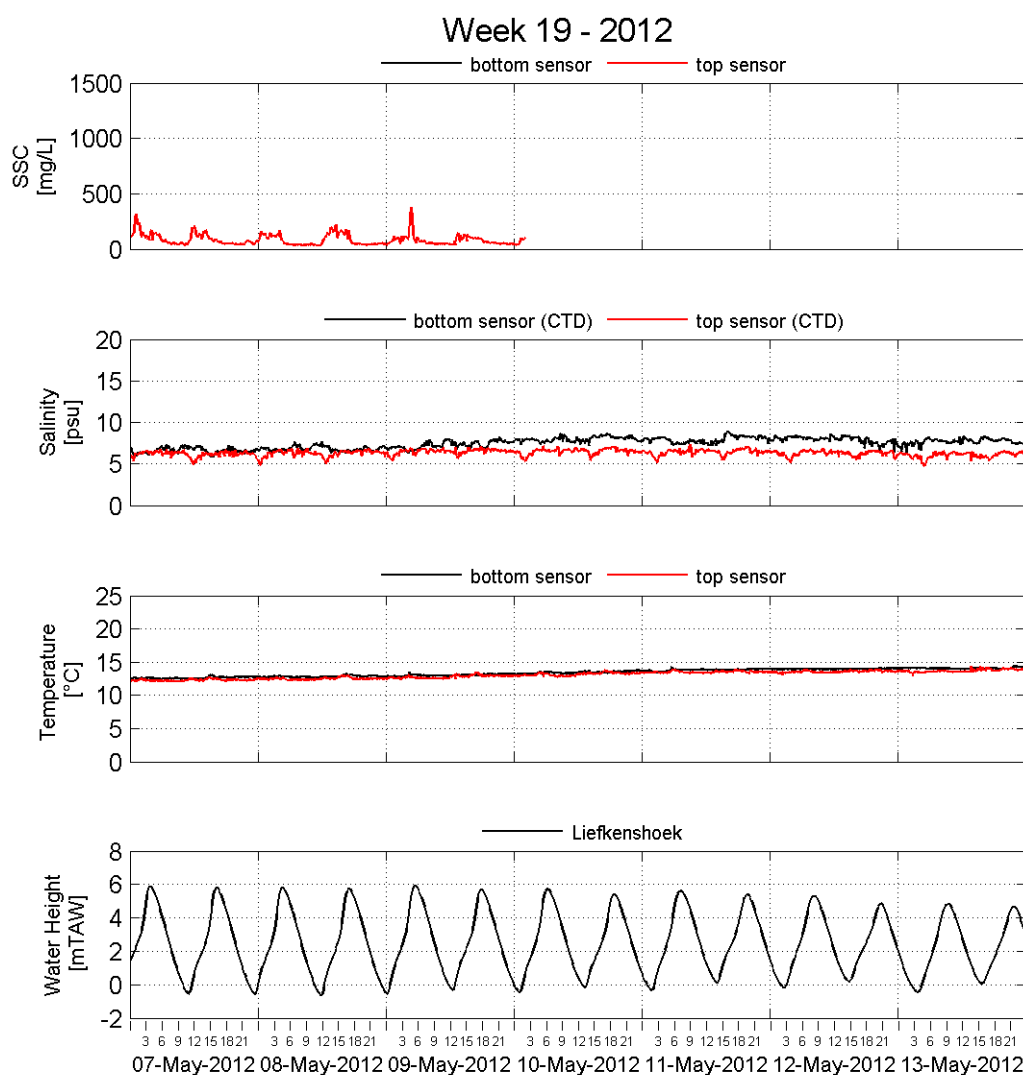


In Association with:



I/RA/11354/10.112/MBO/ANF

11354 - Evaluation external effects Deurganckdok



Week series of Suspended Sediment Concentration,
Salinity, Temperature and Water Level

Location:

Deurganckdok DPW

Processed by:

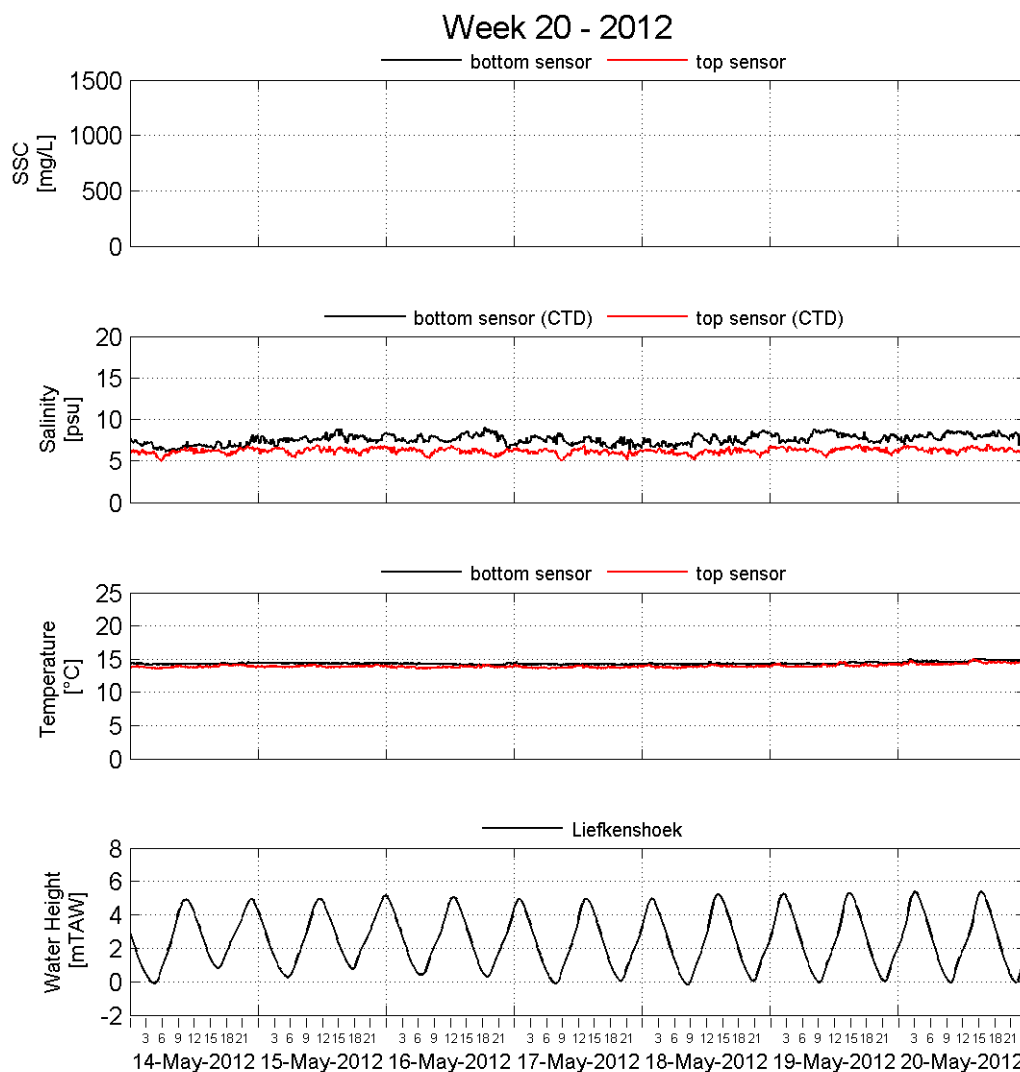


In Association with:



I/RA/11354/10.112/MBO/ANF

11354 - Evaluation external effects Deurganckdok



Week series of Suspended Sediment Concentration,
Salinity, Temperature and Water Level

Location:

Deurganckdok DPW

Processed by:

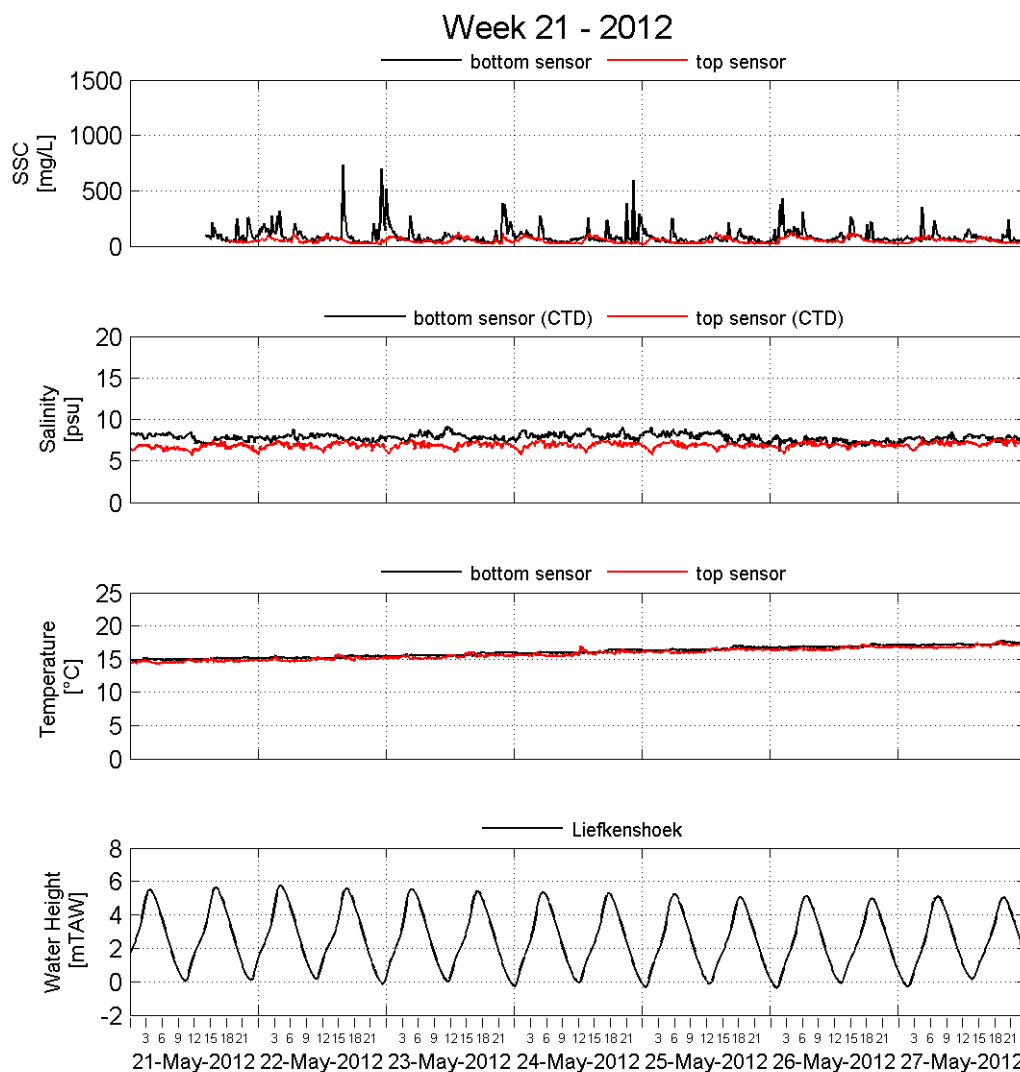


In Association with:



I/RA/11354/10.112/MBO/ANF

11354 - Evaluation external effects Deurganckdok



Week series of Suspended Sediment Concentration,
Salinity, Temperature and Water Level

Location:

Deurganckdok DPW

Processed by:

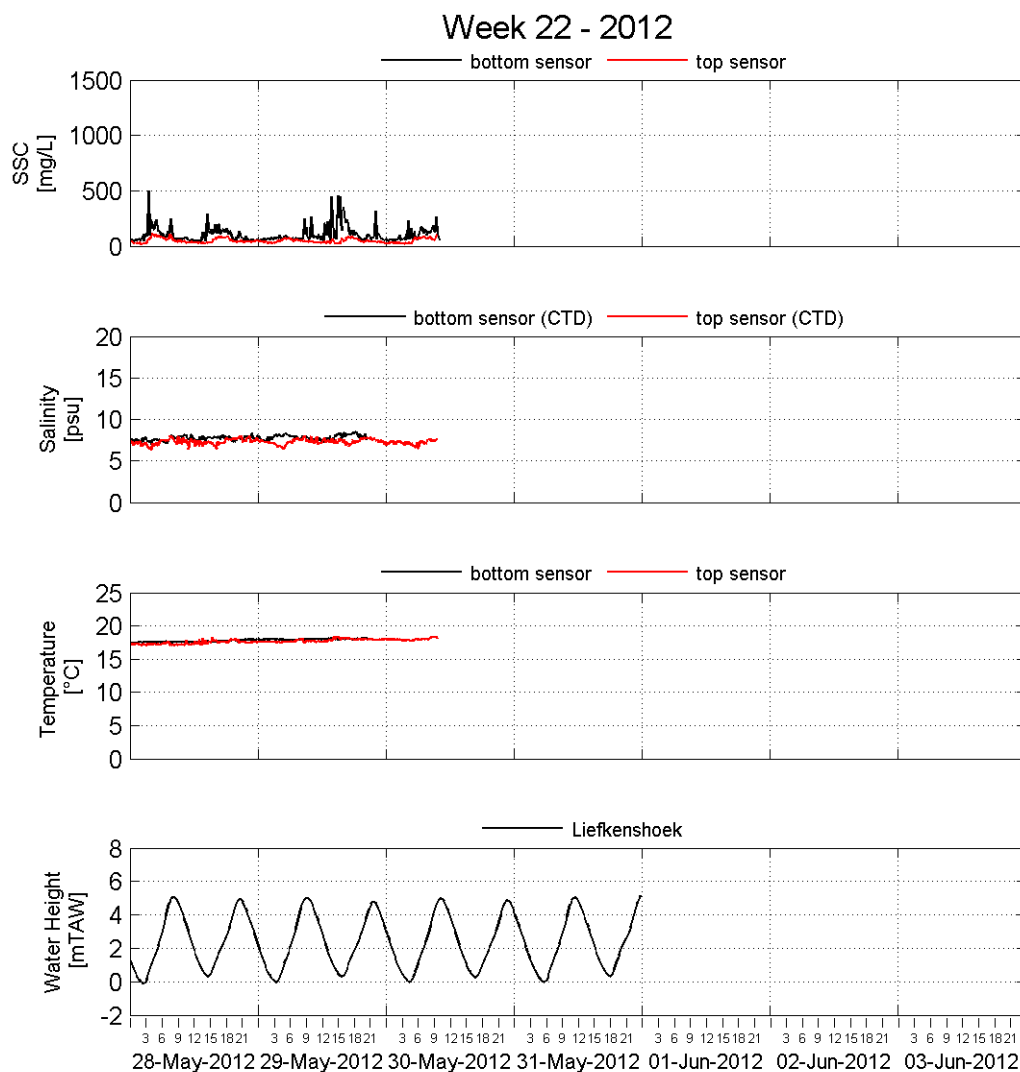


In Association with:



I/RA/11354/10.112/MBO/ANF

11354 - Evaluation external effects Deurganckdok



Week series of Suspended Sediment Concentration,
Salinity, Temperature and Water Level

Location:

Deurganckdok DPW

Processed by:



In Association with:



I/RA/11354/10.112/MBO/ANF

Annex C

Average tidal cycles

C.1 *Local parameters*

Evaluation of external effects on the siltation of Deurganckdok

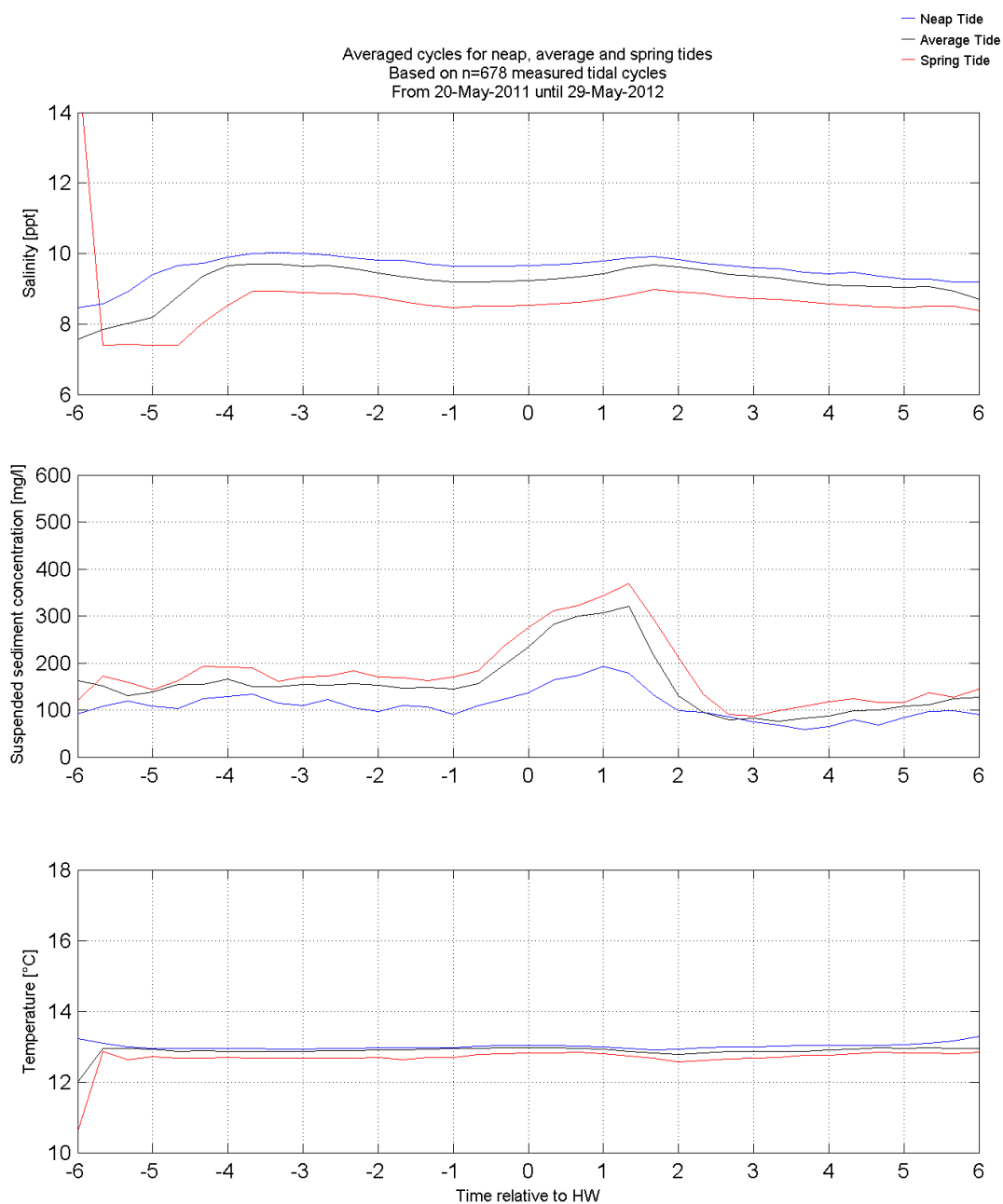
2011-2012

Equipment(s):

OBS-3A-CTD

Location:

N-ENTRANCE bottom



Absolute Parameters for averaged tidal cycle

Data Processed by:

In association with :



I/RA/11354/10.112/MBO/ANF



Evaluation of external effects on the siltation of Deurganckdok

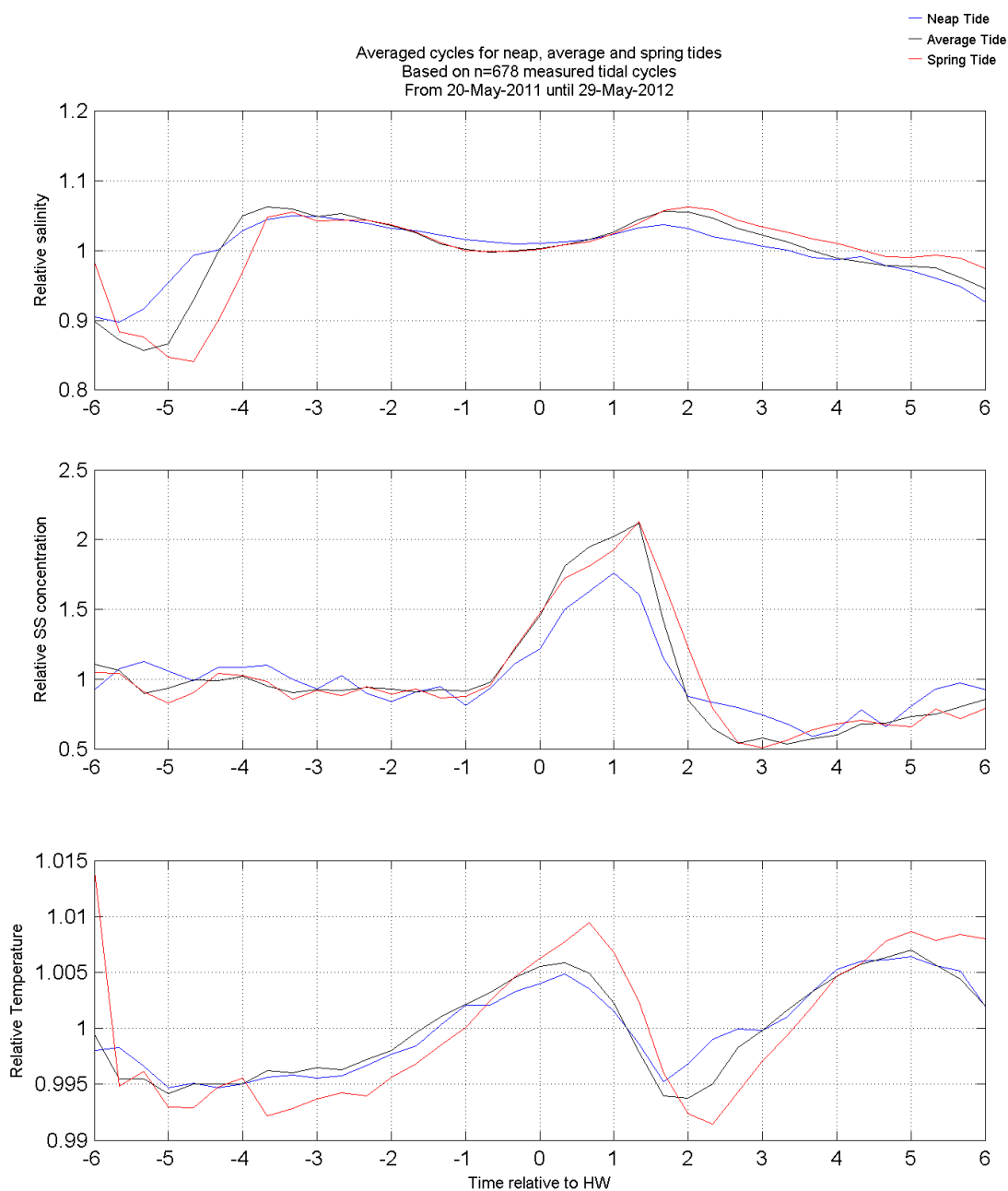
2011-2012

Equipment(s):

OBS-3A-CTD

Location:

N-ENTRANCE bottom



Relative Parameters for averaged tidal cycle

Data Processed by:

In association with :



I/RA/11354/10.112/MBO/ANF



Evaluation of external effects on the siltation of Deurganckdok

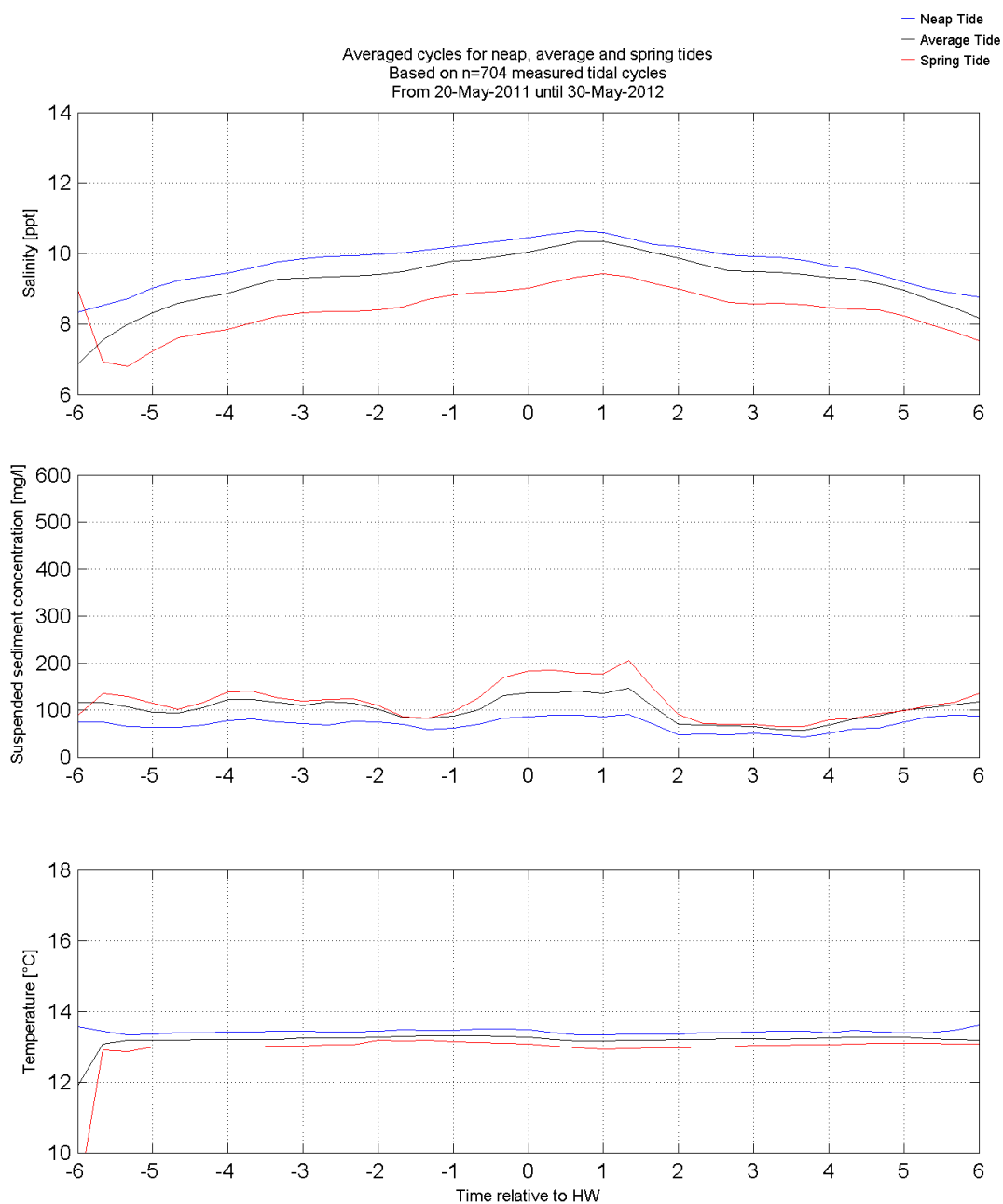
2011-2012

Equipment(s):

OBS-3A-CTD

Location:

N-ENTRANCE top



Absolute Parameters for averaged tidal cycle

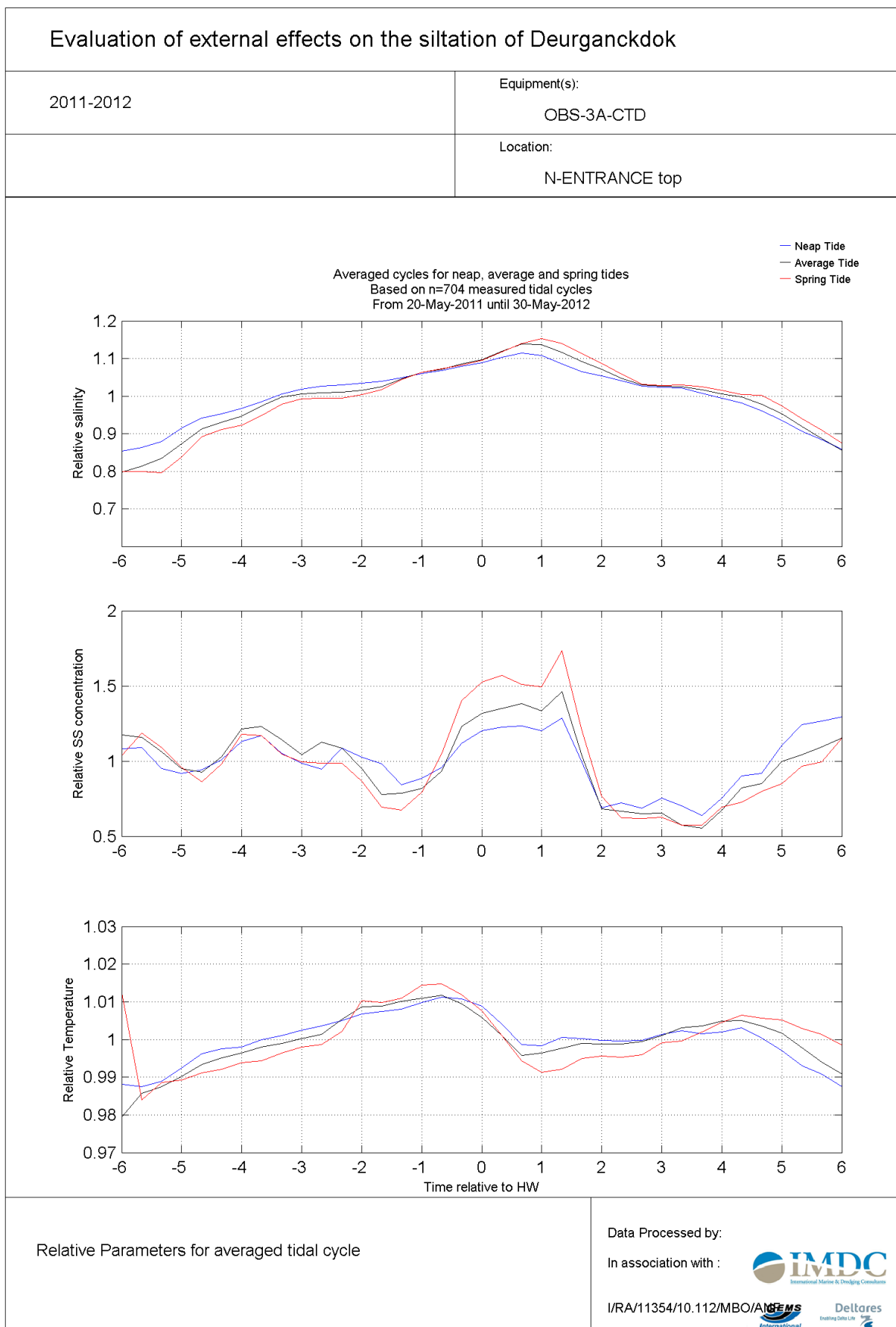
Data Processed by:

In association with :



I/RA/11354/10.112/MBO/ANF





Evaluation of external effects on the siltation of Deurganckdok

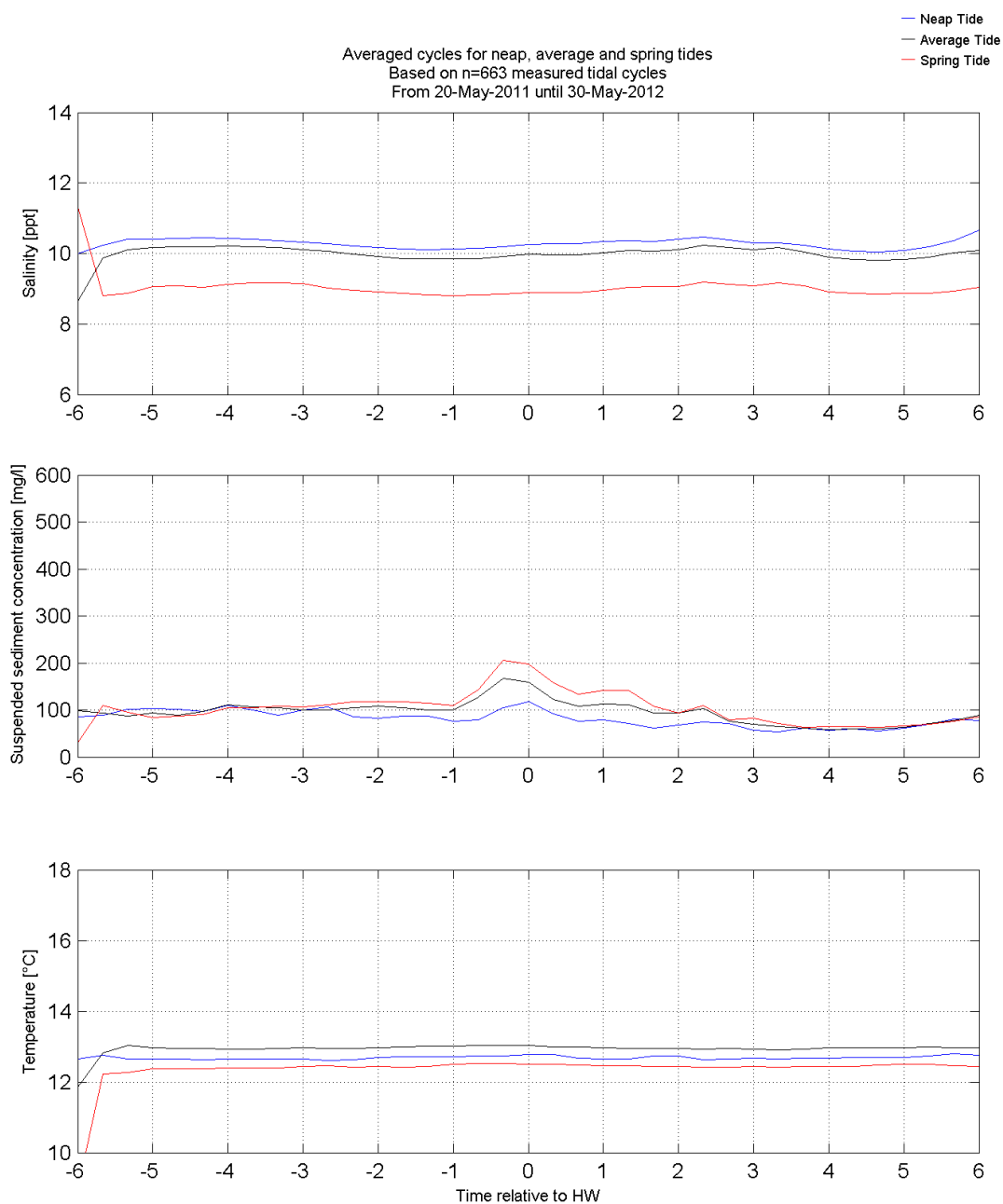
2011-2012

Equipment(s):

OBS-3A-CTD

Location:

S-ENTRANCE bottom



Absolute Parameters for averaged tidal cycle

Data Processed by:

In association with :



I/RA/11354/10.112/MBO/ANF



Evaluation of external effects on the siltation of Deurganckdok

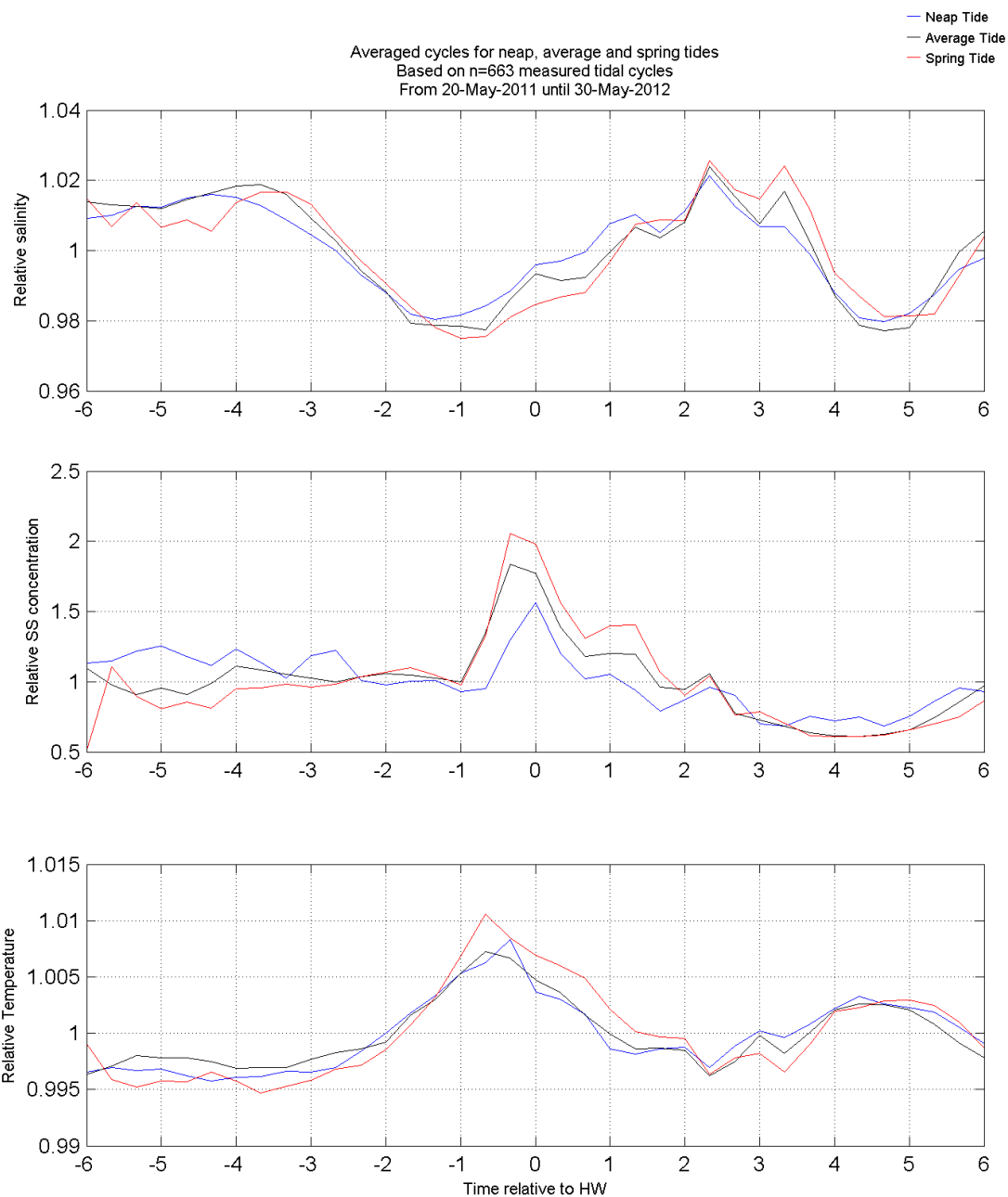
2011-2012

Equipment(s):

OBS-3A-CTD

Location:

S-ENTRANCE bottom



Relative Parameters for averaged tidal cycle

Data Processed by:

In association with :



I/RA/11354/10.112/MBO/ANF



Evaluation of external effects on the siltation of Deurganckdok

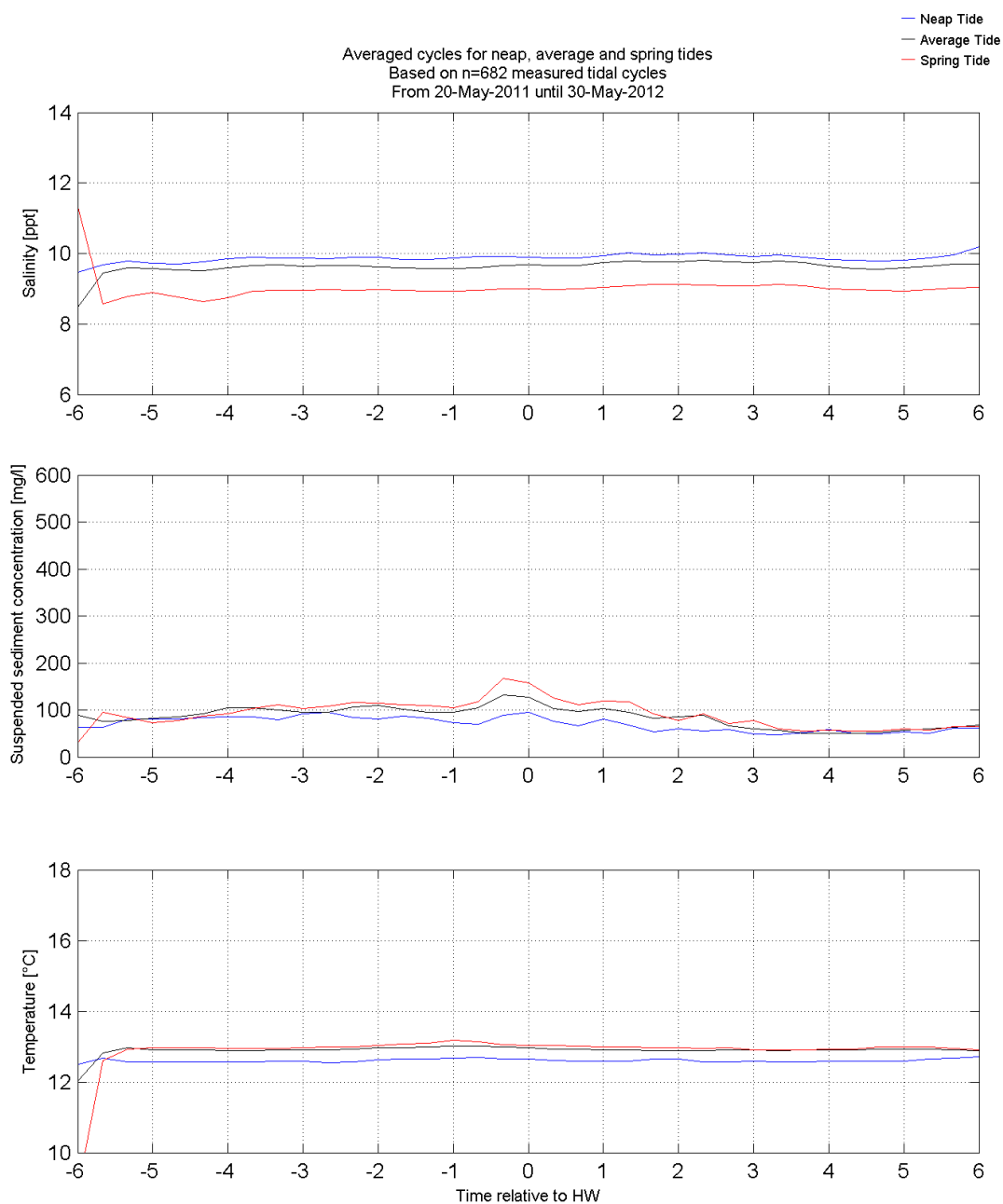
2011-2012

Equipment(s):

OBS-3A-CTD

Location:

S-ENTRANCE top



Absolute Parameters for averaged tidal cycle

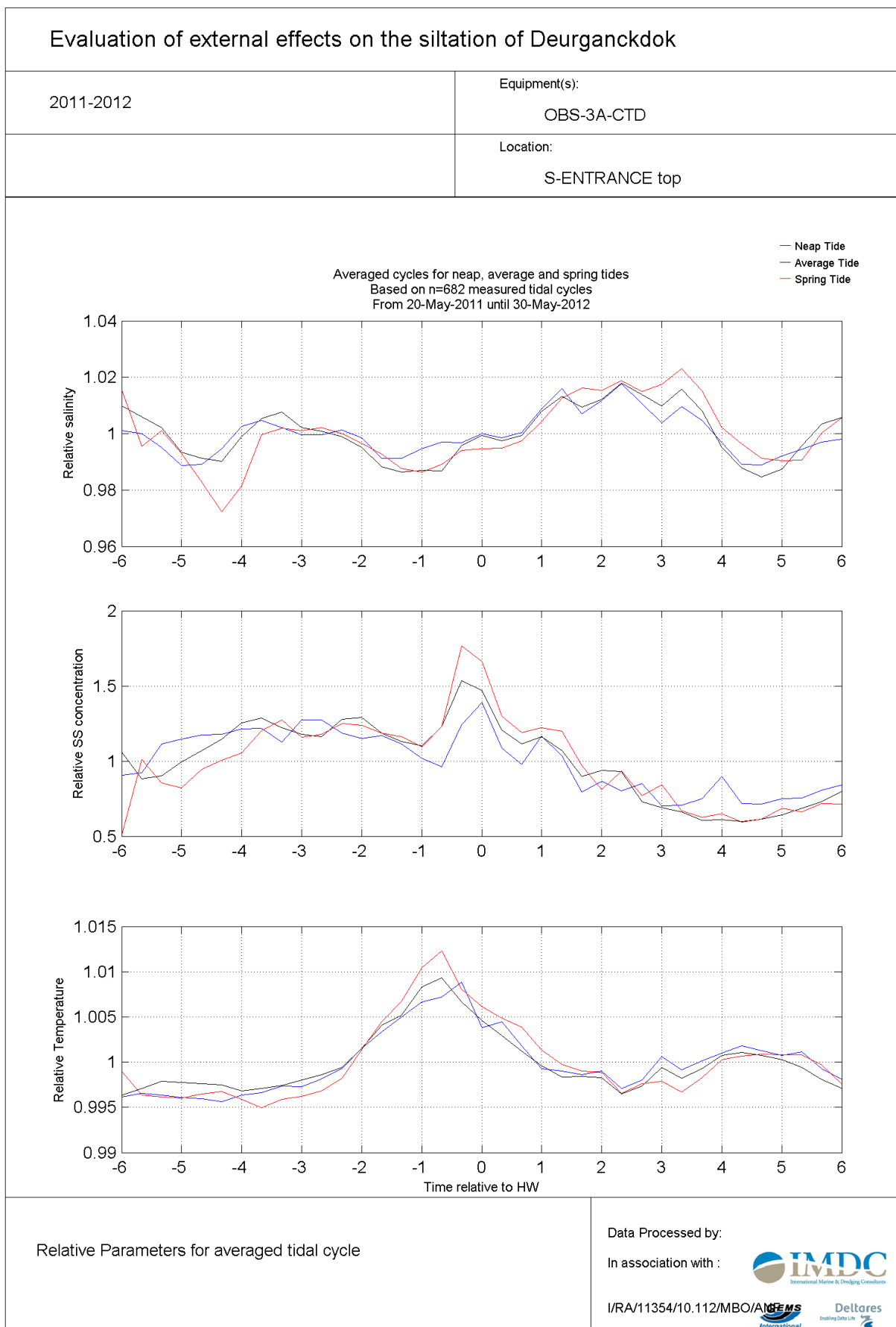
Data Processed by:

In association with :

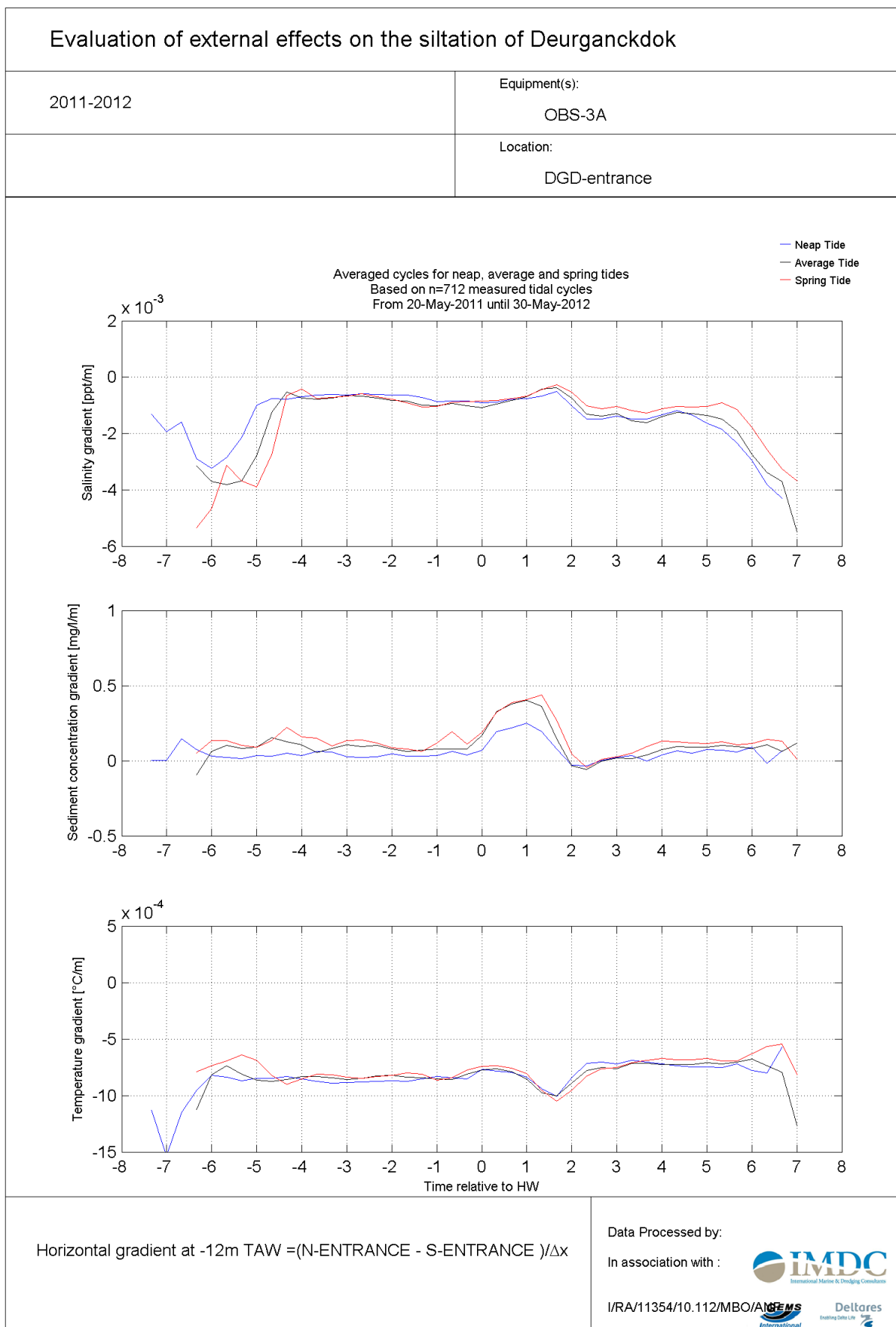


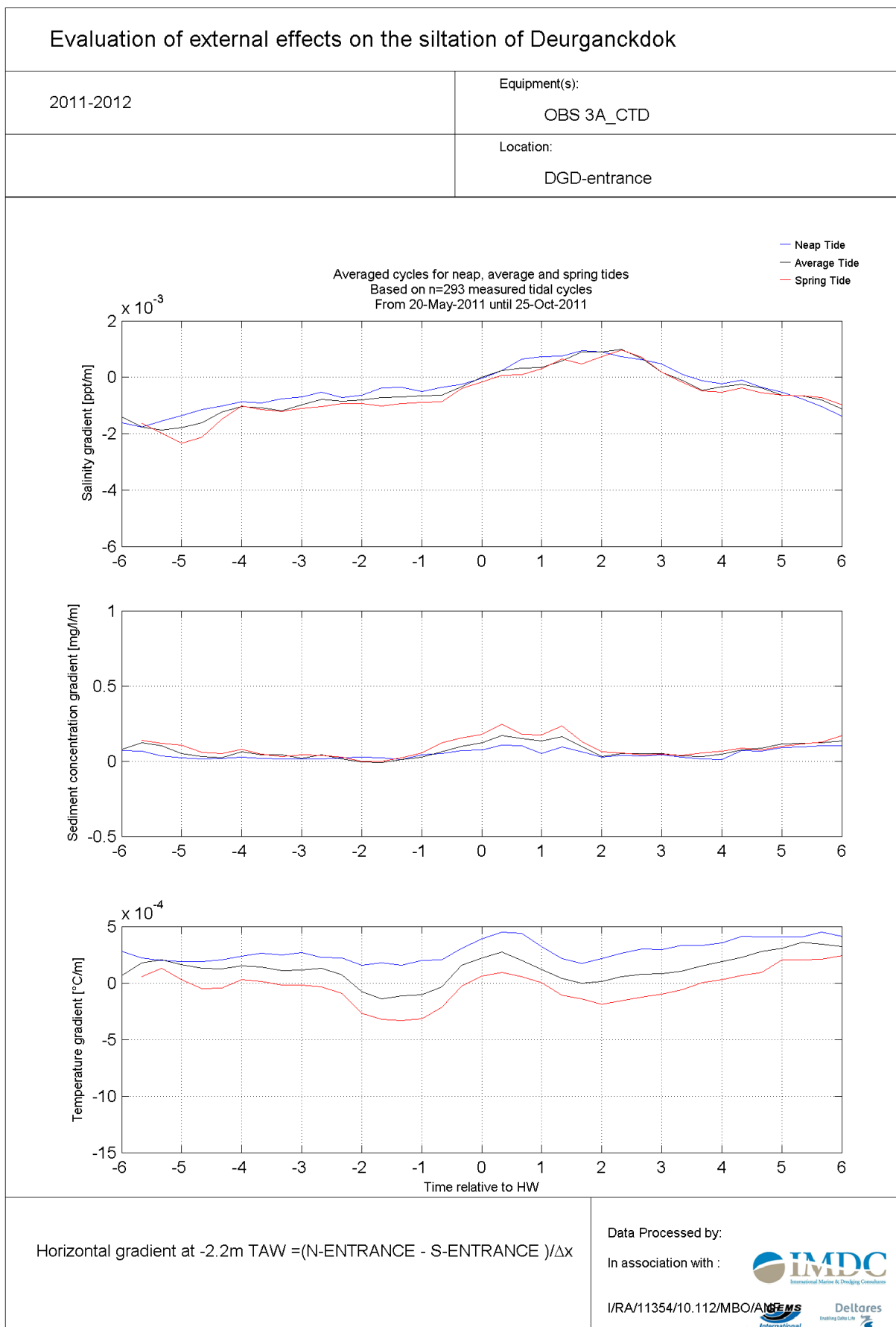
I/RA/11354/10.112/MBO/ANF





C.2 ***Cross dock and vertical gradients***





Evaluation of external effects on the siltation of Deurganckdok

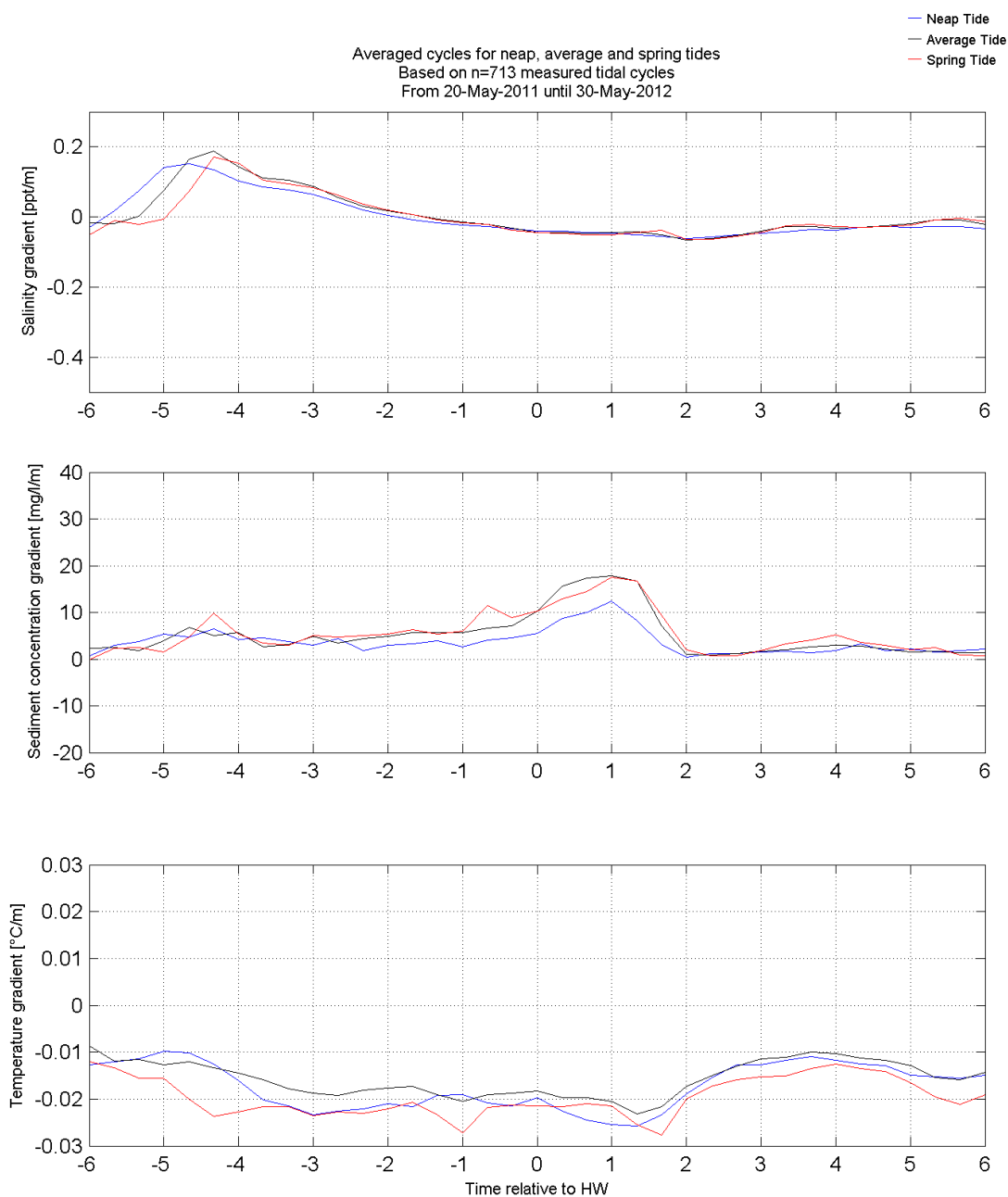
2011-2012

Equipment(s):

OBS 3A-CTD

Location:

DGD-PSA (N-entrance)



Vertical gradient at N-ENTRANCE $= (\text{data}(-13\text{m}) - \text{data}(-2\text{m})) / \Delta z$

Data Processed by:

In association with :



I/RA/11354/10.112/MBO/ANF



Evaluation of external effects on the siltation of Deurganckdok

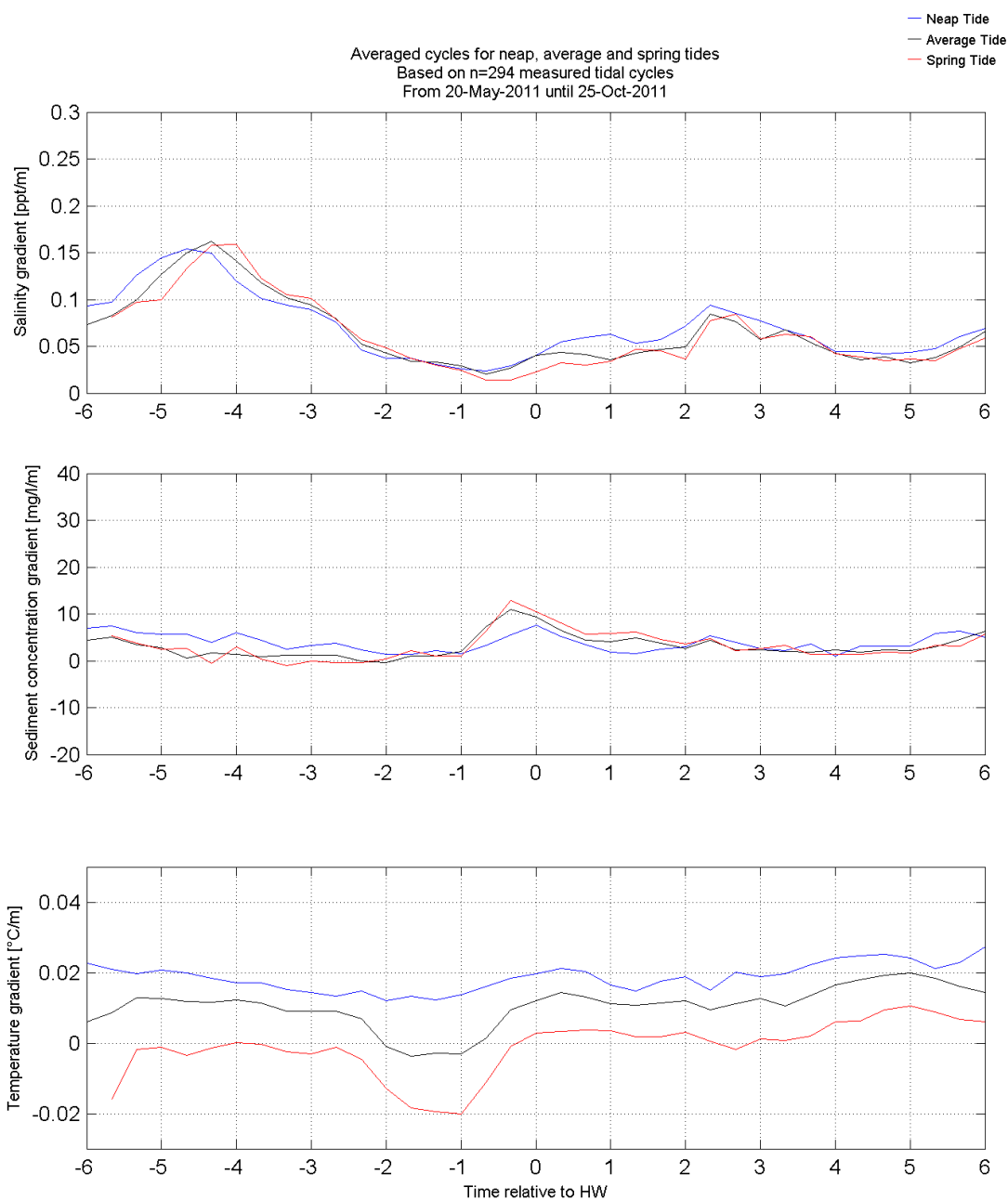
2011-2012

Equipment(s):

OBS 3A-CTD

Location:

DGD-DP (S-entrance)



Vertical gradient at S-ENTRANCE $= (\text{data}(-13\text{m}) - \text{data}(-2\text{m})) / \Delta z$

Data Processed by:

In association with :



I/RA/11354/10.112/MBO/ANF

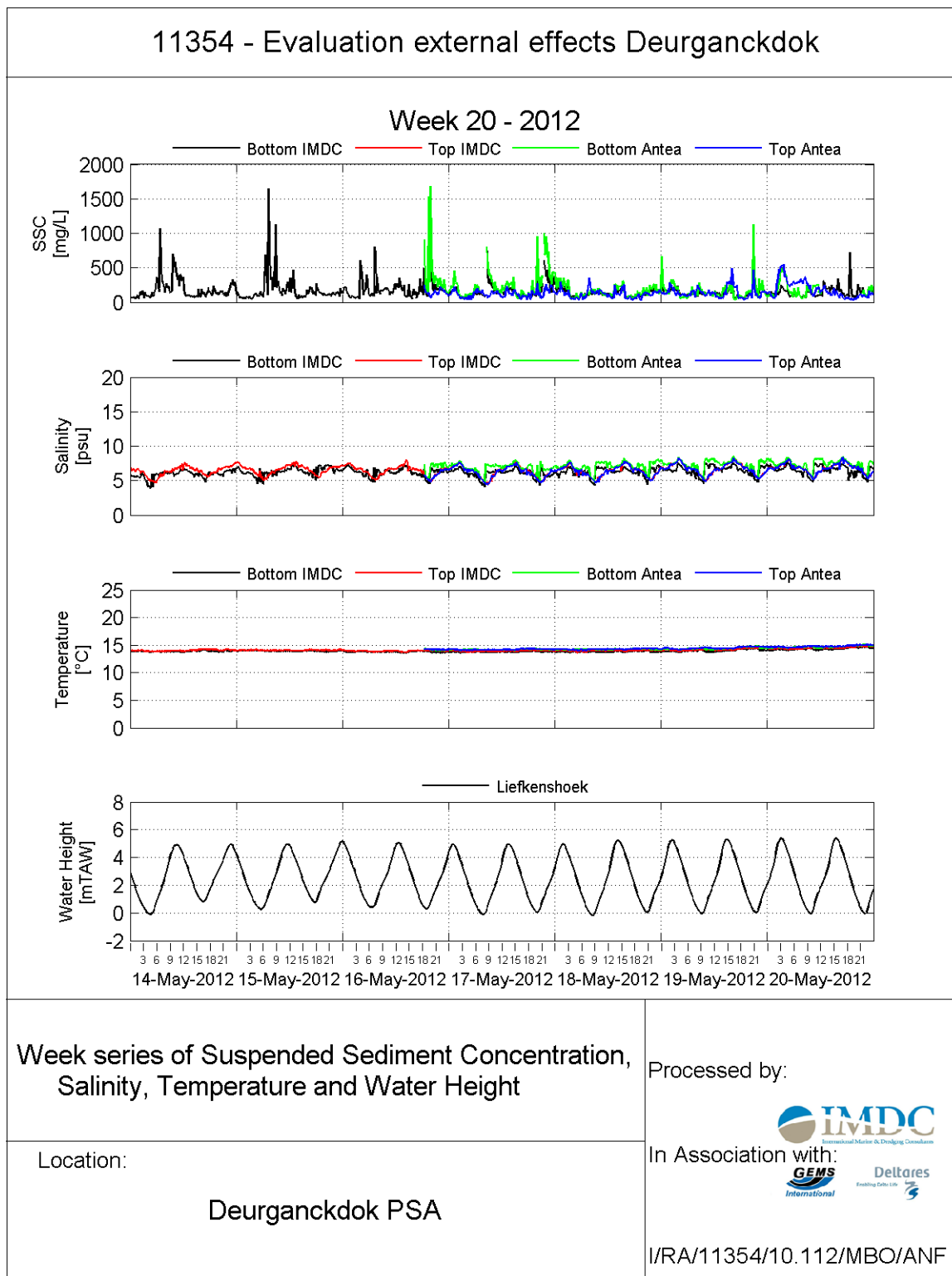


Annex D

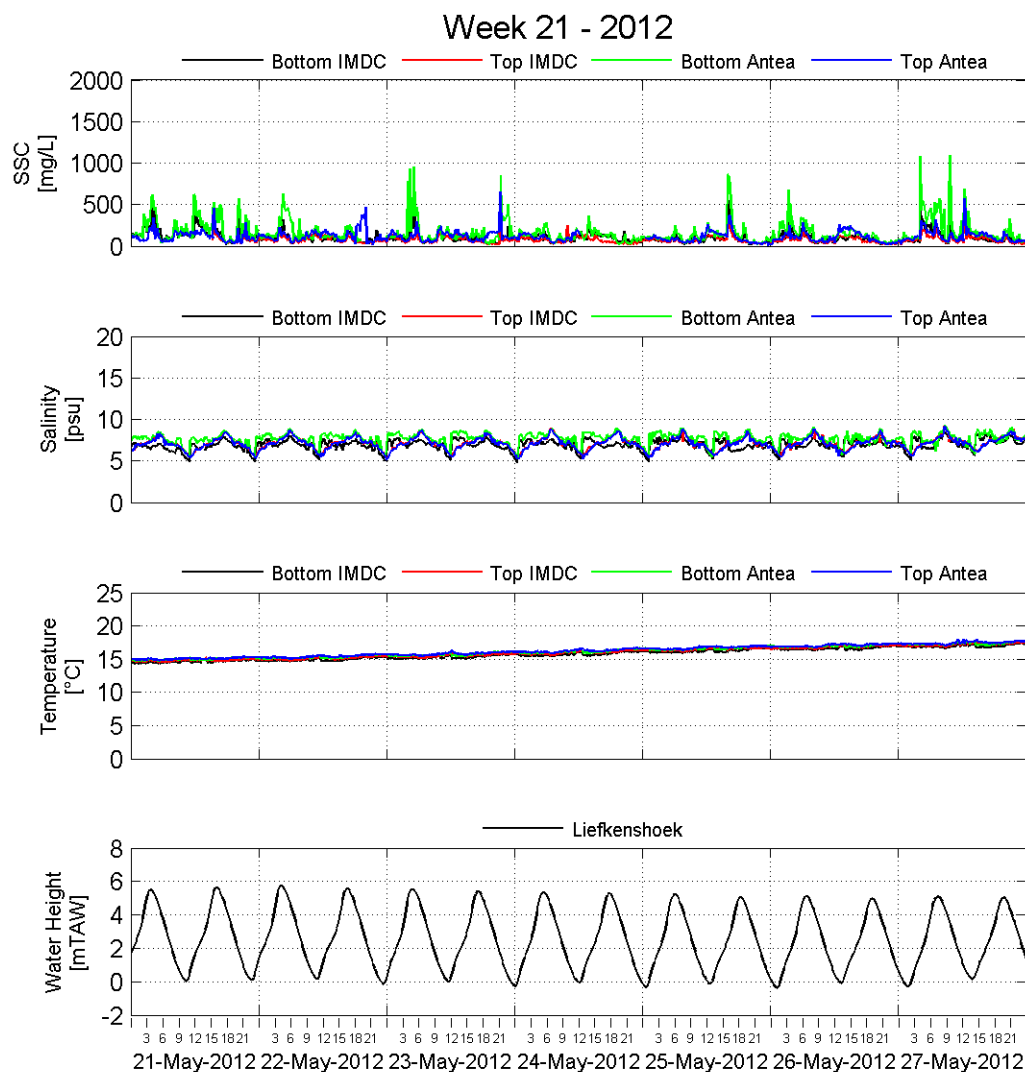
Comparison Antea and IMDC data

D.1 Timeseries

D.1.1 N-entrance (PSA)



11354 - Evaluation external effects Deurganckdok



Week series of Suspended Sediment Concentration,
Salinity, Temperature and Water Height

Processed by:



In Association with:

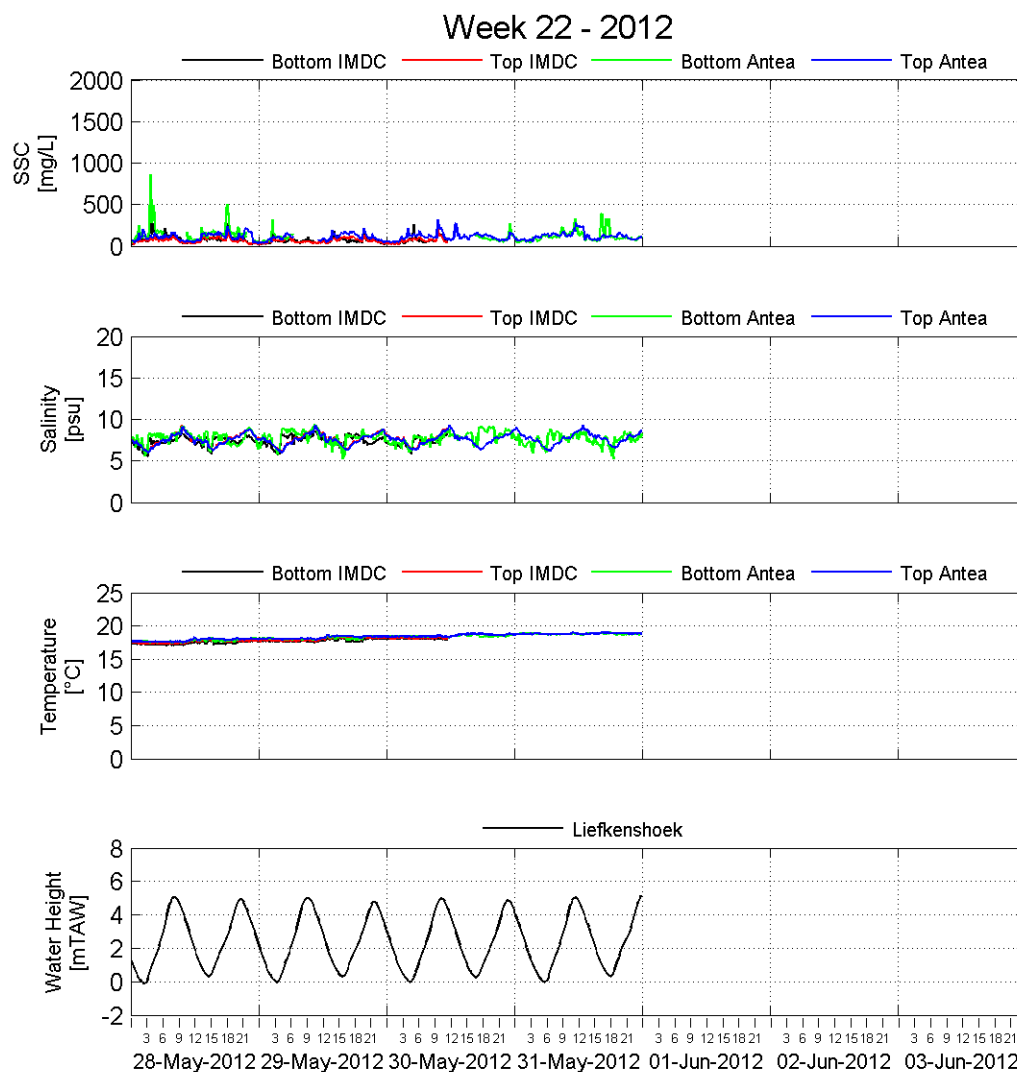


Location:

Deurganckdok PSA

I/RA/11354/10.112/MBO/ANF

11354 - Evaluation external effects Deurganckdok



Week series of Suspended Sediment Concentration,
Salinity, Temperature and Water Height

Processed by:



In Association with:

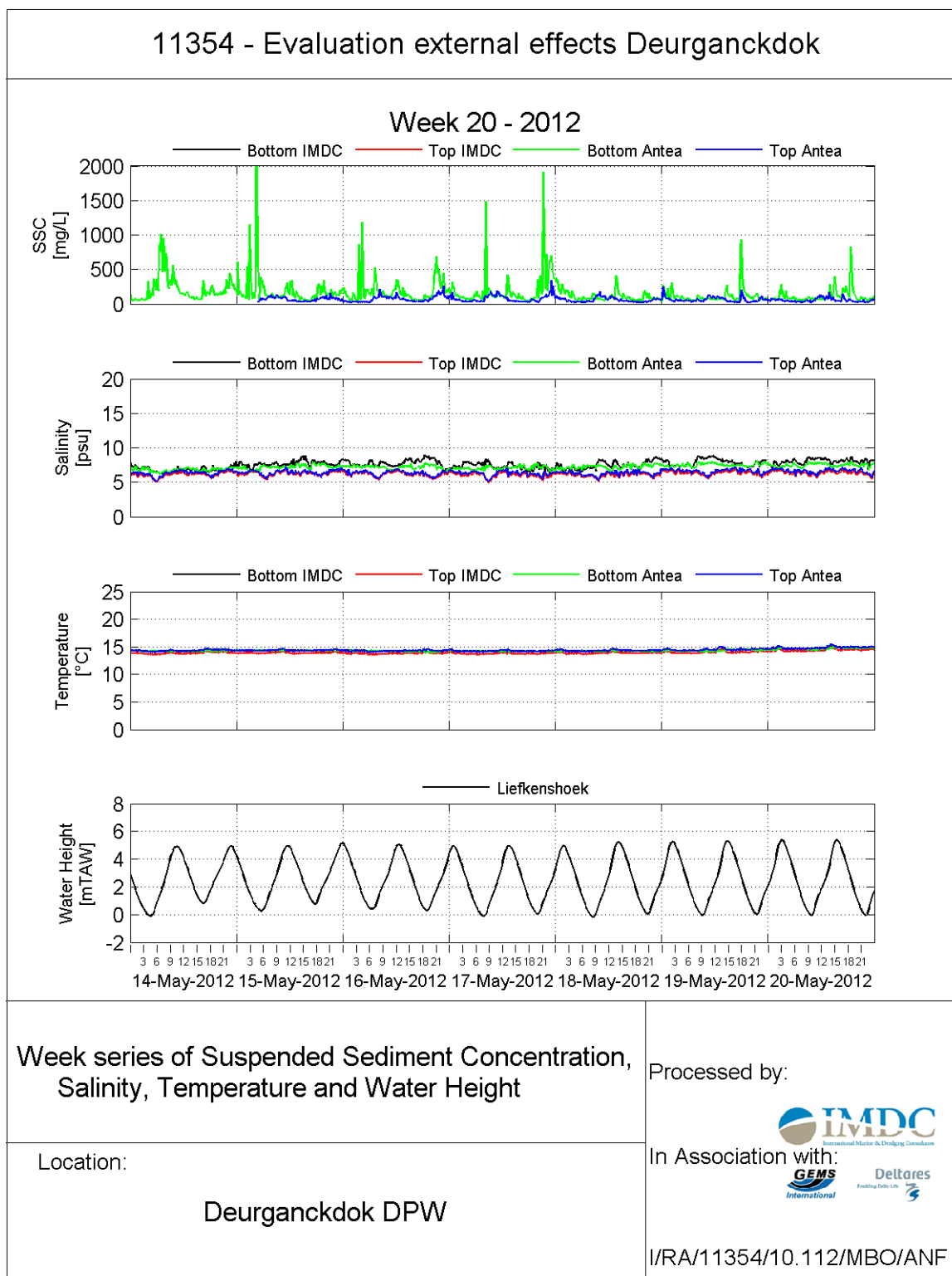


Location:

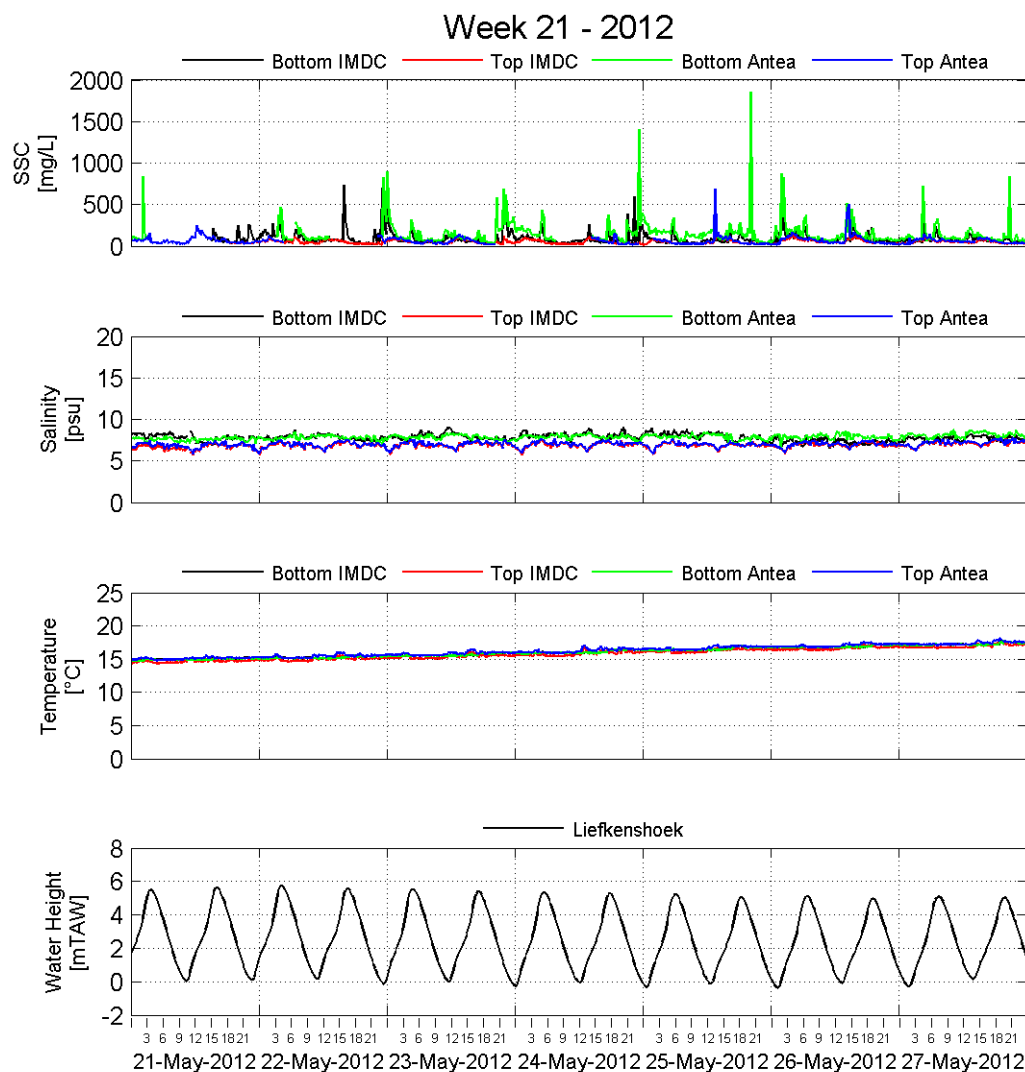
Deurganckdok PSA

I/RA/11354/10.112/MBO/ANF

D.1.2 S-entrance (DPW)



11354 - Evaluation external effects Deurganckdok



Week series of Suspended Sediment Concentration,
Salinity, Temperature and Water Height

Location:

Deurganckdok DPW

Processed by:

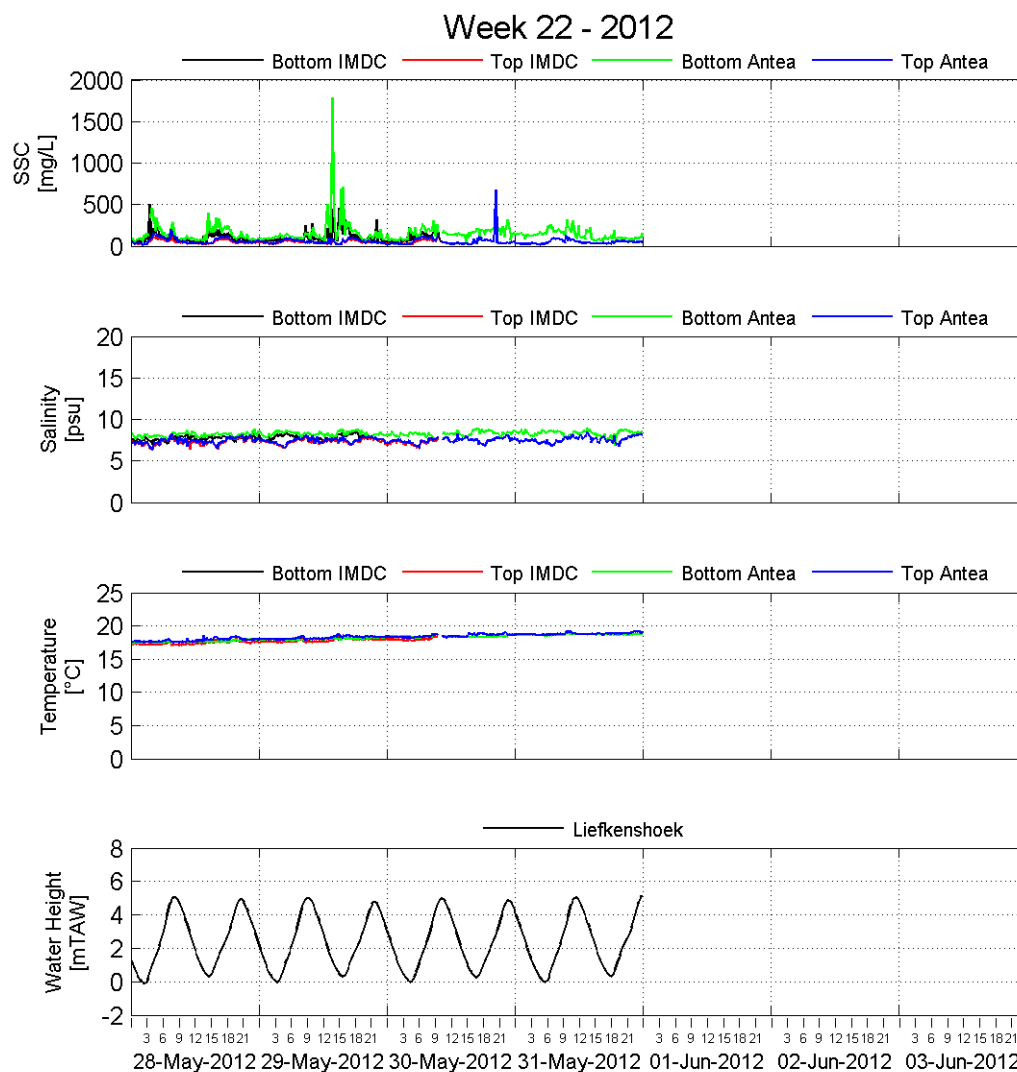


In Association with:



I/RA/11354/10.112/MBO/ANF

11354 - Evaluation external effects Deurganckdok



Week series of Suspended Sediment Concentration,
Salinity, Temperature and Water Height

Processed by:



In Association with:



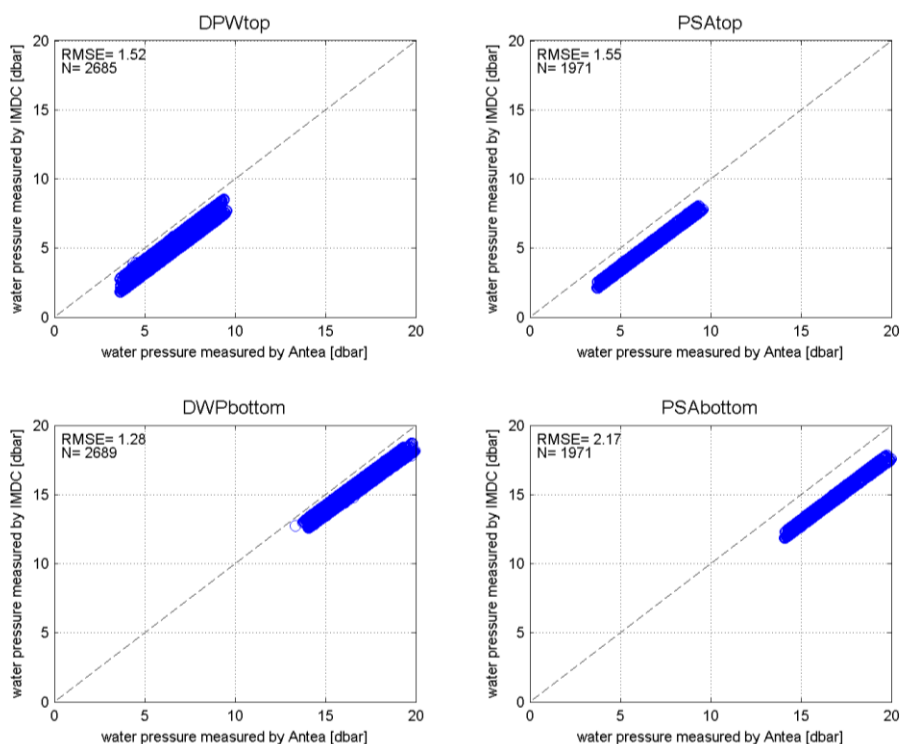
Location:

Deurganckdok DPW

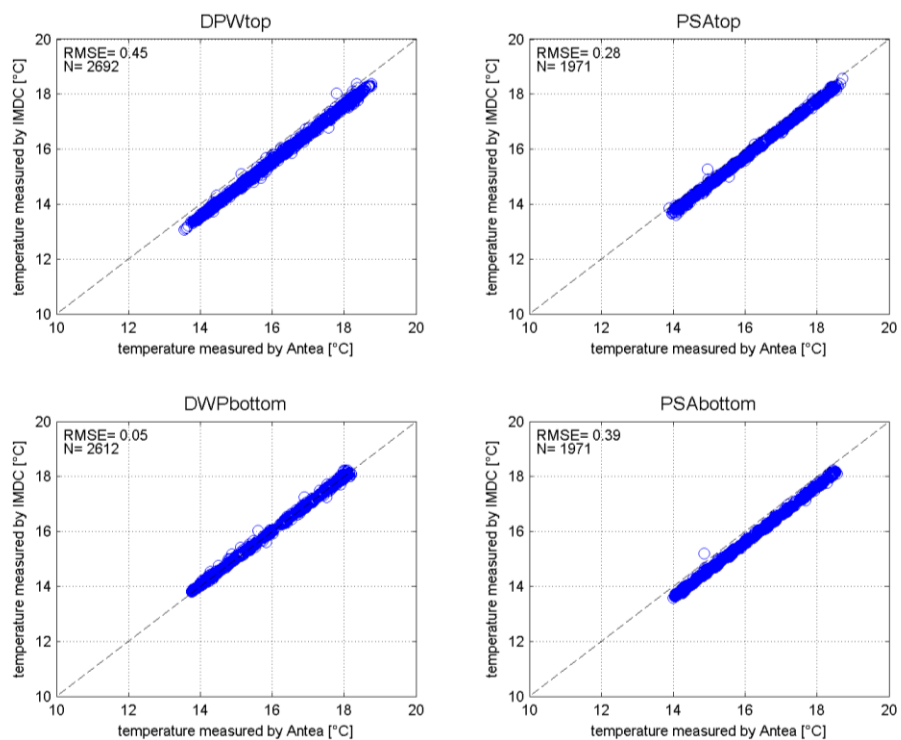
I/RA/11354/10.112/MBO/ANF

D.2 Scatterplots

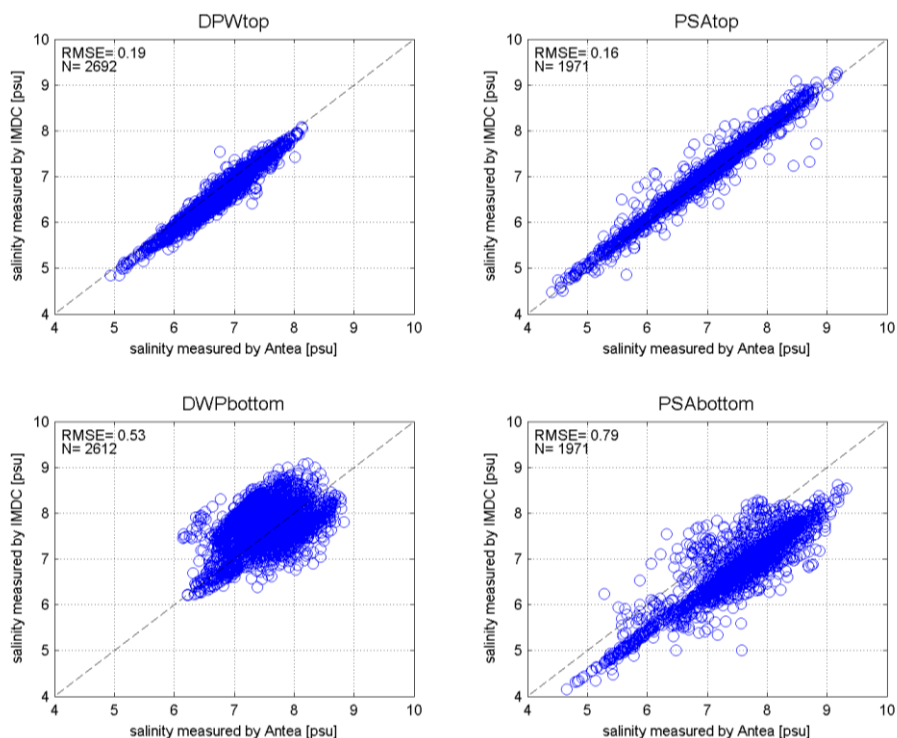
Pressure



Temperature



Salinity



Suspended Sediment Concentrations

