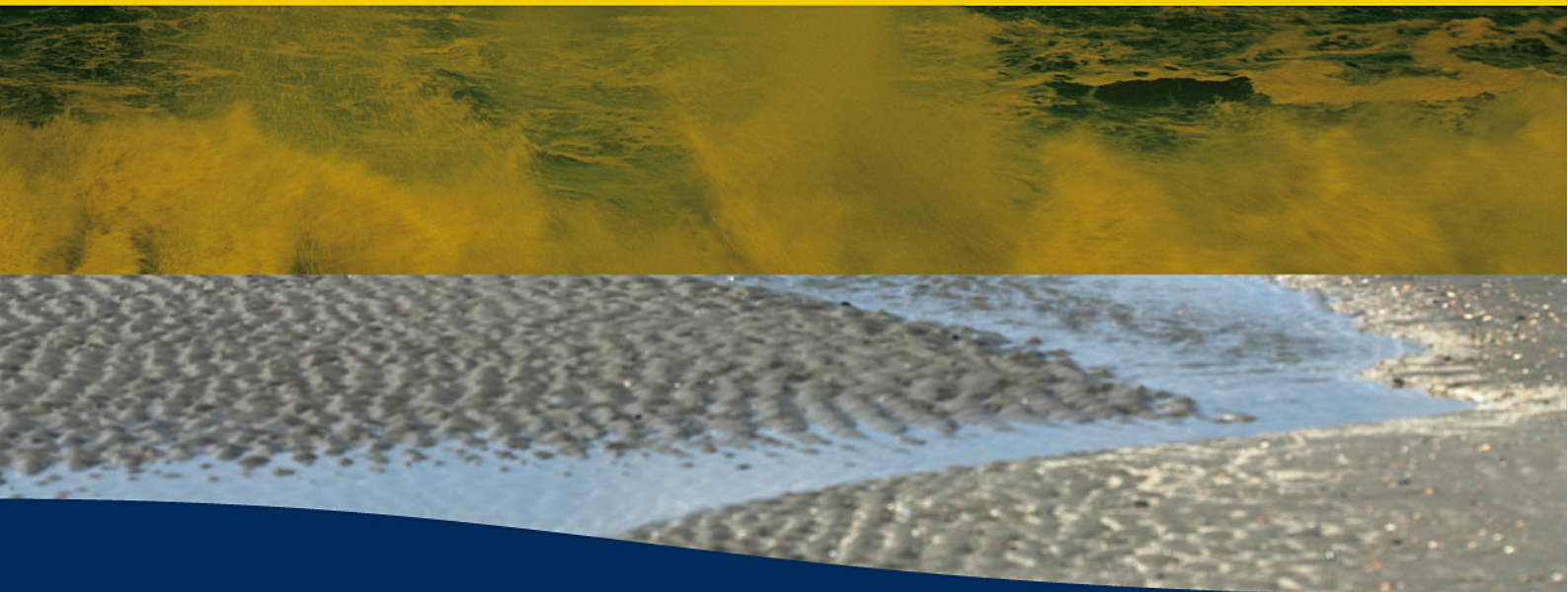




Siltprofiler data collected for Maasvlakte 2

Description of the raw and processed data
Manual for the MATLAB procedure to process the data



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Manual for the MATLAB procedure to process the data

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Introduction

Before, during and after construction of Maasvlakte 2 (2007 – 2013) a monitoring program was executed to measure the physical parameter suspended particulate matter (SPM) that might be involved in the (temporary) impact of the construction activities on the marine environment. The monitoring is described in the Monitoringsplan Aanleg Maasvlakte 2 (kenmerk 9P7008.M1, d.d. 15 augustus 2008, bijgewerkt d.d. 30 september 2008) in chapter 5.3 and appendix 2 (factsheet Z3). The aim of this report is to disclose the by Port of Rotterdam Authority (PoR) collected data to researchers and interested parties.

Design

The design of the monitoring program in 2007 consisted of 100 sampling stations (Fig. 1) in and around the area where effects of the construction of Maasvlakte 2 were expected (see EIA Construction Maasvlakte 2 / MER Aanleg, 2007). In the original plan sampling was restricted to 3 times each year, in total 300 measurements.

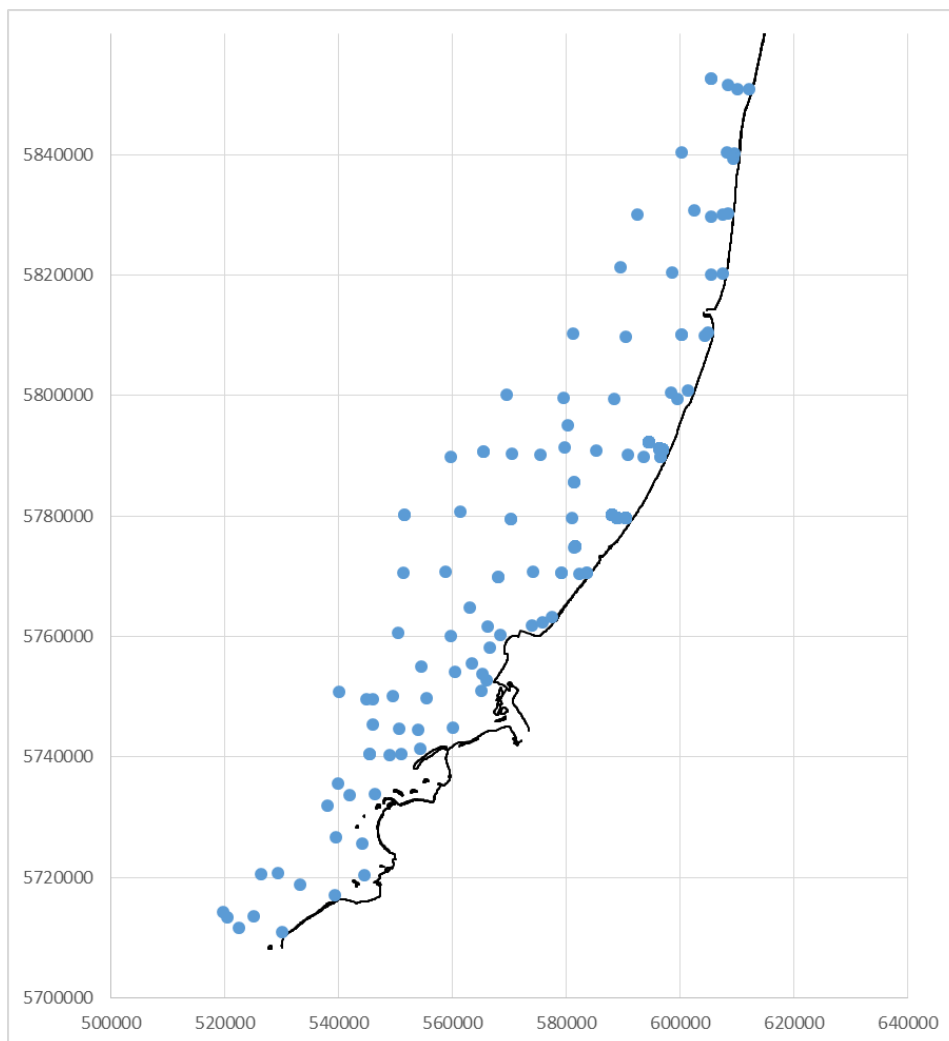


Figure 1. Stations sampled in april 2007

The order in which the sampling stations have been visited was partially randomized, because total randomization is not feasible. The exact location of the sampling stations is not fixed: sampling is done somewhere near the planned station, at comparable depth.

A study concerning the power of statistical analysis of SPM in the Dutch coastal zone (Blaas & vd Boogaard, 2006) showed that a much longer period of time and a very large number of sampling stations was necessary to establish the expected effect with statistical significance. In agreement with the Competent Authorities (RWS Z&D), the Port of Rotterdam Authority (PoR) decided to change strategy and became involved in a model study by Deltares and IVM (Tnul-TSM). This finally led to the development of a new model, commissioned by PoR and developed by Deltares. It was decided to use the measured profiles for validation of this MoS² model.

To reduce spatial autocorrelation, which leads to decrease of statistical power, and to increase the variation in weather conditions it was decided, in agreement with the Competent Authorities, to increase the number of cruises by a factor 2 and to decrease the number of sampling stations per cruise by a factor 2. In this way the total number of measured profiles remains unchanged (6 x 50 locations = 300 measurements a year). However, as a result, the average sailing time between sampling stations increased, although sufficient randomization within one cruise of 100 stations would probably have led to comparable sailing times. Later changes in the monitoring strategy were made on request of the MoS² developers. These changes will be discussed later (Section “Data collected”).

Measuring devices

First siltprofiler

Vertical SPM profiles were measured with two so-called siltprofilers, one existing device (used until 2009) and one newly developed device (from 2009 onwards). In 2009 and 2010 both were used, although not simultaneously. The first siltprofiler consists of a CTD (instruments measuring conductivity, temperature and pressure [depth]), one OBS (later 2), a chlorophyll fluorescence meter, two extinction sensors to determine higher concentrations of SPM, and three Niskin bottles to take water samples. All instruments are mounted on a simple frame, together with a central unit containing batteries, memory (data storage) and a processor to control the measurement. The unit receives its instructions by blue tooth communication from the computer situated on board the survey vessel. A description of the most important instruments is given below.

New siltprofiler

The second instrument frame (the “new siltprofiler” or “measuring platform PMV2”, Fig. 2), specially developed by Deltares for PMV2 (Projectorganization Maasvlakte 2), has more instruments. The central unit, also operated by blue tooth, contains batteries, a data recorder and a processor controlling the instruments.

Each (new) measurement starts by sending instructions (blue tooth) to the central unit, while it is still above water. Next the frame is lowered in a controlled manner (~ 0,1 m/s) into the water. The most important “command” sent to the profiler is the measurement time, the estimated time for completion of a complete cycle, including downcast (measurement during the lowering of the frame) and upcast (measurement during the lifting of the frame).

CT. Conductivity and temperature are measured by two separate sensors on the old siltprofiler. The conductivity sensor is based on electrical resistance. Both sensors are in direct contact with the surrounding water. The new siltprofiler has only one device combining conductivity measurement (by induction) and temperature measurement. Water is passing both sensors through a small channel inside the device.

Pressure sensors measure pressure, which is a substitute for the depth under the water surface.

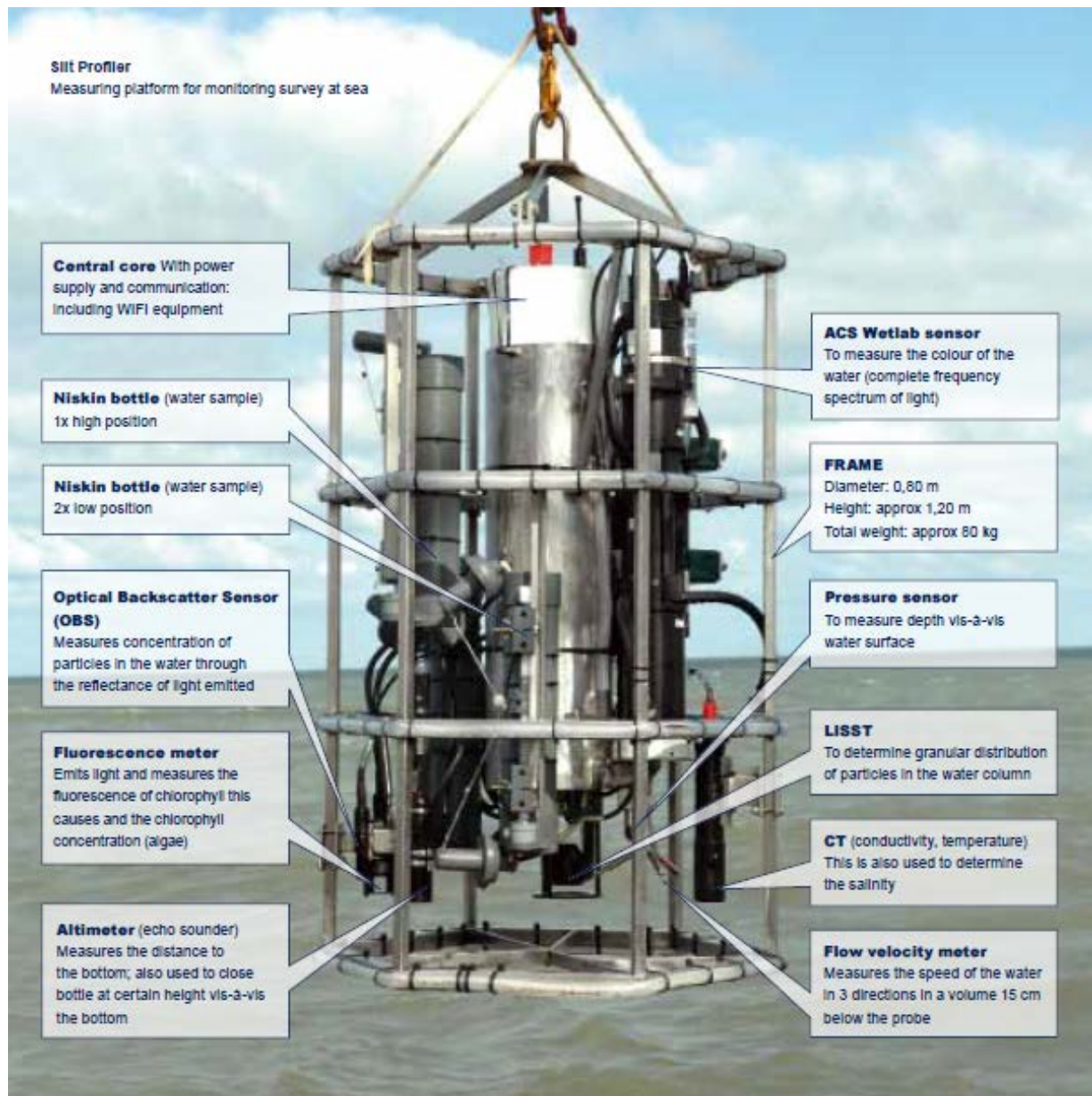


Figure 2. The new silt profiler

OBS sensors (on both profilers “Seapoint” are installed) are measuring optical backscatter. Light is emitted from the sensor into the water and the intensity of the backscattered light is measured. In 2007 the OBS on the old profiler was calibrated on “natural” silt (stemming from the Botlek area). From July 2007 onwards all OBS have been calibrated to FTU (formazine turbidity units) with formazine.

Altimeter. The altimeter on the new profiler is a simple echo sounder (Frequency 220 kHz), measuring the distance to the sediment surface (seabed).

Chlorophyll is measured by sending light into the water, which causes fluorescence (light emission) of chlorophyll. The emitted light is measured and calibrated to chlorophyll concentration in µg/l.

ADV (Acoustic Doppler Velocymeter, Nortek Vector). Like an ADCP (Acoustic Doppler Current profiler) the ADV sends sound into the water. Because particles in the water are moving with the current, the frequency of the backscattered sound is shifted differently in different directions. From the frequency shift in three

directions the current velocity and direction can be estimated. At the same time the intensity of the backscattered sound is a measure for the amount of particles in the water.

LISST100 (Laser In Situ Scatter and Transmission, Sequoia Scientific Instruments; Agrawal et al., 2008; Sequoia, 2012). A laser beam is sent into the water. The light is scattered by particles in the water and the scattered light is measured by a series of concentric sensors. The central sensor measures the transmitted light, which can be converted to extinction, which is linear with the concentration of suspended particles. From the concentric sensor the particle size distribution is estimated.

ACS (spectrophotometer; Wetlabs, 2013). The ACS is a spectrometer which measures the extinction over the whole visible light spectrum. The results of the near surface measurements were supposed to help with the interpretation of remote sensing data in the Tnul-TSM project, but were never analyzed because, after completion of MoS2 WP4 (van der Woerd & de Reus, 2010), IVM refused to analyze the data without payment. The ACS data were collected on request of IVM to improve their algorithm(s) for The North Sea area, i.e. as an extra for PhD research at IVM. The data is still available for interested researchers, however see also the note under data collected in this respect.

Note 1: The SPM values resulting from the measurements by the various instruments on the siltprofiler (OBS, ADV, and the LISST) are a (variable) mixture of organic and inorganic matter.

Note 2: The survey vessels employed were equipped with an ADCP, hence velocity profiles are also measured at each station, provided the instrument worked and logged correctly.

Data collected

In the period from April 2007 to May 2013 ca. 3000 profiling measurements (Table 1) have been taken, at least consisting of a combination of CTD (conductivity, temperature, depth sensors) and an OBS (optical backscatter sensor, for turbidity caused by suspended particulate matter). In most cases also velocity profiles are available from measurements with ADCP (Acoustic Doppler Current Profiler) and/or ADV (Acoustic Doppler Velocimeter). Also estimates for grain size distributions of the suspended particulate matter (SPM) were obtained from measurements with the LISST and data were collected with the ACS (a visible light spectrophotometer).

Note : The ACS data have not yet been processed (see above) and as a result in later years insufficient attention has been paid to calibration of the ACS.

The processing results in data files of different levels (degrees of elaboration).

- Level 0 is the (raw)data as collected by the instruments, but written in a different file format (netCDF files level 0).
- Level 1 is the data after calibration, i.e. after transformation of instrument readings to SPM values, by calibration of the instruments, after correction of measured ADV velocities for drift of the ship and cut values for downcast and upcast (netCDF files level 1).
- Level 2 is different from Level 1 because data for OBS and CTD have been smoothed and summarized in 5 cm depth (or altitude above sediment) bins. Note that ADCP data are in 50cm bins from the start.

Details on the data processing are given in Appendix 1.

The data (raw and processed) are placed at the Deltares repository:

<https://repos.deltares.nl/repos/MOS2Meet/Trunk/Data>

The scripts for processing as used by POR are also available at the Deltares repository:

<https://repos.deltares.nl/repos/MOS2Meet/Trunk/ScriptsV3>

Table 1. Estimated number of profile measurements during each period.

The number of profiles is indicated for each level of processing. The numbers have been derived from lists of file names in which the same profile may have been processed more than once or in which measurements repeated within short time are also included. Transects (not always all stations within the transects have been measured) added, as well as special projects are mentioned in the remarks with the abbreviation which is used further down in the table.

Profiler	OLD SILTPROFILER			NEW SILTPROFILER			Remarks
Period	lv0	lv1	lv2	lv0	lv1	lv2	
2007Aprl	123	123	123				including repeated measurements at several stations and 13 hrs Noordwijk (NW)
2007Juli	139	139	139				
2007OkNo	126	126	126				
2009wk17	138	138	138				
2009wk22	65	65	65				
2009wk30	69	69	69	60 ?	60 ?	60 ?	first week with new profiler ,26 hours NW, Sand mining pit (ZW)
2009wk31	14	14	14	153	153	152	26 hours NW, many unsuccessful attempts
2009wk33	1	1	1	34	34	34	ZW
2009wk38	65	65	65	111	111	111	Egmond transect (EG) first time
2009wk43	101	101	101				
2009wk47	55	55	55				
2010wk07				65	65	65	EG
2010wk16				73	73	73	EG, NW, ZW
2010wk25				131	131	131	
2010wk32				80	80	80	EG
2010wk41				117	117	117	NIOZ transect (NI) first time, ZW
2010wk49				70	70	70	EG, NW
2011wk07				79	79	79	EG
2011wk15				73	73	73	EG, NW, first time Sand Motor (ZM)
2011wk22				70	70	70	
2011wk27				75	75	75	EG, NW
2011wk41				64	64	64	NIOZ 13 hours parallel measurement, NW
2011wk47				72	72	72	Goeree and Schouwen transect RWS (GO, SN) first time, NI, NW
2012wk07				17	17	17	GO, ZM
2012wk16				95	95	95	EG, GO, NI, NW, SN
2012wk25				105	105	105	EG, GO, NI, NW, SN, ZM, ZW
2012wk36				126	126	126	EG, GO, NI, NW, SN,ZM, ZW
2012wk46				71	71	71	GO, NW, SN, ZM
2012wk51				102	102	102	EG, GO, NI, NW, ZM, ZW
2013wk07				90	90	90	EG, ZM
2013wk16				100	100	100	EG, GO, NW, SN, ZM, ZW
2013wk21				152	152	152	Benthos recolonisation, NW
Total Old	961	960	960				
Total New				2125	2125	2124	
Grand total				3086	3085	3084	Old+New Profiler
Subtotal Old+New				2340	2340	2340	after correction for repeated measurements
Planned				1550	1550	1550	according to MEP
% realised				151%	151%	151%	not corrected for 13h and 26 hrs campaigns and special stations

Table 1 shows that ca. 50% more profiles have been measured than planned in the monitoring plan. There are several reasons for that:

- PoR planned a 13 hrs measurement at the Noordwijk transect in the Oktober-November campaign of 2007.
- To validate the model for the Rhine ROFI (Region of Freshwater Influence) developed by G. de Boer, two 26 hour measurements at the Noordwijk transect in 2009 (spring tide and neap tide were carried out.
- During the development of the MoS² model Blaas et al. (lit.) discovered some areas where the model was biased. PoR was asked to measure (if possible) also in the Goeree and Schouwen transects of Rijkswaterstaat.

- Near Scheveningen a transect was laid out.
- PoR cooperated in several projects with third parties (RWS Noord-Holland, NIOZ, TU Delft) resulting in simultaneous measurements in time and space.

Most of the stations in transects were nearby planned sampling stations, so the original sampling design was not violated. Figure 3 shows the stations sampled in 2011.

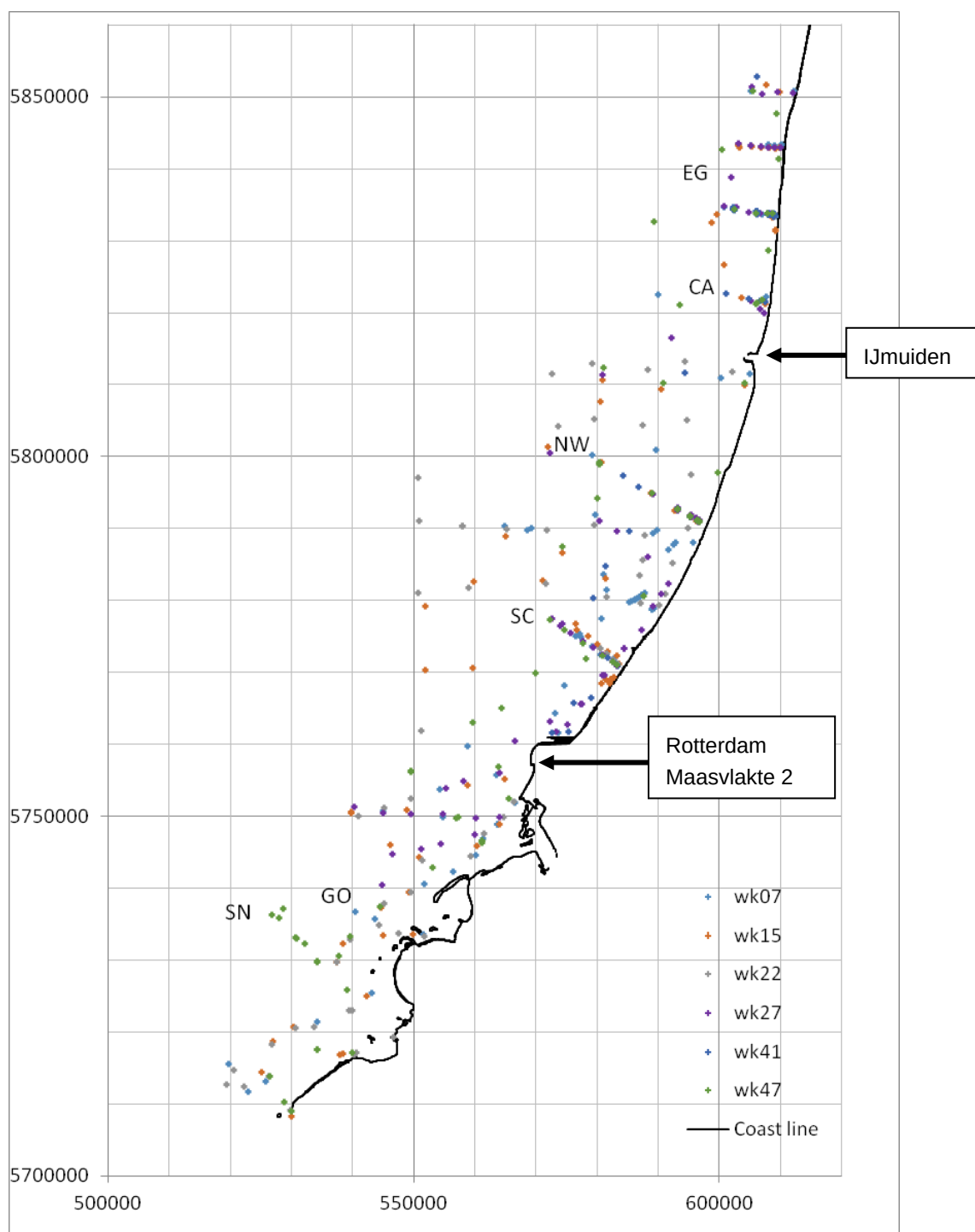


Figure. 3. Sampled stations in 2011, including transects for MoS^2 (Goeree [GO], Schouwen [SN]), extra measurements for RWS-NH (Johan de Kok, Egmond [EG]), project NIOZ (Carola van der Hout [CA]) and transects at Noordwijk ([NW] first sampled 13 hours in 2007, 26 hours in 2009) and Scheveningen [SC]

Table 2. Estimated number of files processed to level 2.

LISST measurements, although processed, and ACS measurements (not processed) are not included.

Yellow highlights indicate that some of the instruments failed too often during a measurement campaign.

Period	New						Old			
	CTD_down	CTD_up	ADCP	ADV_down	ADV_up	GPS_down	GPS_up	CTD_down	CTD_up	ADCP
2007Aprl								123	123	120
2007Juli								137	137	122
2007OkNo								126	126	0
2007 total								386	386	242
2009wk17								134	135	118
2009wk22								123	124	103
2009wk30	64	64	54	41	41	50	50	66	67	63
2009wk31	152	152	146	79	78	75	75	14	14	14
2009wk33	34	34	32	34	34	32	32	1	1	0
2009wk38	111	111	89	83	83	110	110	64	64	33
2009wk43								98	98	85
2009wk47								55	55	0
2009 total	361	361	321	237	236	267	257	555	557	416
2010wk07	65	64	64	64	64	64	64			
2010wk16	73	73	60	73	73	66	66			
2010wk25	128	128	125	89	89	131	131			
2010wk32	80	80	80	80	80	69	69			
2010wk41	117	117	117	115	115	65	65			
2010wk49	70	70	70	70	70	60	60			
2010 total	533	532	516	491	491	455	455			
2011wk07	79	79	79	79	79	79	79			
2011wk15	73	73	73	73	73	73	73			
2011wk22	70	70	69	63	63	63	63			
2011wk27	75	75	75	75	75	75	75			
2011wk41	64	64	52	55	55	59	59			
2011wk47	71	71	70	57	57	58	58			
2011 total	432	432	418	402	402	406	406			
2012wk07	17	17	0	0	0	12	12			
2012wk16	95	95	10	92	91	84	84			
2012wk25	103	103	100	94	94	100	99			
2012wk36	125	125	124	123	123	126	125			
2012wk46	71	71	17	71	71	66	66			
2012wk51	102	102	73	102	102	102	102			
2012 total	513	513	324	482	481	490	488			
2013wk07	90	90	15	17	17	15	15	76	76	72
2013wk16	100	100	99	100	100	83	83			
2013wk21	152	152	142	142	142	132	132			
2013 total	342	342	256	259	259	230	230	76	76	72
Total	2181	2180	1835	1871	1869	1849	1847	1017	1019	1093

Table 2 shows that not all measurements have been processed to level 2. The new profiler became available in week 30 2009. Before that, PoR used the old profiler. However the conductivity sensor of the old profiler often failed from October 2007 to 2009 week 38. From 2009 week 43 onwards the conductivity sensor of the old profiler is OK.

After a first period of tests the stainless steel tubes of the frame of the new profiler were filled with resin to avoid air bubbles and the system's wiring was renewed to avoid errors by short circuits and loose contacts, which led to malfunction on many occasions. During the implementation of these adaptations, PoR used the old profiler (week 43 and week 47, 2009). In week 47 2011 and week 7 2012 the air (and seawater) temperatures were very low, causing the sealing rubber of the LISST to break, creating a short circuit. The LISST problem caused other problems and PoR had to abandon / break off the campaign. The old profiler was not available. In week 7 2013 the winch cable broke and the profiler went down to the bottom of the sea. It was salvaged, although lightly damaged, fortunately PoR could use the old profiler instead.

Literature

N.B. The literature mentioned is a selection of the available literature. Not all references are in the text.

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List of appendices

1 Manual for the MATLAB procedure Siltprofiler_processingV2 and V3

2 Contents of the LOG-file

3 Plot settings

4 Instrument settings

5 Error messages and informative messages

6 Interpretation of the data and data quality, some examples

7 Calibration

APPENDIX 1

Manual for the MATLAB procedures Siltprofiler_processingV2 and Siltprofiler_processingV3

Introduction

The procedure Siltprofiler_processingV2 has been written in the course of the measurement campaigns of Maasvlakte 2. A first version was written in 2010/2011 by Joost van Wiechen during his traineeship as a TU Delft student at the Port of Rotterdam (2010). In 2011 he further developed the procedure, commissioned by Data-Analyse Ecologie (DAE).

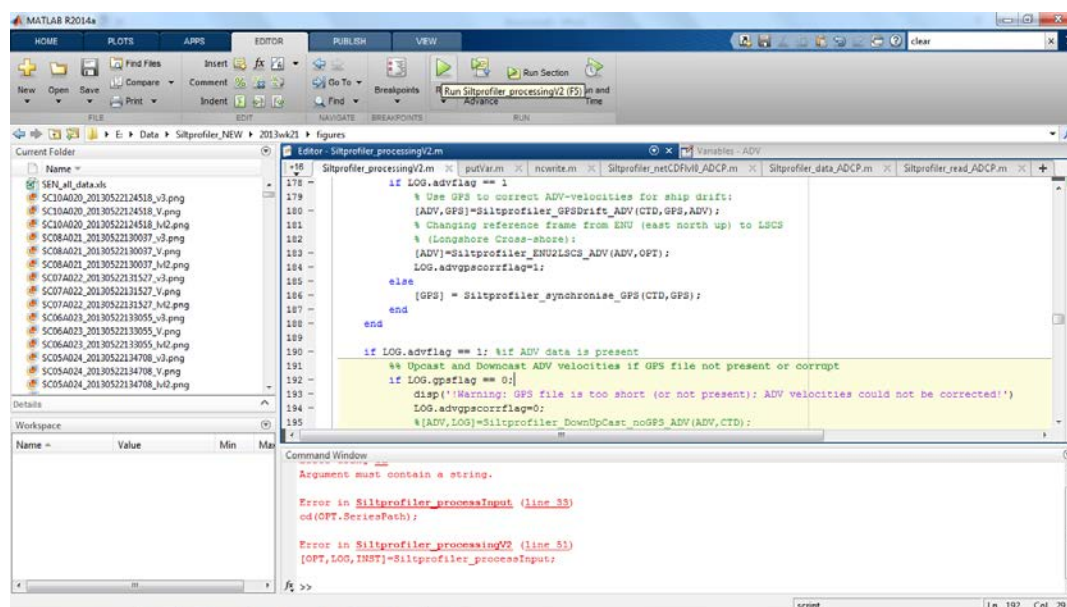
Emma Sirks, during her traineeship (TU Delft, PoR, 2012), was involved in debugging the procedure. In 2013 the procedure was revised by Jasper Dijkstra (Deltares) and Onno van Tongeren (DAE) and many procedures were added, mainly to export the data to netCDF files. Further refinements and additions were made by Sabine Rijnsburger (TU Delft, traineeship at PoR 2013) and Onno van Tongeren. The different programming styles as well as the differences in messages can still be seen in the procedures.

As the procedure is still being developed (and debugged) the manual may deviate from the procedure as it is described at this moment (November 2015). At this moment a Siltprofiler_processingV3 is available on the Deltares repository at Mos2Meet\Trunk\ScriptsV3. The previous versions should not be used anymore. The procedure needs some of the tools developed in the Open Earth project of Deltares. Therefore the procedure "oetsettings" (open earth tools settings) should be run before Siltprofiler_processingV2 is invoked. The procedure oetsettings.m can be found at the Deltares repository in the directory Open Earth Tools.

Siltprofiler_processingV3

The manual (guideline) for the procedure Siltprofiler_processingV3 is written for MATLAB users with some experience. The procedure needs some input files, in which a list of the raw data (log file) and a description of the measuring devices (input instrument) are given. For the MV2 data all log files and instrument position files are available. After running oetsettings (Open Earth Tools, Deltares). Add the open earth tools path to the MATLAB path.

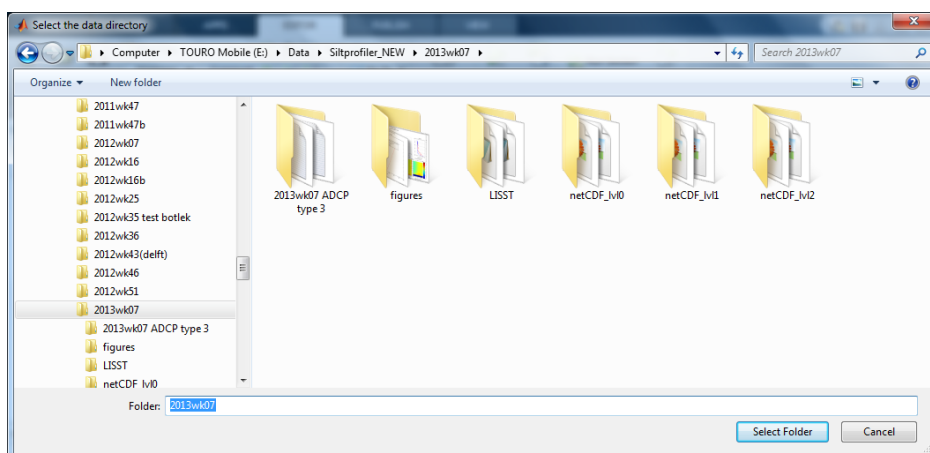
Mos2Meet\Trunk\ScriptsV3\Siltprofiler_processingV3 should be opened, after which it is executed by clicking "Run". Also the path of Siltprofiler_processingV3 should be added to the MATLAB path.



After prompting for the data directory, the procedure first asks to open the log file and the instrument position file, which should be both in the same data directory as the raw data files. Further details and a list of the files are given in appendix 2.

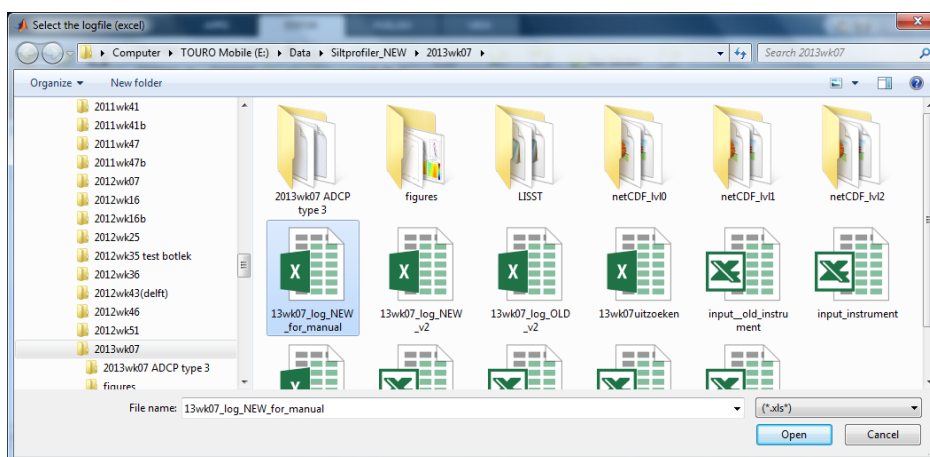
Choose data directory

Check that the separate directories for the output files are present in the data directory. The directory for the figures can have any name, the names of the directories for the netCDF files (netCDF_lvl0, netCDF_lvl1 and netCDF_lvl2) are obligatory (and case sensitive!). If one or more of the directories are not present, they can be added before selecting the data directory (folder).

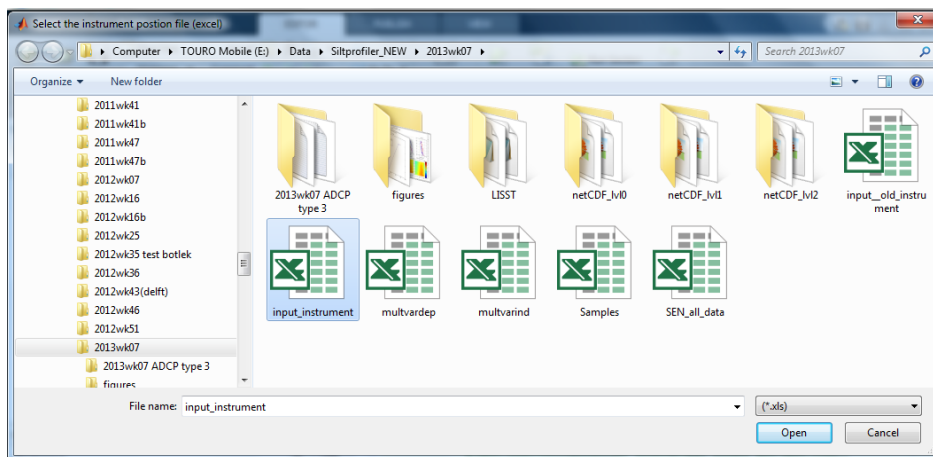


Select the log file and instrument position file and open these

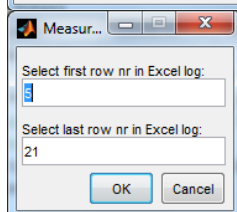
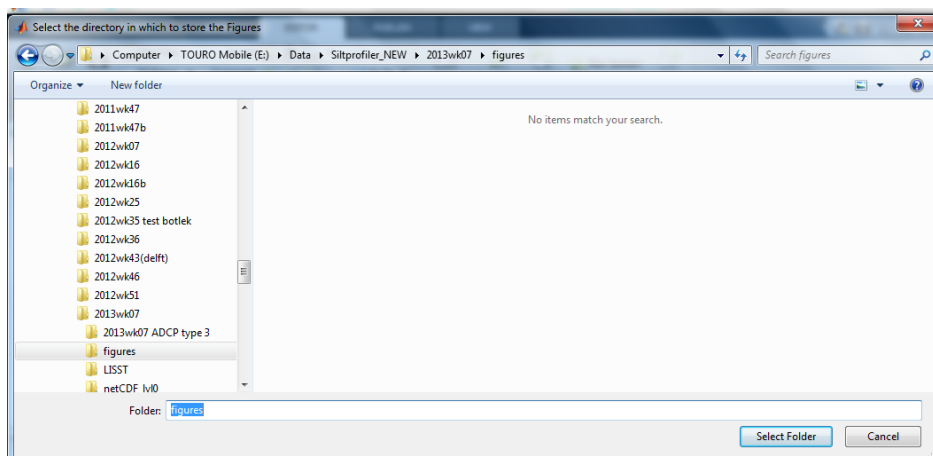
Because the log file is used for input and output (R/W) it should not be opened in another program (Excel). Each directory in Mos2Meet\Trunk\data contains files of the different instruments (CTD, OBS, ADV, ADCP, LISST and ACS) as far as they are available. Data files of the ACS are not yet processed.



Select the instrument position file and open it.



After the input files are chosen, the procedure prompts for a directory to store the figures in. The name of this folder is free (in contrast to the names of the directories for storage of the netCDF files, see above).



The procedure now prompts for the selection of row numbers in the log file. The information on the first measurement is in row 5 (after the header, see appendix 2) and the last row, in this case the 21st, contains the information on the last measurement (see description of the log file in appendix 2).

Interactive processing of the data or batch mode

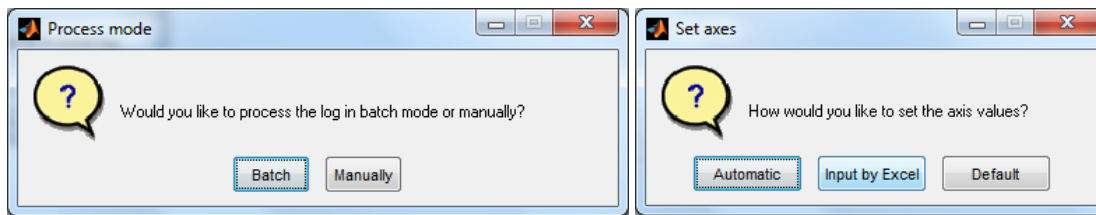
It is possible to process the data in batch mode or in interactive mode (manually). The log file should be complete if batch processing is chosen. The last question concerning general options is about the scaling of the axes. Three options are present, but only the option “Automatic” works correctly at this moment (November 2015):

“Automatic” uses a combination of MATLAB default settings and some settings computed during execution of the program.

“Input by Excel” uses settings as listed in an Excel file.

“Default” uses the defaults as listed in the procedure `Siltprofiler_ProcessInput.m`.

In batch mode the program runs for some time after answering the last question (scaling of the axes of the graphs) and then stops at the MATLAB prompt. If the input files are incomplete, the procedure will switch to manual processing.



Interactive processing

During manual processing the data can be clipped by selecting intervals for the different parts of the measurement cycle (upcast and downcast), thereby removing the data in the beginning (when air bubbles, for example, may influence the measurements), the data collected when the profiler is near or on the sediment (the instruments may cause resuspension of fines that are in the upper layer of the sediment) and the data at the end, when air bubbles again may cause errors in the values.

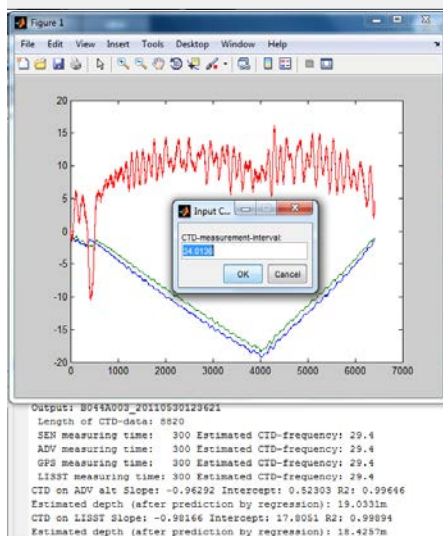
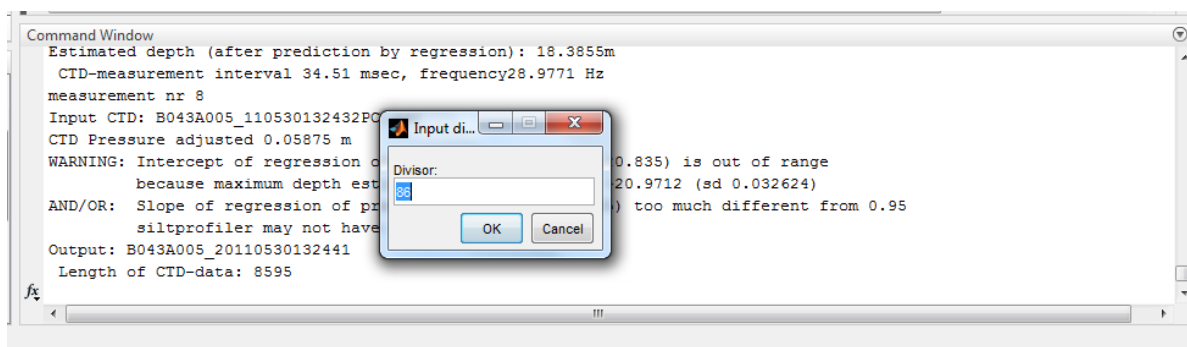
Many steps in the processing of the data are executed automatically without interference of the user and mentioned without further detail.

Reading input files

The procedure now starts processing the measurements in the order of the log file. For each row in the log file the procedure is more or less identical, depending on the availability of data files for the instrument. All available data for each profile are read.

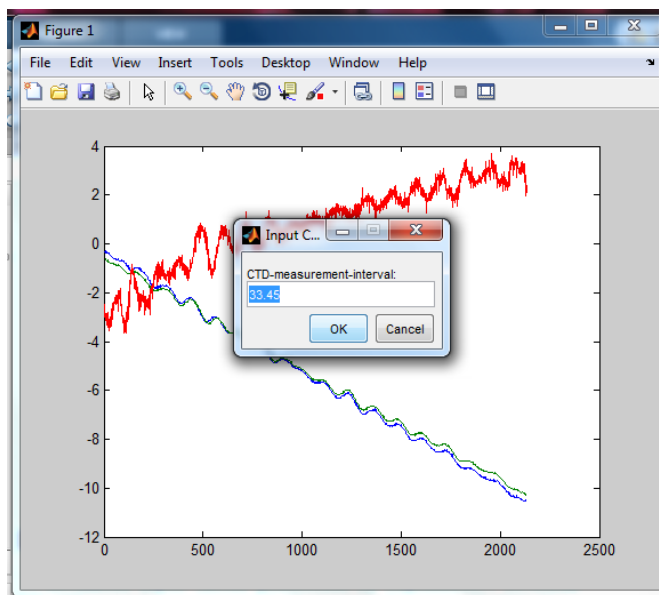
CTD frequency

After reading the data, the CTD measuring frequency from the log is used. This CTD-frequency (which could change unexpectedly by errors in the MPPMV2 software installed on the platform) is estimated. If there is a problem in the estimation of the CTD frequency a divisor is asked to round the number of measurements. Generally it is advised to use 100 or a multiple of 100 for this divisor.



The next question concerns the estimated interval between measurements (If the measurement interval cannot be estimated or if the estimates are very different, the suggested interval is 100 msec by default). In general, this value should be accepted. However, there are many cases (errors in the length of the GPS, ADV or LISST files) where one should be careful in accepting the suggested measurement interval. Some help in finding the correct interval between CTD-data is given (in version 3) by a plot of CTD-depth, ADV-pressure and the difference between both (multiplied by 10). The interference between the wave signals of CTD and ADV can clearly be seen if the measurement interval of the CTD is not correct.

The right CTD-frequency leads to the following plot :



The variation in the red line, a plot of CTD-depth, -ADV-pressure and 10 (CTD-depth – ADV-pressure) should not exceed the variation around both lines representing depth (press). In this case the wave amplitude is ca. 0.8m. The amplitude of the red line is ca. 2m at maximum. Divided by 10, this is 0.2m, which is much smaller than 0.8m. The plot and the question are repeated until OK is clicked without changing the value of the measurement interval

Writing the raw data

Now the raw data and metadata of the different sensors are written to netCDF level 0 files.

Computation of depth and salinity

Depth and salinity are computed from pressure, conductivity and temperature

Computation of SPM concentration

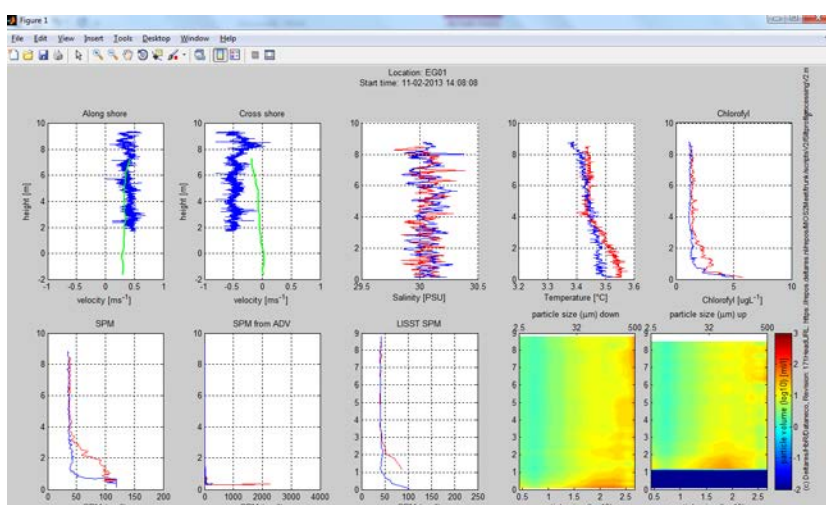
Using the calibration constants for the sensors the OBS turbidity (FTU), ADV backscatter and LISST extinction are converted to estimated SPM concentrations in mg/l.

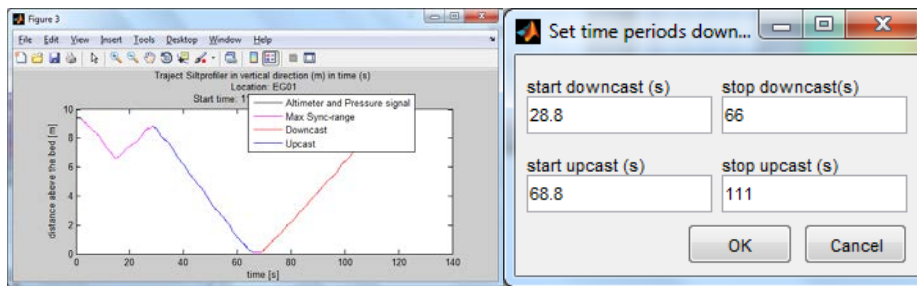
Correction of ADV-velocities

The ADV velocities are corrected for the drift of the ship and converted to roughly along shore and cross shore velocities.

Selecting time ranges for downcast and upcast

After this two plots and a dialog window are displayed. The big plot shows the depth profiles of the parameters as measured by the instruments. Downcast (blue) and upcast (red) are cut of by the procedure, making use of the depth (altitude above the sediment) pattern in time as recorded by the pressure sensor of the CTD and the altimeter (the smaller plot).





The user is asked (dialog window) to change the time period which is to be used for the downcast and the time period to be used for the upcast if other time periods are required. In general it is advised to start and end downcast as well as upcast as close to the water surface and the sediment as possible, at the same time minimizing disturbances in the profiles caused by:

- . instruments being partly or completely above the surface,
- . air bubbles caused by lowering the frame into the water,
- . air bubbles caused by waves passing the frame,
- . air escaping from the holes in the frame (in the first years of the “new profiler”),
- . particulate matter resuspended by the frame when it lands on the sediment,
- . particulate matter resuspended when the frame is dragged over the sediment during the start of the upcast.

In the examples these effects (aberrations) will be explained in more detail, especially how they can be distinguished from the “real” profile.

WARNING: It is seldom possible to cut of upcast and downcast optimally for all instruments simultaneously: The netCDF files as they are on the repository are generally optimised for a few instruments only. If optimised for the instruments which are hardly disturbed by air bubbles (conductivity and temperature) they may show a pycnocline or thermocline very high in the water column, while the SPM estimates are far too high because of air bubbles.

Writing netCDF level 1 files

The SPM-values, velocities,

Smoothing the data

When no value is changed in the clipping dialog and OK is clicked, the procedure starts the data-processing to level 2 by smoothing the SPM, temperature and salinity values. Level 2 data are only different from level 1 data for temperature, salinity and SPM. ADCP current velocities are not binned, because the ADCP data are already binned to half a meter depth bins. ADV velocities are not binned, because the signal to noise ratio are commonly high. The high frequency ADV velocity data can be used for estimation of turbulence. First, outliers are removed from the data as a time series. After this the data are collected into 5 cm bins. Within each bin outliers are subsequently removed, after which the average value for each bin is computed.

Writing netCDF level 2 files

The smoothed values are written to netCDF level 2 files.

The procedure now continues with the next line of the log file.

The procedure stops when all data files in the series have been processed.

APPENDIX 2

Contents of the LOG-file

The log file (Excel) lists the files and options to be used for processing. It starts with two comment lines. The description below may differ from the actual log files: since more columns have been added in later versions as more information than mentioned in the first comment line is needed. Moreover some columns may be filled with values in part of the log files, whereas in other log files formulae have used to construct the values in those columns.

Row 1	comment	# Columns 1,2 and 3 need to be filled in by the user			
Row 2	comment	# What if a file doesn't exist?			
Row 3	variable name	used in theMATLAB procedure in STRUCTs, for example LOG.ctdfilename(a),			
Row 4	variable type or other information on the variable				
From row 5 downward the cells are filled with the information needed for Siltprofiler_processing_V3					
Column	Variable	Type	Value (example)	R/W	Description/comments
B	ctdfilename	[char]	P002A001_101206135041PC.asc	R	file name of the CTD-file (C,T,P,OBS,Chlorophyll,altimeter
C	vhdfilename	[char]	10wk4901.vhd	R	file name of the VHD-file (from Nortek Vector ADV, list of bursts)
D	lisstfilename	[char]	L3401349.asc	R	file name of the LISST file
E	gpsfilename	[char]	P002A001_101206135041PC.gps	R	file name of the GPS-file, a formula is used to derive this file name from the CTD filename
F	senfilename	[char]	10wk4901.sen	R	file name of the SEN-file (from Nortek Vector ADV, sensor output)
G	hdrfilename	[char]	10wk4901.hdr	R	file name of the HDR-file (from Nortek Vector ADV, settings)
H	advfilename	[char]	10wk4901001.dat	R	file name of the DAT-file (from Nortek Vector ADV, burst data: velocity, backscatter, press)
I	adcpfilename	[char]	wk49001t.type3.txt	R	file name of the ADCP-file (PoR uses type3 files, NIOZ uses different files)
J	Filename	[char]	P002A001_101206135041PC	R	File name for output files: all netCDF file names start with this string, but the date time is replaced by the date and time in the CTD file header or the time in the log-file
K	Dummy	#		1 R	A variable used for file identification of the burst files (ADV)
L	burst nr	#		2 R	Burst number
M	index_start	#		R/W	Sequential number of the first value to be used from the CTD-file (not used any more) Columns M – R are transformed to time within the procedure, using the CTD frequency
N	index_end	#		R/W	Sequential number of the last value to be used from the CTD-file (not used any more)
O	down_start	#		9 R/W	Sequential number of the first value to be used from the CTD-file for the downcast
P	down_end	#		701 R/W	Sequential number of the last value to be used from the CTD-file for the downcast
Q	up_start	#		701 R/W	Sequential number of the first value to be used from the CTD-file for the upcast
R	up_end	#		1378 R/W	Sequential number of the last value to be used from the CTD-file for the upcast
S	CTD_freq	Hz		10 R/W	The frequency of the CTD measurements, in the procedure 1/f (interval between measurements)is used
T	Altuse	L		R	0: altimeter data ignored; blank or value > 0: altimeter data used

U	x_ADCP	degrees		4.605370053	W	Average position (longitude) of the ship during the ADCP measurement
V	y_ADCP	degrees		52.80536924	W	Average position (latitude) of the ship during the ADCP measurement
W	x_GPS	degrees		4.604787283	W	Average position (longitude) of the ship during the CTD measurement
X	y_GPS	degrees		52.8057473	W	Average position (latitude) of the ship during the CTD measurement
Y	Date_Time	[char]	2010-12-06 13:50:41		R	This value is used to overrule the date and time in the CTD header (Should occur at least once in the log file. Use the value from the CTD header in the case that no date and time should be overruled)
Z	OBS_cable	#		0.148394864	R	Different OBS-cables have different amplifiers for the OBS-signal. The wrong OBS-cable has been mounted for a long period. The number is a multiplication factor for the OBS signal.
AA	OBS_shape	[char]	linear		R	Shape of the OBS calibration curve (options are linear, power and exponential)
AB	OBS_cal1	mg/l		0	R	Intercept of the OBS calibration
AC	OBS_cal2	mg/l/FTU		1.09	R	Slope of the OBS calibration
AD	ADV_shape	[char]	exponential		R	Shape of the ADV backscatter calibration curve (options are linear, power and exponential)
AE	ADV_cal1	#		0.083	R	Intercept of the ADV calibration
AF	ADV_cal2	#		1.3735	R	Slope of the ADV calibration. Note that the ADV backscatter values have been transformed!
<i>Columns AD-AF may also be used for the second OBS of the old profiler:</i>						
AD	OBS2_shape	[char]	exponential		R	Shape of the ADV backscatter calibration curve (options are linear, power and exponential)
AE	OBS2_cal1	#		0	R	Intercept of the ADV calibration
AF	OBS2_cal2	#		1.09	R	Slope of the ADV calibration. Note that the ADV backscatter values have been transformed!
AG	LISST_shape	[char]	linear		R	Shape of the LISST extinction calibration curve (options are linear, power and exponential)
AH	LISST_cal1	#		0	R	Intercept of the LISST extinction calibration
AI	LISST_cal2	#		86.41898	R	Slope of the LISST extinction calibration
AJ	EXT1_shape	[char]			R	Shape of the "long" extinction sensor calibration curve (options are linear, power and exponential, only old profiler)
AK	EXT1_cal1	#			R	Intercept of the "long" calibration
AL	EXT1_cal2	#			R	Slope of the "long" calibration
AM	EXT2_shape	[char]			R	Shape of the "short" extinction sensor calibration curve (only old profiler)
AN	EXT2_cal1	#			R	Intercept of the "short" calibration
AO	EXT2_cal2	#			R	Slope of the "short" calibration
AP	CHLA_shape	[char]	linear		R	Shape of the chlorophyll calibration curve (options are linear, power and exponential)
AQ	CHLA_cal1	#		0	R	Intercept of the chlorophyll calibration
AR	CHLA_cal2	#		1	R	Slope of the chlorophyll calibration
AS	ADCP_nr	#		1	R	Sequential number of the ADCP file (PoR ADCP only)
AT	ADCPfile	[char]	A001		R	Short name for ADCP file, if necessary used to construct the ADCP filename and the output filename
AU	Sampling_station	[char]	P002		R	Short name for sampling station, if necessary to construct the output filename
AV	Profiler	[char]	NEW		R	Profiler used for the measurement (OLD, NEW or NIOZ)

APPENDIX 3

The plot settings (file input_plots.xls) looks like this.

# Input plots Siltprofiler																	
height_min	height_max	ADV_alshore_min	ADV_alshore_max	ADV_crshore_min	ADV_crshore_max	salinity_min	salinity_max	temp_min	temp_max	chloro_min	chloro_max	sbs_adv_min	sbs_adv_max	obs_ctd_min	obs_ctd_max	lisst_extinction_min	lisst_extinction_max
[cell]	[cell]	[cell]	[cell]	[cell]	[cell]	[cell]	[cell]	[cell]	[cell]	[cell]	[cell]	[cell]	[cell]	[cell]	[cell]	[cell]	[cell]
0	10	-1.5	1.5	-1.5	1.5	25	35	12	18	0	10	0	200	0	200	0	10

In transposed form it is easier to add remarks:

Column	Row 1 comment # Input plots	Row 2 parameter	Row 3 MATLAB type	Row 4 value	Remarks
A	Siltprofiler	height_min	[cell]	0	It is advised to use 0, unit m
B		height_max	[cell]	10	A fixed value scales all plots mentioned in the log in the same way
C		ADV_alshore_min	[cell]	-1.5	Alongshore velocity in m/s
D		ADV_alshore_max	[cell]	1.5	
E		ADV_crshore_min	[cell]	-1.5	Crossshore velocity in m/s
F		ADV_crshore_max	[cell]	1.5	
G		salinity_min	[cell]	25	PSU
H		salinity_max	[cell]	35	
I		temp_min	[cell]	12	°C, depending on season
J		temp_max	[cell]	18	
K		chloro_min	[cell]	0	mg/m ³ = µg/l
L		chloro_max	[cell]	10	
M		sbs_adv_min	[cell]	0	mg/l; Sound backscatter. It is advised to use the same scaling for all SPM values, min 0
N		sbs_adv_max	[cell]	200	mg/l; It is advised to use the same scaling for all SPM values, max depends on sampling period
O		obs_ctd_min	[cell]	0	mg/l; It is advised to use the same scaling for all SPM values, min 0
P		obs_ctd_max	[cell]	200	mg/l; It is advised to use the same scaling for all SPM values, max depends on sampling period
Q		lisst_extinction_min	[cell]	0	mg/l; It is advised to use the same scaling for all SPM values, min 0
R		lisst_extinction_max	[cell]	200	mg/l; It is advised to use the same scaling for all SPM values, max depends on sampling period

APPENDIX 4

The instrument settings (file input_instrument.xls) should not be changed (it may differ between periods) and has the following fields (transposed) for the new siltprofiler.

Row 1	Row 2	Row 3	Row 4
comment	sensor	MATLAB type	value
# Input plots	Siltprofiler		
col A	Druk	[cell]	-0.12 Press sensor, m water, 12 cm above altimeter
col B	Conductiviteit	[cell]	-0.07 Conductivity, 7 cm above altimeter
col C	Temperatuur	[cell]	-0.07 Temperature, 7 cm above altimeter
col D	OBS	[cell]	-0.08 OBS, 8 cm above altimeter
col E	Chlorophyll	[cell]	-0.02 Chlorophyll, 2 cm above altimeter
col F	Altimeter	[cell]	0 Reference level for the new profiler, 15 cm above the bottom of the frame
col G	ACS (N.B.changed!!)	[cell]	-0.17 Etc
col H	LISST	[cell]	-0.09
col I	ADV	[cell]	0.11
col J	SAMPLER1bottom	[cell]	-0.105
col K	SAMPLER2bottom	[cell]	-0.475
col L	SAMPLER3bottom	[cell]	-0.105
col M	SAMPLER1top	[cell]	-0.555
col N	SAMPLER2top	[cell]	-0.925
col O	SAMPLER3top	[cell]	-0.555

APPENDIX 5

Error messages and informative messages

The most frequently displayed message lines from the procedure are listed below in alphabetical order. The list is incomplete, but sufficient to understand what happens. Use the alphabetical list to find the subject of the message if the context of a message is not clear.

1. Alphabetical list

Messages	Subject
!P079A026_101207121712PC.asc	Skip file
!Warning: ADV file missing; skipping parts of mfile	Missing files
!Warning: HDR file missing; skipping parts of mfile	Missing files
!Warning: SEN file missing; skipping parts of mfile	Missing files
!Warning: VHD file missing; skipping parts of mfile	Missing files
> In contourf>parseargs at 470	Matlab errors
> In E:\OpenEarthTools\applications\DelftDashBoard\utils\xml_toolbox.....	Matlab errors
> In Siltprofiler_read_CTD at 158	Matlab errors
2010wk49_log_v2_ST.xlsx ready	Procedure
a future release. Use pcode to regenerate strsplit.p using MATLAB R2007b or later.	Matlab errors
a future release. Use pcode to regenerate unblank.p using MATLAB R2007b or later.	Matlab errors
ADCP-depth adjusted 0.25m	Depth correction
ADCP-depth adjusted 1.1444e-07m	Depth correction
ADCP started later than CTD	Time sync
ADV started later than CTD	Time sync
ADV stopped before CTD	Time sync
AND/OR: Slope of regression of press on altimeter (1.0067) too much different from	Regression
Axes are set automatically by Matlab, using minimum and maximum values	Axes settings
because maximum depth estimated from pressure = -19.0958 (sd 0.41546)	Regression
CTD on ADV alt Slope: -0.94334 Intercept: -0.48729 R2: 0.9999	Regression
CTD on LISST Slope: -0.96137 Intercept: 10.1695 R2: 0.99906	Regression
CTD Pressure adjusted 0.02312 m	Depth correction
Estimated depth (after prediction by regression): 10.5321m	Regression
Estimates for Depth: 11.2224m and 11.0143m	Regression
File !P079A026_101207121712PC.asc is marked with an ! and therefore skipped	Skip file
GPS stopped before CTD	Time sync
In contourf at 67	Matlab errors
In Siltprofiler_plot_main at 74	Matlab errors
In Siltprofiler_plot_main_lvl2 at 54	Matlab errors
In Siltprofiler_plot_main_subplotLISST at 93	Matlab errors
In Siltprofiler_plot_main_subplotLISST_lvl2 at 103	Matlab errors
In Siltprofiler_processingV3 at 291	Matlab errors
In Siltprofiler_processingV3 at 352	Matlab errors
In Siltprofiler_processingV3 at 84	Matlab errors
In Siltprofiler_processingV3 at 84	Matlab errors
In Siltprofiler_read_CTD at 158	Matlab errors
Input CTD: P005A003_101206144857PC.asc	Input/Output
Intercept: -11.0143, slope:0.97853	Regression
Intercept: -19.8218, slope:0.99817	Regression
Lisst file is missing; skipping parts of mfile	Missing files
LISST started later than CTD	Time sync

LISST stopped before CTD	Time sync
measurement nr 5	Input/Output
Output: P002A001_20101206135041	Input/Output
Position of sampler 3 bottom shifted 2 cm up	Depth correction
Position of sampler 3 depth shifted 1 cm up	Depth correction
Processing entire log in batchmode	Procedure
Regression of depth on altimeter:	Regression
Regression of depth on altimeter:	Regression
Set axes automatically	Axes settings
siltprofiler may not have moved vertically	Regression
Starttime adjusted from log file	Time sync
Starttime ADV: 06-Dec-2010 16:02:14	Time sync
This file is marked with ! and will be skipped; skipping this profile	Skip file
Time from file header: 06-Dec-2010 16:22:03	Time sync
Time from filename: 2010-12-06 16:21:54	Time sync
Time range ADCP: 06-Dec-2010 16:19:21 06-Dec-2010 16:26:26	Time sync
Time range GPS: 06-Dec-2010 16:18:22 06-Dec-2010 16:22:39	Time sync
Time range LISST: 06-Dec-2010 16:20:11 06-Dec-2010 16:24:10	Time sync
Warning: Contour not rendered for constant ZData	Matlab errors
WARNING: CTD starttime not found in GPS data, PC-clock not synchronised?	Time sync
WARNING: Intercept of regression of press on altimeter (-19.1702) is out of range	Regression
Warning: The P-code file strsplit.p was generated prior to MATLAB version 7.5	Matlab errors
Warning: The P-code file unblank.p was generated prior to MATLAB version 7.5	Matlab errors

Other MATLAB errors may occur. Often the procedure has stopped on errors. Most of these errors are repaired by debugging, but sometimes errors can only be avoided by changing the code of the procedure or by leaving an input file out of the log.

Therefore the procedure should be only used by experienced MATLAB users.

The most frequently displayed message lines from the procedure are listed below grouped into the subjects mentioned in the alphabetical list. The list is incomplete, but sufficient to understand what happens. Use the alphabetical list to find the subject of the message if the context of a message is not clear. Values and file names are examples and differ from the actual values displayed during execution of the procedure.

2. Table of messages grouped by subject

Axes settings

Set axes automatically

Axes are set automatically by Matlab, using minimum and maximum values

Since the MATLAB procedures are not yet fully tested and for some cases incomplete it is advised to use automatic axis settings: the default settings in the procedure are incomplete and the settings file does not provide settings for all later added graphs.

Depth correction

CTD Pressure adjusted m

The CTD pressure is not always correct. If positive values occur (normally the CTD pressures are negative values), the correction for atmospheric air pressure has not been performed. However, negative values for pressure are no warranty for correctness. Depth computed from press may therefore be overestimated.

ADCP-depth adjusted m

The ADCP-depth is not always correctly set, therefore this depth is set to 2.12m below the surface if the value in the file seems to be incorrect. However, this may lead to incorrect ADCP depths in some cases

Position of sampler 3 depth shifted 1 cm up

Position of sampler 3 bottom shifted 2 cm up

If a Niskin bottles seems to have closed outside the range of measured depths, the depth of the sample is adjusted. If the adjustment is larger than a few cm, the sample cannot be used for calibration

Input/Output

measurement nr 5

Input CTD: P005A003_101206144857PC.asc

Output: P002A001_20101206135041

The measurement number listed is the row number in the Excel log file, the CTD file listed is in column A of this row. The output file name is equal to the CTD file name, except for date and time, which are taken from the header of the CTD-file or, alternatively for the Date/Time field in the log file. It is possible to overrule location and ADCP file indication by setting a different name

Matlab errors

Warning: The P-code file strsplit.p was generated prior to MATLAB version 7.5 (R2007b) and will not be supported in a future release. Use pcode to regenerate strsplit.p using MATLAB R2007b or later.

> In Siltprofiler_read_CTD at 158

In Siltprofiler_processingV3 at 84

Warning: The P-code file unblank.p was generated prior to MATLAB version 7.5 (R2007b) and will not be supported in a future release. Use pcode to regenerate unblank.p using MATLAB R2007b or later.

> In E:\OpenEarthTools\applications\DelftDashBoard\utils\xml_toolbox\strsplit.p>strsplit at 64

In Siltprofiler_read_CTD at 158

In Siltprofiler_processingV3 at 84

These errors are always displayed. Some MATLAB procedures may not work in future MATLAB versions and should therefore be reprogrammed in the future

Warning: Contour not rendered for constant ZData

> In contourf>parseargs at 470

In contourf at 67

In Siltprofiler_plot_main_subplotLISST at 93

In Siltprofiler_plot_main at 74

In Siltprofiler_processingV3 at 291

Warning: Contour not rendered for constant ZData

In Siltprofiler_plot_main_subplotLISST_lvl2 at 103

In Siltprofiler_plot_main_lvl2 at 54

In Siltprofiler_processingV3 at 352

These messages indicate that not sufficient LISST data are available to make a contour plot. The error messages can be avoided by specifying an overlapping downcast and upcast. If not, the result is an empty contour plot.

Missing files

Lisst file is missing; skipping parts of mfile

!Warning: HDR file missing; skipping parts of mfile

!Warning: ADV file missing; skipping parts of mfile

!Warning: VHD file missing; skipping parts of mfile

!Warning: SEN file missing; skipping parts of mfile

Also other files can be missing. This may be caused by empty cells in the log file, but also by misspellings in the file names. File names for the new profiler should follow the format `ssss[aaaa]_yymmddhhmmss[PC].asc`: `ssss` is code for sampling station, `aaaa` is the code for the ADCP-file (not obligatory), `yy` is year, `mm` month, `dd` day, `hh` hour, `mm` minutes and `ss` seconds. Station (and ADCP code) and `_` are added during the cruise as a prefix for the file name, `yymmddhhmmss` is added by the program. `PC` denotes that the file name is constructed using the start time of the instructions for the profiler. If the suffix `PC` is missing, the time is the time of uploading the file from the profiler to the board computer. In both cases, the header should contain the right start time!

Procedure

Processing entire log in batchmode

Manual processing

2010wk49_log_v2_ST.xlsx ready

The first message indicates that the procedure has been run in batch mode, the second message is displayed when manual processing has been performed.

The third message is the final message of each run and shows the name of the log file.

Regression

Regression of depth on altimeter:

Intercept: -11.0143, slope:0.97853

Estimates for Depth: 11.2224m and 11.0143m

Depth is computed from pressure, conductivity and temperature. The intercept of the regression of depth on altimeter is the estimate for the depth at the surface of the sediment. The sound speed, and therefore the height above the sediment may differ from the sound speed used by the altimeter by a few percent. This is no problem, since the altimeter comes very close (15cm) to the sediment. The slope differs from 1 for the same reason, but is not used explicitly. However, the height above the sediment is computed as a weighted average (weight for altimeter decreasing from 1 at the top of the sediment to 0 at 10m above the sediment. The first depth estimate is the maximum pressure + the distance of the pressure sensor from bottom of the profiler. With waves this is an overestimate of depth! The second depth estimate is the intercept of the regression of depth on altimeter and therefore less biased!

CTD on ADV alt Slope: -0.94425 Intercept: -0.48221 R2: 0.99995

Estimated depth (after prediction by regression): 10.5321m

CTD on LISST Slope: -0.96137 Intercept: 10.1695 R2: 0.99906

Estimated depth (after prediction by regression): 10.8195m

For the synchronization of CTD, ADV and LISST, the depth of the CTD (computed from pressure, conductivity and temperature) is regressed on ADV and LISST press values with different lags (and, if necessary, frequencies of the CTD measurements). The maximum in R2 (explained variance) indicates the best possible synchronization. Since, due to the salinity, depth in m is less than pressure in decibars, the slope of the regression should be less than 1 (ca. 0.95 is the generally observed value). The R2 (R-squared) value is of more importance, since it indicates how well the fit of the regression is. Now there are maximally 4 estimates for depth: depth from pressure, salinity and temperature as well as depth as intercept from the regression of depth on altitude (height above sediment). The heights of ADV and LISST above the sediment are computed from the regressions and corrected for the height of pressure sensors and measuring volumes with respect to the bottom of the frame.

WARNING: Intercept of regression of press on altimeter (-19.1702) is out of range

because maximum depth estimated from pressure = -19.0958 (sd 0.41546)
AND/OR: Slope of regression of press on altimeter (1.0067) too much different from 0.95
siltprofiler may not have moved vertically

If the regression of press (depth) on altimeter differs too much from the expected result (generally the slope is ca. 0.95 and the intercept should be almost equal to the maximum computed depth) the maximum depth estimated from press + distance of the press sensor to the bottom of the frame is used instead of the intercept.

Skip file

File !P079A026_101207121712PC.asc is marked with an ! and therefore skipped

!P079A026_101207121712PC.asc

This file is marked with ! and will be skipped; skipping this profile

If the first character of the CTD file name is an exclamation mark, the row of the log file is skipped, the profile is not processed.

Time synchronization

ADCP started later than CTD

ADV started later than CTD

ADV stopped before CTD

GPS stopped before CTD

LISST started later than CTD

LISST stopped before CTD

These messages are self-explanatory

Starttime adjusted from log file

This message is displayed when the start date and time is explicitly mentioned in the log file. This is necessary so (due to a missing workaround for an empty column in the log-file) for at least one line in the log file (a real measurement, for which start date and time are copied from the CTD file or a dummy line), but also necessary if the profiler clock has not been synchronized with the GPS and the computer).

Time from filename: 2010-12-06 16:21:54

Time from file header: 06-Dec-2010 16:22:03

Time range GPS: 06-Dec-2010 16:18:22 06-Dec-2010 16:22:39

Time range ADCP: 06-Dec-2010 16:19:21 06-Dec-2010 16:26:26

Time range LISST: 06-Dec-2010 16:20:11 06-Dec-2010 16:24:10

Starttime ADV: 06-Dec-2010 16:02:14

These lines (or a subset) are displayed in case of any problem with the clocks of the instruments (CTD, ADV and LISST should be synchronized with the computer and the computer should be synchronized with GPS, which is not always true). The ADCP uses the GPS time and is therefore by definition correct (except if the time zone is not set correctly).

Note:

- *Time from filename is computer time (either shortly before start of measurement [suffix PC in filename] or at start of upload [no suffix])*
- *Time from file header is clock time of the profiler, should be equal to computer time*
- *Time range GPS is GPS time (by definition UTC)*
- *Time range ADCP is GPS time (UTC, unless [in some cases in 2007] set to local time)*
- *Time range LISST is clock time of LISST, should be equal to computer time*
- *Time ADV is clock time ADV. Also if synchronized with computer time, the ADV clock often differs from computer time due to battery problems in the ADV.*

WARNING: CTD starttime not found in GPS data, PC-clock not synchronized?

Also if the PC clock is synchronized, the GPS data are incomplete very often, due to communication problems. The GPS recording should start at the start of the measurement and continue to the end, although sometimes the first record of the next measurement is also included in the GPS files

APPENDIX 6

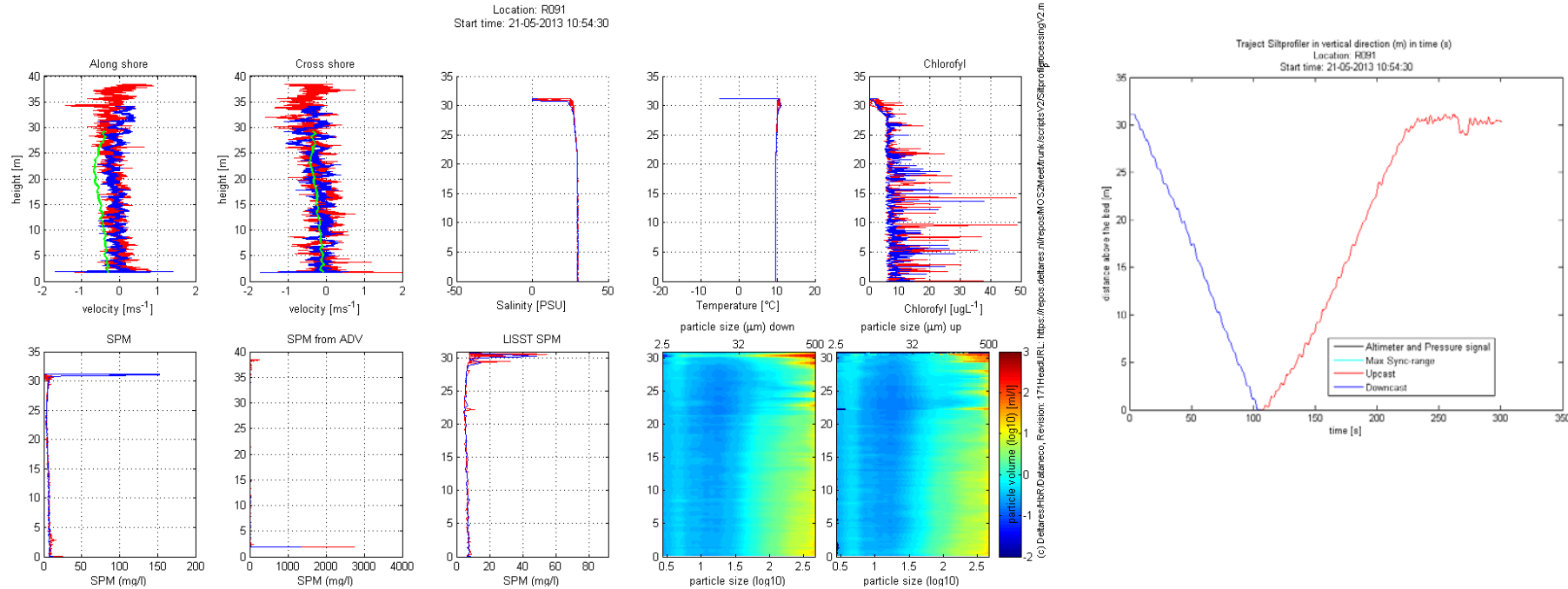
Interpretation of the data and data quality, some examples

On the following pages some examples of profiles measured with both profilers will be interpreted and explained. The aim is not to clarify the profiles in the sense of hydrodynamics, but to clarify some of the technical problems associated with the measurements.

Note that for all measurements three figures are produced by the MATLAB scripts, from which the first two appear repeatedly on the screen after each manual change in the clipping. The third figure appears after the final manual clipping of the profile. After that the three figures are saved:

- The first figure (file name ending with “_V”) that appears on the screen is the raw data, clipped automatically to obtain a downcast and upcast. It includes profiles of every measured parameter during downcast and upcast, except for the ADCP data which are averaged over vertical bins during the whole time of the ADCP measurements.
- The second figure (file name ending with “_v3”) is a time series of the estimated height of the profiler, which shows the parts of the measurements selected for downcast and upcast.
- The third figure (file name ending with “_lvl2”) shows the profiles as they are stored in the netcdf level 2 files and some profiles which are not yet stored as level 2 data. Level 2 data (smoothed) are displayed as symbols and lines, whereas the level 1 data are displayed as lines only. ADCP measurements are shown for downcast (green) and upcast (light blue) separately in the directions South-Nord and East-West. The estimated surface level of the water is indicated by a horizontal line.

General information

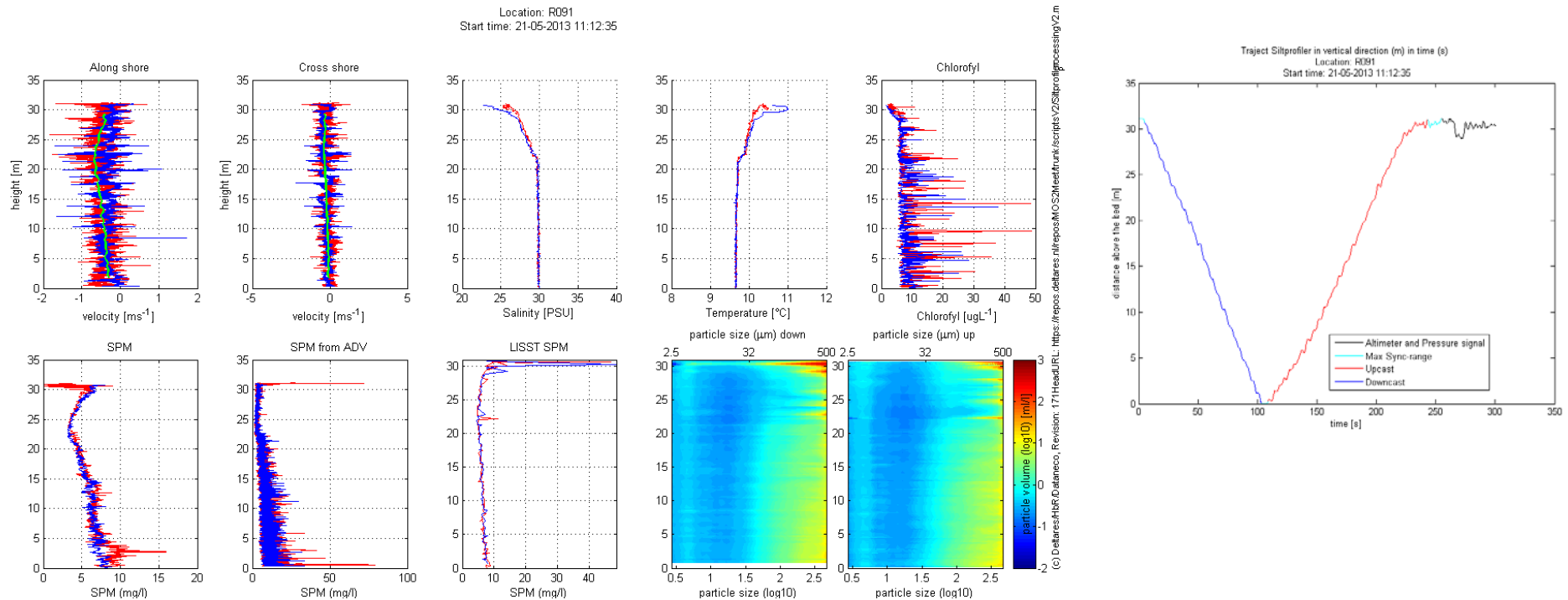


The first example is a complete series of images of a profile measurement, showing the process of clipping the sections at beginning and end of the downcast and the upcast.

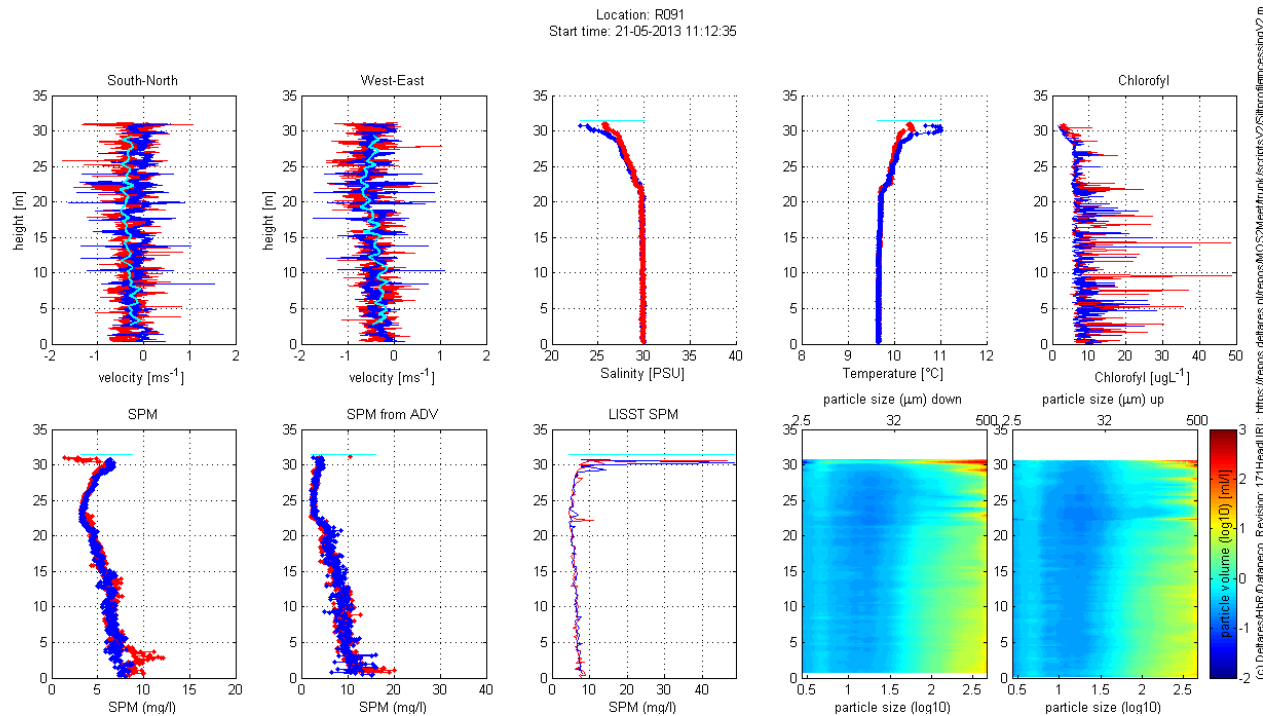
Unfortunately the file chosen for the ADV values is incorrect in this image (because of the large artificial time shift used to obtain figures with different names), but the images on the following pages show the right ADV data.

The first stage, never automatically presented during the execution of the MATLAB procedure, shows all data collected in two figures. The composite larger figure shows the profiles of velocity, salinity, temperature, chlorophyll, calibrated values for SPM (from OBS, bottom row left, ADV backscatter second figure on bottom row and LISST extinction, third figure on the bottom row) and particle size distributions (right two figures on the bottom row). In most figures the downcast is represented by a blue line and the upcast by a red line. The particle size distributions are in two separate figures. The smaller figure shows the movement of the profiler in vertical direction with time. In this case, during calm weather, the profiler is lowered into the water column directly after the start of the measurement and kept at the surface at the end of the measurement.

The ADCP data are averaged over the measurement period of the ADCP, which is normally longer than the measurement period of the other instruments.



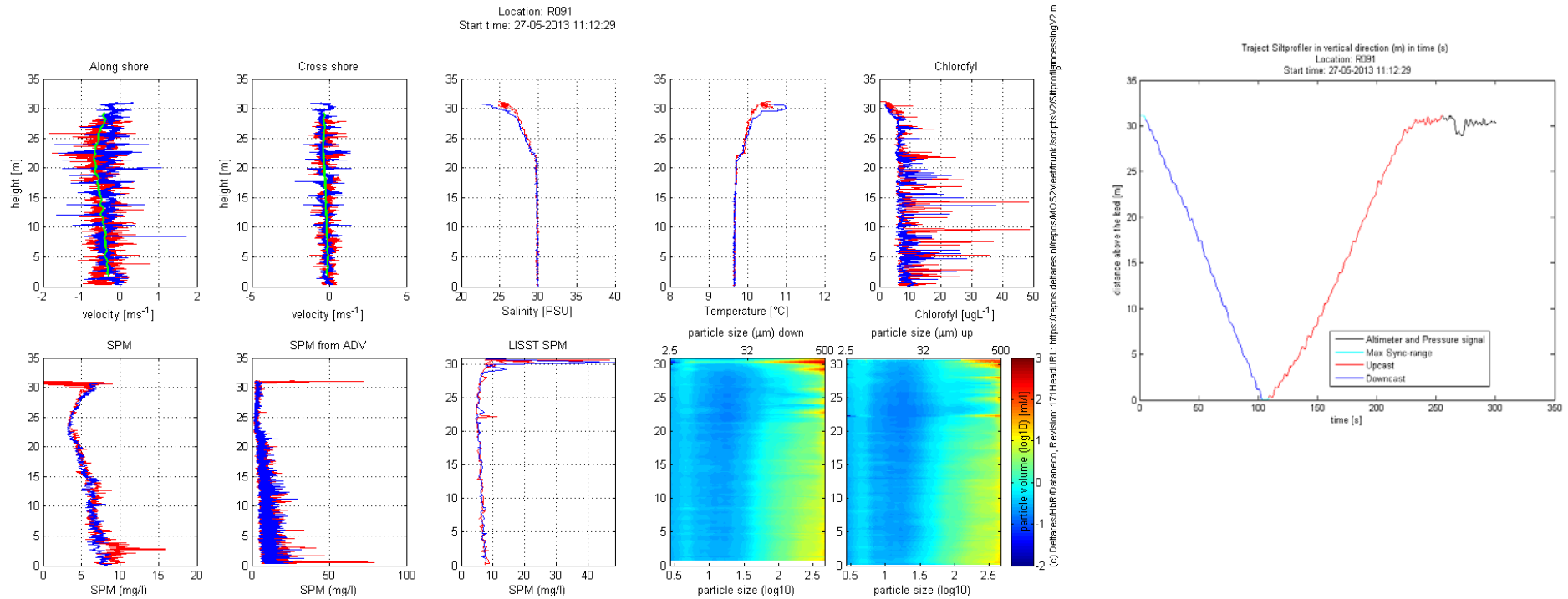
In the second stage, the data have been automatically clipped by the MATLAB procedure. These are the figures that pop up after starting the procedure. Ideally, the start of the downcast is clipped at the bending of the time series before the profiler is lowered into the water, the end of the upcast is clipped at the bending after the faster part of the upcast, and end of downcast and start of upcast are at the average height above the bottom during bottom contact of the frame. However, because of the different shapes of the time series of height above the bottom, the algorithm to determine these points is quite complicated. To know the exact details one should look into the MATLAB procedure. However, because manual adjustment is used to cut the desired parts from the profiles in the next stage, these details may not be very important for the users of the procedure and the profile data.



After the determination of the time range of downcast and upcast (in this case the defaults from the procedure are used) the profiles are smoothed by the removal of spikes and computation of average values per 5 cm height bin above sediment (depth below surface). The chosen criteria for removal of data are not very strong, because otherwise too many data would get lost. In the figures for salinity, temperature and SPM the estimated depth (the height of the water column above the sediment) are displayed by a horizontal line. One should be aware of the fact that these estimates may be different from the real depth because of several reasons:

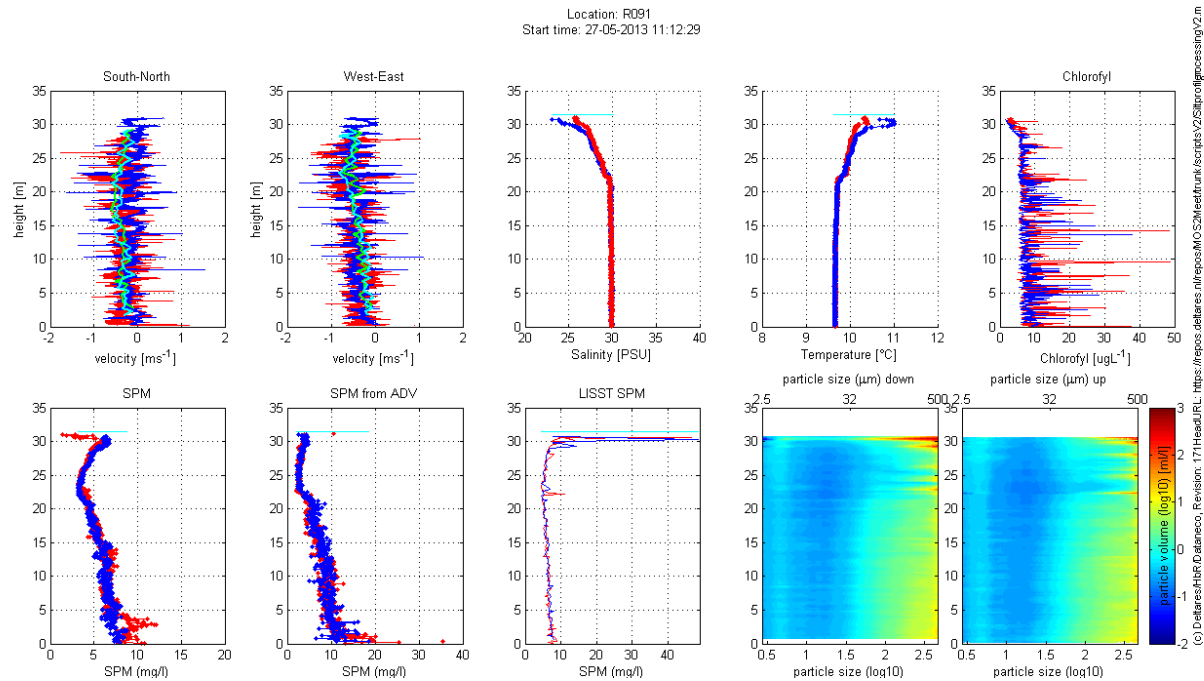
- Waves lead to a positive bias, because maximum pressure is used to estimate the depth. Depth with reference to the mean water level could be achieved by adding a procedure to correct for the pressure differences caused by waves
- Pressure should be standardized with reference to the air pressure. Because in most cases this standardization has not been done, negative values of pressure often occur. These negative values are corrected in the last version by transformation of the pressure scale. However, only if the pressure sensor has been above the surface, the values for pressure can be corrected correctly. Bias in the opposite direction is not corrected at this moment, although, if present, the pressure values for the LISST, could be used for such a correction since the pressure sensor of the LISST is at the top of the frame, which is, because of the blue tooth communication, always higher than the water surface at start of the measurements.

The ADCP data are from the ensemble (averaged over a number of pings) during the downcast (green line) and during the upcast (light blue line)



Stage 3: After this the data are clipped manually, to obtain profiles from which artifacts are optimally removed. Of course, because the different instruments are mounted at different heights and horizontal location in the frame, artifacts caused by air bubbles or resuspension of sediment near the bottom may become apparent at different moments, with different vertical distributions of the sediment. Moreover, the frame of the instrument is not always vertical. Using the registrations of e.g. pitch and roll data from the ADV could lead to improvement in the processed data.

It is, however, more important realizing that the data, because of the before mentioned reasons, cannot be clipped optimally for all parameters. We therefore chose to only remove the data for which all measured variables are questionable, thereby including data which are definitely problematic.



The same data after manual determination of the ranges to be used for downcast and upcast.

The ADCP velocity estimates are in good agreement with the ADV velocity estimates (corrected for drift of the ship during the measurement).

In this case it is clear that the OBS data for SPM are questionable for the very upper part of the upcast. The SPM estimates from the LISST extinction are also questionable for reasons that will be explained in one of the following examples.

When compared to the other examples and to many of the measured profiles the differences between downcast and upcast are relatively small. This is mainly due to the low vertical speed of the frame (0.3 m/s).

This first example does not lead to many problems in the interpretation:

This profile measurement is more or less ideal: The vertical speed (0.3m/s) of the frame is higher than the intended (0.1m/s) speed, however, and the weather is calm.

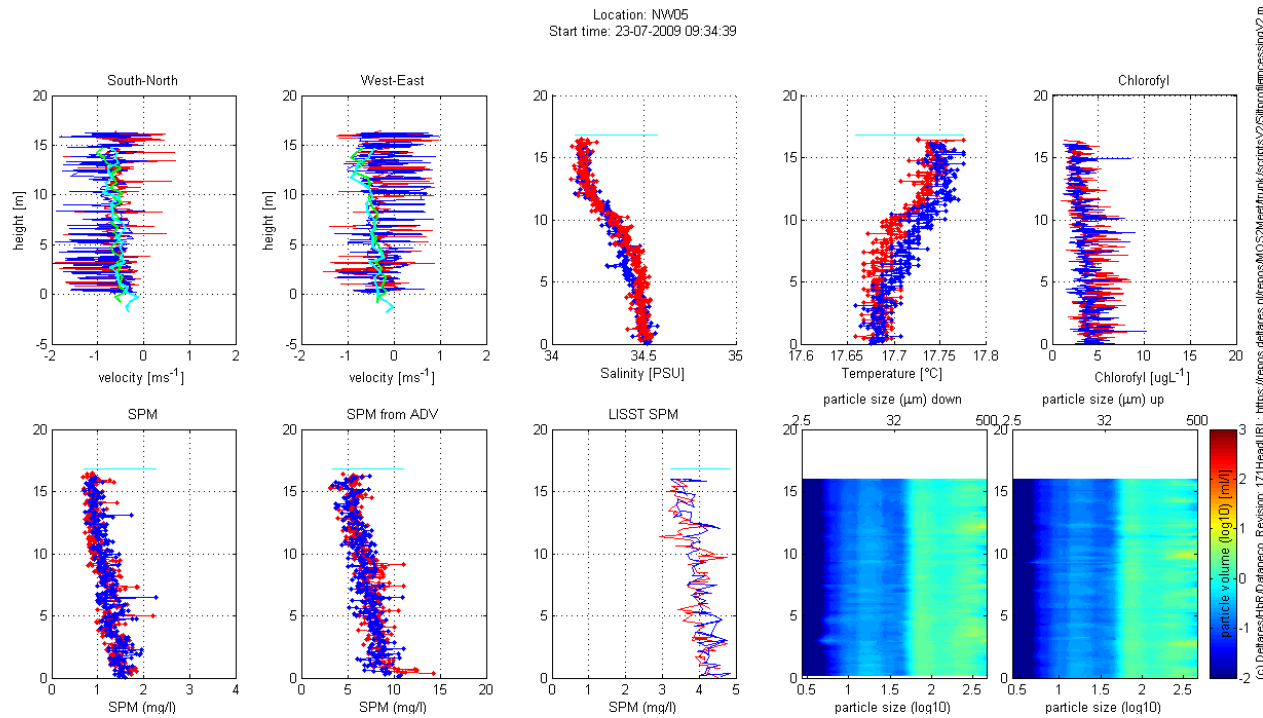
Nevertheless, there are differences between the estimates for SPM of the different instruments. These differences may be due to SPM composition:

- The ADV backscatter of finer particles is lower than the ADV backscatter of coarser particles
- Organic material (algae and detritus) has a lower sound backscatter than minerals
- Although the shapes of the SPM profiles are different, the SPM concentrations are almost equal on average. In this case the ADV shows lower concentrations higher in the water column (more organics?) and higher concentrations near the bottom (larger mineral particles)

The ADCP and ADV current velocity estimates are in good agreement in this case.

Adjustment of ADV parameters, ADCP-depth

Large differences between SPM estimates



This example shows very noisy ADV current velocities. These are caused by the fact that the settings for the ADV (nominal current velocity 1m/s) are too low. However, with some effort the current velocities can be recognized in the ADV graphs. In general there is a good agreement between the two instruments measuring the current velocities.

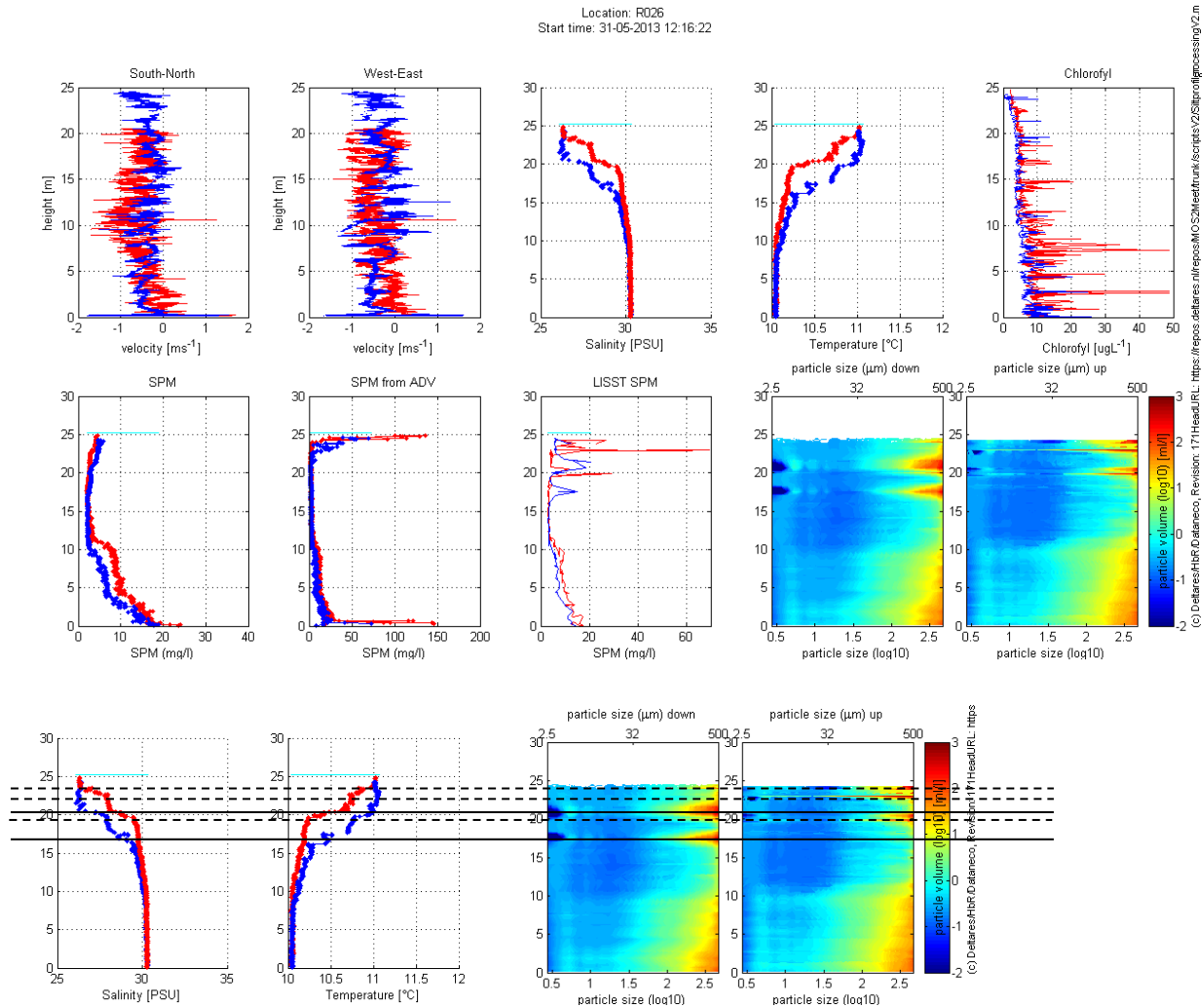
The ADCP seems to have measured current velocities below the sediment surface. Possible causes are:

- Incorrect parameter for ADCP-depth below the surface. The depth of the ADCP below the water level has not very often been measured and may be influenced by the adjustment of the ADCP frame, the total mass of the ship (mainly changing by the use of fuel and water and the presence of heavy instruments e.g. a boxcorer). Moreover pitch and roll of the ship are influenced by the centre of gravity of the ship, which also may cause differences in the ADCP-depth.
- Incorrect salinity in the ADCP settings. Higher salinity causes higher sound speeds and thereby lower estimated depths. However the influence is only a few percent, so the first cause is the most probable one.

The procedure changes the depth of the ADCP automatically, but the criteria may be wrong in some cases.

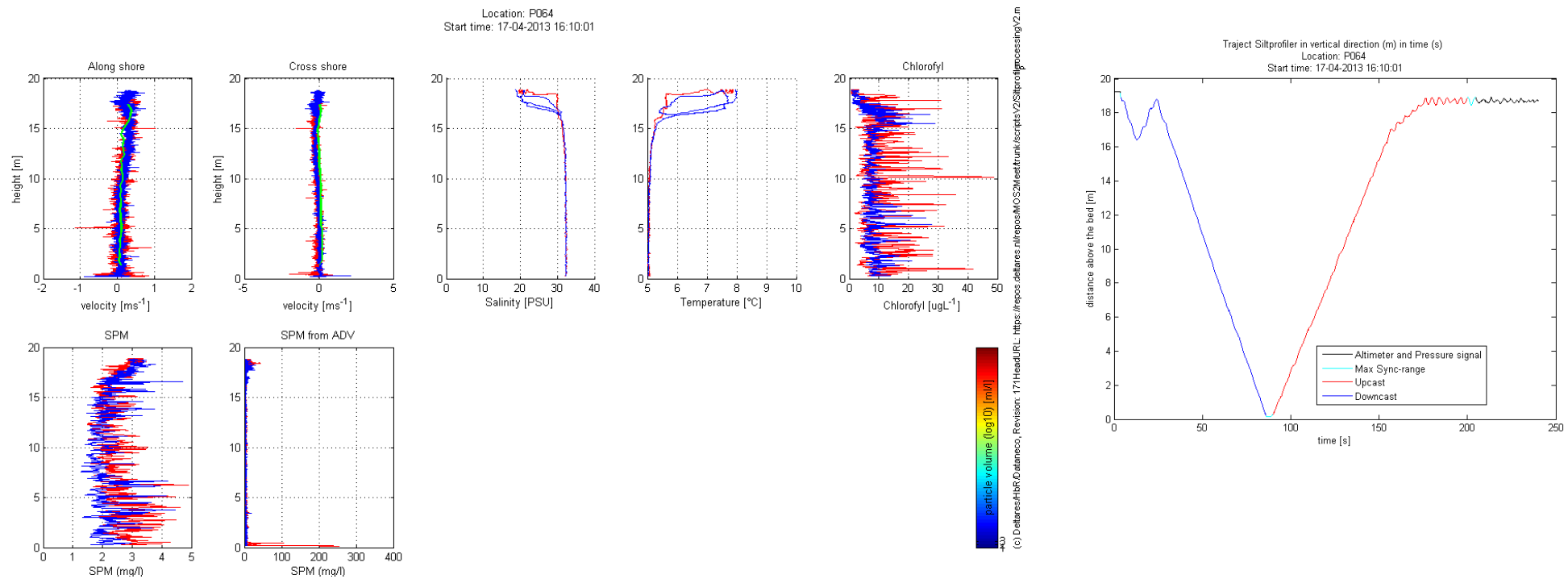
In this figure there are large differences between the estimates for SPM obtained from the OBS, ADV and LISST. It is not impossible that the date and time of this measurement are before the accidental change of the OBS cable and therefore the multiplication factor in the log file should be set to 1 for this measurement.

LISST particle size distributions and thermocline/pycnocline



The upper panel show the ten default graphs of the processed data. The lower panel repeats salinity, temperature and particle size distributions and the relationship. Lines (normal lines for the downcast and dashed lines for the upcast) at the depth of the most sharp changes in salinity and temperature show that clear peaks in larger grain sizes and minima for small particles are present in the estimated grain size distributions of the LISST. These peaks, however, are artifacts caused by deflection of the (scattered) laser light due to density differences of the water in the light pathway.

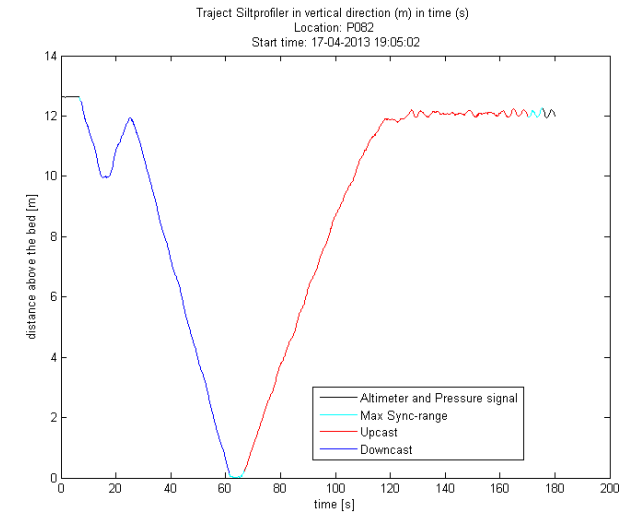
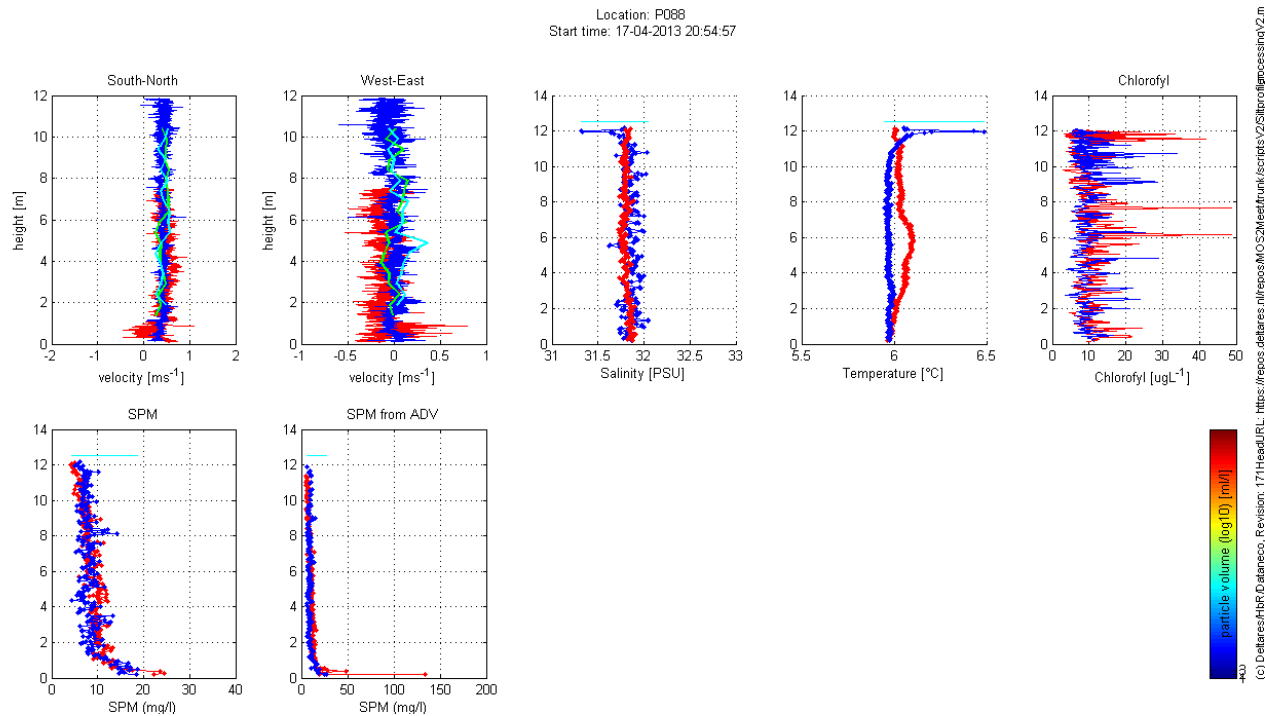
Position of thermocline(s) and pycnocline(s)



In this case, although the weather was calm, the standard procedure has been used: the profiler has been lowered into the water column and raised to the surface before the real downcast started. From the vertical trajectory it can be seen that the initial lowering and raising into the water column as well as a period of time after the upcast have been included in the data. The downcast clearly shows that the frame with the instruments drags the water column down and up. The real thermocline and pycnocline are somewhere between the upper blue line and the lower two. The disturbance of the water column is even worse during the upcast (red line). However when the profiler is near the surface for some time fresher and warmer water flows into the frame and the same salinity and temperature are reached in the end.

Conclusions:

- The thermocline and pycnocline are somewhere between 17.5m and 18.5m above the sediment, which is between 1m and 2m below surface.
- Thermocline and pycnocline are probably much sharper, but are spread out by the mixing caused by the frame.



This example shows a very thin layer (less than 0.5m) of warmer and fresher water in the downcast, which is not detected at first, when the water column is disturbed by bringing the frame into the water. However, the first registrations of higher salinity and lower temperature make apparent that there is no delay in the response of the instruments. Fortunately the period of disturbance is short enough to detect this layer. Although after the end of the upcast a long time has been included in the data the temperature and salinity measurements do not return to the extreme values measured at the start of the procedure. This may be caused by the presence of the ship, which also causes disturbance of the water column.

Appendix 7

Calibration

The SPM concentrations can be derived from the values measured by the instruments and the samples from the Niskin bottles. The values measured by the instruments are in different units and calibrated in the laboratory of Deltares:

Old siltprofiler

The old siltprofiler was calibrated in April 2007 using silt from the Botlek area, therefore the units are mg/l Botlek silt. The “short” extinction sensor was uncoupled in may 2007 and replaced by an additional OBS. From that moment onwards both OBS were calibrated using formazine and therefore the units are FTU (formazine turbidity units)

The samples taken in April were not carefully handled and therefore contaminated with sediment present on the frame of the siltprofiler. From July onwards the samples were taken more carefully. Because the calibration constants of the siltprofiler for both Botlek silt and FTU's are known from the .ini files of the siltprofiler Botlek silt can be recalculated to FTU's and, assuming that there is no shift in the composition of the silt, the calibration of July and Oktober can be used for april too.

Calculation of Botlek silt from digital voltage units:

$$B = 0.3 + 0.72668 \cdot U - 1.68E-4 \cdot U^2 + 2.80E-7 \cdot U^3 \quad (\text{equation 1})$$

where B is the silt concentration in mg Botleksilt/l and U the voltage in digital units

Calculation of FTU from digital voltage units:

$$F = 1.88653233 + 0.984437 \cdot U \quad (\text{equation 2})$$

where F is the silt concentration in Formazine Turbidity units and U the voltage in digital units

The OBS, in combination with its cable, has a range till ca. 125 FTU. The relationship between B en F is almost linear in the range 0 - 150 ($R^2 > 0.995$), so linear regression can be used to calculate FTU's from mg Botlek silt/l for the data collected in April.

$$F = 0.8393 + 1.3925 \cdot B \quad (\text{equation 3, fig. 1})$$

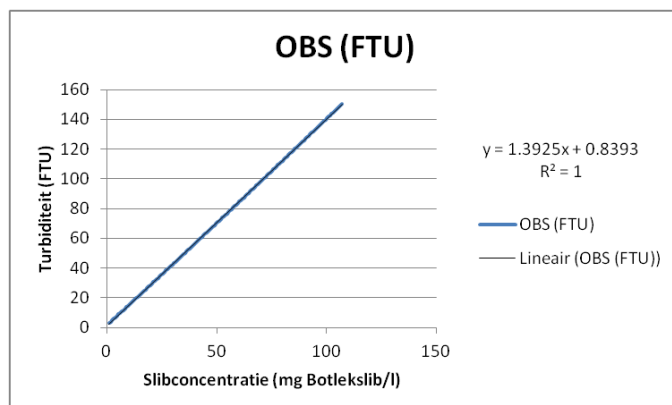


Fig. 1 Calculation of FTU's from Botlek silt concentrations

The data collected in July and October are in FTU's.

From the linear relationship between SPM and FTU:

$$S = a + b * F \quad (\text{equation 4})$$

follows:

$$F = 1/b * S - a/b \quad (\text{equation 5})$$

Using the right calibration method the SPM concentration can be calculated:

There are three different options for the calibration regression: Type I regression (normal linear regression) of FTU on dry matter assessed in the laboratory or dry matter on FTU and a type II regression, in which the relation is estimated symmetrically. Both type I regressions are the extremes. To get an impression of the differences between the results of both type I regressions they are compared here (fig. 2):

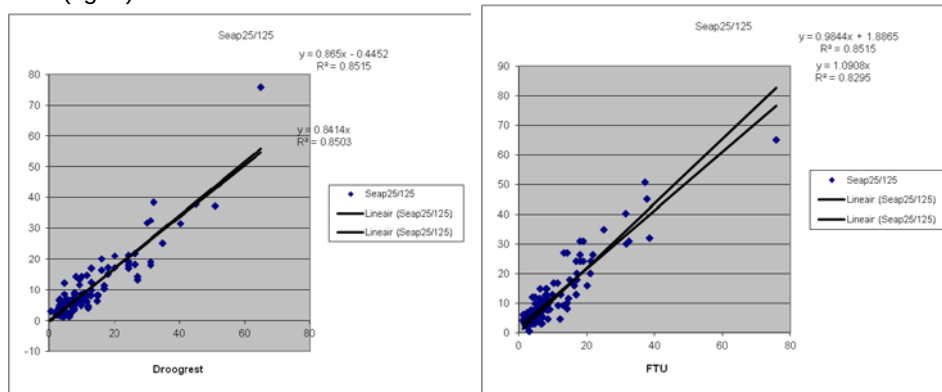


Fig. 2. Regression of FTU on dry matter ("droogrest", left) and regression of dry matter on FTU (right). Values of both OBS are combined in these regressions.

The coefficients of the regression of FTU on dry matter (assumption: error in laboratory determination of dry matter very small compared with the error in the FTU's) are:

intercept -0.4452 en slope 0.8650: $F = -0.4452 + 0.8650 * D$

Applying equation 5 leads to:

$$D = 0.5147 + 1.15607 * F$$

From the regression of D on FTU (assumption: error in FTU's very small compared to the error in the laboratorium) follows:

$$D = 1.8865 + 0.9844 F$$

For low SPM concentrations the regression of D on FTU results in slightly higher values, but for high SPM concentrations the regression of FTU on D results in ca.16% higher values (fig. 3).

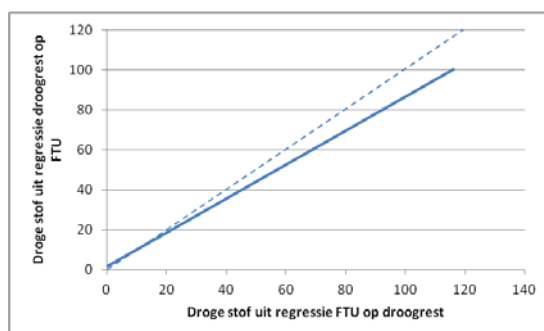


Fig. 3 The relation between SPM concentration estimated from the regression of FTU on dry matter (X) and SPM concentration estimated using the regression of dry matter on FTU. The dashed line is the 1:1 relation.

The SPM-concentrations are estimated from the regression of dry matter on FTU and, for April only, also from the link between "Botlek silt concentration" and FTU:

April: FTU recalculated from Botlek silt (fig. 1), SPM estimated from the calculated FTU, based on the regression of dry matter (lab values) on FTU for both Seapoints (fig. 2)

$$S = (0.8393 + 1.3925 * B) * 0.9844 + 1.8865 = 1.8865 + 0.8393 * 0.9844 + 1.3925 * 0.9844 * B$$

$$S = 2.7127 + 1.16873 * B$$

July and October: SPM estimated directly from FTU's, using the regression of dry matter concentration on FTU.

$$S = 1.8865 + 0.9844 * F \text{ or } S = 1.0908 * F$$

New siltprofiler

The calibration of the new siltprofiler is more complicated for three reasons:

1. Problems with air bubbles stemming from the frame, that were solved in November 2010 by filling the frame with synthetic resin.
2. Problems caused by the connection of the OBS to the central unit. The cable of the OBS was accidentally replaced by a cable with a different amplification factor during the first tests with the new profiler. Higher SPM concentrations could not be measured and therefore only samples with low SPM concentrations were available for calibration. The cable was replaced in October 2011.
3. The laboratory stopped reporting the hand written labels on the bottles in 2011. The match between bottle and sample is only possible using the hand written, Word or Excel documents listing the samples for each survey in relation to the numbers of the labels that are scanned in the lab. In almost 50% of the cases, however, it was possible to link the laboratory results to field samples, because the labels have been glued to the bottles sequentially. If there are more samples taken than listed in the lab results, the match is impossible without the missing documents.

Despite the first problem, most of the samples collected before November 2010 have been used for the calibration after a quick inspection of the profiles in the range of the sampling and omitting questionable samples from the calibration procedure. However a more thorough inspection of the results is still necessary.

Also more lab values may become available, since the laboratory stopped reporting the hand written labels on the sample bottles. The lists of samples may become available later on. The calibration spreadsheet will be updated on the Deltares repository.

The ratio between the maximum FTU's obtained with both cables, as appearing from the measurements in areas with high SPM concentrations was estimated to be 0.148. This ratio has been used as a multiplier for the FTU in the procedure. However, the expected ratio was 0.2. Since the calibration regression improved by applying the 0.2 ratio the ratio 0.2 should be applied. After multiplying the FTU values estimated before October 2011 from the profiles by 1.348 ($=0.2/0.148$) the calibration was done by regression of dry matter on FTU's.

Because there seemed to be marked differences between periods the first test weeks (July 2007, 0707), August and September 2007 (0708-09) and some other periods we start showing the relationships for several periods (fig. 4).

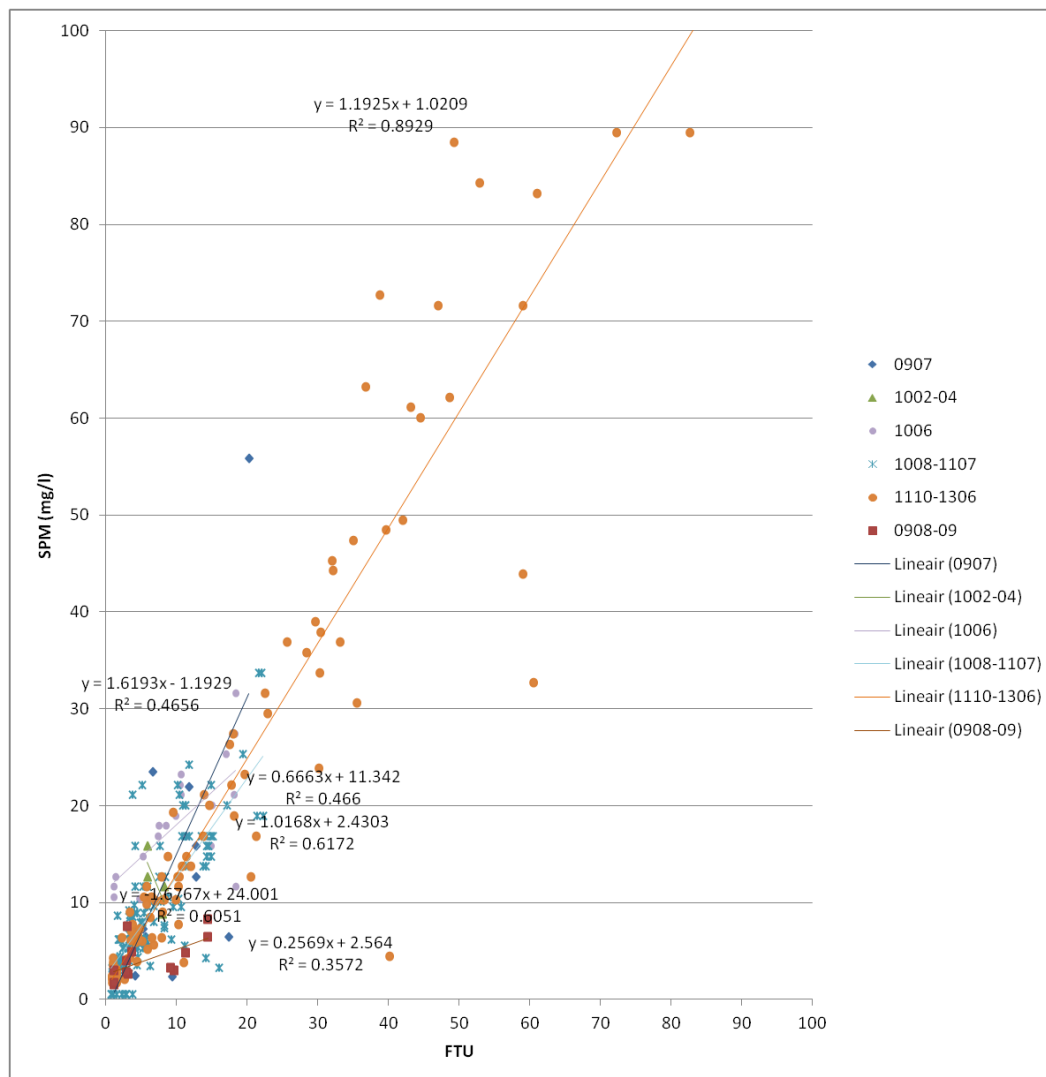


Fig. 4 Problems in the calibration of the OBS

Figure 4 shows that the best relation between FTU and SPM concentrations has been found with the samples collected from October 2011 onwards. The explained variance in all other periods is lower and regression results are untrustworthy. The most extreme is the regression for the period February-April 2010, showing lower SPM laboratory results with increasing FTU's. In June 2010 the intercept is 11, which is unlikely. Other regressions, for the periods July 2007 and August 2010 – July 2011, show results comparable to the result for the period starting in October 2011. Since most of the intercepts are not significantly different from 0 the final calibration regression has been done on all available data and forcing the regression through the origin. The results are shown in figure 5.

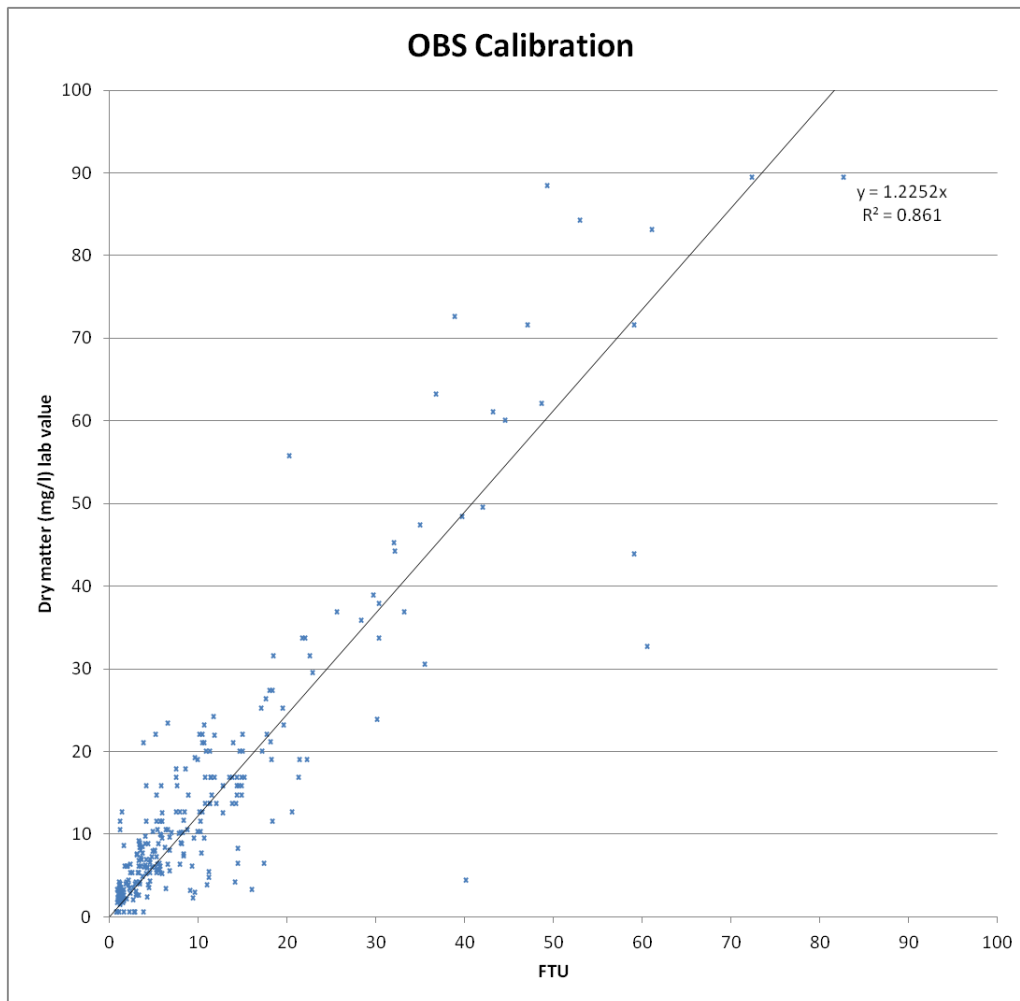


Fig. 5. Calibration of the OBS

A linear relation between LISST extinction and SPM concentrations (Fig 5) is expected. The explained variance, however is low. This is partly due to deviations of the LISST extinction in salinity and temperature gradients. The data should be screened for such deviations, but for this moment the relationship as estimated from the available data will be used.

Also a linear relationship is expected between the transformed ADCP backscatter values and the SPM concentrations is expected (Fig. 6). However, the relationship is not linear, most probably because backscatter by finer sediments is lower and backscatter by organic matter differs from the backscatter by sand, silt and clay particles. Therefore a power curve has been estimated.

The conclusion is that SPM estimated by the OBS is most accurate. However, for values outside the range of the OBS an approximation of the SPM values can be obtained from ADV backscatter and/or LISST extinction.

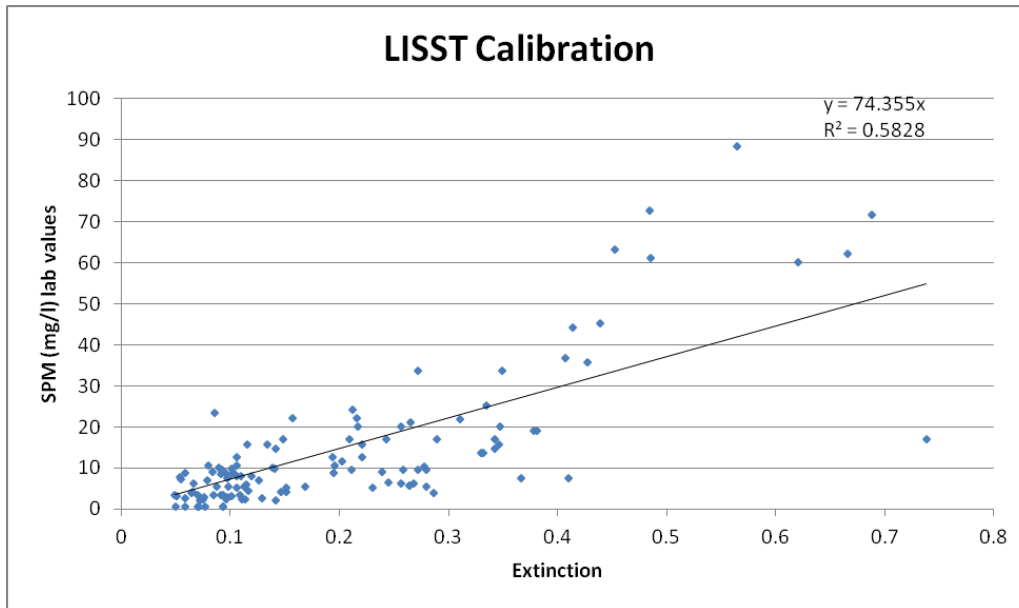


Fig. 6. Calibration of the LISST

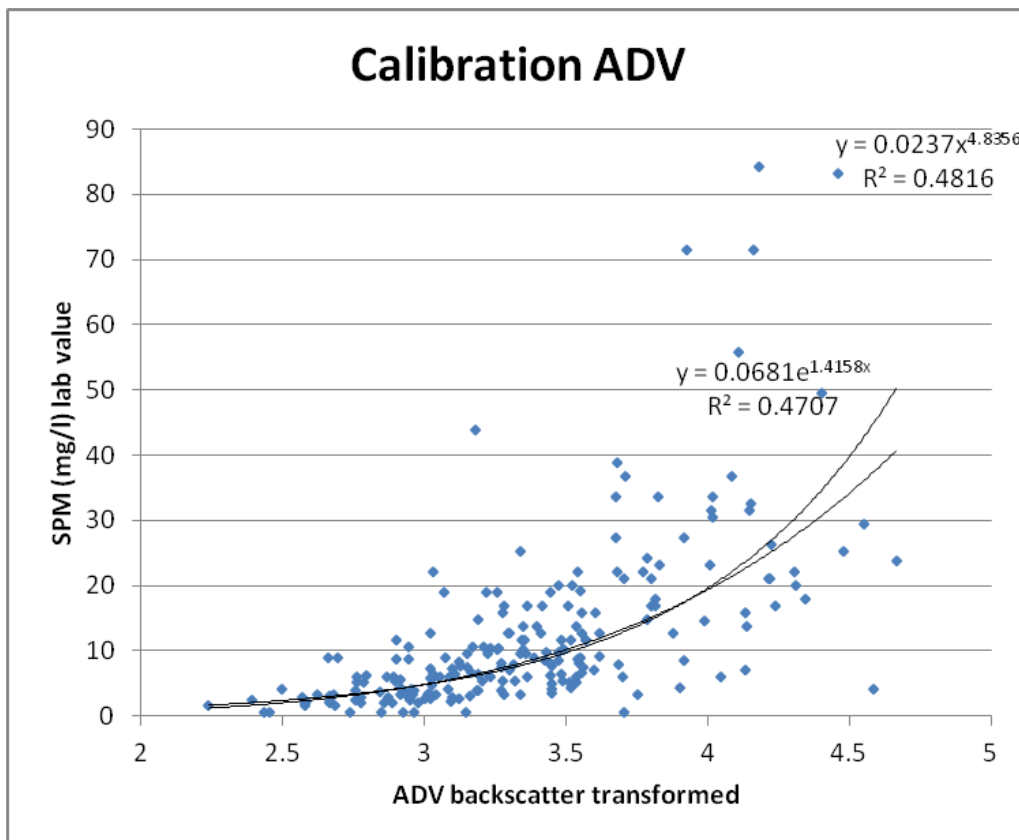


Fig. 7. Calibration of the ADV