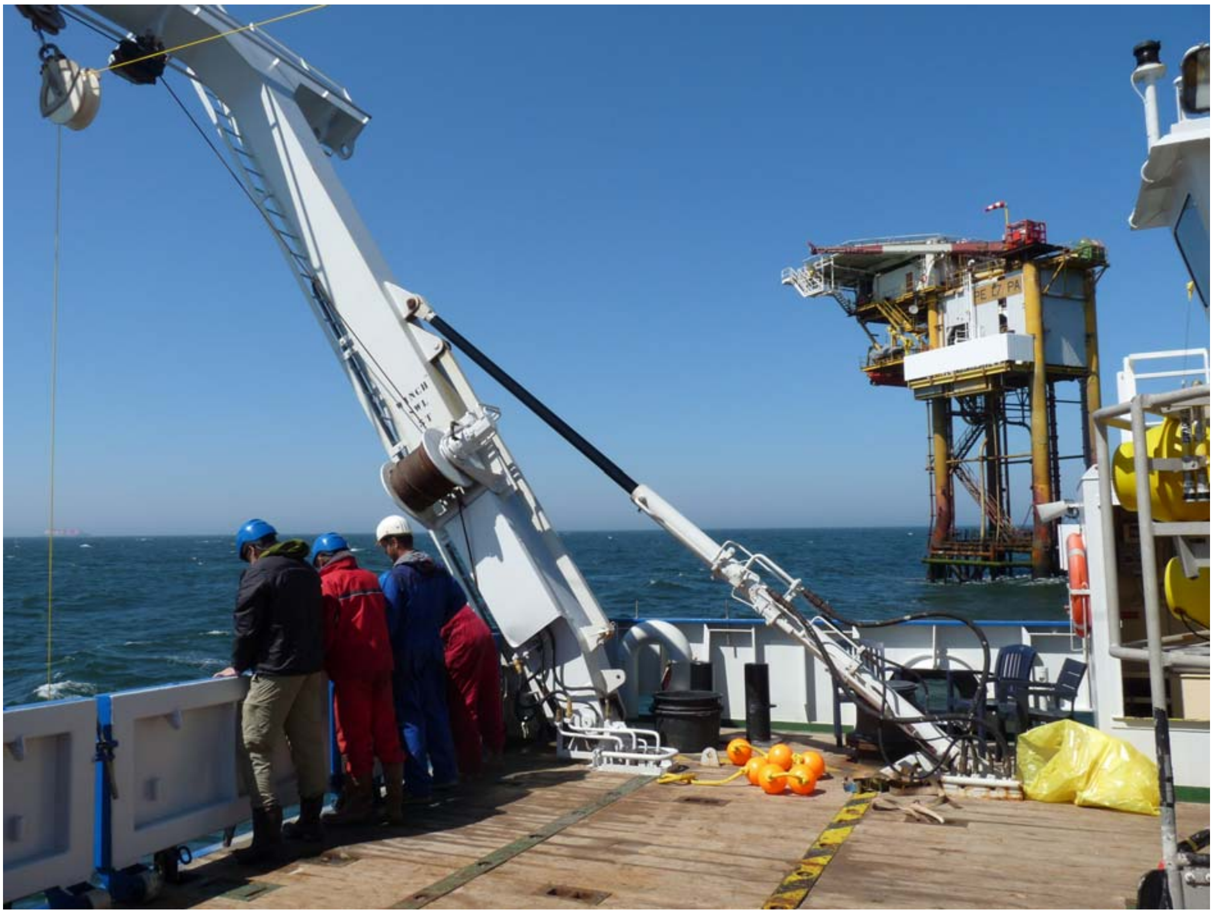
Cruise Report
Cruise 64PE409, Texel-Texel
7-12 May 2016
R.V. Pelagia

F. Mienis, G. Duineveld, and shipboard scientific crew



NIOZ Royal Netherlands Institute for Sea Research, Texel, The Netherlands

INSITE

Measuring the 'shadow' of artificial structures in the North Sea and its effect on the surrounding soft bottom community (SHADOW)

F. Mienis, G. Duineveld, and shipboard scientific crew

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1. Introduction

1.1 Project background

Cruise 64PE409 with the RV Pelagia to Platform L7A was conducted as part of the INSITE project funded by INSITE (www.insitenorthsea.org). Specific goal of the current cruise was to determine if there is a "SHADOW" effect of a platform on the surrounding benthic community in the southern North Sea. In addition we also wanted to define if the platforms form stepping stones by looking at propagules that are coming from the platform.

1.2 Scientific background

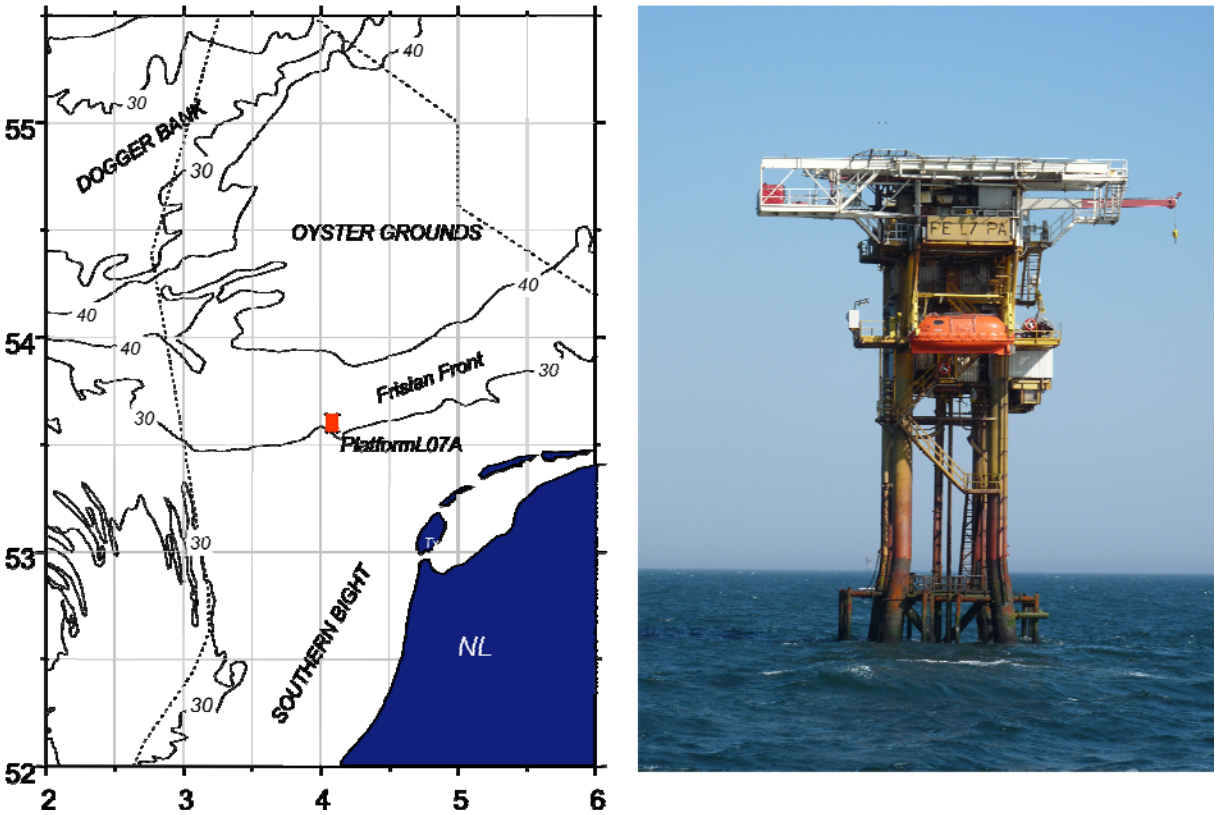
Artificial structures in the North Sea offer hard substrate to a rich and diverse community of epifauna in an area mainly covered by soft sediment. In most cases the epifaunal community on off shore installations is dominated by passive and active suspension feeders (muscles, barnacles, anemones), which attract higher trophic levels like starfish, crabs and fish. It is estimated that the biomass of all fauna growing on off shore installations can be up to 500-fold the biomass of the surrounding soft bottom sediments (Picken et al. 2000). At present very little is known about what the effect of this high biomass is on concentrations of particles and nutrients in the vicinity of such structures. Given the high proportion of suspension feeders, the epifauna on these structures might act as a biofilter, depleting suspended nutritious matter in the water column and enriching the immediate environment by the production of pseudo faeces, excreted dissolved nutrients and larvae. These ideas are based on a study that was carried out by Maar et al. (2009) who indicated a depletion of chlorophyll a at the downstream side of wind turbines that were covered with muscles. Also recently it was shown on satellite images that off shore windfarms have a turbid wake around their turbines which could represent a pseudo trail of faeces from the fouling community (Vanhellemont and Ruddick, 2014).Besides giving rise to enhanced biomass and activity of epifauna submerged structures in the North Sea also provide valuable substrate to species, enhancing biodiversity. Hence, they may act as vectors facilitating the spatial distribution of many species in the North Sea.

Based on the aforementioned evidence, we hypothesize that 1. Oil and gas platforms may act as biofilters creating a Shadow that affects the water column in the vicinity of the platform and the surrounding soft bottom community, and 2. Oil/gas platforms in the North Sea may act as stepping stones for species, enhancing biodiversity.

To test our hypotheses, we had the following objectives for the current cruise:
1) measure concentrations and fluxes of particles (organic matter, larvae) and solutes (nutrients, dissolved organic matter) around an offshore installation,
2) measure impacts on the surrounding benthic community through community parameters (collect samples for biomass, in situ respiration experiments),
3) collect data and observations that can be used to model the "shadow" (benthic landers, CTD and box corer transects), and
4) collect and quantify the production of propagules (CTD water sampling).

1.3 Platform L7A

Platform L7A is situated in the southern North Sea and is owned by Total. The first gas was produced in 1988 and at present the platform is no longer in use. Specific for this platform is that it is clear of discharge of toxic waste. L7A is situated in the shallow part of the North Sea at 35 m water depth near the southern border of the Oyster grounds. The bottom fauna within the 500 m (non-trawling) zone around the platform was investigated earlier in 2007 by NIOZ (Duineveld et al. 2007). This non trawling zone around the off shore installation forms a refuge for vulnerable soft bottom fauna and within this zone anthropogenic influences like fisheries are minimal. During the cruise samples were taken within the "Shadow" of the platform (direction of the strongest currents) and at reference sites outside the "Shadow" mainly within the 500 m non-trawling zone to exclude the effect of fisheries.



Position of platform L7A in the southern North Sea and photograph of the platform taken during cruise 64PE409.

1.4 Cruise 64PE409

We departed from Texel, The Netherlands in the morning of the 7th of May 2016 and returned to Texel on the 12th of May in the late afternoon. The cruise was partially funded by INSITE and in addition funded and organised by the Royal Netherlands Institute for Sea Research (NIOZ), based on Texel, The Netherlands. The cruise was carried out with the NIOZ operated research vessel Pelagia. The scientific crew was formed by a total of 7 scientists from the NIOZ. Scientists were supported by a mechanical engineer from the NIOZ and the crew of the RV Pelagia (Appendix I).

On Saturday May 7th RV Pelagia left Texel and first sailed to Den Helder for calibration of the compass, which was followed by a transit of 7 hours to the study site. Upon arrival Total was contacted to get permission to work in the 500 m zone in the vicinity of the platform. However, at that moment permission was not granted. Therefor it was decided to perform a calibration CTD whereby water samples were taken for SPM calibration and to deploy the two lander systems at 700 m distance from the platform for a first deployment outside the 500 m non-trawling zone. The following day started with a test of the tethered video system outside the non-trawling zone. Since permission was still not granted CTD casts were recorded outside the 500 m zone in a clockwise direction following the movement of the tide, starting in the shadow area of the platform. In the afternoon permission was granted, allowing us to work in the 500 m non-trawling zone between 9 AM and 6PM every day. First action was a video transect, which was recorded from the NW-SE along the southern site of the platform. After this both landers were recovered and prepared for a second deployment the next morning. During the night circles were sailed around the 500 m zone to collect data with the Aquaflow. In the morning of the 9th two towed CTD's were carried out in the "Shadow" part of the platform at 12 and 23 m water depth, respectively. In addition 4 CTD stations were carried out in the "Shadow" direction of the platform. The two landers were again deployed this time at 100 m away from the platform. After deployment two box corer transects were made of 4 stations at 100, 300, 500 and 700 m distance from the platform, respectively. In the evening RV Pelagia sailed away from the platform and box corers were sieved over a 1 mm sieve and samples were on board sorted for their macrofaunal content. Overnight another Aquaflow survey was carried out. The next day started with a CTD transect in the Shadow of the platform. Water samples were taken at three depths at each station. After the CTD transect was finished both landers were recovered and two more box core transects were carried out. Before leaving the 500 m non trawling zone both landers were deployed again at 300 m distance from the platform. The next morning both landers were recovered and instruments were serviced and programmed for a long term deployment. Three more towed CTD's were carried out and a short CTD transect with water sampling was carried out in a non-shadow direction. The next day two moorings were deployed in the vicinity of the platform that will stay there until December 2016 to measure temporal variability in the area.

1.5 Acknowledgements

The shipboard scientific party would like to thank the captain and crew of the R.V. Pelagia and the NIOZ technicians and NIOZ logistics and administrative departments (NIOZ-MRF) for their help with cruise preparations and at sea. The cruise was funded by the Royal NIOZ and INSITE.

1.6 References

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Maar, M., Bolding, K., Petersen, J.K., Hansen, J.L.S., Timmermann, K. (2009) Local effects of blue mussels around turbine foundations in an ecosystem model of Nysted off-shore wind farm, Denmark. Journal of Sea Research 62: 159–174.

Picken, G., Baine, M., Heaps, L., Side, J. (2000) From rigs to reefs in the North Sea. In: A Jensen, K Collins, AP Lockwood (Eds) Artificial Reefs in European Seas, Kluwer, Dordrecht

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2. Sampling methods and first results

2.1 Underwater video imaging

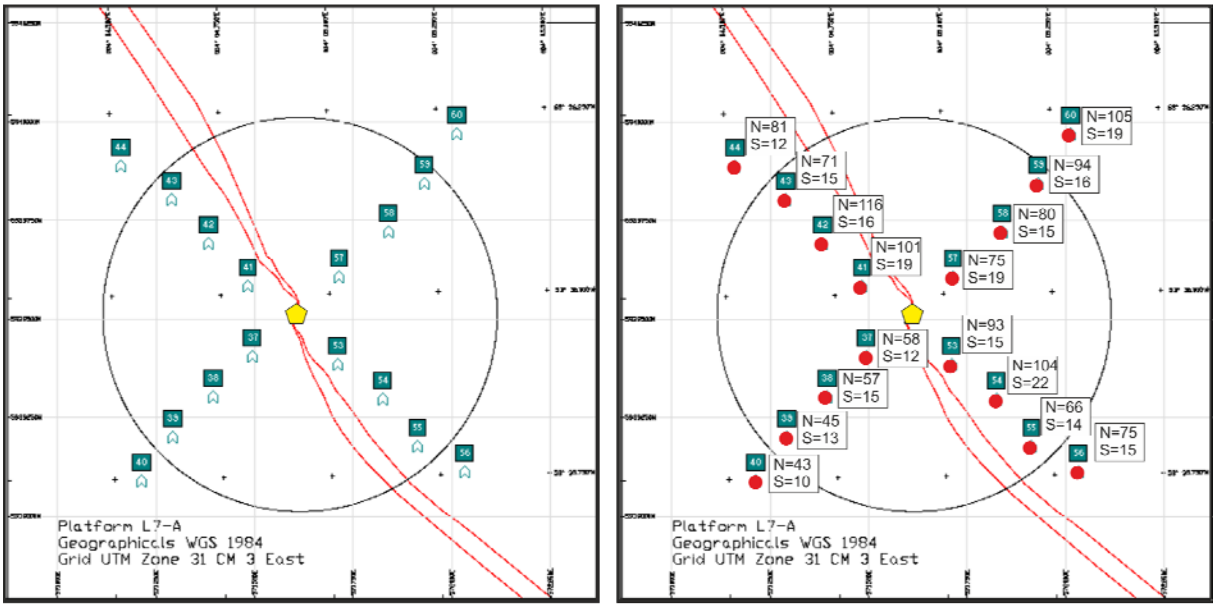
Video-images of the seafloor around platform L7A were made using a tethered camera system attached to a specifically designed frame, holding a downward looking HD digital video camera, a forward looking camera, a power-supply and modem, UW lights, and a set of parallel Oktopus™ laser pointers. The camera system is connected to an optical fibre cable that allows real time transmission of video images. The major purpose of the video transect made during the cruise was to estimate coverage and density by live large benthos and to identify bioturbation patterns. The fixed distance (30 cm) marked by the lasers in the images forms a mean to estimate coverage per square meter. During the cruise one transect was carried out, starting and ending outside the 500 m non-trawling zone and crossing the platform at 100 m distance.

Fortunately visibility near the seabed was relatively good and video could be recorded with the downward looking camera. Due to high particle load in the water column the forward looking camera could not be used. Video showed the presence of soft sediment with lots of burrows, which are likely made by burrowing shrimps. Ophiuridae were commonly observed as well as flat fish.

2.2 Box corer

Box core samples were collected along transects in 4 different directions (SW, SE, NW and NE). All transects consisted of 4 box core samples, which were collected at 150 m distance from each other. All bottom samples were taken with a NIOZ box corer (K16) equipped with a stainless steel cylindrical core of 30 cm in diameter and 55 cm height and a trip valve sealing the box. When the box corer came on deck, the valve was carefully opened and if present the overlying water was siphoned off. The surface of the box core was photographed and a description of the species composition and other characteristics was made (e.g. height of sediment and/or sediment characteristics, living/fossil species). A sub core was taken for sedimentological and radionuclide analyses, which was stored in the fridge at 4 °C. Three surface samples were collected for OM measurements and three syringes were pushed into the sediment to collect material for eDNA. All these samples were stored at -20 °C. The box core samples were sorted for living macro-organisms, whereby the whole sample was sieved over nested 1 mm sieve. All live organisms were sorted and identified during the cruise. All fauna was stored in ethanol for later analysis.

All samples that were taken had a penetration over 35 cm. Overlying water of the box core samples was siphoned off and rinsed over a sieve. At most stations small nodules were found in overlying water that resembled an oil like substance. The sediment found around the platform consisted of fine grained sediment and was characterised by the presence of large burrows that are likely linked to the presence of burrowing shrimps (*Callianassa subterranean, Upogebia deltaura*). First results of the macro faunal abundance did not show a clear trend in the different species that were present along the different transects. However, the number of species differed between transects, showing high abundances in the NW and SE direction and lowest abundance in the SW direction. In general along these transects a decreasing trend was observed moving away from the platform. In the Shadow direction (NE) an increase in number of species was observed with increasing distance from the platform. Most common species observed in the box core samples were *Amphiura filiformis* (N=641, filter feeder), *Lumbrineris* sp. (N=116, deposit feeder), *Phoronida* sp. (N=101, filter feeder) and *Callianassa subterranean* (N=87, deposit feeder).



Map with the location of box core samples taken during cruise 64PE409 and map showing the presence of macro fauna observed in the individual box cores (N= number of individuals, S= number of species).

2.3 Benthic landers

During cruise 64PE409 two ALBEX landers were deployed at three different locations at 100, 300 and 700 m from the platform, respectively. During the deployments both landers were deployed at the same time and same distance from the platform, whereby one lander was placed within the “Shadow” and the other lander was placed at a reference site. During the short deployments the ALBEX lander consisted of an alu tripod equipped with 12 glass Benthos™ floats, two IXSEA acoustic releasers and a single 250 kg ballast weight. The landers were deployed and recovered with a floating line, which was kept at the surface with 5 little floats. An Iridium beacon was attached to the frame to locate it in case of unexpected surfacing. Furthermore, the lander was equipped with an Aquadopp current meter, an ALEC optical backscatter sensor, a Lisst ABS sensor to monitor acoustic backscatter and three NIOZ made benthic chambers to measure respiration activity at the deployment site. In addition the lander that was deployed in the “Shadow” was equipped with a McLane particle pump, which consisted of 24 filter cups over which 3L of water was filtered at an 1 hour interval.

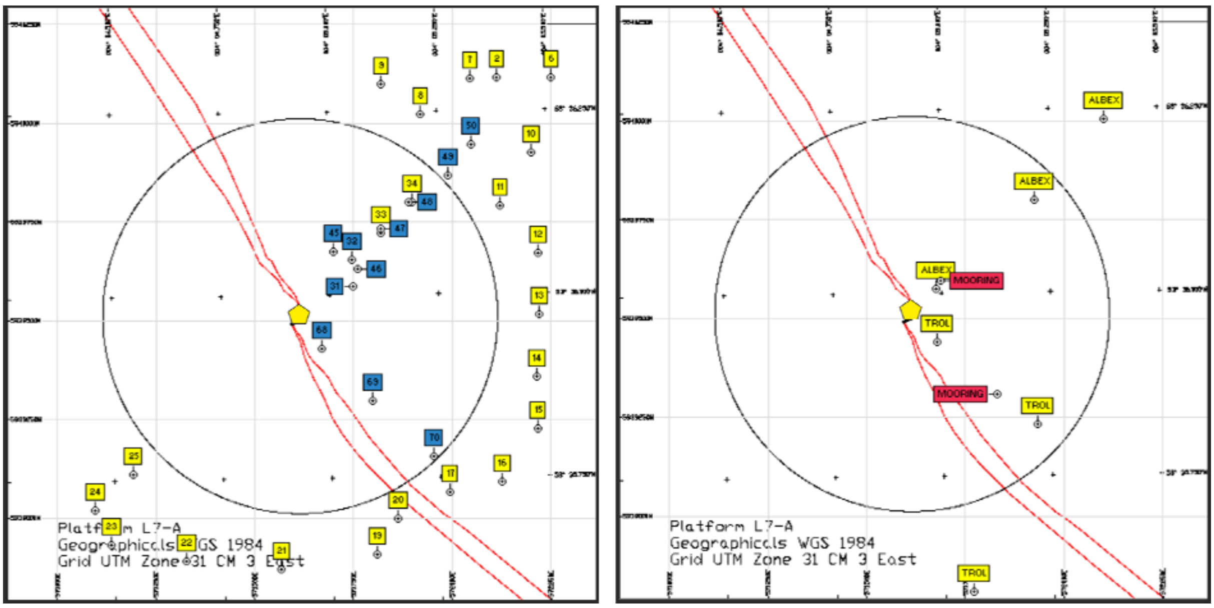
Lander data from the short deployments showed that during the duration of the cruise bottom water temperatures increased up to 1 °C. Increases in current speed during the ebb and flood period of the tide correlated with higher current speeds, leading to peaks in fluorescence, acoustic and optical backscatter. Strongest currents were observed during the flood period of the tide in a NE direction. In addition some peaks in optical backscatter were observed during low current speeds at the deployment site 100 m away from the platform. Different trends were observed in the amount of respiration at different distances from the platform. In the “Shadow” respiration values increased moving away from the platform, while at the reference sites respiration values showed a decreasing trend.

2.4 Moorings

The moorings that were deployed at the end of the cruise consisted of a bottom weight of 400 kg, which was connected to two releases. Along the mooring wire an Aquadopp current sensor and a Lisst ABS sensor with data logger were mounted at 10 m above the bottom. Immediately above the current sensor a Technicap PPS4/3 sediment trap was mounted with a rotating carrousel with 12 bottles that were filled with a preservative (pH buffered $HgCl_2$ solution or DMSO). The sediment trap was programmed at a 14 day interval. At 12 m above the bottom and 16 m below the sea surface an Alec turbidity sensor was attached to the wire. In addition little nets with living *Mytilus edilus* were attached to the wire at 4, 12 and 24 m above the bottom, respectively. These muscles will be used for a growth experiment, whereby growth and biomass of the muscles at different heights in the water column will be monitored.

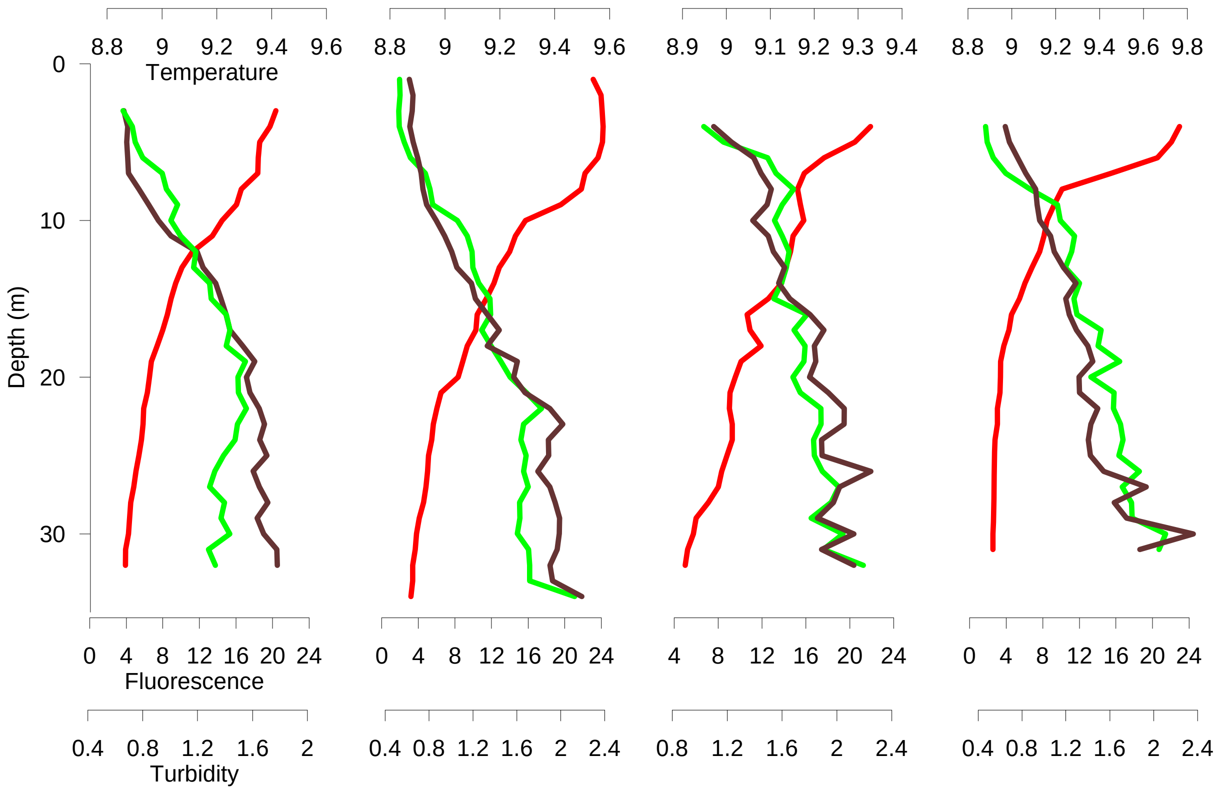
2.5 CTD

During the cruise the CTD-rosette sampler was equipped with 22 Noex bottles of 12 litre, a Seabird™ 911 CTD with auxiliary sensors for oxygen, fluorescence (Chelsea Aqua 3) and turbidity (Transmissometer and Wetlabs FLNTU). Data were acquired using the SeaBird SBEdata Processing –Win 32 software. Several CTD transects were made in the "Shadow" and outside the "Shadow". CTD profiling was mainly performed during the flood period of the tide, since strongest currents were measured in this direction at the study site. In addition CTD transects were performed in which water samples were taken, which were collected at three different depths, as close as possible to the seabed, at mid water depth and at the surface. Samples were collected for DIC, DOC, nutrients and silicate. In addition water samples were filtered over pre-weighed GFF filters to define the amount of suspended matter in the water column. In addition these filters will be used for measurements of organic matter, N and carbon and nitrogen isotopes. A list of all water samples taken for geochemical analysis is given in Appendix III and IV. Three times 10 L of water was filtered over a 50 µm sieve to collect samples for eDNA. These samples were frozen at -80 °C and will be analysed at a later stage at NIOZ.



Map with locations of CTD stations (blue numbers indicate stations where water samples were collected) and map with locations of landers and moorings.

CTD profiles of temperature and salinity showed a stratified water column. Water temperatures near the bottom increased throughout during the cruise, while surface water temperatures stayed constant. Highest turbidity and fluorescence values were observed in the lower 20 m of the water column.



CTD data collected between 8:44 and 13:48 on Sunday 7 May, showing a stratified water column.

2.6 Shipboard ADCP and Aquaflow

Hydrographical information of surface water was recorded by an on board Aquaflow system, which recorded data (temperature, salinity , fluorescence) at a one minute interval. The inlet of the Aquaflow system was situated at 4 m water depth. During the cruise two nights were used to sail circles around the platform in a clockwise direction following the boundary of the 500 m non trawling zone to define if hydrological characteristics of the surface water changed during the tide.

A vessel mounted ADCP (75 kHz) was used to measure current speed and direction in the water column during all CTD casts. Data were recorded on a dedicated computer and data will be processed at NIOZ.

Appendices

Appendix I, cruise participants

Scientific ship board crew

Name	*E-mail*	*Affiliation*
Magda Bergman	magda.bergman@nioz.nl	NIOZ (NL)
Lorendz Boom	lorendz.boom@nioz.nl	NIOZ (NL), technician
Gerard Duineveld	gerard.duineveld@nioz.nl	NIOZ (NL)
Ulrike Hanz	ulrike.hanz@nioz.nl	NIOZ (NL), PhD
Lise Klunder	lise.klunder@nioz.nl	NIOZ (NL), PhD
Marc Lavaleye	marc.lavaleye@nioz.nl	NIOZ (NL)
Furu Mienis	furu.mienis@nioz.nl	NIOZ (NL), chief scientist
Evaline van Weerlee	evaline.van.weerlee@nioz.nl	NIOZ (NL)
Rob Witbaard	rob.witbaard@nioz.nl	NIOZ (NL)

Appendix II, Cruise logbook

Station nr	Gear type	Action	Date	Time	Latitude	Longitude	Depth	Remarks
1	CTD	Begin	07/05/2016	17:38:21	53.6049	4.0899	38	Failed
2	CTD with samples	Begin	07/05/2016	17:54:46	53.6049	4.09	39	Calibration
2	CTD with samples	Bottom	07/05/2016	17:58:15	53.6049	4.0898	39	
2	CTD with samples	End	07/05/2016	18:35:26	53.6048	4.0899	41	
3	Lander ALBEX	Deployment	07/05/2016	20:05:25	53.6039	4.0896	35	
4	Lander TROL	Deployment	07/05/2016	20:34:52	53.5932	4.0844	38	
5	Video	Begin	08/05/2016	7:02:49	53.6069	4.0886	39	
5	Video	End	08/05/2016	7:43:38	53.6046	4.095	39	
6	CTD	Begin	08/05/2016	8:44:24	53.6049	4.0924	39	
6	CTD	Bottom	08/05/2016	8:48:18	53.6049	4.0919	39	
6	CTD	End	08/05/2016	8:50:05	53.6049	4.0918	39	
7	CTD	Begin	08/05/2016	8:59:55	53.6048	4.0889	39	
7	CTD	Bottom	08/05/2016	9:03:47	53.6049	4.0888	39	
7	CTD	End	08/05/2016	9:07:03	53.6049	4.0889	39	
8	CTD	Begin	08/05/2016	9:13:52	53.6043	4.0872	39	
8	CTD	Bottom	08/05/2016	9:16:26	53.6041	4.0869	38	
8	CTD	End	08/05/2016	9:18:18	53.6041	4.0867	39	
9	CTD	Begin	08/05/2016	9:28:54	53.6047	4.0855	35	
9	CTD	Bottom	08/05/2016	9:30:13	53.6048	4.0854	38	
9	CTD	End	08/05/2016	9:33:07	53.6048	4.0852	38	
10	CTD	Begin	08/05/2016	9:49:38	53.6031	4.0912	38	
10	CTD	Bottom	08/05/2016	9:50:53	53.6032	4.0911	38	
10	CTD	End	08/05/2016	9:52:53	53.6032	4.0909	38	
11	CTD	Begin	08/05/2016	9:59:15	53.6021	4.09	38	
11	CTD	Bottom	08/05/2016	10:00:32	53.602	4.0899	38	
11	CTD	End	08/05/2016	10:02:28	53.602	4.0898	39	

12	CTD	Begin	08/05/2016	10:13:22	53.601	4.0912	38	
12	CTD	Bottom	08/05/2016	10:16:28	53.6009	4.0913	39	
12	CTD	End	08/05/2016	10:18:49	53.6009	4.0914	38	
13	CTD	Begin	08/05/2016	10:28:12	53.5997	4.0913	39	
13	CTD	Bottom	08/05/2016	10:31:28	53.5995	4.0913	38	
13	CTD	End	08/05/2016	10:33:13	53.5995	4.0914	38	
14	CTD	Begin	08/05/2016	10:42:44	53.5982	4.0911	37	
14	CTD	Bottom	08/05/2016	10:45:26	53.5981	4.0912	38	
14	CTD	End	08/05/2016	10:47:00	53.5981	4.0912	38	
15	CTD	Begin	08/05/2016	10:55:36	53.5969	4.0912	38	
15	CTD	Bottom	08/05/2016	10:58:25	53.5969	4.0912	34	
15	CTD	End	08/05/2016	10:59:46	53.5968	4.0913	37	
16	CTD	Begin	08/05/2016	11:07:21	53.5959	4.0898	37	
16	CTD	Bottom	08/05/2016	11:11:13	53.5957	4.0898	37	
16	CTD	End	08/05/2016	11:13:18	53.5958	4.0898	38	
17	CTD	Begin	08/05/2016	11:25:33	53.5955	4.0878	37	
17	CTD	Bottom	08/05/2016	11:28:21	53.5955	4.0878	38	
17	CTD	End	08/05/2016	11:30:37	53.5955	4.0877	37	
18	CTD	Begin	08/05/2016	11:44:30	53.5947	4.0889	38	
18	CTD	Bottom	08/05/2016	11:44:34	53.5947	4.0889	37	
18	CTD	End	08/05/2016	11:45:53	53.5946	4.0887	38	
19	CTD	Begin	08/05/2016	11:58:45	53.5942	4.085	37	
19	CTD	Bottom	08/05/2016	12:01:05	53.5941	4.085	38	
19	CTD	End	08/05/2016	12:02:48	53.5939	4.085	37	
20	CTD	Begin	08/05/2016	12:17:18	53.5951	4.0857	38	
20	CTD	Bottom	08/05/2016	12:19:44	53.5949	4.0858	37	
20	CTD	End	08/05/2016	12:21:12	53.595	4.0857	33	
21	CTD	Begin	08/05/2016	12:33:35	53.5939	4.0814	36	
21	CTD	Bottom	08/05/2016	12:36:12	53.5938	4.0813	37	

21	CTD	End	08/05/2016	12:37:58	53.594	4.0813	37	
22	CTD	Begin	08/05/2016	12:49:04	53.5939	4.0779	37	
22	CTD	Bottom	08/05/2016	12:51:35	53.594	4.0777	38	
22	CTD	End	08/05/2016	12:53:13	53.5942	4.0776	36	
23	CTD	Begin	08/05/2016	13:07:26	53.5943	4.075	37	
23	CTD	Bottom	08/05/2016	13:09:47	53.5944	4.0748	37	
23	CTD	End	08/05/2016	13:11:44	53.5943	4.075	37	
24	CTD	Begin	08/05/2016	13:24:08	53.5952	4.075	37	
24	CTD	Begin	08/05/2016	13:24:16	53.5952	4.075	37	
24	CTD	Bottom	08/05/2016	13:34:49	53.5952	4.0742	37	
24	CTD	End	08/05/2016	13:36:24	53.5953	4.0742	37	
25	CTD	Begin	08/05/2016	13:48:14	53.596	4.0757	37	
25	CTD	Bottom	08/05/2016	13:56:15	53.596	4.0757	36	
25	CTD	End	08/05/2016	13:57:51	53.5958	4.0757	37	
26	Video	Begin	08/05/2016	14:26:58	53.6048	4.0751	37	
26	Video	End	08/05/2016	16:55:23	53.5954	4.0862	38	
27	Lander ALBEX	Recovery	08/05/2016	17:23:04	53.5933	4.0857	37	
28	Lander TROL	Recovery	08/05/2016	17:57:48	53.6043	4.0909	38	
29	CTD	Begin	09/05/2016	6:10:09	53.6047	4.0776	39	Towed
29	CTD	Bottom	09/05/2016	6:11:52	53.6046	4.0777	39	
29	CTD	End	09/05/2016	7:23:27	53.5952	4.0864	38	
30	CTD	Begin	09/05/2016	7:56:44	53.6051	4.0791	38	Towed
30	CTD	Bottom	09/05/2016	7:58:06	53.6049	4.0792	39	
30	CTD	End	09/05/2016	8:58:14	53.5958	4.0859	-1	
31	CTD with samples	Begin	09/05/2016	9:17:09	53.6002	4.0845	39	
31	CTD with samples	Bottom	09/05/2016	9:18:26	53.6002	4.0842	40	
31	CTD with samples	End	09/05/2016	9:25:38	53.6002	4.0834	40	
32	CTD with samples	Begin	09/05/2016	9:56:31	53.6011	4.0842	39	
32	CTD with samples	Bottom	09/05/2016	10:02:43	53.6008	4.0842	38	

32	CTD with samples	End	09/05/2016	10:04:25	53.6008	4.0843	39	
33	CTD	Begin	09/05/2016	10:11:25	53.6015	4.0852	38	
33	CTD	Bottom	09/05/2016	10:14:14	53.6014	4.0853	39	
33	CTD	End	09/05/2016	10:16:44	53.6014	4.0853	-1	
34	CTD	Begin	09/05/2016	10:21:53	53.6021	4.0865	38	
34	CTD	Bottom	09/05/2016	10:24:43	53.6021	4.0865	38	
34	CTD	End	09/05/2016	10:26:32	53.6022	4.0866	38	
35	Lander TROL	Deployment	09/05/2016	12:17:45	53.5989	4.0831	39	
36	Lander ALBEX	Deployment	09/05/2016	12:29:44	53.6001	4.0831	39	
37	Boxcore	Bottom	09/05/2016	12:54:43	53.5986	4.0803	39	
38	Boxcore	Bottom	09/05/2016	13:20:15	53.5977	4.0788	37	
39	Boxcore	Bottom	09/05/2016	13:44:42	53.5968	4.0772	37	
40	Boxcore	Bottom	09/05/2016	14:05:10	53.5958	4.076	37	
41	Boxcore	Bottom	09/05/2016	14:28:54	53.6002	4.0802	37	
42	Boxcore	Bottom	09/05/2016	14:48:26	53.6012	4.0787	37	
43	Boxcore	Bottom	09/05/2016	15:05:26	53.6022	4.0773	38	
44	Boxcore	Bottom	09/05/2016	15:21:07	53.603	4.0754	37	
45	CTD with samples	Begin	10/05/2016	6:10:34	53.601	4.0836	39	
45	CTD with samples	Bottom	10/05/2016	6:11:41	53.601	4.0835	39	
45	CTD with samples	End	10/05/2016	6:14:53	53.6006	4.0842	38	
46	CTD with samples	Begin	10/05/2016	6:36:24	53.6006	4.0846	38	
46	CTD with samples	Bottom	10/05/2016	6:39:26	53.6006	4.0844	39	
46	CTD with samples	End	10/05/2016	6:43:09	53.6009	4.0838	39	
47	CTD with samples	Begin	10/05/2016	7:04:07	53.6015	4.0853	39	
47	CTD with samples	Bottom	10/05/2016	7:06:26	53.6015	4.0853	39	
47	CTD with samples	End	10/05/2016	7:12:16	53.6014	4.0853	38	
48	CTD with samples	Begin	10/05/2016	7:36:12	53.6021	4.0865	39	
48	CTD with samples	Bottom	10/05/2016	7:38:25	53.6021	4.0864	39	
48	CTD with samples	End	10/05/2016	7:42:58	53.602	4.0865	39	

49	CTD with samples	Begin	10/05/2016	8:13:25	53.6028	4.0879	40	
49	CTD with samples	Bottom	10/05/2016	8:14:16	53.6027	4.0879	38	
49	CTD with samples	End	10/05/2016	8:19:11	53.6026	4.0877	39	
50	CTD with samples	Begin	10/05/2016	8:41:07	53.6033	4.0888	39	
50	CTD with samples	Bottom	10/05/2016	8:41:49	53.6034	4.0888	39	
50	CTD with samples	End	10/05/2016	8:47:39	53.6032	4.0889	39	
51	Lander ALBEX	Recovery	10/05/2016	8:59:55	53.5997	4.0834	40	
52	Lander TROL	Recovery	10/05/2016	9:21:08	53.5985	4.0836	39	
53	Boxcore	Bottom	10/05/2016	11:16:56	53.5984	4.0836	38	
54	Boxcore	Bottom	10/05/2016	11:35:46	53.5976	4.0853	38	
55	Boxcore	Bottom	10/05/2016	11:55:28	53.5965	4.0866	38	
56	Boxcore	Bottom	10/05/2016	12:24:10	53.5959	4.0884	37	
57	Boxcore	Bottom	10/05/2016	12:46:49	53.6004	4.0837	38	
58	Boxcore	Bottom	10/05/2016	13:02:41	53.6014	4.0856	39	
59	Boxcore	Bottom	10/05/2016	13:17:23	53.6025	4.087	39	
60	Boxcore	Bottom	10/05/2016	13:33:07	53.6036	4.0883	37	
61	Lander TROL	Deployment	10/05/2016	15:31:05	53.597	4.0869	37	
62	Lander ALBEX	Deployment	10/05/2016	15:49:42	53.6021	4.0869	37	
63	Lander ALBEX	Recovery	11/05/2016	11:22:47	53.6016	4.0869	39	
64	Lander TROL	Recovery	11/05/2016	11:37:30	53.5965	4.0866	42	
65	CTD	Begin	11/05/2016	12:05:41	53.6012	4.0767	38	Towed
65	CTD	Bottom	11/05/2016	12:06:07	53.6011	4.0768	38	
65	CTD	End	11/05/2016	12:48:51	53.5968	4.0842	38	
66	CTD	Begin	11/05/2016	13:04:18	53.6009	4.0777	38	Towed
66	CTD	Bottom	11/05/2016	13:04:49	53.6009	4.0777	38	
66	CTD	End	11/05/2016	13:45:07	53.5969	4.0843	37	
67	CTD	Begin	11/05/2016	14:05:05	53.6009	4.0778	38	Towed
67	CTD	Bottom	11/05/2016	14:08:05	53.6009	4.0778	38	
67	CTD	End	11/05/2016	15:03:11	53.5959	4.086	37	

68	CTD with samples	Begin	11/05/2016	15:14:15	53.5988	4.083	37	
68	CTD with samples	Bottom	11/05/2016	15:17:15	53.5988	4.083	38	
68	CTD with samples	End	11/05/2016	15:23:27	53.5988	4.0829	37	
69	CTD with samples	Begin	11/05/2016	15:46:14	53.5976	4.0851	37	
69	CTD with samples	Bottom	11/05/2016	15:48:58	53.5976	4.0849	37	
69	CTD with samples	End	11/05/2016	15:54:07	53.5975	4.0848	37	
70	CTD with samples	Begin	11/05/2016	16:27:05	53.5963	4.0872	37	
70	CTD with samples	Bottom	11/05/2016	16:29:36	53.5963	4.0872	37	
70	CTD with samples	End	11/05/2016	16:35:01	53.5962	4.0872	37	
71	Mooring	Deployment	12/05/2016	7:59:10	53.6003	4.0833	39	
72	Mooring	Deployment	12/05/2016	8:51:35	53.5977	4.0854	38	

Appendix III, Nutrient and SPM samples

Sample origin	Sample code	Date	Nuts no PO4	PO4+acid	Nuts also PO4	Silicate	DIC	DOC	remarks
ALBEX St 3 box 81	1a	8 may 2016	x	x					
ALBEX St 3 box 81	2a	8 may 2016	x	x					
ALBEX St 3 box 81	3a	8 may 2016	x	x					
ALBEX St 3 box 81	4a	8 may 2016	x	x					
ALBEX St 3 box 81	5a	8 may 2016	x	x					
ALBEX St 3 box 81	1b	8 may 2016	x	x					
ALBEX St 3 box 81	2b	8 may 2016	x	x					
ALBEX St 3 box 81	3b	8 may 2016	x	x					
ALBEX St 3 box 81	4b	8 may 2016	x	x					
ALBEX St 3 box 81	5b	8 may 2016	x	x					
ALBEX St 3 box 8C	1a	8 may 2016	x	x					8C=8B
ALBEX St 3 box 8C	2a	8 may 2016	x	x					
ALBEX St 3 box 8C	3a	8 may 2016	x	x					
ALBEX St 3 box 8C	4a	8 may 2016	x	x					
ALBEX St 3 box 8C	5a	8 may 2016	x	x					
ALBEX St 3 box 8C	1b	8 may 2016	x	x					
ALBEX St 3 box 8C	2b	8 may 2016	x	x					
ALBEX St 3 box 8C	3b	8 may 2016	x	x					
ALBEX St 3 box 8C	4b	8 may 2016	x	x					
ALBEX St 3 box 8C	5b	8 may 2016	x	x					
ALBEX St 3 box 86	1a	8 may 2016	x	x					
ALBEX St 3 box 86	2a	8 may 2016	x	x					
ALBEX St 3 box 86	3a	8 may 2016	x	x					
ALBEX St 3 box 86	4a	8 may 2016	x	x					
ALBEX St 3 box 86	5a	8 may 2016	x	x					
ALBEX St 3 box 86	1b	8 may 2016	x	x					

ALBEX St 3 box 86	2b	8 may 2016	x	x					
ALBEX St 3 box 86	3b	8 may 2016	x	x					
ALBEX St 3 box 86	4b	8 may 2016	x	x					
ALBEX St 3 box 86	5b	8 may 2016	x	x					
TROL St 4 box 82	1a	8 may 2016	x	x					
TROL St 4 box 82	2a	8 may 2016	x	x					
TROL St 4 box 82	3a	8 may 2016	x	x					
TROL St 4 box 82	4a	8 may 2016	x	x					4 ml air in syringe
TROL St 4 box 82	5a	8 may 2016	x	x					
TROL St 4 box 82	1b	8 may 2016	x	x					
TROL St 4 box 82	2b	8 may 2016	x	x					3 ml air in syringe
TROL St 4 box 82	3b	8 may 2016	x	x					Small air bubble in syringe
TROL St 4 box 82	4b	8 may 2016	x	x					3 ml air in syringe
TROL St 4 box 82	5b	8 may 2016	x	x					2 ml air in syringe
TROL St 4 box 89	1a	8 may 2016	x	x					Flocs in syringes
TROL St 4 box 89	2a	8 may 2016	x	x					
TROL St 4 box 89	3a	8 may 2016	x	x					
TROL St 4 box 89	4a	8 may 2016	x	x					
TROL St 4 box 89	5a	8 may 2016	x	x					
TROL St 4 box 89	1b	8 may 2016	x	x					
TROL St 4 box 89	2b	8 may 2016	x	x					
TROL St 4 box 89	3b	8 may 2016	x	x					
TROL St 4 box 89	4b	8 may 2016	x	x					
TROL St 4 box 89	5b	8 may 2016	x	x					
TROL St 4 box 87	1a	8 may 2016	x	x					2 ml air in syringe
TROL St 4 box 87	2a	8 may 2016	x	x					
TROL St 4 box 87	3a	8 may 2016	x	x					
TROL St 4 box 87	4a	8 may 2016	x	x					
TROL St 4 box 87	5a	8 may 2016	x	x					

TROL St 4 box 87	1b	8 may 2016	x	x					
TROL St 4 box 87	2b	8 may 2016	x	x					
TROL St 4 box 87	3b	8 may 2016	x	x					
TROL St 4 box 87	4b	8 may 2016	x	x					
TROL St 4 box 87	5b	8 may 2016	x	x					
CTD st31 bottom		9 may 2016			x	x	x	x	
CTD st31 mid		9 may 2016			x	x	x	x	
CTD st31 surface		9 may 2016			x	x	x	x	
CTD st31 bottom		10 may 2016			x	x	x	x	
CTD st31 mid		10 may 2016			x	x	x	x	
CTD st31 surface		10 may 2016			x	x	x	x	
CTD st31 bottom		10 may 2016			x	x	x	x	
CTD st31 mid		10 may 2016			x	x	x	x	
CTD st31 surface		10 may 2016			x	x	x	x	
CTD st31 bottom		10 may 2016			x	x	x	x	
CTD st31 mid		10 may 2016			x	x	x	x	
CTD st31 surface		10 may 2016			x	x	x	x	
CTD st31 bottom		10 may 2016			x	x	x	x	
CTD st31 mid		10 may 2016			x	x	x	x	
CTD st31 surface		10 may 2016			x	x	x	x	
CTD st31 bottom		10 may 2016			x	x	x	x	
CTD st31 mid		10 may 2016			x	x	x	x	
CTD st31 surface		10 may 2016			x	x	x	x	
TROL St 35 box 82	1a	10 may 2016	x	x					
TROL St 35 box 82	2a	10 may 2016	x	x					
TROL St 35 box 82	3a	10 may 2016	x	x					box82: A clear, B flocs
TROL St 35 box 82	4a	10 may 2016	x	x					
TROL St 35 box 82	5a	10 may 2016	x	x					
TROL St 35 box 82	1b	10 may 2016	x	x					

TROL St 35 box 82	2b	10 may 2016	x	x					
TROL St 35 box 82	3b	10 may 2016	x	x					
TROL St 35 box 82	4b	10 may 2016	x	x					
TROL St 35 box 82	5b	10 may 2016	x	x					
TROL St 35 box 87	1a	10 may 2016	x	x					box87: A syringes and 1b,4b clear, others flocs
TROL St 35 box 87	2a	10 may 2016	x	x					
TROL St 35 box 87	3a	10 may 2016	x	x					
TROL St 35 box 87	4a	10 may 2016	x	x					
TROL St 35 box 87	5a	10 may 2016	x	x					
TROL St 35 box 87	1b	10 may 2016	x	x					
TROL St 35 box 87	2b	10 may 2016	x	x					
TROL St 35 box 87	3b	10 may 2016	x	x					
TROL St 35 box 87	4b	10 may 2016	x	x					
TROL St 35 box 87	5b	10 may 2016	x	x					
TROL St 35 box 89	1a	10 may 2016	x	x					box89: A clear, B flocs
TROL St 35 box 89	2a	10 may 2016	x	x					
TROL St 35 box 89	3a	10 may 2016	x	x					
TROL St 35 box 89	4a	10 may 2016	x	x					
TROL St 35 box 89	5a	10 may 2016	x	x					
TROL St 35 box 89	1b	10 may 2016	x	x					
TROL St 35 box 89	2b	10 may 2016	x	x					
TROL St 35 box 89	3b	10 may 2016	x	x					
TROL St 35 box 89	4b	10 may 2016	x	x					
TROL St 35 box 89	5b	10 may 2016	x	x					
ALBEX St 36 box 81	1a	8 may 2016	x	x					box 81: all syringes full, some flocs
ALBEX St 36 box 81	2a	8 may 2016	x	x					
ALBEX St 36 box 81	3a	8 may 2016	x	x					
ALBEX St 36 box 81	4a	8 may 2016	x	x					

ALBEX St 36 box 81	5a	8 may 2016	x	x					
ALBEX St 36 box 81	1b	8 may 2016	x	x					
ALBEX St 36 box 81	2b	8 may 2016	x	x					
ALBEX St 36 box 81	3b	8 may 2016	x	x					
ALBEX St 36 box 81	4b	8 may 2016	x	x					
ALBEX St 36 box 81	5b	8 may 2016	x	x					
ALBEX St 36 box 8B	1a	8 may 2016	x	x					box 8B: 3b,4b and 5b flocs
ALBEX St 36 box 8B	2a	8 may 2016	x	x					
ALBEX St 36 box 8B	3a	8 may 2016	x	x					
ALBEX St 36 box 8B	4a	8 may 2016	x	x					
ALBEX St 36 box 8B	5a	8 may 2016	x	x					
ALBEX St 36 box 8B	1b	8 may 2016	x	x					
ALBEX St 36 box 8B	2b	8 may 2016	x	x					
ALBEX St 36 box 8B	3b	8 may 2016	x	x					
ALBEX St 36 box 8B	4b	8 may 2016	x	x					
ALBEX St 36 box 8B	5b	8 may 2016	x	x					
ALBEX St 36 box 86	1a	8 may 2016	x	x					box 86: b syringes and 4a with flocs
ALBEX St 36 box 86	2a	8 may 2016	x	x					
ALBEX St 36 box 86	3a	8 may 2016	x	x					
ALBEX St 36 box 86	4a	8 may 2016	x	x					
ALBEX St 36 box 86	5a	8 may 2016	x	x					
ALBEX St 36 box 86	1b	8 may 2016	x	x					
ALBEX St 36 box 86	2b	8 may 2016	x	x					
ALBEX St 36 box 86	3b	8 may 2016	x	x					
ALBEX St 36 box 86	4b	8 may 2016	x	x					
ALBEX St 36 box 86	5b	8 may 2016	x	x					
TROL St 61 box 82	1a	11 may 2016	x	x					box 82: clear, b flocs
TROL St 61 box 82	2a	11 may 2016	x	x					
TROL St 61 box 82	3a	11 may 2016	x	x					

TROL St 61 box 82	4a	11 may 2016	x	x					
TROL St 61 box 82	5a	11 may 2016	x	x					
TROL St 61 box 82	1b	11 may 2016	x	x					
TROL St 61 box 82	2b	11 may 2016	x	x					
TROL St 61 box 82	3b	11 may 2016	x	x					
TROL St 61 box 82	4b	11 may 2016	x	x					
TROL St 61 box 82	5b	11 may 2016	x	x					
TROL St 61 box 87	1a	11 may 2016	x	x					box 87: clear, b flocs
TROL St 61 box 87	2a	11 may 2016	x	x					
TROL St 61 box 87	3a	11 may 2016	x	x					
TROL St 61 box 87	4a	11 may 2016	x	x					
TROL St 61 box 87	5a	11 may 2016	x	x					
TROL St 61 box 87	1b	11 may 2016	x	x					
TROL St 61 box 87	2b	11 may 2016	x	x					
TROL St 61 box 87	3b	11 may 2016	x	x					
TROL St 61 box 87	4b	11 may 2016	x	x					
TROL St 61 box 87	5b	11 may 2016	x	x					
TROL St 61 box 89	1a	11 may 2016	x	x					box 89: clear, b flocs
TROL St 61 box 89	2a	11 may 2016	x	x					
TROL St 61 box 89	3a	11 may 2016	x	x					
TROL St 61 box 89	4a	11 may 2016	x	x					
TROL St 61 box 89	5a	11 may 2016	x	x					
TROL St 61 box 89	1b	11 may 2016	x	x					
TROL St 61 box 89	2b	11 may 2016	x	x					
TROL St 61 box 89	3b	11 may 2016	x	x					
TROL St 61 box 89	4b	11 may 2016	x	x					
TROL St 61 box 89	5b	11 may 2016	x	x					
ALBEX St 62 box 81	1a	11 may 2016	x	x					
ALBEX St 62 box 81	2a	11 may 2016	x	x					box 81: a clear, b flocs

ALBEX St 62 box 81	3a	11 may 2016	x	x					
ALBEX St 62 box 81	4a	11 may 2016	x	x					
ALBEX St 62 box 81	5a	11 may 2016	x	x					
ALBEX St 62 box 81	1b	11 may 2016	x	x					
ALBEX St 62 box 81	2b	11 may 2016	x	x					
ALBEX St 62 box 81	3b	11 may 2016	x	x					
ALBEX St 62 box 81	4b	11 may 2016	x	x					
ALBEX St 62 box 81	5b	11 may 2016	x	x					
ALBEX St 62 box 8B	1a	11 may 2016	x	x					box 8B: a clear + 3b, b flocs
ALBEX St 62 box 8B	2a	11 may 2016	x	x					
ALBEX St 62 box 8B	3a	11 may 2016	x	x					
ALBEX St 62 box 8B	4a	11 may 2016	x	x					
ALBEX St 62 box 8B	5a	11 may 2016	x	x					
ALBEX St 62 box 8B	1b	11 may 2016	x	x					
ALBEX St 62 box 8B	2b	11 may 2016	x	x					
ALBEX St 62 box 8B	3b	11 may 2016	x	x					
ALBEX St 62 box 8B	4b	11 may 2016	x	x					
ALBEX St 62 box 8B	5b	11 may 2016	x	x					
ALBEX St 62 box 86	1a	11 may 2016	x	x					box 86: a clear, b flocs
ALBEX St 62 box 86	2a	11 may 2016	x	x					
ALBEX St 62 box 86	3a	11 may 2016	x	x					
ALBEX St 62 box 86	4a	11 may 2016	x	x					
ALBEX St 62 box 86	5a	11 may 2016	x	x					
ALBEX St 62 box 86	1b	11 may 2016	x	x					
ALBEX St 62 box 86	2b	11 may 2016	x	x					
ALBEX St 62 box 86	3b	11 may 2016	x	x					
ALBEX St 62 box 86	4b	11 may 2016	x	x					
ALBEX St 62 box 86	5b	11 may 2016	x	x					
CTD st 68 bottom		11 may 2016			x	x	x	x	

CTD st 68 mid		11 may 2016			x	x	x	x	
CTD st 68 surface		11 may 2016			x	x	x	x	
CTD st 69 bottom		11 may 2016			x	x	x	x	
CTD st 69 mid		11 may 2016			x	x	x	x	
CTD st 69 surface		11 may 2016			x	x	x	x	
CTD st 70 bottom		11 may 2016			x	x	x	x	
CTD st 70 mid		11 may 2016			x	x	x	x	
CTD st 70 surface		11 may 2016			x	x	x	x	

Appendix IV, SPM and POM samples

Filtertype	Filter nr	Station	Niskin	Depth (m)	Sample	amount filtered (ml)	Remarks
PC	1	2	2	29.6	SPM	500	Calibration
PC	2	2	3	29.6	SPM	500	Calibration
PC	3	2	6	14	SPM	2000	Calibration
PC	4	2	7	14	SPM	2000	Calibration
PC	5	2	11	4	SPM	2000	Calibration
PC	6	2	12	4	SPM	2000	Calibration
GFF	49	31	1	33	POM	750	
GFF	50	31	1	33	POM	800	
GFF	51	31	3	20	POM	550	
GFF	52	31	3	20	POM	500	
GFF	53	31	6	1	POM	850	
GFF	54	31	6	1	POM	880	
GFF	55	46	1	33	POM	2000	hole in filter
GFF	56	46	1	33	POM	700	
GFF	57	46	3	14	POM	1000	
GFF	58	46	3	14	POM	1000	
GFF	59	46	5	2.5	POM	1000	
GFF	60	46	5	2.5	POM	1000	
GFF	61	47	1	32	POM	700	
GFF	62	47	1	32	POM	700	
GFF	63	47	9	15.5	POM	1000	
GFF	64	47	9	15.5	POM	1000	
GFF	65	47	11	1.5	POM	850	
GFF	66	47	11	1.5	POM	800	
GFF	67	48	1	32	POM	850	

GFF	68	48	1	32	POM	800	
GFF	69	48	9	15	POM	900	
GFF	70	48	9	15	POM	800	
GFF	92	48	11	2	POM	850	
GFF	93	48	11	2	POM	900	
GFF	94	49	1	34	POM	1000	
GFF	95	49	1	34	POM	1000	
GFF	96	49	9	16	POM	1000	
GFF	97	49	9	16	POM	1000	
GFF	98	49	11	2	POM	1000	
GFF	99	49	11	2	POM	1000	
GFF	100	50	1	32	POM	1000	
GFF	101	50	1	32	POM	1000	
GFF	102	50	10	15.5	POM	1000	
GFF	103	50	10	15.5	POM	1000	
GFF	104	50	12	2	POM	1000	
GFF	105	50	12	2	POM	1000	
GFF	106	68	1	30	POM	1000	
GFF	107	68	1	30	POM	1000	
GFF	108	68	9	14.5	POM	1000	
GFF	109	68	9	14.5	POM	1000	
GFF	110	68	11	2	POM	1000	
GFF	111	68	11	2	POM	1000	
GFF	112	69	1	30	POM	1000	
GFF	113	69	1	30	POM	1000	
GFF	114	69	9	14	POM	1000	
GFF	115	69	9	14	POM	1000	
GFF	116	69	11	3	POM	1000	
GFF	117	69	11	3	POM	1000	

GFF	118	70	1	29.5	POM	1000	
GFF	119	70	1	29.5	POM	1000	
GFF	120	70	9	15	POM	1000	
GFF	121	70	9	15	POM	1000	
GFF	122	70	11	2	POM	1000	
GFF	123	70	11	2	POM	1000	

Appendix V, Box core photographs