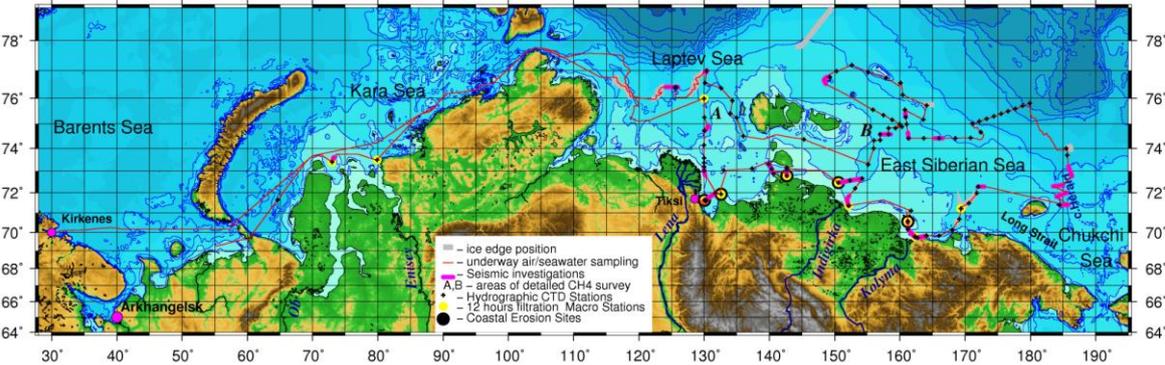


# Cruise report

## International Siberian Shelf Study 2008 (ISSS-08)

ISSS-2008



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# 1. INTRODUCTION AND FRAMEWORK

## 1.1 Participants

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## 1.2 Objectives and Summary

The objective of this cruise report is to serve as a memory support for everyone involved in the ISSS-08 program. It focuses on details of how sampling and any at-sea analysis was actually performed on the Smirnitskyi. It also documents who to contact for even further details and future request for data in the many collaborative constellations that are foreseen to result from this complex marine expedition.

The ISSS-08 field phase has been overall a tremendous success. Participants are now in a good position to put together substantial contributions toward an improved understanding of the functioning of the East Siberian Arctic Shelf Seas. Below, is a brief summary of the expedition drafted with the intent of publication in EOS (Transactions of the American Geophysical Union) together with the an edited version of the cruise track and activity map shown below in section 1.3.

## EOS draft article:

**Title: International Siberian Shelf Study 2008 (ISSS-08): The major IPY ship-based program along the entire Eurasian-Arctic continental shelf with combined biogeochemical and geophysical observations**

*The motivation for ISSS-08 was to alleviate the scarcity of observational data on transport and processing of water, sediment and carbon on the East Siberian Arctic Shelves (ESAS). The ESAS, composed of Laptev, East Siberian and Russian part of Chukchi Sea, is the world's largest continental shelf and at the same time the most understudied part of the Arctic Ocean. It is characterized by tundra discharge through the Lena, Indigirka and Kolyma rivers, coastal erosion, methane seeps from subsea-permafrost reservoirs and shelf-feeding of the Arctic halocline. The region is of particular interest from the perspective of carbon-climate couplings as it has witnessed a 4°C springtime positive temperature anomaly for 2000-2005 compared with preceding decades.*

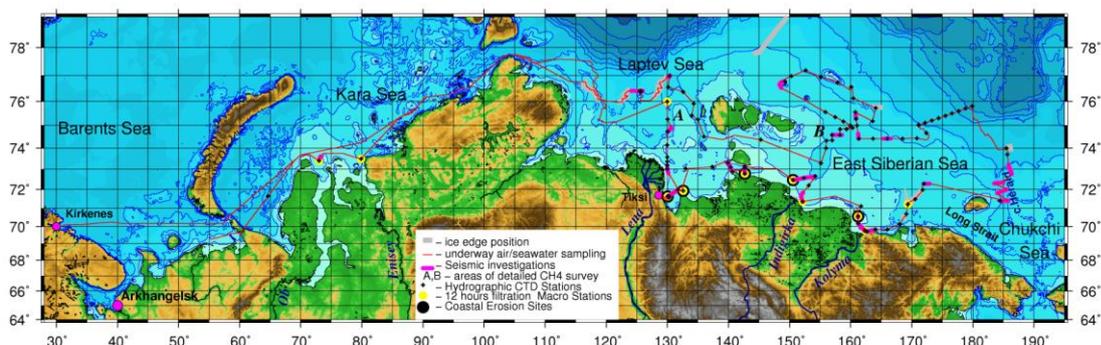
*A complex sampling program was accomplished during the 50-days ISSS-08 cruise August – September 2008 using two vessels by participants from 12 organizations in Russia, Sweden, UK and USA (see Figure). The main vessel H/V Yacob Smirnitskyi traveled the entire length of the Siberian coast from Kirkenes, Norway to Herald Canyon, Chukchi Sea and back along the outer shelf. A second ship sampled the Lena River and the southeastern Laptev Sea.*

*Significant at-sea findings included new methane seeps and bubble plume fields in both the Laptev and East Siberian Sea, several associated with geophysical gas-chimney structures. We also studied Pacific inflow through Herald Canyon and remnants of salty and cold bottom waters on the shelf break.*

*Planned analyses of collected air, seawater, eroding soil and sediment material include molecular and isotopic biomarker composition as well as trace element and isotope characterizations (GEOTRACE protocol) to elucidate provenance, remobilization of "old" terrestrial matter, the relative importance of river versus erosion sources, degradation of organic matter in seawater and sediments and variations in these processes with dynamic climate forcing.*

*This IPY program provides a benchmarking for future expeditions to the vast and enigmatic ESAS. The ISSS-08 is supported by the Swedish Knut and Alice Wallenberg Foundation, the Far-Eastern Branch of the Russian Academy of Sciences, the Swedish Research Council, the Russian Foundation for Basic Research, NOAA, and the Swedish Polar Research Secretariat.*

ISSS-2008



## 2. METHODS: SAMPLING AND AT-SEA ANALYSES

### 2.1 Seawater intake (SWI) system

#### 2.1.1 Kingston connections, pumps, tubings and barrel (Martin)

##### Materials (see Fig. 2.1.1.1)

Pumps: Two parallel-coupled impeller type pumps (Aquaria Self-priming pump, Model ASS-80, Qmax 46L/min).

Pipes: All pipes below deck in the machine room are of steel.

Hoses: On deck the hose leading to the T-piece (TC coupling) and from the T-piece to the barrel is of silicone.

Valves and T-piece: The T-piece and the valves are of stainless steel. Seals in the connections between T-piece and valves are of silicone.

Barrel: The barrel is of hard-plastic and from Aquatech. The original volume is of 500 liters but the actual filling volume was reduced to around 300 liters by ballasting with carbuoys.

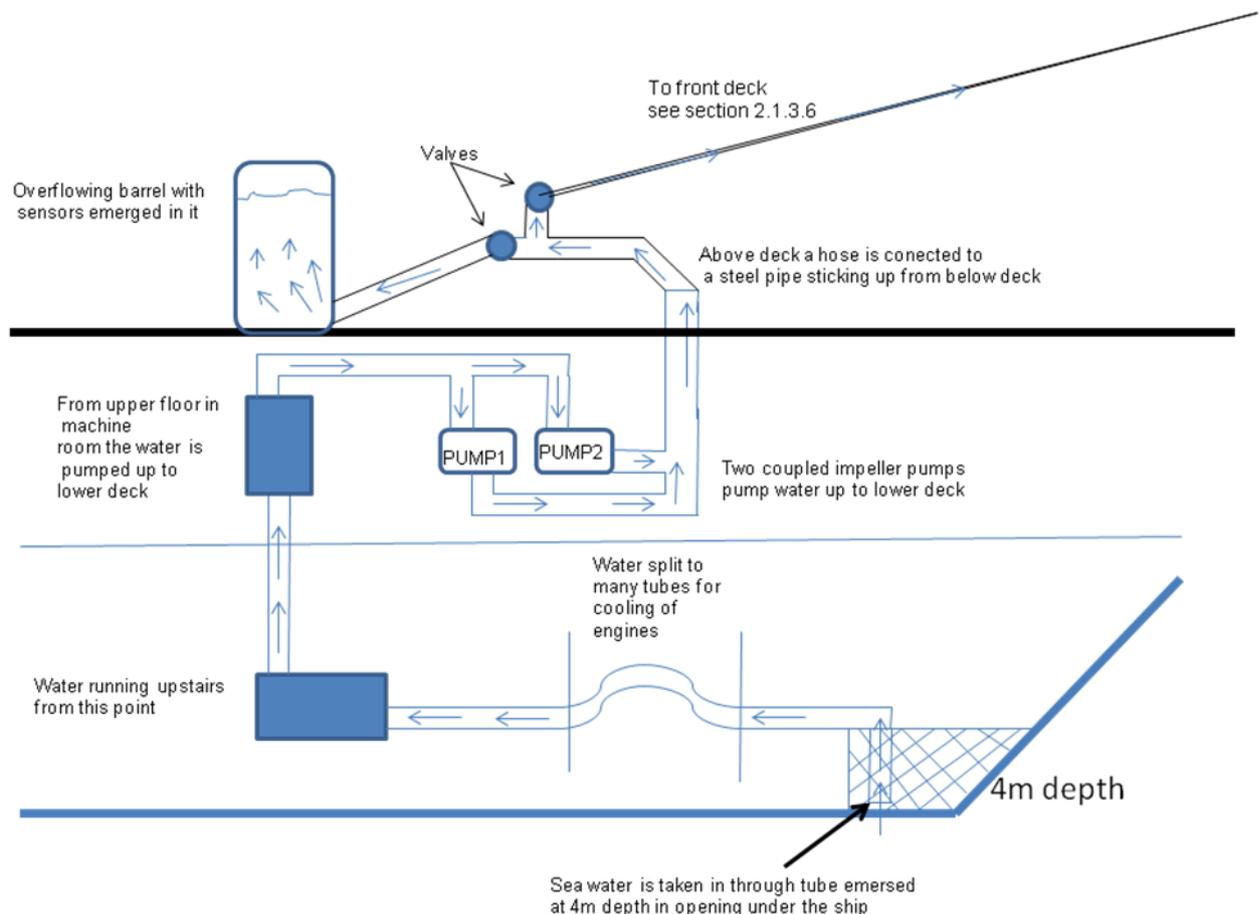


Figure 2.1.1.1 Schematic overview of sea water intake system from Kingston to barrel.

##### Description (See figure 2.1.1-1)

At 4 m depth under the ship's hull there is an opening where sea water is taken in. The water pipe is led into the machine room where it is split into several pipes, (see picture 2.1.1.1). The water pipes

containing cold arctic sea water are used to cool the machines of the ship. After being passed around the machinery the water pipes are joined into one single pipe. This pipe is passed to the upper floor of the machine room and ends in the Kingston (sea chest). A steel tube was retrofitted for ISSS-08 on top of the sea chest and immersed to bottom of the sea chest. Two new impeller pumps delivered water aft-portside deck ending in a stainless barbed hose connector (picture 2.1.1.3). A silicon hose leads to a T-piece with a valve at each out-flow, (picture 2.1.1.4). One out-flow leads to a hose going to water sampling systems on fore deck (see section 2.1.3.6). That valve is normally closed. The other out-flow from the T-piece is to a hose leading to a 300L barrel, (picture 2.1.1.5). The barrel is filled from below at a rate of around 30L/min, giving a turnover of ca 10 minutes. Water is overflowing over the edges of the barrel (picture 2.1.1.5). Sensors were immersed in barrel (section 2.1.2).



Picture 2.1.1.1 Lower floor of machine room



Picture 2.1.1.2 Impeller pumps, Kingston in background.



Picture 2.1.1.3 SWI delivery on deck.



Picture 2.1.1.4 T-piece splitter.



Picture 2.1.1.5 Ballasted barrel with sensors.

## 2.1.2 Sensors in barrel – data acquisition programs

### 2.1.2.1 Seabird-CTD,CDOM,Turbidity (Igor, Anatoly, Irina)

Temperature, salinity/conductivity, colored dissolved organic matter (CDOM), and dissolved oxygen in the surface water will be measured along the ship route each minute using bunch of sensors installed on the CTD Seabird 19+ deployed in the 500 liters barrel with flowing sea water (pumped with rates about 40-50 liters per minute). All these parameters will be validated at oceanographic stations. Surface dissolved methane was sampled each hour and measured in 1-2 hours, while the  $pCO_2$  value was measured each 15 minutes using autonomous SAMI-  $CO_2$  sensor deployed in the same barrel with the CTD. This approach was successfully used in the joint USA-Russia SSS cruises since the summer of 2003 (Semiletov and Pipko, 2007; Semiletov, 2005).

### 2.1.2.2 Hydrosonde (Johan, Fredrik)

From August 18 until September 23, a Hydrolab Minisonde 5 (MS5) water quality multprobe was installed in the seawater intake barrel. This device is referred to as the hydrosonde. This hydrosonde was also deployed in the sea at most of the stations during the expedition for depth profiling (activity lead by Genna).

Parameters measured by the hydrosonde were temperature, conductivity, salinity, pH, oxygen reduction potential, depth, oxygen concentration and chlorophyll a.

**pH:** pH was calibrated at the start, and checked for drift during operation. Fluctuations of the pH levels were from time to time much higher than expected, but during depth profiling, values were

more stable. The reason for these unstable pH measurements from the barrel was never clarified, but time intervals where suspicious measurements occur will be marked in the final data sheet.

**Salinity/conductivity:** As for pH, conductivity was calibrated at the start, and checked for drift during operation. Salinity measurements are closely related to the conductivity of the sample. Due to differences in salinity during this the expedition, it was difficult to make an accurate calibration for the conductivity. Therefore, the salinity measurements from the barrel should be taken from the Seabird instrument. From depth profiling, CTD data should be used preferentially.

**Oxygen:** To obtain oxygen data, the hydrosonde is equipped with the Hach LDO sensor, which is a luminescent dissolved oxygen sensor, an in-situ optical probe. Factory calibration was kept during the expedition. Data is to be calibrated to Winkler titrations performed by the Marine Chemistry group onboard.

**Chlorophyll:** A fluorescence sensor in the hydrosonde was used for determining chlorophyll a. Factory calibration was kept during the expedition. The data obtained by this sensor is to be compared/calibrated to offline measurements onboard by the BGC group according to standard chlorophyll determination protocol.

#### **2.1.2.3 SAMI-pCO<sub>2</sub> sensors (Irina, Igor)**

The autonomous SAMI-CO<sub>2</sub> device described in [www.sunburstensors.com](http://www.sunburstensors.com) (De Grandpre et al., 1999) was used for *in situ* pCO<sub>2</sub> measurement (each 15 minutes). This instrument was deployed in 500 liters plastic barrel (SWI) in parallel with Seabird-19+ conductivity/temperature/depth (CTD) meter.

### **2.1.3 SWI sampling and at-sea analysis programs**

#### **2.1.3.1 Methane (and non-methane hydrocarbons) dissolved in water (Igor-Nina)**

Water sampling was carried out at all bottle horizons (see “bottle” protocol) each station (in total =131) with Niskin bottles. The samples were processed in the ship’s laboratory within 2-3 hours after collection. Water samples were analyzed for CH<sub>4</sub> with a MicroTech-8160 gas chromatograph equipped with a flame ionization detector. The headspace technique for equilibrating between the dissolved and gaseous phases was applied (Semiletov et al., 1996; Shakhova et al., 2005, 2007). The concentration of dissolved CH<sub>4</sub> in the water samples was calculated with the Bunsen adsorption coefficient for CH<sub>4</sub> (Wiesenburg and Guinasso, 1979) at the appropriate equilibration temperature. In total, 1047 CH<sub>4</sub> samples were taken.

#### **2.1.3.2 BGC-core parameters (Laura, Vanja)**

Sea water samples from both Sea Water Intake (SWI) and Niskin bottles (YS-stations) were collected for analysis of POC, DOC, TOC, Optical parameters and Pigments. The SWI samples were sampled

from a hose, receiving water from 4m depth. Niskin bottle samples were drawn from four different depths, aiming for the middle mixing layer (2-4 m), the pycnocline (4-10 m), middle bottom layer and bottom.

At the first CTD station, YS-1, a seawater intake sampling (SWI-7) was also conducted in order to check the reliability of the samples collected from the SWI-barrel. In both cases samples were collected in triplicates and at 4m depth.

### **Total, Particulate, and Dissolved Organic Carbon (TOC/POC/DOC) (Laura, Vanja)**

The organic carbon components were size-defined as follows a) the larger organic particles (POC, filter-defined as  $> 0.7\mu\text{m}$ ), b) the dissolved fraction (DOC, filter defined as  $<0.7$ ), and c) the total fraction of organic C (TOC).

Between 1 and 3 L of sea water was collected in clear polycarbonate bottles and vacuum filtered on board with 25mm diameter glass fiber filters (GF/F) held in an all-glass filtrations system. Once dry, the filters were stored frozen until elemental analysis. From each POC filtrate ( $\sim 1\text{L}$ ), two 60mL Nalgene HDPE bottles were collected for DOC measurements. One was frozen as a back-up, and one was stored cold and measured onboard. Similarly, two 60mL Nalgene HDPE bottles were used to collect seawater intake samples for TOC measurements. Again, one was frozen as a back-up and brought home, and one was stored cold and measured onboard.

DOC and TOC were determined on board by means of catalytic carbon combustion (SHIMADZU TOC-VCPH). Inorganic carbon was removed with acid and the samples were sparged before analysis of the total carbon content (NPOC method). Before each run, Consensus Reference Materials (CRM) of low carbon content ( $1\text{-}2\mu\text{M C}$ ) and deep sea water reference water ( $41\text{-}44\mu\text{M C}$ ) were analysed to ensure the reliability of the data. Batches of CRM ampoules have been tested for DOC concentrations by the laboratories of Drs. Craig Carlson, Jonathan Sharp, Wenhao Chen/Dennis Hansell, and Hiroshi Ogawa. In each run, every tenth sample were a duplicate of an own control sample (Yenesey DOC ca  $450\mu\text{M C}$ , kept cold during the cruise in a 25L carboy on deck) to monitor drift or interruptions during a run. New calibrations were made when the results of the international reference material or/and the Yenesey control sample differed from known concentrations with more than  $\sim 5\%$ . The POC content will be analyzed once in Stockholm, by elemental analysis (EA) of the C content.

### **OPTICAL parameters (Laura)**

100mL brown glass bottles were used to collect water sample and preserve them of light degradation. The samples were kept cool and dark until direct analysis of the following optical parameters.

**Molar absorptivity:** Molar absorptivity at 280nm ( $\epsilon_{280}$ ) gives an estimation of the degree of aromaticity of the organic matter in a sample. In order to calculate  $\epsilon_{280}$ , the absorbance at 280nm ( $A_{280}$ ) is measured by UV-VIS Spectrophotometry (Hitachi UV) and results normalized to TOC:

$$\epsilon_{280} = A_{280} / (1 * \text{TOC}) \quad (\text{Equation 1})$$

The analysis was conducted on quartz cuvetts against distilled water (milli-Q), and the samples were measured in triplicates, rinsing the cuvette with milli-Q water every sample. Blanks of milli-Q water were run every ca. 10 samples, in order to check stability of measurement.

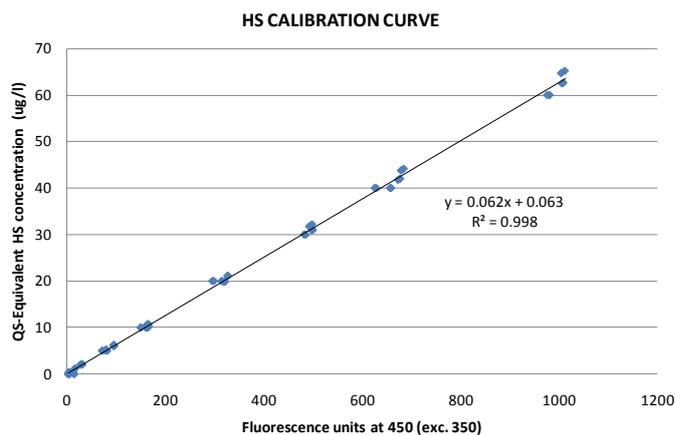
### Humic Substances (HS)

The content of HS was estimated by Fluorescence Spectrometry (Hitachi F-7000 Fluorescence Spectrophotometer), measuring the emission of the samples at 450 nm (bandwidth 10 nm) under excitation at 350 nm (bandwidth 2.5 nm). Since quinine sulphate (QS) is considered to be a good reference material because of its HS-like structure, QS standard was employed for calibration of the measurements. A concentrated QS stock solution was prepared in 0.05M H<sub>2</sub>SO<sub>4</sub> and a 9-point standard curve was constructed (Fig. 1). Each sample was analyzed in triplicates, rinsing with milli-Q water between different samples.

### Colored Dissolved Organic Matter (CDOM)

The content of CDOM in seawater was estimated by Fluorescence Spectrometry (Hitachi F-7000 Fluorescence Spectrophotometer) by measuring the fluorescence emission around 445 nm (2.5 nm bandwidth), under excitation at 355 nm (2.5 nm bandwidth), in relation to the Raman peak of H<sub>2</sub>O at about 405 nm. The fluorescence results of the samples were referenced to those of distilled water, H<sub>2</sub>SO<sub>4</sub> solution (0.5M) and a QS standard solution (10ug/l). Our approach largely followed the method of Hoge et al. (1993).

The method calls for using the maximum intensity of the full emission spectrum. To make it possible to perform all analyses during the expedition we explored the possibility to instead of scanning making measurements at set wavelengths. Hence, the variability in wavelength of the emission maxima for excitation at 355 nm was tested with a subset of samples selected as representative of



the different regimes involved in our studies (rivers n=5; erosion sites n=5; offshore locations n=6). Despite the heterogeneity

Fig. 1: HS calibration curve. HS concentration is calculated in QS-equivalent units in fluorescence intensity of the samples, the wavelength of the maxima obtained were quite similar for the three different regimes (rivers: 444 nm, erosion sites: 443 nm, offshore sites: 442 nm).

Thus, we agreed to use a unique maximum peak (443 nm for CDOM, 407 nm for Raman peak of H<sub>2</sub>O) for all the samples, regardless which regime they belong to.

Once the emission maximum was set at 443nm, the fluorescence of the samples was measured in photometry mode (excitation at 355nm, emission at 407 and 443nm). All samples were analyzed in triplicates and the cuvette was rinsed with milli-Q water between different samples. To calculate the CDOM content of the samples, the emission values of distilled water, 0.5M H<sub>2</sub>SO<sub>4</sub> and 10ug/l QS solution were also needed, so suites of the three standards were periodically run every 10-15 water samples. Thus, the calculation of CDOM, expressed as double-normalized fluorescence units (N.F.I.U.) at excitation wavelength 355nm, was developed according to the following equation:

$$F(355) \text{ N.F.I.U.} = 10 * [(I_{(SW)_{\max}} - I_{(dest)_{\max}}) / I_{(SW)_{\text{Raman}}}] / [(I_{(QS)_{\max}} - I_{(H_2SO_4)_{\max}}) / I_{(QS)_{\text{Raman}}}] \quad (\text{equation 2})$$

$I_{(SW)_{\max}}$  : intensity of water sample at 443nm

$I_{(dest)_{\max}}$  : intensity of distilled water at 443nm

$I_{(SW)_{\text{Raman}}}$  : intensity of water sample at Raman peak at 407nm

$I_{(QS)_{\max}}$  : intensity of 10ug/l QS solution at 443nm

$I_{(H_2SO_4)_{\max}}$  : intensity of 0.5M H<sub>2</sub>SO<sub>4</sub> at 443nm

$I_{(QS)_{\text{Raman}}}$  : intensity of 10ug/l QS at Raman peak at 407nm

## Pigments

The pigment composition of the sea water samples was determined by Visible Spectrophotometry techniques (Hitachi U-2010 UV-VIS Spectrophotometer). Our method largely follows US EPA Method 446 and Parsons et al (1984). Approximately 4 L samples were vacuum filtered with 47mm GF/F filters, adding some drops of MgCO<sub>3</sub> in those cases of samples collected nearby river influence (build-up of low pH on filter may rupture cells). The filters were stored frozen and in darkness in 15mL Falcon tubes until extraction, to avoid the degradation of the pigments. After 10-20 days, the filters were brought back to room temperature and were extracted with ca. 14mL of 90% acetone. They were thoroughly shaken during 2-3min and then allowed to steep for some hours (min. 2 h, no more than 24h). The samples were then centrifuged (5-10 min) to get rid of the filter remains and, once clean, the extract was subjected to UV-VIS analysis to quantify chlorophyll and phaeophytin.

For the estimation of chlorophylls a (chlo-a), b (chlo-b) and c (chlo-c) absorbance at 750, 664, 647 and 630 nm was measured by UV-VIS, whereas wavelengths 750, 664 and 665 nm were employed for pheophytin (phaeo-a). Since chlo-a and phaeo-a signals overlap around 664nm, the degradation of chlo-a by acidification (200 µl of HCl: 10mL/100mL water) and re-measurement at 664-665nm were necessary to correct the chlo-a values. Then, the amount of pigments in the extract solution (~14mL) was calculated by inserting the 750nm-corrected wavelengths (i.e. each wavelength minus 750 nm, to remove the turbidity) in the following equations:

$$\text{Phaeo-corrected Chlo-a} = 26.7 (\text{Abs } 664_{\text{before acidification}} - \text{Abs } 665_{\text{after acidification}}) \quad (\text{equation 4})$$

$$\text{Chlo-b} = 21.03 (\text{Abs } 647) - 5.43 (\text{Abs } 664) - 2.66 (\text{Abs } 630) \quad (\text{equation } 5)$$

$$\text{Chlo-c } (c_1+c_2) = 24.52 (\text{Abs } 630) - 7.60 (\text{Abs } 647) - 1.67 (\text{Abs } 664) \quad (\text{equation } 6)$$

$$\text{Phaeo-a} = 26.7 [1.7 * (\text{Abs } 665_{\text{after acidification}} - \text{Abs } 664_{\text{before acidification}})] \quad (\text{equation } 7)$$

Finally, to calculate the concentration of pigment in the whole water sample the following generalized equation was employed:

$$\text{Concentration of pigment (mg/L)} = [\text{CE} * \text{extract volume (L)}] / [\text{sample volume (L)} * \text{cell length (cm)}]$$

Where: CE = concentration of pigments in the extract solution (phaeo-corrected chlo-a, chlo-b, chlo-c, phaeo-a); extract volume = normally 14mL, sample volume (filtrated) = normally 4L; and cell length = 1cm

### 2.1.3.3 Samples for biogenic silica, $\delta^{13}\text{C-DIC}$ and photolysis (Vanja)

**BSi:** Sampling for biogenic silica was made through the SWI, the submersible pump (unfiltered water) or in one case, the niskin bottles. Up to 1L per sample was filtered through a polycarbonate filter until clogging and put in a petri dish. The filterholder, pump and filtrate container was all made in silica free plastic. All filters are in duplicates.

**$\delta^{13}\text{C-DIC}$ :** The samples for  $\delta^{13}\text{C-DIC}$  were taken from the TOC bottles and transferred into vials. The vials had prior to the cruise carefully been flushed with argon to remove all  $\text{CO}_2$ -containing air. The septa on the vials are air tight. 100 $\mu\text{L}$  of concentrated  $\text{H}_3\text{PO}_4$  and the samples were added with syringes to avoid air contamination. For the Lena transect, duplicates were taken for all stations, and from the other areas, every 8<sup>th</sup> sample had a duplicate. The vials were kept in fridge.

**Photochemical degradation:** 10 L GFF filtered water from the submersible pump (see 2.1.3.6) was filled in prewashed containers and stored on deck in aluminium boxes (cold and dark). The samples were sent to collaborators at Univ. Oslo for further analysis of photodegradation rates.

### 2.1.3.4 Carbonate system and nutrients GU method (Sofia, Sara, Irina, Iréne)

Samples were taken from the seawater inlet system for dissolved inorganic carbon, total alkalinity, pH and nutrients. The samples for nutrients were unfiltered and were analysed for nitrate, phosphate, and silicate. The analytical methods for all parameters are described below (Section 2.2.5.2).

### 2.1.3.5 Carbonate system parameters (“POI” technique). (Irina)

On these cruises we measured  $\text{pH}_{\text{SWS}}$  at  $25 \pm 0.1^\circ\text{C}$  with an ORION 8103 Ross electrode on the SWS-scale, using tris-buffer prepared according to Goyet and Dickson (DOE, 1994), with a precision of  $\pm 0.002$  pH unit. In total 357 pH measurements were done in the ISSS-08 cruise: 320 from Niskin

bottles, and a rest from SWI. Total alkalinity ( $A_T$ ) data were obtained in 71 samples taken from Niskin bottles onboard YS and 127 samples obtained onboard side-vessel TB-0012 by direct indicator titration in an open cell using a 665-Dosimat system with a precision of  $\pm 0.1\%$  ("Goteborg" technique). Values of  $pCO_2$  and total inorganic carbon concentrations ( $C_T$ ) will be calculated using values of  $A_T$ , pH, temperature (T), and salinity (S), following a scheme and constants advocated respectively by Millero (1995) and Goyet and Dickson (DOE, 1994). This technique has traditionally been used on our Siberian Shelf Study (SSS) cruises in the Arctic seas since 1996 (Pipko et al., 2002; Semiletov et al., 2007). POI's pH-values will be inter-calibrated vs spectrophotometric pH –values obtained by Goteborg group.

#### **2.1.3.6 Hi-volume filtrations for molecular-organic studies (Bart, Martin)**

As described in Section 2.1.1 (SWI-Kingston system), pre-rinsed armoured pvc tubing was connected from the stainless steel T-piece near the barrel to the seawater distribution system situated on the portside of the front deck. The total length of this tubing was about 23m. This allowed for hi-volume filtration of sea water from the sea water intake for molecular-organic studies while steaming. When required the connection to the seawater distribution system was opened and at the same time the flow to the barrel was reduced by the other valve. This was necessary since, due to the length of the tubing and the total seawater distribution system, there was a high resistance and if the flow to the barrel was not limited, no water flowed into the water distribution system to allow hi-volume filtration. The intake of sea water through this system was stopped/not used when lying still at a station and for most of the steaming time. The actual 293 mm filtration protocol is described in section 2.9.3.

## ***2.2 CTD and Niskin-bottle water sampling and at-sea analyses***

### **2.2.1 CTD Data acquisition, incl Turbidity sensor specs (Göran)**

The CTD was a standard SeaBird 911+ with conductivity and temperature sensors. After station 1 we added a Wetlabs turbidity sensor ECO NTU S/N NTURTD-126 on the voltage channel. It is attached as a fluorescence Wetlab ECO-AFL/FL sensor in the sensor list available in the Seabird software. The scale factor is just 1 which gives an output signal between 0 and 5 Volts.

At station 4 we added an extra T,C package to force the pump to start at low salinities. The new package was attached as the primary sensors with a closed tube filled with salty water through the conductivity cell. The original sensors was then attached as secondary T and C, but are used as the primary output in all the data processing.

The closed sea-water loop was removed at and after station 36. This gave the possibility to compare the two sensor packages although the primary was not pumped so it had a much longer time constant. The comparison looks rather good with just small discrepancies of a few parts per thousands in salinity judging from screen data in homogeneous layers.

The CTD was mounted on a rosette with 12 Niskin bottles with a volume of about 6.7 liters. At some selected stations an additional 20 liter GoFlo bottle was mounted on the rosette providing some extra larger volume sampling. Water samples was collected on most stations with some exceptions as during the high horizontal density sampling program in the Herald Canyon (stn. 43-78) when water samples was collected at every second station. A total of 1260 water samples were collected.

**Station positions**

**OBS!!** Stations 15, 19, 31 and 108 have wrong positions in the raw data files. This is probably due to restarting the GPS too close in time before the beginning of the cast. It takes probably some minutes for the GPS to initialize properly. The correct positions has been written in manually in the ascii-header files (see below) and then automatically in the station file and so on.

Stn#	Raw data position	Correct position
15	71 37.69 N, 130 03.21 E	71 34.98 N, 130 15.32 E
19	73 02.07 N, 133 27.37 E	73 06.57 N, 137 18.18 E
31	71 35.49 N, 156 24.85 E	71 06.49 N, 161 41.61 E
108	76 46.76 N, 149 12.64 E	75 33.66 N, 155 52.96 E

**General files in ISSS-08 data set**

- stationsdata\_ISSS-08\_CTD.txt : Position, time, Water depth, max CTD depth for all stations.
- ISSS08\_bottle\_file\_CTD.xls : Position, time, CTD-pressure, CTD-salinity, CTD-pottemp (all bottles), and Autosal-salinity (selected bottles)
- iss08\_ctdXXX\_YY.asc : 1 dbar binned CTD data ascii files including pressure, in situ temperature, turbidity and salinity. In total 133 files with XXX denotes station no and YY cast no.
- iss08\_ctdXXX\_YY.hdr : Gives header information for the same files with time, position and all data processing steps.
- ODVformat.txt : General spread sheet format file to be used specially for Ocean Data View. Includes all CTD data in one long list.

**2.2.2 CTD ship-board Data processing scheme ISSS-08 (Göran)**

The data has been processed using the Seabird standard software package through the following routines:

**Data conversion**

**Cell thermal mass** Using coefficients Alpha: 0.03, 1/beta: 7

**Filter** Filter pressure only: LPF B, time constant 0.15

**Loop edit** Use fixed minimum velocity with minimum velocity 0.1 m/s

**Bin average** Bin type: pressure Bin size: 1 dbar

**Derive** Derived variables: Salinity, Salinity2

**Ascii Out**

**Data conversion**

**Bottle summary** Derived variables: Pressure, Cond2, Salinity2

### **2.2.3 Wet deck sheets and identifier systems (Anders)**

For the sampling from the Niskin bottles mounted on the rosette together with the CTD a system with wet deck sheets was used. An example of the deck sheet is included in the appendix.

To plan and optimize the sampling, information on what stations and depths to sample for each parameter was requested in advance. Any changes to the plans were preferably marked on the deck sheet at sampling.

The deck sheet listed the unique six-digit ID# given for each Niskin on each station. Associated with the ID# was a sheet with shelf-adhesive stickers used to mark each sample container. The ID# will be listed in a distributed data file and can there be directly associated with, e.g., station, depth, temperature and salinity.

The deck sheet listed all parameters to be sampled and the sampling order to be followed, from the left to the right. Since the water volume was limited (~6.7 liter / Niskin) it was important not to take any other samples than those listed on each Niskin without checking first. For this purpose the total volume need was also included on the deck sheet for each Niskin.

### **2.2.4 List of sample types drawn from Niskin (Anders)**

As an example of a deck sheet that for Station 86 is given in the appendix. It also include the persons onboard responsible for each sample type.

### **2.2.5 At-sea analysis methods**

#### **2.2.5.1 Bottle salinities (Caroline, Göran)**

Bottle salinities have been analyzed using a General Oceanics Autosal lab salinometer. In total about 200 such samples has been analyzed mainly taken from four depths at the uppermost water column with sharp gradients where it is most critical to have the actual salinity in the bottle.

## **2.2.5.2 Analytical methods used by the GU Marine Chemistry group** (Sofia, Sara, Irene, Anders)

### **2.2.5.2.1 pH measurements**

#### **Principle:**

pH are for 15°C and on the total scale.

Water samples for pH were drawn soon after the rosette was secured on deck, pH samples can be contaminated by the atmosphere and are therefore sampled early. They were then analyzed on board within hours of sampling. The analysis order was the deepest sample first.

pH was measured using a spectrophotometric method (Agilent 8453), based on the absorption ratio of the indicator m-Creosol Purple sodium salt (CAS 62625-31-4) at wavelengths 434 and 578 nm. The indicator solution was prepared by dissolution of 0.382 g pre-weighted amount of indicator in 0.5 L seawater with a salinity that resembles the samples. The indicator was adjusted to a pH in the same range as the samples, approximately  $\pm 0.2$  pH units, by adding a small volume of conc.  $\text{HNO}_3$  or conc.  $\text{NaOH}$ . Before running a set of samples, the pH of the indicator was measured using a 0.02 cm cuvette. Indicator corrections were made according to the recommendations from Chierici et al. 1999. The pH values are corrected to 15°C on the total scale. No corrections for the sample salinities were made.

#### **Accuracy, temperature effect:**

Samples were when weather permitted stored in a thermostat bath at 15°C before the measurement. The system is not thermostated so the sample temperature will change until the measurement is finished. The thermistor used for temperature measurements is placed directly after the cuvette. The thermistor was calibrated before the cruise.

#### **Precision estimated from replicates:**

Replicates were measured from both separate bottles and from the same sample bottle. The bottle was kept at lab temperature between measurements, this means that a volume of approximately 50 ml has been drawn from the bottle for the first sample and the second sample might be affected by a change in  $\text{CO}_2$  content. Precision is previously estimated to about  $\pm 0.0001$  pH-units.

### **2.2.5.2.2 Alkalinity measurements**

#### **Method:**

Alkalinity was measured after pH from the same bottle. The analysis order was the deepest sample first. Alkalinity analyses were done using an open cell potentiometric titration method using a GRAN point determination (Haraldsson et al., 1997). The system measures alkalinity in  $\mu\text{mol/L}$  using the nominal acid concentration of 0.05 mol/L. Certified reference materials (CRMs) as supplied by A. Dickson, Scripps Institution of Oceanography were used to determine accuracy. For all samples and CRMs, the alkalinity in  $\mu\text{mol/kg}$  was calculated using the salinity (from the CTD bottle file and the certified salinity, respectively) and the temperature measured at the beginning of the titration.

Sample results were then multiplied with the factor determined from the CRM measurements at each individual station.

#### **Precision from replicates**

The given precisions were computed as standard deviations of duplicate analyses performed continually during the cruise. Duplicates were run from the same sample bottle since alkalinity is not sensitive to atmospheric contamination. The average precision is previously estimated to about +/- 1.2  $\mu\text{mol/kg}$ .

#### **2.2.5.2.3 Dissolved Inorganic Carbon (DIC) measurements**

##### **Method:**

The sampling and analysis order were the same for DIC as for pH since also DIC samples can be contaminated by the atmosphere. The MIDSOMMA system was used for coulometric DIC determination. The titration is terminated when 4 endpoints are reached, i.e. the counts/minutes are below the blank value four times. With a good coulometric cell, this was achieved normally in 8-9 minutes. New cells were prepared daily. From the total counts the blank is subtracted, by multiplying the blank/minute value with the run time (in minutes). The resulting counts are internally multiplied with a fixed factor (and divided by density) to give DIC in  $\mu\text{mol/kg}$ . The average of the two lowest increments during a titration is used as blank for the sample. Certified reference materials (CRMs) were used for accuracy.

##### **Precision from CRMs and replicate samples:**

In general, from a new CRM bottle, 2 or 3 replicates were measured. Although the bottles may lose  $\text{CO}_2$  when opened, as soon as the samples have been drawn the samples were closed during the titration so this effect is probably less than the precision of the method. The average precision is previously estimated to about  $\pm 2 \mu\text{mol/kg}$ .

#### **2.2.5.2.4 Nutrients**

##### **Principle**

The nutrients analyzed on board were Silicate, Phosphate and Nitrate (also including Nitrite). The samples were first filtered (except for SWI samples) and then measured using an automatic system, SmartChem from Westco, which basically is a spectrophotometer with an automatic sampler. 6 to 8-point calibration curves were used for evaluation. Since the standard stock solutions were forgotten, reference material provided by KANSO co. Ltd. (URL: <http://www.kanso.co.jp/>) was used as standard solution. The system automatically diluted the standard to the given points in the calibration curve using artificially seawater (ASW) of salinity 25 or 10 depending on the salinity of the samples. A calibration curve was run before and after every set of samples. All reagents were pre-weighed and then prepared on board. All utensils were acid washed before departure and packed in plastic bags. Some lab experiments need to be done afterwards to check the method used.

### **Silicate**

For Silicate the following reagents were used; Molybdate solution, Oxalic acid solution and Ascorbic acid and was measured at 880 nm. The reference material used as highest standard for the calibration curve was 58.06  $\mu\text{M}$ , samples with higher concentrations were automatically diluted and rerun. Reagent blanks were measured and corrected for.

### **Phosphate**

For Phosphate the following reagents were used; Sodium molybdate solution and Ascorbic acid solution and was measured at 880 nm. The reference material used as highest standard for the calibration curve was 1.619  $\mu\text{M}$ , samples with higher concentrations were automatically diluted and rerun. Reagent blanks were measured and corrected for.

### **Nitrate**

When estimating Nitrate the Nitrite concentration is needed for subtraction. Hence, for Nitrate the following reagents were used; Imidazole buffer, Sulfanilamide reagent and NED reagent and was measured at 550 nm. The method also uses 10 % Imidazole buffer solution for the “reductor” and HCl,  $\text{HNO}_3$  and Copper sulphate solution for cleaning the same. The reference materials used as highest standards for the calibration curves were 21.42  $\mu\text{M}$  for Nitrate and 0.62  $\mu\text{M}$  for Nitrite, samples with higher concentrations were automatically diluted and rerun. Reagent blanks were measured and corrected for.

### **Ammonia**

Samples from some of the stations, mainly along the coast and in the river plumes, were frozen and will be analyzed for Ammonia at the University of Gothenburg.

### **Estimation of accuracy and precision:**

Reference material for nutrients (provided by KANSO URL: <http://www.kanso.co.jp>) was used for the first time with this method, and will be used to determine the accuracy. Precision was determined from replicates.

### **2.2.5.2.5 Oxygen**

Oxygen was measured using an automatic Winkler titration with UV detection. In the river plumes this was not always possible due to the brown water and those samples were titrated by visible detection. The same sodium thiosulphate solution was used during the cruise and blanks and standards were run every day using a  $\text{KIO}_3$  standard. Precision was determined using replicates from the same depth.

#### **2.2.5.2.6 Chlorofluorocarbons (CFCs)**

The transient chlorofluorocarbon (CFC) tracers CFC-11, CFC-12, CFC-113 and carbon tetrachloride were determined during the cruise. The samples were taken from the Niskin bottles in glass syringes (100 ml), which were stored immersed in cold seawater and analysis took place within six hours after sampling. The analysis is based on on-line purge-and-trap sample work-up of followed by gas chromatographic separation and electron capture detection of the different compounds. The analytical technique is described by Fogelqvist (1999).

The standardisation was achieved by calibration gas prepared at Brookhaven National Laboratory (Happell and Wallace, 1997) and cross-calibrated against gas prepared at Scripps Institute of Oceanography. The standard gases were calibrated against the SIO-93 scale.

The analytical precision, given as the standard deviation for multiple samples taken from different Niskin bottles fired at the same depth, was around 2 % for all the four compounds.

#### **2.2.5.3 POI pH and tot-ALK (Irina)**

See section 2.1.3.5.

#### **2.2.5.4 Biogeochemical-core params (pigments, DOC, optical) (Laura, Vanja)**

See section 2.1.3.2.

#### **2.2.5.5 CH<sub>4</sub> (Irina)**

See section 2.1.3.1

#### **2.2.5.6 Particulate Matter (PM) (Oleg)**

Particulate matter (PM) from 2-4 m of surface water and 1 m below bottom was obtained by filtering 1.5-3.0 l water (from Niskin bottles of CTD-Rosette) through preweighed Millipore 0.47 $\mu$  filters and precombusted Whatman Gf|F filters (organic matter of PM). Millipore filters were dried at 40°C immediately after filtration and Whatman filters were frozen.

Also were filtered two types of nepheloid water (0.5-1.0 l volume) in plastic tube of GEMINI corers: (first type) near 10 sm under the sediments and (second type) — is 30-50 sm under the sediments.

### **2.3 Acoustic Doppler Current Profiler (ADCP) (Sasha, Anatoly)**

An Acoustic Doppler Profiler (ADP) is an instrument that measures the velocity of water using a physical principle called the Doppler shift. The ADP is the principle component of every CurrentSurveyor system.

The geometric orientation of each transducer allows the ADP to calculate the velocity of the water in using a Cartesian (XYZ) coordinate system relative to the position and orientation of the instrument. The internal compass and tilt sensor (roll/pitch) used with all CurrentSurveyor systems is able to calculate the water velocities in Earth coordinates (East-North-Up or ENU) independent of the system’s orientation.

Frequency	Profiling Range (min. – max.)	Cell Size (min. – max.)	Blanking Distance (min.)	Bottom-Track Depth (max.)	Available Configurations
250 kHz	5 – 180 m	2 – 20 m	1.5 m	200 m	Standard only

The ADP uses the bottom-track feature to measure the speed of a vessel (e.g., a boat, the River-Cat system) relative to the river bottom. The vessel speed is then subtracted from the measured water velocity to give the absolute water current profile independent of vessel motion.

- Bottom-track allows the ADP to measure both its velocity (speed and direction) over the Earth, and the depth of the water beneath the system.
- Bottom-track data is used to remove vessel motion from measured water velocity to determine the “true” water speed and direction. That is, when you mount the ADP to a vessel (e.g., a boat, the RiverCat system), bottom-track measures the velocity and direction of ADP/vessel movement over ground.
- True water speed and direction is used with simultaneous water depth measurements to measure discharge in the *CurrentSurveyor* program.
- Accounting for vessel motion is essential when making water velocity measurements from a moving vessel. Bottom-track and GPS data are two ways to account for vessel motion.
- The bottom-track feature comes standard with CurrentSurveyor systems. As the ADP profiles, it transmits a series of *short* pulses to measure the relative water speed. In a CurrentSurveyor system (or a standard ADP system with the bottom-track option enabled), the ADP also transmits a series of *long* pulses that are designed to estimate the velocity of the ADP over ground (i.e., vessel speed). The Doppler shift of the reflected acoustic energy from these long pulses (i.e., bottom-track pings) off the riverbed floor is used to determine the ADP/vessel velocity. Bottom-track pings are transmitted once per second (for each transducer beam). The resulting measurements are averaged at the end of each *profiling interval* to determine the average water depth, vessel speed, and vessel direction during this time. Let us consider the performance of the bottom-track measurements. As mentioned, a bottomtracking ADP determines the velocity relative to the bottom (which is assumed to be identical to the vessel velocity) once each second, and then averages the raw estimates over the user-selected *averaging interval*. Because the bottom velocity is derived from solid object reflections (i.e., the river bed), natural variability (i.e., standard deviation) of the bottom-track velocity measurements is lower by an order of magnitude when compared to the ADP’s water-track data. As such, the precision of bottom-velocity measurements is always better than that of water-velocity data. Based on this comparison, bottom tracking can be considered to introduce no significant errors to water current measurements.

#### Acoustic Frequency 250 kHz

**Blanking Distance**    Range 1.5 - 20.0 m    Default 1.5 m

**Cells Size**                Range 1.0 - 20.0 m    Default 4.0 m

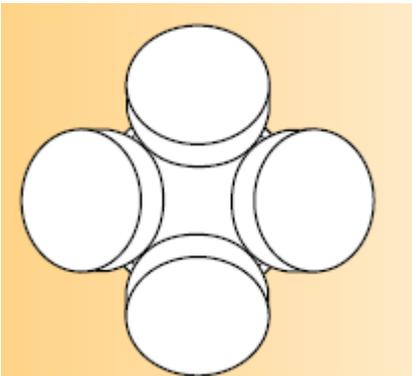
**Number of Cells**    Range 1 – 100        Default 30

### *Velocity Data*

- Range:  $\pm 10$  m/s
- Resolution: 0.1 cm/s
- Accuracy:  $\pm 1\%$  of measured velocity,  $\pm 0.5$  cm/s
- Up to 100 range cells

### *Compass/Tilt Sensor*

- Resolution: Heading, Pitch, Roll  $0.1^\circ$
- Accuracy: Heading  $\pm 2^\circ$
- Accuracy: Pitch, Roll  $\pm 1^\circ$



### *Performance options*

- Bottom tracking/DGPS interface for use from a moving boat
- SonWave wave spectrum package
- Pulse-coherent mode for high resolution profiling (contact SonTek for details)

### *Standard features*

- Robust, digital signal processing
- 8 bit A/D conversion
- Three-beam transducer for 3D current measurement
- Transducer shading for minimal sidelobes
- Oversize piezoelectric ceramic for narrow beams
- Recessed wet-mateable connector
- Temperature sensor



#### **2.4 Hydrosonde vertical profiling** (Genna, Fredrik)

Vertical profiling with the hydrosonde was performed on most stations. Data was acquired about every second meter. The main objective was to collect data from the chlorophyll sensor. On several occasions full profiles of pigment samples from Niskinrosette was collected and analyzed on the absorption spectrophotometer for cross-calibrations.

#### **2.5 Plankton net sampling** (Genna)

Hand-held plankton net tows were performed occasionally and samples preserved in Lugol for plankton speciation in Vladivostok.

#### **2.6 Micrometeorology air-methane and CO<sub>2</sub> and CH<sub>4</sub> fluxes** (Anatoly)

**Micrometeorology.** CO<sub>2</sub> and CH<sub>4</sub> fluxes were measured using micrometeorological method, as we did in the sea (September of 2005-2007) or above the sea ice surface in June of 2002 (Repina et al., 2007; Semiletov et al., 2004, 2007). In our CO<sub>2</sub> and CH<sub>4</sub> exchange study setup, momentum and the fluxes of sensible and latent heat will be measured using the EC technique, which is the most direct

micrometeorological method (Fairal et al., 1997; Edson et al., 1998; Fairal et al., 2000; Baldocchi, 2003). In this technique the vertical flux of a scalar constituent is obtained as

$$F = \overline{w'c'}$$

where  $w$  is the vertical wind speed and  $c$  is the quantity of interest (e.g., temperature, humidity, or gas concentration). An over-bar denotes the time average, and a prime denotes the fluctuation of an instantaneous value from this average, e.g.,

$$w' = \overline{w} - w$$

Fluxes of CO<sub>2</sub> ( $F_{CO_2}$ ), water vapor ( $L_E$ ), and heat ( $H_E$ ) will be calculated using EC technique equations described elsewhere (Baldocchi, 2003):

$$\tau_0 = -\rho_0 \left[ \overline{u'w'^2} + \overline{v'w'^2} \right]^{1/2} = \rho_0 u_*^2$$

$$H_E = c_p \rho_0 \overline{w'T'}$$

$$L_E = \rho_0 \overline{w'q'} L_s,$$

$$F_{CO_2} = \overline{w'c'}$$

where  $\rho_0$  is the air density (kg m<sup>-3</sup>),  $c_p$  is the specific heat (J kg<sup>-1</sup>°C<sup>-1</sup>),  $L_s$  is the latent heat of vaporization for water (J kg<sup>-1</sup>),  $\tau$  is the momentum flux (N m<sup>-2</sup>), and  $u_*$  is the frictional wind velocity (m s<sup>-1</sup>).  $w'$ ,  $u'$  and  $v'$  are the turbulent fluctuations in vertical and two components of horizontal velocities.  $T'$  is the turbulent fluctuation in air temperature, and  $q'$  and  $c'$  are turbulent fluctuations in the specific humidity and CO<sub>2</sub> concentration. Vertical and horizontal wind speed and temperature fluctuations were measured at 10-20 Hz using a three-dimensional sonic anemometer-thermometer aligned with the mean wind direction. CO<sub>2</sub> and water vapor fluctuations were measured at 10-20 Hz with a fast-response open-path infrared Li-Cor 7500 gas analyzer (Fig. X).



Figure X. Shipboard micrometeorological equipment.

**Methane in the air.** The concentration of CH<sub>4</sub> in air was measured with a High-Accuracy Fast Methane Analyzer, HAFMA (response time <0.05 seconds; accuracy better than 1% of reading; concentration range 10ppb-25ppmv; [www.lgrinc.com](http://www.lgrinc.com)) which includes a dry scroll vacuum pump, and is designed to suit many applications including conducting EC flux measurements using established micrometeorological techniques (Fairal et al., 1997; Edson et al., 1998; Fairal et al., 2000; Baldocchi, 2003). We plan to use the data measured with HAFMA for CH<sub>4</sub> turbulent flux estimates. We plan also to compare the turbulent and calculated CH<sub>4</sub> fluxes with the turbulent and calculated CO<sub>2</sub> fluxes which have been measured on our cruises since 2005. The flux package consisted of:

- HAFMA and CSAT-3 sonic anemometer (Campbell Scientific Inc.) measuring the 3D wind vector and sonic temperature;
- Crossbow to detect movement momentum;
- Li-Cor 7500 open path infrared gas analyzer, measuring H<sub>2</sub>O and CO<sub>2</sub>.

The flux package was mounted at a height of ~12m above mean sea level on a meteorological mast.

**C and H isotope signatures of air CH<sub>4</sub>** are frequently adequate to reliably characterize bacterial or thermogenic natural gas type (Whiticar, 1999). In certain situations, such as mixing of different natural gases or where extreme substrate depletion and consumption occur, ambiguous CH<sub>4</sub> isotope signals could be produced. In these cases, the C- and H-isotopes of CH<sub>4</sub>, in concert with coexisting isotope information about CO<sub>2</sub> and H<sub>2</sub>O, are excellent tracers of bacterial formation and consumption processes. To do that 5 l Tedlar bags were filled out by air pump at the top deck, in total at 67 locations. The isotopes will be measured in two places: at the Utrecht University (C-13, and D) and London Hydrometeorological Survey (only C-13)

## ***2.7 Hi-vol aerosol and vapor-phase sampling*** (Martin)

### **Materials**

Pump (picture 2.7.1): Blower type pump (Airvac HB-329, 220V, 0.85kW). Flow meter (Tecfluid Serie SC-250, 8-75Nm<sup>3</sup>/h) is attached to the outflow of the pump.

Filter and PUF holders (picture 2.7.2) was manufactured by Leif Bäcklin at MISU centralverkstad, Stockholm University. Material used was "eloxated" aluminum. Quartz fiber filters (held in Al foil envelopes in double zip-log plastic bags) were pre-combusted at 450°C for 5h. Sampling of the vapor-phase was performed using adsorbents of PUF (Poly Urethane Foam) held behind the filter. PUFs (Skumplastfabriken, Norway) were cylindrically shaped with a diameter of 8cm and 7cm long. PUFs were subject to extensive pre-cleaning in series of solvent extractions.

To prevent water from getting into the system and particles falling directly onto the filter the top of the filter and PUF holder was covered with a plastic bowl which was attached with a strap. The filter and PUF holder was attached to the reeling at the top most deck of the boat, which was 10 m above sea level and 7.5m above lower deck. The filter and PUF holder was 28 m in front of the ships chimney, (picture 2.7.3).

### Sample collection

All filter and PUF changes were done by detaching the filter and puf holder and bringing it to a clean surface (Al foil) in the cabin. The pump was on only when ship was making at least 10 knots.



Picture 2.7.1 Pump and flow meter inside box.





Picture 2.7.3 Distance to chimney from aerosol sampler.

## **2.8 Geophysical – seismic surveying** (Viktor, Georgy, Anatoly)

### **2.8.1 Modified Ship echosounder**

Survey echo sounder “Atlas Deso 10” was modified using transformation of frequency of “floating” signal from 30Khz to 11 Khz converting the analog-digital signal. Special soft was used was applied to detect bubble chimneys in water column by the way.

## 2.8.2 Sub-bottom profiler

**Seismic profiling (Karnaukh).** *GeoPulse Sub-bottom Profiler* manufactured by GeoAcoustics Limited, England was used in the cruise. “GeoPulse transmitter Model 5430A” was used for generation of the signal. The output frequency of the transmitter is adjustable between 2-12 kHz, while the width may be varied within the range 1-32 cycles of the frequency selected and the power output of 10 kW at 0.75% duty cycles. The actual frequency used was 3.5 kHz. The pulse length is 2 cycles of the frequency selected. The power level was variance of 5 to 70 %. The Towfish (Model 136A) contain 4 transducers (Model T135). The Towfish was towed at 2-6 m below sea surface using standard 100 m armoured tow cable. Universal amplifier/filter “GeoPulse receiver Model 5210A” was used for signal receive. The low cut of band pass filter is 3 KHz, high cut is 5 kHz. Sometimes, the Swell Filter (Model 5212B) was used to remove the noisy effect from vessel vertical motion. When Swell Filter is used, the output traces will immediately be delayed be 7.5 milliseconds. For acquisition, logging, image processing of sub-bottom profiler data the GeoPro 2 software application was used. Global Positioning System Model 120 XL was used for navigation needs. The ship’s speed was 4-8 knots.



GeoPulse Sub-bottom Profiler

The investigation was carried out in the Laptev, East Siberia and Chukchy Seas.

### 2.8.3 Side-scan sonar

Sidescan Sonar (the sonar fish) is designed for a wide range of seabed survey. The mid frequency 85 KHz has a useful range in excess of up to 750 metres on either side of the tow track. The survey depth is up to 300 metres. Different morphological settings (pockmarks, pingo-like structures and etc) and gas chimneys are objectives for this survey.



## **2.9 Water pumping for molecular-isotope biogeochemistry** (Bart, Martin, Vanja)

### **2.9.1 Submersible pump system** (Martin, Bart)



#### **Materials**

Submersible pump (Model AN-19, 380V, Flow rate 30l/min; Debe pumpar AB, Sundbyberg, Sweden)

Wetted parts of nylon plastic, brass and stainless steel.

Tubing: Rigid “fire hose” type tubing. 1 in Inner diameter, wetted parts silicone.

#### **Deployment**

The pump was deployed from front deck port side. During the ISSS-08 the pump was always placed in middle of surface mixed layer depth (based on CTD). If anchored, pump was not turned for > 5 minutes. Sediment coring was always done after the in situ pumping was finished. Water was always pumped to the seawater distribution network, see next section 2.9.2. If air temperature was near or below zero the pump was put in a water filled barrel with a heating rod between stations. To prevent water in pump or any other part of the seawater distribution network to freeze, hot water was pumped from the barrel and through all the hoses in the water distribution system and back to the barrel again.

## 2.9.2 Seawater distribution network incl 1000L tanks (Martin)

### Materials and methods

#### 1000L tanks (See picture 2.9.2.1)

Tanks were made of HDPE. Tanks had drainage valves near bottom. On top of each tank there was a lid of ca 30cm in diameter which could be screwed on and off. To each lid 4 holes were drilled to enable the following (See picture 2.9.2.2)

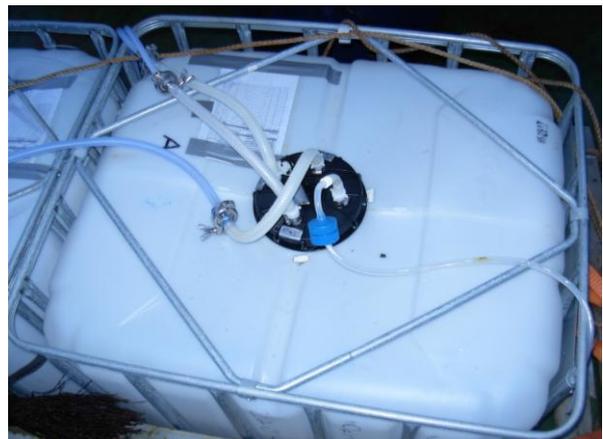
- 1) Filling of the tank with in-situ pump, (see figure 2.9.2.2)
- 2) Re-circulation of excess water not used for GFF-filtrations back to the tank, (see figure 2.9.2.2)
- 3) Pumping water out of the tank with impeller pump to GFF-systems, (see figure 2.9.2.2)
- 4) Air out and inlet. This hole was equipped with a 47mm diameter filter holder and a GFF-filter to not contaminate the water. At the inlet of the filter holder there was a tube of 1m facing down to protect the filter from water.

To each hole there was a piece of armored silicone tubing inserted into the container which was squeezed out with a plastic nipple to perfectly tighten hole in the lid, (see picture 2.9.2.3). The hole for pumping water out of the tank had a silicone hose reaching the bottom of the tank, the other three holes had just a just a small piece of silicone tubing immersed into the tank.

To not contaminate the tank when it was not in use the holes where closed with plastic stoppers, (see picture 2.9.2.3). The stoppers were attached to the nipples with a string not to get lost.



Picture 2.9.2.1



Picture 2.9.2.2



Picture 2.9.2.3

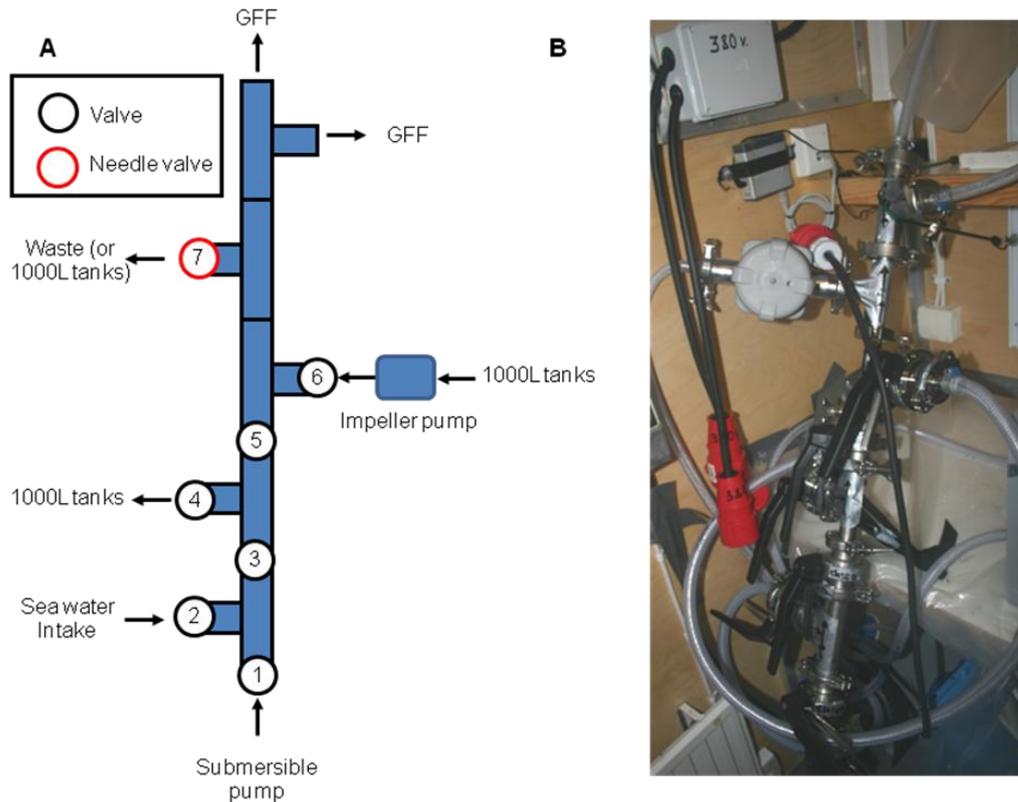


Figure 2.9.2.1 Schematic and picture of “Christmas tree”, i.e. the valves inside the container controlling the water flow in the sea water distribution network. Note that in the schematic in figure 2.9.2.2 the valves are turned 180°.

**Hoses:** All hoses in the sea water distribution network were of armored PVC (Ahlseil) except for the last 2 meters of the hoses leading to the 1000L tanks, and the hose leading down into each 1000L tank. Those pieces of hose were of armored silicone (SweFlow). The reason for that is that armored silicone in contrast to armored pvc remains soft and smooth at most temperatures and could therefore easily be attached and detached from the nipples on the 1000L tanks.

**Valves, T-pieces, hose barb fittings, seals:** Valves, t-pieces, hose barb fittings and seals used to join the different parts in the water distribution network were all of stainless steel and silicone and were purchased from Sveflow, Sweden.

**Nipples:** Plastic nipples on the lids of the tank were from Noax Lab, Sweden.

**Pump for 1000 L tanks** (section 2.9.1): A 220V impeller pump (25L/min) , purchased from Telfa, Sweden.

## Description of system

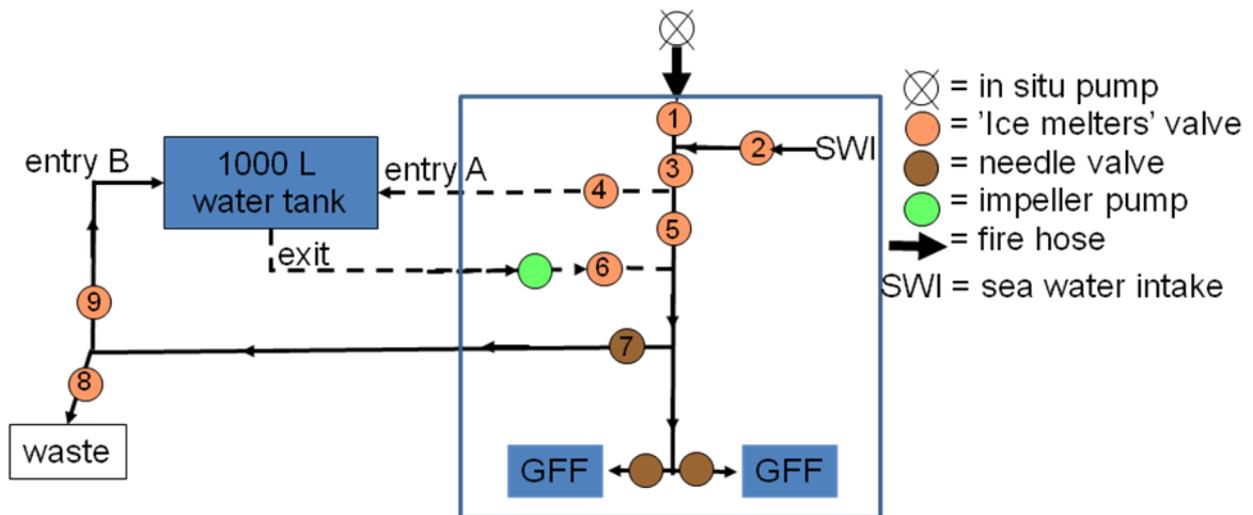


Figure 2.9.2.2 Sea water distribution network. Objects inside square where inside container, objects outside square were out on deck.

The system was mainly controlled from the “Christmas tree” i.e. valves 1-7 inside the container, see figure 2.9.2.1 and figure 2.9.2.2.

System operations of sea water distribution network used during ISSS-08

- 1) Filling of 1000L tank with in-situ pump. To do this valves 1,3, 4, 5, 7 and 9 had to be opened. All other valves closed.
- 2) GFF filtration directly from in situ pump without filling any tanks. To do this valves 1, 3, 5, 7 and 8 and the valves to the GFF-systems had to be opened. All other valves closed.
- 3) Filling of 1000L tank with in-situ pump and doing GFF filtration at the same time. To do this valves 1,3,4,5,7 and the valves to the GFF-systems had to be opened. All other valves closed. By keeping valves 7 and 9 open whatever water not used for GFF filtration is directed to filling the tank so no water is lost.
- 4) GFF filtration by pumping water from the 1000L tank. To do this valves 6, 7, and 9 and the valves to the GFF-systems had to be opened. All other valves closed.
- 5) GFF filtration directly from the sea water intake. To do this valves 2,3,5,7 and 8 and the valves to the GFF had to be opened. All other valves closed.
- 6) Filling of 1000L tank from sea water intake. To do this valves 2, 3, 4, 5, 7 and 9 had to be opened. All other valves closed.
- 7) Filling of 1000L tank from sea water intake and doing GFF-filtration at the same time. To do this valves 2,3,4, 5, 7 and 9 and the valves to the GFF-systems had to be opened. All other valves closed.
- 8) Pumping water from one tank to another. Attach tubing marked entry A and entry B to the inlets of the tank to be filled and attach tubing marked exit to the exit nipple of tank being emptied, see figure 2. 9.2.2. Open valves 4, 5, 6, 7 and 9. All other valves closed. Start impeller pump.

Before filling a tank with sea water at a station the tank was flushed out to clean away water and particles from previous stations. This was done by opening the valve at the lower part of the tank and pumping in water with the in situ pump according to system operation 1 described above. This procedure also flushed out old water left in the tubing and rinsed the system. After 5-10 minutes the

valve was closed and the filling of the tank could start. When a tank was filled the hoses were simply removed from the nipples and placed on another tank.

To avoid freezing in the tubing during low temperatures the barrel and heating rods described in section 2.9.1 were used. The tubing marked entry A, entry B and exit in figure 2.9.2.2 was emerged in the barrel and hot water was then circulated around the system. To keep the whole system ice free this had to be done in two different ways.

- A) If the impeller pump was used for this valves 4,5,6,7 and 9 had to be open. All other valves closed. Doing it this way would not keep the hose to the in situ pump ice free. Therefore alternative B was also needed.
- B) The in situ pump was emerged into the barrel and valves 1,3,4,5, 7 and 9 open. All other valves closed. This way would not however keep the hose marked exit in figure 2.9.2.2 ice free.

Both way A and B could be run at the same time. But it was never needed. During the ISSS-08 the temperature was only slightly below zero for short periods of time so it was never needed to pump hot water through the system for more than a minute a couple of times a day.

### **2.9.3\_\_293 mm filtration + adsorbent systems (Martin, Bart)**

During ISSS08 two 293 mm glass fibre filter (GFF; Whatman Inc.) filtration systems (Fig. 2.9.3.1a) were connected to the seawater distribution system and samples were collected either in situ, from the submersible pump or from the SWI, or indirectly from one of the 1000L water tanks. For collection of samples for the analyses of hydrophobic organic chemicals a holder containing 3 polyurethane foam (PUFs) adsorbent plugs were connected below the filter holder (Fig. 2.9.3.1b).

The large-diameter GFF filtration system was constructed of stainless steel with silicon seals between all connections. The tubing used was pre-rinsed armoured PVC-tubing. To avoid contamination pre-combusted GFF filters and pre-cleaned PUFs were used (see method in e.g., Sobek and Gustafsson, 2004). A detailed cleaning procedure for the PUFs is given in paragraph 2.7. The filters and PUFs were kept in pre-combusted aluminium foil envelopes and aluminium cans, respectively.

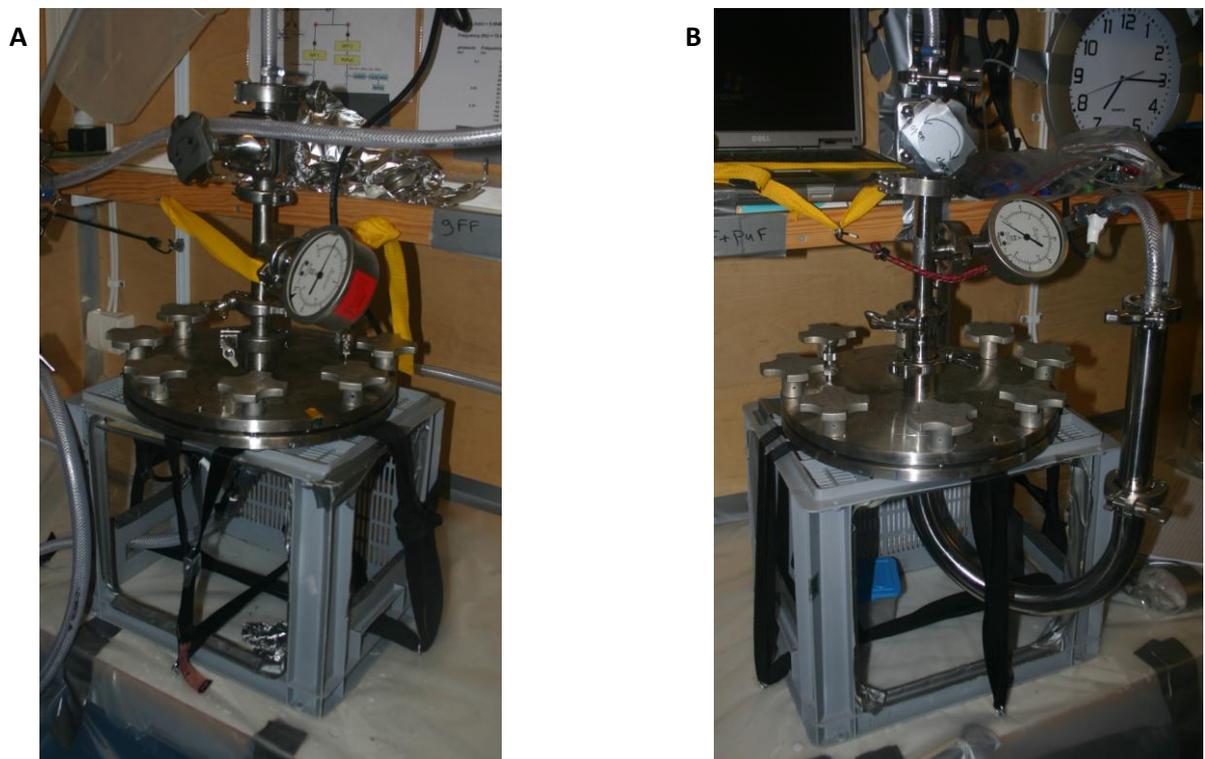
Both systems were set up in parallel (see figure 2.9.3.2) and were often run simultaneously. The systems were connected to an electronic flow meter, in the flow path below the filter, and a pressure meter situated directly above the GFF filter holder (see figure 2.9.3.2). The electronic flow meters were connected to multimeters, which were connected to a computer to log the flow during the runs in order to calculate the total flow through the filter. The multimeters log the flow in Hz and these can be converted into L/min using the following equation:

$$\text{Flow (L/min)} = 0.0648 * \text{frequency (Hz)}$$

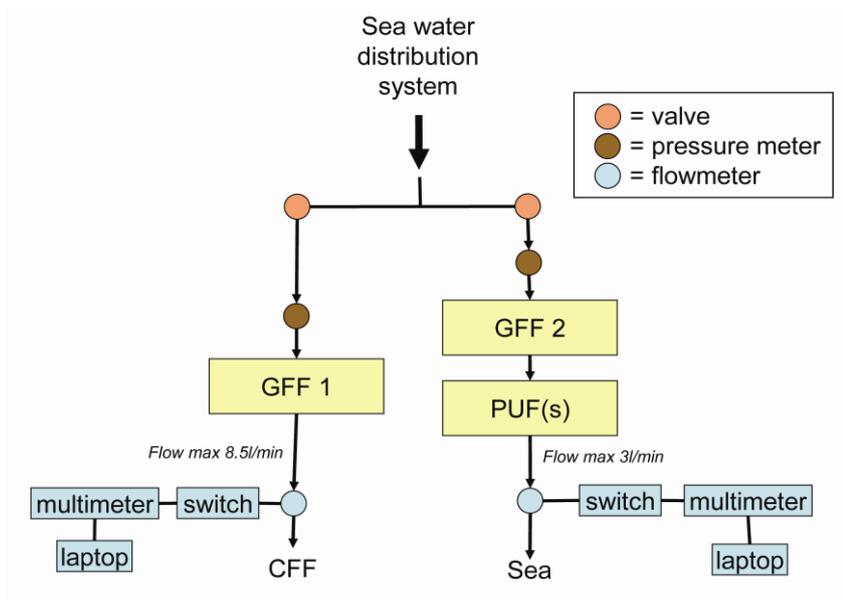
During the runs a flow was maintained with a maximum of about 130 Hz, equal to about 8.5 L/min. In case of PUFs the flow was reduced to a maximum of 46 Hz, equal to about 3 L/min. Filtering was stopped when the backpressure reached 1 bar to avoid cell lysing. In case there was no more time for filtering but the backpressure had not reached 1 bar the filtering was stopped anyway and a comment was made on the logsheet. Filtered water was either collected for cross-flow-filtration or directed back to the ocean. In order to ensure that enough material was collected for the analyses of

hydrophobic organic chemicals as much sea water as possible was filtered. The aim was to filter at least 1000-1200L of sea water per PUF sample, although this was not always possible. This means that multiple GFFs (2 to 5) were collected for a single PUF sample.

After the filters had clogged and the water flow was stopped as much water as possible was sucked off the filter using a handpump. This to make sure the filters were stored with minimal amount of seawater, which reduces the freeze-drying time later as well as reduces the possibility of corrosion of the aluminium envelopes during storage. The filters were folded, put in a pre-combusted aluminium foil envelop and put in a zip-lock bag and stored cold (-20°). All samples were double-labelled with a label both on the aluminium foil bag and the zip-lock bag. The PUFs were put in an aluminium envelop, labelled and stored in a similar manor as the filters.



**Figure 2.9.3.1** GFF system (A) without and (B) with PUF holder



**Figure 2.9.3.2** Schematic overview of the GFF filtration set up. GFF 2 is drawn in a set up with the PUF holder attached but was also run without. In that case the set-up was comparable to GFF 1.

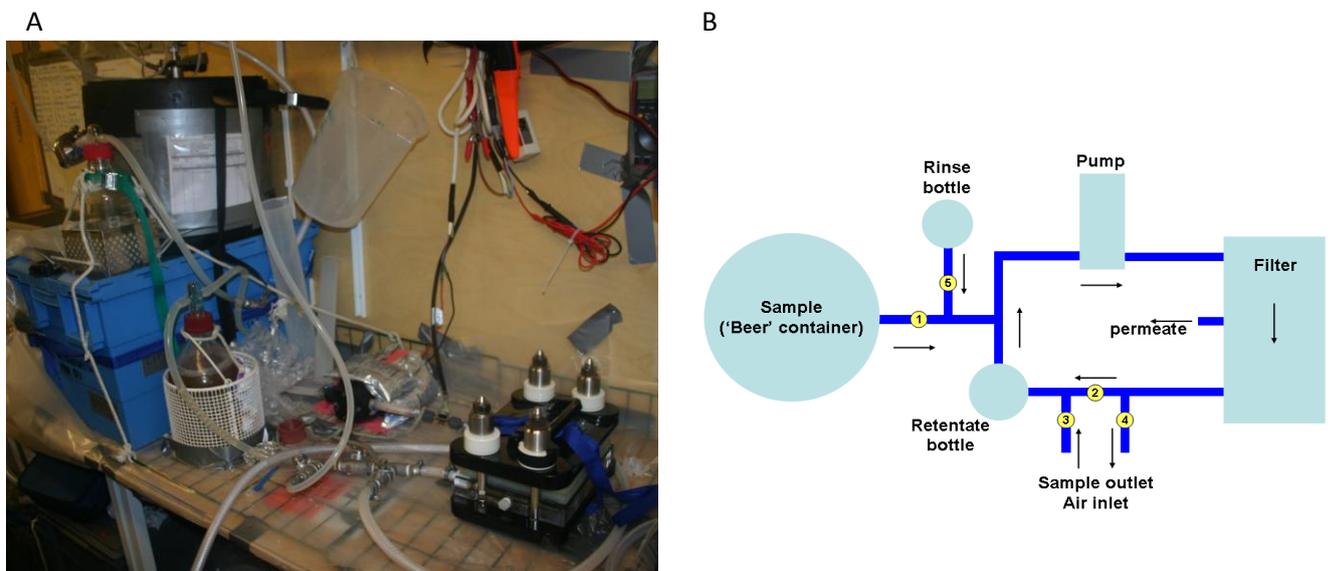
#### 2.9.4. Cross-flow ultrafiltration systems (Bart, Vanja)

During ISSS08 two cross-flow ultrafiltration (GFF) systems were used. The first system (Figure 2.9.4.1a), was used for the collection of CFF samples for molecular and  $^{14}\text{C}$  analysis and the second (Figure 2.9.4.2a) for  $\text{SO}_4^{2-}$ ,  $\delta^{34}\text{S-SO}_4$  and TOT-S measurements. A brief description of both systems is given below.

##### CFFS system 1 (for organic molecular-isotopic analytes)

A schematic overview of the complete system was given in Figure 2.9.4.1b. In order to avoid contamination all tubing in the system is silicon tubing, the valves and the sample feed (< GF/F filtrate) “beer” container were of stainless steel and the bottles (and connections to the bottles) are pre-combusted glass. In addition, air scrubbers were connected to all parts where air can flow into the system (beer container, rinse bottle and valve 3; Figure 2.9.4.1b). The system was operated as follows. Water was pumped/streaming into the system from the beer container/ or rinsing bottle and circulated by a flow-jet pump powered by a car battery. The maximum numbers of days a GFF-filtered water was stored before the CFF filtration was performed was 5 days (Kolyma samples; YS34b and YS39). Depending on the resistance in the system, adjusted by opening/closing valve 2, an average retentate flow of 2.9 to 6.5 L/min could be obtained (with a pressure on the filters between 1-2bar). The water was pumped through a filterholder stacked with two 1-kD Millipore Pellicon 2 CFF filters (regenerated cellulose) and a 2 L glass retentate bottle. The retentate flow was monitored by a flow meter (connected to a multimeter) situated in the system between the pump and the filterholder. During filtration both valves 3 and 4 were closed. A permeate flow between 110 and 160

ml/min was maintained during the filtration. After the water had been filtered the remaining retentate was concentrated by closing valve 1 and (after about 30 sec.) opening valve 3 (to let air in). When the retentate had dropped to about 500 ml in the retentate bottle valve 2 was closed and valve 4 was opened and the retentate sample was collected in a pre-rinsed polycarbonate 1L bottle. The system was rinsed (to collect the remaining retentate) by adding approximately 200-300 ml of remaining GFF filtrate to the retentate bottle. Valve 3 and 4 were closed, valve 2 was opened and the system and this filtrate was cycled through the system for about 1 min, afterwards this rinsing water was combined with the earlier collected retentate in the polycarbonate bottle using the same procedure as described before. In total around 1L of retentate was collected resulting in concentration factors between 77 and 120, which was double labelled and stored cold (-20°). Between samples the system was cleaned as described below. During filtration the flow-jet pump and the retentate bottle were cooled using ice-packs to avoid over-heating of the pump and preservation of the sample. For recovery calculations, the concentration of TOC was measured in the final retentate, the permeate and compared to the DOC concentration already measured from the station (see 2.1.3.2).



**Figure 2.9.4.1** (A) Photo and (B) schematic overview of the cross-flow ultrafiltration system used for the collection of samples for molecular and  $^{14}\text{C}$  analysis during ISSS08

### CFF system 2 (System for Sulfur isotopes etc)

**Setup:** The cross flow filtration system contained a peristaltic pump (master flex from Millipore), pellicon 2 filterholder with two 1kDa filters made of regenerated cellulose, a flow meter, a 5L retentate bottle and a 25L feed bottle. All tubing was in silica, except for the pump tube, which was a composite of polytetrafluoroethylene (PTFE) and platinum, addition cure silicone rubber (Gore & associates inc<sup>®</sup>). The system was refilled from the feed carboy every 20 min, when the retentate bottle contained around 2L. The system is not air tight, and particles from the air could enter the system to the retentate bottle or the feed bottle.

**Sampling:** Samples were taken from the filtered water from the submersible pump (see 2.1.3.6), filled in carboys and stored cold on deck before CFF filtration. The maximum numbers of days a prefiltered sample was stored before CFF filtration was performed was ca 6 days for the Kolyma samples (YS34, YS37 and YS39).

**CFR:** Retentate flow was kept between 60-70Hz per min, and the perm flow was 100-120mL/min, resulting in a CFR of 28-35. For a good recovery and constant cut off at 1kDa, the CFR should be >15 (Larsson et al. 2002) The pressure over the filters was kept around 2.3, except when the final concentration of the samples was performed (reducing the retentate volume from 2 L to 0.5L), when the pressure was kept under 1.8 to avoid losses through the filter.

The retentates were stored in HDPE Nalgene 0.5L bottles and frozen on ship. 30mL was taken in a separate bottle for measurements of  $\text{SO}_4^{2-}$ , and TOT-S concentrations and frozen as well. 0.5L permeate was saved and frozen as well for measurements of  $\delta^{34}\text{S-SO}_4$  measurements. For recovery calculations, the concentration of TOC was measured in the final retentate, the permeate and compared to the DOC concentration already measured from the station (see 2.1.3.2).



Figure CFF filtration (ultra filtration), Sulfur-Vanja's system

### **Cleaning procedure (both CFF systems)**

The filters were cleaned prior to the cruise to remove the formaldehyde they are delivered in. The following washing procedure is recommended from Millipore<sup>®</sup>, with additional advice from Kåre Larsson at Millipore in Sweden. 20L of MilliQ water had been flushed over the filters (the retentate tube not connected to the retentate bottle but emptying the water), and after this, 200L MilliQ water had been passed through the filters to the permeate. The cleaning proceeded with filtration of 5L of NaOH of pH11, 5L of MilliQ, 5L of HCl pH3 and finally MilliQ water until the permeate reached neutral pH was filtered to complete the cleaning process. The filters were then filled with 0.1N H<sub>3</sub>PO<sub>4</sub> to be preserved during the 3 month of storage and shipping time prior to the cruise.

Between the samples YS-2 to YS-30, the filters were cleaned with 5L of NaOH pH 11, 5L permeate from previous station (<1kDa), 5L of HCl pH3, and 5L of permeate. However, the MilliQ system broke down, and we had to reduce the use of MilliQ in the last stations. In between YS-30, YS-34, YS-37 and YS-39, only 3L NaOH was used, and the acid was diluted in permeate from the innermost Lena transect station with sal 1 PSU.

## 2.9.5 $^{234}\text{Th}$ filtrations, wet chemistry and sample treatments

A method that avoids any radiochemical purification was employed. This so-called at-sea direct beta counting method was developed by (Rutgers van der Loeff and Moore (1999) and also described with small modifications in Gustafsson et al. (2006). Method was here scaled down to 10L water samples with volume of added chemicals scaled accordingly.

## 2.10 Water sampling for trace element and isotopes (Per, Don, Johan, Fredrik)

### 2.10.1 60 L and 20 L Go-Flo sampling

60L Go-Flo. A 60L Go-Flo (*General Oceanics*<sup>®</sup> water sampler for trace metals) was used on the inner shelf to obtain waters from below the mixed layer as part of a low-metal blank system. This complemented the sampling of the surface mixed layer sampled using the flagpole (see below) and was used at 20 stations along the coast. A metal-free Go-Flo, with all internal surfaces Teflon-coated, was mounted on a Kevlar cable and lowered on the small A-frame on the port side of the boat deck (Fig.1). Depths were determined using a metering wheel, and the Go-Flo was closed using a Teflon messenger released from the surface. A 27 kg, epoxy-coated steel weight was covered in plastic and attached to the end of the cable, approximately 3m below the Go-Flo. The Go-Flo was emptied on deck into 25L acid-cleaned carboys, using a Si tube (except for samples for Si isotopes). Blanks had previously been run in Stockholm using MilliQ water. The Go-Flo was stored in clean plastic bags and within a case between stations.



Fig. 1. 60L Go-Flo on Kevlar line with Teflon messenger (Photo Jorien Vonk)

### 2.10.2 CTD rosette

On the outer shelves, samplers mounted on the CTD rosette were used to obtain deep waters from various depths (Fig. 2). A 20L Go-Flo, internally coated in Teflon, was used for mid-depths. Samples of surface waters and bottom waters were collected using 2-3 6L Niskin bottles. Samples were emptied into 25L acid-cleaned carboys using either Silicone or Tygon tubing. The CTD was not considered a low metal blank system, and waters were collected primarily for other trace elements and isotopes. Samples were collected from 17 stations using the CTD rosette.



Fig. 2. CTD with rosette 12 Niskin bottles and one 20 L Go-Flo mounted. All non-stainless steel parts of the system were covered in plastic (Photo Per Andersson).

### 2.10.3 Flagpole-extended pumping system

In order to collect surface waters from the mixed layer using low metal blank equipment, and to avoid contamination from the ship, a 14m glasfibre flagpole was extended from the bow of the ship approximately 7m (Fig 2). This system was mainly designed to obtain samples for Fe concentration and Fe isotope determination of particulate material. An acid-cleaned Teflon tubing was suspended from the end of the flagpole, and was lowered into the surface waters using a coated metal weight. Water was pumped directly into a lab container using a peristaltic pump and into clean carboys. Contamination from the ship was avoided by pumping when the tubing was up-current of the ship. The system was not used when the ship was anchored, since the anchor and chain extended to the area of sampling. A total of 21 samples were collected from the flagpole system.



Fig. 2. Flagpole system mounted in the bow of YS for trace metal clean sampling of surface seawater (Photo Jorien Vonk)

#### **2.10.4 Seawater intake**

A total of 6 samples were collected from the seawater intake during transit between some stations. The intake system is described elsewhere but is not considered to be trace metal clean and thus only to be used for isotopes not prone to contamination from the ship.

#### **2.10.5 He isotopes**

Samples for He isotopes were collected from stations expected to have high levels of methane. A 30cm length of 1/8" Cu tubing was connected to the valve of the Niskin or Go-Flo using Tygon tubing. Water was run through the tubing until there were no bubbles within the tubing, and then the Cu tubing was sealed using a crimping tool.

#### **2.10.6 TEI Sample Processing**

All waters were taken into the Hydrolab on boat deck, and filtered using 0.22 $\mu$ m nitrocellulose filters mounted in acid-cleaned polycarbonate filter holders and using a peristaltic pump. For Fe and Fe isotopes a 0.22 $\mu$ m polycarbonate filter were taken from each station. Filters for Fe isotopes and trace

metals were changed in a small clean hood in the Hydrolab. From 15 surface water station a sample was ultrafiltered using a 1kD Millipore Prep/Scale system.

Between 250ml and 500ml was filtered through a preweighted 0.22µm 47mm nitrocellulose filter to obtain a measurement of SPM, suspended particulate material.

All tubings, filter holders, and sample containers had been acid-cleaned prior to use. Samples were acidified to a pH of 2 (1ml HCl or HNO<sub>3</sub> per litre of sample) using ultrapure Seastar<sup>®</sup> HCl or laboratory distilled HNO<sub>3</sub> from ALS, Luleå. Different filter holders were used for particle-rich samples and outer shelf particle poor samples. For the samples of dissolved silicon isotopic composition, modified filter holders were used with a viton o-ring inside instead of the regular one that is made of silicon. Typically, the first filter was completely clogged. Thereafter, between 50-70% of the clogging volume was filtered through the upcoming filters to avoid the discrimination of colloids. Generally as much sample as possible was passed through each filter, and the filters were retained for analysis of the particles. A portion of each sample was first passed through the system as a rinse before sample was collected.

From the water sampled with the Go-Flo bottles, samples were taken for nutrient analysis. The samples were filtered and analysed for phosphate, nitrate and silicate according to the method given in Section 2.2.5.2.4.

## **2.11 Sediment sampling** (Jorien, Oleg)

### **2.11.1 Winches, A-frame, meterwheels, location on ship** (Jorien)

The A-frame used for sediment sampling was located on deck 4, at port side at the middle/back part of the ship. The A-frame was extended and the reeling was partly cut away to be able to lift the sediment grab and coring equipment onboard. The hydraulically driven winch was wired with a 6 mm stainless steel cable, to which a meter wheel (General Oceanics, inc. Miami, Florida, model 4048-P) was connected.

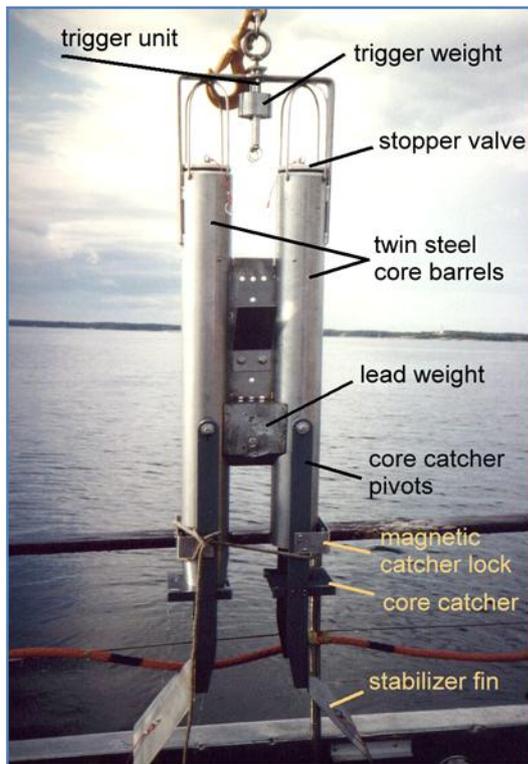
### **2.11.2 Grab sampling** (Oleg)

Sediments were obtained from: grab sampler Van Veen (surface sediments) and GEMINI corers (sediment columns). The samples were stored deep-frozen until freeze-drying in the POI laboratory.

### **2.11.3 Gemini core sampling** (Jorien)

Sediment core sampling was done with a dual gravity corer "GEMAX" (Oy Kart AB, Finland). The corer was modified by Anders Sundberg at the Geology workshop of Stockholm University. He adjusted the stainless steel cutting part of the core so that the tubing could be taken out after every cast without taking out the liners.

To maximize penetration into the sediments, 4 lead weights of 5 kg each were attached during all deployments. Two plexiglass core tubes (800 mm long, 90 mm ID) were inserted into the core barrels before every cast. After retrieving the GEMAX, the plexiglass core tubes filled with sediment and overlying water were sealed using a stopper of natural rubber and duct tape. The cores were labelled and stored in vertical position on deck. Samples of the overlying water for PM and POC analysis were retrieved by suctioning, both for clear top layer and turbid bottom layer (see section 2.12.3).



Within 12 to 48 hours after sampling, the cores were sliced into 1cm slices using an extruder (Oy Kart AB, Finland). A stainless steel spoon was used to transfer the 1cm slices into small containers (65 ml to 210 ml). The sediment containers were marked and frozen the same day at  $-18^{\circ}\text{C}$ . The cores were described during slicing. A PDF document with core lengths, descriptions, time between sampling and slicing, and planned analyses is available on request.



#### **2.11.4 methods for benthic meiofauna sorting (Vovva)**

A large set of very large mass of grab sediments were sorted for studies of benthic meiofauna.

### **2.12 Sedimentology** (Oleg, Örjan)

#### **2.12.1 Wetlab Turbidity sensor on CTD (Örjan, Göran)**

. After station 1, a Wetlabs turbidity sensor ECO NTU S/N NTURTD-126 was attached on the voltage channel of the SeaBird 911+ CTD. It is attached as a fluorescence Wetlab ECO-AFL/FL sensor in the sensor list available in the Seabird software. The scale factor is just 1 which gives an output signal between 0 and 5 Volts. Turbidity sensor data was thus collected at stations 2-131.

#### **2.12.2 PM+POC filtration program from Niskin (Oleg, Laura)**

At same stations that PM and POC was obtained from Gemini overlying water (see section below), we also obtained samples for PM and POC from bottom bottle of the Niskin cast, and in most cases also from surface water at same station.

### 2.12.3 PM+POC filtration from Gemini core overlying water (Oleg, Laura)

Also were filtered two types of nepheloid water (0.5-1.0 l volume) in plastic tube of GEMINI corers: (first type) near 10 sm under the sediments and (second type) — is 30-50 sm under the sediments. This was done in parallel for PM (POI) and POC (SU).

### 2.12.4 Sediment traps (Örjan)

A cylindrical sediment trap system commonly used for upper ocean and continental shelf studies was used. Detailed descriptions of the trap system is available, including testings in hydraulic flumes (Broman et al., 1990) and time-series field calibrations of collection efficiencies using  $^{234}\text{Th}$  (Gustafsson et al., 2004; Buesseler et al., 2007). The moorings employed during ISSS-08 was arranged as follows: traps Bottom-anchored with 40 kg railway tracks and galvanized chains, 3 mm thin line nylon strong (polystrong) tube holders that are of a hydrodynamically stable, self-suspended and buoyant design were positioned below the mixed surface layer and as far above bottom as possible. There was only one trap array per mooring with the array consisting of three PVC cylinders each holding a straight cylindrical glass tube (500 x 100 mm). The gimbaled construction is further equipped with turbulence generators and splitter planes to minimize vortex street formation. A small buoy was attached 3 m above array to lift mooring line. At surface a large spherical buoy was connected with a 10 m line to a flag buoy to minimize the effect of short period wave motion. Since most of the drag on a trap array is from the mooring line itself a 3 mm thin nylon line was used.

In order to minimize artifacts related to zooplankton herniation and solubilization of collected POC into DOC we avoided using brines and any poison. This approach minimizes zooplankton “swimmer” accumulation in the trap. However, some “swimmer picking” was still performed (see Results section).

The mooring was deployed using the starboard winch, while actual traps were hooked onto mooring line from the lower deck below the winch. There were ten sediment trap deployments during ISSS-08 at stations 4 (twice), 11, 12, 13, 14, 15, 23, 26, 30.

Recovered sediment trap glass tubes were allowed to settle for > 1h. The overlying water siphoned off, any visible swimmers were picked w long stainless steel forceps, and solution was quantitatively transferred to 1000 ml polycarbonate bottles and frozen.

The trap program was compromised by sub-optimal maneuvering of the ship. After deployment at station 30, the ship drifted over the mooring line, which got stuck under the aft ship (probably in the silent propeller). We managed to cut mooring and attach new buoys but all glass tubes were later found missing (see Results). Even larger problems with ship maneuvering were experienced during recovery. In seven out of eight recoveries (two trap moorings had be surrendered because of hard winds and time constraints), the ship drifted over the mooring line. This lead to difficult recoveries and many tubes were broken upon recovery (see Results for details).

### **3. RESULTS: GENERATED DATA AND COLLECTED SAMPLES**

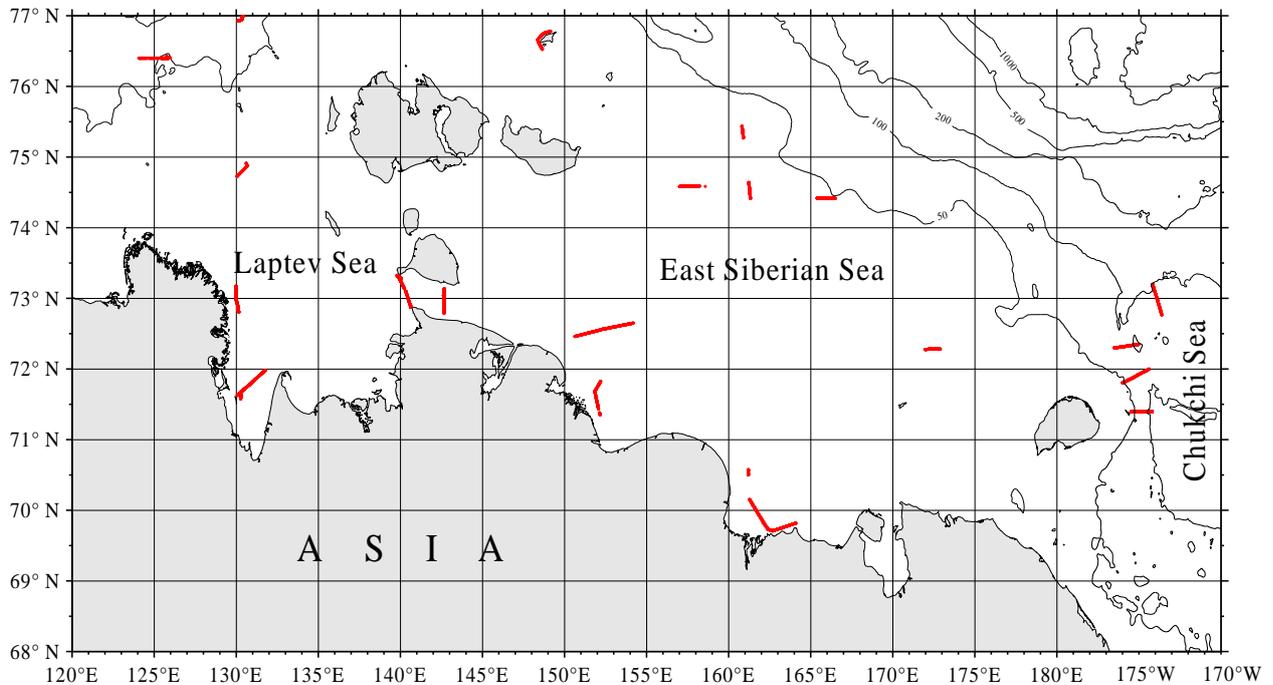
Each program to include information on spatial coverage and/or temporal frequency of sampling. Summary of data and initial data analysis if available (for at-sea generated data). Descriptive lists of samples collected for onshore analysis (state also analytical objectives)

Feel free to include any maps with sample locations, contour plots or any other figures/tables you think may be useful

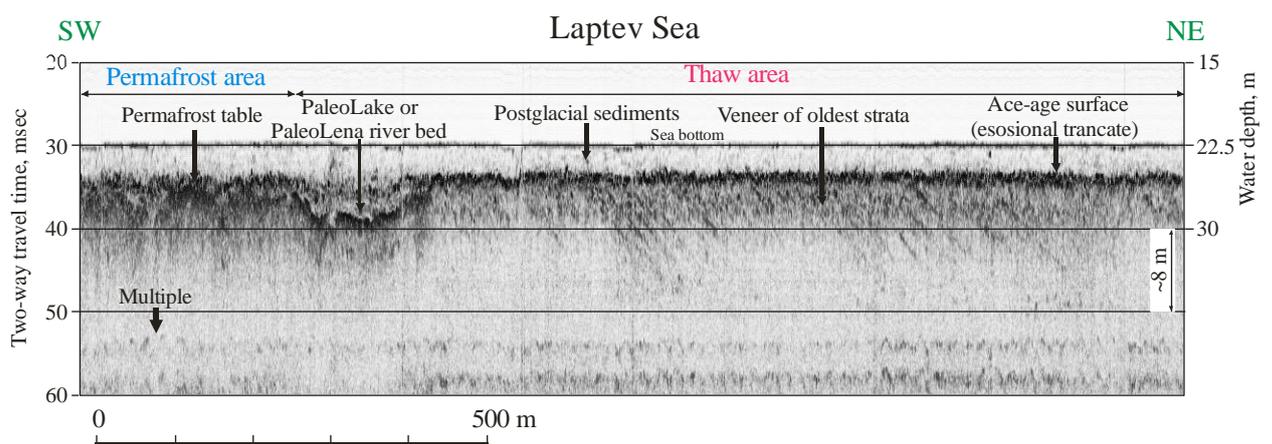
Any ship-generated data also must be provided to Igor. This is a requirement of our scientific permit that the onboard-observer (Igor) collates this information so that it is available to Russian governmental agencies if they ask for it (which Igor says is unlikely).

### 3.1 Geophysics/seismics (Viktor, Georgy, Sasha, Anatoly)

The investigation was carried out in the Laptev, East Siberian and Chukchi Seas. The length of the seismic lines is about 1100 km.



Location of the seismic tracks.



Fragment of the seismic profile in the southern part of the Laptev Sea showing the structures of ace-age surface, distribution of the postglacial sediments and veneer of the oldest strata sediments near Lena river delta. The depth of the Towfish is 3 m. Profiling with Swell Filter.

### **3.2 Methane program (Igor, Anatoly)**

To be written.

### **3.3 Physical Oceanography (Göran, Igor)**

#### **3.3.1 CTD data (Göran)**

##### **3.3.1.1 Collected CTD data.**

In total we collected CTD data from 131 stations of which no. 22 and 34 included 2 casts.

Table showing station number, date, time, position, water depth and maximum CTD pressure for all CTD stations during ISSS-08.

Station #	Cast#	Date	Time (UTC)	Latitude (deg)	Latitude (min)		Longitude (deg)	Longitude (min)		Water depth (m)	CTD pressure (dbar)
1	1	20080818	05.49	71	38.780	N	64	38.530	E	120	116
2	1	20080819	00.59	73	24.300	N	72	59.710	E	30	25
3	1	20080819	23.02	73	29.520	N	79	53.090	E	38	37
4	1	20080823	16.39	75	59.220	N	129	59.050	E	52	50
5	1	20080824	08.22	75	15.950	N	130	0.990	E	44	43
6	1	20080824	14.33	74	43.440	N	130	0.980	E	34	32
7	1	20080824	19.18	74	7.920	N	129	59.980	E	17	16
8	1	20080824	22.40	73	33.940	N	130	0.470	E	13	14
9	1	20080825	01.14	73	21.980	N	129	59.820	E	25	23
10	1	20080825	02.41	73	11.040	N	129	59.740	E	21	20
11	1	20080825	06.17	73	1.110	N	129	59.350	E	12	11
12	1	20080826	01.51	71	54.990	N	132	34.540	E	13	12
13	1	20080826	09.50	71	58.080	N	131	42.080	E	22	19
14	1	20080827	19.39	71	37.820	N	130	2.970	E	8	7
15	1	20080828	04.05	71	34.980	N	130	15.320	E	12	11
16	1	20080828	06.04	71	37.620	N	130	19.070	E	12	11
17	1	20080828	08.02	71	37.800	N	130	11.440	E	11	10

18	1	20080829	01.20	73	1.830	N	133	0.110	E	16	15
19	1	20080829	08.23	73	6.570	N	137	18.180	E	28	27
20	1	20080829	16.06	73	18.320	N	139	53.560	E	9	8
21	1	20080829	18.36	73	5.350	N	140	20.890	E	16	15
22	1	20080829	20.44	72	52.520	N	140	37.720	E	21	20
22	2	20080829	22.49	72	53.180	N	140	37.130	E	16	15
23	1	20080830	03.28	72	47.340	N	142	40.180	E	11	10
24	1	20080830	13.17	73	2.890	N	142	39.990	E	16	15
25	1	20080830	16.14	73	8.590	N	142	40.020	E	11	10
26	1	20080831	06.49	72	27.590	N	150	35.740	E	17	16
27	1	20080831	18.12	72	34.020	N	152	22.360	E	19	18
28	1	20080901	00.03	72	39.050	N	154	11.120	E	29	28
29	1	20080901	04.50	72	11.980	N	153	9.940	E	19	18
30	1	20080901	13.31	71	21.460	N	152	9.160	E	10	9
31	1	20080902	13.59	71	6.490	N	161	41.610	E	21	20
32	1	20080902	18.58	70	33.990	N	161	13.020	E	10	9
33	1	20080903	04.33	70	10.100	N	161	13.040	E	9	8
34	1	20080903	09.18	69	45.580	N	162	19.000	E	15	14
34	2	20080903	12.14	69	42.490	N	162	41.320	E	11	10
35	1	20080903	23.23	69	49.020	N	164	3.410	E	32	31
36	1	20080904	03.57	69	48.990	N	165	59.920	E	33	32
37	1	20080904	08.42	70	8.090	N	168	0.410	E	43	42
38	1	20080904	15.19	70	41.900	N	169	7.890	E	38	36
39	1	20080904	19.24	71	13.150	N	169	22.370	E	46	44
39	2	20080904	20.21	71	13.000	N	169	20.830	E	46	44
40	1	20080905	01.57	71	29.000	N	170	33.190	E	50	49
41	1	20080905	06.38	71	58.090	N	171	47.510	E	44	43
42	1	20080905	09.36	72	16.850	N	171	59.470	E	43	41
43	1	20080906	09.12	71	24.040	N	175	30.090	W	34	33

44	1	20080906	10.11	71	23.900	N	175	20.330	W	45	45
45	1	20080906	10.56	71	23.980	N	175	10.460	W	54	53
46	1	20080906	11.53	71	23.920	N	175	0.700	W	58	57
47	1	20080906	12.36	71	24.020	N	174	51.100	W	79	78
48	1	20080906	13.30	71	24.020	N	174	41.240	W	82	80
49	1	20080906	14.12	71	23.990	N	174	31.550	W	85	84
50	1	20080906	15.08	71	23.990	N	174	21.690	W	55	54
51	1	20080906	15.49	71	23.920	N	174	12.010	W	46	45
52	1	20080906	19.48	71	48.020	N	176	0.100	W	50	49
53	1	20080906	20.48	71	49.250	N	175	50.380	W	56	54
54	1	20080906	21.27	71	50.420	N	175	40.860	W	58	57
55	1	20080906	22.19	71	51.600	N	175	31.200	W	66	64
56	1	20080906	22.58	71	52.780	N	175	21.650	W	70	69
57	1	20080906	23.55	71	54.010	N	175	12.030	W	73	72
58	1	20080907	00.38	71	55.220	N	175	2.390	W	71	70
59	1	20080907	01.34	71	56.420	N	174	52.710	W	68	67
60	1	20080907	02.13	71	57.650	N	174	43.230	W	63	61
61	1	20080907	03.09	71	58.780	N	174	33.610	W	56	53
62	1	20080907	03.50	72	0.020	N	174	24.060	W	53	52
63	1	20080907	08.08	72	18.020	N	176	30.230	W	72	71
64	1	20080907	09.09	72	18.380	N	176	19.100	W	74	72
65	1	20080907	09.50	72	18.740	N	176	8.220	W	84	83
66	1	20080907	10.49	72	19.060	N	175	57.110	W	102	99
67	1	20080907	11.35	72	19.510	N	175	46.270	W	86	85
68	1	20080907	12.34	72	19.890	N	175	35.260	W	80	79
69	1	20080907	13.19	72	20.250	N	175	24.290	W	60	59
70	1	20080907	14.15	72	20.630	N	175	13.330	W	48	46
71	1	20080907	14.59	72	20.990	N	175	2.330	W	50	48
72	1	20080907	18.41	72	46.030	N	173	36.510	W	62	59

73	1	20080907	19.53	72	50.610	N	173	42.670	W	63	62
74	1	20080907	20.43	72	54.720	N	173	48.180	W	65	64
75	1	20080907	21.44	72	59.130	N	173	53.600	W	74	71
76	1	20080907	22.33	73	3.360	N	173	59.090	W	93	92
77	1	20080907	23.37	73	7.670	N	174	4.800	W	111	109
78	1	20080908	00.33	73	11.990	N	174	10.210	W	124	123
79	1	20080908	03.51	73	42.240	N	174	19.780	W	181	178
80	1	20080908	07.07	73	59.300	N	174	31.280	W	202	199
81	1	20080908	22.17	75	47.970	N	179	54.350	E	1115	1112
82	1	20080909	01.25	75	42.120	N	178	47.760	E	892	891
83	1	20080909	04.08	75	36.000	N	177	42.080	E	541	540
84	1	20080909	06.38	75	30.040	N	176	36.060	E	334	332
85	1	20080909	08.53	75	24.070	N	175	30.310	E	238	236
86	1	20080909	11.05	75	18.080	N	174	23.740	E	201	200
87	1	20080909	14.12	75	12.060	N	173	17.950	E	179	177
88	1	20080909	16.29	75	5.960	N	172	11.220	E	143	142
89	1	20080909	19.34	75	0.060	N	171	5.500	E	77	76
90	1	20080910	00.40	74	40.090	N	172	23.290	E	64	63
91	1	20080910	09.51	74	26.020	N	170	51.280	E	57	56
92	1	20080910	14.22	74	25.000	N	168	29.930	E	52	50
93	1	20080910	19.13	74	25.110	N	165	59.940	E	52	51
94	1	20080911	00.32	74	25.080	N	163	39.880	E	50	49
95	1	20080911	04.29	74	25.000	N	161	20.120	E	44	45
96	1	20080911	09.18	74	59.050	N	161	2.590	E	45	44
97	1	20080911	11.25	75	16.240	N	160	53.410	E	50	49
98	1	20080911	14.26	75	33.060	N	160	45.070	E	49	48
99	1	20080911	19.33	75	10.260	N	163	35.170	E	51	50
100	1	20080911	23.03	75	42.940	N	164	4.760	E	60	58
101	1	20080912	04.53	76	7.020	N	160	27.430	E	56	55

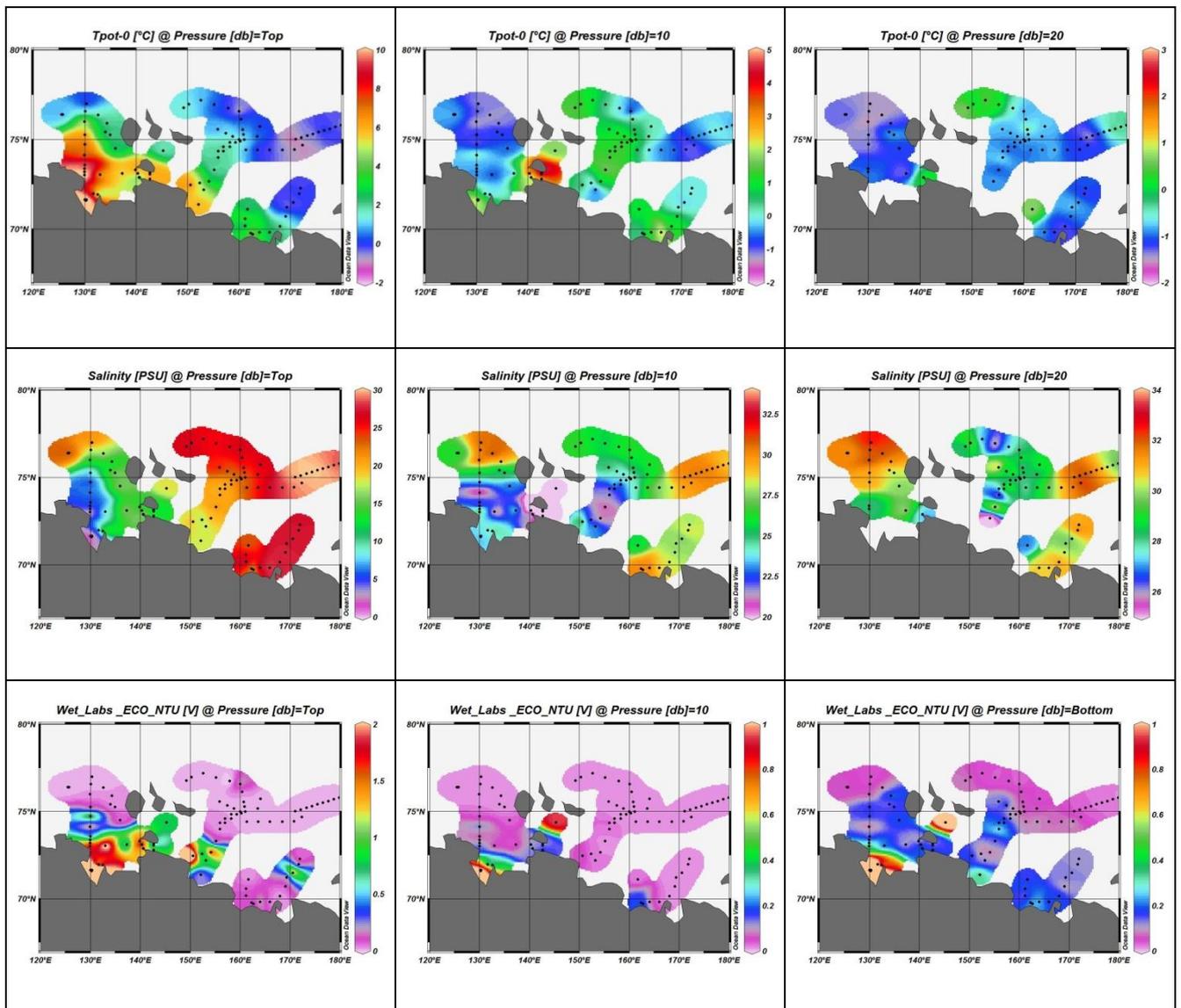
102	1	20080912	08.05	76	33.550	N	160	4.350	E	70	69
103	1	20080912	12.50	76	44.050	N	157	53.850	E	67	66
104	1	20080912	16.31	76	56.030	N	155	10.160	E	58	57
105	1	20080912	20.32	77	10.730	N	152	37.290	E	53	52
106	1	20080913	00.07	76	58.110	N	150	17.470	E	44	43
107	1	20080913	03.05	76	46.290	N	149	14.030	E	39	37
108	1	20080913	20.06	75	33.660	N	155	52.960	E	40	38
109	1	20080913	23.11	75	21.060	N	157	27.530	E	40	39
110	1	20080914	01.47	75	9.830	N	158	48.960	E	42	41
111	1	20080914	04.03	74	59.840	N	160	0.600	E	47	46
112	1	20080914	05.54	74	49.960	N	159	19.810	E	44	42
113	1	20080914	08.12	74	53.730	N	160	18.370	E	44	42
114	1	20080914	11.23	74	50.110	N	158	15.290	E	45	44
115	1	20080914	13.24	74	35.010	N	158	14.790	E	33	30
116	1	20080914	18.28	74	34.970	N	157	0.180	E	38	36
117	1	20080914	20.38	74	20.130	N	157	0.110	E	34	32
118	1	20080914	22.37	74	20.050	N	156	0.460	E	32	28
119	1	20080915	00.56	73	59.990	N	155	59.980	E	36	34
120	1	20080915	05.25	73	17.510	N	155	10.050	E	35	33
121	1	20080916	00.09	74	22.310	N	145	16.850	E	18	17
122	1	20080916	15.14	74	30.190	N	136	0.580	E	28	26
123	1	20080916	19.44	75	15.110	N	134	59.470	E	42	40
124	1	20080916	22.04	75	24.990	N	134	0.590	E	31	29
125	1	20080917	01.08	75	54.060	N	134	19.130	E	47	45
126	1	20080917	04.49	76	21.940	N	132	37.080	E	52	50
127	1	20080917	08.23	76	33.360	N	130	8.930	E	59	58
128	1	20080917	11.14	76	59.220	N	130	21.340	E	60	58
129	1	20080918	06.49	76	23.910	N	125	46.610	E	50	48
130	1	20080918	07.33	76	23.640	N	125	46.110	E	50	48

131	1	20080918	08.57	76	23.890	N	125	28.370	E	51	50
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### 3.3.1.2 Initial observations

The CTD data from Laptev Sea and East Siberian Sea show clearly the warm and low salinity the river water plumes from the Lena and Indigirka rives while higher salinities dominates in the eastern part as influenced by Pacific water. The Lena water shows very high turbidity. Note also that the bottom turbidity is generally enhanced relative to mid column at 10 dbars.

Figure showing potential temperature (deg C), salinity and relative turbidity (Volts) from the Laptev Sea and East Siberian Sea during ISSS-08. Note that the rightmost panel of turbidity is from the bottom layer at each station.



### 3.3.2 ADCP (Igor, Sasha)

To be written.

### **3.4 Marine Chemistry**

#### **3.4.1 Niskin-based program (Sara, Sofia, Irene, Anders)**

Nutrients, oxygen, pH and total alkalinity were determined onboard for 96 stations, DIC on 95 stations and CFCs for 50 stations. Samples were also collected for the determination of ammonium, which will be made by the group at University of Gothenburg after the cruise and additional alkalinity samples were taken for post-cruise analysis at POI. Request and inquiries for any of this data should be directed to Leif Anderson.

Samples were also collected for the determination of  $\delta^{11}\text{B}$ . The isotopic boron composition is planned to be used to reconstruct the boron isotopes in marine carbonates and to reconstruct paleo pH. The analysis will be performed by MC-ICP-MS and this is an external project by Eric Douville, LSCE/IPSL, France.

#### **3.4.2 SWI-based program (Irina)**

To be written.

#### **3.4.3 Intercomparison of two carbonate system techniques (Sara, Sofia, Irene, Anders)**

The main purpose of the collection of alkalinity samples for post-cruise analysis was to make a thorough intercomparison of the onboard GU method and the post-cruise POI method.

#### **3.4.4 Initial observations and plans (Sara, Sofia, Irene, Anders)**

One main issue of this programme was the export from the shelves into the deeper basins. Due to the unfavourable ice conditions it is uncertain if this can be fulfilled at all. The remaining part is the transport through the Herald Canyon. Since the large majority of the stations were located on the shallow shelf the studies will be more focused to this region than originally planned.

### **3.5 Biogeochemistry**

#### **3.5.1 Biogeochemistry core (Laura, Vanja, Sveta)**

##### **3.5.1.1 Particulate and Dissolved Organic Carbon (POC and DOC)**

Nr. of samples collected and analyzed: 106 (see Fig. 2)

SWI: n=49 ; Samples SWI-41, 43 and 44 in triplicates, to track reproducibility of the results

YS: n=57 (YS 1-2, 4-17, 19-39, 41-42, 49, 58, 67, 74, 88, 90, 91, 93, 95, 96, 98, 100, 102, 104, 106, 112, 116 and 120).

Approximately 4 depths (sometimes only 3) have been collected until sample YS-74 (middle mixing layer, pycnocline, middle bottom layer and bottom), then the collection was reduced to only 2 depths (surface and bottom)

Both TOC and DOC samples were analyzed on board, but no definitive results are available yet, since some calibration checking is still needed, with respect to the standards used. The dry POC filters are frozen and ready to analyze (EA Carlo Erba) upon return to Stockholm.

The TOC results derived from the important SWI vs. CTD comparison (SWI-7 vs. YS-1) at 4m depth differed only within the standard deviation of the TOC analyzer. This is encouraging and suggests that the SWI sampling could be considered free from resolvable carbon contamination.

#### **TOC/DOC**

Approximately 600 samples have been analysed for TOC/DOC onboard the ship. The samples are taken from the SWI, all stations, and from the same CTD stations as the POC sampling. The Shimadzu analyser has been carefully monitored and samples has only been run when standards and reference materials have given stable and expected results. However, it is sensitive analyses, and the conditions onboard have been less stable than usual on lab (rolling, vibrations, cold temperature etc), which have requested more calibrations, and more controls than usual and may cause the standard deviation to be slightly higher than usual. Quality insurance of the results is therefore necessary before results can be available, where all the results from samples, calibrations and reference material are going to be looked through and eventually recalculated.

##### **3.5.1.2 Optical parameters**

Nr. of samples collected and analyzed: 218 (see Fig. 2)

SWI: n=49

YS: n=169 (45 sampling sites: YS 1-2, 4-39, 41-42, 49, 58, 67, 74 and 98), by different depths.

Most sites have been sampled at 4 depths (middle mixing layer, pycnocline, middle bottom layer and bottom), except for some stations where only 2 or 3 depths were available

Two samples (YS-29 and YS-39) were analyzed under the 3 optical techniques both on the bulk water samples (as usual) and on the filtrate from the POC (i.e. DOC sample) (Table 1).

Table 1: Comparison of optical measurements in the bulk and DOC water samples of stations Y-29 and Y-39 (the highest ratios are highlighted in bold)

Station	Depth	$A_{280}$ -bulk/ $A_{280}$ -DOC	HS-bulk/HS-DOC	CDOM-bulk/CDOM-DOC
YS-29	2 m	91.0%	99.6%	94.97%
	4 m	102.1%	99.1%	102.53%
	mbl	<b>125.0%</b>	95.7%	89.66%
	bottom	<b>131.7%</b>	80.0%	74.73%
YS-39	4 m	109.5%	100.4%	<b>191.3%</b>
	10 m	<b>116.7%</b>	95.2%	97.0%
	mbl	<b>163.2%</b>	96.7%	109.7%
	bottom	<b>285.0%</b>	102.6%	<b>117.5%</b>

According to the comparison ratios showed in Table 1, there is no big difference in HS between the bulk/unfiltered or in the DOC/filtered water sample. Overall, something similar can be established for the CDOM fraction, except for a couple of depths (YS-39 4m and bottom). However, the difference of measure  $A_{280}$  in the bulk or DOC samples are larger, which is consistent with this technique just measuring absorbance that could be directly affected by particles in solution. The differences resulted from the SWI-CTD comparison accomplished at SWI-7 and YS-1 suggest a good comparability of both sampling systems in terms of  $A_{280}$  and HS, giving SWI/CTD ratios of 94% in both cases. However, larger differences are obtained for CDOM (251%), which shows more than two times concentration in the SWI samples.

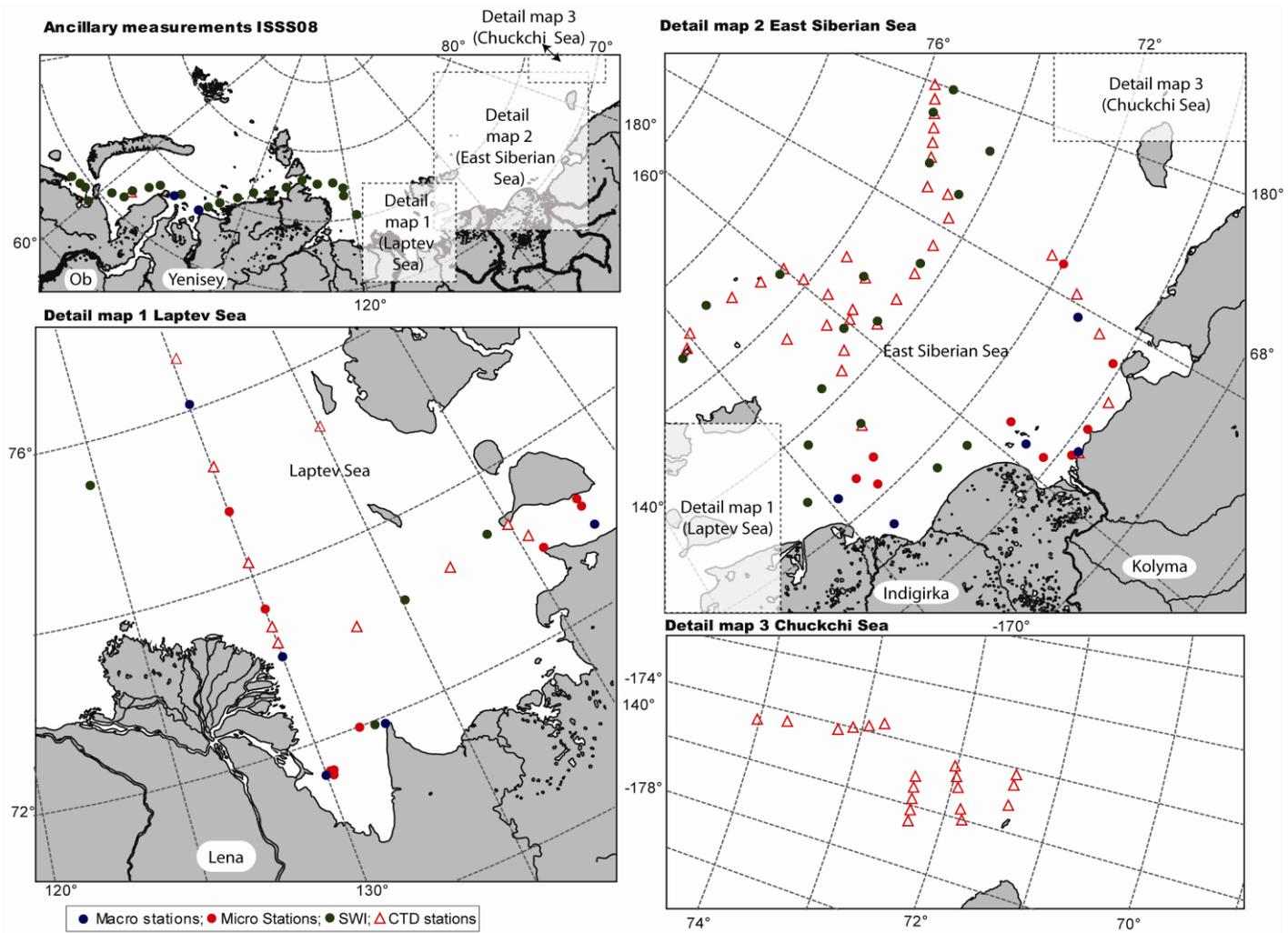


Fig.2: Map showing the location of the sites where water samples were collected for the biogeochemical core analysis. The symbols from the legend refer to SWI samples and YS-stations, including macro-, micro- and only CTD-stations.

## Molar absorptivity

The absorbance at 280nm of all samples (SWI+YS) was measured on board. However, since no TOC values are available yet, the molar absorptivity ( $\epsilon_{280}$ ) can not yet be reported (equation 1). Instead,

### A-280

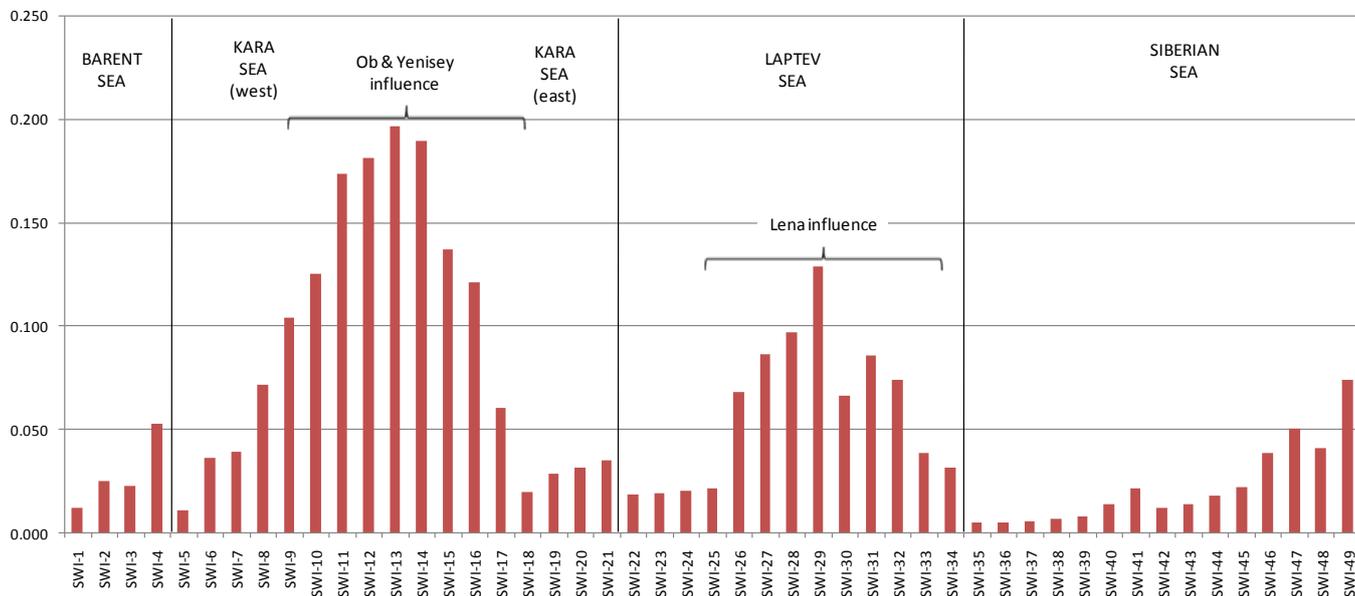


Fig. 3: Plot of the absorbance at 280 nm for the 49 SWI samples.

$A_{280}$  results are complete and are presented here in form of main statistics (Table 2). A summary of the spatial distribution of  $A_{280}$  is plotted in Fig.3 for SWI samples and in Fig.3 for the YS-stations samples, according to the different regimes sampled (rivers, erosion and off shore sites)

Table 2: Main statistics of the Absorbance at 280nm in all the sea water samples. Results are adimensional

Sample type	minimum	maximum	average	Std. deviation
SWI (n=49)	0.005	0.197	0.055	0.066
YS (n=169) <sup>1</sup>	0.003	0.479	0.081	0.093

n=169 comes from 45 samples, by 2-3-4 depths.

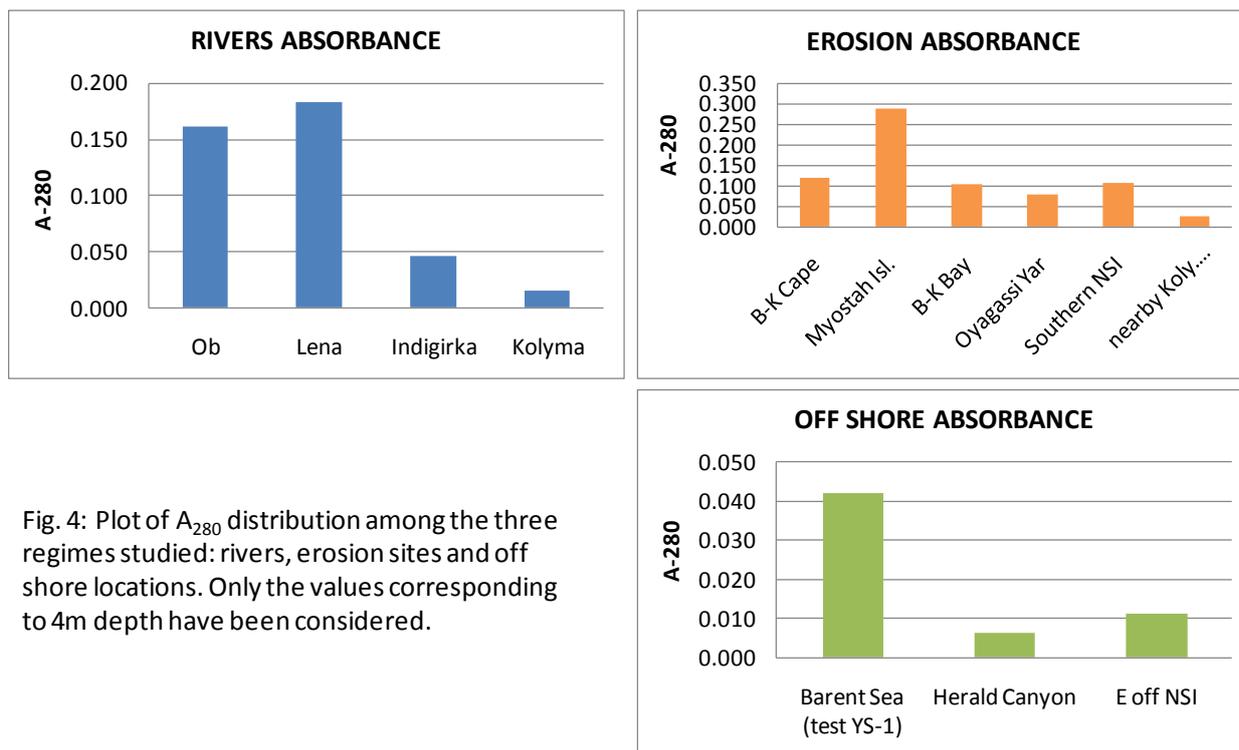


Fig. 4: Plot of  $A_{280}$  distribution among the three regimes studied: rivers, erosion sites and off shore locations. Only the values corresponding to 4m depth have been considered.

According to the spatial distribution plots (Fig.3 and 4), the sites with highest  $A_{280}$  are Lena river (regime rivers), Myostah Island (regime erosion) and Barent Sea test-station (off shore regime)

### Humic Substances (HS)

The results obtained for the HS fraction is summarized as basic statistics in Table 3, for both SWI and YS samples. The spatial distribution sorted by different regimes is plotted in Fig. 5.

Table 3: Main statistics of the HS content of the sea water samples. Results are expressed as QS-equivalent units ( $\mu\text{g/l}$ )

Sample type	minimum	maximum	average	Std. deviation
SWI (n=49)	150.55	15999.52	3197.18	3691.152
YS (n=169) <sup>1</sup>	213.06	15644.68	3564.15	3413.82

n=169 comes from 45 samples, by 2-3-4 depths.

The spatial HS distribution differs from  $A_{280}$  in the river regime, being Ob the richest site in terms of HS. However, one must be cautious when interpreting these results, since results from both Lena, Indigirka and Kolyma have been estimated as an average of several stations composing their transects, and thus the values of the outermost stations may “smooth” the higher levels of the innermost. Ob however represents only one sampling site close to land. On the other hand, both erosion and off shore regimes show the same HS richest sites as  $A_{280}$ : Myostah Island and Barent Sea test-station, respectively.

### Colored Dissolved Organic Matter (CDOM)

The results obtained for CDOM are summarized in Table 4, for both SWI and YS samples.

Table 4: Main statistics of the CDOM content of the sea water samples. Results are expressed as Normalized Fluorescence Units (N.F.I.U.)

Sample type	minimum	maximum	average	Std. deviation
SWI (n=49)	0.36	49.28	18.57	13.36

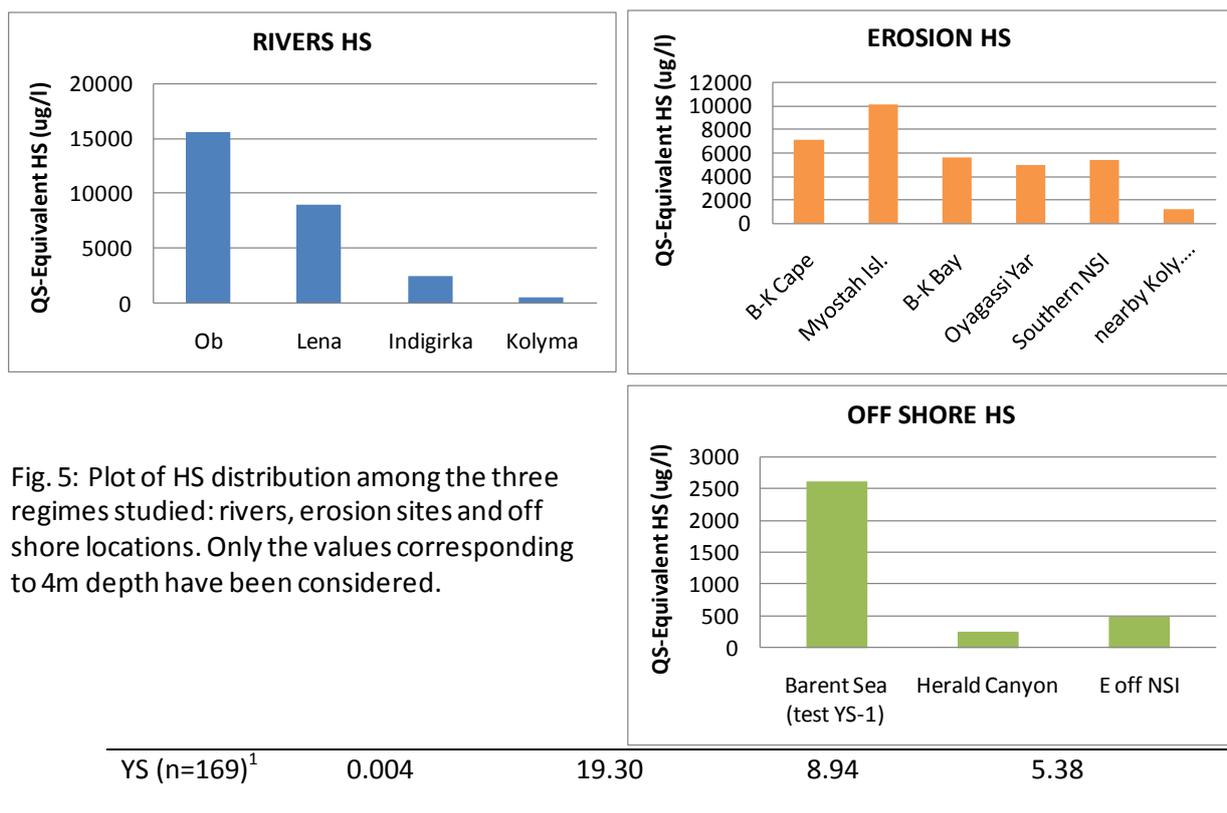


Fig. 5: Plot of HS distribution among the three regimes studied: rivers, erosion sites and off shore locations. Only the values corresponding to 4m depth have been considered.

n=169 comes from 45 samples, by 2-3-4 depths.

Agreeing with HS, the richest CDOM contents are observed in Ob, Myostah Island and Barent Sea test-station, respectively in the river, erosion and offshore regimes (Fig. 6). Considering this similarity, one could wonder about the HS-CDOM correlation in terms of the whole set of samples. Thus, in Fig. 7 HS is plotted against CDOM, for both the SWI and the YS samples and apparently good positive correlation exists between both parameters. Although quite good linear correlations were found in both cases (SWI:  $r^2=0.87$  and YS:  $r^2=0.84$ ), a logarithmic regression seemed to explain even better the correlation between HS and CDOM (SWI:  $r^2=0.90$  and YS:  $r^2=0.87$ ).

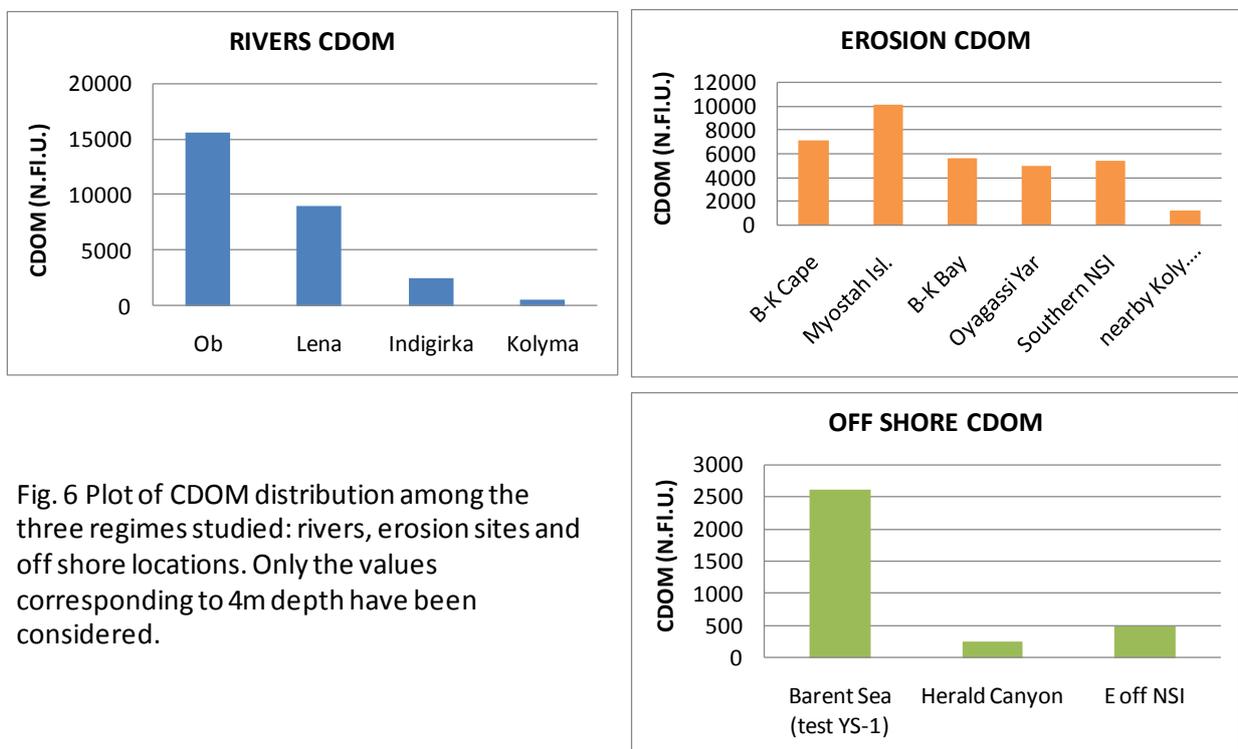


Fig. 6 Plot of CDOM distribution among the three regimes studied: rivers, erosion sites and off shore locations. Only the values corresponding to 4m depth have been considered.

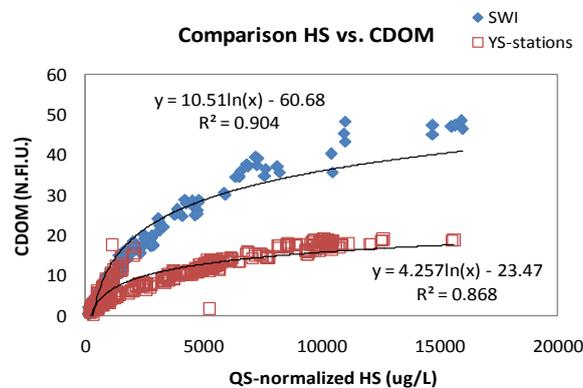


Fig. 7: Relationship between HS and CDOM for both SWI and YS-station samples. All depths and stations have been considered in this plot (SWI: n=49, YS: n=169).

### 3.5.1.3 Pigments

Nr. of samples collected and analyzed: 164 (see Fig. 2)

SWI: n=49

YS: n=115 (53 sampling sites: YS 1-2, 4-17, 19-39, 41, 45, 47, 49, 51, 52, 54, 58, 60, 62, 63, 65, 67, 69, 71, 72, 74, 76, 78, 79, 80-86, 91-96, 98-108, 110, 113-115, 117, 120, 123 and 127), measured at different depths:

For YS-1 and YS-2 two and three depths were taken respectively.

From YS-4 to YS-31 only one depth was sampled (2m).

In both YS-32 and YS-34 four depths were collected (middle mixing layer, pycnocline, middle bottom layer and bottom)

In YS-39 water sample from eleven depths (2, 4, 8, 12, 16, 20, 24, 28, 32, 36 and 44m), in parallel with the hydrozone, in order to analyze the pigment distribution along the whole profile, and compare results obtained from both techniques (UV-VIS and hydrozone).

From YS-41 to YS-76 only one depth was sampled (4m)

YS-78, 79, 81, 98 and 99 were sampled at 2, 3, 2, 2 and 2 depths respectively.

The rest of samples were collected only from 4m depth.

The results of the pigments analyzed (phaeo-corrected chlo-a, chlo-b, chlo-c and phaeo-a) together with some useful ratios (chlo-a/chlo-c: informs about diatoms content; chlo-a/phaeo-a: informs about zooplankton distribution) are summarized in Table 5, for both the SWI and YS samples.

*Table 5:* ain statistics of pigments of the sea water samples. Results are expressed as concentration of pigments in the whole sample ( $\mu\text{g/L}$ )

Sample type	Pigment	minimum	maximum	average	Std. deviation
SWI (n=49)	Chlo-a	0.0000	4.5114	0.7150	0.0010
	Chlo-b	-0.0403	0.4527	0.0787	0.0001
	Chlo-c ( $c_1+c_2$ )	-0.0228	1.2550	0.1342	0.0003
	Phaeo-a	-0.4070	1.2834	0.1194	0.0003
	Chlo-a/chlo-c	-0.16	0.91	0.18	0.20
	Chlo-a/phaeo-a	-50.00	20.00	-0.64	12.35

YS-Stations	Chlo-a	0.0000	6.1125	0.8173	0.0011
(n=115) <sup>1</sup>	Chlo-b	-0.3479	0.5919	0.0644	0.0001
	Chlo-c (c <sub>1</sub> +c <sub>2</sub> )	-0.0820	1.9200	0.1663	0.0003
	Phaeo-a	-0.5197	3.0879	0.2747	0.0005
	Chlo-a/chlo-c	-0.06	17.97	0.44	1.68
	Chlo-a/phaeo-a	-50.00	90.00	1.95	17.42

n=115 comes from 53 sampling sites, by different numbers of depths.

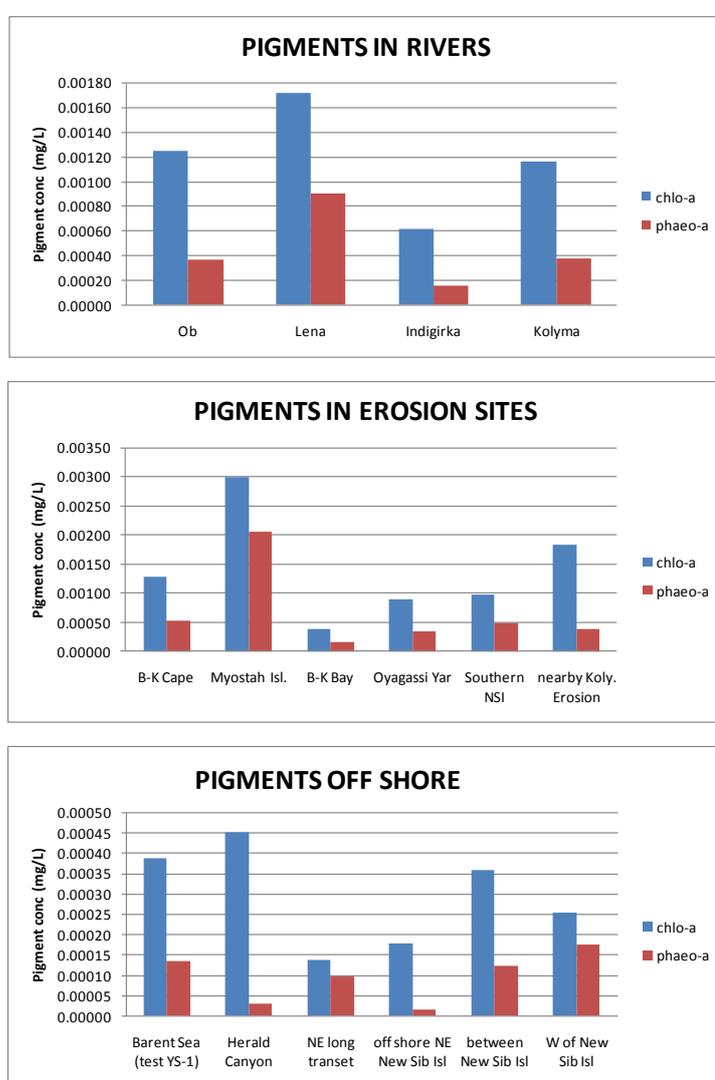


Fig. 8: Plot of pigments (chlorophyll a and phaeophytin a) distribution among the three regimes studied: rivers, erosion sites and off shore locations. In rivers and erosion sites values corresponding to 2m depth have been considered, whereas in off shore sites 4m depth are represented

In Fig. 8 the two most abundant pigments (chlo-a and phaeo-a) are plotted for the three established regimes. Overall, chlo-a represents from 2 to 3 times the concentration of phaeo-a, and comparing regimes, the rivers present the highest contents of pigments, being followed by the off shore sites. Both chlo-a and phaeo-a are more abundant in Myostah Island within the erosion regime, according to the optical parameters. The richest river in terms of pigments is Lena, whereas Herald Canyon contains the highest concentrations of chlo-a.

The data resulted of compare the pigment content in the SWI and CTD systems (SWI-7 vs. YS-1) indicate differences depending on the pigment. While phaeo-corrected chlo-a and chlo-c show relatively good comparability (SWI/CTD ratio=84 and 90%, respectively), both chlo-b and phaeo-a produced larger differences (SWI/CTD ratio=130 and 34%, respectively).

#### 3.5.1.4 Comparison barrel-CDOM sensor and spectrofluorometer-CDOM and DOC (Sveta)

#### 3.5.1.5 biogenic silica, $\delta^{13}\text{C}$ -DIC and photolysis samples (Vanja)

Samples for analysis and lab experiments (photodegradation) for these three parameters were taken at stations according to table 3.5.1.4 with main focus on the Lena and Kolyma estuaries.

StaNo	BSi	Photodegradation	$\delta^{13}\text{C}$ -DIC (from CTD, same depths as TOC)
YS-2	x	x	
YS-3	x		
YS-4	x	x	x
YS-5	x		x
YS-6	x	x	x
YS-7			x
YS-8		x	x
YS-9			x
YS-10	x		x
YS-11	x	x	x
YS-12	x	x	x

YS-13			x
YS-14	x	x	x
YS-15			x
YS-16			x
YS-17	x		x
YS-18			x
YS-19			x
YS-20			x
YS-21			x
YS-22			x
YS-23	x		x
YS-24			x
YS-25			x
YS-26			x
YS-27			x
YS-28			x
YS-29			x
YS-30		x	x
YS-31			x
YS-32			x
YS-33			x
YS-34	x	x	x
YS-35			x
YS-36	x		x
YS-37	x	x	x
YS-38			x
YS-39		x	x

### **3.5.1.6 pigments and plankton ecology; Hydrosonde profiles, pigment-spectrometric data, and plankton net-tow samples for speciation (Genna)**

### **3.5.1.7 Synthesis and outlook**

## **3.5.2 Molecular-isotope biogeochemistry - water column (Bart, Vanja)**

### **3.5.2.1 High-volume GFF filters for molecular and compound-specific <sup>14</sup>C analysis (Bart, Martin)**

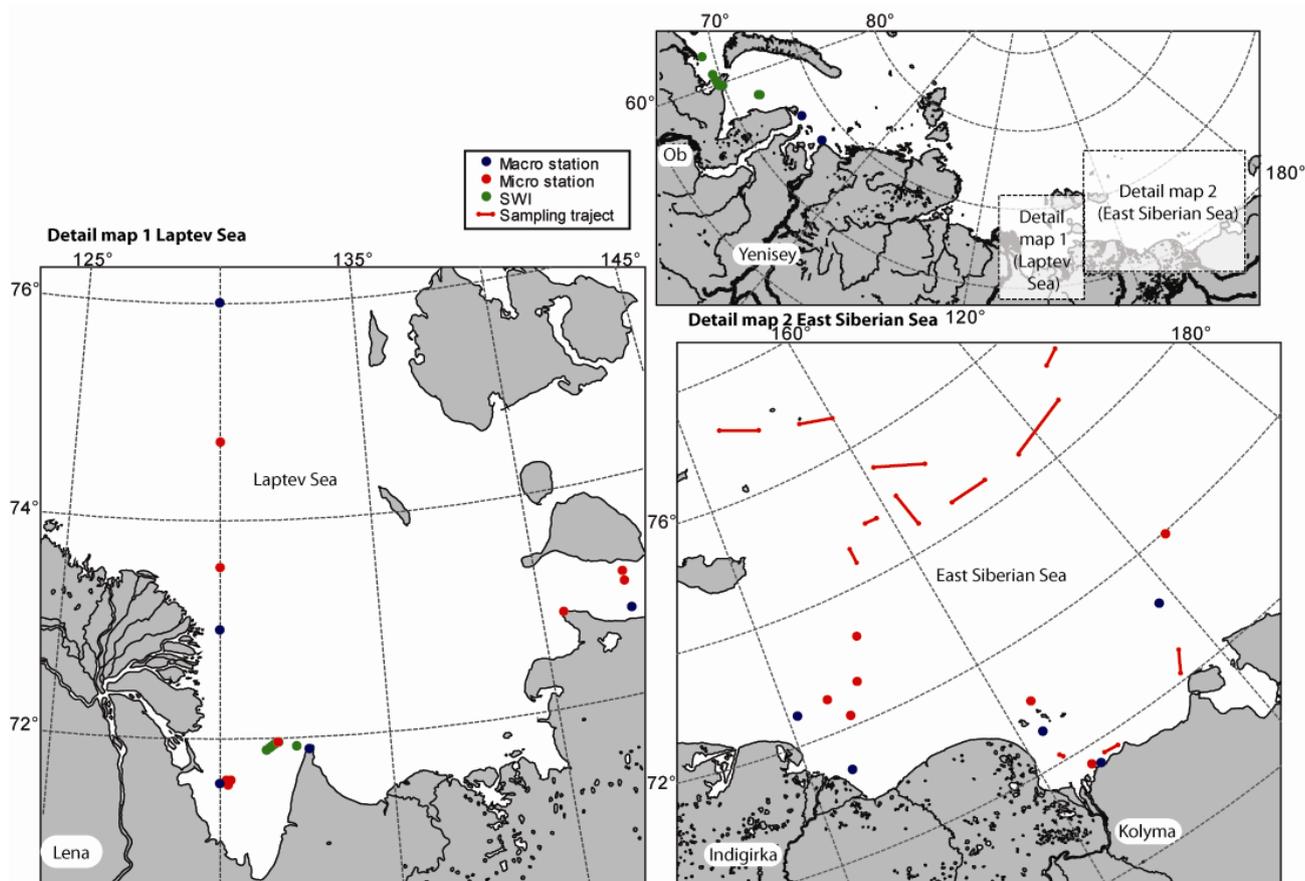
During ISSS08 in total 67607L of Sea water was filtered, divided over 455 GFF filters. Besides GFFs for molecular analysis and harvesting for compound specific radiocarbon analyses (CSRA) this also includes GFFs collected from the SWI for the analyses of hydrophobic organic chemicals (see paragraph 3.5.2.2) and a number of blanks. The exact location of all GFF samples used for molecular analysis and harvesting for CSRA can be found in figure 3.5.2.1.1. A summary of the details of all sampling can be obtained upon request.

The samples collected for molecular analysis and harvesting for CSRA can be divided in sets for different regimes; GRAR estuary samples, GRAR outflow transects and coastal erosion samples/transects.

Estuary GFF samples were collected for all major GRARs (OB, Yenisey, Lena, Indigirka and Kolyma) and GRAR outflow transects of:

- the Laptev Sea transect of the Lena River consisting of stations YS\_4 to YS\_8 although YS\_14 (macro station near Muostoh) could be included in this transect since the salinity at this site was extremely low.
- the Kolyma River transect consisting of stations YS\_34A to YS\_41.
- the Indigirka River transect consisting of stations YS\_28 to YS\_30 and YS\_120

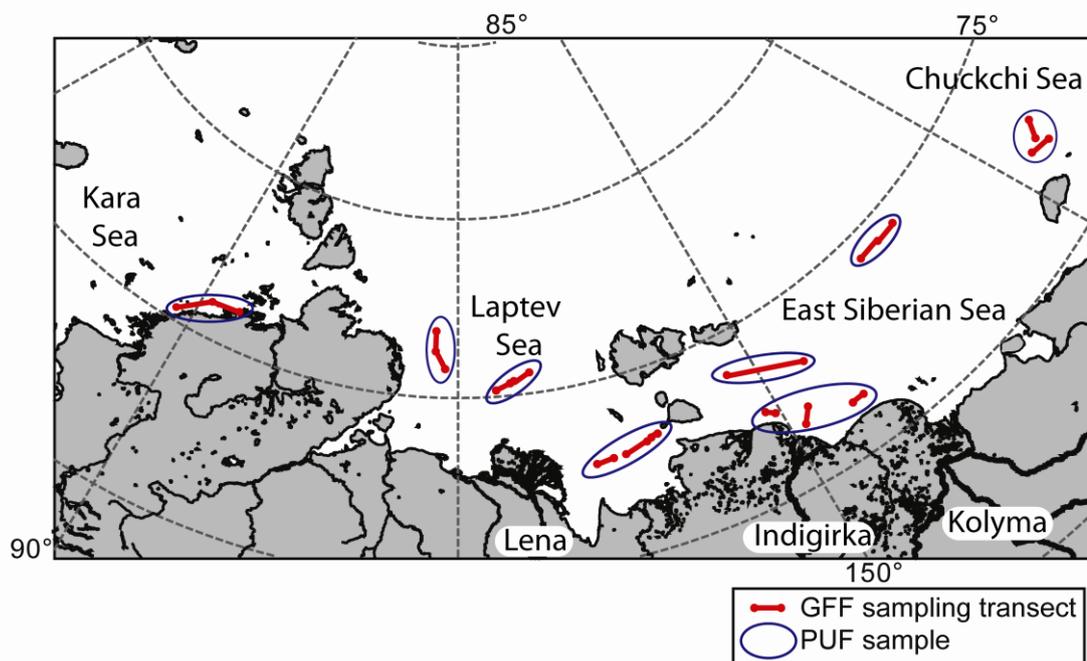
In addition, GFF samples of coastal erosion transects were collected: off Bhuorkhaya-cape and Muostoh Island in the Laptev Sea, in the Dmitri Laptev Strait between the Laptev Sea and the East Siberian Sea and off Oyagosski Yar and 161E in the East Siberian Sea.



**Figure 3.5.2.1.1.** Maps of the GFF sampling locations for molecular analysis and harvesting for compound specific radiocarbon analysis during ISSS08.

### 3.5.2.2 High-volume GFF + PUF samples for hydrophobic organic chemicals (Martin, Bart)

During ISSS08 7551L of Sea water was filtered, divided over 22 GFF filters and 8 PUF samples, for the analyses of hydrophobic organic chemicals. In addition, a number of blank PUFs and GFF filters were collected. A summary of the details of all sampling stations can be obtained upon request. The PUF samples were geographically divided over the Kara Sea (1 sample), Laptev Sea (3 samples), East Siberian Sea (3 samples) and Chuckchi Sea (1 sample). The exact location of all GFF transects and PUF samples used for the analyses of hydrophobic organic chemicals can be found in figure 3.5.2.2.1.



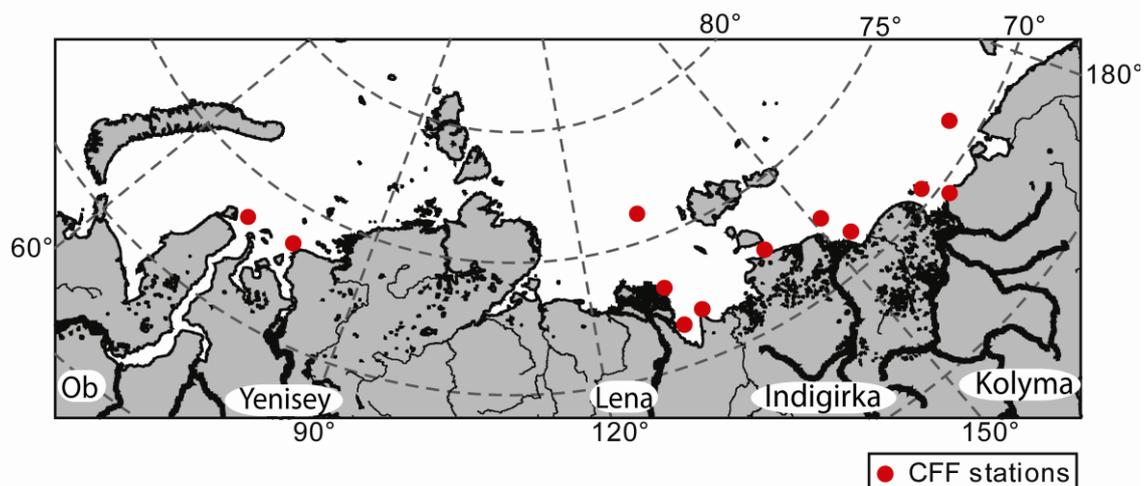
**Figure 3.5.2.2.1** Map of the PUF and GFF sampling locations for the analyses of hydrophobic organic chemicals during ISSS08.

### 3.5.2.3 Cross-flow ultrafiltration (CFF) samples for molecular-<sup>14</sup>C analysis (Bart)

During ISSS08 GFF permeate water from 12 macro stations was collected and concentrated using ultrafiltration. Generally 73 to 109 L was concentrated and between 0.9 and 1.1 L retentate was collected with a cross flow ratio between 23 and 41. These retentates will be used for molecular as well as <sup>14</sup>C analysis. During every filtration, after about 50L, one litre of permeate was collected for <sup>14</sup>C analysis of the permeate. In addition, 3 samples of the permeate (after about 25, 50 and 75L of filtration) and a subsample of the final retentate were taken for TOC analyses. A summary of the details of all sampling stations can be obtained upon request. The exact location of all CFF samples used for molecular analysis and harvesting for CSRA can be found in figure 3.5.2.3.1.

The CFF samples collected for molecular <sup>14</sup>C analysis can be divided in sets for different regimes; GRAR estuary samples, GRAR outflow transects and coastal erosion samples.

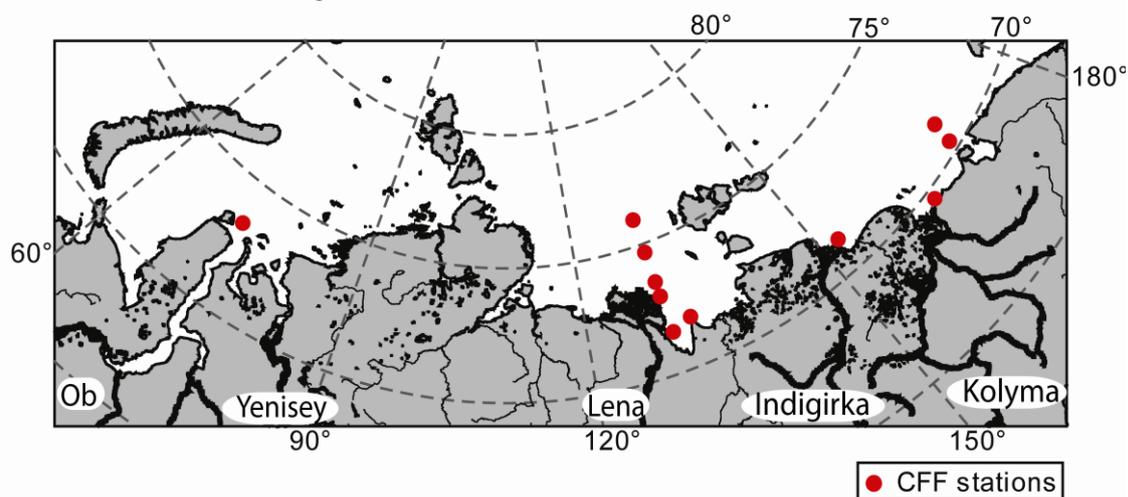
Estuary CFF samples were collected for all major GRARs (OB, Yenisey, Lena, Indigirka and Kolyma). In addition twice, in the case of the Lena (Laptev Sea transect) and Kolyma rivers, an additional sample was taken further off the river to establish a GRAR outflow transects. In case of the Lena river outflow YS\_14 (the macro station near Muostoh Island) could be included in this transect since the salinity at this site was extremely low. In addition a number CFF samples of coastal erosion transects were collected: off Bhuorkhaya-cape and Muostoh Island in the Laptev Sea, in the Dmitri Laptev Strait between the Laptev Sea and the East Siberian Sea and off Oyagosski Yar and 161E in the East



**Figure 3.5.2.3.1** Map of the CFF sampling locations for molecular-<sup>14</sup>C analysis during ISSS08.

### 3.5.2.4 CFF samples for stable C and S isotopes (Vanja)

CFF samples processed in Vanjas CFF system were taken according to the map in fig. 3.5.2.4 with focus on the Lena and Kolyma estuaries.



**Fig. 3.5.2.4** CFF samples taken by Vanja

### 3.5.2.5 Collected $^{234}\text{Th}$ samples for particle transport calculations (Martin)

At all stations, except for the stations marked with x, both particulate  $^{234}\text{Th}$  and dissolved  $^{234}\text{Th}$  was sampled in the surface mixed layer and particulate  $^{234}\text{Th}$  was sampled right above the pycnocline. A total of 51  $^{234}\text{Th}$  samples were prepared for direct beta counting upon return to Stockholm.

Table 3.5.2.5.1  $^{234}\text{Th}$  samples taken during ISSS-08

Stations where $^{234}\text{Th}$ was sampled	Stations where $^{234}\text{Th}$ was sampled only in the surface mixed layer
YS2	
YS3	X
YS4	X
YS6	
YS8	
YS11	
YS12	
YS13	
YS14	X
YS17	
YS23	X
YS26	
YS28	
YS30	
YS32	
YS34B	
YS35	X
YS37	
YS39	X

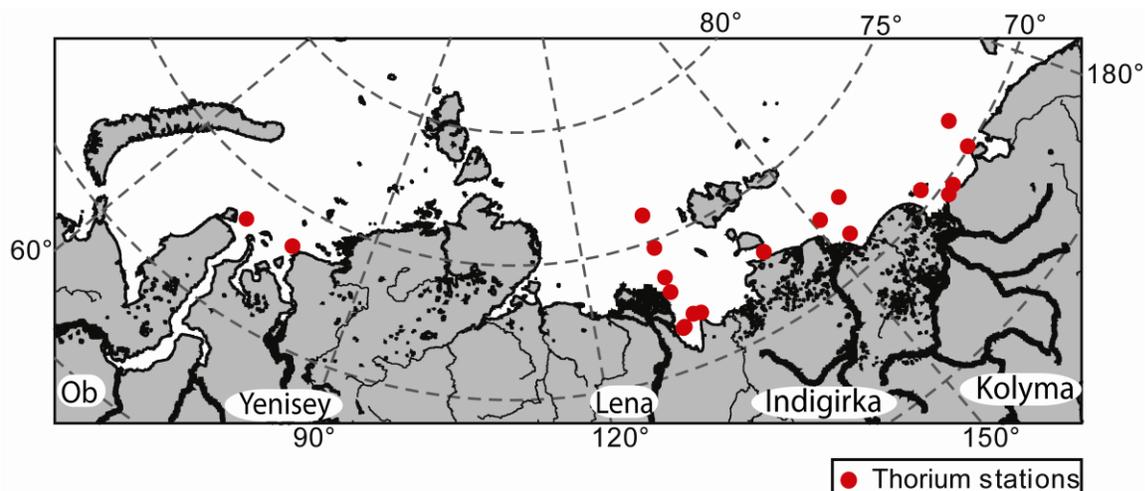


Figure 3.5.2.5.1 Locations where <sup>234</sup>Thorium samples were taken

### 3.5.2.6 Synthesis and outlook (Bart and Vanja)

The water column samples collected during ISSS08 will be used for a number of different projects but the overarching objectives are to investigate the biogeochemical fate of the large-scale releases of terrestrial organic carbon, currently sequestered in northern tundra/taiga areas, to the Eurasian Arctic Ocean, particularly the Laptev and East Siberian Sea, and the effects of climate warming on both the remobilization and degradation of this organic material. For this purpose the distribution patterns, <sup>14</sup>C age of specific terrestrial compounds as well as bulk material and other isotopes ( $\delta^{13}\text{C}_{\text{DOC}}$ ,  $\delta^{13}\text{C}_{\text{DIC}}$ ,  $\delta^{34}\text{S}_{\text{DOS}}$ ,  $\delta^{15}\text{N}_{\text{DON}}$ ) will be determined. The presence of both samples off rivers and coastal erosion sites offers the unique possibility to study both the effects of fate of terrestrial organic carbon and the relative importance of different processes on the mobilization of this material.

### 3.5.3 Molecular-isotope biogeochemistry - aerosols (Martin)

Table 3.5.3.1 Summary of Hi-volume air samples taken during ISSS-08

Sample Name	Sample Name2	total m <sup>3</sup> air filtered
Air-ISSS08-1	Barents Sea1	962
Air-ISSS08-2	Kara Sea1	2340
Air-ISSS08-3	Laptev Sea1	1497
Air-ISSS08-4	East Siberian Sea1	3670
Air-ISSS08-5	Laptev Sea and Eastern Kara Sea	2428
Air-ISSS08-6*	Western Kara Sea and Barents Sea	sample still running 2008-09-23

\*Sample Air-ISSS08-6 was still running during the writing of this report. Planned runtime of sample is until morning of 2008-09-25 or just before arriving to Kirkenes in order to cover the whole Barents Sea.

### **3.5.4 Molecular-isotope biogeochemistry - sediments (Jorien)**

Sediment grab samples and sediment cores have been collected along different regimes in the cruise track; in the mouths of the Great Russian Arctic Rivers (Ob, Yenisey, Lena, Indigirka, Kolyma), along river transects from mouth to shelf (Lena, Indigirka, Kolyma), at coastal erosion sites (Bhuorkhaya Cape, Myostah island, Dmitry Laptev strait, Oyagosski Yar and 161°E) and at the open shelf (East Siberian Sea).

#### **3.5.4.1 Surface sediment grab samples (only for BGC)**

The table below shows all grab samples that were collected for biogeochemical and molecular-isotope analysis. On the attached map one can see all these locations (red and blue circles). The sediment was taken with a metal spoon from the grab sampler, stored in 500 mL containers, labelled and frozen at -18°C the same day.

## ISSS-08 Sediment grab samples

Station	Date	Time (UTC)	Depth (m)	Coordinates		Location	Comments
				N	E		
YS-3	2008-08-19	23:00	37	73.492	79.885	Yenisey estuary	
YS-4	2008-08-24	05:30	50	75.987	129.984	Lena transect: macro	
YS-5	2008-08-24	13:00	43	75.266	130.017	Lena transect: CTD	
YS-6	2008-08-24	20:00	32	74.724	130.016	Lena transect: micro	
YS-8	2008-08-25	04:00	14	73.566	130.008	Lena transect: micro	sandy
YS-9	2008-08-25	05:30	23	73.366	129.997	Lena transect: CTD	
YS-10	2008-08-25	07:00	20	73.184	129.996	Lena transect: CTD	
YS-11	2008-08-25	12:30	11	73.019	129.989	Lena transect: macro	2 containers
YS-12B	2008-08-26	08:00	10	71.922	132.391	Bhuorkhaya Cape erosion	sandy, no CTD station
YS-13	2008-08-26	12:00	19	71.968	131.701	Bhuorkhaya Cape erosion	2 containers
YS-14	2008-08-28	01:30	7	71.630	130.050	Myostah island erosion macro	2 containers
YS-15	2008-08-28	05:15	11	71.628	130.054	Myostah island erosion micro	
YS-16	2008-08-28	07:00	11	71.627	130.318	Myostah island erosion micro	
YS-17	2008-08-28	09:00	10	71.630	130.191	Myostah island erosion micro	
YS-18	2008-08-29	01:30	15	73.031	133.002	South-Eastern Laptev Sea	
YS-19	2008-08-29	09:00	27	73.035	133.456	Laptev Sea	
YS-20	2008-08-29	16:15	8	73.305	139.893	Dmitry Laptev coastal erosion 1	
YS-21	2008-08-29	19:30	15	73.089	140.348	Dmitry Laptev coastal erosion 1	
YS-22	2008-08-29	21:30	20	72.875	140.629	Dmitry Laptev coastal erosion 1	
YS-22B	2008-08-29	22:50	15	72.886	140.619	Dmitry Laptev coastal erosion 1	methane seep station
YS-23	2008-08-30	09:30	10	72.789	142.670	Dmitry Laptev coastal erosion 2	2 containers
YS-24	2008-08-30	14:30	15	73.048	142.667	Dmitry Laptev coastal erosion 2	
YS-25	2008-08-30	17:00	10	73.143	142.667	Dmitry Laptev coastal erosion 2	
YS-26	2008-08-31	12:00	16	72.460	150.596	Oyagosski Yar - Indigirka triangle	
YS-27	2008-08-31	20:00	18	72.567	152.373	Oyagosski Yar - Indigirka triangle	
YS-28	2008-09-01	01:00	28	72.651	154.185	Oyagosski Yar - Indigirka triangle	

YS-29	2008-09-01	06:00	18	72.200	153.166	Oyagosski Yar - Indigirka triangle	
YS-30	2008-09-01	19:30	9	71.358	152.153	Oyagosski Yar - Indigirka triangle	
YS-31	2008-09-02	15:00	20	71.592	161.694	161°E coastal erosion transect	
YS-32	2008-09-03	01:00	9	70.567	161.217	161°E coastal erosion transect	
YS-33	2008-09-03	04:30	8	70.168	161.217	161°E coastal erosion transect	
YS-34B	2008-09-03	18:30	10	69.708	162.689	Kolyma transect	2 containers
YS-35	2008-09-04	00:30	31	69.817	164.057	Kolyma transect	2 containers
YS-36	2008-09-04	04:30	32	69.817	165.999	Kolyma transect	2 containers
YS-37	2008-09-04	09:30	42	70.135	168.007	Kolyma transect	2 containers
YS-38	2008-09-04	16:00	36	70.698	169.132	Kolyma transect	2 containers
YS-39	2008-09-04	23:00	44	71.219	169.373	Kolyma transect	2 containers
YS-40	2008-09-05	02:00	49	71.483	170.553	Kolyma transect	2 containers
YS-41	2008-09-05	06:00	43	71.968	171.792	Kolyma transect	2 containers
YS-86	2008-09-09	12:00	200	75.3013	174.3957	ESS shelf	iron manganese nodules
YS-88	2008-09-09	17:00	142	75.0993	172.187	ESS shelf	
YS-90	2008-09-10	01:00	63	74.6682	172.3882	ESS shelf	
YS-91	2008-09-10	10:00	56	74.4337	170.8547	ESS shelf	
YS-93	2008-09-10	20:00	51	74.4185	165.999	ESS shelf	
YS-95	2008-09-11	05:00	45	74.4167	161.3353	ESS shelf	
YS-98	2008-09-11	15:00	48	75.551	160.7512	ESS shelf	
YS-99	2008-09-11	20:00	50	75.171	163.5862	ESS shelf	
YS-100	2008-09-12	00:30	58	75.7157	164.0793	ESS shelf	
YS-102	2008-09-12	08:30	69	76.5592	160.0725	ESS shelf	
YS-104	2008-09-12	16:30	57	76.9338	155.1693	ESS shelf	
YS-106	2008-09-13	01:00	43	76.9685	150.2912	ESS shelf	large disk shaped iron manganese nodule
YS-111	2008-09-14	04:00	46	74.9973	160.01	ESS shelf	
YS-112	2008-09-14	06:30	42	74.8327	159.3302	ESS shelf/Indigirka paleocanyon	
YS-116	2008-09-14	18:30	36	74.5828	157.003	ESS shelf/Indigirka paleocanyon	
YS-118	2008-09-14	23:00	28	74.3342	156.0077	ESS shelf/Indigirka paleocanyon	
YS-120	2008-09-15	06:00	33	73.2918	155.1675	ESS shelf/Indigirka paleocanyon	

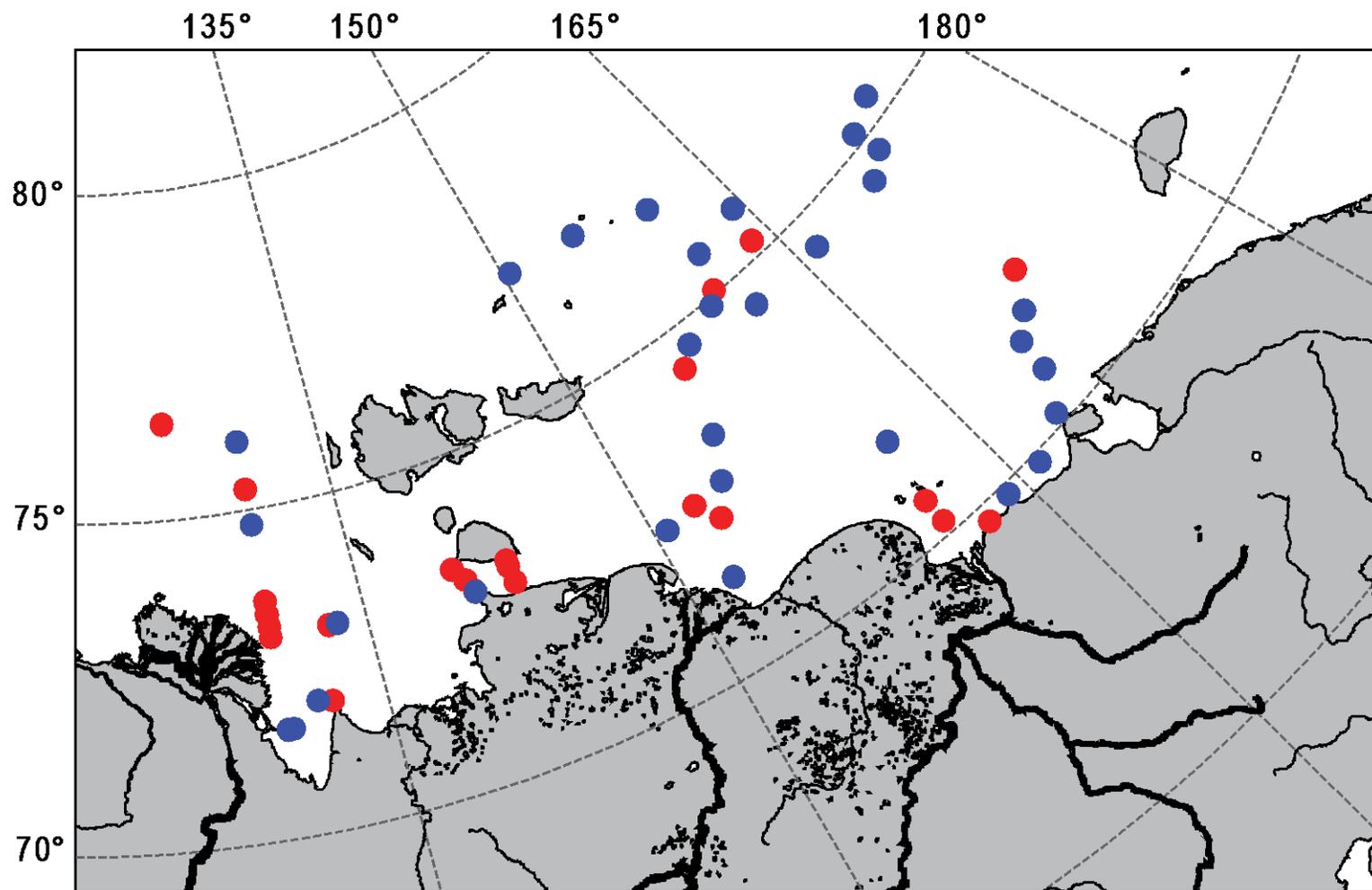
YS-131	2008-09-18	09:30	50	76.3982	125.4728	Laptev Sea	methane area; two small containers
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#### **3.5.4.2 Gemini core samples incl any particular observations (list also for TEI and POI) Jorien**

Sediment cores (for locations, see the blue points on the attached map) have been collected for different kinds of analysis. Stockholm University (SU; Örjan Gustafsson, Jorien Vonk) has collected and sliced cores for gamma counting, biomarker analysis and compound-specific radiocarbon analysis. The Swedish Museum of National History (NRM; Per Anderson, Don Porcelli) will analyze trace metals and isotopes, whereas the Pacific Oceanological Institute (POI; Oleg Dudarev) will study size distributions, mineralogy and diatomic analysis. Detailed descriptions of all the cores are available upon request. The table below lists the locations where cores for which institute have been collected.

#### **3.5.4.3 Synthesis and outlook (Jorien)**

The planned analyses on the large amounts of sediment samples will provide us with better knowledge of the Laptev and East Siberian Seas and a more detailed integrated picture of their drainage basins. Besides bulk geochemical analyses ( $\delta^{13}\text{C}$ ,  $\delta^{15}\text{N}$ , C/N ratios, bulk  $^{14}\text{C}$ ), SU will analyze concentrations and ratios of a wide range of terrestrial and marine biomarkers to improve our understanding of distribution processes and degradation status of terrestrial versus marine matter. By studying sediments in different regimes, we hope to distinguish between the fate of fluvial and coastally eroded transported material. Compound-specific radiocarbon analysis on terrestrial compounds such as long-chain *n*-alkanoic acids will provide information on release mechanisms of terrestrial material from the huge and permafrost-influenced drainage basins of Lena, Indigirka and Kolyma. If we are able to establish a good chronology on some of the sediment cores collected, we will also analyze bulk geochemical parameters, biomarkers and compound-specific radiocarbon analyses downcore. By coupling these results to recent changes in local climate, we hope to say more about the possible effects of recent climate warming on the huge stocks of old frozen carbon in the Siberian tundra region. If  $^{14}\text{C}$  dating of terrestrial biomarkers shows an increase in age towards the top of the core, this could indicate remobilization of old carbon due to accelerated permafrost thawing, potentially leading to positive feedbacks on the ongoing global warming.



## ISSS-08 Sediment cores

Station	Location	Depth (m)	Coordinates		Date	Cores taken and sliced for:				
			Lat	Long		SU	NRM	POI	FESU	
YS-2	Ob	25	73.405	72.9952	2008-08-19	5		2	1	1
YS-3	Yenisey	37	73.492	79.885	2008-08-19	5		2	1	1
YS-4	Lena transect	50	75.987	129.984	2008-08-24	4		1	1	1
YS-6	Lena transect	32	74.724	130.016	2008-08-24	2			1	1
YS-13	Bhuorkhaya gulf	19	71.968	131.701	2008-08-25	5		1	1	1
YS-14	Myostah island	7	71.630	130.050	2008-08-28	4		1	1	1
YS-15	Myostah island	11	71.628	130.054	2008-08-28	2				
YS-16	Myostah island	11	71.627	130.318	2008-08-28	2				
YS-19	Laptev Sea	27	73.035	133.456	2008-08-29	6		1	1	1
YS-22	Dmitry Laptev	20	72.875	140.629	2008-08-29	2			1	1
YS-26	Oyagoski Yar	16	72.460	150.596	2008-08-31	3		1	1	1
YS-28	Oyagoski Yar	28	72.651	154.185	2008-09-01	5		1	1	1
YS-30	Indigirka	9	71.358	152.153	2008-09-01	4		1	1	1
YS-31	161°E	20	71.592	161.694	2008-09-02	2				
YS-35	Kolyma	31	69.817	164.057	2008-09-04	3				
YS-36	Kolyma	32	69.817	165.999	2008-09-04	3			1	
YS-37	Kolyma	42	70.135	168.007	2008-09-04	3			1	
YS-38	Kolyma	36	70.698	169.132	2008-09-04	3				
YS-39	Kolyma	44	71.219	169.373	2008-09-04	5		1	1	1
YS-40	Kolyma	49	71.483	170.553	2008-09-05	3			1	
YS-86	ESS shelf	200	75.3013	174.3957	2008-09-09	2				
YS-88	ESS shelf	142	75.0993	172.187	2008-09-09	3			1	
YS-90	ESS shelf	63	74.6682	172.3882	2008-09-10	2				
YS-91	ESS shelf	56	74.4337	170.8547	2008-09-10	2				
YS-93	ESS shelf	51	74.4185	165.999	2008-09-10	2				

YS-95	ESS shelf	45	74.4167	161.3353	2009-09-11	2			
YS-98	ESS shelf	48	75.551	160.7512	2009-09-11	2			
YS-100	ESS shelf	58	75.7157	164.0793	2009-09-12	2			
YS-102	ESS shelf	69	76.5592	160.0725	2009-09-12	2			
YS-104	ESS shelf	57	76.9338	155.1693	2009-09-12	2			
YS-106	ESS shelf	43	76.9685	150.2912	2008-09-13	2			
YS-112	ESS shelf	42	74.8327	159.3302	2008-09-14	2			
YS-116	Indigirka paleo	36	74.5828	157.003	2008-09-14	2			
YS-120	Indigirka paleo	33	73.2918	155.1675	2008-09-15	5	1	1	1
<b>Total</b>						<b>103</b>	<b>13</b>	<b>17</b>	<b>13</b>

### **3.6 Trace elements and isotopes** (Per, Don, Johan, Fredrik)

The main objective is to characterize the interactions between shelf waters and sediments as reflected in the concentrations of micronutrients, metals, and trace elements. This includes understanding of water-sediment exchange along the shelves, removal to, or supply from, sediments during estuarine mixing, supply of trace elements in areas of strong coastal erosion, and delivery of constituents to the central basins. Data for salinity, O isotopes, nutrients, and DOC has been collected for each sample to complement trace element data. Water analyses will include:

- 1) Trace element concentrations in river water, estuaries and on the shelf determine the distribution of input from river, coastal erosion and water–shelf interaction. Analysis will include REE patterns, trace elements including Hg and Ba.
- 2) The source regions of various elements across the Arctic can be determined using isotopes of element such as Nd, Hf and U.
- 3) A number of elements are expected to exhibit isotopic variations between various phases within the water and removal to sediments. Analysis will include Cd, Cr, Si and Fe

The major analytical work will be done at three institutions including Luleå University of Technology, Swedish Museum of Natural History Laboratory for Isotope Geology (LIG) and Oxford University Department of Earth Sciences. Some of the work includes collaboration with other institutions as listed below.

*Nd isotopes, REE, Ba, U-Th and Cr* analysis will be done at LIG and Oxford

*Hf isotopes* in collaboration with Geomar Kiel, Germany (Dr. Martin Frank)

*Os isotopes* in collaboration with Oxford (Dr. Halliday)

*Cd isotopes* in collaboration with Imperial College, London (Dr. Mark Rehkämper)

*Hg* in collaboration with Oxford (Dr. Tamsan Mathers)

*He isotopes* in collaboration with Scripps Inst. of Oceanography (Dr. Dave Hilton)

*Trace metals* in collaboration between Luleå, LIG and Oxford

*Trace metal speciation* in collaboration with ITM Stockholm (Dr. Kuria Ndungu)

*Fe concentration and Fe isotopes* will be done in Luleå

*Si isotopes* will be done in Luleå

*O isotopes* in collaboration with Stockholm University (Dr. Magnus Mörrth)

Table 1 reports station, depth and collection method for the listed isotopes and metals.

**River waters.** Samples collected from the Lena by the second ship were filtered on board, and will be used to characterize the trace element and isotope composition of the waters and particles discharged by the Lena. Ice and soil samples from the coastal erosion site at Mohtaba Island, Bohrkaya Gulf will be examined for U-Th disequilibrium for possible dating of the ice complex.

**Particles.** All filters from water sample filtration have been retained. Analyses of major elements, trace elements, and isotope compositions will be conducted to characterize the transport of inorganic material in the particulate load.

**Sediment traps** If sufficient material has been recovered from the sediment traps, this will also be analysed.

**Sediments.** As part of the study of the influence of surface sediments on overlying water chemistry, analyses will be conducted on surface sediments. In addition, a series of leaching experiments will be conducted in order to characterize the constituents that are easily desorbed or weathered and so readily lost to the waters. Major element compositions will be determined, and this will complement work by POI on sediment mineralogy and grain size distributions.

**Ferromanganese concretions** were collected at three sites, and where possible the growth rates and ages of the concretions will be investigated.

**He analyses.** He isotopes will be analysed in waters where report of high methane concentrations were found and 45 samples for He analysis were collected. The main objective is to investigate the possibility of a deep heat source being responsible for the release of methane from sediments associated with tectonic structures on the East Siberian Sea Shelf and in the Laptev Sea.

Table 1. List of stations where trace metals and isotopes were collected

Station	Date	UTC Time	Collection method	Sampling Depths (m)
1/2A	17-aug-04	15:17	Seawater intake	5
1/2B	17-aug-04	19:00	Seawater intake	5
YS2	18-aug-04	00:59	Flagpole, Go-Flo 60	4, 20
2/3A	18-aug-04	15:02	Seawater intake	5
YS3	18-aug-04	23:02	Flagpole, Go-Flo 60	4, 25

3/4A	20-aug-04	08:50	Seawater intake	5
3/4B	20-aug-04	17:30	Seawater intake	5
3/4C	21-aug-04	17:25	Seawater intake	5
YS4	22-aug-04	16:39	Flagpole, Go-Flo 60	3, 25
YS6	23-aug-04	14:33	Flagpole, Go-Flo 60	3, 20
YS8	23-aug-04	22:40	Flagpole, Go-Flo 60	3, 9
YS11	24-aug-04	06:17	Flagpole	2.5
YS12	25-aug-04	01:51	Flagpole	4
YS13	25-aug-04	09:50	Flagpole	4
YS14	26-aug-04	19:39	Go-Flo 60	5
YS23	29-aug-04	03:28	Flagpole	3
YS24	29-aug-04	13:17	Flagpole, Go-Flo 60	3, 11
YS25	29-aug-04	16:14	Go-Flo 60	6
YS26	30-aug-04	06:49	Go-Flo 60	8, 12
YS28	31-aug-04	00:03	Flagpole, Go-Flo 60	4, 15
YS29	31-aug-04	04:50	Flagpole, Go-Flo 60	3, 10
YS30	31-aug-04	13:31	Flagpole	3
YS31	01-sep-04	13:59	Flagpole	3
YS32	01-sep-04	18:58	Flagpole	3.5
YS34	02-sep-04	09:18	Flagpole	3
YS34B	02-sep-04	12:14	Go-Flo 60	1, 6
YS35	02-sep-04	23:23	Flagpole, Go-Flo 60	3, 25
YS37	03-sep-04	08:42	Flagpole, Go-Flo 60	3, 36
YS39	03-sep-04	19:24	Flagpole, Go-Flo 60	2, 30
YS41	04-sep-04	06:38	CTD Go-Flo 20	30
YS42	04-sep-04	09:36	CTD Niskin, Go-Flo 20	5, 29
YS47	05-sep-04	12:36	CTD Niskin, Go-Flo 20	4, 50, 77
YS56	05-sep-04	22:58	CTD Niskin, Go-Flo 20	4, 30, 68

YS62	07-sep-08	03:50	CTD Niskin	30
YS65	07-sep-08	09:50	CTD Niskin, Go-Flo 20	4, 30, 82
YS79	07-sep-04	03:51	CTD Niskin, Go-Flo 20	4, 75, 178
YS81	07-sep-04	22:17	CTD Niskin, Go-Flo 20	4, 401, 1111
YS86	09-sep-08	11:05	CTD Niskin, Go-Flo 20	4, 100, 200
YS87	09-sep-04	14:12	CTD GoFlo 20	150
YS90	09-sep-04	00:40	CTD Niskin, Go-Flo 20	4,30, 63
YS95	10-sep-04	04:29	CTD Niskin, Go-Flo 20	4, 32, 43
YS101	11-sep-04	04:53	CTD Niskin, Go-Flo 20	4, 30, 54
YS108	13-sep-04	20:06	CTD Niskin, Go-Flo 20	4, 25, 37
YS120	15-sep-04	05:27	Flagpole, CTD Niskin, Go-Flo 20	4, 15, 33
YS121	16-sep-04	00:09	CTD Niskin, Go-Flo 20	4, 10
YS122	16-sep-04	15:14	CTD Niskin, Go-Flo 20	4, 22, 26
YS126	17-sep-04	04:49	CTD Niskin, Go-Flo 20	4, 25, 50
YS128	17-sep-04	11:14	Flagpole	4

### 3.7 Benthic infauna (Vovva)

### 3.8 Sedimentology (Oleg, Sasha Charkin, Örjan)

#### 3.8.1 CTD-turbidity data (Göran, Örjan)

See section 3.3.1 for preliminary results of Turbidity sensor at 130 stations.

#### 3.8.2 POI sediment and PM filters collected (Oleg)

St. #	Sediment sampling	Preliminary size type of sediments	PM water sampling	PM nepheloid sampling
YS-2	GEMINI, grab	Aleurite pelitic	-	-
-3	GEMINI, grab	n.d.		
-4	GEMINI, grab	Fine aleurite	+	-
-5	Grab	Aleurite pelitic	+	-

-6	GEMINI, grab	Fine aleurite	+	-
-7	-	-	+	-
-8	Grab	Psammite aleuritic	+	-
-9	-	-	+	-
-10	Grab	Coarse aleuritic	+	-
-11	Grab	Coarse aleuritic	+	-
-12	GEMINI, grab	Puble, gravel and fine psammite	+	-
-12a	Grab	Fine spsammite or psammite aleuritic	-	-
-13	Grab	Aleurite psammitic	+	-
-14	GEMINI, grab	Aleurite pelitic	+	-
-15	Grab	Aleurite pelitic	+	-
-16	Grab	Fine aleuritic	+	-
-17	Grab	Aleurite pelitic	+	-
-18	Grab	Psammite aleuritic	+	-
-19	GEMINI, grab	Pelite	+	-
20	Grab	Fine aleurite	+	-
-21	Grab	Coarse-fine aleurite	+	-
-22	GEMINI, grab	Pelite	+	-
-22a	Grab	Pelite		
-23	Grab	Fine aleurite	+	-
-24	Grab	Mictite aleuritic	+	-
-25	Grab	Fine aleurite	+	-
-26	GEMINI, grab	Fine aleurite	+	-
-27	Grab	Aleurite pelitic - fine aleurite	+	-
-28	GEMINI, grab	Aleurite pelitic	+	
-29	Grab	Aleurite pelitic	+	-
-30	GEMINI, grab	Aleurite pelitic	+	+
-31	Grab	Coarse-fine aleurite	+	+
-32	Grab	Coarse-fine aleurite	+	-
-33	Grab	Coarse aleurite	+	-
-34	-	-	+	-
-34b	Grab	Fine aleurite	+	-
-35	Grab	Mictite aleuritic	+	+
-36	GEMINI, grab	Mictite aleuritic	+	+
-37	GEMINI, grab	Mictite aleuritic	+	+
-38	Grab	Aleurite pelitic - fine aleurite	+	+
-39	GEMINI, grab	Aleurite pelitic	+	+
-40	GEMINI, grab	Fine aleurite	+	+
-41	Grab	Fine aleurite	+	-
-43	-	-	+	-

-45	-	-	+	-
-47	-	-	+	-
-49	-	-	+	-
-51	-	-	+	-
-54	-	-	+	-
-56	-	-	+	-
-58	-	-	+	-
-60	-	-	+	-
-62	-	-	+	-
-63	-	-	+	-
-65	-	-	+	-
-67	-	-	+	-
-69	-	-	+	-
-71	-	-	+	-
-72	-	-	+	-
-74	-	-	+	-
-76	-	-	+	-
-78	-	-	+	-
-79	-	-	+	-
-80	-	-	+	-
-81	-	-	+	-
-82	-	-	+	-
-83	-	-	+	-
-84	-	-	+	-
-85	-	-	+	-
-86	Grab	Fine aleurite	+	+
-88	GEMINI, grab	Fine aleurite	+	-
-90	Grab	Fine aleurite	+	+
-91	Grab	Aleurite pelitic - fine aleurite	+	+
-93	Grab	Pelite	+	+
-95	Grab	Pelite	+	+
-97	Grab	Aleurite pelitic	-	-
-98	Grab	Aleurite pelitic	+	+
-99	Grab	Fine aleurite	-	-
-100	Grab	Fine aleurite	-	-
-102	Grab	Fine aleurite	+	+
-104	Grab	Fine aleurite	+	+
-106	Grab	Aleurite pelitic	+	-
-111	Grab	Mictite pelitic	-	-
-112	Grab	Fine aleurite	+	+

-116	Grab	Fine aleurite	+	+
-118	Grab	Aleurite pelitic	+	-
-120	GEMINI, grab	Aleurite pelitic	+	+
-121	Grab	Mictite aleuritic	+	-

In total, 158 filters (surface and near bottom layers), 38 filters from nepheloid layer, and 58 surface sediment samples were collected. All the samples will be studied in onshore labs at POI and other places (for instance, GEOKHI/Moscow), and Stockholm University. Mineral and chemical composition, sizing, and ultra-sizing, isotopes and biomarkers in organic matter will be underway in joint Russia-Sweden team. Clay minerals and diatomic measurements will be studied along the GEMINI cores. Results of all these measurements will be used for deeper insight in modern sedimentology (including its spatial-time variability ) over the vast and least explored East-Siberian Shelf

### 3.8.3 Coupled PM+POC filters from Niskin and Gemini core overlying water (Oleg, Laura)

### 3.8.4 Sediment trap samples (Örjan)

Sediment trap program was challenged by maneuvering problems, causing many failures (see below). The ISSS-08 cruises track did not allow for re-visits at original stations why most recovered trap material are from short deployments (> 12h) and several traps had to be left when cruise track later was changed. It is envisioned that future expeditions out from Tiksi may perform more successful sediment trap programs. Nevertheless, a set of samples were successfully collected and particularly the composition of the PM collected off coastal erosion sites will be investigated.

Station	Deployment	Recovery	Trap z, total z	Comments
4	080823 16:30 UTC	080824 04:00 UTC	Trap 22m, wc 52m	1 tube recovered; brown floc / marine snow. Plenty of fecal pellets.
4	080824 04:00 UTC	Redeployed. Not recovered		
11	080825 06:00utc	080825 14:00utc	Trap 7m wc 11m	2 tubes recovered. Detrital-grey particles
12	080826 02:15 utc	Not recovered		
13	080826 09:45utc	080828 16:00 utc	Trap 10m wc 20m	3 tubes recovered. Swimmers: copepods, appendicularians (3 houses), crustaceans: all picked
14	080826 20:00 utc	Recovered without tubes		

15	080826 21:40 utc	Recovered without tubes		
23	080830 03:00 utc	080830 16:00 utc	Trap 6m wc 11m	3 tubes recovered. Much detrital matter; fine clays and small woody debris(?). One copepod swimmer.
26	080831 06:45 utc	080831 13:45 utc	Trap 8m, wc 16m	3 glass tubes secured. Little PM, some small woody debris.
30	080901 13:00 utc	All tubes broken		

### Surface sediment samples for provenance studies (Polyak)

Surface sediments of ~100 g wet weight were collected from grab samples and stored in whirlpack bags (**23 samples total**). Samples will be used for provenance studies to expand the existing data set. Primary method planned to be employed is measurement of Diffuse Spectral Reflectance in the visual and near-infrared spectra. This non-destructive method allows quantification of various parameters of sediment mineral composition such as Fe-oxides, carbonate, and clay minerals through decomposition of spectra reflectance values by PCA (Ortiz et al., 1999). This work will be performed in collaboration with Joseph Ortiz (Kent State University). We are currently applying DSR measurements to sediment cores collected from the Alaskan continental margin and central Arctic Ocean to understand sedimentary sources and pathways (Ortiz et al., 2006; Ortiz et al., in review). Analysis of the cores that we have scanned thus far has enabled us to extract assemblages related to specific clay minerals and chemical species that characterize various circum-Arctic provinces. In addition to DSR, we will also measure the elemental composition of sediment by non-destructive X-ray fluorescence scanning. Other analyses that may be applied include Malvern **grain-size composition of fine fractions** that is currently explored to gain better understanding of sediment distribution by sea ice in the Arctic Ocean (Darby et al., in review), quantitative X-ray diffraction, dinocyst analysis (in collaboration with A. de Vernal, GEOTOP, Canada). All these measurements will not duplicate the bunch of measurements described above (Dudarev and Gustafsson group)

### **3.9 POSSIBLE CONTRIBUTION FROM PREVIOUS SIBERIAN SHELF STUDIES (SSS)**

#### **Oceanographic transects**

Continuous CTD profiles were made using a SEACAT Profiler SBE 19+. During the “shallow” portion of this survey, we also measured turbidity and CDOM in situ. Three water masses may be identified using the TS data: 1) the warm and fresh water in the southern portion of the transect, which is associated with the Lena River plume; 2) cold halocline water with mean salinity ~32.5psu; and 3) warm Atlantic Water with mean salinity ~ 34.5psu.

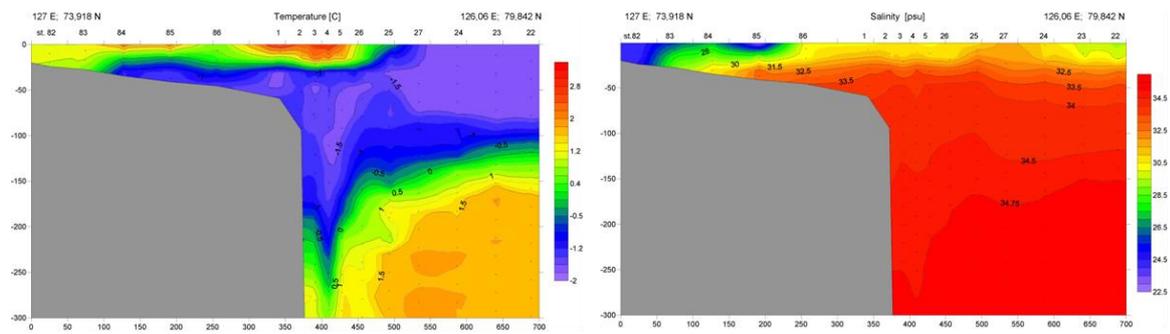


Figure XX. Distribution of temperature (left) and salinity (right) within the ~130E transect along the Laptev Sea (based on joint SSS-06 data with NABOS-06). (Semiletov et al., in preparation)

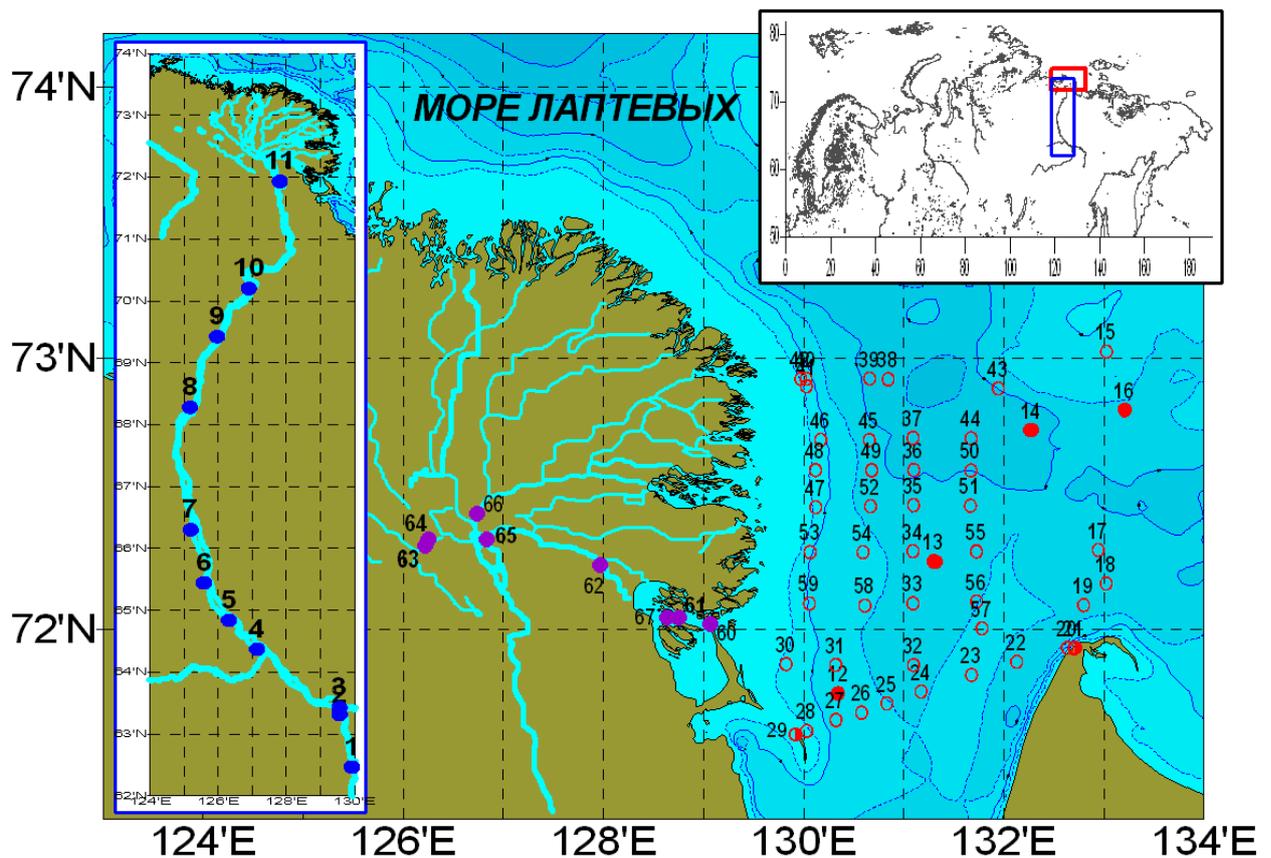
Other hydrological and biogeochemical data obtained in the SSS cruises (1999-2007) may become available for joint studies

#### 4. Brief overview of sub-expedition to Lena River – E. Laptev Sea (Oleg, Igor, Sasha Charkin, Denis Kosmach)

Report on sampling locations, sample techniques, and sample description, using similar format as for Smirnitskiy cruise. Both cruises are parts of the ISSS-08 Program.

#### The Study along the Lena River

Survey was made from August 5 to August 8, 2008: in total 11 riverine stations were accomplished



(Figure X)

Fig. 1. Investigation Regions of Lena River Expedition 2008

CTD casts, water (for further DOC/CDOM, Alk measurements) and sediment sampling, with onboard dissolved methane, pH measurements, and POC/PM filtering.

### 3. Investigations in Lena River Delta

Set of stations was accomplished in the Lena Delta visiting a few ice-complexes. Location of sampling sites is marked on images.



Fig. 2. VRD «Orlan» used in Delta and nearshore zone



Fig. 3. Sampling suites at the ice-complex of Olenekskaya Protoka (Channel)

Fig. 4. Sampling suites at the ice-complex of Muostakh Isl.

#### 4. Investigations in Buor Haya Gulf

Buor-Khaya Gulf was studied in August 12-21. All the samples were delivered onboard Yakob Smirnitskiy.

Fig. 5. RV «TB-0012»



Fig X. Sampling scheme on the Buor Haya Cape beach

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**Appendix A. Station file (contact: Göran)**

Table showing station number, date, time, position, water depth and maximum CTD pressure for all CTD stations during ISSS-08.

Station #	Cast#	Date	Time (UTC)	Latitude (deg)	Latitude (min)		Longitude (deg)	Longitude (min)		Water depth (m)	CTD pressure (dbar)
1	1	20080818	05.49	71	38.780	N	64	38.530	E	120	116
2	1	20080819	00.59	73	24.300	N	72	59.710	E	30	25
3	1	20080819	23.02	73	29.520	N	79	53.090	E	38	37
4	1	20080823	16.39	75	59.220	N	129	59.050	E	52	50
5	1	20080824	08.22	75	15.950	N	130	0.990	E	44	43
6	1	20080824	14.33	74	43.440	N	130	0.980	E	34	32
7	1	20080824	19.18	74	7.920	N	129	59.980	E	17	16
8	1	20080824	22.40	73	33.940	N	130	0.470	E	13	14
9	1	20080825	01.14	73	21.980	N	129	59.820	E	25	23
10	1	20080825	02.41	73	11.040	N	129	59.740	E	21	20
11	1	20080825	06.17	73	1.110	N	129	59.350	E	12	11
12	1	20080826	01.51	71	54.990	N	132	34.540	E	13	12
13	1	20080826	09.50	71	58.080	N	131	42.080	E	22	19
14	1	20080827	19.39	71	37.820	N	130	2.970	E	8	7
15	1	20080828	04.05	71	34.980	N	130	15.320	E	12	11
16	1	20080828	06.04	71	37.620	N	130	19.070	E	12	11
17	1	20080828	08.02	71	37.800	N	130	11.440	E	11	10
18	1	20080829	01.20	73	1.830	N	133	0.110	E	16	15
19	1	20080829	08.23	73	6.570	N	137	18.180	E	28	27
20	1	20080829	16.06	73	18.320	N	139	53.560	E	9	8
21	1	20080829	18.36	73	5.350	N	140	20.890	E	16	15
22	1	20080829	20.44	72	52.520	N	140	37.720	E	21	20
22	2	20080829	22.49	72	53.180	N	140	37.130	E	16	15

23	1	20080830	03.28	72	47.340	N	142	40.180	E	11	10
24	1	20080830	13.17	73	2.890	N	142	39.990	E	16	15
25	1	20080830	16.14	73	8.590	N	142	40.020	E	11	10
26	1	20080831	06.49	72	27.590	N	150	35.740	E	17	16
27	1	20080831	18.12	72	34.020	N	152	22.360	E	19	18
28	1	20080901	00.03	72	39.050	N	154	11.120	E	29	28
29	1	20080901	04.50	72	11.980	N	153	9.940	E	19	18
30	1	20080901	13.31	71	21.460	N	152	9.160	E	10	9
31	1	20080902	13.59	71	6.490	N	161	41.610	E	21	20
32	1	20080902	18.58	70	33.990	N	161	13.020	E	10	9
33	1	20080903	04.33	70	10.100	N	161	13.040	E	9	8
34	1	20080903	09.18	69	45.580	N	162	19.000	E	15	14
34	2	20080903	12.14	69	42.490	N	162	41.320	E	11	10
35	1	20080903	23.23	69	49.020	N	164	3.410	E	32	31
36	1	20080904	03.57	69	48.990	N	165	59.920	E	33	32
37	1	20080904	08.42	70	8.090	N	168	0.410	E	43	42
38	1	20080904	15.19	70	41.900	N	169	7.890	E	38	36
39	1	20080904	19.24	71	13.150	N	169	22.370	E	46	44
39	2	20080904	20.21	71	13.000	N	169	20.830	E	46	44
40	1	20080905	01.57	71	29.000	N	170	33.190	E	50	49
41	1	20080905	06.38	71	58.090	N	171	47.510	E	44	43
42	1	20080905	09.36	72	16.850	N	171	59.470	E	43	41
43	1	20080906	09.12	71	24.040	N	175	30.090	W	34	33
44	1	20080906	10.11	71	23.900	N	175	20.330	W	45	45
45	1	20080906	10.56	71	23.980	N	175	10.460	W	54	53
46	1	20080906	11.53	71	23.920	N	175	0.700	W	58	57
47	1	20080906	12.36	71	24.020	N	174	51.100	W	79	78
48	1	20080906	13.30	71	24.020	N	174	41.240	W	82	80
49	1	20080906	14.12	71	23.990	N	174	31.550	W	85	84

50	1	20080906	15.08	71	23.990	N	174	21.690	W	55	54
51	1	20080906	15.49	71	23.920	N	174	12.010	W	46	45
52	1	20080906	19.48	71	48.020	N	176	0.100	W	50	49
53	1	20080906	20.48	71	49.250	N	175	50.380	W	56	54
54	1	20080906	21.27	71	50.420	N	175	40.860	W	58	57
55	1	20080906	22.19	71	51.600	N	175	31.200	W	66	64
56	1	20080906	22.58	71	52.780	N	175	21.650	W	70	69
57	1	20080906	23.55	71	54.010	N	175	12.030	W	73	72
58	1	20080907	00.38	71	55.220	N	175	2.390	W	71	70
59	1	20080907	01.34	71	56.420	N	174	52.710	W	68	67
60	1	20080907	02.13	71	57.650	N	174	43.230	W	63	61
61	1	20080907	03.09	71	58.780	N	174	33.610	W	56	53
62	1	20080907	03.50	72	0.020	N	174	24.060	W	53	52
63	1	20080907	08.08	72	18.020	N	176	30.230	W	72	71
64	1	20080907	09.09	72	18.380	N	176	19.100	W	74	72
65	1	20080907	09.50	72	18.740	N	176	8.220	W	84	83
66	1	20080907	10.49	72	19.060	N	175	57.110	W	102	99
67	1	20080907	11.35	72	19.510	N	175	46.270	W	86	85
68	1	20080907	12.34	72	19.890	N	175	35.260	W	80	79
69	1	20080907	13.19	72	20.250	N	175	24.290	W	60	59
70	1	20080907	14.15	72	20.630	N	175	13.330	W	48	46
71	1	20080907	14.59	72	20.990	N	175	2.330	W	50	48
72	1	20080907	18.41	72	46.030	N	173	36.510	W	62	59
73	1	20080907	19.53	72	50.610	N	173	42.670	W	63	62
74	1	20080907	20.43	72	54.720	N	173	48.180	W	65	64
75	1	20080907	21.44	72	59.130	N	173	53.600	W	74	71
76	1	20080907	22.33	73	3.360	N	173	59.090	W	93	92
77	1	20080907	23.37	73	7.670	N	174	4.800	W	111	109
78	1	20080908	00.33	73	11.990	N	174	10.210	W	124	123

79	1	20080908	03.51	73	42.240	N	174	19.780	W	181	178
80	1	20080908	07.07	73	59.300	N	174	31.280	W	202	199
81	1	20080908	22.17	75	47.970	N	179	54.350	E	1115	1112
82	1	20080909	01.25	75	42.120	N	178	47.760	E	892	891
83	1	20080909	04.08	75	36.000	N	177	42.080	E	541	540
84	1	20080909	06.38	75	30.040	N	176	36.060	E	334	332
85	1	20080909	08.53	75	24.070	N	175	30.310	E	238	236
86	1	20080909	11.05	75	18.080	N	174	23.740	E	201	200
87	1	20080909	14.12	75	12.060	N	173	17.950	E	179	177
88	1	20080909	16.29	75	5.960	N	172	11.220	E	143	142
89	1	20080909	19.34	75	0.060	N	171	5.500	E	77	76
90	1	20080910	00.40	74	40.090	N	172	23.290	E	64	63
91	1	20080910	09.51	74	26.020	N	170	51.280	E	57	56
92	1	20080910	14.22	74	25.000	N	168	29.930	E	52	50
93	1	20080910	19.13	74	25.110	N	165	59.940	E	52	51
94	1	20080911	00.32	74	25.080	N	163	39.880	E	50	49
95	1	20080911	04.29	74	25.000	N	161	20.120	E	44	45
96	1	20080911	09.18	74	59.050	N	161	2.590	E	45	44
97	1	20080911	11.25	75	16.240	N	160	53.410	E	50	49
98	1	20080911	14.26	75	33.060	N	160	45.070	E	49	48
99	1	20080911	19.33	75	10.260	N	163	35.170	E	51	50
100	1	20080911	23.03	75	42.940	N	164	4.760	E	60	58
101	1	20080912	04.53	76	7.020	N	160	27.430	E	56	55
102	1	20080912	08.05	76	33.550	N	160	4.350	E	70	69
103	1	20080912	12.50	76	44.050	N	157	53.850	E	67	66
104	1	20080912	16.31	76	56.030	N	155	10.160	E	58	57
105	1	20080912	20.32	77	10.730	N	152	37.290	E	53	52
106	1	20080913	00.07	76	58.110	N	150	17.470	E	44	43
107	1	20080913	03.05	76	46.290	N	149	14.030	E	39	37

108	1	20080913	20.06	75	33.660	N	155	52.960	E	40	38
109	1	20080913	23.11	75	21.060	N	157	27.530	E	40	39
110	1	20080914	01.47	75	9.830	N	158	48.960	E	42	41
111	1	20080914	04.03	74	59.840	N	160	0.600	E	47	46
112	1	20080914	05.54	74	49.960	N	159	19.810	E	44	42
113	1	20080914	08.12	74	53.730	N	160	18.370	E	44	42
114	1	20080914	11.23	74	50.110	N	158	15.290	E	45	44
115	1	20080914	13.24	74	35.010	N	158	14.790	E	33	30
116	1	20080914	18.28	74	34.970	N	157	0.180	E	38	36
117	1	20080914	20.38	74	20.130	N	157	0.110	E	34	32
118	1	20080914	22.37	74	20.050	N	156	0.460	E	32	28
119	1	20080915	00.56	73	59.990	N	155	59.980	E	36	34
120	1	20080915	05.25	73	17.510	N	155	10.050	E	35	33
121	1	20080916	00.09	74	22.310	N	145	16.850	E	18	17
122	1	20080916	15.14	74	30.190	N	136	0.580	E	28	26
123	1	20080916	19.44	75	15.110	N	134	59.470	E	42	40
124	1	20080916	22.04	75	24.990	N	134	0.590	E	31	29
125	1	20080917	01.08	75	54.060	N	134	19.130	E	47	45
126	1	20080917	04.49	76	21.940	N	132	37.080	E	52	50
127	1	20080917	08.23	76	33.360	N	130	8.930	E	59	58
128	1	20080917	11.14	76	59.220	N	130	21.340	E	60	58
129	1	20080918	06.49	76	23.910	N	125	46.610	E	50	48
130	1	20080918	07.33	76	23.640	N	125	46.110	E	50	48
131	1	20080918	08.57	76	23.890	N	125	28.370	E	51	50

**Appendix B. Wet deck sheet (contact: Anders)**



Station #	86

Date	2008-09-09

Depth	188

Volume Niskin:	~6.5
Volume, all parameters:	29,8

Parameter #			1	2	3	4	5	6	7	8	9	11	10	12	13	14	15	16	17	18	19	20	21			
Niskin	ID	Pressure	Helium	CFCs	Oxygen	Methane	DIC	pH & TA	pH (post-cruise)	Fe <sup>2+</sup>	Nutrients	δ <sup>11</sup> B	δ <sup>18</sup> O	δ <sup>13</sup> C	POC/DOC	Phytoplankton	TOC	Optical meas.	Salinity	PM	<sup>234</sup> Th	Radioisotopes	Pigments	Needed volume	# of samples	
#	#	dbar	0,5	0,2	0,4	0,8	0,5	0,5	1	0,2	0,05	0,02	0,02	0,10	1,5	0,8	0,2	0,2	0,4	2	7,5	10	3	liters		
1	284884	bottom		1	1	1	1	1	1		1		1	1					1						3,97	
2	284885	bottom																		1		1			7,00	
3	284886	bottom																				1			5,00	
4	284887	150		1	1	1	1	1	1		1		1	1					1						3,87	
5	284888	100		1	1	1	1	1	1		1		1	1					1						3,87	
6	284889	50		1	1	1	1	1	1		1		1	1					1						3,87	
7	284890	25		1	1	1	1	1	1		1		1	1		1			1						4,62	

