

Biogeochemical Studies in the Siberian Shelf Seas

Workshop Report

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S. Gdaniec and K. Volkmann-Lark
March 29, 2016

WORKSHOP ON BIOGEOCHEMICAL CYCLES IN THE SIBERIAN SHELF SEAS



Overview

The workshop was held in order to bring together specialists working from widely different perspectives on biogeochemical studies in the Siberian shelf seas. The goals were to coordinate future efforts in preparation of expeditions to the Siberian shelf seas, to explore possibilities of cooperation in future studies by exchange of data and samples, and to develop a plan for engagement of young scientists.

The workshop was hosted by GEOMAR Helmholtz Centre for Ocean Research in Kiel, Germany, on January 27 and 28, 2016, and organized by the "Secretariate Laptev Sea System", following the conference of the Russian-German project "The Transpolar System of the Arctic Ocean". In the workshop, 31 scientists and 6 early career scientists from 10 countries participated (see Appendix, list of participants).

The program included (i) plenary talks about ongoing programs with objectives, institutions and scientists involved, expeditions, field methods, and major results, (ii) cruise plans, wishes and dreams, (iii) fields of synergy and overarching themes, (iv) gaps in knowledge, and (v) new opportunities for cooperation in trace element research with Russia.

The workshop was funded by the International Arctic Science Committee, German Federal Ministry for Education and Research, GEOTRACES, Scientific Committee on Ocean Research, Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research (AWI) and GEOMAR.

1. Presentations of country reports, projects and research centers participating in the workshop

Swedish-Russian-US Research Cooperation (SWERUS)

SWERUS-C3 is an international multi-disciplinary investigation of the climate-cryosphere-carbon interaction in the eastern Siberian Arctic Ocean. The objectives of the SWERUS-C3 expedition were to quantitatively address processes central to Arctic Ocean climate change feedbacks, specifically:

- CH₄ release from subsea permafrost and deep sea: What are the mechanisms and magnitudes of CH₄ release to the atmosphere? What are the permafrost and gas hydrate stability fields of Arctic subsea CH₄ pools and how will they respond to increased ocean warming?
- The fate of carbon in the shelf sea released from thawing coastal permafrost: Microbial degradation and CO₂ fluxes to the atmosphere? Or re-sequestration through sediment burial and off-shelf export?
- The historical (recent/post-glacial/paleoclimate) sediment record of permafrost carbon releases: Is the present carbon release from thawing permafrost unprecedented since the last glacial period?
- History of Arctic sea ice and its impact on carbon fluxes: Has a perennial Arctic sea ice cover prevailed during the entire post-glacial period or have sea-ice free summers existed previously?

The observations show the distribution of high nutrient waters along the continental margin from about 140 to 180 °E. This nutrient maximum water, classically named the Upper Halocline, is absent in the west over the Lomonosov Ridge. It is clearly seen in the Makarov Basin at 150 °E and gets more intense further to the east. At the intercept of the Mendeleev Ridge and the shelf slope, the nutrient maximum is still intense, but more vertically distributed. Hence, it is also found at higher salinities up to ~34.5. East of 170 °E the transient tracers show significantly less ventilated waters below about 150 m depth, likely an indication of the boundary current from the west steered away from the shelf slope by the Mendeleev Ridge with more isolated waters within the Chukchi Abyssal Cap. The chemical properties of the water of salinities of ~34.5 are high nutrient and low oxygen concentrations as well as low pH, typical of organic matter decay. A deficit in nitrate relative to phosphate also point to this process partly occurring under hypoxia. This indicates that the high nutrient water of S ~34.5 is formed on the shelf slope in the Mendeleev Ridge region from interior basin water that is trapped for enough time to achieve its signature.

Nansen and Amundsen Basins Observational System (NABOS)

The overarching goal of NABOS-II as an element of the Arctic Observing Network is to compile a cohesive picture of the climatic changes in the Eurasian and Makarov basins (EMB) of the Arctic Ocean, with particular focus on understanding three major observational targets:

- Target #1: Along-slope Atlantic Water (AW) transport by the boundary currents.
- Target #2: Interaction of AW branches with shelf waters, deep basin interior and upper ocean.
- Target #3: EMB indications of changes in the upper ocean circulation.

As parts of this study we provide:

- Year-round platforms for multidisciplinary mooring measurements.
- Every-other-year (i.e. 2013, 2015 and 2017) survey information and measurement opportunities, for example for ship-based measurements, and for launching autonomous Lagrangian drifters (including meteorological and oceanographic buoys for various programs).
- Coordinating permissions to make a variety of measurements within the Russian Exclusive Economic Zone (EEZ), based on nine years of successful collaboration with Russian authorities.
- An international shipboard summer school based on our prior experience with offering such summer schools in 2005 and 2006.

The project includes an extensive mooring program. In future NABOS is extended eastward to the East Siberian Sea and will there provide the westward extension of the Russian-US cooperative program RUSALCA.

The program intends a change to a more process-oriented approach.

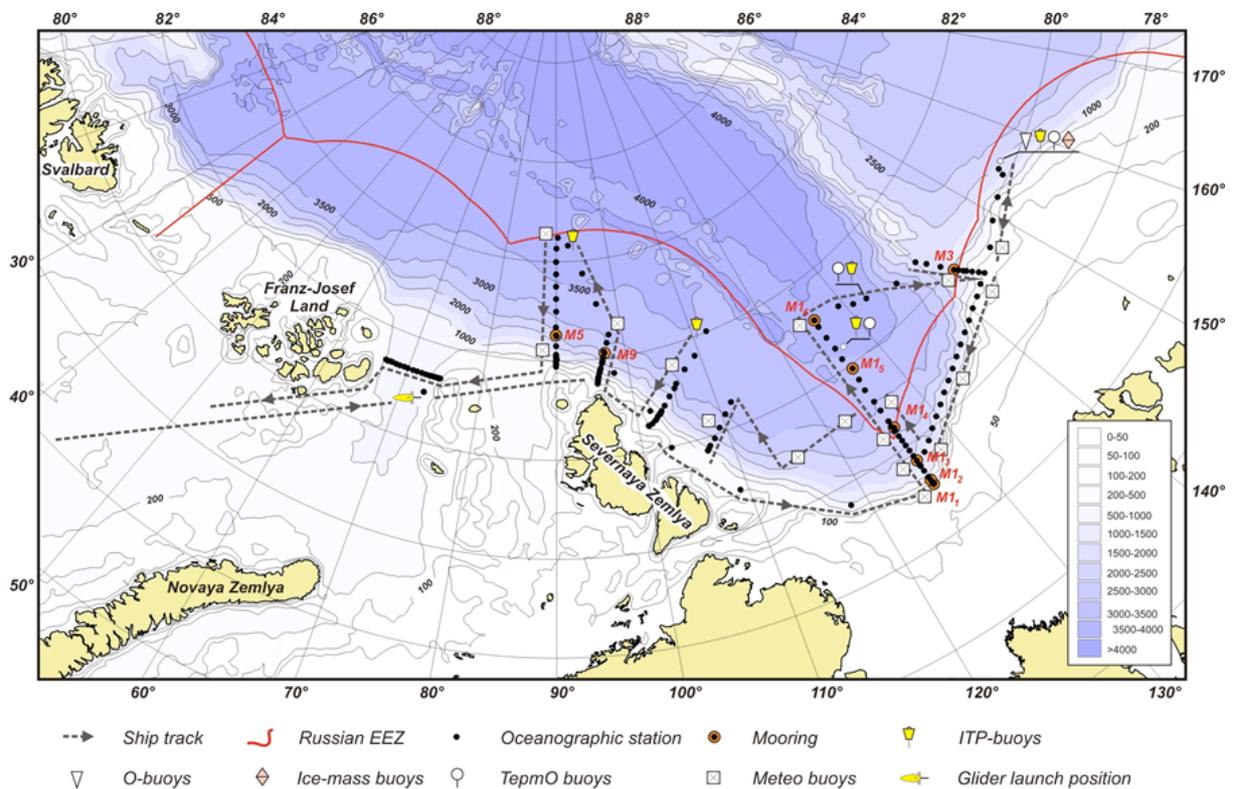


Fig. 1: NABOS 2013 survey.

International Siberian Shelf Study 2008 (ISSS-08)

The ISSS-08 undertook extensive biogeochemical observations and studies of the supply and transport of organic carbon, micronutrients and trace element isotopic tracers from the Siberian Arctic rivers, along the Eurasian-Arctic continental shelf as well as across the shelf. Results from the ISSS-08 show that the behaviour of OC varies along the shelf, with clear indications of breakdown of dissolved organic matter in the East Siberian Sea involving losses of 30 to 50 % of the DOC inventory. However, the DOC degradation seems to be less clear close to the Lena River inflow in the Laptev Sea. Input of trace metals from the large

Siberian Arctic Rivers are being modified during transport across the wide shelf area, with indications of release of metals such as Cd from river particles on the shelf.

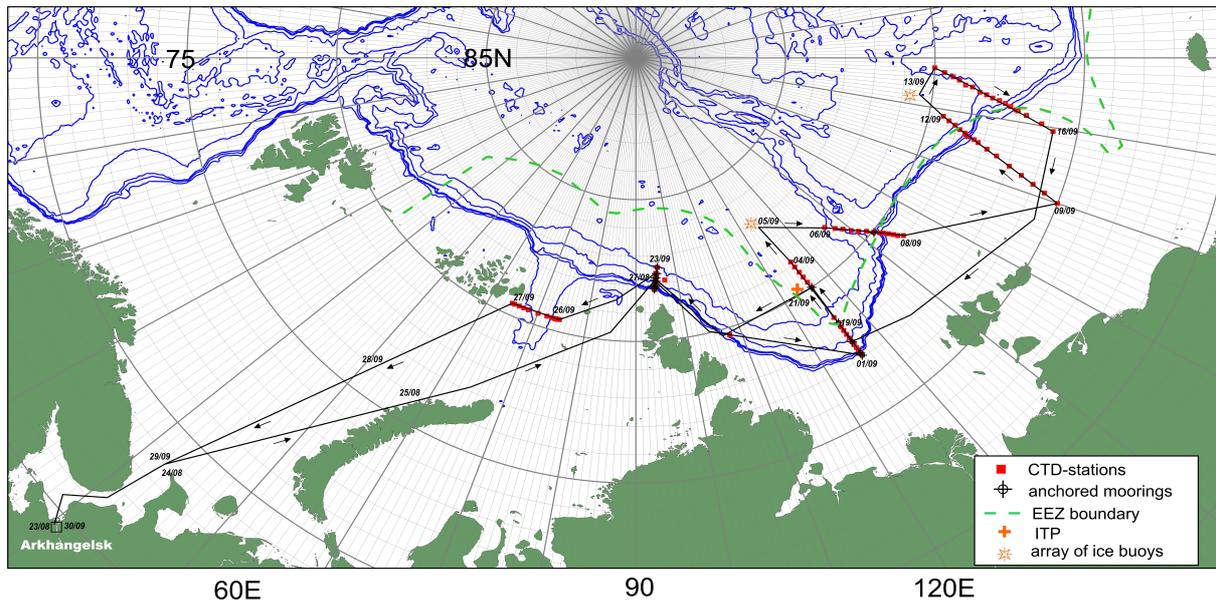


Fig. 2: NABOS 2015 survey.

TRANSDRIFT

The joint Russian-German research project „Laptev Sea System" aims to assess how climate change will affect the highly sensitive Arctic environment and in how far the changes will be of consequence for Europe. Research areas are the Laptev Sea as the most important area of sea-ice production and the Fram Strait as the only deepwater and intermediate water connection between the Arctic Ocean and the Atlantic Ocean. The Transpolar Drift Stream connects both regions. At the same time, the Russian partner institution, the Arctic and Antarctic Research Institute (AARI), St. Petersburg, implements multidisciplinary investigations in the central Arctic Ocean as the key research topic of their research program „Arctic Basin Cluster". The project provides:

- Year-round multidisciplinary mooring measurements.
- Regular oceanographic, biological and hydrochemical surveys in the Russian EEZ since 1993.
- Part of the study concentrates on biogeochemical cycles in the Laptev Sea: water mass provenance and mixing, input and fate of freshwater, water-sediment exchange processes, variability of the Arctic Boundary Current, biogeochemical cycling of nutrients and their relationship to the extent of primary productivity, and the impact of CDOM-rich Lena waters on ocean temperatures, sea-ice melt and biological production.
- First studies on the distribution of rare earth elements and radiogenic Nd isotopes in the Laptev Sea in accordance with GEOTRACES sampling and measurement protocols but not yet within the framework of a dedicated GEOTRACES process study.

More information at: transdrift.info.

GEOTRACES

The mission of the GEOTRACES program is to identify the processes and quantify the fluxes

that control the distributions of key trace elements and isotopes (TEIs) in the ocean, and to establish the sensitivity of these distributions to changing environmental conditions. This includes their concentration, isotope composition, and chemical speciation to evaluate the sources, sinks, and internal cycling in order to characterize more completely the physical, chemical and biological processes regulating their distributions. These investigations are mainly carried out along basin wide ocean sections, which are complemented by process studies. Further process studies in 2015 and 2016 focused / will focus on the inputs of TEIs in dissolved and particulate form from and across the Siberian shelves into the open Arctic Ocean (Fig. 3). The recently completed US Arctic program undertook a "process" section across a shelf-basin transect of the Beaufort shelf with the intent to better understand the role of the sediments in regulating the chemical distributions and the fluxes of TEIs onto or off the shelf.

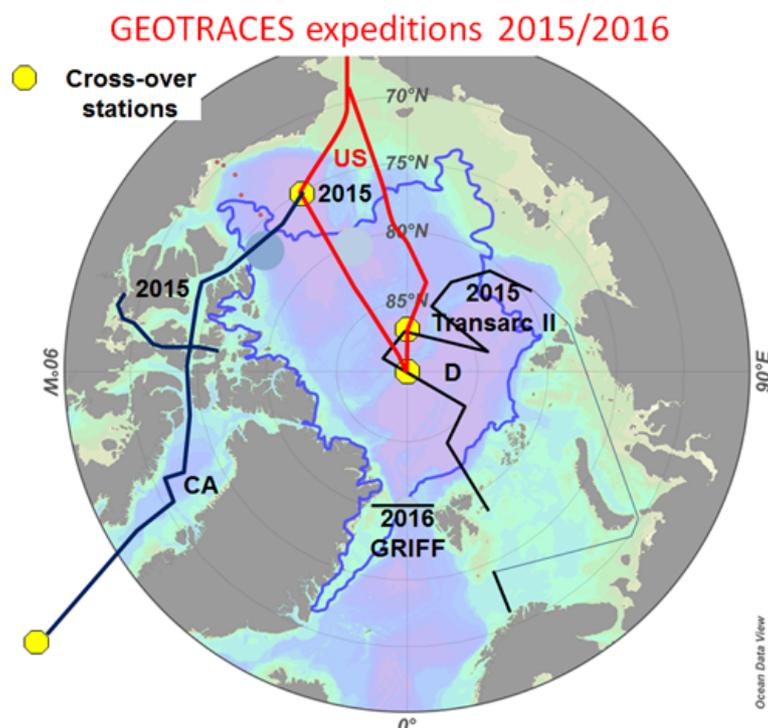


Fig. 3: The main sections of the GEOTRACES studies in the Arctic Ocean in 2015 and 2016.

Arctic Great Rivers Observatory (Arctic-GRO)

Arctic-GRO aims to provide the international research community with essential data about the biogeochemistry and discharge of the six largest Arctic rivers (Yukon, Mackenzie, Lena, Yenisey, Ob' and Kolyma). The team is comprised of over 30 active scientists throughout the Arctic and is led by Max Holmes, James McClelland, Bruce Peterson, Peter Raymond, Robert Spencer and Suzanne Tank. More information at <http://arcticgreatrivers.org/index.html>.

P.P. Shirshov Institute of Oceanology of the Russian Academy of Sciences (IORAS)

Russian GEOTRACES studies were carried out in the Barents, Kara and Laptev seas by IORAS in 2007-2015:

- in the Kara Sea in summer 2007, 2011, 2013, 2014, 2015 (RV AKADEMIK MSTISLAV KELDYSH and RV PROFESSOR SHTOKMAN).

- in the Laptev and Barents seas in September 2015 (RV AKADEMIK MSTISLAV KELDYSH).
- cross-shelf transect in the Barents Sea in summer 2015.

The first Russian GEOTRACES Workshop took place at IORAS in Moscow in 2012. It was suggested to carry out cross-shelf transects in the Laptev, Kara, and Barents seas. Russian GEOTRACES interest includes biogeochemical processes in major river estuaries and shelves with special emphasis on suspended particulate matter and seafloor sediments and aeolian sediment transport in the Arctic.

Japan

In recent years, drastic summer decreases in Arctic sea ice could change the light and nutrient conditions for primary production and may further impact marine ecosystems. JAMSTEC has focused on the Pacific Arctic region, where the sea ice is drastically decreasing, and found that oceanographic and biological responses to the sea ice loss are quite different between the Alaskan and Siberian sides of the region (Fig. 4). However, on the Siberian side, data are still lacking and many biogeochemical processes may remain unknown. The objective to conduct hydrographic and biogeochemical surveys using RV MIRAI on the Siberian side is to investigate the spreading of Siberian shelf water into the Arctic basins and its impact on biological activities.

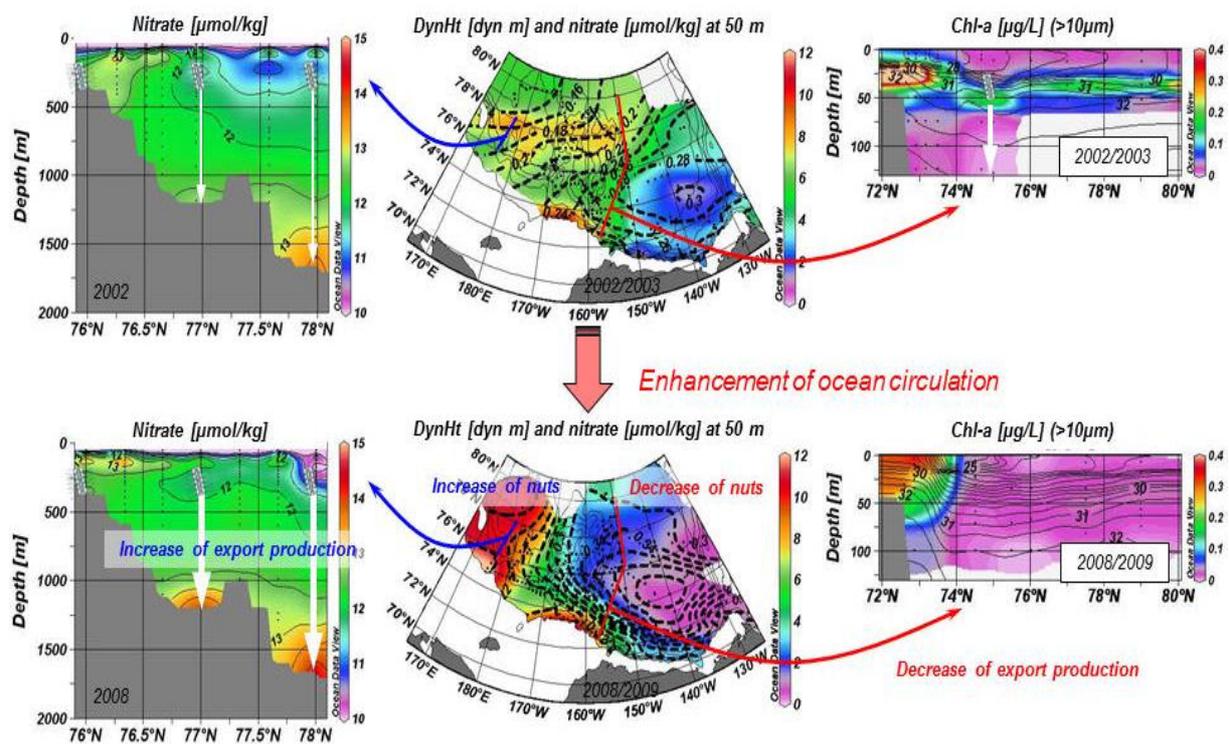


Fig. 4: Schematic of an enhancement of the Arctic Ocean circulation and changes in nutrient distributions and biological activities due to the recent loss of sea ice. (Middle panels): Distributions of dynamic height (dyn. m; dotted lines) at a depth of 50 m relative to 250 m and nitrate ($\mu\text{mol}/\text{kg}$; colors) at the 50 m depth in 2002/2003 (upper panel) and 2008/2009 (lower panel). (Right panels): Vertical sections of phytoplankton chlorophyll a ($\mu\text{g}/\text{L}$) in large-sized cells of $>10 \mu\text{m}$ (colors) and salinity (contours) along red lines in 2002/2003 (upper panel) and 2008/2009 (lower panel). (Left panels): Vertical sections of nitrate ($\mu\text{mol}/\text{kg}$; colors) along blue lines in 2002 (upper panel) and 2008 (lower panel). Data were obtained from cruises by the R/V Mirai in 2002, 2008, and 2009, USCGC Polar Star in 2002, and CCGS Louis S. St-Laurent in 2003.

Russian-American Long-Term Census of the Arctic (RUSALCA)

RUSALCA is a collaborative US-Russian multidisciplinary research project in the Bering and Chukchi seas. These seas are thought to be particularly sensitive to global climate change because they are centers where steep thermohaline and nutrient gradients in the ocean coincide with steep thermal gradients in the atmosphere. The Bering Strait acts as the only Pacific gateway into and out of the Arctic Ocean and as such is critical for the flux of heat between the Arctic and the rest of the world. Monitoring the flux of fresh and salt water as well as establishing benchmark information about the distribution and migration patterns of the life in these seas are also critical pieces of information needed prior to the placement of a climate-monitoring network in this region (www.arctic.noaa.gov/rusalca).

Special Oceanography RUSALCA issue online: <http://tos.org/oceanography/issue/volume-28-issue-03>.

AWI – Lena Delta

Since 2008 there have been several ship-borne expeditions in and around the Lena Delta. Some of the expeditions were based at/around the research Station "Samoylov" (www.awi.de/en/expedition/stations/island-samoylov.html). The focus has been on the following:

- Methane distribution and oxidation around the Lena Delta.
- Characterization of particulate organic matter.
- Origin-specific molecular signatures of dissolved organic matter.
- Impact of wind and tides on the Lena River freshwater plume dynamics.
- Lena Delta hydrology and geochemistry: long-term hydrological data.
- Ocean colour remote sensing.
- Phytoplankton community structure.

A summary can be found in Biogeosciences, "Interactions between the land and sea in the Lena Delta Region", vol. 12, 2012.

2. Cruise plans, wishes and dreams

NABOS-2:

The next expedition is planned in August-September 2017. International team (about 40-45 scientists) with following partners:

- IARC UAF USA
- AARI, St. Petersburg, Russia
- University of Washington, USA
- Woods Hole, USA

Berths are available; there are tight constraints in time and sample volume.

Synoptic Arctic Survey (SAS)

The present knowledge of shelf-basin interaction in the East Siberian Arctic Ocean is very rudimentary and lacks both spatial and temporal observations. To fill this gap repeat surveys of the sections as noted by the full lines in Figure 5 are suggested. The observations should

include CTD and water sampling from the surface to the bottom and preferable also complemented by surface sediment sampling.

Investigations on the carbon cycle of the Arctic Ocean have developed during the last decade, but even so many regions have not yet been studied. Furthermore, a synoptic survey of the Arctic Ocean carbon cycle, including the plankton community, is lacking. An observation program to address this topic is suggested along the interrupted lines of Figure 5. This is in agreement with the initiative SAS (www.synopticarcticsurvey.info). The observations should include CTD and water sampling from the surface to the bottom as well as plankton net sampling.

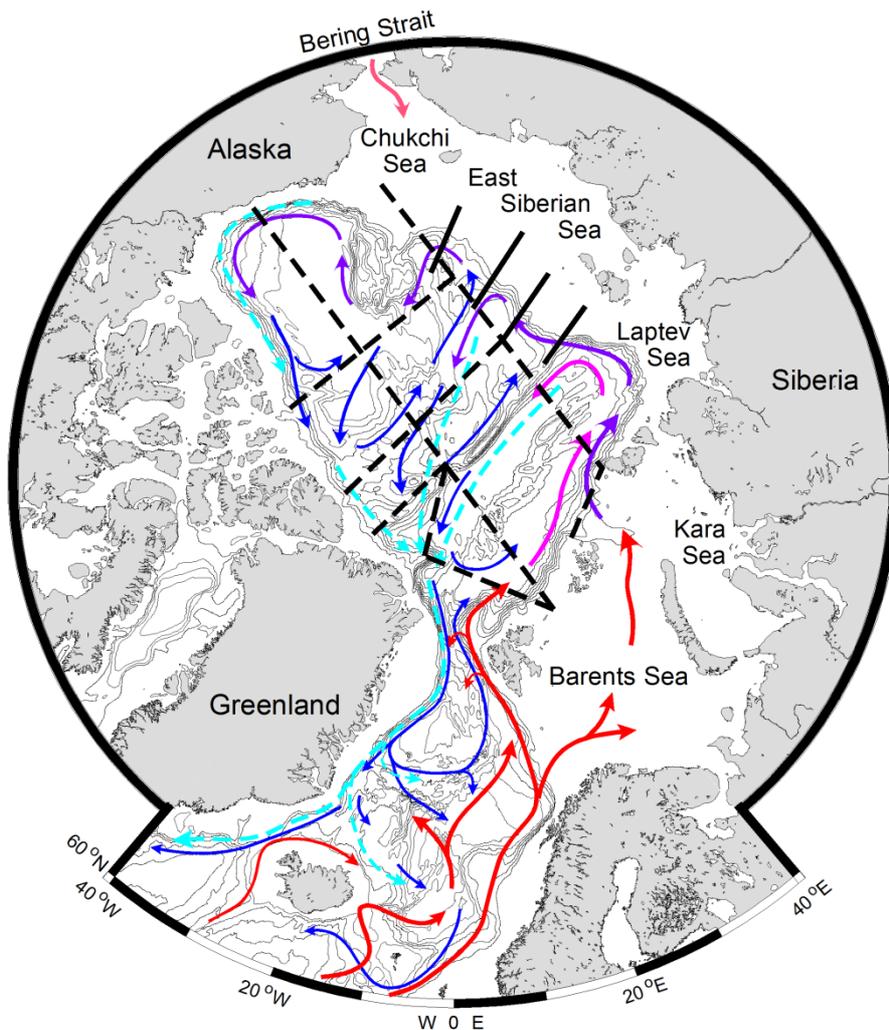


Fig. 5: Map of the Arctic Ocean with suggested sections noted. Solid lines for the study of the East Siberian shelf and basin exchange, interrupted lines for a synoptic study of the central Arctic Ocean.

ISSS and Lena River studies

The ongoing changes with increasing temperatures in the drainage basins of the large Arctic rivers are increasing the water flow as well as the amount and composition of the material transported to the shelf. On the shelf this material is impacted by biogeochemical processes prior to sedimentation or export from the shelf. In combination with less ice-coverage and an increased input from the rivers to the geochemical processes on the shelf, substantial changes are expected. To improve our understanding of the biogeochemical processes on the shelf we suggest sampling of water, particles and sediment along the coast of the Laptev and East

Siberian seas, areas for which there is very limited data. This would investigate various inputs into the shelf, including estuaries of both major rivers with broad watersheds and smaller rivers draining the tundra. Sampling would include campaigns into the lower reaches of the rivers to investigate contrasts in river chemistry. The impact of coastal erosion on the supply of sediments and dissolved constituents would be investigated within the shallowest near-shore regions.

TRANSDRIFT

A proposal has been submitted for a Russian-German three-year project. The main objectives are to investigate:

- the changes in oceanic transfer of energy, matter and momentum in the Transpolar Drift system as a result of climate change;
- the ecological consequences of climate change in the region of the Transpolar Drift Stream;
- regional changes of the atmosphere/sea ice/ocean system in the Arctic.

The planned research area will be the western Laptev Sea including the Vilkitsky Strait and the continental slope (Fig. 6). It is planned to carry out expeditions with Russian research vessels, deployment of seafloor observatories in the Laptev and Kara seas and at the Siberian continental slope, and year-round meteorological measurements at the Russian polar station of Cape Baranov. Of particular interest for the biogeochemical program are studies of new parameters, such as Ba isotopes and concentrations, Si isotopes and concentrations, REE concentrations, Nd isotopes and concentrations, and Hf isotopes and concentrations.

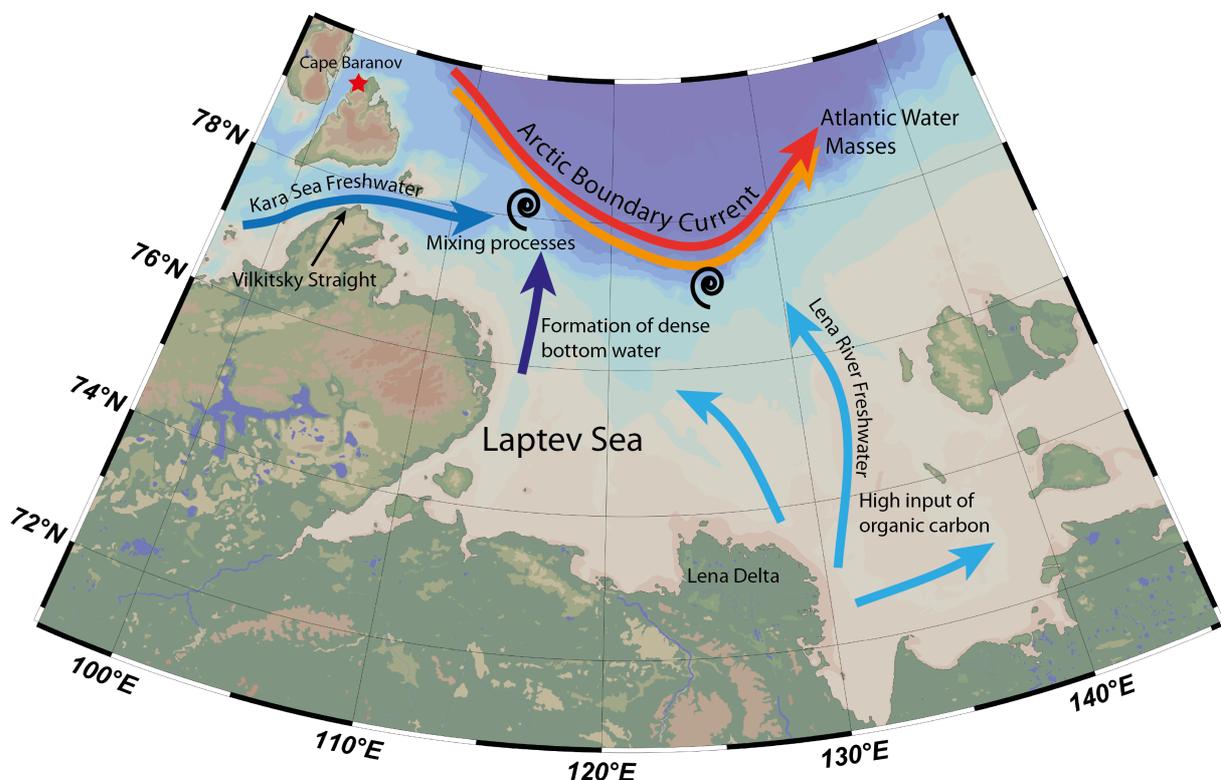


Fig. 6: Key area for the new project: NW-Laptev Sea and boundary current along the Siberian shelf seas.

GEOTRACES

The GEOTRACES breakout group with participants from the US, Sweden, Germany, the UK, France, Switzerland, and the Netherlands would be interested in participating in transects across Siberian Shelves. The idea of two transects, one across a narrow shelf (e.g., in the Kara Sea or Laptev Sea starting in the Lena Delta) and one across a broader shelf (e.g., in the East Siberian Sea) emerged as target scenarios for GEOTRACES process studies focusing on the inputs from land and the land-ocean exchange in this important high-latitude environment. The group was aware that separate studies in the watershed on the one hand (starting in the fresh water region and involving Samoylov Station if possible) and in the area from the estuary to the open shelf and open Arctic Ocean would likely have to be combined. There was an explicit wish to study the TEI behavior during early estuarine mixing in the three major rivers Lena, Yenisei, and Ob.

Japan

Figure 7 presents a plan of the RV MIRAI Arctic Ocean cruise in 2016. In 2017, there will also be a similar cruise for oceanography. Note that the RV MIRAI is planned to be used for meteorology in 2018 and 2019.

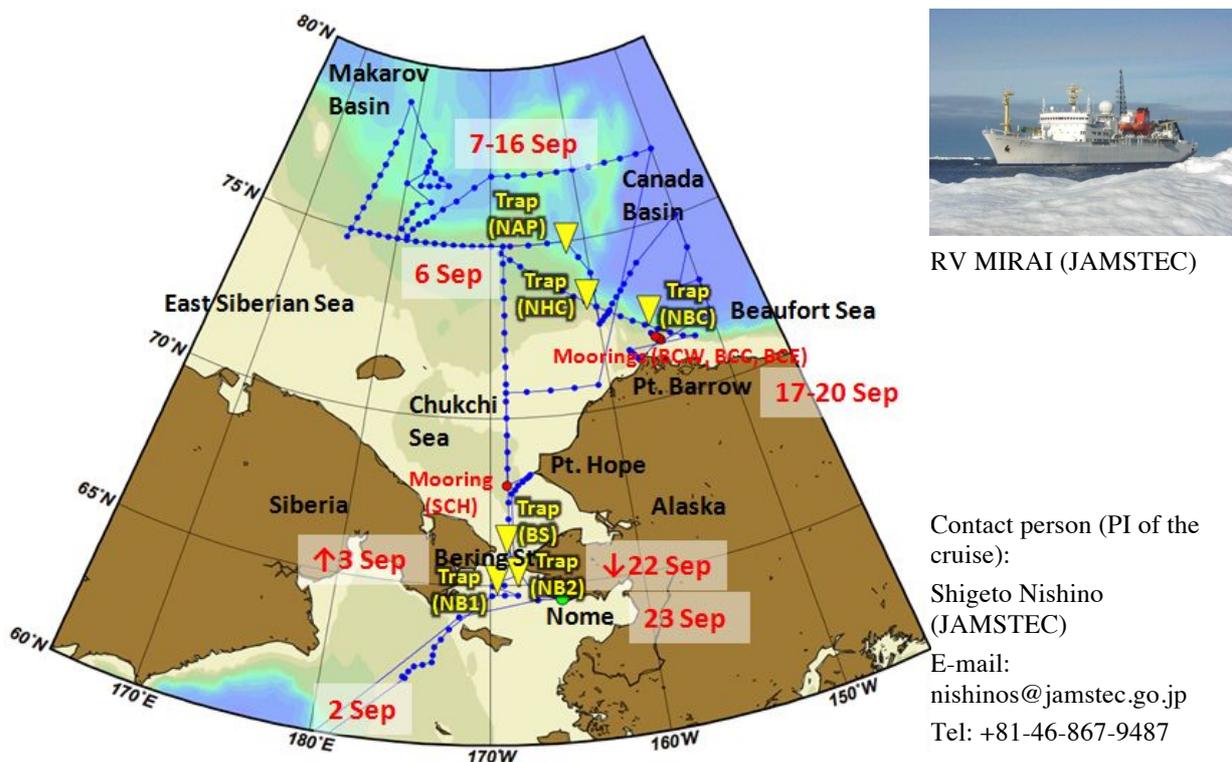


Fig. 7: Geographical areas of the intended work on RV MIRAI in 2016 with locations of sampling stations, and cruise tracks of survey lines in the Arctic Ocean. Planned points of stationary observations are represented by blue dots. Locations of moorings and sediment traps are represented by red circles and yellow triangles, respectively. The stations and cruise tracks are subject to change due to weather, sea ice, and other conditions.

Arctic-GRO

Arctic-GRO will continue to make measurements at the mouths of the six largest Arctic rivers. Here is a link to a map of their watersheds: <http://arcticgreativers.org/index.html>

The program is open to include additional parameters in the sampling program provided that analysis is guaranteed for samples of all 6 major rivers.

RUSALCA

The expedition planned for 2015 had to be cancelled. An expedition and service of moorings is planned for 2016 (Fig. 8). The extension of the working area to the west is now planned to be carried out by NABOS.

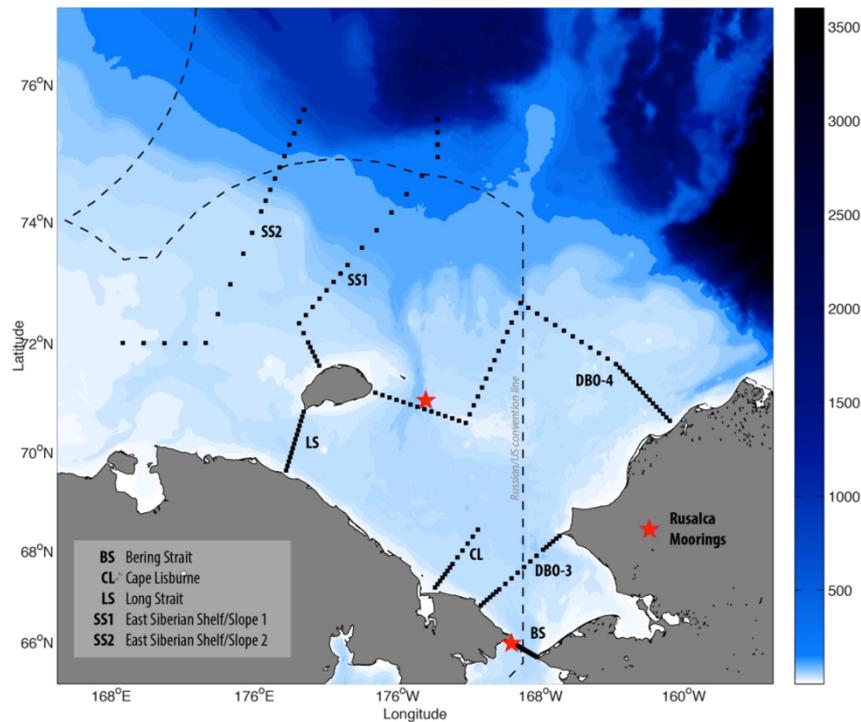


Fig 8: Sampling locations planned for RUSALCA in 2016.

P.P. Shirshov Institute of Oceanology of the Russian Academy of Sciences

Two expeditions to the Barents and Kara seas in summer 2016 are planned. The participation of foreign scientists is welcome in the expedition to the Kara Sea in 2017. The main goals are bacterio-, phyto-, zooplankton and benthos investigations as well as biogeochemical studies on composition of particulate and dissolved matter. The expedition program includes studies in the bays of Novaya Zemlya and the adjacent area. Here we provide monitoring of nuclear dumping areas. There are two potential sources of radioactive contamination: drowned equipment containing radioactive wastes as well as the glaciers on Northern Island of Novaya Zemlya.

In the Barents Sea it is planned to carry out multidisciplinary studies including toxic heavy metals and hydrocarbons. In addition moorings equipped with sediment traps and ADCP will be deployed and surface sediment cores will be taken. The distribution of Fe, Mn, Cd, Cu, Co, Cr, Mo, Ni, Pb, and As will be studied in suspended particulate matter and in sediments.

AWI – Lena Delta

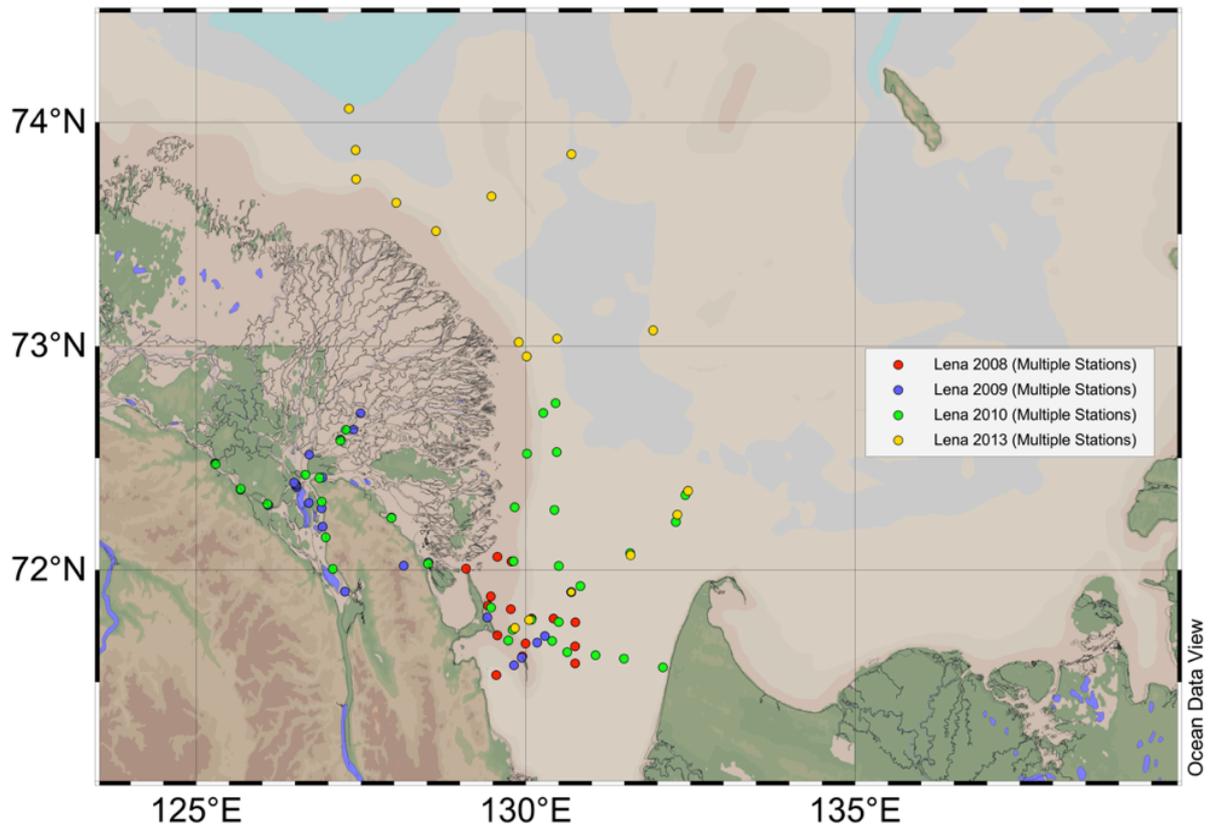


Fig. 9: Planned research work of AWI in 2016: repeated station work of the cruises in 2010 and 2013 (green and yellow dots) with better equipment, i.e., hydro-acoustical survey and information on the distribution of submarine permafrost where local hot spot of methane release could be expected. In addition it would be important to also have information on the winter situation in the Lena Delta.

AWI – Biology

An expedition with RV Polarstern is scheduled 2017 to study the Survival of Polar Cod in a Changing Arctic Ocean (SIPCA) in the region between approx. 28°-43°E, 81°-85°N. The expedition has a biological focus (phytoplankton, zooplankton, fish, particulate organic matter, life in and under the ice) but may give opportunities for cooperation.

3. Fields of synergy and overarching themes

- Freshwater budget
- Transpolar Drift System
- Boundary current studies
- Variability of Pacific and Atlantic water masses
- Land-Shelf-Basin interaction
- River- and estuarine systems (ArcGro)

- Exchange of information and archived samples
- Opportunities in cruise participation

4. Gaps in knowledge

- Seasonal variability and river break-up
- Influence of anthropogenic changes
- Distribution of trace metals (water column and sea ice)
- Bottom-boundary and bottom-nepheloid layer processes
- Reactive processing of DOM in the Siberian Shelf seas

- Sampling during river break-up
- Biochemical sensors and autonomous sampling systems
- Ultraclean sampling

5. New opportunities for cooperation in trace element research with Russia

- Barents/Kara/Laptev Sea expedition in 2017 (IORAS)
- Student training in trace-element analysis and ultraclean sampling (GEOTRACES, SCOR)
- Trace metal sampling onboard Russian research vessels (Teflon samplers, clean rosette system with Dyneema cable, Kevlar wire, clean-lab container etc.)
- Intercalibration programs with Russia

Appendix

- Agenda
- List of participants
- Biogeochemical parameters covered by the various programs

Biogeochemical Studies in the Siberian Shelf Seas

Kiel,
26-28 January 2016

Agenda

Venue:
GEOMAR, Conference Hall, East Shore Campus, main building (no. 8)

Tuesday, 26 January 2016

Arrival of the participants
Checking into the Hotel Am Segelhafen, Schoenberger Str. 32-34, Kiel

19:00 Icebreaker/ dinner at the GEOMAR Cafeteria, main building (no. 8)

Wednesday, 27 January 2016

09:00-09:15 Welcome, schedule, practical details
M. van der Loeff, H. Kassens

Plenary talks: Presentations of ongoing programs with objectives, institutions and scientists involved, expeditions, field methods, major results

Session chair: H. Kassens

NABOS

09:15-09:30 Overview of NABOS-II program
V. Ivanov

Biogeochemical Studies in the Siberian Shelf Seas

09:30-09:45 NABOS
R. Rember

09:45-10:00 NABOS
T. Kanzow

SWERUS/ISSS-08

10:00-10:20 SweRus background and results; some results from ISSS-08
L. Anderson

10:20-10:40 Biogeochemical observations along the Eurasian-Arctic continental shelf, results from the ISSS-08 and the Lena River
P. Andersson, D. Porcelli

10:40-11:00 Carbon cycling on the East Siberian Arctic shelf; results from the ISSS-08 cruise
B. van Dongen

11:00-11:30 Coffee break

GEOTRACES

11:30-11:45 Arctic GEOTRACES - Introduction
M. Rutgers van der Loeff

11:45-12:00 Arctic GEOTRACES - US Expedition 2015
D. Kadko

12:00-12:15 Trace metals in the Atlantic and Arctic Oceans. Do we need to know about the Siberian shelves?
M. Rijkenberg

12:15-12:30 Arctic mercury puzzle(s)
L.-E. Heimbürger

12:30-14:00 Lunch at the GEOMAR Cafeteria

Biogeochemical Studies in the Siberian Shelf Seas

Plenary talks continued

Session chair: M. Rutgers van der Loeff

OTHER BIOGEOCHEMICAL STUDIES IN THE SIBERIAN SHELF SEAS

- 14:00-14:20 Tara Ocean Polar Circle 2013
S. Pisarev
- 14:20-14:40 JAMSTEC researches on the biogeochemical dynamics in the Siberian Arctic Ocean and their differences from those in the Alaskan side
S. Nishino
- 14:40-15:00 Results of research expeditions to the Barents, Kara and Laptev seas by P.P. Shirshov Institute of Oceanology of RAS in 2007–2015. Russian GEOTRACES research in the Arctic
M. Kravchishina
- 15:00-15:20 Variability of the transpolar system of the Arctic Ocean
L. Timokhov
- 15:20-15:40 The Arctic Great Rivers Observatory
R. Spencer (SKYPE)
- 15:40-16:00 Characteristics and flow of Pacific water in the Chukchi Sea: results from the RUSALCA expeditions
M. Pisareva
- 16:00-16:30 Coffee break

TRANSDRIFT

- 16:30-16:45 Transport of dissolved organic matter and associated freshwater pathways in the Laptev Sea
J. Hölemann, D. Bauch and members of the "Laptev Sea System" project
- 16:45-17:00 Hydrochemical conditions on the Laptev Sea shelf in summer
A. Novikhin, V. Povazhnyy, J. Hölemann, F. Martynov
- 17:00-17:15 Water mass provenance and mixing in the Laptev Sea based on dissolved Nd isotopes and REE distributions
G. Laukert, M. Frank, E.C. Hathorne, C. Wegner, D. Bauch, H. Kassens, L. Timokhov

Biogeochemical Studies in the Siberian Shelf Seas

17:15-17:30 Biochemical studies in the Laptev Sea
V. Povazhnyy

Discussions

17:30 Discussions

19:00 Dinner at the GEOMAR Cafeteria

Thursday, 28 January 2016

Plenary talks: Presentations of ongoing programs with objectives, institutions and scientists involved, expeditions, field methods, major results

Session chair: C. Wegner

EARLY CAREER SCIENTISTS: SHORT PRESENTATIONS

09:00-09:15 Particle transport derived from Pa/Th and its impact on biogeochemistry in the Mediterranean and Arctic Ocean
S. Gdaniec

09:15-09:30 U-236 in the Arctic Ocean and implications of using U-236/U-238 and I-129/U-236 as a new dual tracer
N. Casacuberta Arola

09:30-09:45 Phytoplankton communities in the Laptev Sea
I. Kryukova, Ye. Polyakova, F. Martynov, E. Abramova, A. Novikhin, H. Kassens, J. Hölemann

09:45-10:00 Neodymium isotopes and rare earth elements in the Arctic Ocean
R. Paffrath

10:00-10:15 New perspectives on nitrogen cycling in the Arctic Ocean
T. Shiozaki

Biogeochemical Studies in the Siberian Shelf Seas

10:15-10:30 Dissolved organic matter in the Arctic
H. Reader

10:30-11:00 Coffee break

Plenary discussions

Session chair: M. Rutgers van der Loeff

11:00-12:30 Plenary discussions. Suggested topics:

- Where do programs complement each other? Identifying fields of synergy
- Identifying overarching themes: freshwater budget, origin and characteristics of the Transpolar Drift, distinguishing Pacific/ Atlantic water, land-shelf-basin interactions, activities in the estuarine system of the River Lena

12:30-14:00 Lunch at the GEOMAR Cafeteria

Plenary discussions

Session chair: H. Kassens

14:00-15:30 Plenary discussions. Suggested topics:

- Identifying gaps in knowledge
- Explore options for future cooperation in studies and expeditions:
 - How can we involve more Russian scientists?
 - How can we organize future expeditions to the Russian shelf with Russian ships?
 - What options are there to bring ultraclean sampling gear onto Russian ships?

15:30-16:00 Coffee break

Biogeochemical Studies in the Siberian Shelf Seas

Plenary discussions

Session chair: H. Kassens, M. Rutgers van der Loeff

16:00-18:30

Plenary discussions:

- Synthesis of the meeting, distribution of tasks and responsibilities for writing a meeting report and EOS publication
- Outline for meeting report and EOS publication

19:00

Dinner at the GEOMAR Cafeteria

Friday, 29 January 2016

Departure

Biogeochemical Studies in the Siberian Shelf Seas

List of participants

No.	Name	Adress
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Biogeochemical parameters covered by the various projects

	Arctic-GRO	NABOS	TRANSDRIFT	GEOTRACES	ISSS/ Lena	Shirshov	Japan	Synoptic Arctic Survey	RUSALCA	Lena Delta (AWI)	Arctic Ocean (AWI)
Physics											
temperature	x	x	x	x	x	x	x	x	x	x	x
salinity		x	x	x	x	x	x	x	x	x	x
¹⁸ O	x	x	x	x	x			x	x		
² H	x										
LADCP		x							x		
fluorescence		x	x								
light transmission		x				x	x				
turbidity			x					x			
PAR		x					x				
suspended particles	x		x			x					
particles volume concentration						x					
sinking particles (trap)						x					
Chemistry											
pH	x							x			
alkalinity	x	x	x				x	x			
CO2 system		x		x			x	x			
dissolved oxygen		x	x	x		x	x	x		x	
nutrients	x	x	x	x	x		x	x	x		
Anions Cl, SO ₄ , F	x										
Cations Na, Ca, Mg, K	x										
Trace elements											
Fe Al Zn Mn Cd Cu				x	x						
As, Mn, Mo, Ni, Sb, Sr, U	x										
Ba	x	x	x								
Hg	x			x							
²³⁰ Th/ ²³¹ Pa				x							
REE			x	x	x						
Nd isotopes			x	x	x						
Pb isotopes				x							
Fe isotopes					x						
Li Sr isotopes					x						
Ra isotopes				x	x						
¹³⁷ Cs						x			x		
SF ₆								x			
CFC								x			
particulate trace elements				x	x	x (*)					
colloidal fractions					x						
aerosols				x		x					
Organics											
DOC	x		x	x	x			x	x		
DOC ¹³ C, ¹⁴ C	x							x			
CDOM	x		x	x				x			
POC	x			x		x			x		x
POC ¹³ C, ¹⁴ C	x			x	x	x					
PON	x			x		x			x		x
PON 15N	x			x		x					
methane								x		x	
hydrocarbons						x					
Biology											
chlorophyll		x	x			x	x	x	x		x
phytopigment						x					x
bacterioplankton						x					
primary production		x	x				x				
phytoplankton				x		x	x	x			x
zooplankton				x		x		x	x		x
fish										x	x
marine mammals							x		x		
hydroacoustics						x			x		x
Sediment and Ice											
benthos						x	x		x		
ice sampling										x	
bottom sediments composition			x			x		x	x		