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Research in the Laptev Sea region

Proceedings of the joint Russian-German workshop November 8-11, 2010, St. Petersburg, Russia

Edited by
Sebastian Wetterich, Paul Pier Overduin, Irina Fedorova
with contributions of the participants

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1. PREFACE

PP Overduin [(1)], S Wetterich [(1)], I Fedorova [(2)]

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The necessity for a meeting between Russian and German researchers working in the Laptev Region is a direct result of the intense activity and the history of co-operative work that has occurred there over the past two decades. In 2010, for example, over 9 field joint campaigns were planned, in winter and summer months, on land, on the water and from the ice surface, including researchers from many disciplines studying the Laptev Sea region and its place in the Arctic system.
To foster this multi-disciplinarity, to provide a venue for exchange of results and experiences, to inspire one another with scientific insights and to plan and co-ordinate future activities, particularly those to be carried out in 2011, members of the Alfred Wegener Institute for Polar and Marine Research (AWI) in Germany and of the Arctic and Antarctic Research Institute (AARI) in Russia decided to hold a joint workshop on the Laptev Sea. The Otto-Schmidt Laboratory (OSL), a joint venture of the two institutes, offered to host the workshop together with AARI.

The goals of the workshop followed three broad directions:

(1) The main goal was to foster scientific collaboration between disciplines and between groups separated in their field work temporally (by season) or by logistical platform. Through the exchange of results gathered over the past it is hoped that discussions lead to the sparking of new ideas.

(2) Expedition planning for the years 2011-2013 formed the basis for many of the discussions surrounding the science presented at the workshop.

(3) Joint scientific products arising out of the collaborative research and field work include joint papers, special issues, monitoring programs and shared databases, new partnerships and the integration of young scientists in bi-national studies.

The workshop attracted a group with broad interests. Over 60 participants registered, about half of whom were Russian, and half German (Fig. 1-1). About 20 students participated. Six broad themes were identified and provided structure for both science sessions and planning in four discussion groups. During the workshop, in total 68 abstracts were presented as talks or posters. Two presentations given by Joern Achterberg of the German Research

Foundation's (DFG) Moscow office, and Martin Sandhop of the Helmholtz Association of German Research Centres' (HGF) Moscow office, highlighted the current state of and perspectives in Russian-German research cooperation.

Figure 1-1: Group photograph of the participants (Picture taken by H. Kassens).

For over one decade joint Russian-German research in the Laptev Sea region has been kindly supported by the Russian Foundation for Basic Research (RFBR), the German Research Foundation (DFG), the German Academic Exchange Service (DAAD), the Helmholtz Association of German Research Centres (HGF), and the Russian and German Federal Ministries of Education and Research via various programs and funds.

The workshop was a great success due to the enthusiasm and interest of its participants and the technical and logistical support of the AARI/OSL organizing team (Antonina Chetverova, Elena Berezina, many others) which are hereby gratefully acknowledged.

This proceedings volume represents a snapshot of recent and current scientific interests and activities within the framework of joint Russian-German research. It furthermore records and summarizes the discussions held in the thematic working groups in order to promote and facilitate future research in the Laptev Sea region.

2. METHANE AND TERRESTRIAL CARBON STOCKS (SESSION I)

Methane distribution in the Lena Delta

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Methane is an important greenhouse gas with several potential sources in the Arctic region. It may be stored in Permafrost and released with its melting. It could be produced through the anoxic degradation of organic material released by the permafrost, or it could be transported by the Lena River. First results on the methane distribution from the Lena 20008 and 2009 cruise indicate no simple mixing of methane rich river water with methane poor seawater, but a more complex patter, where microbial methane oxidation may also interfere.

Microbiological methane emission in the boreal ecosystems of cryogenic Siberia zones

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Carbon dioxide is known to be the major contributor to the green-house effect; however, its annual increase in the atmosphere has slowed down markedly in recent years. The methane (CH_4) concentration in the atmosphere has more than doubled over the last 300 years and is currently increasing at an annual rate of 0.8 to 1.0% per year [Dedysh , 2002].

The arctic and sub-arctic zones of Siberia are considered to be among the most active atmospheric methane sources. The CH_4 emission is controlled by the degree of drowning, the temperature, the amount of organic matter, the vegetation and the methanogenesis and methanotrophic processes. As a rule on the territory of Siberia the emission of modern biogenic methane, which is active source of atmospheric methane occurred from the natural ecotopes [Galchenko, 2001]. A considerable amount of methane does not participate in the contemporary biogeochemical cycle, since it is stocked in the permafrost together with living anaerobic microorganisms including methane-producing bacteria (Archaea). Methane production can occur at below-zero temperatures

(down to –16.5^{o}C) in permafrost depositions [Rivkina et al., 2006; Gilichinsky, 2002; Wright et al., 1998]. We have carried out our
investigations in the two Siberian regions which are located in the permafrost zone. There are the Central Evenkia (forest ecosystem) and Lena Delta (tundra ecosystem). The general aim is the estimation of microbial emission and the CH_4 absorption of the cryogenic soils simultaneously using of the unified methodology. We used the method of closed chambers (Wagner et al., 2003) for fixing the methane release with the surface of the soil during July and August.

It was determined that from11.7 to 50.4 mg/m^2/day of CH_4 was risen with the soil surface in the tundra ecosystem. The difference in the methane fluxes between of the polygon centre and rims was 1.7-2.8 times. The methane flux value was from 8.9 to 34.7 mg/m^2/day in the forest ecosystem and depended on the amount of precipitations incoming from the atmosphere to the soil. The obtained data permit to tell about the similarity of microbial processes of methane transformation, occurring in the mineral soil layer of the both ecosystems. The methane flux in tundra ecosystem was 2.2 times higher than in the forest ecosystem.

The presence of archaeabacteria was determined by the molecular genetic method. Methanogenic archaea belonging to the uncultivated Rice cluster II of *Euryarcheota* was dominant in our samples and another big archaebacteria group belonged to the uncultivated Rice Cluster IV of *Crenarcheota*.

The work was supported by the Ministry of Education and Science of the Russian Federation: the program “Development of the scientific potential of the Higher School”, the project № 2.1.1/6611 and Russian Foundation for Basic Research (RFBR) 09-04-01 380-a.

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Biomarkers indicating the variability of methanogenic and methano-trophic communities within late Pleistocene and Holocene permafrost deposits of Kurungnakh, Siberia

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Permafrost environments are supposed to be strongly affected by the currently observed global temperature rise. About one third of global soil carbon is stored in permafrost and an increase in temperature might increase the microbial turnover of recent as well as ancient carbon and cause the release of large amounts of greenhouse gases such as methane. To predict the risk for future climate and to estimate the global atmospheric carbon budget, it is important to understand the microbial driven methane dynamics and their response to climate changes in the past. Therefore, a combination of quantitative as well as qualitative analyses of bacterial and archaeal communities was accomplished to reveal variations in permafrost deposits of the Siberian Lena Delta. A 23 m long permafrost core drilled in 2002 on Kurungnakh Island, Lena Delta, Siberia, was examined using biogeochemical as well as microbiological methods. As a general result it is shown that it was possible to recover lipid biomarkers and amplifiable DNA throughout the Kurungnakh permafrost sequence with an age of up to 42 ka. First analyses of intact glycerol dialkyl glycerol tetraethers (GDGTs) were conducted. GDGTs provide paleo-signals of archaeal and bacterial communities, since these lipids are already partly degraded but their core lipids are relatively stable outside intact cells. Highest amounts of ether lipids were found in the upper layer and at the bottom of the core. Generally, the results of GDGT analyses correlate to measured contents of total organic carbon (TOC) and concentrations of in-situ methane in the deposits. Furthermore vertical variations of archaeal biomarkers such as archaeol, caldarchaeol and crenarchaeol could be detected. To complete our information on the qualitative composition of microbial communities, DNA-based analyses using DGGE and clone libraries were conducted using archaeal and methanotrophic specific primer combinations. Fingerprints of archaeal 16 S rRNA gene sequences of the different permafrost samples show variations within the vertical profile. Sequence analyses showed a distinct diversity of methanogens affiliated with Methanobacteriaceae, Methanosarcinaceaea and Methanomicrobiaceae. Highest diversity of methanogens could be detected at depth of 1507 cm and 1745 cm, which were also characterized by high amounts of archaeol. Both biogeochemical as well as microbiological methods revealed variation within the composition of past and present microbial communities and showed indications of response to climate changes.

Freeze back variability of the polygonal tundra – implications for green house gas emissions

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Observations indicate a massive warming in the Arctic during the last decades and climate models predict an even increased warming trend in the following century. The changing climate conditions most likely lead to the degradation of Permafrost, which in wet tundra regions is often related to the formation of thaw lakes [Hinkel et al., 2003]. The relevance of such water bodies for the emission of green house gases in high latitude wetlands has been demonstrated recently [Walter et al., 2006]. The
present discussion mainly focuses on larger lakes, which do not freeze completely during winter. However, small and shallow water bodies occur frequently, in particular in the polygonal tundra which is a typical arctic landscape. According to their depth and energy balance such ponds feature specific periods of unfrozen sediments at the ground, favourable for microbial activity. In this study we present long-term energy balance measurements of a typical polygonal pond at an arctic tundra site in northern Siberia. The measurements reveal a high inter-annual variability of time required for freezing which can differ up to several months, whereas thawing appears to be a more constant process. The observed temporal variability is closely related to the snow cover evolution and the cloudiness, which both significantly alter the surface energy balance during the winter season. These results suggest a high inter-annual variability of green house gas production and storage during the refreezing period, possibly leading to significant differences in green house gas emissions during the melt of ice cover.
Due to the observed sensitivity of refreezing, future work on microbial activity and the energy balance of small water bodies in the Arctic is highly desirable for understanding the emission potential of green house gases of permafrost regions.

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In situ studies of methane turnover in northern wetland soils - application of isotopic measurements

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Arctic northern wetlands are projected to face both the strongest future warming and an increase in precipitation. As they store large quantities of organic carbon, these soils bear the potential to enhance global warming by adding methane emissions to present anthropogenic greenhouse sources and induce a positive feedback. Climate change might affect both the processes of methane production and oxidation. However, the driving biophysical mechanisms and their response to changing environmental parameters are still insufficiently understood and estimates from emission models are highly diverging and therefore not yet included explicitly in climate models. Thus, it is of concern to develop new techniques that better describe the controlling parameters of methane turnover.

Recent studies show that the efficiency of methane oxidation in landfill cover soils and riparian wetlands may be determined by measurements of the stable isotope signatures in methane and carbon dioxide since microbial methane oxidation and diffusion result in a substantial stable isotope fractionation. The applicability of this method for peatlands is studied *in situ* on Samoylov Island in the Lena River Delta, Russia. In addition, the supplemented method will be used to study the impact of water level and temperature change on methane turnover.

The impact of water level on methane turnover is examined at five sites with different hydrology where gas samples are taken at several depths to measure the isotopic composition of soil CH_4 and CO_2 along the diffusive way through the soil. Methane turnover of each site and horizon is calculated.

Measurements at a water-saturated site showed that fractionation by diffusion plays a greater role in the upper horizons which have a higher pore volume (up to 90%). Here, the fractionation factor of the topmost horizon, α_{trans} 1.019, is close to the theoretical maximum value (1.0195). Furthermore, in all horizons diffusion coefficients at field capacity range around $10^{-7} m^2 s^{-1}$ and do not change significantly once macropores are drained. These first results demonstrate that water level and pore volume have to be carefully considered when quantifying methane turnover using stable isotope measurements.

Organic matter composition and dynamics in Siberian permafrost soils

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Rising global temperatures are likely to increase the rate of organic matter decomposition in the active layer of permafrost soils. Most studies on organic carbon dynamics suggest that labile material is decomposed first, followed by the degradation of more recalcitrant organic components. This will lead to considerable changes in the composition of permafrost soil organic matter, i.e. it should become proportionally enriched in more resistant material. Another aspect is the deepening of the active layer thawing during summer which will expose previously frozen organic material to microbial degradation. At present little is known about the quality and degradability of the organic substrate below the permafrost table. Both aspects are crucial for a reliable estimation of the consequences of rising soil temperatures and the release of CO_2 and CH_4 from arctic permafrost soils.

Compositional changes of organic matter can be investigated most efficiently at molecular level. Lipids are a small but important fraction in soil organic matter consisting of different compound classes of different origin and degradability, e.g. fatty acids, n-alkanols and n-alkanes. The distribution of different organic compounds at different soil depths can be used to identify different carbon 'pools'. ^{14}C analysis of bulk soil and compound specific for certain sources gives additional information on the turnover of labile and more recalcitrant organic materials.

The aim of this study is to identify the quality and degradability of organic matter in soil of the Lena Delta region. We present first results on lipid distributions and ^{14}C contents in soils of different polygon structures (centre and rim) on Samoylov Island and Tit-Ary Island, located south of the tree line. Elemental analyses of soil profiles on Samoylov Island indicate better preservation of more strongly decomposed organic matter close to the permafrost table of the polygon rim. Total organic carbon contents and C/N ratios in the polygon centre suggest that organic carbon turnover is faster preventing the accumulation of organic carbon at greater depth of the active layer.

Expanding carbon flux investigations to the regional scale

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Carbon dioxide and methane fluxes between the tundra of the Lena River Delta and the atmosphere have been measured at the Russian-German Research Station Samoylov since 2002, contributing important data on land-atmosphere interactions from an underrepresented region. However, greenhouse gas emissions are spatially and temporally highly heterogeneous. On the other hand, global climate models run on coarse resolutions and thus, measurements from a single point, even if this point covers a few hectares or square kilometres, are not necessarily representative and in any case associated with large uncertainties if extrapolated to larger regions. This problem could be addressed by a monitoring strategy covering both the temporal and the spatial realm: a) continued and long-term micrometeorological measurements at the existing sites should be expanded to year-round operation and remote control (i.e. data streaming to AARI and/or University of Hamburg) to capture the annual and inter-annual variability, and b) spatial representation should be added through the use of the airborne CO_2/CH_4 spectrometer system MAMAP (Methane Airborne Mapper), which can be installed on small airplanes and helicopters. Coordinated deployment of both methods could provide unique and comprehensive data on both terrestrial and marine surface-atmosphere gas exchange and thus also link ongoing research in the Lena River Delta with current and future investigations in the Laptev Sea.

Organic carbon stored in late Quaternary permafrost deposits

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Permafrost deposits constitute a large carbon pool highly sensitive to degradation and potential carbon release due to global warming. Several permafrost sections at coast and river bank sections of the Laptev and East Siberian seas, in the Lena River Delta and in the Indigirka-Kolyma lowland region were studied for total carbon (TC), total organic carbon (TOC), organic matter (OM) parameters (C/N, $\delta^{13}C$), and gravimetric ice content. Such permafrost deposits were formed under different environmental conditions during the Late Quaternary climate cycles. Organic matter stored in these

sequences grew, froze, partly decomposed, and refroze under different periglacial environments reflected in specific cryolithological features and carbon signatures. Frozen organic matter consists of well-preserved wood fragments, roots, leafs, peat inclusions as well as tree stems in interglacial deposits. In addition, numerous filamentous grass roots and organic detritus are common. The vertical organic carbon distribution is highly variable and varies from 0.1 up to 40 wt% of the dry sediment. Variations in organic matter parameters are connected to changes in bioproductivity, pedogenic processes, in decomposition and sedimentation rates, as well as in plant associations related to climate changes. High TOC, high C/N, and low $\delta^{13}C$ reflect less-decomposed OM under anaerobic conditions that is characteristic of interglacial and interstadial periods. Glacial and stadial periods are characterised by less variable, low TOC, low C/N, and high $\delta^{13}C$ indicating stable environments with reduced bioproductivity, stronger OM decomposition under relatively dry, aerobic conditions.
These results were obtained within the frame of the Russian-German science cooperation “SYSTEM LAPTEV SEA” studying permafrost sequences in northern East Siberia as frozen paleoenvironmental archive since 1998. This successful collaboration was realized by joint expeditions, bilateral visits and publications of partners from the Moscow State University, the Permafrost Institute in Yakutsk, the Arctic and Antarctic Research Institute St. Petersburg together with the Alfred Wegener Institute, the Institute of Soil Science Hamburg University and several more Russian and German institutions.

Asymptotic approach to permafrost methane emission problem

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Mathematically, melting tundra process can be described, for example, by the classical Stefan approach. However, it is difficult to resolve the multidimensional Stephan problem numerically. We propose here another approach to this problem using a natural assumption that the horizontal dimensions of the permafrost layer are much larger than the layer depth. This approach has a good theoretical and mathematical base (the phase transition theory), and it can be considered as a generalization of the Stefan method. This generalization has, as we show, many advantages and ideally adapted to the Siberia methane problem. First, we can take into account that the melting layer has a non-zero width. Second, numerically it is more convenient, we need no special methods. It is more natural physically because it is based on the fundamental Ginzburg-Landau physical theory and the concept of the order parameter. Third this leads to transparent final relation for the methane production rate.

This new idea has an important advantage from the numerical point of view. Namely, here we resolve an initial boundary value problem, and the melting front can be found automatically, as a result of this numerical procedure. It is not necessary to search a ice-melt boundary. Moreover, there are possible asymptotical approaches based on so-called the mean curvature motion. This approximation can be obtained for all models where we have an energy functional and where the melting front is narrow. Notice that in this approach the melting layer has a natural size, it is not infinitely narrow. We apply the mean curvature approach following from the phase field equation to a system of a number of small lakes that produces a methane in Siberia. This lakes are swallow and the averaged lake form, approximately, is circular. The last observation is important since this confirms the mean curvature ideas. This approach allows us to obtain a simple formula describing a possible dependence of methane production in Siberia on the temperature. This formula allows to investigate a positive feedback that may generate a climate Armageddon. We show, by numerical simulations and analytical arguments, that this Armageddon effect depends crucially on the parameters of chemical reactions producing the methane. There participate both biochemical and chemical reactions, the results depend on potential barriers involving in these reaction rates.

The Russian-German research station Samoylov, Lena Delta - A key site for polar research in the Siberian Arctic

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The Lena Delta – located at the Laptev Sea coast of northeast Siberia – is a key region for the understanding of the basic processes of the dynamic and development of permafrost in the Siberian Arctic. In the frame of the Russian-German scientific co-operation under the umbrella of the German Federal Ministry of Education and Research (BMBF) and the Russian Ministry of Science and Education projects System Laptev Sea, System Laptev-Sea 2000 and the Dynamics of Permafrost in the Laptev Sea important scientific results for the understanding of carbon dynamics and involved microbial processes and communities, of the energy and water budget of Arctic tundra, of the development of the ice-rich permafrost and of Arctic coastal dynamics could be elaborated. The obtained results are the necessary data and information base for the prognosis of the impact of possible climate changes to the sensitive ecosystems of the Arctic.
For long-term investigations of the processes of permafrost formation and decay, transformation and emission of green house gases (CH_4, CO_2, H_2O), thermal and hydrologic studies on the active layer and – not at least – as a

logistic base for field investigations of the environment, formation and development of the Lena Delta and the relict late Pleistocene permafrost, the small research station Samoylov of the Lena Delta Reserve (LDR) was used and has been developed further under contribution of the Alfred Wegener Institute (AWI) into an ideal location for coastal and terrestrial polar research. Within this context Samoylov Station has been the base and starting point for numerous international expeditions in the Siberian Arctic like the expeditions Lena 1999 through Lena 2010, the expedition COAST I as well as many sub-projects of some marine expeditions to the Laptev Sea.

Investigation of soils and their organic carbon contents along a north-south transect in Northern Yakutia, Russia

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Permafrost-affected soils cover nearly one fourth of the terrestrial surface in the northern hemisphere. The estimations of their carbon pool vary from 15 to 30% of the global soil organic carbon. A huge amount of the carbon pool is permanently frozen and excluded from the atmospheric cycles. In the future, permafrost is likely to become a carbon-source, and formation of CO_2 and CH_4 will probably increase due to the predicted climate change with distinct temperature increase especially in Polar Regions. The knowledge of the soil organic matter pool is still poor for the cold regions of Russia. The estimation of the soil organic carbon pool dimensions in North-East-Siberian permafrost regions is the key is-sue of this project. During an expedition to Yakutia in 2009, investigations of several soil profiles have been carried out along a north-south temperature gradient to deter-mine the quantity and quality of carbon stored in permafrost-affected soils of different vegetation zones from tundra to northern taiga.

The study sites were located along a north-south transect (73° to 69° N) on the western side of the Lena River (Fig. 2-1).

The climate in the investigation area is arctic-subarctic with continental influence and characterized by low temperatures and low precipitation. The mean annual air temperatures, measured in Tiksi (71°41'N / 128°42'E) and Dzhardzhan (68°49'N / 123°59'E) were -13.6 °C and -19.3 °C; respectively. The mean annual precipitation was 319 mm and 130 mm. The average temperatures of the warmest months August in Tiksi and June in Dzhardzhan were 7.1 °C and 14.9 °C, respectively. Warm summers are of vital importance for development of soils and vegetation.

The preliminary results shown below (Tab. 2-1) give a first impression of the extreme high carbon and low nitrogen contents of the different investigated soils. TOC contents and C/N ratios were higher at the southern than at the northern sample points. The pH values vary from 7.3 to 3.7.

The presented data leads to a preliminary conclusion that increasing summer temperatures have an effect on plants growth and the consequential accumulation of organic matter in soils whose decomposition and mineralization is poor. Further analyses will work out the influences of parent material and the different soil properties on the carbon content.

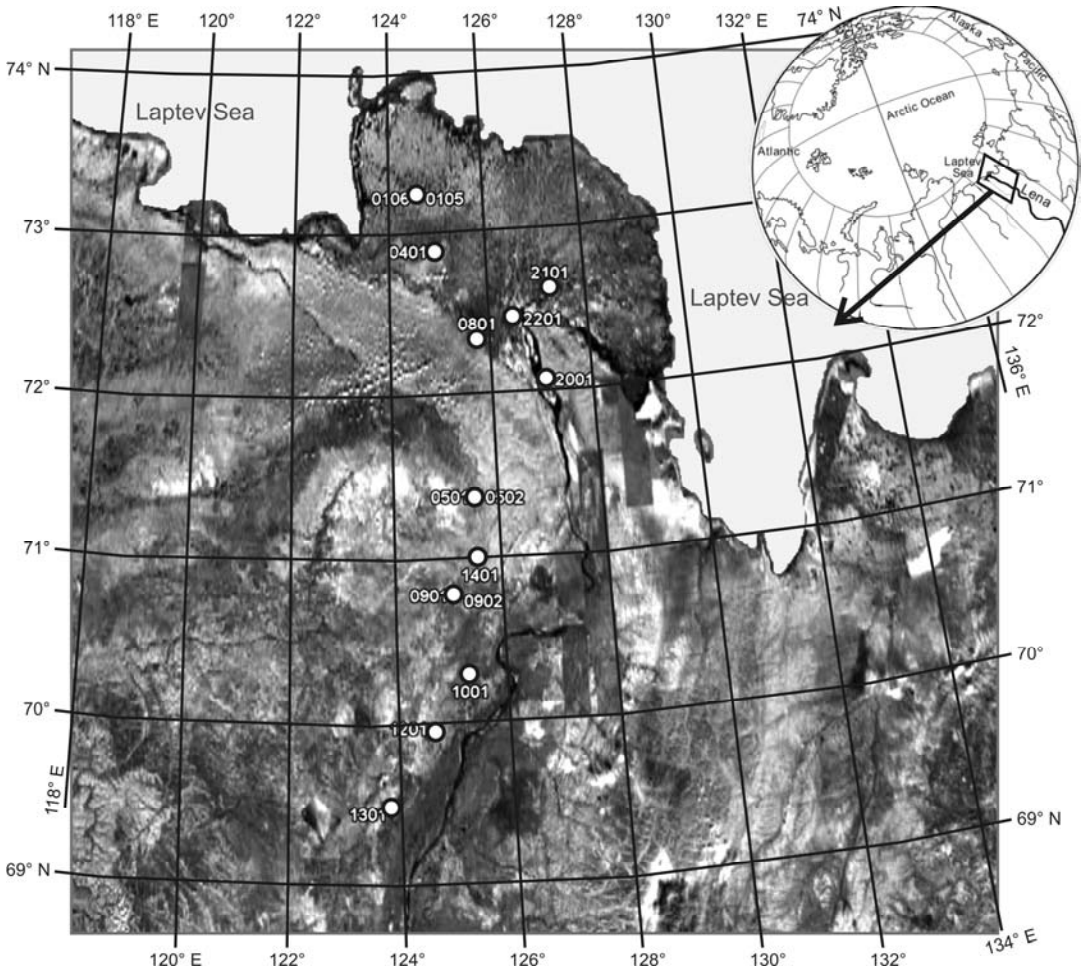

Figure 2-1: Map of the investigation area with position of study sites.

Table 2-1:TOC and pH values and C/N ratios counted per soil profile. Sorted by latitude - southwards. (TOC, N measured by Vario EL III, pH measured by pH-Meter CG820).

Site ID	Latitude	Ø TOC [%]	Ø C/N	pH
0105	73.2°	4.19	16.55	4.95
0401	72.8°	3.52	13.67	7.25
2101	72.6°	7.10	16.68	4.73
2201	72.4°	4.75	22.79	6.39
0801	72.3°	10.96	18.28	5.21
2001	72.0°	3.41	16.88	5.19
0501	71.3°	41.34	21.66	4.19
1401	70.9°	10.89	21.37	4.48
0901	70.7°	37.94	29.72	4.32
1001	70.2°	29.90	23.15	4.57
1201	69.9°	43.43	25.63	3.68
1301	69.4°	4.40	23.46	5.70

3. COASTAL EROSION AND FLUXES FROM LAND TO OCEAN (SESSION II)

Reconstruction of Holocene sea level changes in the area of the New Siberian Islands

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This article presents the newest data on Holocene sea level change in the area adjacent to Zhokhov Island (East Siberian Sea). Diatomic record discovered from the lagoon sediments is in a good agreement with a salinity record obtained by from the same sediments. Geochemistry and diatoms archived in the sediments allow evaluation of continues record of important paleogeographic parameters for the time span from 11 to 5 ^{14}C kyr ago. These data accomplished by the data on sea terraces within the area (correlations between their height and age), which were received by the authors earlier, support suggested reconstruction of the Holocene sea level changes. Thus, transgressions are found for 10, 8-7.5, 4, and 1.2 ^{14}C kyr ago while regressions are dated to 9, 6.5, 2.5, and 1 ^{14}C kyr ago.

Organic carbon flux to Kara Sea from eroding coasts of Kharasavey area, West Yamal Peninsula

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Coastal dynamics were observed near the Kharasavey settlement on the Yamal Peninsula Here stationary observations are conducted along a 21 km section of the coastline from Cape Kharasavey to Cape Burunniy. The northern half of this section is relatively stable, while the southern half is retreating. Observations were carried out using repeated geodetic surveying from 33 benchmarks which were set up in 1981. In total, data on coastal erosion have been collected for an extensive coastal section of the Yamal Peninsula over a long time period (1981-2008 yrs). Using these data, we estimate the scale of morpholithodynamic processes. The average long-term rate of coastal erosion ranges from 0.2 to 2.8 m per year along the coast.

As a result of coastal erosion, 105 ktons of unconsolidated matter moves into the water from the Kharasavey coastal section per year. Up to 80% of the eroded material is composed of fine-grained fractions. During the summer 2008 simultaneously with direct observations of coastal dynamics the sediments from the coastal bluff were sampled along the same coastal section. At each point, samples were taken from the main lithological units and from the organic-rich upper part of the coastal bluff. Total organic carbon (TOC) content in these samples leads to calculations of the carbon carbon flux into the sea along a 10 km of the shore. Previous estimates of carbon flux rates from coastal erosion for Kara Sea are quite different - from 0.4 million tons per year [Streletskaya et al., 2009] to 1 million tons per year [Romankevich & Vetrov, 2001].
Detailed analysis of Kharasavey coast shows 67.2 tonnes TOC per km of eroding coast per year are released. Most of the carbon derives from Pleistocene marine silty clays, not from peaty sediments. Our results support previous lower estimates of carbon flux rates using a different survey method.
This work was supported by Joint Russian-German RFBR-Helmholtz project and Federal Target Program “Scientific and Academic Teaching Personnel of Innovative Russia”.

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Analytical facilities for hydro- and geochemistry at the Alfred Wegener Institute in Potsdam, Germany

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Since the beginning of the Russian-German science cooperation “SYSTEM LAPTEV SEA” in 1998 the lab facilities at the Alfred Wegener Institute in Potsdam have been developed and focused on geochemical analyses using multiple methods for the characterisation of ice, water and sediments. The generation of reliable data from natural samples obtained during fieldwork in Siberia is crucial for any further scientific use. Here, we present our standard analytical applications widely employed by Russian and German colleagues during about the last 12 years of science cooperation in the Siberian Arctic.
One of the most commonly applied analyses uses any kind of liquid water sample from precipitation (snow, rain), surface terrestrial and marine water, subsurface pore water, and ground ice. In particular, the concentrations of ions in the water samples is of interest since it indicates the origin and alteration of the waters and the underlying environmental state and processes. For the measurement of ion concentrations we use Inductively Coupled Plasma-Optical Emission Spectrometry (ICP-OES, Perkin-Elmer Optima 3000 XL) for element analyses (minor elements: Al, Ba, Fe, Mn, Sr in µg l^{-1}; major elements: Ca, K,

Mg, Na, P, Si in mg l^{-1}) , and Ion Chromatography (IC, Dionex DX-320) for anions (Br^-, Cl^-, F^-, NO_3^-, PO_4^{3-}, SO_4^{2-} in mg l^{-1}) whereas hydrogen carbonate concentrations (HCO_3^-) are determined by potentiometric titration with 0.01 M HCl using an automatic titrator (Metrohm 794 Basic Titrino). Depending on initial concentrations, the detection limit for the major ions vary between 0.1 and 0.2 mg l^-, for the minor ions between 20 and 50 µg l^- , taking into account a standard error of ±10 % for every value. Element ratios of sediments can be used to trace changes in the geochemical composition of the sediment and thus to indicate changes in sediment source. This method requires samples to be present as stable solutions after complete digestion by leaching and treating with nitric, hydrofluoric and perchloric acids in a pressure digestion system (PICOTRACE). Afterwards, the concentration of major and trace elements can be determined by ICP-OES (Perkin Elmer Optima 3000XL). A newly introduced method measures the contents of dissolved organic carbon (DOC) and dissolved inorganic carbon (DIC) in any kind of filtrated aqueous solutions using TOC-V CPH, TOC-Analyzer (Shimadzu) by high temperature catalytic oxidation. Here, for the determination of very low DOC or DIC concentrations, contamination-free sampling, filtration, conservation and storage before soon analysis is of high importance. The detection limit here is 0.25 mg l^-.
The methods presented here support a wide variety of field sampling activities in Siberia, including pedology, lake and permafrost sediment analyses, marine hydrochemistry and surface hydrology. Experience has led to a set of best practices for the transport, storage and handling of frozen ice, sediment and soil samples, often under difficult field conditions.

Hydrological and geochemical processes of lakes and the main channels of the Lena River Delta in the last decade

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Hydrology and geochemistry in the river deltas are different from the same processes in their catchments. There are intensive erosion, redistribution of water and suspended material between channels, bed-processes or/and sedimentation activity in a delta. Results of several expeditions during the last decade to the Lena River delta allow determining typical as well as distinctive processes in this region.
Redistribution of water discharge has been changing against of increasing of background runoff.
There are changes of seasonal and long term suspended supply of the main channels [Fedorova et al., 2009a]. Olenekskaya channel is getting shallow especially nearby point of its junction with Bulkurskaya. Tumatskaya has a lot of

bifurcations even in the upstream due to decrease of transporting ability. Sardakhskaya channel after Sardakh Island is more important in comparison with Trofimovskaya Bykovskaya develops like estuary. Transportation and accumulation of suspended material have quite similar features. Active erosion and river influence determine the hydrological and geochemical particularities of delta's lakes. The following geochemical characteristics of the lakes were established: weakly alkaline and neutral values of pH, quit high for arctic water bodies, concentrations of inorganic phosphorus (0.25-1.3 P_2O_5 mg /100g ADW (absolute dry weight)) and organic carbon (0,7%-1,1 %) and high value of cation exchange capacity (49-58 meq/100g ADW) [Fedorova et al., 2009b]. Contrastive analyze geochemical and hydrochemical features of the lakes indicates a high ability of lacustrine sediments to accumulate heavy metals. The results allow estimating self-cleaning ability of lakes ecosystems and their resistance to human impact.

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Fluxes and turnover of dissolved organic matter from Siberian permafrost soils to the Arctic Ocean

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Permafrost soils have accumulated vast stores of organic carbon (~400 Pg C) since the Last Glacial Maximum, representing one fifth of global soil carbon. Over the next century, near-surface permafrost across the circumpolar Arctic is expected to degrade significantly. The transition from a surface-water dominated to a ground-water dominated system will be accompanied by the release of minerals and inorganic nutrients, which will be discharged by rivers to the Arctic Ocean. In addition huge amounts of dissolved organic carbon (DOC) might be released to the Arctic Ocean and either mineralized or transported to the Arctic Deep Ocean. Based on detailed studies on the molecular composition and the release of DOM in the different permafrost soil covered regions around the Arctic Ocean one could estimate the consequences of an increased dissolved organic matter (DOM) discharge to the Arctic Ocean. However, only little is known about the molecular composition of DOM in arctic permafrost soils and rivers as well as the processes of molecular changes in the rivers and the arctic shelf system.

The aim of this project is to determine the mineralization rate of old terrestrial DOM from ice complex melt water in the Lena Delta and to estimate the percentage of permafrost released DOM that will be discharged to the Arctic Ocean (bacterial incubation experiments). In addition the changes in the

molecular composition of the remaining DOM on the way through the Lena Delta to the Bhuor Kaya Bight, where the fresh river water meets the salt water of the Laptev Sea, will be investigated (bacterial- and photo-incubation experiments, direct sampling of outflow, river and bight water).
Ice complex melt water, Lena river water and Bhuor Kaya Bight water was sampled in July/August 2009/2010. Ice complex melt water was inoculated with Lena river water and sampled frequently to estimate the mineralization rate of the old permafrost DOM. A photo incubation experiment with ice complex melt water was performed to obtain information about solar radiation induced changes in the DOM composition. The mineralization rate will be determined by DOC measurement, the molecular changes of the DOM over the time and on the transect through the Lena delta to the Bhuor Kaya Bight will be followed by Fourier Transform Ion Cyclotron Resonance Mass Spectrometry analyses, reversed phase- and size exclusion chromatography of solid phase extracts as well as the analysis of amino acids and amino sugars. Lignin phenols will be used as tracers for terrestrial DOM and amino acid stereo isomers will be used as an indicator for bacterial modification.

Coastal erosion, sediment and organic carbon fluxes in the central sector of the Laptev Sea

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On the whole, the Laptev Sea is characterized by very fast coastal retreat rates and the largest coastal sediment flux to the sea. The Central Sector of the Laptev Sea (CSLS) is located between the Terpyai-Tumsa and Buor Khaya Capes and includes the Olenek Bay, Lena Delta and Buor Khaya Bay.
Due to a strong influence of the Lena River water characterized by comparatively warmer water temperatures in the near-shore zone, the CSLS shore erosion should be much faster than in Northern and Eastern sectors. But, in fact, such conclusion is not confirmed.
According to the available Laptev coast database, the average coastal parameters of the CSLS, composed of distinct 22 coastal segments, are: cliff altitude – 10.66 m; ice content – 20.4%; coast retreat rate – 0.73 m/year; sediment bulk density – 1.63 g/sm^3; organic carbon content – 1.83%. An estimation of referred to above parameters allows us to calculate a coastal sediment flux from CSLS – a little bit more than 16 x 10^6 tons/year, organic carbon flux – 0.3 x 10^6 tons/year. Thereby, portion of total coastal sediment and organic carbon coming to the sea from CSLS coast is just about 25-26 % and 18,5 % of the total Laptev coastal flux (62 and 1.6 x 10^6 tons/year, correspondingly). At the same time, the length of the CSLS coast is about one third of the whole Laptev Sea shoreline. Such disproportion between coastal lengths and sediment fluxes in the CSLS is connected with relatively short

extent of ice-rich coasts within this sector and existence of a very long shore segment of the Eastern Lena Delta, where coastal erosion is very limited.
In summer 2010 the Russian-German team in the frame of the Expedition “Lena 2010” had conducted a field work at the Western coast of the Buor Khaya Peninsula composed mostly of Ice Complex deposits with moderate long term coastal retreat rates (1-2 m/year). The permafrost sedimentation history, coastal retreat rates and landscapes evolution were studied. On-shore and off-shore sampling for detection of costal organic carbon pathways were carried out.
According to annual observations at the key sites of CSLS with ice-rich deposits the rates of coastal erosion since 2005 appreciably exceed average long term (since 1951) rates for these sites. Correspondingly, the up-to-date coastal sediment and organic carbon flux to the sea is rising.

Coastal erosion on the Buor Khaya Peninsula

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This work aims to measure coastline changes and to analyze their causes on a regional scale using optical remote sensing time series. Archived and historical satellite data sets (KH series) in combination with new acquisitions of high resolution image data (KOMPSAT-2, RapidEye, SPOT) allow monitoring of long and short term changes. For comparative purposes with manually digitalized coastline positions, a progress to 3D change detection will be done. Mass movements and material input into the shelf sea will be quantified by comparison of digital elevation models created from these data.
The Buor Khaya peninsula (71-72°N, 132-134°E) in the southern central part of the Laptev Sea Region is situated between the Buor Khaya Gulf in the west and the Yana Bay in the east. The area around the northern cape “Mys Buor Khaya” is a key site of the IPY coastal monitoring programme “Arctic Circumpolar Coastal Observatory Network” (ACCO-Net) and representative for Northeast Siberian lowlands. The peninsula consists of ice rich permafrost deposits and exhibits a typical Alas-Yedoma thermokarst relief with large interconnected depressions, numerous lakes, steep valleys and well drained uplands. Total elevation rarely exceeds 50m a.s.l. The elongated coastline reveals a high heterogeneity of geomorphological units such as alasses, yedoma hills and transition zones. According to previous local studies and preliminary estimations, the coastline of the peninsula retreats at rates of 1-4m per year.
Coastal erosion is not only the displacement of sediments away from the coastline, but also contributes to the movement of carbon from terrestrial to marine environments. Acquisition of detailed field data is necessary for a better process understanding as well as for accurate GIS analyses and interpretation of remote sensing data. Within the framework of the Russian-German Expedition Lena 2010 - Buor Khaya, topographic surveys were conducted at six different coastline sections using precise geodetic methods. More than 1470 points were measured along active alas coast and on inland growing

thermoterraces. These data are used for comparison of shore profiles and as ground truth for digital image processing.

Optical satellite monitoring of Ocean Colour in the Laptev Sea region

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Different bulk water colours are due to different concentrations and the mixture of particulates (phytoplankton, terrigenous particulate matter) and dissolved organic matter in the upper water column. The recent technical development of satellite Ocean Colour missions (MODIS (NASA), SeaWiFS (NASA), MERIS (ESA)) has been accompanied by a wider use of Ocean Colour information (e.g., attenuation=k, first attenuation depth=Z_{90}) and by establishing algorithms (e.g., chlorophyll=Chl-a, suspended particulate matter=SPM, coloured dissolved organic matter=cDOM).

The 'OCoc-from Ocean Colour to Organic Carbon' project (IPY-project 1176), funded by the German Research Foundation (DFG), is an Ocean Colour study joined with the Arctic Coastal Dynamics ACD network and Arctic Circum-polar Coastal Observatory Network ACCO-Net (IPY-project 90). The OCoc project uses multi-annual MERIS data for the monitoring of the spatial patterns of Ocean Colour in the late-summer ice-free waters of the Laptev See region.

The Laptev Sea is characterized by a very shallow topography. The maximum river discharge of the Lena River, the second largest Arctic river in terms of annual fresh water discharge happens during the spring ice-breakup in June under the ice. The Laptev Sea coast is a dynamic, mainly sedimentary ice-rich system that delivers vast amounts of particulate matter and carbon into the coastal waters.

Is there the potential in late-summer ice-free Ocean Colour satellite data to give spatial information on the organic-rich export due to erosion of the Ice-Complex coast?

Is there the potential in late-summer ice-free Ocean Colour satellite data to give spatial information on the organic-rich surface water lens steaming spring/early summer peak discharge?

MERIS Reduced Resolution (RR)-LIB data are processed towards optical aquatic parameters using Beam-Visat4.2 and the MERIS Case2 Regional processor for coastal application (C2R). Calculated aquatic parameters are optical coefficients from the water leaving reflectances (k, Z_{90}). Initial spatio-temporal information is presented. The synoptic information of the optical MERIS-C2R parameters offers an immediate wealth of information. The spatial patterns of the processed MERIS C2R time series show the inter-annual scale of the atmospherically driven circulation patterns. The large-scale

atmospherically driven circulation patterns seem to overlay the optical information on the point sources and fluxes of the terrigenous matter (fluvial and coastal). On event scales, we need to investigate if weather patterns potentially contribute to short pulses and circulation patterns.
As the next step, the calculated satellite products need to be evaluated with expedition data (cDOM, transparency, SPM, turbidity, chlorophyll) from the Russian-German expeditions in Buor Khaya Bay 2008, 2009, 2010 and the Russian-German TRANSDRIFT expeditions.

Traces of high level standing of the Laptev Sea level during Holocene

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The Laptev Sea coastline demonstrates a large amount of evidences that during Holocene its level was higher than nowadays. Sea terraces of the Leno-Anabar shore and Novosibirsk Islands are considered to be the reflection of increase in the Laptev Sea level up to 7-8 meters 2-2.5 and 4 thousand years ago. The river Lena terraces of basin-estuary origin are the reasons to assume the rise of the sea level during early Holocene – 8 thousand years ago and 800-1000 years ago. Analysis of 18-20 century cartographical materials of the region evidenced that the Laptev Sea level rose up in the middle of the 19th century to 3 meters.
The activities carried out during the expedition Lena 2010 (Buor-Khaya team) allowed to discover new traces of the Laptev Sea high level standing during Holocene. The western and eastern coastlines of the northern part of Buor-Khaya peninsula revealed the 7-8 and 10-12 meters high terrace outcrops resting against “edoma”. Its lithological structure is often similar to that of described in the river Lena Delta. They are formed by the horizontally laminated aleurite with significant content of organic material. These surfaces are due to lab tests that would allow to identify its origin; however, it is fair to state already now that irrespective to its genesis – apparently basin or alas – the equal height of surfaces was determined by the changes of erosion basis, i.e. against the Laptev Sea level.

Pocket FerryBox - a monitoring tool for field campaigns

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The application of a so called pocket-FerryBox (pFB) for short-term monitoring purposes in different regions with will be shown. The pocket-FerryBox is a portable self-contained flow-through multi-parametric system for underway

monitoring. The system designed for short-term applications even on very small boats weighs about 32 kg including the housing and so can be transported as normal luggage on an air-plane. The whole system is installed within a stainless steel housing to be protected against rain, sea spray and physical shocks and can be operated just by a car battery.
The presented system has probes for water depth, salinity, turbidity, oxygen, pH, coloured dissolved organic matter (CDOM) and the algal pigments chlorophyll-a, phycocyanin and phycoerythrin. However, it can be assembled with other sensors as well.
In this presentation the successful application of such a system on field campaigns in Brazil (Paranaguá) and Chile (Patagonia) aboard different kinds of boats will be shown. The portability of the pFB makes it ideal to be used for short-term monitoring, in support of field campaigns or for the planning of permanent monitoring networks. The applicability of such a system in the Laptev Sea region will be discussed.

Ice Complex deposits and river water: High-speed retreat of the river banks caused by side erosion (Yana River, Arctic Siberia, Russia)

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Starting 2003, précised instrumental observations on velocities of erosion process are handled as a part of ZHOKHOV-2000 project (Russian-American scientific research effort focused primarily on archaeological excavations of Zhokhov and Yana sites). Lateral river erosion is one of the damage factors for Yana RHS site which is located under 70º 43'N and 135º 25'E on the left bank of the Yana River. Due to that, these observations was organized on the left river bank within the area which surrounds the site, in order to monitor the negative influence of erosion factor as a key for better development of excavation strategies.
The study area is located in the low part of the Yana River north of the Kular Mountings, where the river comes to the coastal plain and forms wide valley with a developed terrace complex. Terraces have different spatial representation. Three terrace levels are found: T3 (Q_{II}?-Q_{III}) is 40 to 30 m , T2 (Q_{III}^{3}- Q_{IV}^{1}) is 18 to 16 m, and T1 (Q_{IV}^{1-3}) is 12 to 10 m high (all elevations are relative). This sequence is followed by a flood plain terrace with a height of 8-7 m and lower surfaces that belong to modern accumulative forms. T3 and T2 bodies are constituted by the deposits formed by similar processes (so-called Edoma type deposits, or ice-complex deposits).
Instrumental observations are organized on the left river bank where T3 and T2 forms are well expressed. The study area covers 2.5 km. Retreat of the edge of the river bank that formed by the deposits with high ice content (ice-complex

deposits) is closely attached to erosion process caused by the Yana river, as well as to the development of thermo denudation and thermokarst processes, and impact of solar radiation (both direct and reflected). Speed of the river bank destruction depends on water discharge for certain years. It is also found that there is a direct connection between the velocity of the river bank retreat and mean summer temperatures. The river bank destruction is accompanied by the development of such land forms as thermo wells, thermo cirques, and erosion niches.

The mean value for the velocity for T3 retreat which is observed for seven years (2003 through 2009) is found to be 12-13 m/year. The maximum meaning of 22 m/year was observed for 2006. Mean value for T2 for the same period of observation equals to 7 m/year, while the maximum velocity is found to be 14 m/year (that was observed in 2006 and 2008). Within the excavation area of Yana RHS the mean value for the velocity of the river bank retreat is also found to be 7 m/year, with the lowest value of 1.8 m/year and 9.8 m/year as the highest one. This observation tells that surprisingly the excavation activity does not contribute to the speed of the erosion process which remains at the same level in all areas. At the same time, it is found that erosion process finds a good correlation with a gradual move of the head part of the river curve that is visible within several years.

Laptev Sea shelf supplies chemical signature of the low halocline and intermediate water

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Historic data from the ICES Oceanographic Database and NODC data set together with data from the NABOS expeditions in 2007-2009 to the Laptev Sea is being analyzed to identify the present structure of the low halocline water (LHW) in terms of its source water masses: Fram Strait Atlantic Water, Barents Sea Outflow Water, River Water, outer Shelf Water and Polynya Water. Water mass distributions are evaluated by applying Optimum Multiparameter Analysis (OMP), which assumes that the LHW is formed by mixing of several source water masses, and evaluates the contributions of each. We use temperature, salinity, dissolved inorganic nutrients, dissolved oxygen as end member values of each source. In addition the two-dimension model is beings applied to calculate nutrient fluxes, with the model constrained by water and salt budgets.

The Arctic continental margin shows consistent cross-slope differences of the LHW properties. The distributions of chemical tracers provide evidence supporting that the warmer and saltier on-slope LHW is modified due to vigorous vertical mixing with underlying Atlantic water and additionally suggest that the on-slope LHW may also be influenced by water from the outer shelf.

Our results suggest that the fraction of outer and middle Shelf Water reach 20% in the water mass structures of the LHW at 125°E. These results are consistent with current knowledge on water mass distributions in the Laptev Sea area.

Seasonal and interannual variability of sediment transport dynamics on the Laptev Sea shelf

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Models for the next 100 years project an increased input of sediments onto the Arctic shelf seas associated to increased mean annual riverine discharge of 10 to 25% for Arctic rivers, and increased coastal erosion due to increased thawing of coastal permafrost, higher sea levels, and the increased potential for severe coastal storms during the extended open water season. A detailed knowledge of the pathways of suspended particulate matter (SPM) and the possible response to climate change is of critical importance to understand and to forecast the impact of environmental changes on the land-shelf-ocean interaction. During the project “Laptev Sea System” four seafloor observatories equipped with Acoustic Doppler Current Profilers (ADCPs) and Conductivity Temperature Depth meters (CTDs) were deployed on the inner, mid- and outer shelf each for the period of one year (August 1998-September 1999; September 2005-August 2007) to monitor the seasonal variability of SPM concentration. In combination with additional detailed oceanographic and hydrochemical process studies during summer and winter conditions these unique data sets have given new insights sediment dynamics on the Laptev Sea shelf and its complex land-shelf-ocean interactions. During and shortly after the river-ice breakup (June/early July) sediment transport is dominated by riverine input and transport onto the eastern Laptev Sea shelf within the surface layer beneath the fast ice. Under ice-free conditions (mid-July to September) the surface distribution of SPM is closely connected to the distribution of the freshwater plume. A key component that controls the freshwater transport on the Siberian shelf environment is the Arctic cyclonicity that plays a central role in the shelf-atmosphere interaction. During summers with prevailing westerly winds part of the riverine derived material is exported to the East Siberian Sea. However, during summers when southerly winds prevail, SPM is transported onto the mid-shelf area within the surface layer, where it sinks down and is transported back onto the inner shelf by bottom currents. During freeze-up (October), SPM in the surface layer on the inner shelf is incorporated into newly formed ice and transported with the ice over the continental margin into the deep Arctic Ocean. Beneath the ice cover (November to June/July) SPM slowly sinks and sediment transport is of minor importance on the inner shelf.

From Soil to Ocean – Residence time of terrigenous biomarkers in Siberian permafrost soils

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Permafrost soils in the Arctic environment store huge amounts of organic matter (OM), which for a large part remained freeze-locked in the ground for thousands of years. Rising global temperatures are expected to have a significant impact on high northern latitudes causing extensive thawing of permafrost and thereby increasing active layer depths. As a result fossil carbon presumably becomes remobilized, partly metabolized and transported by rivers to the Arctic shelf seas. Associated changes in source and molecular composition of the OM will considerably alter carbon budgets and biogeochemical carbon cycling in the Arctic Ocean. Until now, it is rather unknown which compounds are eroded, oxidized, exported and finally buried in the marine environment as well as on which timescales these processes occur. To estimate the effect of climate warming on organic carbon release biomarker-specific isotope analyses can be used. The goals of this project are to characterize OM composition of Holocene permafrost soils, suspended particulate matter (SPM), and sediments in order to describe transport and degradation processes affecting permafrost OM and to identify sources of particulate organic carbon (POC) exported to marine sediments. Furthermore, radiocarbon dating of selected soil biomarkers will be used to determine timescales of residence time and transport of OM from source (permafrost soils) to sink (shelf seas & Arctic Ocean). For this purpose, samples including permafrost soils, SPM in rivers and open water, as well as fluvial and marine sediments were taken in summer 2008 in the Bayelva River drainage area near Ny-Ålesund, Svalbard and in August 2009/2010 within the Lena Delta and adjacent Buor Khaya Bay, NE Siberia. Here, we present results on the biomarker composition and compound-specific radiocarbon ages of soils and sediments from Svalbard and initial results from a Holocene cliff profile in the Lena Delta.

In the Bayelva drainage area on Svalbard, radiocarbon ages of total organic carbon (TOC) of the topsoil were comparatively high (5800±50 yrs BP) and increased with depth to maximum values of 26000±130 yrs BP. Moreover, long-chain aliphatic compounds used as biomarkers for higher plant input document contribution of higher plants to soil organic matter mainly in the upper 30 cm. Compound-specific ^{14}C ages were obtained for higher-plant derived long-chain fatty acids, which imply slow turnover of these compounds within the active layer and export of significantly pre-aged material to the sediments of the adjacent fjord. Additionally, soil samples, SPM and sediments from the Lena Delta and Buor Khaya Bay are currently analyzed for their biomarker composition and radiocarbon content.

4. SUBSEA PERMAFROST (SESSION III)

Subsea permafrost in the Central Laptev Sea

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The Arctic comprises some of the most sensitive elements of the global environment, which are considered to respond rapidly to climate change. In this context the Laptev Sea and its Siberian hinterland are of particular interest because they link the polar margins to the Arctic Ocean and the World Ocean's circulation system. The north Siberian margin today is comprised of a permafrost landscape that has undergone major changes during Quaternary times. Moreover, there is evidence from modern data that the stability of the permafrost is in threat due to global warming. Such a change of the permafrost in the future is of major climatic relevance, considering a potential release of gashydrates that are now trapped in the frozen ground.

Subsea permafrost, such as in the Laptev Sea, was formed under subaerial conditions during the last glacial periods and subsequently underwent submersion due to postglacial sea-level rises. As western part of the Beringian landmass the shallow Siberian shelves became subaerially exposed during glacial maxima. During ensuing postglacial global sea-level rises the region gradually changed from a terrestrial permafrost landscape into shallow marine shelf environments. Geochemical, micropaleontological, and sedimentological data obtained through sediment coring and drilling not only reveal the strong influence of this transformation process on the shelf environment for the time since the last glacial period, they also clearly confirm the existence of permanently frozen, and ice-bearing sediments below a soft, marine sediment package of Holocene age.

Subsea permafrost at the Buor Khaya Peninsula, Eastern Laptev Sea

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Most of the modern Arctic coast is affected by thermo-abrasion of icy permafrost sediments, resulting in coastline retreat rates of up to 25 m a-1. Thermal abrasion of coastlines can lead to thermal destabilization of permafrost by inundation. This is a concern, since warming of subsea permafrost may mobilize carbon stored in or beneath the permafrost, including gas hydrates of greenhouse gases. The predicted response of coastal erosion to increased summer air temperatures, thermokarst subsidence, increased sea-water temperatures and reduced sea ice extent will lead to more rapid inundation of terrestrial permafrost. We investigate subsea permafrost in the near-shore zone of the western coastline Buor Khaya Peninsula in the Laptev Sea, a zone strongly influenced during the open water season by the Lena River hydrological cycle and by the interactions of stratification with synoptic weather patterns. Through surface sediment sampling and geophysical detection of the top of the ice-bearing permafrost in the sediment, we hope to relate spatially and temporally varying rates of coastal erosion to sediment fluxes in the near-shore zone and the rate of degradation of the top of the ice-bearing permafrost. Initial observations from the field suggest that a relatively steep shoreface profile (inclined between 0.002 and 0.005) is underlain by a rapidly (> 5 cm a-1) degrading ice-bearing permafrost table. Electrical conductivity, depth and temperature of the water were measured over the course of a summer storm event. The storm shifted water beneath the halocline shoreward, resulting in episodic step changes in bottom water temperature and salinity closer to shore. Satellite images before and after the storm show its effectiveness in suspending material in the near-shore zone. In the future, these results will be combined with changing rates over coastal erosion over the last half century, to examine how rates of near-shore zone subsea permafrost degradation will respond to future change.

Geochemical studies on subsea permafrost of the Western Laptev Sea

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In order to characterize subsea permafrost and to understand its dynamics during the Quaternary past, a joint Russian-German sea-ice-based drilling campaign (COAST I) was undertaken in spring April 2005 in the western Laptev Sea, Siberia. Coastal permafrost outcrops had already been studied in summer 2003 and represent the upper terrestrial counterpart of the submarine sequences. Here, we present detailed hydrochemistry and stable water isotope data of ground ice and pore water samples from both the subsea and the terrestrial part as tracers for permafrost degradation under subsea conditions. The study site was located on the coast of Cape Mamontov Klyk (73.61°N, 117.18°E), where a 12 km long coring transect of five cores was drilled including four offshore cores at different distances from the coast, and one terrestrial core. The sampled coastal cliff of about 25 m height above the sea level (m a.s.l.) is an additional data source for the sequences of the upper part of core C1. The coring reached a maximal depth below sea level (b.s.l.) of 77 m in the core C2 located furthest from the coast (~12km from the coast). Borehole temperature logging showed increasing ground temperatures seawards from about -12 °C in C1 on land up to -1 °C in the marine cores, pointing to thermal degradation of relict terrestrial permafrost under marine influence. Hydrochemical and stable water isotope data from ground ice in ice-bonded deposits or from pore water in cryotic deposits reveal clear evidence for chemical degradation of relict terrestrial permafrost under subsea conditions. The marine influence acts downwards via conductive heat transfer, via pressure-gradient and via concentration-gradient diffusion of warm, saline and isotopically heavy sea water into the ground. Accordingly, relict terrestrial permafrost shows low ionic contents (measured as electrical conductivity, EC) that increase under marine influence to values much more than 10 mS cm^{-1}. The respective stable water isotopes ($\delta^{18}O$, δD) of relict terrestrial permafrost are generally lighter than -15‰ for $\delta^{18}O$ and -150‰ for δD. In all four marine cores, the infiltration of marine waters into underlying former terrestrial permafrost following the Holocene sea transgression is mirrored by abrupt shifts in hydrochemical and stable isotope parameters in transition zones between degrading and non-degraded permafrost. However, the cryolithologically observed borders between cryotic, but not ice-bonded versus ice-bonded sediments do not correspond to the shifts evident in hydrochemical and stable water isotope data. Based on current coastal erosion rates of 4.5 to 5 m $year^{-1}$ at Cape Mamontov Klyk, the furthest offshore located coring site was likely flooded at about 2500 years ago showing an increase in borehole temperature of more than 10°C during that time.

Taking into account the reconstructed timing of inundation on the Western Laptev Shelf and the depth of non-degraded terrestrial subsea permafrost, a maximum infiltration (or permafrost degradation) rate of 0.7 to 1.3 cm $year^{-1}$ seems to be reliable.

5. ECOSYSTEMS (SESSION IV)

Biological investigations in the Lena Delta and on the Laptev Sea shelf (1987-2010)

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During the joint Russian-German project ”Laptev Sea System” launched in 1993 complex investigations of benthic and pelagic fauna, algae, chlorophyll “a” distribution on the Laptev Sea shelf as well as its bays and deep part, have been carried out. The multiyear data on species composition, distribution pattern and seasonal-interannual variability of zooplankton dependence to primary production, hydrological, hydrochemical and ice conditions were collected on the Laptev Sea shelf during summer and winter TRANSDRIFT I-XVII expeditions. 111 taxa belonging to 10 different types were discovered in the zooplankton of the Laptev Sea shelf. The composition, distribution and abundance of pelagic fauna in this region depend mainly upon the main directions of river water spreading and vary from year to year.

Our results indicate the close interaction of the coupled Laptev Sea- Lena Delta system. Freshwater organisms brought by the river runoff constitute about 50% of the summer total zooplankton abundance in the shallow brackish water bays of the Laptev Sea. In the different water pools of the Lena Delta, 142 taxa of zooplankton belonging to 2 types (Rotatoria and Arthropoda) were determined, 90% of these species is present in zooplankton assemblages of lakes. During the period between 1987 and 2010, we have collected the data on zooplankton species composition, distribution, seasonal abundance and biomass dynamics in the flood-plain lakes, big and small thermokarst lakes from the different region and geomorphological levels of the Lena Delta.

Discovery of human created mass accumulation of Mammoth near the Yana site, Arctic Siberia

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In 2001, Yana RHS site was discovered in the low Yana Valley, in about 100 km of its junction to the Laptev Sea coast. This is the oldest evidence of human habitation in the Arctic before the LGM. Radiocarbon age of this site, by multiple dates, is found to be 27500-28000 BP. Since its discovery, the site is regularly under the excavation in the summer. A number of stone, bone/ivory, and wooden artifacts were unearthed during the excavations. In addition to the artifacts, enormous amount of fragmented bones of Pleistocene mammals was excavated from the cultural layer of the site. Organic artifacts and animal bones have an excellent preservation due to permafrost conditions typical for Northern Yakutia. Many of the bones experienced different kinds of utilization. Interestingly, that species composition found from the fauna remains from the cultural layer, demonstrates significantly less number of mammoth than that found for numerous natural accumulations of Pleistocene animals known within the region. This was interpreted as an indication for the limited role of mammoths for the economy of the Pleistocene Yana people. In 2008, in a distance of a few hundred meters upstream from the excavation area put on the site, a group of local people brought a hydro monitor, trying to find mammoth ivory by sluicing from the frozen riverbank. The place on which they started to work on, for years was known for sporadic findings of mammoth tasks. Summer of 2008 was dry, so the low water level in Yana River was favorable for that. Unexpectedly, they have opened a mass accumulation of mammoth bone, with sporadic stone and bone artifacts among them. A part of bone bearing lens was washed out, but it was found that the lens goes long way inside the riverbank. We were able to watch all these activities. The only benefit of it was an opportunity to study the geology of this place, and an opportunity to collect the bones and study them preliminary. Bone collection unearthed from the mass accumulation includes about one thousand bones of mammoth, with single findings of wooly rhinoceros, Pleistocene bison, Pleistocene horse, and reindeer. After examination of the collection, it was found that there are remains of at least 26 mammoth individuals. Unusual sorting of the bone material (in some cases bones were grouped by anatomical fractions), and almost total absence of small bones in the collection says that the accumulation was not formed by natural process, as it is the case for other “mammoth graveyards” known in Arctic Siberia (such as Berelyokh and Achchagyi-Allaikha), but was created by human activity. Detailed stratigraphic study done on the site, completely excludes from the discussion possible alluvial sorting of bones. A number of radiocarbon dates received directly by dating bone collagen of mammoth bones from the bone-bearing lens, and also by dating different organics from underlying and covering sediments shows a synchronism of the

mass accumulation of mammoth and of the cultural layer of the site. This becomes even clearer if the stratigraphy of both the site and the lens is taken into consideration. The mass accumulation of mammoth belongs to the same surface of paleo topography that bears the cultural layer of the site, with the only difference – Yana humans inhabited the flood plain terrace nearby the water/river, while mammoth remains were concentrating in a local depression attached to a small stream running into the river next to the site area. It is not quite clear if the mass accumulation of mammoth resulted from the hunt. However, it is obvious that mammoth bones and ivory were valuable raw material for the tool production. Artifacts found along with the bones represent a complete technological chain for production of long points made of ivory. Although the principals of this technology are reconstructed for different sites across Eurasia, the Yana case is most probably the oldest one so far known. In addition, it is different from others.

Paleolimnological investigations of selected lakes along a north-south transect from the Lena delta (Laptev Sea region) to its hinterland

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In 2009 a collaborative German-Russian expedition realised an ecological and limnogeological survey along a north-south transect in arctic Siberia. The field studies included 14 thermokarst lake-sites reaching from the Arga region at 73° N within the Lena delta (Laptev Sea regioin) to the Lena hinterland at 69° N crossing the treeline. Based on the findings of this pre-survey (e.g. significant high sedimentation rates) a follow-up expedition in 2010 was undertaken to continue the paleolimnological studies at Lake El'gene Kyuele (71° 18,04' N, 125° 34,15' E) in the middle part of the transect and Lake Kyutyunda (69° 37,89' N, 123° 39,42' E) near the southernmost position of the transect. During this expedition longer sediment cores up to 8 m could be retrieved using an Uwitec piston corer system from a platform. Additionally the catchment area and the lake bathymetry were analysed.

El'gene Kyuele has a length of 2.9 km and a width of 0.5 km. The lake bottom shows a strong relief with a maximum water depth of 10.5 m. The small catchment area reveals intensive thermokarst processes of the surrounded deeply loesslike sediments (Yedoma). The elongated shape corresponding to the regional geological structure of the bedrock also indicates a tectonic component influencing the thermokarst lake genesis.

We intend to compare the sedimentological and paleoenvironmental regimes of 4 selected lakes of the transect in order to gain informations about temporal

environmental changes in the gradient from the north to the south. Our main questions are: How much is the thermokarst erosion influencing the sedimentological regime? Is the lake bathymetry only controlled by thermokarst subsidence processes? Is there a paleoclimate signal triggering the detrital input events? To answer this questions bio-geochemical, geochemical and grain-size studies were conducted on several sediment cores along the selected lakes of the transect.
The aim of the research project is to understand and reconstruct the sedimentary thermokarst processes and the Holocene palaeoenvironmental gradients reaching from the southern extrem continental settings to the Laptev-Sea region.

Sinks and sources through time – carbon in the Siberian Arctic vegetation

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Northern ecosystems are assumed to respond rapidly to “global warming” with the arctic treeline being one of the rare negative temperature-carbon feedbacks. However, our investigation indicated that despite of the strong warming since 1800 AD in northern Siberia, the treeline did not yet move north after its southward retreat during the Little Ice Age possible due to unexpected long lag times. Nevertheless, we found that arctic vegetation deposited continuously in polygon mires in permafrost lowland areas of northern Siberia form large carbon sinks, though its function through time are hitherto almost unexplored. Approximately 15 g C (outer rim: 11.4 g C; inner rim: 13.6 g C; center: 19 g C) were deposited per m^2 per year in a Siberian polygon landscape during the last 1500 years. To better explore the sources and sinks of carbon in Siberian we furthermore improved the BIOME4 vegetation model and run it with high resolution for western Siberia. The modeled present-day vegetation yielded a good fit with observations indicating the general applicability of vegetation modeling to gain further insights into vegetation-climate relationships.
To conclude, the terrestrial carbon storage in Siberian arctic vegetation is hitherto rather unexplored despite of its potential feedback with climate. However, the study of vegetation-climate interaction in the past combining modeling and proxy-based approaches may help to overcome this gap of knowledge.

Ecological estimation of bottom ecosystems of northern seas as a tool of their integrated management plan (by the example of Chukchi Sea)

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The Arctic seas are a rich source of fish resources and minerals. Extremely cold conditions have made these territories poorly economically developed and badly explored. As the development of economy, science and technologies was progressing the question of more active developing the seas arose. Consequently the question of creation of effective system of rational natural management appeared.

The first step in this direction is working out the unified estimation of condition of marine ecosystems and the estimation of the ecosystems' stability to various kinds of influence. Geo-ecological mapping plays an important role in this process. A geo-morphological map provides the basis for a geo-ecological map. The core ecosystem components used during the estimation are benthos and bottom deposits.

We applied the total index of pollution of bottom deposits (Zc) developed by E.P. Yanin to an estimation of condition of bottom deposits of water objects. Calculation of Zc had shown that throughout all studied water area of Chukchi Sea the level of man-caused pollution was low: Zc <10 (from 0 up to 9,74 with mean value equal to 4,79). The territory located between Wrangel and Gerald islands was the only exception where the total index of pollution of bottom deposits was on the average level (Zc = 14,32), and there the main role was played not by man-caused factors but by natural ones. Presence of iron-manganous concretions resulted in a high coefficient of Mn concentration. Also a biota, presented by corals, pearl-weeds, two-folding molluscs and basket stars, caused high Sr concentration there. As to high Cd concentration value it is characteristic for bottom deposits of the whole Chukchi Sea.

Condition of biocenoses of Chukchi Sea can be considered as not damaged (close to a mean annual norm, natural background). As a whole, Chukchi Sea is resistant to chemical pollution. In the row of resistance to chemical pollution of the Arctic seas Chukchi Sea wins the first place. However in the eastern part of the sea and along coast of Chukchi peninsula rather favorable conditions of accumulation of polluting substances were observed. In those areas stability of biocenoses was defined as relatively vulnerable.

The results of the carried out estimation of condition of marine ecosystems can be used as natural background standards during monitoring research, and also in making Estimation of Influence on Environment of carrying out geological surveys, mining operations in the future and by the time of working out the plan of rational usage.

Microplankton assemblages in relation to hydrographic conditions in the Lena Delta

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The composition of phytoplankton species and accompanying physico-chemical parameters was investigated along 4 transects of the Lena Delta in both 2009 and 2010. In addition, 4 coastal transects were sampled in 2010.
The water column was mixed in the river channels, but in the coastal transects an increasing degree of water column stratification (temperature and salinity) was found with increasing distance from the shore. The temperature of surface waters also decreased from 12 ^{o}C near the coast to between 7 and 10 ^{o}C in the stations furthest offshore. These complex hydrographic conditions were reflected in very diverse phytoplankton assemblages, with surface samples usually dominated by freshwater species such as cyanobacteria , chlorophytes and the diatom species ***Asterionella formosa*** and ***Aulacoseira*** cf. ***granulata*** with few marine or brackish water species predominantly of the genus ***Thalassiosira***. Species composition was very similar in all samples so far investigated. Assemblages were also similar in 2009 and 2010 with one notable exception, a bloom of the ciliate ***Myrionecta rubra*** at a coastal station in 2009, at which ***A. granulata*** and ***A. formosa*** also reached their maximum density (14720 cells l^{-1}). ***Myrionecta rubra*** has so far not been observed in 2010.
In addition to the autotrophic components of the plankton assemblages a diverse array of microzooplankton was also observed including several heterotrophic dinfoglagellate species of the genus ***Protoperidinium*** as well as naked ciliates and tintinnid species of the genus ***Tintinnopsis***. The presentation will summarize the preliminary information available about the phytoplankton assemblages revealed by the 2009 and 2010 investigations and discuss potential foodweb interactions.

Joint German-Russian laboratory for studies of environmental dynamics in the terrestrial Arctic (Biological Monitoring - BioM)

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Biological Monitoring (BioM) is an upcoming joint Russian-German research project organized in order to foster multidisciplinary climate and ecological research in the Arctic, initiate bilateral research projects, establish monitoring programs, and transfer of knowledge.
The interlinking research topics for joint projects are Quaternary climate dynamics in the Russian Arctic and biodiversity and stability of Arctic ecosystems.
Three main research directions have been defined as (1) paleoecological and climate research using permafrost and lake sediments archives, (2) modern ecological processes, and (3) ecological expertise and prognosis. The key activities include the development and standardization of analytical methods between all involved partners, paleoclimatic reconstructions, monitoring stations at the White Sea coast, in the Lena Delta, also nearYakutsk and latter on at other sites across the Russian Arctic. The exchange of education and information : visits of specialists, presentations, teaching, joint supervision of diploma and PhD projects, e-learning, workshops, formation of data banks, including a data bank of Russian literature. Publications. We plan attraction of different funds for sponsoring our research e.g. DFG, DAAD; Helmholtz Gemeinschaft, Darwin Initiative, RFBR, Ministry of Nature Protection in Russia.

Regional inference models as a tool for reconstruction of ecological conditions in Russian Arctic

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The reconstruction of the dynamic elements of past environments is extremely important for understanding both the present state and evolutionary trends in future climate development. Since long-term measurements on climate variability very rarely go back more than about 100 years, palaeoclimate and environmental reconstructions based on proxy indicators must be used to validate the output of global climate models. Especially important such reconstructions are in climatologically sensitive and pristine regions such as polar areas, where any small global climate change result in distinct regional variations of temperature, precipitation, and other climate-induced changes. There are few examples of quantitative palaeoclimate studies in Siberia and these data have to be tested by quantitative studies from other sites in this region, inferred from other proxy and using regional calibration datasets and temperature models that were still lacking. At the present state of knowledge, biological indicators from aquatic and terrestrial environments are the most reliable proxies, because they react sensitively to climate change and define different aspects of environments, which should be assessed together for reliable reconstructions. The basis, however, of all quantitative reconstruction approaches are regional calibration datasets from which the empirical reconstruction model (i.e. the transfer function) will be established. Calibration datasets for reconstructing palaeoclimate variables were most effectively established along steep latitudinal temperature gradients in Northern Europe and Canada. But any application of non-regional models for To reconstruction causes difficulty in their interpretation and makes results sometimes controversial. One of the premier methods for quantitative temperature reconstruction in temperate and arctic environments is by means of chironomid-climate inference models. Chironomids compose a family of true flies and are well suited as quantitative indicators of climate change. Merging together three data sets: Norwegian, Northern Ural and Central Yakutian gives us a data set and Combined Temperature model with a good statistical parameters. The model can be applied to sediment cores from Northern Russia in order to obtain reliable temperature reconstructions of Holocene.

Diatoms in sediments of Siberian Arctic freshwaters

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The Arctic regions are more sensitive to global environmental and climatic changes and Arctic lakes and ponds are perfect indicators of increasing of global atmospheric temperatures. Polygonal tundra waters are characteristic features of the Northeast Siberian permafrost zone, they have small depths (up to 3 m), specific thermal and chemical regime which makes them more sensitive to climatic changes. Many studies show that diatoms, wide-spread algae with silica-based frustules that are well-preserved in lake sediments, can be used as biological indicators for estimation past environmental conditions (temperature and hydrochemical features). The main goal of this investigation was a study of diatoms flora of modern sediments in polygonal tundra waters from three regions of Northern Yakutia (Bol'shoy Lyakhovsky Island, Oyogos Yar coast, Lena river delta), their ecological features and the leading abiotic factors, witch play the main role in distribution of diatoms in the Arctic. Investigations of diatoms from 34 Arctic waters showed 161 taxa from 25 genera, 13 familiae, 4 ranges, and 2 classes. 87 of them were identified in Bol'shoy Lyakhovsky Island sediments, 109 – in Oyogos Yar coast sediments, 63 – in Lena river delta sediments. ***Eunotia bilunaris*** (Ehr.) Mills., ***E.praerupta*** Ehr., ***E. tenella*** (Grun) Hust, ***Tabellaria flocculosa*** (Roth.) Kutz., ***Stauroneis anceps*** Hust, ***S. phoenicenteron*** (Nitzsch.) Ehr., ***Cymbella silesiaca*** Bleisch in Rabenhorst, ***Achnanthes minutissima*** Kütz, ***Gomphonema parvulum*** Kutz., ***Navicula pupula*** Kutz. were wide spread species. In diatom flora the benthic cosmopolite oligogalobic and pH indifferent and alkalifilic species predominated. We found tree main (from determined nineteen) abiotic factors (pH, depth, conductivity) using CANOCO 4.5 software. They explain most of the diatom species variability. This investigation was supported by DAAD (Michael Lomonosov Program, A0972849).

The history of the lake development in Yakutia in the Holocene

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The history of the lake development strongly depends on landscape conditions. The investigation of the specific environmental conditions of Yakutia is of a great importance for solving many paleo-geographical and climatological problems. Vast regions of Yakutia and Northeast Siberia are represented mainly by thermokarst water bodies that develop under permafrost conditions. For the first time we developed models for the reconstruction of limnological parameters (temperature, mineralization, pH) of the most characteristic lake provinces in Yakutia. As proxy for the development of the inference models we used diatoms and chironomids. The models have good statistical performance and were applied them to several sediment cores from different regions of Yakutia. Our results have shown that paleo-temperature trends generally reflect regional changes of temperature conditions in Yakutia and Northern Eurasia during the Holocene meanwhile chronologic contrasts in paleo-temperature changes increase southwards.

Polar macrobenthic fauna in the Lena river deltaic sediments

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The hypothesis is explored that the benthic fauna in the sediments of the Lena delta intercepts transports of organic particles from the river catchment area towards the sea, and itself may constitute a rich food source for fish and birds. However, living conditions in the delta may prevent macrobenthic invertebrates to fulfil this ecological role. Early summer flushing due to ice and snow melting, and ice furrowing strongly mobilizes the deltaic sediments of the Lena River entering the Arctic Laptev Sea. Strong currents prevail until winter, keeping most of the riverine sediments in motion. No aquatic vegetation develops along the shores which are primarily composed of sandy beaches. Marine waters are not intruding into the central delta region. In summer 2010 we collected macrobenthic fauna (Fig. 5-1) retained on a 0.5-mm mesh from sediment cores of 200 cm² in area and 20 cm in length (n=48) taken with a box corer at depths between 2 and 7 m, and from cores of 95 cm² area and 20 cm length (n=48) taken with a hand-held tube corer at depths of 0.3 to 1.5 m. The habitat spectrum from deep channels with swift currents to shallow sheltered bays has been included. The invertebrate fauna was predominantly composed of chironomid larvae (66%) and oligochaetes (31%). The overall abundance was

extremely low with an average of 503 individuals m-2 (range 8 - 1508) and 0.04 g organic dry weight m-2. Highest abundance was recorded at a muddy site where opposite currents met. Organic matter was mostly composed of refractory peat material eroded from cliffs within the deltaic region which constitutes a poor food if at all. We conclude that the polar riverine zoobenthos in turn is a negligible food source for fish and birds, and unlike estuarine benthos in the temperate zone contributes little to an estuarine filter between land and sea.

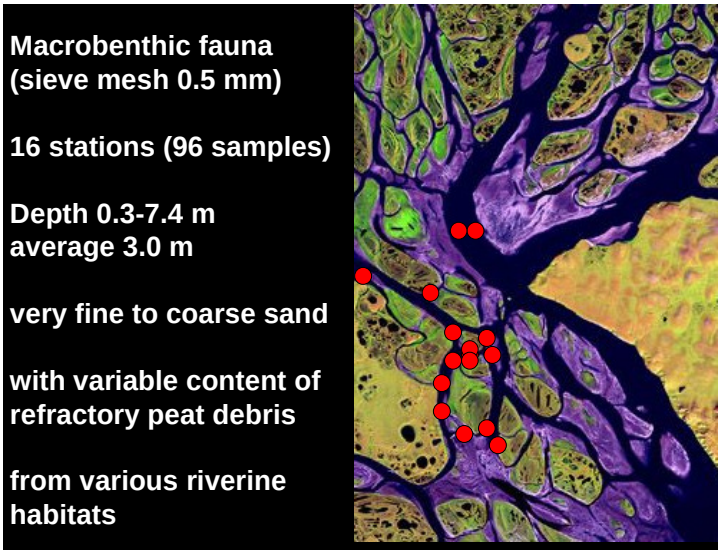

Figure 5-1: Sampling positions in the Central Lena Delta.

Benthos of the Lena Delta and the shallow fringe towards the Laptev Sea

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Estuarine sediments are known to be rich in benthic fauna supported by high organic imports from the river and the sea. We investigate whether this general proposition also holds for the Lena Delta and the adjacent Arctic coastal waters (Fig. 5-2). In view of a highly complex geomorphology, diverse currents and sedimentation patterns, testing this proposition of an inert coastal benthos constitutes a challenge. Based on previous studies and employing a box corer to obtain vertical sediment cores, we quantify benthic diversity and biomass. The study is crucial to understand the ecological function of the Lena delta for fluxes to the Arctic Ocean and to determine food sources for migrant fish and birds in the region.

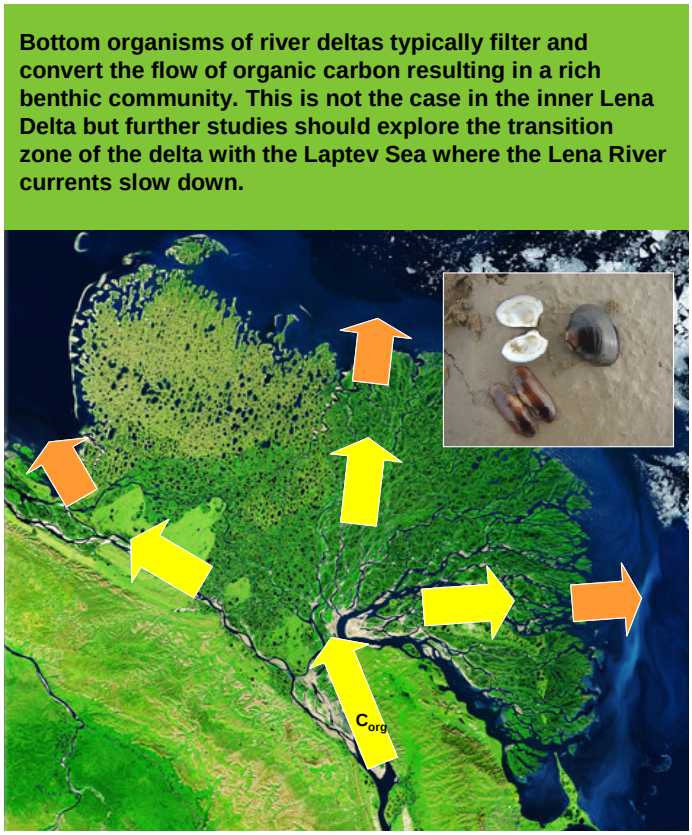

Figure 5-2 Organic matter transport in the Lena Delta.

Holocene paleoevironmental changes of Laptev See region -evidence from pollen records of the Elgene-Kyuele lake

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Vegetation changes reflected in fossil pollen spectra are a primary source of information about climatic fluctuation in the past. Pollen data is widely used in palaegeographical reconstructions. Still there is only a small number of data including spore-pollen results to allow a general view on Holocene palaeoclimatic events particularly within the Laptev Sea region. Really, up to now there are only several publications devoted to pollen investigations of lake sediments of the region [Andreev et al., 2002, 2004; Pisaric et al., 2001; Schirrmeister et al., 2003]. Therefore, the similar studies were initiated in the frameworks of Russian-German collaborations in this region and the first results obtained are presented in this work.

The sedimentary core 135 cm thickness was collected during the “Lena-2009” expedition from the Elgene-Kuele lake (PG1975: coordinates: N 71° 017’ 39,7”, E 125° 33’ 01,7”). The main goals of our study were to carry out pollen analyses of the sedimentary in order to obtain new data for reconstruction of palaeoclimatic history of the Laptev Sea region during the Holocene.

Pollen data indicate that 4 main taxa ***Betula, Alnus fruticosa, Poaceae, Cyperaceae*** dominate from top to bottom of the section. Percentage content of main components of spore-pollen spectra varies insignificantly. Curve of distribution of content of ***Larix*** pollen allowed us to distinguish 4 zones along the sedimentary core.

Zone 1 (135-71 cm). The portion of trees and shrubs pollen fluctuates between 60-70%. The zone is dominated by the pollen ***Betula*** and ***Alnus fruticosa,*** with ***Cyperaceae*** and ***Poaceae***. Pollen of ***Salix*** and ***Larix*** are present. The spectra show relatively high percentages of ***Larix*** pollen (5%). This can indicate to larch forest tundra conditions.

Zone 2 (71-23 cm). The percentage ration of tree and herb pollen is likely previous zone 1. But decrease in larch pollen suggests insignificant climate cooling relatively of zone 1. Zone 3 (23-7 cm). Low percentages of ***Larix*** (less 1%), and increase of herbs pollen (up to 55%) may reflect shrub tundra conditions. This change might be associated with climate deterioration during the Little Ice Age.

Zones 4 (7-0 cm). The final zone marked by negligible increases in ***Larix*** (about 1%) and is dominated by ***Betula*** and ***Alnus fruticosa***. This zone is interpreted as the establishment of the modern forest tundra with birch, alder and larch.

Pollen data from the sedimentary core of the Elgene-Kyuele Lake (PG1975-1, lake 05) showed insignificant variability of spectra along the section. Nevertheless, the most favorable climatic conditions formed during accumulation of Zone 1 when the forest-tundra vegetation was expanded with domination of birch, alder and larch. Spore-pollen spectra of Zone 2 reflect insignificant cooling during which the forest-tundra vegetation becomes more thinned out. Lack of larch pollen in spore-pollen composition provides evidence of even greater deterioration of climatic conditions in Zone 3. Probably, this time can be belonged to the Little Ice Age. Domination of forest-tundra vegetation is fixed in Zone 4 and it reflect contemporary vegetation. Carrying out of radiocarbon dating of the sedimentary cores is required for recognition of sequence and duration of paleoclimatic events in time.

Up to now we have not so much statistical data to make a completed (final) conclusions concerning the palaeoclimatic changes in Holocene within the Laptev Sea region. Hence, we are continuing our palaeoclimatic investigations including comprehensive spore-pollen and geochemical analyses of sedimentary cores from other lakes of the region.

The work was carried out in frames of the OSL project № OSL-10-22.

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Paleolimnological expedition “Lena 2010” - Field results

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In August 2010 the paleolimnological expedition “Lena 2010” has been carried out in the area close to the Lena Delta. The aim of the expedition was to study lakes located in the area of tundra and taiga, and the selection of core sediments. Studies carried out within the framework of a larger project SibLake to reconstruct climatic changes in northern Eurasia during the Pleistocene and Holocene. During the conference we will present the results of field studies.

6. ATMOSPHERE - SEA ICE - OCEAN INTERACTION (SESSION V)

Evaluation of simulated sea-ice concentrations from sea-ice/ocean models using satellite data and polynya classification methods

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Sea-ice concentrations in the Laptev Sea simulated by the coupled North Atlantic – Arctic Ocean – Sea-Ice Model (NAOSIM) and Finite Element Sea-Ice Ocean Model (FESOM) are evaluated using sea-ice concentrations from AMSR-E satellite data and a polynya classification method for winter 2007/08. Simulated sea-ice fields from different model runs are compared with emphasis placed on the impact of a prescribed landfast-ice mask. We demonstrate that sea-ice models are not able to simulate flaw polynyas realistically when used without fast-ice description. Without landfast and coarse horizontal resolution, our investigations indicate that in the polynya regions the mean state of the sea-ice concentration is balanced out by a larger-scale reduction of ice concentration and smoothed ice concentration fields. After implementation of a landfast-ice mask the polynya location is realistically simulated, but the total open water area is largely overestimated. The study shows that further model improvements are necessary in order to achieve the important step from the simulation of large-scale features in the Arctic towards a more detailed simulation of smaller-scaled features (here polynyas) in an Arctic shelf sea.

Changes in distribution of sea-ice derived brine waters on the Laptev Sea shelf in 2007 inferred from stable oxygen isotope studies

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Combined salinity and $\delta^{18}O$ data from summer 2007 reveal a significant change in brine production in the Laptev Sea relative to summer 1994. The distribution of river water and brine enriched waters on the Laptev Sea shelf is derived based on mass balance calculations using salinity and $\delta^{18}O$ data. While in 1994 maximal influence of brines is seen within bottom waters [Bauch et al., 2009a], in 2007 the influence of brines is highest within the surface layer and only a moderate influence of brines is observed in the bottom layer. In contrast to 2007, salinity and $\delta^{18}O$ data from summer 1994 clearly identify a locally formed brine enriched bottom water mass as mixing endmember between surface layer and inner shelf waters on one side and with higher salinity water from the outer Laptev Sea on the other side. In 2007 the brine enriched waters are predominantly part of the surface regime and the mixing endmember between surface layer and outer shelf waters is replaced by a relatively salty bottom water mass. This relatively salty bottom water probably originates from the western Laptev Sea. The inverted distribution of brines in the water column in 2007 relative to 1994 suggests a less effective winter sea-ice formation in winter 2006/2007 combined with advection of more saline waters from the western Laptev Sea or the outer shelf precedent to the climatically extreme summer 2007. The observed changes result in an altered export of waters from the Laptev Sea to the Arctic Ocean halocline.

Atmospheric controlled freshwater release at the Laptev Sea Continental margin: detailed investigation of distribution patterns

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Considerable inter annual differences are observed in river water and sea-ice meltwater inventory values derived from $\delta^{18}O$ and salinity data in the Eurasian Basin along the continental margin of the Laptev Sea in summers 2006, 2005 (NABOS expeditions) 1995 and 1993 [Frank 1996]. The annually different pattern in river and sea-ice meltwater inventories remain closely linked for all years, which indicates that source regions and transport mechanisms for both river water and sea-ice formation are largely similar over the relatively shallow Laptev Sea shelf.
A simple Ekman trajectory model for surface Lagrangian particles based solely on wind forcing can explain the main features observed between years with significantly different wind patterns and vorticities and can also explain differences in river water distributions observed for years with generally similar offshore wind setting. An index based on this simplified trajectory model is rather similar to the vorticity index, but reflects the hydrology on the shelf better for distinctive years. This index is not correlated to the Arctic Oscillation, but rather to a local mode of oscillation, which controls the outflow and distribution of the Eurasian Basin major freshwater source on an annual time scale.

Variations in brine water export from the Laptev Sea Shelf forced by different atmospheric circulation patterns inferred from stable oxygen isotope studies

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Combined $\delta^{18}O$/salinity data reveal a distinctive water mass generated during winter sea-ice formation, which is found predominantly in the coastal polynya region of the southern Laptev Sea. Export of these brine enriched bottom water shows inter-annual variability in correlation with atmospheric conditions.

Summer anticyclonic circulation is favoring an offshore transport of river water at the surface as well as a pronounced signal of brine enriched waters at about 50 m water depth at the shelf break. Summer cyclonic atmospheric circulation favors onshore or an eastward, alongshore water transport and at the shelf break the river water fraction is reduced and the pronounced brine signal is missing, while on the middle Laptev Sea shelf brine-enriched waters are found in high proportions. Residence times of bottom and subsurface waters on the shelf may thereby vary considerably: an export of shelf waters to the Arctic Ocean halocline might be shut down or strongly reduced during “onshore” cyclonic atmospheric circulation, while with “offshore” anticyclonic atmospheric circulation brine waters are exported and residence times may be as short as one year only.

Nonhydrostatic modeling of the Arctic convective boundary layer

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It is well known that the results of climate models show large differences in Arctic regions with regards to many meteorological variables, especially in the regions of the marginal sea ice zone (MIZ). To identify the shortcomings of such models using large grid spacing a collaboration project between the Alfred Wegener Institute (AWI) in Bremerhaven and the Obukhov Institute (IAP RAS) in Moscow was started, which aims to investigate the typical flow regimes in the MIZ by means of mesoscale modelling with different spatial resolution. First results are presented here for the conditions of off-ice flow (cold air outbreaks).
As the basic model the nonhydrostatic mesoscale model NH3D (Miranda and James 1992) run at the Obukhov Institute is used. Since the NH3D model was never applied to simulate polar processes it is validated against the results of the model METRAS (Schlünzen 1990), that was successfully used at the University of Hamburg and at AWI for simulating many different meteorological conditions in the Arctic. Preliminary comparison of the results of the NH3D model simulation of an off-ice flow with the results of the METRAS model showed good agreement of the simulated fields of different meteorological variables.
A validation of the NH3D model against observational data, available at AWI, for the cases of off-ice and on-ice flow will be carried out during the first stage of the further collaboration. The main topic of the further joint research will be the study of the effect of mesoscale circulations on the energy exchange between ocean and atmosphere during off-ice flows.

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Impact of the Arctic Ocean Atlantic water layer on Siberian shelf hydrography

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This report examines the role of the Arctic Ocean Atlantic water (AW) in modifying the Laptev Sea shelf bottom hydrography on the basis of historical records from 1932 to 2008 and 2002–2009 cross-slope measurements. A climatology of bottom hydrography demonstrates warming that extends offshore from the 30–50 m depth contour. Bottom layer temperature time series constructed from historical records links the Laptev Sea outer shelf to the AW boundary current transporting warm and saline water from the North Atlantic. The AW warming of the mid-1990s and the mid-2000s is consistent with outer shelf bottom temperature variability. The 2002–2009 cross-slope observations are suggestive for the continental slope upward heat flux from the AW to the overlying low halocline water (LHW). The lateral on-shelf wind-driven transport of the LHW then results in the bottom layer thermohaline anomalies recorded over the Laptev Sea shelf. We also found that polynya-induced vertical mixing may act as a drainage of the bottom layer, permitting a relatively small portion of the AW heat to be directly released to the atmosphere. Finally, we see no significant warming (up until now) over the Laptev Sea shelf deeper than 10–15 m in the historical record. Future climate change, however, may bring more intrusions of Atlantic-modified waters with potentially warmer temperature onto the shelf, which could have an impact on the stability of offshore submarine permafrost.

Impact of Laptev Sea flaw polynyas on the atmospheric boundary layer and ice production using idealized mesoscale simulations

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The interaction between polynyas in the Laptev Sea and the atmospheric boundary layer (ABL) is examined with the regional, nonhydrostatic atmosphere model COSMO. A thermodynamic sea ice model is used to deal with the sea ice behaviour in response to idealized atmospheric forcing. The idealized regimes represent typical atmospheric conditions for the Laptev Sea region. Cold wintertime conditions with sea ice-ocean temperature differences up to 40 K combined with different wind speed by varying wind direction are investigated. A large impact of Laptev Sea flaw polynyas on the ABL can be shown. Convectively mixed layers up to 1200 m are simulated above the polynyas with

a temperature anomaly of up to 5 K and a horizontal transport of heat more than 500 km downstream of the polynyas. Strong wind regimes lead to a shallow mixed layer with near-surface large-scale impact, while weaker wind regimes show a deeper well-mixed convective boundary layer with horizontal spatially limited influence. Shallow mesoscale circulations are simulated in the vicinity of ice-free and thin ice covered polynyas. Large surface energy fluxes, strong low-level thermally induced convergence, and additionally, cold air flows from the orographic structure at Taymir-Peninsula in the western Laptev Sea region are important forcing factors. Potential sea ice production rates are derived from the simulations to estimate an upper limit of possible sea ice production. Mean production rates between 7.2 cm/d and 21.8 cm/d are derived, based on the surface energy balance.

Simulation of Laptev Sea polynya dynamics using the FESOM model with different atmospheric forcings

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The polynyas of the Laptev Sea are regions of particular interest due to the strong formation of Arctic sea ice. In order to simulate the polynya dynamics and to quantify ice production, we apply the Finite Element Sea Ice-Ocean Model FESOM. In previous simulations FESOM has been forced with daily atmospheric NCEP (National Centers for Environmental Prediction) data. For the period 1 April to 9 May 2008 we examine the impact of different forcing data: Daily and 6-hourly NCEP/DOE (Department of Energy) reanalyses 2 (1.875° x 1.875°), 6-hourly NCEP/NCAR (National Centers for Atmospheric Research) reanalyses 1 (2.5° x 2.5°), 6-hourly analyses from the GME (Global Model of the German Weather Service) (0.5° x 0.5°) and high resolution hourly COSMO (Consortium for Small-Scale Modelling) data (5 km x 5 km). Comparisons with in-situ measurements of the TRANSDRIFT XIII-2 experiment 2008 show that the wind of all atmospheric forcing data is realistic over the fast ice. Apart from the FESOM simulation with daily NCEP data, the opening and closing processes of polynya areas are generally simulated in principle agreement with AMSR-E (Advanced Microwave Scanning Radiometer - Earth Observing System) products. However, there are considerable discrepancies between the sea ice production rates of the different simulations. Hourly high resolution atmospheric data are necessary to quantify ice production in polynyas.

Air-sea-ocean interaction processes and impacts on polynya formation and sea ice production in the Laptev Sea of the Siberian Arctic

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Processes of the exchange of energy and momentum at the sea ice-ocean-atmosphere interface are key processes for the polar climate system. Heat and moisture fluxes are strongly modulated by open water fractions associated with polynyas, having important consequences for the atmosphere, ocean processes, ice formation, brine release, gas exchange and biology. Our paper aims at the study of atmospheric processes forcing and maintaining polynyas in the Laptev Sea of the Siberian Arctic. This region is known as being a highly productive area for the formation of new ice throughout the winter season. We study polynya processes using passive satellite remote sensing data, high-resolution (5km) sea-ice/ocean and atmospheric models, as well as in-situ data obtained during experimental studies in that area. Passive microwave sensor data (SSM/I, AMSR) are used together with atmospheric reanalysis to characterize the long-term spatiotemporal characteristics of polynya events. A special focus lies on the detection of thin ice in polynya areas, which is studied using thermal infrared data (MODIS, AVHRR). Thin ice statistics combined with microwave data allows for estimations of ice production rates for the last decades. The NWP model COSMO is used together with the sea-ice/ocean model FESOM to study polynya dynamics. Model simulations are validated using satellite data and in-situ measurements from two campaigns in the Laptev Sea area.

Near-bottom water warming in the Laptev Sea in response to atmospheric and sea ice conditions in 2007

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We present new data from ship-based measurements and 2-year observations from moorings in the Laptev Sea along with Russian historical data. The observations from the Laptev Sea in 2007 indicate that in consequence of the unusually high summertime surface water temperatures also the bottom water temperatures on the mid-shelf increased by more than 3 °C compared to the

long-term mean. Such a distinct increase in near-bottom temperatures has not been observed before. Remnants of the relatively warm bottom water occupied the mid-shelf from September 2007 until April 2008. Strong polynya activity during March to May 2007 caused more summertime open water and thus warmer sea surface temperatures in the Laptev Sea. During the ice-free period in August and September 2007 a cyclonic atmospheric circulation prevailed, which deflected the freshwater plume of the River Lena to the east thus increasing the salinity on the mid-shelf north of the Lena Delta. This resulted in weaker density stratification and allowed an increased vertical mixing of the water column during storms in late September and early October that led to the observed warming of the near-bottom layer in the still ice-free Laptev See. In summer and autumn 2008 when the density stratification was stronger and sea surface temperatures were close to the long-term mean, no near-bottom water warming was observed. The increase of water temperatures near the seabed may also impact the stability of the submarine permafrost that underlies the Laptev Sea shelf at shallow sediment depth.

Response of shelf-basin exchange in the Laptev Sea on summer ice depletion

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This study was motivated by recent dramatic changes in the Arctic sea ice cover: transition from the dominance of the multiyear ice to the dominance of the first year ice. This change is generally in line with GCM-based prediction of shift towards the seasonal Arctic ice cover within several decades from now on. In recent studies it was shown that retreat of summer ice edge enhances shelf-basin exchange due to upwelling events. This study demonstrates that similar effect may be produced by dense water formation and cascading in winter. Model simulations confirm that enhanced ice formation might substantially intensify shelf-slope exchange. In the north-western Laptev Sea, where salinity on shelf is high, compared with salinity in adjacent slope waters, physically realistic increase of surface forcing pushes shelf origin dense water below intermediate Atlantic Water layer, ventilating all water masses en route. Increase of forcing from 0.02 to 0.03 g/m2/s leads to 3-fold increase of shelf-slope volume flux below the warm core of AW (from 0.04 to 0.12 Sv). Obtained results suggest that in seasonally ice free Arctic Ocean shelf-basin exchange due to cascading events may substantially increase with consequences for water mass structure and water exchange with sub-Arctic seas.

The Laptev Sea flaw polynya impact on the bottom layer hydrography during winter 2008

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In this paper we present the analysis of unconventional thermohaline changes observed in the Eastern Laptev Sea polynya bottom layer in January-April 2008. These changes are evident during period of polynya developing and appear as the recurrent abrupt temperature and salinity decreases and increases in the long-term CTD records. Being in the range of 0.5°C and 1.6 psu the observed changeability was previously associated with the deeper Atlantic layer yielding warmer and saltier outer-shelf waters to the mid-shelf polynya area. But considering both newly available thermohaline and currents records other plausible source of these variations has been proposed.
Our study reveals that periods with fresher waters at the freezing temperatures (indicating the surface convective layer) coincide with northward flows from polynya, while southward currents bring salty waters from the warm bottom layer beneath the pycnocline. It implies that deeper pycnocline depth resides near the fast-ice edge and we suggest that the observed fresher waters in polynya are formed at the mid depths by the entrainment of fresher surface waters due to the penetrative mixing in the density interface. While the source of vertical mixing in intermediate depths is unclear, this mixing likely result from either the thermohaline convection due to the brine release or the enhanced mechanical mixing at the ridged fast-ice edge.

Evaluation of model results for the Laptev Sea region and Lena-river catchment

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In order to investigate climate change in the Siberian region of Laptev Sea and Lena-river catchment consistent data over long time spans are necessary. Due to a sparse meteorological station network observation data is limited in that area. To complement existing data at high spatial and temporal resolution and to provide information of climate parameters for which no measurements have been taken regional climate models can be applied.
Here the regional climate model COSMO-CLM is used with a grid mesh resolution of about 50 km and about 7 km for subregions. Boundary conditions are taken from NCEP reanalysis. To ensure that the model is able to reproduce

climate in that region of the northern high latitudes different configurations will be tested for some periods.
The poster will present an evaluation of spatial and temporal characteristics of simulated temperature and precipitation in comparison to observation data. Since cryosphere plays a crucial role in determining regional climate special attention will be given to the ability of simulating snow and permafrost conditions as well. This knowledge will be used later on to run a climate reconstruction over that domain for the last 60 years.

Sea ice production and water mass modification in the eastern Laptev Sea

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A simple polynya flux model driven by standard atmospheric forcing is used to examine the effect of ice formation taking place during an exceptionally strong Western New Siberian polynya event in February 2004 in the Laptev Sea. The ability of the polynya to form dense shelf bottom water is investigated by adding the brine released during the 2004 polynya event to the average winter density stratification of the water body, pre-conditioned by summers with a cyclonic atmospheric forcing (comparatively weakly stratified water column). Beforehand, the model performance is tested by applying it to the simulation of a well documented event in April 2008. Neglecting the replenishment of water masses by advection into the polynya area, we find the likelihood of convective mixing down to the bottom to be extremely low. The strong density stratification and the apparent lack of extreme polynya events in the eastern Laptev Sea limit convective mixing to a depth of 20 m or less. We conclude that the observed breakdown of the stratification during polynya events is therefore predominantly related to wind- and tidally-driven turbulent mixing.

Late Holocene climate and environmental changes in the Eurasian Arctic as recorded in glacier and ground ice – previous results and future prospects

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The Arctic is a key region for the global climate system and is more affected by ongoing anthropogenic climate change than most other regions. Meteorological time series from the Eurasian Arctic are short. Hence, climate archives are of particular importance for the assessment of the natural climate variability, its causes and interactions before the anthropogenic impact, i.e. in the Late Holocene.

Glacier ice cores are well known as one of the best climate and environmental archives and provide valuable information on past changes.

In Arctic non-glaciated permafrost areas, ice wedges are a widely distributed type of ground ice. They are formed by the periodic repetition of frost cracking and subsequent crack filling mostly by melt water of winter snow. Therefore, ice wedges can be studied by means of stable water isotopes analogously to glacier ice. Their stable isotope composition is indicative for winter climate conditions.

We present Late Holocene stable water isotope ($\delta^{18}O$ and d excess) records of glacier and ground ice from the Russian Arctic as well as future research plans.

The ice core was drilled at Akademii Nauk (AN) ice cap on Severnaya Zemlya (80.5°N, 94.8°E) in 1999-2001, whereas ice wedges exposed at the Oyogos Yar (OY) coast of the Dmitrii Laptev Strait (72.7°N, 143.5°E) were studied in 2007.

Both stable isotope records differ in the temporal resolution but provide valuable paleoclimatic information. AN ice core $\delta^{18}O$ data as temperature proxy for the Western Eurasian Arctic reveal significant changes on different timescales. A long-term decrease does not solely reflect climate cooling but also the growth of AN ice cap. Several rapid decadal-scale warming and cooling events from the 15^{th} to the 20^{th} centuries are probably related to the internal dynamics of the Arctic climate system.

The OY ice wedge $\delta^{18}O$ data indicate a Late Holocene winter warming trend, characterised by a marked variability and several briefer maxima and minima.

Glacier and ground ice stable isotope records show clear evidence that the last century was the warmest in the Late Holocene, reflecting the ongoing Arctic warming. This was accompanied by changes in the moisture sources (visible in d excess), probably related to changes in the atmospheric circulation patterns and/or sea ice dynamics.

Future research aims at the comprehensive reconstruction of Late Holocene climate and environmental changes based on the further study of the AN ice core and ice wedges at different study sites along a west-east transect in the permafrost lowlands of the Siberian Arctic, mainly by means of stable water isotopes. The combination of ice core and ice wedge records will give new

insights in the seasonal, temporal and spatial dynamics of the Late Holocene climate in the Eurasian Arctic and in the moisture generation and transport patterns between the varying impacts of the Atlantic and Pacific Oceans.

Air-sea interaction near polynyas and leads from experimental data and numerical modeling

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Our work was focused on studying the effects of structural and thermal non-uniformity at the ice covered surface on heat and momentum exchange between atmosphere and underlying surface in the Laptev sea in fall period. Of special interest was the effect of polynyas and leads on the heat balance of the Laptev sea. The following objectives were carried out:
Analyze energy exchange between atmosphere and surface using measurements of turbulent fluxes (latent and sensible heat fluxes, momentum fluxes, carbon dioxide fluxes) in the subsurface layer of the atmosphere.
Define the exchange coefficients in the aerodynamic bulk formulas, the surface roughness parameter in respect to the type of the surface and meteorological conditions.
Mesoscale atmospheric model NH3D was used for modeling of atmosphere dynamics in polar regions influenced by interaction of atmosphere with inhomogeneous underlying surface represented by polynyas. The work was sponsored by OSL grant.

The evolution of the bottom water properties over the Eurasian shelf during the 21st century

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The ongoing changes in atmospheric conditions, drifting and landfast ice, and continental runoff will affect the oceanic circulation on the Eurasian shelves. Also the possible weakening of the cold halocline would enable spilling of the warm intermediate Atlantic water onto the shelf, which would lead to accelerated sea ice melt. To examine the future changes of the shelf hydrography we will develop a sea ice - ocean model with the main focus on the realistic representation of the Eurasian shelf sea processes. The model will be validated with the observational data from the Laptev Sea shelf region. The simulation results for the 21st century would supply also the information about the bottom water properties, especially temperature and salinity. This crucial data would then be used further as a boundary conditions in the submarine permafrost models. Permafrost is believed to underlie most of the Kara, Laptev,

East Siberian and Chukchi seas shelves and the bottom water temperature and salinity are the main controls of its modern thermal regime and stability.

Implementation of a thermodynamic sea ice module in the NWP model COSMO and its impact on simulations for the Laptev Sea area in the Siberian Arctic

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Sea ice surface temperature shows a high degree of variability on sub-daily time-scales. Therefore, we have implemented a thermodynamic sea ice module into the NWP model COSMO and performed simulations at a resolution of 15 and 5 km for the Laptev Sea area in April 2008. Temporal and spatial variability of surface and 2m air temperature are verified by four automatic weather stations deployed along the edge of the West New Siberian Polynya during the expedition TRANSDRIFT XIII-2 and by surface temperature charts with a horizontal resolution of 1 km derived from MODIS. The remarkable agreement regarding mean values, temporal and spatial variability of surface and 2m air temperature approves the quality and applicability of the implemented sea ice module. Hourly data of the COSMO simulations are then used to estimate sea ice production for the Laptev Sea polynyas with a spatial resolution of 5 km for the period 14 - 30 April 2008. During these 16 days we derive a mean total sea ice production rate of 0.65 km³/day for all Laptev Sea polynyas under the assumption that the polynyas are ice-free and a rate of 0.37 km³/day if a 10 cm thin ice layer is assumed. Our results indicate an overestimation of ice production in Laptev Sea polynyas in previous studies based on oceanographic and satellite data.

New data on aeolian and ice transport of matter in the Arctic

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Numerous studies have shown that atmospheric and ice transport are of importance for the Arctic environment [Kassens et al., 1999; Lisitzin, 2002, 2010; Shevchenko et al., 2003; Stein & Macdonald, 2003]. New data on aeolian and ice transport of sedimentary matter (including ecotoxicants) were obtained in our studies.

Particulate and dissolved matter was studied in different spheres: snow – ice – under-ice water – nilas, and in lichens. These spheres are the main active collectors of the matter and can be the indicators of the pollutant transport to the Arctic.

All research areas were separated into two groups: with anthropogenic influence and background areas. Minimum of particulate suspended matter is found in the Central Arctic: snow samples were collected in the PAICEX expeditions (2007, 2008, 2009), during the work of the Russian drifting stations (from 2000 to 2009), cruise on board of SV Akademic Fedorov (2000) and i/b Kapitan Dranitsin (2006, 2008). Concentration of matter varied from 0.33 to 3.4 mg/l. Suspended matter is composed of biogenic and mineral particles, fly ash particles are very rare. Composition of matter in snow has strong dependence on the seasonal variability: summer with algae blooming, when the biogenic matter is the main component of the particulate matter in snow and winter when long-range transport is the main source of the matter in Arctic snow.
Samples were taken in the expeditions held in the frame of NABOS project in 2006 and 2008 years. Concentration of SPM is different in different spheres: concentration of suspended particulate matter (SPM) in snow and ice is 2 times more than in nilas or water. Ratio between biogenic, mineral and anthropogenic particles differs in these samples: biogenic particles predominate in ice and nilas samples, mineral – in nilas and under-ice water. Anthropogenic particles can be found very rarely in snow samples.
We studied multi-element composition of terricolous (mostly of genera ***Cladonia*** and ***Cetraria***) and fruticose epiphytic (mostly of genera ***Alectoria***, ***Usnea*** and ***Bryoria***) lichens collected in 2004–2009 in Kola Peninsula, Karelia, Arkhangelsk Region and Komi Republic of NW Russia [Shevchenko et al., 2010]. About 110 samples were analyzed. Element concentrations were determined by inductively coupled plasma-mass spectrometry (ICP-MS) and instrumental neutron activation analysis (INAA). An enrichment factor (EF) was calculated for each element (X) relative to the composition of earth's crust: EF = ((X/Al) in lichen) / ((X/Al) in the earth's crust). Al was used as a crustal indicator [Rudnick & Gao, 2003]. In most samples contents of Ti, V, Cr, Mn, Fe, Co, rare earth elements (REEs), Th, U are at the background level and their EFs are less than 10. These low EF values indicated that, relative to average values for crustal rocks, there was no enrichment of these elements in the lichen concerned. For some elements (Se, Cd, Zn, Sb, Pb, As, Ni, Cu) consistently higher EF values were obtained. These higher values were interpreted in terms of sources of both anthropogenic and natural other than crustal rock and (or) soil. These elements could be derived by long-range atmospheric transport. In lichens collected at the sea coasts, high Na content and EF values were revealed. In general, elemental composition of lichens in the Northwest European Russia reflects complex influence of atmospheric deposition of aerosols from both natural and anthropogenic sources.
Our studies were financially supported by Russian-German Otto Schmidt Laboratory (project OSL-10-24), Department of Earh Sciences of The Russian Academy of Sciences (project "Nanoparticles in the Earth's geospheres"). The authors are indebted to Academician A.P. Lisitzin for valuable recommendations and to all colleagues who helped in field and laboratory studies.

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Longterm variability of polynya dynamics and ice production in the Laptev Sea between the winters of 1979/80 and 2007/08

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Polynyas in the Laptev Sea are examined with respect to recurrence and wintertime ice production. We use a polynya classification method based on passive microwave satellite data to derive daily polynya area from long-term sea-ice concentrations. This provides insight into the spatial and temporal variability of open water and thin ice regions on the Laptev Sea shelf. Using thermal infrared satellite data to derive an empirical thin ice distribution within the thickness range from 0 to 20 cm, we calculate daily average surface heat loss and the resulting wintertime ice formation within the Laptev Sea polynyas between 1979 and 2008 using NCEP reanalysis data as atmospheric forcing. Results indicate that previous studies significantly overestimate the contribution of polynyas to the ice production in the Laptev Sea. Average wintertime ice production in polynyas amounts to approximately 55 km³ ± 27% and is mostly determined by the polynya area, wind speed and associated large-scale circulation patterns. No trend in ice production could be detected in the period from 1979/80 to 2007/08.

Possibilities for the synoptic radar survey of waves and currents causing littoral erosion

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Since 1997 GKSS Coastal Research and PROGNOS/ETU St. Petersburg cooperate in the development of radar application in hydrographical survey. In addition to this development a series of hydrodynamic field experiments have been conducted as well in Russia as in Western Europe. The presentation will give insight into the different radar techniques and analysis methods used for the synoptic survey of wave parameters, current vectors, bathymetry, wave breaking and others. Examples of research issues in morphodynamic, littoral wave energy dissipation and others will be given.
Special emphasis will be given in the proposed contribution to the Laptev Sea experiments observing wave and current parameters during the ship cruises. Wave energy and current interacts as well with the sea ice as with the coasts. A change in ice coverage impacts a change in wave and current fields. Vice versa the wave and current fields play an important role in the erosion of sea ice and the coasts. Thus the synoptic survey of these dynamic parameter provides necessary information for the understanding the status and the change in the ice and at the coasts.

7. HYDROLOGY AND CRYOGENIC PROCESSES (SESSION VI)

Evaluation of climate change impact on runoff generation at small watersheds in Eastern Siberia

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The goal of the project is assess the possible changes of the annual, seasonal and extreme runoff distribution for small watersheds in different landscapes of the Eastern Siberia. The approach of deterministic-stochastic modeling coupled with IPCC climate change scenarios is applied.
The key objectives of the research included: (1) generation of continuous series of daily meteorological data (20, 50, 100 years span) according the IPCC climate change scenarios using the stochastic model; (2) Simulation the water and energy fluxes in the permafrost sites with randomly generated series of meteorological elements as forcing data using the deterministic model; (3) evaluate the changes of annual, seasonal and daily extreme probabilistic curves of runoff characteristics due to permafrost melting impact within different climate change scenarios.
The Deterministic-Stochastic Modeling System consisting of two elements, a deterministic model of runoff formation processes called “Hydrograph” and the Stochastic Model of Weather (SMW), developed in the Sate Hydrological Institute was used.

The analysis and modeling of long-term observational data of Kolyma water-balance station in the scope of studies of climate change impacts on hydrological regime of permafrost landscapes

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Permafrost areas are the special subjects for research as they are distinguished to be the important part of atmosphere-land-ocean system interaction. Mainly they are still insufficiently explored territories in the hydrological sense.
The datasets of long-term detailed process observations are rare and valuable. Surprisingly, till now there are the datasets which are still studied fragmentary.

Mainly they are related to the territory of former Soviet Union, now Russia, which had a number of highly instrumented small watersheds (or nested set of those) intended for long-term collection of observations of runoff, variable states, water balance components, etc in different climate zones, so called water-balance stations. One of them is the Kolyma water-balance station (KWBS) which is situated within the upstream of Kolyma River (the North-East of Russia, 61°54'N, 147°25'E) and is unique for mountainous regions of continuous permafrost. Since 1948, special observations of water balance components, state variables of frozen soil and snow, and other characteristics were carried out at this station. The elevation varies within 800–1700 m range. The average annual temperature is -13° C, precipitation is about 400 mm. The main types of landscapes depending on elevation are mountainous tundra and larch taiga. The data gathered at KWBS is available in paper published form for the period 1948 – 1990 years and absolutely unique in terms of their duration and the level of detail of representation of hydrometeorological forcing and dynamics of various land-surface processes in the Arctic.
Two objectives of the on-going research are 1) to discover and analyze the available data, and use it for improvement of algorithms and assessment of hydrological model parameters; 2) to assess the possible changes in soil, snow cover and runoff formation processes in the small permafrost watersheds in the upper Kolyma on the base of deterministic-stochastic modelling using IPCC climate change scenarios. The details and results of this study will be presented at the meeting.

Modeling of active layer depth on Samoylov Island (Lena River Delta)

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The recently aroused interest to the processes connected with global climate change makes hydrological process studies on permafrost territories important. The calculation of freezing and thawing depth is quite hard to accomplish because of lacking field data. There are different models and equations of calculation. Stephan, Leibenzon, Kudryavtsev equations are widespread. The choice of a modeling method depends on different factors and can be based on thermal soil features, atmosphere and soil heat circulation. The problem of thaw depth calculation is caused by the accuracy lack of the majority of methods and, in addition, lack of stations where all active layer measurements have been done.
In order to the test three formulas, measurements which have been done on Samoylov Island (Lena Delta) in 2004, were chosen. The results revealed the maximum thawing depth according to the Stephan's formula reaches 31 cm that exceeds the measured depth by 5 cm. Leibenzon's formula showed 14 cm excess and Kudryavtsev's formula 17 cm excess.

Thus, the most appropriate for calculation of thawing depth is the Stephan's equation, which is based on freezing/thawing problem statement on the border of phase transitions.
Nevertheless, new methods of freezing/thawing depth calculation, which base on modern high resolution device data, are needed, as well as creating models of thermal processes in permafrost soils connected with climate changes.

Hydrological processes in the Laptev sea basin: current state and future projections

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The hydrological cycle affects both the terrestrial and aquatic systems and is intimately coupled with the atmospheric system. The Lena River inflow is one of the principal sources of freshwater budget in the Laptev Sea. The studies of the Laptev Sea region would not be complete without understanding the impacts of changing heat-water regimes on river streamflow.
The objective of the study is to assess the possible changes of the annual, seasonal and extreme runoff characteristics at the watersheds of different scale in the Laptev Sea drainage. The deterministic-stochastic modelling approach was applied coupled with several climate change scenarios.
The results of runoff process simulations based on the historical data and using climate change scenarios for the watersheds of Laptev Sea Region, including those for the whole Lena River basin with area more than 2 400000 km^2, will be presented and analyzed.

Microrelief and morphology of accumulative surface in frost heave distribution zone

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The mouth part of the Lena Delta is presented by a vast terrace lowland. Within this territory few terrace's level are allocated . Each level is characterized by different litholigical composition, sediment thickness, its age and genesis. In view of temperature regime is also different for whole territory. These factors exert influence on the development of relief formation processes.
The role of cryogenic relief formation processes in landscape transformation is great. Such forms of frost heave processes as bulgunyakh and pingos are widely distributed in the eastern part of the Lena Delta and occur on the third Lena River terrace. It should be noted that bulgunyakhs are also distributed on the level of height flood-land and near to the foot of the second terrace. Some

forms are characterized by fast uplift. Its speed is estimated by meters for last decades. This paper studies landscape, climatic, lithological and geocryological features of third terrace under its influence modern relief of surface was formed (Kurungnakh-Sise Island).

8. SUMMARY OF WORKING GROUPS

In order to provide guidance for the thematic discussion the following questions were outlined and given to the working groups.

(1) What central or important science questions are you working on?

(2) What critical physical processes being studied?

(3) What environmental changes are important/ expected?

(4) Which parameters are being measured by researchers in the group?

(5) Where does field work/ sampling take place (overlaps within the group)?

(6) What logistical support is required? What sampling strategies? Is there any overlap within the group? Between groups?

(7) What equipment is required?

(8) What analyses are required? Can OSL support them?

(9) What teams or complementary measurements can be identified? Are there datasets or sampling campaigns that can be combined or duplicated at different sites?

Methane and terrestrial carbon stocks (session I)

S Zubrzycki [(1)], I Bussmann [(2)]

[(1)] Institute of Soil Science, KlimaCampus, University of Hamburg, Germany; [(2)] Alfred Wegener Institute for Polar and Marine Research, Helgoland and Potsdam, Germany

Group members: J Griess, M Langer, I Preuss, J Rethemeyer, L Schirrmeister, I Sudakov

After everybody's presentation of topics she/he works on we spent good time having a discussion within our working group which was productive and fruitful and let to detailed answers to all suggested questions. Unfortunately, most of the time our group was a "German-speaking"-group. Only I. Sudakov from the

Russian site joined our “Methane and terrestrial carbon stocks”-group after lunch break.
Here we present the answers and comments the group members provided to the suggested questions:

What central or important science questions are you (the group) working on?

- Distribution and genesis of soils which are C-reservoirs
- Organic matter composition, transport and decomposition
- Carbon pools
- Temperature effects on organic matter degradation
- Thermal dynamics of polygonal tundra
- In situ studies on methane turnover
- Methane distribution and oxidation in aquatic environments
- Recent and fossil microbial communities involved in cycling of methane
- Methane flux to the atmosphere and methane content in the atmosphere
- Development of permafrost methane emission models

What critical physical processes are being studied?

- Spatial and temporal variability of freeze and thaw processes
- Boundary layer processes and atmospheric transport
- Mixing of water masses
- Biogeochemical organic matter transformation processes
- Cryogenesis
- Pedogenesis

What environmental changes are important/expected?
We expect changing in energy, water and carbon balance, in detail:

- Permafrost warming
- Active layer depth
- Water discharge
- Vegetation variations
- Ponding (increasing number of ponds)
- Drainage
- Coastal erosion

Which parameters are being measured by researchers in the group?

- Organic matter quality and quantity
- Ice content, bulk density
- Methane in water, soil and atmosphere
- Stable isotopes of bulk TOC
- Compound specific ^{13}C and ^{14}C on organic matter
- Lipid biomarkers
- DNA based analyses on microbial communities
- Different microbial activities
- Soil properties

Where does fieldwork/sampling take place?

- Samoylov
- Lena Delta
- Laptev Sea region
- Northeast Siberia lowlands

What logistical support is required? What sampling strategies? And equipment is required?

- Transport of temperature sensitive samples (frozen, cool)
- Data transfer from remote stations
- Support for winter expeditions
- Year-round observation period
- Ships (suitable for sediment sampling i.e. with winch, box corer), helicopters, all-terrain vehicles
- Chain saw, spades
- Drilling devices, permafrost augers
- Band-saw for core preparation before shipping
- New tents, water and wind proof, heated tents for field camps

What analyses are required? Can OSL support them?

- Soil and sediment analyses ((bio)chemical, physical)
- Gas chromatography
- Gas extractions and handling system
- Botanical analyses
- Online data transfer from climatological stations
- GC-irMS
- DOC analyses
- Working space under hood(s)

What teams or complementary measurements can be identified? Are there datasets or sampling campaigns that can be combined or duplicated at different sites?

- Existing projects and collaborations (i.e. Carbon in permafrost project, PERGAMON -Methane long term monitoring in the Arctic)
- Reanalyses of the huge archive samples we have
- Platform of interdisciplinary exchange of data, samples and publications

Coastal erosion and fluxes from land to ocean (session II)

F Guenther [(1)], MN Grigoriev [(2)]

[(1)] Alfred Wegener Institute for Polar and Marine Research, Potsdam, Germany; [(2)] Melnikov Permafrost Institute, SB RAS, Yakutsk, Russia

Group members: N Belova, A Chetverova, A Eulenburg, I Fedorova, R Flerus, H-W Hubberten, B Koch, P Overduin, E Pavlova, A Urban, W Petersen, S Wetterich

The research activities of the group are wide ranging. The participants of the discussion are working on hydrology, hydrochemistry, biogeochemistry, periglacial and coastal geomorphology. The group wants to handle questions like tracing of chemical signals of the Lena River in the Arctic Ocean, fluxes from tundra soils to the Laptev Sea, coastal erosion in the Kara and Laptev Seas and recent cryogeomorphogenesis. The common theme and accordingly the overall goal is the quantification of any kind of matter fluxes.

Analysing and interpreting the chemistry of water and sea bottom sediments can provide valuable insights into land-river-ocean interactions. For people working mainly on the sea, informations about the material source areas are essential. Researchers working in the coastal zone in contrast are interested in sedimentation patterns of materials released from the coast.

Regarding geomorphodynamics of permafrost affected coasts, erosional processes like thermoabrasion and thermodenudation, as well as their proportion, are studied and quantified. In the coastal hinterland investigations on active frost heave and destructive cryogenic processes are carried out. Within the river deltas transport and accumulation processes of suspended material, as well as sediment redistribution has to be investigated. Bed processes and bottom sediment discharge still remain not well understood. Furthermore, investigations are dedicated to the alternating geochemical influence of lakes, rivers and river bank erosion, spatial distribution of molecular changes of dissolved organic matter using tracers, and inorganic geochemical transformations along transects.

First and foremost the group expects a further increase in river runoff, an earlier date of ice break up and therefore changes in the seasonal and long term material supply in the delta channels. A tendency towards a transition from a surface water dominated to a ground water dominated environment is likely. All kinds of fluxes are expected to increase.

For a further inventory of the coasts and retreat rate determination, volumetric ground ice content, sediment type being eroded, and geomorphometric parameters like coastline position and cliff height are measured. Hydrochemical parameters such as pH, CEC, turbidity, various concentrations of DOM, their mineralization rates, nutrients, and inorganic substances are of increasing interest. Bathymetry has to be continuously remeasured.

Field work is carried out along the Lena Delta main channels to the riverine outflows (zodiacs) and across the brackish environments in the bights (small RVs) to the open ocean (Polarstern cruise). In late winter 2011 a drilling campaign on the westcoast of the Buor Khaya peninsula is planned. On the way from Tiksi to the drilling site across the sea ice, surface water sampling could be organized.

The need for a fixed stationary hydrological equipment was discussed. Since the river runoff is a crucial parameter for calculating fluxes, a fully automated (e.g. laser/ optical) measurement device could register Lena water levels and currents, especially during the flood period. The island of Stolb near the apex of the delta would be most suitable as a station, regardless of several difficulties. A qualified project for the installation of such an observatory is COSYNA. For continuous analyses of water quality parameters during ship cruises, the FerryBox flow through system offers high potential. It came up, that the realization of an aerial survey along the coast would be particularly advantageous for expedition planning, coastal erosion studies, landscape and landcover mapping. Compared to space-borne remote sensing, an airplane or helicopter based in Tiksi would be able to start immediately under blue sky conditions. One has to find Russian organisations, who are able to do air survey mapping, even though it has to be mentioned that the AWI already owns polar airplanes, which could operate such a mission.

Concerning interdisciplinary collaboration, the proposed aerial survey campaign could be jointly developed and organized with the Methane Airborne Mapper (MAMAP) project, which maps total atmospheric column concentrations of CO2, CH4, and O2. Localized terrestrial, coastal, and marine flux measurements of these greenhouse gases could be regionalized using MAMAP concentration maps in conjunction with the appropriate modelling expertise, and regional atmospheric model results (e.g. by Viktor Stepanenko, MSU) could be checked against actual measurements.

The participants of the group mentioned the different large existing datasets, allowing already to publish joint scientific papers.

Ecosystems (session IV)

K Reise [(1)] , EN Abramova [(2)]

[(1)] Alfred Wegener Institute for Polar and Marine Research, Sylt, Germany;
[(2)] Lena Delta Nature Reserve, Tiksi, Russia

Group members: B Biskaborn, C Buschbaum, U Herzschuh, D Kirievskaya, D Lackschewitz, D Moiseev, E Morozova, L Nazarova, L Pestryakova, P Vakhrameeva

The group recognized the wealth of existing biological and ecological literature and data sets relevant for the Laptev-Lena region and discussed the challenge to make all this readily available to investigators.
Participants of the working group represented marine, limnic and terrestrial ecologists concerned with recent and past ecosystem change from the Laptev Shelf Sea over the Lena Delta to the Lena River catchment region, with the overarching question: ***How will Arctic ecosystems of the Lena-Laptev region respond to global warming and what are the potential feedbacks to the climate?***

Participants study the following major ecological processes to anticipate and understand ecosystem change in the Arctic:

- Palaeoecological change reconstructed from species compositions preserved in sediments;
- Monitoring recent change in species distributions;
- Change in function and services of ecosystems at their boundaries.

Anticipated environmental change includes

- increasing summer temperatures,
- extended ice free periods and areas,
- increasing Lena River discharge,
- decreasing nearshore salinity,
- tundra squeeze resulting from coastal retreat and an expanding taiga.

Parameters of ecological analyses cover in particular

- plankton, benthos and fish from the river and lake freshwater habitats to the brackish and marine habitats in the Laptev Sea,
- terrestrial vegetation, micro- and macrofossils

and the interactions with other components of the ecosystems and their physical and chemical environment.

Research in the Lena-Laptev ecoregion may be best divided in three interacting subregions (Fig. 8-1):

- Laptev Shelf Sea,
- Lena Delta tundra and river distributaries,
- Lena taiga region

with ecological change expected to arise most prominently at the ecotones (boundary zones)

- of the Laptev Sea transition to the Lena Delta,
- of the tundra-taiga transition zone in the Lena region,

which should particularly addressed by future research. There seems to be a gap of research in the Lena River upstream of the delta.

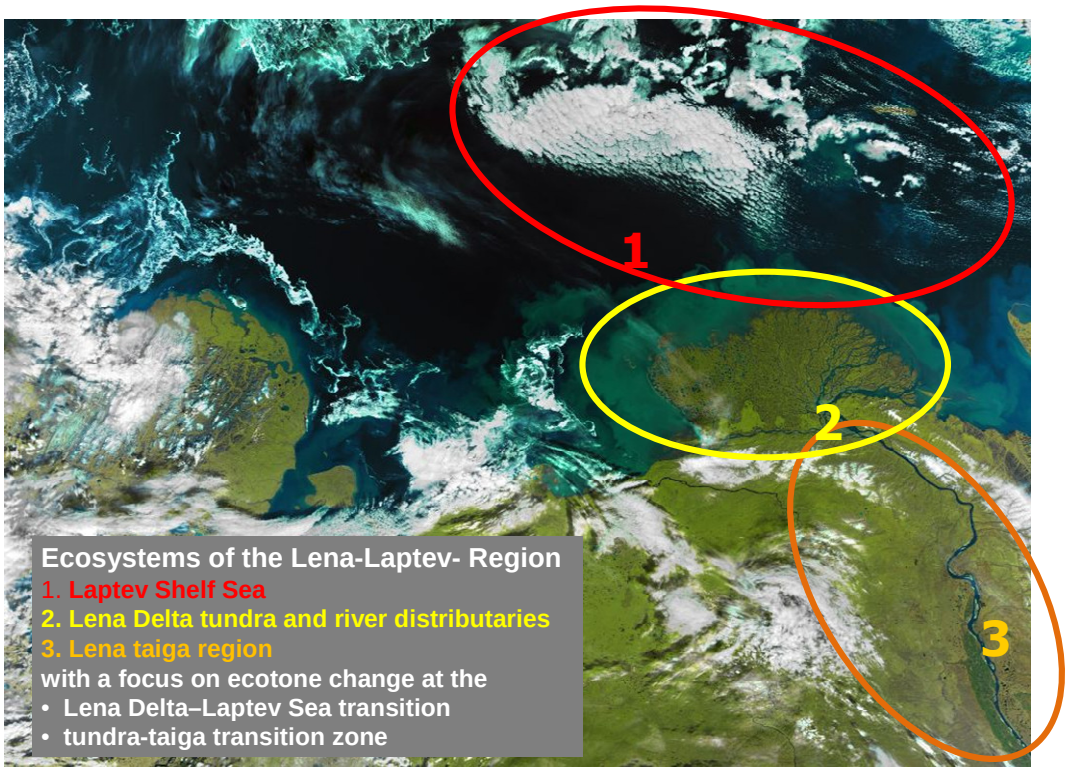

Figure 8-1. Map of the Lena-Laptev Region

Investigations in 2011 are planned for the Laptev polynyas and the ecotones between delta and shelf and between tundra and taiga.
Ecological research could benefit strongly from easy access to physical-chemical data on the environment under study.

Logistical support requires the availability of helicopters to visit the mostly off-road sites and different sizes of ships (and boats) are needed for research in exposed and sheltered shallow coastal waters of the Lena-Laptev region.
Mobile lab containers with microscopes, spectrometer and standard chemical analytics would be desirable for research.

Ecological teams would benefit from a large room at the Otto Schmidt Laboratory for Polar and Marine Research (St. Petersburg) for biological analyses (i.e., sorting and identification of species) with basic keys for species identification.

Existing and planned limnic monitoring programs for Siberian inland lakes and the Lena Delta should be combined under a common framework of questions and methods. Comparative studies with adjacent regions should be encouraged.

Atmosphere - sea ice - ocean interaction (session V)

V Ivanov [(1)], IA Dmitrenko [(2)]

[(1)] Arctic and Antarctic Research Institute, St. Petersburg, Russia; [(2)] Leibniz Institute of Marine Sciences at University of Kiel (IFM-GEOMAR), Kiel, Germany

Group members: D Chechin, JA Hoelemann, M Janout, S Kirillov, A Nikulina, I Repina, V Shevchenko, E Vinogradova, S Willmes, F Ziemer

The research activities of the group are wide ranging. The participants of the discussion are working on physical and chemical oceanography (coastal and deep ocean), atmospheric sciences (boundary layer, interaction at the surface, aerosols, pollution), marine geology (land erosion, sedimentation, seabed permafrost) and remote sensing (satellite and radar). The group members agreed on critical scientific questions, facing Arctic research community. The present day warming (changing?) of climate causes (1) ice depletion, (2) increased methane emissions, (3) changes in water masses (including Atlantic Water warming, erosion of halocline etc.), (3) changes in atmospheric circulation/processes and fingerprints of pollution. The effect of changing processes in the North Polar area on climate in low latitudes (e.g. global thermohaline conveyor -THC).

In their research activities group members use the following sampling strategies/techniques: (1) contact measurements (ship, ice, small boat, aircraft); (2) remote measurements (satellite, radar, aircraft) (3) modeling. Group members and research institutions they represent are reasonably well equipped in terms of major scientific equipment to be used in the field. The issue of equipment shipment through the Russian customs may sometimes be complicated. Possible support from OSL could include analyses using modern equipment in OSL and personnel (OSL grant system to involve students and young scientists). Group members agreed that complementary measurements (studies) in collaboration/partnership with other programs/institutions working on related themes is highly beneficial for overall success of field investigations.

9. PROGRAM OF THE WORKSHOP

November 8, 2010

Arrival

18:30 Registration

19:30 - 22:00 Icebreaker in the Mirror Hall at AARI

November 9, 2010

08:00 Registration

09:00 - 09:15 ***Welcome***
(Prof. Dr. I.Y. Frolov, Director, AARI)

09:15 - 09:30 ***Introduction***
(Prof. H.-W. Hubberten, AWI)

09:30 - 09:45 ***Goals of the workshop***
(Dr. I. Fedorova, OSL; Dr. P. Overduin, AWI)

09:45 - 10:45 ***Session 1 - Methane and terrestrial carbon stocks***
Evgrafova et al. (oral, 15 min, presented by I. Grodnitskaya):
Microbiological methane emission in the boreal ecosystems of cryogenic Siberia zones
Preuss et al. (oral, 15 min):
In situ studies of methane turnover in northern wetland soils – application of isotopic measurements
Sachs (oral, 15 min):
Expanding carbon flux investigations to the regional scale
Sudakov & Vakulenko (oral, 15 min):
Asymptotic approach to permafrost methane emission problem

10:45 - 11:15 Coffee break

11:15 - 12:00 ***Session 2 - Coastal erosion and fluxes from land to ocean***
Petersen & Schroeder (oral, 15 min):
Pocket FerryBox - a monitoring tool for field campaigns
Vinogradova et al. (oral, 15 min):
Laptev Sea shelf supplies chemical signature of the low halocline and intermediate water
Makarov & Bol'shiyanov (oral, 15 min):
Traces of high Laptev Sea level during the Holocene

12:00 - 12:15	***Session 3 - Submarine permafrost*** Kassens et al. (oral, 15 min): Subsea permafrost in the Central Laptev Sea
12:15 - 13:45	Lunch break
13:45 - 14:30	***Session 4 - Ecosystems*** Abramova et al. (oral, 15 min) Biological investigations in the Lena Delta and on the Laptev Sea shelf (1987-2010) Nazarova et al. (oral, 15 min): Regional inference models as a tool for reconstruction of ecological conditions in Russian Arctic Reise et al. (oral, 15 min): Polar macrobenthic fauna in the Lena river deltaic sediments
14:30 - 15:00	Coffee break
15:00 - 17:00	***Session 5 - Atmosphere - sea ice - ocean interaction*** Heinemann et al. (oral, overview, 30 min): Air-sea-ocean interaction processes and impacts on polynya formation and sea ice production in the Laptev Sea of the Siberian Arctic Dmitrenko et al. (oral, 30 min): Impact of the Arctic Ocean Atlantic water layer on Siberian shelf hydrography Hoelemann et al. (oral, 30 min): Near-bottom water warming in the Laptev Sea in response to atmospheric and sea ice conditions in 2007 Ivanov et al. (oral, 30 min): Response of shelf-basin exchange in the Laptev Sea on summer ice depletion
17:00 - 17:30	Coffee break
17:30 - 18:00	***Russian-German Science Collaboration*** (Dr. M. Sandhop, Helmholtz Office Moscow)
18:00 - 18:30	***Russian-German Science Collaboration*** (Dr. J. Achterberg, DFG Office Moscow)

November 10, 2010

09:00 - 10:30	***Session 5 - Atmosphere - sea ice - ocean interaction*** Repina et al. (oral, 15 min): Air-sea interaction near polynyas and leads from experimental data and numerical modelling Shevchenko et al. (oral, 15 min): New data on aeolian and ice transport of matter in the Arctic Ziemer et al. (oral, 15 min): Possibilities for the synoptic radar survey of waves and currents causing littoral erosion Kirillov et al. (oral, 15 min): The Laptev Sea flaw polynya impact on the bottom layer hydrography during winter 2008 Willmes et al. (oral, 15 min): Spatiotemporal variability of sea-ice coverage, polynya dynamics and ice production in the Laptev Sea between 1979 and 2008 Krumpen et al. (oral, 15 min, presented by J.A. Hoelemann): Sea ice production and water mass modification in the eastern Laptev Sea
10:30 - 10:45	***Session 2 - Coastal erosion and fluxes from land to ocean*** Grigoriev et al. (oral, 15 min): Coastal erosion, sediment and organic carbon fluxes in the central sector of the Laptev Sea
10:45 - 11:00	Coffee break
11:00 - 11:15	***Introduction into thematic discussion groups*** (Dr. P. Overduin, AWI) (1) Methane and terrestrial carbon stocks (2) Coastal erosion and fluxes from land to ocean (4) Ecosystems (5) Atmosphere - sea ice - ocean interaction
11:15 - 13:00	***Parallel meeting of thematic discussion groups*** for identifying research needs by defining knowledge gaps, methodological approaches etc.
13:00 - 14:00	Lunch break
14:00 - 15:30	***Parallel meeting of thematic discussion groups*** for science planning for the upcoming years of e.g. field work, data resources, publications etc.
15:30 - 16:00	Coffee break
16:00 - 18:00	***Poster session***
17:30 - 18:00	Parallel to the poster session: ***Visit of the lab facilities at OSL*** (Dr. I. Fedorova, Dr. H. Kassens, OSL)

19:00 - 21:00	Side meeting for collaborators of the Helmholtz-Russian Research Group 100 “Assessing the Sensitivity of the Arctic Coast to Change”

November 11, 2010

09:00 - 11:00	***Reports of the thematic discussion groups*** Reise (oral, 30 min): Ecosystems Zubrzycki (oral, 30 min): Methane and terrestrial carbon stocks Guenther (oral, 30 min): Coastal erosion and fluxes from land to ocean Ivanov (oral, 30 min): Atmosphere - sea ice - ocean interaction
11:00 - 11:30	***Synthesis and outlook*** (Dr. I. Fedorova, OSL; Dr. P. Overduin, AWI)
11:30 - 12:00	Coffee break

Departure

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