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Russian-German Cooperation SYSTEM LAPTEV SEA:
The Expedition Lena 2009

Edited by
Julia Boike, Katya Abramova, Dmitry Yu. Bolshiyanov, Mikhail N. Grigoriev, Ulrike Herzschuh, Gerhard Kattner, Christian Knoblauch, Lars Kutzbach, Gesine Mollenhauer, Waldemar Schneider

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* Anschrift / Address
Alfred-Wegener-Institut
Für Polar- und Meeresforschung
D-27570 Bremerhaven
Germany
www.awi.de

Editor in charge:
Dr. Horst Bornemann

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Birgit Chiaventone

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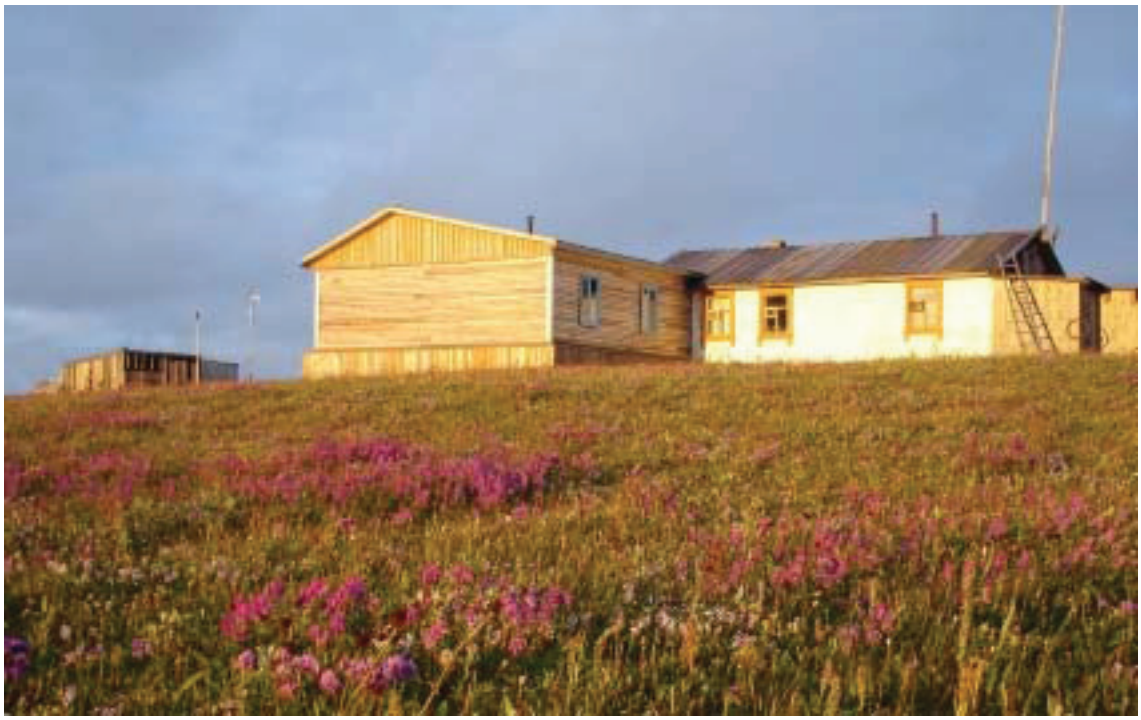

The Field Station Samoylov (Photograph by Peter Schreiber)

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Julia Boike, Ulrike Herzschuh, Waldemar Schneider: Alfred Wegener Institute for Polar and Marine Research, Section Periglacial Research, Telegrafenberg A43, D-14473 Potsdam, Germany

Katya Abramova: Lena Delta Reserve, Academician Fyodorov St. 28, 678400 Tiksi, Yakutia, Russia

Dmitry Yu. Bolshiyanov: Arctic and Antarctic Research Institute, Bering St. 38, 199106 St. Petersburg, Russia

Gerhard Kattner, Gesine Mollenhauer: Alfred Wegener Institute for Polar and Marine Research, Section Periglacial Research, Am Handelshafen 12, D-27570 Bremerhaven, Germany

Christian Knoblauch, Lars Kutzbach: University of Hamburg, Institute of Soil Science, Allende-Platz 2, D-20146 Hamburg, Germany

Mikhail N. Grigoriev: Melnikov Permafrost Institute, Russian Academy of Science, Merslotnaya 36, 677010 Yakutsk, Russia

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Table 1-1 List of participants

Name	Email	Institute	Time
Biskaborn, Boris	Boris.Biskaborn@awi.de	AWI P	29.07.-12.08.
Boersma, Maarten	Maarten.Boersma@awi.de	AWI H	29.07.-12.08.
Boike, Julia	Julia.Boike@awi.de	AWI P	24.06.-15.07.
Carstens, Kristine	Kristine.Carstens@awi.de	AWI H	12.08.-26.08.
Flerus, Ruth	Ruth.Flerus@awi.de	AWI B	12.08.-26.08.
Heim, Birgit	Birgit.Heim@awi.de	AWI P	12.08.-26.08.
Herzschuh, Ulrike	Ulrike.Herzschuh@awi.de	AWI P	29.07.-12.08.
Kattner, Gerhard	Gerhard.Kattner@awi.de	AWI B	12.08.-26.08.
Klemm, Juliane	Juliane.Klemm@awi.de	AWI P	29.07.-26.08.
Knoblauch, Christian	Christian.Knoblauch@uni-hamburg.de	UH	24.06.-29.07.
Koch, Boris	Boris.Koch@awi.de	AWI B	12.08.-26.08.
Kutzbach, Lars	Lars.Kutzbach@zmaw.de	UH	29.07.-26.08.
Liebner, Susanne	Susanne.Liebner@env.ethz.ch	ETH	24.06.-15.07.
Mollenhauer, Gesine	Gesine.Mollenhauer@awi.de	AWI B	12.08.-26.08.
Piel, Konstanze	Konstanze.Piel@awi.de	AWI P	24.06.-15.07.
Preuss, Inken-Marie	Inken.Preuss@ uni-hamburg.de	UH	24.06.-29.07.
Schneider, Waldemar	Waldemar.Schneider@awi.de	AWI P	24.06.-26.08.
Schreiber, Peter	Peter.Schreiber@zmaw.de	UH	24.06.-26.08.
Wille, Christian	Christian.Wille@zmaw.de	UH	24.06.-29.07.
Zielke, Artur	zielke.teltow@t-online.de	AWI P	24.06.-15.07.
Zubrzycki, Sebastian	sebastian@zubrzycki.de	UH	29.07.-26.08.
Abramova, Anna	abramova-any@mail.ru	USP	29.07.-26.08.
Abramova, Ekaterina	abramova-katya@mail.ru	LDR	24.06.-12.08.
Bolshiyanov, Dmitry	Bolshiyanov@aari.nw.ru	AARI	29.07.-26.08.
Chetverova, Antonina	Antoshka4@mail.ru	USP	24.06.-29.07.
Evgrafova, Svetlana	esj@yandex.ru	SIF	29.07.-26.08.
Grgoriev, Mikhail	Grigoriev@mpi.ysn.ru	PIY	12.08.-26.08.
Makarov, Alexander	Makarov@aari.nw.ru	AARI	29.07.-26.08.
Morozova, Elena	Morozova@aari.nw.ru	AARI	29.07.-26.08.
Pestrjakova, Ljudmila	lapest@mail.ru	AUY	29.07.-12.08.
Sandakov, Alexander	alecsanderus@rambler.ru	PIY	24.06.-26.08.
Saveljeva, Larisa		USP	29.07.-26.08.
Solov'ev, Grigori	greansa@gmail.com	LDR	24.06.-26.08.
Urban, Anna	pulemet02@rambler.ru	PIY	24.06.-29.07.
Vakhrameeva, Polina	Vakhrameeva@aari.nw.ru	AARI	29.07.-26.08.

Table 1-2 Institutions of the participants

AARI:	Arctic and Antarctic Research Institute, Bering St. 38, 199106 St. Petersburg, Russia
AUY:	Ammosov Universitiy Jakutsk, Belinski St. 85, 677891 Yakutsk, Yakutia, Russia
AWI B:	Alfred Wegener Institute for Polar and Marine Research, Section Periglacial Research, Am Handelshafen 12, D-27570 Bremerhaven, Germany
AWI H:	Alfred Wegener Institute for Polar and Marine Research, Section Periglacial Research, Kurpromenade 1, D-27498 Helgoland, Germany
AWI P:	Alfred Wegener Institute for Polar and Marine Research, Section Periglacial Research, Telegrafenberg A43, D-14473 Potsdam, Germany
ETH:	Institute for Biogeochemistry and Pollutant Dynamics (IBP), Federal Institute of Technology, ETH-Zentrum CHN G47, Universitaetstrasse 16, CH-8092 Zürich, Switzerland
LDR:	Lena Delta Reserve, Academician Fyodorov St. 28, 678400 Tiksi, Yakutia, Russia
PIY:	Melnikov Permafrost Institute, Russian Academy of Science, Merslotnaya 36, 677010 Yakutsk, Russia
SIF:	Sukachev Institute of Forest Krasnoyarsk SO RAN, 660036 Krasnojarsk, Academgorodok, Russia
UH:	University of Hamburg, Institute of Soil Science, Allende-Platz 2, D-20146 Hamburg, Germany
USP:	University of St. Petersburg WO, 10 Linija 33-35, 199106 St. Petersburg, Russia

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The success of the expedition "Lena 2009" would not have been possible without the support by several Russian, Yakutian, and German institutions and authorities.

In particular, we would like to express our appreciation to the Tiksi Hydrobase and the Lena Delta Reserve, especially to D. Melnichenk and A. Gukov.

2. Introduction

This report summarizes activities and field work results of the joint Russian-German expedition “Lena 2009”. The 11th expedition to the Lena River Delta is part of the Russian-German science cooperation “System Laptev Sea” and continues the long-term investigations of permafrost and periglacial environments in Arctic Siberia. The expedition focused on five research topics:

- Sensitivity of the permafrost system – water and energy budget during climate changes
- Carbon dynamics and microbial processes in periglacial areas
- Carbon and nitrogen fluxes in permafrost soils and the consequences of climate change
- Hydrological conditions of the Lena River Delta
- Coastal dynamics and subsea permafrost
- Permafrost and environmental dynamics during Quaternary climate variations
- Modern environmental dynamics of aquatic ecosystems and vegetation

The expedition took place during the period June 24 to August 26, 2009 in different regions. The study areas comprise (i) the central Lena River Delta, with the Russian German station on Samoylov as base camp (ii) a north-south transect extending from the western part of the lower Lena River into the Lena Delta (realized by helicopter) and (iii) the eastern part of the delta (realized by river boat).

The expedition was coordinated by Prof. H.-W. Hubberten (AWI, Potsdam), Prof. D.Yu. Bolshiyanov (AARI, St. Petersburg) and Dr. M.N. Grigoriev (PIY, Yakutsk).

The report contains short contributions of the participants. The authors are responsible for content and correctness.

3. Heat and water budget of permafrost landscapes on spatial and temporal scales

Julia Boike and Konstanze Piel

Fieldwork period June 26 to July 13, 2009 (on Samoylov and Kurunagh)

Objectives

The main objective is to elucidate the two major cycles (water and heat) in the complex Lena Delta landscape at scales from hundreds of metres to kilometres. This will allow us to close the gap between our small-scale process understanding and the large scale that is accessible by satellite remote sensing. Already established instrumentation on soil thermal and hydrologic dynamics and micrometeorology (eddy covariance, automated soil and climate stations) will be maintained and augmented with additional spatially distributed measurements in permafrost and lakes.

Methods

- eddy covariance for estimation of turbulent heat and water fluxes
- climate stations and radiation budget sensors for estimation of energy budget
- shallow and deeper boreholes for calculation of ground heat flux into permafrost
- spatially distributed surface temperature sensors for upscaling to MODIS and Landsat thermal images
- lake temperature profiles for lake heat budget

Preliminary results

On Samoylov, all data of the automated stations were downloaded and checked. This included: 1) long term climate and 2) soil station, 3) eddy covariance station, 4) lake station, 5) borehole Lednik, 6) borehole Fish lake station, 7)-9) three surface temperature and moisture and ground heat flux stations, and 10) temperature/ground heat flux site at TIR station. Repairs and exchanges of equipment were undertaken as needed. At the long term climate and soil station site, dataloggers were exchanged and a new power system (wind generator) was set up. The eddy covariance station was moved to the centre of the island. In addition to this, the following new sites were established: 1) new ground temperature borehole close to the eddy site in the centre of the island, 2)-8) temperature and (partly) water level profiles in the lakes (Fish lake, Molo lake, Dry lake, Banja 2 lake). For upscaling of surface temperatures, a 10 m thermal infrared camera (TIR) was installed to record surface temperature in 10 min intervals. Additional experiments were carried out under clear sky conditions of several surface covers to test the response of the TIR camera under different angles.

To extend our network of measurements (see also Boike et al., 2008) on larger spatial scales, field work was carried out on the third terrace (ice complex) on Kurunagh. In the Alass depression, an automated climate station (72°19'12.6"N, 126°11'35.7"E) was set up recording hourly net radiation, wind speed and direction, air temperature and humidity, soil moisture and temperature, and surface temperature. A 4 m permafrost core was drilled and core samples were kept frozen for subsequent analysis. The bore hole was installed with a 4 m deep temperature profile chain recording temperatures every hour.

Further exploratory experiments included the set up of gas collection devices (Schott bottles) close to the soil moisture sensors (TDR site). Swimming lake lysimetres at the lake station site did record lake evaporation in the order of 1-2 mm/day.

References

Boike, J., Wille, C., and Abnizova, A. (2008) The meteorology, and energy and water balances of polygonal tundra in the Lena Delta, Siberia during wet and dry years. Journal of Geophysical Research 113, G03025, doi:10.1029/2007JG000540.

4. Environmental controls of methane and carbon dioxide exchange fluxes of polygonal tundra on the ecosystem scale

Peter Schreiber, Christian Wille, and Lars Kutzbach

Fieldwork period June 26 to August 26, 2009 (on Samoylov and Kurunagh)

Objectives

The main goal of our team was to continue the micrometeorological measurements of CH_4 and CO_2 exchange fluxes of polygonal tundra which were recorded during the years 2002-2006 at Samoylov Island (Kutzbach 2006, Kutzbach et al. 2007, Sachs et al. 2008, Wille et al. 2008). We aim to characterize the temporal variability of the CH_4 and CO_2 fluxes on diurnal, seasonal and inter-annual time scales, and to develop a better understanding of the regulation of the exchange fluxes by meteorological, biological and pedological controls on the ecosystem scale.

Methods

A new micrometeorological measurement system was established in the centre of Samoylov Island (N 72°22'43", E 126°29'74") which will be operated jointly by the working groups of L. Kutzbach (University of Hamburg) and J. Boike (Alfred Wegener Institute, Potsdam). The measurement system comprised an eddy covariance system for measuring the turbulent fluxes of momentum, heat, water, CO_2 and CH_4, gradient measurements of temperature, relative humidity and wind speed, as well as sensors for radiation components, photosynthetically active radiation, barometric pressure, soil temperatures, soil heat fluxes, soil moisture and water levels. Fluctuations of wind velocity components and sonic temperature were determined with a three-dimensional sonic anemometer. Fluctuations of H_2O and CO_2 concentrations were measured with an open-path infrared gas analyzer. Fluctuations of CH_4 concentrations were measured with a closed-path fast methane analyzer. A complete list of instruments including installation heights, type and producer of sensors, and precision/accuracy specifications is provided in Table 4-1.

Preliminary results

The micrometeorological measurement system was operational from July 8th to the end of the expedition. The slow-response meteorological sensors and the sonic anemometer delivered data without any technical problems. The measurements of the open-path H_2O/CO_2 infrared gas analyser were often degraded during rainy days as is typical for this type of sensor. The CH_4 analyzer needed elaborate maintenance to keep its measurement performance satisfactory because the high-reflective mirrors had to be cleaned very often due

to contamination by an atmospheric pollutant. Except the CH_4 analyser, all instruments were prepared to continue the measurements over the winter.

References

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Kutzbach L., Wille C., and Pfeiffer E.-M. (2007) The exchange of carbon dioxide between wet arctic tundra and the atmosphere at the Lena River Delta, Northern Siberia. Biogeosciences 4: 869-890.

Sachs T., Wille C., Boike J., and Kutzbach L. (2008) Environmental controls on ecosystem-scale CH4 emission from polygonal tundra in the Lena River Delta, Siberia. Journal of Geophysical Research – Biogeosciences 113: G00A03, doi:10.1029/2007JG000505.

Wille C., Kutzbach L., Sachs T., Wagner D., and Pfeiffer E.-M. (2008) Methane emission from Siberian arctic polygonal tundra: Eddy covariance measurements and modeling. Global Change Biology 14(6): 1395–1408.

Table 4-1 List of sensors of the micrometeorological measurement system established in summer 2009 at Samyolov Island.

Investigation Parameter	Installation heights	Producer & Type	sort of sensor	*Precision* / Accuracy
air temperature (temp.) and relative humidity (RH) probe	2 m 4.2 m 10 m	Campbell HMP45C	temp.: Platinum Resistance Temp. detector RH: capacitive relative humidity sensor	temp.: *0.001° C* ± 0.2° to ± 0.4° C at 20° RH at 20° C: *0.01 % RH* ± 2 % (0-90 % RH) ± 3 % (90-100 % RH) temp. dependence of RH: ± 0.05 % RH/°K
wind direction and wind speed (2-dimensional)	2 m 10 m	Gill 2D Wind Sonic	2- dimension-nal ultra-sonic wind sensor	wind dir.: *1* °; ± 3° wind speed: *0.01 m/s* ± 2 %
radiation short wave (SW) long wave (LW)	8.9 m	Hukseflux NR01	4 component net radiation sensor: SW_{in}, SW_{out}, LW_{in}, LW_{out}	SW: ± *30 W/m² directional response (dr)* LW: < *8 W/m² dr;* SW: *LW: ± 5 % temp. dependence*
photosynthe-tically active radiation (PAR)	4.2 m	Skye Instrum. SKP215	quantum sensor	<± *5 %*
snow height	4.2 m	Campbell SR50	sonic ranging sensor	*0.25 mm* < 1.7 mm
fast wind direction and wind speed (3-dimensional)	4.2 m	Campbell CSAT	three dimensional sonic anemometer	measurements at 20 Hz; horizontal wind between 5° - ± 2 %, 10° ± 3 %, 20° ± 5 %
CH_4 Analyzer	4.2 m	LosGatos FMA	direct-absorption spectroscopy	measurements at 20 Hz; CH_4: *1 ppbv* < ± 1 %

CO_2 and H_2O Analyzer	4.2 m	Licor LI 7500	open path infrared CO_2/H_2O analyzer	measurements at 20 Hz; CO_2: at 370 ppm ± 0.16 ppm H_2O: at 10 ppb ± 6.7 ppm
barometric pressure	1 m	Setra CS 100	capacitive pressure transducer	*0.01 mBar* ± 2 mBar (-20 to 50 °C)
soil temperatures at rim and centre of polygon	-1, -5, -10, -15 cm	Campbell 107	thermocouple reference thermistor	*< 0.08 °C (-55 – 70 °C)* < ± 0.3 °C (-55 – 70 °C)
soil moisture at rim and centre of polygon	-5 cm	Campbell CS 616	time-domain-reflectometry	
soil heat flux at rim and centre of polygon	-10 cm	Campell HFP 01	thermopile to measure temperature gradient	
ground water hight	-37 cm	GE Sensing Techno-logies	submersible pressure transducer	temp.: ± 3 % pressure: ± 1 %
ground water temperature and height measurement at different sites	-30 to -80 cm	Schlum-berger Mini Diver DI 501	Ceramic pressure sensor	*0.2 cm H_2O*; ± 0.5 cm H_2O *0.01° C*; ± 0.1 °C

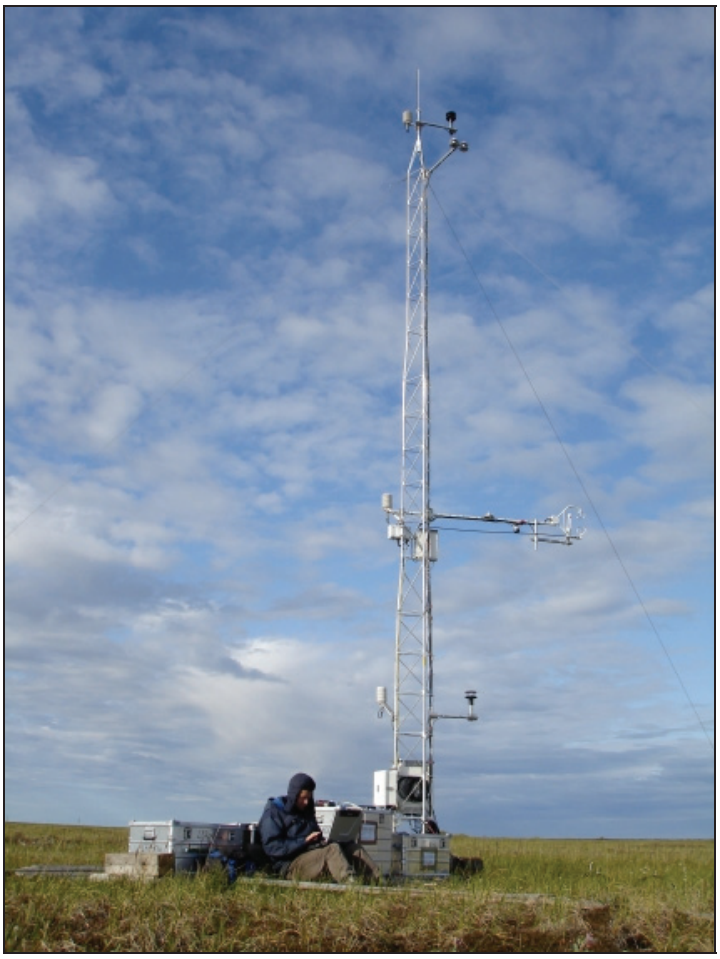

Figure 4-1 The micrometeorological measurement tower in the centre of Samoylov. Photograph by Peter Schreiber.

5. Methane oxidation associated to submerged mosses

Susanne Liebner and Christian Knoblauch

Fieldwork period June 26 to July 27, 2009 (on Samoylov)

Objectives

Associated to mosses, methanotrophic bacteria can consume methane in a completely water-saturated milieu (Raghoebarsing et al., 2005) and might thus reduce methane emissions from natural wetlands. Pore-water methane profiles measured in 2008 (Liebner, own observations) suggest that this process occurs within the polygonal tundra structures on Samoylov Island as well. This year's research concentrated on moss-associated methane oxidation within the waterlogged polygon centre. In particular, the influence of light as the driving force for photosynthesis and, thus, the provision of oxygen for moss-associated methanotrophs was the focus of our investigations. The main objectives were to compare methane fluxes, and depth profiles of methane and oxygen concentrations within a shaded and a non-shaded spot. In addition, methanotrophic abundance was estimated in dependence of light exposure and water level.

Methods

- Pore-water methane concentration profiling
- Oxygen concentration profiling using optodes
- Incubation experiments for the analysis of potential moss-associated methanotrophic activity
- Methane flux measurements using transparent and opaque chambers
- Quantitative (real-time) polymerase chain reaction (PCR) for screening methanotrophic abundance
- Mass spectrometry for analyzing the isotopic fractionation of different moss species

Preliminary results

Shading of submerged mosses using an opaque chamber (Figure 5-1) lead to an immediate increase in near surface methane concentrations (Figure 5-2) relative to a non-shaded spot. Within only three days, light deficient conditions turned a spot of no or even slightly negative methane fluxes (Figure 5-3) into a methane source (Figure 5-4).

Figure 5-1 Sampling spots in a waterlogged polygon centre covered by a transparent (right) and an opaque (left) chamber.

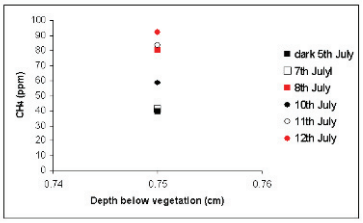

Figure 5-2 Methane concentrations near the moss-vegetation surface of the shaded sampling spot.

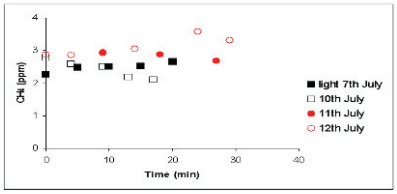

Figure 5-3 Methane concentrations over time in a transparent (“light”) chamber.

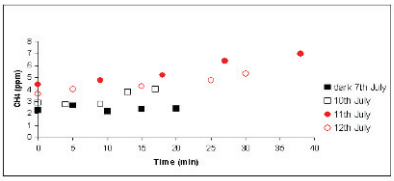

Figure 5-4 Methane concentrations over time in an opaque (“dark”) chamber.

References

Raghoebarsing, A.A., Smolders, A.J.P., Schmid, M.C., Rijpstra, W.I., Wolters-Arts, M., Derkens, J., Jetten, M.S.M., Schouten, S., Damsté, J.S.S., Lamers, L.P.M., Roelofs, J.G.M., Op den Camp, H.J.M., and Strous, M. (2005) Methanotrophic symbionts provide carbon for photosynthesis in peat bogs. Nature 436: 1153-1156.

6. Regulation of methane and carbon dioxide fluxes in the polygonal tundra of Samoylov Island

Inken Preuss, Susanne Liebner, and Christian Knoblauch (on Samoylov)

Fieldwork period June 26 to July 28, 2009

Objectives

The main objective of this study is to test whether the isotopic composition of methane along the diffusive way through the soil in combination with measurements of soil diffusivity is suited to elucidate methane fluxes from the polygonal tundra of Samoylov Island. Thereby, the impact of hydrology on the small-scale methane and carbon dioxide fluxes is emphasized. In addition, *in situ* methane oxidation and its importance for the carbon turnover in the soils will be quantified.

Methods

- measurements of methane and carbon dioxide concentration gradients in soils with different hydrology (dry, semi-wet, wet polygon centre, and polygon rim) on four days
- quantification of carbon dioxide and methane emissions from the selected plots using chamber accumulation technique (Li-8100) at the same sites on the same four days
- measurements of oxygen gradients with optodes at the same sites on the last of the four days
- taking gas samples at all sites for the determination of the stable isotope composition of carbon dioxide and methane on two of the four days
- taking soil samples at all sites for analysis of soil chemical and physical parameters including porosity and diffusivity

Preliminary results

Comparing near surface fluxes of methane and carbon dioxide of a dry, semi-wet, and wet polygon centre first analyses revealed that the semi-wet polygon centre emitted methane while the dry polygon centre did not. The wet polygon centre emitted methane only at the plot with *Carex* vegetation, while no methane emission was observed at the plots without *Carex*. However, data of chamber measurements will be analyzed in more detail soon.

Furthermore, data of methane, carbon dioxide and oxygen gradients will be interpreted. Gas samples will be analyzed for isotopic composition and soil samples for chemical and physical parameters as soon as they arrive in Germany.

7. Studying frost heaving forms on Kurungnakh Island and its formation conditions

Anna Urban

Fieldwork period June 26 to July 26, 2009 (on Kurungnakh)

Objectives

The Territory of Lena Delta is characterized by development of different cryogenic processes. One of these processes is frost heaving. Its development is accompanied by palsa and pingo formation. Studying the composition, structure and conditions provides knowledge about time of its formation and dynamics of development.

Methods

- landscape description
- drilling and analysing characteristics of soil composition
- temperature measurements in boreholes for different sites
- transect sampling from the top of pingo to alas edge
- lake temperature profiles for lake heat budget

Preliminary results

Three boreholes were drilled on the pingo. Two of them were drilled on the top and one at the foot. Depth of each borehole is about 4 m. Core samples were kept frozen for subsequent analysis. Each borehole was equipped with a 4 m long sensors chain recording temperature profile every hour. The depths of loggers installed are 3.8, 2 and 0.5 m.

In addition, a sampling transect from the top of the pingo to alas edge was established. This transect consisted of 11 points, depending on active layer thickness. For these samples pH value was determined, and samples were subsequently frozen.

At one of the lakes bathymetry was performed. Afterwards, temperature loggers were installed on depths 4, 2 and 0.5 m with hourly measurements.

8. Hydrochemical characteristics of Samoylov Island water objects

Antonina Chetverova

Fieldwork period June 26 to July 26, 2009 (on Samoylov)

Objectives

The main objective of the expedition is to study the hydrochemical characteristics of water bodies (lakes, polygons, and Olenekskaya channel water) of the island, as well as their changes during one month (June 26 until July 26). More detailed research on a selected representative lake includes measurements of hydrochemical characteristics in different depths of the lake and in different parts of the catchment. Results will define the conditions of hydrochemical composition, lake formation, and sources of biogenic components.

Methods

- bathymetry of big lakes for calculation of water volume
- assessing monthly dynamics of biogenic elements in a field laboratory by a photo-colorimetric method
- measurements of conductivity, pH, temperature, and dissolved oxygen
- freezing and preserving of samples for future, more detailed analyses in the laboratory (determination of main ions, DOC)
- sampling sediment cores from Fish lake, second and third oxbow lakes
- filtration through GF/F and PC filters
- suspended matter samples from Olenekskaya channel every fifth day
- bathymetry of Fish lake at three points, determination of phosphorus, nitrite, dissolved oxygen, temperature, conductivity, pH
- P/D ratio calculation in Fish lake
- assessing seepage through bottom sediments in Fish lake
- determination of the content of biogenic elements in water at different parts of polygons (rim, transition zone, and bottom) at the beginning and at the end of the month

Preliminary results

During the expedition bathymetric schemes of the island lakes were obtained. Changes in water gauge, water discharge, and calculated suspended matter supply of Olenekskaya channel were recorded during the month of investigation. Water samples, suspended particle samples, and sediment core samples were taken according to plan. Water samples were analysed for phosphorus, nitrite, alkalinity, pH, conductivity, and dissolved oxygen three times per month. Changes in biogenic elements during one month were defined with the peak of vegetation

period coming. Fish Lake was investigated more in detail at three points according to plan.

9. Community structure and activity of heterotrophic microorganisms of Siberian arctic and sub-arctic permafrost-affected soils

Svetlana Evgrafova and Dirk Wagner

Fieldwork period June 26 to August 26, 2009 (on Samoylov)

Objectives

Arctic and sub-arctic areas are predicted to be critically sensitive to climate change (Shaver et al., 1992; Williams et al., 2002; Camill, 2005), and feedbacks are not yet well understood (Giardina and Ryan, 2000; Oechel et al., 2000; Campbell et al., 2005; Knorr et al., 2005; Wagner and Liebner, 2009).

We aim to investigate the microbial community structure and activity of two Siberian regions in the Arctic (N 72°, E 126°) and the sub-Arctic (N 64°, E 100°) to improve the understanding of the carbon dynamics in permafrost under global climate change: “How do the structure and activity of specific microbial populations involved in key processes may change with environmental variables such as temperature, freeze/thaw cycles and humidity?”

Methods

In the study part carried out on Samoylov Island (N 72°22’; E 126°28’), soil samples of moss layer and mineral soil layer (every 5 cm up to the permafrost table) were collected. Basal respiration of soil microbial populations was used for assessment of the heterotrophic respiration rate. Substrate-induced respiration (SIR; Anderson and Domsch, 1978, as modified by Nordgren et al., 1988) was transformed to microbial biomass carbon (C_{mic}) by the equation:

C_{mic} (µg C g soil^{-1}) = 50.4 × SIR (µg CO_2 – C g soil^{-1} h^{-1}) (Sparling and West, 1990).

Simultaneously, soil samples for PLFA and PLEL analyses as well as for DGGE fingerprints were collected and frozen to be transported for further analyses of biodiversity and phylogenetic compositions of microbial community.

Preliminary results

The heterotrophic microorganisms of the investigated soil on Samoylov were mostly concentrated in the moss layer: heterotrophic microbial biomass of 1 g of moss substrate was usually 6-10 times higher than in 1 g of mineral soil substrate. Heterotrophic microbial biomass of active soil layer was uniformly distributed within the soil profile up to the permafrost table and correlated with the basal respiration rate. Variation coefficient of heterotrophic soil microbial biomass is up to 70%; variation coefficient of basal respiration rate of soil is up to 200%.

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10. Biogeochemistry of organic matter in the Arctic permafrost and the Lena Estuary

Kristine Carstens, Ruth Flerus, Mikhail Grigoriev, Birgit Heim, Gerhard Kattner, Boris Koch, Gesine Mollenhauer, and Alexander Sandakov

Fieldwork period August 13-24, 2009 (Lena River Delta)

Objectives

Melting of soils and thermo-erosion in the permafrost of the Lena Delta may cause an increased release of particulate and dissolved organic matter (POM, DOM) and methane which can be transported to the coastal shelf and either mineralized, convected down to the deeper Arctic Ocean (Kattner et al., 2000), or deposited in near-shore or open ocean sediments. The release of inorganic and organic nutrients into coastal waters will affect bacteria, pico- nano and microplankton biomass and diversity.

Our preliminary study addressed the identification and quantification of organic matter sources and turnover rates and related changes in the distribution of plankton species. We aimed at quantifying the fluxes of soil DOM, nutrients and dissolved methane from the permafrost into the Lena estuary and the Arctic shelf-ocean system using bulk methods, isotope approaches and molecular markers.

Methods

Ocean colour satellite data will provide spatial-dynamical information on the land-ocean interaction during ice-free summer months. Coloured dissolved organic matter (cDOM) was applied as a ground parameter for satellite-derived pathways of absorption in coastal waters.

Field sampling was carried out during an 11-day period using the river vessel 405 (Figure 10-1). We sampled soils, run-off water from different ice-complexes (Kurunagh, Bykovsky, Moastakh), permafrost soils (Samoylov, Gogolevsky, Tit Ari), the main channels of the Lena delta and a few near-shore coastal stations in the Buor- Khaya Bay. Approximately 150 DOC, 80 cDOM, 60 suspended particulate matter (SPM), 40 POC, 90 nutrient, 70 H/O isotopes, 70 cations/anions, 60 dissolved methane, 60 soil and 20 sediment samples were taken during the expedition. The rate of erosion in the ice complexes was assessed in the field as part of an annual long-term time series.

The deployment of a probe measuring temperature, salinity, and fluorescence on several wavelengths (for chl-a and phytoplankton groups) at all stations provided an initial characterization of the water body. Irradiance measurements characterized the spectral in-water light field and secchi disc deployments were used to measure turbidity.

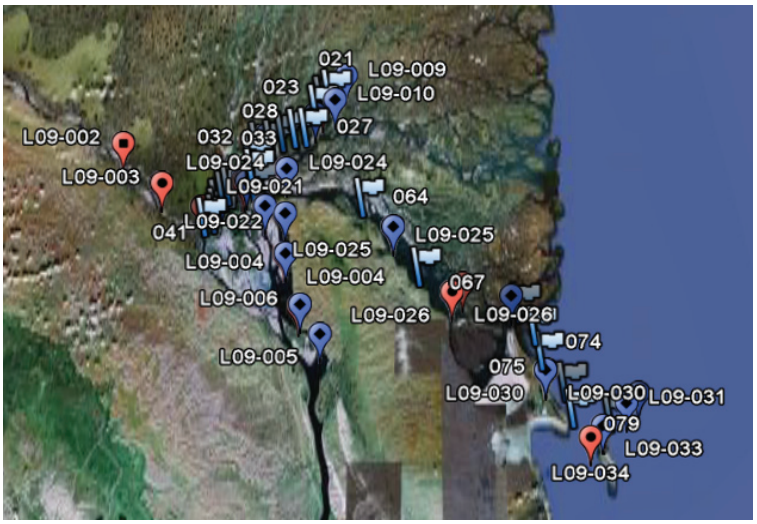

Figure 10-1 Sampling stations of the Lena 09 river campaign.

Sediment samples will be analyzed for the presence of resting stages of marine/freshwater planktonic organisms, particularly diatoms and dinoflagellates. These might be able to exploit any changes in environmental conditions (increase in temperature) and inorganic nutrients. Planktonic organisms in water samples will be counted using standard microscopy techniques and epifluorescence microscopy. Samples containing rare or apparently undescribed species will also be examined with a scanning electron microscope (SEM).

We extracted approximately 40 water samples for subsequent molecular analyses such as amino acid stereoisomeres, as indicators for bacterial modification of DOM. Lignin phenols will be applied as tracers for terrestrial DOM (e.g. Lobbes et al., 2000). Ultra-high-resolution mass spectrometry will allow detailed molecular characterisation of organic matter (e.g. Koch et al. 2005), an important prerequisite for all DOM process studies. Residence times, transport rates (based on existing long-term records of water discharge), and erosion of previously permafrost-stabilized organic matter will also be studied.

In order to assess mineralization rates in the soil-derived DOM pool, filtered water from an outflow of the Kurunakh ice-complex was microbially incubated with river water and photo-incubated in quartz bottles in two 10-day incubation experiments.

Organic biomarkers diagnostic for the Permafrost soils and SPM will be quantified, tracked along the pathway of transport and radiocarbon dated (bulk and compound-specific level) to estimate residence time in the soil and duration of transport. A special emphasis will be on biomarkers diagnostic for soil microbes (tetraether lipids) and lignin. Stable isotope analyses will also be applied to assess the origin of methane in river water.

Preliminary results

All water sample stations were located in freshwater. Profiles for fluorescence, temperature, and salinity showed no change with water depth due to a homogenously mixed water body. Only the bottom water (~ 11 m water depth) of

station 34 showed an increase in salinity and a decrease in temperature due to the inflow of dense marine water.

CDOM spectra were directly measured at the Otto Schmidt Laboratory in St. Petersburg (RU). Preliminary results indicate that cDOM absorption values are of high magnitudes, with highest absorption values near the cliffs of ice complex units. All other chemical and biological parameters will be determined after the samples will arrive in the laboratories in Bremen, Bremerhaven and Helgoland.

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11. Ecological state of permafrost lakes and their catchment along an North-South transect in north-central Yakutia: past and present

Ulrike Herzschuh, Dmitriy Bolshiyanov, Ljudmila Pestrjakova, Maarten Boersma, Katya Abramova, Sebastian Zubrzycki, Boris Biskaborn, Juliane Klemm, and Polina Vakhrameeva

Fieldwork period July 28 to August 12, 2009 (Lena Delta and western Lena side)

Objectives

The main objective of this field trip was the investigation and sampling of permafrost lakes on the western site of the Lena River along a north-south gradient (73°- 69° N) in order to take sediment cores for Late Holocene environmental reconstruction and to collect representative samples for modern environmental conditions that can later serve as modern analogues allowing quantitative environmental reconstruction. We also sampled the biological compartments in the lakes in order to investigate the trophic interactions in the different lakes. By sampling seston, algae, zooplankton, benthic organisms and, where possible, higher trophic levels, we want to investigate the primary sources of energy for the different systems. Using carbon stable isotope analysis we will be able to differentiate between autochthonous production, allochthonous inputs and potentially methane as sources of energy fuelling the food chain. Furthermore, we described and classified the typical units of vegetation and soils in field as an initial investigation. The main question here is to qualify the influence of permafrost on soils and vegetation along a North-South temperature gradient thereby including changes in vegetation zones from tundra to northern taiga.

Methods

Our field work comprised palaeolimnological, limnlogical, pedological and botanical methods forming a comprehensive approach that was conducted in a similar way at each site. The following data were collected in the field: lake area, basin morphology with an echo-sounder, lake water properties (e.g. secchi depth, conductivity, pH), soil description, vegetation analyses following the Braun-Blanquét approach. The following sample types were collected for laboratory analyses in Germany or Russia: Water samples for the analyses of ion composition, dissolved organic carbon analyses, and carbon stable isotope analyses. Plankton samples for phytoplankton and zooplankton analyses. Surface sediments and sediment cores for microfossil (pollen, diatom, chironomid, ostracod, and cladoceran), geochemical, physical, and stable isotopic analyses. Furthermore, zoobenthos was picked directly in field.

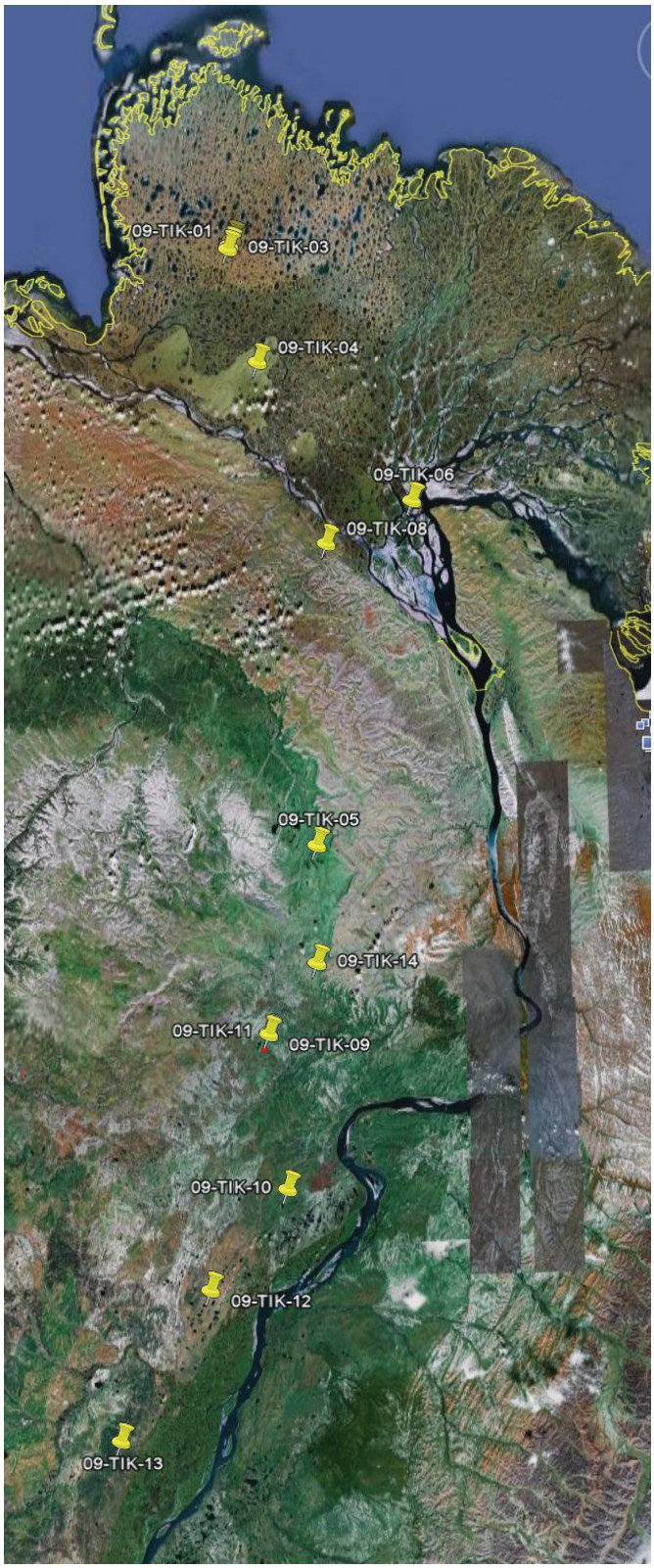

Figure 11-1 Overview of the locations of the study sites. The lakes were reached with the help of a helicopter.

Preliminary results

The sampling area stretches from the typical tundra to the northern taiga zone representing a strong temperature gradient. The different vegetation conditions were obviously reflected in the lake system, hence, changes in the Late Holocene vegetation can be nicely reconstructed with palaeoecological methods that will be applied to lake sediments. In total 14 lakes and their surroundings were investigated with the complete scientific program listed above. 13 sediment cores up to 137 cm length were taken using a Hammer-modified Uwitec Corer with two to three meter liner tubes. Cores from rather shallow lakes (1.7-2.7 m) were also taken by using a Russian Peat Corer. 15 further short cores (30-40 cm length) were taken with a gravity corer.

12. Longterm variability of pelagic fauna in the different lakes in the Lena River Delta

Ekaterina Abramova, Grigoriy Solov'ev, Anna Abramova

Fieldwork period June 26 to August 26, 2009 (on Samoylov and Kurunagh)

Objectives

The numerous tundra lakes may be of considerable importance for the overall fixation, cycling, and storage of carbon in the Arctic ecosystems. The effect of climate variation on high-latitude regions affects all elements of the water ecosystems including benthic and pelagic processes as well as biochemical cycling and its rate. Therefore, the understanding of biological processes in tundra lakes may be critical to understanding and modelling the Arctic response to climate change.

Current research interests in the Lena-2009 expedition were:

- to collect new data about species richness, ecological and geographical distribution of benthos, phyto- and zooplankton in different types of lakes on Samoylov and Kurunagh islands;
- to study the structure and functional characteristics of arctic communities in connection with hydrological and hydrochemical regimes;
- to get new information about seasonal and interannual variations of primary and secondary production in lakes ecosystems;
- to investigate the invasion and distribution of new zooplankton species in the Lena River Delta water bodies in dependence on river runoff and climate variations.

Material and methods

Biological samples were collected from different types of lakes on Samoylov and Kurungnakh islands in the Lena River Delta: flood-plain lakes, big thermokarst lakes, alases, polygon lakes of two types: young shallow polygons with Carex and deep polygons without any plants. Altogether, data from 14 different lakes were collected:

- 51 samples for analysis of Chl "a" distribution and its seasonal dynamic. One liter of water was taken with a bottle from the surface layer from each lake with intervals of 5-10 days during two months. All samples were filtered through glass microfibre filters (GFF) and frozen at -20 oC for preservation.
- 32 net catch (opening diameter 20 cm, mesh size 20 µm) samples were collected for phytoplankton investigations. Samples were fixed with 4% neutral formalin.
- 120 quantitative and qualitative zooplankton samples were collected during two months with a hand net (opening diameter 20 cm, mesh size 100 µm and

55 µm) at the same intervals like the Chl “a” samples. At each lake sampling was carried out through the whole water column in the deepest lake part and in the shallow lake part near the shore. Samples were fixed with 4% neutral formalin.

- Zoobenthos samples (at least two samples per lake, on different depths) were collected with Van Veen Bottom Sampler (surface area of 250 cm²). Samples were washed through a sieve with a cell diameter of 0.5 mm. All animals from samples were sorted and counted. The length and height of Bivalves were measured. Benthos was fixed with 70% ethanol.
- Temperature measurements were conducted simultaneously with the zooplankton sampling.

Preliminary results

The preliminary processing of macrobenthos samples was made on Samoylov in the Lena Delta Reserve. Mostly, the benthic fauna was represented by three groups: larvae of Chironomidae, Oligochaetas and Bivalve mollusca of Pisidiidae and Sphaeriidae families. Over the summer, the structure of all benthic assemblages was comparative stable. Some zooplankton samples obtained from big lakes on Samoylov Island were analyzed during the field period. The abundance of every species and its stages were calculated in a Bogorov’s kamera. We did not observe strong changes in species composition and abundance dynamic in zooplankton population in comparison with the summer 2008. Though, it should be noted that in the previous years we met *Holopedium gibberum* (Cladocera) only in one lake on Samoylov island. This species is typical for the more southern region and for sure came to the delta with river waters. In 2009, *H. gibberum* occupied all big lakes on the island with different abundance. It is a good example of southern species expansion to the northern regions. There is another interesting fact which was observed in summer 2009: Depth measurements were made in all big lakes. Afterwards, zooplankton samples were taken in the deepest parts of two floodplain lakes (up to 8-15 m). In these collections, different stages of the ice relict species *Limnocalanus johanseni* were represented. Previously, this copepoda was found only in Alaska and in the northern part of delta on Sagastyr Island (Abramova and Sokolova, 1999).

Chl “a” measurements will be carried out in the Otto Schmidt Laboratory (AARI, St. Petersburg). Phytoplankton samples will be analyzed at Moscow State University.

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13. Geomorphologic and spore-pollen studies

Alexander Makarov, Larisa Saveleva, and Elena Morozova

Fieldwork period July 29 to August 24, 2009 (on Samoylov, Kurungnakh, Stolb Islands and along the Bulkurskaya Channel)

Objectives

Our team had two main objectives. The first was the creation of an herbarium for the Lena River Delta region and the other was a continuation of previous geomorphologic studies.

Methods

- Water level change measurements
- Geomorphologic route description
- Spore, pollen and plants sampling

Preliminary results

Ten surface samples were collected to study the sub-fossil spore-pollen spectra in the frame work of the expedition "Lena-2009". Additionally, the study of the structure and composition of plant communities were carry out within plots of 1 m x 1 m, which were located in different parts of Samoylov Island, Kurungnakh Island and the Bulkurskaya mouth. Ten plots were described. A summary description of the vegetation was carried out on islands of Sardakh and Stolb, too. The vegetation description was followed by herbarium collection and making images of some exemplars. A preliminary list of plant species was made. It includes about 200 species. 40 species of flowering plants were collected for reference pollen collection of the Lena River Delta. Six samples were collected for macrofossil analysis.

Geomorphologic investigations were realized during a route along the Bulkurskaya channel. During this route, water level changes of the Bulkurskaya channel were measured with a tacheometer. The previous geomorphologic scheme of the investigated area was improved in detail. Two outcrops were described and samples were taken.

14. Investigation on soil and vegetation units along a North-South transect in Northeast Siberia & central part of Lena River Delta, Jakutia

Juliane Klemm and Sebastian Zubrzycki

Fieldwork period July 28 to August 26, 2009 (Lena River Delta and western Lena River side)

Objectives

The objective of the study was to describe and classify typical units of vegetation and soils in the field as an initial investigation. The main question here is to qualify the influence of permafrost on soils and vegetation along a North-South temperature gradient thereby including changes in vegetation zones from tundra to northern taiga. Apart from the descriptive field work, a collection of vegetation and soil samples was made for further analysis in laboratory.

After sampling the north-south gradient (73°-69°) along the western site of the Lena River from July 28 to August 12 (Herzschuh et al. – this report), the focus during the following two weeks in August was the central part of Lena River Delta on the islands Samoylov (72°22' N, 126°29' E) and Sardakh (72°34' N, 127°14' E) as well as the island Tit-Ari located out of the delta (71°59' N, 127°03' E) south-east from Samoylov Island. Tit-Ari is located in the main Lena River channel and is one of the northernmost places of the tree-limit line.

The focus of the soil and vegetation studies was the genesis and spatial distribution of permafrost-affected soils in the southern Lena River Delta.

Methods

For soil investigations, the following proxies were described and measured for every soil horizon of each investigated exposure: content of organic matter and carbonate, hydromorphy, moisture, temperature and soil colour by the Munsell Colour Chart. Vegetation analysis followed the method of Braun-Blanquet (1964) including the identification of species and coverage in analysis units (ranging from four to 25 m²). In addition, a landscape description was made including inclination, exposition, relief description (macro/micro), air temperature and weather conditions of the last 48 hours.

Preliminary results

The thickness of active layer differed from 20 to 50 cm. Due to the depth of the active layer, soil profiles of maximum 50 cm were investigated. The sampled soils were mainly characterized by high amounts of organic matter, which was slightly decomposed, and were dominated by high moisture levels. Typical soil types were Typic Historthels or Typic Glacistels. These soils are comparable to those

we found during the north-south gradient (Herzschuh et al. – this report) with the exception of the soils of the Arga-Complex in the north-western part of the Lena River Delta. These soils were developed on and influenced by sandy (lagoon) deposits, and Psammoturbels were the predominant soil form. Vegetation zones along the transect range from northern typical tundra, shrub and tree tundra to the northern taiga (Polunin, 1959).

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