

Report on 3rd CliSAP workshop "Arctic and Permafrost"

Hamburg, 24-26 February 2016

1. Introduction

The 3rd CliSAP workshop of Topic B1 "Arctic and Permafrost" was held in seminar room 022/23 in Bundesstr. 53 from Wednesday, 24 February 2016, 13.15 to Friday, 26 February 2016, 13.00. The interdisciplinary workshop consisted of four different sessions, which were dedicated to physical, biogeochemical, as well as socioeconomic and ecological interactions in the Arctic polar regions. Additionally, there was a session dedicated to observation techniques. Altogether, 27 talks were presented and 19 posters displayed and discussed during four combined coffee break and poster session time slots. Additionally, the posters were presented by the authors in approximately 3 minute long introductory talks (1-2 slides each). Of the 89 participants that registered at our registration desk, 32 were from the University of Hamburg, 16 from the Max-Planck-Institute for Meteorology in Hamburg, 23 from Germany-based institutions outside of Hamburg, and 18 from foreign institutions. Among the participants of the University of Hamburg were members of nine different institutes, namely the Institutes of Oceanography, Soil Sciences, Geography, Peace Research and Security Policy, Social and Cultural Anthropology, the Meteorological Institute, the Integrated Climate Data Centre, the Department of Mathematics, and the Faculty of Law. The participants affiliated at institutions outside of Germany came from Sweden, Finland, Norway, Denmark, England, Italy, Austria, Switzerland, the Netherlands, and the USA. An estimation of the scientific background of the participants revealed that about 55% of the participants are mainly associated with physical sciences, about 30% are mainly involved with biogeochemistry, and about 15% mainly with socioeconomics (including legal issues). Among the natural scientists, we had a very good mixture of (mainly) modellers and (mainly) observers, which were almost equally represented by the workshop participants. In addition to the oral and poster sessions, we organised an icebreaker event on the evening of the first day and offered the participants of the workshop to join one of the groups that met for a (non-host) dinner on the evening of the second day to encourage further discussions and social activities among the participants. The scientific program of the four sessions is summarised in the following, followed by the program of the workshop, and a list of the (registered) participants.

2. Summary of Day 1: 13.30-18.00

Session "Physical interactions between ocean, atmosphere, and land in the Arctic"

The first session was chaired by Dirk Notz, Stefan Hagemann, Uwe Mikolajewicz, and

Thorsten Mauritsen and opened the workshop with a focus on linkages between the atmosphere and the surface. These were discussed in detail by a keynote lecture given by Timo Vihma from the Finnish Meteorological Institute (FMI). He discussed in particular linkages between changes at high latitude and atmospheric patterns in mid latitudes, giving a broad overview of our current understanding of the possible mechanisms. This overview talk set the scene for the remainder of the workshop, in particular through its identification of the many processes that are still only poorly understood.

The keynote lecture was then followed by two talks that discussed at more detail specific aspects of the surface-atmosphere interaction at high latitudes. Amelie Tetzlaff (University of Hamburg) presented work she had done in collaboration with colleagues at the Alfred Wegener Institute (AWI) on the impact of sea-ice leads on the atmospheric boundary layer. The presentation contained detailed airplane measurements of these interactions, which allowed the audience to appreciate the complexity of the relevant processes and the need for detailed observational programs. Afterwards, Marie Kapsch (MPI-M) presented her work on the different atmospheric circulation regimes that govern the Arctic in years with low September sea-ice extent versus years with high September sea-ice extent. Just before the coffee break, participants with posters had the chance to briefly outline the contents of their poster in short 3-minute overview talks.

After the coffeebreak, Benjamin Rabe (AWI) talked about freshwater within the Arctic Ocean since 1992. He combined models and observations to analyze the variability of the liquid freshwater content. Then, Laura Niederdrenk (MPI-M) showed results from a model study of the formation of the commonly named Arctic Odden, an ice tongue with large daily variability in size and shape in the Nordic Seas. While in observations the Odden formation is associated with formation of new ice, within the model it is advection of ice from the main ice pack. Camila Campos (AWI) presented sensitivity experiments with the new AWI coupled climate model ECHAM-FESOM to study the response of the Arctic ocean to vanishing sea ice. Afterwards, Florian Ziemann (MPI-M) showed simulations of the last glacial with an interactively coupled atmosphere-ocean-ice-sheet model. He presented his analysis on Heinrich events, which occur in this model as part of the internal model variability.

3. Summary of Day 2: 9.00-13.00

Session "Biogeochemistry-Interactions between ocean, atmosphere, and land in the Arctic"

This session was chaired by Christian Knoblauch, Victor Brovkin, and Lars Kutzbach and focused on observational and modeling approaches for understanding and quantifying biogeochemical processes in the Arctic. The session started with an exploration of the link between the loss in sea ice and the increase of methane emissions on land by Frans-Jan Parmentier (Lund University). In his study, three CH₄ emission models were used to calculate spatial correlations between emissions and sea ice patterns. The study revealed strong spatial correlations, in particular during the autumn season.

Dmitry Nicolsky (University of Fairbanks) presented modelling subsea permafrost on the Eastern Siberian shelf. He introduced the history of subsea permafrost research and

expeditions, which led to numerous maps of permafrost on the shelves. He explained challenges related to the modelling of subsea permafrost, as details of permafrost distributions are very scarce, which complicates setting up the initial and boundary conditions in the model simulation.

Christian Beer (Bolin Centre, Stockholm University) presented current progress in his group on modelling the carbon stored in terrestrial permafrost. His group added the physical permafrost model to JSBACH and worked on adding mosses and lichens to the organic layer at the top of the soil. He argued that for soils where cryoturbation is important current methods based on diffusion do not work. He presented a novel methane model implemented into JSBACH and a model of CH₄ emissions from lakes based on the VIC model. There is ongoing fruitful cooperation between the Universität Hamburg, MPI-M, and the Bolin Centre, which will continue in the future.

During the continuation of the oral presentations after the poster session, Mathias Göckede (MPI for Biogeochemistry in Jena) presented several lines of research in his group on constraining regional fluxes of CH₄ and CO₂ in the Arctic. Their study, including a simplified model of terrestrial carbon, suggests that the East Siberian domain is a net sink for carbon at present. Modelling regional permafrost CH₄ emissions using JSBACH is another approach recently started in his group. JSBACH is used to bridge between site-level calibration and large-scale regional estimates of methane fluxes from land. Atmospheric inverse modeling for the ESAS domain is another challenging task addressed by the group at MPI-BGC.

Thomas Kleinen (MPI-M) presented results on the release of carbon from permafrost regions in future climate projections. Several components of the JSBACH model were updated to represent frozen soil carbon in JSBACH. The model was applied for RCP2.6 and 8.5 simulations. In the RCP8.5 run, the model simulates a strong reduction in the permafrost carbon pool by 2100. However, most of this carbon is transferred into the unfrozen pools and slowly increases the heterotrophic respiration. At maximum, 5 PgC/yr could be additionally respired by 2100, but the net effect will be reduced due to a strong increase in NPP.

Mathias Heinze (MPI-M) reported on the ocean physical and biogeochemical changes projected in MPI-ESM simulations until 2300. As the Atlantic Ocean warms, enhanced intrusion of saline Atlantic water into the Eurasian sector of the Arctic Ocean leads to a collapse of the halocline. As a consequence of this major perturbation in the hydrodynamic regime, formation of deep-water convection cells takes place. Such an "Atlantification" of the Arctic Ocean also results in major shifts in ocean biogeochemical cycles. While DIC increases over time, total alkalinity increases in the Eurasian sector, but decreases if averaged over the whole Arctic basin. Because the buffering capacity is decreasing and anthropogenic CO₂ emissions are declining too, the Arctic CO₂ uptake decreases with time (almost by a factor of 2 between 2050 and 2300). The conclusion is that a shift in the hydrographic regime of the Arctic Ocean is the key to understanding changes in patterns of CO₂ uptake.

The discussion that followed the oral session focused firstly on the methane fluxes on the Eastern Siberian shelf, and the possibility of degradation of "meta stable" methane hydrates in the sub-sea permafrost in this region. There was no firm conclusion on this, but the top-down constraint of the methane fluxes from atmospheric inversions seems to be the most

appropriate tool for the present-day conditions. Closing the scaling gap between observations and modeling from local to pan-Arctic scales was addressed as well, and a particular opinion was that data assimilation systems will be a long-term solution to accommodate data of different resolutions. Finally, discussion went into the consideration of several novel processes and their interactions (such as fire-permafrost interactions) which are not yet fully understood and quantified. There is a high potential in constraining these processes and the interactions between them based on new observational datasets.

4. Summary of Day 2: 14.00-18.00

Session "Socioeconomic and ecological interactions in the Arctic"

This session was chaired by Jürgen Scheffran, Michael Brzoska, and Lars Kutzbach. The session began with a presentation by the Anthropologist Joachim Otto Habeck (University of Hamburg) focusing on the consequences of climate change for indigenous people in the Russian North. He featured two different case studies, one from the Republic of Sacha (Yakutia) region in Siberia, where climate change is offering additional options of land use, and the other from the industrialized part of the Republic of Komi, where permafrost dynamics are endangering local infrastructure.

While the first contribution was devoted to a human micro-perspective, the following contributions addressed macro-perspectives, which have very much driven debates of the Arctic as an area of potential conflict between governments.

One such issue has been the deposits of oil and gas in the Arctic region. Arne Riedel (Ecologic Institute, Berlin) emphasized the gaps in current knowledge about geological resources and the costs of their exploitation. Much of the debate is informed by uncertain maximum estimates. At current price levels for oil and gas, there is no prospect for further exploitation as even current levels are cut. Furthermore, and confirmed by Erik van Doorn (University of Kiel), the Arctic is very well governed through treaties and arrangements. Earlier disputes, including over territories with oil and gas deposits, are either settled or under established settlement procedures. In fact, the high cost of exploration in the area has fostered cooperation among states in the area. Furthermore, as Golo Bartsch (Ministry of Defence) explained, naval forces dedicated to Arctic operations are quite small and focused on non-confrontational missions, such as rescue operations.

Considering these assessments, it becomes a puzzle that the Arctic is often seen as a space for geopolitical conflict. Sebastian Knecht (Freie Universität Berlin) provided a perspective for this seeming contraction, which is based on the view of the Arctic as an ungoverned space and particularly fueled by the assumption that such spaces attract power politics. An alternative view was provided by Rasmus G. Bertelsen (University of Tromsø). He illustrated how scientific cooperation also can help to counter political confrontation using joint Chinese-Norwegian project activities as an example. The session closed with a joint discussion with input statements by Michael Brzoska and Jürgen Scheffran. Topics covered included the interaction between local and global effects of climate change as well as possible future research projects on Arctic issues linking natural and social sciences.

5. Summary of Day 3: 9.00-13.00

Session "Observations and methods: remote sensing and measurement techniques"

The last session of the workshop was chaired by Lars Kaleschke (University of Hamburg) and Matthias Drusch (ESA-ESTEC) and was dedicated to observations and methods focussing on satellite remote sensing. Eight presentations were given addressing a wide range of applications and parameters related to permafrost, ice sheets, and sea ice. A variety of satellite data sets were presented, especially in the overview talk of Annett Bartsch (Zentralanstalt für Meteorologie und Geodynamik, Wien). However, in this session, there was a clear focus on the SMOS satellite mission and thus on passive L-band measurements. Mike Schwank (Gamma Remote Sensing / Eidg. Forschungsanstalt WSI, Birmensdorf) gave an overview of the underlying radiative transfer theory and presented a 2-stream model.

Although cryospheric parameters were not targeted through the SMOS mission's original objectives, a number of valuable data sets and applications have been developed in the past years. For example, ice sheet stability (Giovanni Macelloni, IFAC-CNR), snow on sea ice (Nina Maaß, University of Hamburg), and soil frost state (Kimmo Rautiainen, FMI) were mentioned. In addition, a combined sea ice data set for the Arctic using measurements from CryoSat-2 and SMOS was presented that makes use of the different uncertainty statistics and characteristics of the two data products (Stefan Hendricks, AWI). The session was complemented by two presentations on model – observation comparisons (Steffen Tietsche, ECMWF and Friedrich Richter, ESA-ESTEC).

In the final discussion, the data product users expressed a strong need for a proper documentation and characterisation of the satellite-derived data sets. This includes the algorithms, with which the geophysical parameters are derived, but also a description of the physical relationships between the measurements (e.g. radiances, brightness temperatures) and the geophysical products (e.g. albedo, ice temperature) with associated limitations. For the assimilation and model-to-observation comparisons uncertainty estimates should be assigned.

Interest in the combined Cryosat-2 / SMOS sea ice thickness product and the soil state (freeze/thaw) product was expressed; formats, data latency, and dissemination of the products are still under discussion. For future missions, the users suggested data products related to snow (height and density), soil temperature profiles (also covering deeper layers e.g. around 1 m) and precipitation.

PROGRAM of the 3rd CliSAP "Arctic and Permafrost" workshop

24-26 February 2016, University of Hamburg

WEDNESDAY, 24.2.

13.15 Workshop introduction

SESSION "Physical interactions between ocean, atmosphere, and land in the Arctic"

Chairs: Stefan Hagemann, Dirk Notz, Uwe Mikolajewicz, Thorsten Mauritsen

13.30 Timo Vihma (FMI): "Ice-atmosphere interaction processes in local and hemispherical scales"

14.00 Amelie Tetzlaff (Uni Hamburg): "The impact of sea ice leads on the atmospheric boundary layer: a study based on aircraft measurements"

14.20 Marie Kapsch (MPI-M Hamburg): "Arctic atmospheric circulation in years with low September sea-ice extent"

14.40 Short (3 mins) poster introductions

15.00-16.00 COFFEE BREAK and POSTER SESSION

16.00 Benjamin Rabe (AWI Bremerhaven): "Arctic Ocean liquid freshwater content since 1992: variability and implications"

16.20 Laura Niederdrenk (MPI-M Hamburg): "Interannual variability of sea ice in GIN Sea"

16.40 Camila Campos (AWI Bremerhaven): "The impacts of Arctic sea ice reduction on the ocean circulation from global coupled model simulations"

17.00 Florian Ziemer (MPI-M Hamburg): "Heinrich events in transient glacial simulations"

17.20 Wrap-up and open discussions

18.00 ICEBREAKER

THURSDAY, 25.2.

SESSION "Biogeochemistry-Interactions between ocean, atmosphere, and land in the Arctic"

Chairs: Victor Brovkin, Christian Knoblauch, Lars Kutzbach, Eva-Maria Pfeiffer, Tatiana Ilyina

9.00 Frans-Jan W. Parmentier (Lund University): "Does sea ice loss lead to terrestrial carbon loss?"

9.20 Dmitry Nicolsky (University of Alaska Fairbanks): "Modelling sub-sea permafrost"

9.40 Christian Beer (Bolin Centre, Stockholm University): "Prognostic modeling of terrestrial and aquatic permafrost ecosystem dynamics"

10.00 Short (3 mins) poster introductions

10.20-11.20 COFFEE BREAK and POSTER SESSION

11.20 Mathias Göckede (MPI-BGC Jena): "Constraining regional scale CH₄ and CO₂ budgets in the Arctic using top-down and bottom-up approaches"

11.40 Thomas Kleinen (MPI-M Hamburg): "Simulations of GHG release from permafrost in future climate projections"

12.00 Mathias Heinze (MPI-M Hamburg): "Future changes in the Arctic Ocean's hydrodynamic and biogeochemical regimes"

12.20 Wrap-up and open discussion

13.00 - 14.00 LUNCH BREAK

SESSION "Socioeconomic and ecological interactions in the Arctic"

Chairs: Jürgen Scheffran, Michael Brzoska, Lars Kutzbach

14.00 Joachim Otto Habeck (Uni Hamburg): "Indigenous perspectives on permafrost dynamics in the Russian North"

14.25 Arne Riedel (Ecologic Institut, Berlin): "The future of oil and gas resources in the Arctic region"

14.50 Erik van Doorn (Uni Kiel): "Legal issues of climate change and security in the Arctic"

15.15 Sebastian Knecht (Freie Universität Berlin): "Geopolitical paradigms in the Arctic region"

15.40-16.30 COFFEE BREAK and POSTER SESSION

16.30 Golo Bartsch (BMVg): "Military forces in the Arctic region"

16.55 Rasmus G. Bertelsen (University of Tromsø): "Arctic science diplomacy under power transition"

17.20-18.00 Joint discussion with input statements by **Michael Brzoska** and **Jürgen Scheffran**

FRIDAY, 26.2.

SESSION "Observations and methods: remote sensing and measurement techniques"

Chairs: Lars Kaleschke, Matthias Drusch

9.00 Annett Bartsch (ZAMG, Wien): "Possibilities and challenges in using satellite data for permafrost monitoring"

9.30 Mike Schwank (Gamma RS, WSL-Birmensdorf): "Two stream model in application to passive L band observations: Impact on SMOS soil-moisture retrievals, and potential for novel SMOS based snow-density retrievals"

9.50 Kimmo Rautiainen (FMI): "Global monitoring of surface soil freeze/thaw state".

10.10 Nina Maaß (Uni Hamburg): "Retrieval of snow on sea ice using SMOS passive microwave satellite data"

10.30-11.00 COFFEE BREAK and POSTER SESSION

11.00 Stefan Hendricks (AWI Bremerhaven): "A synergetic sea ice thickness product from SMOS and CryoSat2"

11.20 Friedrich Richter (ESA-ESTEC): "Sea ice signatures at L-Band: Brightness temperature comparison based on SMOS and ORAP5 reanalyses using radiation transfer models"

11.40 Steffen Tietsche (ECMWF): "Thin Arctic sea ice observed by SMOS and simulated by the ECMWF ocean reanalysis ORAS5".

12.00 Giovanni Macelloni (IFAC-CNR): "Exploiting the capability of low frequency passive microwave system for monitoring of the polar regions"

12.20 Discussions

POSTERS:

Mikhail Dobrynin (Uni Hamburg): "New wave systems in the ice-free future of the Arctic Ocean"

Friedrich Richter (ESA-ESTEC): "The atmospheric response to Arctic sea ice thickness and concentration changes"

Tim Eckhardt (Uni Hamburg): "Partitioning CO₂ net ecosystem exchange fluxes into photosynthesis, autotrophic and heterotrophic respiration in a polygonal tundra landscape"

Norman Rüggen (Uni Hamburg): "Allocation of atmospheric carbon into sub-surface carbon pools"

Maciej Miernecki (Uni Hamburg): "Decimeter scale sea ice surface roughness over different ice types"

Andreas Wernecke (Uni Hamburg): "On the Origin of Microwave Emissions at Antarctic Ice Shelves observed by SMOS"

Norman Rößger (Uni Hamburg): "Spatio-temporal variability of carbon fluxes in the Lena River Delta"

Rosina Grimm (MPI-M Hamburg): "Assessment of the sea-ice carbon pump: Insights from MPIOM/HAMOCC"

Marko Scholze (Lund University): "Wetlands, Permafrost and Methane Modelling with an Arctic-enabled LPJ-GUESS"

Tido Semmler (AWI Bremerhaven): "Fast atmospheric response to a sudden thinning of Arctic sea ice"

Svetlana Sukneva (North-Eastern Fed. University, Yakutsk): "Demographic dimensions of the socio-economic development in the Arctic regions"

Friedemann Reum (MPI-BGC Jena): "What are the major controls on the pan-Arctic methane budget? Concepts and datasets for a geostatistical inverse model"

Yufang Ye (Uni Bremen): "Improving Multiyear Ice Concentration Estimates with atmospheric temperature and ice drift"

Marco Brogioni (IFAC-CNR): "The STSE Cryosmos Project: Exploiting the Potential of SMOS Data in Antarctica"

Karel Castro Morales (MPI-BGC Jena):

"Simulated methane fluxes from permafrost soils in East Siberia using a regional configuration with JSBACH"

"Decline of Arctic snow depths on sea ice represented by a regional general circulation model"

Marcel Nicolaus (AWI Bremerhaven): "Snow depth on Arctic and Antarctic sea ice derived from autonomous measurements"

Tatiana Egorova (University Yakutsk): "The impact of climatic changes on the organization of transport system in arctic regions of Yakutia"

Georg Heygster (Uni Bremen): "Sea Ice climate data records for ESA's Climate Change Initiative using AMSR-E and AMSR2 data"

List of participants

	<i>Name</i>	<i>Institute</i>
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3	Stefan Kern	ICDC, University of Hamburg
4	Gitta Lasslop	MPI for Meteorology
5	Janosch Michaelis	MI Uni Hamburg
6	Tim Eckhardt	Institute of Soil Science, UHH
7	Nina Maaß	Institute of Oceanography, Universität Hamburg
8	Xueyuan Liu	IfM, CEN
9	Thomas Diehl	Joint Research Centre
10	Felix Bunzel	Max Planck Institute for Meteorology
11	Alexander Lohse	Universität Hamburg, Fachbereich Mathe
12	Xiangshan Tian-Kunze	Institute of Oceanography, Uni Hamburg
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23	Norman Rößger	Institut für Bodenkunde, Universität Hamburg
24	Christian Beer	Bolin Centre for Climate Research, Stockholm University
25	Rosina Grimm	Max-Planck Institute for Meteorology
26	Marko Scholze	Department of Physical Geography and Ecosystem Science, Lund University
27	Hauke Schulz	MPI-M, Uni-HH
28	Gunnar Spreen	University Bremen
29	Simon Wett	Universität Hamburg
30	Tido Semmler	AWI Bremerhaven
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38	Raul Scarlet	Institute of Environmental Physics - Uni Bremen
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40	Marco Brogioni	IFAC-CNR
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47	Tim Hempel	Universität Hamburg
48	Marcel Nicolaus	Alfred-Wegener-Institut
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52	Timo Vihma	Finnish Meteorological Institute
53	Laura Niederdrenk	Max Planck Institute for Meteorology
54	Benjamin Rabe	AWI Bremerhaven
55	Camila Campos	AWI Bremerhaven
56	Amelie Tetzlaff	Institute of Oceanography, University of Hamburg
57	Florian Ziemer	Max Planck Institute for Meteorology
58	Frans-Jan W. Parmentier	Lund University
59	Dmitry Nicolsky	University of Alaska Fairbanks
60	Golo Bartsch	Bundesministerium der Verteidigung
61	Annett Bartsch	Zentralanstalt für Meteorologie und Geodynamik, Wien
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84	Philipp Porada	Stockholm University
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87	Gerd Müller	Meteorological Institute, Universität Hamburg
88	Victor Brovkin	Max Planck Institut für Meteorologie
89	Christian Rodehacke	Danish Meteorological Institute