



716  
2018

# Berichte

zur Polar- und Meeresforschung

Reports on Polar and Marine Research

## **Polar Systems under Pressure**

**27<sup>th</sup> International Polar Conference**

**Rostock, 25 - 29 March 2018**

**German Society for Polar Research**

Edited by

H. Kassens, D. Damaske, B. Diekmann, D. Fütterer,  
G. Heinemann, U. Karsten, E.M. Pfeiffer, J. Regnery,  
M. Scheinert, J. Thiede, R. Tiedemann & D. Wagner

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Herausgeber  
Dr. Horst Bornemann

Redaktionelle Bearbeitung und Layout  
Birgit Reimann

Alfred-Wegener-Institut  
Helmholtz-Zentrum für Polar- und Meeresforschung  
Am Handeshafen 12  
27570 Bremerhaven  
Germany

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Editor  
Dr. Horst Bornemann

Editorial editing and layout  
Birgit Reimann

Alfred-Wegener-Institut  
Helmholtz-Zentrum für Polar- und Meeresforschung  
Am Handeshafen 12  
27570 Bremerhaven  
Germany

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*Titel: Gletscher auf dem Rückzug im Kongsfjorden, Spitzbergen  
(Foto: Ulf Karsten)*

*Cover: Glacier retreat in Kongsfjorden, Svalbard  
(Photo: Ulf Karsten)*

# German Society for Polar Research



27<sup>th</sup> International Polar Conference

„Polar Systems under Pressure“

University of Rostock

March 25 - 29, 2018

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## Editorial Board

Kassens H, Damaske D, Diekmann B, Fütterer D, Heinemann G, Karsten U, Pfeiffer EM, Regnery J, Scheinert M, Thiede J, Tiedemann R & D Wagner

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Rostock, March 2018

## Welcome to the 27<sup>th</sup> International Polar Conference in Rostock

The North and South Pole regions have fascinated people to this day. Not only fauna and flora are attracting us but also the special physical and biogeochemical processes in these cold areas as, for instance, the strong reflection of solar radiation at ice and snow surfaces, the huge temperature contrast with respect to the tropics or the global atmospheric and oceanic circulation that is controlled by the polar regions. These processes are subject to fundamental changes which are even more intensified by anthropogenic influences. The Arctic, for example, is warming twice as fast as other regions on Earth. The serious changes of the polar regions and glaciers of the high mountains (the “third pole”) are closely connected to climate change. Thus, it is of utmost importance to strengthen an active research of the impact of climate change as well as to intensify public outreach in order to explain the consequences to the public. Every day scientists are recording data to capture the dynamics of these changes, to better understand the involved processes, to reconstruct them and enable a better prediction using appropriate models. Under the theme “*Polar Systems under Pressure*” the German Society of Polar Research (DGP) cordially welcomes you to the 27<sup>th</sup> International Polar Conference in Rostock, 25 to 29 March 2018. Experts from universities and research centres will discuss the state-of-the-art of polar sciences with polar teachers and interested laymen.

The volume at hand comprises all abstracts which have been submitted to the 27<sup>th</sup> International Polar Conference. These contributions cover a huge variety of aspects, from the complex impact of climate change on the polar regions and high mountains, and their grounded and floating ice, to biodiversity, the change of food webs and social responsibility. Questions with regard to geological, geophysical and biological processes will be discussed, and the historic dimension of polar research will be debated. Teachers will report on the experiences made in polar regions and how these get incorporated into primary and secondary education. The colloquium of the priority programme of the German Research Foundation on “Antarctic research with comparative investigations in Arctic glaciated areas” (SPP 1158) will provide major contributions to answering open questions.

The 27<sup>th</sup> International Polar Conference will be realized in close cooperation with the University of Rostock and the Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research. We would like to cordially thank both institutions for their generous support.

Now enjoy reading the abstracts of the oral and poster presentations. We are looking forward to a fascinating programme with lively discussions and invite you all to join in when scientists of all disciplines and generations present their most recent research results on the cold regions of our planet. We hope for an inspiring exchange with everybody interested in polar research on “Polar Systems under Pressure”.

Eva-Maria Pfeiffer and all colleagues of the Extended Steering Committee of the DGP

Prof. Eva-Maria Pfeiffer, Vorsitzende – Deutsche Gesellschaft für Polarforschung e.V., c/o Universität Hamburg, Institut für Bodenkunde, Allende-Platz 220146 Hamburg, [www.polarforschung.de](http://www.polarforschung.de)

27th International Polar Conference, University of Rostock, 2018



**Sessions**

History of Polar Research
Polar Biology
Polar Social Sciences
Cool classes
Permafrost and Periglacial Habitats
Atmosphere and Ocean
DFG SPP 1158 Antarctic Research
Climate History at the Poles
Geodynamic Processes
Mass balance & Dynamics of Glacier Systems

IT- und Medienzentrum (ITMZ)  
 Konrad-Zuse-Haus  
 Albert-Einstein-Straße 22  
 18059 Rostock

	Sonntag 25.03.18	Montag 26.03.18	Dienstag 27.03.18	Mittwoch 28.03.18	Donnerstag 29.03.18	Freitag 30.03.18
8:00 - 8:15						
8:30 - 8:45						
8:45 - 9:00		<b>Eröffnung &amp; Ehrungen</b>	Heidbrink	Huhn et al.	Chen et al.	
9:00 - 9:15		Schareck	Lobova	Losa et al.	Klages et al.	
9:15 - 9:30		Karsten	Mishina	Havermans et al.	Weber et al.	
9:30 - 9:45		Pfeiffer	Kallfelz	Dömel et al.	Berg et al.	
9:45 - 10:00		Hubberten	Kaup et al.	Friedl et al.	Grigoreva et al.	
10:00 - 10:15		Thiede et al.	Lehmarr	Lagostina et al.	Sukhanova et al.	
10:15 - 10:45		Gernandt	Abakumov		Dietrich et al.	
			<b>Kaffeepause</b>			
10:45 - 11:00		Fritzsche	Prater et al.	Bomfleur	Kuhn et al.	
11:00 - 11:15		Opel & Opel	de Klerk et al.		Jacobs et al.	
11:15 - 11:30		Lüdecke	Eckhard et al.	Zundel et al.	Jokat et al.	
11:30 - 11:45		Tammiksaar	Hellmer et al.	Menneken et al.	Pappa et al.	
11:45 - 12:00		Schennerlein	Richter M. et al.	Gohli et al.	Koglin & Piepjohn	
12:00 - 12:15		Povazhnyi et al.	Arndt et al.	Schaller et al.	Schammwell et al.	
12:15 - 12:30		Jerosch et al.	Kazlova & Spreen	Busch et al.	Scheinert et al.	
12:30 - 13:30			<b>Mittagspause</b>			
13:30 - 13:45		Trudnowska et al.		Preusser et al.	Fürst et al.	
13:45 - 14:00		Verleyen et al.	Dietrich	Triana et al.	Mayer et al.	
14:00 - 14:15		Beszteri et al.	Bock et al.	Kohnemann et al.	Korth et al.	
14:15 - 14:30		Thebault	Kuepper et al.	Zielinski et al.		
14:30 - 14:45		Thajfe & Marsh	Becker et al.	Markuszewski et al.		
14:45 - 15:00		Mustafa et al.	Meier et al.	Melles et al.		
15:00 - 15:15		Tyrgat et al.	Toohy & Sigl	Taldenkova et al.		
15:15 - 15:30		Dettermeyer-W. & Ott	Ronge et al.	Diekmann et al.		
15:30 - 16:00			<b>Kaffeepause</b>			
16:00 - 16:15	<b>APECS</b>		Winkelmann et al.			
16:15 - 16:30	ITMZ, 15:00-18:00	Moderierte Kurzvorstellung der Poster	Zentek et al.	Moderierte Kurzvorstellung der Poster		
16:30 - 16:45	<b>DGP-Vorstand</b>	<b>Poster</b>	Carlsen et al.	<b>Poster</b>		
16:45 - 17:00	ITMZ, 15:00-17:00	Atrium ITMZ	Muchow & Kaleschke	Atrium ITMZ		
17:00 - 17:15			Pätzold et al.			
17:15 - 17:30			Spreen et al.			
17:30 - 17:45			Heinemann et al.			
17:45 - 18:00						
18:00 - 18:30						
18:30 - 19:00	<b>Icebreaker</b>					
19:00 - 19:30	Atrium ITMZ	<b>Abendvortrag</b>	<b>Abendessen</b>			
19:30 - 20:00		Aula Universität Rostock	Restaurant "Alter Fritz"			
20:00 - 20:30		Boetius (AWI)		Sitzungen der Arbeitskreise Physik: Hörsäle 1, 2, 3 & Seminarräume 1, 2, 3		
20:30 - 21:00						
21:00 - 22:00						

Deutsche Gesellschaft für Polarforschung e.V.

## Program of the 27<sup>th</sup> International Polar Conference

25 – 29 March 2018

Rostock, Germany

### Sunday, 25 March 2018

- 15:00 – 18:00      APECS – Getting involved in Polar Organizations: Opportunities and Challenges (ITMZ, room 110)
- 15:00 – 17:00      DGP Meeting, Executive Board (ITMZ, room 109)
- 18:00 – 21:00      Icebreaker (Atrium ITMZ; sponsored by the shipping company Laeisz GmbH)

### Monday, 26 March 2018

- 08:00 – 08:15      Registration
- 08:30 – 09:45      Opening and honors  
*Wolfgang Schareck, University of Rostock, Rector*  
*Ulf Karsten, University of Rostock*  
*Eva-Maria Pfeiffer, DGP Chairwoman*  
*Hans-W. Hubberten, DGP Vice Chairman*

### History of Polar Research

*Conveners: Jörn Thiede, Erki Tammiksaar*

- 09:45 – 10:00      *Jörn Thiede (Köppen Laboratory, Institute of Earth Sciences, Saint Petersburg State University) – Wladimir Köppen, Alfred Wegener, and Milutin Milankovitch: their impact on modern paleoclimate research and the revival of the Milankovitch hypothesis*
- 10:00 – 10:15      *Hartwig Gernandt (Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research) – German permanent research facilities in Antarctica – a 40 years record*
- 10:15 – 10:45      Coffee break**
- 10:45 – 11:00      *Diedrich Fritzsche (Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research) – Walther Bruns, Gründer der „Aeroarctic“ – ein vergessener Pionier der Deutschen Polarforschung*

- 11:00 – 11:15 *Mechthild Opel, W. Opel* – A new take on Johann August Miertsching
- 11:15 – 11:30 *Cornelia Lüdecke (University of Hamburg)* – Historische technische Innovationen für die Arktisforschung
- 11:30 – 11:45 *Erki Tammiksaar (Estonian University of Life Sciences University of Tartu)* – Schiff oder Schlitten? Über die Eroberung der Pole
- 11:45 – 12:00 *Barbara Schennerlein (DGP AK Geschichte der Polarforschung)* – Land ohne Frauen?

### **Polar Biology**

*Conveners: Ulf Karsten, Julia Regnery*

- 12:00 – 12:15 *Vasiliy Povazhnyi (Arctic and Antarctic Research Institute, Otto-Schmidt Laboratory for Polar and Marine Research), K. von Juterzenka, I. Kryukova* – Towards the deeper understanding of the Laptev Sea biological productivity in the framework of the German-Russian research projects
- 12:15 – 12:30 *Kerstin Jerosch (Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research), L. Beierlein, I. Schloss, R. Sahade, M.L. Quartinio, H. González, G. Ferreyra, D. Abele* – Long-term multidisciplinary research along a gradient of high latitudes to track climate change: from station-based studies to new observatory concepts
- 12:30 – 13:30 Lunch**
- 13:30 – 13:45 *Emilia Trudnowska (Institute of Oceanology Polish Academy of Sciences), R. Boehnke, K. Draganska-Deja, K. Deja, A.M. Kubiszyn, K. Blachowiak-Samolyk* – The content of glacial soup in Svalbard waters and its importance for food web interactions
- 13:45 – 14:00 *Elie Verleyen (POLDIAT consortium / Ghent University – Protistology and Aquatic Ecology), B. Van de Vijver, E. Pinseel, D.A. Hodgson, B. Tytgat, K. Sabbe, W. Vyverman* – The origin of the polar lacustrine diatom biome: evidence from macroecology and paleolimnology
- 14:00 – 14:15 *Bánk Beszteri (Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research), S. Pinkernell, M. Kloster, U. Postel, G. Kauer, U. John, K. Valentin, G. Glöckner* – Collection-based diatom research: collection imaging to biogeography and microevolution in the Southern Ocean
- 14:15 – 14:30 *Justine Alice Thébault (Justus Liebig University Gießen)* – Bioaccumulation and maternal transfer of mercury in fur seals from the Southern Ocean: influence of intrinsic factors and feeding ecology inferred from stable isotopes



- 14:30 – 14:45 *Sven Thatje (University of Southampton), L. Marsh* – In hot and cold water of the Southern Ocean: differential life-history traits are key to success of hydrothermal yeti crab
- 14:45 – 15:00 *Osama Mustafa (ThINK – Thuringian Institut of Sustainability and Climate Protection), H.-U. Peter, M.-C. Rümmler, C. Pfeifer, J. Maercker* – Mapping Antarctic wildlife by use of Unmanned Aerial Vehicles
- 15:00 – 15:15 *Bjorn Tytgat (Ghent University), D. Obbels, M. Sweetlove, Z. Namsaraev, M.-J. Mano, R. Fernandez-Carazo, K. Peeters, S. D’hondt, P. Clercx, A. De Wever, D. Ertz, J. Elster, E. Van Ranst, S. Roberts, K. Sabbe, A. Wilmotte, A. Willems, W. Vyverman, E. Verleyen* – Bacterial and eukaryotic biodiversity patterns in the Sør Rondane Mountains, Dronning Maud Land, East Antarctica
- 15:15 – 15:30 *Nadine Determeyer-Wiedmann (Heinrich Heine University Düsseldorf), S. Ott* – Life strategies on photobiology and metabolite profile of genetic identical photobionts of two different lichen species
- 15:30 – 16:00 Coffee break**
- 16:00 – 16:45 Short presentations of posters (chairpersons H. Kassens, G. Heine-  
mann)
- 16:45 – 18:00 Poster session (Atrium ITMZ)
- 19:30 – 21:00 Public talk at the University of Rostock (Aula)**  
Polarmeere im Wandel: Was wissen wir über die Tiefsee – *Antje Boetius (Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research)*

## Tuesday, 27 March 2018

- 08:00 – 08:15 Registration

### Polar Social Sciences

*Conveners: Renate Treffeisen, Franz Tessensohn*

- 08:30 – 08:45 *Ingo Heidbrink (Old Dominion University, Dept. of History)* – Recent changes in Antarctic tourism and their consequences for selected historical sites
- 08:45 – 09:00 *Vera A. Lobova (Yugra State University)* – Arctic region: human and social factors
- 09:00 – 09:15 *Daria Mishina (University of Lapland)* – Arctic tourist taxation or Arctic charity

### Cool Classes

Conveners: *Renate Treffeisen, Franz Tessensohn*

- 09:15 – 09:30 *Monika Kallfelz (Natural History Museum of the Palatinate – POLLI-CHIA Museum) – Die Versauerung der Polarmeere als Kontext in der Schule*
- 09:30 – 09:45 *Enn Kaup (Department of Geology at Tallinn University of Technology / Estonian Polar Club, Tallinn), M. Hunt, V. Raidla, K. Savomägi, H. Uppin, M. Varvas – Polar knowledge contest and polar expedition for high school students of Estonia*
- 09:45 – 10:00 *Rainer Lehmann (Freie Waldorfschule Hannover-Bothfeld), C. Wüthrich – Ornithogenic tundra and nutrient flux – focus on final secondary-school examination*

### Permafrost and Periglacial Habitats

Conveners: *Christian Knoblauch, Lars Arne Meier*

- 10:00 – 10:15 *Evgeny Abakumov (Department of Applied Ecology, Faculty of Biology, Saint Petersburg State University) – Characterization of soil organic matter of Arctic and Antarctic by <sup>13</sup>C NMR and electron spin resonance spectroscopy*
- 10:15 – 10:45 Coffee break**
- 10:45 – 11:00 *Isabel Prater (Chair of Soil Science, TU Munich), F. Hrbacek, L.A. Meier, C. Braun, D. Nyvlt, C.W. Mueller – Vegetation patches determine the fate of soil organic matter on islands in maritime Antarctica*
- 11:00 – 11:15 *Vyacheslav Polyakov (Department of Applied Ecology, Faculty of Biology, St. Petersburg State University), K. Orlova, E. Abakumov – Soil humic substances of selected soils of Lena Delta River landscapes: elemental and molecular composition*
- 11:15 – 11:30 *Tim Eckhardt (Institute of Soil Science / University of Hamburg), C. Knoblauch, L. Kutzbach, G. Simpson, E.-M. Pfeiffer – Partitioning growing season net ecosystem exchange of CO<sub>2</sub> into photosynthesis, autotrophic and heterotrophic respiration in the Siberian tundra*

### Atmosphere and Ocean

Conveners: *Günther Heinemann, Andreas Preußner*

- 11:30 – 11:45 *Hartmut H. Hellmer (Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research), T. Hattermann, S. Ryan, M. Schröder – The Filchner Trough / Filchner Ice Shelf cavity system*

- 11:45 – 12:00 *Maren Richter (Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research), W.-J. von Appen, C. Wekerle* – On the Formation of the East Greenland Current in Fram Strait
- 12:00 – 12:15 *Stefanie Arndt (Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research), N. Stoll, S. Paul, C. Haas* – Vertical snow structures from in-situ and remote sensing measurements
- 12:15 – 12:30 *Aliaksandra Kazlova (University of Bremen), G. Spreen* – Changes in sea ice deformation and impact of wind forcing
- 12:30 – 13:30 Lunch**

**DFG SPP 1158 Antarctic Research**

Response to Environmental Change

*Convener: Bank Beszteri*

- 13:30 – 14:00 *Daniel R. Dietrich (University of Constance, Human and Environmental Toxicology)* – Does environmental change affect polar microbial communities?
- 14:00 – 14:15 *Christian Bock (Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research), F.C. Wermter, B. Maus, H.-O. Pörtner, W. Dreher* – In vivo observations of OWA induced pH changes in the brain of polar cod *Boreogadus saida*
- 14:15 – 14:30 *Nadja D. Kuepper (Justus Liebig University of Giessen / Department of Animal Ecology & Systematics), C. Marek, N. Coria, M. Nabte, M. Libertelli, P. Quillfeldt* – Torpor and its consequences in developing Antarctic storm petrel chicks
- 14:30 – 14:45 *Burkhard Becker (University of Cologne), B. Büdel, U. Karsten* – Biological soil crust algae in the polar regions – biodiversity, genetic diversity and ecosystem resilience under global change scenarios
- 14:45 – 15:00 *Lars Arne Meier (University of Tübingen), P. Krauze, I. Prater, T. Scholten, D. Wagner, C.W. Mueller, P. Kühn* – How does climate change affect soils and their microbial communities on James Ross Island, maritime Antarctica? Results from an Environmental Simulation Experiment
- 15:00 – 15:15 *Matthew Toohey (GEOMAR Helmholtz Centre for Ocean Research Kiel), M. Sigl* – Using polar ice cores to unveil the connections between global volcanism and climate variability
- 15:15 – 15:30 *Thomas A. Ronge (Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research), W. Geibert, J. Lippold, F. Lamy, B. Schnetger, M. Prange, R. Tiedemann* – Climate, CO<sub>2</sub> and ice sheets – A southern ocean perspective

15:30 – 16:00

**Coffee break**

Dynamics of Climate System Components

*Convener: Silvia Henning*

16:00 – 16:30

*R. Reese, G.H. Gudmundsson, A. Levermann, Ricarda Winkelmann (Potsdam Institute for Climate Impact Research) – The far reach of ice-shelf thinning in Antarctica*

16:30 – 16:45

*Rolf Zentek (Environmental Meteorology, University of Trier), G. Heinemann – Verification of the regional atmospheric model CCLM with measurements in the Antarctic*

16:45 – 17:00

*Tim Carlsen (Leipzig Institute for Meteorology, Leipzig University), G. Birnbaum, A. Ehrlich, M. Schäfer, M. Wendisch – Parameterization of snow BRDF measurements in Antarctica*

17:00 – 17:15

*Mara Muchow (Institute of Oceanography, University of Hamburg), L. Kaleschke – Towards a lead width distribution for Antarctic sea ice: a case study for the Weddell Sea with high resolution Sentinel-2 images*

17:15 – 17:30

*Falk Pätzold (Institute of Flight Guidance, TU Brunswick), T. Krüger, K. Bärfuss, B. Altstädter, S. Nowak, E. Damm, J. Verdugo, A. Lampert – Achievements in project ALICE - Airborne tool for methane Isotopic Composition and polar meteorological Experiments*

17:30 – 17:45

*C. Melsheimer, Gunnar Spreen (University of Bremen, Institute of Environmental Physics), Y. Ye, M. Shokr – Sea ice type distribution in the Antarctic from microwave satellite observations*

17:45 – 18:00

*Günther Heinemann (Environmental Meteorology, University of Trier), R. Zentek, L. Stulic, R. Timmermann, S. Paul, A. Preußner – Sea-ice production in the Weddell Sea by numerical simulation and remote sensing*

19:00 – 22:00

**Dinner at the restaurant „Alter Fritz“**  
(sponsored by the Beer Manufacture Störtebeker)

### Wednesday, 28 March 2018

08:00 – 08:15

Registration

Gateways to Lower Latitudes

*Convener: Florian Leese*

08:30 – 09:00

*Oliver Huhn (Institute of Environmental Physics (IUP), Dept. Oceanography, University of Bremen), T. Hattermann, P.E.D. Davis, E. Dunker, H.H. Hellmer, S. Østerhus, M. Rhein, M. Schröder, J. Sültenfuß, K.W. Nicholls – Melting, re-freezing and subglacial runoff*

- beneath Filchner-Ronne Ice Shelf from first noble gas measurements inside an ice shelf cavity
- 09:00 – 09:15 *Svetlana Losa (Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research), M. Soppa, M. Losch, J. Oelker, T. Dinter, S. Dutkiewicz, A. Richter, V. Rozanov, J.P. Burrows, A. Bracher* – The Antarctic phytoplankton diversity from space and by numerical modelling
- 09:15 – 09:30 *Charlotte Havermans (University of Bremen), W. Hagen, C. Held, H. Auel* – Predatory zooplankton on the move: likelihood of poleward range shifts and their consequences for Antarctic and Arctic food webs
- 09:30 – 09:45 *Jana S. Dömel (University of Duisburg-Essen, Aquatic Ecosystem Research), T.-H. Macher, L. Dietz, C. Mayer, R.R. Melzer, F. Leese* – Revealing the evolutionary history of Southern Ocean sea spiders using genome-wide SNP data
- 09:45 – 10:00 *N. Rybalka, J. Boy, R. Godoy, A. Tzvetkova, C. Roos, A. Noll, Thomas Friedl (Göttingen University, Department Experimental Phycology and Culture Collection of Algae, EPSAG)* – Microalgae communities in Antarctic soils: changes along soil developmental stages and testing for geographical distribution
- 10:00 – 10:15 *Elisa Lagostina (Senckenberg Nature Research Society), M. Scur, A. Lorenz, M. Andreev, V. Friedrichs, F. Dal Grande, C. Printzen* – Fine-scale genetic structure of lichen populations in Patagonia and Maritime Antarctic
- 10:15 – 10:45**      **Coffee break**
- Development of the Continent  
*Convener: Sonja Berg*
- 10:45 – 11:15 *Benjamin Bomfleur (Palaeobotany Research Group, University of Münster)* – A journey into the Triassic polar forests of Antarctica
- 11:15 – 11:30 *Maximilian Zundel (University of Bremen), C. Spiegel, I. Dunkl, A.M. Grunow, F. Lisker* – Tectonic and topographic development of the Elephant Island group, West Antarctica
- 11:30– 11:45 *Martina Menneken (Freie Universität Berlin, Mineralogy-Petrology), T. John, A. Läufer, J. Berndt, J. Giese, M. Whitehouse* – Timing of subduction of the Palaeo-Pacific Ocean in northern Victoria Land (Antarctica) inferred from zircon U-Pb ages
- 11:45 – 12:00 *R. Dziadek, Karsten Gohl (Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research), F. Ferraccioli, N. Kaul, C. Spiegel* – Geothermal heat flux derived from airborne magnetic grids and measured temperature gradients in the Amundsen Sea sector of West Antarctica

- 2:00 – 12:15 *Theresa Schaller (TU Dresden), M. Scheinert, R. Pail, P. Zingerle, P. Abrykosov – The gravity field in Antarctica: geodetic modelling and geophysical inversion*
- 12:15 – 12:30 *Peter Busch (Institute of Planetary Geodesy, TU Dresden), M. Scheinert, C. Knöfel, L. Eberlein, M. Horwath, L. Schröder, A. Groh – Geodetic GNSS measurements to investigate the recent crustal deformation at the Antarctic Peninsula and in the Amundsen Sea Embayment, West Antarctica*
- 12:30 – 13:30 **Lunch**

### **Atmosphere and Ocean**

*Conveners: Günther Heinemann, Andreas Preußner*

- 13:30 – 13:45 *Andreas Preußner (Environmental Meteorology, University of Trier), S. Willmes, K.I. Ohshima, G. Heinemann – Thin-ice thicknesses and ice production in Arctic polynyas between 2002 and 2017 as derived from thermal infrared and passive microwave remote sensing data*
- 13:45 – 14:00 *Arantxa Triana (University of Bremen), G. Heygster, C. Melsheimer, G. Spreen – Arctic-wide Total Water Vapour time series combining two passive microwave satellite algorithms*
- 14:00 – 14:15 *Svenja H.E. Kohnemann (Environmental Meteorology, University of Trier), G. Heinemann, D.H. Bromwich, O. Gutjahr – Extreme changes in Arctic winter warming since the beginning of the 21st century*
- 14:15 – 14:30 *Tymon Zieliński (Institute of Oceanology Polish Academy of Sciences), P. Pakszys, T. Petelski, P. Makuch, M. Cisek, P. Markuszewski, C. Ritter, R. Neuber, M. Mazzola, R. Traversi, M. Posyniak, K. Dziembor, K. Zieliński – Is the Arctic subject to increasing environmental stress in the summer season?*
- 14:30 – 14:45 *Piotr Markuszewski (Institute of Oceanology), T. Petelski, P. Makuch, I. Wróbel, T. Zieliński, J. Piskozub, V. Drozdowska, P. Pakszys – Marine aerosol fluxes: measurements comparison between North Atlantic and the Baltic Sea region*

### **Climate History at the Poles**

*Conveners: Heidemarie Kassens, Nicola Koglin*

- 14:45 – 15:00 *Martin Melles (University of Cologne), A. Andreev, M. Baumer, D. Bolshiyarov, G. Fedorov, L. Frolova, R. Gromig, H. Hafliadason, S. Krastel, E. Lebas, A. Ludikova, H. Meyer, L. Nazarova, L. Pestryakova, L. Savelieva, L. Shumilovskikh, D.A. Subetto, J.I. Svendsen, B.*

- Wagner, V. Wennrich, M. Werner* – The project PLOT (Paleolimnological Transect) – overview and preliminary results on the preglacial to postglacial history of the Russian Arctic
- 15:00 – 15:15 *Ekaterina Taldenkova (Lomonosov Moscow State University, Geographical Faculty), H.A. Bauch, R.F. Spielhagen, Ya. Ovsepyan, N. Chistyakova, A. Stepanova, S. Nikolaev, M. Segl* – Past environmental variability of the Laptev Sea continental margin and Atlantic water advection to the Arctic during the last c.18 cal. kyrs
- 15:15 – 15:30 *Bernhard Diekmann (Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research), R. Wang, H. Kühn, R. Gersonde, R. Tiedemann, G. Kuhn* – Land-Ocean interactions in the late glacial Bering Sea
- 15:30 – 16:00 Coffee break**
- 16:00 – 16:45 Short presentations of posters (chairpersons H. Kassens, G. Heine-  
mann)
- 16:45 – 18:00 Poster session (Atrium ITMZ)
- 18:00 – 20:00 Meetings of the DGP working groups (Arbeitskreise)**  
Physik-Hörsäle 1, 2, 3; Physik-Seminarräume 1, 2, 3

#### Thursday, 29 March 2018

- 08:00 – 08:15 Registration

#### Climate History at the Poles

*Conveners: Heidemarie Kassens, Nicola Koglin*

- 08:30 – 08:45 *Zhihua Chen (Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research), M. Ju, S. Ge, Z. Tang, Y. Huang, R. Zhao, R. Tiedemann, L. Lembke-Jene* – Retreats of ice sheet and ice shelf driven by warm water incursions in the Ross Sea since the Last Glacial Maximum
- 08:45 – 09:00 *Johann P. Klages (Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research), G. Kuhn, C.-D. Hillenbrand, J.A. Smith, F.O. Nitsche, T. Frederichs, K. Grohl, L. Wacker* – Did we find an ice-proximal location in the Amundsen Sea to finally reveal the last interglacial state of the West Antarctic Ice Sheet?
- 09:00 – 09:15 *Michael E. Weber (University of Bonn), C.J. Fogwill, M. DeCesare, N.R. Golledge, N. Gomez, P.U. Clark* – Deglacial dynamics of the Antarctic Ice Sheet revised – Implications for future sea-level rise

- 09:15 – 09:30 *Sonja Berg (University of Cologne), M. Melles, W.-D. Hermichen, J. Rethemeyer, G. Kuhn* – Environmental conditions in terrestrial East Antarctica during the last glacial – new evidence from mumiyo deposits
- 09:30 – 09:45 *Svetlana Grigoreva (Saint Petersburg State University), A. Boronina, A. Sukhanova, S. Popov, M. Kashkevich, V. Kashkevich, V. Martianov, V. Lukin* – Subglacial flood investigations at the Dâlk glacier area, Larsemann Hills, East Antarctica, on the data collected in 2017/2018 field season
- 09:45 – 10:00 *Anastasiia Sukhanova (Saint Petersburg State University), S. Grigoreva, A. Boronina, S. Popov, M. Kashkevich, V. Kashkevich, V. Martianov, V. Lukin* – Geophysical survey for safety reasons at the Progress-Vostok logistic traverse, East Antarctica

### **Geodynamic Processes**

*Conveners: Detlef Damaske and Agnes Dakota Wansing*

- 10:00 – 10:15 *Reinhard Dietrich (TU Dresden, Institute of Planetary Geodesy), A. Richter, E. Ivins, H. Lange, L. Mendoza, L. Schröder, J.L. Hormaechea, G. Casassa, E. Marderwald, M. Fritsche, R. Perdomo, M. Horwath* – Rapid glacial isostatic uplift in Patagonia: Interplay of enhanced ice mass loss and slab window tectonics
- 10:15 – 10:45 Coffee break**
- 10:45 – 11:00 *Gerhard Kuhn (Alfred-Wegener-Institut Helmholtz Centre for Polar and Marine Research), O. Eisen, C. Gaedicke, N. Koglin, A. Läufer, D. Franke, C. Hofstede, B. Biskaborn, E. Smith, R. Tiedemann, F. Wilhelms* – Pre-site survey for deep geological drilling below Ekström Ice Shelf (Sub-EIS-Obs), Antarctica
- 11:00 – 11:15 *Joachim Jacobs (Department of Earth Science, University of Bergen), A. Läufer, M. Elburg, D. Damaske, A. Ruppel, G. Eagles, B. Opås, W. Jokat, S. Estrada* – Geodynamic evolution of East Antarctica revealed by integrating geology and geophysics in Dronning Maud Land
- 11:15 – 11:30 *Wilfried Jokat (Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research), T. Altenbernd, W. Geissler, G. Eagles* – India-Antarctic breakup: Constraints from new geophysical data
- 11:30 – 11:45 *Folker Pappa (Christian Albrechts University Kiel), J. Ebbing, F. Ferraccioli, W. van der Wal, B. Blank* – A 3d integrated lithospheric model of Antarctica and its impact on GIA estimates
- 11:45 – 12:00 *Nikola Koglin (Federal Institute for Geosciences and Natural Resources (BGR)), K. Piepjohn* – The Kulutingwak Formation – evidence for oceanic crust between Pearya and the Franklinian basin (Ellesmere Island, Canada)?



**Mass Balance and Dynamics of Glacier Systems**

*Conveners: Johannes Fürst, Clemens Schannwell*

- 12:00 – 12:15 *Clemens Schannwell (University of Tübingen), N.E. Barrand, S.L. Cornford, D. Pollard – Dynamic response of Antarctic Peninsula Ice Sheet to collapse of Larsen C and George VI ice shelves*
- 12:15 – 12:30 *A. Richter, Mirko Scheinert (TU Dresden), S.V. Popov, A.A. Ekaykin, L. Schröder, M. Horwath, R. Dietrich, V.V. Lukin – Subglacial Lake Vostok: Combination and application of GNSS observations and satellite altimetry data*
- 12:30 – 13:30 Lunch**
- 13:30 – 13:45 *Johannes J. Fürst (Institute of Geography, University of Erlangen-Nuremberg), F. Navarro, F. Gillet-Chaulet, G. Moholdt, X. Fettweis, C. Lang, T. Seehaus, M.H. Braun, D.I. Benn, T.J. Benham, J.A. Dowdeswell, M. Grabiec, J. Kohler, K. Lindbäck, R. Pettersson, H. Sevestre – The ice-free topography of Svalbard*
- 13:45 – 14:00 *Christoph Mayer (Bavarian Academy of Sciences and Humanities), J. Schaffer, T. Hattermann, D. Floricioiu, L. Krieger, P.A. Dodd, T. Kanzow – Large ice loss variability during the last two decades at Nioghalvfjerd-sjorden Glacier, NE-Greenland*
- 14:00 – 14:15 *Wilfried Korth (Beuth University of Applied Sciences Berlin), T. Hitziger, U. Hofmann, K. Pavelka – Monitoring of surface ice height changes in Greenland*
- 14:15 – 15:30 Meeting of the members of the DGP**
- 15:30 – 16:00 Coffee break**
- 16:00 – 16:30 Meeting of the members of the DGP**

**Friday, 30 March 2018**

- 08:30 Excursions

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## CHARACTERIZATION OF SOIL ORGANIC MATTER OF ARCTIC AND ANTARCTIC BY <sup>13</sup>-C NMR AND ELECTRON SPIN RESONANCE SPECTROSCOPY

Evgeny Abakumov

Department of Applied Ecology, Faculty  
of Biology, Saint-Petersburg State  
University, Russia

Soils of Antarctica and Arctic considered as under investigated in terms of soils organic matter (SOM) pools, organic remnants humification/mineralization rates and biogenic-abiogenic interactions. Relatively sparse vegetation cover and short period of biological soil activity result in low humification rates and accumulation of high portion of slightly decomposed organic matter in the fine earth. Numerous investigations were devoted to characterization of SOM content and profile distribution. Only few attempts were done for characterization of SOM composition with use of precise spectroscopy methods. In this study, we investigated humic substances, isolated from various soil of Arctic and Antarctic with <sup>13</sup>-C NMR and electron spin resonance spectroscopy. It was shown, that humic acids of Antarctic soils, formed under various organic materials characterises by decreased portion of aromatic compounds in comparison with Arctic soils. At the same time all the humic substances of numerous polar soils investigated showed the predominance of the aliphatic compounds on aromatic ones. The degree of aromaticity in Antarctic soils is closely connected with the presence and portion of the remnants of *Deshampsia antarctica* in the material of humification precursors. The components of these remnants play an important role as precursor of humification which contents lignin-derived compounds. Data obtained were different from those for soils, formed under mono species bryophyte or lichens communities. There were no essential variation of carboxylic and aliphatic groups content which indicated that functional activity of all investigated humic substances is equal. Diversity of organic precursors is essentially higher in soils of the Arctic, that is why degree of aromaticity of humic substances was higher as well as diversity of carbon species, indicated in spectras of solid state <sup>13</sup>-C NMR. We can conclude that average portion of aromatic type of carbon species in the molecules of humic acids, isolated form Antarctic soil is about 18-25 %. At the same time, main Arctic soil types demonstrate increased values of this index: 20-35 %. Spectroscopy of electron spin resonance indicated that humic acids of suprapermafrost organic soil horizons have lesser free unpaired radical content than organic matter of superficial layers. Also there were increasing of aromaticity degree in humic acids of suprapermafrost horizons of both Antarctic and Arctic soils in comparison with topsoil organic matter. Data obtained show that huge storages of SOM in polar soils are not well stabilized and could be faced to fast degradation in scenarios of rapid climate change.

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## **DEVELOPMENT OF PHOSPHORUS FORMS IN SOIL CHRONOSEQUENCE OF THE NORDENSKIOLDBREEN GLACIER (SVALBARD)**

Adel Allaberdina, Václav Tejnecký

Czech University of Life Sciences  
Prague

Nordenskioldbreen is located between Dickson Land and Bunsow Land. The glacier flows roughly southwestwards and is 25 km (16 mi) long and 11 km (6.8 mi) wide. It has its terminus in Adolfsbukta, a branch of Billefjorden.

After the expedition to the glacier in 2015, soil samples were brought to the Czech University of Life Sciences Prague. We have 42 samples from the south and north of the glacier. With each of them we worked in the laboratory during several months, made a filtration and with the help of robotics got the complete chemical composition of each samples.

At our work we determined the amount of P-form and other soil properties in soils after the Nordenskioldbreen glacier (Svalbard).

The soil properties after the retreat of the Nordenskioldbreen glacier vary with the age of the soil. The amount of accessible P decreases with the age of the soil and the amount of crystalline Fe forms increases. All results of the study are presented in spreadsheet format.

## VERTICAL SNOW STRUCTURES FROM IN-SITU AND REMOTE SENSING MEASUREMENTS

Stefanie Arndt, Nicolas Stoll, Stephan Paul, Christian Haas

Alfred-Wegener-Institut  
Helmholtz-Zentrum für Polar- und  
Meeresforschung

Snow on sea ice alters the properties of the underlying ice cover as well as associated exchange processes at the interfaces between atmosphere, sea ice, and ocean. As Antarctic snow cover persists during most of the year, it contributes significantly to the sea-ice mass budget due to comprehensive physical (seasonal) transition processes within the snowpack. It is therefore necessary to locate and quantify internal snowmelt, snow metamorphism, and snow-ice formation in the Antarctic snowpack on different spatial scales.

Doing so, we present here, on the one hand, *in-situ* observations of physical snow properties from point measurements and transect lines during recent expeditions in the Weddell Sea from 2013 to 2018, covering summer and winter conditions. On the other hand, we used passive microwave (19 and 37 GHz signal frequency) as well as scatterometer observations (5.6 and 13.4 GHz signal frequency) to describe snowmelt processes on Antarctic-wide scales. As different signal frequencies result in different penetration depths, we hypothesize that the different sensors respond to snow melt processes in different depths within the snow cover. The observed differences are consistent with the effects of short- and longwave radiation transmission and absorption, and the related occurrence of strong snow metamorphism, internal snow melt, and superimposed ice formation known to be important on Antarctic sea ice.

Results of the study will improve our understanding on processes and interactions in the snowpack as well as at the snow/ice interface associated with seasonal and inter-annual variations in the sea-ice energy and mass budgets of the Southern Ocean.

## PHENOLOGY OF CALANUS GLACIALIS – COMPARISON BETWEEN ARCTIC AND ATLANTIC DOMAINS AND ITS IMPLICATIONS FOR REPRODUCTIVE SUCCESS OF LITTLE AUKS

Kaja Balazy, Emilia Trudnowska,  
Katarzyna Blachowiak-Samolyk

Institute of Oceanology Polish Academy  
of Sciences

Climate changes can negatively affect the predator-prey interactions, especially in the Arctic, which is warming faster than other regions in the world. In addition, the quality of seabirds' diet and their survival is affected not only by abundance of their prey but also by timing of its occurrence. The aim of the study was to investigate the copepodite structure of *Calanus glacialis* during summer season in the context of the food requirement of the little auk *Alle alle* - the key seabird species in the Arctic ecosystem during chick rearing period. The zooplankton research was conducted in the regions, where the largest foraging grounds for the little auk in Spitsbergen are located, i.e. nearby Hornsund fjord, characterized by the dominance of cold Arctic waters and at another potential foraging ground located nearby Kongsfjord, which is strongly influenced by warmer Atlantic waters. Samples were collected from the upper 50 m water layer using WP2 net with 180 µm mesh size in the first weeks of the chick's life three times during summer season simultaneously in two fjords (Hornsund and Kongsfjord) in 2015 in order to compare the phenology of this cold-water copepod in favorable conditions for its development (Hornsund) and in less-favorable conditions (Kongsfjord). The studies showed a clear development cycle of the copepods with the dominance of the early copepodite stages at the beginning of July and later stages at the turn of July and August. In addition, earlier development of *Calanus glacialis*, concluded from the dominance of later copepodite stages, was observed in Kongsfjord compared to Hornsund. The research results indicate faster development of *C. glacialis* in warmer waters of Atlantic origin, which may cause the shift in food availability with the maximum energy demands of the little auk during chick rearing period along with the progressing warming.

## RESPONSE OF SOUTHERN TUNDRA ECOSYSTEM COMPONENTS ON AERIAL POLLUTION FROM GAS PRE-TREATMENT CENTERS IN WEST SIBERIA

Pavel A. Barsukov

Institute of Soil Science and  
Agrochemistry, Novosibirsk, Russia

Influence of aerial pollutants on ecosystem components was carried out in southern tundra of Tazovskiy peninsula, West Siberia. It was clear prior this study that the pollution in the observed gas industry impacted area is not severe. In order to estimate an influence of such relatively “soft” pollution the index of pollutants load per unite area ( $I_p$ ) was developed. It represents integrated coefficient of pollutants’ deposition (derived from gas pre-treatment centers) that depends on a distance from a source of pollution and a wind direction.

The obtained results didn’t show significant influence of pollutants load level on alterations of (1) high vascular plant biodiversity (species composition and their ability), (2) chemical properties of upper layer (0-30 cm) of soils, (3) emission rates of CO<sub>2</sub> and CH<sub>4</sub> from the soils studied.

However, it was possible to find the following changes in abiotic and biotic tundra ecosystem components.

(A) Chemical composition of surface water of ponds / lakes. Increased index of pollutants’ load positively correlated with concentration of nitrate in water ( $R = 0.50$ ), sulphate ( $R = 0.68$ ), iron ( $R = 0.53$ ) and lithium ( $R = 0.48$ ), but negatively correlated with ammonium ( $R = -0.52$ ).

(B) Chemical composition of upper layer (0-20 cm) of bottom sediments in ponds / lakes. Increase of pollutants’ load led to increase of magnesium ( $R = 0.49$ ) and chromium ( $R = 0.51$ ).

(C) Chemical composition of two selected plant species, lichen *Alectoria ochroleuca* and dwarf shrub *Betula nana* (leaves and stems were analyzed separately). These species were utilized as indicator / diagnostic tools on the base of previous research. Correlation analysis of the elemental composition of the plants with  $I_p$  allowed to establish that increase of pollutants’ load is accompanied by higher chromium content in the lichen *Alectoria ochroleuca* ( $R = 0.78$ ) content of phosphorus ( $R = 0.58$ ), copper ( $R = 0.86$ ) and nickel ( $R=0.84$ ) in the leaves of the dwarf birch content of phosphorus ( $R = 0.70$ ) in the branches of the dwarf birch.

(D) Community of oribatid mites in the studied soil of southern tundra ecosystems. The ratio’s change of two ecological groups of the oribatid mites under influence of pollution is more pronounced than their total abundance. It was found that the best characteristic of pollution’s bioindication is the ratio of litter-topsoil oribatid mites (L) to euedaphic ones (S). Very simple equation with significantly high determination coefficient was obtained to describe this dependence:  $Ration(L/S) = 4.84 \ln(I_p)$ .

## SOIL-ECOLOGICAL EXCURSIONS TO PERMAFROST-AFFECTED AREAS IN WEST SIBERIA FOR EUROPEAN SCIENTISTS AND STUDENTS

Pavel A. Barsukov<sup>1</sup>, S. Platonova<sup>2</sup>,  
S. Gizhitskaya<sup>3</sup>, E. Smolentseva<sup>1</sup>,  
N. Lashchinskiy<sup>4</sup>, A. Babenko<sup>5</sup>,  
I. Lyubechanskiy<sup>6</sup>, O. Saprykin<sup>1</sup>,  
O. Rusalimova<sup>1</sup> Christian Siewert<sup>7</sup>

<sup>1</sup> Institute of Soil Sciences and  
Agrochemistry, Novosibirsk, Russia

<sup>2</sup> Institute of Water and Environmental  
Problems, Barnaul, Russia

<sup>3</sup> Novosibirsk State Pedagogical  
University, Novosibirsk, Russia

<sup>4</sup> Central Siberian Botanical Garden,  
Novosibirsk, Russia

<sup>5</sup> Tomsk State University, Tomsk, Russia

<sup>6</sup> Institute of Systematics and Ecology of  
Animals, Novosibirsk, Russia

<sup>7</sup> Dresden University of Applied  
Sciences, Dresden, Germany

Since 1995, soil-ecological excursions / field courses across climatic zones in West Siberia and West Mongolia have been organized by Siberian and German scientists to meet growing demands for better land use practices. The primary goal of the excursion was to demonstrate the various undisturbed (by human activity) inter-relationships between abiotic and biotic ecosystem components under conditions of continental climate, seasonal frost and permafrost. Nowadays, although the focus of the excursion is still soil formation processes and ecosystem succession, however we pay more attention on the influence of current climate change on the studied issues and on discovering possible ways of its mitigation in the aspect of the rational use of soil and ecosystems for keeping soil health and achieving sustainable development of man-made ecosystems.

Currently, three excursion programs and routes are well developed. The first one covers all latitudinal bioclimatic zones from the taiga to the steppe on the West Siberian Plain and all altitudinal belts from the tundra to the semi-desert in the Altai Mountains region. The second one starts from the forest steppe zone of the West Siberian Plain and goes to the south to West Mongolia through the Russian Altai where most of the glaciers and permafrost ground of this region are located. The third one starts from the steppe of the West Siberian Plain and goes almost directly to the north up to southern tundra of Tazovskiy peninsula (behind the Arctic Circle).

The active development of the excursions enables us to include new areas of increasing interest, to collect data about the region that are only rarely available in English, and to apply basic research in soil and vegetation sciences to such applications as global ecological problems and environmental protection.

## **FREEZING AND HUNGRY? HYDROCARBON DEGRADING MICROBIAL COMMUNITIES IN BARENTS SEA SEDIMENTS AROUND SVALBARD**

Bartholomäus Sven, Nontje Straaten,  
Daniela Zoch, Martin Krüger

Bundesanstalt für Geowissenschaften  
und Rohstoffe

The Polar Regions are characterised by varying temperatures and changing ice coverage, so most of the primary production take place in the warmer season. Consequently, sedimentation rates and nutrient input are low. The diversity and metabolic potentials of the microbial communities inhabiting these sediments in the Northern Barents Sea are largely unknown. Recent reports on natural methane seeps as well as the increase in hydrocarbon exploration activities in the Arctic initiated our studies on the potential of indigenous microbial communities to degrade methane and higher hydrocarbons under *in-situ* pressure and temperature conditions. Furthermore, the subseafloor geochemistry in these areas was studied, together with important microbial groups, like methanotrophs, methanogens, metal and sulfate reducers, which may drive seafloor ecosystems in the Northern Barents Sea.

Sediment samples were collected in several areas around Svalbard in the years 2013-2016 including coastal sediments from Isfjorden, shallow (2-400m) areas on the Svalbard shelf to deep sea areas on the eastern Yermak Plateau (3200m water depths). Shelf sediments showed the highest organic carbon content which decreased with increasing depths. Iron and manganese as potential electron acceptors were found in the porewater especially in the top 50 cm of the cores, while sulfate was always present in substantial amounts in porewater samples down to the end of the up to two metre long cores. Concentrations of dissolved methane and carbon dioxide were low.

The potential of the indigenous microorganisms to degrade methane and higher hydrocarbons as well as different oils under *in-situ* temperatures and pressures was widespread in surface sediments. Degradation rates were higher under aerobic than under anaerobic conditions, and decreased with increasing sediment as well as water depths. Similar pattern were found for other metabolic processes, including sulfate, Fe and Mn reduction as well as carbon dioxide and methane production rates. Ongoing molecular biological analyses of original sediments and enrichment cultures indicate the presence of diverse and varying microbial communities.

## **BIOLOGICAL SOIL CRUST ALGAE IN THE POLAR REGIONS – BIODIVERSITY, GENETIC DIVERSITY AND ECOSYSTEM RESILIENCE UNDER GLOBAL CHANGE SCENARIOS**

Burkhard Becker <sup>1</sup>, Burkhard Büdel <sup>2</sup>  
and Ulf Karsten <sup>3</sup>

<sup>1</sup> University of Cologne, Germany

<sup>2</sup> University of Kaiserslautern, Germany

<sup>3</sup> University of Rostock, Germany

Terrestrial green algae and cyanobacteria are typical and abundant components of biological soil crusts in the polar regions. These communities form water-stable aggregates that important ecological roles in primary production, nitrogen fixation, nutrient cycling, water retention and stabilization of soils. Although available data on green algae and cyanobacteria are generally very limited for the Arctic and Antarctica, their functional importance as ecosystem developers in nutrient poor environments is regarded as high. Therefore, the main goal of the interdisciplinary project is, for the first time, a precise evaluation of their 1.) biodiversity as well as of 2.) the infra-specific genetic diversity, 3.) ecophysiological performance and 4.) transcriptomics of the most abundant taxa in biological soil crusts isolated from the Antarctic Peninsula and Arctic Svalbard. Biodiversity was investigated using a classical culture approach in combination with molecular-taxonomical methods as well as with metagenomics. The infra-specific genetic diversity of the most abundant green algae and cyanobacteria was studied using fingerprinting techniques, and a range of selected populations characterised in relation to their physiological plasticity. Temperature and water availability, two key environmental factors for terrestrial organisms, are currently changing in polar regions due to global warming, and hence their effect on growth and photosynthesis response patterns was comparatively investigated.



## **UDASH - UNIFIED DATABASE FOR ARCTIC AND SUBARCTIC HYDROGRAPHY**

Axel Behrendt, Hiroshi Sumata, Benjamin  
Rabe, Torsten Kanzow and Ursula  
Schauer

Alfred-Wegener-Institut  
Helmholtz-Zentrum für Polar- und  
Meeresforschung

UDASH is a unified and high-quality temperature and salinity data set for the Arctic Ocean and the subpolar seas north of 65° N for the period 1980-2015. The archive aims at including all publicly available data and so far consists of 288 532 oceanographic profiles measured mainly with conductivity/temperature/depth (CTD) probes, bottles, mechanical thermographs and expendable thermographs. The data were collected by ships, ice-tethered profilers, profiling floats and other platforms. To achieve a uniform quality level, suitable for a wide range of oceanographic analyses, approximately 74 million single measurements of temperature and salinity were thoroughly quality-checked. Data outliers, suspicious gradients and other suspect data were flagged for quick identification. The final archive provides a simple way of accessing most of the available temperature and salinity data for the Arctic Mediterranean Sea and represents a unique tool to study long-term changes on a larger scale.

## COMPOUND-SPECIFIC RADIOCARBON CONSTRAINTS ON ANTARCTIC SEDIMENT CHRONOLOGIES

Sonja Berg, Sandra Jivcov, Janet  
Rethemeyer

University of Cologne

Information on past climate and ice sheet evolution of Antarctica can only be obtained from records with good age control. Radiocarbon analysis is the most common method of age determination of Late Pleistocene and Holocene (<55000 years) sediment records. In the absence of carbonaceous fossils radiocarbon dating is often carried out on total organic carbon of sediments, which leads to large uncertainties in age models due to considerable reservoir effects and incorporation of re-deposited older sediments.

We apply compound-specific radiocarbon analysis (CSRA) to marine sediments from different locations in the Antarctic and Sub-Antarctic to provide an improved age assignment for these records. Purification and isolation of lipid compounds was achieved by preparative gas chromatography. The <sup>14</sup>C-analysis of the small samples (25-70 µg carbon) is conducted from CO<sub>2</sub> by a MICADAS. Targets for CSRA are short-chain fatty acids, which are mainly provided by biogenic production, e.g. by diatoms, in the marine environment, and represent the radiocarbon signal of surface waters during their formation.

Our results show that short-chain fatty acid ages are in agreement with total organic carbon ages in a setting with high productivity/good preservation of organic matter and low input of reworked carbon. At another site, which is strongly influenced by glacier input, total organic carbon ages reflect high proportions of reworked, likely fossil carbon. The <sup>14</sup>C-age of the short-chain fatty acids in the surface sediments, however, is within the range of the Antarctic marine reservoir age.

We suggest that CSRA has a great potential to improve Antarctic sediment chronologies, especially in settings where high proportions of re-worked fossil carbon lead to high total organic carbon ages, which do not represent the actual sedimentation age.

## ENVIRONMENTAL CONDITIONS IN TERRESTRIAL EAST ANTARCTICA DURING THE LAST GLACIAL - NEW EVIDENCE FROM MUMIYO DEPOSITS

Sonja Berg, Martin Melles, Wolf-Dieter Hermichen, Janet Rethemeyer, Gerhard Kuhn

University of Cologne

Little is known about the strategies of animals in Antarctica to sustain more extended ice sheets and sea ice coverage during glacial periods. Snow petrels (*Pagodroma nivea*), which are endemic to Antarctica, depend on the availability of un-glaciated land areas for breeding and on open waters or pack ice areas within day-flight distance for foraging to support their chicks. The distribution of snow petrel breeding locations in the past is recorded by stomach oil deposits, so-called mumiyo, which is ejected by the birds and forms centimetre to decimetre thick deposits in front of their nesting cavities. Radiocarbon ages of these deposits suggest that snow petrels occupied inland breeding sites in central Dronning Maud Land during the Last Glacial Maximum and before (Hiller et al., 1995). This finding has not only implications for local ice sheet reconstructions but also indicates the persistent existence of polynyas off Dronning Maud Land.

We conducted a detailed study on mumiyo deposits from different sites in central Dronning Maud Land to explore their potential as a paleoclimate archive. The internal layering of the mumiyo deposits can be interpreted as a temporal succession, since <sup>14</sup>C-ages consistently become younger in higher parts of the deposits. The material consists of organic compounds, which are mainly wax-ethers derived from stomach oil. It also contains changing proportions of mineral grains sourced from the surrounding bedrock and phosphates and urates derived from guano. High-resolution XRF elemental scans indicate that changes in inorganic composition are consistent within one deposit and likely reflect local environmental conditions.

Our data confirm the existence of un-glaciated areas during the Last Glacial Maximum (LGM) and extend the archive far into Marine Isotope Stage (MIS) 3, which is poorly understood in coastal Antarctica.

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## COLLECTION-BASED DIATOM RESEARCH: COLLECTION IMAGING TO BIOGEOGRAPHY AND MICROEVOLUTION IN THE SOUTHERN OCEAN

Bánk Beszteri, Stefan Pinkernell,  
Michael Kloster, Ute Postel, Gerhard  
Kauer, Uwe John, Klaus Valentin,  
Gernot Glöckner

Alfred-Wegener Institut  
Helmholtz Zentrum für Polar- und  
Meeresforschung

The Hustedt Diatom Study Centre is home of one of the largest diatom herbaria world-wide and has, for the last three decades, been part of the polar research institute AWI. In the last years, with substantial support from the DFG Priority Program Antarctic Research and through diverse collaborations made possible by this support, we have established a research program centered around this biodiversity resource and focusing upon Southern Ocean diatoms. The silica-shelled diatoms are the main primary producers of the Southern Ocean, important drivers of the biogeochemical cycles of silicon and carbon, and their siliceous remains in the underlying sediments represent a unique polar-subpolar climate archive. We explored novel ways of working with the Hustedt diatom collection and transforming it into an integrated physical and digital archive useful for addressing scientific questions relevant in the Southern Ocean system, from biogeography and climate change effects upon it through diatom life cycle, morphometric variability in a paleoceanographic context, to microevolutionary genomics. In this presentation, I will introduce these activities and highlight some of the methodological innovations (in particular, high throughput microscopy and image analysis for collection mobilization and diatom analyses) and scientific insights gained through them focusing on prognosed biogeographic shifts in the pelagic Southern Ocean and semi-cryptic microdiversity.

## IN VIVO OBSERVATIONS OF OWA INDUCED PH CHANGES IN THE BRAIN OF POLAR COD *BOREOGADUS SAIDA*

Christian Bock, Felizitas C. Wermter,  
Bastian Maus, Hans-O. Pörtner,  
Wolfgang Dreher

Alfred-Wegener-Institut  
Helmholtz-Zentrum für Polar- und  
Meeresforschung

Ocean warming and acidification (OWA) are believed to have the strongest effects in Polar regions, however, little is known about the impact of OWA on polar organisms. Recently, an OWA induced neurological impairment in the polar cod, *Boreogadus saida*, was observed under conditions as expected towards the end of this century (1). However, the mechanisms responsible for the observed disturbances of polar cod are not clear and need to be resolved. In vivo NMR techniques were extensively used to characterize the metabolic status or metabolic changes in the brain of animals and humans, including observations on changes of neurotransmitters as well as acid-base regulation. Therefore, we developed in vivo NMR techniques to study metabolic changes and acid-base regulation in the brain of polar cod under acute OWA conditions to identify the mechanisms involved in the observed neurological dysfunctions in this species.

The recently developed molecular chemical exchange saturation transfer (CEST) mechanism (2), which allows localized measurements of pH and metabolite concentration changes, was applied to study the impact of OWA on the brain of polar cod. In vivo localized NMR spectroscopy led to the detection of osmolytes such as myo-inositol and trimethylamine-N-oxide (TMAO), the neuronal marker n-acetyl aspartate (NAA), total creatine and major amino acids such as glycine, glutamate/glutamine and taurine in the brain. In vivo data obtained under different ocean acidification scenarios reflect significant changes in the CEST contrast indicating a CO<sub>2</sub> induced drop in intracellular pH in the brain of polar cod. Our results show an OWA induced disturbance in acid-base regulation and capacity in the brain of polar cod, that might be involved in the observed neurological dysfunctions of *B. saida* under OWA conditions.

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## A JOURNEY INTO THE TRIASSIC POLAR FORESTS OF ANTARCTICA

Benjamin Bomfleur

Palaeobotany Research Group  
Westfälische Wilhelms-Universität  
Muenster

Global climates vary throughout Earth History, and temperatures during the Phanerozoic were usually much warmer than they are today. In the Late Triassic greenhouse world, warm climatic conditions enabled forest vegetation to spread far into the Polar Regions of the southern supercontinent Gondwana. Exceptional plant-fossil deposits from the Triassic of Antarctica give detailed insights into the taxonomic composition and ecology of these past Polar forests – a type of ecosystem without modern analogue. The dominant plants in riparian forests and woodland environments belong to the *Corytospermales*, tall forest trees with a Ginkgo-like habit and with characteristic forked, fern-like fronds (*Dicroidium*). *Telemachus* conifers (*Voltziales*) were common sub-canopy elements, and also formed monotonous forest bogs in humid bottomland environments. Further trees and tall shrubs include a broad array of *Peltaspermales*, Ginkgophytes, and cycadophytes. The dark and damp forest understorey was colonized by a wide variety of ferns and fern allies, including mainly *Osmundaceae*, *Marattiales*, and *Gleicheniales*. Various independent lines of evidence indicate that all canopy and subcanopy plants were seasonally deciduous and entered dormancy to endure the long period of winter darkness. The *Petriellales* – a peculiar group of miniature seed plants – established a very different life-mode in this environment: they colonized the forest bottom layer and remained evergreen throughout Polar night. The high-latitude forests of warmer times in Earth History appear to play a significant role in plant evolution: there is mounting evidence that during major biotic crises, such high-latitude ecosystems acted as refugia for relict plant groups that had long disappeared elsewhere.

## LONG-TERM TIME-SERIES OF ARCTIC BRO DERIVED FROM UV-VIS SATELLITE REMOTE SENSING

lias Bougoudis, Anne-Marlene  
Blechsmidt, Andreas Richter, Sora  
Seo, John P. Burrows

Institute of Environmental Physics,  
University of Bremen

Halogens play a key role in the atmospheric composition of the Arctic. During polar spring, bromine is released from sea ice, and through an auto-catalytic chemical recycling process, known as BrO explosion, it depletes ozone, thereby altering the oxidizing capacity of the troposphere. Moreover, halogens oxidize gaseous elemental mercury, transforming it to a reactive form, which is then deposited in the ecosystem, where it is hazardous.

In this research effort, we are presenting results from retrieving a consistent long-term time-series of BrO (about two decades) over the Arctic region from multiple UV-VIS satellite instruments (GOME, SCIAMACHY, GOME-2A, GOME-2B, OMI), using the Differential Optical Absorption Spectroscopy method. Our primary goal is to investigate the impact of Arctic Amplification (the intensified warming observed in the Arctic, which is almost twice as large as the global average warming, compared to the 1951-1980 average) on the halogen abundance in the Arctic troposphere. Moreover, monthly maps of BrO during the polar spring months, when BrO explosion events occur, are displayed and compared. Our results show satisfactory agreement and consistency between the instruments used.

## THE EFFECT OF CLIMATE CHANGE ON THE CARBON BALANCE IN MICROALGAE

Deborah Bozzato, Torsten Jakob,  
Christian Wilhelm

University of Leipzig

The Southern Ocean is an important sink for the atmospheric CO<sub>2</sub> due to the physical and the biological (photosynthetic) activity of phytoplankton. Some studies have investigated the photosynthetic activity of the benthic and pelagic producers, but there is only very scarce knowledge about the carbon losses due to respiration of phytoplankton. The reason for this lack of information is principally methodological limitations. In the light of expected changes of environmental conditions due to the climate change, the aim of the project is to investigate the range of variability of photosynthesis over respiration ratio (rP/R) in response to different growth conditions, namely: different temperatures, water salinity and in dependence on iron availability. In this respect, two key species of the Southern ocean are investigated: the diatom *Fragilariopsis cylindrus* and the prymnesiophyte *Phaeocystis antarctica*.



## SPECIES COMPOSITION AND ABUNDANCE OF THE SHALLOW WATER FISH COMMUNITY OF KONGSFJORDEN, SVALBARD

Markus Brand, Philipp Fischer

Alfred-Wegener-Institut  
Helmholtz-Zentrum für Polar- und  
Meeresforschung

Recent projections suggest that climate change will lead to structural change in Arctic ecosystems. As one major impact, a significant depression of local species in conjunction with an intense species invasion of boreal species from Atlantic waters is discussed. Unfortunately, even though there are stock-abundance data available of the main commercially relevant fish species, only little information is available on the status and the temporal-spatial dynamics of the juvenile fish stocks. Those juveniles use the shallow water areas as habitat for food and shelter in their early development. Especially for the polar winter only little information is given on the shallow water fish community and the polar shallow water dynamics. The missing basic biological data about the Arctic shallow water fish community poses an immediate problem if it comes to the assessment of ecosystem change. Baseline studies in combination with future reassessments are needed to establish such a knowledge on the status quo of these communities and ecosystems. An exemplary multiyear assessment of the shallow water communities of Kongsfjorden (Svalbard) was conducted from 2012 to 2014. The fish assemblage in the depth range from 3 to 12 m was determined with respect to abundance and species composition at a total of 10 sampling sites by fyke net catches. One site at the settlement Ny-Ålesund was equipped with a cabled Underwater Observatory, to continuously assess the hydrography and biota year-round by remote operated sensors (RemOs). Using the catch and remote-sensor data, a baseline assessment of the hydrography, the fish and the macroinvertebrate community was done in the Kongsfjorden ecosystem. The fyke net catch data comprised a total sample size of 2804 fish specimens, representing 12 species and one family (Liparidae). *Myoxocephalus scorpius* and *Gadus morhua* were identified as the most abundant species across all sampling sites. Further, the age classes 0+, 1+, and 2+ represented more than 95 % of the total catch of *G. morhua*. Fish of age class 0+ were found in each sampling year with beginning of the month August. The additional absence of older specimen indicates a distinct use of the shallow water zone by certain ages classes of *G. morhua*.

## DECADAL CHANGES IN A BREEDING POPULATION OF SOUTHERN GIANT PETRELS ON KING GEORGE ISLAND, ANTARCTIC, IN RESPONSE TO HUMAN ACTIVITIES

Christina Braun, Jan Esefeld, Hans-Ulrich Peter

Institute of Ecology and Evolution,  
Friedrich Schiller University Jena

Antarctic terrestrial ecosystems are under increasing pressure from human impact. A paradigm of manifold human activities is the Fildes Region in the southwest of King George Island, Antarctic. The area hosts six Antarctic stations and an airstrip and hence represent a major logistic hub for the northern Antarctic Peninsula. Human activities range from logistic, science, tourism, environmental programs, delegations, etc. At the same time, the area is characterized by a high biodiversity with extensive vegetation as well as with bird and seals concentrations and reproduction sites. As a consequence, an exceptional high human pressure on the local fauna and flora can be stated. Data from a long-term seabird monitoring program (1979/80 – 2017/18) revealed the response of a highly susceptible seabird species, the southern giant petrel (SGP, *Macronectes giganteus*), toward human disturbance. The local SGP population in the Fildes Region consist of several hundreds of breeding pairs and shows large interannual fluctuations. Individual colonies had been considerably affected by the establishment of new Antarctic stations on SGP in the 1980s and subsequently had shown nest site shifts towards undisturbed areas. During the past 10 years, some SGP colonies showed decreasing breeding pair numbers and reduced breeding success. Here only colonies that were subject to extensive visits by station members in their leisure time were affected. In contrast, adjacent but rather unvisited colonies were stable or growing. As environmental conditions (e.g., predation by skuas, climatic conditions, food availability) would affect all colonies in the area equally, the new translocations of SGP breeding sites are only attributable to anthropogenic disturbance. Reoccupation of formerly abandoned nesting sites close to human infrastructure indicate habituation effect toward regular and predictable disturbance. But in these colonies, however, hardly any chick has been successfully raised to fledging. Consequently, in the past decades the local SGP population in the Fildes Region has negatively been affected by the anthropogenic activities. Recently, the total number of SGP shows an increase, presuming a reduction of human disturbance and habituation effects toward predictable and regular disturbance. Nevertheless, low breeding and further declining breeding success in the area is concerning and illustrate the need of effective measures to reduce the risk of anthropogenic pressure on the local SGP population further.

## GEODETIC GNSS MEASUREMENTS TO INVESTIGATE THE RECENT CRUSTAL DEFORMATION AT THE ANTARCTIC PENINSULA AND IN THE AMUNDSEN SEA EMBAYMENT, WEST ANTARCTICA

Peter Busch, Mirko Scheinert, Christoph Knöfel, Lutz Eberlein, Martin Horwath, Ludwig Schröder, Andreas Groh

Institut für Planetare Geodäsie,  
TU Dresden

Current ice-mass changes are of utmost interest as major sources of global sea-level change and, thus, as indicators of climate change. In Antarctica, the essential ice-mass loss can be observed for the West Antarctic Ice Sheet (WAIS), of which the Amundsen Sea sector and the Antarctic Peninsula exhibit the largest changes. There, first GNSS measurements were carried out during campaigns of the German Antarctic Project (GAP) in the region of the Antarctic Peninsula including Peter I. Island in 1995, 1996 and 1998. In 2016, during an expedition of the German research vessel *Polarstern*, we were able to reoccupy some of these GNSS sites. With more than 20 years these measurements comprise one of the longest time spans ever observed by GNSS in Antarctica. In contrast to the Antarctic Peninsula, where a variety of GNSS sites exist, the area of the Amundsen Sea Embayment causes huge challenges in terms of accessibility and logistics. Nevertheless, because of the huge ice-mass changes this region has received increasing attention as a key area for intensified investigations during the last decade. We carried out episodic GNSS measurements at sites specially marked at bedrock during scientific cruises of *Polarstern* in 2006, 2010 and 2017 as well as during a field campaign of the British Antarctic Survey in 2016.

We will discuss the data acquisition and subsequent analyses to yield coordinate changes especially for the vertical component. Special issues of the data analysis using an adapted version of the Bernese GNSS Software v5.1 will be discussed. Due to the long time span of about 10 respectively 20 years the long-term linear rate can be determined in a reliable and stable way. For stations with more than two episodic GNSS measurements we will investigate whether a change of the linear uplift can be deduced.

The observed vertical change can be dedicated to a superposition of glacial-isostatic adjustment (GIA) and the immediate instantaneous elastic response. To reduce the latter effect from the GNSS rates, we utilized Envisat and Cryosat-2 satellite altimetry to determine ice-surface height changes and, subsequently, mass changes which serve as an input to calculate the elastic response both in the frequency and the spatial domain using the well-known load Love number approach.

The (reduced) vertical uplift rates are in the level of a few millimeters per year. For the Amundsen Sea Embayment these rates reach a level of several centimeters per year and are, thus, the highest uplift rates related to GIA we ever observed in Antarctica. These uplift rates exceed, by one order of magnitude, those predicted by recent GIA models (e.g. W12a [Whitehouse et al. 2012] and IJ05R2 [Ivins et al. 2013]). Therefore, there is an urgent need to improve our understanding of GIA both with respect to the variable glacial history and the inner structure of the Earth. We will discuss whether these high uplift rates can be assigned to GIA only or if further sources of deformation (e.g. related to tectonics or recent volcanism) must be considered.

These investigations are part of the project SCHE 1426/16-1 within the DFG Priority Program “Antarctic Research”.

## PARAMETERIZATION OF SNOW BRDF MEASUREMENTS IN ANTARCTICA

T. Carlsen, G. Birnbaum, A. Ehrlich, M. Schäfer, and M. Wendisch

Leipzig Institute for Meteorology,  
Leipzig University

The reflection of solar radiation at snow surfaces is particularly anisotropic in polar regions due to low sun elevations and the anisotropic phase function of ice crystals. The bidirectional reflectance distribution function (BRDF) of snow was derived from airborne measurements of a digital 180° fish-eye camera in Antarctica during austral summer 2013/14. The snow BRDF was obtained for a variety of conditions with different surface roughness, snow grain size, and solar zenith angle.

The airborne measurements covered an area of around 1000 x 1500 km<sup>2</sup> in the vicinity of Kohnen station (75° 0' S, 0° 4' E) at the outer part of the East Antarctic Plateau. The observations (60 flight hours) over Dronning Maud Land include regions with higher (coastal areas) and lower (inner Antarctica) precipitation frequencies.

The calibrated 180° digital camera provides radiance measurements of almost the entire lower hemisphere with an angular resolution of 0.1° per camera pixel. In combination with spectral downward irradiance measured by the Spectral Modular Airborne Radiation measurement system (SMART), BRDF was calculated using an atmospheric correction. The BRDF was analyzed with respect to snow grain size retrieved from spectral surface albedo measurements and surface roughness determined by means of a laser scanner.

The comparison between smooth and rough surfaces (sastrugi) showed significant differences in the BRDF of snow, which are superimposed on the diurnal cycle and the dependence on snow grain size. By inverting a semi-empirical kernel-driven BRDF model, we parameterized the snow BRDF with respect to surface roughness, snow grain size, and solar zenith angle. This allows a direct comparison of the BRDF measurements with BRDF products from satellite remote sensing.

## AIRBORNE AND IN SITU GROUND-BASED MEASUREMENTS OF SURFACE ALBEDO, BIDIRECTIONAL REFLECTIVITY, AND SNOW PROPERTIES ON THE ANTARCTIC PLATEAU

T. Carlsen, M. Belke Brea, G. Birnbaum,  
A. Ehrlich, J. Freitag, G. Heygster,  
L. Istomina, S. Kipfstuhl, A. Orsi, M.  
Schäfer, and M. Wendisch

Leipzig Institute for Meteorology  
Leipzig University

Optical-equivalent snow grain size ( $R_{opt}$ ) and snow BRDF (bidirectional reflectance distribution function) were measured in Antarctica during austral summer 2013/14. We combined long-term observations at Kohnen station ( $75^{\circ} 0' S$ ,  $0^{\circ} 4' E$ ) at the outer part of the East Antarctic Plateau with airborne measurements (60 flight hours) over Dronning Maud Land covering different surface roughness and areas with higher (coastal areas) and lower (inner Antarctica) precipitation frequencies.

The optical grain sizes were retrieved from ground-based surface albedo measurements collected by the COmpact RAdiation measurement System (CORAS) and airborne observations with the Spectral Modular Airborne Radiation measurement system (SMART). They were validated against *in-situ* observations (IceCube device) and spaceborn reflectance measurements by the MODerate Resolution Imaging Spectroradiometer (MODIS). The data shows that snow metamorphism and wind-induced transport of freshly fallen ice crystals lead to a cascading increase, whereas precipitation induced an abrupt decrease of  $R_{opt}$ . Retrieved  $R_{opt}$  were in accordance with *in-situ* observations within the ranges given by the measurement uncertainties. However, SMART data slightly overestimated the ground-based results.

A  $180^{\circ}$  digital camera provides airborne radiance measurements with high angular resolution utilizing detailed radiometric and geometric calibrations. In combination with spectral downward irradiance measured by SMART, the snow BRDF was calculated. The snow BRDF was obtained for a variety of conditions with different surface roughness, snow grain size and solar zenith angle and will be a valuable data set for numerous remote sensing techniques and radiative transfer studies above snow surfaces. The comparison between smooth and rough surfaces (sastrugi) showed significant differences in the BRDF of snow, which is additionally influenced by the diurnal cycle and snow grain size.

## **RETREATS OF ICE SHEET AND ICE SHELF DRIVEN BY WARM WATER INCURSIONS IN THE ROSS SEA SINCE THE LAST GLACIAL MAXIMUM**

Zhihua Chen, Mengshan Ju, Shulan Ge, Zheng Tang, Yuanhui Huang, Renjie Zhao, Ralf Tiedemann, Lester Lembke-Jene

Alfred-Wegener-Institut  
Helmholtz-Zentrum für Polar- und  
Meeresforschung

The stratigraphic data provide direct evidences and opportunities to address questions concerning retreat history of the Ross Ice Sheet and Ice Shelf, but there are significant uncertainties in the chronologies and interpretation. Here, we present and compare stratigraphic records of several sediment cores dredged from the continental shelf and slope of the Ross Sea. The sedimentological and geochemical records reveal the Circumpolar Deep Water (CDW) upwelled, mixed with more surface waters and contained higher oxygen since the Last Glacial Maximum (LGM), while sedimentary facies and paleoenvironmental proxies indicate synchronous and rapid retreats of (ice sheet) grounding-line and (ice shelf front) calving line occurred on the continental shelf especially during Holocene. The stability of marine-based margins of the Antarctic Ice Sheet was evidently controlled by postglacial warm deep-water incursions onto the shelf in the past. Thus, it can be inferred that the ice sheet and ice shelf in the Ross Embayment will melt and retreat faster, or even disastrously collapse and disappear in the future with more incursions of much warmer water in a continuously warming world.

## **INFLUENCE OF BREEZE CIRCULATION ON LOCAL WIND CLIMATOLOGY IN SVALBARD FJORDS**

Małgorzata Cisek, Przemysław  
Makuch, Tomasz Petelski, Jacek  
Piskożub

Institute of Oceanology,  
Polish Academy of Sciences

We analyze data series (1992-2013) of wind measurements from meteorological stations in Ny-Ålesund and Hornsund in Svalbard and compared them to surface layer winds from the NCEP/NCAR reanalysis. We show large discrepancies between the local wind direction and directions of wind compatible with analysis of the pressure fields. We argue that one of the most important factors controlling wind directions in the Svalbard fjords is the temperature difference between the neighboring glaciers and surface sea temperatures of open waters warmed by the West Spitsbergen current. This creates atmospheric circulation patterns similar to night breeze in temperate climates.

## LIFE STRATEGIES ON PHOTOBIOLOGY AND METABOLITE PROFILE OF GENETIC IDENTICAL PHOTOBIONTS OF TWO DIFFERENT LICHEN SPECIES

Nadine Determeyer-Wiedmann,  
Sieglinde Ott

Heinrich-Heine Universitaet  
Duesseldorf, Germany

By photosynthetic activity the photobiont of the lichen symbiosis provides nutrition for the mycobiont for processes of e.g. growth, differentiation and formation of secondary metabolites. It can be postulated that the photosynthetic partner of the lichen symbiosis developed particular adaptation mechanisms to colonise terrestrial sites across Antarctica successfully. The two lichen species *Umbilicaria antarctica* Frey & I.M. Lamb with origin in the southern maritime Antarctic and *Pleopsidium chlorophanum* (Wahlenb.) Zopf collected in North Victoria Land, Antarctic continent are both associated with the genetically identical photobiont *Trebouxia jamesii* clade S (Helms et al. 2001). Despite the genetic identity the experiments resulted in obvious differences between the photosynthetic partners of the two lichen species studied. This might be due to the different environmental conditions of the respective habitats, to the different genera of the lichen mycobiont and different life strategies. The potential to cope with extreme environmental conditions as desiccation followed by rehydration combined with light-stress has been tested on the level of photosynthetic activity (chlorophyll fluorescence measurements of photosystem II and I) and in correlation with the metabolome. The metabolite profile of each isolated photobiont was created during a desiccation process with focus on sugars, polyols and amino acids. Because of observations of color discrepancy of the photobiont cultures of the two different lichen species the chlorophyll content has been investigated. The isolated photobionts from both lichens differed in reactivation kinetics, differences in concentrations and dynamics of the metabolite profiles as well as in differences of the chlorophyll content. The response pattern of the investigated photobionts against stress factors can be described as being genetically fixed and it can be postulated that the mycobiont might have an influence on the respective adaptation mechanisms of the photosynthetic partner in the lichen symbiosis.

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## LAND-OCEAN INTERACTIONS IN THE LATE GLACIAL BERING SEA

B. Diekmann, R. Wang, H. Kühn, R.  
Gersonde, R. Tiedemann, G. Kuhn

Alfred-Wegener-Institut  
Helmholtz-Zentrum für Polar- und  
Meeresforschung

Changes in the marine depositional environment and sediment provenance - as inferred from clay mineralogy, grain-size parameters, and sediment composition - give evidence of land-shelf-ocean linkages of regional environmental change at the northwestern Bering Sea margin (Site SO202-18, 1110 m water depth). During the last glacial stage (30-16 ka BP), the depositional environment was characterized by hemipelagic background sedimentation with overregional sediment sources. A melt-water pulse appeared during late Heinrich Event 1 (16.0 - 14.7 ka BP), documented by the sudden influx of clay-laden meltwaters from Northern Alaska. For the subsequent deglacial Bølling-Allerød interval, meltwater supply changed from glacial-fluvial to more fluvial, caused by warming that probably led to increased snow melt and permafrost thaw. Enhanced nutrient supply fertilized biological productivity. At the same time, a sustained fresh-water lid might have eased local overturning ventilation in the Bering Sea water that promoted the deposition of laminated sediments and the preservation of organic matter until the onset of the Younger Dryas cooling spell (12.6 to 11.4 ka BP). During early Holocene sea-level rise, the shore line moved far away from the site and reduced terrigenous sediment influx. Strong contour currents established in connection with the opening of the Bering Strait and led to the winnowing of sediments and caused residual sand enrichment.

## DOES ENVIRONMENTAL CHANGE AFFECT POLAR MICROBIAL COMMUNITIES?

Daniel R. Dietrich

University of Konstanz, Human and  
Environmental Toxicology

Microbial communities in the polar regions are overtly represented by mats of highly varying thickness (approx. 1mm - >30 cm) and spread and with cyanobacteria being the most visually prominent species, thus cyanobacterial mats. These cyanobacterial mats represent the dominant benthic primary producers of polar freshwater systems and seem well suited for monitoring environmental perturbation, including climate change. Indeed, prolonged climate change may challenge the resilience, plasticity and adaptability and thus affect the community composition of cyanobacterial mats. In order to investigate potential impacts of environmental change we took cyanobacterial mat samples from the Antarctic Peninsula and subjected them in the laboratory to increased temperatures for six months and investigated whether we can see a shift in species distribution and specifically cyanobacterial toxin production. Similarly we tried to simulate decreased wind and increased temperature effects with mat encasings *in-situ* (Rothera), and finally using high-throughput 16S rRNA gene amplicon sequencing, we characterized the microbial diversity of terrestrial and lacustrine biofilms from the Arctic, Antarctic and temperate regions.

While the *in-situ* experiments (Rothera) failed because Skuas continuously stole the encasements, the laboratory experiments were more successful. Indeed, mats exposed to a constant temperature of 8 °C or 16 °C showed high cyanobacterial diversity, commensurate with an increased presence of cyanobacterial toxins. In contrast, mats held at 4 °C and 23 °C seemed low in diversity. Our data thus indicate that a temperature shift to 8 - 16 °C, potentially reached during summer months in polar regions at the present warming rate, could affect cyanobacterial diversity, and in some instances result in a shift to toxin-producing species or to elevated toxin concentrations by pre-existing species that could profoundly alter freshwater polar ecosystems. The latter interpretation was supported by the microbial diversity comparison between the arctic, antarctic and temperate regions. Indeed, these analyses clearly demonstrated that i.) bacterial community compositions at the poles are more similar to each other than they are to geographically closer temperate habitats, with 32 % of all operational taxonomic units (OTUs) co-occurring in both polar regions and ii.) that while specific microbial taxa were confined to distinct regions, representing potentially endemic populations, the percentage of cosmopolitan taxa was higher in Arctic (43 %) than in Antarctic samples (36 %). Although the overlap in polar microbial OTUs may be explained by natural or anthropogenically-mediated dispersal in combination with environmental filtering, current and future changing environmental conditions may enhance microbial invasion, establishment of cosmopolitan genotypes and loss of endemic taxa.

## RAPID GLACIAL ISOSTATIC UPLIFT IN PATAGONIA: INTERPLAY OF ENHANCED ICE MASS LOSS AND SLAB WINDOW TECTONICS

R. Dietrich<sup>1</sup>, A. Richter<sup>1,2,3</sup>, E. Ivins<sup>4</sup>, H. Lange<sup>1\*</sup>, L. Mendoza<sup>2,3</sup>, L. Schröder<sup>1</sup>, J.L. Hormaechea<sup>5</sup>, G. Casassa<sup>6</sup>, E. Marderwald<sup>2,3</sup>, M. Fritsche<sup>1\*</sup>, R. Perdomo<sup>2</sup>, M. Horwath<sup>1</sup>

<sup>1</sup> Technische Universität Dresden, Institut für Planetare Geodäsie, Dresden, Germany

<sup>1\*</sup> Technische Universität Dresden, Institut für Planetare Geodäsie, Dresden, Germany (former affiliation)

<sup>2</sup> Universidad Nacional de La Plata, Facultad de Ciencias Astronómicas y Geofísicas, La Plata, Argentina

<sup>3</sup> CONICET, Argentina

<sup>4</sup> Jet Propulsion Laboratory, California Institute of Technology, Pasadena, USA

<sup>5</sup> Estación Astronómica Río Grande, Río Grande, Argentina

<sup>6</sup> Geoestudios, Santiago, Chile and Universidad de Magallanes, Punta Arenas, Chile

Repeated geodetic GNSS observations at 43 sites distributed over the Southern Patagonian Icefield (SPI) region yield vertical uplift rates of up to 41 mm/a. These observations are used to validate two “end member” ice load history scenarios that approximate unloading since the Little Ice Age (LIA) and to determine rheological parameters of a viscoelastic earth model. The GPS observations link the ice loss to the soft viscoelastic isostatic flow response over the time scale of the Little Ice Age (LIA), including ice loss in the period of observation. The combination of SPI’s rapid melting and the unique regional slab-window tectonics that promotes a relatively low viscosity, is central to the interpretation of the observations. The preferred model and our observations point toward an effective upper mantle viscosity even lower than  $1.6 \cdot 10^{19}$  Pa s and a thin effective lithospheric thickness of 35 km.

## PHYLOGENOMICS OF THE LONGITARSAL COLOSSENDEIDAE: THE EVOLUTION OF A DIVERSE ANTARCTIC SEA SPIDER RADIATION

Lars Dietz, Jana S. Dömel, Christoph  
Mayer, Florian Leese

Zoologisches Forschungsmuseum  
Alexander Koenig

Next-generation sequencing methods have made it possible to generate large amounts of sequence data for phylogenetic and other analyses. However, they have been used only rarely for Antarctic marine organisms. Sea spiders (Pycnogonida or Pantopoda) are a diverse group of marine benthic arthropods showing the highest degree of endemism in the Southern Ocean among all benthic taxa. They are therefore of major interest for the study of evolution of Antarctic organisms, but the phylogeny and phylogeography of this taxon has so far been investigated only with few genes. Here, we present a phylogenomic analysis of the “longitarsal” clade within the sea spider family Colossendeidae. This clade is especially diverse and abundant within the Southern Ocean, but also contains several non-Antarctic species. Using a hybrid enrichment protocol, we sequenced more than 1500 gene loci for 17 species (15 longitarsal and 2 outgroup taxa), most of them represented by more than one specimen. With these data, we generated a comprehensive phylogeny of the longitarsal clade. We use this phylogeny to investigate the biogeographic history of that clade. In particular, we test whether the Antarctic species within the clade are monophyletic (which would suggest a single colonization of the Southern Ocean), polyphyletic (multiple colonization events) or paraphyletic (which suggests dispersal of non-Antarctic taxa out of Antarctica). We also try to assess the time of colonization of the Southern Ocean by this clade. To our knowledge, our study is the first large-scale phylogenomic analysis of a Southern Ocean invertebrate radiation.

## REVEALING THE EVOLUTIONARY HISTORY OF SOUTHERN OCEAN SEA SPIDERS USING GENOME-WIDE SNP DATA

Jana S. Dömel, Till-Hendrik Macher,  
Lars Dietz, Christoph Mayer, Roland R.  
Melzer and Florian Leese

Universität Duisburg-Essen, Aquatische  
Ökosystemforschung

Understanding origin and adaptation of Southern Ocean biota is of great importance, especially in times of rapid global change. Molecular methods have greatly improved our understanding of these evolutionary processes by resolving their phylogenies and identifying patterns of gene flow among populations in the Southern Ocean. Results of several projects funded by the German Research Foundation's priority program 1158 in the past decade have unveiled many cryptic species, endemic to the Southern Ocean, that often show local rather than circumpolar distribution patterns. Sea spiders, or pycnogonids, are a typical taxon for which these findings have currently been found. Prominent examples here are the two sea spider species complexes *Colossendeis megalonyx* and *Pallenopsis patagonica*. However, due to few genetic markers analyzed and partial discordance between nuclear and mitochondrial gene data, detailed information on underlying evolutionary processes remains unclear. Here we report about results of an integrative genomic and morphological study on the *C. megalonyx* species complex with the aim to analyze (i) demographic patterns such as gene flow across migration barriers (ACC and APF), (ii) the influence of successive glacial periods and (iii) selection patterns for adaptations to different habitats. To address these aims, we used a novel target enrichment protocol that generated data for 1,600 genes of 64 specimens from different locations in Antarctic and Sub-Antarctic habitats. In contrast to the previous studies, our integrative approach allows to answer long asked questions on the evolution of Southern Ocean biodiversity with an unparalleled amount of genomic and morphometric data.

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## **GEOHERMAL HEAT FLUX DERIVED FROM AIRBORNE MAGNETIC GRIDS AND MEASURED TEMPERATURE GRADIENTS IN THE AMUNDSEN SEA SECTOR OF WEST ANTARCTICA**

Ricarda Dziadek, Karsten Gohl, Fausto Ferraccioli, Norbert Kaul, Cornelia Spiegel

Alfred-Wegener-Institut  
Helmholtz-Zentrum für Polar- und  
Meeresforschung

The West Antarctic Rift System is one of the least understood rift systems on earth, but displays a unique coupled relationship between tectonic processes and ice sheet dynamics. Geothermal heat flux is a poorly constrained parameter in Antarctica and suspected to affect basal conditions of ice sheets, i.e., basal melting and subglacial hydrology. Thermomechanical models demonstrate the influential boundary condition of geothermal heat flux for (paleo-) ice sheet stability. Young, continental rift systems are regions with significantly elevated geothermal heat flux, because the transient thermal perturbation to the lithosphere caused by rifting requires ~100 Ma to reach long-term thermal equilibrium. We discuss airborne, high-resolution magnetic anomaly data from the Amundsen Sea sector to provide additional insight into deeper crustal structures related to the West Antarctic Rift System in the Amundsen Sea sector. Using depth-to-the-bottom of the magnetic source (DBMS) estimates, we reveal spatial changes at the bottom of the igneous crust and the thickness of the magnetic layer, which can be further incorporated into tectonic interpretations and which is used to derive geothermal heat flux, supplemented by heat flux derived from measured temperature gradients in shelf sediments. We relate the distribution of geothermal heat flux to paleo and present ice sheet flow conditions.

## SEA SPRAY AEROSOL FLUXES IN THE AREA OF THE SPITSBERGEN SHELF AND THE GREENLAND SEA

K. Dziembor, T. Petelski, P. Markuszewski, T. Zieliński, P. Makuch, I. Wróbel

University of Gdansk, Faculty of Oceanography and Geography/  
Institute of Oceanology Polish Academy of Sciences, Air-Sea Interaction Laboratory

The emission of sea droplets and sea salt to the atmosphere is observed most intensively during storms. It affects many climate factors, like light scattering, cloud albedo, or cleaning processes in the sea-air boundary layer from anthropogenic pollutions.

Small particles, solid or liquid, emitted to the atmosphere in stormy circumstances (so called sea spray aerosols – SSA) are significant part of heat, mass and momentum exchange between oceanic and atmospheric environment. They also play an important role in cloud physics, atmospheric chemistry, meteorology and oceanography. Observation and estimation of these processes is possible due to the calculation of sea salt flux (SSF). Although SSF parameterization is a difficult issue, the current emission of sea salt is estimated at 1600-6800 Tg/y (Boucher et al., 2013). This means significant advantage over aerosols from other sources. Simultaneously, relative uncertainty in emission value reaches 80 % (Tsigaridis et al., 2013), what strongly motivates development of measurement methods to analyse sea-surface phenomena.

The main goal of this presentation is to show the results of SSF field measurements, taken from the deck of a Polish Academy of Sciences vessel, R/V *Oceania*, in July 2017. Research was conducted as part of annual polar cruises AREX in the area of the Greenland Sea and the Spitsbergen Shelf. Five optical particles counters OPC-N2 were used. SSF was estimated by using gradient method (Petelski 2003, Petelski and Piskozub 2006) and taking into account the meteorological conditions observed during measurements.

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## **MORE THAN TWO DECADES OF GEODETIC GNSS MEASUREMENTS IN ANTARCTICA, GREENLAND AND PATAGONIA – A TECHNOLOGY REVIEW**

Lutz Eberlein, Mirko Scheinert, Peter  
Busch, Christoph Knöfel, Andreas  
Richter

TU Dresden, Institut für Planetare  
Geodäsie

Since 1994 the Institut für Planetare Geodäsie has been involved in many expeditions to the polar regions as well as to the Patagonian icefields. A major focus of the ground-based investigations has been given to geodetic measurements using Global Navigation Satellite Systems (GNSS). These measurements form an essential part to investigate a number of phenomena, especially recent deformations of the Earth crust or height changes and flow velocities of ice sheets and glaciers.

Over these more than 20 years our institute has established more than 160 geodetic sites on bedrock in Antarctica, Greenland and Patagonia. In Antarctica, we have realized more than 150 observation points on ice. Mostly, these sites were designed for so-called campaign measurements. Therefore, after having realized a first measurement it is necessary to carry out repeated measurements at least for a second time. From these repeated measurements it is possible to infer coordinate changes with an accuracy of a few millimeters (for bedrock sites).

This presentation will elucidate and discuss the technical developments for the set-up of GNSS sites in glaciated areas. Special attention has to be given to the autonomous power supply of the equipment under the harsh polar weather conditions. We will discuss how technological progress has helped to improve the set-up and to exploit the gained advantages especially for campaign measurements. Geodetic GNSS receivers of the latest generation having lower power consumption and increased data storage capabilities have a positive effect. This progress also affects how measurement campaigns can be realized in a more effective way. Furthermore, we will discuss how the GNSS antennas are mounted at special markers and how this influences the resulting coordinates and their changes.



## **ANALYSING THE FLOW VELOCITY OF MAJOR OUTLET GLACIERS IN NORTH GREENLAND USING LANDSAT DATA**

Benjamin Ebermann, Ralf Rosenau,  
Mirko Scheinert, Martin Horwath

Technische Universität Dresden, Institut  
für Planetare Geodäsie

The Greenland Ice Sheet is the world's second largest fresh-water reservoir and a key factor of the climate system. During the period from August 2002 to July 2016 the GIS lost ice mass at a rate of  $-252.3 \pm 14.6$  Gt/yr, corresponding to an equivalent rise in global mean sea level of  $0.70 \pm 0.04$  mm/yr [Groh et al., 2016]. The part that can be attributed to North Greenland is  $-79.1 \pm 4.0$  Gt/yr, which accounts to more than 30 % of the entire mass loss. We focused our study on the analysis of the flow velocity of 12 major outlet glaciers in North Greenland. These include Zachariæ Isstrøm, Nioghalvfjærdsbræ, Academy Gletscher, Hagen Bræ, Harald Moltke Bræ, C.H. Ostenfeld Gletscher, Petermann Gletscher, Ryder Gletscher, Steensby Gletscher, Tracy Gletscher, Heilprins Gletscher and Farquhar Gletscher. For this, we made use of more than 23,000 optical scenes of the Landsat satellites in the period from 1985 to 2017. From these, we succeeded to infer more than 50,000 velocity fields for these glaciers. Based on these processed data we can infer further characteristic parameters such as monthly and yearly medians as well as velocity time series at discrete points. Additionally, we will discuss how flow directions and their changes can be determined over time.

The long time span enables us to determining trends of the flow velocity over different periods. A major achievement can be seen in the fact that a high temporal resolution facilitates the analysis of seasonal flow-velocity variations. Rapid changes like surge events can be detected and analyzed in detail. The presentation will discuss respective results for selected locations in North Greenland.

## PARTITIONING GROWING SEASON NET ECOSYSTEM EXCHANGE OF CO<sub>2</sub> INTO PHOTOSYNTHESIS, AUTOTROPHIC AND HETEROTROPHIC RESPIRATION IN THE SIBERIAN TUNDRA

Tim Eckhardt, Christian Knoblauch, Lars Kutzbach, Gillian Simpson, Eva-Maria Pfeiffer

Institute of Soil Science / University of Hamburg

The Arctic is currently facing amplified climate warming and the rate of this warming is expected to accelerate. A number of changes are predicted in response to warming. On the one hand, warming is expected to cause the deeper thaw of permafrost affected soils leading to enhanced production of carbon dioxide (CO<sub>2</sub>) due to the increasing degradation of soil organic matter (SOM), which could create a positive climate feedback to global warming. On the other hand, due to higher temperatures the assimilation of CO<sub>2</sub> by vegetation will increase. Therefore, it remains uncertain how the carbon (C) sink function of arctic tundra landscapes will react to future changes in climate.

This study aimed to determine the CO<sub>2</sub> fluxes at the soil-plant-atmosphere interface in an arctic tundra ecosystem and to identify the main environmental drivers of these fluxes. Furthermore, as the processes governing CO<sub>2</sub> net ecosystem exchange (NEE) react differently on a changing climate, the CO<sub>2</sub> fluxes were partitioned into gross primary productivity (GPP) and ecosystem respiration (Reco). Reco was further partitioned into its autotrophic (RA) and heterotrophic respiration (RH) components. The study was conducted in 2015 using chamber measurements on the microscale (1 m – 10 m) in a polygonal tundra environment in the Lena River Delta, northeastern Siberia. Two different microsites were investigated; one characterized by water-saturated soils and densely vegetated by vascular plants and mosses in the center of an ice wedge polygon, and the second situated at a dryer polygon rim, with vegetation dominated by mosses. In order to estimate the CO<sub>2</sub> fluxes over the complete growing season, they were reproduced using flux models.

This work finds the polygonal tundra in the Lena River Delta to be a robust sink for atmospheric CO<sub>2</sub>. The net CO<sub>2</sub> uptake at a wet depressed polygonal center over the growing season was more than twice as high as measured at a drier polygonal rim. In addition to higher GPP fluxes, the differences in NEE between the two microsites were primarily caused by lower Reco fluxes at the center compared to the rim. Here, the contrasting hydrological conditions cause the CO<sub>2</sub> flux differences between the microsites, where high water levels lead to lower decomposition rates due to anoxic conditions. For the first time, the different response of *in-situ* measured RA and RH fluxes to hydrological conditions was determined. It was shown that a high water table could lower RA fluxes, most likely due to the submersion of plants while a low water table lead to enhanced RH fluxes and the desiccation of mosses, therefore lowering RA fluxes. The RH fluxes presented in this study are the first *in-situ* measured RH fluxes, which cover an almost complete growing season from the vast Russian arctic tundra.

The partitioning of CO<sub>2</sub> fluxes provides unique insights into the individual contributions of each of the processes governing the CO<sub>2</sub> NEE. Improved knowledge of these contributions is of crucial importance to gain a better understanding of the reaction of arctic ecosystems to changing climatic conditions as these processes react differently to environmental parameters. Furthermore, the presented results provide an improved understanding of the response of CO<sub>2</sub> fluxes to environmental controls from different arctic tundra sites, which is needed to optimize model simulations of future C fluxes.

## **METEOROLOGICAL COLLABORATION IN THE ARCTIC**

Johanna Ekman

Finnish Meteorological Institute

Finland chairs the Arctic Council in 2017-2019. During its chairmanship one of the top priorities is arctic meteorological collaboration. In practice, this means intensified monitoring, improved modeling and tailored meteorological services in and for the Arctic. Our aim is to ensure safe and sustainable Arctic. In this presentation we will tell you why and how.

## **METEOROLOGICAL ASPECTS OF S.A. ANDRÉE'S ATTEMPT TO REACH THE NORTH POLE BY BALLOON IN 1897**

Dieter Etling

Institute for Meteorology and  
Climatology, Leibniz University  
Hannover

On 11 July 1897, a Swedish expedition under Salomon August Andrée attempted to reach the North Pole from Spitsbergen by balloon. The flight was terminated after only three days, as the weight of the balloon increased above a critical limit, due to an ice load caused by freezing fog and drizzle. Here the meteorological context of this expedition is discussed, in particular concerning the planning of the flight and in-flight weather conditions. Based on recently released pressure and wind fields for the Arctic region for July 1897, obtained from the twentieth century reanalysis project (20CR), it can be shown that the Andrée expedition would not have reached the North Pole even with a perfect balloon, due to unfavourable wind conditions in the central Arctic during the days after their departure from Spitsbergen.

## GEODETIC MASS BALANCE ON SOUTH GEORGIA GLACIERS

David Farias-Barahona, Christian  
Sommer, Thorsten Seehaus, Philipp  
Malz, Gino Casassa, Matthias H. Braun

Institute of Geography at the University  
of Erlangen-Nuremberg

The glacier mass balance is crucial to understand the response of glaciers to the changing climate and is significant for the sea level rise estimates. Glacier volume variations are often assessed based on the geodetic glacier mass balance method. In the Southern Hemisphere glacier mass balance information is scarce. Therefore, this gap of information generates an uncertainty about the current status of glaciers.

South Georgia is the largest subantarctic islands, lying south of the Antarctic polar front. About of 56 % of the surface is glacierized. Previous studies carried out on South Georgia have shown heterogeneous pattern of glacial advance and retreat over time. However, mass balance data is still lacking. In this study, we present the first geodetic mass balance of South Georgia based on data of the bistatic TerraSAR-X-Add-on for Digital Elevation Measurements (TanDEM-X) mission. Elevation differences are calculated from interferometrically-derived TanDEM-X and SRTM DEMs over the period 2000 – 2012/2013.

## FROZEN-GROUND CARTOONS: AN INTERNATIONAL COLLABORATION BETWEEN ARTISTS AND PERMAFROST SCIENTISTS

Michael Fritz, Frédéric Bouchard,  
Bethany Deshpande, Julie Malenfant-  
Lepage, Alexandre Nieuwendam,  
Michel Paquette, Ashley Rudy, Matthias  
Siewert, Audrey Veillette, Stefanie  
Weege, Jon Harbor, Otto Habeck, Ylva  
Sjöberg

Alfred-Wegener-Institut  
Helmholtz-Zentrum für Polar- und  
Meeresforschung, Potsdam

Communicating science in an easy, funny, and engaging way, can be a challenge. This is especially true when the phenomenon we talk about - PERMAFROST - is found under ground and defined by its thermal properties. Two years ago, a group of young researchers from Europe and Canada came together to tackle this problem by combining arts and science to produce a series of outreach comic strips about permafrost (frozen ground).

Permafrost should concerns us all. As the climate warms, permafrost thaws and becomes unstable for houses, roads and airports. The thawing also disrupts ecosystems, impacts water quality, and releases greenhouse gases into the atmosphere, making climate change even stronger. The Frozen Ground Cartoon project aims to present and explain permafrost research. We have put an emphasis on field work and the rapidly changing northern environment. The target audience is kids, youth, parents and teachers, with the general goal of making permafrost science more fun and accessible to the public.

The project has so far produced 22 pages of comics through an iterative process of exchanging ideas between two artists and twelve scientists. The project artists were selected through an application call that received 49 applications from artists in 16 countries. The artists Noémie Ross (Canada) and Heta Nääs (Finland) have created a set of beautiful, artistic, humoristic, and pedagogic comics with input from scientists.

The comics are available for free download through the project web page (in English and Swedish), and printed copies have so far been handed out to school kids and general public in Europe and Canada. The next steps of this project are (1) to distribute the comics as widely as possible, (2) work towards translations into more languages, and (3) to evaluate the effectiveness of the science communication through the comics, in collaboration with schools and pedagogic experts.

## THE AKADEMII NAUK ICE CORE AND SOLAR ACTIVITY

Diedrich Fritzsche, Luisa von Albedyll,  
Silke Merchel, Thomas Opel, Georg  
Rugel, Andreas Scharf

Alfred-Wegener-Institut  
Helmholtz-Zentrum für Polar- und  
Meeresforschung

Ice cores are well established archives for paleo-environmental studies, but this requires a reliable ice core chronology. The concentration of cosmogenic radionuclides in ice cores reflects the solar activity in the past and can be used as dating tool for ice cores. Accelerator mass spectrometry (AMS) allows the determination of nuclides in high resolution. Here we present results of a  $^{10}\text{Be}$  study in an ice core from Akademii Nauk (Severnaya Zemlya, Russian Arctic). AMS analyses of more than 500 samples were carried out using the 6 MV accelerator facility of the Ion Beam Centre of the Helmholtz Zentrum Dresden Rossendorf. For the time period 400 to 2,000 CE the temporal variations of  $^{10}\text{Be}$  reflect the centennial variations of solar activity known from similar studies of Greenlandic ice cores and from  $^{14}\text{C}$  production reconstructions. The  $^{10}\text{Be}$  peak of 775 CE, today understood as result of the strongest known solar particle storm, was found by high resolution core analysis. This peak is used as tie point (additionally to volcanic reference horizons) for the development of the depth-age relationship of the Akademii Nauk ice core. Indications of the so called 'Carrington Event' of 1859 CE, 20 to 30 times weaker than 775 CE, could also be detected in the core.

## WALTHER BRUNS, GRÜNDER DER „AEROARCTIC“ – EIN VERGESSENER PIONIER DER DEUTSCHEN POLARFORSCHUNG

Diedrich Fritzsche

Alfred-Wegener-Institut  
Helmholtz-Zentrum für Polar- und  
Meeresforschung

Die Arktisfahrt des LZ 127 „*Graf Zeppelin*“ im Jahr 1931 war die erste und einzige rein wissenschaftliche Arktisexpedition, die mit einem Luftschiff durchgeführt wurde. Zurückzuführen ist sie auf eine Idee von Walther Bruns, Hauptmann a.D. und im 1. Weltkrieg Luftschiffführer, der eine transarktische Luftschifflinie zur Verkürzung der Reisezeit zwischen Europa und dem pazifischen Raum propagierte und den Einsatz von Luftschiffen zum Transport in der Arktis und zu deren ständiger Überwachung vorschlug. Mit einer gemeinsam mit dem Meteorologen und Aerologen Arthur Berson verfassten Denkschrift gewann er führende Wissenschaftler für eine Vereinigung, aus der sich die „Internationale Studiengesellschaft zur Erforschung der Arktis mit dem Luftschiff e.V.“ (Aeroarctic) gründete. Diese Gesellschaft, deren Generalsekretär Bruns war, plante und organisierte die Arktisfahrt des „*Graf Zeppelin*“. Bruns ist heute nur noch in Fachkreisen bekannt. Der Beitrag beschreibt die zentrale Rolle von Walther Bruns, die er in unermüdlicher Arbeit in der Organisation der „Aeroarctic“ gespielt hat. Ohne sein Geschick, wichtige Personen aus Wissenschaft und Luftfahrttechnik für seinen Plan zu gewinnen und ohne seine Ausdauer, auch in schwierigen wirtschaftlichen und politischen Situationen, wäre diese Fahrt nicht zustande gekommen. Weiterhin werden bisher unveröffentlichte biografische Angaben zu Walther Bruns mitgeteilt.



## WARMING AND REDUCTION OF PRECIPITATIONS AFFECT THE MICROBIOME OF RECENTLY DEGLACIATED SOILS IN THE SWISS ALPS

Aline Frossard, Johanna Donhauser,  
Pascal Niklaus, Thomas Rime, Beat  
Frey

Swiss Federal Institute WSL

The impact of climate change is particularly strong in Alpine regions, causing potential important ecological and socio-economical consequences. The glacier retreat is one of the most visible effect of the increase of global temperature, leaving behind large areas of a barren landscape, physically and ecologically unstable. In the absence of vegetation, the soil microbial communities, constituted of about 10 % by cyanobacteria and algae, is especially important for initial soil formation and ecosystem functioning in this deglaciated terrain. The microbial communities inhabiting these soils were found to be directly affected by variation of soil temperature and moisture. However, little is known on the impact of climate change on the diversity and functions of microbial communities in these newly exposed barren soils, especially from *in-situ* experiments in the Alpine environment. A long-term field experiment was set-up in the Damma glacier forefield in the central Alps (Switzerland), where 4 open-top chambers (OTCs) and 4 roofed plots (RPs) simulating an increase of temperature or a reduction of precipitation, respectively. Soils beside each open-top chamber was also monitored and used as a control. Data collected over a 3 consecutive summer seasons showed an averaged increase of temperature of 1.3°C in the OTCs and a reduction of soil moisture of 10 % in the roofed plots. Net ecosystem production was clearly lower in the OTCs compared to the control plots, due to a lower gross primary production and higher soil microbial respiration. Measurements of greenhouse gases showed an increase of CH<sub>4</sub> emissions from the soil in the OTCs, while the soil effluxes of N<sub>2</sub>O were larger in the RPs. Functional genes associated with denitrification were decreased in the RPs, but increased in the OTCs. Contrastingly, no significant changes were detected neither in the bacterial nor in the fungal community structure among the treatments. All together our findings demonstrate the high sensibility of the microbiome in recently deglaciated soils, responding to climate change. This experiment also highlights the importance of long-term *in-situ* field experiments to assess the effects of climate change on the soil ecosystem functioning.

## THE ICE-FREE TOPOGRAPHY OF SVALBARD

Johannes J. Fürst, Francisco Navarro,  
Fabien Gillet-Chaulet, Geir Moholdt,  
Xavier Fettweis, Charlotte Lang,  
Thorsten Seehaus, Matthias H. Braun,  
Douglas I. Benn, Toby J. Benham,  
Julian A. Dowdeswell, Mariusz Grabiec,  
Jack Kohler, Katrin Lindbäck, Rickard  
Pettersson, Heidi Sevestre

Institute of Geography at the University  
of Erlangen-Nuremberg

We present an ice-free topography of the Svalbard archipelago based on a two-step mass-conserving approach for mapping glacier ice thickness. For this reconstruction, almost 73,000 individual thickness measurements were assimilated. The considered surveys covered a total length of ~7,600 km. The approach is further informed by surface mass balance from a regional climate model and several products inferred by satellite remote sensing: a recent digital elevation model, surface elevation changes and glacier surface velocities. For Svalbard, we infer a total ice volume of 6,573 km<sup>3</sup>. Aggregation of the values of an associated error-estimate map provides upper and lower ice-volume bounds of 5,274 and 8,555 km<sup>3</sup>. These bounds are partly exhausted by the last two estimates from volume-area scaling, which reported 5,350 and 9,089 km<sup>3</sup>. Thickness values from a recent distributed reconstruction sum up to an elevated ice volume of 8,123 km<sup>3</sup> (Huss and Farinotti, 2012). Part of this difference is explained by, on average, 50 % higher ice-cliffs of the marine terminating glaciers on Svalbard.

## SCIENTIFIC DRILLING IN ANTARCTICA? COMING TO A NEW DRILLING PROPOSAL

Christoph Gaedicke <sup>1</sup>, Gerhard Kuhn <sup>2</sup>,  
Olaf Eisen <sup>2</sup>, Andreas Läufer <sup>1</sup>, Emma  
Smith <sup>2</sup>, Nikola Koglin <sup>1</sup>, Boris Biskaborn  
<sup>2</sup>, Dieter Franke <sup>1</sup>, Ralf Tiedemann <sup>2</sup>

<sup>1</sup>Bundesanstalt für Geowissenschaften  
und Rohstoffe

<sup>2</sup>Alfred-Wegener-Institut  
Helmholtz-Zentrum für Polar- und  
Meeresforschung

Scientific Drilling through the ice shelves of Antarctica is essential to understand ice sheet dynamics, the transition from greenhouse to ice-house in the Eocene to Oligocene, and the breakup of the Gondwana continent. The Alfred-Wegener-Institute, Helmholtz Centre for Polar and Marine Research (AWI) and the Federal Institute for Geosciences and Natural Resources (BGR) jointly conduct a pre-site survey in order to identify potential drilling locations in the vicinity of the German Neumayer III station. There, a sequence of >1000m thick sediments of potentially Late Mesozoic to Quaternary age has been identified on top of the presumed syn- or post-rift volcanic Explora Wedge between the ice shelf calving line and some 40 km inland under the Eckström Ice Shelf. During a first survey in the Antarctic season 2016/17 eleven high resolution vibro-seismic profiles with a total length of 285 km were obtained (Kuhn et al. 2018, this volume). Based on this data set and additional profiles recorded during the season 2017/18 several locations for sampling of surface sediment were identified. Sampling of the seafloor by retrieving short cores of the oldest and youngest sediments through Hot Water Drill holes was carried out in late December 2017 to late January 2018. As next steps, AWI and BGR agreed to finance a further campaign for additional sampling and oceanographic pre-site studies to be carried out in the following Antarctic season 2018/19. Under the LA-SCAR and PAIS umbrella we will re-establish a D-ANDRILL group to coordinate these related national projects. An international workshop is then planned to bring together researchers with interest in scientific drilling and to discuss and develop a drilling proposal. We particularly like to encourage scientists from the German polar research community based at universities and other research institutions to contribute to this project.

## GERMAN PERMANENT RESEARCH FACILITIES IN ANTARCTICA - A 40 YEARS RECORD

Hartwig Gernandt

Alfred-Wegener-Institut  
Helmholtz-Zentrum für Polar- und  
Meeresforschung

To permanently run a research station is one of the terms for a national Antarctic program to get the consultative status within the Antarctic Treaty system. There was no German activity in Antarctica during the International Geophysical Year (IGY), when 12 nations established firstly permanent research stations. Since 1959 East German scientists stayed more regular over winters at Russian research stations by an invitation of the former Soviet Academy of Sciences. Only occasionally scientists from West Germany worked as guest scientists at some stations in Antarctica in the sixties.

When the GDR accessed the Antarctic Treaty in 1974 a small research base was set up to participate with ground-based observations to the International Magnetospheric Study (IMS). IMS was designed to coordinate a worldwide network for a period of three years in both polar regions from 1976 until 1978. This small research base, later the East German station Georg Forster, was operational started in May 1976 and became the first German permanently occupied research facility in Antarctica.

Only a few years later the Federal Republic of Germany officially announced to establish a national Antarctic research program and to fulfil all conditions for the consultative status. Unknown to the public and as the typical reflexive response to equalize with something coming from the West, the East German authorities decided short in term also to build a new and logistically independent research station. And so it came that two reconnaissance expeditions were on the way during the Antarctic season 1979/80, one to the Filchner Ice Shelf and one with support by the Russian Antarctic expedition to the Larsemann Hills / Olaf Prydz Bay. As a result, two German stations, the Georg von Neumayer station at the Ekström Ice Shelf and the East German research base in the Schirmacher Oasis, worked completely independently in parallel from 1981 until 1990.

After the unification of Germany both rivers of polar programs were joined in 1990. The terrestrial Antarctic activities were being carried out at the newly constructed research station Neumayer II, which replaced the first station Georg von Neumayer in 1992. The scientific activities, such as EPICA and others, considerably extended the summer activities in the region. In 2009 the Neumayer-Station III replaced the former one at the Ekström Ice-shelf, which is now the logistical and scientific center of the German Antarctic program.

Some points of this about 40 years history as scientific motivations, technical developments and policy-induced actions will be considered in some aspects.

## **PRE-GLACIAL AND GLACIAL SHELF EVOLUTION FROM SEISMIC AND SEABED DRILL RECORDS OF THE AMUNDSEN SEA, WEST ANTARCTICA**

Karsten Gohl, Gabriele Uenzelmann-Neben, Robert Larter, Johann Klages, Claus-Dieter Hillenbrand, Torsten Bickert, Steve Bohaty, Ulrich Salzmann, Thomas Frederichs, Catalina Gebhardt, Katharina Hochmuth and Expedition PS104 Science Party

Alfred-Wegener-Institut  
Helmholtz-Zentrum für Polar- und Meeresforschung

The sedimentary sequences of the Amundsen Sea Embayment (ASE) shelf contain records that have the potential to reveal the tectonic, environmental and ice sheet evolution from pre-glacial to glacial times for a very dynamic sector of the West Antarctic Ice Sheet (WAIS). The currently observed massive loss of continental ice in this region may be a precursor to a partial or full collapse of the WAIS. Deciphering paleoclimate and paleo-ice sheet records from the shelf sediments is therefore a major scientific objective for studying processes of past warm times that can be considered as analogues to the present and future WAIS behavior. In previous work, the seismic stratigraphic model of the shelf was based solely on long-distance jump correlation with seismic records from the Ross Sea shelf. New MeBo70 seabed drill cores collected in early 2017 from the ASE shelf contain unconsolidated to highly consolidated sediments spanning time periods from the Holocene to Cretaceous. We are now able to correlate the mapped seismic horizons and units with the physical property and age information from the drill cores to obtain new insight into the tectonic, sedimentary and paleoenvironmental development of the entire shelf. The drill records and seismo-stratigraphic units of the ASE provide new constraints on the timing of the transition from the pre-glacial terrestrial environment and tectonic influences of the Cretaceous – Paleocene to marine transgression thereafter, and the first advances of grounded ice across the shelf.

## THE TURNOVER OF LIPID AND FATTY ACIDS IN POLAR ZOOPLANKTON ORGANISMS REVEALED BY STABLE ISOTOPE ANALYSES

Martin Graeve, Lauris Boissonnot,  
Barbara Niehoff, Wilhelm Hagen

Alfred-Wegener Institut  
Helmholtz Zentrum für Polar- und  
Meeresforschung

High latitude marine ecosystems are characterized by strong seasonality in light and thus primary production and food availability. Polar zooplankton organisms have developed the ability of storing large amounts of lipid reserves to face this variable environment. Lipids are composed of fatty acids, which are transferred from unicellular algae via zooplankton to higher trophic levels. In order to estimate the turnover of lipid and fatty acids in Arctic and Antarctic copepods, individuals were fed with <sup>13</sup>C labelled diatoms (*Conticriba weissflogii*) and the <sup>13</sup>C incorporation was monitored by isotope ratio mass spectrometry (CSIA). Among the small sized copepods *Pseudocalanus minutus* and *Oithona similis*, maximum lipid turnover occurred in *P. minutus*, which exchanged 2.6 % day<sup>-1</sup> of total lipid, whereas 0.5 % day<sup>-1</sup> were exchanged in *O. similis*. In *P. minutus*, the diatom markers 16:1(n-7), 16:2(n-4), and 16:3(n-4) were almost completely renewed from their diet within 21 days, while 15 % of the flagellate markers 18:2(n-6), 18:3(n-3) and 18:4 (n-3) were also exchanged. In *O. similis*, 15 % of both flagellate and diatom markers were renewed within 21 days. In contrast, the Antarctic *Calanus acutus* CV specimens showed an intense lipid turnover with maximum rates of 80 % exchanged total lipids. In particular the long-chain monounsaturated FAs 20:1(n-9) and 22:1(n-11) (MUFA), which are largely stored as energy reserves in wax esters, showed the highest exchange rates in CVs. Lipid exchange rates of *C. propinquus* and *C. acutus* females were much lower (50 % TL). FAs with highest turnover rates were 16:0 and 20:5(n-3) (max. 90 %), followed by 18:0 and 22:6(n-3) (max. 40 %). Fatty alcohols (as wax ester moieties) exhibited the highest exchange rates in *C. acutus* CVs (>90 %), in contrast to much lower rates when compared to the females (max. 40 %). Our findings clearly demonstrate that CSIA is a powerful tool for the investigation of lipid and fatty acid turnover in polar organisms. The accumulation of <sup>13</sup>C is particularly dependent on the life cycle strategies of these investigated copepod species.

## CONTINUOUS PROFILING OF AEROSOLS AND CLOUDS OF THE ARCTIC DURING POLARSTERN CRUISE PS106

Hannes Griesche, Carola Barrientos,  
Ulrike Eggerer, Patric Seifert,  
Johannes Bühl, Ronny Engelmann,  
Holger Baars, Andreas Macke

Leibniz Institute for Tropospheric  
Research

To retrieve the full vertical extent of cloud macro- and microphysical properties for ocean studies the use of cloud radars during ship cruises becomes increasingly frequent. Nevertheless, there are still only a few studies of stabilized cloud radars, which is a necessary requirement to determine also cloud dynamics. In the frame of (AC)3, we investigate aerosol-cloud interactions and the influence of the vertical air motion on the microphysical properties of Arctic clouds. For this aim for the first time ever a stabilized 35-GHz cloud radar of type Mira-35 was deployed on *Polarstern* during the cruise PS106. The stabilization platform was used to minimize the influence of the pitch and roll movement of the vessel onto the point of view of the cloud radar. To enable a later correction of the ship's heave the motion of the vessel was logged with a frequency of 20 Hz and the radar moments were stored at a frequency of 4 Hz. Together with the well-established OCEANET container, carrying continuous measurements of multiwavelength polarization Raman lidar, microwave radiometer, and radiation, the whole vertical cloud and aerosol structure was captured during this two-month cruise (May 25th to July 21st, 2017). The heave correction procedure, the overall meteorological conditions during the cruise retrieved by the synergistic Cloudnet algorithm, as well as a comparison to tethered balloon turbulence measurements performed during PS106 are presented. In addition, the contrast of radiative transfer calculation on the one hand based on lidar and microwave radiometer measurements only and on the other hand also with cloud-radar-retrieved microphysical properties is outlined.

## **SUBGLACIAL FLOOD INVESTIGATIONS AT THE DÅLK GLACIER AREA, LARSEMANN HILLS, EAST ANTARCTICA, ON THE DATA COLLECTED IN 2017/2018 FIELD SEASON**

Svetlana Grigoreva, Alina Boronina,  
Anastasiia Sukhanova, Sergey Popov,  
Marina Kashkevich, Vitalii Kashkevich,  
Viacheslav Martianov, Valerii Lukin

Saint Petersburg State University

Despite the fact that subglacial reservoirs of Antarctica have been a subject of research for many years, real interest to them in present science appeared only after discovery of the Vostok subglacial lake. Many processes taking place in such reservoirs are still poorly understood. Subglacial floods may be pointed among them. Achieving reliable data about subglacial floods is quite important not only for scientific purposes, but also from the practical point of view, considering possible damages they can carry during the logistic operations in the polar regions.

On January 30, 2017 a glacial dip occurred at the western part of the Dâlk glacier (East Antarctica), at the area where the route connecting stations Progress (Russia) and Zhongshan (China) with the snow-runway and formation point of the Russian and Chinese logistic traverse into the interior regions of East Antarctica is located. According to preliminary estimates, the depression size is 183 x 220 meters, its depth reaches 30 meters, and its estimate value is about 800 thousand cubic meters. It is obvious that such events have happened before and may occur later, leading to dangerous situations.

Our presentation is dedicated to the geophysical, hydrological and glaciological data collected in the Dâlk glacier area during the austral summer field season of 2017/2018. This data will be used to gain the first reliable conclusions about morphology of these reservoirs, their hydrological characteristics and structure. This survey will become a first part of our project, which is aimed to better understanding of the subglacial floods phenomenon.

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## PREDATORY ZOOPLANKTON ON THE MOVE: LIKELIHOOD OF POLEWARD RANGE SHIFTS AND THEIR CONSEQUENCES FOR ANTARCTIC AND ARCTIC FOOD WEBS

Charlotte Havermans, Wilhelm Hagen,  
Christoph Held, Holger Auel

Universität Bremen

Climate change proceeding at unprecedented pace is currently redistributing life on Earth. Warming of the upper ocean and the atmosphere have altered sea ice extent and seasonal dynamics in the Arctic, and similar changes are observed in the Atlantic sector of the Southern Ocean and West Antarctic. This affects stocks of major pelagic species such as krill. A so far neglected key player, the predatory amphipod genus *Themisto*, covers a distribution from temperate to polar regions where it regionally represents the dominant food source for higher trophic levels. Poleward range expansions of several *Themisto* species have been already documented or predicted as warming continues. In the Atlantic sector of the Southern Ocean, changes in seasonal sea ice extension are causing strong annual variations of krill stocks, whilst salps are on the rise and shifting their distribution poleward. A third key player, *Themisto gaudichaudii*, is now also anticipated to extend its range southward. In the Arctic, the ice-dependent Arctic *T. libellula* and the sub-Arctic boreal *T. abyssorum* co-exist. Considering the ongoing Atlantification of the Arctic, a range expansion of *T. abyssorum* concomitant with a retraction of *T. libellula*'s range are very likely to occur. Due to major knowledge gaps in the ecology, biology and genetic connectivity of *Themisto* species, the likelihood of range shifts and their consequences for food web structures and biogeochemical cycles remain largely unexplored. We conducted a comparative study of *Themisto* populations to investigate their distribution, connectivity and trophic ecology. Using population genetic methods, the species status and phylogeography of *T. gaudichaudii*, were characterized. A genetic homogeneity and high degree of phenotypic plasticity related to feeding morphology were revealed, indicating the potential of *T. gaudichaudii* lineages to thrive in regions further south. In order to predict the consequences of an increased predation pressure of *T. gaudichaudii* which may influence the standing stock of Antarctic krill and salps, feeding experiments and molecular diet analyses were carried out. Similar analyses were applied on *Themisto* species from the northern hemisphere, in order to characterize their genetic connectivity within and across different water masses (Atlantic vs. polar) in Fram Strait and East Greenland and compare with the Antarctic populations.

## A SURVIVAL PACK FOR ESCAPING PREDATION IN THE OPEN OCEAN? AMPHIPOD-PTEROPOD ASSOCIATIONS IN THE ANTARCTIC POLAR FRONTAL ZONE AND THE WEDDELL SEA

Charlotte Havermans, Christoph Held,  
Holger Auel, Wilhelm Hagen

Universität Bremen

Hyperiid amphipod crustaceans are abundant in Southern Ocean waters from the Polar Frontal Zone to shelf waters where they represent a major prey for fish and seabirds. *Hyperiella dilatata* has evolved a peculiar anti-predatory behaviour: it abducts chemically-protected, shell-less pteropods from the water column and carries them on their dorsal side. Pteropods such as *Clione antarctica* are known to produce de novo a predator-deterrent chemical. Hence, the tandem formation of amphipods, abducting pteropods from the water column, represents an efficient protection from visual predators. This phenomenon was known from shelf waters around the continent, however, in the open ocean it was so far undocumented. We report this association at four different open-water sites in the Southern Ocean. Molecular analyses based on COI “barcode” sequences revealed that one *Hyperiella* lineage abducted Spongiobranchaea pteropods in the Polar Frontal Zone whilst a distinct *Hyperiella* lineage associates with *Clione* further south in the Weddell Sea. Hypotheses on the origin and function of these species-specific associations are provided in the context of biogeographic data and hyperiid phylogenetic histories.

## RECENT CHANGES IN ANTARCTIC TOURISM AND THEIR CONSEQUENCES FOR SELECTED HISTORICAL SITES

Ingo Heidbrink

Old Dominion University,  
Dept. of History

Although Antarctic tourism is not a new development, but has begun several decades ago, recent years brought some substantial changes including increases in activities like overnight stays on the ice, kayaking, snowshoe hiking etc. In addition, a wide variety of tour operators already brought or will bring in the near future additional ships into service or replace existing ships by new ships, most of them designed to offer additional activities beyond the traditional standard program of Antarctic cruises.

The proposed paper will discuss the influence of these changes in the Antarctic tourism industry with a special focus on the consequences of these changes on selected historic sites in the wider Antarctic Peninsula region.

It will be argued that the existing regulatory system for Antarctic cruise ships in combination with the advertisement practice of most operators does not provide an equal distribution of tourism throughout the Antarctic Peninsula region, but causes heavy pressure on some historic places, including a substantial risk of degradation of these places.

In addition, it will be discussed if the current system of training and qualification for tour guides allows for an appropriate protection of historic sites or if this system is to a certain degree mainly comparable to a proverbial fig leave.

It will also be argued that new activities like overnight stays on the ice result in direct pressure on certain historical sites due to close proximity of the overnight camps and the risk that historic structures might be used as emergency shelters.

Finally it will be shown how increased tourism and new activities contribute to the already existing “thumb-war” on potential future Antarctic sovereignty.

Last but not least, it will be discussed how widening Antarctic tourism to non-traditional markets, in particular Asian markets contributes to the described situation becoming even more severe.

While the concluding section of the proposed paper will not be able to offer solutions for all issues described, it will be shown that some (minor) changes within the regulatory system for Antarctic tourism might be able to substantially lower the pressure on at least some historic sites in Antarctica.

## SEA-ICE PRODUCTION IN THE WEDDELL SEA BY NUMERICAL SIMULATION AND REMOTE SENSING

Günther Heinemann<sup>1</sup>, Rolf Zentek<sup>1</sup>,  
Lukrecia Stulic<sup>2</sup>, Ralph Timmermann<sup>2</sup>,  
Stephan Paul<sup>2</sup>, Andreas Preußner<sup>1</sup>

<sup>1</sup>Environmental Meteorology, University of  
Trier, Germany

<sup>2</sup>Alfred-Wegener Institut,  
Helmholtz-Zentrum für Polar- und  
Meeresforschung

The Weddell Sea in the Atlantic sector of the Southern Ocean is one of the most dynamic air/ice/ocean interaction areas. Coastal polynyas occur frequently during winter, which leads to strong sea ice production, brine release and the formation of High-Salinity Shelf Water (HSSW). This dense water mass contributes to the formation of Weddell Sea Deep and Bottom Water, but also is considered to be one of the main drivers of the circulation in the large sub-ice shelf cavities beneath the Filchner-Ronne Ice Shelf (FRIS). Thus the quantification of quantification of sea ice production in Weddell Sea polynyas is of vital interest for the understanding the ocean circulation in this region.

A multi-method approach is used to quantify sea ice production polynyas in the southern Weddell Sea for the period 2002-2016. We use 1) a regional climate model (CCLM) with 5 km and 15 km resolution (C05/15), 2) retrievals from MODIS data at a high resolution of 1-2 km and 3) simulations of a sea ice-ocean Model (FESOM) with a resolution down to 3 km. Methods 2) and 3) need atmospheric forcing, which is taken from different reanalyses (ERA-I, CSFR, JRA55, NCEP2) as well as from CCLM data. Estimates of sea ice production and comparisons of the different methods are presented for different polynya areas of the Weddell Sea. In all methods, the largest ice production is found for Ronne Ice Shelf and for Brunt Ice Shelf. Polynyas associated with iceberg A23a have the third largest ice production. However, significant differences between different methods and forcing data sets are found for polynya area and ice production. In conclusion, an overall sea ice production of  $110 \pm 30 \text{ km}^3$  per year from polynyas is found, which corresponds to about 15 % of the total ice production in the southern Weddell Sea.

## THE IMPACT OF FOEHN EFFECTS ON THE NEAR-SURFACE CLIMATE OVER THE LARSEN ICE SHELF AT THE ANTARCTIC PENINSULA

G. Heinemann, R. Zentek, L. Knopp

Environmental Meteorology,  
University of Trier

The region of the Antarctic Peninsula (AP) has experienced dramatic changes over the past decades. Its warming rates of about 3 K for the last 50 years are among the highest on Earth. The AP is the only region of the Antarctic where widespread surface melting occurs, which is considered to play a significant role in the disintegration of ice shelves in recent years. The increased atmospheric flow over the AP since the 1960s has increased surface melt and is likely to have initiated the collapse of the Larsen A and B ice shelves.

The role of katabatic winds and foehn effects for the region of the Larsen Ice Shelf has been investigated using observations and regional climate model simulations with a high resolution. The regional climate model COSMO-CLM (CCLM) is used for the Weddell Sea region at 5 km (C05) and 15 km (C15) resolution for the period 2002-2016. CCLM was run with nesting in ERA-Interim reanalyses. Sea ice concentrations were taken from microwave satellite measurements and were updated daily to allow for a close-to-reality hindcast.

Comparison between CCLM and ERA-Interim for the AP region show that katabatic winds are higher over the slopes, which leads also to higher temperatures. Foehn events were detected from C15/05 simulations 2002-2015 using objective criteria for changes in wind, temperature and humidity. Only foehn events exceeding 6h were considered, the longest event lasted 48h. The climatology for the 2 m-temperature of foehn and non-foehn events for the Larsen ice shelf shows that foehn events cause melting frequently even for spring and autumn. In winter, a few cases occur as well. Considering that the recent temperature increase has occurred mainly for autumn, winter and spring, the temperature rise expected for the coming century will probably lead to a large increase in melting events due to foehn also in winter.

## ATMOSPHERE-OCEAN-ICE INTERACTIONS IN ARCTIC POLYNYAS: A LONG-TERM ANALYSIS USING HIGH-RESOLUTION SIMULATIONS AND REMOTE SENSING

G. Heinemann, S. Kohnemann, F. Schnaase, A. Preußner, S. Willmes

Environmental Meteorology,  
University of Trier

Polynyas in the Arctic occur in several areas throughout the winter season. These open-water and thin-ice covered areas interact with the atmosphere via large heat and moisture fluxes and have a strong impact on the atmospheric boundary layer. On the other hand, they are strong ice production areas with associated brine release, which is an important driver for the ocean circulation and vertical mixing of the ocean column. Thus the quantification of sea ice production in Arctic polynyas is of vital interest.

We analyse sea ice production using remote sensing methods and numerical simulations with atmospheric and sea-ice/ocean models. We use MODIS thermal infrared data (MOD/MYD29 Col.6) at a high resolution of 1-2 km and a surface energy balance model to estimate the thin-ice thickness, polynya area and ice production for the winter seasons 2002/2003-2016/2017. The energy balance simulated by the regional climate model COSMO-CLM (CCLM) with 15 km (C15) offers the second method to compute ice production. The polynya area in C15 is prescribed by sea ice concentration data from passive microwave satellite measurements (AMSR-E, SSMI/S, AMSR2). C15 was run with nesting in ERA-Interim data in a forecast mode, while atmospheric data from C15 and ERA-Interim were used for the MODIS retrievals. The third method relies on simulations using the Finite Element Sea ice-Ocean Model (FESOM). FESOM is run on a global grid with a resolution of about 9 km for the Arctic with atmospheric forcing from ERA-Interim. While the first two methods do not account for the ocean heat flux, this term is simulated by FESOM.

The three methods are intercompared for the main Arctic polynya areas with a focus on the Laptev Sea and North Water polynyas. The main difference between CCLM and the much coarser reanalyses is the missing or insufficient representation of polynyas and their interaction with the atmospheric boundary layer. The analysis of surface energy balance components shows the sensible heat flux as the largest contributor to ice production. Therefore differences in the parameterizations of this flux in the different methods can be accounted partly for the differences in ice production. However, the differences in polynya area are most important. Overall, FESOM simulates a smaller ice production than CCLM. For the Fram Strait area this can be explained by a relatively high ocean heat flux. In general, larger polynya areas are found by the MODIS retrievals due to the high resolution and therefore an increased ability to resolve narrow bands of open water and thin ice. On average, about 10 % of the ice production in the Arctic results from polynyas.

## FILTER-FEEDING CRUSTACEANS CONQUER A HABITAT DEVOID OF LIFE ON THE UNDERSIDE OF THE ANTARCTIC SHELF ICE

Christoph Held, Dominik Nachtsheim,  
Nils Owsianowski, Claudio Richter,  
Richard Steinmetz, Horst Bornemann

Alfred-Wegener Institut  
Helmholtz Zentrum für Polar- und  
Meeresforschung

The colonization of a new habitat affords an important advantage to the successful pioneer species because competitors, predators and parasites are likely to be out of step. Here, we report the first retrieval and molecular characterization of a cryo-benthic community of isopod crustaceans that live at depths of 80-150m on the underside of a floating shelf-ice tongue at the Drescher Inlet (Riiser-Larsen Ice Shelf), Eastern Weddell Sea. The specimens were retrieved with a sampler mounted on a remotely operated vehicle (ROV) when video transects were carried out.

The molecular analysis of mitochondrial and nuclear genes of four specimens spanning the size range of individuals collected confirmed that (1) all belonged to a single species and that (2) this species has previously been identified in benthic communities in the Eastern Weddell Sea as *Antarcturus cf. spinacoronatus*. The molecular phylogeny shows that the cryo-benthic *A. cf. spinacoronatus* are deeply nested in a family of isopods characterized by increasing complexity of morphological and behavioural adaptations to the acquisition of detrital and planktonic food particles. This demonstrates that the floating shelf-ice was likely colonized from the seafloor and not vice versa and that the filter-feeding life style of *A. cf. spinacoronatus* formed a predisposition playing a key role in the colonization of the new habitat.

Density estimates of *A. spinacoronatus* under the floating shelf ice (25 adults and 190 juveniles per square meter) are significantly higher than on the seafloor, suggesting that the transition to the new habitat devoid of any macrofaunal competition or predation provides a major advantage to the species.

## THE FILCHNER TROUGH / FILCHNER ICE SHELF CAVITY SYSTEM

H. H. Hellmer, T. Hattermann, S. Ryan,  
M. Schröder

Alfred-Wegener-Institut  
Helmholtz-Zentrum für Polar- und  
Meeresforschung

Since austral summer 2013/14 AWI maintains a mooring array on the eastern slope of Filchner Trough at 76°S to monitor any flow of warm waters of open ocean origin towards the Filchner Ice Shelf (FIS) cavity. During the austral summers 2015/16 and 2016/17, seven oceanographic moorings were deployed beneath FIS through hot-water-drilled access holes to investigate and monitor the processes controlling the supply of ocean heat to the ice shelf base. This data, transferred to AWI via satellite link, shows that two 'regimes' exist beneath FIS. Dense High Salinity Shelf Water (HSSW), formed in front of the Ronne Ice Shelf, dominates the southern cavity and exits as Ice Shelf Water (ISW) the cavity along the western flank of the Filchner Trough. Less dense HSSW with a local origin in front of FIS enters the cavity on the eastern side of the Filchner Trough during parts of the year but seems to be trapped at depth, interacting laterally with derivatives of the Ronne-sourced HSSW. No evidence exists that it penetrates to the deep southern FIS grounding line. At 76°S, the flow of warm waters towards FIS is seasonal, limited to late summer/early winter, being replaced by ISW for the rest of the year. The link of the two sub-ice shelf circulation regimes to different regions of dense water formation on the continental shelf, and its sensitivity to the inflow of warm waters need to be further investigated to reduce the uncertainty of estimates on the FIS mass balance for today and the future.



## STUDY OF CLOUD CONDENSATION NUCLEI AND ICE NUCLEATING PARTICLES IN THE SOUTHERN OCEAN

Silvia Henning, André Welti, Markus  
Hartmann, Mareike Löffler, Andrea  
Baccarini, Heini Wernli, Frank  
Stratmann, Danny Rosenfeld, Martin  
Gysel and Julia Schmale

TROPOS Leipzig

The Southern Ocean (SO) is the most pristine aerosol environment on Earth [1], however almost the entire region is considered as heavily under-sampled with regards to any aerosol property. As partner of the “Study of Preindustrial-like-Aerosol Climate Effects” (SPACE) project, we participated in the unprecedented Antarctic Circumnavigation Expedition (ACE, December 2016 – March 2017), which gave us the unique opportunity to conduct high quality aerosol measurements in this remote region. ACE-SPACE in general aims at a detailed characterization of aerosol which is unaffected by anthropogenic pollution and therefore represents an aerosol comparable to that in a pre-industrial atmosphere. Our, i.e., TROPOS’ special focus in context of ACE-SPACE is on aerosol particles involved in aerosol cloud interactions, specifically those that are able to act as cloud condensation nuclei (CCN), as well as to nucleate ice (INP). We will present results concerning the spatial distribution of CCN and INP concentrations around the Antarctic continent, CCN hygroscopicity and INP’s freezing characteristics, as well as possible CCN and INP sources based on the analysis of back trajectories. Further we plan to use the INP and CCN data to constrain satellite retrieval methods.

### Reference

- [1] Hamilton, D. S., Lee, L. A., Pringle, K. J., Reddington, C. L., Spracklen, D. V. & Carslaw, K. S. (2014). Occurrence of pristine aerosol environments on a polluted planet. *Proceedings of the National Academy of Sciences*, 111(52), 18466-18471.

## **AUTOMATED DETECTION AND TIME SERIES ANALYSIS OF SUPRAGLACIAL LAKES ON THE 79°N GLACIER, NORTHEAST GREENLAND: DEVELOPMENT OF A THREE-SENSOR METHOD INCLUDING MODIS, LANDSAT AND SENTINEL 2**

Philipp Hochreuther, Malte Manne,  
Matthias Braun

Institute of Geography at the University  
of Erlangen-Nuremberg

Time series of the amount, size and depth of supraglacial lakes (SGL) provide an indication of changes in glacial mass balances. They are directly linked to the glaciers' temperature regime during the melt season, as well as to ice dynamics due to rapid drainage. The multi-spectral detection routines of SGLs using a single sensor usually suffer from either long revisiting times of the respective satellites, or from coarse resolution preventing accurate SGL detection. The present standard methodology thus is to combine two sensors by employing a high-resolution sensor as ground truth, thus partly eliminating both systematic flaws. Still, the presence of clouds in the high Arctic reduces the number of available high-resolution scenes, and require the a priori manual selection of appropriate data. Here, we present a fully automated three-sensor approach by combining data from MODIS Terra with short revisiting times and coarse resolution, Landsat 8 OLI with longer revisiting times and higher resolution, and Sentinel 2 with short revisiting times and high resolution. Automated scene selection is based on the daily MODIS snow cover product. The multi-sensor approach is tested at the 79°N glacier (Nioghalvfjærdsbræ) in northeast Greenland. First results indicate that the automated pre-selection of Landsat- and Sentinel scenes significantly improves the time and efficiency of the analysis though minimizing the download amount of unsuitable data, and processing time. Additionally, the higher density of high-resolution scenes compared to standard approaches reduces the uncertainties in the detection of timing and duration of SGL drainage events.

## ALTERNATIVE USE OF ICE CHARTS

Jürgen Holfort and  
Sandra Schwegmann

Bundesamt für Seeschifffahrt und  
Hydrographie

The operational ice charts made by the different national ice services are in first case intended for ships navigating in or near the sea ice. We will present some new portrayals which are feasible due to the more data driven delivery of ice charts in S-411. But we hear also about customers using the charts for ice fishing, ski-doo or dog-sledge travel, etc. It would be possible to make special ice charts for such customer, if we know better the exact needs of these customers. For ice fishing it could be a portrayal of fast ice with thickness larger than 10cm in green and all other regions in red. Perhaps also include a yellow region? The needed parameters are already available in the ice charts. But perhaps one could include further parameters if there is some need. We will present some alternative portrayals for actual ice charts and also give some ideas including non-standard parameters. We hope also to get into contact to “alternative” customers to learn about their needs.

## MELTING, RE-FREEZING AND SUBGLACIAL RUNOFF BENEATH FILCHNER-RONNE ICE SHELF FROM FIRST NOBLE GAS MEASUREMENTS INSIDE AN ICE SHELF CAVITY

Oliver Huhn, Tore Hattermann, Peter  
E. D. Davis, Erich Dunker, Hartmut H.  
Hellmer, Svein Østerhus, Monika Rhein,  
Michael Schröder, Jürgen Sültenfuß,  
Keith W. Nicholls

Institut für Umweltphysik (IUP), Abt.  
Ozeanographie, Universität Bremen

The ice shelves surrounding Antarctica are losing mass through submarine melting when in contact with warm ocean water. An accelerated melting as envisioned by global warming would have consequences for the discharge of continental ice into the ocean, and for the formation of Antarctic Bottom Water and thus the strength of the oceanic meridional overturning circulation. The noble gases helium and neon are uniquely suited to detect basal melt water in the ocean. Therefore, for the first time, we collected these gases from water beneath an ice shelf by deploying a novel gas-tight *in-situ* water sampler through hot water drilled bore holes in the Filchner Ice Shelf.

Inside the cavity we quantified basal melt water fractions ranging up to 3.6 % directly below the ice shelf base and still above 0.5 % near the bottom of the cavity, with distinct regional differences. We also identified helium from the crust trapped in the bedrock near ice (13 % of the total melt), most likely originating from the Support Force Glacier. At the bore hole sites 60 km south of the ice shelf edge, we estimated that up to 2.7 % of the melt water had refrozen.“

## GEODYNAMIC EVOLUTION OF EAST ANTARCTICA REVEALED BY INTEGRATING GEOLOGY AND GEOPHYSICS IN DRONNING MAUD LAND

Joachim Jacobs, Andreas Läufer,  
Marlina Elburg, Detlef Damaske,  
Antonia Ruppel, Graeme Eagles,  
Birgitte Opås, Wilfried Jokat, Solveig  
Estrada

Department of Earth Science,  
University of Bergen

The Dronning Maud Land Mountains in East Antarctica form a key area for the better understanding of the geodynamic evolution of East Antarctica. Specifically, the integration of geophysics with geology and geochronology reveals the complex tectonic history of East Antarctica and its significance for Rodinia and Gondwana reconstructions. The international GEA-expeditions (2010-12) revealed three major tectonic provinces: a westernmost part with Kalahari (Africa) affinities and an easternmost part from about 35E with Indo-Antarctic affinities sandwiched in between these two blocks, is an extensive region with juvenile Neoproterozoic crust (ca. 990-900 Ma), the Tonian Oceanic Arc Super Terrane (TOAST) that shows very limited signs of a pre-Neoproterozoic history. We have tested the spatial extent of the TOAST by a regional moraine study that confirm the lack of older material inland, though latest Mesoproterozoic juvenile rocks frequently do occur in the glacial drift and probably record a slightly earlier precursor of the TOAST inland. The TOAST records 150 Ma of almost continuous tectono-metamorphic reworking at medium- to high-grade metamorphic conditions between ca. 650 to 500 Ma. This long-lasting overprinting history is thought to record protracted accretion of ocean island arc terranes and the final amalgamation of East Antarctica along the major East African-Antarctic Orogen. There is no sign of significant metamorphic overprint immediately after the formation of TOAST. Therefore, these island arcs may have formed independent of, or peripheral to Rodinia, and may reveal major accretionary tectonics outboard of Rodinia.

## **LONG-TERM MULTIDISCIPLINARY RESEARCH ALONG A GRADIENT OF HIGH LATITUDES TO TRACK CLIMATE CHANGE: FROM STATION-BASED STUDIES TO NEW OBSERVATORY CONCEPTS**

Kerstin Jerosch, Lars Beierlein, Irene  
Schloss, Ricardo Sahade, Maria L.  
Quartino, Humberto González, Gustavo  
Ferreyra and Doris Abele

Alfred-Wegener Institut  
Helmholtz Zentrum für Polar- und  
Meeresforschung

The coastal polar and subpolar systems are particularly affected by a rapid regional climate change. Gathering hydrographic core and specific ecological data for the past 25 years at the Dallmann-Carlini station in Potter Cove (King George Island, South Shetland Islands) has proven a continuous observation to be essential for understanding the dynamic changes of marine and terrestrial ecosystems in the Northern West Antarctic Peninsula (WAP) sector. Several long-term ecological data series were analyzed to track climate change across system compartments from glaciology to community composition. It is for the first time ever that the ecological impacts of the transgression from a tidewater to an exclusively land based glacier in an Antarctic cove is documented by a multi-disciplinary research team. While focusing on the climate change related processes in the showcase area Potter Cove, expansion of the research scope to compare the local King George Island to the regional recent and late Holocene deglaciation patterns at the WAP are planned through cross station networking with USA and UK partner activities in different areas of the WAP (recent Belmont call on Biodiversity and Ecosystem Services proposal FjordBioServices) and towards the sub-Antarctic systems of Tierra del Fuego. In order to improve our understanding of climate change effects on highly dynamic and understudied areas in the Antarctic and Sub-Antarctic the SCAR community highlighted the importance of coastal observatories. Mirroring our previous multinational, interdisciplinary observations in Potter Cove, BLOOMS, we introduce to the Beagle Land and Ocean Observing and Modelling System, a multinational (Argentinian, Chilean, German, and USA) and interdisciplinary initiative to study the effects of climate change on terrestrial and marine systems. A first workshop on the implementation of an observatory, supported by Argentinian and German funds within the frame of the DynAMo project (Dynamic Effects of Climate Change and loss of ice mass on terrestrial, limnic and marine ecosystems in Patagonia, BMBF), addressed main scientific questions and discussed local stakeholder involvement. A first joint field mission is planned for austral spring 2018, and instruments are planned to be launched in 2019.

## INDIA-ANTARCTIC BREAKUP: CONSTRAINTS FROM NEW GEOPHYSICAL DATA

W. Jokat, T. Altenbernd, W. Geissler,  
G. Eagles

Alfred-Wegener-Institut  
Helmholtz-Zentrum für Polar- und  
Meeresforschung

The India-Antarctica separation is still an open problem due to the absence of critical geophysical data. So far no wide-angle data existed along the conjugate margins of East India and the Enderby Land off East Antarctica to define the position and composition of the continent-ocean boundary - a pre-requisite for any sound reconstruction. Furthermore, along both margins only old marine magnetic random track data are available for identifying seafloor spreading anomalies to describe the drift of both continents in the Cretaceous. The Kerguelen Plateau, located just north of the East Antarctica coast, however, has been drilled several times providing the only reliable age constraint on the formation of this huge magmatic plateau. In general, the poor information resulted a wide variety of kinematic models for the drift of the India.

In the last years several newly acquired geophysical data provide new constraints on its drift. Two deep seismic sounding lines off Prydz Bay and across the Princess Elisabeth Trough show that oceanic crust is already present much closer to the present-day shelf break than previously known. Magnetic data acquired parallel to these lines provide excellent timing constraints for the initial breakup of India. Finally, marine magnetic data gathered in 2017 south of Sri Lanka indicate that here the oceanic crust is definitely younger than magnetic chron M0, questioning several kinematic models for the Indian Ocean. The latest results will be presented.“

## DIE VERSAUERUNG DER POLARMEERE ALS KONTEXT IN DER SCHULE

Monika Kallfelz

Pfalzmuseum für Naturkunde -  
POLLICHIA-Museum

Wie sauer ist der Ozean? Wie sauer kann er werden? Warum sind die Polarmeere besonders betroffen? Wie kommen Lebewesen damit zurecht? Ist das gut für die Atmosphäre und was hat das mit dem Klima zu tun? Solche Fragen äußern Jugendliche, wenn das Stichwort Versauerung der Meere fällt. Eine Möglichkeit sich diesen Fragen zu nähern, bietet der Chemieunterricht der Mittelstufe (Sekundarstufe I). Die Versauerung der Ozeane ist ein interessanter Kontext, wenn es um Säuren und den pH-Wert geht. In Rheinland-Pfalz gibt es sogar ein eigenes Themenfeld „Stoffe im Fokus von Umwelt und Klima“, das ausgezeichnet zu dieser Thematik passt.

Chemiker beschreiben die Vorgänge mit mehreren zusammenhängenden Gleichgewichtsreaktionen. Der Begriff des chemischen Gleichgewichts ist ziemlich abstrakt und in der Schule der Sekundarstufe II vorbehalten. Deshalb tut man gut daran, ohne diesen Begriff auszukommen. Didaktisch reduziert spricht man besser von unvollständig verlaufenden und von umkehrbaren Reaktionen.

Zur Entwicklung des Verständnisses stelle ich eine Serie aufeinander aufbauender Experimente vor, die die verschiedenen Phänomene ganz anschaulich auf der Stoffebene zeigen. Sie ermöglichen Schülerinnen und Schülern Eigenschaften und Reaktionen von Kohlenstoffdioxid experimentell zu untersuchen und ihre Bedeutung für den Ozean, insbesondere in den Polargebieten zu erschließen. Vertiefend werden die chemischen Reaktionen auf der Teilchenebene betrachtet und schließlich in Formelsprache als Reaktionsgleichung formuliert.

**Literatur:** Kallfelz, M., Die Versauerung der Ozeane – Die Rolle des Meeres in Zeiten des Klimawandels  
Biologie im naturwissenschaftlichen Unterricht 5-10, Heft 20, 2017, Seite 34 37

Broschüre: Das andere CO<sub>2</sub> Problem – Ozeanversauerung

Acht Experimente für Schüler und Lehrer

Die in dieser Broschüre vorgestellten Experimente wurden gemeinsam von Lehrkräften und KlimawissenschaftlerInnen im Rahmen der Projekte BIOACID und CarboSchools entwickelt.

Link zum Download [http://www.bioacid.de/front\\_content.php?idart=725:idlang=22](http://www.bioacid.de/front_content.php?idart=725:idlang=22)



## POLAR KNOWLEDGE CONTEST AND POLAR EXPEDITION FOR HIGH SCHOOL STUDENTS OF ESTONIA

E. Kaup<sup>1,2</sup>, M. Hunt<sup>2</sup>, V. Raidla<sup>1</sup>, K. Savomägi<sup>2,3</sup>, H. Uppin<sup>3</sup>, M. Varvas<sup>2</sup>

<sup>1</sup> Department of Geology at Tallinn University of Technology

<sup>2</sup> Estonian Polar Club, Tallinn

<sup>3</sup> Estonian Maritime Museum, Tallinn

In order to increase public interest and awareness in polar areas and to contribute to rising a new generation of polar scientist, Estonian Polar Club organised in 2017 polar knowledge contest and following expedition to North Scandinavia for high school students.

The I stage of contest was Internet-based. During 3 days the attendants had to answer to 40 questions on Arctic and Antarctic environment and its protection, plant and animal life, human activities and research history, incl. contributions from Estonians. There was 258 attendants aged 15-19 from 40 schools all over Estonia. The best 34 students were proposed to write an essay on polar matters and invited to attend the II stage of contest. This took place in Seaplane Harbor of Estonian Maritime Museum and lasted 6 hours.

There was no access to external information at II stage. The tasks included: answer to 20 questions (similar to stage I) ; to demonstrate understanding of popular science paper on hydrological properties of an unusual antarctic lake; to show group work ability solving practical tasks using maps of future expedition activity area. The area was Subarctic Kilpisjärvi region in NW Finnish Lapland. The 5 winners got the award to attend the polar expedition, the others received various polar-related information sources and souvenirs. All attendants viewed the maritime rescue exhibition MAYDAY in Seaplane Harbor.

The expedition proceeded during 22-30 July 2017, 5 students were accompanied by 3 Polar Club members. Included were visits to several polar institutions: Nanoq polar museum in Pietarsaari (Jakobstad), Arktikum science centre and museum in Rovaniemi, Pallastunturi in Lapland, polar museum and northernmost botanical garden in Tromsø. The science activities were centred during 4-days stay at Kilpisjärvi Biological Station of Helsinki University at 69° N. Students attended hands-on in studies of local geology and limnology. Such studies have been carried out there since 2008 by scientists from Department of Geology at Tallinn University of Technology.

The knowledge contest and the following expedition was rather good covered in social and local media. In August there was a concluding conference in Maritime Museum where expedition participant, Polar Club members, students, relatives and friends, media people and interested public attended. An overview of expedition was given, preliminary research results presented and discussed. The students expressed satisfaction with interesting and horizon-widening experience. At least one of 5 winners declared interest in future studies that could pave way to polar areas.

## CHANGES IN SEA ICE DEFORMATION AND IMPACT OF WIND FORCING

Aliaksandra Kazlova, Gunnar Spreen

Universität Bremen

Arctic sea ice is a key element of the climate system, which has impact on the regional climate in the mid-latitudes in Eurasia and Northern America and the global climate. During recent decades, the increase of the sea ice speed by 10-15 % per decade has been observed from buoys and satellites and there is an evidence of change in sea ice deformation from buoys. Sea ice deformation is as an important factor of the sea ice cover with high spatial and temporal variability and covering different scales. In this study, high spatial resolution Synthetic Aperture Radar (SAR) observations from RADARSAT and ENVISAT are analyzed for long-term ice deformation changes. Because both of this datasets are covering different parts of the Arctic Basin and have just a small temporal and spatial overlap, they are analyzed separately. The RADARSAT RGPS data is mainly covering the Canadian Basin and Beaufort Sea (November 1996 – April 2014) and the ENVISAT dataset mainly covers the European Arctic region (January 2007 – April 2012). Findings will contribute to better quantify the changes in Arctic sea ice dynamics and evaluate sea-ice models.

Observed sea ice deformation changes are compared to Atmospheric reanalysis to gain understanding of the causes. On short time scale changes in wind are the main driver of sea ice drift. However, studies show that for most of the Arctic Basin changes in wind speed cannot explain the increase in sea ice drift speed. In this study we compare sea ice deformation fields from satellites to the wind forcing from reanalysis to quantify their relation. In accordance with the increase in sea ice speed, the sea ice deformation in the Canadian Basin increased during the 1996-2014 period. First results show that there is a correlation between the wind and the sea ice deformation.

## **VEGETATION COVERAGE IS DEPENDENT ON MOISTURE AVAILABILITY IN THE ARCTIC (SPITSBERGEN, NORWAY)**

Ramona Kern, Vivien Hotter, Christel Baum, Ulf Karsten

University of Rostock, Applied Ecology and Phycology

Nowhere is the climate change impact more visible than in the Arctic. The Arctic winter temperature increase is two to three times of the planet's average – a phenomenon also known as Arctic amplification (Screen NATURE GEOSCIENCE 2017). Especially the Arctic tundra is sensible to climate change and the microbial responses are known to be complex. However, Arctic soil and lake microbial communities have an important role in e. g. the global carbon cycle. Therefore, a comprehensive understanding of the biodiversity and activity of soil and lake microbial communities is crucial to evaluate their role on ecosystem functions with a focus on the climate change impact. To study the diversity of microbes and plants we chose two study sites at the High Arctic island Svalbard (Knudsenheia and Ossian Sarsfjellet). We analyzed the vegetation coverage and soil properties with a focus on biological soil crusts (BSCs) along an environmental gradient with increased water availability (dry, medium, and wet) at both study sites in summer 2017. Further, we will re-sample the same plots in spring and winter 2018 to investigate the given temporal gradient. In both field sites the investigated vegetation coverage is similar with a large proportion of BSCs and mosses. However, we only find cyanobacteria dominated BSCs. Especially in Knudsenheia, lichens are the dominant vegetation in the dry plots. The investigated vegetation coverage was further compared to the soil parameters like the carbon and nitrogen content.

## DID WE FIND AN ICE-PROXIMAL LOCATION IN THE AMUNDSEN SEA TO FINALLY REVEAL THE LAST INTERGLACIAL STATE OF THE WEST ANTARCTIC ICE SHEET?

J.P. Klages, G. Kuhn, C.-D. Hillenbrand,  
J.A. Smith, F.O. Nitsche, T. Frederichs,  
K. Gohl, L. Wacker

Alfred-Wegener-Institut  
Helmholtz-Zentrum für Polar- und  
Meeresforschung

One of the major questions in palaeoclimate research is whether or not the West Antarctic Ice Sheet (WAIS) collapsed during the warmest phase of the last interglacial period (Marine Isotope Stage 5e 130-116 ka). Several numerical models and sea-level reconstructions suggest such a collapse, but critically it has not been confirmed by WAIS proximal empirical data, yet. Answering this question by analyzing sedimentary sequences from the West Antarctic shelf requires areas that remained unaffected by 1) erosion by grounded ice, and 2) scouring by iceberg keels since MIS 5e. During RV *Polarstern* Expedition ANT-XXVII/3 in early 2010 we discovered such an area on the Amundsen Sea shelf for the first time. We demonstrate that the outermost section of the Cosgrove-Abbot palaeo-ice stream trough in the easternmost Amundsen Sea Embayment was not covered by grounded ice during the last glacial period, and that a part of this area was largely protected from iceberg scouring by its large water depth and a grounding zone wedge located further landward. We present combined geophysical and geological data revealing this unique location at which the state of the WAIS during the last peak interglacial may be reconstructed, and give an outlook on how this could be achieved.

## **HIGH THROUGHPUT MICROSCOPIC IMAGING AND SEMI-AUTOMATED IMAGE ANALYSIS FOR DIATOM PERMANENT SLIDES**

Michael Kloster, Gerhard Kauer, Tim  
Nattkemper, Bábk Beszteri

Alfred-Wegener Institut  
Helmholtz Zentrum für Polar- und  
Meeresforschung

We recently developed a workflow combining high throughput microscopic imaging with image analysis implemented in our custom developed software SHERPA. This workflow enables the extraction of morphometric features from large numbers of specimens mounted onto diatom slides, and can be used for downstream analyses addressing morphometric variability or taxonomic identification. On this poster, we present the workflow and three case studies looking at morphometric variability at the intraspecific and intrageneric level, and give an outlook towards ongoing work aimed at bringing these methods to a next level, i.e., making them applicable for community analyses.

## IMPORTANCE OF METHANE PRODUCTION FOR THE GREENHOUSE GAS BUDGET OF THAWING PERMAFROST

Christian Knoblauch, Christian Beer,  
Susanne Liebner, Mikhail N. Grigoriev,  
Eva-Maria Pfeiffer

Institute of Soil Science / University of  
Hamburg

Permafrost in circum-arctic soils stores as much carbon as the global atmosphere. Permafrost thaw liberates organic matter, which is mineralized by microorganisms to carbon dioxide (CO<sub>2</sub>) and methane (CH<sub>4</sub>). The release of these greenhouse gases (GHGs) may form a positive feedback to atmospheric CO<sub>2</sub> and CH<sub>4</sub> concentrations and accelerate climate change. The microbial formation of CH<sub>4</sub>, which has 28 to 45 times the global warming potential (GWP) of CO<sub>2</sub> (100 years time scale), requires anoxic conditions. Current studies indicate that permafrost thaw at the bottom of well drained (oxic) soils cause a higher formation of GHGs than in water saturated (anoxic) soils since more CO<sub>2</sub> is formed under oxic conditions and only small amounts of CH<sub>4</sub> are formed from permafrost organic matter under anoxic conditions. Here we show through 7-year laboratory incubations and molecular analysis of Siberian permafrost that low CH<sub>4</sub> production from permafrost organic matter is due to the lack of active methanogens. Equal amounts of organic carbon are mineralized to CO<sub>2</sub> and CH<sub>4</sub> under anoxic conditions after an active methanogenic community has established. Field measurements demonstrate that recently thawed permafrost organic matter is a substantial source for CH<sub>4</sub> if primed with surface soil. An organic carbon decomposition model, calibrated with the long-term incubation data, predicts a higher loss of permafrost carbon under oxic conditions but a twice as high production of CO<sub>2</sub>-C equivalents under anoxic conditions when considering a GWP of 28 for CH<sub>4</sub>. Combining these model results with observed permafrost carbon profile data, up-scaled carbon stocks and thaw depth projections suggests a global formation of 3 – 10 Pg CO<sub>2</sub>-C from thawing permafrost in oxic soils compared to 0.2 – 0.6 Pg CO<sub>2</sub>-C and 0.2 – 0.8 Pg CH<sub>4</sub>-C in anoxic soils until 2100. However, based on CO<sub>2</sub>-C equivalents the GHG production in anoxic soils (2 – 9 Pg CO<sub>2</sub>-C equivalents) is similar to those in oxic soils. These findings challenge the view of a stronger permafrost carbon-climate feedback from drained soils and emphasize the importance of CH<sub>4</sub> production in thawing permafrost.

## GREENLAND IN MOTION – GLACIAL ISOSTATIC ADJUSTMENT FROM GROUND-BASED MEASUREMENTS AND ITS LINKAGE TO MASS BALANCE AND DYNAMICS OF THE ICE SHEET

Christoph Knöfel, Susanne Lunz, Mirko  
Scheinert, Martin Horwath, Undine  
Strößenreuther, Ludwig Schröder,  
Andreas Groh

Technische Universität Dresden

The Institut für Planetare Geodäsie of TU Dresden has been working in Greenland since 1995. GNSS sites on bedrock were set up both in West Greenland (between 62° and 71° North) and Northeast Greenland (between 72° and 81° North). We will shortly review these GNSS data recordings and the results gained so far for West Greenland. In Northeast Greenland, GNSS measurements were carried out lastly during a field campaign in July 2017 as well as during the cruises PS100 and PS1009 of the German research vessel *Polarstern* in 2016 and 2017. The entire GNSS data set including the latest measurements has been analysed especially in terms of vertical uplift rates. We will discuss the gained results in order to separate the glacial-isostatic adjustment and the instantaneous elastic response of the Earth's crust related to recent ice-mass changes.

A focus will be given to the 79°N glacier (79NG) that forms – together with its neighbour in the south, the Zachariae Isstroem – the major outlet of the Northeast Greenland Ice Stream (NEGIS). This region is subject to the joint research project “Greenland Ice Sheet – Ocean Interaction” (GROCE) where several German universities and research centres are cooperating. We will shortly introduce this project that aims at investigating in detail how atmosphere, ocean and glaciers are interlinked. Observations and modelling will help to better understand the processes related to, for instance, basal melting, tidal excitation of ice-sheet dynamics beyond the grounding zone or the impact of increased freshwater influx on ocean circulation. There, we also have set up a GNSS station to directly measure ocean tides.

We will give an outlook on future work to be accomplished within the GROCE project that will include investigations on glacial isostasy, mass balance and dynamics of the Greenland Ice Sheet in that focus area. The GIA effect will be determined also by the combination of satellite altimetry and gravimetry, which then can be compared to the results of the *in-situ* GNSS measurements on bedrock. Additional methods and observations like flow velocities, grounding line and frontal positions have the potential to support the separation of the effects of surface mass balance and ice dynamics and will complete the picture of the region of interest.

## REMOTE SENSING ANALYSIS FOR THE EXPLORATION OF SAFE TRANSPORT PATHS ON THE ICE AT DRONNING MAUD LAND, ANTARCTICA

Stefan Knetsch, Stuart McFadzean,  
Christian Pfeifer and Osama Mustafa

ThINK - Thuringian Institut of  
Sustainability and Climate Protection

For scientific and logistic expeditions in Antarctica, identifying safe traverse routes and safe landing areas on snow or ice is a significant challenge. Here we present satellite based approaches to support traverse planning as well as the exploration of a new blue ice runway in Dronning Maud Land, East Antarctica. For traverse planning we used both optical (Landsat 8, 15 m ground sample distance (GSD)) and C-band radar images (Sentinel-1, 10 m GSD and Radarsat-2 1.5 m GSD). Data on ice flow speed helped us to detect shear zones with higher risk of crevasses. For the blue ice runway we used hi-res optical images (World View 2, 0.4 m GSD) and a stereographic derived Digital Surface Model (2 m GSD). By combining and analysing these data sets we could identify dangerous areas (e.g. crevasses, erratica, steep slopes). For the runway exploration additionally hi-res maps on micromorphological parameters (e.g. slope, roughness) and cross sections were created in scales up to 1:12,000. All results were delivered as interactive field maps with offline usability. To deal with highly dynamic glacial areas, near-time support to field teams, using of the most recent satellite images was provided. Antarctica is a high stakes environment and our analyses can identify potential hazards during the planning phase to reduce costs, time and increase the safety of field work.



## THE KULUTINGWAK FORMATION – EVIDENCE FOR OCEANIC CRUST BETWEEN PEARYA AND THE FRANKLINIAN BASIN (ELLESMERE ISLAND, CANADA)?

N. Koglin, K. Piepjohn

Federal Institute for Geosciences and  
Natural Resources (BGR)

The origin and emplacement of the exotic Precambrian Pearya terrane (northern Ellesmere Island, Canada) is still a matter of debate. The boundary between Pearya and the passive margin of the Franklinian basin is assumed within the Petersen Bay Fault Zone (Piepjohn & von Gosen 2017). Within this fault zone, amphibolitic rocks of the Kulutingwak Formation crop out, for which some authors (Trettin et al. 1987; Trettin 1998; Beranek et al. 2015) assume an island-arc affinity and an age of 450 Ma has been determined (Trettin 1998). In contrast, a recent study by (Hadlari et al. 2014) suggests a pericratonic model for the Pearya terrane.

During the CASE19 expedition 2017, amphibolite and metasediments of the Kulutingwak Formation were collected within the Petersen Bay Fault Zone west of Kulutingwak Fiord. Some samples were immediately analysed for preliminary data: The volcanic rocks can be classified as subalkaline andesitic basalt to andesite with tholeiitic to calc-alkaline geochemical signature and oceanic island arc affinity. The metasediments are rich in SiO<sub>2</sub> and Fe<sub>2</sub>O<sub>3</sub> and indicate an arc setting.

Preliminary geochemical results in combination with the 450-Ma age of Trettin (1998) might be an indicator for the existence of an oceanic island arc during Ordovician times and, therefore, an open oceanic basin between Pearya and the northern margin of Laurentia. In this case, the Kulutingwak Formation rocks would represent a suture zone. However, further investigation of the whole sample set is necessary to constrain these preliminary results and to consider a new assignment of the Kulutingwak Formation.

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## **NAPA – NATIONAL ARCHIVE FOR POLAR SAMPLES (NATIONALES POLARPROBENARCHIV) OF THE BGR: A POOL OF SAMPLES FOR RESEARCH OF THE EARTH'S CRUST**

N. Koglin, S. Estrada, C. Gaedicke, A.  
Läufer

Federal Institute for Geosciences  
and Natural Resources (BGR)

The National archive for polar samples (NAPA) in Berlin-Spandau is a long-term storage of rock samples, which stem preferably from geoscientific projects in the Arctic and Antarctic regions. It serves for documentation, comparison and for further scientific work with these samples.

Since 2007, the archive grew up to 50 collection cabinets. The hitherto stored samples stem from different areas of the Arctic (e.g. Spitsbergen, Ellesmere Island) and Antarctic regions (e.g. Victoria Land, Dronning Maud Land, Shackleton Range, Marie Byrd Land) and comprise major rock collections like those from the University of Aachen (Antarctica; Spaeth & Bauer) with c. 1300 samples, the University of Frankfurt (Antarctica; Kleinschmidt and PhD students) with more than 3000 samples and the University of Bremen (Arctic; Scheibner and students) with c. 1500 samples.

All samples are listed in a database and documented in outcrop maps. Currently, a new joint database system is invented, which shall also comprise all samples of the NAPA and which shall be used for online research. Research will be possible for different features as name, location, rock type, researcher, etc. Additionally, during the next year, all samples will be documented by photos, which will be added to the database as well.

Together with the polar rock collection at BGR (Hannover), which comprise all samples taken by BGR members, the NAPA offers a large pool of polar rock samples for further projects and research. The NAPA is under supervision of the working group Polar Geology at BGR in Hannover. For requests, please contact:

## EXTREME CHANGES IN ARCTIC WINTER WARMING SINCE THE BEGINNING OF THE 21ST CENTURY

Svenja H.E. Kohnemann, Günther  
Heinemann, David H. Bromwich, Oliver  
Gutjahr

Environmental Meteorology,  
University of Trier

The high-resolution atmospheric model COSMO-CLM (CCLM, German Meteorological Service) is used to simulate the 2m-temperature and the boundary layer structures in the Arctic for the winter periods (Nov-Apr) from 1987/88 to 2016/17. The CCLM simulations have a horizontal resolution of 15 km and are nested in ERA-Interim data. CCLM simulations are compared with Arctic System Reanalysis data (ASR, Byrd Polar and Climate Research Center), which are available with a horizontal resolution of 30 km for the period 2000-2012.

The analysis shows a high spatial and temporal variability of the recent 2-m air temperature increase. The warming in the 2-m air temperatures for the years before 2000 compared to the years after are extreme and are up to eight times higher since the beginning of the 21st century. The maximum warming is found for March in the Kara Sea and Barents Sea and amounts up to 20°C between 2003 and 2012.

Land-based observations agree with the findings in this region, but do not cover the maximum increase that is located over the ocean and sea ice areas. The comparable ASR data also confirm the increase. The differences between CCLM and ASR are within a 1°C range.

The sea ice decrease is identified as the likely reason for the warming. Vertical temperature profiles show that the warming reaches a height of up to 2 km but the maximum is located near the surface. Averaged over all sea ice and ocean area north of 70°N the increase amounts to 5°C for 2002/2003 to 2011/2012. Additionally to the mean temperature changes, first results of the changes in temperature extreme events will be shown.

## ANTARCTIC GROUNDING-LINE MIGRATION FROM CRYOSAT-2 RADAR ALTIMETRY

Hannes Konrad, Andrew Shepherd, Lin  
Gilbert, Anna Hogg, Malcolm McMillan,  
Alan Muir, Thomas Slater

Alfred-Wegener-Institut  
Helmholtz-Zentrum für Polar- und  
Meeresforschung

Precise grounding-line locations are critical observations for quantifying the discharge of glacial drainage systems into the ocean, as an indicator for the stability of an ice sheet, and as a boundary condition for numerical ice sheet models. Geological records document extensive grounding-line retreat during the deglaciation towards the Holocene in Antarctica. However, observations of Antarctic grounding-line migration during the satellite era remain scarce due to the lack of repeat satellite measurements. Here, we combine observations of ice-elevation change from CryoSat2 satellite radar altimetry and measurements of the ice geometry to track movement of the Antarctic grounding line, by that almost tripling the coverage of all previous studies combined. We estimate that 10 %, 3 %, and 22 % of the Antarctic Peninsula, East Antarctic, and West Antarctic grounding lines, respectively, are retreating at rates faster than 25 m/yr, the typical pace since the Last Glacial Maximum. The continent has lost over 200 square km of grounded ice area per year. As reported by previous studies, by far the fastest rates of retreat occurred in the Amundsen Sea Sector. However, we find that the Pine Island Glacier grounding line has stabilized since the grounding line position was recorded in 2011 - likely as a consequence of abated ocean forcing. Finally, we report an intimate relationship between average ice thickness change at the grounding line and average rates of grounding line migration for Antarctic fast-flowing ice streams which indicates that the geometries of these ice streams are similar despite the various different processes involved in establishing these.

## MONITORING OF SURFACE ICE HEIGHT CHANGES IN GREENLAND

W. Korth, T. Hitziger, U. Hofmann und K.  
Pavelka

Beuth Hochschule für Technik Berlin

In 2002 a long term project for geodetic monitoring of heights and height changes was started. A series of six field campaigns was realized and the project is still running. In result there are precise surface height data available representative for a traverse between Isortoq (East Greenland) and Ilulissat (West Greenland). The measurements were carried out mainly by GNSS in static mode for points close to the camp sites and in kinematic mode for the full traverse since 2015.

The data are showing an increasing of the glacier volume shrinking. Close to the rims of the ice cap in 2015 the lowering of the surface was nearly 150 % of the value of 2002. In the middle of the traverse where the height is about 2,500 m a surface rising of 0.15 m/a changed to a more or less stable surface in 2015. All together this leads to a significant speed up of the negative volume change. Results of satellite missions like GRACE are showing a negative but not increasing mass balance of the region which was investigated. This difference might be caused in refreezing of melting water within the upper snow layers. Therefore at some representative spots density profiles close to the surface were measured and compared to older data. The density data are changed to higher values close to the surface and one can find much more ice layers into the snow. This means that out of the blue ice areas above the equilibrium zone an interpretation of height changes is difficult. A direct link between height and mass is not possible or at least biased.

## **WHAT IS IN THE AIR? AN EXAMPLE OF SUCCESSFUL COOPERATION BETWEEN SCIENTISTS AND EDUCATORS IN CREATING A SERIES OF NON-FORMAL LESSONS ON CLIMATE CHANGE RELATED ISSUES**

Izabela Kotynska-Zielinska, Tymon Zielinski

Today We Have/IO PAN

Aerosols are usually associated with the characteristic, hissing sound they make when they are released from a can of soda. However, aerosols have recently become “famous” due to their role in transporting pollution and creating such atmospheric phenomena as urban smog or Arctic Haze. What are aerosols, what are their different types and sources, how do they affect our planet's climate?

We have created a 4 stage workshop (approx. 3 hours) during which we discuss these issues. Each stage comes with materials for teachers, and includes a theoretical part, a PPT presentation and a set of practical experiments and problems to be solved, which are to be used during the workshop. We also created a set for the learners.

We tested the materials on 21 October 2017 during an educational conference entitled “Cosmos for schools 2017” which was organized by the leading Polish non-formal educational institution, the Copernicus Science Center in Warsaw. Out of the 25 Polish school teachers registered for the workshop, 17 of them appeared.

The overall goal of the workshop was to present the role of aerosols in the formation and modification of the climate through their role in modifying the radiative budget. We presented the attendees how aerosols affect atmospheric radiation transfer and how difficult it is to study them, especially in regions such as the Arctic.

During the Rostock conference we will present the chosen aspects of the lesson set and discuss the outcomes of the event in the Copernicus Science Center in Warsaw.

## **A NON-FORMAL APPROACH TO RAISING AWARENESS OF ENVIRONMENTAL ISSUES. A CASE STUDY OF THE “I LIVE BY THE SEA” INTERNATIONAL CONTEST**

Izabela Kotynska-Zielinska, Martha  
Papathanassiou

Today We Have/IO PAN

In this work we describe an example of an innovative approach to environmental education, with the main focus on the marine environment, including the Arctic. We present an example of a successful project, the “I Live by the Sea” international contest, which has been organized annually by Today We Have since 2015 (<http://todaywehave.com/CONTEST.html>).

The participants submit a photo or short film along with a short text, which describes the scene. We all forms of artistic expression within the film medium, from documentaries, to feature films or theatre plays, through pantomimes to dance or song.

Through the involvement of young people aged between 5 to 21 and their families and friends, we succeed in increasing environmental awareness, as well as commencing an exchange of information and a discussion of controversial issues regarding marine environments among the participants from different parts of the world.

We make a fundamental assumption that no matter how far from the sea people live, next to the beach or far away in the mountains, we all have a great impact on it. And it is up to us whether we create a positive relationship with the sea or have adverse impact on it.

The first editions of the contest were on a local scale, organized in Poland, but the 2016/17 edition had an international scope and the final exhibition of the top 30 submissions was held during the United Nations World Ocean Conference in June 2017 in New York ([http://todaywehave.com/I\\_live\\_by\\_the\\_Sea\\_\\_EXHIBITION.html](http://todaywehave.com/I_live_by_the_Sea__EXHIBITION.html)).

This experience of a non-formal educational activity provides all participants, including our teams, with a mutually valuable experience which provides important contributions for the future collaboration with schools and life marine educational programs.

## THE SPATIAL VARIABILITY OF QUALITATIVE AND QUANTITATIVE STRUCTURE OF PLANKTONIC PROTIST COMMUNITIES IN THE NORTH ATLANTIC CURRENT (THE NORDIC SEAS)

Kubiszyn A.M., Wiktor J.M. Jr., Merchel M., Wiktor J.M.

Institute of Oceanology Polish Academy of Sciences

We investigated the spatial variability of qualitative and quantitative planktonic protist community structure in the Nordic Seas in relation to the environmental factors. Our study was conducted in the summers of 2015 and 2016 during cruises of the Institute of Oceanology PAS to the Norwegian and Greenland Seas. The samples were collected using Niskin bottles from the constant depths covering the euphotic zone (5 m, 15 m, 25 m, 35 m, 50 m) and then integrated, using trapezoidal formula, to represent protist community structure under the square meter of the water column, and fixed with an acidic Lugol's solution and, after 24hs, with a glutaraldehyde (both to a final concentration of 2 %). Samples were analysed according to the Utermöhl method. The lack of a clear variability in the longitudinal-latitude qualitative protist community distribution was accompanied by the absence of distinct differences in the hydrography of the area. The highest total protist abundance was observed in the areas between 70-72 °N and 74-76 °N. The first more southerly-located peak was related to the presence of Bacillariophyceae, which numbers decreased northward, whereas the second peak was likely an effect of the increase in protist cells concentration in the frontal zones. In the longitudinal aspect, the eastward increase in Bacillariophyceae abundance was associated with the decrease in the other protist taxa. The observed communities were represented by four distinct types, distributed without any evident pattern: composed solely of Bacillariophyceae (1), Flagellates (2), Prymnesiophyceae (3) and a mixture of flagellates (Dinophyceae, Cryptophyceae) and Bacillariophyceae (4). Although our investigation seems to exclude the longitudinal-latitude protist zonation in the area, a further protist study under different hydrographic conditions is needed to confirm it. This study was funded by the Ministry of Science and Higher Education in Poland (the AREX project, W12/Norway/2016).



## TORPOR AND ITS CONSEQUENCES IN DEVELOPING ANTARCTIC STORM PETREL CHICKS

Nadja D. Kuepper, Carina Marek, Nestor Coria, Marcela Nabte, Marcela Libertelli, Petra Quillfeldt

Justus Liebig University of Giessen/  
Department of Animal Ecology &  
Systematics

Wilson's storm petrels (*Oceanites oceanicus*) are the smallest marine birds breeding in Antarctica, where events like snow storms often prevent parents from providing their offspring with food on a daily basis. To minimize energy expenses in absence of food, Wilson's storm petrel chicks can reduce their metabolism and body temperature by entering torpor. To avoid negative impacts of torpor as decreased development, we hypothesized that torpor is avoided in well-fed chicks, but will be used during longer fasting times. Chick development in a breeding colony of Wilson's storm petrels on the South Shetland Islands was monitored daily during three consecutive summers by recording chicks' body mass and temperature, as well as environmental parameters. Provisioning, body conditions and torpor use differed among those years. In general body temperature was influenced by age, mass, body condition and the number of meals provided within the last 7 days. While most chicks were able to maintain stable body temperatures when not fed for one day, some chicks' body temperatures decreased significantly. Age did not differ between those two groups, but chicks maintaining their active body temperatures had, relative to their ages, higher weights. When left alone for several days, chicks were frequently found in torpor. This happened for example after snow storms that were typically followed by several days of unreliable food provisioning and continuous days of fasting. Most chicks were able to survive these periods of food shortage, reverse their low body temperatures after the next feeding event, and regain body mass. To investigate further implications of torpor use we analysed different physiological parameters like blood triglyceride concentration or oxidative stress values, and conducted immune assays in relation to the time each chick spent in torpor. We conclude that torpor is a strong survival strategy to endure times of fasting, which might be necessary Antarctic storm petrel chicks to reach adulthood. However, in future scenarios, which may include more frequent snow storms due to climate change, malnourishment could lead to more frequent use of torpor, which could elongate chicks' development, and put them at risk not to fledge in time to survive.

## PRE-SITE SURVEY FOR DEEP GEOLOGICAL DRILLING BELOW EKSTRÖM ICE SHELF (SUB-EIS-OBS), ANTARCTICA

Gerhard Kuhn, Olaf Eisen, Christoph  
Gaedicke, Nikola Koglin, Andreas  
Läufer, Dieter Franke, Coen Hofstede,  
Boris Biskaborn, Emma Smith, Ralf  
Tiedemann, Frank Wilhelms

Alfred-Wegener-Institut  
Helmholtz-Zentrum für Polar- und  
Meeresforschung

During the last seasons and ongoing, pre-site seismic surveys have taken place in the Ekströmisen region of Dronning Maud Land, with the primary goal of building a stratigraphic age framework of the under-ice-shelf sediments. These sediments overlie the Explora Wedge, a syn- or post-rift volcanic deposit. Expected ages range from Late Mesozoic to Quaternary. From new vibroseismic profiles, we selected sites for short core seafloor sampling through Hot Water Drill (HWD) holes of the oldest and of the youngest sediment sequences to confine their age time span. There is further potential for drilling deeper sediment cores with the support of international partner. Deep drilling should recover the sediments overlying the Explora Escarpment, in order to discover the nature of the Explora Wedge. We expect the overlying sediment sequences to reveal the history of polar amplification and climate changes in this part of Antarctica, the build-up of the East Antarctic Ice Sheet during past warmer climates, and its Cenozoic and future variability.

Having HWD holes through the shelf ice and sampling the sea floor will provide the unique opportunity for further piggy back experiments consisting of multi-disciplinary nature. Experiments and measuring setup for oceanography, sea and ice shelf physics, geophysics, geology, hydrography, biogeochemistry could be planned to characterise the ocean-ice-sediment interactions, processes and ecosystem observations. The deployment of Autonomous Underwater Vehicles (AUV) either through a HWD hole or launched from a ship or from the fast ice with the power to operate and measure in the sub-ice shelf cavern may become reality during future campaigns.

## FINE-SCALE GENETIC STRUCTURE OF LICHEN POPULATIONS IN PATAGONIA AND MARITIME ANTARCTIC

Elisa Lagostina, Mayara Scur, Aline Lorenz, Mikhael Andreev, Virginia Friedrichs, Francesco Dal Grande, Christian Printzen

Senckenberg Gesellschaft  
für Naturforschung

Isolation and patchiness are the most prominent features of Antarctic terrestrial biota. The geographic isolation from other continents and restriction to widely scattered and small habitat patches have led to high levels of endemism and strong bioregionalisation. This has created opportunities for genetic differentiation, local adaptation and the evolution of cryptic lineages. Lichens are symbiotic associations consisting of a fungal (mycobiont) and one or more photosynthetic partners (photobionts) and are the dominant component and most important primary producers of Antarctic terrestrial ecosystems. In spite of their ecological importance, there is almost no data on the genetic structure and diversity of Antarctic lichen populations. Levels of inter- and intracontinental gene flow are entirely unknown to date. Lichens have developed reproductive strategies that involve both sexual and asexual propagules. Based on short tandem repeats (microsatellites) we investigate the population structure of four lichens with different propagation strategies. We sampled and genotyped populations of *Usnea aurantiacoatra* and *U. antarctica*, *Placopsis contortuplicata* and *P. antarctica* from several areas of the northern Antarctic Peninsula and southern South America to better understand the genetic variability and structure of their populations and infer possible gene flow between the two continents.

## ACCUMULATION DISTRIBUTION AND AGE STRUCTURE IN THE UPPER BASIN OF FEDCHENKO GLACIER, PAMIR

Astrid Lambrecht, Christoph Mayer,  
Pascal Bohleber

Geodesy and Glaciology, Bavarian  
Academy of Sciences and Humanities,  
Munich

Fedchenko Glacier in the Pamir provides one of the very few potential sites for retrieving climate information from an ice core. In addition, investigations about the evolution of this largest glacier in High Asia depend strongly on information about the high elevation accumulation conditions. Extensive field measurements in 2015 and 2016 covered the major accumulation basin of Fedchenko Glacier with high resolution ground penetrating radar profiles. Also several snow pits and short firn cores were retrieved to quantify annual accumulation amounts. Based on these data, the general accumulation distribution could be derived for the basin. The accumulation history could be reconstructed back until 2001, based on the GPR data, a firn densification model and climate data. In order to evaluate the basin for the preservation of climate information in the ice column, a flow model was used to identify particle trajectories along the major flow lines. As a result the maximum age in the basin can be expected to be in the order of 2,000 years. However, this result strongly depends on the historical accumulation conditions, which are not known, so far.

## THE BREAK-UP OF GONDWANA IN THE AUSTRALIA-NEW ZEALAND-ANTARCTICA (ANZAPF) REGION BASED ON FAULT-SLIP AND AEROMAGNETIC DATA FROM NORTHERN VICTORIA LAND

Andreas Läufer, Laura Crispini, Frank Lisker, Antonia Ruppel, Axel Gerdes

Bundesanstalt für Geowissenschaften und Rohstoffe (BGR)

The plate tectonic configuration of the Australia-New Zealand-Antarctica (ANZAPF) region in the South Pacific evolved as consequence of the break-up and fragmentation of Gondwana since the late Early Jurassic. Within Gondwana, Antarctica was at its centre position, and it thus holds a key position for any plate tectonic reconstruction related to the break-up history of this huge landmass. Northern Victoria Land (NVL) is located at the Pacific end of the Transantarctic Mountains (TAM). This high-elevation mountain chain stretches for more than 3500 km from the Atlantic to the Pacific oceans across the entire Antarctic continent. The modern TAM represent the uplifted western shoulder of the Cenozoic West Antarctic Rift System (WARS). Major uplift commenced around the Eocene-Oligocene boundary (around ca. 35 Ma) following sediment accumulation within a wide mid-Jurassic to early Paleogene sedimentary basin ("Mesozoic Victoria Basin", Lisker & Läufer 2013). The basement rocks of the TAM formed by orogenic processes due to subduction of the Palaeopacific Ocean under East Gondwana during the possibly latest Ediacaran to mainly early Palaeozoic Ross Orogeny. This long-lasting geological history of NVL led to a highly anisotropic crust, which is susceptible to any repeated reactivation. Here, we present multi-methodological evidence for a polyphase structural evolution of NVL after initial break-up of Gondwana in this region indicated by the ca. 180 Ma Ferrar volcanic event. A possibly post-34 to 30 Ma old and mainly Neogene NW-SE striking dextral strike-slip belt with local transtension and transpression, which has overprinted and in parts obliterated older structures, controls the present structural architecture of NVL. It may be interpreted as dynamic response to intra-oceanic fracture zone arrays between Australia and Antarctica reaching into the NVL crust and extending further into the Ross Sea. Structural and geophysical evidence indicates that dextral strike-slip overprints two older increments with (i) WNW-ESE striking sinistral strike-slip and (ii) ENE-WSW directed crustal extension. They are related to the late Mesozoic to early Cenozoic fragmentation of the ANZAPF region involving the development of a left-lateral transform margin between Australia and Antarctica in the middle/late Cretaceous to early Paleogene and followed by large-scale extension of NVL continental crust possibly linked to the Adare Trough spreading event (ca. 43-27 Ma: Cande et al. 2000).

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## **MODERNISATION OF GONDWANA STATION, TERRA NOVA BAY, NORTHERN VICTORIA LAND**

Andreas Läufer, Christoph Kasch,  
Christoph Gaedicke, Felix Goldmann

Bundesanstalt für Geowissenschaften  
und Rohstoffe (BGR)

The German Gondwana Station is a non-permanent facility at Gerlache Inlet of Terra Nova Bay on the Ross Sea, operated by the Federal Institute for Geosciences and Natural Resources (BGR). It was erected during the GANOVEX III expedition in 1982/1983 as a bivouac hut and then extended and converted into a summer station during GANOVEX V (1988/1989). The main building consists of 16 interconnected 20-foot containers. Gondwana Station is accessible by ship or plane capable of landing on the sea ice in Terra Nova Bay. Gondwana Station was used as the main base during numerous BGR expeditions to northern Victoria Land, particularly within the frame of the long-term GANOVEX programme (German Antarctic North Victoria Land Expedition).

After more than 25 years of its existence, a major renovation and modernisation of the station was necessary, which was carried out in the 2015/2016 Antarctic season. In October and November 2016, the renovation and modernization of Gondwana Station was finalized and the construction work was accepted by the responsible authorities. Some final checks were done in October/November 2017. Transport of building material, construction equipment and personnel was done with the logistic support of the Italian National Antarctic Research Programme.

In advance of the planned activities, BGR presented an Initial Environmental Study (IES) in order to evaluate and present the impact on the Antarctic environment. The IES was submitted to the German Environment Agency (Umweltbundesamt, UBA) in April 2015. UBA carried out an Initial Environmental Evaluation (IEE) arriving at the conclusion that the planned activity gives cause to suspect less than a minor and transitory impact on the Antarctic environment. UBA granted an appropriate permit on 13 November 2015 under a condition and several provisos

In general, the modernization of the station will lead to an improvement of working conditions, increase of maintenance feasibility and its operating efficiency, and considerable decrease of the environmental impact and the reduction of human footprint. This could be achieved by installation of the following new facilities:

- a pair of generators (40 kVA each)
- photovoltaic plant (40 kW) and an associated battery installation
- solar air panels
- electric heating installation

- snow melting installation (electrically driven)
- water supply and water treatment system (water disinfection and a reverse osmosis system)
- kitchen and sanitary installations

Further, the new waste management is based on a more efficient state-of-the-art wastewater treatment, which includes a mechanic and a biological component. As a result, the quality of the wastewater, which is discharged into the sea can be improved significantly and meets modern high standards.

The renovation/modernization of the station allows its future operation to continue for at least 25-30 years as a base for scientific research in northern Victoria Land. In case of interest, we encourage scientists from research institutions and universities contacting the BGR.

## PAST ICE-SHEET DYNAMICS IN NORTHERN EURASIAN LAKES AS REVEALED BY HIGH-RESOLUTION SEISMIC REFLECTION DATA

E. Lebas, S. Krastel, T. Averages, C. Görtz,  
R. Gromig, B. Wagner, G. Fedorov, N.  
Kostromina, M. Melles

Christian-Albrechts-Universität zu Kiel

In the framework of the German-Russian PLOT project, three seismic campaigns have been carried out in 2013, 2016, and 2017. In 2013, 1500 km of high-resolution seismic profiles have been collected in Lake Ladoga (NW Russia), allowing us to document in unprecedented detail the sedimentary processes that occurred in the lake during the preglacial and postglacial history. The nature of the material that composes the uppermost seismic units has been tied to information from sediment cores, which were collected during the same expedition. Of particular interest are giant (kilometer-scale), single to composite, sedimentary mounds, whose internal architecture indicates a complex history of deformation that we relate to the past glacier dynamics in the lake. In 2016, ~70 km of seismic profiles were acquired in Lake Levinson-Lessing (Taymyr Peninsula), allowing us to capture the complete lacustrine sedimentary infill (~145 m) down to the basement. The deepest seismic unit has been interpreted as representing till/sand deposits, presumably a moraine. This is documented by south-oriented parallel structures recognized in the southern part of the lake, which can be regarded as push-moraines formed during the advance, readvances, and/or retreat of an ice sheet that had inundated the area. From interpretations of a previous core collected in 1996 (PG1228) and from the total thickness of sediment overlying the unit, we suggest an Early Weichselian age for the formation of the unit. Seismic data were also gathered in Lake Taymyr (Taymyr Peninsula) in 2016, but acoustic penetration was limited due to gas blanking. Processing of the seismic data collected in 2017 in Lake Emanda (Verkhoyansk Range) has been recently undertaken and interpretations are still ongoing. Here, we present the first results of the seismic campaigns carried out in lakes Ladoga and Levinson-Lessing with respect to the glacial history of each lake.



## **ORNITHOGENIC TUNDRA AND NUTRIENT FLUX – FOCUS ON FINAL SECONDARY-SCHOOL EXAMINATION**

Rainer Lehmann, Christoph Wüthrich

Freie Waldorfschule Hannover-Bothfeld

Sea birds carry food and therefore nutrients from the sea to their breeding areas on land. Below the bird cliffs nutrients accumulate in the soil and that leads to an eutrophication and different plant associations. The diversity and biomass differ significantly from the “normal” oligotrophic tundra.

Nutrient flux is a topic in German school curricula and exams. It is an opportunity to choose the ornithogenic tundra to implement students understanding of material flow through geo- and biosphere in polar regions. The presented example of a written examination will show how students have to deal with interactions between birds, soil and soil respiration, vegetation and climate.

## ROLE OF ICE COVER AND MACROFAUNA FOR BENTHIC OXYGEN UPTAKE IN THE SOUTH-EASTERN WEDDELL SEA

Heike Link<sup>1</sup>, Gritta Veit-Köhler<sup>2</sup>, Derya Seifert<sup>1</sup>

<sup>1</sup> University of Rostock, Department Maritime Systems, Rostock

<sup>2</sup> Senckenberg am Meer, German Centre for Marine Biodiversity Research - DZMB, Wilhelmshaven

Studies on ecosystem functions on the Southern Ocean seafloor are needed to understand the effects of climate driven changes on the ecosystem. We aim to describe the current state and mechanistic relations in benthic ecosystem functioning in the Weddell Sea during our project “Role of meio- and macrofauna in benthic ecosystem functioning: Testing effects of different ice cover regimes”. Through experimental and observational approaches, we determine the partitioning between the meio- and macrofaunal compartments in food uptake and remineralisation fluxes (oxygen, silicic acid, nitrate, phosphate, ammonium) under different ice cover conditions. Here, we present preliminary results on the role of ice cover and macrofauna community structure for benthic oxygen fluxes measured in ex situ incubations during RV *Polarstern* expedition PS96 to the south-eastern Weddell Sea (Filchner Trough, 2016). Oxygen uptake by the sediments ranged between 0.2 mmol/m<sup>2</sup>/d on the western Filchner shelf and 3.0 mmol/m<sup>2</sup>/d in the north-eastern Weddell Sea. Variation in oxygen uptake could be explained by macrofaunal community structure, which was driven by ice cover at the time of sampling.

These findings will be integrated with meiofauna community structure, data from the north-western Weddell Sea and experimental results on partitioning in food uptake in the course of the project (see also poster Veit-Köhler et al., Session DFG SPP 1158 Antarctic Research). Overall, combining faunal size classes and different benthic processes will allow to evaluate the net ecological effect of changing ice cover regimes on the Weddell Sea benthic system.

## LIPID DYNAMICS OF ARCTIC PTEROPODS UNDER INCREASING TEMPERATURE AND PCO<sub>2</sub>

Silke Lischka, Dieter Janssen, Ulf Riebesell, Martin Graeve

GEOMAR Helmholtz Centre for Ocean Research Kiel

Lipids play a major role as membrane components and in cell differentiation (Phospholipids, PL), as hormones and for cell signalling (Sterols), as energy reserves (for example triacylglycerols, TAG) and buoyancy aid. The fatty acid compositions of organisms give insight on trophic relations (“Who has eaten what?”). Changes in lipid class and/or fatty acid compositions due to rising temperature and CO<sub>2</sub> concentrations (ocean acidification, OA) may have severe consequences for species and population survival and may impact higher trophic levels by providing less abundant and/or less nutritious food.

During a field campaign in Ny Ålesund (Spitsbergen) in August 2013, we carried out a 7-day lab experiment and incubated early-stage *Limacina* spp. (pelagic mollusk, thecosome pteropod) at two temperature (3.5°C, 5.5°C) and three pCO<sub>2</sub> (approx. 400 µatm, 750 µatm, 1100 µatm) levels to study effects on their lipid dynamics (lipid classes, fatty acid composition). During this phase of *Limacina*'s life cycle, these pteropods grow to juveniles and are dependent to accumulate lipid reserve to overwinter and continue development the following spring.

In general, we found stronger effects of temperature and pCO<sub>2</sub> on lipid classes than on the fatty acid composition. Lipid classes were synergistically affected by temperature and pCO<sub>2</sub> but temperature was clearly the overriding factor. Free fatty acids and sterols increased with temperature and pCO<sub>2</sub>. The share of PL mostly decreased with higher factor levels. TAG's showed varying response at the different levels of temperature and pCO<sub>2</sub>.

Fatty acids did not show strong variation with temperature and pCO<sub>2</sub>. Most variation was found in 16:1(n-7), 18:0, 20:5(n-3), and 22:6(n-3). 20:5 and 22:6 are both important membrane fatty acids and also biomarkers, whereas 18:0 and 16:1(n-7) are marker fatty acids for particulate organic matter and diatoms, respectively. These fatty acids were interactively affected by temperature and pCO<sub>2</sub> with changes in response direction and strength.

Our results suggest pronounced negative effects of rising temperature and pCO<sub>2</sub> on the lipid metabolism of Arctic *Limacina* species. Reduced fitness, nutritional value and a reduced chance to sustain a robust population may be potential consequences that could possibly also propagate through the food web and affect higher trophic levels.

## ARCTIC REGION: HUMAN AND SOCIAL FACTORS

Vera A. Lobova

Yugra State University

A total of 82 representatives of indigenous peoples of the North took part in a research conducted in the Yamal region. Individuals engaged in the research live in Se-Yakha village of the Yamal district situated in the middle of the Yamal Peninsula. The objective of the research is to study the influence of social factors on psychological welfare of Yamal's Nenets people. Peculiarities of work activities, household features, family lifestyle and communication were picked out to be analyzed as social factors. Besides this a life exhaustion factor and personal peculiarities were taken into account.

An urbanization factor was considered while scheduling this research. A random sampling method formed two groups. The first one was a group of 48 Nenets representatives who inhabit the village of Se-Yakha. The second group contained 34 Nenets people living a nomadic life or dwelling in tundra. Average age of the surveyed is  $27.03 \pm 0.90$  years old. To study the social factors affecting the psychological welfare of an individual the Reeder psychological stress scale was employed. Analysis of the data acquired was performed with regard to a gender factor. The research suggests that no-stress people occur more often among tundra male inhabitants as compared to those ones who live in the village (52.6 % and 25.0 % respectively). These variations turned out to be insignificant among women (60.0 and 65.0% respectively). With all that there is an interesting fact showing that hard stress (distress) occurs in tundra men only (5.3%) which might be explained by severe climate and complex households. Besides that females who permanently live in tundra have no distress revealed while it is very frequent among those women living in the village (7.5%).

The analysis of the social factors affecting the psychological welfare of inhabitants confirms that communication sphere is an important personal source. Both men and women remained pleased with their spontaneous and social communication having revealed high performances in this criterion. Moreover it also specifies that the tundra female inhabitants suffer from life exhaustion and are satisfied with family relations in a lesser extent as compared to the village females. It testifies the fact that the Reeder scales test figures titled «Tense relations often happen in my family» and «I am completely physically and emotionally exhausted by the end of the day» have tangible differences in the compared groups of women.

Meanwhile, women who gave up a traditional lifestyle are concerned about their job and get tired of running the house way more. It evidences from negative variations in the Reeder scales test figures «I am very concerned about my job» and «My daily routine causes great stress».

In its turn, when comparing the life exhaustion factor it is more well-defined among the tundra men than among the village ones. The Reeder scales test figures titled «I am completely physically and emotionally exhausted by the end of the day» among reindeer breeders and village men vary significantly. Meanwhile, men who do not run the house in traditional ways begin to be more concerned about their job. Thus, there are significant differences revealed in the «I am very concerned about my job» scale in the village inhabitants as compared to nomadic males. This criterion is more positive in reindeer breeders.

Conclusions. (1) The urbanization factor significantly affects the psychological welfare of indigenous peoples of the North. (2) Life exhaustion, household features and family lifestyle are defined as main social factor affecting the psychological welfare of Nenets. (3) Stress changes related to peculiarities of work activity and living conditions were discovered in Nenets people who enjoy the civilization benefits. (4) Positive indicators on the communication scale were obtained that show communicative comfort and satisfaction with communication in Nenets.

## THE ANTARCTIC PHYTOPLANKTON DIVERSITY FROM SPACE AND BY NUMERICAL MODELLING

S. Losa, M. Soppa, M. Losch, J. Oelker,  
T. Dinter, S. Dutkiewicz, A. Richter, V.  
Rozanov, J.P. Burrows, A. Bracher

Alfred-Wegener-Institut,  
Helmholtz-Zentrum für Polar- und  
Meeresforschung

This study relates to investigating the biogeochemical cycling and ecosystem functioning under present climate changes observed in the Southern Ocean. In particular, we focus on phytoplankton diversity that affects the food web (therefore, the diversity of higher trophic levels) and alters the oceanic role in regulating the climate. When investigating the phenology of various Phytoplankton Functional Types (PFT), we rely on available *in-situ* and satellite observations as well as on coupled ocean - sea ice - biogeochemical modelling (Follows et al., 2007, Dutkiewicz et al., 2015). In the project/presentation we highlight some benefits and challenges of the used satellite-based algorithms for PFT retrievals, such as OC-PFT (Soppa et al., 2014, 2016) based on multi-spectral optical satellite data (OC-CCI) and PhytoDOAS (Bracher et al. 2009, Sadeghi et al. 2012) using available hyper-spectral optical satellite measurements (SCIAMACHY and OMI). We also present an algorithm (SynSenPFT, Losa et al. 2017) that allows to combine synergistically the information on the phytoplankton composition retrieved by the aforementioned methods. *In-situ* PFT observations obtained by a diagnostic pigment analysis are used for evaluation of the retrieval algorithms and model simulations.

## HISTORISCHE TECHNISCHE INNOVATIONEN FÜR DIE ARKTISFORSCHUNG

Cornelia Lüdecke

University of Hamburg

Den Nordpol zu erreichen war das Ziel von Wissenschaftlern und Sensationslustigen, die auf dem Weg dorthin zunächst das unerbittlich driftende und oftmals zu hohen Presseisrücken aufgeworfene Meereis überwinden mussten. Im Vortrag werden beispielhaft drei Innovationen vorgestellt, die einerseits wenig praktikabel oder ihrer Zeit weit voraus waren. Bereits 1874 wurde der Vorschlag gemacht, mit Ballonen eine Expedition zum Nordpol durchzuführen. Ihre Realisierung im Jahr 1897 durch S.A. Andrée scheiterte schon nach drei Tagen an der Vereisung der oberen Ballonhülle. Anstatt sich mit wechselnden Winden zum Nordpol treiben zu lassen, regte der Erfinder Hermann Anschütz-Kaempfe 1902 an, ein Unterseeboot zu verwenden. Allerdings gab es damals noch kein zuverlässiges Navigationssystem, das im eisernen U-Boot funktioniert hätte. So entwickelte Anschütz-Kaempfe 1904 den Kreiselkompass, der schon bald in der Marine eingesetzt wurde. Nach Hubert Wilkins erfolgloser U-Bootfahrt in der Arktis (1931) gelang es erst im Sommer 1958, den arktischen Ozean mit dem U-Boot USS „*Nautilus*“ von Barrow über den Nordpol nach Grönland zu durchqueren. Ein drittes Beispiel liefert das sogenannte Polaribil aus dem Jahr 1950, das als Nordpolstation eingesetzt werden sollte. Nach dem Vorbild der AEROARCTIC wurde zunächst an die Gründung einer Studiengesellschaft gedacht. 1952 wurde schließlich der Verein der Polaribil-Freunde e.V. gegründet, der die „Verwendbarkeit des Polaribils“ weiter propagieren sollte. Über einen Erfolg des Projekts ist nichts bekannt geworden. Diese Beispiele jeweils im historischen Kontext diskutiert.

## FISHING FOR GENOME-WIDE GENETIC MARKERS IN TWO SOUTHERN OCEAN SEA SPIDERS: DEVELOPMENT OF A STANDARDIZED BIOINFORMATIC PIPELINE

Till-Hendrik Macher, Jana S. Dömel,  
Florian Leese

Universität Duisburg-Essen,  
Aquatische Ökosystemforschung

The Southern Ocean represents a unique habitat challenging the biodiversity with extreme abiotic conditions. Organisms that are able to survive in the cold environment and under the strong seasonality are often well adapted and endemic to Antarctica and of great interest in evolutionary studies. Sea spiders (Pycnogonida) are such an organismal group with high species numbers and endemism in the Antarctic and thus a good model to test for effects of glacial periods and potential refugia during those on speciation and species distribution. Previous studies based on two genetic markers (COI and ITS) already found that the sea spider species *Colossendeis megalonyx* and *Pallenopsis patagonica* with a reported circumpolar distribution are in fact species complexes with often limited distribution ranges. However, due to differences in the genetic structure between the two species complexes (including mito-nuclear discordances within *C. megalonyx*) and the limited number of available genetic markers it was difficult until now to analyze the processes that led to the different speciation patterns. Nowadays, new high-throughput sequencing methods gave rise to massive data-sets that allow to test for migration and selection patterns. However, transparent and well-managed workflows are important to actually analyze the heaps of data. Here we report a new bioinformatic pipeline to analyze target hybrid enrichment data for phylogenetic and population genetic data sets. The workflow consists of four steps i) reads quality is analyzed simultaneously for multiple samples, ii) adapter sequences are cut and raw sequences are trimmed based on sequence quality information, iii) filtered reads are assembled and finally iv) the enriched targets are identified per sample or per gene using BLASTn. As a test case we used a 1600 gene data set for a total of 128 specimens from *C. megalonyx* and *P. patagonica*.

## UNUSUALLY RICH FAUNA OF DEEP-SEA SWIMMING ISOPODS MUNNOPSIDAE FROM THE ABYSSAL OF THE SEA OF OKHOTSK: FIRST RECORDS

M. Malyutina

Zhirmunsky Institute of Marine Biology,  
National Scientific Center of Marine  
Biology, Far Eastern Branch of Russian  
Academy of Sciences, Far Eastern  
Federal University

The composition and distribution of the deep-sea family Munnopsidae from the Kuril Basin of the Sea of Okhotsk collected during the Russian-German expedition SokhoBio (Sea of Okhotsk Biodiversity Studies) in 2015 was studied. Isopoda were not known at all for the Kuril Basin. In total 2190 individuals of Munnopsidae from 53 species, 26 genera and 7 subfamilies have been sampled at 19 EBS stations at all 11 sites of the SokhoBio expedition mainly in the abyssal Kuril Basin (7 sites, 3,300-33,66 m depth), on its northern slope (1 site, 1,667 m), but also in the Bussol Strait (1 site, 2,330 m) and on the western slope of the Kuril Kamchatka Trench (KKT) (2 sites, 3,371-4,798 m). The most abundant subfamily in the SokhoBio samples was Ilyarachninae Hansen, 1916 (36 %), followed by Eurycopinae Hansen, 1916 (29 %). In the Kuril Basin 39 species of 20 genera and 5 subfamilies were found, Ilyarachninae were dominated (39 %), followed by the group of genera incertae sedis (31 %) and Eurycopinae (27 %). In terms of diversity and species richness the abyssal munnopsid fauna of the Kuril Basin is an intermediate between the adjacent studied abyssal areas: the semi-isolated basin of the Sea of Japan and the open abyssal of the KKT. No one of four deep sea munnopsids species known from the Sea of Japan were found in the SokhoBio samples, although all four genera recorded for the Sea of Japan were represented in the Kuril Basin by morphologically similar species. Half of the collected SokhoBio species (27) are shared with the KKT area, where 100 species of munnopsids were recorded. Though most species of the abyssal munnopsid fauna of the Kuril Basin belong to typical deep-sea genera which occur in the Pacific abyss, the fauna includes some bathyal elements, e.g. three bathyal genera which were not found in the abyssal KKT area. About 80% of the collected species are new to science. One of the new species, the third species of the rare and aberrant genus *Gurjanopsis* Malyutina and Brandt, 2007, *G. kurilensis* Malyutina and Brandt, 2017 was the first Pacific record of the genus, previously only known from the deep-sea of the Arctic and the Antarctic. In addition to *G. kurilensis*, some other munnopsid species have sibling species from distant localities. Two species of genus *Microcope* Malyutina, 2008 from the Kuril Basin has morphologically very similar congeners: two from the Weddell Sea in the South Ocean (SO), and one from the Australian slope. One of the most abundant species in the studied NW Pacific, *Eurycope* sp. 1 is most similar to *E. elianae* Schnurr and Malyutina, 2014 from the N Atlantic near Iceland *Eurycope* sp. 3, is close morphologically to the Arctic *E. dahli* Svavarsson, 1987 and the Antarctic species *Eurycope* sp. cf. *dahli*. *Paramunnopsis* sp. 1 is similar to the Arctic species *P. justii* Svavarsson, 1987 and *Paramunnopsis* sp. from the Weddell Sea (Malyutina and Brandt, 2007). Morphologically similar deep-sea species separated by long distances might indicate a wide distribution of ancestral species in the past or reflect sampling artifacts, although there are no further records for these genera from several abyssal areas in the Atlantic, SO and Pacific sampled by comparable standardized methods.



## PALEO-LACUSTRINE TERRACES OF LAGO ARGENTINO - WITNESSES OF CRUSTAL DEFORMATION AT THE PATAGONIAN ICEFIELDS SINCE LATE PLEISTOCENE?

E. Marderwald, P. Busch, J.M. Aragón  
Paz, L. Mendoza, J. Strelin, G. Connon,  
J.L. Hormaechea, M. Horwath, M.  
Scheinert, R. Dietrich, A.Richter

CONICET / Universidad Nacional  
de La Plata, Argentina

Lago Argentino is situated at the eastern edge of the Southern Patagonian Icefield, the largest temperate ice mass within the Southern Hemisphere. Intensive mass loss of the Patagonian icefields since the Little Ice Age (LIA) has induced exceptionally rapid crustal uplift due to glacial-isostatic adjustment (GIA) clearly evidenced by geodetic Global Navigation Satellite Systems (GNSS) observations (Richter et al. 2016, Lange et al. 2014, Dietrich et al. 2010). The glacier retreat after the LIA maximum has been preceded by much more dramatic ice-mass changes since the Last Glacial Maximum (LGM). According to current GIA models (Lange et al. 2014) the solid earth relaxation is very fast in this region due to the peculiar tectonic-geological setting imposed by the subduction of an active ocean ridge at the Chile (Ayzen) Triple Junction and the opening of the Patagonian slab window underneath the icefields. The geodetically determined present-day visco-elastic deformation does therefore not provide information on these earlier ice-mass signals. However, between the LGM and the lateglacial Puerto Bandera readvance (climax about 13,000 cal yrs BP, Strelin et al. 2011), the maximum lake level in the Lago Argentino basin was several tens of meters higher than at present (185 m asl, IGN 2015) and has formed paleo-lacustrine terraces which are well preserved along the shores of the eastern and central parts of the lake. The paleo-lake level at the time of terrace formation with respect to the present-day lake level documents the cumulative differential vertical crustal deformation. Intense post-LGM glacial-isostatic uplift centered west of the lake is expected to result in a tilt between the late-Pleistocene and present lake levels with the oldest westernmost paleo-terraces raised higher (55 m) above the present lake level than further east (25 m). Tectonic deformation related to the plate collision to the west might have increased the GIA-induced gradient in relative to present paleo-terrace height. We present first results of a geodetic determination of the geometry and relative height of ten paleo-terrace profiles and one paleo-delta at Lago Argentino based on kinematic GNSS profiling. GNSS buoy observations were combined with the operation of two tide gauges in the lake to derive the present-day mean lake level as a reference surface for the paleo-terraces. Additional data sources such as a high-resolution regional digital elevation model (IGN 2015) and historic aerophotogrammetric material are employed for the geomorphological identification and interpretation of the paleo-terraces.

## MARINE AEROSOL FLUXES: MEASUREMENTS COMPARISON BETWEEN NORTH ATLANTIC AND THE BALTIC SEA REGION

Piotr Markuszewski, Tomasz Petelski,  
Przemysław Makuch, Iwona Wróbel,  
Tymon Zieliński, Jacek Piskozub,  
Violetta Drozdowska, Paulina Pakszys

Institute of Oceanology

I have an honour to introduce the results of nine years of sea spray emission measurements on-board the *r/v Oceania* ship. I am part of a research group which conducts regular aerosol and micrometeorological measurements in the so-called European Arctic (Norwegian Sea, Greenland Sea, Spitzbergen's fiords) and in the southern Baltic Sea region.

The measurements presented were carried out using a gradient method. As the measurement device we used a Laser Particle Counter (PMS model CSASP-100\_HV) placed on one of the masts of the *r/v Oceania*. The measurements were carried out on five different levels above the sea level: 8, 11, 14, 17, and 20 meters.

Based on the results from those experiments the sea spray emission fluxes are calculated for all particles of sizes in range 0.5  $\mu\text{m}$  to 47  $\mu\text{m}$ . The fluxes are used in order to determine the sea spray generation function. This function provides information on the emission of particles of different sizes, depending on several environmental parameters. Therefore, the dependence from parameters, such as: temperature gradient, wind speed, wave age, wave height, or wave period are presented. A comparison between the Baltic Sea and the open Atlantic Ocean is also presented.

Sea spray is an important factor for many branches of geoscience. Constant improvement of quality of climatic models contributes to reduction of uncertainties in modelling future climate. Furthermore, marine aerosol influences radiation balance and radiation forcing. There are two effects connected to the above: the direct effect, which is connected with light extinction (absorption and scattering) on particles and the indirect effect, which is connected with aerosol influence on cloud microphysics. The aerosol influence is one of the biggest uncertainties of climatic radiative forcing. This project may contribute to the decrease of this uncertainty.

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## THE NEW RELEASE OF QUANTARCTICA: A CROSS-PLATFORM, FULL-FEATURED OPEN GIS FOR ANTARCTIC RESEARCH

Kenichi Matsuoka<sup>1</sup>, George Roth<sup>1</sup>, Anders Skoglund<sup>1</sup>, Stein Tronstad<sup>1</sup>, Yngve Melvær<sup>1</sup>, Michiel van den Broeke<sup>2</sup>, Huw Griffiths<sup>3</sup>, Robert Headland<sup>4</sup>, Brad Herried<sup>5</sup>, Katsuro Katsumata<sup>6</sup>, Anne Le Brocq<sup>7</sup>, Kathy Licht<sup>8</sup>, Fraser Morgan<sup>9</sup>, Peter Neff<sup>10</sup>, Jean de Pomereu<sup>4</sup>, Anton van de Putte<sup>11</sup>, Catherine Ritz<sup>12</sup>, Mirko Scheinert<sup>13</sup>, Takeshi Tamura<sup>14</sup>

<sup>1</sup>Norwegian Polar Institute, Tromsø, Norway,

<sup>2</sup>Universiteit Utrecht, Institute for Marine and Atmospheric Research, Utrecht, Netherlands,

<sup>3</sup>British Antarctic Survey, Cambridge, United Kingdom,

<sup>4</sup>Scott Polar Research Institute, University of Cambridge, Cambridge, United Kingdom,

<sup>5</sup>University of Minnesota, Polar Geospatial Center, St. Paul, United States,

<sup>6</sup>Japan Agency for Marine-Earth Science and Technology, Yokosuka, Japan,

<sup>7</sup>University of Exeter, College of Life and Environmental Sciences, Exeter, United Kingdom,

<sup>8</sup>Indiana University Purdue University Indianapolis, Department of Earth Sciences, Indianapolis, United States,

<sup>9</sup>Landcare Research, Auckland, New Zealand,

<sup>10</sup>University of Rochester, Earth and Environmental Sciences, Rochester, United States,

<sup>11</sup>Royal Belgian Institute of Natural Sciences, Brussels, Belgium,

<sup>12</sup>Université Grenoble Alpes, L'Institut des Géosciences de l'Environnement, Grenoble, France,

<sup>13</sup>Technische Universität Dresden, Institut für Planetare Geodäsie, Dresden, Germany,

<sup>14</sup>National Institute of Polar Research, Tachikawa, Japan

“Quantarctica” is a geospatial data package built on the free, open-source, cross-platform QGIS software. It includes a wide range of cartographic basemap layers, scientific datasets, and satellite imagery. It features the capability to entirely operating offline.

Quantarctica was first released in 2013, becoming an official SCAR product in 2014. Now, the completely updated and enhanced version 3 of Quantarctica will be released in early 2018.

For this, the Quantarctica Editorial Board selected peer-reviewed datasets for a wide range of Antarctic users, adding over 150 new basemap and scientific data layers and widening the thematic coverage from Glaciology and Geophysics to other themes such as Atmospheric Science, Biology, Oceanography, Social Sciences, and more. We also expanded the project's extent and data coverage to 40°S, including sub-Antarctic islands.

The contributions will briefly revisit the development process and accomplishments of the Quantarctica project, before showcasing Quantarctica 3's expanded and deepened data coverage, new features, and practical applications in Antarctic research, logistics, education, and outreach. We also present our ongoing efforts and experiences with the Antarctic science community, including workshops, data solicitation and open data sharing.

## LARGE ICE LOSS VARIABILITY DURING THE LAST TWO DECADES AT NIOGHALVFJERDSJORDEN GLACIER, NE-GREENLAND

Christoph Mayer, J. Schaffer, T.  
Hattermann, D. Floricioiu, L. Krieger,  
P.A. Dodd, and T. Kanzow

Bavarian Academy of Sciences and  
Humanities

Despite considerable changes of the Greenland Ice Sheet during the last decades, the northeastern part of the ice sheet was considered rather stable until some years ago. However, it became obvious that this region has the potential to discharge vast amounts of ice through the Northeast-Greenland- Ice-Stream (NEGIS) into the Greenland Sea, in the case of unstable conditions. One indicator of fundamental changes was the disintegration of the floating part of Zacharias Isbræ in the recent past. Its northern neighbor, Nioghalvfjerdingsfjorden Glacier (79 North Glacier), however, showed no significant area change during the past decades. Even though recent surface elevation change measurements indicate a strong mass loss of the large floating tongue, it is not clear how the climatic change impacts the mass balance of this glacier. Here, we show for the first time the multiannual development of the ice loss from this key glacier in Northeast Greenland. We are able to prove that the nearby ocean governs the large ice thickness changes observed. Our analysis demonstrates that extreme ice thickness loss up to 10 m/yr can occur under certain oceanic conditions.

## **HOW DOES CLIMATE CHANGE AFFECT SOILS AND THEIR MICROBIAL COMMUNITIES ON JAMES ROSS ISLAND, MARITIME ANTARCTICA? RESULTS FROM AN ENVIRONMENTAL SIMULATION EXPERIMENT**

L.A. Meier, P. Krauze, I. Prater, T. Scholten, D. Wagner, C.W. Mueller, P. Kühn

University of Tübingen

Referring to the fundamental question in ecosystem research, how biotic and abiotic processes interact, only a few studies exist for Polar Regions that integrate microbiological and soil scientific studies. Soils comprise the complex structure and environment that fosters water storage and nutrient cycling determined by its unique chemical, physical and biological properties with respect to the specific climate and parent material. In the extreme environment of the Antarctic Peninsula Region, soil biological processes are primarily controlled by microbial communities (Bacteria, Archaea and Fungi), and thus microbiota may also determine soils chemical and physical properties in a landscape lacking higher plants at an average air temperature below 0°C. In addition, these processes or the controlling forces are about to change due to changing environmental conditions.

To analyse the effects of climate change on pedogenic processes and microbial communities two soil profiles at St. Martha Cove and Brandy Bay on James Ross Island, maritime Antarctica were sampled to set up an incubation experiment. The samples of both profiles were bulked and part of it sterilized to have control samples. All samples were exposed to 100 freeze and thaw-cycles (-5°C - +5°C) at two constant levels of soil moisture (40 % and 80 %). We will present the results of pH, EC, TOC, TIC, DNA content, microbial abundances and micromorphological analyses at freeze-thaw-cycle 0 in comparison to the results after 100 simulated freeze-thaw-cycles.

## THE PROJECT PLOT (PALEOLIMNOLOGICAL TRANSECT) - OVERVIEW AND PRELIMINARY RESULTS ON THE PREGLACIAL TO POSTGLACIAL HISTORY OF THE RUSSIAN ARCTIC

Martin Melles, Andrej Andreev, Marlene Baumer, Dmitri Bolshiyarov, Grigory Fedorov, Larisa Frolova, Raphael Gromig, Hafliði Hafliðason, Sebastian Krastel, Elodie Lebas, Anna Ludikova, Hanno Meyer, Larisa Nazarova, Ludmila Pestryakova, Larisa Savelieva, Ludmila Shumilovskikh, Dmitri A. Subetto, John Inge Svendsen, Bernd Wagner, Volker Wennrich, Martin Werner

University of Cologne

The joint Russian-German project “PLOT - Paleolimnological Transect” aims to investigate the Late Quaternary climatic and environmental history along a >6000 km-long longitudinal transect across the Eurasian Arctic. For this purpose, seismic surveys and sediment coring were conducted on five lakes, which are located along the transect and have the potential to host preglacial sediments. The data and samples are investigated with state-of-the-art analytical techniques, supplemented by numerical modelling. Following a pilot expedition on Lake Ladoga close to St. Petersburg in summer 2013, the full PLOT project commenced in Nov. 2015, supported for three years by the German and Russian Research Ministries. Since then, sediment coring was conducted at Lake Bolshoye Shuchye (Polar Urals) in summer 2016, followed by a seismic survey and a coring campaign on Lakes Levinson-Lessing and Taymyr (both Taymyr Peninsula) in summer 2016 and spring 2017, respectively. A joint seismic and coring campaign was also achieved on Lake Emanda (Verkhoyansk Range) in summer 2017. Fieldwork at lakes Bolshoye Shuchye, Levinson-Lessing and Taymyr was carried out in collaboration with the Russian-Norwegian project CHASE (Climate History along the Arctic Seaboard of Eurasia). The seismic data, sediment cores, and complementary modern samples are currently under investigation at the collaborating institutions in Germany, Russia, and Norway. First results imply that the sediment cores from all lakes, except Lake Emanda, penetrate into preglacial sediments. Age-depth models, based on radiocarbon and OSL dating, paleomagnetic measurements, identification of cryptotephra, and varve counting (where applicable), are in progress. The records shall be correlated to that of Lake El'gygytyn (NE Russia), in order to test, how representative this long-ranging, Pliocene-recent record is for wider areas of the terrestrial Arctic. Here, we provide an overview about the completed fieldwork for the PLOT project and highlight some of the initial interpretations made on the basis of the seismic and sediment core data.

## SEA ICE TYPE DISTRIBUTION IN THE ANTARCTIC FROM MICROWAVE SATELLITE OBSERVATIONS

Christian Melsheimer, Gunnar Spreen\*,  
Yufang Ye, Mohammed Shokr

University of Bremen, Institute  
of Environmental Physics

Sea ice can be classified into several types, such as young ice (thin and smooth new ice), deformed ice, first-year ice (seasonal ice, formed during the last cold season), and multiyear ice (ice that has survived at least one melt season). The physical properties of sea ice differ significantly for the different ice types. Thus, knowledge of the sea ice type allows some indication of associated ice thickness and is essential for properly modelling of the ice-ocean-atmosphere system.

Here we apply a new satellite-based retrieval of sea ice type in the Antarctic. This retrieval has originally been developed and tested for the Arctic, where it can successfully distinguish first-year and multiyear ice. The motivation to apply the sea ice type retrieval in the Antarctic is that there is a considerable amount of multiyear ice in the Antarctic (albeit less and younger than in the Arctic), and that, however, the ice type distribution in the Antarctic has not yet been investigated much.

The retrieval method uses input data from active and passive microwave instruments (radar scatterometer and radiometer, respectively). In addition, several correction schemes are applied to account for the effect of melt-refreeze processes and snow metamorphosis on the sea ice type retrieval. Furthermore, sea ice drift is used to restrict the area where multiyear ice physically can prevail.

We will present first results of the new retrieval applied to Antarctic sea ice and compare with the results from the Arctic.



## TIMING OF SUBDUCTION OF THE PALAEO-PACIFIC OCEAN IN NORTHERN VICTORIA LAND (ANTARCTICA) INFERRED FROM ZIRCON U-PB AGES

Martina Menneken, Timm John,  
Andreas Läufer, Jasper Berndt, Jörg  
Giese, Martin Whitehouse

Freie Universität Berlin, Mineralogie-  
Petrologie

The Granite Harbour Intrusives (GHI) are a suite of calc-alkaline granitoids distributed throughout the Transantarctic Mountains, including the Wilson Terrane in northern Victoria Land. They are understood as a typical magmatic arc system associated with west-dipping subduction beneath the continental margin of East Gondwana.

Until recently, three main phases of emplacement have been suggested for the GHI. The first phase with ages up to 560 Ma, is best documented in granites from southern Victoria Land (e.g. Encarnacion and Grunow, 1996). In northern Victoria Land, the scarce products of this first phase are limited to the southern part of the Terra Nova Intrusive Complex and the north-western part of the Deep Freeze Range with Pb-Pb zircon ages between 517 and 531 Ma (Rocchi et al. 2004). Rb-Sr whole rock ages for the second main phase are around 510 Ma (e.g. Tonarini & Rocchi, 1994), and the third magmatic phase, associated with the subsequent fading of igneous activity and emplacement of peraluminous leucogranites, occurred around  $481 \pm 10$  Ma (Tonarini & Rocchi et al. 1994). Based on arc-derived detrital zircon ages, Goodge suggested already in 2007 that the subduction process might have started as early as 580 Ma. This is supported by further U-Pb zircon ages with up to ca. 590 Ma from the central Transantarctic Mountains (Goodge et al. 2012) and detrital zircon data by Paulsen et al. (2016), which indicate the presence of previously unrecognized distinct pulses and extended duration of granitoid activity.

Here, we present a combination of U-Pb,  $\delta^{18}O$ , trace element and inclusion data of zircons from granitoids of the GHI, taken during the BGR-expeditions GANOVEX VII (1992/93), GANOVEX VIII (1999/2000) and GANOVEX XI (2015/16), covering a region of about 400 km along strike of the former Palaeo-Pacific active continental margin, as well as about 350 km carton-wards. Careful evaluation of zircon-U-Pb-age data and related isotopic, chemical, and mineralogical features reveal a history of early (from about 580 Ma onwards) magmatic- and fluid alteration events, in contrast to simple inheritance. Our data thus supports that magmatic arc evolution in the Wilson Terrane was related to long-lived, Andean-style accretionary processes at the East Gondwana active continental margin that lasted at least ca. 100 Ma after the transformation of the post-Rodinia rifted margin into an active continental margin of East Gondwana in the late Neoproterozoic.

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## ARCTIC TOURIST TAXATION OR ARCTIC CHARITY

Daria Mishina

University of Lapland

The purpose of this project is to introduce a new Arctic tourism-approach: Arctic tourist taxation. In contrast to other studies, I consider whether business (especially expensive Arctic tourism) can be connected to the direct Arctic development by governmental taxation and/or charity. Specifically, I focus on the needed changes in the understanding of the Arctic tourism in general. (Under the “Arctic tourism”

I analyze Arctic territories (High-Arctic, Low-Arctic and sub-Arctic territories).

The Arctic region suffer from the lack of infrastructure, educational facilities for local habitats, territorial, social, and health development. The results of students interviews in the Russian Northern Arctic region (Yamal) have shown that teenagers (13-18 years old) show interest to the Arctic regions (77 %). However, there is a lack of information about the Arctic, its value and perspectives to work and live in the Northern regions. Moreover, respondents are ready and want to get knowledge about the Arctic by outdoor seminars and conferences (62 %) or have compulsory either facultative lessons with invited Arctic specialists (80 %).

Principles and goals of the “Arctic tourist taxation” or “Arctic Charity” are oriented on help, initiation and promotion of the needed Arctic development by combining business and pleasure. Using qualitative method of analysis, I found the evidence of possibility to manage an “Arctic tourist taxation” as a new program of the Arctic Council or “Arctic Charity” as an independent NGO. I propose to charge tour operators and tourists by 0.5 % of the tour’s price for the further development of the Arctic regions. This approach will build a “checkpoint” in front of the gate to the North. The project can be implemented not only for indigenous and non-indigenous people in the Northern regions, but also for Arctic animals’ protection and for national parks in the Northern regions.

I assume, that “Arctic tourist taxation” will not decrease the number of tourists and even attract more tourists, experts and scientists from many different countries, and more people around the world will know more about the Arctic regions. Every Arctic tourist is able to take part in the further Arctic development personally. The Arctic regions have a bright future, but the way it will be managed depends on our behavior and responsibilities.

## TOWARDS A LEAD WIDTH DISTRIBUTION FOR ANTARCTIC SEA ICE: A CASE STUDY FOR THE WEDDELL SEA WITH HIGH RESOLUTION SENTINEL-2 IMAGES

Mara Muchow, Lars Kaleschke

Institut für Meereskunde Universität  
Hamburg (Institute of Oceanography)

The presentation will focus on investigating the sea ice lead distribution in the Weddell Sea as one part of the DFG SPP project “Modelling and parameterization of lead generated turbulence in the atmospheric boundary layer over Antarctic sea ice”. We use images from the Sentinel-2 satellites, which were launched in June 2015 and March 2017. These satellites provide a high spatial resolution from 10 m to 60 m. The lead width distribution for the Arctic sea ice follows a power law. The power law was derived from satellite data via classification of sea ice leads and measuring their width. Our aim is to analyze if the power law distribution is a suitable statistical parametrization for lead occurrence in the Antarctic sea ice.

Sea ice drastically reduces the exchange of heat from the ocean and the atmosphere. Therefore, open water in leads or leads covered with thin ice play an important role for the heat transfer through the ice. Although the satellite observations show only weakly significant trends of sea ice extent in the Antarctic, it is important to better understand sea ice processes in view of anticipated changes in the future.

In preparation to investigate leads it is first necessary to develop a classification method of different sea ice types for Sentinel-2. We use manually selected cloud-free Sentinel-2 images from Band 4 (665 nm) with a resolution of 10 m, because they provide the highest resolution in the visible spectrum and show thin ice structures.

We identify different ice types based on their reflectance from ten cloud free images and specify thresholds for each type. As a preliminary result we conclude that we can distinguish between open water, nilas, dark-gray ice, light-gray ice and ice covered with snow. Based on the reflectance threshold we use a simple binary algorithm to measure the lead width and derive the statistical lead width distribution.

Our lead width distribution captures a finer scale than the recent one for the Arctic, which starts with 300 m based on CryoSat-2 (Wernecke and Kalschke, 2015), and is more representative as the other one for the Arctic based on one SPOT-image with a 10 m resolution (Marcq and Weiss, 2011).

## ARCTIC OCEAN TOPOGRAPHY FROM OCEAN MODELING AND SATELLITE ALTIMETRY: CORRESPONDENCE, DISCREPANCIES AND PROSPECTS FOR COMBINATION

Felix L. Müller<sup>1</sup>, Claudia Wekerle<sup>2</sup>,  
Denise Dettmering<sup>1</sup>, Wolfgang Bosch<sup>1</sup>,  
and Florian Seitz<sup>1</sup>

<sup>1</sup>Deutsches Geodätisches  
Forschungsinstitut der Technischen  
Universität München  
<sup>2</sup>Alfred-Wegener-Institut  
Helmholtz-Zentrum für Polar- und  
Meeresforschung

Satellite altimetry is providing instantaneous snapshots of the dynamic oceans topography (DOT) for more than two decades. However, they are characterized by an irregular sampling in seasonally sea-ice covered regions (e.g. the Greenland Sea). Furthermore, the spatio-temporal coverage is limited due to the along-track profiling instrument geometry and the fixed orbit and ground track configurations of most satellites (among them the ESA ENVISAT mission and the CNES/ISRO SARAL mission).

In order to fill observation gaps and to bridge periods when altimetry fails, a global ocean circulation model is used. The Finite Element Sea-ice Ocean Model (FESOM), developed at the Alfred Wegener Institute, is one of the first global ocean circulation models based on unstructured meshes. It includes an ocean component and sea surface heights with respect to the ocean bottom topography, as well as a sea-ice component reproducing the major sea-ice drift pattern. The model configuration used in the present study has daily temporal and 1 km spatial mesh resolution in the wider Fram Strait region.

In a first investigation we focus on a comparison between the altimetry-based geodetic DOT and the FESOM derived water level estimates and evaluate the potential for a combination of both data sets. The comparison is based on the analysis of the temporal variability and the frequency domain of both quantities and shall indicate existing systematic differences or consistencies. The study area lies in the Greenland Sea including the Fram Strait, and the investigated period covers eight years of the ENVISAT mission.

## MAPPING ANTARCTIC WILDLIFE BY USE OF UNMANNED AERIAL VEHICLES

Osama Mustafa, Hans-Ulrich Peter,  
Marie-Charlott Rümmler, Christian  
Pfeifer, Jakob Maercker

ThINK - Thuringian Institut of  
Sustainability and Climate Protection

In recent years Unmanned Aerial Vehicles (UAVs) became a fast-developing technology with manifold fields of application. In the field of wildlife biology, it offers the opportunity to quantify populations, to map the spatial distribution of species and to observe the behavior of animals with no or low disturbance. Moreover, UAV based mapping allows to obtain data from sites which are difficult or not accessible and to cover much larger areas than by traditional ground based methods. The advantages of UAV based mapping are of particular relevance under the harsh conditions of Antarctic fieldwork.

The authors present the experiences of four seasons of fieldwork of mapping by help of UAVs at different sites of the southeastern part of King George Island, in the surroundings of Nelson Island and at Deception Island (South Shetland Islands). It was possible to map colonies of three penguin species (*Pygoscelis papua*, *P. antarctica*, *P. adélie*), Southern Giant Petrels (*Macronectes giganteus*), Kelp Gulls (*Larus dominicanus*), Cape Petrels (*Daption capense*) and Blue-eyed Shags (*Phalacrocorax atriceps*). Three species of seals, Southern Elephant Seals (*Mirounga leonina*), Antarctic Fur Seals (*Arctocephalus gazella*) and Weddell Seals (*Leptonychotes weddelli*), were mapped at haul-outs. Mapping of vegetation cover was performed using a Near-Infrared sensor.

Depending on the peculiarities of the different species, different methodological approaches had to be applied. Advantages, challenges and limitations of the method will be discussed as well as aspects of possible impacts it can have on the wildlife. Finally the feasibility of UAV-based mapping will be evaluated for each of the species and recommendations for specific approaches will be given.“

## ANATOMICAL FEATURES OF DIFFERENT CHROMOSOMAL FORMS OF *DESCHAMPSIA ANTARCTICA* E. DESV.

N. Nuzhyna<sup>1</sup>, I. Parnikoza<sup>2</sup>, O. Poronnik<sup>2</sup>, I. Kozeretska<sup>1</sup>, V. Kunakh<sup>2</sup>

<sup>1</sup>Educational and Scientific Centre «Institute of Biology and Medicine», Taras Shevchenko National University of Kyiv

<sup>2</sup>Institute of Molecular Biology and Genetics, National Academy of Sciences of Ukraine, Kyiv

*Deschampsia antarctica* E. Desv. – the species that for a long time has been adapted for harsh living conditions in the periglacial zones of South America, Subantarctic and maritime Antarctic. These fact causes interest in studying of its adaptive mechanisms, in particular on the anatomical level. In our study, we investigated plants of various chromosome forms with normal karyotype  $2n = 26$ : Great Yalour Isl.- lines Y62 and Y67, Berthelot Isl.– BE1, Lahille Isl. – L59, karyotype with B-chromosomes  $2n = 26 + 1-3B$ : Darboux Isl.- DAR12 and hipo-triploid  $2n = 36, 38, 39$  (Great Yalour Isl. – line Y66) grown from seeds collected in Argentine Islands region. These forms are micro-propagating in vitro as separate lines in unified laboratory conditions.

The leaf anatomical structure of *D. antarctica* without any specific peculiarities was shown on the example of plants of Y62 and Y67 lines. It is interesting that in the course of the study, no qualitative particular features were found for plants hipo-triploid line Y66. Among the detected anatomical differences of leafs of DAR12 line plants a significantly larger number of stomata on the abaxial surface, a thicker adaxial epidermis and its outer cell wall, a larger bulliform cells, and a disorder of the epidermal cells placement were shown. On other hand, such disorder of the epidermal cells placement and double and triple stomata on the abaxial side of the leaf blade also are noted for plants of L59. It is also an abnormality, however these plants have  $2n = 26$ . Mostly, plants micro-propagated in vitro have symmetrical 3-rib leaves, but also there were 5-rib leaves in plants from of L59 line, thus BE1 line were presented as plants with symmetrical 3-rib leaves and asymmetric 4-rib leaves. More over, a distinctive feature of BE1 plants was the presence of short small epidermocytes of square shape between conductive bundles and the single-celled non-glandular trichomes above the veins on both sides of the epidermis. The reasons of such heterogeneity will be clarified by studying a set of plants from the original localities in nature.

This work was supported by the National Antarctic Scientific of Ukraine.

## A NEW TAKE ON JOHANN AUGUST MIERTSCHING

Mechtild Opel, Wolfgang Opel

The accomplishments of Johann August Miertsching, who had learned the language of the local Inuit during his time as a Moravian missionary in Labrador and later spent 5 years in the Arctic in search of the Franklin expedition, are still underestimated. His travel diary contains information on the course of HMS Investigator's expedition under Captain McClure – the first to circumnavigate North and South America and during which unknown sections of the Northwest Passage were discovered – as well as on the daily life on board, on the Inuit way of life, on nature, landscape and the weather. It was first published in 1855, in German, followed by abridged editions in French and Danish shortly after. For decades, it was almost forgotten, until an English translation was published in 1967. From now on, it was used as a source of polar research especially in English-speaking countries. During the tracing of Miertsching's footsteps, we came across the original manuscript and recognized considerable text differences to the German book, as well as partly to the English translation. We also found important new documents and surprising news regarding his biography. This not only allows us a more detailed view on that polar expedition, but also on the entire life of Miertsching, an initially underprivileged "outsider" who became an extraordinary personality. His origins as a Sorb and his work with the Inuit in Labrador were a prerequisite for his success as an Inuktitut interpreter and his special accomplishments in the search expedition 1850-54. A proper appreciation of Miertsching is still missing.



## **PRELIMINARY RESULTS OF AEROSOL OPTICAL PROPERTIES DURING LONG-RANGE TRANSPORT OF BB FROM CANADIAN AND GREENLAND DIRECTIONS INTO SVALBARD: JULY-AUGUST 2017**

Pakszys P., Zieliński T., Posyniak M., Makuch P., Petelski T., Ritter C., Mateos D., Mazzola M., Ferrero L., Neuber R., Traversi R.

Institute of Oceanology  
Polish Academy of Sciences

Since early July 2017 intense wildfires were recorded over Canada and Greenland, then driven by winds were observed over Svalbard Island. Wildfires are common last years, especially boreal forests fires of Canada during the summertime. This plume of smoke and trace gases could be rank as one of the biggest last years (as big as in 2015).

We want present preliminary studies of aerosol properties during long-range transport of biomass burning from Canada and Greenland to Svalbard in July and August 2017. Used of passive and active remote sensing methods, modeling of aerosol optical properties, also simulations of variability of Aerosol Optical Depth (AOD), Single Scattering Albedo (SSA), direct aerosol's forcing (and others) will help to describe this event of Biomass Burning (BB) over Arctic.

The wildfire in Greenland was spotted by satellites on 31 July. It was burning about 40 miles from the ice sheet in the western part of Greenland. Higher temperatures combined with summer melting which reveals tundra, facilitate outbreaks of wildfires. At the beginning of July 2017, Canada has experienced a quiet start to the wildfire season with only around 50 % of the 10-year average activity and less than 20 % of average burned area and only three fires had been recorded in British Columbia.

The event of the BB aerosols transport was observed between 28 July and 26 August 2017 in Spitsbergen. Using ceilometer we were able to detect multiple layers of aerosols up to 5 km. According to NASA, the Visible Infrared Imaging Radiometer Suite (VIIRS) on the Suomi NPP satellite captured particularly heavy smoke obscuring a wide swath of northern Canada as of August 15 and 16, 2017, which were transported to the Arctic Circle over Greenland. Back trajectory analysis confirms Greenland and Canada wildfires as a source of aerosols. Sources of BB aerosol were determined using data from MODVOLC, an algorithm that uses low spatial resolution (1-km pixel-size) infrared satellite data acquired by the satellite instrument MODIS to map the global distribution of thermal anomalies in near-real-time.

## **CAMS RESULTS OF AEROSOL OPTICAL PROPERTIES: A COMPARISON BETWEEN NY-ÅLESUND AND HORNSUND. STUDY BETWEEN 2010-2015**

Pakszys P., Zieliński T.

Institute of Oceanology  
Polish Academy of Sciences

This work presents the CAMS model based aerosol optical properties calculated for two Spitsbergen fjords, Kongsfjorden (Ny-Ålesund) and Hornsund (Polish Polar Station in Hornsund) measured between 2010 and 2015. A small decrease in Aerosol Optical Depth (AOD) is shown throughout the study period leading to an alteration of the state of the polar atmosphere. However, the potential differences observed between the stations were not statistically significant. While during the studied period no significant differences in chemical composition between the stations were observed, increasing mean values of Black Carbon (BC) were found to be associated with an increasing number of wild forest fires in remote areas producing smoke plumes, which are further transported over vast distances and reach Spitsbergen.

## **A 3D INTEGRATED LITHOSPHERIC MODEL OF ANTARCTICA AND ITS IMPACT ON GIA ESTIMATES**

Folker Pappa, Jörg Ebbing, Fausto Ferraccioli, Wouter van der Wal, Bas Blank,

Christian-Albrechts-Universität zu Kiel

The lithospheric structure of Antarctica has been investigated by several studies using different geophysical methods. However, the results from the different geophysical methods do not agree, in particular concerning estimations of the depth and geometry of the crust-mantle boundary. This has large implications for predictions of numerical models of glacial isostatic adjustment (GIA).

We present a new 3-dimensional model of the Antarctic lithosphere and upper mantle, integrating seismological and gravity gradient data in a thermodynamically self-consistent framework, which helps to reduce the inconsistencies and ambiguities from separate geophysical methods.

Our results show that Antarctica is largely in isostatic equilibrium, however, the topography of some regions seem to have components which cannot be explained by pure isostasy. Based on this, we establish new estimations of the crustal thickness of the Antarctic continent. The derived temperature distribution of our model is used to estimate mantle viscosity. We find that viscosity values at shallow depth (150 km) in the south part of the Ross Sea, part of the Antarctic Peninsula, and East Antarctic coastal areas are lower than previous estimates of 3D mantle viscosity. This increases the importance of late Holocene ice mass changes in these areas and underlines the requirement of improving mantle viscosity estimates from a combination of geophysical methods.

## VEGETATION MAPPING ON THE MODEL GALINDEZ ISLAND AS THE BASIS FOR STUDY OF ANTARCTIC TERRESTRIAL VEGETATION DYNAMICS

I. Parnikoza<sup>1</sup>, A. Berezkina<sup>2</sup>, I.  
Kozeretska<sup>3</sup>, V. Kunakh<sup>1</sup>

<sup>1</sup>Institute of Molecular Biology and  
Genetics of National Academy of  
Science of Ukraine, Kyiv, Ukraine,  
<sup>2</sup>National Antarctic Scientific Center of  
Ukraine  
<sup>3</sup>Taras Shevchenko National University  
of Kyiv, Ukraine

Galindez Island is an island, lying in the Argentine Islands, Wilhelm Archipelago. Island is a monitoring polygon where according to the old British data archive, nowadays possible to monitor the impact of climate and human factors on terrestrial ecosystems. According to this, vegetation mapping was prepared. In particular, the area generally covered by vegetation of different types was mapped. It was necessary seeing that separate vegetation formations often create a complicate complex on the same area. In particular the moss-carpet sub-formation occupies spaces between the rocks, while the fruticose lichen and moss cushion sub-formation occupies rocks in same surface of the relative high relief elements that are released from the snow on the summer. On other hand, part of relatively low rocky surfaces is covered by poor disperse vegetation of green algae and crustose lichens. Discretely mapping was possible only to some vegetation types with largest continuous stands like *Polytrichum strictum* Brid moss banks. *Deschampsia antarctica* E. Desv. and *Colobanthus quitensis* (Kunth) Bartl. mainly grow in addition to wide spread moss carpet moss-carpet sub-formation and also were mapped.

The main factors influencing the various components of vegetation are the expansion of the nesting colonies of the Gentoo penguin, that leads to the degradation of pre-existing vegetation types and the formation of limiting area groups of nitrophilic algae and groups of pure *D. antarctica* at their periphery territory.

As well mapping of vegetation was also started, including well-mapped groups of moss banks on other islands of the Argentine Islands region.

Particular attention is paid to the spread of rare forms (in particular, the chromosomal forms of *D. antarctica*) and the species of vascular plants - *Colobanthus quitensis*, mosses and lichens. This information will be used for the creation of new strictly protected areas (Ia IUCN) in the region.

## ACHIEVEMENTS IN PROJECT ALICE - AIRBORNE TOOL FOR METHANE ISOTOPIC COMPOSITION AND POLAR METEOROLOGICAL EXPERIMENTS

Falk Pätzold<sup>1\*</sup>, Thomas Krüger<sup>1</sup>,  
Konrad Bärfuss<sup>1</sup>, Barbara Altstädter<sup>1</sup>,  
Stefan Nowak<sup>1</sup>, Ellen Damm<sup>2</sup>, Josefa  
Verdugo<sup>2</sup> and Astrid Lampert<sup>1</sup>

<sup>1</sup> Institute of Flight Guidance,  
Technische Universität Braunschweig  
<sup>2</sup> Alfred-Wegener-Institut  
Helmholtz-Zentrum für Polar- und  
Meeresforschung

Methane is a very effective greenhouse gas, but the role of the Polar Regions in the methane budget and its sources there is subject to discussion. The sparse surface network data and satellite data indicate significant source regions above the polar oceans. The remotely piloted aircraft system (RPAS) of quadrocopter type ALICE was developed at the Technische Universität Braunschweig for taking air samples and high resolution meteorological data to study methane isotopic composition related to different polar atmospheric boundary layer conditions above sea ice and open water.

The quadrocopter ALICE has a maximum take-off weight of 25 kg and a large payload capacity of 18 kg, including batteries. The thrust to weight ratio is high compared to other RPAS to operate in gusty wind speeds up to 70 km h<sup>-1</sup>. The scientific subsystem consists of different meteorological sensors and twelve 100 ml glass bottles for air sampling. Profiles with high resolution meteorological data and selective air samples at operator selected altitudes up to 1000 m can be obtained. A parachute system was embedded to avoid high energy impact risks in case of major malfunctions.

The initially tested prototype system was field operated for the first time during *Polarstern* cruise PS109 (ARK-XXXI/4), so-called GRISO (Greenland ice sheet/ocean interaction) from 12<sup>th</sup> September until 14<sup>th</sup> October 2017. During this proof of concept expedition the safe shipborne operation and system functionality in harsh polar environment was demonstrated successfully.

In this presentation, the design of the RPAS and the scientific payload will be introduced and its functionality discussed, based on test flights and campaign flight results. The approaches for the next improvements will be outlined.

## MASS AND ENERGY EXCHANGE BETWEEN THE SEA AND THE ATMOSPHERE ON THE SPITSBERGEN SHELF OF THE GREENLAND SEA

Tomasz Petelski, Małgorzata Cisek,  
Piotr Markuszewski, Przemysław  
Makuch, Tymon Zieliński

IO PAS

In this work, the following fluxes were analyzed: aerosol, heat, latent heat and momentum, calculated on the basis of measurements conducted from the *r / v* Oceania in 2001-2017. Data from *in-situ* measurements come from summer periods. Using data from the NCEP / NCAR analyses, heat and latent heat fluxes were calculated between the sea and the atmosphere with a resolution of three hours for the entire period considered. Then, the daily mean was calculated and compared with the values of fluxes calculated on the basis of measurements. The comparison of the results obtained from the re-analysis with the measurement results shows correlation. The total energy exchange across the sea surface was also calculated throughout the year. The agreement of estimated components of the heat balance with heat transport through Atlantic water was found.

## **SPATIAL DISTRIBUTION AND NUMBERS OF BREEDING CHINSTRAP PENGUINS AT REMOTE ISLETS OF KING GEORGE AND NELSON ISLAND BY FIXED WING UAV**

Christian Pfeifer, Hans-Ulrich Peter,  
Marie-Charlott Rümmler, Osama  
Mustafa

ThINK - Thuringian Institute of  
Sustainability and Climate Protection

The ice free areas at the northwestern coast of Nelson Island and the southwestern coast of King George Island (South Shetland Islands) have been surveyed for breeding birds in 1980 the last time. To obtain current, accurate and complete data for that region, several flights with an electric powered micro UAV have been carried out during December 2016 and January 2017. The investigation area ranges from Smilets Point at Nelson Island along the coast to Sygit Point at King George Island. In that area all possible breeding sites at larger islets have been mapped by a fixed wing UAV equipped with an optical camera. The images have been post-processed to orthophotomosaics with a ground resolution of about 2 cm. More than 200 rocks, islets or rock outcrops have been surveyed for penguin colonies in the orthophotomosaics. We found 26 sites with breeding chinstrap penguins (*Pygoscelis antarctica*), some of them recorded for the first time. To get changes in the spatial distribution and abundance of the penguin colonies the results were compared with the historic counts. As a result the most complete and accurate dataset on the distribution and numbers of breeding chinstrap penguins in the investigated area was created and will be presented.

## WISSENSCHAFTLICH TECHNISCHE ZUSAMMENARBEIT (WTZ) MIT RUSSLAND – DAS KOPF-PROJEKT: KOHLENSTOFF IM PERMAFROST

Eva-Maria Pfeiffer<sup>1</sup>, Irina Federova<sup>2</sup>,  
Evgeny Abakumov<sup>2</sup>, Tim Eckhardt<sup>1</sup> and  
Guido Grosse<sup>3</sup>

<sup>1</sup> Institut für Bodenkunde, Universität  
Hamburg, Deutschland

<sup>2</sup> Staatsuniversität St.Petersburg,  
Russland

<sup>3</sup> Alfred-Wegener Institut,  
Helmholtz-Zentrum für Polar- und  
Meeresforschung, Potsdam,  
Deutschland

Das Ziel des Verbundprojekts „Kohlenstoff im Permafrost“ (KoPf) ist, basierend auf Beobachtungen und Modellierungen, die Auswirkungen von Klimaänderungen auf den Kohlenstoffkreislauf in Permafrost beeinflussten Landschaften besser zu verstehen und daraus Handlungsempfehlungen für Entscheidungsträger zu entwickeln. In enger deutsch-russischer Kooperation werden die Untersuchungen in Sibirien durchgeführt, der Region mit den weltweit größten Permafrostgebieten, die bisher aber nur unzureichend untersucht wurden. Die modelbasierten Hochrechnungen zum tauenden Permafrost und Rückkopplungen mit dem Klimasystem sind unerlässlich für die Konzeption von geeigneten Minderungs- und Anpassungsstrategien zum Klimawandel. Das Verbundvorhaben besteht aus vier Teilprojekten (TP):

TP 1 leistet die wissenschaftlich-logistische Koordination im Verbund und einen wesentlichen Beitrag zur verbesserten Nutzung sibirischer Datensätze für die internationale arktische Gemeinschaft. TP 2 entwickelt bestehende Erdsystemmodelle weiter, um relevante Prozesse in Permafrostlandschaften abzubilden. Simulationen unterschiedlicher Erwärmungsszenarien werden verwendet, um zu ermitteln, wann sich die arktische Kohlenstoff-Senke in eine Kohlenstoff-Quelle verwandelt. TP 3 verwendet biogeochemische und mikrobielle Prozessstudien, um verbesserte Abschätzungen zur Langzeitstabilität von organischem Kohlenstoff im Permafrost und den Beitrag von tauendem Permafrost zur Treibhausgasbilanz von Böden und Landschaften Sibiriens zu entwickeln. TP 4 wird auf lokaler, regionaler und kontinentaler Skala mittels Felderhebungen und Fernerkundungsmethoden die Änderungen der sibirischen Landoberflächen, ihrer Ökosysteme und der Kohlenstoffspeicher untersuchen und deren Auswirkungen auf die Treibhausgasemission in Permafrostregionen quantifizieren. Die Datensätze der TPs werden eine verbesserte Simulation der langfristigen Treibhausgasflüsse (regional bis global) ermöglichen. KoPf kombiniert hierbei neue Methoden der Biogeochemie, Mikrobiologie, Ökologie, Mikrometeorologie, Fernerkundung und numerischen Modellierung. Die modelgestützten Projektionen für den tauenden Permafrost und die Rückkopplungen mit dem Klimasystem sind notwendig für nachhaltige Verminderungs- und Anpassungsstrategien.



## ARCTIC BENTHIC DIVERSITY RESEARCH WITH PANABIO: SCALE, SHARING, AND MODELLING

Dieter Piepenburg, Jan Holstein, Paul Kloss, Tom Brey and Casper Kraan

Alfred-Wegener Institut  
Helmholtz Zentrum für Polar- und  
Meeresforschung

Arctic marine biota are affected profoundly and at large scales by accelerating environmental change, such as ocean warming and sea-ice decline. Moreover, increasing human activities add further cumulative pressures. Substantial shifts in ecosystem functions and services, including biodiversity, are expected. To understand, predict, and mitigate the profound ecological consequences of such shifts, it is critical to identify and analyze the relationships between environmental drivers and ecosystem functions at a range of scales (local, regional, and pan-Arctic). We address this challenge by means of a pan-Arctic knowledge system on benthic biota (PANABIO). Underpinned by international efforts to combine data and expertise, PANABIO integrates quality-controlled and geo-referenced data on benthic communities in a public data-warehouse. The system allows for (a) providing ecological baseline-data to gauge ecosystem changes, (b) analysing coupling mechanisms between environmental drivers and ecosystem functions/services on regional and pan-Arctic scales, (c) developing future ecosystem scenarios in response to external forcing, and (d) creating online stakeholder-oriented visualization and analysis tools. The talk will demonstrate the huge up-scaling of benthic data with PANABIO, our achievements to support data-sharing, as well as first results of community-level distribution models to discern benthic communities in relation to multiple-factor environmental forcing, including sea-ice dynamics.

## SOIL HUMIC SUBSTANCES OF SELECTED SOILS OF LENA DELTA RIVER LANDSCAPES: ELEMENTAL AND MOLECULAR COMPOSITION

Vyacheslav Polyakov, Ksenia Orlova  
and Evgeny Abakumov

Department of Applied Ecology,  
Faculty of Biology, St. Petersburg State  
University

A significant amount of organic compounds stored in the soils of the Lena River Delta. The organic matter demonstrates various properties in terms of humus content, quality and degree of stabilization. Therefore, the studying the humic acids elemental and structural compositions are we conducted with special reference to evaluation of organic matter stabilization rate. The advantage of spectroscopy approach is the possibility to quantify the content of groups of structural fragments and identify individual structural fragments in humic acid molecules, as well as use to evaluate possible changes in SOM index decomposition and humification. So far, investigations of the quality of SOM from polar ecosystems have revealed a generalized low degree of decomposition of organic molecules that retain most of the chemical content of their precursor matter due to the low progress of humification. This is very important since polar soils are characterized by a specific composition of humification precursors.

Humic acids were extracted from 5 soil samples: 1- Entic Podzol (Placic); 2- Cryic Histosol; 3- Histic Umbrisol; 4-Folic Cryosol; 5-Entic Podzol. Samples were taken from the upper soil horizons from Kurungnakh Island, the central part of the Lena River Delta, and also from the Stolb Island, the butte of a watershed slope of the delta, where the process of humification is most active. All soils belong to the second terrace (ice complex) and are not affected by the annual flooding process.

Humic acids were extracted according to a standard procedure. Solid-state <sup>13</sup>C-NMR spectra of humic acids were measured with a Bruker Avance 500 NMR spectrometer in a 4-mm ZrO<sub>2</sub> rotor. The groups of structural fragments were identified by the magnitude of the chemical shift.

The obtained data of elemental composition of humic acids of the soils of the Lena River Delta show that an accumulation of the aromatic groups of humic substances takes place if compare with soils of other polar environment. This indicates that in the delta soil formation is ongoing according to the podzol type, rather than by cryogenic. Sample 4 is characterized by the cryogenic type of soil formation, aliphatic compounds in the soil are prevalent over aromatic compounds. The high content of alkyl groups (long aliphatic chains from wax resins, fatty acids, cutin, and cell- characteristic wall phospholipids) is due to the accumulation of organic substances derived from organic residues. Also in their physical characteristics Podzols differ from Cryosols, they are more aerated and drained, thus, creating suitable conditions for microorganisms. Accumulation of aromatic compounds containing the groups -OH, -NH<sub>2</sub>, and -OCH<sub>3</sub> are explained by intense processes of humification.

In Lena River Delta intense humification processes in the soil take place, this is explained by the high content of aromatic compounds in the soil. Those soils are characterized by a podzol type of soil formation. The soils where the process of cryoturbation is expressed prevail the aliphatic fragment that is explained by the accumulation of organic compounds in the soil and its disposal.

We have presented two different soil processes in the Lena Delta River, podzol and cryogenic types. For soils where podzol type formation takes place, a high degree of humification is characteristic, which is reflected in the accumulation of aromatic compounds in the soil. While the type of cryogenic is characterized by the accumulation of alkyl compounds, the result is a low level of humification in the soil.

### **Acknowledgments**

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## **RUSSIAN NEAR-SURFACE GLACIOLOGICAL AND GEOPHYSICAL INVESTIGATIONS AT THE AREAS OF MIRNY AND PROGRESS STATIONS, EAST ANTARCTICA, IN 2013-2018**

Popov S.V., Poliakov S.P., Grigoreva S.D., Boronina A.S., Sukhanova A.A., Kashkevich M.P., Priakhina G.V., Martianov V.L., Lukin V.V.

Polar Marine Geosurvey Expedition

Logistic and scientific operations in Antarctica were always complicated with specific and stern conditions of the sixth continent. This presentation is dedicated to recent investigations of the hazardous crevasses fields at the areas of Russian Mirny and Progress stations.

Mirny station was the first Soviet station in Antarctica and exactly this station for many years has been a place from which logistic and scientific traverses were leaving to discover the interior areas of the continent. Unfortunately, an extensive crevasse area surrounding the station has become a serious disadvantage of this location. Despite this fact, from the moment of formation till 1991 the station had landing strips operating successfully. In the last decade necessity to renew the flight connection with the Mirny station became obvious. To make this possible wide range of geophysical, geodesic and glaciological investigations accompanied with airborne photography was carried out with authors' participation. By 2016 this project resulted in initiating a new snow-runway, where on 10th of February, 2016 a middle-range airplane DC-3T (BT-67) "Turbobustler" landed. Thereby, flight connection with the Mirny station was reestablished after the long quarter of century.

Area of the Progress station is also well-known for the similar problems. The logistic traverse route connecting Progress with the intercontinental station Vostok crosses wide crevasse field. It often leads to accidents in which people and transport are damaged. Considering this, annual surveying of this area is one of the prior tasks for the Russian Antarctic Expedition. It is getting especially significant due to the plans of reconstruction of the Vostok station. For this purpose a complex of investigations similar to the one at the Mirny station area was set in 2013-2016 and helped to locate unsafe areas of the route.

Field season of 2017/2018 brought extra logistic duty to Mirny and Progress stations. Because of this, near-surface investigations will be supplemented with hydrological and seismic survey.

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## **TOWARDS THE DEEPER UNDERSTANDING OF THE LAPTEV SEA BIOLOGICAL PRODUCTIVITY IN THE FRAMEWORK OF THE GERMAN-RUSSIAN RESEARCH PROJECTS**

Vasily Povazhnyi, Karen von  
Juterzenka, Irina Kryukova

Arctic and Antarctic Research Institute,  
Otto-Schmidt Laboratory for Polar and  
Marine Research

Serious progress in biological oceanography studies of the Laptev Sea (LS) area was achieved since the launch of the first German-Russian “Transdrift” expeditions in early 90-s. The basic understanding of biodiversity and key ecological features in pelagic and benthic communities was obtained. Yet the quantitative assessment of energy and mass balance in the LS is still a matter of discussion with modeling and satellite data actively involved. The short open-water period in the LS limits the majority of pelagic field data to “post-bloom” period, allowing only for partial reconstructions of the productivity features. This also elevates the importance of chlorophyll data from long-term moorings, recently obtained in the LS. To assess the peculiarities of the carbon cycle in the Sea from chlorophyll, direct measurements of primary production (PP) are of great importance. C14-based measurements of PP in the LS are scarce and difficult to organize on the available small RVs. The optical oxygen sensor-based method proved to be sensitive enough to be used in the LS. These measurements were initiated in “Transdrift” 2014 and are planned for future expeditions to the LS. With satellite data and modeling assessments combined and verified by ground truth of field data, a major step is to be achieved in the understanding of the LS biological productivity.

## VEGETATION PATCHES DETERMINE THE FATE OF SOIL ORGANIC MATTER ON ISLANDS IN MARITIME ANTARCTICA

Isabel Prater, Filip Hrbacek, Lars Arne Meier, Christina Braun, Daniel Nyvlt, Carsten W. Mueller

Chair of Soil Science, TU München

Conditions for soil development in the Antarctic Peninsula region are unique. The mountain ridge of the Antarctic Peninsula divides the region's climate: On King George Island (KGI), located to the west, a maritime cold climate prevails, while James Ross Island (JRI) east of the peninsula faces the continental cold climate of a polar desert with less precipitation and distinctly more pronounced temperature variations throughout the year.

With Fildes Peninsula (KGI) and Ulu Peninsula (JRI), both islands provide large ice-free areas where climatic differences are reflected in the respective autochthonous vegetation. While it solely consists of lichens, mosses and terrestrial algae on JRI, also vascular plants are endemic on KGI.

The different conditions on these islands offer the opportunity to study fundamental principles of soil organic matter (SOM) sequestration and soil structure development under diverse polar conditions with a varying presence of vegetation. In this steady cold environment, the assumed predominant mechanism for stabilization is the reduction of microbial decay due to low temperatures. To gain a better understanding of the mechanisms determining the fate of organic carbon, it is necessary to understand how SOM is distributed within specific fractions and how it responds to slight differences in climate conditions.

Elemental analysis showed a variability of carbon and nitrogen contents reflecting the distance to vegetation patches. The samples were fractionated according to particle size subsequent analysis demonstrated largest carbon and nitrogen contents for clay fractions throughout all samples. This underlines the pertinence of organo-mineral complexes for the sequestration of soil organic carbon and indicates the unique role of pristine Antarctic soils for a better understanding of interactions between microorganisms and soil minerals. As climate change proceeds, it is assumable that an altering distribution and composition of vegetation implicates an altering storage and composition of SOM.

## THIN-ICE THICKNESSES AND ICE PRODUCTION IN ARCTIC POLYNYAS BETWEEN 2002 AND 2017 AS DERIVED FROM THERMAL INFRARED AND PASSIVE MICROWAVE REMOTE SENSING DATA

Andreas Preußner<sup>1</sup>, Sascha Willmes<sup>1</sup>,  
Kay I. Ohshima<sup>2</sup>, Günther Heinemann<sup>1</sup>

<sup>1</sup>Environmental Meteorology, Fac. of  
Regional and Environmental Sciences,  
Trier University, Trier, Germany

<sup>2</sup>Ocean and Sea Ice Dynamics, Institute  
of Low Temperature Science (ILTS),  
Hokkaido University, Sapporo, Japan

A profound knowledge of the thin-ice thickness distribution and associated wintertime sea-ice production in polynyas is not only important to increase the understanding of atmosphere – sea-ice – ocean interactions, but also to evaluate frequently used climate and ocean models. In this study, we present a high-resolution (~2 km) MODIS thermal infrared satellite data set featuring spatial and temporal characteristics of 17 coastal polynya regions over the entire Arctic basin is presented for winter seasons 2002/2003 to 2016/2017. Besides the extended data record of 15 winter seasons, the data set features the most recent updates of the employed MOD/MYD29 sea ice product (Col. 6) which include improvements to the cloud masking and land/ocean separation. Thin-ice thickness distributions ( $\leq 20$  cm) are calculated from MODIS ice-surface temperatures, combined with ECMWF ERA-Interim atmospheric reanalysis data in an energy balance model. Daily thin-ice thickness composites are subsequently computed. A gap-filling approach is applied to account for clouds and missing data in the thermal infrared imagery. The most recent winter season in the data set (2016/2017) features the so far highest annual ice production with a volume of 2,258 km<sup>3</sup>, presumably originating from highly active polynyas throughout the eastern Arctic (Laptev Sea, Kara Sea) and/or a particularly thin and less extensive wintertime sea-ice coverage that season. We additionally use thin-ice thicknesses from AMSR-E passive microwave data for the period 2002/2003 to 2010/2011 to evaluate and quantify sensor-specific differences. AMSR-E ice thickness data are based on an empirical approach that utilizes a distinct polarization ratio (PR) – ice thickness relationship for thin sea-ice. This direct comparison enables further insights into sensor-specific capabilities and error sources for a large-scale pan-Arctic polynya monitoring. Despite obvious differences, such as the acquired signal at the sensor, varying spatial resolutions or the individual sensitivity for cloud cover, both data sets are coherent in terms of capturing the general spatial and temporal characteristics of Arctic polynyas for the overlapping 9-yr period.

## THE FAR REACH OF ICE-SHELF THINNING IN ANTARCTICA

R. Reese, G.H. Gudmundsson, A.  
Levermann and R. Winkelmann

Potsdam Institute for Climate  
Impact Research

Floating ice shelves, which fringe most of Antarctica's coastline, regulate ice flow into the Southern Ocean. Their thinning or disintegration can cause upstream acceleration of grounded ice and raise global sea levels. So far the effect has not been quantified in a comprehensive and spatially explicit manner. Here, using a finite-element model, we diagnose the immediate, continent-wide flux response to different spatial patterns of ice-shelf mass loss. We show that highly localized ice-shelf thinning can reach across the entire shelf and accelerate ice flow in regions far from the initial perturbation. As an example, this "tele-buttressing" enhances outflow from Bindschadler Ice Stream in response to thinning near Ross Island more than 900 km away. We further find that the integrated flux response across all grounding lines is highly dependent on the location of imposed changes: the strongest response is caused not only near ice streams and ice rises, but also by thinning, for instance, well-within the Filchner-Ronne and Ross Ice Shelves. The most critical regions in all major ice shelves are often located in regions easily accessible to the intrusion of warm ocean waters, stressing Antarctica's vulnerability to changes in its surrounding ocean.



## ANTARCTIC SEA-ICE LEAD FREQUENCIES AND REGIONAL DISTRIBUTION FROM SATELLITE DATA

Fabian Reiser, Günther Heinemann,  
Sascha Willmes

University of Trier,  
Environmental Meteorology

Leads are elongated cracks within the pack ice more than 50 m in width and up to several hundreds of kilometers in length. Mechanical forces such as ocean currents or wind stress mainly drive the development of leads. Within these cracks open water and thin ice occurs. Subsequently, the lower atmosphere is influenced by increased fluxes of moisture and sensible heat from the ocean to the atmosphere. Sea-ice leads are also important for the production of sea ice and contribute to the formation of saline Antarctic shelf water. Since sea-ice leads are short-living objects an accurate monitoring of their temporal and spatial characteristics is required. We use satellite thermal imagery from the MODIS sensor to produce daily potential lead maps for the entire Southern ocean at a spatial resolution of 1.5 km. Data are analyzed for the winter periods from 2002 to 2017. By means of digital image processing and advanced filtering techniques leads are automatically identified in satellite thermal imagery due to their positive temperature anomaly in comparison to the surrounding sea-ice. Based on this information fuzzy logic is applied to minimize errors induced by a misclassification of leads caused by clouds. A variety of lead characteristics retrieved by digital image processing e.g. the object eccentricity is taken into account to distinguish between leads and artifacts. Here we present improvements of the filtering algorithms as well as adjusted concepts for the lead identification in the Southern Ocean.

## SUBGLACIAL LAKE VOSTOK: COMBINATION AND APPLICATION OF GNSS OBSERVATIONS AND SATELLITE ALTIMETRY DATA

Andreas Richter, Mirko Scheinert,  
Sergey V. Popov, Alexey A. Ekaykin,  
Ludwig Schröder, Martin Horwath,  
Reinhard Dietrich, Valery V. Lukin

Technische Universität Dresden

Lake Vostok, located in the remote interior of East Antarctica, is the largest of Antarctica's subglacial lakes. The height of the ice surface within the area of the lake represents an equilibrium of processes and forcings in the subglacial water body and in the ice sheet (Richter et al. 2014). We present recent results of geodetic observations of spatio-temporal height changes of the ice surface in the Lake Vostok area. These are based on complementary geodetic observation techniques: Repeated GNSS observations on markers fixed at the ice surface, repeated ice-surface height profiling by kinematic GNSS and ICESat satellite laser altimetry. The combination of these data sets serves three different goals: (1) Provision of geometric-geodetic models as a basis for multidisciplinary research in the Lake Vostok region, (2) Contribution of new insights into the Lake Vostok system through quantitative characterizations of hydrological, hydrodynamic, glacio-dynamic and surface-loading processes, (3) Determination of systematic effects in ICESat ice-surface elevation data products used to infer ice-surface height change rates and ice-mass balance estimates in different regions and scales. We present absolute bias corrections of ICESat laser operation periods for GLA12 ice-surface elevation data (Rel. 634) based on a regional crossover adjustment within the hydrostatically equilibrated area above Lake Vostok tied to independent surface height profiles derived from kinematic GNSS observations on convoy vehicles. Our results prove the ice-sheet surface above Lake Vostok to be stable in height for more than a decade (Richter et al. 2014, Richter et al. 2016, Schröder et al. 2017) and, thus, constrain the magnitude of possible subglacial water exchange and local ice-mass imbalance.

These investigations have been supported by several grants of the German Research Foundation (DFG, most recent: SCHE 1426/20-1) and the Russian Fonds of Basic Research (RFBR, most recent: 175512003 NNIO\_a).

## ON THE FORMATION OF THE EAST GREENLAND CURRENT IN FRAM STRAIT

Maren Richter, Wilken-Jon von Appen,  
Claudia Wekerle

Alfred-Wegener-Institut  
Helmholtz-Zentrum für Polar- und  
Meeresforschung

Warm Atlantic Water (AW) flows around the Nordic Seas in a cyclonic boundary current loop. Some AW enters the Arctic Ocean where it is transformed to Arctic Atlantic Water (AAW) before exiting through Fram Strait. There the AAW is joined by recirculating AW. Here we present the first high resolution summer synoptic study of this confluence in Fram Strait that forms the East Greenland Current (EGC). Absolute geostrophic velocities and hydrography from observations in 2016, including four sections crossing the East Greenland shelfbreak, are compared to output from an eddy-resolving numerical model. Far offshore (120 km at 80.8°N) AW warmer than 2°C is found in northern Fram Strait. The Arctic Ocean outflow there is broad and barotropic, but gets narrower and more baroclinic toward the south as recirculating AW increases the cross-shelfbreak density gradient. This forms the well-known EGC boundary current flowing along the shelfbreak. Between 80.2° N and 76.5° N, the southward transport along the East Greenland shelfbreak increases from 1Sv to 4Sv and the warm water composition changes from 10 %AW/90 %AAW to 80 %AW/20 %AAW. Consequently, in southern Fram Strait, AW can propagate into Norske Trough on the East Greenland shelf and reach the large marine terminating glaciers there. High instantaneous variability observed in both the synoptic data and the model output is attributed to eddies, the representation of which is crucial as they mediate the westward transport of AW in the recirculation.

## CLIMATE, CO<sub>2</sub> AND ICE SHEETS – A SOUTHERN OCEAN PERSPECTIVE

Thomas A. Ronge, Walter Geibert,  
Jörg Lippold, Frank Lamy, Bernhard  
Schnetger, Matthias Prange, Ralf  
Tiedemann

Alfred-Wegener-Institut,  
Helmholtz Zentrum für Polar- und  
Meeresforschung

A prominent two-step rise in atmospheric CO<sub>2</sub> marked the end of the last glacial. The steps coincided with climatic intervals Heinrich Stadial 1 (HS1) and the Younger Dryas (YD). Records of <sup>231</sup>Pa/<sup>230</sup>Th on sediment cores bathed by NADW, revealed a rapid reduction of the Atlantic Meridional Overturning Circulation (AMOC), during these intervals. It was argued that a weakened AMOC would have significantly reduced the efficiency of the biological pump and thus might have contributed to the rise in atmospheric CO<sub>2</sub>. Despite playing an important role, this process fails to account for the enigmatic drop in atmospheric  $\Delta^{14}\text{C}$  and  $\delta^{13}\text{C}$  during HS1 that marks the first step of the CO<sub>2</sub>-rise. Increasing CO<sub>2</sub>-concentrations with a simultaneous drop in their  $\Delta^{14}\text{C}$ , call for the ventilation of an old and <sup>14</sup>C-depleted carbon reservoir. In this respect, several studies point to the presence of very old, <sup>14</sup>C-depleted deep-waters in the glacial Southern Ocean, which rejuvenated during the last deglaciation. However, the accumulation of <sup>14</sup>C-depleted, carbon-rich waters in the deep Southern Ocean requires circulation patterns that significantly differ from today's.

Here we present a set of multi-proxy records to understand the evolution of the Southern Indian and the Southwest Pacific Oceans over the last 35,000 years. Our reconstructions are based on transects of four sediment cores from the South Indian and five sediment cores from the Southwest Pacific, covering the AAIW as well as the UCDW and LCDW. Our data show that throughout the last glacial the deep-water circulation of both Southern Ocean sectors weakened. This reduction favored the observed accumulation of <sup>14</sup>C-depleted CO<sub>2</sub> in Circumpolar Deep Waters (CDW) and allowed for the expansion of Antarctic ice sheets up to the continental shelf edge. Parallel to the HS1 increase of atmospheric CO<sub>2</sub>, the deep circulation picked up its pace and recovered toward the Holocene. This trend is in remarkable agreement with atmospheric changes in CO<sub>2</sub>,  $\Delta^{14}\text{C}$  and  $\delta^{13}\text{C}$  as well as the deglacial collapse of ice sheets. Hence, we are confident that the Southern Ocean played the dominant role in the first rise in atmospheric CO<sub>2</sub>. In addition the observed deglacial SPOC strengthening may have supported the transport of warm CDW onto the shelf areas since the timing of retreating Antarctic ice sheets is in good agreement with our recent reconstructions.

## SCALING AND BALANCING METHANE FLUXES ASCERTAINED IN A HETEROGENEOUS TUNDRA ECOSYSTEM OF THE LENA RIVER DELTA

Norman Rößger, Christian Wille, Lars Kutzbach

Universität Hamburg

Methane fluxes on an active flood plain situated in the Lena River Delta were studied applying the eddy covariance methodology. During the growing season, the observed fluxes exhibited a great deal of temporal variability, which was largely the result of the pronounced spatial variability of soil and vegetation characteristics within the footprint. Explaining this variability was based on three data-driven modelling approaches: the automatically operating algorithms stepwise regression as well as neural network, and a mechanistic model, which utilises exponential relationships between the methane flux and both flux drivers soil temperature and friction velocity. A substantial improvement in model performance was achieved by applying footprint information in the form of relative contributions of three vegetation classes to the flux signal. This indicates that the vegetation served as an integrated proxy for flux drivers, which permanently vary according to the source area composition. The neural network performed best in explaining the variability of the observed methane fluxes. However, validating the models' generalisability revealed that the mechanistic model provided the most predictive power suggesting that this model best captured the causality between the methane flux and its drivers. After integrating the gap-filled time series, all models yielded footprint budgets that were similar in magnitude. These budgets, however, lacked representativity due to their strong dependence on tower location, measurement height and wind field conditions (sensor location bias). Thus, an unbiased budget of the total area of the flood plain was estimated utilising the mechanistic model. Initially, a downscaling procedure partitioned the observed flux into three individual vegetation class fluxes accounting for shrubs, sedges and intermediate vegetation. These decomposed fluxes in turn formed the basis for the upscaling procedure employing a classified high resolution image of the flood plain. Overall, the application of fine-scale information on flux drivers is crucial for both modelling flux dynamics and adequately estimating budgets of heterogeneous ecosystems being abundant in the Arctic.

## IMPACT OF FLY-OVERS WITH DIFFERENT UAV MODELS ON VARIOUS ANTARCTIC SPECIES

Marie-Charlott Rümmler, Jan Esefeld,  
Osama Mustafa, Hans-Ulrich Peter

Friedrich Schiller University Jena

The impact of unmanned aerial vehicles (UAVs), of which numerous applications in different scientific fields have led to an enormous increase in numbers in recent years worldwide as well as in polar regions, has been a highly discussed topic during the last year. The protection of the pristine wildlife of the Antarctic from such impact seems especially important and calls for detailed knowledge about the strength of disturbances caused by UAVs. Our previous studies (Ruemmler et al. 2016, Mustafa et al. 2017) as well as those of others (Goebel et al. 2015, Korczak-Abshire et al. 2016) led us to first insights into the reaction of Adélie, chinstrap and gentoo penguins (*Pygoscelis adeliae*/*P. antarctica*/ *P. papua*) to UAV surveys. Weimerskirch et al. (2017) examined 11 subantarctic species regarding their reaction to UAV fly-overs. Those first results suggest, amongst other things, that the reaction differs between various types of UAVs (differing in engine, size, shape and other attributes), and between species. A complete picture of the impact is needed to conclude guidelines for the safe use of UAVs in pristine environments.

In the field season 2016/17, we started to extend these studies by including other wildlife species not yet (or only little) studied occurring on Fildes peninsula: for Southern giant petrels (*Macronectes giganteus*), kelp gulls (*Larus dominicanus*), south polar- and brown skuas (*Catharacta maccormickii*/*Catharacta lonnbergii*) and mammals like Antarctic fur seals (*Arctocephalus gazella*) and Southern elephant seals (*Mirounga leonina*) the behaviour was recorded during fly-overs with 3 different UAV models in various flight altitudes. The results show a high variety of sensitivity between the different species and between different models of UAVs, which will be shown and discussed in the presentation.

## MICROALGAE COMMUNITIES IN ANTARCTIC SOILS: CHANGES ALONG SOIL DEVELOPMENTAL STAGES AND TESTING FOR GEOGRAPHICAL DISTRIBUTION

Nataliya Rybalka, Jens Boy, Roberto Godoy, Ana Tzvetkova, Christian Roos, Angela Noll and Thomas Friedl

Georg-August-Universität Göttingen,  
Abt. EPSAG

The diversity of eukaryotic algae along a soil chronosequence, i.e. the lateral glacier retreat gradient, “Meseta” (Boy et al. 2016), in a glacier forefield of Fildes Peninsula, King George Island (Southern Shetlands, Maritime Antarctica), has been studied using two complementary culture-independent approaches, cloning and Illumina MiSeq (2x250) paired ends sequencing targeting the ITS2 rRNA gene. Group-targeted PCR amplification was required to minimize biases in biodiversity assessments because eukaryotic algae often seemed to be underrepresented in the DNA extracts from the soil samples. PCR primer pairs targeting various green algal classes (e.g. Trebouxiophyceae, Klebsormidiophyceae) and the stramenopile Xanthophyceae were employed. With those for the Xanthophyceae ITS2 rRNA genes of no other organisms were recovered. Long ITS1-5.8S-ITS2 amplicons were separated by cloning and sequenced. For Illumina MiSeq (2x250) paired-ends sequencing suitable shorter fragments comprising full ITS2 region were re-amplified using unspecific primers. This approach revealed a high algal diversity of 3299 green algal and 421 xanthophyte OTUs (97 % identity level). Across the chronosequence total numbers of OTUs varied only little. However, no more than 184/15 green algal/xanthophyte OTUs were shared among all sites of the chronosequence. Based on OTUs the sites close and at middle distance to the glacier front were rather similar among each other, whereas the sites farthest from the glacier (oldest soil developmental stages) were clearly different from the younger stages. Cloning/sequencing resulted in a total of no more than 134 eukaryotic algal OTUs (97 % identity level), i.e. from green algae (85 OTUs) and the stramenopile Xanthophyceae (43 OTUs). No saturation was reached. The scarcity of reference sequences available for the ITS2 region prevented assignment of most of the Ulvophyceae and Xanthophyceae OTUs to a more precise taxonomic position. Despite the NGS approach revealed a high diversity of xanthophytes, longer ITS2 sequences (>380bp) as recovered by clone libraries for this algal group were absent, indicating that the xanthophyte diversity as revealed by NGS may have been biased. Ubiquitous species already known from geographic regions other than Antarctica as well as species probably confined to Antarctica, i.e. so far recovered only by our study, were revealed.

## **A NEW GLACIAL-ISOSTATIC ADJUSTMENT MODEL FOR GREENLAND CONSTRAINED BY GPS UPLIFT RATES AND RELATIVE SEA-LEVEL DATA**

Ingo Sasgen, Shafqat Abbas Khan,  
Bert Wouters, Sarah Woodroffe

Alfred-Wegener-Institut  
Helmholtz-Zentrum für Polar- und  
Meeresforschung

The bedrock displacement recorded with GNET-GPS stations in Greenland reveal viscoelastic uplift rates that strongly contradict published predictions of glacial-isostatic adjustment (GIA). In particular, GPS provides evidence that GIA-induced uplift rates are considerably higher in the northwest and southeast of the ice sheet. Both regions are characterized by a lack of relative sea level (RSL) data to constrain the past ice sheet evolution and related viscoelastic displacement, thus causing large uncertainties in GIA predictions. Here, we develop a new GIA prediction by adjusting the geomorphological ice-sheet reconstruction of Fleming & Lambeck (2004) simultaneously to the RSL indicators and the newly available GPS data. Special focus lies on south Greenland, where an increasing number of high-quality RSL indicators from isolation basins suggest a fast relaxation of the solid Earth. This finding is consistent with global seismic models indicating a gradient in the lithosphere thickness and asthenosphere viscosity from high values in the northwest to low values in the southeast. We demonstrate that the GIA prediction fits the GPS and RSL data significantly better for a lateral varying distribution of Earth model parameters. Finally, we evaluate the impact of our new GIA model on determining ice-mass balances from GRACE. We show that commonly used GIA predictions have underestimated the solid Earth response by 17 Gt/yr, which is about 7 % of Greenland current ice-mass loss.



## JOINT INVERSION ESTIMATE OF REGIONAL GLACIAL ISOSTATIC ADJUSTMENT IN ANTARCTICA CONSIDERING A LATERAL VARYING EARTH STRUCTURE (ESA STSE PROJECT REGINA)

Ingo Sasgen, Alba Martín-Español,  
Alexander Horvath, Volker Klemann,  
Elizabeth J. Petrie, Bert Wouters,  
Martin Horvath, Roland Pail, Jonathan  
L. Bamber, Peter J. Clarke, Hannes  
Konrad, and Mark R. Drinkwater

Alfred-Wegener-Institut  
Helmholtz-Zentrum für Polar- und  
Meeresforschung

The mass balance of the Antarctic ice sheet from satellite gravimetry, and to a lesser extent altimetry, observations remains uncertain due to the poorly known correction for the glacial isostatic adjustment of the solid Earth (GIA). Although much progress has been made in consistently modelling ice-sheet evolution, related bedrock deformation and sea-level change, predictions of GIA remain ambiguous due to the lack of observational constraints in Antarctica. Here, we present an improved GIA estimate based on the joint inversion of GRACE, Envisat/ICESat and GPS measurements, making use of the different sensitivities of the satellite observations to surface-mass and solid Earth processes. We base our joint inversion on viscoelastic response functions to a disc load forcing, allowing us to account for lateral variations in the lithosphere thickness and mantle viscosity in Antarctica. Our estimate is able to reproduce extreme GPS-measured uplift rates (up to 3 cm yr<sup>-1</sup>) in the Amundsen Sea Embayment, indicating that large parts of the uplift are caused by GIA induced by recent load changes in the presence of a low-viscosity upper mantle. We compare our GIA inversion estimate with the prediction obtained with a coupled model of the ice sheet and solid Earth, as well as with published estimates. We evaluate its impact on the determination of ice-mass balance in Antarctica from gravimetry and altimetry. The results presented here are the final results of the Support To Science Element Project REGINA and its Supplementary Study of the European Space Agency, [www.regina-science.eu](http://www.regina-science.eu).

## THE GRAVITY FIELD IN ANTARCTICA: GEODETIC MODELLING AND GEOPHYSICAL INVERSION

Theresa Schaller, Mirko Scheinert,  
Roland Pail, Philipp Zingerle, Petro  
Abrykosov

TU Dresden

The gravity field reflects the mass distribution of the Earth. Thus, it allows studying its inner structure and tectonic evolution. In this respect, it is important to gain precise knowledge of the geometry of specific boundary surfaces respectively surfaces of distinct density contrast such as the topography and the crust-mantle boundary (Mohorovicic discontinuity). In Antarctica, the subglacial topography that is covered by an ice sheet of up to 4,000 m thickness is of special interest. Additionally, the geoid as a distinct equipotential surface serves as a reference surface, for instance, in oceanography (for dynamic ocean topography) and in geodesy (for height systems and a globally unified height datum).

For the very first time it will now be possible to study the gravity field in Antarctica on a continental scale and in a homogeneous and consistent way. This is facilitated by the recent availability of a new Antarctic-wide compilation of ground-based gravity data (Scheinert et al., 2016) as well as the successful completion of the satellite gravity missions GRACE and GOCE providing homogeneous and high-accuracy information of the global gravity field with a spatial resolution of 70-80 km (Pail 2015).

Based on these achievements and expertise, in 2017 we started the project AntGrav (SCHE 1426/24 and PA 1543/18) within the DFG Priority Program "Antarctic Research". Its main goal is to determine a combined, consistent, high-resolution gravity field model of Antarctica. This will be based on a thorough validation and homogenization of the Antarctic terrestrial gravity data and their combination with satellite gravity data. We will address the development of innovative methods for an optimal combination of all gravity data investigating regional and regionally tailored global approaches taking different properties like accuracy and spectral resolution into account. The latest example of a high-resolution global model, XGM2016 (Pail et al. 2017), will be presented. Subsequently, we will give an outlook on how an improved continental-wide gravity field model will be used to investigating a lithospheric inversion including density and geometry (subglacial topography, Moho depths). We will discuss how the improvement of both geopotential and lithospheric models will advance our understanding of various processes interlinking cryosphere, solid earth and gravity field.

## 3D ICE-SHEET MODELLING OF THE EKSTRØM ICE SHELF EMBAYMENT, EAST ANTARCTICA

Clemens Schannwell, Reinhard Drews,  
Christoph Mayer, Olaf Eisen, Emma  
Smith, Todd A. Ehlers

University of Tuebingen

Antarctica is fringed by floating ice shelves through which more than 80 % of the overall ice is discharged. These ice shelves provide the main interface between the Antarctic Ice Sheet and the surrounding ocean. Virtually all ice shelves are either laterally constrained by embayments or locally reground on topographic highs causing the formation of ice rises. In both cases the locally enhanced friction is transmitted upstream, resulting in a restraining force that decelerates ice discharge and controls rates of sea-level rise. As ice rises are typically on the order of tens to a few hundred kilometers in diameter, they are usually not resolved, both in the observations and the physical approximations, in large-scale ice-sheet models. In addition to their stabilising influence, ice rises also provide a proxy for stable ice-sheet condition in the past as they archive their own evolution in their stratigraphy, providing the opportunity to derive a Pan-Antarctic archive for the deglaciation history.

To adequately simulate ice rise evolution, the full stress balance needs to be considered including the full coupling of ice sheet, ice shelf, and ice rise. Here, we use the Full-Stokes ice-sheet model Elmer/Ice for the Ekstrøm Ice Shelf embayment in Dronning Maud Land, East Antarctica, to study the effect of ice rises on the overall stability of the ice sheet. We initialise the model for prognostic simulations using today's surface velocity to invert for basal drag and ice-shelf rigidity in full Stokes. To account for inconsistencies in the input data we relax the initial geometry over 10 years resulting in a quasi-steady state which stays close to today's observations. As a first application of this 3D model including the fully coupled system with a dynamic grounding line, we derive erosion rates for the outlet glaciers of the Ekstrøm Ice Shelf embayment, revealing moderate rates of up to  $\sim 0.75$  mm/yr, using published sliding-erosion ratios from other areas. This will be compared to sedimentary structures derived from seismic measurements. We study the effect of ice-rise buttressing using a suite of perturbation experiments with variable atmospheric/oceanic forcings. This in turn will permit to evaluate the importance of ice rises for the past and future timing of sea-level rise, and represents a first step towards using ice rises as a Pan-Antarctic archive to constrain paleo ice-sheet simulations.

## **DYNAMIC RESPONSE OF ANTARCTIC PENINSULA ICE SHEET TO COLLAPSE OF LARSEN C AND GEORGE VI ICE SHELVES**

Clemens Schannwell, Nicholas E.  
Barrand, Stephen L. Cornford, David  
Pollard

University of Tuebingen

Episodic disintegration of ice shelves surrounding the Northern Antarctic Peninsula since the 1950s has led to speed-up, thinning, and retreat of upstream tributary glaciers and increases to rates of global sea-level rise. The southward progression of these episodes indicates a climatic cause, and in turn suggests that the larger Larsen C and George VI ice shelves may undergo similar collapse. However, the extent to which removal of Larsen C Ice Shelf will affect upstream tributary glaciers and add to global sea levels is unknown. Here we apply numerical ice-sheet models of varying complexity to show that the centennial sea-level commitment of Larsen C embayment glaciers following immediate shelf collapse is low (<1.5 mm to 2,100, <3 mm to 2,300). Despite its large size, Larsen C does not provide strong buttressing forces to upstream basins and its collapse does not result in large additional discharge from its tributary glaciers in any of our model scenarios. In contrast, the response of inland glaciers to collapse of George VI Ice Shelf may add up to 8 mm to global sea levels by 2100 and 22 mm by 2,300 due in part to the mechanism of marine ice sheet instability. Our results demonstrate the varying and relative importance to sea level of the large Antarctic Peninsula ice shelves at risk of imminent collapse.

## LAND OHNE FRAUEN?

Barbara Schennerlein

DGP AK Geschichte der Polarforschung

Im allgemeinen Bewusstsein sind die Eroberung neuer Gebiete in der Arktis und die wissenschaftliche Erschließung der Polarregionen fest mit der Vorstellung von wagemutigen Männern im ewigen Eis verbunden. Berichte über großartige Leistungen von Pionieren in der Arktis bestätigen dies auch eindrücklich. Weniger Aufmerksamkeit in der Polargeschichte hat die Tätigkeit von Frauen während einer Vielzahl von arktischen Expeditionen erfahren. Näher mit der Materie Befasste werden an dieser Stelle widersprechen und mindestens Namen wie Lady Jane Franklin, Christiane Ritter oder besonders Josephine Peary nennen, der zugeschrieben wird, als erste weiße Frau in der Arktis überwintert zu haben. Gerade Letzteres entspricht nicht der Realität. Um etwas über die oft stillen Leistungen vieler Polarforscherinnen zu erfahren, sollte der Blick viele Längengrade von Europa aus nach Osten, nach Russland gerichtet werden.

Dieser Beitrag möchte einige der vergessenen oder nie bekannten Polarfrauen vorstellen, die auf ihrem Gebiet oft die Ersten waren. Frauen, die schon zu Zarenzeiten in Russland an Polarexpeditionen teilnahmen wie Juliette Jean oder Hermine Shdanko oder auch die erste Frau unter den Überwinterern schon vor fast 400 Jahren – Tatjana Prontschischewa während der 2. Kamschatka-Expedition unter Vitus Bering

Nach der Oktoberrevolution und Gründung einer Vielzahl von wissenschaftlichen Institutionen zur systematischen Erschließung des Nördlichen Seeweges änderte sich auch das Rollenbild der Frau in der Gesellschaft. Ende der 20-er, Anfang der 30er Jahre des vergangenen Jahrhunderts, als in kurzer Zeit eine Vielzahl von Polarstationen neu errichtet wurde, war die Teilnahme von Frauen an Polarexpeditionen und Überwinterungen auf Polarstationen zunächst noch eine Seltenheit, wurde aber bald zur Normalität. Auch Familienüberwinterungen und Geburten unter den schwierigen arktischen Bedingungen waren keine seltenen Ausnahmen mehr.

Einige dieser Wissenschaftlerinnen aus dieser Hochzeit der Polarforschung, die in vielen Fällen Neuland betreten haben, sollen im Vortrag gewürdigt werden.

## BEENCHIME SALAATINSKY CRATER (BSC) IN NORTHERN YAKUTIA - A COMBINED STUDY TO REVEAL THE ORIGIN AND ENVIRONMENTAL DYNAMICS OF THE 8-KM CIRCULAR STRUCTURE

Georg Schwamborn<sup>1</sup>, Christoph Manthey<sup>1,2</sup>, Ulli Raschke<sup>3</sup>, Lutz Schirrmeister<sup>1</sup>, Bernhard Diekmann<sup>1</sup>, Anatoly Zhuravlev<sup>4</sup>, Nikolai Oparin<sup>4</sup>, Andrei Prokopiev<sup>4</sup>

<sup>1</sup>Alfred Wegener Institute Helmholtz Center for Polar and Marine Research, Potsdam (Germany),

<sup>2</sup>University of Potsdam, Institute of Earth and Environmental Science, Potsdam (Germany),

<sup>3</sup>Bundesanstalt für Geowissenschaften und Rohstoffe (BGR), Geozentrum Hannover (Germany),

<sup>4</sup>Diamond and Precious Metal Geology Institute (IDPMG), Siberian Branch Russian Academy of Sciences, Yakutsk (Russia)

Short-term scientific goals of the ongoing study are to reveal (i) the origin of the crater (impact crater or volcanic crater) and (ii) the late Quaternary environmental history in the area. In a pilot study during summer 2016 we sampled several features from permafrost of the basin interior (river terraces, lake depressions) and geologic formations (Paleozoic bedrock and river sediments). In addition, GPR surveys have been carried out around a thermokarst lake in the basin center.

Our long-term scientific goals are to identify, if the site is a suitable target for deep drilling efforts in order to study the depth and depositional history of the million years old basin filling and to aid reconstructing the crater origin. Optionally boreholes and cores can serve to study the permafrost temperature field and the extreme habitat of microbial life. BSC has a crater diameter of 8 km and is located west of the Olenyok River in northern Yakutia. The area belongs to the northern slope of the Olenyok uplift, which frames the Siberian Craton to the east.

Following geomorphological pre-surveys, it is assumed that the basin is the result of a Mesozoic volcanic explosion similar to Kimberlite Pipes elsewhere in Yakutia (Pinchuk et al., 1971, Khain, 1985). Alternatively, a meteorite impact is blamed, because suevitic breccias have been identified (Mikhailov et al., 1979, Masaitis, 1999). According to geomorphological age estimates, the crater is between 65 and 40±20 Ma old (Moon et al., 2001; Grieve, 1987, Earth Impact Database, 2016).

The BSC's altitude difference is approximately 60 m (140-208 m above sea level) with forest tundra (i.e. larches) and shrubs and grass covering the area. The basin structure consists of three geomorphic levels: a lower level at 140-150 m a.s.l. with polygonal frozen ground, partly boggy and filled with water in the meadows, the drainage pattern is seasonally active;

a medium level at 150-165 m a.s.l. has slopes and erosive remains of old fluvial terraces; the upper level at 165-208 m a.s.l. consists of bedrock that forms the crater rim.

In the central part of BSC one of three thermokarst lakes, 300 m in diameter, has been studied using 50 MHz GPR profiles and short cores. In addition, at four sites of the lower and medium levels soil pits were dug into the ground and short cores of about 1 m drilled into the permafrost extended the sediment records. Placer examinations are in progress to identify the precious metal and heavy mineral fractions from fluvial samples. Several fractions are obtained by sieving the fractions 2-1, 1-0.5, 0.5-0.25, and 0.25-0.16 mm. Bedrock studies on various samples from outcrops are based on polarized light microscopy that allows identifying possible signs of shock metamorphosis effects. In fact, shocked quartz was discovered in a sample taken from a sandstone outcrop in the crater interior; PDFs (planar deformation fractures) were found in several thin sections and their orientations were recorded accordingly.

We sum up our results in a preliminary scenario for a Paleozoic impact event, a Mesozoic overburdening and subsequent erosion in the course of the Olenyok Uplift. Finally, we propose late Quaternary landscape dynamics based on sediment dating and sediment properties in the crater; fluvial sediment transport is documented for the MIS 3 period whereas mid to late Holocene sediments indicate increasing aridity in the area with lowering of the lake level during the past ca. 2000 years.

## SEASONAL SEA ICE COVERAGE IN THE BALTIC AND NORTH SEAS IS SHRINKING

Sandra Schwegmann, Jürgen Holfort,  
Natalia Schmelzer

Bundesamt für Seeschifffahrt und  
Hydrographie

The German Ice Service holds sea ice information for the south-western Baltic Sea and German Bight from the beginning of the last century on up to today. Using that information, a measure for the ice winter strength has been calculated for every year such as the frequency of each winter type, i.e. weak, moderate and strong winters. The result of those calculations indicates that weak winters have become more likely nowadays than strong ones. Since the mid-1960s, consistent measurements of ice coverage and ice thickness have been made. Those data are the basis for studies of changes that the ice situation has been underlain over the last five decades. It could be shown that the ice coverage and the ice volume have decreased in both parts, partly significantly. Here, we want to present to which degree the sea ice parameters like concentration, time of freeze up and melt onset etc. have changed and how these changes are in accordance with other parts of the Baltic Sea, which reveals in total a decreasing ice volume for the last 50 years as well. Drivers for these changes like the major impact of air and the minor effect of ocean temperatures are discussed as well as other, manmade influences like the deepening of fairways.



## ICE DISCHARGE OF LARSEN C ICE SHELF TRIBUTARY GLACIERS

Thorsten Seehaus, Peter Friedl,  
Matthias Braun

Universität Erlangen-Nürnberg

Several ice shelves along the Antarctic Peninsula significantly retreated or even disintegrated in the last decades. The Larsen C Ice Shelf is the largest ice shelf on the Antarctic Peninsula. Currently a rift is evolving in the ice shelf, which might lead to a large calving event and a destabilization of the ice front. Previous studies point out an accelerated ice flow in the northern section of ice shelf. The mass balance of an ice shelf is dominated by the inflow of its tributary glaciers. Therefore, we quantify the mass discharge of major Larsen C tributaries and its temporal evolution. Flow velocities are derived from multi mission remote sensing data sets and in combination with ice thickness measurements close to the grounding line, ice mass flux is estimated.

I

## VARIABILITY IN BREEDING PHENOLOGY OF ADÉLIE AND GENTOO PENGUINS BETWEEN 2014 AND 2018

Martin Senf, Christina Braun, Jan Esefeld, Hannes Grämer, Jakob Maercker, Hans-Ulrich Peter, Christian Pfeifer, Daniel Prowaznik, Marie-Charlott Rümmler, Osama Mustafa

Institut of Ecology, Polar and Bird Ecology Group, Friedrich Schiller University of Jena and Thuringian Institute of Sustainability and Climate Protection

Penguins are among the top predators of the Antarctic ecosystem. They are strongly adapted to the harsh conditions and temporal cycles of this region. Therefore, they are considered as indicators of changes of biotic and abiotic conditions in the environment. One possible response to climate variability is a temporal shift in the breeding phenology.

A colony of *Pygoscelis* penguins on Ardley Island, next to the southwestern part of King George Island, South Shetland Islands, has been studied in four consecutive breeding seasons (2014/15 - 2017/18). About 120 nests of gentoo penguins (*Pygoscelis papua*) and about 30 of Adélie penguins (*Pygoscelis adeliae*) were chosen to represent all topographic characteristic (altitude, slope, etc.) and biotic factors (nest group size, predator activity). The marked nests were controlled in intervals of three days and the dates of important breeding events, e.g. peak of egg laying and peak of hatching, were recorded. The resulting breeding phenology is representative for the temporal breeding pattern of the entire colony during the respective season. Thus, differences in the breeding phenology between the species and between seasons could be assessed.

The breeding phenology of Adélie penguins was nearly consistent throughout all four studied seasons. In contrast, gentoo penguins showed a much higher annual variability in their temporal breeding pattern. The peak of hatching was observed on December 4, whereas in the other two previous seasons the peak was around December 18th. Accordingly, the whole phenology was preponed by about two weeks. The likely reason for the early start of the 2016/17 breeding cycle was the average snow height in spring, which was much lower than in the two previous years and allowed early access to snow-free breeding grounds. Therefore, the snow cover at the beginning of the breeding season seems to play an important role for the breeding phenology of the more flexible gentoo penguins, while the Adélie penguins did not show a response in terms of a temporal shift in their breeding phenology.

In the future it is planned to involve remote sensing data. The aim is to develop and optimize methods for the study of the breeding phenology, which are less invasive than regular nest controls.

## LATE QUATERNARY DEPOSITS OF THE NORTHERN VERKHoyANSK MOUNTAINS: GEOCHRONOLOGY AND QUESTIONS OF THEIR GENESIS

C. Siegert, A.J. Sergeenko, L.  
Schirrmeister

Alfred-Wegener-Institut  
Helmholtz-Zentrum für Polar- und  
Meeresforschung  
Potsdam

Using accelerator mass spectroscopy (AMC), it was first possible to obtain age dates from late Quaternary deposits of the Northern Verkhojansk (Kharaulakh) Mountains. The presented results showed that frozen sediments covering pre-Quaternary rocks in the studied areas are relatively young

their accumulation began only in the Karginy Interstadial (MIS 3). Within the Kharaulakh structural-facial zone (the Kharaulakh Mountains), the age of the Quaternary deposits ranged from about 28 000 BP up to the present time. In the adjacent territory of the foothill plain that located in the Buorkhaya structural-facial zone their ages ranged from about 48,000 BP to the Holocene.

The sediments studied in two catchment areas of the Kharaulakh mountains were linked to relief forms (cirques turning into terraced surfaces), which indicate their accumulation under the influence of nival processes associated with snowfields. This conclusion is confirmed by the regularly stratified structure of the investigated sediment sections that was caused by seasonal snowfields melting and the associated transport and sorting of detrital material. Measured ages suggest that these processes were especially common in the last phase of the Karginy interstadial (MIS 3) and at the beginning of the Sartanian stadial (MIS 2), as well as during the late Holocene. The ages of alluvial deposits from the Khara-Ulakh River valley indicated that sedimentation began at the end of the Sartan stadial (MIS 2) – about 12 thousand years ago – and continues to the present day. These data confirm the young age of the Kharaulakh depression. At a similar time, the formation of the Khorogorsk depression in the northern part of the Kharaulakh Mountains occurred. Ice-rich sediments with polygonal ice wedges on the foothill plain at Cape Ogolokh-Tumsa located in the Buorkhaya structural-facial zone are comparable with the very thoroughly studied section of the ice complex deposits on the Bykovsky Peninsula.

## GLOBAL GLACIER MASS BALANCES FOR THE YEARS 2003-2017 RECOVERED WITH GRACE

Jonathan Simon<sup>2</sup>, Ingo Sasgen<sup>1</sup>,  
Hannes Konrad<sup>1</sup>

<sup>1</sup>Alfred-Wegener Institute Helmholtz  
Centre for Polar- and Marine Research,  
Department of Geography,

<sup>2</sup>Universität Heidelberg

We present global mass balance estimates of large glacier systems based on GRACE satellite gravimetry data using forward-modelling inversion. First, we cluster the spatial distribution of glaciers obtained from a global glacier model to larger entities resolvable by GRACE. We then forward model the signal of these clusters, assuming a homogeneous distribution of mass change within each cluster. The forward models are then adjusted, in a least-squares sense, to the GRACE observations. The forward model and the GRACE data are filtered to minimize effect of far-field signal (leakage) and noise in mass balance estimates. Contributions from terrestrial water storage and glacial-isostatic adjustment are removed using hydrology and solid Earth deformation models, respectively. We experiment with the cluster dimension, the filtering, as well as with the distribution of mass change within each clustered entity. We analyse the temporal components in the mass balance time series. We infer regions, where long-term trends are significantly larger than the interannual variability, and discuss the related climatic drivers.

## THE ROLE OF CLIMATE CHANGE AND CLIMATE VARIABILITY ON THE DISTRIBUTION OF *GADUS MORHUA* IN THE ARCTIC

Lisa Spotowitz, Felix Mark, Christoph Held, Markus Brand, Philipp Fischer

Alfred-Wegener Institut  
Helmholtz Zentrum für Polar- und Meeresforschung

In recent years, several studies postulate a significant increase in the transport of warm Atlantic water masses towards Svalbard driven by climate change. A consequence of this Arctic “Atlantification” seems to be a higher abundance of *Gadus morhua* (Atlantic cod) in these areas. Similar increases in cod stocks were reported between the 1920s and 1960s, a period known as Early Arctic Warming. As a major competitor for food and habitat resources, an increase in the overall abundance of *G. morhua* in the Arctic will have considerable consequences for the ecosystem. The native cod stock of *Boreogadus saida* (polar cod) is most susceptible to these changes in the area. In this study, we hypothesis that *G. morhua* has established a local “non-migratory” spawning stock at Svalbard, similar to a local coastal cod stock in Norway. We specifically focus on two questions:

1. Is there a correlation between the overall abundance and distribution patterns of Atlantic cod stocks at the coast of Svalbard with longer-term temperature patterns? Is there an increase in the overall abundance of *Gadus morhua* during periods when warmer water surround Svalbard?
2. Is the Atlantic cod stock on the west coast of Svalbard genetically / morphologically distinguishable from that of the Norwegian coast, where the migratory origin of *Gadus morhua* is assumed? And if so, can this stock establish as a local spawning stock?

In the framework of a cooperative sampling programme from 2018 to 2020, together with Norwegian and AWI colleagues, genetic analysis at individual and population level will be conducted. Together with catch data modelling approaches, we aim to improve our knowledge on possible future distribution patterns of Atlantic cod migrating towards Arctic waters and their effects on the local Arctic community.

## GLACIER SURFACE AND MASS BALANCE VARIATION IN ALASKA AND SOUTHERN GREENLAND

W. Stempfhuber, W. Korth, T. Hitziger  
und U. Hofmann

Beuth Hochschule für Technik Berlin

The Juneau Icefield Research Program (JIRP) in Alaska is a long-term glacier monitoring project with unique records in the area of biology, meteorology, resource and environmental studies, geology, geomorphology and geophysics, terrestrial photogrammetry, remote sensing and land surveying. The Juneau Icefield is one of several icefield regions and glaciated areas stretching from southern British Columbia to the Alaska Peninsula and across the Canada border with approximately 40 main- and 140 sub-glaciers.

The first data sets have been recorded in the year 1946. Annual GNSS profile measurements over approximately 4.400 square kilometers have been measured since 1992. These unique records in combination with geotechnical data sets represent a detailed report of weather conditions in northern regions. A low cost based L1 GNSS monitoring will be installed in the next field session 2018 to determine glacier velocity and elevation. Terrestrial laser scanning and SfM-methodes will be used to supplement the terrasat X tandem DGM.

The second glacier research region of our institute is Greenland. GNSS profiles from coast to coast have been observed over the last 15 years. The paper will describe similarities and differences of the total mass balance and global effects. Both glacier regions are indicating elevation changes related to temperature plus rain- or snowfall. Remote sensing datasets provide additional measurement result to discuss this research approach.

## AN IMPROVED METHOD OF INTERPOLATING HEIGHT CHANGES OF ICE SHEETS DERIVED BY SATELLITE ALTIMETRY

Undine Strößenreuther, Martin Horwath,  
Ludwig Schröder, L. Krieger, Dana  
Floricioiu, Mirko Scheinert, Christoph  
Knöfel

Technische Universität Dresden

Satellite altimetry provides height measurements of the Antarctic and Greenland ice sheets. The typically applied repeat-track analysis to derive height changes yields an incomplete and inhomogeneous sampling of the investigated areas. By a reasonable interpolation of the irregular pattern the spatial resolution can be improved. Previous studies showed that, amongst different interpolation methods, kriging is capable to yield superior results. However, the commonly used ordinary kriging (OK) neglects errors of the original data. Heterogenous measurement-error filtered kriging (HFK) includes these errors in it's formulation. We investigate these different kriging methods in a closed-loop simulation. For that, a simulated dataset was used, which is based on real data to reflect actual measurement and error conditions. The results clearly demonstrate the benefits of HFK including the improvement of interpolation and provision of meaningful error measures. Finally, this algorithm is applied to height changes derived from the CryoSat-2 satellite altimetry mission in the northeast of the Greenland ice sheet. These rates are compared to surface elevation changes acquired by differencing TanDEM-X subsequent elevation models.

## **GEOPHYSICAL SURVEY FOR SAFETY REASONS AT THE PROGRESS-VOSTOK LOGISTIC TRAVERSE, EAST ANTARCTICA**

Anastasiia Sukhanova, Svetlana  
Grigoreva, Alina Boronina, Sergey  
Popov, Marina Kashkevich, Vitalii  
Kashkevich, Viacheslav Martianov,  
Valerii Lukin

Saint Petersburg State University

Logistic and scientific operations in Antarctica have always faced with difficulties associated with specific climate conditions of the continent. Crevasse fields might be undoubtedly named among them. The effective way to reveal such hazardous areas was found in near-surface geophysics in the recent years.

During the austral summer field season of 2017/18 GPR and seismic surveys are planned to be carried out in three areas, where the aim of geophysical survey will be to study the upper part of the glacier to find the safety and reliable ways for logistic operations.

First area is located between Progress (Russia) and Zhongshan (China) stations and the point of Russian and Chinese logistic traverses formation point near the aerodrome. Due to the fact that the wide icy depression has destroyed the part of the existing route on January 30, 2017 there, it is very important to study this area to reveal crevasses. The second important area of the investigations is situated near the Thala Fjord. It is considered as a new possible discharge point of the “*Academic Fedorov*” research vessel. The investigations of this area will be a good support to concern safety of the logistic operations. The last area is situated in the crevasse zone which crosses the way to the inland stations Vostok (Russia) and Kunlun (China).

Such kind of the survey involve either applied (to provide the safety of the logistic operations) and the fundamental scientific research that seems to be a good opportunity to the deeper investigation of the ice dynamics and the crevasse zone.



## PAST ENVIRONMENTAL VARIABILITY OF THE LAPTEV SEA CONTINENTAL MARGIN AND ATLANTIC WATER ADVECTION TO THE ARCTIC DURING THE LAST C.18 CAL. KYRS

Taldenkova E., Bauch H.A.,  
Spielhagen R.F., Ovsepyan Ya.,  
Chistyakova N., Stepanova A.,  
Nikolaev S., Segl M.

Lomonosov Moscow State University,  
Geographical Faculty

Knowledge about the extent and timing of past inflows of Atlantic waters (AW) carrying heat and salt to the Arctic Ocean is essential for reconstructing short and long-term climate changes. Our research is aimed at tracing eastward propagation of AW towards the continental margin of Siberian Arctic in relation to ice sheet dynamics, freshwater inputs and sea-ice extent during different time intervals of the last c. 18 cal.kyrs. Sediment cores from the western (PS51/154) and eastern (PS2458) Laptev Sea continental margin and a core from the eastern Fram Strait (MSM5/5-723) with well-established chronologies were studied for IRD, benthic and planktic foraminifers, ostracods, and benthic stable isotopes (core PS2458).

Comparison of IRD records from Fram Strait and the Laptev Sea revealed their different timing. Whereas the most active IRD flux to site MSM5/5-723 took place 12-15 cal.ka, in the Laptev Sea the only strong IRD flux from Severnaya Zemlya ice caps occurred in its western part prior to 16 cal.ka. Iceberg production by Severnaya Zemlya ice caps was probably coeval with the SE extension of the Barents-Kara ice sheet towards Taymyr that might have blocked the river outflow for a certain time. Its retreat resulted in a meltwater outflow to the Laptev Sea. In the basal part of core PS51/154 (16-17.6 cal.ka) we found abundant authigenic concretions formed under strong freshwater influence. In core PS2458, simultaneous freshening is evidenced by negative excursions in  $\delta^{18}\text{O}$  and  $\delta^{13}\text{C}$  records of benthic foraminifer *Cassidulina neoteretis*. The excursions could also be partly explained by the subsurface advection of relatively warm and poorly ventilated AW as in the same units exotic warm-water planktic foraminifers occur that are absent in the overlying beds.

In all studied areas deglacial benthic foraminiferal assemblages were dominated by *C. neoteretis* until 13 cal.ka. This species preferring a stratified water column with sea-ice cover is regarded in the Arctic as an indicator of subsurface AW. Therefore, there probably existed an unmodified subsurface inflow of AW with a northern Fram Strait branch (FSBW) that was especially strong 14.7-13.2 cal.ka. A freshening event of yet unknown origin is reconstructed in the Laptev Sea close to 13 cal.ka based on negative  $\delta^{18}\text{O}$  excursions in planktic and benthic records, changes in the abundance and composition of microfossils, and abundant vivianite concretions in core PS2458. During the Younger Dryas cold interval 13-12 cal.ka, in both Laptev Sea cores *C. neoteretis* was largely replaced by the typical Arctic species *Cassidulina reniforme* preferring colder water environments. A similar "switch" between the dominant species occurred in the eastern Fram Strait and other sites on the northern pathway of AW. It is possible that the freshwater and sea ice export from the Arctic to the Nordic Seas was strong enough to reduce the subsurface AW inflow.

The meltwater influence in the Fram Strait area diminished at the beginning of the Holocene. The change in the benthic assemblage at 11.5 cal.ka to a dominance of deep-living species *Cibicidoides wuellerstorfi* and *Oridorsalis umbonatus* together with *C. reniforme* marked the onset of deep convection implying AW at the surface and cold, well-oxygenated waters at the bottom. The propagation of surface AW far northward during the times of highest northern hemisphere summer insolation and eventual active heat loss together with deep convection in the region around Fram Strait resulted in a somewhat reduced AW advection with the FSBW to the Laptev Sea. Here *C. neoteretis* is either totally lacking after 12 cal.ka (until 7 cal.ka) in core PS51/154 or strongly reduced in abundance in the deeper core PS2458. More AW also deviated into the Barents Sea. For instance, in the SW Barents Sea beneath the BSBW pathway an opposite change of species occurred at 11.7-12 cal.ka: *C. reniforme* decreased down to less than 5 %, while *C. neoteretis* increased up to 50 %.

Climate cooling started after 7 cal.ka when the meltwater was gone, the sea level almost reached its present position, Arctic shelves were flooded, and modern-like atmospheric circulation evolved. In the Laptev Sea, the cooling trend is documented by peaks of IRD originating from Severnaya Zemlya and the growing representation of ice-rafted shallow-water microfossils in the otherwise deep-water assemblages. As seen from the benthic assemblages in core MSM5/5-723, the strength of deep convection in the Fram Strait decreased, time-coeval with surface-water cooling and growing extent of the seasonal sea-ice cover. Due to active sea-ice formation on the Eurasian shelf seas and riverine water inputs, considerable amounts of freshwater and sea ice were transported to the western Fram Strait with the East Greenland Current that was likely compensated by enhanced subsurface AW inflow to the Arctic with the FSBW. Correspondingly, the relative abundance of *C. neoteretis* in the Laptev Sea increased after 7 cal.ka.

The proportion between the dominant benthic species *C. neoteretis* and *C. reniforme* in deglacial and Holocene sediments of the Eurasian Arctic seas reflects variability in AW inflow to the Arctic in relation to freshwater influence. *C. neoteretis* is related to subsurface inflow of relatively warm AW, but it is also dependent on the presence of seasonal sea-ice cover and water stratification. *C. reniforme* is an ecologically more tolerant Arctic species, generally preferring colder bottom water conditions than *C. neoteretis*, be this convection-produced deepwater or water in glacial proximal and polynya areas. Overall, the Laptev Sea microfossil records mirror changes in the character of AW in upstream regions, primarily in those under the northern pathway through the eastern Fram Strait.

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## SCHIFF ODER SCHLITTEN? ÜBER DIE EROBERUNG DER POLE

Erki Tammiksaar

Estonian University of Life Sciences  
University of Tartu

Der Pol als geographischer Punkt spielte lange Zeit keine Rolle als Ziel der Entdeckungsreisen. Erst in der zweiten Hälfte des XVIII. Jahrhunderts wurde von den Russen während Vasilij Čičagovs Expedition der erste erfolglose Versuch unternommen, mit zwei Schiffen den Nordpol zu erobern. Um 1818 versuchte es der Brite David Buchanan und um 1827 William Edward Parry – wieder ohne Erfolg. Alle drei waren überzeugt, dass es während der Sommermonate westlich von Spitzbergen möglich sei, mit Schiffen und kleinen Booten bis zum Nordpol vorzudringen. Der Grund dafür ist augenscheinlich – diese Gegend war durch den Robbenfang am besten bekannt. Aber die physischen Gegebenheiten des Nordpolarmeeres waren stattdessen noch völlig unbekannt, insbesondere wusste man sehr wenig über die Stärke und Richtung der Polarströmungen.

Um die komplizierten Eisverhältnisse des Nordpolarmeeres während der Sommermonate nördlich von Spitzbergen zu vermeiden, entwickelte der Deutschbalte Alexander Theodor von Middendorff 1846 einen völlig neuen Plan zur Eroberung des Nordpols. Während seiner sibirischen Expedition (1842 – 1845) hatte er viel Hundeschlitten benutzt und wollte nun als Leiter einer kleinen Hundeschlittenexpedition den Pol erreichen. Die Expedition würde schon im März aufbrechen, wenn das ganze Meer noch komplett mit Eis gedeckt war, um schnell auf dem Eis vorwärtszukommen. Einen ähnlichen Plan hatte auch der Balte Ferdinand von Wrangell im Jahre 1846 vorgeschlagen. Im Gegensatz zu Middendorff hatte er seinen Ausgangspunkt an der Nordküste Grönlands gewählt.

Wie die weiteren Versuche, den Nord- und auch den Südpol zu erreichen, beweisen, hatten die Europäer auf den ersten Blick meistens den Komfort in vermeintlich sicheren Schiffen bevorzugt. Außerdem gab es auch nur wenig zuverlässige Beobachtungen der geografischen Bedingungen des Nord- und Südpolararmeeres. Aus diesem Grund erreichten letztendlich Hundeschlittenexpeditionen als erste die Pole, weil sie weniger von den geografischen Bedingungen vor Ort abhängig waren.

## CASE STUDIES CONCERNING THE AIR MASS INFLUENCE ON THE NUMBER CONCENTRATION OF CLOUD CONDENSATION NUCLEI IN THE SOUTHERN OCEAN REGION DURING ACE

Christian Tatzelt, Silvia Henning, André Welti, Andrea Baccharini, Martin Gysel, Danny Rosenfeld, Julia Schmale, Heini Wernli, and Frank Stratmann

Leibnitz-Institut für  
Troposphärenforschung e.V

From December 2016 to March 2017 the R/V “*Troyshnikov*” went round the Antarctic continent on the Antarctic Circumnavigation Expedition. Among a wide variety of experiments onboard aiming at the biology, oceanography and others, also atmospheric parameters were sampled, e.g., within the “Study of Preindustrial-like-Aerosol Climate Effects” (SPACE) project. As partner in this project, TROPOS focused on aerosol particles involved in aerosol cloud interactions, specifically those that are able to act as cloud condensation nuclei (CCN), as well as particles able to nucleate ice (INP). Along the 3-month lasting cruise, we observed several periods of special interest, such as several days with high number concentrations of small particles, a cold air outbreak, and air masses originating from a volcano plume.

The mean CCN number concentration at 0.2 %, averaged over the whole cruise, was 120 #/cm<sup>3</sup>. Extreme values were found close to the Antarctic continent. At Mertz Glacier we observed very low CCN concentrations (around 15 #/cm<sup>3</sup>, January 30, 2017), but also the highest pristine concentrations (up to 300 #/cm<sup>3</sup>, February 6, 2017) were measured close to this region. In this contribution, we will discuss possible factors (e.g., air mass origin) influencing CCN concentration and hygroscopicity.

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## GIGAMAP, GEOLOGISCHE KARTEN NORD VICTORIA LANDS, ANTARKTIS

Franz Tessensohn

Im Jahr 1995 wurde das deutsch-italienische Gemeinschaftsprojekt GIGAMAP (German-Italian Geological Antarctic MAP Program) ins Leben gerufen, um die partnerschaftlichen geologischen Feldarbeiten im Nord Victoria Land der Antarktis zu dokumentieren. Eine gemeinsam erarbeitete Legende bildet die Grundlage für den einheitlichen Stil der Karten. Der Maßstab 1 : 250 000 der geologischen Karten wurde durch die einzige vorhandene topographische Grundlage vorgegeben, die vom US Geological Survey zur Verfügung gestellt wurde.

Anlässlich des 30. Jahrs des italienischen Forschungsprogramms in der Antarktis wurde 2016 ein Schuber mit allen 8 Karten des italienischen Anteils herausgegeben (Pertusati, P.C., Ricci, C.A. & Tessensohn, F. (eds.).-Terra Antartica Reports 15). Neben den Karten mit eingedrucktem Erläuterungstext enthält der Schuber eine sehr nützliche Kartenversion auf CD. Kartenbeispiele werden als Poster vorgestellt.

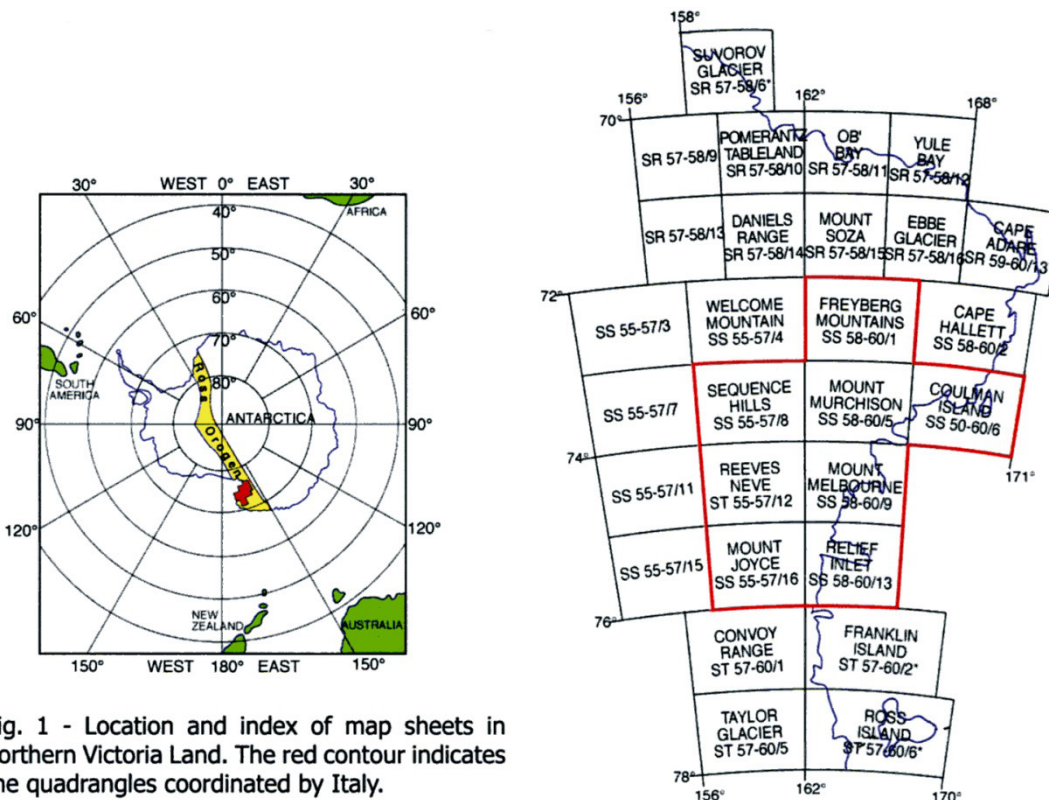


Fig. 1 - Location and index of map sheets in northern Victoria Land. The red contour indicates the quadrangles coordinated by Italy.

## IN HOT AND COLD WATER OF THE SOUTHERN OCEAN: DIFFERENTIAL LIFE-HISTORY TRAITS ARE KEY TO SUCCESS OF HYDROTHERMAL YETI CRAB

Sven Thatje, Leigh Marsh

University of Southampton

Few species of reptant decapod crustaceans thrive in the cold-stenothermal waters of the Southern Ocean. However, abundant populations of a new species of anomuran crab, *Kiwa tyleri* Thatje, 2015 occur at hydrothermal vent fields on the East Scotia Ridge. As a result of local thermal conditions at the vents, these crabs are not restricted by the physiological limits that otherwise exclude reptant decapods south of the polar front. We reveal the adult life history of this species by piecing together variation in microdistribution, body size-frequency, sex ratio, and ovarian and embryonic development, which indicates a pattern in the distribution of female Kiwaidae in relation to their reproductive development. High-density “Kiwa” assemblages observed in close proximity to sources of vent fluids are constrained by the thermal limit of elevated temperatures and the availability of resources for chemosynthetic nutrition. Although adult Kiwaidae depend on epibiotic chemosynthetic bacteria for nutrition, females move offsite after extrusion of their eggs to protect brooding embryos from the chemically harsh, thermally fluctuating vent environment. Consequently, brooding females in the periphery of the vent field are in turn restricted by low-temperature physiological boundaries of the deep-water Southern Ocean environment. Females have a high reproductive investment in few, large, yolky eggs, facilitating full lecithotrophy, with the release of larvae prolonged, and asynchronous. After embryos are released, larvae are reliant on locating isolated active areas of hydrothermal flow in order to settle and survive as chemosynthetic adults. Where the cold water restricts the ability of all adult stages to migrate over long distances, these low temperatures may facilitate the larvae in the location of vent sites by extending the larval development period through hypometabolism. These differential life-history adaptations to contrasting thermal environments lead to a disjunct life history among males and females of *Kiwa tyleri*, which is key to their success in the Southern Ocean hydrothermal vent environment. We highlight the complexity in understanding the importance of life-history biology, in combination with environmental, ecological and physiological factors contributing to the overall global distribution of vent endemic species.

## BATHYAL KING CRABS FACE NO THERMAL BARRIER TO EMERGENCE IN ANTARCTICA

Sven Thatje, Kathryn E. Smith, James B. McClintock, Per-Olav Moksnes, Jonathan N. Havenhand, Richard B. Aronson

University of Southampton

The Southern Ocean's cold-water environment has excluded durophagous (skeleton-breaking) predators from the Antarctic seafloor for millions of years. Rapidly warming seas off the western Antarctic Peninsula (WAP) could now facilitate their return to the continental shelf, with profound consequences for the endemic fauna. King crabs (Lithodidae) living in reproductively viable populations on the adjacent slope are among the likely first arrivals. We used underwater imagery to survey slope-dwelling populations of the lithodid crab *Paralomis birsteini* and their prey off Marguerite Bay, WAP, where lithodid densities averaged 4280 ind km<sup>-2</sup> at depths of 1,100 – 1,499 m (range 3,440 – 5,010 ind km<sup>-2</sup>), and off Anvers Island, where densities were lower, averaging 2,060 ind km<sup>-2</sup> at the same depths (range 660 – 3270 ind km<sup>-2</sup>). Analysis of the gut contents of *P. birsteini* off Marguerite Bay suggested that they are generalized predators of invertebrates. Three commonly eaten, skeletonized taxa – ophiuroids, echinoids, and gastropods – were negatively associated with *P. birsteini* off Marguerite Bay, where lithodid densities were higher, but not off Anvers Island. With water temperatures on the outer shelf (400 – 500 m depth) already warm enough, and with sufficient prey densities in the outer-shelf environment, there appear to be no barriers to prevent the lithodids from expanding upward and emerging on the outer shelf. However, temperatures remain too cold for them to survive in shallow, coastal environments (<200 m). Lateral or vertical range expansions of *P. birsteini* could substantially reduce populations of their prey, overprinting the direct impacts of rising temperatures on the distribution and diversity of the shelf benthos.

## BIOACCUMULATION AND MATERNAL TRANSFER OF MERCURY IN FUR SEALS FROM THE SOUTHERN OCEAN: INFLUENCE OF INTRINSIC FACTORS AND FEEDING ECOLOGY INFERRED FROM STABLE ISOTOPES

Justine Alice Thébault

Justus-Liebig Universität Gießen

Mercury (Hg) is a metallic trace element highly toxic, which can lead to broad deleterious effects on biota even at low doses by altering the functioning of nervous, reproductive and immune systems. It is released in the environment from both natural and anthropogenic sources. Nevertheless, human activities have substantially modified the cycling of this trace element on a global scale. The elemental form of Hg is extremely volatile, and can be transported over long distances. As a result, high concentrations can be found not only in the vicinity of pollution sources, but also in remote environments such as polar and sub-polar regions.

Hg accumulates in organisms and biomagnifies within food webs, so long-lived apex predators such as marine mammals are at risk of high exposure and have therefore been widely used to monitor the degree of pollution in marine ecosystems.

Using carbon and nitrogen stable isotopes as a proxy of the ecological niche ( $\delta^{13}\text{C}$  reflecting feeding habitats, and  $\delta^{15}\text{N}$  the diet/trophic level), we quantified the influence of foraging ecology on Hg concentrations of two species of fur seals (*Arctocephalus tropicalis* and *A. gazella*) breeding at Crozet Archipelago, Southern Indian Ocean. Moreover, the influence of individual traits (species, sex, age, duration of the lactation period) was investigated. Total and methyl-Hg concentrations were determined in blood of males, females and pups. Milk sampled on lactating females was analysed to study the maternal transfer of Hg.

Adult Hg exposure was similar for both species. Blood concentrations of pups were higher for *A. tropicalis* than for *A. gazella*, which may result from an age difference.

Sex was not found to be a factor affecting blood Hg levels of adults, even though some *A. gazella* males presented low Hg concentrations due to a krill rich diet in Antarctic waters.

Pups, despite feeding a full trophic level higher than their mothers, presented lower Hg concentrations than adults as a result of a shorter period of bioaccumulation. The duration of the rearing period was positively correlated to Hg burdens in pups.

In blood, Hg consisted mainly in methyl-Hg; the opposite pattern was found in milk, inorganic Hg being the main chemical form.

The Hg concentrations in the blood and the milk of females presented no correlation. Mammal glands could exert an important role in restricting the transfer of Hg to milk. Placenta may play a greater role in Hg transfer than does milk, raising questions regarding how Hg exposure could affect the offspring during this very sensitive development period.

Our results confirm an efficient biomagnification of Hg across food webs. However, the use of  $\delta^{15}\text{N}$  values to compare the trophic level of populations foraging across large geographic scales does not take into account disparities in baseline values between food webs. Further investigations using compound-specific analyses of amino acids would help to better understand the trophic transfer of Hg.



## MERCURY CONTAMINATION AND PLASTIC DEBRIS RESIDUES IN ANTARCTIC PETREL SPECIES

Justine Alice Thébault, Petra Quillfeldt

Justus-Liebig Universität Gießen

Marine ecosystems are renowned to be major repositories of environmental contaminants, such as heavy metals, persistent organic pollutants or plastics. Long-lived apex predators, for instance seabirds, are at risk of high exposure and have therefore been widely used to monitor the degree of pollution in marine ecosystems. Nevertheless, mercury and plastic exposure of petrel species are still poorly documented.

During this poster session will be discussed the preliminary results of our ongoing project investigating the mercury and plastic contamination in storm petrels, prions and blue petrels breeding in the Southern Ocean.

Fieldwork will be carried out during early and late breeding season, at different sites in Antarctic (King George Island, Adélie Land) and Subantarctic (Diego Ramirez Islands, Kerguelen Island, Falkland Islands) zones.

Plastic pollution in the ocean is now a global concern. Empirical studies provide evidence of large-scale exposure of wildlife that ingests plastic debris. The impacts of plastics exposure include direct mortality from physical blockage or perforation of the digestive organs, as well as acute and chronic toxicity induced by chemicals contained within and adsorbed to the plastic. However, there has been little systematic assessment of the risk imposed by plastic pollution. The presence of common plasticizers will be determined in the waxy preen oil using a recently established GC-MS protocol. Additionally, plastic exposure of seabirds breeding in the Southern Ocean will be compared with storm petrel breeding in the North-east Pacific (San Benito Islands, Mexico), an area renowned to display a high plastic contamination.

Mercury (Hg), a highly toxic pervasive trace element, will be measured from the same birds using feathers and blood samples. Hg is a non-essential heavy metal that can lead to broad deleterious effects on biota even at low doses, by altering the functioning of nervous, reproductive and immune systems with potential impacts at the population level. The elemental form of this metal is extremely volatile, and can be transported over long distances. As a result, high concentrations can be found not only in the vicinity of pollution sources, but also in remote environments such as Antarctica. Elevated levels of Hg exposure have been reported in seabirds from the Southern Ocean.

We will test for differences in the level of contamination associated with breeding and inter-breeding distribution and trophic level (determined using compound-specific stable isotope analyses). Furthermore, a comparison between samples collected during the early and late Antarctic breeding season (e.g. November versus March) will enable us to quantify carry-over effects of the exposure in the inter-breeding season.

## WLADIMIR KÖPPEN, ALFRED WEGENER, AND MILUTIN MILANKOVITCH: THEIR IMPACT ON MODERN PALEOCLIMATE RESEARCH AND THE REVIVAL OF THE MILANKOVITCH HYPOTHESIS

Jörn Thiede

Köppen-Laboratory, Institute of Earth  
Sciences, Saint Petersburg State  
University, RF

Wladimir Köppen (1846-1940, originally from St. Petersburg), Alfred Wegener (1880-1930, originally from Berlin) and Milutin Milankovitch (1879-1958, originally from Dalj/ Serbia) made very important contributions to paleoclimatology during the early years of the 20th century. Köppen described the global climate zonation, Wegener defined the continental drift during the Phanerozoic, using Köppen's climate zonations applied to paleogeographic scenarios of the geological past, and Milankovitch introduced regularly changing orbital parameters as controls of past climatic changes providing a precise time scale for Glacials and Interglacials during the Quaternary. By combining their scientific efforts, they succeeded to change our understanding of Earth history in a fundamental way, each of them with their specific expertise and their wide scientific horizons.

Alfred Wegener achieved world renown with the publication of his book "The Origin of Continents and Oceans" in 1915. With four editions printed between 1915 and 1929, Wegener's hypothesis on the "origin of continents and oceans" was highly controversial at that time. At first, Köppen was skeptical of Alfred Wegener's ideas about the "Origin of Oceans and Continents", but later (around 1919) he changed his scientific position and became an ardent defender of Wegener's ideas. The peak of their scientific relationship was reached when Wladimir Köppen and Alfred Wegener jointly published their monograph on "Die Klimate der geologischen Vorzeit" (Climates of the Geological Past) in 1924. This book contains an important monographic interpretation on the causal relationships of climate change in the geological past (Köppen & Wegener 1924).

The scientific relationship between Milankovitch, Köppen and Wegener has been elucidated in a book edited by A. Berger (1995), based on the autobiography of Milankovitch, but widened in scope by remarks of the son Vlasko Milankovitch. The most important influence of Milankovitch on Köppen and Wegener was related to the timing of insolation changes and the impact of changes of the geometry of the orbit of planet Earth around the sun on climate changes between glacials and interglacials during the most recent geological past. But Wegener and Köppen also influenced Milankovitch's thinking on the causes of changes of the planetary magnetic field and its consequences on the paleopositions of poles. Together with Wegener he speculated a lot about the physical state of the interior of the Earth's interior and the causes of the changes of the magnetic field.

## USING POLAR ICE CORES TO UNVEIL THE CONNECTIONS BETWEEN GLOBAL VOLCANISM AND CLIMATE VARIABILITY

Matthew Toohey, Michael Sigl

GEOMAR Helmholtz Centre for Ocean  
Research Kiel

The injection of sulfur into the stratosphere by explosive volcanic eruptions is a source of significant climate variability. Based on sulfate records from a suite of ice cores from Greenland and Antarctica, the eVolv2k database provides estimates of the magnitudes and approximate source latitudes of major volcanic stratospheric sulfur injection (VSSI) events from 500 BCE to 1900 CE. The VSSI estimates incorporate improvements to the ice core records, in terms of synchronization and dating, and refinements to the methods used to estimate VSSI from ice core records. A long-term, latitudinally and monthly resolved time series of aerosol optical properties has been reconstructed from the eVolv2k VSSI estimates using the Easy Volcanic Aerosol (EVA) forcing generator. Compared to prior volcanic reconstructions, the EVA(eVolv2k) forcing reconstruction shows better correlation with NH temperature reconstructions from tree rings, and suggests that a large proportion of preindustrial climate variability is due to volcanic forcing. This work provides the foundation for improved understanding of the impacts of volcanism on both past and future climate, for example, providing essential information on the different climate impacts of tropical vs. extratropical eruptions, and the potential origins of the “Little Ice Age”. The eVolv2k dataset is the recommended volcanic forcing dataset for paleoclimate model simulations within the 6th phase of the Coupled Model Intercomparison Project (CMIP6), which supports the upcoming Intergovernmental Panel on Climate Change (IPCC) Sixth Assessment Report.

## FIVE YEARS OF ONLINE SEA ICE KNOWLEDGE AND DATA PLATFORM: WWW.MEEREISPORTAL.DE

Renate Treffeisen<sup>1</sup>, Stefanie Arndt<sup>1</sup>,  
Annekathrin Bartsch<sup>1</sup>, Bernadette  
Fritzschi<sup>1</sup>, Klaus Grosfeld<sup>1</sup>, Stefan  
Hendricks<sup>1</sup>, Georg Heygster<sup>2</sup>, Monica  
Ionita-Scholz<sup>2</sup>, Thomas Krumpfen<sup>1</sup>,  
Christian Melsheimer<sup>2</sup>, Marcel  
Nicolaus<sup>1</sup>, Robert Ricker<sup>1</sup>, Gunnar  
Spreen<sup>2</sup>, Marietta Weigelt<sup>1</sup>

<sup>1</sup>Alfred-Wegener-Institut  
Helmholtz Zentrum für Polar- und  
Meeresforschung  
<sup>2</sup>Institut für Umweltphysik (IUP) der  
Universität Bremen

Sea ice in both Polar Regions is an important indicator for the expression of global climate change and its polar amplification. It also plays an important role in modulating the global climate system. Consequently, a broad scientific, as well as societal interest exists on sea ice, its coverage, variability and long-term change which require up-to-date information at different levels for various target groups. Until now, most sea-ice related web pages are only available in English, in particular with regard to actual information and data. Given these considerations meereisportal.de was developed as a comprehensive German knowledge platform concerning sea ice in both Polar Regions, initiated in the framework of the Helmholtz climate initiative REKLIM as a joint project of the University of Bremen (Institute for Environmental Physics) and the Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research under the management of the regional Helmholtz climate office at the Alfred Wegener Institute. The platform has been online since April 2013 and provides (1) comprehensive background information on sea ice, (2) expert statements on recent observations and developments and (3) an extensive map and data archive. Since its launch, all three pillars of meereisportal.de are constantly improved and extended. We will present the portal, its content and function and a first statistics about its use and the user requirements.

## ARCTIC-WIDE TOTAL WATER VAPOUR TIME SERIES COMBINING TWO PASSIVE MICROWAVE SATELLITE ALGORITHMS

Arantxa Triana, Georg Heygster,  
Christian Melsheimer, Gunnar Spreen

University of Bremen

Water vapour is one of the main components of Arctic climate change over the last decades. Therefore, determining its temporal and regional evolution is a crucial element to understand better the Arctic climate system. Therefore, a continuous global retrieval of atmospheric water vapour is needed. Since in the polar regions ground measurements are very sparse, these needs are not met.

For this, satellite measurements have proven their usefulness: they allow us to obtain the vertically integrated water vapour content of the atmosphere (total water vapor, TWV) on a global scale. Microwave imagers like SSM/I or AMSR-E have routinely provided daily total water vapour over open ocean for more than 30 years, but not over the vast areas of the polar sea and land ice. Over those surfaces, a newer method based on data of the microwave humidity sounders AMSU-B and MHS, on the NOAA and METOP satellites respectively, allow retrieving TWV.

The present work aims to merge these two complementary TWV retrievals, creating an Arctic-wide daily dataset of 50 km resolution with seamless coverage from the high Arctic to mid latitudes from 2002 until now. Using this merged dataset, we provide an assessment of water vapour distribution and temporal variations for the first decade of data.

## THE CONTENT OF GLACIAL SOUP IN SVALBARD WATERS AND ITS IMPORTANCE FOR FOOD WEB INTERACTIONS

E. Trudnowska, R. Boehnke, K.  
Draganska-Deja, K. Deja, A.M. Kubiszyn,  
K. Blachowiak-Samolyk

Institute of Oceanology  
Polish Academy of Sciences

Most of Svalbard coastal waters are strongly affected by the glacier retreat as an effect of progressing climate warming. The glacier plumes can be distributed over many kilometres in a form of “brown zones”, which has a substantial impact on many physical and ecological processes occurring in the Arctic marine ecosystems. First of all the primary and secondary production are strongly affected by unfavourable light conditions, which to some extent have also the impact on planktivores belonging to higher trophic levels and directly on benthic communities.

In this study we took an effort to quantify the contribution of various components of the “glacial soup”, i.e. phytoplankton, zooplankton and marine aggregates within the waters that are located in the close vicinity of the Svalbard glaciers. We analysed the composition of the glacial soup in fjords affected by intense glacier retreat (Hornsund, Isfjorden, Kongsfjorden, Wijdefjorden, Rijpfjorden) as well as in coastal waters close to the glaciers that terminate on large islands (Nordaustlandet, Edgeøya) in the summer of 2016. The high resolution automatic measurements of the Laser Optical Plankton Counter (LOPC) were performed in order to analyse the size spectra and abundance of particles and plankton as well as to estimate the amount and transparency of aggregate fraction within the water column. The LOPC platform was equipped with CTD and fluorometer sensors in order to analyse also the hydrographical and algal conditions. The aggregate fraction was also quantified from the underwater camera deployments in fjords. Additionally, to investigate nano- to mesoplankton taxonomic composition and abundance, traditional plankton samples via nets and Niskin bottles were collected at some stations.

We observed huge particle concentrations near glacier fronts and a sharp decrease in their abundances towards open waters. The horizontal and vertical dimensions of the glacier plumes differed considerably among various locations in terms of pelagic components diversity. As expected, water turbidity and hydrographical regimes had a substantial impact on feeding conditions for planktivores, because of various plankton composition and the aggregate contribution. The results provide a new data of particles and plankton concentrations and size structure near glaciers, which is essential knowledge for production and feeding conditions estimations. Furthermore these unique observations can constitute an important premise for predicting future changes scenarios on Arctic ecosystems functioning under rapid climate changes.

## BACTERIAL AND EUKARYOTIC BIODIVERSITY PATTERNS IN THE SØR RONDANE MOUNTAINS, DRONNING MAUD LAND, EAST ANTARCTICA

Bjorn Tytgat, Dagmar Obbels, Maxime Sweetlove, Zorigto Namsaraev, Marie-José Mano, Rafael Fernandez-Carazo, Karolien Peeters, Sofie D'hondt, Pia Clercx, Aaike De Wever, Damien Ertz, Josef Elster, Eric Van Ranst, Stephen Roberts, Koen Sabbe, Annick Wilmotte, Anne Willems, Wim Vyverman and Elie Verleyen

Ghent University

The microbial biodiversity of inland Antarctic terrestrial habitats and the factors shaping these communities are poorly understood. We used the Illumina MiSeq and the Roche 454 platforms to analyse the bacterial and eukaryotic community structure of a variety of habitats in ice-free regions of the western Sør Rondane Mountains (Dronning Maud Land, East Antarctica), including endolithic communities and epiphytic communities on mosses. A particular focus was put on studying the bacterial community structure in soil samples, which is the most abundant habitat type in the region, in relation to environmental variability. OTUs belonging to the Rotifera, Chlorophyta, Tardigrada, Ciliophora, Cercozoa, Fungi, Bryophyta, Bacillariophyta, Collembola and Nematoda were present with a relative abundance of at least 0.1 % in the eukaryotic communities studied. Cyanobacteria, Proteobacteria, Bacteroidetes, Acidobacteria, FBP, and Actinobacteria were the most abundant bacterial phyla across the different habitats. In the soils, ordination analyses revealed that total organic carbon content was the most significant variable in structuring prokaryotic communities, followed by pH, electric conductivity, bedrock type and moisture content, while spatial distance was of relatively minor importance. Acidobacteria (Chloracidobacteria) and Actinobacteria (Actinomycetales) dominated mineral soil samples situated on gneiss derived bedrock, while Proteobacteria (Sphingomonadaceae), Cyanobacteria, Armatimonadetes and candidate division FCB (OP11) dominated soil samples with a high total organic carbon content mainly on granite derived bedrock. Despite these strong environmental controls, part of the unexplained variation in community structure might be related to unmeasured differences in microclimate conditions that potentially exert large effects on these barren soils. A striking feature in all datasets was the detection of a relatively large amount of sequences new to science, which underscores the need for additional biodiversity assessments in Antarctic inland locations.

## EXTREME BACFINDER: MICROBIAL DIVERSITY AND DISTRIBUTION WITHIN THE VICINITY OF THE CONCORDIA ANTARCTIC STATION

Nikea Ulrich, Kaisa Koskinen, Beth Healey, Floris van den Berg, Christine Moissl-Eichinger, and Ralf Moeller

Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR)

The extreme terrestrial environment of the Antarctic ice sheet serves as an excellent probing ground for the adaptation of extremotolerant microorganisms. To inhabit this hostile environment, microorganisms resist sub-zero temperatures, wide temperature fluctuations, high incidence of solar UV radiation, desiccation, and very low nutrient availability. The propagation of microorganisms, and in particular, human-associated and potential pathogenic species, can be facilitated through numerous exposure routes (e.g. air, personal contact, water, excretions, etc.). The Concordia Research Station is a confined, isolated habitat, providing an ideal location to monitor the indigenous microbial diversity and the dispersal of human-associated microorganisms on the surface of continental Antarctica. The BacFinder project (ESA project No. AO-13-Concordia-23) encompassed a two-year study (2015-2016), during which surface snow was sampled monthly at three areas varying in proximity (10 m, 500 m, and 1 km) to the Concordia Station. As a preliminary investigation, the snow samples from months January, March, May, July, September, and November of both years (n=36) were phylogenetically profiled via sequencing of the 16S rRNA gene to identify microbial presence and abundance with respect to spatial and temporal vectors. This study highlighted a robust examination of *in-situ* microbial community structure of the Antarctic habitat and enabled a deeper understanding of the extent to which human contamination has potentially spread from the Concordia Research Station. Ultimately, this study will further inform improvements or modifications to the existing methods and techniques to interrogate the microbial ecology in extreme (sub-zero) environments as well as provide suggestions for future life-detection driven space missions.



## THE ROLE OF MEIOFAUNA IN BENTHIC FUNCTIONING – A QUESTION OF TIME?

Gritta Veit-Köhler<sup>1</sup>, Erik Kusch<sup>1,2</sup>,  
Merten Bohn<sup>1,3</sup>, Ursula Witte<sup>4</sup>,  
Christoph Mayr<sup>5</sup>, Heike Link<sup>6</sup>

<sup>1</sup> Senckenberg am Meer, German  
Centre for Marine Biodiversity  
Research - DZMB, Wilhelmshaven,  
Germany (gveil-koehler@senckenberg.  
de)

<sup>2</sup>University of Bergen, Bergen, Norway

<sup>3</sup> Carl-von-Ossietzky University  
Oldenburg, Department of Biology and  
Environmental Science, Oldenburg,  
Germany

<sup>4</sup> Oceanlab, University of Aberdeen,  
Newburgh, United Kingdom

<sup>5</sup> University of Erlangen, Institute of  
Geography, Erlangen, Germany

<sup>6</sup> University of Rostock, Department  
Maritime Systems, Rostock, Germany

For the Southern Ocean little is known about the role of meiofauna (animals of the size class 32– 1000 µm) in benthic remineralisation processes. Previous studies on carbon cycling in sediments and by benthic communities showed that meiofauna incorporated only small amounts of isotopically marked food sources. Antarctic nematodes had very low uptake rates of added carbon and contributed negligibly to carbon remineralisation. However, these experiments with a max. duration of 16 days were either carried out with sediments from Bransfield Strait or from the Antarctic deep sea. As part of our project “Role of meio- and macrofauna in benthic ecosystem functioning: Testing effects of different ice cover regimes” we aim to investigate 1) the time span meiofauna communities need to incorporate and 2) the response of different meiofauna compartments (copepods vs nematodes) to food input. We performed the on-board pulse-chase experiment MeioFEx (Meiofauna Feeding Experiment) during the RV *Polarstern* expedition PS96 with the longest experimental time span so far. We collected sediments from the high Antarctic Weddell Sea shelf (483 m) west of the Filchner Trough and added <sup>13</sup>C- and <sup>15</sup>N-isotopically marked freeze-dried microalgae (*Chaetocystis* sp., 3.3 mg per core). Samples were taken after 1, 3, 6, 12 and 18 days of incubation. With this experiment we complete a set of stations sampled for natural stable isotope distribution and benthic functioning incubations (see also poster Link et al., Session DFG SPP 1158 Antarctic Research). The results will enable us to address the question whether meiofauna react to a food pulse with a time-lag compared to macrofauna and whether they feed mostly on degraded or on fresh organic matter.

## MICROPLASTICS AS HORIZONTAL GENES VECTORS ACROSS ARCTIC FRESHWATER BODIES

David Velázquez, Miguel González-Pleiter, Roberto Rosal, Antonio Quesada, Francisca Fernández-Piñas

Universidad Autonoma de Madrid

Over the last five decades millions of tons of plastic have been produced around the world (PlasticEurope, 2015) and many plastics finally reach the environment. Plastic debris – the so-called microplastics – are known to be present in all compartments of the environment worldwide. Studies of plastic in seawater over four decades have found that they are distributed across all the oceans due to their buoyancy and durability. They display exceptional persistence and consequently the plastics travel around the world for decades.

It is well known that plastic debris could exert some damage over marine ecosystems. However, their ecological impact in freshwater networks is not well understood. Here, we investigated the colonization process of plastic debris in an Arctic freshwater pond from Svalbard during the first CLIMARCTIC fieldwork. Microbeads of poly(hydroxybutyrate) (PHB), polystyrene (PS), and low-density polyethylene (LDPE) were exposed *in-situ* to Arctic freshwater to analyze the early colonizing population of bacteria and protists.

## THE ORIGIN OF THE POLAR LACUSTRINE DIATOM BIOME: EVIDENCE FROM MACROECOLOGY AND PALEOLIMNOLOGY

Elie Verleyen, Bart Van de Vijver,  
Eveline Pinseel, Dominic A. Hodgson,  
Bjorn Tytgat, Koen Sabbe, Wim  
Vyverman

POLDIAT consortium / Ghent University  
- Protistology and Aquatic Ecology

The geological, glacial, tectonic and climatic history of regions (the history of place) profoundly influenced the composition, diversity and distribution of their present-day biota (the history of lineages). These differences in plant and animal communities have led to the delineation of the terrestrial biosphere into distinct biogeographical realms, each characterised by a unique biotic constellation. For microorganisms, contemporary biogeographic patterns remain largely understudied because species identification is generally hampered by the lack of discriminating morphological features and a high amount of cryptic species diversity. The advent of high-throughput sequencing techniques is now enabling us to study large-scale macroecological and biogeographical patterns in microbial communities. Here we use the case of high latitude diatom biomes to explore the current and past biogeography of lacustrine microbial floras using a combination of microscopy-based identification of morphospecies (on extant and fossil materials) and with high throughput amplicon sequencing of marker genes. Fossil evidence suggests that in Antarctic lakes, modern diatom communities appear to have evolved from a distinct Gondwana flora which became impoverished in response to climatic forcing and decreasing habitat availability since the Mid Miocene cooling event. Today, lake dwelling diatom floras in (sub)Antarctica have strong affinities with terrestrial floras in the region and lack key functional groups such as planktonic forms compared to the Arctic. The bioregionalisation patterns between both polar regions are remarkably congruent with other microscopic eukaryotes studied using marker genes and multicellular organisms, and suggest a shared evolutionary history. Combined these macroecological and paleolimnological approaches form compelling evidence for the combined role of historical and contemporary processes in shaping eukaryotic microbiomes in polar lake ecosystems.

## HOLOCENE DEGLACIATION, ISOSTATIC UPLIFT, AND PALEOENVIRONMENTAL CHANGES AT SKARVSNES, LÜTZOW- HOLM BAY, EAST ANTARCTICA

Elie Verleyen, Ines Tavernier, Dominic  
A. Hodgson, Katrien Heirman, Stephen  
J. Roberts, Sakae Kudoh, Satoshi  
Imura, Marc De Batist, Koen Sabbe,  
Wim Vyverman

POLDIAT consortium / Ghent University  
- Protistology and Aquatic Ecology

The Holocene deglaciation, isostatic uplift, and climate history of many parts of coastal East Antarctica remain poorly understood. We analysed fossil pigments, siliceous microfossils, sedimentology and geochemistry of radiocarbon-dated sediment cores from Kobachi Ike (Skarvsnes, Lützow-Holm Bay, East Antarctica) to determine the timing of deglaciation, isostatic uplift, and the palaeoecological evolution of the lake. The site was initially a marine basin. This became deglaciated around c. 6800 cal. yr BP, which is at the lower end of the 10 - 6 ka BP range determined by regional cosmogenic isotope dates. Isostatic uplift resulting from deglaciation isolated the basin from the sea between c. 2730 and c. 2290 cal. yr BP. This was shown as an increase in brackish-water diatoms, total carotenoids and chlorophylls, total nitrogen and myxoxanthophyll, linked to freshwater cyanobacteria and the establishment benthic microbial mats. Palaeoclimate inferences include the presence of seasonally open-water marine conditions between c. 4900 and 2570 cal. yr BP, inferred from a diverse diatom community composed of *Chaetoceros* resting spores co-dominant with sea-ice diatoms. Around c. 2025 cal. yr BP, a drastic shift in the lithology, decrease in magnetic susceptibility, and increases in total organic carbon and brackish-water diatoms might be linked to the (partial) disappearance of multi-year snow banks in the catchment area, consistent with a Mid- to Late-Holocene warm period recorded elsewhere in East-Antarctica.

## PROPERTIES AND CIRCULATION OF GLACIALLY MODIFIED WATERS AT THE 79 NORTH GLACIER

Luisa von Albedyll, Janin Schaffer,  
Torsten Kanzow

Alfred-Wegener-Institut  
Helmholtz-Zentrum für Polar- und  
Meeresforschung

Submarine melting of Greenland's marine-terminating glaciers is an important part of their mass balance and warming of the waters in contact with the glaciers is suspected to trigger significant thinning, followed by an acceleration of the ice flow and glacier retreat. Enhanced melting increases freshwater input that has the potential to alter the ocean dynamics by influencing the fjord's stratification, currents and sea ice cover.

Nioghalvfjerdingsjorden (79 North Glacier) is the largest outlet of the Northeast Greenland Ice Stream, that drains the second-largest basin of the Greenland Ice Sheet and was recently observed to undergo dynamical thinning. The 79 North Glacier has an 80 km long floating ice tongue beneath which a deep cavity is located. Here, warm waters of Atlantic origin are present causing strong basal melting at the grounding line where additionally inflow of subglacial runoff takes place. Glacially modified waters within the cavity are exchanged through two deep passages beneath the main calving front where significant in- and outflow velocities were identified. Here, we use hydrographic measurements taken during two *Polarstern* cruises carried out in summers 2016 and 2017 to analyze the properties and circulation patterns of the outflowing, glacially modified waters. An Optimum Multiparameter Analysis was applied using potential temperature, salinity and oxygen as conservative properties to determine fractions of basal meltwater and subglacial runoff. Close to the glacier front, basal meltwater fractions reach 2 % whereas subglacial runoff accounts for 0.4 %. Effective export pathways of the meltwater from the glacier front to the shelf break are analyzed by the help of hydrographic and velocity measurements obtained during the cruises. In addition, first results from our one-year-long moored timeseries give insights into the temporal variability of the meltwater export. Understanding the role of meltwater in the fjord system will contribute to a better assessment of how increased freshwater input could alter the ocean circulations in this region.

## COMBINED MODELLING OF SATELLITE AND AIRBORNE MAGNETIC DATA FOR EAST ANTARCTICA

Agnes Dakota Wansing, Jörg Ebbing

Christian-Albrechts-Universität zu Kiel

In recent years, the aeromagnetic coverage over Antarctica has improved significantly. Nevertheless, aeromagnetic data suffer from a long-wavelength spectral gap compared to satellite data. That is due to how aeromagnetic data are acquired and processed. We examine, if by combination of satellite and aeromagnetic data, helps in geophysical inverse and forward modelling with a case example from the Gamburtsev Province, east Antarctica.

In the modelling, we did not aim to produce a combined magnetic field model, but used the susceptibility distribution inverted from a satellite model as an input for modelling the aeromagnetic data. The results are compared with a second model, inverted without satellite data. The inclusion of the long-wavelength information from the satellite inversion does affect the final model, but does not significantly alter the location of sources in the upper crust. Hence, the combination is less important for geological interpretation, but significant for interpretation of the deepest magnetic sources.

To determine the impact of the satellite models, we tested two different satellite models based on the CHAMP (MF7 @ 300 km) and Swarm (SIFM @ 400 km) satellite missions. In the last step, we validate the combined final models against the aeromagnetic and satellite data.

## DEGLACIAL DYNAMICS OF THE ANTARCTIC ICE SHEET REVISED – IMPLICATIONS FOR FUTURE SEA-LEVEL RISE

Michael E. Weber, Christopher J.  
Fogwill, Matthew DeCesare, Nicholas  
R. Golledge, Natalya Gomez, and Peter  
U. Clark

University of Bonn

Knowledge on the response of the Antarctic Ice Sheet (AIS) to deglacial changes is very limited because most shallow marine and terrestrial sediment sequences cannot be dated adequately, reveal only the late stage of ice retreat, or resolve only local responses, leaving much room for speculation during the last two decades on the true nature and dynamics of events and their contribution to past sea-level rise. Novel findings from far-field, deep-ocean sediment records from Iceberg Alley revise our current understanding of ice-sheet dynamics. The record of iceberg-rafted debris (IBRD) in deep-ocean sediment from the Scotia Sea provides a nearly continuous, integrative history of eight AIS discharge events (AIDs) during deglaciation (Weber et al., 2014). The highly-resolved records indicate that AIS collapse occurred extremely rapidly - within one or a few decades, and once initiated, continued for centuries. Major AIS mass loss brackets Meltwater Pulse 1A (AID6) and 1B (AID2), between ~14.7 – 11.3 ka. Even throughout the Holocene repeated decadal-to-centennial scale fluctuation in AIS mass volume are documented with far-reaching effects (Bakker et al., 2016).

Independent confirmation comes from analysis of the Patriot Hills blue ice area, indicating marked AIS elevation draw down (in excess of 650 m) and mass loss across the Weddell Sea Embayment during the Antarctic Cold Reversal (ACR, 14.7 - 12.7 ka) (Fogwill et al., 2017). Comparing the Patriot Hills and Scotia Sea records indicates that greater AIS mass loss enhanced surface cooling in the Southern Ocean, led to higher seasonal variability in sea-ice extent, and increased ocean productivity in the sea-ice zone during the ACR, slowing the rate of atmospheric CO<sub>2</sub> rise and establishing a globally significant carbon sink (Fogwill et al., in review).

Foraminiferal radiocarbon ages from shallow-marine sediment archives in the eastern Ross Sea (DeCesare et al., pers. com.) directly constrain grounding line retreat of the West Antarctic Ice Sheet at 14.7 ka (30 km) and 11.5 ka (200 km), likely contributing to AID6 and AID2, respectively. These ages also constrain ice shelf collapse approximately the size of Larsen-B occurred 12.3 ka, likely contributing to AID3.

Close agreement between geological and ice-core records and thermodynamic ice-sheet modelling driven by deglacial ocean temperature changes simulated in an intermediate complexity climate model, confirm that the AIS was highly-dynamic during the last glacial termination (Golledge et al., 2014). Its dynamism most likely arose from a combination of a high sensitivity to subsurface ocean warming and basal meltwater or substrate feedbacks that allowed rapid propagation of ice marginal thinning into the interior of the ice sheet.

Preliminary results with a dynamic ice sheet model coupled to a global sea level model (Gomez et al., 2013) suggest that the ice discharge in Antarctica may have also responded to short timescale sea level variations associated with Northern Hemisphere ice cover changes through the deglaciation.

All these recent findings are in marked contrast to previous scenarios of minor and late deglacial dynamics, and argue for a much more dynamic deglacial AIS, which is important in light of current discussions on potential AIS collapse in the near future and its impact on sea-level rise for the coming decades to centuries.

To promote research on past AIS dynamics, we submitted two full proposals to the International Ocean Discovery Program (IODP) (Weber et al., in revision

Weber et al., 2017). The later one is now scheduled as IODP Expedition 382 for March to May 2019 ([https://iodp.tamu.edu/scienceops/expeditions/iceberg\\_alley\\_paleoceanography.html](https://iodp.tamu.edu/scienceops/expeditions/iceberg_alley_paleoceanography.html)).

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## **IODP EXPEDITION 382 – ICEBERG ALLEY PALEOCEANOGRAPHY & SOUTH FALKLAND SLOPE DRIFT**

Michael E Weber

University of Bonn

I will report about upcoming International Ocean Discovery Program (IODP) Expedition 382, which is scheduled for March 20 to May 20, 2019. The expedition with RV *Joides Resolution* aims to recover 600 m long Late Neogene sedimentary sequences from the Scotia Sea to reconstruct past variability in Antarctic Ice Sheet (AIS) mass loss, oceanic and atmospheric circulation and to provide the first spatially integrated record of variability in iceberg flux from Iceberg Alley, where a substantial number of Antarctic icebergs exit into the warmer Antarctic Circumpolar Current (ACC). This will (a) constrain iceberg flux during key times of AIS evolution since the Middle Miocene glacial intensification of the East Antarctic Ice Sheet, (b) provide material to determine regional sources of AIS mass loss, address interhemispheric phasing of ice-sheet and climate events, and the relation of AIS variability to sea level, (c) provide information on Drake Passage throughflow, meridional overturning in the Southern Ocean, water-mass changes, CO<sub>2</sub> transfer via wind-induced upwelling, sea-ice variability, bottom water outflow from the Weddell Sea, Antarctic weathering inputs, and changes in oceanic and atmospheric fronts in the vicinity of the ACC, and (d) provide dust proxy records to reconstruct changes in the Southern Hemisphere westerlies to evaluate climate-dust coupling since the Pliocene, its potential role in iron fertilization and atmospheric CO<sub>2</sub> drawdown during glacials. Expedition 382 will also core a sediment drift on the Falkland slope to obtain subantarctic multi-proxy intermediate water depth records of millennial to orbital scale variability in the ocean, atmosphere, nutrients, productivity and ice-sheet dynamics in the SW Atlantic through at least the last 1 Ma.

## **ELEVATION CHANGES AT FEDCHENKO GLACIER, PAMIR MOUNTAINS, FROM 2000 TO 2016**

Anja Wendt , Christoph Mayer, Astrid Lambrecht, Dana Floricioiu

Bayerische Akademie der Wissenschaften

With a length of more than 70 km, Fedchenko Glacier in the Pamir Mountains is among the largest mountain glaciers outside the polar regions. Although its frontal position has been relatively stable since the first survey in 1928, the glacier has experienced thinning of more than 80 m near the debris covered glacier front during the same time.

We use a series of digital elevation models (DEMs) based on TanDEM-X data acquired between 2011 and 2016 to investigate seasonal and interannual elevation changes. Based on the high temporal density of the available DEMs, different sensor-dependent as well as medium-related processes can be analysed and separated. While the interferometrically derived DEMs possess a high resolution and accuracy and can be acquired independent from weather conditions and solar illumination, they are subject to elevation biases due to penetration of the radar signal into ice and snow. However, the simultaneous analysis of radar backscatter helps to identify the instantaneous surface conditions that determine penetration properties. Our combined analysis of ice elevation and backscattering reveals ice thinning throughout the glacier for the period 2011 to 2016. In the lower part of the glacier up to an elevation of 4,000 m, the recent rates are comparable to the ones derived from comparison with the SRTM data from the year 2000. However, ice thinning intensified higher up and even affects the highest accumulation basins of the glacier.

## ECOSYSTEM MATURATION CONCEPT FOR THE WARMING ARCTIC

Jan Marcin Weslawski, Lech Kotwicki,  
Maria Włodarska-Kowalczyk, Joanna  
Legezyńska, Marta Gluchowska

Institute of Oceanology  
Polish Academy of Sciences

Kongsfjorden, the Atlantic influenced fjord on Svalbard when compared with colder local fjords shows the peculiarities characteristic for the maturing ecosystem - namely higher diversity, more dispersed and more stable food web. The biomass of both plankton and benthos is higher, system is using more carbon directly, and less carbon is buried. All those features are along the concept of ecosystem maturation coined by E.O. Odum. This may help us to understand and predict the future fate of warmed Arctic.

## **TOWARD A BETTER UNDERSTANDING OF MACROALGAE INTERACTION WITH A CHANGING ARCTIC ENVIRONMENT. ISFJORDEN: A MULTIDISCIPLINARY CASE STUDY**

J. Wiktor, A. Kruss, A. Tatarek, Jr. J. Wiktor

Institute of Oceanology PAN

Macroalgal beds are an important component of coastal zones in Arctic regions. Those highly productive habitats provide food and a living space for vast number of associated invertebrates and fishes. Some of kelps new production is transported ashore feeding this way terrestrial ecosystem. Knowing distribution and standing stock of macroalgae is essential for estimating the overall productivity of the Arctic area and for understanding processes occurring at the sea-shore interface. Macroalgae are sensitive to changes in environmental factors (temperature, salinity, turbidity, current velocity), which may limit or influence their spatial distribution and health.

In July 2016 and 2017, we carried out a multidisciplinary expedition to investigate the spatial distribution of macroalgae in Isfjorden (Svalbard). The acoustic detection of macroalgae in 8 designated areas distributed around the fjord was combined with biological and environmental studies. Along with acoustic data from single- and multi-beam echosounders, we collected numerous underwater video recordings covering all the depths in the euphotic zone within selected polygons. ADCP measurements in each sampling zone were carried out and CTD profiles were collected (with additional turbidity and oxygen sensors).

We found considerable differences in kelp species abundance and distribution on the bottom between the northern and the southern parts of the fjord, where environmental conditions are significantly different. The southern part is influenced by salty, transparent shelf waters, while the northern part is under the influence of glaciers that bring fresh water with dense sediment suspension.

Although the results that we would like to present here are at the early stages of processing, they already offer interesting insights into the benefits of multidisciplinary studies in polar regions and into possible interactions between climate change and the Arctic environment.

Project was financed by Polish National Science Centre (UMO-2015/17/B/NZ8/02473) and Svalbard Environmental Protection Fund.

## ICE DIATOMS – STRESSED OR NOT STRESSED?

Angela Wulff, A. Torstensson, M.  
Hedblom, M. Chierici, J. Andersson,  
M.X. Andersson, J. Dinasquet, L.  
Riemann, M. Mattsdotter Björk, A.  
Fransson

Dept of Biological and Environmental  
Sciences, University of Gothenburg

Benthic diatoms and sea ice algae, dominated by pennate diatoms, are a vital part of the primary production in polar regions and provide a substantial carbon source for higher trophic levels. Studies on climate change effects on this part of the basis of the polar food web should, thus, not be neglected. We need to study physiological acclimation to environmental change to address how different stressors may influence organisms' capacity to tolerate both naturally- and climatically-driven changes. Extremophiles, like sea ice algae, growing close to their physiological limits may be especially susceptible to environmental stressors.

In a series of studies, we investigated how environmental stressors, such as increased temperature and elevated CO<sub>2</sub>, affect microbial physiology and community structure in polar areas. The ecophysiology of sea ice microorganisms was addressed in laboratory experiments and in field measurements. In brief, relatively small changes in temperature had considerable effects on the physiology of sea ice diatoms, and indirectly affected the structure of sea ice bacterial communities. Increasing temperature (on both climatic and seasonal scales) positively affected the growth and primary productivity of two sea ice diatom species, and negatively affected the taxonomic richness and diversity of sea ice bacterial communities, probably by the subsequent changes in salinity. On the other hand, sea ice diatoms were quite tolerant to changes in pH and partial pressure of CO<sub>2</sub> (pCO<sub>2</sub>) in terms of growth, probably due to the fact that they grow in an environment with large seasonal variations in the carbonate system. However, increased pCO<sub>2</sub> resulted in other cellular changes that may have important ecological consequences, such as cellular stoichiometry. This includes changes in fatty acid composition and dissolved organic carbon exudation, which are important components in food webs and biogeochemistry in many marine ecosystems.

Although most studies on marine organisms have focused on short-term responses to increased pCO<sub>2</sub>, acclimation and adaptation are key components in order to identify the consequences of climate change in biological systems. The physiological responses to long-term acclimation to high pCO<sub>2</sub> were investigated in the sea ice diatom *Nitzschia lecointei*. After long-term acclimation (194 days), a small reduction in growth was detected at high pCO<sub>2</sub>. Previous short-term experiments have failed to detect altered growth in *N. lecointei* at high pCO<sub>2</sub>, which illustrates the importance of experimental duration in ocean acidification studies.

## VERIFICATION OF THE REGIONAL ATMOSPHERIC MODEL CCLM WITH MEASUREMENTS IN THE ANTARCTIC

Rolf Zentek and Günther Heinemann

Environmental Meteorology,  
University of Trier

Measurements of atmospheric variables (e.g. wind, temperature) are scarce in the Antarctic region. The default data are from automatic weather stations (AWS), manned station (MS) and radio soundings (RS). We investigate the benefits of wind lidar measurements for the verification of regional models. While the RS, MS and AWS data feature all a point or 1D perspective, the lidar data feature a 2D perspective with many vertical measurements in a short period of time. Thus atmospheric changes on a vertical scale of 1 km and a temporal scale of hours (e.g. low level jets) can be further investigated as well as the ability of regional models to simulate these. We use the model COSMO CLM (CCLM) with 5 and 15 km resolution and force it with ERA-Interim data for the years 2002 to 2016. The model domain covers the Weddell Sea. A long-term verification using standard data and an intercomparison with lidar data for a *Polarstern* cruise in 2015/16 is presented. The RMSE using radio sounding data for winter (April – September) is around 4 m/s for wind speed and 2°C for temperature.

## **IS THE ARCTIC BECOMING MORE POLLUTED? SOURCES, PATHWAYS AND EXAMPLES OF AEROSOL POLLUTION EVENTS IN THE SVALBARD REGION**

Kasper Zieliński, Tymon Zieliński

Institute of Oceanology  
Polish Academy of Sciences

For many generations, the Arctic has been considered to be a pristine environment with limited anthropogenic influence. Today, however, we know that the Arctic environment is continuously contaminated by pollutants transported from lower latitude sources.

Pollution is the introduction of contaminants into the natural environment which cause adverse changes. Pollutants can be anthropogenic substances (e.g. some organic contaminants or radioactive isotopes), or naturally occurring substances e.g. nutrients. Their pathways include atmospheric transport, ocean current transport, riverine transport and sea ice transport.

Due to the lack of significant local anthropogenic pollution sources, the extremely sensitive ecosystem of the Arctic is mostly affected by aerosols and pollution transported through atmospheric circulation. However, the main local anthropogenic emissions within the Arctic are associated with NO<sub>x</sub> (e.g. from shipping, oil and gas activities, transport) and SO<sub>2</sub> sources from limited industrial areas.

In this work we present typical sources and pathways of pollution advection to the Arctic, with special emphasis on atmospheric advection. We also discuss new types of pollution, namely microplastics, which are being introduced into the Svalbard area.

## IS THE ARCTIC SUBJECT TO INCREASING ENVIRONMENTAL STRESS IN THE SUMMER SEASON?

Tymon Zieliński, Paulina Pakszys,  
Tomasz Petelski, Przemysław  
Makuch, Małgorzata Cisek, Piotr  
Markuszewski, Christoph Ritter,  
Roland Neuber, Mauro Mazzola, Rita  
Traversi, Michał Posyński, Katarzyna  
Dziembor, Kasper Zieliński

Institute of Oceanology  
Polish Academy of Sciences

Over the past 30 years, the Arctic region has been the subject of extensive international studies focused on elucidating the transport pathways of pollution into the Arctic. Due to the lack of significant local anthropogenic aerosol sources, the extremely sensitive ecosystem of the Arctic is mostly affected by aerosols and pollution transported through atmospheric circulation, mainly through influencing the Arctic surface radiation budget. The increasing scientific interest in feedback mechanisms related to climate change has led to a solid scientific foundation for investigations of climate change related environmental adaptations currently observed in the Arctic.

In this work we present examples of three different extreme aerosol events which had significant impact on the radiative budget in the Svalbard region. We show that in the last 5 years summer biomass burning events are beginning to play a very important role in aerosol related pollution in the Svalbard region.

In 2006, the European Arctic experienced an abnormally warm spring, and smoke from agricultural fires in Eastern Europe was intruded into the region causing severe air pollution episodes. Two significant volcanic eruptions, i.e. the Eyjafjallajökull (April-May 2010) and Grímsvötn (May 2011) eruptions produced layers of high aerosol concentration, which have been observed over Svalbard several days after the eruptions. The third aerosol event involves the biomass burning episode related to intense forest fires in North America in July 2015.



## TECTONIC AND TOPOGRAPHIC DEVELOPMENT OF THE ELEPHANT ISLAND GROUP, WEST ANTARCTICA

Maximilian Zundel, Cornelia Spiegel,  
István Dunkl, Anne M. Grunow, Frank  
Lisker

University of Bremen

The Elephant Island group is located north of the Antarctic Peninsula and consists of several small, extensively ice-covered islands, which rise up to ~2000 meters above sea level and are characterized by a very steep topographic relief. The Elephant Island group lies in the vicinity of the active boundary of the Scotia and Antarctic Plates, which are of particular interest for understanding the geodynamic evolution of the Scotia Sea and the opening of the Drake Passage after Gondwana break-up.

Cretaceous metamorphic rocks and Oligocene to Miocene plutonic rocks mainly describe the rock exposures on the islands. These rocks were sampled for absolute age dating and to reconstruct their evolution throughout geologic time. Obtained intrusion and thermochronological ages suggest that the Elephant Island group was uplifted and eroded during the opening of the Drake Passage, ~30 Ma ago. Later on, the eastern parts of the island group have been rapidly exhumed and uplifted in response to plate tectonic reorganisations in the last ~5 Ma. The impressive relief of the island is considered to have formed during that last episode.

The Elephant Island group reveals a dynamic, relatively young, tectonic and geomorphologic evolution, which has been closely coupled to the ever-changing plate tectonic situation of the Scotia Sea and surrounding areas.



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HELMHOLTZ-ZENTRUM FÜR POLAR-  
UND MEERESFORSCHUNG

**BREMERHAVEN**

Am Handelshafen 12  
27570 Bremerhaven  
Telefon 0471 4831-0  
Telefax 0471 4831-1149  
[www.awi.de](http://www.awi.de)

