

# Berichte

zur Polar-  
und Meeresforschung

659  
2013

**Reports  
on Polar and Marine Research**



## *Changing Polar Regions*

25<sup>th</sup> International Congress on Polar Research  
March 17-22, 2013, Hamburg, Germany

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German Society for Polar Research

Edited by

Eva-Maria Pfeiffer, Heidemarie Kassens, Mirko Scheinert,  
Ralf Tiedemann, and Members of the DGP Advisory Board



**Alfred-Wegener-Institut**  
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### \* Anschrift / Address

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## **VORWORT ZUR POLARTAGUNG 2013 IN HAMBURG**

Die gravierenden Änderungen in der Arktis und Antarktis in Folge des Klimawandels haben die Polarregionen in den Focus der wissenschaftlichen, gesellschaftlichen und wirtschaftlichen Aufmerksamkeit gerückt. Deshalb hat die Deutsche Gesellschaft für Polarforschung (DGP) für die 25. Internationale Polartagung das Thema „Polargebiete im Wandel“ gewählt.

Vom 17. bis 22. März 2013 treffen sich in Hamburg Fachwissenschaftler, Experten und interessierte Laien, um sich zu den drängenden Fragen des raschen Klimawandels in den Kältegebieten unseres Erdsystems auszutauschen. In sechs thematischen Sitzungen werden neben der interdisziplinären Polar- und Gletscherforschung auch die Geschichte der Polarforschung und polare Themen im Schulunterricht präsentiert.

Wir freuen uns, dass wir Ihnen im Rahmen dieser Tagung auch aktuelle Ausstellungen mit Bezug zur Polarforschung zeigen können und Ihnen Einblicke in Expeditionen in die Arktis („Lebende Ausstellung“ und „Expedition Arktis“) und künstlerische Impression in die Weite der Antarktis (Photoausstellung „Erlebnis Polarexpedition“) bieten können. Das Programm eröffnet ebenso die Möglichkeit die naturwissenschaftlichen Museen der Universität Hamburg zu besuchen.

Die Tagung wird von der DGP in enger Kooperation mit der Universität Hamburg, dem Alfred-Wegener-Institut, Helmholtz-Zentrum für Polar- und Meeresforschung, und dem KlimaCampus Hamburg organisiert. Dies wäre nicht möglich, ohne die vielen ehrenamtlichen Unterstützer. Unser Dank gilt in erster Linie den Helfern der Universität Hamburg im Vorfeld der Organisation der Tagung und den Mitgliedern des Wissenschaftlichen Beirats der DGP für die Erstellung des wissenschaftlichen Programms. Ebenso danken wir dem KlimaCampus der Universität Hamburg für die finanzielle Unterstützung der Nachwuchswissenschaftler aus Mittel- und Osteuropäischen Ländern. Unser Dank gilt weiterhin dem BMBF für die Einbindung der „Lebenden Ausstellung“ sowie der BGR und dem AWI für die Realisierung der Ausstellung „Expedition Arktis“ im Rahmen der 25. Polartagung.

Der Vorstand der DGP wünscht Ihnen interessante und diskussionsreiche Tage in Sachen „Polargebiete im Wandel, Ihre/Ihr

Mirko Scheinert, Ralf Tiedemann und Eva-Maria Pfeiffer

22. Februar 2013

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## Vortragsprogramm

### Sonntag, 17. März 2013

- 15:00 – 17:15 DGP-Sitzung, erweiterter Vorstand sowie Beirat und Gäste
- 18:00 – 21:00 Registrierung / Icebreaker

### Montag, 18. März 2013

- 09:00 – 10:30 Eröffnung *Grußworte: Prof. Dr. Eva-Maria Pfeiffer, DGP, Prof. Dr. Heinrich Graener, Dekan MIN-Fakultät*
- 09:30 – 10:00 *Prof. Dr. Heinrich Miller (Alfred-Wegener-Institut Helmholtz-Zentrum für Polar- und Meeresforschung Bremerhaven) - Die Polarregionen im Klimawandel*
- 10:00 – 10:30 Ehrungen der DGP

### Kaffeepause

### Klimawandel in Polargebieten

- 11:00 – 11:15 **Eingeladener Vortrag**  
*Helmut Rott (Enveo IT, Innsbruck), Michael Eineder, Wael Abdel Jaber, Dana Floricioiu, Gabriele Bippus, Thomas Nagler - Retrieving volume changes and mass depletion of glaciers by means of TanDEM-X Data*
- 11:15 – 11:30 *Lars Kutzbach (University of Hamburg) - CH<sub>4</sub> and CO<sub>2</sub> fluxes of Siberian polygonal tundra: eddy covariance measurements und modelling*
- 11:30 – 11:45 *Georg Schwamborn (Alfred-Wegener-Institut Helmholtz-Zentrum für Polar- und Meeresforschung, Potsdam), G. Fedorov, L. Schirrmeister, H. Meyer, A. Andreev, D. Mottaghy, V. Rath - Permafrost-lake interactions in the 3.6 Ma old El'gygytyn Crater, NE Russia*
- 11:45 – 12:00 *Sebastian Zubrzycki (University of Hamburg) - Organic Carbon Pools in Permafrost-Affected Soils of Siberian Arctic Regions*
- 12:00 – 12:15 *Anne Zschocke (University of Hamburg), Annette Eschenbach - Klimawandel und Extremereignisse: Influence of freezing processes on organic contaminant migration*
- 12:15 – 12:30 *Christian Knoblauch (University of Hamburg), Christian Beer, Alexander Sosnin, Dirk Wagner, Eva-Maria Pfeiffer - Long-term trace gas release from thawing permafrost*

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12:30 – 12:45 *Karsten Piepjohn (Bundesanstalt für Geowissenschaften und Rohstoffe, Hannover) - Ausstellung Expedition Arktis*

**Mittagspause**

**Geologie und Geophysik der Polargebiete**

13:30 – 13:45 **Eingeladener Vortrag**  
*Joachim Jacobs (University of Bergen), Andreas Läufer, C. Clark, I. Kleinhanns, M. Elburg, A. Ruppel, S. Estrada, D. Damaske, W. Jokat, S. Riedel, N. Lucka - Neoproterozoic/Lower Palaeozoic geodynamic evolution of Dronning Maud Land: integrating geology and geophysics*

13:45 – 14:00 *Nicole Lucka (University of Bremen), F. Lisker, A. Läufer, C. Spiegel - From basin to mountains: the uplift of the Shackleton Range*

14:00 – 14:15 *Olaf Eisen (Alfred-Wegener-Institut Helmholtz-Zentrum für Polar- und Meeresforschung, Bremerhaven), Coen Hofstede, Anja Diez, Yngve Kristoffersen - Subglacial geology of Halfvarryggen ice dome, Antarctica, inferred from seismic measurements*

14:15 – 14:30 *Doreen Kasper (University of Hamburg), D. Steinhage, A. Humbert - Subglacial lakes at the onset of Recovery Glacier, Antarctica*

14:30 – 14:45 *Johann Philipp Klages (Alfred-Wegener-Institut Helmholtz-Zentrum für Polar- und Meeresforschung, Bremerhaven), G. Kuhn, C.-D. Hillenbrand, A.G.C. Graham, J.A. Smith, R.D. Larter, K. Gohl - New marine geological and geophysical evidence for the extent, flow, and retreat of a West Antarctic palaeo-ice stream offshore from the Hobbs Coast*

14:45 – 15:00 *Christian Rodehacke (Max-Planck-Institut für Meteorologie, Hamburg), Miren Vizcaino, Uwe Mikolajewicz - Two-way coupled ice sheet-earth system simulations: consequences of raising CO<sub>2</sub> concentration for the Greenland and the interacting climate system*

15:00 – 15:15 *Estella Weigelt (Alfred-Wegener-Institut Helmholtz-Zentrum für Polar- und Meeresforschung, Bremerhaven), Wilfried Jokat, Dieter Franke - Seismostratigraphy of the Siberian Arctic Ocean and adjacent Laptev Sea Shelf*

15:15 – 15:30 *Karsten Piepjohn (Bundesanstalt für Geowissenschaften und Rohstoffe, Hannover), Werner von Gosen, Franz Tessensohn - Die Struktur der oberen Erdkruste zwischen Naresstraße und Polarmeer - ein Transect durch Ellesmere Island*

**Kaffeepause**

16:00 – 16:15 *Martina Dolezych (Senckenberg Natural History Collections, Dresden) - Conifer woods – emending findings in the Arctic Palaeogene forests of Svalbard and Ellesmere Island*

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16:15 – 16:30 *Mirko Scheinert (TU Dresden), Joachim Schwabe* - Anwendung der Satelliten- und Fluggravimetrie für die Schwerefeldbestimmung in der Antarktis

**Biodiversität, Migration und Nahrungsnetze**

16:30 – 16:45 *Angelika Brandt (University of Hamburg)* - ANDEEP-SYSTCO (SYSTEM COUPLING): contributions to the biodiversity and feeding biology of Southern Ocean deep-sea benthos

16:45 – 17:00 *José Xavier (University of Coimbra)* - Challenges in Antarctic marine biodiversity and food webs studies: a top predators perspective

17:00 – 17:15 *Daniel Zitterbart (Alfred-Wegener-Institut Helmholtz-Zentrum für Polar- und Meeresforschung, Bremerhaven), A. Ancel, C. LeBohec, A. Nesterova, R. Gerum, C. Metzner, B. Fabry* - Collective motion in penguin colonies

17:15 – 17:30 *Hans-Ulrich Peter (University of Jena), Christina Braun, Jan Esefeld, Thora Herrmann, Jeong-Hoon Kim, Johannes Krietsch, Michel Stelter* - Klimawandel, natürliche Witterungsphänomene und direkte anthropogene Einflüsse beeinflussen Vogelpopulationen auf King George Island/ Antarktis

17:30 – 17:45 *Ulrike Ruprecht (University of Salzburg)* - Diversity and richness of myco- and photobionts in Antarctic lichen

17:45 – 18:00 *Victoria Ivanets (National University of Kyiv-Mohyla Academy, Kyiv)* - New data about materials for nest building by the kelp gull in the Argentine Island area (Maritime Antarctica)

18:00 – 18:15 *Kathleen R. Stoof-Leichsenring (Alfred-Wegener-Institut Helmholtz-Zentrum für Polar- und Meeresforschung, Potsdam), Ludmila Pestyakova, Ralf Tiedemann, Ulrike Herzsuh* - Insights into intra-specific diatom diversity using historical DNA from arctic lake sediments: can we use genetic diversity to infer paleoenvironmental changes?

18:15 – 18:30 *Heidemarie Kassens (Helmholtz-Zentrum für Ozeanforschung Kiel (GEOMAR), Henriette Kolling, Antonina Chetverova, Bennet Juhls, Sergey Kostygov, Stepan Krasheninnikov, Irina Kryukova und Julia Antsibor* - Lebende Ausstellung: Brennpunkte der deutsch-russischen Zusammenarbeit auf dem Gebiet der Meeres- und Polarforschung

18:30 – 20:00 Poster, Wein und Bier

**Dienstag, 19. März 2013**

**Biodiversität, Migration und Nahrungsnetze**

- 09:00 – 09:30 **Eingeladener Vortrag**  
*Karin Lochte (Alfred-Wegener-Institut Helmholtz-Zentrum für Polar- und Meeresforschung, Bremerhaven) - The future of polar science*
- 09:30 – 09:45 *Benoît Sittler (University of Freiburg), Johannes Lang - Karupelv Valley Project - A long term study of lemming cycles in high Arctic Greenland in the grip of climate change*
- 09:45 – 10:00 *Theresa Hegemann (University of Freiburg), M. Dees - Recent snow cover changes of lemming habitats in high Arctic Greenland as derived from Landsat TM imagery*
- 10:00 – 10:15 *Annette Bombosch (Alfred-Wegener-Institut Helmholtz-Zentrum für Polar- und Meeresforschung, Bremerhaven), Ilse van Opzeeland, Daniel P. Zitterbart, Mary S. Wisz, Claudio Richter, Stephan Frickenhaus, Olaf Boebel - Modelling habitat suitability of humpback and Antarctic minke whales in the Southern Ocean*
- 10:15 – 10:30 *Ilse Van Opzeeland (Alfred-Wegener-Institut Helmholtz-Zentrum für Polar- und Meeresforschung, Bremerhaven), Annette Bombosch - Modeling year-round marine mammal habitat preferences in the Southern Ocean based on passive acoustic observations*

**Kaffeepause**

**Klimawandel in Polargebieten**

- 11:00 – 11:15 *Hans-Wolfgang Hubberten (Alfred-Wegener-Institut Helmholtz-Zentrum für Polar- und Meeresforschung, Potsdam) - Die Erwärmung der Arktis und ihre Auswirkungen auf die Permafrost-Landschaften*
- 11:15 – 11:30 *Reinhard Dietrich (Technische Universität Dresden), A. Groh, H. Ewert, M. Fritsche, M. Schreinert, A. Richter, R. Rosenau - Geodätische Untersuchungen zu Eismassenbilanz und Glazialisostasie in der Westantarktis*
- 11:30 – 11:45 *Claus-Dieter Hillenbrand (British Antarctic Survey), James A. Smith, Gerhard Kuhn, Chris Poole, David A. Hodell, Harry Elderfield, Sev Kender, Mark Williams, Victoria L. Peck, Robert D. Larter, Johann P. Klages, Alastair G. C. Graham, Matthias Forwick, Karsten Gohl - Deglaciation of the West Antarctic continental shelf in the Amundsen Sea sector since the Last Glacial Maximum*
- 11:45 – 12:00 *Wilfried Korth (Beuth Hochschule für Technik Berlin) - Veränderungen der küstennahen Eiskappe im südlichen Grönland*



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12:00 – 12:15 *Manfred Stober (Hochschule für Technik Stuttgart), Jörg Hepperle - Glazial-geodätische Langzeitstudie (1991-2011) zu Massenbilanz und Eisdynamik im Paakitsoq-Gebiet (West-Grönland)*

12:15 – 12:30 *Joachim Schwarz (JSC, Großhansdorf) - Impact of climate change on marine transportation on the Northern Sea Route. Present results of the EU-project ACCESS*

**Mittagspause**

13:30 – 13:45 *Frank Rödel und Eberhard Fahrbach: Terra Incognita – Bilder einer Polarsternexpedition*

13:45 – 14:00 *Hans Oerter (Alfred-Wegener-Institut Helmholtz-Zentrum für Polar- und Meeresforschung, Bremerhaven) - Accumulation and stable-isotope studies at Kohnen Station, Dronning Maud Land, Antarctica, from 1999 through 2011*

**DFG-SPP: Arktis im Erdsystem**

14:00 – 14:30 **Eingeladener Vortrag**  
*Martin Melles (University of Cologne), Sieglinde Ott, Hartmut Hellmer, Andreas Läufer, Oliver Stock - The DFG Priority Program 1158 "Antarctic research with comparative investigations in glaciated areas of the Arctic"*

14:30 – 14:45 *Joachim Jacobs (University of Bergen), Andreas Läufer, Marlina Elburg - Blue ice moraine gypsum, SørRodane, East Antarctica*

14:45 – 15:00 *Nadine John (University of Jena), Robert Schöner, Axel Gerdes, Reinhard Gaupp - Provenance of the Permian Takrouna Formation, Antarctica - Implications on basin geometry and paleogeography*

15:00 – 15:15 *Jannis Prenzel (University of Bremen), F. Lisker, M. L. Balestrieri, A. Läufer, C. Spiegel - Burial and exhumation of the Terra Nova Bay region, Transarctic Mountains*

15:15 – 15:30 *Karsten Gohl (Alfred-Wegener-Institut Helmholtz-Zentrum für Polar- und Meeresforschung, Bremerhaven), Gabriele Uenzelmann-Neben, Ansa Lindeque – Paleo-dynamics of the West Antarctic Ice Sheet from processes observed along the Pacific margin*

**Kaffeepause**

16:00 – 16:30 **Eingeladener Vortrag**  
*Doris Abele (Alfred-Wegener-Institut Helmholtz-Zentrum für Polar- und Meeresforschung, Bremerhaven) - ESF-IMCOAST: how glacial melting affects an Antarctic coastal ecosystem*

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- 16:30 – 16:45 *Andres Sadowsky (Heinrich Heine University of Düsseldorf), J. P. de Vera, S. Ott - The role of photobionts in Antarctic lichens: stress physiology and photobiology*
- 16:45 – 17:00 *Sebastian Lindhorst (University of Hamburg), I. Schutter - The sedimentary architecture of polar beach ridges - implications for reconstruction of past climate variations (King George Island, West Antarctic Peninsula)*
- 17:00 – 17:15 *Boris P. Koch (Alfred-Wegener-Institut Helmholtz-Zentrum für Polar- und Meeresforschung, Bremerhaven), Oliver J. Lechtenfeld, S. Leigh McCallister, Philippe Schmitt-Kopplin, Gerhard Kattner - Weddel Sea and global carbon cycling: the role of the refractory dissolved organic matter*
- 17:15 – 18:30 Poster, Wein und Bier
- 18:15 – 19:15 **Arbeitskreise der DGP: Glaziologie, Geologie und Biologie**
- 20:00 – 21:00 **Öffentlicher Abendvortrag**  
*Martin Claußen (Max-Planck-Institut für Meteorologie, Hamburg) - Boreale Wälder heizen das Klima auf.*

**Mittwoch, 20. März 2013**

**DFG-SPP: Arktis im Erdsystem**

- 09:00 – 09:30 **Eingeladener Vortrag**  
*Michael Weber (University of Cologne), D. Spreng, G. Kuhn, P. U. Clark, A. Timmermann, R. Gladstone, X. Zhang, G. Lohmann, L. Menviel, M. Chikamoto, T. Friedrich - Iceberg Alley - Antarctic gateway to lower latitudes*
- 09:30 – 09:45 *Christian Printzen (Senckenberg Forschungsinstitut und Naturmuseum Frankfurt) - Symbiont switching as an adaptational strategy of the widespread polar lichen *Cetraria aculeata*?*
- 09:45 – 10:00 *Christine Wesche (Alfred-Wegener-Institut Helmholtz-Zentrum für Polar- und Meeresforschung, Bremerhaven), Thomas Rackow, Wolfgang Dierking - Southern Ocean iceberg drift*
- 10:00 – 10:15 *Monika Rhein (University of Bremen), Oliver Huhn - Changes in the Antarctic Bottom Water*
- 10:15 – 10:30 *M. Kohno (University of Göttingen), S. Kipfstuhl, K. Krüger, G. Wörner - Search for volcanic signatures of the Toba super-eruption recorded in EDML core (Antarctica) and Southern Ocean sediment cores: implication for its climate impact*

**Kaffeepause**

- 11:00 – 11:30      **Eingeladener Vortrag**  
*Günther Heinemann (University of Trier), L. Ebner, R. Timmermann, V. Haid - Berichtskolloquium SPP 1158: polynya formation processes in the Weddell Sea region*
- 11:30 – 11:45      *Verena Haid (Alfred-Wegener-Institut Helmholtz-Zentrum für Polar- und Meeresforschung, Bremerhaven), Ralph Timmermann, Lars Ebner, Günther Heinemann - Dense shelf water formation in the southwestern Weddell Sea and the role of coastal polynyas*
- 11:45 – 12:00      *Sascha Willmes (University of Trier) M. Nicolaus, G. Heinemann, R. Timmermann, M. Hoppmann, S. Paul, P. Hunkeler, U. Baltes - Sea ice mass balance influenced by ice shelves: the SIMBIS project - objectives and preliminary results*
- 12:00 – 12:15      *Tim Stöven (Helmholtz-Zentrum für Ozeanforschung Kiel (GEOMAR) Transient tracers in the Southern Ocean and the benefits of a constrained TTD model*
- 12:15 – 12:30      *C. Plate (TU Kaiserslautern), J. Christmann, A. Humbert, R. Müller - On calving*

**Mittag**

**Klimawandel in Polargebieten**

- 13:30 – 13:45      *Yufang Ye (University of Bremen), Georg Heygster – Arctic multiyear ice concentration retrieval from SSM/I data*
- 13:45 – 14:00      *Johann Jungclaus (Max Planck Institute for Meteorology, Hamburg), D. Zanchettin, A. Beitsch - Arctic climate and sea-ice changes over the last millennium in paleo-reconstructions and model simulations*
- 14:00 – 14:15      *Lena Hellmann (Swiss Federal Research Institute, Birmensdorf), Willy Tegel, Ólafur Eggertsson, Fritz Hans Schweingruber, Robert Blanchette, Alexander Kirilyanov, Holger Gärtner, Ulf Büntgen - Tracing the origin of Arctic driftwood*
- 14:15 – 14:30      *Florian Ziemann (Max Planck Institute for Meteorology, Hamburg), Christian Rodehacke, Uwe Mikolajewicz - Heinrich Events modeled with a coupled complex ice sheet climate model*
- 14:30 – 14:45      *Daniel Steinhage (Alfred-Wegener-Institut Helmholtz-Zentrum für Polar- und Meeresforschung, Bremerhaven), Sepp Kipfstuhl, Veit Helm - Akkumulationsverteilung in Nordgrönland - abgeleitet aus hochauflösenden flugzeuggestützten EMR-Messungen*
- 14:45 – 15:00      *Jörn Thiede (St. Petersburg State University), A. L. Zhironov, V. J. Kuznetsov, D. V. Lopatin, L. A. Savelieva - East Siberian river run-off and its impact on the history of the arctic sea ice cover*

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15:00 – 15:15 *Kevin Schiele (Alfred-Wegener-Institut Helmholtz-Zentrum für Polar- und Meeresforschung, List/Sylt), H. Christian Hass, Matthias Forwick - A unique fine-grained sediment layer deposited west off Svalbard during the initial warming after the Last Glacial Maximum (Bølling/Allerød)*

15:15 – 15:30 *H. Christian Hass (Alfred-Wegener-Institut Helmholtz-Zentrum für Polar- und Meeresforschung, List/Sylt), G. Kuhn, N. Wittenberg, A.-C. Wöflfl, C. Betzler - The modern depositional environment in Potter Cove, King George Island, Antarctica*

**Kaffeepause**

16:00 – 16:15 *Valeria Bers (Alfred-Wegener-Institut Helmholtz-Zentrum für Polar- und Meeresforschung, Bremerhaven) - Analysis of long-term environmental data from King George Island (Antarctica): relationships between global climatic oscillations and local system response*

16:15 – 16:30 *Günther Heinemann (University of Trier), Clemens Drüe, Thomas Ernsdorf - IKAPOS: Untersuchung der atmosphärischen Grenzschicht im katabatischen Wind und über der North Water Polynja mit Flugzeugmessungen*

16:30 – 16:45 *Felix Pithan (Max Planck Institute for Meteorology, Hamburg), Thorsten Mauritsen -Boundary-layer processes cause GCM biases in arctic winter*

16:45 – 17:00 *Jan Erik Arndt (Alfred-Wegener-Institut Helmholtz-Zentrum für Polar- und Meeresforschung, Bremerhaven), Hans Werner Schenke, Martin Jakobsson, Frank O. Nitsche, Gwen Buys, Bruce Goleby, Michele Rebesco, Fernando Bohoyo, Jongkuk Hong, Jenny Black, Rudolf Greku, Gleb Udintsev, Felipe Barrios, Walter Reynoso-Peralta, Morishita Taisei, Rochelle Wigley - The International Bathymetric Chart of the Southern Ocean Version 1.0 – A new bathymetric compilation covering circum-Antarctic waters*

17:00 – 17:45 **Arbeitskreise der DGP: Polargeschichte, Geodäsie, Polarpädagogik, Polarpädagogik, Permafrost**

17:45 – 18:45 Besuch des Mineralogischen Museums

19:00 – 21:00 Gemeinsames DGP-Abendessen im Zoologischen Museum, Vorstellung des Museum

**Donnerstag, 21. März 2013**

**Geschichte der Polarforschung**

- 09:00 – 09:15      **Eingeladener Vortrag**  
*Reinhard A. Krause (Alfred-Wegener-Institut Helmholtz-Zentrum für Polar- und Meeresforschung, Bremerhaven) - Koch / Wegener - eine denkwürdige Forschungsreise quer durch Nordgrönland, 1912/13*
- 09:15 – 09:30      *Cornelia Lüdecke (AK Geschichte der Polarforschung), Erki Tammiksaar - Adolph Erman und sein Beitrag zur Erforschung des Erdmagnetismus der Erde*

**Cooler Klassen: Polare Themen im Schulunterricht**

- 09:30 – 09:45      *Rainer Lehmann (Freie Waldorfschule Hannover-Bothfeld) - Sechs Jahre Cooler Klassen – was wurde erreicht, wie geht es weiter?*
- 09:45 – 10:00      *Monika Kallfelz (Pfalzmuseum für Naturkunde, Bad Dürkheim) - Spannender Unterricht live aus dem ewigen Eis – Lehrerbegleitung Polarstern ANT XXVIII / 2 (2011/12 Kapstadt- Neumayer- Kapstadt)*
- 10:00 – 10:15      *Gerto Bal (Realschule Plus St. Martin, Kelberg) - Authentisches Lernen und die lebenslangen Folgen*
- 10:15 – 10:30      *Armin Hellmann (IGS Am Nanstein und Realschule plus, Kaiserslautern) - "Pfalz trifft Antarktis"*

**Kaffeepause**

- 11:00 – 11:15      *Heinz Kiko (Merien-Gymnasium Werl) - Langzeitprojekte mit Schülergruppen und Persönlichkeits-Bildung*
- 11:15 – 11:30      *Thees Dornheim (Thor-Heyerdahl-Gymnasium, Kiel) - GANOVEX X - als Geographielehrer in die Antarktis*
- 11:30 – 12:00      *Franz Tessensohn (Bundesanstalt für Geowissenschaften und Rohstoffe, Hannover) - Brückenprobleme zwischen Wissenschaft und Schule. Ein kritischer Erfahrungsbericht von „Cooler Klassen“*

**Biodiversität, Migration und Nahrungsnetze**

- 12:00 – 12:15      *M. Malyutina (A. V. Zhirmunsky Institute of Marine Biology FEB RAS, Vladivostok) - Where are relatives of tiny deep-sea Antarctic isopod *Microcope denticulate* from?*
- 12:15 – 12:30      *Birgit Sattler (University of Innsbruck), M. Tilg, C. Kohstall, M. C. Storrie-Lombardi – L.I.F.E. (Laser Induced Fluorescent Emission) as non-invasive tool to assess phototrophic pigments in ice ecosystems*

**Mittag**

- 13:30 – 13:45 *Iryna Kozeretska (University of Kyiv), Igor Andreev, Ivan Parnikoza, Kateryna Spiridonova, Roman Volkov, Dmytro Maidaniuk, Viktor Kunakh - Genetic characteristics of *Deschampsia antarctica* in context of its origin history*
- 13:45 – 14:00 *Ivan Parnikoza (Institute of Molecular Biology and Genetics NAS of Ukraine), Iryna Ozheredova, Natalyia Miryuta, Iryna Kozeretska, Jerzy Smykla, Viktor Kinakh - Comparative analysis of different parameters of *Deschampsia antarctica* population success in one polar season*
- 14:30 – 15:30 DGP-Mitgliederversammlung

**Kaffeepause**

- 16:00 – 17:00 Stefanie Kaiser (Zoological Museum, University of Hamburg) – Measuring southern ocean benthic biodiversity: decadal progress and future challenges
- 17:00 Posterprämierung

**Freitag, 22. März 2013**

**Exkursionen**

**Wissenschaftler gehen in die Schule**

**DGP-Halbtages Exkursion**

1. Periglazial in Schmalenfelde
2. Liether Kalkgrube
3. Klimaforschung Himmelmoor

## **ESF-IMCOAST: HOW GLACIAL MELTING AFFECTS AN ANTARCTIC COASTAL ECOSYSTEM**

Doris Abele

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

Rapid climatic change of the coastal (eco-)system has been observed within the past 20 years at King-George Island (KGI, South Shetland archipelago). The island at the Northern tip of the Antarctic Peninsula lies in the area showing the most dramatic trend of recent global warming. Continuous measuring programs were started in 1991 and involved Argentine-German teams collaborating at Dallmann laboratory on Carlini Station (former Jubany Station at KGI). ESF-IMCOAST(2010-1013) is an international program which takes an interdisciplinary approach relating causes to effects within the complex scenario of observed system change. Primary drives that connect climate events to ecosystem change are the rapid retreat of the coastal glaciers and the resulting release of melt water and ablated inorganic sediments into the coastal environment. IMCOAST coordinates European and South American cooperation in glaciological, geological and biological teams conducting field and experimental investigations, remote sensing and modeling, and continues hydrographical and biological monitoring. Importantly, data from the past 20 years of investigations have been sustainably archived (PANGAEA). A follow-up project IMCONet has been granted (Expertise Network in FP7, 2013-2016) and has the following objectives:

- To quantify variability and changes in fresh water budgets in coastal ecosystems and to provide the physical boundary conditions for geochemical, sedimentological and biophysical research
- Understand the effect of glacial retreat on sub-glacial and land run-off dynamics in the past and at present
- Analyse carbon recycling in the sediment surface of the coastal systems with and without impact of sedimentation, and the benthic-pelagic coupling in KGI coastal food webs

This talk will provide an overview of ongoing IMCOAST research and current results.

## **THE ROLE OF ORGANIC MATTER AND IRON OXIDES IN TRACE METALS DISTRIBUTION IN PERMAFROST-AFFECTED SOILS, NORTHERN SIBERIA, RUSSIA**

I. Antcibor<sup>1</sup>, S. Zubrzycki<sup>1</sup>, A. Eschenbach<sup>1</sup>, L. Kutzbach<sup>1</sup>, E.-M. Pfeiffer<sup>1</sup>, D. Bolshiyarov<sup>2</sup>

<sup>1</sup>Institute of Soil Science, KlimaCampus, University of Hamburg, Hamburg, Germany

<sup>2</sup>State Research Center - Arctic and Antarctic Research Institute, St. Petersburg, Russia

Organic matter is the universal soil colloid that is capable of forming organo-mineral complexes binding the majority of trace metals. The amount and distribution of iron oxides are known to influence soil properties such as anions adsorption and pollutant retention in soils. In arctic environments these two major compounds act as geochemical barriers that regulate ecosystem metal flows and protect the sensitive environments from farther migration of trace elements. This is especially important since the Arctic ecosystems are considered to be very sensitive to climatic changes as well as to chemical contamination. However, predicted global warming together with other anthropogenic influences on Arctic terrestrial environments may affect biogeochemical processes, and enhance leaching and migration of trace metals in upper layers of permafrost-affected soils. This study characterizes background levels of trace metals in permafrost-affected soils of the Lena River Delta and its hinterland in Northern Siberia (73.5° N – 69.5° N), representing a remote region far from evident anthropogenic trace metal sources. Investigations on total element contents of iron (Fe), arsenic (As), manganese (Mn), zinc (Zn), nickel (Ni), copper (Cu), lead (Pb), cadmium (Cd), cobalt (Co) and mercury (Hg) in different soil types developed in different geological parent materials have been carried out. Highest concentrations of the majority of the measured elements were observed in soils belonging to ice-rich permafrost sediments formed during the Pleistocene (ice-complex) in the Lena River Delta. Correlation analyses of trace metal concentrations and soil-chemical and soil physical properties of permafrost-affected soils of the Lena River Delta Region showed that the main factors controlling the trace metal distribution in these soils are organic matter content and iron oxides contents, as well as soil texture. The Principal Component Analysis (PCA) revealed the significant relationship between the Zn, As, Ni and Pb concentrations and iron oxides in the top horizons and in the bottom horizons. Occurrence of organic matter contributed mainly to Cd binding in top soils and Cu binding in bottom horizons. Observed ranges of the background concentrations of majority of trace elements were similar to background levels reported for other pristine arctic areas and did not exceed mean global background concentrations examined for the continental crust as well as for the world's soils.



## **THE INTERNATIONAL BATHYMETRIC CHART OF THE SOUTHERN OCEAN VERSION 1.0 – A NEW BATHYMETRIC COMPILATION COVERING CIRCUM-ANTARCTIC WATERS**

Jan Erik Arndt<sup>1</sup>, Hans Werner Schenke<sup>1</sup>, Martin Jakobsson<sup>2</sup>, Frank O. Nitsche<sup>3</sup>, Gwen Buys<sup>4</sup>, Bruce Goleby<sup>5</sup>, Michele Rebesco<sup>6</sup>, Fernando Bohoyo<sup>7</sup>, Jongkuk Hong<sup>8</sup>, Jenny Black<sup>9</sup>, Rudolf Greku<sup>10</sup>, Gleb Udintsev<sup>11</sup>, Felipe Barrios<sup>12</sup>, Walter Reynoso-Peralta<sup>13</sup>, Morishita Taisei<sup>14</sup>, Rochelle Wigley<sup>15</sup>

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The International Bathymetric Chart of the Southern Ocean (IBCSO) version 1.0 is the first polar Digital Bathymetric Model (DBM) covering the entire Southern Ocean up to 60° S. It is going to be available to the public to serve as a base data set to several groups in Antarctic research, i.e. oceanographers, geophysicists and biologists. Just as its Arctic equivalent the International Bathymetric Chart of the Arctic Ocean (IBCAO) the IBCSO was initiated as a General Bathymetric Chart of the Oceans (GEBCO) regional mapping project. The project is endorsed by the Intergovernmental Oceanographic Commission (IOC) of UNESCO, the International Hydrographic Organization (IHO) and the Scientific Committee on Antarctic Research (SCAR). The IBCSO steering committee is an Expert Group of the Standing Scientific Group of Geosciences (SSG-GS) of SCAR and works in collaboration with the IHO Hydrographic Commission on Antarctica (HCA). Furthermore, an Editorial Board was established consisting of experts in Antarctic bathymetry from nations that acquire data in the Southern Ocean that collectively gathered bathymetric data from more than 30 institutions, in 15 different countries.

The final version of the IBCSO version 1.0 DBM as well as its accompanied printable chart is going to be presented. This will include a description of specific techniques used to derive the DBM and an overview of the incorporated data sets. Furthermore, the result will be compared to other global bathymetric data compilations to show the improvement. In addition, the development of the printable chart and the chart itself is going to be described briefly.

## **INTERNATIONALE POLARTAGUNG, HAMBURG 2013 - AUTHENTISCHES LERNEN UND DIE LEBENSLANGEN FOLGEN**

Gerto Bal

Coole Klassen, Realschule Plus St.  
Martin, Kelberg

Das Thema Antarktika wird, von Grundschulklassen bis zu Gymnasiumklassen, mit Hilfe von Live-Unterricht von „Polarstern“ aus, zu einer wichtigen und bleibenden Bildungs- und Lebenserfahrung für Schüler und Schülerinnen. Dies wird an Hand eines Schulprojekts in einer Hauptschulklasse in Rheinland-Pfalz dargestellt.

Erfahrungen aus der Kindheit wirken bis heute

In meiner Jugend erzählte mir einen Walfänger des Öfteren von seinem Beruf. Ich war nachhaltig beeindruckt. Es gab längere „Wal-lose“ Perioden in meinem Leben, aber das Thema „Wale und die beiden Pole“ ließ mich letztendlich nicht mehr los. Schauen Sie doch mal bei sich selbst: Was Sie in der Kindheit erfahren haben, ist oft bleibend.

Seit 2003 befasste ich mich wieder zunehmend mit Walen und Walfanggeschichte und entwarf Unterrichtsreihen bezüglich dieses Themas für die Fächer Erdkunde, Geschichte, Biologie und Ethik.

Eine Fortbildung, ein „Antarktika“- Projekt und die DGP

Im Jahr 2010 lud Fr. Kallfelz zu einer Fortbildung mit dem Thema „Antarktis- ein Pol im Unterricht“ ein. Sie machte mich bekannt mit der „Polarstern“ und ich startete durch: meine Leidenschaft für Wale konnte bestens eingebunden werden in ein Großprojekt. So wurde „Antarktika, eine Ausstellung“ erfolgreich in meiner Klasse durchgeführt. Ziel: Eltern und Kinder am Tag der offenen Tür mittels einer Ausstellung zu begeistern für das Südpolargebiet.

Also werden einen Eisbär, ein Albatros, ein Kaiserpinguin und ein Pottwal in wahrer Größe angefertigt, werden Kurzfilme gedreht, die Neumayer-Station und die Polarstern werden in Miniatur nachgebaut, 100 Jahre alte Skier, kleine und große Kuscheltiere und Globusse und Poster werden angetragen, Karten mit der Position der „Polarstern“ werden aufgehängt, das Wettrennen um die Entdeckung des Südpols zwischen Scott und Amundsen wird dargestellt und wir folgen der täglichen Berichterstattung von Fr. Kallfelz, die sich zu dieser Zeit an Bord der „Polarstern“ befindet. Ein Quiz wird ausgedacht, es gibt kleine Preise zu gewinnen. Das Highlight des Projekts ist ein Telefonat mit Fr. Kallfelz.

Meine Unterrichtserfahrungen mit authentischem Lernen, Projektarbeit und der Antarktis:

Die Suche nach Grenzen, Echtheit und Extremen ist Kindern angeboren. Sie suchen Grenzen im Verhalten, in anderen Ländern und Kulturen, im Tierreich, aber auch in ethischen Fragen. Außerdem begeistern wahre Geschehnisse Kinder.

Mein Projekt ist das Gegenteil von einem Lehrwerk, von gekünstelten Aufträgen, von frontalem Unterricht und den Lehrplänen der Länder. Das Thema Antarktika ist in seiner Extremheit, gespickt mit extremen Geschichten, prädestiniert für authentischen, selbst motivierenden Projektunterricht.

Es lässt, in Verbindung mit Projektarbeit, viel Kreativität in Kindern aufkommen, die außerdem fachübergreifend ihre Talente und Stärken nutzen und darstellen.

Es wurde dazu gearbeitet/gelernt für ein echtes, authentisches Ziel: Eine Ausstellung.

Oberflächliches auswendig lernen fällt also weg. Live-Unterricht von der „Polarstern“ aus macht, dass gelernte Fakten verinnerlicht werden. Vier Ziele wurden erreicht:

Viele Fakten rund um die Antarktis wurden in den einleitenden Unterrichtssequenzen verinnerlicht.

In einem ca. 50 - Stündigen Projekt wurde eine Ausstellung zum Thema hergestellt.

Die Ausstellung selbst wurde ein Erfolg.

Die tägliche Verbindung mittels Blog und Email mit der Polarstern und das einmalige, 30-minütige Telefonat mit einer Lehrerin an Bord hat alles verinnerlicht und zu einem unvergesslichen Ereignis gemacht. Hinzu kommt, dass ein Fernseheteam unseren Unterricht und das Telefongespräch aufgenommen hat.

## THE ROLE OF MOSSES FOR PRIMARY SUCCESSION IN A PROGLACIAL AREA IN SE-ICELAND

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Þórhallsdóttir<sup>1</sup>, Krittín  
Svavarsdóttir<sup>2</sup>

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Facilitation and positive interactions are widely recognized processes that shape plant communities. They are expected to be especially important in harsh environments. On the glacial outwash plain of Skeiðarársandur, a mosaic of early successional communities is developing with minimal human interference. Although the physical environment appears homogeneous, diverging successional processes are clearly operating on the sandur. In the uppermost part, mosses form discrete patches of varying size on an otherwise sandy/gravelly plain. Moss patches may influence vascular plant establishment and growth by 1) acting as physical barrier and therefore trapping seeds more effectively than barren ground, 2) creating safe sites for germination or 3) improving growing conditions for vascular plants by modifying the microclimate and/or soil moisture retention.

To examine the potential roles of moss, we compared seed rain and seed bank in moss patches and surrounding barren areas in the north part of Skeiðarársandur. To test the effect of moss on vascular plant germination, establishment and survival we transplanted homogeneous moss mats into two sites with different substrate (fine vs. coarse) in the barren central part of Skeiðarársandur in 2010. A seedling transplant and sowing experiment with locally collected seeds started in spring 2011 to compare germination rates, seedling establishment and plant survival for five selected species (*Silene acaulis*, *Campanula rotundifolia*, *Luzula multiflora*, *Rumex acetosella* and *Betula pubescens*).

There was no significant difference in seed rain and seed bank size between moss patches and bare ground but most of the viable seeds were found beneath moss. Germination rate on the experimental sites was significantly higher in bare ground than in moss. Germination rate was higher on coarse substrate. In general, germination in the different treatments varied markedly between species, ranging from 0% to 56%. Substrate type affected winter survival of seedlings which was highest on coarse substrate.

Our results indicate facilitation effects of the moss due to better seed survival in winter. Higher germination rate after winter leads to higher density and species richness of vascular plants in moss patches. Frost heaving did not appear to be strong, but might be an important factor for seedling survival. Our study shows the importance of facilitation in plant succession and emphasizes the widely underestimated role of mosses in ecosystems.

## **NUTRIENTS (N & P) IN THE POLYGONAL TUNDRA – LIMITATIONS AND AVAILABILITY**

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Comparatively much is known about carbon pools and potential emissions from thawed permafrost soils (Tarnocai et al., 2009). However, other important macronutrients like nitrogen (N) and phosphorus (P) in permafrost soils are so far insufficiently investigated. Higher nutrient availability will enhance plant primary production which could partially offset higher CO<sub>2</sub> emissions (Schuur et al., 2008). Changes in the carbon budget of arctic ecosystems will have global implications (Sturm et al., 2005). Hence, a comprehensive knowledge about nutrient availability and potentially enhanced mobilization under changed climatic conditions is needed to predict future development of arctic tundra. Open questions are:

- How are soil nitrogen and phosphorus contents distributed within the polygonal tundra landscapes?
- What are the limiting factors for plant growth and microbial activity in the polygonal tundra?
- Which amounts of nutrients can be mobilized in the course of climate change?

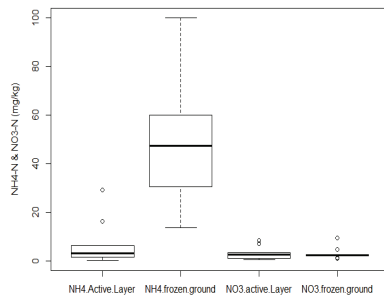
### Methods

Fieldwork has been conducted during two expeditions to north-eastern Siberia in the Indigirka lowlands as well as in the Kolyma lowlands.

Ten soil cores of 100cm and more have been drilled and were analyzed for their amounts of plant available Ammonium und Nitrate.

One single Ice-wedge polygon has been analyzed at a high detailed resolution (2\*2m). To understand the limitation mechanisms at this site all soil profiles were analyzed for their amounts of plant available Nitrogen and Phosphorus, microbial Nitrogen and Phosphorus as well as total Nitrogen and Phosphorus. Additionally, also the according vegetation was analyzed for their total content of Nitrogen and Phosphorus.

In Arctic tundra is mainly limited by a low supply of Nitrogen. But furthermore it shows that there are large amounts of potentially available Nitrogen while largest parts of the total Phosphorus are recently an active part of the biogeochemical cycle.



*Fig. 1 the mean values of plant available Ammonium and Nitrate in all investigated peat cores are shown.*

In total, the concentration of plant available Ammonium in the frozen ground was seven times higher than in the active layer. The concentration of plant available Nitrate was lower than the concentration of plant available Ammonium. There were no significant differences between the concentrations of plant available Nitrate in the active layer and the frozen ground.

The results of the different nutrient pools (not shown) in the investigated polygon confirm that plant growth in Arctic tundra is mainly limited by a low supply of Nitrogen. But furthermore it shows that there are large amounts of potentially available Nitrogen while largest parts of the total Phosphorus are recently an active part of the biogeochemical cycle.

#### Conclusion

We discover that there are large pools of potentially available Nitrogen in the active layer as well as in the permanently frozen ground of the polygonal tundra which could mitigate Nitrogen limitation of these areas in the course of projected climate change.

## **ANALYSIS OF LONG-TERM ENVIRONMENTAL DATA FROM KING GEORGE ISLAND (ANTARCTICA): RELATIONSHIPS BETWEEN GLOBAL CLIMATIC OSCILLATIONS AND LOCAL SYSTEM RESPONSE**

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A long-term environmental data set from King George Island, Western Antarctic Peninsula, was analysed using statistical approaches that can deal with missing values. Since the WAP region belongs to the most rapidly warming regions on earth it is vital to find methods that take into account the incompleteness of Antarctic time series, but are still applicable to analyze general patterns in the series to arrive to conclusions on long term trends and inter-annual variability in the face of the rapidly changing climate in Western Antarctica. We applied U statistics after Pettit and Buishand to detect sudden changes over time, a dynamic factor analysis as well as additive modelling to detect common trends and patterns related to climatic cycles such as the Southern Annular Mode and El Niño Southern Oscillation. Our results not only reveal sudden changes for sea surface temperature and salinity, but also clear patterns in all investigated variables (sea surface temperature, salinity, suspended particulate matter and Chlorophyll a) that can be directly be assigned to climatic cycles. Hence, our statistical analyses may prove valuable for other polar environmental data sets and contribute to a better understanding of the regional variability of climate change and its impact on coastal systems.

## **ICE RISE INVENTORY USING HIGH-RESOLUTION TERRASAR-X IMAGERY**

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Ice rises play a key role in the stability of unbounded ice shelves and they often determine the shape of the calving front. Grounding lines around ice rises and ice shelves retreat when sea level rises. Ungrounding may cause a destabilizing situation and promotes disintegration of ice shelves. Located in the interior of an ice shelf, they cause different effects: (1) For a long time they are supposed to stabilize ice shelves, as they act as pinning points located at the ice front. (2) The ice shelf around ice rises is often a genesis of inhomogeneities. They could be made up of discontinuous mass which play an important role in ice shelf dynamics. (3) Ice rises are also a well known feature for formation of failure zones (rifts). In the absence of a compressive stress zone that hinders rift propagation, they have a destabilizing factor.

The work presented aims to build up an inventory for ice rises. Therefore, high-resolution radar imagery of the TerraSAR-X are used to classify ice rises over most of the Antarctic ice shelves. This is done with respect of their contribution to buttress inland ice masses, the kind of inhomogeneities they cause and whether they determine the calving front position. This study is concentrated to smaller ice rises which are particularly prone to ungrounding under rising sea level. The newly detected ice rises will be included and classified in an ice rise inventory. In order to prove the detection and classification remotely sensed surface elevations (e.g. ICESat GLAS) and surface velocities (e.g. Radarsat-1 (MAMM) and MEaSURES InSAR) will be used as ice rises cause small scale variations in both fields.



## **ERKUNDUNG TEMPERIERTER GLETSCHER DES NÖRDLICHEN PATAGONISCHEN EISFELDS MIT HELIKOPTER-RADAR**

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Messungen an tiefen temperierten Gletschern mit Helikopter-GPR sind aufgrund von hoher Absorption, interner Streuung und der Rauigkeit von Oberfläche und Felsbett sehr anspruchsvoll. Nur bei niedrigen Mittenfrequenzen lassen sich die Streu- und Rauigkeitseffekte so weit reduzieren, dass Radardaten guter Qualität gewonnen werden.

Das nördliche patagonische Eisfeld (Campo de Hielo Norte) in Chile ist ein Rest des einstigen patagonischen Eisschildes mit immer noch beeindruckend großen Auslassgletschern, deren Geometrie bislang nur unzureichend bekannt ist. Von diesen untersuchten wir im Jahr 2010 die am östlichen Rand liegenden Glaciar Nef und Glaciar Colonia auf ca. 220 Profilkilometern mit dem 30MHz-Helikopter-Radarsystem der BGR.

Die Oberflächen der zwei bis drei Kilometer breiten und 20 km langen Gletscher zeigen ausgedehnte Zonen mit Spalten, Schmelzwasser und Moränenmaterial. Die Geometrie beider Eiskörper kann trotz dieser messtechnischen Schwierigkeiten in den beflogenen unteren Bereichen gut abgebildet werden. Eisdicken und Eindringtiefen im Untersuchungsgebiet erreichen maximal 700 m.

## **MODELLING HABITAT SUITABILITY OF HUMPBACK AND ANTARCTIC MINKE WHALES IN THE SOUTHERN OCEAN**

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Monitoring the recovery of cetacean stocks in the Southern Ocean has been at the core of IWC (International Whaling Commission) activities during the past three decades. However, collecting data in the Southern Ocean is particularly difficult due to the region's remoteness, limited seasonal accessibility and presence of sea ice. As a result, distribution patterns and cetacean-habitat preferences, which are necessary to properly design population surveys for robust stock assessments, are still insufficiently described.

Early attempts to study habitat preferences of cetaceans in the Southern Ocean used descriptive techniques, such as overlaying cetacean sightings with maps of habitat variables and simple correlation analyses. Increasing availability of remotely sensed environmental data and recent advances in habitat modelling techniques now provide the necessary data and tools to perform more sophisticated analyses of habitat requirements. While most habitat models developed for the Southern Ocean rely on presence-absence data from line-transect surveys, latest improvements of modelling algorithms extend their applicability to presence-only data.

We developed habitat models for humpback (*Megaptera novaeangliae*) and Antarctic minke whales (*Balaenoptera bonaerensis*) using ship-based presence-only data. Cetacean sightings have been collected opportunistically, but were systematically logged by the nautical officers on board the research icebreaker *Polarstern* during expeditions to the Southern Ocean since 2005. A custom-built software tool "WALOG" was used to ensure a standardized protocol to log cetacean sightings and associated metadata. To develop habitat models, we used a maximum entropy approach, called Maxent, which was specifically designed to analyse presence-only data. Environmental parameters used in the model included both static variables, such as depth or slope, and dynamic variables, such as sea surface temperature or sea ice concentration, at a daily resolution. To account for spatial bias potentially inherent in the data, we used 10,000 randomly selected background locations from the cruise tracks to describe the environmental conditions as encountered throughout the study area. Sample sizes of cetacean sightings allowed the development of habitat models for humpback whales (N=93) during austral summer and two separate habitat models for minke whales during austral summer (N=139) and winter (N=44) to investigate potential inter-annual differences in minke whale habitat preferences.

Overall differences between the two species revealed more northern habitat preferences for humpback whales within ice free areas, whereas minke whales featured a higher habitat affinity further to the South. Throughout the summer season, however, habitat suitability for humpback whales increased southwards towards the Antarctic continent. Habitat suitability for either species was furthermore not homogeneously distributed throughout the Southern Ocean, but several distinct areas of high habitat suitability were identified.

## **ANDEEP-SYSTCO (SYSTEM COUPLING): CONTRIBUTIONS TO THE BIODIVERSITY AND FEEDING BIOLOGY OF SOUTHERN OCEAN DEEP-SEA BENTHOS**

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ANDEEP – SYSTCO builds on the close cooperation of scientists from different disciplines, such as physical oceanography, planktology, biogeochemistry, sedimentology, and bathymetry with benthologist concentrating on various aspects to shed light on atmospheric-pelagic-benthic coupling processes.

SYSTCO investigates a) the diversity, distribution and abundance of deep-sea organisms from meiofaunal foraminifera to megafaunal organisms in relation to the surface water productivity, sediment composition and biogeochemistry of the sediment-water interface as well as the upper sediment layer, and b) the ecology of deep-sea fauna with regard to coupling processes utilizing different approaches, like classical gut content analyses as well as biochemical investigations (fatty acid profiles and stable isotope C and N ratios).

## **UPWELLING IN THE WEDDELL SEA INFERRED FROM HELIUM ISOTOPE DISEQUILIBRIUM**

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Upwelling plays an important role regarding the physical and biogeochemical characteristics of the mixed layer, and it may also counteract the uptake of atmospheric gases like CO<sub>2</sub>. However, estimates of upwelling velocities are rare, particularly in the Antarctic Ocean. Since upwelling velocities are too small to be measured directly - approximately a few meters per day - an indirect method to infer upwelling velocities from the helium isotope disequilibrium in the mixed layer is applied here instead. Helium isotope data measured during austral summer 2010/11 in the Weddell Sea and south of 57°S along the Greenwich Meridian show a significant excess of <sup>3</sup>He in the mixed layer. The influence of the prevailing wind fields and the ice coverage is studied and first results will be presented.

## **ANTARKTIKA IST EIN KONTINENT UND EWIGES EIS NUR DEM NAMEN NACH EWIG! IDEEN ZUR GESTALTUNG DES UNTERRICHTS ZU DEN POLARGEBIETEN AUF BASIS VON SCHÜLERVORSTELLUNGEN ZUR KALTEN ZONE**

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In den Polargebieten sind aufgrund des Klimawandels in den nächsten Jahrzehnten gravierende Veränderungen zu erwarten. Grund genug, die kalte Zone in Zukunft im schulischen Kontext stärker als bislang zu behandeln. Die wichtigsten Bausteine des Lernens bilden die Vorstellungen, die Schüler mit in das Klassenzimmer bringen. Lernen bedeutet aus konstruktivistischer Sicht Umlernen. Im Vortrag werden die Ergebnisse einer im Rahmen des Projekts *Cooler Classes* durchgeführten Zulassungsarbeit zu Schülervorstellungen zu den Polargebieten vorgestellt. Den Schwerpunkt bilden dabei Vorstellungen zur Kryosphäre. Auf Basis der Ergebnisse werden Leitlinien zur Vermittlung im Unterricht vorgestellt.

## **GEODÄTISCHE UNTERSUCHUNGEN ZU EISMASSENBIlanz UND GLAZIALISOSTASIE IN DER WESTANTARKTIS**

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Das Gebiet der Pine-Island-Bay in der Westantarktis weist die größte Eismassendynamik in Antarktika auf. Wir nutzen Daten der Satelliten-Schwerefeldmission GRACE, um aus monatlichen Schwerefeldlösungen Massenvariationen für das Gebiet abzuleiten. Parallel dazu werden Daten der Satellitenaltimetermission ICESat verwendet, um Höhenänderungen zu bestimmen. Sowohl die Massen- als auch die Höhenänderungen sind ein kombinierter Effekt von fester Erde (Glazialisostasie) und Eis (Massenbilanz).

Wir zeigen, dass eine Kombination beider Datensätze eine Trennung der Effekte ermöglicht. Wir erhalten eine stark negative Eismassenbilanz und ein unerwartet positives Signal für die Glazialisostasie. Die resultierende Hebung in dem Gebiet wird durch GPS-Messungen, die während zweier Polarstern-Fahrten in das Gebiet gewonnen wurden, bestätigt.

## **CONIFER WOODS – EMENDING FINDINGS IN THE ARCTIC PALAEOGENE FORESTS OF SVALBARD AND ELLESMERE ISLAND**

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Conifer woods are the most investigated morphogenera in the European and American Arctic Palaeogene. Some prominent conifers, which today are only relictual occurring in Asia, had their emission centre in Arctic Palaeogene regions. This contribution summarizes knowledge on taxonomy, preservation and paleoecology of some important taxa.

In the Central Tertiary Basin of Svalbard on Nathorstland, taxodiaceous woods, comprised in a fossil Lagerstätte, are explored in Palaeogene sediments of the Aspelintoppen Formation. The findings are partially silicified, coalified, resinous wood remains. One has been established as a Taxodioxylon-morphospecies, *T. vanderburghii*, which is related to modern wood to *Metasequoia*. Additionally, the same morphospecies of a petrified, partially coalified fossil has been recovered from Palaeogene sediment of the Pavy Formation near Nares Strait on northeastern Ellesmere Island. That supports, nonetheless, the notion that *Metasequoia* has had wide ecological amplitude, and similar environmental conditions prevailed during the early Palaeogene for Ellesmere Island and Svalbard; plate tectonic reconstructions for the Paleocene suggest that Svalbard and Ellesmere Island were close to each other.

Other fossil forests, many 'in situ' stumps and relics of trunks lying at their original position, were explored at Split Lake area, Stenkul Fiord, Vendom Fiord and south of Strathcona Fiord on Ellesmere Island. The mummified as well as differential petrified wood fossils were taken from Palaeogene coal-bearing sediments of the Mt. Lawson, Mt. Moore, and Mt. Margaret Formations. Further taxodiaceous and pinaceous woods were also discovered: *Glyptostroboxylon* with the affinity to *Glyptostrobus*, *Cupressinoxylon* with affinity to *Taiwania* and *Piceoxylon* with the affinity to *Larix* and *Picea*.

The found taxa, mostly regarded as huge trees, represent prominent constituents of the vegetation in the Polar Broadleaved- and Coniferous Forests. As these plants are often found in situ in the respective lignite stratum, a direct insight into the ecology and structure of the phytocoenosis is possible. Nevertheless, it is not so certain that these polar fossil conifers provide environmental information based on their corresponding modern woods. Some fossil taxa have a wider ecological range than today and the vegetation in Palaeogene grew under an ice-free polar light regime of Northern Hemisphere.



## **GANOVEX X - ALS GEOGRAPHIELEHRER IN DIE ANTARKTIS**

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Im Zuge des Projektes Coole Klassen, das in und aus dem Internationalen Polarjahr 2008/2009 heraus ins Leben gerufen wurde und an dem Lehrer aus ganz Deutschland mit einem Faible für die polaren Regionen unseres Planeten teilnahmen, wurde es mir ermöglicht, im Winter 2009/2010 an der Antarktisexpedition GANOVEX X unter Führung der Bundesanstalt für Geowissenschaften und Rohstoffe (BGR) teilzunehmen. Diese Möglichkeit ergab sich extrem kurzfristig, sodass eine längerfristige inhaltliche Vorbereitung in der Schule nicht mehr erfolgen konnte, sondern das Hauptaugenmerk auf der Verwertung der Expeditionserfahrungen im Nachhinein lag.

Von Neuseeland ging es mit dem Versorgungsschiff ITALICA, auf dem sich neben der Crew ein italienisches Forscherteam und unser 32köpfiges, internationales Team unter deutscher Leitung befanden, ins antarktische Ross Meer. Unser Team bestand aus Wissenschaftlern Deutschland und Australien, deutschen Logistikern, Heli-Piloten und Bergführern aus Neuseeland, einem ZDF-Fernsehteam und mir als Lehrer. Im Ross Meer angekommen splittete sich unser Team mit sehr unterschiedlichen Forschungsschwerpunkten auf drei verschiedene Regionen auf: a. die Region im Umfeld der deutschen Sommerstation GONDWANA; b. die Region um den Mariner Glacier c. die Region auf der Mesa Range im Transantarktischen Gebirge, wo für einige Wochen ein Außencamp auf ca. 2000m Höhe errichtet wurde, von dem aus wiederum ein dreiköpfiges Team als Satellit noch weiter ins Gebirge ausgeflogen wurde.

Während meiner ca. dreiwöchigen Aufenthaltszeit in der Antarktis wurde es mir gestattet, in den drei Hauptregionen jeweils für einige Tage mit den unterschiedlichen Teams ins Feld zu gehen. So gut es ging, machte ich mich nützlich – was vor allem beim Schleppen der diversen Gesteinsproben willkommen war... zudem sah man ein passablen Koch gern. So erhielt ich einige erste Einblicke z.B. in die Arbeiten der Paläomagnetik, Aeromagnetik, Geochemie, Gravimetrie, Geomikrobiologie, Sedimentologie, Strukturgeologie und Lichenologie.

Als Geographielehrer lag mir weniger daran, in die Details der geologischen Feldarbeit und ihrer Auswertung einzusteigen – zumal das auf dem extrem hohen Level der Spezialisierung der teilnehmenden Wissenschaftler für mich auch nicht zu leisten war. Mein Ansatz war ein anderer. Die BGR hatte nicht zuletzt auch deswegen einen Platz für einen Lehrer bereitgestellt, damit neben dem Bewusstsein für die polaren Regionen unserer Erde auch die Arbeit der BGR in solchen Regionen unseren SchülerInnen näher gebracht wird. Mit dieser Vorgabe habe ich nach meiner Rückkehr die Verwertung in der Schule umgesetzt. Neugier zu wecken bei den Schülern gelingt relativ einfach, weil eine derartige Expedition nach wie vor ein

großes Abenteuer darstellt. Eine Präsentation mit eigenen Bildern und kleinen Anekdoten wirkte als Appetit-Anreger für eine Unterrichtseinheit über die Antarktis vorzüglich. Fragen entwickelten die SchülerInnen von selbst, die Neugier war geweckt. Allerdings zeigte sich, dass es weniger die Geologie war, die von Interesse war, sondern andere Fragen: Wie organisiert man solch eine Expedition? Was muss man mitnehmen? Welche Gefahren gibt es? Aber über die Frage „Was für merkwürdige Wissenschaftler waren dabei?“ konnte ich immer wieder das Augenmerk auch auf die eigentliche Feldarbeit lenken. Die Erfahrung hat mir gezeigt, dass es in der Schule nicht darum gehen kann, dass dort weitergehende wissenschaftliche Ergebnisse vertiefend behandelt werden. Neugier zu entfachen, gepaart mit ein wenig Abenteuerlust – wenn das gelingt, dann entspringt aus den SchülerInnen vielleicht auch der eine oder andere wissenschaftliche Nachwuchs mit Forscherdrang, den sich nicht zuletzt die BGR wünscht... das zeigte sich sowohl in der 7 und 8 Jahrgangsstufe wie auch in der 12. und 13. gleichermaßen.

## **SUBGLACIAL GEOLOGY OF HALVFARRYGGEN ICE DOME, ANTARCTIA, INFERRED FROM SEISMIC MEASUREMENTS**

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We carried out a combined vibro-explosive seismic survey on Halvfarryggen, a local ice dome south of Neumayer III. The Vibroseis survey was grid shaped to provide spatial information about the glaciological and geological substructure. The center survey line was also surveyed with explosive reflection and refraction seismic set-ups. The ice bed contact we interpret as a frozen till layer overlaying bedrock. Velocity analysis from refractions seen in far offset data, we obtain a pressure-wave velocity >5000 m/s. We therefore interpret the bedrock as igneous.

## **DAS NATIONALE POLARPROBENARCHIV AN DER BGR – EIN FUNDUS FÜR DIE TERRESTRISCHE POLARFORSCHUNG**

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Das Nationale Polarprobenarchiv (NAPA) in Berlin-Spandau dient der langfristigen Aufbewahrung von Gesteinsproben, die vorzugsweise von universitären geowissenschaftlichen Antarktis- und Arktis-Projekten stammen, zu Dokumentationszwecken aber auch zur weiteren wissenschaftlichen Bearbeitung.

Die Idee zu einem zentralen Archiv für Gesteinsproben aus den Polargebieten entstand beim Treffen des Arbeitskreises "Geologie und Geophysik der Polargebiete" der Deutschen Gesellschaft für Polarforschung 2004 in Hannover auf Anregung von Gerhard Spaeth (Aachen). An Universitätsinstituten können bedingt durch Ruhestand der beteiligten Professoren und/oder Umstrukturierung diese Proben nicht ständig aufbewahrt werden. Das bei teuren Polar-Expeditionen gewonnene Material muss jedoch für weitere wissenschaftliche Verwendung erhalten bleiben. Auf Bitte des Landesausschusses SCAR/IASC erklärte sich die BGR 2005 bereit, die Einrichtung eines Nationalen Polarprobenarchivs zu übernehmen.

Als Standort des NAPA wurde der Dienstbereich Berlin-Spandau, Wilhelmstr. 25-30, gewählt, wo sich große Teile der Gesteinssammlungen der BGR befinden. Hier wurde 2007 ein Lagerraum im Haus 4 mit zunächst 35 Sammlungsschränken bestückt. 2010 wurde die Kapazität um weitere 15 Sammlungsschränke erweitert.

Die bisher eingelagerten Proben stammen aus verschiedenen Gebieten der Antarktis, wie Viktorialand, Dronning-Maud-Land, Shackleton Range, Marie-Byrd-Land und wurden während Expeditionen zwischen 1979 und heute genommen. Kernstücke sind die Antarktis-Gesteinsprobensammlungen der Uni Aachen (Sammlung Spaeth und Bauer) mit ca. 1300 Proben und der Uni Frankfurt (Sammlung Kleinschmidt und Doktoranden) mit über 3000 Proben. Die Proben sind in einer Access-Datenbank erfasst und in Aufschlusskarten dokumentiert. In Zukunft soll für die gesamten Sammlungsbestände der BGR einschließlich des NAPA auch eine Recherche über das Internet möglich sein.

Zusammen mit den in der BGR am Standort Hannover aufbewahrten Gesteinsproben aus den Polargebieten, die von BGR-Mitarbeitern genommen wurden, steht der deutschen terrestrischen Polarforschung ein umfangreicher Fundus zur Verfügung, auf den für weitere Projekte zugegriffen werden kann. Das NAPA wird durch den Arbeitsbereich Polargeologie der BGR betreut, Ansprechpartnerin ist Dr. Solveig Estrada (Tel. 0511 643 3233).

## **DER BEITRAG DER ERWÄRMUNG DES TIEFEN- UND BODEN- WASSERS IM WEDDELLMEER ZUM GLOBALEN KLIMAWANDEL**

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Der Südliche Ozean trägt durch die Bildung des Antarktischen Bodenwassers (AABW) wesentlich zur globalen ozeanischen Umwälzbewegung bei. Im Südlichen Ozean ist das Weddellmeer das Gebiet mit dem bedeutendsten Beitrag. Die AABW-Bildung wird durch den Einstrom von Quellwassermassen, Transformationsprozesse und den Ausstrom des neugebildeten Wassers bestimmt. Der globale Temperaturanstieg in der Atmosphäre erscheint im letzten Jahrzehnt reduziert. Wir diskutieren hier die Möglichkeit, dass Wärmespeicherung im tiefen antarktischen Ozean zu einem wesentlichen Beitrag zur Dämpfung des atmosphärischen Temperaturanstiegs beiträgt.

Daten, die zwischen 1992 und 2013 auf 9 Wiederholungsschnitten, und mit verankerten Geräten im Weddellwirbel auf dem Meridian von Greenwich – mit dem FS Polarstern - gewonnen wurden, werden genutzt, um die Veränderungen der Temperatur im Weddell-System mit einer Genauigkeit von 1/1000 K zu quantifizieren. Nach anfänglichen Beobachtungen von Veränderungen in den neunziger Jahren im Zirkumpolaren Tiefenwasser, die aus der Literatur bekannt sind, wurde nun gefunden, dass die Veränderungen nahezu die gesamte Wassersäule erfasst haben. Dies bedeutet, dass über große Teile des Ozeans auch die Tiefsee merklich von der Ozeanerwärmung betroffen ist und nicht nur die oberflächennahen Bereiche, die durch Standardmessungen (z.B. Argo floats) erfasst werden und die bislang in globale Betrachtungen einbezogen wurden. So ergab sich am Greenwich Meridian als Mittelwert zwischen dem Boden und 100 m Tiefe eine Temperaturzunahme von 0,02 K über 20 Jahre. Im Weddellmeer-Bodenwasser (WSBW) war die Erwärmung im gleichen Zeitraum mit 0,04 K noch stärker. Diese Veränderungen können durch Einstrom in den Wirbel und der Zirkulation in ihm entstehen. Eine Phasenverschiebung der Erwärmung von Osten nach Westen entlang der Wirbelachse deutet auf die Verlagerung des Wirbels nach Westen oder eine Verstärkung des Einstroms von wärmerem Wasser aus dem Osten hin. Eine deutliche Abkühlung im Westen ist nicht zu erkennen, die der Erwärmung entgegen wirken würde. Eine mögliche Erklärung kann auf mehreren Ursachen beruhen: Die nahezu homogene Wassersäule ermöglicht durch geringe Veränderungen in den atmosphärischen Antriebskräften die Veränderung der tiefgreifenden vertikalen Vermischung, das Absinken an der Küste und den Aufstieg im Inneren der zyklonalen Wirbel, was zur langfristigen Zunahme der Temperatur führen kann. Wenngleich die gemessene Temperaturzunahme sehr gering ist, führt die

vertikale Erstreckung über nahezu die gesamte Wassersäule zur Speicherung von signifikanten Wärmemengen, da die Wärmekapazität des Meerwassers um etwa einen Faktor 4000 höher ist, als die der Atmosphäre. Somit kann die Erhöhung der mittleren Wassertemperatur um  $0,01^{\circ}\text{C}$  über die gesamte Wassersäule der Weltozeane die mögliche Erwärmung der Atmosphäre um  $1^{\circ}\text{C}$  reduzieren. Da der Südliche Ozean etwa 13% der Erdoberfläche einnimmt, würde dadurch ein erheblicher Teil der durch den erhöhten Treibhauseffekt gewonnenen Wärme nicht zur Erwärmung der Atmosphäre sondern des Ozeans beitragen und damit das Weddellmeer zum Tor des Wärmespeichers über längere Zeiträume machen. Der zirkumpolare Charakter des Südlichen Ozeans erlaubt, dass die Wärmespeicherung über den Zeitraum von Jahrzehnten ein nahezu globales Volumen erfassen kann. Wenn diese Wärmemenge nicht vom Ozean aufgenommen worden wäre, wo sie über 3900 m Tiefe zur Erwärmung von 0,04 K geführt hat, hätte sie in der darüber liegenden Atmosphäre eine Erwärmung von etwa  $1^{\circ}\text{C}$  über 24 Jahre bewirkt, bzw. hat die zu erwartende Erwärmung um etwa diesen Betrag gedämpft. Wie Johnson und Purkey (2012) an Hand des WOCE-Datensatzes zeigen, ist die Erwärmung nicht auf den Südlichen Ozean beschränkt, sondern breitet sich entlang des Ausstroms von AABW in die nördlichen Becken aus und ist daher langfristig von globaler Bedeutung.

## **ICE MATTERS. ARCTIC AND ANTARCTIC UNDER-ICE COMMUNITIES LINKING SEA ICE WITH THE PELAGIC FOOD WEB**

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In both Polar Regions, sea ice environments are undergoing rapid environmental change. Because sea ice constitutes an important habitat for numerous species, as well as an important carbon source during critical periods of the year, these changes impact significantly on ecosystem functioning, biodiversity, species distribution and population sizes, including commercially exploited fish stocks. Species dwelling at the ice-water interface (e.g. Antarctic krill and Arctic cod) play a key role in this context as trophic carbon transmitters from the sea ice into pelagic food webs, and ultimately to the deep sea benthos. Quantifying under-ice communities was hampered in the past by the inaccessibility of the ice underside to conventional sampling gear. Using a new under-ice trawl, it could be shown that Antarctic krill concentrates under sea ice almost year-round, and that krill dwelling under ice are significantly under-estimated by pelagic nets and sonars. An Arctic expedition in 2012 using the same sampling gear brought evidence of a vivid under-ice community even in the biologically poor-considered central Arctic Ocean. Using a bio-environmental sensor array during under-ice fishing enabled fine-scale characterization of sea ice habitat properties as a basis for statistical modeling of under-ice species distribution. During the talk, past results from under-ice fishing in the Southern Ocean will be summarized, and complemented by preliminary results from the Arctic Ocean to elucidate similarities and differences of polar under-ice communities in both hemispheres.

## **DAS KLIMA DER EURASISCHEN ARKTIS IN DEN LETZTEN 2000 JAHREN - ERGEBNISSE EINER EISKERNSTUDIE VON SEWERNAJA SEMLJA**

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Die Arktis ist eine Schlüsselregion des globalen Klimasystems und wird von der gegenwärtigen Erwärmung mehr beeinflusst als andere Regionen. Die Kenntnis natürlicher Klimaschwankungen der Vergangenheit ist für die Einschätzung heutiger Klimaveränderungen und für verlässliche Prognosen erforderlich. Repräsentative meteorologische Beobachtungen liegen in den meisten Regionen der Arktis erst seit ca. 1900 vor. Klimarekonstruktionen früherer Epochen beruhen hauptsächlich auf Untersuchungen von Eis- und Sedimentkernen oder Baumjahresringen die sogenannte Stellvertreterdaten (proxy data) liefern.

Vorgelegt werden die Variationen des Sauerstoffisotopenverhältnisses  $^{18}\text{O}/^{16}\text{O}$  und ausgewählter Hauptionen während der letzten 2000 Jahre in einem 724 m langen Eiskern, gebohrt im Zentrum der Eiskappe Akademii Nauk (Sewernaja Semlja, Russische Arktis). Der Vergleich mit der längsten verfügbaren meteorologischen Temperaturmessreihe der Region (Vardø, Nord-Norwegen) zeigt, dass die  $\delta^{18}\text{O}$  Daten von Akademii Nauk als proxies der Temperatur gut geeignet sind und damit eine Rekonstruktion mittlerer Jahrestemperaturen möglich machen. Kritisch ist dabei die Datierung des Eiskerns, die nicht durch übliche Fließmodelle möglich ist. Die Eiskappe hat sich, zumindest in dem hier untersuchten Zentralteil, nicht im dynamischen Gleichgewicht befunden, was aus der Tiefenlage von vulkanischen Horizonten bekannten Alters abzulesen ist.

Gute Übereinstimmung zeigen die  $\delta^{18}\text{O}$  Reihen von Akademii Nauk und Austfonna (Svalbard) wobei die letztere nur 800 Jahre zurück reicht. Typisch für beide Zeitreihen sind ein absolutes Temperaturminimum um 1800 und eine Erwärmung im frühen 20. Jahrhundert, die auf Svalbard, Sewernaja Semlja und in Nord-Norwegen in 2 Phasen verlief, was in anderen arktischen Regionen so nicht beobachtet wurde. Die Sauerstoffdaten von Akademii Nauk spiegeln regionale Besonderheiten wieder und weichen zum Teil erheblich von Rekonstruktionen der oberflächennahen Lufttemperatur der Gesamtarktis ab. Ein mittelalterliches Klimaoptimum und der Beginn der Kleinen Eiszeit treten in der  $\delta^{18}\text{O}$  Reihe von Akademii Nauk nicht deutlich hervor.



## **PRE-GLACIAL TO GLACIAL SEDIMENTATION OF THE AMUNDSEN SEA EMBAYMENT SHELF, WEST ANTARCTICA, FROM SEISMIC SURVEYING**

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Studies of the sedimentary architecture and characteristics of Antarctic shelves provide clues of past ice sheet advance-retreat cycles and help improve constraints for paleo-ice dynamic models since early glacial periods. A first seismostratigraphic analysis of the Amundsen Sea Embayment shelf and slope of West Antarctica reveals insights into the structural architecture of the continental shelf and slope and shows stages of sediment deposition, erosion and transport history from pre-glacial times to early glaciation and to the last glacial periods. The shelf geometry consists of a large pre- and syn-rift basin in the middle shelf region between outcropping basement of the inner shelf and basement ridge and highs of the outer shelf. A middle shelf sub-basin exists which can be associated with motion along an early West Antarctic Rift System branch. At least 4 km of pre-glacial strata has been eroded from the present inner shelf and coastal hinterland since the onset of glaciation by ice sheet advances. Parts of the eroded sediments deposited as a progradational wedge extending the outer shelf by 25 to 65 km oceanward of the pre-glacial shelf-break. Comparing the observed seismic characteristics with that of other Antarctic shelf sequences, we assign an Early Cretaceous age for bottom sedimentary unit ASS-1, a Late Cretaceous to Oligocene age for unit ASS-2, an Early to Mid-Miocene age for unit ASS-3, a Mid-Miocene age for unit ASS-4, a Late Miocene to Early Pliocene age for unit ASS-5, and a Pliocene to Pleistocene age for the top unit ASS-6. The survival of buried grounding zone wedges in the upper part of unit ASS-5 of the outer shelf is consistent with the onset of a long warming phase and a retreated ice sheet in the early Pliocene as observed for the Ross Sea shelf and predicted by paleo-ice sheet models. Our data also reveal that the paleo-paths of central Pine Island Trough system have remained in stationary positions across the middle and outer shelf since early glacial advances. This study and its stratigraphic constraints will serve as a basis for future drilling operations required for an improved understanding of processes and mechanisms leading to West Antarctic Ice Sheet retreats as presently observed in high rate for the Amundsen Sea Embayment.

## **PALEO-DYNAMICS OF THE WEST ANTARCTIC ICE SHEET FROM PROCESSES OBSERVED ALONG THE PACIFIC MARGIN**

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Data from sparsely existing drill information and numerical model simulations suggest that the West Antarctic Ice Sheet (WAIS) has behaved in a highly dynamic fashion in response to climatic variations. The analyses of drill cores from the Ross Sea shelf, for instance, infer that the WAIS underwent partial or full collapses in Pliocene times, and possible in the Miocene, when atmospheric carbon dioxide and temperature levels reached and exceeded those predicted for the next centuries. The collection of substantial seismic and other geophysical data as well as sediment cores along the West Antarctic margin from the Ross Sea to the Amundsen and Bellingshausen Sea in the recent years allows a first quantitative comparison of glacially influenced sedimentary transport and deposition processes from shelves to the continental rise of the southernmost Pacific. Sediment drift deposits of the continental rise document stages of particular dynamic bottom-currents and associated sedimentary transport activities. Drifts in the Ross Sea deep-sea record support an inferred Oligocene WAIS expansion to the outer shelf. Observations from the Amundsen Sea indicate bottom-current activity and hence a cold climate for the late Paleogene in an area, which today lies under the influence of Antarctic Bottom Water originating in the Ross Sea. The generation of drift bodies is accompanied by the occurrence of mass transport deposits leading to the identification of a phase of strong ice sheet expansion (15-4 Ma), which was followed by less material input during the last 4 m.y. due to a change in ice regime from wet-based to dry-based.

A first seismostratigraphic analysis of the Amundsen Sea Embayment shelf reveals insights into the structural architecture and shows stages of sediment deposition, erosion and transport history from pre-glacial times to early glaciation and to the last glacial periods. At least 4 km of pre-glacial strata has been eroded from the present inner shelf and coastal hinterland since the onset of glaciation by ice sheet advances. The survival of buried grounding zone wedges in the upper part of the outer shelf is consistent with the onset of a long warming phase and a retreated ice sheet in the early Pliocene as observed for the Ross Sea shelf and predicted by paleo-ice sheet models. These studies and their stratigraphic constraints will serve as a basis for future drilling operations required for an improved understanding of processes leading to West Antarctic Ice Sheet retreats mechanisms.

## **COASTAL POLYNYAS IN THE SOUTHWESTERN WEDDELL SEA: INFLUENCE ON HEAT FLUX AND SEA ICE FORMATION**

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Coastal polynyas open where the sea ice is driven away from the coastline, usually by strong off-shore winds. The resulting reduction in ice cover enables very strong heat fluxes to the atmosphere throughout the winter months and results in exceptionally high freezing rates. Therefore coastal polynyas have often been referred to as 'ice factories'.

We investigate the coastal polynyas in the southwestern Weddell Sea with the Finite Element Sea ice-Ocean Model (FESOM) which is a coupled system of a primitive-equation, hydrostatic ocean model and a dynamic-thermodynamic sea ice model. The global, unstructured grid features a horizontal resolution of up to 3 km along the southwestern Weddell Sea coastline and 37 depth levels of which 6 are within the uppermost 100 m. The model was initialized on 01.01.1980 with data from the Polar Hydrographic Climatology and run using boundary conditions from the NCEP/NCAR Reanalysis. The period 1990-2009 is used for analysis.

During the average winter season (May-September) we find coastal polynyas covering 9000 km<sup>2</sup>, with a mean heat flux of 370 W/m<sup>2</sup> to the atmosphere (thereof 61% sensible, 24% latent, 16% longwave and -1.5% shortwave). 50 W/m<sup>2</sup> are supplied by cooling the water column and the remainder induces a sea ice production of 9 cm/d (in total 1·10<sup>11</sup> m<sup>3</sup>/season). However, momentary values can differ far from the mean and interannual variability is strong. The robustness of our results was tested using different forcing data sets and while locally strong variations appear, the large-scale results are consistent.

## **DENSE SHELF WATER FORMATION IN THE SOUTHWESTERN WEDDELL SEA AND THE ROLE OF COASTAL POLYNYAS**

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For the formation of Antarctic Bottom Water, for which the Weddell Sea is considered a major source region, the salinity-enriched dense shelf water is a necessary ingredient. Dense shelf water is produced during winter on the Antarctic continental shelves by cooling and brine-rejection in the sea ice formation process. Coastal polynyas – due to their reduced ice cover – feature high freezing rates and thus are of great influence on the dense shelf water production.

We investigate processes in the southwestern Weddell Sea with the Finite Element Sea-ice Ocean Model (FESOM), a combination of a primitive-equation, hydrostatic ocean model and a dynamic-thermodynamic sea ice model. We use a global, unstructured grid that features a horizontal resolution of up to 3 km along the southwestern Weddell Sea coastline and 37 depth levels with increasing resolution toward the surface. The model was initialized on 01/01/1980 with data from the Polar Hydrographic Climatology and forced with daily NCEP/NCAR Reanalysis data.

The analysis of the years 1990-2009 gives  $2.5 \text{ kg m}^{-2}\text{d}^{-1}$  as a mean seasonal (May-September) salt input from sea ice formation ( $9 \text{ cm d}^{-1}$ ) in the southwestern Weddell Sea polynyas. Therefore a seasonal increase of 0.3 psu occurs in the bottom salinity at the Ronne Ice Shelf front and  $5 \cdot 10^4 \text{ km}^3$  of dense shelf water are produced. Interannual variability, however, is high and shows a strong dependence on the coastal polynya activity. On average 5.2 Sv of dense shelf water are exported, but since a large fraction is diluted by mixing with ambient water and leaves the Weddell Sea at intermediate levels, not all of this water contributes to the formation of Weddell Sea Deep/Bottom Water.

## **THE MODERN DEPOSITIONAL ENVIRONMENT IN POTTER COVE, KING GEORGE ISLAND, ANTARCTICA**

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King George Island belongs to the South Shetland Islands that are located north of the northern tip of the Antarctic Peninsula (AP). It is situated slightly north of the area where climatic warming in Antarctica is strongest. In places the annual mean temperatures increased by 0.5 K per decade through the past 60 years (Faraday/Vernadsky Station, AP). The air temperatures in the immediate working area increased by about 0.35 K per decade (Schloss et al. 2012) during the past 20 years which is still in the range of the recovery of temperatures from the Little Ice Age maximum to the end of the 19th century.

IMCOAST, a multidisciplinary international project investigates the modern and the late Holocene environmental development of the fjordic environment of south King George Island. In this part of the project we aim at reconstructing the modern sediment distribution in the inner part of Potter Cove using an acoustic ground discrimination system (RoxAnn) and more than 136 ground-truth samples.

The impact of the warming trend is clearly visible in the form of retreating glaciers and melting ice sheets, loss of sea ice and strong meltwater discharge into the coastal zone. Potter Cove is a small fjord characterized by a series of moraine ridges produced by a tidewater glacier (Fourcade Glacier). Presumably, the farthest moraine is not much older than about 500 years (LIA maximum), hence the sediment cover is rather thin as evidenced by high resolution seismic data (see presentation by Wittenberg et al.). Since a few years at least the better part of the tidewater glacier has retreated onto the island's mainland. It is suggested that such a fundamental change in the fjord's physiography has also changed sedimentation patterns in the area. Potter Cove is characterized by silty-clayey sediments in the deeper inner parts of the cove. Sediments are coarser (fine sand to coarse sands and boulders) in the shallower areas; they also coarsen from the innermost basin to the mouth of the fjord. Textural structures follow the seabed morphology, i.e. small v-shaped passages through the moraine ridges. The glacier still produces large amounts of turbid melt waters that enter the cove at various places. We presume that very fine-grained sediments settle from the meltwater plumes and are eventually transported by mid-depth or even bottom currents towards the mouth of the fjord. Older sediments that are more distal to the glacier front and sediments in shallower places

(e.g. on top of the moraine ridges) become increasingly overprinted by coarser sediments from the shallow areas of the fjord. These areas are prone to wave induced winnowing effects as well as disturbances by ploughing icebergs. It can be concluded that coarsening of the fjord sediments will continue while supply of fine-grained meltwater sediments might cease due to exhaustion of the reservoirs.

## **RECENT SNOW COVER CHANGES OF LEMMING HABITATS IN HIGH ARCTIC GREENLAND AS DERIVED FROM LANDSAT TM IMAGERY**

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Snow cover as an essential component of the ecology of high arctic species has been monitored by remote sensing as part of a long term project documenting lemming cycles in North East Greenland. For this purpose, data available via Landsat TM imagery has been used to assess the spatial and temporal changes of the snow pack in the Karupelv Valley study area within the last three decades. Based on the analyses of 237 images, we could assess ongoing changes both in the phenology of the snow melt in late spring as well as in the establishment of the autumnal snow pack. Despite a great interannual variability of these parameters, significant long term trends suggest an increase by more than 3 weeks of the length of snow free period that affects demographic processes within this high arctic terrestrial community.

## **IKAPOS: UNTERSUCHUNG DER ATMOSPHERISCHEN GRENZSCHICHT IM KATABATISCHEN WIND UND ÜBER DER NORTH WATER POLYNJA MIT FLUGZEUGMESSUNGEN**

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Das flugzeuggestützte Experiment IKAPOS (Investigation of Katabatic winds and Polynyas during Summer) wurde im Juni 2010 durchgeführt. Ziel der Studie war die Untersuchung des katabatischen Windsystems unter sommerlichen Bedingungen in Küstenbereich von Nordwest-Grönland und die Erfassung von Wechselwirkungsprozessen von Atmosphäre, Meereis und Ozean über der North Water (NOW) Polynja. Die Messungen erfolgten mit dem Forschungsflugzeug POLAR5 des Alfred-Wegener-Instituts (AWI, Bremerhaven). Neben den Navigationssystemen und einer meteorologischen Basis-Instrumentierung war das Flugzeug mit Strahlungssensoren, zwei Laser-Höhenmessern, Videokameras und Digitalkameras ausgestattet. Zur Messung von turbulenten Wärme- und Impulsflussdichten wurde POLAR5 mit einem Turbulenz-System an einem Nasenmast instrumentiert (Datenrate 100 Hz).

Es konnten insgesamt sechs Forschungsflüge durchgeführt werden, davon zwei im katabatischen Windsystem über dem Humboldt- bzw. Steenstrup-Gletscher. Unter Bedingungen von schwachem synoptischen Antrieb ist das Windsystem sehr flach und erreicht Windstärken von 7-9m/s. Bei starkem synoptischen Antrieb werden bis zu 14m/s erreicht.

Über der NOW-Polynja wurde die voll turbulente, aber stabile Grenzschicht mit Windstärken zwischen 15 und 20 m s<sup>-1</sup> vermessen. Aufgrund der sehr stabilen Schichtung mit einer Bodeninversion in den untersten 100-200 m wurden starke Kanalisierungseffekte im Bereich des Smith Sounds beobachtet. Mit Hilfe von Querschnitten konnte die Struktur eines Grenzschicht-Strahlstroms (low-level jet, LLJ) erfasst werden. Dieses mesoskalige LLJ-System führt zu einer bedeutsamen Erhöhung des Wind-induzierten Meereis-Exports aus Nares-Straße.

Zur Berechnung der turbulenten Flussdichten wurde die geeignete Mittelungslänge mit Hilfe der Spektren ermittelt. Dabei ergeben sich Längenskalen von 500 m–1000 m (Polynja) und 250m (katabatischer Wind). Der turbulente Fluss sensibler Wärme ist zur Oberfläche gerichtet und erreicht Werte von bis zu 30W/m<sup>2</sup>.

Der IKAPOS-Datensatz ist dazu geeignet, die Güte von numerischen Modellen für sommerliche arktische Bedingungen zu überprüfen und trägt zum quantitativen Verständnis der Austauschprozesse über Polynjen und dem grönländischen Eisschild bei.



## **BERICHTSKOLLOQUIUM SPP 1158: POLYNIA FORMATION PROCESSES IN THE WEDDELL SEA REGION**

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Coastal polynyas play an important role for the coupling between the components of the sea ice-ocean-atmosphere system in polar areas. They are associated with locally enhanced surface exchange processes, which have important consequences for the atmosphere, ocean processes, ice formation, gas exchange and biology. In the Weddell Sea, recurrent coastal polynyas form throughout the winter season, largely triggered by atmospheric forcing. The general perception in textbooks is that katabatic winds play the major role for this forcing.

The paper will highlight the atmospheric aspect of polynya formation and ice-ocean-atmosphere interaction. The different forcing processes for strong offshore winds (katabatic, synoptic) are investigated using high-resolution (5km) atmospheric simulations of the non-hydrostatic atmosphere model COSMO for the winter 2008. Different flow regimes such as katabatic winds, the barrier wind along the Antarctic Peninsula (AP) and flow over AP mountains can be identified as climatological signals. Katabatic wind dynamics are investigated by splitting the pressure gradient in the katabatic and synoptic components, respectively.

## **„PFALZ TRIFFT ANTARKTIS“**

Armin Hellmann

IGS Am Nanstein und Realschule plus  
Landstuhl, Germany

Im November 2011 begannen unsere Aktivitäten zum Projekt „Coole Klassen“.

Mit der Anbahnung des Kontaktes zu Frau Kallfelz und der Bereitstellung von Materialien über Polarforschung stellten wir schnell eine Verknüpfung mit den Lehrplänen der Fächer Gesellschaftslehre und Naturwissenschaften in der Klassenstufe 5 her.

Fächerübergreifend erfuhren die Schülerinnen und Schüler Zusammenhänge zwischen der Polarforschung und den Themen „Orientierung auf der Erde“ und „Ökologie“.

Die Klasse brachte Information zu den Rahmenbedingungen der POLARSTERN-Expedition in die Antarktis im Dezember 2011/Januar 2012 in Erfahrung und verfolgte mit großem Interesse die Blogs von Frau Kallfelz über die Internetpräsenz der Tageszeitung „Die Rheinpfalz“.

Die Kinder übten Kurzvorträge, vertieften ihre Kenntnisse über das Gradnetz und konnten ihre Kreativität bei der Erstellung von Pins unter Beweis stellen.

Sie verschafften sich damit Einblicke in die technischen Raffinessen des Forschungseisbrechers und der Neumayer-Station III. Weiterhin begriffen sie durch die Berichte über die Arbeiten der Forscherinnen und Forscher, dass das Forschen viel Mühe bei der Vorbereitung, Durchführung und Nachbereitung kostet.

Als Highlight erachteten die Schüler die Ankündigung, dass wir die Antarktis-Besucherin Frau Kallfelz in die Schule einladen wollten. Jetzt war man noch motivierter sich über das „Ewige Eis“ zu informieren und Berichte in den Medien zu verfolgen. Meine Tutorin im Fach Naturwissenschaften führte in der Zwischenzeit einen Versuch zur Polschmelze durch.

Als die Zeitzeugin nun tatsächlich im April 2012 in der Schule eintraf und ihre Berichte, ihren Polaranzug und viele Versuchsaufbauten im Stationsbetrieb an die Schülerschaft brachte, wurden die Augen immer funkelnder und der Ehrgeiz mehr über die Polargebiete zu erfahren immer größer. Schnell wurden selbstgebastelte Pinguine zu Autogrammkarten umfunktioniert, um ein Souvenir von diesem besonderen Erlebnis zu haben.

Als Bonbon für die eifrige, interessierte und disziplinierte Arbeit durfte die Truppe kurz vor den Sommerferien das Pfalzmuseum für Naturkunde in Bad-Dürkheim besuchen. Die Kinder bestaunten das Eisbären- und das Pinguin-Präparat, den Wegweiser von Neumayer I, ein Modell der La Rochelle und viele andere Exponate. Sie hatten keine Mühe sich mit dem Audioguide im Museum zu bewegen und waren ein weiteres Mal intensiv mit polaren Themen befasst und sehr beeindruckt.

In Klassenstufe 9 behandelte ich im Fach Geschichte mit einer Schülergruppe die Anfänge der Polarforschung und ermöglichte den Schülern, Vergleiche zu den Expeditionen zu Zeiten von Roald Amundsen bzw. Robert Falcon Scott und heutiger Forschungsreisen zu ziehen.

Sehr spannend für mich selbst war der Austausch mit den betreuenden Lehrerinnen und Lehrern anderer „Cooler Klassen“. Es eröffnete mir weitere Ideen für fächerübergreifenden, handlungsorientierten Unterricht.

## **TRACING THE ORIGIN OF ARCTIC DRIFTWOOD**

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Arctic driftwood is exceptional regarding its spatial dispersal distance and ability to be preserved over most of the Holocene, and therefore represents a unique paleo-environmental archive at the interface of marine and terrestrial environments. Here, we present the world's largest compilation of >1500 Arctic driftwood samples from Svalbard and the east coast of Greenland. All wooden remains were in situ differentiated between natural (with root-collar) and artificial (logged) material, and include a maximum variety of sample dimensions and characteristics. Each sample was macro- and microscopically analyzed and wood anatomically identified. Tree-ring widths of ~400 logged pines were measured and cross-dated against regional chronologies from Siberia. Our results reveal the existence of five conifers (*Pinus sylvestris*, *Pinus sibirica*, *Picea sp.*, *Larix sp.*, *Abies sp.*) and three broadleaf species (*Populus sp.*, *Salix sp.*, *Betula sp.*). *Pinus sylvestris* represents >40% of the driftwood and likely originates from Eurasia and Siberia, which was confirmed by first cross-dating trials. Anatomical wood identification and consideration of the complex boreal species distribution is essential for precisely tracing the origin of Arctic driftwood. The future aim is to elaborate a circumpolar network of tree-ring chronologies for all genera in the different boreal catchments, which will guarantee a precise spatial and temporal driftwood classification, and thus enable the reconstruction of boreal climate, ocean currents and postglacial uplift.

## **DEGLACIATION OF THE WEST ANTARCTIC CONTINENTAL SHELF IN THE AMUNDSEN SEA SECTOR SINCE THE LAST GLACIAL MAXIMUM**

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The Amundsen Sea sector of the largely marine-based and therefore conditionally unstable West Antarctic Ice Sheet (WAIS) contains enough ice to raise global sea level by ca. 1.5 metres. At present, ice streams draining this sector into the Southern Ocean, especially glaciers flowing into Pine Island Bay in the eastern Amundsen Sea embayment, are undergoing considerable mass loss characterised by major thinning, flow acceleration and rapid grounding-line retreat. Sub-ice shelf melting by relatively warm Circumpolar Deep Water (CDW) upwelling onto the continental shelf is held responsible for these dynamical changes but atmospheric warming in West Antarctica may also have contributed to them. In contrast to the modern situation, the long-term history of the Amundsen Sea sector and the mechanisms forcing its deglaciation during the Holocene are only poorly constrained.

We will present new palaeoenvironmental data obtained from marine sediment cores collected in Pine Island Bay. The cores targeted shallow sites on the inner continental shelf and successfully recovered sedimentary sequences bearing calcareous microfossils. Radiocarbon ages on these microfossils demonstrate that the grounding line of the WAIS retreated to within ~100 km of its modern position before ca. 10 kyr BP (thousand years before present), which is consistent with an early WAIS retreat from near-coastal locations in the western Amundsen Sea embayment. Currently, there is no evidence that the grounding line had retreated landward of its modern position during the Holocene. Therefore, the chronological constraints may imply that during the last 10 kyr any episodes of fast grounding-line retreat similar to those observed today were short-lived and rare.

Preliminary geochemical data from benthic and planktonic foraminifera tests in the cores from Pine Island Bay reveals that intense CDW upwelling coincided with and may have forced the deglaciation of the inner continental shelf. Furthermore, we observe a significant change of the benthic foraminifera fauna during the early Holocene, which we interpret to indicate the collapse of an ice shelf covering the inner part of the bay. We speculate that this ice shelf had buttressed ice draining into the eastern Amundsen Sea embayment, and that its removal triggered rapid ice-sheet thinning in the hinterland.

## **ICEMAR: BETTER ACCESSIBILITY TO ACTUAL SEA ICE INFORMATION.**

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Funded by the EU, ICEMAR ([www.icemar.eu](http://www.icemar.eu)) is a project for better delivery of actual sea ice information onto ships, but can also be used in the field and on land as long as a communication channel is available. The information can be in form of ice charts, but also satellite information of ice forecasts from numerical models. A server, based somewhere in the world, collects the information from different providers, the user aboard gets a catalog of available (now and in the near future) information and can manually choose which information he wants, but can also subscribe to certain feeds. It is also possible to order only a subset (e.g. geographic area, lower spatial and temporal resolution) of a certain product. The system can also take into consideration that the ship moves and adjust the area of interest accordingly. The on-board ICEMAR manager then takes care that the information gets aboard using the ship's communication line, taking also into consideration that the transfer speed can be quite low in polar regions.

The "on board" ICEMAR manager will be available on a laptop at the conference for a real time experience.

## **DIE ERWÄRMUNG DER ARKTIS UND IHRE AUSWIRKUNGEN AUF DIE PERMAFROST-LANDSCHAFTEN**

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Etwa ein Viertel der kontinentalen Erdoberfläche wird von Permafrost unterlagert. Dieser dauerhaft gefrorene Untergrund ist vor allem in den weiten Permafrostgebieten der Tundren und der borealen Waldgebiete Asiens und Nordamerikas mit Mächtigkeiten bis über 1000 m weit verbreitet. Klimaänderungen verändern das thermische Regime des Permafrosts, führen zu seiner Degradation und wirken sich vielfältig auf die Landschaft, die Infrastruktur in besiedelten Regionen und die Ökosysteme insbesondere der Arktis und Subarktis aus.

Die raschesten Reaktionen auf wechselnde Klimabedingungen werden an der Grenzschicht Permafrost – Atmosphäre ablaufen, wobei es bei einer Erwärmung vor allem zu einer Erhöhung der saisonalen Auftautiefe kommen wird. Dies hat unter anderem einen starken Einfluss auf die Stabilität des organischen Kohlenstoffs der in großen Mengen in den Böden gebunden ist und je nach Änderung des Energie- und Wasserhaushaltes der oberflächennahen Schicht, zu positiven als auch zu negativen Rückkopplungseffekten in Bezug auf das Anwachsen der Treibhausgase Kohlendioxid und Methan in der Atmosphäre führen kann.

Neben dem oberflächennahen Kohlenstoffumsatz durch die Aktivität von Mikroorganismen findet man freies Methan auch in tiefer liegenden gefrorenen Schichten des Permafrosts. Ein klimabedingtes Tauen des Permafrosts und eine Intensivierung der Erosion der eisreichen arktischen Küsten kann zu einer Freisetzung von bislang noch nicht abschätzbaren Treibhausgasmengen in die Atmosphäre führen.

In den Schelf- und Tieflandsgebieten Eurasiens und Nordamerikas treten im Permafrost selbst oder im Untergrund hohe Methankonzentrationen in Form von Gashydraten auf, deren Degradation als Folge der Klimaerwärmung zu einem derzeit nicht abschätzbaren zusätzlichen Methan-Eintrag in die Atmosphäre führen kann.

Verschiedene internationale Projekte, die in enger Verzahnung von Prozessstudien mit Langzeitreihen sowie Energie-, Wasser- und Treibhausgasflüssen am Boden und deren Verknüpfung mit Klimamodellen diese komplexe Problematik erfassen möchten, haben in der letzten Zeit begonnen. Neben dem vom AWI koordinierten FP 7 Projekt der EU „PAGE21“ sind das Japanische GRENE-TEA Projekt und das Kanadische ADAPT-Projekt zu nennen.



## NEW DATA ABOUT MATERIALS FOR NEST BUILDING BY THE KELP GULL IN THE ARGENTINE ISLAND AREA (MARITIME ANTARCTICA)

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During the last 50 years, the region including the Antarctic Peninsula and its adjacent archipelagos, also known as the Maritime Antarctic, has experienced one of the fastest rates of regional climate warming recorded on the planet. One biological consequence attributed to this climatic warming and associated changes has been a considerable increase in the population numbers and extents of the two native species of vascular plants, *Deschampsia Antarctica* Desv. and *Colobanthus quitensis* (Kunth.) Bartl. occurring in the region. Birds have been suggested to be partially responsible for this spread, potentially transporting adhering seeds or other viable plant fragments. However, explicit confirmation of any mechanism by which birds may have transported such propagules into the Antarctic or between locations therein remains unavailable.

Recently, based on published reports of plant species utilization by Antarctic birds during nest construction, we have proposed three regionally resident candidate species to be capable of transferring vascular plant propagules, the kelp gull (*Larus dominicanus*), the south polar skua (*Catharacta maccormicki*), and the brown skua (*Catharacta lonnbergi*). As these species spend time on or near land both during the austral summer in Antarctica and in the winter after migration to South America, in principle they could act as transfer vectors for viable propagules both on local and inter-regional scales, i.e. by collecting and moving plant material in the local area while building nests, and by inadvertently carrying attached propagules (zoochory) during migratory transfer from South America into the Antarctic. Yet another species, the southern giant petrel (*Macronectes giganteus*) has also been reported to utilize grass as a nesting material. However, this species is very sensitive to disturbance and its nesting behaviour is difficult to study. It also does not associate with land

other than during the nesting season. The Imperial shag (*Phalacrocorax atriceps* King, 1828) has also been observed to incorporate components of Antarctic herb tundra vegetation within its nests.

In the present study, our goal was to assess the extent to which *Larus dominicanus* rely on vascular plants as a nest building material in the Argentine Islands region, and hence whether this species could be considered a major dispersal agent for components of the Antarctic herb tundra formation.

Over the 2009/2010 season, 22 samples from *Larus dominicanus* nests were collected and analysed in details in the vicinity of the Argentine Islands. Nearly half of the available gull nests were sampled in the Argentine Islands region. All the nests were inspected rapidly and with care in order to minimize disturbance. Additionally, we examined material lost by kelp gulls around nests.

We demonstrate that, in the Argentine Islands region, *D. antarctica* and some bryophytes provide most of the nest building material for the kelp gull. Other materials, including lichens, limpet shells and gull feathers, are used less frequently. Combined evidence, thus, suggests that *Larus dominicanus* may be an important spread agent of the Antarctic herb tundra formation in general and *Deschampsia antarctica* and some bryophytes in particular. The absence of *Colobanthus quitensis* in the studied nests clearly reflects the rarity of this plant in the study area.

We express our gratitude to the National Antarctic Scientific Center of the State Agency for Science, Innovation, and Information of Ukraine. This study was conducted under the contract between the National Antarctic Scientific Center and the Institute of Molecular Biology and Genetics NAS of Ukraine # H/3-2011 "Development of a bioindicator system of climate change in coastal Antarctica based on the dynamics of terrestrial plant cenoses" (2011-12), as well as a joint project between the NAS of Ukraine and Polish Academy of Sciences: "Ecological and genetic basis of plants adaptation to extreme environments" (2012-14).

## **BLUE ICE MORaine GYPSUM, SØR RODANE, EAST ANTARCTICA**

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During the international GEA-II expedition to Sør Rondane (East Antarctica), large aggregates of gypsum crystal were found within blue-ice moraines on the south side of the mountain range (Fig. 1A). Gypsum aggregates reach one meter in diameter with individual crystal length up to 20 cm. Apparently, the gypsum grows in-situ and as a result of sublimation of the blue ice on the gravel of the moraine. Individual cobbles are incorporated into the gypsum aggregates. The gypsum does not show signs of transport. In thin section, the gypsum shows an irregular growth zoning and in part bent cleavage planes. Abundant primary fluid inclusions are present parallel to the growth zoning as well as parallel to cleavage plains (Fig. 1C). First Sr-isotope data indicate relative high values and suggest crustal affinities. This type of gypsum formation is enigmatic and has never been described before. It might indicate an important and thus far not described process, characterising a special way of interaction between the lithosphere and the cryosphere.

## NEOPROTEROZOIC/LOWER PALAEOZOIC GEODYNAMIC EVOLUTION OF DRONNING MAUD LAND: INTEGRATING GEOLOGY AND GEOPHYSICS

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East Antarctica probably formed by amalgamation of a number of cratons along distinct Ediacaran mobile belts, including the ca. 600-500 Ma East African-Antarctic Orogen (EAAO) that dissects Dronning Maud Land (DML). New field-work during the international expeditions *Geodynamic Evolution of East Antarctica* (GEA) I + II in the austral summers 2010/11 and 2011/12, and first geochronological results from eastern DML reveal a complex tectonic architecture across the belt.

In western DML, the EAAO reworks older Mesoproterozoic crust of the Maud Belt; the westernmost boundary of the mobile belt is characterized by a major dextral transpressional shear zone. In central DML, a major magnetic anomaly, the Forster anomaly, was interpreted as a cryptic suture of the EAAO (Riedel et al. 2012). The area where the Forster anomaly crosses the DML mountains is poorly investigated so far, but appears to coincide with a major strike slip shear zone in the southern Kurze Mts. and the occurrence of major Ediacaran granulite bodies. East of the Forster anomaly, the magnetic anomaly pattern changes significantly and typical Maud type crust is not present any longer. GEA II targeted a range of nunataks between Sør Rondane and central DML that had never been visited previously (from Blåklettane and Bergekongen in the E to Urna and Sørsteinen in the W). These nunataks are dominated by medium- to high-grade metasedimentary and metavolcanic rocks of possibly Neoproterozoic age, including abundant marble and graphite schists. Sør Rondane in eastern DML, is dominated by two distinct blocks separated by the dextral Main Shear Zone. The northwestern block is still part of the eastern EAAO, where new SHRIMP zircon data from metamorphic rims provide ages of ca. 560 Ma. The southeastern block is made up of a TTG terrane, which provides

four new SHRIMP zircon dates between 990-980 Ma, interpreted as igneous crystallization ages (oceanic arc). The TTG terrane shows limited tectonic overprint and is likely the southeastern foreland of the EAAO. Close to the contact of the two blocks grey gneisses and augen-gneisses gave zircon crystallization ages of ca. 750 Ma, ages which were previously unknown from the EAAO. The Forster anomaly therefore separates distinctly different parts of the EAAO: a) a reworked, mainly Grenville-age crust to the W (the overprinted margin of the Kalahari Craton) and b) a part of the orogen dominated by Neoproterozoic accretionary tectonics to the E. This difference is also reflected in the geochemistry of voluminous late-tectonics granitoids across the belt.

## **IDENTIFICATION OF BIOGEOCHEMICAL PROVINCES IN THE SOUTHERN OCEAN BY SPATIAL MODELING OF GEOCHEMICAL, SEDIMENTOLOGICAL AND BIOLOGICAL DATA – THE APPROACH**

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Compared to biogenic silica, little is known about benthic particulate organic carbon fluxes in situ in the Southern Ocean, a key region for the global marine carbon cycle. Because of the lack of data, the Southern Ocean south of 60° is still excluded from the global carbon budget calculations. Our knowledge of rates and spatio-temporal variability is patchy, therefore coupling of these processes into regional or global models remains difficult and error prone. Meanwhile the public availability and dissemination of biological, geochemical and sedimentological research data as well as multivariate analysis methods applied in marine sciences is undergoing major developments, towards improving interdisciplinary data analysis.

This poster aims to illustrate the approach of modeling benthic particulate organic carbon fluxes which is the objective of the DFG-Priority Programme SPP 1158 project started in December 2012. For this purpose, correlating parameters as biogenic silica, benthic organisms and other environmental parameters will be used which mimic the geochemical situation as proxies. Biogeochemical provinces in the Southern Ocean combining in situ measurements, experiments and multivariate models, will indicate areas of defined oxygen and carbon fluxes by GIS-based statistical modeling methodology. These provinces are also needed to quantify potential species occurrence and biomass and can be used to optimize sampling strategies during scientific expeditions. The spatial distribution and the dimensions of the Southern Ocean provinces will reduce the gap of knowledge regarding the global geochemical cycles. Furthermore, the exploration of the spatial variation regarding the location and extent of the provinces which are to be expected due to global warming contribute to the prediction of quantitative changes in geochemical fluxes in the Southern Ocean.

## **PROVENANCE OF THE PERMIAN TAKROUNA FORMATION, ANTARCTICA - IMPLICATIONS ON BASIN GEOMETRY AND PALEOGEOGRAPHY**

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During the Late Carboniferous and Permian a series of sedimentary basins occupied the eastern margin of Gondwana. Many uncertainties exist regarding the extent and nature of some of these basins. In northern Victoria Land the Takrouna Formation presents the fossil record of the northern part of this basin system, exposed within an outcrop belt with an E-W extension of 125 km and an N-S length of more than 160 km. The up to 300 m thick succession of siliciclastic deposits documents the onset of sedimentation after the Late Carboniferous to Early Permian glaciation of Gondwana. The Takrouna Formation includes fluvial conglomerates, sandstones and carbonaceous fine-grained rocks that were deposited in a braided river system, draining towards Tasmania.

This study combines heavy mineral with new U-Pb age data of the Takrouna Formation. CL imaging of the zircons, a typologic study and detrital zircon dating, populations of the sandstones have been performed for sections of five mountain ranges. Both metamorphic and igneous sources must be considered for the detrital zircons. Populations with Grenvillian and early Paleoproterozoic zircon ages, as well as rare older Archean ages are present in all samples. The most abundant age population reveals Pan-African zircons. One key aspect regarding the basin extent can be concluded from heavy-mineral data. The heavy-mineral contents include zircon, tourmaline, rutile, garnet, epidote-group minerals, hornblende, titanite, apatite and minor amounts of anatase and monazite. The abundance of the different heavy minerals show systematic variations related to stratigraphy as well as regional trends. A major input of material derived from distinct local sources filling a pre-existing topography must be assumed for the stratigraphic lower parts of all sections. The examination of garnet varieties indicates low- to medium-grade metamorphic source rocks that reveal an unknown source, located to the east of the study area. However, in most cases the heavy-minerals can be related to sources equivalent to rocks found in the basement or in the vicinity of northern Victoria Land. Similar heavy-mineral assemblages are present in sandstones of the Permian Weller Coal Measures in southern Victoria Land. Based on these results our paleogeographic model suggests a trough-shaped elongated basin with a basin margin of unknown composition to the east. A connection of both the northern and southern part of the Victoria Basin or very similar sources can be concluded.

## **ARCTIC CLIMATE AND SEA-ICE CHANGES OVER THE LAST MILLENNIUM IN PALEO-RECONSTRUCTIONS AND MODEL SIMULATIONS**

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Arctic climate is characterized by pronounced variations on multidecadal to centennial time scales. Recent high-resolution reconstructions based on multiple terrestrial proxies and geological archives allow for an assessment of such variability over the last 2000 years. Model simulations carried out in the framework of the third phase of the Paleo Model Intercomparison Project (PMIP3) cover dedicated simulations over the last millennium that can be used to achieve a process-based understanding of the mechanisms behind the variability and to provide a large-scale context for local or regional reconstructions. The simulations demonstrate that both internal variability and the response to external forcing show aspects of Arctic amplification. The low-frequency character of the variability suggests a role of ocean dynamics and, in particular, changes in meridional heat transports in the ocean. We explore the role of ocean heat advection and atmosphere-ocean-sea ice coupling in driving such multidecadal variations in the Max Planck Institute Earth System Model. Finally, we discuss the recent, unprecedented changes observed in the Arctic in the context of the climate evolution of the last millennium.



## **MEASURING SOUTHERN OCEAN BENTHIC BIODIVERSITY: DECADAL PROGRESS AND FUTURE CHALLENGES**

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The scarce information available on Southern Ocean biodiversity patterns suggest that they have been shaped by complex interactions of factors at varying scales; long-term oceanographic and thermal isolation by the Antarctic Circumpolar Current coupled with recurrent glaciations probably drove vicariant speciation and endemism, whilst physical disturbance is thought to maintain (shelf) biodiversity at local to regional scales. Across ecological, and to some extent evolutionary time scales, the Southern Ocean seabed has been remarkably constant and had potentially experienced the least direct anthropogenic impact. Thus, it represents one of the most 'natural laboratories' to study organisms' biodiversity, distribution and responses to changing climatic conditions.

We are now at a key period to assess and interpret biodiversity and distributions through amassed knowledge but we are also in a time of current and impending, potentially pivotal environmental change. So, one of the greatest challenges, not only in the Southern Ocean but globally, is probably to balance the conservation of, and an increasing demand to exploit its natural resources and services.

Achievements over the past ten years, especially in the course of the International Polar Year initiative, the Census of Marine Life as well as SCAR (Scientific Committee of Antarctic Research) programs, have considerably altered our perception of patterns and processes shaping the biodiversity of Southern Ocean benthos. Here I evaluate decadal progress in Antarctic benthic biodiversity research, discuss present research knowledge gaps and identify potential priorities for future research that will provide deeper insights into our understanding of the Southern Ocean ecosystem structure and function.

## **CRUSTAL STRUCTURE OF THE AMUNDSEN SEA EMBAYMENT, WEST ANTARCTICA: IMPLICATIONS FOR ITS TECTONIC EVOLUTION FROM A GEOPHYSICAL DATASET.**

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The Amundsen Sea Embayment of West Antarctica is a centrepiece in understanding the history of the New Zealand – Antarctica breakup. This region plays a key role in plate kinematic reconstruction of the southern Pacific from the collision of the Hikurangi Plateau with the Gondwana subduction margin to the evolution of the West Antarctic Rift System. During two RV Polarstern cruises in 2006 and 2010, a large geophysical dataset was collected consisting of seismic refraction and reflection profiles, shipborne gravity and helicopter magnetic measurements. The data provide constraints on the crustal architecture, the structural evolution and the tectonic block formation during and after the Cretaceous continental breakup. We present two continental rise-to-shelf P-wave velocity models which were derived from forward travel-time modelling of ocean bottom hydrophone recordings which provide an insight into the crustal and upper mantle architecture beneath the Amundsen Sea Embayment for the first time. The sedimentary sequences and the basement were constrained by seismic reflection data. A 2-D density-depth model supports and complements the P-wave modelling. Observed P-wave velocities show 10 to 14 km thick crust of the continental rise and up to 28 km thick crust beneath the middle and inner shelf. The crust of the continental rise is characterized by a small gradient in thickness. Including horst and graben structures this can be associated with wide-mode rifting. A high velocity zone with velocities ranging between 7.1 and 7.6 km/s indicate magmatic underplating of variable thickness along the entire transect. We classify this margin as one of volcanic type rather than magma poor because of the high-velocity zone and seaward dipping reflectors observed from the seismic reflection data. We discuss the possibility of a serpentinized upper mantle caused by seawater penetration at the Marie Byrd Seamounts. The crustal structure, distinct zones in potential field anomalies indicate several phases of fully developed and failed rift systems and a possible branch of the West Antarctic Rift System in the Amundsen Sea Embayment.

## **IRO-2 EISVORHERSAGE UND EIS-ROUTEN-OPTIMIERUNG**

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Bedingt durch den Klimawandel haben nicht nur die Ausdehnung, das Volumen und die Dicke des Eises in der Arktis stark abgenommen, sondern es hat sich auch das Verhältnis zwischen erstjährigem und mehrjährigem Eis dramatisch verändert. Diese Entwicklung begünstigt nicht nur die Nutzung der nördlichen Seewege, North-West-Passage und Northern-Sea-Route, als kürzester Verbindung von Europa oder Nord-Amerika nach Ost-Asien, sondern auch die Gewinnung und den Abtransport von Rohstoffen aus der Arktis. Das wirtschaftliche und sichere Befahren der nördlichen Seewege sowie der Abtransport von Rohstoffen aus und die Versorgung von arktischen Häfen mit Gütern auch in Monaten mit leichten Eisverhältnissen erfordert eine verlässliche und sowohl zeitlich als auch örtlich hochaufgelöste Eisvorhersage sowie eine sich hierauf stützende optimierte Routenberatung. Um die Voraussetzungen für eine derartige Dienstleistung zu schaffen, hat sich eine Gruppe aus Forschungseinrichtungen sowie kleinen und mittleren Unternehmen, KMUs, zusammengefunden, um im Forschungsvorhaben IRO-2 die bei ihnen vorhandenen Methoden und Verfahren zur Eisvorhersage und Routenoptimierung zu verfeinern und verbessern. Die geplante Eisvorhersage basiert auf der Verbesserung und Optimierung vorhandener ozeanographischer und meteorologischer Vorhersagemodelle und deren Zusammenführung zu einem übergreifenden Eisvorhersagesystem. Hierbei soll vor allem die flächenhafte Auflösung auf etwa 5x5 km erhöht werden. Der Vorhersagezeitraum soll 3-5 Tage betragen. Als Eingangsdaten für die Modelle werden Satelliten- und In-situ- Daten in einem neu entwickelten Assimilations- und Vorhersageverfahren verwendet. Das vorhandene

Navigationsmodell wird bezüglich seiner Vorhersagefähigkeit in deformiertem Eis, Presseisrücken und Packeis, verbessert, die Routenberatung wird weiter optimiert und auf aktuelle Datenauswertung umgestellt. Die Resultate der Eisvorhersage sowie der Routenvorschlag werden dem Anwender in nutzerfreundlichen Standard-Formaten zur Verfügung gestellt. Im dritten Jahr des Forschungsprojektes wird dieses gekoppelte operationelle Eisvorhersage- und Eisnavigationssystem mit all seinen Komponenten auf Funktionalität und Praxistauglichkeit getestet. Auf der Basis der Testergebnisse soll dann untersucht werden, inwieweit die in diesem Verbundvorhaben entwickelte Eis-Routen-Optimierung und Eisvorhersage den Transport auf den nördlichen Seewegen sicherheitstechnisch und wirtschaftlich verbessert hat. Weiter soll geprüft werden, ob das entwickelte System bereits Marktreife erreicht hat, um es über eine zu gründende Verwertungsgesellschaft zu vermarkten, oder ob weitere Entwicklungsschritte vor der Markteinführung notwendig sind. Das Projekt IRO-2 (<http://iro-2.de/index.html>) wird durch das Bundeswirtschaftsministerium für Wirtschaft und Technologie von Oktober 2011 bis September 2014 im Rahmen des BMWi-Förderprogramms "Schifffahrt und Meerestechnik für das 21. Jahrhundert" gefördert.

## **PFALZMUSEUM UNTERWEGS – MIT COOLEN KLASSEN - DER OUTREACH DER LEHRERBEGLEITUNG ANT-XXVIII / 2**

Monika Kallfelz

Coole Klassen, Pfalzmuseum für  
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Im Rahmen des Projekts „Coole Klassen“ begleitete ich Polarstern im Winter 2011/12. Das Projekt wird in einem Vortrag dieser Polartagung vorgestellt.

Nachweislich mindestens 20 Schulen haben sich aktiv beteiligt, mit mindestens 45 Lehrkräften in den Fächern: Naturwissenschaften, Biologie, Erdkunde, Mathematik, Ethik, Deutsch

10 Klassen waren im Zusammenhang mit der Expedition im Museum

7 Klassen habe ich im Zusammenhang mit der Expedition besucht, 2 davon mit Fernsehteams.

Bis zwei Monate nach der Expedition gab es 17431 Klicks auf den Blog.

Die Blogbeiträge sind als Broschüre beim Museum erhältlich.

Lehrerfortbildungen führten interessierte Lehrkräfte in die Thematik und die Forschungsvorhaben ein, ermöglichten die Entwicklung von Begleitprojekten und dienten dem Informationsaustausch. 3 Lehrerfortbildungen (insgesamt 4 Tage) in Rheinland-Pfalz erreichten 40 Lehrkräfte, 1 Lehrerfortbildung (Workshop) in Kiel und 1 Vortrag mit Workshop beim MNU Bundeskongress in Hamburg (März 2013) fanden bisher statt.

Zahlreiche Zeitungsbeiträge erschienen in der regionalen und auch der überregionalen Presse. 6 Hörfunk- und 7 Fernsehbeiträge entstanden in unmittelbarem Zusammenhang zur Expedition.

135 Gäste besuchten 2 öffentliche Vorträge über die Expedition im Museum, ca 60 Zuhörer gab es bei 2 weiteren öffentlichen Vorträgen.

Ca 100 Gäste waren es bei einem Themenabend für Eltern an einer Schule, weitere ca 100 Gäste sahen meine Präsentationen bei einem Tag der offenen Tür.

In der Folge der Expedition entstand am Pfalzmuseum eine interaktive Sonderausstellung „Polarforschung zum Anfassen“, die ich konzeptionell, inhaltlich und organisatorisch planen durfte. Die Ausstellung wurde vom 4.11.2012 bis 17.2.2013 gezeigt und von ca. 4000 Personen besucht.

Aus der Ausstellung erwächst eine „Mobile Museumskiste Polarforschung“, die von Schulen in Rheinland-Pfalz mit fachkundiger Begleitung (!) angefordert werden kann.

Die Erfahrungen dieser Expedition fließen direkt ein in die aktuelle rheinland-pfälzische Lehrplanentwicklung für die naturwissenschaftlichen Fächer in der Sekundarstufe I.

In Arbeit ist ein Themenheft „Polarforschung“ in Zusammenarbeit mit einem Schulbuchverlag.

## **SPANNENDER UNTERRICHT LIVE AUS DEM EWIGEN EIS – LEHRERBEGLEITUNG POLARSTERN ANT-XXVIII / 2 (2011/12 KAPSTADT- NEUMAYER- KAPSTADT)**

Monika Kallfelz

Cooler Klassen, Pfalzmuseum für  
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Endlich ist es soweit: Seit den Anfängen der modernen deutschen Forschung in der Antarktis Anfang der 80er Jahre begeistere ich mich für diese Region, möchte sie gern selbst erleben und wünsche mir, solche Erfahrungen für meinen Beruf nutzen zu können. Im IPY nehme ich Kontakt auf zu Dr. Lehmann, dem Lehrerkoordinator des Projekts Cooler Klassen. Ich besuche ein Arbeitstreffen in Karlsruhe, nutze ein Besuchsangebot auf Polarstern und nehme an der internationalen Polartagung 2010 in Obergurgl teil. Zufällig schlägt es mich parallel mit einem Teil meiner Lehrerstelle an das Pfalzmuseum für Naturkunde in Bad Dürkheim, das eng verknüpft ist mit dem Pfälzer Georg von Neumayer und daher eine lange Tradition an Angeboten zu polaren Themen hat. Im Rahmen eines Projektes „schule@museum“ erarbeite ich im Tandem mit der örtlichen Realschule einen Hörführer, neudeutsch Audioguide, zu unseren polaren Exponaten.

Ich entwickle ein Konzept für eine mögliche Lehrerbegleitung auf Polarstern und: Die Bewerbung ist erfolgreich!

Um viele Lehrkräfte einzubinden, plane ich vorab eine Lehrerfortbildung, bei der der Fundus des Museums und der Audioguide genutzt werden und bei der der wissenschaftliche Fahrtleiter „meines“ Expeditionsabschnittes die vorgesehenen Forschungsprojekte vorstellt. Es entsteht die Idee, an Schulen im Foyer eine wachsende Stellwand aufzustellen, an der jeweils die neuesten Informationen vom Schiff ausgehängt werden. Schüler geben mir Fragen und Aufträge mit auf den Weg.

Täglich liefere ich einen Blogeintrag zu den Forschungsaktivitäten und dem Leben an Bord, bei dem auch bestimmte, vorher vereinbarte Informationen enthalten sind. Lehrkräfte können eigene Projekte entwickeln, je nach Unterrichtsfach, Klassenstufe und ihrer Situation und sich an der Stellwand bedienen. Die meisten Lehrkräfte gehen die Thematik mit 5. oder 6. Klassen an. Sie legen großen Wert auf die authentische Situation und möchten sehr gern mit Polarstern telefonieren. Schließlich räumt das AWI diese Möglichkeit ein. Es entstehen Plakate, Ausstellungen, Forschertagebücher und Modelle, die an etlichen Schulen für Mitschüler, Eltern und die Öffentlichkeit präsentiert werden. Vor und nach der Expedition besuche ich Schulklassen und betreue Schulklassen im Museum. Wir befassen uns mit den Gegebenheiten in der Antarktis, mit der Geschichte der Erforschung, mit Lebewesen und mit aktuellen Forschungen. Und natürlich stelle ich „meine“ Expeditionserlebnisse vor.

Im Nachgang nutze ich meine Erfahrungen im Bereich Lehrerfortbildung, in der Lehrplanarbeit und in der Zusammenarbeit mit Verlagen. Die Öffentlichkeit zu

erreichen gelingt über die Anbindung an das Museum sehr zwanglos. Es gibt öffentliche Vorträge und ein überraschend großes Interesse der Medien in allen Phasen der Expedition.

Im weiteren Verlauf kann ich für das Museum eine Sonderausstellung konzipieren und umsetzen. Sie stellt im Kern 6 aktuelle Forschungsprojekte vor und ist stark interaktiv und experimentell ausgerichtet. Darüber hinaus ermöglicht sie eine Vorstellung von dem Leben als Forscher und von den wichtigsten deutschen Forschungseinrichtungen.

Eine Zusammenfassung des „Outreach“ in Zahlen wird im Rahmen der Posterausstellung dargestellt.

## **SUBGLACIAL LAKES AT THE ONSET OF RECOVERY GLACIER, ANTARCTICA**

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More than 360 subglacial lakes are suggested to exist below the Antarctica ice sheet. Subglacial lakes are suggested to be responsible for the initiation of an ice stream, either by changing the ice sheets basal thermal regime or by introducing water into the path of the ice stream through periodic drainage events (Bell et al., 2007). One of the least explored territories on Earth is the Recovery Glacier, East Antarctica including the Recovery subglacial lake area. No other ice stream expands further into the East Antarctic ice sheet like the Recovery Glacier (Langley et al., 2011). The Alfred-Wegener-Institut Helmholtz-Zentrum für Polar- und Meeresforschung performed in 2010/2011 a radio echo sounding survey across the upper, larger lakes with the research aircraft Polar 5. In the season 2012/13 and 2013/14 a campaign will survey large parts of the Recovery drainage basin. Radar features identifying subglacial lakes contain specified radar reflection properties. Thus subglacial lakes are characterized by flat and extremely smooth ice-surfaces above the lakes and bright basal reflectors and are as well confined by upstream troughs deeper in the ice surface and downstream ice-surface ridges (Langley et al., 2011). The bed reflectivity derived by bed returned power (reflection coefficient), considering the attenuation rate in ice, as well as a measurement for specular of interfaces or the basal hydraulic head, are basic parameters to determine for data analysis of radio-echo sounding data above subglacial lake (Carter et al., 2007, Oswald & Gogineni, 2008) . We present an analysis of a profile and a comparison with the findings of Langley et al. (2011).



## **WEST-ANTARCTIC ICE SHELVES: WHERE DOES THE ENERGY COME FROM FOR BASAL MELTING?**

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Recently the West Antarctic Ice Sheet (WAIS) is reported to lose mass at an elevated rate. The sensitivity of the marine WAIS to external forces has been proposed earlier as well as its significance for global sea level rise. The important role of ocean water and its capability of transporting Circumpolar Deep Water (CDW) at a temperature of +3°C above freezing point has been reported by Hellmer et al. 1998. The question is, if this is the only source of heat, which can accelerate basal melting of the West Antarctic glaciers. Geothermal heat flow is often observed to be increased in tectonic active regions and the Amundsen Sea Embayment (ASE) is a region, where major faults are expected. Even recent volcanism has been reported some 130 km west of the Pine Island Bay.

During RV Polarstern expedition ANT XXVI/3 (January - May 2010) into the WAIS area we carried out 29 measurements to determine geothermal heat flow in the marine part of the bay. Due to the favorable ice conditions, many areas could be assessed, which have been ice covered in previous years. As the bottom water temperature and changes of it have major impact on sea floor temperature and the stability of sub bottom temperature gradients, a thorough understanding of the oceanography of the area is necessary. A detailed survey of the water column by CTD transects was observed within Pine Island Bay area during that season (2010).

The temperature measurements were planned to test first of all the probability of heat flow determinations in this relatively shallow shelf area and second to proof any of the hypotheses on elevated heat flow.

Summing up the results of heat flow measurements, we could observe a vigorous activity of bottom currents and warm water inflow but only normal to slightly elevated values of geothermal heat flow. Geothermal energy does not make the difference.

## **PHYTOPLANKTON PRODUCTIVITY IN THE LAKES OF THE BUNGER HILLS, ANTARCTICA**

Enn Kaup

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Phytoplankton Chl a and primary production (PP) were investigated during two summer-autumn seasons in ten lakes of the Bunger Hills, East Antarctica. The Chl a varied over all water bodies within 0.05-9.6 and 0.11-5.0 mg Chl a m<sup>-3</sup> during the first and second season, respectively. The variations of daily PP in first and second season, respectively, were within 0.18-110 and 0.60-172 mgC m<sup>-3</sup> d<sup>-1</sup>. General trend of increasing PP with growing water salinity was observed. In most lakes the differences of average Chl a and PP between two seasons were 2-4 times due to variable environmental conditions (presence/absence of ice cover, light, mixing conditions). In one of the largest antarctic lake, Lake Algae, Chl a and PP increased several times and remained at higher levels for at least 6 weeks after a major storm thoroughly mixed the lake and probably inoculated particles of algal mats into water column. In the marine Rybiy Khvost Gulf the average Chl a and PP varied c. twofold between the two seasons and the values were close to typical antarctic near-coast marine ecosystems. The chlorophyll-specific assimilation rates (AR) varied commonly within 0.1-2.0 mg C(mg Chl a)<sup>-1</sup> h<sup>-1</sup> in freshwater lakes and 0.7-5.9 mg C(mg Chl a)<sup>-1</sup> h<sup>-1</sup> in saline lakes. Much lower and higher AR were observed by decreased light and increased water temperature, respectively. The results indicate the importance of multiple sampling (intra- and interannually) for characterization of phytoplankton biomass and productivity in antarctic lakes.

## **LANGZEITPROJEKTE MIT SCHÜLERGRUPPEN UND PERSÖNLICHKEITS-BILDUNG**

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Mit drei aufeinanderfolgenden Schülergruppen von 2004 bis 2012 wurden am Marien-Gymnasium in Werl (ab 2004) und Heinrich-Heine-Gymnasium Dortmund (ab 2007) experimentelle Langzeitprojekte durchgeführt, die jeweils eine Dauer von etwa drei Jahren hatten. Den Start in die gemeinsame Arbeit stellte jedes Mal das Tonnen-Projekt dar, ein ökologisches Langzeitprojekt mit künstlichen Mesokosmen in Regentonnen. Projektpartner hierzu war das HIGHSEA-Schulprojekt am AWI in Bremerhaven. Höhepunkte der Projektarbeit waren zwei „Forschungsreisen“ mit Schülergruppen nach Tromsø in Nord-Norwegen in den Jahren 2008 und 2011.

Zentrales Ziel aller Teilprojekte war das Heranführen von interessierten Jugendlichen an wissenschaftliches Arbeiten. Dabei sollte das eigene Tun – Vorbereitung, Untersuchung, Auswertung, Dokumentation, Präsentation – im Vordergrund stehen. Im Rückblick auf die abgeschlossenen Projekte ergab sich, dass neben diesen Zielen ein weiterer wichtiger Aspekt resultierte, nämlich die Bedeutung für die Persönlichkeits-Bildung der beteiligten Jugendlichen. Dieser Aspekt soll nach einem Überblick zu den Projekten den Schwerpunkt des Vortrages bilden.

## **NEW MARINE GEOLOGICAL AND GEOPHYSICAL EVIDENCE FOR THE EXTENT, FLOW, AND RETREAT OF A WEST ANTARCTIC PALAEO-ICE STREAM OFFSHORE FROM THE HOBBS COAST**

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Palaeo-ice stream beds that are exposed today on polar continental shelves provide unique archives of conditions at the base of ice sheets that are difficult to assess beneath their modern counterparts. During the last decade, several of these palaeo-ice stream beds have been studied in detail to reconstruct the extent of the West Antarctic Ice Sheet (WAIS) at the Last Glacial Maximum (LGM), the patterns of ice drainage, and the timing of grounding-line retreat during the last deglaciation. However, despite significant advances, such information still remains poorly constrained in numerous drainage sectors of the WAIS. In particular, the maximum extent of ice at the LGM remains ambiguous for key drainage basins of the ice sheet. Whether the WAIS extended to the shelf break in the entire Pacific sector, or it advanced, at least locally, only to a middle or outer shelf position, is a crucial piece of information required for reconstructing and modeling patterns of ice-sheet change from past to present.

Here we present new marine geological and geophysical data that we collected on R/V "Polarstern" expedition ANT-XXVI/3 in early 2010 to investigate the extent, flow, and retreat of the WAIS from an especially poorly studied part of the West Antarctic shelf, offshore from the Hobbs Coast in the western Amundsen Sea. Here, a landward deepening palaeo-ice stream trough is incised into the shelf. The seafloor within the western-central part of the trough is characterized by a large grounding zone wedge (GZW), ~70 m thick and ~17 km long, which overlies a high of seaward dipping sedimentary strata. Directly seaward of the GZW a ~20 km wide 80±10 m deep relatively flat basin is mapped. The back-slope of the GZW is characterized by highly elongate streamlined bedforms suggesting fast palaeo-ice flow towards NW. In contrast, the outer shelf seafloor offshore from the GZW is predominantly smooth, at numerous locations scoured by icebergs and characterized by a distinct and ~2 m-deep subbottom reflector. As in other Antarctic shelf sectors, this subbottom reflector is likely to mark the top of a subglacial stiff till that is probably of LGM age, because a calcareous microfossil from the thin layer above the subbottom reflector provided a radiocarbon age of ~9.0 corr. ka BP at 98 cmbsf (centimeter below seafloor). A radiocarbon date from the inner shelf shows that the grounded ice here had retreated landward from the GZW remarkably early (before ~13.0 cal 14C yrs). This early deglaciation is in agreement with other minimum deglaciation ages from the

Amundsen Sea embayment (e.g. Pine Island Bay and Dotson-Getz Trough). For the GZW we propose two possible formation scenarios: either (1) that it formed during a prolonged stillstand when the WAIS retreated from the outer shelf following the LGM, or (2) it marks the maximum grounding-line extent at the LGM. Although we rather propose, that grounded ice extended all the way or close to the shelf edge during the LGM, we cannot yet exclude the possibility that the GZW marks the LGM limit of grounded ice. Here we specifically point to the size and volume of the GZW, which are more comparable to grounding-line features marking LGM-positions around Antarctica (e.g. in Prydz Bay), and less similar to GZWs deposited during episodic ice-stream retreat (e.g. in Pine Island Trough and Marguerite Trough). In order to test these two formation scenarios for the GZW and constrain the timing and duration of its formation, we will try to obtain additional ages from seasonal-open marine units in cores seaward of the GZW. This will help to decide whether LGM-or older ice was grounded in the basin directly seaward of the GZW.

We will present preliminary interpretations of these data, which will aim to resolve the extent of the WAIS in this sector, provide new information on GZW formation in this trough and, at the same time, contribute an update on the dynamics of West Antarctic palaeo-ice streams, which drained the former ice sheet.

## **PAN-AFRICAN GRANITOID MAGMATISM IN CENTRAL DRONNING MAUD LAND DERIVED FROM A MANTLE SOURCE, NOT A LOWER CRUSTAL SOURCE: EVIDENCE FROM GEOCHEMICAL AND SR-ND ISOTOPE SIGNATURES**

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Dronning Maud Land represents the southern end of the East African-Antarctic orogen (EAAO) that was constructed during the Neoproterozoic collision of parts of East- and West-Gondwana. The orogen spans more than 8000 km from the northern part in present Egypt-Arabia down to present Mozambique and Antarctica. The EAAO shows a strong along strike variation in orogenic styles separated by the E-W-trending Lurio belt in Mozambique with accretion in its northern part and continent-continent collision in the southern part. South of the Lurio belt numerous Pan-African granitoids are observed. Two different models are debated to explain the occurrence of these late-tectonic Pan-African melts (530-485 Ma): (i) SE-directed thrusting of nappes from the combined Damara-Zambesi mobile belt towards Dronning Maud Land [1] explaining the granitoid magmatism via crustal melting through crustal thickening; (ii) extensional tectonics with delamination of the orogenic root [2] explaining the granitoid magmatism by upwelling of hot asthenosphere under a thinned continental crust. We present major and trace element data and Sr-Nd WR signatures of granitoids that constitute an E-W profile along the 72°S-latitude starting from the Mühlig-Hofmann mountains (MH) (4°-7°E) via central Dronning Maud Land (cDML) (8°-14°E) and finally samples from Sør Rondane (SR) (23°-25°E). Most granitoid from MH and cDML show subalkaline ferroan signatures. This coincides with their interpretation as extension-related granitoids in the scheme of Maniar & Piccoli [3]. WR Nd isotope signatures show Paleo- to Mesoproterozoic model ages that, as the oldest zircons found in that area to date are Grenville-aged, are taken as indication for the participation of the subcontinental lithospheric mantle (SCLM) during petrogenesis of these granitoids thus favouring the delamination model. Since the WR Nd signatures further are unrelated to the corresponding SiO<sub>2</sub>-content it can even be proposed that the SCLM represents the source region for the granitoid melts. The situation for the SR granitoids is different as they show calcalkaline magnesian signatures that typically are interpreted in terms of active continental margin derivation. The corresponding TDM (Nd) are Grenville-aged at ~1.1 Ga. We therefore conclude that SR granitoids evolved in a different geodynamic setting and

possibly represent the eastern suture of the EAAO whereas the MH and cDML granitoids are located in an extensional setting probably related to the orogenic collapse of the EEAO. Sr isotope signatures for both regions are similar and show a homogenisation during time of emplacement during Pan-African times. Finally, comparison with samples from the Lurio belt allows to place constraints on paleogeographical position as Mozambiquan late-tectonic granitoids show large similarities with results from MH and cDML, but are different to SR granitoids.

## **ASSESSMENT OF A MODERN POLLEN-CLIMATE CALIBRATION SET FOR ARCTIC TUNDRA AND NORTHERN TAIGA BIOMES FROM EASTERN SIBERIA**

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The Arctic is expected to respond stronger and earlier to future global warming than other regions world-wide. This region is of particular importance because, on the one hand, even humble climate oscillations can be amplified through complex terrestrial ecosystem reactions. On the other hand, Arctic changes may feedback globally via atmospheric and oceanic circulations or variation of greenhouse gas concentrations. Past variations need to be documented with high confidence to gain important insights in constraints and magnitude of predicted Arctic changes. Long-term information can be obtained by analyses of sedimentary archives such as pollen records of lacustrine cores. Reliable climate reconstruction from the warming-sensitive Arctic region are hitherto lacking because a) modern pollen spectra were rarely collected from sedimentary origin, and b) because the obtained reconstructions were not rigorously evaluated.

This investigation aims to establish, evaluate, and apply a modern pollen-climate data set from the transition zone between arctic tundra and light taiga in Arctic Siberia. Our study area is located in the Northern Siberian Lowlands of Yakutia. Lacustrine samples (n=96) were collected along four north-to-south transects, which cover the major vegetation types and span a broad summer temperature and precipitation gradient (TJuly: 7.5–18.8°C; Pann: 114-315mm). Performance of transfer functions for temperature and precipitation were validated and applied to the one lake pollen record, which covers the last 12,000 years and was retrieved in the Siberian Arctic. The application of the models to fossil pollen spectra yielded cold conditions for the Late Glacial period (1-2°C below present TJuly). Warm and moist conditions were reconstructed for the Early to Mid Holocene (2°C higher TJuly than present). Modern conditions were reconstructed for the last 3,500 years.

In conclusion, our regional modern data set fills the gap of existing calibration sets with regard to under-representation of samples from the modern tundra-taiga transition zone and of lake sedimentary origin. Our Holocene climate reconstruction indicates that the Holocene temperature deviation from modern values was only moderate despite the assumed Arctic sensitivity to present climate change.



## **LONG-TERM TRACE GAS RELEASE FROM THAWING PERMAFROST**

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The currently observed Arctic warming will increase permafrost degradation followed by mineralization of formerly frozen organic matter to carbon dioxide (CO<sub>2</sub>) and methane (CH<sub>4</sub>). Despite increasing awareness of permafrost carbon vulnerability the potential long-term formation of trace gases from thawing permafrost remains unclear. Therefore, the release of trace gases from permafrost organic matter was quantified in Holocene and Pleistocene permafrost deposits in the Lena River Delta, Northeast Siberia. CO<sub>2</sub> and CH<sub>4</sub> production was measured for 1200 days in aerobic and anaerobic incubations at 4°C. The derived fluxes were used to estimate parameters of a two pool carbon degradation model. Total CO<sub>2</sub> production was similar in Holocene permafrost (1.3 ± 0.8 mg CO<sub>2</sub>-C gdw<sup>-1</sup> aerobically, 0.25 ± 0.13 mg CO<sub>2</sub>-C gdw<sup>-1</sup> anaerobically) as in 34,000 to 42,000 year old Pleistocene permafrost (1.6 ± 1.2 mg CO<sub>2</sub>-C gdw<sup>-1</sup> aerobically, 0.26 ± 0.10 mg CO<sub>2</sub>-C gdw<sup>-1</sup> anaerobically). The main predictor for carbon mineralization was the content of organic matter. Anaerobic conditions strongly reduced carbon mineralization since only 25% of aerobically mineralized carbon was released as CO<sub>2</sub> and CH<sub>4</sub> in the absence of oxygen. CH<sub>4</sub> production was low or absent in most of the Pleistocene permafrost and always started after a significant delay. After 1200 days on average 3.1% of initial carbon was mineralized to CO<sub>2</sub> under aerobic conditions while without oxygen 0.55% were released as CO<sub>2</sub> and 0.28% as CH<sub>4</sub>. The calibrated carbon degradation model predicted cumulative CO<sub>2</sub> production over a period of 100 years accounting for 15.1% (aerobic) and 1.8% (anaerobic) of initial organic carbon, which is significantly less than recent estimates. The multi-year time series from the incubation experiments helps to more reliably constrain projections of future trace gas fluxes from thawing permafrost landscapes.

## **CRYOSAT-2-VALIDIERUNG IM BLAUEISGEBIET: ERGEBNISSE DER CRYOVEX-KAMPAGNEN 2009 UND 2011**

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Die Radar-Altimeter-Mission CryoSat-2 soll unter anderem Informationen zu Änderungen der Mächtigkeit kontinentaler Eisschilde in Arktis und Antarktis liefern. Damit soll ein wesentlicher Beitrag zur Bestimmung der bisher unzureichend bekannten Eismassenbilanz geliefert werden. Validierungsaktivitäten dienen dazu, die Genauigkeit der aus CryoSat-2-Beobachtungen abgeleiteten Eisdicken und Eismassentrends abzuschätzen. In den antarktischen Saisons 2008/09 und 2010/11 wurden in einem Blau eisgebiet in der Region der Schirmacheroase, Dronning Maud Land, Ostantarktis, Feldkampagnen zur Datenvalidierung durchgeführt (CryoSat Validation Experiment, CryoVEx). Durch seit Jahren wiederholte bodengebundene Eishöhen- und -geschwindigkeitsmessungen im Gebiet ist die langzeitige Eismassenbilanz gut bekannt. Das Blau eisgebiet ist dadurch prädestiniert für Validierungszwecke. Während der CryoVEx-Kampagnen wurden die Eishöhen mittels kinematischem GNSS entlang von Traversen und quasi flächenhaft in ausgewählten Testgebieten (Gitter) bestimmt. Die Langzeitbeobachtungen im Blau eisgebiet konnten so fortgesetzt werden. In der Präsentation werden wichtige Ergebnisse der beiden durchgeführten CryoVEx-Kampagnen in Verbindung mit den zurückliegenden Messungen im Blau eisgebiet vorgestellt. Bis zum Jahr 2008 ließen sich aus den geodätischen Beobachtungen Höhenänderungen von -15..-20cm/a ableiten. Die aus den CryoVEx-Kampagnen bestimmten Höhenänderungsraten zeigen dagegen einen überraschenden positiven Trend gleicher Größenordnung, der vermutlich auf Niederschlagsanomalien im Jahr 2009 zurückzuführen ist. Wiederholungsmessungen innerhalb einer Kampagne liefern saisonale Höhenvariationen des Untersuchungsgebiets. Weiterhin werden die bodengebundenen Ergebnisse mit nahezu zeitgleich durchgeführten flugzeuggestützten Messungen des AWI verglichen (Radar- und Laseraltimeter), die als Zwischenstufe für die Validierung der CryoSat-2-Daten dienen. Schließlich werden die Resultate von ersten direkten Vergleichen mit CryoSat-2-Daten (Level 2) präsentiert.

## **WEDDELL SEA AND GLOBAL CARBON CYCLING: THE ROLE OF THE REFRACTORY DISSOLVED ORGANIC MATTER.**

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Dissolved organic matter (DOM) in the deep sea is of refractory nature with mean residence times of 4,000–6,000 years and it comprises almost 75% of the global ocean organic carbon inventory. Refractory DOM is a long-term buffer in the global carbon cycle but its chemical composition, structure, and biochemical formation and degradation mechanisms are still unresolved. Here, we compiled the so far most comprehensive molecular data set of 197 Fourier transform ion cyclotron resonance mass spectrometry analyses from solid-phase extracted marine DOM covering two major oceans, the Atlantic sector of the Southern Ocean and the East Atlantic Ocean. Molecular trends and  $\Delta^{14}\text{C}$ -dating of 34 DOM samples, ranging from -229 to -495‰, were combined to model an integrated degradation rate for bulk dissolved organic carbon (DOC) resulting in a predicted age of >24 ka for the most persistent DOM fraction. First order kinetic degradation rates for 1,557 mass peaks indicate that numerous DOM molecules cycle on timescales much longer than the turnover of the bulk DOC pool resulting in estimated residence times of >75 ka. In contrast to young DOM, these most persistent compounds encompass only a narrow range of elemental ratios H/C ( $1.17 \pm 0.13$ ), and O/C ( $0.52 \pm 0.10$ ) and molecular mass ( $360 \pm 28$  and  $497 \pm 51$  Da) reflecting the most stable composition in the oceanic environment. In the Southern Ocean, we identified 339 mass peaks which likely contribute to an increased DOC concentration and potentially reflecting an accumulation or enhanced sequestration of refractory DOC.

## **SEARCH FOR VOLCANIC SIGNATURES OF THE TOBA SUPER-ERUPTION RECORDED IN EDML CORE (ANTARCTICA) AND SOUTHERN OCEAN SEDIMENT CORES: IMPLICATIONS FOR ITS CLIMATE IMPACT**

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Large volumes of volcanic ash and volatile can be released to the atmosphere at the time of a volcanic eruption. Sulfuric acid aerosols forming by oxidation of the volcanic SO<sub>2</sub> in the stratosphere disperse to the polar region and are preserved in both polar ice sheets. Atmospheric aerosols absorb solar radiation and thereby have a significant cooling effect on global climate ("volcanic winter", Rampino et al., 1988). Such tephra also introduces instantaneously a large amount of nutrients to soils and oceans. Fertilized surface ocean water promotes phytoplankton photosynthetic activity, an increase in marine primary productivity and phytoplanktonic fixation of CO<sub>2</sub>. It leads to a net removal of CO<sub>2</sub> from the atmosphere into the ocean and enhances cooling (Frognier et al., 2001). Thus, estimation of both, the amounts of the sulfuric acid aerosols, and the distribution and deposition of distal tephra are essential to assess potential climate change following a large plinian eruption.

Toba volcano in Indonesia (2°45' N, 98°45' E) is known for its "super-eruption" that took place in ~74 ka ago, the largest volcanic event in the Quaternary Period. Four distinct sulfate (SO<sub>4</sub><sup>2-</sup>) signals were found in layers dated between 74.0 and 74.8 ka B.P. in ice cores from GISP2, Greenland and EDML, Antarctica. They can be attributed to the aerosols deposited from the Toba eruption.

The amount of the sulfuric acid aerosols ejected into the atmosphere during an eruption can be estimated by glaciological method, assuming that: (1) transport of aerosols is controlled by the atmospheric circulation, (2) the behavior of the volcanic and nuclear bomb-produced aerosols are the same on a global scale all time. We applied the highest peak among the 4 signals to estimate the Toba emission and estimated the emission to ca. 2 Gt. It is 20 times higher than the emission of a historical large eruption of Tambora in 1815 (Indonesia) which lowered the temperature by a maximum of 0.7 °C.

We will, further, search for the Toba ash in marine sediment cores in the Indian Ocean and the EDML ice core, estimate stable isotope ratios of sulfur (<sup>33</sup>S/<sup>32</sup>S, <sup>34</sup>S/<sup>32</sup>S and <sup>36</sup>S/<sup>32</sup>S) that allow to assess high-altitude atmospheric processes, and evaluate the climate response to an extremely large volcanic eruption with the General Circulation Model (GCM) MAECHAM5-HAM.

## **SIND BOHRLOCHTEMPERATUREN IM PERMAFROSTBODEN VERGLEICHBAR?**

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Temperaturmessungen im Permafrostboden sind nicht gerade trivial und stellen ganz besondere Herausforderungen an die Messtechnik.

Die Klimaveränderung im Permafrostboden an Hand der Temperatur nachzuweisen, stellt eine große Herausforderung dar und ist auch zu einer Schlüsselposition geworden.

Allerdings muss man schon unterscheiden, wo diese Temperaturen gemessen werden. Im Gebirgspermafrost ist meistens eine gute Überwachung der Messeinrichtungen gegeben, kann kontrolliert werden und wenn nötig auch geeicht. Das gleiche gilt auch, wenn in unmittelbarer Nähe einer Forschungsstation, wie z.B. in Barrow, Alaska gemessen wird.

In den letzten Jahren konnten erfreulicherweise immer mehr tiefere Bohrungen im Permafrost Sibiriens, Kanadas und Alaskas durchgeführt werden, um Bohrkerne zu gewinnen.

Diese Bohrlöcher waren natürlich auch sehr gut geeignet, um sie anschließend mit Thermoketten zu instrumentieren.

Hier stellt sich eine ganz andere Situation dar, weil die Messtechnik mindestens ein Jahr (meistens noch länger) völlig autark arbeiten muss, ohne jegliche Kontrolle. In Sibirien sind die höchsten Anforderungen der Technik zu erfüllen. Die meisten Wissenschaftler schauen nur auf den Sensor, den sie benutzen und verlassen sich bei der Messwerterfassung auf den Hersteller mit seinen Angaben. In Sibirien haben wir es mit Temperaturen von  $-55^{\circ}\text{C}$  bis  $+30^{\circ}\text{C}$  zu tun, also einer sehr große Spannweite. Kein Hersteller gibt einen Temperaturkoeffizienten (TK) für seinen Datenlogger bis  $-50^{\circ}\text{C}$  an. Aus Herstellersicht ist es sogar verständlich, weil es ein sehr großer Aufwand ist. Für die Sensoren (PT100 /PT1000) lassen sich durchaus solche Angaben finden. Die Temperaturveränderungen im Permafrostboden sind sehr klein, je tiefer gemessen wird. Aber gerade diese Messwerte sind sehr interessant, um festzustellen, ob der Bodenkörper sich als Ganzes verändert und nicht nur an der Oberfläche. Diese zu erfassen stellt aber die höchsten Anforderungen, an die Messwerterfassung. Ein Bohrloch im Permafrostboden nieder zu bringen, ist eine kostspielige Angelegenheit. Umso unverständlicher ist es, dass dann ausgerechnet an der Messtechnik gespart wird. Fast jeder favorisiert sein System, unterschiedlicher kann es nicht sein. Um die Temperaturmessungen auch mit mehreren Bohrlöchern zu vergleichen, sollte eine internationale Standardisierung

geschaffen werden z.B. bei der IPA (International Permafrost Association), mit einigen folgenden wichtigen Kriterien:

Die komplette Messwerterfassung (nicht nur der Sensor) sollte von einem zertifiziertem Institut oder Firmen geeicht werden bis  $-50^{\circ}\text{C}$  über mehrere Eichpunkte und ein TK erstellt werden. Das kann durchaus teurer sein als der verwendete Datenlogger.

Eine Quantisierung der Analog-Digital-Wandler sollte vorgegeben werden, um kleine Änderungen überhaupt zu erfassen. Mit welcher Genauigkeit sollte bzw. muss relativ gemessen werden? Die zu erwartenden Veränderungen betragen nur wenige Zehntel Grad  $\text{C}^{\circ}$  Änderung.

Der Abstand der Temperatursensoren sollte einheitlich sein mit Angabe der Tiefe.

Wie sollte das Bohrloch befüllt sein? (Luft, Sand , Erdreich)

Wie erfasse ich den Alterungsprozess der eingesetzten Messtechnik? Dieser Fehler ist nicht zu vernachlässigen bei Langzeitmessung.

Fehlen all diese Angaben in den Publikationen, dann lassen sich die gemessenen Temperaturwerte von verschiedenen Bohrlöchern nur sehr schwer vergleichen. Einen Temperaturtrend lässt sich durchaus nachweisen, aber eine genaue Größenordnung erfordert schon etwas mehr Aufwand. Diese Daten werden aber auch für die Modellierung gebraucht.

## **VERÄNDERUNGEN DER KÜSTENNAHEN EISKAPPE IM SÜDLICHEN GRÖNLAND**

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Seit 2002 wird im südlichen Grönland ein geodätisches Programm zur Überwachung von Volumenänderungen der Eiskappe realisiert. Insgesamt viermal, 2002, 2006, 2010 und 2012, fanden Feldkampagnen statt. Mittels präziser GNSS-Messungen konnten über ein Jahrzehnt hinweg Eishöhenänderungen entlang einer ca. 700 km langen Traverse über das Inlandeis mit einer Genauigkeit von 2-3 cm/a bestimmt werden.

Dabei ist in den letzten Jahren ein deutlicher Anstieg des Eisrückgangs insbesondere im Randbereich zu beobachten. Für den mittleren Teil der Traverse in Höhen über 2000 m ist eine direkte Interpretation der Höhenänderungen als Eismassenveränderungen schwierig, da größere Mengen des Schmelzwassers versickern und wieder gefrieren. Anders als noch vor 5 Jahren, sind daher die sommerlichen und winterlichen Akkumulationen kaum noch zu unterscheiden, da beide mit einer Vielzahl von Eishorizonten durchsetzt sind. Die Höhenänderungen liegen hier aber in einer Größenordnung von weniger als einem Dezimeter jährlich, so dass diese Unsicherheit in der Gesamtbilanz keine wesentliche Rolle spielt.

In den Küstennahen Bereichen ist am Ende des Sommers die Schneeauflage komplett abgeschmolzen. Die Höhenänderungen können dort direkt als Volumen- und Massenverluste angesehen werden. Bemerkenswert ist, dass die Ablationszonen an der Ost- und Westseite der Eiskappe starken Veränderungen unterworfen sind. Die Ausdehnung hat sich im letzten Jahrzehnt mehr als verdoppelt. Aktuelle Auswertungen von Fernerkundungsdaten, z.B. von LandSat-Szenen, zeigen ein weiteres Fortschreiten dieses Prozesses. Im Einzugsgebiet Gletschers Sermeq Kujalleq (Ilulissat Icefjord) ist der schneefreie Randbereich in 10 Jahren von etwa 30 auf ca. 90 km angewachsen. Zusätzlich haben die Schmelzwassersysteme und -seen ihre Ausdehnung und signifikant vergrößert.

Die Traverse folgt einer historischen Route, die 1912 von einer schweizerisch-deutschen Expedition unter der Leitung des Meteorologen Alfred de Quervain erstbegangen wurde. Es war damals die erste geowissenschaftliche Expedition über das Inlandeis hinweg, bei der auch umfangreiche geodätische Messungen eingeschlossen waren. Es ist möglich, die Höhendaten von 1912 mit denen, die 100 Jahre später gewonnen wurden, direkt zu vergleichen. Auch unter Beachtung der relativ geringen Genauigkeit der historischen Höhenbestimmungen, die zwischen 3 und 10 m liegt, ist dieser Vergleich interessant und aussagekräftig. Begünstigend ist dabei, dass die barometrischen Höhenbestimmungen von 1912 besonders im interessanten Randbereich, also nahe an den Referenzstationen, eher 3-5 m genau sein dürfte. Im Sommer 2012 wurde daher der östliche Randbereich der Traverse

genauer betrachtet. Auf einem etwa 120 km langen Abschnitt der historischen Route wurden an identischen Punkten und entlang eines identischen Profils Höhenbestimmungen vorgenommen.

Die Höhendifferenzen liegen, unter Beachtung der erreichbaren Genauigkeiten, zwischen 0 (oberhalb 2000 m Höhe) und -130m in etwa 20 km Abstand zum Rand der Eiskappe. Dabei muss davon ausgegangen werden, dass die Höhenänderungen in den 100 Jahren nicht gleichmäßig verlaufen sind, sondern vor allem in den letzten 2-3 Jahrzehnten stattgefunden haben. Da aktuell eine deutliche Beschleunigung des Abschmelzens zu beobachten ist, muss für die kommenden 100 Jahre mit einem deutlich größeren Massenverlust gerechnet werden. In den vergangenen 4 Jahren haben sich die negativen Höhendifferenzen in diesem Bereich der Eiskappe etwa vervierfacht.

Wegen logistischer Probleme konnte 2012 leider der westliche Randbereich, in dem nicht nur die eigenen und die Daten von 1912 vorliegen, sondern auch die Ergebnisse der EGIG-Traversalen, nicht untersucht werden. Daher sind zukünftig weitere Feldarbeiten im Einzugsgebiet des Ilulissat Icefjord vorgesehen.



## GENETIC CHARACTERISTICS OF *DESCHAMPSIA ANTARCTICA* IN CONTEXT OF ITS ORIGIN HISTORY

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Regardless of the vast variety of studies concerning characteristics of Antarctic endemic fauna, its particular moment and vector of its distribution within the region remains still uninvestigated. It became clear recently that the solution should be acquired through the phylogenetic studies via molecular methods. We performed the comparative analysis of RAPD-markers for polymorphism and 18S-25S nuclear rDNA ITS1-ITS2 data for 15 plants of *Deschampsia antarctica* from the region of the Argentine Islands and Point Thomas oasis at King George Island.

The comparative study of ITS1-ITS2 shows that at least three different groups of *D. antarctica* are currently present in the Antarctic. The majority of *D. antarctica* populations are very close to the similar species in South America because the difference between the samples from Tierra del Fuego and Falkland Islands is only one mutation in ITS2 gene. We could not establish any well-defined distinction between plants from King George Island and the Argentine Islands. Moreover, three Antarctic populations contain an evolutionarily novel ITS variant, but it remains unclear if the corresponding mutation appeared before or after their immigration to the Antarctic. One sample, which contains ITS variant of independent origin, was found on King George Island. This unique form probably originated from an independent immigration event.

Possible reasons for such picture might be: 1. A later colonization by the latter and the founder effect. This might suit the hypothesis well in accordance with the findings of a unique ITS1-ITS2 variant on King George Island, which indicate that the gene pool of this metapopulation had been forming based on a more diverse material as a result of crossing between plants having different origins. 2. The more inclement conditions of the Argentine archipelago (this region is 330 km farther away from the equator) with the resulting more intensive selection or periodic population decreases – the more decreased genetic heterogeneity should be expected. It should be noted,

that like other studies, our methods showed low heterogeneity of *Deschampsia*. However what does such heterogeneity show? It is commonly said that is an evidence for early introduction of species into the region, as the conformable genetic heterogeneity is shown for true relict plants using the same methods.

Withal the mean pairwise Jaccard genetic distance ( $D_j$ ), % acquired using the RAPD - 2,9, for 10 plants out from both regions was compared with the same parameter for other PCR marker: ISSSR (12,2) , RGAP (3,1), LP-PCR (11,6), IRAP (9,8). The consequences of such comparison testify for deliberation of so called "Low genetic heterogeneity" of Antarctic plants, acquired using any single molecular-genetic method.

We express our gratitude to the National Antarctic Scientific Center of the State Agency for Science, Innovation, and Information of Ukraine. This study was done under the contract between the National Antarctic Scientific Center and the Institute of Molecular Biology and Genetics NAS of Ukraine # H/3-2011 "Development of a bioindicator system of climate change in coastal Antarctica based on the dynamics of terrestrial plant cenoses" (2011-12), as well as a joint project between the NAS of Ukraine and Polish Academy of Sciences: "Ecological and genetic basis of plants adaptation to extreme environments" (2012-14).

## **KOCH / WEGENER EINE DENKWÜRDIGE FORSCHUNGSREISE QUER DURCH NORDGRÖNLAND, 1912/13.**

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Der Geodät Johan P. Koch (1870-1928) und der Geophysiker Alfred Wegener (1880-1930) hatten sich während der dänischen Nordostgrönland-Expedition (1906-08) angefreundet, deren Leitung Koch übernahm, nachdem der Initiator des Unternehmens, Ludvig Mylius-Erichsen (1872-1907) ab 1907 verschollen blieb. Während der zweimaligen Überwinterung in Danmarkshavn schmiedeten die Herren Pläne für künftige Forschungsreisen. Neben einer favorisierten Reise in die Antarktis wurde auch die Querung Grönlands auf der Breite um 77°N diskutiert. Diese Idee, die schon von Mylius-Erichsen diskutiert worden war, konnte dann durch die Initiative von Koch verwirklicht werden. Aber auch Wegener konnte finanzielle Mittel beisteuern.

Die Reise ist durch drei Tagebücher dokumentiert; und wenn Else Wegener die Aufzeichnungen ihres Mannes, die in erst 1961 in Buchform erschienen, als Tagebuch eines Abenteuers überschrieb, traf sie damit den Nagel auf den Kopf.

Der Grönlandquerung wurde mit einer Überwinterung am Rande des Inlandeises eingeleitet. Alleine das Erreichen dieses rund 100 km von der Küste entfernten Ortes war von erheblichen Anstrengungen und lebensgefährlichen Ereignissen geprägt, die aber durch die 1000 km lange und drei Monate dauernde Querung noch übertroffen wurden.

Die wissenschaftlichen Ergebnisse der Reise erschienen erst 1930. Der Vortrag thematisiert sowohl den logistischen Aufwand und den Ablauf als auch den wissenschaftlichen Hintergrund des Unternehmens.

## **A MECHANISM OF ICE-GROWTH INHIBITION BY AFPS**

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Antifreeze proteins (AFPs) are surface-active molecules and inhibit the ice-crystal growth during the freezing process. They interact with the diffusive water/ice interface and prevent a complete solidification. Microstructures evolve as a result of the phase separation in the presence of AFPs. The thermodynamics of pure water-ice phase transition is modified by the inhibitory effect of AFPs on the ice formation which mechanism is still debated. We apply a Ginzburg-Landau type approach to describe the phase separation in the two-component system (ice, AFP). The free energy density involves two fields: one for the ice phase with low AFP concentration, and one for the liquid water with high AFP concentration. Two coupled partial differential equations describe the time evolution of the phase field (ice) and the second field (AFP). We compute the interfacial energy from kink solutions to determine the modification of the surface tension. The AFPs lower the surface energy and allow less stable critical nucleus sizes to be formed for the ice crystal. Furthermore they block the adsorption of water molecules and stop the further growth of ice grains.

## **CH<sub>4</sub> AND CO<sub>2</sub> EXCHANGE FLUXES OF SIBERIAN POLYGONAL TUNDRA: EDDY COVARIANCE MEASUREMENTS AND MODELLING**

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Permafrost-affected soils are estimated to contain up to 1700 Gt organic carbon which equals about 2.5 times the carbon pool in the global vegetation. The currently observed warming of the Arctic will probably increase permafrost degradation followed by microbial mineralisation of organic carbon to carbon dioxide (CO<sub>2</sub>) and methane (CH<sub>4</sub>). Here, we present eddy covariance measurements and empirical modelling analyses of CO<sub>2</sub> and CH<sub>4</sub> fluxes from polygonal tundra in the Lena River Delta, northern Siberia (72°22' N, 126°30' E). The study site is characterized by a polar and distinctly continental climate, very cold and ice-rich permafrost, and its position at the interface between the Eurasian continent and the Arctic Ocean. The soils at the site are characterized by high organic matter content, low nutrient availability and pronounced water logging. The vegetation is dominated by sedges and mosses. Flux measurements were performed during different periods since 2003, covering shoulder seasons, peaks of several growing seasons, early winter, and one entire season in 2006. The main carbon exchange processes – gross photosynthesis, ecosystem respiration, and CH<sub>4</sub> emissions - were generally found to be of low intensity. Over the 2004/2003 growing season (June-September), the downward CO<sub>2</sub> flux due to gross photosynthesis accumulated to -9.8 mol m<sup>2</sup>, the upward CO<sub>2</sub> flux due to ecosystem respiration to +7.5 mol m<sup>2</sup>, and the net CH<sub>4</sub> flux to +0.125 mol m<sup>2</sup>, respectively. Day-to-day variations of photosynthesis were mainly controlled by radiation fluctuations related to the synoptic weather conditions. Variations of ecosystem respiration were best explained by an exponential function of surface temperature, which indicates that plant respiration plays a major role within the tundra carbon balance. The factors controlling CH<sub>4</sub> emissions were found to be soil temperature, near-surface atmospheric turbulence and air pressure variations. The influence of atmospheric turbulence was attributed to the high coverage of open water surfaces in the tundra. For the 2003-2004 investigation period, winter fluxes were modelled based on interpolation between early winter and late winter measurements. According to this approach, the polygonal tundra of the Lena River Delta is still a robust carbon sink of about -1.4 mol m<sup>-2</sup> yr<sup>-1</sup> with CH<sub>4</sub> emissions accounting for 14 % of the annual ecosystem carbon balance. In the presentation, we will present new CO<sub>2</sub> and CH<sub>4</sub> flux datasets from 2010 to 2011 which will be used to assess inter-annual variability in the greenhouse gas balance of the polygonal tundra.

## **30 JAHRE GONDWANA-STATION DER BGR**

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Die Antarktis ist ein zu ca. 98 % von Eis bedeckter Kontinent, der nur an wenigen Stellen der direkten geologischen Untersuchung zugänglich ist. Er wird vom Transantarktischen Gebirge, der größten Gebirgskette der Erde, durchzogen. Das Nord-Viktoria-Land, wo die Bergketten weit aus dem Eis heraus ragen, mit dem angrenzenden Ross-See ist das regionale Schwerpunktgebiet der Landgeologie und Landgeophysik der BGR. Dort führt die BGR seit 1979 mit ihrem GANOVEX-Programm (German Antarctic North Victoria Land Expedition) geowissenschaftliche Untersuchungen durch, zuletzt im Südsommer 2009/10. Die BGR unterhält im Nord-Viktoria-Land zwei Landstationen. Während GANOVEX I wurde im Januar 1980 eine Biwak-Hütte am Lillie Glacier, die Lillie-Marleen-Hütte, errichtet. Diese Hütte wurde während der XXVIII. Antarktis-Konsultativtagung (ATCM) 2005 in Stockholm als erste deutsche "Antarctic Historic Site and Monument" anerkannt. Die Gondwana-Station der BGR liegt am Gerlache Inlet der Terra-Nova-Bucht des Rossmeeres. Sie wurde während GANOVEX III im Januar 1983 installiert und war zunächst eine einfache Biwak-Hütte wie die Lillie-Marleen-Hütte. Während GANOVEX V (1988/89) wurde sie zur Sommerstation ausgebaut. Die Gondwana-Station ist per Schiff oder mit dem Flugzeug erreichbar, die auf dem Meereis in der Terra-Nova-Bucht landen können. Sie ist jedoch prinzipiell auch mit Hercules-C-130-Flugzeugen über den Browning Pass zu erreichen. Dort waren während GANOVEX IV (1984/85) auch die beiden Polarflugzeuge Polar-2 und Polar-3 des AWI stationiert. Die Terra Nova Bucht stellt einen der wenigen, für einen Stationsbau geeigneten Plätze entlang der Rossmeerküste dar. Ausgedehnte, von der Küste flach ansteigende Schotterterrassen, die zudem oft früh in der Saison schneefrei und gegen die katabatischen Winde vom polaren Plateau relativ gut geschützt sind, bieten hierfür ideale Bedingungen. Dies ist auch einer der Hauptgründe, warum in der Nachbarschaft zur Gondwana-Station in der Antarktis-Saison 1986/87 auch die italienische Station „Terra Nova Bay“ (heute „Mario Zucchelli“) errichtet wurde. Ebenso hat jüngst Südkorea nur etwa 1-2 km von der Gondwana-Station entfernt mit dem Bau ihrer neuen Überwinterungsstation „Jang-Bogo“ begonnen, die in der Saison 2014/15 fertig gestellt werden soll. Das Hauptgebäude der Gondwana-Station besteht aus sechzehn miteinander verbundenen 20-Fuß-Containern. Es umfasst Reparatur-, Aufenthalts- und Arbeitsräume, eine Küche, sanitäre Einrichtungen, eine Generatorstation und eine Seewasser-Aufbereitungsanlage. Die Station verfügt über eine kleine biologische Abwasserreinigung. Damit versuchte die BGR bereits vor Inkrafttreten des Umweltschutzprotokolls zum Antarktisvertrag einen Maßstab für umweltbewusstes Verhalten in der Antarktis zu setzen. Die Gondwana-Station diente während zahlreicher Expeditionen der BGR in Nord-Viktoria-Land als Hauptbasis, zuletzt während GANOVEX X (2009/10). Nach Rücksprache mit der BGR kann die

Gondwana-Station auch anderen Arbeitsgruppen zur Verfügung gestellt werden. So wurde sie in den beiden Antarktis-Saisons 2006/07 und 2007/08 durch das neuseeländische Antarktisprogramm genutzt. Im Augenblick bereitet die BGR umfassende Renovierungs- und Modernisierungsarbeiten an der Station vor, die ab 2014/15 durchgeführt werden sollen.

## **SECHS JAHRE COOLE KLASSEN – WAS WURDE ERREICHT, WIE GEHT ES WEITER?**

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Die deutschen Schulen sind weitgehend von aktuellen Forschungsarbeiten abgekoppelt, und eine Schnittstelle zwischen Wissenschaft und schulischer Bildung existiert nicht. Dies trifft oder traf insbesondere auf die gesamte Bandbreite der Polarforschung zu. In Lehrplänen und Curricula werden die Polargebiete wenig und wahllos berücksichtigt. Im Vorfeld des Internationalen Polarjahres 2007/09 entstand vor diesem Hintergrund die Idee eines fächer- und länderübergreifenden Projekts, das die aktuellen Fragestellungen, Forschungsmethoden und –ergebnisse an die Schüler heranträgt.

Die Umsetzung dieser Idee verlangte weitere Kreativität, um auftauchende Hürden zu überwinden: Die Förderung durch die Robert-Bosch-Stiftung musste auf den Weg gebracht und Kontakte zur Wissenschaft aufgebaut werden. Eine Herausforderung ist es weiterhin, Lehrkräfte in ganz Deutschland zu erreichen.

Die Einbindung des Projektes im IPY erlaubte die Vorstellung der Idee in der Deutschen Kommission für das Internationale Polarjahr und führte zu deren Unterstützung, die sich in der Bereitstellung von Expeditionsplätzen für Lehrkräfte durch das AWI, der BGR und schließlich des IfB bei voller Kostenübernahme ab Expeditions-Startpunkt ausdrückte.

Was wurde erreicht:

Seit 2007 existiert das bundesweite Netzwerk aus polarinteressierten Lehrkräften unterschiedlicher Fächer wie Geographie, Biologie, Physik, Chemie und Sozialwissenschaften, das seitdem ständig weiter wächst und heute über 200 Mitglieder zählt, die Ideen und Materialien austauschen. Von der Grundschule bis zum Gymnasium sind alle Klassenstufen und viele Schulformen eingebunden. Die beteiligten Lehrer wirken als Multiplikatoren und führen ihre Schüler an faszinierende Themen der Polarforschung heran. Dabei erreichen sie nicht nur ihre eigenen Schüler, sondern auch die anderer Schulen. Die Initiativen und Aktivitäten der Polarlehrer sind in einer groben Übersicht:

- Polartage an Schulen
- Virtueller Unterricht aus Arktis und Antarktis
- Ein Modell der Neumayer-Station III im Maßstab 1:50 incl. Hydraulik
- Fachdidaktische Forschungsarbeit zum polaren Alltagswissen von Schülern
- Schülerprojekte
- Künstlerische Wettbewerbe für Schüler
- Kontakte zu Schulen in Polargebieten
- Besuche von jungen Menschen aus den Polargebieten an deutschen Schulen



- Publikationen
- Entwicklung von museumspädagogischen Angeboten

#### Webseite

- Beteiligung an Forschungsprojekten
- Expeditionsteilnahmen (AWI, BGR, IfB)
- Fortbildungsangebote für Lehrkräfte
- Begleitung und Beratung externer Kollegen oder Schulen bei der Durchführung von Projekten zu polaren Themen
- Vorstellung des Projekts bei großen Veranstaltungen mit vielen Lehrkräften

Neben der Vermittlung allgemeiner, nichtsdestoweniger meist unbekannter Grundlagen zu den Polargebieten, wurde folgende spezielle Themenfelder durch Lehrer an Schulen vermittelt: Physikalische Ozeanographie, Meeresbiologie, Geowissenschaften wie Geophysik oder Geologie.

Regelmäßige Aktivitäten des AK sind:

- Der Newsletter, mit dem Publikationen, besondere Angebote für Schulen, Fortbildungsveranstaltungen oder Ausschreibungen für Expeditionen gestreut werden.
- Die arbeitskreisinternen Fortbildungen, von denen bisher sechs Meetings/AK-Treffen durchgeführt wurden.
- Besuch der Internationalen Polartagungen und anderer Polartagungen (Oslo, Montreal, PEI).
- Die Teilnahme von Lehrern an Polarexpeditionen.

Wie geht es weiter:

Das Bewährte wie Newsletter, AK-Treffen, Expeditionsteilnahmen und Publikationen werden auch zukünftig etabliert sein. Schwerpunkte in der Weiterentwicklung bilden externe Lehrer-Fortbildungen, das Einwerben neuer Fördergelder und das Voranbringen der Publikationen. Neue Ideen und Initiativen, die die Einbindung von SchülerInnen und Lehrkräften fördern sowie unser Netzwerk erweitern, sind willkommen. Der Kontakt zu WissenschaftlerInnen, die sich für die junge Generation engagieren wollen, soll ausgebaut und intensiviert werden.

Der AK bietet die Möglichkeit, sich im Rahmen der Lehrplanvorgaben und darüber hinaus effektiv für die Polargebiete einzusetzen. Die bisher im Rahmen von Coole Klassen durch engagierte Lehrer und Lehrerinnen realisierten Projekte sind äußerst vielfältig, wodurch das Projekt breit aufgestellt ist. Das Engagement und die Breitenwirkung von Coole Klassen führte schließlich zur Gründung des AK Polarlehrer in der DGP 2008, unter deren Dach das Projekt eine Heimat gefunden hat. Der AK Polarlehrer ist für jeden interessierten Lehrer offen. Er und damit Coole Klassen leben von der Initiative, der Begeisterungsfähigkeit und dem Durchhaltevermögen einzelner „polarbesessener“ Menschen, die sich für die für unsere Gesellschaft bedeutenden Gebiete engagieren und die eine Schnittstelle zwischen Schule und Wissenschaft aufbauen.

Kooperationspartner:

AWI, BGR, Robert Bosch Stiftung, DGP, IfB

## **VARIABILITY OF SEA-ICE AND UPPER MIXED LAYER HYDROGRAPHY IN THE SUBARCTIC NORTH PACIFIC DURING THE LAST 16,000 YEARS AND POTENTIAL RELATIONS TO POLAR NORTH ATLANTIC ENVIRONMENTAL CHANGES**

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The World's subpolar oceanic regions constitute key areas that can contribute to understanding past and future climatic changes in the „classic“, high-latitude polar oceans. The subarctic marginal seas of the North Pacific, in particular, possess characteristics such as recurring seasonal sea ice cover, high sensitivity to heat flux and riverine freshwater forcing, or high primary production that make them suited candidates for comparisons to Arctic regions under warmer than present climates with non-permanent ice covers. In addition, these subarctic regions themselves have been receiving increased attention recently due to rapid environmental changes over the past decades with decreases in sea ice extent and duration, or oxygen supply and productivity anomalies that are unprecedented in the instrumental record [1-4]. However, knowledge about the past climatic and oceanographic variability in the subarctic North Pacific and its marginal seas is limited. Few high-resolution datasets exist, with spatial and temporal coverage being insufficient to gain a detailed picture of past variations.

We here report new results from key sediment records in the Okhotsk Sea. Our cores were recovered from water depths between 650 m and 1000 m off the East Sakhalin continental margin, a region that is directly fed by the sediment discharge of the Amur drainage and seasonal sea ice transport of lithogenic materials. In addition, high biological productivity by calcareous and bio-siliceous plankton is a main contributor to the depositional environment. Based on a coherent, AMS 14C-derived stratigraphic framework, the high sedimentation rates in the selected cores (60-200 cm/kyr) enable us to decipher rapid climatic changes on interdecadal to millennial time scales over the last glacial–interglacial transition and the Holocene. We use IRD counts, coarse fraction content and magnetic susceptibility as indicators of ice transport, while XRF-scanning provides elemental distributions that serve as indicator for riverine vs. sea ice supply. Stable isotope data from planktic foraminifera species *Neoglobobulimina pachyderma* (sin.) and *G. bulloides* provide complementary information about surface and mixed layer hydrography on a slightly lower resolution. Planktic oxygen isotope data suggest a high variability in the formation of water masses on the Sakhalin margin, linked to large fluctuations in the discharged Amur's

freshwater volume, that influences the stratification of local surface water masses and the formation of sea ice. Isotope and IRD proxy data show a principal shift in the upper mixed layer around 4.5 kyr BP, with increased sea ice action and a warming/freshening during the late Holocene. This significant shift of climatic baseline conditions into a different state at 4.5 kyr BP was accompanied by changes towards higher frequency/amplitude variations in our proxy series and is likely linked to established global mid-Holocene reorganisations of climate forcing factors [e.g. 5, 6].

On shorter timescales, our results record the millennial-scale deglacial Younger Dryas stadial and warm Bølling-Allerød interstadial phases with good temporal resolution. In addition, we trace for the first time about six rapid short centennial-scale cold events in the early Holocene around 11.3, 10.9, 10.2, 9.8, 8.2 and 7.6 cal. kyr BP in the Pacific subarctic region [e.g. 7, 8]. These cold spells have been previously reported from various Greenland ice core and Polar North Atlantic records, with some being attributed to freshwater discharge events from disintegrating Northern Hemisphere ice sheets [9, 10]. Our results indicate that resulting climate anomalies are not restricted to the North Atlantic/Arctic realm, but can be traced over long distances to Siberia and the Pacific Far East, and are expressed in increased sea ice action, IRD transport and cold mixed layer anomalies. We hypothesise that atmospheric circulation anomalies similar to a long-term expression of an NAO/AO Northern Hemispheric pattern are likely drivers of wintertime cold spells over the subarctic North Pacific by influencing the Aleutian Low/Siberian High strength and/or location, thus forming an effective tele-connection pattern analogue to those observed on shorter, instrumental timescales.

## **THE SEDIMENTARY ARCHITECTURE OF POLAR BEACH RIDGES - IMPLICATIONS FOR RECONSTRUCTION OF PAST CLIMATE VARIATIONS (KING GEORGE ISLAND, WEST ANTARCTIC PENINSULA)**

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Sedimentary architecture and development of polar beaches are poorly known. Controlling factors on beach-ridge development are waves, sea-level, and sediment supply. As all of these react on climatic changes beach ridges bear the potential to host a valuable record of climate variations. Based on geophysical and sedimentological data, this study aims to decipher the internal architecture of polar beach systems, to reconstruct the processes that lead to their development, and to evaluate their potential as climate archive. It is shown that the internal architecture of beach ridges record the local wave run-up height during the period of ridge development. This archive is best developed at sheltered coasts where more ridges develop in the same period than at exposed coasts.

Beach-ridge systems along the coasts of Potter Peninsula (King George Island, West Antarctic Peninsula) are investigated using ground-penetrating radar (GPR) and sedimentological methods in an integrated approach. A time frame for the interpretation of beach development is provided by AMS radiocarbon dating of shells, seaweed, and organic sediment recovered from the ridges.

GPR data show that Holocene beach sediments have a maximal thickness of 5 m, and unconformable overlay moraine deposits and volcanic rocks. Beach ridges develop on top of the prograding beach sequence. They consist of poorly sorted gravel with a sandy matrix and are formed by multiple storms. Ridges terminate on the seaward side with an erosional unconformity and are separated from each other by the seaward dipping beds of the prograding beach. Local reduction of accommodation space or stronger storm impact at exposed settings lead to ridge amalgamation. With regard to the active berm, contemporaneous ridges are situated at the same elevation throughout the working area. However, sheltered coast segments are characterized by numerous small ridges (which cluster around the given elevation), whereas exposed coasts exhibit fewer but larger composite ridges. In sheltered areas, the sedimentary ridge architecture allow to distinguish two beach-ridge types: Type I ridges show seaward dipping internal beds interpreted to result from swash deposition; Type II ridges are characterized by an aggradational bedding pattern as the result of wave overtopping. Ridge types are interpreted to reflect different wave run-up heights with Type I run-up height  $\leq$  ridge height and Type II run-up height  $\geq$  ridge height. At exposed beaches, differentiation between Type I and Type II ridges is not possible due to ridge amalgamation and formation of composite ridges. These ridges, classified as Type III, show geometrical characteristics of both, Type I and II. In addition, washover fans usually develop on the landward side of Type III ridges, indicating wave run-up heights  $\gg$  ridge height.

## **THE FUTURE OF POLAR SCIENCE**

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The International Polar Year has been a great boost to polar science. International coordination, collection of valuable data sets, intensified outreach to the public and education has created increased awareness for polar issues in society. A major new development of the IPY is the inclusion of the Humanities. Efforts are now underway to maintain the high level of polar research as we are all aware that climate change will affect the high North and parts of Antarctica more severely than the rest of the world. In many countries strategic plans for polar science are being developed and SCAR initiates a "Horizon Scan Activity" to capture the vision for future polar science. In Germany the Ministry for Science and Education (BMBF) jointly with the German SCAR/IASC Committee published a strategic plan for Arctic research focusing on 6 major topics. Antarctic research in Germany is so far only supported via the German Science Foundation (DFG) and the AWI, but should also be underpinned by an Antarctic science strategy. Ideally, a new Polar Research Strategy of the German Government should be developed encompassing the bipolar approach of German polar science.

A way into the future of polar science should focus on some new aspects: a) Natural science and humanities need to collaborate on an equal footing as the research questions gain more and more socio-economic relevance. Fields of science outside the 'normal' polar science need to be explored. b) Observations of both Polar Regions have to be improved by new technologies in order to provide much needed data for model development. It should include year round, automated observations in the sea and on the ground to complement satellite measurements. These data need to be easily accessible. c) International coordination of polar infrastructure is required to improve access to the remote Polar Regions for all scientists and to use the available infrastructure most effectively. It is suggested that this is a task for the Horizon 2020 programme of the EU.

## **FROM BASIN TO MOUNTAINS: THE UPLIFT OF THE SHACKLETON RANGE**

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The Shackleton Range is situated between 80° – 81°S and 19° – 31°W where it forms the continuation of the Transantarctic Mountains to the Weddell Sea sector. Regional geological architecture comprises Precambrian igneous and (meta-) sedimentary rocks of an Early Paleozoic nappe stack and post-orogenic red beds. The nappe stacking was a consequence of the collision of East and West Gondwana. The uplift and exhumation history of the Shackleton Range has been analysed via thermochronological methods, especially fission track analysis. Fission track data refer to cooling temperatures of 230° – 350°C (zircons) and 60° – 110°C (apatites), respectively. Zircon ages from vertical sample profiles in the Shackleton Range vary between ~160 to 210 Ma, while apatite ages range from ~95 to ~170 Ma (Schäfer, 1998; Lisker et al., 1999). Originally, these data and associated proxies have been interpreted qualitatively in terms of two cooling/ exhumation stages during Jurassic and mid-Cretaceous times.

However, the recognition of volcanoclastic rocks associated with the ~180 Ma Ferrar event in the vicinity of the sample locations (Buggisch et al., 1994) challenges this exhumation concept. The superficial position of these sediments in Jurassic times and the accumulation of much younger fission track ages is in rigorous contradiction within a continuous cooling concept.

New fission track proxy data and first apatite (U-Th-Sm)/He ages (referring to cooling to temperatures of 40° – 80°C) were generated within DFG grant LI 745/15-1 to develop a new exhumation scenario. (U-Th-Sm)/He ages of 88 – 171 Ma are only little younger than fission track ages of the same samples. Tentative thermal history modelling of the combined thermochronological data suggests early Mesozoic cooling followed by (post) Jurassic re-heating. Final cooling to surface temperatures occurred since the Late Cretaceous. This scenario requires burial of the Shackleton Range region, and thus the existence of a sedimentary basin. Subsequent basin inversion then triggered isostatic compensation associated with uplift. The thickness of the now vanished sedimentary strata did unlikely exceed 2 – 3 km. Future work includes additional apatite fission track analyses to quantify geometry, depth and timing of this depocentre and the evaluation of potential links with the coeval basin (system) along the Transantarctic Mountains and/ or similar settings in Dronning Maud Land (e.g., the Heimefrontfjella).

## **ADOLPH ERMAN UND SEIN BEITRAG ZUR ERFORSCHUNG DES ERDMAGNETISMUS DER ERDE**

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Adolph Erman (1806–1877), der in den Jahren 1828–1830 eine Umsegelung der Welt unternommen hatte, ist heute wenig bekannt. Seine wissenschaftliche Tätigkeit war in großem Maße mit Russland verbunden. Die von ihm gesammelten Angaben über den Geomagnetismus, die Geologie, die Geografie und die Meteorologie Ost-Sibiriens sowie seine ethnografischen Untersuchungen wurden seinerzeit zum wichtigsten Grundlagenmaterial über die Naturverhältnisse und das Leben der Menschen in Ost-Sibirien. Die größte Bedeutung für die Russlandkunde hatten jedoch Ermans astronomische Ortsbestimmungen an vielen Punkten Sibiriens, die wesentlich zu einer ersten genauen Kartographie Sibiriens beitrugen.

Während seiner Weltreise hatte Erman an insgesamt 350 Punkten nicht nur die Abweichung und Neigung, sondern auch die Intensität der magnetischen Kraft gemessen. Diese Angaben wurden in der Folgezeit häufig genutzt und von vielen Wissenschaftlern wie z. B. Carl Friedrich Gauss (für seine Theorie des Erdmagnetismus), Edward Sabine und Christopher Hansteen hoch geschätzt. Heinrich Berghaus und Alexander von Humboldt verwendeten Ermans geomagnetischen Beobachtungen auf ihren Kartendarstellungen. In der zweiten Auflage des „Berghaus' Physikalischen Atlases“ hatte Erman eine vollständige Karte der Deklinationsbeobachtungen aus den Jahren 1827 bis 1831 zusammengestellt. Seine Angaben fanden auch Eingang in die Atlas-Karten über Meeresströmungen und die magnetische Intensität. In den 1860er Jahren reduzierten Erman zusammen mit dem englischen Wissenschaftler Heinrich Petersen nach der Gauss'schen Theorie des Erdmagnetismus mittels der angenommenen Säkular-Änderung alle bis 1870 vorhandenen magnetischen Beobachtungen auf 1829 und berechneten nun auf 10 Breitenparallele gleichweit voneinander abstehende Meridianpunkte. Diese Angaben wurden im Jahre 1874 im Werk "Die Grundlagen der Gaussischen Theorie und die Erscheinungen des Erdmagnetismus im Jahre 1829" publiziert und im Jahre 1891 vom Direktor der Seewarte in Hamburg, Georg Neumayer, in der IV. Abteilung des "Berghaus' Physikalischer Atlases" unter dem Titel "Atlas des Erdmagnetismus" auf die Karte übertragen.

Im Vortrag soll gezeigt werden, warum Ermans Name in Vergessenheit geraten ist.

## **WHERE ARE RELATIVES OF TINY DEEP-SEA ANTARCTIC ISOPOD *MICROCOPE DENTICULATE* FROM?**

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The genus of deep-sea minute isopods of the family Munnopsidae, *Microcope* Malyutina, 2008 is an example of taxa with not clear taxonomic position into the family and interesting distribution. It was described for three species: two new species from the Southern Ocean and southern Atlantic and known species, *Eurycope ovatum* Birstein, 1970 from the north-western Pacific. The genus is considered as an intermediate between three subfamilies of Munnopsidae as it combines characters common for some genera of Eurycopinae, Betamorphinae and Syneurycopinae, but cannot be related to any known genus of the existing subfamilies. *Microcope* species can be distinguished by minute seed-like broad oval body with fused pereonites 5–7, the short, not visible head hidden under the anterior flange of pereonite 1, with narrow mouthfield protruded ventrally.

*Microcope denticulate* Malyutina, 2008 from the Scotia and Bellingshausen seas, another southern Atlantic species, *M. levissima* Malyutina, 2008 from the Cape Basin and *M. ovata* (Birstein, 1970) from the Kurile-Kamchatka Trench were recorded mainly from abyssal depths down to 5054 m. Recently a new species of *Microcope* was found from the Chatham Rise near the New Zealand on a shelf depths around 300 m. This finding extended the range of geographical and vertical distribution of the genus, making this group even more interesting for future phylogenetic analysis.



## **THE DFG PRIORITY PROGRAM 1158 "ANTARCTIC RESEARCH WITH COMPARATIVE INVESTIGATIONS IN GLACIATED AREAS OF THE ARCTIC"**

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Since more than 30 years the German Research Foundation (DFG) provides substantial funding of polar research in coordinated and priority programs (Schwerpunktprogramm, SPP), starting with Antarctica and later expanded to the Arctic. Major motivation for this coordinated funding is to support German scientists to use a variety of polar research platforms, such as the RV "Polarstern", polar research stations, or polar planes, provided by the Alfred-Wegener-Institut Helmholtz-Zentrum für Polar- und Meeresforschung (AWI) in Bremerhaven and the Federal Institute for Geosciences and National Resources (Bundesanstalt für Geowissenschaften und Rohstoffe, BGR) in Hannover.

In 2012, the DFG Priority Program 1158 (Antarctic research with comparative investigations in glaciated areas of the Arctic) was extended by 6 years (for the period 2013 - 2018). For this funding phase, the SPP has reduced and reoriented its major research topics. The topics no longer are disciplinary in nature. Instead, they aim on providing important contributions to the role of Antarctica in the Earth System by focusing on the four overarching, interdisciplinary research topics "Development of the Continent", "Gateways to Lower Latitudes", "Dynamics of Climate System Components", and Response to Environmental Change".

This talk provides an introduction into the SPP 1158, with its importance for German polar research and its development during the past years. The talk introduces a total of 18 succeeding scientific talks, in which significant findings concerning our interdisciplinary research topics, funded by the SPP, are presented in four scientific sessions on Tuesday afternoon and Wednesday morning. These presentations function as a public Report Colloquium of the SPP, but also intent to present and discuss major scientific results with polar researchers and interested scientists not involved in the SPP.

## **SOUNDSCAPES OF THE SOUTHERN OCEAN: PASSIVE ACOUSTIC MONITORING IN THE WEDDELL SEA**

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The Southern Ocean provides an important habitat for marine mammals, both residential and migratory, yet long term studies of their habitat usage are hampered by the region's seasonal inaccessibility. To overcome this problem, two autonomous underwater passive acoustic recorders were deployed in the Weddell Sea in 2008 to collect multiyear passive acoustic data. The recorders were retrieved in 2010 and the acoustic recordings were analyzed in terms of broad- and narrow-band noise. Noise in this context is defined as the acoustic energy not assignable to a specific singular source. It comprises both biotic as well as abiotic components. Noise levels were determined by selecting the quietest 10 s of each 5 min recording to exclude energetic contributions from nearby singular acoustic sources. The respective sound pressure levels (SPL) and spectra were correlated with time series of environmental covariates.

The ambient noise levels of both recorders were found to be highly variable in time, ranging from 102 to 115 dB re 1  $\mu$ Pa (broadband SPL 5th and 95th percentile), and were correlated with the sea ice cover and wind speed. The annual variation of the ice cover caused a bimodal distribution of broadband SPL. In winter the SPL mode was 106 dB re 1  $\mu$ Pa. By contrast, storms over the open ocean in summer resulted in an SPL mode of 111 dB re 1  $\mu$ Pa. Variation in the ambient noise spectra could be correlated to wind speed and ice coverage. The acoustic presence of several mysticete (Antarctic blue whale, *Balaenoptera musculus intermedia*, fin whale, *Balaenoptera physalus*) and pinniped (leopard seal, *Hydrurga leptonyx*, crabeater seal, *Lobodon carcinophaga*) species created distinct bands in the spectra that contributed considerably to ambient noise levels. Comparison of the timing of these noise bands between the two acoustic data sets revealed offsets in the occurrence of acoustic activity between both recorders, suggestive of marine mammal latitudinal migration. At 66°S (the northern recorder position) fin whales were acoustically present earlier and longer in summer than at 69°S. Similarly, the blue whale chorus was more intense at 66°S than at 69°S. This might be related to the response of these species to the seasonal variation in the extension and density of sea ice. Seasonal cycles were also detected in the noise band attributed to crabeater seal vocalisations. They were annually present in September and November, followed by the leopard seals noise band, which is discernible between December and January.

Results from this latitudinal recorder pair give a first impression on possible marine mammal migration patterns as well as the spatial and temporal distribution of marine

mammal acoustic presence in the Southern Ocean. Additional recorders deployed in the basin wide HAFOS array will expand the spatial and temporal resolution of the acoustic dataset and allow conducting detailed multiyear studies of marine mammal acoustic presence and behavior throughout the Weddell Sea.

## **THE KOHNEN LINEAMENT – A PROMINENT MAGNETIC ANOMALY PATTERN IN SOUTHERN DRONNING MAUD LAND, EAST ANTARCTICA**

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The Pan-African (650-500 Ma) collision of East- and West Gondwana affected a major part of the Dronning Maud Land. The western front of this collision zone is exposed at the nunataks of the Heimefrontfjella, where a major shear zone separates Pan-African metamorphic overprinted rocks in the east from non-overprinted rocks in the west. The shear zone causes an elongated magnetic anomaly, which allows tracing the shear zone into the ice-covered areas NE and SW of the Heimefrontfjella. A similar elongated magnetic anomaly has been detected 300 km farther east close to the Kohnen Station, named Kohnen lineament. The anomaly stretches out from NE to SW over a distance of about 100 km. In the NE it links to the Forster Magnetic Anomaly, whereas it passes into another narrow and stretched anomaly in the SE, indicating a possible continuation. However the causing geological structures are inaccessible for direct geological sampling, as the area is completely covered by ~3 km thick ice, but the aeromagnetic data indicate that the Kohnen Lineament could represent the eastern front of the East-West Gondwana collision zone in this region.

## **SIMULATING THE EFFECT ANTHROPOGENIC CLIMATE CHANGE ON THE GREENLAND ICE SHEET**

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In the standard simulations of CMIP5 the coupling with the ice sheets is not included. Only few groups have been able to perform CMIP5 simulations with interactively coupled ice sheets. Beside its importance for the future development of global mean sea level, the Greenland ice sheet has also the potential to strongly affect deep water formation especially in the Labrador Sea but also in the Nordic Seas. Here simulations are presented with interactively coupled ice sheet models which allows to assess the uncertainty arising from ice sheet model and coupling technique.

The climate model ECHAM5/MPIOM is coupled interactively to two different ice sheet models using two different coupling strategies. The ice sheet models are a Greenland set-up of SICOPOLIS (10km), and Greenland (10km) and northern hemisphere (20km) set-ups of PISM. The coupling is done either with a simple positive degree days approach or a mass-balance scheme calculating the surface melting with an energy-balance scheme. The models are run without flux correction of anomaly coupling.

The resulting net mass loss rates for the Greenland ice sheet in a 1 percent scenario capped at 4x preindustrial atmospheric CO<sub>2</sub> concentrations showed a considerable dependence on both ice sheet model and coupling technique. The resulting differences in atmospheric climate, however, are small within the first centuries and restricted to the immediate vicinity of Greenland.

The feedbacks between atmosphere, ocean and the Greenland ice sheet are studied in a series of sensitivity experiments. It turns out that the future development of the Atlantic overturning and its associated heat transport are quite important for the future development of the mass of the Greenland ice sheet: The stronger the Atlantic overturning remains, the stronger the mass loss of the Greenland ice sheet.

## **DIE POLARREGIONEN IM KLIMAWANDEL**

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Im globalen Klimasystem spielen die Polarregionen eine herausragende Rolle weil sie mit ihren großen von Eis und Schnee bedeckten, weißen Gebieten den Strahlungs- und damit den Energiehaushalt der Erde entscheiden beeinflussen. Gleichzeitig aber reagieren sie in besonderer Weise auf Veränderungen des globalen Klimas, die es uns ermöglichen sie als Frühwarnsysteme künftiger Veränderlichkeit zu nutzen.

Auch wenn die polaren Regionen weit von uns entfernt sind so beeinflussen sie – und hier insbesondere die Arktis – doch auch unser tägliches Leben, z.B. über ihre Fernwirkung auf unser Wettergeschehen oder über die Veränderungen des Meeresspiegels.

Nach einem einführenden Teil über den gegenwärtigen Zustand dieser Regionen wird anhand einzelner Fallbeispiele gezeigt, wie unser Wissen über die Veränderlichkeit zustande kommt und auch welchen Aufwand es bedeutet in diesen Regionen zu forschen. Aus diesem Wissen lassen sich dann Prognosen für künftige Veränderungen ableiten. Allerdings sind diese Prognosen noch mit großen Unsicherheiten behaftet, weil wir noch zu wenig wissen über verschiedene Prozesse, die zu Veränderungen führen.

Daraus lässt sich künftiger Forschungsbedarf ableiten, der im Ausblick exemplarisch dargestellt wird.

## **ACCUMULATION AND STABLE-ISOTOPE STUDIES AT KOHNEN STATION, DRONNING MAUD LAND, ANTARCTICA, FROM 1999 THROUGH 2011.**

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The area of the later Kohnen station (75°00'06"S, 0°04'04"E) in Dronning Maud Land, Antarctica, was visited the first time during the EPICA-pre site survey in the austral summer 1997/98. In 1999/2000 the construction of the base started. At the same time a glaciological programme was initiated to study snow accumulation and stable isotope in the surroundings of the base and the site of the EDML ice core, respectively. The data of 20 snow pits cover the period 1986-2010. The pits had been sampled with a depth resolution between 1.5cm and 5cm. Linear fits through the time series do not show a significant trend neither for accumulation nor  $\delta^{18}\text{O}$  content. However, for the year 2008 an outstanding high accumulation rate was found in all 6 snow pits which were dugged in January 2011. The average  $\delta^{18}\text{O}$  content and mean accumulation rate for the period 1259-1816 from 4 nearby firn cores (B32, B34, B37 and EDML) is  $-45.01 \text{ ‰-SMOW}$  and  $62.3 \text{ kg m}^{-2} \text{ a}^{-1}$ , respectively. Both the mean annual isotope content and the mean annual accumulation rate during the past 25 years are above the long term average. They display values of  $-44.00 \pm 1.07 \text{ ‰-SMOW}$  and  $72.5 \pm 11.2 \text{ kg m}^{-2} \text{ a}^{-1}$  respectively. Thus, the results of the snow pit studies fit into the general pattern of increasing accumulation rates and increasing stable-isotope contents of snow during the 20<sup>th</sup> century.

## **LATE QUATERNARY PALEOCLIMATE INFORMATION FROM STABLE WATER ISOTOPES IN ICE WEDGES AT THE DMITRY LAPTEV STRAIT, NORTHEAST SIBERIAN ARCTIC**

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Ice wedges are the most abundant type of ground ice in the ice-rich permafrost deposits of the Northeast Siberian Arctic. They are formed by the periodic repetition of frost cracking and subsequent crack filling in spring, mostly by melt water of winter snow. Ice wedges can be studied by means of stable-water isotopes. Their isotopic composition is directly linked to atmospheric precipitation (i.e. winter snow) and, therefore, indicative of past winter climate conditions even though also genetic aspects, i.e. sublimation, melting and refreezing in the snowpack and the frost crack, have to be taken into account.

Here we present stable-water isotope data of ice wedges at the Oyogos Yar coast of the Dmitry Laptev Strait (72.7°N, 143.5°E). The ice wedges from different stratigraphic units comprising pre-Eemian sediments, Middle Weichselian Ice Complex (Yedoma) sediments and Holocene thermokarst (Alas) sediments were studied and sampled in 2002 and 2007. Stable-water isotopes were measured in the stable-isotope lab of the Alfred Wegener Institute in Potsdam, Germany.

Ice wedge stable-water isotope data indicate substantial variations in Northeast Siberian Arctic winter climate conditions ( $\delta^{18}\text{O}$ ) as well as shifts in the moisture generation and transport patterns (d excess) during the Late Quaternary, in particular between Glacial and Interglacial but also during the last centuries.

Ice wedges of the pre-Eemian Kuchchugui and Bychchaguy Suites exhibit mean  $\delta^{18}\text{O}$  values of about -30‰ and -34‰, respectively, indicating cold to extreme cold winter temperatures. The latter represents the coldest conditions found in ice wedges at the Oyogos Yar coast. Mean d-excess values are about 3‰ and 6‰, respectively. Small ice wedges in Eemian sediments show distinctly warmer mean  $\delta^{18}\text{O}$  values of about -24‰ and mean d-excess values of about 4‰. However, probably they represent younger epigenetically grown ice wedges with an isotopic composition that might be influenced by sediment-ice interaction. Huge syngenetic ice wedges of the Weichselian Yedoma Suite are characterized by mean  $\delta^{18}\text{O}$  values of -29‰ to -33‰ and mean d-excess values around 6‰ in different altitude levels, reflecting cold to extreme cold winter temperatures. On top of the Ice Complex as well as in a thermokarst depression, formed during the Late Glacial, Holocene ice wedges could be found. They have been grown predominantly in the Middle and Late Holocene and



exhibit mean  $\delta^{18}\text{O}$  values of about -25‰ and mean d-excess values of 8‰, mirroring distinctly warmer winter temperatures in the Holocene. Recent ice wedges grown in the last decades are characterized by mean  $\delta^{18}\text{O}$  values of about -22‰ and mean-d excess values of 8‰, testifying the recent winter warming in the Arctic.

## COMPARATIVE ANALYSIS OF DIFFERENT PARAMETERS OF *DESCHAMPSIA ANTARCTICA* POPULATION SUCCESS IN ONE POLAR SEASON

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A number of measures can be designated to monitor plant population fitness in Antarctica, however any of these indices will only be reliable if the information retrieved from such measurements is consistent across different approaches. Thus, finding correlated indices would provide a more robust system of population success assessment, which in turn would allow developing appropriate parameters for plant population monitoring. To address this question, in the present paper we analyze correlation between biometric parameters, relative nuclear DNA content in leaf parenchyma cells, and finally individual projective cover of *D. antarctica* in the vicinity of Admiralty Bay during one polar season.

Specifically, we carried out a complex study of different populations of *Deschampsia antarctica* from the Admiralty Bay area (King George Island). The field survey and sampling was conducted in the austral summer season 2005/06. During the fieldwork, a network of different, relatively homogenous vegetation stands was established and surveyed, the sites being located in the ice-free areas of Point Thomas and Keller Peninsula. The following population parameters were estimated: percentage cover, generative stem height, leaf length, inflorescence length, flower length, number of flowers in an inflorescence and relative content of DNA.

To examine differences in biometric and cytological parameters of *D. antarctica*, distribution curves were plotted for each parameter over all sampling sites. Differences in the distribution curves were tested by nonparametric median test. Extreme grouping of pairwise plant comparisons was applied to data from six populations of *D. antarctica* in respect to the following parameters of population success: biometric traits ( $\Delta Ph$ ) – percentage cover ( $|\Delta S|$ ), relative nuclear DNA content ( $\Delta rcD$ ) – percentage cover ( $|\Delta S|$ ), and biometric traits ( $\Delta Ph$ ) – relative nuclear DNA content ( $\Delta rcD$ ).

Analysis of data has allowed to cluster populations with significant positive correlations between traits and with negative correlations. In the case of positive correlation, population success by one parameter correlated with success by other

parameters. In the cases of negative correlation, the populations appeared to have chosen a strategy when a high value of one parameter was accompanied by decrease in other parameters (perhaps due to compensatory effects). We separated out populations which, based on success by all the studied parameters, had formed clusters of peculiar complex population success.

Monitoring of population status of *D. antarctica* can be carried out based on a greater number of parameters, while the search for optimal conditions can be done by looking for correlations among currently investigated parameters. However, population success should not be estimated based on a single parameter.

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## **LONG-TERM STATISTICS OF POLYNYAS IN THE WEDDELL-SEA AREA USING SATELLITE-BASED THIN ICE RETRIEVALS**

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An algorithm for the retrieval of thin ice thicknesses (TIT) from infrared satellite data is applied for the Antarctic Weddell Sea in order to determine long-term statistics of polynyas. The algorithm uses MODIS Terra/Aqua data (1km resolution) in combination with an energy balance model and ECMWF ERA-Interim reanalyses as atmospheric forcing for the period 2002-2011. From this TIT dataset, quantities like polynya area (POLA), polynya days (PD), thin ice thickness distribution and ice production rates were derived and compared to recent studies using passive microwave derived data and reference sea ice concentration data from AMSR-E. The higher spatial resolution of MODIS compared to SSM/I or AMSR-E allows for the detection of very narrow polynyas. Although the method is restricted to cloud-free conditions, the spatial coverage is good because of the large number of overpasses at polar latitudes.

## **KLIMAWANDEL, NATÜRLICHE WITTERUNGSPHÄNOMENE UND DIREKTE ANTHROPOGENE EINFLÜSSE BEEINFLUSSEN VOGELPOPULATIONEN AUF KING GEORGE ISLAND/ ANTARKTIS**

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Der Klimawandel macht sich in der Antarktis besonders im Bereich der Westlichen Antarktischen Halbinsel bemerkbar, an dessen Rand das Untersuchungsgebiet King George Island liegt.

Im Vortrag werden anhand von Langzeituntersuchungen an Pinguinen auf Ardley Island die Auswirkungen auf Brutpaarzahlen und Größe der Kolonien aufgezeigt. Insbesondere die Adeliepinguine (*Pygoscelis adeliae*) werden durch steigenden Wintertemperaturen und geringere Eisausdehnung beeinflusst.

Weitere Arten zeigen eine deutliche S-Ausbreitung: Bemerkenswert ist der Brutnachweis des Rußalbatrosses (*Phoebastria palpebrata*) auf King George Island als erster Nachweis in der Maritimen Antarktis, ca. 1000km südlich der Brutplätze in der Subantarktis.

Anhand von 2012/13 laufenden Untersuchungen wird auf die Bedeutung von extremen Witterungssituationen (späte Schneeschmelze im Frühjahr, Schneestürme im Sommer) für das Brutgeschehen und den Bruterfolg von Pinguinen, Dominikanermöwen (*Larus dominicanus*), Antarktisseeschwalben (*Sterna vittata*) und Skuas (*Catharacta spec.*) hingewiesen. Solche witterungsbedingte Effekte werden durch anthropogene Einflüsse (z.B. Störungen in Brutkolonien des Südlichen Riesensturmvogels durch Flugverkehr und Besucher) überlagert.

**ÜBERLEGUNGEN ZU PERMAFROST BEEINFLUSSTEN BÖDEN  
– IN GEDENKEN AN DAVID GILICHINSKY**

**CONSIDERATION ON PERMAFROST-AFFECTED SOILS  
– IN REMEMBRANCE OF DAVID GILICHINSKY**

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Der russische Permafrostforscher, Geokryologe und Kryopedologe David Gilichinsky ist im Februar 2012 plötzlich und unerwartet verstorben. Als Leiter des Geokryologischen Labors des Institutes für Physico-chemische und Biologische Probleme in Bodenkunde an der Russischen Akademie der Wissenschaften hat er über Jahrzehnte die Permafrostforschung auf nationaler und internationaler Ebene mitgeprägt. David Gilichinsky war aktives Mitglied der Cryosol Working Group (CWG) der Internationalen Permafrost Assoziation (IPA) und seine Überlegungen zur Systematik der Permafrost beeinflussten Böden (Cryosols, Frost-affected Soils) hat die Gemeinschaft in vielschichtiger Weise zur Diskussion gezwungen und für neue Erkenntnisse gesorgt. Es werden systematischen Diskussionsbeiträge von David Gilichinsky zur Begrifflichkeit und Einteilung von Cryosolen zusammengestellt und der Wert seiner differenzierten Ideen für die künftige Permafrostforschung herausgestellt.

|  |                            |                           |
|--|----------------------------|---------------------------|
| Differentiation of Frost-Affected Soils (Cryosols) |                            |                           |
| Permafrost-affected                                |                            | Seasonally frost-affected |
| coupled permafrost                                 | non-coupled permafrost     | non frozen deposits       |
| permanently frozen                                 | seasonally thawed          | seasonally frozen         |
| ice cemented<br>frosty                             | ice cemented<br>overcooled |                           |

The Russian permafrost scientist, geocryologist and cryopedologist David Gilichinsky dies suddenly and unexpected in February 2012. As the Head of the Geocryology Lab, Institute for Physicochemical and Biological Problems in Soil Science at the Russian Academy of Sciences David embossed the Permafrost science on national and international level over the decades. David Gilichinsky was an active member of the Cryosol Working Group (CWG) of the International Permafrost Association (IPA). His consideration concerning to the systematic of permafrost affected soils (Cryosols, Frost-affected Soils) forced the community to discussions and lead to new knowledge. In this talk his systematic contribution on the terminology and classification of permafrost soils will presented and the added value for future permafrost science will pointed out.

## **DIE STRUKTUR DER OBEREN ERDKRUSTE ZWISCHEN NARESSTRAÙE UND POLARMEER - EIN TRANSSECT DURCH ELLESMERE ISLAND**

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Im Anschluss an die kaledonische Orogenese wurden Svalbard, Nordgrönland und der kanadische arktische Archipel von der unterkarbonischen Ellesmerischen Orogenese und der tertiären Eureka-Deformation betroffen. In allen drei Gebieten überschneiden sich die Strukturen beider tektonischer Ereignisse und verlaufen oft parallel. Daher ist es äußerst schwierig, beide Ereignisse im Gelände zu unterscheiden, vor allem dann, wenn post-ellesmerische und prä-eurekanische Sedimentbecken (Sverdrup-, Wandelsee- und Zentralspitzbergen-Becken), wie in weiten Teilen der kanadischen Arktis, fehlen.

In der kanadischen Arktis hat die Ellesmerische Orogenese zu einer intensiven Deformation der jung-neoproterozoisch bis devonischen Füllung des Franklin-Beckens des nördlichen passiven Kontinentalrandes Laurentias geführt. Zwischen dem Pearya-Terrane im NNW und der Naresstraße im SE werden die ellesmerischen Strukturen von kilometer-großen Falten dominiert, die meist durch sub-vertikale Faltenachsenflächen und eine parallel dazu verlaufende penetrative Schieferung in den inkompetenten und eine Bruchschieferung in den kompetenten Schichten gekennzeichnet werden. Die ellesmerischen Transporte sind nach SE bis SSE gerichtet (z.B. Petersen Bay Fault, Lake Hazen Fault Zone, Archer Fiord Fault Zone).

Es ist nicht nötig, mehrere separate Ellesmerische Faltengürtel auf Ellesmere Island zu unterscheiden (z.B. Hazen Fold Belt, Central Ellesmere Fold Belt) weil die gesamte paläozoische Faltungs- und Überschiebungstektonik zwischen Pearya und der Naresstraße die Folge einer einzigen Deformation ist. Die Unterschiede des tektonischen Baustils, insbesondere die enge Verfaltung auf dem Hazen Plateau und die weiten Falten zwischen Lady Franklin Bay und Naresstraße, sind viel eher auf die unterschiedliche Zusammensetzung der Sedimentfolge als auf verschiedene tektonische Phasen zurückzuführen. Der gesamte Ellesmerische Falten- und Überschiebungsgürtel wird wahrscheinlich von einem regionalen kompressiven Abscherungshorizont in vermutlich 7 bis 10 Kilometern Tiefe unterlagert.

Im Gegensatz zur faltungs-dominierten Ellesmerischen Deformation werden die Strukturen der Eureka-Deformation im Franklin-Becken (im Unterschied zum Sverdrup-Becken!!) durch die Bildung von spröden Aufschiebungs- und Lateralstörungen gekennzeichnet, die teilweise ältere ellesmerische Störungen reaktivieren. Parallel zur Naresstraße sind auf der nordöstlichen Judge Daly

Promontory bis zu 500 Meter breite, NNE-SSW-streichende, sinistrale Störungszonen aufgeschlossen. Richtung SSW werden bei Cape Back diese Lateralstörungen durch ESE-gerichtete Aufschiebungen reaktiviert, während zwischen Cape Lawrence und der Princesse Marie Bay vor allem große Überschiebungszonen dominieren (Cape Lawrence Thrust, Parrish Glacier Thrust), die teilweise kilometer-mächtige Pakete des Franklin-Beckens auf paläozäne Konglomerate aufschieben.

Die großen, NE-SW-streichenden Störungszonen nordwestlich des Hazen Plateaus (Lake Hazen Fault Zone, Porter Bay Fault, Inlet Head Thrust) werden durch kompressive und laterale Bewegungen charakterisiert. Im Gegensatz zu den Störungen entlang der Naresstraße fanden die lateralen Bewegungen hier nach der kompressiven Phase statt und wurden durch dextrale Bewegungen bestimmt.

Die Transporte der tertiären Cape Lawrence Thrust, Parrish Glacier Thrust, Archer Fiord Fault und Lake Hazen Fault Zone sind nach ESE und SE gerichtet. Im Gegensatz dazu sind die Überschiebungen in der Yelverton Thrust Zone und die Inlet Head Thrust zwischen Yelverton Inlet im NW und Yelverton Lake im SE nach NW gerichtet. Die Inlet Head Thrust ist die nordwestlichste kompressive Struktur der Eureka-Deformation auf Ellesmere Island: die tertiären Störungszonen zwischen der Inlet Head Thrust und der Küste des Polarmeeres sind ausschließlich durch laterale Bewegungen gekennzeichnet.

Die tertiäre Eureka-Deformation hat den ellesmerischen Abscherungshorizont reaktiviert und wird durch kompressive Aufschiebungszone beziehungsweise laterale Störungszonen dominiert. Die Gebiete zwischen den tertiären Störungszonen (z.B. der so genannte Hazen Stable Block) wurden von der tertiären Tektonik nicht direkt betroffen. Man beachte, dass die enge ellesmerische Verfaltung, die zu einer Verkürzung von etwa 50% führte, eine erneute Verfaltung der Sedimente während der tertiären Deformation nicht mehr zugelassen hat.

Die Strukturen der ellesmerischen Orogenese werden gekennzeichnet durch:

- i) Faltenstrukturen im kilometer-Maßstab mit subvertikalen Faltenachsenflächen;
- ii) die Formation einer subvertikalen Schieferung;
- iii) sehr niedriggradige Metamorphose und duktile Deformation im untersten Teil des Franklin-Beckens;
- iv) die Formation von spröden Aufschiebungszone mit Transportrichtungen nach SE, sowie die Bildung eines tiefen Abscherhorizontes unter dem Franklin-Becken, welches in Form der basalen Cape Lawrence Thrust und Parrish Glacier Thrust im Bereich der Naresstraße an der Erdoberfläche ausstreicht.

Im Gegensatz dazu sind die Strukturen der Eureka-Deformation gekennzeichnet durch:

- (1) spröde sinistrale Störungszonen parallel der Naresstraße;



- (2) ESE- bis SE-gerichtete spröde Aufschiebungszonen, welche die Ellesmerischen Aufschiebungen und die sinistralen tertiären Störungen von Phase (1) reaktivieren;
- (3) spröde dextral und sinistrale Störungen nordwestliche des Hazen Plateaus, welche teilweise die Ellesmerischen und die tertiären Aufschiebungen von (2) reaktivieren.

## **DIE TEKTONISCHE EVOLUTION DER NEUSIBIRISCHEN INSELN**

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Die Neusibirischen Inseln liegen auf dem weiten, sibirischen Schelf zwischen der Laptewsee im Westen und der Ostsibirischen See im Osten. Geologisch bildet die Inselgruppe den westlichsten Bereich der so genannten Arktischen Alaska-Tschuktschi Mikroplatte (AACM). Sie wird im Westen vom Laptewsee-Graben, im Norden vom passiven Kontinentalrand zum Arktischen Ozean hin und im Süden von der Anyui-Suturzone begrenzt. Die Neusibirischen Inseln bilden eine Schlüsselstellung für die Rekonstruktion der Entstehung und Öffnung des Amerasischen Beckens. Eine Hauptfrage in diesem Zusammenhang ist, ob die AACM vor dem beginnenden Zerfall Laurasias im Jura am Rande Nordamerikas gelegen hat. In einem derartigen plattentektonischen Szenario hätten die Neusibirischen Inseln vor der Öffnung des Polarmeeres irgendwo nördlich von Svalbard bzw. Grönland/Ellesmere Island gelegen.

Die Bildung des Sedimentbeckens auf den Neusibirischen Inseln wird von einer mehr oder weniger kontinuierlichen Sedimentation vom Oberkambrium bis ins Neogene hinein charakterisiert. Unterbrochen wird die Folge von einigen nicht sehr bedeutenden Diskordanzen im mittleren Karbon, im Oberperm, in der frühen Trias, in der Unterkreide und von der Oberkreide bis ins Paläogen. Der untere Teil des Beckens (Kambrium, Ordovizium) wird von klastischen Tiefwassersedimenten auf den DeLong Inseln und von Karbonaten auf den Anyui Inseln aufgebaut. Im Silur und Devon wurden mächtige Kalksteine abgelagert, die von feinklastischen Sedimenten im Karbon, Perm und Mesozoikum abgelöst wurden. Magmatische Gesteine wurden im Ordovizium, im Karbon, in der Permotrias, in der Unterkreide und im Neogen/Pleistozän gebildet

Verglichen mit der strukturellen Entwicklung auf Sewernaja Semlja, Franz-Josef-Land und Svalbard ist die sedimentäre Abfolge der Neusibirischen Inseln nur wenig von tektonischen Bewegungen betroffen worden. Es gibt keinerlei strukturellen Hinweise auf die Kaledonische Orogenese und die Svalbardisch/Ellesmerische Deformation. Abgesehen von einigen spät-ordovizischen Vulkaniten erfolgte die Sedimentation ohne große Unterbrechungen vom Kambrium bis ins mittlere Karbon, eine Zeitspanne, die diese beiden großen Deformationsphasen beinhaltet. Weiterhin

zeigt die paläozoische Evolution des Sediomentbeckens größere Ähnlichkeiten mit der Sibirischen Plattform als mit Sewernaja Semlja, Franz-Josef-Land und Svalbard.

Im Gegensatz zu Svalbard und dem Nordrand Nordamerikas wurden die Neusibirischen Inseln nur von einer bedeutenden Phase tektonischer Bewegungen erfasst, die mit der plattentektonischen Umstrukturierung der Arktis, dem Zerfall des Superkontinents Laurasia und der Öffnung des Arktischen Ozeans in Verbindung steht. Die Deformation auf den Anyui Inseln wird von offenen, weiten Sätteln und Mulden mit NW-SE-streichenden Achsen bestimmt. Nach Westen nimmt die Intensität der Deformation dramatisch zu: die Gesteine an der Westküste der Kothelny-Insel und auf der Belkovsky-Insel sind eng verfaltet, von Aufschiebungen durchzogen und bereichsweise intensiv geschiefert. Die NE-vergente Falten und die Orientierung von Schichtung und Schieferung sprechen für NE-gerichtete Transporte während der Deformation. Auf Nowaja Sibir und auf den De Long-Inseln findet man hingegen kaum noch Hinweise auf eine NE-SW-Einengung.

Strukturgeologische Untersuchungen während der Expedition CASE 13 im Sommer 2011 lassen vermuten, dass die Deformation im Westen der Neusibirischen Inseln mit dem Beginn der Bildung des Laptewsee-Grabens während des Paläozäns in Zusammenhang steht, und zwar vor der Anomalie 24 (vor 55 Millionen Jahren) und vor dem Beginn der Ozeanbodenspreizung im Eurasischen Becken. Der Vergleich der sedimentären und tektonischen Ereignisse zeigt, dass sich die Entwicklung der Neusibirischen Inseln sehr von der Evolution auf Sewernaja Semlja, Franz-Josef-Land, Svalbard und Nordgrönland/Ellesmere Island unterscheidet, aber recht ähnlich verlaufen ist wie die auf der südlichen Taimyr Halbinsel und im Khatanga/Anabar-Gebiet. Das bedeutet, dass sich die Neusibirischen Inseln (als westlichster Bereich der AACM) niemals in der Nähe von Svalbard und Nordgrönland/Ellesmere Island befunden haben.

## **STRUKTURELLE ENTWICKLUNG DER NORDGRENZE DES KANADISCHEN ARKTISCHEN ARCHIPELS: EIN PASSIVER KONTINENTALRAND DOMINIERT VON TERTIÄRER LATERAL-TEKTONIK (EUREKAN)**

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Der Nordrand des kanadischen arktischen Archipels zum Kanadabecken und dem Alfarücken hin wurde seit der oberen Unterkreide von mehreren tektonischen und magmatischen Ereignissen betroffen, die mit dem Zerfall des Superkontinents Laurasia in Zusammenhang stehen. Die Orientierung des entstehenden passiven Kontinentalrandes Nordamerikas wurde durch ältere Störungszonen und Gräben auf Ellesmere Island, in Nordgrönland und in Svalbard bestimmt, die bereits im Anschluss an die Svalbardisch-Ellesmerische Orogenese im untersten Karbon entstanden. Diese bereits existierenden Strukturen bereiteten den Weg für den vollständigen Zerfall von Laurasia während der plattentektonischen Umstrukturierung der Arktis in der Kreide und im Tertiär und sind möglicherweise die Ursache für den über 2500 Kilometer langen, erstaunlich geradlinigen Verlauf des passiven Kontinentalrandes Nordamerikas zwischen dem McKenzie-Delta im SW und Nordgrönland im NE.

Die strukturelle Entwicklung des heutigen Kontinentalrandes wird durch die folgenden magmatischen und tektonischen Ereignisse charakterisiert:

- i) Intrusionen tholeiitischer Basaltgänge vor 123 bis 97 Millionen Jahren, die auf ein extensives oder transtensives Regime deuten;
- ii) Intrusion des "Wootton Intrusive Complex" (WIC) vor 93 bis 92 Millionen Jahren;
- iii) vertikale Bewegungen im Kilometerbereich zwischen 93 und 80 Millionen Jahren, die die Gesteine des WIC in ihr heutiges Niveau hoben;
- iv) Extrusion des "Hansen Point Volcanic Complex" vor 80 Millionen Jahren;
- v) sowohl sinistrale als auch dextrale tektonische Bewegungen entlang bereits existierender, kontinentrand-paralleler Störungszonen nach dem Altpaläozän.

Verglichen mit der tektonischen Entwicklung des Atlantischen und Arktischen Ozeans fanden die Platznahme der tholeiitischen Basaltgänge (i) und des Wootton Intrusive Complex (ii) sowie die anschließenden vertikalen Bewegungen (iii) zeitgleich mit der einsetzenden Extension in der Labradorsee statt. Die Extrusion der Hansen Point-Vulkanite (iv) stimmt mit der Ozeanbodenspreizung in der südlichen Labradorsee und Extension in der Baffin Bay überein. Die sinistralen und dextralen Lateralbewegungen (v) haben sowohl die Hansen Point-Vulkanite als auch die altpaläozänen Sedimente der Eureka Sound Group betroffen und können daher mit

dem Beginn der Eureka-Deformation und/oder dem Beginn der Trennung des Lomonosowrückens von Eurasien korreliert werden.

Bis heute können zwei Beobachtungen nicht erklärt werden: i) die Abwesenheit tektonischer und/oder magmatischer Aktivitäten (bis auf die tholeiitischen Basaltgänge) während der Öffnung des Amerasischen Beckens vor 150 bis 115 Millionen Jahren, und ii) die Ursache für das dextrale tektonische Regime entlang der SW-NE-streichenden großen Störungszonen parallel des heutigen passiven Kontinentalrandes von Ellesmere Island.

## **WEG-ZEIT-DIAGRAMM DER SCHRÖDER-STRANZ EXPEDITION (DEA) UND DER NORWEGISCHEN UND DEUTSCHEN RETTUNGSEXPEDITIONEN VOR 100 JAHREN (1912/1913)**

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Vor 100 Jahren spielte sich in Spitzbergen und Nordaustlandet eines der größten Dramen in der Erforschung des Spitzbergen-Archipels statt: Im Spätsommer 1912 startete die von Herbert Schröder-Stranz initiierte und organisierte Deutsche Arktis-Expedition (DAE) an die Nordküste Svalbards, um Erfahrungen für eine geplante Befahrung der Nordostpassage im Sommer 1913 zu sammeln. Nachdem Schröder-Stranz mit drei Begleitern nahe der Nordküste Nordaustlandets abgesetzt worden war, musste das Expeditionsschiff „Herzog Ernst“ im Sorgfjorden Schutz suchen und überwintern.

Bereits vier Wochen später löste sich die DAE in Einzelgruppen auf. Bis Ende Dezember 1912 waren bis zu drei Gruppen mit wechselnden personellen Zusammensetzungen auf dem „Herzog Ernst“ und auf dem Weg Richtung Longyearbyen unterwegs oder warteten an verschiedenen Orten auf bessere Bedingungen. Zwischen Januar und August 1913 fanden insgesamt fünf Hilfsexpeditionen nach Nordspitzbergen und Nordaustlandet statt, um nach Schröder-Stranz und seinen Begleitern zu suchen. Erst diesen Hilfsexpeditionen gelang es, die Überlebenden zu versorgen und nach Longyearbyen zurückzubringen. Von 15 Expeditionsteilnehmern kehrten acht nicht mehr zurück.

Der Ablauf der DAE und der Hilfsexpeditionen ist also durch die vielen Gruppen, die teilweise zeitgleich an mehreren Orten im Norden Svalbards unterwegs waren, äußerst kompliziert, wodurch es schwer fällt, einen zeitlichen und räumlichen Überblick über die verschiedenen Gruppen, Expeditionsrouten und Ereignisse zu bekommen.

In der topographischen Karte von Nordspitzbergen und Nordaustlandet sind die Routen der DAE und der Hilfsexpeditionen eingetragen. Diese Expeditionsrouten ergeben sich aus den vorhandenen Karten und den Beschreibungen in den Expeditionsberichten und aus den eigenen Kenntnissen der topographischen Verhältnisse besonders in Ny Friesland und im Wijdefjorden.

Das Weg-Zeit-Diagramm stellt das „Hauptwerkzeug“ da, weil man hier direkt ablesen kann, welche Gruppen sich zur gleichen Zeit an welchen Orten aufgehalten haben. In diesem Diagramm sind die wichtigsten geographischen Orte und Stationen der Expeditionen und der Zeitablauf verzeichnet. Auf der x-Achse sind von unten (im Süden) nach oben (im Norden) die wichtigsten geographischen Stationen der Expeditionen relativ zu ihrer geographischen Breite angeordnet (ohne Berücksichtigung der geographischen Länge). Auf der y-Achse ist die Zeit von links (beginnend mit dem 5. August 1912) nach rechts (endend mit dem 16. August 1913)

aufgetragen. Horizontale Linien bedeuten in dieser Darstellung, dass sich Gruppen oder Einzelpersonen der Expeditionen über einen längeren Zeitraum am selben Ort aufgehalten haben. Schräg nach rechts oben führende Linien zeigen den Weg nach Norden und schräg nach links unten verlaufende Linien den Weg nach Süden an. Je steiler eine Linie ist, umso schneller wurde der Weg zwischen zwei Lokalitäten zurückgelegt. In den folgenden Kapiteln wird der Ablauf der DAE und der Hilfsexpeditionen unter Zuhilfenahme der Karte und des Weg-Zeit-Diagramms zusammengefasst.

## **BOUNDARY-LAYER PROCESSES CAUSE GCM BIASES IN ARCTIC WINTER**

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Temperature inversions are a common feature of the Arctic wintertime boundary layer. They have important impacts on both radiative and turbulent heat fluxes and partly determine local climate change feedbacks. Inversions and the associated surface fluxes are poorly represented in current climate models, with many models overestimating the typical strength of temperature inversions. Understanding the spread and biases in inversion strength modelled by global climate models is therefore an important step in better understanding Arctic climate and its present and future changes.

Here, we show how the cooling of relatively warm and moist air masses advected from lower latitudes leads to the emergence of a clear and a cloudy state of the Arctic winter boundary layer. During this process of formation of Arctic air, radiative cooling leads to saturation and thus triggers the formation of a high-emissivity liquid-containing cloud which limits surface radiative cooling in the cloudy state. Further radiative cooling drives the transition to a low-emissivity ice cloud which allows the surface to cool radiatively and is therefore associated with the clear state of the boundary layer. Temperature inversions are initially created by warm air advection, then eroded by radiative cooling aloft in the cloudy state and created again by surface cooling in the clear state. This results in stronger typical inversions in the clear than in the cloudy state.

Comparing model output to observations, we find that many CMIP5 models do not realistically represent the cloudy state. This results in excessive surface radiative cooling, which leads to an overestimation of inversion strength in one group of models, whereas other models produce weak inversions despite strong surface cooling.

An idealised single-column model experiment of the formation of Arctic air reveals that the lack of a cloudy state is linked to inadequate mixed-phase cloud microphysics. In models lacking a cloudy state, freezing of cloud liquid water occurs at too warm temperatures. Excessive turbulent and conductive heat fluxes can weaken temperature inversions despite surface radiative cooling, which can explain why some models produce weak inversions despite lacking a cloudy state.

A redistribution from the clear to the cloudy state in a warming climate would act to amplify Arctic surface warming. Results from the MPI-ESM-LR suggest that such a feedback does indeed exist. A better understanding and model representation of Arctic mixed-phase clouds is required to verify and quantify the effect of this mechanism on Arctic climate change.



## ON CALVING

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Calving is one of the least understood glaciological processes. While small icebergs are calving of the ice shelf fronts on short time scales, the calving of giant icebergs with sizes of 100-1000km<sup>2</sup> are singular events. For prognostic studies of the mass balande of ice sheets, calving rates are required for the evolution of the calving front. Hence, we aim to develop calving laws leading to calving rates by using a fracture mechanical approach. To this extent two scenarios are studied: Small scale calving is simulated by applying a transient visco-elastic Kelvin-Voigt model using finite elements, while for calving of larger icebergs (500-700km<sup>2</sup>) the crack propagation path is simulated and compared to remote sensing observations of calving.

For small scale calving a simplified 2D-geometry, in which the gravity force is the only load is used for a first analysis. The stresses on the surface in the vicinity of the calving front are computed with the finite element software COMSOL. The boundary conditions are the water pressure at the front and bottom of the ice shelf and a constant displacement at the inflow. A stationary state will reappear until eventually the subsequent calving event occurs. Based on the time interval and the flow velocity of the ice shelf we estimate the calving rate. This is compared to simulations using the 2D-geometry of the Ekstroem Ice Shelf, Antarctica.

On the floating tongue of Pine Island Glacier, a marine based outlet glacier of the West Antarctic Ice Sheet, in October 2011 a new 24km long rift has formed and propagated to a length of 28km in the subsequent weeks. The rift widened from initial 50m to 540m in February. Since then the width remained unaltered until in May a 30km<sup>2</sup> iceberg separated from a ~720km<sup>2</sup> remaining large area to form a tabular iceberg. We present a comparison with previous calving events at this location and a fracture mechanical analysis of the crack propagation. To this extent, a linear-elastic fracture mechanical model using body forces are applied to a two-dimensional model of the floating part of Pine Island Glacier including initial cracks estimated from remote sensing imagery. The simulated propagation path for the 2007 and 2011 events agree well with observations.

## **BURIAL AND EXHUMATION OF THE TERRA NOVA BAY REGION, TRANSANTARCTIC MOUNTAINS**

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The uplift and exhumation history of the Transantarctic Mountains chiefly relies on apatite fission track data that were traditionally interpreted in terms of several exhumation stages since the Early Cretaceous (e.g., Fitzgerald, 2002). However, recent evaluation of geological and geomorphological observations, such as the presence of ~180 Ma volcanic rocks above peneplained basement, require the establishment of consistent thermal history models and a thorough reinterpretation of the regional thermochronological data base (Lisker and Läufer, in revision).

New apatite fission track and U-Th-Sm/He data were obtained from vertical profiles of basement rocks from the Eisenhower and Deep Freeze Ranges in the Terra Nova Bay region, northern Victoria Land. Fission track ages between  $32\pm 2$  Ma and  $259\pm 18$  Ma and associated proxies correlate with altitudes between 220 and 3120 m. U-Th-Sm/He ages from the same samples cover a wide age spectrum of  $28\pm 3$  to  $274\pm 17$  Ma and are usually 10-50 Ma younger than corresponding fission track ages.

Thermal history modeling of the thermochronological data from both mountain ranges indicates Jurassic to Late Eocene heating of the studied crustal sections, and final cooling commencing at ~35 Ma. This requires burial, and therefore the existence of a Mesozoic sedimentary basin on basement and volcanic rocks in the Terra Nova Bay region as recognized by Lisker and Läufer (in revision). We suggest that the Terra Nova Bay region was part of an extensive Mesozoic intra-Gondwana basin in the hinterland of the Paleo-Pacific margin between Antarctica and Australia. Basin inversion and fast erosion of the sediments initiated at the Late Eocene. The correlation of modelled paleotemperatures refers to a high Jurassic geothermal gradient of up to ~60°C/km and subsequent decrease towards a conventional Cretaceous-Eocene gradient of ~20-30°C/km within the basin. This implies a maximum basin depth above basement and volcanic rocks of ~2.5 km for the Eisenhower Range and ~4 km for the Deep Freeze Range. The comparison of the new results with the outcome of published fission track studies from adjacent regions and the Australian shelf juxtaposed to the Ross Sea margin of East Antarctica will give more information about the extension and geometry of the sedimentary basin. This will derive new implications on the Gondwana break-up and further improve our knowledge about the development of landscape contrasts within the Terra Nova Bay region and the interplay between climate, tectonics and lithology.

## SYMBIONT SWITCHING AS AN ADAPTATIONAL STRATEGY OF THE WIDESPREAD POLAR LICHEN *CETRARIA ACULEATA*?

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Lichens are symbioses consisting of a fungus (mycobiont) and one or several different algae (photobionts). *Cetraria aculeata* is a lichen that grows in both polar regions as well as high mountain ranges in between. In addition, it is found in temperate biomes from central Asian steppes to sand-dunes and light forests of western Europe. The species evolved in the northern hemisphere and expanded its range southwards during the Pleistocene. The observation that polar photobionts are genetically more closely related to each other than to temperate ones prompted us to investigate whether the mycobiont can adapt or acclimate to the harsh conditions of polar ecosystems by associating with locally adapted photobionts (photobiont switching). Lichen thalli from temperate and polar regions show different photosynthetic responses. However, molecular genetic data indicates that photobiont switching occurred only rarely over evolutionary time scales. Bayesian Skyline Plots and Stochastic Character Mapping on phylogenetic trees shows that a photobiont switch during the Pleistocene coincided with strong growth of the Mediterranean population. We conclude that algal switching enabled a cold-adapted *C. aculeata* to colonize temperate biomes, but it does not contribute to acclimation. Instead, transplantation experiments suggest that *C. aculeata* acclimates by up- and down-regulation of photobiont cell numbers. While transplants between polar and dry temperate regions survived two years, transplants between humid and dry regions did not survive the treatment. The potential for acclimation is, hence, limited, but temperature is not the decisive factor. This is also supported by the observation that polar and temperate photobiont cultures show very similar temperature optima.

## **COAL SCREE FOUND BURNING IN AUGUST 2011 ON SOUTHERN ELLESMERE ISLAND (NUNAVUT, ARCTIC CANADA)**

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Coal scree of Tertiary Eureka Sound Group coals was found burning on the 24th August 2011 during expedition CASE 12 of the Federal Institute for Geosciences and Natural Resources (Germany) on southern Ellesmere Island. The burning outcrop is located below a steep canyon wall of a small river, which is draining the Prince of Wales Icefield. The river erodes tectonically disturbed coal bearing sediments of the Mount Bell (TMB) and Mount Lawson Formations (TML) of the Eureka Sound Group. These form scree that obviously was set on fire by spontaneous combustion of the coal pieces, which are scattered all over the talus. The surrounding clasts of claystone and siltstone of the TML/TMB sediments are strongly affected by the heat of the burning coal, i.e. they are pyrometamorphically altered forming all sorts of reddish and beige hard clinker.

Indications for pyrometamorphism related to the spontaneous combustion of coal on Ellesmere Island were previously mentioned for example from the Fosheim Peninsula, where one location is called "clinker" in Dawson et al. (1976). Ricketts (1994) labeled two spots in a section north of Strathcona Fiord with the term "bocanne", a name specifying "naturally burning shale banks" according to the definition of Crickmay (1967). Recently, Piepjohn et al. (2007) and Estrada et al. (2009) reported the occurrence of paralava in the Stenkul Fiord and Split Lake areas on southern Ellesmere Island. One coal fire near Split Lake could be dated to have burnt  $3.3 \pm 0.5$  Ma ago in the Middle Pliocene ( $^{40}\text{Ar}$ - $^{39}\text{Ar}$  incremental heating dating on wholerock silicate paralava). At all these localities the coal bearing Eureka Sound Group sediments of Tertiary age crop out over wide areas.

The burning coal scree location gives the possibility to understand in more detail how the widespread occurrences of clinker, i.e. the previous sites of pyrometamorphism, occurring around Strathcona Fiord and Stenkul Fiord were formed.

## **CHANGES IN THE ANTARCTIC BOTTOM WATER**

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In the last decades, the Antarctic Bottom Water (AABW) warmed and got less dense, and the changes were intensified in the Southern Ocean. Here we use a 27 year long time series of CFC observations in the Weddell Sea to study the changes in ventilation and content of anthropogenic carbon ( $C_{ant}$ ) in deep and bottom water in the Weddell Sea, the local precursors to AABW. Applying the Transit Time Distribution (TTD) method we find that all deep water masses in the Weddell Sea have been continually growing older and getting less ventilated during the last 27 years. The ventilation rate decline of Weddell Sea Deep and Bottom Water, however, seems to be mainly caused by mixing with Warm Deep Water, which aged much faster. Increasing entrainment of Warm Deep Water or a slowing down of the Weddell Gyre circulation may also play a role. As a consequence of the aging, the  $C_{ant}$  increase in the deep and bottom water formed in the Weddell Sea slowed down.

## **EVIDENCE FOR RECENT COLONIZATION OF THE AMUNDSEN-SEA SHELF BY THE ISOPOD CRUSTACEAN MACROSTYLIS ROALDI**

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The Amundsen Sea in the Southern Ocean is amongst the most rapidly changing environments of the world, yet its benthic marine inhabitants are barely known. A new deep-sea isopod crustacean, *Macrostylis roaldi*, has recently been discovered and described. It is the first new isopod described from the Amundsen-Sea shelf. Its currently known range spreads across 300 km from the inner shelf at Pine Island Bay right to the shelf break as well as bathymetrically across 1,000 m.

Based on DNA barcodes (COI) and additional mitochondrial markers (12S, 16S), a homogenized gene pool across space and depth was detected. This is seen as an indication for a genetic bottleneck and a recent colonization history. Our results suggest further that migratory or dispersal capabilities of some species of brooding macrobenthos have been underestimated. This might be relevant for the species' potential to cope with effects of climate change. To determine where this species could have survived the last glacial period, alternative refuge possibilities are discussed.

## **TWO-WAY COUPLED ICE SHEET-EARTH SYSTEM SIMULATIONS: CONSEQUENCES OF RAISING CO<sub>2</sub> CONCENTRATION FOR THE GREENLAND AND THE INTERACTING CLIMATE SYSTEM**

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The observed distinct warming in the Arctic and the northward flow of tropical water masses seems to trigger enhanced melting of the Greenland ice sheet, which adds more fresh water into the ambient ocean. A continuation of the observed accelerated/increased melting during the last decade would stabilize the upper column in the adjacent deep water formation sides. With our fully coupled ice sheet-earth system we approach the question if this weakens the formation of deep water masses and reduces the oceanic thermohaline driven meridional overturning circulation (MOC). In our two-way fully coupled ice sheet-earth system model system we perform idealized future projections to investigate the response of the interaction under raising atmospheric carbon dioxide (CO<sub>2</sub>) concentration.

We will present the building blocks of our fully coupled system, which includes a physical based calculation of the ice sheet's surface mass balance and ice sheet-ocean interaction; The ESM instead is subject to orographic changes and fresh water fluxes, for example. Since the behaviour of an ice sheet in the near future is controlled by both the external forcing and by its initial conditions, we have performed Latin Hyper Cube (LHC) simulations of the ice sheet model PISM over more than one glacial-interglacial cycle utilizing standard techniques to obtain a reasonable initial state. According to several quantities the best performing LHC member is exposed afterwards to boundary conditions determined from energy balance calculations again obtained from simulated forcing fields. Finally the fully coupled system is brought near a quasi equilibrium under pre-industrial conditions before idealized scenarios have been started. In contrast to commonly used strategies, our coupled ice sheet inherits the memory of a glacial cycle simulations obtain exclusively from ESM fields. Furthermore we use a mass conserving scheme, do neither apply flux corrections nor utilize anomaly coupling.

Under different CO<sub>2</sub> forcing scenarios -- for example, raising CO<sub>2</sub> by 1%/year until four times the pre-industrial concentration (4xCO<sub>2</sub>) has reached, abrupt raise to 4xCO<sub>2</sub> -- the response of the coupled system is analysed. For instance, an abrupt CO<sub>2</sub> forcing leads to an immediate response of the Greenlandic ice sheet. The surface mass balance turns strongly negative with a couple of years, causing

skyrocketing melting rates and sea level rise. The contribution of the ocean-ice sheet interaction decreases instead, because the ice sheets retreats from the coast and is therefore less susceptible to an eroding ocean. The additionally released fresh water and the heat both have to potential to stifle the MOC. However sensitivity experiments indicate that the additional fresh water has a negligible influence on the MOC with a time scale of a century or more in our model system.

For the study we use the current CMIP5 earth system model MPI-ESM that comprises the atmosphere model ECHAM6 (T63Lxx), vegetation model JSBACH and the ocean biogeochemical model MPIOM / HAMOCC (nominal horizontal resolution of 1.5deg with one pole over Greenland). The ESM is coupled to the Parallel Ice Sheet Model (PISM) covering Greenland. PISM has a horizontal resolution 10 km.



## **THE GREENLAND ICE SHEET AS AN INTERACTING CLIMATE COMPONENT IN A HIERARCHY OF NUMERICAL MODELS.**

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Numerous modeling efforts are being performed to describe, in particular, the Greenlandic ice sheet and its interaction with the climate system at the (Danish Climate Center of the) Danish Meteorological Institute. The applications range from a two-way coupled complex global climate-ice sheet model system to spatially high resolution models forecasting the daily surface mass balance over Greenland. These different aspects are covered in comprehensive talk.

Two spatially high resolution atmospheric models (a climate and a weather forecast model) are used in concert to determine the surface mass balance of the Greenland ice sheet. These models provide an up to 10 days forecast of the surface mass balance. The forecast product is offered to the community by the DMI's web site to allow accessing these forecasts during daily field campaigns. The mechanisms, the setup, and the validations of the surface mass balance are presented to the audience. For example the extra ordinary melt event last summer has been reliably forecasted by our system.

The global climate model EC-earth, comprising the ECMWF's atmospheric model IFS and the ocean model NEMO, has been coupled to the Parallel Ice Sheet Model (PISM). We will present the building blocks of our fully coupled system that determines the surface mass balance through a physical based calculation energy balance calculation and includes ice sheet-ocean interaction. The ESM receives, for example, orographic changes and fresh water fluxes from the ice sheet. Before coupling the different pieces together, the ice sheet has be pre-initialized and driven through a glacier-interglacial cycle, so that ice sheet reacts according to the imprinted memory of the glacial-interglacial cycle. Finally, from the fully coupled system, which is in a quasi equilibrium under pre-industrial conditions, idealized scenarios have been started.

Under different idealized CO<sub>2</sub> forcing scenarios we present the response of the climate system and in particular the ice sheet of Greenland. A very strong climatic forcing leads to an immediate response of the ice sheet. For example in the most extreme case, where the atmospheric CO<sub>2</sub> raises from one day to the next to four-times the pre-industrial value, the surface mass balance turns negative within several years. Consequently the ice mass melts and contributes to a raising sea level. The released additional melt water has the potential to reduce the formation of deep waters that drives the global meridional overturning circulation. Sensitivity experiments indicate however that the additional fresh water has a negligible influence.

## **RETRIEVING VOLUME CHANGES AND MASS DEPLETION OF GLACIERS BY MEANS OF TANDEM-X DATA**

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Interferometric radar data (InSAR) offer the capability for precise, spatially detailed measurement of the surface topography of glaciers and ice sheets. Repeat observations in different years deliver changes of glacier volume which can be converted into changes of glacier mass by estimating the mean density of the depleted or gained volume. The application of single-pass InSAR systems is of particular interest for mapping glacier surface topography because these measurements are not affected by temporal decorrelation and atmospheric phase delay. First spaceborne single-pass InSAR systems operated on the Space Shuttle in February 2000, the Shuttle Radar Topography Mission (SRTM) with C-band and X-band dual antenna SAR systems, mapping the topography of land masses between 60°N and 56°S. The German TanDEM-X satellite mission, launched in June 2010 and operating in bi-static interferometric configuration with the TerraSAR-X satellite, offers improved capabilities for mapping the topography of global land surfaces. The DEMs have a spatial resolution of about 12 metres and 2 metre vertical point-to-point error. For determining the elevation of glacier surfaces it is necessary to correct for the penetration of the radar signal into snow and ice. This is of particular importance if different sensors types, such as optical stereo sensors and InSAR, are used for estimating topographic change. The InSAR elevation refers to the position of the scattering phase centre of the radar signal. Depending on the physical state of snow and firn, at X-band the shift of interferometric surface elevation may range from zero (for melting snow and ice) to a few metres (for dry, fine-grained snow). In the presentation the technical and physical background for analysing glacier volume changes by means of InSAR is discussed. Based on SRTM and TanDEM-X data, examples for analysed volume changes and inferred multi-year mass balance are presented for glaciers in the Ötztal Alps, Austria, and for selected glaciers of the Patagonia Icefield. For glaciers of the Ötztal Alps with mass balance measurements the mass depletion over the period 2000 – 2012, derived from SRTM and TanDEM-X data, agrees well with in situ measurements, confirming the great potential of the method for estimating the mass balance of glaciers world-wide.

## **PALEO SOILS AS DOCUMENTS OF LOCAL CLIMATE CHANGES DURING THE PLEISTOCENE**

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Paleo soils are useful documents of earth history. Properly interpreted, they allow conclusions about site specific paleoenvironmental conditions. In a sand pit next to Jahrsdorf in Schleswig-Holstein (N 54,048°, E 009,620°), an Eemian aged (127 - 115 ky bp) paleo soil above Saalian sands has been exposed during excavation activities (Grube, 2012).

Photography of soil-morphological features and in situ analysis of hydromorphic properties and soil colours, as well as laboratory analysis of Fe-, C and N- content, C/N ratio and granulometric distribution has been conducted. With the acquired set of data, the pedological past of the sediments and paleoenvironmental conditions that governed the region from the latest Saalian periods to the Holocene, were concluded. The paleo soil is suggested to be of podzolic nature and represent a period during the Pleistocene in which the local climate was temperate and humid (Precipitation exceeded Evapotranspiration) and during which the geomorphology of the landscape was stable (no erosion potential at this site, no sedimentation from other sites). Subsequently, the soil was covered by sediments and overprinted by cryogenic processes – this implies arctic-like conditions during the Weichselian glacial period. In the Holocene, on the modern surface, a cambisol formation took place. Later during the Holocene, the soil was transformed into arable land. Soil data delivered information that allowed the reconstruction of the site-specific paleoenvironmental conditions.

## **FLUXES OF DISSOLVED ORGANIC CARBON FROM POLYGONAL TUNDRA ON SAMOYLOV ISLAND, LENA RIVER DELTA, SIBERIA**

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Arctic landscapes often contain carbon-rich wetland features overlying permafrost. These wetlands drain towards the Arctic Ocean in complex channel pathways and carry a nutrient load that includes dissolved organic carbon (DOC). This important part of the carbon cycle is linked to changes in the permafrost landscape expected from climate change, including thermokarst development and shifts in the timing and magnitude of precipitation and temperature.

In this study, we present the results of a measurement campaign in the summer of 2012, in a patterned polygonal landscape in the low tundra of Siberia's Lena River Delta. The geographical structure of this landscape contains an interconnected ice wedge network slowly draining the wet, low-lying polygon centers. We installed and calibrated three weirs to measure hydrological discharge from a polygon network on Samoylov Island. Water samples were taken weekly to calibrate an in-stream UV-Visible light absorption instrument used to estimate the dissolved organic carbon concentrations in these streams. Through analysis of the absorption characteristics, qualitative indicators of the carbon content are also derived, yielding insight about the aromaticity and molecular structure of the carbon. We found that this drainage is punctuated by storm events overlain across a slow-draining hydrology governed by summer permafrost thaw. The lateral outflux of DOC is substantially less in carbon terms than the landscape's carbon sink function (driven primarily by plant photosynthesis in the summer). We will present a preliminary estimate of the DOC outflux from this polygon landscape during the summer growing season, and analyze how qualitative characteristics of this DOC change during the season. We conclude by investigating the utility of the qualitative characteristics for flow source partitioning.

## **NEW CONSTRAINTS ON THE STRUCTURAL EVOLUTION OF EAST ANTARCTICA: THE MAIN SHEAR ZONE OF SØR RONDANE, EASTERN DRONNING MAUD LAND**

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Structural investigations were carried out along the Main Shear Zone (MSZ) of western Sør Rondane (22°–25°E, 71.5°–72.5°S) to gain new information about the position of the East-/West-Gondwana suture and the ancient plate tectonic configuration during Gondwana amalgamation. These studies are part of the longer-term GEA (Geodynamic Evolution of East Antarctica) project of BGR, jointly carried out in cooperation with AWI.

The WSW-ENE striking MSZ divides south-western Sør Rondane in a northern amphibolite-facies terrane and a southern tonalite–trondhjemite–granodiorite (TTG) terrane. The structure can be traced over a distance of ca. 100 km and reaches several hundred meters in width. It is characterized by a right-lateral sense of movement and marked by a transpressional and also transtensional regime.

Ductilely deformed granitoids (ca. 560 Ma: SHRIMP U-Pb of zircon) and ductile – brittle structures, which evolved in a transitional ductile to brittle regime in an undeformed syenite (ca. 499–459 Ma, Ar-Ar mica), provide a late Proterozoic/ early Paleozoic time limit for the activity of the shear zone (Shiraishi et al., 2008; Shiraishi et al., 1997).

Documentation of ductile and brittle deformation allows reconstructing up to eight deformation stages. Cross-cutting relationships of structural features mapped in the field complemented by published kinematic data reveal the following relative age succession: [i] Dn+1 - formation of the main foliation during peak metamorphism, [ii] Dn+2 - isoclinal, intrafolial folding of the main foliation, mostly foliation-parallel mylonitic shear zones (1-2 meter thick), [iii] Dn+3 - formation of tight to closed folds, [iv] Dn+4 - formation of relatively upright, large-scale open folds, [v] Dn+5 - granitoid intrusion (e.g. Vengen granite), [vi] Dn+6 - dextral shearing between amphibolite and TTG terranes, formation of the MSZ, [vii] Dn+7 - intrusion of late- to post-tectonic granitoids, first stage of brittle deformation (late shearing along MSZ), intrusion of post-kinematic mafic dykes, [viii] Dn+8 - second stage of brittle deformation including formation of conjugate fault systems. The latter point to a WNW-ESE respectively NW-SE oriented maximum paleostress direction and indicate the latest deformation event; they are possibly related to the break-up and fragmentation of Gondwana.

## **DIVERSITY AND RICHNESS OF MYCO- AND PHOTOBIONTS IN ANTARCTICLECIDEOID LICHENS**

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Lichens as a symbiosis between a fungus (mycobiont) and a photosynthetic partner (photobiont) are the most successful vegetation forming organism in the arid and cold deserts of the southern Polar regions. Although Antarctica's ecosystems represent some of the simplest in the world, it is increasingly becoming clear that their biodiversity is far greater than previously thought and that spatial variations in species diversity are complex, possibly reflecting regional to local variations in climate.

As part of a comprehensive study on a crustose lecideoid lichen group in Antarctica, not only the mycobiont- but also the photobiont diversity and abundance were investigated. Considering the climatic factors a phylogeny of the photobiont sequences (ITS) in combination with samples from Arctic and Alpine and other temperate regions reveals the presence of five, possibly even six major *Trebouxia* clades in twelve different species of Antarctic lecideoid lichens. Two clades are formed by members of the cosmopolitan *T. jamesii* and *T. impressa* aggregates but for all other clades no close match of any known *Trebouxia* species could be found in the sequence databases. One genetically uniform and well supported *Trebouxia* clade was only found in the climatically unique cold desert regions of Antarctica (preliminarily named *Trebouxia* sp. URa1). This clade may represent an endemic photobiont species since it seems to be restricted to the Antarctic cold deserts, a habitat that has no ecological counterpart elsewhere in the world.

*Trebouxia* sp. URa2 and URa3 are widely distributed and abundant in the investigated areas. The Antarctic lichens studied here are predominantly not specific for a single photobiont species or lineage except for *Lecidella greenii* and *L. siplei*. These two species are preferably associated with *Trebouxia* sp. URa2, although in the sampling areas of both species, a pool of several other photobionts is available. On the other hand, *Lecidea cancriformis*, the most widespread lichen in Antarctica associates with the highest diversity of the available photobiont clades.

## **THE ROLE OF PHOTOBIONTS IN ANTARCTIC LICHENS: STRESS PHYSIOLOGY AND PHOTOBIOLOGY**

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The flora of continental Antarctica is dominated by lichens. These symbiotic associations consist of a fungus (the mycobiont) and a green alga or cyanobacterium (the photobiont) essential for carbon nutrition of the symbiotic organisms. Lichen thalli occur in crustose and more complex growth forms. In non-crustose species (macrolichens) of continental Antarctic habitats, green algal photobionts of the genus *Trebouxia* clade S are the most widespread. In the study presented, the role of the photobionts concerning stress tolerance was examined by physiological experiments with isolated photobionts and entire lichen thalli. The study has been performed in situ and under laboratory conditions with lichens from North Victoria Land, continental Antarctica. Photobionts were isolated from lichens collected at North Victoria Land, Coal Nunatak (Alexander Island) and Rothera Point (Antarctic Peninsula), as well as from a European site (Gotland, South Sweden) for comparison. The physiological response of the various isolated *Trebouxia* photobionts to desiccation/rehydration, freezing/thawing and high light intensities indicates a habitat-specific stress physiology. The photobionts of endemic Antarctic lichens showed peculiar resistance towards the applied stressors. While desiccation and high light intensities caused long-term reduction of the studied photobionts' vitality, freezing could easily be tolerated. The results will improve knowledge on a) the role of adaptations on the photobiont level in the physiology of lichen thalli, and b) the physiological prerequisites of lichens for the successful colonization of the terrestrial Antarctic biome.

The novel comparative approach of the study presented will give fundamental information on the physiology of lichens, additionally providing a baseline for the recognition and interpretation of the consequences of environmental change in future decades.

## **NITROGEN AVAILABILITY AND NITRIFICATION IN PERMAFROST AFFECTED SOILS OF SAMOYLOV ISLAND IN THE LENA RIVER DELTA**

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Permafrost soils (Gelisols) cover about a quarter of the northern hemisphere surface. Gelisols are in subsoils continuously frozen throughout the year and only the active layers thaw during the short vegetation period. The main characteristic of these soils covered by polygonal carex-sedge tundra vegetation is the extreme soil moisture and temperature regime, which ranges from -30°C to +18°C. Element cycles of carbon (C) and nitrogen (N), which are mostly driven by microorganisms, are influenced by these extreme environmental parameters. In this study, nitrification as one important part of the microbial controlled N-cycle was investigated in typical wet arctic tundra sites of the Lena river delta, Northeast Siberia, Russia. During nitrification ammonia is oxidized in two steps via nitrite to nitrate.

Dissolved inorganic nitrogen (DIN, ammonia, nitrite and nitrate) were analyzed as an indicator for N-limitation in different soils over the vegetation period and additionally potential nitrification and N-mineralization rates were determined for giving insight into the ongoing N-cycle in the investigation sites.

Different permafrost soils on Samoylov Island in the Lena river delta were analyzed: Polygonal tundra (Typic Aquiturbel and Typic Historthel) was characterized as water saturated organic rich soils with high C/N ratios and slightly acid pH values. The dry sandy soils of the floodplain areas (Typic Psammenorthel and Psammentic Aquorthel) were characterized by neutral pH value, a high mineral content and low water content.

DIN was generally detected in small amounts. In the water saturated polygons ammonium was present in all samples and the main element of DIN, nitrate wasn't detectable: so the polygonal tundra can be characterized as nitrogen limited. At the soils of the beach without vegetation nitrate was enriched by the end of the vegetation period. In the sandy, but organic matter rich layers of the beach and cliff, remineralized ammonium was detectable but decreasing during the vegetation period. Nitrite was in general present in trace amounts. In soil samples of the floodplain areas higher nitrification potentials were measured than in the water saturated peaty soils of the polygonal tundra. The potential nitrification and N-mineralization rates were in comparison to soils in moderate climate very low.

In Samoylov Island the soils of the polygonal tundra are N-limited; in the sandy soils of floodplain required N species are available. They are provided by the slowly occurring but important process of nitrification.



## **CAVE.LIFE: SCHOOLS WORKING ON LAMPENFLORA IN AN ENGLACIAL SYSTEM (HINTERTUXER EISPALAST)**

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Bridging schools and science is sometimes a hard nut to crack. However, the program Sparkling Science (based in Austria) offers best conditions for establishing those contacts. The scope of CAVELIFE is the investigation of ice caves as a glacial refugium for microbes. In order to sustain reproduction and metabolism the living communities in this harsh environment must adapt to extreme conditions such as low temperatures, low nutrient concentrations and very limited availability of liquid water. So far, knowledge about the microbial loop in ice ecosystems such as ice caves with its various compartments (ice, melt water, sediment and ambient air) is scarce. Moreover, most of these caves in Central Europe are subject to touristic usage which most likely provokes an impact on the original composition of the cave flora and fauna. To assess the ecological potential of those ice caves in term of biomass and metabolism (respiration, carbon production) we intend to conduct a series of studies together with various schools from Austria and the US. Additional experiments will be subject to study the consequences of anthropogenic impact. Since ice caves are ultra-oligotrophic habitats, hence there is a specific need for the application of non-invasive techniques to detect biosignatures. With a laser application which is able to detect photosynthetic active pigments, amino and nucleic acids in ice, respectively, we intend to establish a non-invasive mode to be able to detect these molecules via a rover even in niches of the ice caves with limited access. Furthermore, the scanning mode of the laser with various applications could improve the resolution of data points substantially when compared to traditional coring and sampling. Together with schools of Innsbruck and the US we plan to describe biological communities with this modular laser system of which a portable prototype already exists. These future investigations should shed light on so far neglected ecosystems which are extremely sensitive to slight temperature changes.

## L.I.F.E. (LASER INDUCED FLUORESCENCE EMISSION) AS NON-INVASIVE TOOL TO ASSESS PHOTOSYNTHETIC PIGMENTS IN ICE ECOSYSTEMS

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Laser-induced fluorescence emission (L.I.F.E.) is an *in situ* laser scanning technique to detect photoautotrophic pigments such as phycoerythrin of an ice ecosystem without invasion. The sensitivity of many psychrophiles to even moderate changes in temperature, and the logistical difficulties associated with either *in situ* analysis or sampling makes it difficult to study microbial metabolism in ice ecosystems in a high resolution. In general, the ice habitat has to be disrupted using techniques that usually include coring, sawing and melting. Samples are also often chosen blindly, with little indication of probable biomass. The need for an *in situ* non-invasive, non-destructive technique to detect, localize, and sample cryosphere biomass in the field is therefore of considerable importance.

Surface communities of cold ecosystems are highly autotrophic and therefore ideal systems for L.I.F.E examinations. 532nm green lasers excite photopigments in cyanobacteria and produce multiple fluorescence signatures between 550nm and 750nm including carotenoids, phycobiliproteins which would enable a non-invasive *in-situ* measurement.

L.I.F.E has already been tested in remote ecosystems like Lake Untersee and Lake Fryxell (Antarctica) as well as High Arctic and Alpine glaciers, but until now no calibration was set to convert the L.I.F.E. signal into pigment concentration. Here we describe the standardization for detection of phycobiliproteins (phycoerythrine) which are found in red algae, cyanobacteria, and cryptomonads. We could relate different concentrations of phycoerythrine and also chlorophyll<sub>a</sub> with a corresponding fluorescence signal. Furthermore the dependency of the L.I.F.E. signal with the depth of phycoerythrine in the ice, as well as with the concentration of sediments was analysed.

Similar methods are already used for detection of phytoplankton in liquid systems like oceans and lakes by NASA's Airborne Oceanographic LIDAR since 1979. The possibility to use L.I.F.E. in ice ecosystems though is a novelty.

## **ANWENDUNG DER SATELLITEN- UND FLUGGRAVIMETRIE FÜR DIE SCHWEREFELDBESTIMMUNG IN DER ANTARKTIS**

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Die Bestimmung des äußeren Schwerfelds der Erde ist eine Hauptaufgabe der Geodäsie. In vielen Problemstellungen -- und nicht nur in der Geodäsie -- spielen schwerfeldbezogene Größen eine wichtige Rolle. So ist das Geoid eine beste Approximation der Figur der Erde und Referenzfläche für Höhensysteme. In der Ozeanographie ist die mittlere Meeresoberflächentopographie auf das Geoid bezogen. In einer glaziologischen Anwendung wird mit Hilfe von Freibordhöhen und Dichteannahmen sowie des Geoids die Dicke von Schelfeisen abgeleitet. Globale, die längeren Wellenlängen des Schwerfelds erfassende Modelle beruhen im Wesentlichen auf Satellitenmessungen, während für höher auflösende Modelle global verteilte, terrestrische Daten hinzugefügt werden müssen. Beide Messmethoden haben in der Antarktis ihre Vor- und Nachteile. Insbesondere entsteht aufgrund der nicht exakt polaren Bahnen der dedizierten Schwerfeldsatelliten eine polare Datenlücke. Terrestrische Daten sind -- aufgrund der bekannten Bedingungen in der Antarktis -- kontinental nicht mit der notwendigen Dichte durch Bodenmessungen erfassbar. Hier stellt einzig die Fluggravimetrie eine leistungsfähige Methode zur oberflächennahen Messung von Schweredaten zur Verfügung.

In der Präsentation wird auf die Methoden der Satelliten- und Fluggravimetrie eingegangen. Die aktuellen Modelle, die insbesondere Daten der Schwerfeldmission GOCE benutzen, werden in Hinblick auf ihre Auflösung und Genauigkeit in der Antarktis untersucht. Aktuelle und geplante gravimetrische Befliegungen, die durch verschiedene polarforschende Institutionen -- unter anderem das AWI -- durchgeführt werden, werden diskutiert. Soweit möglich, werden solche Schweredaten im Rahmen der Subcommission 2.4f "Gravity and Geoid in Antarctica" der Internationalen Assoziation für Geodäsie (IAG) gesammelt und für die regionale Schwerfeldverbesserung genutzt. Schließlich soll ein sich in Planung befindliches Projekt vorgestellt werden, bei dem das neue deutsche Forschungsflugzeug HALO für eine gravimetrische Befliegung in der Antarktis genutzt werden soll. Erste Erfahrungen konnten mit diesem Flugzeug durch die Realisierung der GEOHALO-Mission (Juni 2012) gesammelt werden. Schließlich werden Anwendungen in der Geodäsie und Nachbardisziplinen vorgestellt.

## **A UNIQUE FINE-GRAINED SEDIMENT LAYER DEPOSITED WEST OFF SVALBARD DURING THE INITIAL WARMING AFTER THE LAST GLACIAL MAXIMUM (BØLLING/ALLERØD)**

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The study aims to elucidate the processes that caused the deposition of a unique fine-grained sediment layer at the onset of the last deglacial basically along the western Svalbard margin and the western Yermak Plateau. Grain-size analyses of 11 sediment cores west and north off Svalbard and the Yermak Plateau reveal an exceptionally fine-grained sediment layer that was deposited within a relatively short period of ~300 years during the Bølling interstadial. The layer was found in cores located below the West Spitsbergen Current (WSC) that conveys Atlantic (AW) and mixed water masses northwards along the continental slope. The mixed waters are underlain by Norwegian Sea Deep Water (NSDW, water depth > 1000 m). North of Svalbard the upper 500 m (sill depth) branch off and flow in easterly direction to form the Svalbard Branch of the WSC. Further north the Yermak Slope Current (YSC, water depth: 1000 to 1500 m) advects NSDW towards the Arctic Ocean where it quickly loses its signature north of the Yermak Plateau. The studied fine-grained layer reveals a sortable-silt mean grain size of 15 to 20 µm. The fineness of this layer is basically the result of a coarse-silt subpopulation between 36 and 63 µm that is absent in this layer but present throughout most of the cores. As yet the sediment layer was found in 32 sediment cores (mostly published data) from ~75°N to ~82°N at water depths ranging from ~300 m (Kveithola) to 1880 m (Yermak slope) south, west and north of Svalbard. Very low magnetic susceptibility, a distinct decrease in Ca-ratios and slightly increased Ti-ratios are further key characteristics for the investigated layer (XRF analyses of 4 cores). AMS age determinations of another 4 cores show a doubled to ten-fold increased sedimentation rate for the period of deposition of this layer. The greatest thickness of the fine-grained layer appears in sediment cores from ~1400 to ~1500 m water depth and decreases in cores deeper than ~1600 m and cores shallower than ~1100 m water depth (except for Kveithola), respectively. Thus, the fine-grained material was transported northwards in a relatively narrow strip along the western Svalbard and Yermak slopes. The distribution and thickness of the investigated sediment layer can be linked to both, the rapid melting of the Svalbard and the Barents Sea ice sheets in response to the intense warming at the onset of the Bølling period. Since Kveithola trough is assumed to be fully deglaciaded since 14.7 cal. years BP a sediment source in the adjacent Barents Sea as well as from local fjords of Spitsbergen is likely.

Reference for the oceanographic information: Schlichtholz and Houssais, 1999.

## **3D-MODELLIERUNG VON SCHWERE- UND MAGNETFELD-DATEN IN NORD-VIKTORIALAND (ANTARKTIS): NEUE ERKENNTNISSE ÜBER DAS AUSEINANDERBRECHEN GONDWANAS**

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Auf der Basis verschiedener geophysikalischer Daten ist es möglich, die Struktur des Untergrunds auf verschiedensten Skalen zu untersuchen. Ein Beispiel hierfür ist die 3D-Modellierung von Schwerefeld-daten. In Nord-Viktorialand (Antarktis) sind gravimetrische Daten aus verschiedenen Quellen verfügbar (terrestrisch, Schiffsgravimetrie, Satellitendaten), die zur Modellierung mit dem Programm IGMAS+ genutzt werden können. Dieses Programm bietet die Möglichkeit, gemeinsam mit gravimetrischen Daten auch Magnetfelddaten zu modellieren; die entsprechenden Daten sind aus aeromagnetischen Messungen vorhanden.

Ziel der Modellierung ist es, einen Beitrag zur Klärung der Entwicklungsgeschichte der Region zu liefern, insbesondere hinsichtlich des Auseinanderbrechens des Großkontinents Gondwana. Erweiterte Erkenntnisse zur Struktur der Kruste können dazu Anhaltspunkte liefern.

Nach der Zusammenstellung und einer ersten Evaluierung der Daten ist es möglich, Modelle zu entwickeln, die, ausgehend von allen bekannten geologischen und geophysikalischen Informationen (z.B. geologische Grenzen, Störungen, Dichten und krusteninterne Strukturen), für einzelne Bereiche der Region die geophysikalischen Anomaliefelder bestmöglich erklären.

## **FOSSIL ORGANIC MATTER IN ARCTIC PERMAFROST**

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Permafrost deposits constitute a large organic carbon pool vulnerable to degradation and potential carbon release due to global warming. Permafrost sections along coastal and river bank exposures and subsea cores in northeastern Siberia were studied for organic matter characteristics and ice content. Organic matter stored in permafrost grew, accumulated, froze, partly decomposed, and refroze under different periglacial environments, reflected in specific biogeochemical and cryolithological features. For the studied individual strata (Saalian ice-rich deposits, Pre-Eemian floodplain, Eemian lake deposits, early to middle Weichselian fluvial sands, middle and late Weichselian Yedoma, Taberites, Holocene cover, Holocene thermokarst and thermoerosional sediments, submerged lagoon and fluvial deposits) organic matter accumulation, preservation, and distribution are strongly linked to a broad variety of paleoenvironmental factors and specific surface and subsurface conditions.

Permafrost deposits include twigs, leaves, peat lenses, grass roots, fine-distributed plant detritus, and particulate and dissolved organic matter. The vertical distribution of total organic carbon (TOC) in exposures varies from 0.1 wt % in fluvial deposits up to 45 wt % in Holocene peats. High TOC, high C/N, and low  $\delta^{13}\text{C}$  values reflect less decomposed organic matter accumulated under wet, anaerobic conditions characteristic of relative temperate interglacial and interstadial periods. Glacial and stadial periods are characterized by less variable, low TOC, low C/N, and high  $\delta^{13}\text{C}$  values indicating stable periglacial environments with reduced bioproductivity but stronger decomposition of organic matter under dryer, aerobic conditions.

We present an in-depth studies of organic matter distribution for the arctic permafrost zone, indicating the variability of organic matter distribution between different stratigraphical units, between the same stratigraphical unit at different study sites, and even within stratigraphic units at the same site that need to be taken into account in future inventories.

## **LINKING MUNNOPSIDAE (CRUSTACEA, ISOPODA, ASELOTOTA) OF ICELANDIC WATERS TO LONG-TERM OCEANOGRAPHIC DATA**

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Diversity, composition and distribution of selected isopod genera of the family Munnopsidae Lilljeborg, 1864 in Icelandic waters were studied based on samples of the BIOICE (Benthic Invertebrates of Icelandic Waters) and IceAGE (Icelandic marine Animals: Genetics and Ecology) projects. Icelandic waters are important for observations on climate change, being situated at the transitions between the warmer northern North Atlantic and the colder Nordic Seas, where water exchanges are constrained by the Greenland-Scotland Ridge. Data from the NISE (Norwegian Icelandic Seas Experiment) project were used to model long-term near-bottom mean temperature and salinity values, which were afterwards connected to species data and further used for species prediction models. Of the six munnopsid genera examined in this study, 15 species were identified. In all 10,787 individuals were determined to species level. Some species were either restricted to areas north (four) or south (three) of the ridge, while most species (eight) were present on both sides. The distributional patterns of the evaluated munnopsid genera are heavily influenced by depth. Temperature and water mass appear to play a less important role in driving the distributional pattern of Munnopsidae whereas salinity and sediment type does not appear to influence the species distribution within the study area.

## **PERMAFROST-LAKE INTERACTIONS IN THE 3.6 MA OLD EL'GYGYTGYN CRATER, NE RUSSIA**

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Lake El'gygytgyn provides a continuous record from the Arctic spanning the the last 3.6 Ma, and for much of this time the permafrost dynamics, lake level changes and the tectonical framework played a crucial role for sediment delivery to El'gygytgyn Crater Lake.

Our report provides an overview on how permafrost dynamics affected the lake archive based on multidisciplinary studies of cored deposits in and around the lake. The following questions are addressed:

- how did periglacial slope processes control the sediment transport, the frequent debris flows and the mass wasting to the lake
- how did lake level changes affect the permafrost build-up
- how thick is permafrost
- how old is permafrost

We conclude that (i) tectonics presumably caused extended alluvial fan inception in the catchment. (ii) The progradational sediment transport constantly delivers material to the lake basin. (iii) The slope inclination supports sliding events. (iv) Times of higher relative lake levels during the Quaternary have induced permafrost thaw (i.e. talik) in the lake margin and have destabilized the slopes. (v) The permafrost thickness around the lake is about 330 to 360 m. (vi) The permafrost temperature measured in a 141 m deep borehole is not in equilibrium with the modern climatic conditions, but has inherited a temperature signal from the Last Glacial Maximum. (vii) Cryogenic weathering (freeze-thaw weathering including ice in the deposits) favors the break-up of quartz particles and the enrichment of quartz in the silt fraction on the permafrost slopes. (viii) The permafrost is about 2.5 Ma old, this is the time when the cryogenic weathering became distinctly intense.



## **IMPACT OF CLIMATE CHANGE ON MARINE TRANSPORTATION ON THE NORTHERN SEA ROUTE. PRESENT RESULTS OF THE EU-PROJECT ACCESS**

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During the last 12 years the increase of temperatures on earth have especially affected the decrease of ice in the Arctic Ocean. According to studies of several international research institutions the ice volume (ice area x thickness) was about 76% less than 1979. These institutions predict that in summer 2020 or even earlier the entire Arctic Ocean will be free of ice.

Parallel to these developments in the Arctic a group of 27 research institutions from 11 European countries have started two years ago the EU-Project ACCESS with the aim to investigate the effect of climate change on

- 1. Arctic Environment
- 2. Marine Transportation and Tourism
- 3. Fisheries
- 4. Resource Extraction and
- 5. Governance, Sustainable Development and Synthesis

This presentation will concentrate on Marine Transportation on the Northern Sea Route (NSR) with presenting the scope of work and some first research activities/results on a) Air pollution measurements behind ships by DLR; b) Calculation of travelling time needed on the NSR in the past, present and in the years to come by HSVA; c) Increase of shipments along the NSR from Europe to East Asia by Nordic Bulk Carriers.

## **KARUPELV VALLEY PROJECT – A LONG TERM STUDY OF LEMMING CYCLES IN HIGH ARCTIC GREENLAND IN THE GRIP OF CLIMATE CHANGE**

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Because it harbours one of the most simple vertebrate communities, the high arctic offers unparalleled opportunities to provide new insights into the mechanisms that underlie population dynamics and community processes. For now 25 years in a row, fluctuations of a lemming (*Dicrostonyx groenlandicus*) population have been closely monitored in the North East Greenland National Park, along with the functional and numerical responses of four predators (stoat, arctic fox, snowy owl, long tailed skua).

While it could be shown that the cyclic dynamics within this vertebrate community are primarily driven by predator-prey interactions, recent trends including a fading of these cycles suggest some main responses to climate change possibly related to significant changes in snow cover, with cascading effects on the whole vertebrate community.

This study also highlights how important long term observations are to detect such changes at the community level. Some new approaches are now included in this project to better apprehend the subtle ongoing changes affecting high-arctic environments.

## **DECADAL- TO MILLENNIAL-SCALE ICE-SHEET OSCILLATIONS IN SOUTHEASTERN WEDDELL SEA DURING THE LAST GLACIAL MAXIMUM**

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Until now high-resolution sediment records from the Southern Ocean covering the Last Glacial Maximum (LGM) are very rare. Therefore there is limited knowledge about short-term regional climate fluctuations and their global correlations. To gain insight into annual to decadal-scale climate changes it is imperative to investigate varved archives. We present varved sediment records from the continental slope of the southeastern Weddell Sea. The cores originate from up to 300 m high and up to 100 km long sediment ridges, located on a terrace in 2000 – 3000 m water depth, and are accompanied by channels on their southeastern side.

During the LGM, when the grounded East Antarctic Ice Sheet margin had advanced to the shelf break, coastal polynyas formed, supported by intensified katabatic winds. This led to increased sea-ice formation, which induced brine rejection. The produced dense, high-salinity water masses sank down the continental slope, reworked sediments and drained as contour currents into the channels. Seasonally variable current velocities led to deposition of either a muddy or silty layer, forming an annual layer couplet, a siliciclastic varve. Accordingly, the varved sediment is indicative for ice-sheet advance. Occasional interruption by bioturbated sediments, which must have been deposited during open-water conditions with inactive thermohaline convection, points to ice-sheet retreat (Weber et al., 2011).

We used the BMPix and PEAK tools (Weber et al., 2010a) to distinguish and count the siliciclastic varves. Varve thickness varies quite strongly in time and between different core sites, with a mean thickness of 0.3 – 0.75 cm, hence a mean sedimentation rate of 3 – 7.5 m/kyr. Correlations of the sites using AMS 14C ages and varve counts show that the facies changes from bioturbated to laminated sediment occurred around the same time, i.e., 23 ka, 21.5 ka, 20 ka, and 19 ka. Although the sites only describe about five millennia during the LGM, the pacing of 1000 – 1500 years may correspond to the 1470-yr cycle (Bond et al., 1997) known from the Northern Hemisphere.

For further information on varve thickness variation we conducted bulk and evolutionary spectral analysis on laminated sections using the REDFIT (Schulz and Mudelsee, 2002) and ESALAB (Weber et al., 20b) programs. All varved sediment sections show similar decadal-scale cyclic thickness variations, with a dominant 50 –

85-yr cyclicality. Evolutionary spectral analysis shows, that the 50 – 85-yr cycle appears to have been a rather robust feature during the LGM. This frequency band could either relate to the Gleissberg cycle (Gleissberg, 1944) with an 87-yr cyclicality, and thus be of solar origin, or to the Atlantic Multidecadal Oscillation, a 55-80-yr cyclic North Atlantic sea surface temperature fluctuation, and thus relate to internal atmosphere-ocean interaction.

## **AKKUMULATIONSVERTEILUNG IN NORDGRÖNLAND - ABGELEITET AUS HOCHAUFLÖSENDEN FLUGZEUGGESTÜTZTEN EMR-MESSUNGEN.**

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Die regionale Verteilung der Akkumulation auf Eisschilden ist ein wichtiger Parameter in der Bestimmung der Massenbilanz sowie in der Modellierung. Zur Bestimmung der Akkumulationsraten müssen Proben aus Schneeschächten oder Firn-/Eisbohrkernen genommen, datiert und gewogen werden. Dies ist eine sehr zeitintensive Arbeit und erfordert direkten Zugang zum Untersuchungsgebiet. Daher sind die Akkumulationsraten üblicherweise der am schlechtesten bekannte Parameter hinsichtlich der regionalen Verteilung der zur Bestimmung der Massenbilanz oder Modellierung erforderlichen Datensätze.

Mit den an Eisbohrkernen gemessenen dielektrischen Eigenschaften können Eisbohrkerne sowohl datiert als die Dichte des Eises bestimmt und somit die Akkumulationshistorie rekonstruiert werden. Sie erlauben auch die Übertragung der mittels EMR-Messungen im Eisschild detektierten internen Schichten auf die Eisbohrkerne. Somit können durch Verfolgen von Isochronen, altersgleichen internen Schichten im Eis, die einzelnen Lokationen an denen die Akkumulation bestimmt wurde, miteinander verbunden werden, ohne das dazwischen interpoliert werden muss. Des Weiteren kann aus dem Verlauf der Isochronen abgeleitet werden, wie repräsentativ die jeweils bestimmten Zutragraten sind.

Mit der Erweiterung des geophysikalischen Instrumentariums der Polarforschungsflugzeuge des Alfred-Wegener-Instituts um ein hochfrequentes FMCW-EMR-System (frequency modulated continuous wave electromagnetic reflexion system) wurde es möglich in den Jahren 2010 und 2012 große Bereiche des nördlichen grönländischen Eisschilds hinsichtlich der internen Struktur in den oberen 150 m in jeweils 2-3 Wochen zu kartieren. 2010 wurde ein engmaschiges Raster von 30 x 60 km<sup>2</sup> mit einem Profilabstand von 1 km um die NEEM Tiefbohrung (N 77° 30' / W 051° 18') abgedeckt und in der zweiten Messkampagne wurden Profile zwischen den diversen Eisbohrlokation der Nordgrönland Traverse (NGT) des AWIs geflogen. Dabei wurden über 10000 Profilkilometer oberhalb der 2000 m Isohypse des Eisschilds geflogen. Basierend auf diesen Daten werden nun detailliertere Karten der Akkumulationsverteilung der abgedeckten Region als erstellt als es auf Basis der Bohrungen allein möglich ist. Im Vergleich mit diesen neuen Datensatz wird sich zeigen, in wie weit großskalige Klimamodelle die Akkumulationsverteilung wiedergeben und auch aus Satellitenmessungen abgeleitete Akkumulationsverteilungen können validiert werden.

## **GLAZIAL-GEODÄTISCHE LANGZEITSTUDIE (1991-2011) ZU MASSENBILANZ UND EISDYNAMIK IM PAAKITSOQ-GEBIET (WEST-GRÖNLAND)**

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Seit 1991 bis 2011 haben 11 Kampagnen stattgefunden, um die Fließgeschwindigkeit des Eises und die Höhenänderung bzw. Massenbilanz des Inlandeises im Bereich Paakitsoq (Westgrönland) zu untersuchen. Dabei handelt es sich um präzise GPS-Messungen von Pegelnetzen in zwei Untersuchungsgebieten. Eines befindet sich beim Swiss-Camp in einer Meereshöhe von ca. 1170 Meter, wo ursprünglich die Gleichgewichtslinie vermutet wurde. Das zweite Gebiet, genannt ST2, liegt etwa in Fließrichtung in tieferer Lage bei ca. 1000 m ü.NN. Dieses Pegelnetz wurde erst 2004 angelegt. Hier fanden bislang 4 Wiederholungsmessungen 2005, 2006, 2008 und 2011 statt. Das Resultat der Höhenänderungen zeigt sehr deutlich eine stark beschleunigte Höhenabnahme der Eisoberfläche. Während bei Swiss-Camp im Zeitraum 1991-2002 sich  $-0,25$  m/Jahr ergab, waren es 2002-2006 bereits  $-0,60$  m/Jahr und zuletzt in 2006-2011 sogar  $-1,10$  m/Jahr. Bei ST2 ergab sich eine Höhenabnahme 2004-2006 von  $-0,34$  m/Jahr und 2006-2011  $-1,31$  m/Jahr, somit ebenfalls eine starke Beschleunigung. Generell ist die Eisdickenabnahme jetzt dreimal größer als der Trend der früheren Jahre. Aus den Höhenänderungen wurden Massenbilanzen zwischen den Messkampagnen berechnet und mit meteorologischen Daten der AWS des GC-Netzes verglichen. Höhenänderungen wurden auch aus flächenhaften digitalen Höhenmodellen abgeleitet. Hierbei zeigte sich, dass lokale Unterschiede der Höhenänderungen auftreten, die vermutlich durch Variationen der örtlichen Albedo begründet sind. Die Fließbewegung des Eises wurde am Swiss-Camp im gesamten Zeitraum 1991 bis 2011 ermittelt. Es zeigt sich eine signifikante Zunahme der Fließgeschwindigkeit. Dieser Langzeittrend wurde auch in der letzten Messung 2011 bestätigt. Die dynamische Komponente des Eisverlustes vergrößert sich somit. Verglichen wird dieser Befund mit Modellrechnungen, z. B. mit (COLGAN et al., JoGlac. 2011), wobei auch auf saisonale Effekte eingegangen wird. Aus der horizontalen Deformation der Pegelnetze wurden die Strain-Komponenten bestimmt. Unter Anwendung der Inkompressibilitätsbedingung ist damit auch die vertikale Komponente bestimmbar, aus der sich eine vertikale dynamisch bedingte Höhenänderung bestimmen lässt. Die digitalen Höhenmodelle konnten auch zur Validierung von Satelliten-Altimetrie genutzt werden. Beispiele für ICESat und CryoSat-2 werden gezeigt. Das Projekt wurde 2010-2012 mit Mitteln der DFG gefördert.

## INSIGHTS INTO INTRA-SPECIFIC DIATOM DIVERSITY USING HISTORICAL DNA FROM ARCTIC LAKE SEDIMENTS: CAN WE USE GENETIC DIVERSITY TO INFER PALEOENVIRONMENTAL CHANGES?

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Diatoms of the genus *Staurosira* and related fragilaroid species dominate many cold and shallow waters in the Arctic. These minute taxa are morphologically very similar and thus hardly to distinguish. Our morphological studies confirmed the dominance of diatoms from the *Staurosira* species complex in surface and core sediment samples from shallow thermokarst lakes in north-western Yakutia, Siberia. In this study we utilize molecular genetic analyses of the ribulose-1,5-bisphosphate carboxylase/oxygenase large subunit (rbcL) gene to refine the microscopic results and to provide insights into the genetic diversity of *Staurosira* lineages. The genetic diversity was investigated by two different approaches a.) a spatial approach, analyzing the genetic diversity along three transects (in total 21 lakes) spreading from typical tundra to northern taiga using a 191bp rbcL fragment and b.) a temporal approach that discovered the genetic diversity through a sediment core (covering approximately the last 8000 years of lake history) availing a shorter 73bp rbcL fragment. Our analyses showed that sedimentary DNA in arctic sediments can detect inter and intra specific diatom diversity utilizing short rbcL fragments as barcoding markers. Both markers (191bp and 73bp) detected group specific genetic diversity in *Staurosira* and showed evolutionary distinct lineages in space and time. Our analysis indicated that the occurrence of these distinct genetic lineages might be correlated to environmental changes, like differences in water chemistry and/or in the surrounding terrestrial vegetation that is either dominated by typical tundra or northern taiga. Hence this study, for the first time, uses species-specific genetic lineages of diatoms as a paleolimnological proxy inferring past environmental changes in sedimentary records of the Arctic.

## **TRANSIENT TRACERS IN THE SOUTHERN OCEAN AND THE BENEFITS OF A CONSTRAINED TTD MODEL.**

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The *Transit-Time-Distribution* (TTD) model is used for the determination of water mass mean ages and in second order as an approach of the *anthropogenic carbon* ( $C_{ANT}$ ) column inventory. The TTD model can be applied to transient tracers, e.g. CFC's,  $SF_6$  or further components with a time varying source in the atmosphere and without sinks in the ocean's interior. For meaningful results it is indispensable to constrain the TTD model with a tracer couple such as CFC-12 and  $SF_6$ . Both tracers were measured during the Polarstern-Expedition *ANT-XXVIII/3* in 2012 as part of the Eddy-Pump-Project. The data set includes several full depth zonal and meridional sections in the Southern Ocean and thus provides information about transport processes, mean ages and the column inventory of  $C_{ANT}$ .



## **BRÜCKENPROBLEME ZWISCHEN WISSENSCHAFT UND SCHULE. EIN KRITISCHER ERFAHRUNGSBERICHT VON „COOLE KLASSEN“**

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Seit dem IPY 2007-2009 läuft das Projekt „Coole Klassen“. Ein wichtiges Element ist die Vermittlung von aktuellen Forschungsansätzen in die Schulen durch die Beteiligung von Lehrern an Polar-Expeditionen. Ein weiteres Feld ist inzwischen mit Lehrerfortbildungen hinzugekommen, die in Zusammenarbeit mit pädagogischen Instituten der Länder durchgeführt werden. „Coole Klassen“ konnte bisher den Personalanforderungen auf beiden Feldern, sowohl auf Lehrer- wie auf Wissenschaftlerseite, gerecht werden.

Zunehmend treten aber Probleme in der Zusammenarbeit auf, die oft im mangelnden Verständnis beider Seiten für die wechselseitigen Arbeitsumstände begründet sind. Zeitrahmen und Freiheitsgrade in der Arbeitsgestaltung sind auf beiden Seiten sehr verschieden, was besonders bei Tagungen und Vorträgen deutlich wird. Gravierend sind auch unterschiedliche Auffassungen hinsichtlich der Weitergabe von Ergebnissen. Es werden Beispiele um die Stichworte Expeditionen, Tagungen, Vorträge und Forschungsergebnisse diskutiert.

Ziel des Vortrags ist es, durch eine offene Diskussion um mehr Verständnis bei der Zusammenarbeit zu werben.

## **EAST SIBERIAN RIVER RUN-OFF AND ITS IMPACT ON THE HISTORY OF THE ARCTIC SEA ICE COVER**

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Extent and thickness of the Arctic sea ice cover are presently subject of fast changes. During the late summer of 2012 the extent of the sea ice cover was reduced substantially beyond the minimum of September 2007. The reduction is exceeding far what models predicted, and speculations exist that it may disappear much earlier than assumed hitherto. At the same time the Siberian river run-off is changing in response to the dynamics of the ongoing global change.

From Arctic Ocean sediment cores we know that a sea ice cover existed for the past 48 Mio. yrs., much earlier than assumed hitherto. It is an unresolved question if it existed the entire time span because the stratigraphic record is interrupted by 2 long lasting hiatuses. Strangely its early origin is preceded by a stratigraphic interval where Sediments are flooded with the spores of a fresh water fern (*Azolla*) adapted to subtropical climatic zones - indicating that the Arctic Ocean during the Early Eocene suddenly received large amount of fresh water. We believe that this event marked the plate tectonic collision of the Indian plate with the southern Eurasian Continental margin, resulting in the initial built-up of mountain chains to the South of the Siberian platform and the generation of a drainage pattern of the Siberian rivers to the North. The large amounts of fresh water entering the Arctic Ocean then generated an environment conducive for the initiation of a sea ice cover in the Arctic much earlier than the formation of the Antarctic ice cover. The later part of the Tertiary history of the Siberian river run-off is still shrouded in mystery.

During the Neogene and Quaternary the Arctic Ocean sediment record formed frequently under the influence of intensive melt water events from the glacial ice sheets. The events of the past 200 000 years are known in considerable detail, but it is difficult to link them to the history of the large rivers draining the Siberian hinterland. As part of a major study of the paleomorphology of Northernmost Eurasia we have therefore initiated a project aiming at resolving the history of the Lena River from its upper to the lowermost reaches. During 2 expeditions in 2011 and 2012 we have sampled a substantial number of sections from a large variety of sedimentary environments. Since the sampled materials still await dating, our report can be considered preliminary only.

The late Quaternary history of the upper Lena is complicated by the hypothesis (supported by the distribution of sedimentary facies) that a river transport across Lake Baikal was possible. This hypothesis is in contradiction to most stratigraphic data of Lake Baikal Sediments and of our understanding of age and nature of origin of Lake Baikal itself.

## **PHASE-FIELD THEORY OF BRINE ENTRAPMENT IN SEA ICE: SHORT-TIME FROZEN MICROSTRUCTURES**

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We analyze the early phase of brine entrapment in sea ice, using a phase field model. This model for a first-order phase transition couples non-conserved order parameter kinetics to salt diffusion. The evolution equations are derived from a Landau-Ginzburg order parameter gradient dynamics together with salinity conservation. The numerical solution of model equations by an exponential time differencing scheme describes the time evolution of phase separation between liquid water with high salinity and the ice phase with low salinity. The numerical solution in one and two dimensions indicates the formation of one dominant wavelength, which sets the length scale of the short-time frozen structures. A stability analysis provides the phase diagram in terms of two Landau parameters. It is distinguished an uniform ice phase, a homogeneous liquid saline water solution and a phase where solidification structures can be formed. The Landau parameters are extracted from the supercooling and superheating as well as the freezing point temperature of water. With the help of realistic parameters the distribution of brine inclusions is calculated and found in agreement with the measured samples. The size of the ice domains separating regions of concentrated seawater depends on salinity and temperature and corresponds to the size of sea ice platelets obtained from a morphological stability analysis for the solidification of salt water.

## **WAS BEDEUTET KLIMAWANDEL FÜR JUNGE MENSCHEN AUF DER GANZEN WELT?**

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Was bedeutet Klimawandel für junge Menschen auf der ganzen Welt? Wer ist für die Klimaveränderungen verantwortlich und wer trägt die Konsequenzen? Um diese Aspekte rund um das Thema „Klimagerechtigkeit“ besser nachvollziehbar zu machen, hat das Klimabüro für Polargebiete und Meeresspiegelanstieg am Alfred-Wegener-Institut im Jahr 2011 das von der Deutschen Bundesstiftung Umwelt geförderte Projekt „climateXperience“ durchgeführt. Darüber hinaus organisiert das Klimabüro im Oktober 2012 den Deutsch-Französischen Workshop „Gateway to the Arctic“ am AWI in Bremerhaven, der junge Wissenschaftlerinnen und Wissenschaftler aus unterschiedlichen Disziplinen der Natur und Sozialwissenschaften mit Schwerpunkt Arktis zusammenbringt, um ihnen einen Blick und Austausch über die eigene Disziplin hinaus zu ermöglichen. Der Tagungsbeitrag soll einen Einblick in die Arbeit des Klimabüros geben.“

## **AMUNDSEN SEA, SOUTH PACIFIC: DISTRIBUTION AND DEPOSITIONAL PATTERNS AS AN ARCHIVE OF PALAEOCLIMATE AND PALAEOCEANOGRAPHY**

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The distribution of sedimentary sequences at the Antarctic continental slope and rise documents sediment transport and deposition via dynamic bottom currents and ice sheets. Analysing seismic reflection data we try to reconstruct sediment input (path and hence provenance, amount) and sediment transport patterns as an indication for climate changes and modifications in palaeoceanography. Depocentres and sedimentation rates of four sedimentary units show distinct differences in location and shape. The oldest unit ASR-I (> 21 Ma) shows a narrow depocentre parallel to the continental slope interpreted to represent low energy material input via a river estuary, which later formed Pine Island Trough East (PITE). Sediment drifts observed in the elevated Marie Byrd Seamount area point towards a significant sea ice cover but not full glacial conditions for the period before 21 Ma.

A strong increase in sediment input documented by a larger depocentre and much higher sedimentation rates is interpreted as evidence for glacial conditions in West Antarctica already during the Early Miocene. Warming as the result of the Mid Miocene Climatic Optimum resulted in a wet ice sheet, and led to a higher sediment supply for the period 21-14.1 Ma. Material was input along a broad front but with a focus via PITE and Abbot Trough (AT). Most of the material was transported into the eastern Amundsen deep sea where it was shaped into levee-drifts by a re-circulating bottom current. Two smaller depocentres seaward of AT and Pine Island Trough West (PITW) and reduced sedimentation rates indicate a cooler and dryer ice sheet resulting from the onset of stronger cooling after 14 Ma. A dynamic ice sheet since 4 Ma showing growth and decline during warm and cold phases is documented by a strong increase in sedimentation rates. Since 4 Ma material input was dominant via AT and PITW, where it interacted with a west-setting bottom current resulting in the continued formation of levee-drifts in the eastern and central Amundsen Sea.

## MODELING YEAR-ROUND MARINE MAMMAL HABITAT PREFERENCES IN THE SOUTHERN OCEAN BASED ON PASSIVE ACOUSTIC OBSERVATIONS

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An understanding of marine mammal distribution patterns forms the basis of the design and implementation of effective management measures. Habitat modeling offers a valuable approach to combine information on species presence (or absence) with local environmental parameters to explore species-specific habitat affinities. Most habitat modeling approaches require marine mammal presence-absence data which can only be obtained during dedicated visual surveys. However, in the Southern Ocean, the collection of visual data is complicated by the region's remoteness, limited seasonal accessibility and the dependency on favorable light and weather conditions to conduct visual observations. Passive acoustic monitoring, by contrast, is highly suitable for long-term monitoring of marine mammals as they use sound in many behavioural contexts and species can be readily identified by their acoustic signatures. Passive acoustic data provide accurate information on temporal patterns in acoustic presence and time spent in the vicinity of the recorders. Furthermore, knowledge on the behavioral context in which specific sound types are produced can be used to derive information on habitat usage.

Here we describe an approach for combining multi-year, year-round marine mammal presence data from passive acoustic recorders with a selected set of relevant environmental parameters to develop species-specific habitat models. Our project comprises multi-year passive acoustic data collected in Antarctic coastal as well as offshore areas throughout the Weddell Sea. Some of the species recorded are sighted only rarely during visual surveys, but are acoustically abundant in our recordings, such as the Antarctic blue whale (*Balaenoptera musculus intermedia*), humpback whale (*Megaptera novaeangliae*), fin whale (*B. physalus*), leopard seal (*Hydrurga leptonyx*), crabeater seal (*Lobodon carcinophaga*) and Ross seal (*Ommatophoca rossii*). The model will incorporate both static environmental variables, such as depth or slope, and dynamic variables, such as sea surface temperature, sea surface height, sea ice concentration and their derivatives.

The project aims at furthering our current understanding of marine mammal habitat affinities in the Southern Ocean by constructing species-specific habitat models at yet unprecedented spatial and temporal time scales.

## **RECONSTRUCTION OF THE ANAEROBIC CARBON CYCLING IN DEEP ARCTIC ENVIRONMENTS**

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Microbiological studies over the last two decades have shown the existence of diverse and active microbial ecosystems in the deep subsurface. It has been estimated that out of the total pool of prokaryotes inhabiting the Earth, between 75% and 94% occur in deeply buried marine and terrestrial sediments. Another surprising fact is that the biomass of the deep subsurface ecosystems is greater in numbers than the one in surface near habitats. This indicates the fundamental role of biomass from the deep biosphere for the global biogeochemical cycles over short and long time scales. However, the deep subsurface of the Earth, especially in arctic environments, remains relatively unexplored in the field of microbiology. Deep sediments of the Arctic play a key role for the Earth's climate because of the huge amounts of belowground carbon that are preserved in the frozen ground and the fact that global warming is most pronounced in polar regions. Especially the thawing of terrestrial permafrost is suggested to be associated with a massive release of greenhouse gases, in particular methane. To understand how the system will respond to climate changes it is not only important to investigate the current status of microbial carbon turnover but also to reconstruct the systems' response to climate changes in the past. Therefore, a comprehensive study was conducted, comprising 400 ka old archives of past microbial activity and recently active microorganisms in terrestrial permafrost deposits recovered from central Lena Delta and lake sediments in Chukotka, NE-Russia. Using a broad set of analytical methods (including ribosomal RNA gene based approach and lipid biomarker analyses) in Middle- to Late Pleistocene deposits we show a strong correlation between organic matter concentration and microorganism abundance. Lipid biomarkers that are stable in geological time scales were used to reconstruct the past microbial communities and their response to climate changes. In particular, archaeol demonstrated changes in the abundance of methanogenic archaea throughout the last 42 ka. This suggests, past warming trends caused an increase of methanogenic communities, while cooling trends cause a decline. Furthermore, analyses of phospholipid esters (PLFAs) and ethers (PLELs), characteristic markers for living bacteria and archaea, suggest the presence of living microbial cells in up to 400 ka old deposits. This was supported with incubation experiments, where significant methane production rates were observed. Our results show a quantitative and qualitative temperature response

of the microbial communities in deep arctic deposits to past climate changes. Microorganisms do not only survive in the frozen ground, but they can be also metabolic active under energy limited conditions contributing to the carbon transformation in arctic environments.



## **ICEBERG ALLEY – ANTARCTIC GATEWAY TO LOWER LATITUDES**

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To understand the natural sea-level rise during the last deglaciation is a key to understand current and future climate change. Here, the role of the Antarctic Ice Sheet is poorly understood, yet crucial because ice-sheet collapse in a warming world could cause rapid sea-level rise. We developed a chronology for the Weddell Sea sector of the East Antarctic ice sheet (EAIS) that, combined with ages from other Antarctic ice-sheets, indicates that the advance to (at 29 –28 ka) and retreat from their maximum extent (at 19 ka, and again, at 16 ka) was nearly synchronous with Northern Hemisphere ice sheets (Weber, M.E., Clark, P. U., Ricken, W., Mitrovica, J. X., Hostetler, S. W., and Kuhn, G. (2011): Interhemispheric ice-sheet synchronicity during the Last Glacial Maximum. – *Science*, 334, 1265-1269, doi: 10.1126/science.1209299).

Using an atmospheric general circulation model we conclude that surface climate forcing of Antarctic ice mass balance would likely cause an opposite response, whereby a warming climate would increase accumulation but not surface melting. Furthermore, our new data support teleconnections involving a sea-level fingerprint forced from Northern Hemisphere ice sheets as indicated by gravitational modeling. Also, changes in North Atlantic Deepwater formation and attendant heat flux to Antarctic grounding lines may have contributed to synchronizing the hemispheric ice sheets.

Recent data from two well-dated deep-sea sites from the Scotia Sea (Weber, M.E., Kuhn, G., Sprenk, D., Rolf, C., Ohlwein, C., and Ricken, W. (2012): Dust transport from Patagonia to Antarctica – a new stratigraphic approach from the Scotia Sea and its implications for the last glacial cycle. – *Quaternary Science Reviews*, 36, 177-188,

doi: 10.1016/j.quascirev.2012.01.016) provide the first integrative and representative record of Antarctic Ice Sheet instability. These sites, located in the central transport route of virtually all Antarctic icebergs, the so-called Iceberg Alley, demonstrate a highly dynamic Antarctic Ice Sheet during the last deglaciation with eight distinct phases of enhanced iceberg routing, dubbed Antarctic Ice Sheet Events (AIE), in contrast to existing models of a late and monotonous ice-sheet retreat with little contribution to the last, natural, sea-level rise 19,000 to 9,000 years ago. We found the first direct evidence for an Antarctic contribution to Meltwater Pulse 1A in the flux rates of ice-rafted debris.

Using an ensemble of transient deglacial model simulations we could show that increased export of warmer Circumpolar Deep Water towards Antarctica contributed to Antarctic Ice Sheet melt by ocean thermal forcing (Weber, M. E., Clark, P. U., Kuhn, G., Timmermann, A., Sprenk, D., Gladstone, R., Zhang, X., Lohmann, G., Menviel, L., Chikamoto, M., Friedrich, T., submitted: Millennial-scale variability of the Antarctic Ice Sheet throughout the last deglaciation. – *Science*, under review). These new findings hold the potential to substantially revise and improve our understanding of the transient response of the ice sheet to external and internal forcings, and the contributions to the postglacial isostatic adjustment as well as to the last, natural, sea-level rise. Our results will also help improving projections of future sea-level rise by implementing enhanced ocean thermal forcing.

## **SEISMOSTRATIGRAPHY OF THE SIBERIAN ARCTIC OCEAN AND ADJACENT LAPTEV SEA SHELF**

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The contribution presents a new seismostratigraphic model for the East Siberian part of the Arctic developed on the base of multichannel seismic reflection lines collected along a transect at 81°N. Age control for the sedimentary units was acquired via links to seismic lines and drill site data of the Canada Basin, the Lomonosov Ridge, and the adjacent Laptev Shelf. The data provide an insight into the sedimentary cover and crustal surface in which in turn tectonic and glacial processes are documented.

Two distinguished seismic interfaces were mapped throughout the area, which form a crucial link between the stratigraphy of the Laptev Sea and models on the evolution of the Lomonosov Ridge. The lower one, a pronounced sequence of high-amplitude reflectors is the most striking feature in the Siberian Arctic Ocean. It indicates a strong and widespread change in deposition conditions. Probably it developed during Oligocene times when a reorientation of Arctic Plates took place, accompanied by a widespread regression of sea level. The top of the reflector band is suggested to mark the end of Oligocene, and consequently the sedimentary sequences above are younger than 23 Ma. The upper interface parallels the seafloor in a depth of about 200ms. It is marked by a change from a partly transparent sequence with weak amplitude reflections below to a set of continuous high-amplitude reflectors above. The high amplitudes indicate a strong alternation in deposition conditions. Likely this interface marks the transition to large-scale glaciation of the northern hemisphere, and consequently is dated to top of Miocene (5.3 Ma).

## **SOUTHERN OCEAN ICEBERG DRIFT**

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Icebergs are fragments of glacier ice, which break-off from the ice shelves and glacier tongues all around Antarctica. After calving, icebergs drift through the ocean, driven by a number of forces. The main forces are the ocean currents and the wind, but also the Coriolis force, sea surface tilt, sea ice concentration and strength, as well as the wave radiation do influence the drift of icebergs. The relative contributions of the individual forces depend on the environmental conditions (e. g. sea ice or open water) and the iceberg size and thickness.

A drift algorithm is used to simulate the drift of icebergs through the Southern ocean. The iceberg drift algorithm is implemented in the Finite Elemente Sea-ice Ocean Model (FESOM), which has a spatial resolution of 10 km close to the ice shelf edge and 30 km offshore.

A test was carried out to study the effect of iceberg size and thickness as well as model set ups on the drift pattern. "Test icebergs" of a simplified shape were released into the model domain from 77 locations around Antarctica to simulate and analyse their path. The model results were compared with available observations.

Additionally to the drift, the model also calculates the melting of icebergs and therefore the freshwater input into the ocean.

## LIMITATIONS OF NORTHWARD TREELINE EXPANSION IN SIBERIA: COMPARING FIELD SURVEY RESULTS WITH INDIVIDUAL-BASED VEGETATION MODELLING

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The Siberian treeline, which is exclusively formed by different *Larix* species, follows approximately today's 10-12° C July isotherm. A northward expansion of boreal forests into tundra regions due to climate change is assumed and might result in e.g. decreased albedo, increased carbon sequestration and evaporative cooling, as well as altered vegetation composition. Hence, the question of when and how far the treeline advances is of particular interest. Reproductive capacity and the establishment of seedlings at the treeline are assumed to represent major processes that limit northward treeline expansion.

We investigate past treeline transitions by applying two different procedures. Our first approach is based on a detailed field survey, conducted in 2011 near the Taimyr Peninsula, North Siberian Lowland, during which we investigated the stand structure of *Larix gmelinii* at four different sites (between 70.6° N and 72.4° N) in the tundra-taiga ecotone.

There is reason to suspect that different limitations govern the reproductive success across the arctic treeline along a north-south gradient. Based on our data we hypothesise that reproductive success in the north, at the species boundary, is mainly limited by the amount of seed-producing trees, whereas in more southern regions, with denser crown cover, competition is the main restricting factor. Between these edges of the tundra-taiga ecotone, we hypothesise temperature to be the most important factor controlling reproduction.

The second approach comprises a vegetation model in order to test our hypothesis with different input-scenarios. In this next step, we want to investigate the influence of various driving factors on the reproductive success of *L. gmelinii* in the tundra-taiga ecotone and point out possible future changes of the treeline position in this region.

## **SEA ICE MASS BALANCE INFLUENCED BY ICE SHELVES: THE SIMBIS PROJECT - OBJECTIVES AND PRELIMINARY RESULTS**

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The overall goal of the SIMBIS project is to improve our understanding of formation processes and properties of Antarctic sea ice and how these are influenced by its snow cover and platelet ice. Platelet ice is ice that is formed in the water column from super-cooled water originating from ice shelf cavities. In order to achieve this goal, we will combine in-situ measurements with satellite observations and numerical studies. Measurements of sea-ice thickness, snow depth, and the under-ice platelet-ice layer thickness will reveal the role of ice shelves for sea-ice formation and its seasonality. Energy balance and measurements, focusing on optical properties, will be performed to describe thermodynamic properties of sea ice and its snow cover. In order to upscale the local measurements, we will analyze several data products from satellites and work towards new multi-sensor approaches for sea-ice analyses. Numerical simulations will be used to quantify the mass contributions from snow and from platelet ice on regional and circumpolar scales. The first field campaign was performed on land-fast sea ice of Atka Bay close to Neumayer III station, Antarctic, between November 2012 and January 2013. Routine measurements of snow and sea-ice properties from July to January are performed annually by the wintering teams since 2011 and add to this project. We will give an overall introduction into the project objectives, methods and first results from the recent field campaign.

## **SEDIMENTATION IN MAXWELL BAY (KING GEORGE ISLAND, WEST ANTARCTIC PENINSULA) DURING THE UPPER HOLOCENE**

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Numerous studies have shown that the Western Antarctic Peninsula is currently experiencing a temperature increase that is higher than in other parts of Antarctica. King George Island belongs to the South Shetland Islands that are located approx. 120 km west off the northern tip of the Antarctic Peninsula. On King George Island the ice sheet is waning with accelerating speed. Almost all tidewater glaciers in the adjacent coves of Maxwell Bay have already retreated on land. During austral summers meltwater discharge can be observed in these coves. The meltwater is loaded with suspended fine-grained material. This fine-grained material is transported in plumes out of the coves and settles in Maxwell Bay.

Results from sub-bottom profiles underline this observation. The profiles show different acoustic patterns: (1) Very well stratified layers down to 50 m below the seafloor in Maxwell Bay whereas (2) within the tributary fjords at water depths < 200 m very thin, disturbed and often almost acoustically transparent packages have been recorded.

During RV Polarstern cruise ANT-XXIII/4, marine sediment cores were recovered along a profile from the eastern slope of Maxwell Bay. The cores were taken in high-accumulation areas at the entrances of Collins Harbor, Marian and Potter coves. Results from radiocarbon dating of biogenic carbonate suggest that the cores cover approximately the last 2000 years.

Grain size distributions were measured in 1-cm steps in each core with a laser diffraction particle analyzer to be able to identify variations in grain size compositions in a very high resolution. The magnetic susceptibility (MS) parameter fluctuates throughout the cores. It is negatively correlated to the amount of total organic carbon (TOC) and biogenic opal, suggesting dilution of the MS signal through higher input of organic material.

We assume that the presence of fine-grained sediments appearing in the cores in Maxwell Bay reflect periods of intense glacier melting. This allows us together with other parameters to identify warmer and colder periods that are most likely related to Holocene climate fluctuations.

## **CHALLENGES IN ANTARCTIC MARINE BIODIVERSITY AND FOOD WEBS STUDIES: A TOP PREDATORS PERSPECTIVE**

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The Southern Ocean holds a diverse range of unique marine ecosystems. Characterized by extreme environmental conditions, it provides habitats for highly adapted and specialized organisms and communities, some of which are targets of commercial exploitation. Furthermore, the Southern ocean are among the regions that are most susceptible to rapid ocean warming and acidification, two of the most pressing effects of global climate change. This presentation aims to highlight the most recent research work focused on Antarctic marine ecosystems, specifically on the feeding and foraging ecology of top predators (particularly penguins, albatrosses and seals), the development of methods applied to improve this knowledge (e.g. quantifying methods for prey biodiversity, identification guides for prey), modelling tools to predict changes in the future and insights into the conservation of top predators in the Southern Ocean.



## **ARCTIC MULTIYEAR ICE CONCENTRATION RETRIEVAL FROM SSM/I DATA**

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Global warming is most pronounced in the Arctic. The Arctic sea ice extent is a sensitive climate indicator. As a consequence of the strongly decreasing trend of yearly Arctic sea ice minimum in September, the area of multiyear ice, which has survived more than one summer, is decreasing too. Multiyear ice is important because it differs from first year ice in physical and biological respect. Multiyear ice is thicker and therefore conducts less heat from ocean to atmosphere, it has more resistance against deforming forces of wind and currents and it is populated by microorganisms which are at the beginning of the food chain. Therefore multiyear ice area and extent need to be determined as exactly as possible. In this study, we retrieve multiyear ice concentration with two existing methods, namely the NASA Team algorithm, Comiso's algorithm, and a new developed algorithm, the NASA Team algorithm with dynamic tie points. Dynamic tie points are used in the second and third methods to compensate the seasonal impact of brightness temperature variation. To assess the performance of the three methods, analyses were made for the winters from 1998 to 2008. The results show that methods with dynamic tie points yields higher estimates. For all the three methods, there is a clear declining trend of multiyear ice area from 1998 to 2008, which is consistent with the decrease of the yearly minimum ice extent. Furthermore, the ice extent of multiyear ice decreases during the winter, reflecting the expected loss of multiyear ice by melt and export to more southern latitudes.

## **HEINRICH EVENTS MODELED WITH A COUPLED COMPLEX ICE SHEET CLIMATE MODEL**

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We investigate glacial climate variability with a coupled ice sheet model (ISM) atmosphere-ocean-vegetation general circulation model (AOVGCM) system, focusing on one of the most prominent features of glacial climate variability, the Heinrich events. Modeling past climates and periods of past climate change is an important test of the capability of climate models to correctly represent future climate changes. Only if we can correctly represent past climates and climate changes, we can be confident about our predictions of future climate changes. We show results from two experiments: (1) a steady-state LGM experiment where the ice sheet model is accelerated by a factor of 10 compared to the climate model covering 30 kyrs in the ISM (3 kyrs in the AOVGCM) and (2) a synchronously coupled experiment focusing in on one ice sheet collapse covering 3.2 kyrs in both models. For the experiments, we coupled a modified version of the Parallel Ice Sheet Model (mPISM) bidirectionally with the AOVGCM ECHAM5/MPIOM/LPJ. ECHAM5 and LPJ were run in T31 resolution (3:75), MPIOM on a grid with a nominal resolution of 3 and poles over Greenland and Antarctica, mPISM on a 20km grid covering most of the northern hemisphere. In the models, as well as in the coupling, no ux correction or anomaly maps are applied. The ice sheet surface mass balance is computed using a positive degree day scheme with lapse rate correction and height desertification ect. In the experiments, the surges of the Hudson Strait Ice Stream reach discharge rates of 60 000m<sup>3</sup>/s and show a typical recurrence interval of 7 kyrs, matching the basic characteristics for Heinrich events inferred from proxy data. The surges are consequences of an internal instability mechanism suggested by MacAyeal (1993) and various parts of the ice sheets show repeated surging. The large ice discharge during a surge of the Hudson Strait Ice Stream causes an expansion of the sea ice cover in the Labrador Sea and the adjacent North Atlantic. The freshwater, that is released when the ice melts, stabilizes the density stratification in the northern Atlantic. Consequently, the north Atlantic deepwater (NADW) cell weakens by about 10% and the Antarctic BottomWater cell strengthens slightly. The weaker NADW cell transports less heat to the north and thus the ocean heat release decreases. With the increase in sea ice cover and the decrease in ocean heat release, the over the northern Atlantic cools. This cooling spreads downwind into Eurasia. The lower temperature and the increased sea ice cover reduce the evaporation over the northern Atlantic and the Nordic Seas. Consequently, Eurasia receives less precipitation. All in all, the changes in the climate system caused by the ice stream surges are consistent with the proxy reconstructions for Heinrich events.

## **COLLECTIVE MOTION IN PENGUIN COLONIES**

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In Polar Regions, highly adapted social behavior is crucial for the survival of several species. Prominent examples are the huddling behavior of Emperor Penguins, or the crèche (group) formation of King Penguin chicks. To understand how penguins solve the physical problem of movement in densely packed (jammed) groups, we observed Emperor Penguin huddles and King Penguin fledglings with time-lapse/video imaging, and used individual bird tracking and optical flow methods to analyze their movements. We found that Emperor Penguins overcome jamming by moving periodically in large, coordinated clusters. Every 30 - 60 seconds, all penguins make small steps, which travel as a wave through the entire huddle. Over time, these small movements lead to large-scale reorganization of the huddle. Groups of King Penguin fledglings moved in irregular intervals, often attributable to predator attacks, but the individual penguins in the group also moved collectively in a coordinated fashion to ensure the integrity of the group. Our data show that the dynamics of penguin huddling and group formation is governed by intermittency and approach to kinetic arrest in striking analogy with inert non-equilibrium systems. Basic aspects of this behavior can be reproduced with a simple model of interacting point particles. Individual animals are treated as self-driven agents with situation-dependent behavior, similar to simulations of collective swarm behavior in flocks and herds. Both the spontaneous huddle formation and the observed wave patterns emerge from simple rules that only encompass the interaction between directly neighboring individuals. As an important result, our model demonstrates that a collective movement can be triggered by a forward step of any individual within the dense huddle. It remains an open question, however, why individual penguins in a huddle trigger a movement, and by which mechanism the experimentally observed periodicity of huddle movement (~ 40 seconds) remains stable.

## **KLIMAWANDEL UND EXTREMEREIGNISSE: INFLUENCE OF FREEZING PROCESSES ON ORGANIC CONTAMINANT MIGRATION**

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Arctic regions undergo dramatic changes due to climate change, additionally anthropogenic actions such as mining, exploration and refining increase and cause pollution in arctic soils.

Impact, transport and fate of the contaminants are strongly influenced by the special climatic conditions of the region. If contaminants enter permafrost affected soils they are subjected to repeated freezing and thawing within the active layer. It is hypothesized that due to freezing the distribution of contaminants is affected and a zone of higher contaminant concentrations is developed.

This effect was shown in laboratory column experiments for the water soluble organic contaminant 1-Propanol by (Konrad and Seto, 1991) . The underlying processes to create the zone of higher contaminant concentration are water migration and rejection of 1-Propanol during the growth of pore ice, cooling rates smaller than 4°C per day are required for the processes to occur.

The redistribution of raw oil in soil column experiments due to the freezing process was investigated by Chuvilin et al. (2001). For sandy soils it is shown that the oil was rejected and expelled at the freezing front, resulting in low oil contents in the frozen part and elevated oil contents in the unfrozen part right below the freezing front. This part of the column was the one with the lowest freezing rates. Results for fine grained materials such as silt and clay dominated soil materials are not as clear, because two zones of elevated oil contents occur.

Our studies focus on the effect of freeze - thaw cycles on the distribution of hydrophobic organic compounds in soils of different texture. In column experiments the influence of the freezing process on the behavior of the contaminants is investigated. The freezing temperature chosen results in very low freezing rates at the freezing front. First results of these laboratory experiments will be shown and discussed.

## **VARIABILITY OF SOIL ORGANIC CARBON STOCKS OF DIFFERENT PERMAFROST-AFFECTED SOILS: INITIAL RESULTS FROM A NORTH-SOUTH TRANSECT IN SIBERIA**

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Twelve sites within a north-south climatological transect in Siberia were investigated to classify the soils and to determine their soil organic carbon stocks in the top 30 cm of the active layer (SSOC-30). There was a distinct arrangement into three groups of increasing SSOC-30 along the transect with decreasing latitude. The greatest SSOC-30, with mean values of  $24 \pm 9 \text{ kg m}^{-2}$ , were identified for the southern group of forest tundra and taiga sites on the ancient Central Siberian Plateau. The soils of the sand-dominated northwestern part of the Lena River Delta, the second river terrace, had a SSOC-30 of only  $4 \pm 2 \text{ kg m}^{-2}$ , whereas the delta's third and first river terraces stored on average  $12 \pm 3 \text{ kg m}^{-2}$  in the top 30 cm of the active layer. The climatological gradient with changing vegetation productivity and different parent materials result in varying pedogenetic processes and were identified as key controls on the soil organic carbon stocks.

## **ORGANIC CARBON AND TOTAL NITROGEN STOCKS IN SOILS OF THE LENA RIVER DELTA**

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The Lena River Delta, which is the largest delta in the Arctic, extends over an area of 32,000 km<sup>2</sup> and likely holds more than half of the entire soil organic carbon mass stored in the seven major deltas in the northern permafrost regions. The geomorphic units of the Lena River Delta which were formed by true deltaic sedimentation processes are a Holocene river terrace and the active floodplains. Their mean soil organic carbon stocks for the upper 1 m of soils were estimated at 29 kg m<sup>-2</sup> ± 10 kg m<sup>-2</sup> and at 14 kg m<sup>-2</sup> ± 7 kg m<sup>-2</sup>, respectively. For the depth of 1 m, the total soil organic carbon pool of the Holocene river terrace was estimated at 121 Tg ± 43 Tg, and the soil organic carbon pool of the active floodplains was estimated at 120 Tg ± 66 Tg. The mass of soil organic carbon stored within the observed seasonally thawed active layer was estimated at about 127 Tg assuming an average maximum active layer depth of 50 cm. The soil organic carbon mass which is stored in the perennially frozen ground below 50 cm soil depth, which is excluded from intense biogeochemical exchange with the atmosphere, was estimated at 113 Tg. The mean nitrogen (N) stocks for the upper 1 m of soils were estimated at 1.2 kg m<sup>-2</sup> ± 0.4 kg m<sup>-2</sup> for the Holocene river terrace and at 0.9 kg m<sup>-2</sup> ± 0.4 kg m<sup>-2</sup> for the active floodplain levels, respectively. For the depth of 1 m, the total N pool of the river terrace was estimated at 4.8 Tg ± 1.5 Tg, and the total N pool of the floodplains was estimated at 7.7 Tg ± 3.6 Tg. Considering the projections for deepening of the seasonally thawed active layer up to 120 cm in the Lena River Delta region within the 21<sup>st</sup> century, these large carbon and nitrogen stocks could become increasingly available for decomposition and mineralization processes.

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