ALFRED-WEGENER-INSTITUT
HELMHOLTZ-ZENTRUM FÜR POLAR- UND MEERESFORSCHUNG

762
2022

Berichte

zur Polar- und Meeresforschung

Reports on Polar and Marine Research

Polar Regions, Climate Change and Society

28th International Polar Conference
Potsdam, 01 - 05 May 2022
German Society for Polar Research

Edited by

H. Kassens, D. Damaske, B. Diekmann, F. Flisker, G. Heinemann, J. Herrle, U. Karsten, N. Koglin, F. Kruse, R. Lehmann, C. Lüdecke, C. Mayer, B. Sattler, M. Scheinert, C. Spiegel-Behnke, and R. Tiedemann

HELMHOLTZ GEMEINSCHAFT

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Titel: Eisalgenbeprobung an ostantarktischer Küste im Rahmen der Expedition PS128 mit dem Forschungseisbrecher POLARSTERN im Jahr 2022
Foto: Bernhard Diekmann

Cover: Ice algae sampling on the East Antarctic coast as part of Expedition PS128 with the research icebreaker POLARSTERN in 2022
Photo: Bernhard Diekmann

DEUTSCHE GESELLSCHAFT FÜR POLARFORSCHUNG e.V.

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„Polar Regions, Climate Change and Society“

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DEUTSCHE GESELLSCHAFT FÜR POLARFORSCHUNG e.V.

Potsdam, May 2022

Welcome to the 28th International Polar Conference in Potsdam

For many of us, this has been the first on-site conference for several years and thus a special occasion. However, we are all aware that the pandemic situation is not over yet, and we will take all precautions to make this not only a scientifically interesting but also a safe meeting. The pandemic situation is also the reason why this conference had to be postponed several times. Originally meant to bridge the gap until we are able to reconvene, the DGP together with APECS Germany developed the format "Polarstunde", a bi-monthly online meeting where an expert together with an early-career scientist introduce a selected topic, addressing a wider, non-specialist audience. This format turned out to be a huge success with more than 100 participants in some of these meetings. Thus, DGP and APECS decided to continue this format and will resume the "Polarstunde" next autumn.

Another "outcome" of the pandemic situation is that the role of science in society is intensively discussed. This is also true for another of the big challenges society is currently facing, namely global climate change. This is a topic of particular importance for polar research which is in the focus of this and several previous International Polar Conferences. Only in recent years, however, and thanks also to the engagement of the younger generation, society has become increasingly aware of the problems related to climate change. This awareness is also reflected by the intense media coverage of the Arctic MOSAiC Expedition. We are particularly happy that Markus Rex, chief scientist of the MOSAiC project, agreed to give the public evening lecture at this year's polar conference. Unfortunately, the 28th International Polar Conference is also overshadowed by a third large crisis; a war in the middle of Europe waged by Russia against Ukraine. Like many other scientific disciplines, polar research relies on international cooperation. Thus, this crisis is directly affecting the work of many of us. The current fundamental changes makes it likely that the present generation of students and early-stage researchers will not be able to develop their careers within the seemingly borderless scientific community the older generation has grown accustomed to. Also with this in mind, the DGP will continue and increase its efforts to particularly support schools, students, and early-career scientists interested in polar research. In that sense, we also decided to award this year´s Karl Weyprecht Medal to two scientists who have earned huge merits in the promotion of early-career scientists.

The 28th International Polar Conference has been organized in close cooperation with AWI Research Unit Potsdam, APECS Germany and the Coordination Office of the DFG Priority Program "Antarctic Research", which we gratefully acknowledge. We hope you enjoy the programme, the talks and posters, and we are looking forward to having many inspiring discussions with you.

Prof. Cornelia Spiegel-Behnke, Head – Deutsche Gesellschaft für Polarforschung e.V.,
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www.polarforschung.de

Deutsche Gesellschaft für Polarforschung e.V.

Program of the 28th International Polar Conference

01 – 06 May 2022

Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research
Potsdam, Germany

Sunday, 01 May 2022

Wissenschaftsetage Bildungsforum Potsdam

15:00 – 18:00 APECS Meeting

16:00 – 18:00 DGP Executive Board Meeting

18:00 – 21:00 Icebreaker

Monday, 02 May 2022

08:00 – 08:30 Registration, Wissenschaftspark Albert Einstein (Haus H)

08:30 – 09:45 Opening and honors
- Bernhard Diekmann
- Manja Schüle, Minister, Brandenburgian Ministry of Science, Research and Culture
- Cornelia Spiegel-Behnke
- Frigga Kruse & Heidemarie Kassens

09:45 – 10:00 *Dieter Piepenburg (Alfred Wegener Institute Helmholtz Center for Polar and Marine Research)* – The key messages of the 6th Assessment Report 2022 of the Intergovernmental Panel on Climate Change (IPCC) regarding the impacts and risks of and adaptation options to climate change in polar regions

Needs for Innovative Polar Infrastructure

10:00 – 10:15 *Heinrich Miller (Alfred Wegener Institute Helmholtz Center for Polar and Marine Research)* – Planning for Polarstern II

10:15 – 10:45 Coffee break

Glaciers, Ice Sheets and Sea Level Rise
Conveners: Stefanie Arndt & Maria Kappelsberger

10:45 – 11:00 *Moritz Kreuzer (Potsdam Institute for Climate Impact Research), W. Huiskamp, T. Albrecht, S. Petri, R. Reese, G. Feulner, and R. Winkelmann* – Millennial-scale interactions of the Antarctic Ice Sheet and the global ocean

11:00 – 11:15 *Theresa Diener (Alfred Wegener Institute Helmholtz Center for Polar and Marine Research), I. Sasgen, J. Fürst, M. H. Braun, H. Konrad and X. Fettweis* – Acceleration of dynamic ice loss in Antarctica from satellite gravimetry

11:15 – 11:30 *Johannes Fürst (Institute of Geography, Friedrich-Alexander-Universität Erlangen-Nürnberg)* – The hidden freshwater treasures of the Patagonian icefields

11:30 – 11:45 *Johannes Feldmann (Potsdam Institute for Climate Impact Research), R. Reese, R. Winkelmann, A. Levermann* – Shear-margin melting causes stronger transient ice discharge than ice-stream melting according to idealized simulations

11:45 – 12:00 *Steven Franke (Alfred Wegener Institute Helmholtz Center for Polar and Marine Research), N. Neckel, H. Eisermann, J. Asseng, D. Steinhage, V. Helm, O. Eisen, R. Drews, G. Eagles, H. Miller and D. Jansen* – Radio-echo sounding and satellite observations inform about recent and past processes at the ice-sheet base of Jutulstraumen drainage basin (Antarctica)

12:00 – 12:15 *Klaus Strübing (Federal Maritime and Hydrographic Agency (BSH, Hamburg)); member emeritus of International Ice Charting Working Group (IICWG))* – Recent iceberg tracks in the Weddell Sea sector – A study on the basis of Sentinel-1 SAR images

12:15 – 12:30 *Matthias Willen (TU Dresden), M. Horwath, A. Groh, V. Helm, B. Uebbing, J. Kusche* – Spatially resolved glacial isostatic adjustment and ice sheet mass changes within a global inversion framework: feasibility proven by experiments with simulated satellite data

12:30 – 12:45 *Ingo Sasgen (Alfred Wegener Institute Helmholtz Center for Polar and Marine Research), A. Salles, M. Wegmann, B. Wouters, X. Fettweis, B. P. Y. Noël & C. Beck* – Arctic glaciers record wavier circumpolar winds

12:45 – 13:00 *Erik Loebel (TU Dresden), M. Scheinert, M. Horwath, K. Heidler, J. Christmann, A. Humbert* – Automatic glacier calving front extraction by deep learning: methodology and resulting product for Greenland 2013-2021

13:00 – 13:15 *Luisa Näke (Technical University of Denmark), T. Hitziger, J. Heim* – Ice elevation change based on GNSS measurements along the Greenland Korth Expedition

13:15 – 14:30 Lunch

Coole Klassen - Polarbildung in der Schule
Conveners: Rainer Lehmann & Jasmin Stimpfle

14:30 – 14:45 *Falk Ebert (Herder-Gymnasium Berlin)* – Eiskalte Experimente

14:45 – 15:00 *Rainer Lehmann (Europa-Universität Flensburg) & Monika Kallfelz (Pfalzmuseum für Naturkunde - POLLICHIA-Museum)* – Graphiken schülergerecht aufarbeiten - Transferierung wissenschaftlicher Ergebnisse der Polarforschung in graphischer Darstellung in schülergerechtes Arbeitsmaterial

15:00 – 15:15 *Josefine Lenz (Alfred Wegener Institute Helmholtz Center for Polar and Marine Research, Association of Polar Early Career Scientists)* – A personal science accessibility assessment: From Sci-Fi to SciCom to SciIQ

15:15 – 15:30 *Emily Rudolph (Dathe Gymnasium Berlin)* – Raising Awareness: A multimedia Fair about the Arctic

15:30 – 15:45 *Paul Ducommun (Swiss Polar Institute), A. Feierabend* – Swiss Polar Class – An educational programme about the polar regions

15:45 – 16:00 *Frederike Krüger (IGS Bothfeld)* – Ergebnisse didaktischer Bearbeitung von Themen der MOSAiC-Expedition

16:00 – 16:30 Coffee break

DFG SPP 1158 Antarctic Research - Report Colloquium: Response to environmental change and linkages with lower latitude
Conveners: Ulf Karsten & Angelika Graiff

16:30 – 17:00 *Paco Bustamante (La Rochelle Université-CNRS, Institut Universitaire de France (IUF)* – Exposure, bioaccumulation and adverse effects of mercury in polar seabird

17:00 – 17:15 *Helena Herr (University of Hamburg), S. Viquerat, B. Meyer* – Return of the fin whales. Evidence for population recovery 35 years after the end of commercial whaling in the Southern Ocean

17:15 – 17:30 *Charlotte Havermans (Alfred Wegener Institute Helmholtz Center for Polar and Marine Research), D. Martinez-Alarcon, K. Praebel, O. Wangensteen, H. Auel, W. Hagen, C. Held* – The amphipod Themisto gaudichaudii is poised to move poleward: which are the consequences for the pelagic ecosystem of the warming Southern Ocean?

17:30 – 17:45 *Judith Piontek (Leibniz Institute for Baltic Sea Research Warnemuende), A. Engel, C. Hassenrück, K. Jürgens Leibniz* – Organic matter availability drives the spatial variation in the community composition and activity of Antarctic marine bacterioplankton

17:45 – 18:00 *Scarlett Trimborn (Alfred Wegener Institute Helmholtz Center for Polar and Marine Research), J. Heiden, M. P. Meredith, H. J. W. de Baar* – Sensitivity of Western Antarctic Peninsula phytoplankton to climate change

18:00 – 21:00 Meetings of the DGP working groups

Tuesday, 03 May 2022

08:00 – 08:30 Registration, Wissenschaftspark Albert Einstein (Haus H)

Glaciers, Ice Sheets and Sea Level Rise
Conveners: Stefanie Arndt & Maria Kappelsberger

08:30 – 08:45 *Ailsa Chung (CNRS-IGE (Le Centre national de la recherche scientifique - Institut des Geosciences de l'Environnement*), *F. Parrenin, D. Steinhage, S. Lenius, R. Mulvaney, M. Cavitte, O. Eisen, D. Lilien, D. Dahl-Jensen, D. Taylor, P. Gogineni, H. Miller* – Age-depth model using radar measurements at Little Dome C

08:45 – 09:00 *Oliver Huhn (University of Bremen), M. Rhein, J. Sültenfuß, R. Steinfeldt, D. Kieke* – Tracing submarine meltwater from Northeast Greenland towards the South

Changing Atmosphere-Land-Ocean Systems in the Eurasian Arctic
Conveners: Danièle Rod & Thomas Opel

09:30 – 09:15 *Heidemarie Kassens (GEOMAR Helmholtz Center for Ocean Research Kiel), J. Hölemann, S. Jaccard, M. Makhotin, C. de Marliave, V. Povazhny, D. Rod, G. Schaepman-Strub and the Shipboard Scientific Party* – The international expedition ArcticCentury to the Eurasien Arctic

09:15 – 09:30 *Hanno Meyer (Alfred Wegener Institute Helmholtz Center for Polar and Marine Research), T. Opel, T. Tessendorf and the Arctic Century team* – Hydroclimate and cryospheric changes in the Russian High Arctic

09:30 – 09:45 *Jens Hölemann (Alfred Wegener Institute Helmholtz Center for Polar and Marine Research)* – The importance of fast ice on the Siberian shelves for geochemical cycles in the Arctic Ocean

09:45 – 10:00 *Guangyu Li (Institute for Atmospheric and Climate Science, ETH Zurich), A. Welti, and Z. A. Kanji* – Measurements of ice nucleating particles over the Kara and Laptev Sea in the Russian Arctic

10:00 – 10:15 *Felix L. Müller (Deutsches Geodätisches Forschungsinstitut der Technischen Universität München (DGFI-TUM), S. Paul, D. Dettmering, and S. Hendricks* – A comparison between CS2 radar altimetry and MODIS imagery for monitoring thin ice in the Laptev sea

10:15 – 10:45 **Coffee break**

Atmosphere, Sea ice, Ocean and Land Interactions
Conveners: Günther Heinemann & Lena Nicola

10:45 – 11:00 *Marcel Nicolaus (Alfred Wegener Institute Helmholtz Center for Polar and Marine Research), H. L. Rossmann, S. Arndt, M. Lehning, N. Wever, C.Haas* – Snow depth and properties on Antarctic sea ice from autonomous observations and numerical simulations

11:00 – 11:15 *Bernd Kutschan (FH Münster) & Silke Thoms (Alfred Wegener Institute Helmholtz Center for Polar and Marine Research)* – Modelling of small scale processes in Antarctic sea ice - nucleation and crystal growth

11:15 – 11:30 *Andrea Thom & Tim Ricken (University of Stuttgart)* – Modeling of small-scale processes in Antarctic sea ice - a multi-phase continuum approach

11:30 – 11:45 *Janosch Michaelis & Christof Lüpkes (Alfred Wegener Institute Helmholtz Center for Polar and Marine Research)* – The influence of lead patterns on domain-averaged atmospheric profiles over sea ice

11:45 – 12:00 *Günther Heinemann (University of Trier), L. Schefczyk, , C. Drüe, A. Makshtas,* – A three-years climatology of the wind field structure at Cape Baranov (Siberia) from SODAR observations and high-resolution regional climate model simulations during YOPP

12:00 – 12:15 *Alfredo J. Costa (Instituto Antártico Argentino), G. E. Silvestri, A.L. Berman* – Extreme warm events and associated atmospheric patterns in Potter Cove at the South Shetlands, Antarctica

Facing Polar Climate Change: Insights from the Past
Conveners: Nikola Koglin & Vivian Sinnen

12:15 – 12:30 *Karsten Gohl (Alfred Wegener Institute Helmholtz Center for Polar and Marine Research), G. Uenzelmann-Neben, J. Gille-Petzoldt, J. Klages, R. Lamb, C. -D. Hillenbrand, S. Bohaty, S. Passchier, T. Frederichs, J. Wellner, G. Leitchenkov and IODP Expedition 379 Scientists* – Glacially driven shelf-to-rise transport from seismic stratigraphy linked to IODP Expedition 379 drill sites in the Amundsen Sea, West Antarctica

12:30 – 12:45 *Johann P. Klages (Alfred Wegener Institute Helmholtz Center for Polar and Marine Research), C.- D Hillenbrand, S. M. Bohaty, U. Salzmann, K. Gohl, T. Bickert, , G. Kuhn, G. Lohmann, H.S. Knahl, P. Gierz, L. Niu, J.Titschack, T. Frederichs, J. Müller, T. Bauersachs, R.D. Larter, K. Hochmuth, W. Ehrmann, G. Nehrke, F.J. Rodríguez-Tovar, G. Schmiedl, S. Spezzaferri, T. van de Flierdt, , A. Eisenhauer, G. Uenzelmann-Neben, O. Esper, J.A. Smith, H. Pälike, C. Spiegel, T. Freudenthal, and the Science Team of Expedition PS104* – Asymmetry in Antarctic ice sheet cover during the early Oligocene glacial maximum

12:45 – 13:00 *Henning Bauch (Alfred Wegener Institute Helmholtz Center for Polar and Marine Research), E. Taldenkova, O. Rudenko, A. Stepanova* – The Eurasion Ice Sheet during Saalian times (MIS 6) and its impact on the Boreal Transgression and subarctic interglacial development

13:00 – 13:15 Robert F. Spielhagen *(GEOMAR Helmholtz Centre for Ocean Research Kiel), F. Robert, M. Forwick, F. Lemmel* – Latest Pleistocene and Early Holocene deglaciation history of the NE Greenland shelf as recorded in a sediment core from the western Fram Strait (79°N)

13:15 – 14:30 Lunch

Tectonic Processes and Stratigraphy
Conveners: Frank Lisker & Antonia Ruppel

14:30 – 14:45 *Frank Lisker & Andreas Läufer (University of Bremen)* – Antarctica prior to glaciation: a basin system within Gondwana

14:45 – 15:00 *Karsten Gohl (Alfred Wegener Institute Helmholtz Center for Polar and Marine Research), C. Gaedicke, E. Weigelt, O. Eisen, G. Leitchenkov, Y. Schulze Tenberge, J. Klages, G. Kuhn, H. Bauch, R. Tiedemann, N. Koglin* – Seismic stratigraphy offshore Ekström Ice Shelf indicates stable East Antarctic Ice Sheet in Dronning Maud Land sector since early Oligocene glaciation

15:00 – 15:15 *Cornelia Spiegel-Behnke (University of Bremen), M. Zundel, C. Mark, D. Chew, I. Millar, Y. Najman, J. Klages, G. Kuhn, F. Lisker, K. Gohl* – Evidence for a>1500 km pre-glacial transcontinental river system in West Antarctica

15:15 – 15:30 *Jörg Ebbing (University of Kiel), M. Lösing, A. Wansing, B. Heincke, M. Moorkamp* – Enhancing sub-ice geology with geophysical inversion and cluster analysis

15:30 – 15:45 *Katrin Meier (University of Bremen), P. O'Sullivan, M. Jochmann, P. Monien, K. Piepjohn, F. Lisker, C. Spiegel* – Connecting the thermal evolution of Northern Greenland and Svalbard by dating thermal anomalies in Upper Cretaceous-Paleogene sediments

15:45 – 16:00 *Nikola Koglin (Bundesanstalt für Geowissenschaften und Rohstoffe), A. Läufer, K. Piepjohn, A. Gerdes, D. W. Davis, U. Linnemann, S. Estrada* – Paleozoic sedimentation and new Caledonian terrane architecture in NW Svalbard: Indications from U–Pb geochronology and structural analysis

16:00 – 16:30 Coffee break

16:30 – 16:45 *Christoph Gaedicke (Bundesanstalt für Geowissenschaften und Rohstoffe), K. Gohl, J. Klages, A. Läufer, N. Koglin, R.. Tiedemann, E. Smith, O. Eisen, G. Mollenhauer, G. Kuhn, D. Franke, R. Gromig, A. Ruppel, F. Wilhelms* – Towards a continental drilling proposal for recovering Late Mesozoic to Cenozoic sedimentary strata from beneath the Ekström Ice Shelf, Weddell Sea, Antarctica

Humans in Changing Polar Regions
Conveners: Heidemarie Kassens & Anette Salles

16:45 – 17:00 *Volker Rachold (German Arctic Office, Alfred Wegener Institute Helmholtz Center for Polar and Marine Research)* – Political and Scientific Cooperation in the Arctic – Back to Square One?

17:00 – 18:00 General Meeting of the DGP

19:00 – 20:30 **Public Evening Lecture**
Convener: Bernhard Diekmann

Markus Rex (*Alfred Wegener Institute Helmholtz Center for Polar and Marine Research*) – Expedition MOSAiC

Wednesday, 04 May 2022

08:00 – 08:30 Registration, Wissenschaftspark Albert Einstein (Haus H)

DFG SPP 1158 Antarctic Research – Report Colloquium: Dynamics of climate change components
Conveners: Ulf Karsten & Angelika Graiff

08:30 – 08:45 *Doris Ilicic (IGB Leibniz Institut für Gewässerökologie und Binnenfischerei), J. Woodhouse, U. Karsten, J. Zimmermann, T. Wichard, M. L. Quartino, G. L. Campana, A. Livenets, S. Van den Wyngaert, H. -P. Grossart* –Antarctic meltwater impacts fungal parasites

08:45 – 09:00 *Fatemeh Ghaderiardakani (Friedrich Schiller University Jena), M. L. Quartino, E. Barth, T. Wichard* – Deciphering the collaborative adaptation of the holobiont of Ulva to cold temperatures in Antarctica

09:00 – 09:30 *Ruth Mottram (Danish Meteorological Institute)* – The surface mass budget of Antarctica: open questions, uncertain answers, large impacts

09:30 – 10:00 *Tom Bracegirdle (Polar Climate and Prediction Group Leader, British Antarctic Survey)* – The past and future of winds over the Southern Ocean and Antarctica and current priorities for research

10:00 – 10:15 *Stefanie Arndt (Alfred Wegener Institute Helmholtz Center for Polar and Marine Research)* – Sensitivity of sea ice growth to snow properties in opposing regions of the Weddell Sea, Antarctica

10:15 – 10:45 Coffee break

10:45 – 11:00 *Carolin Mehlmann (Max Planck Institute for Meteorology)* – New sea ice dynamics in ICON:: Icosahedral Nonhydrostatic weather and climate model

DFG SPP 1158 Antarctic Research – Report Colloquium: Improved understanding of polar processes and mechanisms
Conveners: Ulf Karsten & Angelika Graiff

11:00 – 11:30 *Sonja Berg (University of Cologne)* – Integrating marine and terrestrial sedimentary records from East Antarctica to explore late Pleistocene to Holocene ice sheet (in)stability

11:30 – 11:45 *Eric Buchta (TU Dresden), M. Scheinert, L. Eberlein, M. Kappelsberger, C. Knöfel, M. Horwath* – Interaction between mass changes of the Antarctic Ice Sheet and solid Earth in Dronning Maud Land, East Antarctica

11:45 – 12:00 *Mareen Lösing (University of Kiel), Ricarda Dziadek, Tobias Stål, Alex Burton-Johnson* – Antarctic geothermal heat flow – challenges and opportunities

12:00 – 12:15 *Larysa Istomina (Alfred Wegener Institute Helmholtz Center for Polar and Marine Research), G. Heygster, H. Enomoto, S. Ushio, T. Takeshi, C. Haas* – Remote sensing retrieval of Antarctic sea ice surface melt using Sentinel-3 data

12:15 – 12:30 *Nina Maaß (University of Hamburg)* – Comparison of snow height buoy measurements with 1D snow cover simulations in the Weddell Sea

12:30 – 12:45 *Timm Schultz (Technische Universität Darmstadt), A. Humbert, R. Müller* – Towards a physics informed firn densification model

Humans in Changing Polar Regions
Conveners: Frigga Kruse & Anette Salles

12:45 – 13:00 *Volker Strecke (Independent Researcher (formerly Alfred Wegener Institute Helmholtz Center for Polar and Marine Research)* – 60 Years Antarctic Treaty – Celebration in Radio Waves

13:15 – 14:30 Lunch

Permafrost in a Warming World: Impacts and Consequences
Conveners: Gerlis Fugmann & Hugues Lantuit

14:30 – 14:45 *Moritz Langer (Alfred Wegener Institute Helmholtz Center for Polar and Marine Research), T.. Schneider von Deimling, S. Westermann, R. Rolph, R. Rutte, V. Rachold, M.. Schultz, G. Grosse* – Thawing permafrost poses environmental threat to thousands of sites with legacy industrial contamination

14:45 – 15:00 *Thomas Schneider von Deimling (Alfred Wegener Institute Helmholtz Center for Polar and Marine Research), T. Ingeman-Nielsen, E. Trochim, J.. Nitzbon, M. Langer* – Modelling consequences of permafrost degradation for Arctic infrastructure – a case study of the Dalton highway

15:00 – 15:15 *Andrew Frampton & Alexandra Hamm (Dept. Physical Geography and Bolin Centre for Climate Research, Stockholm University, Sweden)* – Implementing physically based models for studying thermal gradients and lateral flows in the active layer of hillslopes in permafrost regions

15:15 – 15:30 *Anna M. Irrgang (Alfred Wegener Institute Helmholtz Center for Polar and Marine Research), M. Bendixen, L. M. Farquharson, A. V. Baranskaya, L. H. Erikson, A. E. Gibbs, S. A. Ogorodov, P. P. Overduin, H. Lantuit, M. N. Grigoriev, B. M. Jones* – Dynamics of Arctic Permafrost Coasts in the 21st Century

15:30 – 15:45 *Jan Nitzbon (Alfred Wegener Institute Helmholtz Center for Polar and Marine Research), G. Krinner, T. Schneider von Deimling, M. Werner, M. Langer* – Quantifying the Permafrost Heat Sink in Earth's Climate System

15:45 – 16:00 *Ngai Ham Chan (Helmholtz-Zentrum Potsdam Deutsches GeoForschungsZentrum GFZ), M. Langer, B. Juhls, S. T. Rettelbach, P. Overduin, K. Huppert, J. Braun* – Arctic Delta Reduced Complexity Model and its Reproduction of Key Geomorphological Structures

16:00 – 16:30 Coffee break

16:30 – 18:00 Poster session

18:30 – 22:00 Conference dinner

Thursday, 05 May 2022

08:00 – 08:30 Registration, Wissenschaftspark Albert Einstein (Haus H)

Permafrost in a Warming World: Impacts and Consequences

Conveners: Gerlis Fugmann & Hugues Lantuit

08:30 – 08:45 *Helene Köhnen (University of Potsdam, Alfred Wegener Institute Helmholtz Center for Polar and Marine Research), C. Treat, U. Herzschuh, A. Hodson* – Investigating methane emissions from an open-system pingo on Svalbard

08:45 – 09:00 *Kerstin Brembach (Alfred Wegener Institute Helmholtz Center for Polar and Marine Research), A. Pleskachevsky, H. Lantuit* – Detecting wave patterns in Arctic nearshore waters using SAR imagery at Herschel Island - Qikiqtaruk, Yukon, Canada

Polar Organisms and Ecosystems

Conveners: Birgit Sattler & Anabel von Jackowski

09:00 – 09:15 *Anabel von Jackowski (GEOMAR Helmholtz Centre for Ocean Research Kiel), M. J. Hopwood, Y. Gu, A.. Filella, and A. Engel* – Gel particle distribution and dynamics along the East coast of Greenland

09:15 – 09:30 *R. Parmar, A. Linda (Panjab University)* – Hydro-chemical composition and seasonal variation of high altitude lake: A case study of Lam Dal, Chamba, Himachal Pradesh, India

09:30 – 09:45 *Finn Corus (Senckenberg am Meer – DZMB), B. Degen, F. Säring, B. Behrend, H. Link, G. Veit-Köhler* – Sea-ice cover is crucial for meiofauna community composition in the Weddell Sea

09:45 – 10:00 *Simeon Lisovski (Alfred Wegener Institute Helmholtz Center for Polar and Marine Research), J. Conklin, P. Battley, K. Gosbell, J. van Gils, M. Klaassen, T. Lameris* – Large scale consequences of rapid environmental change and limited capacity to adjust migration schedules in arctic breeding shorebirds

10:00 – 10:15 *Marie-Charlott Rümmler (ThINK GmbH), J. Esefeld, C. Pfeifer, O. Mustafa* – Emperor penguins and drones: investigations on the sensitivity of the largest penguin species to small aerial observers

10:15 – 10:45 Coffee break

10:45 – 11:00 *Benoît Sittler & Johannes Lang (Naturschutz & Landschaftsökologie Univ. Freiburg)* – Lemming cycles in the grip of climate change - Insights from an ongoing long term study in Northeast Greenland

11:00 – 11:15 *Osama Mustafa (ThINK GmbH), C. Pfeifer, M. -C. Rümmler, F. Hertel* – First German proposals of potential candidates for Antarctic Specially Protected Areas (ASPA)

11:15 – 11:30 *Friederike Säring (University of Rostock), K. Jerosch, H.Pehlke, A. Bick, G.Veit-Köhler, H. Link* – Antarctic polychaete communities: predicting functional and taxonomic patterns using species archetype modelling

Humans in Changing Polar Regions

Conveners: Frigga Kruse & Annette Salles

11:45 – 12:00 *Birgit Sattler & Klemens Weisleitner (University of Innsbruck, Institut für Ökologie und Österreichisches Polarforschungsinstitut)* – ICE – An aesthetic approach to a vanishing good

Needs for Innovative Polar Infrastructure
Conveners: Frigga Kruse & Annette Salles

11:15 – 11:30 *Julia Regnery (formerly Alfred Wegener Institute Helmholtz Center for Polar and Marine Research), I. Schewe, D. Steinhage* – Polar LK II research infrastructure of the Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research

Humans in Changing Polar Regions
Conveners: Frigga Kruse & Annette Salles

11:30 – 11:45 *Cornelia Lüdecke (University of Hamburg)* – Erich von Drygalski's Arctic experience used in Antarctica

11:45 – 12:00 *Barbara Schennerlein (Deutsche Gesellschaft für Polarforschung)* – Nikolai V. Pinegin – A talented artist in service of polar research

12:00 – 12:15 *Enn Kaup, M. Hunt, K. Savomägi, M. Varvas (University of Tallinn* – Second polar knowledge contest and polar expedition for high school students of Estonia

Lunch

Half-day excursion

- E1 - Brickyard Museum Glindow
- E2 - Potsdam City Tour

Friday, 06 May 2022

One-day excursion

- E3 - Geological Bike Tour

28th International Polar Conference, 01 – 05 May 2022, Potsdam, Germany

	Sunday 01.05.22	Monday 02.05.22	Tuesday 03.05.22	Wednesday 04.05.22	Thursday 05.05.22	Friday 06.05.22
8:00 - 8:15		**Registration (Wissenschaftspark Albert Einstein, Haus H)**				
8:15 - 8:30						
8:30 - 8:45		**Opening and honors**	A. Chung et al.	D. Ilicic et al	H. Köhnen et al.	**One-day excursion: Geological Bike Tour (E3)**
8:45 - 9:00			O. Huhn et al.	F. Ghaderiardakani et al.	K. Brembach et al.	
9:00 - 9:15			H. Kassens et al.	R. Mottram	A. von Jackowski et al.	
9:15 - 9:30			H. Meyer et al.		R. Parma & A. Linda	
9:30 - 9:45			J. Hölemann	T. Bracegirdle	F. Corus et al.	
9:45 - 10:00		D. Piepenburg	G. Li et al.		S. Lisovski et al.	
10:00 - 10:15		H. Miller	F. Müller et al.	S. Arndt	M.-C. Rümmler et al.	
10:15 -10:45		**Coffee break**				
10:45 - 11:00		M. Kreuzer et al.	M. Nicolaus et al.	C. Mehlmann	B. Sittler & J. Lang	
11:00 - 11:15		T. Diener et al.	B. Kutschan & S. Thoms	S. Berg	O. Mustafa et al.	
11:15 - 11:30		J. Fürst	A. Thom & T. Ricken		F. Säring et al.	
11:30 - 11:45		J. Feldmann et al.	J. Michaelis & C. Lüpkes	E. Buchta et al	B. Sattler	
11:45 - 12:00		S. Franke et al.	G. Heinemann et al.	M. Lösing	J. Regnery	
12:00 - 12:15		K. Strübing	A. Gosta et al.	L. Istomina	C. Lüdecke	
12:15 - 12:30		M. Willen et al.	K. Gohl et al.	N. Maaß	B. Schennerlein	
12:30 - 12:45		I. Sasgen et al.	J.P. Klages et al.	T. Schultz et al	E. Kaup et al.	
12:45 - 13:00		E. Loebel et al.	H.A. Bauch et al.	V. Strecke		
13:00 - 13:15		L. Näke et al.	R.F. Spielhagen et al.			
13:15 - 14:30		**Lunch (Kantine Haus H)**				
14:30 - 14:45		F. Ebert	F. Lisker & A. Läufer	M. Langer et al.	**Half-day excursions: Brickyard Museum Glindow (E1) Potsdam City Tour (E2)**	
14:45 - 15:00		R. Lehmann & M. Kallfelz	K. Gohl et al.	T. Schneider von Deimling et al.		
15:00 - 15:15	**Wissenschaftsetage Bildungsforum Potsdam**	J. Lenz	C. Spiegel et al.	A. Frampton & A. Hamm		
15:15 - 15:30		E. Rudoph	J. Ebbing et al.	A.M. Irrgang et al.		
15:30 - 15:45		P. Ducommun & A. Feierabend	K. Meyer et al.	J. Nitzbon et al.		
15:45 - 16:00	APECS 15:00 - 18:00 Uhr	F. Krüger	N. Koglin et al.	N.-H. Chan et al.		
16:00 - 16:30		**Coffee break**				
16:30 - 16:45	DGP Executive Board Meeting	P. Bustamante	C. Gaedicke et al.	**Poster session** Wissenschaftspark Albert Einstein (Haus H)		
16:45 - 17:00			V. Rachold			
17:00 - 17:15		H. Herr et al	**General Meeting of the DGP**			
17:15 - 17:30	16:00 - 18:00 Uhr	C. Havermans et al				
17:30 - 17:45		J. Piontek et al				
17:45 - 18:00		S. Trimborn et al				
18:00 - 18:30	**Wissenschaftsetage Bildungsforum Potsdam**	**Meetings of the DGP working groups**				
18:30 - 19:00						
19:00 - 19:30			**Public Evening Lecture**	**Conference dinner**		
19:30 - 20:00			M. Rex: Expedition MOSAiC			
20:00 - 20:30	**- Icebreaker -**		Wissenschaftspark Albert Einstein			
20:30 - 21:00						
21:00 - 22:00						

Sessions

- Glaciers, Ice Sheets and Sea Level Rise
- Coole Klassen - Polarbildung in der Schule
- DFG SPP 1158 Antarctic Research: Report Colloquium
- Changing Atmosphere-Land-Ocean Systems in the Eurasian Arctic
- Atmosphere, Sea ice, Ocean and Land Interactions
- Facing Polar Climate Change: Insights from the Past
- Tectonic Processes and Stratigraphy
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S. Arndt	M.-C. Rümmler et al.	
Coffee break		
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S. Berg	O. Mustafa et al.	
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E. Buchta et al	B. Sattler	
M. Lösing	J. Regnery	
L. Istomina	C. Lüdecke	
N. Maaß	B. Schennerlein	
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- Needs for Innovative Polar Infrastructure

Contents of Abstracts

Stefanie Arndt ✉ *stefanie.arndt@awi.de*

Poster – Atmosphere, Sea Ice and the Polar Ocean

Stefanie Arndt, Mara Neudert, Ilka Peeken, Marcel Nicolaus, Christian Haas

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

EAST VS. WEST: CONTRASTING SNOWPACK PROPERTIES IN THE WEDDELL SEA, ANTARCTICA

As Antarctic snow cover persists during most of the year, it contributes significantly to the sea ice mass and energy budgets due to comprehensive seasonal transition processes within the snowpack. The Weddell Sea has a particular role in this respect as it consists primarily of perennial sea ice in the west, while seasonal sea ice is dominant in the east, as reflected in the respective snow characteristics. However, the spatial and seasonal variability of the snow properties associated with, for example, prevailing atmospheric conditions and the corresponding influence on the underlying sea ice have not yet been investigated in detail.

To do so, we present here a comprehensive compilation of in-situ snow pit observations of physical seasonal and perennial snowpack properties obtained during numerous expeditions in the Weddell Sea since the 1990s, covering spring, summer, autumn, and winter conditions.

First results show a highly heterogeneous snow microstructure in the eastern Weddell Sea in late summer, ranging from small wind slab crystals (<0.5 mm) to large depth hoar crystals (>4 mm). From north to south there is a dominant slush fraction in the north due to the relatively thin sea ice beneath. In contrast, observations further south indicate widespread temperature gradient snow metamorphism evidenced by a high fraction of depth hoar due to colder atmospheric conditions. In contrast, widespread wet snow metamorphism dominates the snowpack in the northwestern Weddell Sea at this time of year, indicated by a high fraction of melt-freeze clusters caused by latitudinally higher solar radiative fluxes. Preliminary seasonal comparisons in the northwestern Weddell Sea show higher mean bulk densities up to 350 kg m-3 associated with high proportions of compacted wind slab and faceted crystals in spring and early summer, while high proportions of depth hoar crystals result in lower bulk densities in winter and early autumn.

Combining these snow observations with atmospheric and oceanic conditions along the previous drift trajectories of the sampled ice floes will provide substantial insight into the associated regional differences in the seasonal sea ice mass and energy budgets in the Weddell Sea.

Stefanie Arndt ✉ *stefanie.arndt@awi.de*

Oral – DFG SPP 1158 Antarctic Research - Report Colloquium: Dynamics of Climate Change Components

Stefanie Arndt

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

SENSITIVITY OF SEA ICE GROWTH TO SNOW PROPERTIES IN OPPOSING REGIONS OF THE WEDDELL SEA, ANTARCTICA

The sensitivity of sea ice to the contrasting seasonal and perennial snow properties in the southeastern and northwestern Weddell Sea is not yet considered in sea ice model and satellite remote sensing applications. However, the analysis of physical snowpack properties in late summer in recent years reveal a high fraction of melt-freeze forms resulting in significant higher snow densities in the northwestern than in the eastern Weddell Sea. The resulting lower thermal conductivity of the snowpack, which is only half of what has been previously assumed in models in the eastern Weddell Sea, reduces the sea ice bottom growth by 18 cm. In the northwest, however, the potentially formed snow ice thickness of 12 cm at the snow/ice interface contributes to an additional 2 cm of thermodynamic ice growth at the bottom. This emphasizes the enormous impact of unappreciated regional differences in snowpack properties on the thermodynamic ice growth.

Henning Bauch ✉ *hbauch@geomar.de*

Oral – Facing Polar Climate Change: Insights from the Past

H.A. Bauch, E. Taldenkova, O. Rudenko, A. Stepanova

Alfred-Wegener-Institut für Meeres- und Polarforschung c/o GEOMAR

THE EURASION ICE SHEET DURING SAALIAN TIMES (MIS 6) AND ITS IMPACT ON THE BOREAL TRANSGRESSION AND SUBARCTIC INTERGLACIAL DEVELOPMENT

The last interglacial climate (Eemian) development and sea level rise in the North Polar region after the penultimate glacial maximum (PGM) differed significantly from the Holocene climate pattern after the LGM. It has been suggested that the cause for it must be sought in the particular volumes and maximal geographical extensions of the Saalian (pre-Eemian) and Weichselian (pre-Holocene) ice sheets, respectively. While in the mid-latitudes both interglacials show a comparable, insolation- driven climate development after each glacial maximum, this pattern deviates in Arctic and sub- Arctic realms. But, understanding the paleoenvironmental history of that important region is particularly hampered by a scarcity of continuous Eemian records, especially on land. To fill that gap a 4.5 m thick sequence of Eemian marine beds from just south of Kanin Peninsula (Arctic Russia). The sequence directly overlies Saalian till and allows for a detailed evaluation of past events and their chronology vs. ocean records by using a multiproxy data set. The record is time-coeval with the collapse of the huge Saalian shelf-based ice sheet which left a glaciostatically overdeepened Barents- Kara seas shelf region. The situtation provided a pathway for rapid inundation of the Eurasian margin as far east as the Taymyr Peninsula – so-called Boreal Transgression – causing an early post-Saalian regional sea level high. The oldest marine sediments reflect a period of harsh, fluvially-affected environmental conditions with cold turbid waters and heavy seasonal sea-ice cover. The later occurrence of a typical Arctic shelf and deep-sea microfossil assemblage together with broad-leaved species in pollen spectra is representative of the climatic amelioration in the early Eemian. The final stage of the record is marked by regression due to regional glaciostatic adjustment. Although conditions remained largely humid and warm - these did gradually deteriorate towards the end of the record - there is no direct indication from the microfossil community for enhanced penetration of warm Atlantic waters. The rich malacofauna, among them abundant Arctica islandica, however, reflect conditions akin to the early Holocene in Svalbard's fjords. At face value, U/Th ages of this species indicate that these sediments were deposited shortly after the PGM during early global sea level rise.

Mackenzie Baysinger ✉ *mackenzie.baysinger@awi.de*

Poster – Permafrost in a Warming World: Impacts and Consequences

M.Baysinger, S. Liebner, J. Strauss, L. Golde, C. Treat

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

EXPLORING GREENHOUSE GAS EMISSION CONTROLS IN HIGH-LATITUDE PEATLAND SYSTEMS DURING THE NON- GROWING SEASON

High-latitude wetlands are of global importance for their ability to sequester vast amounts of carbon. Previous research has focused on greenhouse gas flux dynamics in these landscapes in the growing season, as that is where it has been assumed that is where the majority of biological processes happen (Treat et al., 2018). However, recent measurements by Treat et al., 2018 have shown that non-growing season methane (CH4) emissions accounts for 10 – 100% of annual CH4 flux in high- latitude ecosystems, but our current climate models fail to capture the emission out of the growing season.

My research aims to explore the processes that govern greenhouse gas production in high-latitude wetlands. I aim to isolate potential controls on carbon cycling in laboratory conditions by using soil cores taken from a boreal peatland and a subarctic palsa.

I implement lab-based methods to isolate different potential controls on carbon flux in the field. Using soil cores gathered in both Siikaneva and Finnish Lapland, the experimental treatments will consist of both short and long term incubations and of microbial community analysis. This project will help advance our understanding of how the substantial amounts of carbon currently sequestered in these systems will respond to a changing climate.

Sonja Berg ✉ *sonja.berg@uni-koeln.de*

Oral – DFG SPP 1158 Antarctic Research - Report Colloquium: Improved Understanding of Polar Processes and Mechanisms

Sonja Berg

Universität zu Köln

INTEGRATING MARINE AND TERRESTRIAL SEDIMENTARY RECORDS FROM EAST ANTARCTICA TO EXPLORE LATE PLEISTOCENE TO HOLOCENE ICE SHEET (IN)STABILITY

Mass changes of the East Antarctic Ice Sheet (EAIS) have a direct impact on global sea level. Interaction of the EAIS with the surrounding ocean also causes changes in Southern Ocean circulation and the biological carbon pump. While the EAIS has been regarded to be less sensitive to climatic changes than the marine-based West Antarctic Ice Sheet, recent observations have detected thinning, hence negative mass balances, of some glacier systems of the EAIS. This indicates that the EAIS may be more dynamic and more vulnerable to climatic and oceanographic forcing than previously thought.

Ice sheet retreat histories from different catchments along the East Antarctic margin show some heterogeneity in the timing and extent of EAIS changes since the Last Glacial Maximum (LGM, c. 24-19 thousand years ago). This points to catchment-specific reactions to overall climatic forcing, which can be attributed to different oceanographic settings in the different sectors of the Southern Ocean but also to factors such as individual sub-ice bed topographies and shelf bathymetries. Regional comparisons can reveal which parameters drive ice sheet dynamic in individual catchments and help to identify which portions of the EASI may be particularly vulnerable for rapid mass loss.

To improve the understanding of processes and mechanisms of ocean–ice–continent interactions linked to EAIS dynamics paleoclimate and paleo ice sheet reconstructions can be used. Presently un-glaciates land areas along the EAIS margin, inland nunataks as well as the Antarctic shelf areas contain various types of geological records, such as lacustrine and marine sediments, glacial deposits and fossil avian stomach oil deposits. By integrating evidence from the different archives, important information on ice-sheet proximal climate conditions as well as on the timing and magnitude of ice sheet changes can be gained.

Sonja Berg ✉ *sonja.berg@uni-koeln.de*

Poster – DFG SPP 1158 Antarctic Research - Report Colloquium

Sonja Berg, Louise Emmerson, Michael Zech, Ulrich Wand, Wolf-Dieter Hermichen, Tanja Fromm, Eric Buchta, Gerhard Kuhn, Martin Melles, Christine Heim

Universität zu Köln

MARINE ECOSYSTEM RESPONSE TO LATE PLEISTOCENE CLIMATE CONDITIONS - EVIDENCE FROM SNOW PETREL STOMACH OIL DEPOSITS IN EAST ANTARCTICA

The ecosystem of the Southern Ocean is tightly linked to Antarctic sea-ice, affecting primary productivity and access to foraging grounds for higher level predators, such as sea birds. Microfossil records from marine sediments show large shifts in species assemblages and nutrient cycling in response to changing climatic conditions and sea-ice extent during the Late Pleistocene and Holocene. While the northern latitudes of the Southern Ocean are relatively well covered by sedimentary records, little is known about past changes in sea ice coverage and the abundance and activity of polynyas, and associated ecological changes in near coastal areas off East Antarctica. In this respect, deposits of fossil stomach oil of snow petrels (*Pagodroma nivea*) (also termed Antarctic mumiyo) are unique records of the occupation histories of breeding localities in un-glaciated terrestrial areas of Antarctica. Absolute age assignment by radiocarbon dating and stratigraphic analysis of individual deposits allows for reconstructing changes in snow petrel diet and inferring summer sea-ice variability in coastal regions (Berg et al. 2019, McClymont et al. 2022).

We will present results from a current DFG-funded project (SPP1158) that aims at further development of snow petrel stomach oil deposits as archives for past marine environmental conditions, biogeochemical cycling, and food web structure. For this multi-proxy study, we use fossil stomach oil deposits of various ages (Late Pleistocene to modern) and regional origins (western Dronning Maud Land to Wilkes Land) as well as fresh stomach oils. In order to characterise regional and temporal differences in the diet and foraging habitats of the snow petrels we analyse alkanoic acids and alkanols, which are highly abundant lipids in fresh and fossil stomach oils, and conduct stable isotope measurements on bulk material (δ13C and δ15N) and on lipids (compound-specific δ13C). Focus of the discussion will be to what extent the deposits may be affected by post- depositional alteration, and how this has to be taken into account for the interpretation of lipid- and isotopic proxies in paleo-reconstructions.

References

Berg, S. et al. (2019). Evaluation of mumiyo deposits from East Antarctica as archives for the Late Quaternary environmental and climatic history. Geochemistry, Geophysics, Geosystems 20, 260-276. doi.org/10.1029/2018GC008054

McClymont, E. et al. (2022). Summer sea-ice variability on the Antarctic margin during the last glacial period reconstructed from snow petrel (*Pagodroma nivea*) stomach-oil deposits. Climate of the Past 18, 381-403. doi.org/10.5194/cp-18-381-2022

Julia Boike ✉ *julia.boike@awi.de*

Poster – Permafrost in a Warming World: Impacts and Consequences

Julia Boike, Sarah Chadburn, Julia Martin, Simon Zwieback

Permafrost Research, Geosciences, Alfred Wegener Institute Helmholtz Center for Polar and Marine Research, Potsdam, Germany

STANDARDIZED MONITORING OF PERMAFROST THAW: A USER-FRIENDLY, MULTI-PARAMETER PROTOCOL (T- MOSAIC)

Climate change is destabilizing permafrost landscapes, affecting infrastructure, ecosystems and human livelihoods. The rate of permafrost thaw is affected by surface and subsurface properties and processes, all of which are potentially linked with each other. Yet, no standardized protocol exists for measuring permafrost thaw and related processes and properties in a linked manner. The permafrost thaw action group of the Terrestrial Multidisciplinary distributed Observatories for the Study of the Arctic Connections (T-MOSAiC) project has developed a protocol, for use by non-specialist scientists and technicians, citizen scientists and indigenous groups, to collect standardized metadata and data on permafrost thaw. The protocol introduced here addresses the need to jointly measure permafrost thaw and the associated surface and subsurface environmental conditions. The parameters along transects are: snow depth, thaw depth, and vegetation height, soil texture and water level. The metadata collection includes data on timing of data collection, geographical coordinates, land surface characteristics (vegetation, ground surface, water conditions), as well as photographs. The comprehensive description and management of all data with metadata, central data storage and controlled data access is applied through the Observation to Archives (O2A) dataflow framework.

Through this standardized procedure, data can be monitored in near-real time and their spatial distribution visualized. The dedicated user-friendly application (app) myThaw facilitates the data entry of field measurements and provides standardized data collection and documentation. We started our first measurements during March 2021 with snow depth measurements at the Bayelva site along a 10 meter transect. Several INTERACT sites in Svalbard, Alaska, Canada and Siberia have also agreed to start this data collection. This openly available dataset will also be highly valuable for validation and parameterization of numerical and conceptual models, thus to the broad community represented by the T-MOSAIC project.

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Oral – DFG SPP 1158 Antarctic Research - Report Colloquium: Dynamics of Climate Change Components

Tom Bracegridle

British Antarctic Survey

THE PAST AND FUTURE OF WINDS OVER THE SOUTHERN OCEAN AND ANTARCTICA AND CURRENT PRIORITIES FOR RESEARCH

Climate models simulate a robust poleward shift and strengthening of the main eddy-driven belt of Southern Hemisphere (SH) mid-latitude near-surface westerly winds (hereinafter referred to as the ‘westerly jet’ or ‘jet’) in response to future scenarios of increased greenhouse gas concentrations. Such changes have wide-reaching implications both regionally and globally relating to impacts on, for example, uptake of thermal energy and CO2 in the Southern Ocean and ice-ocean interactions around Antarctica. However, there is a larger inter-model spread in the magnitude of jet responses.

In this talk, recent research will be discussed which demonstrates the importance of coupled atmosphere/ocean/sea ice interactions in influencing future wind changes. Specific regions around Antarctica of particular interest for considering impacts on the Antarctic cryosphere (sea ice, ice shelves and land ice) will be discussed. Recent advances climate modelling will be summarised, along with major outstanding challenges for future research.

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Oral – Permafrost in a Warming World: Impacts and Consequences

Kerstin Brembach, Andrey Pleskachevsky, Hugues Lantuit

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

DETECTING WAVE PATTERNS IN ARCTIC NEARSHORE WATERS USING SAR IMAGERY AT HERSCHEL ISLAND - QIKIQTARUK, YUKON, CANADA

The Arctic is one of the most impacted regions by climate change. Rising air temperatures and the shortening of sea ice periods lead to accelerated erosion rates of permafrost coasts. With coastal erosion, the input of sediment and organic matter into nearshore waters increases, influencing local economies, ecosystems and climate by releasing greenhouse gases. When investigating erosion processes in the Arctic, mechanical erosion by ocean waves is an important factor that must be considered. However, spatial and temporal patterns of significant wave heights (H_s) in these waters are not well known, since in situ measurements are often costly and time consuming and optical spaceborne imagery is bound to cloud free and daylight conditions. The aim of this study is to use the empirical XWAVE algorithm on high resolution SAR X-band imagery to investigate patterns of wind generated H_s in an Arctic nearshore environment that is threatened by rapid coastal erosion. Several TerraSAR-X and TanDEM-X scenes were combined to calculate means of H_s under changing wind conditions in the coastal waters of Herschel Island Qikiqtaruk (HIQ) in the western Canadian Arctic since 2009. We use calibrated mulitlook data acquired in the Strip Map mode with dual and single polarisation and the XWAVE algorithm to calculate the sea state of each available ice free scene in that region. We map the spatial patterns of H_s under different wind conditions and time periods in order to find significant wave patterns that might influence coastal morphology. First results show that over the ice free period, waves appear to be highest northwest of the island while there is a long calm strip along the southeast coastline. This matches the overall westerly wind regime through which HIQ protects the easterly nearshore waters. The northwestern sea state is also characterised by the highest variability in H_s which could coincide with the fetch length depending on sea ice conditions further off-shore. In contrast, the eastern and south-eastern near-shore sea state is more stable as these waters are bordered by land.

Our results show the potential of SAR imagery to detect sea state patterns in remote environments, but also show the need to specifically tune the algorithm to nearshore waters.

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Oral – DFG SPP 1158 Antarctic Research - Report Colloquium: Improved Understanding of Polar Processes and Mechanisms

Eric Buchta, Mirko Scheinert, Lutz Eberlein, Maria Kappelsberger, Christoph Knöfel, Martin Horwath

Technische Universität Dresden

INTERACTION BETWEEN MASS CHANGES OF THE ANTARCTIC ICE SHEET AND SOLID EARTH IN DRONNING MAUD LAND, EAST ANTARCTICA

There is still a high variability of modelled GIA (glacial isostatic adjustment) induced vertical displacement rates in Antarctica regarding their spatial pattern and magnitude (Whitehouse et al. 2019). GNSS (global navigation satellite system) measurements on bedrock allow to determining secular trends of solid Earth deformation and, therefore, provide valuable constraints on GIA modelling. While in West Antarctica, the Antarctic Peninsula and parts of Victoria Land a comparably large number of GNSS stations exists, East Antarctica exhibits big gaps in GNSS coverage. Reasons for this can be found in the lack of bedrock outcrops and the difficult accessibility.

TU Dresden has conducted multiple GNSS measurement campaigns in Dronning Maud Land, which were started already in the mid-1990s. Within an ongoing project funded by the DFG SPP 1158, named “Interaction between mass changes of the Antarctic Ice Sheet and solid Earth in Dronning Maud Land, East Antarctica”, existing GNSS points in the Heimefrontfjella region (western Dronning Maud Land) were observed for a second time in 2020 after their first measurement in 2004/2005. Additionally, two new continuously recording GNSS stations were installed at Kottas Mts. and at Forstefjell Nunatak, also in 2020. Furthermore, in the Thala Hills (Enderby Land) three further GNSS points could be re-measured in February 2022. Thus, it will be possible for the first time to infer deformation rates for the GNSS points in western Dronning Maud Land as well as to extend the time basis for those in Enderby Land to more than 15 years. Thus, also the spatial coverage of the deformation pattern measured by geodetic GNSS will be improved in these parts of East Antarctica.

Here we present first results of a consistent reprocessing of all GNSS measurements in Dronning Maud Land and Enderby Land. We estimate vertical deformation trends with realistic uncertainties considering temporal correlations between daily coordinate solutions. Elastic deformations due to recent ice mass changes are estimated using surface elevation changes from satellite altimetry (Schröder et al., 2019) and from surface mass balance (SMB) models. These elastic deformation trends are then subtracted from the GNSS derived deformations rates, which will then be compared with predictions inferred from global and regional GIA models.

Furthermore, we will discuss the results in relation to an ongoing re-processing of all available geodetic GNSS data in Antarctica (GIANT-REGAIN) in order to gain better insights into the behavior of solid Earth deformation. Since the observed deformation is linked both to processes in the Earth interior (lithosphere and mantle) and to past and present ice sheet changes and dynamics if provide key information advance our understanding of these processes.

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Oral – DFG SPP 1158 Antarctic Research - Report Colloquium: Response to environmental change and linkages with lower latitude

Paco Bustamante

La Rochelle Université – CNRS

EXPOSURE, BIOACCUMULATION AND ADVERSE EFFECTS OF MERCURY IN POLAR SEABIRD

Mercury is a highly neurotoxic non-essential element whose concentrations in the environment have increased sharply since the industrial revolution. Volatile, it is released into the atmosphere by human activities, and transported through the atmospheric pathway and by marine currents. Consequently, it contaminates all the marine ecosystems of the planet, including the polar environments. In its methylated form, mercury bioaccumulates in organisms all along their life and it biomagnifies along food webs, meaning that long-lived top predators such as seabirds are highly contaminated. Because it is possible to sample feathers or blood from birds at the time of reproduction, information on the level of contamination of the marine environment can be obtained from seabirds. As a result, seabirds are very good bioindicators of the state of contamination of the marine environment. Various factors determine the degree of mercury contamination of seabirds, in particular their trophic ecology, which should be well known in order to interpret the results. Due to the toxicity of methylmercury, seabirds have evolved mercury detoxification systems allowing to eliminate this metal in their feathers and/or to co-precipitate mercury with selenium to form a chemically inert compound called tiemannite (mercury selenide). Despite such efficient detoxification systems, mercury can produce various reprotoxic effects in seabirds. These effects can be reduced by the presence of selenium in large quantities or exacerbated if selenium is deficient or by the presence of other contaminants such are organic contaminants. Through different examples concerning Arctic and Antarctic seabirds, the presentation will illustrate the different factors that determine the contamination degree of polar seabirds, the importance of the detoxification mechanisms involved and the effects observed in different situations and for different species.

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Oral – Permafrost in a Warming World: Impacts and Consequences

Ngai-Ham Chan, Moritz Langer, Bennet Juhls, Sara Tabea Rettelbach, Paul Overduin, Kim Huppert, Jean Braun

Helmholtz-Zentrum Potsdam Deutsches GeoForschungsZentrum GFZ

ARCTIC DELTA REDUCED COMPLEXITY MODEL AND ITS REPRODUCTION OF KEY GEOMORPHOLOGICAL STRUCTURES

Arctic deltas form an important component in the evolution of permafrost landscapes. As the climate warms, the future of Arctic deltas will likely take a different course, with implications both local in scale and on the wider Arctic Ocean. One way to model these complex deltas is to use reduced- complexity models (RCMs), of which a representative example is the DeltaRCM-Arctic (Lauzon et al., GRL, 2019). In this work, we applied a series of modifications to DeltaRCM-Arctic to arrive at an updated model, called ArcDelRCM.jl. This model is able to replicate an important and ubiquitous feature observed in Arctic deltas — the underwater ramp that extends from the shoreline of a delta for tens of kilometres towards the ocean at a depth of roughly two metres, which is coincidental with the winter ice thickness. We found that the delayed breakup of bed-fast ice on the outer rims of deltas is ultimately responsible for the development of the ramp feature. However, a series of modifications made to the modelling of permafrost erosion and of the protective effects by bed-fast ice are also important contributors. We also tested a pessimistic warming scenario (in terms of discharge and ice cover) on the simulated deltas of ArcDelRCM.jl. We found that the ramp features degrade on the time scale of centuries and effectively disappear in under a millennium. Ocean processes, which are not included in these models, may further shorten the time scale.

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Poster – Permafrost in a Warming World: Impacts and Consequences

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SIMULATING THE THERMAL REGIME OF RAILWAY EMBANKMENT STRUCTURE ON THE TIBETAN PLATEAU UNDER CLIMATE CHANGE

The Qinghai-Tibet Railway, which is located in the largest high-altitude permafrost area, is a vital transportation infrastructure leading over roughly 500 km of perennially frozen ground. With global warming and its amplifying effect in the Tibetan Plateau, the permafrost on the Tibetan Plateau has been significantly degraded, manifested by decreased permafrost thickness, increased active layer thickness, thermokarst, and surface subsidence, causing severe damage to the infrastructure. For better understanding and assessing the stability of the Qinghai-Tibet Railway in the future, there is a need for physically-based model analyses of the thermal regime of the railway embankment and the evaluation of the risk of railway failure under future climate change.

In this study, we used a laterally coupled version of the one-dimensional CryoGrid3 land surface model, which adopted a tiling approach to represent different sections of the embankment, to simulate the thermal regimes of railway subgrade under present climate conditions, and to provide estimates of future subgrade stability under a low and high climate warming scenario. Our modelled results reveal a satisfactory performance with respect to the comparison between measured and modelled ground thermal regimes. Under present climate conditions, our simulation results suggest mostly thaw-stable conditions as maximum thaw depths do not reach the embankment base. The sunny side (southeast face) is more vulnerable to suffering from thaw settlement or thermal erosion than the shady side (northwest face). Under future climate conditions, our results indicate that the extent of future railway failure due to thawing permafrost will depend on the magnitude of warming. For conditions typical of our investigated case site at Beiluhe (situated on continuous permafrost), our simulations indicate that the railway embankment might largely maintain safe operation until the end of the century under a scenario of climate stabilization (RCP2.6). In contrast, inevitably subsidence of the entire railway subgrade is likely to occur around mid-century under strong warming (RCP8.5), with the first occurrences of railway structure failure expected to occur on the sunny side.

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Oral – Glacier, Ice Sheets and Sea Level Rise

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CNRS-IGE (Le Centre national de la recherche scientifique – Institut des Geosciences de l'Environnement)

AGE-DEPTH MODEL USING RADAR MEASUREMENTS AT LITTLE DOME C

Over the past 5 years, 3 sets of radar measurements were taken (UT, BAS, AWI/CPH/UA) around the 2 areas of interest for the European Beyond EPICA - Oldest Ice project, which aims to retrieve a 1.5 Ma old ice core - Patch A and Patch B of Little Dome C (BELDC). With the preparations of the BELDC drill site completed this season, we now use a combination of radar observations and numerical models to understand the age-depth distribution and dynamic properties of the ice in the area surrounding the drill site.

Several internal horizons have been traced and dated by linking them to the 800 ka old European Dome C ice core. We combine a 1D numerical model which uses inverse methods, constrained by the traced radar horizons and the AICC2012 EDC core accumulation profile.

Modelled results include the age of ice and thickness of a layer of stagnant ice along the radar lines for each of the 3 radar datasets. At BELDC, the average modelled age 60m above the stagnant was around 1.5 million years. We compare the thickness of modelled stagnant ice with that of the basal layer observed in the most recent measurements, and propose that they are the same.

These modelled results are directly relevant for the Beyond EPICA project and for the Australian team planning to drill at Patch A in the Million Year Old Ice project. With radar measurements from other areas in Antarctica the model could be applied to other planned drill projects such as those of Japan, China and the US. Currently, our 1D model is stable around ice sheet domes. We plan to develop a 2.5D model which takes into account ice flow, so could model regions of Antarctica with more varied topography.

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Oral – Polar Organisms and Ecosystems

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SEA-ICE COVER IS CRUCIAL FOR MEIOFAUNA COMMUNITY COMPOSITION IN THE WEDDELL SEA

The Antarctic marine ecosystem is altering due to global warming. Changing sea-ice cover and duration impact the ecosystem and benthic communities which depend on sinking food from the water column. We studied how different sea-ice cover concentrations affect the composition of meiofauna communities in the Weddell Sea. During RV *Polarstern* expedition PS118 to the North- Western Weddell Sea, sediment samples for meiofaunal analysis were taken with the Multicorer (MUC). Three stations were chosen based on differences in sea-ice cover and similarity of sediment grain size. Meiofauna such as Nematoda, Copepoda, Kinorhyncha, Bivalvia, and Annelida were extracted from the sediment samples and counted on higher taxon level. Environmental factors that impact food availability at the sea floor are important for community structure. Sea-ice cover of the last 9 years, previous to sampling, influences the abundance and composition of meiofauna most.

Meiofauna is highly abundant in regions with seasonal sea-ice cover. These findings are the same on larger scales as well as on the here investigated small regional scale. The importance of sea-ice cover for meiofauna communities stresses the need for assessing the effects of climate change on the Antarctic marine ecosystem.

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Oral – Atmosphere, Sea Ice, Ocean and Land Interactions

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EXTREME WARM EVENTS AND ASSOCIATED ATMOSPHERIC PATTERNS IN POTTER COVE AT THE SOUTH SHETLANDS, ANTARCTICA

This work aims to analyze near-surface air temperature at Potter Cove (PC), where *Carlini* Antarctic Station is located, in order to study extreme warm events over this area of 25 de Mayo (King George) Island at the South Shetland Archipelago, located to the northwest of the Antarctic Peninsula (AP).

Daily extreme warm events for each month of the year as well as the record-breaking high temperature event for the 1985-2022 period were considered to study the associated atmospheric circulation patterns. The record-breaking high temperature over PC took place on 7 February 2022 reaching +13.6°C, the highest temperature since records began. Reanalysis data from ERA5 from ECWMF (European Centre for Medium-Range Weather Forecasts) are used to analyze the circulation patterns associated to these extreme warm events in PC, evidencing a northerly large-scale flow as well as a wind speed maximum upstream of the study region which favour the conditions for the occurrence of such events. Furthermore, a foehn effect may have played a relative role regarding topographic features over the area and the evolution of temperature, relative humidity and wind direction and speed along the extreme event. Even though, reanalysis data resolution may not be suitable for understanding the whole forcings, mainly those of local extent, they give an approximate diagnosis of the situation which led to the conditions for the observed extreme events.

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Oral – Atmosphere, Sea Ice and the Polar Ocean

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RECORD-BREAKING COLD TEMPERATURE EVENT REGISTERED AT CARLINI STATION IN POTTER COVE (SOUTH SHETLANDS, ANTARCTICA)

The scope of this study is to analyze the coldest extreme event at *Carlini* Argentine Antarctic Station for the 1985-2021 period, located in Potter Cove (PC), over 25 de Mayo (King George) Island at the South Shetland Archipelago, to the northwest of the Antarctic Peninsula (AP). This was a 4-day extreme event and took place between the 23 and 26 July 1994, with a low record-breaking temperature of -27.3°C since records began regarding the daily minimum July mean temperature is - 9°C. Reanalysis data from NCEP/NCAR (National Centers for Environmental Prediction/National Center for Atmospheric Research) and ERA5 from ECWMF (European Centre for Medium-Range Weather Forecasts) are used to analyze the atmospheric circulation patterns associated to this extreme event in PC which show an easterly large-scale flow favouring the occurrence of such cold extreme event. Additionally, sea ice may have played a relative role since trajectories from the southeast are analysed from the NOAA (National Oceanic and Atmospheric Administration) HYSPLIT (Hybrid Single-Particle Lagrangian Integrated Trajectory) model.

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Oral – Glaciers, Ice Sheets and Sea Level Rise

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ACCELERATION OF DYNAMIC ICE LOSS IN ANTARCTICA FROM SATELLITE GRAVIMETRY

The dynamic stability of the Antarctic Ice Sheet is one of the largest uncertainties in projections of future global sea-level rise. Essential for improving projections of the ice sheet evolution is the understanding of the ongoing trends and accelerations of mass loss in the context of ice dynamics. Here, we examine accelerations of mass change of the Antarctic Ice Sheet from 2002 to 2020 using data from the GRACE (Gravity Recovery and Climate Experiment; 2002–2017) and its follow-on GRACE-FO (2018-present) satellite missions. By subtracting estimates of net snow accumulation provided by re-analysis data and regional climate models from GRACE/GRACE-FO mass changes, we isolate variations in ice-dynamic discharge and compare them to direct measurements based on the remote sensing of the surface-ice velocity (2002–2017). We show that variations in the GRACE/GRACE-FO time series are modulated by variations in regional snow accumulation caused by large-scale atmospheric circulation. We show for the first time that, after removal of these surface effects, accelerations of ice-dynamic discharge from GRACE/GRACE-FO agree well with those independently derived from surface-ice velocities. For 2002–2020, we recover a discharge acceleration of -5.3 ± 2.2 Gt yr−2 for the entire ice sheet; these increasing losses originate mainly in the Amundsen and Bellingshausen Sea Embayment regions (68%), with additional significant contributions from Dronning Maud Land (18%) and the Filchner-Ronne Ice Shelf region (13%). Under the assumption that the recovered rates and accelerations of mass loss persisted independent of any external forcing, Antarctica would contribute 7.6 ± 2.9 cm to global mean sea-level rise by the year 2100, more than two times the amount of 2.9 ± 0.6 cm obtained by linear extrapolation of current GRACE/GRACE-FO mass loss trends.

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Poster – Polar Ecosystems: State, Changes and Management

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TROPHIC ROLE OF GELATINOUS ZOOPLANKTON IN THE ARCTIC MARINE FOOD WEB

Gelatinous zooplankton (GZP) comprising ctenophores, cnidarians and tunicates, gained more interest in recent years. During favorable conditions GZP is known to rapidly increase in biomass and several dominant species are able to exploit the zooplankton standing stock. It is assumed that GZP will increase in biomass with the ongoing warming and Atlantification of the Arctic Ocean. Hence, it is crucial to gain insights into the role of gelatinous zooplankton in the current and future Arctic marine food web. This study targets both benthic and pelagic components of the Arctic marine food web.

First, we aim to determine the role of so-called “jellyfalls”, or jelly carcasses on the seafloor, as a food source for the benthic community. To do so, we investigate the stomach content of benthic scavenging amphipods in Kongsfjorden sampled during Polar night with DNA metabarcoding. Second, we will look at the role of jellyfish as predators in the pelagic system. We focus on a widely distributed boreal-Arctic hydrozoan species, Aglantha digitale, which is also assumed to be a climate- change winner in an “Atlantified” Arctic. Its feeding ecology is scarcely studied, in particular in the Arctic region.This jellyfish is believed to feed on a wide range of zooplankton including copepods.

Due to its high abundance in the Arctic regions, both in summer and winter, it is crucial to investigate spatio-temporal patterns in its diet. Hence, we use DNA metabarcoding of Aglantha’s stomach content to reveal its prey composition in different seasons and regions in order to better predict its future role in an ice-free and Atlantified Arctic.

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Poster – DFG SPP 1158 Antarctic Research - Report Colloquium

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

ARCTIC VS. SUB-ARCTIC PELAGIC AMPHIPODS IN THE FACE OF CLIMATE CHANGE: INSIGHTS INTO THE GENETIC CONNECTIVITY AND DIET SPECTRUM OF THEMISTO LIBELLULA AND T. ABYSSORUM

Rapid warming in the Arctic is drastically impacting marine ecosystems, affecting pelagic communities and food web structure. Themisto amphipods are dominant in the Arctic zooplankton community and represent a key link between secondary producers and higher trophic levels. In the Arctic seas, two coexisting species are found in high biomass: *Themisto libellula*, considered a true Arctic species and *Themisto abyssorum*, a sub-Arctic, boreal species. Many aspects of the ecology and genetic structure of these two species are not well studied, despite their importance in the food web. First, we tested both species for levels of genetic diversity and then assessed their diet spectrum with molecular methods, with a regional focus on the Greenland shelf, Fram Strait and Svalbard. Spatial genetic structure was evaluated using the mitochondrial cytochrome c oxidase subunit 1 gene (COI). Our results revealed strikingly different levels of genetic diversity: low levels in *T. libellula* contrasted with higher diversity in *T. abyssorum*. No spatial genetic structure was found, and both species exhibited high levels of connectivity and evidence of historic demographic expansion. The observed low genetic diversity, in combination with cold adaptations, could cause *T. libellula* to be more susceptible to the warming Arctic. In contrast, high diversity likely increases adaptive potential in *T. abyssorum*. In order to comprehensively characterize the prey spectrum of both Themisto species, we also applied DNA metabarcoding, also using COI, on gut contents. Both species showed a regional variation in prey spectrum. *T. abyssorum*'s diet showed a clear dominance of reads identified as chaetognath species, whereas *T. libellula* had a broader prey spectrum, including ice-associated taxa such as polar cod. Calanoid copepods did not appear as important as prey as assumed from previous (morphological) studies. Several previously overlooked jellyfish taxa were found in the stomachs of both species. The broad prey spectrum of *T. libellula* may indicate a higher flexibility in the light of ongoing food web changes. This work provides new data on these two ecologically important species, which can contribute to predicting how pelagic communities and species interactions will change under further climate change.

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Oral – Coole Klassen – Polarbildung in der Schule

Paul Ducommun and A.Feierabend

Swiss Polar Institute

SWISS POLAR CLASS – AN EDUCATIONAL PROGRAMME ABOUT THE POLAR REGIONS

Swiss Polar Class is a free educational programme for primary schools developed by the Swiss Polar Institute. It was launched in spring 2020. Swiss Polar Class aims to raise awareness of the polar regions and their fragility among Swiss primary school students. The programme is made available to teachers, students or anyone interested in discovering polar regions and has been developed for students from 8 to 12 years old, and beyond. Based on the scientific activities of the Swiss Polar Institute, the programme develops learning content in French and German which includes amongst others theory sheets, worksheets, classroom experiments and videos. Topics such as ice and snow, polar climate, polar animals, polar expeditions or geography of high latitudes are addressed.

Swiss Polar Class gives presentations in classrooms all over Switzerland every month and organizes various events and activities such as an annual drawing competition or online Q&A sessions with scientists. Most recently, Swiss Polar Class participated in the Arctic Century Expedition to produce exciting videos and content about the expedition for students.

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Poster – Stratigraphy and Evolutionary Dynamics at High Latitudes

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WAS OCEANIC ANOXIC EVENT 2 TRIGGERED BY THE EMPLACEMENT OF THE HIGH ARCTIC LARGE IGNEOUS PROVINCE?

The mid-Cretaceous oceanic anoxic event 2 (OAE 2) marked one of the most severe perturbations of the global carbon cycle. OAE 2 was associated with extreme greenhouse conditions characterized by atmospheric CO2 concentration exceeding 1500 ppm and the highest (deep) ocean temperatures of the last 115 Ma. Rapid and extensive outgassing of volcanic CO2 is considered as the most likely trigger of OAE 2. The volcanic source regions, however, remain controversial. The High Arctic Large Igneous Province (HALIP) has become a focus of scientific attention, as its emplacement is thought to have occurred contemporaneously with OAE 2. Yet, the dearth of precise age determinations for HALIP magmatism complicates a robust correlation of events. Here, we present sedimentological and geochemical results from a sedimentary section at Glacier Fiord (Axel Heiberg Island, Nunavut, Canada) that was deposited on the N-Canadian continental shelf within a distance of <300 km of the eruptive centers of Strand Fiord flood basalts, a remnant of mid-Cretaceous HALIP volcanism. Carbon and osmium isotope stratigraphy clearly demarcates OAE 2 and its characteristic sub-events (carbon isotope segments A–C) at Glacier Fiord, providing a robust stratigraphic framework. U-Pb dating of zircons (so far available for a single stratigraphic level) supports the synchronicity of OAE 2 in the High Arctic and at the global stratotype section in the Cretaceous Western Interior Seaway (KWIS).

Volcanogenic sediments at Glacier Fiord occur as discreet bentonite layers that are readily discernable in the field, as well as volcanoclastic material dispersed in the black mudstones that constituted the background sedimentation. These dispersed ashfall deposits are identified based on their distinct grain-size and geochemical signature. Predominating coarse silt with sporadically occurring sand suggest a short aeolian transport of volcanoclastic material. Relatively high Ti- contents indicate a mafic volcanic source, supporting Strand Fiord volcanism as the main source. Two pulses of HALIP volcanism are identified during the early and late stages of OAE 2, respectively, interrupted by a period of volcanic quiescence. Based on the correlation with astronomically constrained reference sections from the KWIS, the first pulse commenced ~60 k.y. prior to OAE 2, concomitant with a globally recognizable shift in the Os isotopic composition of sea water. The period of volcanic quiescence appears to be coeval with the Plenus Cold Event, an interval of global cooling during OAE 2. These temporal relationships may indicate that the waxing and waning of carbon emissions from HALIP volcanism had an important impact on global climate dynamics during OAE 2.

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Oral – Tectonic Processes and Stratigraphy

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Kiel University

ENHANCING SUB-ICE GEOLOGY WITH GEOPHYSICAL INVERSION AND CLUSTER ANALYSIS

The sub-ice geology of Greenland and Antarctica is still not well known as outcrops are limited to coastal regions. The sub-ice geology of Greenland and Antarctica is still not well known as outcrops are limited to coastal regions. However, sub-ice geology has an impact on ice-sheet dynamics by effecting basal friction and melting due to its thermal and compositional structure. Hence, improved models of sub-ice geology and the related physical parameters are needed to improved understanding of the Solid Earth-Cryosphere coupling.

To improve our understanding of the sub-ice geology, we apply a joint inversion approach of gravity and magnetic data – two data sets which have covered large parts of the Polar regions - and exploit how their combination is sensitive to crustal structures. Both datasets are combined through a coupling method which increases the mutual information to get similar and statistically compatible inversion results. Hereby, we minimize data misfit and model similarity under the coupling constraint. Subsequent cluster analysis on the resulting models provides a mean to define geological domains and, hence, interpolate geological structures from the coast under the inland ice. This detailed analysis builds on lithospheric scale models that address the regional background and the consistency between these models has to be carefully controlled. For validation of the results, we rely on existing petrophysical and geochemical data sets, which in addition can be used to extrapolate additional parameters as for example heat production to the interior of the regions.

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Poster – Tectonics and Geodynamic Processes

L. Eberlein, M. Scheinert, E. Buchta

TU Dresden

AUTONOMOUS CONTINUOUSLY RECORDING GNSS STATIONS IN POLAR REGIONS

For more than 25 years, our group at the Technische Universität Dresden has been carrying out GNSS campaign observations in Greenland, Antarctica and Patagonia. Because such campaign observations are only to some extent or even not at all sensitive to seasonal changes, for a long time efforts have been made to establish continuously recording GNSS stations in polar regions. Since 2018 our group has taken up this challenge and has been operating four autonomous GNSS stations in polar regions, two stations in Antarctica (Queen Maud Land) and two stations in south-west Greenland. A further station in north-east Greenland is about to be finally assembled and to start operation in summer 2022. For a flexible assembly and an economic transportability, we have developed a modular system. This also results in a feasible scalability of the energy storage system. Thus, we are able to adapt to the actual conditions in the best way.

In this presentation, we will look in more detail at the technical challenges of energy supply for continuous measurement systems in polar regions, with the polar night being the biggest challenge. We will show how to use metadata of GNSS recordings to draw conclusions on the performance of the energy system and, thus, to enable improving it by small adjustments. Furthermore, we will discuss the advantages and disadvantages of different types of batteries (w.r.t. to their different chemical compound).

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Oral – Coole Klassen - Polarbildung in der Schule

Falk Ebert

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DER KLIMAWANDEL IST IN ALLER MUNDE - ABER IST ER AUCH IM KOPF?

Bei vielen Schüler:innen ist angekommen: Das Klima verändert sich. Die Veränderungen werden ihr Leben maßgeblich beeinflussen. Und alles hat irgendetwas mit CO2 zu tun. Darüber hinaus ist das Verständnis der naturwissenschaftlichen Hintergründe oft sehr vage. Und auch die Vorstellung von „wissenschaftlicher Erkenntnis“ ist oft stark durch mediale Einflüsse verzerrt.

Basierend auf den Erfahrungen, die im Laufe eines Jahres mit einem Klimaphysik-Kurs in der 8. Klasse eines Gymnasiums gemacht wurden, wird dargestellt, welche Fehlvorstellungen auftreten können und wie damit umgegangen werden kann.

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Oral – Coole Klassen - Polarbildung in der Schule

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EISKALTE EXPERIMENTE

Von September-Oktober 2019 hatte ich die außergewöhnliche Gelegenheit, an der größten Arktisexpedition aller Zeiten teilzunehmen. Die MOSAiC (Multidisciplinary drifting Observatory for the Study of Arctic Climate) Expedition hatte als Ziel, das arktische Klima über ein ganzes Jahr möglichst umfassend zu untersuchen, um damit dringend benötigte Daten für globale Klimamodelle zu erhalten. Zurück in Deutschland will ich nun zumindest Ausschnitte dieses Systems für Schüler:innen greifbar und verständlich machen. Und als Instrument dazu sollen Experimente dienen, die jeweils einen Teilaspekt beleuchten, aber in der Vor- und Nachbereitung auch auf die Zusammenhänge eingehen. Markus Rex, der Expeditionsleiter hat nach seiner Rückkehr gesagt, man hätte dem Meereis beim Sterben zugesehen. Diese Aussage klingt dramatisch, ist für Schüler:innen aber erst einmal schwer greifbar, weil Meereis weit weg ist und scheinbar keinen Einfluss auf das Leben in Mitteleuropa hat.

Diese Experimentierreihe eine Serie von Schülerexperimenten, die alle einen Aspekt aus Klima- oder Meeresforschung beinhalten. Viele haben einen Modellcharakter insofern als dass sie Phänomene übertrieben deutlich darstellen. Das ist aber im schulischen Rahmen unvermeidlich, um reale Effekte, die auf langen Zeitskalen passieren, innerhalb einer Schulstunde erlebbar zu machen. Aber im Zusammenhang wird es möglich, Phänomene wie „Eis-Albedo-Rückkopplung“ und „Kipppunkte“ nachzuvollziehen.

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Oral – Glaciers, Ice Sheets and Sea-Level Rise

Olaf Eisen, Linda Ort, Julia Regnery

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30 YEARS OF SURFACE SNOW ACCUMULATION MEASUREMENTS AT NEUMAYER STATION, ANTARCTICA

Surface mass balance is one of the key glaciological variables to determine the present state and future evolution of an ice mass under global climate heating. In particular in Antarctica, surface mass balance is still insufficiently know. Given the size of the ice sheet direct observations or reconstructed values from firn and ice cores are sparse. Indirect satellite remote sensing methods either provide only an integral view of the mass balance (e.g. from gravity missions like GRACE), observe the total change of surface elevation or, like passive microwave observations, come along with considerable uncertainties.

With the end of the year 2021 a 30-year record of surface snow accumulation at the German *Neumayer* overwintering stations has been completed. The data were recorded at approximately fortnightly intervals at the stake farm of the “Pegelfeld Süd“. This provides us now with a time series over a standard climate period which can be used to investigate the interaction of surface accumulation with other environmental properties like temperature, wind, sea ice cover and alike. Moreover, it can be used to validate other products, e.g. from remote sensing or regional climate modelling. The surface accumulation data are complemented by less regular density measurements as well as a second stake farm established in 2009 at the *Neumayer Station III*. We will present first and preliminary result of the annual evolution as well as seasonal characteristics of surface accumulation.

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Poster – Permafrost in a Warming World: Impacts and Consequences

Saskia Eppinger, Michael Krautblatter, Hugues Lantuit, Michael Fritz, Josefine Lenz, Michael Angelopoulos

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PROLONGED AND PROFOUND CHANGES OF RETROGRESSIVE THAW SLUMPS (HERSCHEL ISLAND – QIKIQTARUK, YUKON, CANADA)

Along Arctic coastlines retrogressive thaw slumps (RTS) are common thermokarst landform. They deliver a large amount of material rich in organic carbon to the nearshore zone. In the last century the number of RTS has strongly increased in the Canadian Arctic. Mainly characterized by rapidly changing topographical and internal structures (such as mud flow deposits, thaw bulbs, warm permafrost bodies or seawater-affected sediments) RTS are strongly influenced by incising gullies. We propose that due to thermal and mechanical disturbances, especially large RTS are likely to develop a polycyclic behavior.

Several electrical resistivity tomography (ERT) profiles were carried out in 2011, 2012 and repeated in 2019 on the biggest RTS on Herschel Island – Qikiqtaruk, a highly active and well-monitored study area in the Yukon, Northwest Canada. The 2D ERT transects are crossing the RTS longitudinal and transversal, reaching the undisturbed tundra on the edges. Crossing the main gully draining the slump and quasi-parallel to the shoreline, we measured seven ERT profiles in 2012 and 2019 to reveal internal changes in a 3D model. To calibrate the ERT data, we conducted frost probing to detect the unfrozen-frozen transition in the field and in the laboratory, we measured the bulk sediment resistivity versus temperature curves on samples.

Thermal and topographical disturbances by gullies leading to large erosional features like RTS cause long recovery rates for disturbed permafrost. In this study, we show that ERT can be used to detect prolonged and profound thermal and mechanical disturbances in RTS. We demonstrate that these disturbances are likely to increase the susceptibility of RTS to a polycyclic behavior.

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Poster – Permafrost in a Warming World: Impacts and Consequences

Erkens, E., Angelopoulos, M., Overduin, P., Boike, J.

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IMPROVEMENT OF MARINE ELECTRICAL RESISTIVITY TOMOGRAPHY (ERT) INVERSION TO QUANTIFY ONGOING SUBSEA PERMAFROST DEGRADATION ACCELERATING COASTAL EROSION AT TUKTOYAKTUK ISLAND (NWT, CANADA / BEAUFORT SEA)

The ongoing degradation of subsea permafrost and the resulting release of greenhouse gases might contribute to global warming as a positive feedback mechanism. In addition, thawing of permafrost can accelerate coastal erosion with significant infrastructural and socioeconomic consequences.

This is the case at Tuktoyaktuk Island (NWT, Beaufort Sea), which currently provides a natural barrier protecting the town's harbour but is projected to disappear in the coming 2 to 3 decades.

Although subsea permafrost degradation has a crucial impact on coastal erosion, degradation rates have not been determined and the controlling processes in shallow water are not well understood.

To determine the present state of degradation, the current ice-bearing permafrost table around the island is inferred based on marine ERT surveys (vertical sounding profiles collected in 2021).

The collected data contains profiles north and south of Tuktoyaktuk Island, parallel and perpendicular to the shoreline, each consisting of numerous adjacent vertical soundings in a (quasi- symmetric) reciprocal Wenner-Schlumberger array, using a floating cable towed behind a boat. For the first time, GPS positions of the electrode streamer were recorded, improving pre-processing by excluding measurements for which the cable was curved and electrode positions deviated too widely from their nominal values.

Furthermore, the inversion of floating electrode resistivity survey data was improved by optimizing the inversion method, including considerations of the roll-along 1-D sounding nature of the measurements and of electrode position uncertainty. Local search algorithms and parametrizations were compared in order to obtain the depth of the current subsea permafrost table in accordance with recent seismic and borehole data.

We present inferred thaw depths of permafrost on the northern and southern shores of the island and make recommendations on the use of GPS positioning and inversion techniques for the processing of floating electrode surveys.

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Oral – Glaciers, Ice Sheets and Sea-Level Rise

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SHEAR-MARGIN MELTING CAUSES STRONGER TRANSIENT ICE DISCHARGE THAN ICE-STREAM MELTING ACCORDING TO IDEALIZED SIMULATIONS

Basal ice-shelf melting is the key driver of Antarctica's increasing sea-level contribution. In diminishing the buttressing force of the ice shelves that fringe the ice sheet, the melting increases the ice discharge into the ocean. Here we contrast the influence of basal melting in two different ice- shelf regions on the time-dependent response of an isothermal, inherently buttressed ice-sheet-shelf system. In the idealized numerical simulations, the basal-melt perturbations are applied close to the grounding line in the ice-shelf's 1) ice-stream region, where the ice shelf is fed by the fastest ice masses that stream through the upstream bed trough and 2) shear margins, where the ice flow is slower. The results show that melting below one or both of the shear margins can cause a decadal to centennial increase in ice discharge that is more than twice as large compared to a similar perturbation in the ice-stream region. We attribute this to the fact that melt-induced ice-shelf thinning in the central grounding-line region is attenuated very effectively by the fast flow of the central ice stream. In contrast, the much slower ice dynamics in the lateral shear margins of the ice shelf facilitate sustained ice-shelf thinning and thereby foster buttressing reduction. Regardless of the melt location, a higher melt concentration toward the grounding line generally goes along with a stronger response. Our results highlight the vulnerability of outlet glaciers to basal melting in stagnant, buttressing-relevant ice-shelf regions, a mechanism that may gain importance under future global warming.

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Oral – Permafrost in a Warming World: Impacts and Consequences

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IMPLEMENTING PHYSICALLY BASED MODELS FOR STUDYING THERMAL GRADIENTS AND LATERAL FLOWS IN THE ACTIVE LAYER OF HILLSLOPES IN PERMAFROST REGIONS.

Climate warming is extremely pronounced in the arctic with significant impacts on the active layer in permafrost regions. It is very important to understand hydrological changes in the active layer because it is a critical zone of exchange between the atmosphere and biosphere. It is also important to understand effects of anthropogenic pollution with its subsequent effects on the environment and arctic water resources, because subsurface flows can transport energy and dissolved solutes through permafrost landscapes. However, the characteristics of the flow processes in the active layer are not well understood because the dynamics are very complex, with heat and water flow occurring in a partially saturated and partially frozen porous media, leading to highly nonlinear energy and mass transport effects. This applies both for current climate conditions, where it is necessary to consider the strong seasonal variability exhibited in arctic regions, as well as for changes due to climate warming.

In this contribution, a physically based numerical model which couples surface-subsurface heat and flow processes is adopted and applied to conditions relevant for a hillslope setting in Adventdalen, Svalbard. A multi-year time series of hydro-meteorological measurements is used to drive the model with daily temporal resolution. The model is then used to investigate flow of water and heat in the active layer. We find that in current climate conditions, the subsurface hydrothermal state of the active layer along the hillslope transect is affected by surface recharge and lateral groundwater percolation and flow, leading to differences in moisture distribution throughout the active layer and along the hillslope transect. Although lateral heat advection along the transect is found to be negligible for these hydro-meteorological conditions, we observe that the moisture distribution by gravitationally-driven seepage and flow along the hillslope leads to unexpected temperature differences between the uphill and downhill parts of the transect, such that a cooling effect is observed downhill, corresponding to the valley base. The cooling on the downhill side is primarily attributed to an increase in soil evaporation due to its increase in moisture content. Similarly, an uphill warming effect is observed, attributed to a combination of advective heat by surface recharge as well as reduced soil evaporation. Furthermore, we discuss the potential implications this has for changes in hydro-meteorological inputs corresponding to foreseeable future changes, as well as impacts on transport of solutes, and highlighting complexities and challenges for predictive modelling.

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Oral – Glaciers, Ice Sheets and Sea-Level Rise

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RADIO-ECHO SOUNDING AND SATELLITE OBSERVATIONS INFORM ABOUT RECENT AND PAST PROCESSES AT THE ICE- SHEET BASE OF JUTULSTRAUMEN DRAINAGE BASIN (ANTARCTICA)

Future sea-level predictions require that the history and physical state of the Antarctic ice sheet is well understood and constrained by observations. Much of the ice sheets' ice-dynamic properties are governed by processes at the ice-bed interface which can be imaged with radar sounding surveys.

Moreover, certain processes at the ice-sheet base can have an effect all the way to the ice surface, which in turn can be observed with satellites. Here we use a combination of ultra-wideband radio- echo sounding data, satellite radar and laser altimetry data to characterize the evolution of the subglacial morphology of the Jutulstraumen drainage basin (western Dronning Maud Land, Antarctica). Based on the classification of the bed topography, we reconstruct the step-by-step modifications the subglacial landscape has experienced since the beginning of the glaciation of Antarctica, 34 million years ago. In addition, between 2017 and 2020, we find evidence of active episodic cascade-like subglacial water transport along the subglacial valley network. The combination of these observations will represent an important step towards a better understanding of large-scale ice-sheet dynamics in western Dronning Maud Land.

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Oral – Glaciers, Ice Sheets and Sea-Level Rise

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THE HIDDEN FRESHWATER TREASURES OF THE PATAGONIAN ICEFIELDS

The two Patagonian icefields cover an area of roughly 20 times the size of Berlin and the ice cover has an average thickness of more than 250 m. Altogether the two icefields store almost 40 times as much ice as all glaciers in the Alps. Over the icefield interior, thickness values locally exceed 1000 m and there might well be some over-deepened bedrock sections below sea-level far inland. Moreover, glacier flow speeds are exceptionally high and reach several kilometers per year, matching the largest outlet glaciers of Greenland and Antarctica. These elevated velocities are explained by the high mass turn-over, which results from prolific snowfall. This precipitation stems from predominantly westerly winds impinging on the Andes. I expect that these unique climatic and ice-dynamic conditions are imprinted in the basal topography but it remains unclear to what extent the total ice volume estimate is affected. To this day, existing estimates of the ice-thickness distribution mostly ignored these unique conditions as well as most available ground-truth measurements. The quality of existing thickness-map products is therefore controversial, and at best mediocre along the fast-flowing outlet glaciers.

Here, I present results from an assimilation technique for mapping glacier ice thickness based on mass conservation. It considers contemporaneous information on the climatic, geometric and ice- dynamic conditions. The largest asset is however that all available in-situ measurements of ice thickness were compiled and considered. These observations comprise radar, gravimetry and seismic surveys, remotely sensed glacier retreat as well as bathymetric information near the ice fronts of marine- or lake-terminating outlet glaciers. These thickness observations are readily assimilated and serve to locally constrain the resultant thickness map. Results largely confirm previous volume estimates. Yet we report on important differences in the thickness distribution, primarily along the outlets. Striking differences are for example seen for the largely unsurveyd San Quintin Glacier, the most prominent outlet of the northern icefield. Near snout thicknesses are likely at the lower end of previous estimates ranging from several hundred to above 1000m. For Pio XI Glacier, a recently advancing glacier of the southern icefield, the existing thickness map products either suggest a deeply incised fjord beneath the first 10 km from the current snout position or a valley floor above sea-level. Aerial images from the retreated stage suggest an outwash valley plain towards the South more consistent with our updated map.

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Oral – Tectonic Processes and Stratigraphy

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TOWARDS A CONTINENTAL DRILLING PROPOSAL FOR RECOVERING LATE MESOZOIC TO CENOZOIC SEDIMENTARY STRATA FROM BENEATH THE EKSTRÖM ICE SHELF, WEDDELL SEA, ANTARCTICA

Antarctica plays a key role for the Earth's climate development. Understanding the continent's past climatic variability is therefore essential for understanding its recent response to increasing greenhouse gas emissions. Scientific drilling is crucial for obtaining records on the long-term climatic and tectonic evolution since the breakup of the Gondwana continent. Marine and continental data from near the Antarctic continent are available from the international ODP/IODP and ANDRILL projects in a few Antarctic sectors, but a major gap of understanding exists in the Weddell Sea region and the Dronning Maud Land margin.

The goal of the joint Sub-EIS-Obs project, a collaboration between AWI and BGR, is the collection of geophysical, geological and oceanographic site-survey data for a drilling proposal through the Ekström Ice Shelf into sedimentary strata below. During several field campaigns since 2016, some 615 km of on-ice vibroseis profiles, surface sediment samples and seafloor observations were collected from the ice shelf. The Explora Wedge underlies the base of those sedimentary strata. This volcanic succession was formed during rifting processes that result in the breakup of Gondwana in the Late Jurassic. Thus, sediments above the Explora Wedge may document both the tectonic and paleoclimatic evolution after that breakup. Recently collected marine multi-channel seismic profiles link the on-ice vibroseis data with pre-existing seismic lines that are connected to ODP Site 693 to establish a preliminary seismostratigraphy.

The next steps are (1) to cross-check the seismic correlation for a reliable sub-ice shelf stratigraphic model, (2) to evaluate the potential of the recovered sediments as paleoclimate archives, and (3) to develop a solid drilling proposal on an international workshop.

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Poster – DFG SPP 1158 Antarctic Research - Report Colloquium

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HYSTERESIS OF THE ANTARCTIC ICE SHEET

More than half of Earth's freshwater resources are held by the Antarctic Ice Sheet, which thus represents by far the largest potential source for global sea-level rise under future warming conditions. Its long-term stability determines the fate of our coastal cities and cultural heritage. Feedbacks between ice, atmosphere, ocean, and the solid Earth give rise to potential nonlinearities in its response to temperature changes. So far, we are lacking a comprehensive stability analysis of the Antarctic Ice Sheet for different amounts of global warming. Here we show that the Antarctic Ice Sheet exhibits a multitude of temperature thresholds beyond which ice loss is irreversible. Consistent with palaeodata we find, using the Parallel Ice Sheet Model, that at global warming levels around 2 degrees Celsius above pre-industrial levels, West Antarctica is committed to long-term partial collapse owing to the marine ice-sheet instability. Between 6 and 9 degrees of warming above pre- industrial levels, the loss of more than 70 per cent of the present-day ice volume is triggered, mainly caused by the surface elevation feedback. At more than 10 degrees of warming above pre-industrial levels, Antarctica is committed to become virtually ice-free. The ice sheet's temperature sensitivity is 1.3 metres of sea-level equivalent per degree of warming up to 2 degrees above pre-industrial levels, almost doubling to 2.4 metres per degree of warming between 2 and 6 degrees and increasing to about 10 metres per degree of warming between 6 and 9 degrees. Each of these thresholds gives rise to hysteresis behaviour: that is, the currently observed ice-sheet configuration is not regained even if temperatures are reversed to present-day levels. In particular, the West Antarctic Ice Sheet does not regrow to its modern extent until temperatures are at least one degree Celsius lower than pre- industrial levels. Our results show that if the Paris Agreement is not met, Antarctica's long-term sea- level contribution will dramatically increase and exceed that of all other sources.

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Oral – DFG SPP 1158 Antarctic Research - Report Colloquium: Dynamics of Climate Change Components

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DECIPHERING THE COLLABORATIVE ADAPTATION OF THE HOLOBIONT OF ULVA TO COLD TEMPERATURES IN ANTARCTICA

The underlying infochemical-mediated strategies causing changes in algal–bacterial interaction are not still completely known but given that bacteria release algal growth- and morphogenesis- promoting factors (AGMPFs) required for (green)macroalgae growth and development, adaptive responses to environmental stressors must be considered within the community structure too. To investigate and assess the complex interactions underlying macroalgae and its microbiome responses to various stress factors particularly temperature and also to decipher the contribution of the metabolic stress response of the bacteria and algae, we propose a reductionist analysis of a tripartite model system consisting of the axenic green alga *Ulva* (Chlorophyta) re-infected with two essential bacteria. This analysis will allow us to determine the stress response of each symbiont within this cross-kingdom interaction and will help to understand the enormous ecological success of Ulva. This research includes the effect of recently isolated bacteria from the Potter Cove, King George Island (Isla 25 de Mayo) in Antarctica, on the model system *Ulva mutabilis* Føyn purified gametes. The results indicate that cold-adapted bacteria release AGMPFs, inducing cell differentiation, and cell division in purified cultures. Moreover, the production of polar low molecular weight compounds in the presence and absence of bacteria upon a temperature shift to 2 °C has been showed. Integrating the chemical ecology to aquatic-microbiome investigations will allow us to shed light on underlying adaptation and acclimation mechanisms in macroalgae to stress situations with implications, e.g., for the sustainable management of aquacultures.

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Oral – Tectonic Processes and Stratigraphy

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SEISMIC STRATIGRAPHY OFFSHORE EKSTRÖM ICE SHELF INDICATES STABLE EAST ANTARCTIC ICE SHEET IN DRONNING MAUD LAND SECTOR SINCE EARLY OLIGOCENE GLACIATION

The large East Antarctic Ice Sheet (EAIS) with a sea level equivalent of about 60 m is an unknown factor with regard to its future development and sea level contribution in a warming world. Ice sheet stability or instability along its fringes of the various sectors plays a major role in future climate and sea level projections. Some regions, such as the Dronning Maud Land (DML) sector, show currently a positive ice mass balance mainly due to increased precipitation, while others lose ice mass at a considerable rate, such as the Totten Glacier region.

In an assessment of a multichannel seismic network from various surveys along the western DML margin and recently recorded seismic lines across the shelf, slope and rise off Ekström Ice Shelf, including vibroseis lines from the ice shelf, we developed a seismic stratigraphic model to analyse the sedimentation processes since early East Antarctic glaciation in the late Eocene and early Oligocene. About 1.5-2.5 km thick sedimentary sequences were deposited along this continental margin on an elevated basement terrace. This terrace remained as the top of a stretched and thinned continental or transitional crust with its volcanic Explora Wedge after the Cretaceous tectonic breakup from southern Africa. Sedimentation on this continental terrace is dominated by mostly horizontally layered sequences of glacially transported sediments since the early Oligocene which constitute, on average, about 50% of the column of the entire sedimentary cover above basement. Major canyons, some with main trunks as well as several side valleys, truncate these glacially transported sediments from late Pliocene down to the Eocene-Oligocene layers. Several canyon flanks show traces of slope failures and slumps. Some ridges between canyons appear like large sediment drift features with collapsed flanks.

We discuss our observations and provide suggestions for an interpretation of this peculiar submarine landscape in combination with the mountainous hinterland with regard to the EAIS evolution in this DML sector. Our preliminary interpretation suggest a relatively stable ice sheet in this sector since early Oligocene glaciation that sustained both a steady sedimentation and submarine erosion.

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Oral – Facing Polar Climate Change: Insights from the Past

Karsten Gohl, Gabriele Uenzelmann-Neben, Johanna Gille-Petzoldt, Johann Klages, Rachel Lamb, Claus-Dieter Hillenbrand, Steven Bohaty, Sandra Passchier, Thomas Frederichs, Julia Wellner, German Leitchenkov and IODP Expedition 379 Scientists

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GLACIALLY DRIVEN SHELF-TO-RISE TRANSPORT FROM SEISMIC STRATIGRAPHY LINKED TO IODP EXPEDITION 379 DRILL SITES IN THE AMUNDSEN SEA, WEST ANTARCTICA

The Amundsen Sea sector of the West Antarctic Ice Sheet (WAIS) is currently losing large amounts of ice, driving hypotheses on ice sheet collapses during past warm times, such as those in the Pliocene, with similar climatic conditions as predicted for the near future. International Ocean Discovery Program (IODP) Expedition 379 aimed to collect sediment cores from the continental shelf and rise of the Amundsen Sea Embayment in order to analyse records of changes in glacially driven sedimentation to decipher and analyse major phases of intense ice sheet advances and retreats across the shelf. The expedition recovered continuous late Miocene to Holocene sediments only from a sediment drift on the continental rise due to severe sea ice on the shelf, but the high- resolution drill records allow assessment of sedimentation processes in response to climate and ice sheet dynamic cycles and trends since the late Miocene. An adjacent deep-sea channel and other channels meander from the foot of the continental slope and have transported suspended sediments from the outer shelf into the deep sea, thereby supplying much of the drift deposits. Via seismic correlation to the shelf, we interpret massive prograding sequences that extended the outer shelf by 80 km during the Pliocene through frequent advances of grounded ice. Buried grounding zone wedges on the outer shelf indicate prolonged periods of ice-sheet retreat, or even collapse, during an extended mid-Pliocene warm period from about 4.2 to 3.2 Ma inferred from Expedition 379 drill records. These results indicate that the WAIS was highly dynamic during the Pliocene and major long- lasting retreat events may have occurred along the Amundsen Sea margin.

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Poster – Permafrost in a Warming World: Impacts and Consequences

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MAPPING ARCTIC TREELINE VEGETATION USING LIDAR DATA IN THE MACKENZIE DELTA AREA, CANADA

Arctic vegetation adapts to the dynamically changing permafrost environment, which is not only subject to climate warming but also to shifts in the moisture regime and increasing likelihood of disturbance. As field observations are scarce and not easily obtainable, remote sensing is needed to quantify vegetation distribution. This does not only contribute to our understanding of ecological processes but also helps to estimate active layer and permafrost properties using vegetation as a proxy. We used high resolution airborne optical images in combination with field experience to create training and validation datasets of vegetation types at our study site of 150 km² around Trail Valley Creek, NWT, Canada. Apart from this training data, we created the vegetation map solely based on airborne LiDAR data. The advantage of using LiDAR data as compared to optical data is the direct representation of vegetation height as most important proxy of vegetation type. LiDAR return amplitude and echowidth and the detailed digital elevation model contribute to the classification accuracy. Furthermore, unlike optical data, the LiDAR data is not affected by shadowing and illumination differences. We combined the results of multiple machine learning algorithms with manually defined decision trees and a custom discriminant analysis in a way which allowed us to enforce prior knowledge and definitions onto the final classification result. This approach proved useful to prevent overestimation of tree cover in areas with short vegetation as well as to tune the model to low likelihoods for rare vegetation types. The final map of 1 m² spatial resolution had a good overall accuracy, in particular for the most relevant classes of trees (covering about 0.6% of the landscape) and tall shrubs (6% cover). The map is needed to reduce confounding effects in our analysis of airborne radar data acquired at the same site. Furthermore, it enables the analysis of vegetation patterns at high spatial resolution, which is challenging in the highly heterogeneous tundra vegetation. Our map serves as a baseline for studying vegetation change as well as subsurface processes such as wetting.

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Oral – DFG SPP 1158 Antarctic Research - Report Colloquium: Response to environmental change and linkages with lower latitude

Charlotte Havermans, Diana Martinez-Alarcon, Kim Praebel, Owen Wangensteen, Holger Auel, Wilhelm Hagen, Christoph Held

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THE AMPHIPOD THEMISTO GAUDICHAUDII IS POISED TO MOVE POLEWARD: WHICH ARE THE CONSEQUENCES FOR THE PELAGIC ECOSYSTEM OF THE WARMING SOUTHERN OCEAN?

The Southern Ocean, in particular the southwest Atlantic sector, is experiencing rapid environmental changes. A long-term trend of density changes of key pelagic species has been noted over the last decades: Antarctic krill populations are declining whilst salps are on the rise and shifting their distribution poleward. A similar poleward expansion is anticipated for a third key player, the hyperiid amphipod crustacean *Themisto gaudichaudii*, leading to an increasing overlap of the distributions of these three species. Due to major knowledge gaps in the ecology, and genetic connectivity of *T. gaudichaudii*, the likelihood of this anticipated shift and its consequences for the pelagic food web structure remain largely unexplored. In this context, Themisto's genetic and trophic connectivity as well as thermal response were investigated with state-of-the-art molecular methods.

Phylogeographic analyses showed genetic homogeneity between localities in the Southern Ocean and Atlantic waters combined with high degree of phenotypic plasticity enabling different lineages to thrive in regions further south. Diet analyses using DNA metabarcoding were applied to characterize regional variation in diet. These analyses showed a diet predominantly composed of krill, in particular in the Antarctic Peninsula region, showing that Themisto's poleward range expansion can further impact the already declining krill stocks. It also unexpectedly revealed ctenophores to be an important prey, despite their reputation as "trophic dead-end". Transcriptome analyses were used to study the thermal response of Themisto individuals from different geographic populations that were experimentally exposed to heat and cold treatments. The analysis of differentially expressed genes showed that genetic lineages differ in thermal tolerances. It also revealed a wide range of molecular mechanisms in *Themisto amphipods* to cope with thermal stress. These findings contribute to better predict the impact of climate-driven range shifts on the pelagic ecosystems in the Southern Ocean.

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Oral – Atmosphere, Sea Ice and the Polar Ocean

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A THREE-YEARS CLIMATOLOGY OF THE WIND FIELD STRUCTURE AT CAPE BARANOV (SIBERIA) FROM SODAR OBSERVATIONS AND HIGH-RESOLUTION REGIONAL CLIMATE MODEL SIMULATIONS DURING YOPP

The generation of new data sets of in-situ observations of the atmospheric boundary layer (ABL) in the high Arctic is necessary for the verification of regional climate models and process studies of the ABL. This was the approach of the Year of Polar Prediction (YOPP) 2017-2019, where two Special Observing Periods (SOPs) were defined for the Arctic (February - March 2018 and July - September 2018). We performed measurements of the ABL structure for three years (Oct. 2017 – Aug. 2020) at the Russian observatory “Ice base Cape Baranova” (79°17’N, 101°37’E) as YOPP project CATS_BL in the frame of a joint German-Russian project. ABL measurements were made using a SODAR (Sound Detection And Ranging) and a RASS (Radio Acoustic Sounding System). The SODAR yields vertical profiles of the wind speed, wind direction and the turbulence characteristics with a vertical resolution of 10m and a temporal resolution of 20min (height range 30-400m). The RASS extension allows for the determination of the temperature profile with the same resolution. In addition to the measurements, we performed simulations using the regional climate model COSMO-CLM (CCLM) with 5 km resolution for 2017-2020. CCLM was run with nesting in ERA5 data in a forecast mode, and the ABL measurements were used for verification.

The measurements are presented with a focus of SODAR measurements of the ABL wind structure, since RASS data were only available for the first months of the campaign due to limited maintenance possibilities. SODAR measurements are biased to wind speeds <12m/s, since the signal is often lost for higher winds. The SODAR data show a topographical channeling effect for the wind field in the lowest 200m and some low-level jets (LLJs). The verification of CCLM with near-surface data of the observatory shows good agreement for the wind and a negative bias for the 2m-temperature. The comparison with SODAR data shows a positive bias for the wind speed of about 1m/s below 100m, which increases to 1.5m/s for higher levels. In contrast to the SODAR data, CCLM data show the frequent presence of LLJs associated with the topographic channeling.

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Poster – Atmosphere, Sea Ice and the Polar Ocean

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ANNUAL CYCLE IN ANTARCTIC CLOUD CONDENSATION (CCN) AND ICE NUCLEATING PARTICLE (INP) CONCENTRATIONS AND PROPERTIES AT NEUMAYER STATION III

The earth's climate changes at rates unprecedented in thousands, if not hundreds of thousands of years, with the polar regions being the fastest warming areas on earth. Polar regions have also a strong global impact on climate conditions and therefore affect lives and livelihoods across the world. Despite the progress polar climate research made, poorly understood processes remain, one of those being the aerosol – cloud – climate interaction, which still cannot be modelled with satisfying accuracy. Clouds and their interactions with the climate system are one of the most difficult components to model, especially in the polar regions. This is, among others, due to difficulties in obtaining high-quality measurements. The availability of high-quality measurements is therefore of crucial importance for understanding processes and for driving and/or evaluating atmospheric models.

Starting with December 2019, TROPOS continuously performs in-situ Cloud Condensation Nuclei (CCN) and Ice Nucleating Particles (INP) measurements at *Neumayer Station III* (NM III, 70° 40′ S, 8° 16′ W), which is located at the Atka Bay on the Ekström Ice Shelf to improve the data base and thereby the knowledge of the locally important particle formation processes for either one.

Two full years of CCN data for NM III have been gained. Number concentrations in general are low and a clear annual cycle is found for CCN as well as for the total particle number (CN). The latter is similar to results reported for the Belgian *Princess Elisabeth Station*, located 200 km inland in the escarpment zone of Dronning Maud Land at an altitude of 1400 m (Herenz et al., 2019). Lowest number concentrations are observed in austral winter months May to August with monthly averages below 20 cm-3 at, e.g., the supersaturation of 0.1% and an CN concentration below 100 cm-3 during this time. In January, CCN increased to 90 cm-3 at 0.1% and CN increased to 610 cm-3.

Besides CCN also INP sampling was established at the NM III. Filter samples are collected on polycarbonate filters and immediately frozen for later analysis in the TROPOS laboratories. In general, the INP concentrations are very low even compared to other measurements in the southern hemisphere. As a preliminary result only very few samples are ice active at temperatures warmer than -15°C, which might point towards the absence of biological INP sources in the region.

We will present data such as CCN number concentrations, hygroscopicity, INP freezing spectra etc. linked to meteorological information (e.g. back trajectories) and information on

the chemical composition of the prevailing aerosol particles for identifying sources of INP and CCN over the full annual cycle. A result of this project will be a deeper understanding which processes dominate the CCN and INP population in high latitudes.

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Oral – DFG SPP 1158 Antarctic Research - Report Colloquium: Response to environmental change and linkages with lower latitude

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RETURN OF THE FIN WHALES. EVIDENCE FOR POPULATION RECOVERY 35 YEARS AFTER THE END OF COMMERCIAL WHALING IN THE SOUTHERN OCEAN.

Southern Hemisphere fin whales (*Balaenoptera physalus quoyi*) were brought to near extinction by 20th century industrial whaling. Until today, recovery rates of the population are unknown and fin whales are listed as ‘endangered’ on the IUCN red list of threatened species. Compared to other large whale species, very little is known about the distribution and ecology of fin whales in the Southern Hemisphere. Fin whales presumably migrate to Antarctic waters to feed on krill, but their migratory routes and the location of lower latitude wintering grounds are unknown.

A recent increase of opportunistic sightings of fin whales along the Antarctic Peninsula called for dedicated research efforts to investigate the population status. Within the framework of the DFG SPP 1158- Antarctic Research, the project ‘Recovery status and ecology of fin whales at the West Antarctic Peninsula’ was established in order (1) to estimate fin whale abundance (2) to investigate distributional relationships between whales and krill (3) and to determine migration routes and migratory destinations. Here, we report on the outcomes of an aerial abundance survey and the first satellite tags deployed on fin whales at Elephant Island, Antarctica.

Our survey data confirm a return of fin whales to historical Antarctic feeding grounds in high numbers. In addition, observations of large feeding aggregations suggest a re-establishment of ancestral behaviours. We interpret these results as signs of population recovery. The tracking of fin whales tagged at Elephant Island revealed migration into the South East Pacific at the end of the feeding season, providing the first indication for population connectivity and possible locations of breeding grounds.

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Poster – Polar Research in a Changing Society

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THE WORLDVIEWS OF ICE: COGNITIVE FRAMES AND CONSTRUCTIONS OF THE ARCTIC AND THE SCIENCE/POLITICS-INTERFACE

We will present the project 'The Worldviews of Ice: Cognitive Frames and Constructions of the Arctic at the Science/Politics-Interface', funded by the German Research Foundation at the University of Bielefeld. The project inquires how geopolitical images contribute to framing mostly natural science research agendas in and on the Arctic. The project aims to understand how these images feed back into the policymaking process through the particularly dense networks between science and politics in Arctic research. The project studies how competing narratives of the Arctic, imbued with geopolitical images, are produced in, and altered through, closely interconnected epistemic communities that link the science to politics. The project pursues three case studies:

- Case Study 1: Preparing knowledge: funding

This case study examines the development of funding priorities on Arctic research in Germany, Canada and Norway between 1990 and 2020, and traces the nature of consultation processes between the main actors involved on the science and on the politics sides.

- Case Study 2: Generating knowledge: images in research

This case study explores worldviews through the evolution of programmatic statements of major Arctic research institutes, and through in-depth interviews with Arctic scientists from a variety of national and disciplinary backgrounds.

- Case study 3: Transmitting knowledge: science in the Arctic Council

This case study analyses the intensity and quality of interactions between actors from science and politics in Arctic Council meetings.

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Oral – Atmosphere, Sea Ice, Ocean and Land Interactions

Jens Hölemann

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THE IMPORTANCE OF FAST ICE ON THE SIBERIAN SHELVES FOR GEOCHEMICAL CYCLES IN THE ARCTIC OCEAN

The results of our research in the “Laptev Sea System” projects show that the formation and melting of fast ice in the Laptev and East Siberian Seas shapes the concentration distribution and geochemical pathways of dissolved and particulate matter in the Arctic Ocean (AO). The duration of the land-fast-ice season in the LS is reduced by 2.8 days per year (observational period 1999 to 2013), while in the second decade of the 21st century the onset of the spring freshet of the Lena River happens about 6 days earlier than at the beginning of the observational period in 1940. Further changes of the ice regime and the timing of spring freshet will certainly have an impact on the dynamics of geochemical cycles in the AO.

In addition, the decline of Arctic sea ice and the associated longer ice-free season will lead to changes in wind forcing in the shelf systems of the Arctic and to an increased input of solar radiation into the water column. This will significantly change freshwater transport pathways, the heat content of the water column, and stratification in the LS and ESS. The heat content in turn influences the formation of new ice and thus also the production of brines. Since density stratification also determines where and at what depth the salt-rich brine produced during the formation of sea ice leaves the shelf, changes in stratification also affect future transport pathways in the AO.

Studying these processes is important not only to decipher the carbon cycle in the Arctic, for example, but also, as in the case of dissolved organic matter, because it also regulates physical processes such as radiative forcing in the upper ocean, which has important effects on sea surface temperature, water column stratification, and UV penetration.

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Oral – Glaciers, Ice Sheets and Sea Level Rise

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TRACING SUBMARINE MELTWATER FROM NORTHEAST GREENLAND TOWARDS THE SOUTH

The Greenland Ice Sheet faces accelerated melting under changing climate conditions. In particular, the warming ocean affects the marine terminating glaciers, e.g. the Nioghalvfjerdsbræ (79 North Glacier, 79NG) with its floating ice tongue at the Northeast Greenland Shelf, and other glaciers further downstream along the Greenland coast. This freshwater input may contribute to sea level rise and might alter the global ocean circulation by increasing stratification. However, freshwater from submarine melting is hardly distinguishable from other freshwater sources by salinity alone. Hence, we use oceanic helium (He) and neon (Ne) observations to identify and to quantify the distribution of submarine meltwater (SMW). These noble gases allow detecting SMW sources and tracing the SMW pathways around Greenland.

SMW from the 79NG is present on the entire Northeast Greenland Shelf but dilutes from 1.8% at the 79NG calving front to nonsignificant in Fram Strait. The SMW formation rate of the 79NG was estimated to be 14.5 ± 2.3 Gt per year. A surplus of He compared to Ne near the calving front and below 100 m indicate the addition of crustal He, formed by radioactive decay in the underlying bedrock of the glacier. A surplus of Ne compared to He in the upper 100 m observed on most of the Northeast Greenland Shelf is caused by He/Ne fractionation during sea ice formation. Combining the Ne excess with the ventilation time on the shelf of 1.5 years yields an average sea ice formation rate of 4 m per year.

More recently available He and Ne observations near the 79NG indicate that also the Zacharias Isstrøm and the Storstrømmen Glacier likely discharge significant amounts of SMW to the Northeast Greenland Shelf. Moreover, our completed noble gas data set around Greenland allows to detect additional SMW sources from fjords further downstream, and to trace the SMW pathways from the Northeast Greenland Shelf, along the eastern, southern, and southwestern Greenland coast and shelf.

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Oral – DFG SPP 1158 Antarctic Research - Report Colloquium: Dynamics of Climate Change Components

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ANTARCTIC MELTWATER IMPACTS FUNGAL PARASITES

Aquatic ecosystems are frequently overlooked as fungal habitats, although there is increasing evidence that their diversity and ecological importance are greater than previously considered. Aquatic fungi are critical and abundant components of nutrient cycling and food web dynamics, e.g. exerting top-down control on phytoplankton communities and forming symbioses with many marine microorganisms. However, their relevance for microphytobenthic communities is almost unexplored. In the light of global warming, polar regions face extreme changes in abiotic factors with a severe impact on biodiversity and ecosystem functioning. Therefore, this study aimed to describe, for the first time, fungal diversity in Antarctic benthic habitats along the salinity gradient and to determine the co-occurrence of fungal parasites with their algal hosts, which were dominated by benthic diatoms. Our results reveal that Ascomycota and Chytridiomycota are the most abundant fungal taxa in these habitats. We show that also in Antarctic waters, salinity has a major impact on shaping not just fungal but rather the whole eukaryotic community composition, with a diversity of aquatic fungi increasing as salinity decreases. Moreover, we determined correlations between putative fungal parasites and potential benthic diatom hosts, highlighting the need for further systematic analysis of fungal diversity along with studies on taxonomy and ecological roles of Chytridiomycota.

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Oral – Permafrost in a Warming World: Impacts and Consequences

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DYNAMICS OF ARCTIC PERMAFROST COASTS IN THE 21ST CENTURY

Climate warming is particularly pronounced in the Arctic with temperatures rising twice as much as in the rest of the world. It seems natural that this warming has profound effects on the speed of erosion of Arctic coasts, since the majority consists of permafrost, composed of unlithified material and hold together by ice. Permafrost stores approximately 1307 Gt of carbon, which is almost 60 % more than currently being contained in the atmosphere. Understanding the main drivers and dynamics of permafrost coastal erosion is of global relevance, especially since floods and erosion are both projected to intensify. However, the assessment of the impacts of climate warming on Arctic coasts is impaired by little data availability. We reviewed relevant scientific literature on changing dynamics of Arctic coast, potential drivers of these changes and the impacts on the human and natural environment. We provide a comprehensive overview over the state of the art and share our thoughts on how we envision potential pathways of future Arctic coastal research. We found that the overwhelming majority of all studied Arctic coasts is erosive and that in most cases erosion rates per year are increasing, threatening coastal settlements, infrastructure, cultural sites and archaeological remains. The impacts on the natural environment are also manifold and reach from changing sediment fluxes which limit light availability in the water column to a higher input of carbon and nutrients into the nearshore zone with the potential to influence food chains.

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Oral – DFG SPP 1158 Antarctic Research - Report Colloquium: Improved Understanding of Polar Processes and Mechanisms

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REMOTE SENSING RETRIEVAL OF ANTARCTIC SEA ICE SURFACE MELT USING SENTINEL-3 DATA

An unprecedented case of sea ice surface melt was observed in January 2017 in the vicinity of the Antarctic *Syowa Station* by the shipboard party of the RV *Shirase*. In situ observations of melt pond occurrence at other locations of the Antarctic sea ice have also been documented in recent years. However, till now no sorted dataset of such melt pond occurrences or their retrievals of better spatial coverage have been performed.

In this study, we apply a remote sensing melt pond retrieval algorithm earlier applied in the Arctic to Antarctic sea ice. The retrieval uses OLCI and SLSTR data (both sensors onboard ESA Sentinel-3 satellite) and utilizes an optical forward model of a melt pond on top of sea ice. The melt pond fraction (MPF) retrieved within a case study near the Japanese *Syowa Station* in East Antarctica in January 2017 is found to be in correspondence with visual observations of surface melt in the same area. A similar melt pond occurrence near *Syowa Station* has also been detected both in situ and via remote sensing retrieval in January 2018 and in the following years, as well as increased surface melt at other locations detected during the global Antarctic sea ice data processing. Daily and weekly averages of global Antarctic sea ice melt are presented as a step towards a regular dataset of the Antarctic sea ice melt, similar to existing Arctic studies.

One possible application of such Antarctic MPF retrievals is also presented and consists of the improvement of the existing passive microwave sea ice concentration (SIC) retrievals which are known to misinterpret the melt ponds for open water and thus create a bias when estimating ice volume of the region.

Longer time sequences of the presented sea ice melt pond and blue ice fractions can be used to evaluate the recent change of the Antarctic sea ice conditions in comparison to the earlier years and to the recent Arctic melt pond development.

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Oral – Coole Klassen - Polarbildung in der Schule

Kallfelz, M. & Lehmann, R.

Pfalzmuseum für Naturkunde - POLLICHIA-Museum

GRAFIKEN SCHÜLERGERECHT AUFARBEITEN

Transferierung wissenschaftlicher Ergebnisse der Polarforschung in graphischer Darstellung in schülergerechtes Arbeitsmaterial

Eine zentrale Aufgabe des Arbeitskreises Polarlehrer ist die Vermittlung aktueller Polarforschung möglichst zeitnah in die Gesellschaft und insbesondere an die junge Generation. Dabei sind Fragestellung und Methoden der Wissenschaft zentrale Themen für den Transfer in die Schulen. Die Ergebnisse aus den Forschungsarbeiten sind jedoch auf längere Sicht entscheidend, um Phänomene verständlicher aufzuzeigen und letztlich Entscheidungen in der Gesellschaft nachvollziehen und begründen zu können. Wesentliche Ergebnisse werden sobald sie vorliegen auch graphisch mithilfe von Abbildungen in wissenschaftlichen Publikationen dargestellt um das Verständnis für neue Erkenntnisse anzulegen und zu fördern.

Die Polarlehrkräfte arbeiten seit vielen Jahren daran, Graphiken für den Unterricht an den Schulen aufzuarbeiten. Diese inhaltlich und stilistisch völlig unterschiedlich gestalteten Quellen müssen für den Unterricht an Schulen vereinfacht und auf die jeweilige Klassenstufe sowie den Fachbereich bei Beibehaltung der Kernaussagen angepasst werden. Der Vortrag zeigt an verschiedenen Beispielen aus den naturwissenschaftlichen Fachbereichen mit fachübergreifenden Aspekten die Hürden, die dabei überwunden werden müssen und wie das gelingen kann.

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Poster – Glaciers, Ice Sheets and Sea-Level Rise

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ADVANCING ICE ALTIMETRY ANALYSIS TO CONSTRAIN THE ANTARCTIC ICE SHEET'S RESPONSE TO CLIMATE CHANGE

The Antarctic Ice Sheet's response to climate variability and climate change is poorly constrained. To improve the understanding and quantification of the processes that drive changes in ice mass or ice sheet elevation, we exploit ice altimetry. We advance the processing of satellite radar altimetry, in particular the waveform retracking, the correction for topographic effects and the minimization of firn penetration effects. In addition, to improve the SEC records, we optimize the interpolation of elevation and/or SEC to derive ice sheet wide continuous raster products. A focus is the use of neural networks to minimize the influence of radar speckle during retracking and to optimize the interpolation procedure, as common methods tend to smear large SEC signals observed in steep catchment areas.

The main glaciological processes that cause the SEC are changing ice flow dynamics and fluctuations in the firn layer at various time scales. Fluctuations in the firn layer are related to surface mass balance (SMB) and firn compaction. We analyze their characteristic temporal and spatial pattern by distinguishing between fluctuations at decadal to monthly time scales ('weather effects') and long- term trends due to past and ongoing climate change ('climate effects'). We use firn thickness variations from SMB and firn modeling results to identify dominant temporal patterns characterizing the weather effects. The patterns are fitted to altimetric SEC by estimating the related amplitudes and spatial patterns. By means of this parametrization scheme, the weather-induced fluctuations in firn thickness are characterized in a statistical sense and quantified in a deterministic sense, while unexplained signals in the altimetric SEC are investigated for potential long-term effects, either related to SMB or to changing ice flow dynamics.

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Oral – Humans in Changing Polar Regions

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

Second polar knowledge contest and polar expedition for high school students continues to increase public interest and awareness in polar areas and to contribute to rising a new generation of polar scientist. Specifically, it is also a part of several public activities (conferences, exhibitions, media discussions, etc) that are organized in connection with application of Estonia to become an observer member of Arctic Council. The contest took place in winter of 2019/20 but because of Covid-19 the expedition to North Scandinavia is possible only in April 2022. It is a follow-up of the first such enterprise of 2016/17. The winner of the latter is currently concluding her MSc studies at the University Centre in Svalbard.

The I stage of contest was again Internet-based. The 159 attendants from all over Estonia had to answer to 40 questions on Arctic and Antarctic environment and its protection, plant and animal life, human acivities and research history, incl. contributions from Estonians. The best 27 students were proposed to write an essay on polar matters and invited to attend the II stage. This took place in January 2020 in Fat Margaret canon tower, a part of Estonian Maritime Museum.

There was no access to external information in II stage. The tasks included: answer to 20 questions similar to stage I and to 10 questions from European Commission to demonstrate understanding of Green Transition in Europe. The 5 winners got the award to attend a polar expedition, the others received various polar-related information sources and souvenirs. All viewed the exhibitions of Maritime Museum.

The expedition will proceed during 04-10 April 2022, five students will be accompanied by four supervisors from Estonian Polar Club. Planned are visit to Tromsö (Polar Institue, Secretariat of Arctic Council, Polaria, Polar Museum). Then five days in *Kilpisjärvi Biological Station* of Helsinki University will include lake research on Saanajärvi, collecting field data on polar architecture and North Saami culture, environmental problems of polar research activities, weather & climate, ski hiking. In Kiruna the Ice Palace and a reindeer farm will be visited. The expedition will be followed by a concluding seminar.

The budget of contest & expedition is ca 15 000 € and is co-sponsored by European Commission, Ministry of Education and Research, Estonian Maritime Museum, Albion Travel Co and Estonian Polar Foundation. Contest and expedition activities are receiving media coverage.

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Oral – Facing Polar Climate Change: Insights from the Past

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

ASYMMETRY IN ANTARCTIC ICE SHEET COVER DURING THE EARLY OLIGOCENE GLACIAL MAXIMUM

The Eocene-Oligocene transition (EOT; ~34.4–33.7 Ma) was a major transition in Earth's long-term climatic evolution, marking the cooling from the Early Paleogene greenhouse to the icehouse regime that has prevailed from the Oligocene until today. However, it remains uncertain which landmasses were already covered by ice sheets during the Early Oligocene Glacial Maximum (EOGM; ~33.7–33.2 Ma), an interval of peak glaciation immediately following the EOT. The scarcity of earliest Oligocene climate records in both Arctic and Antarctic regions hitherto prevented the reconstruction of environmental conditions and ice-sheet extent during the EOGM. This, however, is critical for assessing ice–ocean–atmosphere interactions during the early stages of the Cenozoic icehouse. Here, we present the first shallow-marine drill-core record of earliest Oligocene environmental conditions in the Pacific sector of West Antarctica. It comprises marine mudstones documenting the presence of a cool-temperate *Nothofagus*-dominated forest situated within a productive archipelago at a palaeolatitude of ~73.5°S. Any evidence for marine terminating glaciers is lacking, thus no land-based ice or only small ice caps existed in West Antarctica during the EOGM. Data-calibrated climate modeling confirms that West Antarctica remained ice sheet-free whereas a major ice sheet already covered East Antarctica at this time, explaining the prominent early Oligocene oxygen isotope shift.

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Poster – Tectonics and Geodynamic Processes

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MANIFESTATIONS OF TIMANIAN ROCK FRAGMENTS AND STRUCTURES ALONG THE NORTHWESTERN ARCTIC MARGIN

The Timanian Orogeny affected the northeastern margin of Baltica in late Cryogenian to early Cambrian times. Rocks with Timanian radiometric ages can be found today along the circum-arctic continental margins. Their distribution provides important information for the post-Rodinia palaeogeographic reconstruction of the Arctic. Here we present examples from northwestern Svalbard, North Greenland and the Pearya Terrane (northern Ellesmere Island, Canadian Arctic).

The Richarddalen Complex in northwestern Svalbard, now interpreted as Caledonian mélange, comprises to a large extent felsic and mafic meta-igneous rocks with U–Pb zircon ages of 687 and 670 Ma, respectively, partly eclogite-facies metamorphosed at c. 656 Ma, as well as metasedimentary rocks with a dominant detrital zircon population of 730–600 Ma related to a Timanian orogenic event (1).

Further west, the Midtkap igneous suite in northernmost Greenland forms isolated outcrops in early Palaeozoic deep-water sediments of the Franklinian Basin. The suite of supra-subduction zone origin is composed of intermediate and felsic intrusive rocks, serpentinite, and heterogeneous volcanic breccia (mélange). Intermediate intrusive rocks have Timanian zircon ages of 650–570 Ma (2, 3) and biotite from granite yielded an Ar–Ar age of 535 Ma (3).

In the composite Pearya Terrane, late Cambrian–early Ordovician volcaniclastic sediments of Succession 3 (4) are almost completely sourced from a Timanian volcanic arc as evidenced by detrital zircon ages of 590–560 Ma, peaking at around 570 Ma (5). The volcaniclastic sediments of Succession 3 rest probably on Timanian arc basement.

Seismic data from the northern Norwegian Barents Sea have revealed Timanian E-W striking structures and suggest the existence of a pre-Caledonian crustal block in the central Barents Sea (6). During the Caledonian Orogeny, fragments of a long-lasting Timanian volcanic-arc system were possibly split off from the block and displaced northwestwards by large-scale sinistral strike-slip movements.

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Oral – Tectonic Processes and Stratigraphy

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PALEOZOIC SEDIMENTATION AND NEW CALEDONIAN TERRANE ARCHITECTURE IN NW SVALBARD: INDICATIONS FROM U–PB GEOCHRONOLOGY AND STRUCTURAL ANALYSIS

Svalbard´s Northwestern Basement Province is traditionally divided into the Albert I Land and the Biscayarhalvøya terranes. New U-Pb age data on zircon and monazite, structural and geochemical data provide first evidence of early Palaeozoic deposits south of the Biscayarhalvøya Terrane indicating the possible existence of a third terrane: the Germaniahalvøya Terrane. This area is represented by a Cambro-Ordovician succession of mica schist and marble (Lernerøyane Group) with youngest detrital zircon ages between 571 and 492 Ma and its higher-grade metamorphic equivalent (Liefdefjorden Migmatite Complex) yielding youngest non-metamorphic detrital zircon ages between 579 and 511 Ma. Both successions were affected by migmatization during the Taconian phase at c.

469 Ma and metamorphic overprint up to anatexis during the Scandian phase (c. 422–415 Ma) of the Caledonian Orogeny.

New isotopic data from the eclogite-bearing Richarddalen Complex of the Biscayarhalvøya Terrane imply the formation as Ordovician–Silurian collision-related mélange dominantly composed of c. 730 to 600 Ma Timanian island-arc derived detritus and igneous rocks, partly eclogite-facies metamorphosed at c. 656 Ma, and Tonian meta-igneous rocks. After amphibolite-facies metamorphism of the mélange matrix at c. 423 Ma, the Richarddalen Complex and the Stenian– Tonian Biscayarfonna Group were juxtaposed and mylonitized by the dextral Biscayarhalvøya Deformation Zone.

Differences in structural development indicate that the Germaniahalvøya and Biscayarhalvøya terranes were independent tectonic units the Taconian phase of the Caledonian Orogeny. The Scandian phase is the first phase that evidently affected both terranes: the Germaniahalvøya Terrane by migmatization and the subsequent intrusion of late Caledonian granites and leucogranites and the Biscayarhalvøya Terrane by amphibolite-facies metamorphic overprint. The events were followed by the formation of the Biscayarhalvøya and Lerner deformation zones in the Biscayarhalvøya Terrane and the Germaniahalvøya Terrane, respectively. Intense ductile shearing and similar orientation of lineations suggest that they belong to the same stage of late Caledonian shearing. This is confirmed by the age data of 422–415 Ma (Lerner Deformation Zone) and c. 423 Ma (Biscayarhalvøya Deformation Zone). Along these deformation zones, the Biscayarhalvøya and Germaniahalvøya terranes had been (?) juxtaposed during late Caledonian ductile shearing.

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Poster – Organisms in the Face of Climate Change: Discoveries and New Approaches

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ANTARCTIC MIDGE BELGICA ANTARCTICA (DIPTERA: CHIRONOMIDAE): SPECIES DISTRIBUTION AND SOME GENETIC FEATURES

The ecosystems of the Antarctic Peninsula are being seriously affected by emergence of invasive species and increased tourism activity in the region, underscoring the importance of monitoring of the local habitats. Antarctic midge *Belgica antarctica* Jacobs, 1900 (Diptera: Chironomidae) is endemic to the Antarctic Peninsula mainland and adjacent islands. Thorough studies of the variation of this species were not performed in past decades. Here, we report on *B. antarctica* collected in 2007–2021 (XII, XIV, XVI, XXIV, and XXV Ukrainian Antarctic Expeditions). The midge was recorded at 26 mainland localities on the Antarctic Peninsula and 212 localities on 55 nearest islands between - 66.144000, -65.726972 (Cape Evensen, Stresher Peninsula) and -62.195750, -58.961278 (King George Island, South Shetland Islands). For islands 42 and 55 (Wilhelm archipelago, South Shetland Islands, Palmer archipelago and other Islands of West Coast of Graham Land), the antarctic midge was reported for the first time.

The genome of *Belgica antarctica* has also been sequenced. However, there is no consensus set of inversion markers that has ever been assigned to the species. Using the cytogenetic methods of isolation and analysis of polytene chromosomes from *B. antarctica larvae*, we found three heterozygous inversions located on the second (two heterozygous inversions) and third chromosomes (one heterozygous inversion) in the *B. antarctica* population from the cape of Wiencke Island, 500 m to SW from Port Lockroy. Data on chromosome composition and chromosome variability were similar to reports from the previous studies (Atchley and Davis 1979). We did not find a sex-linked inversion on chromosome III and heterozygous inversion on chromosome I, which was reported then. For the first time, we observed a bold heterochromatin disk on chromosome III telomere region. The three inversions have been preserved in the species for about 40 years confirm their adaptive value and stability against the habitat changes.

Also, we analyzed mitochondrial DNA haplotypes via COI gene sequencing in species collected around the *Vernadsky Station*. It is reported that all analyzed species specimens belong to haplotype

D. One of the sequences contained A->T substitution at position 598. Notably, this particular substitution was observed neither for D haplotype, nor for other haplotypes over the previous studies.

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Oral – Permafrost in a Warming World: Impacts and Consequences

Helene Köhnen (Dr. Claire Treat, Prof. Ulrike Herzschuh, Prof. Andrew Hodson)

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INVESTIGATING METHANE EMISSIONS FROM AN OPEN-SYSTEM PINGO ON SVALBARD

Permafrost landscapes are known to contribute to global warming through methane emissions. Pingos could be significant point sources of methane in permafrost landscapes which are so far not included in emissions estimates. We are interested in emissions from Lagoon Pingo on Svalbard. The pingo is known to be part of a complex groundwater system in association with increased hydraulic pressure after permafrost aggradation near the coastline. Hodson et al. detected in 2017 significant methane emission from Lagoon Pingo. We estimated the total summer methane flux using chamber measurements and a physical diffusion model in 2020 and 2021. The flux showed a high seasonal variability, and rises the question how much methane is emitted every year in long-term, also at other pingo sites.

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Poster – Polar Ecosystems: State, Changes and Management

Manuela Krakau, Mathias Ulrich

German Environment Agency

CHALLENGES FOR THE SCIENCE-POLICY-INTERFACE: KNOWLEDGE TRANSFER ON EFFECTS OF CLIMATE CHANGE ON AND IN POLAR REGIONS

The effects of global climate change are particularly visible in the Arctic and Antarctic, but the knowledge transfer of these effects is challenging on the science-policy-interface. The protection of the polar regions is the concern of international alliances of states, such as the Arctic Council or of the signatories to the Protocol on Environmental Protection to the Antarctic Treaty.

The polar oceans are important CO2 sinks due to the formation of deep water, which is endangered by increasing warming, increased freshwater input due to ice melt and also due to changing ocean chemistry (e.g. acidification). Coincidently, the thawing of terrestrial permafrost becomes an ever- increasing source of CH4. One of the current challenges is to identify climate-relevant tipping points and cascading effects in the polar regions as well as knowledge gaps regarding climate relevant carbon uptake capacity or sink stability, especially in relation to the oceanic biological carbon pump and terrestrial permafrost dynamics. Another one is to prepare scientific information for decision- makers, with the aim to better feed into political processes and thus support the increasingly needed ambitions to polar environment protection.

Our goal is to create an interface that brings together relevant and available data and knowledge from various completed projects based on purposeful evaluation and processing of these information and to process them as tailored basis for decision-making at the political level in order to increase national understanding of the special relevance of the polar regions in climate protection.

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Poster – Glaciers, Ice Sheets and Sea-Level Rise

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THE 1950-2020 VARIABILITY OF THE GREENLAND ICE SHEET SURFACE MASS BALANCE

We use the diurnal Energy Balance Model (dEBM) in combination with ERA5 reanalysis forcings to simulate the surface mass balance (SMB) of the Greenland Ice Sheet (GrIS). The dEBM (Krebs-Kanzow et al., 2021) is based on the energy balance of glaciated surfaces. In contrast to most empirical schemes, it accounts for variations in the radiative forcing due to changes in the Earth's orbit and atmospheric composition. The dEBM scheme only requires monthly atmospheric forcing (precipitation, temperature, shortwave and longwave radiation and cloud cover) and is computationally inexpensive, which makes it particularly suitable to investigate the response of ice sheets to long-term climate change. After calibration and validation, we investigate the contribution of individual climate forcings (temperature, precipitation, clouds and radiation) to the interannual SMB variability.

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Oral – Glaciers, Ice Sheets and Sea Level Rise

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MILLENNIAL-SCALE INTERACTIONS OF THE ANTARCTIC ICE SHEET AND THE GLOBAL OCEAN

Increased sub-shelf melting and ice discharge from the Antarctic Ice sheet has both regional and global impacts on the ocean and the overall climate system. Additional meltwater, for example, can reduce the formation of Antarctic Bottom Water, potentially affecting the global thermohaline circulation. Similarly, increased input of fresh and cold water around the Antarctic margin can lead to a stronger stratification of coastal waters, and a potential increase in sea-ice formation, trapping warmer water masses below the surface, which in turn can lead to increased basal melting of the ice shelves.

So far these processes have mainly been analysed in simple unidirectional cause-and-effect experiments, possibly neglecting important interactions and feedbacks. To study the long-term and global effects of these interactions, we have developed a bidirectional offline coupled ice-ocean model framework. It consists of the global ocean and sea-ice model MOM5/SIS and an Antarctic instance of the Parallel Ice Sheet Model PISM, with the ice-shelf cavity module PICO representing the ice-ocean boundary layer physics. With this setup we are analysing the aforementioned interactions and feedbacks between the Antarctic Ice Sheet and the global ocean system on multi-millenial time scales.

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Oral – Coole Klassen – Polarbildung in der Schule

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ERGEBNISSE DIDAKTISCHER BEARBEITUNG VON THEMEN DER MOSAIC-EXPEDITION

Es werden Möglichkeiten vorgestellt, komplexe wissenschaftliche Zusammenhänge didaktisch zu reduzieren und kind- bzw. jugendgerecht für den Unterrichtseinsatz und Schulalltag sowie für die breite Masse öffentlichkeitswirksam herunterzubrechen und darzustellen. Als Schnittstelle zwischen Wissenschaft und Öffentlichkeit/Schule fungieren Lehrkräfte hier in einer besonderen Rolle, die Frau Krüger näher erläutern wird. Dabei gibt Friederike Krüger zum einen Einblick in die didaktische Vorplanung und Arbeit an Bord, zum anderen stellt sie die Ergebnisse der intensiven Nachbereitung ihrer Expeditionsteilnahme vor. In ihrem Vortrag bietet sie Raum für Fragen zur Expeditionsteilnahme und Arbeit als Lehrkraft. Außerdem präsentiert die Lehrkraft einige Unterrichtsmaterialien und Einsatzmöglichkeiten am konkreten Beispiel. Sie zeigt ihren eigens erstellten Dokumentationsfilm für den Unterrichtseinsatz, Doppelseiten aus Schulbüchern, Gruppenarbeiten und Vortragsausschnitte.

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Oral – Atmosphere, Sea Ice, Ocean and Land Interactions

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MODELLING OF SMALL SCALE PROCESSES IN ANTARCTIC SEA ICE - NUCLEATION AND CRYSTAL GROWTH

Sea ice formation covers several orders of magnitude in space and time and begins at a critical temperature with the phase transition from water to ice with a nucleation and growth process. During this process, salt is squeezed from the ice and a network of brine channels is created as a habitat for microorganisms. Antifreeze proteins can also inhibit crystal growth and influence channel structure. This presentation only deals with the processes up to anisotropic crystal growth and the early phase of brine channel formation. A general approach for pattern formation during phase transitions is given by the time dependent Landau-Ginzburg theory, which describes the phase transition in terms of the free energy change as a function of an order parameter. The driving forces of the phase transitions are based on the nonlinearities in the order parameter. At the phase transition the ordered as well as the disordered state have the same free energy, this means that the double-well potential in the order parameter is symmetrical and degenerate, i.e. each of the two minima of equal depth lies on a double real zero. Under these conditions so called kink or antikink solutions of the Landau-Ginzburg equations can arise as a non-dissipative solution for which the energy density does not vanish. The kink solutions play a special role during the pattern formation since they represent the different state of order at the phase boundaries. They are basic components for pattern formation in one and multi-dimensional systems, whereby in two and three-dimensional spaces the number of degrees of freedom increase in each case. The mechanisms of the kink formation can give an insight into the dynamics of phase transitions. In particular, a wave equation for the kink can be derived and therefore a propagation speed of the wave front (phase boundary) can be determined analytically, because a fixed phase relationship exists. From the solution of the time dependent Landau Ginzburg theory we get diverse morphological structures. For steady state conditions a bridge between the classical nucleation theory and the phase field theory is developed. The nucleation and growth process are coupled by two fields, the nucleation- and the growth field, which are connected by a parabola. If a kink and an antikink move away from each other, this is called a freezing or growth process and the influence of the nucleation field disappears more and more. We will modify the mechanism of brine entrapment to couple brine channel formation with the theory of porous media (TPM).

The project is supported by the SPP 1158 of the DFG.

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Poster – Facing Polar Climate Change: Insights from the Past

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SEA ICE AND OCEAN TEMPERATURE RECONSTRUCTIONS ALONG THE ANTARCTIC CONTINENTAL MARGIN: PROS AND CONS OF THE BIOMARKER APPROACH

While the role of sea ice as a crucial component within the global climate system is widely acknowledged, its variability over geological times remains only partly understood. In particular, sea ice reconstructions along the Antarctic continental margin lack robust proxy records. The highly branched isoprenoid (HBI) diene IPSO25 (Belt et al., 2016), has gained pronounced attention as a proxy for Southern Ocean sea-ice reconstructions. Recent studies propose the additional consideration of phytoplankton-derived biomarkers such as certain sterols and/or tri-unsaturated HBIs to determine the so-called PIPSO25 index - a novel approach targeting on semi-quantitative sea ice estimates (Vorrath et al., 2019; Lamping et al., 2020). In order to further test and validate the reliability of this index and also to evaluate GDGT-based ocean paleothermometers in polar latitudes, we investigated several seafloor surface sediments from the Amundsen Sea, the Antarctic Peninsula and the Weddell Sea and compare the proxy-based sea-ice and ocean temperature reconstructions to satellite observations, instrumental measurements and modelling outputs (Lamping et al., 2021). We note the general capability of these proxies to determine oceanic key variables properly but also identify weaknesses associated with uncertainties regarding source specificity of certain lipids and existing calibrations.

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Oral – Permafrost in a Warming World: Impacts and Consequences

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THAWING PERMAFROST POSES ENVIRONMENTAL THREAT TO THOUSANDS OF SITES WITH LEGACY INDUSTRIAL CONTAMINATION

Permafrost thaw is expected to become widespread in this century, threatening Arctic ecosystems, communities, and infrastructure. To date, industrial contaminants that have accumulated in Arctic permafrost regions have largely been neglected in climate impact analyses. Using publicly available data, we estimate that more than 10,000 contaminated sites originate from industrial activities in Arctic permafrost regions. We find a wide range of toxic substances, most of which are associated with industrial activities in mineral exploration and extraction, processing, and energy. By 2050 to 2100, climate change will significantly increase the risk of pollution and mobilization of toxic substances by exposing 500 to 1,500 additional known industrial sites and 1,000 to 3,500 estimated contaminated sites to permafrost degradation. Our analysis points to the severe environmental hazard posed by the legacy of past and ongoing industrial activities in the Arctic, which will be exacerbated by permafrost thaw.

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Poster – Permafrost in a Warming World: Impacts and Consequences

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LINKS BETWEEN GREENHOUSE GAS EMISSIONS AND MICROBES SHIFT DURING SHORT-TERM PERMAFROST THAW UNDER ANAEROBIC CONDITIONS

Soils in the permafrost region have acted as carbon sinks for thousands of years. However, as a result of global warming, permafrost soils are thawing and releasing greenhouse gases (GHG) such as methane and carbon dioxide. In order to help understand this phenomenon, this study focused on the relationship between carbon emissions and soil parameters, as well as microbial evolution during a permafrost thaw experiment equivalent with the time of an Arctic summer. Therefore, six soil samples from the Lena Delta along a transect from upland to floodplain were incubated for 68 days at two different temperatures and microbiological assessment was performed in parallel. Samples located in upland or on the slope remained in a lag phase during the whole incubation, while those located in the floodplain showed high productions of CH4 (6.5 10+3 µg CH4-C .gC-1) and CO2 (6.9 10+3 µg CO2-C .gC-1). A relationship was established between these high productions and landscape localisation. Annual or biannual flooding likely allowed to establish favorable methanogenesis conditions. The presence higher number of methanogenic Archae in the active layer of the floodplain from the beginning (1.5 to 9.6 higher) until the end of the incubation time (1.1.10+1 to 7.10+2 higher), supported this hypothesis. In addition, our study pointed out different anaerobic CO2 production pathways according to landscape position.

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Oral – Coole Klassen – Polarbildung in der Schule

Josefine Lenz

Alfred Wegener Institute and Association of Polar Early Career Scientists

A PERSONAL SCIENCE ACCESSIBILITY ASSESSMENT: FROM SCI-FI TO SCICOM TO SCIQ

The poles are far away for most of us – for most citizen, for many students, teachers and even for most polar researchers. Its beauty and fragility, however, is pulling people's attention and the adventurous, illusive polar explorer still creates imaginary, dreamy pictures in people's heads, while we all know that climate change is well underway.

Meeting expectations and bringing emotional connectivity to respective audiences is a common part of effective polar science communication. This presentation shows examples of successful outreach approaches on the topic of permafrost and Arctic landscape change, as well as a collection of highlights of international science communication efforts. While the complexity of fruitful learning is approached from a rather personal angle, this contribution concludes with a more holistic approach of sustainable knowledge exchange and meaningful engagement of Northern communities, called Inuit Qaujimajatuqangit (ScIQ). In an outlook, a new permafrost citizen science project is presented and opportunities of getting involved are being discussed – with the overall aim to bring the poles closer to us all.

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Poster – DFG SPP 1158 Antarctic Research - Report Colloquium

Lešić, Nina-Marie; Kuhn, Gerhard; Streuff, Katharina; von Dobeneck, Tilo; Bohrmann, Gerhard

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HOLOCENE DEPOSITIONAL ENVIRONMENTS AND ASSOCIATED GLACIER BEHAVIOUR ON THE SOUTHERN SHELF OF SUB-ANTARCTIC SOUTH GEORGIA

South Georgia island is located in the sub-Antarctic zone and its climate is therefore strongly dependent on the Southern Westerlies and the highly energetic Antarctic Circumpolar Current fronts. These, in turn, are influenced by Southern Hemisphere climate variability and affect, inter alia, moisture supply and temperature on the island and along-shelf current strength on the continental shelf over time. This leads to waxing and waning of the South Georgia ice cap and a complex deglaciation history that was archived on- and offshore after the Last Glacial Maximum. The warm Holocene interglacial phase defines the most recent deglaciation phase on South Georgia and has been dominated by a superordinate ice retreat towards the island and glacier fluctuations within the fjords. For this period, radiocarbon dating on six sediment cores from two glacially incised troughs on the southern continental shelf and sub-bottom profiler data show high sedimentation rates that indicate high temporal resolution in the geological climate record. Even so, unconformities in Jacobsen trough affect this record and are dated to 7.7 cal ka BP and 1.5 - 2.5 cal ka BP. Along with multi-proxy analyses, these data suggest that depositional environments and conditions in the inner Drygalski Trough and in Jacobsen Trough varied during the Holocene, likely influenced by glacier fluctuations and bottom current strength. This dataset therefore has the potential to investigate spatial variability and (a-)synchronicity in past glacier behaviour and past current variability around the island.

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Poster – DFG SPP 1158 Antarctic Research - Report Colloquium

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GLACIMARINE SEDIMENTS IN A SEDIMENT CORE FROM DRYGALSKI TROUGH, SUB-ANTARCTIC SOUTH GEORGIA – EVIDENCE FOR EXTENSIVE GLACIATION DURING THE LAST GLACIAL MAXIMUM

South Georgia is one of the largest sub-Antarctic islands, still partially glaciated, and uniquely located within the Southern Ocean. It is influenced by the moisture-supplying Southern Westerlies and the Antarctic Circumpolar Current (ACC). Their reaction to Southern Hemisphere climate variability likely makes South Georgia, and thus its ice-sheet, more sensitive to climate change than the large and more isolated Antarctic ice sheets, resulting in highly responsive ice sheet waxing and waning and consequential geomorphological changes on the island and its continental shelf. Glacial trough sediments have been archiving this ice sheet behaviour since at least the Last Glacial Maximum (LGM) and are therefore an important target to investigate past ice sheet evolution and climate variability. Despite several studies on land and the surrounding shelf, much of this glacial history is still unclear, due to a lack of offshore data. Composite multi-proxy-analyses on gravity core PS119_5- 1 from the outer Drygalski trough, together with radiocarbon dating, sub-bottom profiler and high- resolution bathymetric data partly fill this gap. The presented dataset suggests the presence of a sub- glacial cavity with restricted water access in the outer trough after the LGM, that facilitated grounding zone-proximal sedimentation and strong tidal influence at the core site until ~17.5 ka, when the area opened up and was dominated by iceberg melting. Increasing sedimentation rates during the Antarctic Cold Reversal (ACR; 14.5 – 12.7 ka BP) imply that the LGM subsequent retreat was interrupted by a re-advance associated with increased hinterland erosion. Hemipelagic sedimentation and low sedimentation rates in the outer trough during the Holocene indicate that the only re-advance affecting outer trough sedimentation after the LGM was the one related to the ACR. Our findings support an extensive glaciation during LGM and a quick but step-wise retreat towards the island with one significant interruption during the ACR.

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Oral – Atmosphere, Sea Ice, Ocean and Land Interactions

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MEASUREMENTS OF ICE NUCLEATING PARTICLES OVER THE KARA AND LAPTEV SEA IN THE RUSSIAN ARCTIC

Climate change has accelerated warming in the Arctic region. We are studying the effect of aerosol particles on the microphysical properties of Arctic clouds, one of the many factors that could be responsible. The cloud feedback mechanism on Arctic climate is highly uncertain and differs for water, mixed-phase, and ice clouds. Primary ice formation in the Arctic mixed-phase clouds is initiated by a subgroup of aerosol particles called ice nucleating particles (INPs). The extent to which a cloud is glaciated affects the optical properties and related radiative effects both at the surface and the top of the atmosphere. Accurate quantification of INP number concentrations could therefore contribute to a better representation of cloud microphysical processes when estimating the cloud phase-related feedback in weather and climate models. To date, there is little information on the abundance, variability and potential sources of INPs in the Arctic, particularly in the maritime environment. We present preliminary results from the recent cruise-based Arctic Century Expedition, which took place from 5 August to 6 September in 2021 in the preciously uncharted Kara and Laptev Sea in the Russian Arctic. INP number concentrations measured in the immersion freezing mode, relevant for ice crystal formation in the Arctic mixed-phase clouds, are presented together with their relationships to the environment in which they occurred, e.g., the size distribution of the ambient aerosols. In addition, the geographical variability of INPs along the ship track is investigated to assess the influence of different landscapes, e.g., coastal areas or sea ice cover.

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Oral – Tectonic Processes and Stratigraphy

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ANTARCTICA PRIOR TO GLACIATION: A BASIN SYSTEM WITHIN GONDWANA

The East Antarctic Craton constitutes the major part of the Antarctic continent and once formed the heart of the supercontinent Gondwana. Since the glaciation of Antarctica commencing ~34 Ma ago, an up to 4 km thick ice cover gradually pushed the bulk of this landmass below sea level. Now only a few scattered outcrops are exposed along the continental margins (for example, Dronning Maud Land ranges, Shackleton Range, and Transantarctic Mountains) or as radial structures across the continent (Prince Charles Mountains). Most of these often extensive and up to 4500 m high mountain ranges are characterised by a distinctive tableland morphology and largely lack any Mesozoic and Cenozoic sedimentary record.

However, this present pattern of very low interior planes bound by high-standing basement plateaus does not necessarily represent a past Antarctic landscape within Gondwana. The geological history of the Gondwana interior can only be assessed by combining thermochronological and geophysical data, detrital provenance record and kinematic, thermal and geomorphological indicators. Numerous studies conducted during the last two decades, mainly from the Transantarctic Mountains, produced a comprehensive data set of >500 apatite fission track and (U-Th-Sm)/He data. These age data between ~20 and ~350 Ma were traditionally interpreted in terms of monotonous cooling and referred to stepwise exhumation and uplift of the Antarctic rift structures and passive margins since Jurassic times. However, many of the thermochronological data were obtained from basement rocks that are covered by Mesozoic sedimentary deposits or volcanic rocks extruded at ~180 Ma. Such a crossover relationship between stratigraphic information and thermochronological age data implies heating of the Mesozoic surfaces to temperatures in excess of 100°C. Supplementary petrographic and geochronological analyses also indicate elevated post-Jurassic paleotemperatures, with diachronous thermal peaks.

Thermal history modelling of the thermochronological data suggests substantial burial of the now exposed rocks, and refers to heterogeneous heat flow. Our approach allowed us to identify a whole system of Jurassic–Paleogene sedimentary basins throughout the Transantarctic Mountains, in Dronning Maud Land, Marie Byrd Land, Mac.Robertson Land, and the Shackleton Range. Other basins, such as the Wilkes Subglacial Basin and the Aurora Through, have been recognized from geophysical data. The development of the Mesozoic – early Cenozoic Antarctic depocentres is obviously related to intracontinental extension within Gondwana that eventually led to the dispersal of the supercontinent. These Antarctic basins all correlate with counterparts of the once juxtaposed Gondwana fragments. They represent a crucial tool for reconstructing continental breakup processes and define the setting for long-term climate evolution.

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Oral – Polar Organisms and Ecosystems

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LARGE SCALE CONSEQUENCES OF RAPID ENVIRONMENTAL CHANGE AND LIMITED CAPACITY TO ADJUST MIGRATION SCHEDULES IN ARCTIC BREEDING SHOREBIRDS

The Arctic is warming faster than any other region on the globe. This rapid change results in strong phenological responses across organisms. However, lower trophic levels advance their activities such as the onset of reproduction much quicker than organisms higher up the food chain. This can lead to increased trophic mismatches, carry-over effects with negative consequences for reproductive success and population dynamics. Migratory birds are central players in terrestrial Arctic environments and weak or inadequate phenological responses are commonly observed, as are general declines in migratory populations, highlighting limitation to the capacity for adaptations.

However, using long-term observations (>10 years) from ruddy turnstones (*Arenaria interpres*) from Tasmania migrating to eastern Siberia, and bar-tailed godwits (*Limosa lapponica*) departing New Zealand towards Alaska, we show that migration initiation advanced significantly in both species, and that within-individual advancement was sufficient to explain this population-level change. However, tracking data also suggests that earlier departure did not lead to earlier arrival or breeding in the Arctic, due to prolonged stopovers en-route that are likely driven by habitat degradation in Asia.

Furthermore, we show that increasing temperatures can buffer some effects of trophic mismatches across arctic breeding shorebirds but rarely enough to fully mitigate negative consequences such as juvenile growth reduction and reduced survival rates. Overall, our studies highlight that Arctic breeding shorebirds are extremely vulnerable to climate change and that consequences will likely affect the entire polar ecosystem.

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Oral – Glaciers, Ice Sheets and Sea-Level Rise

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AUTOMATIC GLACIER CALVING FRONT EXTRACTION BY DEEP LEARNING: METHODOLOGY AND RESULTING PRODUCT FOR GREENLAND 2013 – 2021

Accurately parameterizing calving rates of marine terminating outlet glaciers is crucial for understanding glacier dynamics and constraining ice sheet models. Although the increasing availability of satellite imagery opens the prospect of continuously mapping calving front locations, a majority of current products are based on manual delineation, which is infeasible considering the immense data volume. In this contribution, we present an automated workflow to extract calving front positions from multi-spectral Landsat-8 imagery. The workflow is built around a semantic image segmentation using a convolutional neural network, followed by vectorizing the output mask. We evaluate the proposed method using an independent set of diverse test images, as well as by comparing with ESA-CCI and CALFIN data products. With a mean prediction error of less than two pixels, which corresponds to a distance of less than 60 m, automatically extracted frontal positions show small or even non-distinguishable differences to manually delineated locations.

Eventually, we apply the proposed method to 23 of the most important Greenland outlet glaciers for the period from 2013 to 2021. Due to automated and rapid calving front delineation as well as short satellite revisit times we process more than 10,000 satellite acquisitions achieving sub-weekly sampling for most glaciers outside polar night.

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Oral – DFG SPP 1158 Antarctic Research - Report Colloquium: Improved Understanding of Polar Processes and Mechanisms

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ANTARCTIC GEOTHERMAL HEAT FLOW – CHALLENGES AND OPPORTUNITIES

Polar geothermal heat flow is a critical parameter influencing the ice-bedrock interactions and predictions of sea-level changes. Temperature gradients measured in-situ and inferred geothermal heat flow (GHF) are sparse and restricted to few accessible areas in Antarctica, but essential for ground-truthing of indirect models. Previously, these models were commonly based on inverse modeling of glaciological properties, Curie point depth analysis from magnetic data, forward modeling or empirical comparison of seismic data in a regional or continental magnitude.

In recognition of the ambiguity and importance of Antarctic GHF, an increasing number of similarity analyses and machine learning approaches seek to include geological, geophysical and glaciological information with promising results. One drawback remains the relatively low resolution of continent- wide GHF models, that reaches at most 20 km due to the dependency on global data sets so that small-scale spatial variability cannot be captured. Magnitude and spatial distribution are strongly dependent on thermal parameters, such as heat production and thermal conductivity and thus, geology. Therefore, effort must be made to infer the subglacial tectonics, expand petrophysical databases and understanding how and where it affects ice sheet simulations. Thereby, we can detect areas most vulnerable to small-scale GHF variability and which need to be prioritized for future investigations and additional probing.

Our aim is to continue the development of a multinational interdisciplinary science community dedicated to the urgent topic of Antarctica's geothermal contribution to past and future sea-level changes. At this stage, we focus on including a broad expertise from the direct measurement community, glaciologists and ice sheet modelers and introduce the INSTANT* GHF subcommittee's goals and Antarctic-specific problems to the polar science community. We present an on overview of geothermal heat flow studies in Antarctica, future research directions and report on the activities and milestones of the subcommittee.

*INStabilities and Thresholds in ANTarctica

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Oral – Humans in Changing Polar Regions

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ERICH VON DRYGALSKI'S ARCTIC EXPERIENCE USED IN ANTARCTICA

When Erich von Drygalski planned to investigate the movement of small local glaciers and big glaciers at the west coast of Greenland 1891-1892, he knew that he had to relay of the knowledge and the help of the local people. As European scientist on one hand he had a special academic background but on the other hand no idea at all about living, travelling, and surviving in the Arctic. During his short preliminary expedition (1891) he became acquainted with fur clothes and boots, dog sledges, kayaks and ferries made out of kayaks. He used his chance to learn as much as possible from the Greenlanders. However, ten years earlier, Carl Hagenbeck had given the order to bring a group of Inuit from Labrador to Hamburg as a new attraction for his zoological garden where they were displayed as strange creatures showing their amazing skills like the kayak roll.

A Greenlandic family joined Drygalski's main expedition and assisted them through the winter night. They showed the German group of three scientists how to hunt and prepare seals for dinner, how to prepare fur and to sew cloths and boots. Drygalski was very fond of the friendliness of the local people and remembered most of them with names in his personal photo album. In his report to Ferdinand Frhr. von Richthofen he even mentioned that he experienced the most cheerfulness party in his life with the Greenlanders.

With the knowledge gained in Greenland Drygalski planned the equipment of the first German South Polar Expedition (1901-1903), which should use fur clothes and dog sledges to investigate the unknown region of Antarctica at 90°E.When scientists assumed a possible drift of the "Gauss" with an ocean current crossing the South Pole region by analogy to Nansen's drift on board the "Fram" towards the North Pole, Drygalski provided a seat in a one- or two-person wooden kayak for each expedition member just in case the expedition ship "Gauss" had to be abandoned.

In the end, Drygalski's application of his personal Arctic experience to Antarctica referring to dog sledges, food, clothes, and the use of snow as material for buildings was successful. Only very weak evidence of scurvy, but no serious frostbites occurred.

Literature

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Oral – DFG SPP 1158 Antarctic Research - Report Colloquium: Improved Understanding of Polar Processes and Mechanisms

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COMPARISON OF SNOW HEIGHT BUOY MEASUREMENTS WITH 1D SNOW COVER SIMULATIONS IN THE WEDDELL SEA

In the Snow Covers impact on Antarctic Sea Ice (SCASI) project, we combine snow simulations on Antarctic sea ice with buoy observations and satellite data. The overall goal is to develop a new and consistent snow data product for Antarctic sea ice that quantifies amount, distribution and physical properties of snow on various length scales and different seasons. The product will be useful for sea ice and radiation models, altimetry-based ice thickness retrievals and other research that depends on information on snow on sea ice, e.g. regarding biological production or geo-chemical cycles. To achieve this goal, we compare snow depth simulated with the sea ice version of the 1D snow cover model SNOWPACK (Wever et al., 2020) with snow buoy measurements in the Weddell Sea. The SNOWPACK simulations are initiated with the snow and ice thicknesses as measured when deploying the buoys and are run with meteorological ERA5 reanalysis data. We analysed 23 snow buoys drifting autonomously on sea ice for altogether ~5000 days. Here, we present how well precipitation (non-)events in ERA5 reanalysis data coincide with snow height as measured by the buoys. First, we identify days with low wind speeds and either low (a) or high (b) precipitation. We expect the buoy-observed snow heights on these days to show no changes (a) or positive changes (b), respectively. In only half of the cases (out of ~900 days), the expected snow height changes are observed by the buoys. Deviations can be caused by the uncertainty of the reanalysis data, the difficulties to interpret snow buoy data, and the very local scale of the buoy measurements (~1m, not necessarily representative for a larger area). The agreement with simulated snow depth is (of course) higher: 70...90% agreement, depending on model settings for snow drift and thresholds for wind speed. This analysis can help us to identify suitable cases for comparison with satellite data. A further goal is to combine the SNOWPACK model with microwave emission models for simulating passive microwave radiation and investigating the impact of snow properties on satellite retrieval methods.

Literature

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Poster – Permafrost in a Warming World: Impacts and Consequences

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FATE AND TRANSPORT OF ORGANIC CARBON INPUT THROUGH PERMAFROST THAW ALONG THE BEAUFORT SEA COAST AND TUKTOYAKTUK HARBOUR, NORTHWESTERN TERRITORIES, CANADA

Around 65% of the Arctic coastline consists of permafrost soils which are currently thawing on an accelerating rate due to rising global air temperatures. The uncontrolled and rapid thaw of permafrost soils leads to increased coastal erosion and input of large amounts of organic carbon (OC) into the coastal ocean. Here, the OC can either be degraded (leading to production and emission of greenhouse gases that strengthen climate warming) or be sequestered over short or long timescales (attenuating climate warming).

In order to obtain more insight into the fate of the eroding material, we will use hydrodynamic fractionation on a variety of actively eroding coastal cliffs. Hydrodynamic fractionation accounts for the sediment sorting of particles when exposed to different energy conditions such as waves and wind. With this technique we will fractionate based on density and grainsize to mimic the route in the marine system.

Our project focusses on the fate and transport of these different fractions and their OC content on a bigger scale along the Beaufort Sea Coast as well as on a smaller scale along the coast line of the harbour of Tuktoyaktuk, a community in the Inuvialuit Settlement Region.

Tuktoyaktuk, located along Kugmallit Bay has the only deep water port on the Arctic Ocean that is fully accessible (via the Inuvik Tuktoyaktuk Highway) to Canada and North America. The harbour has a strong influence on and importance to marine transport, subsistence fishing, economic development and even Arctic sovereignty. It is mainly influenced by water and sediment input from the proximate Mackenzie River, however we believe the acceleration of erosion along the Beaufort Sea Coast has increased the suspended sediment load being delivered into the harbour. A better understanding of the suspended sediment dynamics and transport into this vital harbour is critical for marine management of infrastructure and sustainability of important aquatic ecosystems.

Here we present first results of both parts of the project, ranging from geochemical parameters such as OC contents, δ13C values, water column properties for Tuktoyaktuk Harbour as well as data of hydrodynamically and grain size separated permafrost soil fractions along the Beaufort Sea Coast.

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Oral – DFG SPP 1158 Antarctic Research - Report Colloquium: Dynamics of Climate Change Components

Carolin Mehlmann

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NEW SEA ICE DYNAMICS IN ICON: ICOSAHEDRAL NONHYDROSTATIC WEATHER AND CLIMATE MODEL

Sea ice in the Arctic and Antarctic oceans plays an important role in the exchange of heat and freshwater between the atmosphere and the ocean, and thus in climate in general. Climate models must describe the dynamics of sea ice on large scales and couple them with general ocean circulation models. The topic of this talk is the performance of the new sea ice dynamics in ICON.

In the first part of the talk we discuss the numerical realization of the new sea ice dynamics in ICON. The challenge in numerically discretizing sea ice dynamics is to reproduce the physical properties as well as possible while achieving external coupling with the ocean in a natural way. In the second part of the talk we explore the role of sea ice dynamics in a in a Paleo-climate setup. The talk ends with an outlook on the development of a new hybrid sea ice model that addresses the shortcomings of currently used sea ice models.

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Oral – Tectonic Processes and Stratigraphy

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CONNECTING THE THERMAL EVOLUTION OF NORTHERN GREENLAND AND SVALBARD BY DATING THERMAL ANOMALIES IN UPPER CRETACEOUS-PALEOGENE SEDIMENTS

Prior to the break up between Greenland and Svalbard, the Wandel Sea basin formed in eastern North Greenland. Its Carboniferous to Paleogene deposits were influenced by rifting associated with transtension, and the compressional- transpressional Eurekan deformation, the last major period of Arctic tectonism before the northern North Atlantic opened. Vitrinite reflectance values > 7 % from Upper Cretaceous rocks along the east coast of North Greenland point towards an unusually high thermal maturity that exceeds the thermal maturity associated with Eurekan deformation further inland. High thermal maturation is also observed in Paleogene sediments further North and also along the conjugated North Atlantic margin in western Svalbard. Here, the deposits yield vitrinite reflectance values up to 4% with values also decreasing further inland. Cause and origin of the increased heat flux indicated by the thermal maturation values are not well understood yet, nor is the timing clearly defined.

As both margins of the North Atlantic were affected by heating, we examined whether this pattern originated at the same time and marks a thermal event after the Eurekan. Because vitrinite reflectance data suggest temperatures high enough to reset low-temperature chronometers, we applied apatite fission track (AFT) and (U-Th-Sm)/He thermochronology (AHe) and thermal history modelling to constrain the time when the thermal anomaly has formed, and its geodynamic context.

Our data provided evidence for at least two thermal events. AFT and AHe ages of the Upper Cretaceous sediments of North Greenland indicate that intense thermal overprinting occurred in the Late Cretaceous to Early Paleocene. We assume that magmatic activity was involved to a major extent. AFT and AHe ages of the Paleogene sediments exposed in North Greenland slightly north of the Upper Cretaceous deposits clearly show a later thermal overprint, postdating the late Cretaceous to Paleocene heating. Sediments exposed along the Svalbard side of the North Atlantic may have been heated coevally with the Paleogene sediments of the Greenland side, but in any case, the Svalbard margin was exposed to elevated temperatures for a longer time, as compared to the Greenland margin. Heating of the Paleogene sediments may be related to increased heat flux and fault activity associated with the Eurekan during the Paleocene-Eocene. While cooling of the Greenland margin began during the Eocene, sediments on the Svalbard margin started cooling from elevated temperatures during the Oligocene. This is presumably related to graben formation and horst exhumation on the western margin of Svalbard during post-Eurekan extension, associated with the transtensional movements that preceded the opening of the Fram Strait.

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Oral – Glaciers, Ice Sheets and Sea Level Rise

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HYDROCLIMATE AND CRYOSPHERIC CHANGES IN THE RUSSIAN HIGH ARCTIC

The High Arctic is assumed to be the last reserve of a stable cryosphere. Recent publications from the Canadian High Arctic indicate, however, that changes are currently happening much faster than expected, and the future trajectory is unknown. The rate and magnitude of recent climate warming has implications for the stability of ice, especially in the far north. Moreover, air temperatures at unprecedently high levels lead to drastic retreat in sea ice extent, i.e, larger and longer ice-free shelf seas, which now may act as a “new Arctic” moisture source with clear impact on the regional hydrological and cryospheric processes.

Terrestrial ice (glaciers and ice caps, ice fraction in permafrost) in the high Russian Arctic is expected to change. This terrestrial ice is a freshwater inventory on land that has been preserved in a stable state for hundreds of years. It contains unique information about past and present climate changes which is stored in the terrestrial ice to be studied, i.e. with stable isotope methods. In this presentation, we focus on the stable hydrogen and oxygen isotopes as a unifying proxy employed for addressing cryospheric, atmospheric, marine and terrestrial research questions.

In the framework of the Arctic Century 2021 expedition, we addressed the hydroclimate situation of High Arctic Islands, by studying short ice cores from three visited ice caps. Here, Windy Ice Dome (WD, Franz-Josef-Land) and Akademii Nauk ice cap (AN, Severnaya Zemlya) have been revisited and cored after more than 20 years, now complementing earlier longer ice cores. The University ice cap (UN, Severnaya Zemlya) has been cored for the first time. Key observations were intensive near- surface melt processes inducing the percolation of meltwater, numerous thick melt layers (reaching up to 80 cm), as well as liquid water in the borehole at AN and UN ice caps. The ice-coring program (5 cores, 27.2 m of core) has been accompanied by snow sampling (N=126) and an extensive hydrological program including 170 sea water samples, 16 terrestrial surface waters and 31 precipitation samples. Moreover, ice-wedge samples were retrieved from a permafrost exposure at Severnaya Zemlya. The Arctic Century Expedition took place in August/ September 2021 and was jointly organized by the Swiss Polar Institute, the Arctic and Antarctic Research Institute, Russia and the Helmholtz Centre for Ocean Research GEOMAR in Germany.

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Oral – Atmosphere, Sea Ice, Ocean and Land Interactions

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THE INFLUENCE OF LEAD PATTERNS ON DOMAIN-AVERAGED ATMOSPHERIC PROFILES OVER SEA ICE

Thick sea ice on the polar oceans acts as a good insulator between the cold atmosphere and the relatively warm water, especially during late winter and early spring, when air temperatures are low. A turbulent exchange of energy at the atmosphere-ocean interface is then almost limited to regions with polynyas or leads. The latter represent elongated channels in sea ice, either ice-free or covered by thin, new ice. Large temperature differences between the surface of leads and the near-surface atmosphere cause strong turbulent convection (convective plumes) and enhanced transports of heat, moisture, and momentum. These rather small-scale processes can have a profound impact on the characteristics of the lower atmosphere on different spatial scales.

In regional climate or numerical weather prediction models, leads with potentially different characteristics are not resolved with the typical grid sizes of such models. Open water is accounted for only by a continuous open-water fraction rather than by separated leads as in nature. Thus, neither leads, nor related convective plumes, nor a changing lead configuration (pattern) from one grid cell to the next one can be resolved. We examined potential implications for such models by not resolving these subgrid-scale patterns, which in nature are inhomogeneously distributed over an area of a typical grid cell. To study such drawbacks, we used a model with a grid size to appropriately resolve convection over individual leads but not the turbulent eddies as in large eddy simulation (LES) models. Nevertheless, its turbulence parametrization was adjusted to results of LES applied to scenarios of convection over leads.

We considered simulations of the flow over the same domain but with six different lead patterns. In five domains, we prescribed leads of different widths separated by 100% sea ice on a microscale grid. The sixth domain was considered as representative for a few grid cells of a regional climate model with much coarser grid spacing. Its grid cells consisted of a fractional sea ice cover of 91% to account for the leads indirectly. However, averaged over each domain, the mean sea ice concentration was the same in all simulations. We found considerable differences in domain-averaged vertical profiles of wind, temperature, and turbulent fluxes. This points to a strong impact of both the leads and their geometry on atmospheric patterns and to a relevance of the treatment of leads in regional climate modelling.

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Oral – Needs for Innovative Polar Infrastructure

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PLANNING FOR *POLARSTERN II*

Polarstern, the world class icebreaking research vessel will reach the end of its useful lifetime by 2027. It will then have been in service for 45 years.

In order to be able to support polar research in its broadest sense planning for a replacement vessel has been ongoing for some years by now.

The presentation will give an overview of the planning for the new vessel and its expected characteristics. The depth to which details can be discussed will depend upon the stage of the public tender which we will see at the time of the conference.

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Oral – DFG SPP 1158 Antarctic Research - Report Colloquium: Dynamics of Climate Change Components

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THE SURFACE MASS BUDGET OF ANTARCTICA: OPEN QUESTIONS, UNCERTAIN ANSWERS, LARGE IMPACTS

Mass budget in Antarctica is largely driven by snowfall at the surface with ice dynamics and sub-shelf melting under the fringing ice shelves being the primary sources of mass loss. Given the relative paucity of ground station measurements, climate models and estimates from satellite data dominate estimates of ice sheet surface mass budget (SMB), yet recent work by the SMB community show relatively high uncertainties on mass budget estimates driven by present day climate reanalysis, that suggest even the sign of Antarctic mass budget trends may be difficult to determine. Modelled snowfall rates are highly sensitive to model resolution and physics, and on a basin scale correlate to atmospheric indices such as the Southern Annular Mode. High magnitude but rare snowfall events often linked to atmospheric rivers can significantly affect regional and local SMB estimates on annual timescales. Here we look at ways to reduce these unknowns and uncertainties using models, remote sensing and ground observations. I will also introduce two new EU projects that aim to better represent

Antarctica in climate models.

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Poster – Polar Ecosystems: State, Changes and Management

Ayla Murray, Charlotte Havermans

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

WHO'S THERE? A COMPREHENSIVE EDNA METABARCODING SURVEY OF GELATINOUS ZOOPLANKTON BIODIVERSITY IN THE FRAM STRAIT

The Arctic is warming two times faster than the global mean, and a phenomenon known as the 'Atlantification of the Arctic' via the Fram Strait is having growing influences on both biological and physical processes in the region. Changes to community composition and function are already underway and these environmental changes will continue to rapidly alter Arctic ecosystems. A greater understanding of how this impacts local marine biodiversity is crucial for formulating accurate predictions of future Arctic marine ecosystems and management decisions. Gelatinous zooplankton (GZP) is a highly diverse group of taxa, including cnidarians, ctenophores, and tunicates. Very little is currently known about GZP ecology, particularly in the Arctic Ocean, and even less about how they are being impacted by climate-related changes. Not only are they often actively left out of zooplankton surveys, but GZP are notoriously difficult to catch in good condition because their fragile bodies are easily destroyed by traditional sampling methods. These challenges contribute to GZP taxa regularly being underestimated in biodiversity, distribution, and abundance, which has led to a lack of reliable and comprehensive baseline data available, especially in the Arctic. The aim of this study is to apply non-invasive environmental DNA (eDNA) metabarcoding methods to investigate GZP biodiversity and distribution across the Fram Strait. COI mitochondrial and 18s rRNA amplicons from water and sediment samples will be sequenced with Next Generation Sequencing (NGS) and validated with depth-stratified net-catch data. Net-caught specimens will be barcoded where possible, to complement existing reference databases. Oceanographic data will then be incorporated in order to form a holistic baseline dataset of GZP biodiversity across the region. Such data would be a valuable contribution to future research into the deviations in Arctic GZP biodiversity, community composition, and distribution over time, as a result of ongoing environmental changes.

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Oral – Polar Organisms and Ecosystems

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ThINK

FIRST GERMAN PROPOSALS OF POTENTIAL CANDIDATES FOR ANTARCTIC SPECIALLY PROTECTED AREAS (ASPA)

The Antarctic Treaty Parties are currently endeavouring to establish a coherent network of protected areas in the Antarctic, incorporating the existing protected areas. With this project, Germany would like to contribute to this for the first time by identifying and proposing candidates for the designation as Antarctic Specially Protected Areas.

To identify potential ASPAs, we conducted a search for suitable sites based on the following criteria:

- Ecological, biological, geological or geomorphological features or peculiarities,
- Classification as Important Bird Area,
- Significance for seals and vegetation,
- Scientific significance,
- Potential threats

As a result, we compiled a list of 13 appropriate areas. Supported by an advisory board of German polar institutions we selected two candidates to be proposed for presenting prior assessments at CEP XXIV in Berlin 2022. The prior assessment is the first formal step towards an ASPA designation.

The proposed area ‘Danger Islands’ comprises a set of seven islands off the north-eastern coast of the Antarctic Peninsula. It mainly qualifies by containing one of the largest concentrations of Adélie penguin (*Pygoscelis adéliae*) breeding sites.

By contrast, the proposed area ‘Otto-von-Gruber-Gebirge’ represents a continental high mountain oasis in the Wohlthatmassiv region of Dronning Maud Land. Main features of this area are the microbial ecosystems of perennially ice-covered lakes and one of the largest colonies of snow petrels (*Pagodroma nivea*). In this presentation we introduce the proposed areas and explain their characteristics and values to be protected.

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Oral – Atmosphere, Sea Ice, Ocean and Land Interactions

Felix L. Müller, Stephan Paul, Denise Dettmering, and Stefan Hendricks

Deutsches Geodätisches Forschungsinstitut der Technischen Universität München (DGFI-TUM)

A COMPARISON BETWEEN CS2 RADAR ALTIMETRY AND MODIS IMAGERY FOR MONITORING THIN ICE IN THE LAPTEV SEA

The increasing number of open water areas and thinning sea ice has significant impacts on the energy exchange between the atmosphere and the ocean and on sea ice dynamics in the Arctic Ocean. In particular, polynyas or leads are not permanently open, but are partially frozen over and covered by a thin layer of ice up to a thickness of about 25 cm. The surface temperature of so-called thin ice is between open water and thicker sea ice surfaces, which modulates the heat exchange between the ocean and the atmosphere. This influence of thin ice on the heat fluxes complicates for example the simulation of climate models or forecasting systems. In order to support model simulations and ship operations, various Earth Observations sensors are used to routinely monitor thin ice surface extent–primarily using passive microwave or side-looking SAR missions.

In the present investigation, a classification scheme is presented which detects open water, thin ice, and thicker sea ice surfaces using an unsupervised, artificial learning approach solely based on Cryosat-2 Synthetic Aperture Radar (SAR) altimeter reflections (waveforms). The unsupervised classification approach identifies similar patterns among a subset of randomly collected waveforms and groups them into a specific number of classes without the use of training data. Further, the classes are assigned to different surface conditions. Primarily this approach was designed to reliably identify water openings within the sea ice cover (Müller et al., 2017). However, extended investigations and improvements in the classification algorithm additionally enable the detection of thin ice surfaces.

The results of the classification approach are compared to thin ice thickness retrievals from MODIS thermal imagery. Here, we make use of the higher spatial resolution of MODIS compared to the frequently used passive-microwave approaches as well as the better spatial coverage compared to available SAR systems. The thin-ice thickness data are computed from MODIS ice-surface temperatures derived from the standard MOD/MYD02 radiances data using a surface-energy-balance model together with atmospheric reanalysis data from ERA5 and suitable overpasses are screened manually for cloud-cover artefacts and suitability (Paul et. al., 2015). Moreover, radar images of the ESA Copernicus mission Sentinel-1 are used to support the evaluation of MODIS and Cryosat-2 thin ice comparisons. In these comparisons, special attention is paid to minimal acquisition time gaps up to a maximum of 30 minutes and large spatial overlap areas, to reduce the impact of drifting sea ice, changing thin-ice conditions and strong air temperature differences.

The presented results show how the monitoring of polar oceans can be improved, and contribute to the knowledge about the Arctic ice cover, specifically observing the full sea ice thickness

distribution. Moreover, the Cryosat-2 classification can support the development of improved waveform retracker algorithms enabling a more reliable estimation of the sea ice freeboard or sea level in the polar seas.

To sum up our contribution includes the presentation of:

- Thin ice detections by an unsupervised classification approach using Cryosat-2 waveforms
- Waveform-derived characteristics w.r.t. a changing thin ice thickness
- Thin ice thickness retrievals gathered from MODIS thermal imagery
- Visual and quantitative comparisons of both datasets close in time and space

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Oral – Glaciers, Ice Sheets and Sea-Level Rise

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ICE ELEVATION CHANGE BASED ON GNSS MEASUREMENTS ALONG THE GREENLAND KORTH EXPEDITION

Since 2002, repetitive measurements have been taken on the southern Greenland ice sheet to study the change in ice elevation along a historical route defined by Alfred de Quervain. Until 2012, static GNSS measurements were carried out every 20 km under the responsibility of Wilfried Korth (Greenland Korth Expedition GKE). Since 2015, kinematic GNSS measurements have been recorded every second along the entire traverse from the East (near Tasiilaq) to the West (near Ilulissat).

The kinematic repeat measurement took place in summer 2020, but it had to be ended prematurely and therefore the area of influence of Jakobshavn Isbræ could not be examined. Two comparison methods were used. On the one hand that of the crossing points and on the other hand that of the minimum distances. Both methods give similar results for the Greenland ice sheet. Another expedition took place in spring 2021, which kinematically measured the entire traverse. Based on this data, an estimate for the missing area from 2020 can be made and thus the comparability to the previous campaigns at the same season can be established. Likewise, the change in winter from the end of the thaw period to the beginning of it can be examined.

Along the traverse, the influence of the two outlet glaciers Helheim in the East and Jakobshavn Isbræ in the West on the change in elevation is significant. In the accumulation area, a maximum gain of 2.1 m is recorded, whereas in the ablation area, a loss of up to 38.7 m occurs in the period from 2002 to 2021.

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Poster – Glaciers, Ice Sheets and Sea-Level Rise

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SNOWFALL CHANGES IN ANTARCTICA: WHAT IS THE SENSITIVITY OF ANTARCTIC PRECIPITATION TO TEMPERATURE?

Snowfall is by far the most important positive contributor to the overall mass balance of the Antarctic Ice Sheet, potentially buffering temperature-induced dynamical ice loss in a warming climate. Previous studies have proposed that Antarctic snowfall will increase along the Clausius–Clapeyron relationship, describing the saturation water vapour pressure as a function of temperature (7% change for 1°C of warming). Due to cold temperatures and continentality in the interior, this general, first-order explanation may not hold true for snowfall changes across the ice sheet. In this study, we investigate how this first-order approximation can be modified to more reliably represent snowfall changes in a warming climate for simulations of the Antarctic Ice Sheet.

To characterise the present-day precipitation pattern, we use reanalysis data and make use of state- of-the-art model data from the CMIP6 modelling project as well as regional model data. We analyse how the sensitivity of Antarctic precipitation to temperature changes is represented in models and how it potentially changes in the future. We use least-squares linear regression to determine the sensitivity factor, that is used in ice-sheet models to scale precipitation.

With our statistical analyses, we show that sensitivities of column-integrated water vapour, precipitation, snowfall, net precipitation, and surface mass balance to temperature changes are fairly similar under present-day conditions; implying that the exponential relationship of saturation water vapour pressure to temperature could generally lead to additional mass gains of the Antarctic Ice Sheet with warming. However, we find that the relationship of Antarctic precipitation to temperatures across the ice sheet is not constant, but decreases with ongoing warming. Taking these changes into account could give a more reliable estimate of future precipitation changes than existing approaches. We demonstrate that a linear approximation of the exponential relationship between Antarctic precipitation and temperature becomes more and more imprecise in a warming climate, both for computing the sensitivity factor and to scale Antarctic precipitation in models.

We propose a new way to extract the sensitivity factor of Antarctic precipitation to temperature which takes regional variations and the temperature dependence into account. The temperature dependence becomes more important the higher the warming becomes. Considering local warming rates, we show the necessity of introducing a temperature-dependent scaling factor in ice-sheet models, especially for high-end or long-term sea-level projections.

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Oral – Atmosphere, Sea Ice, Ocean and Land Interactions

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SNOW DEPTH AND PROPERTIES ON ANTARCTIC SEA ICE FROM AUTONOMOUS OBSERVATIONS AND NUMERICAL SIMULATIONS

Antarctic sea ice is covered with snow most of the year in most regions. The snowpack affects sea ice mass balance, albedo, light transmission, and gas fluxes between atmosphere, sea ice and ocean. It controls all surface properties and is a critical component for most remote sensing observations and for climate studies. Here we present results from 10 years of snow depth observations in the Weddell Sea, based on autonomous measurements by Snow Buoys. We also present results of the one-dimensional numerical snow model SNOWPACK, simulating snow depth and snow properties along the drift trajectories of the Snow Buoys. This combination provides detailed insights into internal snowpack processes and how they impact sea ice mass and energy budgets. The numerical simulations also enable advanced analyses of the observational data. We find a tremendous difference between snow accumulation from reanalysis data, the actual simulated snow depth and observed surface heights. The main reasons are hidden snow processes, in particular snow ice formation. While partly more than 1.5 m of snow are accumulated on the sea ice along some of the trajectories, the maximum snow depth within the annual cycle was 0.48 m +/- 0.10 m (single buoy maximum: 0.78 m). All additional snow is converted into snow ice due to surface flooding and refreezing. As a result, we also find that almost half (48 %) of the sea ice consists of snow ice, and thus includes former snow into sea ice mass balance. In addition, we will discuss the role of ocean heat flux for sea ice and snowpack simulations. We obtain best agreements between the simulation and the Snow Buoy measurements with an ocean heat flux of 4 Wm-2. Sensitivity studies reveal that ocean heat flux is a major factor which controls the above-mentioned thresholds. In conclusion we will show that snow depth does not reflect snow accumulation on sea ice and thus that e.g., snow depth measurements are not sufficient to discuss precipitation and might mislead sea ice mass balance studies.

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Oral – Permafrost in a Warming World: Impacts and Consequences

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QUANTIFYING THE PERMAFROST HEAT SINK IN EARTH'S CLIMATE SYSTEM

Due to an imbalance of incoming and outgoing radiation at the top of Earth's atmosphere, excess heat has been accumulating in its climate system in recent decades, driving global warming and climatic changes. To date it has not been quantified how much of this excess heat is being used for the melting of ground ice in the terrestrial permafrost region. Here, we diagnose changes in sensible and latent heat contents in the northern terrestrial permafrost region from ensemble simulations of a numerical permafrost model. We find that about 3.9 (+- 1.1) ZJ of heat, of which about 45% were used to melt ground ice, were taken up by permafrost from 1980 to 2018. This suggest that permafrost is a persistent heat sink similar in magnitude to other components of Earth's cryosphere. Better knowledge of pan-Arctic ground ice distribution as well as direct observations of changes in latent heat contents would allow to improve this estimate. We conclude that permafrost should be considered explicitly in assessments of Earth's energy budget, and we promote an energy-based perspective on permafrost degradation to complement the classical focus on ground temperature and active-layer thickness.

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Poster – Facing Polar Climate Change: Insights from the Past

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THE BATAGAY MEGASLUMP IN EAST SIBERIA AS ARCHIVE OF CLIMATE-PERMAFROST INTERACTIONS DURING THE MIDDLE AND LATE PLEISTOCENE

The Batagay megaslump (67.58 °N, 134.77 °E) is the largest known retrogressive thaw slump on Earth, and located in the Yana River Uplands near the town of Batagay in east Siberia. The slump headwall is about 55 m high and exposes ancient permafrost deposits that provide a discontinuous record of the Middle and Late Pleistocene that dates back to at least 650 ka.

Cryostratigraphy and dating results provide evidence for several periods of both permafrost formation and degradation. Permafrost formation and stability during Marine Isotope Stage (MIS 16) or earlier (lower ice complex), MIS 7–6 or earlier (lower sand unit), MIS 4–2 (upper ice complex), and MIS 3–2 (upper sand unit) are reflected by the presence of deposits with syngenetic ice wedges and composite (i.e., ice–sand) wedges. In contrast, permafrost thaw and erosion are shown by sharp, erosional discordances above reddish and organic-rich layers and by the accumulation of woody (forest) remains in erosional downcuts. Permafrost thaw and erosion likely took place during one or several periods between MIS 16 and MIS 7–6 as well as during MIS 5 and the late Pleistocene– Holocene transition.

We present stable-isotope data of ice and composite wedges (winter signals) and pore ice (summer to annual signals) from all four main stratigraphic units of the Batagay megaslump to gain regional seasonal-scale climate signals for this extremely continental region.

To draw large-scale conclusions on climate–permafrost interactions across east Siberia we compare our data to independent climate and permafrost reconstructions from the terrestrial (cave deposits, lake sediment cores, and permafrost deposits) and marine Arctic.

The Batagay megaslump is a key study site of the Leverhulme Trust funded research project “Reconstructing Siberian permafrost dynamics using stable & clumped isotopes” (IsoPerm, https://isoperm.net). IsoPerm investigates environmental controls on east Siberian permafrost dynamics along a transect of key study sites from the Laptev Sea coast to the Lake Baikal focusing on the analysis of speleothems and permafrost deposits (ground ice, fossil ostracods and mollusks) using stable and clumped isotope methods.

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Poster – Needs for Innovative Polar Infrastructure

Hans-Jürgen Paech

Pensioner

THE VENUE OF THE CONFERENCE 'TELEGRAPHENBERG' IN THE PAST

The Telegraphenberg area attaining the altitude of 96 m a.s.l. was formed during the Weichselian glacier advance ~15,000 years ago. It is mainly composed of fluvioglacial sands, locally folded in the push moraine and overlain by undeformed kames formations.

The history of the Telegraphenberg area will be outlined by illustrations, mostly by maps:

Great Elector Frederic William (1640-1688) considered the dense mixed forest ideal for hunting ground.

Soldier king Frederic William Ist (1713-1740) needed timber for the expanding city of Potsdam, which meant predominantly deforestation.

Frederic IInd (1740-1786): this period was characterized by reforestation with monotonous coniferous wood.

In 1813 the area was fortified against the threat of the Napoleonic forces. Here on top of the hill the main retrenchment (Feldschanze) was erected which was additionally reinforced by two barricade lines (Verhack) constructed of nearby cut trees. These lines attained length of ~6 km in total, which meant again deforestation.

In 1832 this wood-free summit considered to offer optimal conditions for erecting the station 4 of the Royal Prussian Optical Telegraph Line linking Berlin and Koblenz. The line covered a distance of 588 km allowing a relatively rapid transmission of informations. In 1846/ 1849 it was substituted by the more comfortable electro-magnetic system out of the Telegraphenberg area. In 2009 the signal installation of the optical telegraph was reconstructed and can be visited in operation during a lunch break of the conference.

Starting in 1875 the by now named Telegraphenberg had step by step been occupied by scientific institutions in an autarkic park with own water supply, which later was completed by gas and electricity. Without exception the charming architecture of the historical buildings of the 19th century was designed by P.E. Spieker (1826-1896). However, the road pattern may seem a bit confusing. But the transport of the heavy klinkers for the first observatory on top of the hill needed a gentle ascent, whereas the empty vehicles could use a steeper road. Thus, the first road was constructed one-way in the shape of the number eight. Later on further roads are added.

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Oral – Polar Organisms and Ecosystems

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HYDRO-CHEMICAL COMPOSITION AND SEASONAL VARIATION OF HIGH ALTITUDE LAKE: A CASE STUDY OF LAM DAL, CHAMBA, HIMACHAL PRADESH, INDIA

The present work contains a preliminary analysis of hydrochemical processes prevalent in high- altitude lakes of Himalaya, Lam Lake (dal) and its six consecutive lakes in the Chamba district of Himachal Pradesh. Water samples were collected during pre-monsoon and post-monsoon season for three years i.e. 2017, 2018 and 2019 respectively and a comprehensive study was performed to understand the processes controlling the geochemistry of lake water. The anion concentration for all the seven lakes had a trend of HCO3- > NO3- > Cl- > SO42- > PO43- whereas that of cation was Ca2+ > Mg2+ > Na+ > K+ for both pre-monsoonal and post-monsoonal seasons.The dominance of Ca2+- HCO3- over Mg2+-HCO3- reflects the possibility of the natural order of dominance in the geology of the catchment area. The low Na+ + K+ / TZ+ (total cations) ratios, high Ca2+ + Mg2+ / TZ+ (total cations) ratios and (Ca2+ + Mg2+) / (Na+ +K+) ratios reflects dominance of carbonate weathering.

The average carbon ratio of all the seven studied lakes (L1 to L7) were around 0.97 and 0.98 respectively for pre-monsoon and post-monsoon, suggesting that proton is primarily derived from the oxidation of sulphide along with coupled reactions involving carbonate dissolution. The hydrochemistry of these lakes is mostly controlled by weathering and erosional patterns prevailing in the area triggered by the amount of monsoonal precipitation and snowmelt runoff. Further to trace the imprints of climate change and seasonal variations in the high-altitude lakes, long term monitoring is recommended along with isotopic tracer techniques.

Keywords: High-altitude Lakes, Hydrochemistry, Geochemistry, Carbonate Weathering, Major Ions

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Poster – Changing Atmosphere-Land-Ocean Systems in the Eurasian Arctic

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STUDYING THE DYNAMICS OF THE SANTA ANNA TROUGH USING RARE EARTH ELEMENTS AND THORIUM: PRELIMINARY RESULTS

The global ocean exerts a strong influence on Earth's weather and climate through its leverage on the meridional heat, moisture transport and the exchange of carbon with the atmosphere. The chemistry and physics of the ocean are sensitive to climate with yet uncertain impacts on our planet in the face of anthropogenic warming. In particular, the Arctic Ocean is experiencing the effects of global warming faster than anywhere else. This accelerated change has the potential of directly affecting human livelihoods through its impact on the global climate system. The reduction of the Arctic cryosphere has been attributed in part to an increased advection of "warm" Atlantic waters. These waters enter the Arctic basin through two main pathways: The Fram Strait Throughflow (FST) and the Barents Sea Throughflow (BST). So far, most studies have been focused on the first one, leaving a significant gap on the BST, particularly at the Santa Anna Trough, where it mixes with the FST and enters the deep Eurasian basin. In this work, we present preliminary data on rare earth elements and thorium concentrations for this region. We expect that the combined use of REE and Th-232 will allow us to better understand the particle dynamics of the Santa Anna Trough and surrounding waters, providing insights into the scavenging dynamics and the potential role of the dissolution of shelf sediments and increased melting on the nutrient inventory. These findings, together with results from other geochemical tracers, will contribute to obtaining a better understanding of the role of this region in the accelerated warming of the Arctic and its potential impacts on global climate and the carbon cycle.

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Poster – Organisms in the Face of Climate Change: Discoveries and New Approaches

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SATELLITE IMAGES REVEAL THE EFFECTS OF EARLY BREAKUP OF FAST ICE FOR EMPEROR PENGUIN COLONIES AND THE PARTIAL MIGRATION ONTO THE ICE SHELF AS A POSSIBLE ADAPTATION

The breeding biology of emperor penguins (*Aptenodytes forsteri*) is strongly dependent on seasonal fast ice. Recent studies showed the vulnerability of emperor penguins to a changing environment (namely sea ice loss) induced by the ongoing climate change, which could consequently result in the distinction of the species. In this study, we show recent examples of how sea ice loss could affect emperor penguin colonies and how they possibly adapt.

We used Sentinel-2 and Landsat-8 medium resolution satellite images of Halley Bay and Atka Iceport to detect the extent of the fast ice and the position of the local emperor penguin colonies during the breeding season 2021/22. The analysis shows a complete loss of the Halley Bay colony due to early fast ice break up, while at Atka Iceport a migration of parts of the colony onto the ice shelf is visible. Satellite and UAV based elevation data will be used to conclude why such a migration onto the ice shelf did not occur at Halley Bay.

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Oral – Polar Ecosystems: State, Changes and Management

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THE KEY MESSAGES OF THE 6TH ASSESSMENT REPORT 2022 OF THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE (IPCC) REGARDING THE IMPACTS AND RISKS OF AND ADAPTATION OPTIONS TO CLIMATE CHANGE IN POLAR REGIONS

The Intergovernmental Panel on Climate Change (IPCC) is a United Nations body created in 1988 to provide decision makers with regular, neutral, policy-relevant but not policy-prescriptive scientific assessments on climate change, its impacts and potential future risks, as well as to put forward adaptation and mitigation options. The Working Group II contribution to the Sixth Assessment Report (AR6 WGII), which has been approved and published end of February 2022, assesses climate-change impacts, risks, adaptations and vulnerability for various systems (e.g., land and freshwater ecosystems, ocean and coastal ecosystems, water, food, fibre and other ecosystem products, cities and key infrastructure, health, and livelihoods) and regions, including polar areas, as well as frame options for sustainable development pathways integrating adaptation and mitigation measures. In this presentation, I will provide an overview about the AR6 cross-chapter paper on polar regions, focusing on the key messages about the specific polar climate-driven impacts on and risks for socio- ecological systems in high-latitude areas, as well as the opportunities, adaptive capacities, and response options related to climate change.

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Oral – DFG SPP 1158 Antarctic Research - Report Colloquium: Response to environmental change and linkages with lower latitude

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ORGANIC MATTER AVAILABILITY DRIVES THE SPATIAL VARIATION IN THE COMMUNITY COMPOSITION AND ACTIVITY OF ANTARCTIC MARINE BACTERIOPLANKTON

Carbon cycling by Antarctic microbial plankton is poorly understood but it plays a major role in CO2 sequestration in the Southern Ocean. We investigated the summer bacterioplankton community in the largely understudied Weddell Sea, applying amplicon and shotgun sequencing combined with measurements of bacterial production and the chemical analyses of organic matter. The results revealed that the patchy distribution of productive coastal polynyas and less productive, mostly ice- covered sites was the major driver of the spatial changes in the taxonomic composition and activity of bacterioplankton. Gradients in organic matter availability induced by phytoplankton blooms were reflected in the concentrations and composition of dissolved carbohydrates and proteins. Abundant bloom-responsive bacterial lineages were predominately affiliated with ubiquitous marine taxa, suggesting a widespread genetic potential for adaptation to sub-zero seawater temperatures. The construction of metagenome-assembled genomes provided insight into the metabolic strategies of bacterial key players in the Weddell Sea. Overall, our study demonstrates that heterotrophic bacterial communities along the ice shelves were primarily constrained by the availability of labile organic matter rather than low seawater temperature.

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Oral – Polar Organisms and Ecosystems

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MICROBIAL DIVERSITY AND BIOGEOGRAPHY IN POLAR AND SUBPOLAR REGIONS

A wide range of microorganisms inhabit terrestrial environments of Polar Regions. These taxa live and thrive under extreme conditions and, moreover, play important roles in biogeochemical cycling. Nevertheless, the structure of polar microbial communities and their geographic distribution remains ambiguous. Here, we studied the diversity and abundance of bacteria and microeukaryotes in biocrusts and other terrestrial environments of the Antarctica, Arctic and Iceland using amplicon metagenomic sequencing. In general, bacterial community composition was dominated by Chloroflexi, while the majority of eukaryotes were assigned to Chloroplastida. Furthermore, multivariate statistical analyses showed that microbial diversity in Antarctica is more distinct from the Arctic and Iceland. Indeed, samples from Antarctica exhibited higher numbers of reads assigned to Cyanobacteria or/and Firmicutes within bacteria and Metazoa within eukaryotes.

Considering man-made climate changes have a particularly large impact on polar and subpolar regions, research on microbial diversity is needed. This study will contribute to monitor microbial community composition changes in the future.

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Poster – DFG SPP 1158 Antarctic Research - Report Colloquium

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DISTRIBUTION AND MERCURY CONTAMINATION IN ANTARCTIC STORM PETRELS

The diet and distribution of predators determine the prevalence and risk associated with exposure of wildlife to contamination such as the highly toxic metal mercury. Migratory seabirds such as storm- petrels may forage in areas with different contaminant levels throughout the annual cycle, and may show a carry-over of mercury from the winter quarters to the breeding areas in their tissues. We here compare data on distribution and mercury contamination of two species of storm-petrels breeding in the South Shetland Islands. We collected inert body feathers and metabolically active blood samples, representing longer (feathers) and shorter (blood) exposure during different periods ranging from early non-breeding (moult) to late breeding. Feathers represent mercury accumulated over the annual cycle between two successive moults. Black-bellied Storm-petrels had threefold higher values than Wilson's Storm-petrels, and species differences in the blood samples were similar to those in feathers. Over the breeding season, mercury decreased in blood samples of Wilson's Storm-petrels, but did not change in Black-bellied Storm-petrels. We discuss this in the context of differences in the distribution and prey choice, and also compare to mercury concentrations in Subantarctic and temperate species.

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Oral – Humans in Changing Polar Regions

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POLITICAL AND SCIENTIFIC COOPERATION IN THE ARCTIC – BACK TO SQUARE ONE?

During the last three decades the Arctic has been a region for constructive dialogue between nations and people living in the North, including Indigenous Peoples. Scientific cooperation, uniting researchers from all countries engaged in Arctic research, substantially contributed to this dialogue. Triggered by President Gorbachev´s Murmansk speech in 1987, two organizations formed in the 1990s and played a central role in the development of Arctic political and scientific cooperation. The Arctic Council, established in 1996, is the leading political forum addressing environmental protection and sustainable development of the region. The International Arctic Science Committee (IASC), established in 1990, is fostering scientific cooperation in all aspects of Arctic research.

The consequences of the Russian invasion of the Ukraine are a far-reaching setback for Arctic political and scientific cooperation. Following the statement that “Canada, the Kingdom of Denmark, Finland, Iceland, Norway, Sweden, and the United States condemn Russia’s unprovoked invasion of Ukraine and note the grave impediments to international cooperation, including in the Arctic, that Russia’s actions have caused”, the Arctic Council decided to pause all official meetings of the Council and its subsidiary bodies until further notice. IASC stated that they “unreservedly condemn the unprovoked Russian invasion of Ukraine and the resulting war and loss of life and human suffering this causes”.

Other Arctic bodies and forums reacted in a similar way.

This presentation will analyze and discuss the immediate and long-term impact of the Russian invasion and the subsequent international reactions and sanctions on Arctic political and scientific cooperation.

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Oral – Needs for Innovative Polar Infrastructure

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POLAR LK II RESEARCH INFRASTRUCTURE OF THE ALFRED WEGENER INSTITUTE, HELMHOLTZ CENTRE FOR POLAR AND MARINE RESEARCH

The Helmholtz Association offers access to its research infrastructure also to external users, e.g., from universities and other national and international institutes. It distinguishes between large-scale facilities, which serve the institute's own research and LK II (Leistungskategorie II) research infrastructure, which is made available to an even larger extent to external users. The polar LK II infrastructures include the research icebreaker *Polarstern*, the Antarctic research stations *Neumayer III* and *Kohnen* and the research aircraft *Polar 5* and *Polar 6* of the Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research (AWI). Research projects can be proposed by national and international user communities on a regular basis, depending on the schedule of the respective infrastructure. All proposals are reviewed and selected in transparent processes by external advisory boards. Here we present AWI's polar LK II infrastructures with their technical and logistical specifications. We will inform about the application procedures and schedules of the different LK II research infrastructures.

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Oral – DFG SPP 1158 Antarctic Research - Report Colloquium

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CENOZOIC VOLCANISM AND LANDSCAPE EVOLUTION IN NORTHERN VICTORIA LAND

Northern Victoria Land (NVL) forms the Pacific termination of the Transantarctic Mountains with particularly diverse landscapes. In the Mountaineer Range of NVL, nearshore outcrops of the Cenozoic Meander Intrusives are associated with dissected high-relief topography up to 3400 m in elevation that contrasts with planar morphologies further southwest and inland. We investigate the role of this syn-rift volcanism in terms of exhumation processes and landscape evolution applying apatite fission-track (AFT) and (U-Th-Sm)/He-thermochronology on apatite and zircon. A total of 41 samples was included in our analysis covering five vertical profiles in four outcrops of Meander Intrusives and surrounding host rock. Magmatic activity between ~50 and ~25 Ma formed intrusive complexes highly variable in fabric, mineralogical composition, geometry and dimensions, ranging from syenitic plutons to gabbroic, dioritic, basaltic and trachyandesitic dyke swarms to layered intrusions. The occurrence of two separate plutons represents a shift in volcanic activity from the SW (50-39 Ma) to the NE Mountaineer Range (34-25 Ma).

While holocrystalline textures indicate moderate rates of solidification well below the surface, AFT ages recovered from Cenozoic Meander Intrusives commonly overlap with crystallisation age data, suggesting rather shallow emplacement. The temporal relationship between cooling of host rocks and nearby volcanism is complex and differential. Recorded AFT ages increase with elevation from 25 Ma at sea level to 45 Ma at 2650 m in the SW Mountaineer Range, while they cluster at ~34 Ma further NE. Mean track lengths of 13.5-14.5 µm and conspicuously narrow track length distributions refer to high cooling rates throughout. Particularly in the NE Mountaineer Range, thermochronological patterns coincide with recorded pulses of igneous activity at 34 Ma and 25-26 Ma. Combined with aeromagnetic data, this tight coupling is interpreted as distortion by a thermal aureole sourced from an underlying pluton of ~20 km in diameter. Its accelerating effect on exhumation is evident in the increasing rates since ~32 Ma, from 60-130 m/Ma to ≥2000 m/Ma at 26- 25 Ma, resulting in a total amount of ≥ 5 km.

We postulate that peaks of lithospheric cooling in the Mountaineer Range of NVL are linked with thermally induced upwarping due to rift-related magmatic activity. This process involved rapid inversion of a Mesozoic sedimentary basin and efficient downwearing at high rates reaching 2 km/Ma. Fast Oligocene denudation required powerful erosive agents which we propose were provided in the form of well-lubricated temperate glaciers during the onset of large-scale Antarctic glaciation at ~35 Ma. Ultimately, additional thermal support during uplift allowed for incision to a deeper crustal level, the removal of a Jurassic palaeosurface that is present in southwestern plateau morphologies and the evolution of a more mature, segmented topography.

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Oral – Glaciers, Ice Sheets and Sea-Level Rise

Sebastian Rößler, Andreas Dietz, Celia Baumhoer

German Aerospace Center DLR

POLAR MONITOR - CROSS-INSTITUTE COLLABORATION PROJECT ON REMOTE SENSING OF POLAR REGIONS

In the Polar Monitor project, four DLR institutes are working together on research questions relating to remote sensing of polar regions. In addition to the German Remote Sensing Data Center (DFD), the Remote Sensing Technology Institute (IMF), the Microwaves and Radar Institute (HR) and the Institute of Optical Sensor Systems (OS) are involved. Since the start of the project in spring 2020, almost all goals have been achieved. The Global SnowPack (GSP) processor has been implemented in the operational service, which means that global snow cover information is now freely available in near real-time and without data gaps due to clouds or polar night. Besides the near-real-time data, the snow cover extent (SCE) for each day since February 2000 as well as the derived snow cover duration (SCD) for each hydrological year are also archived. In addition, an "Ice Lines" processor was developed that automatically detects antarctic ice shelf edges and creates shape files from them. Both products are provided through the Earth Observation Center's (EOC) GeoService. In addition, a method of semi-automatic mapping of the grounding line for individual glaciers was successfully developed and tested. At the conference we will present the products we have produced so far and how they can be used. Moreover, the first results of the joint field and flight campaign on the Aletsch Glacier in late summer 2021 will be presented and an outlook on the intended second phase of the project will be given.

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Oral – Coole Klassen – Polarbildung in der Schule

Emily Rudolph
Dathe Gymnasium Berlin

RAISING AWARENESS: A MULTIMEDIA FAIR ABOUT THE ARCTIC

As an English and Geography teacher and member of Polar Educators Germany (Arbeitskreis Polarlehrer) I consider myself responsible for bridging the gap between science and schools by teaching my students relevant, current and especially authentic contents. Hence, I made discussing climate change in the Arctic and learning about the newest scientific research results one of the main objectives in my 10th grade Geography class.

While preparing the teaching unit and suitable teaching materials, I came across two major problems. First of all, how to awaken the teenager's interest for a region that is so far away and at first glance of no relevance for my 15 year old students in Berlin. Second of all, how to motivate the learners to prepare extensive projects which are informative for other people of their age and raise awareness about problematic developments researchers also warn about in scientific publications or the media.

I solved these problems by compiling a teaching unit that not only informs my students about the Arctic, current trends and their impact, but furthermore motivates them to continuously work on the topic thoroughly and creatively: I prepared learner-oriented tasks and materials, which will help my students to produce digital learning products, using their favorite media platforms like Instagram, TikTok, Podcast Apps, or Snapchat, which they present at an environmental fair at school and also share online for others to watch or listen to and in order to continue the exchange.

At the conference I plan to present the concept, specific tasks and parts of the materials of the envisioned teaching unit I prepared.

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Poster – Polar Research in a Changing Society

Ruppel, A., Koglin, N., Läufer, A., Piepjohn, K., Gaedicke, C., Kasch, C., Goldmann, F.

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TERRESTRIAL POLAR RESEARCH AT THE FEDERAL INSTITUTE FOR GEOSCIENCES AND NATURAL RESOURCES

The BGR has been conducting geoscientific research in the polar regions for > 40 years. With the background in hard rock geology and geophysics, the BGR is committed to provide answers to two overarching scientific questions: the formation, development and disintegration of continental landmasses like Rodinia and Gondwana up to today's Antarctic continent, and the opening of the Arctic Ocean and the development of its surrounding continents.

Northern Victoria Land in the Pacific part of Antarctica has been the target of BGR's Antarctic research since 1979, with 14 expeditions so far, all under the programme name GANOVEX (German Antarctic North Victoria Land Expedition). As main logistic base, the BGR relies on its *Gondwana Station* at Terra Nova Bay. The station was set up in 1983, converted into a containerised summer station in 1988/89, and modernised up to the latest environmental standards in 2015 to 2017. The station is now among those Antarctic stations with a very small ecological footprint.

GEA (Geodynamic Evolution of East Antarctica) is BGR's second major Antarctic research program. It is a collaborative programme with the AWI as co-organiser and various national and international partners. GEA focuses on Dronning Maud Land in the Atlantic and Indian Ocean sectors of Antarctica, and builds upon a series of earlier projects in various regions of East Antarctica.

BGR was also involved in two international drilling projects in the Ross Sea (Cape Roberts Project, ANDRILL), currently participates in the preparation of the New Zealand-led drilling project SWAIS 2C, and is pushing ahead with a drilling project on the Ekström Ice Shelf off Dronning Maud Land with the AWI.

The BGR has been active in the Arctic since 1992 mainly under the umbrella of CASE (Circum-Arctic Structural Events). The plate tectonic evolution of the Arctic Ocean as a result of the opening of the Amerasian and Eurasian basins by studying geodynamic processes on its surrounding continental margins has thus been the main scientific focus of the CASE programme. Thematically linked to the CASE programme are aerogeophysical surveys, such as the joint AWI-BGR project NOGRAM.

As a request from the National Committee of SCAR-IASC, the BGR operates the National Polar Sample Archive (NAPA) in Berlin. The archive comprises close to 10,000 samples from the German polar research community, which were collected in the Arctic and Antarctic, catalogued and made available for further research.

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Poster – Tectonics and Geodynamic Processes

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HIGH-RESOLUTION MAGNETIC SIGNATURES CONSTRAIN POLYPHASE TERRANE BOUNDARY IN THE TRANSANTARCTIC MOUNTAINS

The Lanterman-Mariner Fault Zone (LMFZ) constitutes a major tectonic boundary in northern Victoria Land, at the Pacific end of the Transantarctic Mountains. It separates the inboard Wilson Terrane, characterized by low- to high-grade metamorphism, from two very low- to low-grade outboard lithotectonic units, the Bowers and the Robertson Bay terranes. The three units formed due to subduction of the Palaeo-Pacific Ocean under the active continental margin of East Gondwana during the late Ediacaran-early Paleozoic Ross Orogeny. The LMFZ represents a complex and polyphase fault zone that runs more than 400 km from the Ross Sea coast northwestward to the Pacific Ocean. It is characterized by a tectonic mélange including UHP mafic and ultramafic bodies and layers within a gneiss-dominated matrix and strongly deformed metaconglomerates, separated by anastomosing faults and shear zones.

We present new high-resolution aeromagnetic data from the Mountaineer Range/Mariner Glacier (Ross Sea coast), the Lanterman Range and its northern continuation across the lower Rennick Glacier and Bowers Mountains towards the Pacific Ocean. The surveys were carried out during several expeditions within the GANOVEX (German Antarctic North Victoria Land Expedition) research programme led by the Federal Institute for Geosciences and Natural Resources (BGR) between 2015 and 2022, in cooperation with the Italian National Antarctic Research Program (PNRA). The helicopter-based surveys with a setup of 2 km line spacing and 10 km tie lines were complemented by structural and petrological field work as well as ground truth magnetic susceptibility readings.

Magnetic signatures in the Mountaineer Range/Mariner Glacier tightly correlate with post-Ross igneous complexes, which most likely intruded along inherited Ross-aged structures and therefore help to trace fault systems within the LMFZ and define their crosscutting relationships. The magnetic signatures at the Pacific side of the study area are more complex and show various prominent, nearly parallel magnetic lineaments. These lineaments occur throughout the three terranes and their trends follow the strike of the Wilson-Bowers terrane boundary. Within the Lanterman Range, one of the magnetic lineaments correlates well with the aforementioned tectonic mélange of mafic-ultramafic rock fragments, gneisses and meta-conglomerates delineating the Wilson-Bowers terrane boundary. The eastern magnetic lineaments cannot be directly associated to any exposed lithology in the area, which show rather low magnetic susceptibility values, but give new constraints on the complex collision process. Future modelling of the data set will help to identify the specific nature and origin of these anomalies.

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Oral – Polar Organisms and Ecosystems

Rümmler, Marie-Charlott; Esefeld, Jan; Pfeifer, Christian; Mustafa, Osama

ThINK GmbH

EMPEROR PENGUINS AND DRONES: INVESTIGATIONS ON THE SENSITIVITY OF THE LARGEST PENGUIN SPECIES TO SMALL AERIAL OBSERVERS.

Drones (UAVs, unmanned aerial vehicles) are increasingly used in Antarctic science for monitoring and survey purposes. The emperor penguin, one of the flagship species of Antarctica, has not yet been subject to aerial surveys by drones, despite the pressing need for population data in view of threats posed by climate change. We investigated the behavioural reaction of emperor penguin chicks and adults to UAV overflights in different altitudes, different flight directions (vertical vs. horizontal) and with two different UAV models (fixed-wing vs. multicopter) as well as to human approaches. We found that only small proportions of the investigated individuals (<30 %) showed distinct behavioural reactions, which usually lasted for less than one minute. Chicks reacted more strongly to UAV flights than adults, with vertical approaches causing the highest reactions. The strongest behavioural changes in adults were observed during human approaches, which was also the only experimental setting where adults reacted more strongly than chicks. The reaction to the multicopter UAV was slightly stronger than to the fixed-wing UAV, and tended to increase later in the season. We can conclude that emperor penguins, in terms of potential disturbance, are a suitable species for UAV based population assessment, which could help increase our knowledge on the population status of the species greatly.

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Poster – Humans in the Changing Arctic

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RESILIENCE AND ADAPTATION OF FIRST NATIONS COMMUNITIES IN CANADA TO DISAPPEARING WINTER WOAD INFRASTRUCTURE IN A CHANGING CLIMATE

Arctic regions are warming at two to three times the global mean temperature increase (IPCC, 2018). In northern Canada, it threatens the physical integrity of overland transport routes (winter roads constructed over seasonally frozen sea, land, lakes, rivers and creeks) as well as the societies they sustain. Winter roads are not only vital for the transport of heavy equipment, cargo and fuel, they also provide the physical connections that foster social and cultural interactions among remote First Nations communities. In the project's intended study area in northern Manitoba, climate change has already shortened the operational length of winter roads, and the frost-free season is projected to increase by 40 days (40-50%) until 2080 in a high radiative forcing (RCP8.5) scenario. First Nations (FN) communities live across more than 630 settlements in Northern Manitoba and Ontario and depend on winter roads to receive essential supplies needed to build and sustain their livelihoods.

Mapping of existing seasonal roads, simulating their operational length under current conditions and tracking the ice thickness where they cross water bodies will provide the foundation for modelling the response of the different winter road terrains to future climate scenarios. In a twofold approach, the research also aims to identify the existing vulnerability and adaptation of First Nations Communities to historical climate and natural weather variability and to examine potential adaptation mechanisms to enhance their resilience to future climate change.

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Oral – Glaciers, Ice Sheets and Sea-Level Rise

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ARCTIC GLACIERS RECORD WAVIER CIRCUMPOLAR WINDS

Glaciers in the Arctic respond sensitively to climate change, recording the polar amplification of global warming with increasing mass loss. Here, we use glacier mass balances in Svalbard and northern Arctic Canada to categorize tropospheric variability and the associated summer circulation over the Arctic. We establish a link between annual glacier mass balances and their respective atmospheric forcings since 1950 using GRACE/GRACE-FO satellite data (2002–2021), as well as regional climate models and reanalysis data (1950–2019). We find that asynchronous behaviour of mass balance between the regions has become very likely since the early 2000s, exceeding the range of previous decadal variability. Related tropospheric circulation exhibits more meridional patterns, a greater influence of meridional heat advection and a wavier summer circulation. The traceable impact on glacier mass balances emphasizes the importance of dynamic next to thermodynamic climate changes for the future of glacier mass loss, Arctic ecology and societal impacts.

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Oral – Humans in Changing Polar Regions

Birgit Sattler und Klemens Weisleitner

Universität Innsbruck, Institut für Ökologie und Österreichisches Polarforschungsinstitut

ICE – AN AESTHETIC APPROACH TO A VANISHING GOOD

Kept in perspective, ice offers numerous possibilities of research. However, ice is more than a cold and frozen matter by combining mysticism, supernatural power, ambiguous forms of appearance and simply sheer beauty. The intersection of this emotional approach is packed into this exhibition. Over a number of years, two limnologists have captured hundreds of shades of ice during their research expeditions to Antarctica and the High Arctic. The scale spans from millimeter to entire landscapes and combines science and fascination for this frozen world as a vulnerable vanishing good. Ice appears in manifold facets, in a fascinating dynamics and sheer beauty. One can lose himself when ice puts its spell on. However, we have to face the fact that these bizarre worlds are a vanishing good.

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Poster – Organisms in the Face of Climate Change: Discoveries and New Approaches

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DETECTIVE WORK TO IDENTIFY THE UNKNOWN FROM THE SEAFLOOR: A NEW ANOBOTHRUS SPECIES (POLYCHAETA, AMPHARETIDAE) FORM THE SOUTHERN OCEAN WITH INFORMATION ON HABITAT CONDITIONS

Despite extensive sampling and new identification methods, many benthic species of the Southern Ocean are still unknown. Here we present a detailed description of a new Ampharetidae (Polychaeta) species, *Anobothrus konstantini* Säring & Bick 2022 sp. nov. from the Weddell Sea including its detailed habitat description. The identification process was challenging and resembled detective work. Since not all diagnostic characters were visible with established techniques (light microscopy and scanning electron microscopy), we included micro-computed tomography (micro-CT) for the first time for a species description of Anobothrus. Using light microscope and scanning electron microscope, we identified the following diagnostic characters: presence of a circular glandular band on segment 6; an elongated ridge between notopodia on segment 12 and modified notochaetae on this segment; sixteen thoracic, two intermediate and ten abdominal segments. The micro-CT images provided information on the shape of the prostomium (Ampharete-type) and the arrangement of branchiae (four pairs in two rows, without a gap). This method helps to detect diagnostic features that are difficult to recognize in poorly preserved or small individuals. In addition, this study presents a detailed habitat description for the new Anobothrus species based on the measured environmental parameters at collection sites (chlorophyll a content, organic matter content, chloroplastic pigment equivalents, grain size). The combination of taxonomic and ecological studies provides the essential basis for modelling habitat and species distribution, an important tool for management and species conservation of the Southern Ocean ecosystem.

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Oral – Polar Organisms and Ecosystems

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ANTARCTIC POLYCHAETE COMMUNITIES: PREDICTING FUNCTIONAL AND TAXONOMIC PATTERNS USING SPECIES ARCHETYPE MODELLING

The Antarctic Peninsula and the Weddell Sea are increasingly threatened by effects of climate change. In order to establish conservation strategies, it is essential to determine and understand benthic community compositions and taxa distributions in these regions. High spectra and diversity of functional groups combined with high abundances make polychaetes an important group in benthic soft bottom ecosystems of the Southern Ocean. Despite increasing sampling effort and research interest, knowledge on spatial distribution patterns of polychaetes is scarce and patchy, partially because of inaccessibility. We focus on two regions (Antarctic Peninsula and Filchner Trough) and investigate polychaete communities and their relation to environmental drivers. Using a model-based spatial approach we predict polychaete community compositions. Samples were collected during three expeditions with *Polarstern* (PS 81: tip of the Antarctic Peninsula, PS 96: South-Eastern Weddell Sea, PS 118: North-Western Weddell Sea). Faunal analyses were carried out on sediment cores taken with a multicorer. The environmental data set combined data on sampling locations (temperature, salinity, and chlorophyll a for the water column; grain size, TOC, TN, and pigment content for the sediment) and spatial data from databases (current speed, distance to coast, ice cover, benthic terrain index). For community predictions the species archetype modelling (SAM) was used, which generates archetypes independent of a-priori assumptions of species grouping.

Polychaete distribution patterns for taxonomic and functional community compositions across two regions in the Weddell Sea were predicted. Based on the shared environmental response, the determined multispecies archetypes need similar conservation strategies. Our research improves the establishment of a recent modelling approach and the understanding of the Antarctic ecosystem structure and function on larger scales. Moreover, the findings will encourage conservation management strategies.

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Poster – Glaciers, Ice Sheets and Sea-Level Rise

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GEODETIC MONITORING OF ICE DYNAMICS AND MASS BALANCE IN CENTRAL DRONNING MAUD LAND, EAST ANTARCTICA

For more than 30 years the region between Schirmacheroase and Wohlthatmassiv, central Dronning Maud Land, East Antarctica, has been the subject to numerous geodetic and glaciological investigations. This region is characterized by the Potsdam Glacier, which exhibits a relatively low flow velocity, and by a vast blue ice area extending in south-eastern direction to Otto-von-Gruber-Gebirge. Additionally, the Otto-von-Gruber-Gebirge has been proposed recently as a possible candidate for an Antarctic Specially Protected Areas (ASPA).

Repeated ground-based surveys (mainly GNSS) conducted in that time period serve as a basis to studying the long-term evolution of surface elevation, ice velocity, accumulation and ablation in this region. In recent years, these ground-based measurements have been supplemented by simultaneous airborne radar and lidar observations. Furthermore, laser and radar satellite altimetry data acquired by the missions ERS-1/2, Envisat, ICESat, and CryoSat-2 satellites enable us to compare these with the ground-based observations. Especially, the ground-based and airborne observations were used in ESA projects for the calibration and validation of CryoSat-2. Additionally, satellite imagery (e.g., from Landsat satellites) provides optical snapshots over several decades.

The long-term evolution of the ice regime will be especially discussed in terms of changes of surface elevation and ice flow velocities. With respect to mass balance, the combination of ground-based, airborne and satellite-based data provides a comprehensive picture of the entire region.

In this presentation we will present the current status of the analyses based on observations over the past 30 years and discuss the derivation of temporal changes of the respective parameters mainly in terms of linear trends. It is shown that an ongoing, permanent (or at least repeated) observation is essential for deriving reliable long-term trends for this region.

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Oral – Humans In Changing Polar Regions

Barbara Schennerlein
DGP

NIKOLAI V. PINEGIN - A TALENTED ARTIST IN SERVICE OF POLAR RESEARCH

The contribution presents a personality whose work combined extraordinary artistic skills with an unconditional engagement for the exploration of the North. The activities of Nikolai Pinegin come at a time full of enthusiasm to explore the still white spots in the Arctic with scientific methods, in the 1920s and 1930s.

Pinegin (1883 – 1940), educated at art academies in Kazan and St. Petersburg, actively promoted social democratic ideas during the Russian Tsarist era.

Passionate about the North, already 1905 he organised a first visit to the Northern Dvina region. His bad experiences did not stop him from further stays.

The lecture outlines some of his stations in life, which are closely related to outstanding expeditions in Russian and Soviet polar history, for example the Sedov expedition 1912-1914, his merits during the first research flights in 1924 over Novaya Zemlya and his activity as a leader in the construction and operation of the first research station on the New Siberian Islands. Not only did he learn the basics of navigation, astronomy and ship handling, but he also became a qualified meteorologist. In a rarely fortunate combination, he was able to use these scientific skills with his artistic skills on all expeditions. Re-mapping of polar regions, first-time documentation in photos and film, many paintings, scientific and popular science books are the results of his work.

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Poster – Permafrost in a Warming World: Impacts and Consequences

Lutz Schirrmeister, Guido Grosse, Sebastian Wetterich, Jens Strauss

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YEDOMA PERMAFROST LANDSCAPES AS PAST ARCHIVES, PRESENT AND FUTURE CHANGE AREAS

Ice-rich permafrost deposits of late Pleistocene age (Yedoma Ice Complex) covered several million km2 of the Arctic main land spanning from West to East between the Taymyr Peninsula and the Yukon of Northwest Canada and from South to North between Central Yakutia and the Arctic shelves during the Last Glacial Maximum. Today about 2.6 million km2 in Siberia, Alaska and Northwest Canada belong to the Yedoma domain. Similar cold and dry (continental) climate conditions defined common depositional features such as prevalent fine-grained sediments, large syngenetic polygonal ice wedges, specific ground ice structures, significant buried amounts of well-preserved organic matter, and fossil remains of the mammoth megafauna and other tundra-steppe faunal and floral fossils. The once extensive periglacial landscapes of the Yedoma domain developed over tens of millennia in unglaciated regions where late Pleistocene syngenetic permafrost formation expanded and later underwent widespread degradation during the Lateglacial and early-Holocene warming.

This last period of rapid thaw transformed the Yedoma domain from tundra-steppe polygonal tundra into lake-rich thermokarst landscapes. At the same time, vast shares of the continental Arctic shelf were flooded by the postglacial transgression of Arctic seas. Ice-rich Yedoma deposits were and still are very vulnerable to climate warming, leading to diverse landscape responses such as surface subsidence, thermokarst, thermo-erosion, deepening of the active layer as well as remobilization of buried freeze-locked organic matter and subsequent release of greenhouse gases.

Papers written in a paper collection by Frontiers in Earth Science represent a broad view on the current state of knowledge in permafrost research with respect to Yedoma landscapes in the past, present, and future. Yedoma research had been conducted from many decades and still remains active and important for the study of past, present and future response of permafrost to climate change. The Yedoma domain once covered vast areas of the terrestrial Arctic and still stores considerable amounts of carbon some of which likely will be mobilized under ongoing and future warming. Understanding the formation and storage of organic matter preserved in Yedoma deposits requires paleoenvironmental research to estimate the extrinsic (climate) and intrinsic (periglacial processes) controls on permafrost aggradation and degradation. The 26 studies in the Research Topic origin from an international group of authors highligh the common interest in this particularly important type of permafrost and the potential of Yedoma research as a scientific bridge between disciplines and nationalities.

This paper collection is the final activity of the International Permafrost Association (IPA) action group “The Yedoma Region: A Synthesis of Circum-Arctic Distribution and Thickness.”

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Oral – Permafrost in a Warming World: Impacts and Consequences

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MODELLING CONSEQUENCES OF PERMAFROST DEGRADATION FOR ARCTIC INFRASTRUCTURE – A CASE STUDY OF THE DALTON HIGHWAY

The fate of infrastructure in the Arctic and in high altitude regions is heavily depending on the stability of frozen ground which it is built on. Climate change and consequent degradation of permafrost will negatively affect various infrastructure types and can cause ultimate failure. Comprehensive pan-Arctic assessments are urgently needed to better quantify environmental, economic and societal risks and to help adaptation planning. The use of physical models can be a powerful tool for risk evaluation, but modelling challenges remain with respect to resolving construction details at infrastructure scales together with decadal-scale climate change impacts. Here we used the dynamic permafrost land-surface model CryoGrid3 for capturing both - the effects from the interaction of small-scale infrastructure with permafrost and large-scale climate change effects evolving in the 21st century. We discuss how infrastructure can affect ground temperatures, and how climate change increases the risk of future infrastructure failure. As an exemplary case of permafrost-affected infrastructure failure, we modelled a gravel road on continuous permafrost at Prudhoe Bay (Alaska). We investigate the timing of infrastructure failure from soil subsidence in dependence of assumed embankment thickness and depth of excess ice in the ground.

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Oral – DFG SPP 1158 Antarctic Research - Report Colloquium: Improved Understanding of Polar Processes and Mechanisms

Timm Schultz, Angelika Humbert, Ralf Müller

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TOWARDS A PHYSICS INFORMED FIRN DENSIFICATION MODEL

Knowledge about the density of firn, that is covering the ice sheets, is not only essential for current estimates of mass loss in Greenland and Antarctica, but also to obtain information about the history of those ice sheets. Firn is the intermediate product between snow and ice, originating in areas where the annual accumulation of snow exceeds the amount of melt. Due to the ongoing accumulation of snow the firn densifies until it becomes ice.

During this air gets trapped in bubbles within the firn. These air bubbles can be used to learn about past climate conditions on earth. But it is difficult to date the age of these bubbles. Due to circulation within the firn the trapped air can be several hundreds of years younger than the ice surrounding it. With help of firn densification modelling the age of the firn at pore close-off can be constrained.

Another topic which requires firn densification modelling is the transfer from volume loss of the ice sheets to mass loss. Modern satellite systems allow us to measure the height change of ice sheets up to a very precise level. Such height changes can only be translated to mass changes if the density of an ice sheet is known. While the density of solid ice is constant, the density of the firn cover varies depending on past and current climate conditions.

Only a relatively small amount of firn density measurements were conducted within the last decades compared to the size of the ice sheets. Therefore, it is necessary to simulate the process of firn densification. Attempts in modelling the firn density often follow a so called semi-empirical approach. A great deal of models using this approach but different parameter sets illustrates that there are numerous shortcomings. Therefore a model describing the processes leading to the densification of firn is investigated. The model is able to provide promising results, but using it within an established one dimensional framework uncovers problems. Simplifications regarding the stress acting on the firn have to be overcome to improve current firn density models.

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Poster – Permafrost in a Warming World: Impacts and Consequences

Schwamborn, G., Schirrmeister, L., Mohammadi, A., Meyer, H., Kartoziia, A. Maggioni, F., Strauss, J.

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THE SIBERIAN LOWER LENA RIVER SEDIMENT HISTORY OVER THE LAST TWO GLACIAL-INTERGLACIAL CYCLES

Arctic warming and permafrost thaw visibly expose changes in the landscape of the largest Arctic delta. Determining the past and modern river regime of thick deltaic deposits shaping the Lena River mouth in north-eastern Siberia is critical for understanding the history of Arctic delta formation and carbon sequestration. Using a new 65 m long sediment core from the delta apex we apply a set of sedimentological techniques to aid reconstructing the Lena River history including the emplacement of the modern-day delta. The analysis includes (i) grain-size measurements and the mineral determination of the bedload composition, (ii) XRF, XRD, and magnetic susceptibility measurements and heavy mineral analysis for tracking mineral change, (iii) pH, electrical conductivity, ionic concentrations and the δ18O and δD stable isotope composition from ground ice for reconstructing ground ice formation. In addition, sediment analysis is flanked by (iv) total and dissolved organic carbon measurements. Chronology is based on (vi) radiocarbon-AMS dating from organic material and OSL dates. We infer the river history back to 200.000 years BP. This includes transitional periods from traction, over saltation, to suspension load sedimentation and the postglacial delta growth in the course of the sea level rise. Minerogenic signals do not indicate provenance change over time.

They rather reflect the change from high energy to a lower energy regime after LGM time parallel to the fining-up grain-size trend. A prominent minimum in the ground ice stable isotope record at early Marine Isotope Stage 1 highlights that a Lena River branch migration and an associated refreeze of the underlying river talik has altered the isotopic composition at that time. Fluvial re-routing might be explained by internal dynamics in the Lena River lowland or due to a tectonic movement, since the study area is placed in a zone of seismic activity. In the area of the Laptev Sea shelf onshore continental compressional patterns are bordering offshore extensional normal faults.

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Oral – Organisms in the Face of Climate Change: Discoveries and New Approaches

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HABITAT CHANGES OF POLAR BEARS IN SUMMER AS ASSESSED BY LONG TERM OBSERVATIONS IN THEIR NORTHEAST GREENLAND RANGE

Large reductions in sea ice extent are currently affecting the habitats of ice-dependant marine top- predators. The response of polar bears (*Ursus maritimus*) that are dependent on sea ice for hunting seals has been documented every summer on a yearly basis since 1988 in a coastal site on Traill Island, Northeast Greenland. Summer occurrence of polar bears, measured as the probability of encountering bears on land and the number of days with bear presence, has increased significantly from the 1990's to present. The strongest changes took place in the early 2000s. The shifts in polar bear occurrence coincided with trends for shorter sea ice seasons and less spring sea ice in the Greenland Sea, off the coast of NE Greenland

This resulted in a strong inverse relationship between the probability of bear encounter on land and the length of the sea ice season. Besides their visits at remains of muskox carcasses in tundra dating back to late winter, it was also shown that bears regularly check offshore islets supporting arctic tern and eider duck colonies. Observations made in this site are in line with similar surveys made at the west coast of Svalbard, suggesting that increased summer occurrence of polar bears on land and associated negative effects on bird reproduction is now occurring on a large geographic scale in the Arctic.

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Oral – Polar Organisms and Ecosystems

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LEMMING CYCLES IN THE GRIP OF CLIMATE CHANGE - INSIGHTS FROM AN ONGOING LONG TERM STUDY IN NORTHEAST GREENLAND

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 34 years in a row, fluctuations of a lemming (*Dicrostonyx groenlandicus*) population have been closely monitored in Northeast Greenland, along with the functional and numerical responses of the four main 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.

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Oral – Tectonic Processes and Stratigraphy

Cornelia Spiegel, Max Zundel, Chris Mark, David Chew, Ian Millar, Yani Najman, Johann Klages, Gerhard Kuhn, Frank Lisker, Karsten Gohl

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EVIDENCE FOR A >1500 KM PRE-GLACIAL TRANSCONTINENTAL RIVER SYSTEM IN WEST ANTARCTICA

Since most of Antarctica is covered by ice, knowledge on its preglacial landscape is scarce. When exactly large-scale glaciation of West Antarctica initiated is still a matter of debate, as it may have happened coevally with East Antarctica, at the Eocene-Oligocene transition, or later. One of the crucial but still unknown boundary conditions to answer this question is the topographic evolution of West Antarctica, because the formation of a large-scale ice shield under the warmer climate of the geological past requires emergent land.

Here we report data from the first drilling campaign on the Amundsen Sea shelf of West Antarctica. Analysis of the drilled section revealed a large gap in the sedimentary record, with strata deposited

~40 Ma ago, during the Eocene, overlying strata with a sedimentation age of ~83 Ma. The Eocene strata were deposited at a time shortly before the onset of large-scale ice sheet formation in Antarctica, and at a time when, after a long period of tectonic quiescence, the Transantarctic Mountains of East Antarctica started to rise. Sand-sized grains from the Eocene sediments were analysed with respect to radiometric ages and isotope compositions, indicating that part of the material was derived from the Transantarctic Mountains, i.e., at least 1500 km away from the Amundsen Sea. The sediment was apparently transported by a fluvial system. Etching structures on certain minerals suggest that deposition took place in a highly acidic environment, presumably under swamp-like conditions. Previous data already showed that during the Eocene, West Antarctica was mostly tectonically inactive, presumably with a low-lying topography close or even below sea level. Our data now suggest that the hinterland of the Amundsen Sea Embayment was formed by a vast lowland hosting a >1500 km river system that connected the Transantarctic Mountains in the interior of Antarctica with the South Pacific Ocean. The existence of this river system also shows that, even though low-lying, large parts of West Antarctica were emergent above sea level.

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Oral – Facing Polar Climate Change: Insights from the Past

Spielhagen, Robert F., Forwick, Matthias , Lemmel, Frithjof

GEOMAR Helmholtz Centre for Ocean Research

LATEST PLEISTOCENE AND EARLY HOLOCENE DEGLACIATION HISTORY OF THE NE GREENLAND SHELF AS RECORDED IN A SEDIMENT CORE FROM THE WESTERN FRAM STRAIT (79°N)

Sediment core PS93/031-5 from the NE Greenland continental margin (79.3°N, 3.5°W, 2135 m water depth) has been analyzed to reconstruct the Late Quaternary environmental history in the western Fram Strait and the deglaciation of the adjacent NE Greenland shelf. The core was investigated for grain sizes, sediment composition (by XRF core scanning), the lithological composition of ice-rafted debris (IRD, >250 µm), and stable oxygen and carbon isotopes of planktic and benthic foraminifers. The age model is based on seven radiocarbon datings which cover the interval between 21 and 4 ka, with a hiatus between 18.6 and 12.7 ka. Of particular interest is a 10 cm thick, fine-grained, laminated section deposited 12.7-10.2 ka. According to the dating results, the lower part of this section may have been deposited within only one or two decades. Stable isotopes measured on two morphotypes of planktic foraminifers *Neogloboquadrina pachyderma* from the laminated interval suggest that near-surface salinities at site PS93/031 decreased during a strong freshwater event by up to 4-5 practical salinity units, if compared to the last glacial maximum and the early/middle Holocene (10.2-4 ka). While the IRD composition is dominated by quartz and feldspar grains (>75 grain-%) throughout the core, the laminated section shows a characteristic increase in fragments of sedimentary rocks which may be derived from the Paleozoic foldbelts and basins in NE Greenland.

This is supported by characteristic changes in the elemental composition derived from XRF core scanning.

The NE Greenland shelf morphology is characterized by two major troughs which were formed during the glacial(s) by continental ice mainly fed by the North-East Greenland Ice Stream. Our results indicate a two-phase retreat of the ice sheet margin on the shelf during the last deglaciation. The first ice front recession recorded in our core occurred before 12.5 ka (onset unknown) and resulted in a strong export of freshwater and fine-grained sediments through the (northern) Westwind Trough and possibly also troughs in the Wandel Sea towards the continental margin.

Benthic foraminifer isotope data from the laminated section suggest reduced bottom water salinities, possibly from the sinking of sediment-laden water plumes at the trough mouths and the southward transport by bottom currents of low-saline waters and sediments along the margin.

During the younger part of the deglaciation (ca. 12-10 ka) the ice recession was possibly slower (as indicated by lower sedimentation rates at site PS93/031) and/or the sediment transport occurred mostly southward through Norske Trough. The freshwater event at the continental

margin ceased when the ice sheet margin reached the modern coastline.

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Poster – Coole Klassen - Polarbildung in der Schule

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DIE ABENTEUER VON ODONTELLINA - DAS LEBEN EINER KLEINEN ALGE IM SÜDPOLARMEER

Das Kinderbuch Die Abenteuer von Odontellina – das Leben einer kleinen Alge im Südpolarmeer entstand im Zuge des Cold Regions – Cool Facts Wettbewerbs, der im Oktober 2020 von APECS Germany und der DGP ausgerichtet wurde. Die Geschichte erklärt mit einfachen Worten und witzigen Analogien die Rolle von Phytoplankton (Mikroalgen) im Ökosystem des Südpolarmeers. Unser Ziel dabei ist es Kindern im Grundschulalter näherzubringen, dass polare Regionen keine toten Eislandschaften sind. Wir wollen durch die unbeschwerte und lustige Geschichte Interesse und Neugierde wecken sich weitergehend mit diesem extremen Lebensraum zu beschäftigen und dabei auf Organismen aufmerksam machen, von denen oft nicht einmal Erwachsene gehört haben: Phytoplankton ist maßgeblich daran beteiligt, dass wir die Luft auf unserem Planeten atmen können, indem es durch Photosynthese Sauerstoff produziert und unser Klima reguliert, indem es Kohlenstoffdioxid aufnimmt.

Nach der Auszeichnung mit dem ersten Platz im Cold Regions – Cool Facts Wettbewerb haben wir ein didaktisches Konzept entwickelt, wie das Buch in den Schulunterricht mit eingebunden werden kann, um auf angesprochene Themen (was ist die Antarktis und wo liegt sie / was ist Kohlenstoffdioxid und wie produzieren wir Menschen es / Biodiversität von Phytoplankton / was ist Photosynthese und wie funktioniert sie / Nahrungskreisläufe) tiefer einzugehen.

Das Buch und das Unterrichtskonzept werden für Lehrkräften kostenfrei (online und evtl. gedruckt) zur Verfügung gestellt. Beides wollen wir auf der Polartagung 2022 in der Session Coole Klassen – Polarbildung in der Schule vorstellen und bewerben.

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Poster – Coole Klassen - Polarbildung in der Schule

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DGP – Mitglied

DIE ABENTEUER VON ODONTELLINA

Das Kinderbuch Die Abenteuer von Odontellina – das Leben einer kleinen Alge im Südpolarmeer entstand im Zuge des Cold Regions – Cool Facts Wettbewerbs, der im Oktober 2020 von APECS Germany und der DGP ausgerichtet wurde. Die Geschichte erklärt mit einfachen Worten und witzigen Analogien die Rolle von Phytoplankton (Mikroalgen) im Ökosystem des Südpolarmeers. Unser Ziel dabei ist es Kindern im Grundschulalter näherzubringen, dass polare Regionen keine toten Eislandschaften sind. Wir wollen durch die unbeschwerte und lustige Geschichte Interesse und Neugierde wecken sich weitergehend mit diesem extremen Lebensraum zu beschäftigen und dabei auf Organismen aufmerksam machen, von denen oft nicht einmal Erwachsene gehört haben: Phytoplankton ist maßgeblich daran beteiligt, dass wir die Luft auf unserem Planeten atmen können, indem es durch Photosynthese Sauerstoff produziert und unser Klima reguliert, indem es Kohlenstoffdioxid aufnimmt.

Nach der Auszeichnung mit dem ersten Platz im Cold Regions – Cool Facts Wettbewerb haben wir ein didaktisches Konzept entwickelt, wie das Buch in den Schulunterricht mit eingebunden werden kann, um auf angesprochene Themen (was ist die Antarktis und wo liegt sie / was ist Kohlenstoffdioxid und wie produzieren wir Menschen es / Biodiversität von Phytoplankton / was ist Photosynthese und wie funktioniert sie / Nahrungskreisläufe) tiefer einzugehen.

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Oral – Glaciers, Ice Sheets and Sea-Level Rise

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THIRTY YEARS (1991 TO 2021) ICE ELEVATION CHANGES AT SWISS CAMP (WEST GREENLAND)

Since 1991 a long-term project exists for investigation of ice elevation change, ice flow velocity and deformation.at Swiss Camp (West Greenland, inland ice, 80 km from Ilulissat). The site was measured by the author with precise geodetic GNSS measurements on ground since 1991 until 2014 by 12 campaigns, and studied in relation to climatic indicators.

In spring 2012 an expedition of the HEIM group traversed the Greenlandic inland ice from East to West. They conducted GNSS measurements along their entire route in order to continue the former measurements of KORTH 2002 and later by HITZIGER. Motivated by the author the HEIM expedition could also re-measure completely the research area at Swiss Camp in end of May 2021. Here we report about the results in context of former campaigns.

The 2021 GNSS measurements were performed by a Trimble R12 receiver mounted on a sledge which was transported over the snow surface to the old stake positions. Together with kinematical measurements of all path ways the current heights were used to determine the elevation changes by digital elevation models and 48 single point comparisons.

Together with the old results from 1991 to 2014 by the author the current elevation changes now result in a unique long-term 30-year time series of elevation changes from precise geodetic ground measurements on the Greenlandic ice sheet.

During the overall observation period from 1991 to 2021 the ice height decreased by 19.3 meter. The new results show that in the period from 2014 to 2015 until 2021 the ice height is still distinctly decreasing, but less than 2006 to 2014. The peak was reached in 2011-2014 with 1,4 m/year. Since 2014 to 2021 the decrease in height was 0.9 m/year on average. These results are discussed together with climatic indicators. Air temperature and pdd-values correlate well with these elevation changes and show lower melting rates in this period. This is agreeing with mass balance results from satellite observations (GRACE resp. GRACE-FO). So the locally derived height changes from geodetic ground measurements confirm the large-scale satellite results.

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Oral – Humans in Changing Polar Regions

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60 YEARS ANTARCTIC TREATY – CELEBRATION IN RADIO WAVES

Abstract. The International Antarctic Treaty, successfully negotiated and signed in 1959, entered into force after ratification by the 12 original signatory countries in 1961. Under the Antarctic Treaty, research activities are now carried out in Antarctica by 54 countries. These are 29 consultative and 25 non-consultative parties. Radio communications have always been an important part of all scientific activities in research stations, ships and aircraft in Antarctica. Historic expeditions in the 19th century and early 20th century had to use wired telegraph stations after returning from expeditions. Between 1911 and 1913, Wilhelm Filchner and Douglas Mawson were the first Antarctic expeditioners to explore the possibilities of wireless telegraphy. Mawson succeeded in establishing radio communications from Antarctica to Australia for the first time in 1912. Today, the use of communication technologies is almost taken for granted. Direct amateur radio communications via shortwave are a flexible backup and an effective addition to communications about the Antarctic. On the occasion of the sixtieth anniversary of the Antarctic Treaty, a major international radio activity was launched in the second half of 2021 with which an important contribution to communication to the public was made. Amateur radio is now an important part of research activities in Antarctica.

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Oral – Glaciers, Ice Sheets and Sea Level Rise

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RECENT ICEBERG TRACKS IN THE WEDDELL SEA SECTOR – A STUDY ON THE BASIS OF SENTINEL-1 SAR IMAGES

The drift of tabular icebergs in Antarctic waters could by studied in more detail since the late 1960- ies, when weather satellites became operational on polar orbits. However, due to often cloud cover the observations were more or less sporadic. Nevertheless, since 1978 the former US. Navy NOAA Joint Ice Center (now US. National Ice Center – USNIC) identified and documented/published the positions of icebergs 20 sqNM or greater, or 10 NM on its longest axis. The resulting data set was the basis for the knowledge on the general drift pattern of icebergs e. g. in the Weddell Sea region.

Especially, since Radar Satellites are operational (e.g. Sentinel-1 since 2014), more details on the drift of the icebergs can be investigated. PolarView (http://polarview.org/about/) is providing SAR images of the ESA satellite Sentinel-1 for the polar and sub-polar regions in near-real time (NRT). They are freely accessible and can easily been downloaded from the WEB page https://www.polarview.aq/antarctic. This service is of great value for science and operations in ice- covered areas and related applications. During the last months a greater number of distinct tabular icebergs “populate” the region of the Weddell Sea. Their individual behaviour (track, rotation, deterioration) – documented by short-term sequences of SAR images – will be presented and possible relations to wind and currents highlighted.

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Poster – Permafrost in a Warming World: Impacts and Consequences

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LATERAL GROUND FLUXES AND THERMOKARST DEVELOPMENT IN BOREAL PERMAFROST

Boreal forests efficiently protect underlying permafrost from thawing, giving rise to a sensitive interplay between vegetation, climate, and the hydrothermal regime of the ground. In the light of ongoing climatic changes and shifts in boreal forest covers, ecosystem changes have become more visible and frequent in boreal permafrost. Such changes threaten the vulnerable thermal equilibrium between the atmosphere, the vegetation, and permafrost. Especially in ice-rich areas, melting of ground ice can lead to permafrost degradation, forest loss, and thermokarst formation in the form of thaw lakes. The development of such thaw lakes is tightly coupled to local conditions like snow accumulation, topography, and vegetation cover.

We aim to understand when and under which hydrothermal and climatic conditions thermokarst-inducing processes occur in boreal permafrost. We implement lateral water- and energy ground fluxes in a detailed, numerical permafrost-forest model (CryoGrid-Vegetation) to analyze the initial and further development of thaw lakes. We run simulations to understand the timing of thermokarst development under different boreal forest covers and climate warming scenarios until the end of the century. Furthermore, we aim to understand the direction of the belowground hydrological fluxes in typical thaw lake formations in boreal permafrost, which consist of the three surface entities: lakes, marshy grasslands around the water bodies and forests. This gives us insights into the relationship between initial thermokarst-inducing processes, the pooling of water in thaw lakes, and the related possible water stress for surrounding forests, potentially leading to additional forest changes and permafrost degradation.

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Poster – Glaciers, Ice Sheets and Sea-Level Rise

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MODELLING SURFACE MELTWATER AND ICE DYNAMICS INTERACTIONS AT THE NORTHEAST GREENLAND WITH A FULLY-COUPLED ICE-FLOW - HYDROLOGY MODEL

The dependence of basal friction, and with it the ice flow, on basal meltwater has been known for decades, as pressurised water facilitates ice slip over the underlying bed. However, changes in basal water amount have a non-linear effect on ice dynamics, as an increase in meltwater can either enhance or decrease water pressure depending on the prevalent drainage system established at the ice-bed interface. Since the amount of basal meltwater is modulated by the percolation of surface runoff, an increase in the latter due to rising temperatures may not accelerate the ice flow under certain basal hydrologic conditions. Here we investigate the impact of the recent increase in surface meltwater production on the ice dynamics in Northeast Greenland. Our modelling strategy builds on the full coupling of the open-source finite-element Elmer/Ice model with the subglacial hydrology module (GlaDS). The latter module is capable of representing the bi-model characteristics of subglacial water drainage. The coupled ice-flow - hydrology model is forced by high resolution (1 km) daily surface mass balance and runoff values for years 2014-2018 simulated by the surface energy balance model COSIPY. Surface runoff is then modelled to be routed downstream and reach the bed through crevasses opening. Fully-coupled simulations for the period 2014-2018 are performed at daily resolution to capture surface melt - basal sliding interactions from daily, via seasonal to inter- annual temporal scales. This advanced modelling framework helps us to investigate the complex interactions between surface melt and ice flow during the ablation season, via changes in basal conditions, as well as to characterise the multi annual dominant ice-flow pattern arisen from the increased surface runoff observed during the last years.

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Oral – Atmosphere, Sea Ice, Ocean and Land Interactions

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MODELING OF SMALL-SCALE PROCESSES IN ANTARCTIC SEA ICE – A MULTI-PHASE CONTINUUM APPROACH

In this project we aim to develop a holistic multi-scale model, which gives insight into the small-scale coupled physical processes of freezing and melting sea ice, the connection to the size and distribution of the enclosed brine channels and, furthermore, the coupling to algal growth and the unavoidable impact on the biological carbon pump. The porous microstructure of the sea ice floes may change by climatic changes, which possibly will have influence on the coupled bio-physical processes.

The continuum model of an Antarctic sea ice floe mathematically simulates the complex coupled relationships between ice formation, nutrient transport, salinity and brine channel distribution, and prospectively photosynthesis and carbonate chemistry. Different scenarios of sea ice formation, its effects on the growth of sea ice algae and their impact on vertical carbon export will be simulated for future Southern Ocean conditions. For that, the well-established Theory of Porous Media (TPM) provides a suitable tool to formulate a macroscopic continuum-mechanical model of multi-phase, multi-component fluid-saturated porous media, *cf*. (2), which will be coupled with the phase field model for the early phase of brine entrapment in sea ice by (1).

Acknowledgements

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Poster – Changing Atmosphere-Land-Ocean Systems in the Eurasian Arctic

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MODERN CLIMATE CHANGES IN THE RUSSIAN ARCTIC DEDUCED FROM THE STABLE ISOTOPE COMPOSITION OF THE ARCTIC CENTURY ICE CORES

The Arctic is exposed to drastic climate changes. In recent decades, the high northern latitudes have warmed more than twice as fast as the global mean. During the Arctic Century Expedition in 2021, we drilled new short ice cores on Franz-Josef-Land and Severnaya Zemlya in the Barents and Kara Seas region. Those are of great importance to better understand climate variability on a regional scale. The ice cores from Windy Dome ice cap (Franz-Josef-Land), from Akademii Nauk ice cap and University ice cap (both Severnaya Zemlya) as well as supplemental snow profiles of all three sites are analyzed as part of a master´s thesis. Based on the isotopic composition (δ18O and δD, and d excess) of the ice cores, on the supplemental density and snow profiles, temperature variations and changing accumulation rates in the Eurasian Arctic are going to be investigated. The results will be complementarily related with meteorological data from nearby stations as well as stable isotope data from ice cores drilled on the same ice caps in the 1990s to validate recent climate variability and precipitation patterns in the Barents and Kara Seas region.

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Oral – DFG SPP 1158 Antarctic Research - Report Colloquium: Response to environmental change and linkages with lower latitude

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SENSITIVITY OF WESTERN ANTARCTIC PENINSULA PHYTOPLANKTON TO CLIMATE CHANGE

The Western Antarctic Peninsula, one of the most productive regions of the Southern Ocean, is currently affected by very rapid environmental changes. In addition to ocean acidification, rising temperatures and increasing ice melt will alter surface ocean stratification, which in turn may alter vertical mixing with consequences for light availability and iron input from deeper layers. To assess the potential for future biological CO2 sequestration of this region, we incubated natural phytoplankton assemblages from Ryder Bay, Adelaide Island, simulating future climate change scenarios (CO2, irradiance, iron). Despite similar particulate organic production rates, phytoplankton community composition was sensitive to ocean acidification, but not to different dynamic light regimes, being dominated by the diatom *Fragilariopsis pseudonana* at ambient and the prymnesiophyte *Phaeocystis antarctica* at high pCO2. Under ocean acidification combined with a constant saturating light regime, however, the diatoms *F. pseudonana* and *Chaetoceros* sp. were most abundant. Next to ocean acidification, iron addition also altered phytoplankton species composition, pointing towards different species-specific iron requirements. Overall, we observed significant changes in the relative species abundance of the two most common phytoplankton groups, prymnesiophytes and diatoms, which could have important implications for future carbon uptake and export potential of these Antarctic coastal waters.

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Poster – Permafrost in a Warming World: Impacts and Consequences

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FLUXWIN – THE ROLE OF NON-GROWING SEASON PROCESSES IN THE METHANE AND NITROUS OXIDE BUDGETS IN PRISTINE NORTHERN ECOSYSTEMS

The importance of non-growing season greenhouse gas fluxes to annual budgets in pristine northern terrestrial ecosystems is growing in awareness. Greenhouse gas (GHG) fluxes during the non-growing season and freeze-thaw dynamics are still underrepresented and may be a reason why current process-based models predict inadequate annual methane (CH4) and nitrous oxide (N2O) budgets.

FluxWIN is therefore investigating ecological and biogeochemical processes in global carbon (C) and nitrogen (N) cycles during the non-growing and shoulder seasons by combining high-frequency greenhouse gas measurements, biogeochemical monitoring and process-based modeling. Siikaneva, nearby Hyytiälä Research Station in boreal Finland, is an ICOS-certified site and well situated within long-term scientific infrastructure to compare and combine high-frequency greenhouse gas measurement techniques and investigate freeze-thaw dynamics. An automated static chamber technique is used with inline laser gas analysis to obtain soil-atmosphere CH4 and N2O exchange in real time. Additional automated sampling of diffusion tubing will sample soil gas concentrations in the same analytical system. We control for climatic variability and isolate differences in non-growing season emissions by using a moisture gradient from well-drained upland soils to adjacent wetland ecosystems. The use of these automated high-frequency GHG measurements in combination with year-round biogeochemical monitoring maximizes the likelihood of capturing episodic emissions and their drivers, which are particularly important during fall freeze and spring thaw periods. The gained information on ecosystem function and biogeochemical cycles for temperate, boreal, and arctic regions will improve feedback estimates to climate change by including non-growing season processes in global-scale process-based models.

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Oral – Polar Organisms and Ecosystems

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GEL PARTICLE DISTRIBUTION AND DYNAMICS ALONG THE EAST COAST OF GREENLAND

Gel particles are three-dimensional networks of organic polymers in the micrometer size range that play a significant role in elemental cycling, air-sea exchange, and microbial processes. The polymer networks can either contain polysaccharides, classified as transparent exopolymer particles (TEP), or contain proteins that would classify them as Coomassie stainable particles (CSP). Despite much research on both gel particle classes, whether they originate from different driving factors remains unclear. TEP predominantly originates from phytoplankton and has been observed to increase as plankton growth approaches nutrient depletion, but the origin of CSP is less clear. Here, we assessed how biological (i.e., phytoplankton) or physical factors (i.e., fjord dynamics) relate to TEP and CSP concentrations along the east coast of Greenland.

The samples were collected along Greenland's east coast between from 63°N to 78°N and the 27th of July to 11th of August 2019 onboard the RV Maria S. Merian (MSM85). The gel particles were stained on board using the standard dyes: TEP with Alcian Blue and CSP with Coomassie Brilliant Blue. Back at GEOMAR, the total amount of dye absorbed was quantified by spectrophotometric measurements and converted into TEP and CSP concentrations. Furthermore, we estimated phytoplankton biomass using satellite chlorophyll-a (chl-a) concentrations from the Ocean Colour project of the ESA Climate Change Initiative (CCI) between May and September with resolutions of 8 days and 4 km.

Biological and physical processes showed spatial variability along the east coast of Greenland. The seasonal bloom phenology initiates that the phytoplankton bloom started in May along the entire coast, then slowly moved offshore, and terminated in the middle of June (chl-a < 0.85 mg m-3). Later in the season, local pulses of phytoplankton biomass significantly correlated with CSP at 6.01 +/- 3.14 µg BSA L-1 ($r=0.31$, $p<0.001$). In contrast, physical processes appeared to be the main driving factor of TEP. TEP was enriched at Scoresby Sound at 74.06 +/- 10.12 µg XG eq L-1. Scoresby Sound has been reported to facilitate the mixing of intermediate and polar water masses that likely stimulated the coagulation of polysaccharides and thus the formation of TEP. Based on these results, we infer that the distribution and dynamics of TEP and CSP were uncoupled, suggesting that the two particle classes are produced and consumed independently in response to biological and physical variability. Our observations show the importance of resolving gel particle dynamics on spatial scales in the context of temporal scales. Understanding the biological and physical controls of gel particle dynamics will help disentangle controls on the oceanic carbon cycle and the possible consequences of climate change on biogeochemical cycles in vulnerable regions like the Arctic Ocean.

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Poster – Tectonics and Geodynamic Processes

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A REVIEW OF SEISMIC SURVEYS ON THE LOMONOSOV RIDGE AND CONCLUSIONS ON ARCTIC OCEAN PALEOCEANOGRAPHY

The Lomonosov Ridge and Fram Strait represent prominent morphologic features in the Arctic Ocean. Their tectonic evolution control ocean circulation, sedimentation environment, glacial processes and ecosystem through time.

The poster presents an overview on a set of seismic surveys across the Lomonosov Ridge, and into the adjacent Amundsen and Makarov/Podvodnikov Basins. The data image up to 2300 m thick sedimentary sequences that provide constraints on the Paleoceanography of the Arctic Ocean.

Prominent reflectors, reflector configuration, as well as the reflection pattern of seismic units were correlated with coring information and magnetic anomalies to establish a seismostratigraphic model.

In the early Cenozoic the LR still was above or close to sea level and experienced erosion of its Mesozoic core strata. Its crest, faulted flanks and the initial Amundsen Basin were covered with syn- rift sediments of Paleocene to early Eocene age likely eroded off the Barents-Kara and Laptev Sea shelves. The connection to North Atlantic waters via the Fram Strait was not yet established, and anoxic conditions prevailed in the young, still isolated Eurasian Basin. Also, the LR was above or close to sea level and posed an obstacle for water exchange between the Eurasian and Amerasian basins.

The time between early Eocene and late Oligocene, as indicated by a regional and prominent high- amplitude-reflector sequence (HARS) was an era of widespread changes in depositional conditions, likely controlled by the ongoing subsidence of the LR and gradual opening of the Fram Strait. Episodic incursions of water masses from the North Atlantic and erosion of the ridge's crest probably were the consequences, and led to the deposition of sediments of strongly different lithology.

The seismic units above the HARS show reflection characteristics and thicknesses similar all over the southeastern Arctic Ocean indicating that basin-wide pelagic sedimentation prevailed at least since late Oligocene. Drift bodies, sediment waves, and erosional structures indicate the onset of a modern ocean circulation system and paleo-bottom current activity in the early Miocene in the Arctic Ocean. At that time, the LR no longer posed an obstacle between the Amerasia and Eurasia Basins. Finally, a drape of high-amplitude reflectors is associated with the onset of glacio-marine deposition since the Pliocene.

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Poster – Glaciers, Ice Sheets and Sea-Level Rise

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ICE FLOW VELOCITIES AND ELEVATION CHANGES DURING TWO RECENT GLACIER SURGES IN WESTERN PAMIR

Glaciers are indicators for climate change, because they respond to temperature and precipitation changes. Surge-type glaciers are an exception from this rule as they show mass redistributions independent from climate conditions that are still not fully understood. Many of these surge-type glaciers are concentrated in High-Mountain Asia, namely in the Karakoram and the Pamir Mountains.

Here, recent surges of two neighbouring glaciers in western Pamir are presented. Gando Glacier started its active surge phase in 2018 while its northern neighbour Sugran Glacier started surging in 2020. Time series of ice flow velocities and elevation changes, derived from different satellite sensors, e.g. Sentinel-2, ASTER and TanDEM-X, show the temporal evolution and spatial extension of the surge. Acceleration of Gando Glacier started on its equally sized tributary with velocities increasing from about 1 m/a in spring 2018 to 6 m/a in autumn. The surge spread to the main glacier in 2019 and velocities still have not lowered to pre-surge level on its entire length. Ice elevation increased by more than 100 m at the confluence of the tributary in the first year of the surge. Later the elevation increase propagated down the main glacier by more than 6 km, followed by surface lowering in the upper reaches. The magnitude of the surge on neighbouring Sugran Glacier is smaller so far but shows no sign of ceasing. Properties of both surges are compared in the light of a possible surge mechanism.

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Oral – Glaciers, Ice Sheets and Sea-Level Rise

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SPATIALLY RESOLVED GLACIAL ISOSTATIC ADJUSTMENT AND ICE SHEET MASS CHANGES WITHIN A GLOBAL INVERSION FRAMEWORK: FEASIBILITY PROVEN BY EXPERIMENTS WITH SIMULATED SATELLITE DATA

Mass loss estimates for the Antarctic Ice Sheet and Greenland Ice Sheet over 2010–2019 vary from 94 to 202 gigatons per year and from 197 to 290 gigatons per year, respectively, according to the the 6 th IPCC Assessment Report quoting The IMBIE-Team. For gravimetric mass balance estimates, a large part of the uncertainty propagates from the uncertainty of solutions for the mass effect of Glacial Isostatic Adjustment (GIA). For both ice sheets, solutions of the GIA mass effect differ by several tens of gigatons per year.

We present work towards resolving the present-day effect of GIA over ice sheets by combining satellite gravimetry, satellite altimetry data, and products from regional climate and firn modelling. To overcome limitations of regional investigations, we set up a global inversion framework. In Greenland, we parametrize GIA with a single fingerprint. In Antarctica, we apply a more spatially resolved GIA parametrization using a number of locally concentrated, globally defined GIA patterns. Furthermore, we parametrize ice mass changes and changes of the firn air content over both ice sheets.

Here, we examine whether a joint estimate of GIA and ice mass change is feasible under the presence of realistic errors in the data sets. Simulation experiments demonstrate that the GIA signal in Antarctica can be spatially resolved when realistic error covariance information is incorporated. Over an observation period of 10 years, the error of the integrated Antarctic GIA effect is 8 % and 5 % of the integrated GIA signal based on two alternative global GIA models. The spatial RMS error amounts to 31 % and 51 %, respectively, of the RMS of the two modelled signals.

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CLIMATOLOGY OF ANTARCTIC LOW-LEVEL JETS

Low-level jets (LLJs) are horizontal wind speed maxima of a vertical profile in lower atmosphere (usually below 1 km). They are a common feature of katabatic winds that form over the Antarctic ice sheet but LLJs can also occur over the ocean. Our main analysis was based on a 15-year simulation (2002-2016) over the Weddell Sea region but we also show first results for a simulation over whole continent at the beginning (2000-2014) and end (2086-2100) of the century. The climatological analysis includes distributions of height, wind speed, directional sheer and stability of the LLJs. We further investigated the frequency and length of LLJs. Our findings show that LLJs are very depended on topography and occur seldom over sea ice or the ocean, but very often over sloped inland terrain during the winter period. Katabatic LLJs in the simulation have heights below 200 m and wind speeds around 10-20 m/s, while other LLJs are typically higher.

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