22nb3952

What we need to know about nutrients to predict the future darkening of the Greenland Ice Sheet.

Martyn Tranter, DEEP PURPLE Science Team

Corresponding author: Martyn Tranter

Corresponding author e-mail: martyn.tranter@envs.au.dk

Presenting author: Tranter Martyn

Ice algae contribute to the darkening of the Greenland Ice Sheet during the ablation season. The melt zone will continue to expand in our warming world, and it is natural to question whether these new melt environments will be colonised by ice algae in future, and so expand the zone of biologically darkened ice. One limiting factor on the colonisation may be the concentration of macro-nutrient N and P. Here, we summarise what is known to date about their concentrations and sources, and we conduct simple nutrient mass balance exercises to estimate the number of ice algae that melting supraglacial environments can sustain. It will be readily apparent that sources of P are very important, as is the detection of the low levels of dissolved inorganic P that are found in Greenland ice and meltwater. Additionally, the C:N:P ratio of the ice algae needs to be determined with certitude. How this ratio changes over time and in relation to environmental stresses may also impact on ice algal numbers. The data in the literature to date, when joined up, suggest that a major research question is why are there not more ice algae in the annual blooms, rather than why are they there in such numbers.

22nb3953

Weathering crust evolution on the surface of the Greenland Ice Sheet

Ian Stevens, Lou-Anne Chevrollier, Joe Cook, Alex Anesio, Liane Benning, Martyn Tranter

Corresponding author: Ian Stevens

Corresponding author e-mail: ian.stevens@envs.au.dk

Presenting author: Ian Stevens

Weathering crust evolution on the surface of the Greenland Ice Sheet

22nb3954

Remote sensing of ice albedo using harmonized Landsat and Sentinel 2 datasets: validation

Shunan Feng

Corresponding author: Shunan Feng

Corresponding author e-mail: shunan.feng@envs.au.dk

Presenting author: Shunan Feng

Remote sensing of ice albedo using harmonized Landsat and Sentinel 2 datasets: Validation

22nb3955

High resolution ocean modelling of plume dynamics and basal melting at Ryder Glacier, North Greenland

Jonathan Wiskandt, Inga Koszalka, Johan Nilsson

Corresponding author: Jonathan Wiskandt

Corresponding author e-mail: jonathan.wiskandt@misu.su.se

Presenting author: Jonathan Wiskandt

We use a two dimensional, high resolution, non-hydrostatic regional model (MITgcm) to explore the melt induced circulation in Sherard Osborn Fjord (SOF) under the floating tongue of Ryder Glacier (RG). This fjord-glacier system was for the first time surveyed in 2019 and, based on these observations, this is the first modeling study addressing the ice shelf-ocean interactions and resulting circulation in this region.

Low grounding-line water temperatures, complex ice-tongue and sill geometries, narrowness and permanent sea-ice cover outside the fjord, make the ice-ocean interactions in this particular setting rather different from those in the more well-studied nearby Petermann Fjord and other well-studied fjord in Greenland and Antarctica. The control simulation uses 2019 hydrographic observations as initial conditions. A set of model experiments is conducted to analyze the dependency of the basal melt, plume dynamics, and the fjord circulation on the the temperature forcing from the in-flowing Atlantic water and buoyancy input through subglacial discharge of fresh water.

22nb3956

Modelling weathering crust processes and their impact on the surface albedo of the Greenland ice sheet

Lou-Anne Chevrollier, Ian Stevens, Joseph M. Cook, Alexandre M. Anesio, Liane G. Benning, Martyn Tranter

Corresponding author: Lou-Anne Chevrollier

Corresponding author e-mail: lou.chevrollier@envs.au.dk

Presenting author: Lou-Anne Chevrollier

Modelling weathering crust processes and their impact on the surface albedo of the Greenland ice sheet

22nb3957

Recovering snow cover dust load from spectral reflectance: A field test in Kiruna, Sweden

Christian Zdanowicz, Alexandre Langlois, Éloïse Brassard, Bjarne Almqvist

Corresponding author: Christian Zdanowicz

Corresponding author e-mail: christian.zdanowicz@geo.uu.se

Presenting author: Christian Zdanowicz

Airborne particulate matter deposited in snow includes light-absorbing particles (LAPs; e.g., black carbon, mineral dust) as well as potential contaminants (e.g., toxic metals). As the spatial and spectral resolution of space- and air-borne sensors keeps improving, this opens up possibilities to recover the mass loading of such particulates by remote sensing, thus helping to map and quantify

airborne pollutant dispersal, and how deposition of LAPs affect the snow surface albedo. Recent theoretical developments (Kokhanovsky et al., 2018, 2021) have presented a relatively simple methodology by which information on LAP in snow may be derived from reflectance measurements at a few discrete wavelengths in the VIS-NIR range. This approach was tested in April 2022 using a portable spectroradiometer to measure in-situ reflectance of snow layers contaminated with fugitive iron oxide dust in the Kiruna iron mining district of northern Sweden. Other optically-relevant properties of the snow cover (density, snow specific surface area) were also measured, and the mass loading of iron oxide in snow (primarily magnetite) was separately estimated by gravimetry and from magnetic susceptibility measurements. This presentation will provide an account of the results obtained thus far from this field experiment.

22nb3958

The control of cyclic ice mélange weakening episodes on the calving activity of Kangerdlugssuaq Glacier, Greenland

Adrien Wehrlé, Martin P Lüthi, Andreas Vieli

Corresponding author: Adrien Wehrlé

Corresponding author e-mail: adrien.wehrle@hotmail.fr

Presenting author: Adrien Wehrlé

The dense mixture of iceberg of various sizes and sea ice observed in many of Greenland's fjords, called ice mélange (sikussak in Greenlandic), has been shown to have a significant impact on the dynamics of several Greenland tidewater glaciers mainly through the seasonal support it provides to the glacier terminus in winter. However, a clear understanding of shorter-term ice mélange dynamics is still lacking, mainly due to the high complexity and variability of the processes at play at the ice-ocean boundary. Here, we use a combination of Sentinel-1 radar and Sentinel-2 optical satellite imagery to investigate in detail intraseasonal ice mélange dynamics and its link to calving activity at Kangerdlugssuaq Glacier, East Greenland. In this fjord, we identified recurring ice mélange weakening (IMW) episodes consisting in the up-fjord propagation of a discontinuity between jam-packed and weaker ice mélange towards the glacier terminus. At a late stage, i.e. when the IMW front approaches the glacier terminus, these episodes were often correlated with the occurrence of large-scale calving events. We analyzed IMW dynamics during the June–November period from 2018 to 2021 and detected 30 IMW episodes with a recurrence time of 24 days, propagating over a median distance of 5.9 km and for 17 days, resulting in a median propagation speed of 400 m/d. We found that 87 % of the IMW episodes occurred prior to a calving event visible in spaceborne observations and that ∼75 % of all detected calving events were preceded by an IMW episode. These results therefore present the IMW process as a clear control on the calving activity of Kangerdlugssuaq glacier. Finally, using a simple numerical model for ice mélange motion, we showed that a slightly biased random motion of ice floes without fluctuating external forcing can reproduce IMW events and their cyclic influence, and explain observed propagation speeds. These results further support our observations in characterizing the IMW process as self-sustained through the existence of an IMW-calving feedback.

22nb3959

The Early-career Glaciologists Group (EGG) of the International Glaciological Society (IGS)

Adrien Wehrlé

Corresponding author: Adrien Wehrlé

Corresponding author e-mail: adrien.wehrle@hotmail.fr

Presenting author: Adrien Wehrlé

The Early-career Glaciologists Group (EGG) of the International Glaciological Society (IGS)

22nb3960

Long or strong, which changes in melt season has the most impact on ice dynamics

de Fleurian Basile, Langebroek Petra M., Davy Richard

Corresponding author: Basile de Fleurian

Corresponding author e-mail: basile.defleurian@uib.no

Presenting author: Basile de Fleurian

In recent years, temperatures over the Greenland ice sheet have been rising, leading to an increase in surface melt. This increase however can not be reduced to a simple number. Throughout the recent years we have seen some extreme melt seasons with melt extending over the whole surface of the ice sheet (2012) or melt seasons of lower amplitudes but with a longer duration (2010). The effect of those variations on the subglacial system and hence on ice dynamic are poorly understood and are still mainly deduced from studies based on mountain glaciers. Here we apply the Ice-sheet and Sea-level System Model (ISSM) to a synthetic glacier with a geometry similar to a Greenland ice sheet land terminating glacier. The forcing is designed such that it allows to investigate different characteristics of the melt season such as its length or intensity. Subglacial hydrology and ice dynamics are coupled within ISSM allowing to study the response of the system in terms of subglacial water pressure and the final impact on ice dynamics. Of particular interest is the evolution of the distribution of the efficient and inefficient component of the subglacial drainage system which directly impacts the water pressure evolution at the base of the glacier. We note that the initiation of the melt season and the intensity of the melt at this period is a crucial parameter when studying the dynamic response of the glacier to different melt season characteristics. From those results, we can infer a more precise evolution of the dynamics of land terminating glaciers that are heavily driven by their subglacial drainage system. We also highlight which changes in the melt season pattern would be the most damageable for glacier stability in the future.

22nb3961

Automotive lidar, dgnss and inertia sensors for glaciological applications: first experience and future potential

Thomas Goelles, Birgit Schlager, Stefan Muckenhuber, Jakob Abermann, Christoph Gaisberger

Corresponding author: Thomas Goelles

Corresponding author e-mail: thomas.goelles@uni-graz.at

Presenting author: Thomas Goelles

Sensors from the automotive industry offer a big potential for glaciological applications. They are small, lightweight, robust and comparably cheap. Currently, for example a lidar sensors costs around 5000 EUR and with a 360° field of view and a 45° vertical angle, a range of 120m, a spatial resolution of a few cm and a temporal resolution of 10 to 20Hz. While prices are expected to drop down to a few 100s EUR in the next years due to the demand of the automotive industry. Their wavelength of typically 850 to 905nm make them also well suited for snow and ice applications. I will present our initial experience during field campaigns in Svalbard and the Austrian Alps and introduce ideas for more application

22nb3962

Using ground penetrating radar to investigate changes in the cold surface layer of Storglaciären

Hannah Watts, Peter Jansson, Benedict Reinardy

Corresponding author: Hannah Watts

Corresponding author e-mail: hannah.watts@natgeo.su.se

Presenting author: Hannah Watts

Using ground penetrating radar to investigate changes in the cold surface layer of Storglaciären

22nb3964

The evolution of Sermeq Kujalleq (Jakobshavn Isbræ) due to Late-Holocene warm water intrusions and the LIA cooling

Karita Kajanto, Camilla Andresen, Helene Seroussi, Basile De Fleurian, Kerim Nisancioglu

Corresponding author: Karita Kajanto

Corresponding author e-mail: karita.kajanto@uib.no

Presenting author: Karita Kajanto

The evolution of Sermeq Kujalleq (Jakobshavn Isbræ) due to Late-Holocene warm water intrusions and the LIA cooling

22nb3965

Rapidly-rising glacier outburst floods – theory and observations

Tómas Jóhannesson, Benedikt G. Ófeigsson, Krista Hannesdóttir, Thomas Zwinger, Peter Råback

Corresponding author: Tómas Jóhannesson

Corresponding author e-mail: tj@vedur.is

Presenting author: Tómas Jóhannesson

Glacier outburst floods, or jökulhlaups, from subglacial geothermal areas, marginal lakes and subglacial volcanic eruptions are common in Iceland and they pose a substantial hazard to settled areas as well as to roads, communication lines and other infrastructure near glaciers. Jökulhlaups have attracted increasing attention in recent years in many glacier areas because of an increased frequency due to the formation of terminus and marginal lakes in connection with global warming and the associated glacier downwasting. Jökulhlaups can be categorized into two groups, slowly and rapidly rising, with marked differences in the flood hydrographs. Slowly-rising jökulhlaups are traditionally explained by the theory of Nye (1976) through a conduit-melt–discharge feedback mechanism. The initial subglacial propagation and the development of the flood hydrograph of rapidly-rising jökulhlaups is, on the other hand, not quantitatively understood. We present observations of glacier outburst floods from W-Vatnajökull in Iceland that may be interpreted in terms of a conceptual theory for such floods as a pressure wave in the basal hydraulic system that propagates downglacier and creates the initial flood path by lifting the glacier from its sole. This theory is suitable for the development of a numerical model for rapidly-rising jökulhlaups in the Elmer/Ice Open-Source Finite-Element Software. The aim of the model is to explain the speed of propagation of the subglacial flood front at the beginning of the flood as well as the time-dependent flood hydrograph after the flood bursts out from under the glacier at the ice margin.

22nb3966

Rapidly-rising glacier outburst floods – numerical modeling

Thomas Zwinger, Tómas Jóhannesson, Juha Ruokolainen, Peter Råback

Corresponding author: Thomas Zwinger

Corresponding author e-mail: thomas.zwinger@csc.fi

Presenting author: Thomas Zwinger

On the basis of the observational data and conceptual theory described in the twin-abstract (T. Jóhannesson et al.), we present a glacier outburst flood model for rapidly-rising jökulhlaups implemented with the Elmer/Ice Open-Source Finite-Element Software. The model describes the subglacial propagation of the jökulhlaup front using visco-elastic plate dynamics for the overlying glacier ice combined with a turbulent sheet model for the subglacial water flood. The evolution of the subglacial flooded area is simulated numerically through the solution of a contact problem that represents the lifting of the ice from the underlying glacier bed where the subglacial water pressure exceeds the normal stress in the ice at the sole of the glacier. We hence can identify 4 crucial components of the model: 1) A visco-elastic ice deformation model, 2) a two-dimensional pressurized water sheet model based on the Manning's law for turbulent friction in water flow, 3) the solution of a contact problem induced by hydraulic jacking of the glacier, and 4) the consistent (in terms of the stress spatial distribution) solution of the fluid–structure interaction between the ice and the water-sheet. We present and discuss these different aspects in terms of their numerical implementation in Elmer/Ice. The final goal is to explain the speed of propagation of the subglacial flood front at the beginning of the flood as well as the time-dependent flood hydrograph after the flood bursts out from under the glacier at the ice margin.

22nb3967

Light absorbing particles in Svalbard snow: black carbon, dust and organics

Susan Kaspari, JC Gallet, Elisabeth Isaksson, Jack Kohler

Corresponding author: Susan Kaspari

Corresponding author e-mail: kaspari@geology.cwu.edu

Presenting author: Susan Kaspari

Preliminary results of light absorbing particle (LAP) concentrations in snow from Svalbard are presented. LAP include black carbon (BC) produced by the incomplete combustion of fossil and biofuels, dust from regional sources and long-range transport, volcanic ash, and organics (e.g. snow algae and bacteria). When deposited on snow and ice surfaces, LAP darken the snow/ice surface (i.e. lower the albedo), which causes an increase in solar energy absorption, warming of the snow/ice, and accelerated snow and ice melt. LAP affect the Earth's energy balance and water resources. Previous studies of LAP in Svalbard snow have primarily focussed on a single LAP type (i.e. BC or dust or organics), but do not address the role of all LAP. Preliminary results of LAP concentrations in snow from Kongsvegen and Holtedahlfonna are presented, as well as modelled LAP albedo reductions based on results from previous studies. The results of this study will improve understanding of the relative contribution of different LAP types to albedo reductions and melt on Svalbard.

22nb3969

Wet, noisy and under pressure: updates from MAMMAMIA

Thomas V Schuler, Coline Bouchayer, Jack Kohler, Pierre Marie Lefeuvre, Ugo Nanni, Louise Steffensen Schmidt

Corresponding author: Thomas V Schuler

Corresponding author e-mail: t.v.schuler@geo.uio.no

Presenting author: Thomas V Schuler

The MAMMAMIA project investigates mechanisms of glacier acceleration at the base of Kongsvegen glacier, Svalbard. We have drilled and instrumented boreholes to the base and set up equipment at the surface to collect a multi-variable dataset of glacier seismicity, subglacial hydraulics and sediment properties, along with meltwater production and surface speed. The presentation will give an account of fieldwork in 2022 and discuss preliminary results.

22nb3971

Introducing ELSA – an isochronal model for ice sheet layer tracing

Therese Rieckh, Gerrit Gülle, Andreas Born, Alexander Robinson

Corresponding author: Therese Rieckh

Corresponding author e-mail: trieckh@gmail.com

Presenting author: Therese Rieckh

We are introducing the ice sheet model ELSA - a model that explicitly represents individual layers of accumulation that are fixed in time (isochronal). Over time, new layers are added on the top and older layers subside and become thinner as ice flows towards the margins. With this approach, numerical diffusion is eliminated by design, and ELSA faithfully represents the englacial stratification.

ELSA is not a stand-alone ice sheet model, but is coupled uni-directionally to a full ice sheet model ("host model"), which provides the ice physics and dynamics. Via ELSA's layer tracking, the host model's output can be evaluated throughout the interior using ice core or radiostratigraphy data.

Currently we investigate the stability and resolution-dependence of this coupled modeling system in simulations of the last glacial cycle of the Greenland ice sheet with yelmo as the host model. Key questions concern the impact of layer deposition frequency in ELSA, coarser horizontal resolution of ELSA, and required update frequency of ELSA by the host model. These results set the requirements for offline forcing of ELSA with output from a range of existing ice sheet models.

The long-term goal is to have a well-documented, flexible, and easily adaptable code to effectively force ELSA with (any) existing full ice sheet model. Code management via git will ensure that ELSA can be used and developed by the community as a new way to evaluate the interior of ice sheet models.

22nb3973

Understanding evolution of surface meltwater lakes in Dronning Muad Land, East Antarctica

Anirudha Vijay Mahagaonkar, Geir Moholdt, Thomas Schuler

Corresponding author: Anirudha Vijay Mahagaonkar

Corresponding author e-mail: anirudha.mahagaonkar@npolar.no

Presenting author: Anirudha Vijay Mahagaonkar

After the collapse of Larsen-B ice shelf, triggered by the rapid development and expansion of several surface meltwater lakes, a few years ago, much attention has been given to understanding surface hydrology over different ice shelves of Antarctica. Presented here are the results from our work on understanding the evolution of surface ponding in Dronning Maud Land. We find there is large and inconsistent interannual variability in ponding extents over different ice shelves of Dronning Maud Land. We try to establish a relationship of surface accumulation to near-surface temperature, but find that there is ambiguity in the relationship, and the large variations over different ice shelves of DML go unexplained. We will try to work with other climatic and environmental factors to identify the controls of surface meltwater ponding in Dronning Maud Land, and this will help in understanding what lies in the future with respect to implications on ice shelf stability in the region.

22nb3974

Analysing seasonal snow cover trends and patterns on Svalbard

Dhruv Maniktala

Corresponding author: Dhruv Maniktala

Corresponding author e-mail: dhruv270@gmail.com

Presenting author: Dhruv Maniktala

Rapid warming in the Arctic is highly impacting the cryosphere in the region, causing melting of the sea ice, retreat of glaciers and reduction in the snow cover. If suffering further temperature increase, the albedo of the region would reduce due to higher absorption of the solar radiation in snow-free areas. The variations in seasonal snow cover in Arctic regions can impact a lot of things including the ecosystem, biodiversity, hydrological cycle, and many other physical processes. Therefore, it is beneficial to have the knowledge of processes determining the snow distribution and to understand the trends and patterns of the seasonal snow cover.

In this project, seasonal snow cover trends and patterns have been studied for a 30-year period from 1991 to 2020 using a newly developed reanalysis dataset called Copernicus Arctic Regional Reanalysis (CARRA). A validation of the CARRA data set has been done for the snow depth using point observation data from the Norwegian weather stations and a visual snow cover comparison using Sentinel-2 remote sensing data. Thereafter, interannual variability in day of snow disappearance, day of snow onset, duration of snow-free period, and maximum snow depth have been analysed and these trends are then discussed in detail.

The results show that for the most non-glaciated regions in Svalbard, the snow onset is happening later in the winter season while the day of snow disappearance is arriving earlier in the spring. Consequently, the duration of snow-free period has increased in almost all regions of Svalbard except a few sites where the duration of the snow free-period has decreased most likely due to local climatic factors. These factors can be better understood by incorporating meteorological elements like precipitation, air temperature and wind speed. Overall, the CARRA reanalysis dataset is very good in determining snow cover trends in non- glaciated regions of Svalbard and with some updates and modifications, it might be able to determine snow cover for the glaciated regions in future.

22nb3978

Proglacial icings may act as low-friction beds for glacier advances

Erik Schytt Mannerfelt, Andrew J. Hodson, Gabrielle E. Kleber

Corresponding author: Erik Schytt Mannerfelt

Corresponding author e-mail: e.s.mannerfelt@geo.uio.no

Presenting author: Erik Schytt Mannerfelt

Glaciers on Svalbard commonly form proglacial icings from meltwater or groundwater in their glacial forefields during winter. These icings are 1–6 m thick and usually persist until the latter half of summer. In the winter field season of 2022, we noticed two glaciers in Rindersbukta, central Spitsbergen, that show evidence of past or current glacier surges overriding their icings instead of bulldozing them. Glacier advances are generally largely hindered by the friction of their rough substrates, but a clean flat ice surface could potentially act as a low-friction bed that could speed up an ongoing advance. We use drone-based photogrammetry and chemical analysis of outcropping ice to infer this occurrence, and suggest that understanding the dynamics between proglacial icings and advancing glaciers are worth further investigation. In addition, historical imagery from late-1800s glacier advances show signs of potential proglacial icing incorporation in the strata of glacier termini. This interplay may therefore not just be limited to glacier surges, but might also apply to mass balance driven advances.

22nb3979

New measurements of ice thickness on Jostedalsbreen ice cap reveal vulnerability to future fragmentation

Mette Gillespie, Jostein Bakke, Kjetil Melvold, Liss Marie Andreassen, Jan Magne Cederstrøm, Halgeir Elvehøy, Bjarne Kjøllmoen, Even Loe, Marte Meland, Sigurd Daniel Nerhus, Kamilla Hauknes Sjursen, Eivind Nagel Wilhelm Støren, Simon de Villiers, Kåre Øst, Jacob Clement Yde

Corresponding author: Mette Gillespie

Corresponding author e-mail: mette.kusk.gillespie@hvl.no

Presenting author: Mette Gillespie

Jostedalsbreen ice cap is the largest ice mass in mainland Europe with an area of 458 km2 (2019). Ice thicknesses were measured in some regions of the ice cap in the 1980s and 1990s, and reveal ice thicknesses of up to 600 m. In the JOSTICE research project (2020 - 2025) we aim to improve our understanding of Jostedalsbreen ice cap today through renewed measurements of ice thicknesses, snow distribution, surface topography and important meteorological parameters. We will use these measurements to produce a model of ice thickness and bed topography that meets modern day standards of uncertainties. The model will allow for simulations of future changes in glacier extent, meltwater discharge and local climate using novel modelling approaches. Ultimately, we wish to provide the local community with a high-quality dataset on expected regional change, and provide mitigation strategies and tools for adaptation for farmers, tourist operators and hydropower companies, all of which will be influenced by changes in Jostedalsbreen ice cap.

Here, we present the preliminary results of radar measurements of ice and snow thicknesses collected during several field campaigns on Jostedalsbreen ice cap between 2018 and 2022. Ice thickness was measured using a range of antenna frequencies to best cover both thin and thick ice. The thickest ice was sampled using Blue System IceRadars with either 2.5 or 5 MHz, while Malå ground penetrating radars (GPRs) with 25 and 50 MHz antennas were applied to the thinner regions of the ice cap. Variations in snow and firn were mapped using Malå GPRs with either 450 or 500 MHz antennas. Measurements were collected primarily using snow scooters, but steep and heavily crevassed regions were covered using a newly developed 5 MHz helicopter IceRadar system. Results show ice thicknesses up to 650 m in the catchments of the largest outlet glaciers, while thin ice in narrow regions of the ice cap illustrates that Jostedalsbreen ice cap is vulnerable to fragmentation in the near future. Jostedalsbreen ice cap is temperate, and intense scattering of the radar signal at times obscures the bed reflection, even in the 2.5 MHz dataset. This corresponds well with observations on other Norwegian glaciers, and poor penetration depth remains one of the main challenges of conducting radar measurements on temperate ice.

22nb3980

Climatic mass balance and runoff simulations of glaciers in the Barents Sea Region, 1991–2022

Louise Steffensen Schmidt, Thomas V. Schuler, Sebastian Schuler, Erin Emily Thomas

Corresponding author: Louise Steffensen Schmidt

Corresponding author e-mail: l.s.schmidt@geo.uio.no

Presenting author: Louise Steffensen Schmidt

The Arctic is undergoing increased warming compared to the global mean, which has major implications for melting of seasonal snow and glaciers and the associated freshwater runoff into the oceans. Here, we present simulations of the climatic mass balance and runoff from glaciers in the Barents Sea region (Svalbard, Franz Josef Land and Novaya Zemlya) over the last 30 years and investigate if the near-real time forecast product AROME-ARCTIC can be used to provide high-quality simulations of runoff in this region.

22nb3981

The Greenland ice sheet impact on the climate by 2300 in a coupled NorESM2-CISM simulation

Konstanze Haubner, Heiko Goelzer, Petra Langebroek, Andreas Born

Corresponding author: Konstanze Haubner

Corresponding author e-mail: konstanze.haubner@uib.no

Presenting author: Konstanze Haubner

The Greenland ice sheet's mass loss is increasing and so is its impact to the climate system. Yet, Earth System models mostly keep ice sheets at a constant extent or treat interactions with the ice sheets fairly simple.

Here, we present the first simulations of NorESM2 coupled to the ice sheet model CISM over Greenland. We compare NorESM2 simulations from 1850 to 2300 with and without an evolving ice sheet over Greenland based on the ssp585 scenario and its extension to 2300. Ocean and atmosphere horizontal resolution are on 1deg, while the coupled ice sheet module CISM is running on 4km. The coupling setup is based on CESM2. Ice extent and elevation are provided to the atmosphere every 5years and the land model every year. Whereas the ice sheet receives updated surface mass balance every year.

We show the evolution of the Greenland ice sheet and changes in atmosphere, ocean and sea ice.

Overall global mean surface air temperatures (SAT) change from 14°C to 24°C by 2300 with the steepest increase between 2070-2200. Over the Southern ocean and Antarctica, SAT are increasing by 10°C, while over the Northern hemisphere we see a change of 15-28°C by 2300. At the end of the simulations (year 2300), SAT over Greenland are 6°C warmer when including an evolving ice sheet. In contrast, the ocean surrounding Greenland shows SAT that are 2°C colder in the coupled system, compared to the simulation with a fixed Greenland ice sheet. Sea surface temperatures show the same ∼2°C difference around Greenland in coupled and uncoupled simulation. The overall change in sea surface temperatures is 12°C.

Minimum and maximum sea ice extent differs only slightly with and without the coupling, indicating that the overall warming seems to dictate speed of the sea ice retreat.

22nb3982

Melt conditions at A. P. Olsen Ice Cap 2008-2022

Signe Hillerup Larsen

Corresponding author: Signe Hillerup Larsen

Corresponding author e-mail: shl@geus.dk

Presenting author: Signe Hillerup Larsen

Reporting on the glaciological monitorring of A P Olsen Ice Cap in NE Greenland.

22nb3983

Impacts of mountain glacier processes on societies in a changing climate: zoom into Glacier Lake Outburst Floods.

Ursula Enzenhofer

Corresponding author: Ursula Enzenhofer

Corresponding author e-mail: ursula.enzenhofer@ntnu.no

Presenting author: Ursula Enzenhofer

Glacierized mountain areas are undergoing rapid change, however the impact of resulting natural hazards are still difficult to predict precisely. Globally, one of the most common glacier hazards, Glacier Lake Outburst Floods (GLOFs) have led to at least 12445 documented losses of lives. In Norway alone, eight glacier systems have been documented as potentially hazardous and may cause further GLOFs in the future. Even thought many studies have contributed to the development of knowledge about lake occurrence, drainage and physical process description through equations, the overall understanding lacks especially in situ measurements and interdisciplinary approaches. This study provides a new knowledge base for ice-dammed lakes from source to sink in Norway and Chile. The mechanisms leading to drainage initiation and flood routing are investigated using various instruments deployed directly in the study area of an active GLOF prone ice-dammed lake and the neighboring glacier system. Moreover, the methodology will further include modelling as addition to in situ observations and a focus on the social aspect of the impacted valley population downstream and their risk management strategies. Ultimately, this project will use the identified spatio-temporal GLOF signatures to design an applicable early warning system which complies to common risk management practices and can be transferred to other GLOF sites, worldwide.

22nb3984

Understanding the destabilization of Kongsvegen, an Arctic surge-type glacier

Ugo Nanni, Coline Bouchayer, Andreas Kholer, Louise Steffensen Schmidt, Pierre Marie Lefeuvre, John Hult, Thomas Schuler

Corresponding author: Ugo Nanni

Corresponding author e-mail: nanni@uio.no

Presenting author: Ugo Nanni

Glacier flow instabilities, such as surges and collapses, are mainly caused by changes at the ice-bed interface, where basal slip and sediment deformation drive basal glacier movement. Observation of basal processes and their response to hydraulic forcing (precipitation, melt events) remains difficult due to scarce and limited access to the glacier bed and is still poorly understood. In this study, we examine variations in subglacial mechanical conditions of the Konsgvegen Glacier (Svalbard). Having undergone a surge in 1948, this glacier has recently shown strong indications of an imminent new surge event. Since spring 2021, we have instrumented two sites with seismic sensors located both at the surface and near the glacier bed. The first site is located near the equilibrium line elevation where the glacier experienced a tenfold acceleration, while the second is 5 km lower where the velocity stagnated. We use these measurements to invert the subglacial hydraulic conditions and to locate basal stick-slips. On a seasonal scale, we observe that subglacial channels are in equilibrium with runoff, whereas on a multi-day scale (rainfall, melt event), the input of meltwater causes a rapid acceleration of the glacier. Linked to these short duration events, we observe bursts of seismicity, both at the surface and near the glacier bed. Such bursts are more present at the upper site, suggesting a rapid change in basal conditions. We complement our observations with measurements of basal water pressure and basal drag, and discuss the spatial stability of the glacier and potential surge propagation. Our study sheds light on the mechanisms governing the destabilisation of the glacier over a full year.

22nb3989

Kongsvegen surge update

Jack Kohler

Corresponding author: Jack Kohler

Corresponding author e-mail: jack@npolar.no

Presenting author: Jack Kohler

The Kongsvegen surge continues its build-up: details to follow....

22nb3990

Ocean-driven Antarctic Ice Sheet changes over nine glacial cycles

David Chandler, Petra Langebroek, Ronja Reese, Torsten Albrecht, Ricarda Winkelmann

Corresponding author: David Chandler

Corresponding author e-mail: davemchandler@gmail.com

Presenting author: David Chandler

Antarctic Ice Sheet simulations covering previous glacial cycles provide insights into ice sheet response to ocean warming. However, simulating or reconstructing deep ocean temperature, which is a crucial boundary condition over these times scales, remains very difficult. Here we compile the limited available proxy evidence for deep ocean temperature changes, and compare this compilation with ocean temperatures estimated by a linear response function (Albrecht et al., *Cryosphere* **14**, 2020). Given encouraging agreement between these completely independent methods over the last 9 glacial cycles (800 000 years), we use the linear response function as a boundary condition in PISM ice sheet simulations for this period. We will report our latest results from ongoing work to explore the roles of ocean temperature and basal processes in ice sheet response to past warm periods.

22nb3991

The Greenland Climate Network v.2 - a new era of monitoring the Greenland ice sheet

Andreas P. Ahlstrøm, Jason E. Box, Nanna B. Karlsson, William T. Colgan, Robert S. Fausto, Signe B. Andersen, Baptiste Vandecrux, Anja Rutishauser, Penelope R. How, Kenneth D. Mankoff, Jakob Jakobsen, Christopher L. Shields, Allan Ø. Pedersen, Michele Citterio, Alexandra Messerli, Anne M. Solgaard, Signe H. Larsen

Corresponding author: Andreas P. Ahlstrøm

Corresponding author e-mail: apa@geus.dk

Presenting author: Andreas P. Ahlstrøm

The Greenland Ice Sheet plays an important role in the global climate system by influencing the global radiation budget and the circulation of the atmosphere and ocean, with a contribution of 16 mm to global sea level rise in the last 50 years and accelerating. While satellites currently enable deriving total ice mass changes, ice movement and ice sheet elevation change and regional climate models provide constraint for the key mass fluxes of snow accumulation and meltwater runoff, only in-situ observations can reliably reveal if these remote assessments are accurate. Automatic weather stations (AWS) deliver ground-truth near real-time data for the study of local surface mass balance processes, for the evaluation of satellite-derived products and regional climate models and for assimilation within weather forecast models. The Greenland Climate Network, currently consisting of 16 AWS on the Greenland ice sheet, primarily established in the period 1995 to 1999, with the Swiss Camp station beginning June 1990, through the initiative of the late Prof. Konrad Steffen. Prof. Steffen led the effort gaining funding from NASA Polar Program, the US National Science Foundation and the Swiss Federal Institute for Forest, Snow and Landscape until 2020, at which point the Geological Survey of Denmark and Greenland (GEUS) was invited to continue the operation. With GEUS, partnering with Asiaq Greenland Survey, GC-Net will become part of a Greenland-wide network of 40 AWS on Greenland ice, consisting of 16 AWS situated in the accumulation area and 24 in the ablation area, with 34 AWS placed on the ice sheet and 6 on local glaciers and ice caps. Here, we present the development initiated to carry GC-Net into the future, describing changes in instrumentation, open data processing and availability policies under the FAIR principles, field procedures as well as novel activities and initiatives reaching beyond AWS maintenance.

22nb3992

Assimilating real-time observations to update modeling glacier mass balance in Svalbard

Wenxue Cao, Thomas Schuler, Kristoffer Aalstad, Louise Steffensen Schmidt, Andreas Max Kääb, Sebastian Westermann

Corresponding author: Wenxue Cao

Corresponding author e-mail: wenxue.cao@geo.uio.no

Presenting author: Wenxue Cao

Assimilating real-time observations to update modeling glacier mass balance in Svalbard

22nb3993

A new approach to meteorological and glaciological observations in remote polar regions using open-source internet of things technologies

Simon Filhol, Pierre-Marie Lefeuvre, J. David Ibañez, John Hulth, Steve Hudson, Jean-Charles Gallet, Thomas Schuler, John Burkhart

Corresponding author: Simon Filhol

Corresponding author e-mail: p.m.lefeuvre@geo.uio.no

Presenting author: Pierre-Marie Lefeuvre

Experiences and solutions to collect geophysical observations on Arctic glaciers are presented using Internet-of-Things (IoT) technologies and low-cost electronics. A network of modular monitoring systems for weather and snow is deployed to collect spatially distributed, in-situ data with real-time connectivity at costs comparable to those of a single autonomous weather station. A part of the presented system also pushes data to online servers for immediate and long-term usage. Two networks on Kongsvegen and Midtre Lovenbreen in Svalbard colected data from May 2021 to April 2022. Our system collected reliable data and has sufficient power resources to survive 4-5 months of darkness during the polar night. Here, we present the design considerations and performance metrics, report our lessons learned from such a challenging deployment and suggest pathways for future improvement. along with reflections for improving collectively porting IoT technology to the geoscientific community.

22nb3994

PhD project ideas 'Assessing glacial-hydrological systems in Scandinavian mountains and the international context using remote sensing and field observations'

Ronja Lappe, Yongmei Gong, Irina Rogozhina

Corresponding author: Ronja Lappe

Corresponding author e-mail: ronja.lappe@ntnu.no

Presenting author: Ronja Lappe

Glacier Lake Outburst Floods (GLOFs) represent sudden events often associated with significant damage to people, infrastructure, industry, and agriculture (Carrivick and Tweed 2016). They belong to the most well-known glacier-related natural hazards worldwide and have attracted increasing attention in both science and spatial planning in past decades (Emmer et al. 2022). Since glacial lakes are expanding due to increased meltwater availability, the frequency of GLOF events is expected to increase in the future (Nie et al. 2013, Zheng et al. 2021). However, the mechanisms that trigger the timing of GLOFs remain poorly understood (Carrivick et al. 2017), which makes prediction difficult and results in GLOFs often occurring unexpectedly.

The main objective of my PhD project is to gain new knowledge on external forcings of GLOF events through an automated large-scale detection of lake drainage using satellite imagery and field observations. Field measurements have already been and will be carried out in different geographic settings in Norway, the Chinese Karakorum and potentially the Chilean Andres to validate satellite-based mapping results. To support local decision making, the PhD project further aims on developing an automized impact estimation approach for identified GLOF lakes. The methodological framework of this project shall further be provided as a globally applicable open-source toolbox, which can be used by the scientific community as well as the public stakeholders to support GLOF risk management strategies.

22nb3995

Antarctic ice stream thickening under Pliocene warmth

Martim Mas e Braga, Richard S. Jones, Jorge Bernales, Jane L. Andersen, Ola Fredin, Mathieu Morlighem, Alexandria J. Koester, Nathaniel A. Lifton, Jonathan M. Harbor, Yusuke Suganuma, Neil F. Glasser, Irina Rogozhina, Arjen P. Stroeven

Corresponding author: Martim Mas e Braga

Corresponding author e-mail: martim.braga@natgeo.su.se

Presenting author: Martim Mas e Braga

Ice streams regulate most ice mass loss in Antarctica. Determining their response to Pliocene warmth could provide insights into their future behaviour, but is hindered by poor representation of subglacial topography in ice-sheet models. We address this limitation using a high-resolution regional model for Dronning Maud Land (East Antarctica). We show that the region's largest ice stream, Jutulstraumen, thickens by 700 m under warm late-Pliocene conditions despite ice-shelf collapse and a retrograde bed slope, while nearby ice streams thin. While it is known that unstable retreat on a retrograde slope can be slowed under certain conditions, this finding illustrates that an ice stream can thicken and gain mass. We attribute thickening to high lateral stresses at its flux gate, which constrict ice drainage. Similar stress balances occur today in 27% of East Antarctica, and understanding how lateral stresses regulate ice-stream discharge is necessary for accurately assessing Antarctica's sea-level rise contribution.

22nb3996

Master’s thesis: Changes in firn stratigraphy on the Austfonna ice cap based on shallow firn cores

Satu Innanen

Corresponding author: Satu Innanen

Corresponding author e-mail: satu.innanen@outlook.com

Presenting author: Satu Innanen

Master's thesis: Changes in firn stratigraphy on the Austfonna ice cap based on shallow firn cores