IASC Workshop on the dynamics and mass budget of Arctic glaciers

Abstracts and program

Network on Arctic Glaciology annual meeting &
IASC cross-cutting activity on **”Arctic glacier hazards”**

26-28 January 2026, Obergurgl, Austria

Organised by: Regine Hock, Ward van Pelt and Jakob Abermann

IASC Network on Arctic Glaciology

Contents

Schedule

The meeting takes place at the University Center in Obergurgl, Austria, on 26 - 28 January 2026.

Monday 26 January

08:30 - 08:50	Registration. Please upload your presentations for the morning session.
08:50 - 08:55	Welcome
Session I:	**Ice dynamics**
08:55 - 09:10	The Cryologger Glacier Velocity Tracker: A Low-Cost, Open-Source Solution for Glacier Dynamics Monitoring - Adam Garbo
09:10 - 09:25	Short term processes on a fast ice stream - Martin Lüthi
09:25 - 09:40	Current state and future evolution of the largest ice cap in mainland Europe: Jostedalsbreen, Western Norway - Thorben Dunse
09:40 - 09:55	Evidence for the Identification of two surge-type glaciers on Southern Prince of Wales Icefields - Wesley Van Wychen
09:55 - 10:10	Ice velocity and discharge monitoring over the Greenlandic Ice Sheet - Bryan Cantal
10:10 - 10:50	Coffee break + group photo
Session II:	**Glacier mass & energy balance**
10:50 - 11:05	Ice Darkening across southern Baffin Island, Nunavut: Causes and implications - Laura Thomson
11:05 - 11:20	Proglacial areas changes along the South West coast of Kalaallit Nunaat (Greenland) based on Digital Elevation Models and hydrological data - Marjolein Gevers
11:20 - 11:35	What happens if the glacier boundary layer is rotated by 90°? - Marie Schroeder
11:35 - 11:50	Impacts of Recent Warming on Canada's high Arctic Glaciers and Ice Caps - David Burgess
11:50 - 16:00	Afternoon break (coffee from 15:30)
Session III:	**Ice dynamics (cont'd)**
16:15 - 16:30	Widespread glacier surging and variable dynamic behaviour on Manson Icefield, SE Ellesmere Island - Benoît Lauzon
16:30 - 16:45	Grounding Line Migrations at Cañon Glacier, Ellesmere Island, Canadian Arctic - Jae Hun Kim

16:45 - 17:00	Modern Elevation and Velocity Changes of Coronation and Maktak Glaciers, Penny Ice Cap, Nunavut - Domynik Huot
17:00 - 18:50	Poster session
19:00	Dinner

Tuesday 27 January

Session IV:	**Cross-cutting session**
09:00 - 09:25	[Keynote] Managing glacier-related risks - Steph Matti
09:25 - 09:40	Development Potential and Risks of the Ice and Snow Industry in Northwest China - Shuodong Zhao
09:40 - 09:55	Evolution of an ice-dammed marginal glacial lake drives changes in outburst flood volume - David Polashenski
09:55 - 10:10	Glacier Mass Loss Preconditioning the Regime Shift in Glacial Lake Outburst Floods of the Zackenberg River, NE-Greenland - Bernhard Hynek
10:10 - 10:45	Coffee break
Session V:	**Cross-cutting session (cont'd)**
10:45 - 11:10	[Keynote] Glacier-related hazards in the Alps - a mountain range in transition - Matthias Huss
11:10 - 11:25	Subglacial lake drainage event at a tidewater outlet glacier in South Greenland - Armin Dachauer
11:25 - 11:40	Cryospheric changes in the Northwest Himalaya under the CMIP6 climate change scenarios - Mayank Upadhyay
11:40 - 11:55	From Ice to Instability: Assessing the Drivers of Motion at the Barry Arm Landslide - Gabriel Wolken
11:55 - 16:00	Afternoon break (coffee after 15:30)
16:00 - 16:45	Cross-cutting discussion
16:45 - 16:50	Short break
16:50 - 18:30	IASC Network on Arctic Glaciology – Open forum
19:00	Dinner

Wednesday 28 January

Session VI:	**Glacier mass & energy balance (cont'd)**
09:00 - 09:15	Centennial Changes in Microclimate and Surface Mass Balance: A West Greenland Case Study - Florina Roana Schalamon

09:15 - 09:30	Fog forcing of surface energy balance from timelapse and weather station data on Arctic glaciers - Hester Jiskoot
09:30 - 09:45	Hidden ice quakes in the Greenland ice sheet from brittle creep - Olaf Eisen
09:45 - 10:00	Comparing Glacier Mass-Balance Estimates: Challenges and Recommendations - Regine Hock
10:00 - 10:15	- Announcements etc
10:15 - 10:45	Coffee break
Session VII:	**Glacier hydrology**
10:45 - 11:00	Matrix vs. Preferential Flow: Partitioning Meltwater Infiltration and Refreezing in Greenland Firn - Joel Harper
11:05- 11:15	Relationships between changes in supraglacial hydrology and the 2021-2022 surge of Nàłùdäy (Lowell Glacier), Yukon - Luke Copland
11:15 - 11:30	Thermal characteristics of Greenlandic ice-marginal lakes from in-situ temperature data, and possible implications for ice dynamics - Pete Tuckett
11:30 - 11:45	Aufeis (Proglacial Icing) in the forefield of a land-terminating outlet glacier in West Greenland – multi-annual and seasonal variability and drivers - Jakob Abermann
11:45 - 12:00	Closing

Posters

- Determining glacier surface runoff using laser distance and reflectance data - Alexander Prokop
- Estimating Greenland's ice thickness using inverse modeling - Alice Furlotti
- Investigating Greenland's wet future - the LIQUIDICE project - Andreas Ahlstrøm
- Summer Extreme Rainfall Events Intensify Southern Greenland Ice Sheet Melt - Baojuan Huai
- Annual geodetic and glaciological mass balances of a peripheral glacier of Greenland - Bernhard Hynek
- Enigmatic Island Formation During the Retreat of a Canadian Arctic Tidewater Glacier: Early Results and Fieldwork Plans - Cassie Ferrante
- Early Detection of Snowpack Wetting Using Sentinel-1 Data: Improving Snowmelt Monitoring Under Cloud-Covered Conditions on the Brøgger Peninsula, Svalbard (2022–2025) - Eric Bernard
- Modelling the evolution of the hydrothermal structure of polythermal glaciers in Svalbard - Francisco Navarro
- Polarstern II - Heinrich Miller
- Mass Balance and Velocity Changes of Selected Glaciers in the Karakoram, Pakistan in Response to Climate Change during 2000-2024 - Imran Hussain
- Glacier surges and glacial lake outburst floods in a warming climate: the case of Aavatsmarkbreen, Svalbard - Justyna Dudek
- A Comparative Study of Climate Data and Reanalysis Model Validation in the St-Elias Mountains, Yukon, from the 1960s to Present - Tatiana Solfjell Huard
- Improved mass balance modeling of Svalbard glaciers - Ward van Pelt

Participants

1. **Adam Garbo** (adam.garbo [at] uottawa.ca)
   University of Ottawa, Canada
2. **Alexander Prokop** (alexander.prokop [at] univie.ac.at)
   University of Vienna, Austria
3. **Alice Furlotti** (alice.furlotti [at] geo.uu.se)
   Uppsala University, Sweden
4. **Andreas Ahlstrøm** (apa [at] geus.dk)
   GEUS, Denmark
5. **Anton Neureiter** (anton.neureiter [at] geosphere.at)
   Geosphere Austria, Austria
6. **Armin Dachauer** (armin.dachauer [at] geo.uzh.ch)
   University of Zurich, Switzerland
7. **Baojuan Huai** (huaibaojuan [at] 126.com)
   Shandong Normal University, China
8. **Benoît Lauzon** (blauz052 [at] uottawa.ca)
   Unversity of Ottawa, Canada
9. **Bernhard Hynek** (bernhard.hynek [at] geosphere.at)
   Geosphere Austria, Austria
10. **Bryan Cantal** (bryan.cantal [at] enveo.at)
    ENVEO IT GmbH, Austria
11. **Cassie Ferrante** (cassieferrante99 [at] gmail.com)
    University of Manitoba, Canada
12. **Damian Forck** (damianforck [at] yahoo.de)
    Helmholtz Centre for Environmental Research, Germany
13. **David Burgess** (david.burgess [at] nrcan-rncan.gc.ca)
    Natural Resources Canada, Canada
14. **David Polashenski** (dpolashenski2 [at] alaska.edu)
    University of Alaska Southeast, USA
15. **Domynik Huot** (dhuot030 [at] uottawa.ca)
    University of Ottawa, Canada
16. **Eric Bernard** (eric.bernard [at] cnrs.fr)
    CNRS / Louis Pasteur University, France
17. **Florina Roana Schalamon** (Florina.schalamon [at] uni-graz.at)
    University of Graz, Austria
18. **Francisco Navarro** (francisco.navarro [at] upm.es)
    Universidad Politécnica de Madrid, Spain
19. **Gabriel Wolken** (gjwolken [at] alaska.gov)
    International Arctic Research Center/University of Alaska Fairbanks, USA
20. **Heinrich Miller** (heinrich.miller [at] awi.de)
    Helmholtz Center for marine and polar research, Germany
21. **Hester Jiskoot** (hester.jiskoot [at] uleth.ca)
    University of Lethbridge, Canada
22. **Imran Hussain** (imranshigari12 [at] mails.ucas.ac.cn)
    Institute of Mountain Hazards and Environment Chinese Academy of Sciences, China

23. **Jae Hun Kim** (jaehun.kim [at] uwaterloo.ca)
University of Waterloo, Canada
24. **Jakob Abermann** (jakob.abermann [at] uni-graz.at)
Graz University, Austria
25. **Joel Harper** (joel [at] mso.umt.edu)
University of Montana, USA.
26. **Julien Nahon** (julien [at] nahon.ca)
Environment Canada, Canada
27. **Justyna Dudek** (justyna_dudek [at] wp.pl)
Polish Academy of Sciences, Poland
28. **Laura Thomson** (l.thomson [at] queensu.ca)
Queen´s University, Canada
29. **Luke Copland** (luke.copland [at] uottawa.ca)
University of Ottawa, Canada
30. **Marie Schroeder** (marie.schroeder [at] uibk.ac.at)
University of Innsbruck, Austria
31. **Marjolein Gevers** (marjolein.gevers [at] unil.ch)
University of Lausanne, Switzerland
32. **Martin Lüthi** (martin.luethi [at] geo.uzh.ch)
University of Zurich, Switzerland
33. **Matthias Huss** (huss [at] vaw.baug.ethz.ch)
ETH Zürich, Switzerland
34. **Mayank Upadhyay** (mayankupadhyay06 [at] gmail.com)
Indian Institute of Technology Roorkee, India
35. **Mohan Xu** (zzxmh.526 [at] gmail.com)
Peking University, China
36. **Olaf Eisen** (oeisen [at] awi.de)
Alfred Wegner Institute, Bremerhaven, Germany
37. **Pete Tuckett** (pete.tuckett [at] york.ac.uk)
University of York, UK
38. **Regine Hock** (regineho [at] uio.no)
University of Oslo, Norway
39. **Shoudong Zhao** (shoudongzhao [at] outlook.com)
Chinese Academy of Meteorological Sciences, China
40. **Stephanie Matti** (steph.matti [at] gmail.com)
Icelandic Meteorological Office, Iceland
41. **Tatiana Solfjell Huard** (tsolf065 [at] uottawa.ca)
University of Ottawa, Canada
42. **Tereza Uhlíková** (tereza.uhlikova [at] helsinki.fi)
University of Helsinki, Finland
43. **Thorben Dunse** (Thorben.Dunse [at] hvl.no)
Western Norway University of Applied Sciences, Norway
44. **Ward van Pelt** (ward.van.pelt [at] geo.uu.se)
Uppsala University, Sweden
45. **Wesley Van Wychen** (wvanwychen [at] uwaterloo.ca)
University of Waterloo, Canada

Abstracts

The Cryologger Glacier Velocity Tracker: A Low-Cost, Open-Source Solution for Glacier Dynamics Monitoring

Adam Garbo[1], Luke Copland[1], Wes Van Wychen[2], Christine Dow[2], Enrico Mattea[3], Albin Wells[4]

[1] University of Ottawa
[2] University of Waterloo
[3] University of Fribourg
[4] Carnegie Mellon University

The high costs and proprietary constraints of commercial Global Navigation Satellite Systems (GNSS) pose significant barriers to glacier monitoring, particularly in remote environments where continuous, high-resolution data are essential for understanding glacier dynamics. Traditional glacier studies often rely on survey-grade GNSS receivers, which, while precise, are costly and demand substantial power and logistical support, limiting large-scale deployment. Recent advancements in low-cost, low-power GNSS technology offer new opportunities for glaciological measurements. Here, we introduce the Cryologger Glacier Velocity Tracker (GVT) (`https://github.com/cryologger`), an affordable, modular, open-source GNSS-based data logger designed for high-temporal-resolution glacier velocity monitoring. Each GVT integrates a u-blox ZED-F9P multi-frequency GNSS receiver and Arduino microcontroller, along with rugged solar panels, battery, weatherproof enclosure, and tripod. Constructed from readily available components, the Cryologger GVT is customizable and demonstrates robust field performance in extreme environments. We present findings from Cryologger GVTs deployed across high-latitude glacier sites. Between 2021 and 2025, 28 GVTs were deployed globally, including in the Canadian Arctic, Alaska, and Central Asia. This analysis focuses on data from deployments on Lowell Glacier, Yukon, and the Belcher Glacier on Devon Island, Nunavut, to assess system performance. Results indicate that Cryologger systems maintained consistent daily operation under challenging winter conditions, achieving positional accuracies of 1–3 cm using Precise Point Positioning (PPP) post-processing techniques. In addition to advancing our understanding of glacier dynamics, these results provide essential ground truth for validating remote sensing methods of glacier velocity estimation. To our knowledge, this study represents the first fully open-source GNSS deployment on Arctic glaciers, underscoring the Cryologger platform's potential as a cost-effective and accessible tool for advancing glacier measurements.

Determining glacier surface runoff using laser distance and reflectance data

Alexander Prokop[1], Jean-Michel Friedt[2], Eric Bernard[2], Florian Tolle[2]

[1] University of Vienna
[2] Université de Franche-Comté

TBD

Estimating Greenland’s ice thickness using inverse modeling

Alice Furlotti[1], Ward van Pelt[1]

[1] Uppsala University

The Greenland Ice Sheet (GrIS) has experienced sustained mass loss since the 1980s, driven by increased surface meltwater runoff and the retreat of fast-flowing marine-terminating glaciers, and is projected to contribute 4–30 cm to global mean sea level by 2100. Quantifying the GrIS contribution to sea-level rise relies heavily on ice-flow models; however, their accuracy is limited by uncertainties in present-day initial conditions, particularly basal topography and basal friction, which remain poorly constrained due to sparse observations.

Inverse methods help address these limitations by iteratively adjusting model initial conditions to reproduce observed surface properties. A range of inversion strategies has been developed, spanning kinematic approaches that invert the mass-conserving continuity equation, and dynamic approaches that invert the equations of momentum conservation.

This work is aimed at inferring Greenland’s basal topography through the application of a mathematically simpler iterative inversion scheme, originally proposed by van Pelt et al. (2013) and refined by Frank et al. (2023). The method is designed to find the unique ice thickness solution which minimises the misfit between satellite-derived surface elevation change rates over recent years and corresponding model-simulated rates. Concurrently, assimilation of high-resolution surface velocity data and complementary observational datasets enables the joint optimisation of basal friction in fast-flowing areas, or ice hardness in slow-flowing areas. The expected outcome is a spun-up, internally consistent ice sheet state that reflects contemporary subglacial geometry at a high resolution and with limited error margins. This model configuration will be employed in forward simulations to quantify future GrIS mass loss and its contribution to global mean sea level rise up to the year 2300.

Investigating Greenland's wet future - the LIQUIDICE project

Andreas Ahlstrøm[1], Jason Box[1], Synne H. Svendsen[1], Baptiste Vandecrux[1], Rasmus B. Nielsen[1], Henrik T. Jakobsgaard[1], Penelope How[1], Lill Rastad Bjørst[2], Christian Rodehacke[3]

[1] GEUS
[2] University of Copenhagen
[3] DMI & AWI

In LIQUIDICE, we aim to re-assess the past and future century climate-induced changes to the Greenland ice sheet (Sermersuaq) and climate vulnerable locations across the Alps, Norway, High Mountain Asia and Svalbard. The approach is to develop new, expanded and harmonised data from satellite sensors and ground stations and use these data to improve ice sheet and glacier models with Earth System Models. The goal is to obtain new process understanding and inform socio-economic strategies regarding water resource management, hydropower and winter tourism. Here, we focus on the effort in two ice-sheet catchments in western Kalaallit Nunaat (Greenland): the Qinnguata Kuussua (Watson River) behind Kangerlussuaq, and Paakitsoq north of Ilulissat which provides meltwater for a hydropower plant. The ground observational component consists of two new instruments, complementing current weather station data by improving our measurements of snow accumulation: a GNSS device to obtain distributed snow heights and a cosmic-ray detector to measure snow water equivalent (SWE). Further, the data processing chain for the subsurface temperature of the firn is being improved. To enhance the satellite-derived albedo, a four-decade, daily, cloud-cleared snow and ice albedo record is presented across multiple catchments by merging time series from a variety of sensors, into a single harmonized dataset. Further, a cascade of modelling efforts will dynamically downscale global coupled Earth System-Ice Model output through energy-balance modelling with the CISSEMBEL model, implicitly incorporating effects of ice sheet-climate feedback loops. It informs ice-dynamic modelling with the Parallel Ice-Sheet Model, thereby investigating future runoff and catchment variations. A parallel effort will address public debates on local climate change and energy policies in Kalaallit Nunaat (Greenland), exploring how the impacts of climate change on inland ice, snow cover, and permafrost affecting water resources can inform local policy dialogues, citizen engagement, and democratic participation.

Subglacial lake drainage event at a tidewater outlet glacier in South Greenland

Armin Dachauer[1], Andrea Kneib-Walter[1], Ethan Welty[1], Andreas Vieli[1]

[1] University of Zurich

Subglacial lakes act as important hydrological reservoirs within the Greenland ice sheet and its outlet glaciers, supplied primarily by surface meltwater that drains to the bed. Their episodic drainage events can mobilize large volumes of water, altering subglacial morphology, and influence local ice dynamics. Under ongoing climate warming, increasing meltwater production is expected to amplify both the frequency and magnitude of these drainage events. Yet, direct observations of large subglacial lake outbursts remain rare. At the tidewater outlet glacier Eqalorutsit Kangilliit Sermiat in South Greenland, we document a subglacial drainage event of about 0.3 km^3, which led to considerable ice surface lowering, a large increase of freshwater discharge, and consequently a speed-up of the glacier's terminus area.

Summer Extreme Rainfall Events Intensify Southern Greenland Ice Sheet Melt

Baojuan Huai[1]

[1] Shandong Normal University

Rainfall events over Greenland Ice Sheet (GrIS) have become more frequent in recent decades. Several observed extreme rainfall events are accompanied by high GrIS surface melt. However, their role in surface energy budgets and the associated physical mechanisms remain poorly understood. Here we employ a surface energy balance model to quantify the relative contributions of energy terms to surface melt energy (Q_m) during extreme rainfall (ER) events at QAS_L and QAS_U stations in southern GrIS. We further investigate the energy anomalies in terms of synoptic-scale atmospheric conditions during ER events lasting three or more days (ER+3d). Our results indicate that during ER+3d events, nonradiative energy contributes 54% of Q_m at QAS_L, near the ice sheet margin, with turbulent fluxes serving as the primary energy source. In contrast, at QAS_U, closer to the equilibrium line, Q_m remains dominated by radiative energy, accounting for 61% of Q_m. The contribution of rainfall heat flux remains small, at approximately 4% at QAS_L and 2% at QAS_U. Rainfall-related atmospheric conditions trigger positive anomalies in turbulent fluxes and net radiation, due to strengthened cloud radiative forcing and increased turbulence scales in the near surface, which collectively contribute to high surface melt during ER+3d events. Therefore, the increased rainfall events have the potential to exacerbate surface mass loss by adding excess radiative and turbulent energy inputs in the future.

Widespread glacier surging and variable dynamic behaviour on Manson Icefield, SE Ellesmere Island

Benoît Lauzon[1], Luke Copland[1], Wesley Van Wychen[2], Élodie Bracquart[3]

[1] Unversity of Ottawa
[2] University of Waterloo
[3] Université du Québec à Rimouski

Glacier surges interrupt long periods of quiescent slow flow, causing surface velocities to increase by a magnitude or more above background levels. For marine-terminating glaciers, this can trigger iceberg calving and increased meltwater discharge, posing risks to navigation and influencing oceanic primary production. Surge-type glaciers are non-uniformly distributed across the Earth, clustering in specific geographic regions largely controlled by climate. The Canadian Arctic is one such cluster, with Manson Icefield exhibiting the highest concentration of surge-type glaciers within the region. In this study, we identify and describe glacier dynamic instabilities on Manson Icefield by analysing changes in terminus position, surface characteristics, glacier velocities, and surface elevation since the late 1950s.

Long-term surface elevation changes from declassified KH-9 reconnaissance images reveal significant thickening near (exceeding 100 m) at the termini of several glaciers, indicating major mass redistribution from surges. These patterns are most pronounced between 1976 and 2001, suggesting that many surges occurred over this period. Preliminary results indicate that at least 46% of the glacierised area of Manson Icefield is affected by dynamic instabilities, with nine surges identified thus far, including four newly confirmed surge basins, and most marine-terminating glaciers exhibiting evidence of past surging. The most notable case is the 15-year (1992–2007) surge of Mittie Glacier, the largest glacier on Manson Icefield (2,000 km^2), which reached the highest velocity ever recorded in the Canadian Arctic at 5 km a^{-1}. Manson Icefield provides a unique setting for studying divergent dynamic instability behaviours, including; long-term, high-intensity surges, shorter-term, lower-magnitude surges and pulses, and extended periods of advance indicative of slow surges.

This study further characterises the frequency and dynamics of surging in this region and will provide insights into why Manson Icefield hosts a significantly higher concentration of surge-type glaciers than the rest of the Canadian Arctic.

Annual geodetic and glaciological mass balances of a peripheral glacier of Greenland

Bernhard Hynek[1], Anton Neureiter[2], Alexander Prokop[2], Melina Frießenbichler[2], Signe H. Larsen[2]

[1] Geosphere Austria
[2] University of Vienna

Between 2013 and 2021 accumulation by avalanches contributed significantly to the mass balance of Freya Glacier (74.38°N, 20.82°W), a small (5.5 km^2, 2021) mountain glacier in Northeast Greenland. While avalanche deposits have been visible on the glacier surface to a limited extent almost every year, the avalanches in February 2018 were clearly outstanding, covering more than one third of the glacier area and contributing 0.35 m w.e. to the winter mass balance of 2018. Some avalanches depositis were more than 15 m thick, leading to a high spatial variability of surface mass balance, which naturally cannot be captured by the stake network. To overcome this shortage and measure the mass balance of the glacier more acurately, the glacier was surveyed again in spring 2024 and 2025 using terrestrial LIDAR and UAV-based photogrammetry. Here we compare annual elevation changes and geodetic mass balances with glaciological mass balances to better capture the contribution of avalanches on an annual timescale.

Ice velocity and discharge monitoring over the Greenlandic Ice Sheet

Bryan Cantal[1], Thomas Nagler[1], Jan Wuite[1], Markus Hetzenecker[1]

[1] ENVEO IT GmbH

As the flagship SAR mission of the Copernicus program Sentinel-1 (S1) has demonstrated remarkable success across various applications for over a decade. Most notably, S1 has been a cornerstone for monitoring polar glaciers and ice sheets since 2014.

One of the mission's key strengths lies in its systematic acquisition strategy for the polar regions, which ensures continuous coverage of the Greenland Ice Sheet and the Antarctic Ice Sheet margins, as well as of other polar ice caps. This has enabled operational monitoring of key parameters such as ice velocity and discharge, capabilities that were previously limited to selected glaciers and specific dedicated campaigns. With the recently launched Sentinel-1C (December 2024) and Sentinel-1D (November 2025) the Sentinel-1 mission family will have two operating platforms with a planned live time to 2033. Additionally, enhance synergies of Sentinel-1 with other satellite systems, such as the NASA/ISRO NISAR mission and to upcoming Copernicus ROSE-L mission will maximize monitoring capabilities of polar ice sheets and ice caps.

We will present the current status and recent developments achieved within the ESA CCI and Polar+ programs, as well as the EU Copernicus Climate Change Service (C3S) ice sheets portfolio, focusing on ice velocity and ice discharge monitoring using SAR Earth Observation data. These advances include the generation of enhanced ice velocity products that integrate InSAR and offset-tracking techniques, while combining observations from multiple sensors operating at different frequency bands, such as C-band and L-band. The resulting velocity maps, together with ice thickness information, provide the basis for deriving ice discharge, freshwater fluxes, and assessing changes in ice sheet mass balance. We will showcase examples of monthly ice velocity profiles for major Greenland outlet glaciers and the variability in monthly ice discharge across Greenland Ice Sheet sub-basins over the last 10 years. Opportunities and challenges related to monitoring ice sheets with emerging satellite missions will also be discussed. Finally, we will provide information on the available products, their quality, and how to access them.

Enigmatic Island Formation During the Retreat of a Canadian Arctic Tidewater Glacier: Early Results and Fieldwork Plans

Cassie Ferrante[1]

[1] University of Manitoba

Uncertainties in sea-level-rise projections arise in part because of our incomplete understanding of processes at the ice-ocean interface. Glaciers that terminate into the ocean (tidewater glaciers) provide an opportunity to study these interactions. Due to the hazards of directly surveying dynamic calving fronts, this study will use an autonomous surface vehicle (ASV) to collect in situ data at Illaulittuq (Coronation) Glacier on Baffin Island, Nunavut. The glacier's retreat is creating a new sediment island that is atypical for tidewater glaciers and suggests a possible unique mode of subglacial sediment delivery. To investigate the formation of this island, we present satellite time-series data and high-resolution elevation data derived from drones. In future field seasons, we will map the glacier front and surrounding seafloor using multibeam sonar. Additional CTD casts will collect data to assess possible subglacial meltwater contributions and local circulation patterns. These physical observations will provide new insights into subglacial hydrological processes at the ice-ocean boundary and improve understanding of these melting patterns for global sea-level-rise projections.

Glacier Mass Loss Preconditioning the Regime Shift in Glacial Lake Outburst Floods of the Zackenberg River, NE-Greenland

Daniel Binder[1], Signe Hillerup Larsen[2], Mikhail Mastepanov[3], Jakob Abermann[4], Michele Citterio[2], Eva P. S. Eibl[5], Arno C. Hammann[6], Bernhard Hynek[7], Kristian Kjellerup Kjeldsen[2], Daniel Alexander Rudd[3], Wolfgang Schöner[4], Kirstine Skov[8], Erik V. Sørensen[2], Mikkel Tamstorf[3], Kirsty Langley[6]

[1] Potsdam University, Germany
[2] Geological Survey of Denmark and Greenland (GEUS)
[3] Aarhus University
[4] University of Graz
[5] University of Potsdam
[6] Asiaq - Greenland Survey
[7] GeoSphere Austria
[8] UNDO Carbon Ltd

Since the Zackenberg River monitoring began in 1996, regular flood waves have been recorded, caused by the drainage of a meltwater lake dammed by a local glacier. Continued glacier mass loss has caused downwasting of the ice dam which acted as long-term preconditioning factor for the abrupt change in glacier lake outburst flood characteristics observed since 2019. We show that prior to 2019, rapid subglacial lake drainages were dominant, with timing primarily dependent on the seasonal development of a channelized subglacial drainage system. The 2019 lake outburst marked the onset of progressive ice dam disintegration which initiated a transition to ice-marginal flood routing with more moderate drainage rates and declining lake volumes. We present a conceptual model for this newly established lake drainage mechanism and propose that it will ultimately lead to the collapse of the ice dam and the cessation of the outburst floods.

Impacts of Recent Warming on Canada's high Arctic Glaciers and Ice Caps

David Burgess[1], Brad Danielson[1], Jaime Dube[2]

[1] Natural Resources Canada
[2] University of Ottawa

Plateau ice caps and valley glaciers that are separate from the larger dynamic ice caps cover about 15,000 km^2, or roughly 20% of the glacierized area across the Queen Elizabeth Islands. Arctic Canada. These smaller ice masses are primarily remnants of the Little Ice Age (1250–1850) and lie almost entirely below the regional post-2000 equilibrium line altitude where surface melting (ablation) occurs across their entire extent except during years with anomalously cool summers. In this study, we examine changes in area and thickness for two ice caps (Meighen and Melville) and one glacier (Aussuiktuq) between 1960 and 2023. Our results show that these ice masses have lost 40–60% of their area over the 63-year study period. In response to post-2000 warming, areal shrinkage rates were two to three times faster than during the four decades prior to 2000. For ice masses of relatively uniform thickness, ie. Aussuiktuq Glacier and the Melville Ice Cap, rates of area change were well synchronized with the cumulative thickness changes measured. By contrast, the dome-shaped Meighen Ice Cap showed a delayed response of areal retreat to measured thinning. Additional impacts of post-2000 warming on the ice caps include slope steepening, increased bedrock exposure, and fragmentation. These processes act as positive feedback mechanisms to precondition the ice masses for enhanced melt under future warming scenarios. Our findings suggest that small ice caps and glaciers independent of the larger ice caps are likely to disappear almost entirely by 2100.

Evolution of an ice-dammed marginal glacial lake drives changes in outburst flood volume

David Polashenski[1], Jason Amundson[1], Eran Hood[1], Jamie Pierce[2], Crane Johnson[3], Johnse Ostman[3], Aaron Jacobs[3], Christian Kienholz[1]

[1] University of Alaska Southeast
[2] USGS
[3] NWS

Recent satellite-based studies have documented an overall decline in the area of ice-dammed basins across Alaska, suggesting that glacial lake outburst flood (GLOF) volumes associated with these basins are decreasing due to climate change. However, these studies neglect to consider the entire life cycle of ice-dammed GLOFs because satellite imagery cannot effectively identify and quantify newly emergent ice-marginal basins with significant ice coverage. Here, we use an 8-year time series of digital elevation models derived from drone surveys of Suicide Basin along Mendenhall Glacier to document changes in the storage capacity of an ice-dammed basin in the early stages of the outburst flood life cycle. Since 2011, this formerly ice-filled tributary has filled with water each summer and drained at least once per year causing GLOF events in the downstream Mendenhall Valley. The GLOFs from this basin have resulted in new record river discharge for the past three consecutive summers causing significant property damage. We utilize over 45 digital elevation models of the basin and a 15-year record of flood hydrographs to describe the rapid evolution of these flood events. We constrain iceberg volume in the basin, effective and total estimated lake volume, lake surface area, and ice dam elevation. Overall, we find the lateral expansion of Suicide Basin and decline in ice mélange volume has increased the water storage capacity of this ice-dammed marginal lake by approximately 20% creating the potential for larger outburst floods. We also note a potential shift in the drainage behavior of this system over time, transitioning from partial drainage events to more recent events where nearly the full storage capacity drains. We hope to constrain estimates of future lake volume to inform the ongoing efforts to implement an engineered geotechnical solution which seeks to mitigate the downstream impacts of these record GLOF events.

Modern Elevation and Velocity Changes of Coronation and Maktak Glaciers, Penny Ice Cap, Nunavut

Domynik Huot[1], Luke Copland[1], Karen Alley[2], Pénélope Gervais[1]

[1] University of Ottawa
[2] University of Manitoba

Outlet glaciers on Baffin Island have undergone some of the most rapid changes in the Canadian Arctic Archipelago in recent decades, yet regional quantification of these changes remains limited. Coronation Glacier (tidewater) and Maktak Glacier (land-terminating) are similarly sized neighbouring outlets of Penny Ice Cap exposed to similar climatic forcing, making them ideal for assessing the modern evolution of two contrasting terminus types. To assess their evolution, surface velocities from ITS_LIVE image-pair records, surface elevation change from ArcticDEM strips and ASTER stereo images, and terminus positions mapped from optical satellite imagery, were quantified for our study period (2000-2024).

Sustained thinning and a marked decrease in surface velocity were detected for both glaciers over the study period, with the strongest changes occurring in their lower ablation zones. Annual velocity trends indicate a persistent slowdown, with more pronounced deceleration after the mid-2000s. Along their centrelines, reductions of approximately 1-2 m a^{-1} were observed for Coronation Glacier over the past 25 years, while Maktak Glacier experienced reductions of 1-3 m a^{-1}. Seasonal analyses reveal distinct recent patterns: in the past four years, Maktak has displayed increased terminus speeds in spring, whereas Coronation has recorded elevated velocities 15-20 km up-glacier in autumn and winter. Elevation-change records indicate widespread thinning since 2005, with Coronation thinning by roughly -1 to -2 m a^{-1} and Maktak by -1 to -3 m a^{-1}. Terminus mapping indicates amplified retreat since the mid-1990s, with Coronation and Maktak retreating approximately 1 km and 650 m, respectively. Together, these findings indicate that two glaciers with different terminus types are undergoing broadly similar recent changes, with Coronation Glacier potentially transitioning toward a land-terminating-style behaviour.

Early Detection of Snowpack Wetting Using Sentinel-1 Data: Improving Snowmelt Monitoring Under Cloud-Covered Conditions on the Brøgger Peninsula, Svalbard (2022–2025)

Eric Bernard[1], Jean Michel Friedt[1]

[1] CNRS / Louis Pasteur University, France

The evolution of the snowpack during the melt season on an Arctic glacier is investigated using a combination of ground-based oblique-view cameras, spaceborne optical imaging, and spaceborne RADAR observations. Systematic, repeated acquisitions from the European Space Agency's Sentinel-1 Synthetic Aperture RADAR (SAR) satellites provide continuous monitoring of the snow-covered glacier surface under all weather and illumination conditions, enabling an assessment of its meltwater production potential. Comparing SAR backscatter with optical and multispectral imagery highlights the distinct physical variables captured by each sensor—liquid water content for SAR versus surface albedo for optical data—and demonstrates their complementarity in resolving snowmelt processes. The analysis further reveals a significant temporal lag between the visually detectable onset of spring snowmelt and the internal metamorphism of the snowpack. SAR observations indicate that structural and hydrological changes within the snowpack can be detected approximately 30 days before its visible retreat begins.

Centennial Changes in Microclimate and Surface Mass Balance: A West Greenland Case Study

Florina Roana Schalamon[1], Sebastian Scher[1], Andreas Trügler[1], Wolfgang Schöner[1], Jakob Abermann[1]

[1] University of Graz

The local microclimate is a key driver of glacier changes, but glacier change also influences the local microclimate. This feedback becomes particularly relevant in rapidly changing regions such as West Greenland, where Qaamarujup Sermia has retreated by approximately 2 km between 1930/31 and 2022. This is the historical site, where Alfred Wegener's last expedition took place and they conducted pioneering glaciological and meteorological measurements. We revisited the original research concept by installing a similar, spatially distributed monitoring network ranging from the coastline to the glacier top. This network consists of automatic weather stations, distributed air temperature and humidity sensors, and surface mass-balance stakes. Our dataset allows us to investigate how altitudinal air-temperature profiles respond to the increasing ice-free area in the valley. Cluster analyses of temperature gradients reveal that the often-assumed environmental lapse rate of -6.5 K km^{-1} only applies under certain conditions. In some cases it holds only for the ice-free section of the valley, while in other situations temperature increases from the coast inland before decreasing with elevation. The variability of the profiles is related to variable synoptic situations and cloud conditions, leading to varying depths of inversion layers. We hypothesize that ice-free surface heating increases as glacier retreat continues to expose additional valley surfaces. To assess the implications for glacier melt, we combine the microclimate observations with high-resolution melt measurements from an automated stake and conventional annual stake readings on the glacier. Together, these datasets enable us to quantify how evolving microclimatic structures contribute to ongoing mass-balance changes at Qaamarujup Sermia.

Modelling the evolution of the hydrothermal structure of polythermal glaciers in Svalbard

Francisco Navarro[1], Lucie Bacchin[1], Guillaume Jouvet[2], Thomas Gregov[2], Ruth Mottram[3]

[1] Universidad Politécnica de Madrid
[2] University of Lausanne
[3] Danish Meteorological Institute

Modelling the evolution of Svalbard glaciers under given greenhouse gas emission scenarios requires the use of thermomechanical models, as most of them are polythermal. The geometry of Svalbard glaciers is diverse and complex, enforcing the use of high-order models. The latter, however, are computationally expensive. Here we use the Instructed Glacier Model (IGM) to model the evolution of the hydrothermal structure (i.e. the internal spatial distribution of cold and temperate ice) of Svalbard glaciers. IGM is an open-source Python-based tool, which integrates ice thermomechanics, climate-driven surface mass balance, mass conservation, and other processes, and that accelerates high-order ice-flow computation by using physics-informed machine learning together with graphics processing units. We have available a large set of ground-penetrating radar (GPR) measurements in this region, in which we can observe the englacial boundary between cold and temperate ice (cold-temperate transition surface, CTS). The comparison between the observed and modelled CTS helps us to calibrate the model parameters. We here present some preliminary results for Werenskioldbreen, a land-terminating glacier on Wedel Jarlsberg Land, southern Spitsbergen.

From Ice to Instability: Assessing the Drivers of Motion at the Barry Arm Landslide

Gabriel Wolken[1], Helen W. Dow[2], Brian D. Collins[2], Charles P. Miles[2], Johannes Gassner[3], Dorota Medrzycka[4]

[1] International Arctic Research Center/University of Alaska Fairbanks
[2] US Geological Survey
[3] Geopraevent
[4] University of Ottawa

Climate-driven cryospheric warming can initiate cascading geologic hazards, exemplified by the destabilization of an ice-marginal 500 Mm^3 landslide along the west fjord wall at Barry Arm, Alaska. This study examines how seasonal meteorology and glacier hydrology control landslide displacement between 2022 and 2024. Sub-hourly ground-based synthetic aperture radar (GBInSAR) measurements reveal episodic differential motion of landslide kinematic elements during late summer 2022 and 2023, with no detectable motion in 2024. Ice-penetrating radar imaging of the adjacent Cascade Glacier identifies an over-deepened subglacial basin, indicating a potential hydrological connection to the landslide. A spatially distributed melt model shows that landslide acceleration lagged peak subglacial meltwater discharge by approximately four days. The absence of a comparable discharge peak in 2024 is consistent with the lack of observed motion. Together, these results demonstrate that subglacial hydrology, modulated by glacier bed geometry, is a primary trigger for landslide displacement. This process-level linkage provides a basis for anticipating climate-driven geohazards using meteorological and glaciological monitoring.

Polarstern II

Heinrich Miller[1]

[1] Helmholtz Center for marine and polar research

After now 44 years of year-round service for research and logistics in both polar regions the German Research and Supply vessel Polarstern nears the end of its usable service life. A procurement for a replacement vessel has started in 2020 on the basis of a functional tender and at present we are in the engineering phase with all the main particulars already finalized.

length: 159,8 m, icebreaking 1,8m + 20% snow at 3 knots

width: 27,3 m, 140 persons max on board

draught: 10,9 m, diesel-electric propulsion 28,5MW max

endurance: 90 days, 17 MW Battery system allows clean system state.

After being built in the shipyard in Wismar and an extensive testing phase where the science and icebreaking capabilities must be demonstrated the new Polarstern will be put in service in August 2030. As with the present Polarstern ship time allocation will be based on scientific merit and is open for applications from anywhere. As there will be 2 helicopters on board there is always the potential for shorebased work logistically supported from the vessel. This may be of particular interest for projects within the network of arctic glaciers.

Fog forcing of surface energy balance from timelapse and weather station data on Arctic glaciers

Hester Jiskoot[1], Gaëlle Gilson[1], Tara Collett[1], Amy Fossheim[1], Ben Fox[1], Thomas Fox[1], Mariah Hierath[1], Craig VandeLigt[1], Brad Danielson[2], Matt Nolan[3], Shin Sugiyama[4]

[1] University of Lethbridge
[2] Natural Resources Canada
[3] Serving Earth Science Inc
[4] Hokkaido University

Whereas cloud forcing of the surface energy balance of glaciers and sea ice has increasingly received attention, no analysis of fog forcing exists to date. Melt-season fog occurrence is high in the Arctic, and, alongside decreasing sea ice extent, both the frequency and density of Arctic fog have increased regionally over recent decades. Marine coastal fog can advect far inland/up-fjord and cover large areas of (near) coastal glaciers as well as the Greenland ice sheet. There, fog can hinder field logistics. For this study, we analysed multi-year melt-season timelapse camera observations on three Arctic glaciers (Beaudoin Glacier; Belcher Glacier; McCall Glacier), in conjunction with concurrent glacier energy balance station data. From > 21 000 timelapse images we extracted fog occurrence, characteristics, and fog extent over the glaciers, and in addition recorded cloud cover and sea ice conditions. For Belcher and McCall glaciers we quantified the resulting fog forcing – focussing on fog radiative and air temperature effects on surface energy balance - while considering concurrent sky conditions. Fog occurs circa 10 – 40 % of the time, peaks in July-August, and can be > 200 m thick over the glaciers' ablation zones. From case studies and longitudinal analyses we derive that fog forcing can be significant and can differ from cloud forcing. Dense fog reduces net radiation and causes temperature inversions, and net dense-fog forcing is in all cases stronger than cloud forcing without fog. Thin fog can increase net radiation relative to clear sky conditions without fog: this "radiation paradox" is similar to that found elsewhere under specific conditions of cloud forcing. Net fog forcing is most often positive and dominated by the longwave radiation component, except early in the melt season. Overall, fog forcing is complex as its radiative and temperature impacts depend on fog vertical extent and density, time of day, seasonal surface albedo, and solar zenith angle.

Mass Balance and Velocity Changes of Selected Glaciers in the Karakoram, Pakistan in Response to Climate Change during 2000-2024

Imran Hussain[1], Peng Cui[1]

[1] Chinese Academy of Sciences, China

Glaciers and snow cover in the Karakoram are essential for sustaining the Indus River system. Despite its importance, limited studies on the glacier and snow cover response to local climate in this region are available. In this study, seven representative glaciers in the three river basins Hunza, Gilgit, and Shigar (Karakoram, Pakistan) were focussed. The geodetic glacier mass balance (GMB) and mean annual velocity were estimated from 2000 to 2024. The GMB was estimated using publicly available DEM (e.g., GLO30), laser altimetry data (ICESat-2), and elevation difference data from literature. Furthermore, the snow cover analysis over the three river basins was conducted using the MODIS 8-day snow cover product. The climate trends (e.g., temperature and precipitation) from 2000 to 2024 were studied using meteorological station data from three river basins. The results show (1) all seven glaciers showed an increase in annual glacier mass loss and annual velocity between 2000 to 2024. (2) The most negative mass balance was observed in the Hispar Glacier (-0.78 $\pm$ 0.40 m w.e.a^{-1}), and least negative mass balance was observed in the Biafo Glacier (-0.56 $\pm$ 0.47 m w.e.a^{-1}). Two glaciers showed an overall positive mass balance, the Karambar Glacier (0.07 $\pm$ 0.30 m w.e.a^{-1}) and Salili Glacier I (0.29 $\pm$ 0.39 m w.e.a^{-1}). (3) The overall glacier velocity ranged from 3.57 m a^{-1} for Glacier I to 12.21 m a^{-1} for Batura Glacier, during 2000 to 2022. (4) The study observed an abrupt increase in glacier mass loss and velocity after the period 2018 to 2020 suggesting that the Karakoram Anomaly is ending. Meteorological data from three stations Ziarat, Shigar, and Naltar reveal significant warming trends and extreme variability in precipitation, with Shigar and Ziarat experiencing greater climatic instability compared to Naltar.

Grounding Line Migrations at Cañon Glacier, Ellesmere Island, Canadian Arctic

Jae Hun Kim[1], Wesley Van Wychen[2], Katie Croutch[2]

[1] University of Waterloo, Canada
[2] University of Waterloo

The Canadian Arctic is a major contributor to global sea level rise, with extensive glacier retreat observed across the Queen Elizabeth Islands (QEI). This study investigates Cañon Glacier, one of the fastest glacier outlets of the Agassiz Ice Cap on Ellesmere Island, which has been identified as a pulse-type glacier, potentially featuring a floating terminus. Using multi-mission C-band Synthetic Aperture Radar (SAR) data from ERS-1, Sentinel-1, and RADARSAT Constellation mission (RCM), 43 Differential SAR Interferograms (DInSAR) were processed to delineate grounding lines (GLs) and assess their migration over time. Results show that GL retreats up to 1.8 km, indicating kilometer-scale seawater intrusion beneath the glacier and a possible pinning point near the center of fjord. Comparison with BedMachine (BMv5) bed topography data suggests that BMv5 underestimates fjord complexity and does not adequately represent the potential presence of the pinning point. These findings imply that Cañon Glacier likely maintains a floating terminus, where seawater intrusion may enhance basal melting and influence glacier stability.

Aufeis (Proglacial Icing) in the forefield of a land-terminating outlet glacier in West Greenland – multi-annual and seasonal variability and drivers

Jakob Abermann[1], Andreas Trügler[2], Harald Zandler[2], Helena Bergstedt[2], Florina Schalamon[2], Sebastian Scher[2], Wolfgang Schöner[2]

[1] Graz University, Austria
[2] ??

In this contribution, we share observations of a braided river plain adjacent to the little ice age moraine of a land-terminating outlet glacier in West Greenland at around 71°N. During three visits in spring (2023 - 2025), we document a plain of refrozen water. We report on the extent, genesis and decay of the aufeis plain and hypothesize on drivers building it. Time-lapse and high-resolution satellite imagery allow us to assign the build-up of the aufeis during core winter until spring and the decay throughout the melting season. We find that long after the disappearance of the snow cover at the adjacent glacier and ice-free environment, the aufeis still is in place. Using multispectral satellite imagery (Sentinel-2) we derive a time series of aufeis extent ranging from virtually no coverage to almost 0.5 km^2 for the period 2016-2025, using a random forest classification. DEM differences derived from photogrammetric acquisitions using UAVs enable us to estimate ice volumes between $49x10^3$ (April 2025) and $110x10^3$ m^3 (April 2024), respectively. To understand atmospheric conditions for meltwater generation, we use automated weather station data near the aufeis plain. As another reason for ice formation, we discuss potential water sources related to groundwater aquifers in porous ground moraine material. Finally, bias-corrected CARRA model output was applied to reconstruct meteorological conditions relevant for aufeis formation. Based on a lagged correlation approach, we find statistically significant ($p = 0.05$) correlations between cumulative positive air temperature departures and aufeis extent summing up approx. 7 years before the respective icing occurrence. While simplified, we discuss a possible long-term relation between icing extent and meltwater generation.

Matrix vs. Preferential Flow: Partitioning Meltwater Infiltration and Refreezing in Greenland Firn

Joel Harper[1], Taylor Moon[2], Neil Humphrey[3]

[1] University of Montana
[2] Univ. British Columbia
[3] Univ. Wyoming

Meltwater infiltration in snow and firn is becoming increasingly important with rising surface melt and rainfall in the accumulation zones of glaciers and ice sheets. However, the complexities of unsaturated flow, including matrix flow behind wetting fronts and preferential flow through isolated pathways, remain poorly understood and difficult to model. Limited observations, particularly in the high cold content environment of ice sheets, further hinder model validation. Here, we analyze in situ thermal measurements from the Greenland Ice Sheet to partition meltwater infiltration and refreezing between matrix and preferential flow paths. Data were collected from instrumented boreholes (10–100 m deep) across 17 sites along a ~90 km transect. Time series of subsurface temperatures tracked the progression of the wetting front using 0°C isotherms, and localized warming from latent heat release identified preferential flow events. Wetting fronts extended 0–5 m deep and persisted for up to 100 days during summer. Preferential flow events occurred episodically, reached depths of up to 9 m, and refroze within hours. We estimated refrozen water associated with each flow regime by differencing a thermal diffusion model, constrained by observed initial and boundary conditions, with measured temperature fields. Partitioning between flow regimes was highly variable, with preferential flow accounting for 5–85% of refrozen meltwater. Lower melt conditions tended to favor preferential flow, while higher melt conditions led to more equal partitioning between flow regimes. These findings quantify the importance of preferential flow and its implications for improving the fidelity of models used to simulate firn evolution in wet conditions.

Glacier surges and glacial lake outburst floods in a warming climate: the case of Aavatsmarkbreen, Svalbard

Justyna Dudek[1], Mirosław Błaszkiewicz[1]

[1] Polish Academy of Sciences, Poland

Glacial hazards in the Arctic are increasingly shaped by interactions between dynamic glacier behavior, unstable moraine dams, and proglacial lakes. A recent example comes from Oscar II Land, Svalbard, where the 2013–2015 surge of the tidewater glacier Aavatsmarkbreen triggered a cascading hazard sequence. Prior to the surge, the glacier's lateral moraine dammed meltwater in the foreland of Erikkabreen, forming a substantial ice-marginal lake. During the surge, destabilization of this moraine led to tunnel formation and the sudden release of impounded waters as a glacial lake outburst flood (GLOF).

The surge itself was one of the most dynamic observed in Svalbard in recent decades, advancing the glacier front by over 1 km and increasing its surface area by more than 2 km^2. Maximum ice velocities reached 4.9 m day^{-1}, accompanied by widespread fracturing, full-depth radial crevasses, and large-scale basal sliding over water-saturated sediments. The resulting high pore-water pressures and rapid ice advance destabilized the moraine complex, demonstrating how surge dynamics can indirectly trigger outburst floods.

The GLOF not only altered local hydrology but also drove extensive erosion, slope failures, and redistribution of sediments across the proglacial landscape. This rarely documented hazard pathway highlights the need to account for glacier surges as indirect triggers of GLOFs, in addition to more commonly recognized triggers such as melting-driven dam failures. This case study underscores the complex feedbacks between glacier dynamics, moraine stability, and proglacial hydrology in a rapidly warming Arctic.

Ice Darkening across southern Baffin Island, Nunavut: Causes and implications

Laura Thomson[1], Carolyn Gorwill[2], Christopher Omelon[2]

[1] Queen´s University
[2] ??

Multispectral imagery acquired over the Akshayuk Pass region of Auyuittuq National Park, Nunavut (Arctic Canada south), has recently revealed distinctive pink- and purple-hued snow and ice across several ice masses in the summer months. This research presents a characterization of light absorbing particles (LAPs) over snow and ice from Turner Glacier, a minor outlet glacier of Penny Ice Cap, and the associated implications for glacier albedo and melt. Field sampling and spectroradiometer measurements were conducted over two days in August 2024. Samples from 16 sites revealed the presence of 6 types of algae with mesotaenium berggrenii being the most abundant, followed by ancylonema nordenskioeldii. The average algal cell abundance within the top 2 cm of ice was 4.98×10^4 cells/mL, with a maximum cell abundance of 12.7×10^4 cells/mL. Broadband albedo derived from spectroradiometer measurements show a strong correlation between algal cell abundance and broadband albedo reductions ($R^2 = 0.67$, $p = 0.0001$), however the role of mineral content in albedo reduction is not yet accounted for. Albedo reductions related to the presence of algae are shown to increase melt rates by up to three times the rates observed for clean, relatively algae-free ice. Spectral signatures spanning 320 nm to 1100 nm from each field sample site have supported the development of a remote sensing index to facilitate the remote detection and mapping of surface algal blooms across the region using Sentinel-2 multispectral imagery. Preliminary results of these mapping efforts and plans for future analysis will be discussed.

Relationships between changes in supraglacial hydrology and the 2021-2022 surge of Nàłùdäy (Lowell Glacier), Yukon

Luke Copland[1], Jaime Dubé[1], Christine Dow[2], Brittany Main[2,3], Dorota Medrzycka[1], Peter Wray[2]

[1] University of Ottawa
[2] University of Waterloo
[3] Yukon University

Nàłùdäy (Lowell Glacier) underwent a dramatic surge in 2021-22, with peak velocities reaching >4 km/yr. The surge had a two-phase initiation, with the first phase beginning in spring 2021 at the terminus following a calving event that took place the previous winter. The second acceleration phase began in fall 2021 with surge velocities peaking in spring 2022, before returning to quiescence by late fall 2022. This is the first time that an upglacier-propagating surge has been reported for a lake-terminating glacier, a process which has been previously only seen on marine-terminating surges.

The total length of supraglacial streams on the glacier surface pre- to post surge dropped by over 50%, with the resulting supraglacial system transporting water less efficiently. The location of the second acceleration coincides with a clustering of moulins which provided water input from the surface to a subglacial overdeepening. This highlights the connection between supraglacial hydrology and surge dynamics, where surge initiation is driven by water input location and subglacial topography, and supraglacial hydrology is impacted by surface changes such as crevassing driven by ice deformation and basal sliding during the surge.

What happens if the glacier boundary layer is rotated by 90°?

Marie Schroeder[1], Rainer Prinz[1], Ivana Stiperski[1], Michael Winkler[2], Jakob Steiner[3], Jakob Abermann[3]

[1] University of Innsbruck
[2] Avalanche Warning Service Tyrol, Innsbruck, Austria
[3] University of Graz

This question arises when studying ice cliffs, whose vertical geometry forces the surface boundary layer (SBL) to interact with the atmosphere in a fundamentally different way than on flat or gently sloping glacier surfaces. The exchange of energy between ice and atmosphere happens in the SBL and therefore it plays a key role in glacier ablation. In addition to the radiative energy balance, turbulent heat and moisture fluxes, driven by temperature and vapour pressure gradients and wind speed, are essential components of this exchange.

On flat glaciers, these processes are comparatively well understood, with widely applied parameterizations such as the bulk aerodynamic method including stability corrections. However, in a vertical ice cliff, the orientation of the surface changes the structure of the boundary layer, the distribution of wind fields, and disturbs concepts like atmospheric stability as usually found over glacier surfaces. As a result, it remains unclear whether parameterizations developed for horizontal surfaces are directly transferable to vertical ones.

Although our primary study site is at Red Rock, an ice cliff at the Nunatarssuaq ice cap in Northwestern Greenland, we make use of a unique turbulence dataset collected at a 25 m high near-vertical ice cliff on the summit of Kilimanjaro. There, eddy-covariance instruments were deployed to measure sensible and latent heat fluxes directly at the face of a land-terminating ice cliff. This rare dataset provides an opportunity to evaluate whether standard flux parameterizations remain valid under these extreme geometric constraints and allow the analysis of the atmospheric structure of the boundary layer in such a unique setup.

If a transfer to other ice cliffs is found to be valid, these insights might be incorporated into the surface energy balance modelling of our study-site ice cliff in Greenland, enabling a more complete understanding of the cliff's energy exchange with the atmosphere.

Proglacial areas changes along the South West coast of Kalaallit Nunaat (Greenland) based on Digital Elevation Models and hydrological data

Marjolein Gevers[1], Floreana Miesen[2], Stuart Lane[2], Ian Delaney[2]

[1] University of Lausanne, Switzerland
[2] ??

The retreat of outlet glaciers along the Greenland Ice Sheet has an effect on the proglacial areas in front of them. Despite the potentially increasing role of these areas in modulating sediment export to the ocean, the geomorphic processes in these areas, and their evolution, remain uncertain. This study investigates the evolution of six proglacial areas on the South West coast of Kalaallit Nunaat (Greenland) using a time series of Digital Elevation Models (DEMs), ranging from the dataset AERODEM (from 1978–1987) to the most recent available ArcticDEM strips (2023). The link between modelled glacial runoff and surface elevation change is explored by comparing the surface elevation change to the average of the MAR/RACMO discharge model. All bedrock confined proglacial areas investigated have a negative mean height change over the time steps analysed, potentially showing a supply limited system dominated by erosion. In addition to the six proglacial areas along the South West coast, a detailed case study based on hydrologica, seismic and UAV field data, AERODEM and ArcticDEM, is conducted on the proglacial area of Leverett glacier. In the Leverett glacier proglacial area we see a link between increased modelled glacier runoff and erosion mostly driven by fluvial processes and bank erosion.

Short term processes on a fast ice stream

Martin Lüthi[1], Ana Nap[2], Fabian Walter[2], Adrien Wehrlé[2]

[1] University of Zurich
[2] ??

Short-term processes on fast flowing glaciers and ice streams are difficult to observe, yet have the potential to change the state of the ice flow system. Due to the strong coupling between many relevant processes, these changes might be irreversible. Here, we report on extensive high-rate field observations on Sermeq Kujalleq in Kangia (SKK; Jakobshavn Isbrae) with seismic, GNSS and terrestrial radar methods that are used to investigate the short-term dynamics of the ice stream and the coupling to the surrounding slow-moving ice sheet. Of special interest are large-scale disturbances the are used as natural experiment to estimate the coupling strength, and the dynamic stability of the ice stream system.

Glacier-related hazards in the Alps - a mountain range in transition

Matthias Huss[1]

[1] Laboratory of Hydraulics, Hydrology and Glaciology (VAW), ETH Zurich, Zurich, Switzerland

The cryosphere is a dynamic element of the mountain landscape, responding quickly to changes in climatic forcing. This leads to widespread glacier retreat and a corresponding shift in the alpine landscape, as well as permafrost warming and thaw. Related to these changes, a variety of effects on the hazard situation has been observed in the European Alps. This affects hiking and mountaineering activities, as well as scientific data acquisition. The recent stability shifts have culminated in several large rock/ice avalanches in the last years, most notably the Blatten disaster in Switzerland on 28 May 2025 that erased an entire village. The present contribution provides a general overview over the trends of the rock and ice stability changes in the Alps and possible drivers. It focusses on specific compound events shedding light on precursors, processes and the potential of monitoring.

Cryospheric changes in the Northwest Himalaya under the CMIP6 climate change scenarios

Mayank Upadhyay[1], Ajanta Goswami[1]

[1] Indian Institute of Technology Roorkee, India

The Indian Himalayan region is experiencing significant transformations due to persistent warming trends. The historical and future trends derived from CMIP6 data indicate a concerning rate of change in the snow glacier regime. The two scenarios of CMIP6 SSP245 and SSP585 indicate intensified precipitation and increased temperatures relative to the global average. Precipitation under SSP245 may increase by 0.3 mm/year, whereas under SSP585, it may rise by 1.46 mm/year. Similarly, the temperature is projected to rise by 1.4 degrees under SSP245 and by 3 degrees by the end of this century. The climatic input in SPHY indicates variability and a notable reduction in snow cover area, specifically a decrease of 20%, accompanied by the retreat of the snowline to higher elevations. Similarly, the study indicates that the glacier melt rate will accelerate by mid-century, resulting in increased inflow in glacial rivers, and by this time, the disappearance of glaciers will be predominant.

Hidden ice quakes in the Greenland ice sheet from brittle creep

Olaf Eisen[1], Andreas Fichtner[2], Coen Hofstede[2], Brian L. N. Kennett[2], Anders Svensson[2], Julien Westhoff[2], Fabian Walter[2], Jean-Paul Ampuero[2], Eliza Cook[2], Dimitri Zigone[2], Daniela Jansen[2]

[1] AWI
[2] ??

How ice streams flow, an essential element of understanding how ice sheets lose mass, is incompletely known, making it difficult to project sea level and ice sheet size change as accurately as desired. Using measurements made with fiber-optic cables, we present observations of brittle deformation in the Greenland Ice Sheet that reveal a non-viscous flow mechanism caused by englacial ice quake cascades. This effect should help to reconcile results from current ice sheet models and observations.

Thermal characteristics of Greenlandic ice-marginal lakes from in-situ temperature data, and possible implications for ice dynamics

Pete Tuckett[1], Connie Harpur[2], Alex Scoffield[2], Duncan Quincey[2], David Rippin[1]

[1] University of York
[2] University of Leeds

Large parts of the land-terminating sectors of the Greenland Ice Sheet are fringed by ice-marginal (or ice-contact) lakes. These lakes have increased in number and size as a result of enhanced ice melt and ice sheet retreat over recent decades. It has traditionally been assumed that ice-marginal lakes exist at a relatively uniform temperature of around 1°C, thus having minimal influence on ice dynamics and subaqueous melt rates at the ice-water interface. However, to date, almost no in-situ temperature measurements have been gathered at ice-marginal lakes in Greenland, meaning their influence on future ice sheet behavior remains unclear. Here, we present results from the first in-situ, continuous time series of Greenlandic ice-marginal lake water temperatures, gathered between July 2024 and August 2025. We combine our sub-hourly lake temperature measurements with meteorological, turbidity and ice front calving data, enabling us to investigate sub-diurnal to seasonal controls on lake temperature variability. Lake surface temperatures reached highs of >10°C, whilst water temperatures greater than 4°C were observed throughout the entire water column of one study lake during summer months. Our results also show how neighbouring lakes can have markedly differing thermal characteristics, likely due to differences in size, localised topography and variable meltwater inputs. These results highlight how uniform temperature values are likely unsuitable when modelling ice-lake dynamics, and that lake terminating sectors of the ice sheet may be experiencing greater rates of frontal ablation than previously realised.

Icelandic's proglacial lakes: managing risks, tourism and communication

Philippe Sara[1]

[1] University Centre of the Westfjords

Proglacial lakes in the Arctic are expanding, increasing their environmental dynamics and posing more hazards on visitors than ever. This 'last-change tourism' concept is a problem for many areas of the world, where people will use airplanes – for the most part – to reach those pristine and vulnerable destinations. In Iceland, these lakes are inviting for many tourists, which go there to see them before they disappear further. Retreating glaciers are deepening proglacial lakes and exposing the mountain's surface to the air, increasing the risk of rockfalls, landslides and glacial outburst floods. Moreover, tourist going on the proglacial lake on kayaks or boats (zodiacs and amphibian boats) face risks that they may not even be aware of, such as hypothermia, weather changes, iceberg flipping, calving from icebergs and the glacier, and more. This ongoing study is analysing the tourist's perceptions of risks while touring on two popular proglacial lakes in South Iceland, Jökulsárlón and Fjallsárlón, as well as risk communication related to proglacial activities. Initially, rangers and tour guides gave insights on what they think the main risks are, as well as how operations go. Then, tourists filled a questionnaire underlying their perceptions of the risks, as well as how they were communicated with them beforehand. The entirety of this project is supervised by Steph Matti, keynote speaker at IASC.

Comparing Glacier Mass-Balance Estimates: Challenges and Recommendations

Regine Hock[1,2], Matthias Huss[3,4], Etienne Berthier[5], Matthias Braun[6], Alex Gardner[7], Bert Wouters[8], Michael Zemp[9]

[1]University of Oslo, Norway
[2]Geophysical Institute, University of Alaska Fairbanks, Fairbanks, USA
[3]Laboratory of Hydraulics, Hydrology and Glaciology (VAW), ETH Zurich, Zurich, Switzerland
[4]Swiss Federal Institute for Forest, Snow and Landscape Research (WSL), Sion, Switzerland
[6]LEGOS, Université de Toulouse, CNES, CNRS, IRD, UPS; Toulouse, France
[6]Institute of Geography, Friedrich-Alexander-Universität Erlangen-Nürnberg, Germany
[7]Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA, USA
[8]Institute for Marine and Atmosphere Research and Delft University of Technology, The Netherlands
[9]World Glacier Monitoring Service, University of Zurich, Switzerland

Observing glacier mass changes is fundamental for projecting the impacts of climate change on sea level, freshwater resources, and natural hazards, and for providing data used to develop, calibrate, and validate glacier-evolution models. The principal measurement approaches —glaciological based on in situ point observations, geodetic (surface-elevation differencing), and gravimetric — each operate most effectively at different spatial and temporal scales. We evaluate these methods with emphasis on the challenges that arise when comparing published mass-balance estimates. Comparability is frequently limited by: (1) inconsistent reporting and omission of essential metadata; (2) differences in which mass-balance components are included; (3) mismatched time spans; and (4) differing spatial domains over which mass balance is reported. We offer concrete recommendations for more rigorous and comprehensive reporting of glacier and ice-sheet mass-balance estimates to improve their comparability and facilitate robust synthesis of reported changes.

Development Potential and Risks of the Ice and Snow Industry in Northwest China

Shoudong Zhao[1], Minghu Ding[1]

[1] Chinese Academy of Meteorological Sciences

Since the Beijing Winter Olympics, China's ice and snow industry has experienced rapid growth, accompanied by a substantial increase in public participation in winter sports. Northwestern China is located in an inland arid and semi-arid region; however, moisture transported by the prevailing westerlies from the Atlantic and Arctic Oceans generates considerable snowfall in mountainous areas such as the Tianshan and Altai Mountains, providing favorable climatic conditions for the development of the ice and snow industry. In this talk, we show the development potential of the ice and snow industry in Northwestern China using multiple indicators, including snow depth, natural snow reliability, the number of potential snowmaking days, and ski season length. We further evaluate the current state of the industry by analyzing ski resort characteristics such as total slope length, total skiable area, and mean slope gradient. Finally, we identify key challenges for future development, including limited meteorological support and avalanche risks.

Managing glacier-related risks

Stephanie Matti[1]

[1] Icelandic Meteorological Office

A range of glacier-related hazards can have potentially disastrous impacts on people and infrastructure. These risks can be broadly grouped into three categories. Sudden-onset hazards affect people on or very close to glaciers and occur with little warning—seconds to minutes. These include collapsing ice caves and snow bridges, ice avalanches, sudden failure of hanging glaciers, glacier calving, flipping icebergs, and unstable proglacial sediments. Mid-range hazards affect people and infrastructure in the surrounding area, often with warning times ranging from hours to years. These include glacial lake outburst floods (GLOFs), unstable moraines, and slope debuttressing caused by glacier retreat, which can trigger landslides and rockfalls. Far-reaching, system-wide hazards operate over longer timescales—decades to several decades—and are typically driven by changes in glacial runoff. These include sea-level rise, altered seasonal water availability, ecological shifts, and changes in hydropower potential. Many glacier-related risks are being amplified by climate change, growing glacier tourism, changing population dynamics, and cascading disaster processes.

Understanding the physical processes that drive glacier-related hazards is only one component of effective risk management. Also important is understanding the exposure and vulnerability of people and infrastructure to these hazards, and how risks are managed and communicated. Key questions include: What hazards exist, and where? How are they likely to evolve in the future? To what extent are people and infrastructure exposed under different hazard scenarios? What makes people and infrastructure more or less vulnerable? What is the role of different stakeholders in managing risk? How are risks communicated and to whom? What groups are not included in decision-making processes and risk communications? How does this affect their vulnerability? How do risk management decisions affect local people? And what level of risk understanding is required to meet the requirements of informed consent for people exposed to a hazard?

A Comparative Study of Climate Data and Reanalysis Model Validation in the St-Elias Mountains, Yukon, from the 1960s to Present.

Tatiana Solfjell Huard[1], Luke Copland[1], Scott Williamson[1,2]

[1] University of Ottawa
[2] Polar Knowledge Canada

High elevation northern mountains are more sensitive and responsive to climate change than lower latitude regions due to Arctic amplification and phenomena such as elevation-dependent warming, yet climate reanalysis models based on large-scale, global atmospheric data are still commonly used for such complex regions. Validation of climate reanalysis models using in situ data, particularly for mountainous and glacierized regions for periods in the 20th century when little instrumental data is available, is then essential because results obtained from such interpolated models can provide an unrepresentative picture of the actual climate.

In this study, summer temperature observations from the Icefield Ranges Research Project (1960-1970) and measurements from modern automated weather stations (2000-present) are combined and assessed to determine whether atmospheric warming has occurred at Kluane Lake Research Station and on the surfaces of Kaskawulsh, Nàłùdäy (Lowell), and Dän Zhùr (Donjek) glaciers in the St. Elias Mountains of Kluane National Park, Yukon. Preliminary results indicate that the warmest summer months on record have predominantly occurred in the last ten years and that the coldest are typically restricted to the 1960s. Upon completion, this research will provide one of the first quantitative assessments of historical and modern temperature variability in the St. Elias Mountains and improve understanding of how global reanalysis models represent sub-Arctic mountain climates.

Current state and future evolution of the largest ice cap in mainland Europe: Jostedalsbreen, Western Norway

Thorben Dunse[1], Kamilla Hauknes Sjursen[1], Henning Åkesson[3], Liss Marie Andreassen[2], Thomas Vikhamar Schuler[3], Mette Kusk Gillespie[1], Jacob Clement Yde[1]

[1] Department of Civil Engineering and Environmental Sciences / Western Norway University of Applied Sciences
[2] NVE
[3] Oslo University

Jostedadalsbreen, covering 458 km2 is the largest ice cap in mainland Europe, located in western Norway. It features a high elevation plateau that feeds 81 individual glacier units, including several steep outlet glaciers. This presentation highlights key findings from glacier simulations performed as part of the JOSTICE project (2020-2025), which aimed at assessing ongoing and future changes in the mass balance and ice volume of Jostedalsbreen, along with their ecological and societal impacts on hydropower production, tourism and agriculture.

To investigate the historical climatic mass balance of Jostedalsbreen, we employed a temperature-index approach with gridded temperature and precipitation data from seNorge. Our model was calibrated using in-situ observations of seasonal and annual mass balances, supplemented by decadal geodetic mass balances for each glacier through Bayesian inference. Between 1960 and 2020, the overall mass balance of Jostedalsbreen was near zero; however, significant spatiotemporal variability as observed, driven by trends in winter precipitation and snow accumulation before 2000, followed by increasing summer temperatures and ablation in subsequent years.

For future projections, we conducted coupled simulations of glacier mass balance and ice-dynamics to fully account for the mass-balance elevation feedback. Three-dimensional ice-dynamic simulations capitalize on new maps of ice thickness and bedrock topography, derived from extensive ice-radar surveys as part of the JOSTICE project. Our findings indicate moderate mass losses until the mid-21st century, with increased accumulation over the glacier plateau partially offsetting progressively more negative mass balances at the glacier termini. However, we anticipate accelerated mass losses in the second half of the century as the ablation area expands to include substantial portions of the glacier plateau. We predict that Jostedalsbreen could lose between one half to two thirds of its current ice volume by 2100, depending on climate model and greenhouse-gas emission scenarios RCP4.5 and RCP8.5, respectively. Furthermore, Jostedalsbreen is expected to fragment into three separate glaciers, regardless of the emission scenario.

Improved mass balance modeling of Svalbard glaciers

Ward van Pelt[1]

[1] Uppsala University

In this work, a new dataset of climatic mass balance (CMB), subsurface conditions and runoff for all glaciers in Svalbard is presented. Improvements relative to a previous application of the model (Van Pelt et al. 2019) are: 1) higher spatial resolution (500 m instead of 1 km), 2) a new seasonal snow densification model (as in Van Kampenhout et al. 2017), 3) a new Monin-Obukhov based turbulent flux model (as in Fitzpatrick et al. 2018), and 4) the use of CARRA reanalysis as a meteorological forcing. These modifications required (re)calibration of model parameters affecting melt and accumulation against stake data (primarily parameters affecting albedo, precipitation and turbulent heat exchange) and seasonal snow densification (parameters affecting fresh snow density, and scaling coefficients for destructive metamorphism, compaction by overburden pressure, and wind compaction). We find a net mean CMB for 1990-2025 of -0.11 m w.e. a^{-1} and a trend of -0.07 m w.e. a^{-1} per decade dominated by a CMB decline in southern Svalbard.

A sensitivity experiment with refreezing turned off reveals that 1) subsurface temperatures drop by >10°C and densities decrease by several 100's of kg m^3 in accumulation zones, and 2) the CMB impact of refreezing is about 1/3 lower than the refreezing itself. The latter is caused by indirect effects of refreezing; refreezing releases heat and mass in snow packs, which in turn enhance the subsurface heat flux and lower the surface albedo, thereby amplifying melt rates. A second sensitivity experiment with the seasonal snow compaction model turned off reveals that the agreement with bulk snow densities observed in snow pits at six glaciers in Svalbard declines markedly. On the other hand, the CMB impact of using a detailed snow compaction model for seasonal snow (instead of using a firn densification model for both snow and firn) is found to be negligible.

Evidence for the Identification of two surge-type glaciers on Southern Prince of Wales Icefields

Wesley Van Wychen[1], Tamara Marchant[1], Jae Hun Kim[1]

[1] University of Waterloo

In this study, we examine the elevation, geometry and velocity evolution of two marine-terminating glaciers located on the southern coast of Prince of Wales Icefield within the Canadian High Arctic. Glacier velocities retrieved from the ITS-LIVE portal indicate a speed up of 300-400 m a^{-1} for the South-2 Glacier over the 2013-2022 period and a 200-300 m a^{-1} acceleration for Palisade Glacier between 2017 and 2022. Differencing of ArcticDEM 2 m resolution StripMap products over the 2011-2023 period reveals a pattern of high elevation thickening (0.5 – 1.5 m a-1) and lower elevation thinning (-0.5 - -2.5 m a^{-1}) for South-2 Glacier that is out of sync with the elevation changes of nearby glaciers. Likewise, the elevation pattern of Palisade glacier, which indicates thickening 0.25 - 0.5 m a^{-1} over nearly the entire main trunk of the glacier, is also out of sync with regional patterns. Finally, terminus positions delineated for both glaciers from optical imagery reveal overall retreat since 1959, but interspersed with periods of relative stability or advance. Collectively, these results indicate that these two glaciers likely experience ‘surge-like’ behavior and add two new entries into the catalogue of glaciers that experience dynamic instability within the Canadian Arctic. We end this presentation with a discussion of how the behaviors of Palisade and South-2 Glaciers compare with other ‘surge-type’ glaciers within the region.

Accelerated shrinkage of Pamir glaciers

Zebokhonim Khushnazarova[1], Nazirzoda Kamollidin[2]

[1] Agency for hydrometeorology, Tajikistan
[2] Glaciology Center of the Hydrometeorology Agency

TBD