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 **"Impacts of the changing land-based cryosphere on Arctic society"**

21-23 January 2025, Niseko, Japan

Organised by: Shin Sugiyama, Ward van Pelt and Wesley Van Wychen

IASC Network on Arctic Glaciology

ISBN: 978-91-531-4331-4

Participants of the 2025 IASC workshop on Arctic Glaciology in Niseko, Japan. (Photo: Shin Sugiyama)

Contents

Preface

In a beautiful winter setting in Niseko, Japan, on 21-23 January 2025, glaciologists, social scientists, atmosphere scientists, and terrestrial scientists gathered for the IASC Network on Arctic Glaciology (NAG) meeting. In addition to the general workshop on the dynamics and mass budget of Arctic glaciers, the workshop hosted a cross-cutting activity on "Impacts of the changing land-based cryosphere on Arctic society", and attracted 60 in-person participants representing 15 countries. A livestream ran during the entire meeting and was viewed by up to 38 registered participants. We thank Climate and Cryosphere (CliC), the Japanese Tourism Agency, and the IASC Cryosphere, Atmosphere and Social & Human Working groups for supporting the meeting and cross-cutting activity, which, among others, provided travel support for 25 early-career scientists. Big thanks to local organizer Shin Sugiyama, who made this meeting in a unique location possible!

The meeting program included oral presentation sessions, a poster session, cross-cutting discussion session, and the NAG open forum. Total contributions, i.e. to both the NAG meeting and cross-cutting activity, included as many as 57 presentations, of which 33 oral presentations and 24 posters; about 20 of the presentations were within the theme of the cross-cutting activity. Two invited presentations on current and future glacier hazards (Regine Hock) and avalanche safety in Niseko (Satoru Yamaguchi) were included in the cross-cutting sessions. The cross-cutting discussion led to stimulating discussions between glaciologists, social scientists, and snow experts, e.g. on connecting natural sciences, social sciences and the interests of Arctic communities. The general workshop on Arctic glaciology included presentation sessions on glacier mass balance, glacier hydrology, and glacier dynamics. A poster session on January 21 included contributions to both the general workshop and cross-cutting activity.

During the open forum meeting, Regine Hock has been appointed as the new chair. I will continue as vice-chair. Furthermore, it was confirmed that the next IASC NAG meeting will be held in Obergurgl, Austria, in January 2026. A preliminary decision was also taken to have the 2027 meeting in Geilo, Norway, and the 2028 meeting again in Obergurgl.

A photo album with pictures of the meeting by Shin Sugiyama can be accessed here: `https://www2.lowtem.hokudai.ac.jp/gisg/sugishin/photo_album/nag2025/nag2025.html`.

Thanks to all of you for joining the meeting and I hope to see you back in Austria next year!

All the best,
Ward van Pelt

Schedule

The meeting takes place at Hilton Niseko Village, Niseko, Japan, on 21 - 23 January 2025.

Tuesday 21 January

08:30 - 09:00	Registration. Please upload your presentations for the morning session.
09:00 - 09:10	Welcome
Session I:	**Glacier mass balance**
Convener:	*Masashi Niwano*
09:10 - 09:25	How to measure accumulation on the Greenland Ice Sheet? - Andreas Ahlstrøm
09:25 - 09:40	Variations in surface melt over the Greenland ice Sheet from regional climate models - Qinglin Zhang
09:40 - 09:55	Mass balance modeling on McCall Glacier - Matt Nolan
09:55 - 10:10	Glacier-climate interactions and their impact on hydrological connectivity in a high-latitude ecosystem - Nicolas Cullen
10:10 - 10:45	Coffee break
Session II:	**Glacier hydrology**
Convener:	*Brittany Main*
10:45 - 11:00	The Importance of Solving Subglacial Hydrology in Modeling Glacier Retreat: A Case of Study for Hansbreen, Svalbard - Eva De Andrés
11:00 - 11:15	Greenland ice sheet slush observations and modeling - Jason Box
11:15 - 11:30	Formation and drainage of Setevatnet, a glacial lake of Kongsvegen in Svalbard - Takuro Imazu
11:30 - 11:45	Characteristics and rapid drainage of a large subglacial lake on SE Ellesmere Island, Canadian Arctic - Luke Copland
11:45 - 12:00	Understanding supraglacial hydrology during a surge: A case study of Nàłùdäy's (Lowell Glacier) 2021-22 surge - Jaime Dubé
12:00 - 15:30	Afternoon break
15:30 - 16:00	Coffee break
Session III:	**Glacier hydrology & more**
Convener:	*Satu Innanen*

16:00 - 16:15	Mapping buried ice and groundwater pathways in a sub-arctic deglaciating valley (YT, Canada) - Eole Valence
16:15 - 16:30	Decades of Surface Melt and Supraglacial System Evolution on Ellesmere Island's Glaciers - Pénélope Gervais
16:30 - 16:45	Application of deep learning techniques for the automatic detection of the cold-temperate transition surface of polythermal glaciers using field and synthetic GPR data - Francisco Navarro
16:45 - 17:00	Numerical modeling of biological processes on snow and glacier ice surfaces in the Arctic region - Yukihiko Onuma
17:00 - 19:00	Poster session
19:15	Dinner

Wednesday 22 January

Session IV:	**Cross-cutting session**
Convener:	*Archana Dayal*
08:45 - 09:05	[Keynote] Glacier hazards: Will they change in the future? - Regine Hock
09:05 - 09:20	Impacts of Glacial Retreat on Proglacial Hydro-Systems: Insights from Aufeis Formation Analysis - Bastien Charonnat
09:20 - 09:35	Glacial-fjord monitoring with passive and active acoustics (Inglefield Bredning, Greenland) - Evgeny Podolskiy
09:35 - 09:50	Understanding changes in iceberg - ship coexistence throughout the eastern Canadian Arctic: 2012-2019 - Abigail Dalton
09:50 - 10:05	Glacial lakes outburst floods of Svalbard, A Case Study of Isfjord - Iwo Wieczorek
10:05 - 10:40	Coffee break

Session V:	**Cross-cutting session (cont'd)**
Convener:	*Shin Sugiyama*
10:40 - 11:00	[Keynote] Scientific Contributions to Avalanche Safety Management at Ski Resorts: Co-Creation with Local Governments and Ski Resorts in Niseko - Satoru Yamaguchi
11:00 - 11:15	Avalanche risk management: Integration of natural and social sciences - Steph Matti
11:15 - 11:30	Assessing Shipping Trends and Hazards from Ice Islands in the Western Canadian Arctic - Erika Brummell
11:30 - 11:45	Surface Methanogenesis on Glaciers: A Novel Source of Methane in the Warming Arctic - Archana Dayal
11:45 - 12:00	Observed increasing glacier and glacial landsystem instability in Mt. Gongga - Qiao Liu

12:00 - 15:30	Afternoon break
15:30 - 16:00	Coffee break
16:00 - 16:40	Cross-cutting discussion
16:40 - 16:45	Short break
16:45 - 18:15	IASC Network on Arctic Glaciology – Open forum meeting
19:15	Dinner

Thursday 23 January

Session VI:	**Glacier Dynamics**
Convener:	*Shuntaro Hata*
09:00 - 09:15	Quantifying upward surge propagation rates of the marine-terminating glaciers in Svalbard - Whyjay Zheng
09:15 - 09:30	Terminus dynamics of Taku Glacier, Alaska, during the recent transition - Arlec Chang
09:30 - 09:45	Customized NASA autoRIFT (CautoRIFT) for measuring rapid changes in ice dynamics - Jukes Liu
09:45 - 10:00	Mapping global glacier terminus types - Will Kochtitzky
10:00 - 10:15	Ice thickness modelling of every glacier on Earth - Thomas Frank

10:15 - 10:45	Coffee break + group photo

Session VII:	**Glacier Dynamics (cont'd)**
Convener:	*Dorota Medrzycka*
10:45 - 11:00	Exploring the Dynamics of Belcher Glacier, Nunavut, Canada using GNSS-Derived Daily Velocities (2021-2023) - Tamara Marchant
11:00 - 11:15	Glacier Surges Controlled by the Close Interplay Between Subglacial Friction and Drainage - Thomas V. Schuler
11:15 - 11:30	Decadal Glacier Dynamics in Nunavut's Auyuittuq and Sirmilik National Parks, Canadian Arctic: A Photogrammetric Analysis from 1958 to 2023 - Wai Yin Cheung
11:30 - 11:45	Evolving surge dynamics and ongoing glacier acceleration on Devon Island's Southeast basin, Canadian Arctic - Benoît Lauzon
11:45 - 12:00	Observations of episodic processes at a major Greenland ice stream - Martin Luethi

12:00 - 12:05	Final words

Posters

- A unique dataset of Austre Lovenbreen glacier in Svalbard showing record melting in 2024 - Alexander Prokop
- A daily, 1 km resolution Greenland rainfall climatology (1958-2020) from statistical downscaling of a regional atmospheric climate model - Baojuan Huai
- Accumulation by avalanches as significant contributor to the mass balance of a peripheral glacier of Greenland - Bernhard Hynek
- Assessing the impact of expanding proglacial lakes on glacier dynamics: a case study from Llewellyn Glacier, Canada - Brittany Main
- Multidecadal Ice Thickness and Velocity Changes of Coronation and Maktak Glaciers, Baffin Island, Nunavut - Domynik Huot
- Glacier change and an updated glacier extent inventory for Devon Island, Arctic Canada - Dorota Medrzycka
- ICELINK: Advancing Knowledge of North Atlantic Land ICE – LINKing Observations and Models - Guðfinna Aðalgeirsdóttir
- Sør-Spitsbergen National Park, Svalbard – glacier changes from 1990 to 2020 - Justyna Dudek
- CH4 emission from glacier areas in Alaska - Keiko Konya
- Modelling past discharge from Qaanaaq Glacier in northwestern Greenland during 1950–2023 - Ken Kondo
- Ice surface observations using an unmanned aerial vehicle on Qaanaaq Glacier in northwest Greenland - Kotaro Yazawa
- Dynamic Variation of Yelverton Glacier: An Examination of Change from 2011-2023 - Kristie Shannon
- Inland Limits to Subglacial Channel Development beneath the Greenland Ice Sheet from Surface-Velocity Observations - Kuba Oniszk
- Improving Our Understanding of Processes at The Base of Glaciers: A New and Improved Multi-Sensor Ploughmeter - Maiken Kristiansen Revheim
- Estimation of freshwater input to Brepollen (Svalbard) - Małgorzata Błaszczyk
- Cryosphere Integrated Observatory Network on Svalbard (CRIOS) and harmonisation of the Svalbard cooperation (HarSval) - Małgorzata Błaszczyk
- Initial evaluation of a long-term (1980-present) NHM-SMAP simulation for Greenland forced by ERA5 - Masashi Niwano
- Towards a spatio-temporal perennial firn aquifer distribution throughout Svalbard - Satu Innanen
- Changes in coastal environments and their impact on society in northwestern Greenland - Shin Sugiyama
- Optical televiewer observation of the borehole of Kongsvegen Glacier in Svalbard - Shuntaro Hata
- Acoustic sensing of Qaanaaq Glacier runoff, northwestern Greenland - Tomohiro Nakayama
- Bed topography and thickness maps for Svalbard and the Canadian Arctic - Ward van Pelt

- Projection of Glacier Changes over the Laohugou Glacier No. 12, Northeast Tibetan Plateau, China from 2020 to 2100 - Weijun Sun
- Flow Speeds and Variations of Sydkap Glacier, Canadian High Arctic revealed through a dense record of TSX/TSX imagery - Wesley Van Wychen

Participants

1. **Abigail Dalton** (abigail.dalton [at] uottawa.ca)
University of Ottawa, Canada
2. **Alexander Prokop** (alexander.prokop [at] univie.ac.at)
University of Vienna, Austria
3. **Andreas P. Ahlstrøm** (apa [at] geus.dk)
GEUS, Denmark
4. **Archana Dayal** (archanadayal [at] gmail.com)
Aberystwyth University, UK
5. **Arlec Chang** (arlecchang [at] lowtem.hokudai.ac.jp)
Hokkaido University, Japan
6. **Baojuan Huai** (huaibaojuan [at] 126.com)
Shandong Normal University, China
7. **Bastien Charonnat** (bastien.charonnat.1 [at] ens.etsmtl.ca)
Université du Québec, Canada
8. **Benoît Lauzon** (blauz052 [at] uottawa.ca)
University of Ottawa, Canada
9. **Bernhard Hynek** (bernhard.hynek [at] geosphere.at)
Geosphere Austria, University Graz, Austria
10. **Brittany Main** (brittany.main [at] uwaterloo.ca)
University of Waterloo, Canada
11. **Domynik Huot** (dhuot030 [at] uottawa.ca)
University of Ottawa, Canada
12. **Dorota Medrzycka** (dorota.medrzycka [at] uottawa.ca)
University of Ottawa, Canada
13. **Eole Valence** (eole.valence [at] mail.mcgill.ca)
McGill University, Canada
14. **Erika Brummell** (ebrum084 [at] uottawa.ca)
University of Ottawa, Canada
15. **Eva De Andrés** (eva.deandres [at] upm.es)
Universidad Politécnica de Madrid, Spain
16. **Evgeny Podolskiy** (evgeniy.podolskiy [at] gmail.com)
Hokkaido University, Japan
17. **Francisco Navarro** (francisco.navarro [at] upm.es)
Universidad Politécnica de Madrid, Spain
18. **Guðfinna Aðalgeirsdóttir** (gua [at] hi.is)
University of Iceland, Iceland
19. **Iwo Wieczorek** (iwo.wieczorek [at] uwr.edu.pl)
University of Wroclaw, Wroclaw, Poland
20. **Jaime Dubé** (jdube074 [at] uottawa.ca)
University of Ottawa, Canada
21. **Jason Box** (jbox.greenland [at] gmail.com)
GEUS, Denmark
22. **Jukes Liu** (Jukesliu [at] boisestate.edu)

Boise State University, USA

23. **Justyna Dudek** (justyna_dudek [at] wp.pl)
Polish Academy of Sciences, Poland
24. **Keiko Konya** (conya [at] jamstec.go.jp)
JAMSTEC, Japan
25. **Ken Kondo** (ken_kondo [at] nagoya-u.jp)
Nagoya University, Japan
26. **Kotaro Yazawa** (yazawa.kotaro.z2 [at] elms.hokudai.ac.jp)
Hokkaido University, Japan
27. **Kristie Shannon** (kmshanno [at] uwaterloo.ca)
University of Waterloo, Canada
28. **Kuba Oniszk** (jagon [at] dtu.dk)
Technical University of Denmark, Denmark
29. **Luke Copland** (luke.copland [at] uottawa.ca)
University of Ottawa, Canada
30. **Maiken Kristiansen Revheim** (maikenkr [at] geo.uio.no)
University of Oslo, Norway
31. **Martin Luethi** (martin.luethi [at] geo.uzh.ch)
University of Zurich, Switzerland
32. **Masashi Niwano** (mniwano [at] mri-jma.go.jp)
Meteorological Research Institute, Japan
33. **Matt Nolan** (matt [at] drmattnolan.com)
Serving Earth Science, Inc., USA
34. **Małgorzata Błaszczyk** (malgorzata.blaszczyk [at] us.edu.pl)
University of Silesia in Katowice, Poland
35. **Minghu Ding** (dingminghu [at] foxmail.com)
Chinese academy of meteorological sciences, China
36. **Nicolas Cullen** (nicolas.cullen [at] otago.ac.nz)
School of Geography, University of Otago, New Zealand
37. **Pénélope Gervais** (pgerv058 [at] uottawa.ca)
University of Ottawa, Canada
38. **Qiao Liu** (liuqiao [at] imde.ac.cn)
Chinese Academy of Sciences, China
39. **Qinglin Zhang** (qinglin_zhang [at] foxmail.com)
Chinese Academy of Meteorological Sciences, China
40. **Ramona Schneider** (ramona.schneider [at] geo.uu.se)
Uppsala University, Sweden
41. **Regine Hock** (regineho [at] uio.no)
University of Oslo, Norway
42. **Satoru Yamaguchi** (yamasan [at] bosai.go.jp)
National Research Insitute for Earth Science and Disaster Resilience, Japan
43. **Satu Innanen** (satu.innanen [at] outlook.com)
University of Oslo, Norway
44. **Shin Sugiyama** (sugishin [at] lowtem.hokudai.ac.jp)
Hokkaido University, Japan
45. **Shuntaro Hata** (hata [at] lowtem.hokudai.ac.jp)
Hokkaido University, Japan
46. **Steph Matti** (steph.matti [at] gmail.com)
Icelandic Meteorological Office, Iceland

47. **Takuro Imazu** (takuro_imazu [at] lowtem.hokudai.ac.jp)
Hokkaido University, Japan
48. **Tamara Marchant** (tmarchan [at] uwaterloo.ca)
University of Waterloo, Canada
49. **Thomas Frank** (thomas.frank [at] geo.uu.se)
Uppsala University, Sweden
50. **Thomas V Schuler** (t.v.schuler [at] geo.uio.no)
University of Oslo, Norway
51. **Tomohiro Nakayama** (nakayama.tomohiro.t3 [at] elms.hokudai.ac.jp)
Hokkaido University, Japan
52. **Trudy Wohlleben** (twohlleb [at] uottawa.ca)
University of Ottawa, Canada
53. **Wai Yin Cheung** (w.cheung [at] queensu.ca)
Queen’s University, Canada
54. **Ward van Pelt** (wjjvanpelt [at] gmail.com)
Uppsala University, Sweden
55. **Weijun Sun** (sunweijun [at] sdnu.edu.cn)
Shandong Normal University, China
56. **Wesley Van Wychen** (wvanwychen [at] uwaterloo.ca)
University of Waterloo, Canada
57. **Whyjay Zheng** (whyjayzheng [at] gmail.com)
National Central University, Taiwan
58. **Will Kochtitzky** (wkochtitzky [at] une.edu)
University of New England, USA
59. **Xin Wang** (wangx [at] hnust.edu.cn)
Hunan University of Science and Technology, China
60. **Yukihiko Onuma** (onuma.yukihiko [at] jaxa.jp)
Japan Aerospace Exploration Agency (JAXA), Japan

Minutes of the IASC-NAG open forum meeting

Chair: Ward van Pelt
Minutes: Kristie Shannon
Invited to attend: all participants of the workshop.

Agenda

1. Recent developments
2. Chair, vice-chair and national contacts
3. Upcoming meetings
4. Meeting structure and livestreaming
5. Cross-cutting activity
6. Website & promotion

Recent developments

Ward van Pelt presents an overview of activities of the Network on Arctic Glaciology since the last meeting in January 2024. Developments included requesting cross-cutting funding from IASC (Jan-Mar 2024), IASC funding decision (Apr 2024), CliC funding application (Apr-Jun 2024), first meeting announcement on Cryolist (May 2024), registration & abstract submission (Aug-Oct 2024), Japan meeting preparations, application to IASC for next cross-cutting activity on Arctic Glacier Hazards (Nov 2024 -Jan 2025).

IASC Network on Arctic Glaciology

An overview is given of the general aims and objectives of the Network on Arctic Glaciology, its history, and its connection to IASC and its working groups. It is highlighted that main objectives of the annual meetings are to 1) present and discuss new research, 2) coordinate fieldwork, 3) discuss future project ideas and collaboration, 4) networking. Meeting attendance since 2005 was shown and indicated above-average attendance in 2025 and a positive trend since 2020. The roles of the chair, vice-chair, national contacts, local organizer, and IASC WG members were discussed.

Chair, vice-chair, and national contacts

A new chair was appointed, Regine Hock, replacing Ward van Pelt. Ward van Pelt was appointed as the new vice-chair, replacing Wesley Van Wychen. A new national contact for China has been appointed, Baojuan Huai, replacing Songtao Ai. The new national contact for Sweden is Ward van Pelt, replacing Per Holmlund. Suggestions for potential new national contacts for India and South Korea were given, but none have been appointed to date. Depending on her future affiliation, Archana Dayal is willing to be a new national contact for either India or the UK.

Upcoming meetings

The 2026 meeting will be held in Obergurgl, Austria, on 26-28 January. Local organizer is Jakob Abermann. 24 double rooms are available at the University Center (25-29 January 2026), which is likely not enough to accommodate all participants.

A preliminary decision, based on voting, was taken to have the 2027 meeting in Geilo, Norway, and the 2028 meeting in Obergurgl, Austria. Regarding the frequency of having meetings in Europe and outside of Europe, the most favored solution is to have a non-Europe meeting every third year. Local organizer for the Geilo meeting (2027) is Regine Hock, who indicated the good accessibility by train, and the potential to have the meeting in February. Alternative meeting locations were discussed, e.g. a meeting in Maine, USA (local organizer Will Kochtitzky) or Mont Tremblant, Canada (local organizer Luke Copland). These options were in the end not favored for the 2027, 2028 meetings e.g. because of the high costs, potential low attendance, and/or issues with visas. The Canadian participants further indicated to not seeing travelling to Europe for the meeting as a large burden. China volunteers to host the meeting sometime in the future (2028 or 2029), and suggested two potential locations in China, which however are somewhat remote (5-hour flight from Beijing + 2-hour bus ride). The decisions on the 2027 and 2028 meeting locations were not final as there was not a very distinct majority vote, and further discussions will follow among the NAG national contacts, and possibly at the next NAG meeting in January 2026.

Meeting structure & hybrid solutions

The current hybrid solution (non-interactive livestream advertised on the Cryolist) is still the preferred option for future meetings. In addition to this, we will consider to record presentations and make them available up to 1 day after the presentations so that online participants in other time-zones can view them. There were no objections to continue with the structure and length (2.5 days) of the meeting.

Cross-cutting activity

The suggested topic for a cross-cutting activity is: Arctic glacier hazards. This topic has a clearer glaciological focus than previous activities. IASC support is sought from the Atmosphere, Cryosphere, Social & Human and Terrestrial Working Groups. €12,000 is requested. The proposal was submitted on January 6, presented to the working groups in early February and a decision on the funding is taken at ASSW in late March. As full funding from IASC is unlikely, it is worth exploring other additional funding sources. Some ideas were brought up for future cross-cutting proposals (to be submitted in January 2026), including e.g. hydropower, geoengineering and Indigenous knowledge/communication.

Website & promotion

The state of the website was briefly discussed. The layout is a bit outdated and a fresher look would be welcomed. The idea to merge 'Publications' and 'Activities' was approved (no one objected). Pretty photos, e.g. from fieldwork, are welcomed for integration into the website.

Abstracts

Understanding changes in iceberg - ship coexistence throughout the eastern Canadian Arctic: 2012-2019

Abigail Dalton[1], Luke Copland[1], Wesley Van Wychen[2], Jackie Dawson[1], Alison Cook[3], Adam Garbo[1], Derek Mueller[4], Adrienne Tivy[5]

[1] University of Ottawa, Canada
[2] University of Waterloo, Canada
[3] Scottish Association for Marine Science & University of Ottawa, Canada
[4] Carleton University, Canada
[5] Environment and Climate Change Canada, Canada

Icebergs present a known hazard to ships operating in ice-infested waters. As iceberg production rates vary, potentially compounded by climate change, it is becoming increasingly important to understand the extent to which icebergs pose navigational hazards. In this study, historic ship tracks derived from automatic identification system (AIS) were combined with iceberg drift locations obtained from in-situ satellite trackers and the Canadian Ice Island Drift, Deterioration, and Detection (CI2D3) Database, to identify the coexistence of icebergs and ships throughout the eastern Canadian Arctic (ECA) from 2012-2019. Comparing 2012-2015 to 2016-2019, the total number of unique vessels operating in the ECA more than doubled. At the same time, icebergs were consistently observed throughout the entire ECA, specifically in Nares Strait, eastern Lancaster Sound, and east of Baffin Island. Regions where the largest increases in both icebergs and ships occurred along the east coast of Baffin Island and east of Bylot Island, most often involving dry bulk vessels, and in Smith Sound between Ellesmere Island and NW Greenland involving passenger vessels. Recent reductions in the mean ice strengthening of ships operating in the ECA means the seriousness of any potential collision is likely increasing towards present day.

A unique dataset of Austre Lovenbreen glacier in Svalbard showing record melting in 2024

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

[1] University of Vienna, Austria
[2] Univ. Franche-Comté, France

At the Austre Lovenbreen glacier basin near Ny Alesund, Svalbard a unique monitoring set-up containing of different measurement and analyses techniques has been established in the last 10 years. Within this work we like to focus on data collected using high resolution laser scanning surveys to complete geodetic mass balance measurements in cm resolution and additionally to a continuous 1-D laser snow and ice depth measurement that allows classifying melt rates utilizing laser reflectance data. We like to put the record melting season of 2024 into perspective of recent years and show what the analyses of the mentioned datasets reveal. While terrestrial laser scanning data is used to understand spatial melting patterns throughout the whole glacier surface the continuous 1-D laser snow and ice depth data shows when and in what speed melting occurred. We further discuss advantages and limitations of our measurement set-up in comparison to traditional methods.

How to measure accumulation on the Greenland Ice Sheet?

Andreas P. Ahlstrøm[1], R.S. Fausto[1], J.E. Box[1], N.B. Karlsson[1], W.T. Colgan[1], S.B. Andersen[1], B. Vandecrux[1], A. Rutishauser[1], P.R. How[1], K.D. Mankoff[1], A.M. Solgaard[1], S.H Larsen[1], K. Kjeldsen[1], J. Jakobsen[1], C.L. Shields[1], A.Ø. Pedersen[1], M. Citterio[1], A. Messerli[2], K. Langley[2], M. Winstrup[3], A. Kusk[3]

[1] GEUS, Denmark
[2] Asiaq, Greenland
[3] DTU Space, Denmark

The Arctic climate is currently undergoing rapid change, causing a sustained, uninterrupted mass loss from the Greenland Ice Sheet over the last 28 years. The Danish-Greenlandic governmental monitoring programmes Greenland Climate Network (GC-Net) and Programme for Monitoring of the Greenland Ice Sheet (PROMICE) aims to assess the mass balance, combining remote sensing, modelling and in-situ observations. The largest component of the ice sheet mass balance is the accumulation of snow, which is notoriously hard to represent correctly in models, but also hard to observe from satellites. Consistent, automated in situ measurements of accumulation are thus crucial to validate and calibrate regional climate models and satellite products, but are challenging to retrieve in the extremely remote and harsh environment of the ice sheet. Here we present our current efforts to address this problem, using everything from plywood to Cosmic Ray Neutron Sensing, focusing on the technical and practical challenges.

Surface Methanogenesis on Glaciers: A Novel Source of Methane in the Warming Arctic

Archana Dayal[1]

[1] Aberystwyth University, UK

With warming temperatures in the High Arctic, a significant reduction in the ice volume is taking place. This process is unveiling a new source of methane, such as subglacial sediments advected to the glacier surface as the ice melts. Methane is a potent greenhouse gas, and previous studies have shown that subglacial sediments actively produce methane, which has implications for global climate change. In this study, I conducted fieldwork on the Foxfonna glacier in Svalbard to quantify methane (CH_4) and carbon dioxide (CO_2). Using a Los Gatos analyzer and a 20-litre chamber, eight surveys were performed across three sites on the glacier surface. Measurements focused on gas fluxes from conical and flat debris piles—accumulations of subglacial sediment exposed by melting ice. To understand the microbial processes contributing to methane production, I conducted laboratory incubation experiments. Debris samples were incubated under anoxic conditions, amended separately with acetate and H_2/CO_2 to stimulate different methanogenic pathways, that simulated field temperatures. These experiments aimed to identify the metabolic pathways of methane production within the microbial community. The talk will present novel results from this field campaign and the laboratory incubations. The novelty of this study lies in the first documentation of surface methanogenesis on a glacier surface and its unknown contribution to global methane budgets with significant implications for global warming.

Terminus dynamics of Taku Glacier, Alaska, during the recent transition

Arlec Chang[1], Shin Sugiyama[1], Jason Amundson[2], Lynn Kaluzienski[2], Ian Joughin[3]

[1] Hokkaido University, Japan
[2] University of Alaska Southeast, USA
[3] University of Washington, USA

Ice loss from Alaskan glaciers accounted for 25 % of the total loss from global mountain glaciers between 2000 and 2019 (Hugonnet et al., 2021). Importantly, 14 % of the ice loss in Alaska is from tidewater glaciers, which may advance and retreat independent from climate conditions. While most glaciers in Alaska retreated during the period, Taku Glacier, the largest outlet glacier in the Juneau Icefield, had been advancing throughout the 20th century and first part of the 21st century. However, it started to show retreating signs around 2015. In this study, we quantified changes in terminus position, surface elevation and surface velocities to better understand the dynamics during the glacier's transition from advance to retreat, utilising satellite data (Landsat 4, 5, 7, 8, 9 and Sentinel-2 imageries, ArcticDEM Strips). As a result, terminus position illustrated spatiotemporal variabilities from 1984-2024, with a significant retreat (∼-217 m) observed in the east section from 1984-1998 while the rest of the terminus advanced. Moreover, advancing rate in 1998–2015 varied in different parts of the frontal margin, i.e. larger in the middle section, 14.7 m/a, and relatively smaller in the east and west sections, 8.7 m/a and 5.4 m/a, respectively. As regards surface elevation change, surface lowering was observed across the study area between 2014 and 2021, with a significantly large magnitude near the glacier margins, up to -30 m in the west section. In addition, seasonal variations in surface flow speed were noticeable in the western area, reaching a maximum of 0.73 m/d in summer and hitting a minimum of 0.28 m/d in winter. On the contrary, seasonal signal was less obvious in the eastern area, which fluctuated between 0.25 and 0.39 m/d.

A daily, 1 km resolution Greenland rainfall climatology (1958-2020) from statistical downscaling of a regional atmospheric climate model

Baojuan Huai[1], Michiel R. van den Broeke[2], Carleen H. Reijmer[2], Brice Noël[3]

[1] Shandong Normal University, China
[2] Utrecht University, Netherlands
[3] University of Liege, Belgium

A daily, gridded 1 km rainfall climatology (1958-2020) for Greenland is presented, including the Greenland ice sheet (GrIS), the peripheral ice caps (GIC), and ice-free tundra. It is obtained by statistically downscaling the 5.5 km output of the regional climate model RACMO2.3p2 to a resolution of 1 km, using the elevation dependence of snowfall fraction. Based on this new product, the average total annual rainfall in Greenland during 1958-2020 is estimated to be 111.4±11.2 Gt/year, of which 28.6±6.1 Gt/year falls on the GrIS, 11.4±1.4 Gt/year on the GIC and 71.4±9.0 Gt/year on the tundra. The downscaled 1 km product better resolves especially the relatively small GIC, more than doubling (+124%) their rainfall compared to the 5.5 km product. The relatively warm southern regions of Greenland have the highest rainfall amounts, with annual values locally exceeding 1,000 mm. We confirm a significant positive trend in Greenland rainfall (>40 mm/decade), notably in the northwest and mainly due to an increase in rainfall fraction (>3.5%/decade) during July and August. For the whole of Greenland, over 1991∼2020 the seasonal rainfall peak has shifted from July to August, with significant increases in September which receives more rain than June. An analysis of rainfall fraction and near surface temperature shows that local warming rates are a good predictor of recent rainfall changes.

Impacts of Glacial Retreat on Proglacial Hydro-Systems: Insights from Aufeis Formation Analysis

Bastien Charonnat[1], Michel Baraer[1], Maxime Tarka[1], Thomas Bonnerot[2], Théo Flumian[2], Eole Valence[3], Janie Masse-Dufresne[1], Jeffrey McKenzie[3]

[1] Université du Quebec, Canada
[2] Polytech Montpellier, France
[3] McGill University, Canada

Subarctic and Arctic mountain ranges are increasingly impacted by climate change, particularly affecting small glaciers (<10 km^2). These glaciers are highly vulnerable to rising temperatures, leading to significant ablation and retreat. In extreme cases, they lose their accumulation zones, exposing bare ice across their entire surface by late summer. This rapid glacial retreat has profound implications for proglacial hydrology, including enhanced infiltration and potential disconnections in the subsurface drainage networks, which can manifest as discontinuous aufeis formation. Such changes can have long-lasting effects on the hydrological behavior of deglaciating catchments and their water resources.

This study examines these impacts in the Shäŕ Ndü Chù (Duke River) catchment, a 654 km^2 catchment in the St. Elias Mountains (Yukon, Canada) with 9% glacier coverage. We document glacier surface and albedo changes from 1948 to 2024 through historical aerial photos and satellite imagery, quantifying the extensive retreat and accumulation loss.

These trends are then correlated with changes in the catchment's proglacial hydro-systems. We analyze the evolution of hydrogeological processes by monitoring aufeis formation at 54 sites from 1970 to 2024, using Landsat and Planet imagery. Aufeis formations are categorized depending on their susceptible water sources (glacial or not glacial), based on their location and formation trends. providing insights into how glacial retreat influences proglacial hydrology. Comparative analysis between glacial retreat and aufeis formation trends provides insights into how glacial retreat influences proglacial hydrology. Our findings, by exploring downstream implications of glacier loss, contribute to a better understanding of the evolving water resources in deglaciating catchments, crucial for assessing the broader impacts of climate change in Arctic and subarctic regions.

Evolving surge dynamics and ongoing glacier acceleration on Devon Island's Southeast basin, Canadian Arctic

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

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

During a surge, glacier velocity can increase by an order of magnitude or more, leading to heightened iceberg calving and meltwater discharge, which pose risks to navigation and affect oceanic primary production. The Southeast basin on Devon Island, Nunavut, is the second largest in the Canadian Arctic (∼2600 km^2). A dynamic instability of these glaciers may significantly increase their contributions to sea level rise and disrupt local ecosystems. This study investigates the dynamics and surge history of Southeast-1 and Southeast-2 glaciers, which share a common terminus. Using remote sensing data, we analyse changes in glacier terminus position, surface characteristics, elevation, velocity, and trends in synthetic aperture radar backscatter to assess dynamic changes.

Between the mid-1970s and mid-1980s, both Southeast-1 and Southeast-2 glaciers surged, reaching a maximum measured velocity of ∼2000 m a^{-1} near the terminus in 1977. This abrupt acceleration advanced their terminus by up to ∼4 km. Velocities then declined, first abruptly near the terminus and later gradually up-glacier, continuing for more than 15 years in the upper regions. However, Southeast-2 Glacier has since reaccelerated near its terminus, with a ∼10-fold increase in median terminus velocity since 2013, reaching a maximum of ∼450 m a^{-1} in 2023–2024. This acceleration, propagating up-glacier, mirrors behavior seen in other marine-terminating surge-type glaciers in the Canadian Arctic. In contrast, Southeast-1 Glacier has remained stable so far, though the previous surge suggests it may eventually experience a similar instability as the acceleration of Southeast-2 continues.

This study contributes to our evolving understanding of surge-type glaciers in the Canadian Arctic, refining mechanisms driving these instabilities and highlighting potential future changes.

Accumulation by avalanches as significant contributor to the mass balance of a peripheral glacier of Greenland

Bernhard Hynek[1]

[1] University Graz, Austria

Greenland´s peripheral glaciers are losing mass at an accelerated rate and are contributing significantly to sea-level rise, but only a few direct observations are available. In this study we use the unique combination of high-resolution remote sensing data and direct mass balance observations to quantify the contribution of a singular avalanche event 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. Elevation changes calculated from repeated photogrammetric surveys in August 2013 and July 2021 show a high spatial variability, ranging from -11 m to 18 m, with a glacier-wide mean of 1.56 + 0.10 m (1.33 + 0.21 m w.e.). A significant influence on the near decadal mass balance stems from the exceptional winter mass balance of 2017/18, which was 2.5 standard deviations above average (1.89 + 0.05 m w.e.). After heavy snowfall in mid-February 2018, snow avalanches from the surrounding slopes affected more than one third of the glacier surface and contributed 0.35 + 0.04 m w.e., which is close to 20% to the total winter mass balance of 2017/18. Remote sensing data show, that Freya Glacier is prone to avalanches also in other years, but to a lesser spatial extent. Due to a gap in mass balance point observations caused by high accumulation rates (buried stakes) and the COVID-19 pandemic the recently reported glacier-wide annual mass balance are rather crude estimates and show a negative bias of -0.22 m w.e. a^{-1} compared to the geodetic mass balance.

Assessing the impact of expanding proglacial lakes on glacier dynamics: a case study from Llewellyn Glacier, Canada

Brittany Main[1], Christine Dow[1], Ashley Dubnick[2], Peter Wray[1], Kyra St. Pierre[3], Luke Copland[3]

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

Glaciers in the Yukon, Alaska, and northern British Columbia (BC) are experiencing some of the fastest mass loss rates outside of the Greenland and Antarctic ice sheets. As they retreat, proglacial lakes can form at their termini, potentially impacting glacier velocities through processes such as terminus flotation. Despite this, the regional impact of these lakes on glacier dynamics remains poorly understood, and the detailed evolution of proglacial lakes and their downstream effects have not been fully explored. This project seeks to address these gaps by quantifying the relationship between proglacial lakes and glacier flow through two main objectives: (1) an in-depth study of Llewellyn Glacier, BC, and (2) a regional remote sensing-based evaluation of proglacial lake influence on glacier velocities across the Yukon, northern B.C., and Alaska.

Since 1985, the proglacial lake area in front of Llewellyn Glacier, BC has expanded dramatically—from 4.8 km^2 to 13.5 km^2—whilst the glacier's terminus has retreated by ~1.7 km. This study explores the relationship between proglacial lake size, terminus extent, and glacier velocities (e.g. ITS_LIVE), from 1985 to present. Results will later be integrated with reconstructed records of ice thicknesses over the same period, derived from airborne ground-penetrating radar surveys. These models will be integrated with manually delineated lake boundaries and existing ice velocity datasets, enabling a comprehensive analysis of how lake expansion, ice thickness, and glacier flow have evolved across this region since 1985. This research has critical implications for communities relying on glacial meltwater for hydropower and water resources, and as critical habitat for fish and wildlife. Additionally, retreat could affect tourism and disrupt the cultural connections of Indigenous communities, including Taku River Tlingit First Nation. Understanding how the growth of proglacial lakes will impact glacial dynamics is crucial for addressing the societal impacts of glacier retreat in this region.

Multidecadal Ice Thickness and Velocity Changes of Coronation and Maktak Glaciers, Baffin Island, Nunavut

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

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

Penny Ice Cap, located on southern Baffin Island, features a unique configuration of two outlet glaciers, Coronation and Maktak. Both glaciers are similar in size and situated in close proximity, yet they have distinct termini: Coronation is ocean-terminating, while Maktak is land-terminating. To understand controls on the long-term evolution of these glaciers, their surface velocities, derived from both optical and radar satellite imagery, are analyzed in conjunction with changes in terminus conditions and geodetic mass balance. These mass balance estimates are derived using ArcticDEM strips and structure-from-motion photogrammetry, incorporating both recent and historical aerial photography.

Existing literature indicates that between 1985 and 1997/98, Maktak Glacier showed increasing velocities, followed by a gradual decline in ice speeds. In contrast, Coronation Glacier exhibited a steady decline in velocities starting in 1985, which intensified after 1997/98. Both glaciers have also experienced significant terminus retreat and thinning over this period, with Coronation Glacier retreating more substantially than Maktak Glacier. Ongoing analyses reveal significant thinning near the terminus of Coronation Glacier, with losses ranging from 3 to 5 m between 2015 and 2019 in its lower section. As of the summer of 2024, the lower portion of the glacier is approximately 220 to 250 m thick and is approaching complete retreat from its fiord.

Glacier change and an updated glacier extent inventory for Devon Island, Arctic Canada

Dorota Medrzycka[1], Luke Copland[1]

[1] University of Ottawa, Canada

Mass balance estimates for glaciers and ice caps in Arctic Canada have become increasingly negative, particularly since the start of the 21st century, with small land-terminating glaciers at lower elevations experiencing the highest relative area losses, and several of the smallest ice masses disappearing entirely since the 1960s. Yet, for most of the region, existing glacier inventories have not been updated since around the year 2000.

Here, we present an updated inventory of the extent of all ice masses on Devon Island, mapped from optical satellite imagery from ∼2023. Comparing data from existing inventories, we quantify glacier area change across the island over the past two decades. Over 95% of current glaciated area is concentrated in the 50 glaciers of Devon Ice Cap, which collectively lost 770 km^2 (∼4%) since 2000. Of the original 40 marine-terminating glaciers flowing from the ice cap, four have since retreated onto land. For the remaining glaciers, average relative area losses ranged between 40% for the largest three ice caps with an area of >100 km^2, to 85% for those <5 km^2. Out of the 160 individual ice masses initially mapped in 2000, 60% have disappeared entirely, with all 97 of them being <5 km^2 at the start of the study period. Currently, glaciers <5km^2 account for only <1% of the island-wide ice cover, but nearly 90% of the remaining glacier population.

Mapping buried ice and groundwater pathways in a sub-arctic deglaciating valley (YT, Canada)

Eole Valence[1], Bastien Charonnat[2], Adam Tjoelker[3], Michel Baraer[4], Adrien Dimech[4], Janie Masse-Dufresne[4], Jeffrey M. McKenzie[1]

[1] McGill University, Canada
[2] Ecole de Téchnologie Supérieure (ETS), France
[3] Ohio States University, USA
[4] ETS, Canada

Glacierized catchments represent the iconic storage of water in mountain areas and are often referred to as the World's water towers. In Northern and Western Canada, glacierized catchments are a critical component of water resources as they provide water for downstream regions. If the clean ice part of glaciers has received much focus in the past decades, quantifying the hydrological role of debris covered parts and isolated buried ice is still challenging. Debris covered sections of glaciers are made of ice that is partially or completely covered by rock and sediment debris, making their delineation, ice content and melting rates difficult to monitor. Given the ice acts as impermeable barrier to water, accurately mapping the buried ice is crucial to follow groundwater pathways. Geophysical methods such as electrical tomography (ERT) measurement or ground penetrating radar (GPR) are generally used to map the subsurface in such environment. However, the terrain steepness and instability found on debris-covered ice often limits the applicability of these methods. Therefore, only few studies have been able to map the sub-surface of a debris covered glacier and even fewer were focused on the ice hydrological impact in deglaciating valleys. My project aims to combine extensive drone-based GPR, with ERT measurements and surface magnetic nuclear resonance (sMNR) to map the groundwater pathways in a debris covered ice environment. Using drone-based GPR to map buried ice allows to cover a large area with a relatively high density of measurements. However, interpretations from such geophysical methods gain from being validated by other methods such as ERT. sMNR being sensible to liquid water only, allows the identification of groundwater pathways through the sub-surface, constrained by the ice. At this stage, the objective is to develop a new multi-method approach allowing comprehensive a view of subsurface dynamics in deglaciating valley.

Assessing Shipping Trends and Hazards from Ice Islands in the Western Canadian Arctic

Erika Brummell[1], Luke Copland[1], Jackie Dawson[1]

[1] University of Ottawa, Canada

Arctic amplification and the disproportionate warming of the Arctic has resulted in glacier mass losses in the Canadian North, where ice discharge from tidewater glaciers and ice shelves is responsible for the production of icebergs and ice islands. The recent deterioration of ice shelves across northern Ellesmere Island has resulted in the production of large numbers of these tabular ice features, which may present a risk to vessels and infrastructure in the Western Arctic, including the Beaufort Sea. As changes in sea ice conditions enable more diverse vessels to travel in this region with increased frequency, less ice strengthened vessels are now able to navigate Arctic shipping routes such as the Northwest Passage. However, gaps remain in understanding how frequently ice islands drift into areas traversed by these ships, the risk that this poses to vessels of different kinds, and if this risk has increased over time.

In this study we use iceberg tracking beacon data, satellite imagery and in situ observations from the Meteorological Service of Canada's Canadian Ice Service and International Arctic Buoy Program, to evaluate the distribution and frequency of ice islands and icebergs in the Beaufort Sea and assess how this has changed over the last 20 years. Ship and iceberg interactions are explored using Automatic Identification System Data from the past decade combined with NORDREG shipping reports since 2012. Together, these datasets provide insight into the changing distribution of ice islands in navigable waters over time, allowing for an assessment of whether the potential risk of iceberg-related shipping hazards has increased due to a changing climate.

The Importance of Solving Subglaciar Hydrology in Modeling Glacier Retreat: A Case of Study for Hansbreen, Svalbard

Eva De Andrés[1], José M. Muñoz-Hermosilla[1], Kaian Shahateet[2], Jaime Otero[1]

[1] Universidad Politécnica de Madrid, Spain
[2] Université Grenoble, France

Arctic tidewater glaciers are retreating, serving as key indicators of global warming. This study aims to assess how subglacial hydrology affects glacier front retreat by comparing two glacier-fjord models of Hansbreen glacier: one incorporating a detailed subglacial hydrology model and another simplifying subglacial discharge to a single channel centered in the flow line. We first validate the subglacial hydrology model by comparing its discharge channels with observations of plume activity. Simulations conducted from April to December 2010 revealed that the glacier front position aligns more closely with observations in the coupled model than in the simplified version. Furthermore, mass loss due to calving and submarine melting is greater in the coupled model, with calving mass loss reaching 6 Mt by the end of the simulation, compared to 4 Mt in the simplified model. These findings highlight the critical role of subglacial hydrology in predicting glacier dynamics and emphasize the importance of detailed modeling in understanding the responses of Arctic tidewater glaciers to climate change.

Glacial-fjord monitoring with passive and active acoustics (Inglefield Bredning, Greenland)

Evgeny Podolskiy[1], Kohei Hasegawa[1], Mayuko Otsuki[1], Masahiro Minowa[1], Monica Ogawa[1], Jean-Baptiste Thiebot[1], Nicolas De Pinho Dias[2], Yoko Mitani[3], Shin Sugiyama[1]

[1] Hokkaido University, Japan
[2] Institut de Physique du Globe de Paris, France
[3] Kyoto University, Japan

Inglefield Bredning is a 100-km-long fjord with many rapidly changing outlet glaciers, representing calving ground glaciologically and biologically. On the one hand, fast-flowing glaciers, such as Bowdoin, Tracy, and Heilprin, generate major calving events, corresponding to regionally detectable glacial earthquakes and tsunami waves affecting the local population. On the other hand, this boisterous fjord system is a summering ground for the largest subpopulation of narwhals in Greenland. As part of comprehensive studies on the environment in the area, in 2022-2024, we attempted to run simultaneous observations using a seismo-acoustic network composed of surface seismometers, underwater hydrophones, and an active acoustic upward-looking profiler. So far, this effort has been a mixed success because instrumentation and data could not always be retrieved in a harsh ice-clad environment. Nevertheless, retrieved long-term data provided overlapping time series of seismic and hydroacoustic records, potentially containing many multidisciplinary insights. Here, we report our ongoing effort and share preliminary analysis, which includes seasonal seismo-acoustic noise variation, whale acoustic presence, iceberg keel depth, and etc., most of which are strongly related to sea-ice, ice melange, and glacier dynamics. Importantly, by sharing our practical experience and lessons learned, we also hope to encourage discussion for finding the best technological solutions valuable for research communities working in similarly harsh oceans.

Application of deep learning techniques for the automatic detection of the cold-temperate transition surface of polythermal glaciers using field and synthetic GPR data

Francisco Navarro[1], Unai Letamendia[1], Iván Ramírez[2], Beatriz Benjumea[3], Emanuele Schiavi[2], Ivan Lavrentiev[4]

[1] Universidad Politécnica de Madrid, Spain
[2] Universidad Rey Juan Carlos, Spain
[3] Instituto Geológico y Minero de España-CSIC, Spain
[4] Russian Academy of Sciences, Russia

Understanding the hydrothermal structure of polythermal glaciers is fundamental to study their dynamics. The cold-temperate transition surface (CTS) is the englacial boundary between cold and temperate ice. Ground-penetrating radar (GPR) has been shown to be a useful technique to identify this transition, due to the high contrast in permittivity between cold ice and water-rich temperate ice. This interpretation is traditionally a manual and time-consuming task. Here we show an approach based on deep learning for the automatic detection of the CTS. The training data were collected in Svalbard, using a GPR with central frequency of 20-25 MHz, along various campaigns spanning the period 2010-2022, carried out on glaciers in Sabine Land, Nordenskiöld Land and Wedel Jarlsberg Land. To extend the volume of training data we have also generated synthetic data by forward modelling with gprMax, which solves the electromagnetic wave propagation equations using the finite-difference time-domain (FDTD) method. The deep learning algorithms are based on convolutional neural networks (CNN), following a feature pyramid network architecture. Classification results using various metrics will be presented.

ICELINK: Advancing Knowledge of North Atlantic Land ICE – LINKing Observations and Models

Guðfinna Aðalgeirsdóttir[1], Christine Hvidberg[2]

[1] University of Iceland, Iceland
[2] University of Copenhagen, Denmark

ICELINK will bridge the knowledge gap between climate models, ice-flow models, satellite observations and in-situ observations to accelerate the understanding of how glaciers and ice sheets in the North Atlantic respond to climate change, and their impacts on climate and ecosystems. Observations in the past decades have alerted for the rapid changes in land ice in this region. Record temperatures, melting ice and increased fresh water flux may destabilise the atmosphere and ocean circulation, with severe consequences for regional weather system, sea level rise, and affecting Europe and beyond.

An improved understanding of trends and variability of ice evolution is important, and ICELINK will address this challenge by integrating Earth Observation data, in-situ observations and ice flow and climate models into an improved understanding of the processes that control the evolution of glaciers. Through improved understanding of snow, surface mass balance and the ice dynamical response to meltwater runoff, ICELINK will provide new knowledge of the response of Icelandic glaciers and the Greenland ice sheet to global warming and the impacts on climate and ecosystems. ICELINK will engage closely with local communities to co-develop and disseminate new knowledge, needed to support adaptation strategies, mitigate risks and enhance their resilience.

A novel approach in ICELINK is to investigate the effect of increasing surface melting on ice evolution of the Greenland Ice Sheet by using Icelandic glaciers as a data-observation laboratory for understanding the response in a warmer world with more melt. The improved models and new insights will feed into the World Climate Research Programme's Cryosphere Project, IPCC, IPBES, assist development of Copernicus, and support the Destination Earth Initiative. ICELINK will produce results that are in high demand in order to plan and adapt for the future.

Glacial lakes outburst floods of Svalbard, A Case Study of Isfjord

Iwo Wieczorek[1], Mateusz C. Strzelecki[2], Łukasz Stachnik[1], Jan Kavan[3], Jacob C. Yde[4], Krzysztof Senderak[1]

[1] University of Wroclaw, Wroclaw, Poland
[2] Alfred Jahn Cold Regions Research Centre, Poland
[3] University of South Bohemia, Czech Republic
[3] Western Norway University of Applied Sciences, Norway

The Svalbard Archipelago located in the High Arctic, often referred to as the 'Arctic Tropics', is warming four times faster than the global average (Rantanen et al., 2022). This is reflected, for example, in the rate of evolution of Svalbard's glacial lakes (Wieczorek et al., 2023) and the occurrence of Glacial Lakes Outburst Floods (GLOFs) (Kavan et al., 2022; Woloszyn et al., 2022; Dudek et al., 2023; Wieczorek et al., 2023; Wieczorek, 2024). Svalbard, due to its low population density (approx. 0.044 os./km^2), is not an area where GLOF phenomena directly threaten people and infrastructure. However, due to the numerous scientific studies carried out there and the increased tourist traffic, studies are being produced on geohazards from landslides (Nicu, Lombardo and Rubensdotter, 2021) or avalanches (Sydnes, Sydnes and Hamnevoll, 2021). The most frequented and also populated area is the Isfjord catchment, where there are numerous glacial lakes. Using available teldetection data and scientific studies and reports, I have attempted to create a glacial flood risk map for Isfjord, the largest fjord in Svalbard. In this study, I would like to present the research methods developed, the pattern of observations made and the first results indicating a few sites of particular interest. This work was supported by Polish National Science Centre, project GLOWS [2023/49/N/ST10/01075].

Understanding supraglacial hydrology during a surge: A case study of Nàłùdäy's (Lowell Glacier) 2021-22 surge

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

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

Glacier surges in the St. Elias Mountains are typically thought to be triggered by shifts in subglacial hydrology, transitioning from a channelized to a distributed system. Surge phases in the region generally last 1-2 years, in which glaciers experience dramatic increases in velocity, resulting in extensive surface crevassing and terminus advance. Once these surges subside, the glaciers enter quiescent periods, exhibiting minimal movement for 10-20+ years. Observations of surges in the region have revealed significant changes to the glacier surface, but to date no study has looked at the evolution of supraglacial hydrological features throughout a surge cycle. This is crucial for understanding the role of meltwater inputs to the glacier interior and bed during both the quiescent and surge phases of the cycle.

Nàłùdäy (Lowell Glacier), Yukon, experienced its most recent surge in 2021-2022, following an 11-year quiescent phase. The latest surge timing was determined using satellite-based offset tracking. Evolution in crevasse extent and density are analyzed over a 9-year period (2015-2024) using SAR imagery to visualize surface roughness through backscatter strength changes. Additionally, high-resolution orthomosaics generated from piloted Structure from Motion (SfM) surveys provide detailed maps of supraglacial hydrological features, such as streams and moulins, from 2019 to 2024. By comparing changes in these supraglacial hydrological features with velocity changes, this study provides new information concerning the link between hydrology and the dynamic behavior of surging glaciers in the St. Elias Mountains.

Greenland ice sheet slush observations and modeling

Jason Box[1], Masashi Niwano[2]

[1] GEUS, Denmark
[2] Japan Meteorological Agency, Japan

The space time dependence of Greenland ice sheet slush conditions is investigated using in-situ data from automatic weather stations, satellite optical remote sensing and regional climate modeling. The work is to yet further examine slush using the Japan Meteorological Agency Non-Hydrostatic atmospheric Model and the Snow Metamorphism and Albedo Process model (NHM–SMAP) over the 1980 to 2023 period. Focus is made on a collection of extreme events to gain process understanding for Greenland ice sheet slush conditions.

Customized NASA autoRIFT (CautoRIFT) for measuring rapid changes in ice dynamics

Jukes Liu[1], Ellyn Enderlin[1], Rainey Aberle[1], Madeline Gendreau[2]

[1] Boise State University, USA
[2] US Department of Defense, USA

Global glacier velocity records with high temporal resolution, such as the NASA ITS_LIVE dataset, have facilitated the study of Arctic glacier dynamics at sub-seasonal timescales. However, ITS_LIVE velocities are produced using NASA's autoRIFT feature-tracking algorithm with standard search parameters for mapping entire regions that may miss large changes in flow speed, such as surges. Here, we present a streamlined pipeline to customize inputs to autoRIFT (e.g., chip sizes, search distance, reference velocities, etc.) in order to capture order-of-magnitude changes in flow speed that occur over weeks to months, filling gaps in ITS_LIVE velocity records. This customized autoRIFT (CautoRIFT) pipeline outputs georeferenced velocity maps with uncertainties of 0.5 m/day or less using image pairs from Landsat 8 and 9, Sentinel-2, and PlanetScope and can accommodate cross-platform image pairs (i.e., first image from Landsat 8 and a second image from Sentinel-2), further increasing the temporal coverage and resolution of velocity time series. The open-source CautoRIFT code is maintained at `https://github.com/jukesliu/CautoRIFT`. We showcase the utility of the CautoRIFT pipeline for mapping and analyzing sub-seasonal dynamic changes observed across the Arctic, such as speedups associated with seasonal runoff (e.g., at Sít' Kusá, Alaska) and terminus retreat / mélange breakup (e.g., at Kangerlussuaq Glacier, east Greenland). Our example applications demonstrate that CautoRIFT can be used to efficiently identify weekly to seasonal variations in glacier processes that may impact future changes to the mass budget of Arctic glaciers.

Sør-Spitsbergen National Park, Svalbard – glacier changes from 1990 to 2020

Justyna Dudek[1], Aleksandra Wołoszyn[2]

[1] Polish Academy of Sciences, Poland
[2] University of Wroclaw, Poland

Consequences of increasing air temperatures, observed globally since the termination of the Little Ice Age (LIA), are especially noticeable in the Arctic, where the rate of climate warming exceeds the global average by several times. The Arctic's amplified warming leads to accelerated ice melt, causing glaciers to lose mass and their fronts to retreat. Spitsbergen, the largest island of the Svalbard archipelago in the European Arctic, is particularly vulnerable to this phenomenon, as glaciers play a crucial role in shaping its unique landscape, covering a significant portion of its surface area. This work presents 30 years of changes in the geometry of glaciers in Sør-Spitsbergen National Park, located in the southern part of Spitsbergen.

For our research, we used data available from the archives of the Norwegian Polar Institute (NPI) representing the years 1990 and 2010 and consisting of shapefiles with glacier boundaries, aerial images, and digital elevation models (NPI). We supplemented this data with two Landsat 5 TM scenes acquired in the summer of 1990 (allowing correction of glacier boundaries in the places where NPI data was inexistent) and a set of the scenes acquired in the year 2020 by Sentinel serving as the base for delineation of contemporary glacier boundaries. For extracting changes in glacier elevations we used the most recent Arctic DEM. The created database allowed us to assess changes in glacier extent and thickness in the following periods: 1990-2010, 2010- 2020, and 1990-2020.

CH4 emission from glacier areas in Alaska

Keiko Konya[1], Go Iwahana[2], Ttsuo Sueyoshi[3], Tomoaki Morishita[4], Jun Uetake[5], Masahide Wakita[6]

[1] JAMSTEC, Japan
[2] UAF, USA
[3] NIPR, Japan
[4] FFPRI, Japan
[5] Hokkaido University, Japan
[6] JMATSEC, Japan

We observed methane and carbon dioxide concentrations in the ambient air near the meltwater outlet, fluxes of these gases at the surface of runoff water and riverbank sediments, and dissolved methane content in the runoff water were measured at glaciers in Alaska. Three glaciers showed conspicuous signals of methane emissions from runoff water. One of those glaciers terminus exhibited a methane concentration three times higher than background levels.

Modelling past discharge from Qaanaaq Glacier in north-western Greenland during 1950–2023

Ken Kondo[1], Koji Fujita[1]

[1] Nagoya University, Japan

Glacial meltwater discharge is increasing in Greenland under recent warming climate. As a consequence, floods and damages on infrastructures are reported on outlet streams of land terminating glaciers. For example, discharge from Qaanaaq Glacier in northwestern Greenland rapidly increased in the summers of 2015, 2016, 2022, and 2023 that resulted in destruction of roads in the Qaanaaq village. The disasters indicate impacts of the recent glacier changes on the coastal communities in Greenland. To understand the influences of the climate change on glaciers and population in the Arctic region, it is important to understand past fluctuations of the glacial discharge and its link with climate. Here, we demonstrate long-term reconstruction for the past glacial discharge from Qaanaaq Glacier in 1950–2023 using a glacier mass balance model, which was calibrated by in-situ and satellite data. Climate reanalysis data, ERA5-Land, was used for the model input.

Annual discharge from Qaanaaq Glacier showed increasing trend from 1961 to 2023 at a rate of 0.11 Mt a^{-1} ($p < 0.01$). The discharge variations significantly correlated with summer mean air temperature ($r = 0.77$, $p < 0.01$), which also exhibited rising trend over the same period (0.033 °C a^{-1}, $p < 0.01$). The discharge time series showed quasi-decadal periodicity with the lowest 5 discharge years in 1964, 1976, 1986, 1992, and 1996 corresponding with low summer air temperature and/or high winter precipitation. The greatest daily discharge over the past 73 years was computed on 22 August 2023 due to a heavy rainfall, corresponded with the destruction of the roads in the settlement. Our results demonstrated the importance of climate conditions for the glacial runoff and the communities along the coast of Greenland. Therefore, substantial efforts should be taken in place to mitigate further warming over the Arctic.

Ice surface observations using an unmanned aerial vehicle on Qaanaaq Glacier in northwest Greenland

Kotaro Yazawa[1], Soratakato Yamada[1], Takuro Imazu[1], Shin Sugiyama[1]

[1] Hokkaido University, Japan

Glaciers and ice caps surrounding Greenland are rapidly losing mass. Meltwater discharge from the glaciers is affecting coastal environments as well as contributing to sea level rise. While satellite image analysis is an effective technique to quantify glacial changes, UAV (unmanned aerial vehicle) measurements have advantages for studying glaciers with higher spatial and temporal resolutions. In this study, we report UAV observations on Qaanaaq Glacier, a land-terminating glacier in northwest Greenland (77° 28’ N, 69° 14’ E). The field activities were performed in the summers of 2022–2024. We utilize aerial photographs obtained by the UAV for analyzing ice surface elevation change and development of supraglacial rivers. UAV surveys were conducted over the ablation area of Qaanaaq Glacier (200–800 m a.s.l.), five times in July-August in 2022, six times in July-August in 2023, and three times in July 2024. We used DJI phantom4 pro V2.0 in 2022 and 2023, and used DJI mavic3M in 2024. The latter device is equipped with a multi-spectral camera, which captures images in near infrared (860nm), red edge (730nm), red (650nm), and green band (560nm). During the UAV survey, wooden plates were placed on and off the glacier as GCPs (ground control points) and surveyed using a kinematic GPS (Global Positioning System) positioning technique. By using the Agisoft Metashape software, DEMs and ortho-mosaic images were generated from the images using the coordinates of the GCPs. This presentation aims to report the initial results of the data analysis, focusing on surface elevation change and the development of supraglacial rivers in 2022–2024.

Dynamic Variation of Yelverton Glacier: An Examination of Change from 2011-2023

Kristie Shannon[1], Wesley Van Wychen[1]

[1] University of Waterloo, Canada

Tidewater glaciers are important indicators of global climate change as they respond dynamically to changes in both air temperature and ocean temperature. Yelverton Glacier on Northern Ellesmere Island in Nunavut is a large tidewater-terminating glacier that has experienced increasing loss of floating ice cover at its tongue from 1999 to 2015, as a result of climate change. As Yelverton Glacier has the highest ice flux to the ocean on this icefield, understanding how climate change has also influenced the dynamic behaviour of Yelverton Glacier over the past two decades can provide knowledge on future sea level rise contributions from similar glaciers. Multi-annual changes in ice flow can help determine changes in ice flux to the ocean as ice mass is funneled downglacier along Yelverton's trunk. A 12-year analysis of velocity on Yelverton Glacier provides the basis of the work presented here. Velocity data is via offset tracking of Synthetic Aperture Radar imagery acquired from, RADARSAT-2 (2011-2020), and Sentinel-1 (2014-2023) satellites and analyzed using ArcGIS Pro. Mean velocities for each year are then compared temporally to climate data for the region (retrieved from Environment and Climate Change Canada's Historical Climate Data Archive) in order to understand the influence of air temperature change on the recent dynamics of Yelverton Glacier. This project aims to fill in gaps in the research of this glacier and provide a well-rounded investigation of the behaviour of Yelverton under changing climate conditions to help quantify future iceberg discharge.

Inland Limits to Subglacial Channel Development beneath the Greenland Ice Sheet from Surface-Velocity Observations

Kuba Oniszk[1], Shfaqat Abbas Khan[1], William Colgan[2]

[1] Technical University of Denmark, Denmark
[2] Geological Survey of Denmark and Greenland, Denmark

Meltwater generated at the glacier surface penetrates towards the ice-bed interface where it becomes routed in the subglacial drainage system. In the process, this modifies the efficiency of the network and, through its influence on basal effective pressure, controls the flow of the overlying ice and the rate of mass advection into the ablation area.

This hydro-dynamic coupling is understood in the context of the two-component theory of subglacial drainage systems. It is assumed that at the beginning of the melt season, the hydrological systems of Greenland are in a distributed form which does not allow for the removal of all the incoming melt, promoting ice-substrate separation, and inducing seasonal ice-flow acceleration. Continued supply of liquid-water runoff may eventually lead to the development of a channelised hydrological system, allowing for efficient drainage which induces a pronounced late-summer slowdown.

This negative feedback between the increasing supply of surface-produced melt and ice flow has been hypothesised to be a long-term self-regulation mechanism of the ice sheet. Consequently, the effect of subglacial hydrology has been largely disregarded in future ice-mass-loss predictions. However, the applicability of the long-term slowdown effect away from the margins persists as an unresolved factor in Greenland hydrodynamics.

This project aims to find empirical limits to the development of subglacial channels for a selected number of outlet glaciers across Greenland, expanding on the previous mapping efforts that concentrated on its western coast. For that purpose, we generate surface-velocity timeseries of high temporal resolution based on the offset-tracked ITS_LIVE MEaSUREs data and infer presence of channels from the details of ice-flow seasonal signals at a given location. We conduct intercomparison of channel inland extents between ice-sheet sectors and years of study and discuss likely causes for the observed differences.

Characteristics and rapid drainage of a large subglacial lake on SE Ellesmere Island, Canadian Arctic

Luke Copland[1], Laurence Gray[1], Benoit Lauzon[1], Adam Garbo[1], Wesley Van Wychen[2], Christine Dow[2], Will Kochtitzky[3], Karen Alley[4]

[1] University of Ottawa, Canada
[2] University of Waterloo, Canada
[3] University of New England, USA
[4] University of Manitoba, Canada

Using a combination of digital elevation models derived from the ArcticDEM, ICESat-2 data, and optical and radar satellite imagery, we provide details of the largest subglacial to date discovered in the Canadian Arctic. Located under Manson Icefield, SE Ellesmere Island, the lake occupies an area of 17 x 3 km when full, with a total area of 52 km^2. Over a period of approximately 30 days in early 2021 the ice surface over lake sank by 140 m, implying a total subglacial water outflow of around 4 km3. This resulted in the formation of a single 15 km long subglacial flow path under an adjacent glacier, which terminates in the ocean and is detectable from a post-outflow surface depression. The shape of the surface depression, 600–800 m wide by 2–4 m deep, reflects the shape of the subglacial channel prior to closure. A review of historical imagery, and the presence of distinctive glacier-wide hinge cracks that form in relation to drainage events, suggests that previous major outflows occurred in 1993 and 2007/8, suggesting a repeat interval of approximately 14 years. Newly acquired in situ GNSS data indicates that the lake was filling at a rate of ∼10 cm/month during winter 2023/24.

Improving Our Understanding of Processes at The Base of Glaciers: A New and Improved Multi-Sensor Ploughmeter

Maiken Kristiansen Revheim[1], John Hult[1], Anja Kohfeldt[1], Thomas V. Schuler[1]

[1] University of Oslo, Norway

Understanding subglacial processes is crucial for predicting future sea-level rise, but in situ measurements remain challenging due to difficult accessibility and harsh conditions. Current subglacial measurement technologies have seen little advancement since the 1990s. To address these challenges, we introduce a new multi-sensor ploughmeter to gather detailed measurements at the glacier base.

Our instrument can measure ploughing stress, water pressure, and pore pressure to explore their interrelationships, investigate ice-bed coupling and assess the influence of surface meltwater on sliding. Additionally, it includes a differential pressure sensor for studying sediment weakening through clast ploughing [1] and an electrical conductivity sensor to differentiate water sources and understand the connectivity of the subglacial hydrological system. Recognizing the limitations of previous analog ploughmeters [2], our design incorporates an inertial measurement unit (IMU) providing instrument attitude to better separate physical and instrument-induced responses, thus enhancing data interpretation.

In this poster presentation, we will outline the design, testing, and calibration procedures required for autonomous operation of the ploughmeter in extreme conditions. Our multi-sensor approach represents an advancement in subglacial measurement technology, offering the potential to gain new insights into the coupling of ice and the bed, as well as subglacial hydrology.

1. Rousselot, M., & Fischer, U. H. (2005). Evidence for excess pore-water pressure generated in subglacial sediment: Implications for clast ploughing. Geophysical Research Letters, 32(11). https://doi.org/10.1029/2005GL022642
2. Fischer, U. H., & Clarke, G. K. C. (1994). Ploughing of subglacial sediment. Journal of Glaciology, 40(134). https://doi.org/10.1017/S0022143000003853

Observations of episodic processes at a major Greenland ice stream

Martin Luethi[1]

[1] University of Zurich, Switzerland

Sermeq Kujalleq in Kangia (SKK; Jakobshavn Isbrae) is flowing at 30-40 m per day. Such fast and large scale gravity-driven flows are characterized by both long-term continuum and short-term episodic dynamics which drive the evolution of the system. Fast glacier flow is often associated with non-continuous processes such as thrusting, folding and stick-slip motion. All of these processes result in bulk flow dynamics that are different from the conventionally assumed smooth fluid flow approximation. Here, we report on extensive high-rate field observations at SKK 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.

Initial evaluation of a long-term (1980-present) NHM-SMAP simulation for Greenland forced by ERA5

Masashi Niwano[1]

[1] Meteorological Research Institute, Japan

To understand the ongoing rapid changes in meteorological and glaciological conditions around the Greenland ice sheet, Niwano et al. (2018, TC) developed a spatially high-resolution (5 km) regional climate model NHM-SMAP. The model was initially forced by the Japanese reanalysis JRA-55. Model output data from NHM-SMAP forced by JRA-55 contributed to clarifying the impacts of clouds on the ice sheet surface melt and surface mass balance (Niwano et al., 2019, Sci. Rep.), performing the Greenland ice sheet surface mass balance model intercomparison (Fettweis et al., 2020, TC), and unveiling detailed recent states of rainfall over the ice sheet (Niwano et al., 2021, GRL; Box et al., 2023, Meteorol. Appl.). In recent years, some new-generation atmospheric reanalyses of the global climate have been available. Here, we use the fifth-generation ECMWF atmospheric reanalysis ERA5 to drive NHM-SMAP. Other model settings are the same as those developed by Niwano et al. (2018, TC). For example, the model domain and horizontal resolution (5 km) are the same as those set in Niwano et al. (2018). We will present the performance of NHM-SMAP forced by ERA5 from various perspectives such as surface atmospheric conditions and surface mass balance. Also, we will discuss our plans for future model development.

Mass balance modeling on McCall Glacier

Matt Nolan[1]

[1] Serving Earth Science, Inc., USA

I will use the long record of mass balance measurements on McCall Glacier in Arctic Alaska to evaluate performance of a new mass balance model. The analysis indicate that modeled melt, driven by solar insolation and air temperature, yields a superior result for glacier-wide mass balance than traditional methods utilizing point measurements.

Estimation of freshwater input to Brepollen (Svalbard)

Małgorzata Błaszczyk[1], Michał Laska[1], Dariusz Ignatiuk[1], Tazio Strozzi[2]

[1] University of Silesia in Katowice, Poland
[2] Gamma Remote Sensing, Switzerland

The Arctic is particularly vulnerable to contamination, as the environmental impacts of climate change are amplified in this region. Consequently, fjord ecosystems are likely receiving higher loads of contaminants today than in the past, which may pose a threat to the ecosystem. This study is part of the project "Quantification of Heavy Metal Discharge with Freshwater Runoff to an Arctic Fjord Ecosystem (Hornsund, Spitsbergen)". We assess here the seasonal changes in freshwater input to Brepollen, the inner part of the Hornsund fjord, a semi-enclosed glacial bay with limited water exchange, during the 2022-2023 period. The primary sources of freshwater input to the fjord include: frontal ablation and surface melting of the four tidewater glaciers in Brepollen basin, as well as atmospheric precipitation and meltwater runoff from non-glacierized catchments. Frontal ablation and changes in glacier geometry were determined using imagery from TerraSAR-X, supplemented with Sentinel-1 satellite data. The estimation of mass balance was based on the measurement of seasonal snow cover depth and its spatial distribution, carried out using Ground Penetrating Radar. Detailed snow stratigraphy from snow pits was used to calculate bulk density. Atmospheric precipitation and meltwater runoff from non-glacierized areas were assessed using meteorological and hydrological data collected at Polish Polar Station Hornsund.

Cryosphere Integrated Observatory Network on Svalbard (CRIOS) and harmonisation of the Svalbard cooperation (HarSval)

Małgorzata Błaszczyk[1], Natalia Łatacz[1], Dariusz Ignatiuk[1], Michał Laska[1]

[1] University of Silesia in Katowice, Poland

The acceleration of the Arctic warming causes significant changes in the cryosphere of Svalbard (faster melting of glaciers, thawing of the permafrost, changes in melting period onset and winter thaws) and stimulates faster energy exchange between atmosphere, cryosphere and ocean and freshwater transfer from land to the sea. The observed fluctuations in measured meteorological variables demonstrate regional/local differences in climate warming and subsequently, response to other environmental factors. Thus, monitoring of such variables and the environmental response has to be done in many localities in Svalbard.

The Cryosphere Integrated Observatory Network on Svalbard (CRIOS) project aims to modernize and expand an automated monitoring network focused on the cryosphere of Svalbard as a calibration/validation system for indirect research. All measurement stations will operate following the standardized measurement protocols developed as part of joint workshops and training sessions based on the SIOS Core Data process, Shared Arctic Variables (SAVs) and WMO standards. The key element of the observatory network will be real-time data transfer to the open repositories, following the FAIR principles, for researchers and stakeholders.

The implementation of the predefined CRIOS project has had a positive impact on the integration of the Polish polar research community and the strengthening of bilateral relations with Norway. Building on the experiences and accomplishments initiated in the project, we continue and broaden – under the Fund for Bilateral Relations – the promising bilateral activities, as a predefined initiative implemented by the Polish-Norwegian partnership: harmonisation of the Svalbard cooperation (HarSval). The activities increased the range of research and involved a much broader range of partners. The Polish-Norwegian cooperation also exploited to enhance competencies and skills, as well as achieve internalisation and increased visibility of the Polish polar community.

Glacier-climate interactions and their impact on hydrological connectivity in a high-latitude ecosystem

Nicolas Cullen[1], Marte Hofsteenge[1], Tamara Pletzer[1], Jono Conway[2], Eva Nielsen[3], Peyman Zawa-Reza[3], Marwan Karturji[3], Charles Lee[4]

[1] University of Otago, New Zealand
[2] NIWA, New Zealand
[3] University of Canterbury, New Zealand
[4] University of Waikato, New Zealand

The glaciers in the McMurdo Dry Valleys of Antarctica are unusual as there is no clear evidence they are in retreat, and they do not appear to have been impacted by the warming world that surrounds them. As such, they provide us with a unique opportunity to assess the physical processes governing the generation of meltwater from glaciers that have not yet breached a significant threshold of change, unlike the majority of glaciers in the Arctic and elsewhere. What sets the McMurdo Dry Valleys apart from other glaciated environments is that changes in the surface energy balance are the primary control on meltwater generation and mass balance, due to the extremely limited precipitation. In this context, this presentation reports on key findings of a multi-disciplinary project funded by the New Zealand Antarctic Science Platform that has targeted how climate forcing impacts hydrological connectivity in the McMurdo Dry Valleys. A multi-scale atmospheric approach to assess glacier-climate interactions, combined with novel distributed hydrological modelling, have provided key insights into the connections between atmosphere, glaciers, bare land, stream channels and lakes (hydrological reservoirs), revealing how sensitive this unique high-latitude ecosystem is to small perturbations in climate. These findings are expected to be of particular interest to researchers working in the high Arctic, where similar ecosystems are experiencing comparable or even more significant changes.

Decades of Surface Melt and Supraglacial System Evolution on Ellesmere Island's Glaciers

Pénélope Gervais[1], Luke Copland[1], Dorota Medrzycka[1], Brice Noël[2], Dorthe Dahl-Jensen[3], Karen Alley[3]

[1] University of Ottawa, Canada
[2] University of Liège, Belgium
[3] University of Manitoba, Canada

Over the past two decades, the Canadian Arctic Archipelago has experienced substantial glacier mass loss, with surface melt contributing 90% to the overall decline since 2005. This study offers the first in-depth analysis of the evolution of supraglacial drainage patterns along Ellesmere Island's ∼830 km latitudinal gradient, using satellite imagery, historical aerial photographs, and digital elevation models from 1959 to 2020. Five glaciers were examined, revealing surface drainage patterns shaped by surface topography. Notably, the expansion of perennial rivers, especially at higher elevations, has increased drainage density over time. Unnamed 1 Glacier on northern Ellesmere displays pronounced channelization and a stable perennial system, while southern glaciers like Unnamed 2 and John Evans Glacier exhibit more ice canyon development. Cold ice near the surface of northern glaciers favors greater drainage density, whereas southern glaciers with moulin fields demonstrate stronger supraglacial-subglacial connectivity. Despite increased channelization, changes in sinuosity have remained insignificant, highlighting dynamic canyon behavior influenced by surface slope and discharge.

These results align with modeled increases in surface melt, which are particularly important on glaciers further south on Ellesmere Island, where supraglacial systems have expanded more rapidly. As climate warming continues, further increases in the height of the Equilibrium Line Altitude are expected, accelerating melt and particularly impacting glaciers with a substantial amount of ice at mid-elevations. Although far northern glaciers such as Unnamed 1 may further develop their supraglacial systems at higher elevations, the absence of an accumulation zone suggests a potential for complete glacier loss in the near future.

Observed increasing glacier and glacial landsystem instability in Mt. Gongga

Qiao Liu[1]

[1] Chinese Academy of Sciences, China

Anthropogenic climate change is rapidly altering high mountain environments. Especially in mountain glacier zones, increasing water-mass movement and instability of both glacier itself (surge, crevassing and collapse, etc.) and glacial landsystems (moraine slope movement and failure collapse, lateral rock fall and rock avalanches, proglacial fluvial dynamics, etc.) usually generate cascading cryogenic disaster risks, threatening the ever-expanding mountain communities and downstream infrastructures. With more than 70 modern glaciers, Mt. Gongga, located in center Hengduan Mountains and southeastern Tibet Plateau, is one of the major monsoon-temperate glacier regions in High Mountain Asia. Since Little Ice Age, temperate glaciers in Mt. Gongga retreat substantially and show an accelerating deglaciation rate during the recent decade. The remarkable thinning and retreat glaciers expose new but most unstable landscapes around the Mt. Gongga, susceptible to rapid glacial geomorphological and biological changes. In this talk, I will review the observed glacier and paraglacial changes in Mt Gongga, evidence will be presented with the aid of archive long-term satellite monitoring and the recently developed high temporal-spatial remote sensing technology (including repeat UAVs), as well as automatic ground inspections such as time-lapse cameras and automatic environment sensor stations. Drivers, processes and impacts of glacier and glacial landsystem instability will be discussed with categorized typical cases/events happened in recent years.

Variations in surface melt over the Greenland ice Sheet from regional climate models

Qinglin Zhang[1]

[1] Chinese Academy of Meteorological Sciences, China

Due to global warming, the Arctic cryosphere has become the fastest-warming region globally. Since the end of 20th century, the Greenland Ice Sheet (GrIS) has experienced continuous mass loss, primarily driven by increasing surface melt. This study uses regional climate models (RACMO and MAR) to analyze changes in surface melt and extreme melt events over the GrIS since 1958. The key findings are as follows: (1) The GrIS annually generates an average of 641.6 (541.7) Gt of surface melt, with summer melt contributing 85.3 (92.2)%. Surface melt exhibited a decreasing trend until the mid-1980s, after which it increased rapidly at rates of 8.2±5.3 (10.0±6.0) Gt/yr^2 since the 1990s. (2) Regional variations in melt trends are apparent, ranging from 0.5±0.7 (0.9±0.9)%/yr to 3.6±1.8 (4.3±2.2)%/yr, with northern GrIS showing stronger increases than the southern GrIS. (3) Extreme melt events have also intensified, with the cumulative duration of summer extreme melt events (top 10%) increasing significantly post-1990 (+9.8/8.8 days on average for RACMO/MAR) compared to 1958-1990. Medium- and long-duration extreme events now contribute 31/33% and 49/44%, respectively, to the overall increase in summer melt. (4) The phase transitions in the Greenland Blocking Index (GBI) and the North Atlantic Oscillation index have been critical in the increased surface melt since the 1990s. Changes in the GBI explain 70% of the variance in summer melt anomalies. Increased atmospheric blocking has led to higher surface net shortwave and downward longwave radiation over western Greenland. Concurrently, enhanced southerly winds have transported warm, moist air to northern Greenland, amplifying downward longwave radiation and sensible heat flux.

Glacier hazards: Will they change in the future?

Regine Hock[1]

[1] University of Oslo, Norway

Glaciers can present serious hazards with potentially disastrous impacts on people and infrastructure, evolving as glaciers retreat due to climate warming. Glacier retreat is a major contributor to global sea-level rise, which exacerbates the risk for extreme sea-level events and flooding. Glacier outburst floods are one of the most dangerous glacier hazards. For example, an outburst flood from an ice-dammed lake at Mendenhall Glacier in Alaska has caused severe property damage in nearby Juneau, in 2023. Another flood in 2024 exceeded the peak flow in 2023. Glacier thinning and increased volume of the ice-marginal lake have contributed to the outburst floods which only started in 2011. In other parts of Alaska outburst floods have led to increased bank erosion of large rivers with potential impacts on the trans-Alaskan oil pipeline. Mountain slopes can become unstable as the buttressing effect by the glacier ice is reduced as glaciers retreat. For example, a massive landslide in 2015 at the head of Taan Fiord, an arm of Icy Bay in Alaska, caused a large tsunami reaching the opposite slope of the fjord up to 190 m above sea level.

Limited understanding of the processes causing glacier hazards complicates risk prediction. As glaciers shrink or disappear, some glacier-related hazards may become more intense and frequent, while others might diminish. Adverse effects are exacerbated as human activities increasingly expand into hazard-prone regions.

Scientific Contributions to Avalanche Safety Management at Ski Resorts: Co-Creation with Local Governments and Ski Resorts in Niseko

Satoru Yamaguchi[1]

[1] National Research Insitute for Earth Science and Disaster Resilience, Japan

In the Niseko area of Hokkaido, a unique rule, designated the 'Niseko Rule', has been established to regulate the opening and closing of gates in accordance with the prevailing risk of avalanches. This rule permits skiing off-piste. In recent years, there has been a demand for scientific evidence that can explain the Niseko Rule correctly, as well as for the development of human resources and the establishment of an organisational structure to ensure its continued operation. In order to achieve this, we have been working in collaboration with the local government and ski resorts to develop a system that provides crucial information for the assessment of the avalanche risk in the Niseko area. Furthermore, we are also providing this information in real time during the winter season. Through these activities, our objective is to achieve sustainable ski resort safety management by enabling the opening and closing of gates based on scientific information.

Towards a spatio-temporal perennial firn aquifer distribution throughout Svalbard

Satu Innanen[1], Erik Schytt Mannerfelt[1]

[1] University of Oslo, Norway

Firn aquifers are regions of firn where surface meltwater fills available firn pore space and is retained without fully refreezing. They can delay runoff and water input to subglacial channels, or the aquifer water can be carried to the glacier bed through hydrofracturing. Liquid water storage in firn is a substantial energy reservoir, impacting the thermal regime of the ice. Thus, the presence or absence of a firn aquifer may be a large factor for the dynamics of the glacier. Decreasing firn cold content and higher melt rates may lead to an expansion of firn aquifers but decreasing firn pore space and shrinking firn areas may lead to an opposite effect.

There are a few reported observations of firn aquifers in Svalbard. Nevertheless, there is a considerable knowledge gap in understanding how widespread they are in Svalbard glaciers and how they change under a warming climate. Here, we present a set of newly collected ground-penetrating radar data from Holtedahlfonna and Austfonna, Svalbard, and discuss the required steps to obtain a regional distribution of firn aquifer extent and evolution throughout the Svalbard archipelago. Furthermore, we assess how the presence of aquifers could possibly be predicted based on climatic conditions.

Changes in coastal environments and their impact on society in northwestern Greenland

Shin Sugiyama[1], ArCS II Coastal Environments Project

[1] Hokkaido University, Japan

Coastal environments around Greenland are rapidly changing under the influence of a warming climate. Melting glaciers are affecting ocean environments, resulting in a wide range of impacts on marine ecosystems. Steep terrains along the coast are destabilized by thawing permafrost and heavy rain events. These changes in the land-based cryosphere are serious concerns of Greenlandic societies. An increasing amount of glacial melt causes flooding of streams. Settlements at the foot of steep slopes are threatened by landslide hazards. To investigate changing cryosphere and their impact on coastal society in Greenland, we have been running a research project in Qaanaaq, a small village in northwestern Greenland, under the framework of Japanese Arctic research projects GRENE (Green Network of Excellence), ArCS (Arctic Challenge for Sustainability) and ArCS II. On Qaanaaq Ice Cap, annual mass balance and ice speed have been measured since 2012. Discharge of a glacial stream is measured to study the mechanism of foods, which frequently destroy a road connecting the village with Qaanaaq Airport. A slope affected by a landslide was surveyed to study the triggering mechanism of failure. In glacial fjords, using boats operated by local collaborators, seawater properties are measured, moorings are installed for year-round measurements, and habitats of fish, seabirds and marine mammals are surveyed. Recently, our study has been extended to issues directly related to society, such as waste management and living environment of buildings. Project activities and study results are reported to the community in a workshop organized in Qaanaaq since 2016. This is because the involvement of local society in scientific research is a matter of importance in the Arctic. To contribute to the sustainable future of Arctic societies, we continue collaboration, conversation and designing research together with the local community.

Optical televiewer observation of the borehole of Kongsvegen Glacier in Svalbard

Shuntaro Hata[1], Shin Sugiyama[1], John Hult[2], Maiken K. Revheim[2], Satu Innanen[2], Thomas V. Schuler[2]

[1] Hokkaido University, Japan
[2] University of Oslo, Norway

The internal structure of glaciers provides valuable information about the processes of glacier flow and sediment intrusion into the ice. However, direct observations are rare especially near the glacier bed because the access is difficult. To investigate the internal structure of glacier ice and sediment layer, we performed an optical televiewer observation at a tidewater glacier in August 2024. Here we report the preliminary analysis of images obtained in a borehole drilled to the base of the glacier.

Kongsvegen (78°48’N, 12°59’E) is a ∼100 km^2 tidewater glacier in Svalbard, flowing into Kongsfjorden. Kongsvegen is a surge-type glacier. The last surge was in 1948 and currently the glacier is in the quiescent phase. Because the glacier is underlain by a soft-sediment layer, the glacier ice near the bed potentially includes sediments entrained during the process of glacier flow.

In August 2024, we drilled to the glacier bed using a hot-water drill and reached the base at 361-m depth. We performed borehole observation by using a televiewer BIP-6 (Raax Co. Ltd.), which captures 360-degree lateral view with a cone-shaped mirror in the probe. The system contains a digital magnetometer inside to account for the probe rotation in the borehole. We captured the image for full length of the borehole, with the resolutions of ∼1 mm for vertical/lateral directions.

The televiewer captured different types of layers in the glacier. Ice layers are distinguished by brightness, which is affected by the amounts of included bubbles . Sediment layers were observed at 255–361 m depth. We counted 48 sediment layers from visual inspection of the televiewer images. The intervals between the layers were smaller in the deeper region. In the presentation, we will show the analysis of sediment layers (dip, direction and distributions) and discuss the televiewer data with images from a down-looking video camera.

Avalanche risk management: Integration of natural and social sciences

Steph Matti[1]

[1] Icelandic Meteorological Office, Iceland

Risk stands at the intersection between natural hazards, exposure and vulnerability. In avalanche risk management, emphasis is not placed on the distinction between natural and social sciences, but rather on the interconnected chain of inputs that informs effective risk management strategies. This chain includes meteorology, snow mechanics, snowpack stability, terrain analysis, triggering mechanisms, avalanche formation, forecasting, hazard zoning, risk behaviour, evacuations, and rescue operations. Each element plays a crucial role in the overall risk management process, underscoring the importance of an integrated approach over disciplinary boundaries. This presentation explores how this integrated approach has been developed for avalanche risk management, how it works in practice, and lessons that can be learnt for the management of other hazards including glacial lake outburst floods, permafrost thaw and flooding.

Formation and drainage of Setevatnet, a glacial lake of Kongsvegen in Svalbard

Takuro Imazu[1], Thomas V. Schuler[2], Shuntaro Hata[1], Jack Kohler[3], Shin Sugiyama[1]

[1] Hokkaido University, Japan
[2] University of Oslo, Norway
[3] Norwegian Polar Institute, Norway

Setevatnet (78°49' N, 12°37' E) is an ice-dammed lake of Kongsvegen, a tidewater glacier in Svalbard. Because the lake has been formed and drained into the base of Kongsvegen every summer, a significant impact is expected on the hydrology and dynamics of the glacier. To better understand the impact on the glacier dynamics, the detailed mechanism of the formation and drainage processes are required to be constrained. Here, we report the results of satellite and field observation using a geophone during the lake formation and drainage in 2024.

Using 38 satellite images acquired from 3 May to 12 August 2024, we measured the surface area and water volume of Setevatnet. We utilized NDWI (normalized differential water index) to distinguish water pixels. The lake bathymetry was obtained by ArcticDEM after the drainage (31 August 2013, 8 August 2015, and 16 September 2015). The lake water volume was estimated from the bathymetry and the lake-surface elevation, derived from the shoreline location of each image. On the glacier, we installed a geophone with a sampling frequency of 200 Hz, ∼900 m from the lake, and 1 m below the surface to identify icequake events.

The lake was first formed on 27 May and expanded towards 4 July. The maximum lake area and water volume were $1.80\times105 \pm 0.20\times105$ km^2 and $2.08\times106 \pm 0.30\times106$ m^3. The drainage period was from 4 to 16 July. The number of seismic events increased rapidly when the lake began formation and gradually decreased during the drainage period. The increase in seismic events on the glacier implies the connection between the lake and the subglacial (or englacial) hydrological system during the lake expansion.

In the presentation, we discuss the drainage mechanism and its impact on the ice dynamics, with further analysis of acoustic data and time-lapse camera images.

Exploring the Dynamics of Belcher Glacier, Nunavut, Canada using GNSS-Derived Daily Velocities (2021-2023)

Tamara Marchant[1], Wesley Van Wychen[1], Adam Garbo[2], Luke Copland[2], Anna Wendleder[3]

[1] University of Waterloo, Canada
[2] University of Ottawa, Canada
[3] German Space Agency (DLR), Germany

Belcher Glacier is the largest outlet glacier of Devon Ice Cap (Nunavut, Canada) and provides a significant source of ice discharge to the ocean. Previous literature indicates dynamic changes are occurring there, as near-terminus flow velocities derived from RADARSAT-2 imagery averaged ∼300 m a-1 in the winter seasons of 2009-2014, which accelerated to ∼400 m a-1 in the winters of 2015-2020. This is important, as other large tidewater glaciers within the region, such as the Trinity-Wykeham Glacier basin, have experienced dynamic thinning and acceleration over the last decade and may be susceptible to collapse. This study investigates whether the process of near-terminus floatation operating at Trinity-Wykeham Glaciers are also responsible for the recent acceleration of Belcher Glacier by: (1) developing a record of Belcher Glacier's velocity from August 2021-2023 from in situ Global Navigation Satellite System (GNSS) data collected by open-source GNSS receivers; and (2) using the GNSS records to validate 11-day separated velocity maps derived from TerraSAR-X/TanDEM-X collected since 2022. GNSS data was processed using NRCan's Precise Point Positioning service to create daily velocity outputs, while remotely sensed data was processed through GAMMA offset tracking procedures. During the period of study, average annual velocities collected between September of each year decreased, from ∼152 m a-1 (2021-2022), to ∼145 m a-1 (2022-2023) at the GNSS station nearest to the terminus. Seasonal summer variability in 2022 began in early June, reaching a peak daily velocity of ∼416 m a -1 between July 11-12th, while in 2023, annual speed-up began in early July, reaching peak daily velocity August 18-19th at ∼407 m a-1. The validation of SAR-derived velocity products is calculated and compared to the nearest GNSS station values to provide insight into the efficacy of SAR remote sensing's strengths as a tool for monitoring glacier velocities in Canada's north.

Ice thickness modelling of every glacier on Earth

Thomas Frank[1], Ward van Pelt[1], Regine Hock[2]

[1] Uppsala University, Sweden
[2] Oslo University, Norway

Despite there being previous studies on the ice thickness and bed topography of glaciers worldwide, there remain large uncertainties which are crucial to address. Here, we present the setup, methodology and first results of a new global glacier thickness inversion study that is entirely constrained by observations and validated against independent ice thickness measurements. Novelties include the use of a fully distributed, physics-informed deep learning model (IGM; Jouvet and Cordonnier, 2023) and a fast, observationally constrained inversion method (Frank et al., 2023), resulting in ice thickness maps that are consistent with higher-order ice flow physics and the dynamic state of the glaciers. We discuss progress made so far, challenges encountered and comment on differences and similarities to previously published global thickness products.

Glacier Surges Controlled by the Close Interplay Between Subglacial Friction and Drainage

Thomas V. Schuler[1], Kjetil Thøgersen[1], Adrien Gilbert[2], Coline Bouchayer[1]

[1] University of Oslo, Norway
[2] University Grenoble Alpes, France

The flow of glaciers and ice sheets is largely influenced by friction at the ice-bed interface that can trigger rapid changes in glacier motion ranging from seasonal velocity variations to cyclic surge instabilities or even devastating glacier collapse. This wide range of transient glacier dynamics is currently not captured by models, and its implications for long-term glacier evolution are uncertain. Here, we present a model combining rate and state friction with subglacial hydrology processes that spontaneously generates glacier surges. A wide range of glacier behavior emerges from the model, including periodic and quasi-periodic glacier surges. These can be understood from the interaction between friction and the subglacial drainage system. Glacier surges are possible if the efficiency of the drainage system is not high enough to drain the water that enters and is produced at the glacier base. This allows water pressure to increase over time, which can potentially trigger a frictional instability. Depending on the configuration of the subglacial drainage and how it evolves in response to sliding, glaciers can be stable or surge-type, in addition to exhibiting several different classes of velocity variations. We advocate accounting for feedback loops between friction and drainage as a promising avenue for future research to better understand dynamical instabilities of glaciers and ice sheets.

Acoustic sensing of Qaanaaq Glacier runoff, northwestern Greenland

Tomohiro Nakayama[1], Evgeny A. Podolskiy[1], Takuro Imazu[1], Kotaro Yazawa[1], Shin Sugiyama[1]

[1] Hokkaido University, Japan

Glaciers, ice caps, and the Greenland Ice Sheet have significantly contributed to sea level rise in recent decades. To estimate the contribution of glacial meltwater to the sea level rise, discharge observations of glacier outlet rivers are essential. In addition, glacier outlet rivers sometimes cause flooding due to extreme melting as well as heavy rain fall, that might impact local societies. Hence, it is crucial to observe the discharge of glacier outlet rivers continuously.

However, previous methods of discharge monitoring required researchers to enter the turbulent stream, manually holding an expensive electromagnetic current meter, with a risk of being swept away. Alternatively, passive acoustic methods can be very cost- and labor-effective because they may allow noninvasive monitoring by simply placing acoustic sensors near the river. However, the limitations and advantages of such a sound recording approach are poorly understood.

In the summer of 2024, we deployed four acoustic sensors and three time-lapse cameras along a glacier outlet river in Qaanaaq, Greenland, to explore the potential of comprehensive acoustic monitoring for discharge estimation. In addition, we repeated discharge measurements using an electromagnetic current meter to establish a relationship with continuous water-depth measurements by a pressure sensor as well as the acoustic data.

Here, we demonstrate that the sound generated by the glacier outlet river correlates with discharge at all stations and can be used as a continuous proxy for the runoff. We also discuss the associated errors and advantages of using multiple sensors along the stream, as their combination might inform us about the average water flow speed. This study highlights how simple acoustic sensors can provide valuable information about glacier runoff.

Decadal Glacier Dynamics in Nunavut's Auyuittuq and Sirmilik National Parks, Canadian Arctic: A Photogrammetric Analysis from 1958 to 2023

Wai Yin Cheung[1], Laura Thomson[1]

[1] Queen's University, Canada

Understanding the dynamics of Arctic glaciers is critical for predicting future sea-level rise and assessing regional climate impacts on Arctic societies, particularly local communities such as those in Pond Inlet and Pangnirtung. This study quantifies six decades of glacier changes in Auyuittuq National Park (ANP) on Baffin Island and Sirmilik National Park (SNP) on Bylot Island, Nunavut, Canada. Utilizing photogrammetric analysis of historical aerial photographs from 1958/59 to 2023, supplemented with modern satellite imagery and high-resolution digital elevation models (DEMs), we document significant glacier retreat and thinning in these regions. In ANP, glaciers such as Nakarpog and Nerutusoq exhibited substantial reductions in centerline length (up to 15.82%) and area (up to 19.94%), highlighting the pervasive impact of climate warming. Conversely, Fountain Glacier in SNP showed pronounced thinning (elevation loss of -24.90$\pm$1.77 m water equivalent) with minimal areal change, underscoring the complex dynamics of polythermal glaciers. Overall, the observed negative mass balance trends, punctuated by localized mass gains, reflect nuanced responses to regional climatic variations.

Methodological advancements, including the application of ArcticDEM and regional hypsometric interpolation, were instrumental in overcoming challenges such as data voids and photogrammetric errors, enhancing the robustness of our findings. These results have significant implications for predicting future glacier contributions to sea-level rise and for understanding broader impacts on Arctic hydrology and ecosystems, which are vital for local communities like Pond Inlet and Pangnirtung. The changing glacier dynamics affect freshwater availability, traditional hunting routes, and the overall livelihood of these communities. This research provides valuable insights into the mass balance and dynamics of Arctic glaciers, contributing to improved models for future glacier behavior under accelerating climate change.

Bed topography and thickness maps for Svalbard and the Canadian Arctic

Ward van Pelt[1], Thomas Frank[1], Dorota Medrzycka[2], Luke Copland[2]

[1] Uppsala University, Sweden
[2] University of Ottawa, Canada

Knowledge of the thickness, volume, and subglacial topography of glaciers is crucial for a range of glaciological, hydrological, and societal issues, including studies on climate-warming-induced glacier retreat and associated sea level rise. We present new maps of the ice thickness and subglacial topography for every glacier on Svalbard, and discuss ongoing thickness estimation in the Canadian Arctic. Using remotely sensed observations of surface height, ice velocity, rate of surface elevation change, and glacier boundaries in combination with a modeled mass balance product, we apply an inverse method that leverages state-of-the-art ice flow models to obtain the shape of the glacier bed. In Svalbard, we modeled large glaciers with the Parallel Ice Sheet Model (PISM) at 500 m resolution, while we resolve smaller mountain glaciers at 100 m resolution using the physics-informed deep-learning-based Instructed Glacier Model (IGM). Actively surging glaciers are modeled using a perfect-plasticity model. We find a total glacier volume for Svalbard (excluding the island Kvitøya) of 6800±238 km^3, corresponding to 16.3±0.6 mm sea level equivalent. In the Canadian Arctic, we attempt to use a single ice flow model (IGM) for all glaciers. First test results for Devon Ice Cap are presented.

Projection of Glacier Changes over the Laohugou Glacier No. 12, Northeast Tibetan Plateau, China from 2020 to 2100

Weijun Sun[1], Mengyuan Liu[1], Baojuan Huai[1]

[1] Shandong Normal University, China

Alpine glacier meltwater from the Qilian Mountains (QMs), northeast Tibetan Plateau, is main source of water for the surrounding arid zones. Accurately reconstructing long-term mountain glacier mass balance (MB) and prejecting glacier changes under climate warming are pivotal in cryospheric scientific research. In this study, Laohugou Glacier No. 12 (LHG12), in the western QMs, was selected as a study area. Based on the evaluated and corrected CMIP6 model data, the degree-day and glacier retreat model were used to predict the glacier changes under three scenarios for 2020–2100. The results showed that 1) from 2020–2100, the annual mass loss of LHG12 simulated using CanESM5 and EC-Earth3 increased compared to the measured data in the historical period (2010–2014) (i.e., annual MB of -0.26 m w.e) by a factor of 1.04 and 1.73 under SSP1-2.6, 4.62 and 4.88 under SSP3-7.0, and 6.23 and 7.15 times under SSP5-8.5. 2) By 2100, the ice volume of LHG12 simulated using CanESM5 and EC-Earth3 reduced to 1.00×109 (58.2 %) and 1.27×109 (74.0 %) m3 under SSP1-2.6, 0.18×109 (10.2 %) and 0.15×109 (8.9 %) m3 under SSP3-7.0, and 0.03×109 (1.6 %) and 0.01×109 (0.4 %) m3 under SSP5-8.5, respectively. 3) Under SSP5-8.5, the LHG12 area simulated using CanESM5 and EC-Earth3 was only 1.87 and 0.75 km^2 by 2100. This study lays a foundation for predicting the peak and inflection points of runoff change in the QMs.

Flow Speeds and Variations of Sydkap Glacier, Canadian High Arctic revealed through a dense record of TSX/TSX imagery

Wesley Van Wychen[1], Anna Wendleder[2], Tamara Marchant[1]

[1] University of Waterloo, Canada
[2] German Aerospace Center, Germany

Sydkap Glacier is a tidewater terminating outlet glacier of Sydkap Ice Cap, located on the southern portion of Ellesmere Island. Since the mid-1900s, the glacier has been in a general state of terminus retreat, punctuated by periods of relative stability, likely related to lateral and basal pinning points. Radarsat-2 derived glacier velocities suggest that the glacier has accelerated in recent years, although the record of ice motion is limited to imagery collected only during the winter months, meaning that the understanding of how the flow speeds of Sydkap Glacier evolve within a year are largely unresolved. In this work, we utilize a dense record of TerraSAR-X and TanDEM-X imagery collected every 11 days over Sydkap Glacier from 2022 to ∼present to resolve seasonality of glacier system. These results are augmented with historical records of ice motion resolved from ALOS PALSAR data with the goal of placing the recent dynamic evolution of Sydkap Glacier within a wider context. Collectively, this work contributes to our understanding of how tidewater glaciers within the Canadian are evolving through time.

Quantifying upward surge propagation rates of the marine-terminating glaciers in Svalbard

Whyjay Zheng[1], Han-Yu He[1]

[1] National Central University, Taiwan

Unlike the typical glacier surge that initiates at the upstream region and propagates downward, many marine-terminating glaciers in Svalbard enter the surge phase by the frontal speed-up, followed by the upward propagations of ice flow acceleration and dynamic thinning. Significant retreat and thinning at the terminus zone may provide an environment favoring surge initiation at the front. However, how this local perturbation leads to a glacier-wide dynamic change remains unclear. Here, we attempt to capture the upward surge propagation in a fine spatial and temporal resolution by stacking the abundant ArcticDEM strips for marine-terminating glaciers in Svalbard that surged in the past ten years. We design a workflow that extracts the monthly time series of the ice surface elevation at every 100 m along the center flowline. We then calculate the monthly elevation change rate for every time series and locate the thinning center locations over time. A preliminary test performed at Wahlenbergbreen, Spitsbergen, successfully revealed that during its surge phase between 2014 and 2017, the thinning center traveled at ∼3 km/yr upward (8 m/day; ∼18 km in three years). The results give clues about the most important controlling factors and their magnitude in a kinematic wave framework of glacier surge. With more analyses done in the future, we can potentially obtain insight into whether the warming ocean and climate have changed the surge behavior or made the upward surge propagation occur more frequently.

Mapping global glacier terminus types

Will Kochtitzky[1], Will Kochtitzky[1], Jakob Steiner[2], Robert McNabb[3], William Armstrong[4], Tobias Bolch[5], Rodrigo Aguayo[6], Fabien Maussion[7]

[1] University of New England, USA
[2] University of Graz, Austria
[3] Ulster University, UK
[4] Appalachian State University, USA
[5] Graz University of Technology, Austria
[6] Vrije Universiteit Brussel, Belgium
[7] University of Bristol, UK

Knowing if a glacier is land, marine, lake, or shelf terminating is critical information for global glacier studies including mass balance and various modeling efforts. However, the Randolph Glacier Inventory has yet to include a globally consistent inventory for terminus types. Here, we present the first global attempt to identify all glacier terminus types including updates in RGI 7 and a community effort to identify lake terminating glaciers. Globally, marine-terminating glacier make up about 1% of glaciers by number with about half of those in the Arctic and the other half in Antarctica. However, by area marine-terminating glaciers account for 38.9% of Arctic glacier area, including Alaska. Globally, marine and shelf-terminating glaciers make up 40.5% of glacier area. We map lake-terminating glaciers as either being definitely, probably, or possibly relevant for glacier dynamics (classes 1, 2, and 3). We found that 1.8% of glaciers globally end in lakes, the majority of which occur outside of polar regions. However, lake terminating glaciers account for 15.2% of global glacier area. We expect a full updated dataset of terminus types to be available in 2025.

Numerical modeling of biological processes on snow and glacier ice surfaces in the Arctic region

Yukihiko Onuma[1]

[1] Japan Aerospace Exploration Agency (JAXA), Japan

Biological processes on snow and glacier surfaces in the Arctic region play a key role in causing albedo reduction called as "Bio-albedo effect" due to blooms of snow and glacier phototrophs. The bio-albedo affects the hydrological cycle by accelerating the snow and ice melting. Because the bio-albedo effect varies temporally and spatially due to their biological properties including growth, death and migration, the biological processes need to be separated from accumulation processes of the other impurities such as aeolian mineral dust and black carbon. In addition, different processes causing the bio-albedo effect, which are known as red snow, dark ice and cryoconite holes, are observed in the Arctic snowpacks and glaciers. To understand the bio-albedo effect quantitatively, a numerical model to reproduce such biological processes as well as a physically based albedo model should be established. We recently established several numerical models: the snow algae model to simulate red snow phenomena caused by snow algal blooms, the glacier algae model to simulate dark ice phenomena caused by glacier algal blooms and the cryoconite hole model to simulate vertical dynamics of cryoconite holes. In this workshop, I will introduce cryo-microbial activities under climate change via field observations and numerical modeling works.