



**NEWS BULLETIN  
OF THE INTERNATIONAL  
GLACIOLOGICAL  
SOCIETY**





# Ice

## News Bulletin of the International Glaciological Society

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*Cover picture:* Paintings by Jesus Mari Lazkano on display at the Bilbao symposium, acrylic on canvas. Left to right: Svalbard II; Todo lo sólido se desvanece en el aire II [Everything solid fades in the air II]; Svalbard III. Photo by Sérgio Henrique Faria.

**EXCLUSION CLAUSE.** While care is taken to provide accurate accounts and information in this Newsletter, neither the editor nor the International Glaciological Society undertakes any liability for omissions or errors.

# From the Editor

Dear IGS member

It is time for the next ICE. Reprehensibly it is the first ICE of 2022 but such is life.

First, I would like to raise the issue of the newly established Membership Management Committee. One of their remits is to oversee and maintain our commitment to Diversity, Equality and Inclusivity as set out in the IGS core values. But in order to do so we need to collect information on the composition of our membership such as gender, age, demographics, career status, etc. The best way to do this is to ask our members to log into IGSCoconnect, our membership database, and fill in the relevant information for us to get an insight into the status of our members. All information will be strictly confidential and it will be stored and handled in strict compliance with Governmental Data Protection Regulation, GDPR. The dissemination of all information will be anonymous and untraceable. But that information will enable us to closely monitor our progress toward being fully gender-neutral and equality- and inclusivity-driven.

I thus very strongly plead with our membership to help us all by supplying us with the information we so desperately need to fulfil our commitment.

Next, I would like to address another issue I feel strongly about and that is the general involvement of our members in our Society's development and growth. We do our best to provide you with interesting happenings, meetings, workshops and symposia. We need your support and involvement at every level of the Society. Let me start with the IGS correspondents. We have 29 correspondents in 25 countries worldwide. The remit of these correspondents was recently restructured. Their previous task prior to the restructuring was to regularly compile reports on the research and projects within their respective countries. This was scrapped on the premise that the information they were collecting was already available online and thus their work was redundant. The new remit is best described on the Correspondents website <https://www.igsoc.org/about/correspondents>.

The item I would like to focus on first is the 'submission to the IGS Secretary General of brief news items on glaciological activities or projects developed in their country, for dissemination though ICE and/or the IGS website news or social media'. It does not have to be brief, a nice example is the historic piece by the Icelandic correspondent, Hrafnhildur Hannesdóttir, about the Icelandic Glaciological Society published in our Covid issue of *ICE*, [https://www.igsoc.org/wp-content/uploads/2022/03/ice\\_182\\_184\\_2020.pdf](https://www.igsoc.org/wp-content/uploads/2022/03/ice_182_184_2020.pdf). In the same issue of *ICE*, we also had a nice piece by our Argentinian correspondent, Lucas Ruiz and a contribution by Paola Araya from the Geophysics Department, University of Chile, on 'Between Women and Glaciers: a historical perspective on the representation of women in glaciology and its current challenges'.



Another thing we like to improve on is the representation from IGS branches. I strongly encourage the organizers to file a report on each Branch meeting, with pictures, to the IGS office. Some branches are doing well on this front and we have recently been reorganising the 'Branches' website, starting with the second oldest IGS branch, the Nordic one. Please visit the site <https://www.igsoc.org/about/branches/nordic-branch>. Next, I plan to attack the British Branch. Sadly, I am unable to attend all branch meetings, for obvious reasons, to push for those reports so I have to rely on the participants in those meetings and the organizers to step up to the plate. Those that are able to can establish their own site similar to what the New Zealand Branch has done (see <https://sirg.org.nz>), or you can work with the IGS office to build up your own site. I cannot stress enough what a wonderful and very interesting archive we are building up. As time permits, I am scouring through the old issues of *ICE*, now all online at <https://www.igsoc.org/publications/ice>, to dig up historic 'Branch news'. But we need the input from all of you!

I will stop my ramblings for now so we can start on the next issue of *ICE* in our never-ending quest to 'catch up'.

**Magnús Már Magnússon**  
Secretary General



# Report on the Karthaus 2022 Summer School on Ice Sheets and Glaciers in the Climate System

**24 May–4 June 2022, Karthaus, Schnalstal, northern Italy**

Finally, after 2 years of having to cancel the course because of the covid-19 situation, the 20th Karthaus summer school on Ice Sheets and Glaciers in the Climate System took place from 24 May to 4 June 2022 in Karthaus, Schnalstal, northern Italy. Because the 2020 and 2021 events had to be cancelled, the number of applications was twice the usual and we inevitably had to disappoint a lot of students. In the end, 36 students (mainly PhD) affiliated to institutes from 12 countries took part.

The students had lectures in various topics within glaciology, including topics such as continuum mechanics, kinematics, ice rheology, sliding and hydraulics, numerical modelling, polar meteorology, ice–ocean interaction, ice cores, interaction of ice sheets with the solid earth, glacier fluctuations and climate change.

During the first day all students presented their research topics in 3-minute pitches. This is always an important aspect of the start of the course, because students and teachers get to know each other quickly. In addition to lectures and exercises, computer projects, carried out by groups of three students, were also part of the daily Karthaus programme. At the end of the course, the outcomes of these projects were presented in 12 presentations.



*Students working on their computer projects.*

On Sunday 29 May, there was a well-deserved break from the theory and computer exercises, and an excursion took place. In snowy conditions we made a hike from Kurzras up to the Lazaun rock glacier. After sightseeing of the rock glacier, lunch was taken at the Lazaun restaurant. During



*Group photo of the Karthaus 2022 participants.*



*The village of Karthaus with, at lower right, the Haus der Dorfgemeinschaft where the lectures were given.*

lunch the weather cleared and most of the students then hiked down to Vernagt from where they took the bus back to Karthaus, while others took the bus back from Kurzras.

Even though the course was able to go ahead, covid-19 still had an impact. Several



*Small fountain in the village square illustrating the history of the village.*

students and teachers became infected and had to go into quarantine. However, they could still follow the lectures on line and also continued to collaborate in and present the group projects on line. We are very grateful to the management and staff of Hotel Goldene Rose for the way they handled the situation and took good care of us.

A full list of students and lecturers can be found at the Karthaus-2022 website: <http://www.projects.science.uu.nl/iceclimate/karthaus/>, which also contains the full program and more comments on the social aspects of the course.



*Lazaun rock glacier. For scale, see the small line of students to the right of the glacier snout.*



### Additional information:

The 20th Karthaus summer school was sponsored by:

The Institute for Marine and Atmospheric Research, Utrecht University

The Netherlands Earth System Science Centre (NESSC)

Projecting Sea-Level Rise: from Ice Sheets to Local Implications PROTECT (EU Horizon2020 program)

Dutch Polar Climate and Cryosphere Change Consortium (NWO Dutch Polar Program)

The International Glaciological Society

The International Arctic Science Committee &Trewitax – GlaciersAlive

The registration fee per student was 800 euro.



*Students working on exercises. When the weather was nice we went outside. (Photo: R. Shone)*

**Carleen Tijm-Reijmer**

## Report from the Sixth International Summer School in Glaciology

**7–17 June 2022, McCarthy, Alaska, USA**

*What is the most defining event in the life of a researcher?* Perhaps it is a graduate student's first paper, breakthrough research, passing your comprehensive exams, graduation, a personal goal intersecting your professional side of life, and/or more. However, if we look at one common denominator, all these experiences can be summed up as encounters. Whether good or bad, professional encounters always kickstart the motion of discovery.

After more than 2 years of learning and unlearning during the covid-19 pandemic, where students suffered by losing opportunities for in-person networking, taking coffee breaks with colleagues, and

meeting up with peers or lab mates, the 2022 International Summer School in Glaciology in McCarthy, Alaska, USA, was more necessary than ever before. We are lucky as glaciologists to evolve in a unique field of study where researchers and students can have a significant impact on the community and the world.

The International Summer School in Glaciology is not a regular summer school – it is a place that pushes the usual boundaries of the classroom, lab, and/or fieldwork to have students and researchers meet in the most unique conditions. Imagine camping at the foot of a glacier, being stinky for days, the



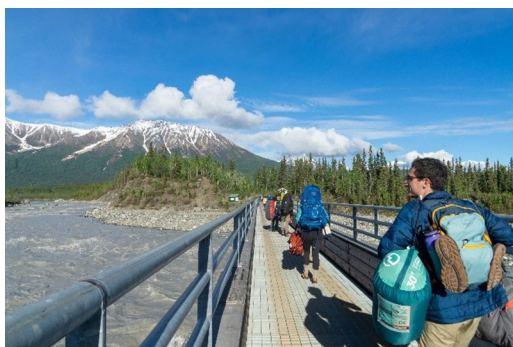
**Figure 1.** A group shot of the 2022 cohort of the International Summer School in Glaciology on Root Glacier holding flags representing their different countries. Photo: Dave Sabell.

unlimited resources of glaciology knowledge around you, and the possibility of a bear snatching your snacks! In these unique conditions, we guarantee that the people you meet will surely stay in your professional life for a long time.

For us, this amazing adventure started in Fairbanks, Alaska, at the rhythm of the incoming planes from France, Norway, the Netherlands, USA, Canada, and other parts of the world. As we are still in a pandemic, everyone took serious precautions to prevent the spread of covid-19 and one of the ways we did this was by establishing our McCarthy Summer School ‘bubble’ with our group of 28 graduate students and 9 lecturers (Figure 1). From Fairbanks, we drove 12 hours to McCarthy, Alaska, with breathtaking stops

at Black Rapids Glacier, Rainbow Mountain, Gulkana Glacier, Copper River, and more, along the way. At each stop, we gained a greater understanding and appreciation of glaciological processes as the instructors described how glaciers shaped the landscape. We gazed in awe at the scenery, with each site highlighting a unique glacier landform. But perhaps the most breathtaking view of them all was when we reached our destination and stepped out of our vehicles with the Kennicott and Root Glaciers in sight (Figure 2).

After setting up camp, we were briefed and warmly welcomed by the wonderful staff at the Wrangell Mountains Center who hosted us for the rest of the summer school. Beyond representing a gathering place for artists and scientists alike, the Wrangell



**Figure 2.** Students’ first sight at the Kennicott and Root Glaciers after a 12-hour drive from Fairbanks, crossing the bridge to the Town of McCarthy. Photo: Andy Aschwanden.



**Figure 3.** Glaciology students during a morning lecture at Porphyry Place. Photo: Andy Aschwanden.





**Figure 4.** A panoramic photo of the summer school poster session at the Wrangell Mountains Center on Day 2 showing all student posters hung on the western outside wall of the building and on clotheslines. Photo: Philipp Arndt.

Mountains Center holds significance to glaciologists thanks to Porphyry Place, the former residence of glacier and avalanche researcher Edward LaChapelle. Our daily programming included a variety of dynamic activities, ranging from daily lectures in Porphyry Place (Figure 3), a student poster session (Figure 4), problem sets and exercises, group projects, public lectures, and a glacier excursion (of course). It was a privilege to learn not only from our peers, but more importantly from the lecturers who are renowned experts in the field of glaciology. The McCarthy Summer School lecturers made students coming from different academic backgrounds feel included and comfortable with the lectures' content. Essentially, in the end, we felt like one big, happy family working together, reinventing linear algebra, calculating surface mass balance, mapping glacier velocities, and trying to solve Ed Bueler's problem set(s) (Figure 5).

With each passing day, our knowledge of theoretical glaciological concepts deepened. This newly acquired information was indispensable for the group projects, in which pairs of students were mentored by the course instructors. Each day, the students and instructors worked diligently on cutting-edge research, from investigating the development of glacier tables to the tidewater glacier cycle, and much, much more. On the last day of the summer school, we presented our findings in a mini-conference, and the energy in Porphyry Place was palpable. All our hard work and dedication had paid off,

and we all exceeded our own expectations of what we were capable of achieving in just 10 short days with no internet connection!

During the 10-day summer school, there were several activities that grew to be student favourites. To highlight a few, the glacier excursion onto Root Glacier was one to remember, especially for the participants who had never hiked across a glacier before. As we ventured across the glacier, we were rewarded by panoramic views of rock glaciers, moraines, moulins, and surface streams. Not only were the glacier surface features spectacular, but the excursion also gave us the opportunity to apply our knowledge learned from the lectures. The instructors shared first-hand accounts of how the landscape has changed since the first summer school in 2010, providing us with a deeper appreciation of the sensitivity of glacierized regions to climate change. For



**Figure 5.** Taking a quick break from working together on problem sets. Photo: Andy Aschwandten.



**Figure 6.** Drained proglacial lake adjacent to Root Glacier as a lunch stop for our glacial excursion. Phot: Andy Aschwanden.

several brave students, the excursion also afforded the opportunity to enjoy a glacier dip/swim in some of the supraglacial lakes!

By luck, a proglacial lake to the west of Root Glacier near Donahoe Falls had also drained earlier that day, which opened breathtaking views to a subglacial cavity and cave-like fluvial system (Figure 6). For some, you could even say that it was love at frost sight. We also owe a special thanks to Doug the Dog (Figure 7), a veteran glacier trekker, who was a great guide and companion on



**Figure 7.** Doug the Dog on the foot of Root Glacier accompanying us on our glacial excursion. Photo: Hannah Verboncoeur.

our hike! While not everything in the summer school was centered completely on glaciers, we also had some pure fun and games along with some ‘free’ time! Other student favourites were the local McCarthy Friday Night Softball Game (Figure 8) and of course – drumroll please – the annual McCarthy Summer School football/soccer game whereby (as tradition upholds) the entire summer school is divided into two teams and the game begins. Even though all the summer school students were playing their



**Figure 8.** McCarthy Friday Night Softball Game played by local McCarthy residents, staff, and summer school students. Everyone (including the McCarthy dogs) is a winner! Photo: Hannah Verboncoeur.

best with such competitive spirit, perhaps the most competitive players of all were the summer school lecturers and Wrangell Mountains Center staff who humbled us all with their football/soccer skills!

Overall, the game was one of the highlights of the summer school as it provided us with the chance to bond, work as a team – and not score any goals when Regine Hock was the (pro) goalkeeper because she was awesome. To reward our efforts, we celebrated with ice cream – after all, we’re glaciologists and if there’s ice involved, we’re interested!

During our limited free time at McCarthy–Kennicott while not in lectures, we would split up into groups and spend our time exploring the town’s history and local culture by visiting the McCarthy–Kennicott Historical Museum, hiking the Bonanza Mine Trail, swimming in the cold freshwater pond near our camp, and some even had a chance to go flightseeing over parts of the Wrangell–St Elias National Park and Reserve overlooking glacial valleys and spectacular tributary glaciers of the Root and Kennecott glaciers.

The summer school broke the mould for many of us who started our academic careers in the virtual environment. The immersive, in-person setting of the summer school was invigorating, as was the spontaneous exchange of research ideas and engaging discussions between students and instructors. By virtue of the summer school, we built connections with like-minded researchers with a passion for glaciology. At the final banquet, we reflected

on the conversations and the unforgettable experiences we shared throughout our time together at the summer school. These fond memories and friendships will stay with us as we move through our careers.

Finally, check out [https://www.youtube.com/watch?v=\\_KxGA7-qFOE](https://www.youtube.com/watch?v=_KxGA7-qFOE) for a 1-second every day video compilation of the 2022 International Summer School in Glaciology. We would like to acknowledge the support of our summer school sponsors without whom none of these unique encounters would have been possible. A huge thanks to the National Aeronautics and Space Administration (NASA), the Norwegian–North American Glaciology Exchange Program RemoteEx, the International Glaciological Society (IGS), the International Association of Cryospheric Sciences (IACS), the International Arctic Science Committee (IASC), the journal *Frontiers in Earth Science*, the International Union of Geodesy and Geophysics (IUGG), the Geophysical Institute, University of Alaska Fairbanks, and two private (glaciologist) donors.

### **Chimira Andres**

Earth & Space Science, York University

### **Victor Devaux-Chupin**

Geophysics, University of Alaska Fairbanks

### **Anna-Mireilla Hayden**

Geography and Environmental Management, University of Waterloo





# International Symposium on Ice in a Sustainable Society

5–10 June 2022, Bilbao, Basque Country, Spain

This symposium represented quite a giant step for the IGS, reaching out to the social sciences, arts and humanities, and actively engaging with the uncomfortable world of people's opinions, feelings and emotions. There were five sessions, all containing a very mixed audience on 'Glaciology meets ...' (1) Physical Sciences, (2) Formal Sciences and Engineering, (3) Life and Environmental Sciences, (4) Social Sciences and (5) the Humanities. It takes a very special type of person to be able to span this range of interests, and to stimulate and moderate discussion, and we were very fortunate that Sérgio Henrique Faria, the Symposium Organizer, is just that sort of person. His energy, enthusiasm, patience and understanding of such a broad

range of topics were humbling. He maintained such good humour and great courtesy to all while becoming increasingly sleep-starved as the conference progressed. He did a great job of keeping all of us on track, together and sufficiently stimulated to do that most awkward of things – to venture outside the comfort zone of the glaciological things that we think we know about and into non-scientific subject areas with a different interest in glaciology from those we commonly encounter.



*The venue was very impressive!*



*At the Icebreaker we could all catch up with colleagues who in many cases we had not seen in the flesh for the last 2 years.*



*The posters were up already for viewing.*



*The Arts presentations made an interesting addition to the usual sequence of purely scientific talks.*



*And some of the presentations in the main hall were on subjects not usually tackled at glaciology meetings.*

The meeting started well with a keynote lecture by Valérie Masson-Delmotte, 'The Cryosphere in the IPCC Sixth Assessment Cycle', which led into a Panel discussion of IPCC past, present and future. It provided a great opportunity for early-career researchers to learn about the IPCC process, and for some of the more experienced folk to ask questions about future IPCC cryospheric directions and priorities. The talks by other scientists in the session, who ranged from near-first-time speakers to older stagers, set high standards for the rest of the meeting to follow.

The lunch breaks were generous, and fitted in with the café and bar culture of Bilbao, and the afternoon and early evening sessions gave our social science, arts and humanities colleagues the opportunity to appreciate that there is an art to the presentation of scientific results and advocacy in their interpretation. The afternoon coffee slots provided opportunities to experience both installations and art that has been inspired by glaciology. A particular favourite of mine was the crevassed ice front art of Jesús Mari Lazkano (see front cover). The different shades of blue in the ice were just perfect, and the lines of the images made you want to read the stress feels and ice motion, as in the field. Most scientists are inspired by music, but on display in the exhibitions was imagery that made you feel proud to be a glaciologist, and resolve to strive to do better work in future.

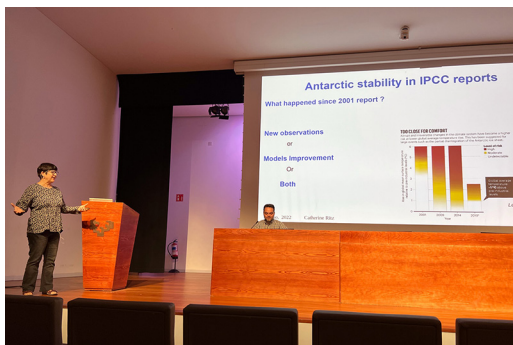
Subsequent keynotes were delivered by Alexandre Anesio – 'Recent Advances in Cryospheric Microbiology' – and Michael Bravo – 'The Cryosphere's Shared Past: Nature and Culture'. These led to a Panel discussion on Transdisciplinary glaciology



*The coffee breaks provided a welcome opportunity for long-delayed networking ...*



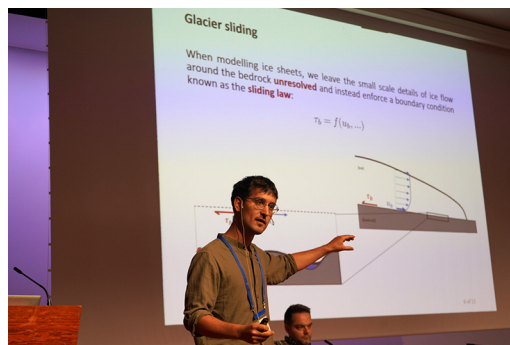
*... and the snacks were as delicious as they always are at IGS symposia!*



*On Thursday morning the Keynote talk was Catherine Ritz's Seligman Crystal lecture.*

and social responsibility, and Moving Ice, the latter being a discussion about the social, cultural and emotional responses to the wasting away of alpine/mountain glaciers in particular, and sea level rise as a result of cryospheric mass wastage. It is a pleasure to report that delegates contributed to these transdisciplinary debates from across the spectrum of the of the five 'Meets' fields, and that great efforts were made by all to understand the positions and research trajectories of those in fields far different from their own.

This type of meeting required the speakers and poster designers to make an extra effort to pitch and explain their topics to an audience of greater academic diversity than many of us are used to. Hats off to our Seligman Crystal Lecturer, Catherine Ritz, who gave



*The winners of the awards for best student oral presentation were Gonzalo Gonzalez de Diego and Linda Rivera Macedo. Here Gonzalo is talking on numerical approximation of viscous contact problems applied to glacial sliding.*

her Seligman Crystal lecture as Thursday's Keynote and did a great job of making her subject area, 'A history of challenges and advances in ice sheet modeling', come to life, illustrating the reasoning why certain strands of modelling research took place at particular times over the past 40 years. This was not only the result of the key science questions being posed at the time, but also the available computational resources and skill sets of the major players in the research arena of those times. It was very evident that there are sociological reasons why great research results just where and when it does.



*Here Bittor Muniozguren Arostegi is pictured beside his award-winning poster illustrating a technique of immersion microscopy on ice.*



*The other winner of the best student poster award was high-school student María Díez Gallego. Here she is preparing to enlarge on her poster on the disappearance of Monte Perdido glacier*





*The Panel discussions were a notable feature of the symposium.*

On Wednesday afternoon some of us went on the main midweek excursion of the symposium, which took about 4 hours. The hike started from Bakio beach and we walked along the coast between trees and farmhouses to one of the most emblematic and touristic places in the Basque Country: the hermitage of San Juan de Gaztelugatxe, a protected biotope and filming location for the famous series *Game of Thrones*. The weather this day was very typical for the Basque coast: overcast skies and sirimiri (very light and continuous rain). On the way we enjoyed a nice walk with impressive views of coves and cliffs. The walk helped in getting to know each other better in a more informal and relaxed way, and at the same time we learned about the



*Despite the less than perfect weather the views were beautiful. This is Bakio beach.*



*The path up to the hermitage is as spectacular as the scenery.*



*There were many things to look at on the hike, as well as making friends with fellow symposium participants*



*A pause on the way back for the obligatory group photo*

history, geography, biology and geology of the place thanks to the guide we had. A gale gave us the opportunity to see the fierceness of the sea breaking against the piece of land that joins the island to the coast. That piece of land is just a narrow path that contains 241 steps and zigzags its way back and forth to the top of the island. Gaztalugatxe's meaning in Basque had already warned us of the difficulty of the path: it translates as *gaztelu-aitz* (rocky castle) or *gaztelu-gatxe* (inaccessible castle). Somewhat tired, we finally reached the top of the island, where we could visit the hermitage. Some of us also rang the bell on the front of the façade: according to the legend, once you have

completed the ascent, you have to ring the bell three times and make a wish. Finally, we had some time to take pictures and enjoy the awesome views before getting back on the bus for our return to the venue.

Throughout the meeting, Sérgio and his fantastic organizing committee and helpers ensured that socializing and excursions ran smoothly. The final social highlight was a private tour and banquet at the Guggenheim Museum. It was quite a place and an event. We were guided through several exhibitions as appetizers, one on the merging and black and white patterns that could easily have been the melt zone of the Greenland Ice Sheet during the summer. The meal in the



*Those who were not on the hike to Gaztalugatxe visited the town of Bermeo to the east where they explored the harbour and were particularly struck by the group of statuary (entitled '¡Ya Vienen!') representing a family watching for boats caught out at sea by a particularly ferocious gale in 1912*



*There were other options available for those, like our Secretary General, several of whose joints are no longer original, who preferred a less strenuous excursion on Wednesday.*



*It was even possible to view the hermitage that the others were visiting, but at a comfortable distance from the clifftop path.*





*The Banquet took place at the spectacular Guggenheim Museum.*



*A very convivial evening was enjoyed by everyone.*

basement of the museum was memorable, not only for the great food, wine and company, but also the Basque dancing and the poems and songs sung by the different nationality groups among the delegates. Here, the prizes for the best student presentations and poster displays were presented. Gonzalo Gonzalez de Diego (Oxford), speaking about 'Numerical approximation of viscous contact problems applied to glacial sliding' and Linda Rivera Macedo (Geneva), 'Drivers behind international adaptation aid for mountain regions', won the Oral Prizes. Bittor Muniozguren Arostegi (BC3), 'Development of a technique of immersion microscopy on ice', and María Díez Gallego, 'Monte Perdido Glacier disappearance', won the poster prizes. It is worth noting that Maria was just finishing secondary school, and was to start University in the Autumn. The overall standard of talks and poster presentations by our early-career scientists was very high, as always, and deciding on these prizes was even tougher than usual. The future is bright for glaciology, even if the extent and mass of our subject matter is declining in our warming world.

What is also certain is that the emotional and metaphorical impact of our declining cryosphere has resonance in the social sciences and arts. My hope is that the combination of science, social science and arts pressures on our societal leaders and influencers will orchestrate to curtail the dangerous climatic experiment we find ourselves living through. Several of us older persons were left to regret



*And of course there was more great food.*



*The Banquet was the setting for the presentation of the Seligman Crystal by IGS President Francisco Navarro to 2021 awardee Catherine Ritz.*



*The awards for best student oral presentations and posters were also made at the Banquet. Martyn Tranter, head of the judging panel, is here awarding the prize for best student oral to Linda Rivera Macedo.*

not making the case for carbon neutral living as strongly as our early-career researchers when we were as young. This to me seems a damning legacy.

My overwhelming reflections from the meeting are how strongly glaciers inspire the imaginations and creativity of individuals across the five ‘Meets’, and how there is a common language underlying our different glaciological pursuits, one that involves concern and responsibility for the glaciers that impact on our cultures and environmental sustainability. I’d like to finish by thanking the participants at the meeting for dragging

me out of my usual glaciological discourse and considerations into a more societally responsive domain.

### **Martyn Tranter**

with a contribution on the excursion from **Patricia Muñoz Marzagon**



*Presentations of IGS dishes were also made to members of the Organizing Committee ...*



*... and Sérgio H. Faria was also the recipient of an IGS tie, which he promptly put on – and very distinguished he looked in it.*



## Presentation of the Seligman Crystal to Catherine Ritz

On the Thursday evening of the Bilbao Symposium, a presentation was made to Catherine Ritz of the Seligman Crystal, which she had been awarded in 2021 (see ICE 182–184, p. 46). The President of the IGS, Francisco Navarro, read the citation for the award, which was as follows:

Catherine Ritz has made outstanding contributions to ice sheet and paleoclimate research and particularly to ice-sheet modelling. She pioneered the development of three dimensional thermo-mechanically coupled ice-sheet models for studying large-scale evolution of ice sheets and ice-core dating. She also made significant advances in the analysis of ice-sheet temperature profiles. Together, these have enabled better understanding of how ice sheets behave during glacial–interglacial cycles, the future behaviour of ice sheets in a warming world, and estimates of their future contribution to sea-level rise.

She has also investigated Heinrich events, Snowball Earth, ice fabrics, the effects of thermal diffusion on firn densification, and much more. Her contributions have a long-lasting impact on the development of ice-sheet modelling and the interpretation of ice-core records. She introduced ensemble modelling and Bayesian calibration into model intercomparison; she led integration of borehole temperature analysis, ice-sheet mechanical modelling and ice-core geochemistry to improve the dating and



interpretation of ice-core records; and she continues to impact future directions in glaciological research through her leadership in several international bodies.

In view of each of these bases, but above all her groundbreaking and inspirational science, the Council of the International Glaciological Society has decided to award the Seligman Crystal to Catherine Ritz.

Dr Ritz had given her Seligman Crystal talk on the Thursday morning before the Banquet. The slides that accompanied this presentation are reproduced below.



*The President reads the citation.*



*The Seligman Crystal lecture.*



# A History of Challenges and Advances in ice sheet modeling

Catherine Ritz  
With inspiration from many others



Bilbao, 2022 Catherine Ritz



## Antarctic stability in IPCC reports

What happened since 2001 report ?

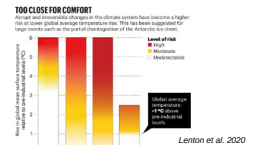
New observations

or

Models Improvement

Or

Both



Bilbao, 2022 Catherine Ritz

## What is an ice sheet model

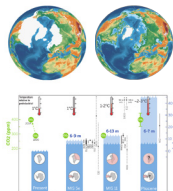
A numerical tool based on physical principles, that simulates the evolution of an ice sheet under a changing climate

➢ In the past, at the glacial-interglacial scale

- Explain 100 ky cycle
- abrupt changes:
  - Heinrich events
  - Deglaciation
  - High sea level stands

➢ For ice cores interpretation

- In the context of climate change
  - Implication for sea level rise



Dutton et al. 2015

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## Processes to account for

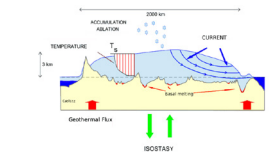
Gravity flow

- Non linear viscous law
- Sliding law
- Thermomechanical coupling

Mass conservation

Interactions with

- Atmosphere
- Ocean
- Solid Earth



Strong horizontal/vertical ratio

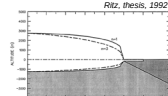
- Allows various « shallow » approximations
- First law of glaciology: ice flows along the steepest slope of the ice surface, ...
- In 1964, this approximation was named « shallow ice approximation » (Hutter)

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## Pre-computer time : analytical solutions

Steady ice sheet profile (flow line or axi-symmetric)

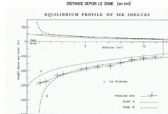
- Parabolic
- Valov 1958 (accounts for viscous law)
- Some refinements
- Past ice sheets reconstructions
  - Denton and Hughes, 1981



Ritz, thesis, 1992

Ice shelf profile

- Weertman 1957: longitudinal strain rate
- Sanderson 1979: Equilibrium Profile



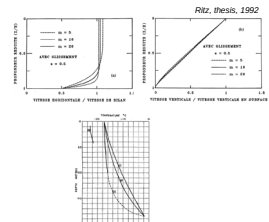
Sanderson, 1979

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## Analytical solutions in the vertical direction

Vertical profiles

- Shear Stress and strain rate
- Velocity
  - Nye 1957
  - Libboutry, 1979
- Temperature (Robin 1955)
  - At a dome
  - Steady state
  - With linear vertical velocity



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## Emergence of Computers

Pioneering works had already established the basic equations of ice sheet modeling

Analytical solutions were great but :

- Were most often only 1D (horizontal or vertical)
- Had limitations due to the approximations.
- Did not deal well with time dependency

W.S.B. Paterson, the physics of glaciers

Non-Steady Flow of Glaciers and Ice Sheets

"If God had consulted me before embarking on the Creation, I would have suggested something simpler."

Alfred of Castele (19<sup>th</sup> Century)

The emergence of computer resources opened new fields of application

- But at the beginning they were rather limited

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## Time dependent Ice sheet profile

Objective : reproduce glacial-interglacial ice sheets volume, under

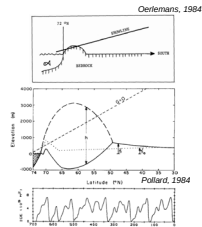
- Volume from deep-sea records

Understand the 100,000 years response to higher frequency orbital forcing

- Ghil and Le Treut, 1981
- Pollard 1983
- Oerlemans, 1983, 1984

Precursor work in 2D horizontal

- M. Mahaffy 1976. vertically integrated model for Barnes ice cap



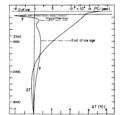
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## Time dependent temperature at a dome

Solve the time dependent heat equation (1D)

To compare with observed profiles

- Paterson and Clarke 1978, Ritz et al, 1978



Temperature perturbation at Dome C due to past surface temperature variations. Ritz et al. 1978

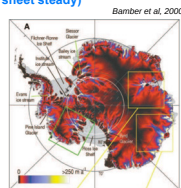
To infer the impact of past temperature on thickness evolution

- Whillans 1978

## Derive Ice sheet Characteristics

Balance velocities (velocities that keep the ice sheet steady)

- First in Budd Radok Jensen
  - Several methods: flow lines, grid
- Allow to derive other characteristics
  - Temperature in ice (single column)
  - Age
- Used to interpolate bedrock topography
  - Warner and Budd 1998
  - BedMachine



It is an inverse approach

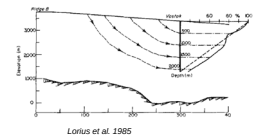
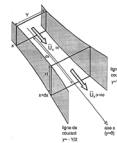
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## Dating an ice core

Balance velocities in 1.5 dimension

First dating of the Vostok ice core



This approach, associated with temperature profile calculation is still used for ice core dating and search of very old ice

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## Thermomechanically coupled ice sheet models

MILESTONE

Time dependent, ice flow-temperature coupling

Flow line

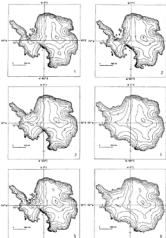
- Huybrechts and Oerlemans, 1988
- Ritz, 1992

3D ice sheet

- Jensen, 1977, Huybrechts 1990

Based on the shallow ice approximation (SIA)

- For the ice shelves, equation not yet stabilized
- Still not true 3D



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## European Ice Sheet Modelling Initiative (EISMINT)

At this level, we needed ways to validate/verify/calibrate the models.

EISMINT was a coordinating program from the European Science foundation

- From 1992-1997 funded ~ 5 workshops a year.
- Processes (rheology, sliding, ...)
- Coupling with the other components : Solid earth, atmosphere, ocean
- Intercomparison experiments.
- Summer schools (Grindelwald that became Karthaus)

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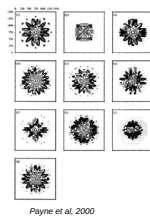
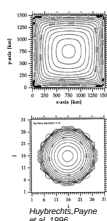
## First EISMINT experiments

Coordinator P. Huybrechts

Check numerics

When there is a "yes/no" condition, numerics is important

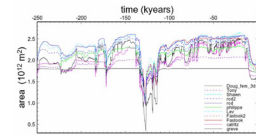
- cold/temperate
- float/no float
- Positive feedbacks enhance small changes



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## Greenland experiments

Coordinator C. Ritz

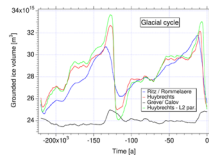


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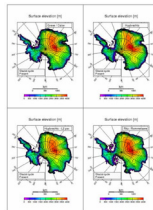
## Antarctic experiment

Coordinator P. Huybrechts



Concern : how to deal with the grounding line

Bilbao, 2022 Catherine Ritz EISMINT report 1998



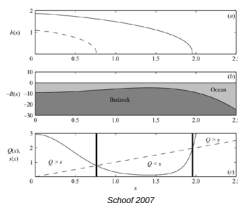
## Ice flux at the grounding line

Asymptotic approach

- Barcelona and MacAyeal 1993
- Chugunov and Wilchinsky 1996
- Schoof 2007

Marine Ice sheet instability MISI

- Weertman 1974
- Ice flux at the GL is proportional to thickness  $\sim 7$

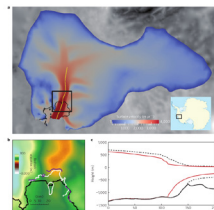


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## Modeling MISI in a real case

Pine Island

- 3 models
  - Elmer/Ice (full Stokes)
  - Bisicles (higher order)
  - Ua (SSA)
- Different numerical approaches
- Several melting scenarios



Favier et al. 2019

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## Ice shelves intercomparison experiment

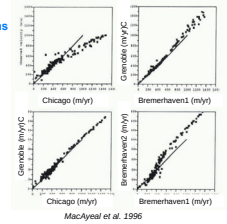
Coordinator V. Rommelaere

5 ice shelves models compared to observations

- Chicago (MacAyeal)
  - Finite elements, SSA
- Grenoble (Ritz/Rommelaere)
  - SSA
- Bremerhaven 1 (Huybrechts)
  - SSA
- Bremerhaven 2 (Deteman)
  - Different equation

Fixing the equation to be used (SSA)

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## Approximations for velocities in the transition zone

MacAyeal 1989 « dragging ice shelves » Extend SSA domain

- Ritz et al. 2001 → GRISLI. Replace sliding law by a dragging law
- PISM (Beuler) 2008 and many others

Add some stresses

- Huybrechts all first articles

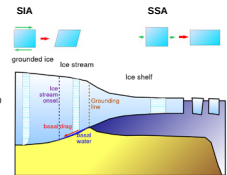
Higher order models

- Pattyn/Blatter 2003
- Hindmarsh 2004 for a systematic classification
- Intercomparison, Pattyn et al. 2008
- Golberg/Arthem 2010, Schoof and Hindmarsh 2010

Full Stokes

- Elmer/Ice Gilet-Chiolat 2012
- ISSM Larour et al. 2012

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## MISMIP marine ice sheet model intercomparison

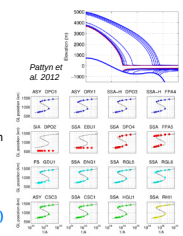
MILESTONE

Designed for an advance and a retreat

- Every model compared with « Schoof » solution and Full Stokes, and must reproduce hysteresis
- SIA does not work
- Very little grid mesh at the GL is necessary
- «Schoofing» the model : Prescribing the flux with Schoof equation allows larger grid mesh (Pollard and De Conto 2009)
- Subgrid and moving grid strategies

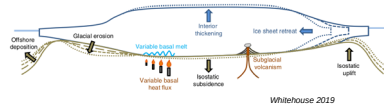
2D (Pattyn et al. 2012) and 3D (Pattyn et al. 2103)

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## Coupling with the other elements

### Solid Earth



- Time scale close to that of ice sheets
- Several ways of dealing with
  - Le Meur and Hubrechts (1995) compared them and a manageable method can be used for many applications
  - Sophisticated models for sea level equation

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## Interaction with the Ocean

### Crucial for ice shelves (basal melting)

#### Global ocean models

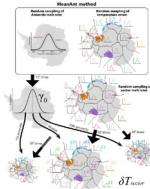
- Often do not go in the sub ice shelf cavity
- Resolution too coarse

#### Strategies between large scale ocean models and sub ice shelf cavities

- Parameterization with an index (for paleo)
- Sub cavity models
  - Plume (Jenkins 1991)
  - Heimer et al. 2012
  - PICO (Reese et al. 2018), PICOP, Pelle et al. 2019)
  - Comparison with real coupling: Favier et al. 2019

#### Intercomparison of a full coupling : MISOMIP

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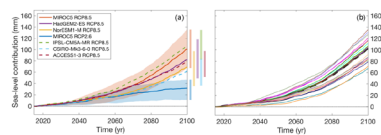
For ISMIP6  
Jourd'ain et al. 2020

## ISMIP6 Greenland

### Set up

- 14 ice sheet models
- 6 AOGCMs, 11 experiences

#### H. Goelzer et al.: Multi-model ensemble study of ISMIP6



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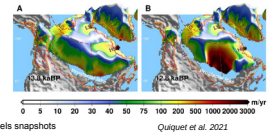
## Interaction with the atmosphere

### Crucial for surface mass balance

#### Atmosphere : Very short time scale

#### Strategies with a climatic index

- From ice core records
- PDD positive degree days
  - And other parameterizations
- Interpolation between Atmospheric models snapshots



Quigley et al. 2021

#### Forcing/coupling

- Intermediate complexity Earth models for paleo experiments ex. with Lovelick (Roche et al. 2014)
- Forcing or coupling with AOGCM on short time scales (Le clech et al. 2019) or asynchronous (De Conto and Pollard, 2015). Sometimes with a regional model like MAR (Fettweis)

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## ISMIP6 Antarctic

### Set up

- 13 ice sheet models
- 5 AOGCMs, 21 experiences

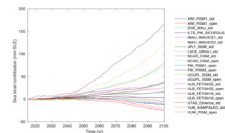


Figure 4. Evolution of ice volume above flotation (in mm SLE) over 2015-2100 from the NoESM1-M RCP 8.5 scenario (exp01 and exp05) relative to ctrl\_pgm.

#### H. Seroussi et al.: ISMIP6 Antarctica projections

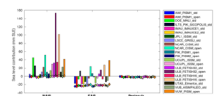


Figure 5. Regional change in volume above flotation (in mm SLE) and integrated SMB changes over the grounded ice (diamond shapes, in mm SLE) for the 2015-2100 period under medium RCP 8.5 forcing from NoESM1-M RCP 8.5 scenario (exp01 and exp05) relative to ctrl\_pgm.

Enhance the dependency on atmosphere-ocean models

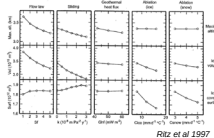
## Calibrating ice sheet models with observations

### Input data

- Surface and bed present topography

#### Calibrating the models: Old style

- 1) Start a long time ago with a parameter set
- 2) Run the model forced by a climate index
- 3) Compare with observed topography



Ritz et al 1997



enhancement factor

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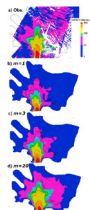
## Calibrating Ice sheet models recent methods

### New data thanks to satellite observations

- Ice velocities
- Thickness changes

#### Calibrating the model

- Inversion to fit observed velocities (variational)
  - Ice shelf velocities Rimmelaere and Mackyeal 1996
  - Basal friction map Arthern, R. J. and Gudmundsson 2010
  - Basal friction and its non linear exponent Gillet-Chaulet et al. 2016
  - Basal friction and ice damage (Cornford 2015)
- Inversion to fit also thickness change
  - Pollard and De Conto 2012, Ritz et al. 2015 (iterative)
  - Bonan et al. 2014, Gillet-Chaulet 2020 (ETKF)
  - Goldberg 2015 (variational)



Velocity differences between 2010 and 1996  
Gillet-Chaulet et al. 2016

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## MILESTONE

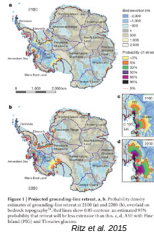
## Assimilation methods

**Assimilation: retrieve best parameters or initial state**

- Variational: Derive an inverse model
- Statistical: Monte Carlo, Kalman filter

**Ensemble : run an ensemble of members**

- give a weight depending on agreement with observation
- Ensemble Kalman Filter



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## Emulators based on existing simulations

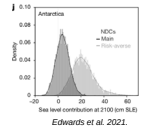
### MILESTONE

#### Interest

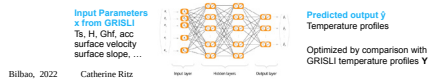
- Allow probabilistic projections
- Can take advantage of multimodels
- Make statistical inversion possible

#### Kriging method

- Edwards et al (2018, 2021)



#### Deep learning. An example for an ice temperature emulator (in progress)



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## Conclusions

### Improvements all along

- Continuous theoretical work (especially on processes)
- Continuous increase of computer power
- Intercomparisons at every step

### Important Milestones

- Thermomechanical models
- Grounding line treatment
- Inverse methods and satellite data
- Emulators

### Public and stakeholders concern increasing

- More funding ?

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## Remaining challenges

### Coupling with the atmosphere

- Albedo
- hydrofracturation

### Coupling with the ocean

- Basal melting and 2 ways coupling

### Ice Damage

- Calving, MICI

### Sliding and subglacial hydrology

### Use past to improve future projection

### Learn how to communicate.

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## My International most significant inspiration

### And programs

- EISMINT
- Ice2sea
- ISMIP6
- Protect
- Beyond EPICA
- ISMASS
- INSTANT



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## The wonderful French team I have been working with





# The Melting Artist

Paper arising from the IGS symposium in Bilbao, June 2022

The inner human does not bear witness to a fact, to a violent event that it would have seen, that it would have heard, tasted or touched.... There can be no witness of this blow that, we repeat, abolishes the periods, the surfaces of the archive. The tables of memory fall to dust, the blow has not passed.

Lytotard, *The Confessions of Augustine*

William Turner (1775–1851) painted UK landscapes and weather views at the moment of industrialization. It seems he found an internal symmetry in the worldly smog and grime of pollution, matching the dirty outward reality with emotion and longing (longing as a state as well as for something better).

Here we contemplate the melting artist as someone who paints, writes, or makes video art inspired by the sublime views of landscapes, including icy ones. They work with understanding the present moment as Turner did; yet they also want to reveal the damage of climate change, to be inspired by scientific research and data; and they want their creative practice to be a place of opening, sharing, and talking, to help thaw any conceptual view that stops change. The melting artist navigates a new performative space in the sense that their role isn't merely object-based. The melting artist invites people to be honest and exploratory about the internal space we all share. The melting artist has a connection to the explorer of old, yet this includes the potentiality of a mirroring journey within, one that could contribute to societal shifts.

Scientific research and art could be seen to share the same act of witnessing. This witnessing relates to the act of looking, as in plein air painting or studying samples using scientific tools, yet includes a moral

and ethical aspect. Traditionally defined, a witness is someone 'who is or was present and is able to testify from personal observation', and 'to be able to be a witness includes some form of visual or bodily connection to the matters witnessed' (Lindroos and Möller 2017). Witnessing encompasses an initial passion, for a painter or scientist (and other professions), it is the eye we turn to face the world with.

Witnessing for me is not only about being right, but about vulnerability, the feeling tone and uncertainty we all share in relationship to the changing planet; and this witnessing almost seems like it is not witnessing, as it permeates everything and everywhere. Turner's dirt and fog now has the addition of invisible microbes and on a scale unfathomable – as Lyotard suggested, the blow has not passed, the blow is unfolding, moving, and changing.

## Dr Sally Payen – Ice works from the Hormonal Seas body of work

I had been talking to climate researchers at BC3 (Basque Country, Spain), chiefly Sérgio Henrique Faria, for a number of years. This is an account of the decision making process. To paint using water (or melted ice from the freezer) and watercolours instead of oil, seemed a good place to start and felt pragmatic in terms of speed of making and transporting the works to Bilbao from the UK. I initially decided to continue my thread of making work about plant forms with symbolic ecological significance, and was introduced to researchers at Black and Bloom who aim to unravel how dark particles (black) and microbial processes (bloom) darken and accelerate the melting of the Greenland Ice Sheet. The blooms are red algae and are found



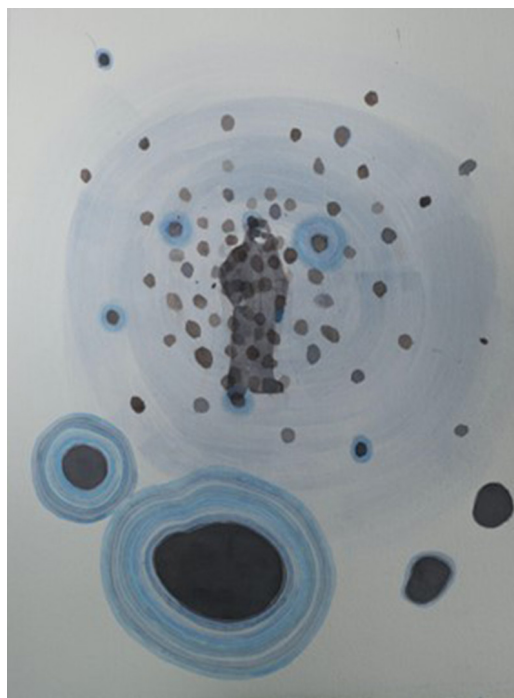
*Sally Payen, 'Scientist contemplating the connectivity between pollution and black holes'; left, 'Macro/Micro', right, both 2022, watercolour on museum quality paper, 76 × 56cm.*

on ice sheets in multiple icy environments - the ice has literally turned pink and in other places black or deep purple. I asked Martyn Tranter from Deep Purple for personal study photographs and he put me in contact with PhD student Laura Halbach - I received photos from both micro images of the bloom and also vast Greenland landscape views. I also asked Sérgio Henrique Faria, Ikerbasque Professor BC3, for some personal slides of his work.

My process for this on-going body of work in essence came from the visual meaning I found in the places, shapes, and forms in the range of photographs I had gathered up. It was and is an intuitive process that initially included reading articles and getting a loose and potentially poetic understanding of the area. This had a great beginning with such visual research titles like Deep Purple and Black and Bloom, but once the work was emerging it became about revealing other ideas and most of all a journey toward a

kind of visual truth. I began to realise that the scientists I had been talking to could also be sited in the work, as they seemed to have visionary inspired personalities, similar to some artists. I wanted people placed in some of the artworks as a kind of magnet, and it felt really important that this was personal and not random, hence I went back to Laura and Sergio with requests for more photographs of them out in the field. For me, it made the work much more real and tangible, and on reflection, this now feels like a personal desire to witness their efforts; that although each person in the watercolours is a symbolic scientist, it is also a particular person. I could add a particular person doing particular work on a particular day, but that wouldn't be accurate as I created a new reality in the way I put together the different forms, shapes and colours in my final artworks. I don't tend to copy nature in my work, I'm not really a plein air painter; I am more of a symbolic painter who connects forms and





*Sally Payen 'Black spores and spreading bloom', left, 'Scientist contemplating the connectivity between pollution and black holes', right, both 2022, watercolour on museum quality paper, 76 × 56cm.*

shapes to suggest something else. It's kind of porous, an in-between space, and includes responding to particular issues in climate change, but also it is about what it means to be here, the human condition. I deliberately stop working on an artwork when I am left dangling in a mysterious place, yet at the same time in these particular works all the parts have come together.

The titles are significant and have a clarity for me. The first piece I finished was 'Scientist contemplating the connectivity between pollution and black holes'. In this work I was inspired by a photograph from Sergio of a Sherpa and PhD student at the foot of the Himalayas. In my work, the Sherpa made a great mysterious shape,

seemingly enveloped in a snow storm. I wanted the universe of the painting to be coming out of the person, and I wanted to connect the black holes in the ice with a more cosmic outer space feel. Another title 'Scientist contemplating ice bubbles and the dark sky' is exploring a similar micro yet cosmic space. My personal favourite is 'Macro/Micro', as I feel that there are new potential directions for me to explore. An artwork finally feels finished when an audience receives it and finds new meanings, which is what happened in the symposium on Ice in a Sustainable Society: the insights from the scientists themselves added new dimensions and reminded me of the importance of trusting liminality.



## Pearl Jackson-Payen – A poet's response

The poet places language beyond the reach of time: or, more accurately, the poet approaches language as if it were a place, an assembly point, where time has no finality, where time itself is encompassed and contained.

John Berger, 1984.

While travelling through and in between the glacial-volcanic landscapes of Iceland, language evaded me. Slowly, over the following 3 years, I made sense of the profound unravelling landscapes. They moved deep within, they became me. Poetry eventually arrived. In offering 'a place, an assembly point, where time has no finality, where time itself is encompassed and contained', it was my only means of approaching nature.

The poems I showed at the symposium on Ice in a Sustainable Society were part of this body of work. Short, haiku-like phrases; breathy, abstracted, distant, close. Lines and phrases came like dust, while walking through Reykjavík, or standing in the window at night. In their abstractions they spoke to my deep stirring emotion. The glacier within responding to the glacier without.

1.  
In the beginning, a movement underground.  
A stirring  
A coiling  
A becoming unstuck.

2.  
Soft red visions slowly thickening and open.  
Now, walking through Reykjavík, I  
remember.  
A lupin flower, the edge of solidness, the  
bellowing walls.  
My love from the mountain is close.  
Soft red visions slowly thicken.

3.  
Part of Iceland now, I am coated in the  
world.  
Steaming slowly in hot springs,  
I remembered the stars weep too,  
And tears of space.

4.  
Unravelling form, physical movement,  
breathing it.  
Snow fills the window,  
Snow fills the black amnesias of me.

5.  
Volcanic ash smothering my feet,  
To think of the edge of dust, the valley of  
the spiralling tear.

6.  
O unmarked parts of space!  
My heart drenched water yet again.  
A glimpse then of the angel. She!

## Jaime Jackson – A polyphonic response

Polyphony is a type of musical texture consisting of two or more simultaneous lines of independent melody, as opposed to a musical texture with just one voice.

Polyphony, as a form of relational (kinship) co-produced art practice, offers a decolonized approach to the cryosphere. Polyphony means abandoning individualistic approaches. The human separation of self from nature has caused the climate crisis, and we can't hope to heal using the same type of communication. If we impose our view of a dominating self onto nature, we can never understand or work with it. Nature operates in a non-binary way. In order to share scientific knowledge with society, I needed to create a speculative space of nature in my work, where there could be a new way of communicating.

In nature, as in relational art practice, there is no leader '...although each is free to wander, their wanderings can't be seen as separate from the others. There is no main voice. There is no lead tune. There is no central planning. Nonetheless, a form emerges.' (Sheldrake 2021)

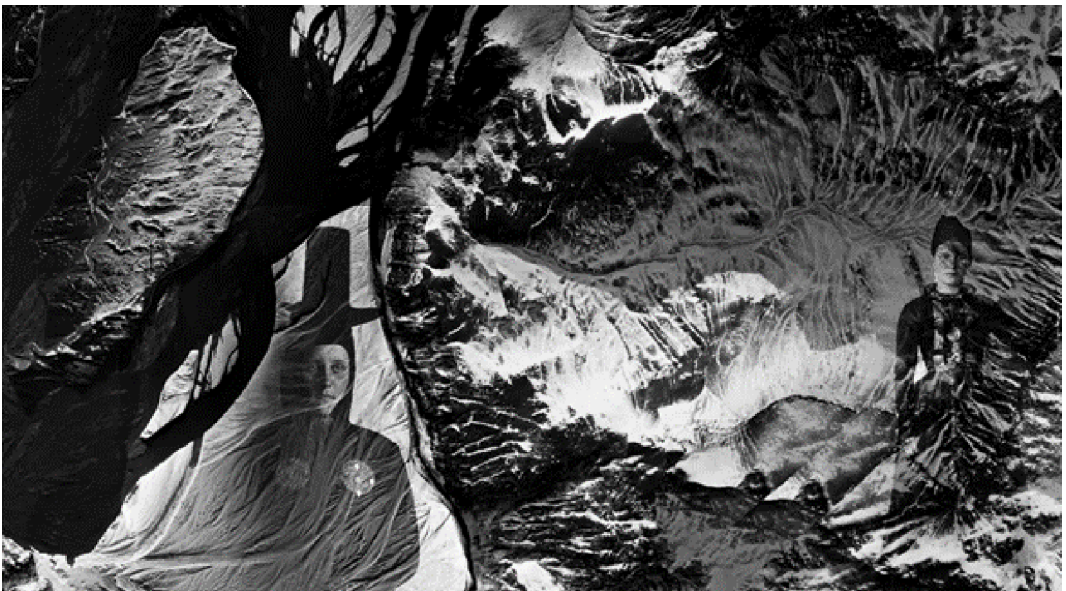
When art and science come together in this way, multiple stories are woven, a musical texture is created, our attention has to become softened and more distributed.

'The many songs coalesce to make one song that doesn't exist in any one of the voices alone. It is an emergent song that I can't find by unravelling the music into its separate strands.' (Sheldrake 2021)

## Making work for the symposium

Last year, I contacted the Icelandic glaciologist Þorvarður Árnason, Director of the University of Iceland's Research Centre in Hornafjörður to talk about his work. I was directed to an archive of aerial photographs of Iceland, taken over many decades, demonstrating melting glaciers, as well as to the glacier time-lapse films made by his colleague Baxter Kieran Andrew.

I digitally connected photographs from the aerial archive to black and white photographs of women wearing historic Icelandic clothing. Merging these strange and beautiful images together created a hybrid human-nature landscape. This work points out a view that we are connected to the mountains, to the



Jaime Jackson, 'Lómagnúpur–Skeiðarárjökull' moving image loop still 1'22" 2022.



*'Evoking The Arctic Spirit' moving image loop 2'04'' symposium installation, Bizkaia Aretoa centre Bilbao 2022*

volcanos, and to the glaciers. It also looks to the living folklore of Iceland, in which belief in and respect for the hidden people permeates the Icelandic sense of nature and identity.

For my other moving image work, I mixed the Inuit throat singer Annie Aningmiuq's song 'Evoking the arctic spirit' with AI-generated imagery bred from Greenland ice archive photographs. The indigenous cultural view is that humans are deeply connected with nature; the two are kin, equal and interdependent. AI doesn't involve any notion of self. Therefore, using it in an artistic practice deconstructs the notion of the individual.

We are always wondering whether artificial machines have intelligence. Maybe instead we should be asking whether a plant or fungi has intelligence in their mutually beneficial interactions. In my work I ask how we can move away from hypermasculinity to develop natural non-extractive relationships with the cryosphere.

## Moving forward

In scientific circles imagination usually goes by the name of speculation and is treated with some suspicion. [...] Imagination forms part of the everyday business of enquiring. Science isn't an exercise in cold-blooded rationality. Scientists are – and have always been – emotional, creative, intuitive, whole human beings, asking questions about a world that was never made to be catalogued and systematised.

Sheldrake 2021, 22.

Knowledge of the climate crisis brings trauma and eco-anxiety. Through relational art, we can mitigate that pain and take restorative action:

We need collective solutions to this, it's a collective problem. It is an opportunity to develop psychological resilience, emotional maturity and emotional intelligence because those are the things that will help us navigate it.

Hickman, 2022.



*Jaime Jackson symposium art exhibition presentation, Bizkaia Aretoa centre, Bilbao 2022*

In this spirit, we have included some words and responses from conference speakers and delegates:

*‘Art can reflect the feelings of scientists too. When you investigate as a physical/chemical scientist, your work influences yourself, and it is a shame that we produce numbers only. That is why we need art to show what is behind the numbers, why we are doing the work, what it is for.’*

*‘I’ve been trying to understand how to become more of a socially responsible and respectful scientist, and how to reach out and interact with social scientists and artists. I have been interested in the different ways we go about our work, and the ways we become inspired and ideas are created. I can see parallels across the disciplines better now.’*

*‘I think that the art presentation helped me to understand more about the explorations and the science. It’s very important to express science with art to explain more to society.’*

*‘Even if usually, we don’t realize, the scientist and the artist have many things in common: both of them are observers.’*

*The scientist observes the world and tries to explain it using logic. The artist observes the same world and tries to explain it using emotions. And the results couldn’t seem more different. I believe that indeed they are NOT. And glaciology has the ability to remind us that these two worlds aren’t apart from each other.’*

*‘Maybe it’s not about creating but letting yourself get inspired. The drama of the seasonal growth of the cryosphere. The dance of the icebergs in the ocean. The poetry of glaciers slowly dying. What we can assure is that the cryosphere should be listened to and protected. Maybe scientists can protect it but the world needs to listen. I think that art may be an ally worth being studied.’*

*‘The scientist - the results. The artist - the process. Which one involves society and creates social learning for true understanding, empowering and social actions? Can science operate with situated knowledge to develop a truly curious practice?’*

*‘I think art can be the bridge between the two different disciplines as approaches and*

*that it is becoming increasingly important for science outreach as well. It can serve to communicate different feelings and world views. The effort to have conversations across differences and divides is very good, it is important to face these differences and learn from them. Enabling means for how we understand our constitutive limitations can help us to appreciate how we might be able to communicate and where our limitations might lie. The juxtapositions have worked well simply letting the differences speak for themselves. The juxtaposition has also exposed ignorance and resistances, which is also good, but difficult.'*

**A Salt Road exhibition project for BC3 and IGS with artists Dr Sally Payen, Jaime Jackson, Dr Neelambari Phalkey and Pearl Jackson-Payen**

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# 25th Alpine Glaciology Meeting 2022

24–25 March 2022, Munich, Germany

After so long without in-person meetings due to the global pandemic it was really wonderful to gather together, partly in person and partly on line, at the Carl Friedrich von Siemens Stiftung in Munich for the 25th Alpine Glaciology Meeting organized together by the Bavarian Academy of Sciences and the University of Milan. The spring weather was perfect, the facilities were outstanding and the hybrid format worked smoothly with contributions from across the Alpine glaciology community, and engaging questions and discussion in the room, in the zoom and in the sunny garden over coffee and cake.

There were 45 participants on-site and about 30 online, spanning more than 11 nationalities hosted in institutes in Germany, France, Italy, Austria and Switzerland. In total there were 34 presentations (19 live and 15 online) and 14 posters (13 live and 1 online). Several presentations showcased diverse advances in ground-penetrating radar applications, including new sensors, new deployments, new analysis tools, and novel applications relevant to interpreting former ice sheet behavior, finding the oldest ice in Antarctica, glacier hazards, cave ice and glacier tongue collapses. Glacier topics in High Mountain Asia were also well represented in both the talks and the posters, including studies on glacier mass change, surging, aufeis, ice stupas, hydrology and GLOFs. In addition to a couple of talks about glaciers rock glaciers and snow accumulation



*Perfect spring weather at the Carl Friedrich von Siemens Stiftung, Munich, Germany.*

in Greenland and Antarctica, we heard plenty about research on our local glaciers in the European Alps; biodiversity of glacier life, microplastics in glaciers, the development of the glacier foreland/lakes/hydrology following glacier retreat, how to make artificial moulins, snowcover and snowpack modeling, use of high temporal resolution terrestrial laser scans, surface and atmospheric measurements from UAVs, the non-linear sensitivity of temperature index models, simulation of ice avalanches, the use of big data and deep learning, and new initiatives in connecting this work to the wider public. So all in all an impressive sweep of topics covered by this community, and if you want to find out more then the full abstract list is at: [https://geo.badw.de/fileadmin/user\\_upload/Files/GLAZ/pdf/AGM2022\\_abstracts.pdf](https://geo.badw.de/fileadmin/user_upload/Files/GLAZ/pdf/AGM2022_abstracts.pdf).



*Some of the speakers were really there...*



*... and some were virtually there.*



*Social distancing and mask wearing seemed sensible precautions.*



*The garden was a perfect venue for the poster session, as well as the coffee breaks.*



*New at this year's meeting was *The Robot*, which kept tabs on the assembled company.*



*The traditional Banquet at a local Gasthof was a great success.*

Lunches and coffee breaks outside in the sun and a wonderful traditional dinner at a local Gasthof gave ample opportunity for informal exchanges and making friends for future research collaborations. The organizing

committee did an outstanding job, and we are looking forward to the next meeting in Birmensdorf on 9–10 February 2023.

**Lindsey Nicholson**



*Group photograph.*





## Obituary: Renoj J. Thayyen 1968–2021

It is with great sadness that we belatedly acknowledge the loss of Dr Renoj J. Thayyen, a valued member of the Himalayan glaciology community and of the International Glaciological Society.

Born in Kannur, Kerala State of India on 9 April 1968, Dr Thayyen was married to Jins Renoj and together they had two sons. After working as a Senior Research Fellow at Jawaharlal Nehru University, New Delhi (1992–98), he earned his PhD in Geology with a specialization in Glaciology from H.N.B. Garhwal University (Uttarakhand, India) in 1999. Dr. Thayyen was a passionate scientist who believed in generating quality research data through detailed field investigations, and his PhD research focused on the hydrology of the Dokriani Glacier catchment in the Garhwal Himalaya.

Dr Thayyen worked at the Wadia Institute of Himalayan Geology in Dehradun between 1998 and 2006, and since 2006 he had been working at the National Institute of Hydrology in Roorkee. During his career, Dr Thayyen established monitoring networks on Phuche and Khardung glaciers in the Ladakh Range and produced glacier mass balance and surface energy balance datasets. He also investigated monsoonal controls on glacier discharge in the Dokriani Glacier catchment, the 2010 flash flooding in Leh, Ladakh, and was a pioneering investigator of high mountain permafrost in India. In 2016, he organized an international workshop on permafrost, and he had recently developed a detailed understanding of temperature lapse rates in different climatic regimes



of the Himalayas. Dr Thayyen also played a crucial role in setting up a world class experimental catchment in Henval valley in Uttarakhand by NIH, and his last field work was conducted in March 2021.

In addition to his research accomplishments, Renoj was an excellent singer and a keen badminton player with an unending willingness to help his colleagues. His departure at a time when he was in the most productive phase of his life is a big setback to his parent institute and, indeed, to the glaciological community. He will be sadly missed by all who knew him.

Adieu.

**Joseph Shea**



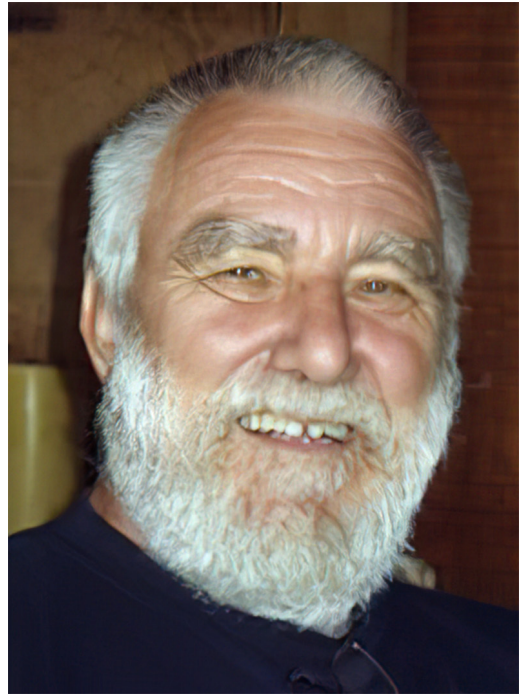


## Obituary: Gerd Wendler 1939–2021

Gerd Wendler died from lung cancer at home in Fairbanks, Alaska, USA, on 13 October 2021 at the age of 82. He was born in Hamburg, Germany, on 16 June 1939 to Friedrich and Hildegard Wendler. After his father was killed in the war, his mother raised him, along with two siblings.

Dr Wendler's interest in mountain glaciers started in Innsbruck, Austria, where he received his PhD in 1964. His research involved the study of the heat and mass balance of Austrian Alpine glaciers. He moved to Alaska, USA, in 1966 and worked on several on-going projects before he became a faculty member at the Geophysical Institute of the University of Alaska. In 1969 he, and his colleagues from the University of Alaska focused on year-long studies of McCall Glacier in Arctic Alaska. In addition to mass balance studies, he studied the katabatic winds that flow down the glacier. Together with studies begun on the glacier during the International Glaciological Year and with follow-up research, in more recent years, this created a long-term database that allowed the glacier to be identified as an index glacier of climate change.

Dr Wendler also conducted research at the other side of the globe, studying the katabatic winds on the Antarctic ice slopes and offshore, using data from automated weather stations and shipboard observations from US icebreakers. Dr Wendler's research in Antarctica was widely recognized, and he managed to receive continuous scientific support for his Antarctica research from the US National Science Foundation and other agencies for over 20 years. Some of these studies were carried out jointly with French scientists at the French Dumont D'Urville



station; the French post office even issued a postage stamp depicting the array of instruments involved in the studies.

Gert Wendler was also broadly involved in Alaska climatological studies on clouds, ice fog, snow, and river ice, as well as satellite observations of sea ice in the Arctic. He was the head of the Alaska Climate Research Center, which collects and analyzes weather and climate statistics from around Alaska. Together with his colleague Martha Shulski, he co-authored the book *The Climate of Alaska*, which to date is still the reference publication on the weather and climate of Alaska for the scientist as well as for the non-specialist. The book is in addition to Gerd's list of over 100 scientific papers. His

outreach activities included an interview on Polar Climate for the American Museum of Natural History. He was also a dedicated member of Rotary International.

In 1969, he married Jacqueline Mosny from France and they had two children, Karina and Friedrich (Fred). Sadly, Jacky died in 1981. In 1984 Gert married Ruth Massingberd-Mundy from England and they had two sons, Kyle and Enzo. He loved to travel and the Alaskan lifestyle of canoeing, hunting and fishing. An outstanding trip that he and Ruth did together was a 4-month

long drive in a Volkswagen camper van from Fairbanks to the southern tip of South America. For his friends Gert and Ruth were superb hosts and provided wonderful cozy dinner parties. He loved to prepare and serve good food to his friends, and his hearty laugh was appreciated and is missed by all who knew him.

**Carl Benson and Martin Stuefer**



## Obituary: Gorow Wakahama 1927–2021

Gorow Wakahama, a professor emeritus of Hokkaido University and an IGS honorary member, died on 18 December 2021. Gorow had been an active member of the society since he joined the IGS in 1970. He served as Vice President 1988–91 and acted as the national correspondent of Japan for many years. He was also the President of the Japanese Society of Snow and Ice 1995–98.

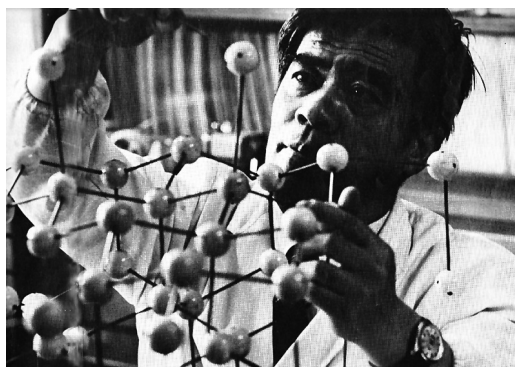
Gorow was born in 1927 in Tokyo, Japan. In 1942 he moved to Edajima in Hiroshima Prefecture to enter the Naval Academy, one of the most prestigious schools in Japan before and during the Second World War. Gorow recalled his school life as a great opportunity to study in a quiet and favorable environment in the middle of the war. His education in Edajima was not put to use in the navy, because the war ended in the year of his graduation. He returned to Tokyo to continue his studies at the Meteorological College of the Japan Meteorological Agency and later at Tokyo University of Science, majoring in physics and mathematics. During and after his studies, he worked at the Seismological Section of the Japan Meteorological Agency from 1949–55.

In 1955, Gorow moved to Sapporo to be an assistant professor at the Institute of Low



Temperature Science, Hokkaido University, where he became engaged in glaciology. With guidance from Ukichiro Nakaya, Zyungo Yosida and other colleagues at the institute, he began his snow and ice research by means of laboratory experiments and field survey. He developed a technique to prepare a thin section of snowpack and applied this technique for studying the snow densification process. This study was published in 1962 as his doctoral thesis, submitted to the Faculty of Science, Hokkaido University. For his outstanding achievement in this work, the Japanese Society of Snow and Ice awarded him the Science Prize in 1966. He extended his experimental studies on microscopic processes of snow and ice deformation using a microscope, which he called 'Microscopic Glaciology'.

He was active also in the research of snow and ice related disasters. A number of field surveys were conducted by his team during the 1950s and 1960s, when Japan suffered from



*Gorow Wakahama in the 1970s.*



*Field trip to Mount Daisetsu in 1977. Gorow Wakahama is second from left at the front.*

heavy snowfall affecting railways and electric power lines. Based on wind tunnel experiments as well as his fieldwork, he made an important contribution to the prevention and mitigation of disasters due to snow accretion and icing.

In 1964, Gorow participated in a glacier research expedition in Alaska, USA, which was led by Akira Higashi from the Engineering Faculty of Hokkaido University. Research activity at Mendenhall Glacier inspired him to investigate the transformation of firn to ice, the formation of superimposed ice, and the deformation and fracturing of ice. He also studied percolation and retention of meltwater in the snowpack, which are now recognized as crucial processes in the mass balance of the Greenland ice sheet and glaciers in the polar regions. Based on his experience and study on Alaskan glaciers, he wrote an introductory book on glaciers and glaciology.



*At the Icebreaker during the IGS Symposium in Sapporo in 2010. L to R: Atsushi Sato, Gorow Wakahama, Atsumu Ohmura and Magnús Már Magnússon*



*Carl Benson visited Gorow in Sapporo in 2001.*

During the expedition in 1964, Gorow met Carl Benson from the University of Alaska Fairbanks and they became good friends. They were the same age, and both had a connection to the navy during the Second World War. Carl has sent Gorow's family a message of condolence, with stories of their friendship for over half a century. The relationship of Gorow and Carl brought active interaction and collaboration between the glaciology groups of the two universities.

Gorow was not only respected as a great scientist, but also loved by everyone as a friendly and generous person. He spent the last 20 years of his life as the president of the flower club of Eniwa City where he lived. He dedicated himself to local society through the activities of the club, such as planting flowers in the town, developing and distributing new subspecies of plants, organizing lectures and arranging exhibitions of gardening.

On 25 November 2021, the Institute of Low Temperature Science celebrated its 80th anniversary. Gorow, the former director of the institute, sent a message to the celebration as he had done many times on similar occasions. In his message, written a few weeks before his death, he quoted the words of Ukichiro Nakaya, 'Enjoy your research. Do novel study'. We cherish the memory of Gorow and express our sincere condolences to his family.

**Shin Sugiyama, Atsushi Sato,  
Takayuki Shiraiwa and Atsumu Ohmura**





## Obituary: David G. Barber 1960–2022

Dr David George Barber died on Friday 15 April 2022, following complications from a cardiac arrest.

David was one of Canada's most influential Arctic researchers. He was a Distinguished Professor at the University of Manitoba, Founding Director of the Centre for Earth Observation Science, and Associate Dean Research of the Clayton H. Riddell Faculty of Environment, Earth, and Resources. David also held a Canada Research Chair in Arctic System Science and Climate Change. Through his vision, leadership and endless efforts, David established the University of Manitoba as a global leader in Arctic research.

Professionally, David is best known for his pioneering work on snow over sea ice and application of satellite technologies for their characterization. Most notably David had a talented ability to see links between the ocean, ice and atmosphere across scales, and connections with people and habitat. Coupled with his incredible dedication, drive and perseverance, David was instrumental in the development of many large international multidisciplinary networks for Arctic research. These include the Network of Centres



of Excellence ArcticNet, the Canadian Arctic Shelf Exchange Study (CASES), the International Polar Year – Circumpolar Flaw-Lead study (IPY-CFL), and more recently the Hudson Bay System Study (BaySys). His dedication also helped secure major Arctic research infrastructure, such as the Canadian research icebreaker CCGS *Amundsen*, and the Churchill Marine Observatory (CMO). His tireless work has helped to place Canada at the forefront of Arctic research, and created opportunity for innumerable students, professors and research staff collectively working to better understand the rapidly changing Arctic, and its impacts on people, diverse habitats in the Arctic and beyond.

David was a gifted speaker who could express complex scientific ideas in terms that policy-makers, media and the public could easily understand. It was this ability that not only led to signature outreach programs, including 'Schools on Board' and 'Expedition Churchill: Gateway to Arctic Research', but



*On the ice.*



*David speaking at the IGS Sea Ice at the Interface symposium in 2019.*

also to fostering strong university–industry research partnerships, most notably with Manitoba Hydro.

David’s extraordinary ability and contributions have been recognized with the highest awards and distinctions, including Officer of the Order of Canada, Fellow of both the Royal Society of Canada and the Royal Canadian Geographical Society, and the Northern Science Award for exemplary achievement in the field of northern research (Polar Knowledge Canada). He was also recognized through an honorary doctorate from the Université Laval.

David was a visionary researcher with a passion for the Arctic, a scholar with



an entrepreneurial spirit, and a generous mentor and friend. Despite his numerous professional accomplishments, David was first and foremost a family man. He is survived by his wife (Lucette) and three kids: Jeremy (Jodi), Julien, and Jamie (Luke), his step-grandson (Ryden), and grandson (Luca).

He has touched the lives of countless people, and will be missed greatly. Our thoughts and condolences are with his family, and with all who knew him.

With heavy hearts,

**His close colleagues and friends**



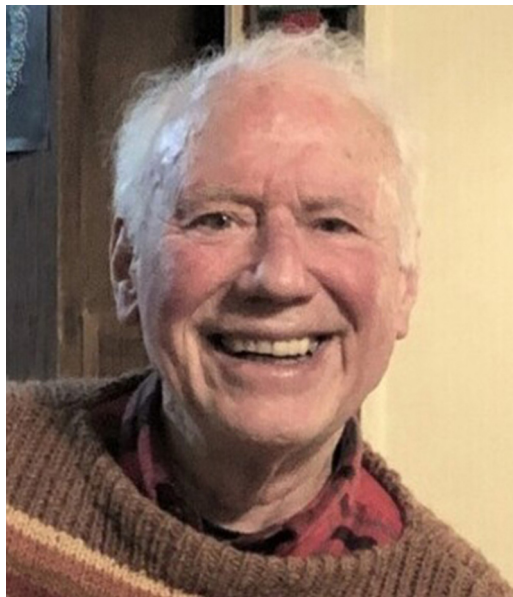
## Obituary: Hermann Engelhardt 1936–2022

Hermann Engelhardt, of Frostburg, Maryland, USA, died peacefully on Monday 27 June 2022 at UPMC–Western Maryland (part of the University of Pittsburgh Medical Center, UPMC), aged 85. He had been a loving husband, father, grandfather, brother and companion.

Born 20 October 1936 in Augsburg, Germany, he was the son of Johannes and Frieda Engelhardt. He was preceded in death by his beloved wife, Luise, and a brother, Manfred Engelhardt.

Hermann is survived by his children, Michael Engelhardt and wife Liz, Katharina Engelhardt and husband Bob Hilderbrand; grandchildren Anna and Corinna Hilderbrand; brothers Guenter Engelhardt and wife Ingrid, and Erwin Engelhardt and wife Helga; sister-in-law Eva Bullmann and husband Franz; nieces and nephews; and his dear friend Connie Otto and her daughters Annelies, Lura and Marijke, and grandchildren Jeremiah, Evelyn and Ezra.

Hermann joined the International Glaciological Society (IGS) in 1973; he



was still a member when he died. He was a regular contributor to the IGS journals, the *Journal of Glaciology* and the *Annals of Glaciology*. He also attended IGS symposia whenever possible.

Passionately interested in understanding the processes that allow our beautiful Earth to function and sustain life, Hermann devoted his career to the study of ice. He received his PhD in Physics in 1964 from the Technische Universität in Munich, and worked as a postdoctoral fellow at the National Research Council in Ottawa, Canada, where he accomplished the production of the highly elusive crystalline high-pressure phase of Ice IV. After building up the Physics Department at the Universidad del Valle in Cali, Colombia, Hermann focused on glaciology, the study of ice. He taught and studied at the Eidgenössische Technische Hochschule in Zürich, Switzerland, but spent most of his career in a leading role



*Hermann with a friend.*





*Skiing in Antarctica.*

in the glaciology program at the California Institute of Technology (Caltech) in Pasadena, California, USA.

Hermann's studies led him and his wife Luise to live in diverse places in the world, and brought him to remote corners of the earth, from Greenland and Alaska to Antarctica, where he studied the stability of ice streams and how climate change can impact that stability. This work led him to be very concerned about climate change even before the term was widely known.

Hermann also had a huge passion and love for people. He loved humanity's great diversity and wanted to experience it to its fullest. His travels led him to Afghanistan and Russia; Colombia, Mexico, Nicaragua and Honduras; and Cuba. He was deeply concerned with the injustices of this world, and was a fervent supporter of all people



*With colleagues.*

who are denied the means or the right to live their life in dignity. Hermann was also an avid supporter of music and delighted in his children and grandchildren playing various instruments.

Hermann was a member of Christ Lutheran Church, and was a supporter of Witness for Peace Solidarity Collective, Alliance for Global Justice, The Nature Conservancy, Lutheran World Relief, UNICEF, among many other organizations.



*Christmas in Antarctica*



INTERNATIONAL GLACIOLOGICAL SOCIETY

## International Symposium on Snow



Davos Congress Centre  
Davos, Switzerland  
25–30 September 2022

SECOND CIRCULAR  
August 2022  
<https://www.igsoc.org/symposia/2022/davos2022/>



The International Glaciological Society will hold an International Symposium on ‘Snow’ in 2022. The symposium will be held at the Davos Congress Centre, Davos, Switzerland on 25–30 September 2022.

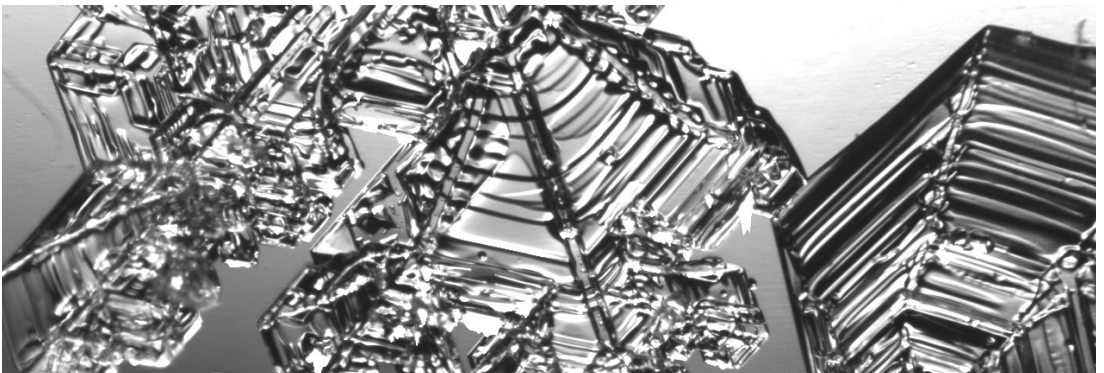
#### THEME

Snow is a complex material, transient and of singular beauty. While our understanding has improved over the recent decades, it still offers numerous scientific challenges. The snow cover plays a crucial role in the climate of cold regions – from high latitudes to high elevations – and impacts societies and their activities. Because of its high climate sensitivity, snow is declining, with far-reaching consequences for the environment and humanity.

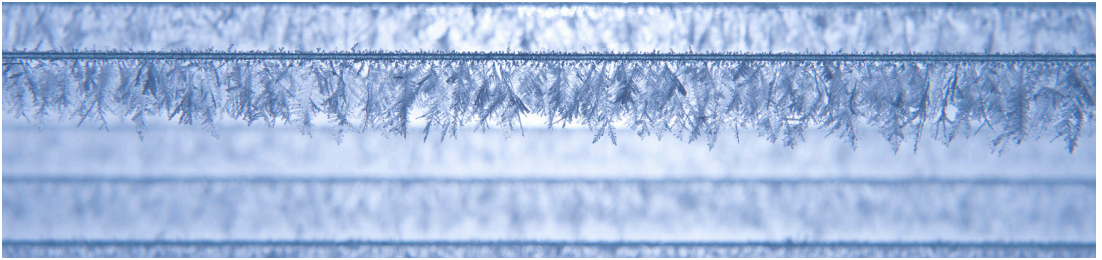
Given these prospects and improvements in advanced technologies for monitoring and modelling, we announce a symposium focused on understanding snow and its impacts on the environment, people and infrastructure.

Snow will be examined at all scales – from the microscale of snow structure to the global scale.

This meeting seeks to address various challenges by bringing together scientists from diverse communities engaged in research on snow. We welcome snow-related contributions, including ground-based observations, remote sensing, laboratory experiments, numerical modelling, data compilations and analyses, risk management, water resources, climate and social impact assessment.







## SUGGESTED TOPICS

These include (but are not limited to):

### **1. Observing and modelling of snow and its changes at different scales:**

Snow microstructure; distribution and variability of snow cover, snow depth and SWE; Snow stratigraphy; modelling seasonal snow, including coupling of cryosphere models with regional climate models, and intercomparison of models; snow and climate – projections and forecasts of seasonal snow under a changing climate, role of meteorological extreme events

### **2. Snow physics and chemistry:** heat and mass transfer in snow, snow metamorphism; physical and mechanical properties of snow; snow chemistry

### **3. Snow as a component of climate,** including snow–atmosphere interactions and snow–ground interaction

### **4. Remote sensing of seasonal snow and avalanches** from local to global scale, applying platforms from ground-based to satellite, including snow on sea and lake ice, snow and avalanche mapping

### **5. Snow in motion and snow engineering:** snow avalanches – formation, including stability evaluation, avalanche forecasting and warning; snow avalanches – dynamics, including avalanche impact, mitigation and hazard mapping; snow tribology, including winter sports and mobility on snow; snow loads on structures

### **6. Snow and biosphere,** including snow-vegetation/forest interactions

### **7. Snow hydrology,** including snow distribution, snow melt and runoff.





## PROGRAM

True to tradition, the symposium will include oral and poster sessions interlaced with ample free time to facilitate interactions between the participants. Additional activities include an opening icebreaker, a banquet dinner and a choice of five different excursions during the mid-symposium afternoon break.

We offer participants the opportunity to organize small workshops on specific topics, e.g. drone measurements of snow depth, stability tests, new methods to measure snow properties. If you are interested in conducting such a workshop, please contact the Science Steering and Editorial Committee.

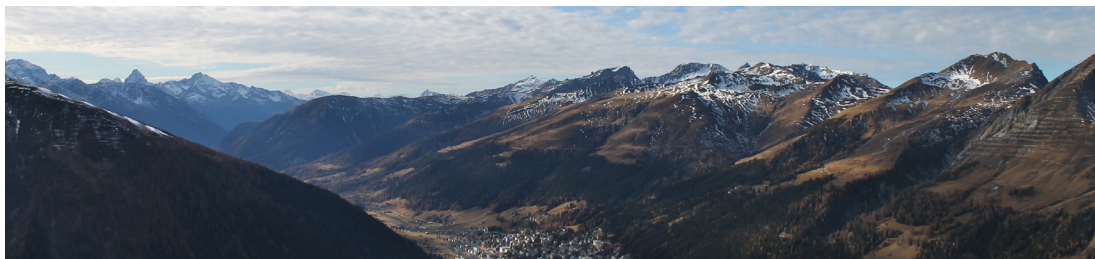
## VENUE

The SLF is well known worldwide as a leading research institute in its field. Around 150 staff study snow, atmosphere, mass movements, permafrost and mountain ecosystems and translate their knowledge into innovative products for practical use. Within the framework of the CERC (Climate Change, Extremes, and Natural Hazards in Alpine Regions Research Centre), the SLF investigates the effects of climate change on extreme events and natural hazards in mountain regions.

The SLF also provides various services, including the Avalanche Bulletin, advice on avalanche protection measures, and expert opinions on avalanche accidents, and is active in the development of warning systems for natural hazards.

The Symposium will take place in the Davos Congress Centre, centrally located between Davos Dorf and Davos Platz. The Congress Centre offers a selection of perfectly organized rooms, equipped with top-of-the-line presentation technology.





## REGISTRATION FEES

All fees are in Swiss francs, CHF

*Early registration until 23 August 2022*

– Participant (IGS member):	CHF 650
– Participant (not IGS member):	CHF 730
– Student or retired (IGS member):	CHF 350
– Student or retired (not IGS member):	CHF 400
– Accompanying person (≥18):	CHF 190
– Accompanying person (7–17):	CHF 155
– Accompanying person (≤6):	Free

### *Surcharges*

– Registration after 23 August 2022:	add CHF 40
– Registration after 12 September 2022:	add further CHF 100

All prices will be charged in UK£ equivalent at the exchange rate valid near the date of transaction.

The fees include:

- **Participants:** Attendance at the conference sessions and activities, the Icebreaker, the midweek excursion, the Banquet and coffee-break refreshments from Monday to Friday.
- **Accompanying persons:** the Icebreaker, the midweek excursion and the Banquet. **Attendance at the presentation sessions is not included.**

**Non-member registration includes a year's membership of the IGS.**

**Please check whether you will require a visa to enter Switzerland.** If you need an invitation letter, please contact the IGS office.

**Please ensure you have the correct covid-19 vaccination status** for the trip to Davos at the time of travel. This is the responsibility of individual travellers.







## LOCATION

Davos is located 1560 m.a.s.l. in the heart of the Canton of Grisons in the eastern Swiss Alps. September temperatures average highs of 14°C and lows of 4°C. The town of Davos is easily accessible by train. It is about 130 km southeast of Zurich from where the train journey takes about 2½ hours. There is a major international airport in Zurich and right at the airport you can board a train (changes required at Zurich main station and Landquart).

## ACCOMMODATION

There are many hotels in Davos, from simple to luxurious. It may be worth looking on the common internet platform, but we have also contacted some hotels that cover a wide range of comfort and price. They offer a special price and have a block of rooms available until the end of August.

Category I (CHF 55–90): [Youth Hostel](#) (double and shared rooms)

[Hotel Ochsen](#) (single and double rooms)

[Hotel Strela](#) (single and double rooms)

[Hotel Dischma](#) (single and double rooms)

Category II (CHF 90–120): [Spenglers Inn](#) (single and double rooms)

Category III (CHF 130–150): [Hotel Morosani Schweizerhof](#) (single and double rooms)

[Kongresshotel](#) (single rooms; double rooms on request)





To benefit from the special rate, please book your accommodation using the keyword 'IGS2022'. For a shared room, or for a longer stay (beyond 25-30 September), please enquire directly with the hotel. Bookings must be made by phone or email. You will not receive a special rate if you book through Booking.com or similar sites. The allocated rooms are guaranteed until 30 August 2022. After that, there is no guarantee of room availability or special rates.

Price basis for the categories is a single room including breakfast.

**Please note that in case of a cancellation, the individual hotels might have different refunding policies.**

## **SOCIAL EVENTS**

### **ICEBREAKER**

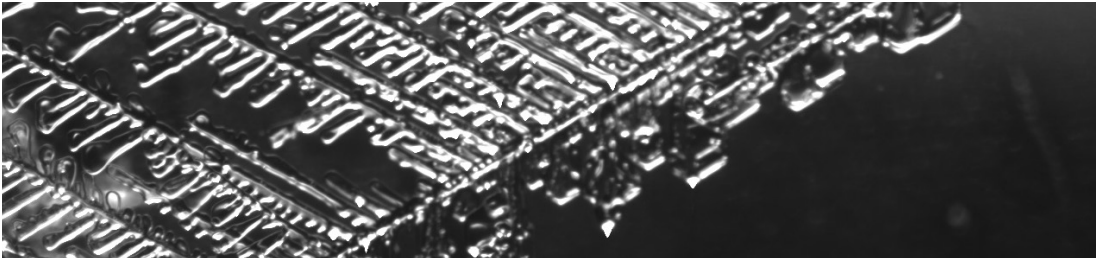
We plan to hold an icebreaker reception at 17:00 on Sunday 25 September at the Davos Congress Centre. Food and beverages will be available. Participants can also use this opportunity to complete their registration and collect their conference materials.

### **BANQUET**

The traditional Symposium Banquet will be held at 19:00 on the evening of Thursday 29 September, also at the Davos Congress Centre.







## MID-WEEK EXCURSIONS

There will be a choice of five excursions:

**(1) Flüelapass, permafrost (Marcia Phillips)** On this trip we will see mountain permafrost landforms in a spectacular setting at 2400 m a.s.l. Flüelapass was the first permafrost research site in the Swiss Alps in the early 1970s and ground temperatures and ice contents have been monitored ever since. We will see different types of instrumentation and discuss interesting phenomena such as ice-rich permafrost in a lake shore, a rock glacier advancing towards a road or air fluxes streaming through a talus slope. The field trip includes a 2–3 hour hike with an elevation difference of 300 m in mountainous terrain and requires good fitness, hiking shoes and warm, waterproof clothing.

**Please note there is a limit of 23 participants for this excursion.**

**(2) Weissfluhjoch, Study plot, Snow and Avalanches (Christoph Marty/ Charles Fierz)** This excursion brings us to the Weissfluhjoch, where we will visit the oldest test site of the WSL Institute of Snow and Avalanche Research SLF with a continuous series of measurements since the 1930s. It is equipped with numerous measuring instruments. It is the only place in the world at this elevation where a continuous daily series of weather and snow measurements has been in place for more than 80 years. From the test site we will then enjoy a beautiful 1-hour hike to the station Höhenweg. For this excursion good fitness and hiking shoes are required.







**(3) Höhenweg-Böden, Avalanche protection (Stefan Margreth)** This excursion takes us to the middle station of the Parsenn cable car: Parsenn-Höhenweg. From there we will enjoy a beautiful 2-hour hike to Davos Dorf. On the way we can observe several avalanche protection measures. For this excursion good fitness and hiking shoes are required.

**(4) Seehornwald, Carbon observation system, rock slope failure (Susanne Burri, Caprez Ingenieure)** This excursion takes us to the Davos-Seehornwald research site, which is located just out of the town of Davos in a subalpine forest at 1640 m a.s.l. mainly consisting of Norway spruce trees that are about 30 m tall and up to 450 years old. Here, scientists investigate how air pollution and climate change affect forest health, growth and development as well as the forest's greenhouse gas budget. The first CO<sub>2</sub> flux measurements started as early as 1995 and the site is one of the oldest ecosystem flux sites globally (continuous eddy covariance flux data since 1997). It is the only subalpine Class 1 forest site within the European Research Infrastructure ICOS (Integrated Carbon Observation System). We will get a brief overview of the station as well as its environmental surroundings and we present some interesting scientific observations from long-term research. The excursion includes an easy hike through the Seehornwald, so hiking shoes are required.

In March 2020, a major rockfall occurred on the southern flank of the Seehorn. Where there were many trees before, one now looks onto a boulder field. The area affected by the rockfall is so large that it is clearly visible even from Davos Platz without binoculars. About 10 000 m<sup>3</sup> of debris and earth material were released. The area where the rockfall occurred is not called rockfall forest for nothing. How did the event occur? You will find out on this excursion.





#### **(5) Stillberg, Snow-forest interaction, mountain ecosystem (Peter Bebi)**

On this excursion, we will explore the Stillberg, German for ‘silent mountain’, and the alpine treeline from the valley floor. The Jakobshorn gondola will take us to the Jakobshorn peak. From there we hike down to the Stillberg and Teufi. We will discuss the results of a 45-year long afforestation study at the treeline and various ecosystem manipulation experiments studying the effects of elevated atmospheric CO<sub>2</sub>, nutrient fertilization and warmer climatic conditions. Good hiking shoes and adequate clothes are required.

#### **ABSTRACT AND PAPER PUBLICATION**

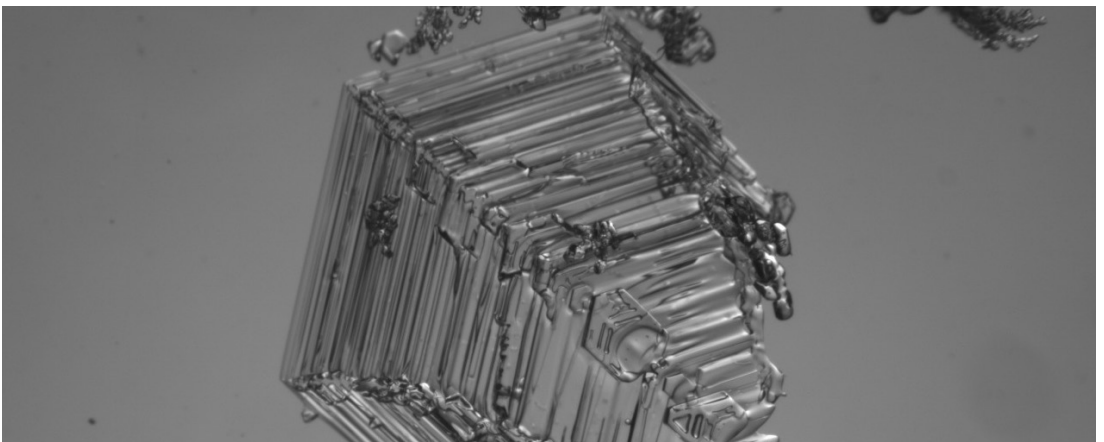
Participants who wish to present a paper (oral or poster) at the Symposium will be required to submit an abstract by 30 June 2022. Accepted abstracts will be posted on the Symposium’s website. The Council of the IGS will publish a thematic issue of the *Annals of Glaciology* on topics consistent with the Symposium themes. Participants are encouraged to submit manuscripts for this *Annals* volume.

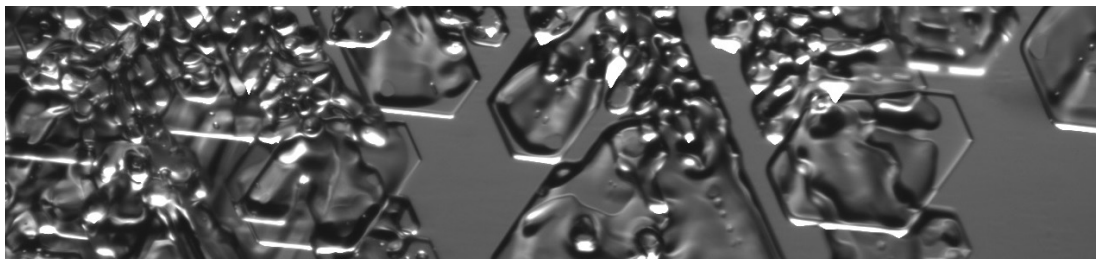
#### **SYMPOSIUM ORGANIZATION**

Magnús Már Magnússon (International Glaciological Society)

#### **LOCAL ORGANIZING COMMITTEE**

Jürg Schweizer, Martin Schneebeli, Nadine Salzmann, Marion Hofmänner, Cornelia Accola





#### SCIENCE STEERING AND EDITORIAL COMMITTEE

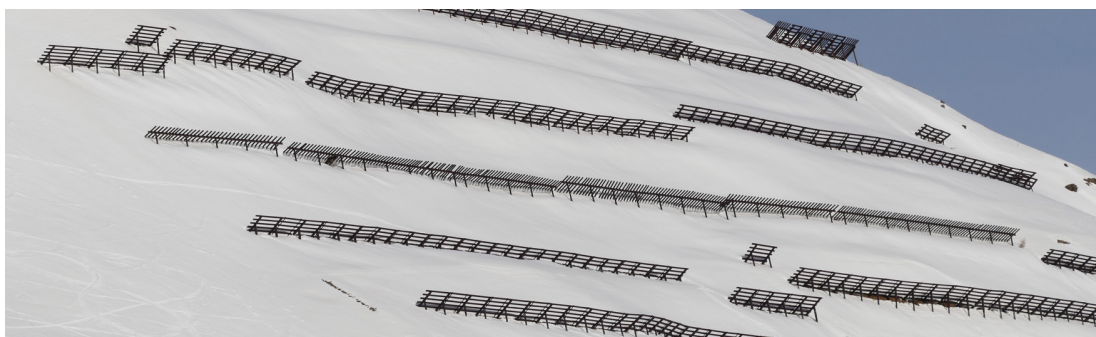
Martin Schneebeli, Nadine Salzmann, Michael Lehning, Yves Bühler, Tobias Jonas, Henning Löwe, Alec van Herwijnen, Marcia Phillips, Perry Bartelt, Charles Fierz, Betty Sovilla, Christoph Marty, Chris Pielmeier, Michael Bründl, Rebecca Mott, Stefan Margreth (SLF Davos), Jan-Thomas Fischer, Michaela Teich (BFW Innsbruck, Austria), Ingrid Reiweiger, Franziska Koch (BOKU Vienna, Austria), Marie Dumont, Pascal Hagenmüller (CEN, MétéoFrance, Grenoble, France), Nicolas Eckert (INRAE Grenoble), Pascal Haegeli (Simon Fraser University), Karl Birkeland (US Forest Service), Ruzica Dacic (University of Wellington, NZ), Johan Gaume (EPF Lausanne), Ulrich Strasser (University Innsbruck), Hans-Peter Marshall (Boise State University), Alex Langlois (University Sherbrooke, Canada), Chris Derksen (ECCC, Canada), Shichang Kang (Northwest Institute of Eco-Environment and Resources, China), Teruo Aoki (National Institute of Polar Research, Tokyo, Japan), Juha Lemmetyinen (Finnish Meteorological Institute, Finland), Rune Engeset (NVE, Norway), Maurine Montagnat (Université Grenoble Alpes), Nick Rutter (Northumbria University, UK)

#### FURTHER INFORMATION

If you wish to attend the symposium, please register online at <https://www.igsoc.org/symposia/2022/davos2022/>

Information will also be updated on the local website: <https://www.slf.ch/en/about-the-slf/events-and-courses/international-symposium-on-snow-2022/>

Please use the symposium hashtag #IGSDavos2022 when you tweet about it







## IMPORTANT DATES

### *Snow*

Opening of online abstract submission:	18 April 2022
Abstract submission deadline:	30 June 2022
Opening of online registration:	14 July 2022
Notification of abstract acceptance:	8 July 2022
Early registration deadline:	23 August 2022
Deadline for full refund:	5 September 2022
Deadline for refund on a sliding scale:	15 September 2022
Late registration surcharge starts:	12 September 2022
Symposium starts:	25 September 2022

### *Annals of Glaciology* volume 65

Paper submission deadline:	1 April 2023
Final revised papers deadline:	30 November 2023

The Call for Papers for the *Annals of Glaciology* is posted on [https://www.igsoc.org/annals/call\\_4\\_papers/](https://www.igsoc.org/annals/call_4_papers/). Accepted papers will be published as soon as authors have returned their proofs and all corrections have been made.

Hard copy publication is scheduled for mid to late 2024.





# Glaciological diary

\*\* IGS sponsored

\* IGS co-sponsored

## 2023

26–28 January 2023

### **IASC Workshop on the Dynamics and Mass Budget of Arctic Glaciers**

Obergurgl, Austria

Website: <https://nag.iasc.info/workshop>

29 January–4 February 2023

### **EGU Snow Science Winter School 2023**

SFL, Davos, Switzerland

Website: <https://www.slf.ch/more/snowschooll>

6–8 February 2023

### **10th Workshop on Remote Sensing of Land Ice and Snow**

Bern, Switzerland

Website: <https://www.earsel.org/SIG/Snow-Ice/workshop/call.php>

6–10 February 2023

### **International Advanced Training Course on Snow and Avalanches ‘Practice meets science’**

SFL, Davos, Switzerland

Website: [www.slf.ch/more/training](http://www.slf.ch/more/training)

9–10 February 2023

### **26th Alpine Glaciology Meeting**

Birmensdorf, Switzerland

Website: <https://www.wsl.ch/en/about-wsl/events/details/alpine-glaciology-meeting.html>

13–17 February 2023

### **2nd MOSAiC Science Conference**

Boulder, Colorado, USA

Website: <https://mosaic.colorado.edu/second-science-conference>

17–24 February 2023

### **Arctic Science Summit Week (ASSW) 2023**

Vienna, Austria

Website: <https://assw.info/>

10–16 March 2023

### **Glacier modelling: Practical applications with the Open Global Glacier Model**

Lahore, Pakistan

Website: <https://huc-hkh.org/events/training-on-glacier-modelling-practical-applications-with-the-open-global-glacier-model>

21–23 March 2023

### **Sea Ice Data Assimilation Workshop**

Oslo, Norway

Website: <https://iicwg-da-11.met.no>

28–29 March 2023

### **Workshop: Ice-sheet modelling initialization**

Utrecht, Netherlands

Website: <https://www.igsoc.org/event/two-day-workshop-on-ice-sheet-model-initialisation>

1–8 April 2023

### **Field school: Physics of Arctic Snowpacks and Climate**

Ikaluktutiak Nunavut, Canada

Website: <https://sentinellenord.ulaval.ca/en/arcticsnow2023>

24–27 April 2023

### **AITC 2023: Mapping the Arctic**

Nuuk, Greenland

Website: <https://dtu.events/aitc2023/conference-description.html>

15–19 May 2023

### **Polar Postdoc Leadership Workshop**

Nederland, Colorado, USA

Website: <https://psecco.org/outreach/conferencesworkshops/polar-postdoc-leadership-workshop>

24 May–2 June 2023

### **23rd Karthaus Summer School: Ice sheets and glaciers in the climate system**

Karthaus, Italy

Website: <http://www.projects.science.uu.nl/iceclimate/karthaus/>

4–9 June 2023

**\*\*International Symposium on Sea Ice across Spatial and Temporal Scales**

Bremerhaven, Germany

Website: [https://www.igsoc.org/event/bremerhaven\\_2021](https://www.igsoc.org/event/bremerhaven_2021)

6–8 June 2023

**79th Annual Eastern Snow Conference**

Easton, Pennsylvania, USA

Website: <https://www.easternsnow.org/>

18–22 June 2023

**6th European Conference on Permafrost**

Puigcerdà, Spain

Website: <http://eucop2023.com/>

19–22 June 2023

**36th Forum for Research into Ice Shelf Processes (FRISP 2023)**

Stalheim, Norway

Website: <https://www.tipaccs.eu/frisp2023/>

2–7 July 2023

**\*\*International Symposium on the Edges of Glaciology**

Limerick, Ireland

Website: [https://www.igsoc.org/event/limerick\\_2023](https://www.igsoc.org/event/limerick_2023)

3–7 July 2023

**Polenet Training school: Glacial Isostatic Adjustment Modelling**

Gävle, Sweden

Website: <https://polenet.org/2023-gia-training-school/>

3–7 July 2023

**Ross Sea Conference**

Naples, Italy

Website: <http://www.rossseaconference.org>

11–20 July 2023

**IUGG General Assembly**

Berlin, Germany

Website: <https://www.iugg2023berlin.org/>

23–27 July 2023

**17th US National Congress on Computational Mechanics**

Albuquerque, New Mexico, USA

Minisymposium on Geomechanics of the Cryosphere

Website: <https://17.usnccm.org/705>

14–18 August 2023

**SOOS Symposium: Southern Ocean in a Changing World**

Hobart, Tasmania, Australia

Website: <https://soos.aq/soos-symposium-2023>

4–8 September 2023

**15th International Conference on Physics and Chemistry of Ice (PCI-2022)**

Sapporo, Japan and Online

Website: <http://www.lowtem.hokudai.ac.jp/ptdice/PCI-2022/index.html>

20–22 September 2023

**\*\*International Symposium on Ice Drilling Technology**

Bremen, Germany

Contacts: Secretary General, International Glaciological Society (IGS)

**2024**

4–9 August 2024

**\*\*International symposium on Verification and Validation of Cryospheric models**

Northumbria University, Newcastle, UK

Contacts: Secretary General, International Glaciological Society (IGS); Jan De Rydt <[jan.rydt@northumbria.ac.uk](mailto:jan.rydt@northumbria.ac.uk)>

**2025**

20–25 July 2025

**\*\*International symposium on Ice Streams and Outlet Glaciers**

Durham, UK

Contact: Secretary General, International Glaciological Society (IGS)

20–25 July 2025

**IAMAS-IACS-IAPSO BACO-25 Joint Assembly**

Busan, South Korea



17–22 August 2025

**\*\*International symposium on Artificial Intelligence in Glaciology**

Hanover, New Hampshire or Baltimore Maryland, USA,

Contact: Secretary General, International Glaciological Society (IGS)

**2026**

5–10 July 2026

**\*\*International Symposium on Interactions of Ice Sheets and Glaciers with the Ocean**

La Jolla, California, USA

Contact: Secretary General, International Glaciological Society (IGS)

16–21 July 2026

**\*\*International symposium on Radioglaciology**

Tübingen, Germany

Contact: Secretary General, International Glaciological Society (IGS)



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# International Glaciological Society

Secretary General M.M. Magnússon

	Council Members	Concurrent service on Council, from
President	G. Flowers	2021–2024
Vice-Presidents	P. Heil	2021–2024
	C. Hulbe	2019–2022
	A. Glazovski	2021–2024
Immediate Past President	F.J. Navarro	2021–2024
Treasurer	A.A. Leeson	2018–2021
Elected Members	*M. Błaszczyk	2019–2022
	*R. Bhakta Kayasth	2021–2024
	*I. Das	2019–2022
	*Jing Gao	2022–2024
	*M.E. Hansson	2019–2022
	*M. Huss	2019–2022
	*J. Kohler	2021–2024
	*L. Ruiz	2021–2024
	*A Sakai	2021–2024
	*R. Schlegel	2021–2024
	*M. Schneebeli	2021–2024
	*D.M. Schroeder	2019–2022

\*First term of service on the Council

## IGS Committees

Awards	J. Bassis (Chairman)
Nominations	F.J. Havarro (Chairman)
Publications	B.P. Hubbard (Chairman)

## Correspondents

Argentina	L. Ruiz	Finland	T. Zwinger	Russia	I. Lavrentiev,
Australia	P. Heil	France	É. Berthier		S. Sokratov
Austria	L. Nicholson	Germany	D. Jansen	Spain	F.J. Navarro
Belgium	P. Huybrechts	Iceland	H. Hannesdóttir	Sweden	W. van Pelt
Brazil	J. C. Simões	Italy	G. Diolaiuti	Switzerland	F. Paul
Canada	W. van Wychen	Japan	S. Sugiyama	UK	S. Buzzard
Chile	A. Rivera	Netherlands	C. Tijm-Reimer	USA (Alaska)	M. Truffer
China	Yao Tandong,	New Zealand	H. Purdie	USA (Eastern)	K. Schild
	Jing Gao	Norway	G. Moholdt	USA (Western)	T.J. Fudge
Denmark	A.P. Ahlstrøm	Poland	G. Rachlewicz		

## Seligman Crystal

1963 G. Seligman	1990 C.R. Bentley	2009 P.A. Mayewski
1967 H. Bader	1990 A. Higashi	2011 A. Iken
1969 J.F. Nye	1992 H. Röthlisberger	2012 D.E. Sugden
1972 J.W. Glen	1993 L. Lliboutry	2013 P. Duval
1972 B.L. Hansen	1995 A.J. Gow	2019 R. Hindmarsh
1974 S. Evans	1996 W.F. Budd	2019 D.R. MacAyeal
1976 W. Dansgaard	1997 S.J. Johnsen	2020 A. Fowler
1977 W.B. Kamb	1998 C. Lorius	2020 C. Ritz
1982 M. de Quervain	1999 C.F. Raymond	2021 A. Jenkins
1983 W.O. Field	2000 S.C. Colbeck	
1983 J. Weertman	2001 G.S. Boulton	
1985 M.F. Meier	2001 G.K.C. Clarke	
1986 G. de Q. Robin	2003 K. Hutter	
1989 H. Oeschger	2005 R.B. Alley	
1989 W.F. Weeks	2007 L.G. Thompson	

## Honorary Members

G.K.C. Clarke	J.W. Glen
V.M. Kotlyakov	M. Kuhn
G. Wakahama	Yang Zhenning

## Richardson Medal

1993 H. Richardson	2013 A. Weidick
1997 D.R. MacAyeal	2016 T. Chinn
1998 G.K.C. Clarke	2016 E.M. Morris
1999 J.A. Heap	2017 J.M. Palais
2003 C.S.L. Ommannney	2019 J. Oerlemans
2010 T.H. Jacka	2020 C. Hulbe
2012 W.S.B. Paterson	2020 E. Wolff
2013 J.W. Glen	2021 R. Hock

The Society is registered as a charity in the United Kingdom with the Charity Commissioners – No. 23104

# International Glaciological Society

High Cross, Madingley Road  
Cambridge CB3 0ET, UK

## MEMBERSHIP

Membership is open to all individuals who have a scientific, practical or general interest in any aspect of snow and ice. Benefits include a 10% discount on 'Author Processing Charges' when you publish in the *Journal* and *Annals of Glaciology*. Members also receive substantial discounts when attending IGS symposia. To join please see our website at [www.igsoc.org/membership](http://www.igsoc.org/membership).

## ANNUAL MEMBERSHIP FEE 2023

	Sterling
Ordinary members	£20–50
Supporting members	£277
Contributing members	£137
Retired/partner members	£10–25
Student/Junior members (under 30 years or in full-time study (e.g. PhD/MSc)	£10–25

The new membership fee structure is based on the member's country of work and the 'World Bank country classifications by income level', which classifies countries into four groups according to Gross Net Income.

Retired membership is available to those who have been ordinary members of the IGS for at least 15 years.

Payment may be made on line using MasterCard, AmEx or VISA/Delta.

## ICE

Editor: M.M. Magnússon (Secretary General)

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