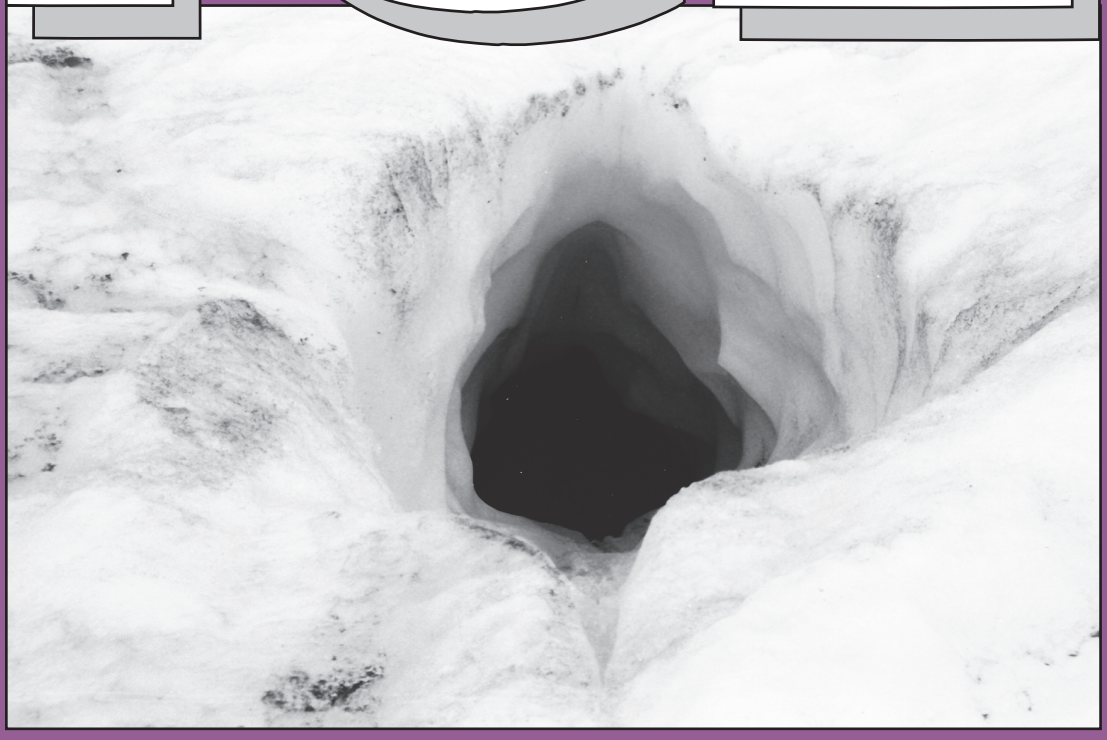
Number 179 *1st Issue 2019*

ICE



NEWS BULLETIN OF THE INTERNATIONAL GLACIOLOGICAL SOCIETY

ISSN 0019–1043

Ice

News Bulletin of the International Glaciological Society

Number 179 1st issue 2019

Contents

Cover picture: .A moulin on Turtmanngletscher, Switzerland. Photo by Jaap J.M. van der Meer.

From the Editor

Dear IGS member

Welcome to the first issue of *ICE* for 2019. A bit overdue but you must be used to that by now. At least *ICE* comes out regularly, albeit usually a bit late.

This year has been very busy. At the time of writing we have already held two symposia and the third one will take place in 3 weeks time. The first one was in May in Madison, Wisconsin, with the theme 'Glacial Erosion and Sedimentation' and the second last month at Stanford University, California, on 'Five Decades of Radioglaciology'. And the final IGS symposium this year will be held in Winnipeg, Manitoba, with the theme 'Sea Ice at the Interface'. As usual with the IGS sea ice meetings it is proving to be very popular. We are expecting between 350 and 400 delegates, which will make it one of the best attended of IGS symposia.

The reason I bring this up is that I have a request for our future delegates. During abstract submission and registration we sometimes get the impression that you do not take much care to read the instructions provided and check things before you press Enter. For example, you need to think carefully before you start about who your co-authors are so we do not need to add authors at a later date and you also need to be careful to put the authors in the order they are to appear on the abstract, and to be sure you have finalized which of you is to be the corresponding author and which the presenter. All the information goes into a database from which we can automatically generate the abstract booklet and fill in the program. Sadly, we quite often we get requests to add new authors or change the order of authors. We can do it, but it takes time, and when you have a symposium like the Sea Ice meeting, where we have had in excess of 400 abstracts submitted, it can take quite some time to edit the database. Plus, it increases the risk of mistakes being made. In addition, if these requests come to us late in the day the abstracts have already been circulated to various individuals and it can be tricky to correct things everywhere. Another issue that regularly crops up is that, although it specifically says not to include figures and references in your abstract, a surprising number of authors do so. And some of you include the title, all authors and their affiliations at the top of the abstract. If you are doing a 'cut and paste', please only paste the text of the abstract, no title, no authors, no figures and no references. Of course there are always instances where the information is not available beforehand and in such cases we are more than happy to make necessary changes for you. But we are trying to be economical and efficient, so please, submit your abstracts with great care.

Next, I'd like to mention the process of registering for the symposium. When you register, we ask you several questions that will help us with the logistics relating to the meeting, for example whether you will be attending the banquet and the Icebreaker. We ask this so we can ensure the catering is aware how many people are coming. At

the Stanford symposium we held the banquet on board a cruise boat. We needed to know how many would be attending so we could ensure the boat was big enough to accommodate everyone. Nor did we want to reserve a boat that was much too big. We also ask you whether you plan to come to the mid-week excursion. We do this so we can order the appropriate number of busses. If we order too many, and only fill one bus, we still must pay for the extra bus even though we do not use it. And we ask you if you are a student presenter. We usually give out awards for the best student oral and poster presentations. Hence we need to know which presentations need to be included in the judging for this. If we don't know that you are a student you may miss out on an award. It does look good on your CV should you get one! Again, there will of course always be instances where things change and the information you provided is no longer valid. In these cases we are happy to make such changes for you. After all, it is in our interests for the information to be correct so we can give you the very best experience when you attend our symposia. Let me say that invariably we get feedback from our delegates that the IGS symposia are fantastic. We want to keep it that way.

But enough complaining. You will have noticed that we awarded two Seligman crystals and a Richardson medal very recently. I would like you to start thinking about whether one of your peers deserves this very special type of recognition. The next deadline for nominations will be near the middle of next year but it does take some effort to put together a nomination package, so it is best to start sooner rather than later.

The awardees this year were very worthy of the honour. The IGS awarded the Seligman crystal to Richard Hindmarsh and Doug MacAyeal and the Richardson Medal to Hans Oerlemans. All three names are familiar to you no doubt, so the standard is very high. You can see the citations on the IGS website at

https://www.igsoc.org/awards/seligman/richardhindmarsh.html
https://www.igsoc.org/awards/seligman/dougmacayeal.html
https://www.igsoc.org/awards/richardson/oerlemans.html

To finish off this issue's editorial in my usual fashion I would like to encourage all of you to renew your membership and, if you are not a member, please join. I also encourage you to submit your paper to the highly respected and prestigious *Journal of Glaciology* or to the *Annals of Glaciology*. In doing so you are supporting the glaciological community, i.e. yourselves.

Magnús Már Magnússon
Secretary General

International Glaciological Society

JOURNAL OF GLACIOLOGY

Papers accepted for publication between 1 January and 30 April 2019. The papers are listed in alphabetical order by first author. Some of these papers have already been published.

Jakob Abermann, Dirk Van As, Stefan Wacker, Kirsty Langley, Horst Machguth, Robert Fausto
Strong contrast in mass and energy balance between a coastal mountain glacier and the Greenland ice sheet

Martina Arcangioli, Angiolo Farina, Lorenzo Fusi, Giuseppe Saccomandi
Constitutive equations with pressure dependent rheological parameters for describing ice creep

Joaquín Belart, Eyjólfur Magnússon, Etienne Berthier, Finnur Pálsson, Guðfinna Aðalgeirsdóttir, Tómas Jóhannesson
The geodetic mass balance of Eyjafjallajökull ice cap for 1945–2014: Processing guidelines and relation to climate

Etienne Berthier, Fanny Brun
Karakoram geodetic glacier mass balances between 2008 and 2016: persistence of the anomaly and influence of a large rock avalanche on SiachenGlacier

Bo Cao, Baotian Pan, Weijin Guan, Zhenling Wen, Jie Wang
Changes in glacier volume on Mt Gongga, southeastern Tibetan Plateau, based on the analysis of multi-temporal DEMs from 1966 to 2015

Philip Crivelli, Enrico Paterna, Michael Lehning
Spatiotemporal dynamics of snow erosion, deposition and horizontal mass flux

Rebecca Dell, Rachel Carr, Emrys Phillips, Andrew Russell
Response of glacier flow and structure to proglacial lake development and climate at Fjallsjökull, south-east Iceland

Zbyněk Engel, Jan Kropáček, Jana Smolíková
Surface elevation changes on Lachman Crags ice caps (north-eastern Antarctic Peninsula) since 1979 indicated by DEMs and ICESat data

Daniela Festi, Werner Kofler, Klaus Oeggl
Comments on Brugger and others (2018) 'A quantitative comparison of microfossil extraction methods from ice cores'

Mukesh Gupta, Carolina Gabarro, Antonio Turiel, Marcos Portabella, Justino Martinez
On the retrieval of sea ice thickness using SMOS polarization differences

Regine Hock, Andrew Bliss, Ben Marzeion, Rianne Giesen, Yukiko Hirabayashi, Matthias Huss, Valentina Radić, Aimee Slangen
GlacierMIP: a model intercomparison of global-scale glacier mass-balance models and projections

William Kochtitzky, Hester Jiskoot, Luke Copland, Ellyn Enderlin, Robert McNabb, Karl Kreutz, Brittany Main
Terminus advance, kinematics, and mass redistribution during eight surges of Donjek Glacier, St Elias Range, Canada, 1935–2016

Qi Liang, Chunxia Zhou, Ian Howat, Seongsu Jeong, Ruixi Liu, Yiming Chen
Ice flow variations at Polar Record Glacier, East Antarctica

Lin Liu, Liming Jiang, Yongling Sun, Hansheng Wang, Yafei Sun, Houze Xu
Diurnal fluctuations of glacier surface velocity observed with terrestrial radar interferometry at Laohugou No.12 Glacier, western Qilian mountains, China

Grant Macdonald, Alison Banwell, Ian Willis, David Mayer, Becky Goodsell, Douglas MacAyeal
Formation of pedestalled, relict lakes on the McMurdo Ice Shelf, Antarctica

Andrew Malone, Alice Doughty, Douglas MacAyeal
Interannual climate variability helps define the mean state of glaciers

Dorota Medrzycka, Luke Copland, Wesley Van Wychen, David Burgess
Seven decades of uninterrupted advance of Good Friday Glacier, Axel Heiberg Island, Arctic Canada

Alexis Moyer, Peter Nienow, Noel Gourmelen, Andrew Sole, Donald Slater, Martin Truffer, Mark Fahnestock
Spatio-temporal variations in seasonal ice tongue submarine melt rate at a tidewater glacier in southwest Greenland

Sher Muhammad, Lide Tian, Marcus Nüsser
No significant mass loss in the glaciers of Astore Basin (North-Western Himalaya), between 1999 and 2016

Johannes Reinthaler, Frank Paul, Hugo Delgado Granados, Andrés Rivera, Christian Huggel
Area changes of glaciers on active volcanoes in Latin America between 1986 and 2015 observed from multi-temporal satellite imagery

Alan Rempel, Colin Meyer
Premelting increases the rate of regelation by an order of magnitude

Julius Rix, Robert Mulvaney, Jialin Hong, Dan Ashurst
Development of the British Antarctic Survey Rapid Access Isotope Drill

Tomotaka Saruya, Koki Nakajima, Morimasa Takata, Tomoyuki Honma, Nobuhiko Azuma, Kumiko Goto-Azuma
Effects of microparticles on deformation and microstructural evolution of fine-grained ice

Jessica Scheick, Ellyn Enderlin, Gordon Hamilton
Semi-automated open water iceberg detection from Landsat applied to Disko Bay, West Greenland

Rossana Serandrei-Barbero, Sandra Donnici, Stefano Zecchetto
Projected effects of temperature changes on the Italian Western Tauri glaciers (Eastern Alps)

Adrienne White, Luke Copland
Loss of floating glacier tongues from the Yelverton Bay region, Ellesmere Island, Canada

Kunpeng Wu, Shiyin Liu, Zongli JIang, Junli Xu, Wei Junfeng
Glacier mass balance over the central Nyainqentanglha Range during recent decades derived from remote-sensing data

Guoqing Zhang, Tobias Bolch, Simon Allen, Andreas Linsbauer, Wenfeng Chen, Weicai Wang
Glacial lake evolution and glacier-lake interactions in the Poiqu River basin, central Himalaya, 1964–2017

Yushan Zhou, Zhiwei Li, Jia Li, Rong Zhao, Xiaoli Ding
Geodetic glacier mass balance (1975–99) in the central Pamir using the SRTM DEM and KH-9 imagery

ANNALS OF GLACIOLOGY 59(77)

The following papers have been selected for publication in Annals of Glaciology *59(77) (thematic issue on Cryosphere and Biosphere), edited by Alex Anesio, Andrew J. Hodson and Martyn Tranter*

Antonio Mondini, Johanna Donhauser, Corina Itcus, Constantin Marin, Aurel Persoiu, Paris Lavin, Beat Frey, Cristina Purcarea
High-throughput sequencing of fungal communities across the perennial ice block of Scărișoara Ice Cave

Naoko Nagatsuka, Nozomu Takeuchi, Ki-Cheol Shin, Takanori Nakano
Spatial variations of Sr–Nd isotopic ratios, mineralogical and elemental compositions of cryoconite in an Alaskan glacier

Tanuj Shukla, Shipika Sundriyal, Lukasz Stachnik, Manish Mehta
Carbonate and silicate weathering in glacial environments and its relation to atmospheric CO_2 cycling in the Himalaya

Robin Wojcik, Johanna Donhauser, Beat Frey, Stine Holm, Alexendra Holland, Alexandre Anesio, David Pearce, Lucie Malard, Dirk Wagner, Liane Benning
Linkages between geochemistry and microbiology in a proglacial terrain in the High-Arctic

Annals 59(77) is now complete.

ANNALS OF GLACIOLOGY 60(78)

The following paper has been selected for publication in Annals of Glaciology *60(78) (thematic issue on Timescales, Processes and Glacier Dynamics), edited by Jesse Johnson and Cornelis van der Veen*

Hao Ke, Yuande Yang, Fei Li, Zemin Wang, Bo Sun, Dongchen E, Bo Jin, Minghu Ding
Re-establishment of ice surface velocity field and snow surface elevation change around Dome Argus, East Antarctica

Annals 60(78) is now complete

ANNALS OF GLACIOLOGY 60(79)

The following papers have been selected for publication in Annals of Glaciology *60(79) (thematic issue on Progress in Cryoseismology), edited by Fabien Walter*

Jade Cooley, Paul Winberry, Michelle Koutnik, Howard Conway
Tidal and spatial variability of flow speed and seismicity near the grounding zone of Beardmore Glacier, Antarctica

Dominik Gräff, Fabian Walter, Brad Lipovsky
Crack wave resonances within the basal water layer

Thomas Hudson, Jonathan Smith, Alex Brisbourne, Robert White
Automated detection of basal icequakes and discrimination from surface crevassing

Siobhan Killingbeck, Adam Booth, Phil Livermore, Landis West, Benedict Reinardy, Atle Nesje
Subglacial sediment distribution from constrained seismic inversion, using MuLTI software: examples from Midtdalsbreen, Norway

Andreas Köhler, Valerie Maupin, Christopher Nuth, Ward van Pelt
Characterization of seasonal glacial seismicity from a single-station on-ice record at Holtedahlfonna, Svalbard

Yuri Konovalov
Ice-shelf vibrations modelled by a full 3-D elastic model

Rebecca Schlegel, Anja Diez, Henning Löwe, Christoph Mayer, Astrid Lambrecht, Johannes Freitag, Heinz Miller, Coen Hofstede, Olaf Eisen
Comparison of elastic moduli from seismic diving-wave and ice-core microstructure analysis in Antarctic polar firn

Amandine Sergeant, Anne Mangeney, Vladislav Yastrebov, Fabian Walter, Jean-Paul Montagner, Olivier Castelnau, Eléonore Stutzmann, Pauline Bonnet, Velotiana Jean-Luc Ralaiarisoa, Suzanne Bevan, Adrian Luckman
Monitoring Greenland ice-sheet buoyancy-driven calving discharge using glacial earthquakes

More papers for *Annals* 60(79) will be listed in the next issue

ANNALS OF GLACIOLOGY 61(81)

The following paper has been selected for publication in Annals of Glaciology *61(81) (thematic issue on Five Decades of Radioglaciology), edited by Dustin Schroeder*

Bangbing Wang, Bo Sun, Jiaxin Wang, Jamin Greenbaum, Jingxue Guo, Laura Lindzey, Xiangbin Cui, Duncan Young, Donald Blankenship, Martin Siegert
Removal of 'strip noise' in airborne radio-echo sounding data using combined wavelet and 2-D FFT filtering

More papers for *Annals* 61(810) will be listed in the next issue

Timescales, Processes and Glacier Dynamics

IGS Symposium Buffalo, New York, USA, 3–8 June 2018

The IGS symposium in Buffalo brought together 80 delegates for 5 days of presentations, discussions, field trips and social interactions focusing on a broad range of contemporary and past glacier and ice-sheet problems. The symposium was co-sponsored by various units of the University at Buffalo, the US National Science Foundation, NASA and the National Snow and Ice Data Center (NSIDC) associated with the University of Colorado. The venue was the Lafayette Hotel in the heart of Buffalo's brewery district and within a mile of historic Canalside on Lake Erie. This magnificent historical hotel was designed by the first professional female architect in the USA, Louise Blanchard Bethune, and built in 1904, during Buffalo's industrial heyday.

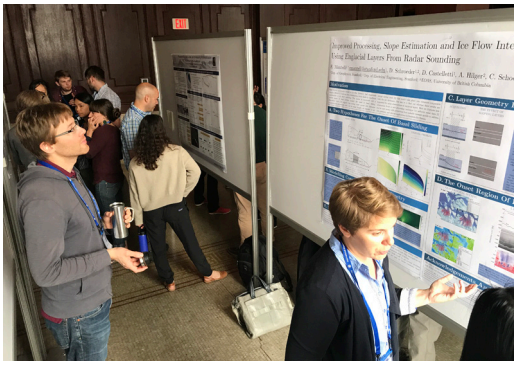
The symposium featured oral and poster sessions on a variety of forefront research areas, including new directions in ice-sheet and ice-sheet-process model development, analysis of time-series data in alpine glacier environments, debris cover and its effects, new paleoclimate/paleoglaciological data, perspectives and methods, Antarctic and Greenland ice-sheet instability processes, subglacial processes and environments, ice–ocean interactions, supra-glacial hydrology, and cryoseismology. Featured among these presentations were many graduate students who were presenting their latest research. In the audience were many experienced old-timers who offered valuable advice and motivating commendation to the students and other early-career presenters.

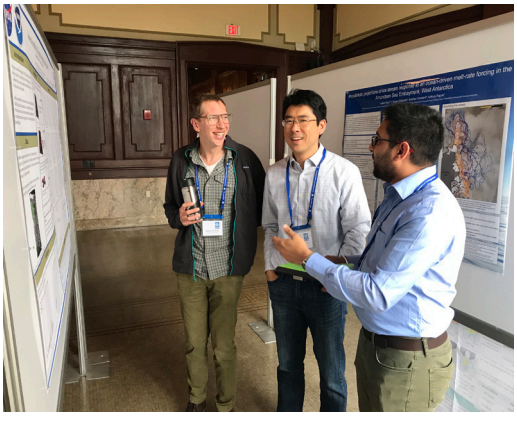
The presentations took place in the palatial surroundings of the Lafayette Hotel.

Interspersed among the scientific sessions were special-focus lectures with panel discussions. Long-time IGS member Robin Bell, also the current President of the American Geophysical Union (AGU), gave a perceptive lecture on 'Building an ethical sustainable future: from the poles to our homes'. In her lecture, Robin covered a wide variety of topics ranging from how the AGU has designed a new headquarters building that captures heat from the Washington DC sewer system to the important issue of civil, non-harassing behavior in the field and laboratory.

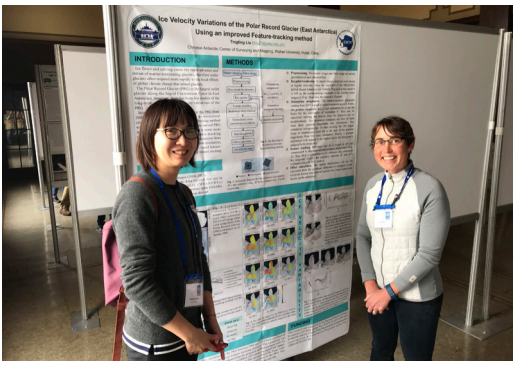
The food at the Icebreaker was delicious and very temptingly presented to hungry travelers.

Robin Bell and Gwenn Flowers catching up before her lecture.





Tuesday's convivial poster session.



Following a lively discussion of Robin's lecture, the symposium participants were treated to a 'communicating science' workshop where Shane Hanlon, a science journalist and podcaster, discussed how storytelling and social media can help bring science communication to a more effective level. Following Shane's presentation, there was lively discussion over BEvERages provided by the University at Buffalo.

On Thursday, immediately prior to the symposium banquet, a special public lecture was given as part of the University at Buffalo's Institute for Research and Education in Energy, Environment and Water (RENEW). Following a welcome given by the University of Buffalo Provost and RENEW director, Professor Amit Goyal, Polar Explorer Sebastian Copeland gave a chilling presentation on his experience traveling by foot to the North Pole. His talk was entitled 'From Pole to Pole: the call of the ice – how the ice foretells the next systematic transformation'. Following his talk, a fireside-style discussion was enjoyed between Sebastian and distinguished glaciologist and Seligman Crystal laureate Richard Alley.

Richard Alley (left) and Sebastian Copeland provided the special public lecture and discussion on Thursday, introduced by the University at Buffalo's Amit Goyal (right).

Because of the University at Buffalo's strength in acquiring paleo-climate data, this domain was well represented at the symposium, representing fully 10% of talks and posters. Participants from this area provided a new perspective on the theme of timescales and processes being developed at the symposium.

IGS symposia always involve a variety of social experiences where scientific discussion can proceed less formally and where scientists can meet new colleagues and enjoy reconnecting with old friends. The Icebreaker on Sunday evening featured significantly delicious hors d'oeuvres that arriving participants could feast on in lieu of dinner. Tuesday evening featured an informal tour of the many breweries surrounding the symposium venue.

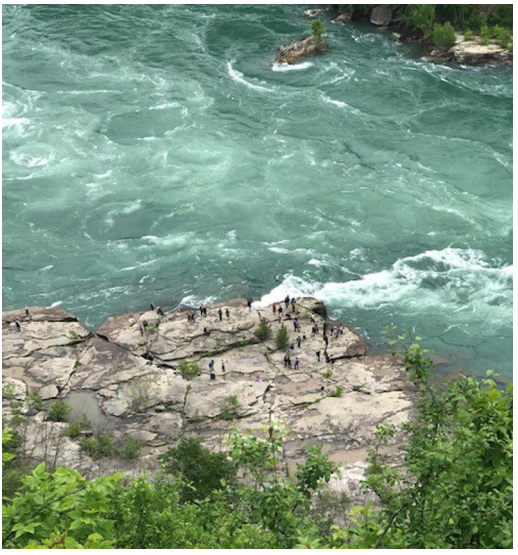
The symposium's mid-week excursion was to the Niagara Falls and gorge downstream. While no symposium participants had the courage to try their luck floating over the falls in a barrel, many did hike the steep trail down into the zone of whirlpools just below the falls where Lake Erie flows into Lake Ontario. There they examined the peculiar geology of North America's largest waterfall as well as the former spillway from the period of deglaciation, which is now inactive. A period of free time was allowed so that hundreds of selfies could be snapped by participants in the misty area just adjacent to the falling torrent.

The symposium banquet was held, it could be said very aptly, in the former Buffalo State Asylum for the Insane, now converted to the Henry Hotel and Conference Center. Again, the food and drinks were magnificent.

Buffalo's craft breweries were well worth a visit....

...and of course once participants had inspected the brewing process it was necessary to test the finished product!

Mid week excursion to Niagara Falls. Participants view the falls up close.



Other members of the party hiked down into the gorge immediately downstream of the Falls.

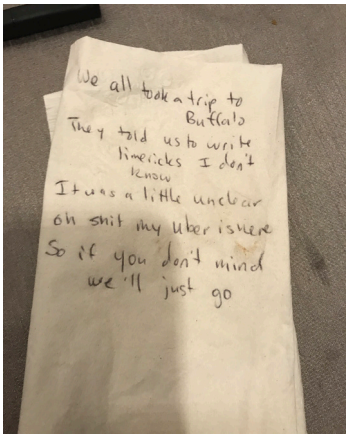
Group photo at Niagara Falls.

At one point during the symposium banquet, a limerick (short poem) 'battle' broke out. It is said that many of the best limerick composers are also glaciologists; and this impromptu event did not contradict this saying. While there are no 'winners' in limerick battles, it was generally acknowledged that many of the early-career and graduate student scientists conveyed themselves with true superiority in eroding away the big egos of some of the more senior scientists. Most of the limericks must remain unpublished, as 'poems composed in Buffalo, stay in Buffalo'. But here are a couple:

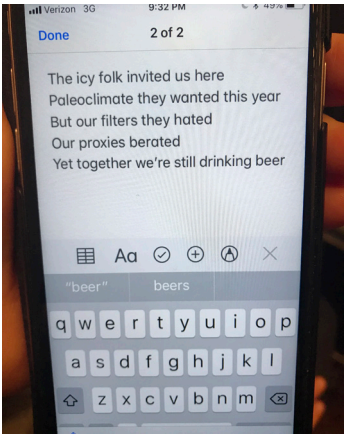
There once was a man named MacAyeal,
Whose verse we all found a bit stale.
Though clever with ice,
His rhymes don't suffice,
So his overall grade is a fail.

There once was a theorist called Bell
Whose postdocs said it was hell,
They worked on the shelf
Suppressing their self
But the data collected was swell.

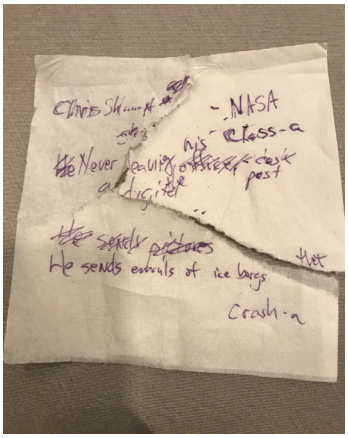
The banquet was held on Thursday night. After some time spent eating, drinking and socializing, many tables became entirely focused on the limerick competition.



The limericks were created using old technology...



...and new technology....



....but they still defeated some people altogether..

At the banquet also, presentations of IGS dishes were made to members of the Local Organizing Committee who had done so much to make the symposium a success.

Best student presentation awards, From the left: IGS Secretary General Magnús Már Magnússon, Soroush Rezvanbehbahani and Caitlyn Florentine (joint best oral presentation), Brandon Graham, (best poster) Beáta Csathó, Christopher Shuman and IGS immediate past President Douglas MacAyeal.

At the conclusion of the symposium on Friday afternoon, student presentation (both oral and poster) awards were presented to Soroush Rezvanbehbahani, Caitlyn Florentine and Brandon Graham. In the evening, many of the participants who remained in Buffalo because of travel constraints or in order to join the post-symposium excursion were elegantly wined and dined at the house of the Chair of the Symposium's Local Organizing Committee, Bea Csathó, in the countryside near Buffalo.

On Saturday, immediately following the conclusion of the symposium, the post-symposium field excursion to examine the glacial geology of upstate New York got under way. This one-day outing focussed on the I-90 corridor as it passed along the old Erie Canal through the drumlin fields that surround the Finger Lakes. There were many stops along the way where University of Buffalo Professor Jason Briner explained the features and exposures. At the first stop, a particularly large drumlin was ascended, and there the excursion participants also had the chance to see a significant place featured in the religious history of the Mormon faith. The summit of this drumlin was where Joseph Smith received the golden plates that became the Book of Mormon.

The excursion eventually wound its way along the shoreline of Lake Canadaiqua to the Heron Hill Winery Tasting Room. There, many of the excursion participants who had grown up skeptical that any good vintage could possibly come from upstate New York, were gladly corrected by the complex nature of the wines produced in the region.

Overall the symposium held in Buffalo was highly informative and effective in stimulating

Lunch on the shores of Lake Ontario at Chimney Bluffs State Park.

At the summit of a drumlin is the spot where an angel gave Joseph Smith the golden tablets fundamental to the Mormon faith. This is the view from the top.

At a stop on the excursion, Jason Briner explains to other participants what glacial features can be seen on the ground.

The spectacular Chimney Bluffs are formed from eroded drumlins and are always changing.

the exchange of ideas that are at the forefront of many issues in glaciology. The symposium would not have been possible were it not for the extraordinarily conscientious organization of Beáta Csathó and her colleagues: Jason Briner, Kristin Poinar, Elizabeth Thomas, Barbara Catalano and Carolyn Roberts of the University at Buffalo and Ted Scambos of NSIDC.

Doug MacAyeal

Tasting the wine at the Heron Hill winery on the shore of Lake Canadaigua.

New Zealand Branch Meeting 2019

Snow and Ice Research Group Annual Workshop 20–22 February 2019

On 20–22 February the New Zealand Snow and Ice Research Group (SIRG) held its annual workshop in Kurow, a small rural town on the banks of the Waitaki River in the central South Island. The responsibility of organizing each year's workshop is rotated among the three New Zealand universities with large cryospheric research programmes, namely the University of Otago, the University of Canterbury and the Victoria University of Wellington. This year it was the University of Otago at the helm.

A total of 35 participants attended the workshop. In addition to staff and graduate students from the universities, scientists from Crown Research Institutes (NIWA and GNS) and from private and public sector organizations (Aqualinc, Waitaki District Council) also attended, along with three international participants from the USA, UK and Australia.

The conference got under way with presentations focusing on snow accumulation processes, including advances in drone and satellite technologies, and projections for New Zealand's frozen water resources under a changing climate. Brewster and Tasman Glaciers remain key sites for glaciological research. A presentation by masters student Hamish Prince (University of Otago), on 'The development and calibration of a distributed glacier mass balance model for Brewster Glacier' earned him third-prize for a student talk at the workshop, while later that afternoon, PhD candidate Clarrie Macklin (Victoria University of Wellington), took the top student prize with 'A finite-element approach for investigating basal friction during episodes of accelerated sliding at Haupapa/Tasman Glacier'.

The arrival of a mobile coffee caravan helped get Day 2 under way. The depth and breadth of Antarctic sea-ice research being currently undertaken by participants was outstanding. Gemma Brett (PhD candidate, University of Canterbury) delivered the second-prize-winning student talk on 'Variability in the distribution of fast ice and the sub-ice platelet layer near an Antarctic ice shelf'. Conversations about sea ice were interspersed with results from recent ice-shelf investigations, and the day's talks were rounded off by thinking about whether the New Zealand dairy industry should be concerned about climate change, and an overview of progress towards establishing a UNESCO Geopark in the Waitaki valley region.

Before the last day of talks was brought to a close, Inga Smith led a fitting tribute to the late Trevor Chinn. Trevor never missed a SIRG workshop, and was an active planner with the University of Otago team for the 2019 workshop, particularly the field trip. His recent passing had undoubtedly left a big 'gap' in our community. Drew Lorrey (NIWA) read the eulogy he had delivered at Trev's memorial service in Hawea in January, and showed two videos relating to Trev's work on the New Zealand end-of-summer snowline glacier assessment. Drew spoke of Trev's helpful, humble and kind nature, and his lasting legacy to glaciology.

Brian Anderson (Victoria University of Wellington) told the audience of how he met Trev

The 2019 workshop participants

2019 student presentation winners (from left to right) Hamish, Gemma and Clarrie.

at the first SIRG workshop in 2001, and how Trev showed him how the landscape of New Zealand had been shaped by glaciation. He described Trev's persistence in the face of funding and institutional/bureaucratic hurdles, his creativity, his generosity with his data, and his determination that science should be fun.

Tim Kerr (Aqualinc) concluded the tribute by showing Trev's sense of humour and dedication to outreach with a presentation of many of Trev's cartoons, mostly schematic diagrams with humorous flourishes (such as the bulldozers to indicate plate tectonic processes). He explained that many of the cartoons had appeared in places such as the *New Zealand Alpine Journal* (a climbing magazine), explaining the science of geomorphology, weather and climate to a wider audience than would have been reached through purely scientific journals.

In addition to providing an important venue for research dissemination, the SIRG group prides itself on ensuring that the annual workshops are relaxed, friendly and affordable. Graduate students chair the presentation sessions, and everyone pitches in to create tasty meals that, once enjoyed, are cleaned up with the same communal flair. The riverside location of the Kurow Holiday Park venue also had the added bonus of a natural swimming pool, and many participants took advantage of the great summer weather and opted to bring tents. On the last night, participants got to relax a bit more and enjoy dining out at the Waitaki Braids restaurant, a small local cafe that did a marvellous job of catering for our large

Lunch break on LGM moraine, Lake Ohau. Keen participants look on as David Barrell (centre) arranges geomorphological maps of the area.

group, and that had an impressive choice of Central Otago Pinot Noir.

On our last day, the field-trip participants took advantage of our Waitaki Valley location and the expertise of Dr David Barrell (GNS Research) to undertake a convoy-style field trip. The tour started at Aviemore Dam with a great first-hand story about dam-building, earthquakes and the importance of geological investigation! In good New Zealand fashion, the convoy was temporarily paused enroute to Benmore Dam by a mob of sheep. After a brief stop in Omarama, the convoy proceeded to the Ostler Fault to view a 20 m high fault scarp, noting the large glacial outwash plains. A picnic lunch was enjoyed on an 18 000-year-old terminal moraine at the end of Lake Ohau. After lunch David presented some new results from the Lake Ohau Climate History project on behalf of Marcus Vandergoes and colleagues who could not make the field trip. The final stop on the shores of Lake Ohau was a great place to reflect on the impressive scales over which glaciers operate, and cast our eyes upwards to a small contemporary glacier – the Glenmary – reminding participants of Trevor and his glaciological legacy that the SIRG seeks to continue.

The organizing committee for SIRG 2019 was from the University of Otago: Shona Mackie, Greg Leonard, Pat Langhorne, Inga Smith and Kelly Gragg.

Sponsors were the University of Otago, NIWA, Antarctica New Zealand, GNS and the University of Canterbury, and Student Prize sponsors were Cardrona Alpine Resort, Cactus Outdoor, NZ *Wilderness* magazine and the Waitaki Whitestone Geopark.

Inga Smith and Heather Purdie

News

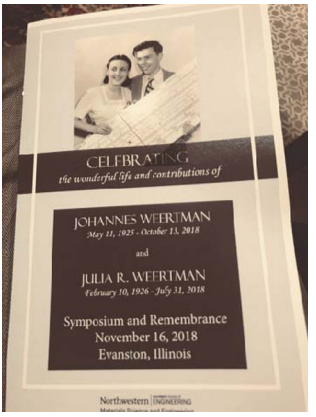
Symposium and Remembrance

celebrating the wonderful life and contributions of Johannes Weertman (1925–2018) and Julia R. Weertman (1926–2018)

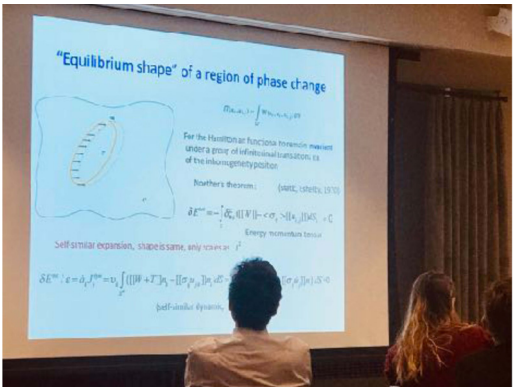
In honor of the life and contributions of Johannes 'Hans' Weertman and his wife of 68 years, Julia Randall Weertman, Northwestern University (where Hans was a faculty member since 1959, and Julia since 1972) held a symposium and remembrance on 16 November 2018, in Evanston, Illinois, USA. The one-day symposium was attended by 87 people from around the world and included both eminent scientists who had known Hans or Julia, and Weertman family members. Deeply respected by their students and colleagues, the Weertmans received many honors celebrating their contributions to materials science and engineering, geophysics and education. The day was filled with both scientific talks and personal recollections that illuminated the influence the Weertmans had on these scientific fields as well as celebrating their lives well lived.

The day featured 22 20-minute talks and a grand reception in the newly refurbished atrium of the Technological Institute at Northwestern University. Many of the talks are available on video at the website: https://www.mccormick.northwestern.edu/materials-science/events/weertman-symposium.html. Titles of some of the presentations give a sense of the great breadth of science that the Weertmans covered: Helena Swygenhoven, Professor at the École Polytechnique Fédérale de Lausanne (EPFL), Switzerland, gave a keynote presentation on 'Retaining the nano', citing some of the contributions Julia made to nanotechnology in materials science; Seth Stein and James Neely of Northwestern University talked about 'The Weetmans and the San Andreas Fault: how their dislocation solution became a key tool in earthquake studies'; Linn Hobbs, professor at Massachusetts Institute of Technology, gave a

The day-long symposium featured 22 scientific talks and remembrances and was attended by 87 scientists from around the world as well as by Weertman family members including Hans's son, Bruce Weertman (visible wearing the Hawaiian shirt in the center) and Hans's brother, William.



This photograph of Julia and Hans displays them with a giant version of an object that few people in the glaciological community now know how to use. Julia and Hans met as graduate students working on doctoral degrees in materials science at Carnegie Institute of Technology in the late 1940s.

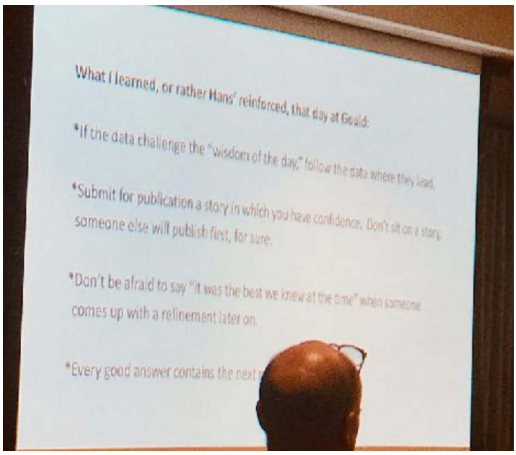


Many of the talks were on complex subjects that the Weertmans loved to simplify.

The 2(!) Seligman Crystals awarded to Hans. The one originally handed to him at the ceremony had a misspelling: 'Glociological'.

talk on 'Lines, points and (not-so-) ridiculously disordered solids and the Weertmans'; Koichi Tsuchia, Managing Director of the International Center for Young Scientists and the National Institute for Materials Science of Japan, spoke on 'Nanocrystalline functional intermetallics by severe plastic deformation'; Paul Sanders, professor at the Deakin University in Australia gave a talk on 'Gas-like grain boundaries and the inverse Hall-Petch'.

Two glaciological presentations were made: David Cole from the US Cold Regions Research and Engineering Laboratory (CRREL) talked on 'The Weertman model of dislocation creep in ice – underlying mechanism and current applications', and Doug MacAyeal gave a presentation on 'Hans



Hans Weertman's advice: 'If the data challenge the wisdom of the day, follow the data where they lead', 'Submit for publication a story in which you have confidence. Don't sit on a story', 'Don't be afraid to say "It was the best we knew at the time" when someone comes up with a refinement later on', and 'Every good answer contains the next question'.

Weertman as a young glaciologist.' The day-long series of presentations was concluded with an elegant reception that allowed the symposium participants a chance to share their remembrances with the Weertman family over excellent food and drink.

In celebrating the lives and legacy of Hans and Julia Weertman, the day of talks and personal reflections made it exponentially clear that these two people had lives that were well lived.

Doug MacAyeal

Hans and Julia Weertman in 1951.

Members of the Weertman family at the reception.

Obituary: Almut Iken, 1933–2018

On 10 December 2018 Dr Almut Iken died peacefully at the Johanniter Haus in Bremen, Germany.

Almut was born on 1 October 1933 in Bremen. Shortly afterwards her family moved to Leipzig, where her father ran a book store. In 1945, with the approach of the Red Army, the family fled empty-handed back to Bremen. In the following years they struggled financially. By Almut's good fortune her high-school director and teacher, Dr Hermine Ruschmann, recognized Almut's talent for physics and mathematics and paid her school costs, enabling her to complete high school. Happy years followed when, together with a classmate, she prepared the laboratory exercises in chemistry and physics for her school-mates.

In 1953 Almut entered the University of Heidelberg, spending 1 year at the University of Hamburg. It was during these years, when she spent her free time hiking in the Black Forest and in the Swiss Alps, that she had her first view of magnificent glaciers. She graduated from the University of Heidelberg in 1959, presenting her thesis in X-ray crystallography.

After 8 years teaching mathematics and physics at a *Gymnasium* in Bremerhaven, in 1967 Almut joined Fritz Müller's group of Arctic researchers at McGill University in Montreal as a PhD student. Her first assignment at the High Latitude Research Station on Axel Heiberg Island was a short-term observation of glacier movement on White Glacier. Fritz Müller had an intuitive feeling that meltwater could reach to the depths of a High-Arctic glacier, which at that time was believed to be frozen to the underlying ground. For two consecutive weeks in August 1967 Almut carried out 3-hourly observations of the surface movement by means of two stakes placed on the middle ablation area of White Glacier. The results astounded everybody, and especially Almut, because the movement showed a clear diurnal fluctuation, indicating that the glacier might be affected by meltwater that reached the glacier bottom. This revelation undoubtedly led her to concentrate on the subject of glacier sliding and the role of water in glaciers for many years to come. Almut followed Fritz Müller to ETH Zurich in 1970 and in early 1973 received her PhD there under his supervision.

Almut worked as a research scientist in the Glaciology Section of the Laboratory of Hydraulics, Hydrology and Glaciology (VAW) at ETH Zurich from 1972 until her retirement in 1995. At VAW she continued her work on the effects of water in glaciers, first on Swiss glaciers and later participating in and guiding many field campaigns in Switzerland, Alaska and Greenland. She also pushed numerical techniques ahead and was one of the first glaciologists to use the finite element method. Following a large ice-mass breaking off from an alpine glacier was a matter of card punching and running back and forth between her office and the computing centre with mesh adjustments of the breaking ice mass. She redesigned the FE-net after each time increment to understand how the ice was really breaking off. Almut thus pioneered an understanding of the onset of dangerous ice avalanches and at an earlier stage of the potential danger of hanging glaciers at the present day and under future conditions of climate warming.

Almut succeeded in developing the theory of glacier sliding, related to water pressure and geometry at the glacier bottom. Her contributions to theory and observation techniques are today, three decades later, still in use. Her theory of glacier sliding is widely used today to simulate glacier movement from mountain glaciers, tidewater glaciers and ice sheets. For her significant contributions in the field of glaciology she was awarded the International Glaciological Society's Seligman Crystal in 2011.

Almut's later years were spent modestly caring for her mother and enjoying nature walks in Bremen and in the Swiss Alps. To protect the natural environment she so loved, Almut created a trust fund, Dr Almut Iken Stiftung, that after her death will support projects for nature and for animal protection.

The glaciological community worldwide has profited significantly from Almut's dedication and determination to answer fundamental questions about glaciers. Her life work has inspired many young scientists and encouraged women to follow her into the study of ice.

Atsumu Ohmura and Kolumban Hutter

The citation for Almut Iken's Seligman Crystal reads:

Almut Iken was awarded the Seligman Crystal for groundbreaking contributions to glaciology and for mentoring many of the most distinguished glaciologists working in the area of ice flow/basal water interaction. She pioneered research into the role of basal water on subglacial motion via a combination of theoretical, modelling and bespoke field studies during the 1980s and 1990s. This work provided motivation and inspiration for the next generation of eminent glaciologists to follow on and extend the reach of her work, which has been transferred from valley glaciers to ice sheets. Her classic papers continue to be well cited today, testimony to the game-changing nature of her contribution to the discipline.

Dr Iken completed an undergraduate study of mathematics, physics and chemistry at the University of Heidelberg in 1959. She started her PhD under Fritz Müller at McGill University in Canada. When Professor Müller moved back to Switzerland, Iken transferred to ETH in Zurich, where she received her Dr.Sc.Nat. in 1973. Her professional affiliation has been exclusively with ETH in Zürich, Switzerland.

Dr Iken commenced her research into the linkage between glacier motion and basal water pressure variations during her PhD studies, where

she demonstrated for the first time that velocity variations of White Glacier (Canadian Arctic) were linked to basal water pressure variations, following careful measurements of water pressure in moulins (Iken, 1972). She then demonstrated that this was a pervasive feature of Alpine valley glaciers (Iken, 1978). This work led to three pivotal papers in the 1980, which ultimately resulted in carefully designed field experiments to elucidate the physical mechanisms behind this connection. A pleasure of being Chair of the Nominations Committee is that one is obliged to revisit these papers. Iken (1981) extends ideas formulated by Lliboutry and Kamb to provide a model framework that associates the growth and decay of water-filled cavities on basal motion. She used finite element methods with a free boundary to simulate cavity growth, finding relationships between water pressure, cavity size and sliding speed. Modelling moving boundaries with non-linear fluids remains challenging to this day. She postulated that basal motion was a function of both basal water cavity evolution and water pressure. Growing pressurized basal cavities promoted the highest basal velocities, while shrinking basal cavities were associated with lowest basal velocities. These ideas were tested first on Unteraargletscher via means of camera measurements and theodolite measurements (Iken and others, 1983). Maximum horizontal movement of the glacier coincided with the period of maximum vertical uplift, as she had predicted, and so it seemed that water pressure and cavity evolution were of more importance than the total amount of water stored at the bed. These surface measurements now required direct measurement of water pressure variations at the bed. Findelengletscher was chosen as the location for 11 × ~70m boreholes drilled to the bed. Surface velocity variations were shown to correlate with subglacial water pressures, suggesting that bed separation occurred during

velocity increases (Iken and Bindschadler, 1986). A key observation was that water pressures were higher than predicted by steady state flow through straight cylindrical channels, so that the latter were thought unlikely to transmit waters of high pressure. Dye tracing revealed complexity in water flow paths, and it was noted that areas of the bed were relatively unconnected with the main drainage system.

The next step was to examine whether or not the pressured bed phenomenon was found in larger systems, and a smart place to look next was readily identified – the ice streams of Greenland. The simple solution to accessing the bed through some 1500m of ice, 50km upstream of the terminus of Jakobshavns Isbræ, was 20 hours of hot water drilling for each of 11 holes. These holes stayed open sufficiently long for thermistors and tilt sensors to be deployed within them. A substantial amount of temperate ice was found at the bed beneath the centre of the ice stream, suggesting that internal deformation made a large contribution to the ice stream motion. The southern margin of the ice stream was underlain by a low-pressure drainage system, which had the capacity to carry excess water fed into it from the borehole. This suggested that extensive sliding and bed separation was occurring. The location of the temperature minimum within the ice column was deeper in the marginal ice than that of the central ice, testimony to the greater internal deformation of the central ice. Dr Iken suggested that the kinematic funnelling of ice into a depression with a soft bed was a plausible mechanism for explaining the presence of ice streams, a phenomenon that has been readily imported into studies of Antarctic ice streams.

Finally, she revisited the problem of drainage system structure and surface velocity variations at Findelengletscher (Iken and Truffer, 1997). She correctly identified that the drainage system structure evolved during the melt season, and that this impacts significantly on the sliding law. This work inspired new studies of subglacial drainage system evolution that were tested in the Alps and are currently being applied to the margins of the Greenland Ice Sheet.

In 2002, the term 'Iken bond' first began to appear in the glaciological lexicon. This term refers to the upper bound on water-pressure-mediated basal friction first discovered by Dr Iken (Iken, 1981). The concepts she developed form the basis for continuing studies on the effects of bed geometry on ice flow, and on how these effects influence unstable behaviours in glaciers and ice sheets.

Dr Iken's scientific life has been guided by an extremely methodological approach, and always with an open mind towards new methods. She has been as meticulous with her field studies as with her modelling. She conducted her work with dedication, an incredible patience and attention to detail. She was one of the first researchers to seriously consider the role of water in basal motion and drove significant advances in this field for over 20 years. The lasting impact of Dr Iken's work can be appreciated by noting that her publications continue to influence current work even though she has not been active in research since 1995. Some 17 of her papers have citations in the past 2 years, and almost her entire publication record is referenced in the latest edition of The Physics of Glaciers. This is testimony to someone who has changed the subject.

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Martyn Tranter
for the Awards Committee of the International Glaciological Society

Obituary: Keiji Higuchi, 1927–2018

Honorary member of the IGS Professor Keiji Higuchi passed away on 19 October 2018. He was 91 years old. Keiji Higuchi was born in 1927 in Mokpo, Korea, the son of a Japanese businessman. As he approached school age, his father sent his family back to his native Kyoto to attend elementary school. The young Keiji's fascination for the science of snow and ice and its surrounding environment was stimulated during his preparatory schooling at the old Third High School (the present undergraduate stage at Kyoto University), which has been a cradle of noted Japanese alpinists and explorers. After completing preparatory schooling in Kyoto, Higuchi proceeded to Hokkaido University in Sapporo to pursue the study of snow and ice under Professor Ukichiro Nakaya. His initial works in the Nakaya School were made in the area of ice physics, and contributed significantly to the clarification of the layer structure of snow crystals, and its role in crystal growth in the laboratory. His experience of the ice-core study at T-3 in 1960 appeared to have evoked his youthful fascination with the ice of the polar and high-mountain regions.

After his appointment as professor at Nagoya University in mid-1960s, Higuchi launched his long-time engagement in glaciology in the Asian high-mountain regions. This was however, difficult, as the country had more urgent priorities barely two decades after the destructive end of the Second World War and after the temporary termination of the Japanese Antarctic expeditions. It was precisely against this background that Higuchi's effort to start high-mountain research evoked a passion for glaciological studies in the minds of young people who were later to play leading scientific and national/international roles in Japan and other countries.

As a preliminary stage, there was a project to study glaciers in the high mountains of Asia, under the Glacier Inventory of the Himalayan Glaciers. Later, Professor Higuchi launched the first glaciological project to be carried out outside Japan with field works in Alaska in 1968. In 1973 he launched the long-lasting Glaciological Expedition of Nepal Himalaya (GEN). This project, which was conducted in close cooperation with the Nepalese Department of Hydrology and Meteorology (DHM), contributed to clarifying the mechanisms of glacier mass balance in the Himalayas.

Higuchi's far-sighted works in glaciology over the last 50 years have initiated new future directions of research. Many of the questions he raised during the 1960s and 70s, have come into the awareness of the glaciological community decades later. For example, he worked for many years on the investigation of glacierlets, embryo glaciers. He sought for an answer to the fundamental question of the necessary conditions for their survival and eventual growth to full-size glaciers, or alternatively their disappearance. This subject was first presented in 1969 in the IGS symposium on glacier hydrology. Many may remember his unusual proposal to create an artificial glacier, for which the term 'baby glacier' was coined. Although a baby glacier remains unborn, the techniques of artificially controlling glacier mass balance have been put into practice on glaciers that are used for year-round skiing. During the course of this investigation, as one of the earliest contributors, Professor Higuchi raised the question of the effect of dust and aerosol

deposited on glaciers on the mass balance. This subject has recently become important, as the effect of lowering of albedo by black carbon and aerosol, including biogenic, has been identified as a potential factor in rapid mass-balance changes. Keiji Higuchi carried out one of the first field observations of the effect of the surface debris on glacier mass balance. Calculating the mass balance of Himalayan glaciers at present is not possible without considering the effect of widely spread debris. The project produced more than 10 000 photographs of Himalayan glaciers in the early 1970.

Following the GEN, Higuchi's international engagements were intensified to support Earth and environmental science in Asian and African countries within the Global Change System for Analysis, Research, Training (START), the Asian–Pacific Network for Global Change Research (APN), and other national and international programs. Many young scientists who were fortunate to work with Professor Higuchi later assumed leading positions and contributed immensely to shaping present glaciology in the tropics and polar regions. Some colleagues may have the impression that the name Keiji Higuchi is not widely known. If this is the case, it was by Professor Higuchi's deliberate intention. For him, true leadership had to be modest and discreet.

Beside his scientific works, Prof. Higuchi was known to have been an accomplished essayist and painter, who took his themes from what he experienced during his field works.

Tetsuzo Yasunari and Atsumu Ohmura

Obituary: John Frederick Nye, 1923–2019

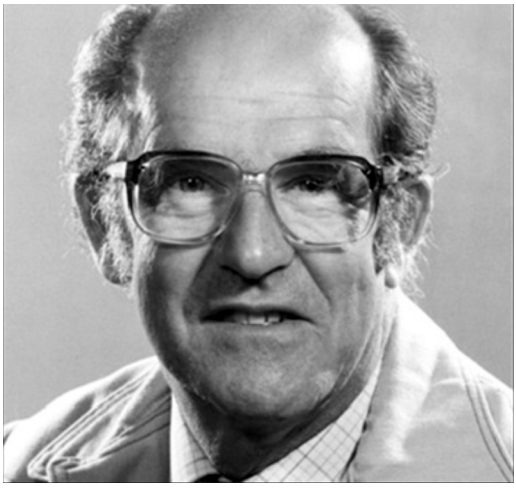
Professor John Frederick Nye, internationally renowned physicist, died on 8 January 2019, a month before his 96th birthday. John Nye was born in Hove, Sussex. He was a student in Cambridge, and carried out postdoctoral research at Bell Laboratories in the USA. In 1953 he moved to the University of Bristol, where he was a member of the physics department, while employed and after formal retirement, for 66 years.

He made major achievements to physics in three areas: crystals, ice and light. In crystals, his emphasis was on the defects that disrupt the regular arrangement of their atoms; in the spirit of his Bristol colleague Charles Frank: 'Crystals are like people: it is their imperfections that make them interesting.' His first contribution to science, in 1947, was a collaboration with the Nobel Prizewinner Sir Lawrence Bragg; they explored crystal defects with an analogue experiment, in which the atoms in a crystal were represented by a raft of bubbles. He was among the first to realize that for some purposes a crystal can be regarded as a gas of continuously distributed defects. This phase of his research culminated in his 1957 text *Physical Properties of Crystals*; this is still in print, and remains a uniquely accessible treatment of a difficult subject.

We will now discuss his contributions to glaciology and optics in more detail.

Glaciology

John Nye's contribution to glaciology was very important. Through most of the earlier parts of the 20th century, most work on glacier theory had been based on treating ice as a Newtonian viscous liquid with a very high viscosity. New laboratory work had shown that this was far from the case, and Nye's first paper, in 1951, took a completely different model. It treated ice as a perfectly plastic material, i.e. one which was completely rigid until a certain shear stress was reached when it would flow as much as necessary to retain this level of stress. This means that a wide glacier or ice sheet would have a definite thickness related to the slope of its bed and if the bed slope changed the ice would shear until the right stress for the new slope was achieved. This led him to predict the strain that would need to occur and thus to predict the pattern of shear strain in the glacier. One of us (JWG) accompanied him on a visit to Switzerland where we found evidence of thrust



planes, discontinuities of some glaciers which reflected his theoretical predictions.

In 1953 he wrote a further paper that compared measurements made of the rate of closure of tunnels in glaciers, laboratory measurements and the measurements made on the movement of a borehole drilled through a large glacier. He showed that these were all consistent apart from one set of measurements: those of the rate of closure of a tunnel in the Arolla Glacier in Switzerland, which was closing much faster than expected; he discussed possible reasons for this.

A further paper in 1957 discussed the distribution of stress in glaciers and ice sheets, using longitudinal velocity gradient as the determining factor, and a further paper in 1958 applied kinematic wave theory (which had been developed to explain movement of traffic on roads) to explain the occurrence of surges in some glaciers and ice sheets.

In 1959 Nye considered temperature and its effect on the rate of ice flow and showed that consequently much of the shear strain occurring in many glaciers will be concentrated in the lowest layers, and also showed how surface waves on the Antarctic Ice Sheet are due to mountains under the ice. He followed this in 1960 with a paper on the response of glaciers and ice sheets to seasonal and climatic temperature changes which shows why glaciers are such sensitive indicators of climatic change. This led in 1963 to a paper on

the theory of the advance and retreat of glaciers and also to the theory of how glaciers change in response to changes in nourishment and wastage.

In 1967 Nye turned to understanding 'regelation': the process by which a wire under stress moves through ice by melting beneath it and refreezing above. He showed that this involved both a heat-flow problem and a water-flow problem that are not independent and in a later paper showed how this was relevant to the flow of a glacier over a wavy bed.

A further paper proposed a method for determining the movement of large ice sheets by detailed mapping of the radio echoes from the bed, which would remain the same as the ice sheet flowed over them thus allowing measurements on the glacier surface to determine where the details of the bed were situated. This was the starting-point of his original research in optics and electromagnetism, discussed below.

Further evidence of Nye's remarkable originality was his emphasis, in a 1970 paper on glacier sliding, on the fact that the rock bed contains irregularities on a wide range of scales, so it is impossible to separate roughness from geography. In envisaging a statistically self-similar distribution of heights, he anticipated the central idea in what was later to emerge as a major area of applied mathematics: 'fractal geometry'.

Over all this time John Nye was quite preeminent in using advanced mathematical techniques to solve glaciological problems. He also played his part in the proceedings of the body which, after name changes, became the International Glaciological Society, including a term presiding over its council. He received the prestigious Seligman Crystal ('awarded from time to time to one who has made an outstanding scientific contribution to glaciology so that the subject is now enriched').

Optics

John Nye was always interested in the physics of light. *Physical Properties of Crystals* included a treatment of polarized light in anisotropic media. This was a pedagogical account of standard material, self-contained and with the clarity that characterized all his writing. It was around 1970 that his original and fundamental contributions to our understanding of electromagnetic waves, and light in particular, began, and they continued for almost half a century until his death in 2019.

The spark that ignited this change in his scientific direction was the measurements of the thickness of ice sheets by radio echo-sounding. In this technique, a quasimonochromatic pulse was reflected from the the bottom, and information about the underlying topography was obtained from the delay between emission and the reception of the first part of the echo, reflected from the rock directly below the source. Nye realized that the long disorderly tail of the echo was scattered by distant roughness and contained potential information about it. To investigate this in the laboratory, he devised a student project, in which the radio waves of wavelength ~5 m were replaced by ultrasound of wavelength ~5 mm, and the roughness of the ice–rock interface was modelled by crinkled aluminium kitchen foil. The relatively low frequency (~100 kHz) enabled the oscillations in the reflected wave to be studied in detail.

While moving the source-receiver, Nye noticed something unexpected: occasionally, two oscillations would separate and a new one would be born between them, or, in the time-reversed phenomenon, an oscillation would disappear. His genius was to realize what this implies for the geometry of the wavefronts in the reflected wave: these can have edges, and the birth and death of oscillations happens when such an edge encounters the detector. He understood the morphological similarity to the dislocations in crystals that he had studied in his early research: a wavefront with an edge resembled a half-plane of atoms – a defect disrupting the regularity of the crystal lattice. Therefore he denoted the edges by the term 'wavefront dislocations'.

It quickly became clear that wavefront dislocations were a fundamental feature of waves of all kinds, not previously recognized as such. The deepest way to think about them is to model the wave as a complex scalar field, whose wavefronts are moving surfaces of constant phase. The edges are moving lines in space, on which smoothness and single-valuedness implies that the phase of the wave is undefined and the wave amplitude is zero. Therefore wavefront dislocations are also 'phase singularities' and 'nodal lines'. The trajectories normal to the wavefronts, which can be regarded as the local

With John Glen.

wavevectors, along which wave energy flows, circulate around the dislocation lines, so yet another term for them is 'wave vortices'. They are the most delicate features of waves, representing intricate topological structure on scales much smaller than the wavelength.

The paper reporting this discovery was initially rejected by the Royal Society's anonymous referee on the grounds that the calculations were too simple for the idea to have significance. A second referee, later self-identified as Frank Nabarro, who had been in Bristol in the crystal dislocation years, agreed with our rebuttal that simplicity was a positive, rather than a negative, feature, adding that wavefront dislocations were (MB quotes from memory) 'missed by Lord Rayleigh, who should have discovered them'. The paper has now attracted more than 2000 citations, and 'optical vortex theory', as it has come to be called, is a thriving area of what has come to be called 'singular optics', described in several textbooks and review articles, and hundreds of papers.

Nye next turned his attention to optics on the coarsest scale, where a field of light is represented by a family of rays, and the singularities are the *caustics*: envelopes of the ray families, on which the light is focused. Caustics are familiar as the cusped curve in an illuminated coffee-cup, and the dancing patterns of sunlight refracted onto the bottoms of swimming-pools. Two new aspects of this ancient branch of optics had led to the study of caustics being reinvigorated in Bristol in the early 1970s. The first was the mathematics of 'catastrophe theory', providing a library of the sometimes-unexpected forms that caustics can take when they are stable under perturbation – termed 'natural focusing' by our colleague John Hannay – in contrast to the artificial focusing by lenses and telescope mirrors. The second was the discovery that each of the stable caustics is decorated by a characteristic pattern of interference: 'diffraction catastrophes', the simplest being the Airy function of 1838, now recognized as describing first in a hierarchy of patterns.

An early application had been to the study of the caustics underlying the distorted images of streetlights viewed by people wearing spectacles through raindrop 'lenses on the lenses' Nye entered this field with several experimental and theoretical studies of lensing by water-drops deformed by gravity. A central aspect was the way in which catastrophe theory explains how the intricate pattterns of caustics change as parameters vary.

There is a sense in which caustics are complementary to wavefront dislocations. Observing dislocations requires the scrutiny of waves on the finest scale, where the caustics are obscured because their geometry is blurred by diffraction. Observing caustics requires viewing on large scales, where phase detail, including dislocations, is too small to see distinctly. This complementarity was recognized in the original dislocations paper. Nevertheless, dislocations and caustics are connected. because each diffraction catastrophe, beyond the simplest Airy wave, possesses an intricate pattern of dislocations, constituting a skeleton underlying it. Nye made a fundamental contribution to this connection across optical scales, by providing much of the conceptual understanding, and experimental confirmation, in an analysis, with Francis Wright and MB, of the 'elliptic umbilic diffraction catastrophe'. Later, he elucidated the dislocation structure of other diffraction catastrophes.

Phase, organized by wavefront dislocations, and intensity, dominated by caustics, are two important features of waves. In the case of electromagnetism, there is the additional property of *polarization*: the third in the trilogy of fundamental concepts. Here too Nye made fundamental contributions, by identifying the singularities of polarization. He started by pointing out the analogy between singularities in the pattern of directions in polarized light and the 'disclination' singularities of nematic liquid crystals. This was soon followed by his definitive contribution: recognizing the two distinct polarization singularities in general optical fields. First are his 'C lines', on which the polarization

is purely circular; these are singularities because the principal axes of the polarization ellipse are undefined when it is a circle. Second are his 'L lines', on which the polarization is purely linear; these are singularities because the normal to the polarization ellipse is undefined when it collapses to a line.

Nye's seminal paper, with Jo Hajnal, identified these singularities, and Hajnal investigated them experimentally in microwaves. To distinguish these geometric features in the presence of confusing waves (for example those reflected from boundaries), they developed the 'modulated scatterer' sensing technique, for which he and Hajnal were awarded the 1986 Metrology Award by the UK National Physical Laboratory.

In 1999, Nye summarized his central contributions to the three pillars of singular optics, namely the singularities of phase, caustics, and polarization, in his book *Natural focusing and fine structure of light*. He explains the physics of the mathematics, and the natural philosophy of the physics, combining theory, computer simulation and beautiful experimental photographs, with a clarity that cannot be improved upon. The underlying organizing principle, emphasized throughout, is 'structural stability': the singularities are natural, in the sense that they are preserved under perturbation.

Nye's list of publications reveals many applications and connections of his three main contributions to singular optics. A few of these scientific treasures are: wave dislocations and phase saddles in the tides (with Jo Hajnal and John Hannay); settling the old problem of specifying an optically black screen (with John Hannay and W. Liang); caustics in seismology; rainbows from ellipsoidal raindrops; and a new type of fully electromagnetic singularity (with John Hannay). In his 96th year, he published a technical paper on an optical aspect of the Riemann–Silberstein electromagnetic vector. And in the days just before he died, he speculated on the curious fact that 'stars are often represented on national flags and depicted in paintings either symbolically or with apparently intended realism, as blunt stellated polyhedra, whereas the human eye sees a very small point source, far below the limit of resolution, rather as a glint surrounded by radial lines and points'.

Personal qualities

John Nye was admirable personally as well as scientifically. He was always a most courteous man who helped explain the complications of theory to less mathematical able colleagues. As John Wettlaufer wrote from Yale:

> *I learned a great deal, technically and personally, from [John] and Georgiana. I recall a visit to Bristol in 1994 in which I was (unfortunately) in the … position of criticizing a piece of work by Charles Frank, and John masterfully saved me from being eaten alive… [such was the variety of his research, that] if someone looks [John Nye] up in a scientific database it would …[seem]… that there are multiple individuals with the same name and affiliation. … John had a herculean influence on so many fields and people, in such a subtle and subdued manner…[he was a] jewel of theoretical physics and geophysics'.*

'Subtle and subdued' well describes John Nye. He was the epitome of the English scientific gentleman: wise, engaged, determined yet always polite, with a gentle wit, and always giving due credit to others: a quiet man who did not need to shout.

He is greatly missed: by glaciologists worldwide, by his students and colleagues in the Bristol School of Physics and in the wider university, and by his wife Georgiana and their three children Stephen, Hilary and Carolyn.

John W. Glen and Michael Berry

INTERNATIONAL GLACIOLOGICAL SOCIETY

International Symposium on

Ice Streams and Outlet Glaciers

Durham University
Durham, UK
19–24 July 2020

Co-sponsored by:
Department of Geography, Durham University

FIRST CIRCULAR
June 2019
http://www.igsoc.org/symposia/2020/durham

The International Glaciological Society will hold an International Symposium on 'Ice Streams and Outlet Glaciers' in 2020. The symposium will be hosted by the Department of Geography, Durham University, Durham, UK on 19–24 July 2020.

THEME

Ice streams and outlet glaciers are important components of an ice sheet's mass balance and their behaviour directly impacts on sea level. These corridors of fast-flowing ice have been described as the 'arteries' of an ice sheet and their distinction is largely semantic, with ice streams bordered by slower-moving ice and outlet glaciers bordered by exposed bedrock at the surface. Since the recognition of the importance of these features in the 1970s, there has been a huge growth in their investigation. This began with the pioneering work on West Antarctic ice streams and has subsequently expanded to studies of ice streams and outlet glaciers in all of the world's major ice sheets and ice masses. Of urgent concern for society are recent observations of dynamic changes in ice streams and outlet glaciers, which are thought to be responsible for an acceleration in global eustatic sea-level rise.

In parallel, those studying palaeo-ice sheet beds have long recognized the distinctive geomorphology of ice streams in both marine and terrestrial settings. The study of palaeo ice streams offers an unprecedented opportunity to reconstruct their behaviour over time-scales much longer than modern observations permit, generating new insights into the spatial and temporal controls on their flow, including longer-term perspectives on retreat rates and thinning histories. The beds of palaeo ice streams and outlet glaciers are also more accessible for investigation, leading to new insights regarding the mechanisms of sediment erosion, transport and deposition beneath fast-flowing ice, including the formation of subglacial bedforms.

In addition to empirical studies, there have been major advances in our ability to simulate ice-stream and outlet-glacier behaviour in numerical models. Moreover, observations and reconstructions of ice streams/outlet glaciers have provided useful data to test and calibrate numerical models and recent developments have seen improved projections of mass loss.

The aim of this symposium is to bring together scientists working on both modern and palaeo ice streams/outlet glaciers, together with those using numerical modelling, in order to facilitate greater interaction and the cross-pollination of ideas, data and theoretical insight on one of glaciology's most important topics.

SUGGESTED TOPICS

We seek papers and presentations on any aspect of ice streams and outlet glaciers, including observations at a range of spatial and temporal scales and insights gleaned from numerical modelling. Key topics include (but are not limited to):

1. Observations of ice streams/outlet glaciers and their links to the ocean–climate system
2. Interactions between ice streams/outlet glaciers and floating ice shelves/ice tongues
3. Geophysical studies of ice streams/outlet glaciers, including englacial and subglacial observations, and processes of sediment erosion, transport and deposition
4. Reconstructions of palaeo ice streams/outlet glaciers, including their links to the ocean–climate system and terrestrial investigations of their subglacial sediments and landforms
5. Numerical modelling studies of past, present and future ice-stream/outlet-glacier behaviour and/or of key processes relating to their behaviour
6. The role of ice streams/outlet glaciers in ice-sheet instabilities (e.g. Heinrich events).

PROGRAMME

The symposium will include oral and poster sessions, with ample free time for discussion. Additional activities will include an opening Icebreaker, a banquet dinner in the magnificent Durham Castle and a mid-week day-trip to explore the glacial history and glacial geomorphology of palaeo-ice-stream beds in northern England, including a visit to the UNESCO World Heritage site of 'Hadrian's Wall'.

ABSTRACT AND PAPER PUBLICATION

Participants who wish to present a paper (oral or poster) at the Symposium should submit an abstract by 14 February 2020. Accepted abstracts will be posted on the Symposium website. The Council of the International Glaciological Society will publish a thematic issue of the *Annals of Glaciology* on topics consistent with the Symposium themes and participants are encouraged to submit manuscripts for this volume.

SYMPOSIUM ORGANIZATION

Magnús Már Magnússon (International Glaciological Society).

SCIENCE STEERING AND EDITORIAL COMMITTEE

Co-chairs: Chris Stokes and Colm Ó Cofaigh.
Scientific Editors will be announced in the Second Circular.

LOCAL ORGANIZING COMMITTEE

Chris Stokes (Chair, Durham University), Jennifer Arthur (Durham), Rachel Carr (Newcastle University), Louise Callard (Newcastle), Dave Evans (Durham), Stewart Jamieson (Durham), Bertie Miles (Durham), Colm O'Cofaigh (Durham), Dave Roberts (Durham).

VENUE

The symposium will be held in the Department of Geography, Durham University, which is located on the Mountjoy Campus, just 10 minutes walk from the historic centre of Durham city, where there are numerous restaurants and traditional pubs, bars and cafes, as well as several tourist attractions and walking trails along the wooded banks of the River Wear. Durham University is England's third oldest and the Department of Geography (founded in 1928) is recognized as one of the leading centres of geographical research and education in the world and with a strong focus on ice sheets, ice streams and sea-level change.

LOCATION

Durham is a small (pop. 65 000), but spectacular cathedral city in northeast England with a rich heritage. Narrow cobbled streets wind their way around the rocky peninsula carved by a meander in the River Wear to the majestic Norman cathedral and castle, which are a designated UNESCO World Heritage site.

The city is well served by various transport links. Newcastle International Airport is only 45 min by road/rail and is well-connected to various European hubs (e.g. London, Amsterdam, Paris). There are also regular train services along the East Coast railway line to London (3 h) and Edinburgh (1 h 40 min), and regular services to Manchester, including direct train routes to Manchester Airport (2 h 30 min).

FURTHER INFORMATION

If you wish to attend the symposium, please register your interest online at http://www.igsoc.org/symposia/2020/durham/

The Second Circular will give further information about accommodation, the scientific programme/steering committee, additional activities, and preparation of abstracts and final papers. Members of the International Glaciological Society, as well as all those who have pre-registered, will automatically receive the Second Circular. Information will also be updated on the IGS conference website as it becomes available and a local website will be available in Autumn 2019.

Glaciological diary

** IGS sponsored * IGS co-sponsored

2019

5–11 May 2019
USC Next Generation Polar Research Symposium
Wrigley Marine Science Center, Catalina Island, California, USA
Website: https://dornsife.usc.edu/polar

9–10 May 2019
Chilean Society of the Cryosphere (SOCHICRI) annual meeting
La Serena, Chile
Contact: sochicri@gmail.com
Website: http://sochicri.cl/

10 May 2019
Antarctic Climate Symposium
Brussels, Belgium
Website: https://ees.kuleuven.be/aerocloud-event/www.gsw2019.org/chgcs/

10–14 May 2019
Workshop: Cryosphere and Hydrosphere for Global Change Studies (CHGCS 2019)
Enschede, Netherlands
Website: http://www.gsw2019.org/chgcs/

12 –17 May 2019
****International Symposium on Erosion and Sedimentation**
Madison, Wisconsin, USA
Contacts: Secretary General, IGS
Neal Iverson <niverson@iastate.edu>

13–17 May 2019
ESA Living Planet Symposium
Milan, Italy
Website: https://lps19.esa.int/

14–16 May 2019
Arctic Data Workshop
Orono, Maine, USA
Website: http://arctic.icecoredata.org/

15–17 May 2019
Geological Society of America Cordilleran Section 115th Annual Meeting
T20. Glaciers of the North American West.
Conveners: Andrew G. Fountain, Claire Todd, Erin Whorton
Portland, Oregon, USA
Website: https://www.geosociety.org/GSA/Events/Section_Meetings/GSA/Sections/cd/2019mtg/techprog.aspx

19–23 May 2019
15th Conference on Polar Meteorology and Oceanography
hosted by the American Meteorological Society
Boulder, Colorado, USA
Website: https://www.ametsoc.org/index.cfm/ams/meetings-events/ams-meetings/15th-conference-on-polar-meteorology-and-oceanography1/

22–30 May 2019
International Arctic Science Committee 21st Arctic Science Summit Week
Arkhangelsk, Russia
Website: https://en.assw2019.science/
Contact: info@assw2019.science

4–6 June 2019
76th Eastern Snow Conference
Fairlee, Vermont, USA
Website: https://www.easternsnow.org/

16–22 June 2019
Third Innsbruck Alpine Summer School, on Close Range Sensing Techniques for Alpine Terrain
Obergurgl, Austria
Website: https://www.uibk.ac.at/geographie/summerschool/2019/

17–21 June 2019
Cryospheric Science with ICESat-2 (CSI): Hackweek 2019
Seattle, Washington, USA
Contact: email-icesat@uw.edu
Website: https://icesat-2hackweek.github.io/

17–21 June 2019
4th Open Global Glacier Model (OGGM) workshop
Grenoble, France
Website: https://oggm.org/2019/02/08/4th-workshop-announcement/

2–5 July 2019
Third International Congress on Stratigraphy (Strati 2019)
Session ST6.1: Combining Arctic and Antarctic paleoclimate and paleoceanographic stratigraphic records with models to understand past and future evolution of bipolar linkage . Conveners: Florence Colleoni, Peter Bjil, Jochen Knies, Laura De Santis
Milan, Italy
Contact: Florence Colleoni <flocolleoni@gmail.com>

4–6 July 2019
Snow Microwave Radiative Transfer (SMRT) model training workshop
Waterloo, Ontario, Canada
Website: https://smrt2019.sciencesconf.org/

8–12 July 2019
****International symposium on Five Decades of Radioglaciology**
Stanford, California, USA
Contacts: Secretary General, IGS
Dustin Schroeder <Dustin.M.Schroeder@stanford.edu>

8–19 July 2019
Life and Earth Sciences and Sustainable Global and Regional Development (AKTRU2019)
International Symposium and Summer Schools
Altai Mountains, Russia
Website: https://nanoandgiga.com/aktru2019/
Contact: Anatoli Korkin <korkin@nanoandgiga.com>

9–16 July 2019
International Association of Cryospheric Sciences meeting
at International Union of Geodesy and Geophysics General Assembly
Montréal, Québec, Canada
Contact: Andrew Mackintosh <Andrew.Mackintosh@vuw.ac.nz>

22–26 July 2019
13th International Symposium on Antarctic Earth Science (ISAES 2019)
Incheon, Republic of Korea
Website: https://www.scar.org/general-scar-news/isaes2019-1st-circ/

25–31 July 2019
20th Congress of the International Union for Quaternary Research (INQUA) 2019
Dublin, Ireland
Session: Quaternary glaciations: Processes, Sediments and Landforms. Conveners: Lorna Linch <L.Linch@brighton.ac.uk>, Danni Pearce, Jan Piotrowski, Dave Evans

12–16 August 2019
Community Earth System Model (CESM) Polar Modeling Workshop
Boulder, Colorado, USA
Application form at: https://goo.gl/forms/CvRemR7262HzRN3I2

18–22 August 2019
18th International Conference on Cold Regions Engineering and 8th Canadian Permafrost Conference
Québec, Québec, Canada
Website: http://https//www.agora-inscription.ca/iccre-cpc2019

18–23 August 2019
Goldschmidt Conference
Barcelona, Spain
Session 09c: Biogeochemical Cycling in Changing Glacial Habitats and Downstream Ecosystems. Conveners: Trista Vick-Majors <tristyv@gmail.com>, Alexander Michaud, Katja Laufer, Susann Henkel
Website: https://goldschmidt.info/2019/program/programViewThemes

18–26 August 2019
****International Symposium on Sea Ice**
Winnipeg, Manitoba, Canada
Contacts:
Secretary General, IGS
David Barber University of Manitoba <David.Barber@umanitoba.ca>

26–30 August 2019
Glacial Isostatic Adjustment (GIA) Training School
Gävle, Sweden
Website: http://polenet.org/2019-glacial-isostatic-adjustment-gia-training-school

2–4 September 2019
Workshop: Debris-covered glaciers – from remote sensing and field-based tools to local communities
London, UK
Website: https://www.geolsoc.org.uk/GSL-Debris-Covered-Glaciers

4–5 September 2019
***International Glaciological Society British Branch Meeting**
Northumbria University, Newcastle, UK
Contact: Nick Rutter <nick.rutter@northumbria.ac.uk>

4–6 September 2019
ARCTIC FUTURES 2050: Science for Policy in a Changing Arctic
Study for Environmental Arctic Change (SEARCH)
Washington, DC, USA
Webpage: https//www.arcus.org/sites/all/modules/civicrm/extern/url.php?u=10456&qid=1589603

8–12 September 2019
International Mountain Conference
Innsbruck, Austria
Website: https://www.uibk.ac.at/congress/imc2019

9–13 September 2019
5th YES (Young Earth Scientists Network) Congress
Berlin, Germany
Session 1.9: The Role of Polar Regions in the Earth System. Convenors: Josefine Lenz, Loeka Jongejans <loeka.jongejans@live.nl>, Gerlis Fugmann
Website: https://yesdeutschland.weebly.com/call-for-abstracts.html

10–21 September 2019
Karthaus course: Ice Sheets and Glaciers in the Climate System
Karthaus, Italy
Website: http://www.projects.science.uu.nl/iceclimate/karthaus/
Contact: Hans Oerlemans <J.Oerlemans@uu.nl>

11–13 September 2019
UK Arctic Science Conference
Loughborough University, Loughborough, UK
Website: https://www.arctic.ac.uk/ukarcticconf/

15–18 September 2019
33rd Forum for Research into Ice Shelf Processes (FRISP)
Oxford, UK
Contact: frisp2019@bas.ac.uk

18–19 September 2019
International Thwaites Glacier Collaboration annual meeting
Oxford, UK
Details to follow

23–28 September 2019
Ice Core Analysis and Techniques (ICAT) PhD school
Niels Bohr Institute, Copenhagen, Denmark
Website: https://indico.nbi.ku.dk/event/1221/

24–26 September 2019
Workshop: Glacial Isostatic Adjustment, Ice Sheets, and Sea-level Change – Observations, Analysis, and Modelling
Ottawa, Canada
Contact: Thomas James <thomas.james@canada.ca>

30 September–3 October 2019
8th International Ice Drill Symposium
Copenhagen, Denmark
Contacts: D. Dahl-Jensen or S.B. Hansen on <(icedrillsymposium@nbi.ku.dk>
Website: www.icedrillsymposium.dk

16–18 October 2019
2019 West Antarctic Ice Sheet Workshop
Camp Cedar Glen, Julian, California, USA
Website: http://waisworkshop.org/

17–18 October 2019
Symposium – Women in Antarctica: Celebrating 50 years of Exploration
Byrd Center, Columbus, Ohio, USA
Website: https://byrd.osu.edu/celebrate-womenwaisworkshop.org

30 October –3 November 2019
International Glaciological Society Nordic Branch Meeting
Reykholt, Iceland
Contact: Hrafnhildur Hannesdóttir <hh@vedur.is>
Website: http://earthice.hi.is/IGSNB2019/main_page

4–14 December 2019
First Southern Hemisphere Conference on Permafrost (SouthCOP)
Queenstown, New Zealand
Website: https://southcop19.com/

2020

2–6 March 2020
Sixth International Symposium on Arctic Research
Tokyo, Japan
Website: http://www.jcar.org/isar-6/

2–8 March 2020
36th International Geological Congress
New Delhi, India
Theme 8: The Polar World – Past Present and Future
Theme 9: Glacier Mass Balance
Theme 12: Quaternary Environments: Sedimentation and Landform Evolution – Symposium 12.4: Glaciers Past and Present
Website: https://www.36igc.org/

19–24 July 2020
****International Symposium on Ice Stream Dynamics**
Durham, UK
Contacts: Secretary General, IGS
Chris Stokes <c.r.stokes@durham.ac.uk>

21–24 September 2020
***Cryosphere 2020: International Symposium on Ice, Snow and Water in a Warming World**
Reykjavík, Iceland
Contacts: Secretary General, IGS
Þorsteinn Þorsteinsson <thor@vedur.is>

2021

27 June–2 July 2021
****International Symposium on Interactions of Ice Sheets and Glaciers with the Ocean**
La Jolla, California, USA
Contacts: Secretary General, IGS
Helen Amanda Fricker <hafricker@ucsd.edu>

2022

June 2022
****International Symposium on Maritime Glaciers**
Juneau, Alaska, USA
Contacts: Secretary General, IGS
Jason Amundson <jmamundson@alaska.edu>

September 2022
****International Symposium on Southern Hemisphere Glaciers under Pressure: subglacial lakes, subaquatic environments, calving glaciers and climate**
Valdivia, Chile
Contacts: Secretary General, IGS
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New members

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International Glaciological Society

Secretary General M.M. Magnússon

	Council Members		Concurrent service on Council, from
President	F. Navarro	2017–2020	2017
Vice-Presidents	G. Flowers	2018–2021	2014
	*G.H. Gudmundsson	2017–2020	2017
	*J. Stroeve	2017–2020	2017
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Treasurer	*A.A. Leeson	2018–2021	2018
Elected Members	*L.M. Andreassen	2016–2019	2018
	*K. Fujita	2017–2020	2017
	*A. Glazovskiy	2018–2021	2018
	R. Hock	2018–2021	2018
	C. Hulbe	2018–2021	2018
	*M. Ivanov	2016–2019	2016
	*N. Karlsson	2017–2020	2017
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	*S. MacDonell	2018–2021	2018
	*D. Notz	2016–2019	2016
	*A. Pope	2016–2019	2016
	*A. Treverrow	2017–2020	2017

*First term of service on the Council

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