

ICE



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Contents

- 2 From the Editor**
- 3 Recent work**
- 3 China
 - 3 Glacier fluctuation and modelling
 - 5 Glaciers and the environment
 - 6 Paleo glacier reconstruction
 - 6 Remote sensing
 - 7 Hydrology
 - 7 Ice cores
 - 8 Permafrost
 - 8 Snow
 - 9 New monitoring technologies
 - 9 Database
 - 9 Abbreviations
- 10 International Glaciological Society**
- 10 *Journal of Glaciology*
- 12 *Annals of Glaciology* (58) 74
- 12 *Annals of Glaciology* (59) 75
- 13 *Annals of Glaciology* (59) 76
- 14 Report on the workshop: ‘Communicating Science for Polar Researchers’, August 2017
- 16 Report on the IGS Boulder Symposium, Colorado, USA, August 2017
 - 23 Post-symposium tour I report
 - 25 Post-symposium tour II report
- 28 Report on the British Branch Meeting, Lancaster, September 2017
- 31 News**
- 31 Report from the Karthaus Summer School, Karthaus, Italy, June 2017
- 33 Obituary: Charles R. (Charlie) Bentley, 1929–2017
- 36 Richardson Medal for Julie Palais
- 37 Second Circular: International Symposium on Timescales, Processes and Glacier Dynamics, Buffalo, New York, USA, June 2018
- 49 First Circular: International Symposium on Glacier Erosion and Sedimentation, Madison, Wisconsin, USA, May 2019
- 53 First Circular: International Symposium on Five Decades of Radioglaciology, Stanford, California, USA, June 2019
- 57 Glaciological diary**
- 60 New members**

Cover picture: Iceberg on the Greenland west coast. Photo by Twila Moon.

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From the Editor

Dear IGS member

Welcome to the last issue of *ICE* for 2017. Yet again it contains a lot of interesting articles and information which we trust you will enjoy.

As of the IGS Annual General Meeting held during the AGU Fall Meeting on 14 December 2017, we have a new President, Francisco Navarro, whom many of you will know, and two new Vice Presidents, Julienne Stroeve and Hilmar Gudmundsson. The new Council members are Koji Fujita, Nanna Karlsson and Adam Treverrow.

The main task the new Council faces is the declining membership of the IGS. Back in 2015 we had almost 1100 members, in 2017 we had 861 and so far in 2018 we have only 500. Why is that? I have previously suggested that it is probably because, as the *Journal* and the *Annals* are now Gold Open Access (GOA), people no longer see the need to join the Society. We went GOA because that is what our membership wanted. But we do more than just publish the *Journal* and *Annals*. Most importantly, we organize symposia, which are very popular with glaciologists. As I covered this subject quite extensively in a recent *ICE* editorial (172, 3rd issue of 2016), I will not dwell on it here. However, I would like to point out that IGS members get a healthy discount to attend our symposia. Another incentive we created for members was to substantially reduce the membership rate, by as much as 28%. And now you can sign up for two years at once to guarantee the current rate for another year.

But we do more. We have a very prestigious awards system – who hasn't heard of the Seligman Crystal? – and with a rejuvenated Awards Committee we are planning to modernize the system and be more proactive in getting members to nominate colleagues they deem worthy. We are also planning a new award relating to 'mentoring and outreach'. The new Chair of the Awards Committee, Lora Koenig, is planning to write an extensive report for *ICE* once things are finalized. I can also refer you to the editorial in the last issue of *ICE*, a double issue of nos 173 and 174.

Magnús Már Magnússon
Secretary General

Another task of the new Council is finding new ways of engaging young glaciologists. At its last meeting, Council approved the idea of commissioning a proposal for an early-career and student committee to give the younger generation an important say in the running of the IGS. Again, I expect you will be able to read more about this new committee in future issues of *ICE*.

I would also like to draw your attention to the fact that there has been a major change in the Publications Committee. Christine Hulbe, who has led the committee for several years, with stalwart help from her team, is now retiring. Also retiring are Eric Wolff and Ralph Greve. Over the last few years the committee has led us through the monumental transition to GOA. This was a difficult period and Christina and Eric in particular put a lot of work into the project. We are grateful to all the Committee for their contribution. However, we now have a new Chair. Gwenn Flowers, who has been a Committee member for several years, has agreed to pick up the baton and lead us forward. One of the major tasks of the rejuvenated Committee is to encourage more submissions to the *Journal* and *Annals*. As you may know, by going GOA we lost all our revenue from subscriptions and page charges. Along with our membership fees (recently substantially reduced), our main source of income now is the royalties we get from our publishing partner, Cambridge University Press. They collect all revenues and then pay us royalties, which are dependent on the number of papers published. So the more papers that are published the better chance we have of supporting summer schools and the other activities of our members.

So, to finish off this issue's editorial, I would like to encourage all of you to renew your membership and, if you are not a member, please join and get your colleagues to join. I also encourage you to submit your papers to the highly respected and prestigious *Journal of Glaciology* and to the *Annals*. In doing so you will be supporting the glaciological community, i.e. yourselves.



Recent work

China

GLACIER FLUCTUATION AND MODELLING

Long-term glacier mass balance monitoring

Tandong Yao (ITP-CAS), Zongqing Li (NIEER-CAS), Wei Yang (ITP-CAS), Shenghai Li (ITP-CAS), Wusheng Yu (ITP-CAS), Huabiao Zhao (ITP-CAS), Meilin Zhu (ITP-CAS), Jianchen Pu (NIEER-CAS), Zhen Li (NIEER-CAS)

On the Tibetan Plateau (TP), there are more and more glaciers with continuous mass balance observations. The mass balances were measured by direct measurements of accumulation and ablation at the end of ablation season. The longest and continuous mass balance observations are Ürümqi Glacier No.1, Tien Shan, and Xiaodongkemadi Glacie, central TP. Since 2005, more than 20 glaciers have been selected in the TP and other mountains for long-term observations. Most of these glaciers are maintained by the glaciologists from the ITP-CAS and NIEER-CAS. Among these glaciers, Ürümqi Glacier No.1 and Parlunq Glacier No.94, southeast TP, are reporting mass-balance data annually to the World Glacier Monitoring Service for sharing with the international community.

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Two different types of glaciers on the Tibetan Plateau

Tandong Yao (ITP-CAS), Baiqing Xu (ITP-CAS), Wei Yang (ITP-CAS), Shenghai Li (ITP-CAS), Wusheng Yu (ITP-CAS), Huabiao Zhao (ITP-CAS), Meilin Zhu (ITP-CAS), Zhen Li (NIEER-CAS)

Supported by the Chinese Academy of Sciences, this is a key research program. Both in-situ measurements and remote sensing studies indicate that there is a contrasting pattern of glacier changes on the Tibetan Plateau, with significant shrinkage/mass loss in the monsoon-influenced Himalayas and the southeastern Tibetan Plateau, and with obvious stability and mass gain in the Westerlies-dominated Parnir-Karakoram-western Kunlun Mountains. However, the mechanism controlling the contrast pattern across the Tibetan Plateau and Himalayas is the precipitation process. Further studies are under way. The comprehensive and inter-comparative glaciological-meteorological-hydrological observations, combined with remote-sensing data and Unmanned Aerial Vehicle (UAV) measurements, are proceeding at six benchmark glaciers, three in the western

Kunlun and three in the Himalaya. These data in high elevations will unravel the main glaciological/meteorological process in the monsoon-dominated and Westerlies-dominated high-elevation regimes and will advance our understanding of the mechanism of the contrasting pattern of the cryosphere in the Third Pole region. On this basis, we will develop the regional dynamic models for evaluating the impacts on regional climate and hydrological processes between these two different types of glaciers.

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WEB-GM: An advanced glacier mass balance model

Baohong Ding (ITP-CAS), Kun Yang (ITP-CAS), Wei Yang (ITP-CAS), Xiaobo He (NIEER-CAS)

A Water and Enthalpy Budget-based Glacier mass balance Model (WEB-GM) has newly been developed. WEB-GM is fully based on the energy budget, but it uses enthalpy rather than temperature to establish the energy balance equation. This transformation greatly simplifies computation of energy transfer through the water phase change and the movement of liquid water in the snow. The model also uses several parameterizations developed by the CAS center, including a dynamic scheme for precipitation type identification, a scheme to consider the impact of sleet and shallow snow on albedo, and a surface turbulent heat flux parameterization scheme. This model is driven by surface meteorological data. An independent evaluation has been implemented in the ablation zone of Parlunq Glacier No. 4, southeast Tibetan Plateau, and the results show the model can reproduce the glacier ablation depth, surface albedo, surface temperature, sensible heat flux and latent heat flux with high accuracy.

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Glacier mass balance modeling in High Mountain Asia

Liyun Zhao, Yi Yang, Ran Ding, John C. Moore (all BNU)

During the past few years, a simple method for glacier area and volume change has been developed and applied to all the individual glaciers in High Mountain Asia. It is based on a novel surface mass balance (SMB)-altitude parameterization fitted to all available measured data, and various volume-area scaling approaches. It makes use

of equilibrium line altitude (ELA) sensitivities to temperature and precipitation, glacier outlines from the Randolph Glacier Inventory and surface elevation from Shuttle Radar Topography Mission. Glacier contribution to sea-level rise is projected under different climate scenarios. Regional glacier elevation change is compared with satellite altimetry data. The uncertainty of glacier volume loss due to different factors is examined. The ELA sensitivities to climate for each glacier and the SMB gradients with altitude on the glaciers cause the largest uncertainty, which suggests that more surface mass-balance observations, meteorological data from the glaciated areas, or longer and higher-spatial-resolution time series of satellite altimetry data would better constrain the projected mass losses in the future.

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Numerical simulation of the ice flow and age at Dome A, Antarctic

Bo Sun (PRIC), John C. Moore (BNU), Liyun Zhao (BNU), Xueyuan Tang (PRIC), Dong Zhang (PRIC), Xiangbin Cui (PRIC)

Dome A is a potential location where ice older than 1 million years can be found. Chinese scientists have started to drill a deep ice core at Kunlun station near Dome A. The flow, temperature and the age of the ice are simulated by applying the ELMER/Ice three-dimensional, thermo-mechanically coupled full-Stokes model to a $70 \times 70 \text{ km}^2$ domain around Kunlun station, using isotropic non-linear rheology and different prescribed anisotropic ice fabrics that vary the evolution from isotropic to single maximum at one-third or two-thirds depth. Strongly variable basal ages are found across the domain, and any basal melting effectively removes very old ice in the deepest parts of the subglacial valleys. Comparison with dated radar isochrones in the upper one-third of the ice sheet cannot sufficiently constrain the age of the deeper ice, with uncertainties of 500 000 years in the basal age. Basal age and thermal state sensitivities to geothermal heat flux and surface conditions are assessed.

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Understanding glaciers and hydrological changes between debris-free and debris-covered glaciers in the southeastern Tibetan Plateau using high-resolution monitoring and modelling

Wei Yang, Tandong Yao, Meilin Zhu (all ITP, CAS) Many Tibetan and Himalayan glaciers are covered by thick debris on their surface, which modifies the exchange of energy with the atmosphere and thus glacier ablation and glacier mass balance. Thus the relevant hydrological and climatic response between the debris-free and debris-

covered glaciers should display different patterns. We will collect novel data of surface changes using dGPS and ablation measurements, of meteorology and runoff, on a debris-free and a debris-covered glacier in the southeastern Tibetan Plateau, which is deeply influenced by the Indian summer monsoon system. We will use these data to understand the physical processes controlling glacier ablation in the two types of glacier and will apply advanced models of glacier mass balance and a glacio-hydrological model for runoff simulations. The project will considerably advance our understanding of the cryosphere and hydrology of high-elevation catchments.

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Water phase transition in the third pole region and environmental influence

Tandong Yao (ITP-CAS), Ninglian Wang (NIEER-CAS), Kun Yang (ITP-CAS), Linping Zhu (ITP-CAS) Cryosphere-based water phase transition studies are scientifically significant for understanding Third Pole atmosphere-cryosphere-hydrosphere interaction and the role of water resources in the region. The core task of this project is to study glacial mass-energy balance and glacier melting process and, at the same time, to reveal connections between glacier melting, lake basin water balance and river runoff. With this scientific purpose in mind, the project established two major observation networks to monitor glacial mass-energy balance and lake levels respectively. With field observation data experimental data and satellite data, research was conducted into Third Pole glacier changes and the implications of their hydrological processes: by analyzing glacial area change, terminal fluctuation and ice loss, spatial layout and the extent of change in Third Pole glaciers were clarified as specific to the three modes under the interaction between the Westerlies and Indian summer monsoon; the role these two circulations played in Third Pole glacier changes is also revealed, as different atmospheric circulation patterns were found responsible for systematic differences in glacier status. Besides, differences in surface energy and mass balance among glaciers of various climates were illustrated; lake water change in the region over the last 40 years was described, and the underlying mechanism for spatial differences in rapid lake expansion was revealed; and the contribution of ice and snow melting to major rivers on the Third Pole was analyzed with large-scale land surface hydrological model. The representative achievement was published in the high-quality academic Journals such as Nature Climate Change.

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Compilation of the second Chinese glacier inventory

Shiyin Liu (NIEER-CAS), Wanqin Guo (NIEER-CAS), Junli Xu (NIEER-CAS), Lizong Wu (NIEER-CAS), Donghui Shangguan (NIEER-CAS), Xiaojun Yao (NNU), Junfeng Wei (NIEER-CAS), Weijia Bao (NIEER-CAS), Qiao Liu (IMHE-CAS), Zongli Jiang (HUST)

The Second Chinese Glacier Inventory (CGI-2), which was funded by a project of the Chinese National Foundational Scientific and Technological Work Programs of the Ministry of Science and Technology (MOST) (entitled 'Investigation on glacier resources and their changes in China', PI of Professor Shiyin Liu), was compiled based on remote sensing and GIS techniques via the widely using imageries acquired by the Landsat series satellites since 2008. At the end of 2014, the first version of CGI-2, which covers 86% of the glacierized regions of western China, was formally released in Beijing. The data were uploaded to the Cold and Arid Regions Science Data Center (CARD), Lanzhou, and were also submitted to the GLIMS database and combined into the latest Randolph Glacier Inventory (RGI 5.0). Updating of the more complete version, which covers all Chinese glacierized regions, is also ongoing and will be released very soon. Another work that was also funded by the MOST project has re-digitized all the topographical maps used in the compilation of the First Chinese Glacier Inventory (CGI-1) and generated the new digitized CGI-1, with a lot of updates comparing to the old CGI-1 published in 2002. The main differences between the updated and original CGI-1 locate on several aspects. The most important difference is the more accurate area calculation via GIS techniques than the original planimeter or quadrille paper measured area. The second is the update on many glaciers that were omitted by old CGI-1 in some regions.

GLACIERS AND THE ENVIRONMENT

Glacial lake change across the Third Pole regions
Guoqing Zhang (ITP-CAS), Weicai Wang, Tandong Yao (ITP-CAS)

We compiled an inventory of glacial lakes across the Third Pole and found that majority of glacial lakes are located in the Himalaya. All of these lakes have experienced a rapid extension in area in the past four decades in an increasingly warmer world. We divide glacial lakes into supra-glacial lakes and pro-glacial lakes to examine changes to them. Small lakes (<0.2 km²) are more sensitive to climate change. Lakes closer to glaciers and at higher altitudes, particularly those connected to glacier termini, have undergone larger area

changes. We are conducting a project about the differences in change to glacier-fed and non-glacier-fed lakes in the Third Pole region. An international corporation project about the recent and future evolution of glacial lakes in China between China and Switzerland was supported in 2016. We will develop and implement a comprehensive methodological approach to investigate the recent and future evolution of glacial lakes and their related hazard potential in different climatological, geomorphological, and topographic settings.

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Risk assessment of GLOFs in the Himalaya

Yong Nie (IMHE-CAS), Shiyin Liu (NIEER-CAS)
Glacial lake outburst floods (GLOFs) in the Himalaya have resulted in catastrophic damage and fatalities in past decades. Recent warming has caused dramatic glacial lake changes and increased the potential GLOF risk in the Himalaya. We seek here to demonstrate glacial lake changes at regional scales based on satellite observations, especially considering the Himalaya as a whole, and improve the methods for hazard and risk assessments according to field survey, historical GLOF events and GLOF modeling. Recently, we have mapped the current (2015) distribution of glacial lakes across the entire Himalaya and analyzed the spatially explicit evolution of glacial lakes over five time periods from 1990–2015 using a total of 348 Landsat images at 30 m resolution. These data covering the entire Himalaya are crucial for regional hazard and risk assessment of GLOF. Meanwhile, field investigations for historical GLOF events and rapidly expanding glacial lakes via unmanned aerial vehicles and satellite remote sensing will greatly support the model revision and GLOF modeling. Our project is dedicated to improve the understanding on relationship between glacial lakes, glaciers and climate change, and contribute to risk management for local communities in the Himalaya.

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Ice avalanches

Tandong Yao, Guangjian Wu, Shenghai Li, Wentao Hu, Meilin Zhu, Wei Yang (ITP-CAS)

Two ice avalanches occurred in Aru Village, western Tibetan Plateau, in 2016: one in July, and the other in September. The first detached ice mass from the glacier killed nine local herders and hundreds of livestock and formed an icy debris fan as large as 9.4 km², 2.4 km in width and 5.7 km in length. The second formed an icy debris fan as large as 6.5 km², 1.9 km in width and 4.7 km in length. Such ice avalanches have never been observed on the Tibetan Plateau. These

two, however, flatly contradicted the previous understanding. Glaciers once thought stable are stable no more. The sudden ice avalanche of mountain glaciers represents one of the least understood phenomena in the cryosphere. Are these ice avalanches merely an isolated event, or are they warning signs that global warming has pushed the stability of these glaciers to the tipping point? This is the top concern for glaciologists. There is therefore an urgent need for research into the region's glacier collapse, as more scientific insights can help make sense of the ice avalanche and set up early warning systems accordingly.

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Glacier-lake ecosystem monitoring

Yongqin Liu (ITP-CAS)

Glaciers and lakes are two important sections of the water cycle system on the Tibetan Plateau. Although glaciers and lakes are responding sensitively to climate change in their own way, they interact closely with each other and jointly influence microbes in the aquatic system on the Tibetan Plateau. As the global warming, climate-induced glacier retreat increases glacial meltwater runoff, glacier-fed streams with relatively larger inflow carry more allochthonous material to the lakes and change the temperature, turbidity, nutrient condition and pH value of lake water and sediment. These will influence the microbe community composition, diversity, and function in the lake. Meanwhile, the lake enhances its impact on the glacier ecosystem. Increasing temperature, strengthening radiation and evaporation raise lake-effect precipitation and lake-sourced organic aerosol to the glacier. Aiming to understand the mechanisms of glacier-lake interaction and driving the ecological structure and function of glacier and lake, two glacier-lake ecosystem (GLE) monitor sites were set up at Qiangyong Glacier and Muzutaga Glacier, located on monsoon and Westerlies domains, respectively, on the Tibetan Plateau. We continuously observe meteorological parameters, glacier surface energy and lake water level, measure ions and nutrient concentrations in the snow, stream and lake, analyze microbial abundance and community in different habitats. After analysis and calculation, we will build a glacier-lake microbe dynamic model, aiming to explore the dynamic response of microbes to the climatic environment. This study will improve knowledge of the correlation between microbes in the glacier-lake interaction system and evolution of the climatic environment.

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PALEO-GLACIER RECONSTRUCTION

Past glacier-climate modeling based on ^{10}Be chronology of glaciation in the western Nyaiqentanglha Shan, Tibetan Plateau

Xiangke Xu (ITP-CAS), Chaolu Yi (ITP-CAS), Jindong Zhao (NIEER-CAS)

An NSFC-funded project aims to quantitatively rebuild the glacier expansions (glacier volume changes) since the Last Glacial in the western Nyaiqentanglha Shan, and then infer the climate conditions that supported these glacier dynamics. The approach is mainly based on extensive ^{10}Be chronology of the glacial relics (such as moraines, eroded bedrocks) left by each of these glacier expansions, and on numerical modeling that relates glacier variation to mountain terrain and climate. Simulations are performed in local and spatially distributed modes aiming at better understanding of the associated response of the glacier to changes in the macro-scale atmospheric conditions. This also considers the skill of different meteorological data sets and methods to derive spatially distributed data for initialization and forcing of glacier mass-balance and ice-flow models. The effort is supported by investigation of the distribution of trimlines and moraines preserved in the mountain valleys and by numerical dating (CRN ^{10}Be) for these geomorphologic features, which is of particular importance to spatially and temporally constrain the simulated past glaciers under certain climate scenarios in the glacier-climate models.

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REMOTE SENSING

The response of the Tibet Plateau to climate change, major special project – the China High-Resolution Earth Observation System (30-Y30B12-9003-14/16-01)

Yang Gao (ITP-CAS), Tandong Yao (ITP-CAS)

Based on the High-Definition Earth Observation Satellite (HDEOS), this project is constructing key technology for glacier length monitoring and glacier thickness change monitoring. The main data used in this project include Gaofen-1 to Gaofen-3. The glacier boundary extraction is mainly retrieved by the difference between the ice, snow and the surrounding bedrock. Based on the single-band threshold method and the normalized glacier index, the optimal threshold is automatically iterated to automatically classify and obtain the boundary. The glacier length extraction mainly combines the glacier centerline method and the glacier mainline method, based on the glacier boundary and corresponding DEM. Accuracy evaluations were conducted in the Puruogangri and Geladandong areas.

The maximum difference between Gaofen and Landsat 8 is not more than 3%, and the average error is about 0.4%. Compared with the glacier length obtained by visual interpretation, the accuracy of glacier length can reach 97.9%. The typical glacier and field data are compared with measured data on the same day. And comparison with field data from the same day shows that the end position of the glacier tongue is consistent. Glacier thickness change monitoring uses the SAR differential interferometry method, and the differential interference phase of ice surface deformation is obtained by phase unwrapping. Glacier thickness change information is then calculated though the deformation in the glacier surface along the line of sight. Evaluation in the Dongkemadi indicates that the error is less than 1 cm compared with ice ablation measurement in the same period.

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HYDROLOGY

Air temperature estimation on glacier surfaces in the Tibetan Plateau using MODIS LST data

Hongbo Zhang, Fan Zhang, Guoqing Zhang, Yaoming Ma, Kun Yang (all ITP, CAS)

MODIS LST data were used for air-temperature estimation in high-elevation glacierized areas based on ground observations at four glaciers across the Tibetan Plateau. Linear models based on each of the individual MODIS LST products from two platforms (Terra and Aqua) and two overpasses (nighttime and daytime) have been built to estimate daily air temperatures. RGS models show higher accuracy than LGS models. In addition, RGS models based on MODIS nighttime LST data perform obviously better in estimating daily mean, minimum and maximum air temperatures, not only than the ones based on MODIS daytime LST but also than using temperature lapse rate derived from local stations, and thus can help alleviate the air temperature data-sparse problem in glacierized areas of the Tibetan Plateau.

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Snowmelt modeling in the Tibetan Plateau

Fan Zhang, Hongbo Zhang, Sahadeep Thapa (all ITP, CAS)

Snow accumulation and melting in the Tibetan Plateau (TP) was simulated using a distributed degree-day model through zonal calibration and validation of MODIS SCA. The simulation results during 1979–2010 show that: (1) about 20% of the precipitation in the TP supplied the rivers, lakes or groundwater in the form of snowmelt; (2) the interacting impacts of temperature and

precipitation introduced increasing annual snowmelt in the northern TP but decreasing annual snowmelt in the southeast; (3) snow accumulated through fall and winter was mainly consumed in the following spring and summer; and (4) significant increasing trends of spring snowmelt were detected in most parts of TP, which might benefit local water use in spring for irrigation etc.

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ICE CORES

Drilling program in recent years

Tandong Yao (ITP–CAS), Baiqing Xu (ITP–CAS), Guangjian Wu (ITP–CAS), Shichang Kang (NIEER–CAS), Shugui Hou (NU), Huabiao Zhao (ITP–CAS) With the aim of understanding past climate and environmental changes on the Tibetan Plateau (TP) and its surroundings, many ice cores have been extracted from the spatially distributed sites over this area in the 2010s. In the summer of 2012, two ice cores (38°12 N, 75°11 E, 5700 m a.s.l.) from Kuokusele glacier at Muztagh Ata, western TP, were recovered, with lengths of 170 m and 188 m. Following that, two ice cores (35°14 N, 81°07 E, 6010 m a.s.l.), 131.9 m and 135.3 m in length, were drilled from Chongce ice cap, West Kunlun Mountains, northwestern TP. Three East Rongbuk ice cores, the longest 142 m (28°01 N, 86°57 E, 6450 m) were extracted from the northern slope the mid-Himalaya in 2013. In May 2014, two ice cores (33°18 N, 88°42 E, 5890 m) 109 m in depth were drilled from Qiangtang No.1 Glacier, mid-TP. In the autumn of 2016, Chinese scientists revisited Dunde ice cap, northeastern TP, and obtained three ice cores (38°06 N, 96°24 E, 5320 m a.s.l.) from the summit, each of which is 132 m long. All above ice cores are recovered using Chinese electromechanical drills. In November 2012, a 109 m long ice core was extracted from Zuoqiupu glacier, a maritime glacier in the southeastern TP, with an electrical thermal drill. The Sino–US cooperation expedition, organized by the Institute of Tibetan Plateau Research, CAS and Byrd Polar and Climate Research Center, recovered a 208.6 m ice core (34°19 N, 85°50 E, 6064 m) on the Zangser Kangri glacier in 2013, the longest ice core ever drilled by Chinese engineers. The cooperation expedition has also successfully drilled three ice cores each 51 m long (35°17 N, 81°29 E, 6664 m a.s.l.) on the summit and two cores of 70 m and 310 m long (35°14 N, 81°28 E, 6089 m a.s.l.) on the plateau of Guliya ice cap in 2015.

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Climate and environment reconstruction from ice core

Tandong Yao (ITP-CAS), Baiqing Xu (ITP-CAS), Guangjian Wu (ITP-CAS), Shichang Kang (NIEER-CAS), Shugui Hou (NU), Yongqin Liu (ITP-CAS), Huabiao Zhao (ITP-CAS)

Ice cores from the Tibetan Plateau represent a valuable archive for studying climate and environmental changes, including the history of anthropogenic emissions from the surrounding regions. A rapid warming trend during the second half of the 20th century and the following warming hiatus have been observed from several ice-core stable-isotope records in the northwestern Tibetan Plateau. Apart from the local climate parameters, the effect of atmospheric circulation related to the Indian monsoon and the Westerlies on the stable isotope records are progressing. The concentrations, chemical composition, morphology and grain size of dust particles in ice cores are being investigated to explore its radiative effect in the past. The combination of black carbon and levoglucosan concentrations are used to differentiate the contribution of fossil fuel combustion from biomass burning to the variations of black carbon series in ice cores. Anthropogenic emissions from South Asia contribute most of the carbonaceous aerosol to the deposition on a maritime glacier in the southeastern Tibetan Plateau. The increasing trend of Hg concentration recorded in a Tibetan ice core also indicates a continuous increase in anthropogenic Hg emissions from South Asia. Levoglucosan, as a good biomass burning biomarker, has now been widely measured in Tibetan ice cores. For accurate ice core chronology, the techniques of ³⁹Ar dating of trapped gas and ¹⁴C dating of pollen are being introduced in the Dunde ice cores.

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PERMAFROST

Permafrost monitoring and research, the Tibetan Plateau

Lin Zhao (NIEER-CAS)

The Cryosphere Research Station on the Qinghai-Xizang Plateau is mainly involved in permafrost-related research on the Tibetan Plateau (TP) since 1987. The monitoring sites was established all over the main plateau, which is consisted with about 100 ground temperature monitoring boreholes, 34 sites on hydro-thermal dynamics of active layer and 11 three- to four-layer automatic meteorological towers. The monitoring includes not only ground temperatures in boreholes, soil temperature and moisture gradients, and nearly all meteorological variables, but also surface deformation (heave

and settlement), vegetation, soil organic matters, greenhouse-gas emission and annual surface survey by geophysical methods (GPR and electromagnetic method). A new permafrost map of the TP, new maps of soils, vegetation and soil organic carbon density in the permafrost regions of the TP were compiled and published. Modeling on hydro-thermal dynamics of active layer and permafrost was conducted by different models, such as ground temperature statistical models, Common Land Surface Model (CoLM), Noah land surface model and TTOP models. The results showed that the thermal state of permafrost was well correlated with elevation, and regulated by annual precipitation, local geological, geomorphological and hydrological conditions through heat exchanges between ground and atmosphere. The monitoring data also indicated that the permafrost temperature and active layer thickness were increasing all over the TP since 1970s, which were well correlated with air temperature increasing.

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SNOW

In situ and Remote Sensing investigations of snow cover in China

Tao Che (NIEER-CAS)

The Ministry of Science and Technology of the People's Republic of China funded a 4-year project on in situ and remote-sensing investigations of snow cover in China. The aims are to establish a snow survey guide and then measure snow depth, snow water equivalent, density, grain size, liquid water content, temperature, particle shape, hardness, stratigraphy, black carbon and chemical parameters in snow-accumulating, stable, and depletion periods, to develop a series of retrieval algorithms to produce the snow cover, snow depth and snow albedo data based on optical and microwave remote-sensing data, and finally to classify snow cover in China based on the data from in situ and remote-sensing investigations. Snow properties in China are chartered with low density and large grain size, in particular, the patchy snow cover in the Qinghai-Tibetan plateau, which is different from snow cover in high-latitude regions. The different snow properties lead to large uncertainties regarding global remote-sensing snow product. We developed an iterative optimal method that was used to retrieve the forest transmissivities at 18 and 36 GHz based on the snow and forest microwave radiative transfer models and the snow properties measured in field experiments. On the other hand, we developed a method to reconstruct the snow cover in cloudy conditions based on the optical and microwave

snow products. According to the remote sensing of snow cover data, the snow cover has a different change pattern in spatial and temporal: snow depth is slightly increased in winter while obviously decreased in spring, and increased in west China while decreased in northeast China. Contact: chetao@lzb.ac.cn

NEW MONITORING TECHNOLOGY

A new method for estimating mass balance based on InSAR observations

Jianmin Zhou(RADI-CAS), Zhen Li (RADI-CAS) Interferometric Synthetic Aperture Radar (InSAR) offers direct means of monitoring changes in surface elevation over mountain glaciers and can achieve centimeter-level accuracy. We present a new method for estimating mass change in mountain glaciers using InSAR data. The method utilized observations of glacier surface deformation to derive the thickness changes and then calculated the mass change. This method not only can derive the glacier annual mass balance, but also can estimate the glacier seasonal mass change. Our method thus fills a gap in the current methods and can derive more detailed information about glacier mass balance changes. We applied the method to Koxkar glacier, Tien Shan, China and analyzed the spatial characteristics of the mass changes in the ablation zone for the first time. The results show considerable spatial and seasonal variability. By the verification of error analysis and test, the results confirmed the feasibility and potential of the presented approach based on InSAR observations for the retrieval of mass changes the mountain glacier, despite the lack of ground measurement data.

Contact: zhoujm@radi.ac.cn

DATABASE

Third Pole Environment Database

The Third Pole Environment Database was established by the Institute of Tibetan Plateau Research of the Chinese Academy of Sciences, specifically to carry out the reception, preservation, management and service work for scientific data from the Tibetan Plateau. It aims to support the research staff who derived the original data in sharing and providing a unified platform for sharing scientific data and application of analytical

results about the Third Pole environment. The data involving glaciers, hydrology, atmospheric physics and environment, ecology, etc. can be freely downloaded by scientists worldwide and can be used for future studies, in agreement with the CAS guidelines on data sharing. The website for access is <http://www.tpedatabase.cn> Contact: sdb@itpcas.ac.cn

World Data System for Cold and Arid Regions

World Data System for Cold and Arid Regions (CARD) is a new scientific data-sharing system that has been established on the basis of the former World Data Center for Glaciology and Geocryology, Lanzhou, and other data centers hosted by the Cold and Arid Regions Environmental and Engineering Research Institute of the Chinese Academy of Sciences. World Data System for Cold and Arid Regions is one of the constituents of World Data System. The data sharing system's main goals are to collect, manage and store the scientific data of the Cold and Arid Regions area in China and provide the services for scientific research in Cold and Arid Regions.

Contact: estdc@lzb.ac.cn

ABBREVIATIONS:

ITP-CAS	Institute of Tibetan Plateau Research, Chinese Academy of Sciences
CETES	Center for Excellence in Tibetan Plateau Earth Sciences
NIEER-CAS	Northwest Institute on Eco-Environment and Resources, Chinese Academy of Sciences
RADI-CAS	Institute of Remote Sensing and Digital Earth, Chinese Academy of Science
IMHE-CAS	Institute of Mountain Hazards and Environment, Chinese Academy of Science
BNU	Beijing Normal University
NNU	Northwest Normal University
NU	Nanjing University
HUST	Hunan University of Science and Technology
PRIC	Polar Research Institute of China, Shanghai, China

Tandong Yao



International Glaciological Society

JOURNAL OF GLACIOLOGY

Papers accepted for publication between 1 August and 31 December 2017. The papers are listed in alphabetical order by first author. Some of these papers have already been published.

Tristan Amaral, Cameron Wake, Jack Dibb, Elizabeth Burakowski, Mary Stampone

A simple model of snow albedo decay using observations from the community collaborative rain, hail, and snow-albedo (CoCoRaHS-Albedo) network

Mohd Farouk Azam, Patrick Wagnon, Etienne Berthier, Christian Vincent, Koji Fujita, Jeffrey Kargel

Review of the status and mass changes of Himalayan–Karakoram glaciers

Caroline Aubry-Wake, Dorian Zephir, Michel Baraer, Jeffrey McKenzie, Bryan Mark
Importance of longwave emissions from adjacent terrain on patterns of tropical glacier melt and recession

Kenji Baba, James Renwick

Aspects of intraseasonal variability of Antarctic sea-ice in austral winter related to ENSO and SAM events

Perry Bartelt, Othmar Buser

Avalanche dynamics by Newton: reply to comments on avalanche flow models based on the concept of random kinetic energy

Julien Brondex, Olivier Gagliardini, Fabien Gillet-Chaulet, Gael Durand

Sensitivity of grounding line dynamics to the friction law formulation

Bo Cao, Baotian Pan, Weijin Guan, Jie Wang, Zhenling Wen

Changes in ice volume of the Ningchan No.1 Glacier, China, from 1972 to 2014, as derived from in situ measurements

Christine Chen, Ian Howat, Santiago de la Peña
Formation and development of supraglacial lakes in the percolation zone of the Greenland ice sheet

JiZu Chen, Qin Xiang, Shichang Kang, Wentao Du, Weijun Sun, Yushuo Liu

Effects of clouds on surface melting of Laohugou No. 12 Glacier, Western Qilian Mountains, China

Anders Damsgaard, Jenny Suckale, Jan Piotrowski, Morgane Houssais, Matthew Siegfried, Helen Fricker

Sediment behavior controls equilibrium width of subglacial channels

Geoffrey Evatt, Christoph Mayer, Amy Mallinson, I. Abrahams, Matthias Heil, Lindsey Nicholson

The secret life of ice sails

Mette Gillespie, Wendy Lawson, Wolfgang Rack, Brian Anderson, Donald Blankenship, Duncan Young, John Holt

Geometry and ice dynamics of the Darwin–Hatherton glacial system, Transantarctic Mountains

Jayne Kamintzis, John Jones, Tristram Irvine-Fynn, Tom Holt, Peter Bunting, Stephen Jennings, Philip Porter, Bryn Hubbard

Assessing the applicability of Terrestrial Laser Scanning for mapping englacial conduits

Yasushi Fukamachi, Daisuke Simizu, Kay Ohshima, Hajo Eicken, Andrew Mahoney, Katsushi Iwamoto, Erika Moriya, Sohey Nihashi
Sea-ice thickness in the coastal northeastern Chukchi Sea from moored ice-profiling sonar

Roberto Garzonio, Biagio di Mauro, Daniele Strigaro, Micol Rossini, Roberto Colombo, Mattia de Amicis, Valter Maggi

Mapping the suitability for ice-core drilling of glaciers in the European Alps and the Asian High Mountains

Thomas Goelles, Carl Bøggild

Albedo reduction of ice caused by dust and black carbon accumulation: a model applied to the K-transect, West Greenland

Marijke Habermann, Martin Truffer, David Maxwell

Error sources in basal yield stress inversions for Jakobshavn Isbræ, Greenland, derived from residual patterns of misfit to observations

Dieter Issler, James Jenkins, James McElwaine
Comments on avalanche flow models based on extensions of the concept of random kinetic energy

Hester Jiskoot, Thomas Fox, Wesley Van Wychen
Flow and structure in a dendritic glacier with bedrock steps

Ian Joughin, Benjamin Smith, Ian Howat
A complete map of Greenland ice velocity derived from satellite data collected over 20 years

William Kochtitzky, Benjamin Edwards, Ellyn Enderlin, Jersy Marino, Nelida Manrique
Improved estimates of glacier change rates at the Nevado Coropuna ice cap, Peru

James Lever, Susan Taylor, Arnold Song, Zoe Courville, Ross Lieb-Lappen, Jason Weale
The mechanics of snow friction as revealed by micro-scale interface observations

Lindsey Nicholson, Jordan Mertes
Thickness estimation of supraglacial debris above ice cliff exposures using a high resolution digital surface model derived from terrestrial photography

Kira Olsen, Meredith Nettles
Patterns in glacial-earthquake activity around Greenland, 2011–2013

Thomas Shaw, Ben Brock, Alvaro Ignacio Ayala Ramos, Nick Rutter, Francesca Pellicciotti
Centreline and cross-glacier air temperature variability on an Alpine glacier: Assessing temperature distribution methods and their influence on melt model calculations

Christian Sommer, Michael Lehning, Charles Fierz
Wind tunnel experiments: Saltation is necessary for wind-packing

Nozomu Takeuchi, Ryutaro Sakaki, Jun Uetake, Naoko Nagatsuka, Rigen Shimada, Masashi Niwano, Teruo Aoki
Development and decay of cryoconite holes on Qaanaaq Glacier in northwest Greenland

Dorothee Vallot, Rickard Pettersson, Adrian Luckman, Douglas Benn, Thomas Zwinger, Ward Van Pelt, Jack Kohler, Martina Schäfer, Björn Claremar, Nick Hulton
Basal dynamics of Kronebreen, a fast-flowing tidewater glacier in Svalbard: non-local spatio-temporal response to water input

Lauren Vargo, Brian Anderson, Huw Horgan, Andrew Mackintosh, Andrew Lorrey, Merijn Thornton
Using structure from motion photogrammetry to measure past glacier changes from historic aerial photographs

Stephen Veitch, Meredith Nettles
Assessment of glacial-earthquake source parameters

Chaomin Wang, Shugui Hou, Hongxi Pang, Yaping Liu, Heinz Gaeggeler, Marcus Christl, Hans-Arno Synal
^{239,240}Pu and ²³⁶U records of an ice core from the eastern Tien Shan (central Asia)

Wei Yang, Yao TanDong, Meilin Zhu, Yongjie Wang
Comparison of the meteorology and surface energy fluxes of debris-free and debris-covered glaciers in the southeastern Tibetan Plateau

Joanna Young, Anthony Arendt, Regine Hock, Erin Pettit
The challenge of monitoring glaciers with extreme altitudinal range: mass balance reconstruction for Kahiltna Glacier, Alaska

Xiaoying Yue, Jun Zhao, Li Zhongqin, Mingjun Zhang, Jin Fan, Lin Wang, Puyu Wang
Spatial and temporal variations of the surface albedo and other factors influencing Urumqi Glacier No. 1 in Tien Shan, China

ANNALS OF GLACIOLOGY 58(74)

The following papers have been selected for publication in Annals of Glaciology 58(74) (thematic issue on Interactions of ice sheets and glaciers with the ocean), edited by Helen Amanda Fricker

Seth Campbell, Zoe Courville, Samantha Sinclair, Joel Wilner

Brine, englacial structure, and basal properties near the terminus of McMurdo Ice Shelf, Antarctica

Rachel Carr, Chris Stokes, Andreas Vieli

Threefold increase in marine-terminating outlet glacier retreat rates across the Atlantic Arctic: 1992–2010

Monica Nelson, Bastien Queste, Inga Smith, Gregory Leonard, Benjamin Webber, Kenneth Hughes

Measurements of Ice Shelf Water beneath the front of the Ross Ice Shelf using gliders

Yuri Romanov, Nina Romanova, Peter Romanov

Geographical distribution and volume of Antarctic icebergs derived from ship observation data

Craig Stevens, Won Sang Lee, Giannetta Fusco, Sukyoung Yun, Brett Grant, Natalie Robinson, Chung Yeon Hwang

The influence of the Drygalski Ice Tongue on the local ocean

Annals 58(74) is now complete

ANNALS OF GLACIOLOGY 59(75)

The following papers have been selected for publication in Annals of Glaciology 59(75) (thematic issue on The cryosphere in a changing climate), edited by Ian Allison

Michael Allchin, Stephen Dery

A spatio-temporal analysis of trends in Northern Hemisphere snow-dominated area and duration, 1971–2014

Gonzalo Barcaza, Samuel Nussbaumer, Guillermo Tapia, Javier Valdes, Juan Luis Garcia, Yohan Giering, Albornoz Amapola, Victor Arias
Glacier inventory and recent glacier variations in the Andes of Chile, South America

Sourav Laha, Reshama Kumari, Sunil Shah, Aditya Mishra, Tushar Sharma, Argha Banerjee, Harish Nainwal, R. Shankar

Evaluating the contribution of avalanching to the mass balance of Himalayan glaciers

Kathrin Naegeli, Matthias Huss

Sensitivity of mountain glacier mass balance to changes in bare-ice albedo

Laura Thomson, Luke Copland

Changing contribution of peak velocity events to annual velocities following a multi-decadal slowdown at White Glacier

Waqar Younas, Rachel Hay, Matthew MacDonald, Siraj Islam, Stephen Dery
A strategy to represent impacts of subgrid-scale topography on snow evolution in the Canadian Land Surface Scheme

Jiechen Zhao, Bin Cheng, Qinghua Yang, Timo Vihma, Lin Zhang

Observations and modelling of first-year ice growth and simultaneous second-year ice ablation in the Prydz Bay, East Antarctica

Annals 59(75) is now complete

ANNALS OF GLACIOLOGY 59(76)

The following papers have been selected for publication in *Annals of Glaciology 59(76)* (thematic issue on *Polar ice, polar climate, polar change*), edited by Mark Serreze

Thomas Ballinger, Edward Hanna, Richard Hall, Thomas Cropper, Jeffrey Miller, Mads Ribergaard, James Overland, Jacob Høyer
Anomalous blocking over Greenland preceded the 2013 extreme early melt of local sea ice

Marcos Freitas, Cláudio Mendes Júnior, Jorge Arigony-Neto, Juliana Costi, Jefferson Simões
A multiscale subpixel mixture analysis applied for melt detection using passive microwave and radar scatterometer image time series of the Antarctic Peninsula (1999-2009)

Laura Gledhill, Andrew Williamson
Inland advance of supraglacial lakes in north-west Greenland under recent climatic warming

Hoi Ming Lam, Gunnar Spreen, Georg Heygster, Christian Melsheimer, Neal Young
Erroneous sea ice concentration retrieval in the East Antarctic

Jan Lenaerts, Stefan Ligtenberg, Brooke Medley, Willem Van de Berg, Hannes Konrad, Julian Nicolas, Melchior Van Wessem, Luke Trusel, Robert Mulvaney, Rebecca Tuckwell, Anna Hogg, Liz Thomas
Climate and surface mass balance of coastal West Antarctica resolved by regional climate modelling

Jean Negrel, Sebastian Gerland, Anthony Dougeris, Tom Rune Lauknes, Line Rouyet
On the potential of hand-held GPS tracking of fjord ice features for remote-sensing validation

Ge Peng, Walter Meier
Temporal and regional variability of Arctic sea ice coverage from satellite data

Anja Rösel, Jennifer King, Anthony Dougeris, Penelope Wagner, A. Malin Johansson, Sebastian Gerland
Can we extend local sea-ice measurements to satellite scale? An example from the N-ICE2015 expedition

Randall Scharien, Rebecca Segal, John Yackel, Stephen Howell, Sasha Nasonova
Linking winter and spring thermodynamic sea ice states at critical scales using an object-based image analysis of Sentinel-1

Dustin Schroeder, Andrew Hilger, J. Paden, Duncan Young, Hugh Corr
Ocean access beneath the southwest tributary of Pine Island Glacier, West Antarctica

Matthew Siegfried, Helen Fricker
Thirteen years of subglacial lake activity in Antarctica from multi-mission satellite altimetry

More papers for *Annals 59(76)* will be listed in the next issue

Making your communication more effective

Workshop: 'Communicating Science for Polar Researchers'
Boulder, Colorado, USA, 12–14 August 2017

You may have heard some version of the saying, 'If I had more time, I would have written a shorter letter.' This statement has been accredited to many great people from Mark Twain to Cicero to Winston Churchill, but it was actually Blaise Pascal – a French mathematician, theologian, physicist and inventor – who penned the original that has been paraphrased for nearly 400 years.

Although Pascal championed his way through many fields of science in the 17th century, his wit still offers a good lesson in humility to scientists today when it comes to communicating their research. Putting complex ideas into simple, direct language can take a lot of effort, as a group of us recently learned.

For three days in August 2017, 32 researchers from around the world (the majority of whom were early-career) gathered at the University of Colorado in Boulder, Colorado, USA, for a workshop to improve their skills in 'Communicating Polar Science'. Sponsored by the US National Science Foundation and NASA, and co-organized by the IGS, the Association of Polar Early Career Scientists (APECS) and USAPECS, this event was led by science communication professionals.

The first two days focused on oral communication, led by instructors from the Alan Alda Center for Communicating Science at Stony Brook University, New York. Using role playing exercises and games from the world of improvisation, we learned how to connect with a range of audiences by finding common ground, telling stories and painting evocative pictures.



Danya AbdelHameid (left) and Sasha Leidman practice sharing and explaining their research to people who may not have a background in polar science. Photo Credit: Mike Lucibella, *The Antarctic Sun*

Our first lesson was that communicating well requires listening and thinking from the perspective of your audience. Our instructors illustrated this point by noting how reading a scientific paper for a layperson is like someone with no knowledge of baseball trying to read a technical newspaper account of a game. In a parallel to oral communication, we performed an improv exercise in pairs in which one person had to precisely mirror the motions of the other. When in the role of the leader, we realized we had to adapt the speed and complexity of our motions so that the copier could follow, in the same way that great communicators read and adapt to the reactions of their audience. We also practiced techniques to better get to know and understand our audience, such as asking questions to establish their level of understanding, or breaking an opponent's views down into shared core values (e.g. equality, honesty) when in a debate to reveal their line of reasoning.

Another key skill we honed at the workshop was how to engage an audience and convey a foreign concept using metaphors and analogies, along with movie quotes and song lyrics. Learning by doing, we practiced giving TV interviews; each being filmed and then critiqued by the group. Feedback covered tone (e.g. show more passion), clarity (e.g. shorter sentences, repeat key points) and body language (e.g. more eye contact, stay present). This collaborative format nurtured team building, too: participants began to coach one another and, as the paths of communication opened up, everyone became more animated and confident. We also learned the power of putting your key message up front and then using repetition to embed it in the minds of your audience. Other highlighted techniques included stating something surprising about your research or showing how it relates to your audience's lives, to create intrigue, and revealing why you care about what you study, to generate rapport.

The final day of the workshop focused on written communication. Dr Max Boykoff and his team from the Center for Science and Technology Policy at CU Boulder provided new perspectives on how to develop different writing styles for different media, from academic journal articles to social media posts. We learned how to build a Twitter following by finding your niche tweeting topic, along with sharing parts of your non-scientist personality, such as external interests.



There were more formal talks too.

Studying examples, we saw how photographs (e.g. animal encounters), short videos (e.g. interviews) and graphics can make a critical difference in achieving a wide reach. Comparing and discussing articles in groups, we saw how keeping language free of jargon, using a frame (e.g. adventure journalism), and incorporating characters and human interest (e.g. food) could be employed to great effect.

The workshop provided many opportunities to step outside one's comfort zone and to develop the skills to talk effectively with the wider public. Participants practiced using the 'Yes, and...' exercise when confronting an opposing viewpoint. Instead of responding 'No' and setting up a debate where we remain opposed, we started with 'Yes, and...' to build positive momentum on what someone else thinks, creating a bond by agreeing with something they find important. After they understand you're listening, they are more willing to hear what you want to say. This simple technique can be used in everyday life in both formal and informal settings. Participant Robin Matthews said, 'I came away with a deeper understanding that communication should have a clear purpose. Now, instead of jumping straight into the how of my communicating, I first ask myself – what do I want my audience to think, feel or do?'

Christian Wild, a PhD candidate at the University of Canterbury in New Zealand, put his training to use even before leaving Boulder. 'I was thrown in at the deep end when I joined a panel discussion on science communication at the IGS symposium immediately after our workshop, along with workshop participant Michaela King and two more senior scientists. During this discussion and the question session from the audience, I was particularly thankful for the improvisation techniques that we learned



Here, Christian Wild is practicing the art of the television interview...



... which was recorded so he could see the results.

from the Alda team just a few days earlier. Paying close, dynamic attention to others, reading their body language and nonverbal cues helped me to shift my focus from what I was saying to what the audience was receiving.'

This workshop report from 'Communicating Science for Polar Researchers' was written by Robin Matthews, Paul Rosenbaum and Christian Wild, who, as international participants, received funding from the International Arctic Science Committee (IASC) and the Scientific Committee on Antarctic Research (SCAR) to attend the workshop. The workshop was organized by Alice Bradley, Elyn Enderlin, Mahsa Moussavi and Allen Pope and funded by the NSF Office of Polar Programs (Award #1720574) and the NASA Cryosphere Program (Award #NNX17AK61G).

❄️ Polar Ice, Polar Climate, Polar Change

IGS Symposium, Boulder, Colorado, USA, 14–19 August 2017

The summer 2017 IGS International Symposium was hosted at the University of Colorado Boulder during 14–19 August. The symposium theme was ‘Polar Ice, Polar Climate, Polar Change: Remote sensing and modeling advances in understanding the cryosphere’, bringing together cryosphere scientists working on glaciers, ice sheets, snow, polar climate and sea ice.

The goals of the symposium were: (1) to provide a forum for presenting the current best observational data of all aspects of sea ice and polar ice sheets in both hemispheres, and their ongoing changes, (2) to present and discuss results from models of ongoing polar climate and cryospheric processes, and interactions between sea ice and the climate system, (3) to examine the likely future course of the sea-ice, ice-sheet and polar-climate systems as revealed by coupled models, and (4) to entrain the global polar science community, at all stages of career development, in discussing the state and direction of the Earth’s polar regions.

The program ran from Monday evening through Saturday, offset from the standard work week to accommodate a post-symposium field trip to view the upcoming solar eclipse. The first morning of the symposium focused on sea ice and climate, with speakers covering a variety of the latest results on Arctic sea ice dynamics, snow on sea ice, and advances in monitoring and measuring sea ice. Most talks provided a clear reminder that Arctic summer sea ice – and particularly

multi-year ice – is in decline. The importance of distinguishing between first-year and multi-year ice was also highlighted, for example, as speakers discussed different influences of snow on first-year versus multi-year sea ice.

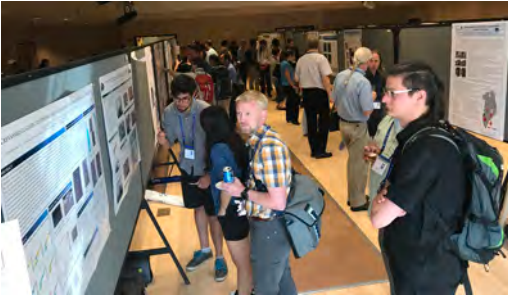
During Tuesday afternoon, we had our first of several sessions on ice sheets. Most afternoon talks focused on Antarctica, beginning with a keynote from Project MIDAS, presented by Adrian Luckman, bringing everyone up to date on the Larsen C rift and iceberg formation. Several additional talks discussed ice shelf rifts and stability. We also heard about emerging research examining the possible stabilizing influence of landfast ice at an ice shelf edge and studying formation and drainage of ice shelf surface lakes. Michalea King held her own



The first keynote presentation of the symposium was given by Ola Persson.

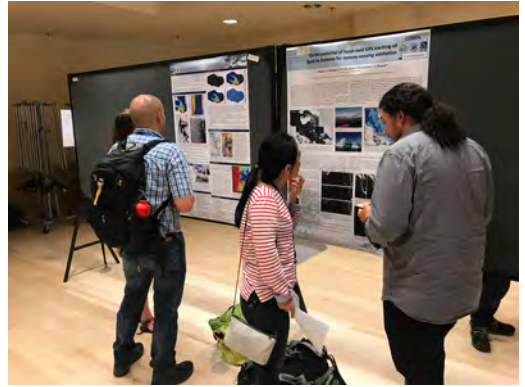


The Glen Miller Ballroom provided a spacious venue.



The poster sessions are always busy and provoke much animated discussion. And the provision of excellent refreshments always helps the flow of conversation.

as the sole Greenland-focused speaker, presenting ongoing work to create a subseasonal record of Greenland glacier discharge reaching back to the start of the 21st century. Tuesday wrapped up with a boisterous poster session complete with tasty snacks and drinks.



Jean Negrel (top) Abigail Ahlert and Jack Kohler (middle) and Joaquín Belart (bottom) describing their posters. Joaquín's poster on 'Winter mass balance of Drangajökull ice cap derived from satellite sub-meter stereo images' made him joint winner of the award for best student poster.



On Wednesday afternoon, the bus trip to the brewery provided an ideal opportunity for everyone to check their e-mails.

The ice sheet focus continued on Wednesday morning, with our attention turning toward ice sheet surface hydrology. Marco Tedesco provided an introductory keynote highlighting the new hydrological regime for the ice sheet surface – warmer, wetter, darker – and the recently released report from the Greenland Surface Mass Balance workshop (available at www.cryocity.org/uploads/1/3/0/5/13056389/final_report_smb_workshop.pdf). Across the talks, we learned that East Greenland firn aquifers are likely to be continuously active features, that ice lenses likely reduce vertical permeability to values below horizontal permeability values, and that predicting the type of Greenland surface lake drainage (rapid v. non-rapid) from basic hydrologic, glaciological, morphological, or surface mass balance metrics is not straightforward.

After a morning caffeine boost, attention turned to mountain glaciers and ice caps, with updates on GLIMS and western Greenland glacier inventories, a discussion of changing flow in High Mountain Asia (the Third Pole!), and a look at glaciers and perennial snowfields in the symposium backyard – the Rocky Mountains. Following lunch, talks returned to ice sheets. Twila Moon updated us on the revolution in velocity data for the keynote, providing inspiration for increased use of publicly accessible ice velocity data. We also learned about the evolving ArcticDEM, the potential to use Landsat sea surface temperature measurements to understand Greenland fjord characteristics, patterns of Greenland thinning from ICESat, and mass budget and shear margin evolution in Antarctica.

On Wednesday afternoon, 60 symposium participants had the chance to explore some of Boulder's 'cultural' contributions (and products of locally sourced snowmelt) at a local brewery



At the Upslope Brewery there was first a talk on the brewery's history...

and distillery. At Upslope Brewery's Flatirons Park Tasting Room, we heard about the brewery's outdoorsy history (including one founder from the Beagle Brewery in Ushuaia) and sampled a flight of five beers before experimenting with the rest of the tap list. The group moved on to Vapor Distillery's speakeasy-themed bar, where we split into two groups for a behind-the-scenes tour of the distilling process. One of the Vapor co-owners dispensed tasters of their full range of spirits and the group explored their extensive cocktail menu. Finally,



... followed by some very convivial and enthusiastic product sampling.



Marco Tedesco and Alison Banwell enjoying the different beers on offer at the Upslope Brewery.



Outdoor testing was of course also required.

four participants were dropped off at downtown Boulder's Pearl Street pedestrian mall to find some dinner. More important than the local libations, though, was the chance to break the ice with colleagues outside of the conference hall.



The group were able to taste the full range of spirits produced by the Vapor Distillery.



The distillery tour was interesting and informative.

Rejuvenated, Thursday began with a captivating but sobering discussion of projections for Arctic amplification and extreme weather events for the 21st century, with expectations of substantial surface warming and North American drying. Additional morning talks discussed the potential anthropogenic role in Antarctic sea ice variability and outlined a new snow-sea ice model. Finally, two morning talks looked at the potential influence of increased climate forcing (associated with global temperature increases of 1.5+°C on formation of a sea-ice-free Arctic. While one study suggests a relatively small difference in the likelihood of a sea-ice-free Arctic with 1.5°C warming v. 2°C, a study examining IPCC RCP scenarios noted significant differences in the frequency of sea-ice-free Arctic conditions as the forcing increased.



And of course some more field testing was essential.



During the week there were talks illustrating the work of the symposium's sponsors. On Wednesday, Gif Miller gave a presentation about INSTAAR.

Nathan Kurtz opened the Thursday afternoon session with a keynote highlighting the long-term decline of Arctic sea ice and outlining efforts to improve seasonal and decadal sea ice forecasting. Subsequently, the session focused primarily on remote sensing of sea ice, with some discussion of snow, glacier surging, and a look at the capabilities of the upcoming ICESat-2 mission.

After the scientific session ended, Allen Pope organized an hour-long panel discussion on science communication. The panel included two science communication experts, Waleed Abdalati and Twila Moon, and early career scientists Michalea King and Christian Wild, who had attended the Polar Science Communication Workshop that preceded the IGS meeting. Based on the excellent attendance and overflow of questions, it was clear that science communication is a topic of interest across the community. Tips from the group included



Thursday featured a very popular panel session on science communication.



And on Friday Waleed Abdalati described the work of CIRES.

understanding your audience, pre-planning a specific message and useful analogies, telling engaging stories and personalizing information, exploring communication pathways that are personally exciting, and building relationships to foster trust. For a complete report on the science communication workshop, please see the separate article by Robin Matthews, Paul Rosenbaum, and Christian Wild on page 14.

Following the 'scicomm' panel, the marathon meeting day continued with the evening banquet. Hosted on a top floor of the University of Colorado stadium, all attendees enjoyed stunning views, good food and drink, and plenty of friendly conversation. Magnus gifted vintage IGS plates to all the hardworking organizers who made the meeting possible, with every dish making it out of the stadium building in one piece.

On Friday, Dustin Schroeder's entertaining keynote outlined efforts to digitize 1970s Antarctic radar data to explore decades of ice sheet change, with enticing hints about small and low-cost radar instruments in development. The following session talks focused primarily on the acquisition, improvement and use of radar data. We explored new subglacial topography maps in East Antarctica; melt ponding, subsurface refreezing and basal melt on ice shelves; new instrument development; subglacial conditions in the Amundsen Sea embayment and across the Greenland Ice Sheet; and surface roughness of the Antarctic Ice Sheet.

Sophie Nowicki kicked off the afternoon session on ice sheet, ocean and climate models with a keynote overview of the ISMIP6 (Ice Sheet Model Intercomparison) project, discussing its development, challenges and opportunities. The session filled out with presentations



Chair of the Local Organizing Committee, Ted Scambos, gave a talk on Antarctic megadunes on Friday afternoon.

examining the skill and variability of a wide variety of climate reanalysis products and climate model projections of Antarctic climate and sea ice, setting vulnerability and timing for marine ice sheet instability changes in West Antarctica, and the substantial role of the greenhouse gas forcing in driving Southern Ocean sea ice variability. Friday wrapped up with the second of two poster sessions. A wise planning decision meant that all posters were up throughout the week, so folks too busy socializing during the Tuesday session took advantage of the Friday session to catch up on the latest research and posters highlighted in talks throughout the week.

Warm Saturday weather made dedicated meeting attendees happy to be in a cool room with talk of exciting science. The morning session explored a variety of Antarctic topics. Speakers took us on a tour of the slowing, thickening Fimbulisen Ice Shelf and sea ice thickness in East Antarctic, a look at waves at the Ross Ice Shelf, and development of ice thickness using DInSAR and grounding zone flexure. We also heard about grounding line retreat in the Marie Byrd Land sector, creating DEMs for the Transantarctic Mountains using structure-for-motion, and the advantages of hyperspectral remote sensing data (e.g. for identifying surface melt on debris-covered glaciers). After a short lunch, we reconvened for a brief session in which we heard about an effort to create consistent surface mass balance related datasets for modeling – including an appeal for field data! Other speakers presented Northern Hemisphere maps of pre-melt albedo changes, techniques for using Sentinel and



Refreshments accompanying the Friday poster session were just as good as those served on Tuesday.

MODIS to remotely sense snow wetness, and validating MODIS albedo products in the Russian Arctic.

We wrapped up the week by awarding the student presentation awards. The judging committee, Walt Meier, Brent Minchew and Brooke Medley, had a difficult task, and convinced Magnus that the maximum number of awards should be used. Aleah Sommers and Maddie Smith snagged the top oral presentation awards and Joaquín Belart and Sasha Nasonova were awarded the top poster prizes. Congratulations!! Finally, with extra cheers for the inspiring week, we dispersed into the beautiful Boulder afternoon, some preparing for the post-symposium geology and eclipse fieldtrips and others eager to get back to their desks with new science ideas.



The smooth running of the symposium was in the capable hands of Virginia Schultz and her assistants from CU Conference Services.



Walt Meier, chair of the judging panel, presented certificates to the joint winner of the best oral presentation by a student, Maddie Smith (center), and joint winner of the best student poster, Sasha Nasonova. The other winners, Aleah Sommers and Joaquín Belart, had already left the symposium venue.

With another fantastic IGS symposium successfully completed, extra thanks go to the hardworking organizing committee. The symposium was also sponsored by the National Snow and Ice Data Center (NSIDC), Cooperative Institute for Research in Environmental Sciences (CIRES), Institute of Arctic and Alpine Research (INSTAAR), National Center for Atmospheric Research (NCAR), and University Corporation for Atmospheric Research (UCAR). Each sponsoring



A competition was running through out the symposium for the best selfie, with special marks for imaginative photo-bombing. Here is a very creditable effort from Allen Pope, with the assistance of Lynn Kaluziensky, Jessica Scheick and Shane Grigsby.

organization was introduced during the week, giving attendees an overview of several important research organizations based in Boulder. We hope everyone returns for a science visit!

Twila Moon

National Snow and Ice Data Center
CIRES, University of Colorado

Post-symposium tour 1, 20 August 2017

Geology and geologic hazards tour of the Front Range

Any visitor to Boulder and the Colorado Front Range will immediately recognize why the American West is such a good place to learn about geology. The bones of the Earth are laid pretty bare here, although these are even more visible further afield in the western part of the state, as well as in Wyoming and in the states further to the southwest. The Front Range, however, has another particular advantage for the curious geoscientist: the close proximity of geologic hazards to large populations provides an ideal place to study geologic hazards. Colorado seems to have it all – almost – with an abundance of evidence of landslides, flash floods, rockfall, debris flow, avalanches and even, at least in the geologic record, volcanism. Only earthquakes are unrepresented to any significant degree – and, with a base elevation over 1500 m, sea-level rise. Combined with both well planned and thoughtless human intervention into the natural landscape, the variety of risks to which the public is exposed here make a fascinating study.

One the Sunday following the Symposium, a happy group of a dozen participants joined Tad Pfeffer, a CU Boulder Glaciologist and Civil Engineer, on a full-day tour of Front Range geologic history and geologic hazards. Departing from the CU campus on a loop of some 150 km, the group first crossed a series of high and old (~1 ma BP) erosion surfaces before descending to Golden, Colorado (home of the Colorado School of Mines, and Coors Brewery), where an extraordinary highway excavation, made for the East–West trending interstate highway I-70, shows the stratigraphy of sediments deposited on the eastern slopes of the Rocky Mountains, following their first episode of uplift some 300 ma BP. From Golden the group moved on into Clear Creek canyon, cut deeply into the Precambrian granodiorite that makes up the core of the Rockies. Along the way, Tad pointed out complex structures



Cenozoic stratigraphy displayed along interstate highway I-70 in Golden, Colorado.



Tad expounding on the sediments at the I-70 road cut.



OK, what are they looking at?



The Secretary General searching for a decent pub among the casinos of Central City.



Looking East at I-70 as it descends Floyd Hill, crossing actively creeping slopes.



19th century architecture in Central City.



The Dome, a popular climber's destination in Boulder Canyon.

in the heavily deformed bedrock, actively creeping slopes impinging on the highway, and the evidence of the 1859 Colorado goldrush: piles of tailings alongside the channel of Clear Creek, left from large-scale placer mining operations conducted as

miners worked their way upstream to the motherload deposits in the towns of Idaho Springs, Black Hawk and Central City.

After following the miner's traces up the Clear Creek valley, the party then moved to a much newer track: the new and privately owned highway providing direct access to the town of Central City. Explanations were in order, and Tad recounted the 1992 legalization of gambling in the towns of Central City and Black Hawk and the ensuing feuding between the towns as they competed for customers. One result of that competition was the \$30M 'Central City Parkway', which provided direct access to Central City, bypassing the town of Black Hawk completely. Benefits to gambling aside, the highway is interesting geologically as it climbs out of the Clear Creek valley to an elevation of 2700 m, traversing ancient erosion surfaces, views of landslides and debris flow scars across the Clear Creek valley, and one riveting example of topographic inversion: an exposure of a ~3 ma BP alluvial deposit, now some 280 m above the modern stream valley.

After a picnic lunch beside the celebrated Central City Superfund Site (more mining history) and a stop to appreciate Central City's wonderful 19th century architecture, the group settled down for a longish drive north across the gently rolling Rocky Mountain pediment to the town of Nederland. With less in the way of geologic hazards, or anything else scientific, at hand to better the minds of his audience, Tad gave them the brief, confusing, hilarious and entirely true history of Nederland's Frozen Dead Guy. Originally the end product of a Norwegian ex-patriot's experiments in cryopreservation (conducted on his grandfather), the Frozen Dead Guy, known variously as Grandpa Bredo and the GrandPopsicle, is now a ward of the town and its principal tourist attraction. Visitors arriving at the right time of the year (March) can even enjoy Nederland's own winter carnival, Frozen Dead Guy Days.

The route from Nederland back home to Boulder leads through Boulder Canyon, a steep-walled and elegant incision into more solid granite than was seen in Clear Creek Canyon. Stops were made at the Barker Reservoir dam, a gravity dam built in 1908 to provide hydroelectric power, and at several examples of rock reinforcement, made to reduce the likelihood of large rockfalls onto the highway.

Arriving in Boulder, a last few glimpses of flood control modifications made adjacent to Boulder Creek brought the group back to the CU Campus. Some would be returning home, but others went back to their hotels to rest up for the Symposium's next tour: a drive the next morning of 400 km to view the total eclipse of the sun in Nebraska.

Tad Pfeffer

Post-symposium tour 2, 21 August 2017

The great IGS eclipse adventure

The IGS eclipse excursion was a complete and awe-inspiring success – a truly moving and soul-connecting experience for the group that made the journey.

Our target, Alliance, Nebraska, was exactly on the mid-line of the path of the shadow, offering 2 minutes 30 seconds of total eclipse. Nineteen of us from the IGS meeting, and another eight or so from NSIDC and CIRES, gathered at the bus at 4:50 am. We loaded coolers of food, water, cameras, telescopes, tripods and of course extra eclipse glasses, and headed east in the pre-dawn darkness.

Both weather and traffic were major concerns. The forecast for western Nebraska was marginal, using words like ‘patchy’, ‘stationary’ and ‘scudding’... not a vocabulary that instills confidence. Still, we went with the plan, and forerunners of the group in their own vehicles sent messages that things looked good, above and ahead, on the route. The bus, a modern marvel with wifi, power at the seats and a bathroom (or loo) at the back, rumbled across the high plains as the sun rose, lighting up high wispy clouds. It was a better sky than had been forecast, but still worrisome, with mist and low puffs of cloud, and even fog at Alliance in the early morning.

With just ten minutes before the moon first touched the disk of the sun, we arrived at the Alliance Rodeo Grounds, which turned out to be a large area of pasture (and all that that implies) with stadium seating incongruously rising out of the sage. The ‘bus zone’ was a throwback to a different era, an outdoor ‘drive-in’ theater – among the last ones still in operation apparently. We hopped out and began to set up gear, to don our special glasses, and to look for that first dark arc to bite into the solar disk. The group chatted, sharing what they knew about what to expect,



As the sun rose we were already on the road.



The IGS contingent disembarked from the bus accompanied by a large number of blue cooler boxes full of refreshments.

and what to look for, as we assembled cameras and other ways of observing. A thermometer was placed so that it could measure the expected temperature drop as all of us at Alliance waited for ‘totality’.



The people of Alliance were out in the street as our bus passed through, ready to greet the eclipse.



Mark Serreze and his wife Susan were kitted out with the regulation eclipse glasses.



Some serious equipment was unloaded from the bus and deployed. On the right, while Chris Schuman checks the precise details of the eclipse's progress, Jennifer Hill is getting to grips with a sun filter.

The sun has been in an unusually quiet phase in the past few years, and there was some thought that this eclipse would offer only a rather plain-looking view of the corona (the sun's atmosphere). But about a week ago, a large group of sunspots appeared, and by eclipse day they had moved to the center of the disk. Even better, our telescope projected views of a new sunspot group that could be seen on the eastern edge, having just emerged into view from the Earth a day earlier.

Only after 60% or so of the sun had been covered did we begin to notice the cooling air and the dimming of the light. As the blinding crescent waned still further, a kind of hush came over us, with just a few excited shouts to one another. Clouds wisped by, but by this point we knew we would see the full show. As the crescent narrowed to a short arc, a pale ragged ring began to outline the moon — the corona!

And then the last gleaming, short arc of brilliant plasma was winked out, and the full majesty of the eclipse stood there in the sky. The corona was a wispy, pearly halo, with three huge petals spanning four times the sun's diameter or more, rose-tinged in a dark blue sky that faded to red at the horizon, presenting us with the other-worldly experience of the light of a sunset in every direction. But the truly stunning aspect was the impossibly black perfect circle standing before the sun.

It was beyond awesome. It was mind- and soul-expanding, a connecting event like nothing else you can experience. Like a continuing crescendo in a symphony, one felt transported — not to somewhere but simply outward, skyward, into the universe and to everyone watching across the continent... across the globe... while still standing there... in a pasture in Nebraska.

Clouds still decorated the sky, actually adding to the skyscape rather than detracting from it.

Towards the end of totality, a patch of thin cloud swept across the eclipse. At that point, with the spectacle centered in the cloud, a beam of light lit the sky and the cloud, creating a second brilliant diamond ring effect, but this time as if seen through a veil. It drew gasps from the crowd. Not a few tears were seen on faces.

And then... slowly... we all returned to Earth. The light from the sun returned to a level like daylight. Being lunchtime, we opened the boxes we had and continued to relate what we had all seen and felt — the parts that could be put into words, at least. Other feelings were expressed with hugs, high-fives and simple quiet happiness.

About an hour after the eclipse, we boarded the bus again and headed back towards Boulder with about 200 000 of our closest friends. Although we had made the trip out with relatively little traffic, the first few miles were like leaving



Others proceeded to view the eclipse with the help of much simpler technology.

a major sporting event – or perhaps several of them, ending at the same time. Using our phones showed us a way around the main problem – a traffic light in Alliance – but our short cut was foiled by three huge lumbering trains. Alliance is a major rail center, for grain, coal and oil. Those trains were miles long and reminded us of both the achievements and the challenges facing humanity in the coming decades.

But the trains slid by and the traffic finally parted. We wove our way across the prairie into Boulder at 10 pm.



Ted Scambos



It got quite dark, and there was the extraordinary effect of a sunset in every direction.



Ted Scambos seized the opportunity to take what was undoubtedly the winning selfie, complete with photobomb (on his forehead) from the eclipse itself.



In the end some pretty spectacular photos were taken of the eclipse. Photos: Ted Scambos.



British Branch Meeting 2017

Lancaster University, Lancaster, UK, 5–7 September 2017

The 42nd International Glaciological Society British Branch Meeting was hosted by Lancaster Environment Centre, Lancaster University, from 5–7 September. On 5 September there was a hugely successful pre-session early career researcher training event on ‘Environmental Data Science for Polar Scientists’ kindly sponsored by Lancaster University’s Data Science Institute. The meeting proper kicked off in style with a barbecue icebreaker in the Environment Centre’s quad that evening, with the last of the British summer holding out for outdoors-based food, drink and discussion. The next morning meeting leader Amber Leeson welcomed over 100 delegates to two days packed full of talks and posters. The programme included 38 talks and 50 posters on an incredibly diverse variety of glaciological research in the UK, from subglacial lakes in the Antarctic to eskers on Mars, gases released from glacial comminution and modelling of the British and Irish Ice Sheet, to name but a few topics. Masters and PhD students were responsible for nearly a third of all talks and over two-thirds of posters, maintaining the British Branch Meeting’s strong history in promoting early-career science.

Day 1 started with talks on glacio-volcanism, weaving seamlessly between Antarctica, Iceland and Mars. Keynote speaker John Smellie gave an excellent demonstration of presenting to a diverse audience, and Open University PhD student Frances Butcher gave a fascinating insight into potential glacial geomorphological features on



A barbecue icebreaker allowed delegates to relax and socialise before the meeting kicked off. Photo: @LancsUniEarth (Twitter)

the surface of Mars. We then moved onto the glacial biogeochemists, with second keynote speaker Jemma Wadham telling us why ice sheets should be considered an important and dynamic component of the global carbon cycle, and PhD student Moya MacDonald giving us an insight into mechanochemical reactions under ice and their potential importance in maintaining microbial life, among others. Lunch followed, with delegates encouraged to chat and look round the array of posters on offer.

The afternoon session opened with glacial lakes. Andy Smith and Steve Plamer gave us an insight into subglacial lakes under the ice sheets, while Evan Miles and Andrew Williamson talked about supraglacial lakes in Greenland and the Himalayas. The science-packed first day of talks finished with a session on ice shelves, covering everything from remote sensing of changes to ground observations and modelling ice flow. Addy Pope from ESRI gave the final talk of the day, with some fascinating and inspiring outreach examples using GIS data and ArcGIS in school classrooms. ESRI also kindly donated the beverages for the busy poster session that followed, rounding off an excellent day of glacial science.

Post-science decompression gave the opportunity to visit Lancaster Brewery for a tour and to sample a wide range of local brews, as well as the infamous British Branch Meeting banquet. Pete Nienow turned back the years, and his hairline, with an excellent after dinner speech. It was especially fascinating (and encouraging!) to hear of all the early-career success stories in the UK glaciological community over the past



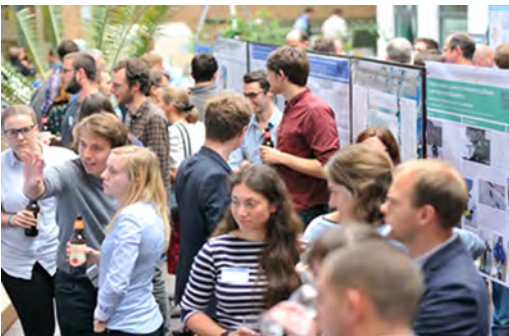
Lancaster University’s Data Science Institute hosted a data science training session for polar researchers before the conference, which attracted a large number of early-career researchers. Photo: Amber Leeson



More than two thirds of posters presented were from masters and PhD students. Photo: Simon Chew



Delegates listen attentively to a talk about the Lancaster Brewery during a tour of their facilities before the conference dinner.



The poster session in full flow. Photo: Simon Chew



The banquet was held at the Brewery.

five years, with a huge number of Aberdeen BBM (2012) early-career attendees now in full employment or in postdoctoral positions. Socializing and discussions continued late into the evening in Lancaster city centre.

The second day began bright and early with the first of two glacial dynamics sessions. The presenters did an outstanding job of presenting complex physics and mathematical theory to the lay person (i.e. me), with Joe Todd showing a particularly interesting 3-D video of Stor Glacier's calving front, and PhD student Arminel Lovell identifying the first surge-type glacier in the Himalayas, among others. Impressively, John Woodward managed to mention both the Dreamworks motion picture *Antz*, snails and glaciers in his talk on potential hydrophobic surfaces under glaciers.

The afternoon sessions kicked off with Ice Sheets and Climate Change. The final keynote speaker, Robert Mulvaney, gave a fascinating insight into ice-core climatic records, and the international race to find the oldest ice on earth in Antarctica, and we learnt about ENSO effects on Antarctic mass balance courtesy of Masters student Julien Bodart. Chris Stokes and PhD



Pete Nienow's after-dinner speech recalled the old days of glaciology when he had hair. Photos: Magnús Már Magnússon



Ian Willis enthusiastically presents his work on the Bach Ice Shelf in front of delegates. Photo: Simon Chew

student Vincent Verjans rounded off the session by looking at East Antarctic and Greenland response to climatic warming. The final session of a highly successful meeting started with Nick Rutter and David Ashmore talking all things snow, and Niall Gandy providing an insight into the British and Irish Ice Sheet using modelling, ending with special guest appearances from South African colleagues John Dunlevey and Alan Smith.

The final task of the meeting was the award of the John Glen prizes for student presentations, as is customary. There could unfortunately only be two winners, although the quality of all

student talks and presentations was extremely high. The prize for oral presentation, presented by Rachel Carr, went to Frances Butcher of the Open University for her talk on 'Recent basal melting of mid latitude glaciers on Mars', and the poster prize, presented by John Woodward, went to Alejandra Urra of the University of Bristol for her work 'Dynamics of weathering rates under contrasting hydrological forcing regimes in Greenland'. Commendations were given to Andrew Williamson, Kyrah McKenzie and Niall Gandy (oral presentations), and Joshua Williams, Jack Garnett and Heather Bell (poster presentations). A stellar effort from all students – well done!

I'm sure I speak for all attendees by thanking the local organizing committee, Amber Leeson, Jennie Gilbert, Peter Wynn, Hugh Tuffen, Crispin Halsall, Jacqueine Owen and Mounir Takriti, for arranging a successful and stimulating meeting! British glaciological research continues to be world leading, on the evidence of the research presented over the two days in Lancaster. I'm sure everyone is already looking forward to the 2018 meeting at the University of Exeter next year.

Jon Hawkings



John Glen prize winners (left) Alejandra Urra and (right) Frances Butcher receive their awards. Photo: Magnus Mar Magnusson

Report from the Karthaus Summer School

Karthaus, Italy, 11–17 June 2017

The Karthaus Summer School is a ten-day experience set in the mountain village of Karthaus, located in the narrow Schnalstal valley in Südtirol, Italy. The program focuses on ice sheets and glaciers in the climate system. Over 30 PhD students and postdoc candidates participated, as well as a very nice team of well known professors.

During the morning we had four-hour lessons about continuum mechanics, rheology of ice, thermodynamics, ice–ocean interactions, ice cores, glacier hydrology, geophysics and geodynamics, with a special focus on numerical modeling and its applications for investigating ice–climate interactions, geophysical and remote-sensing methods. After lunch we first focused on exercises where we applied the theories discussed in the morning, and then we developed computer projects using real-world applications for specific research problems. At the end of the course all the groups had to present their results during a 15 minute group presentation. We also had some free time after these sessions, which some of us spent hiking, running or playing soccer.

During the evenings we enjoyed amazing regional meals with five-course menus, each accompanied by delicious regional wines. We also enjoyed live piano sessions performed by Frank Pattyn. During the final evening we also had the opportunity to savour a lovely tango performance with Hans Oerlemans on guitar and Frank on the piano. Throughout the time we spent in the village, all the students had a great attitude and friendly discussions, which was reflected in



The afternoon session doing exercises with the team. Photo: Valentina Zorzut.

the evening meetings at the bar of the Goldene Rose Hotel, where we played cards or talked about many different topics, not necessarily related to glaciology.

But not everything revolved around lectures and exercise; we also enjoyed a day walking to a number of glaciers in the Ötztal Alps. As the field trip of the course, we went to the ski center of the Hochjochferner, and during the walk down we observed the changes affecting glaciers in the region. Some of us continued hiking until the peak at the Hintereisferner, a valley glacier on the Austrian side of the border. On the way back we stopped to have lunch at the Schöne Aussicht (Bellavista) hut (2845 m a.s.l.).



The crowd at the Karthaus Summer School: 2017 vintage. Photo: Carleen Reijmer.



An afternoon spent hiking over the local glaciers provided another opportunity for a group photo. Photo: Carleen Reijmer.



The idyllic village of Karthaus, nestled in the narrow Schnalstal, Südtirol. Photo: Valentina Zorzut.

After participating in this incredible experience I would like to emphasize that I definitely recommend this course to all glaciology students. Although the course is intense, it is an amazing opportunity to learn from specialists in different related topics in a friendly and motivating environment. Spending ten days with other young scientists for me was immensely valuable as it

helped me to better understand what I am doing, and to assess my own research into a new and refreshing light.

I greatly appreciated the opportunity to participate in the 2017 Karthaus summer school and meet other fellow students and respected scientists to establish the foundation for future professional collaborations. I would also like to express my gratitude to all professors and in particular Johannes Oerlemans for their great attitude and disposition and to the village of Karthaus and all the staff for those memorable ten days! I am really looking forward to working with you here in the Argentinean Andes or elsewhere in the future.

Valentina Zorzut

Valentina Zorzut is a PhD candidate at IANIGLA (Mendoza), working with Lucas Ruiz. Her research focus is to estimate the present ice volume of Argentina's glaciers and their possible future behavior under different climate scenarios. Her project combines field studies and numerical models to calculate ice thickness and glacier-climate interactions. Contact: vzorzut@mendoza-conicet.gob.ar

Obituary: Charles Raymond Bentley, 1929–2017

Charles R. Bentley, Professor Emeritus of Geophysics, University of Wisconsin-Madison, and well-known Antarctic geophysicist and glaciologist, passed away on 19 August 2017. He was 87. According to Molly Bentley, his daughter, he died from complications of Parkinson's disease at his home in Oakland, California, USA.

Charlie was born to Charles Raymond, known as Raymond, and Janet (Everest) Bentley on 23 December 1929, in Rochester, New York. He graduated from Phillips Academy in Andover, Massachusetts, then attended Yale University, where he majored in physics and graduated in 1950.

The beginning of Charlie's scientific career dates to summer 1950, when he served on an oceanographic expedition in the Atlantic, led by Professor Maurice Ewing of Columbia University, an experience that caused him to abandon his previous plans to attend law school.

Subsequently he became a graduate student at Columbia, where he studied geophysics under Ewing. This was the time period leading up to the International Geophysical Year (IGY, 1957/8). He spent two summers on the Greenland Ice Sheet using seismic methods to investigate the depth-dependent variation of wave velocities, which are a function of the physical properties of the ice, and the ice thickness. When he was a PhD candidate, one of his professors, Frank Press, asked a group of students if any would like to go to Antarctica. Charlie said he would. By then, IGY plans were being finalized; it was scheduled to begin in July 1957. He defended his PhD dissertation successfully in late 1956 – but received his degree in 1959, because he neglected to pay his dissertation fee before departing immediately afterwards for Antarctica.

Charlie arrived at Little America V station, near the calving front of the northeastern Ross Ice Shelf, in February 1957, near the end of the 1956/7 austral summer. That was necessary because only at the end of the summer field season had the sea ice retreated sufficiently for ships to reach Antarctica. He and four companions then set off in tracked snowcats up the newly-constructed 1040 km trail to Byrd Station, deep in the interior of the West Antarctic Ice Sheet (WAIS) at 1553 m a.s.l. They carried out seismic sounding and other geophysical and glaciological work along this traverse route.

Expecting to find that WAIS was thin ice over elevated bedrock, Charlie was surprised when, after they crossed the grounding line between the floating



Ross Ice Shelf and the inland ice sheet, his seismic data showed the bed was going down. As they continued toward Byrd Station, the bed kept getting deeper – a result so unexpected Charlie feared he was looking at double reflections while somehow missing the first reflection. Finally, he realized his seismic data were indeed telling him that the bed of WAIS descended far below sea level along the trail to Byrd Station, continuously getting deeper toward the WAIS interior.

With 23 companions (12 Navy, 12 civilians), Charlie wintered over at Byrd Station, which consisted of about half a dozen prefab buildings connected by tunnels. At the beginning of the next field season they dug themselves out, then Charlie and four others set off on a snowcat traverse to investigate the extent to which the WAIS interior was grounded below sea level. Their party included Ned Osteno (Charlie's assistant seismologist), glaciologist Vern Anderson, his assistant Mario Giovinetto and mechanic Jack Long. Anxious to measure the bed north and east from Byrd Station, they went first toward Mt Takahe and then toward the Sentinel Range of the Ellsworth Mountains, which they partially surveyed. A high peak there is named after Charlie: Mt Bentley, 4137 m. (The elevation was measured accurately with GPS on 29 December 2006 by Jed Brown and Damien Gildea, after their first complete ascent of the northeast ridge. The GPS receiver was retrieved from the summit the next day by two other members of their expedition.)

The traverse took about 3 months, during which Charlie and his companions slept in their snowcats. On their way back, they discovered an extensive depression with the deepest bed beneath



In the field in Antarctica, 1964. Photo: US Navy.

WAIS, 2555 m below sea level, overlain by ice up to 3500 m thick. Named the Bentley Subglacial Trench, it is the lowest point of the solid Earth's topography not covered by ocean.

Afterwards, thinking he might not have another opportunity to return to Antarctica after the IGY, Charlie spent a second winter at Byrd Station in order to continue his explorations of the subglacial topography. At the beginning of the 1957/8 field season, he set off on a second 3-month snowcat traverse to the south and east, toward the Horlick Mountains. In his American Institute of Physics Oral History interview, he described it as follows.

We had a regular routine of traveling a day then doing station work for a day. We would travel 24 or 30 nautical miles, then we'd do seismic sounding and study the wave velocities in the upper ice sheet, while the glaciologist dug a pit to estimate accumulation rates from the stratigraphy. That was a day's work; the next day we'd travel again. While traveling we stopped every 3 miles for gravity and snow hardness measurements. We also estimated the surface elevations using aneroid altimetry.

Charlie was in Antarctica for 25 months. After returning to New York to pay his dissertation fee (thus receiving his PhD in 1959), he moved to the University of Wisconsin-Madison and became a project scientist, along with a number of IGY colleagues, because George Wollard, a professor there, had a grant from the National Science Foundation to analyze the IGY Antarctic geophysical traverse data. This was the beginning of the Geophysical and Polar Research Center at UW-Madison. Other IGY colleagues went to Ohio State University, where Dick Goldthwaite had an NSF grant for analysis of the surface glaciology data. Charlie and his

colleagues published their traverse results, including their discovery that WAIS was grounded far below sea level (Bentley & Osteno (1961) 'Glacial and subglacial topography of West Antarctica'. *Journal of Glaciology* 3(29), 882–911). He began teaching a course in theoretical seismology and joined the faculty as an assistant professor in 1961.

Returning to Antarctica in 1960/1, and again in 1962/3, Charlie used seismic refraction to further investigate the crustal structure beneath West Antarctica along a traverse from Byrd Station to the Bellingshausen Sea (west of the Antarctic Peninsula). From 1964–9, he and his colleagues ran three traverses from the South Pole to the remote Pole of Inaccessibility, and to the US Plateau Station (a high-elevation station farther northwest), then out into the middle of Dronning Maud Land.

On 3 July 1964 Charlie and Mary Belle (Goode) Bentley were married. Mary Belle was a talented artist who attended Grinnell College, Iowa, and graduated from the University of Wisconsin-Madison with a BS in art. Later she earned an MA in comparative literature. They lived together for 40 years in Madison and raised two children: Molly Clare and Raymond Alexander. She was a remarkable woman who contributed greatly to Charlie's life until her unfortunate death from lung and liver cancer on 13 October 2004.

After his pioneering multi-month traverses of the West and East Antarctic interiors, Charlie continued his prominence in Antarctic research. Among the projects in which he and his graduate students, including John Clough, Kenneth Jezek, Sion Shabtaie and Lawrence Greischar, played key roles was the Ross Ice Shelf Geophysical and Glaciological Survey (RIGGS, 1973 through 1978/9), which was carried out in collaboration with well-known British glaciologist Robert H. Thomas (1937–2015) and his then graduate student Douglas R. MacAyeal. The RIGGS results included the first extensive measurements of the physical properties of the vast Ross Ice Shelf over its ~487 000 km² area, and the ocean depth and sea floor beneath it, and the first high-resolution finite element model (by D.R.M.) of a large ice mass.

RIGGS increased the level of interest among glaciologists and other scientists in the question of whether WAIS, as a marine ice sheet, is subject to instability. The closely related question of whether the many ice streams discharging WAIS might be subject to accelerated discharge, and the role the Ross and the other WAIS ice shelves might play in buttressing the ice streams, led to a multi-year study of the West Antarctic ice streams. This, in turn, led to what is arguably Charlie's additional most important discovery, with his then graduate students Don Blankenship, Sean Rooney and Richard Alley. It was the discovery of the mechanism by which West



Engaged in the WAIS Divide Ice Coring Project, 2000s. Photo: David Holland.

Antarctic ice streams move rapidly through the more sluggish mass of the surrounding ice sheet.

Briefly, Charlie and his co-authors showed, using high-resolution seismology, that Ice Stream B (now Whillans Ice Stream) is underlain by a ~6 m-thick (on average) layer of water-saturated subglacial till beneath the 1000 m-thick ice stream, with pore water pressure almost equal to the ice overburden pressure. In a series of four papers (in the 1987 fast glacier-flow issue of the *Journal of Geophysical Research*), they demonstrated that the rapidly deforming subglacial till accounts for most of the surface motion. The implied basal erosion rate suggested that a till delta tens of kilometers long had been deposited down-glacier beneath the grounding zone of the ice stream. With a non-steady flow model, they demonstrated the speed at which a perturbation at the margin (say, in the grounding zone) can propagate up the ice stream.

During his long career on the Department of Geosciences (formerly Geology and Geophysics) faculty at the University of Wisconsin-Madison, Charlie became the A.P. Crary Professor of Geophysics and mentored at least 22 graduate students, at least eight of whom continued on in glaciology: Richard Alley, Sridhar Anandakrishnan, Don Blankenship, Kenneth Jezek, Craig Lingle, Ben Smith, Kendrick Taylor and Donghui Yi.

When he became emeritus, Charlie was recruited to be director of the NSF-funded ice coring contract, which was based at the UW-Madison Space Science and Engineering Center. He served as such from 2000 to 2013. He noted that the project, which started in the 1990s, was originally to bury neutrino detectors in the Antarctic Ice Sheet. The principal investigators were at UW-Madison. The Polar Ice Coring Office (PICO) was doing the drilling with hot water for speed, not taking cores. Much of the work was transferred to a physical sciences laboratory at UW-Madison, so those who were doing it decided to bid on the whole PICO contract. They succeeded on the second try, roping in Charlie (as he put it)

because they wanted a glaciologist and he did not yet have a post-retirement job. So, Charlie became the director, with a full-time engineering staff doing all of the contract ice-core drilling work.

This work returned Charlie to West Antarctic research when the National Science Foundation Office of Polar Programs, with Dr Julie Palais as program manager for Antarctic glaciology, funded the WAIS Divide Ice Coring Project. The chief scientist was Dr Kendrick Taylor; the chief driller was Jay Johnson. This challenging effort, at a remote and harsh location ~1750 m a.s.l. characterized by stormy weather, began during the 2005/6 field season. It was completed on 28 January 2011, when the last core segment was brought to the surface (from 50 m above the bed to avoid contamination of subglacial water with drilling fluid). It is the longest ice core, 3405 m, recovered to date by the US Antarctic Program. It is also the cleanest deep ice core with the highest time resolution recovered anywhere; it is accurately dated to 67 748 years before present at the bottom. The results of analyses by scientists at tens of institutions include (as noted in Wikipedia) the natural variations of carbon dioxide in the Earth's atmosphere; the effects of ocean circulation on these variations; insight into the origins of the abrupt climate changes that occurred during the last ice age; and the effects on climate of variations in the Earth's orbit.

The success of the WAIS Divide Ice Coring Project was a fitting capstone for Charlie's 56-year career in Antarctic glaciology. He retired (again) in 2013.

Charlie authored and co-authored over 200 scientific papers. He was awarded a Seligman Crystal in 1990, the highest honor for outstanding work awarded by the International Glaciological Society. He received a Bellingshausen–Lazarev Medal in 1971 from the Soviet Academy of Sciences. He was elected a fellow of the American Geophysical Union, the American Association for the Advancement of Science and the Arctic Institute of North America. He served on the National Academy of Sciences Polar Research Board for ~20 years, chairing the P.R.B. from 1981 to 1985.

Few people have been among the first to explore, survey and measure the remote and harsh interior of a vast continental ice sheet. Professor Charles R. Bentley was among them. His contributions to Antarctic glaciology and geophysics, and his professional contributions to his graduate students and colleagues, were immense. He will be greatly missed.

Craig S. Lingle

Research Professor Emeritus/Glaciology
Geophysical Institute
University of Alaska Fairbanks

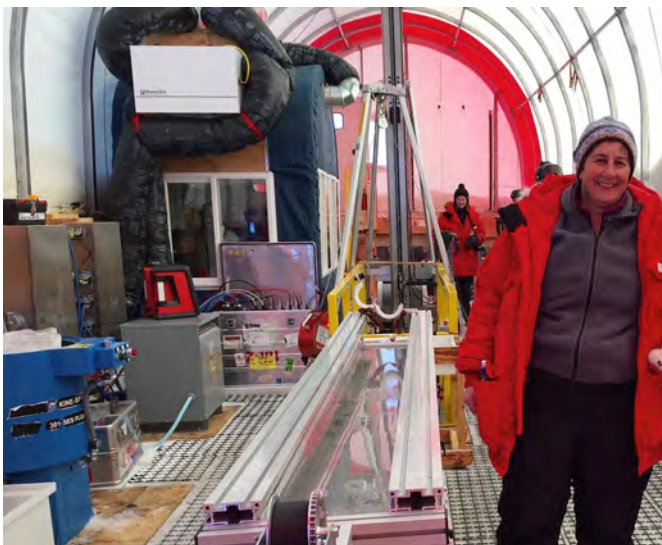
Richardson Medal for Julie Palais

The IGS has awarded the Society's Richardson Medal to Julie M. Palais, a longstanding member of the International Glaciological Society.

Dr Palais has made extraordinary contributions to glaciology through establishment and decades of facilitation of glaciological and ice-core science in the USA, and in addition she has facilitated the establishment and international leadership of the International Partnerships in Ice Core Sciences (IPICS) in 2004, early in the planning for the International Polar Year. The glaciology and ice-core science communities have produced groundbreaking discoveries that would not have been possible without the insightful and steadfast advocacy of Dr Palais through her service at the National Science Foundation.

Dr Palais began working in glaciology and ice-core science during her graduate research at Ohio State University. Her research for her Master's degree focused on depositional and diagenetic processes influencing firn stratigraphy at Dome C, Antarctica; this served as a catalyst for her PhD research at Ohio State, which focused on tephra layers and ice chemistry in the Byrd Station ice core. She continued in research and academia as faculty at the University of New Hampshire. Dr Palais was productive in publishing a variety of discoveries that she made on the topic of volcanic records in ice cores from both the Antarctic and Arctic Ice Sheets. Her strong background in glaciology and ice-core science became a key asset for the National Science Foundation when she began her work there.

For over 26 years, Dr Palais served as a Program Director at the NSF, managing peer-review processes and reviews, coordinating interdisciplinary coalitions of scientists to encourage scientific collaborations, including serving as Antarctic Glaciology Program Director. In this capacity her scientific vision, collaborative style and personal influence served to nurture and grow the ice core science program in the USA, and also she fostered international collaboration in ice core sciences. Not only was she successful in finding creative ways to make the most efficient



and effective use of NSF resources, but Dr Palais was always very responsive to, and an advocate for, the scientific community. As a result, the Antarctic Glaciology Program that Dr Palais led at NSF has been one of the most productive and impactful programs within the NSF. Through her service to the scientific community while at NSF, Dr Palais fostered groundbreaking discoveries of importance to all society.

Dr Palais has been recognized through a number of awards, including the Chateaubriand Fellowship by the government of France, the US Antarctic Service Medal and the Lowell Thomas Award from the Explorer's Club. In recognition of her prominence, Palais Bluff and Palais Glacier in Antarctica are named after her. Dr Palais is internationally recognized in glaciology.

As a productive scientist, as a senior NSF Program Director whose groundbreaking efforts established a strong, internationally coordinated US ice-core research program, and as an internationally recognized glaciologist and ice-core scientist, Dr Julie Palais has made outstanding service contributions to the US and international glaciological and climate science communities.

The Awards Committee of the International Glaciological Society



INTERNATIONAL GLACIOLOGICAL SOCIETY

International Symposium on
Timescales, Processes and Glacier Dynamics



Hotel Lafayette
Buffalo, New York, USA
3–8 June 2018

Co-sponsored by:

- ❄ Center for Geohazards, University at Buffalo
- ❄ Department of Geology, University at Buffalo
- ❄ College of Arts and Sciences, University at Buffalo
- ❄ Research and Education in eNergy, Environment and Water
(RENEW) Institute, University at Buffalo
- ❄ National Snow and Ice Data Center, University of Colorado Boulder

SECOND CIRCULAR

January 2018

<http://www.igsoc.org/symposia/2018/buffalo>



The International Glaciological Society will hold an International Symposium on 'Timescales, Processes and Glacier Dynamics' in 2018. The symposium will take place at the Lafayette Hotel in downtown Buffalo, New York, USA on 3–8 June 2018.

THEME

The physical processes controlling glacier dynamics form the basis of modern glaciology. In spite of the rapid growth in observational data, the ultimate scientific challenge continues to be relating observations to processes. Time-series observational data are essential to understanding processes; however, their analysis often reveals processes operating on timescales ranging from diurnal to millennial. Individual processes may underpin long-term glacier stability, promote instability or drive natural variability in the glacier state. For example, gravitationally driven flow is among the most fundamental processes in glaciology and is controlled by ice-surface slope and thickness. The evolution of the ice surface, in turn, reveals processes related to the mechanical controls on ice flow, firn compaction, development of supraglacial meltwater flow networks, basal melt, isostasy and surface mass balance. Each of these processes alters the surface elevation and is characterized by a different timescale. Assessment of the processes producing changes over a particular time interval poses a major challenge. Hence, even routinely acquired data are difficult to reason about. Interpretation of other data, such as surface velocity, climatological data, radar stratigraphy, glacier history, ice core records, paleoclimate proxies and in situ observations, are also confounded by relations between processes and timescales.





TOPICS

We seek papers and presentations that advance the understanding of ice sheets and glaciers and glacier dynamics on different timescales. Key focus areas include (but are not limited to):

1. Processes that control glacier dynamics and ice flow
2. Processes that reflect natural variability versus trends critical to glacier and ice-sheet stability
3. Processes that link climate and ocean changes with ice sheet and glacier evolution
4. Time-series data analysis of glacier and ice-sheet data
5. Process models for ice–ocean–atmosphere interactions, glacier–bedrock interactions, meltwater impacts, etc.
6. Processes and timescales associated with ice-sheet and glaciological hazards
7. Paleoclimate indicators of key-processes and changes in glaciers, ice caps, and ice sheets and linking paleoclimatology to contemporary glacier studies.





REGISTRATION FEES

All fees are in US dollars.

Early registration until 31 March 2018

– Participant (IGS member):	\$550
– Participant (not IGS member):	\$650
– Student or retired (IGS member):	\$425
– Student or retired (not IGS member):	\$500
– Accompanying person (21+):	\$250
– Accompanying person (12–20):	\$200
– Accompanying person (<12):	Free
– Delegate registration after 31 March 2018:	add \$50
– Delegate registration after 15 May 2018:	add further \$100

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

The fees include the Icebreaker, the mid-conference excursion, the Symposium Banquet, breakfast, lunch, morning/afternoon refreshments Monday through Friday and travel to breweries on Tuesday. Please register for the symposium through the IGS website. If you cannot do this, contact the IGS office directly at igsoc@igsoc.org. If payment by credit card is not possible, contact the IGS office to arrange for a bank transfer.

Please check whether you will require a visa to enter the USA. If you need an invitation letter, please contact the IGS office at igsoc@igsoc.org. The sooner you do this the more likely it is that your visa will be processed in time.





ACCOMPANYING PERSONS

The accompanying person's registration fee includes the Icebreaker, the Tuesday afternoon brewery excursion, the midconference excursion and the Symposium Banquet. **It does not include attendance at the presentation sessions.**

STUDENT AND EARLY-CAREER SUPPORT

We anticipate being able to fund airfare and registration for a limited number of early-career researchers (graduate students, postdocs, recent hires in permanent positions). Awards of full or partial scholarships will be given on a competitive basis. An announcement will be made when the early-career support budget is confirmed, and travel support applications will be posted at that time.

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 3 March 2018. Abstracts need to be submitted via the IGS website. Accepted abstracts will be posted on the Symposium's website. The Council of the International Glaciological Society will publish a thematic issue of the *Annals of Glaciology* (vol. 60 (2019), issue 78) on topics consistent with the Symposium themes. Participants are encouraged to submit manuscripts for this *Annals* volume. The deadline for submitting papers is 19 April 2018 and the call for papers is posted on <https://www.igsoc.org/annals/call4papers.html>.





PROGRAM

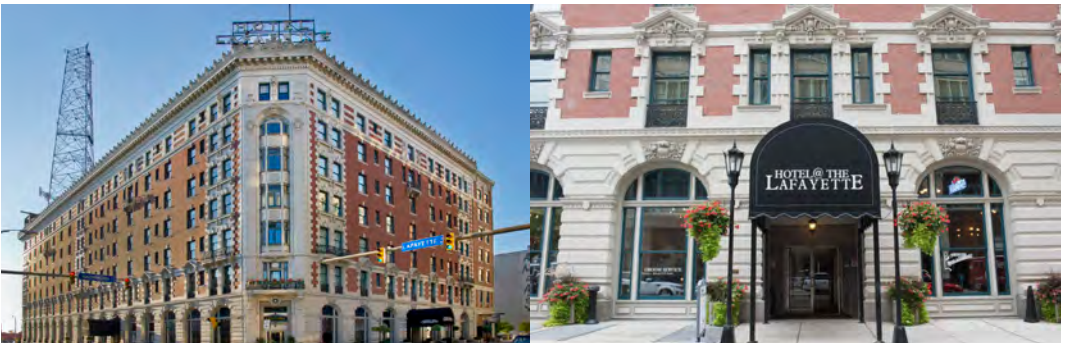
True to tradition, the symposium will include oral and poster sessions interlaced with ample free time to facilitate the interactions of the participants. Additional activities include an opening Icebreaker, a Banquet dinner and a trip to Niagara Falls during the mid-symposium Wednesday afternoon break (6 June). A post-symposium glacial geology and landscape excursion is also planned.

VENUE

The symposium will be held at the **Lafayette Hotel** in downtown Buffalo, in the heart of Buffalo's brewery district and within a mile of historic Canalside on Lake Erie. The 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 Icebreaker on Sunday 3 June will be held in the Crystal Ballroom, while the oral and poster sessions on Monday to Friday (4–8 June) will be held in the Marquis Ballroom. The hotel is located minutes from Shea's Performing Arts Center, Coca-Cola Field and the First Niagara Center. There are excellent restaurants just a short walk away and several hotels within walking distance.

LOCATION

Early summer in Buffalo is consistently pleasant, with warm weather on most days. 'The City of Good Neighbors' is home to about 259 000 Buffalonians, with over 1.13 million residents in the



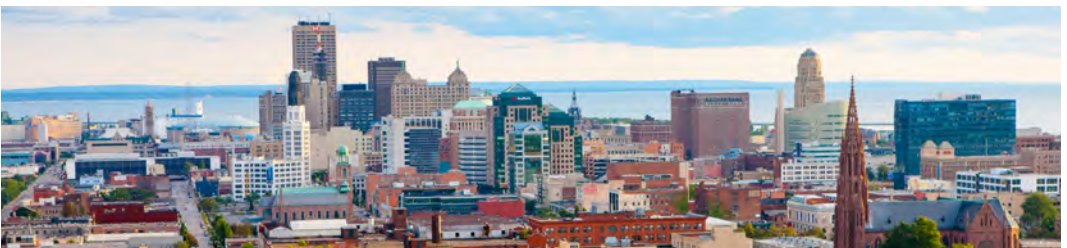


surrounding Buffalo–Niagara Falls metropolitan area. Indeed, it is the second-largest metropolitan area in New York State.

By the late 19th/early 20th century, the burgeoning grain, steel, and automobile industries had transformed Buffalo into a prominent trade center. Some of the greatest examples of the American architecture of this period, as well as Frederick Law Olmsted’s Buffalo Park system, make Buffalo an exciting destination. Buffalo is also home to the world’s oldest fireboat, the third-oldest Zoo in the USA, the historic site of Theodore Roosevelt’s Inauguration Ceremony and the Anchor Bar – the birthplace of the Buffalo chicken wing. The redeveloped waterfront of the former Erie Canal Harbor, Canalside, is a popular destination, with hundreds of events in the summer, including concerts, artisan markets and countless other activities. Located just 17 miles north-northwest of the city is Niagara Falls, one of the most popular tourist sites in the world, famed for its beauty and as a source of hydroelectric power.

ACCOMMODATION

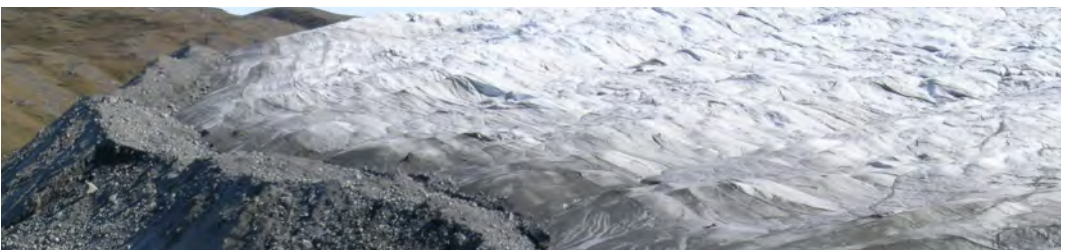
A number of hotels have provided group rates for our conference. You must contact these hotels and make the bookings yourself. To book and guarantee your room, please provide them with your credit card details at least 60 days prior to arrival. Use the codes provided below (different for each hotel) to secure your room. All hotels listed are located within walking distance of the conference venue. June is peak tourist season in the Buffalo–Niagara region. Therefore, we recommend that you book as early as possible.

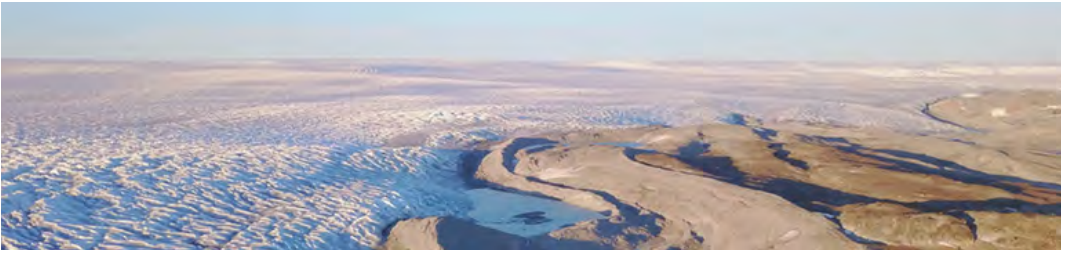




The following hotels are offering group rates for the IGS for 3 June arrival through 10 June departure. Please note that rates may vary depending on property and the specific dates requested.

- Embassy Suites, 200 Delaware Avenue, Buffalo, New York, 14202 (0.5 km to Lafayette Hotel), \$149 per night + tax single/double standard. Breakfast included. Use Code UBG for reservations. Phone: +1-716-842-1000.
Website: <http://embassysuites3.hilton.com/en/hotels/new-york/embassy-suites-by-hilton-buffalo-BUFESES/>
- Hilton Garden Inn, 10 Lafayette Square, Buffalo, New York, 14203 (next to Lafayette Hotel), \$159 per night + tax single/double. No self-parking available; valet parking is \$20 per night. Use group code UBGEO for reservations on phone – Hilton reservation line: +1-855-446-1178 or Hilton Garden Inn: +1-716-848-1000. Use www.buffalodowntown.hgi.com for online reservation. Before selecting the Check Rooms and Rates button, click the link underneath to ‘Add a Special Rate Code’ and enter the code UBGEO.
Website: <http://hiltongardeninn3.hilton.com/en/hotels/new-york/hilton-garden-inn-buffalo-downtown-BUFMSGI/>
- Holiday Inn Express, 601 Main Street, Buffalo, NY 14203 (0.5 km to Lafayette Hotel), \$119 per night + tax single/double. Breakfast included. Free high-speed internet. Hotel parking is available nearby at additional charge in parking garage. Use the block code UBG for reservations. Phone: +1-716-854-5500.
Website: <https://www.ihg.com/holidayinnexpress/hotels/us/en/buffalo/bufms/hoteldetail>





- Lafayette Hotel, 391 Washington Street, Buffalo, NY, 14203 (conference venue), \$169 per night + tax for a standard room and \$229 per night + tax for a one-bedroom suite. Breakfast included. Free internet. Valet parking is \$20 per night. For reservations call the hotel at +1-716-853-1505 to speak with Management and Guest Services and refer to 'University at Buffalo International Workshop' room block.
Website: <http://www.thehotellafayette.com/>

ICEBREAKER

The Icebreaker, will be held on Sunday 3 June 4:00–8:00 pm in the Crystal Ballroom of the Lafayette Hotel, the conference venue. Refreshments (cash bar) and finger food will be available from 5:00 pm to 7:00 pm. Delegates can also use this opportunity to complete their registration and collect their conference bag materials.

BANQUET

The Banquet will be held at the Hotel Henry on the evening of Thursday 7 June. Hotel Henry is a new, exciting urban retreat at the National Historic Landmark Richardson Olmsted Campus. The Banquet will be served buffet-style with a complimentary drink. A cash bar will be available and will require a valid government issued ID. Transportation will be provided between the symposium venue and the Hotel Henry.





MID-CONFERENCE FIELD TRIPS

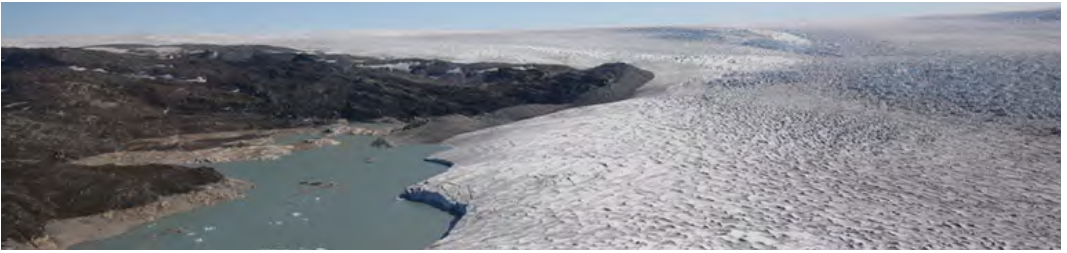
Brewery Tour:

Following a century of population decline and a stale economy, the city of Buffalo is currently undergoing a resurgence. A canary of this upturn in the city's vitality has been new microbreweries splashing up around town. On Tuesday 5 June after the poster session there will be an optional field trip to two of Buffalo's hottest new microbreweries: Resurgence and Big Ditch. The pre-dinner tour will end in downtown Buffalo within short walking distance of restaurants and the symposium venue.

Niagara Falls and Niagara Gorge:

On Wednesday 6 June, there will be a mid-conference field trip to Niagara Falls and the Niagara Gorge, departing at 1:30 pm from the symposium venue. Just 20 minutes drive from downtown Buffalo, the Falls has played a key role in the history of geology as a science. That history, along with the ice-sheet history of western New York State and the subsequent evolution of the Niagara Gorge, will be the focus of the excursion. The trip will include a visit to the American Falls (on the US side, no passport required) and a 2 mile (3.2 km) round-trip hike down to the river in the Niagara Gorge on a relatively well-maintained trail. Those who do not wish to hike into the gorge can relax at the top and enjoy the view. The trip will end at the symposium venue at 6 pm.





POST-CONFERENCE FIELD TRIP

Drumlin Fields and Wineries:

Organizer: Jason Briner (jbriner@buffalo.edu)

On Saturday 9 June an optional (separate fee) one-day field trip will be offered to tour New York's world famous drumlin field – and wineries! The Laurentide Ice Sheet generated spectacular glacial geology in New York during the last glaciation, and the drumlins in particular have been a well-studied enigma for more than a century. Not only is New York's terroir ripe for stunning subglacial features, it is also home to the Finger Lakes wine region, an important American Viticultural Area often compared to German wine regions along the Rhine. On this field trip we will be treated to a tasty blend of drumlins and wine.

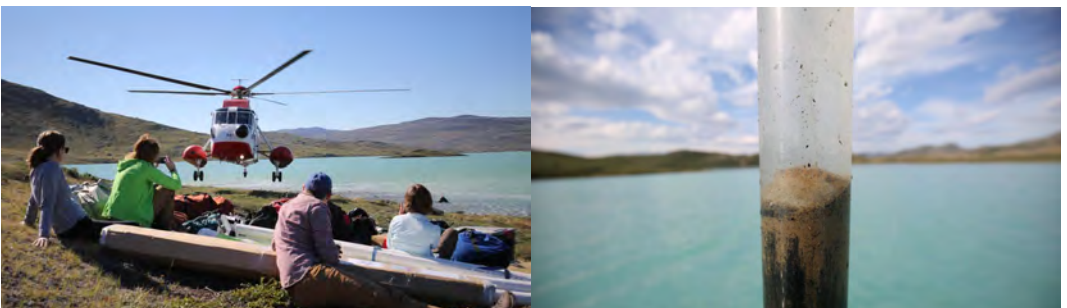
SYMPOSIUM ORGANIZATION

Magnús Már Magnússon (International Glaciological Society).

SCIENCE STEERING AND EDITORIAL COMMITTEE

Chief Editors: Jesse Johnson (University of Montana) and Cornelis van der Veen (University of Kansas).

Scientific Editors: Robert Anderson (University of Colorado), Mark Fahnestock (University of Alaska Fairbanks), Gwen Flowers (Simon Fraser University), Joel T. Harper (University of Montana), Toby Meierbachtol (University at Montana), Christian Schoof (University of British Columbia), Leigh Stearns (University of Kansas) and Andreas Vieli (University of Zürich).





LOCAL ORGANIZING COMMITTEE

Beáta Csathó (University at Buffalo (UB); Chair), Jason Briner (UB), Kristin Poinar (NASA/GSFC), Ted Scambos (National Snow and Ice Data Center), Elizabeth Thomas (UB).

Check the local website for further details:

<https://geohazards.buffalo.edu/conferences-and-workshops/igs-2018/>

IMPORTANT DATES

Timescales, Processes and Glacier Dynamics

Opening of online abstract submission:	1 February 2018
Opening of online registration:	1 March 2018
Abstract submission deadline:	3 March 2018
Notification of abstract acceptance:	12 March 2018
Early registration deadline:	31 March 2018
Deadline for full refund:	30 April 2018
Deadline for refund on a sliding scale:	15 May 2018
Late registration surcharge starts:	16 May 2018
Symposium starts:	3 June 2018

Annals of Glaciology volume 60, issue 78

Manuscript submission deadline:	19 April 2018
Final revised papers deadline:	22 July 2018

The Call for papers for the *Annals of Glaciology* is posted on <https://www.igsoc.org/annals/call4papers.html>. 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 early 2019.



INTERNATIONAL GLACIOLOGICAL SOCIETY

International Symposium on
Glacial Erosion and Sedimentation



Pyle Center
Madison, Wisconsin, USA
12–17 May 2019

Co-sponsored by:

- ❄ Department of Geoscience, University of Wisconsin-Madison
- ❄ Wisconsin Geological and Natural History Survey

FIRST CIRCULAR
December 2017
<http://www.igsoc.org/symposia/2019/madison>

The International Glaciological Society will hold an International Symposium on 'Glacial Erosion and Sedimentation' in 2019. The symposium will be held at the Pyle Center in downtown Madison, Wisconsin, USA on 12–17 May 2019

THEME

Since the last IGS symposium on glacial erosion and sedimentation in Reykjavik in 1995, techniques for characterizing these processes and their associated landscapes and sediments have improved markedly. Diverse remote-sensing techniques measure subaerial and submarine landforms at extraordinarily high resolution, and geophysical methods reveal evolving subglacial landscapes and processes. New and refined geochronological techniques better constrain rates of erosion and deposition. Increased computer power allows models that address coupled processes of glacier flow, bedrock erosion, sediment transport and tectonic change over long time and length scales. New field and laboratory methods provide insight into the mechanics and kinematics of sediment-transport processes and their manifestations in glacial sediments.

Interesting and stubbornly enduring questions accompany these advances. How can glacial sediments and landforms inform us about glacier dynamics and how are glacier dynamics modulated by sediment-transport processes? How can large-scale models of glacial landscape evolution better approximate the small-scale processes that drive erosion and sediment transport? How can past climate variability be inferred from glacial sediments and landforms? How have rates of glacial erosion and sedimentation changed through time? How are drumlins and other subglacial bedforms sculpted, and what data can provide definitive hypothesis tests?

SUGGESTED TOPICS

We seek papers and presentations on processes and products of glacial erosion and sedimentation and their relationships to glacier dynamics. Key focus areas include (but are not limited to):

1. Processes and patterns of glacial erosion, sediment transport and deposition
2. Glacial history and dynamics, as inferred from sediments and landforms
3. Sediment transport feedbacks on glacier dynamics
4. Models of glacial landscape evolution
5. Rates of glacial erosion and sedimentation
6. Origins of glacial landforms
7. Geophysical studies of glacial landforms and subglacial processes
8. Climate signals of glacial sediments
9. Hazards associated with glacial sedimentation and erosion.

PROGRAM

True to tradition, the symposium will include oral and poster sessions, interlaced with ample free time to facilitate the interactions of the participants. Additional activities will include an opening icebreaker, a banquet dinner and a trip to the Kettle Moraine region during the mid-symposium afternoon break.

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 12 January 2019. Accepted abstracts will be posted on the Symposium's 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. Participants are encouraged to submit manuscripts for this *Annals* volume.

SYMPOSIUM ORGANIZATION

Magnús Már Magnússon (International Glaciological Society).

SCIENCE STEERING AND EDITORIAL COMMITTEE

Co-chairs: Neal Iverson (Iowa State University) and Lucas Zoet (University of Wisconsin-Madison).

Scientific Editors: David Egholm, Gwenn Flowers, Neal Iverson, Mark Johnson, Chris Stokes, Martin Truffer, Lucas Zoet.

LOCAL ORGANIZING COMMITTEE

Lucas Zoet, Dave Mickelson, Elmo Rawling, Shaun Marcott, Carrie Jennings and Urs Fischer.

VENUE

The symposium will be held at the Pyle Center in downtown Madison, on the shores of Lake Mendota. The Pyle Center is just blocks from State Street, where there are numerous eating venues, and is less than a five minute walk from the Memorial Union Terrace, which has a lakeside sitting area and beer garden.

LOCATION

Madison is the second largest city in Wisconsin with a population of more than 208 000 people, and is surrounded by the classic geomorphology of the Green Bay Lobe of the Laurentide ice sheet.

The city is the home of the University of Wisconsin–Madison and the State Capitol and offers a large array of activities. Most of downtown Madison sits on an isthmus between Lake Mendota and Lake Monona. The University's Memorial Union is located on Lake Mendota and serves as a popular gathering place for people to socialize and listen to live music. State Street, the heart of downtown Madison, is alive with activity every day. Connecting the Capital to the University, State Street features specialty shops, art galleries, cafes and restaurants, theatres, museums and more than 200 shops.

Madison is commonly considered the bike capital of the Midwest with over 100 miles of bike paths, including paths to the Pyle Center. B-cycle stations are located throughout the city for hourly or daily bike checkout.

FURTHER INFORMATION

If you wish to attend the symposium, please register your interest online at <http://www.igsoc.org/symposia/2019/madison/>

The Second Circular will give further information about accommodation, the scientific programme, additional activities, 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, <http://www.igsoc.org/symposia/2019/madison/> as it becomes available. A local website will open in 2018.



INTERNATIONAL GLACIOLOGICAL SOCIETY

International Symposium on
Five Decades of Radioglaciology



IGS 2019
Five Decades of
Radioglaciology

Stanford University
Stanford, California, USA
23–28 June 2019

FIRST CIRCULAR
December 2017
<http://www.igsoc.org/symposia/2019/stanford>

The International Glaciological Society will hold an International Symposium on 'Five Decades of Radioglaciology' in 2019. The symposium will be held at Stanford University in Stanford, California, USA on 24–28 June 2019

THEME

Radio echo sounding is a powerful geophysical approach for directly characterizing the subsurface conditions of terrestrial and planetary ice masses at the local, regional and global scales. As a result, a wide array of orbital, airborne, towed and in situ instruments, platforms and data analysis approaches for radar sounding have been developed, applied or proposed. Terrestrially, airborne radar sounding data has been used in glaciology to observe ice thickness, basal topography, englacial layers and for more than five decades. More recently, it has also been exploited to estimate the extent and configuration of subglacial water, the ice sheet surface, the geometry of subglacial bedforms, the spatial variation of melt, temperature, and the transition between frozen and thawed bed. Planetary radar sounders have been used or are planned to observe the subsurface and near-surface conditions of Mars, Earth's Moon, comets and the icy moons of Jupiter. These instruments provide critical subsurface context for surface sensing, particle, and potential-field instruments in planetary exploration payloads. This symposium will discuss advances in radar sounding systems, mission concepts, signal processing, data analysis, modeling and scientific interpretation.

SUGGESTED TOPICS

We seek papers and presentations that advance the understanding of radar sounding and its use in physical glaciology. Key focus areas include (but are not limited to):

1. **Radar systems:** development, performance and platforms
2. **Data:** intercomparison, validation and release
3. **Radar processing:** propagation, inversion and automation
4. **Englacial structure:** layers, deformation and accretion bodies
5. **Attenuation:** near surface properties, temperature and chemistry
6. **Bed conditions:** topography, roughness, thermal state and hydrology
7. **Interpretation:** comparing observations with modeling and theory.

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 an excursion during the mid-symposium afternoon break.

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 1 February 2019. Accepted abstracts will be posted on the Symposium's 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. Participants are encouraged to submit manuscripts for this *Annals* volume.

SYMPOSIUM ORGANIZATION

Magnús Már Magnússon (International Glaciological Society).

SCIENCE STEERING AND EDITORIAL COMMITTEE

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VENUE

Stanford University is one of the world's leading research universities. It is known for its entrepreneurial character, drawn from the legacy of its founders, Jane and Leland Stanford, and its relationship to Silicon Valley. Areas of excellence range from the humanities to social sciences to engineering and the sciences. Stanford is located in California's Bay Area, one of the most intellectually dynamic and culturally diverse areas of the USA.

LOCATION

Stanford and the adjacent city of Palo Alto are less than an hour (by car or train) from the city of San Francisco, less than an hour from beaches in Santa Cruz or Half Moon Bay, less than two hours from the wine regions of Napa and Sonoma, and less than four hours from National Parks in Yosemite or Lake Tahoe. With June weather averaging highs of 78° and lows of 52°F (26° and 11°C), 0.08 in (2 mm) of precipitation, and numerous pedestrian and bike paths along the bay and in the hills, the greater Palo Alto area is ideal for hiking, biking and other outdoor activities. The 8000 acre (32.375 km²) campus is a few blocks away from the suburban garage where Hewlett and Packard created their audio oscillator, cited as the 'birthplace of Silicon Valley' in the national register of historic places. The region is also home to the headquarters of Apple, Google, Facebook, Netflix, Cisco, Adobe, Intel, Tesla, Uber and numerous other companies and startups pushing the frontiers of scientific and technological innovation.

FURTHER INFORMATION

If you wish to attend the symposium, please register your interest online at

<http://www.igsoc.org/symposia/2019/stanford/>

The Second Circular will give further information about accommodation, the scientific programme, additional activities, preparation of abstracts and final papers. Members of the International Glaciological Society, as well as all those who have pre-registered, will automatically receive notification of the Second Circular.

Information will also be updated on the IGS conference website, <http://www.igsoc.org/symposia/2019/stanford/> as it becomes available. A local website will open later in 2018.



Glaciological diary

** IGS sponsored

* IGS co-sponsored

2018

3–5 January 2018

QRA Annual Discussion Meeting

Plymouth, UK

Website: <https://www.plymouth.ac.uk/whats-on/qra-annual-discussion-meeting-2018>

Contact: Caroline Clason <caroline.clason@plymouth.ac.uk>

8–12 January 2018

4th International Conference on the Physics and Chemistry of Ice

Zurich, Switzerland

Website: <http://indico.psi.ch/event/PCI2018>

Contact: Thorsten Bartels-Rausch <thorsten.bartels-rausch@psi.ch>

9–11 January 2018

Snow Measurement Field School

Fraser, Colorado, USA

Website: <http://cuahsi.memberclicks.net/message2/link/0d746cfd-b984-45ba-97ab-9da13705b52c/9>

15–18 January 2018

Fifth International Symposium on Arctic Research (ISAR-5)

Tokyo, Japan

Website: <https://jcar.org/isar-5/>

22–24 January 2018

Workshop on the dynamics and mass budget of Arctic glaciers/IASC Network on Arctic Glaciology Annual Meeting

Obergurgl, Austria

Contact Thorben Dunse <thorben.dunse@geo.uio.no>

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

8–11 February 2018

Snow Microwave Radiative Transfer model training workshop

Col du Lautaret, France

Contact Ghislain Picard <ghislain.picard@univ-grenoble-alpes.fr> or Melody Sandells <melody.sandells@coresscience.co.uk>

11–16 February 2018

Ocean Sciences Meeting 2018

Portland, Oregon, USA

Website: <https://www.arcus.org/sites/all/modules/civicrm/extern/url.php?u=3981&qid=263607>

11–17 February 2018

4th Snow Science Winter School

Col du Lautaret, France

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

12–15 February 2018

International Conference on Snow Hydrology (SnowHydro18)

Heidelberg, Germany

Website: <http://www.geog.uni-heidelberg.de/hydro/snow2018.html>

21–23 February 2018

Workshop on Antarctic Surface Hydrology and Future Ice-shelf Stability

Lamont–Doherty Earth Observatory, Palisades, New York, USA

Contact Frances Simpson <fsimpson@ldeo.columbia.edu> by 8 January

1–2 March 2018

Alpine Glaciology/Glaciologist Meeting

Chamonix, France

Contact: Christian Vincent <christian.vincent@univ-grenoble-alpes.fr>

14–19 March 2018

****International Symposium on Cryosphere and Biosphere**

Kyoto, Japan

Contacts: Secretary General, IGS

Professor Nozomu Takeuchi, Chiba

University, Chiba, Japan <ntakeuch@faculty.chiba-u.jp>

21–23 March 2018

Taking the Temperature of the Antarctic Continent: Workshop on Antarctic geothermal heat flux

Hobart, Tasmania, Australia

First circular as PDF: http://www.igsoc.org/symposia/ant_ghf_wkshp_firstcirc1.pdf

25–29 March 2018

27th International Polar Conference

Rostock, Germany

First circular as PDF: http://www.dgp-ev.de/pdf-2017/International-Polar-Conference-2018_First_Circular.pdf

8–13 April 2018

European Geosciences Union General Assembly 2018

Vienna, Austria

Website: <https://www.egu.eu/>

9–12 April 2018

Arctic System Change Workshop

Boulder, Colorado, USA

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

17–27 April 2018

Second Polar Prediction School 2018

Abisko Scientific Research Station, Sweden

Website: <http://www.apecs.is/events/upcoming-event-highlights/polar-prediction-school-2018.html>

25–27 April 2018

Workshop on Cryospheric Extremes

Helsinki, Finland

Website: <https://iasc.info/outreach/news-archive/384-announcement-of-workshop-on-cryospheric-extremes-helsinki-finland-25-27-april-2018>

2–4 May 2018

International Conference on Geology and Earth Sciences

Rome, Italy

Website: <http://http://geoscience.madridge.com/>

7–9 May 2018

5th Polar Prediction Workshops

Montreal, Canada

Contact Amélie Bouchat <amelie.bouchat@mail.mcgill.ca>

10–19 May 2018

2nd SCAR Summer School on Polar Geodesy

Ladozhskoe Ozero, Russia

Website: <https://www.polarforschung.de/2nd-scar-summer-school-on-polar-geodesy/>

14–17 May 2018

1st Tvärminne Polar Microbes Symposium

Helsinki, Finland

Contact: Eeva Eronen-Rasimus <eeva.eronen-rasimus@ymparisto.fi>

Website:

<https://www.arcus.org/sites/all/modules/civicrm/extern/url.php?u=6970&qid=857595>

20–24 May 2018

Japan Geophysical Union Meeting

Tokyo, Japan

Website: http://www.jpogu.org/meeting_e2018/

29 May–9 June 2018

Arctic Field Summer School 2018: Arctic Coastal Environments in Rapid Transition

Utqiagvik (Barrow), Alaska, USA

For US-based graduate students only

Contact Tohru Saito <tsaito@alaska.edu>

3–8 June 2018

****International Symposium on Timescales, Processes, and Ice Sheets Changes**

Buffalo, NY, USA

Contacts: Secretary General, IGS

Beáta Csathó; University at Buffalo, NY, USA

<bcsatho@buffalo.edu>

4–9 June 2018

28th IAHR Symposium on Ice

Vladivostok, Russia

Contact: Tatiana Uvarova <searay@yandex.ru>

5–9 June 2018

75th Eastern Snow Conference

College Park, Maryland, USA

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

5–15 June 2018

University of Alaska, Fairbanks: Fifth International Summer School in Glaciology

McCarthy, Alaska, USA

Website: <https://glaciers.gi.alaska.edu/courses/summer-school/2018>

11–12 June 2018

Ice Sheet System Model Sea-Level Workshop

University of Hawaii, Manoa, Hawaii, USA

Website: <https://issm.jpl.nasa.gov/issmworkshop2018/>

15–26 June 2018

POLAR2018 – the SCAR and IASC/ASSW Conference

15–18 June SCAR and IASC/ASSW Business & Satellite Meetings

19–23 June SCAR/IASC Open Science Conference

24–26 June SCAR Delegates Meeting & 2018

Arctic Observing Summit

Davos, Switzerland

Website: <http://www.polar2018.org/>

Contact: Anja Schilling Hoyle, conference

manager <polar2018@slf.ch>

23–24 June 2018

Permafrost Young Researcher Network Workshop

Chamonix, France

EUCOP website: <https://eucop2018.sciencesconf.org/>

23 June–1 July 2018

5th European Conference on Permafrost (EUCOP)

Chamonix, France

Website: <https://eucop2018.sciencesconf.org/>

13–17 August 2018

**CESM (Community Earth System Model)
Polar Modeling Workshop**

Boulder, Colorado, USA

Website: <http://www.cesm.ucar.edu/events/workshops/2018PMWS/>

4–5 September 2018

****International Glaciological Society British
Branch Meeting**

University of Exeter, Exeter, UK

Contact: Anna Le Brocq <a.lebrocq@exeter.ac.uk>

24–29 September 2018

**Symposium: 25 years of Progress in Radar
Altimetry**

Ponta Delgada, São Miguel Island, Azores
(Portugal)

Contact: Jérôme Benveniste <jerome.benveniste@esa.int>

9–11 October 2018

2nd Arctic Biodiversity Congress

Rovaniemi, Finland

Website: <https://www.arcticbiodiversity.is/congress>

Contact: CAFF <caff@caff.is>

24–26 October 2018

****International Glaciological Society Nordic
Branch Meeting**

The Arctic Centre, Rovaniemi, Finland

Contact: Rupert Gladstone

<rupertgladstone1972@gmail.com>

2019

12–17 May 2019

****International Symposium on Erosion and
Sedimentation**

Madison, Wisconsin, USA

Contacts: Secretary General, IGS

Neal Iverson <niverson@iastate.edu>

24–28 June 2019

****International symposium on Five Decades
of Radioglaciology**

Stanford, California, USA

Contacts: Secretary General, IGS

Dustin Schroeder <Dustin.M.Schroeder@stanford.edu>

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>

August 2019

****International Symposium on Sea Ice**

Winnipeg, Manitoba, Canada

Contacts:

Secretary General, IGS

David Barber University of Manitoba <David.Barber@umanitoba.ca>

22–27 September 2019

****International Symposium on Snow and
Avalanches**

Manali, India

Contact: Secretary General, IGS

2020

Late August/early September 2020

****International Symposium on Ice Stream
Dynamics**

Durham, UK

Contacts: Secretary General, IGS

Chris Stokes <c.r.stokes@durham.ac.uk>

2021

Summer 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>

September 2021

****International Symposium on Southern
Hemisphere Glaciers under Pressure:**

**subglacial lakes, subaquatic environments,
calving glaciers and climate**

Valdivia, Chile

Contacts: Secretary General, IGS

Andrés Rivera, Centro de Estudios Científicos,
arivera@cecs.cl

2022

June 2022

****International Symposium on Maritime
Glaciers**

Juneau, Alaska, USA

Contacts: Secretary General, IGS

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International Glaciological Society

Secretary General M.M. Magnússon

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President	D.R. MacAyeal	2014–2017	2010
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	S. Sugiyama	2014–2017	2011
Immediate Past President	E. Brun	2014–2017	2008
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	*J.K. Hutchings	2015–2018	2015
	*M. Ivanov	2016–2019	2016
	*Kang Schichang	2015–2018	2015
	*A. Mackintosh	2015–2018	2015
	*M. Montagnat	2014–2017	2014
	*D. Notz	2016–2019	2016
	*A. Pope	2016–2019	2016
	A. Rivera	2014–2017	2014
	*B. Stenni	2014–2017	2014
	*C. Tijm-Reijmer	2015–2018	2015
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	P. Langhorne		
	C Ritz		

*First term of service on the Council

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Nominations	E. Wolff (Chairman)
Publications	C.L. Hulbe (Chairman)

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1963 G. Seligman	1989 H. Oeschger	2001 G.K.C. Clarke
1967 H. Bader	1989 W.F. Weeks	2003 K. Hutter
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1972 J.W. Glen	1990 A. Higashi	2007 L.G. Thompson
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1974 S. Evans	1993 L. Lliboutry	2011 A. Iken
1976 W. Dansgaard	1995 A.J. Gow	2012 D.E. Sugden
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1982 M. de Quervain	1997 S.J. Johnsen	
1983 W.O. Field	1998 C. Lorius	
1983 J. Weertman	1999 C.F. Raymond	
1985 M.F. Meier	2000 S.C. Colbeck	
1986 G. de Q. Robin	2001 G.S. Boulton	

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

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1997 D.R. MacAyeal	2013 J.W. Glen
1998 G.K.C. Clarke	2013 A. Weidick
1999 J.A. Heap	2016 T. Chinn
2003 C.S.L. Ommanney	2016 E.M. Morris
2010 T.H. Jacka	2017 J.M. Palais

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International Glaciological Society

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Membership is open to all individuals who have a scientific, practical or general interest in any aspect of snow and ice and benefits include online access to the *Journal* and *Annals of Glaciology* and *ICE*. To join please see our website at www.igsoc.org/membership.

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ICE

Editor: M.M. Magnússon (Secretary General)

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