1210. Evaluation of empirical approaches for modeling glacier ablation under volcanic tephra covers

Rebecca Möller, Peter Kukla, Marco Möller, Christoph Schneider

Presentation type requested: Poster
Presenting author: Möller
Correspondence: rebecca.moeller@geo.rwth-aachen.de

Snow and ice ablation is known to be influenced by supraglacial debris coverage. Various modeling approaches have been developed to calculate glacier melt beneath the covering material. Most of these methods target on the influence of moraine debris or of deposition of atmospheric black carbon. They are designed to cope with meter or sub-millimeter scale thicknesses of the material layer on top of the ice. The intermediate range of centimeter to decimeter scale is rarely represented. However, fallout from volcanic eruptions in glacierized regions often results in the deposition of tephra of such intermediate thickness. Based on a field experiment on Svinafellsjökull, Iceland, we present different approaches for incorporation of tephra coverage in semi-empirical ablation models. Ablation under a set of artificial plots with volcanic tephra top-layers of varying thickness was continuously monitored, as were air temperature and shortwave radiation. The data were used to calibrate different types of ablation models. In a first step, the two traditional types of glacier ablation models, i.e. temperature-index model and temperature-net shortwave radiation index model, are modified to incorporate the influences of supraglacial tephra coverage. This is realized by varying the empirical parameters of the models according to a function of tephra thickness. In a second step, the models are modified to also account for measured thermal conductivity of the tephra. We analyze the modeling performance of the different approaches. Results show that melt decreases exponentially with increasing thickness of the tephra cover and that this relationship can be reliably reproduced by all of the models considered. We observe an increasing performance with increasing model complexity. This suggests that the incorporation of thermal-conductivity information into index-based ablation models is a valuable measure to increase the accuracy of calculating ablation underneath of tephra deposits.

1211. Evolution of 29 Svalbard glaciers over the 21st century

Marco Möller, Francisco Navarro, Alba Martin-Español, Roman Finkelnburg

Presentation type requested: Oral
Presenting author: Möller
Correspondence: marco.moeller@geo.rwth-aachen.de

Sea level rise is one of the major challenges for mankind in the oncoming decades. The Arctic glaciers and ice caps are known to play a major role in this respect due to their large surface area and their location in the region of highest predicted air temperature increases over the 21st century. One of the most heavily glacierized archipelagos in the Arctic is Svalbard. It holds about 36,000 km² of glaciers and ice caps. What is known about the future evolution of Svalbard's ice masses so far suffers rather high uncertainties as future mass balance and volume change assessments have only been performed as part of global-scale studies.

We here present a high resolution modelling study of the climatic mass balance and related changes in ice volume for 29 individual glaciers spread throughout Spitsbergen, the largest island of the archipelago. Our model calculates glacier mass balance and area/volume changes using a temperature-index approach in combination with a surface elevation change parameterization. The initial glacier topographies and volumes have been assessed from extensive ground penetrating radar measurements that have been carried out in recent years. The calculations are performed for the 21st century and are forced by statistically downscaled output of ten different global circulation models representing the four SRES RCP scenarios 2.6, 4.5, 6.0 and 8.5.

Results indicate a strongly decreasing ice volume over the 21st century, especially for smaller glaciers. However, substantially different magnitudes of ice volume evolution are evident over the entire set of glacier size classes and dependent on the climate-change scenarios used. Based on statistical upscaling of the results from our individual glaciers we are able to extrapolate them to the entire set of smaller ice bodies on Spitsbergen and present an estimate of 21st century sea level rise originating from these glaciers.

1222. Drivers of movement at Sólheimajökull, Iceland, examined using a terrestrial time-lapse approach

Penelope How, Peter Wynn, Mike James, Hugh Tuffen

Presentation type requested: Oral
Presenting author: How
Correspondence: p.how@ed.ac.uk

The presence of a subglacial volcanic system is suspected to introduce an additional point of bottom-up forcing at Sólheimajökull, an outlet of the Mýrdalsjökull ice cap. Here, we present a new approach to terrestrial time-lapse photogrammetry, which has been used to evaluate the drivers of movement at Sólheimajökull. A non-specialised time-lapse set up collected data over two consecutive summers, and the results were compared to secondary data from the nearby monitoring station, Jökulsá á Sólheimasandi. A 12-hour time-lapse interval proved effective in measuring glacier movement. Top-down forcing is the prevailing driver of movement, based on links between movement, surface melt and precipitation. Abnormal water conductivity data and past observations suggest that geothermal basal melting is an additional influence, producing a solute-rich injection of melt into the subglacial system and promoting basal lubrication. Supporting evidence is inconclusive from the time-lapse analysis, however Sólheimajökull's response to the recent activity at Katla may offer some enlightenment in the near future.

1322. A 3-years full-scale mechanical ice deformation test from the artificial drainages of the Tête Rousse cavity

Olivier Gagliardini, Jean Krug, Fabien Gillet-Chaulet, Gaël Durand, Adrien Gilbert, Julien Brondex, Emmanuel Thibert, Christian Vincent

Presentation type requested: Oral
Presenting author: Gagliardini
Correspondence: olivier.gagliardini@ujf-grenoble.fr

History of the city of Saint Gervais Mont Blanc, in the french Alps, is deeply marked by the 1892 disaster which killed 175 persons, after the unexpected release of 100000 m3 of water contained in a hidden cavity inside the Tête-Rousse glacier. During summer 2010, a pressurised water-filled cavity of at least 50000 m3 was again discovered within the glacier. To avoid a repetition of the 1892 disaster, an unprecedented initiative has been risen up to drain the water cavity under this high altitude glacier. This procedure was further repeated in Autumns 2011 and 2012 since the cavity was permanently refiled in-between two drainages. However, as the cavity was decreasing in size due to the creep of ice when the water level was low, the total water volume drained out of the cavity was decreased each Autumn.

At the same time, a dense network of stakes was deployed to survey the glacier surface displacements above the cavity during the pumping. Record of the water level evolution within the cavity together with the surface displacement measurements along an almost 3-years period constitute a very well documented full-scale experiment to characterise ice deformation. When the water level is low, the cavity is shrinking, whereas when the cavity is full of pressurised water, the cavity is growing. Because of the density ratio between ice and water, closing is approximately 9 time faster than opening.
This dataset is completed by recently acquired surface and bedrock DEMs, as well as an image of the cavity geometry from sonar and radar measurements. This unique dataset was then used to constraint the finite-element ice flow model Elmer/Ice and perform transient simulations over the 3-years period. Both the evolution of the surface displacements and of the cavity volume are compared to measurements. We show the importance of accounting for ice damage to reproduce the observed surface displacements. Such modelling could present an interest in the risk assessment of jökulhlaup events. Indeed, the flux of melt water transferred to the lake could be inferred from the observed changes in the glacier surface elevation at the caldera and above the lake.

1330. Geodetic and direct mass balance of glaciers in Jotunheimen, southern Norway

Liss Marie Andreassen

Presentation type requested: Oral
Presenting author: Andreassen
Correspondence: lma@nve.no

The Jotunheimen massif is the highest area in mainland Norway. Direct surface mass balance has been measured at Storbreen since 1949, and Hellstugubreen and Gråsubreen since 1962. These three mountain glaciers are reference glaciers of the World Glacier Monitoring Service. Four more glaciers in Jotunheimen were measured for shorter periods in the 1960/1970s. Moreover, measurements started on a small ice patch in 2010. The glaciers have been mapped repeatedly since measurements began, latest by laser scanning in 2009 and 2011. The geodetic method is used to calculate the cumulative surface mass balance to assess changes for glaciers without direct measurements and for an independent validation of the direct field method. In this study the mass balance results are presented and evaluated. Measurements reveal a remarked mass balance gradient in this region with smaller mass turnover towards east. All three long term glaciers have had a cumulative mass deficit since measurements began; over 1962-2013 the mean surface mass balance was –0.3 m w.e./a. The mass deficit has accelerated over the past decade, and the mean mass balance over 2001-2013 was –0.8 m w.e./a. Storbreen has lost about 1/5 of its volume since measurements began in 1949. Results for the reference glaciers reveal that the geodetic and direct measurements are in reasonable agreement, also for the latest mapping period 1997-2009, although discrepancies occur in some periods. Calibration and correction of the direct records with the geodetic results may be appropriate for some periods.

1331. A 1-D coupled model for ice shelf-ocean interaction

Yemeng Li, Liyun Zhao, John Moore

Presentation type requested: Poster
Presenting author: Li
Correspondence: zhaoliyun@bnu.edu.cn

Interaction between ice shelves and the ocean is important for both the mass change of ice sheet and deep ocean properties. Circulation and mixing of ice shelf meltwater and sea water are driven by thermohaline differences which result from the mass and energy exchange at the ice shelf-ocean interface. This process has been described by a one-dimensional plume model. Since melting beneath an ice shelf is a source of buoyancy to the plume and also thins the ice shelf at the same time, we coupled the 1D plume model with 2D full-Stokes model on simple ice shelf flow lines to theoretically investigate the interaction between an ice shelf and the plume near grounding line, the distribution and rate of basal melting beneath an ice shelf and how these could respond to the changes in the ocean temperature. This is our first step of coupling ice sheet model with ocean models.

1334. Analysis of factors controlling inter-annual variability and trends in surface melt over Greenland

Martina Schäfer, Ilona Välisuo, Timo Vihma, Roberta Pirazzini

Presentation type requested: Oral
Presenting author: Schäfer
Correspondence: martina.schafer@fmi.fi

Melt over Greenland and its effects on ice sheet dynamics and sea level rise have been addressed in numerous studies. Nevertheless, deeper apprehension between weather conditions that drive the melt, its intensity and extent, is still to be acquired. This study focuses on the understanding of such links between weather conditions and extensive melt.

Essential variables influencing the number of meltdays during each meltseason (defined as March to August) are identified and studied with statistical methods. For this purpose we present Greenland ice surface temperature (MODIS IST record), cloud cover and heat fluxes based on reanalysis (NCEP-CFSR), air mass trajectories calculated with the HYSPLIT model based on NCEP-CFSR wind fields, albedo from MODIS and CLARA (AVHRR) data, large-scale circulation indices, as well as reanalysis data (ERA-Interim) on upper-tropospheric jet streams for the period 2000 to 2013.

For each point of a regular Lat/Lon grid, which covers the whole Greenland ice-sheet, monthly values of these variables are related to the yearly number of meltdays. We define different regions designated by their inter-annual variability of number of meltdays and focus on our results in the area of high melt at the east coast.

1335. Glacier volume and area change by 2050 in high mountain Asia

Liyun Zhao, Ran Ding, John C. Moore

Presentation type requested: Oral
Presenting author: Zhao
Correspondence: john.moore.bnu@gmail.com

We estimate individual area and volume change by 2050 of all 67028 glaciers, with a total area of 122,969 km2, delineated in the Randolph Glacier Inventory 2.0 of high mountain Asia (HMA). We used the 25 km resolution regional climate model RegCM 3.0 temperature and precipitation change projections forced by the IPCC A1B scenario. Glacier simulations were based on a novel surface mass balance-altitude parameterization fitted to observational data, and various volume-area scaling approaches using Shuttle Radar Topography Mission surface topography of each individual glacier. We generate mass balance-altitude relations for all the glaciers by region using nearest available glacier measurements. Equilibrium line altitude (ELA) sensitivities to temperature and precipitation change vary by region based on the relative importance of sublimation and melting processes. We also made simulations with mass balance tuned to match satellite observations of glacier thickness changes in HMA from 2003-2009. Net mass loss is half as much using the tuned model than using just glaciological calibration data, suggesting the representativity of benchmark glaciers is a larger source of uncertainty in future HMA contributions to sea level rise than errors in glacier inventories or volume-area scaling. Both models predict that about 35% of the glaciers in Karakoram and the northwestern Himalaya are advancing, which is consistent with the observed slight mass gain of glaciers in these regions in recent years. However, we find that 76% of all the glaciers will retreat, most of which are of the maritime type. We project total glacier area loss in high mountain Asia in 2050 to be 22% (in the tuned model) or 35% (un-tuned) of their extent in 2000, and they will contribute 5 mm (tuned model) to global sea level rise.

1336. Arctic sea ice and atmospheric circulation under the GeoMIP G1 scenario

John Moore

Presentation type requested: Oral
Presenting author: Moore
Correspondence: john.moore.bnu@gmail.com

We analyze simulated sea ice changes in eight different earth system models that have conducted experiment G1 of the Geoengineering Model Intercomparison Project (GeoMIP). The simulated response of balancing abrupt quadrupling of CO2 (abrupt4xCO2) with reduced shortwave radiation successfully moderates annually averaged Arctic temperature rise to about 1°C, with modest changes in seasonal sea ice cycle compared with the pre-industrial control simulations (piControl). Changes in summer and autumn sea ice extent are spatially correlated with temperature patterns, but much less in winter and spring seasons. However there are changes of ±20% in sea ice concentration in all seasons, and these will induce changes in atmospheric circulation patterns. In summer and autumn, the models consistently simulate less sea ice relative to pre-industrial simulations in the Beaufort, Chukchi, East Siberian and Laptev Seas, and some models show increased sea ice in the Barents/Kara Seas region. Sea ice extent increases in the Greenland Sea, particularly in winter and spring, and is to some extent associated with changed sea ice drift. Decreased sea ice cover in winter and spring in the Barents Sea is associated with increased cyclonic activity entering this area under G1. In comparison, the abrupt4xCO2 experiment shows almost total sea ice loss in September and strong correlation with regional temperatures in all seasons consistent with open ocean conditions. The tropospheric circulation displays a Pacific North America (PNA) pattern-like anomaly with negative phase in G1-piControl and positive phase under abrupt4xCO2-piControl.

1337. Glacier-related incidents in Norway

Miriam Jackson, Galina Ragulina

Presentation type requested: Oral
Presenting author: Jackson
Correspondence: mja@nve.no

A new report has just been released giving an overview of all jøkulhlaups, ice avalanches and mountaineering accidents related to glaciers in Norway.
Many glaciers in Norway can cause catastrophic events such as jøkulhlaups (Glacier Lake Outburst Floods) or icefalls. Jøkulhlaups have occurred from 20 different glaciers, and there are a further eight glaciers where such an event could occur. Previous floods have caused extensive damage, but the event can be beneficial, such as when meltwater drains into a hydropower reservoir giving a hydropower company a sudden bonus of millions of kroner. Over the last few years the number of jøkulhlaups has increased, due to glaciers thinning and creating glacier-dammed lakes.
Ice avalanches tend to be a more localised problem than jøkulhlaups but can also be serious and are responsible for at least eight fatalities in Norway. Some of these were avoidable, such as the case of two German tourists who stood too close to Nigardsbreen in August and were killed when ice fell on them. However, a 1986 incident when three Dutch tourists were killed was harder to avoid as the ice volume was much larger, several hundred thousand cubic metres, and fell several hundreds of metres from the glacier Baklibreen in a hanging valley.

1338. High frequency GPR measurements in comparison to detailed snow profiles

Lisa Kreitmeier, Martin Schneebeli, Stefanie Weißbach

Presentation type requested: Poster
Presenting author: Kreitmeier
Correspondence: lisa.kreitmeier@arcor.de

Snow stratigraphy in Antarctica is strongly influenced by wind. This results in a complex stratigraphy. Yearly accumulation is often masked by intermediate erosion and deposition events. Kohnen-Station has a higher accumulation than the very low accumulation areas of East Antarctica, and therefore is suited to investigate complex stratigraphy. Here we use very high frequency GPR at 1.6 GHz to resolve stratigraphy. We compared the GPR measurements with detailed snow profiles measured using near-infrared photography and translucent profiles. Detailed depositional features, as dunes and cross-bedding are visible. First results show very complex patterns, which are not easily correlated to other features, and not necessarily to yearly accumulation.

1339. Greenland mass balance reconstruction since the Little Ice Age

Jason Box

Presentation type requested: Oral
Presenting author: Box
Correspondence: jeb@geus.dk

The Box (2013) century-plus Greenland near surface air temperature (T) and land ice surface mass balance (SMB) reconstruction is calibrated to RACMO2 output. The calibration for air temperature and ice melt rate is based on the 1960-2012 overlap period. The calibration for snow accumulation rate is based on the 1960-1999 overlap period, shorter because ice core data availability drops after 1999. Calibration is made using a.) regression coefficients for each grid cell match the average of the reconstruction to RACMO2 and b.) a variability adjustment that matches the variances of the two data sets. Refinements to Box (2013) surface mass balance reconstruction include:
1.) multiple station records now contribute to the near surface air temperature or a given year, month and grid location across the inland ice sheet, adding information to the reconstruction. In the Box (2013) version, only the highest correlating available station datum drove the temperature value for a given year, month and grid location.
2.) The RACMO2 data have a higher native resolution of 11 km as compared to what Box (2013) used, 24 km Polar MM5 with 24 km resolution.
3.) The estimation of values is made for a domain that includes land, sea, and ice. Box (2013) reconstructed T over only ice.
4.) The revised surface mass balance data end with year 2012. Box (2013) end in 2010.
5.) The annual accumulation rates from ice cores are dispersed into a monthly temporal resolution by weighting the monthly fraction of the annual total for each grid cell in the domain. This fraction is evaluated using a 1960-2012 RACMO2 data.
6.) a physically-based meltwater retention scheme is incorporated. Box (2013) used a constant retention criterion.

1340. Current status and past changes of ice rises in Dronning Maud Land, Antarctica

Vikram Goel, Joel Brown, Kenichi Matsuoka

Presentation type requested: Oral
Presenting author: Goel
Correspondence: vikram.goel@npolar.no

Ice rises are grounded ice bodies surrounded (at least partially) by the floating ice shelf. These ice rises play a key role in controlling the shape and dynamics of the Antarctic Ice Sheet. In turn, evolution of an ice rise is affected by the surrounding coastal environment. We are investigating the Blåskimen ice rise, located west of the Fimbul Ice Shelf, Dronning Maud Land, East Antarctica. The Dronning Maud Land coast is a 1000-km-long interconnected system of ice shelves, outlet glaciers and ice rises. Data were collected during the field seasons of 2013 and 2014. We made GPS stake measurements to derive the flow field over the ice rise. Ice-penetrating radar is used to see the bed topography and englacial layering. Ice cores were obtained to date the near surface radar reflectors and estimate recent surface mass balance. We present synthesis of these field data and preliminary results of the present-day mass balance.

1341. Environmental controls on snow cover thickness and water equivalent in two sub-Arctic mountain catchments.

Christopher Cosgrove, Christian Zdanowicz, Susanne Ingvander

Presentation type requested: Either
Presenting author: Cosgrove
Correspondence: chrislcosgrove@me.com

Spatial variability of seasonal snow depth poses a challenge when estimating snow water equivalent (SWE) from in-situ measurements in mountainous areas. Poor accessibility, complex topographic effects and localized microclimates make extrapolation of in-situ SWE measurements to a basin scale difficult. Remotely-sensed passive microwave SWE products are also inaccurate in complex terrain and/or at the forest-alpine tundra transition zone. To address these caveats, we investigated the relative importance of landscape qualities (altitude, slope, aspect, vegetation) and climate (winter temperatures, precipitation) on SWE distribution in two sub-Arctic mountainous catchments in Hemavan, Sweden, and Wolf Creek, Yukon, Canada. The two catchments are comparable, but have contrasted climate regimes. In-situ SWE measurements were made in March-April 2014 across the forest-tundra ecotone in both catchments. These were supplemented with historical snow-survey data since 2012 in Hemavan, and 1993 in Wolf Creek. Pairwise linear regressions of SWE against different landscape factors indicate that overall, altitude exerts the largest control on SWE at both Hemavan and Wolf Creek, but its effect is lesser within individual vegetation zones. In other respects, the two sites differ. SWE is inversely correlated to surface slope at forested sites in Hemavan ($R^2 = 0.57$, $p = 0.25$), but not in Wolf Creek. Slope aspect is positively correlated with SWE at forest-tundra transition sites ($R^2 = 0.49$, $p = 0.12$) in Wolf Creek, but not in Hemavan. For alpine tundra sites, slope angle strongly influences SWE in Hemavan ($R^2 = 0.58$, $p = 0.24$), but only weakly in Wolf Creek ($R^2 = 0.05$, $p = 0.71$). We discuss possible causes of these inter-catchment differences, and also evaluate the effect of inter-annual climate variations on SWE distribution at Wolf Creek using the long-term snow-survey record.

1342. UAVs to investigate a tidewater glacier in Greenland

Jonathan Ryan, Alun Hubbard, Nicolas Toberg, Poul Christoffersen

Presentation type requested: Oral
Presenting author: Ryan
Correspondence: jor44@aber.ac.uk

Unmanned Aerial Vehicles (UAVs) offer exciting opportunities for acquiring high-resolution data that bridge the gap between satellite imagery and ground-based measurements. We present data, methods and preliminary results from 62 surveys of the terminus of Store Glacier, Greenland from May to July 2014 using a fixed-wing UAV. Around 90,000 overlapping aerial images were captured which allowed the production of high-resolution (<50 cm) orthophotos and digital elevation models using stereophotogrammetry. These products provide us with a unique opportunity to investigate glaciological processes at a fine spatial and temporal scale. For example, we extracted surface velocity fields, patterns and morphology of crevasses, the distribution of water-filled crevasses and changes in the position and thickness of the calving front throughout the melt season. The results shed light on the dynamics of Store Glacier before, during and after the ice mélange break-up and the impact of water-filled velocities on calving rate. We conclude that the results and techniques used in this study demonstrate the applicability of repeat UAV surveys to assess the short-term dynamics of tidewater outlet glaciers.

1343. An evaluation of terrestrial time-lapse techniques for ice velocity analysis of Kronebreen, Svalbard

Silje Smith-Johnsen, Penelope How, Nick Hulton, Doug Benn, Adrian Luckman

Presentation type requested: Poster
Presenting author: Smith-Johnsen
Correspondence: silje.smith.johnsen@gmail.com

We compare the capability of a range of different methods to reliably track glacial features, and to measure ice velocity from terrestrial time-lapse photography. This is explored using oblique mono and stereo imagery from Kronebreen, a fast flowing tidewater glacier in Svalbard, taken from May to September 2014. The project forms part of the CRIOS (Calving Rates and Impact on Sea Level) program whose overall aim is to develop better calving-process models.

Two automated terrestrial digital SLR time-lapse cameras are used to take overlapping oblique photographs of the ice margin every 30 minutes. We consider both stereo- and mono-photogrammetric techniques coupled with the use of a DEM (the TanDEM-X IDEM product) and ground control points. The ideal software for this project would be automated, user-friendly with minimal inputs and capable of tackling illumination changes to reliably measure ice velocity. In this case, we also have the opportunity to evaluate the fine temporal-resolution terrestrial data with TerraSAR-X data (at 11-day resolution) by integrating our data over suitable time windows. By comparing the feasibility of several methods, we aim to maximise measurement precision and to augment the production of quantifiable measurements of glacier movement through time.

1344. Constraining models of marine-based deglaciation using geophysical evidence from the Barents Sea ice sheet as a palaeo analogue

Henry Patton, Alun Hubbard, Karin Andreassen, Monica Winsborrow

Presentation type requested: Poster
Presenting author: Patton
Correspondence: henry.patton@uit.no

Process understanding relating to the retreat of marine-based ice sheets, such as in West Antarctica and in parts of Greenland today, is poorly understood. In particular, the role of ice-stream instabilities and oceanographic dynamics in driving their collapse are poorly constrained beyond observational timescales. Over the course of numerous glaciations during the Quaternary, a marine-based ice sheet has waxed and waned over the Barents Sea continental shelf, characterised by numerous ice streams extending to the shelf edge and subsequent rapid deglaciations. Over the last decade, an increasing availability of offshore and onshore geophysical data has significantly enhanced our knowledge of the pattern and timing of retreat of this Barents Sea Ice Sheet (BSIS), particularly so from its Late Weichselian maximum extent. A review of these constraints that detail the dynamic evolution of this BSIS is presented, providing numerical modellers and geophysical workers alike with a useful benchmark dataset with which to tune ice-sheet reconstructions and explore ice-sheet sensitivities, forcings and dynamic behaviour. Although constraining data are generally spatially sporadic across the Barents and Kara seas, behaviours such as ice-sheet thinning, major ice-divide migration, asynchronous and rapid flow switching, and ice stream collapses are all evident. Investigation of the drivers of such dynamics of marine-based ice sheets is therefore seen as a priority for advancing our understanding of ice-sheet deglaciations, both in the past and future.

1345. Model of the western Laurentide Ice Sheet, North America

Evan Gowan, Paul Tregoning, Tony Purcell

Presentation type requested: Poster
Presenting author: Gowan
Correspondence: evan.gowan@natgeo.su.se

I present a new numerical model of the western Laurentide Ice Sheet, defined as the region between Lake Superior and the Cordillera, after the Last Glacial Maximum (LGM). This model is constructed by integrating observations of geomorphology, chronological information and glacio-isostatic adjustment. The margin history is determined by careful assessment of existing radiocarbon, optical and cosmogenic dates, and late-glacial landforms indicating the direction of retreat. The basal shear stress is the main variable that was changed to adjust ice thickness. Glacio-isostatic adjustment was determined using a lithospheric thickness of >100 km, an upper mantle viscosity of 3-5x10^{20} Pa s and a lower mantle viscosity >5x10^{21} Pa s. Calculated sea level along the northwestern coast of mainland North America, southern Banks Island and Victoria Island and western Hudson Bay matches most post-glacial sea level indicators. The modelled tilt of proglacial lakes, including Lake Agassiz and Lake McConnell, is consistent with dated strandlines and deltas. The calculated contemporary uplift is consistent with observations from GPS uplift rates and differential tilting of large lakes in the study area. At the LGM, the maximum ice thickness was 4000 m, near Great Slave Lake. The gradient of the ice surface was shallow in the Canadian Prairies, consistent with a weak bedded ice sheet. By the start of the Younger Dryas (13,000 yr BP), the ice sheet was largely restricted to the Canadian Shield, and peak thickness was about 2000 m. By 8000 yr BP, little ice remained within the study area.

1346. Seasonal evolution of basal friction coefficients in Kronebreen, Svalbard using Elmer/ICE

Dorothée Vallot, Rickard Pettersson, Martina Schäfer, Thomas Zwinger, Jack Kohler, Adrian Luckman, Björn Claremar, Doug Benn

Presentation type requested: Poster
Presenting author: Vallot
Correspondence: dorothee.vallot@geo.uu.se

One of the most prominent consequences of global warming is sea-level rise and its socio-economic implications. Discharge of mass from land-based glaciers and ice sheets are one of the major contributors to current sea-level change. These dynamic flow units are strongly influenced by mechanical properties at the bed upon which their stability is dependent.

Kronebreen is a grounded tidewater glacier situated in North West Svalbard that has been recorded as one of the fastest in the archipelago. Recent observations have shown a sudden start of retreat pattern that makes it a fairly interesting study site in terms of sea level rise and the contribution of glaciers. A large accumulation area drained into a narrow channel associated with sliding at the base are believed to play a role in controlling these high velocities. The amount of melt water routed to the glacier bed as well as the presence of soft deformable sediments under the glacier or the roughness of the bed would cause changes in basal lubrication. and ice flowing at the bed.
The goal of this study is to understand the pattern of basal friction coefficients through time and be able to reproduce it in prognostic runs. From the observed surface velocities, we used the inverse method to infer the spatially and temporally varying basal friction coefficients. The ice flow is solved with the Navier-Stokes equations using the open-source finite-element model Elmer/ICE. The model is constrained by digital elevation models of the surface and bedrock topography as well as a time-series of 11-days average surface velocities for 2013-2014 determined from the TerraSAR-X satellite.
The results of the numerical modelling is then compared to the surface water available. We are then able to invert two years of data and analyze the seasonal evolution of these coefficients in relation with other parameters influencing motion.

1347. Subglacial drainage of a land-terminating section of the Greenland Ice Sheet

Katrin Lindbäck, Rickard Pettersson

Presentation type requested: Poster
Presenting author: Lindbäck
Correspondence: katrin.lindback@geo.uu.se

Meltwater plays a vital role in governing ice sheet dynamics. Although considerable research exists which quantifies surface melt of the Greenland Ice Sheet, extensive knowledge of the basal regime at sufficient resolution and spatial coverage is currently lacking. Here we present subglacial hydrological drainage basins from a digital elevation model with high spatial resolution (250 m) of a land-terminating section of the Greenland Ice Sheet (6500 km2). The bed topography is rough and the water drainage is bed routed in trough systems towards the margin directed by the surface slope. The large amounts of small sinks in the basal topography, mirroring supraglacial lakes at the ice surface, indicate that there can be subglacial retention inter-annually in ephemeral ponds, too temporary and small to be detected in remote sensing. Comparison of subglacial hydrological networks with supraglacial hydrology, structure, and ice flow illustrates the complex spatial relationships between the routing of meltwater and ice flow. Large differences between subglacial and supraglacial catchments in the interior of the ice sheet (>50 km from the margin) infer that supraglacial drainage basins are not recommended to be used to define subglacial drainage catchments. Varying subglacial water pressure by 10% suggests that there is also a potential for subglacial drainage basins to vary by 15 to 50% in size due to lateral water-piracy by adjacent subglacial catchments in areas with valley conjunctions. These findings suggest that drainage basins can vary on short time scales during the melt season as the subglacial pressure regime changes. The results presented in this study illustrate the great spatial and temporal variations in subglacial drainage for a land-terminating margin of the Greenland Ice Sheet and add to the currently limited knowledge of the basal regime of the Greenland Ice Sheet.

1348. Two decades of surface elevation change of Nordenskiöldbreen, Svalbard.

Veijo Pohjola

Presentation type requested: Poster
Presenting author: pohjola
Correspondence: veijo.pohjola@geo.uu.se

The warming of the Arctic is an issue of large attention, in which change of glacier elevation is a method to monitor change where other environmental records are lacking. Remote sensed data is an excellent tool as it gives a large spatial coverage. The back-side is usually relative large uncertainties which hamper analyses over short time periods. On the other hand are surface profiles from kinematic DGPS giving high precision output, but to the cost of spatial coverage. Here we combine the spatial cover from remote sensed products, with the high precision data from surface DGPS campaigns to derive a 22 year analysis of surface change of one of the largest outlet glaciers on the east coast of Spitsbergen, Svalbard.

We use GPS elevations from repeated surface campaigns between 1991-2013, spatially extended using remote sensed data from aerial altimetry (NASA: 1996 and 2002), satellite altimetry (ICESat: 2003-2009), and satellite stereography (SPOT5: 2007-2009) to derive a geodetic elevation change over the glacier spanning the last two decades over Nordenskiöldbreen, Svalbard.

We further discuss the elevation found surface change in relation to SMB from measurements and from output from an Energy-Balance Model, and atmospheric data from experiments with the WRF atmospheric model.

We further discuss the elevation found surface change in relation to SMB from measurements and from output from an Energy-Balance Model, and atmospheric data from experiments with the WRF atmospheric model, and assess the the recorded change in dh/dt in perspective to changes in the wind field.

1349. Snow modeling in hydrological models

Ingunn Weltzien, Thomas Skaugen

Presentation type requested: Oral
Presenting author: Weltzien
Correspondence: ingunhw@student.matnat.uio.no

An important source of uncertainty and errors in predictions of snowmelt floods models is the snow modeling. The flood forecast service in Norway uses two rainfall-runoff models; the HBV model and the new Distance Distribution Dynamics (DDD) model. The purpose of the DDD model is to improve the predictions of runoff by derive parameters from observed catchment features through GIS and runoff records, and thus reduce the number of calibrated parameters.

A new routine for estimating the spatial distribution of SWE is developed and tested in the DDD model. The routine is tested on the Sula catchment situated south in Jotunheimen mountain area.

In the DDD model, the current spatial distribution of a snowfall event is lognormal with a calibrated coefficient of variation (CV). Snowmelt is spatially uniform. The new routine uses a gamma distribution as the spatial frequency distribution of both accumulation and melt. The gamma distribution has two parameters estimated from observed spatial variability of precipitation.

Testing the new routine for Sula resulted in a better NSE–value and lower variance for the validation data. This indicates reduced predictive uncertainty and confidence in the new routine. The implementation of this routine implies the removal of one calibration parameter (CV).

1350. Simulating the climatic response of Hardangerjøkulen ice cap since the Little Ice Age with ISSM

Henning Åkesson, Kerim H. Nisancioglu, Rianne H. Giesen, Mathieu Morlighem

Presentation type requested: Either
Presenting author: Åkesson
Correspondence: henning.akesson@student.uib.no

Glaciers and small ice caps respond considerably faster to climate change than the large ice sheets Greenland and Antarctica. Evidently, half of the current sea-level contribution from the cryosphere comes from glaciers and small ice caps. Here we use the Ice Sheet System Model (ISSM) to model the dynamics and evolution of the maritime-continental Hardangerjøkulen ice cap (73 km2, 60.55°N, 7.43°E) in southern Norway from the Little Ice Age (LIA) until today. ISSM is a finite-element model with anisotropic mesh capabilities (resolution can be refined in regions of interest) and includes different approximations for the dynamics of ice flow, including the shallow-ice approximation (SIA) and full-Stokes. The SIA neglects important stresses when topography is complex; however, it has proved accurate in representing glacier volume fluctuations on decadal and longer timescales. As Hardangerjøkulen has relatively gentle slopes and lacks areas of very fast flow, we choose to use the SIA to study this ice cap on climatic timescales. We include a simple yet spatially variable basal sliding formulation. As forcing for the ice flow model, we use a dynamically calibrated mass-balance history corresponding to moraine evidence from the LIA maximum in 1750 AD, as well as later direct mass balance measurements. Outlet glacier front positions from moraines and in situ observations, along with ice cap extents and surface DEMs from aerial photographs, are used for calibration. We investigate total ice volume and outlet glacier responses since the LIA. The sensitivity to surface mass balance as well as the applicability of the SIA to small ice masses is also discussed.

1351. Assessment of snow cover stability for avalanche prediction

Elena Marchenko

Presentation type requested: Poster
Presenting author: Marchenko
Correspondence: eklmnk@gmail.com

Monitoring and forecast of avalanche activity implies indispensable measures for protection of human lives and infrastructure.
Assessment of snow cover stability on slopes is an inherent part of avalanche forecast. It demands detailed information on snowpack at avalanche sites which is rarely available by field measurements. Modern layered models of snow cover evolution can provide such knowledge basing on data of meteorological observations. However, such models are one-dimensional which limits their application for avalanche warning.
Recently a complex method for spatial assessment of snow cover stability in local scale has been developed and tested on the Olympic slopes in Sochi, Caucasus. It is based on one-dimensional modeling of layered snowpack and spatial data analysis of both input and output parameters of snow model. We applied Swiss model SNOWPACK developed in Davos, Switzerland to simulate snow cover evolution at the nodes of previously constructed geographically-distributed grid covering avalanche starting zones during winter season 2011-12 and then extracted data on snow stability from the model's output. As a result we obtain spatial pattern of zones where snow cover is likely to collapse and cause an avalanche.

The results were compared with the data on avalanche activity during the season. Unstable zones had been modeled in every site where avalanche releases were observed. However, unstable zones were also presented at sites where no avalanches occurred which can be a result of an applied approach to define snowpack stability.

1352. Mapping of climate fields between GCM's and ice models with OBLIMAP 2.0

Thomas Reerink, Roderik van de Wal

Presentation type requested: Either
Presenting author: Reerink
Correspondence: tjreerink@gmail.com

OBLIMAP has been designed in order to couple climate models with ice sheet models. OBLIMAP is an accurate, robust, freely available and well-documented mapping method using optimal centred oblique projections. The oblique stereographic and the oblique Lambert azimuthal equal-area projections for both the sphere and the ellipsoid (WGS84) are available in OBLIMAP. Both model grids are allowed to be arbitrary and irregularly spaced. OBLIMAP 2.0 also allows 'online' coupling i.e. full coupling of an ice model and a GCM during their execution. This meets the growing demand in climate science to couple ice models and GCM's which are executed with different time steps at different grids based on different coordinate systems. OBLIMAP 2.0 includes masked mapping which for instance enables the use of field values at ice covered grid points at the interpolation step while excluding those from the remaining area. Furthermore it is possible to map multiple time records and multiple field records. It is also possible to map 3D fields. OBLIMAP 2.0 comes with an optimised computational scheme which resulted in a dramatic performance improvement for large grids. This enables the mapping of new high resolution topographic and climate forcing data sets for Greenland and Antarctica.

1353. Simulations of the mass balance distribution of Midtre Lovénbreen, Svalbard, using a full Stokes glacier model

Ilona Välisuo, Nicholas E. Barrand, Timothy D. James, Jack Kohler, Timo Vihma, Thomas Zwinger

Presentation type requested: Either
Presenting author: Välisuo
Correspondence: ilona.valisuo@fmi.fi

Midtre Lovénbreen (MLB) (78.53°N, 12.04°S) is a small valley glacier in northwest Spitsbergen. Several studies show that MLB has had a predominantly negative mass balance during the last century, with a resultant frontal retreat by ~ 1 km since the 1920s. We present simulations of MLB flow carried out with the thermo-mechanically coupled full-Stokes glacier model Elmer/Ice. Earlier studies using Elmer/Ice obtained results that agreed well with the observed glacier state. The main goal of the present study is to reconstruct mass balance from the simulations for different time periods from 1936 to 2005. We perform steady-state simulations and reconstruct mass balance by solving surface elevation changes and mean flow velocities between two years for which there exist accurate DEMs. We compare modeled mass balance to in situ measurements, which have been made from 1967 to the present. Finally, we evaluate the difference between model results including and excluding the effect of firn densification. Gaining a better understanding of the accuracy of simulated mass balance in the past decades makes it is possible to improve estimates for future changes in prognostic simulations.

1354. Long term trends and seasonal snow cover in the Finnish Arctic region

Ioanna Merkouriadi, Matti Leppäranta

Presentation type requested: Oral
Presenting author: Merkouriadi
Correspondence: ioanna.merkouriadi@helsinki.fi

Long term trends of snow conditions were examined in the Finnish Arctic region based on 10 years of data (2002-2011). Data from several weather stations were analyzed in order to estimate the average winter duration (sub-zero temperature days), snow cover, snow thickness and water equivalent. In addition, two snow stations were deployed in Kilpisjärvi and Pallas in winters 2011-12 and 2012-13 with daily snow temperature records in different depths. This served to examine the snow temperature evolution in the winter, the temperature gradient within the snowpack and the ground temperature influence in the metamorphosis. We finally considered the implications of the snow conditions on the tourism and the ecology of the Finnish Arctic.

1355. Mapping firn stratigraphy with an optical borehole camera system on the Austfonna Ice Cap, Svalbard

Lisbeth Langhammer, Kirsty Langley, Thorben Dunse, Elisabeth Isaksson, Jon Ove Hagen

Presentation type requested: Poster
Presenting author: Langhammer
Correspondence: lisbeth.langhammer@erdw.ethz.ch

Geodetic mass balance estimates of ice masses are generally based on the assumption of homogeneous snow and firn densities. In regions with percolation and refreezing of meltwater in firn, ground based surveys are recommended to assess the impact of densification caused by refrozen meltwater on volume to mass conversions.
On the Austfonna Ice Cap, Svalbard, a borehole camera system was operated to log the firn stratigraphy. Additionally, a borehole camera video processing and analysis tool was developed to derive the stratigraphic composition of the borehole wall from video records. We present the concepts of the processing and analysis tool as well as the firn stratigraphy data from the summit area of the ice cap.

Depending on the intensity of the logged borehole wall, the processing tool classifies sections as ice or firn. To evaluate the intensity-derived firn stratigraphy, the records are compared to firn core data from the same boreholes. Our results show high to moderate agreement in ice layer distribution and ice content between the two data sets. The analysis tool detects thick ice layers more accurately than thin ones. In general, the latter are underrepresented in the intensity-derived stratigraphy record.

Our evaluation demonstrates that ground truth data acquisition with the optical borehole camera system can be a time efficient and less expensive procedure than firn core drilling.

1356. ImGRAFT: Image GeoRectification And Feature Tracking: An Engabreen example

Alexandra Messerli, Aslak Grinsted

Presentation type requested: Oral
Presenting author: Messerli
Correspondence: messerli@nbi.ku.dk

Terrestrial time-lapse is becoming an increasingly popular method for observing and understanding the cryosphere from lake drainage and calving events to velocity fields. ImGRAFT is a new feature tracking toolbox that is designed for use with terrestrial images and satellite images. The toolbox contains two major parts; firstly algorithms to take two unregistered images and rectify them to a known coordinate system, and second, feature tracking algorithms that track visible features between two images to determine displacement. The advantage of this toolbox is that the code is freely available and adaptable to specific applications, something that to the best of our knowledge is not available in such a complete form. Another positive aspect is that that the entire package only requires one piece of software, MATLAB. We present results from terrestrial image feature tracking at Engabreen, northern Norway.

1357. Spatial variability of snow/firn/ice stratigraphy derived by ice cores, borehole camera surveys and radar studies at Lomonosovfonna, Spitsbergen in April 2012-2014

Sergey Marchenko, Rickard Pettersson, Veijo Pohjola, Christian Zdanowicz, Dorothée Vallot, Horst Machguth, Carl Egede Bøggild

Presentation type requested: Oral
Presenting author: Marchenko
Correspondence: sergey.marchenko@geo.uu.se

Stratigraphy of snow, firn and ice profiles is a product of processes involved in mass and energy exchange occurring therein. Occurrence of ice layers and lenses in subsurface glacier layers is commonly used as a proxy for assessment of water infiltration and refreezing rate, it has implications for ice core studies, application of remote sensing techniques using microwaves, radar surveys.

Ice layers form when water refreezes at boundaries between existing stratigraphic horizons. Initial inhomogeneity of snow and preferential flow of water in icy media can result in high spatial variability in occurrence of the layers.

Detailed studies of snow, firn and ice stratigraphy in upper 12 meters of glacier profile were undertaken at Lomonosovfonna, Spitsbergen. For that 3 ice cores were recovered, 22 boreholes were examined using a camera and high frequency radar surveys were done on spots 12*12 m or less during 3 consecutive field seasons (April 2012-2014). Quantitative assessment of similarity between camera derived borehole stratigraphies revealed the highly stochastic nature of ice layer formation process. Several prominent ice layers appear in most of the boreholes and can be traced in GPR records as spatially continuous reflectors, while thinner features demonstrate less consistency in spatial occurrence.

1358. 2014 Velocity fields and flux for 5 major Greenland outlet glaciers

Alexandra Messerli, Nanna B. Karlsson, Aslak Grinsted

Presentation type requested: Poster
Presenting author: Messerli
Correspondence: messerli@nbi.ku.dk

We present 2014 velocity fields for five marine terminating Greenlandic glaciers; Helheim, Kangerdlugssuaq, Nioghalvfjerdsbrae, Petermann and Jakobshavn. The velocity fields are produced using ImGRAFT a new feature tracking toolbox and Landsat 8 panchromatic band data. Additionally we estimate ice flux near the grounding line for each of the glaciers, these fluxes match well with existing estimates from other studies. With the relatively high repeat passes of Landsat 8 we are able to produce several velocity fields over a year. From these we have been able to identify clear seasonal variability presented in flowline plots from each of the glaciers. We stack the velocity fields to get an annual mean velocity estimate for each glacier.

1359. ALBEDO CHANGES ON VATNAJÖKULL ASSOCIATED WITH DUST EVENTS, ICELAND

Monika Dragosics, Thröstur Thorsteinsson, Finnur Pálsson

Presentation type requested: Poster
Presenting author: Dragosics
Correspondence: mod3@hi.is

The project focuses on the source mechanics and impacts of deposition of airborne aerosols (dust, volcanic ash, and black carbon) on the glacier surface albedo and possible consequences for the mass balance.
Albedo changes related to snow/ice impurities in Iceland are influenced by deposition of dust in normal years and deposition of volcanic ash after major eruptions, such as the 2010 eruption of Eyjafjallajökull and Grímsvötn 2011.
In most years several dust storms blow dust or tephra on the ice caps and influence their melting patterns. These changes in albedo measured at automatic weather stations (AWS) are investigated and compared with Satellite observations (MODIS images) and ground based data. Therefore snow samples from Vatnajökull with impurities were collected in October 2013, and two ice cores from Brúarjökull were taken in June 2014.
The ice cores are analysed to detect dust layers and to measure volume, density as well as turbidity (in ppm). The ice cores are compared with the analysis of the snow samples of 2013 as well as how the dust layers vary from year to year and the amount of dust in different areas. Albedo data from AWS‘ are analysed and a method will be developed in how to detect dust events in connection with meteorological patterns. The albedo results will be implemented in the glacier surface energy balance Qn=Qsw+Qlw+Qh+Qle and the influence on the mass balance will be visible.

1360. Basal conditions at Engabreen inferred from surface velocity fields

Anne Solgaard, Alexandra Messerli, Aslak Grinsted, Thomas Schellenberger, Miriam Jackson, Thomas Zwinger, Dorthe Dahl-Jensen

Presentation type requested: Either
Presenting author: Solgaard
Correspondence: solgaard@gfy.ku.dk

In this study, we explore how the basal conditions at Engabreen in northern Norway change over the year using an inverse method to determine basal friction coefficients from observed surface velocities. We investigate how much of the total velocity component can be attributed to sliding and deformation, respectively. The open-source finite element code Elmer/Ice, which solves the full Stokes problem is used. Our input data to the model consists of three surface-velocity fields obtained from Radarsat and TerraSAR-X covering periods in July, August and February. Geometries are taken from radar measurements of the ice thickness as well as a high-resolution surface DEM from recent laser-scan measurements. Due to the coarse resolution of the radar data, we improve the ice thickness distribution in the lower part of the glacier by combining ice flux considerations and information from the surrounding ice-free topography.

1361. Programme for monitoring of the Greenland Ice Sheet

Signe Bech Andersen, Andreas Ahlstrøm, Morten Langer Andersen, Jason Box, Michele Citterio, Robert S. Fausto, William Colgan, Dirk van As

Presentation type requested: Either
Presenting author: Andersen
Correspondence: siba@geus.dk

Programme for Monitoring of the Greenland Ice Sheet (PROMICE) was established in 2007. The aim of the programme is to quantify the mass loss of the Greenland ice sheet and track changes in the extent of the glaciers, ice caps and ice sheet margin.
Within PROMICE data sets from several activities are collected. These include a network of currently 19 automatic mass-balance stations (AMS) on the margin of the Greenland ice sheet measuring ice ablation as well as meteorological parameters. Airborne surveys, yielding surface elevation and ice depth along the entire margin of the Greenland ice sheet. Mapping of all Greenland ice masses, based on the highest detail aero-photogrammetric maps produced from mid-80's aerial photographs.
Real-time data from the PROMICE is shown in at the web site www.promice.org and the data is freely available for download.

1362. The geomorphological and sedimentary impact of jökulhlaups generated by the 2010, Eyjafjallajökull eruption

Andy Russell, Rob Duller, Andy Large, Stuart Dunning, Matthew Roberts, Anne-Sophie Mériaux, Fiona Tweed, Jonathan Carrivick, Qiuhua Liang

Presentation type requested: Oral
Presenting author: Russell
Correspondence: andy.russell@ncl.ac.uk

This paper details the geomorphological and sedimentary impact of a series of jökulhlaups generated by the 2010 Eyjafjallajökull eruption within the Gígjökull basin and Markarfljót River system. The initial jökulhlaup (2640m3s−1) from Gígjökull on April 14 was relatively water-rich contrasting with the ice-rich and sediment-laden April 15th jökulhlaup (1400 m3 s−1). Between 15 April and 16 May a further 140 discrete relatively low magnitude (< 600m3s-1) jökulhlaups occurred. The April 14 and 15 jökulhlaups had very different sedimentary impacts reflecting their radically different rheology. Ice-rich breccias such as those deposited during the April 15 jökulhlaup have only been inferred from the sedimentary record, having not previously been observed during volcanic eruptions in Iceland. Later, lower magnitude jökulhlaups deposited a proximal outwash fan within the Gígjökull basin completely burying earlier jökulhlaup deposits and reflecting deposition from 'pulsed' turbulent transitional flows (Fr No. ~1). The variability of jökulhlaup characteristics and impacts resulting from the same volcanic eruption represents a challenge for the interpretation of the sedimentary record as well as the management of volcano-glacial hazards.

1363. Glacier change in Sweden from the end of "Little Ice Age" to 2008

Moa Hamré, Peter Jansson, Gunhild Rosqvist, Per Holmlund

Presentation type requested: Poster
Presenting author: Hamré
Correspondence: moa.hamre@natgeo.su.se

Swedish glacier change since end of the "Little Ice Age" (LIA) (~AD 1916) to 2008 was assessed using orthophotos from 2008, a Digital Elevation Model, topographical maps, historical photos together with previous inventories from 1973, 2002 and 2008. Using a Geographical Information System-based method, glacier area for 294 glaciers for LIA and 2008 were manually digitized where LIA extents were determined mainly from moraines visible in orthophotos. Glacier area, volume, slope, aspect and elevation change were then calculated. Total area change from end of LIA to 2008 was 127 km2 or a 34% decrease resulting in a calculated volume loss of 7.9 km3 or 41%. Relative area change ranged from 57% for the smallest glaciers to 27% for larger glaciers but absolute area change was most prominent for larger glaciers. Decadal area change between end of LIA and 1973 was 2.3% compared to Jotunheimen, Norway, European Alps and New Zeeland Southern Alps from LIA maximum to 1970/80s which was 1.2%, 2.8% and 3.9% respectively. From 2002 to 2008 annual area change had accelerated to 1.6% compared to 0.3% from LIA to 2002

1365. Water retention and internal accumulation in the percolation zone of the Greenland ice sheet

Charalampos Charalampidis

Presentation type requested: Either
Presenting author: Charalampidis
Correspondence: cc@geus.dk

In the lower accumulation area along the K-transect, Kangerlussuaq, West Greenland (67 °N 47 °W, 1850 m a.s.l.), a thermistor string installation including instrumentation for surface height, air temperature and radiation components captured the thermal changes during the extreme melt season of 2012 and the season of 2013. Firn cores were drilled in spring 2012 and 2013. The temperature variations in the firn reveal water percolation and refreezing in the uppermost 2.7 m during July and August 2012. Near melting-point temperatures at larger depths (approx. 6 m) recorded in autumn 2012 suggest the presence of liquid water, unable to penetrate the ice layers below. Comparing 2012 and 2013 firn cores reveal that refrozen melt water has filled most of the remaining pore space in the uppermost 7 meters. Below that depth there is no indication of melt water percolation and the temperature variations can be explained by conduction alone. The firn temperature measurements reveal a uniform 4 C warming of the upper 10 meters from May 2012 to May 2013. The formation of an impermeable ice layer along with the recorded albedo decrease is evidence of a rapidly changing area. If large melt events persist, the area will experience a transition towards a superimposed ice regime, or even turn into ablation area, drastically impacting melt and melt extent in the area.

1366. Radar wave penetration of snow and ice; implications for deriving surface elevations

Kirsty Langley

Presentation type requested: Either
Presenting author: Langley
Correspondence: kirstyl@geo.uio.no

Here we consider the error (or bias) associated with deriving DEMs from satellite radar altimeter data.

A high resolution near global DEM derived from the C-band radar (5.3 GHz) is a product of the Shuttle Radar Topography Mission (SRTM) conducted over an 11 day period in February 2000. This product has been used as a baseline dataset in various elevation change studies, and its value in such studies will only increase with time. However, uncertainty remains as to how to deal with the error, or bias, inherent in the DEM associated with radar penetration. A similar question will arise concerning the upcoming TanDEM-X datasets.

1367. Glacier and snow cover observations based on pluri-annual and intraseasonal time-series of optical satellite images

Solveig Havstad Winsvold, Andreas Kääb

Presentation type requested: Poster
Presenting author: Winsvold
Correspondence: s.h.winsvold@geo.uio.no

Optical satellite imagery is frequently used for glacier mapping, and for existing mapping methods optimal satellite scenes must have minimal snow and cloud cover. Unfortunately, the time period between such optimal scene conditions might amount to several years. Sentinel-2, launching in spring 2015, has similar settings to the Landsat TM/ETM+/OLI satellites. Together these satellites will give higher temporal resolution and promote multi-temporal and multi-sensor based analysis, particularly in high-latitude areas.

Throughout the year, glaciers display a unique sequence of optical properties. When combining multi-temporal satellite images, each pixel on a glacier has a specific temporal signature that is in most cases different from the temporal signatures of off-glacier terrain, and can thus be used for classification purposes. The use of multi-temporal imagery in this way has not yet been fully exploited.

We present preliminary results using two temporal approaches: 1) Pluri-annual approach; by using a RGB tricolor separation process on Landsat scenes from the entire archive for selected locations, we present a method for mapping snow-masked maximum glacier extent. 2) Intraseasonal approach; we use several Landsat images from one season to simulate the temporal content of Sentinel-2 data over glacial terrain, and thereby map glacier extent. This can lead to more automated selection of optimal scenes and glacier classification.

1368. Kronebreen time-lapse camera platforms: Place your bets on which survived!

Penelope How, Nick Hulton, Silje Smith-Johnsen, Heïdi Sevestre, Doug Benn, Adrian Luckman

Presentation type requested: Poster
Presenting author: How
Correspondence: p.how@ed.ac.uk

Seven time-lapse camera platforms were installed at Kronebreen, a fast-flowing tidewater glacier in Svalbard, during April 2014 as part of the Calving Rates and Impact on Sea Level (CRIOS) program at the University Centre in Svalbard (UNIS). These cameras take photos every 30 minutes, collecting data to measure glacier velocity, calving rate, surface lake drainage, and changes in margin position. The seven cameras will provide full coverage of the glacier tongue, allowing for both monoscopic and stereoscopic analysis to be conducted, with DEM data enabling absolute measurement transformations.

It became evident during the field work in April that the installation protocol had to be adapted for each platform. Unsettled terrain and permafrost were the biggest challenges, limiting the stability of some of the platforms. Internal problems may include battery failure and plug connection issues, related to the cold climate. Although we reduced these potential risks with the platform design and extensive field checks, it is unknown which platforms will have worked and which will have failed come September 2014 when they are retrieved. Can you guess which have survived and which haven't? This is an exercise demonstrating the unpredictable nature of terrestrial time-lapse camera installations.

1369. Precision and accuracy of newly developed CryoSat-2 LRM and SARin processors over glaciated terrain

Johan Nilsson

Presentation type requested: Either
Presenting author: Nilsson
Correspondence: jnils@space.dtu.dk

New retracking methods have been developed for improving the CryoSat estimates of height changes over the Greenland ice sheet, as well as Arctic ice caps. In this study two CryoSat-2 special modes (LRM and SARin) processors under development at DTU Space are presented. The processors have been developed for robust surface elevation retrieval over glaciated terrain for the purposes of elevation change studies. The processors have been validated using both airborne laser data and crossover analysis, over the Greenland ice sheet and several Arctic ice caps. To date the SARin processor have been validated over several Arctic ice caps, and shows an approximate 50% improvement in precision and accuracy, compared to the current ESA implementation. Validation is still ongoing to determine the accuracy and precision of the LRM processor. Preliminary results, based on crossover analysis, indicates an relative precision of 15 cm in the flat interior of the Greenland ice sheet. This represent better results that several currently available retrackers.

1370. MODELLING RUNOFF FROM GLACIATED DRAINAGE BASIN USING A COUPLED GLACIO-HYDROLOGICAL MODEL IN A CHANGING CLIMATE

Kjetil Melvold, Stein Beldring

Presentation type requested: Oral
Presenting author: Melvold
Correspondence: kjme@nve.no

The future runoff from two highly glaciated catchments in western Norway is assessed for the period 1961-2100 using a glacio-hydrological model. The hydrological model is a distributed HBV model, simulating mass balance, runoff response as a function of altitude based on temperature and precipitation. The HBV model is coupled to flow models computing the length and volume change of the glaciers with time. The model is calibrated using observed discharge, or mass balance data and elevation change data. The model is run with transient simulations spanning a range of possible future changes. We apply gridded scenarios for daily temperature and precipitation data derived from regional climate models. Three selected climate projections from the ENSEMBLES project with the A1B emission scenario have been used. Before 2005, the model is forced with gridded temperature and precipitation values from seNorge.no based on data from the Norwegian meteorological station network. Model simulations reveal that during the first half of the 21st century, substantial future variations in runoff superimposed on a rising trend and a reduction in ice volume. The runoff changes from the glaciated part fluctuates close to ~2.8 m/y for the first decades after 2005, rising to ~3.8 m/y near the middle of the century and continue to increase to ~4-5 m/y at the end of the century. If we look at the total runoff from the catchment the picture is different in the later part of the century. The runoff then drops down to present level.

1371. Two summers with contrasting spatial variability in glacier basal pressure

Pierre-Marie Lefeuvre, Miriam Jackson, Gaute Lappegard, Jon Ove Hagen

Presentation type requested: Poster
Presenting author: Lefeuvre
Correspondence: p.m.b.e.lefeuvre@geo.uio.no

At the Svartisen Subglacial Laboratory, load cells installed at the ice rock interface under ~200 m of glacier ice have been recording basal pressure for 20 years. Synchronous pressure variations between load cells are investigated as evidence of hydrological bed connectivity and stress redistribution.

A running Pearson correlation is used to gain insights into the temporal variation in response within a sensor array. By studying the nature of this correlation as well as the correlation between sensor pairs, it is possible to investigate evolution of the degree of synchronous response and to some extent basal connectivity at the glacier bed. Persistent seasonal variations associated with the melt season are observed over the entire measurement period, indicating dependence on surface hydrological forcing. Overlying this trend, particular years with longer periods of positive and negative correlation are presented to show contrasting inter-annual variability in basal pressure. Stable weather appears to enhance connectivity of the sensors, which may be attributed to the development of a persistent drainage system. An anti-correlated connectivity is associated with an increase in the rate of daily subglacial discharge measured nearby, and may be related to channel migration or cavity opening at the glacier bed.

1372. Glacier snow evolution in the atmospheric model WRF

Björn Claremar, Sergey Marchenko

Presentation type requested: Poster
Presenting author: Claremar
Correspondence: bjorn.claremar@met.uu.se

Surface mass balance is a complex process and difficult to model due to the uncertainties in precipitation but also in the melting and what happens with the melt water in the snow pack. Additionally the redistribution of the snow due to wind can be significant in exposed areas. This study investigates the process of the retention and refreezing of melt water and the sensitivity of a number of parameters in the atmospheric model WRF.
The WRF model was set up over the Svalbard domain with ERA-Interim as atmospheric forcing and sea surface temperature (SST) and sea ice forcing from the OSTIA database. The original glacial mask was replaced by land use data from Norwegian Polarinstitutt (NPI). Two land surface schemes, Noah-MP and CLM4 (the latter including the SNICAR snow model) were utilized and compared in a sensitivity study where the horizontal resolution was set to 16.5 km. Further, parameters like water holding capacity, snow thermal conductivity and initialisation, all affecting the snow pack evolution, were changed. Some simulations with the finer resolution 5.5 km were also compared to snow measurements at the ice plateau of Lomonosovfonna.

1373. A comparison of in situ and remote techniques to detect changes in an Arctic glacier basin: from ablation stakes to photogrammetry

Florian Tolle, Alexander Prokop, Eric Bernard, Jean-Michel Friedt, Christelle Marlin, Madeleine Griselin

Presentation type requested: Oral
Presenting author: Tolle
Correspondence: florian.tolle@univ-fcomte.fr

The Austre Lovénbreen glacier basin (Svalbard, 79°N) is subject to a monitoring program since 2006. A network of ablation stakes is in place and maintained. Winter mass balance is measured during snow drilling campaigns in spring. In addition, a set of automatic cameras is covering most of the glacier basin area. Each year, maximum snow cover, glacier mass balance, and water equivalent values are computed. Geometrically corrected pictures acquired 3 times a day allow for a precise follow-up of the snow cover melt during the season.

Over the last 3 years, terrestrial laser scanning surveys have been conducted focusing on the glacier snout, equilibrium line zone, and accumulation zone. Special attention was also granted to the scanning of slopes surrounding the glacier, in an attempt to gather data on processes occurring in these steep areas. All scans were produced once in April and repeated in August. Annual snow cover and summer to summer ground surface variations could then be derived. Recently, photogrammetry approaches have been tested using Structure from Motion algorithms to produce elevation models.

1374. Variability of surface mass balance in East Antarctica measured with ground based radars

Anna Sinisalo, Karsten Müller, Kirsty Langley, Helgard Anschütz, Elisabeth Isaksson, Jack Kohler, Joe McConnell, Svein Erik Hamran, Mats Jorgen Oyan, Jon Ove Hagen

Presentation type requested: Poster
Presenting author: Sinisalo
Correspondence: a.k.sinisalo@geo.uio.no

Many challenges remain for estimating the Antarctic ice sheet surface mass balance (SMB), which represents a major uncertainty in predictions of future sea-level rise. Validating continental scale studies is hampered by the sparse distribution of in-situ data. We present a SMB measured over large regions in East Antarctica. We compare these data to results of large-scale SMB studies for similar time periods, obtained from regional atmospheric modeling and remote sensing. Our in-situ data include ground penetrating radar, firn core and mass balance stake measurements, and provide information on both temporal and spatial scales. The results emphasize the importance of using a combination of ground based validation data, regional climate models and remote sensing over a relevant time period in order to achieve a reliable SMB for Antarctica.

1375. Present changes in extent and thermal regime of Swedish glaciers

Per Holmlund, Caroline Clason, Klara Blomdahl

Presentation type requested: Oral
Presenting author: Holmlund
Correspondence: per.holmlund@natgeo.su.se

During the last decade the recession speed of most Swedish glaciers has dramatically increased. The dynamics of the glaciers is influenced both by changes in thermal regime and by thinning. On several glaciers we have successive digital terrain models covering the period 1960-2008 and shorter time series of thermal regime changes. Between 1963 and 2008 the annual mass balance of Storglaciären was on average -0.1 m/y w.e while Pårteglaciären lost approximately 0.5 m w.e. Though very high mass losses the thermal regime of Pårteglaciären is rather stable showing only a slight thinning of the cold surface layer over the last 18 years, though the geometry of the tongue is changing significantly.. The corresponding annual mass balance of Mikkaglaciären was -0.4 m w.e. and its thermal regime has changed significantly over the years causing very high recession rates over the last decade. On a significant number of glaciers, nunataks have appeared close to the fronts influencing glacier flow and thus temperature regime and recession rates. The little summit glacier still acting as the highest point of Sweden on mount Kebnekaise is slowly shrinking and in current climate conditions another summit on the same mountain will become the highest peak. In this paper we will make an over view of the present state of the glaciers and discuss differences in glacier response in a thermal perspective.

1376. A record of Ice Velocity and Water Pressure Fluctuations at Kronebreen, Svalbard

Nick Hulton, Doug Benn, Adrian Luckman, Bryn Hubbard, Penelope How, Willem Boot

Presentation type requested: Either
Presenting author: Hulton
Correspondence: Nick.Hulton@ed.ac.uk

This research considers the relationship between recorded ice velocity fluctuations, borehole water pressure, and calving activity at Kronebreen, Svalbard. The work forms a core part of the CRIOS programme, the overall aim of which is to better understand and thus represent calving processes in Ice Sheet models. The data extend from Sept 2013-Sept 2014 and consist of a combination of i) survey-grade GPS stations on the glacier ii) Borehole basal water-pressure observations iii) Terrestrial time-lapse photography overlooking the glacier iv) 11-day TerraSAR-X data. Here we present preliminary results from these observations and consider how the pattern of velocity modifies over the year and whether any observed variation can be explained in terms of water-pressure fluctuation. We consider the ability to derive meaningful data at different spatial and temporal resolutions and to combine it effectively. The GPS and borehole data have high temporal resolution but low spatial sampling, whereas the satellite data has excellent spatial coverage but lower (11-day) temporal resolution; the terrestrial camera data has 30 minute temporal resolution, but variable spatial coverage. A key factor is whether we can link specific calving events to changes in glacier velocity upstream and vice-versa and thus also consider whether and how changes in tongue geometry caused by marine melt, can propagate to cause acceleration of the glacier or further accelerations in calving rate. For the future, we will explore how these data can most effectively be explained by modelling approaches that explain well the operation of these processes.

1377. Gridded orographic precipitation for mass balance modelling and simulating the evolution of the outlets of SE-Vatnajökull ice cap, Iceland

Hrafnhildur Hannesdóttir, Guðfinna Aðalgeirsdóttir, Sverrir Guðmundsson, Tómas Jóhannesson, Philippe Crochet, Finnur Pálsson, Eyjólfur Magnússon, Hálfdán Ágústsson, Sven Sigurðsson, Helgi Björnsson

Presentation type requested: Oral
Presenting author: Hannesdóttir
Correspondence: hrafnha@hi.is

Simulations of the evolution of three outlet glaciers of SE-Vatnajökull (Skálafellsjökull, Heinabergsjökull and Fláajökull) are presented. A coupled degree day mass balance and Shallow-Ice-Approximation ice flow model is applied that uses modelled orographic precipitation on a 1 km grid as input. The distributed orographic precipitation model is necessary for the simulations in order to capture the winter mass balance variance. 14 years of in situ mass balance measurements are used to calibrate the mass balance model, indicating that the model explains 87% of the variation of the winter balance and 92% of the summer balance. The modelled equilibrium line (ELA) altitude compares well with the snowline at the end of the summer, derived from MODIS images 2007–2010. Calculated sensitivity of annual balance to 1°C warming is –1.51 to –0.97 m w.e. a-1 and for 10% increase in precipitation +0.16 to +0.65 m w.e. a-1 . The history of area and volume changes since the end of the Little Ice Age (LIA) ~1890 to 2010 is used to constrain the model. The observed ice volume of the LIA (15–30% larger than in 2000) is reconstructed with a 1°C cooling and 20% reduction in the annual precipitation, relative to the period 1980–2000 (which is in line with temperature and precipitation records from the end of the 19th century at nearby lowland stations). Applying a step increase in temperature of 2°C, and precipitation increase of 10%, results in >50% decrease in ice volume and terminus retreat as much as 10 km according to our model runs. A warming of 3°C and same precipitation increase would, however lead to almost disappearance of the outlets, a volume loss of 80–90%.

1378. Retrieving the mass balance of Icelandic glaciers based on historical photographs combined with airborne LiDAR

Joaquín Muñoz-Cobo Belart, Eyjólfur Magnússon, Tómas Jóhannesson, Águst Þor Gunnlaugsson, Finnur Pálsson

Presentation type requested: Oral
Presenting author: Muñoz-Cobo Belart
Correspondence: jmm11@hi.is

The recent survey of glaciers in Iceland with airborne LiDAR has opened new opportunities for deriving the geodetic mass balance through the comparison and subtraction of Digital Elevation Models (DEMs). Here we show a study in several Icelandic glaciers with relatively little or no information on mass balance in the past. We create series of DEMs obtained from historical aerial photographs, which are used for the calculation of geodetic mass balance averaged over periods of ~10-15 years, starting c. 1945 with the flights of the American Mapping Service (AMS). We use LiDAR High Resolution DEMs to support the photogrammetric processing of historical aerial photographs. Features in ice-free areas in the vicinity of the glacier and nunataks are used to extract Ground Control Points (GCPs) and constrain the orientation of the photographs. The mass balance records for glaciers in various locations around Iceland allows the study of possible trends in the bass balance in space and time. The study covers the glaciers of Drangajökull (NW Iceland), Tungnafellsjökull (Central Iceland), Þrándarjökull and Hofsjökull Eystri (East Iceland), Breiðarmerkurjökull (South Iceland) and Snæfell (Central Iceland).

1379. Modeling the runoff components of Engabreen, northern Norway

Markus Engelhardt, Pierre-Marie Lefeuvre

Presentation type requested: Oral
Presenting author: Engelhardt
Correspondence: Markus.Engelhardt@geo.uio.no

In highly glacierized catchments, snow and ice melt are the most important contributors to the magnitude and variations in streamflow. Changes in discharge are connected to both, changes in temperature and precipitation and can be amplified or balanced by the presence of a glacier in the catchment. Therefore, variations in annual glacier mass balances alter the streamflow regime and with ongoing climate change, it is expected to see major changes in timing and magnitude of future water availability.
Daily discharge rates are available for the catchment of Engabreen (38 km²) at three different locations comprising a) 33 km² (100 % glacier cover), b) 40 km² (95 % glacier cover), and c) 53 km² (73 % glacier cover). These measurements are compared with simulated discharge rates calculated from a melt model for both, the glacierized and, if applicable, the non-glacierized parts of the catchment. The model uses gridded temperature and precipitation from seNorge (http://senorge.no) as input and runs on a daily time step from 1957 to present. It accounts for evaporation, retention of surface water, refreezing processes and transformation of snow to firn and ice. The simulated discharge data can be split up into their water sources rain, glacier melt and snowmelt both on and outside the glacier area. For calibration and validation of the model, both measured seasonal and annual mass-balance measurements of the glacier are used. Additionally, the runoff components are compared with basal pressure records from the Svartisen Subglacial Laboratory situated 200 m below the glacier surface.

1380. Effect of diurnal surface melt and capacity of the subglacial drainage system on glacier bed perturbations

Pierre-Marie Lefeuvre, Miriam Jackson, Gaute Lappegard, Jon Ove Hagen

Presentation type requested: Oral
Presenting author: Lefeuvre
Correspondence: p.m.b.e.lefeuvre@geo.uio.no

We investigate the relationship between glacier bed response and successions of days with melt driven diurnal discharge as an attempt to quantify the temporal evolution of the capacity of the subglacial drainage system, or in other words its history.

The study focuses on successive diurnal discharge that identifies when the drainage capacity is greater than/or in balance with surface melt input. We quantify how the bed responds during these periods based on a 20 year record of direct observations of basal pressure from the Svartisen Subglacial Laboratory (under ~200m thick ice). Results show an intermittent connection between series of daily discharge and daily pressure events. The bed response is maximal at first, but the diurnal signal dampens non-linearly over the next days to finally reach local ice overburden pressure. Decrease in pressure events amplitude is assumed to indicate a reduction of the area affected by pressurised channels through load transfer mechanisms. A full Stokes model with simple mesh geometry reproduces these basic amplitude variations.

Our observations contrasts with the perception from surface boreholes that subglacial water pressure can vary from atmospheric to ice overburden on diurnal time scale. We discuss the differences.

1381. Implementation of a hydrology model for Basin 3, Austfonna Ice Cap, Svalbard

Yongmei Gong, Thomas Zwinger, Rupert Gladstone, de Fleurian Basile, Martina Schäfer, John Moore

Presentation type requested: Poster
Presenting author: Gong
Correspondence: thomas.zwinger@csc.fi

The outlet glacier in Basin 3, Austfonna is one of the fastest outlet glaciers in Svalbard. It has experienced dramatic speed up throughout all seasons since 1995. Several studies have suggested that feedbacks involving till deformation and basal hydrology may explain both the distinct seasonal accelerations and the inter-annual speed up. We currently attempt to implement a double continuum hydrology model to work with a full Stokes ice dynamic model. Although the hydrology model employs a dual continuum porous equivalent approach, we mainly use the inefficient drainage component that is modeled as sediment layer to have a first look at the applicability of the model on the Austfonna set-up in the ice dynamic model. Basal sliding velocity is calculated from a non-linear water pressure dependent friction law, which includes the effective water pressure given by the hydrology model as input. We take this study as a preliminary experiment for further investigation aiming to eventually reveal the major hydrological factors governing the seasonal and inter-annual speed up. Through parameter tuning and sensitivity tests we hope to achieve a viable basal boundary condition for the ice dynamic simulation involving sub glacial hydrology.

1382. Renland ice cap project, East Greenland – glaciological investigations in preparation for a new deep drilling in 2015

Christine S. Hvidberg, Aslak Grinsted, Iben Koldtoft, Anne M. Solgaard, Bo Vinther, Prasad Gogineni, John Paden, Ruth Mottram

Presentation type requested: Oral
Presenting author: Hvidberg
Correspondence: ch@gfy.ku.dk

The Renland ice cap is located in Eastern Greenland on a high-elevation plateau of the Renland Peninsula. The Center for Ice and Climate, University of Copenhagen is preparing for the REnland ice CAP project (RECAP) - a new deep drilling project at Renland in 2015. The new ice core will provide information on Eastern Greenland climatic conditions and sea ice extent for the past glacial cycle, and the project will help constrain the past evolution of the Renland ice cap. Here we will report from glaciological investigations in preparation of the deep drilling. The Renland ice cap covers the entire high-elevation areas above 2 km of the Renland Peninsula. The ice cap drains by several glaciers, of which some are reaching the fjords at sea level. The ice thickness of the Renland ice cap is generally a few hundred meters, but reaching up to approximately 600m. The bedrock topography has been surveyed by airborne radar along a few radar tracks. The glaciological investigations have primarily focused on deriving a reliable ice thickness map of the main part of the Renland ice cap. We are using a combination of data and models to infer the bedrock topography and overall flow pattern, and results will be reported.

1383. Validating a high-resolution 55 year climate input dataset for mass balance modeling of Svalbard glaciers

Thomas V Schuler, Torbjørn I Østby, Thorben Dunse, Jon Ove Hagen

Presentation type requested: Either
Presenting author: Schuler
Correspondence: t.v.schuler@geo.uio.no

Simulating the climatic mass balance of all Svalbard glaciers requires meteorological input at high temporal and spatial resolution. Here we present a dataset to be used for forcing a coupled energy balance-snowpack model based on the ERA 40 and ERAinterim atmospheric reanalyses. To overcome the scale gap between the coarsely resolved reanalysis (0.75 deg) and the resolution needed to adequately reproduce the hypsometry of Svalbard glaciers (1km), we applied disaggregation schemes that account for the elevation difference between a 1km DEM of Svalbard and the large scale orography. In doing so, we capitalize on essential information of the reanalyses, for instance by accounting for the temperature lapse rate, atmospheric stability and cloudiness of the large scale model when disaggregating the variables needed to drive the energy and mass balance model: air temperature, relative humidity, incoming fluxes of solar and thermal radiation, wind speed and precipitation. The product is a 1km-resolution climatology of Svalbard in time steps of 6 hours from September 1957-June 2014.

We present a thorough validation effort based on a multitude of observational data from Svalbard. In detail we exploit timeseries from synoptical and research weather stations as well as magnitude and spatial patterns of snow accumulation, measured at a number of glaciers. The results confirm an overall usefulness of the disaggregated dataset, some systematic deviations indicate potentials for further refinement of the disaggregation schemes and periods of enhanced bias may point at shortcomings in the underlying reanalyses, presumably due to inaccurate representations of clouds and sea ice coverage.

1384. The effect of a subglacial lake on the dynamics of an artificial ice stream

Eythor Gudlaugsson, Angelika Humbert, Thomas Kleiner, Karin Andreassen

Presentation type requested: Poster
Presenting author: Gudlaugsson
Correspondence: eythor.gudlaugsson@uit.no

Recent studies have presented compelling evidence of rapid transport of water stored in subglacial lakes indicating that drainage can happen either episodically or in a transient manner on relatively short time scales. Lakes can form part of a connected hydrological network with upstream lakes draining into downstream ones as the subglacial water moves down the hydrological gradient. Transport of both ice and water moves with it a significant amount of sediment that gets deposited in the lakes, thus reducing their size over long time scales.

The presence of a subglacial lake is typically seen as a flattening of the ice surface, given that the lake is in hydrostatic equilibrium and as a local speed-up of ice velocities. This draws down cold ice over the lake and deflects isochrone layers within the ice. Temporal changes in lake geometry and basal conditions of the ice are thus recorded in the isochrone structure. The aim of this study is to investigate the influence of a subglacial lake on the dynamics of an artificial ice stream and the effect it has on the isochrone structure within the ice. For that purpose we use a fully 3D, polythermal Full-Stokes ice sheet model, developed in the commercial finite element software COMSOL. We employ a newly published enthalpy method in order to account for the (softening) effect of increasing temperature and water content within the ice on ice viscosity and we show how temporally varying basal conditions can lead to the appearance of flow bands, or arches and troughs, within the isochrone structure (internal layering) downstream of the original flow disturbance. We also compare steady states for different sizes of the lakes and investigate their influence on the thermal structure of the overlying ice.

1385. Basal mass budget of Ross and Filchner-Ronne ice shelves from Lagrangian analysis of ICESat altimetry

Geir Moholdt

Presentation type requested: Oral
Presenting author: Moholdt
Correspondence: moholdt@npolar.no

Traditional methods of deriving temporal variability of Antarctic ice-shelf elevation from satellite altimetry use a fixed ("Eulerian") reference frame, where the measured changes include advection of ice thickness gradients between measurement epochs. We present a new method which removes advection effects by using an independent velocity field to compare elevations in a moving ("Lagrangian") reference frame. Applying the technique to ICESat laser altimetry for the period 2003-2009 over the two largest Antarctic ice shelves, Ross and Filchner-Ronne, we show that the Lagrangian approach reduces the variability of derived elevation changes by about 50% compared to the Eulerian approach, and reveals clearer spatial patterns of elevation change. The method simplifies the process of estimating basal mass budget from the residual of all other processes that contribute to ice-shelf elevation changes. We use field data and ICESat measurements over ice rises and the grounded ice sheet to account for surface accumulation and changes in firn air content, and remove the effect of ice-flow divergence using surface velocity and ice thickness data. The resulting maps of basal mass budget confirm that melt rates are highest (>5 m a-1) near the deep grounding lines of major ice streams, but the smaller melt rates (<5 m a-1) near the ice-shelf fronts are equally important to total meltwater production. Integrating over the ice-shelf areas, we obtain basal mass budgets of -50 ± 64 Gt a-1 for Ross and -124 ± 66 Gt a-1 for Filchner-Ronne, with changes in firn air content as the dominating error source.

1386. Multi-millennial ice volume changes of the Greenland ice sheet

Konstanze Haubner, Jason E. Box, Kurt H. Kjær

Presentation type requested: Poster
Presenting author: Haubner
Correspondence: KHaubner@gmx.de

The possibility for rapid melting of the Greenland ice sheet ranks among the most serious societal climate threats. For reliable predictions it is helpful to know more about past ice volume changes.

This project puts the rate of contemporary climate change-driven Greenland ice mass change into perspective and can conclude whether the contemporary ice loss is unprecedented in the Holocene. A data assimilation ice flow model can enable interpolating between the observations to produce a smoothly varying result, including peripheral smaller isolated ice bodies. The resulting volume changes exert: 1) a space-time variable loading on the solid earth; 2) a sea level contribution; and 3) ocean freshwater flux.
We first plan to have a look at the Sermilik Isbrae on the Qagssimiut lobe of the southern ice sheet and compare observed and modeled motions there. Inverting ice flow for basal friction is one target. Step by step the model will be trained by the data and evaluated over time for realism. The next steps could be applying this model on other glaciers and widen the regional focus.

1387. Extreme icing event in snowpack at High Arctic site

Jack Kohler

Presentation type requested: Oral
Presenting author: Kohler
Correspondence: jack@npolar.no

Winter snow is a key factor affecting many aspects of polar ecosystems. For example, winter snow thickness, ice layers formed within and, more particularly, at the base of the snowpack, have all been linked to fluctuations in in High Arctic animal populations in Svalbard. At a field site in northwestern Svalbard, measurements of snow and snow properties (e.g. ice layers) have been made along a series of transects around the peninsula Brøggerhalvøya. These measurements are typically made over a 1-2 day period in April/May, and have been performed annually since 2002. The typical procedure is to sound at 100-200 m intervals along the transects, digging snow pits at regular intervals to determine the snowpack stratigraphy, in particular the basal ice layer thickness, if present. In a few years these measurements have been supplemented with 900 MHZ ground-penetrating radar (GPR) profiles. In January-February 2012 there was an extreme warm period across all of Svalbard, with temperatures well above freezing (up to 7°C) across the entire archipelago and record-breaking precipitation (nearly 10 cm of rain falling in one day at Ny-Ålesund). This extreme event led to a pervasive ground-ice layer 5-20 cm thick across most of the low-lying terrain around Brøggerhalvøya. I compare measurements made in this year to those made in other years, including a comparison of GPR profiles made in 2012 and in 2007, a year with very little ground-ice.

1389. How to spread the word to the general public on the impact of climate change

Andreas Peter Ahlstrøm, Signe Hillerup Larsen, Signe Bech Andersen

Presentation type requested: Either
Presenting author: Ahlstrøm
Correspondence: apa@geus.dk

“THE END IS 32.4% LIKELY TO HAPPEN IN APPROXIMATELY 200 YEARS!” yelled the scientist, yet barely anyone bothered even turning their heads as they passed her on the street. Having done her duty, she quickly returned to her office. Such is the reality of communicating climate change for many scientists: poor targeting of audience, bad messaging and lack of interest on both sides. Then, how on Earth do we tell people what we now understand about climate change? Most often, scientists are highly dedicated… scientists; that is, few scientists are gifted communicators, and even those often prefer to spend their time on science. Generally, rewards for spending considerable time on communicating findings to the public are scarce. Although we have an obligation to inform the public, most proposals aim to minimize the outreach effort. Here we argue for a completely different approach: outreach must be given a status comparable to science in proposals and evaluated accordingly. Engaging professional or experienced science communicators from the onset to establish a viable project plan is crucial. Here we present one such “project deliverable” from the Nordic Centre of Excellence SVALI: the e-learning website “The Ice School” and the strategic reasoning behind it.

1390. Geodetic mass balance of Hofsjökull 2008–2013 measured with repeat lidar surveying

Tómas Jóhannesson, Thorsteinn Thorsteinsson, Johann Stötter, Rudolf Sailer, Eyjólfur Magnússon, Finnur Pálsson, Etienne Berthier

Presentation type requested: Oral
Presenting author: Jóhannesson
Correspondence: tj@vedur.is

Geodetic mass balance estimates for the Hofsjökull ice cap, central Iceland, have been derived for the periods 1986–1999, 1999–2004, 2004–2008 and 2008–2013 on the basis of Digital Elevation Models (DEMs) from lidar surveys in 2008, 2010 and 2013 and earlier surveys based on aerial photographs, GPS measurements and SPOT5 satellite images. The mass loss of the ice cap, which had an area of 850 km² in 2008, is similar in all three periods 1999–2004, 2004–2008 and 2008–2013, 1–1.5 m w.e. per year in areal average. This is approximately three times more rapid than for the period 1986–1999 when the ice cap mass was reduced by approximately 0.4 m w.e. per year on average. Traditionally measured mass balance using a stake network underestimates the downwasting of the ice cap by approximately 0.4 m w.e. per year.

1392. Reconciled freshwater flux into the Godthåbsfjord system from satellite and airborne remote sensing

Sebastian B. Simonsen, Valentina R Barletta, Louise S. Sørensen, Rene Forsberg

Presentation type requested: Poster
Presenting author: Simonsen
Correspondence: ssim@space.dtu.dk

As the rapid reduction in ice volume of the Greenland ice sheet (GrIS) continues, increased melt water flux from the GrIS enters the deep Greenlandic fjords. This increased freshwater flux may change the salinity and eventually the ecology of the fjords. Here, we present a case study in which we, from various remote sensing datasets, estimate the freshwater flux from the GrIS into a specific fjord system, the Godthåbsfjord, in southwest Greenland. The area of the GrIS draining into Godthåbsfjord covers approximately 36700 km^2. The large areal extent and the multiple outlets from the GrIS hamper in situ observations. Here, we evaluate available data from remote sensing and find a drainage basin in rapid change. An analysis of data from the GRACE satellites shows a mean seasonal freshwater flux into Godthåbsfjord of 18.2±1.2 Gt, in addition to an imbalance in the mass balance of the drainage basin from 2003-2013 of 14.4±0.2 Gt/yr. Altimetry data from various sensors also suggests rapid changes in the outlet glacier dynamics, and finds that only consider data from the ICESat mission, a widely used dataset for ice change estimates, the mass change of the drainage basin is significantly underestimated. When including additional laser-altimetry surveys, to account for changes in the outlet glaciers elevation, not captured by ICESat, the altimetry data were able to reconcile the basin mass balance with the gravimetric estimate and provide a higher spatial resolution of the mass changes.

1393. Glacier ice albedo and surface material quantified from in situ measurement on the Greenland ice sheet margin

Carl Egede Bøggild, Gabriel Fulton, Horst Machguth

Presentation type requested: Poster
Presenting author: Bøggild
Correspondence: cebo@byg.dtu.dk

In August 2011 all the major outlets form the ice sheet in the Nuuk region was investigated by in situ data sampling at multiple locations of each outlet. At each location the spectral surface albedo was measured at multiple surfaces together with photo documentation and surface sampling of "surface impurities". In total 62 different surfaces was investigated. This dataset enable quantification between the measured albedo and its relation with the dry mass of impurities on different melting ice surfaces.
The rationale behind this campaign has been to derive some relation between the observed albedo and the mass of surface material as well as its spatial variability on different surfaces. This relation can shed light on deposition, storage and removal of surface material observed from satellite albedo over larger areas.
Results show that the accumulation regime varies between locations on each outlet. But, there is evidence of somehow less albedo impact of accumulation of surface material on the most dynamic outlets. This again indicates more material per fraction of surface coverage– or a greater thickness of the surface material on the dynamic outlets. The observations from this south-western sector of the ice sheet margin are in line with observations in the Kronprins Christians Land margin in north-east Greenland.

1394. Seasonal-trend decomposition of GPS time series to derive the GIA response to the downwasting of Icelandic glaciers

Zonetti Simone, Jóhannesson Tómas, Ófeigsson Benedikt G.

Presentation type requested: Poster
Presenting author: Simone
Correspondence: simone@vedur.is

GPS measurements in Iceland show accelerating crustal uplift rates during the last two decades in response to the downwasting of glaciers due to warming climate. This uplift signal is superimposed on seasonal variatiations due to the annual glacier mass-balance cycle, tectonic signals related to various geophysical processes such as plate movements, earthquakes and eruptions, and corrupted by artificial shifts due to problems arising in the international base-station network and equipment malfunction as well as set-up changes. We report on the decompositon of the GPS-signal into a (quasi) periodic seasonal component and a longer-term trend that provides a consistent estimate of the long-term GIA signal as well as a robust estimate of the amplitude and shape of the seasonal variation. This processing is accompanied by semi-automated detection of and correction for shifts in the GPS time-series that is essential to obtain accurate uplift rates. The derived seasonal component of the crustal movements provides constraints on the amplitude of the seasonal mass-balance cycle of the Icelandic glaciers.

1395. A 25-year mass balance record from Hofsjökull ice cap, Central Iceland

Þorsteinn Þorsteinsson, Bergur Einarsson, Oddur Sigurðsson, Tómas Jóhannesson

Presentation type requested: Poster
Presenting author: Þorsteinsson
Correspondence: thor@vedur.is

Hofsjökull is a circular-shaped ice cap with an area of 850 km² lying between 650 and 1790 m a.s.l. in the central highlands of Iceland. Since 1989, the annual mass balance of Hofsjökull has been monitored using the glaciological method, i.e. winter balance measurements by snow coring in the spring and summer balance determination from ablation stake readings at the end of the melt season. Measurements have been conducted at 25–30 locations within three ice-flow basins (N, SE and SW basin) that comprise 40% of the total area of the ice cap. In the year 2013–2014, the mass balance of Hofsjökull was found to be negative for the 20th consecutive year since 1995. During this 20 year period, the annual balance of the N-basin was found to average –0.8 m/yr, the SE-basin –0.9 m/yr and the SW basin –0.8 m/yr. Significant trends are not observed in the annual mass balance of the individual basins during this period, but the annual balance at the ice-cap summit displays a positive trend of 4 cm/yr² on average during 1995–2014. Comparison with geodetic mass balance estimates from lidar measurements and other surveys indicates that the traditional mass balance measurements underestimate the downwasting of the ice cap by 0.4 m/yr. We discuss the possible causes for this discrepancy, including the effect of stake locations within the measured basins and the possibility of vertical stake movement in snow, firn and ice on Hofsjökull.

1397. Modelling the Svalbard-Barents Sea Ice Sheet using a Fast Full Stokes numerical model: steps for model development, testing, and application

James Lea, Evan Gowan, Josefin Ahlkrona, Nina Kirchner

Presentation type requested: Poster
Presenting author: Lea
Correspondence: james.lea@natgeo.su.se

Here we present an intended plan for the development, testing and application of a Fast Full Stokes (FFS) model to the Svalbard-Barents Sea Ice Sheet. The application of Full-Stokes numerical models to palaeo-ice sheet simulations have previously been highly impractical/impossible due to the considerable computational resources required to complete even relatively short (i.e. <100 year) simulations. In the FFS model we utilise approximations to the Full Stokes equations (i.e. shallow ice, and shallow shelf approximations) wherever their application is meaningful/correct, only using the Full Stokes equations where necessary (i.e. at the ice divide, grounding line, and ice sheet/stream flow transitions). This allows the FFS model to capture important ice sheet dynamics at a lower computational cost than when solving the full Stokes equations over an entire ice sheet, opening up the potential to conduct physically accurate centennial to millennial timescale simulations.
The FFS model will first be tested against idealised ice sheet scenarios of increasing complexity. This will allow validation of model behaviour as glaciologically realistic. The model will then be applied to the simulation of various aspects of the Svalbard-Barents Sea Ice Sheet, aiming to capture increasingly complex observed behaviour. This stepwise increase in complexity will play a crucial role in constraining parameter space uncertainty. Specific criteria for model success/failure will also be outlined with respect to both idealised and palaeo-simulation scenarios during the course of the project.

1399. Precipitation on Holtedahlfonna and Kongsvegen

Ankit Pramanik

Presentation type requested: Poster
Presenting author: Pramanik
Correspondence: ankit.pramanik@npolar.no

Snow is a crucial parameter in glacier mass balance modelling since the albedo contrast between snow and ice strongly affects the energy balance. Distributed energy balance models at the landscape scale typically do a reasonable job at extrapolating or interpolating parameters such as temperature from measurement sites, but snowfall is a more difficult parameter to specify, in the absence of dense measurement networks. Here we analyze hourly data sonic ranger data obtained at four Automatic Weather Stations situated on two large Svalbard glaciers, Holtedahlfonna and Kongsvegen, with data covering the period from 2007 to 2013. We identify and analyze precipitation events, comparing them across the sensor network, to precipitation data from the nearby reference meteorological site in Ny-Ålesund, and to output from a regional climate model. Results will be used to improve energy balance modelling efforts for the glaciers in the Kongsfjord catchment basin.

1400. Modeling the surface mass balance and firn evolution of glaciers around Kongsfjorden, Svalbard

Ward van Pelt, Jack Kohler

Presentation type requested: Poster
Presenting author: van Pelt
Correspondence: wjjvanpelt@gmail.com

A coupled modeling approach is applied to simulate the long-term (1961-2012) surface mass balance and subsurface evolution of the Kongsvegen and Holtedahlfonna glacier systems in western Svalbard. Principle aims are: 1) to quantify and analyze the distributed surface mass balance evolution, 2) to estimate the contribution of melt water refreezing and internal accumulation to the mass balance, and 3) to detect changes in firn conditions over the simulation period. In order to achieve this, HIRLAM regional climate model output for 1961-2012 is projected onto the 100-m model grid and serves as input for a coupled model surface energy balance – firn model. Available stake measurements since 1987, together with weather station data and snow profiling observations, are used for parameter estimation, as well as validation of the model results. Extensive spin-up is performed to provide initialized subsurface conditions at the start of the experiments. Results indicate a slightly positive area-averaged surface mass balance of 0.08 m w.e. yr-1, which only fractionally compensates for mass loss by calving. Refreezing (average 0.30 m w.e. yr-1) provides a strong buffer for mass loss and substantial internal accumulation (up to 0.22 m w.e. yr-1) adds uncertainty to mass balance observations in the accumulation zone. An increasingly negative surface mass balance over the last two decades has led to a retreat of the firn line and a substantial reduction of the firn air content. Together with a negative trend in the albedo and elevated melt/runoff this could mark the onset of accelerated near-future mass loss.

1401. How continuous is the blue ice climate record at Patriot Hills, Horseshoe Valley, West Antarctica?

Kate Reid, John Woodward, Neil Ross, Stuart Dunning, Chris Turney, Chris Fogwill, David Sugden, Andy Hein and Shasta Marerro

Presentation type requested: Oral
Presenting author: Kate Reid
Correspondence: kate.reid@northumbria.ac.uk

Sampling of the blue ice in front of Patriot Hills, Horseshoe Valley, West Antarctica, has produced a horizontal Holocene climate record. The record reveals two rapid changes in climate, transitions which have been matched to similar Holocene changes in the North Greenland and EPICA ice cores. High resolution step-and-collect ground penetrating radar (GPR) surveyed along the horizontal climate sequence shows continuous, conformable dipping isochrones from 0 m – 246 m, 249 m – 359 m and 362 m – 800 m. These areas represent periods of stable flow conditions and snow accumulation. At 247 m and 360 m there are unconformities in the isochrone layers. These unconformities represent changes in either i) flow conditions, including ice velocity and flow line trajectory, ii) local interaction of topography, snow accumulation and wind, iii) regional patterns in wind intensity or direction. GPR data, analysed in conjunction with deuterium isotope results and in-situ stake measurements suggest that the flow line trajectory of ice in Horseshoe Valley is unlikely to have changed since the Last Glacial Maximum. This infers that accumulating snow and ice layers have passed through two blue ice areas in front of the Liberty and Marble Hills, where the former ice surfaces were eroded by localised, strong katabatic winds, producing unconformities in the sequence stratigraphy. The GPR record, showing convergent, prograding and occasionally truncated isochrones near the blue ice/firn margin also suggests more recent changes in regional wind intensity. The unconformities in the GPR data therefore indicate breaks in the climate record rather than zones of correlation with the North Greenland and EPICA ice cores.

1402. Lab report on the quantification of glacier volume and velocity changes of the Morsárjökull outlet glacier (Southern Iceland)

Doris Hermle, Rudolf Sailer, Þorsteinn Sæmundsson, Tómas Jóhannesson, Esther Jensen, Johann Stötter

Presentation type requested: Poster
Presenting author: Doris Hermle
Correspondence: Doris.Hermle@student.uibk.ac.at

Morsárjökull is a regenerated outlet glacier of the Vatnajökull icecap situated in Skaftafell National Park, Southern Iceland. In spring 2007, a rock avalanche released from the eastern flank fell onto the glacier covering a large area of the glacier tongue. The objectives of this study are the assessment of the behaviour of both, the glacier and the rock avalanche mass in terms of their extent, cubature and movement.
Given a multi-temporal data set based on length observations since 1935, aerial photographs (1982, 1988, 1994, 1997, 2003, 2007), LiDAR (light detection and ranging) data by airborne (2011) and terrestrial laser scanning (2014), the derivation of DGM's and orthophotos is possible. Multitemporal data analyses allow to quantify different processes which helps to put a new complexion on existing interpretations.
Although Morsárjökull showed an advance from 1982 to 1988 and a stagnation phase from about 1994 to 1997 a steady decrease both in length and mass can be observed (length measurements, aerial photographs and LiDAR analysis) until present. As typical for many glaciers, based on the combined analysis of aerial photographs and LiDAR data, an increasing volume loss from the headwalls towards the glacier snout, even accelerating in recent years, can be observed. In contrast, an almost uniform loss over the entire glacier tongue can be calculated for the period from 1997 to 2003.
In addition, there is clear evidence for protection from insolation by the rock fall mass resulting in higher elevation loss in the surrounding boulder-free glaciated area. In the area of the rock mass there is unequal change in height. The foremost steep front shows a distinctive difference with high positive values, the front part has less change in loss as the rear part. Preliminary results of the glacier dynamics show a regular movement of the whole glacier mass of ca. 100 m per year between 2007, the year of the rock fall event, and 2011.

1403. Changes of the Breiðamerkurjökull outlet glacier, SE-Iceland, from its maximum extent in the late 19th century to the present

Snævarr Guðmundsson, Helgi Björnsson, Finnur Pálsson, Hrafnhildur Hannesdóttir

Presentation type requested: Poster
Presenting author: Snævarr Guðmundsson
Correspondence: snaevarr@nattsa.is

We have reconstructed digital elevation models (DEMs) of Breiðamerkurjökull, one of the largest outlet glaciers of the Vatnajökull ice cap, SE-Iceland, during its highstand of 1890 (LIAmax) and in 1945. The models were constructed by use of several sources: LiDAR DEM from 2010–2011, aerial and oblique aerial photographs, topographic maps from 1904 and 1945, written historical documents along with geomorphological field evidence. We estimate the retreat of the terminus as >5 km since the LIAmax to 2010, as a consequence of which ~114 km2 of land has become exposed. Average annual loss of glaciated area amounts to about 0.95 km2/yr to the year 2010. The period was divided into two intervals; 1890–1945 [55 yr] and 1945–2010 [65 yr]. The response is in accordance with climate changes and ice mass loss accelerated with increasing summer temperature. The total volume loss over 120 years is 69 ± 8 km3 water equivalent (w.e.). This corresponds to an annual average specific mass loss of 0.64 m w.e./yr, 0.34 km3 w.e./yr from 1890 to 1945 and 0.74 km3 w.e./yr from 1945 to 2010. About 2/3 of the ice loss has occurred after the mid-20th century.

1404. Correlating glacier velocity to weather forcing on Breiðamerkurjökull, Iceland.

Tayo van Boeckel, Alexander H. Jarosch

Presentation type requested: Poster
Presenting author: Tayo van Boeckel
Correspondence: tvb1@hi.is

Previous studies have demonstrated a distinct relationship between surface water input and subsequent increased speed up of glaciers. The focus of these studies has either been on relatively short time scales covering single hydrological events or an entire season. We specifically target the combination of inter annual, seasonal as well as single event flow speed variations, and present a dataset of two high resolution GPS rovers on Breiðamerkurjökull, Iceland, that cover most of 2012 and 2013. Breiðamerkurjökull has an average winter velocity of 1 m/day that increases by on average 20% during melting season. We observe both small diurnal velocity fluctuations, as a result of daily melt-induced speed up, and larger speed up events with velocities up to 3.7 m/day lasting for about 2-3 days, induced by precipitation events that reach up to 125 mm/day. As precipitation patterns vary strongly throughout southeast Iceland, we have chosen to correlate the glacier velocity record with a 2.5 km gridded weather forecast model output rather than distant weather station data.

1405. Bárðabunga and Breiðamerkurjökull: exciting times for glaciology

Alexander H. Jarosch

Presentation type requested: Oral
Presenting author: Alexander H. Jarosch
Correspondence: alex@hi.is

In the spirit of the IGS branch meetings, I will present an overview of my currently ongoing glaciological research with a focus on two regions of Vatnajökull, Iceland:

During the ongoing eruption at Holuhraun (north of Vatnajökull) the subglacial volcano caldera at Bárðabunga (north-west corner of Vatnajökull) has started to subside, which results in a highly interesting deformation of the overlying glacier. The subsidence is assumed to be caused by the emptying of the volcano's magma chamber underneath Bárðabunga, feeding the Holuhraun eruption site. Understanding the deformation of the overlying glacier is crucial for the interpretation of the bedrock subsidence as the only observations available are from the glacier surface. This poses an exciting glaciological inversion problem for which I will present initial modeling results using a FEM-Stokes (aka. Full Stokes) ice flow model.

In the previous summer, I have initiated a fixed-wing UAV based aerial survey program of the calving front dynamics at Breiðamerkurjökull (south-east Vatnajökull). Inspired by the ongoing, exiting work by Ryan et al. at Store Glacier, Greenland, this program also aims to understand the short-term dynamics of tidewater glaciers, yet in the distinctly different and very easily accessible setting of Breiðamerkurjökull. I will summarize the results of the first field season and detail the additional instrumentation at the glacier maintained by the glaciology group here in Iceland.

1406. Short and long term ablation modelling in Iceland based on Automatic Weather Station data and Regional Climate Model, the project SAMAR

Guðfinna Aðalgeirsdóttir, Sverrir Guðmundsson, Finnur Pálsson, Helgi Björnsson

Presentation type requested: Oral
Presenting author: Guðfinna Aðalgeirsdóttir
Correspondence: gua@hi.is

The project SAMAR aims to improve the predictive capabilities of surface energy balance models applied to estimate glacier melt. The models will be operated both on short time scales (days and weeks) and on century time scale, for improved projections of the contribution of glaciers to sea level rise. The short time scale results are useful for operation of hydroelectric power plants and for making flood warnings. This project is a close collaboration between the University of Iceland, and the Danish Meteorological Institute. It will take advantage of the wealth of mass balance measurements and data from automatic weather stations that have been collected in Iceland during the last two decades. The surface energy balance module within the regional climate model HIRHAM5 will be further developed and upgraded based on the outcome of the study. Energy balance observations from Automatic Weather Stations (AWS) on Vatnajökull ice cap are presented and a comparison with model output from HIRHAM5 made for the year 2010. The year 2010 was particular because the tephra from the eruption in Eyjafjallajökull was distributed over the ice caps in Iceland and caused enhanced melting. The albedo variability observed in the AWS is not yet realistically simulated by HIRHAM5 and improving the representation of albedo in the model is the primary task of the project.

1407. The geodetic mass balance of Tungnafellsjökull ice cap: 1946-2013

Ágúst Þór Gunnlaugsson[1], Eyjólfur Magnússon[1], Guðfinna Aðalgeirsdóttir[1], Finnur Pálsson[1], Joaquín Muñoz-Cobo Belart[1] & Etienne Berthier[2]

[1]Institute of Earth science, University of Iceland
[2]LEGOS, CNRS, Université de Toulouse

Presentation type requested: Poster
Presenting author: Ágúst Þór Gunnlaugsson
Correspondence: athg8@hi.is

Tungnafellsjökull is a 33 km^2 ice cap, situated in the centre of the Icelandic Highlands. Unlike its neighbouring ice caps, Vatnajökull and Hofsjökull, little is known of its mass balance since the end of the Little Ice Age. A combination of a relative small size, remoteness and difficult access, contributes to the fact that little work has been done on the Tungnafellsjökull ice cap. The aim of this study is to determine the geodetic mass balance of Tungnafellsjökull, for the period 1946 to 2013. Aerial images from 1946, 1960, 1986-7 and 1995 are used for photogrammetric processing and construction of Digital Elevation Models (DEMs). DEMs created by the SPIRIT project (2008) and Pleiades satellite (2013) are also included in this study. A DEM from LiDAR survey in 2011 provides an important information on the shape and topography of the glacier and the landscape outside the ice cap margin. In addition, the LiDAR DEM also provides valuable control data for accurate photogrammetric DEM extraction.

To obtain relative mass change of the ice cap and to enable prediction of Tungnafellsjökull development in the near future, knowing the bedrock topography is important. 135 km of radio-echo sounding (RES) profiles were measured in the spring of 2013 covering most of the glacier with ~250 m between profiles. Preliminary results show greatest ice thickness of 160 m at the south part of the glacier. Mean ice thickness of the RES profiles is 76 m, but it should be noted that 10% of the glacier including the steepest slopes where the ice is expected to be thin, were not measured. A complete map of the glacier-bed surface topography is in preparation. At the same time as the RES was carried out the, winter balance of the year 2012-13 was measured at three locations and in August 2013 the summer balance was measured. The results of these measurements yield net balance was negative below 1350 m, -2.5m w.eq at 1135m and + 0.5 w.eq at 1450 m.

1408. Impact of spatial variability in bare-ice albedo on melt rates at the margin of the Greenland ice sheet, Nuuk region

H. Machguth and C. E. Bøggild

Centre for Arctic Technology, Danish Technical University, DK-2800, Kgs. Lyngby

Presentation type requested: Poster
Presenting author: H. Machguth
Correspondence: homac@byg.dtu.dk

The glacier surface albedo controls the amount of shortwave radiation that is absorbed by the glacier surface. Hence the albedo has an important influence on the glacier surface energy balance.

The albedos of snow and ice surface show differing properties. Parameterizations have been developed to describe the processes governing snow albedo. The current change in climate, however, leads to a decrease in snow-covered accumulation areas and raises the importance of the bare-ice albedo of the ablation areas. In contrast to snow albedo, the spatial and temporal variability of ice albedo is still poorly understood. The related lack of parameterizations is a major source of uncertainties in future projections of glacier changes.

Data required for the development of bare-ice albedo parameterizations were carried out on Svalbard and Greenland with black carbon content, cryoconite dry mass, cryoconite surface coverage and surface albedo being measured. We here use these data to derive spatial variability of albedo in the Nuuk area of the Greenland ice sheet margin and to quantify its influence on surface melt.

First we analyse the albedo observations with respect to spatial, temporal and statistical variability of albedo in the region. A glacier energy balance model is then forced with meteorological observations from three AWS located in the ablation zone of the Greenland ice sheet and evaluated using the related ablation data. A series of additional model runs is produced by varying ice albedo within its observed range in the region. The resulting variability in surface melt is finally analysed with respect to measured cryoconite properties, such as cryoconite dry mass, surface coverage and black carbon content.

1409. A comprehensive data base of glacier surface mass balance observations from the ablation area of the ice sheet and the local glaciers of Greenland

H. Machguth[1,2], H.H. Thomsen[1], A. Weidick[1], J. Abermann[3], A. P. Ahlstrøm[1], M. L. Andersen[1], D. van As[1], C. E. Bøggild[2], J. Box[1], W. Colgan[1], R. S. Fausto[1], K. Gleie[1], B. Hynek[4], H. Oerter[5], K. Steffen[6] and R. S. van de Wal[7]

[1] Geological Survey of Denmark and Greenland GEUS, DK-1350 København K
[2] Centre for Arctic Technology, Danish Technical University, DK-2800, Kgs. Lyngby
[3] Asiaq, Nuuk, Greenland
[4] Zentralanstalt für Meteorologie und Geodynamik, Vienna, Austria
[5] Alfred Wegener Institute, Bremerhaven, Germany
[6] Swiss Federal Institute for Forest, Snow and Landscape Research WSL, Birmensdorf, Switzerland
[7] Institute for Marine and Atmospheric research, Utrecht, The Netherlands

Presentation type requested: Poster
Presenting author: H. Machguth
Correspondence: homac@byg.dtu.dk

Glacier mass balance measurements on Greenland started nearly a century ago. Observations can be divided into measurements carried out in ablation and accumulation zones. While the latter have been compiled in a number of studies, no comprehensive overview of the data from the ablation zone of the ice sheet and from the local glaciers exists. These data are missing in the evaluation of modelled glacier mass balance, but they also bare the potential of specifying changes in glacier melt independently from modelled data.

Here we present a comprehensive data base of glacier mass balance observations from the ablation zone of the Greenland ice sheet and the local glaciers. The data base contains a total of >2300 mass balance observations from 36 sites. For each mass balance observation X, Y and Z coordinates, starting and ending dates and a number of quality flags are provided. Sources are given for each entry and for all metadata. The mass balance data is accompanied by a literature base including all sources in digital form.

Most data were collected from grey literature and unpublished archive documents. 50% of the data have not been published before and were thus inaccessible to the scientific community. Only 13% of the data already existed in tabulated form including dates and coordinates.

The data cover all regions of Greenland except for the southernmost part of the east coast. The earliest measurements date from 1938; the 50s see a first peak in activities in the Thule region. At their maximum in the 80s and early 90s measurements were both focused on the southwest and northeast of the ice sheet.

The data base reveals a lack in longer term time series. Numerous extensive and systematic campaigns were carried out but nearly all of them were discontinued after a few years, only the observations along the K-Transect and at Swisscamp exceed 20 years. Once published, the mass balance data base including all sources becomes openly accessible.

1410. Analyses of the discharge in the glacial river Jökulsá á Fjöllum during the recent volcanic activity in the ice-covered Bárðarbunga volcano

Bergur Einarsson, Gunnar Sigurðsson and Matthew J. Roberts

Icelandic Meteorological Office

Presentation type requested: Poster
Presenting author: Bergur Einarsson
Correspondence: bergur@vedur.is

During the recent volcanic activity in the Bárðarbunga subglacial stratovolcano, three subsidence cauldrons were formed in the glacier surface on the eastern flanks of the volcano. These cauldrons are within the estimated watershed of the glacial river Jökulsá á Fjöllum. Increased discharge due to melt water from the cauldron formation was therefore expected in the river. No marked changes were observed in the discharge in the river at two hydrometric gauging stations of the Icelandic Meteorological Office. Further analyses of the discharge in Jökulsá á Fjöllum and comparison to nearby glacial rivers will be presented. The aim of this analysis was to estimate whether extra discharge of the amount expected to be melted during the cauldron formation could have passed unnoticed by the gauging stations. Additional discharge, caused by geothermal or volcanic melting of ice, was also investigated by examining the conductivity–discharge relationship for the two hydr ometric stations. Based on these investigations, it is very unlikely that more than one third of the estimated melt water, if any at all, could have drained into Jökulsá á Fjöllum. It is, therefore, considered more likely that this meltwater was infiltrated into groundwater or drained to other watersheds.