ES15: Advances in cold regions geomorphology

Convener(s): Scott F. Lamoureux and Philip P. Bonnaventure

Co-chairs: Scott F. Lamoureux and Philip P. Bonnaventure

[1] Scott Lamoureux, Department of Geography and Planning, Queen's University, scott.lamoureux@queensu.ca, 613-533-6033;
[2] Philip Bonnaventure, Department of Geography, University of Lethbridge, philip.bonnaventure@uleth.ca, 403-317-5028

Session description

This session seeks to bring together researchers working in cold regions, including polar and mountain settings. Topics will include but are not limited to studies in geomorphic domains including: periglacial, glacial, slope processes and dynamics, as well as fluvial and coastal processes and landforms. In particular research related to interactions with surface and subsurface hydrology, microclimate and vegetation in cold environments will be welcome. Studies can also include topics focusing on geomorphic modelling of both process and distribution or on the use of remote sensing for change detection analysis. Given recent climate change experienced in many cold regions, the geomorphic response of these landscapes and approaches to quantifying process rate changes is especially relevant.

Primary session affiliation

NOTE: THIS DOCUMENT CONTAINS INFORMATION FOR ALL SESSION SUB-SECTIONS. PRESENTER ABSTRACTS ARE FOUND AT THE END OF THE DOCUMENT.

SCHEDULE MAY BE SUBJECT TO CHANGE.

ORAL SESSION ES15a

Chairs: S. Lamoureux and P. Bonnaventure **Room: GEOG 229**

Monday, May 29th

TIME	AUTHORS	TITLE
11:00 (30 min)	Gabriel Chiasson-Poirier, Jan Franssen, Dan Fortier, Tommy Tremblay, Melissa Lafrenière, Jamal Shirley, Scott Lamoureux	Hydrogeomorphic factors controlling the routing of surface and shallow groundwater flows in permafrost environments
11:30	Doug M. Bonno*, Daniel H. Shugar, Jeremy Venditti	Rapid kettle formation due to tsunami erosion of submarine glacier ice, Taan Fiord, Alaska
11:45	Kristen Kennedy, Panya Lipovsky, and Louis-Philippe Roy	Controls on the distribution and frequency of rapid periglacial wasting events in Old Crow, Yukon
12:00	Jonathan Cripps*, Tracy Brennand, Julien Seguinot, Andrew Perkins & John Gosse	Empirically testing the Cordilleran Parallel Ice Sheet Model over the southern Interior Plateau of BC
12:15	Alun Hubbard, Henry Patton, Karin Andreassen, Monica Winsborrow, Arjen P. Stroeven, Amandine Auriac, Jakob Heyman	The evolution and geological legacy of the last Eurasian ice sheet complex

---

SUBMITTED ABSTRACTS

ES15-01 Rapid kettle formation due to tsunami erosion of submarine glacier ice, Taan Fiord, Alaska

Doug M. Bonno[1]*, Daniel H. Shugar[1], Jeremy Venditti[2]

[1] Water, Sediment, Hazards and Earth-surface Dynamics (WaterSHED) Lab, School of Interdisciplinary Arts and Sciences, University of Washington Tacoma, Tacoma, WA, 98402, USA
email: dshugar@uw.edu phone: 253-692-4926
[2] Department of Geography, Simon Fraser University, Burnaby, BC, Canada, V5A 1S6

Abstract
On Oct 17, 2015, a massive landslide collapsed in Taan Fiord, southeast Alaska. Some of the landslide debris covered the terminus of tidewater Tyndall Glacier, but most entered the waters of the fjord, triggering one of the largest tsunamis ever recorded on Earth. The impacts of the tsunami ranged from scouring the ocean floor, to stripping forest cover down fjord to elevations often exceeding 50 m asl. Following the event, high-resolution satellite imagery revealed extensive subaerial white patches ~8 km down fjord that disappeared in subsequent months. We interpret these patches as relict, formerly buried glacial ice that was uncovered during the tsunami. Following erosion of the insulating veneer of sediment, these ice bodies rapidly melted, forming large kettle holes. High-resolution multibeam sonar bathymetric mapping of an adjacent embayment revealed dozens of subaqueous kettles, up to ~15 m deep. We will describe and compare the morphology of these kettles with others from the literature. [154 words]

Presentation type: Poster Presentation

ES15-02 Controls on the distribution and frequency of rapid periglacial wasting events in Old Crow, Yukon

Kristen Kennedy[1], Panya Lipovsky[1], and Louis-Philippe Roy[2]

[1] Yukon Geological Survey, Whitehorse, YT, Y1A 2C6
Phone: 867-393-7188, E-mail: Kristen.Kennedy@gov.yk.ca
[2] Northern Climate ExChange, Yukon Research Centre, Whitehorse, YT

Abstract
Recent community-scale (1:10,000) surficial geological mapping in Old Crow, Yukon Territory, has documented more than 100 landslide head scarp features across the ~6 km long escarpment above the community. Mass wasting processes include both slow periglacial wasting (solifluction, slopewash, nivation), and rapid periglacial wasting processes (thaw detachment slides and retrogressive thaw failures). Thaw detachment slides in the community range in size from very small failures (<10 m^2) to large failures (>5000 m^2) and have the potential to impact both residents and infrastructure. This study characterizes landslide distribution using LiDAR-generated slope and aspect models, as well as stratigraphic and geologic landslide controls. Resulting maps of landslide-related risk can be used for long-term development and planning in the community. Risk mitigation related to the timing of rapidly-forming active layer detachments requires careful monitoring of both heating and precipitation events occurring in middle to late summer when deep seasonal thaw occurs and the region experiences peak rainfall. Radiocarbon ages from mass wasting deposits at the base of the Old Crow escarpment broadly correlate with the Medieval Climate Anomaly (800-1200 years AD), when climate reconstructions for northwestern North America suggested relatively warmer and wetter conditions than modern times. With climate projections for the region suggesting increases in mean temperature and annual precipitation over the coming decades, the frequency and/or magnitude of active layer detachments and other periglacial mass wasting processes may also increase. [229 words]

Presentation type: Oral Presentation

ES15-03 Hydrogeomorphic factors controlling the routing of surface and shallow groundwater flows in permafrost environments

Gabriel Chiasson-Poirier[1], Jan Franssen[1], Dan Fortier[1], Tommy Tremblay[2], Melissa Lafrenière[3], Jamal Shirley[4], Scott Lamoureux[3]

[1] Geography Dept., Université de Montréal, Montréal, QC, H2V 2B8
Phone: (514)-343-6111 x29444, E-mail: jan.franssen@umontreal.ca
[2] Canada-Nunavut Geoscience Office, Iqaluit, Nunavut
[3] Department of Geography and Planning, Queen's University, Kingston, Ontario
[4] Nunavut Research Institute, Iqaluit, Nunavut

Abstract
Climate change is impacting the hydrology of northern rivers. Recent studies suggest that climate change and associated permafrost degradation are contributing to a widespread upward trend in minimum daily flows. Understanding the link between permafrost thaw and altered flow regimes requires fundamental knowledge of the processes controlling the flow and storage of water within the seasonally thawed soils above permafrost (i.e., active layer). However, few field studies have investigated movement of water within the active layer. Better knowledge of active layer processes is critical to our understanding of the impact of climate change on the hydrology, geochemistry, and ecology of northern rivers; and on the delivery of water, nutrients, sediments and carbon to the Arctic Ocean. Here we present preliminary results of a hillslope scale field study conducted in the Niaqunguk (Apex) River watershed located northeast of the City of Iqaluit, Nunavut. To assessed how different thaw depths and deposit characteristics influenced hydrological connectivity across a hillslope-stream sequence we: (i) tracked the flow direction and accumulation patterns of suprapermafrost groundwater across the hillslope, (ii) characterized the relation between the dominant physical controls (i.e., surface or frost-table topography and soil properties) thought to govern the routing of shallow groundwater, and (iii) quantified the relative importance of shallow groundwater contributions compared to other water sources (rain, lakes, overland flow) that contribute streamflow to an adjacent headwater stream. Our results provide fundamental knowledge necessary to determine the impact of climate-related changes on the hydrology of northern rivers. [244 words]

Presentation type: Oral Presentation

ES15-04 The evolution and geological legacy of the last Eurasian ice sheet complex

Alun Hubbard[a], Henry Patton[a], Karin Andreassen [a], Monica Winsborrow [a], Arjen P. Stroeven [b,c], Amandine Auriac [d], Jakob Heyman[e]

[a] CAGE—Centre for Arctic Gas Hydrate, Environment and Climate, Department of Geosciences, UiT The Arctic University of Norway, 9037 Tromsø, Norway. Email: ahu012@uit.no

[b] Geomorphology & Glaciology, Department of Physical Geography, Stockholm University, Stockholm, Sweden
[c] Bolin Centre for Climate Research, Stockholm University, Sweden
[d] Department of Geography, Durham University, South Road, Durham, DH1 3LE, UK
[e] Department of Earth Sciences, University of Gothenburg, Göteborg, Sweden

Abstract
During the last glaciation, Eurasia was covered by three independent ice sheets that between 26 and 19 ka BP coalesced to form a single Eurasian ice-sheet complex (EISC) which had an immense span of over 4,000 km. This complex was the third largest ice mass on the planet, which with a combined volume around three times the present Greenland ice sheet accounted for over 20 m of eustatic sea-level lowering during the Late Glacial Maximum (LGM). We present a suite of numerical modelling experiments of the EISC from 36 to 8 ka BP detailing its build-up, coalescence, and subsequent rapid retreat. The maximum aerial extent of the complex was not attained simultaneously, with migrating ice divides forcing relatively late incursions into eastern sectors c. 20-21 ka BP compared to c. 23-25 ka BP along western margins. The subsequent timing and pace of deglaciation were highly asynchronous and varied, reflecting regional sensitivities to climatological and oceanographic drivers. Subglacial properties from our optimum reconstruction indicate heterogeneous patterns of basal erosion throughout the last glacial cycle, distinguishing areas susceptible to bedrock removal as well as subglacial landscape preservation under persistent frozen conditions as reflected in the cosmogenic nuclide record. High pressure-low temperature subglacial conditions across much of the Barents Sea and Norwegian shelf promoted the formation of extensive gas hydrates. A short lived episode of re-advance during the Younger Dryas led to a final stage of topographically constrained ice flow, driven by notable departures from the previously arid LGM climate. The ice sheet complex along with its isostatic footprint had a major impact on fluvial hydrology of western Eurasia, damming the Baltic and White Sea proglacial lakes from c. 17.8 ka BP through to the Holocene and diverting many river systems. [288 words]

Presentation type: Oral Presentation / Poster

ES15-05 Empirically testing the Cordilleran Parallel Ice Sheet Model over the southern Interior Plateau of BC

Jonathan Cripps[1]*, Tracy Brennand[1], Julien Seguinot[2], Andrew Perkins[1] & John Gosse[3]

1. Department of Geography, Simon Fraser University, Burnaby BC, Canada, V5A 1S6. Email: jecripps@sfu.ca; Phone: +1-778-782-3823
2. Laboratory of Hydraulics, Hydrology and Glaciology, ETH Zurich, Switzerland
3. Department of Earth Sciences, Dalhousie University, Halifax NS, Canada

Numerical ice sheet models that are reliably validated against empirical evidence from ancient ice sheets are vital tools in predicting the future response of modern ice sheets to climate forcing. The last Cordilleran Ice Sheet (CIS) of northwestern North American is likely a good analogue for the modern Greenland Ice Sheet, due to its similar scale and topographic setting, and recent numerical modelling utilising the Parallel Ice Sheet Model (PISM) has assisted in the development of new hypotheses of CIS decay. However, the paucity of empirical studies of the last CIS prevents robust verification of the boundary conditions of the PISM. Evidence from recent studies on the Interior Plateau, central British Columbia (BC), is here compared to PISM results. Ice marginal geometries inferred from moraines and paleo-ice-dammed lakes correspond with general ice margin configurations postdicted by the PISM. New ^{10}Be deglacial ages from the northern Thompson plateau of between 14.7 and 13.6 ka largely conform to modelled ice margin positions using GRIP climate forcing; new and existing ^{10}Be dates from the southern Fraser Plateau and Marble Range of between 15.2 and 14.0 ka are notably older than the GRIP-forced modelled margins in this region, requiring more robust dates or a reassessment of model boundary conditions and/or forcing. Modelled ice-proximal glacioisostatic tilts of around 1.5 m/km are lower than those recorded by ice-dammed lake shorelines and deltas of between 1.7 and 2.5 m/km; this discrepancy may be because the PISM mantle viscosity input is too high, or the ice thickness output is too low. The PISM and recent empirical evidence are in broad agreement. Ongoing research will expand the coverage of empirical studies to validate the PISM over a wider area and test competing hypotheses of the style of last CIS decay.

Presentation Type: Oral Presentation