PROGRAM AND ABSTRACTS

45th International Arctic Workshop
May 10–13, 2015
Bergen, Norway

Supporters

University of Bergen

The Research Council of Norway

Arctic Workshop 2015

45th International Arctic Workshop
May 10–13, 2015
Bergen, Norway

Department of Earth Science
University of Bergen, Norway

Bjerknes Centre for Climate Research
Bergen, Norway

Organizing Committee

Jostein Bakke
University of Bergen and Bjerknes Centre for Climate Research

Martin Miles
Uni Research, Bjerknes Centre for Climate Research, and
Institute for Arctic and Alpine Research (INSTAAR), University of Colorado

Natalia Ivanova
Nansen Environmental and Remote Sensing Center (NERSC)
and Bjerknes Centre for Climate Research

Overview and history

The 45th International Arctic Workshop will be May 10–13, 2015, on the campus of the University of Bergen, Norway. The meeting is hosted by the Department of Earth Science and the Bjerknes Centre for Climate Research. Advisory support is provided by the Institute of Arctic and Alpine Research (INSTAAR), University of Colorado at Boulder. This workshop has grown out of a series of informal annual meetings started by John T. Andrews and sponsored by INSTAAR and other academic institutions worldwide. In keeping with this tradition, there are no formalized topics and the workshop has been organized around themes developed from the abstracts submitted.

Web site

http://arcticworkshop2015.b.uib.no/

Arctic Workshop 2015
Program Summary

SUNDAY 10 MAY

University of Bergen, Natural Science Building 'Realfagbygget', Allégaten 41

17:30–19:30 **Icebreaker Reception** *Department of Earth Sciences, 3rd floor*

MONDAY 11 MAY

University of Bergen, Law Building 'Dragefjellet', Magnus Lagabøtes plass 1

8:00–8:50 **Check-in and Registration** *Atrium* (Upload presentations. Set up posters.)
09:00 **Introduction and Welcome** *Auditorium 2*
09:20 **Paleoceanography I** *Auditorium 2*
10:50 Morning Break *Atrium*
11:10 **Paleoceanography II** *Auditorium 2*
12:25 LUNCH *Cafeteria*
13:05 **Atmosphere–Ocean–Ice Modelling** *Auditorium 2*
14:50 Afternoon Break *Atrium*
15:10 **Glaciology I** *Auditorium 2*
17:00 **POSTER SESSION** *Atrium*
18:00 End of science sessions for Monday

University of Bergen, Natural Science Building 'Realfagbygget', Allégaten 41

19:00 **Students-only pizza and beverages** *Department of Earth Sciences, 3rd floor*

TUESDAY 12 MAY

University of Bergen, Law Building 'Dragefjellet', Magnus Lagabøtes plass 1

8:00–8:20 **Check-in and registration** *Atrium* (Upload presentations.)
08:30 **Surface and subsurface environments** *Auditorium 2*
10:15 Morning Break *Atrium*
10:35 **Glaciology II** *Auditorium 2*
12:20 LUNCH *Auditorium 2*
13:00 **Paleoceanography III** *Auditorium 2*
14:30 Afternoon Break *Atrium*
14:50 **Paleoclimate – "Changes in Arctic hydroclimate"** *Auditorium 2*
16:35 End of science sessions – Announcements

Radisson Blu Royal Hotel, Bryggen

19:00 **Workshop Banquet** (optional) *Vaagen*

WEDNESDAY 13 MAY

University of Bergen, Natural Science Building 'Realfagbygget', Allégaten 41

9:00–18:00 (approximately) **Post-conference Excursion** (optional)

END OF ARCTIC WORKSHOP

Arctic Workshop 2015
Program Details

Sunday 10 May

University of Bergen, Natural Science Building 'Realfagbygget', Allégaten 41

Icebreaker Reception	(Department of Earth Science
17:30–19:30	3rd floor, PhD room 3153)

Monday 11 May

University of Bergen, Law Building 'Dragefjellet', Magnus Lagabøtes plass 1

A.M. MONDAY 11 MAY

8:00 – 8:50	***Check-in, registration, presentation upload, poster placement***	(Atrium)

Welcome and Introduction (Auditorium 2)

9:00	**Introduction** Jostein Bakke and Martin Miles
9:10	**Welcome** Tore Furevik

Paleoceanography I – Atlantic Arctic (Auditorium 2)
Chair: Anne Jennings

9:20	**Early Pliocene Nordic Seas palaeoceanography – relation with ocean gateways** De Schepper, Stijn; Schreck, Michael; Beck, Kristina M.; Mangerud, Gunn; Matthiessen, Jens
9:35	**Sea-ice extent in the Nordic Seas around the Pliocene–Quaternary transition** Clotten, Caroline; Fahl, Kirsten; Stein, Rüdiger; De Schepper, Stijn
9:50	**Last glacial phases on the southern Norwegian margin – evidence from upper continental slope sediment cores.** Becker, Lukas W. M.; Sejrup, Hans Petter; Hjelstuen, Berit Oline; Haflidason, Haflidi; Berstad, Ida
10:05	**Holocene millennial-scale variability of the East Greenland Current and warm subsurface Atlantic waters in northern Denmark Strait** Perner, Kerstin; Jennings, Anne E.; Andrews, John T.; Moros, Matthias; Wacker, Luckas; Jansen, Eystein
10:20	**On the reconstruction of ocean circulation and climate based on the "Gardar Drift"** Mjell, Tor Lien; Langehaug, Helene R.; Otterå, Odd Helge; Eldevik, Tor; Ninnemann, Ulysses S.; Kleiven, Helga (Kikki) F.
10:35	**A brief history of climate - the northern seas from the Last Glacial Maximum to global warming** Eldevik, Tor; Risebrobakken, Bjørg; Bjune, Anne E.; Carin Andersson; Birks, H. John B.; and 8 others
10:50	**Morning Break (20 min.)**

Paleoceanography II – Marine Environments (Auditorium 2)

Chair: Martin Miles

11:10	**History of seafloor methane emissions and relationship to Pleistocene climatic events** Schneider, Andrea; Panieri, Giuliana; Lepland, Aivo; Knies, Jochen
11:25	**Natural variability of benthic foraminiferal assemblages and metal concentrations in the Ingøydjupet trough, SW Barents Sea** Dijkstra, Noortje; Junttila, Juho; Husum, Katrine; Carroll, JoLynn; Hald, Morten
11:40	**Mg/Ca-paleo thermometry for cold water benthic foraminifera: development and application from the Arctic Water-Atlantic Water boundary of the European Arctic** Skirbekk, Kari; Hald, Morten; Junttila, Juho; Marchitto, Thomas Jr.
11:55	**Reconstruction of the annual climate variability of North Atlantic water masses flowing into the Arctic: A molluscan sclerochronological approach** Bonitz, Fabian G. W.; Andersson, Carin; Trofimova, Tamara
12:10	**Lunch Break (55 min.) – Cafeteria**

P.M. MONDAY 11 MAY

Atmosphere–Ocean–Ice Modelling (Auditorium 2)

Chair: Martin Miles

13:05	**Controlled meteorological (CMET) balloon profiling of the Arctic atmospheric boundary layer around Spitsbergen compared to a mesoscale model** Roberts, Tjarda J.; Dütsch, Marina; Hole, Lars R.; Voss, Paul B.
13:20	**Climatology of the atmospheric boundary-layer in the high latitudes** Davy, Richard; Esau, Igor
13:35	**A 23-year Arctic ice-ocean reanalysis with the TOPAZ system using an Ensemble Kalman Filter** Bertino, Laurent; Xie, Jiping; Counillon, Francois
13:50	**Multi-decadal variability in the Arctic** Outten, Stephen; Esau, Igor
14:05	**The stabilizing effect of sea-ice on a freshwater perturbation** Jensen, Mari Fjalstad; Nisancioglu, Kerim Hestnes; Nilsson, Johan
14:20	**Could massive Arctic sea ice export to the North Atlantic be the real cause of abrupt climate change during the last deglaciation?** Coletti, Anthony J.; Condron, Alan
14:35	**Subpolar versus subtropical freshwater forcing: The different role of icebergs and meltwater in triggering abrupt climate change** Condron, Alan
14:50	**Afternoon Break (20 min.)**

Glaciology I (Auditorium 2)
Chair: Jostein Bakke

15:10	**Simulated englacial tracer transport to reconstruct past climates and ice sheet volumes** Born, Andreas
15:25	**Growth and decay of the last Eurasian Ice Sheets; a chronological database and time-slice reconstruction, DATED-1** Hughes, Anna; Gyllencreutz, Richard; Mangerud, Jan; Svendsen, John Inge; Lohne, Øystein S.
15:40	**Glacial and climate history over the last 60,000 yrs inferred from lake records in the Polar Urals, Russian Arctic** Svendsen, John-Inge; Bakke, Jostein; Bjune, Anne; Haflidason, Haflidi; Nordvik Hovland, Morten
15:55	**A dynamical marine-based ice sheet on the n-Norwegian shelf, from late MIS-3 to Heinrich Stadial 1** Brendryen, Jo; Haflidason, Haflidi; Rise, Leif; Chand, Shyam; Vanneste, Maarten; Longva, Oddvar; L'Heureux, Jean S.; Forsberg, Carl F.
16:10	**Interpreting the moraine record of debris-covered glaciers: A Neoglacial case study on Baffin Island, Arctic Canada** Crump, Sarah; Anderson, Leif; Miller, Gifford H.; Anderson, Robert S.
16:40	**GIS-analyses of lake density and terrain ruggedness to identify ice-sheet erosional impacts on the exposed shield of Baffin Island, Eastern Canadian Arctic** Ebert, Karin

Afternoon Refreshment

Poster Session – **List of Presentations: pgs. 10 –12** (Atrium)
17:00–18:00

University of Bergen, Natural Science Building 'Realfagbygget', Allégaten 41

Students-only pizza and beverages (Department of Earth Science, 3rd floor)
19:00–

Tuesday 12 May

University of Bergen, Law Building 'Dragefjellet', Magnus Lagabøtes plass 1

A.M. TUESDAY 12 MAY

8:00 – 8:20	***Check-in, registration, presentation upload***	(Atrium)

Surface and subsurface environments

(Auditorium 2)

Chair: Ninis Gunhild Rosqvist

8:30	**Late Pliocene - Pleistocene depositional environments in the northern North Sea** Reinardy, Benedict; Hjelstuen, Berit; Sejrup, Hans Petter; Augedal, Hans
8:45	**The Weichselian chronostratigraphical framework of the Kongsfjorden Fan System, W-Spitsbergen** Wiberg, Daniel H.; Haflidason, Haflidi; Laberg, Jan Sverre
9:00	**Morphologies and triggers of submarine mass failures in Frobisher Bay, Baffin Island, Nunavut** Deering, Robert; Bell, Trevor; Forbes, Don
9:15	**Dynamic simulations of potential methane release from the East Siberian continental slope sediments** Stranne, Christian; Jakobsson, Martin; O'Regan, Matt
9:30	**Effects of excess ground ice on projections of permafrost in a warming climate** Lee, Hanna; Swenson, Sean C.; Slater, Andrew G.; Lawrence, David M.
9:45	**Exploring of subsurface flowpaths in arctic hillslopes** Votyek, Emily; Rushlow, Caitlin; Godsey, Sarah; Singha, Kamini
10:00	**Climate, grass growth, and hay yield in northeastern Iceland A.D. 1700 to 1950** Ogilvie, Astrid; Sigurðardóttir, Ragnhildur; Júlíusson, Árni Daníel; Hreinsson, Viðar; Hicks, Megan
10:15	**Morning Break (20 min.)**

Glaciology II

(Auditorium 2)

Chair: Jason Briner

10:35	**Holocene tephra on South Georgia** Oppedal, Lea Toska; Bakke, Jostein; Balascio, Nicholas; Øyvind, Paasche
10:50	**Arctic Holocene glacier fluctuations reconstructed from lake sediments at Mitrahalvøya, Spitsbergen** Røthe, Torgeir; Bakke, Jostein; Vasskog, Kristian; Gjerde, Marthe; D'Andrea, William J.; Bradley, Raymond S.
11:05	**A full Holocene record of glacier variability on Svalbard reveals a dynamic Holocene in the Arctic** van der Bilt, Willem G. M.; Bakke, Jostein; Vasskog, Kristian; D'Andrea, William J.
11:20	**Fluctuations of local glaciers in western Greenland during the late Holocene** Schweinsberg, Avriel D.; Briner, Jason P.; Miller, Gifford H.; Bennike, Ole
11:35	**Deglaciation and late Holocene glacier re-advances beyond the LIA extension in Hornsund, Svalbard, based on 10Be surface exposure ages** Gislefoss, Lina; Linge, Henriette; Hormes, Anne; Fabel, Derek; Xu, Sheng

11:50	**The deglaciation of Kongsfjorden, Svalbard, based on surface exposure dating of glacial erratics and Quaternary mapping of Blomstrandhalvøya** Grant, Oliver; Linge, Henriette; Hormes, Anne; Fabel, Derek; Xu, Sheng
12:05	**Reconstructing southwestern Scandinavian Ice Sheet history using 10Be dating** Gump, Dale; Briner, Jason P.; Svendsen, John-Inge; Mangerud, Jan
12:20	**Lunch Break (40 min.) – Auditorium**

P.M. TUESDAY 11 MAY

Paleoceanography III – N American and Atlantic Arctic (Auditorium 2)
Chair: Olafur Ingolfsson

13:00	**Was Baffin Bay covered by an ice shelf during the LGM and H1?** Jennings, Anne; Andrews, John; Ó Cofaigh, Colm; St-Onge, Guillaume; Belt, Simon; Cabedo-Sanz, Patricia
13:15	**Marine signature of early Holocene glacial events of the eastern margin of the Laurentide Ice Sheet** Pearce, Christof; Andrews, John T.; Bouloubassi, Ioanna; Hillaire-Marcel Claude; Jennings, Anne E.; Olsen, Jesper; Williams, James; Kuijpers, Antoon; Seidenkrantz, Marit-Solveig
13:30	**Age and origin of multiple ice-rafted debris horizons in the Canadian Beaufort Sea: implications for Arctic Ocean stratigraphy and paleoclimate** Lakeman, Thomas; Pieńkowski, Anna J.; Nixon, F. Chantel; Furze, Mark F. A.; Blasco, Steve; Andrews, John T.
.13:45	**The marine signal of a collapsing ice margin: the catastrophic advance and collapse of the end Pleistocene Viscount Melville Sound Ice Shelf, Canadian Arctic Archipelago** Furze, Mark F. A.; Pieńkowski, Anna J.; Nichols, Keir A.; Reedman, Amy; Esteves, Mariana S. R.; Cage, Alix G.; Bennett, Robbie
14:00	**Atlantic water inflow in the early Holocene Northwest Passage marked by planktonic foraminifera (Neogloboquadrina pachyderma)** Pienkowski, Anna J.; Cage, Alix G.; Furze, Mark F. A., de Figueiredo Martins, A. S., England, John; MacLean, B.; Blasco, Steve
14:15	**Holocene paleomagnetic synchronized records from the Arctic** Ólafsdóttir, Sædís; Bakke, Jostein; Stoner, Joseph
14:30	**Afternoon Break (20 min.)**

Paleoclimate – "Changes in Arctic Hydroclimate" (Auditorium 2)
Chairs: Ray Bradley

14:50	**High Resolution brGDGT-based paleotemperatures from Marine Isotope Stage 31 at Lake El'gygytgyn: a 50,000 year long interglacial in Siberia prior to the Mid-Pleistocene Transition?** De Wet, Greg; Castañeda, Isla; Brigham-Grette, Julie; Salacup, Jeff
15:05	**Holocene environmental changes in the Skallingen area, eastern North Greenland, based on a lacustrine record** Bennike, Ole; Wagner, Bernd

15:20	**Algal pigments display varying response to Holocene climate variability between lakes in Baffin Island and Iceland** Florian, Christopher R.; Miller, Gifford H.; Geirsdottir, Áslaug; Fogel, Marilyn L.; Wolfe, Alexander P.; Vinebrooke, Rolf D.
15:35	**Using modern gridded climate data to help interpret terrestrial paleoclimate records: Application to Iceland and the North Atlantic region** Anderson, Leif; Geirsdóttir, Áslaug; Miller, Gifford
15:50	**Abrupt centennial-scale departures superimposed on Holocene insolation forcing across the northern North Atlantic** Geirsdóttir, Áslaug; Miller, Gifford H.; Briner, Jason; Schweinsberg, Avriel; Pendleton, Simon; Larsen, Darren; Florian, Christopher
16:05	**High-resolution hydroclimate records from glacier-fed lakes** Vasskog, Kristian; Bakke, Jostein; Nielsen, Pål Ringkjøb; Meidell, Susanne
16:20	**Regime shifts in the northern North Atlantic during the past 6,000 years: A record of seabird population size and precipitation isotopes on Bjørnøya, Svalbard** De Andrea, William J.; Hormes, Anne; Bakke, Jostein; Nicolaisen, Line

END OF SCIENCE SESSIONS

Announcements

Radisson Blu Royal Hotel, Bryggen

Conference dinner (optional) (Vaagen)
19:00–

Wednesday 13 May

University of Bergen, Natural Science Building 'Realfagbygget', Allégaten 41

Post-conference excursion (optional) (Allégaten 41)
9:00–18:00 (approximately)

Wear hiking shoes and weatherproof clothing

END OF ARCTIC WORKSHOP 2015 – Thanks for attending!

Poster Session
List of presentations

1	**Combining terrestrial and marine glacial archives – a geomorphological map of Nordenskiöldbreen forefield, Svalbard** Allaart, Lis; Friis, Nina; Ingólfsson, Ólafur; Schomacker, Anders; Håkansson, Lena; Noormets, Riko
2	**Sea surface temperature variability in the eastern Nordic Seas during the Pliocene** Bachem, Paul Eduard; Risebrobakken, Bjørg; McClymont, Erin
3	**'Black ice' formation in the Hurrungane mountains, Norway?** Bergbjørn, Anna Karin; de Villiers, Simon; Yde, Jacob Clement
4	**Active layer thickness and soil organic carbon of frozen peatlands: relationship and spatial variability (CALM R1, western Siberia, Russia)** Bobrik, Anna; Goncharova, Olga; Matyshak, Georgy
5	**The Latest Pleistocene and Holocene glacier record from the Brooks Range, Arctic Alaska** Briner, Jason P.; Pendleton, Simo; Ceperley, Liz; Kaufman, Darrell; Zimmerman, Susan
6	**High-resolution Holocene reconstruction of Annabreen glacier from proximal Gjøavatnet Lake sediments, Amsterdamøya, NW Svalbard** de Wet, Greg; Bakke, Jostein; Gjerde, Marthe
7	**Bio-monitoring using benthic foraminiferal assemblages – examples from the SW Barents Sea** Dijkstra, Noortje; Junttila, Juho; Sørensen, Steffen Aagaard
8	**A sub-centennial view of Holocene modulations within the Earth's largest ice and freshwater pathway: The East Greenland Current** Dylmer, Christian Valdemar; Miles, Martin
9	**Neoglaciation and Little Ice Age (LIA) glaciers and ice caps on Svalbard** Farnsworth, Wesley R.; Ingólfsson, Ólafur; Schomacker, Anders; Retelle, Michael
10	**Arctic and Subarctic Ostracode Database: Biogeographic and paleoceanographic applications** Gemery, Laura; Cronin, T. M.; Briggs, Jr., W. M., Brouwers, E. M. ; Stepanova, A.; Wood, A. M.; Yasuhara, M.
11	**Reconstructed Holocene glacier activity and Neoglacial winter precipitation at Ålfotbreen, western Norway, using distal glacier-fed lake sediments** Gjerde, Marthe; Bakke, Jostein; Vasskog, Kristian; Nesje, Atle; Hormes, Anne
12	**Coastal to Central: Integrating late-Holocene lacustrine climate proxies in NW Iceland** Gunnarson, Sydney; Geirsdóttir, Áslaug; Miller, Gifford
13	**The frequency and pattern of the volcanic activity in the N-Atlantic petrographic province during the last glacial period: a record from the deep-sea core PS2644, South Greenland Sea** Haflidason, Haflidi; Voelker, Antje H. L.
14	**Mapping glacier change between the end of "Little Ice Age" and 2008 using orthophotos and a DEM** Hamré; Moa; Rosqvist, Gunhild; Jansson, Peter; Holmlund, Per

15 **Reconstructing Holocene climate and ice cap evolution in Vestfirðir, Iceland**
Harning, David; Geirsdóttir, Áslaug; Miller, Gifford

16 **To what extent can the available historical temperature proxy network be utilised for investigating Arctic amplification**
Hind, Alistair; Zhang, Qiong

17 **Acoustic communication signals underneath the Arctic sea ice**
Hope, Gaute; Sagen, Hanne

18 **Deglaciation history of Bjørnøya, Svalbard, between 25 ka and 12.9 ka**
Hormes, Anne; Briner, Jason

19 **A 2000 year record of marine climate variability from Arnarfjörður, NW Iceland**
Jónsdóttir, Ingibjörg R.; Ólafsdóttir, Sædís; Geirsdóttir, Áslaug

20 **Seasonal changes in benthic foraminifera assemblages in surface sediments of Adventfjorden (west Spitsbergen) – preliminary winter studies results**
Kucharska, Małgorzata; Łącka, Magdalena; Pawłowska, Joanna; Lønne, Ole Jørgen; Zajączkowski, Marek

21 **New insight on the age and geomorphic history of tuyas in the northern volcanic zone of Iceland from cosmogenic 36Cl surface exposure dating**
Licciardi, Joseph M.; Houts, Amanda N.; Bryce, Julia G.; Finkel, Robert C.; Zimmerman, Susan H.

22 **Microbial diversity and community structure along a glacier forefield chronosequence at Styggedalsbreen, central Norway**
Mateos-Rivera, Alejandro; Øvreås, Lise; Reigstad, Laila J.; Finster, Kai W.; Yde, Jacob C.

23 **Trends in the normalized difference vegetation index (NDVI) associated with urban development in arctic and subarctic Western Siberia**
Miles, Victoria; Esau, Igor; Davy, Richard; Kurchatova, Anna

24 **Chronology of the last retreat of the Norwegian Channel Ice Stream**
Morén, Björn M.; Sejrup, Hans Petter; Hjelstuen, Berit Oline

25 **New magnetostratigraphic results from the Polar Urals, Russia: indication of a short lasting excursion**
Ólafsdóttir, Sædís; Svendsen, John-Inge; Bakke, Jostein; Haflidason, Haflidi; Stoner, Joseph; Hovland, Morten N.

26 **An emerging perspective on Quaternary cryosphere–climate interactions and landscape evolution on Cumberland Peninsula, Baffin Island**
Pendleton, Simon; Miller, Gifford; Crump, Sarah

27 **Using 10Be dating to improve the history of the Svalbard-Barents Sea Ice-Sheet on Kong Karls Land, Svalbard: preliminary results**
Philipps, William; Briner, Jason P.; Koffman, Toby; Hormes, Anne

28 **Holocene equilibrium line altitude (ELA) reconstructions in Sarek National Park, northern Sweden**
Regnéll, Carl; Hormes, Anne

29 **Environmental impact of submarine mine tailings deposited between 1972–1978 in Repparfjorden, northern Norway – preliminary results**
Skirbekk, Kari; Sternal, Beata; Junttila, Juho; Forwick, Matthias; Carroll, JoLynn

30	**XRF analysis of lacustrine sediment from Linnévatnet, Svalbard** Strand, Sarah
31	**Earth Surface Sediment Laboratory (EARTHLAB)** Støren, Eivind Wilhelm Nagel; Bakke, Jostein
32	**Challenges and perspectives in coastal environmental reconstructions based on Arctica islandica sclerochronological records from the eastern Norwegian Sea** Trofimova, Tamara; Andersson, Carin
33	**Marine outlet glacier stability on centennial time scales** Åkesson, Henning; Nisancioglu, Kerim H.; Svendsen, John-Inge; Mangerud, Jan; Hughes, Anna; Vasskog, Kristian; Nick, Faezeh M.

Arctic Workshop 2015
List of Participants

Allaart, Lis
The University Centre in Svalbard, Norwegian University of Science and Technology
lis.allaart@unis.no

Anderson, Leif
Institute of Earth Sciences, University of Iceland
leifstefanthor@gmail.com

Andersson Dahl, Carin
Uni Research
carin.andersson@uni.no

Bachem, Paul
Uni Research Climate
paul.bachem@uni.no

Bakke, Jostein
Department of Earth Sciences, University of Bergen
jostein.bakke@geo.uib.no

Balino, Beatriz
Bjerknes Centre for Climate Research
beatriz.balino@uib.no

Barry, Roger
NSIDC, Univ of Colorado, Boulder,
rbarry@nsidc.org

Becker, Lukas
University of Bergen
lukas.becker@uib.no

Bennike, Ole
GEUS
obe@geus.dk

Berben, Sarah
University of Bergen
sarah.berben@uib.no

Bergbjørn, Karin
Faculty of Engineering and Science, Sogn og Fjordane University College, Norway
karinbergbjorn@outlook.com

Bertino, Laurent
Nansen Environmental and Remote Sensing Center
laurent.bertino@nersc.no

Bjune, Anne E
Uni Research Climate
anne.bjune@uni.no

Bobrik, Anna
Department of Soil Science, Lomonosov Moscow State University
ann-bobrik@yandex.ru

Bonitz, Fabian
Uni Research Climate Bergen
fabian.bonitz@uni.no

Born, Andreas
Climate and Environmental Physics, University of Bern
born@climate.unibe.ch

Bradley, Raymond
University of Massachusetts, Amherst
rbradley@geo.umass.edu

Brendryen, Jo
Department of Earth Science, University of Bergen
jo.brendryen@geo.uib.no

Briner, Jason
University at Buffalo
jbriner@buffalo.edu

Clotten, Caroline
Uni Research Climate, Bjerknes Centre for Climate Research
caroline.clotten@uni.no

Coletti, Anthony
University of Massachusetts-Amherst
ajcolett@geo.umass.edu

Condron, Alan
University of Massachusetts-Amherst
alan.condron1@gmail.com

Crump, Sarah
University of Colorado - Boulder
sarah.crump@colorado.edu

D'Andrea, William
Lamont-Doherty Earth Observatory
dandrea@ldeo.columbia.edu

Davy, Richard
Nansen Environmental and Remote Sensing Center, Bjerknes Centre
richard.davy@nersc.no

De Schepper, Stijn
Uni Research Climate and Bjerknes Centre for Climate Research
stijn.deschepper@uni.no

de Wet, Greg
University of Massachusetts, Amherst
gdewet89@gmail.com

Deering, Robert
Department of Geography, Memorial University of Newfoundland
rld453@mun.ca

Dijkstra, Noortje
UiT - Department of Geology
noortje.dijkstra@uit.no

Dylmer, Christian Valdemar
Uni Research Climate, Bjerknes Centre for Climate Research
christian.dylmer@uib.no

Ebert, Karin
Department of Physical Geography, Stockholm University
karin.ebert@natgeo.su.se

Farnsworth, Wesley
The University Centre in Svalbard
WesleyF@unis.no

Florian, Christopher
University of Colorado, INSTAAR and Geological Sciences Institute of Earth Sciences, University of Iceland
florian@colorado.edu

Furevik, Tore
Bjerknes Centre for Climate Research
tore.furevik@gfi.uib.no

Furze, Mark
MacEwan University, Alberta, Canada
furzem@macewan.ca

Geirsdóttir, Áslaug
Institute of Earth Sciences, University of Iceland
age@hi.is

Gemery, Laura
U.S. Geological Survey
lgemery@usgs.gov

Gislefoss, Lina
University of Bergen, University Centre in Svalbard
linagislefoss@hotmail.com

Gjerde, Marthe
University of Bergen
Marthe.gjerde@uib.no

Grant, Oliver
University of Bergen
ogr013@student.uib.no

Gump, Dale
SUNY Buffalo
dale.gump@gmail.com

Gunnarson, Sydney
University of Iceland
sydney.gunnarson@gmail.com

Haflidason, Haflidi
University of Bergen, Department of Earth Science
Haflidi.Haflidason@uib.no

Hall-McKim, Eileen
University of Colorado
eileen.mckim@colorado.edu

Harning, David
University of Iceland
dharning@gmail.com

Hind, Alistair
Department of Mathematics
alistair.hind@natgeo.su.se

Hjelstuen, Berit Oline
University of Bergen
berit.hjelstuen@uib.no

Hole, Lars Robert
Norwegian Meteorological Institute
lrh@met.no

Hope, Gaute
Nansen Environmental and Remote Sensing Center
gaute.hope@nersc.no

Hormes, Anne
University Centre in Svalbard/ University of Gothenburg
anne.hormes@gvc.gu.se

Hughes, Anna
University of Bergen
anna.hughes@uib.no

Ingolfsson, Olafur
University Centre in Svalbard (UNIS)
olafuri@unis.no

Ivanova, Natalia
Nansen Environmental and Remote Sensing Center
natalia.ivanova@nerc.no

Jansen, Eystein
Bjerknes Centre for Climate Research/University of Bergen
eystein.jansen@uib.no

Jennings, Anne
INSTAAR, University of Colorado
anne.jennings@colorado.edu

Jensen, Mari Fjalstad
University of Bergen
mari.f.jensen@uib.no

Jónsdóttir, Ingibjörg R.
Institute of Earth Sciences, University of Iceland
irj2@hi.is

Kucharska, Małgorzata
Institute of Oceanology, Polish Academy of Sciences
malkuch@iopan.gda.pl

Lakeman, Thomas
Geological Survey of Norway
Thomas.Lakeman@ngu.no

Langehaug, Helene Reinertsen
Nansen Environmental and Remote Sensing Center
helene.langehaug@nersc.no

Lee, Hanna
Uni Research Climate
hlee6321@gmail.com

Licciardi, Joseph
University of New Hampshire
joe.licciardi@unh.edu

Lind, Ewa
Stockholm University
ewa.lind@natgeo.su.se

Linge, Henriette
Department of Earth Science, UiB and Bjerknes Centre
henriette.linge@uib.no

Mangerud, Jan
University of Bergen
Jan.Mangerud@uib.no

Mateos-Rivera, Alejandro
Department of Biology, University of Bergen
alejandro.mateos.rivera@hisf.no

Meckler, Nele
Department of Earth Sciences, University of Bergen
nele.meckler@uib.no

Miles, Victoria
Nansen Environmental and Remote Sensing Center
victoria.miles@nerc.no

Miles, Martin
Uni Research Climate, Bjerknes Centre of Climate Research, and INSTAAR
martin.miles@uni.no

Morén, Björn
Dept. of Earth Science, University of Bergen
bjorn.moren@uib.no

Müller, Oliver
University of Bergen
Oliver.Muller@bio.uib.no

Nisancioglu, Kerim Hestnes
Department of Earth Science, University of Bergen
kerim@uib.no

Ogilvie, Astrid
Stefansson Arctic Institute and INSTAAR
astrid.ogilvie@colorado.edu

Ólafsdóttir, Sædís
Department of Earth Science, University of Bergen
saedis.olafsdottir@gmail.com

Oppedal, Lea Toska
Department of Earth Science, University of Bergen, Bjerknes Centre for Climate Research
lea.oppedal@uib.no

Outten, Stephen
Nansen Environmental and Remote Sensing Center
stephen.outten@nersc.no

Paasche, Øyvind
Bergen Marine Research Cluster
oyvind.paasche@uib.no

Pearce, Christof
Department of Geological Science, Stockholm University
christof.pearce@geo.su.se

Pendleton, Simon
University of Colorado Boulder/INSTAAR
simon.pendleton@colorado.edu

Perner, Kerstin
Leibniz Institute for Baltic Sea Research
kerstin.perner@io-warnemuende.de

Philipps, William
University at Buffalo
wep3@buffalo.edu

Pienkowski, Anna
MacEwan University (Canada)
pienkowskia@macewan.ca

Regnéll, Carl
Göteborg University
carlregnell@gmail.com

Reinardy, Benedict
University of Bergen
benedict.reinardy@uib.no

Risebrobakken, Bjørg
Uni Research Climate and the Bjerknes Centre for Climate Research
bjorg.risebrobakken@uni.no

Rosqvist, Ninis Gunhild
Stockholm university, University of Bergen
gunhild.rosqvist@natgeo.su.se

Røthe, Torgeir Opeland
Dept. of Earth Science, University of Bergen
torgeir.rothe@geo.uib.no

Schneider, Andrea
University of Tromsø, CAGE
andrea.schneider@uit.no

Schweinsberg, Avriel
University at Buffalo
a.schweinz@gmail.com

Sejrup, Hans Petter
University of Bergen
sejrup@uib.no

Simon, Margit
Uni Research Climate
margit.simon@uni.no

Skirbekk, Kari
Department of Geology, University of Tromsø
kari.skirbekk@uit.no

Skoglund, Rannveig Øvrevik
Department of Geography, University of Bergen
Rannveig.skoglund@uib.no

Strand, Sarah
The University Centre in Svalbard
sarahstranded@gmail.com

Stranne, Christian
Department of Geological Sciences, Stockholm University
christian.stranne@geo.su.se

Støren, Eivind
University of Bergen
eivind.storen@uib.no

Svendsen, John Inge
Dept. of Earth Science, University of Bergen
John.Svendsen@geo.uib.no

Trofimova, Tamara
Uni Research Climate
tamara.trofimova@uni.no

van der Bilt, Willem
University of Bergen
willemvanderbilt@geo.uib.no

Vasskog, Kristian
University of Bergen
kristian.vasskog@uib.no

Voytek, Emily
Colorado School of Mines
evoytek@mines.edu

Wiberg, Daniel
University of Tromsø. Department of Geology.
daniel.h.wiberg@uit.no

Åkesson, Henning
Department of Earth Science, Bjerknes Centre for Climate Research
henning.akesson@uib.no

Arctic Workshop 2015
Abstracts

Combining terrestrial and marine glacial archives – a geomorphological map of Nordenskiöldbreen forefield, Svalbard

Allaart, Lis (1,2), Friis, Nina (1,3) Ingólfsson, Ólafur (1,4), Schomacker, Anders (2), Håkansson, Lena (1,2) and Noormets, Riko (1)

1 Arctic geology department, University Centre in Svalbard, Norway; 2 Department of Geology and Mineral Resources Engineering, Norwegian University of Science and Technology, Trondheim, Norway; 3 Department of geosciences and natural resource management, University of Copenhagen, Denmark; 4 Institute of Earth Sciences, University of Iceland, Reykjavík, Iceland

Abstract: Many of the Svalbard ice caps and glaciers reached their maximum Holocene extent during the Little Ice Age (LIA). Studying these landsystems is important to improve our understanding of glacier and ice cap response to climate fluctuations. A better understanding of the glacier behaviour is crucial for giving better input to the climate modellers.

It is a necessity to assess both the marine and terrestrial record as some glacial fingerprints are better preserved in the marine realm. Nordensköldbreen is a polythermal, tidewater glacier located in inner Billefjorden, central Spitsbergen. It is one of the three main outlet glaciers draining the Lomonosov ice cap and terminates in Adolfbukta. This on-going MSc project aims to produce a high-resolution geomorphological map of the recently deglaciated area in front of Nordenskiöldbreen. A holistic approach is taken and the map will be created in ArcGIS software on the background of analysis of aerial images (from 2009) and high-resolution swath bathymetry from the fjord. Ground verification was partly carried out during a field campaign in August 2014 and is to be finished in July 2015.

Nordenskiöldbreen has been overriding a marine basin, as shell fragments are found in the subglacially shaped landforms. Several drumlins, flutes and glacially scoured bedrock occur in the glacial forefield. Drumlins are thought to be either erosional or depositional landforms, but our data suggests that the Nordenskioldbreen drumlins were formed by a combination of the two processes. The working hypothesis is that the landforms were created during Little Ice Age (LIA) advances, but could possibly originate from a short-lived surge event.

The outcome of the study will be a high-resolution geomorphological map and landsystem model for a polythermal tidewater glacier with sediment-landform association. The project is a part of the larger research project: “Holocene history of Svalbard Ice Caps and Glaciers”.

Using modern gridded climate data to help interpret terrestrial paleoclimate records: Application to Iceland and the North Atlantic region

Anderson, Leif (1), Áslaug Geirsdottir (1), Gifford Miller (2)

1 Institute of Earth Sciences, University of Iceland; 2 Department of Geological Sciences, University of Colorado-Boulder

Abstract: The prediction of future climate depends on our understanding of the climate systems' sensitivity to changes in forcings. Quaternary paleoclimate reconstructions are especially important as they provide insight into climate states significantly different from the present, allowing us to test climate model sensitivity. Constraining the uncertainty of paleoclimate reconstructions and their spatial coherence is therefore of the utmost importance. Glacier dimensions (or lake sediment core derived proxies) provide vital indications of past climate. But the interpretation of these records can be complicated by the myriad influences on each system (glacier or lake). In order to improve the interpretation of these records and better constrain their spatial relevance to Iceland we apply several methods using gridded climate (and sea surface temperature) data from the last 60 years. We explore temperature and precipitation spatial coherence across the North Atlantic region. We also use an energy-balance-based mass balance model to explore the pattern of modern ELAs around the North Atlantic as well as ELA sensitivity to climate variability (Rupper and Roe, 2008). These analyses, based on modern data, are most relevant to Holocene climate states because of the similarity of boundary conditions through the last 10 thousand years.

Year-to-year summer air temperature variations are strongly coherent across Iceland and East Greenland. Positive summer air temperature correlations exist between southeast Baffin Island, West Greenland, Svalbard, and Iceland, implying that proxies dependent on summer air temperature may show similar responses across the region. Year-to-year precipitation variability has a similar, yet contracted pattern compared to summer air temperature, but with no correlation between southeast Baffin, West Greenland, Svalbard, and Iceland. Based on the correlation of summer air temperature and winter precipitation across the North Atlantic, glacier response in Iceland and East Greenland should be coherent for glaciers of similar geometry. If glacier response is primarily controlled by summer air temperature then glacier response may show some coherence between southeast Baffin, West Greenland, Svalbard, and Iceland. Summer air temperature over Iceland shows a strong positive correlation with summer SSTs in the Norwegian Sea (correlation coefficient of 0.7). The coherence between SSTs and air temperature opens the possibility that past air temperatures over Iceland could be reconstructed from paleo SSTs proxies.

Sea surface temperature variability in the eastern Nordic Seas during the Pliocene

Bachem, Paul Eduard (1,2); Risebrobakken, Bjørg (1); McClymont, Erin (2)

1 Uni Research Climate, and Bjerknes Centre for Climate Research, Bergen, Norway; 2 Department of Geography, Durham University, Durham, DH1 3LE, UK

Abstract: The Nordic Seas, made up of Norwegian Sea, Greenland Sea and Iceland Sea, are small on the global scale but present a highly dynamic and oceanographically complex setting of great importance. The North Atlantic current brings warm water into the Nordic Seas which flows northward through the Norwegian Sea and partially into the Arctic Sea. As the initially warm water cools along its route, it becomes an important factor in the formation of deep water.

In order to estimate the range of natural variability, and in anticipation of a future climate that is globally warmer than during any time in human history, we investigate the setting of the Nordic Seas during the Pliocene epoch. The Pliocene is understood to be on average several degrees warmer than today and northern hemisphere glaciation had not yet been established.

Here we present a sea surface temperature (SST) record from the Norwegian Sea covering part of the Pliocene. This new record, based on the alkenone biomarker proxy, shows the range of SST variability and several episodes of noteworthy climate change that took place in the Nordic Seas during the generally warm Pliocene.

Last glacial phases on the southern Norwegian margin – evidence from upper continental slope sediment cores.

Becker, Lukas W.M., Hans Petter Sejrup, Berit Oline Hjelstuen, Haflidi Haflidason
Ida Berstad

Department of Earth Sciences, University of Bergen

Abstract: The NW European continental margin was repeatedly covered by shelf edge glaciations during the last glacial cycles. Here, we present a compilation of new and previously published data from seven sediment cores raised from the upper continental slope close to the shelf edge from Rosemary Bank, west of Scotland, in the south to the Vøring Plateau, mid-Norwegian margin, in the north. These cores cover the period from 10 to 40 ka BP and monitor the Atlantic inflow via the Norwegian Atlantic surface current.

This study focuses on Ice Rafted Debris (IRD) and includes chalk grain counts as well as IRD flux data. The presence of sub polar planktonic foraminifera (% Neoglobigerinoides pachyderma sinistral) is used as a proxy for the strength of the inflow of warm Atlantic surface water. To ensure comparable chronologies, new age models have been constructed for all cores with a smooth spline function through AMS C14 dates in the R-based software CLAM. The age models are not corrected for a local reservoir effect, which is suggested to be up to 800 a in this age interval.

The main finding is the general similar development in all cores for the investigated parameters. However, the northern core MD99-2289 does not show any IRD flux signal in the period between 33.5 and 27 ka. Furthermore, during this period core MD99-2283, located at the southern edge of the North Sea Fan, shows much finer grains compared to the IRD deposited during the 24.5-18.5 ka interval (LGM) indicating a different source region and/or different processes involved. Compared to the Rosemary Bank core, it is likely that this source region is connected to the British Irish Ice Sheet (BIIS). This suggests that the Norwegian Channel Ice Stream (NCIS) was only active during the 24.5-18.5 ka interval, bringing much coarser sediment to the location of MD99-2283 and the cores further north. The activity of the NCIS, however, seems to have varied throughout the LGM and can generally be divided into four events. Especially the first event is characterised by a large spike in chalk grains, most likely with a provenance from northern Denmark / southern Skagerrak. A spike in warm surface water, reflected in the planktonic foraminifera counts, preceded each of these IRD spikes. This suggests that some of the LGM variability in the extent of the NCIS is related to a change in water temperature.

A large meltwater plume event, close to 18.5 ka, is identified in both northernmost cores through rapidly deposited, laminated sediments. This plume may reflect that the NCIS has retreated/lowered so much that the BIIS and the Fennoscandian Ice Sheet unzipped and meltwater/ice dammed sourced water were drained into the Norwegian Channel and deflected northwards into the North Atlantic.

Holocene environmental changes in the Skallingen area, eastern North Greenland, based on a lacustrine record

Bennike, Ole (1); Wagner, Bernd

1 Geological Survey of Denmark and Greenland; 2 University of Cologne

Abstract: The Skallingen area in North-East Greenland was deglaciated in the early Holocene, prior to 8200 cal. a BP. Deglaciation was probably triggered by high temperatures, but it took more than 1000 years until the lake and the catchment had stabilised. Chironomids were amongst the first invertebrates to colonise the lake. The fossil chironomid assemblage is fairly rich and comparable to other records from farther south in Greenland. The pioneer vegetation in the area consisted of mosses and herbaceous plants. The oldest remains of woody plants (Salix arctica) are dated to c. 7700 cal. a BP, and remains of Dryas integrifolia appear at around 6.7 cal. ka BP; these are the only woody plants recorded. Maximum concentrations of chironomids, maximum occurrence of ephippia of the water flea Daphnia pulex, highest organic matter contents and lowest minerogenic input from c. 7700 to 4400 cal. a BP probably reflects the Holocene thermal maximum (HTM), but the peak of the HTM may have occurred around 7000 cal. a BP, based on the occurrence of Salix arctica. Comparisons with Holocene records from East and North Greenland show similar immigration histories and similar trends, but the timing of the HTM differs from site to site, partly due to delayed deglaciation. The occurrence of several warmth-demanding species in the early Holocene sediments indicates redeposition from interglacial layers and implies that temperatures in the past were significantly higher than during the Holocene HTM.

‘Black ice’ formation in the Hurrungane mountains, Norway?

Bergbjørn, Anna Karin; Villiers, Simon de; Yde, Jacob Clement

Faculty of Engineering and Science, Sogn og Fjordane University College, Norway

Abstract: The term ‘Black Ice’ that is used within the alpine climbing community refers to a type of ice typically encountered on steep (greater than 45˚) non sun exposed aspects at high relative altitude in glaciated mountain regions. ‘Black ice’ is often encountered during dry/cold season when accumulation of recent snow deposits on steep alpine faces is at a yearly minimum. The name comes from the observation that it has a darker color than is observed on commonly encountered glacier ice, refrozen meltwater, or névé. This darker color could originate from a higher debris concentration, a difference in the concentration or distribution of air bubbles within the ice or a combination of both. The notoriety of ‘black ice’ in the alpine climbing community stems from the observation that it is extremely hard and brittle (and thus difficult and unsafe to climb upon) in comparison with other ice types, and in addition that this hardness and brittleness is relatively independent of ambient air temperature. It has been hypothesized that the properties of black ice stem from its age and that it is old ice composed from the remnants of earlier glacial periods. Thus ‘black ice’ has also been referred to as ‘fossil ice’, however little evidence in support of this hypothesis is presented within the relevant scientific literature. The study presented is an investigation ice samples obtained from steep slopes with a northerly aspect at an altitude of 2300 m in the Hurrungane mountain region in central Norway. The isotopic composition of δ^2H and $\delta^{18}O$ in these samples is analyzed in order to investigate the role of sublimation, melting and refreezing processes in the history of the ice encountered, and the ice is evaluated with respect to the concept of ‘black ice’ as defined by the alpine climbing community.

A 23-year Arctic ice-ocean reanalysis with the TOPAZ system using an Ensemble Kalman Filter

Bertino, Laurent, Jiping Xie, Francois Counillon

Nansen Environmental and Remote Sensing Center and Bjerknes Centre for Climate Research, Bergen, Norway

Abstract: We will present a synthesis of the ice-ocean TOPAZ4 reanalysis for the period 1991-2013. TOPAZ4 is a modeling and data assimilation system based on the Nansen Center's version of the HYCOM model (at horizontal resolution of about 12 km) and an Ensemble Kalman Filter (EnKF), integrating a dynamical ensemble of 100 members. The multivariate properties of the EnKF allow the TOPAZ system to assimilate several ocean and sea ice data types simultaneously, both in real-time forecasts applications (exploited operationally at MET Norway) and in reanalysis mode. The TOPAZ system constitutes the Arctic component of the MyOcean system (http://www.myocean.eu) and has been selected for the Arctic component of the Copernicus Marine Environmental Monitoring System.

The results from a 23-years reanalysis show a good stability of the EnKF used in realistic settings and its ability to provide physically consistent error estimates for most variables assimilated. The reanalysis however reveals some limitations of the ocean and the sea ice model (especially in terms of ocean model resolution and sea ice drift) and motivates further developments of new sea ice rheology models.

Active layer thickness and soil organic carbon of frozen peatlands: relationship and spatial variability (CALM R1, western Siberia, Russia).

Bobrik, Anna; Goncharova, Olga; Matyshak, Georgy

Department of Soil Science, Lomonosov Moscow State University

Abstract: Global warming, recorded in recent decades in the North West Siberia, leads to a change in soils temperature regime, changing plant associations, gradual degradation of permafrost and changing landscape as a whole. The Circumpolar Active Layer Monitoring (CALM) program developed over the last decade as a leading edge in comprehensive efforts to study the impacts of climate change in permafrost environments. Monitoring of active layer thickness, soil moisture, soil and air temperature are typical for all CALM sites. In connection with this CALM polygons are convenient for the study of spatial and temporal variation of soil parameters at fine scales. What does determine variability of soil organic carbon of CALM permafrost-affected soils? It's the main question of our work.

The research CALM SITE R1 (Nadym Grid) (N65°20', E72°55') is located in north of western Siberia (Russia, since 1997) within the zone of sporadic permafrost of north taiga. It is 1-ha (100m*100m) grid consists of a square array of permanent stakes separated by 10 m (121 data points per grid for all measurements). Permafrost is closely associated with frozen peatlands, bog and frost mounds. The typical soils are Turbic Cryosol of frozen peatland and Histosols of bog. For each point of CALM R1 site active layer thickness, carbon dioxide effluxes were measured in August 2013, 2014. Content of soil total organic carbon (TOC), carbon of water extractable organic matter (WEOC) and carbon of microbial biomass (MC) were measured in August 2013.

Active layer thickness and soil CO2 effluxes are characterized by high spatial and temporal variability. Active layer thickness varies from 45 to 200 cm and more; average thickness is 136±10* cm (2013) and 166±8 cm (2014). Strong spatial variation of this parameter related with the different soil cover and the organic layers dimensions. Areas with deepest thaw (more than 200 cm) are developed in large sedge-moss pools within peatlands and in bogs and were not included in calculations. In general, soil carbon dioxide emission is low and does not differ from year to year (156 ± 21 – 2013; 132±17 – 2014) mgCO2m-2h-1 (ranging from 10 to 450 mgCO2m-2h-1). Average content of TOC in the upper 15 cm of soil is high (34,24±1,92%). Soil of pearland is characterized with high spatial variation of labile organic carbon (WEOC) and the microbial carbon (MC) in organic layers: average WEOC=1400±300 mgC*kg-1 soil (ranging from 100 to 3920 mgC*kg soil-1); average MC=4260±880 mgC *kg-1 soil (ranging from 100 to 9840 mgC*kg-1soil). The values of microbial biomass are high, but geocryological and hydrothermal conditions inhibit all soil biological processes.
*(mean±1,96*SD)

Based on the regression analysis among more than 10 characteristics (hydrothermal, geocryological, soil) for CALM R1 site was revealed a high and significant correlation soil carbon dioxide efflux only with the active layer thickness (r=0,45, p-level<0,05; y=112 +0,13*x) and microbial carbon (r=0,25, p-level<0,05; y=90 +0,20*x). Water-extractable organic carbon was correlated with total organic carbon (r=0,47, p-level<0,05; y=456+30*x)

and soil moisture content (r=0,62, p-level<0,05; y=-254+28*x). Microbial carbon was correlated with total organic carbon (r=0,62 , p-level<0,05; y=352+123*x) and soil moisture content (r=0,70, p-level<0,05; y=-1481+97*x). We consider the main factor, which determine the soil carbon efflux is the depth of permafrost table; it determines the type of ecosystem in such transitional landscapes and organic matter transformation processes. Underestimation of the spatial variability of soil and vegetation cover in the region of discontinuous permafrost can lead to substantial distortion of estimates of the total greenhouse gases balance.

Reconstruction of the annual climate variability of North Atlantic water masses flowing into the Arctic: A molluscan sclerochronological approach

Bonitz, Fabian G.W. (1,2), Andersson, C. (1,2) and Trofimova, T. (1,2)

1 Uni Research Climate, Allégaten 55, N-5007 Bergen, Norway; 2 Bjerknes Centre for Climate Research, Bergen Norway

Abstract: In this study we aim to reconstruct the natural climate variability of North Atlantic water masses from the Faroe Current on an annual scale by applying molluscan sclerochronology on the Faroese shelf. The Faroe Current is considered to be the most important inflow branch of warm and saline North Atlantic water masses into the Arctic regions and therefore largely influences the climate variability in the Arctic and Northern Europe. However, the reconstruction of the climate variability of these water masses on an annual scale is still limited due to a lack of annually resolved paleorecords in higher latitudes. A promising approach for reconstructing the climate variability on annual time scales is the investigation of the growth increments in bivalve shells. The growth increments can be counted and measured similarly to the analysis of tree-rings and resulting patterns can be related to environmental parameters. In this study, we develop a molluscan shell-based paleo climate record from the shelves around the Faroe Islands by investigating the annual growth increments of the ocean quahog Arctica islandica. A. islandica is a long-lived species and its growth increments can be measured in the umbo as well as along the ventral margin in direction of the maximum shell height. By cross-matching growth increment patterns of live-collected and sub-fossil specimens we build a multi-centennial master chronology, which we compare with instrumental records of temperature, salinity and primary productivity. Additionally, we will analyse the d18O composition of single growth increments in selected intervals in the master chronology to reconstruct past sea surface temperatures in the Faroe Current. So far, seven living and eight sub-fossil specimens have been successfully cross-matched resulting in a first chronology, which covers the period from 1929 – 2013. Further, the examination of more than 60 living and articulated specimens from the western side of the Faroe Islands confirms the occurrence of similar growth increment patterns suggesting external forcing on the growth rate of the bivalve species. This clearly shows the potential to apply molluscan sclerochronology on the Faroese shelf and to obtain a more detailed insight into past climate developments over Northern Europe and in Arctic regions.

Simulate englacial tracer transport to reconstruct past climates and ice sheet volumes

Born, Andreas

Climate and Environmental Physics, University of Bern; Oeschger Centre for Climate Change Research

Abstract: The full history of ice sheet and climate interactions is recorded in the vertical profiles of isotopic and other geochemical tracers in polar ice sheets. In addition, recent advances in radiostratigraphy uncover the englacial layering that contains information of past surface topographies and thus ice sheet volumes and sea level. Numerical simulations of these archives could afford great advances both in the interpretation of paleoclimatic tracers as well as to help improve ice sheet models themselves and future projections. However, fundamental mathematical shortcomings in existing ice sheet models subject tracers to spurious diffusion that renders such attempts unfeasible.

Here, I propose a new vertical discretization for ice sheet models that eliminates numerical diffusion entirely. Vertical motion through the model mesh is avoided by mimicking the real-world ice flow as a thinning of underlying layers. Simulations of the last glacial cycle are presented that show good skill in reproducing the reconstructed profile of the oxygen isotopic ratio (d18O) and the age scale (http://www.climate.unibe.ch/~born/ice_model.html).

A dynamical marine-based ice sheet on the n-Norwegian shelf, from late MIS-3 to Heinrich Stadial 1

Brendryen, Jo (1, 2); Haflidason, Haflidi (1, 2); Rise, Leif (3); Chand, Shyam (3); Vanneste, Maarten (4); Longva, Oddvar (3); L'Heureux, Jean S. (4); Forsberg, Carl F. (4)

1 Department of Earth Science, University of Bergen; 2 Bjerknes Centre for Climate Research; 3 Geological Survey of Norway; 4 Norwegian Geotechnical Institute

Abstract: We present an account of the marine-based glacial dynamics covering the late Marine Isotope Stage (MIS) 3 to the Heinrich Stadial (HS) 1 on the Lofoten-Vesterålen margin, northern Norway, close to the junction of the Scandinavian and Barents ice sheets. This account is based on an analysis of the sediment stratigrapy on the upper slope, close to the ice sheet grounding line at the continental shelf edge, and an analysis of the glacial morphology on the shelf areas. Our results show that a dynamic ice sheet waxed and waned on the Lofoten-Vesterålen continental shelf from the late MIS-3, through the Last Glacial Maximum (LGM) and the HS 1. Small scale debris flow units that were deposited along the Lofoten-Vesterålen upper slope are interpreted to represent glacigenic debris flows. These, and the deposition of laminated diamicts close to the former grounding line, suggest that the ice sheet reached the shelf edge at least five times. These are dated to ~25.5 ka BP (HS3), between 21.1 and 21.7 ka BP, ~19.5 ka BP, 15.6 ka BP and 14.4 ka BP (uncorrected 14C ages). A contouritic sorted sand unit that according to the micropaleontological fauna likely formed in a relatively warm interval during Late MIS-3, suggests that a strong Norwegian Atlantic Slope Current also developed during glacial interstadials implying that the oceanic circulation in the eastern Norwegian Sea was similar as today. Generally, the ice sheet advanced onto the shelf during cold period with little influx of Atlantic Water to the Norwegian Sea and retreated toward the coast during intervals with higher temperatures and higher influx of warm Atlantic Water. The last ice advance to the continental shelf edge occurred during HS1.

The Latest Pleistocene and Holocene glacier record from the Brooks Range, Arctic Alaska

Briner, Jason P. (1); Simon Pendleton (2); Liz Ceperley (1); Darrell Kaufman (3); Susan Zimmerman (4)

1 University at Buffalo; 2 Department of Geology, University of Colorado Boulder; 3 Northern Arizona University; 4 Lawrence Livermore National Laboratory

Abstract: In the Arctic, the late Pleistocene mountain glacier record is limited due to expansive occupation of the high latitudes by vast ice sheets. The Holocene record is more widespread in the Arctic, but nevertheless, only in a few areas is there more than a basic understanding of Holocene glaciation because the most extensive glacier advance occurred recently (e.g., during the Little Ice Age). In addition, the chronology of Holocene glaciation is usually defined by morphostratigraphy, lichenometry, and with limited constraints by radiocarbon dating.

The glaciation of the Brooks Range, Arctic Alaska, during the late Pleistocene was alpine in nature, thus affording a unique glimpse of Arctic glacier behavior during the last deglaciation. In addition, there are many pre-Little Ice Age moraines preserved throughout the Brooks Range, which archive a longer history of late Holocene glacier fluctuations than is typically available in the Arctic. We capitalized on the unique glacial record in the Brooks Range, building on a sturdy foundation of prior mapping and chronology by previous investigators, by using cosmogenic 10Be dating on latest Pleistocene and Holocene glacial features.

This presentation will summarize the results from our 2010-2015 research program that aimed to improve the absolute glacial chronology of the Brooks Range. Our main findings are: (1) an early episode of glacier retreat immediately followed the culmination of the LGM ~21 ka; (2) moraines deposited ~17 ka were followed by a rapid and widespread retreat of glaciers through their valleys and into the cirques between ~16-14 ka; (3) a definitive lack of Younger Dryas moraines; and (4) pre-Little Ice Age moraines have been securely dated to ~4.5 ka, ~3.5 ka, ~2.7 ka and ~ 1 ka. These findings allow us to make inferences about forcing mechanism of deglaciation and Neoglaciation in the western Arctic.

Sea-ice extent in the Nordic Seas around the Pliocene–Quaternary transition

Clotten, Caroline (1,2); Fahl, Kirsten (3), Stein, Rüdiger (3), De Schepper, Stijn (1,2)

1 Uni Research Climate, Bergen, Norway; 2 Bjerknes Centre for Climate Research; 3 Alfred-Wegener-Institute, Bremerhaven, Germany

Abstract: Sea ice is a crucial component in Arctic and global climate because it is highly sensitive to climate change, affects Earth's albedo and plays a role in polar amplification. Although the Pliocene (5.33–2.58 Ma) is characterized by higher temperatures, sea levels and CO2 concentrations (e.g. Haywood et al., 2011) compared to today, a gradual cooling took place from 3.6 Ma and resulted in the intensification of the Northern Hemisphere Glaciation around 2.7 Ma (e.g. Mudelsee and Raymo, 2005). Based on a recent multi-proxy study of sediments from the Yermak Plateau area (ODP Sites 910 and 911), Knies et al. (2014) postulated that the first modern winter maximum extent in the Arctic Ocean occurred around 2.6 Ma. Results of an IP25 and dinocyst pilot study of sediments from ODP Site 911, on the other hand, suggest that sea ice was probably already present in the early Pliocene and may have reached modern extension at least occasionally (Stein et al., 2014; Stein and Fahl, unpubl. data 2013/2014). In the Pliocene Nordic Seas, the sea-ice distribution and its effect on regional and global climate remain currently even more unclear. Therefore, we attempted to reconstruct the Pliocene to early Quaternary (~3 to ~2.4 Ma) Nordic Seas sea-ice extent using biomarkers (IP25, brassicasterol, dinosterol) from three (Integrated) Ocean Drilling Program sites (ODP 907, ODP 987 and IODP U1307). The biomarkers can provide semi-quantitative sea-ice cover estimates and information on sea-ice cover dependent primary productivity.

Our preliminary results show fluctuations between a lasting ice-cover during spring and summer and fully ice-free conditions in the Iceland Sea and Labrador Sea in the late Pliocene and early Quaternary. The data indicate that periods of perennial sea-ice cover were longer in the Iceland Sea than in the Labrador Sea. Periods with perennial sea-ice cover in the Labrador Sea coincide within the phases of lasting sea ice cover in the Iceland Sea. Our sea-ice proxies are absent at Site 987 in the Greenland Sea.

The presence of sea ice in the Iceland Sea and Labrador Sea during the intensification of the Northern Hemisphere Glaciation suggests that an increased albedo may have amplified the cooling of the Artic region. Together with the thermal isolation of Greenland from warm Atlantic waters, such conditions favor the build-up of ice sheets in the Arctic region.

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Could massive Arctic sea ice export to the North Atlantic be the real cause of abrupt climate change during the last deglaciation?

Coletti, Anthony J.; Condron, Alan

Department of Geosciences, University of Massachusetts, Amherst, MA, 01003, USA

Abstract: Using a coupled ocean-sea ice model (MITgcm), we investigate whether the break-up and mobilization of thick, multiyear, Arctic sea ice might have supplied enough freshwater to the Nordic Seas to reduce North Atlantic Deep Water (NADW) formation and weaken the Atlantic Meridional Overturning Circulation (AMOC).

Simulations of a Last Glacial Maximum (LGM) environment show the potential for sea ice to grow ~30 m thick, storing ~1.41x1014 m3 of freshwater as ice in the Arctic Ocean (this is ~10 times the volume of freshwater currently stored in the Arctic). If this ice was released from the Arctic in 1yr (10yrs) it would have been equivalent to a high-latitude freshwater forcing of ~4.5 Sv (0.45 Sv), which is comparable (or larger) in magnitude to most estimates of meltwater emanating from land-based glacial lakes such as Lake Agassiz. Modifications to atmospheric and land boundary conditions were implemented to find possible mechanisms for sea ice export and mobilization. Opening of the Bering Strait and Barents Sea are two plausible mechanisms that may have initiated sea ice mobilization. Alterations to these gateways represent land and ice sheet changes associated with cold-to-warm (stadial to interstadial) climate transitions. Opening of the Bering Strait increases sea ice and freshwater transport through Fram Strait, resulting in a fresher North Atlantic and a 22% weakening of AMOC for thousands of years. Opening the Barents Sea does surprisingly little to sea ice thickness but does weaken AMOC by ~8%. In our simulation with both straits open there is a transition to a near-modern sea ice circulation, although interestingly the effects on AMOC differ only slightly (~2%) to when the Bering Strait is open. Experiments testing the results of the Bering Strait open and artificially capped sea ice thickness show barely any change compared to our Bering Strait open simulations with normal sea ice growth. As a result, sea ice may not be a trigger for AMOC weakening nevertheless, geographical changes may mask the effect of sea ice export. Other analyses being done involve testing other gentler export mechanisms, such as changes in 10-m surface winds.

Subpolar versus subtropical freshwater forcing: The different role of icebergs and meltwater in triggering abrupt climate change

Alan Condron

CSRC, UMASS Amherst

Abstract: High resolution climate model simulations of massive glacial outburst floods from the Laurentide ice sheet show that meltwater quickly bypassed sites of deep water formation in the subpolar gyre by being routed directly to the subtropical North Atlantic (20-40N). This 'fast-track' pathway is supported by iceberg scours along the entire east coast of North America, all the way to Southern Florida, and by IRD at Bermuda Rise. Here I use a newly developed iceberg model (MITberg) to explicitly simulate icebergs in meltwater floods. In these experiments 6.3x103 Gt/yr of ice are calved into the ocean at the same time as a 5Sv (1-yr duration) meltwater flood is released from Hudson Bay. Tens-of-thousands of the icebergs are entrained in the meltwater and are quickly transported south by the narrow Labrador Current. At the Grand Banks of Newfoundland, icebergs follow the meltwater along the east coast of the United States before being advected into the center of the subtropical gyre by narrow meltwater filaments and instabilities. Our model shows that once the meltwater flood ends, icebergs are no longer transported into the subtropical gyre, but become confined to the subpolar gyre, with little penetration south of 40°N. As such, the appearance of icebergs in the low-latitudes of the North Atlantic was probably quite infrequent during the last deglaciation, occurring only during times of very high meltwater runoff from the Northern Hemisphere ice sheets. Given the typical subpolar drift of icebergs (across the 'Ruddiman Belt') it seems likely that increased freshwater input to the ocean from increased iceberg calving was more effective at weakening deep water formation than short-lived (1-2yr) glacial outburst floods that were routed to the subtropics, far to the south of climatically sensitive regions of the North Atlantic.

Interpreting the moraine record of debris-covered glaciers: A Neoglacial case study on Baffin Island, Arctic Canada

Crump, Sarah E. (1); Anderson, Leif (2); Miller, Gifford H. (1); Anderson, Robert S. (1)

1 University of Colorado – Boulder; 2 University of Iceland

Abstract: Mountain glaciers change length in response to small climate perturbations. Former glacier lengths, recorded by terminal moraines, can therefore provide key paleoclimate information. Cosmogenic radionuclide dating is one of the most reliable and widely applicable methods to date glacier moraines, but deriving accurate dates and paleoclimate information from these dates relies upon several key assumptions: 1) the sampled boulder surfaces have no inherited nuclide inventory; 2) sampled boulders have been stable and uncovered since deposition; 3) past climate can be estimated (and uncertainty constrained) using bare-ice glacier models and typical parameter selections. The first two assumptions are frequently discussed in moraine dating studies, but the third is considered less frequently and may have significant implications for the estimation of paleoclimate from moraines.

We used 10Be to date 24 moraine boulders from two ice-cored Neoglacial moraine sequences on Cumberland Peninsula, Baffin Island. Nine 10Be ages (three excluded due to inheritance) from the distal portion of a composite moraine at Snow Creek Glacier range from ~1.8 ka to ~5.7 ka, and twelve ages from the two most distal moraine crests at Throne Glacier range from ~1.1 ka to ~4.6 ka. We interpret the wide spread of ages at both of these moraine complexes to indicate post-emplacement moraine degradation due to ice core melting and subsequent re-advances disturbing moraine boulders, resulting in a violation of assumption 2. Because these processes result in the exposure of fresh boulder faces at a moraine crest through time, effectively resetting the 10Be clock, the oldest non-inherited ages in these datasets likely represent a minimum age for the initiation of moraine formation. Thus, Neoglaciation was likely underway between 6 and 5 ka on Baffin Island; this timing is in agreement with other climate reconstructions in the region but represents some of the oldest Neoglacial moraine ages.

In order to hone our abilities to interpret the complications associated with the third assumption, we explore the moraine-forming process in these settings using a numerical glacier model that accounts for the effect of debris cover on the glacier surface. Englacial debris is transported along flow lines and emerges on the glacier surface below the ELA. Debris thicker than a few centimeters insulates ice and reduces ice melt rates. Thus, the debris-covered toe of a glacier experiences lower melt rates than the debris-free surface immediately up valley, which can result in the abandonment of the debris-covered toe (i.e., the formation of an ice-cored moraine) during periods of negative glacier mass balance. Moreover, surface debris cover amplifies glacier advances and dampens terminus retreats (for small mass balance perturbations) relative to an equivalent glacier with no debris cover. Even with the same climate forcing, debris-free and debris-covered glaciers will therefore create moraine records that differ; this may in part explain the existence of pre-Little Ice Age Neoglacial moraines in settings with high above-glacier hillslope erosion rates that in turn generate debris capable of enacting these feedbacks.

Regime shifts in the northern North Atlantic during the past 6,000 years: A record of seabird population size and precipitation isotopes on Bjørnøya, Svalbard

D'Andrea, William J. (1); Hormes, Anne (2); Bakke, Jostein (3,4); Nicolaisen, Line (5)

1 Lamont-Doherty Earth Observatory of Columbia University; 2 Department of Earth Sciences, University of Gothenburg; 3. Department of Earth Sciences, University of Bergen; 4 Bjerknes Centre for Climate Research; 5 Department of Geoscience and Natural Resource Management, University of Copenhagen

Abstract: The northeastern North Atlantic Ocean, and the Norwegian and Greenland Seas are subject to large hydrographic changes. These variations can influence oceanic heat transport to the Arctic, meridional overturning circulation, and atmospheric circulation patterns and therefore can impact global climate patterns. Marine records suggest that there have been numerous large-scale changes in the hydrography of the northern North Atlantic during the middle to late Holocene. Here, we report a record of nitrogen and hydrogen isotope measurements from a lake sediment core from Bjørnøya, Svalbard (74.38°N, 19.02°E) that documents major regime shifts in the climate of the northern North Atlantic during the past 6,000 years. Bjørnøya is the nesting ground for one of the largest seabird populations in the North Atlantic. As top predators in the marine ecosystem, seabirds (and their guano) are enriched in 15N, and during spring and summer months they deliver this isotopically enriched nitrogen into the catchment of their nesting area. We developed a record of changes in the seabird population on Bjørnøya based on the δ15N record from a sediment core collected from lake Ellasjøen. The record reveals multiple multicentennial scale changes in the δ15N (varying between ~8-12‰) of the lake's sediments that reflect changes in the size of seabird populations. From the same sediment core, we also developed a record of δD of precipitation, based on plant wax δD. The time intervals with the largest inferred bird populations correspond with the most enriched δD of precipitation, and represent a more Atlantic climate; whereas periods with reduced inferred seabird populations correspond with intervals with more negative δD of precipitation and represent a more Arctic climate. The records signify major regime shifts in the oceanography, marine ecosystem, and atmospheric circulation of the northern North Atlantic that are likely related to variations in the strength of the subpolar gyre.

Climatology of the atmospheric boundary-layer in the high latitudes

Davy, Richard (1,2); Esau, Igor (1,2)

1 Nansen Environmental and remote sensing center 2 Bjerknes Centre for Climate Research

Abstract: The presence of sea-ice strongly reduces heat and moisture fluxes between the ocean and atmosphere, and so has a major influence on the climatology of the atmospheric boundary layer (ABL) in the Arctic. Over thick, multi-year ice we get very stably-stratified ABLs, which have been shown to strongly determine the enhanced warming observed in the Arctic in recent decades. However, as the sea-ice retreats, we can expect the heat release from the ocean to strongly alter the thermal structure of the boundary layer with enhanced vertical mixing and deeper boundary layers.

Global climate models do not capture the processes that occur in stable boundary layers and we have shown that they are biased towards over-estimating the amount of mixing under stable-stratification. This has led to a systematic bias in GCMs to under-estimating how much surface temperatures respond to changes in the surface energy budget. We look at the climatology of stable boundary layers in reanalysis and in climate models in the high latitudes, and intend to investigate how the models and reanalysis capture the changes in the ABL as sea-ice is removed.

Morphologies and triggers of submarine mass failures in Frobisher Bay, Baffin Island, Nunavut

Deering, Robert (1); Bell, Trevor (1); Forbes, Don (1)

1 Department of Geography, Memorial University of Newfoundland

Abstract: With advances in seabed mapping technology and its application in the Canadian Arctic, new records of submarine mass failures (SMF) are being revealed in coastal and nearshore environments. SMFs are typically features of continental and island margins, ranging from small-scale features (<100 m3) to enormous failures (3000 km3). The largest SMFs in shelf and slope environments have received more attention, understandably, than smaller inshore features. Recent mapping, however, has shown that small failures are common features in the fjords of eastern Baffin Island, while studies in Norway and Scotland have demonstrated that small failures may be potentially destructive hazards; for example, causing tsunamis in fjords and damaging seabed infrastructure. SMFs can be triggered in a number of ways, such as overloading by sediments, undercutting of slopes, and seismic events. Of particular interest is the potential for triggering SMFs by sea-level adjustments. The easternmost fringe of Baffin Island has experienced substantial postglacial relative sea-level rise (30-50 m). Through coring of SMF deposits, it may be possible to determine the ages of events in relation to episodes of rapid relative sea-level change. Our research methods include mapping and characterizing the morphology of mass movements to develop a typology of forms and associated processes, multibeam bathymetric surveying of features to examine the seabed settings in which these events occur, and acoustic subbottom profiling to examine the stratigraphy underlying past events. These data will permit a fuller understanding of SMF events and their seabed settings, as well as their potential triggers in Baffin Island fjords.

Early Pliocene Nordic Seas palaeoceanography – relation with ocean gateways

De Schepper, Stijn (1,2,3); Schreck, Michael (4,5); Beck, Kristina M. (2); Mangerud, Gunn (2); Matthiessen, Jens (4)

(1) Uni Research Climate, Bergen, Norway; (2) Department of Earth Science, University of Bergen, Bergen, Norway; (3) Bjerknes Centre for Climate Research; (4) Alfred Wegener Institute for Polar and Marine Research, Bremerhaven, Germany; (5) Arctic Research Centre, Korea Polar Research Institute, Incheon, Korea

Abstract: In the Arctic region, organic-walled phytoplankton is often the only microfossil group present in the marine sediment record that can be used for palaeoceanographic and palaeoenvironmental reconstructions. We present recently collected dinoflagellate cyst and acritarch records from the Norwegian Sea ODP Site 642 and compare this record with published data from Iceland Sea ODP Site 907. This reveals a wide-scale, major assemblage transition that includes the extinction of several taxa, disappearance of heterotrophic species and productivity decrease around 4.5 Ma. These changes can be attributed to a surface-water cooling across the entire Nordic Seas and reorganization of the surface ocean circulation that heralds the establishment of a modern-like Norwegian Atlantic Current and proto-East Greenland Current.

The timing at around 4.5 Ma corresponds favorably to the timing of reconfigurations at the Northern Hemisphere Pacific–Atlantic ocean gateways. The Central American Seaway shoals in the early Pliocene (4.8-4.2 Ma) and flow of Pacific water via the Bering Strait into the North Atlantic is evidenced by the first arrival of Pacific molluscs in Iceland (Tjörnes section). Also outside the Nordic Seas, increased sediment accumulation at several North Atlantic drifts (e.g. Gloria and Eirik drifts), illustrate the important early Pliocene changes in North Atlantic deep-water circulation.

High Resolution brGDGT-based paleotemperatures from Marine Isotope Stage 31 at Lake El'gygytgyn: a 50,000 year long interglacial in Siberia prior to the Mid-Pleistocene Transition?

de Wet, Greg (1,2,3); Castañeda, Isla (1,2); Brigham-Grette, Julie (1,2); Salacup, Jeff (1,2).

1 Geosciences Department, University of Massachusetts, Amherst, 2 Climate System Research Center, University of Massachusetts, Amherst, 3 Department of Earth Science, University of Bergen.

Abstract: Previous periods of extreme warmth in Earth's history are of great interest in light of predicted anthropogenic warming. Numerous so called "super interglacial" intervals have been identified in the 3.6 million year (Ma) lake sediment record from Lake El'gygytgyn, northeast Russia, but to date a high-resolution paleotemperature reconstruction from any of these periods is lacking. Here we present paleotemperatures based on branched glycerol dialkyl glycerol tetraethers (brGDGTs) from Marine Isotope Stage (MIS) 31 with an average sample resolution of ~500 yrs. To our knowledge this is the highest resolution paleotemperature reconstruction through this interval from anywhere in the world. Our results suggest the entire period currently defined as MIS 33-31 (~1114-1062 kyr BP) was characterized by warm/highly variable conditions at the lake, with cold "glacial" conditions during MIS 32 lasting only a few thousand years. Close similarities are seen with records from high southern latitudes, supporting the suggestion that the duration of MIS 31 was longer than previously thought (Teitler et al., 2015). While absolute reconstructed temperatures must be treated with caution, warming during MIS 31 appears comparable only to MIS 11 during the Pleistocene at Lake El'gygytgyn.

High-resolution Holocene reconstruction of Annabreen glacier from proximal Gjøavatnet Lake sediments, Amsterdamøya, NW Svalbard.

de Wet, Greg (1,2,3); Bakke, Jostein (3,4), Gjerde, Marthe (3,4,5)

s: 1 Geosciences Department, University of Massachusetts, Amherst, 2 Climate System Research Center, University of Massachusetts, Amherst, 3 Department of Earth Science, University of Bergen, 4 Bjerknes Centre for Climate Research, 5 The University Centre in Svalbard.

Abstract: Text: Past Holocene glacial activity is reconstructed from a ~2m sediment core from Gjøavatnet Lake on Amsterdamøya Island, NW Svalbard. The lower section of the core comprises dense till with highly variable clast sizes, suggesting the entire deglacial sequence was captured. The lake is only ~9m above sea level currently, separated from the ocean by a narrow (~50m) rocky beach. Changes in elemental concentrations (based on XRF data) suggest the isolation of the basin from the ocean happened early in the lake's history. Brown, organic rich sediment makes up the majority of the Holocene portion of the record, suggesting little glacial influence, although small increases in detrital input are evident from lower organic matter concentrations and detrital elemental counts, which could be the result of small scale glacial reactivation during the Neoglacial. Finally, the upper ~15cm of the record consists of dense gray clay with some larger clasts, likely representing the Little Ice Age on Amsterdamøya. Our age model will be based primarily on radiocarbon dates of macrofossils, generally abundant throughout our record, and aided by a 210Pb accumulation profile and identification of tephra. Planned future analyses include high-resolution determination of biogenic silica using Fourier transform infrared spectroscopy (FTIRS) as well as measuring biomarkers such as branched glycerol dialkyl glycerol tetraethers (brGDGTs) and/or alkenones to reconstruct temperature and measuring the deuterium isotopic composition of leaf waxes to reconstruct precipitation. Our Gjøavatnet record will supplement ongoing research from other lakes nearby (Røthe et al., 2015; van der Bilt et al., in prep), including another from Amsterdamøya (Gjerde et al., in prep) to better understand the regional climate history of this sensitive Arctic region.

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Natural variability of benthic foraminiferal assemblages and metal concentrations in the Ingøydjupet trough, SW Barents Sea

Dijkstra, Noortje (1), Junttila, Juho (1), Husum, Katrine (2), Carroll, JoLynn (1,3), Hald, Morten (1)

1 UiT The Arctic University of Norway, Department of Geology, Tromsø, Norway; 2 Norwegian Polar Institute, Tromsø, Norway; 3 Akvaplan-niva AS, Tromsø, Norway

Abstract: Benthic foraminifera have large potential for bio-monitoring the state of the environment. The use of benthic foraminifera as bio-monitoring tool for contaminants is however complicated due to the natural variability of both the ecosystem and the physical environment. Detailed site specific studies are therefore of importance to distinguish between natural environmental change and anthropogenic induced environmental change.

While today, the SW Barents Sea is a relatively pristine area, industrial activities related to the petroleum industry are projected to increase in this area in the coming decades. This makes the area a valuable natural laboratory to establish pre-impacted baselines as a precursor for future seabed monitoring programs. In this study we present benthic foraminiferal assemblages and metal concentrations in four sediment cores from the Ingøydjupet trough, SW Barents Sea, covering approximately the last 150 years. This information can be used as input for a bio-monitoring tool applicable in high latitudes.

At all stations, metal concentrations in sediments corresponded to background levels. The down core metal concentrations are mainly attributed to natural variability in the clay fraction and total organic content of the sediments. Patterns in foraminiferal assemblages at the near-shore stations suggest a strong variability in strength of the bottom current during the last 150 years, attributed to a strong Norwegian Coastal Current. In contrast, foraminiferal assemblages in offshore stations correlate with calm bottom current conditions and they are mainly influenced by Atlantic Water inflow. At all stations, benthic foraminiferal trends indicated an increasing influence of Atlantic Water inflow toward the present-day during the past 150 years. The study contributes to a better understanding of natural environmental variability thus serving as an important baseline data set prior to increasing industrial activities.

Bio-monitoring using benthic foraminiferal assemblages – examples from the SW Barents Sea

Noortje Dijkstra; Junttila, Juho; Sørensen, Steffen Aagaard

UiT The Arctic University of Norway, Department of Geology, Dramsveien 201, N-9037 Tromsø, Norway

Abstract: The SW Barents Sea contains significant oil and gas resources. Exploration activities were initiated during the 1980s, gas production started at the Snøhvit Field in 2007 and oil production will begin at the Goliat Field in the near future. Petroleum exploration in the region is projected to expand significantly in the coming years, increasing the potential for releases of waste associated to drilling activities into the marine environment. With these prospects, the region is a valuable natural laboratory to monitor and assess the impact of increasing petroleum industry related activities on the environment.

Macrofauna is traditionally used to demonstrate the impact of petroleum industry related activities on the Norwegian continental shelf. However, benthic foraminifera are also sensitive indicators of environmental conditions, due to their specific environmental preferences and fast reproductive cycles. Additionally, benthic foraminiferal tests remain in the fossil record, enabling the reconstruction of past environments and therefore pre-impact conditions at already impacted sites.

The use of fauna as a monitoring tool is however often complicated due to natural variability in both the ecosystem and the physical environment. As a result, site-specific impact studies are needed in a variety of habitat types in order to develop an accurate bio-monitoring tool using benthic foraminifera.

The Barents Sea drill cuttings research initiative (BARCUT) –project will be presented. The main objective of the study is to identify the distribution and accumulation of pollutants in bottom sediments related to drill cuttings and their effect on benthic foraminiferal assemblages.

Benthic foraminiferal assemblages, in addition to heavy metal concentrations and grain size properties are being studied close to drilling sites in the Ingøydjupet trough to capture potential environmental impacts of previous exploration activities. Additionally, the same parameters are being studied in more distal locations of the SW Barents Sea, to capture the natural variability of the area. This enables to distinguish between natural environmental change and anthropogenic induced environmental change in the future. The outcome of this study might contribute to the development of a bio-monitoring tool based on benthic foraminifera for the SW Barents Sea.

A sub-centennial view of Holocene modulations within the Earth's largest ice and freshwater pathway: The East Greenland Current

Dylmer, Christian Valdemar (1,2,); Miles, Martin (1,2,3)

1 Uni Research Climate, Bergen. Norway, 2 Bjerknes Centre for Climate Research, Bergen. Norway, 3 Institute for Arctic and Alpine Research, University of Colorado, Boulder, USA

Abstract: A dramatic decline over the last 30 years has been observed in the summer distribution and thickness of Arctic sea ice through satellite imagery. Sea ice formation and melting constitute some of the most important feedback mechanisms to the global climate system, as sea ice effectively insulates the atmosphere from the ocean, restricting the exchanges of heat, mass, momentum and chemical components. In addition, together with snow-covered continental areas, sea-ice from its high albedo contributes to a high extent to the radiative balance of the Earth. Getting a better knowledge on the dynamics of the natural variability of the East Greenland Ice - the world`s largest ice and freshwater pathway - during the present Interglacial (the Holocene) is therefore of outmost importance to fully comprehend the anthropogenic vs. natural impacts and feedbacks at play in present times of global warming, and to assess the evolution of the global climate in the coming decades and centuries. Despite its importance, the long-term natural variability of the East Greenland Ice is yet not well known. Previous research has been fragmentary, often focused on isolated records, and with uncertainties from using a single-proxy rather than a multi-proxy approach. There have been no comprehensive reconstructions of changes in the East Greenland Ice, partly due to limited data records in the EGC pathway. The increasing number of Holocene records recently developed for sea ice and ocean proxies along and within the vicinity of the EGC pathway now opens up for an opportunity to more comprehensively identify changes and linkages in an important and exceptionally complex regional system.Here we present the preliminary results of a new research effort focused on constraining and understanding the East Greenland Ice through the Holocene i.e. (a) Advance our understanding of sea-ice–ocean changes along the EGC pathway and downstream, during three earlier warm periods: the Holocene Climatic Optimum (HCO), Medieval Climate Anomaly (MCA) and Early 20th Century Warming (ETCW), (b) explore linkages between changes in sea ice, the presence/advection of temperate Atlantic waters and their effects along the ice sheet marine margins, and (c) investigate far-field linkages between sea ice / polar waters associated with the EGC and northward-flowing Atlantic waters through the Nordic Seas. These goals are being explored through a targeted, inventive and integrated data synthesis of spatially dispersed and disparate (marine, lacustrine, ice core) paleo records, comprised primarily of existing and emerging records indicative of sea-ice and ocean conditions around the margins of Greenland.

GIS-analyses of lake density and terrain ruggedness to identify ice-sheet erosional impacts on the exposed shield of Baffin Island, Eastern Canadian Arctic

Ebert, Karin

Department of Physical Geography, Stockholm University, Stockholm, Sweden

Abstract: The erosional impacts of former ice sheets on the low-relief bedrock surfaces of Northern Hemisphere shields are not well understood. This project assesses the variable impacts of glacial erosion on a part of Baffin Island, eastern Canadian Arctic, between 68 and 72°N and 66 and 80°W. This tilted shield block that has been covered repeatedly by the Laurentide Ice Sheet during the late Cenozoic. The impact of ice-sheet erosion is examined by GIS-analyses using two geomorphic parameters: lake density, and terrain ruggedness. Both parameters were analyzed by two different GIS-techniques each to compare results. High lake density and high terrain ruggedness were used as indicators for strong impact of ice-sheet erosion on the shield surface, few or no lakes and smooth terrain as indicator for weak ice-sheet erosion.

The resultant patterns generally conform to published data from other remote sensing studies, geological observations, cosmogenic exposure ages and the distribution of the chemical index of alteration for tills. Lake density and terrain ruggedness are thereby demonstrated to be useful indicators of variable ice-sheet erosional impacts across Baffin Island.

Ice-sheet erosion was most effective in the lower western parts of the lowlands, in a west-east oriented band at around 350-400 m a.s.l. and in fjord onset zones in the uplifted eastern region. Above the 350-400 m a.s.l band and between the fjord onset zones, ice-sheet erosion was not sufficient to create extensive ice-scoured bedrock surfaces. The exception where lake density and terrain ruggedness indicate that ice sheet erosion had a scouring effect all across the study area was in an area from Foxe Basin to Home Bay. This area does not exceed elevations of 400 m a.s.l.. These morphological contrasts link to the cumulative effects of former ice sheet basal thermal regimes through the Pleistocene. The similar elevations, of non-eroded, weakly eroded, and ice-scoured shield bedrock surfaces indicate that even in areas of high lake density and terrain ruggedness the total depths of ice-sheet erosion were low.

A brief history of climate - the northern seas from the Last Glacial Maximum to global warming

Eldevik (1), Tor; Bjørg Risebrobakken (2), Anne E. Bjune (2) , Carin Andersson (2), H. John B. Birks (3), g, h, Trond M. Dokken b, Helge Drangea, Mirjam S. Glessmer (1), Camille Li (2), Jan Even Ø. Nilsen (4), Odd Helge Otterå (2), Kristin Richter (5), Øystein Skagseth (6)

1 Geophysical Institute, University of Bergen, and Bjerknes Centre for Climate Research, Bergen, Norway; 2 Uni Research Climate, and Bjerknes Centre for Climate Research, Bergen, Norway; 3 Department of Biology, University of Bergen, and Bjerknes Centre for Climate Research, Bergen, Norway; 4 Nansen Environmental and Remote Sensing Center, and Bjerknes Centre for Climate Research, Bergen, Norway; 5 Institute for Meteorology and Geophysics, University of Innsbruck, Innsbruck, Austria; 6 Institute of Marine Research, and Bjerknes Centre for Climate Research, Bergen, Norway; 7 Environmental Change Research Centre, University College London, London, UK; 8 School of Geography and the Environment, University of Oxford, Oxford, UK

Abstract: The understanding of climate and climate change is fundamentally concerned with two things: a well-defined and sufficiently complete climate record to be explained, for example of observed temperature, and a relevant mechanistic framework for making closed and consistent inferences concerning cause-and-effect. This is the case for understanding observed climate, as it is the case for historical climate as reconstructed from proxy data and future climate as projected by models. The present study offers a holistic description of northern maritime climate – from the Last Glacial Maximum through to the projected global warming of the 21st century – in this context. It includes the compilation of the most complete temperature record for Norway and the Norwegian Sea to date based on the synthesis of available terrestrial and marine paleoclimate reconstructions into continuous times series, and their continuation into modern and future climate with the instrumental record and a model projection. The role of the Norwegian Atlantic Current – the Gulf Stream's extension towards the Arctic – is assessed in particular. This includes the introduction of an explicit and relatively simple diagnostic relation to quantify the change in ocean circulation consistent with reconstructed ocean temperatures. It is found that maritime climate and the strength of the Norwegian Atlantic Current are closely related throughout the record. The nature of the relation is however qualitatively different as one progresses from the past, through the present, and into the future.

Neoglaciation and Little Ice Age (LIA) glaciers and ice caps on Svalbard

Farnsworth, Wesley (1,2); Ingólfsson, Ólafur (1,3); Schomacker, Anders (4); Retelle, Michael (1,5)

(1) Dept. of Arctic Geology, University Centre in Svalbard, UNIS (2) Department of Earth Science, University of Tromsø, UiT Tromsø Norway (3) Institute of Earth Sciences, University of Iceland, Reykjavík, Iceland. (4) Department of Geology, Norwegian University of Science and Technology Trondheim, Norway (5) Department of Geology, Bates College, Lewiston, Maine USA.

Abstract: Holocene climate has displayed a range of variability, fluctuating between warm and cold as well as humid and dry conditions on the multi-decadal to multi-centennial timescale. Arctic glaciers and ice caps are particularly sensitive to changes in high-latitude winter precipitation and summer temperatures. Thus the reconstruction of Svalbard glacier chronologies through the Holocene will provide valuable insight regarding the response of glaciers on Svalbard to antecedent changes in climate. At present, knowledge of the spatial changes of glaciers and ice caps on Svalbard through the Holocene lacks key details. For example, the LIA is the best documented climate event during the Holocene but the spatial extent, onset, duration, and causal factors remain underdeveloped. Additionally numerous glacial landforms and deposits that pre-exist the LIA features are present around Svalbard, yet little is known about the spatial and temporal relations of these landforms. This introduces a four-year doctoral project that will create detailed geomorphological maps of glacier forelands on Svalbard by analyzing aerial images in digital-stereo-view. Also extensive sedimentological mapping in the field, coring of threshold lakes and retrieving samples for dating will be conducted. This project will strive not only to distinguish spatial trends in ice expansion of Svalbard glaciers and ice caps through the Holocene, but to correlate phases of ice-expansion with climate periods, internal glacial processes, sea-level fluctuations, or some form of combination.

Algal pigments display varying response to Holocene climate variability between lakes in Baffin Island and Iceland

Florian, Christopher R. (1,2), Gifford H. Miller (1,2), Áslaug Geirsdottir (2), Marilyn L. Fogel (3), Alexander P. Wolfe (4), Rolf D. Vinebrooke (4)

1 INSTAAR and Geological Sciences, University of Colorado, Boulder, CO 80309-0450, USA, 2 Institute of Earth Sciences, University of Iceland, Sturlugata 7, Reykjavík 101, Iceland, 3 School of Natural Science, University of California, Merced, 4 Department of Biological Sciences, University of Alberta, Edmonton, AB, Canada T6G 2E9

Abstract: In order to better compare Holocene climate history and lake biogeochemical evolution across the North Atlantic sector, we developed two multi-proxy records from lakes with similar morphometry in Baffin Island, Arctic Canada and North Iceland. These records integrate algal pigment abundances with more traditional geochemical and microfossil proxies. Sediment cores from lakes Qivitu Highlands (abbreviated KHL, Baffin Island, 67°57'33.16"N, 65° 2'34.17"W) and Torfdalsvatn (66° 3'41.73"N, 20°23'14.26"W) obtained in 2010 and 2012 were subsampled at centennial to multi-decadal resolution and analyzed for total organic carbon, carbon and nitrogen atomic ratios and stable isotopes, FTIRS-inferred biogenic silica, diatom species assemblages, and algal pigments. The KHL record suggests early Holocene warmth peaked between 10 and 7.5 ka, concurrent with the local July insolation maximum. After this peak warmth, algal pigment-inferred community structure shifts toward a lesser relative abundance of green algae and higher plants and an increase in the relative abundance of diatoms. Additional cooling is detected from changes in diatom species assemblages and geochemical proxies at 3 ka, intensifying at 1.5 ka. The coldest inferred temperatures of the Holocene occurred during the Little Ice Age (LIA), in synchrony with local plateau ice cap expansion. However, pigments change little during late Holocene cooling, suggesting that the algal communities remained stable since the mid Holocene. The Torfdalsvatn record shows a delayed early Holocene warming, with soil development and peak aquatic productivity not occurring until after 8 ka. We do not observe a primary response of algal pigments to regional climate events at Torfdalsvatn with the exception of cyanobacterial relative abundance, which peaks during the regional Holocene Thermal Maximum (HTM). This implies that algal assemblages are controlled by variables such as nutrient availability at this locality. Diatom relative abundance is highest when total pigment-inferred productivity is lower, suggesting that in both locations, overall diatom abundance is less sensitive to environmental changes than other algal groups. Late Holocene cooling is regionally coherent between the two sites over the past 2 ka, with the coldest inferred Holocene temperatures at Torfdalsvatn also occurring during the LIA. Pigment composition at KHL returns to an HTM-like state in the last century, however this recent change is not observed at Torfdalsvatn. The difference in response of pigment-inferred algal assemblages to Holocene climate variability between sites helps constrain how algal groups in different lacustrine environments may change due to anthropogenic warming.

The marine signal of a collapsing ice margin: the catastrophic advance and collapse of the end Pleistocene Viscount Melville Sound Ice Shelf, Canadian Arctic Archipelago

Furze, Mark F.A. (1); Pieńkowski Anna J. (1, 2); Nichols, Keir A. (1, 3); Reedman, Amy (1); Esteves, Mariana S.R. (2); Cage, Alix G. (3); Bennett, Robbie (4).

1 Earth & Planetary Sciences, Department of Physical Sciences, MacEwan University, Edmonton, Alberta, T5J 4S2, Canada; 2 School of Ocean Sciences, Bangor University, Menai Bridge, Isle of Anglesey, Wales, LL59 5AB, UK.; 3 Department of Geography, Geology and the Environment, Keele University, Keele, Staffordshire, England, ST5 5BG, UK; 4 Natural Resources Canada - Geological Survey of Canada (Atlantic), Bedford Institute of Oceanography, P.O. Box: 1006, Dartmouth, Nova Scotia, B2Y 4A2, Canada

Abstract: Recent work in the western Canadian Arctic Archipelago has seen a dramatic re-evaluation of the timing and extent of Late Wisconsinan glaciation by a primarily cold-based Laurentide Ice sheet. Although the pattern of ice extent and retreat is now better constrained terrestrially, questions remain regarding ice retreat southeastwards onto mainland Canada.

Earlier research along the coasts of Viscount Melville Sound has demonstrated the re-establishment of a floating iceshelf during regional deglaciation ~10.9 cal ka BP. Molluscan chronologies suggest the establishment of the iceshelf was extremely rapid, persisting for less than 800 years, and subsequently undergoing an equally rapid collapse.

These terrestrial observations are now complemented by piston cores from central Viscount Melville Sound that document the short-lived ice shelf. The presence of water-lain diamictons as well as ice rafted debris indicative of a southern provenance is considered a result of deposition from a debris-rich tongue of floating glacial ice originating in M'Clintock Channel, thus permitting on-shore rafting of ice and emplacement of coastal tills and iceshelf moraines. The rapid transition from sub-iceshelf sediments to ice-proximal and distal deposits is also consistent with terrestrial evidence for the rapid retreat of the iceshelf. 14C-dated benthic foraminifera provide a minimum age on iceshelf collapse c.10.6 cal ka BP. Age-depth model projections indicate an approximate iceshelf collapse date far earlier than previously indicated, suggesting an even more dramatic event than hitherto hypothesised: an iceshelf establishing itself in Viscount Melville Sound and then collapsing in <400 cal yrs.

This detailed study contributes towards an improved understanding of the constraints placed on the streaming of ice from M'Clintock Channel and the resulting draw-down and destabilization of the NW sector of the Laurentide Ice Sheet. Emerging foraminiferal, diatom, and biogeochemical data provide valuable insights into the deglacial and postglacial history of the western Northwest Passage.

Abrupt centennial-scale departures superimposed on Holocene insolation forcing across the northern North Atlantic

Geirsdóttir, Áslaug (1); Miller, Gifford H. (2,1); Briner, Jason (3); Schweinsberg, Avriel (3), Pendleton, Simon (2), Larsen, Darren (4), Florian, Christopher (1,2)

1 Institute of Earth Sciences, University of Iceland; 2 INSTAAR & Dept of Geological Sciences, University of Colorado, Boulder, CO; 3 Department of Geology, State University of New York at Buffalo, Buffalo, NY; 4 Department of Geology & Planetary Science University of Pittsburgh, PA

Abstract: Landmasses throughout the North Atlantic Arctic exhibit greater responses to Holocene forcings than other Arctic regions and more than elsewhere in the Northern Hemisphere, presumably tied to the strong linkage to energy transport through changes in the coupled North Atlantic ocean-atmosphere circulation. A series of new, high-resolution and securely dated lake records from Iceland provide a firm basis for evaluating rates of environmental change in the region during the Holocene. Despite substantial differences in catchment-specific processes that dominate the lake records, the multi-proxy reconstructions are remarkably similar, particularly during the late Holocene. Here, we couple the high-resolution environmental reconstructions from the Icelandic lakes with 14C dates on entombed plants emerging from beneath receding ice caps to better constrain the nature of sustained (multicentennial), abrupt climate departures during the Holocene, characterized by persistent cold summers and an expanded cryosphere. Our studies in Iceland, Svalbard, West Greenland, and Arctic Canada document changes in summer temperature between the Holocene thermal maximum and the Little Ice Age of 4 to 5 °C, with summers in recent decades now the warmest of at least the past 5 ka. Environmental reconstructions at 10- to 30-year resolution through the past 8 ka suggest that cooling occurred in abrupt step changes at common dates throughout most of the North Atlantic Arctic, with the coldest summers of the past 8 ka occurring during the peak LIA (ca. 1750 – 1850 AD). Global modeling experiments suggest that changes in sea ice extent and duration provides one of the strongest feedbacks that may help to explain both the magnitude of the change and the abrupt nature of summer-cold departures.

Arctic and Subarctic Ostracode Database: Biogeographic and Paleoceanographic Applications

Gemery, Laura (1); Cronin, T. M. (1) Briggs, Jr., W. M. (2); Brouwers, E. M. (3); Stepanova, A. (4) Wood, A. M. (5); Yasuhara, M. (6)

1 U.S. Geological Survey, Reston, VA; 2 Institute of Arctic and Alpine Research (INSTAAR), University of Colorado (Retired); 3 U.S. Geological Survey, Denver, CO (Emeritus); 4 Texas A&M University, Department of Oceanography; 5 Coventry University, Department of Geography, England; 6 The University of Hong Kong, School of Biological Sciences, China

Abstract: A newly expanded Arctic Ostracode Database-2015 (AOD-2015) provides census data for 97 species of benthic marine Ostracoda from 1192 modern surface sediments from various parts of the Arctic Ocean and adjacent subarctic seas. Ostracodes are a meiofaunal bivalved Crustacea group, ranging in size from ~0.5 to 2.0 mm, which secrete a calcareous (CaCO3) shell commonly preserved in sediments. Many ostracode species have ecological limits controlled by temperature, salinity, oxygen, sea ice, food and other habitat-related factors. Unique species ecology, shell chemistry (Mg/Ca,ratios, stable isotopes), and limited stratigraphic ranges make them a useful tool for paleoceanographic reconstructions and biostratigraphy. Until recently, attempts to apply ostracodes to Arctic paleoceanography have been hampered by inconsistent taxonomy, limited analysis of recent material, and use of qualitative methodologies. This dataset, with updated taxonomy, facilitates the investigation of modern ostracode biogeography, regional community structure and ecology. These data, when compared to downcore faunal data from sediment cores, can be used to obtain a better understanding of how the Arctic region has been affected by climatic and oceanographic change during the Quaternary.

We will present biogeographic maps of key species and discuss their ecological significance. For example, some indicator/diagnostic ostracode taxa (and their ecological significance) include: Acetabulastoma arcticum and Pseudocythere caudata (near perennial sea ice), Polycope spp. (productivity and sea ice), Krithe hunti and Henryhowella asperrima (deep ocean water masses), Cytheromorpha macchesneyi (shallow, brackish coastal water), Rabilimis spp. (near-shore shelf environments) and Acanthocythereis dunelmensis (shallow, muddy substrates).

Publication of AOD-2015 will be open sourced and available online at several public websites with latitude, longitude, water depth, bottom water temperature and salinity for most samples. It will include material from abyssal plains, ridges and plateaus, continental shelves of the Kara, Laptev, East Siberian, Chukchi, Beaufort Seas and several subarctic regions (e.g. Bering Sea, Greenland, Norwegian Seas). This database is updated from that originally published in 1991 (Cronin et al. 1991) and later updated in 2010 (Cronin et al. 2010a & b). Significant new data has been added since 2010 (Gemery et al. 2013) incorporating faunal analyses from several Arctic expeditions. In addition to the surface sediment faunal database, downcore data from Quaternary cores and from recent cruises (USCGC Healy 2013-01, 2013-02, SWERUS Oden 2014) will be made available in the near future.

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Deglaciation and late Holocene glacier re-advances beyond the LIA extension in Hornsund, Svalbard, based on 10Be surface exposure ages

Gislefoss, Lina (1,2); Linge, Henriette (1); Hormes, Anne (2,3); Fabel, Derek (4); Xu, Sheng (5)

1 University of Bergen; 2 University Centre in Svalbard; 3 University of Gothenburg; 4 School of Geographical and Earth Sciences, University of Glasgow, Glasgow G12 8QQ, Scotland, UK; 5 AMS Laboratory, Scottish Universities Environmental Research Centre, East Kilbride G75 0QF UK

Abstract: Tidewater glaciers on Svalbard are sensitive to climate and ocean circulation changes. Here, we reconstruct the deglaciation history of innermost Hornsund with the tidewater glaciers Hyrnebreen, Hornbreen, Storbreen, Svalisbreen and Mendeleevbreen. The reconstruction is based on a Quaternary map of the Treskelen area and 10Be surface exposure ages of glacially transported boulders. Treskelen is an approximately 3,8 km long bedrock peninsula of tilted middle Carboniferous – early Jurassic rocks continuing into the anticline of Hyrnefjellet, as well as acting as a threshold for glaciers in the fjord. The primary objectives of research in this area are to 1) determine the timing of deglaciation of the fjord, and 2) investigate the extent of neoglaciation. Our findings are to be compared with other terrestrial and marine records from Svalbard. We present the 10Be surface exposure dating results from our first 12 glacially transported boulders situated between 13 and 156 m a.s.l. using the Arctic 10Be production rate and the analytical uncertainty (for internal comparison only). Boulders between 110 and 156 m a.s.l. on the crest of Treskelen outside the mapped Neoglacial moraines show 10Be surface exposure ages between 1.79 and 15.35 ka (n=5). Both end-members can be considered to be outliers as the remaining three overlap and yield a mean age of 13.00±0.50 ka. No overall elevation trend in surface exposure ages is apparent. Boulders between 13 and 108 m a.s.l., sampled at moraines, show 10Be surface exposure ages between 0.49 and 6.35 ka (n=8). An average age of 0.70±0.22 ka (n=4) includes both the lowest and highest situated boulders. The boulder at 13 m a.s.l. yielding one of the youngest ages is also the one positioned furthest west away from the previous glacier margin. Whilst another group of ages (n=4) cluster around a mean age of 1.88±0.33 ka.

Reconstructed Holocene glacier activity and Neoglacial winter precipitation at Ålfotbreen, western Norway, using distal glacier-fed lake sediments

Gjerde, Marthe (1,2,3); Bakke, Jostein (1,2); Vasskog, Kristian (1,2,4); Nesje, Atle (1,2,4); Hormes, Anne (3,5)

1 Department of Earth Science, University of Bergen, 2 Bjerknes Centre for Climate Research, Bergen, 3 Department of Arctic Geology, The University Centre in Svalbard, 4 Uni Research Climate AS, Bergen, 5 Department of Earth Sciences, Gothenburg

Abstract: Glaciers and small ice caps respond rapidly to climate perturbations, and the mass-balance of temperate Norwegian glaciers is governed mainly by summer temperature and winter precipitation. Records of past winter precipitation can give important insight into long-term changes in atmospheric circulation, but few proxies are actually able to capture winter climate variations in Scandinavia. Reconstructions of equilibrium-line-altitude (ELA) variations from glaciers that are sensitive to changes in winter precipitation therefore provides a unique opportunity to quantify past winter climate in this region. Here we present a new, Holocene glacier activity record for the maritime ice cap Ålfotbreen, western Norway, based on investigations of distal glacier-fed lake sediments. Several lake sediment cores have been subject to a suite of laboratory analyses, including measurements of physical parameters such as dry bulk density (DBD) and loss-on-ignition (LOI), geochemistry (XRF), surface magnetic susceptibility (MS), and grain size distribution, to identify glacial sedimentation in the lake. A robust chronology was constructed applying both radiocarbon (14C) and 210Pb ages. A novel approach, based on modifying an existing ELA-model with instrumental climate and mass-balance data, was used to calibrate the sedimentary record, which allowed a calculation of continuous ELA changes for Ålfotbreen during the Neoglacial (last ~1400 years). Furthermore, the resulting ELA-variations were combined with an independent summer temperature record to calculate Neoglacial winter precipitation using the 'Liestøl'-equation. The resulting winter precipitation record is of higher resolution than previous reconstructions from glaciers in Norway and shows the potential of glacier records to provide high-resolution records of past hydroclimate. Complete deglaciation of Ålfotbreen occurred ~9700 cal yr BP, and the ice cap was subsequently absent or very small until a short-lived glacier event is seen in the lake sediments ~8200 cal yr BP. The ice cap was most likely completely melted until a new glacier event occurred around ~5300 cal yr BP, coeval with the onset of Neoglacial at several other Norwegian ice caps. Ålfotbreen was thereafter absent (or very small) until the onset of the local Neoglacial period ~1400 cal yr BP. The 'Little Ice Age' (LIA) ~650-60 cal yr BP was the largest glacier advance of Ålfotbreen since deglaciation, with a maximum extent from ~400-200 cal yr BP. The late onset of the Neoglacial at Ålfotbreen is suggested to be a result from its low-altitude. A regional synthesis of Neoglacial ELA fluctuations along the coast of Norway indicates a time-transgressive trend in the maximum extent of the LIA, which seems to occur progressively later as we move northwards. We suggest this trend is likely forced by regional winter precipitation differences along the coast of Norway.

The deglaciation of Kongsfjorden, Svalbard, based on surface exposure dating of glacial erratics and Quaternary mapping of Blomstrandhalvøya

Grant, Oliver (1,2); Linge, Henriette (1); Hormes, Anne (2,3); Fabel, Derek (4); Xu, Sheng (5)

1 Department of Earth Science, University of Bergen; 2 University Centre in Svalbard; 3 Department of Earth Sciences, University of Gothenburg; 4 School of Geographical and Earth Sciences, University of Glasgow, Glasgow G12 8QQ, Scotland, UK; 5 AMS Laboratory, Scottish Universities Environmental Research Centre, East Kilbride G75 0QF UK

Abstract: Blomstrandhalvøya is a ca. 16.4 km2 pre-Devonian marble island within Kongsfjorden, Northwest Spitsbergen, Svalbard. Preliminary AMS results are presented for 10Be exposure ages of glacial erratics sampled on the island (n=18). The samples were taken from varying elevations on two transects to model the deglaciation of Kongsfjorden following the Late Glacial Maximum (LGM). We will explore if the Kongsfjorden ice stream collapsed dramatically following the LGM or if there was a gradual thinning and retreat. Quaternary geomorphological mapping will be used to help elucidate the complex ice-flow configuration and processes operating on Blomstrandhalvøya following the glacial maximum.Initial results from the western transect suggest that erratic boulders between elevations 78 and 367 m a.s.l. show an average 10Be surface exposure age of 14.8 ka ± 0.8 ka (n=5) with no elevation trend. One group of ages (n= 7) cluster around an average age of 12.7 ± 0.7 ka. Our preliminary map from Blomstrandhalvøya suggests that these samples mark the outer limit of a local readvance of an outlet glacier from the Blomstrandøya plateau and samples spread on elevations between 49 and 174 m a.s.l.The samples from the eastern transect (n=6) provide a more chaotic picture, with a range of 21.1 ± 1.9 ka between the youngest (8.2 ± 0.5 ka) and oldest (29.3 ± 1.4 ka) exposure ages. Such a spread in ages may represent a complex glaciological and geological history of the transect, with no discernable elevation trend.Radiocarbon ages from lithostratigraphic sections and marine sediment cores in Kongsfjorden suggested a rapid collapse of the Kongsfjorden ice stream during the Bølling interstadial (15.1-14.2 ka) (Hormes et al. 2013). Our elevation transect between 78 and 367 m suggest that the ice stream thinned considerably during the Bølling. The local readvance with 7 samples clustering around 12.7 ka indicates that the outlet glacier already reached its maximum position at the beginning of the Younger Dryas (12.9-11.7 ka) as boulder already became stabilized and ice-free at the time, this may reflect an earlier climate signal.

Reconstructing Southwestern Scandinavian Ice Sheet History Using 10Be Dating

Gump, Dale J (1); Briner, Jason P (1); Svendsen, John-Inge (2); Mangerud, Jan (2)

1 State University of New York at Buffalo; 2 University of Bergen

Abstract: We used cosmogenic 10Be exposure ages to constrain Scandinavian Ice Sheet deglaciation in southwest Norway. We complement previous work as part of an ongoing project in order to constrain the timing of the Norwegian Channel Ice Stream (NCIS) breakup following the Last Glacial Maximum and subsequent deglaciation of the Scandinavian Ice Sheet (Briner et al., 2014, JQS 29, 370-380; Svendsen et al., 2015, QSR 107, 231-242). Here, we present the first nine 10Be ages (~33% of total data set) from glacial erratic boulders, although 11 more are expected by the time of the Workshop. These first nine 10Be ages are from: (1) northern and southern Karmøy on the outer coast of southwestern Norway, (2) Bokn, a small island slightly inland and bordering the major fjord Boknafjorden, (3) from mainland Norway at a moraine near Falkeid that we have named the "Cleng Peerson" moraine and (4) from Sandvikfjellet, which neighbors Falkeid at a higher elevation.

A 10Be age of 19.8 ± 0.8 ka from southern Karmøy agrees with previously published ages from elsewhere on southern Karmøy of 20.9 ± 0.6 ka (n=3). Two erratics from northern Karmøy average 15.8 ± 0.9 ka, which is in close agreement to previously published ages of 15.9 ± 0.5 ka and 16.3 ± 0.4 ka at Våg, 15 km to the northeast. Two ages from the western coast of Bokn average 16.0 ± 1.0 ka. On Boknfjellet (~285 m asl), one erratic dated so far is 15.1 ± 0.6 ka. Finally, farther east still at Sandvikfjellet (~169 m asl), one erratic dated so far is 15.9 ± 0.7 ka, and, one moraine boulder dated so far from the low-lying Cleng Peerson moraine (~49 m asl) is 14.8 ± 0.8 ka.

The agreement that we found between these ages from southern Karmøy and those previously published from both this area and on neighboring Utsira reaffirms that the breakup of the NCIS must have been rapid, as this locale is some 400 km to the south of the Last Glacial Maximum ice margin (Svendsen et al., 2015). After the immediate coast was rendered an ice-free corridor at ~20 ka, the ages identify ~16 ka as a period of a possible culmination of re-advance, but almost certainly the onset of the next substantial retreat. These findings are promising for the possibility of long lake sediment archives from southern Karmøy. Our ages from northern Karmøy, as well as those from lower elevations at Bokn, Falkeid, and Sandvikfjellet, are very similar in age to deglaciation to the north (Våg) and south (Tananger).

These 10Be ages complement our previous findings that the NCIS and the main Scandinavian Ice Sheet unzipped as early as ~20 ka (Svendsen et al., 2015) followed by a second pulse of deglaciation at ~16 ka. By coupling our new 10Be ages of erratic boulders from the tops of hills bordering Boknafjorden, with topographic profiles and rudimentary ice-sheet profile calculations (Benn and Hulton, 2010), we plan to estimate spatial and temporal Scandinavian Ice Sheet history. Our results have not only filled geographic gaps and corroborated previously published deglacial ages from the surrounding area, but have also shed new light on a three-dimensional reconstruction of the Scandinavian Ice Sheet.

Coastal to Central: Integrating late-Holocene lacustrine climate proxies in NW Iceland

Gunnarson, Sydney (1,2), Geirsdóttir, Áslaug (1) Miller, Gifford (2,1)

1 Department of Earth Sciences, University of Iceland; 2 INSTAAR & Department of Geological Sciences, University of Colorado Boulder

Abstract: Since the disappearance of massive ice sheets after 10 kyr BP, the fate of Iceland's climate has been determined by abrupt changes that are uniquely tied to its position both in an active volcanic zone and next to the complex Atlantic Meridional Overturning Circulation (AMOC) in the North Atlantic Ocean. Understanding the responses of the Icelandic climate to these agitations and forcings is key to placing the current Arctic warming trend into a broader regional context for future climate predictions. This study focuses on gathering high-resolution, multi-proxy paleoclimatic data from lake sediments in a transect from NW (Vestfirðir) to central Iceland in order to understand the spatial and temporal differences in the effects of climate forcings throughout West Iceland. The results from this study will be used as paleoclimatic inputs for the larger Icelandic ANATILS (Abrupt North Atlantic Transitions: Ice, Lakes, and Sea) climate project, dedicated to constraining and modeling these abrupt climate changes.

Iceland's lakes are a particularly good target for capturing abrupt climate changes in the last 10 kyr because their high sedimentation rates provide good temporal resolution for records, their propensity to collect tephras ensures precise age models for records, and their ubiquity allows for high spatial coverage. We intend to investigate how the timing and intensity of the following Holocene phenomena are affected by proximity to the ocean: the retreat of massive ice sheets, the onset and termination of the Holocene Thermal Maximum (HTM) and the Little Ice Age (LIA), and the effect of changes in the AMOC. Marine cores from the Icelandic shelf are available for comparison with the terrestrial records obtained in this study in order to determine the changes in the AMOC.

In the spring of 2015, we obtained cores from 3 lakes in NW and central Iceland: Laugabólsvatn (~ 10 m length), Gjögursvatn (~3 m), and Arnarvatn Stóra (~9 m) using a Bolivia coring device. These lakes are shallow (<3 m depth) and are not glacially fed today, but each are thought to have captured the deglaciation of both Vestfirðir and central Iceland and the transition into warmer Holocene climate within the sediments. Age models will be based on tephra layers found in the sediment identified by the use of microprobe analyses and will confirm the timing of this transition in the lake core sediment. Proxies to be analyzed on the lake cores include total organic carbon (TOC), biogenic silica (BS), C and N isotopes and C/N ratios, magnetic susceptibility (MS), and density. Preliminary MS and density data from the Arnarvatn Stóra cores show suspected deglacial sediment at the base and numerous tephra layers, which may help further constrain the retreat of Langjökull from central Iceland and the onset and termination of the HTM and LIA in this area.
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The frequency and pattern of the volcanic activity in the N-Atlantic petrographic province during the last glacial period: a record from the deep-sea core PS2644 South Greenland Sea

Haflidason, Haflidi (1,2) and Voelker, Antje H.L.(3)

1 Department of Earth Science, University of Bergen, P.O.Box 7803, 5020 Bergen, Norway; 2 Bjerknes Centre for Climate Research, University of Bergen; 3 Divisão de Geologia e Georecursos Marinhos, Instituto Português do Mar e da Atmosfera (IPMA), Avenida de Brasília 6, 1449-006 Lisboa, Portugal

Abstract: The PS2644 deep-sea core sequence, retrieved from the northwestern margin of Iceland and covering the last c. 90 ka, exhibits high sedimentation rates during the last glacial cycle that allow the clear distinction of Greenland stadial (GS)/ interstadial (GI) cycles in the various proxy records. Abundance records of rhyolitic, basaltic and tachylytic tephra grains reveal several maxima. Tephra grains of all types were geochemically analyzed in 44 levels. A total of 84 tephras with a distinctive character have been defined within the glacial sequence of gravity core PS2644-5, whereas the Holocene record is dominated by reworked Vedde Ash grains and not suitable for tephra stratigraphic work. Of the 84 tephras only 11 geochemical populations have been linked with confidence to previously defined tephra layers such as from the Vedde Ash, Faeroe Marine Ash Zones (FMAZ) II and III and North Atlantic Ash Zone (NAAZ) II. For the glacial period informal names were given to 71 new tephras, most of which are basaltic tephras. Several of these layers have a unique geochemical character and might become new chronostratigraphic markers in the North Atlantic region. In addition, an indication of as much as 77 tephra volcanic events has been found. However, as these are recorded as single grains further investigation is needed to confirm whether these single grains represent an eruption event or only a reworked tephra. Linking the tephra populations to the volcanic system producing them revealed that Icelandic eruptions dominate with 76 tephra geochemical populations and Jan Mayen with 8. Around 43% of the informal tephra layers linked to the Icelandic volcanic province are produced from either the Grimsvötn or the Veidivötn-Bardarbunga volcanic systems. The central rift zone and unspecified or flank zone eruptions contribute 22%. Tephra from the Katla-Eyjafjallajökull volcanic systems make up only 6% percent of the tephra layers found. Eighteen of the new populations are of Jan Mayen (10%). The intervals spanning from Greenland Stadial (GS) 3 to Greenland Interstadial (GI) 4 (23.3-28.9 ka BP), from GI 8 to GS 10 (36.6-40.8 ka BP) and from GI 14 to GI 15.2 (49.6-55.8 ka BP) are the periods with the highest number of eruptions, all of which are associated with known tephra zones. Low eruption periods are found during the late MIS 3 and MIS 5a.

Mapping glacier change between the end of the “Little Ice Age” and 2008 using orthophotos and a DEM

Hamré, Moa; Gunhld Rosqvist, Peter Jansson, Per Holmlund

Department of Physical Geography, Stockholm University, Stockholm, Sweden

Abstract: 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 (DEM), topographical and geomorphological maps, historical photos together with previous inventories from 1950s/60s, 2002 and 2008. Using a Geographical Information System-based method, glacier area for 294 glaciers for LIA and 2008 were manually digitized where the LIA extents were determined mainly from moraines visible in orthophotos. Glacier area, volume, slope, aspect, elevation and hypsometry were determined and the change of the parameters was then calculated. The results show that the total area decrease from end of LIA to 2008 was 127 ± 7 km2 corresponding to 34 ± 7% or a estimated volume loss of 7.9 km3 or 41%. Glaciers with an area smaller than 1.0 km2 represent 78% of the total number of glaciers in 2008. These have suffered the largest relative area change contributing to as much as 32% of the total area loss with an increasing scatter of glacier area change and topographic character with decreasing glacier size. This illustrates the importance of including a large sample of studied glaciers covering all size classes in order to understand the glaciers response to climate change of a region. The relative area decrease for Swedish glaciers of 34% is the same as that detected for Jotunheimen, southern Norway between 1750-2003 (35%), smaller compared to the change recorded in the European Alps (50% between 1850 and 2000) and in the Southern Alps of New Zeeland (49% between 1850 and 1975) and larger than glaciers located on Baffin Island, Canada (13% between 1920 and 2000). Between 2002 and 2008 the rate of area decrease has increased to 1.6% a-1 compared to 0.3% a-1 for the period between 1916 and 2002. Thus, if this rate of glacier recession continues most glacier area could be gone by 2070.

Reconstructing Holocene climate and ice cap evolution in Vestfirðir, Iceland

Harning, David (1,2), Áslaug Geirsdóttir (1), Gifford Miller (2,1)

1 INSTAAR and Department of Geological Sciences, University of Colorado at Boulder, Boulder, CO, USA; 2 Institute of Earth Sciences, University of Iceland, Reykjavík, Iceland

Abstract: In light of the Arctic's inherent sensitivity to abrupt climate change it is imperative to place current Arctic warming in the context of long-term natural variability. In this project we focus on employing a multi-proxy approach to reconstruct the Holocene climate history of Vestfirðir, Iceland and the glacial extent of the region's largest ice cap, Drangajökull. Vestfirðir lies at the boundary between major oceanic and atmospheric circulation systems making both its regional climate and ice cap sensitive to any changes in these frontal positions. There is currently a lack of continuous well-dated terrestrial Holocene records from this region, limiting our capacity to understand the spatial response of Holocene climate change in Iceland to external and internal modes of climate variability. Therefore, the first part of this project targets two lakes in the vicinity of Drangajökull, non-glacial Skorarvatn (SKR) and glacial Tröllkonuvatn (TRK). Sediment cores from each lake were collected during the winter 2014 field season and have been analyzed at high-resolution for a wide-range of physical and geochemical proxies including magnetic susceptibility (MS), density, δ13C, δ15N, % total organic carbon (TOC), % nitrogen (TN) and computed for C:N elemental ratios. The 2.56-meter SKR core displays relatively elevated levels of TOC and TN and low C:N for the first half of the core followed by decreases in TOC and TN and an increase in C:N up core. The 4.51-meter TRK record displays a more gradual increase in TOC and TN from the base reaching maxima in the upper half of the core with C:N trends broadly similar to SKR except with a higher degree of variability. The uppermost 20 cm in SKR highlight a rapid increase in OM proxies while TRK displays a significant decrease at the surface. Density and MS for both cores are relatively stable since local deglaciation and trends tend to mirror those of the OM proxies. Radiocarbon dates of aquatic macrofossils from both cores are pending and tephrochronology development is currently underway for age control. Taken together, these preliminary results provide the first high-resolution Holocene records for Vestfirðir. To complement the lake-derived climate records, the second portion of this project capitalizes on the radiocarbon dating of in situ vegetation revealed from underneath Drangajökull as the ice margin retreats, as a proxy for past ice cap extent. Here we present 6 radiocarbon-dated moss samples collected in September of the 2013 and 2014 field seasons recording pre-modern calibrated ages which suggest the most recent period of persistent cooling and subsequent ice cap expansion along the northern margin occurred around 1850 cal. BP and within the last 250 years along the southern margin, potentially coincident with LIA cooling recognized throughout the North Atlantic region.

To what extent can the available historical temperature proxy network be utilised for investigating Arctic amplification?

Hind, Alistair (1,2); Zhang, Qiong (2)

1 Department of Mathematics, Stockholm University; 2 Department of Physical Geography, Stockholm University

Abstract: It has long been known that the Arctic region has warmed prefferentially in comparison to increasing global average temperatures over the last few decades. Evidence for this 'Arctic amplification' having occured during earlier parts of the 20th century as well as further back in time (based on palaeoclimate proxy reconstructed temperatures) is mounting. A preliminary investigation of reanalysis temperature data from 1979-present (ERA-Interim, ECMWF, UK) indicates that the recent warming over the Arctic has been concentrated over the Barents Sea region. It is of interest to investigate whether the characteristics (such as enhanced warming over the Barents Sea) of temperature changes in the Arctic were similar to the present during historical occurences of Arctic amplification.

In order to investigate the regional character of temperatures during past occurences of Arctic amplification, a pseudoproxy experiment is conducted, replicating available temperature proxy information in the Arctic region during periods featuring large changes in global climate in the Holocene (such as the 'Little Ice Age' and 'Holocene Thermal Maximum'). Presently, it seems the inhomogeneity of proxy networks can result in misrepresentation of the magnitude of Arctic amplification and the ability to resolve historic regional Arctic warming/cooling depends on having proxy information in representative locations where the greatest warming/cooling has occured.

Acoustic communication signals underneath the Arctic Sea Ice

Gaute Hope; Hanne Sagen

Nansen Environmental and Remote Sensing Center

Abstract: To explore the ocean underneath the Arctic sea-ice with remote or autonomously operated underwater vehicles we need means of communication and navigation. The all-year sea-ice cover prevents access to the surface, and a radio or GPS connection is not possible. In the end, the only viable option for wireless communication or navigation below the sea-ice is acoustic waves.

In the fall of 2013 we anchored an acoustic buoy to the sea-ice at 82N with a short array of receiving hydrophones reaching down to 15 meters below the sea-ice. A source operated from KV Svalbard transmitted an acoustic signal at increasing distances. We have used the OASES package to model acoustic transmission loss and reflection coefficients for this particular situation, we intend to compare the modelled signals with the received signals to understand and put constraints on the sensitivity for acoustic communication signals to change in sea-ice parameters and ocean environment.

The characteristic ocean environment below in the Arctic ocean creates a surface duct trapping the acoustic energy. A cold, fresh, water layer, approximately 100 meters thick, bounded by the sea-ice on top and the warmer Atlantic water below cause the acoustic waves to be refracted upwards and bounce of the rough and irregular underside of the sea-ice. In consequence, you have an acoustic propagation environment dependent on the sea-ice parameters and the ocean environment.

Furthermore an attempt to compare the transmitted signals with synthetic signals to understand the propagation in this environment will be made. In this poster our preliminary results will be presented.

Deglaciation history of Bjørnøya, Svalbard, between 25 ka and 12.9 ka

Hormes, Anne (1,2); Briner, Jason (3)

1 The University Centre in Svalbard, N-9171 Longyearbyen, Norway; 2 University of Gothenburg, S-405 30 Gothenburg, Sweden; 3 University at Buffalo, Buffalo NY 14260, USA

Abstract: The specific configuration and history of the marine-based Barents Sea ice sheet has been under dispute for decades. Bjørnøya is situated between northern Fennoscandia and the Svalbard archipelago and therefore lies in a key position for understanding the maximum configuration and initial retreat of the ice sheet. Bjørnøya also lies between two important trough systems that contributed to the ice sheet drainage: the Bjørnøya and Storfjorden palaeo-ice streams. We obtained 24 cosmogenic 10Be exposure ages from glacial erratics on southern Bjørnøya to 1) investigate the timing of initial deglaciation of the Barents Sea ice sheet, and 2) determine the timing of complete deglaciation of the island.

The 10Be ages are from glacially transported sandstone and conglomerate boulders situated in the southern part of the island, calculated using the Arctic 10Be production rate, and presented with analytical uncertainty. 18 10Be ages exhibit a very strong mode from 11.9 to 14.5 ka, averaging 12.9 ± 0.6 ka, a much smaller mode from 24.6 to 26.2 ka (averaging 25.6 ± 1.2 ka), and three samples were excluded as outliers scattering at different times (3.6 ± 0.2 ka, 16.3 ± 0.7 ka and 19.6 ± 1.0 ka).

Boulders between 17 and 293 m a.s.l. and the highest samples from Antarcticafjellet (340-351 m a.s.l.) indicate ages averaging 12.9 ± 0.6 ka. These boulders indicate the final deglaciation of restricted local remnants of ice covering the higher Antarctic and Alfred mountains and leaving well preserved moraine sequences in the lowlands.

Three old boulders between 137 and 293 m a.s.l. are interpreted as a possibly rather early start of deglaciation of the Barents Sea ice sheet ~25 ka, a similar time of initial deglaciation data in NW Spitsbergen (Gjermundsen et al. 2013). Alternatively, the samples have inheritance and provide no meaningful information about deglaciation; 26Al data are pending, which may allow us to identify them as containing inheritance.

Reference

Gjermundsen, E.F., Briner, J.P., Akçar, N., Salvigsen, O., Kubik, P., Gantert, N., Hormes, A., 2013. Late Weichselian local ice dome configuration and chronology in Northwestern Svalbard: early thinning, late retreat. Quaternary Science Reviews 72, 112-127.

Growth and decay of the last Eurasian Ice Sheets; a chronological database and time-slice reconstruction, DATED-1

Hughes, Anna L.C. (1,2), Gyllencreutz, Richard (3), Mangerud, Jan (1,2), Svendsen, John Inge (1,2), Lohne, Øystein S. (4)

1 Department of Earth Science, University of Bergen; 2 Bjerknes Centre for Climate Research; 3 Department of Geological Sciences and Bolin Centre for Climate Research, Stockholm University; 4 Sweco Norge AS, Bergen

Abstract: Numerical ice sheet and glacial isostatic adjustment models both require ice-sheet scale empirical constraints on past ice extent that are specified in time and include uncertainty estimates. Glacial geologists, require state-of-the-art regional summaries of empirical data in order to set individual records in context and build a picture of overall ice sheet evolution. Motivated by these two demands, in 2005 we started a project (DATED) to compile and archive all published dates relating to the build-up and retreat of the last Eurasian Ice Sheets including the British-Irish, Scandinavian and Svalbard-Barents-Kara Seas (BIIS, SIS and SBKIS respectively). Here we present the result; a new time-slice reconstruction documenting the changing limits of the Eurasian Ice Sheets during the last 40-10 ka. The dates were assessed for reliability and used together with mapped ice-sheet margin positions to reconstruct time-slice maps of the ice sheets extent every 1000 years between 25-10 ka, and selected older periods. From these data we observe: i) both BIIS and SBKIS achieve maximum extent, and commence retreat earlier than the larger SIS; ii) the eastern terrestrial margin of the SIS reached its maximum extent more than 3000 years later than the western margin; iii) a maximum ice volume of ~24 m sea-level equivalent was reached 21-19 ka and is dominated by the SIS. Large uncertainties exist for key sectors, especially where there is an absence of data; predominantly across marine sectors (e.g. the timing of coalescence and separation of the SIS and BKIS) but also in well-studied areas due to conflicting yet equally robust data.

We expect the time-slices and derived area and volume estimates to be useful for numerical and isostatic modelling requiring empirical constraints on past ice sheet extent, and design the reconstructions for this purpose. The ice sheet margin is delineated every 1000 years for the last 25 ka. We also present some reconstructions at uneven intervals back to 40 ka. Uncertainty estimates are represented by maximum, minimum, and preferred positions for each time-slice, reflecting conflicting evidence and gaps in the ice sheet chronology. The database and reconstructions will be updated on an on-going basis as new information becomes published and future versions will also include landform evidence to constrain ice sheet geometry (e.g. ice stream locations and ice thickness). Each date is attributed to the source publication, fully documented with information relevant to its interpretation and searchable by metadata including original author, location, dated material, dating technique, stratigraphic position or setting, derived age and associated errors, pertinent comments from the source publication and sample elevation or depth, core name, laboratory id and/or sample name as applicable.

Was Baffin Bay Covered by an Ice Shelf during the LGM and H1?

Jennings, Anne (1); Andrews, John (1); Ó Cofaigh, Colm (2); St-Onge, Guillaume (3); Belt, Simon (4); Cabedo-Sanz, Patricia (4)

1 INSTAAR and Department of Geological Sciences, University of Colorado, Campus Box 450, Boulder, CO 80309-0450 USA; 2 Department of Geography, Durham University, South Road, Durham DH1 3LE, United Kingdom; 3 Institut des sciences de la mer de Rimouski (ISMER) Université du Québec à Rimouski and GEOTOP Rimouski, Québec, Canada S5L 3A1; 4 School of Geography, Earth and Environmental Sciences, University of Plymouth, Plymouth PL4 8AA United Kingdom

Abstract: In several modeling experiments to test the potential role of an ice shelf fronting the Hudson Strait Ice Stream in the dynamics of Heinrich events, an ice shelf grows initially from thick sea ice, extends across the Labrador Sea to SW Greenland, grounds on the Davis Strait and fills Baffin Bay (Hulbe et al., 1997; Marcott et al., 2011; Álvarez-Solas et al., 2011; 2013). The incentive for these studies was to explain the timing of Heinrich events and the role of ocean warming during periods of reduced AMOC as triggers for ice shelf disintegration (Álvarez-Solas et al., 2011; Marcott et al., 2011). Hemipelagic sediments in central West Greenland trough mouth fan cores are critical for testing whether an ice shelf covered Baffin Bay during the late LGM and H1 and to investigate the role of ocean warming in initiating and/or sustaining retreat of the Greenland Ice Sheet from the shelf edge. We use benthic and planktic foram assemblages, the sea ice biomarker IP25, ice-rafted detritus (IRD), lithofacies and quantitative mineralogy to reconstruct paleoceanographic conditions. HU2008029-12PC has the longest record in our set of trough mouth fan cores. It extends to at least 22 cal ka BP, with radiocarbon dates from intervals of relatively abundant planktic forams. There are two main units defined by the CT scan images of this core. A high CT number interval from 11.3 m to 4.7 m is mainly composed of stratified sandy mud. The upper unit, above 4.7 m, has low relatively low CT number and high IRD content. The boundary between the two units dates to 16.2 cal ka BP. CT scans also reveal that the entire core has some level of bioturbation, indicating an active benthic fauna throughout the time period represented by the core. Planktic foram abundance spikes coincide with abundance spikes of benthic foram species indicative of chilled Atlantic Water and episodic marine productivity. IRD and IP25, however, are rare prior to 16.2 cal ka BP. These characteristics are consistent with the ice margin at the shelf edge meeting a heavily sea-ice covered ocean with occasional formation of leads in the ice cover, and with chilled Atlantic Water at depth; thus, the data do not provide evidence for a fully ice shelf-covered Baffin Bay. The transition to the upper unit suggests that initial deglaciation from the West Greenland margin began ca. 16.2 cal ka BP. Ice retreat is recorded by the lithofacies shift from turbidites and plumites to bioturbated mud with dispersed IRD and continued presence of Atlantic Water benthic species. After 16.2 cal ka BP, IP25, large diatoms and benthic forams indicative of sea-ice edge productivity reflect warming conditions. The implication for the Heinrich Events and ocean warming/ice shelf hypothesis is that proxy data do not support a full ice shelf cover over Baffin Bay. Alternatively, sea-ice cover may be sufficient to explain retention of subsurface ocean warmth and perhaps smaller fringing ice shelf off the Hudson Strait outlet is sufficient to provide the back pressure release required by the ocean warming/ice shelf hypothesis (Hulbe et al., 2004).

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The stabilizing effect of sea-ice on a freshwater perturbation

Jensen, Mari Fjalstad (1,2); Nisancioglu, Kerim Hestnes (1,2); Nilsson, Johan (3)

1 Dept. of Earth Science, University of Bergen, Norway; 2 Bjerknes Centre for Climate Research, Norway; 3 Dept. of Meteorology, Stockholm University, Sweden

Abstract: A retreating sea-ice cover is one of the hypothesized mechanisms for the abrupt warming observed during Dansgaard-Oeschger events of the last glacial. It has been proposed that a warming of the subsurface ocean during cold stadials could explain the rapid retreating sea-ice cover in the Nordic Seas at the start of each interstadial (Dokken et al., 2013). The warming of the subsurface ocean would gradually weaken the vertical stratification and lead to a sudden convective overturning as the vertical density difference disappeared.

In this study, we show that the circulation can become unstable even before the vertical density difference vanishes. We study the stability of a salinity-dominated circulation to freshwater perturbations in the presence of sea-ice, by using a one-dimensional, analytical model. The model represents the sea-ice covered Nordic Seas, and consists of a sea-ice component and a two-layer ocean; a cold, fresh surface layer above a warmer deep ocean. The sea-ice thickness depends on the atmospheric energy fluxes as well as the ocean heat flux. We introduce a thickness-dependent sea-ice export.

The stabilizing effect of sea-ice to a freshwater perturbation is shown to depend on the representation of vertical mixing. In a system where the mixing increases with density differences, the sea-ice acts as a positive feedback to a freshwater perturbation. If the mixing decreases with density differences, the sea-ice acts as a negative feedback. However, both representations lead to a circulation that breaks down when the freshwater input at the surface is small. As a consequence, we get rapid changes in sea-ice. In addition to low freshwater values, increasing deep-ocean temperatures promote instability and the disappearance of sea-ice.

Reference:

Dokken, T. M., Nisancioglu, K. H., Li, C., Battisti, D. S. and Kissel, C. (2013), `Dansgaard Oeschger cycles: interactions between ocean and sea ice intrinsic to the Nordic Seas,' Paleoceanography 28

A 2000 year record of marine climate variability from Arnarfjörður, NW Iceland

Jónsdóttir, Ingibjörg R. (1), Ólafsdóttir, Sædís (2), Geirsdóttir, Áslaug (1)

1 Institute of Earth Sciences, University of Iceland; 2 University of Bergen, Norway

Abstract: A high-resolution sedimentary record from the subarctic Arnarfjörður in northwestern Iceland is being studied, with the ultimate goal to reconstruct the marine climate and the environmental history of Arnarfjörður for the past 2000 years. We believe that the fjord provides a regional oceanographic climatic signal reflecting changes in the Irminger Current, a branch from the warm and saline North Atlantic Current and the fresher East Greenland Current from the north, and changes in sea ice cover in the region.

The sediment core from Arnarfjörður is 520 cm long, collected from 98 m water depth from the middle part of the fjord. Based on four radiocarbon dates and two micro-tephra layers (not confirmed with chemical analysis), the sediment core spans approximately 2000 years and thus offers a high resolution record for that time interval, which includes both the Medieval Climate Anomaly (MCA) and the early to middle part of the Little Ice Age (LIA). The reconstruction is based on magnetic susceptibility and density records, total carbon measurements together with carbonate and quartz measurements and x-radiographs, which are used to identify ice rafted debris (IRD). The main focus is, however, on benthic foraminifera study where down-core distributional patterns of benthic foraminifera is used to describe the oceanographic settings and to identify environmental changes in the study area.

The benthic foraminiferal studies provide multidecadal time resolution. Three species dominate the fauna: Cibicides lobatulus; Cassidulina reniforme and Elphidium excavatum. Less abundant are Astrononion gallowayi, Quinqueloculina stalkeri and Bucella spp. The foraminiferal assemblages indicate that considerable environmental changes have occurred during the last 2000 years in Arnarfjörður. The cosmopolitan species C. lobatulus, which reflects strong bottom water conditions, dominates the lower part of the core until 1350 AD. whereas the upper part has a more modern faunal composition with the arctic species C. reniforme and E. excavatum, both known from other fjords in Vestfirðir today. E. excavatum which is often associated with near-glacial environments is most common after 1200 AD.

We used transfer function on the down-core faunal composition to estimate the bottom water temperatures (BWTTF) and salinities (BWSTF) based on the Sejrup et al. (2004) recent benthic foraminifera database. The BWT for Arnarfjörður fluctuates from ca. 1,5° C to 4,75° C. The highest estimated temperature is found at the bottom of the core with a decreasing trend until ca. 800 AD where there is a period of higher bottom water temperature related to a warming during the MCA. At ca. 1150 AD the temperature starts to decrease towards the top, with distinctive lows around 1300, 1500 and 1700 AD (LIA).

The core was divided into three units based on clustering analysis which was applied to the foraminifera records. From the bottom of the core to ca. 800 AD the conditions are fairly stable but indicate gradual cooling with the least amount of fluctuation for each proxy. This is also the interval where no IRD was detected in the x-radiographs. From 800 to 1150 AD is

a period of warming (MCA) with higher estimated temperature and salinity values, than below possibly due to increasing strength of the Irminger Current. Around 1200 AD the proxies start to show signs of colder conditions related to the onset of the LIA in the area with increasing IRD, peak in the MS and decrease in both the total carbon and the BWTTF. The data from Arnarfjörður is in parallel with previously reported LIA characteristics, described as a period of high amplitude fluctuations, with non-stable conditions and cold bottom waters.

Seasonal changes in benthic foraminifera assemblages in surface sediments of Adventfjorden (west Spitsbergen) – preliminary winter studies results.

Kucharska, Małgorzata (1); Łącka, Magdalena (1); Pawłowska, Joanna (1); Jørgen Lønne, Ole (2); Zajączkowski, Marek (1)

1 Institute of Oceanology, Polish Academy of Sciences, Powstańców Warszawy 55, 81-712 Sopot, Poland; 2 The University Centre in Svalbard (UNIS), P.O. Box 156, N-9171 Longyearbyen

Abstract: Foraminifera are broadly used in ecological and palaeoecological studies, however many aspects of their phenology and life span are still unknown. That's why a new investigations on these organisms are constantly undertaken and more accurate analyses are carried out. The main aim of our project is to investigate the relationship between seasonal hydrological/environmental changes in the Arctic fjord and related changes in foraminiferal assemblages. Our project assume seasonal sampling and analyses of benthic foraminifera assemblages, including polar night.

Adventfjorden, the southern arm of Isfjorden is easy to reach year-round and within last few years no permanent ice cover was observed in this fjord during the winter. The first sampling campaign was conducted in January 2015 from aboard of University Centre in Svalbard vessel Polarcirkel. The sediment cores 10 cm in length were taken at three stations (40 m, 60 m and 80 m water depth) using a gravity corer off 7 cm diameter. Additionally hydrological properties were measured with Sensordata 204 CTD equipped with turbidity sensor. Sediment cores were cut in 1 cm thick slices and Bengal rose stained, to distinguish living organisms. As life organisms were counted calcareous individuals with at least two chambers stained. Analysis was done using stereo microscope and organisms were identified to the species level. The biodiversity indicators were calculated using the Primer 6 software package using the total number of species, Margalef's species richness index, and Simpson's diversity index.

In general 34 species have been noted, 18 agglutinated and 16 calcareous. Among agglutinated species most abundant were Spiroplectammina biformis and Textularia earlandi. Among calcareous species the most numerous were Nonionellina labradorica, Elphidium excavatum and Cassidulina reniforme. Within the all three taxons stained individuals were dominating. The upper 3 cm of sediment at the station at 40 m water depth were bare in foraminifera and no foraminifera was also noted in the top 1 cm of sediment at station at 60 m water depth. The stained individuals were observed down to 10 cm in sediment. This finding shows that foraminifera are able to migrate vertically in sediment and survive if only they have access to food supplies. This information is significant especially for palaeoecological studies in which environmental conditions are assessed on the basis of ecological preferences of identified foraminifera species.

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Age and origin of multiple ice-rafted debris horizons in the Canadian Beaufort Sea: implications for Arctic Ocean stratigraphy and paleoclimate

Lakeman, Thomas R. (1), Pieńkowski, A.J. (2), Nixon, F.C. (3), Furze, M.F.A. (2), Blasco, S. (4), Andrews, J.T. (5)

(1) Geological Survey of Norway, Trondheim, Norway; (2) Department of Physical Sciences, MacEwan University, Edmonton, Alberta, Canada; (3) Nova Scotia Department of Natural Resources, Halifax, Nova Scotia, Canada; (4) Geological Survey of Canada, Bedford Institute of Oceanography, Dartmouth, Nova Scotia, Canada; (5) Institute of Arctic and Alpine Research, University of Colorado, Boulder, Colorado, USA

Abstract: Uncertainties regarding the age and origin of shelf and slope sediments in the Beaufort Sea constitute a major barrier to understanding the geological evolution of the western Canadian Arctic. Multiple sediment cores collected from the upper slope of the Beaufort Sea and from adjacent Amundsen Gulf provide evidence for rapid, intermittent deposition of discrete ice-rafted debris (IRD) horizons during the last deglaciation (i.e. 16–11 cal ka BP). The mineralogy of the IRD is defined by new quantitative x-ray diffraction (qXRD) analyses, which confirm a source area in the Canadian Arctic Archipelago. In addition, multiple radiocarbon ages of planktonic and benthic foraminifera constrain the ages of the IRD horizons. Three IRD events are identified in the shelf and slope sediments based on their age, stratigraphic position, and composition. Two, paired, closely spaced IRD horizons (each 10 to 20 cm thick) occur in the upper 230 cm of the sediment cores from Amundsen Gulf and the upper slope. Multiple radiocarbon ages imply that these two, upper IRD horizons were deposited during the Younger Dryas chronozone. A third IRD horizon (up to 30 cm thick) occurs at greater depth in two of the sediment cores from the upper slope. A radiocarbon age indicates that this lower IRD horizon was deposited during the late Bølling-Allerød chronozone. The occurrence and age of these new IRD horizons bears on the timing and nature of ice sheet retreat from the Canadian Arctic Archipelago during the last deglaciation. Specifically, the IRD is inferred to represent sporadic deposition by icebergs produced during phases of rapid or catastrophic withdrawal of a former ice stream in Amundsen Gulf. Importantly, the age of the two, upper IRD horizons accords with previous inferences of rapid ice stream withdrawal in Amundsen Gulf during regional deglaciation, based on detailed mapping and dating of the glacial geomorphology of Banks and Victoria islands. These new constraints on past ice stream dynamics provide insight into the variables that occasioned deglaciation of the marine channels of the archipelago, and constitute an important analogue for extant ice sheets. Further, recognition of discrete periods of high iceberg fluxes to the Arctic Ocean (during intervals of ice stream retreat) aids in understanding deglacial paleoclimatic archives. Finally, knowledge of the sources and timing of IRD entering the Arctic Ocean (i.e. glacier vs. sea ice) has implications for understanding the stratigraphy of sediment cores recovered from the deep basin and elsewhere.

Effects of excess ground ice on projections of permafrost in a warming climate

Lee, Hanna (1,2), Sean C. Swenson (3), Andrew G. Slater (4), David M. Lawrence (3)

1 Uni Research Climate, Allégaten 55, Bergen, Norway; 2 Bjerknes Centre for Climate Research, Bergen, Norway; 3 Climate and Global Dynamics Division, National Center for Atmospheric Research, Boulder, Colorado, USA; 4 National Snow and Ice Data Center, Boulder, Colorado, USA

Abstract: In permafrost soils, 'excess ice', also referred to as ground ice, exists in amounts exceeding soil porosity in forms such as ice lenses and wedges. Here, we incorporate a simple representation of excess ice in the Community Land Model (CLM4.5) to investigate how excess ice affects projected permafrost thaw and associated hydrologic responses. We initialize spatially explicit excess ice obtained from the Circum-Arctic Map of Permafrost and Ground-Ice Conditions. The excess ice in the model acts to slightly reduce projected soil warming by about 0.35°C by 2100 in a high greenhouse gas emissions scenario. The presence of excess ice slows permafrost thaw at a given location with about a 10 year delay in permafrost thaw at 3 m depth at most high excess ice locations. The soil moisture response to excess ice melt is transient and depends largely on the timing of thaw with wetter/saturated soil moisture conditions persisting slightly longer due to delayed post-thaw drainage. Based on the model projections of excess ice melt, we can estimate spatially explicit gridcell mean surface subsidence with values ranging up to 0.5 m by 2100 depending on the initial excess ice content and the extent of melt.

New insight on the age and geomorphic history of tuyas in the northern volcanic zone of Iceland from cosmogenic 36Cl surface exposure dating

Licciardi, Joseph M. (1); Houts, Amanda N. (1); Bryce, Julia G. (1); Finkel, Robert C. (2); Zimmerman, Susan H. (3)

1 Department of Earth Sciences, University of New Hampshire, Durham NH 03824, USA; 2 University of California Berkeley, and Center for Accelerator Mass Spectrometry, Lawrence Livermore National Laboratory, Livermore, CA 94550, USA; 3 Center for Accelerator Mass Spectrometry, Lawrence Livermore National Laboratory, Livermore, CA 94550, USA

Abstract: Tuyas, also widely known as table mountains, are flat-topped steep-sided volcanic edifices that form when lava erupts through a thick glacier or ice sheet. The unique origin and distinctive characteristics of these landforms offer the opportunity to provide constraints on the volcanic, glacial, and geomorphic evolution of the regions in which they occur. Tuyas are widespread landscape features in Iceland, where the interaction between volcanism and glaciation has generated keen interest and ongoing debate. An essential key to resolving these dynamic interactions rests on accurate dating of volcanic and glacial landforms. In this regard, it has been challenging to determine the age of basaltic tuyas in Iceland, owing to low concentrations of potassium required for K-Ar and Ar-Ar dating and the scarcity of preserved organic material for radiocarbon dating.

Surface exposure dating using cosmogenic nuclides offers a powerful alternative technique for developing high-resolution age control for glacial and volcanic units. In prior work, cosmogenic 3He concentrations were measured in subaerially erupted basaltic lava caps of tuyas in the neovolcanic zones of Iceland to obtain a chronology of their formation. The resulting 3He exposure ages fall within the last deglaciation for all but one of the 13 dated tuyas. Local calibrations of cosmogenic 3He and 36Cl production rates have also been established in Iceland, thus bolstering the accuracy of exposure dating with these nuclides.

Here we report new cosmogenic 36Cl surface exposure ages obtained from the summit of Sellandafjall (988 m elevation), a prominent tuya in the northern volcanic zone of Iceland. In sharp contrast to the unglaciated tuyas previously targeted for 3He exposure dating, Sellandafjall bears evidence of extensive glacial scouring and exhibits ice-sculpted landforms such as roches moutonnées on the capping lava plateau. Cosmogenic 36Cl concentrations were measured in whole-rock basalt samples collected from scoured bedrock surfaces at two separate sites near the summit. Major and trace element analyses indicate extremely low concentrations of K and native Cl in these rocks; hence the vast majority of in situ 36Cl production occurs via Ca spallation. Exposure ages were calculated using the locally calibrated Ca-spallation 36Cl production rate, in conjunction with the same set of nuclide production parameters employed in the 36Cl calibration study.

The two 36Cl exposure ages from Sellandafjall agree within uncertainty and yield a mean age of approximately 12 ka. These new ages align closely with the published mean 3He ages from nearby tuya summits in the Mývatn district, most notably those from Bláfjall (14.4 ± 0.4 ka; n = 3; 1288 m elevation) and Búrfell (10.8 ± 0.3 ka; n = 3; 953 m elevation). The 36Cl ages from Sellandafjall are interpreted to date the emergence of the glacially

scoured tuya summit from the ice sheet as it thinned. In this view, these new results reinforce previous arguments for the timing of ice sheet thinning in northern Iceland as suggested by the published 3He ages from tuyas in this region. It is important to note that the 36Cl ages from Sellandafjall cannot be used to define the eruptive age of this tuya, as extensive glacial scouring testifies to removal of surface rock and the likely “resetting” of exposure-dating clocks. Accordingly, these ages do not preclude a much older eruptive age for Sellandafjall, which remains a viable possibility that awaits further appraisal from independent dating methods.

Microbial diversity and community structure along a glacier forefield chronosequence at Styggedalsbreen, central Norway

Mateos-Rivera, Alejandro (1,2); Øvreås, Lise (1); Reigstad, Laila J. (3); Finster, Kai W. (4); Yde, Jacob C. (2)

1 Department of Biology, University of Bergen, Norway; 2 Faculty of Engineering and Science, Sogn og Fjordane University College, Norway; 3 Department of Earth Science, University of Bergen, Norway; 4 Department of Bioscience, Aarhus University, Denmark.

Abstract: As a consequence of increasing temperatures, most glaciers have gone through recession since the end of the Little Ice Age (LIA) (c. 1750 AD). Styggedalsbreen, located in central Norway, has retreated around 800 meters since the LIA and as a consequence its forefield has become successively exposed to environmental changes. In order to obtain new insights into how the structure and diversity of proglacial microbial communities are affected by soil formation and age, soil samples from six successional stages along a chronosequence in the Styggedalsbreen glacier forefield were collected. "Next-generation sequencing technology" was applied to study the microbial community composition and distribution between the sites. Illumina sequencing analyses revealed a marked shift in the microbial community compositions along the chronosequence. In addition, the collected soil samples were analysed for organic carbon (OC), total nitrogen (TN), and pH. The content of carbon along the chronosequence showed an increase as a function of soil age (from 0.39 mg/g to 53.06 mg/g), likely due to the increments of biomass and microbial activity. The pH turned to more acidic values (7.89 to 4.74) with soil age due to the soil development (pedogenesis). Total Nitrogen content was low along the chronosequence (only up to 2.9 mg/g) with an increase with soil age. The number of prokaryotes was found to be low in the newly exposed soil, and increased with soil age. The results also showed an increase with age in the copy number of members from both the Bacteria (from 106 to 108) and Archaea (from 104 to 106) domains along the chronosequence, using 16S rDNA as the target for amplification.

The recently deglaciated areas were dominated by members from Proteobacteria (Bacteria) and Euryarcheota (Archaea), however, both these phyla decreased as a function of soil age. Therefore, methane production along the first stages in the chronosequence will be expected as those areas are perfect ecosystems for the anaerobic conditions required by methanogens (Euryarcheota) followed by ammonia oxidation caused by members from Thaumarcheota phylum; other microbial processes i.e. carbon dioxide production, sulphur oxidation and methane oxidation during the transect are predicted due to major presence of members from Oxalobacteraceae, Comamonadaceae and Methylophilaceae families (β-Proteobacteria). Very few nitrogen fixing organisms were observed probably linked to the low TN concentration in the young soil. The results from Styggedalsbreen forefield add new insights to our understanding of changes in the proglacial microbial ecosystems and contribute with a better perception on potential global warming consequences where greenhouse gases release processes such as carbon dioxide (CO2) and methane (CH4) are very likely to occur.

Trends in the normalized difference vegetation index (NDVI) associated with urban development in arctic and subarctic Western Siberia

Miles, Victoria (1); Esau, Igor (1); Davy, Richard (1); Kurchatova, Anna (2)

1 Nansen Environmental and Remote Sensing Centre / Bjerknes Centre for Climate Research, Bergen, Norway; 2 Institute of the Earth's Cryosphere / Tyumen Oil and Gas University, Tyumen, Russia

Abstract: Changes in normalized difference vegetation index (NDVI) in the high Arctic north of 70N have been reliably documented, with widespread "greening" (increase in NDVI), specifically along the northern rim of Eurasia and Alaska. Whereas in West Siberia south of 65N, widespread "browning" (decrease in NDVI) has been noted, although the causes remain largely unclear. In this study we report results of statistical analysis of the spatial and temporal changes in NDVI around 28 major urban areas and industrial installations in the arctic and subarctic Western Siberia. Exploration and exploitation of oil and gas reserves has led to rapid industrialization and urban development in the region. This development has significant impact on the environment and particularly in the vegetation cover in and around the urbanized areas. The analysis is based on 15 years (2000-2014) of high-resolution (250 m) Moderate Resolution Imaging Spectroradiometer (MODIS) data acquired for summer months (June through August) over the entire arctic and subarctic Western Siberian region. The analysis shows that the NDVI background trends are generally in agreement with the trends reported in previous coarse-resolution NDVI studies. Our study reveals greening over the arctic (tundra and tundra-forest) part of the region. Simultaneously, the southern (boreal taiga forest) part is browning, with the more densely vegetation areas or areas with highest NDVI, particularly along Ob River showing strong negative trend.

The unexpected and interesting finding of the study is statistically robust indication of the accelerated increase of NDVI ("greening") in the older urban areas. Many Siberian cities become greener even against the decrease in the NDVI background. Moreover, interannual variations of urban NDVI are not coherent with the NDVI background variability. We also find that in tundra zones, NDVI values are higher in a 5-10 km buffer zone around the city edge than in rural areas (40 km distance from the city edge), and in taiga in a 5-10 km buffer zone NDVI value are lower compare with rural zone. We speculate that the observed "greening" or "browning" around urban areas could be caused by the vegetation cover response to the anthropogenic urban heat island (UHI) effect. The general regional trend is amplified in very close proximity to the urban areas, possibly due to UHI effect.

On the reconstruction of ocean circulation and climate based on the “Gardar Drift”

Mjell, Tor Lien (1,3,5); Langehaug, Helene R. (2,5); Otterå, Odd Helge (3,5); Eldevik, Tor (4,5); Ninnemann, Ulysses. S. (1,3,5); Kleiven, Helga (Kikki) F. (1,3,5)

1 Department of Earth Science, University of Bergen, 2 Nansen Environmental and Remote Sensing Center, 3 Uni Climate, Uni Research, 4 Geophysical Institute, University of Bergen, 5 Bjerknes Centre for Climate Research

Abstract: Sediment based reconstructions of bottom water velocity at the Gardar Drift are commonly interpreted to reflect changes in the eastern Nordic Seas overflows. Here we use a 500-year long simulation of the Bergen Climate Model (BCM) to investigate the relationship between changes in the water that overflows through the Faroe Shetland Channel (FSC) and downstream bottom velocity at the location of the Gardar Drift. We identify a region in our simulation proximal to the geographical location of the northern Gardar Drift where 76 % of the variance in bottom velocity can be explained by changes in the transport and density of the FSC overflow. By contrast, Labrador Sea Water (LSW) changes do not appear to play any significant role in the bottom flow over the Gardar Drift. Our findings support the assumption in the paleo literature that reconstructions of bottom water velocity at the Gardar Drift reflect past changes in the eastern Nordic Seas overflows. However, our results suggest that velocity changes downstream of the actual overflows are not a simple metric for upstream changes in transport, with density playing the largest role.

Chronology of the last retreat of the Norwegian Channel Ice Stream

Morén, B. M.; Sejrup, H. P.; Hjelstuen, B. O.

Department of Earth Science, University of Bergen

Abstract: The Norwegian Channel Ice Stream flowed through the Norwegian Channel in the NE North Sea and reached the shelf break numerous times during the Weichselian. New evidence (Becker et al. in prep.) from the shelf break suggests that the outer part of the Norwegian Channel Ice Stream, from the shelf break to Stavanger, experienced a number of retreats and advances between 24 and 19 ka. From seismic, bathymetric and sediment-core data, the glacial geomorphology (end moraines, grounding-zone wedges and mega-scale glacial lineations) and stratigraphy (diamicton, glacimarine and hemipelagic sediments) have been mapped, and are used to infer the ice-stream behaviour and dynamics during the last deglaciation.

Newly dated sediment cores together with published radiocarbon dates from the Norwegian Channel suggest that the Norwegian Channel Ice Stream started retreating from its maximum extent at the continental shelf break c. 19.1 ka. The grounding-line reached an area outside Stavanger c. 17.1 ka and the deglaciation of the Norwegian Channel was completed c. 16.3 ka. The first part of the retreat, from the shelf edge to Stavanger, was slower than the second part, from Stavanger to the inner part of Skagerrak. During its retreat, the ice stream experienced a number of stand-stills and slow-downs of its grounding-line, which are evident from the grounding-zone wedges that are found in the outermost half of the Norwegian Channel, along with end moraines.

Contrasting with the radiocarbon dates, available cosmogenic exposure dates from the island of Utsira, located in the Norwegian Channel close to Stavanger, give deglaciation ages of between c. 20.2 and c. 25.1 ka (Svendsen et al. 2015). Comparing the radiocarbon and cosmogenic exposure ages, there is a difference in calculated deglaciation rate of the outer part of the Norwegian Cannel of up to 3 ka. The fact that radiocarbon dates are relatively consistent, whilst there is age spread in the cosmogenic exposure ages from Utsira may suggest that less weight should be put on the latter. We suggest that the somewhat higher exposure ages may be linked with the scenario of repeated ice-stream glaciations of relatively thin ice on the island of Utsira.

Climate, grass growth, and hay yield in Northeastern Iceland A.D. 1700 to 1950

Ogilvie, A.E.J. (1,2); Sigurðardóttir, Ragnhildur (3); Júlíusson, Árni Daníel (3); Hreinsson, Viðar (3); Hicks, Megan (4)

1 Stefansson Arctic Institute, Akureyri; 2 INSTAAR, University of Colorado; 3 Reykjavik Academy; 4 Hunter College, CUNY.

Abstract: This presentation will focus on climatic and socio-economic impacts associated with hay and grass harvesting in the Mývatn area in the northeastern highlands of Iceland. The name Mývatn literally means "Midge Lake" and refers to the lake that the region takes its name from, and the flies or midges, Tanytarsus gracilentus, also associated with the area. The midge population is of vital importance for the local ecosystem. Not only does it provide food for the water birds that flock to the area, as well as the fish in the lake, but their population fluctuates dramatically, and they sometimes occur in such great numbers that when they die their remains blanket the surrounding landscape with nutrients that are especially high in nitrogen and phosphorus, greatly increasing productivity (see e.g., Ives et al., 2008).

Until the early part of the twentieth century, the inhabitants of Mývatn lived almost entirely on the proceeds of the land by farming, fishing for trout, and collecting the eggs of wild birds. With its North Atlantic location, marginal for agriculture, grass was the only viable crop in Iceland, and the economy focused primarily on animal husbandry until comparatively recent times. Thus, the success or failure of the grass crop, coupled with winter rangeland grazing, was the one aspect of the economy on which all else rested. The harvesting of hay was thus the farmers' most important annual task. If there was not enough hay in the winter to feed the livestock they could die, and this could lead to famine and death among the human population. This unfortunate train of events occurred many times in Iceland's history, and not least in the Mývatn district.

Clearly, climate and weather played a significant role in the success or failure of the grass crop and hay harvest which were frequently precarious. Variable weather during the growing season, with alternating frosts and thaws, could have an adverse affect, as could unusually cold weather. Very rainy weather could jeopardize the harvest. There was no particular means of drying the grass for hay other than reaping it, and leaving it on the ground to dry, after which it was gathered and conveyed to the farm, usually on horseback. The presence of sea ice off the coasts significantly lowered temperatures on land and invariably adversely affected the crop (Ogilvie, 2010). In addition to the constraints of the natural world, governance by state and church, and the system of land tenure in use in the Mývatn area were also of importance for farm management and the economy (Júlíusson et al., 2013). The situation regarding trade was also a salient feature in the development of the community. Of particular relevance was the strictly enforced Danish trading monopoly (1602-1787) that caused much hardship. This presentation, drawing on a recently-funded NSF project (Investigations of the Long Term Sustainability of Human Ecodynamic Systems in Northern Iceland) will consider the different elements that contributed to sustainability in the region.

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Holocene Paleomagnetic Synchronized Records from the Arctic

Ólafsdóttir, Sædís (1,2); Bakke, Jostein (1,2); Stoner, Joseph (3)

1 Department of Earth Science, University of Bergen; 2 Bjerknes Centre for Climate Research; 3 College of Earth, Ocean, and Atmospheric Sciences, Oregon State University

Abstract: From the Polar Regions only scattered palomagnetic records are available, mostly being rare because of accessibility and logistical difficulties of obtaining them. The rare records available strive to contain both temporal resolution and the chronological accuracy required to document centennial or shorter scale changes. In global context the geomagnetic field as many other atmospheric or climate phenomena in the Arctic is very important to document and understand. Here, paleomagnetic secular variation (PSV) records reconstructed through alternating filed demagnetization of u-channel samples from several lacustrine archives from Svalbard, Bjørnøya and Arctic Norway (HAP-212; GL-1, BJP-213; BGP-211), along with marine shelf record from western Norway (GS13-182), were analyzed to synchronize various sediment archives and thus paleoclimate and paleoenvironmental proxies across the Arctic. This unique transect of paleomagnetic records, from the high to low Arctic attest the nature of the paleomagnetic field and also importantly provides a robust high-resolution magnetostratigraphic dating tool for paleoclimate and paleoenvironmental studies. The PSV-synchronized sediment cores will allow in the future first hand attempt to evaluate the variability of the Arctic climate system and the feedbacks that lead to rapid and pronounced changes, such as those currently taking place.

New magnetostratigraphic results from the Polar Urals, Russia: indication of a short lasting excursion

Ólafsdóttir, Sædís (1,2); Svendsen, John-Inge (1,2); Bakke, Jostein (1,2); Haflidason, Haflidi (1,2); Stoner, Joseph (3), Hovland, Morten N. (1)

1 Department of Earth Science, University of Berge; 2 Bjerknes Centre for Climate Research; 3 College of Earth, Ocean, and Atmospheric Sciences, Oregon State University

Abstract: A new high-resolution magnetostratigraphic record from the northern Ural Mountains has yielded evidence for possibly a short lasting excursion inferred from shallow inclination and lows within the relative paleointensity. Lake Bolshoye Schuchye (67.85618N; 66,35836W) is situated in the interior of the Polar Urals, north of the Arctic Circle. The deep (140 m) and long (13 km) NW-SE facing lake basin contains 130 m of acoustically laminated sediments. The sediment core presented here is 24 m long obtained at 100 m water depth and contains well preserved laminated sediments. The geographical location of the record is unique as most of the available magnetostratigraphic records are situated in Europe, North America and East Asia, with only scattered paleomagnetic archives from North Asia. Regional scale changes in the geomagnetic field as preserved within magnetic minerals in the sediments can provide a sediment paleomagnetic secular variation (PSV) record that offers the potential for synchronization. Directions of the characteristic remanent magnetization (ChRM) were derived from vector analysis of the results from alternating field (AF) demagnetization of u-channel samples. Orthogonal demagnetization diagrams indicate a high stability of the magnetization directions and low MAD values further confirm suitable physical properties of the sediments for consistent PSV reconstruction. Several intervals of shallow inclination were found in the record but the most significant one is found around 20 ka Cal yr BP, along with low relative paleointensity values suggesting a possible short lasting geomagnetic excursion.

A low in intensity during this interval has previously been described in the literature, but never before has the duration and a record with this high-resolution from this part of the world been described.

Holocene Tephra on South Georgia

Oppedal, Lea Toska (1,2); Bakke, Jostein (1,2), Nicholas Balascio (3), Paasche, Øyvind (2)

1 Department of Earth Science, University of Bergen; 2 Bjerknes Centre for Climate Research; 3 Lamont-Doherty Earth Observatory

Abstract: Tephra deposited on land, ice or the ocean floor provide excellent opportunities for linking different paleoclimatic archives in a region. A comprehensive tephra record exists for the North Atlantic Region where tephrochronology is starting to become a standard dating and correlation tool. In the South Atlantic Region the tephra record is less developed. Expanding the tephra record here would improve our ability to tie together paleoclimatic records from Antarctica, Patagonia, the sub-Antarctic islands and the surrounding ocean.

As part of a study of Holocene glacier and climate fluctuations on South Georgia, the potential for building a tephrochronology for South Georgia is being investigated. Cryptotephra has been extracted from a two meter long bog sequence going back to 4300 years BP. Tephra counts reveal a good potential for finding tephra horizons in South Georgian sediment records. A peak in tephra concentration is found at approximately 3100 years BP.

Multi-decadal variability in the Arctic

Outten, Stephen, Esau, Igor

Nansen Environmental and Remote Sensing Center and Bjerknes Centre for Climate Research, Bergen, Norway

Abstract: A vital component for maintaining Earth's climate is the meridional transport of heat through both the ocean and atmosphere, and understanding the decadal to multi-decadal changes of these transports can provide an insight into the natural variability of the climate system. In 1964, Jacob Bjerknes proposed that the total energy transported by the climate system should remain approximately constant if the ocean heat storage and fluxes at the top-of-the-atmosphere were unchanging. This would mean that large anomalies in the oceanic heat transport should be balanced by opposing variations in the atmospheric heat transport; a process later named Bjerknes Compensation.

Bjerknes compensation has been identified in the 600 year control run of the Bergen Climate Model by examining the anomalies of the implied meridional heat transports in both the ocean and atmosphere. These anomalies show strong anti-correlation ($r = -0.72$, $p \leq 0.05$), and a multi-decadal variability with a period of approximately 60-80 years. Spatial patterns associated with this multi-decadal variability highlight part of the underlying mechanism which occurs through changes in the sea-ice cover resulting in strong ocean-atmosphere fluxes and the formation of a thermal low that changes the large scale flow over the Northern Hemisphere. The anomalies in atmospheric heat transport are not only found to be well correlated to the anomalies in Arctic sea-ice, but also to the strength of the sub-polar gyre, suggesting a possible feedback of the atmosphere to the ocean on multi-decadal timescales.

Marine signature of early Holocene glacial events of the eastern margin of the Laurentide Ice Sheet

Pearce, Christof (1,2); Andrews, John T. (3); Bouloubassi, Ioanna (4); Hillaire-Marcel Claude (5); Jennings, Anne E.(3); Olsen, Jesper (6); Williams, James (1); Kuijpers, Antoon(7); Seidenkrantz, Marit-Solveig (2).

1 Department of Geological Sciences and Bolin Centre for Climate Research, Stockholm University, Sweden; 2 Centre for Past Climate Studies & Arctic Research Centre, Department of Geoscience, Aarhus University, Denmark; 3 INSTAAR and Department of Geological Sciences, University of Colorado, Boulder, CO, USA; 4 LOCEAN-IPSL (CNRS/IRD/UPMC/MNHN), Paris, France; 5 GEOTOP, Université du Québec à Montréal, Montréal, Québec, Canada; 6 AMS 14C Dating Centre, Institute of Physics and Astronomy, Aarhus University, Aarhus, Denmark; 7 Geological Survey of Denmark and Greenland (GEUS), Copenhagen, Denmark.

Abstract: The gradual demise of the Laurentide Ice Sheet during the last deglaciation was characterized by large-scale and abrupt glacial events along its eastern margin. During the early Holocene, several episodes of iceberg and meltwater release originated from glacial advances and retreats mostly from the Hudson Strait region. Evidence for these events can be found in marine sediment cores from large areas of the Labrador Sea as increased input of ice-rafted debris and detrital carbonate. These events are especially clear from sites proximal to Hudson Strait and downstream the Labrador Current on the Labrador Shelf. In this study we present signals for several of such early Holocene ice sheet instabilities from more distal study sites. Sedimentological analyses of marine sediment cores from different bays in eastern Newfoundland revealed long distance transport of detrital carbonate during short-lived intervals of the early Holocene. The layers were investigated using a multi-proxy approach consisting of high resolution X-ray fluorescence (XRF) core scans, grain size analysis, quantitative X-ray diffraction (XRD), and biomarker analysis. The presence of detrital carbonate was most clearly found from elevated calcium – strontium ratios based on XRF core scanning results and further confirmed by increased content of calcite and dolomite and an ancient biomarker composition. Based on radiocarbon dating, the detrital carbonate layers can be linked to glacial events Heinrich 0, the Gold Cove event and possibly the Noble Inlet advance. The wide spread signature of these glacial events can be used for correlation of climate archives over a large geographic area. We propose that by detailed fingerprinting of the composition of these layers, they can be used as time-synchronous correlation tools, which may be used to infer past leads and lags in climatic and oceanographic variability as well as help to unravel unknown past marine radiocarbon reservoir ages in the Labrador Sea.

An Emerging perspective on Quaternary cryosphere-climate interactions and landscape evolution on Cumberland Peninsula, Baffin Island.

Pendleton, Simon; Miller, Gifford; Crump, Sarah

Department of Geology, University of Colorado Boulder and INSTAAR, Boulder, CO

Abstract: Recent summer warming has now raised the equilibrium line altitude above almost all ice caps on Baffin Island, resulting in surface lowering and marginal recession everywhere. Retreating cold based ice caps are exposing preserved landscapes and in situ tundra vegetation which contain important records of ice fluctuations during the Holocene and throughout the Quaternary (e.g. Anderson et al., 2008; Miller et al., 2013; Briner et al., 2014). Radiocarbon dates for each plant records when cold summers dropped regional snowline below the site, killing the plants, and snowline remained below the site (on multi-decadal average) until the collection date. The kill dates also likely represent the last time that the climate was warm enough to expose the sampling location. In situ vegetation samples (n=102) collected in 2013 and 2014 from Cumberland Peninsula have been dated, with significant age clusters at ~0.5, 1.8, 2.3, and 3.6 ka. The absence of ages around ~1.0, 2.0, 3.0, 4.5, and 5.5 ka suggest periods of either no snowline depression or retreat. Twenty-eight vegetation samples returned ages >45 ka (3 replicates; 25 unique sites). It is postulated that those samples with non-finite radiocarbon ages were killed as ice expanded following the last interglaciation (~120 ka), the last time climate was as warm as present. This growing set of emerging radiocarbon dead landscapes further suggests that present climate is similar to that of the last interglaciation. In addition to plant collections, bedrock exposures at the ice margins were sampled for 26Al/10Be cosmogenic nuclide dating. Seven samples from ice-cap margins on Cumberland Peninsula returned maximum exposure ages from ~ 0.6-0.9 Ma and total exposure-burial histories of ~0.6-1.5 Ma. In general, samples from the margin of the large (6000 km2) Penny Ice Cap exhibited less exposure (~20% of total history) than those samples from smaller, local mountain ice caps (~55%). The complex exposure-burial histories and estimated erosion rates begin to delineate the timing and extent of erosive continental ice sheets across the Cumberland Peninsula. More specifically, initial sampling suggests that fjord incision began ~1.5 Ma, which has implications for the distribution of large ice sheets during the Quaternary. Utilizing both the dates on in situ moss and 26Al/10Be on sites only recently ice free provides new insight into both the recent activity and long-term evolution of ice on Baffin Island. In particular these new data help to shed light on how late Holocene coolings affect both large and small ice bodies and how this behavior is represented in the longer-term burial/exposure record contained within the rock surface. However, additional sampling for both datasets and the targeting of specific landscape type localities is needed to more fully resolve the short (~10 kyr) and long term (~2 Myr) climate-cryosphere-landscape histories.

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Holocene millennial-scale variability of the East Greenland Current and warm subsurface Atlantic waters in northern Denmark Strait

Perner, Kerstin (1), Jennings, Anne E. (2), Andrews, John T. (2), Moros, Matthias (1), Wacker, Luckas (3), Jansen, Eystein (4,5)

1 Leibniz Institute for Baltic Sea Research, Seestraße 15, 18119 Rostock, Germany; 2 Institute of Arctic and Alpine Research, University of Colorado, Boulder, CO 80309-0450, USA; 3 Laboratory of Ion Beam Physics (LIP), ETH, Otto-Stern-Weg 5, 8093 Zürich, Switzerland; 4 Bjerknes Centre for Climate Research, University of Bergen, Allégaten 55, Bergen 5007, Norway; 5 Department of Earth Science, University of Bergen, Allégaten 41, Bergen 5007, Norway

Abstract: Marine sediments from the East Greenland shelf near Denmark Strait, are ideally located to study past changes in surface freshwater outflow from the Arctic Ocean, via the East Greenland Current (EGC) and subsurface Atlantic Water inflow carried by the Irminger Current (IC), a branch of the North Atlantic Current (NAC).

We present a new centennial-scale resolved multi-proxy study of Holocene paleoceanographic changes from the Nansen Trough, north of Denmark Strait. Based on benthic and planktic foraminiferal assemblage data we investigate i) the evolution of the IC and ii) constrain the influence of Arctic surface waters from the EGC. Counts of ice-rafted debris (IRD), qXRD and grain size analyses supplement our foraminiferal records in order to identify changes in sediment delivery and glacial influence via iceberg rafting at our core site.

Our new data indicate that meltwater influence from the retreating Greenland Ice Sheet (GIS) prevailed until c. 8 ka BP. This period is characterized by low surface water productivity, a weak IC flow and enhanced terrestrial sediment delivery from Greenland. A subsequent reduced meltwater influence from the GIS accompanied increasing surface water productivity and subsurface warming due to a strengthened IC. After c. 5 ka BP, we note enhanced influence of the EGC on surface water conditions, by increased drift ice and IRD occurrence. Concomitantly, a conspicuous rise of the productivity indicator Alabaminella weddelensis is seen. Likely, a distinct halocline/oceanic front developed between the cold/fresh surface waters (EGC) and the warm/saline subsurface Atlantic waters (IC) and caused the observed increased productivity. The late Holocene period (last c. 3.5 ka BP) of our record, is characterized by a continuous increase of IRD and drift ice suggesting further advance of the GIS and a strengthened EGC. However, we find distinct surface and subsurface warming from c. 2.2 to 1.5 ka BP. The warming around c. 2.0 ka BP occurs simultaneous to a warming reported from sites located within the NAC and its branches that likely corresponds to the time of the Roman Warm Period.

Using 10Be dating to improve the history of the Svalbard-Barents Sea Ice-Sheet on Kong Karls Land, Svalbard: preliminary results

Philipps, William (1), Jason P. Briner (1), Toby Koffman (2) and Anne Hormes (3)

1 Department of Geology, University at Buffalo; 2 Lamont–Doherty Earth Observatory; 3 Department of Arctic Geology, University Centre in Svalbard and Department of Earth Sciences

Abstract: The Svalbard-Barents Sea Ice-Sheet (SBSIS) was a multi-domed, polythermal ice sheet that covered Svalbard and parts of the Svalbard-Barents Sea during the Late Pleistocene. Within the archipelago of Svalbard, the Kong Karls Land (KKL) island group makes up the southeastern most landmass adjacent to the Svalbard-Barents Sea, potentially preserving a history of the last time the SBSIS occupied this location. The central island of Kongsøya (78°54'43.23"N, 28°31'7.40"E) is of particular interest because it contains marine terraces >110 m asl that are radiocarbon dated to 11,289±97 cal yr BP at 100 m asl (Salvigsen, 1981). This gives the island the distinction of the highest marine limit in all of Svalbard (Ingólfsson and Landvik, 2013). The raised terraces give way to plateaus >275 m asl in the southern portion of the island. The island's location and high marine limit made KKL the location of a hypothesized ice dome during the Last Glacial Maximum (LGM; Landvik et al., 1998). However, few absolute ages exist from the island chain, adding to the ongoing debate about the age and location of paleo-ice domes of the SBSIS during the LGM (Ingólfsson and Landvik, 2013).

In the summer of 2014, we visited Kongsøya to better constrain the SBSIS's behavior during the Quaternary Period. Here, we present the first 10Be exposure ages from the island's high plateaus. We sampled three erratic boulders, which have a granitic lithology that differ greatly from the sedimentary sequences with basaltic intrusions that make up the bedrock of the islands. We conclude that the boulders are not sourced from KKL, but most likely from Spitsbergen or Nordaustlandet. Thus far, we have two 10Be ages from erratics that are 52.8± 0.9 and 33.7 ± 0.6 ka. We also sampled fourteen locally sourced quartz clasts that weathered out of the local bedrock, to help us understand landscape evolution and ice sheet history. These samples may possibly relate to periglacial activity or reveal a longer-term exposure/burial history. Three of the bedrock clasts have 10Be ages of 49.1 ± 2.1, 17.9± 0.3, and 12.7± 0.3 ka.

The ages of the erratics could point to two possible depositional scenarios. The first is that they were deposited during the Late Weichselian glaciation with a high degree of inheritance. The second scenario is that the erratics were deposited on KKL during the Early or Middle Weichselian glaciation, and have since survived beneath cold-based ice cover during the Late Weichselian. We consider it unlikely that the boulders were transported >100 km and still contain inheritance. Rather, we interpret the high plateau areas of Kongsøya to have had cold-based ice present during the Late Weichselian, preserving erratics that were deposited previously. Two of the bedrock clasts have 10Be ages similar to the expected LGM deglaciation age of the KKL, suggesting that there may have been locally erosive ice; we also observed striations at one site on the plateau. These preliminary results beg for discussion and the completion of 26Al, 36Cl, in-situ 14C and additional 10Be analysis.

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Atlantic water inflow in the early Holocene Northwest Passage marked by planktonic foraminifera (Neogloboquadrina pachyderma)

Pienkowski, A.J. (1, 2), A.G. Cage (3), Furze, M.F.A. (1), de Figueiredo Martins, A.S. (2), England, J. (4); MacLean, B. (5), Blasco, S. (5)

1 Dept of Physical Sciences, MacEwan University; 2 School of Ocean Sciences, Bangor University; 3 Dept of Geography, Geology and the Environment, Keele University; 4 Dept of Earth & Atmospheric Sciences, University of Alberta; 5 Geological Survey of Canada-Atlantic

Abstract: Four marine piston cores from the central Canadian Arctic Archipelago (CAA), investigated for sedimentology, micropalaeontology, and biogeochemistry (52 AMS radiocarbon dates), uniformly show the prominent early Holocene (˜10 cal ka BP) appearance of planktonic foraminifera immediately following deglaciation. These planktonic populations are exclusively composed of Neogloboquadrina pachyderma [sensu Darling et al. 2006], including morphotypes previously described from the Arctic Ocean, and aberrant, right-coiling forms. Today, planktonics are rare in the central CAA, dwelling in adjacent offshore areas influenced

by Atlantic water. The early Holocene planktonics signal is interpreted reflecting the inflow of deep Atlantic-sourced water into the archipelago, likely facilitated by higher deglacial sea-levels (due to glacio-isostatic depression) permitting increased flow across inter-channel sills at the CAA entrances. The planktonic influx intervals are accompanied by the benthic foraminifer

Cassidulina neoteretis, an indicator of chilled Atlantic water. Collectively, this indicates an early Holocene oceanographic circulation and water mass structure different from today, marked by greater oceanic connection to adjacent basins, notably Baffin Bay.

Though the precise pathway of Atlantic water is cryptic, an eastern source via Baffin Bay Atlantic Water is likely, given shallow palaeo-water-depths to the west across the oceanographically critical Lowther sill. As glacio-isostatic rebound progresses, deeper waters carrying planktonics are progressively excluded from the central CAA as channels and sills shoal. Essentially modern oceanographic circulation is established by ˜6 cal ka BP. This early Holocene planktonics peak is noted throughout Parry Channel (the main east-west axis of the Northwest Passage), from Lancaster Sound in the east to as far west as southern McDougall

Sound/Barrow Strait. This suggests planktonic foraminifera can constitute a valuable regional marker for the entry of Atlantic-derived oceanic waters upon deglaciation into the CAA. Furthermore, the signal highlights the potential for major oceanographic change in complex archipelago settings occurring independently of climatic forcing.

Holocene equilibrium line altitude (ELA) reconstructions in Sarek National Park, northern Sweden

Regnéll, Carl; Hormes, Anne

University of Gothenburg

Abstract: Past extent of Holocene glaciers in Sarek National Park, northern Sweden, was reconstructed using newly published high resolution LiDAR-data. End moraines and lateral moraines were mapped to define past ice extent of the glaciers and enable reconstruction of paleo-Equilibrium Line Altitudes (ELA) using the Area x Altitude (AA) and Accumulation Area Ratio (AAR) methods.

The higher resolution of DEMs created from LiDAR-data has enabled more accurate measurements of geomorphological features than possible before with associated better basis for glacier reconstructions. There have previously only been a few geomorphological maps of glacier forefields produced in Sweden and existing chronologies of glacier advances are mainly based on highly extended lichen growth-curves supported by a few 14C-dates at some localities (Karlén, 1973; Karlén & Denton, 1976) and additional absolute dates are hence needed. A revision of the glacier chronologies is also required as there are presently discrepancies between results attained by different methods. Glacier advances inferred by dated moraines contrast with studied lake sediments (Snowball & Sandgren, 1996; Berglund et al., 1996; Rosqvist et al., 2004), particularly concerning possible advances suggested to have occurred during early and middle Holocene. Geomorphological maps were thus created of selected glacier forefields where numerous and prominent ice marginal landforms are present. The new geomorphological maps will be used to target ice marginal landforms for a sample campaign for 10Be exposure-dating during fieldwork in summer 2015. The 10Be data will allow for a revision of the glacier chronology of northern Sweden. Further have paleo-ELAs previously not been estimated for Swedish glaciers and hence will this work add vital novel data that will help to understand the timing and extent of past glacier advances with its associated climatic significances.

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Late Pliocene - Pleistocene depositional environments in the northern North Sea

Reinardy, Benedict (1); Hjelstuen, Berit (1); Sejrup, Hans Petter (1); Augedal, Hans (2)

1 Department of Earth Science, University of Bergen; 2 Lundin Norway AS, Oslo

Abstract: We combine a regional 3D seismic dataset with numerous commercial well and shallow core data in the northern North Sea to identify the changing sediment type and architecture from the Late Pliocene to Present. To be able to refine the chronology of the Plio-Pleistocene sediments we have carried out new dating analyses (strontium and amino acid) on shallow cores/well material. There is a general coarsening of sedimentary input through Early to Mid Pleistocene times reflecting the increased glacial influence in the North Sea. In our study area the Late Pliocene to Early Pleistocene transition is characterised by a change from sand dominated sediments to finer clay and silt material, indicated by gamma ray logs and samples from wells. The Early Pleistocene is represented by a regional seismic unit containing parallel, high amplitude reflectors which we relate to glacimarine deposition during a marine transgression. However, on at least one occasion during the Early Pleistocene the study area was subaerially exposed with fluvial channels being formed. Mega-scale glacial lineations indicate that grounded ice was present on at least one occasion during the Early Pleistocene which could be linked to tills recovered below the Brunhes-Matuyama boundary. A distinct high amplitude erosive boundary can be traced across the study area and we suggest that this marks the onset of shelf-edge glaciation around Marine Isotope Stage 12. The Mid to Late Pleistocene units are characterised by increased sand content reflected in decreased gamma ray values and several till units have been recovered in shallow boreholes while numerous tunnel valleys are observed in the seismic data.

Arctic Holocene glacier fluctuations reconstructed from lake sediments at Mitrahalvøya, Spitsbergen

Røthe, Torgeir O. (1,2); Jostein Bakke (1,2); Kristian Vasskog (2,3); Marthe Gjerde (1,2); William J. D'Andrea (4); Raymond S. Bradley (5)

1 Department of Earth Science, University of Bergen, Allégaten 41, 5007 Bergen, Norway; 2 Bjerknes Centre for Climate Research, Allégaten 55, 5007 Bergen, Norway; 3 Uni Climate, Uni Research, Allégaten 55, 5007 Bergen, Norway; 4 Lamont-Doherty Earth Observatory of Columbia University, Palisades, NY 10964, USA; 5 Department of Geosciences, University of Massachusetts, Amherst, MA 01003, USA

Abstract: Here, we present a continuous record of past changes in Equilibrium-Line Altitude (ELA) for the alpine glacier Karlbreen, located on the northwest coast of Spitsbergen (79o N), based on sediment analyses from the distal glacier-fed lake Kløsa. A multivariate statistical analysis suggests that the concentration of geochemical elements Ti, Si and K in the lake sediments, together with the physical parameter dry-bulk-density (DBD), reflect changes in the amount of inorganic detrital input to Kløsa, which is closely linked to the size and ELA of the upstream glacier Karlbreen. A linear regression model based on historically documented glacier extents was used to calculate continuous ELA changes back to ~3500 cal. yr. BP. From about 9200 to 3500 cal. yr. BP, the sedimentary record indicates that Karlbreen was very small or had completely melted away. Karlbreen was probably close to its maximum Holocene extent several times during the Neoglacial, first around 1700 cal. yr. BP, then later at 225 and 135 cal. yr. BP. An ice-cored moraine system in front of Karlbreen extends well into the main basin of Kløsa, and it is difficult to explain how this moraine could have formed without disturbing the sedimentary record in the lake (e.g. through slumping events). The sedimentary record in Kløsa is continuous and undisturbed over the past 6700 years, suggesting that the outermost moraine formed prior to this time and that it most likely survived the Holocene Thermal Maximum (HTM) on Svalbard.

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History of seafloor methane emissions and relationship to Pleistocene climatic events

Schneider, Andrea (1); Panieri, Giuliana (1) Lepland, Aivo (2); Knies, Jochen (2)

1 UiT, CAGE 2 NGU, CAGE

Abstract: Gas hydrates occur in shallow seas and continental margins worldwide. Gas hydrates are ice-like substances storing large amounts of gas, mainly the powerful greenhouse gas methane, in water molecules encaging the gas molecules. The stability of gas hydrates in the Arctic Ocean is of outstanding interest with regard to climate warming. Methane release from the seafloor may have a substantial influence on abrupt climate variability if the methane reaches the atmosphere. Its impact on past, present and future climate change is currently under debate.During cruises with R/V Helmer Hanssen in 2013 and 2014, gravity cores were taken along the Vestnesa Ridge, a sediment drift at 79°N offshore NW Svalbard that is a large and dynamic gas hydrate reservoir. The target of my research is to develop proxies for the reconstruction of methane emission dynamics of the Vestnesa Ridge during the Pleistocene. The major focus is to employ foraminifera as indicators of methane emissions from the seafloor. Changes in species abundance and diversity as well as the stable carbon isotope composition of their tests are the most powerful and promising tools. Secondary overgrowth of the foraminifera tests and authigenic carbonate precipitation have the potential to act as important additional proxies of former geochemically active environments at the seafloor. Identifying methane emission events and correlating them to past climate variability may allow to evaluate the future behavior of methane emissions from the Arctic Ocean seafloor in a warmer climate

Fluctuations of local glaciers in western Greenland during the late Holocene

Schweinsberg, Avriel D. (1); Briner, Jason P. (1); Miller, Gifford H. (2); Bennike, Ole (3)

1 Department of Geology, University at Buffalo, 2 INSTAAR and Department of Geological Sciences, University of Colorado, 3 Geological Survey of Denmark and Greenland

Abstract: Local glaciers and ice caps provide useful archives of regional paleoclimate because they responded sensitively to past climate changes. In contrast to the extensive research of the Greenland Ice Sheet (GIS) margin, few data exist that constrain fluctuations of local glaciers independent of the ice sheet, whose reconstructions generally provide higher resolution records of climate variability than those of former GIS extents. We use a multi-proxy approach to document the timing of local glacier advance and retreat by combining: (1) proglacial lake sediment analysis, (2) cosmogenic 10Be exposure dating of late Holocene moraines, and (3) radiocarbon dating of ice-cap-killed in-situ plants. We interpret stratigraphic transitions in the sedimentary records to reflect when the glacier was within or outside the catchment and that increases in minerogenic input are primarily driven by enhanced glacier activity. 10Be exposure ages document the timing of moraine abandonment and radiocarbon ages from recently exposed vegetation at cold-based ice cap margins indicate when the regional snowline dropped below a particular site and caused subsequent ice cap expansion. Here, we present results from each method to provide a detailed record of glacier fluctuations throughout the past ~5 ka from Disko island and Nuussuaq peninsula, western Greenland. In addition, we evaluate if periods of enhanced glacier activity and retreat are correlative between datasets.

Radiocarbon ages (n=54) of in-situ plants reveal net snowline lowering beginning ~5 ka that continued episodically through the late Holocene, and suggests ≥2-3°C of net cooling between ~5 ka and the pre-industrial period. Modes of ice-cap-killed vegetation indicate distinct ice cap expansion phases at ~3.7, ~3.0, ~1.5 ka, and during the Little Ice Age (LIA). Radiocarbon-dated sediment cores from Sikuiui and Pauiaivik proglacial lakes on Nuussuaq exhibit pronounced increases in minerogenic-rich sediment between ~4.5 and 2.5 ka, revealing the first strong episode of enhanced glacial activity in the late Holocene. Both lake sediment core sites also reveal periods of increased minerogenic sediment input during the LIA. The mean 10Be age of a late Holocene moraine on Nuussuaq is 879 ± 34 cal yr BP and reveals that some local glaciers in this region approached their LIA maximum extent prior to the classic LIA interval, and furthermore that local glaciers on Nuussuaq may have been near their LIA maximum through the Medieval Warm Period.

The gradual net snowline lowering over the past ~5 ka recorded in the dead plant dataset is concurrent with the onset of Neoglaciation recorded in Sikuiui and Pauiaivik lakes. The most pronounced snowline lowering event ~4-3 ka is expressed in both lake sediment records by a major influx of mineral-rich sediments. Most ice cap expansion phases are broadly correlative with elevated minerogenic input in Sikuiui and Pauiaivik lakes with some modes in the vegetation record occurring just prior to increases in mineral-rich sediment input, possibly suggesting a lagged response in the sedimentary archive. The moraine sequence on Nuussuaq was deposited during an interval of high magnetic susceptibility in the sedimentary sequences from Sikuiui and Pauiaivik Lakes; however, the

moraine age corresponds to an interval of net snowline rise or stability in this region. Reconstructions of local glacier variability throughout the past ~5 ka in western Greenland are in general agreement between the three different techniques. Ongoing efforts include comparing our reconstructions of local glacier variability against regional paleoclimate records and fluctuations of the GIS margin as a means of better understanding controls on past and future glacier change.

Mg/Ca-paleo thermometry for cold water benthic foraminifera: development and application from the Arctic Water-Atlantic Water boundary of the European Arctic

Skirbekk, Kari (1); Hald, Morten (1); Junttila, Juho (1); Marchitto, Thomas Jr. (2)

1 Department of Geology, Arctic University of Norway, UiT, N-9037 Tromsø, Norway, 2 Department of Geological Science and Institute of Arctic and Alpine Reserarch, University of Colorado, Boulder, Colorado, USA

Abstract: The purpose of this study was to investigate the modern relationship between Mg/Ca in marine benthic foraminifera and bottom water temperatures. Further, the aim was to use these results to reconstruct past temperatures in Late Holocene marine records from the western Barents Sea and Svalbard margin, emphasizing on the natural variation of Atlantic Water inflow to the Arctic Ocean. In the years 2005-2010, several cruises were conducted during different seasons in the Svalbard area, retrieving both surface and down core samples.

Three cold water species of benthic foraminifera were sampled in order to evaluate the relationship between Mg/Ca and temperature. These species were: Buccella frigida, Nonionella labradorica and Islandiella helenae. Initially, no correlation was seen between the two parameters. However, when confining the data to specific seasons, an Mg/Ca-ratio – temperature relationship was observed, implying the annual growth seasons for the three species. B. frigida indicated a growing season lasting from July-November; N. labradorica appeared to grow in October/November and I. helenae/norcrossi in July/August. Hence, the temperature equations made were based on data from the specific seasons.

Two marine sediment cores retrieved from the Atlantic Water-Arctic Water boundary in the European Arctic were also studied. From the Western Barents Sea a 1400 year Mg/Ca-derived temperature records based on Islandiella helenae/norcrossi and Buccella frigida are presented in addition to an Oxygen Isotope (δ18O) derived temperature record based on Melonis barleeanus. From Kongsfjorden, Western Svalbard, Mg/Ca-derived temperature records based on I. helenae/norcrosi and Nonionella labradorica are presented, as well as δ18O derived temperature equations based on N. labradorica, comprising the last 1700 years. In addition paired Mg/Ca- δ18O records were used to calculate salinity for both records. The two sites are currently influenced by both Atlantic Water (AW) and Arctic Water (ArW) within an annual cycle. The δ18O derived temperatures are potentially biased by large salinity fluctuations, and hence they are not used directly in the reconstructions. Differences in range and evolution between the Mg/Ca temperature records are interpreted to represent different water masses, explained by different timing of shell growth for the species, as is also seen in the modern data.

The site in Western Barents Sea reflected changes directly associated with the Polar Front and regional variations, while the signals at the Kongsfjorden site appeared to be more diluted and affected by local processes. Between AD 400 and 1000 the AW water influence at the two sites appeared to be out of phase. Around AD 1000 a distinct drop in AW inflow to the Western Barents Sea occurs, inferred to represent a southward Polar Front

migration. After this the AW inflow to the two sites can be correlated, indicating that AW fluctuations along western Svalbard are in phase with AW fluctuations in the Western Barents Sea. At the entrance to the Little Ice Age the AW influence are strong at both sites. Between AD 1650 and 1750 there is a rapid drop in AW inflow to both sites, associated with a southward shift in Polar Front position and stronger influence of ArW. After this the AW influence increase steadily towards present. A modern warming is observed in all records, and seems to amplify after AD 1950.

Environmental impact of submarine mine tailings deposited between 1972-1978 in Repparfjorden, northern Norway – preliminary results.

Skirbekk, Kari (1), Beata Sternal (1), Juho Junttila (1), Matthias Forwick (1), JoLynn Carroll (1, 2)

1 University of Tromsø – The Arctic University of Norway, Department of Geology, N-9037 Tromsø, Norway 2 Akvaplan-niva AS, FRAM – High North Research Centre for Climate and Environment, 9296, Tromsø, Norway

Several ores enriched in copper are present close to the surface southwest of Repparfjorden (~70°30'N/24°E) in Finnmark County, northern Norway. Folldal Verk exploited these formations between 1972 and 1978, and approx. 1 000 000 tons of mine tailings were deposited in the innermost basin of the fjord during this period. It is currently discussed to resume mineral exploitation in the area and to use inner Repparfjorden for the deposition of submarine tailings placements.

One major objective of the Environmental Waste Management (EWMA; http://site.uit.no/ewma/) project is to study the influence of industrial waste and pollution related to petroleum and mining activities on the marine environment in Arctic areas. This includes also studies reconstructing the influence of past mining activities on fjord environments. Such investigations are based on multi-proxy analyses of sediment cores.

We present preliminary results of a study from Repparfjorden where we investigate how the deposited mine tailings influenced the fjord biota in space and time and, in particular, how the fjord environment developed after the termination of mine-tailings deposition. Such knowledge is particularly valuable to predict the influence of future mine-tailings deposition on the fjord environment.

Several multicores are currently dated and analysed to study the spreading of fine particles and heavy metals in the fjord before, during and after tailings deposition. In addition, benthic foraminifera faunas will be studied. The correlation of these proxies shall reveal if/how the benthic foraminifera fauna reacted to stress related to tailings deposition and also how it reacted after the termination of this stress.

XRF analysis of lacustrine sediment from Linnévatnet, Svalbard

Strand, Sarah (1,2)

1 Arctic Geology, The University Centre in Svalbard, 2 Department of Geosciences, The University of Oslo

Abstract: Linnévatnet, western Spitsbergen, Svalbard is a proglacial lake with varved sediment. Previous analyses of sediment from Linné have been based in varve counting and thickness; this project investigates data yielded by a technique previously unutilized on long cores from Linné: XRF spectrometry. XRF elemental signatures depicted prominent laminations and bands at the top of a transect of three cores taken across the southern end of the lake. Calcium and iron exhibited the strongest correlation with varves at the top of the cores, indicating the potential use of these elements as paleoclimate proxies. Laminations thin down-core, so a higher resolution XRF scan than was completed in this study would be needed to accurately distinguish deeper varves via their elemental composition. Linnévatnet's low sedimentation rate makes the application of XRF data much more difficult than when used with varves of greater thickness. However, the correlation of elemental signatures with conspicuous laminae in the top portions of the cores shows XRF spectrometry can detect changes in run-off within the catchment area. Ultimately, XRF analysis may help with Linnévatnet paleoenvironmental reconstructions if data is collected with high enough spatial, and thus temporal, resolution.

Dynamic simulations of potential methane release from the East Siberian continental slope sediments

Stranne, Christian; Jakobsson, Martin; O'Regan, Matt

Department of Geological Sciences, Stockholm University

Abstract: Sediments deposited along the Arctic Ocean continental margin are presumed to host large amounts of temperature and pressure sensitive methane hydrates. Here we apply numerical simulations to assess the potential of hydrate dissociation and methane release from the East Siberian continental slope sediments. Simulations are based on a hypothesized bottom water warming of 3 °C over 100 years. The simulation results show that the dynamic response of the methane hydrate sediment system over time is slow and gas fluxes are limited by low sediment permeability. When a sediment fracture criteria is applied less than one gigaton methane gas is released during the first 100 years of the simulation. The methane gas flux is reduced by about 90% over the first 100 years when considering the partial depletion of the hydrate reservoir that theoretically should have taken place during the last glacial maximum (LGM) due to a lower sea level. If this methane reaches the atmosphere, it would add < 0.1 % per year to the present-day atmospheric methane budget.

Glacial and climate history over the last 60,000 yrs inferred from lake records in the Polar Urals, Russian Arctic

Svendsen, John Inge (1,2); Bakke, Jostein (1,2); Bjune, Anne (2); Haflidason, Haflidi (1,2); Nordvik Hovland, Morten (1)

1 Department of Earth Science, University of Bergen; 2 Bjerknes Centre for Climate Research; 3 Bjerknes Centre for Climate Research, UNI Research Climate

Abstract: Comprehensive field based paleo-environmental research has been carried out in in the Polar Urals over the last two decades as part of a long-lasting collaboration between Russia and Norway. A principal aim has been to reconstruct the glacial and environmental history during the last interglacial-glacial cycles and up to the present. In order to obtain continuous records of climate variability back in time seismic records and sediment cores have been collected from the floor of 4 selected mountain lakes; Kuzty, Gerdizty, Bolshoye Shuchye and Malaya Shuchye.

Lake Kuzty, situated on the western side of the mountain chain, formed when buried glacier ice (presumably stemming from the MIS4 glaciation) were thawing in response to the Holocene warming. A series of small paleoglaciers along the steep valley slope next to the lake predate the Holocene. A small present-day glacier (Chernov) that occupies a north facing cirque within the catchment area appears to have regenerated during the late Holocene reaching its maximum dimension during the Little Ice Age or later. The sediment record that was obtained from lake Gerdizty is spanning a protracted period that lasted more than 60,000 yrs. This lake came into existence when a large ice cap that covered most of the Polar Urals during MIS4 melted away. The pollen stratigraphy reflects treeless tundra-steppe vegetation throughout MIS3-2 and with the establishment of an open forest in response to the early Holocene warming.

The lakes Malaya Schuchye and Bolshoye Schuchye, situated near the water shed in the interior northernmost Urals, contain strikingly different sediment sequences. The thickest strata were found in Bolshoye Shuchye, the largest and deepest lake in the Ural Mountains. This lake, which is 13 km long and 140 m deep, contains more than 130 m of acoustically laminated sediments. Up to 24 m long sediment cores were obtained from the lake and radiocarbon dates reveal that this part of the sequence accumulated over the last 24,000 years providing unique high resolution records of the climate and glacial history for this period. The nature and age of the thick strata below this level is still not known, but it seems a possibility that the basin contained a sub-glacial lake during MIS4 when this part of the mountain chain most likely hosted a sizeable ice cap that that must have filled the central mountain valleys. At any rate, it seems clear that numerous but restricted mountain glaciers existed in the Polar Urals during MIS2 feeding meltwater and sediments into the basins.

In view of the obtained results from Bolshoye Schuchye, as well as other geological and geochronological data (OSL- and exposure dates) from the surrounding areas, we can now demonstrate the probability that main valleys in the Polar Urals, even within the interior of the mountain chain, remained ice free during the Last Glacial Maximum (LGM), forming a strong contrast to the development in Svalbard and other Arctic areas further to the west.

Controlled meteorological (CMET) balloon profiling of the Arctic atmospheric boundary layer around Spitsbergen compared to a mesoscale model

Roberts, Tjarda J. (1,2), Marina Dütsch(3,4), Hole, Lars R. (3), Paul B. Voss (5)

1 LPC2E/CNRS, 3A, Avenue de la Recherche Scientifique, 45071 Orléans, cedex 2, France; 2 Norwegian Polar Institute, Fram Centre, 9296 Tromsø, Norway; 3 Norwegian Meteorological Institute, Bergen, Norway; 4 ETH Zürich, Switzerland; 5 Smith College, Picker Engineering Program, Northampton MA, USA

Abstract: Observations from a CMET (Controlled Meteorological) balloon campaign are analyzed in combination with mesoscale model simulations to provide insights into tropospheric meteorological conditions (temperature, humidity windspeed) around Svalbard, European High Arctic. Five Controlled Meteorological (CMET) balloons were launched from Ny-Ålesund in Svalbard over 5-12 May 2011, and measured vertical atmospheric profiles above Spitsbergen Island and over coastal areas to both the east and west. One notable CMET flight achieved a suite of 18 continuous soundings that probed the Arctic marine boundary layer over a period of more than 10 hours. The CMET profiles are compared to simulations using the Weather Research and Forecasting (WRF) model using nested grids and three different boundary layer schemes. Variability between the three model schemes was typically smaller than the discrepancies between the model runs and the observations. Over Spitsbergen, the CMET flights identified temperature inversions and low-level jets (LLJ) that were not always captured by the model. Nevertheless, the model largely reproduced time-series obtained from the Ny-Ålesund meteorological station, with exception of surface winds during the LLJ. Over sea-ice east of Svalbard the model underestimated potential temperature and overestimated wind speed compared to the CMET observations. This is most likely due to the full sea-ice coverage assumed by the model, and consequent underestimation of ocean-atmosphere exchange in the presence of leads or fractional coverage. The suite of continuous CMET soundings over a sea-ice free region to the northwest of Svalbard are analysed spatially and temporally, and compared to the model. The observed along-flight daytime increase in relative humidity is interpreted in terms of the diurnal cycle, and in the context of marine and terrestrial air-mass influences. Analysis of the balloon trajectory during the CMET soundings identifies strong wind-shear, with a low-level channeled flow. The study highlights the challenges of modelling the Arctic atmosphere, especially in coastal zones with varying topography, sea-ice and surface conditions. In this context, CMET balloons provide a valuable technology for profiling the free atmosphere and boundary layer in remote regions where few other observations are available for model validation.

Challenges and perspectives in coastal environmental reconstructions based on Arctica islandica sclerochronological records from the eastern Norwegian Sea

Trofimova Tamara (1,2), Andersson Carin (1,2)

1 Uni Research Climate, 2 Bjerknes Centre for Climate Research

Abstract: Highly resolved paleoproxy data provide an information of past climate variability and are therefore essential for the prediction of future climate states. At high latitudes only few established marine paleo archives enable the reconstruction of key ocean processes at annual to sub-annual time-scales and can extend instrumental hydrographic records back through time. Therefore, identification and development of new high-resolution archives and proxies have a clear priority for marine climate science. Carbonate shells of bivalves represent an archive of marine climate variability with a high potential for the Arctic region. Many species form annual growth increments and can be used for the construction of growth chronologies. Arctica islandica is a unique species due to its exceptional longevity combined with sensitivity to changes in environmental conditions. It also has a wide geographical distribution. A. islandica shells have successfully been used for sclerochronological studies in the relatively deep water regions of the North Atlantic. In contrast, previous studies on A. islandica from the shallower depths suggest low synchronicity of growth within a population and reveal constrains for environmental reconstructions. The aim of this study is to test the potential of shallow water sclerochronological records of A. islandica from the eastern Norwegian Sea for chronology construction and the possibility of using it to extent instrumental hydrographic records and increase our understanding of the Norwegian Coastal Current (NCC) variability.

In this study we use shells of A. islandica collected by dredging along the seabed from shallow water sites off the coast of Eggum (Lofoten, Norway) and Tromsø. Both locations are exposed to the NCC. It is expected that similarity in oceanographic conditions is reflected in synchronous growth between the shells, which is a prerequisite for successful chronology building. For this purpose we examine the growth patterns of living and subfossil shells. The work mainly focuses on the construction of a composite growth chronology based on increment-width time series. Preliminary results suggest that A. islandica from the eastern Norwegian Sea can be used for chronology construction. However, the results also indicate that bivalve shells from certain setting (e.g. shallow water depth) can be more challenging to work with.

A full Holocene record of glacier variability on Svalbard reveals a dynamic Holocene in the Arctic

van der Bilt, Willem G.M. (1), Jostein Bakke (1), Kristian Vasskog (2) and William J. D`Andrea (3)

(1) Department of Earth Science, University of Bergen, Allégaten 41, 5007, Bergen, Norway, (2) Uni Climate, Uni Research, Allégaten 55, 5007 Bergen, Norway, (3) Lamont-Doherty Earth Observatory, Columbia University, Palisades, NY 10964, USA

Abstract: The Arctic is the fastest warming region of the planet. Proxy records are increasingly used to understand Arctic climate dynamics beyond the instrumental period and contextualize this amplified response. Unfortunately, available datasets are scarce, unevenly distributed and lack resolution. Glaciers sensitively respond to climate shifts and transfer this continuous signal to the sediment record of glacier-fed lakes. Here, we present a full Holocene record of glacier variability from Hajeren, a glacier-fed lake in northwest Spitsbergen. Our reconstruction is based on a continuous, undisturbed sediment cores that comprises the entire Holocene and resolves climate variability on centennial scales due to tight chronological control. A combination of physical, geochemical and magnetic proxies as well as numerical techniques has allowed us to detect glacier activity long with other processes governing lacustrine sedimentation. Variations in sediment density (DBD), validated by changes in Ti count rates (kcps), show that glaciers were active in the catchment throughout the Early Holocene. Based on geomorphological as well as lacustrine evidence, we infer a Holocene glacier maximum around 9.5 ka BP. Concurrent timing with meltwater pulses in the Hudson Strait may indicate that Early Holocene activity was driven by outburst floods from the melting Laurentide Ice Sheet (LIS). Our findings suggest that glaciers disappeared after a late Holocene Thermal Maximum (HTM), between 7400-6700 ka BP. Subsequently, two short-lived advances between 4250-4050 and 3380-3230 cal. yr BP, mark the onset of the Neoglacial. These coincide with other regional advances as well as episodes of North Atlantic cooling. We argue that this short-term forcing, against a background of orbital cooling, created the right boundary conditions for the reformation of glaciers in the catchment. These findings emphasize the sensitivity of the studied small glaciers to rapid climate shifts. Prolonged Neoglacial glacier activity only commenced around 700 yr BP, in line with documented advances on Svalbard. The presented work advocates a Holocene climate history of Svalbard that is successively driven by meltwater pulses from the LIS, periods of Atlantic cooling and an orbitally driven decline in summer insolation. However, though the Hajeren record provides a full Holocene record of glacier variations, the fundamental drivers of this climate signal have yet to be understood.

High-resolution hydroclimate records from glacier-fed lakes

Vasskog, Kristian (1,4), Jostein Bakke (2,4), Pål Ringkjøb Nielsen (3), and Susanne Meidell (2)

(1) Uni Research Climate, Allégaten 55, Bergen, Norway, (2) Department of Earth Science, University of Bergen, Bergen, Norway, (3) Department of Geography, University of Bergen, Bergen, Norway, (4) Bjerknes Centre for Climate Research, Bergen, Norway

Abstract: In Scandinavia, few proxies are able to capture changes in winter hydroclimate, which makes reconstructing past changes in atmospheric circulation patterns from proxy data particularly challenging. Glaciers along the west coast of Norway are highly sensitive to changes in winter precipitation, making them potentially valuable recorders of past hydroclimate and related atmospheric circulation. However, the main challenge associated with interpreting glacier records is that they integrate signals related to both summer temperature and winter precipitation. We present a 1200-year long spatiotemporal reconstruction of Nordfonna, a maritime plateau glacier in western Norway, based on an integrated study of terrestrial moraine sequences, sub-glacial topography, and multi-proxy records from two distal glacier-fed lakes located at the opposite sides of the glacier in a west-east transect. Winter precipitation in western Norway is closely linked to the strength of the wintertime westerlies, which also affect the amount of snow being transported by wind across a plateau glacier. Based on this principle, and the assumption that summer ablation is spatially uniform, we use temporal changes in the west-to-east tilt of the Equilibrium-Line-Altitude (ELA) across the ice cap to infer the strength of the wintertime westerlies over the past 1200 years. This approach eliminates the need for an independent record of summer temperature (which introduces additional age uncertainties) for the purpose of isolating the winter precipitation signal in a glacier record. While multidecadal fluctuations in the regional ELA can be explained to a large extent by large-scale temperature changes, our data suggests that the local 'Little Ice Age' maximum glacier expansion (AD 1700-1750) was caused mainly by strengthened westerlies and the related increase in winter precipitation. The wintertime westerlies over southern Norway are closely linked to the North Atlantic Oscillation (NAO), and our record therefore represents a unique proxy of past changes in the NAO.

Exploring of subsurface flowpaths in Arctic hillslopes

Voytek, Emily (1), Rushlow, Caitlin (2); Godsey, Sarah (2); Singha, Kamini (1, 3)

1 Hydrologic Science and Engineering Program, Colorado School of Mines, 2 Department of Geoscience, Idaho State University, 3 Department of Geology and Geological Engineering, Colorado School of Mines

Abstract: Subsurface hydrologic flowpaths control the reaction and transport rates of biogeochemical materials and link terrestrial and aquatic ecosystems. Despite their importance, the location and geometry of flowpaths are difficult to determine. In Arctic systems near-surface flow is usually limited to a shallow active layer of thaw above permafrost. Here we use two techniques, electrical resistivity (ER) and depth-to-refusal frost probing, to estimate active layer thaw of arctic hillslopes in and around common drainage features called water tracks. We identify areas of low electrical resistivity in water tracks that are significantly deeper than thaw measurements from manual frost probing, suggesting that frost probing may underestimate active layer thaw and the extent of the flowpath network on arctic hillslopes. To translate the two-dimensional active layer thaw data collected along ER transects into three dimensions we generate flow accumulation maps that allow for spatially distributed comparisons of surface and subsurface topography. Our results lay the groundwork for future investigations into the seasonal dynamics, hydrologic connectivity, and climate sensitivity of spatially distributed flowpath networks on arctic hillslopes.

The Weichselian chronostratigraphical framework of the Kongsfjorden Fan System, W-Spitsbergen

Wiberg, Daniel H. (1), Haflidi Haflidason (2) and Jan Sverre Laberg (1)

1 Department of Geology. University of Tromsø – The Arctic University of Norway; 2 Department of Earth Science, University of Bergen, Bergen, Norway

Abstract: The high-latitude Kongsfjorden Trough-Mouth Fan (TMF) is situated on the upper continental margin, outside Kongsfjorden about 70 km off the western coast of the Spitsbergen Island (Svalbard archipelago). The trough-mouth fan is the most distal part of the Kongsfjorden paleo-ice stream system, and is one of the remaining mega-scale glacial features which can be found along the continental margin off Spitsbergen. The fan itself is mainly composed of materials which have been deposited either during the glacial maximum extent or initial break-up of the Barents-Svalbard Ice Sheet. The Kongsfjorden TMF therefore allows for a near continuous record of the glacial deposits and evolution/development of the Barents-Svalbard Ice Sheet. By using both a long core sedimentary record and regional high-resolution seismic data has made it possible to obtain an improved understanding of the origin of the younger sediments within the fan. By establishing the properties and origin of the different layers and their respective ages from core samples, these data can be traced from the core location and correlated with other, nearby-sedimentary features displayed by the seismic profiles. The aim of this study is to establish a framework for the chronology of the active sedimentary processes in the upper layers of the Kongsfjorden TMF, focusing on the emplacement and age of the youngest two generations of glacigenic debris flows (GDF).

During a survey in 2010, a regional seismic grid was established in the survey area, consisting of 17 high-resolution seismic 2D lines (TOPAS). There were also retrieved a 12.6 meter long sediment core from the southern part of the Kongsfjorden TMF at 846 m water depth. The upper half of the core displays a very varied character, with layers comprising ice rafted debris (IRD) inter-bedded with hemipelagic sediments. An anomalous layer (at 270-335 cm) have been estimated to have an age between 23 300 – 25 000 ka, and is interpreted to comprise sediments from the last glacial maximum (LGM). The lower half of the core appears fairly homogenous and has been interpreted to consist of alternating layers of GDFs and IRD. The upper 5 meters of the core have been dated with the aid of AMS 14C. As the AMS 14C-method is reaching its limit at this depth, there is a need to introduce/apply other methods for dating the lower part of the core. By correlating the core and the seismic data, a rough initial age estimate has been developed for the core, interpreted to represent the deposits covering the last ca. 70 000 ka.

The preliminary conclusions of the study fits well with the currently proposed development models, which indicates that during the Weichselian glacial (117 – 11.6 ka) paleo-ice streams from the west coast of Spitsbergen advanced to the continental shelf-break three times. During these advances, vast amounts of sediments were deposited on the Kongsfjorden TMF. The new data acquired, allow us to study the last two advances in greater detail than previously available.

Marine outlet glacier stability on centennial time scales

Åkesson, Henning (1,2); Nisancioglu, Kerim H (1, 2); Svendsen, John-Inge (1, 2); Mangerud, Jan (1,2); Hughes, Anna (1, 2); Vasskog, Kristian (1, 2), Nick, Faezeh M. (3)

1 Department of Earth Science, University of Bergen; 2 Bjerknes Centre for Climate Research; 3 The University Centre in Svalbard

Abstract: Many of Greenland's marine-terminating glaciers have thinned, accelerated and retreated during the last decade, broadly consistent with warmer atmospheric and oceanic conditions. However, these patterns involve considerable spatial and temporal variability, with a large diversity in glacier behavior within the same regions. Similarly, reconstructions of marine-terminating glaciers indicate highly asynchronous retreat histories. This highlights the danger in extrapolating glacier trends in space and time and point towards topographic controls of marine outlet glacier behavior.

Here, we test the hypothesis that marine outlet glacier stability is largely controlled by fjord geometry, and to a lesser extent regional climate and ocean forcing. We employ a dynamic flowline model on idealized glacier geometries (representative of different outlet glaciers) to investigate geometric controls on decadal to millennial time scales. The model accounts for driving and resistive stresses of glacier flow as well as along-flow stress transfer. It also has a physical treatment of iceberg calving and a time-adaptive grid allowing for continuous tracking of grounding-line migration. We assess the relative importance of basal and lateral pinning points, and whether shallow and wide fjords are more likely to host rapid retreat than deep and narrow ones.