UK Arctic Science Conference 2019

Book of abstracts

11th to 13th September, Loughborough University

The UK Arctic Science Conference is hosted by Loughborough University with financial and administrative support from the NERC Arctic Office.

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General information:

Venue: West Park Teaching Hub, Loughborough University

Date: 11th to 13th September 2019

Registration desk: This will be open from 1230 on 11th September and remain open throughout the conference.

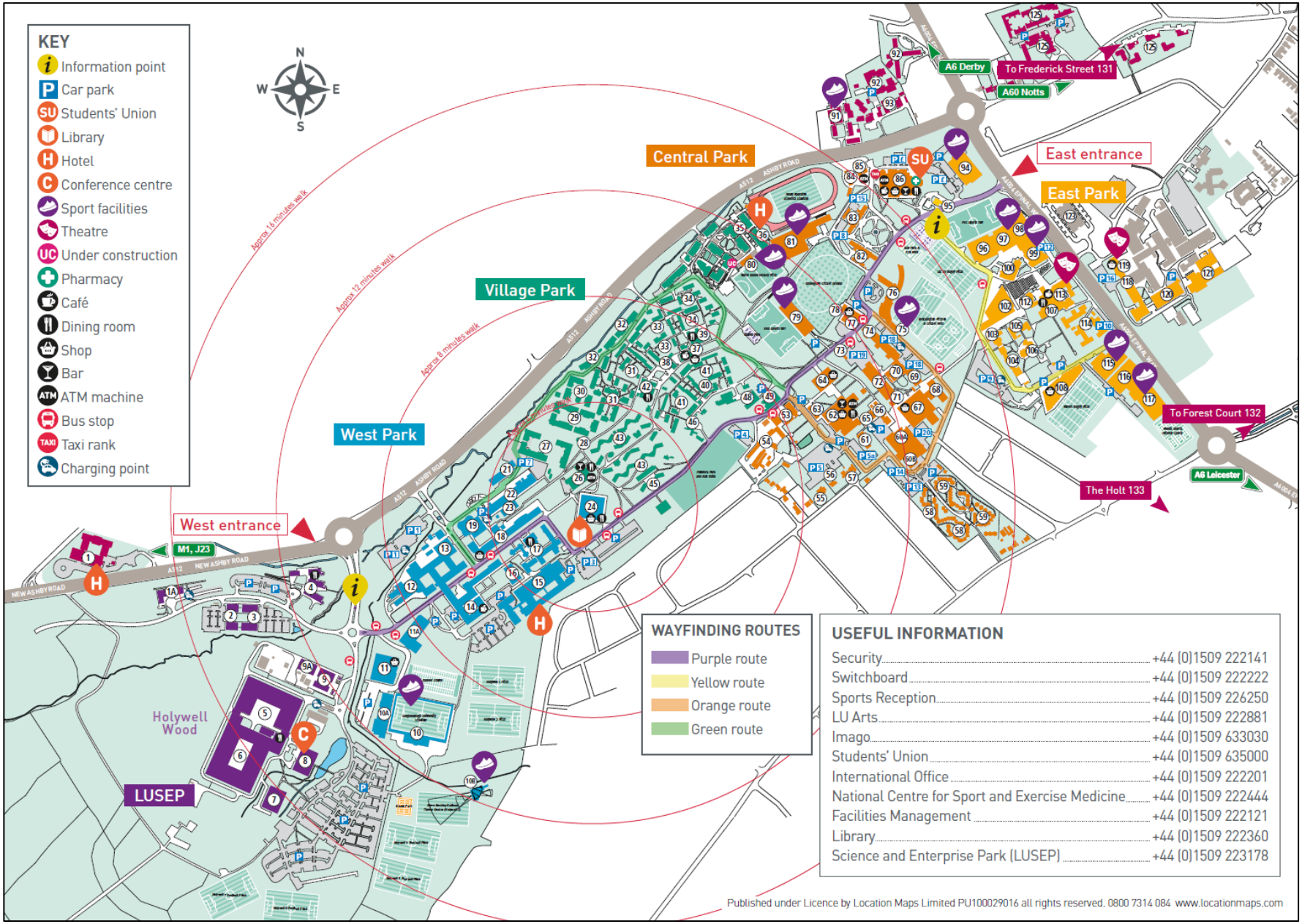
Poster session: Wednesday 11th September 1830 to 1930. Refreshments will be available. Posters will then remain on display throughout the conference.

Please note: Teas and coffees will be available during the breaks. A buffet lunch is provided on Thursday only.

Social Media: If tweeting from the Conference, please use **#ArcticConf2019**.

Travel to Loughborough:

Information about travelling to Loughborough can be found here: https://www.lboro.ac.uk/about/find-us/ - the conference venue, **West Park Teaching Hub**, is building number 11, near the West Entrance – see maps below.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Village Park
West Park
East Park
East entrance
West entrance
A6 Derby
To Frederick Street 131
A60 Notts
To Forest Court 132
A6 Leicester
The Holt 133
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WEST PARK

BUILDING NAME A-Z	BUILDING	MAP NO.
Burleigh Court (Imago Venues)	BU	15
David Collett Hall	DC	17
David Davies (Sir)	DAV	14
Frank Gibb (Sir)	RT	19
Frank Gibb (Sir) Laboratories	RL	22
Holywell Fitness Centre		10A
John Pickford	HH	21
Keith Green	KG	16
Loughborough University Stadium		10
Outside Teaching Area		
Pilkington Library	PIL	24
S Building	S	13
STEMLab		11A
Steve Backley National Throws Centre		10B
Stewart Miller	SM	12
West Park Teaching Hub	WPT	11
Wolfson Annex	TT	23
Wolfson	T/TW	18

KEY

- Information point
- Car park
- Students' Union
- Library
- Hotel
- Conference centre
- Sport facilities
- Theatre
- Under construction
- Café
- Dining room
- Shop
- Bar
- ATM machine
- Bus stop
- Charging point

UK Arctic Science Conference 2019 Programme

Wednesday 11th September 2019

1230 Registration

1330 Welcome

Session 1: Chair – Caroline Kennedy-Pipe, Loughborough University

1350 A Global Britain for the Arctic: Assembling a Strategic Narrative,
Dr. Duncan Depledge, Loughborough University

1410 Regional linear retreat patterns of Greenlandic tidewater glaciers over the past 34 years in response to climate forcing
Dr. James Lea, University of Liverpool

1430 Arctic Live: Engaging Global Classrooms with a Changing Arctic
Hannah Green, University of Exeter (on behalf of Dr Helen Findlay, Plymouth Marine Laboratory)

1450 Direct dating of hydrothermal copper- gold systems using calcite U-Pb dating from the central Yukon Territory, Canada
Dr. Catherine Mottram, University of Portsmouth

1510 The UK Polar Network and APECS Russia: international collaboration for the next generation of polar scientists
Yulia Zaika, APECS Russia and Chelsey Baker, UK Polar Network/University of Southampton

1530 Science diplomacy as a means of reducing conflict in the Arctic region
Maxim Gutenev, South Ural State University

1550 BREAK

Session 2: Chair – Katharine Hendry, University of Bristol

1620 Using a multi-proxy approach to distinguish between natural and anthropogenic drivers of recent environmental change in Arctic Russia to inform the conservation and management of the Bewick's Swan
Professor Viv Jones, University College London

1640 Evaluating Arctic meteorology modelled with the Met Office Unified Model
Dr. Gillian Young, University of Leeds

1700 BAS Science and Logistics Support in the Polar Regions - What it can do for you, and how to access it
Professor David Vaughan, British Antarctic Survey

1720 GNSS-R for the monitoring of Arctic ice
Jessica Cartwright, National Oceanography Centre, Southampton

1740 How sum-meter spatial variability affects upscaling estimates in Arctic wetlands
Kassandra Reuss-Schmidt, University of Sheffield

1830 Poster session – refreshments will be provided

Thursday 12th September 2019

Session 1: Chair – James Lea, University of Liverpool

0900 **NERC Arctic Office & researchers - communication, representation and new opportunities**
Henry Burgess, NERC Arctic Office

0920 **A critical approach to community-based participatory research in Alaska**
Anuszka Mosurska, University of Leeds

0940 **Spread of glacier mass loss to Barents Sea margins revealed by CryoSat-2**
Ashley Morris, Norwegian Polar Institute

1000 **Increases in primary production in response to aeolian dust deposition into Arctic lakes**
Dr. Clay Prater, Loughborough University

1020 **Quantifying the climate impact of present and near-future Arctic shipping in the context of incoming emission regulations and an evolving natural baseline; preliminary modelling results from the SEANA project.**
Dr. Jo Browse, University of Exeter

1040 **BREAK**

1100 **UK Arctic and Antarctic Partnership Horizon Scanning Session**

1300 **LUNCH**

Session 2: Chair – Emma Dodd, University of Leicester

1350 **UK Science and Innovation Netwo**rk
Tatiana Iakovleva and Rosa Degerman, UK Science and Innovation Network

1410 **Stomach contents of the snow crab Chionoecetes opilio and other benthic decapods in the Pechora Sea (SE Barents Sea)**
Anna Gebruk, University of Edinburgh

1430 **Anthropocene changes in lakes in permafrost regions**
Professor Mary Edwards, University of Southampton

1450 **Iceland is an episodic source of atmospheric ice nucleating particles relevant for mixed-phase clouds**
Alberto Sanchez-Marroquin, University of Leeds

1510 **Polar Traffic, Polar Noise**
Greer Crawley, Royal Holloway, University of London

1530 **BREAK**

Session 3: Chair – Finlo Cottier, SAMS

1600 **Warm proglacial lakes following extreme heat events and rapid retreat of a lake terminating Arctic glacier**
Adrian Dye, University of York

1620 **The changing under-ice light field of the Arctic Ocean**
Dr. Gaelle Veyssiere, British Antarctic Survey

1640 **Arctic Geopolitics: State, Space and International Relations Theory**
Pedro Allemand Mancebo Silva, Escola de Guerra Naval

1700 **Towards A Combined Surface Temperature Dataset for the Arctic from the Along-Track Scanning Radiometers (ATSRs)**
Dr. Emma Dodd, University of Leicester

1720 **Misplaced thermospores in Svalbard - what can distribution tell us about barriers and dispersal history**
Giacomo Vitali, Queen Mary University, London

Friday 13th September 2019

Session 1: Jutta Vuellers, University of Leeds

0900 **Predicting Extinction – Climate Change Science in Arctic Endangered Species Litigation in the USA**
Sarah Mackie, Newcastle University

0920 **The pan-Arctic ozone seasonality: modelling vs measurements**
Dr. Xin Yang, British Antarctic Survey

0940 **Snowball worlds: Cryoconite ecosystems of the Cryogenian and the modern day**
Jaz Millar, Natural History Museum, London

1000 **Model Arctic Council at Secondary School**
Dr. Anthony Speca, Polar Aspect

1020 **BREAK**

Session 2: Jo Bullard, Loughborough University

1100 **Silicon Isotopes in Arctic and sub-Arctic Glacial Meltwaters: the Role of the Subglacial Weathering in the Silicon Cycle**
Dr. Katharine Hendry, University of Bristol

1120 **The Arctic Boundary Layer during the Arctic Ocean 2018 expedition**
Dr. Jutta Vuellers, University of Leeds

1140 **Geopolitical Issues of the Barents Euro-Arctic Region and Arctic Policy-making**
Iuliia Mitina, Saint Petersburg State University

1200 **Carbon release during 21st century glacier recession: A positive feedback in the global carbon cycle**
Saule Akhmetkaliyeva, Manchester Metropolitan University

1220 **Old carbon from a methane seep and peat erosion enters the food web in Lake Teshekpuk, Alaska**
Dr. Maarten van Hardenbroek, Newcastle University

1240 **Closing remarks**

1400 **Schools Outreach**

Oral Abstracts

A GLOBAL BRITAIN FOR THE ARCTIC: ASSEMBLING A STRATEGIC NARRATIVE

Duncan Depledge

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Many different narratives about the Arctic have emerged as the international community's fascination with the region has grown. They tell stories of the Arctic's past, present and possible future, identify the main characters, illuminate the most important issues, and order systems of relations. Drawing on the strategic narrative framework set out by Miskimmon et al. (2013), this study is interested in happens when states devise and project narratives strategically with the aim of influencing others. Using the example of the United Kingdom, a country with a long history in the Arctic, but crucially, no sovereign territory in the region, the paper examines what kinds of narratives the British government is producing about the UK's relationship with the Arctic (particularly in the context of an emerging foreign policy based on the concept of 'Global Britain'), to what end, and to what effect. Put simply, are the UK Government's narratives at all influential in Arctic geopolitics? The paper will present an overview of the preliminary findings, based on the analysis of official documents, speeches and semi-structured interviews with current and former British governmental officials.

REGIONAL LINEAR RETREAT PATTERNS OF GREENLANDIC TIDEWATER GLACIERS OVER THE PAST 34 YEARS IN RESPONSE TO CLIMATE FORCING

James Lea[1], Dominik Fahrner[1,2] Alec Davies[1] Jakob Abermann[3,4] Martin Olsen[4]

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Greenland's tidewater glaciers (TWG) have contributed 66±8 % to the total mass loss of the Greenland Ice Sheet over the past 46 years and their calving dynamics are a controlling factor on ice sheet mass balance. Yet a comprehensive annual data set of terminus positions during the satellite era is still lacking.

We present a data set of annual late summer terminus positions for 208 TWGs in Greenland for the period 1984 – 2017 based on Landsat 4 – 8 and Sentinel 2 imagery. The data set was manually digitised using the cloud-computing based Google Earth Engine Digitisation Tool (GEEDiT) and changes were quantified using the curvilinear box method within the Margin Change Quantification Tool (MaQiT; Lea, 2018). The results were analysed alongside seasonal oceanic and atmospheric climate data (air and sea surface temperatures), which were subsequently subjected to the application of the supervised tree ensemble machine learning method Random Forests.

After clustering the TWGs and normalising the terminus behaviour, our analysis highlights distinct linear trends in the regional response of TWG termini. The south-west, north-west and south-east regions are all found to display analogous behaviour (advance/stability until mid-1990s followed by sustained retreat until 2017). The north-east, however, showed sustained retreat until 2004/2005 followed by accelerated retreat until 2017.
The results of the machine learning analysis suggest the existence of oceanic and atmospheric temperature thresholds that may be predictors of advance/retreat behaviour. We foresee that the results presented in this study provide the possibility for the creation of simple empirically based models to predict TWG change on regional scales.

ARCTIC LIVE': ENGAGING GLOBAL CLASSROOMS WITH A CHANGING ARCTIC

Helen Findlay[1], Ceri Lewis[2], Hannah Green[2]

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Arctic Live is an innovative live streaming education event that has been connecting classrooms around the world with the Arctic since 2014. Run from the UK NERC Arctic Station in Ny-Ålesund, Svalbard and in collaboration with educational non-profit organisation Encounter Edu, we deliver innovative live lesson events and Skype Classrooms aimed at developing ocean literacy and knowledge about Arctic marine ecosystems for school children of all ages. Learning activities are based on the 'Frozen Oceans' programme of schools resources for primary and secondary schools developed following the pioneering Catlin Arctic Survey, with a scientific focus on the impacts of ocean acidification and climate change. Live classrooms run alongside a scientific sampling programme in Kongsfjord investigating ocean acidification processes and microplastics pollution, enabling classes to follow the scientists in real time as the undertake their research and question them directly on their work. Students can also undertake their own experiments based directly on the science programme and designed carefully to be curriculum relevant. In 2018 alone this directly engaged with over 21,000 students from 200 schools in 30 countries and overall these live events have now reached 46,100 students worldwide. In this talk we will share both the science underpinning these learning experiences and what we have learned about remote educational outreach to an international audience.

DIRECT DATING OF HYDROTHERMAL COPPER- GOLD SYSTEMS USING CALCITE U-PB DATING FROM THE CENTRAL YUKON TERRITORY, CANADA

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Economic metals can concentrate in fluids and magmas within the Earth's crust. For example, interaction between magmatic intrusions, fluids and the surrounding rocks causes enrichment of metals such as Cu, Au, Mo in 'porphyry style' deposits. In these settings the metals are intimately associated with veins containing minerals such as quartz and calcite. In order to develop predictive models for mineralised systems it is imperative to understand the timing of emplacement of these veins. Dating of hydrothermal veins, however, has proved challenging due to lack of suitable 'datable' material. Here we aim to use the newly-developed U-Pb calcite dating technique to test the capabilities of calcite dating for providing robust and critical timing constraints for ore-deposit models.

The Canadian Cordillera is one of the Earth's foremost examples of an accretionary mountain belt, formed over the last >200 million years. The central Yukon region of the northern Cordillera underwent a prolonged history of deformation, faulting, magmatism and related mineralisation during Cordilleran accretion. The Dawson Range in the central Yukon is locally enriched in Au, Cu, Mo and other metals largely association with magma bodies (porphyry, epithermal and skarn type deposits) hosted in large continental-scale strike-slip fault zone systems, such as the Big Creek Fault (BCF) system.

Here, we use in-situ laser ablation U-Pb calcite dating to directly-date mineralised carbonate veins from the Late Cretaceous porphyry deposits associated with ther BCF. Initial results indicate two unambiguous carbonate veining events, one during the Late Cretaceous (~73 Ma) and a second during the Paleocene (~55-60 Ma). This suggests that there were distinct pulses of mineralisation associated with granitoid emplacement and faulting on the BCF.

Our results represent a significatnt contribution to tectonic and mineralisation models for the region and explore the role of major faults, such as the BCF for hosting and facilitating deposition of economic Cu-Au deposits. Furthermore, our results demonstrate the potential for calcite U-Pb dating to provide timing constraints for hydrothermal mineralisation processes in a variety of deposit-type settings.

THE UK POLAR NETWORK AND APECS RUSSIA: INTERNATIONAL COLLABORATION FOR THE NEXT GENERATION OF POLAR SCIENTISTS

Yulia Zaika[1], Chelsey Baker [2,3], Anna Belcher[2,4], Archana Dayal[2,5], Joe Cook[2,5], Sammie Buzzard[2,6], Holly Jenkins[2,3], Nadia Mamontova[2,7], Saule Akhmetkaliyeva [2,8] and Kyle Mayers [2,9]

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[3] University of Southampton, University Road, Southampton, SO17 1BJ, United Kingdom
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[9] NORCE Norwegian Research Centre AS, Bergen, Norway

The Association of Polar Early Career Scientists (APECS) is a worldwide organisation of early career researchers (ECRs) interested in the polar regions. National branches of APECS organise career development events for ECRs in addition to running education and outreach activities to enthuse and inspire young people about the polar regions. Recently, two national branches of APECS, APECS Russia and the UK Polar Network have begun to collaborate extensively to run a series of events for ECRs in both countries. This involved two workshops in Cambridge and Moscow to foster research relations and develop bilateral networks. During the POLAR2018 conference, the two committees signed a statement of collaboration, and developed the idea to run a research school for ECRs in Arctic Russia. ARCTIS2019 took place in February 2019 in the Murmansk region of Arctic Russia, and involved 15 UK and 15 Russian ECRs from different academic disciplines attending a combined field and lecture course within this Arctic region. The field course provided an interdisciplinary perspective on Arctic research as well as the research methods behind them. The course also facilitated opportunities for networking, collaboration, and advice on applying for funding to carry out international science. APECS Russia and the UKPN continue to build on our previous successes with two future events: an ECR joint workshop with APECS Norway at the Svalbard Science Conference in November 2019 focusing on undertaking 'Research in Svalbard' and ARCTIS2020 in February 2020 in Khanty Mansiysk focusing on building strong links between UK and Russia ECRs with Arctic stakeholders. APECS Russia and the UK Polar Network will continue to work together, to enhance our great network and develop further ideas to enhance the scientific output of ECRs in both nations.

Keywords: Early career, education, collaboration, Arctic, Russia

SCIENCE DIPLOMACY AS A MEANS OF REDUCING CONFLICT IN THE ARCTIC REGION

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The agreement on strengthening international Arctic scientific cooperation, which was signed by the Ministers of the Arctic and Arctic States on may 11, 2017, says that there is a need to develop international scientific cooperation in the Arctic and the ways of this interaction are relevant. The impact of scientific diplomacy on the level of conflict in the Arctic region will be the main issue in this study.

The tension in the Arctic region shows that traditional types of diplomacy do not solve all the controversial issues between the States in the Arctic. New environmental challenges, problems related to climate change and the development of the Arctic shelf require new methods of international cooperation. Science diplomacy can serve as a great means of reducing conflict.

Hypothesis – as the level of scientific diplomacy in the Arctic increases, the level of conflict in the region decreases and Vice versa.

The object of the study is the global Arctic policy.

The subject of the research is science diplomacy as a means of reducing conflict in the Arctic region.

The aim of the study is to determine the impact of the use of science diplomacy on the level of conflict in the Arctic.

1) Determine the level and dynamics of conflict in the Arctic;
2) Analyze theoretical and practical aspects of science diplomacy to determine the relevance of its application;
3) Determine the level and dynamics of scientific diplomacy in the Arctic;
4) Identify the relationship between the level of conflict and the level of science diplomacy in the Arctic region.

USING A MULTI-PROXY APPROACH TO DISTINGUISH BETWEEN NATURAL AND ANTHROPOGENIC DRIVERS OF RECENT ENVIRONMENTAL CHANGE IN ARCTIC RUSSIA TO INFORM THE CONSERVATION AND MANAGEMENT OF THE BEWICK'S SWAN

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Arctic environments are highly sensitive to global climatic and environmental changes due to a number of feedback mechanisms. Responses to multiple stressors are already being observed with significant implications for the biota that rely on their ecosystems. The migratory Bewick's Swan is one such species whose population has declined since the 1990s, however significant uncertainties remain regarding the main driver(s) of its demise.

Applying a landscape-scale approach, using a combination of top-bottom core analyses and the more detailed investigation of 210Pb dated cores we reconstruct terrestrial and aquatic ecosystems over the last century in the Pechora Delta, northeast European Russia, one of the main breeding and summer feeding areas for the Bewick's Swan. Multi-proxy analyses, including cladocera, macrofossil, pollen, diatoms and geochemical analyses (XRF, ICP, C and N isotope) are employed to investigate ecological responses to pressures in the region and explore the ultimate impacts on breeding and moulting populations of the Bewick's Swan.

Since the late 20th century, there is clear evidence of community restructuring at the landscape scale across both aquatic and terrestrial ecosystems. The most prominent transformation within aquatic communities involves the replacement of large- bodied cladocera, primarily D. pulex, by the smaller-bodied species, Daphnia longispina. Concurrently, major shifts in water level are inferred from declines in less moisture-tolerant mosses (D. fuscescens and Polytrichum spp.) and littoral macrophytes (Juncus spp. and E. hydropiper), increased abundances of submerged macrophytes, and shifts from benthic (mainly Fragilaria sensu lato) to planktonic diatom species with evidence for increased primary production. There is a similar timing of ecosystem change in the terrestrial landscape with typical tundra heath communities being replaced by increasingly dominant boreal components, including Betula nana, Alnus, Betula tortuosa and Salix spp. The agreement between macrofossil and pollen records in the timing of community shifts corroborates a universal driver of ecosystem changes in the region. Although there is some evidence of atmospheric pollution, climatic variables appear to be most effective in explaining the trends observed with terrestrial vegetation potentially responding to increased air temperatures and enhanced moisture regimes, while changes in aquatic ecosystems may relate to enhanced hydrological connectivity promoted by increased river discharge and rising sea levels. Changes in vegetation and habitat indicated by the palaeolimnological evidence have significant implications for arctic species such as the Bewick's swan.

EVALUATING ARCTIC METEOROLOGY MODELLED WITH THE MET OFFICE UNIFIED MODEL

Gillian Young[1], Jutta Vüllers[1], Paul Field[1, 2], Ian M. Brooks[1], Peggy Achtert[3], Michael Tjernström[4], John Prytherch[4] and Ryan Neely III[1]

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With accelerating Arctic warming, we need suitable numerical models to predict how the atmosphere will change on short weather prediction and longer climate time scales. However, models across all scales are notoriously poor at reproducing the Arctic boundary layer and the persistent mixed-phase clouds which commonly form within it. Therefore, there is an urgent need to evaluate model performance and develop improved schemes for representing Arctic meteorology.

State-of-the-art models such as the Met Office Unified Model are crucial tools for forecasting future Arctic change. In this presentation, we will show preliminary evaluations of model performance with comparison to observations made during the Arctic Ocean 2018 campaign, where a suite of remote-sensing instrumentation was active aboard the Swedish icebreaker Oden measuring summertime Arctic cloud and boundary layer properties, and indicate which model processes need to be improved to capture summertime Arctic meteorology more effectively.

BAS SCIENCE AND LOGISTICS SUPPORT IN THE POLAR REGIONS - WHAT IT CAN DO FOR YOU, AND HOW TO ACCESS IT

David Vaughan

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British Antarctic Survey has a role to support UK Science in the polar regions. In this presentation, I will review how BAS goes about discharging this responsibility, and how researchers can draw on it to support their activities. I will include a brief summary of Antarctic logistics, but focus on the Arctic. I will highlight not just logistics but Key Scientific Capabilities that have recently been funded under NERC's National Capability commissioning process, and which are available to support projects work led by UK researchers. I will also focus on the UK's new polar research vessel, RRS Sir David Attenborough, and the programme of sea trials, equipment trials and rehearsal cruises that will bring it into service in coming years, and a new mechanisms that is will provide a long-term view of the opportunities available to use SDA for ambitious research programmes. Finally, I will provide points-of-contact to those hoping to develop science plans and proposals to work with BAS.

GNSS-R FOR THE MONITORING OF ARCTIC ICE

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Measurements of Arctic sea ice and the Greenland Ice Sheet are essential if we are to fully understand the changing climate and the ways in which it affects the planet's physical systems. Due to the remote nature and scale of these areas, the only practical way to do this is using satellite data. Here we present a novel remote sensing technique for land ice altimetry and sea ice detection using reflected navigation signals of opportunity. For such work, the sensor is low-cost, low-power and low-mass. In this study, data comes from 33 months of the UK technology demonstration mission TechDemoSat-1, launched by Surrey Satellite Technology Limited in 2014, using a sensor originally designed for sea state and wind retrieval.

The altimetry work displays an improvement of the technique previously applied over the Antarctic Ice Sheet (Cartwright et al., 2018) through improved re-tracking and yields highly promising results with low error. Due to higher data availability over the Greenland ice sheet, compared to the Antarctic, this application results in a higher resolution DEM.

When applied to sea ice detection, GNSS-R attains an agreement of over 96% in the Arctic (98% in the Antarctic), compared to ESA's CCI (European Space Agency's Climate Change Initiative) sea ice concentration product. Application of this technique to the entirety of the TechDemoSat-1 dataset shows seasonal and multi-year changes in sea ice distribution of the Arctic and the versatility of this technique means it can also be applied in the Antarctic. The relatively small footprint of this sensor when considered over sea ice (6 km x 0.4 km) makes it ideal for application to this problem and shows potential for a future GNSS-R polar mission.

HOW SUM-METER SPATIAL VARIABILITY AFFECTS UPSCALING ESTIMATES IN ARCTIC WETLANDS

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The Arctic is warming at twice the rate of the global mean. This warming could further stimulate methane (CH4) emissions from northern wetlands and enhance the greenhouse impact of this region. Arctic wetlands are extremely heterogeneous in terms of geochemistry, vegetation, microtopography, and hydrology, and therefore CH4 fluxes can differ dramatically within the meter scale. Eddy covariance (EC) is one of the most useful methods for estimating CH4 fluxes in remote areas over long periods of time. However, when the areas sampled by these EC towers (i.e. tower footprints) are by definition very heterogeneous, due to encompassing a variety of environmental conditions and vegetation types at different times, modelling environmental controls of CH4 emissions becomes even more challenging, confounding efforts to reduce uncertainty in baseline CH4 emissions from these landscapes.

In this study, upscale CH4 fluxes from four EC towers located in wetlands on the North Slope of Alaska. In previous work the spatiotemporal variability of the footprint, has a significant influence on the observed CH4 fluxes, contributing to between 3% and 33% and spatial bias (i.e. difference between the spatial indices in the tower footprint and the 0.36 Km2 domain around the tower), between -51% and 18% depending on the index. This study highlights the ability of footprint modelling to infer the representativeness of the carbon balance measured by eddy covariance towers in these highly heterogeneous polygonised tundra ecosystems, and the need to evaluate footprint variability when upscaling EC site-level data to a larger domain.

NERC ARCTIC OFFICE & RESEARCHERS - COMMUNICATION, REPRESENTATION AND NEW OPPORTUNITIES

Henry Burgess

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The NERC Arctic Office supports research in the high north; provides advice to policy makers; and develops international scientific cooperation across all aspects of Arctic research. It works for and with the whole of the UK-based Arctic research community and with those whose research can be extended to the Arctic. This is an opportunity to hear more about the recent work of the Office, find opportunities to engage and hear about the plans for the future.

A CRITICAL APPROACH TO COMMUNITY-BASED PARTICIPATORY RESEARCH IN ALASKA

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The combined impacts of fast-paced social change and environmental change in the Arctic has disproportionately affected Alaska Native peoples. This has attracted research in environment, health, education and other fields at the local scale. Much of this research acknowledges the contentious histories of colonial, extractive research that, at best did not benefit Alaska Native peoples, and at worst, was harmful to them. Community-based participatory research (CBPR) is therefore the preferred approach in these contexts, as it seeks to actively involve participants in research, ensuring research is relevant to community concerns, and instigates positive social change. Nevertheless, concepts such as 'participation' and 'community' have been critiqued, which are not necessarily considered within CBPR. Equally, there are concerns that CBPR has become a buzzword, with tokenistic participation of communities in Arctic research. Therefore, this research systematically evaluates how CBPR is operationalised in Alaska in relation to critical notions of community, participation, as well as ethical and political dimensions of researching with Indigenous peoples. This is important to ensure that research does not perpetuate existing unequal power structures within communities, as well as between researchers and communities more broadly. Key findings show that, although researchers across disciplines largely do engage participants through each phase of the research (from research development through to research dissemination), there is a lack of critical consideration of exactly who participates in the research, who is excluded, and how this influences the research and any initiatives that result. This is also combined with a lack of recognition of the heterogeneity of communities, which could result in participatory research being co-opted by local elites, further marginalising those already most marginalised within communities.

SPREAD OF GLACIER MASS LOSS TO BARENTS SEA MARGINS REVEALED BY CRYOSAT-2

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The Norwegian archipelago of Svalbard is located in the most rapidly warming area of the Arctic, at the interface of Arctic and Atlantic air and ocean masses. This results in steep gradients in temperature and precipitation across the archipelago. The 34,000 km² ice cover varies from cirques, valley glaciers and icefields on mountainous Spitsbergen, to large ice caps on the eastern islands, with a significant proportion exhibiting cyclic dynamic changes known as surges. The potential for rapid changes in climatic mass balance and ice dynamics necessitates regular monitoring through satellite remote sensing.

Here, we present an assessment of 2011-2017 Svalbard mass balance based on swath processing of roll-angle-corrected CryoSat-2 SARIn-mode radar altimetry. We estimate 7-year rates of elevation change from least-squares plane fits to individual elevation measurements within km-scale grid cells, and use the elevation residuals to derive time series of change. A regional polynomial describing the relationship between elevation and elevation change is used to extrapolate to unsurveyed grid cells. We find a total Svalbard rate of mass change of -16±2 Gt/a, of which 10.4 Gt/a is from non-surging ice and -5.6 Gt/a from surging ice. This is equivalent to a global SLR contribution of 0.044mm/a. This represents a considerable acceleration in mass loss since the comparable period of ICESat laser altimetry in 2003-2009, and we compare the assessments from the two satellites to study the spatial pattern of this acceleration.

The results demonstrate that the west coast glaciers remain the major contributor to (non-surging) mass loss, but mass loss is also spreading into areas bordering the Barents Sea, including the southeastern coast of Spitsbergen, Olav V Land, Barentsøya and Edgeøya, and southern and eastern margins of Austfonna. Regions of low magnitude mass change are limited to Vestfonna, northern Austfonna, and high elevation portions of northeast Spitsbergen.

We show sea ice decline and lower atmospheric warming have occurred adjacent to the areas experiencing an increased mass loss, and suggest that the 'Atlantification' of the Barents Sea is a likely driver, consistent with a pattern of increasing glacier mass loss across the Eurasian high Arctic.

INCREASES IN PRIMARY PRODUCTION IN RESPONSE TO AEOLIAN DUST DEPOSITION INTO ARCTIC LAKES

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Rapidly changing climate conditions are altering both physical and biological processes in the Arctic. These effects are often coupled in near-glacial environments where changing ice dynamics can strongly influence surrounding ecosystems. For example, in southwestern Greenland, seasonal melting of land-terminating glaciers releases large quantities of sediment-laden meltwater onto proglacial floodplains. This material is then dried out and picked up by katabatic winds and deposited onto the surrounding terrestrial landscape. This glacial dust contains high quantities of both macro- and trace-elements, thus potentially serving as an important subsidy to surrounding low-nutrient ecosystems such as lakes. This paper examines relationships between dust deposition and algal production in contemporary lake populations and over a 1500-year sediment record in 6 lakes located across a regional dust deposition gradient. Growth bioassays demonstrated that dust inputs can alleviate nutrient limitation in contemporary algal communities. Similar relationships were found in the sediment record with the greatest increases in algal production occurring with elevated dust inputs over the last ~250 years. These patterns suggest that lake ecosystems are strongly influenced to regional dust inputs and that continued increases in dust deposition may alter the structure and function of lakes in this region.

QUANTIFYING THE CLIMATE IMPACT OF PRESENT AND NEAR-FUTURE ARCTIC SHIPPING IN THE CONTEXT OF INCOMING EMISSION REGULATIONS AND AN EVOLVING NATURAL BASELINE; PRELIMINARY MODELLING RESULTS FROM THE SEANA PROJECT.

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Shipping is one of the most important sources of anthropogenic aerosol in the marine atmosphere contributing 5-8% of global SO2 emissions and 2% of BC emissions. Aerosol from shipping can directly reflect (and absorb) short-wave (and long-wave) radiation cooling (and warming) the sea surface. Additionally, aerosol emitted from ships can increase cloud droplet number brightening marine clouds and cooling the surface. Quantifying the impact of shipping is challenging due in part to large uncertainties in the natural marine baseline. This is particularly true in the Arctic where the sources and processes controlling marine aerosol are unclear. Arctic shipping is dominated by transport, a industry expected to significantly expand in the next few decades as sea-ice retreats. This expansion is potentially mitigated by new IMO regulations which are expected to reduce SO2 emissions from shipping by at least 80%. However, the retreat of sea-ice is also expected to shift the (already uncertain) natural baseline and all shipping impacts must be judged in the context of this rapidly evolving system. Here, we present preliminary modelling results from the SEANA (shipping emissions in the Arctic and North Atlantic) project. Our results suggest that in the present day (in some regions) shipping may contribute significantly to background aerosol (up to 14% of boundary layer cloud condensation nuclei). Nevertheless, despite significant expansion of the industry predicted for 2050 our models predict Arctic-wide decreases in aerosol associated with reductions in fuel sulphur content and perturbation of natural aerosol sources. However, this response is predicated on the representation of natural aerosol sources (particularly nucleation) in the model.

UK ARCTIC AND ANTARCTIC PARTNERSHIP (UKAAP) HORIZON SCANNING SESSION

A session hosted by the UK Arctic-Antarctic Partnership for all delegates to discuss priorities for future Arctic Research. Following an introduction, we'll ask all delegates to join break-out groups based on the five themes below, before reconvening for a plenary. Everyone's views are welcome.

- Future use of the Sir David Attenborough and Arctic Ocean priorities – (add brief comments via anonymous virtual post-it notes at https://pinup.com/fVpkqvxpT)
- Priorities for Terrestrial Arctic Research (https://pinup.com/mzLAAwFTt)
- Priorities for Arctic research in the Social sciences (https://pinup.com/EfS2en0gK)
- Priorities for Arctic research in the Atmosphere (https://pinup.com/wef2tPREA)
- Priorities for Arctic research in the Cryosphere (https://pinup.com/f3u-MYZGc)

UK SCIENCE AND INNOVATION NETWORK

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International collaboration is essential to maintaining the excellence of UK science and innovation. International partnerships offer access to funding, infrastructure, talent and data at a scale and scope beyond the reach of the UK acting in isolation. The UK Science and Innovation Network (SIN) has been instrumental in building dynamic research partnerships and expanding collaborations globally in support of the UK's research community, filling capability gaps and ensuring value by leveraging international resources. The Network is managed jointly by the Foreign and Commonwealth Office (FCO) and the Department for Business, Energy and Industrial Strategy (BEIS). It consists of over 100 officers located at the UK's diplomatic missions in over 50 countries and territories.

Arctic has been championed as one of our sectoral priority areas by SIN teams based in Russia, the Nordic countries and Canada. By working closely with the NERC Arctic Office, UK universities and research centres we have maximised the impact of UK-based scientists in the Arctic and created new collaborative opportunities and platforms for engagement. In 2018-2019 SIN Nordics and SIN Russia delivered impactful sessions on plastic pollution, marine research and Arctic education at major international Arctic fora (UArctic, Arctic Frontiers, Arctic Circle), ensuring greater visibility of UK Arctic science excellence and links with new partners in the Arctic States. SIN Russia together with the NERC Arctic Office has supported the growing number of collaboration with the Russian Arctic science community. Bilateral early career events, workshops, science visits in Russia and the UK, facilitating institutional partnerships and access to research infrastructure across the North, in Siberia and the Far East have generated new partnership opportunities.

Through 2019-2020 the level of the UK's multilateral and bilateral engagement in the Arctic is set to increase. UK based researchers taking part in the MOSAIC expedition beginning in September and more SIN-led Arctic-related activities planned in the UK and the Arctic States will help demonstrate the significance of the Arctic Council facilitated Agreement on Enhancing International Arctic Science Cooperation. The UK Arctic Science conference offers the potential to enhance links between SIN and the UK Arctic science community at this important moment. It will enable the two sides to share opportunities for prospective engagement, upcoming projects and events, including potentially access to support, and opportunities to raise the profile of UK Arctic science work via the #UKinArctic SIN Global digital campaign. SIN Russia and SIN Nordics Arctic leads are submitting this abstract to request a speaking slot in the main conference programme to deliver a joint presentation.

STOMACH CONTENTS OF THE SNOW CRAB CHIONOECETES OPILIO AND OTHER BENTHIC DECAPODS IN THE PECHORA SEA (SE BARENTS SEA)

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The snow crab Chionoecetes opilio is an important commercial species that established a non-indigenous self-sustaining population in the Barents region. Bycatch of the snow crab was recorded for the first time in 1996 in the Barents Sea, and later in 2003 it was also found in the south-eastern part of the Barents Sea, the Pechora Sea, thereafter forming a self-producing population and predicted to further grow in numbers. Snow crabs are benthic omnivores and their presence in the Pechora Sea pose potential threats to benthic habitats and biodiversity. There are currently no data on snow crab diets in the Pechora Sea and trophic relations with other benthic predators including other benthic decapods that are native to the Barents Sea. In this study, we investigate stomach contents of most abundant benthic decapods in the Pechora Sea including non-native species snow crab and two native species spider crab Hyas araneus and hermit crab Pagurus pubescens. Stomach contents of 70 decapod specimens collected in 2017 from water area nearby Vaigach Island were studied and twenty categories of prey items (taxa) were identified. Average 28% of stomachs had digested microplastics among other items. The most frequently occurring prey items included bivalve mollusks (specifically Cliatocardium ciliatum, Ennucula tenuis, Macoma calcarea, Mytilus edulis agg and Dacridium vitreum), polychaetes, crustaceans and plant debris. Diets, overlaps and preferences of the 3 species were compared and discussed.

LONG-TERM CLIMATE CHANGE AND RECENT HUMAN IMPACT ACROSS NORTHERN EURASIA. THE DEVELOPMENT OF THE UK-RUSSIA DIMA WORKING GROUP.

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Scientific collaboration between Russia and other nations has had a patchy and sometimes dramatic history, moving from the near exclusion of western scientists during the cold war, to the opening up and blossoming of cooperation with the introduction of glasnost and onward post-1992, to a growth in administrative red tape and increased difficulty of access in recent years. The best collaborative projects usually reflect good personal relations between scientists. Based on this premise, we used personal contact to develop a network of scientists across northern Siberia (>50°N) and the Russian Far East who share an interest in long-term environmental change on timescales of decades to millennia (DIMA). Since March 2018, we have help two successful workshops in Russia, and the Russian membership now reflects 16 different institutions. The geographic region was chosen as it is relatively poorly studied, both because of challenging field logistics and the tendency for the Russian government to downplay the importance of the vast hinterland east of the Urals. It is nevertheless at the forefront of global change in northern regions: much is underlain by permafrost, warming trends are above the global average, and the response of extensive regions with organic soils and boreal forest cover will be critical to northern-hemisphere feedbacks to the carbon cycle. Looking forward, the DIMA group is seeking (in the first instance) UK collaborators from early-career (ECR) to more established researchers who would be interested in working in Siberia/Far East Russia and developing large or small bilateral proposals to do work in Russia. The DIMA groups also currently has funds for training, and several Russian ECRs have visited/will visit a range of labs in the UK. This poster will provide more information on the network and its current activities, including an upcoming meeting in Southampton (Sept 15-19) with Russian scientists. Funding is already distributed but anyone is welcome to attend the sessions. Contact Mary or Maarten.

ICELAND IS AN EPISODIC SOURCE OF ATMOSPHERIC ICE NUCLEATING PARTICLES RELEVANT FOR MIXED-PHASE CLOUDS

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Atmospheric particles capable of nucleating ice can dramatically alter the radiative properties of cold clouds. These Ice-Nucleating Particles (INPs) can trigger heterogeneous ice formation in supercooled cloud droplets at temperatures well above those required for homogeneous ice-nucleation. Ice formation is followed by a cascade of microphysical processes that deplete supercooled liquid water in high latitude clouds. Mineral dust from low latitude arid sources is known to be one of the most important types of INPs worldwide, due to both its ice-nucleation efficiency and its abundance. While dust from low latitude sources has been studied extensively for its ice nucleating properties, very little work has been done on dust from mid- to high-latitude sources such as Iceland, Greenland or Alaska. These sources are responsible for significant dust emissions, which could play an important role as INPs on a regional scale. The Arctic, for example, is an area very sensitive to climate change, and where mixed-phase clouds strongly affect the radiative fluxes.

Here we have used aircraft collected Icelandic aerosol samples in combination with a droplet based freezing assay, as well as electron microscopy, to quantify the ice-nucleation efficiency of Icelandic dust. Our results show that Icelandic dust is an efficient ice-nucleator, exhibiting an activity comparable to some low-latitude dust samples. The Icelandic dust ice-nucleation efficiency data have been used in combination with a global aerosol model, showing that this dust is emitted and transported to locations and altitudes where it acts as an INP at ambient temperature. Our work suggests that Icelandic dust is most important for ice nucleation during the summertime over the North Atlantic and the Arctic.

Since Iceland is only one of many high latitude dust emission sources, we anticipate that the combined effect of all the high-latitude dust sources will be a significant contribution to the INP population in the Arctic. In addition, since high-latitude dust emissions are likely to increase under most climate change scenarios, this INPs source might become even more significant in the coming decades.

POLAR TRAFFIC, POLAR NOISE

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This presentation will consider the nature of collaboration and co-production and the specifics of how and why artists and scientists embark on what can be mutually beneficial work.

We will discuss some of our experiences, methods and outcomes of 'co-produced works', specifically in the Military, the Deep Ocean, The Arctic, Water and Ice. We will clarify our joint interest to visually represent research – to work together with scientists and between ourselves as artists.

Our focus in the North is two-fold: the sublime submarine space beneath the ice, the 'noise' of recording and surveying equipment trying to claim/ understand this space, as well as investigating the new emerging territories around the "New Silk Road", where landscapes and life above and below the water's surface is going through unprecedented state changes.

Greer Crawley has extensively researched the scenography of war and examined notions of the staged landscape and the adoption of theatrical language and methodologies by the military. Emma Critchley has worked with the British Antarctic Survey, the Californian Ocean Alliance and with the Ice Memory Team from Ca' Foscari University of Venice. Mariele Neudecker has developed work with Alex Rogers, Professor of Conversation and Marine Biology, University of Oxford, the Nike Missile site on the Marin Headlands, San Francisco, as well as with anthropologists in Amani, Tanzania.

We share an interest in exploring multiple layers of coinciding realities and narratives as well as the challenges of investigating and making accessible the invisible, inaudible, remote and unknown.

WARM PROGLACIAL LAKES FOLLOWING EXTREME HEAT EVENTS AND RAPID RETREAT OF A LAKE TERMINATING ARCTIC GLACIER

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Glaciers in contact with proglacial lakes show accelerated mass loss rates through mechanical and thermal processes, particularly through the formation of thermal notches in the ice front (Carrivick and Tweed, 2013). As glaciers retreat from their Little Ice Age maxima (~100 years ago) and respond to increasing air temperatures (particularly in Arctic Scandinavia: cf July 2018) they often develop proglacial lakes. However, the prevalence, status and role of proglacial lakes in Arctic glacial systems have received relatively little attention. As a consequence, despite significant increases in air temperatures, a common assumption persists that smaller proglacial lakes remain at a uniform 1oC.

We present the first recorded proglacial lake temperatures and time lapse imagery from the front of an actively calving Arctic glacier (67.954878°N, 18.561535°E), which rapidly lost 10,523m2 of ice (0.67% of area in RGI, 2008) between 2014 to 2018. We present temperature observations directly from the ice front in July 2017 from the innovative use of thermal infrared imagery, supplemented by several detailed thermistor temperature surveys (using a remote controlled boat). Previous melt models for lacustrine terminating glaciers have been compromised by a lack of data from the hazardous water to ice contact point and assume a uniform temperature (e.g. 1oC). Here we report night time temperatures of 3oC directly at the ice-water contact point following numerous ice berg calving events above thermal notches (captured in time lapse imagery). Day time maximum proglacial lake surface temperatures of 8oC were observed during the fieldwork and surface skin temperatures of 8oC have been observed in ASTER satellite 2014 thermal image analysis.

We present thermistor data of lake surface temperatures that shows a strong validation (R2 = 0.9365) of the surface skin temperatures from the AST08 temperature product. At the regional scale, analysis of ASTER AST08 data demonstrate that 11 out of the 12 largest proglacial lakes in Arctic Sweden had daytime surface skin temperatures of >4oC in August 2014. We also present AST08 data from 2018 with higher lake surface temperatures with all 12 lakes having skin surface temperatures of between 4 to 18oC. Based upon these data we advocate (a) the extended use of the ASTER LST product for measurement of proglacial lakes surface skin temperatures for other regions and (b) the development of new high resolution thermal satellite sensors for investigating the surface skin temperature not only of proglacial lakes, but other water bodies and proglacial environments, such as fjord systems.

The temperatures reported by this study are substantially warmer than expected from an Arctic proglacial lake. Combined with rapid thermal notch development and associated calving, this study provides the first direct evidence of proglacial lake temperatures directly impacting on the retreat of an Arctic glacier.

THE CHANGING UNDER-ICE LIGHT FIELD OF THE ARCTIC OCEAN

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Changes in the light field under the sea ice is one of the main drivers that will affect large-scale ecosystem structure and biogeochemical functioning of the Arctic marine environment. Sea ice and snow is a major factor influencing the light field, but the Arctic sea ice is changing; it is melting earlier and forming later. In fact, the Arctic is no longer a region dominated by a thick multi-year ice (MYI), but it is a regime controlled by thinner, more dynamic, first year ice (FYI). This shift from MYI to FYI has consequences on the radiative transfer, as well as for changes in the ecosystem dynamics. To quantify the biological response to this changing Arctic, we need to better describe the complexity of the coupled physical-biological system, especially over an annual cycle. To do this appropriately we need a long-term presence making the appropriate measurements over an annual cycle. Here, we describe the recent in situ measurements from a dedicated Arctic sea ice programme, as well as modeling efforts that are underway to better understand how the changing light field will impact ecosystem dynamics.

ARCTIC GEOPOLITICS: STATE, SPACE AND INTERNATIONAL RELATIONS THEORY

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After the 2007 Arktika expedition, and the related deployment of a Russian flag on the maritime floor of the North Pole, much attention and effort has been dedicated to the discussion of Arctic geopolitics. Scholars working within a wide variety of disciplines and theoretical frameworks have dedicated some effort to the comprehension of the phenomena encompassed by the label. The paper proposes a bibliographical review of the production about the subject of Arctic Geopolitics within the field of International Relations. Our hypothesis is that, in this field, narratives of an "empty Arctic" and of the Arctic as a "new" scenario have great impact in the debate that is unfolding within the discipline of IR, due to what is described as the "territorial trap" (AGNEW;CORBRIDGE, 2010), i.e. the spatial blindness of international relations theory, rooted in its geographical assumptions. The debate about the general lines on which Arctic geopolitics are discussed within the IR theory is followed by the discussion of how the dialogue with political geography – and with critical geopolitics in particular - could improve the analyses and enhance the explanatory power of current readings of Arctic geopolitics within the field. The paper also aims to explore ways in which discussions about spatial practices and the relation between state and the spaces in which they operate can be integrated in the IR traditional discussions.

TOWARDS A COMBINED SURFACE TEMPERATURE DATASET FOR THE ARCTIC FROM THE ALONG-TRACK SCANNING RADIOMETERS (ATSRS)

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Surface Temperature (ST) changes in the Polar Regions are predicted to be more rapid than either global averages or responses in lower latitudes. Observations of STs and other changes associated with climate change increasingly confirm these predictions in the Arctic. Furthermore, recent high profile events of anomalously warm temperatures have increased interest in Arctic surface temperatures. It is, therefore, particularly important to monitor Arctic climate change.

Satellites are particularly relevant to observations of Polar Regions as they are well-served by low-Earth orbiting satellites. Whilst clouds often cause problems for satellite observations of the surface, in situ observations of STs are much sparser. The ATSRs are accurate infra-red satellite radiometers, designed explicitly for climate standard observations and particularly suited to ST observations. ATSR radiance observations have been used to retrieve sea and land ST for a series of three instruments over a period greater than twenty years. This series has been extended with the launch of SLSTR sensors on Sentinel satellites 3A and 3B, which have the same key design features.

We have combined land, ocean and sea-ice ST retrievals from ATSR-2 and AATSR to produce a new ST dataset for the Arctic; the ATSR Arctic combined Surface Temperature (AAST) dataset. The method of cloud-clearing, use of auxiliary data for ice classification and the ST retrievals used for each surface-type will be described. We will establish the accuracy of sea-ice and land-ice retrievals with results from validation against in situ data. We will also discuss the issues and complexities in producing a combined surface temperature dataset for this region.

MISPLACED THERMOSPORES IN SVALBARD - WHAT CAN DISTRIBUTION TELL US ABOUT BARRIERS AND DISPERSAL HISTORY

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Endospores of thermophilic bacteria in the phylum Firmicutes ("thermospores") are dispersed from warm sources to habitats that are not suitable for thermophilic growth - most notably, Arctic marine sediments. Although the diversity of thermospores in the sediments of Svalbard (Norway) has been extensively characterised, the source environment(s) from which they originate remain unknown.

We hypothesise that thermospores in Svalbard marine sediments originate from marine, warm deep biosphere habitat(s), such as mid-ocean ridge venting systems or off-shore petroleum reservoirs, and are dispersed long-distances as dormant spores via ocean currents. If so, thermospore communities will differ in marine sediments as compared to nearby soils and thermospore abundance in narrow fjords will decrease with distance from the open sea to the shore.

To test these hypotheses, we compared the abundance patterns of two thermospore phylotypes in three fjords of Svalbard using quantitative PCR (qPCR). We also compared the 16S rRNA gene composition of thermophilic Firmicutes of the northernmost fjord (Kongsfjorden) with nearby soils. To target dormant thermophilic Firmicutes, samples were first pasteurised and incubated in brackish medium under anoxic conditions at 50 °C for 48 – 144 hours.

In concordance with our hypotheses, we found that the community composition of enriched thermophilic Firmicutes was starkly different between soils and sediments (ANOSIM: $R = 0.97$; $p = 0.0001$) with only 4 out of a total 596 Firmicutes OTUs being present in both soils and sediments. We also found that the abundance of two thermospores phylotypes (F and G) generally decreases with distance in Svalbard fjords, the abundance of G is less consistent and more patchy as compared to F.

These findings suggest that thermospore communities in Svalbard sediments are unlikely to be derived from atmosphere or soil and there must be distinct sources of thermospores in marine and terrestrial environments of Svalbard. This observation was corroborated by comparing differences of geographical distribution patterns of phylotypes F and G, which implies separate dispersal histories as well as the existence of dispersal barriers for thermospores in Arctic sediments. Overall, this work uses novel techniques to explore the decade-long conundrum of the existence of thermophiles in Arctic climates, while also providing a window into the dispersal ecology of deep sea bacterial communities.

PREDICTING EXTINCTION – CLIMATE CHANGE SCIENCE IN ARCTIC ENDANGERED SPECIES LITIGATION IN THE USA

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Predicting Extinction – Climate Change Science in Arctic Endangered Species Litigation in the USA
The Arctic is melting and it is melting fast. In 2007, the Intergovernmental Panel on Climate Change's fourth assessment report predicted that Arctic sea ice would be reduced by between 22 and 33% by 2080-2100 with the Arctic predicted to be nearly ice free in the summer by the end of the century. In fact, Arctic sea ice has been melting much faster. Observations taken since 2007 now indicate that the Arctic could be nearly ice free as soon as 2040. This will have severe implications for the Arctic environment.

Federal agencies in the United States have been using the model in the IPCC's fourth assessment report (2007) to designate species which rely on sea ice for all or much of their lives as 'threatened' under the Endangered Species Act. These species are not currently endangered but are reliant on sea ice so their existence would be threatened should the sea ice melt.

In the past few years there have been a series of cases regarding the designation of various Arctic species as 'threatened'. Both the National Marine Fisheries Service and the US Fish and Wildlife Service have had their decisions challenged in court with those suing the government arguing that climate change predictions are not an appropriate factor for consideration under the Endangered Species Act. In October 2016 the Ninth Circuit Court of Appeals overturned a decision of the lower court, finding that it was reasonable to rely on climate change predictions up to the end of the century when designating the Pacific bearded seal as a threatened species. The Court of Appeals made a similar finding in relation to the designation of the polar bear as a threatened species and also in the litigation surrounding the decision to designate a critical habitat for the polar bear. Further litigation is currently ongoing in relation to the Arctic ringed seal and the Pacific walrus, the latter being particularly interesting because the refusal to list the Pacific walrus was an early environmental decision of the current administration.
Using the litigation relating Arctic species as case studies, this paper will consider the role of climate change science in relation to Arctic environmental protection in the courts of the United States.

Sarah Mackie is a PhD candidate at Newcastle Law School in the United Kingdom. She has recently submitted a thesis on the subject of comparative endangered species protection in the Arctic. In conducting her research, Sarah has held posts as a visiting researcher at the University of Lapland, Harvard Law School, the University of Greenland and the University of Tromsø. Sarah is due to defend her thesis later this term and will then take up a post with the Arctic Initiative at the Harvard Kennedy School.

Sarah holds a law degree from St John's College, Cambridge University and an LL.M in Environmental Law from Newcastle University. Prior to beginning her PhD, Sarah worked as an extern for Trustees for Alaska, an environmental public interest law firm based in Anchorage, Alaska and was Judicial Assistant to the Lord Chief Justice of England and Wales. Sarah is qualified as a solicitor in England and Wales and teaches Public Law and Contract Law at Newcastle Law School.

THE PAN-ARCTIC OZONE SEASONALITY: MODELLING VS MEASUREMENTS

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Within the framework of the International Arctic Systems for Observing the Atmosphere (IASOA), we report a modelling study of the surface ozone at eight high Arctic locations, which are Summit (Greenland), Pallas (Finland), Barrow (USA), Alert, Eureka, Resolute (Canada), Tiksi (Russia), and Villum Research Station (Danmark). We focus on surface ozone seasonality, but with particular interest in ozone depletion (ODE) observed at pan-Arctic coastal sites during spring. Our model integrations shows that the coastal spring ODEs are solely related to sea-ice-sourced bromine emission, via the sea salt aerosol (SSA) produced from blowing snow on sea ice. Although open-ocean-sourced bromine, via sea spray bromide depletion, can significantly cause atmospheric ozone, it does not directly contribute to ODE. Rather its effect on polar boundary layer ozone is mainly through remotely transported air which has been influenced by open ocean.

Both satellite (GOME-2) based and ground-based remote-sensing BrO data are used to evaluate model bromine chemistry. The consistence between the model and the remote sensing BrO data (both satellite- and ground-based) indicates that relevant parameterizations implemented to the models work reasonably well, and the two global chemistry models can well reproduce most large scale ODEs observed at both coastal and at inland sites. Model results strongly indicates that sea ice surface can significantly affect spring ozone and modify its seasonality. Therefore in a waring climate with rapid change of Arctic sea ice extent and type (multiyear vs young sea ice) can greatly change snow chemical compounds on sea ice and thus potentially affect halogens emission and then on polar atmospheric chemistry and regional climate.

SNOWBALL WORLDS: CRYOCONITE ECOSYSTEMS OF THE CRYOGENIAN AND THE MODERN DAY

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Cryoconite holes are unique glacial ecosystems. They form when organic and inorganic matter accumulates on the glacier surface. This cryoconite matter absorbs solar radiation and melts the underlying ice forming a pocket of meltwater with a layer of cryoconite sediment at the bottom. Cryoconite holes may provide an answer to how life survived the Cryogenian Snowball Earth 720—635 million years ago. During the Snowball Earth the planet was completely covered in ice from the poles to the equator. Not only did a wide rangte of microbial life persist, this time was a turning point — the beginning of multicellular life. As cryoconite holes are a cold-climate habitat that supports a range of organisms and biogeochemical processes, they are of particular interest to Snowball Earth researchers. Our aim was to identify and study Cryogenian analogues from modern day cryoconite samples.

Cryoconite samples were selected from several locations across both the Arctic and Antarctic for 16S and 18S rRNA gene amplicon sequencing. We present further evidence for the taxonomic diversity of cryoconite across both poles. Although the most abundant phyla were consistent across all locations, community composition of cryoconite varies considerably between Arctic and Antarctic cryoconite ecosystems. Arctic cryoconite contains a much higher proportion of Opisthokonta than that of the Antarctic, and a lower proportion of Cyanobacteria. In addition, we compared the taxonomic analysis of modern cryoconite to fossils, molecular clocks and cryogenian biomarkers. We report that cryoconite holes support key Cryogenian eukaryotic taxa.

MODEL ARCTIC COUNCIL AT SECONDARY SCHOOL

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Growing interest in the Arctic Council amongst scholars and educators has recently stimulated a number of Model Arctic Councils (MACs). MACs are pedagogical simulations at which participants play the roles of delegates to a cycle of Arctic Council meetings. MACs are normally aimed at university students, but since 2016 I have developed and launched two MACs at secondary schools in the UK and Spain, Norwich MAC (NORMAC) and MAC Bilbao. In this presentation, I describe how these MACs work, and I discuss challenges to running secondary-school MACs, including attracting participants, assisting with preparatory research and consensus building, balancing realism with creative learning, and sustaining interest in the Arctic. I highlight differences with university MACs (including a university MAC that I also run in collaboration with Trent University and the University of East Anglia), as well as deviations from actual Arctic Council procedures designed to accommodate secondary-school pupils. I also evaluate data from surveys of delegates to four separate MACs over two years: NORMAC 2018 and 2019, and MAC Bilbao 2018 and 2019. These data show that both MACs are meeting their educational objectives of raising awareness and understanding of the Arctic amongst secondary-school pupils; inspiring them to learn more about the Arctic, its peoples and its challenges; and helping develop their skills in public speaking, negotiation and consensus building. I conclude with a brief discussion of future plans for secondary-school MACs.

SILICON ISOTOPES IN ARCTIC AND SUB-ARCTIC GLACIAL MELTWATERS: THE ROLE OF THE SUBGLACIAL WEATHERING IN THE SILICON CYCLE

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Glacial environments play an important role in high-latitude marine nutrient cycling, potentially contributing significant fluxes of silicon (Si) to the polar oceans, either as dissolved silica (DSi) or dissolvable amorphous silica (ASi). Si is a key nutrient in promoting marine primary productivity, contributing to atmospheric CO2 removal. We present the current understanding of Si cycling in glacial systems, focusing on the silicon isotope (δ30Si) composition of glacial meltwaters. We combine existing glacial δ30Si data with new measurements from twenty sub-Arctic glaciers, showing that glacial meltwaters export consistently isotopically light DSi compared to non-glacial rivers (+0.16‰ versus +1.38‰). Glacial δ30SiASi composition ranges from -0.05 ‰ to -0.86 ‰ but exhibits low seasonal variability. Si fluxes and δ30Si composition from glacial systems are not commonly included in global Si budgets and isotopic mass balance calculations at present. We discuss outstanding questions, including the formation mechanism of ASi and the export of glacial nutrients from fjords. Finally, we provide a contextual framework for the recent advances in our understanding of subglacial Si cycling and highlight critical research avenues for assessing potential future changes in these environments.

THE ARCTIC BOUNDARY LAYER DURING THE ARCTIC OCEAN 2018 EXPEDITION

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Modelling Arctic weather and climate is challenging for models as there are feedback processes and atmospheric conditions, which are unique compared to the rest of the world. There is significant scope to improve the models by understanding the physical processes involved and improving the related parameterizations. Process understanding can best be achieved with direct measurements, which are also necessary for testing new parameterization schemes.

Coordinated atmospheric and aerosol measurements were undertaken during the Arctic Ocean 2018 (AO2018) expedition. The Swedish research icebreaker Oden drifted with an ice floe around 89°N 40°E from 14 August until 14 September 2018. A suite of surface-based remote-sensing instruments, were deployed to monitor the surface energy budget, the vertical structure of the atmospheric boundary layer and cloud/fog properties.

In this presentation we will show some preliminary results of the meteorological conditions during the expedition, including the vertical structure of the boundary layer (e.g. inversions and stratification), as well as cloud and fog properties.

GEOPOLITICAL ISSUES OF THE BARENTS EURO-ARCTIC REGION AND ARCTIC POLICY-MAKING

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At the present stage of the Barents Euro-Arctic region development a certain number of theoretical, methodological and practical issues have arisen. Most of them are related to the nature and trends in the development of cross-border cooperation in the northern regions of Russia and Europe and the diversity of its specific manifestations. The phenomenon of "cross-border cooperation" in the BEAR is viewed from the position of two rather contradictory processes that are in dialectical dependence on each other - the processes of globalization and regionalization. The globalization of the BEAR space implies the unification and transnationalization of the interests within economic and political interaction, and regionalization acts as a mean of reflecting the specific conditions and experience of the individual areas. This once again proves that the Barents Euro-Arctic region occupies a special geopolitical position in interstate cooperation, within the framework of which intensive interaction of territorial communities and regional organizations / representative offices takes place.

Currently, four regional organizations are active in the North of Europe: the Arctic Council (CA), the Nordic Council of Ministers, and the European Union with its Northern Dimension program. The main aspect of cooperation is its effectiveness, but despite several important "layers" of cooperation: the Barents Euro-Arctic Council, the Northern Dimension and the Arctic Council, it is sometimes quite difficult to achieve efficiency. But in recent years the situation has stabilized, and at this stage, the BEAC plays an increasing role at the national and regional levels, having a clear strategic approach. Cross-border cooperation programs also contribute to the development of effective cooperation; the most striking example is the CBC KOLARCTIC 2014-2020 - a financial tool to support cooperation between the North Callot (Finland, Sweden, Norway) and North-West of Russia. Projects implemented in the framework of CBC KOLARCTIC help to maintain the vitality of the economy, increase the attractiveness of the region, rational use of its natural resources, and also favorably combine respect for the environment, potential for economic growth, free mobility of people, knowledge and technology.

Artic policy 2020 is filled with real content: deep socio-economic integration, growth of welfare and prosperity of the participating countries on the basis of common civilized values.

CARBON RELEASE DURING 21ST CENTURY GLACIER RECESSION: A POSITIVE FEEDBACK IN THE GLOBAL CARBON CYCLE

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Glaciers cover 11% of Earth's surface and contain significant reserves of glacial organic carbon (GOC). Much of the GOC is stored within glacial ice, subglacial and proglacial sediment and soils in northern latitudes, and is discharged as glaciers recede. When GOC in the form of dissolved and particulate organic carbon, and nutrients, are released as glaciers melt, potent greenhouse gases are released into the atmosphere creating positive feedback on global warming, as well as seeding biological production downstream. However, despite the importance of GOC, its release from receding glaciers in the Arctic and Subarctic regions has not been previously studied in detail. Therefore, this study aims to elucidate the role of GOC as a carbon source in the dynamic Arctic and Subarctic regions by comparing carbon transportation in two contrasting glacial systems (Oræfajökull ice cap in Iceland and Tarfala in Sweden). This is being achieved by understanding the main source of GOC and downstream microbial metabolism of released GOC, which will allow us to quantify GOC and nutrient fluxes, and to understand the organic carbon transformations along the downstream transect from the glacial front. Water, soil and sediment samples have been collected as a result of two successful field campaigns to Iceland and Sweden in summer 2018. Soil and sediment samples were analysed for total and organic carbon and nitrogen concentrations. Soil samples from moraines in front of Svínafellsjökull showed highest organic carbon concentration (up to 5.5%) in Iceland, and the samples from the bank of the Tarfala lake yielded highest results (0.7%) in Sweden, while sediment samples from both study areas barely had any carbon signal. To ensure effectiveness of further analysis, 28 soil and sediment samples with highest total organic carbon concentrations were selected for organic biomarker identification based on the results obtained from carbon and nitrogen analysis. Results from biomarker analysis show clear signs of soil markers in soil samples. Sum of bacterial hopanoids and R'soil index show development of soils over time from the glacial front to moraines. These data combined with other analyses such as particulate and dissolved organic carbon, elemental and ionic concentrations, microbiological DNA extractions of collected glacial meltwater and proglacial lake water, soil and sediment samples will facilitate assessment of how released carbon is mobilized, eroded and degraded in deglaciating systems in the Arctic (Sweden) and Subarctic (Iceland) regions.

OLD CARBON FROM A METHANE SEEP AND PEAT EROSION ENTERS THE FOOD WEB IN LAKE TESHEKPUK, ALASKA

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Methane seeps can vent large quantities of carbon into the atmosphere. Part of this methane is oxidised in the top sediments and the water column by methanotrophic bacteria, which can form part of the diet of aquatic invertebrates. Here, we investigate the extent to which a large methane seep in Lake Teshekpuk, Alaska, is providing carbon to the aquatic food web, using a combined analysis of stable carbon and nitrogen isotopes and AMS 14C dating of invertebrates. When invertebrates incorporate methane-derived carbon, the characteristically low stable carbon isotope (d13C) value of methane is passed on to invertebrates. If emitted methane is of geothermal origin or from thawing organic-rich Pleistocene deposits, it is characterised by old radiocarbon ages, and this 'old' carbon is taken up by living invertebrates. Chironomid larvae collected near the seep had an average d13C value of -37 permille, whereas larvae collected away from the seep had average d13C values of -27 permille. The average radiocarbon age of larvae from the seep was 384 cal yr BP, and the average age away from the seep in the littoral was 468 cal yr BP, with one extreme age of 1400 cal yr BP. The study clearly indicates the incorporation of methane-derived 'older' carbon with low d13C values near the seep, but also shows feeding on another source of old carbon from peat in the littoral zone of the lake. The unexpectedly 'old' larvae away from the seep can be explained by feeding on eroded peat in the littoral.

Posters

#	Name	Affiliation	Title
1	Keechy Akkerman	Loughborough University	Within-lake variability of diatom community composition in the low-Arctic
2	Chris Aldridge	British Antarctic Survey	British Antarctic Survey operational capabilities in the Arctic
3	Chris Aldridge	British Antarctic Survey	Arctic Training Short Course (ATSC)
4	Adel Allaberdina		Development of phosphorus forms in soil chronosequence of Nordenskioldbreen glacier (Svalbard)
5	Helen Andersen	Svalbard Science Forum	Svalbard Science Forum
6	Dr. David Ashmore	University of Liverpool	Meltwater percolation, impermeable layer formation and runoff buffering on Devon Ice Cap, Canada
7	Chelsey Baker	University of Southampton/ UK Polar Network	The UK Polar Network: Engaging the next generation of polar scientists
8	Clarissa Baldo	University of Birmingham	Chemical and Mineralogical Composition of Icelandic Dust: Implication for the Radiative Balance
9	Bassey Bassey	Cranfield University	Abatement of Operational Discharges from Offshore Vessels and Structures in an Emerging Zero Spill Regime
10	Dr. Stephen Brough	Newcastle University	Dynamic changes of east Greenland marine-terminating glaciers, 2013-2017
11	Nicola Munro, Henry Burgess, Nick Cox	NERC Arctic Office	NERC Arctic Station - the UK's permanent research facility in Svalbard
12	Karley Campbell	University of Bristol	Variability in algal production between first-year and multiyear sea ice habitats
13	Prof Peter Convey	British Antarctic Survey	Area protection in and around Antarctica – lessons from the other pole
14	Dr. Kirsty Crocket	University of Edinburgh	NERC Changing Arctic Ocean
15	Dr. Lewis Drysdale	National Oceanography Centre	What is driving changes in primary productivity along the Arctic Ocean shelf edge?
16	Prof Mary Edwards	University of Southampton	Long-term climate change and recent human impact across Northern Eurasia. The development of the UK-Russia DIMA working group.
17	Dr. Jennifer Freer	British Antarctic Survey	Two models, one aim: predict the response of Arctic copepods to a changing 3D environment
18	Amy Gray	Loughborough University	Getting to the core of climate change

#	Name	Affiliation	Title
19	Siobhan Johnson	University of Cape Town	Evaluation of the structure of artificial columnar sea ice using medical devices
20	Ilona Kater	University of Durham	Changing ecology in a warming Arctic: Snow, vegetation, traditional ecological knowledge and Saami reindeer herding
21	Timo Kelder	Loughborough University	Recent temperature and precipitation changes over Svalbard
22	Jack Landy	University of Bristol	A consistent multi-decadal record of pan-Arctic sea ice surface roughness through the application of a numerical altimeter echo model to Envisat RA-2 and Cryosat-2 SIRAL
23	James Lea	University of Liverpool	Supraglacial lake mapping of the entire Greenland Ice Sheet using Google Earth Engine
24	Ben Lincoln	Bangor University	Primary productivity driven by escalating Arctic nutrient fluxes
25	Michelle McCrystall	University of Exeter	The influence of ENSO on Arctic surface temperatures
26	Anuszka Mosurska	University of Leeds	A critical approach to community-based participatory research in Alaska
27	Joseph Nolan	European Polar Board	European Polar Board
28	Louisa Norman	University of Liverpool	Setting the Baseline for the Arctic Isoscape: a first view of the stabe N isotopes
29	Lottie Pearson	University of Exeter	“A quantitative assessment of Arctic thermokarst changes in response to climate warming”
30	Kassandra Reuss-Schmidt	University of Sheffield/CEH	How sum-meter spatial variability affects upscaling estimates in Arctic wetlands
31	Tom Rippeth	Bangor University	Mixing driven by the tides in the Arctic Ocean
32	Jamie Rodgers	Scottish Association for Marine Science	Will the Barents Sea mixing increase with the Atlantification?
33	Jennifer Ross	University of Sheffield	The reducing Greenland Ice Sheet and the implications for the ocean.
34	Laura Seddon	Durham University	Measurement, Knowledge, and Representation in the Arctic Marginal Sea-Ice Zone
35	Zongbo Shi	University of Birmingham	Shipping Emissions in the Arctic and North Atlantic Atmosphere - SEANA
36	Connor Shiggins	Keele University	Micro-Scale Isotopic Analysis of Basal Ice Facies Frozen from Supercooled water

#	Name	Affiliation	Title
37	Guy Tallentire	Loughborough University	Fjord meltwater and sediment delivery in a fast changing high Arctic environment
38	Maud van Soest	Loughborough University	Quantification of aeolian dust deposition on a vulnerable Arctic landscape in SW Greenland
39	Baosheng Wang	China University of Mining and Technology	A new triaxial test system and method for studying the effect of freezing pressure on ice mechanical properties