Wednesday 4th November					
09:00	**Welcome and registration Tea/Coffee**				
09:15	David Vaughan Director of Science	**Welcome address:**			
Session 1: Land					
09:30	Jennifer Brown	Seasonal penguin colony colour change at Signy, Antarctica			
09:50	Elise Biersma	First evidence of long-term persistence of mosses in Antarctica			
10:10	Tun Jan Young	Resolving flow and deformation of store glacier, west Greenland using FMCW radar			
10:30	**Tea/Coffee**				
Session 2: Air					
10:50	Ian White	Dynamical response to the equatorial QBO in the northern winder extratropical stratosphere			
11:20	Michelle McCrystall	Modelling the influence of remote teleconnection on Arctic climate variability			
11:40	Jenny Turton	Spatial and temporal characteristics of foehn winds over the Larsen ice shelf			
12:00	Hoi Ga Chan	Modelling nitrogen oxide emission from snow			
12:20	**Lunch**				
13:30	**First year welcome**	Hayley Allison Jesamine Bartlett David Buchanan Harriet Clewlow	Tracey Dornan Rebecca Frew Tom Hudson Amy King	Irene Malmierca Christine McKenna Emily Potter	Zoe Roseby Felipe Lorenz Simoes Rebecca Vignols
13:45	David Vaughan	**Keynote talk 1:** "Ice sheets, climate and sea-level"			
Session 3: Water: Circulation					
14.15	Lewis Drysdale	The seasonal distribution of freshwater from meteoric sources and sea ice melt in Svalbard fjords			
14.35	Heather Regan	Sources and fate of freshwater in the ocean west of the Antarctic Peninsula			
14.55	Ewa Karczewska	3-D transport pathways from the southern ocean			
15:15	**Tea/Coffee**				
15.45	Ryan Patmore	Making a gyre, the southern ocean way			
16.05	Erik Mackie	Has Antarctica ice loss altered the circulation of the southern ocean?			
16:25	**Group Photo**				
16:30	**Poster Session and wine reception**				
17:30	**Finish**				
18:00	**Conference Dinner: The Grain and Hop Store**				

Thursday 5th November		
09:15	**Welcome Day 2: Tea/Coffee**	
	Session 4: Water - Palaeo	
9.30	Jennifer Horrocks	First high resolution record of the late quaternary environmental changes in the Amundsen sea, West Antarctica, revealed by multi-proxy analysis of drift sediments
9.50	Jenny Roberts	Current affairs: Variations on the ACC strength over glacial terminations
10.10	Thomas Williams	The southern ocean in motion: Deep water circulation over the last 800,000 years
10:30	**Tea/Coffee**	
	Session 5: Ice	
10.50	Ashleigh Massam	Application of ultra-high resolution trace-element analysis on glacial ice from Weddell Sea deep ice cores, West Antarctica
11.20	Max Holloway	Modelling ice sheet collapse and sea ice retreat during the last interglacial peak
11.40	William Dickens	Reconstructing the glacial history of the South Orkney Islands, NE Antarctic Peninsula
12.00	Martin Wearing	Investigating the flow dynamics at ice shelf calving fronts
12:20	**Lunch**	
13:45	Jen Jackson	**Keynote talk 2:** Understanding whale dynamics, exploitation history and recovery pattern in the Southern Ocean
	Session 6: Water - Nutrients	
14.15	Kymberley Pyle	Silicate, sea-ice and shelf mixing: Relative controls on dissolved Barium distributions at the WAP
14:35	Anna Mikis	The use of individual planktonic foraminifera from sediment traps to assess seasonal variability along the West Antarctic Peninsula
14:55	Anna Belcher	The role of particle associated microbes in remineralisation of faecal pellets in the upper mesopelagic of the Scotia Sea
15:15	**Tea/Coffee**	
	Session 7: Water - Biology	
15:45	Victoria Sleight	Seashell formation: a molecular approach to using damage-repair experiments
16:05	Emma Cross	Acclimation to ocean acidification – its not all doom and gloom for brachiopods!
16:25	**Winners of poster and talks announced**	
16:30	**Finish**	

Oral sessions

Session 1: Land

Session chair: Jenny Roberts

Seasonal penguin colony colour change at Signy, Antarctica

Brown, Jennifer[1,2]; Rees, Gareth[2]; Trathan, Phil[1]; Fretwell, Peter[1]

[1]British Antarctic Survey
[2]University of Cambridge

Four penguin species breed on the Antarctic continent: emperors, Adélies, chinstraps and gentoos. These are important Antarctic upper trophic level predators and under predicted climate change are believed threatened. The inaccessibility and size of many colonies makes ground based monitoring difficult with remote sensing providing an alternative, relatively low cost, monitoring method. Advancing current penguin monitoring methods will help improve estimates of population trajectories at a regional scale. Recent and future progress in remote sensing, with new satellite sensors and platforms, offers an increased potential for accurate, consistent large scale data collection. This will enable us to address previously untested hypotheses on penguin population change. Antarctic penguins are long lived predators so are potentially sensitive indicator species of their marine ecosystem. Accurate monitoring of populations is therefore of growing importance owing to the changing environment in which they live, particularly on the Western Antarctic peninsula where rapid warming is occurring.

This research focuses on difficult to monitor brush-tailed penguins (Adélies, chinstraps and gentoos), aiming to develop new techniques and algorithms to improve their monitoring. Penguin detection in satellite imagery is based on the red/brown guano (poo) stains that colonies create. Fieldwork undertaken in Antarctica (November 2014 - January 2015) using a field spectroradiometer obtained significant reflectance spectra of Adélie and chinstrap guano. The fieldwork investigates guano colour change, addressing development over time and differences between species. This work aims to improve penguin species detection from satellite imagery.

First Evidence of Long-Term Persistence of Mosses in Antarctica

Biersma, EM[1,2] Jackson, J[1], Linse, K[1], Griffiths, H[2] and Convey, P.[1]

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How long has life persisted on Antarctica? Glaciological reconstructions estimate that thick ice sheets covered most terrestrial areas of Antarctica during the Last Glacial Maximum (LGM; ~22–18ka), as well as previous glaciations, suggesting no life could have survived on land during these periods. However, recent studies show most groups of the contemporary Antarctic terrestrial biota have a hundred thousand to multi-million year persistence on the continent. The most dominant group of Antarctic flora - the bryophytes (mosses) - seems to stand distinct from these patterns. Their low species number, low endemism levels and distribution patterns (with bipolar, worldwide, and temperate distributions dominating) suggest that today's moss biota are recent (post-LGM) colonists.
Here, using population genetics and molecular dating methods, we found the first evidence for multi-million year persistence of bryophytes in Antarctica. Focusing on several moss species, we find evidence of both long-term in situ persistence in the Antarctic, as well as more recent migrations to the continent. This study suggests that, despite apparent low endemism levels based on morphology, the genetic evidence reveals that mosses may have had a much longer persistence in the Antarctic than previously thought.

Resolving flow and deformation of Store Glacier, west Greenland, using FMCW radar

Young, Tun Jan[1]; Christoffersen, Poul[1]; Nicholls, Keith[2]; Doyle, Sam[3]; Lok, Lai Bun[4]; Brennan, Paul[4]; Hubbard, Bryn[3]; Bougamont, Marion[1]; Stewart, Craig[1]; Todd, Joe[1]; Hubbard, Alun[3]

[1]Scott Polar Research Institute, University of Cambridge
[2] British Antarctic Survey
[3] Aberystwyth University
[4] University College London

The dynamics of glacier flow are influenced by internal deformation within the ice column and by basal lubrication and motion close to the ice-bed interface. The precise processes and mechanisms involved in the components of ice motion, however, are still poorly constrained. In particular, there is a paucity of data to describe how the penetration of surface meltwater influences basal motion on diurnal, seasonal, and annual timescales. To study these processes, we installed a phase-sensitive, frequency-modulated continuous-wave (FMCW) radar array ~30 km up-flow of the tidewater terminus of Store Glacier in West Greenland. Located in the centre of a GPS strain network and within the immediate vicinity of four instrumented boreholes drilled to the bed as part of the SAFIRE research programme, the radar obtained a continuous time series of strain changes through the ice column at temporal resolution of one hour. Our results show persistently high strain throughout the vertical profile over a three-month period, with especially high and rapid changes occurring near to the ice-bed interface. Intriguingly, a reversal in the vertical strain regime was observed at the onset of the 2014 ablation season. By resolving vertical strain, we obtain a record of ice sheet motion, which improves our understanding of subglacial and englacial environments and processes, and provide first results of radar-measured strain in the 'interior-marginal' zone of a fast-flowing tidewater glacier.

Session 2: Air

Session chair: Ashleigh Massam

Dynamical Response to the Equatorial QBO in the Northern Winter Extratropical Stratosphere

White, Ian[1,2]; Lu, Hua[1]; Mitchell, Nicholas[2]; Philips, Tony[1].

[1] British Antarctic Survey
[2] University of Bath

Wave-mean flow interactions associated with the stratospheric Holton-Tan effect (HTE) whereby the tropical winds, the quasi-biennial oscillation (QBO), modulates the strength of the high-latitude Northern-hemisphere winter polar vortex, are studied using the ERA-Interim reanalysis dataset. Strong evidence of the HTE in isentropic coordinates is found, with a weaker and warmer polar vortex present when the lower stratospheric QBO is in its easterly phase (QBOe). For the first time, we quantify the QBO modulation of waveguides, wave forcing of the mean flow and wave decay/growth via a calculation of potential vorticity (PV)-based measures, the zonal-mean momentum budget and up/down-gradient eddy PV fluxes. The effect of the tropospheric subtropical jet on QBO modulation of the wave activity is also investigated. In the subtropical to midlatitude lower stratosphere, QBOe is associated with an enhanced upward flux of wave activity, and corresponding wave convergence and wave growth, which leads to a stronger poleward zonal-mean meridional circulation and consequently a warmer polar region. In the middle stratosphere, QBOe is associated with increased poleward wave propagation, leading to enhanced wave convergence and in-situ wave growth at high latitudes and contributing to the weaker polar vortex. In agreement with recent studies, our results suggest that the critical-line effect cannot fully account for these wave anomalies associated with the HTE. Instead, it is suggestive of a new, additional mechanism that hinges on the QBO-induced meridional circulation effect on the latitudinal positioning of the subtropical jet. Under QBOe, the QBO-induced meridional circulation causes a poleward shift of the subtropical jet, encouraging more waves to propagate into the stratosphere at midlatitudes.

Modelling the influence of remote tropical teleconnections on Arctic climate variability

McCrystall, Michelle R[1,2].; Hosking, Scott[1]; Maycock, Amanda[3]; Pyle, John[2]

[1] *British Antarctic Survey*
[2] *Centre for Atmospheric Science, Department of Chemistry, University of Cambridge*
[3] *University of Leeds*

The Arctic is an area which experiences large variability on a range of timescales due to the interaction of the cryosphere, ocean and atmosphere and also from non-local influences such as remote teleconnection patterns. This was demonstrated in a study by Ding et al. (2014) which found recent changes in tropical sea-surface temperatures (SSTs) generated poleward propagating wave trains that resulted in a trend of increasing geopotential heights and surface warming over north Canada and Greenland. In this study, we aim to further investigate the role of tropical teleconnections on Arctic climate variability. We make use of the UK Met Office model HadGEM3-A, to see the response of the Arctic climate to forced changes in SSTs across the entire tropical region. The results presented here are demonstrably different to findings from Ding et al's paper. We found an increase in geopotential height over the Aleutian low region and over parts of Scandinavia, however not over Canada and Greenland as discovered by Ding et al. These results could be due to differences in model and experimental design however it signifies the need for further research on tropical influence of Arctic climate.

Spatial and temporal characteristics of foehn winds over the Larsen Ice Shelf

Turton, Jenny[1,2]; Kirchgaessner, Amélie[1]; King, John[1]; Ross, Andrew[2]; Gadian, Alan[2]

[1] *British Antarctic Survey*
[2] *University of Leeds*

Over the past two decades, the eastern Antarctic Peninsula has experienced expansive loss of ice shelves. The most concerning was the collapse of the Larsen Ice Shelf (LIS), where 13,000km2 of ice was lost in just a number of weeks. One theory behind loss of the LIS is the 'föhn hypothesis'. The föhn winds flow down the eastern slopes of the AP and are a feature of the interaction of the mountain range with the prevailing circumpolar westerlies. The theory suggests that the warm, dry conditions which characterise föhn winds prompted surface melt of the LIS, and may be continuing on the remainder of the ice shelf.
The occurrence and characteristics of föhn conditions over the LIS, identified from a combination of observational and model data, will be presented here. The observational data consists of four years of data from six automatic weather stations. The model data is provided by the Antarctic Mesoscale Predication System (AMPS). The AMPS archive holds outputs from the Weather Research and Forecast (WRF) model run operationally over the Antarctic and Southern ocean by the National Centre for Atmospheric Research, USA. Archived model output from January 1st 2009 to January 1st 2012 is used here.
From the spatial distribution, it is clear that these föhn winds are wide spread events, but with localised features. The temporal scale ranges from short, six-hour events to much longer (over 72 hours) events. These conditions can be both persistent and intermittent, and occur at either a range of, or specific locations. A comparison of the föhn characteristics within the observational and model data shows that there is a good overall agreement between the two datasets. However, there are variations in timing, strength and frequency of the föhn conditions between the model and observational data.

Modeling nitrogen oxide emission from snow

Chan, H.G[1,2].; Frey, M.M.[1]; King, M.D[2].

[1]British Antarctic Survey
[2]Royal Holloway University of London

Snow photochemical processes drive production of chemical trace gases, such as nitrogen oxide, and radicals in snowpacks which are then released to the lower atmosphere. The snow emitted nitrogen oxide (NOx) have significant impacts on the oxidizing capacity in the troposphere by altering concentration of ozone, a pollutant and greenhouse gas, and of the hydroxyl radical (OH), which is responsible for the removal of many atmospheric pollutants. The changes of atmospheric ozone in turn can influence the regional energy balance and climate, where as OH controls the build up other green house gases.

A quantitative description of the emission of NOx by snow stills suffers from limited knowledge of snow physical properties and understanding of the nature and location of reactive molecules in snow. An updated numerical air-snow model for NOx emission, by improving the parameterization of 1) actinic flux profile within the snowpack and 2) the physical exchange between snow grain and snowpack interstitial air, will be presented.

Session 3: Water – Circulation

Session chair: Michelle McCrystall and Hoi Ga Chan

The seasonal distribution of freshwater from meteoric sources and sea ice melt in Svalbard fjords

Drysdale, Lewis[1]; Meredith, Michael[1]; Cottier, Finlo[2]; Abrahamsen, Povl[1]; Inall, Mark[2]; Jenkins, Adrian[1]

[1] British Antarctic Survey
[2] Scottish Association for Marine Science

Accelerated retreat of glaciers in regions of the Arctic, such as Svalbard, causes the release of excess freshwater to coastal estuaries. This freshwater has a stratifying effect on the water column, thus influencing processes such as shelf exchange, heat delivery to the surface, and biological productivity. The freshwater budgets of high latitude fjord systems, however, are poorly understood, with multiple sources (including also sea ice melt and direct precipitation) contributing. The use of stable isotopes of oxygen as a water mass tracer, when measured alongside salinity, is a powerful technique for quantitatively decomposing the freshwater budget. We present a new record of glacial melt and sea-ice melt distributions during late summer and early spring from three different fjords around Svalbard using full depth profiles of oxygen isotopes. We find that glacial meltwater is widespread in the western fjords where there has been a strong influence of Atlantic water, while sea ice melt was the dominant source of freshwater to the north of the archipelago. These results are examined in the context of a simple model of the region, which is used to determine the circulation and stratification response under changing freshwater forcing conditions.

Sources and fate of freshwater in the ocean west of the Antarctic Peninsula

Regan, Heather[1,2]; Holland, Paul[1]; Meredith, Michael[1]; Pike, Jennifer[2]

[1] British Antarctic Survey
[2] Cardiff University

The Antarctic Peninsula is warming more rapidly than any other location in the Southern Hemisphere, with air temperatures increasing by nearly 3 degrees Celsius since 1950. The consequences of this, such as ocean warming and ice loss, are still not fully understood. While atmospheric warming is thought to be a driver, the rise is not sufficient to have caused the observed speeds of glacial retreat on the Peninsula, providing evidence that ocean forcing in the nearby Bellingshausen Sea is contributing to the loss of glacial ice. Salinity is the dominant control on density near the freezing point of sea water, hence freshwater plays a key role in the dynamics of the Bellingshausen Sea. However, the different components of the freshwater balance - glacial ice, sea ice, and precipitation - are affected by warming in complex ways. Oxygen isotope data exists from which information on the freshwater balance can be obtained, both in a contemporary context (from research cruises and time series sites) and on longer timescales from sediment records. However, interpretation is made difficult by the general sparsity of such data.

To better understand the freshwater balance of the Bellingshausen Sea, a high-resolution model of the region has been developed, using MITgcm to represent ocean, sea ice, and ice shelves. Experiments have been conducted that track the advection, mixing and fate of freshwater from different sources, and demonstrate the differing spatial and temporal scales of their impacts on ocean structure. Results will be used to investigate the causes and consequences of warming and freshwater change west of the Antarctic Peninsula.

3-D Export Pathways from the Southern Ocean

Karczewska, Ewa[1,2]; Haynes, Peter[1]; Meijers, Andrew[2]; Shuckburgh, Emily[2];
Jones, Dan[2]; Sallee, Jean-Baptiste[2,3]

[1] University of Cambridge
[2]British Antarctic Survey
[3]L'Ocean

The Southern Ocean has been identified as an important region for the sequestration of heat, carbon dioxide and other tracers and, more generally, for communication between the atmosphere and the subsurface ocean. This communication is accomplished through the subduction and upwelling of different water masses such as circumpolar deep water, mode water and intermediate water. This circulation is understood in a circumpolarly averaged sense, but the detailed three dimensional pathways of these different water masses remains poorly known.

In the study reported here we map out and quantify transport through a Lagrangian approach in which large ensembles of particles (typically 105-106) are advected over periods of 10-20 years using offline 3-D velocity fields. The latter are taken either from the Southern Ocean State Estimate (SOSE) or from 20+ year integrations of the MITGCM, at 5-day time resolution and at 1/6 degree spatial resolution.

We first consider possible definitions of the Antarctic Circumpolar Current (ACC) northern boundary including Lagrangian-based definitions. We then use these definitions to consider 'permanent' transport of particles between the ACC and the subtropical gyres. We show that this transport occurs in localised regions and investigate the dependence of these regions on the vertical level of particle release. We compare these results with the total transport, i.e. including transport which does not result in the particles staying in the subtropical gyres, and use this comparison to identify regions of 'efficient' transport from the ACC northwards and examine the upstream pathways within the ACC that lead to such export.

Making a Gyre, the Southern Ocean way

Patmore, Ryan[1]; Holland, Paul[1]; Meredith, Mike[1]; Naviera Garabato, Alberto[2]; Stevens, David[3]

[1] British Antarctic Survey;
[2] National Oceanography Centre, Southampton;
[3] University of East Anglia

Sverdrup theory is a simple and well established concept based on the dynamics of the North Atlantic Gyre. It is based on the key interplay between curl in wind stress and western boundary currents formed by the existence of the Coriolis force. The Southern Ocean is home to large scale circulations akin to the North Atlantic Gyre, one such circulation is the Ross Gyre located in the Ross Sea. The North Atlantic Gyre is dependent on the western boundary created by the east coast of North America whereas in the Ross Sea there is no apparent significant landmass that can enable this kind of dynamics. Thus, there must be an alternative mechanism. Through the use of idealised modelling, we can show that the system in not actually too dissimilar from the North Atlantic Gyre in that it is still just a balance of topography and wind curl. We have explored this scenario using an idealised channel model with varying ridge topography and a westerly wind coherent with reality. We demonstrate that the presence of the ridge perturbs the flow from purely zonal to a flow that is representative of reality as we converge the real ridge height. It has been found that the large topographic submarine ridge called the Pacific-Antarctic ridge that lies north-west of the Ross Sea is what permits the dynamics giving rise to the Ross Gyre. The Ross Gyre could be a crucial component in Antarctic bottom water formation, sea ice transports and the melting of the ice on the western side of the Antarctic Peninsular and it is important that we gain an understanding of its workings.

Has Antarctic ice loss altered the circulation of the Southern Ocean?

Mackie, Erik[1,2]; Bingham, Rory[1]; Holland, Paul[2]; Bamber, Jonathan[1]; Meredith, Michael[2]

[1] *University of Bristol*
[2] *British Antarctic Survey*

The Southern Ocean plays a key role in the carbon cycle and the global climate system, but despite its importance there remain many uncertainties about this remote and inhospitable ocean. Research has shown that the rate of ice loss from Antarctica has increased dramatically over the past 20 years, but there is currently limited knowledge about the impact of this rapid change in freshwater input on the circulation of the Southern Ocean. It is recognised that ocean dynamics can enhance ice sheet melting so potentially any change in circulation could lead to further ocean-induced melting. Using remotely sensed data from satellite altimetry and gravity missions such as GRACE and GOCE, combined with in-situ observations, this research project aims to create a detailed mapping of the Southern Ocean's changing circulation over the last 20 years. Once this has been completed, the next stage of the project will then be to interpret any changes in circulation in relation to observed changes in the freshwater input from Antarctica.

Session 4: Water – Palaeo

Session Chair: Ashleigh Massam

First high-resolution record of Late Quaternary environmental changes in the Amundsen Sea, West Antarctica, revealed by multi-proxy analysis of drift sediments

Horrocks, Jennifer*[1,2].; Ó Cofaigh, Colm[1].; Lloyd, Jerry[1]. ; Hillenbrand, Claus-Dieter[2].; Kuhn, Gerhard[3].; Smith, James. A.[2].; Ehrmann, Werner[4].; Esper, Oliver[4].

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The Amundsen Sea sector of the West Antarctic Ice Sheet (WAIS) is experiencing rapid mass loss, and there is a pressing need to place the contemporary ice-sheet changes into a longer term context. The continental rise in this region is characterised by large sediment mounds that are shaped by westward flowing bottom currents and that resemble contouritic drifts existing offshore from the Antarctic Peninsula. Similar to the Antarctic Peninsula drifts, marine sediment cores from the poorly studied sediment mounds in the Amundsen Sea have the potential to provide reliable records of dynamical ice-sheet behaviour in West Antarctica and palaeoceanographic changes in the Southern Ocean during the Late Quaternary that can be reconstructed from their terrestrial, biogenic and authigenic components.

Here we use multi-proxy data from three sediment cores recovered from two of the Amundsen Sea mounds to present the first high-resolution study of environmental changes on this part of the West Antarctic continental margin over the glacial-interglacial cycles of the Late Quaternary. Age constraints for the records are derived from biostratigraphy, AMS 14C dates and lithostratigraphy. We present magnetic susceptibility, grain size and ice-rafted debris counts to comment on changes in terrigenous sediment supply in response to the advance and retreat of the WAIS across the Amundsen Sea shelf. Sortable silt data are used to reconstruct changes in bottom current speed and to identify episodes of current winnowing likely linked to Antarctic Bottom Water production. Total Organic Carbon, CaCO3 and biogenic opal are used to infer changes in biological productivity that are mainly controlled by the duration of annual sea-ice coverage.

The Southern Ocean in Motion: Deep water circulation over the last 800,000 years

Williams, Thomas[1,2]; Hillenbrand, Claus-Dieter[1]; Piotrowski, Alex[2]; Allen, Claire[1]; Smith, James[1]; Hodell, David[2]; Frederichs, Thomas[3]; Ehrmann, Werner[4]

[1] British Antarctic Survey
[2] University of Cambridge
[3] University of Breman
[4] University of Leipzig

Although paced by changes in the Earths orbit, the magnitude and temporal structure of glacial-interglacial cycles requires feedbacks within the climate system. Ice core data demonstrate the closely coupled relationship between temperature and greenhouse gases – particularly CO2 – over the last 800 thousand years, suggesting the carbon cycle is a key control on the Earths climate. My research examines the role of changes in past ocean circulation and mixing, alongside changes in the carbon budget of the deep ocean, play in glacial-interglacial cycles over the past 800 ka. In particular my research focuses on changes to the theromohaline circulation occurring across glacial-interglaical cycles in the Southern Ocean.

The Southern Ocean is a key region linking ice sheets, ocean circulation and the atmosphere, and acts as a locus for a variety of drivers of global climate. Changes in circulation and marine-atmosphere exchange in the Southern Ocean have been previously identified as playing an important role in past changes in the Earth's climate. Here I present unique new geochemical data from a previously under-sampled region of the Southern Ocean to (i) for the first time fully explore changes in the circulation history of the Antarctic Circumpolar Current over the last 800,000 years, (ii) constrain previous hypothesis for a Southern Ocean control on past climatic change, in particular changes affecting the global carbon cycle and glacial-interglacial shifts in atmospheric CO2.

Current Affairs: Variations in the ACC strength over glacial terminations

Roberts, Jenny[1,2],; McCave, Nick[1], ; Peck, Vicky[2], Kender, Sev[1], Hodell David[1]

[1] *Godwin Laboratory for Palaeoclimate Research, University of Cambridge*
[2] *British Antarctic Survey, High Cross, Cambridge*
[3] *British Geological Survey, Keyworth, Nottingham*

The Antarctic Circumpolar Current (ACC) is the world's largest current system. It plays a crucial role in Earth's climate system; regulating the exchange of nutrients between the world's major oceanic basins, and thermally isolating the Antarctic Ice Sheet. Whilst the flow of the ACC is fairly well monitored today, the information that we have about the strength of the ACC in the past is less well understood and often contradictory. In this study we show the first records of variations in ACC flow speed spanning the last two glacial cycles (150,000 years). We find that interglacials are characterised by current speeds in the north of the ACC up to 20% faster than during glacial times. We suggest that this provides strong evidence of a latitudinal shift in the position of the South Westerly Wind belt over glacial-interglacial timescales.

Session 5: Ice

Session chair: Michelle McCrystall

Application of ultra-high resolution trace-element analysis on glacial ice from Weddell Sea deep ice cores, West Antarctica.

Massam, Ashleigh[1,2]; Mulvaney, Robert[1]; Whitehouse, Pippa[2]; Lee, Geoff[3]; Tuckwell, Rebecca[1]; Sneed, Sharon[4]; Mayewski, Paul[4]

[1] *British Antarctic Survey*
[2] *Durham University*
[3] *UEA*
[4] *University of Maine; University of Maine*

Current standard laboratory practices offer a relatively coarse-resolution trace element analysis. Sub-annual profiles are principally reserved for the upper depths of ice cores where compaction due to vertical strain has not reduced the annual layer thickness to values smaller than the typical sampling resolution. After this threshold is reached, it is necessary to reconstruct climate profiles by applying glaciological modelling techniques.

Recent developments in direct trace-element analysis using laser ablation inductively-coupled plasma mass spectrometry (LA ICP-MS) confirm the viability of making ultra-high resolution measurements on ice cores. Alternatively, a second method capable of extracting a chemical profile at a higher resolution than standard laboratory techniques analyses discrete samples cut using a microtome at mm-resolution by ion chromatography. Sections of ice from deep ice cores drilled at Fletcher Promontory (FP) and Berkner Island (BI), Weddell Sea, have been analysed using these two methods and present a sub-annual profile of Antarctic climate during the last glacial period.

The high-resolution results are compared with annual layer thickness values estimated using a combination of modelling techniques. The outcomes of this study are: (i) confirmation of the potential of LA ICP-MS as a technique capable of sub-annual resolution on annual layers of thickness below the standard resolution; (ii) an assessment of annual layer thickness modelling techniques by comparison with observed data; (iii) the construction of a more robust age-depth profile for deep ice core; and (iv) an improved understanding of the relationship between surface temperature and the amplitude of accumulation change during the last glacial cycle. The impact of this research significantly improves chronological reconstructions of ice cores which currently rely on untested glaciological modelling.

Modelling ice sheet collapse and sea ice retreat during the last interglacial peak

Holloway, Max[1,2]; Sime, Louise[1]; Singarayer, Joy[3]; Tindall, Julia[4]; Bunch, Pete[5]; Valdes, Paul[2]

[1]*Ice Dynamics and Paleoclimate, British Antarctic Survey, Cambridge, UK*
[2] *School of Geographical Sciences, University of Bristol, Bristol, UK*
[3] *Department of Meteorology, University of Reading, Reading, UK*
[4] *School of Earth and Environment, University of Leeds, Leeds, UK*
[5] *Department of Engineering, University of Cambridge, Cambridge, UK*

Ice sheet and sea ice changes can exert major control over spatial water isotope variations in Antarctic surface snow. During the last interglacial (LIG; 130,000 to 115,000 years ago) global climate was warmer than today and global mean sea level was 6-9 m higher. Recent NEEM Greenland ice core results imply that Greenland likely provided a modest 2m contribution towards this global sea level rise. This implies that a significant contribution from the West Antarctic Ice Sheet (WAIS) is necessary to explain the LIG sea level maxima. However, the timing of the sea level maxima during the LIG is poorly constrained. The maximum in Antarctic ice core isotopic records during the LIG, around 128,000 years ago (128 ka), is associated with peak Antarctic temperatures and has thus been proposed as the most likely timing for a collapse of the WAIS. Here we model the isotopic response to differing WAIS collapse scenarios, freshwater hosing, and sea ice configurations using a fully coupled General Circulation Model (GCM). We present results from a multi-ice core data-model comparison to resolve the LIG isotope maximum.

Reconstructing the glacial history of the South Orkney Islands, NE Antarctic Peninsula

Dickens, W.A.[1,3]; Graham, A.G.C.[2]; Smith, J.A.[1]; Dowdeswell, J.A.[3]

[1] *British Antarctic Survey*
[2] *University of Exeter*
[3] *Scott Polar Research Institute*

Advances in the coverage and quality of marine geophysical and geological data have led to significant improvements in our understanding of ice dynamics during former glacial periods across the Antarctic Peninsula (AP) and sub-Antarctic. Despite these advances, very little is known about the history or past behaviour of ice caps that once dominated the South Orkney Islands (SOI), northeast of the AP. Here we present new analyses of geophysical and geological data collected on cruise JR244 of the RRS James Clark Ross to the South Orkney continental shelf in 2011.

A gridded compilation of new and existing echo-sounding (multibeam and singlebeam) data depicts the regional bathymetry of the SOI in greater detail than was previously possible. From the new dataset, broad-scale ice drainage patterns during former glacial periods are revealed. The new bathymetry indicates that the continental shelf is dominated by at least seven glacially eroded troughs and a large, c.250km long glacial depocentre suggests that ice was only ever grounded to the c.300 m contour in the South and did not extend beyond.

Alongside regional constraints on palaeo-ice cap extent, we also present results from the detailed mapping of glacial bedforms from a number of trough and inter-trough areas. On the northern shelf, glacial lineations indicate the presence of fast flowing ice; this may have been enhanced by high volumes of basal meltwater, as inferred from the presence of bedrock eroded by subglacial meltwater. In contrast, the southern continental shelf shows little evidence of fast ice flow or meltwater activity, but an abundance of deglacial moraines indicates that ice retreat occurred progressively, with varying retreat rates and dynamics. These contrasts are discussed together with ongoing sediment core analyses which aim to test inferred rates of deglaciation and constrain the timing of ice cap retreat following the Last Glacial Maximum.

Investigating the Flow Dynamics at Ice Shelf Calving Fronts

Martin Wearing[1,2]; Richard Hindmarsh[1]; M. Grae Worster[2]

[1] British Antarctic Survey
[2]University of Cambridge

Ice-shelf calving-rates and the buttressing ice shelves provide to grounded ice are both difficult to model and quantify. An increased understanding of the mechanics of this process is imperative in determining the dynamics of marine ice sheets and consequently predicting their future extent, thickness and discharge.

Alley et al. (2008) proposed an empirically derived calving law, relating the calving rate to the strain rate at the calving front. However, Hindmarsh (2012) showed that a similar relationship could be deduced by considering the viscous flow of the ice shelf. We investigate the relationship between the ice shelf flow field and the strain rate field in the area close to the calving front.

Analysis is undertaken of ice surface velocity data for a range of Antarctic ice shelves (data from Rignot et al., 2011) and an inferred strain rate field produced from that data. These geophysical results are compared with a simple mathematical model for laterally confined ice shelf flow. Good agreement is observed between the expected theoretical scaling and geophysical data for the flow of ice near the calving front in the case of laterally confined ice shelves.

Session 6: Water - Nutrients

Session Chair: Hoi Ga Chan

Silicate, sea ice, and shelf mixing: Relative controls on dissolved barium distributions at the WAP.

Pyle, Kimberley[1]; Hendry, Kate[2]; Meredith, Mike[3]; Sherrell, Rob[4]; Hall, Ian[1];

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[3] British Antarctic Survey,
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Barium cycling in the ocean is associated with a number of processes, inlcuding biological cycling, freshwater fluxes, and alkalinity. As a result, the biogeochemical cycle of barium offers interesting insights into past and present oceanic conditions. Barium is currently utilised in various forms as a palaeoproxy for components of organic and inorganic carbon storage, and as a conservative water mass tracer in some polar regions of the modern ocean. However, the nature of the oceanic barium cycle is not fully understood, particularly in cases where multiple processes may be interacting simulatneously with the dissolved and particulate barium pools. This is particularly the case in coastal polar regions such as the West Antarctic Peninsula, where biological drawdown occurs in tandem with sea ice formation and melting, glacial meltwater input, and potential fluxes from shelf sediments. The relative control of these various coastal processes on the barium cycle can be investigated using spatial and temporal datasets of dissolved barium from the Palmer LTER Grid and the Rothera Times Series. These datasets suggest that whilst surface barium distributions are strongly linked to silicate cycling, changes in the coastal freshwater regime also exert a significant secondary control. Increased levels of sea ice melt are assocaited with anomalously low dissolved barium concentrations, potentially due to non-conservative biotic or abiotic processes removing barium from solution within the sea ice environment. Meteoric water input, conversely, exerts little or no control on local barium levels, indicating that glacial melt is not a coastal source of barium to the region. These regional conclusions are considered in conjunction with a larger dataset of dissolved barium measurements from the Drake Passage and the Scotia Sea.

The use of individual planktonic foraminifera from sediment traps to assess seasonal variability along the West Antarctic Peninsula

Mikis, Anna[1]; Peck, Vicky[2]; Meredith, Mike[2]; Ducklow, Hugh[3]; Pike, Jenny[1]; Hendry, Kate[4]

[1] Cardiff University,
[2] BAS
[3] Lamont-Doherty Earth Observatory
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Planktonic foraminifera play an important role in the marine carbon cycle and their fossil record is widely used to interpret past changes in climate. Planktonic foraminifera abundance and flux vary spatially and temporally, the latter varying from one month up to seasonal and even interannual scales. Intra-annual variability follows the seasonal cycle of environmental changes, thereby potentially altering the proxy signal provided by fossil planktonic foraminifera in climate records. Seasonality in living foraminifera is recorded in the timing of the peak flux of the organisms and the amplitude of the seasonal cycle, both of which can potentially alter the proxy record. Due to the limited availability of foraminifera-bearing sediments in the high latitudes, only a few number of seasonality studies have been conducted in the Southern Ocean.

The aim of this study is to complete a unique investigation of seasonal ocean variability along the West Antarctic Peninsula (WAP), in particular, to assess the variations in the input of glacial meltwater along the WAP and their effect on the stable isotope composition of foraminiferal calcite. To achieve this, foraminifera specimens were collected from monthly sediment trap samples from PAL-LTER station. The time-series sediment trap has been deployed 130 km offshore in the mid-shelf region of the WAP since 1992. Samples are measured for total dry weight, particulate organic carbon, particulate nitrogen and particulate phosphate after collection. In this study sediment trap samples collected between 2006 and 2013 are assessed for planktonic foraminifera flux. Foraminifera specimens are counted and stable isotope analyses of individual specimens is going to be carried out in samples with a minimum of 30 specimens. A morphometric study is also carried out to assess intra- and inter-annual patterns in size distribution due to environmental changes. Preliminary analyses show intra-annual variations consistent with temporal pattern of organic carbon and organic nitrogen. Main peak flux is observed in the late-spring to early summer, following sea-ice retreat. Results will be compared to a number of different proxies to help constrain future studies of past meltwater flux.

The role of particle associated microbes in remineralisation of faecal pellets in the upper mesopelagic of the Scotia Sea, Antarctica

Belcher, Anna[1]; Iversen, Morten[2]; Manno, Clara[3]; Henson, Stephanie[1]; Tarling, Geraint[3]; Sanders, Richard[1]

[1] National Oceanography Centre
[2] Alfred Wegener Institute for Polar and Marine Research, and MARUM
[3] British Antarctic Survey

Faecal pellets (FP) are a key component of the biological carbon pump, as they can efficiently transfer carbon to depth. Like other forms of particulate organic carbon (POC), they can be remineralised in the ocean interior (particularly in the upper 200 m) or alternatively, they can be sequestered to the sediments. However, the controls on the attenuation of FP flux with depth are not fully understood, in particular, the relative contributions of zooplankton and microbes to FP remineralisation. Collection of sinking particles using Marine Snow Catchers at three ecologically contrasting sites in the Scotia Sea, Antarctica, revealed large differences in POC flux composition (5-96% FP) and attenuation despite similar temperatures. To determine the importance of microbial respiration on the attenuation of FP flux in the upper mesopelagic, we carried out the first measurements of small scale oxygen gradients through the boundary layer at the interface of krill FP collected from the Scotia Sea. Estimated carbon-specific respiration rates of microbes within FP (0.009 and 0.065 d-1) were too low to account for the observed large decreases in FP flux over the upper 200 m. Therefore, the observed rapid declines in downward FP flux in the upper mesopelagic are more likely to be caused by zooplankton, through coprophagy, coprorhexy, and coprochaly. Microbial respiration is likely to be more important in regions of higher temperatures, and at times of the year, or in depths of the ocean, where zooplankton abundances are low and therefore grazing and fragmentation processes are reduced.

Session 7: Water - Biology

Session chair: Jenny Roberts

Seashell formation: a molecular approach using damage-repair experiments

Sleight, Victoria; Thorne, Michael; Peck, Lloyd; Clark, Melody

British Antarctic Survey

From the ancient nautilus to the humble clam, thousands of mollusc species share a common feature – a shell. Molluscs construct their characteristic shell in a process termed biomineralisation; minerals are transported across the mantle (shell secreting organ) and laid down as organised crystals onto an organic matrix. How molluscs control and co-ordinate the shell-building process, at a molecular level, remains unclear. This talk will discuss damage-repair experiments used to study biomineralisation in two different bivalves: the Antarctic clam Laternula elliptica and the blunt-gaper clam Mya truncata. The tools used to understand molecular mechanisms, and what such methods tell us about shell production, will be explained.

Acclimation to ocean acidification – it's not all doom and gloom for brachiopods!

Cross, Emma[1,2]; Peck, Lloyd[2]; Harper, Elizabeth[1]

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Since the industrial revolution, there has been a dramatic increase in atmospheric CO2 due to human activities, mainly through burning fossil fuels. The oceans have absorbed about a third of this excess CO2 which has caused changes in the chemistry of the surface seawater. This has resulted in an increase in ocean acidity and a decrease in pH by 0.1 units, which is predicted to fall a further 0.3-0.5 pH units by the end of the century. Ocean acidification also reduces the availability of carbonate ions which animals use to build shells and skeletons, indicating the vulnerability of these marine organisms to this aspect of climate change. Brachiopods are probably the most calcium carbonate dependent organisms due to >90% of their dry mass residing in their shell and other support structures. Despite this, long-term experiments simulating predicted environmental conditions by 2100 have shown no impact on the shell characteristics of potentially the most vulnerable species, the Antarctic brachiopod and also in a common temperate New Zealand brachiopod. Museum collections of this New Zealand brachiopod collected from the same sampling site every decade since 1900 to the present day also indicate no variation in shell characteristics. Therefore, the ability of these species to continue shell production and maintenance suggests that brachiopods can acclimate to forecasted conditions. Comparable long term studies are crucial to increase our knowledge of the capability of these integral organisms to succeed in our changing world.

Poster session

The seasonal cycle of ocean-atmosphere CO2 flux in Ryder Bay, West Antarctic Peninsula

Legge, Ollie[1]; Bakker, Dorothee[1]; Johnson, Martin[1]; Meredith, Mike[2]; Venables, Hugh[2]; Brown, Pete[3]; Lee, Gareth[2]

[1] University of East Anglia
[2] British Antarctic Survey
[3] National Oceanography Centre

Approximately 15 million km2 of the Southern Ocean is seasonally ice covered, yet the processes affecting carbon cycling and gas exchange in this climatically important region remain inadequately understood. Here, 3 years of dissolved inorganic carbon (DIC) measurements and carbon dioxide (CO2) fluxes from Ryder Bay on the west Antarctic Peninsula (WAP) are presented. During spring and summer, primary production in the surface ocean promotes atmospheric CO2 uptake. In winter, higher DIC, caused by net heterotrophy and vertical mixing with Circumpolar Deep Water, results in outgassing of CO2 from the ocean. Ryder Bay is found to be a net sink of atmospheric CO2 of 0.90–1.39 mol Cm−2 yr−1 (average of 3 years). Seasonal sea ice cover modifies the net annual CO2 uptake, but its effect on gas exchange remains poorly constrained. A reduction in sea ice on the WAP shelf may reduce the strength of the oceanic
CO2 sink in this region.

Soil fungal responses to warming in polar regions

Marta Misiak[1,2]; Dr KK Newsham[1]; Prof L Boddy[2]; Prof P Convey[1]

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[2]Cardiff School of Biosciences, Cardiff University

Temperature increases in polar regions are already having effects on ecosystems, but still little is known of how warming might affect polar soil fungi. Filamentous fungi are abundant in Arctic regions and are key components of Arctic soils. They are pivotal to many ecosystem processes, notably nutrient cycling. It is not known how climate warming will affect fungal community composition and activity, or nutrient cycling and soil organic carbon storage in cold environments. A soil warming experiment was set up in autumn 2014 at Kvadehuken, Brøggerhalvøya Peninsula, Svalbard to address the effect of experimental warming on soil

fungi. Open top chambers are used to warm soil, along water added to mimic changes likely to occur in the ecosystem in the future. Soil samples were gathered at time zero of the experiment, prior to any treatment application, and will continue to be gathered on a yearly basis to follow soil fungal community changes over time. Both, molecular and conventional microbiological techniques, are used in this study to analyse the fungal community and its response to warming. Fungi are identified by the PCR amplification of genes encoding the ITS region and by genetic fingerprinting using denaturing gel electrophoresis. Microbiological techniques are used for soil fungi isolation and culturing, to investigate of how growth rates, activity and extracellular enzyme production of different fungi present in Arctic soils are affected by altered temperature and matric water potential in controlled laboratory experiments. The study represents a significant step forward in understanding the effects of warming in Arctic ecosystems on soil fungi. Efforts will be made to answer the following research questions: what effect does warming have on soil fungal community structure? Are the growth rates of soil fungi affected by warming? Are the enzyme activities of fungi present in Arctic soil affected by warming?

Seismic Imaging of Circumpolar Deep Water Exchange across the Antarctic Peninsula Shelf Break

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The western Antarctic Peninsula is an area of recent extreme atmospheric warming. In the adjacent ocean, there is particular interest in on-shelf movement of Circumpolar Deep Water as a possible link to changing climate by affecting ice shelf processes. Here, we investigate on-shelf intrusions using two-dimensional seismic imaging of the water column which has vertical and horizontal resolutions of ~10 m. 8 seismic profiles were acquired in February 2015 using the RRS James Clark Ross. These profiles traverse the shelf break and cross two bathymetric features, the Marguerite and Biscoe troughs, which may play a role in water exchange processes. Seismic data were acquired using two Generator-Injector air guns fired every 10 s with a pressure of 2000 psi. Reflections were recorded on a 2.4 km streamer of 192 receivers spaced every 12.5 m. Observed reflections in the processed records are caused by rapid changes of temperature (~ 80%) and salinity (~ 20%), delineating water masses of different properties. 13 XCTDs and XBTs plus a 38 kHz echo-sounder profile were simultaneously acquired along seismic profiles and used for calibration. Preliminary results show the top of the Winter Water layer as a bright reflection at 50-120 m depth across the entire survey, corresponding to temperatures ≤ -1°C. Curved, discontinuous, eddy-like reflections, also seen on echo-sounder profiles, are attributed to

modified Upper Circumpolar Deep Water with temperatures ≥ 1.34°C. A warm core eddy, 11 km long and 220 m high, is visible ~2 km inland of the shelf break. Pure Upper Circumpolar Deep Water of temperatures ≥ 1.80°C is aligned with weak but discernible, lens-shaped reflections. Eddy-like structures and the overall reflective morphology yield useful insights into shelf exchange processes, suggestive of three potential mechanisms: (i) topography controlled flow; (ii) an `ice-pump` mechanism; and (iii) mesoscale eddies.

Deep-keeled iceberg ploughmarks in Pine Island Bay, West Antarctica, and their implications for past ice dynamics.

Wise, Matthew G.[1,2]; Dowdeswell, Julian A.[1]; Larter, Robert D.[2]

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High-resolution multi-beam swath bathymetry of the mid-shelf region of Pine Island Trough and the adjacent banks reveal an abundance of linear-curvilinear depressions. These features, interpreted as relict iceberg ploughmarks, indicate the importance and ubiquity of iceberg ploughing within the late Quaternary marine-geomorphic record of Pine Island Trough since ice retreat from the outer- and mid-Pine Island Bay shelf before ~12.3 k cal. a B.P. Observed over a contemporary water depth range of 506 m to 848 m, analysis of ploughmark width, incision depth and cross-sectional shape indicates an absence of bathymetric and water-depth control, suggesting little variance in glacial ice dynamics over the period of ploughmark formation. This has maintained the iceberg population morphology during deglaciation, despite changes in relative sea-level and glacial thickness. Relatively small ploughmark dimensions, a dominant v-shaped cross-sectional shape, and, a lack of parallelism between adjacent features, does not support the grounding and ploughing of large tabular icebergs. A population of smaller, deep-keeled, more irregular pinnacle-shaped icebergs is instead preferred, formed from the fragmentation of larger icebergs, and, from direct production at the calving margin. Based on a high stand relative sea-level, at most, 20 m above present ~12 k cal. a B.P., iceberg keel-depths on average 160 m above those of the modern Pine Island Glacier are indicated. These icebergs calved from a fast-flowing ice-stream, similar to the modern Pine Island Glacier, given the topographically unconstrained layout of Pine Island Bay. Preferred north-northeast directional orientations of 650 ploughmarks indicate seaward iceberg drift out of Pine Island Bay, analogous to the observed drift path of iceberg B-31, meaning that icebergs likely calved from the palaeo-Pine Island-Thwaites ice stream. Variable reversible orientations and ice-core proxy analysis, suggest an open ocean environment, free of sea-ice, ice mélange or an iceberg armada at the time of iceberg ploughmark formation.

A ‘strange event’: unexplained signals recorded in a Pleistocene Antarctic ice core

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Mani (2010) identified an interesting and unexplained phenomenon in an ice core record from Berkner Island, Antarctica, that followed two significant Antarctic Isotope Maxima (AIM) events (8 and 12). Between approximately 48 and 35 ka nitrogen gas isotope measurements (δ15N) from entrapped air bubbles covaried with the hydrogen water isotopic record (δD) from the ice, suggesting a locally temperature-controlled δ15N. However, the possibility that this signal reflects only temperature is undermined by a large positive excursion (the ‘Strange Event’ (Mani, 2010)) beginning at approximately 35 ka and not returning to ambient for almost 10 ka; a similar excursion is not seen in the coeval δD record. δ15N is controlled by both temperature-dependent and gravitational fractionations, although the gravitational component can be quantified using the isotopic fractionation of argon isotopes (δ40Ar), which responds primarily to gravity. Once the gravitational component is quantified it can be subtracted from the δ15N signal to reveal the temperature difference between the top and base of the diffusive column. A firn densification and heat diffusion model can then convert this to surface temperature change. However, Mani’s (2010) δ40Ar measurements were inconclusive and so he corrected for gravitational fractionation using only a firn densification model, which may be less informative. One possible cause of the Strange Event is a large increase in the local ice accumulation rate which would have increased the diffusive column height, and thus gravitational fractionation. The observed δ15N-δD divergence certainly suggests some additional fractionation mechanism besides temperature. Future work will attempt dual measurements of δ15N and δ40Ar from the same core and across the same events which will quantify both temperature-dependent and gravitational fractionations. Here, however, we present initial high-resolution ion chromatography measurements of the ice to establish seasonality, constrain ice accumulation rates, and thus explore the origins of the Strange Event.

Liverwort-fungal symbiosis in really cold places.

Foot, George[1,2]; Newsham, Kevin[1]; Goodall-Copestake, Will[1]; Convey, Pete[1]; Griffiths, Howard[2]

[1] *British Antarctic Survey*
[2] *University of Cambridge*

Symbioses between plants and fungi are ubiquitous and play key roles in terrestrial ecosystems. Plants provide the fungi with carbon and in return fungi provide their host plants with limiting nutrients such as nitrogen and phosphorus. These associations, often referred to as mycorrhiza, have been hypothesised as a key innovation that helped facilitate the colonisation of Earth by land plants. However, we still know very little about fungal symbioses in one of the most ancient groups of land plants – the liverworts – and even less still about liverwort-fungal associations in polar regions. This study provides the first large-scale survey of fungal colonisation of Antarctic liverworts, increasing our knowledge of these symbioses in the region from three to 34 liverwort species. Fungal DNA present in the 12 most frequent liverwort species was also sequenced to establish the identities of the mycobionts present. Furthermore, the relative abundance of δ15/14N isotopes were analysed for the first time in polar liverworts to explore whether the fungal species present, and their frequencies of colonisation, are associated with liverwort N nutrition. Of the 34 liverwort species surveyed, fungal colonisation was prevalent, with Sebacina being one of the most abundant fungal taxa. It was shown that dark septate endophyte coils, blue staining coils and rhizoid colonisation all correlated positively with plant N content, suggesting that fungi provide nutrients to their liverwort hosts. This supports previous assertions that liverwort-fungal associations are symbiotic in nature.

Why do SNP assays fail? Insights from the Antarctic fur seal genome

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Single nucleotide polymorphisms (SNPs) are the most abundant form of genetic variation in the genome and provide many benefits over traditional genetic markers such as microsatellites, given their ease of use and low error rates. SNPs are being used to address

questions across a broad range of ecological fields including population structure, demographic history, behaviour and conservation. SNP-chips are an array-based platform offering a powerful and flexible approach for genotyping thousands of known SNPs in wild populations, however they often experience high failure rates, which is undesirable both from a financial perspective and due to the loss of data.

Here, we explored the factors affecting SNP assay success rates in the Antarctic fur seal (Arctocephalus gazella) by generating a draft genome and exploring the genomic context of 144 previously genotyped SNPs. We show that probe sequence uniqueness and proximity to intron-exon boundaries strongly influence the propensity of a SNP to convert and demonstrate how filtering and predictive approaches can help to improve SNP genotyping outcomes.

We have incorporated these approaches into a SNP detection pipeline in order to successfully develop the first pinniped SNP-chip. Data generated from this resource, coupled with long-term data collected the Antarctic fur seals on Bird Island, will provide an unprecedented opportunity to increase the resolution available for studying inbreeding effects in the wild. By addressing such important questions with greater genetic resolution and by providing a novel and effective resource for researchers worldwide, this work represents a significant advance for pinniped genomics.

A mesh movement package for the finite element modelling of dynamically evolving ocean-ice interfaces beneath ice shelves

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[2] British Antarctic Survey

The West Antarctic Ice Sheet is drained to the ocean by a number of relatively fast-moving ice streams that terminate in floating ice shelves. Melting at the ice-ocean interface of the fastest moving glaciers is driven by the intrusion of warm circumpolar deep-water onto the continental shelf. When warm water accesses the grounding line of a glacier, it causes melting and results in a warm, buoyant meltwater plume that rises along the underside of the ice shelf, causing additional melting and refreezing along the way. Many modelling studies have been performed to analyse ocean-induced melting beneath ice shelves and how it is affected by ice geometry. We plan to extend this work by changing the modelled ice geometry in time as a result of melting and refreezing, explicitly capturing the feedbacks between evolving geometry and hydro- and thermodynamics. In this poster, we present the development of a mesh movement package, employing the FEniCS finite element software,

which will allow us to evolve the domain boundary while maintaining a high-quality mesh. We illustrate the strengths and weaknesses of several of the included mesh movement methods and demonstrate their application to some idealised sub-shelf domains.

In search of the last collapse of the West Antarctic Ice Sheet: Insights into Glacial Erosion and Transport Using a Multi-Proxy Provenance Toolbox

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The toolbox of isotope geochemistry offers a powerful way to the trace the provenance of marine detrital sediments. Applied back in time, and next to glaciated areas, this approach can furthermore help to unravel past ice dynamics, as demonstrated in case studies off Greenland and East Antarctica. However, little attention has so far been given to the West Antarctic realm.

The goal of my PhD work is to add constrains on the stability of the West Antarctic ice sheet during past warm periods throughout the Late Pleistocene. In order to understand modern ice drainage and sediment provenance, a first step is to analyse 45 well-characterised proximal and distal circum-West Antarctic core top sediments for their geochemical composition. Initial results have been obtained for terrigenous fine-grained (<63µm) sediment fractions (neodymium (Nd) isotopes) and individual ice-rafted hornblende and biotite grains (>150µm).

Following the composition of sediments along the path of paleo-ice drainage troughs on the shelf in the Amundsen Sea area, I find distinct near shore compositions, and mixed signatures on the shelf. More negative Nd values found in terrigenous sediment close to the Pine Island Glacier drainage might indicate a different subglacial geology from what is observed in the surrounding areas.

40Ar/39Ar ages of near-coastal ice-rafted biotites are rather homogenous in their provenance and match the thermochronological age of proximal outcrops. Typical ages range from 75 to 125 Ma. More distal samples, in contrast, are characterized by a variety of biotite ages, indicating mixture of IRD supplied by local and far-travelled icebergs

Future steps will include the analyses of other isotope systems in fine-grained and coarse

grained sediment phases, as well as downcore records on cores PS58-254 and PC493 from the Amundsen Sea to investigate the record of the past 800,000 years

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Measuring supraglacial debris thickness using ground-penetrating radar: a feasibility study on Lirung Glacier, Nepal

McCarthy, Michael[1,2]; Pritchard, Hamish[1]; Willis, Ian[2]

[1] British Antarctic Survey
[2] Scott Polar Research Institute

Supraglacial debris thickness is a key control on sub-debris melt rate, and an important input parameter for sub-debris melt models. Digging pits to measure debris thickness is time consuming, physically difficult, and impractical on a large scale. Taking a controlled approach, we test the feasibility of using ground-penetrating radar (GPR) to measure debris thickness on Lirung Glacier, Nepal. We find the ice surface can be interpreted confidently through debris 0.15 to 2 m thick, provided an appropriate centre frequency is used. Manual picks of the ice surface after processing show good agreement with pit measurements ($r^2 > 0.8$). Wave speed was found to vary from 0.07 to 0.14 m/ns during the survey period. We produce a probability density function (PDF) of debris thickness for the area studied and estimate water content variability. Depth penetration was poor throughout due to the high clay content of the debris. We recommend that GPR is a good method for surveying thick-debris areas, but that pits are better for thin debris (GPR is still physically difficult and requires lots of processing time). Correcting for topography can make interpretation easier if topography data is available at high spatial resolution. Our results highlight the existence of a relationship between debris thickness and surface slope.

Records of Antarctic seasonal variation preserved in bivalve shells across the Cretaceous/Paleogene mass extinction

Joanna Hall

University of Leeds

The Late Cretaceous to Early Paleogene of Antarctica has long been highlighted as a time of extreme seasonality on a scale unseen in modern temperate climates. This potential for heightened seasonal variability is often overlooked in interpretations of geochemical proxy records which may result in misleading paleoenvironment reconstructions.

Seymour Island's many species of thick-shelled bivalves serve as valuable high resolution multiproxy archives in the marine realm. Microanalysis of well-preserved original shell carbonate can be used to provide near-monthly paleoenvironmental data including proxies for temperature, water geochemistry and productivity during annual growing seasons.

Long-lived bivalves of the genus Lahillia and Cucullaea, found in the pre-extinction and recovery fauna across the Cretaceous-Paleogene boundary sequence have been examined to assess preservation for use as archives of seasonal climate information. High resolution stable isotope results show trends related to visible annual growth banding in the valve and tooth which allow reconstruction of age and growth history of individual specimens. Here we present the results of preservation studies and initial high resolution geochemical analyses and discuss subsequent potential for reconstruction of seasonal trends through the stratigraphic sequence on Seymour Island to yield new paleoecology data.

Post-seismic and post-glacial deformation of self-gravitating earth models

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[3] Department of Geosciences, Princeton University

The time-dependent response of the Earth to different forces is governed by its rheology. The nature of the response depends on the time scale of the process - for example, the Earth responds elastically on short time scales (e.g. seismic wave propagation). Viscoelastic behaviour is observed on intermediate time scales, for example, after an earthquake (post-seismic deformation) or after the melting of an ice sheet (post-glacial deformation).

We have developed a forward model of these viscoelastic processes in spherically symmetric earth models to calculate time-dependent displacements and gravity perturbations. We have also begun to consider the inverse problem - using displacements to attempt to calculate the earth structure. This has enabled us to calculate sensitivity kernels - how a change in model parameter (particularly rheology) would affect the calculated displacements.

Comparative effects of long-term hyperoxia on the survival of five Antarctic invertebrates

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I will present the results of long-term (100-300day) experiments testing the effect of hyperoxia on the survival of five different species of Antarctic invetebrates: Paraceradocus meirsii, Odontaster validus, Heterocucumis steineni, Cucumaria sp., and Sterechinus neumayeri

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Heating up the ocean: Effect of warming on recruitment and marine benthic community development in Antarctica

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Our understanding of community level responses of marine ecosystems is poor, even though species are rarely altered in isolation. Knowledge of how macro-organism communities will respond to change, in terms of establishment, survival, ecophysiological performance and interactions is crucial, in order to predict overall biodiversity and ecosystem level impacts. Studies incorporating this information are rare in marine environments. By using a novel heated settlement panel approach, we can access effects of warming on early community development.

The evolution and Ecology of Myctophidae

Jennifer J. Freer

University of Bristol

Lanternfish of the family Myctophidae inhabit depths to 1000m and are some of the most abundant fishes in the global oceans. They are central to ecological food webs and their diel migration plays a key role in oceanic nutrient cycling. However, as the deep pelagic remains the least explored of all marine environments, comparatively little is known about its biodiversity and how future environmental changes will affect the species occupying these depths. This PhD project aims to help close this gap.

With 252 species of lanternfish, myctophids are extraordinarily diverse. It has been hypothesised that mate recognition via species specific photophore patterns has aided their diversification. If this is the case, it can be expected that sympatric species will show evidence of photophore character displacement in order to facilitate the recognition of conspecifics. I aim to test this hypothesis by comparing photophore pattern divergence estimates between allopatric and sympatric species using comparative phylogenetic analyses.

Furthermore, I will use species distribution models to investigate how myctophids in the Southern Ocean will respond to projected environmental change. These results can then be used to quantify the change in the availability of suitable foraging habitat of their predators - King penguins and Southern elephant seals. Finally, I will explore the potential of environmental DNA as an effective tool to sample deep pelagic species, whereby the presence of a species can be detected from traces of DNA found in a sample of seawater.

Antarctic researchers in shorts & t-shirts: providing scientific support for a tropical marine protected area.

Oliver Hogg

British Antarctic Survey

Ascension Island is a young (~1my), tropical, mid-Atlantic island, administered as a UK Overseas Territory. There are small scale commercial and artisanal fisheries, and the region is under consideration for designation as a Marine Protected Area. Comparatively little is known about the marine biodiversity surrounding the island, most research conducted to date concerns the turtle and seabird populations and shallow water assemblages (from diving). This paucity of baseline scientific data from the marine environment is a major barrier to the effective management and conservation of the Island's marine resources. In October 2015 BAS scientists working in collaboration with international partners aboard RRS James Clark Ross targeted the region in an attempt to radically improve the state of marine biodiversity knowledge and understanding. Here I present our methodology for an integrated ecological and geophysical approach to habitat mapping as an effective tool to inform on marine spatial planning in the region. Given the challenges of working with almost no knowledge of the benthic marine environment, with little science time, and with political pressure for rapid policy implementation, we present habitat mapping as an effective solution to a complex management problem, with broad application not limited to one tropical island.

First year introductions

Hayley Allison
Jesamine Bartlett
David Buchanan
Harriet Clewlow
Tracey Dornan
Rebecca Frew
Tom Hudson
Amy King
Irene Malmierca
Christine McKenna
Emily Potter
Zoe Roseby
Felipe Lorenz Simoes
Rebecca Vignols