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ABSTRACTS

OF

ORAL PRESENTATIONS

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Abstracts are listed in order of the respective AFI round and project reference number.

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AFI7/05	Soil microbial biodiversity on Antarctic Peninsula	**Professor David Hopkins**[1], Dr Paul Dennis[1], Victoria Ord[2], Dr Kevin Newsham[3], Professor Stephen Rushton[2], Professor Tony O'Donnell[4]	[1]University of Stirling and Scottish Crop Research Institute [2]University of Newcastle upon Tyne [3]British Antarctic Survey [4]University of Western Australia
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PRESENT AND FUTURE STABILITY OF THE LARSEN C ICE SHELF (SOLIS) [AFI8/05]

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Many ice shelves on the Antarctic Peninsula have retreated in the light of ongoing climatic warming. The dramatic break-ups of the Larsen A and B ice shelves in 1995 and 2002 have seen particularly pronounced scientific and public interest. As climatic warming is progressing southwards on the Antarctic Peninsula, scientific focus has been shifting to the southern neighbour, the Larsen C ice shelf. This ice shelf is one of the largest in Antarctica and is buttressing a considerable number of outlet glaciers that evacuate large quantities of ice from the Antarctic interior. Identifying the role of internal and external control mechanisms in regulating the present stability of the Larsen C ice shelf is therefore a global research priority.

The fundamental hypothesis of the SOLIS (Stability Of Larsen Ice Shelf) project, funded by the UK Natural Environment Research Council, is that mechanically soft 'flow stripes' sandwiched between mechanically stiffer units of glacier ice represent a governing control on ice shelf stability. Satellite and structural glaciological observations suggest that the softer flow stripes critically control rates of rift propagation. Here we present initial geophysical results from the first field season of the SOLIS project as well as initial model studies and discuss the implications of these findings for ice shelf stability.

Anisotropic, multi-component seismic reflection and anisotropic ground-penetrating radar (GPR) surveys were conducted to determine the detailed structure of the ice shelf at two control sites within and on either side of an inferred softer flow stripe on the southern Larsen C ice shelf, and to elucidate the ice mechanical properties at these sites. These surveys focused on common-midpoint (CMP) and reflection measurements to determine density-depth and temperature-depth relationships, as well as on identifying preferred ice crystal alignments within and on either side of the softer flow stripe. These surveys were complemented by Common-Offset GPR surveys that reflect the anomalous englacial structure and mechanical properties of the flowstripe as compared to the glacier ice on either side of it.

The geophysical field measurements yielded essential information about the ice physical properties required for the modelling of crevassing and crevasse propagation. We identified regions of potential crevassing on Larsen C by using a two dimensional fracture criterion for propagation of sharp cracks introduced by Rist et al., previously applied to the Filchner-Ronne and the Larsen B Ice Shelves. The stress distribution across the Larsen C ice shelf is provided by a numerical ice shelf model developed by H. Sandhäger which also provides the possibility to investigate the weakening effect of the crevasse zones. As an additional source of ice shelf velocity and for model validation we gathered feature tracking ice shelf velocities close to the grounding line from Landsat and MODIS images.

The calculated stress intensity derived from both observed and modelled data of the ice shelf in its current state shows critical values along the grounding line but also indicates areas in the centre of the northern inlets and west of Francis Island as region of possible crevassing. These results are in good agreement with zones of crevasse formation derived by analysis of remote sensing data of various sources (Landsat, MODIS, Envisat SAR).

CHALLENGING THE PARADIGM FOR PLANT-MICROBIAL RESOURCE PARTITIONING IN ANTARCTIC ECOSYSTEMS [AFI8/08]

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Nitrogen is a primary driver of productivity in terrestrial polar ecosystems, however, our knowledge about the N cycle remains fragmented. Many polar soils have a substantial proportion of their soluble nitrogen in an organic form. Most N enters the soil as protein, which may be of either plant, animal or microbial origin. Consequently, following primary cleavage of proteins, soluble N will be present in soil solution as amino acids and small peptides. Traditionally, plant acquisition of N has been thought to be via mineral forms (NH_4^+ and NO_3^-) after microbial decomposition of organic N. Thus an ability to take up and utilise peptide and amino acid N may represent a method for plants to short-circuit the N-cycle. Higher plants such as *Deschampsia antarctica* are increasing in abundance in the maritime Antarctic. As temperatures increase, it is also likely that the rate of production of amino acids and peptides in soils is increasing. An ability to compete effectively with soil microbes for peptide and amino acid N may be providing higher plants with a valuable resource to facilitate their proliferation. Although L-enantiomeric forms predominate, peptides and amino acids are present in soil as both D- and L-enantiomers. D-amino acids are most-likely of bacterial origin and are generally considered to be unavailable to plants as a source of N.

We collected soils from contrasting sites on Signy Island in the S. Orkneys (60º 43' S, 45º 36' W). Principally, they were those from under *D. antarctica* swards, moss or very sparsely vegetated fellfield soils. We investigated uptake and mineralisation rates using isotopically-labelled amino acid and peptides. Microorganisms in all soils were able to take up and utilise alanine, and di- and tri-peptides of alanine in both D- and L-entantiomeric forms. Uptake was extremely rapid, but the rate of uptake and mineralisation was dependent upon both soil origin and peptide length, especially in relation to D-enantiomers. Similarly, we now have direct evidence of peptide uptake and utilisation by non-symbiotic higher plants, without prior hydrolysis or mineralisation by soil microbes. However, in this case the preference was for the L-amino acid whilst uptake of the D-peptide was minimal. Further work will determine whether plants are able to effectively compete with soil microbes for amino acid and peptide N, but it is very likely that amino acid and peptide N are of considerable importance to terrestrial N cycling in the maritime Antarctic. Our results are important as they suggest that competition for N occurs at a higher point in the N cycle than previously thought (in any ecosystem so far studied). It also suggests that we need to redraw the terrestrial N cycle to include these new plant uptake pathways.

ANTARCTIC DEEP WATER RATES OF EXPORT (ANDREX) [AFI8/14]

Loic Jullion[1], Alberto Naveira Garabato[1], Sheldon Bacon[1], Paul Morris[1], Richard Sanders[1],Mike Meredith[2], Dorothee Bakker[3], Marie-Jose Messias[3], Andrew Watson[3], Pete Brown[2,3], Chris Ballentine[4], Roisin Moriarty[4], Bill Jenkins[5], and Mario Hoppema[6]

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The ANDREX project seeks to quantify the Weddell gyre's role in global ocean circulation and biogeochemical cycling through the measurement of water mass, nutrient and carbon exchanges across the gyre's outer rim. The Weddell gyre can be thought of as an oval-shaped, clockwise current that occupies the southern rim of the South Atlantic and Southwest Indian oceans. It is believed to be a key region in the formation of Antarctic Bottom Water and the ventilation of the deep ocean, and to potentially host much sequestration of carbon into the abyss. The progress of the fieldwork stage of the project and initial analyses will be reviewed in this talk.

THE PRODUCTION OF OZONE-DEPLETING BROMOCARBON GASES IN NEAR-SHORE ANTARCTIC WATERS [AFI8/22]

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Bromocarbon trace gases such as bromoform ($CHBr_3$) and dibromomethane (CH_2Br_2) are known to be produced naturally in seawater. The sea-to-air flux of these compounds and subsequent photolysis releases reactive bromine which contributes to tropospheric ozone-depletion. Our previous work at the Rothera Time-Series (RaTS) site has shown that the seawater concentrations of $CHBr_3$ and CH_2Br_2 increase significantly during the summer microalgal bloom that occurs annually in Marguerite Bay. Calculations based on coupled seawater and air measurements have demonstrated that this increase drives high rates of sea-to-air bromine flux. As part of AFI8/22 we participated in the summer season 2008/2009 at Rothera to continue this time-series of bromocarbon measurements at the RaTS site, and resolve dominant production pathways. Here we present results which show that alongside recent changes in the ecosystem in Marguerite Bay and subsequent reduction in the magnitude of the annual microalgal bloom, we observed relatively lower seawater bromocarbon concentrations than had been measured during previous summers. Calculations based on these measurements suggest that ecosystem variability has resulted in reduced sea-to-air bromine flux. We also present results from incubation and microalgal isolation work aimed at identifying the organisms responsible for bromocarbon production at the RaTS site.

ISOLATING THE LARSEN-C ICE SHELF MASS INSTABILITY [AFI8/25]

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During the past decade, the Larsen Ice Shelf has progressively thinned and two large sections have collapsed, catastrophically, leading to increased ice discharge into the oceans and a global sea level rise of about 0.07 mm yr-1. If similar events are to occur at the remaining Larsen-C section, the fate of a tenfold greater ice reservoir hangs in the balance. Although the origin of the underlying instability has yet to be determined, only three processes can realistically be to blame; enhanced basal or surface melting, or accelerated flow.

To quantify rates of basal ice melting, we deployed a phase sensitive radar at the Larsen-C Ice Shelf in 2008. The radar is a high-precision instrument that directly measures changes in ice thickness at the base of the ice shelf, in contrast to indirect methods which infer basal melting from surface observation while assuming steady state equilibrium. During the spring 2008, we established three sites at the Larsen-C where time-series of satellite altimeter data are also available. In the spring 2009, the 3 sites are to be re-visited twice with the objective of measuring yearly and summer rates of basal melting. We combine the phase sensitive radar observations with measurement of surface mass balance, gps-determined strain rates, surface velocity field from InSAR and elevation chanes from altimetry to quantify the role of basal melting in the overall mass balance of the Larsen-C Ice Shelf.

SOIL MICROBIAL BIODIVERSITY ON ANTARCTIC PENINSULA [AFI7/05]

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This AFI project is now in the third and final year following two field seasons (2007/8 and 2008/9) and then an intensive period of laboratory analysis. The overall objectives for the research are to assess the diversity of the microbial communities in soils on a latitudinal gradient, to investigate the flow of carbon from plant materials and model compounds into and through the soil microbial communities, to determining the effect of experimental manipulations of temperature and liquid water content on the diversity and functioning of the soil microbial communities, and to developing models for investigating the dynamics of nutrient flow and energy flow in microbial communities. The emphasis of the presentation will be on the first and last of these objectives.

Soil microbial activities are of central importance to terrestrial ecosystem functioning (e.g. nutrient cycling or degradation of organic materials), but theoretical relationships between microbial diversity and function remain largely untested in all terrestrial ecosystems while in Antarctica the underlying data needed have not even been collected systematically. The (perceived) relative simplicity (i.e. the small biomass and low diversity) of Antarctic soil communities compared to those at lower latitudes provides an opportunity to advance knowledge of these relationships and their responses of the organisms to environmental (including climate) change. Soil samples have been collected from 70 sites between 53 and 74°S along the Antarctic peninsula and subject to a comprehensive set of soil physical, chemical and biological analyses including phenotypic analyses (e.g. biomass size and microbial lipid analysis), functional or activity measurements of ecosystem processes (e.g. respiration and nitrification) and genetic approaches (e.g. transcription restriction fragment length polymorphism and 454 pyrosequencing). These data have been used to explore the hypotheses that microbial diversity declines with increasing latitude, that microbial diversity is linked to the distribution of resources, and that microbial diversity is linked to rates of ecosystem processes. Alongside these analyses, a conceptual model of how environmental and resource drivers affect soil microbial community structure has been developed and tested using structural equation modeling.

OCEAN TIDES UNDER THE LARSEN C AND FILCHNER-RONNE ICE SHELVES: GPS COMPARISON WITH MODELS [AFI7/22]

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Abstract: The ocean tides under the Larsen C and Filchner-Ronne Ice Shelves are some of the least well observed on Earth. Data to assimilate into ocean tide models is sparse and often of low quality, and the accuracies of the models are likewise difficult to assess. Tide model errors alias into measurements of ice shelf elevation from satellite altimetry and ice mass change estimates from the Gravity Recovery and Climate Experiment (GRACE). To address this shortcoming, three geodetic-quality GPS receivers were deployed on Larsen C Ice Shelf and ten on Filchner-Ronne Ice Shelf during Nov. 2007. About half of these were left for the austral winter and retrieved during early 2009, with the others retrieved during Feb-March 2008. Three-dimensional coordinate time series are determined using a precise point positioning approach. The analysis of the data is split between the vertical component, dominated by tides, and the horizontal component which exhibits apparent tidal motion at all sites. We compare the observed ocean tides with those from a range of global ocean tide models and various regional ocean tide models including the circum-Antarctic CATS2008a. For the horizontal modulation of flow, we show that the type of signal seen is similar to that seen on Brunt Ice Shelf and on the grounded Rutford Ice Stream, with signal at 2 weeks and 182 days amongst others. These signals require a non-linear response to the tidal constituents. Using data from the Larsen C ice shelf, we examine three potential models for the tidal modulation: 1) tilting of the ice shelf; 2) tidal currents; and 3) non-linear forcing at the ice shelf grounding line. Forcing from tidal currents is shown to be too small to explain the signal, and we will discuss the results from the other models.

ARCHAEAN-PROTEROZOIC EVOLUTION IN DRONNING MAUD LAND, EAST ANTARCTICA AND ITS CONNECTION TO SOUTH AFRICA [AFI7/03]

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The Grunehogna Craton (GC), western Dronning Maud Land (East Antarctica) was part of the Archaean to Palaeoproterozoic Kalahari Craton of Southern Africa prior to the Jurassic breakup of Gondwana. The basement of the GC is almost entirely covered by ice and is only exposed within a small area (2x4 km^2) comprising the leucocratic Annandagstoppane granite crosscut by garnet-bearing pegmatite dykes. Less common are darker varieties of biotite granite, biotite-rich cumulate fragments and Jurassic (?) basalt dykes. The granite (and hence the craton) has been dated previously only by Rb-Sr and Pb-Pb mica and whole-rock methods in the 1970s to 1980s.

We sampled the granite in the 2007/08 field season and employed modern techniques for zircon separation, such as electric-pulse fragmentation, and in-situ dating techniques, namely laser-ablation ICP-MS and secondary-ion mass spectrometry. Zircon U-Pb data from both mass-spectrometric dating methods show excellent agreement, resulting in a crystallization age for the Annadagstoppane granite of 3,066 ±5 Ma. The granite also revealed various zircon crystals that were inherited from its country rock or from the source region of the magma. These grains fall into three age groups of ~3,435 Ma, ~3,280 Ma and 3,200 Ma.

The crystallization age determined here is in agreement with the results from the previous Rb-Sr and Pb-Pb studies and is coeval with the granites and rhyolites of the Dominion Group (Witwatersrand) in South Africa. In addition, the inherited grains are coeval with the tonalite-trondhjemite-granodiorite (TTG) intrusions in the South African Barberton region. Our geochronologic data, therefore, support the palaeogeographic reconstructions underlining that the GC was part of the Kalahari Craton throughout most of Earth's history.

The sedimentary cover of the GC is well exposed in a 250 km long mountain range at its eastern margin and consists of the Mesoproterozoic Ritscherflya Supergroup. It was deposited in a marine tidal environment at 1,100 ±30 Ma, exceeds 2,500 m in total thickness and is siliciclastic with volcanic intercalations. Detrital zircons in the clastic sediments are rounded due to sedimentary transport (100–400 µm in length) and show a large variety of internal zoning patterns. Results on their age distribution show the dominant peak at 1,110 to 1,160 Ma, i.e., close to the sedimentation age and contemporaneous with the arc magmatism of the Grenvillian orogeny of the adjacent metamorphic Maud belt, which bounds the GC to the East and South. Several older age peaks in the Ritscherflya sediments were found, including Archaean groups at 2,700–2900 Ma and 3200–3350 Ma, providing further evidence of the cratonic basement.

This study is now focusing on the extraction age of the GC crust from the convecting mantle, by employing the isotope systems of O and Hf. Mantle extraction ages are essential for models of the global evolution of the continental crust. Although, Antarctica forms ~9 % of the continental crust, data from this land mass are very scarce and none are yet available for the GC.

GENE FUNCTION IN ANTARCTIC KRILL: DETERMINING THE ROLE OF CLOCK-GENES IN SYNCHRONISED BEHAVIOURAL PATTERNS [AFI7/06]

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Antarctic krill (*Euphausia superba*) is a keystone species in the Southern Ocean ecosystem where it constitutes the main consumer of phytoplankton and the main food item of many higher predators. Synchronised behaviour is extremely important to krill. The large body size makes individuals particularly vulnerable to visual predation whereas the constant need to keep swimming places a large demand on their energy intake. The dilemma is that both phytoplankton and predators are most abundant at the surface of the ocean. Krill solve the conflict by forming swarms and by moving to the ocean's interior in the day and to the surface layers at night, resulting in large numbers of organisms moving upwards at dusk and downwards at dawn in a highly synchronised manner. Although the functional significance of this diel vertical migration (DVM) is clear and its modulation by environmental factors has been described, the involvement of an endogenous circadian clock in this behaviour was not fully resolved. We have obtained behavioural data in a laboratory setting suggesting that the circadian clock is indeed involved in this daily behaviour. We have cloned the first molecular components of the clock in krill and we are analysing their pattern of expression. We are also undertaking a microarray approach to identify novel clock and clock controlled genes in *Euphausia*.

Synchronisation among individuals is also evident in physiological functions, such as moulting. This is a periodic occurrence for krill with a cycle of about 20 days in summer. In winter, the cycle takes longer to complete or it halts. The coordinated occurrence of moulting in a swarm might be important for the reduction of cannibalism and for the synchronisation of spawning which, takes place just before moulting. We have evidence that the photoperiod modulates the switch from a fast moulting cycle in summer to quiescence in winter. We are currently performing experiments to identify genes differentially regulated during the moulting cycle, some of which might provide insights on how synchronisation is initiated and maintained.

THE HORMONAL CONTROL OF LIFE-HISTORY VARIATION IN ALBATROSSES, PETRELS AND PENGUINS BREEDING AT BIRD ISLAND [CGS9/43]

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The recent declines of albatrosses and large petrels in the Southern Ocean have come mostly by way of the dual threats of fisheries related mortality and climate change. Fisheries in particular are pushing the albatrosses to near extinction, and these currently rank as the world's most endangered family of birds, with 20 of the 21 species listed as threatened by the International Union for the Conservation of Nature (IUCN). Though long-line and to a lesser extent trawl fisheries have been largely responsible for these declines, changes in regional and global climate that influence the duration and extent of sea-ice and are known to have caused changes in the distribution and abundance of zooplankton and fish. Within this context, the conservation of seabirds relies in part on understanding the effects of these large-scale environmental processes on individual breeding success, but few studies have sought to link this with high-seas distributions, foraging patterns and physiological condition. We used physiological sampling and breeding observations to investigate these processes in sympatric Black-browed (*Thalassarche melanophris*) and Grey-headed (*T. chrysostoma*) albatrosses. In Additionally, we are examining some fundamental aspects of the breeding biology of Giant Petrels (*Macronectes giganteus* and *M. halli*), specifically the hormonal mechanisms that allow these birds to moult during reproduction. Also, we are studying the physiological underpinning of A:B egg dimorphism, and the hormonal control of foraging behaviour in breeding Macaroni penguins (*Eudyptes chrysolophus*) South Georgia. Fieldwork was successfully conducted during the austral summer of 2008-09, and at present physiological samples are pending analysis.

FIELD SPECTROSCOPY ON ADELAIDE ISLAND IN SUPPORT OF LITHOLOGIC AND VEGETATION REMOTE SENSING ON THE ANTARCTIC PENINSULA (CGS 10/45)

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The large size, severe terrain and harsh environment of the Antarctic Peninsula provide severe limitations to field geological mapping and vegetation mapping/monitoring. The British Antarctic Survey is currently investigating the potential of spaceborne multispectral and hyperspectral remote sensing to undertake lithologic and vegetation mapping on the Antarctic Peninsula. In support of the analysis of multispectral ASTER and Landsat ETM+ data from the Wright Peninsula region of Adelaide Island, spectral reflectance measurements (0.35 to 2.50 µm wavelength region) were acquired from rocks and vegetation in the region of the BAS Rothera research station during the austral summer of 2008/09. Validation of preliminary remote sensing results and the acquisition of field spectra to undertake data calibration was also undertaken. Reflectance spectra of ~50 rock samples were acquired that display absorption features mainly associated with low-grade alteration minerals. The granitoids and silicic volcanic rocks exposed in the study area display distinctive spectral reflectance properties that enable their unique discrimination in ASTER reflectance data. Spectra of more intermediate to basic igneous rocks and the sedimentary units are less distinctive and are difficult to discriminate at ASTER wavelengths. Spectra were acquired from 31 samples of grasses, mosses, and lichens present on Rothera Point and the islands in Ryder Bay. These display absorption features consistent with photosynthetic (PV) and non-photosynthetic vegetation (NPV) types. The results of a field survey across part of Anchorage Island were used to estimate the fractional cover of different vegetation types with results consistent with aerial photography. Field observations indicate that the seasonal growth of grasses is likely to have a strong affect on satellite vegetation maps derived using the Normalised Difference Vegetation Index (NDVI). The outcomes of this fieldwork have provided important ground-truth measurements in support of spectral lithologic and vegetation remote sensing on the Antarctic Peninsula. The results have contributed directly to lithologic mapping of the Wright Peninsula region using ASTER data and provide a sound basis for future vegetation mapping work.

NEW PARTICLES AND AEROSOL IN THE SEA ICE ZONE [CGS10/47]

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Bursts of new particles were observed in the Antarctic sea ice zone, during a cruise into the Weddell Sea in 1992 (Figure 1).

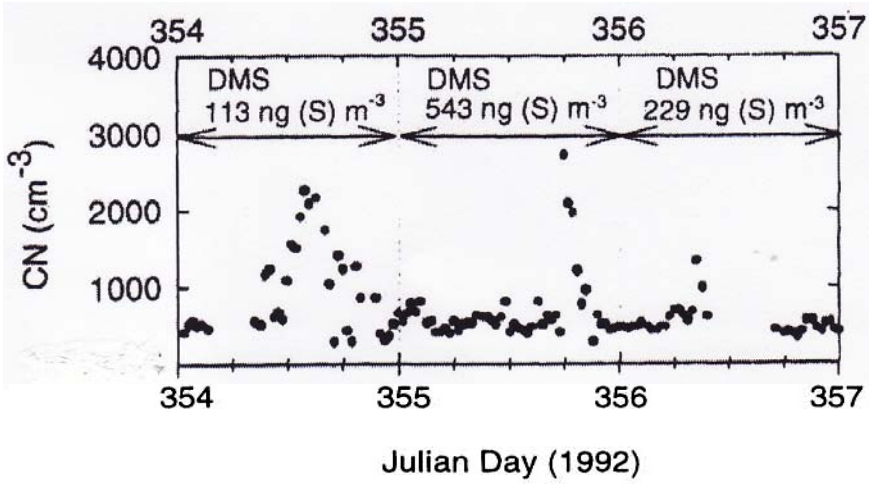


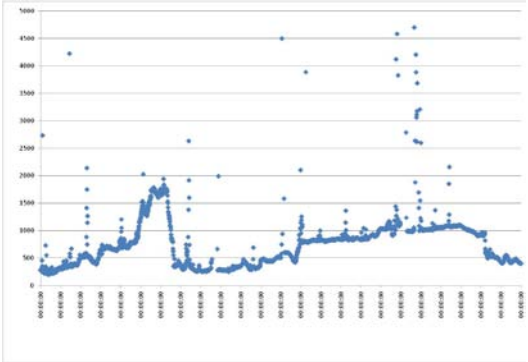
Figure 1. Total particle counts and atmospheric DMS concentrations.

The instrumentation on that cruise provided no information on the size distribution or composition of the aerosol though the sudden particle bursts suggested production of new particles of a small size.

The recent Weddell Sea cruise measured aerosol number density in the size range 5 to 1000 nm and size spectra from 10 to 1000 nm over a 6 week period from January to March 2009.

Total particle counts of only a few hundred particles per cm^3 indicative of clean background aerosol concentrations were often observed during the cruise, Figure 2. Occurrences of elevated CN counts coinciding with open aerosol size spectra so indicating episodes of new particle formation were observed.

These episodes occurred during travel through areas of sea ice so strengthening the theory that precursor gases originating from marine diatoms colonise present in the sea ice were the source of precursor gases responsible for the homogeneous nucleation episodes.



A STUDY OF THE IRON BIOGEOCHEMISTRY IN THE SCOTIA SEA [CGS10/48]

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The Southern Ocean plays a key role for the climate of the Earth. Large amounts of anthropogenic CO_2 are removed from the atmosphere through the solubility pump. The carbon (C) drawdown depends on various physical and biological processes, including C assimilation by phytoplankton and subsequent export into the deep ocean as particles. This 'biological carbon pump' depends on the availability of iron (Fe) and silicon (Si), which affect the dynamics of phytoplankton blooms. Fe is required for photosynthesis and nitrogen uptake. Due to limited supply and low solubility, dissolved Fe concentration in remote open oceans is very low (<0.5 nM).

In the "high nutrient, low chlorophyll" (HNLC) regions of the Southern Ocean, where nitrate and phosphate are replete, primary productivity strongly depends on Fe availability. Our study suggests that the largest phytoplankton blooms in the Antarctic Circumpolar Current near South Georgia are sustained by Fe from sediments of the Scotia Ridge injected into nitrate and phosphate replete waters.

INVESTIGATING THE DEGLACIAL HISTORY OF THE EASTERN ANTARCTIC PENINSULA USING TERRESTRIAL COSMOGENIC NUCLIDE ISOTOPE ANALYSIS AND GEOMORPHOLOGICAL MAPPING [CGS10/49]

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Here we present the results of field investigations undertaken in Northern Palmer Land during 2008-09. The study location stretches from Mount Faith in the Eternity Range to Engel Peaks, providing a 100 km transect from the backbone of the Peninsula towards the coast. We aim to reconstruct past ice sheet changes since the Last Glacial Maximum (LGM) using detailed geomorphological analysis, which will be tested by cosmogenic isotope analysis.

At present the Antarctic Peninsula Ice Sheet (APIS) is poorly understood in terms of its behaviour since the LGM. Here we record erratics at heights up to 600 metres above the modern ice. Deeply weathered and pitted surfaces were found across the whole vertical profile of the study sites. Weathering was more evident above the maximum altitude of erratics. No striations or trimlines were visible in the study area, suggesting the sites being in close proximity to the Ice centre. This evidence can be used to reconstruct palaeo ice heights, flow patterns, surface profiles in this region and integrate these with other regional proxy records. This will help us reconstruct the large changes in APIS that occurred during the last glacial interglacial transition, which potentially has important implications for ice sheet and sea level change. Although models show that the Larson Ice Shelf is a potential source of melt water during deglaciation and a possible source for the Meltwater Pulse-1A (MWP-1A), previous work on the last glacial maximum has concentrated on the western side of the Peninsula. This work represents the first attempt to constrain ice sheet behaviour in the region.

MWP-1A created an annual increase in sea level of 40mm over a 500-year period. The event is responsible for 20-25% of eustatic sea-level rise observed from the last glacial maximum to present. Such rapid large-magnitude event would have a significant effect on global climate depending on the distribution of melt water sources for this event. Recent research suggests that the MWP-1A originating from a source in the southern hemisphere could explain the onset of the Bølling-Allerød warm interval. However this result remains controversial given the current debate on whether the mwp-1A event was sourced primarily from the northern or southern hemispheres.

LINKING SEA ICE VARIABILITY WITH DIATOM ASSEMBLAGE CHANGES AND NUTRIENT DYNAMICS IN THE ANTARCTIC SEA-ICE ENVIRONMENT: A COLLABORATIVE STUDY WITH RaTS LTMS PROGRAMME [CGS10/50]

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The primary aim of this project is to investigate the complex interrelationships between sea-ice dynamics, physical oceanography, carbon and nutrient biogeochemical cycling and phytoplankton productivity, within the context of current climate change. Sea-ice melt releases algal seed populations into the underlying water column, while also acting to stabilise the surface water through stratification. Spring sea-ice melt is associated with favourable high-light conditions for algae, and initiation of the spring bloom throughout the western Antarctic Peninsula. However, climate records show a 40% decline in sea-ice coverage since 1979, with potentially significant ramifications for biological productivity in this region.

This study comprises time-series analysis of water and biological particulates and hydrographic data collected in Ryder Bay, in conjunction with the Rothera Oceanographic and Biological Time Series (RaTS) Long-term Monitoring and Survey (LTMS). Samples were collected for dissolved nutrients, phytoplankton community assemblage, stable isotopic composition of organic matter, and radiocarbon signatures.

Results from long-term RaTS monitoring indicate a three-year shift (2006-2009) towards lower chlorophyll concentrations and biological productivity concurrent with decreasing winter sea-ice coverage. This potentially signals a regime shift resulting from current climate change. The difference between 07/08 and 08/09 chlorophyll levels relative to previous years is particularly drastic, suggesting a non-linear response to multi-decadal trends in sea-ice decline. Preliminary analyses of nutrient concentrations and elemental and isotopic composition of organic matter from 2008/2009 will be presented in comparison with previous (AFI 4/02) monitoring of biological production in Ryder Bay.

This issue raises some important questions: (1) Whether the low chlorophyll levels will continue; and (2) If there is a recovery in chlorophyll, how does this system compare with previous high-productivity years? These questions will be discussed in the context of sampling from 2008/2009 and the upcoming 2009/2010 field season. During the coming austral summer, the project has been extended to include several additional parameters that will better enable us to address these issues. These additions include: a comprehensive study of iron dynamics, use of radium radioisotopes to estimate mixing rates with shelf sediments and the open waters of Marguerite Bay, and an assessment of the biogeochemical implications of periodic incursions of upper circumpolar deep waters for the Ryder Bay surface environment.

DISEASES OF KRILL IN THE SOUTHERN OCEAN: EFFECTS ON STANDING STOCK AND IMPLICATIONS OF CHANGING CLIMATES [CGS10/51]

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Krill are a keystone species in the Antarctic aquatic environment. Despite this, studies on disease and its contribution to mortality are lacking. The need for such knowledge is made all the more urgent given recent BAS research reporting significant declines in Southern Ocean krill stocks from causes that are yet to be fully elucidated. The aim of this project is to generate pathogen profiles (viruses to metazoans) for krill across their habitat range in the Southern Ocean. Collections of krill were made from net samples taken during the BAS cruise JR200, which was a multi-disciplinary oceanographic cruise carried out in March-April 2009 in the Scotia Sea and South Georgia region. Almost 2000 Antarctic krill plus 400 individuals of other euphausiid species were extracted from net samples covering a range of open-ocean and shelf environments. The specimens were preserved appropriately for histology, electron microscopy (EM) and molecular diagnostics using either a combination of Davidson's seawater preservative/industrial methylated spirits, glutaraldehyde or ethanol. The total length and sex of all specimens was established before preservation. The hepatopancreas, which is organ likely to contain the vectors and symptoms of many diseases, was removed from a subset of specimens and preserved separately. The range of analytical techniques applied from this comprehensive sample set will provide unique and thorough profiles of the type and prevalence of krill diseases in the Southern Ocean. Furthermore, through sampling across a wide range of environments, the relative prevalence of disease can be related to abiotic- and biotic factors, particularly to temperature and life-cycle stage. This will enable relationships between environmental factors and the prevalence of disease to be established, which is of particular relevance to assessing the impact of regional climate change to krill stocks. Furthermore, the stage-specific information can be incorporated into life-cycle- and stock assessment models to improve forecasts of fisheries yield and help in the setting of precautionary catch limits.

MICROBIAL SPATIAL VARIABILITY IN THE SCOTIA SEA DURING THE AUSTRAL SPRING 2008 [CGS10/52]

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The marked spatial variability of microbial plankton at the mesoscale (1-100 km) is generally regarded as purely a source of noise in data. Specifically, it makes it very difficult to extrapolate point measurements to larger scales to obtain accurate regional estimates of standing stocks and production of planktonic (including phytoplankton) populations. The mesoscale microbial variability in the Scotia Sea was examined using discrete water samples collected underway around the clock to give a horizontal sampling resolution of ~2 km. Bacterioplankton as well as small (1-10 μm) algae and protozoa were enumerated using flow cytometry. Rare larger (>40 μm) plankton were concentrated using a novel *in situ* size fractionation net and live microplankton organisms were counted using a FlowCam cytometer. The assessments of mesoscale spatial variability of microbes enabled to place the point measurements of bacterioplankton production as well as abundance of netted microplankton into a basin-scale frame.

SASSI UK: SYNOPTIC ANTARCTIC SHELF-SLOPE INTERACTIONS STUDY [AFI8/17]

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An array of five moorings was deployed in January and March 2009 across the Antarctic shelf and slope in front of the Riiser-Larsen Ice Shelf, in the southeastern Weddell Sea (~18°W), as part of the UK contribution to the multi-national Synoptic Antarctic Shelf-Slope Interactions (SASSI) study, an approved project for the International Polar Year led by UEA. The moorings have been instrumented to quantify the components of the freshwater transport by the flows on the continental shelf and slope, in an area located upstream of the regions of deep water formation in the southwestern Weddell Sea. They will provide the first year-round observations of the upstream processes influencing the formation of Antarctic Bottom Water and the melting of ice shelves in the Weddell Sea.

Two moorings have been deployed on the shelf and three on the continental slope, spanning a distance of 50 km. The shallowest instruments on the moorings are Acoustic Doppler Current Profilers (ADCP) that have been deployed between 416 and 469m deep (except on the shallowest mooring where it is at 256m) to minimise the risk of instrument loss through snagging or scouring from icebergs. The ADCPs have a range of ~ 500m, so they will measure currents up to the sea surface, where currents have been previously observed to be the strongest in this area. Single-point current meters, and temperature and salinity sensors, have been deployed at various depths to resolve the barotropic (depth-independent) transport and the hydrographic properties of the slope and coastal currents. On the two shelf moorings, thermistors chains cover the full water column and automated water samplers collect 500ml of in-situ water weekly, to measure salinity and the ratio of the stable isotopes of oxygen, which will identify the origin of the freshwater component (sea ice vs. ice shelf melt water).

Two hydrographic sections were undertaken during the mooring deployments, along with measurements of currents from lowered ADCPs, separated by three weeks. They confirm the existence of surface-intensified southwestward currents, with significant barotropic transports consistent with previous observations, and located at different distances from the coast on the two sections. They also reveal the existence of northeastward undercurrents trapped against the steepest part of the slope, and associated with an onshore upward sloping of isopycnals through thermal-wind balance. This brings the Warm Deep Waters closer to the shelf break, past which they could be transported and mixed with the colder Shelf Waters, through advection by tides, shelf waves and eddies, thus providing heat to melt the ice shelves. The moorings will enable us to quantify these processes and their impacts on ice shelves melting and consequent freshening of the waters flowing into the regions of deep water formation.

GEOPHYSICAL EXPLORATION OF SUBGLACIAL LAKE ELLSWORTH, WEST ANTARCTICA [AFI7/02]

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Subglacial lakes are extreme environments and unique biological habitats, which could play an important role in influencing the mechanics of ice sheet flow. The sediments that have accumulated at the bottom of these lakes are likely to contain key records of Antarctic ice sheet history.

Subglacial Lake Ellsworth (SLE) is a subglacial lake located beneath 2.95-3.28 km of ice close to the central ice divide of the West Antarctic ice sheet. Recent geophysical data (radio-echo sounding, seismic reflection and GPS) acquired during the 2007/08 and 2008/09 Antarctic field seasons have been used to establish: i) the shoreline and bathymetry of the lake; ii) physical properties of the sub-lake sedimentary package; iii) morphology of the subglacial catchment; (iv) structure, thickness and flow of the overlying ice sheet.

Seismic reflection surveys indicate that SLE has a maximum water column thickness of 150 m and a total water-body volume of ~1.4 km^3. Analysis of the seismic data suggests that the lake floor is characterised by high-porosity, low-density sediments indicative of accumulation in a low-energy depositional setting.

Radio-echo sounding data acquired over the upflow subglacial catchment between SLE and the ice divide ~30 km to the southeast reveal that the lake is located at the base of a deep, >40 km long, laterally constrained, fjord-like subglacial trench. This valley is bounded, to both the east and west, by steep, 2 km high, mountainous subglacial topography. A closely spaced grid of radio-echo sounding lines (spacing ~300 m) has also been used to map the outlet area of the lake in unprecedented detail, with the aim of identifying possible drainage routes.

The ice sheet overlying SLE is characterised by high-amplitude buckling of internal ice sheet layers. Comparison of the 3D orientation of these layers with GPS measurements suggests that the current ice-flow regime has been a stable feature of this sector of the ice sheet throughout the LGM-Holocene transition. This is significant given the well-documented changes in the configuration of the West Antarctic Ice Sheet during this period, with implications for our understanding of the processes that influence long-term ice-sheet stability.

GENE FLOW IN ANTARCTIC FISHES: THE ROLE OF OCEANOGRAPHY AND LIFE HISTORY [AFI6/16]

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Marine organisms with pelagic larvae are generally assumed to experience high gene flow and low levels of population differentiation. However, variability in life histories and environmental characteristics can significantly influence dispersal, and their relative effects are often unclear. This AFI project has been examining the influence of oceanography and life history variations on gene flow in two species of Antarctic fish, namely *Champsocephalus gunnari* and *Notothenia rossii*. These species are broadly sympatric in their distribution, but differ in aspects of life history that are expected to have a strong influence on their dispersal capabilities, including the pelagic or demersal nature of their eggs. This study has employed two modelling approaches: low-resolution large-scale modelling for predictions of larval transport on circumpolar and basin scales, and fine-resolution regional modelling to investigate finer-scale cross-shelf transport and retention around South Georgia. To compare predictions from the oceanographic models with patterns of population differentiation at both circumpolar and regional scales, we have used mtDNA and microsatellite markers to examine historic and contemporary gene flow. Using these different scales of resolution allows us to examine the effect of drift and retention of early life history stages in more detail, providing insight into the nature of biological and environmental constraints on dispersal and gene flow.

ADELIE: ANTARCTIC DRIFTER EXPERIMENT – LINKS TO ISOBATHS AND ECOSYSTEMS [AFI6/25]

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In February 2007 we occupied a hydrographic section in the northwest Weddell Sea, crossing the continental shelf and slope into the deep Weddell Sea. Twenty closely-spaced stations were undertaken with CTD, LADCP, and dissolved oxygen. Forty surface drifters, drogued at 15 m depth, were released and subsequently tracked for the next few months until they became trapped in sea ice.

The flow is dominated by three barotropic northward-flowing currents: the Antarctic Coastal Current, Antarctic Slope Front and Weddell Front. The strongest baroclinic flows are confined to the region between the Slope Front and the Weddell Front over the steepest part of the continental slope. The total transport across the ADELIE section is 46 +/-8 Sv, considerably larger than previous estimates because the full-depth and de-tided LADCP measurements allowed the narrow (~20 km) frontal currents to be resolved, leading to more accurate estimates of the barotropic component of the flow. The outflow of Antarctic Bottom Water across the ADELIE section has become colder and fresher in recent years, consistent with an increase of glacial ice melt content.

The drifters revealed the pathways taken by water masses on the continental shelf and slope, and likely also by passive particles such as krill larvae. Some drifters were carried westward around the Peninsula; some followed the 1000-m isobath to the east along the southern edge of the South Scotia Ridge, and some became entrained in a large standing eddy over the South Scotia Ridge. Historical drifters and icebergs also become trapped by this eddy, which exhibits a minimum in surface chlorophyll deduced from ocean colour imagery. Shear in the mean flow provides dispersion along topography, with eddy processes more important for dispersing particles across topography.

Global eddy-permitting or eddy resolving models are evaluated in the Weddell Sea against observational data sets. ORCA is found to be the preferred model for surface currents, whereas OCCAM produces the most realistic deep water masses. Virtual drifters are deployed in the velocity fields of ORCA to determine interannual variability in the pathways between the Peninsula and South Georgia. The high-frequency signals revealed by the ocean drifters (inertial oscillations and tides) are used to tailor the random walk for the virtual drifters, and thus to improve the simulation of drifter paths.