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ABSTRACTS

OF

ORAL PRESENTATIONS

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AFI4/02	Behaviour of stable isotopes and trace elements: reconstructing the Antarctic sea-ice environment	**Kate Hendry[1]** Amber Annett[2] Damien Carson[2] Dr Ros Rickaby[1] Dr Raja Ganeshram[2] Professor Harry Elderfield[3]	[1] University of Oxford [2] University of Edinburgh [3] University of Cambridge

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AFI6/28	Terminal Cretaceous climate change and biotic response in Antarctica	**Professor Jane Francis[1]** Dr Vanessa Thorn[1] Dr Jim Riding[2] Dr Alan Haywood[1,3] Stephen Hunter[1,3] Professor Rob Raiswell[1] Dr Duncan Pirrie[4] Professor Jim Marshall[5] Dr Alistair Crame[3] Dr Richard Hindmarsh[3] Abigail Clifton[1] Kay Johnson[1] Janine Pendleton[1] Rob Newton[1] Phil Robinson[1] Peter Frost[4]	[1] University of Leeds [2] British Geological Survey [3] British Antarctic Survey [4] University of Exeter [5] University of Liverpool
AFI5/03	Glacial history of the Ellsworth mountains, Weddell sea embayment, west Antarctica	**Dr Mike Bentley[1,2]** Dr Chris Fogwill[3] Dr Alun Hubbard[4] Anne Le Brocq[1] Professor David Sugden[3]	[1] Durham University [2] British Antarctic Survey [3] University of Edinburgh [4] University of Wales, Aberystwyth
AFI5/25	Accretionary units and events on Alexander Island, Antarctic Peninsula	Dr Craig Storey[1] **Professor Simon Kelley[1]** Dr Alan Vaughan[2] Dr Ian Millar[3]	[1] The Open University [2] British Antarctic Survey [3] NERC Isotope Geosciences Laboratory
AFI5/39	The metabolic costs of terrestrial locomotion in two closely related species of albatrosses and its relationship to nest site	**Dr Alexander Kabat[1]** Dr Richard Phillips[2] Professor John Croxall[2] Dr Anthony Woakes[1] Professor Patrick Butler[1]	[1] University of Birmingham [2] British Antarctic Survey

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AFI6/33	Did Antarctic octopuses colonise the deep sea?	**Dr Jan Strugnell[1,2]** Dr Alex Rogers[3] Dr Paulo Prodöhl[1] Dr Martin Collins[2] Dr Louise Allcock[1]	[1] Queen's University Belfast [2] British Antarctic Survey [3] Institute of Zoology
AFI5/01	Seasonal cycle of volatile bromocarbon compounds in Marguerite Bay on the Antarctic Peninsula: Implications for sea-to-air bromine fluxes	**Dr Claire Hughes[1]** Dr Adele Chuck[1] Dr Sue Turner[1] Professor Peter Liss[1] Professor Andrew Clarke[2] Paul Mann[2] Helen Rossetti[2]	[1] University of East Anglia [2] British Antarctic Survey
CGS7/25	Sensible heat flux over the Ronne Polynya, Antarctica: Comparison of model with fieldwork data	**Emma Fiedler[1]** Dr Ian Renfrew[1] Dr Tom Lachlan-Cope[2] Dr John King[2]	[1] University of East Anglia [2] British Antarctic Survey
CGS7/26	Physiological ice relations of the Antarctic limpet *Nacella concinna*	Dr Tim Hawes[1] **Dr Roger Worland[2]**	[1] University of Birmingham [2] British Antarctic Survey
CGS8/27	Iron biogeochemical cycling in the scotia sea	**Maria Nielsdóttir[1]** Thomas Bibby[1] Rebecca Korb[2] Mick Whitehouse[2] Eric Achterberg[1]	[1] National Oceanography Centre [2] British Antarctic Survey
CGS8/28	The marine carbon cycle in contrasting production regimes of the Atlantic sector of the Southern Ocean	**Elizabeth Jones[1]** Dr Nick Hardman-Mountford[2] Dr Angus Atkinson[3] Dr Dorothee Bakker[1] Professor Andrew Watson[1]	[1] University of East Anglia [2] Plymouth Marine Laboratory [3] British Antarctic Survey
CGS8/29	Marine productivity from dissolved gas measurements in the Southern Ocean	**Karel Castro-Morales** Dr Jan Kaiser	University of East Anglia

SEDIMENT TRANSFER FROM ANTARCTICA TO THE DEEP OCEAN – FIRST INVESTIGATION USING THE *ISIS* REMOTELY OPERATED VEHICLE [AFI6/14]

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Marine sediments on the Antarctic continental margin contain a unique record of past ice-sheet extent, sub-glacial processes, erosion of the continent, and environmental changes. However, the understanding of this record is complex in terms of both the process environment in which sediments are deposited and reworked and palaeo-environmental interpretation.

In January and February 2007 the *Isis* remotely operated vehicle (ROV) was used to investigate a series of sedimentary environments on the Antarctic margin at an unprecedented level of detail. Sixteen *Isis* dives were carried out from RRS *James Clark Ross* on Cruise JR157. The dives were targeted to investigate eight different environments ranging from the head of a fjord (Blind Bay) to 3500 m water depth on the continental rise. The latter dive was the deepest ever by an ROV around Antarctica. Most of the target sites were selected on the basis of multibeam bathymetry data collected on previous cruises.

Before each dive *Isis* was configured for either high-resolution swath sonar survey or sea-floor sampling. Several video cameras and a digital stills camera were carried in both configurations. For swath sonar surveys a Kongsberg SM2000 echo sounder, which transmits a 200 kHz signal, was mounted on the ROV and was 'flown' 20 m above the sea floor. The resulting swath width was 70 m and the data have enabled us to produce bathymetric images with grid cell sizes smaller the 1 m^2, which is between one and two orders or magnitude higher-resolution than the best that can be achieved with ship-mounted systems. On sampling dives a number of 30 and 50 cm-long push cores, a scoop, and a biological sample box and suction sampler were carried. All dives were carried out cooperatively with marine biologists working on a separately funded project, and the interaction between scientists from different disciplines was regarded as a positive aspect of the cruise by both science teams.

Isis moved along dive transects at <0.5 kts, and the ship moved at the same rate to maximize manoeuvrability of the ROV. This made possible collection of multibeam echo sounding data with exceptionally dense reflection point coverage using the hull-mounted Kongsberg EM120 system, enabling us to generate finer bathymetric grids of the regions around dive sites than was possible from previous data. Gravity cores and box cores were collected at several dive sites to obtain information about sediment types, sedimentation rates and environmental changes since the last glacial maximum.

The results from the *Isis* dives provide new insights into a range of processes including bottom current influenced sedimentation on the continental rise, erosion of the flanks of sediment drifts by large turbidity current channels and resulting slope instability, erosional and depositional processes on the continental slope, erosion of channels by subglacial meltwater flow, and sedimentation from meltwater plumes close to a glacier front.

THE ANTARCTIC SLOPE FRONT: WHAT HAPPENS TO IT AT THE TIP OF THE ANTARCTIC PENINSULA? [AFI6/25]

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The tip of the Antarctic Peninsula is a fascinating place, where water from the southernmost part of the Weddell Sea is brought into confluence with the Antarctic Circumpolar Current system, and the topography of the shelf and slope plays a vital role. As it circumnavigates the Weddell Sea, much of the cyclonic flow is concentrated in a shelf-slope frontal system, the Antarctic Slope Front. At the tip of the Peninsula, however, we postulated that the associated flow splits into two components. The first flows west over the ridge, and may pass through or circumnavigate Bransfield Strait. The second continues east as the Weddell Front, also tied to the topography, marking the northern boundary of the waters of the Weddell Sea, and the southern boundary of the Weddell Scotia Confluence.

To test these hypotheses, in February 2007 we conducted a hydrographic section of 20 CTD stations across the continental shelf and slope at the tip of the Antarctic Peninsula, into the deep Weddell Sea. We deployed 40 surface drifters drogued at 15 m. We calculate the transport associated with the Antarctic Slope Front, deduced from geostrophy referenced to de-tided Lowered Acoustic Doppler Current Profiler data. We show the paths of the satellite tracked drifters, and illustrate how they remained tightly tied to the topographic contours.

Eddy resolving numerical ocean-ice models have been used to predict the paths of the drifters by particle tracking in their velocity fields. We will present the predicted paths in three models, the OCCAM one twelfth degree version, TPAC (one-eighth degree resolution), and ORCA (one quarter degree resolution). We discuss the extent to which the numerical models agree with the observed drifter tracks. The drifters mimic the behaviour of krill spawned on the Antarctic shelf.

COPEPODS, PROTOZOANS AND THE BENTHOS AS FOOD SOURCES FOR ANTARCTIC KRILL [AFI5/09]

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Body morphology and enzyme composition suggest that Antarctic krill (*Euphausia superba*) are well adapted to feed on phytoplankton. However, phytoplankton can be scarce in the Southern Ocean, not only during winter, but also on regional scales during spring and summer when krill have their main period of growth and reproduction. Within regions/ times of phytoplankton scarcity, several studies have found krill to survive and grow much better than predicted from the phytoplankton abundance, suggesting their use of alternative food sources. Food-switching between phytoplankton and alternative sources has been studied in the laboratory, and highlighted the importance of copepods. However, detailed field studies on the diet of krill are rare. To understand the survival and energy budget of krill during harsh times, it is essential to know the complete range and relative importance of their food sources.

The aim of our AFI-project is to study the diet of krill over a large range of food environments inclusively all four seasons and a comparison between Scotia Sea and Lazarev Sea. Combining stomach content analysis with fatty acid- and stable isotope analysis, we are able to detect solid as well as easily digested food items. As an overall result, we hope to gain new insights into the nutritional quality of different pelagic communities and into the seasonal energy allocation in krill.

We are currently holding frozen krill samples from 15 different cruises between 1999 and 2007, with 8 of them already analysed for krill stomach content, including samples from the AFI fieldwork in November 2006. This spring cruise (JR 161) covered a transect from Signy towards South Georgia, encountering relatively low phytoplankton abundance near the ice edge and variable, but also very high phytoplankton abundance in the open Scotia Sea. Results from krill stomach content analysis from this cruise generally resemble results from other cruises: 1. over relatively small spatial scales, there are large differences in the amount of food recently ingested, 2. diatoms are usually the main item found in krill stomachs, 3. when diatoms are rare, krill starve, feed on moults or on the benthos, but rarely on copepods, 4. diatom blooms dominated by *Fragilariopsis kerguelensis* and associated protozoans seem to be of particularly high nutritional value for krill.

Overall, the study has drawn our attention towards protozoans and the benthos as food sources for krill – but does not support the common assumption about the importance of copepods. Winter-feeding on the seafloor has been found in krill from South Georgia but not from the Lazarev Sea, and might be a specific over-wintering strategy in this area.

MERGING MOLECULAR AND OCEANOGRAPHIC PROCESSES IN THE SCOTIA SEA AND BEYOND [AFI6/16]

Jenny Rock[1], Emma Young[2], Gary Carvalho[1], Eugene Murphy[2], Bill Hutchinson[3], Mike Meredith[2], Sally Thorpe[2], Tony North[2], Mark Belchier[2], Martin Collins[2], Inigo Everson[2], Lorenz Hauser[4] and Paul Rodhouse[2]

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Although marine organisms with pelagic larvae are generally assumed to experience high gene flow and low levels of population differentiation, variability in life history and environmental characteristics can significantly influence the dispersal of all life stages and the mechanisms and effects of these relationships remain unclear. Our research examines the influence of oceanographic processes and life history variation on gene flow in two species of Antarctic fish: *Champsocephalus gunnari* and *Notothenia rossii*. These species are broadly sympatric in much of their distribution, but differ in aspects of life history that are expected to strongly affect their dispersal capabilities. We are employing oceanographic models including (1) OCCAM and (2) a high resolution model (using POLCOMS) to predict larval transport around Antarctica as well as 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 geographic scales, we are using mtDNA and microsatellite markers to examine historic and contemporary gene flow. Here we present data from large scale oceanographic models in combination with evidence for inter-specific variation in mitochondrial gene flow at the circumpolar level.

BEHAVIOUR OF STABLE ISOTOPES AND TRACE ELEMENTS: RECONSTRUCTING THE ANTARCTIC SEA-ICE ENVIRONMENT (AFI4/02)

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Central to the global impact of the Southern Ocean and Antarctica on both past and future climate change is the sea-ice surrounding the continent. Sea-ice plays a significant role in atmospheric gas exchange, regional weather patterns and biological productivity. Variations in biological productivity may be an important factor modifying atmospheric carbon dioxide levels, for example, over glacial-interglacial timescales. However, we do not yet fully understand how biological productivity has varied in the past, how past and future changes in sea-ice extent may influence this productivity and how these changes may impact carbon dioxide levels. In addition, we do not understand how biogeochemical cycling in a sea-ice environment may impact geochemical proxies such as the stable isotopic and trace element composition of organic matter and diatom opal.

The purpose of this project is to understand how primary productivity in the surface oceans varies in a nearshore, seasonal sea-ice environment off the Western Antarctic Peninsula. Field expeditions and cruises to Ryder Bay, Adelaide Island, have been undertaken to collect sea-ice, water column, phytoplankton, sinking particulates and surface sediment samples in combination with nutrient assays and physical oceanographic measurements. A final sampling trip was to be carried out in 2006-2007. Samples are being analysed in Edinburgh and Oxford for stable isotope (carbon, oxygen and nitrogen) and trace elements (barium, uranium, aluminium, cadmium and zinc). The aims of this talk are to discuss our final field season, explain our methods and present some results. This unprecedented time series of geochemical and physical data is coming to a close, and will illuminate biogeochemical processes in a sea-ice environment which will have important implications for high latitude palaeoproductivity proxies.

BIOGEOCHEMICAL PARTICLE FLUX STUDY IN MARGUERITE BAY ANTARCTIC PENINSULA [AFI4/13]

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The coastal waters of the Antarctic Peninsula are highly productive in terms of phytoplankton biomass, despite being surrounded by relatively low productivity Southern Ocean Waters. This productivity is probably at least party responsible for the high biomass of krill and marine mammals in this area. The Antarctic Peninsula is already subject to significant climate change and this can be expected to result in significant changes in productivity, for instance as the extent of sea ice changes. The unique access provided by the Rothera base to Marguerite Bay allows the full seasonal cycle of phytoplankton productivity to be investigated in this large coastal embayment on the Antarctic peninsula. This project aims to describe this cycle, understand the physical and biogeochemical reasons for the high phytoplankton productivity and the fate of this material in Marguerite Bay.

MEASURING CHANGES IN THE SIZE OF THE ANTARCTIC PENINSULA ICE SHEET [AFI4/16]

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The coastal glaciers of the Antarctic Peninsula are shrinking in length, and accelerating in flow speed, perhaps as a consequence of the rapid warming that this part of Antarctica has experienced in recent decades. The aim of this project is to find out how the thicker ice away from the coast of the Peninsula is being affected. We set out to obtain direct measurements at four remote field sites in the Antarctic Peninsula. Local thickness change can be measured directly by GPS. In addition, borehole sensors check snow compaction every hour, and are sensitive to downward movements smaller than a millimetre. A weather station measures the snow arriving at hourly intervals, along with temperatures in the air, and temperatures in the upper layers of snow. The instruments were recovered in the 2006/7 field season. Some of these results are presented and use of the data for modelling snow compaction is considered.

TERMINAL CRETACEOUS CLIMATE CHANGE AND BIOTIC RESPONSE IN ANTARCTIC [AFI6/28]

Jane Francis[1], Vanessa Thorn[1], Jim Riding [2], Alan Haywood[1,3], Stephen Hunter[1,3], Rob Raiswell[1], Duncan Pirrie[4], Jim Marshall[5], Alistair Crame[3], Richard Hindmarsh[3], Abigail Clifton[1], Kay Johnson[1], Janine Pendleton[1], Rob Newton[1], Phil Robinson[1] and Peter Frost[4]

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This project investigates the nature of latest Cretaceous to early Tertiary (~70-64 Ma) climates in the James Ross Basin, Antarctica. In particular, we aim to determine whether this warm greenhouse climate was punctuated with cold phases that allowed glaciation on Antarctica.

During the field season in 2006 over 1200 metres of the latest Cretaceous and earliest Palaeogene (Maastrichtian-Danian) sedimentary sequence on Seymour Island was measured, logged and sampled. The monotonous sequence of bioturbated muddy siltstones was sourced from the volcanic arc to the west and deposited in a subsiding but rapidly filling marine basin (the James Ross Basin).

Ongoing studies of the fossil faunas, floras (palynology and wood), sediments and glauconite horizons indicate that environmental conditions changed on several scales during this period. The high latitude temperate marine fauna indicates a general shallowing in the depositional environment with periods of low oxygen bottom water conditions. At times, however, the green iron-enriched silicate mineral glauconite was able to form, indicating that sedimentation rates were periodically extremely low, probably due to high sea levels. At other times conditions must have been more energetic as pebble layers formed, the pebbles of igneous rock originally being derived from the adjacent volcanic arc and then rounded on the Cretaceous shoreline. How the pebbles were transported approximately 100km offshore is still unknown; were they carried by ice?

Initial palynomorph studies indicate that the Cretaceous/Tertiary (K/T) boundary is marked by a transition in the marine dinocyst flora that reflects unstable ocean palaeoecology after the K/T catastrophe. Conversely, there is little change in the terrestrial palynology across the K/T, with only a gradual increase in angiosperm pollen noted into the Danian. Oxygen and carbon isotope analyses are in progress and will yield data about the palaeotemperatures and carbon signal of the ocean waters across this boundary and through the whole sequence.

Climate simulations for the Maastrichtian using the fully coupled ocean-atmosphere global climate model HadCM3L have been performed to understand the global context. Results indicate that ice could have been present on East Antarctica with atmospheric CO_2 levels 4 x pre-industrial levels; with CO_2 concentrations equivalent to 2 x pre-industrial level an East Antarctic ice sheet could have existed that was equivalent in size to the present Greenland ice sheet (~7m sea level change). These results tentatively suggest that bipolar glaciation was possible, even during the Late Cretaceous greenhouse.

GLACIAL HISTORY OF THE ELLSWORTH MOUNTAINS, WEDDELL SEA EMBAYMENT, WEST ANTARCTICA [AFI5/03]

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We report here the results from a programme of geomorphological mapping and sampling for cosmogenic isotope analysis in the Ellsworth Mountains. The overall aim of the project is to establish the timing and rate of thinning of the West Antarctic Ice Sheet (WAIS) from its maximum extent in an area inland of the Weddell Sea embayment. We have data from along a 350 km-long transect, stretching from Pirrit Hills (81º06′S, 85º31′W) in the south to the ridge between Mt Bentley and Mt Hubley in the north (78º09′S, 86º41′W). Most sites are on the western (WAIS) side of the range but we also have data from the Flowers Hills (78º24′S, 84º31′W) on the east side of the range, adjacent to the Rutford Ice Stream. We studied the geomorphology of 11 field locations in detail, including studies of drift sheets, weathering of sediments and bedrock, plus closely-spaced sampling of erratics and bedrock along altitudinal transects at each site. Our geomorphological mapping has allowed us to determine a series of ice sheet advances and we discuss a preliminary landscape and glacial history of the Ellsworth Mountains extending from the pre-Quaternary to the present-day, including a record of Holocene thinning. Our cosmogenic ^{10}Be and ^{26}Al chronology for the mapped glacial fluctuations suggests that (i) Alpine glaciation of the Ellsworths probably occurred prior to the Quaternary, (ii) a high, previously-mapped trimline records WAIS expansion >700 ka, and that there may have been multiple expansions to this level; (ii) a lower, less distinct trimline records WAIS expansion at the Last Glacial Maximum, and implies a thinner WAIS in the Weddell Sea embayment than has been previously supposed; (iv) thinning from the maximum occurred from ~ 15 ka to the Late Holocene. These data are being used to constrain an ice sheet model of the Weddell Sea embayment.

ACCRETIONARY UNITS AND EVENTS ON ALEXANDER ISLAND, ANTARCTIC PENINSULA [AFI5/25]

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The Western Domain of the Antarctic Peninsula exposed on Alexander Island comprises a c.300km wide Mesozoic subduction-accretion complex known as the LeMay Group, overlain unconformably by an Upper Jurassic to Lower Cretaceous forearc basin, known as the Fossil Bluff Group. Previous work in central Alexander Island has indicated that slivers of oceanic crust (metamorphosed pillow basalts overlain by cherts and argillites) were accreted to the base of trench-fill terrigenous sediments during continued intra-prism deformation. However, little was known about the age of this accretion event, nor differences in provenance of the different sedimentary units, and how they might correlate with other accretion events around the margin of Gondwana during the Mesozoic. The key aim of this study was to test whether the units formed close to their present day position, or represent exotic slivers that have travelled far round the margin of Gondwana prior to accretion.

In this study we have dated directly the age of shear zones between accreted units by selecting cataclastic and mylonitic fault rocks with known kinematics that contain synkinematic white mica within the foliation. We have also selected various undeformed weakly metamorphosed sediments across a major shear zone that separates sediments from the prism from oceanic crust with overlying sediments, and dated both detrital white micas and zircons.

In-situ IR laser Ar-Ar spot ages from various shear zone samples give a best age of deformation of c.125 Ma, which is somewhat older than the c.107-105 Ma deformation documented on the mainland of the Antarctic Peninsula along the East Palmer Land Shear Zone. In-situ IR laser single grain white mica Ar-Ar analysis and UV laser single grain zircon U-Pb analysis were performed on detrital grains from various sediments. Sediments in the hanging wall (i.e. the prism) have a maximum age of c.220 Ma and the detrital micas and zircons age spectra correlate well with certain other parts of the LeMay Group e.g. the Walton Mountains to the south. However, sediments within the footwall (i.e. sediments overlying the accreted oceanic crust) have a maximum age of c.107 Ma and the micas and zircons yield age spectra much more reminiscent of sediments found further west on Charcot Island and indeed within foreland basin sediments of the Fossil Bluff Group to the east. These younger sediments have undergone at least one period of folding, which must therefore be younger than c.125 Ma deformation and may correlate with events on the mainland.

These new data confirm that the LeMay Group consists of at least two separate sedimentary successions of different age and imply repeated accretionary events along the long-lived Gondwana margin. The detrital age spectra are non-unique and do not require that the sediments were deposited in exotic loci. However, the accreted oceanic crust units contain red shales and cherts that contain Upper Jurassic to Lower Cretaceous radiolaria considered to have been deposited at c.30°S. In this time period Gondwana occupied a high-latitude and this suggests that parts of the LeMay Group may well be exotic. Further work is planned to address this issue.

THE METABOLIC COSTS OF TERRESTRIAL LOCOMOTION IN TWO CLOSELY RELATED SPECIES OF ALBATROSSES AND ITS RELATIONSHIP TO NEST SITE [AFI5/39]

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This study investigated the metabolic cost, mechanical efficiency, and gait characteristics of terrestrial locomotion on a level and an incline plane in two species of albatrosses, *Thalassarche melanophrys* and *Thalassarche chrysostoma*. This was to investigate if there is an effect of colony philopatry on terrestrial locomotory by determining: (1) if there is a difference in terrestrial locomotive ability between these two closely related species, and (2) what physiological or behavioural adaptations may account for any differences identified. This study has shown that there is a difference in terrestrial performance ability between these two species of albatross. *Thalassarche chrysastom* were able to perform at a much greater speed than *T. melanophrys* without reaching a significantly different maximal rate of oxygen consumption ($\dot{V}_{O_2}$), where as *Thalassarche melanophrys* were able to move up a significantly steeper incline than *T. chrysastom* while maintaining a similar maximal $\dot{V}_{O_2}$. *T. melanophrys* typically nest in steeper a habitat than *T. chrysastom*, and each species has evolved stride length (behavioural) and leg length (morphological) adaptations that minimise the cost of traversing their chosen colonies. It is clear that there is a relationship between terrestrial performance and topography of the colony site. However, it is not possible to determine if the difference in performance ability results from differences in colony topography, or if choice of colony site is dictated by ability to traverse the topography.

DEVELOPING THE DON PARADIGM: THE ROLE OF HIGH MOLECULAR WEIGHT PROTEINS AND PEPTIDES IN PLANT AND MICROBIAL NUTRITION IN ANTARCTIC SOILS [AFI5/32]

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Until recently the focus of research into plant uptake of N has focused on inorganic species (i.e. NO_3^- and NH_4^+). Current research focused on the role of amino acids in plant and microbial nutrition has confirmed that higher plants can capture N from amino acids in cold climate and other soils (e.g. Schimel and Chapin 1996). This direct uptake of organic N provides an effective short circuit of the N cycle removing the need for ammonification and nitrification (e.g. Schimel and Chapin, 1996; Jones et al., 2005; Bardgett et al., 2003). It was thought that in order for DON uptake to occur, all proteins and peptides undergo enzymatic cleavage into constituent amino acids. Results in this laboratory suggest that scientists may have overlooked the most important N uptake pathway, that of direct peptide uptake (i.e. amino acid chains of ca 2-20 unit lengths) by plants and soil microorganisms. Peptide transport in microorganisms is well documented and recent evidence has demonstrated the presence of a range of peptide transporters in plants (Williams and Miller, 2001). Our results indicate that peptide uptake rates by soil microorganisms are of the same order or faster than that of amino acids and that under controlled conditions plant roots can take up exogenously applied peptide as sole source of N for growth. In this talk we suggest a short circuit whereby plants and microorganisms may directly utilise complex organic N sources.

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DID ANTARCTIC OCTOPUSES COLONISE THE DEEP SEA?
[AFI6/33]

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This proposal uses octopuses as model organisms to test the hypothesis that the Antarctic has acted as a centre for evolutionary innovation and radiation and as a source of taxa that have invaded the deep sea. It is likely that the deep-sea fauna was depauperate following extinction events associated with past global climate change causing, for example, deep-ocean oxygen minima. Such events have been recorded from the Late Cretaceous and Palaeocene/early Eocene, prior to the opening of the Drake Passage. The subsequent development of deep-water connections between the Southern Ocean and the major oceans which surround it would have facilitated the expansion of biogeographic boundaries. This study aims to characterise the macro-evolutionary processes of endemic Antarctic octopod fauna using molecular methodologies. Bayesian analytical procedures incorporating fossil constraints will then be used to estimate the divergence times of these taxa thereby providing a means of testing the hypothesis that, in evolutionary history, Antarctic taxa invaded the deep sea.

SEASONAL CYCLE OF VOLATILE BROMOCARBON COMPOUNDS IN MARGUERITE BAY ON THE ANTARCTIC PENINSULA: IMPLICATIONS FOR SEA-TO-AIR BROMINE FLUXES [AFI5/01]

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Volatile bromocarbon compounds such as bromoform ($CHBr_3$) and dibromomethane (CH_2Br_2) are known to be produced naturally in seawater. Sea-to-air bromocarbon flux and subsequent photo-dissociation in the atmosphere results in the formation of reactive radical species (BrO_x) which are involved in catalytic ozone depletion in the troposphere and stratosphere. A major uncertainty in models of atmospheric bromine is a lack of understanding of the sources of this element to the atmosphere. Here we present the results of bromocarbon measurements made at the Rothera Time-Series site in Marguerite Bay on the Antarctic Peninsula from February 2005 to March 2007. We will show that bromocarbon concentrations increase significantly following the retreat of the ice and coincide with the phytoplankton bloom that occurs annually in this area. Saturation anomalies reach 1062 % for $CHBr_3$ and 263 % for CH_2Br_2 suggesting that large sea-to-air bromine fluxes occur during this time. The implications of these results for the chemistry and composition of the Antarctic atmosphere will be discussed. We will also present our plans to further investigate bromocarbon production in the seasonal ice-edge zone in our newly funded AFI project.

SENSIBLE HEAT FLUX OVER THE RONNE POLYNYA, ANTARCTICA: COMPARISON OF MODEL WITH FIELDWORK DATA [CGS7/25]

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The Ronne Polynya, in the Southern Weddell Sea, is a coastal polynya. This is an area of open water in pack ice caused by the offshore advection of ice by strong continental winds as quickly as it can form. Due to the large air-sea temperature differences, air above and downwind of the polynya is warmed by the open water, leading to the formation of a convective internal boundary layer (CIBL).

The large ocean-atmosphere heat fluxes and continual removal of ice by the wind result in high rates of ice production and extensive brine rejection. This produces a water mass known as High Salinity Shelf Water (HSSW), which leads on to the formation of Antarctic Bottom Water (AABW).

Quantifying the turbulent heat fluxes is a step towards quantifying the surface heat budget, which, together with the surface moisture budget, will aid understanding of the key processes governing deep water formation in this region.

High frequency wind and temperature data from low-level flights over sea ice was collected during the recent fieldwork season of the BAS MASIN project. Data from a flight over the Ronne Polynya on 27th February 2007 (Flight 54) was used to calculate the sensible heat flux over the polynya, using both the bulk and eddy covariance methods. The sensible heat flux was also modelled, using a fetch-dependent CIBL model (Renfrew and King, 2000) forced with AWS data from the ice shelf upwind of the polynya. The sensible heat flux calculated from the aircraft data was then compared to the model output.

The expected decrease in the sensible heat flux with fetch was observed for all methods. However, the modelled heat flux is too large. This is most likely to be due to the model assumption of an open water surface across the polynya, when, at the time of the data collection, the surface was observed to be mostly of thin ice.

The drag coefficient (C_D) and exchange coefficient for sensible heat flux (C_H) were also calculated from the aircraft data. A possible relationship between ice thickness and these coefficients is currently being investigated.

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PHYSIOLOGICAL ICE RELATIONS OF THE ANTARCTIC LIMPET *NACELLA CONCINNA* [CGS7/26]

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Survival of sub-zero temperatures was investigated in intertidal and subtidal (c.7-15m) phenotypes of the Antarctic limpet *Nacella concinna*. Our investigations provide strong support for the 'mucus buffer' hypothesis: that freezing of tissues is retarded by mucus. Lower lethal temperature survival (proportion self-righting after low temperature exposure and 48h recovery) and tissue crystallisation temperatures are both markedly lower than the crystallisation temperatures of whole animals. Observations confirmed that whole animal crystallisation temperatures were produced by the initiation of freezing in the mucal film of the animal, not the animals themselves. Further experiments examined the effects of exposure duration and short-term acclimation on sub-zero survival.

IRON BIOGEOCHEMICAL CYCLING IN THE SCOTIA SEA [CGS8/27]

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Iron, as an essential component of the photosynthetic system, is of major importance for aquatic photosynthetic organisms. Due to the insolubility of Fe(III), the concentration of iron in oxygenated seawater is extremely low (<0.5 nM in the open ocean). Iron is supplied to the surface ocean via atmospheric transport of dust and its deposition, as well as by upwelling, entrainment, or mixing of deeper waters relatively rich in nutrients and metals. Furthermore, a run-off effect supplying iron from ice, sea ice and brine, has been found to contribute significantly to the iron budget in higher latitudes. There are very few measurements of iron in the Scotia Sea. Observations made previously in the area indicated a significant difference between the phytoplankton physiology upstream and downstream of South Georgia. It is now hypothesised that parts of the region are fertilised by run-off effect from South Georgia.

In order to examine this hypothesis, iron and associated biological parameters were examined during an austral spring 2006 cruise in the Scotia Sea, on the RRS *James Clark Ross*, as part of the BAS 'Discovery 2010' programme. A survey was carried out for dissolved iron, and iron addition experiments were used as a mean of investigating iron limitation in the resident phytoplankton. Results from the cruise will be presented.

THE MARINE CARBON CYCLE IN CONTRASTING PRODUCTION REGIMES OF THE ATLANTIC SECTOR OF THE SOUTHERN OCEAN [CGS8/28]

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The global oceans act as buffers for the anthropogenic carbon dioxide released into the atmosphere. The air-sea exchange of CO_2 varies across each oceanic region with additional seasonal variations due to temperature and biological activity. The area of the Southern Ocean between The Falkland Islands, the Antarctic Peninsula and South Georgia is thought to be a strong net CO_2 sink although sparse shipboard measurements have made it difficult to accurately quantify this sink zone. A CASIX (Centre of Observation of Air-Sea Interactions and Fluxes) underway pCO_2 (partial pressure of carbon dioxide) instrument was installed on the British Antarctic Survey research ship RRS *James Clark Ross* to provide an additional pCO_2 data set that will be added to existing data sets for surface pCO_2 to increase the overall spatial and temporal coverage of carbon measurements in this region. The data obtained will be co-located with satellite data of chlorophyll and sea surface temperature, parameters that can be used to inform on processes affecting pCO_2 in the surface ocean. It is hoped that the spatial and temporal variation of both the satellite and shipboard data will help to unravel the processes that drive the carbon cycle in this region.

MARINE PRODUCTIVITY FROM DISSOLVED GAS MEASUREMENTS IN THE SOUTHERN OCEAN [CGS8/29]

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The oceans play an important role in the biogeochemical cycling of climatically important gases (CO_2, N_2O, CH_4, DMS, etc). Dissolved gases can be used as tracers of biogeochemical processes and reflect the biological activity and physical processes acting on the system. The most concentrated gases in aerobic waters are N_2, O_2 and Ar; O_2 is affected by both biological and physical processes whereas N_2 and Ar are mainly affected by physical processes.

Ar is a biologically inert gas, and because it has similar solubility properties to O_2, we can use the ratio between this two gases in the mixed layer to determine the contribution of the physical processes (mainly diffusive and bubble-mediated gas exchange, heat and fresh water forcing) and calculate the flux due to biological processes (photosynthesis and respiration) to estimate net and gross community production.

To achieve this approach we propose using Membrane Inlet Mass Spectrometry (MIMS). This analytical technique offers in situ high precision measurements of various dissolved gases and their ratios. MIMS is a fast way to measure with no time consuming equilibration and extraction of dissolved gases from the water sample.

High temporal and spatial resolution estimates will be obtained, in the order of one data each 50 m distance. This resolution can not been achieved by the traditional bottle incubation and satellite remote sensing methods, which can achieve a resolution of around 1 Km distance in the surface ocean to estimate primary production. Also bottle incubation technique has the implication of noise introduction due to enclosure effects.

Measurements of the difference between the triple oxygen isotope (^{16}O, ^{17}O and ^{18}O) composition in discrete samples from the mixed layer, will contribute to this approach, to differentiate the atmospheric and biogenic O_2 contribution and the rate of air-sea oxygen exchange.

Because of the characteristics of the Southern Ocean in terms of size, absence of physical boundaries in the east, west and north and close links to the deep ocean, is has a strong coupling of biogeochemical processes and physical forcing that affect air-sea balance, in particular in the global carbon cycle. High resolution net/gross production estimates are needed to understand dissolved gases and carbon fluxes variability as a result of the implication of global climate change.

We are planning to measure at several sites in the Southern Ocean (depending on availability of oceanographic cruises) and link the results with small scale processes as dissolved gases contribution due to upwelling and contribute with newer information to use in prediction models.

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