NATURAL ENVIRONMENT RESEARCH COUNCIL

British Antarctic Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

Antarctic Funding Initiative [AFI]
Fourth Workshop

New Hall, Cambridge
27-28th September 2005

ABSTRACTS
OF
ORAL PRESENTATIONS

ABSTRACTS OF ORAL PRESENTATIONS

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

Speakers are identified by **bold** typeface in the following Table.

Project	Title	Authors	Affiliations
AFI1/05	The RABID project: activities on Rutford ice stream, west Antarctica	**Dr. Andy Smith**[1] Prof. Tavi Murray[2] Dr. Keith Nicholls[1] Dr. Keith Makinson[1] Guðfinna Aðalgeirsdóttir[2] Dr. Alberto Behar[3]	[1]British Antarctic Survey [2]Department of Geography, University of Wales, Swansea [3]Robotic Vehicles Group, NASA-JPL, Pasadena, CA 9110, USA
AFI2/34	Latitudinal clines in physiological capacities and upper lethal limits in Antarctic marine invertebrates	Prof. Lloyd Peck **Dr. Simon Morley**	British Antarctic Survey
AFI2/43	The eco-physiology of Antarctic fishes: A year under the ice	**Dr. Hamish Campbell**[1] Dr. Stuart Egginton[1] Prof. Lloyd Peck[2]	[1]University of Birmingham [2]British Antarctic Survey
AFI3/03	The Chemistry of the Antarctic Boundary Layer and Interface with Snow – *CHABLIS*	**Dr. Anna Jones**[1] **Dr. Rhian Salmon**[1] Dr. Stéphane Bauguitte[1] Dr. Eric Wolff[1] Dr. Alistair Lewis[2] Dr. Katie Read[3] Prof. Dwayne Heard[3] James Lee[3] Dr. William Bloss[3] Dr. Andrea Jackson[4] Sarah Walker[4] Dr. Kevin Clemitshaw[5] Zoe Fleming[5] Dr. David Ames[5] Dr. Dudley Shallcross[6] Paul Hamer[6] Dr. William Sturges[7] Dr. Graham Mills[7] David Worton[7] Prof. John Plane[7] Alfonso Saiz-Lopez[7]	[1]British Antarctic Survey [2]Department of Chemistry, University of York [3]School of Chemistry, University of Leeds [4]School of the Environment, University of Leeds [5]Department of Environmental Science and Technology, Imperial College London [6]School of Chemistry, University of Bristol [7]School of Environmental Sciences, University of East Anglia

Project	Title	Authors	Affiliations
AFI3/16	Moorings to investigate intra-annual variability in krill abundance and water-mass physical characteristics at South Georgia	Doug Bone[1] Dr. Mark Brandon[3] Dr. Andrew Brierley[2] **Dr. Peter Enderlein[1]** Sarah Jenkins[3] Prof. Eugene Murphy[1] Ryan Saunders[2]	[1] British Antarctic Survey [2]Gatty Marine Laboratory, University of St Andrews [3]Department of Earth Sciences, Open University
AFI3/36	The sub-Antarctic and polar fronts of the Antarctic circumpolar current at the North Scotia Ridge	Dr. Inga Smith[1] **Dr. David Stevens**[2] Prof. Karen Heywood[1] Dr. Mike Meredith[3]	[1]School of Environmental Sciences, University of East Anglia [2]School of Mathematics, University of East Anglia [3]British Antarctic Survey
AFI4/02	Behaviour of stable isotopes and trace elements: Reconstructing the Antarctic sea-ice environment	**Kate Hendry[1]** **Damien Carson[2]** Samia Mantoura[3] Dr. Rosalind Rickaby[1] Dr. Raja Ganeshram[2] Dr. Christina de la Rocha[3, †] Prof. Harry Elderfield[3]	[1]Department of Earth Sciences, University of Oxford [2]School of Geosciences, University of Edinburgh [3]Department of Earth Sciences, University of Cambridge ([†] now at AWI-Bremerhaven)
AFI4/13	Biogeochemical particle flux study in Marguerite Bay – season 2004-05	Prof. Tim Jickells[1] Prof. Andrew Clarke[2] **Dr. Mike Meredith[2]** Dr. Paul Dennis[1] Dr. Keith Weston[1]	[1]School of Environmental Sciences, University of East Anglia [2]British Antarctic Survey
AFI4/05	Testing Gondwana plume and break-up models: Constraints from magma flow directions	**Prof. Donny Hutton[1]** Dr. P. Turner[1] Dr. Bill Owens[1] Dr. Mike Curtis[2] Dr. Phil.Leat[2]	[1]School of Geography, Earth and Environmental Sciences, University of Birmingham [2]British Antarctic Survey
AFI4/09	Improving ice core interpretation: The role of storm track changes on the sub-annual peninsula precipitation variability.	**Georgina Miles** Dr. Gareth Marshall John Turner Dr. Robert Mulvaney Dr. Tom Lachlan-Cope	British Antarctic Survey
AFI4/16	Measuring changes in the size of the Antarctic peninsula ice sheet	**Dr. Robert Arthern** Dr. David Vaughan	British Antarctic Survey

Project	Title	Authors	Affiliations
AFI4/17	Palaeoenvironmental changes in the southern Bellingshausen Sea since the last glacial period – a reconstruction based on the sedimentary record	**Dr. Claus-Dieter Hillenbrand[1]** Dr. Colm Ó Cofaigh[2] Dr. Rob Larter[1] Prof. Julian Dowdeswell[3] Dr. Carol Pudsey[1] Prof. Werner Ehrmann[4] Dr. Hannes Grobe[5]	[1]British Antarctic Survey [2]Department of Geography, University of Durham [3]Scott Polar Research Institute, University of Cambridge [4]Institute for Geophysics and Geology, University of Leipzig [5]Alfred Wegener Institute for Polar and Marine Research, Bremerhaven, Germany
AFI5/01	Alkyl nitrates and organo-halogens in the Antarctic: Production in seawater and role in atmospheric chemistry	**Dr. Claire Hughes** Dr. Adele Chuck, Dr. Sue Turner Prof. Peter Liss	School of Environmental Sciences, University of East Anglia
AFI5/25	Tectonic and thermal history of suspect terranes on the Pacific margin of Gondwana	**Dr. Craig Storey**[1] Dr. Simon Kelley[1] Dr. Alan Vaughan[2] Dr. Ian Millar[3]	[1]Department of Earth Science, The Open University [2]British Antarctic Survey [3]NERC Isotope Geosciences Laboratory
AFI5/38	A meteor radar at Rothera for studies of the mesosphere and lower thermosphere	**Dr. Peter Younger[1]** Prof. Nick Mitchell[1] Dr. Patrick Espy[2]	[1]Centre for Space, Atmospheric and Oceanic Science, University of Bath [2]British Antarctic Survey
CGS6/13	Dynamic and static responses to low summer temperatures in the Antarctic mite, *Halozetes Belgicae*	**Tim Hawes[1]** Prof. Jeff Bale[1] Dr. Roger Worland[2] Dr. Peter Convey[2]	[1]School of Biosciences, University of Birmingham [2]British Antarctic Survey
CGS6/14	Field validation of iceberg detection on synthetic aperture radar images	**Tiago Silva[1]** Prof. Grant Bigg[1] Dr. Keith Nicholls[2]	[1]Department of Geography, University of Sheffield [2]British Antarctic Survey
CGS6/16	Swimming activity of Antarctic krill, *Euphausia superba*	**Dr. Magnus Johnson**[1] Dr. Geraint Tarling[2] Dr. Paul Chapman[3]	[1]Centre for Coastal Studies, University of Hull at Scarborough [2]British Antarctic Survey [3]SimVis Research Group, Department of Computer Science, University of Hull
CGS7/18	Optical properties of the sea around South Georgia: implications for remote sensing and primary production modelling	**Iain Carrie[1]** Dr. Beki Korb[2] Dr. Alex Cunningham[1]	[1]Environmental Optics Group, Physics Department, University of Strathclyde [2]British Antarctic Survey

THE RABID PROJECT: ACTIVITIES ON RUTFORD ICE STREAM, WEST ANTARCTICA [AFI1/05]

Andy Smith, BAS[1], Tavi Murray[2], Keith Nicholls[1], Keith Makinson[1], Guðfinna Aðalgeirsdóttir[2] and Alberto Behar[3]

[1]British Antarctic Survey, High Cross, Madingley Road, Cambridge CB3 0ET
[2]Department of Geography, University of Wales, Swansea SA2 8PP
[3]Robotic Vehicles Group, NASA-JPL, Pasadena CA 91109

The RABID Project (AFI 1-05) was designed to determine a full knowledge of the glacial history, flow dynamics and basal conditions of one West Antarctic ice stream in a single field season. Rutford Ice Stream is over 2 km thick and the central core of the project was to access the bed using a large hot-water drill. This would allow core samples to be retrieved from the bed and ice, and arrays of instruments to be deployed within the basal sediment and the boreholes. Activities on the ice surface were to include seismic, radar and GPS surveys.

Achieving these aims required a supply of 200 fuel drums (36 tonnes) and the deployment of around 25 tonnes of equipment, far more than is feasible in a single field season. It was made possible by scheduling a 5-year period between award and fieldwork. This allowed enough time for BAS Operations to establish the required depot, and the fieldwork was carried out in 2004-05, as originally planned.

We established a large field camp – suitable for up to 8 people plus numerous regular visitors – and the drill was assembled and tested. At the same time, surface arrays of GPS/passive seismic stations were deployed and a number of seismic reflection surveys completed. Drilling operations ran very smoothly, but unfortunately, within metres (literally) of reaching the bed, a hose failure occurred from which we were unable to recover. This was a serious blow to the project. Access to the ice stream bed was the project core, around which the other activities were tailored. However, these other project components continued to the end of the season and were very successful in their own right, showing remarkable new features of subglacial conditions and ice flow.

LATITUDINAL CLINES IN PHYSIOLOGICAL CAPACITIES AND UPPER LETHAL LIMITS IN ANTARCTIC MARINE INVERTEBRATES
[AFI2/34]

Lloyd Peck and Simon Morley

British Antarctic Survey, High Cross, Madingley Road, Cambridge CB3 0ET

The stable low temperature environment of the Southern Ocean has lead to the evolution of traits specific to polar marine ectotherms (cold blooded animals). At these temperatures the slow speed of cellular reactions results in low metabolic rates and a consequent reduction in the scope for activity. To compensate for this, cell physiology has adapted to ensure that vital bodily processes can be maintained, particularly through elevated mitochondrial densities (as seen in fish). These traits, that adapt animals so well for life in the cold, result in a very limited thermal tolerance (stenothermality). As temperature increases metabolic costs rapidly outpace the animals ability to produce energy. The balance between an organism's oxygen demand, for energy production, and ability to supply that oxygen, appears to be crucial in defining temperature tolerances.

In the high Antarctic annual variation in sea temperature can be less than 0.1°C, but at lower latitudes within the Southern Ocean there is a distinct annual variation in temperature (-1 to +4°C at The Island of South Georgia, 54°N). Animals from these latitudes are expected to be less stenothermal, more able to tolerate wider ranges in temperature, and better able to adapt to increased temperatures than Animals from Rothera (67°N). Understanding the mechanisms defining temperature limits and adaptation capability should give insights into evolutionary processes. Temperature limits also have added significance as we try to predict the impact of the current trend for environmental warming on Antarctic communities.

Through October and November specimens (*Laternula*, *Nacella* and *Harpagifer*) were collected simultaneously by SCUBA diving from JCR (at South Georgia and Signy 60°S) and SCUBA diving at Rothera. Insufficient densities of *Laternula* were found at South Georgia for collection so specimens were collected by German divers at Jubany (62°S). Animals collected aboard JCR were then transported in an aquarium at 0°C to Rothera, although this took 6 weeks longer than planned due to sea ice. Oxygen consumption was compared between all populations as temperature was raised in 2.5°C steps. Tissue samples were taken at each temperature and frozen in liquid nitrogen for subsequent analysis of changes in tissue biochemistry which indicate upper temperature limits. Tissue samples were also preserved for analysis of mitochondrial density and structure which will be correlated with degree of stenothermality. In parallel experiments the siphoning activity, blood oxygen saturation and heart rate were monitored to improve our knowledge of *Laternula* activity and energy budgets. *Nacella* from South Georgia, Signy and Rothera and a further set of Rothera *Laternula* are being acclimated at 3°C to study adaptive capabilities.

THE ECO-PHYSIOLOGY OF ANTARCTIC FISHES: A YEAR UNDER THE ICE [AFI2/43]

Hamish Campbell[1], Lloyd Peck[2] and Stuart Egginton[1]

[1]Department of Physiology, University of Birmingham, Edgbaston, Birmingham B15 2TT
[2]British Antarctic Survey, High Cross, Madingley Road, Cambridge CB3 0ET

The Notothenioid group of fishes make up 90 - 95% of the fish biomass caught in Antarctic waters. Consequently, notothenioids occupy niches filled by taxonically diverse groups of fishes in temperate and tropical oceans, and as such the Antarctic fish have been hypothesized as a comparable opportunity for studying evolutionary biology and to examine responses to selection in the environment. Perhaps because of this more is known about the molecular and physiological make-up of Antarctic fishes than any other group. In contrast, limited research has been dedicated to looking at the eco-physiology, behaviour and habits of these fish within their own environment. It was the purpose of this study to determine how Antarctic fish manage to survive in the sub-zero marine waters that are extremely seasonal in both photoperiod and food availability.

At Rothera research station the fish *N. corriiceps* is caught in abundance, and is almost exclusively the only inshore species. It may therefore be suggested as an important species in the food web of the Antarctic Peninsula. TO examine its eco-physiology novel biotelemetry electronics were utilised, which measured parameters from free-ranging fish throughout the austral year. Body temperature and heart rates were recorded by miniaturised datalogging devices, and the fishes movements determined by acoustic telemetry. This data from wild fish was correlated with controlled laboratory studies, and longer-term ID tag and recapture studies.

Results showed seasonal shifts in the central physiological mechanisms controlling the heart, and correlations with metabolism, and behavioural repertoires. Tracking studies showed that the depths that the fish chose to inhabit, were not sternothermal as expected, but showed 2-3^{0}C seasonal shifts due to the formation of a seasonal thermocline. These temperature fluctuations spanned the boundary of expected ice crystal formation for Antarctic fish (1.1^{0}C), and this would undoubtedly be a strong factor influencing physiology and consequently behavioural repertoires.

Subsidiary studies to look at genotypic and phenotypic responses were also carried out on similar inshore species on the other side of the continent at McMurdo sound, and on similar genotype species that have now adapted to temperate inshore waters around New Zealand.

THE CHEMISTRY OF THE ANTARCTIC BOUNDARY LAYER AND THE INTERFACE WITH SNOW – *CHABLIS*
[AFI3/03]

Anna Jones[1], Rhian Salmon[1], Stéphane Bauguitte[1], Eric Wolff[1], Alistair Lewis[2], Katie Read[3], Dwayne Heard[3], James Lee[3], William Bloss[3], Andrea Jackson[4], Sarah Walker[4], Kevin Clemitshaw[5], Zoe Fleming[5], David Ames[5], Dudley Shallcross[6], Paul Hamer[6], William Sturges[7], Graham Mills[7], David Worton[7], John Plane[7] and Alfonso Saiz-Lopez[7]

[1]British Antarctic Survey, High Cross, Madingley Road, Cambridge CB3 0ET
[2]Department of Chemistry, University of York, Heslington, York YO10 5DD
[3] School of Chemistry, University of Leeds, Leeds LS2 9JT
[4]School of Earth and Environment, University of Leeds, Leeds LS2 9JT
[5]Department of Environmental Science and Technology, Imperial College, Silwood Park Campus, Buckhurst Road, Ascot, Berkshire SL5 7PY
[6]School of Chemistry, University of Bristol, Bristol BS8 1TS
[7]School of Environmental Sciences, University of East Anglia, Norwich NR4 7TJ

CHABLIS is a major initiative to explore the atmospheric chemistry of the Antarctic boundary layer in far greater detail and for a longer period of time than has been achieved hitherto. It combines the skills and expertise of research groups from 5 U.K. universities plus the British Antarctic Survey (BAS). From the small amount of work that has previously been done, it is already clear that the Antarctic boundary layer behaves in very unexpected ways, driven by the extreme cold, long periods of darkness alternating with continuous sunlight, and a strong chemical coupling between the snowpack and the overlying atmosphere. The results from *CHABLIS* will be of great intrinsic interest, and have in addition, two broad aims. Firstly, to improve our understanding of the relationship between the chemical climatology of the atmospheric boundary layer and the chemical constituents in firn and ice which is crucial for the correct interpretation of the cores that are used in palaeo-atmospheric reconstruction. Secondly, to enable atmospheric chemistry models, describing the detailed interactions of highly reactive radical species, to be tested under extreme conditions and in a pristine environment. Successfully validated models can then be used with increased confidence for modelling the global atmosphere.

CHABLIS activities are framed within 3 specific research foci, each of which have a number of underlying questions:

1) Seasonal studies of oxidant chemistry in coastal Antarctica:
   - *What is the annual climatology of radical precursors in the Antarctic troposphere?*
   - *Is there evidence for radical chemistry during the Antarctic winter period?*
   - *Can we balance the budget of tropospheric O_3 in Antarctica during spring/summer?*
2) Year-round studies of the NO_y budget in coastal Antarctica:
   - *What controls the NO_y budget throughout the year?*
   - *How does this affect tropospheric NO_x and ice core nitrate ?*
3) Air/snow transfer studies:
   - *What is the connection between snow and the boundary layer concentrations of key species?*

To address these foci, field measurements for *CHABLIS* commenced during the summer season 2004, and ran throughout the Antarctic winter. During the summer season 2005, additional instruments were deployed to allow intensive study of Antarctic oxidants.

In this talk, we present an overview of the project, including the challenge of conducting such an extensive campaign in Antarctica, together with early results. Additional results will be made via post presentations.

MOORINGS TO INVESTIGATE INTRA-ANNUAL VARIABILITY IN KRILL ABUNDANCE AND WATER-MASS PHYSICAL CHARACTERISTICS AT SOUTH GEORGIA
[AFI3/16]

Doug Bone[1], Mark Brandon[3], Andrew Brierley[2], Peter Enderlein[1], Sarah Jenkins[3], Eugene Murphy[1] and Ryan Saunders[2]

[1] British Antarctic Survey, High Cross, Madingley Road, Cambridge CB3 0ET
[2]Gatty Marine Laboratory, University of St Andrews, Fife KY16 8LB
[3]Department of Earth Sciences, Open University, Milton Keynes MK7 6AA

Interannual variability is a characteristic feature of Southern Ocean ecosystems. Within year fluctuations are known to be an important of aspect of these changes in ecosystem operation between years. However, there is little information available on the factors affecting the timing and magnitude of such intra-annual variability. In the Scotia Sea region, studies of interannual variability have focussed on understanding the physical and biological interactions generating fluctuations in abundance of Antarctic krill at South Georgia. In this study we used continuously recording sub-surface moorings to investigate intra-annual variability in krill abundance and local oceanography. Two moored instrument arrays, each housing a 120 kHz Water Column Profiler (WCP) a 300 kHz Acoustic Doppler Current Profiler and a Conductivity/Temperature/Depth logger (CTD), were deployed in an on-shelf and off-shelf location to the north west of South Georgia. The deployments have been highly successful and have generated over 30 months of continuous oceanographic and acoustic backscatter data. These data are providing unique insights into the links between fluctuations in krill abundance and oceanographic variability over time scales previously unavailable from short-term research cruises. This talk will report on the successful completion of the field project and present analyses of intra-annual variability in oceanography, zooplankton migration and krill abundance that are changing our view of the operation of the local ecosystem.

THE SUBANTARCTIC AND POLAR FRONTS OF THE ANTARCTIC CIRCUMPOLAR CURRENT AT THE NORTH SCOTIA RIDGE
[AFI3/36]

I. J. Smith[1], D. P. Stevens[2], K. J. Heywood[1], and M. P. Meredith[3]

[1]School of Environmental Sciences, University of East Anglia, Norwich, NR4 7TJ
[2]School of Mathematics, University of East Anglia, Norwich, NR4 7TJ
[3]British Antarctic Survey, High Cross, Madingley Road, Cambridge CB3 0ET

The Subantarctic and Polar Fronts account for the majority of the volume transport associated with the Antarctic Circumpolar Current (ACC). After passing through Drake Passage, these fronts veer northward over the steep topography of the North Scotia Ridge. Interaction of the ACC with this ridge determines which waters are made available for exchange with the subtropics. The ridge is an obstacle to the flow of deep water, with the majority of the deep waters flowing through the gap in the ridge known as Shag Rocks Passage. This passage has a maximum depth of 3300 metres. The export of deep water across the ridge is an important process in the thermohaline circulation, but one that has been virtually unmeasured.

The North Scotia Ridge Overflow Project (AFI 3/36) included the first extensive Conductivity-Temperature-Depth (CTD)/Lowered Acoustic Doppler Current Profiler (LADCP) survey of the ridge, carried out in April and May 2003. The CTD/LADCP stations measured water properties such as temperature, salinity, dissolved oxygen and nutrients as well as the speed of the ocean currents. The total net transport across the North Scotia Ridge was found to be approximately 117 Sv (1 Sv = $10^6 m^2 s^{-1}$). The transport contains major contributions from the Subantarctic Front (approximately 50 Sv) and the Polar Front (approximately 60 Sv), with the remainder being contributed by weaker flows of varying direction. The partitioning of the transport into separate water mass categories and comparison of results with known transports upstream and downstream of the ridge system will be discussed.

Current meter/CTD moorings and bottom pressure recorders were deployed in Shag Rocks passage during the CTD/LADCP survey in 2003 and were recovered in November and December 2004. Initial results from these instruments will be presented.

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

K. Hendry[1], D. Carson[2], S. Mantoura[3], R. Rickaby[1], R. Ganeshram[2], C. de la Rocha[†,3] and H. Elderfield[3]

[1]Department of Earth Sciences, University of Oxford, Parks Road, Oxford, OX1 3PR
[2]School of Geosciences, University of Edinburgh, The King's Buildings, West Mains Road, Edinburgh, EH9 3JW
[3]Department of Earth Sciences, University of Cambridge, Downing Street, Cambridge, CB2 3EQ

[†]Now at: AWI-Bremerhaven, Postfach 12 0161, D-27515 Bremerhaven

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, are being undertaken to collect sea-ice, water column, phytoplankton, sinking particulates and surface sediment samples in combination with nutrient assays and physical oceanographic measurements. Time series sediment traps were deployed in January 2005 and will be retrieved during the 2005/2006 field season. These samples are being analysed in Edinburgh, Oxford and Cambridge for stable isotope (carbon, oxygen, nitrogen, germanium and silicon) and trace elements (barium, uranium, germanium, silver, cadmium and zinc). This unprecedented time series of geochemical and physical data 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 – SEASON 2004-05 [AFI4/13]

T. J. Jickells[1], A. C. Clarke[2], M. M. Meredith[2], P. Dennis[1] and K. Weston[1]

[1] School of Environmental Sciences, University of Norwich, Norwich NR4 7TJ
[2] British Antarctic Survey, High Cross, Madingley Road, Cambridge CB3 0ET

The aim of this project is to develop biogeochemical and physical budgets for Marguerite Bay which lies adjacent to Rothera. This is achieved using two moorings deployed in early 2005 from RRS James Clark Ross in Marguerite Bay. The moorings contain instruments to measure the physical properties (temperature, salinity) and currents in the water column. These are being used to further our understanding of water movements in the area which contribute to heat, salt and biogeochemical budget calculations. The moorings also contain sediment traps which collect sinking particulate matter which will be subsequently analysed to understand nutrient budgets and the controls on primary production (algal growth) in this region. These moorings will be recovered and redeployed in late 2005. We therefore have no samples/results from these moorings currently. We aim to deploy moorings in Marguerite Bay in early summer and early winter for the next two seasons at Rothera.

In addition to mooring work from research ships, samples were taken using small boats from Rothera during early 2005 to measure phytoplankton primary (including new and regenerated) production at the Rothera Biogeochemical Time Series (RaTS) site. This latter sampling is currently being continued by the Rothera Marine Assistant and will be more intensively sampled from November 2005- February 2006. Preliminary results from this sampling programme will be presented but the 2005-06 campaign was compromised by the well known difficulties resulting from the delayed relief of Rothera. We therefore decided to reduce our Rothera based campaign in 2004-05 and refocus sampling effort on the 2005-06 season. This is more likely to be effective since the necessary equipment is now at Rothera.

In summary this project will enable an assessment of physical and biogeochemical controls on primary production and particle flux and the controls on heat fluxes between the water and the atmosphere in this important region.

TESTING GONDWANA PLUME AND BREAK-UP MODELS:CONSTRAINTS FROM MAGMA FLOW DIRECTIONS [AFI4/05]

D. Hutton[1], P. Turner[1], W. Owens[1], M. Curtis[2] and P. Leat[2]

[1] School of Geography, Earth and Environmental Sciences, University of Birmingham, Edgbaston, Birmingham, B15 2 TT.
[2] British Antarctic Survey, High Cross, Madingley Road, Cambridge CB3 0ET

The Theron sill complex of the Transantarctic mountains is a stack of Jurassic tholeiite sills of quartz dolerite composition intruded into a thick sequence of sub-horizontal Carboniferous-Permian sandstones and shales of a delta top environment. The sills, which are individually up to 200m thick form a sharp, approximately 500m high and nearly 100km long escarpment (Theron Mountains).The age and chemistry of these bodies has been used to suggest that they belong to a basaltic superplume that impacted on the base of the lithosphere beneath the nearby Weddell Sea just before Gondwana break-up at the west Antarctic-Southeast Africa break-up site. Our project was designed to test this hypothesis and particularly that magma flow in the Therons should be from north to south (from centre to southern rim of the superplume. Two principle methods were used for this: field observational data and AMS (Anisotrophy of Magnetic Susceptibility). AMS involves the collection of some 1 metric tonne of oriented samples and the lab based determination of the magnetic fabric (= magmatic flow fabric) of the rock. The field based determination of flow, using such features as sill steps, sill bridges, orientated phenocrysts and asymmetric structures in sheared melt zones beneath some sills will be described here.

IMPROVING ICE CORE INTERPRETATION: THE ROLE OF STORM TRACK CHANGES ON THE SUB-ANNUAL PENINSULA PRECIPITATION VARIABILITY [AFI4/09]

Georgina Miles, Gareth Marshall, John Turner, Robert Mulvaney and Tom Lachlan-Cope

British Antarctic Survey, High Cross, Madingley Road, Cambridge, CB3 0ET

The West Antarctic Peninsula exhibits high meteorological inter-annual variability. This coupled with the sensitivity of the region to climate change promotes it as an important location for scrutiny.

The aims of this project are principally concerned with discerning the character and variability of precipitation and accumulation in the southwest of the Antarctic Peninsula. The project is at an early stage. In the previous field season, three micro-power Automatic Weather Stations, complete with twin sonic range sensors to detect snow accumulation, were successfully deployed at the three drill sites. The AWS's will record a full year of in-situ data. It is anticipated that blowing snow events will be able to be identified to improve accumulation estimates. Shallow ice cores will be obtained in the 05/06 field season from Rothschild, Latady and Smyley Islands, all in a region of relatively high annual accumulation. Within these ice cores and accompanying snow pits, chemical species variability indicative of changes in the season and origin of air masses bringing precipitation will be sought.

To aid in understanding fieldwork-derived results, an in-depth analysis of the modes of accumulation variability in the region west of the Peninsula has begun. Empirical orthogonal function (EOF) analysis using ECMWF ERA40 reanalysis data show that the two leading patterns together capture half of all the variance in accumulation. Both patterns are uncorrelated coherent spatial structures, which implies that they are a robust physical representation of much of the region's variability in accumulation. There are shortcomings with the dataset, particularly where the reanalysis model's land-sea mask is poorly resolved around the Peninsula. The ice core sites are on islands but are represented by sea in the model. A direct comparison between the modelled and actual accumulation rates should illuminate the principal disparities.

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

Robert Arthern and David Vaughan

British Antarctic Survey, High Cross, Madingley Road, Cambridge CB3 0ET

The glaciers of the Antarctic Peninsula are shrinking in length, 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 the necessary measurements through a two person field party transported to four remote field sites by Twin Otter aircraft. At each site we drilled ice cores to reveal the history of snowfall, and how the snow gets denser as it is crushed. We measured the glacier flow using stakes, surveyed by GPS. Comparing the flow away from our sites with the snowfall from the ice cores will reveal imbalances, which might be driving changes in sea level. Local thickness change will be measured directly by GPS, and compared to data from the European Space Agency satellite Cryosat, due for launch October 7th. 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 will continue to record data until they are recovered in the 2006/7 field season, giving two years of data on how the recent warming has affecting the thick ice of the Antarctic peninsula. The data will provide a valuable check of thickness changes measured by Cryosat. Furthermore, they will help to explain those changes so that the future behaviour of the ice sheet may be predicted more accurately.

PALAEOENVIRONMENTAL CHANGES IN THE SOUTHERN BELLINGSHAUSEN SEA SINCE THE LAST GLACIAL PERIOD – A RECONSTRUCTION BASED ON THE SEDIMENTARY RECORD
[AFI4/17]

Claus-Dieter Hillenbrand[1], Colm Ó Cofaigh[2], Rob Larter[1], Julian Dowdeswell[3], Carol Pudsey[1], Werner Ehrmann[4] and Hannes Grobe[5]

[1]British Antarctic Survey, High Cross, Madingley Road, Cambridge CB3 0ET
[2]Department of Geography, University of Durham, South Road, Durham DH1 3LE
[3]Scott Polar Research Institute, University of Cambridge, Cambridge CB2 1ER
[4]Institute for Geophysics and Geology, University of Leipzig, Talstrasse 35, D-04103 Leipzig, Germany
[5]Alfred Wegener Institute for Polar and Marine Research, Columbusstrasse, D-27568 Bremerhaven, Germany

Multibeam swath bathymetric data and sub-bottom acoustic profiles collected during RRS *James Clark Ross* Cruise JR104 revealed the existence of a major glacial trough ("Belgica Trough") on the West Antarctic continental shelf in the southern Bellingshausen Sea (75°-90°W, 69°-73°S), and of a trough mouth fan on the adjacent slope. Distinct seabed morphological features, such as mega-scale glacial lineations, drumlins and grounding-zone wedges, indicate that Belgica Trough represents the former pathway of a grounded ice stream, which had advanced to the shelf break during the last glacial maximum (LGM). Moreover, the orientation of the subglacial bedforms suggests that the ice stream was fed by grounded ice draining both through Eltanin Bay and Ronne Entrance, located to the south and south-east of Belgica Trough, respectively. These results give evidence that, in contrast to the present drainage pattern of the West Antarctic Ice Sheet, ice drainage to the southern Bellingshausen Sea played a significant role during the LGM.

Sedimentary sequences recovered with gravity cores in the southern Bellingshausen Sea document a whole suite of (sub-)glacial and glaciomarine environmental settings. The basal units in the cores from the slope, the outer shelf and Ronne Entrance consist of grey, massive, lithogenic diamictons. The diamictons on the slope represent glaciogenic debris flow deposits (GDFs), consisting of the detritus initially delivered by the grounded ice stream to the shelf edge during the LGM. In contrast, the lithologically similar diamictons on the shelf are interpreted as a combination of deformation tills deposited directly by the grounded ice, and sub-ice shelf sediments deposited during subsequent deglaciation. The basal sediments in cores from Eltanin Bay consist of grey-olive, lithogenic, massive to stratified gravelly muddy sands. Their deposition probably results from a combination of iceberg-rafting and sediment gravity flows. At other shelf sites thin-bedded units of lithogenic sandy muds overly the sub-ice shelf sediments. The GDFs on the slope are capped by similar lithogenic muds, which are interbedded with silty and sandy layers. These units are interpreted as distal turbidites. Like the muddy, sandy units on the shelf, the turbidites may have been deposited during the transition from subglacial to glaciomarine conditions. During the present interglacial period brown, bioturbated foraminifer-bearing muds were deposited on the middle to outer shelf and on the slope. Manganese-coated, iceberg-rafted debris (IRD) is often scattered on the sediment surface and points to low sedimentation rates (<1 cm/kyr). A seaward increase in sand contents and AMS ^{14}C ages of core tops is likely to result from current-induced winnowing of the fine fraction. Olive to brown, bioturbated diatomaceous muds were found on the inner shelf. IRD concentrations in these surface sediments are low, and Holocene sedimentation rates there are assumed to be significantly higher than farther offshore. Both the foraminifer- and the diatom-bearing sediments document plankton production in a seasonally open-marine setting.

ALKYL NITRATES AND ORGANO-HALOGENS IN THE ANTARCTIC: PRODUCTION IN SEAWATER AND ROLE IN ATMOSPHERIC CHEMISTRY
[AFI5/01]

Claire Hughes, Adele Chuck, Sue Turner and Peter Liss

Laboratory for Global Marine and Atmospheric Chemistry, School of Environmental Sciences, University of East Anglia, Norwich NR4 7TJ

The sea-to-air transfer of naturally-produced trace gases such as the alkyl nitrates and the organo-halogens is known to have an important influence on atmospheric processes related to climatic and environmental change. For example, the alkyl nitrates play an important role in regulating tropospheric ozone levels in remote marine regions. Additionally, the organo-halogens are known to be involved in ozone depletion reactions occurring from the marine boundary layer to the stratosphere, and new particle or cloud condensation nuclei formation. To establish the environmental implications of sea-air trace gas transfer it is vital that we have knowledge of (or can predict) spatial and temporal variations in the compounds of interest, and have an understanding of the processes controlling their production and loss in seawater. The aim of this AFI project is to extend our knowledge of alkyl nitrate and organo-halogen dynamics to Southern Ocean waters to establish the extent to which the polar regions are a source of these compounds. In this presentation we will report seawater and air, organo-halogen and alkyl nitrate concentration distributions measured during a research cruise on RRS *James Clark Ross* (November, 2004) in the Scotia Sea and provide estimated sea-air fluxes of specific compounds. Additionally, a series of depth profiles measured on- and off-shelf within the Western Box Core will be presented. These data, together with results from our preliminary laboratory incubation studies, will be used to assess the potential importance of the sea-air flux of alkyl nitrate and organo-halogen compounds from Southern Ocean waters. Our plan of research for the forthcoming Summer Season at Rothera will also be discussed.

TECTONIC AND THERMAL HISTORY OF SUSPECT TERRANES ON THE PACIFIC MARGIN OF GONDWANA
[AFI5/25]

Craig Storey[1], Simon Kelley[1], Alan Vaughan[2] and Ian Millar[3]

[1] Department of Earth Sciences, The Open University, Walton Hall, Milton Keynes, MK7 6AA
[2] British Antarctic Survey, High Cross, Madingley Road, Cambridge CB3 0ET
[3] NERC Isotope Geosciences Laboratory, c/o BGS, Keyworth, Nottingham, NG12 5GG

The Antarctic Peninsula comprises a collage of three terranes, some of which may be suspect. The Eastern Domain (ED), cropping out in eastern Palmer Land comprises part of the Mesozoic Gondwanan margin, The Central Domain (CD) of western Palmer Land is considered to be a micro-continental magmatic arc terrane and the Western Domain (WD) exposed on Alexander Island represents a subduction-accretion complex. These terranes may have been formed thousands of kilometres apart and accreted together diachronously along the margin of Gondwana prior to docking in their present configuration, or else they may represent one more or less contiguous piece of crust that has a history of only minor tectonic reconfiguration.

Key to testing the terrane hypothesis further and refining the chronology and geometry of possible accretionary events along the Gondwanan Margin, and the palaeo-geography of the terranes during the Mesozoic, lies within subduction-accretion units forming the Mesozoic Le May Group (LMG) of the WD. The LMG crops out extensively on the western side of Alexander Island and comprises terrigenous sedimentary units, oceanic crustal units and seamount volcanic units. One of the best areas to study the relationships between these lithologic associations is in central Alexander Island. A field season in 2004/05 was undertaken to re-examine this key area and collect strategic samples for micro-structural and geochronologic studies. We present new field observations and an enhanced tectonic model for this part of Alexander Island and discuss how geochronologic studies will help further understand the mechanisms involved and how these events relate to the larger-scale amalgamation of the Antarctic Peninsula.

A METEOR RADAR AT ROTHERA FOR STUDIES OF THE MESOSPHERE AND LOWER THERMOSPHERE
[AFI5/38]

P. T. Younger[1], N. J. Mitchell[1] and P. J. Espy[2]

[1]Centre for Space, Atmospheric and Oceanic Science, University of Bath, Claverton Down, Bath, BA2 7AY
[2] British Antarctic Survey, High Cross, Madingley Road, Cambridge CB3 0ET

The mesosphere and lower thermosphere (MLT) region at heights of ~ 50 - 100 km is the least explored part of the Earth's atmosphere and is notoriously difficult to observe. In February 2005, a meteor radar was deployed at Rothera Point to study the Antarctic MLT. The radar routinely makes three types of measurement:

1. *horizontal winds at heights of ~ 75 – 105 km from the drifting of meteors as they are carried by the winds of the MLT*
2. *atmospheric temperature from the decay rate of meteor echoes*
3. *meteor fluxes, derived from several thousand meteors per day*

The radar is being used with an identical system in Northern Sweden to investigate Antarctic/Arctic asymmetries, free from instrument biases and so investigate inter-hemispheric differences in wind and temperature. The radar has operated faultlessly from first operation on February 14th, 2005. Data are being recorded continuously and more than 4,000 individual meteors are detected per day. In this presentation, the meteor radar and its installation will be described. Preliminary results presented about the meteor flux observed, the observed background winds, tides and temperatures.

DYNAMIC AND STATIC RESPONSES TO LOW SUMMER TEMPERATURES IN THE ANTARCTIC MITE, *HALOZETES BELGICAE* [CGS6/13]

T. C. Hawes[1], J. S. Bale[1], M. R. Worland[2] and P. Convey[2]

[1]University of Birmingham, Department of Biosciences, Edgbaston Birmingham B15 2TT
[2]British Antarctic Survey, High Cross, Madingley Road, Cambridge CB3 OET

Cues governing the acquisition and loss of cold hardiness of *H. belgicae* at Antarctic summer temperatures were investigated over a range of time scales. Animals acclimated at 5 and 10ºC showed clear responses to feeding, wetting, and acclimation temperature. Animals from the 5ºC treatment had SCPs typical of the wintering state. Mites from the 10ºC treatment shifted their freezing points to the low group (freezing below –20ºC) after just 2 h exposure to 0ºC. *H. belgicae* showed evidence of a dual summer cryoprotection strategy, combining dynamic (i.e. rapid cold hardening) and static (i.e. semi-permanent cold hardiness) responses to low summer temperatures. Such a strategy sits well with the small body size (conferring high supercooling potential) and exposed situation of *H. belgicae* feeding on lichen-encrusted rocks that are liable to substantial variability in surface warming and cooling.

FIELD VALIDATION OF ICEBERG DETECTION ON SYNTHETIC APERTURE RADAR IMAGES
[CGS6/14]

T. A. M. Silva[1], G. R. Bigg[1] and K. W. Nicholls[2]

[1]Department of Geography, University of Sheffield, Sheffield S10 2TN
[2]British Antarctic Survey, High Cross, Madingley Road, Cambridge CB3 0ET

Giant icebergs (>18 km in length) around Antarctica have been monitored using low resolution satellite imagery since the late 70s. Synthetic Aperture Radar provides high resolution imagery independently of cloud cover or sun illumination, being thus well suited for Antarctic coastal areas. We conducted a ship-based iceberg survey in the Western Weddell and the South Orkneys to assess the quality of automatic iceberg detection on 150 m resolution SAR images. Unforeseen changes to the ship's itinerary led to a limited amount of data being collected. We found the main source of error to be multiyear sea-ice, in particular fast ice, and the implications of this are discussed. We also present results from a similar survey conducted on Greenland's coast this summer with 25 m resolution SAR images.

SWIMMING ACTIVITY OF ANTARTCTIC KRILL, *EUPHAUSIA SUPERBA* [CGS6/16]

Magnus Johnson[1], Geraint Tarling[2] and Paul Chapman[3]

[1] Centre for Coastal Studies, University of Hull at Scarborough, Filey Road, Scarborough YO11 3AZ
[2] British Antarctic Survey, High Cross, Madingley Road, Cambridge CB3 OET
[3] SimVis Research Group, Computer Science Dept, University of Hull HU6 7RX

Euphausiids are amongst the most prolific swimmers of all crustacea, which may be a key to their success in productive, patchy environments such as that of the Southern Ocean. They are also social animals and occur in swarms that may be tens of km long.

Very little is known of the ways in which such animals respond to external stimuli, internal conditions and each other. Although there have been some elegant studies of the behaviour of free swimming and tethered krill in aquaria, it is often difficult to quantify their swimming activity and responses to particular stimuli. A system capable of quantifying swimming activity in terms of thrust and swimming cycles of Nordic krill (Meganyctiphanes norvegica) in a land-based laboratory was modified for use with Antarctic krill whilst at-sea. Data allowed the examination of differences between male and female swimming behaviour and the effect of moult stage on performance. Results will feed into the development of a virtual krill swarm that will allow ecologists to visualise and investigate the mechanisms behind aggregation behaviour.

OPTICAL PROPERTIES OF THE SEA AROUND SOUTH GEORGIA: IMPLICATIONS FOR REMOTE SENSING AND PRIMARY PRODUCTION MODELLING [CGS7/18]

Iain Carrie[1], Beki Korb[2] and Alex Cunningham[1]

[1]Environmental Optics Group, Physics Department, University of Strathclyde, 107 Rottenrow, Glasgow G4 0NG
[2]British Antarctic Survey, High Cross, Madingley Road, Cambridge CB3 0ET

The inherent optical properties of seawater, including the coefficients of attenuation and absorption in nine wavebands, and backscattering in two wavebands, were measured at 55 stations to the south and west of South Georgia in December 2004 and January 2005. Distances from the island ranged from approximately 10 km to 100km with Optical measurements made down to a maximum depth of 200 m. Supporting measurements included CTD casts and determinations of the concentrations of phytoplankton pigments, coloured dissolved organic matter and organic and inorganic suspended particulate material. Examination of the variability in the relationship between inherent optical properties indicated that this was a promising method of discriminating between water masses dominated by different classes of suspended particles (for example diatom frustules near the sea surface and resuspended minerals close to the sea bed). Measurements of fluorescence (at 685 nm) and absorption (at 675 nm) were used to interpolate between discrete pigment determinations from water bottle samples, and to increase the spatial resolution of profiles of phytoplankton abundance. Optical profiles were also used as inputs for constructing mathematical models of radiance transfer in the South Georgia region (using the Hydrolight software package) in order to calculate sea surface reflectance spectra and variations in the underwater light climate with depth. The spectral resolution of the calculated underwater light field, combined with measurements of phytoplankton absorption spectra, can be used to refine estimates of euphotic depth for primary production modelling. The calculated water-leaving radiances were used to assess the potential accuracy of remote sensing of chlorophyll concentrations for these waters, using standard algorithms for SeaWiFS and MODIS satellite radiometer wavebands. It is unlikely that the NASA target of +/- 30% accuracy will be met for the range of chlorophyll concentrations encountered on this cruise (below 5 $\mu g\ l^{-1}$).