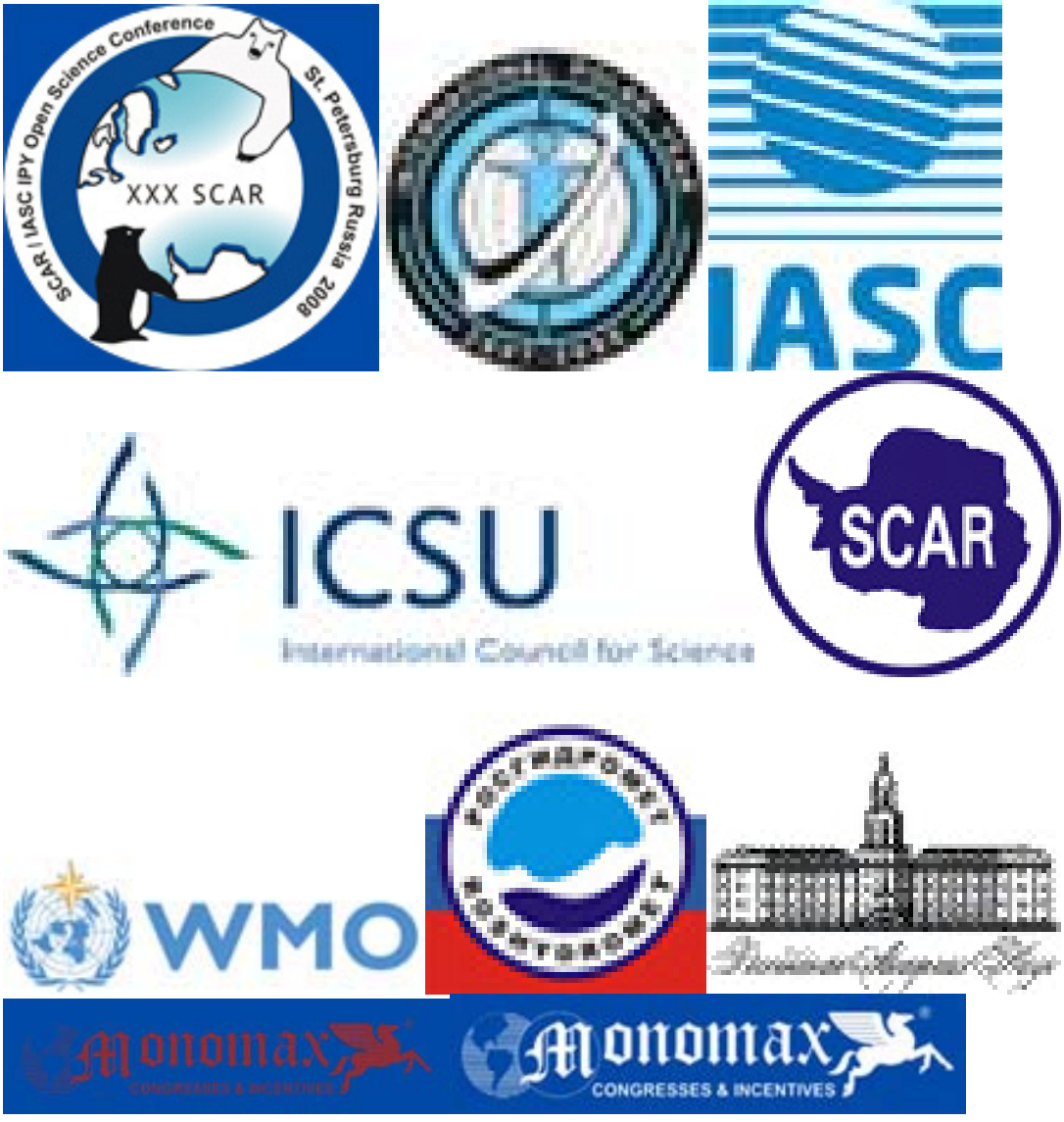
Scientific Committee on Antarctic research (SCAR)
International Arctic Science Committee (IASC)

Polar Research – Arctic and Antarctic perspectives in the International Polar Year

SCAR/IASC IPY Open Science Conference

St. Petersburg, Russia, July 8-11, 2008



Ocean, Ice, and Atmospheres

SEA ICE VARIABILITY AROUND NORTHWEST ANTARCTIC PENINSULA INFERRED FROM JOINVILLE ISLAND ICE CORE

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S2.1/P01

Sea ice variability has been recognized as an important tool for the understanding of the global climatic system, considering its affects on ocean circulation and the heat exchanges between ocean and the atmosphere. A study of the sea ice seasonal variability at Northwest Antarctic Peninsula region was accomplished through the integrated analysis of proxies (Na+, Cl- and MSA) at Joinville island icecap, complemented by regional sea ice and meteorological databases. The marine derived proxies were studied through the snow/ice stratified samples collected from a shallow (depth of 8m) ice core recovered at 560m a.s.l. The dating of the ice core, inferred from 18O analysis, corresponded to approximately 13 years of atmospheric precipitation, enclosing the period 1993-2005. Combined ionic analysis and satellite image processing of sea ice area from Weddell and Bellingshausen-Amundsen seas, allowed a detailed analyze of the relative contribution of different sections of sea ice cover with respect to marine ions deposits. Correlation analysis among Na+, Cl-, MSA concentrations (μEq L-1) and sea ice area showed r-Pearson for n=13 and < 0.05: rNa+=+0.66, rCl-=+0.74 and rMSA=+0.80. Our results indicate that MSA is a consistent proxy parameter for the sea ice area reconstruction in the Northwest Antarctic Peninsula region.

NASA TEAM AND ARTIST SEA ICE CONCENTRATIONS: COMPARISONS WITH RUSSIAN SHIPBORNE OBSERVATIONS OF 15 CRUISES

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S4.1/P01

Satellite microwave radiometry enables to monitor sea ice under all sky conditions every day. Visual ship-borne observations provide detailed continuous information about numerous sea ice characteristics such as total ice concentration (TIC), and melting stage. We compare such observations made during 15 expeditions in the Eurasian Arctic within 1996-2005 (summer and winter) with the daily average TIC obtained from Special Sensor Microwave/Imager (SSM/I) data using two different algorithms: the NASA Team (NT) and Artist Sea Ice (ASI) algorithm. The latter uses 85 GHz SSM/I data, enabling a four-fold resolution improvement compared to the NT algorithm. Ship-borne observations are co-located with the SSM/I data and averaged over one day within carefully selected bounds. Both algorithms under- (over-) estimate the TIC relative to the ship observations under compact (open) ice conditions. Absolute average errors vary between 11% and 23% (both NT) and, when obtained with ASI algorithm TIC values, are typically half of those for NT algorithm TIC values. Values below 20% are underrepresented in the NT

algorithm TIC, particularly during summer, when ASI algorithm TIC values - albeit exhibiting a larger spread – agree considerably better with ship-borne data. The influence of the melting stage on the errors identified is assessed.

RECENT PROPERTY CHANGES OF ANTARCTIC BOTTOM WATERS

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S1.2/O04

Recent hydrographic surveys have revealed dramatic changes of Antarctic Bottom Waters (AABW) in the Indian-Pacific ocean sectors of the Southern Ocean. Repeat summer hydrographic observations clarified a significant change of Adelie Land Bottom Water (ALBW) between the mid-1990s and 2002-2003; the bottom water cooled by 0.2 ?C and freshened by 0.03 psu. Comparison of the recent data to high quality historical observations showed that the ALBW also freshened between the late 1960s and the mid-1990s. The simplest explanation of the observed changes is that there has been a long-term and continuing freshening of the source waters supplying bottom water to the Australian-Antarctic basin. Recent hydrographic observations also showed that Ross Sea Bottom Water (RSBW) warmed and freshened. Limited evidence suggests the freshening of these bottom waters can be traced to a decline in salinity of the shelf waters. In contrast to these two region, a relatively small change was observed in the eastern Weddell-Enderby Basin. Given the global influence of AABWs on the properties of the abyssal waters, identification of their mechanisms is of a high priority in future climate research.

ANTARCTIC PENINSULA SNOWMELT DYNAMICS AS DETECTED BY SAR IMAGERY DURING THE SUMMER 2006/2007

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S4.3/P02

Recent drastic changes in the Antarctic Peninsula glacial systems are associated to a significant warming trend and comprise changes in precipitation patterns, reduction of the seasonal sea ice cover, disintegration of ice shelves, retreat of glacier fronts, upward shift of the dry snow line, and an increase in the duration of melting conditions. However, due to the lack of systematic observations in this region, it is difficult to estimate glacier runoff and to predict ice masses responses to environmental changes. This paper shows the results of an algorithm to monitor the Antarctic Peninsula snowmelt dynamics using Envisat ASAR WideSwath data. Several surface melting events were detected on both sides of the Antarctic Peninsula using sixty ASAR scenes acquired during the austral summer 2006/2007, this phenomenon occurred even when surface air temperature were well below freezing point at nearby stations. The widespread melting indicates that simple snowmelt and runoff models based only on positive degree-days, calculated from nearby weather stations data, may underestimate the energy in the snowpack available for melting. These models can be improved by considering the snowpack information (i.e., snow wetness) derived from SAR data.

RECENT CHANGES IN ANTHROPOGENIC CARBON UPTAKE IN AN ISOPYCNIC OCEAN CARBON CYCLE MODEL

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S1.2/O22

For recent decades observations indicate a reduction in the strength of major oceanic carbon sinks, in particular those at high latitudes. We use an ocean carbon cycle model based on the isopycnic ocean model MICOM and the ocean biogeochemistry model HAMOCC5.1 to investigate possible mechanisms behind these changes. Isopycnic ocean models represent the ocean as layers of constant density and thus mimic the structure of the interior ocean. This avoids the spurious diapycnal mixing present in z-level models and makes them well suited to simulate tracer transport in the ocean interior. The model was initialised from mean observed nutrient, DIC and alkalinity profiles and spun up using a NCEP-based monthly climatology. We forced the model with observed CO2 emissions 1860-2000. Global uptake pattern, magnitude and the evolution of the atmospheric CO2 level in the prognostic slab atmosphere agree well with observations. We investigated the effect of changes in atmospheric forcing on CO2 uptake by comparing model experiments forced by climatological forcing and NCEP reanalyses 1948-2000. While global CO2 uptake is not significantly different between the two experiments, large differences appear regionally especially in the North Atlantic, Nordic Seas and Arctic Ocean.

A 150-YEAR RECONSTRUCTION OF THE SOUTHERN ANNULAR MODE

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S1.5/O31

Southern Hemisphere climate variability is dominated by two oscillating drivers: the Southern Annular Mode (SAM) and the El Nino Southern Oscillation (ENSO). Combined, the two forcings can enhance or partially off-set their influence on Southern Hemisphere climate. A 130m deep ice core record (d18O, dD, deuterium excess, major ion and trace elements) from coastal Victoria Land in the Ross Sea Region provides insights into the relationship between regional temperature, sea-ice extent, SAM, and ENSO. Our results show that more than 50% of the regional temperature variability can be explained by combined SAM and ENSO forcing. Sea-ice extent is negatively correlated to temperature variability with more (less) extensive sea-ice during warmer (colder) years. This inverse relationship is explained by a positive ENSO forcing of sea-surface temperatures and a negative ENSO forcing of regional air temperature. Transfer functions are used to convert water isotope and deuterium excess records into a proxy index for SAM. Our data suggest that over the last 150 years mean annual SAM increased overall by almost 1 sigma standard deviation. The increase occurs predominantly during 1868-1944 and 1971-present. We conclude that ozone depletion can only partially explain the observed intensification of the polar vortex.

INTRASEASONAL EXTREME TEMPERATURE ANOMALIES IN THE ANTARCTIC PENINSULA AND ATMOSPHERIC MECHANISMS

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S1.6/O19

Previous studies suggest that interactions tropics-extratropics and the dynamics of the stratosphere are important factors to understand climate variations in the extratropics. We examined intraseasonal extreme anomalies of surface air temperature in the Antarctic Peninsula during the winter, spring and summer season, investigating the interactions tropics-extratropics and troposphere-stratosphere on intraseasonal time-scale (20-100 days). Cold *intraseasonal extreme temperature (IET)* are associated with persistent upper level cyclonic anomalies, easterly anomalies of the polar jet and cold advection in low levels over the Peninsula. Opposite features are observed during warm IET. An extratropical wave-train is observed during all IET with stronger intensity during winter and spring. This feature resembles the Pacific South American (PSA) teleconnection pattern. The stratosphere-troposphere interaction during IET events was examined with composites of the Eliassen-Palm Flux intraseasonal anomalies (EPIS). During spring, the wave activity is more intense and the EPIS direction is opposite to winter. Intraseasonal anomalies in the circulation and the wave activity in the troposphere and stratosphere lead the IET in about 10 days. Therefore, the intraseasonal activity in the extratropics and the interactions stratosphere-troposphere are important factors for a complete understanding of the temperature variability over the Antarctica Peninsula.

TWENTY FIRST CENTURY CLIMATE CHANGE IN THE POLAR REGIONS

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S1.5/O01

Here we will present an assessment of polar climate change over the twenty first century based on data from 19 of the 24 models that were submitted for the Intergovernmental Panel on Climate Change (IPCC) Assessment Report Four (AR4). Different models produce a range of responses to climate forcing, even under a single scenario. To provide more reliable estimates of future change, a weighting scheme has been applied to the AR4 models, which depends on a measure of their ability to reproduce the climate of the late 20th century. For the Southern Hemisphere the results show a seasonal variation of increases in circumpolar westerlies around Antarctica, which show the largest increases of 27% in autumn. This seasonal cycle was found to be consistent with projected changes in the semi-annual oscillation (SAO). The weighting gives a larger increase of the autumn SAO peak, up to 30% larger for April. For the Northern Hemisphere it was found that the models that produce the closest match to observed climatological sea ice concentration patterns show larger sea ice reductions over the 21st century.

ON POSSIBLE ASSOCIATION BETWEEN ANTARCTIC SEA ICE CONCENTRATION AND ALL INDIA RAINFALL

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S1.6/P07

The existence of polar sea-ice and its variability affects the global climate over a range of time scales. Therefore, the long-term impact of Antarctic sea ice concentration (AnSIC) on the all India rainfall (AIR) is studied using correlation analysis of AIR with the AnSIC lag time series. The AnSIC time series lagging by 11 months is strongly correlated with the AIR showing a

possible aassociation between the two. Possibility of utilizing this association is explored by investigating the predictability of AIR anomalies from AnSIC using a multimodel ensemble of nonlinear models of Artificial Neural Networks (ANN) with error backpropagation learning algorithm. The model shows considerable skill in predicting the anomalous AIR up to 11 months in advance. The correlation coefficients are found to be > 0.9 both for the training and the test cases. The root mean squire error values are also significantly smaller than the standard deviation of the observed rainfall anomalies. Thus, the model is capable of making predictions well in advance. The success of the model may be attributed to the domination of the AIR due to the presence of few distinctive modes in the coupled air-sea-ice system and to the model's ability to detect these modes.

ICE CONDITIONS IN THE ANTARCTIC AND THE EVOLUTION OF ENSO

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S2.1/P06

Tropical climate variability influences the Antarctic sea ice on different time scales and vice versa. The strongest amongst them is the El-Nino Southern - Oscillation (ENSO) teleconnection on the inter-annual time scale. The polar tropical teleconnection has been attributed to factors like the stationary Rossby wave associated with the tropical convection, meridional thermal gradient change due to changes in the tropical sea surface temperatures and regional meridional circulation change in the atmosphere. However, the present investigation shows that the changes in the ice conditions in the Antarctic and the evolution of the ENSO influence each other. Of special importance is the connection between the Weddell sea ice and the ENSO that appear to get liked through the meridional circulation. This investigation is expected to provide better insight to the tropical-polar circulation during El-Nino period.

IRON IN WATERS OF THE WESTERN BELLINGSHAUSEN SEA DURING SIMBA

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S1.2/P10

During the SIMBA (Sea Ice Mass Balance in the Antarctic) ice drift station on board R/V *Nathaniel B. Palmer* (cruise NBP0709) from Sept. 1 Nov. 1, 2007, five vertical dissolved iron (DFe) profiles from surface to bottom were obtained in the western Bellingshausen Sea along the continental slope (water depths 1680-3050m) and in the close vicinity of Peter I Island (water depth 1000m). Measurements were done by a novel isotope dilution multi-collector ICP-MS technique. We observed smooth nutrient type DFe profiles, which increased from 0.6-0.7 nM to 1.1-1.2 nM in deep water in function of distance to the continental shelf and water depth. Near-bottom enrichment up to 1.6nM may originate from diagenetic iron diffusion and/or sediment resuspension. Iron in the upper 250m was patchier (0.2-1.1 nM), especially at one station in the wake of an iceberg that approached the ship to 500m. Near Peter I Island there was 10 nM DFe in the upper 200m and 2-3 nM until the seafloor. We surmise that not only the numerous

icebergs and melting sea ice are significant pelagic iron sources in this region to support primary productivity, but also continental and island shelves.

POLAR CLIMATE: REGIONAL FEEDBACKS AND GLOBAL LINKS

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S1.6/O26

Sensitivity experiments using a coupled regional atmosphere-ocean-ice model of the Arctic has been conducted in order to identify the requirements needed to reproduce observed sea-ice conditions and to address uncertainties in the description of Arctic processes. While more sophisticated schemes for the albedo, the treatment of lateral freezing and melting, and the snow cover have been successfully introduced into the model, the parameterization of clouds is an open issue. The global influence of Arctic climate feedbacks connected with sea-ice albedo changes and stratospheric ozone changes have been investigated. The simulations show significant changes over the Arctic and the whole globe due to changes of planetary wave patterns, which trigger the Arctic Oscillation (AO) and influences the sea -ice cover. The impact of an interactive stratospheric ozone chemistry on the tropospheric circulation have been studied on the basis of the atmosphere-ocean-sea ice general circulation model ECHO-GiSP. The results show a sensitivity of the tropospheric circulation dynamics to the stratospheric chemistry. With enabled interactive stratospheric chemistry the model tends to the negative phase of the AO mode and a more unstable polar vortex. To improve the nonlinear feedbacks between regional and global circulation structures an adaptive barotropic atmospheric model has been developed.

A HIGH RESOLUTION COUPLED SEA-ICE/OCEAN MODEL FOR THE ANTARCTIC PENINSULA REGION: WARM OCEANIC WATER INTRUSIONS ONTO THE SHELF

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S1.2/P12

A high-resolution (4 km) regional ocean circulation model that includes a dynamic sea-ice model and thermodynamically active ice shelves has been developed for the Antarctic Peninsula area. The dynamic sea-ice model (Budgell, 2005) is based on thermodynamics that include two ice layers, a snow layer, and a molecular sub layer at the ice/ocean interface. The sea-ice dynamics are based on an elastic-viscous-plastic rheology. The ice shelves in the model are assumed to have no flexural rigidity and are just floating on the water beneath. The ice shelf thermodynamics are based on a three equation viscous sub-layer model. Atmospheric forcing comes from several sources including the operationally used Antarctic Mesoscale Prediction System. Simulations have been compared with observation from several sources including data from the Southern Ocean Global Ocean Ecosystems Dynamics field program in order to asses the model's suitability as a platform for studying the environmental effects on the region's biology, including ocean exchange and shelf retention. The locations of intrusions of warm Circumpolar Deep Water onto the continental shelf match those found in observations. Also, the model shows a gyre circulation in the Marguerite Bay area that corresponds with suggestions in biological observations of a retention area.

VARIATIONS OF WATER MASSES IN THE ATLANTIC SECTOR OF SOUTHERN OCEAN OBSERVED IN CASO

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S1.2/O02

Data from a presently ongoing cruise with RV Polarstern in the context of the IPY Climate of Antarctica and the Southern Ocean (CASO) project in the Atlantic sector of the Southern Ocean extent the time series of observations of water mass properties beginning in 1989 to 2008. Measurements from moored instruments and under-ice floats complement the data set. They reveal significant temperature and salinity variations of the Warm Deep Water and the Weddell Sea Bottom Water. In the bottom water of the Weddell Sea proper a temperature increase by 0.12°C was observed over 16 years from 1989 to 2005. At the prime meridian warming occurred in the Warm Deep Water from 1984 to 1996 followed by cooling since then. The warming trend in the bottom water is detected here as well and started in 1992. The salinity of the Winter Water was subject to significant increase reducing the stability of the upper water column. The data obtained during the present cruise will allow shedding further light into the processes being the origin of the changes and help to estimate the role of decadal variability.

AIRCRAFT OBSERVATIONS OF THE ATMOSPHERIC BOUNDARY LAYER OVER THE RONNE POLYNYA, SOUTHERN WEDDELL SEA, ANTARCTICA

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S1.6/O09

The Ronne Polynya is a coastal polynya, which is an area of open water in pack ice caused by the offshore advection of the ice by strong continental winds as quickly as it can form. The atmosphere above and downwind of the polynya is warmed by the open water, leading to the formation of a convective internal boundary layer (CIBL). Quantification of the ocean-atmosphere heat fluxes is a step towards quantifying the surface energy budget, which will aid understanding of the key processes governing deep water formation in this region. High frequency wind and temperature data from three surface layer flights over the Ronne Polynya were collected on separate dates in February 2007 from the British Antarctic Survey s newly instrumented twin otter aircraft. The evolution with offshore distance of sensible and latent heat fluxes and CIBL structure have been calculated for these cases. Relationships between surface ice thickness and the neutral drag coefficient (CDN) and exchange coefficient for sensible heat flux (CHN) have also been investigated. The data have been used to validate and improve the output of heat fluxes and boundary layer height from a simple fetchdependent CIBL model.

SURFACE HEAT FLUXES AND GLOBAL CLIMATE VARIABILITY IN THE ROSS AND WEDDELL SEAS

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S2.1/P08

In the Ross and Weddell Seas, interactions between atmosphere and ocean are strongly influenced by the presence or absence of the ice cover, hindering sensible heat fluxes and preventing latent heat loss. In the first step, a new algorithm was implemented to estimate the sea ice and snow thickness from SSM/I brightness temperature in the Ross and Weddell Seas.

Results show that in the Ross Sea the mean value of ice thickness (90 cm) is about 10 cm greater than in the Weddell Sea. Then we analyze the heat budget estimated using ERA-40 re-analysis and operational data provided by the ECMWF. By integrating the surface heat fluxes over the studied areas we obtained monthly and yearly means. During the available period, in the Ross Sea, the heat loss reaches its maximum in 1989 (-130 Wm-2) and its minimum (-86 Wm-2) in 1980. In the Weddell Sea the heat loss reaches its maximum in 1979 (-122 Wm-2) and its minimum (-91 Wm-2) in 1989. The studied areas show synchronous or opposite variations depending on the period. Explanation of this behaviour is linked to the signature of global climate variability expressed by ENSO, SAM and ACW.

BIPOLAR ATLANTIC THERMOHALINE CIRCULATION BIAC

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S1.2/P16

Arctic and Antarctic Ocean shelf ventilation processes and their impacts on the bipolar Atlantic thermohaline circulation are addressed. Two key observation areas are identified: the Barents Sea and the southern Weddell Sea. Cooling, ice formation and subsequent brine release determine the characteristics and volume of deep water formation over the continental shelf areas in Polar Regions. In the Antarctic, water at great pressures underneath vast floating glaciers is super-cooled with respect to the surface freezing point making it potentially denser than the Arctic brand of bottom water. In the Antarctic the deep water formation sites are adjacent to the world ocean abyss, and the sills separating the two regions are more than 3 km deep The dense water formed in the north-eastern Barents Sea continues on a long journey (years to decades) around the Arctic perimeters where it mixes with the dense water formed on the shallow shelves. The dense water leaves the Arctic via the Fram Strait, following the east Greenland coast and eventually enters the Norwegian Sea at about 2000 m depth. Finally, this water enters the North Atlantic abyss by overflowing the sills between Greenland and Scotland.

VARIABILITY OF THE SOUTHERN OCEAN ICE EXTENT AND WATER MASSES CHARACTERISTICS DURING THE LAST 100 YEARS IN A CLIMATE MODEL USING DATA ASSIMILATION

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S1.2/O07

The goal of this study is to combine the few long term observations with model results in order to provide new insights in the changes that occurred in the Southern Ocean during the 20th century. To do so, we analyse simulations performed with the climate model of intermediate complexity LOVECLIM using a simple data assimilation technique to force the model to follow the observations of land-surface temperature over the period 1851-2000. This technique could be briefly described as follows. For each year, a large ensemble of simulations is performed (96 here). The member of the ensemble that is the closest to observations is then selected as representative for this particular year and used as the initial condition for the subsequent year. The results of this run are compared to the available long term salinity and temperature observations in the Southern Ocean to check that the model simulation provides a coherent reconstruction of the past changes in the Southern Ocean. Finally, we investigate if the recent

changes observed in the Southern Ocean during the 20th century are consistent with the forced response simulated by models or if internal variability is the most likely cause of those changes.

SEA ICE THICKNESS AND ICE PRODUCTION IN THE LARSEN POLYNYAS, WEDDELL SEA

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S1.2/O25

Since the disintegration of the Larsen A and Larsen B ice shelves, large amounts of new sea ice are formed in and exported from the resulting sea bays, potentially affecting bottom water formation in the Weddell Sea. Satellite synthetic aperture radar (SAR) imagery and a thermodynamic ice growth model were used to study polynya processes and ice drift throughout the winter of 2006, and to estimate the amount of sea ice production. SAR imagery and the model result were validated by means of extensive airborne ice thickness measurements performed in October 2006, during the WWOS cruise of the German icebreaker RV Polarstern. The SAR imagery revealed very dynamic sea ice and iceberg calving conditions in the region. Mean ice drift was directed eastwards in the inner bays, turning northeast and accelerating further east in the transition to the Weddell Gyre. Modal and mean ice thicknesses were 1.2 m and 1.6 to 2.0 m in the outflowing branches of the Larsen A and Larsen B bays, respectively, in good agreement with model results. Combination of model results and ice drift result in an estimate of 0.7 and 3.7 km3 of sea ice produced in the Larsen A and B polynyas, respectively.

AUTONOMOUS UNDERWATER VEHICLE MEASUREMENTS OF SURFACE WAVE PROPERTIES IN THE MARGINAL SEA ICE ZONE

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S3.4/O03

The Autosub AUV (autonomous underwater vehicle) of the National Oceanography Centre (UK) carried out several missions under sea ice in March 2003 in the western Bellingshausen Sea. Data from the upward-looking Acoustic Doppler Current Profiler (ADCP) indicate a strongly-oscillating horizontal velocity of the ice due to ocean swell. The nature of the swell depends on distance from the ice edge, evident from the three missions in which the vehicle traveled from the ice edge to the interior of the ice pack. Swell period, height, direction, and directional spread have been computed every 800 m from the ice edge to 10 km inward for these missions. Exponential, period-dependent attenuation of waves propagating through sea ice was observed. Mean period increased with distance from the ice edge. The wave field was refracted during propagation through the ice cover. The directional wave spread does not seem to relate to distance from the ice edge, although higher frequencies tended to be more spread. An ordinary ADCP suitably deployed from an autonomous or fixed platform may be used with this technique to study both scalar and directional properties of waves in open or ice-covered water.

UNDER-ICE TURBULENCE MEASUREMENTS IN THE ARCTIC SUMMER MADE BY AN AUTONOMOUS UNDERWATER VEHICLE

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S3.4/O12

Horizontal profiles of ice-ocean boundary layer fluxes in summer were obtained using data collected by an Autonomous Underwater Vehicle (AUV) during the Surface Heat Balance of the Arctic Ocean (SHEBA) experiment of 1998. Scalars and their fluxes, as well as vertical stability, varied in the horizontal direction with correspondence to the changes in the overlying surface. A highly-stable fresh layer of ice and snow melt was formed in leads and grew in thickness over June and July. Subsequently, a storm removed this layer via shear-generated turbulence, supercritical hydraulic flow speeds, and ice divergence. Strong fluxes were observed under and downstream of rough, ridged ice, and properties changed rapidly with distance downstream of leads. The location and signs of the fluxes suggest that fresh surface water was forced under more dense salty water downstream of leads and/or ridges. Simulations from a 2-D unsteady model suggest that both mechanical forcing from ice topography and a dynamic instability near downstream lead edges may enhance vertical mixing, particularly when ice velocity is large. The horizontal variability in interfacial fluxes observed at SHEBA may explain the difference between the observed melt rates and those calculated using a bulk relationship.

SENSITIVITIES OF SEA-ICE EXPORT THROUGH FRAM STRAIT IN A COUPLED OCEAN/SEA-ICE ADJOINT MODELING FRAMEWORK

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S1.2/O26

The sensitivity of sea-ice export through Fram Strait to changes in various elements of the ocean and sea-ice state, and to elements of the atmospheric forcing fields through time and space is assessed by means of a coupled ocean/sea-ice adjoint model. The adjoint model furnishes full (two- or three-dimensional) spatial sensitivity maps (also known as Lagrange multipliers) of the export metric to a variety of model variables at any chosen point in time, providing the unique capability to quantify major drivers of sea-ice export variability. The underlying model is the MIT ocean general circu- lation model (MITgcm), which is coupled to a Hibler-type dynamic/thermodynamic sea-ice model. The configuration is based on the Arctic face of the ECCO2 high- resolution cubed-sphere model, but coarsened to 36-km horizontal grid spacing. The adjoint of the coupled system has been derived by means of automatic differentiation using the software tool TAF. To assess the sensitivity behavior with respect to different basic states, three five-year forcings, (1) covering a phase of high NAO (1977 to 1981), (2) cover- ing a phase of low NAO (1989 to 1993), and (3) covering the recent period (2003 to 2007). The results show a complex interplay between atmospheric forcing patterns, heat transport carried by extensions of the North Atlantic current, and sea-ice evolu- tion. Apparent dominant patterns on various time scales underline the transient nature of the problem.

CHANGES IN THE DENSE WATER OUTFLOW FROM THE WEDDELL SEA

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S1.2/O03

The ocean properties of the Weddell Sea at the Antarctic Peninsula, together with the export of cold, dense Weddell Sea Deep and Bottom Water, have been monitored regularly since the late 1980s primarily by AWI as a contribution to WOCE and CLIVAR. As well as temperature and salinity, the stable isotopes of oxygen have been measured on several repeat cruises. The most recent of these was during the ADELIE project in early 2007. Here we reveal that the densest water found within the ribbon of Weddell Sea Bottom Water hugging the continental slope of the Weddell Sea has freshened and cooled during the last decades. Over 16 years the densest water has cooled by about 0.1 degrees Celsius and freshened by about 0.04. Isotopically it has become lighter by about 0.1 per mille indicating a greater proportion of glacial ice melt has contributed to the decreased temperature and fresher salinity. Nonetheless the water masses remain on the same mixing line indicating that the same formation processes are likely to be at work.

PATTERNS OF GLACIER RESPONSE TO DISINTEGRATION OF THE LARSEN B ICE SHELF, ANTARCTIC PENINSULA

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S1.4/O11

Glaciers that flowed into the former Larsen B ice shelf have responded to its March 2002 disintegration in different ways. The responses include prolonged front retreat, advance followed by retreat, and maintenance of a stable front position. Retreating glaciers initially accelerated and thinned dramatically, although the rate of change has since declined on at least one large glacier. Here, response patterns are documented and discussed in the context of tidewater glacier processes. The distinct classes of behavior observed around the Larsen B embayment demonstrate the importance of the three-dimensional, geographic setting to the response of outlet glaciers to perturbations at their downstream ends.

OCEAN TIDES UNDER THE LARSEN C AND FILCHNER-RONNE ICE SHELVES: GPS COMPARISON WITH MODELS

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S1.2/P22

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 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-Mar. 2008. About half of these will be left for the austral winter and retrieved during late 2008. Three-dimensional coordinate time series are determined using a precise point positioning

approach. The resulting height time series are dominated by the ocean tides but are contaminated by the effects of atmospheric pressure variations (the inverse barometer effect). After correcting for these using local atmospheric pressure data, a harmonic analysis is then be applied to these time series to resolve the individual tidal constituents at each site. The poster will report on the comparison of the observed ocean tides with those from a range of global ocean tide models including TPXO6.2, TPXO7.1, FES2004, and CSR4, and various regional ocean tide models including the circum-Antarctic CATS07.01 and a Weddell Sea model based on assimilation of ICESat satellite laser altimetry.

A MODEL STUDY OF THE INFLUENCE OF SEA-ICE AND THE ROSS ICE SHELF ON WATER PROPERTIES

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S1.2/O24

A regional ocean model (ROMS), with a 5 km grid spacing, has been developed for the Ross Sea which includes thermodynamically active ice shelves and dynamic sea ice. Simulations are driven by ECMWF (ERA-40) daily averaged, 2.5 degree atmospheric conditions. Observed winds are used to force the Terra Nova Bay (TNB) polynya. The CICE sea-ice model is coupled to the ocean model. The seasonal Ross Sea polynya opening and advance is well captured. Winter heat loss over the polynya region is 90% replaced by lateral heat flux. Volumes and fluxes of water in various T/S classes are calculated. High Salinity Shelf water (HSSW), the dense precursor to Antarctic Bottom Water, is created in the western Ross Sea primarily in the coastal polynyas, mainly TNB. Strong katabatic winds are required to produce HSSW. Coastal polynyas produce 1 Sv of HSSW, but 0.4 Sv is converted to Ice Shelf Water (ISW) by circulation under and basal melting of the Ross Ice Shelf (RIS). The warm Circumpolar Deep Water intrudes over the shelf break (0.7 Sv) providing heat to moderate the sea ice cover and to support basal melt under the RIS. The simulated Ross Sea exports 2.2 Sv of Antarctic Bottom Water.

AN OBSERVATIONAL STUDY OF THE CAUSES AND EFFECTS OF SNOW ACCUMULATION IN THE ANTARCTIC

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S1.6/P12

Beginning in 2003, several acoustic depth gauges (ADGs) have been placed in many remote areas of Antarctica, including the Ross Ice Shelf, East Antarctica, and on several icebergs, with the primary purpose being to measure snow accumulation at each location. The ADGs have been installed on automatic weather stations (AWS) which measure temperature, pressure, relative humidity, wind speed, and wind direction, with the data available in near real time via NOAA polar-orbiting satellites. Since the data from the ADGs cannot uniquely determine the causes of accumulation, these measurements, coupled with measurements from the AWS, can give a clearer understanding of the causes of snow depth change at each location. In particular, the AWS data allows a partitioning of the ADG data into five types: accumulation caused by blowing snow, precipitation, or a combination of the two, as well as two unknown source categories. This talk will discuss the methodology used in determining this classification system,

discuss accumulation trends across the Antarctic, and introduce a new blowing snow threshold for the Antarctic.

PRECIPITATION IN THE ANTARCTIC GRADUALLY DECREASED

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S1.4/O08

This paper contributes precipitation behavior in the Antarctic to the International Polar Year. There is no consensus at present on how to determine the mass balance of the Antarctic ice sheet. Although most researchers consider that the ice sheet in East Antarctica is growing and that in West Antarctica is contracting, the current balance of these two parts of the ice sheet, and its changes in the past have not been established. Accumulation assessments restricted to 10-year periods and climatic models of reanalysis cannot characterize the present-day oscillations of the snowfall volume with necessary precision. Uncertainty in the prediction of the behavior of the Antarctic ice sheet may be decreased by longterm series of precipitation measurements and elucidation of causes of its oscillations. Despite forecasts that global warming will increase Antarctic snowfall, there is some evidence that exactly the opposite is true. Analysis of the Global Precipitation Climatology Project (GPCP) data indicates a decrease in the accumulation on the Antarctic ice sheet over the last 28 years. The GPCP satellite remote sensing data, spanning the years 1979 to 2006, exhibits 6-year cycles in precipitation rate. Precipitation in these cycles from 1982 to 2005 has gradually decreased by 15%. This reduction is statistically significant. Accumulation is determined by two regimes of precipitation behavior: inter-annual low-frequency variations, which characterize large-scale changes, and intra-annual seasonal oscillations (periodicity). The latter can arbitrarily be attributed to high-frequency oscillations. Primary data are represented in two versions: 1) monthly precipitation on a grid of 2.5 2.5 degrees latitude - longitude spanning the years 1979-2006 and 2) daily measurements on a grid of 1 1 degree 1DD from January 1997 to 2006. This work was supported by the Presidium of the Russian Academy of Sciences (program 16, part 2, project 3.3, subprogram Study and Investigation of Antarctica), the Federal Targeted Program World Ocean (project no. 5), and the Russian Foundation for Basic Research (project 05-05-64168). The 1DD data and monthly precipitation were provided by the NASA Goddard Space Flight Center s Laboratory for Atmospheres, which develops as a contribution to the GEWEX Global Precipitation Climatology Project.

ANTARCTIC PENINSULA WARMING DIAGNOSTIC STUDY

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S1.6/O16

The complex study of warming processes observed over Antarctic Peninsula region being of main hemispheric hot spots is provided on the base of current meteorological (surface and upper-air), solar radiation, ozone, hydrological, sea ice and greenhouse gases concentration data for total measurements period. These data are obtained at and in the frames of SCAR READER, IPY CLICOPEN, ANTPASS and COMPASS Projects. The probabilistic analysis of comprehensive time series of surface air temperature, sea level pressure and other key climate parameters is

undertaken for determining the inter-annual variability characteristics which show the annual cycle modulation by synoptic scale variability. Statistical analysis of long term time series demonstrated that inter-annual tendencies of seasonal surface and troposphere temperatures over Antarctic Peninsula are more prominent than those observed in continental Antarctica. It is demonstrated, that modulation component of inter-annual variability significantly exceeds variations of annual mean values. The estimates of annual trends over different ranges of variability are provided. The statistical analysis of meteorological observations data at standard synoptic hours allowed to determine quantitatively the contribution of different time scale processes into formation of observed changes of climatic regime parameters of the surface atmospheric layer in the vicinity of the Antarctic Peninsula.

ENERGY AND GAS EXCHANGE PROCESSES OVER SEA ICE IN THE CENTRAL ARCTIC

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S1.6/O09

The experimental data from Russian drifting stations about seasonal variability of turbulent and radiation heat fluxes between atmospheric surface layer and upper ocean in presence of sea ice cover are presented. Dynamic thermodynamic sea ice model with 50-km spatial and 24-hour temporal resolution and one-dimensional thermodynamic sea ice model are applied to investigate long-term spatial and temporal variability of the sea ice cover and surface energy exchange in the Arctic Basin. The models satisfactorily reproduce characteristics of sea ice and surface heat exchange for different parts of the Arctic Basin. Same time the evaluation of atmospheric forcing data, namely air surface level temperature, surface wind velocity, and total cloudiness from NCEP show large disagreement with data obtained on the drifting stations North Pole . The numerical experiments with one-dimensional sea ice model reveal that some negative feedbacks existing in nature and reproducing in the models artificially reduce the influence of inaccuracy of forcing parameters on the results of modeling. Some preliminary data about peculiarities of carbon dioxide exchange in presence of sea ice cover are presented.

EXTREME CLIMATE CHANGE AND THE ROLE OF OCEAN HEAT IN THE WEST ANTARCTIC PENINSULA

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S1.4/O09

The Antarctic Peninsula (**AP**) is undergoing extraordinary climate change, showing, for example: (1) strong winter warming (~5.4 times the global average), (2) 87% of the glaciers in retreat, and (3) a >3 month decrease in the sea ice season, with complete loss of perennial sea ice on the western margin of the AP (**WAP)**. The only *substantial* source of winter heat is the ocean (Upper Circumpolar Deep Water: **UCDW**, at 3.5 - 4 C above freezing). 12 years of Palmer Long Term Ecological Research (LTER) data show that the heat content of the UCDW on the WAP continental shelf has increased. During the 1990s increased upwelling of UCDW onto the shelf explains ~84% of this increase; ~21% is attributed to warmer UCDW. Comparison of LTER data (1993) to historical data, suggests that UCDW heat content supplied to the WAP via that Antarctic Circumpolar Current jumped considerably in the 1980s. This region impacted by the warmed UCDW extends for the entire length of the Antarctic Peninsula to the eastern-most edge of the Amundsen Sea, suggesting that the ocean changes observed in the mid-peninsula region

may apply down to the Pine Island Glacier region. Our IPY moorings will allow better refinement of these results.

RESPONSE IN THE CSIRO MK3.5 CLIMATE MODEL IN THE SOUTHERN OCEAN REGION TO 20TH AND 21ST CENTURY CLIMATE SCENARIOS

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S1.2/O30

The CSIRO Mk3.5 climate model has improved Southern ocean stratification, ocean currents and minimal climate drift in the control simulation compared to the earlier CSIRO Mk3.0 simulation. There is now a 1000 year control simulation which has been analyzed in detail for modes of ice-ocean variability in the region on inter-annual to multidecadal and an ensemble of three 20th century simulations and three 21st Century SRES scenarios. It is these last set of runs which will be discussed in this talk, earlier results with both CSIRO Mk2 and Mk3.0 models indicated a major decrease in the ventilation of Antarctic bottom water in warmer climate scenarios. Preliminary analysis of Mk3.5 show less change in z-space but will now be analyzed in sigma-co-ordinate space. The decay of sea ice, change in ice-ocean fluxes, change in ocean currents, rate of heat subduction into intermediate and mode water masses which has implications for sea level rise and can be compared with observations, will all be include in the presentation.

LIGHT STRESS IN BOTTOM ICE MICROALGAL COMMUNITIES FROM THE EAST ANTARCTIC PACK ICE

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S1.2/O28

High irradiance or extremely low temperatures can induce an imbalance between light energy utilised in photosynthesis and metabolic requirements. Adjustments in photosynthesis are critical to maintain the balance of energy flow in the cell. Light stress in combination with low temperatures can induce a high level of excitation pressure, where the absorbed energy exceeds both the capacity for photochemistry and the capacity for non-photochemical heat dissipation, resulting in long-term photodamage. Sea ice microalgae (predominantly diatoms) were collected during a sea ice voyage on the *RV Aurora Australis* during September and October 2007. Microalgal cells receiving 5-20 µmol photons m-2 s-1 from 1 m thick sea ice showed no change in photosynthetic efficiency. However, cells exposed to high-light (200 µmol photons m2 s-1) were photoinhibited by up to 50 % (decline in Fv/Fm) over 5 hours, but were able to recover their photosynthetic activity to control levels within 3 hours. Fast induction curves revealed the impact site responsible for the decline in Fv/Fm as a change in QA reduction rates within high-light exposed cells. These results suggest that bottom sea ice algae are able to cope with short-term exposure to high irradiance with only minimal photodamage occurring

SIMULATIONS OF LAGRANGIAN PARTICLES ON THE WESTERN ANTARCTIC PENINSULA: THE EFFECT OF CIRCULATION DYNAMICS

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S1.2/P36

The western Antarctic Peninsula (WAP) continental shelf is mostly covered by sea ice during the austral winter, is ice free in summer, and the sea ice extent of this region is characterized by considerable interannual variability. Simulated circulation fields for this region were obtained using the Regional Ocean Modeling System (ROMS) with prescribed sea ice fields and a dynamic sea-ice model that includes thermodynamically active ice shelves. The simulated circulation fields obtained from each model were compared with Lagrangian particle tracking studies. Floats were released along the outer and mid-shelf regions at different seasons and depths. In general, the simulated particle trajectories released at depths where Circumpolar Deep Water is found (200 to 600 m) showed preferred sites for cross-shelf exchange and onshelf intrusions, which were similar for both circulation-sea ice models. The strongest differences were observed in the trajectories of the surface floats. The dynamic sea ice reduces the ocean surface circulation on parts of the continental shelf due to the large ice concentrations in winter limiting the direct effects of the wind on the water. This reduces particle displacement and alters exchanges. These results illustrate the importance of using realistic circulation sea ice models, especially if cross-shelf exchanges are of interest.

PREDICTION OF ANTARCTIC SEA ICE EDGE USING ARTIFICIAL INTELLIGENCE

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S1.6/O28

Antarctic sea ice cover plays an important role in shaping the earth s climate, primarily by insulating the ocean from the atmosphere and increasing the surface albedo. The convective processes accompanied with the sea ice formation result the bottom water formation. The cold and dense bottom water moves towards the equator along the ocean basins and takes part in the global thermohaline circulation. Sea ice edge is an potential indicator of climate change. Additionally, fishing and commercial shipping activities as well as military submarine operations in the polar seas need reliable ice edge information. However, as the sea ice edge is unstable in time, the temporal validity of the estimated ice edge is often shorter than the time required to transfer the information to the operational user. Hence, an accurate sea ice edge prediction as well as determination is crucial for fine-scale geophysical modeling and for near-real-time operations. In this study, active contour modeling (commonly called snake) and non-rigid motion estimation techniques have been used for predicting the sea ice edge (SIE) in the Antarctic. For this purpose the SIE has been detected from sea ice concentration derived using special sensor microwave imager (SSM/I) observations. The 15% sea ice concentration pixels are being taken as the edge pixel between ice and water. The external force, gradient vector flow (GVF), of sea ice edge for total the Antarctic region is computed on daily as well as weekly basis. These vector fields have been used to predict the sea ice edge for subsequent periods (daily and weekly) using non-rigid motion estimation technique. The predicted edge has been validated with that of SSM/I as well as other high resolution satellite images.

AIR-ICE INTERACTION OBSERVATIONS IN THE ARCTIC SEAS

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S1.6/O07

The present work is focused on studying the effects of structural and thermal non-uniformity at the ice covered surface on heat ad momentum exchange between atmosphere and underlaying

surface. Transformation of air flow caused by change of the underlaying surface type is also envisaged. Eddy-covariance method allows direct measurements of turbulent fluxes under various background conditions. Exchange coefficients, calculated using direct measurements do not correlate with any single meteorological parameter, but rather depend on an ensemble of factors, which are usually difficult to estimate. Profile method of turbulent flux calculation provides results, which coincide with direct measurements only under the conditions when Monin-Obukhov theory is valid. Calculation of turbulent fluxes in the confined area with irregular underlying surface requires careful selection of method of calculation and type of parameterization of coefficients. Measurements of the atmospheric turbulence characteristics directly from ice, in the absence of the ship effect and vibration, allow to receive more accurate results, especially at small values of turbulent fluxes. When breaks are formed in ice, strong outgoing fluxes are formed due to a large difference in temperature. The heat fluxes over polynyas are one or two orders of magnitude greater than those over the pack ice.

ON THE IMPORTANCE OF ICE-SHELF MELTING IN ANTARCTICA

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S1.2/O01

The mass balance of the Antarctic ice sheet is governed by the subtle imbalance between the input of snowfall in the interior and the advection and ablation of ice toward the periphery of the ice sheet. At the coast, ablation proceeds mainly from iceberg calving and ice-shelf melting. The traditional view has been that iceberg calving dominates, yet few data have been obtained on iceberg production, and even fewer observations have been made for ice-shelf melting. Here, we compared iceberg calving and the net removal of ice from melting by the ocean waters using a compilation of satellite observations of ice elevation, ice velocity and grounding line positions. We find that ice-shelf melting controls half of the ablation, and iceberg calving the other half. This implies that ice-ocean interactions play a larger role in the evolution of the Antarctic ice sheet than assumed until now. Ice-shelf melt rates vary significantly from one ice shelf to the next. Melt rates are in the 20-30 cm/yr range on average for the large ice shelves in the Ross and Weddell seas, but rise to 10-20 m/yr on the smaller ice shelves that buttress the glaciers flowing into the Amundsen sea, or two orders of magnitude larger. This is in large part attributed to differences in ocean water temperature that are able to reach the glacier grounding lines and the depression of the melting point of ice with pressure at the km depth of glacier grounding lines. The order magnitude sensitivity to thermal forcing from the ocean is 1 m/yr melting per 0.1 degree increase in ocean temperature. The rapid melting of ice in the Amundsen sea is fueled by circumpolar deep water that is 2-3 degrees warmer than the freezing point, whereas large Antarctic ice shelves in the Ross and Weddell are distant from warm waters. Closer to the grounding lines, larger rates of ice shelf melting are observed. This has important consequences for the dynamics of glaciers, which are not controlled by the average melt rate of the ice shelf, but by the melt rate near the zone of grounding. We also estimated these rates and how they vary around Antarctica. This yields an update of the relationship between ice-shelf melting and thermal forcing of the ocean compared to our first study of 2002. The melt rates near the grounding line range from a few meters per year in cold waters to 50-60 m/yr in the warm waters bathing Pine Island Glacier. The most rapid changes in ice flow observed at present are taking place in areas bathing in warm waters. Ice-ocean interactions therefore play a major if not

dominant role in determining the mass balance of the Antarctic Ice Sheet. Warmer ocean waters along the coast of West Antarctica have in particular the potential to destabilize the ice sheet well before a warming of air temperatures will have a chance to melt snow and ice.

CONTINUED RAPID FRESHENING OF THE ANTARCTIC BOTTOM WATER OF THE INDIAN AND PACIFIC OCEANS

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S1.2/O05

As part of the Climate of Antarctica and the Southern Ocean (CASO) and Synoptic Antarctic Shelf-Slope Interaction (SASSI) programs of the IPY, a number of oceanographic stations occupied in the 1970s and 1990s were re-occupied in 2008. The area sampled lies between 140E and 150E, south of 63S, and includes portions of WOCE lines SR3, S4, P11A and stations from a number of earlier voyages. The eastern line sampled bottom water flowing west from its source in the Ross Sea (RSBW); the western lines are downstream of the outflow of Adelie Land Bottom Water (ALBW). At every repeat station, the bottom water is fresher in 2008 than observed in the WOCE sections of the mid-1990s, continuing a freshening trend detected in comparisons of data from the early 1970s and 1990s. At 150E, the salinity of the RSBW has decreased to such an extent that the prominent salinity maximum observed near the sea floor in 1971 is now a weak salinity minimum. The ALBW salinity has also decreased, with bottom salinity at 140E lower by 0.025 in 2008 than in 1994. The freshening is most likely caused by increased melting of glacial ice.

LABORATORY EXPERIMENTS ON FRAZIL AND GREASE ICE GROWTH UNDER WAVE CONDITIONS

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S1.2/O27

The accelerated Arctic sea ice loss leads to a transition to increased wave fetch affecting the autumn freeze up of large open water areas. Ice formation processes in these areas, such as the frazil and grease ice development into pancake ice, is one of the least well documented mechanisms within sea ice research. We present integrated measurements from two 20m long and 1m deep salt water tanks (ARCTECLAB, Hamburg). Ice was grown at -12C under wave conditions generated by a paddle placed at the end of each tank and operating at varying frequencies and amplitudes. The experiments document the full transition from open water waves through to an ice cover consisting of congealed frazil and pancake ice. A maximum ice thickness of 11 cm was reached after 24 hours of freezing and the ice concentrations measured are comparable to field measurements from Svalbard. The wave field was monitored with ultrasonic sensors from above, and with pressure sensors from below the free surface. We present rate of ice growth and the brine drainage during different ice growth stages. A relationship between the ice properties and wave parameters is suggested by analysis of the gradual compaction and thickening of the grease ice layer and the resulting wave damping.

THE PRECIPITATION REGIME OF DRONNING MAUD LAND, ANTARCTICA: IMPLICATIONS FOR ICE CORE INTERPRETATION

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S1.5/O35

Polar ice cores provide rich archives of past climate variability. However, for a correct climatic interpretation of ice core properties, a thorough knowledge of the atmospheric processes that formed the ice is necessary. The precipitation regime of Dronning Maud Land (DML), Antarctica, where two deep drilling locations, Kohnen and Dome Fuji, are situated, was studied using high-resolution data from a mesoscale circumpolar atmospheric model. Mean annual precipitation fields derived from the model confirm earlier, coarser-resolution calculations as well as a recently published glaciologically derived accumulation map of Western DML. Interannual variability of monthly sums of precipitation was found to be fairly high due to the influence of synoptic activity in the circumpolar trough, which affects not only the coastal areas, as previously thought; it also has an impact on precipitation at the drilling locations in the interior of the continent. In spite of prevailing clear-sky precipitation, a few synoptically caused events can yield a large amount of the annual precipitation. This result questions one of the basic assumptions in ice core interpretation, namely that precipitation is always equally distributed over the year with no major changes in the seasonal distribution of precipitation.

THE CURRENT AIR TEMPERATURE COOLING IN THE NORTH OF THE ANTARCTIC PENINSULA

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S1.6/O27

Series of surface air temperature available for the north of the Antarctic Peninsula are used to present the cooling tendency observed in the last 11 years. In particular, the data from the Islands of Orcadas and King George/Admiralty Bay are considered because they comprise the longest series available in the region; the former started in 1902 and the latter in 1949. Although a long-term increase of ~0.25oC/decade characterizes the sequences, the last 20 years show no significant gradient and the last 11 years, starting with 1998-99, present a cooling trend of ~0.6oC/decade.The sequences of air temperature data are analyzed also according to the four seasons and the results indicate that the variations of the temperature gradients follow different patterns. 2007, the coolest in the last 20 years, is used an example to show how the temperature in the region is highly dependent on the geographical origin of the air masses.

THE FORMATION AND MAINTENANCE OF THE NORTH WATER POLYNYA

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S1.2/P42

The North Water Polynya (NWP), located in northern Baffin Bay between Ellesmere Island and Greenland, is an important area of enhance air-sea interaction in the Arctic region. The northern boundary of NWP is well defined by an ice arch, which forms in the southern end of Kane Basin and prevents influx of ice from the north. Ice formed in the North Water is swept southward under the combine effects of wind and currents. The southern boundary of NWP is less clearly defined because the ice conditions gradually merge toward those of Baffin Bay. The formation

and maintenance of NWP is investigated using a coupled ice-ocean model. The observation and model simulation for the 2004-2005 ice season shows that an area of low ice concentration appears on the Greenland side of Smith Sound in winter. Ice concentration and thickness decrease, and the area increases in size toward spring. The North Water becomes ice free in June. An analysis of the model results indicate that there is enhanced ice growth and ocean surface heat loss in the North Water. Surface heat loss is balanced by advection and frazil ice growth in the water column. Salt flux from ice growth is balanced by advection. The exchange is predominantly horizontal and not coastal upwelling.

A DOUBLING IN SNOW ACCUMULATION IN THE WESTERN ANTARCTIC PENINSULA SINCE 1850

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S1.5/O40

We present results from a new medium depth (136 metres) ice core drilled in a high accumulation site (73.59°S, 70.36°W) known as Gomez, on the south-western Antarctic Peninsula during 2007. The Gomez record reveals a doubling of snowfall since the 1850s, with acceleration in recent decades. Comparison with published accumulation records indicates that this rapid increase is the largest observed across the region. Evaluation of the relationships between Gomez accumulation and the primary modes of atmospheric circulation variability reveals a strong, temporally stable and positive relationship with the Southern Annular Mode (SAM). Furthermore, the SAM is demonstrated to be a primary factor governing decadal variability of accumulation at the core site however, the association with ENSO is complex: while sometimes statistically significant, the relationship is not temporally stable. Thus, at decadal scales we can utilise the Gomez accumulation as a suitable proxy for SAM variability but not for ENSO. These initial studies reveal that the Gomez site is sensitive to hemispheric-scale circulation patterns and thus we will present additional chemistry and isotope data from the new ice core to investigate the sub-seasonal relationships with the SAM.

MAJOR RESULTS OF THE SEA ICE THICKNESS OBSERVATIONS DURING ARCTIC CORING EXPEDITION-2004 ONBOARD THE ICEBREAKER ODEN

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S1.2/P44

During the ACEX-2004 expedition in August-September 2004, the observations of sea ice thickness were executed in the North Pole region. Special observations of sea ice thickness continued over a period of 500 hours in increments of 30 minutes. This observation is tantamount to a thickness measurement of profile 180km long measured in steps of 180meters. Observations were realized by visual methods using 2 measuring rods of ±5sm accuracy. Three major groups stand out in the variability row of sea ice thickness: a) 5-15sm, b) 1,0-2,0 meters, c) 2,0-3,0 meters Ice coverage consisted of different ice thicknesses in the following percentages:
5% new and young ice 5-15sm,
19% of ice 150-200sm,
65,2% of ice 200-300sm,
5,6% of ice with thickness exceed 350sm.

Obtained data were compared with average multiyear thickness of sea ice from Atlas of the sea ice and snow characteristics in the Arctic Basin . These comparisons don t show significant decrease of the average sea ice thickness. The executed thickness profile could be considered to be a random sampling and testify apparently that interannual variations of the sea ice thickness are not beyond the scope of the natural variability, based on the data accumulated since the 1930 s.

RECENT ANTARCTIC CLIMATE CHANGE AS OBSERVED IN THE IN-SITU METEOROLOGICAL OBSERVATIONS

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S1.6/O15

The surface and upper air in-situ meteorological observations from the Antarctic stations provide the most accurate record of climate change across the continent. Many time series start around the IGY in 1957/58. The surface temperature data show a broadscale pattern of warming across the Antarctic Peninsula and little change, or even a small cooling, around the coast of East Antarctica. The summer/autumn warming on the eastern side of the Peninsula and cooling along East Antarctic can be attributed to the shift of the Southern Annular Mode into its positive phase, primarily as a result of the ozone hole. Although the ozone hole is a phenomena of the Austral spring, its greatest impact is felt at the surface in summer and autumn. The radiosonde data show a winter-season warming of the midtroposphere above the continent, which has been linked to the increase in polar stratospheric cloud as stratospheric temperatures have dropped in recent decades. The winter season near-surface warming on the western side of the Antarctic Peninsula has been linked to a reduction in sea ice extent, but it is not know whether this is a result of natural climate variability, or whether there is an anthropogenic cause.

ASSESSING THE IMPACTS OF FUTURE TWO-DEGREE C GLOBAL WARMING ON SOUTHERN OCEAN CETACEANS

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S1.5/O03

Predicting the impact of global warming on polar marine ecosystems will require the combined efforts of climate modelers and marine ecologists. A subset of IPCC AR4 climate model output for emission scenario A1B was used to identify the time period at which globally averaged surface air temperature increases by 2 C above pre-industrial levels. The impacts of the predicted change in Southern Ocean sea-ice extent, concentration and seasonality, ocean circulation and frontal positions on resident cetacean populations (i.e. Antarctic minke whales) and migratory cetaceans are examined for the time of 2 C warming.

MODELLING SALINITY IN A SEA ICE THICKNESS DISTRIBUTION MODEL

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S1.2/P45

The sea ice thickness distribution theory is generalized to include ice salinity and included in LIM3, a 3D dynamicthermodynamic model which includes the impact of ice salinity on ice

thermal properties. Thermodynamic changes in ice salinity are computed using a simple parameterization of brine entrapment and drainage. LIM3 is coupled to the ocean model OPA9 and run over 1970-2006. The seasonal cycle of the simulated sea ice salinity averaged over thickness categories and salinity distribution in thickness space agree with observations. Due to hemispherical differences in the forcings, the model simulates Arctic and Antarctic salinity elds that differ signi cantly. The simulated large-scale sea ice mass balance is found sensitive to the model representation of ice salinity. In the Arctic, including an in interactive salinity distribution enhances ice growth / melt rates through a direct impact on ice thermodynamics. In contrast, around Antarctica, the role of ice-ocean interactions is dominant: using a variable salinity enables to maintain signi cant ice growth with relatively small salt uxes to the ocean, which in turn further reduces oceanic heat uxes and enhances ice growth. Therefore, sea ice salinity variations should be included in future climate projections.

SIMULATING THE MASS BALANCE AND SALINITY OF ARCTIC AND ANTARCTIC SEA ICE WITH LIM3-OPA9

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S1.2/P46

The new version of the Louvain-la-Neuve sea ice model, LIM3, coupled to the ocean general circulation model OPA9 is used to investigate the evolution of the mass balance of Arctic and Antarctic sea ice over the last four decades. LIM3 is a thermodynamic-dynamic sea ice model with an elastic-viscous-plastic rheology on a C-grid with subgrid-scale distributions of ice thickness, enthalpy, salinity and age. The model is evaluated by performing a hindcast simulation of the Arctic and Antarctic sea ice over the period 1970-2007 driven by the NCEP/NCAR reanalyses of surface air temperatures and winds. Results from this simulation are thoroughly compared to available in-situ and satellite data and to outputs from other models. The mean seasonal cycle of sea ice is relatively well reproduced in both hemispheres, with snow depths and ice concentrations, thicknesses, salinities and drifts in reasonable agreement with observations. The model also captures the high interannual variability of the Arctic and Antarctic ice packs as well as the recent negative trend in summer Arctic ice extent. Analysis shows that the differences in atmospheric forcing between Arctic and Antarctic induce ice growth and decay mechanisms that differ significantly.

SURFACE ENERGY BALANCE, CLOUDS AND RADIATION OVER ANTARCTIC SEA ICE DURING AUSTRAL SPRING

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S1.6/P30

In Sept-Oct 2007, a sea ice drift station, *Ice Station Belgica*, was established in the Bellingshausen Sea. Over twenty seven days, measurements of meteorological variables, radiation and surface albedo were performed by combining ship-based and in situ data, in order to assess the surface energy balance. Visual observations of the state of the sky

(clear or overcast) were also done. The sampled floe was characterized by thin (0.6m) and medium thick (1.1m) firstyear ice and older, second-year ice of greater than 2m mean thickness. Snow cover depth varied from zero cm over the new ice to > 0.8m on the second year ice. The weather at Ice Station Belgica was characterized by typical spring conditions. Synoptic variability was mostly driven by the wind direction, which determines the origin continental or oceanic of the air masses. Under northerly winds, warm (from -5 to 0 °C) and wet (relative humidity from 90 to 100%) oceanic air was advected on the floe. Under southerlies, cold (from -20 to -10°C) and dry (70-85 %) continental air was brought on site. In turn, this also determined the state of the sky, with clear (overcast) skies mostly associated to continental (oceanic) weather. The incoming solar radiation was on average 124 W/m?, with a trend of 3.5 W/m? over the ice station, while the incoming longwave radiation was on average 227 W/m?, with no trend. As expected, the incoming solar radiation shows a marked diurnal cycle, while LW does not. The day-to-day variability in radiation is largely determined by changes in the state of the sky. Broadband surface albedo was measured in situ, using a bidirectional pyranometer, on two sites respectively covered by thin (10-15 cm) and deep (30-40 cm) snow. Both sites were visited every 5 days and albedo was measured on 6 points, spaced by 5 m on an 25-m long albedo line. Snow depth was also monitored every meter along the albedo line. The mean albedo is 0.83 ± 0.05. Variations around this mean value are explained primarily by the nature of the light (diffuse or direct), controlled by the local cloud clear sky pattern. Cloud-sky albedo is on average higher and less variable (0.85 ± 0.03) than under clear sky (0.81 ± 0.06). Secondary factors controlling surface albedo are snow depth and age. The deep snow site has a slightly higher clould-sky albedo (0.87 ± 0.01) than the thin-snow site (0.84 ± 0.03). The albedo was the highest under cloudy skies and over deep, young snow. As the state of the sky and the associated change in the type of the light (direct or diffuse) induces large changes in radiation as well as changes in broadband surface albedo, it is crucial to work toward inclusion of clouds in future assesments of surface energy balance in polar regions.

THE INTERNATIONAL ANTARCTIC INSTITUTE

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S2.4/O11

The International Antarctic Institute (IAI) is a consortium developed by leading global Antarctic educational and research-intensive institutes which formally came into being in 2006. Its purpose is to facilitate cooperation and collaboration between member universities in undergraduate and postgraduate multi disciplinary education in Antarctica and Southern Ocean sciences. As has been seen over the past half-century, international cooperation is the key to the success of large-scale research programs in Antarctica and Southern Ocean. By sharing teaching resources between international partner universities we can create educational opportunities on a scale unattainable by any one institute or through traditional bilateral alliances. The IAI is presently establishing multi-institute degrees whereby students enrol in their home institutions (IAI - affiliated university) and take up to an agreed proportion of their course units at other member institutions. The units taken during this exchange are credited through their home university. Courses and degrees are jointly badged by the participating institutions of the IAI with the first courses having started this year. Members and associated members presently include institutes from: Australia, Brazil, Chile, France, Germany, Italy, Japan, Malaysia, New Zealand, Norway, Spain, UK and USA. The IAI is open to institutes who presently or potentially have an Antarctic educational mandate.

IMPROVEMENT IN SEA ICE CLASSIFICATION USING TEMPORAL VARIABILITY OF SEA ICE VERSUS HIGH WIND FIELDS

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S1.2/P49

Sea ice variability has an important role in accelerating the climate change. Sea ice detection from space-borne scatterometer data is affected by ambiguity problem between the backscattering of sea ice and the high winds over open ocean. Several investigators have attempted sea ice edge detection from Scatterometer data using combinations of the backscattering coefficients (0) in the horizontal (HH) and vertical (VV) polarizations. However, falsely identified sea ice still occurred at several places within the marginal ice zones. History of sea ice cover also has been used for detecting ice fields separated from ice packs during summer, and for manual corrections. However, manual correction has limitations, and therefore we have attempted to automate the sea ice detection process, using temporal variability as a feature vector. Since, the ice fields vary over a few days and the wind fields change in a few hours, their temporal signatures are quite discernible and greatly improved sea ice detection accuracies are achieved by using this method.

FRESHWATER TRANSPORT AT FIMBULISEN, ANTARCTICA

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S1.2/P50

The intricate near-circumpolar system of fronts and currents surrounding Antarctica isolates much of Earth's freshwater from the saline oceans immediately north. The Antarctic Slope Front sustains bathymetrically-steered flow at the shelf break whereas the shallow Coastal Current travels rapidly alongside the ice front. A hydrographic survey of the northeastern Weddell Sea finds these two features to have merged near the narrow (<40 km wide) continental shelf at Fimbulisen. On the prime meridian, its Trolltunga ice tongue overshoots the shelf break into this slope current. Observations either side of this feature demonstrate its retarding effect on the westward-flowing waters it overhangs and its contribution to the freshwater budget. From oxygen isotope ratio measurements and referenced geostrophic shears, we find the combined glacial meltwater and sea ice melt transport to account for 1.2% of the total 1.6±0.2 Sv westward transport (Sv = 106 m3 s-1). Downstream from Trolltunga at 3ºW, we find this figure to ultimately increase to 0.9% of 2.8±0.4 Sv. This highlights the disproportionately large role Fimbulisen plays in preconditioning shelf waters before they reach broad continental shelves in the southwestern Weddell Sea where their transformation to bottom waters helps drive the shallow and deep limbs of the meridional overturning circulation.

MONITORING CHANGES IN ANTARCTIC WATERS

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S1.2/P51

The Southern Ocean interacts with the polar atmosphere and cryosphere all year round. Such active exchange of heat and freshwater facilitates the more rapid propagation of observed changes in the Antarctic environment. Ocean currents further carry these signals to the abyssal layers of basins farther to the north. The lack of adequate long-term measurements at key locations along these corridors has made it difficult for oceanographers to fully assess the magnitude of change in the oceans climate. Nonetheless inspection of historical oceanographic data has revealed longterm variability in water properties over the Antarctic continental shelves. This variability is becoming more apparent in Antarctic basins offshore due to reoccupation of hydrographic sections in recent years, particularly from the comparison of high-quality data collected during the World Ocean Circulation Experiment (1990s) and the current CLIVAR/CO2 programs. We present preliminary results from the analysis of historical and repeat hydrography in the Southern Ocean to describe the observed temporal variability of Antarctic waters in relation to climate change.

LATE WINTER HYDROGRAPHY BENEATH EAST ANTARCTIC SEA ICE DURING SIPEX-07

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S1.2/P52

Sparse hydrographic datasets from the Antarctic margin are traditionally biased towards spring/summertime by observational programs carried out when there is minimal sea ice. In

September-October 2007, the Australian IPY project SIPEX (Sea Ice Physics and Ecosystem experiment) was conducted in the sea ice zone over the East Antarctic margin between 110 and 130ºE, and rare oceanographic measurements were collected beneath the sea ice. Independent Conductivity-Temperature-Depth (CTD) and Acoustic Doppler Current Profiling (ADCP) systems were designed and deployed at 11 ice-stations, observing the sub-ice hydrographic and current regimes at the end of the sea-ice growth season. Stations were conducted on the continental slope and shelf region in the fast ice. The CTD data revealed the properties of the wintertime mixed layer that deepened from 120-400 m as the voyage progressed across the Antarctic Slope Front, and an intrusion of warm Modified Circumpolar Deep Water. ADCP data showed strong currents in the observed 50-100 m range that often correlated better with ice drift (observed by GPS compass), than the surface winds. The range of the ADCP varied diurnally in conjunction with vertical migration of zooplankton. These preliminary results increase our knowledge of the wintertime hydrography and reinforce the importance of ocean currents to sea ice drift models.

DOWNSLOPE MIXING OF ANTARCTIC BOTTOM WATER FROM EAST ANTARCTIC POLYNYAS

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Antarctic Bottom Water (AABW) production is a key component of the global climate system, providing the vertical transport that closes the lower part of the Southern Ocean's meridional overturning circulation and ventilating the world's abyssal depths. In East Antarctica, up to 25% of total AABW by volume forms as dense shelf water in continental depressions beneath coastal polynyas that ultimately mixes down the continental slope. Over the last ten years, the Adélie Depression and Mertz Glacier Polynya system (140-147ºE) has been identified as the major source of East Antarctic AABW production, and examined in a series of ship-based hydrographic surveys, mooring arrays and numerical modelling studies. We present observations and modelling results on the formation and export of dense shelf water (0.1-0.5 Sv), including the influence of Ice Shelf Water produced beneath the Mertz Glacier, and the ultimate downslope mixing, entrainment and volume production of AABW from this source (up to 0.4-2 Sv). These results have important implications for the potential of other sites in East Antarctica capable of producing AABW, in particular the Cape Darnley region (65-70ºE), which together with the Adélie Depression will host hydrographic mooring arrays during the International Polar Year. Greater understanding of the processes and sensitivities of AABW production will assist the ongoing development of numerical global climate models that seek to predict the impact of climate change.

APPLICATION OF NOVEL GEOCHEMICAL PROXIES TO ESTIMATE SEA ICE COVER AND SEA SURFACE TEMPERATURES

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S1.5/O42

Historically, there has been a difficulty in applying traditional paleoenvironmental proxies in Antarctica because of problems that include insufficient dating of recovered sequences,

complexities introduced by glacial activity, sea ice cover and poor calcium carbonate preservation, although some partial records have been obtained so far. Recently, several organic geochemical proxies, specifically the long chain diol index as a proxy for diatom productivity and the TEX86 paleothermometer, have been developed in marine sediments, though mainly applied in temperate and tropical environments. To test those novel proxies on polar regions a sediment core (NBP-0107 JPC-33) from the North-Western Antarctic Peninsula covering the last 8500 yr has been investigated. The age model was obtained by tuning the relative paleomagnetic intensity record with other published absolute and relative paleomagnetic intensity curves, providing a high resolution, continuous age model. The special location of JPC-33, together with its high sedimentation rate (65 cm·ky-1) makes it very suitable to test the sensitivity of those proxies to past climatic conditions, and further test the response of the Western Antarctic Peninsula to the ENSO fluctuation. Initial results suggest that the diol index is strongly linked to the melting frequency of sea ice.

ANTARCTIC SEA ICE AND SNOW COVER THICKNESS USING AIRBORNE RADAR AND LASER ALTIMETRY

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S1.2/O29

Our current knowledge of the thickness distribution of Antarctic sea ice and snow cover is based on a synthesis of field and ship-based observations over several decades. This provides a valuable first order estimate, but is insufficient for monitoring change. In September/October 2007, the Australian Sea Ice Physics and Ecosystem eXperiment (SIPEX) used laser altimeter and wide-band radar, mounted in a helicopter, to capture regional-scale information on the freeboard and snow thickness of Antarctic sea ice East Antarctica. In conjunction with in situ measurements of the thickness and density of the sea ice and snow cover, we have calculated the distribution of sea ice thickness across the study region. The field program was coincident with the operation of the Geoscience Laser Altimeter System (GLAS) aboard ICESat, enabling us to make a large-scale statistical comparison of the helicopter and space-borne techniques over Antarctic sea ice. Specific comparisons of aircraft-based and space-based laser data will be shown over fast ice, pack ice and grounded icebergs, together with examples of radar data showing the resolution of two distinct peaks for the air/snow and snow/ice interfaces. Our long-term goal is to develop a robust aircraft-based system that will provide a long-term monitoring capability.

LAKE VOSTOK AS A TRIGGER OF HUGE SUBGLACIAL WATER FLOODS UNDER THE EAST ANTARCTICA ICE SHEET

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S3.1/O17

Recent data show that the system of subglacial lakes and subglacial water layers and films in between are very unstable and some events exist, which could be described as subglacial water floods. This conclusion puts question on possibility of huge subglacial wares floods triggered by lake Vostok too. It is shown, that some profiles of the surface of the ice sheet of central

Antarctica can be explained in a favor of existence of huge lake Vostok water subglacial floods, directed under the Emery Ice Shelf. Study of a structure of internal layers of radio echo sounding reflections from the ice sheet of central Antarctica shows that same of these layers are broken for separate and somehow chaotic parts, which we interpreted as disturbances of the ice sheet body by huge lake Vostok triggered subglacial floods. There are some evidences and tracks of huge subglacial floods of previous time in relief and structure of sediments at subglacial bed and at areas of East Antarctica, free of ice.

Polar Marine Ecosystems

THE ANNUAL CYCLE OF ANTARCTIC SEA ICE THERMODYNAMICS: STRUCTURING THE BIOGEOCHEMICAL RESPONSE AND FLUXES

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S1.9/O19

Time series studies on sea ice during late-winter spring were conducted on Ice Station Belgica (ISB)(Sept-Oct 2007). By combining these measurements with midwinter (AnzFlux 1994), spring-summer transition (ISPOL 2004), and summer-autumn transition (ISW 1992) measurements, we develop a conceptual model of the complete annual cycle of Antarctic sea ice thermodynamics and the biogeochemical response. Particularly, ISB results (Sept-Oct) show that the nutrient recharge during flood-freeze induced upwelling causes enhanced algal and microbial activity, leading to up to 3000nmol/kg of DMS concentration in the upper sea ice layer. Cold brine, containing microbial material and the DMS, are later flushed into the upper ocean increasing concentrations under the ice. Three to seven cycles take place , based on temperature results from an autonomous buoy on the site until early December. For biogeochemical fluxes, the most active phase is spring where flood-freeze and light optimize to produce several strong episodes of air-iceocean interaction. This period of highest fluxes per unit area also coincides with maximum winter sea ice extent, making the total biogeochemical contribution of the ice cover particularly high.

CONTRASTING ARGOS AND FAST-GPS TAGS TO EXAMINE WINTER FORAGING OF WEDDELL SEALS IN REGARD TO SEA ICE FEATURES

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S1.8/O34

The Weddell seal is one of the most studied Antarctic predators. However, very little is known of their foraging movements and diving behaviour in the winter months although individuals have been recorded both close to their nearshore breeding sites and offshore in the icepack. The physical characteristics and dynamics of the winter sea-ice are also poorly known. We deployed Conductivity-Temperature-Depth Satellite-Relayed Data Loggers which provided ARGOS

quality locations (approximately +- 1000 m) and Fast-GPS tags, which provided high precision locations (+- 50 m) on adult female Weddell seals at Dumont D Urville over two consecutive winters to study foraging behaviour in relation to oceanographic conditions and sea-ice features. We used a Bayesian method for estimating best seal location, based on location quality, rate of travel and the topography. We present a comparison of the spatial patterns using the two different techniques when simultaneously obtained from the same individuals to establish the minimum scale of movement that could be used in larger scale analysis of ARGOS tracks using MODIS satellite images to quantify how the seals use sea-ice features. This knowledge will assist the investigation of repercussions of long-term changes in winter pack ice properties associated with climate variability on the Southern Ocean ecosystem.

DIFFERENCES IN KRILL SPECIES (E. SUPERBA , E. CRYSTALLOROPHIAS) AND ABUNDANCE BETWEEN FORAGING AREAS OF MINKE WHALE, CRABEATER SEAL AND ADELIE PENGUIN IN THE ROSS SEA

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S1.8/O36

Studies on krill *(E.superba, E. crystallorophias*) were conducted during four expedition in the Ross Sea (Nov./Dec.1994, Dec./Jan.1997-98 and 1999-2000, Jan./Feb. 2004) to evaluate their spatial distribution and abundance in relation to their main predators: Minke whales *(Balaenoptera acuturostrata)*, Crabeater *(Lobodon carcinophagus)* seals and Adelie Penguins *(Pygoscelis adeliae)*. In the offshore regions, where was the nucleus of Antarctic krill population (density > 200 g/m2), herds of Minke whales (> 5 individuals per km2), in cooperative behaviour, were found. In contrast, the inshore regions, where mostly Ice krill occurred at low density (< 10 g/m2), resulted the favoured foraging areas of penguins and only isolate individuals of Minke whale were found. In the offshore areas Antarctic krill was large (> 42 mm) and close to surface, in the inshore areas krill tended to be at deeper range (from 50 to 150 m) with occasional occurrences of juveniles of both species. Contrary to what might expected, seals distribution extended well offshore, in the whole Antarctic krill distribution areas. Thus the abundance, the species and behaviour of krill, as well the associated type of krill-eating predators, were totally different in the offshore and inshore regions. The reasons of these differences are discussed.

POPULATION GROWTH AND PERSISTENCE OF ADELIE PENGUIN COLONIES: THE ROLE OF ENVIRONMENTAL VARIATIONS

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S1.8/O09

In Antarctica, the population dynamics of seabirds are dominated by the effects of environmental fluctuations. We used vital rates estimated by the analysis of detailed long-term individual data to build a matrix population model for Adelie penguins of Edmonson Point (Victoria Land, Ross Sea). Deterministic perturbation analyses indicated that adult survival is the parameter mostly affecting the population growth rate, (mean sensitivity 0.78), followed by first-year survival (0.20) and fledging success (0.12). Stationary stochastic population projections were used to estimate the log stochastic growth rate (log = 0.9443 ± 0.0007), and the probability of the present

population (2500 breeding pairs) to reach a quasi-extinction threshold of 100 breeding pairs. Probabilities were 27% and 100% at 50 and 100 years respectively. Moreover population trajectories were simulated for a positive and a negative trend in winter sea-ice extent anomalies in the region where Adelie penguins are thought to winter. Log stochastic growth rates and quasiextinction probabilities indicated a faster decline of the population in warmer conditions.

SEA ICE MICROENVIRONMENTS DURING EARLY SPRING IN THE EAST ANTARCTIC PACK ICE ZONE

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S3.3/P05

Pack ice and underlying seawater were sampled during the ARISE in east Antarctic cruise during September-October 2003 (64°- 65°S/112°-119°E, *RV Aurora Australis*) to determine the physico-chemical conditions, abundance and biomass of algae, protozoa and bacteria. The accumulation of algae did not seem to be limited by nutrients at the beginning of the productive season, but rather by available internal surfaces in brine channels and pockets. High dissolved and particulate organic carbon concentrations forming an extracellular gel biofilm , embedding microorganisms, were observed. More than 88 % of microorganisms were attached to the surface of brine channels and pockets. Biofilm forms protective and favorable microenvironments for the development of microorganisms in highly fluctuating environments such as sea ice. A large proportion of microorganisms appeared to be viable. High retention of nutrients and low presence of predators, allowed a significant accumulation of algae. The ratio of heterotrophic/autotrophic organisms measured in the sea ice is characteristic of an eutrophic environment where algae are bottom-up controlled, i.e. by abiotic factors rather than by grazing. Micro-sized diatoms mainly contributed to the increased autotrophic biomass. The fate of sea ice biofilm at the time of the ice melting is also discussed.

ECOLOGICAL RESPONSES OF ANTARCTIC TOP PREDATORS TO RECENT CLIMATE CHANGES

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S1.8/O29

Recent changes in Antarctic top predator populations may reflect direct and indirect responses to regional climate change. These observed changes are heavily biased in the directions predicted from global warming and have been linked to local or regional climate change through correlations between climate and biological variation. Perhaps best documented are demographic and population changes linked to variations in sea-ice and sea surface temperature of several species of seabirds and seals. Large reductions in population abundances along the extreme northern populations of Antarctica have been observed, potentially leading to future range contractions. Shifts in breeding and/or foraging areas have been observed for some penguins and whales species in relation to changes in sea ice distribution or to the position of the polar frontal zone, revealing some degree of plasticity. Phenological changes are still poorly documented, but some Antarctic seabird species seem to breed later in response to climate change. Overall, studies reveal that winter sea-ice has a profound influence on the behaviour, distribution and dynamics of Antarctic top predators. However, our current understanding of the impact of

climate change on predator-prey interactions is extremely poor, and studies assessing the rate of adaptation (microevolution) of Antarctic top predators are also needed.

THE COASTAL FISH ASSEMBLAGE AT TERRA NOVA BAY IN SEA-ICE AND OPEN WATER CONDITIONS

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S2.2/P02

The sea ice coverage plays an important role in structuring Antarctic marine habitats, mainly by reducing the light intensity and affecting the primary production. Nevertheless, the influence of seasonal changes in fish assemblages is still poorly known. To investigate the structure of the ichthyofauna and the possible changes related to the sea-ice coverage variations, we undertook a study on the shallow (0-150 m) coastal fish community at Terra Nova Bay (Ross Sea) in late summer and spring-time. This area is covered by the fast-ice most of the year, and ice-free in late summer. Data were collected by fishing nets, for conventional sampling, and by ROV, for *in situ* observations. Both the conventional sampling and the ROV surveys showed a higher species diversity during the period of sea-ice coverage. Moreover, some species such as *Trematomus eulepidotus,* present in low amount during summer, were abundant beneath the spring sea-ice. The results indicate a seasonal shift of fish towards shallow waters during the period of seaice coverage. In addition, small sized species, such as *Prionodraco evansii,* that can escape conventional sampling, were found in both the periods by ROV, thus stressing the need for complementary sampling approaches, to get accurate faunistic fish inventories.

RADIOMETRIC AGE VALIDATION AND SPATIAL DISTRIBUTION OF THE ANTARCTIC TOOTHFISH, DISSOSTICHUS MAWSONI: IMPLICATIONS FOR A DEEP-SEA ANTARCTIC FISHERY

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S5.2/O04

Antarctic toothfish (*Dissostichus mawsoni*) are subject to an increasingly important commercial fishery in the Southern Ocean, yet many of their life history characteristics and population structure remain largely unknown. In this study, Antarctic toothfish otoliths were obtained from American long-line fishing vessels in the Ross Sea, Antarctica. Age, growth and longevity were validated using lead-radium dating confirming that Antarctic toothfish live at least 39 years and grow relatively slowly ($k = 0.111$). Validated ages were then superimposed on a habitat map of the Ross Sea, Antarctica and broken into discrete spatial areas. Differences in age data within these areas were tested using ANOVA. Fish age and maturity increased with depth; younger, less mature fish were more often found on the shallower continental shelf and older fish were more often found in the deeper regions on the continental slope. The older and most mature individuals were found on ridges in the northern Ross Sea, supporting the hypothesis of an austral summer spawning migration. An effective management strategy might focus on protecting the northern ridge habitat to maintain long-term viability of Antarctic toothfish populations. Additionally, Antarctic toothfish vital rates should be considered before expanding the Ross Sea fishery.

BIOLOGY AND ECOLOGY OF ANTARCTIC KRILL, EUPHAUSIA SUPERBA DURING THE ANTARCTIC EXPEDITIONS 2006 AND 2007

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S1.8/O40

Biological and fishery data on Antarctic krill was analyzed during two Scientific Cruises of Peru to Antarctica (Austral summers 2006 and 2007) aboard the Research Vessel Humboldt. The study consisted in two phases: (1) a synoptic prospections in Bransfield strait and Elephant Island and (2) a small scale experiment between Elephant and Clarence islands. By the Austral summer 2006, the size structure of krill populations in both the Bransfield strait and our experimental zone was predominantly adult, with a total average length of 46 mm. However, in 2007, juveniles were mainly found in Bransfield strait and Oceanic Front, different to our experimental zone, where adults and sub-adults were the most abundant. During the summer 2006, the Antarctic krill was moderately and intensively fed. In contrast, in summer 2007, most krill was slightly fed; it could be attributed to a decrease in phytoplankton abundance (Ochoa *et al*, 2007). In general, the krill diet was based on diatoms and tintinnids, which confirms that krill mainly feeds on phytoplankton during Austral summers in order to grow and store energy to survive the extreme conditions (Falk-Petersen *et al*, 1990). There were not changes in the diet respect to size, hours and depth of catch.

INTEGRATING SOUTHERN OCEAN ECOSYSTEM SCIENCE ON A CIRCUMPOLAR SCALE

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S1.8/P11

Results from the past two decades of Southern Ocean research clearly demonstrate that integrated approaches are needed to improve understanding of the circumpolar ecosystem and the response of this system to variability and change. This is key to predicting impacts of climate and harvesting, improving sustainable management, and elucidating the role of the Southern Ocean in the Earth System. However, ecosystem modelling for the region is in its early stages; often restricted in geographic and/or trophic scope. Integration of relevant data resources, field efforts, and experimental studies is vital to improving models. Circumpolar data collation and rationalisation are required to identify gaps in coverage and knowledge, and to address these through coordination of international fieldwork. Acknowledging these challenges the Integrating Climate and Ecosystem Dynamics in the Southern Ocean programme (ICED) will cross traditional disciplinary boundaries to integrate research on ecosystems, biogeochemistry and climate at the circumpolar scale. Here we outline the focal points of the ICED Science Plan and Implementation Strategy. We discuss how ICED will generate new circumpolar datasets, undertake coordinated field activities, and develop models to determine the process interactions underlying Southern Ocean ecosystem variability and change.

INTERANNUAL VARIABILITY OF PELAGIC ECOSYSTEM PARAMETERS, INCLUDING KRILL, IN THE ANTARCTIC PART OF THE ATLANTIC

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S1.8/O24

The structure and dynamics of water masses with different spatial and temporal scales are main factors effecting interannual variability of pelagic ecosystem in the Antarctic part of the Atlantic. In this study the results of the complex surveys including measurements of hydrophysical, hydrochemical and hydrobilogical observations have been used, as well as data on krill biology and density distribution, data on parameters of atmospheric dynamics (1972-2002), and data on the former USSR fisheries statistics for 1972-91. Here the main characteristics of water masse circulation and transport of the different krill groups between the Antarctic Peninsula and South Georgia Island are presented. The special attention is given to the boundary between high- and lowlatitude modifications of the Antarctic water masses (i.e. the Weddell-Scotia Confluence zone), which is characterized by extended gyring and so this zone is the most stable area for krill concentration processes. It is shown that krill distribution around South Georgia Island, South Orkney Islands, and South Shetland Islands depends on meso-scale water masse dynamics, which in its turn depends on large-scale atmospheric processes. The results of direct estimation of krill transport factors between these regions in different years are discussed.

SEAWIFS CHLOROPHYLL DISTRIBUTIONS, SEA ICE DYNAMICS, AND KRILL RECRUITMENT WEST OF THE ANTARCTIC PENINSULA

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S1.8/O40

Southern Ocean GLOBEC cruises to the western Antarctic Peninsula during fall and winter 2001 and 2002 revealed high densities of larval krill during 2001 and one of the highest recruitments of juvenile krill over the last 25 years in 2002. These observations led us to investigate chlorophyll dynamics in the region, since successful recruitment should be linked to food availability for reproducing adults and larvae. We analyzed SeaWiFS (Sea-viewing Wide Field-of view Sensor) derived chlorophyll data between September 1997 to December 2004 using high-resolution (~1 km/pixel) daily images. Climatology patterns showed that the Bellingshausen Sea and southern Antarctic Peninsula (Marguerite Bay and south) consistently had higher and more persistent chlorophyll concentrations than more northern areas along the Antarctic Peninsula shelf and the western Scotia Sea. A seasonal shift in chlorophyll distribution occurred with elevated concentrations offshore or near the shelf-break during spring, progressing on-shelf by December. In general, ice-edge blooms were only a significant feature in southern regions, particularly the Bellingshausen Sea. High larval krill densities in 2001 were coincident with above-average chlorophyll concentrations throughout much of the study area. The role of Bellingshausen Sea and southern Antarctic Peninsula phytoplankton blooms in supporting regional food web dynamics warrants further investigation.

EFFECTS OF ENVIRONMENTAL AND CLIMATE CHANGE VARIABLES ON CONTROLLING THE ROSS SEA ALGAL COMMUNITY STRUCTURE (CORSACS)

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The largest and most predictable phytoplankton spring bloom in the Southern Ocean occurs in the Ross Sea, Antarctica. Phytoplankton community structure in the Ross Sea is dominated by the colonial haptophyte, *Phaeocystis Antarctica* and various species of pelagic and sea ice diatoms. Although these annual blooms occur regularly, the interplay of environmental factors responsible for initiating, maintaining and terminating these blooms are still unresolved. In 2005 and 2006, hydrography and underway measurements of CO2, dissolved iron, macronutrients, biogenic sulfur, HPLC algal pigments, POM, and delta C-13 of particulate organic carbon were determined during the austral spring and summer period in the Ross Sea. Low levels of dissolved iron (ca. 0.1 nM) were observed in surface waters during both the early spring and summer periods and along with low Fv/Fm values (ca. 0.3) suggested the presence of strong iron limitation. A strong correlation was observed between the delta C-13 signal and algal community structure. Semicontinuous and continuous experiments were performed to investigate the interaction of iron, light, vitamin B12, temperature and CO2 levels on algal community structure and biogeochemistry. Batch culture experiments indicated colimitation of the algal community by iron and vitamin B12. Semi continuous experiments demonstrated that CO2 levels could significantly alter the diatom species composition and hence new production. Continuous culture experiments indicated that high iron and high light conditions were conducive to colonial formation in *Phaeocystis antarctica*. Results will be discussed within the context of climate change.

SEASONAL HYDROGRAPHIC CONTROL ON NET COMMUNITY PRODUCTION AND THE SEASONAL FLUX OF ORGANIC MATTER WITHIN THE ROSS SEA POLYNYA, ANTARCTICA

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The hydrography and biogeochemistry of the Ross Sea water column was surveyed during CORSACS (Controls on Ross Sea Algal Community Composition) cruises in December-January, 2005-2006, and November-December, 2006. Open water photic zone temperatures during January, 2006, ranged from -1.9 to 3.0°C, whereas in December, 2006, they ranged from -1.9 to -1.2°C. Rapid solar heating and melting of sea ice in December can produce strong upper water column stratification. During January, pycnocline depth in stratified regions generally ranges from 10 to 30 meters, well within the photic zone. Significant spatial variability in upper water column stability results from 1) the largely predictable annual cycle of sea ice melting and displacement as the Ross Sea polynya opens, and 2) interannual and interseasonal variability in wind regime, ocean circulation and sea surface radiation balance. Here we combine CORSACS hydrographic, nutrient, and C system data sets with similar data from JGOFS (1996-1997), ROAVERRS (1996-1998), RSE (1994-1995), and the RSFE (1990-1992) projects to examine the relationship between thickness, areal extent, and temperature of the upper water column stratified layer and the drawdown and vertical export of organic C. Our analysis supports the view that maximum possible C drawdown (e.g., a macro- and/or trace nutrient consumed) is dependent on the timing and extent of water column stratification.

THE UNKNOWN ANTARCTIC BENTHOS: DISCOVERIES IN THE SOUTHERN BELLINGSHAUSEN AND AMUNDSEN SEAS

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S3.2/O07

In February to April 2008 during cruise JR179, biologists on board RRS James Clark Ross investigated the benthic biodiversity of the southern Bellingshausen and Amundsen seas. This least sampled Antarctic region constitutes an important gap in biogeographical analyses and no specimens from this region were available for molecular phylogenetics before. The BAS BIOPEARL project is assessing biodiversity at local and regional scales along vertical transects from the shelf to the deep slope. Onboard, DNA will be extracted from selected taxa (e.g. bivalves, gastropods, amphipods, isopods, pycnogonids) for phylogenetic studies and from a wide systematic range of marine invertebrates for CAML barcoding work. Detailed specimen photographs will illustrate faunal identities and richness. Two BAS geological projects, QWAD and PEP-G, collected marine sediment cores to reconstruct the climate record and to support the biology by analysing sediment composition. The joint biological, geophysical and sedimentological results will be used to determine the role of Antarctica and extreme environments in general in evolutionary innovation and generation of global biodiversity. In this talk we present the first results from the expedition, describing the benthic habitats and assemblages discovered at the sample sites and comparing them to data from the Scotia, Weddell and Ross Seas.

THE ROLE OF THE ANTARCTIC SEA ICE HABITAT FOR SYMPAGIC AND PELAGIC MACROFAUNA

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S1.8/P24

The Antarctic seasonal sea ice zone is well known for its richness in marine life including sea mammals, penguins and flying birds. Primary production in the sea ice probably nourishes large parts of the prey stocks needed to explain the food demand of these top predators. Macrozooplankton and nekton dwelling at the ice-water interface and in the surface layer of the open ocean were sampled using a new under-ice trawl during autumn 2004, winter 2006 and summer 2007/08 in the Lazarev Sea. Top predator censuses were conducted concurrently. More than 30 species of macrozooplankton, squid and fish were encountered under the ice, some of which were possibly sympagic. Dense under-ice aggregations of Antarctic krill *Euphausia superba* occurred hundreds of kilometers south from the ice edge, both in summer and winter. In open water, surface krill abundance often exceeded average abundance integrated over 200 m depth. Macrofauna from the ice-water interface layer formed a valuable food reservoir for the top predators. Their food demand was especially high in areas covered by sea ice, suggesting that the extent and composition of sea ice in the Southern Ocean is probably crucial for the survival of its wildlife stocks.

THE IMPORTANCE OF SEA ICE: PREY

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S1.8/P25

Macrozooplankton and nekton dwelling at the ice-water interface and in the surface layer of the open ocean were sampled using a new under-ice trawl during summer 2007/08 in the Lazarev Sea. Thirty species of macrozooplankton, squid paralarvae and juvenile fish were encountered under the ice, some of which were possibly sympagic. Bulk zooplankton biomass was significantly higher under ice floes than in open water, mainly due to high densities of Antarctic krill *Euphausia superba*. The size composition of krill was dominated by first-year juveniles, highlighting the importance of the sea ice habitat as a nursery ground.

PREDICTING TRENDS IN THE ANTARCTIC KRILL FISHERY

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S5.2/O03

The Antarctic krill fishery has been stable for the past decade at approximately 120 000 tonnes with a small number of countries participating in the fishery. Persistent concerns about a rapid escalation in the fishery have been driven by demands for new krill products, new fishing technologies and new entrants into the fishery. To date, there have been no accepted ways of obtaining firm information on future developments in the krill fishery. We have used a variety of sources of information to examine potential trends in the krill fishery. These include patent information, information submitted to CCAMLR (responsible for managing the krill fishery), examinations of world commodity markets and industry consultations. We will present our consolidated information which indicates that a substantial increase in the krill fishery in the near future is very likely.

INVESTIGATION OF THE VULNERABILITY OF THE BIOLOGICAL PRODUCTIVITY OF THE SOUTHERN OCEAN SUBSYSTEMS TO CLIMATE CHANGE : THE SOUTHERN ELEPHANT SEAL ASSESSMENT FROM MID TO HIGH LATITUDES

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S1.8/O30

Polar marine ecosystems are among the most vulnerable ecosystems on earth to climate change, with conflicting evidences on how the biological productivity of the Southern Ocean (SO) will respond to global warming. As part of the IPY program MEOP (No: 153), this research program assess the spatio-temporal variability of oceanographic condition but also productivity of SO with direct consequences on the amount of CO2 'fixed' by the biological pump, and on the biology of top marine predators. The program associate experts in ocean biogeochemistry, satellite oceanography, primary production (PP) modelling, geostatistics and biology, and use an innovative sampling fluorescence approach to quantify phytoplankton concentration at sea. The

studied geographic region will be the Indian Sector of the SO, and the main predator, the Southern elephant seal (SES). From 2004 to 2008, 46 elephant seals from Kerguelen Islands were fitted with a new generation of Temperature and salinity satellite-relayed data loggers, collecting temperature, salinity throughout the top 1000 m of the water. In 2007, two females were fitted by prototypes of a new generation of satellite-relayed data loggers measuring temperature, salinity as well as fluorescence through the first 200 meters. Oceanographic data as well as foraging behaviour and success information were obtained over a vast area extending from the polar front to the Antarctic continent. The results obtained provide the first synoptic view of the 3 dimension distribution of temperature, salinity and now fluorescence through a vast sector of the Southern Indian Ocean. This sector is mainly characterized by deep maximum fluorescence, undetectable from satellite pictures, with fluorescence concentration up to 10 times the values observed at surface. Fluorescence distribution is strongly related to temperature and salinity features with marked effect of currents front and divergence. The spatial variation of the foraging success of female SES highlighting the importance of the most productive SO subsystems : the Frontal Zone, located between the Subtropical and Polar Fronts, and the Marginal Ice Zone for female SES. While the highly productive Kerguelen-Heard and the peri-antarctic plateau constitute the main foraging area of males SES. Stable isotope method (δ13C, δ15N) are also used to reconstruct time series of δ13C values using SES blood and teeth collected over many years and were used to identify shift in foraging areas and/or productivity of the Southern Indian Ocean in relation to the past and recent change in the population size of SES at Kerguelen but also to identify differences in the foraging ecology between males and females SES.

LIFE STRATEGIES AND LIPID DYNAMICS OF DOMINANT ANTARCTIC EUPHAUSIID SPECIES

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S1.8/O37

Environmental seasonality is the crucial factor in determining the life strategies of many polar marine animals. Lipid accumulation represents an important energetic adaptation in pelagic organisms to cope with the pronounced seasonal productivity in the Southern Ocean. We compare four dominant Antarctic euphausiid species of the genus *Euphausia, E. crystallorophias, E. superba, E. frigida* and *E. triacantha* with regard to their lipid characteristics. Lipid accumulation is more pronounced in high-Antarctic krill species and may be utilised for metabolic maintenance during overwintering or for reproductive processes in spring. All these *Euphausia* species store large amounts of the unusual depot lipid phosphatidylcholine, a polar lipid with highly unsaturated fatty acids. However, they exhibit strong differences in their neutral lipid compounds, which may either consist of wax esters or triacylglycerols, but also of both types of lipid classes. The major end-products of the fatty acid and fatty alcohol biosynthesis, respectively, are also quite different. The ecophysiological implications of these deviating lipid characteristics may determine biogeographical zonation patterns and affect the vulnerability of Antarctic krill species to global warming.

EXPLORATION OF MICROBIAL BIODIVERSITY IN POLAR GLACIAL ICE AND SUB-GLACIAL WATER

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The polar ice caps do not only provide an understanding of climate variability over the past glacial cycles but also contain information about the paleoenvironment associated changes in microbial communities over time. Biological studies on polar ice cores are rare and focus on basal sections as well as accreted ice of sub-glacial lakes. Sub-glacial lakes isolated for at least a million years were not sampled so far because there is no unanimously accepted drilling procedure to keep this environment in pristine condition while sampling it. At the EPICA (European Project for Ice Coring in Antarctica) Dronning Maud Land (EDML) deep drilling project we drilled into the bottom of the East Antarctic ice sheet out of an under-pressured hole. At the bottom of the hole, sub-glacial water entered the drill-hole at a flow rate of more than one litre per minute. The samples we took from the top of the column at the water-drill-liquidinterface were contaminated by the drill liquid. Decontamination turned out to be difficult with this mixture. We started to study the microbiota of the sub-glacial water by means of the automated detection of target cells with the Chem*Scan* solid phase cytometer and detected a high amount of small particles some stained by SybrGreen I. A combination of molecular biological and microbiological tools was employed to differentiate between allochthonous and autochthonous organisms and to get more information about diversity, phylogeny, structure, and physiological adaptations of this unique microbial assemblage.

THE INFLUENCE OF WINTER SEA-ICE EXTENT ON FORAGING SUCCESS IN ADULT FEMALE SOUTHERN ELEPHANT SEALS

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S1.8

Winter pack-ice is known to be an important habitat for Antarctic zooplankton and that its extent is linked to springtime primary productivity. However, the relationships between winter ice extent and higher trophic levels is less well understood. In particular, it is difficult to relate the foraging success and, by extension, reproductive performance of higher predators such as birds and mammals to winter sea-ice extent. This study related the foraging success of more than 40 individual adult female southern elephant seals that had been tracked throughout the winter between 1999 and 2005 to the winter ice extent at those times. During this time there was considerable inter-annual and site-specific variation in the pack-ice between longitudes 80oE and 110OW, the broad region utilised by the seals from Macquarie Island. There was also significant inter-annual variation in the foraging success of the seals in those years, measured in terms of mass change from the start to the end of the 250 day winter foraging trip, with the lowest success in 1999 and the highest in 2004. Further, generalised linear modelling demonstrated that foraging success during a particular winter was positively related to the extent of the winter pack-ice in that year. That sea-ice extent can influence animals that breed on distant sub-Antarctic Islands has several implications for understanding both the historical population trends in this species and also for predicting population trends into the future.

THE SOUTHERN OCEAN GLOBAL OCEAN ECOSYSTEM DYNAMICS PROGRAM

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S1.8/P30

The Southern Ocean Global Ocean Ecosystems Dynamics (SO GLOBEC) Program objectives focus on understanding physical and biological factors that contribute to Antarctic krill (*Euphausia superba*) growth, reproduction, recruitment, and survivorship throughout the year. Overwintering strategies were highlighted as an important but largely unknown component of the Antarctic ecosystem. The SO GLOBEC science questions reflect a broad view of the Antarctic marine ecosystem that includes studies of the habitat, prey, predators and competitors of Antarctic krill, as well as studies specifically focused on Antarctic krill biology and physiology. This program included national field efforts in different areas of the Antarctic and is now in its synthesis and integration phase. The extensive multidisciplinary data sets resulting from SO GLOBEC are providing new and important understanding of Antarctic marine ecosystems. This poster overviews the SO GLOBEC program and highlights key results. The knowledge gained from the SO GLOBEC program provides a strong basis for the next phase of Southern Ocean research.

RESULTS FROM THE SOUTHERN OCEAN GLOBAL OCEAN ECOSYSTEM DYNAMICS PROGRAM

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S1.8/O19

The Southern Ocean Global Ocean Ecosystem Dynamics (SO GLOBEC) program focused on understanding physical and biological factors that contribute to enhanced Antarctic krill (*Euphausia superba*) growth, reproduction, recruitment, and survivorship. The extensive multidisciplinary data sets from SO GLOBEC are providing new and important insights and understanding of Antarctic marine ecosystems, such as 1) the role of circulation and sea ice in structuring Antarctic krill distributions, 2) understanding of the suite of overwintering mechanisms used by Antarctic krill, 3) knowledge of the importance of Circumpolar Deep Water in producing biological hot spots, 4) the effect of this biological production at all trophic levels, especially during winter, 5) the importance of alternative food webs and implications for carbon and nitrogen cycling, 6) the importance of fish as alternative food source for upper trophic level predators, and 7) the significance of climate variability at interannual and sub-decadal scales as a moderator of ecosystem processes. The recognition that larger scale processes affect regional physical and biological interactions provides a basis for the Integrating Climate and Ecosystem Dynamics (ICED) program. The knowledge and lessons learned from the SO GLOBEC program provide a strong basis for continuing into this next phase of Southern Ocean research.

SIGNIFICANT CHANGES IN THE ZOOPLANKTON COMPOSITION IN THE SOUTHERN OCEAN AND SEA ICE ZONE

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S1.8/O04

Antarctic waters are expected to be particularly sensitive and vulnerable to climate change. Global warming will affect sea ice patterns and plankton distributions. Increased UV levels, ocean acidification and invasive plankton species are also potential major impacts. Such events may trigger changes in Antarctic plankton with subsequent flow on effects through the ecosystem as observed in the North Sea and Atlantic. The Southern Ocean Continuous Plankton Recorder Survey was established in 1991 to map the spatial-temporal patterns of zooplankton

and then to use the sensitivity of plankton to environmental change as early warning indicators of the health of the Southern Ocean. Seven nations tow CPRs in the Southern Ocean providing a near circum-Antarctic Survey. The Survey has identified two major changes in zooplankton composition in eastern Antarctic waters. The first was in the sea ice zone (SIZ) around year 2000 when smaller zooplankton became more dominant instead of Antarctic krill. The second change occurred in 2004/05 north of the SIZ when pelagic foraminiferans exceeded 50% of the numerical abundance instead of the 2% long term average, replacing *Oithona* as the dominant species. Such changes in food size and type could have a major impact on the survival of higher predators.

CHANGES IN FORAGING BEHAVIOR AND HABITAT UTILIZATION OF SOUTHERN ELEPHANT SEALS IN RELATION TO OCEANOGRAPHY

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S1.8/O31

We examined the foraging behavior of 30 female southern elephant seals (*Mirounga leonina*) in the Western Antarctic Peninsula (WAP) in 2005, 2006 and 2007. The animals were tagged after the annual molt during February at Cape Shirreff, Livingston Island (South Shetland Islands). We obtained data on location, diving behavior, and water column temperature and salinity. There was significant interannual variation in the regions used by seals. In 2005, most animals foraged along the WAP. In 2006, animals presented a broader dispersion, some foraging as far as 170°W or south of Falkland Islands. In 2007, animals demonstrated a restricted distribution between 56° and 94°W, foraging over the continental shelf along the WAP. Our analyses showed significant interannual differences in the diving behavior of elephant seals. In 2006, seals displayed a pelagic diving behavior, as opposed to a benthic behavior in 2005 and 2007.We compared Area Restricted Search (ARS) zones of these animals using the fractal landscape technique. The analysis of oceanographic conditions allowed us to relate foraging of elephant seals with specific water masses along the WAP, as well as to identify differences on the surface and at-depth environmental conditions between ARS zones or transit segments of the tracks.

BIODIVERSITY OF THE SOUTHERN OCEAN S KNOWN UNKNOWN: ISOPOD RICHNESS ACROSS SCALES IN THE AMUNDSEN SEA

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S1.8/O18

The Amundsen Sea has long been known to represent the biggest unknown of Southern Ocean (SO) shelf/slope biodiversity - samples there potentially advance our knowledge more than those taken anywhere-else. Decades of increasingly intense SO sampling have yet to reveal much more than a mere list of taxa by site. Recent work has highlighted that SO macrobenthic biodiversity varied as much in samples tens km apart as across whole ocean basins. To interpret biodiversity we need to investigate the scale at which variability in richness and abundance occurs and what causes this. Here the most detailed multiscale, multifactor study of any taxon is reported from the

least sampled sea on the planet. Multiple Epi-Benthic Sledge (EBS) shelf/slope samples were taken 102, 101 and 100 kilometres apart with linked environmental data on topography, oxygen, granulometry and organic content. Richness and abundance of isopod crustaceans, which represent one of the better studied taxa across SO depths, was investigated. In the current study Amundsen Sea biodiversity is reported, how it varies across multiple scales, depths and taxonomic levels and which factors may drive variability. The knowns and unknowns about SO deep-sea, slope and shelf biodiversity are reevaluated in the context of these results.

ANTARCTIC SEA ICE: HABITAT CHARACTERISTICS, METAZOAN FAUNA, AND ADAPTATIONS TO LOW TEMPERATURE

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S3.2/O08

The sea ice of polar regions represents one of the largest ecosystems on earth with specially adapted organisms. In the Southern Ocean up to 18 million km2 are covered by sea ice in winter. Sea ice is permeated by small brine channels which house a diverse fauna and flora. Temperatures within the ice range from 0 °C down to -22°C, therefore these channels represent one of the coldest environments on earth. In-situ studies show that sympagic (ice-associated) harpacticoid copepods and turbellarians cope well with temperatures down to -4°C and corresponding salinities of 69. The sympagic calanoid copepod *Stephos longipes* is well adapted to a temperature range of at least -1.2 °C (S = 25) and -3.1 °C (S = 55). This species is slightly hyperosmotic to seawater in a range of S = 25 to 45 and exhibits a thermal hysteresis of 0 to -3.8 °C (median -1.0 °C). Analysis of a cDNA-library of *S. longipes* enriched for genes expressed at -3.1 °C revealed the presence of a putative antifreeze protein. Furthermore, a high representation of genes envolved in transcription and translation in this library indicates that large structural rearrangements are essential for an adaptation to osmotic and temperature stress.

DIVERSITY, ABUNDANCE AND FEEDING ECOLOGY OF ARCTIC AND ANTARCTIC SYMPAGIC MEIOFAUNA

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S1.8/P37

Sympagic (ice-associated) algae contribute substantially to primary production in ice-covered areas. We hypothesize that sympagic meiofauna (metazoans > 20 µm), feeding on algae or small heterotrophs, play an important role within polar food webs. Data from four cruises are presented (ANT-XXIII/7, Weddell Sea, winter 2006; SIPEX, East Antarctic, winter 2007; ARK-XXII/2, Central Arctic, summer 2007; CFL, Canadian Arctic, spring 2008). Diversity and abundances of sympagic meiofauna in winter were low in the East Antarctic (seasonal ice), but high in the Weddell Sea (perennial ice). In the Central Arctic, abundances in summer were within the range of earlier studies. In both Arctic and Antarctic, several metazoan taxa were found in sea ice for the first time (e.g. ctenophores, rhabditophor plathyelminthes). Feeding experiments revealed grazing of several meiofauna taxa on algae (e.g. acoel plathyelminthes, harpacticoid copepods *Halectinosoma* sp. and *Tisbe* sp.), but several taxa also preyed on ciliates or other meiofauna

(e.g. cnidarians, ctenophores, acoel plathyelminthes, *Halectinosoma* sp.). Varying densities of grazers / predators and food allow calculation of feeding rates, including functional response and concurrence effects. Methods particularly adapted to sympagic meiofauna have been developed for gut content, stable isotope and fatty acid analyses, which reveal *in situ* feeding habits.

CHARACTERIZATION OF ICE-BINDING PROTEIN FROM ANTARCTIC SEA ICE DIATOM, CHAETOCEROS NEOGRACILE

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S3.3/O23

Polar sea ice diatoms grow well under low temperature and high salinity environmental condition, and these diatoms are responsible for a conciderable part of Antarctic photosynthesis. Their successful growth may due to the secretion of macromolecules that have ice recrystallization inhibition activity and to the ability to act as cryoprotectants. Ice-binding protein (IBP) is one of these molecules. These proteins cause pitting and other irregularities on the surface of growing ice crystals. In this study, we isolated IBP cDNA from Antarctic sea ice diatom, *Chaetoceros neogracile* and characterized this protein. *C. neogracile* IBP showed 61% identity of sequence homology with *Navicula glaciei* IBP-8 based on the alignment of amino acid sequences. Besides, we investigated the copy number of IBP in *C. neogracile* using Southern blot analysis. We are under examining the activity of *E. coil* expressed IBP to bind ice and inhibit the recrystallization of ice and the expression analysis by using the real time PCR.

PROCESSES GOVERNING THE SUPPLY OF IRON TO PHYTOPLANKTON IN THE SOUTHERN OCEAN: A MODEL STUDY

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S1.2/P23

An upgraded version of the biogeochemical model SWAMCO4 (Pasquer et al., 2005) is coupled to the ocean-sea-ice model NEMO-LIM (Timmermann et al., 2005) to explore processes governing the supply of iron to phytoplankton. The 3D NEMO-LIM-SWAMCO4 model, constrained by chemical (Fe, N, P, Si), physical (light, temperature, salinity) and biological (zooplankton grazing) controls, explicitly details four relevant phytoplankton (diatoms, nanophytoflagellates, coccolithophorids and *Phaeocystis*) and three heterotrophic (bacteria, heterotrophic nanoflagellates, microzooplankton) functional groups with respect to C, N, P, Si, Fe cycling and climate change. The 3D NEMO-LIM-SWAMCO4 model is implemented in the ocean domain south of latitude 30°S and runs are performed for the period September 1990 - August 2000, making use of climatological fields for N, P, Si, DIC and alkalinity initial conditions. For iron and biological state variables, initial conditions are retrieved from published observations and transformed for adjustment to the model currency when necessary. Model scenarios include and cross-compare different iron sources (inputs from atmospheric deposition, iceberg melting and continental sediments) and iron accumulation mechanism in the sea ice. Model results are analysed with respect to observed iron and phytoplankton bloom distributions and point the key role played by continental sediments as iron source and as process for the winter transient storage in the ice of iron, released and made available to phytoplankton in spring when ice melts.

CONTROLS ON ROSS SEA ALGAL COMMUNITY STRUCTURE AND DIMETHYLSULFONIOPROPIONATE

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S1.8/P41

Iron, light and CO2 are thought to be three key factors in determining phytoplankton community structure in the Ross Sea, Antarctica. However, the interactive effects of these factors are largely unknown, but are likely to impact significantly the biogeochemical cycling of carbon, nutrients and sulfur, thus providing positive and negative feedbacks on climate. A shipboard incubation experiment was conducted to elucidate the interactive effects of these parameters on phytoplankton community structure and its associated impact on dimethylsulfoniopropionate (DMSP) in the Ross Sea. The relative dominance of diatoms:*Phaeocystis*, as measured by the Fucoxanthin:19 –Hexanoyloxyfucoxanthin ratio, was greatest under conditions of low light/high iron, followed by low light/low iron and high light/high iron with lowest dominance under conditions of high light/low iron. Chlorophyll *a* followed the same trend. The response of DMSP to the experimental manipulations was somewhat more complicated. Increased iron resulted in increased particulate DMSP irrespective of changes in the other parameters. DMSPp:Chl *a* ratios were highest when Chl *a* was lowest (i.e. under high light conditions) suggesting changes in Chl *a* were largely responsible for changes in DMSPp:Chl *a*. Conversely, DMSPp:PON ratios showed no changes due to changes in light and only minimal changes due to iron or CO2.

THE CIRCUMPOLAR FLAW LEAD (CFL) SYSTEM STUDY

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S1.8/O47

The circumpolar flaw lead (CFL) is a perennial characteristic of the central Arctic. The CFL system is formed when the central pack ice (which is mobile) moves away from coastal fast ice, opening a flaw lead which occurs throughout the winter season, forming first in the fall, and continuing as thin ice areas during the winter season. The flaw lead is circumpolar, with recurrent and interconnected polynyas occurring throughout the Arctic. The CFL study is a major international effort that involves 15 countries and over 200 researchers. The project focuses on the Canadian component near Banks Island, NT and is designed to examine the importance of climate processes in changing the nature of a flaw lead system, and the effect these changes will

have on the marine ecosystem, contaminant transport, carbon fluxes, and greenhouse gases. We will measure all aspects of the marine ecosystem and the physical system. There is a strong emphasis on the integration of traditional knowledge with western science. The project involves the over-wintering of the Canadian Research Icebreaker CCGS *Amundsen* within the Cape Bathurst polynya in the Southern Beaufort Sea. This represents the first time ever that a research icebreaker has studied the annual cycling of physical and biological processes in the Circumpolar Flaw Lead (CFL) system. We present information on the design of the CFL field program and highlight the scientific programs being conducted, preliminary results obtained and aspects of outreach of this International Polar Year (IPY) project.

ARCTIC ENVIRONMENTAL CHANGES INFLUENCE THE NUTRITIONAL QUALITY OF ICE ALGAE

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In seasonally ice covered marine ecosystems ice algae represent an important early food source for sympagic amphipods and herbivorous zooplankton. The onset, extension and quality of algal blooms will supposedly alter in the future due to the rapid decrease of Arctic sea ice extent and thickness. We followed the seasonal changes in algal food quantity and quality, together with their major determinants light, nutrients and hydrography in a high Arctic fjord (80° N) from March to October. We measured ice thickness, snow cover, light transmission, and nutrients. Quantitative samples of ice algae were obtained from ice cores, and analyzed for fatty acid composition, stoichiometry, pigments and taxonomy. Ice algae were found from March until June. Their fatty acid composition changed profoundly over time, reflecting biochemical and physiological responses to increasing light intensities and nutrient limitation. By the end of April, polyunsaturated fatty acids (PUFAs) accounted for up to 40% of total lipids, whereas samples from June contained only 20% PUFAs. The dominating fatty acid during the late phase was 16:1 n-7 (almost 50%), probably indicating storage lipid formation. We discuss which factors determine mainly the algal fatty acid composition and how these may change in a warming Arctic.

ENSO DRIVES INTERANNUAL AND DECADAL-SCALE VARIABILITY OF THE ANTARCTIC PENINSULA PELAGIC MARINE ECOSYSTEM

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The West Antarctic Peninsula region is a major source of Antarctic krill (*Euphausia superba*) to the Southern Ocean. From 1980-2007 primary and secondary production, krill recruitment success and sea ice extent here were significantly correlated with the atmospheric Southern Oscillation Index and exhibited three- to five-year frequencies characteristic of ENSO variability. This linkage was associated with movements of the Southern Antarctic Circumpolar Current Front and Boundary, changing influence of Oceanic and Weddell Sea waters, eastward

versus westward flow and mixing processes that are consistent with forcing by the Pacific-South America and Antarctic Dipole high-latitude climate mode. Significant ecological changes indicative of a change in Antarctic Dipole forcing after 1998 reflect large scale climate variability. Natural environmental variability associated with interannual- and decadal-scale changes in ENSO forcing must be considered when assessing impacts of climate warming in the Antarctic Peninsula-Weddell Sea region.

CONSTRAINING PRODUCTIVITY IN THE ROSS SEA: A COMPARISON OF METHODS IN A DYNAMIC POLAR ECOSYSTEM

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S1.8/O57

Primary production in the Southern Ocean mediates carbon transfer to depth, potentially an important control of atmospheric CO2 on glacial-interglacial and anthropogenic time scales. The response of production to changing climate is uncertain, however; thus, regular and accurate measurement of Southern Ocean production is important to understand climate feedback in global carbon cycling. Here, we present data obtained on two recent oceanographic surveys of the Ross Sea. The magnitude of primary production and net community production has been estimated *in situ* at varying temporal and spatial scales. We compare results from water column carbon and nutrient inventories, surface O2/Ar measurements made by membrane-inlet mass spectrometry, and triple-isotope composition of dissolved oxygen. *In situ* measurements are compared to satellite-derived productivity estimates as well as *in vitro* primary production determined by 14C uptake. This study is unique in bringing together a diverse suite of tracer data in an Antarctic continental shelf environment, permitting checks on the consistency of mass balance terms. Results indicate that O2-based methods, while yielding similar broad spatial patterns, tend to underestimate production in the polynya environment. This is due to the highly transient nature of bloom dynamics and the relatively quick equilibration time for oxygen across the air-sea interface.

IN SITU RESPONSE OF SEA-ICE MICROBES TO HABITAT VARIABILITY: INSIGHT INTO GLOBAL WARMING OR JUST ANOTHER FLIPPIN ICE CORE ?

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S1.8/O56

Sea ice represents a harsh physicochemical environment, yet diverse microbial communities reside in the brine inclusions and interstices of the ice matrix. These microbes are integral to the energy base of the Antarctic coastal ecosystem, but little attention has been paid to their response to physiological stressors, or the short-term ability of these organisms to respond to environmental changes. We used a reciprocal transplant experiment to examine the *in situ* response of both bacteria and microalgae to habitat variability. A series of ice cores from annual fast ice within Terra Nova Bay, Antarctica, were flipped and left *in situ* for 18 days. Core analyses determined Chl *a* concentrations, bacterial and microalgal cell counts and bacterial

community composition from three regions of each ice core. Environmental data were collected throughout the time period by deploying light and temperature loggers within the ice matrix. This talk will examine how the microbial community is structured by the physicochemical gradients within the ice matrix and the extent to which these microbes can adapt under experimentally induced changes.

NEW INSIGHTS INTO OVERWINTERING STRATEGIES OF FOUR LARGE ANTARCTIC COPEPOD SPECIES

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S1.8/P46

Large Antarctic copepod species have different life cycle strategies, which are closely connected with seasonal changes in the environment. The present study aimed to discover certain differences in winter activity of *Calanus propinquus*, *Metridia* spp., *Calanoides acutus* and *Rhincalanus gigas* in relation to their life cycle strategies. Respiration and feeding rates of copepodids III-V and adults were investigated during the expedition ANT XXIII/6 with RV Polarstern to the Lazarev Sea (June-August 2006). The experiments were conducted under different conditions, including (a) natural seston concentrations, (b) surplus concentrations of natural seston, and (c) added sea ice algae (simulation of the ice melting period). Winter inactivity of *R. gigas* and deep-dwelling *Metridia* spp. (females, CV), *C. propinquus* (CIII, CIV) and *C. acutus* (CV) was indicated by both respiration and feeding rates. Surface *Metridia* spp. (CV) and *C. propinquus* (CV) remained active and had significantly higher respiration and feeding rates. They also responded quickly to addition of ice algae and increased their feeding activity threefold within 8 hours. We propose new additions to the concept of the overwintering behaviour of Antarctic copepods. Copepods remaining active in winter have more preferences in ingested food and quick responses to changing feeding conditions, which indicates a strong dependence on the food supply during the ice melting period.

SEA ICE ECOSYSTEM OBSERVATIONS AT NELLA FJORD, PRUDZ BAY, EASTERN ANTARCTIC

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S1.8/P49

During the 2007 Russian Antarctic Expedition (RAE), the IPY project Study of the Antarctic Sea Ice Ecosystems (SASIE) was launched. SASIE is a part of the IPY cluster project Integrated analyses of circumpolar Climate interactions and Ecosystem Dynamics (ICED) which is an international initiative aimed at coordinating integrated, multidisciplinary, circumpolar analyses of Southern Ocean ecosystems. The IPY field observations were conducted at Nella fjord (Prudz Bay) nearby the Russian continental station Progress (69° 22 S and 76° 23 E) located at Ingrid Christensen Coast (Larsemann Hills, Princes Elizabeth Land, Eastern Antarctic). During the period 26.12.06 through 9.01.07 there were collected both sea ice cores and under ice water samples at the profile across the Nella fjord for salinity, mineral and organic compounds measurements and species composition identifications. It was shown that sea ice flora consists of mainly by dinoflagellate cysts, but marine diatoms were presented only by single cells, that are probably caused by freshening of ice. Due to Nella fjord observations, the multicomponent system was detected which is consisted of: (i) ice with fresh and sea water influence, (ii) under ice brackish water layer with salinity of 4-5 and 50 60 cm thick, and (iii) sea water layer with salinity of 34-35 . This multifloor sea-ice-water

system is synchronous vertically displaced due to tides up to 2 m, but sufficiently stable during the melting season while the sea-ice cover is put off the water-wave mixing. The SASIE is planned to continue after the IPY as a long-term ecological research project under umbrella of the RAE.

THE IPY PANARCTIC ICE CAMP EXPEDITION, APRIL 2007

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S1.8/O46

Recent climate change in the central Arctic Ocean predicts shifting of ice-edge to the north, decreasing of sea-ice extent and thickness, increasing of ice-free areas, warming and freshening of surface water. All evidences indicate that a complex suite of interrelated atmospheric and oceanic changes are now underway, affecting every part of the polar environment and ecosystems. Taking into account a noticeable gap of knowledge about physical, chemical, and biological processes in the central Arctic Ocean, in April 2007 the Pan Arctic Ice Camp Expedition (PAICEX) was conducted. A major goal of PAICEX was to develop several manned sea-ice platforms to support multi-disciplinary observations with a focus on studies of low atmosphere-sea ice-upper ocean system. All observations were conducted at mezoscale polygon nearby the North Pole in four ice drifting ice camps using synchronous time schedule for samplings, same field sampling methods, nets, bottles, CTD profilers, and lab processing methods. PAICEX 2007 materials have shown that (1) the average sea-ice cover thickness in the vicinity of the North Pole is twice less of the thickness observed here three decades earlier; (2) the upper level of warm Atlantic water is 30-40 m higher in comparison to climatic position boundary in this region; (3) species composition of sea ice biota is quality and quantity poor in comparison to observations in past decades; (4) in April salinity of sea-ice associated water layer is 16 , that is remarkable fresh and long before beginning of active summer melting season. The PAICEX 2007 materials have also shown that there are urgent needs in long-term monitoring the atmosphere-sea ice-upper ocean system in same season and geographical region to understand, assess and forecast the environment, ecosystem and climate dynamics in the recent marine Arctic.

VARIABILITY AND CHANGE IN THE SCOTIA SEA ECOSYSTEM

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S1.8/P61

The Scotia Sea ecosystem is a key part of the wider Southern Ocean system, being an area of relatively high production supporting large predator colonies and major fisheries. It is also known to be affected by rapid changes in sea-ice and oceanic conditions and by long-term harvesting; significant biological changes have also been recorded in this area during the last few decades. Integrated analyses and modelling at a range of scales are being used to determine the main controls on pelagic food web structure and ecosystem operation. The regional ecosystem shows marked spatial and temporal variability, analyses of which reveals some of the potential mechanisms involved in determining the dynamics of species operating at different trophic levels. These analyses provide insight into the factors generating decadal changes in the system. Possible ecological impacts of projected future change in Southern Ocean physical systems are discussed, highlighting the complexity of ecological systems, which can show bottom-up and

top-down control, feedback effects and non-linear responses to change. These analyses emphasise the need to understand the operation of the whole ecosystem, including the wider circumpolar links.

IS ANTARCTIC PACK ICE ALGAE FE-LIMITED?

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S3.2/O09

The availability of the micronutrient iron is known to exert control on phytoplankton growth and community composition in much of the Southern Ocean. The role of this trace element in regulating primary production in Antarctic pack ice is however, largely unknown. To investigate the availability of iron to microalgae in Antarctic pack ice, immunoassays were developed for the proteins ferredoxin and flavodoxin. In pervious studies these proteins have been shown to be regulated by iron availability in many temperate marine phytoplankton and have the potential to be used as indicators of iron availability *in situ*. Antibodies generated towards ferredoxin and flavodoxin purified from a temperate diatom were found to have good cross-reactivity with the proteins from a range of sea ice diatoms. The putative iron stress protein flavodoxin was found to be expressed constitutively in several sea ice diatoms from both the Antarctic and Arctic. Along with constitutive flavodoxin expression some sea ice diatoms were observed to never express ferredoxin suggesting that these organisms have lost the ability to produce this protein, possibly as a means to reduce cellular iron quotas. The effects of iron availability on *Fragilariopsis curta* and *Fragilariopsis cylindrus* were determined in laboratory cultures of these organisms. Growth rates, ferredoxin and flavodoxin expression and photophysiological parameters determined by pulse amplitude modulation (PAM) fluorometry were investigated in relation to iron supply. Half saturation constants for growth were similar for both *F. cylindrus* and *F. curta* and photosynthetic parameters showed quantitatively similar reductions for both organisms in response to reduced iron supply. Different patterns in the expression of ferredoxin and flavodoxin were observed in these two organisms. Iron replete *F. curta* only expressed flavodoxin (without ferredoxin) and cellular levels of this protein were not regulated by iron availability. In *F. cylindrus* ferredoxin was expressed under iron replete conditions and was replaced completely by flavodoxin as a very early response to iron stress, prior to reductions in growth rate or decreases in photosynthetic parameters such as Fv/Fm. Ice cores collected from Southern Ocean pack ice north of the Adelie Land coast were analysed for both ferredoxin and flavodoxin. Flavodoxin was detected in the majority of core sections and the concentration of this protein was significantly correlated with chlorophyll concentration. Ferredoxin was less widely distributed, being detected in approximately half of all core sections examined, and flavodoxin was always detected along with this protein. These results are consistent with constitutive expression of flavodoxin in many sea ice diatoms and in combination with the culture experiments demonstrate that flavodoxin cannot be used as a stand alone marker for iron stress in this environment. High concentrations of ferredoxin were associated with the top half of ice floes and were never observed in bottom communities which were the most highly productive. The observed distribution of this protein suggests that differences exist in the ability of these communities to access iron, however iron availability did not regulate the distribution of biomass within these floes.

VARIABILITY OF THE DICOTHERMAL LAYER IN THE ANTARCTIC OCEAN AND ITS INFLUENCE ON MARINE ECOSYSTEM

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S1.2/P35

The dicothermal layer, a peculiar temperature structure of cold water sandwiched between the warm waters above and below, is acting as a physical barrier in the surface layers in vertical direction. The dicothermal layer is conspicuous only during summer and extends upto about 50-degree south from the Antarctic Coast. This layer occupies between 50m and 150m depths. The present study describes the characteristics such as salinity, temperature, density, oxyty, nutrients and the sound velocity in the dicothermal layer and tried to bring out the variability. The available historic observations and the sections covered during World Ocean Circulation Experiment have been utilized. Large spatial and temporal variability has been noticed in the structure and characteristics of the dicothermal layer in the Antarctic Ocean. The influence of dicothermal layer on productivity is analyzed using the Chlorophyll data. The dicothermal layer is associated with relatively high gradient of salinity, density and oxyty. The sound velocity seems to be minimum along this layer. The structure of this layer is much controlled by the upwelling warm deep water and the summer heating of the surface waters.

CIRCULATION ON THE WESTERN ANTARCTIC PENINSULA AND IMPLICATIONS FOR BIOLOGICAL PRODUCTION

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S1.8/O55

Field observations from the U.S. Southern Ocean Global Ocean Ecosystem Dynamics Program showed that marine mammals and other predators concentrate in specific areas of the western Antarctic Peninsula (WAP) continental shelf. The relative contribution of circulation in producing these regions was investigated with Lagrangian particle tracking simulations that used a high-resolution version of the Regional Ocean Modeling System that included a dynamic sea-ice model and thermodynamically active ice shelves. Floats were released along the WAP outer and mid-shelf regions at a range of depths in different seasons. The simulated particle trajectories showed preferred sites for cross-shelf exchange and onshelf intrusions, which corresponded to areas where higher predator abundance was observed. These results suggest that circulation is potentially important in developing localized areas of high predator abundance perhaps through facilitating aggregation of prey and/or providing areas of enhanced nutrient availability and biological production. The trajectories of floats released along the southwestern portion of the model domain showed inputs to the WAP shelf from the Bellingshausen Sea (BS) with a time scale that is consistent with the time required for krill eggs spawned in the BS to develop into larvae. These results suggest connectivity between WAP and BS krill populations.

FISH LIFE UNDER THE ANTARCTIC ICE

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S5.5/P09

Low impact and high efficiency make the Remotely Operated Vehicles (ROVs) technology an important tool for Antarctic biologists to get insights into the secrets of seafloor communities. At the Italian Antarctic base (Mario Zucchelli Station) underwater recording is made by using Romeo, a ROV designed for mid water marine science applications, with high horizontal manoeuvrability and precision altitude control. By Romeo, a survey specifically focused on fish was carried out at MZS in Austral Spring (October-November 2005/2006) when the coastal region is completely covered by the pack ice. Eleven fish species from 4 notothenioid families were observed in their habitat and their behaviour recorded as video clips. Among the most interesting film segments, large shallow schooling of *Trematomus newnesi*, nesting and parental care of *Pagetopsis macropterus*, digging of *Chionodraco hamatus,* and predation of *Histiodraco velifer* were recorded. Beside their scientific meaning, the collected images have an educational value and can be used to build up a documentary video and e-learning materials. In that way, according to IPY aims, Antarctic scientists will share their results in a wide context of not specialized public and the large public will be provided with up-date scientific information through familiar media.

INFLUENCE OF ENVIRONMENTAL CONDITIONS ON THE FORMING OF THE POPULATION OF SPINY ICEFISH (CHAENODRACO WILSONI) AND ITS FISHERIES IN COSMONAUT SEA (ANTARCTICA)

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S5.5/P10

Data were collected in eight summer seasons from 1982 till 2001 in Cosmonaut and adjacent Seas of Antarctica. West Coastal Current is basic factor that determines of spiny icefish population structure in Cosmonaut Sea. WCC predetermines allocation of age groups within population and direction of moving of the same age groups eastward during the process of ontogenetic development. Supposed moving at winter only, when current speed under flouting ice is lower. In the first year of life larvae and young fishes move with stream to the west periphery of the Sea. They are living first three years there. Iceberg scouring of epifauna on the shelf is basic factor influenced on distribution of spawning and post-spawning aggregations of icefishes on the shelf. Noted spawning and existence of post-spawning aggregations of icefish are on places where no sponges, corals and another animals on the bottom within depths 200-300 m. Bottom overgrown with sponges for 3 years and fish aggregations move to the next suitable places. Fishing guided to finding scoured by icebergs small fishing grounds. As a result of this minimized influence of fishing gears on bottom fauna. Observed daily forage migration of icefishes from bottom (near bottom temperature -1.8°) to surface (surface temperature 2°). Represented analysis of fishing and changing of fishing situations for some fishing seasons.

ARCTIC POPULATIONS OF MARINE AMPHIPODS ARE LESS ADAPTABLE THAN THEIR SOUTHERN COUNTERPARTS

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S1.8/O03

To further examine the adaptability of polar marine invertebrates to climate change, metabolic rates (MR) and thermal tolerances were determined in several species of marine gammarid amphipods living at different latitudes (78-38 N). Comparisons were made between an Arctic species, *Gammarus setosus,* a cold-temperate species, *G. ceanicus,* and a warm-temperate

species with Mediterranean ancestry, *G. locusta*. MRs, measured as rates of oxygen uptake, were taken at the habitat temperatures recorded at the time of capture and scaled to a standard wet mass of 1mg. Between species, MRs were significantly lower (Krusskal-Wallis $P<0.001$) in *G. setosus* (7.7±2.6 nmolO2.h-1.mg-1) and arctic populations of *G. oceanicus* than in *G. locusta* (25.0±1.6 nmolO2.h-1.mg-1). Thermal tolerance and aerobic scope also decreased at higher latitudes. Arctic populations (78 N) of *G. oceanicus* had significantly (Krusskal-Wallis $P<0.05$) lower MRs (10.5±1.4 nmolO2.h-1.mg-1) than more temperate populations (58 N; 22.1±4.0 nmolO2.h-1.mg-1). In contrast, latitude had no effect on the MRs of *G. locusta*. It appears that warm-temperate species compensate for temperature-related changes in MRs, whereas the Arctic/cool-temperate species do not. Such differences could be related to their ancestral origins and thermal histories, and have an effect on their ability to respond to further environmental change.

NOVEL ICE-BINDING PROTEINS FROM A PSYCHROPHILIC ANTARCTIC ALGA (CHLAMYDOMONADACEAE)

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S3.3/O24

Many cold-adapted unicellular plants express ice-active proteins, but at present, only one type of such proteins has been described, and shows no resemblance to higher plant antifreezes. Here we describe four isoforms of a second and very active type of extracellular ice-binding protein from a unicellular Chlamydomonad alga collected from an Antarctic intertidal location. The alga is euryhaline and genetically very close to an Antarctic snow alga; it thus might be a snow alga that was carried to the intertidal region by melting snow. The protein has a size of 35 kDa and does not resemble any known antifreezes, and its closest known relatives are bacterial proteins. The recombinant protein has strong recrystallization inhibition activity that may increase survival of the cells in freezing environments.

DISTRIBUTION OF BALEEN WHALES (MYSTICETI) IN THE WESTERN ANTARCTIC PENINSULA REGION: RELATIONSHIPS WITH KRILL DEMOGRAPHY AND OCEANOGRAPHY

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S1.8/O35

We conducted surveys to quantify the distribution of Baleen Whales (*Mysticeti*), and Krill (*Euphausia superba*) as part of the U.S. Antarctic Marine Living Resources (AMLR) program during 2003-2007. Commercial krill fisheries may cause potential negative interactions between fisheries and whales. Thus, conservation policies and management strategies are needed for whales and krill near the Western Antarctic Peninsula. We investigate spatial variability of whale/krill distribution in CCAMLR sub-area 48.1 to quantify habitat requirements of whales in areas finer than the proposed Small-Scale Management Units (SSMU s). We ask the following: (1) Are there predictable locations where whales occur annually? (2) Does distribution of Humpback and (*Megaptera novaeangliae*) Fin Whales (*Balaenoptera physalus*) vary in relation to Krill distribution? (3) Do Humpback and Fin Whales use different foraging locations? We found persistent locations each year where whales tended to aggregate. Aggregations of Humpback whales were more likely to occur near concentrations of juvenile krill coinciding with

Antarctic coastal and Weddell Sea waters. Moreover, Fin Whales tended to aggregate in offshore waters near the southern boundary Antarctic Circumpolar Current which coincided with dense aggregations of adult krill. The distributional data described here (5 years) shows that the annual occurrence of whales is predictable and that different species exhibit preferences relating to krill size and demography.

CLIMATE CHANGE IMPACTS ON ANTARCTIC MARINE ECOSYSTTEM AND KRILL FISHERY

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S1.8/O23

Life of Antarctic krill, which supports predators as well as fishery, is strongly associated with sea ice, inherently subjected to climate changes. Concurrent examination of sea ice and chlorophyll from the satellite imagery identifies a number of critical areas for the maintenance of krill population that undergo predictable sea ice development and subsequent algal blooms. Field survey and analyses of recent sea ice indicate that part of the Weddell Sea is more important as krill source than previously thought but the sea ice in the area is likely to suffer a fairly rapid decline when climate change proceeds at current rates. Continued loss of sea ice beyond natural variability will result in much less over-winter grounds available for krill population. This should drastically alter the fate and distribution of krill population, and hence the well-being of predators as well as the behavior of krill fishery. Control of fishing efforts, which is already limited in affecting the dynamics of krill, will do little to impact either the predators or the krill fishery in any way, and will be overwritten by climate changes.

ICE CORE METHYLSULFONATE AND SEAWIFS CHL A: CONCENTRATIONS, TRENDS, AND CONNECTIONS

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S2.1/P13

Methansulfonic acid is a biogenic compound that is preserved in ice cores as the anion methylsulfonate (MS-). In Antarctica the only source of MS- is marine phytoplankton. MS- concentrations have been used as proxies for sea ice extent, sea surface temperature, and atmospheric circulation patterns such as El Nino Southern Oscillation and the Antarctic Dipole. Although affected by oceanic and atmospheric processes the ultimate controlling factor of MSconcentration is the amount of phytoplankton. We measure the MS- concentrations in the upper meters of a core collected from Hercules Dome, Antarctica (86.5S, 108.0W, 2586 masl), as part of the 2002 International Trans-Antarctic Scientific Expedition. Chlorophyll data are from the level 3 mapped images provided by Goddard Space Flight Center. Sea level pressure from NCEP/NCAR Reanalysis is used to indicate pressure centers and relative intensity. The years containing large MS- concentrations have a clear correlation with significant regional phytoplankton blooms and intensification of low pressure systems.

REPRODUCTION AND GROWTH OF CALANUS GLACIALIS: TIMING TO ICE ALGAL AND PHYTOPLANKTON BLOOMS

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We investigated life history traits of the Arctic key herbivore copepod *Calanus glacialis* in Rijpfjorden, Svalbard (80?N). We studied its development, vertical distribution, dry weight, lipid content, and egg production from March to October in 2007. The fjord was ice-covered from February to July, with maximum thickness in June. In March most of the females were found in the upper 100 m and a limited egg production was detected. Ice algae were present in March, but high densities occurred first in April and June. Copepods with green guts were found in April, two months prior to the phytoplankton bloom. Highest egg production was found in June when ice algae started to sink out, and phytoplankton growth was initiated. From July to October too few females were found to measure egg production. In September-October the population consisted mainly of copepodite stage V, suggesting a 1-yr life cycle. Those that had descended to depth in September were twice as lipid-rich as those in the upper 50 m. In October most of the population had descended to overwintering depths. By utilizing both ice algae and phytoplankton, *C. glacialis* extend its growth season substantially, which can explain its rapid development in this high-Arctic fjord.

PLATELET ICE AS A SPAWNING HABITAT FOR THE ANTARCTIC SILVERFISH PLEURAGRAMMA ANTARCTICUM

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The Antarctic silverfish Pleuragramma antarcticum is the dominant pelagic fish on the continental shelf of the high Antarctic. Here it plays a key role in the coastal ecosystem, being a major item in the food web. The identification of silverfish spawning sites at Terra Nova Bay, Ross Sea, has recently increased our knowledge of its life cycle, revealing that in the springtime embryonated eggs occur under the sea-ice, trapped in interstices within the platelet ice layer. In 2005 and 2006 extensive surveys were performed by drilling through the sea-ice, in order to evaluate the extent of the nursery and to investigate the linkage between the early-life stages of the fish and the sea-ice. P. antarcticum eggs were concentrated in an area of about 200 km2, surrounding the tongue of Campbell Glacier, more than 100 eggs/ litre of sea-water were found. The distribution of the eggs overlapped the area of platelet ice, thus indicating that the platelet ice layer could be a crucial habitat for the reproduction of P. antarcticum, in this region. Such a close linkage between this key-species and the sea-ice has ecological implications in terms of the possible effects of ongoing environmental change on the coastal ecosystem.

THE ROLE OF THE ANTARCTIC SEA ICE FOR MARINE TOP PREDATORS

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S1.8/P88

As a partner in the Lazarev Sea Krill Study (LAKRIS), IMARES focuses on the biology in the upper water layer in the seasonal sea ice zone. In a top down approach we specify the food requirements of top predators in relation to the availability of prey under the sea ice. In a

number of research cruises on board research icebreaker Polarstern it was shown that throughout the year the seasonal sea ice zone of the Lazarev Sea south of 55°S meets food demands from birds and mammals that are higher than those in the permanently open water further north including the Polar Front zone. Even in midwinter, top predators are attracted deep into the heavy pack ice. Recently formed sea ice in autumn and winter appears less attractive, but gains importance when it matures. The melting of the older ice in spring and summer releases such abundant iceassociated food that migratory animals move in from 1000 s of km s away. The sea ice fuels the foodweb. Thus, not only local animal abundance and diversity, but from a much wider area depends on the continued existence of the Antarctic seasonal sea ice. Understanding the role of sea ice in sustaining the Antarctic foodweb is vital to the assessment of ecological impacts of climate change.

THE IMPORTANCE OF GRAZING IN THE FOOD WEB WEST OF THE ANTARCTIC PENINSULA

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S1.8/P90

Grazing by macrozooplankton west of the Antarctic Peninsula impacts rates of carbon sedimentation and can alter phytoplankton composition by selective grazing of Antarctic krill (Euphausia superba) on diatoms. In this study we show that zooplankton grazing consumes an average 50% of the phytoplankton primary production in the region, 14% to 21% by micro- and 21% to 40% by macro-grazers. Micro-zooplankton grazing rates vary from 0.000 to 0.299 d -1 and are significantly positively correlated with phytoplankton growth on shelf waters, but not in coastal environments (r2 = 0.91). Phytoplankton populations grow within the euphotic zone at 0.05 to 0.66 d -1, maintaining primary production rates of 1.1 to 377 mg C m-3 d-1. This comparison yields the relative impact of the macro- and micro- grazers at the height of the growth season, with a range of macro-zooplankton abundance from inner shelf to shelf break. Significant interannual variability in macrozooplankton grazing impact is observed in conjunction with the 5-6 year cycle in abundance of Antarctic krill and the characteristic episodic events of salps (Salpa thompsoni). Observed trends in macrozooplankton species abundance in this region may change the balance of carbon transfer to higher trophic levels by emphasizing micro-zooplankton grazing.

PRELIMINARY RESULTS OF THE RELATIONSHIP BETWEEN SEA ICE AND KRILL FROM THE SIPEX (SEA ICE PHYSICS & ECOSYSTEM EXPERIMENT) VOYAGE, EASTERN ANTARCTICA 110-130 OE (SEPTEMBER- OCTOBER 2007)

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S1.8/P91

As part of IPY Australia played a lead role in the multinational, multidisciplinary SIPEX expedition (Sea Ice Physics & Ecosystem eXperiment) including 45 scientists and 2 teachers. SIPEX was conducted in late winter/early spring (September-October 2007) in the region off East Antarctica between 110°E and 130°E. The purpose of this expedition was to investigate the relationships between the physical sea ice environment and the structure of Southern Ocean

ecosystems. Major questions posed to address Antarctic sea ice in the global climate system and ecosystem dynamics included: How thick is the sea ice? How much algae is growing beneath it? Is the snow cover thickness changing? And how is this affecting the amount of light penetrating into the ocean? What is the impact on Southern Ocean ecosystems? How fast is the ice drifting? There is a close relationship between the extent of winter sea ice and the subsequent recruitment and abundance of Antarctic krill in certain areas. We know that the juvenile krill need to feed on the algae growing on the underside of the ice in the winter, although we have very little data supporting this because of the difficulties of working in the southern ocean during winter. During SIPEX two methods were used to study the under ice environment, an instrumented Remotely Operated Vehicle and a custom built trawl that allowed us to sample the zooplankton directly under the ice. Krill were observed feeding on sea ice communities, but whether these communities are a major food source over the entire range of krill and off the East Antarctic coast is uncertain. Results will be presented discussing the relationship between sea ice and krill using under ice footage. Preliminary results of krill demography and condition in the region will be presented in relationship to environmental parameters.

Technology, Data, and Remote Sensing

AUTOSUB-UNDER-ICE: COMBINED SCIENCE USE AND TECHNICAL DEVELOPMENT IN A POLAR PROGRAMME

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S3.4/O02

The United Kingdom s Autosub-Under-Ice(AUI) programme (2000-2007) brought together scientists and technologists to build a special polar-capable autonomous underwater vehicle (AUV) and use it for scientific research on three dedicated cruises of the research icebreaker, J.C. Ross, in both the Arctic and Antarctic. The Autosub AUV was specifically funded to investigate the ice shelf cavities and under sea ice environment in both polar regions. We discuss the merits and challenges of the approach used whose ultimate aim was to use the vehicle simultaneously on a number of highly disparate programs; from mapping using swath bathymetry, water sampling and CTD while underway, measuring ocean currents using ADCP, and digital photography of the benthic life. Technical challenges included deve autonomous precision navigation , obstacle avoidance systems and a water sampler. Science advice and support proved vital in identifying difficult operating conditions and in building cruises to maximize Autosub and vessel utilization. A current challenge is to work internationally, at present highly encumbered because of the structure of national research programmes where suitable working vessels are in different nations than the UK. Developing international cooperation is therefore crucial to allow this new polar capability to be maximized for scientific gain.

SUSTAINING REGIONAL ARCTIC AND SOUTHERN OCEAN OBSERVING SYSTEMS AS LEGACIES OF THE INTERNATIONAL POLAR YEAR AND CONTRIBUTIONS TO THE GLOBAL OCEAN OBSERVING SYSTEM

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S4.1/O01

The Global Ocean Observing System (GOOS) has been in existence for over a decade. During this first decade, GOOS has been primarily engaged in planning observational strategies and developing the international governance structures required to facilitate multi-national ownership and development of the system. The most important challenge now facing GOOS is to complete and sustain an integrated, global system with clear user benefits. Substantial progress has been made, with more than half of the in-situ open ocean observing system for climate already in the water, including buoys, moorings, floats, tide gauges and repeat hydrographic lines. Operational warnings for coastal hazards based onthis GOOS observational backbone are widely available providing clear societal benefits. However substantial challenges remain, especially in the polar regions. The polar research community is neither ensuring their observations fully contribute to, nor that their research fully benefits from, the system. New mechanisms for increasing polar research community participation and governmental commitments to sustaining the system will be presented. The talk will begin with a brief overview of the status of the global ocean observing system highlighting in particular the Arctic and Southern Ocean components, then milestones achieved and conclude with key future challenges for ensuring that Southern Ocean and Arctic regional systems are sustained as a legacy of the International Polar Year.

DESIGN AND CONSTRUCTION OF AN AUTONOMOUS UNDERWATER VEHICLE PROTOTYPE

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S3.4/P01

This paper describes the design and construction of an Autonomous Underwater Vehicle (AUV) prototype, created for underwater monitoring, exploration and surveillance in the sea environment. The main goal is to further the design of a low cost Antarctic AUV. The AUV can travel in a determined three dimensional space in the sea and can also collect samples of the temperature and conductivity. These data can be saved in the CPU and used for generating a three dimensional scalar map for a specific (or particular) sea region. The AUV length is less than 1m and it is composed of seven modules: propulsion, power, motor driver, CPU, sensor suite, camera system and RF module. The propulsion module is formed by three thrusters, two axial and one oriented vertically, they are mounted on a PVC cylindrical frame; this configuration gives the AUV three degrees of freedom: heave, yaw and surge. The power module provides the necessary energy to all modules. The motor driver regulates the speed of the thrusters' motors following the CPU commands. The CPU processes the information from the RF module and all sensors of the AUV; it also executes the mission planning and generates the signals control. The sensor suite contains all the sensors of the AUV that are: inertial measurement unit, compass and inclinometer for the AUV's dynamics measurement, temperature and conductivity sensors for the environment measurement. The camera system is formed by a TV camera with illumination. The RF module provides a data link for telemetry and communication with the ground station while the AUV is on the surface. Simulation results were generated using MATLAB/SIMULINK for the propulsion module, motor driver and CPU

software architecture, i.e. the transient response of the propulsion system. These results are described and compared with experimental results obtained in a controlled environment.

COLLABORATIVE AUTOSUB SCIENCE IN EXTREME ENVIRONMENTS PROGRAMME SUMMARY

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S3.4/P03

This programme has reviewed the use of Autonomous Underwater Vehicle (AUVs) technology and science in polar environments through two international workshops: Masterclass in AUV Technology for Polar Science, NOCS, Mar. 06.
http://www.noc.soton.ac.uk/CASEE/CASEE2/Introduction.html
AUV Science in Extreme Environments, SPRI, Apr. 07
http://www.noc.soton.ac.uk/CASEE/CASEE2/pages/Science.html
The proceedings of both have been published reviewing the achievements of Autosub and other AUVs. Autosub uniquely has ventured beneath the Fimbul ice shelf. AUVs have measured ice thickness, undertaken sidescan surveys of the seabed and the underside of ice, used ADCPs and CTDs data to determine flows and thus calculate heat fluxes
beneath ice masses, collected water samples for isotopic analysis, photographed seabed features with associated megafauna and mapped krill distribution. This poster illustrates the results of these studies and summarises the range of programme outreach activities including web broadcasts and young research bursaries to promote international
collaboration.

DEVELOPING A LONG TERM STRATEGY FOR USING AUVS IN POLAR RESEARCH

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S4.1/O06

Three international workshops have reviewed the use of Autonomous Underwater Vehicles (AUVs) in polar and extreme environments:
(1) Acoustic Navigation and Communications for High-latitude Research, Seattle, Feb.06
http://anchor.apl.washington.edu/index.html
(2) Masterclass in AUV Technology for Polar Science, NOCS, Mar. 06
http://www.noc.soton.ac.uk/CASEE/CASEE2/Introduction.html
(3) AUV Science in Extreme Environments, SPRI, Apr. 07
http://www.noc.soton.ac.uk/CASEE/CASEE2/pages/Science.html
The proceedings for the latter two have been published and case studies are being presented within Session 3.4 of this meeting. AUV technology is well developed and can answer a range of scientific questions beyond the capabilities of other technologies. The third workshop identified that there was a need for strategic planning for the incorporation of AUVs into polar research, especially given the long term legacy objectives of IPY specifically:
- A collective multinational programme drawing upon national assets and resolving the institutional barriers toimplementing this.

- A move from short expeditions to long term effort, (sufficiently resourced to withstand occasional setbacks) for example: routinely launching and recovering AUV from bases around the Antarctic, Lagrangian drifters and acoustic navigation networks (ANCHOR).
- The need for interoperability, standardisation of equipment and support infrastruct

AN ACQUISITION STRATEGY FOR SAR AND INSAR DATA COORDINATED RESPONSE OF THE SPACE AGENCIES TO IPY SCIENCE OBJECTIVES

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S4.3/O03

As part of ongoing IPY Space Task Group activities, the Canadian Space Agency hosted an IPY SAR/InSAR workshop on 5-6 March 2008.. The goal of the meeting was to try and develop an acquisition strategy for SAR and InSAR data that achieves the maximum number of IPY science objectives in such a way as to distribute the acquisition load across the different agencies understanding that no single agency can accommodate all of the tasks. This task required a level of coordination between the space agencies that has not yet been attempted. The workshop was primarily focus on data acquisition requirements, as outlined by the scientific community, based on Agencies' strategic plan for IPY and unique capabilities of their systems. Although data processing and data distribution issues were a topic for discussion, the primary objective was to ensure the collection of a legacy dataset within the unique window of opportunity during IPY 2007-2008. The main workshop tasks were:

1) To review existing GIIPSY science requirements as outlined in the Global Inter-agency IPY Polar Snapshot
Year (GIIPSY) Strategy Document. The document can be found under the following link: http://bprc.osu.edu/rsl/GIIPSY/documents/GIIPSY_Science_Sum_Nov_3.doc
2) To present each Agency s strategic priorities - in line with IPY science activities;
3) To present and review SAR data which are being collected, and are planned for collection during the IPY;
4) To present the satellite and ground segment operators system capabilities and constraints related to the
acquisition of data in support to IPY;
5) To forge a coordinated / multi-agency SAR acquisition plan for the remainder of IPY acquisitions.

In order to meet these ambitious objectives, 35 international specialists from the science and operational communities, space agencies operating SAR satellite; space agencies with data transmission, ground segment and processing capabilities, and ground segment operators, were present and actively contributed to the achievement of the workshop
objectives. As a result of the discussions, the group identify 4 scientific priorites to be monitored by the SAR operating space agencies: A) 3 to 5 day snapshots for the Arctic ocean during the remaining of IPY to be acquired in C-Band for for sea ice motion monitoring; B) Winter Pole to Coast InSAR coverage of the Antarctic in high-res mode; C) Winter Greenland and Major Canadian Icefields InSAR coverages; and finally D) Multi-date monitoring of research supersites in C-, X- , and L-Band with various imaging configurations. The paper will present the Space

Agencies commitment in response to the scientific objectives and the potential scientific opportunities the dataset presents today and as a legacy.

GLOBAL INTER-AGENCY IPY POLAR SNAPSHOT YEAR (GIIPSY): GOALS AND EARLY ACCOMPLISHMENTS

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S4.3/O01

Satellites have revolutionised our ability to observe polar processes. No other technology developed since the International Geophysical Year (IGY) of 1957 provides the high-resolution, continental-scale, frequent-repeat, and allweather observations available from spaceborne sensors. The utility of such technology is evidenced by related scientific advances including measurements of long term trends in polar sea ice cover and extent, the realisation that the polar ice sheets can change dramatically on sub-decadal time scales, and the quantification of relationships between processes at the poles and at mid and equatorial latitudes. Large-scale coordinated experiments continue to be important for polar scientists seeking to understand the role of polar processes in climate change, including for example the contribution of the polar ice sheet to sea level, ice sheet-ocean interactions, and the dynamics of ice sheets and sea ice. Coordination is challenging in part because of resource allocation issues and in part because space programmes are operated by a host of national and international agencies. To overcome such challenges, and as part of the IGOS-Cryosphere Theme implementation, GIIPSY (http://bprc.osu.edu/rsl/GIIPSY) has collected key requirements for planning of spaceborne and in-situ observations of polar regions and polar processes during the International Polar Year 2007-2008. The primary goal is to advance polar science by obtaining critical benchmarks for processes in the Arctic and Antarctic and to set the stage for acquiring sustained observations beyond IPY. A second objective is to coordinate polar observations with spaceborne and in-situ instruments and then make the resulting data and derived products available to the science community. To achieve these goals GIIPSY has developed a mechanism by which to plan and synchronise IPY satellite acquisition requests. This was necessary 1) in order to receive approval from participating organisations for support of the satellite observations; 2) to anticipate required volumes of IPY data; 3) to accomplish mission planning; and 4) data processing and distribution demands. The first step towards goal was to establish an inter-Agency Space Task Group (STG) within the Sub-Committee on Observations of the ICSU/WMO Joint Committee for IPY. The STG convenes meetings of flight agency representatives, which together have adopted the GIIPSY science community requirements. The STG is now focused on assembling IPY data portfolios that attempt to address many of the GIIPSY science requirements. The STG has convened a number of meetings of international flight agencies in 2007 and 2008, at which the acquisition, data processing, and archiving plans for the IPY legacy data have been discussed. This presentation will summarise the successes of the first year of IPY snapshots and the extent to which the observation requirements are being met. Examples will be used to illustrate the progress towards achieving key GIIPSY scientific objectives.

UNDERSTANDING THE SCATTERING MECHANISM IN SEA ICE AND ITS RELATION TO REMOTE SENSING

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S4.3/P05

Satellite images can be easily interpreted with a deep understanding of the scattering process in a particular terrain. Good scattering models can give us information on the scattering process, the components of the scattering, such as surface, volume and surface-volume scattering. In this paper, with the aid of multilayer model developed for sea ice, scattering process involved in sea ice is presented. The microwave scattering model was developed based on radiative transfer theory and design to cater snow covered sea ice area. The model also can be used for bare sea ice area and ice shelfs. The model treats snow and sea ice media as dense media and takes into account the coherent effect between the scatterers in the medium. The scattering component information is vital as it gives us extra knowledge on the parameters that influences the backscattering, such as thickness, volume fraction and so on. Using the developed model, the analysis and further interpretation of the satellite SAR images to assist other scientists in understanding and explaining their observation of sea ice physical phenomena are pursued with good results.

THE SOUTHERN OCEAN OBSERVING SYSTEM (SOOS)

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S4.1/O02

The importance of the Southern Ocean to the global climate system and the uniqueness of its ecosystems are well known. The region is remote and logistically difficult to access and thus is one of the least sampled regions on theplanet. Design and implementation of an observing system that encompasses physical, biogeochemical and ecological processes is therefore a formidable challenge. Building on meetings held in Hobart in 2006, Bremen in 2007 and St. Petersburg in 2008 we present a draft plan for a Southern Ocean Observing System (SOOS). This document examines: (i) why sustained observations are needed in the Southern Ocean and what science/policy questions they address; (ii) what mix of observations are required to address these questions; (iii) what is presently done and possible and (iv) a vision for the future. SOOS is a key component of the SCAR Pan Antarctic Observing System (PantOS) and is cosponsored by the Scientific Committee on Antarctic Research (SCAR), the Scientific Committee on Oceanic Research (SCOR), the Census of Antarctic Marine Life (CAML), the Partnership for Observation of the Global Oceans (POGO) and the Global Ocean Observing System (GOOS). Other organisations, in particular the National Oceanic and Atmospheric Administration (NOAA), have provided significant funding.

ELEPHANTS THROUGH STRAWS (OR IMPROVING ACCESS TO SATELLITE REMOTE SENSING DATA OF THE ANTARCTIC)

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S4.5/O10

This talk will describe two International Polar Year (IPY) projects that have made access to satellite data of the Antarctic easier for those involved in IPY science research and supporting logistics. Firstly the recently completed Landsat Image Mosaic of Antarctica (LIMA) is a new satellite mosaic of the entire continent. In addition to providing the highest resolution visible image of Antarctica, it is also a rigorously processed surface reflectance dataset of high value to many applications including glaciology, geology, topographic mapping and field logistics. We will review the issues involved in processing and providing access to this large image dataset and describe the methods used to make it freely and easily available. Secondly the Antarctic Polar View program has completed its second year of delivering near-real-time sea ice information to ships in the Southern Ocean. Based on high-resolution radar imagery from the European Envisat satellite, a key issue has been making these high volume images visible to users with very restricted data connections. We will describe the successful new techniques, based on the JPEG2000 image compression, employed to achieve this.

THE INTERNATIONAL PROGRAMMES FOR ARCTIC AND ANTARCTIC BUOYS CORNERSTONES OF COORDINATED POLAR OBSERVING SYSTEMS

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S4.1/O08

The International Arctic Buoy Programme (IABP) and International Programme for Antarctic Buoys (IPAB) maintain networks of drifting buoys in the Arctic and Southern Ocean, in particular over sea ice, to provide meteorological, sea ice and oceanographic observations for operational requirements and research purposes. Their real-time data are broadcasted worldwide through the meteorological Global Telecommunication System. Both programs are endorsed by and implement research needs of WCRP and SCAR. IABP s and IPAB s ice drift, sea level pressure and surface air temperature data have been essential for:
1. Monitoring polar and global climate change,
2. Forecasting weather and sea ice conditions,
3. Validation of satellite measurements, and
4. Forcing, assimilation, and validation of weather and climate models.

IABP operates since 1979, and provides the longest continuing record of observations from the Arctic Ocean. In contrast, IPAB was founded in 1994. Its operations face significantly more challenges due to the remoteness of the Southern Ocean and the divergent, seasonal nature of Antarctic sea ice. The talk summarizes operations and achievements of both programs, with focus on recently ramped up research activities as part of the International Polar Year 2007/08.

AUTONOMOUS UNDERWATER VEHICLES IN POLAR EXPLORATION: QUANTIFYING RISKS FROM SEA ICE

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S3.4/O04

Autonomous Underwater Vehicles (AUVs) are becoming highly capable platforms for multi-disciplinary science investigations in the polar oceans. However, their operation under ice does involve a significant degree of risk of losing the vehicle. A risk assessment and management process (RMP-AUV) has been devised that balances the risk appetite of the responsible owner with the reliability of the vehicle and the probability of loss. This last step involves expert judgement, and is sensitive to the type of ice cover. In contrast to the simple, high risk, case of operation under an ice shelf, sea ice offers a more complex risk environment. However, the risk is further modified by the characteristics of the support vessel, including its ice-breaking capability. We explore how the ASPeCt sea ice characterisation protocol can be used within RMP-AUV to quantify risk under different conditions on ships of differing ice capabilities, and how experts have scored the relative risk of operations of the Autosub AUV under shelf and under sea ice.

HIGH LATITUDE OCEANOGRAPHY USING THE AUTOSUB UNDERWATER VEHICLE

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S3.4/O01

We use a combination of measurements using Autosub, an autonomous underwater vehicle (AUV), and those from ship-based instruments to describe the oceanographic conditions beneath Fimbul ice shelf, Antarctica. The data show an intricate oceanographic regime that is suggestive of variability at seasonal or longer time scales. The snapshot survey data complement those obtained from instruments moored beneath the ice shelf. These also show substantial temporal variability including events where the potential temperature beneath the ice shelf increased by as much as 0.2 degrees. We contrast the two techniques and discuss how one might optimise observation strategies in future campaigns. An Autosub campaign in an East Greenland fjord is used to highlight other observational constraints and opportunities, looking at the meltwater from a tidewater glacier.

PHOTOGRAPHIC ASSESSMENT OF POLAR BENTHIC COMMUNITIES USING AN AUTONOMOUS UNDERWATER VEHICLE

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S3.4/O05

We outline the development, integration and use of a digital stills camera system for the Autosub Autonomous Underwater Vehicle and describe its use in polar benthic community assessment. The operational limitations of Autosub, particularly the safe flying altitude of 10m required solutions for effective photography. A high-sensitivity Starlight SXV-H9 monochrome CCD camera system and Minolta 3600HS zoom flash were integrated into Autosub; the system was small enough to fit into the limited scientific payload space and had low power consumption. The camera required autonomy in operation and links to the onboard computer systems on Autosub. The system successfully carried out science missions in East Greenland (September 2004) and the Weddell Sea, Antarctica (Feb 2005). Autosub photographs were suitable for

biological and geological analysis and allowed comparable assessment of faunal density and diversity with those obtained with a towed camera platform (WASP), they covered a comparable area and were more consistent but had a slightly lower resolution and lacked colour information. While the expense of AUVs is a consideration in their imaging potential, their autonomous nature allows use in remote polar environments where community assessment is impossible with existing technology.

THE CRYOSPHERE OBSERVING SYSTEM: REQUIREMENTS, GAPS, AND RECOMMENDATIONS

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S4.1/O07

The ideal cryosphere observing system includes more than simply measurements of snow and ice properties. It must include satellite remote sensing instruments, networks of ground-based instrumentation, aircraft-based measurements, modeling, assimilation, and reanalysis systems, and a data management system. The Integrated Global Observing Strategy (IGOS) Cryosphere Theme was created to develop a framework for these components. It will improve the coordination of cryospheric observations, and guide the generation of data and information needed for operational services and research. To date, it has provided an in-depth assessment of current measurement capabilities and observational requirements, and has put forth recommendations for improving and sustaining the observing system in three phases. The first phase corresponds to the International Polar Year (IPY). The second phase will focus on activities required to preserve the legacy of the IPY observing, data, and information system. During the third phase, beyond 2015, we envision new satellites for observing snow and ice, and new operational observations of currently under-sampled or poorly observed parameters such as solid precipitation and snow water equivalent.

GETTING SCINI IN ANTARCTICA: A REMOTELY OPERATED VEHICLE DEVELOPED FOR USE THROUGH THE SEA ICE

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S3.4/O07

In marine habitats worldwide, the zone between scuba-diving depths (to 40 m) and surge-free depths (below 200 m) has been poorly studied. Remotely operated vehicles (ROVs) are often limited to deeper depths by wave surge that hampers the ability to maneuver and maintain a fixed station. Under ice-covered seas, wave motion is minimal, but ROV deployment requires a hole in the ice. Commercially available, scientifically functional ROVs now require a minimum hole diameter of 1m. Holes this size require considerable logistic support and time to make, and are therefore expensive, limited to regions near logistic centers, and restricted in number. The SCINI ROV deploys through a 20cm hole in the ice, which can be drilled with a hand-held power head, requiring minimal logistical support and technical expertise. Multiple holes allow SCINI to survey very large areas of seafloor by overlapping coverage. In the first year of operation, we

searched for and successfully relocated historical experiments at greater than scuba-diving depths in McMurdo Sound, Antarctica. The new ROV provides access to regions that remain unstudied because of their distance from logistical support or safety considerations, expanding our scientific reach and ability to address new questions.

GOING BI-POLAR: ARCTIC COMPOSITE SATELLITE OBSERVATIONS

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W4.3/O02

Antarctic satellite composite imagery has been generated for over fifteen years as a part of the Antarctic Meteorological Research Center s (AMRC) commitment to weather observation over the Antarctic region. These composites have revolutionized the way research, education, and forecasting are conducted over a region where meteorological observations are sparse. These satellite images give a full-size view of the weather in three hour intervals, and cover the entire continent using a process of splicing together data from multiple satellites. Recently, the AMRC has also developed these satellite composites for the Arctic and Northern Hemisphere. The routine generation of Arctic satellite composite imagery comes at a critical time with the start of intensive study of the Earth s polar regions during the International Polar Year (IPY). This project aims to build on the success of the Antarctic efforts and apply lessons learned toward the Arctic. This talk will discuss the methodology of generating these mosaics, and show sample applications.

STUDY OF NORTHERN POLAR CRYOSPHERE USING MULTI SENSOR PASSIVE MICROWAVE BRIGHTNESS TEMPERATURE DATA

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S1.4/P14

In this work an endeavor is made to study sea ice coverage in the northern hemisphere surrounding the Arctic Ocean form the satellite microwave remote sensing observations. Passive microwave remote sensing time series data from different sensors Indian Remote Sensing sensor, Oceansat-1(IRS-P4), SMMI and SSM/I are analyzed to study the interannual Sea Ice coverage variation in northern hemisphere. Brightness temperature (Tb) observed by these sensors can be used to discriminate land, water and ice (Vyas et. el 2001). Spaceborne Passive radiometer observed Tb is dependent on emissivity and dielectric constant of features (Ulabi et. el). It is observed that emissivity is highest for ice covered region in the northern pole of the earth and for water it is lowest. On the basis of high brightness temperature variations, a transect is drawn which shows boundary between water and sea ice. We have studied the time series of multisensor data of last 25 years for monitoring the sea ice coverage in North Polar Region between 45o N and 90 o N latitude. Multi Sensor Microwave Radiometer (MSMR) onboard Oceansat 1 was dedicated to study of ocean and polar region. We have used MSMR derived sea ice data for analysis of interannual variability of ice coverage. It is found that summer sea ice coverage shows decreasing trend over different time scale. Arctic Ocean peak summer sea ice cover is decreasing at alarming rate and in the year 2002 melting was highest. Sea Ice extent variations in Polar Regions, on various time scale indicates effects of global warming.

IN-SITU DEEP-UV PROBE FOR EXAMINING BIOCHEMICALS AND STRATIGRAPHY IN DEEP GLACIERS AND SUB-GLACIAL LAKES

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S3.1/O06

One pathway to understand extremophiles has been examining biochemicals in deep glacial ice and subglacial lakes. Lake Vostok is the most discussed subglacial lake because of size, great depth and substantial sediment bed. Questions arose about the existence of biological material under conditions of limited energy and nutrients. Investigating biology in Vostok via in-situ methods should await proven techniques that will not contaminate the lake. Lake Ellsworth is smaller, very deep with a sediment bed. It provides an opportunity to build in-situ systems that consider bio-cleanliness approaches for examination of lake water, sediment bed, and roof zone accretion ice for biochemicals. We are developing deep-UV fluorescence and Raman instrumentation to locate and classify organic materials. New optical measurement techniques allowed us to design and begin prototype fabrication of a biochemical sensing probe that can be inserted into a hot-water drilled ice borehole and function to depths of 6000 m. Real-time control and analysis occur from a surface science station. We use deep Vostok ice cores to validate our science analysis approaches. We will describe the field instrumentation we are developing for the British Antarctica Survey Lake Ellsworth field campaign, and an operational scenario for the kinds of measurements possible.

A STUDY OF THE INVERSION PROBLEM FOR APPLICATION IN SEA ICE USING ACTIVE MICROWAVE REMOTE SENSING

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S4.3/P08

In this paper, an inverse scattering model based on the Radiative Transfer Theory to estimate sea ice thickness is presented. The inverse model is a combination of the Radiative Transfer Theory with Dense Medium Phase and Amplitude Correction Theory (DMPACT) and the Levenberg Marquardt Optimization algorithm. The Radiative Transfer Theory with DMPACT is applied as the forward model to generate the radar backscatter data from a set of sea ice input parameters. The DMPACT is included as part of the forward model to account for the close spacing effect among the scatterers within the medium. Radarsat and Envisat satellite images of Ross Island are acquired to obtain the actual radar backscatter data. This set of radar backscatter data will be compared with the radar backscatter data generated from the forward model to calculate the error. The Levenberg Marquardt Optimization algorithm is then applied to reduce the error and to improve on the set of input parameters until the sea ice thickness can be estimated. A comparison between the sea ice thickness estimated from the inverse model, the data from the ground truth measurement conducted in Ross Island and the measurement results reported in the literature shall also be presented.

SEA ICE FREEBOARD IN THE WEDDELL SEAUSING ICESAT LASER ALTIMETRY AND THE PGM2007 GEOID

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S4.3/O06

Laser altimetry is used to determine the sea ice freeboard height. The Geoscience Laser Altimeter System mounted on NASAs ICESat satellite measures its distance to the Earth surface with centimeter accuracy. Knowing the height of the satellite relative to an Earth reference ellipsoid (from orbit determination), the surface elevation relative to this ellipsoid can be derived. To obtain the sea ice freeboard, which is the part of the ice including snow above the waterline, the sea surface height (SSH: geoid height plus dynamic topography and tides) is subtracted from the derived surface elevation. An accurate geoid height is most important. Therefore, in addition to the Earth s Geopotential Model EGM96 geoid (maximum degree 360), the new Preliminary Gravitational Model PGM2007 geoid (maximum degree 2160, precursor of the upcoming EGM2008 model) is used to identify the potential improvement. To further approximate the SSH, leads are recognized by applying the lowest elevation method (originally developed for the Arctic, adapted for the Weddell Sea) along single ICESat over-flights with the help of quasi-coincident Synthetic Aperture Radar images. Sea ice freeboard heights are estimated for austral fall 2005 and 2006 for the Weddell Sea and checked for consistency with snow depth and ice type distributions.

PREDICTION OF ANTARCTIC SEA ICE EDGE USING ARTIFICIAL INTELLIGENCE

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S1.6/O28

Antarctic sea ice cover plays an important role in shaping the earth s climate, primarily by insulating the ocean from the atmosphere and increasing the surface albedo. The convective processes accompanied with the sea ice formation result the bottom water formation. The cold and dense bottom water moves towards the equator along the ocean basins and takes part in the global thermohaline circulation. Sea ice edge is an potential indicator of climate change. Additionally, fishing and commercial shipping activities as well as military submarine operations in the polar seas need reliable ice edge information. However, as the sea ice edge is unstable in time, the temporal validity of the estimated ice edge is often shorter than the time required to transfer the information to the operational user. Hence, an accurate sea ice edge prediction as well as determination is crucial for fine-scale geophysical modeling and for near-real-time operations. In this study, active contour modeling (commonly called snake) and non-rigid motion estimation techniques have been used for predicting the sea ice edge (SIE) in the Antarctic. For this purpose the SIE has been detected from sea ice concentration derived using special sensor microwave imager (SSM/I) observations. The 15% sea ice concentration pixels are being taken as the edge pixel between ice and water. The external force, gradient vector flow (GVF), of sea ice edge for total the Antarctic region is computed on daily as well as weekly basis. These vector fields have been used to predict the sea ice edge for subsequent periods (daily and weekly) using non-rigid motion estimation technique. The predicted edge has been validated with that of SSM/I as well as other high resolution satellite images.

SPATIO-TEMPORAL VARIABILITY OF SNOW MELT ON SVALBARD DERIVED FROM SPACEBORNE SCATTEROMETER DATA

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S1.4/P23

Due to the effect of global warming a dramatic reduction in the Arctic snow and ice coverage is currently observed, associated with an extended and longer lasting melting. Previous studies have demonstrated the capacities of active microwave instruments for the detection of surface melt and freeze-up due to the high sensitivity of radar backscatter to snow wetness. For our study we utilize microwave backscattering measurements continuously carried out by the Kuband scatterometer QSCAT since fall 1999. Meteorological data from weather stations around Svalbard are available to investigate links between atmospheric circulation, moisture transport, near surface air temperature and corresponding deposition and melting of snow, respectively. Svalbard is characterized by a highly variable climate throughout the year due to its position within a zone that includes both the polar ocean and atmospheric fronts between the Arctic Ocean, Nordic Seas and Barents Sea. Accordingly results show pronounced regional and interannual variability in snow melt duration. However, a climatic trend of earlier melt onset and an increasing number of melt days per year can be observed for the time of observation. The analysis demonstrates that coarse resolution scatterometer data can be usefully applied to trace consequences of a warming climate in the Arctic.

DETAILED TERRAIN MAPPING OF THE UNDERSIDE OF SEA ICE USING TWO TYPES OF AUV

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S3.4/P12

We report on results from two types of AUV operation to obtain three-dimensional terrain maps of the underside of sea ice, using a large long-range and a small short-range AUV. The large AUV was Autosub II which obtained 450 km track-length of data using a Kongsberg EM2000 multibeam sonar from the multi-year fast ice off NE Greenland in summer 2004. The AUV was deployed from a ship. Its large scale mapping work was continued by using a similar sonar on the submarine Tireless in March 2007. The small AUV was Gavia, deployed through holes in the ice, which obtained detailed terrain maps of individual pressure ridges from the APLIS ice camp in the Beaufort Sea in April 2007. It was equipped with a Geoswath interferometric sonar, and detailed surface truth was obtained from swath laser overflights, a helicopter-borne electromagnetic systems and divers. We contrast the statistical information available from the larger vehicle with the detailed structural information of the smaller vehicle, which weighs only 80 kg. We also present early results from new through-ice AUV work to be carried out in May 2008.

RECENT ADVANCES IN SMALL UNMANNED AIRBORNE SYSTEMS (UAS) AND SENSOR TECHNOLOGIES FOR APPLICATION TO POLAR REGIONS

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S3.4/O11

Development of small unmanned aerial systems (UAS) has progressed dramatically in recent years along with miniaturization of sensor technology. The small UAS is deployable from ships

or glaciers to carry a range of sensor payloads for a broad range of scientific applications. Recent applications include small UAS for studies involving hurricanes, volcanic activity, sea ice changes, glacier melt, biological monitoring of land and sea species, wildfire monitoring, and others. Small UAS sensor capabilities that are currently available include optical imagers (including multi- and hyperspectral); gas spectrometers; chemical sensors and samplers; microbal sensors; and numerous others, including magnetometers and LIDARS. Other technologies such as nanotechnology and imaging software offer another new range of sensing capabilities and many other technologies. A recent example of UAS assisting in polar research includes utilizing a miniaturized hyperspectral sensor in a preliminary study at the Greenland Ice Sheet in August 2007. Several models of small UAS (developed by Advanced Ceramics Research) and developmental sensor technologies (including LIDAR) were evaluated in Greenland at that time. The scientific goal was to collect preliminary data to use the hyperspectral sensor to remotely measure the depth of the supra-glacial meltpools to assist in quantifying the rate of glacial melting.

RETRIEVAL OF SNOW GRAIN SIZE AND POLLUTION AMOUNT IN POLAR REGIONS FROM MODISDATA

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S4.3/P11

This paper presents a new analytical algorithm to retrieve Snow Grain Size and Pollution concentration (SGSP) from satellite spectral data developed in the framework of the DAMOCLES Integrated Project. The algorithm is based on a new approach to snow optics. The underlying model considers snow pack as a medium with close-packed, irregularly shaped particles. Traditionally, more idealistic models of snow as a medium with independent spherical particles have been used. The main advantage of the new algorithm is that that it does not need any a priori assumptions about the snow particle shapes. Moreover, the SGPS analytical retrieval (instead of the LUT technique) provides an extremely fast satellite data processing. The accuracy of the SGSP for the specific conditions of Polar Regions (first of all, for large sun zenith angles) has been shown to be satisfactory. The satellite data processing includes cloud masking and atmospheric correction.. The first results of the retrieval of snow grain sizes and soot pollution amount for Polar Regions from MODIS satellite data are presented and discussed.

SUBMERSIBLE CAPABLE OF UNDER ICE NAVIGATION AND IMAGING

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S3.4/P13

SCINI is a remotely operated vehicle (ROV) purpose designed and built for operation through sea ice. This places a design constraint of 15cm maximum diameter on the vehicle, corresponding to the size of a drill bit that can be operated by 1-2 people with a lightweight, portable drill head. For Antarctic use, the ROV must be extremely reliable and utilize primarily parts that are easily replaceable industry standards. Massive amounts of research and development have gone into commercially available components; we capitalize on this and use off-the-shelf hardware and software whenever possible. This keeps costs low in addition to improving vehicle reliability. Through cooperation with industry leader VideoRay, we are

utilizing GTO thruster technology and modifying the PC Pilot software interface. The imaging system is a 5 megapixel video camera manufactured by Elphel and running open source transmission and compression code. Command and control, as well as imagery and instrumentation data, are transmitted via Ethernet and modulated along with 110 vAC over a two conductor, small diameter tether. By keeping the entire system simple and utilizing existing technology when available, we have developed an inexpensive, reliable, sturdy ROV that can access areas of the Antarctic that have been hitherto unexplored.