



# BE-POLES WORKSHOP

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## **Sea Ice Biogeochemistry in a Climate Change Perspective (SIBClim): an integrated interdisciplinary project funded by the Communauté Française de Belgique (ARC)**

*The SIBClim Community Members:* Becquevort S., Chou L., de Jong J., Delille B., Dumont I., Lancelot C, Lannuzel D., Masson F., Sauvée M.-L., Schoemann V., Tison J-L., Trevena A. & Verbeke V.

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This paper presents the main objectives of the Belgian **SIBClim** project (2002-2007) and discusses its present-day achievements in terms of new methodology, laboratory work and field data acquisition.

SIBClim is a multidisciplinary consortium combining the skills of glaciologists, biologists, geochemists and ecosystems-modellers of the Université Libre de Bruxelles (ULB) in Belgium. The goal of the project is to study, understand and quantify the physical and biogeochemical processes associated with the sea ice biota that govern fluxes of carbon, nutrients and marine gases of climatic significance. In this context, particular attention is paid to Carbon Dioxide (CO<sub>2</sub>), Dimethyl Sulphide (DMS), and trace metals (especially iron), all potentially actively involved in the sea ice microbial metabolism.

The research methodology combines field investigations, process-oriented studies both “in situ” and in the laboratory, and modeling work in order to quantify key biological, geochemical and physical interactions between the sea ice, ocean and atmosphere. The development of methods for use with sea ice is a key component of the project. These include, direct measurement of pCO<sub>2</sub> in brines, CO<sub>2</sub> fluxes from chamber measurements and pCO<sub>2</sub> gradients in crushed ice, trace and atmospheric gas chromatography (DMS, CH<sub>4</sub>, O<sub>2</sub>, N<sub>2</sub>, CO<sub>2</sub>), Fe sampling and analysis (concentrations by flow injection analysis and isotopic compositions by MC-ICP-MS), fluorescent probes and molecular methods (PCR, DGGE).

Results from the “ARISE in the east” Antarctic cruise<sup>1</sup> (September-October 2003, 64-65°S/112-119°E) and from the ISPOL<sup>2</sup> Polarstern cruise (November-January 2004, 70°S, 50°W) will also be briefly presented.

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1. Antarctic Remote Ice Sensing Experiment. Thanks to the Australian Antarctic Division

(ACE) glaciologists Drs I. Allison, V. Lytle, R. Massom, and A. Worby.

2. Ice Station Polarstern (1). Thanks to the Alfred Wegener Institute (AWI, Germany), Drs. G. Dieckmann and C. Haas.

## **LAQUAN and HOLANT: coastal Antarctic lakes - Archives of past changes in climate, ultraviolet radiation, relative sea level, and autotrophic community structure**

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During the BelSPO funded **LAQUAN** project, the present and past microbial diversity in lakes of the Larsemann Hills, East Antarctica was studied. A reference dataset of cyanobacterial sequences was constructed for living microbial mat samples and used to compare with fossil mat sequences up to 6000 years old. We developed novel biological proxies and expanded and fine-tuned inference models to quantitatively reconstruct past environmental changes. Application of these models on lake sedimentary archives revealed the history of late Quaternary variation in the moisture balance, ultraviolet (UV) radiation, and relative sea-level.

The main paleoenvironment-related results obtained within LAQUAN can be summarized as follows. During the Last Glacial Maximum one of the main peninsulas in the Larsemann Hills was only partly glaciated, as evidenced by uniquely long lake sedimentary records extending into the previous interglacial period (Eemian). Diatom-based inference models revealed that this interglacial was probably warmer and wetter than the Holocene, which was further supported by the presence of currently sub-Antarctic endemics in the Eemian diatom flora. The last glacial period was characterized by dry and cold conditions prevailing over the Larsemann Hills. High levels of the cyanobacterial UV-screening compound scytonemin in fossil microbial communities from this period suggest that UV radiation exposure exceeded three times the present-day values. Shortly after 13,500 yr BP, deglaciation of the Larsemann Hills and the continental shelf in Prydz Bay intensified. The collapse of this part of the East Antarctic Ice Sheet (EAIS) thus coincided and may have contributed to melting water pulse 1A, which was one of the most rapid sea-level rises since the end of the last glacial period. During the Holocene, several warm periods were detected, coinciding with more productive coastal waters. Marine sediments in isolation basins from this period are characterized by open water taxa and high chlorophyll a concentrations. Based on a relative sea level curve, we inferred that during the last warm period (the Hypsithermal) increased moisture supply to this part of the EAIS might have contributed to the global sea level fall between 4000 and 2500 yr BP. The high sediment accumulation rate in the isolation lakes further enabled us to identify several dry episodes and periods of higher UV radiation penetration during the past 2000 years.

Together, our results highlight the potential of coastal Antarctic lakes for the reconstruction of past environmental changes and underscore the need for continued studies of lacustrine sediment sequences from this climate sensitive region. The BelSPO funded **HOLANT** project will build on our expertise and will determine how the climate of coastal Antarctic regions has varied during the Holocene. More specifically, we aim to reveal how records from these coastal areas and inland locations (ice cores) are interrelated with respect to timing, duration and magnitude of climatic variation. In addition, we will relate previous temperature excursions to changes in regional ice-sheet volume and global-scale climate anomalies. To this end, we will quantitatively analyze biological proxies at high resolution in precision-dated lake-sediment cores from coastal (Sub-)Antarctic regions (e.g. Trinity Peninsula, Pourquoi-Pas Island, Syowa Oasis, Annenkov Island and the Kerguelen Islands) and integrate these results with non-biological information (e.g. sedimentary infill properties analyzed using seismic surveys and physical sedimentology techniques). In parallel, we will exploit our expertise to study fossil DNA in lake sediments in order to reveal the response of the basal food web to climate anomalies during the past 10,000 years.

## **IPY in the Antarctic Peninsula – Ice Shelves, Oceans, and Climate... the US contribution to the “Antarctic Peninsula Ice and Climate System Initiative (APICS)”**

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An integrated multi-disciplinary field program is outlined that addresses the rapid and fundamental changes now taking place across the Antarctic Peninsula region. By making use of a marine research platform we can bring glaciologists, oceanographers, marine geologists and biologists together on the same team, working collaboratively to answer vital questions with regard to:

- 1) the stability of the Larsen Ice Shelf and Antarctic Peninsula ice sheet
- 2) the integration of paleoclimate records from marine and lacustrine sediment cores
- 3) the response of, or contribution of, oceanographic systems to ice shelf disintegration
- 4) the climate history of the Peninsula as recorded in ice cores, and
- 5) biotic changes in the ocean, including wide ranging shifts in benthic ecosystem dynamics.

Although the logistics of such a program (**APICS**) are multilayered, the field work makes use of existing technologies aboard the N. B. Palmer and will allow access (via helicopter support) to a wide range of glacial systems adjacent to the Larsen Ice Shelf system. At these locations we will conduct both dynamic monitoring of glacial flow and recover high resolution ice core histories using light-weight drilling equipment, successfully tested at other sites around the world. We will also maximize the use of seafloor imaging systems of the Palmer by extending existing swath mapping coverage, into previously unexplored regions. Recovery of long sediment cores (up to 26 m) will be facilitated by use of a proven jumbo piston core system and will target newly discovered sedimentary sections of expanded resolution now lying exposed in the Larsen B embayment. Long-term monitoring of deep water outflow will, for the first time, be integrated into changes in ice shelf extent (bottom water source) by linking near source observations (five instrumented moorings are now in place in front of the Larsen A, B and C) to distal sites of concentrated outflow (the South Orkney Plateau channel now has 10 + years of bottom water flow data). Sediment traps are now connected to both proximal and distal moorings and the records of sediment flux can be linked directly with existing ice dynamics (post break-up surging of tidewater glaciers) and future changes in the ice shelf extent. Finally, the robust space and dynamic positioning of the Palmer will allow an international team to deploy a remotely operated vehicle (ROV) to examine, map, and sample a newly discovered chemotrophic ecosystem that was uncovered by the loss of the Larsen B ice shelf in 2002. Such access is vital to assessing life in extreme environments and understanding the role of rapid (climate) change on the ice shelf and benthic ecology.

The results of this international, multi-disciplinary effort will significantly advance our understanding of linkages amongst the earth's systems in the Polar Regions and are proposed in the true spirit of IPY.

## **BIANZO – BI**odiversity of **AN**tartic **ZO**obenthos

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Polar Regions experience greater rates of climate change than elsewhere on the planet. Their uniquely adapted biota may be vulnerable to shifts in climate. In this context, it is widely recognized that a structured assessment of the Southern Ocean biodiversity is urgently needed as well as a better understanding of its ecofunctional role.

**BIANZO** concentrated on the investigation, at different structural and functional levels, of the biodiversity of the Antarctic zoobenthos through three representative groups of different size categories: the nematodes (meiobenthos), the amphipod crustaceans (macrobenthos), and the echinoids (megabenthos).

The first phase of the research was devoted to the description and understanding of the nature and distribution of biodiversity. Comprehensive syntheses of present knowledge were made and biodiversity surveys were conducted for the first time in unknown Antarctic areas such as the deep Scotia and Weddell seas. A special attention was paid to symbiotic associations which can be source of biodiversity increase, especially in food-limited environments such as deep-sea.

The second objective aimed at better understanding the ecofunctional role of biodiversity. Different dynamic features were analysed in the target groups: biomass, turnover rates, niche diversity and occupation, reproduction patterns, or variety of trophic types. An integration of the three studied groups in the Antarctic global food web was attempted by the use of stable isotopes as tracers.

The third objective concerned the development of a "biodiversity information system" for the Antarctic zoobenthos. The pioneering biodiversity databases formerly developed for the three groups were implemented with newly gained information, especially on deep-sea species. New common mapping applications were developed as well as interactive identification tools where needed. The databases were linked and made available to the scientific community.

## Molecular tools for evolutionary research on the ichthyofauna of the Southern Ocean

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For the past 40 million years there has been an almost complete replacement of the fishes on the Antarctic shelf. A diverse, cosmopolitan temperate community from the late Eocene has been succeeded by a highly endemic, cold adapted modern community. Within the **PELAGANT** project we developed molecular tools to study this unique ichthyofauna. We initiated the construction of a database for Antarctic teleosts with reference DNA sequence information (DNA barcodes). Currently we have access to tissues samples of approximately 40 Antarctic fishes and have sequenced the mitochondrial COI gene of approximately 30 species. This makes a reliable and semi-automated DNA based identification feasible. The correct identification of species represents a crucial step in biological research and is sometimes impossible based on morphological characteristics if only tissue, young stages or body parts are available. The DNA based techniques may assist with the unambiguous identification of eggs and larvae in plankton samples, the identification of stomach contents, the enforcement of fisheries law and the tracing of processed fish products.

Secondly we developed microsatellite markers for three Antarctic fish species in order to study their spatio-temporal population structure. It is unknown to what extent Antarctic aquatic organisms move between water masses. The main water mass of the Southern Ocean rotates over several years in an easterly direction around the Antarctic continent. This would suggest that plankton cannot avoid a high degree of genetic mixing over an extended time scale. However, there is also oceanographic evidence for the separation between water masses in the Southern Ocean. For example the Weddell-Scotia Confluence separates water west of the Scotia Arc from that immediately the east. Other water masses show rotational movements (gyres) of long duration, which may lead to planktonic species being retained, and thus genetically isolated. The microsatellite markers make it possible to analyse the effects of these oceanic processes on the genetic structure of Antarctic fishes.

## **SCAR-MarBIN: the Antarctic Marine Biodiversity Information Network**

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For decades, Antarctic research has produced a wealth of marine biodiversity data, which is often scattered, barely accessible and/or vanishing. These data hold information which is critical in assessing the Southern Ocean biodiversity, potential impacts of environment variations, and for conservation, modelling and management purposes. Existing databases offer valuable information on Antarctic species of particular taxonomic groups, but coverage is generally limited to those groups. In order to integrate and optimize the use of existing data, **SCAR-MarBIN** has been endorsed as part of the new SCAR-EBA programme, as the information component of the Census of Antarctic Marine Life (CAML; [www.caml.aq](http://www.caml.aq)), and as a prominent part of the International Polar Year (IPY; [www.ipy.org](http://www.ipy.org)). SCAR-MarBIN objectives are to: (i) compile, integrate and disseminate Antarctic marine biodiversity information (ii) help SCAR contribute to global biodiversity information initiatives, (iii) satisfy marine biodiversity information requirements from the Antarctic Treaty System and SCAR, and (iv) contribute to assess the state of knowledge and promote marine biodiversity research in Antarctica. Implementation of SCAR-MarBIN is in progress, and the presentation is intended to show users and data providers, in an interactive fashion, the evolution and the potential of the Network.

## Impact of a Greenland deglaciation on climate during the next millennia

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A new Earth system model of intermediate complexity, **LOVECLIM**, has been developed in order to study long-term future climate changes. It includes an interactive Greenland and Antarctic ice sheet model (AGISM) as well as an oceanic carbon cycle model (LOCH). Those climatic components can have a great impact on future climate. The few studies in recent literature assessing the impact of polar ice sheets on future climate draw very different conclusions, which shows the need for developing such a model. A set of numerical experiments have been performed in order to study the possible perturbations of climate induced by human activities over the next millennia. A particular attention is given to the Greenland ice sheet. In most of the projections, the Greenland ice sheet undergoes a continuous reduction in volume, leading to an almost total disappearance in the most pessimistic scenarios. The impact of the Greenland deglaciation on climate has therefore been assessed through a sensitivity experiment using the scenario SRES A2. The removal of the Greenland ice sheet is responsible for a regional amplification of the global warming inducing a total melt of Arctic sea ice in summer. The freshwater flux from Greenland generates large salinity anomalies in the North Atlantic Ocean that reduce the rate of North Atlantic Deep Water formation, slowing down slightly the oceanic thermohaline circulation.

## **Silicon isotopes, <sup>234</sup>Thorium and mesopelagic Barium to constrain the dynamics of a Southern Ocean diatom bloom induced by in situ iron fertilization (EIFEX)**

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**EIFEX**, a large-scale iron fertilization experiment, took place in the Polar Front Zone of the Atlantic sector of the Southern Ocean in summer 2004. An eddy was fertilized with 7 tons of iron sulfate, monitored and sampled for 36 days afterwards. A diatom bloom was observed during this period. Multi-proxy data from the upper 1000m inside and outside the patch will be presented. 23 days after fertilization, surface silicon isotopic signature displayed the heaviest composition ever measured in seawater ( $\delta^{29}\text{Si}$  more than 1.3 ‰). This is in good accordance with what is expected from the starting conditions, Si content changes, and current knowledge of diatom fractionation factor, which confirms the occurrence of large diatom Si consumption rather than mixing process. In the same time, <sup>234</sup>Th fluxes pointed toward the onset of significant particle export from the mixed layer whereas meso-Ba-xS displayed some increase spread out up to 1000m, suggesting relatively deep carbon remineralization. The comparison with macronutrients and proxy profiles from outside the patch, where biological activity was also significant, will allow a more comprehensive view of this Fe induced blooms.

## **Antarctic Subglacial Processes and Interactions: the role of transition zones in ice sheet stability**

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The aim of **ASPI** (Antarctic Subglacial Processes and Interactions) is (i) to understand the interactions between the ice sheet and the subglacial environment and the processes that control the Antarctic ice sheet, and (ii) to quantitatively determine the stability of the ice sheet in a changing climate and the impact of climatic variations on the coastal ice sheet. A key factor in such quantification and impact assessment is the existence of transition zones within the ice sheet. Such transition zones are examples of specific boundary layers widely found in glaciology. Basically they are parts of the ice sheet which overlie basal transition zones where the flow is anomalous. Typical examples of such transition zones are the grounding lines, i.e. the interface between the ice sheet and an ice shelf, between an ice sheet and a subglacial lake, as well as between an ice shelf and its pinning points. These transition zones are probably among the least understood elements of ice sheets, although they determine to a large extent the processes and dynamics of lateral expansion and retreat of ice sheets as well as the stability of marine ice sheets.

ASPI seeks to investigate (i) the processes responsible for grounding line migration in marine ice sheets (present and future behaviour), (ii) the effect of marine ice formation on the rheology and ice viscosity of the transition zone, hence the stability of ice shelves, (iii) the stability of subglacial lakes over longer time spans, and (iv) basal processes and interactions in order to unravel the paleoclimatic signal in deep ice cores.

## Biogeography of (Sub-)Antarctic moss-inhabiting diatoms

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The (sub-)Antarctic Region consists of a number of relatively small islands and archipelagos, situated in the southern part of the Atlantic, Indian and Pacific Ocean. They all have a very oceanic climate. Water never is a limiting factor and co-determines the aspect and vegetation of these islands.

Several field campaigns were conducted on these islands (Crozet, Kerguelen, Marion, Macquarie, Heard, Prince Edward), resulting in a collection of about 750 moss samples. The non-marine diatom flora of all samples has been thoroughly investigated using the most modern light and electron microscopic techniques. A very diverse diatom flora of more than 250 taxa has been observed, showing a large tendency towards a 'regional endemism'. This result clearly contrasts with the widely held viewpoints regarding the general presence of so-called cosmopolitan taxa.

The diatom flora of the sampled islands was compared using different methods, resulting in a general biogeographical view of the (sub-)Antarctic Region. The results also suggest the existence of a latitudinal gradient in the diatom composition in both the number of taxa present and the turnover of typical taxa.

In addition, the relationship between the (sub-)Antarctic Region and islands and archipelagos to the north and south (including South Georgia, King George Island, Gough Island, Amsterdam & St. Paul Island) has been investigated to determine the possible distribution limits of certain (sub-)Antarctic key taxa.

## The temporal variation in the meiobenthos along a bathymetrical gradient ('Hausgarten', Arctica): impact of climate oscillations

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Ice edges and associated water column features are key areas of increased productivity in all regions of the Arctic (Smith and Sakshaug, 1990). Stability of the water column and ice edge associated currents allows phytoplankton to be retained in a defined active photosynthetic layer at the margin of the ice (Marshall 1957). In many areas, the ice edge phytoplankton bloom follows the retreat of the ice margin, and can extend to 50 km or more from the ice edge (Smith and Sakshaug 1990).

In the framework of the **HAUSGARTEN** project, 9 Arctic deep-sea stations (between 1000-5500 m depth) along this Ice Margin have been intensively sampled since the year 2000 by the Alfred-Wegener Institute with Polarstern and will be sampled for another 6 years. In this study meiofauna samples of the first five years will be analyzed with emphasis on nematode and copepod communities which will be identified up to species level. Density, biomass and productivity, diversity ( $\alpha$ -,  $\beta$ - and  $\gamma$ -diversity) will be assessed. Obtained data will be linked to biological and physical environmental variables (especially food supply) in order to link climatic oscillations with changes in these communities. Results will be put in a conceptual model in order to predict changes in the meiobenthos community due to global warming. Preliminary results show links between changing NAO indices and ice extent. Meiofauna densities, however, show no clear differences in densities over the time series. Nematode diversity may be linked to the varying food supply as a result of the changing Ice margin.

## Neutrino astrophysics: a new window on the Universe from South Pole

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With the beginning of the construction of the IceCube detector at South Pole, the nascent field of neutrino astronomy is currently at a milestone. More sensitive and precise than its predecessor **AMANDA** (Antarctic Muon And Neutrino Detector Array), the future largest neutrino detector will undoubtedly help scientists to improve their understanding of the most violent phenomena of the Universe. Neutrinos are indeed precious astronomical messengers as they are uncharged subatomic particles which interact only weakly with matter. Unlike photons, they can travel cosmic distances without being absorbed or deflected from their initial direction of propagation and deliver unaltered information related to the site of their emission. The early Universe being transparent to photons only up to modest energies, neutrinos are thus the incontrovertible partners of conventional astronomy to probe the most violent astrophysical objects (indeed, in addition to a possible absorption by the interstellar medium, gamma rays above 10 GeV interact with the extragalactic background light, affecting the observed spectral shapes). The observation of neutrino point sources would unambiguously sign hadronic acceleration and solve a century-old mystery: the origin of cosmic rays. Besides a quest for individual point sources, neutrino detectors also have a cosmological connection in searching for a signature resulting from pairwise neutralino annihilation in the center of the Sun (or the Earth). These particles are the MSSM candidates to the dark matter. Finally, AMANDA and IceCube are sensitive to most supernovae occurring in our galaxy.

In this poster, we will review the different goals and challenges of neutrino astronomy, explain the techniques of detection of those evanescent particles and present the different technologies exploited to that aim. The different phases of construction of IceCube will be illustrated as well as the first recorded data.

## Activity-stability relationships in extremophilic enzymes

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$\alpha$ -Amylases, xylanases and DNA ligases from psychrophilic, mesophilic and thermophilic microorganisms have been studied as regards their conformational stability, heat inactivation, irreversible unfolding, activation parameters of the reaction, properties of the enzyme in complex with a transition state analog and structural permeability. These data allowed us to propose an energy landscape for these extremophilic enzymes based on the folding funnel model, integrating the main differences in conformational energy, cooperativity of protein unfolding and temperature dependence of the activity. In particular, the shape of the funnel bottom, which depicts the stability of the native state ensemble, also accounts for the thermodynamic parameters of activation that characterize these extremophilic enzymes, therefore providing a rational basis for stability-activity relationships in protein adaptation to extreme temperatures.

## Cyanobacterial diversity in extreme environments of the Pensacola Mountains (Transantarctic Mountains)

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The bottom of Forlidas Pond, a ice-covered waterbody located in the Pensacola Mountains (51°16'48"W, 82°27'28"S), is covered by a saline slush that was not frozen at the time of sampling, and where the salinity is ca four times higher than seawater. These extreme conditions suggest that life, if present, should be represented by a low biodiversity and possibly adapted taxa. Light microscopy and molecular diversity studies (clone library based on the 16S rRNA gene) showed that only one cyanobacterium was present. The sequence is related (99%) to a clone isolated from lake Rauer2, an hypersaline lake in Eastern Antarctica, and it belongs to a cosmopolitan genotype found outside Antarctica.

One cyanobacterium was isolated in culture from the sample and its rRNA sequence was identical to the clone sequences. On the basis of its morphology, it can be identified as *Pseudanabaena antarctica*.

Close to Forlidas Pond, a terrestrial cyanobacterial mat was also investigated. There, we find 2 different 16S rRNA gene sequences. The sequences are similar to the strain *Phormidium autumnale* Ant-Orange of a pond in the Mc Murdo Ice Shelf (Ross Sea Sector) (98%) and to a clone sequence from lake Fryxell in the McMurdo Dry Valleys (BGC-Fr056) (99%). They correspond to genotypes that are also found outside Antarctica.

## Mesopelagic C mineralization under natural and Fe-amended conditions

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We studied the effect of natural and artificial iron-induced bloom on C mesopelagic mineralization in the Southern Ocean by measuring mesopelagic Ba<sub>xs</sub> (particulate biogenic Ba) during the **KEOPS** (natural Fe fertilization conditions from Kerguelen continental shelf) and **EIFEX** (fertilization experiment by artificial Fe addition) cruises. Mesopelagic Ba<sub>xs</sub> stock is build-up during the growth season as a result of export and degradation of biogenic aggregates from the mixed layer in the mesopelagic zone. Using an algorithm relating mesopelagic Ba<sub>xs</sub> (meso-Ba<sub>xs</sub>) contents to oxygen consumption, allowed us to estimate Particulate Organic Carbon remineralized fluxes.

All stations during KEOPS present high meso-Ba<sub>xs</sub> contents, with highest values observed off-shelf. In the mesopelagic waters, there is little change over time and Ba<sub>xs</sub> concentrations remain relatively constant over a 3 week period. In contrast, a temporal increase of the meso-Ba<sub>xs</sub> content is observed off shelf, suggesting larger mesopelagic -C remineralization fluxes than on-shelf. This situation suggests that on shelf particulate organic matter could be exported efficiently to the sediments (at 520m) with little mineralization in the water column, while off-shelf higher remineralization efficiency of exported organic material occurs within the water column.

During the EIFEX cruise iron enrichment induced a relatively deep C mineralization starting 10 days after iron infusion. Ba<sub>xs</sub> concentrations increased from 273 to 415 pM in the upper 1000 m but did not reach higher values than those occurring naturally just before the Fe fertilization. Moreover, Ba<sub>xs</sub> concentrations reached remained of similar magnitude to those observed for natural blooms in other regions of the Southern Ocean indicating a limited impact of iron enrichment on the bulk C budget.

## Biological control of CO<sub>2</sub> air-sea exchange in the iron-limited Southern Ocean

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The Ocean plays an important role as a buffer to global warming, by absorbing ~ 30-40 % of the CO<sub>2</sub> released annually. This net uptake results from the solubility and the biological pumps. In the context of climate change, the Southern Ocean has been identified as one of the most sensitive area of the global ocean, because of its unique hydrodynamic and ecological features. In the HNLC (High Nutrient Low Chlorophyll) areas such as the Southern Ocean, iron (Fe) plays a crucial role in controlling phytoplankton production, species composition and the biological carbon pump. However, few existing Fe measurements suggest Fe accumulation in the sea ice. The release of Fe from the sea ice at the time of melting could constitute a significant source of Fe for phytoplankton blooms and explain their location at the ice-edge.

The interactions between Fe cycling and biological processes are being investigated in the ice and pelagic ecosystems of the Southern Ocean, based on field observations, process-level studies in the field and under laboratory-controlled conditions and biogeochemical modeling. Here we report results on (i) observational evidence of the role of micro-organisms during the sea ice formation in the Fe accumulation in the sea ice (ii) the Fe control of primary production and phytoplanktonic community structure making use of key Antarctic algae cultures (diatoms-*Thalassiosira gravida*, *Phaeocystis antarctica*) as model and (iii) the direct or indirect Fe control of phytoplankton-derived organic matter remineralisation. This knowledge was incorporated in the SWAMCO-4 model, a complex model of marine planktonic system calculating C, N, P, Si, Fe cycling within the upper Southern Ocean, the export production and the exchange of CO<sub>2</sub> between the ocean and atmosphere. SWAMCO-4 was applied to study the impact of the sudden release of Fe accumulated in the sea ice on *Phaeocystis* blooms in the marginal ice zone of the Ross Sea.

**BELCANTO: Dix ans de recherche multidisciplinaire sur le cycle du carbone dans l'océan austral**  
**De koolstofcyclus in de Zuidelijke Oceaan: Tien jaar pluridisciplinair onderzoek in het kader van het BELCANTO netwerk**

Dehairs F.<sup>1</sup>, Jacquet S.H.M.<sup>1</sup>, Savoye N.<sup>1</sup>, Cavagna A.-J.<sup>1</sup>, Lancelot C.<sup>2</sup>, Becquevort S.<sup>2</sup>, Schoemann V.<sup>2</sup>, Masson F.<sup>2</sup>, Dumont I.<sup>2</sup>, André L.<sup>3</sup>, Fripiat F.<sup>3</sup>, Cardinal D.<sup>3</sup>, Borges A.<sup>4</sup>, Delille B.<sup>4</sup> & Goosse H.<sup>5</sup>

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**F :**

**BELCANTO** (BELgian research on Carbon uptake in the ANTArctic Ocean) est un projet de recherche multidisciplinaire sur l'étude du rôle de l'Océan Austral dans les cycles biogéochimiques globaux du carbone, de l'azote, de la silice, du phosphore et du fer et de l'impact de ces cycles sur la régulation du climat (liée notamment à sa capacité à absorber le CO<sub>2</sub> atmosphérique, un des principaux gaz à effet de serre). L'objectif général du projet est de construire et de valider un modèle biogéochimique tridimensionnel du système glace-océan dans la zone située au sud de 30°S. Ce modèle intègre la connaissance acquise depuis plus de 10 ans des facteurs régulant les interactions air-mer, la circulation océanique et les processus biogéochimiques impliqués dans la formation et le devenir de la matière organique. Pour atteindre cet objectif, la méthodologie de recherche combine de manière itérative (i) des études de processus dans des conditions contrôlées en laboratoire (ii) des campagnes de mesures dans des régions clés de l'Océan Austral de paramètres biogéochimiques classiques combinés à des approches innovantes "multi-traceurs" (iii) le développement d'outils numériques de modélisation et leur exploitation.

**NL :**

**BELCANTO** (BELgian research on Carbon uptake in the ANTArctic Ocean) is een pluridisciplinair project dat de rol bestudeert van de Zuidelijke Oceaan in de globale biogeochemische cycli van koolstof, stikstof, fosfaat, silicium en ijzer, alsook de impact van deze cycli op het klimaat. Dit laatste is gerelateerd aan de capaciteit der Zuidelijke Oceaan voor opname van atmosferisch CO<sub>2</sub>, een belangrijk gas met broeikaseffect. De overkoepelende doelstelling betreft de constructie van een driedimensioneel biogeochemisch model van het oceaan-ijs systeem ten zuiden van 30°Z. Dit model integreert kennis aangaande zee-lucht interacties, oceanische circulatie en biogeochemische processen betrokken bij de synthese en translocatie, afbraak van organisch materiaal in de waterkolom, bekomen tijdens het voorbije decennium. Ten einde het gestelde doel te bereiken wordt volgend iteratief werkschema toegepast: (i) processtudies onder gecontroleerde laboratoriumcondities; (ii) terreinwerk in cruciale gebieden van de Zuidelijke Oceaan met analyse van voornaamste biogeochemische parameters en dit in combinatie met een multi-proxy aanpak; (iii) ontwikkeling en toepassing van numerische modellen.

## Diversity of Plankton Assemblages in the Austral Ocean Coastal and Shelf Waters

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The diversity and the distribution of some plankton key-species has been determined in relation to the biotic and abiotic factors of the environment in various areas of the coastal and shelf waters south of the Antarctic Divergence.

The plankton assemblage diversity is particularly sensitive to the ice coverage and to the variations in physical vertical structure of the ocean, and are probably affected by climate changes.

A large set of plankton components including microplankton, copepods, macrozooplankton, krill and fish larvae were analysed during international cruises ICOTA (Ichthyologie ctire Antarctique- IPEV France) and ITALIANTARTIDE (Italian researches in Antarctic) where the **PELAGANT** group was invited as expert. An exhaustive comparison of our data with the literature emphasis that a larger plankton diversity occurs in the coastal and shelf waters than in the offshore area

Some examples of vertical, horizontal and temporal distribution of plankton components in Terre Adélie and the Ross Sea areas are discussed

The multitude of habitats generated by the Coastal and Shelf Zone, is responsible of a large multiplicity of plankton assemblages and food webs.

1. The highly diversified "Multivorous Web assemblage" occurs in the central Ross Sea, where the important ice melting determines a vertical stability and, stimulates the phytoplankton productivity. Both phyto and zooplankton species are numerous (Diatoms, Dinoflagellates, Prymnesiophytes, ciliates, copepods and *Euphausia superba*) and provide food resources for whales and birds.

2. The "*Phaeocystis* assemblage" dominates in the Southern Ross Sea, along the permanent ice shelf. The zooplankton is scarce and no predation by higher trophic levels occurs. The diversity is strongly reduced.

3. The "*Limacina* assemblage" dominates in the Terra Nova Bay polynya. The Pteropod *Limacina helicina* is the major herbivore feeding on *Fragiliaropsis curta* or small *Navicula*. The larvae stages of *Pleurogramma* sp. represent the carnivorous level 4. Other assemblages plankton exist: the classical "Herbivorous Web assemblage" (diatom-krill-whales) in the Northern Ross Sea along the periantarctic marginal ice edge and the "Microbial Web assemblage" including Cyanobacteria, Tintinnids and Salps. The various plankton assemblages illustrated here are not to be taken as different ecosystems but more realistically as different states of a typical ecosystem locally controlled by specific abiotic physical constraints. The plankton assemblages correspond to local particularities and seasonal succession of different phases of the plankton ecosystem progressing from pack ice to ice-free waters and controlled by specific physical conditions. The succession of physical processes in the marginal ice zone during ice retreat and melting determine the succession of biological events and plankton assemblages in the water column. As the ice retreat is not simultaneous everywhere, a spatial heterogeneity is observed.



## BE-POLES WORKSHOP

### Talks

1/ De Baar H.J.W., Timmermans K.L., Twining B.S., Wolf-Gladrow D., Bozec Y., Gerringa L., Rijkenberg M., Laan P., *Modern Iron Fertilization Experiments in the Southern Ocean: Key to Past and Future Atmospheric Carbon dioxide and Climate?*

2/ [Dehairs F.](#), Lancelot C., André L., Goosse H., Frankignoulle M., Becquevort S., Borges A., Cardinal D., Delille B., Elskens M., Jacquet S., Lefebvre W., de Montety A., Pasquer B., Savoye N., Schoemann V., *BELCANTO: Carbon fluxes and processes in the Southern Ocean: Regional or Global importance.*

3/ Gutt J., *Climate-induced biodiversity shifts in polar macro-benthic communities?*

4/ Volckaert F.A.M., Beans C., Koubbi P., Lecointre J., Maes J., Van de Putte A., Vandewalle P., Van Houdt J., Hecq J.H., *PELAGANT: pelagic diversity of the Southern Ocean.*

5/ De Ridder C., David B., Choné, T., De Broyer C., *Biodiversity and Biogeography of the Antarctic benthos: the cases of echinoids and amphipods.*

6/ Vanreusel A., Mesel I., Vanhove S., Hoste E., Ingels J. and Fonseca G., *Benthic biodiversity in polar deep-seas: a bipolar comparison based on meiobenthos.*

7/ De Broyer C., Danis B., *The Census of Antarctic Marine Life and SCAR-MarBIN: the Antarctic marine biodiversity information network*

8/ Wilmotte A., Taton A., Schmoker C., Fernandez R., Calusinska M., Lemaire C., *Diversity and distribution of cyanobacteria in Antarctic microbial mats.*

9/ Beyens L., Vincke S., Van de Vijver B., Ledeganck P., *Biogeography and diversity of protists in the Polar Regions.*

10/ Raynaud D., *The polar ice core record of atmospheric air.*

11/ Pattyn F., *Interaction of the Antarctic ice sheet with subglacial lakes.*

12/ Tison J.L., de Jong J., Becquevort S., Schoemann V., Dumont I., Masson F., Lancelot C., Lannuzel D., Chou L., Delille B., Borges A., *Sea Ice Biogeochemistry in a Climate Change Perspective (SIBCLim): an integrated interdisciplinary project*

**13/ Samyn D., Basal ice processes: their importance for the knowledge of environmental evolution in Polar Regions.**

14/ Goosse H., Arzel O., de Montety A., Driesschaert E., Fichetef T., Lefebvre W., Renssen, H., *Climate change and climate variability in Polar regions.*

15/ Vyverman W., Verleyen E., Hodgson D.A., Squier A.H., Leavitt P.R., Keely, B.J., Sabbe K., *Coastal Antarctic lakes: archives of past fluctuations in the moisture balance and ultraviolet radiation.*

- 16/ Escutia C., *Cenozoic history of the Antarctic Ice Sheet and its links to global climate and sea level fluctuations – an IODP proposal for drilling the Wilkes Land margin.*
- 17/ De Batist M., *Reconstructing extent and dynamics of ice sheets during former glacial periods by acoustic mapping of Antarctic shelves and slopes.*
- 18/ Herquet P., *A new window on the universe: neutrino astrophysics at the South Pole station.*
- 19/ Grunewald B., *Een winter door in Antarctica / Un hiver en Antarctique*
- 20/ Tison J.L., Goosse H., *Het verhaal van ijs en klimaat in de polaire gebieden / Une petite histoire de la glace de mer et du climat des régions polaires*
- 21/ Halzen, F., *Neutrinos in het ijs / Neutrinos dans la glace.*
- 22/ Berte J., *Het Belgisch Antarctisch onderzoeksstation / La station de recherche Belge en Antarctique.*
- 23/ Volckaert F., *De ongewone evolutie van mariene organismen in de Zuidelijke Oceaan / L' évolution inhabituelle des organismes marins dans l'océan Austral.*
- 24/ Pattyn F., Lorrain R., *Diepe ijskernen in Antarctica: Het klimaat lezen in het ijs – is er leven onder de ijskap? / Les sondages profonds en Antarctique: lire le climat dans la glace, y-a-t-il de la vie sous la glace ?*
- 25/ Vyverman W., *De reconstructie van de hoeveelheid ultraviolette straling gedurende de laatste 120,000 jaar / Reconstruction du rayonnement ultra-violet durant les 120 000 dernières années*
- 26/ Beyens L., *Avontuur en Wetenschap in de Poolgebieden. Sciences et Aventure dans les Regions Polaires.*
- 27/ Decler H., *Het internationaal polair jaar (IPY 2007-2008). L'année polaire internationale (IPY 2007-2008).*
- 28/ Henriët J.P., De Hauwere A., Foubert, A., Guidard S., Vanhove, S., Vanneste M., [Class@Poles](#) : een educatief platform voor 'bereikbaar' polair onderzoek / *Class@Poles : une plate-forme éducative pour rendre accessible la recherche polaire*

## Modern Iron Fertilization Experiments in the Southern Ocean: Key to Past and Future Atmospheric Carbon dioxide and Climate ?

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High Nutrient Low Chlorophyll regions, comprising ~40% of the world ocean, have been the theatre for a suite of *in-situ* iron fertilization experiments at 50-225 km<sup>2</sup> scales. The combined findings demonstrate much lower carbon/iron efficiencies than previously thought. These are consistent with lower cellular C/Fe quota than previously thought, which in itself will be compared via Fe diffusion limitation concepts with the growth rates of large oceanic diatoms in natural seawater without EDTA perturbation.

The low C/Fe efficiency is most dramatic in the Antarctic Ocean where phytoplankton response is modest due to severe light-limitation by deep wind mixing. Due to the low C/Fe efficiencies in the Antarctic Ocean, the termination of Fe dust input into the Antarctic region after the Last Glacial Maximum may account for only 0.5% to 2% of the observed initial ~80 10<sup>-6</sup> atm rise of atmospheric CO<sub>2</sub> in the ice core record. This estimate is very sensitive to the thus far unknown partial dissolution and fate of Fe dust in Antarctic sea-ice. Large scale iron fertilization of the modern Antarctic Ocean to enhance the oceanic sink for anthropogenic CO<sub>2</sub> would not be efficient.

## **Climate-induced biodiversity shifts in polar macro-benthic communities?**

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Bottom communities of Arctic and Antarctic shelf areas differ pronouncedly in composition, diversity and abundance, reflecting major evolutionary and ecological differences between both regions. The significance of the coupling between sea-ice, water column and the seabed biota – and, as a consequence, the food availability for the benthos – varies markedly among regions but is generally higher for the shallow Arctic shelf ecosystems than for the deeper Antarctic ones. Disturbance levels are assumed to be generally higher in the Arctic. Though polar systems are in general thought to be particularly sensitive to the climate-induced environmental changes, it is likely that Arctic and Antarctic bottom assemblages will respond differently to the external forcing. In the Arctic, increased water temperatures and fluvial run-off as well as reduced ice cover are assumed to effect severe ecosystem changes through all trophic levels. This might result in a switch from a benthos driven by sea-ice algae to that driven by a phytoplankton–zooplankton dominance. Obvious shifts in the Antarctic benthos due to an increase in sea-temperature are not likely for the near future. However, a continuing disintegration of ice-shelf areas will have a major impact to bottom communities at a regional scale.

## PELAGANT: pelagic diversity of the Southern Ocean

Volckaert F.A.M.<sup>1</sup>, Beans C.<sup>2</sup>, Koubbi P.<sup>3</sup>, Lecointre J.<sup>4</sup>, Maes J.<sup>1</sup>, Van de Putte A.<sup>1</sup>, Vandewalle P.<sup>3</sup>, Van Houdt J.<sup>1</sup> & Hecq J.H.<sup>2</sup>

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PELAGANT is an interdisciplinary project studying the key components of the pelagic ecosystem of the Southern Ocean. It deals with the criteria for the inventory, maintenance and modification of biodiversity. The first task relates to the quantification of the distribution of Antarctic pelagic key-species in relation to biotic and abiotic factors. During five cruises (Lazarev Sea - summer 2004 & winter 2006; Western Sector of the Southern Ocean - 2006; Terre d'Adélie - 2005 & 2006) we sampled the phyto-, zoo- and ichthyoplankton communities. Complementary data on the hydrodynamic structure of the water column and the associated communities were obtained. Interesting community and ecological gradients were observed on several in- and offshore transects. The second task relates to the analysis of the pelagic diversity at the species, population and ecosystem level. We have joined the Barcoding of Fishes project for the taxonomic characterisation of a selection of Antarctic fishes. So far, about 40 taxonomically well identified species are being typed molecularly. We have started large-scale sampling of four key Antarctic fishes (*Electrona antarctica*, *Notothenia corriiceps*, *Trematomus newnesi* and *T. bernachii*). The aim is to understand their ecology and genetic structure in relation to the local oceanography and geography. The third task aims at improving a conceptual and numerical ecohydrodynamical model of the pelagic ecosystem. We have developed an individual biological model of the common pelagic fish *Pleuragramma antarcticum* in view of determining ontogenic habitat shifts during its life-history. We have also upgraded a hydrodynamical model of the phyto- and zooplankton. The information should help to assess the stability of the biotic assemblages, their sensitivity to environmental constraints and especially the response to climate change. Our future research will build on a more detailed analysis of the pelagic ecosystem of the Southern Ocean.

## **Biodiversity and Biogeography of the Antarctic benthos: the cases of echinoids and amphipods.**

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In the context of environmental changes experienced by the Southern Ocean and their potential impacts on the distribution of biodiversity, reliable and detailed baseline information about species occurrence appears of critical importance. In the framework of the BIANZO project, the biodiversity and biogeography of two representative groups of the Southern Ocean benthos are investigated: the echinoids, as an important and widely distributed component of megabenthos and the amphipod crustaceans, as one the most speciose and diverse group of macrobenthos. Emphasis is put on the comparison of the respective species richness, and on the geographical and bathymetrical distribution patterns, tentatively interpreted on the basis of biological features.

Echinoids are free-living epi- or endobenthic animals that range from the intertidal zone to the abyssal depths. There are 79 Antarctic species (7 orders, 9 families), with 63% of the species (27% of the genera) endemic to the Southern Ocean. Most (*ca* 65%) of the Antarctic echinoids species only belongs to 2 families: Cidaridae (with 21 spp) and Schizasteridae (with 30 spp). Obviously, the diversification occurs at species and not at genus level. The diversification of Antarctic echinoids will be discussed in terms of reproduction and feeding strategies.

The amphipod crustaceans occur at all depths of the Southern Ocean and in very diverse microhabitats. They occupy a large variety of trophic niches and constitute a primary food source for the upper trophic levels. About 500 benthic amphipod species have been described from the Antarctic region with over 85% endemics. Their main mode of life and distribution traits are characterized and compared with the patterns exhibited by echinoids.

## **Benthic biodiversity in polar deep-seas: a bipolar comparison based on meiobenthos**

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Polar systems are characterized by extreme low temperatures during long periods of the year, resulting in a permanent ice cover at central parts and seasonal changing ice margins. Upwelling processes along ice margins, in combination with rising temperatures and changing light conditions in spring, cause strong and concentrated phytoplankton blooms. This makes polar margins among the most productive surface waters worldwide. Permanently ice covered waters in contrast, show a very low productivity. However, differences between both polar systems are at least as striking as the similarities. Primarily their geological histories, continental influences and the prevailing physical processes make both earth poles different ecosystems, seemingly leaving no reasons for comparison. Nevertheless, bipolar comparisons remain a challenge until today, since many aspects of hidden habitats remain poorly explored, and hamper the understanding of polar biodiversity. Slowly, our insight in the plenitude of habitats present at the poles is growing, allowing further comparisons of possible parallel ecosystems. Meiofauna (smallest metazoan benthic component) research at both poles only got off the ground since the 90's. Initially, subtidal areas and shelves were investigated, whereas recently more efforts have been done during international expeditions (ANDEEP and LAMPOS) to sample the unexplored margins and deep-sea. Benthic deep-sea productivity is mainly driven by surface primary production and transport processes to the seafloor, resulting in high (meio-)benthic standing stocks at ice margins and low benthic productivity in ice covered areas like the central Arctic basins. The deepest places of polar seas lined by steep slopes, like the South Sandwich trench (up to 6300 m) in the Antarctic or the Molloy deep at 79 North (with a depth of 5500 m), are both characterized by higher meiobenthic standing stocks than abyssal areas at shallower depths. These observations point to the more intensive collection of organic matter in these narrow structures. None of both poles harbored (as known so far) many new meiobenthic taxa higher than the species level. The prevailing nematode genera for instance are in accordance to what is found at other shelves, slopes and abysses worldwide. Since the first BIANZO (BelSPo) project started in 2001, special attention was given to the biodiversity and biogeography of Antarctic species, while the Arctic long term (10 yr) station at Hausgarten site was intensively investigated for both nematode and copepod species distributions along a bathymetric gradient in collaboration with the deep-sea biology group at AWI. This approach revealed the presence of many new species at both poles. It gave us insight in the high regional diversity at the Weddell Sea, with a high turn over in species composition between adjacent geographical areas. In contrast, many species show a wide bathymetric distribution not restricted by depth along the Weddell Sea slopes. Furthermore evidence is given for the distribution of species along the Scotia Arc, connecting the Peninsula with South America. The connectivity between the Arctic slopes and the northern European margins is even more evidenced as many species are shared between both areas. Definitely, under-sampling still hampers any sound conclusion so far. A full comparison of the Arctic with the Antarctic marine environment is also difficult especially since the large habitat heterogeneity at both poles is not yet fully explored. The planned expedition to the area of the broken Larsen B ice shelf is promising, amongst others due to the presumed presence of reduced environments such as cold seeps.

## **The Census of Antarctic Marine Life and SCAR-MarBIN: the Antarctic Marine Biodiversity Information Network**

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In the framework of the International Polar Year (IPY), comprehensive baseline information on the Antarctic marine biodiversity will be established by the “Census of Antarctic Marine Life” (2005-2010; <http://www.caml.aq>), a regional subset of the global programme ‘Census of Marine Life’, an unprecedented and ambitious ten-year initiative, which aims at assessing and explaining the nature, distribution and abundance of the past, present and likely future biodiversity of the oceans (<http://www.coml.org>).

Current knowledge of the Antarctic marine biodiversity is highly patchy in terms of coverage of taxonomic groups, size spectrum, habitats, geography and bathymetry.

For decades, Antarctic research has produced a wealth of marine biodiversity data, which is often scattered, barely accessible or vanishing. These data hold information which is critical in assessing the Southern Ocean biodiversity, potential impacts of environment variations, and for conservation, modelling and management purposes. In order to integrate and optimize the use of existing data and the management of new data, SCAR-MarBIN has been endorsed as part of the new SCAR-EBA programme, as the information component of the Census of Antarctic Marine Life (CAML; [www.caml.aq](http://www.caml.aq)) and the OBIS Antarctic Regional Node, and as a prominent part of the International Polar Year (IPY; [www.ipy.org](http://www.ipy.org)).

SCAR-MarBIN objectives are to: (i) compile, integrate and disseminate Antarctic marine biodiversity information, (ii) help SCAR contribute to global biodiversity information initiatives, (iii) satisfy marine biodiversity information requirements from the Antarctic Treaty System and SCAR, and (iv) contribute to assess the state of knowledge and promote marine biodiversity research in Antarctica.

Implementation of SCAR-MarBIN is in progress, and the presentation is intended to show users and data providers, in an interactive fashion, the evolution and the potential of the Network.

## **Diversity and distribution of cyanobacteria in Antarctic microbial mats.**

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Cyanobacteria are a major component of Antarctic biotopes. They can be found free-living in diverse and extreme biotopes, as hypoliths, endoliths, benthic mat-formers in ponds, crust-formers on soils, etc. To assess their taxonomic diversity, the use of molecular markers is necessary. Indeed, they have quite simple and plastic morphologies.

We present the biodiversity and distribution of Antarctic cyanobacteria based on the rRNA gene sequences recorded in databases plus new data from strains and clones obtained from microbial mats in 25 lakes from Eastern Antarctica and in 2 seepages from the Antarctic Peninsula.

Operational Taxonomic Units (OTU) were defined as groups of sequences that exhibited more than 97.5% similarity. Each OTU might correspond to more than one species, following the bacteriological standards, but it is surely distinct from other OTUs at the specific level.

A total of 67 OTUs were identified, of which 47 have not been recorded for non-Antarctic sites (or at least were absent from the circa 4300 cyanobacterial sequences present in the databases). This suggests a high degree of endemism. Moreover, 55% of the non-polar OTU were widely distributed, whereas this was the case of only 15% of the Antarctic ones. This would fit with the idea that non-polar OTU had to be well adapted to transport and dissemination and thus, were quite successful in spreading to new Antarctic habitats in different regions.

In each sample studied, several new OTUs were found. Furthermore, most of the sequence data came from 3 regions only. Thus, the bulk of the cyanobacterial genomic diversity in Antarctic biotopes still remains to be discovered.

## **Biogeography and diversity of protists in the Polar Regions**

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The research group Polar Ecology, Limnology and Palaeobiology from the University of Antwerp is active in the polar regions since 1978 and is specialized in the use of specific groups of protists (diatoms and testate amoebae) to define environmental changes. In addition to the protistological research, a subgroup is committed to the study of rotifers.

Research covers both Arctic and Antarctic regions and is based on three major objectives, covering past, present and future:

Recent ecology is the foundation of all further research. Community data are sampled in a wide variety of places. This allows to discover patterns in biogeography and biodiversity. Main research question here is the possibility to divide the Arctic and/or Antarctic in distinct biogeographical zones, based on diatoms and testate amoebae. The construction of training sets and transfer functions for relevant environmental parameters forms the bridge to the second objective. The palaeo-ecological component of our research has shifted in recent years towards the detection of changes in species assemblages, due to the effects of the Medieval Climate Optimum and the Little Ice Age.

The last part of our research covers experimental studies on Climate Change. Effects of global warming on the soil are mimicked with active and passive heating systems, and the reaction of diatoms and testate amoebae is monitored.

## The polar ice core record of atmospheric air

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The ice cores retrieved in polar regions contain a wealth of paleo-information about climate and ice sheets. The most popularized aspect is the long and unique greenhouse trace gas record, which presently covers 650,000 years. The isotopic signatures of atmospheric gases trapped in ice can provide an accurate paleothermometer recording temperature changes at the surface of the ice sheets. The air content in ice depends on atmospheric pressure prevailing at the surface, and then can be used as a paleo-barometer or –altimeter. The air content and the O<sub>2</sub>/N<sub>2</sub> ratio contain a signature of the local insolation.

I will discuss some of the implications of the different signatures of the air record in polar ice, in terms of climate and ice sheet understanding and of lesson for the future.

## **Interaction of the Antarctic ice sheet with subglacial lakes**

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Lake Vostok lies in the heart of the Antarctic continent hidden beneath 4 kilometers of ice. As big as Lake Ontario in North America, Lake Vostok is one of the world's biggest freshwater lakes. Lake Vostok has been covered by the vast Antarctic ice sheet for up to 25 million years. More than 145 lakes have been identified beneath the thick Antarctic ice sheet. Most of these lakes, covered between 3-4 kilometers of ice, are several kilometers long. All these lakes are in hydrostatic equilibrium with the overlying ice, which has consequences for the stability of these lakes. Large subglacial lakes (such as Lake Vostok) influence the regional ice flow as the ice flow over a subglacial lake resembles the flow of an imbedded ice shelf. Some lakes therefore become the onset of enhanced ice flow, which influences the ice flux and drainage in the coastal areas of the Antarctic ice sheet.

## Sea Ice Biogeochemistry in a Climate Change Perspective (SIBClim): an integrated interdisciplinary project

The SIBClim community members:

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This paper presents the main objectives of the Belgian SIBClim project (2002-2007), a program funded by the Communauté Française de Belgique (ARC), and discusses its present-day achievements in terms of new methodology, laboratory work and field data acquisition.

SIBClim is a multidisciplinary consortium combining the skills of glaciologists, biologists, geochemists and ecosystems-modellers of the Université Libre de Bruxelles (ULB), working in close collaboration with The Chemical Oceanography Unit of the ULg. The goal of the project is to study, understand and quantify the physical and biogeochemical processes associated with the sea ice biota that govern fluxes of carbon, nutrients and marine gases of climatic significance. In this context, particular attention is paid to Carbon Dioxide (CO<sub>2</sub>), Dimethyl Sulphide (DMS), and trace metals (especially iron), all potentially actively involved in the sea ice microbial metabolism.

The research methodology combines field investigations, process-oriented studies both "in situ" and in the laboratory, and modeling work in order to quantify key biological, geochemical and physical interactions between the sea ice, ocean and atmosphere. The development of methods for use with sea ice is a key component of the project. These include, direct measurement of pCO<sub>2</sub> in brines, CO<sub>2</sub> fluxes from chamber measurements and pCO<sub>2</sub> gradients in crushed ice, trace and atmospheric gas chromatography (DMS, CH<sub>4</sub>, O<sub>2</sub>, N<sub>2</sub>, CO<sub>2</sub>), Fe sampling and analysis (concentrations by flow injection analysis and isotopic compositions by MC-ICP-MS), fluorescent probes and molecular methods (PCR, DGGE).

Results from the "ARISE in the east" Antarctic cruise<sup>1</sup> (September-October 2003, 64-65S/112-119E) and from the ISPOL2 Polarstern cruise (November-January 2004, 70S, 50W) will be presented and discussed.

1. Antarctic Remote Ice Sensing Experiment. Thanks to the Australian Antarctic Division (ACE) glaciologists Drs I. Allison, V. Lytle, R. Massom, and A. Worby.
2. Ice Station Polarstern (1). Thanks to the Alfred Wegener Institute (AWI, Germany), Drs. G. Dieckmann and C. Haas.

## **Basal ice processes: their importance for the knowledge of environmental evolution in Polar Regions**

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« Basal ice » refers to the portion of an ice body that is in contact and interacts with the glacial bed. The ice present e.g. at the bottom of a glacier, an ice sheet or an entirely frozen lake meets this definition. As a result of its specific location within the ice body, basal ice generally displays a higher debris content as well as a more variable structure as compared to the overlying ice. These characteristics confer to the basal zone distinctive physical and chemical properties, which will often influence the behaviour of the entire ice body itself. For these reasons, the study of basal ice properties are essential to the understanding of glacial dynamics. Here, some of the major processes responsible for the formation of basal ice will be reviewed. The importance of the knowledge of basal ice processes in reconstructing and predicting the evolution of polar environments will also be illustrated through different analytical case studies.

## Climate change and climate variability in Polar Regions

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Marked climate variations have occurred in the high latitudes of the Northern Hemisphere during the last decades. These changes include a large increase in surface air temperature with a trend of as much as 2°C per decade in spring in some regions and a decrease in the Arctic ice extent decreased of  $0.9 \cdot 10^6 \text{ km}^2$  from 1972 through 2002. Although marked fluctuations have occurred in the past, this warming is clearly anomalous compared to the climate of the last 1000 years. By contrast, the ice extent and temperatures in the Southern Ocean appear relatively stable during the last 30 years. We do not have precise estimates on longer timescales but we cannot presently state that the late 20<sup>th</sup> century was the warmest period of the last 1000 years in Antarctica and surrounding regions. In the future, the temperatures are expected to strongly rise in both hemispheres, leading to large decrease of the ice extent in both hemispheres. This could lead to an ice free Arctic in summer before the end of the 21<sup>st</sup> century.

## Coastal Antarctic lakes: archives of past fluctuations in the moisture balance and ultraviolet radiation

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Within the context of global change issues, Antarctica is often referred to as the ‘the canary in the coalmine’, because some of the recently observed climate anomalies are amplified (i.e., temperature rise) or even restricted to Polar Regions (e.g., the ‘ozone hole’ and the related increase in ultraviolet radiation). Baseline information about long-term natural climate variability and its effect on ecosystems is however largely lacking. This was recognised in the BelSPO funded project LAQUAN in which biological proxies were used to reconstruct past environmental changes.

This presentation will illustrate some of the findings of the project. More in particular, we will how microfossils and pigments in a sediment core from Lake Reid (Larsemann Hills, east Antarctica) are used to reconstruct natural fluctuations in the climate-related moisture balance and the ultraviolet radiation (UVR) penetration during the last glacial-interglacial cycle.

Application of diatom-based inference models indicated that the previous interglacial (the Eemian) was probably wetter (and warmer) than the current warm period (the Holocene) as evidenced by high lake water levels. Warmer conditions at this time are further confirmed by the presence of currently sub-Antarctic endemics in the fossil diatom flora of nearby Progress Lake and by a diverse and productive biological community in the catchment area as inferred using fossil pigments. Eemian sediments in Antarctic lakes might thus be good historical analogues for future warming in the region and its effects on terrestrial ecosystems.

The last glacial period was characterized by dry and cold conditions prevailing over the Larsemann Hills, with lake level minima, floristic changes in the algal communities and the local extinction of the moss inhabiting diatom flora. Pigment composition indicates that the mean exposure of benthic algae to UVR was three times greater in the last glacial period than during the Holocene era. Similar changes in UVR, yet of lower amplitude, are detected during three periods in the past 2000 years, which are also unlikely to arise from alterations in lake-water optical properties, depth, salinity, temperature, or fossil preservation.

Coastal Antarctic lakes contain long and detailed records of past environmental changes and underscore the need for continued studies of lacustrine sediment sequences from this climate sensitive region.

## **Cenozoic history of the Antarctic Ice Sheet and its links to global climate and sea level fluctuations-and IODP proposal for drilling the Wilkes Land margin**

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For the past 34 million years, Antarctica has been heavily glaciated, with ice sheets fluctuating considerably, which has been ascribed as one of the major driving forces for changes in global sea level and climate throughout the Cenozoic Era. In the last decade many high-quality marine sediment sections recording ice sheet inception and evolution and Southern Ocean paleoceanography have been recovered. Ice sheet behaviour records include, for example, the Ocean Drilling Program (ODP) Leg 178 in the Antarctic Peninsula and Legs 119 and 188 in Prydz Bay, as well as the Cape Roberts Project-CPR (Naish et al., 2001, Wilson et al., 2004). Proxy indicators from drilling in the Southern Ocean have also provided numerous discrete events of paleoenvironmental change such as are for example short but significant water warming events, episodes of increased sediment flux from Antarctica, and a drastic decrease in sediment flux around Antarctica starting at about 2.7 Ma. However, all these records remain too few in number and are often poorly constrained chronostratigraphically. Therefore, the record from ice sheet fluctuations has been largely constrained by oxygen isotope records and by applying sequence stratigraphy in distal ocean basins and passive continental margins. As a result, the spatial scale and temporal pattern of the Antarctic ice sheet fluctuations is subject to considerable debate. However, the existing discrepancies between these records can be addressed through the study of Antarctic margin and Southern Ocean sediment records.

The overall aim of the proposed IODP drilling of the East Antarctic Wilkes Land margin is to provide a long-term record of Antarctic glaciation, and its relationship with global sea-level, paleoclimate and paleoceanographic changes. This includes the critical periods in Earth climatic evolution (i.e., the Eocene/Oligocene, the upper Miocene and the Pliocene) when the Antarctic cryosphere formed and evolved to assume its present day configuration, characterized by a relatively stable East Antarctic ice sheet. To attain this objective, the drilling strategy is to constrain the age, nature and paleoenvironment of deposition of the now inferred glacial sequences in the Wilkes Land continental rise and abyssal plain. The drilling will target stratigraphic intervals that have the potential for preserving an Antarctic ice sheet and paleoceanographic record of episodes and events of regional and global significance. The drilling is designed to test the present hypothesis regarding: 1) the timing or first arrival of grounded ice sheets to the Wilkes Land margin, now inferred to occur during the early Oligocene cooling climate trend (i.e., 33.4-30 Ma); 2) warm events and ice advances during the Miocene, a time when interpretations of isotopic records suggest that East Antarctic glacial ice evolved from a polythermal to a permanent ice sheet, this transition is inferred to take place during the late Miocene-early Pliocene in the Wilkes Land margin; 3) high-resolution Neogene and ultra-high resolution Holocene records of climate variability. The Wilkes Land is the only known margin around Antarctica where the unconformity separating inferred pre-glacial strata below from glacial strata above can be traced from the shelf to the abyssal plain, allowing stratigraphic links between the proximal and distal records of glaciation to be established, which until present are not fully understood.

## **Reconstructing extent and dynamics of ice sheets during former glacial periods by acoustic mapping of Antarctic shelves and slopes**

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Growing concern about the possible response of the Antarctic ice shelves and ice sheets to global warming emphasises the need for a better understanding of ice-sheet behaviour under external conditions that are different than today's, and this both on long (millions of years) and on short (millennia) time scales.

Such understanding can only be obtained by learning from the past, i.e. by investigating archives of past glacial conditions and/or ice-sheet fluctuations, and by confronting the outcomes of these archive studies with modelling studies.

Over the past years, increased multi-beam bathymetry mapping efforts have gradually unveiled the detailed morphology of significant parts of the Antarctic continental shelves. This has revealed that these shelves are intensely sculpted by the action of grounded ice during periods of ice-sheet expansion, and that the resulting relief reflects the basal dynamics and flow regime of these paleo ice sheets. Current research combines this powerful mapping method with high-resolution reflection seismic profiling and sediment coring aiming at reconstructing 1) variations in basal dynamics, flow regime, flow direction and hence ice-sheet behaviour through time, and 2) rates and modes of ice-sheet retreat in response to external forcing.

A series of examples and case studies will be discussed in order to highlight the potential and the need for this type of studies.

## **A new window on the Universe: neutrino astrophysics at the South Pole station**

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This talk explains why a cubic kilometer telescope buried deeply in the South Pole ice is needed to indirectly detect neutrinos emitted from galactic and extragalactic cataclysmic events. The NSF IceCube/Amanda projects open completely new windows on the universe by detecting high energy neutrinos from Active Galactic Nuclei, Supernova remnants, Gamma Ray Bursts and new particles candidates for dark matter. The talk gives also a description of the detector deployment and its performances as well as a brief summary of the scientific results obtained up to now. The very non homogeneous short scale properties of the ice between -1 and -2.5 km will also been described because they need to be measured and understood to exploit the full potential of the detector.

## Overwintering in Antarctica

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Overwintering in Antarctica is a unique experience, and one that very few people have the privilege of undertaking. This talk will illustrate what it is like to live in an Antarctic station for 14 months through 2 summers and a winter. Besides a discussion of the scientific programs conducted, the talk will also focus on the human aspects of living in close confines with relative strangers and the team dynamics involved in having a successful year. At the end the talk will show what it's like to visit Antarctica as a tourist, illustrating the types of things and experiences that the average tourist may see as a means to compare that to overwintering. In addition to images, items of clothing used throughout the winter will be on display as well as educational leaflets made available to the public.

## Het verhaal van ijs en klimaat in de polaire gebieden / Une petite histoire de la glace de mer et du climat des régions polaires

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La glace de mer, qui provient de la congélation de l'eau de mer, recouvre en moyenne environ 20 millions de km<sup>2</sup>, avec une grande variation saisonnière (de 4 à 20 millions de km<sup>2</sup> en Antarctique et de 8 à 14 millions de km<sup>2</sup> en Arctique). Sa présence modifie profondément les échanges entre l'atmosphère et l'océan. En effet, la glace peut réfléchir jusqu'à 90% du flux de chaleur provenant du soleil, pour 10% pour l'océan. La glace est aussi un très bon isolant qui limite les échanges de chaleur et de divers gaz entre l'océan et l'atmosphère. Elle est cependant le siège d'importants processus physico-chimiques et biologiques qui pourraient bien contribuer de manière significative au bilan des flux de gaz à effet de serre, particulièrement en automne et au printemps. Par ailleurs, elle est à l'origine de la production d'une proportion importante des eaux océaniques de fond, qui constituent un des moteurs de la circulation océanique globale. En été, lors de sa fonte, elle est au contraire responsable de la stratification temporaire des eaux antarctiques de surface, avec pour conséquence le développement rapide d'efflorescences algales qui sont la base de la pyramide écologique de l'océan antarctique. Ces processus, et d'autres encore, jouent un rôle important dans la réponse du système climatique aux perturbations induites par les activités humaines. D'ailleurs, la température en Arctique a fortement augmenté au cours des dernières années (avec une extension minimale record observée de la banquise en 2005), et on aura peut-être un océan Arctique libre de glace en été avant la fin du siècle. Par contre, dans l'océan Austral, l'étendue de la glace de mer est restée stable au cours des 30 dernières années. On s'attend cependant aussi à ce qu'elle diminue fortement au cours du 21<sup>ème</sup> siècle.

## Icebound Neutrinos

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In the frozen Antarctic ice, neutrino physicists are constructing the largest particle detector in the world. When completed in about 2009, the instrument will comprise a volume of about one kilometer on each side. Appropriately called, IceCube, this experiment will look for the interactions of high-energy neutrinos that travel through the cosmos and crash into the hydrogen atoms in the ice. Suspended within the ice will be arrays of light-detectors that will see the shimmering blue light created from these collisions. The ice itself, therefore, becomes the IceCube detector. We will discuss the data of our operating first generation telescope, AMANDA, which represents a proof of concept for IceCube.

The neutrinos will be cosmic messengers from the most violent processes in the Universe, for instance those associated with quasars and gamma-ray bursts, dark matter trapped in the Sun, and perhaps, the telltale signatures of additional dimensions in space. But the main motivation for IceCube is discovery: every time we have looked at the sky in a new way—by using infrared or ultraviolet light, by using X-rays, or by using radio waves—we have been surprised.

## The Belgian Research Station in Antarctica

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The new station construction is situated approximately 1 km North of Utsteinen Nunatak, on a small relatively flat granite ridge (71°57'S 023°20'E), 173 km inland from the former Roi Baudouin base and 55 km from the former Japanese Asuka station. With the closing of Asuka station in 1992, the 20-30 degrees east sector of Antarctica became again a vast territory having witnessed up to now only brief periods of systematic investigation. The new station will thus reoccupy the 1072 km empty stretch between Syowa station (684 km) and the Russian station Novolazarevskaya (431 km).

The new platform is offered to the Belgian and international scientific community in a flexible way both operationally and with respect to research opportunities. The station will serve as a hub for field exploration in the 20-30 degrees east sector of Antarctica.

The construction of the summer station is planned in the austral summer of 2007-2008. In this period the station will be built, the system acceptance test performed and then it will be handed over to the Belgian Science Office at the end of the season. The expected design life is 25 years minimum.

The station is designed for optimal use by 12 people with a surface area (living, technical, research, storage) of 800 m<sup>2</sup>. The use of a station "extension" will make it possible to accommodate another 8 to 18 people. This extension consists of heated shelters used for sleeping only. The station's facilities (kitchen, sanitary installations, offices ...) are designed to cope with the larger occupation.

The station has a hybrid design, with the main building above ground-level and anchored onto snow-free rock area. The adjacent garage/storage building is located nearby and is mainly constructed under the surrounding snow surface. Both buildings are inter-connected by a weather protected corridor. The design and layout of the facilities will minimise snow management.

Consistent with the philosophy of the project, the station design will make best use of the terrain conditions for the integration of the buildings and will be such that it minimises impact on the environment and on the landscape during the construction, operation and removal of the station.

The system design of the station is based on sustainable technology and high energy efficiency, with a full-year monitoring and remote sensing capability. Nevertheless safety, health, comfort, functionality and cost are equally important design drivers. The facilities will use renewable energy as the primary energy source, integrating a comprehensive energy management regime, thereby minimising the use of fossil fuels. To assure a constant energy supply, two back-up generators will be installed. The amount of fuel used at the station will be mainly for vehicles.

The station will have a comprehensive waste management regime. Waste treatment will include the treatment of grey/black water and sewage and recycling capability for non-potable water applications. The station has been designed for low maintenance and recycling. Lifetime maintenance strategies will reduce the running costs. It is designed for easy repair and damage control. The manual handling and multiple handling of all stores and equipment will be minimised across all operations, including annual relief, normal operation and eventual decommissioning of the facilities. A risk contingency plan will be developed. By design the station has extended upgrade capability. It will be easy to integrate new state of the art technologies and, if required, the station can be upgraded to a full year station with minimal effort.

The use of sustainable technology as the primary energy source, without compromising functionality, comfort or safety demands, implies an integrated design methodology similar to the one used in applied technology projects (cfr. industry & space). The project management has been structured according to this method.

On the conceptual design level a verification method with four major lines of approach (environment, human factors including safety, technology and cost) is used to evaluate and steer all conceptual decision making. All prime project partners work together from the start of the iterative design process thereby guaranteeing that the different fields of interest are taken care of in a homogeneous way.

Prior to the actual design process of the station a comprehensive study covering the wide spectrum of characteristics typical to the Antarctic building tradition was done. This study, with the valuable support and feedback of different polar institutes and individuals experienced in the field, led to an exhaustive specification

and requirement list including guidelines and lessons learned. The approach, as for the whole of this project, was fourfold: environment, human factors, technology and cost. A key-element to define the programme (and energy needs) were the user scenarios. These gave a detailed insight on how people will live and work in and out of the station.

The extensive study of the user scenario's resulted in a building programme that foresees in a total building surface of +/- 800m<sup>2</sup>. Taking into account the requirements of the building programme and the terrain conditions it was decided to construct two major building units separate from stand-alone facilities for specific scientific activities.

The air-conditioned main building is the living area of the station and has a usable floor space of approximately 350 m<sup>2</sup>. The "garage/storage" building accommodates secondary functions such as work shops and storage of supplies and spare parts. The station will provide an efficient and pleasant living/working environment for the crew but the programme is also developed according to energy efficiency needs and the specific technical demands imposed by the winter close-down of the station.

The main building has a concentric architecture laid out around a "technical core". All temperature-sensitive installations and equipment, such as the waste water treatment system, are concentrated in this area of the building. A second concentric layer around the technical core consists of space for active systems such as the kitchen, sanitary, laundry and the station's energy management system. It also has storage for fragile office equipment during winter. A third concentric layer consists of "passive" areas, for example, the living and sleeping rooms. Temperature buffer spaces are included below the floor and above the ceiling. The fourth and last of the containment levels is the outer shell. This structure consists out of a number of passive and active elements such as insulation materials, air-gaps for buffering and energy-related systems.

For winter each individual layer is "sealed" thereby creating a number of temperature-controlled buffer zones against the cold exterior environment. This makes it possible to maintain all layers at a guaranteed minimum temperature with minimal energy supply, protecting installations and whole year active systems located in the technical core as well as the appliances located in the second layer. The "passive" area (third layer) acts as an additional buffer zone. All building zones will be monitored for temperature routinely.

The building layout will guarantee good acoustic comfort. The distribution of noise sources and the layout of the functionalities and storages (acting as buffer-zones) in the building have been reviewed for compatibility with the user scenarios to assure there is minimal disturbance caused by the activities. Wind-induced noise (turbulence areas on the building) has also been studied and a number of noise limiting measures will be used in the detailed design phase of the project.

This garage/storage building is an under-snow surface construction connected by an aerodynamically shaped and weather-protected staircase to the main building, and follows the design philosophies of minimal environmental and visual disturbance, best comfort and energy efficiency. The roof is used as an airflow diffuser.

This construction protects the crew against bad weather conditions (note that there is increased wind speed in this part of the site) and minimises walk distances. All tubing and cabling between both building units will be integrated, minimising the heat load required for water tubing and facilitates maintenance.

## **De reconstructie van de hoeveelheid ultraviolette straling gedurende de laatste 120 000 jaar / Reconstruction du rayonnement ultra-violet durant les 120 000 dernières années**

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De vermindering in de atmosferische ozonconcentratie tijdens de Antarctische lente, beter bekend als het 'gat in de ozonlaag', is één van de grootste milieuproblemen van de laatste decennia. Het 'gat in de ozonlaag' leidt immers tot een verhoging van de hoeveelheid ultraviolette (UV) straling, wat op zijn beurt gevolgen heeft voor zowel planten, dieren als de mens. Hoewel onze kennis over de effecten van een verhoogde UV straling op levende wezens de laatste jaren enorm is toegenomen, zijn er slechts weinig gegevens voorhanden over lange-termijn variaties. De meeste informatie die beschikbaar is, is afkomstig van directe metingen (de laatste 60 jaar) of van indirecte schattingen op basis van gegevens over zonnevlekactiviteit, terug te vinden in historische documenten (laatste 1000 jaar). Recent beginnen echter ook de eerste gegevens beschikbaar te worden over lange-termijn veranderingen in de hoeveelheid UV straling. Onze onderzoeksgroep is er immers in geslaagd, samen met Britse en Canadese onderzoekers, de hoeveelheid UV straling in Antarctica gedurende de voorbije 120 000 jaar te reconstrueren. Hiertoe werden fossiele resten van microscopisch kleine plantjes in de sedimenten van Antarctica kustmeren geanalyseerd. Deze plantjes produceren onder invloed van UV licht immers speciale pigmenten die hen beschermen tegen deze schadelijke straling. De pigmenten worden goed bewaard in de sedimenten, die jaar na jaar en laag na laag worden afgezet op de meerbodem. Onze resultaten tonen aan dat de gemiddelde jaarlijkse hoeveelheid UV straling tijdens de laatste ijstijd 3 keer hoger was dan gedurende de laatste 10 000 jaar; de huidige warme periode die bekend staat als het Holoceen.

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La réduction printanière de la concentration atmosphérique en ozone en Antarctique, mieux connue comme « trou de la couche d'ozone », est un problème environnemental majeur de ces dernières décennies. Le « trou de la couche d'ozone » entraîne une augmentation du niveau de radiation en ultraviolets (UVR) influençant ainsi le monde vivant dont les hommes font parti. Malgré une avancée importante des connaissances sur l'impact des UVR sur les organismes vivants, il reste encore de nombreuses lacunes concernant les variations à long terme. La plupart des informations actuelles ont été obtenues grâce à des mesures directes (pour les 60 dernières années) ou à des estimations indirectes basées sur les données de la documentation historique des activités d'éruptions solaires (pour les 100 dernières années). Les reconstitutions de la quantité d'UVR à plus long terme ne sont possibles que depuis peu. Notre groupe de recherche, en collaboration avec des scientifiques Anglais et Canadiens, a permis d'établir les changements intervenus dans les UVR en Antarctique depuis 120 000 ans. Pour cela, les restes de micro-organismes fossilisés préservés dans les sédiments de lacs Antarctiques côtiers ont été analysés. Sous une forte concentration en UVR, ces plantes minuscules produisent des pigments particuliers qui les protègent contre ces radiations nuisibles. Ces pigments sont facilement fossilisés dans les sédiments des lacs qui s'accumulent sur le fond année après année, couche après couche. Nos résultats indiquent que la quantité moyenne annuelle d'UVR pendant la dernière période glaciaire était trois fois plus importante que celle observée durant les 10 000 dernières années, c'est-à-dire pendant la période de réchauffement actuelle, connue comme l'holocène.

## **Adventure and Science in the Polar Regions.**

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Science is adventure, but mostly it is meant as an intellectual experience. But it can also be the physical part of it. The lecturer is a biologist, and for his field work he climbed mountains in East-Greenland, man-hauled his sledge in the winter on ice-caps, and made trekkings over endless tundralandscapes. His talk is about this and his research.

## **Avontuur en Wetenschap in de Poolgebieden.**

Wetenschap is avontuur, maar meestal wordt hier het intellectuele onderzoeken mee bedoeld. Het kan evenwel ook fysiek avontuur zijn, en dit wordt tijdens deze voordracht toegelicht. De voordrachtgever is bioloog, en voor zijn veldwerk heeft hij bergen beklommen in Oost-Groenland en in de winter honderden kilometers ver zijn slede voortgetrokken over ijskappen, trektochten gemaakt over eindeloze toendra's. Over dit en het onderwerp van zijn onderzoek gaat zijn verhaal.

## **Class@Poles: an educational platform for 'accessible' polar research**

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Class@Poles is an educational contest within the Belgian network of polar research BE-POLES. It paves the way to polar research, 'accessible' to school classes with an entrepreneurial spirit, in a sustainable way. Classes from the second level of secondary education have been invited to (1) formulate a question dealing with a topic from a wide spectrum of polar research, and (2) design a project and expedition to seek the answer. 'Junior scientists' (a total of 5) delegated by the winning classes will soon take their question to the field, in the framework of an expedition coached by experienced young researchers.

The expedition will take place in Northern Norway and Spitsbergen (Eastern 2006) and consists of two 'Legs', some 10 days each. The first Leg, starting March 31st, will bring Roxane and Werner to Tromsø and Longyearbyen on Spitsbergen. Both juniors are strongly interested in environmental and biological issues. They will have access to the University Centre In Svalbard, where they will meet students and scientists and even will attend a lecture on Arctic Ecology, in the true spirit of a class@poles. Beyond that, they will explore the glacial and socio-economic environment of Spitsbergen, under professional guidance.

Back in Tromsø, they will meet on April 7th the team which will have arrived for the second Leg: Stan, Eelco and Alexandre. The complete team will visit in Tromsø various institutions, where they will further find replies to their question. While Roxane and Werner are returning home April 9th, Stan, Eelco and Alexandre, most motivated by glaciological experiments and geophysics, will get access to a glacier in the Lyngen Alps, site for their self-designed experiment on albedo. The expedition will also lead to the Svartisen Glacier on the Polar circle, where they will learn more about a unique subglacial laboratory, 200m under the ice surface. Proceeding over the Lofoten Islands, they will spend a whole day at the Andoya Rocket Range, the international launching site of rockets and balloons for investigations of Northern Light. The expedition returns April 17th.

Throughout the expedition, the juniors will report on Internet, and occasional webcam sessions will allow interested classmates to interact and help find the solutions to the scientific questions. Jointly with the PhD researchers, post docs and local contacts, the juniors scientists will elaborate their planning for furthering their research, beyond the contest.

Class@Poles is associated with the European research and training networks OMARC and EURODOM, dealing with (polar) ocean margin research.