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Inside

The Southern Ocean Continuous Plankton Recorder Survey

Brian Hunt

In recent years much interest has been shown in the biological impacts of climate change, including warming and ozone depletion, in Antarctic and Southern Ocean ecosystems. Polar ecosystems are likely to be the first affected by global climate change (Zwally, 1994). Evidence indicates that in the Antarctic a warming of air and sea temperature and a reduction in sea-ice extent have already occurred during the last century, while ozone depletion and enhanced UV radiation are well documented. However, the ecological consequences of these changes remain poorly understood and require continued monitoring. It is in view of this need for monitoring that Dr Graham Hosie of the Australian Antarctic Division, Kingston, Tasmania, established the Southern Ocean Continuous Plankton Recorder (CPR) Survey in 1991.

Zooplankton play a major role in all of the Southern Ocean sub-systems, functioning as grazers, predators and scavengers, and ultimately providing the link between primary producers and the upper trophic levels, represented by top predators such as seabirds and whales. Zooplankton are also vital components of biogeochemical cycles, including the removal of CO_2 from the atmosphere, although their contribution to the latter varies strongly between species and communities. Environmentally forced changes to zooplankton communities therefore have significant implications for ecosystem functioning. Through a combination of environmental sensitivity, short life histories, and an inability to escape their surroundings, zooplankton are vulnerable to change. Inadvertently this makes them excellent indicators of environmental variability and perturbations.

> "*... plankton can integrate meteorological variability and as such may have value in mapping the environmental consequences of climate change in the marine environment.*" (Reid and others, 1998a, p. 282, para. 2)

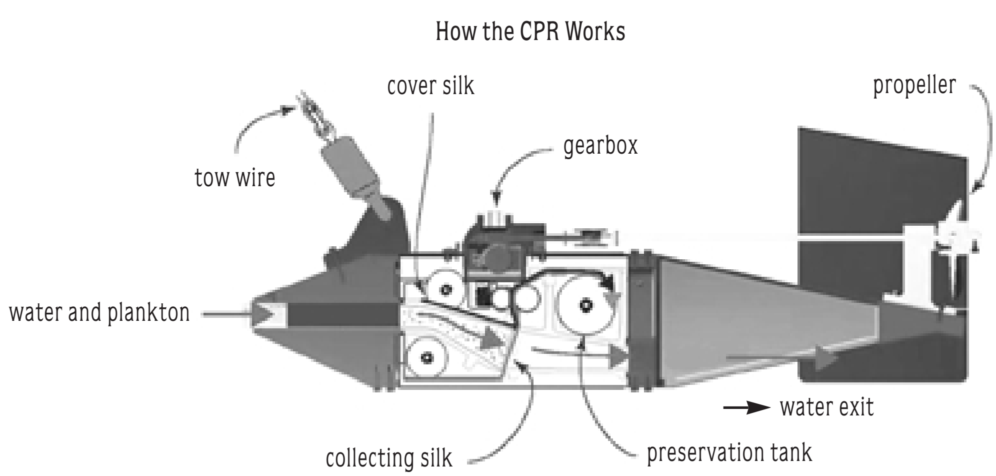

Figure 1
Since 1931 only minor design changes have been made to the CPR, but the fundamental sampling characteristics have largely remained the same. Plankton are trapped on the collecting silk, sandwiched by the cover silk, and subsequently rolled onto a spool in the preservation tank. The spooling of the silk is driven mechanically by the tail propeller.

The Continuous Plankton Recorder (Fig. 1, CPR) was conceived by Sir Alister Hardy to overcome one of the fundamental problems faced by plankton biologists:

> *"The composition of the plankton is in qualitative as well as quantitative relations very irregular, and the distribution of the same in place and time in the ocean also very unequal."*
>
> (Haeckel (1890) in Hardy, 1936, p. 513, para. 3)

In summary, the CPR is a robust, easy-to-use plankton sampling instrument that can be towed at 5–20 knots behind any large vessel with a suitable towing winch. Plankton are collected continuously on a roll of silk and integrated into segments representing a 5 or 10 nautical mile section of a transect. In combination, these characteristics enable zooplankton surveys with large spatial coverage, as well as high temporal resolution, to be conducted rapidly and frequently. The CPR has an averaging towing depth of ~ 10 m, and therefore focuses attention on the surface layers of the ocean, while the combination of small mouth area (1.6 cm^2) and relatively fine mesh (270 μm) means that sampled zooplankton are predominantly in the mesozooplankton size range (0.5–10 mm).

The prototype CPR was first used in the Southern Ocean, during the 1925–27 expedition of the RRS *Discovery*. Design problems encountered on this voyage were rectified on return to the U.K. and an improved Mark II model was deployed in September 1931 on a transect from Hull to Hamburg. From these small beginnings, CPR sampling expanded rapidly as the instrument was deployed from an increasing number of "ships of opportunity", including ferries and cargo vessels. Ultimately this sampling evolved into a long-term monitoring program which provided monthly coverage of the North Sea and North Atlantic. Currently under the auspices of the Sir Alister Hardy Foundation for Ocean Science (SAHFOS), the Northern Hemisphere CPR program has generated one of the most spatially extensive and temporally comprehensive long-term marine datasets. Time-series analyses have identified long-term changes in plankton abundance, migration behaviour, population cycles and community structure in response to oceanographic change, climate cycles (*e.g.* the North Atlantic Oscillation), Northern Hemisphere warming trends, and eutrophication. These changes have cascaded upwards through the ecosystem, impacting negatively on higher trophic levels, including seabirds and the recruitment of commercially important fish species such as cod and salmon (*e.g.* Aebischer and others, 1990; Beaugrand and Reid, 2003).

It is the success of the Northern Hemisphere CPR program that inspired the formation of a sister program in the Southern Ocean. Initial sampling efforts were focused on the seasonal ice zone. However, in 1996 the Southern Ocean survey was expanded to include routine sampling in the permanently open ocean zone (POOZ), taking advantage of re-supply routes between Tasmania and Australia's Antarctic stations, and dedicated marine science voyages. Since 1997, an average of 6946 nautical miles of CPR tows have been completed per year aboard the Australian research and supply vessel the *Aurora Australis*. Since 1999, a further 3414 nm/yr have been collected from the vessels of the Japanese

Figure 2
Location of CPR tows conducted in the Southern Ocean to date.

Antarctic Research Expedition. In 2004 Germany joined the survey, beginning annual sampling in the Indian Ocean sector and increasing the coverage of the Southern Ocean by the CPR to ~45%.

By comparison with its Northern Hemisphere counterpart, the Southern Ocean CPR survey (Fig. 2) is in its infancy. Initial research focused on identifying communities and their spatial patterns, providing the first high-resolution large-scale zooplankton sampling in the region south of Australia. Subsequently, the seasonal succession of communities was described, providing the baseline data required to interpret future change. In addition, a number of methodological studies have been completed which are relevant to all CPR research, *i.e.* CPR samples have been calibrated against traditional vertical net tows, while flow meters have been used to quantify clogging and volume filtered by the apparatus under different conditions. The next step in the process is to begin analysis of the interannual variation.

> *"The problem is that long-term monitoring is often incompatible with short-term decisions about funding. Once a continuous sequence of data is broken it can never be recovered."*
>
> (Nick Carter, Rothamsted Insect Survey, 1989)

In the light of the Southern Ocean CPR Survey recently being made a SCAR (Scientific Committee on Antarctic Research) Action Group, and the growing international collaboration on the program, it appears as though this is a monitoring program for the future. It is with great anticipation that we look forward to the years to come, and what this survey will teach us about Southern Ocean and Antarctic marine ecosystems.

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Note: For an overview of the Northern Hemisphere CPR survey see Reid and others (2003), and of the Southern Ocean CPR survey see Hosie and others (2003).

Brian Hunt (bhunt@eos.ubc.ca), a graduate of Rhodes University, South Africa, and the University of Tasmania, Australia, is a research collaborator on the Southern Ocean CPR Survey. He is currently a post-doctoral fellow in the Department of Earth and Ocean Sciences at the University of British Columbia, conducting research into pelagic trophic ecology and biogeochemical cycling.

Southern Ocean Changes Due to Human Influence

John C. Fyfe and Oleg A. Saenko

We have recently shown that the higher than expected warming of intermediate level waters in the Southern Ocean in recent decades (Fig. 1) is reproduced in the latest series of global climate model simulations, which include time-varying changes in anthropogenic greenhouse gases, sulphate aerosols and volcanic aerosols in the Earth's atmosphere (Fyfe, 2006). The remarkable agreement between observations and state-of-the-art global climate models suggests significant human influence on Southern Ocean temperatures, which is suppressed to a large extent by the incidence of volcanic dust and industrial aerosols in the atmosphere. Global climate model simulations also show human-induced strengthening and poleward-shifting of surface wind stress (Fyfe, 2003; Fyfe and Saenko, 2006; Kushner and others, 2001) which appears to be consistent with the observed shifting of the Southern Annular Mode (SAM) toward a higher index state (Fyfe and others, 1999; Marshall, 2003; Thompson and others, 2000). In other recent work we have shown that changes in the zonal and meridional circulation of the ocean in the region are broadly consistent with the changes in zonal wind stress (Fyfe and Saenko, 2005, 2006; Saenko and others, 2005). In particular, we find strengthening and poleward shifting of the Antarctic Circumpolar Current (ACC), as well as increased southward geostrophic transport in the ocean below about 2000 m in the unblocked latitudes of Drake Passage. Predictions for the future indicate that the ACC will continue to strengthen and shift poleward. We have suggested that these future changes, if they occur, could have important consequences on the uptake of anthropogenic CO_2 and hence the ability of the world ocean to mitigate the impact of global warming (Fyfe and Saenko, 2006).

Our most recent work is directed towards understanding the role that strengthening and poleward shifting of subpolar westerly surface winds (*e.g.* in association with the shift of the SAM toward a higher index state) may have played in the higher than expected anthropogenic warming of the Southern Ocean since the 1950s (Fyfe and others, 2006). To this end a global climate model of intermediate complexity has been driven in combination, and separately, with time-varying (a) CO_2 emissions and (b) surface wind stress derived from the latest series of fully coupled global climate model simulations (Fyfe and Saenko, 2006). These

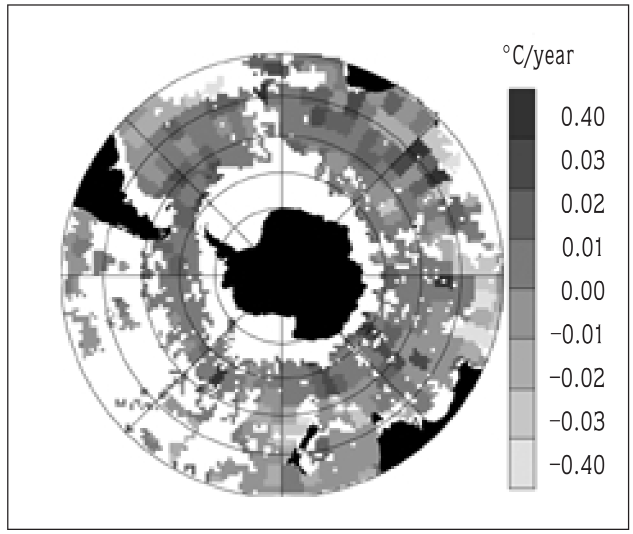

Figure 1
Mid-depth differences between temperature trends computed from autonomous lagrangian circulation explores (ALACE) and those obtained from shipboard measurements bin-averaged in 5° longitude by 5° latitude squares (following Gille, 2002). The ALACE/hydrographic pairs were used if the hydrographic measurements were collected after 1930, and were separated by at least 10 years in time and by less than 220 km in space. Latitude circles start at 30°S and are spaced at 10° intervals. Averaging from 35°S to 65°S yields a mean warming rate of 0.004 ± 0.001 °C/yr, which is nearly double the rate of change in the upper 1000 m of the World Ocean as a whole (Levitus and others, 2000). (For colour version see Fyfe, 2006.)

experiments suggest about equal contribution to the subsurface Southern Ocean warming structure from increasing CO_2 emissions and poleward intensifying westerlies. The experiments also confirm some recent high-resolution ocean model experiments suggesting that enhanced mesoscale eddy activity, associated with the strengthening subpolar westerlies could influence the structure of the Southern Ocean warming. In particular, we find that increased poleward heat transport across the ACC, associated with increased eddy activity, significantly enhances the Southern Ocean warming south of the ACC.

In collaboration with the University of Victoria Climate Modelling Group, we have been exploring the response of the global carbon cycle to human-induced changes in subpolar westerlies. It has been found that poleward intensified winds have an opposite effect on global oceanic carbon uptake between model experiments with zero and increasing CO_2 emissions. In the zero emissions case, changing winds lead to net outgassing of CO_2 through the 20th and 21st centuries, whereas under increasing CO_2 emissions they act to first inhibit during the 20th century and then enhance CO_2 uptake thereafter (Zickfeld and others, 2006).

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John Fyfe (john.fyfe@ec.gc.ca), a graduate of the Universities of Regina and McGill is interested in climate variability, predictability and change. Oleg Saenko (oleg.saenko@ec.gc.ca), a graduate of the Marine Hydrophysical Institute, Sevastopol, Ukraine, is interested in ocean circulation and climate. Both are Research Scientists at the Canadian Centre for Climate Modelling and Analysis in Victoria, British Columbia.

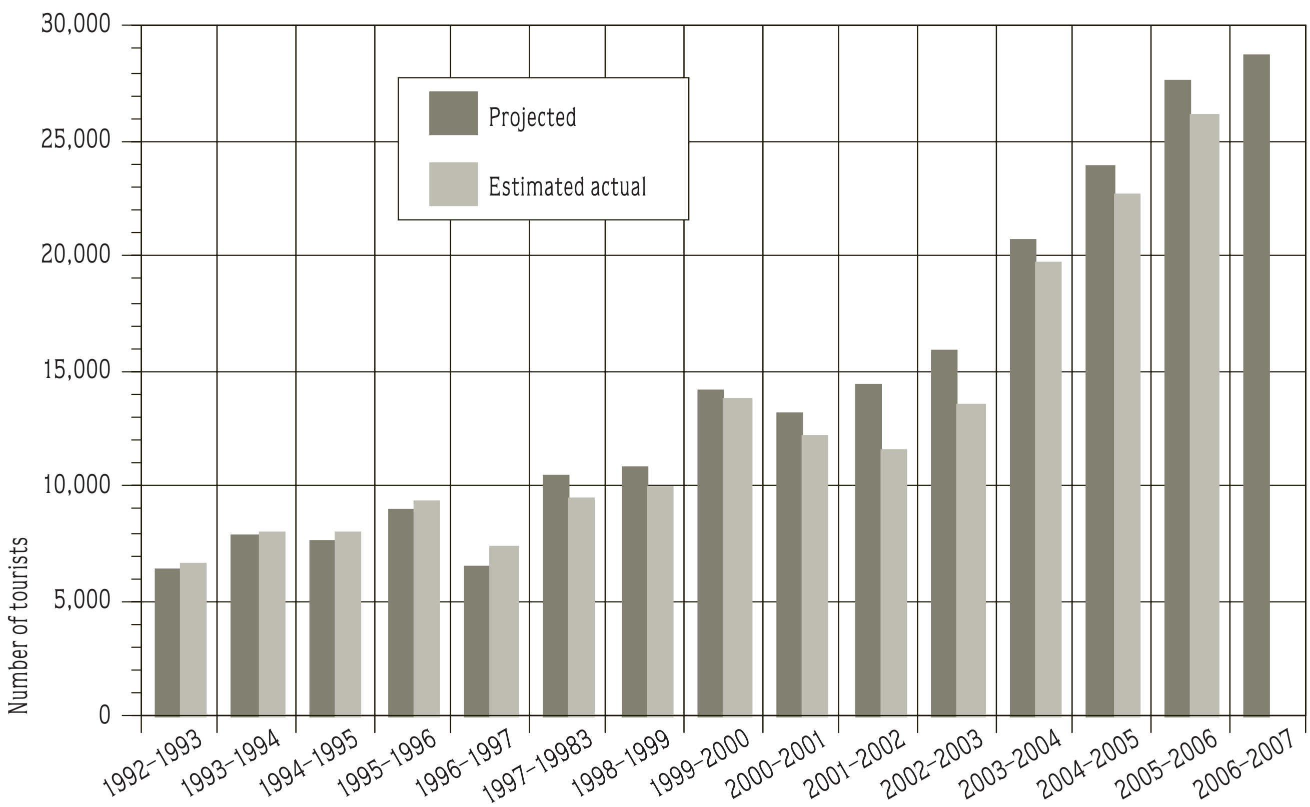
Antarctic Site Inventory

Louise K. Blight

In November and December 2006, I will be going to the Antarctic Peninsula aboard the tourist vessel *Endeavour* to participate in another season of efforts by the U.S.-based Antarctic Site Inventory (ASI). The ASI has been operating in the Peninsula region since November 1994, using expedition cruise ships to travel among sites and monitor local human impacts on penguins and other Antarctic wildlife. Since 2003, ASI has also maintained a seasonal research camp at Petermann Island.

Tourist numbers in Antarctica have risen dramatically over the past decade, tripling from 9,604 in 1997–98 to an estimated 28,826 in the coming 2006–07 season (Fig. 1). Most of those visitors will be concentrated at sites in the Peninsula region. The primary purpose of the ASI is to inventory and monitor penguins and other marine birds at tourist-visited sites from the South Orkney Islands to Marguerite Bay on the southwest Antarctic Peninsula. Baseline data are also collected on a range of biological and physical variables at each study site. Data and information collected by the ASI are made available internationally, and particularly assist Treaty nations in managing activities at visitor sites.

Louise K. Blight (lkblight@sfu.ca) is a seabird ecologist based in Victoria, B.C. This will be her second season working for the Antarctic Site Inventory since its inception. She also summered at Cape Royds in 2003–04 as a researcher with a National Science Foundation-funded Adélie penguin project. In January 2007, Louise starts her Ph.D. in marine conservation biology at the University of British Columbia.



Antarctic Pelagic Tunicates: Life-Cycles and Ecological Significance (SO-GLOBEC)

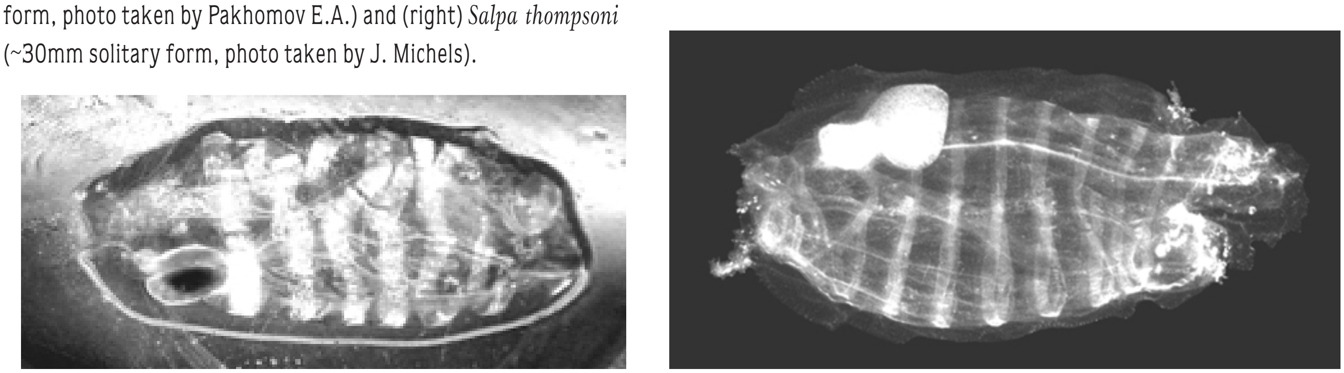
Evgeny A. Pakhomov

During the last decade, there has been an increasing interest in pelagic tunicates in the Southern Ocean, particularly *Salpa thompsoni* (Pakhomov and others, 2002). Salps are considered to be the most important large filter-feeders south of the Subtropical Convergence in terms of wet mass, and ranking the third among metazoans, including copepods and Antarctic krill, *Euphausia superba,* in terms of carbon mass (Voronina, 1998). Due to their capability for rapid asexual reproduction (budding), salps are able to form dense swarms, dominating zooplankton in various regions of the Southern Ocean and altering the high Antarctic pelagic food-web economy (Pakhomov and others, 2002; Walsh and others, 2001). A fine-meshed feeding net of salps enables micro-sized particles to be filtered out of the water column and incorporated partly into metazoan biomass, but mainly into very fast sinking fecal pellets; thus channelling biogenic carbon out of the surface waters into long-living pools or into the deep sea (Le Fèvre and others, 1998).

S. thompsoni was once regarded as an organism found in low Antarctic (45–55°S) waters with only limited records in the coastal seas surrounding the Antarctic continent (Foxton, 1966). However, salp distribution has changed over the last half century by shifting southwards (Atkinson and others, 2004; Pakhomov and others, 2002). As *S. thompsoni* is a cold-temperate species, this indicates that a large-scale environmental shift in Antarctic regions may have occurred or is in progress (De la Mare, 1997). Since continuing warming of the ocean-current systems south of 45°S is likely (Levitus and others, 2000), we cannot exclude the possible establishment of continuous salp populations further south, *e.g.* in the coastal Antarctic seas. Should *S. thompsoni* survive and propagate permanently in these areas, they would have a dramatic impact on ecosystem structure and biogeochemistry. It has been hypothesized that the southward expansion of *S. thompsoni* may be coupled with a dramatic fall in the stock and productivity of Antarctic krill (important commercial fishery species) due to a decrease in the spatial extension of its biotope (Pakhomov and others, 2002).

Since 2001, jointly with Dr C. Dubischar and Prof. U. Bathmann of the Alfred Wegener Institute for Polar and Marine Research, Bremerhaven, I have been involved in the salp component of the Southern Ocean Global Ocean Ecosystems Dynamics (SO-GLOBEC) program. During the past three years, our efforts were concentrated in the Lazarev Sea, under the umbrella of the multi-year German "Lazarev

Figure 1
Antarctic pelagic tunicates: (left) *Ihlea racovitzai* (~ 40 mm solitary form, photo taken by Pakhomov E.A.) and (right) *Salpa thompsoni* (~30mm solitary form, photo taken by J. Michels).



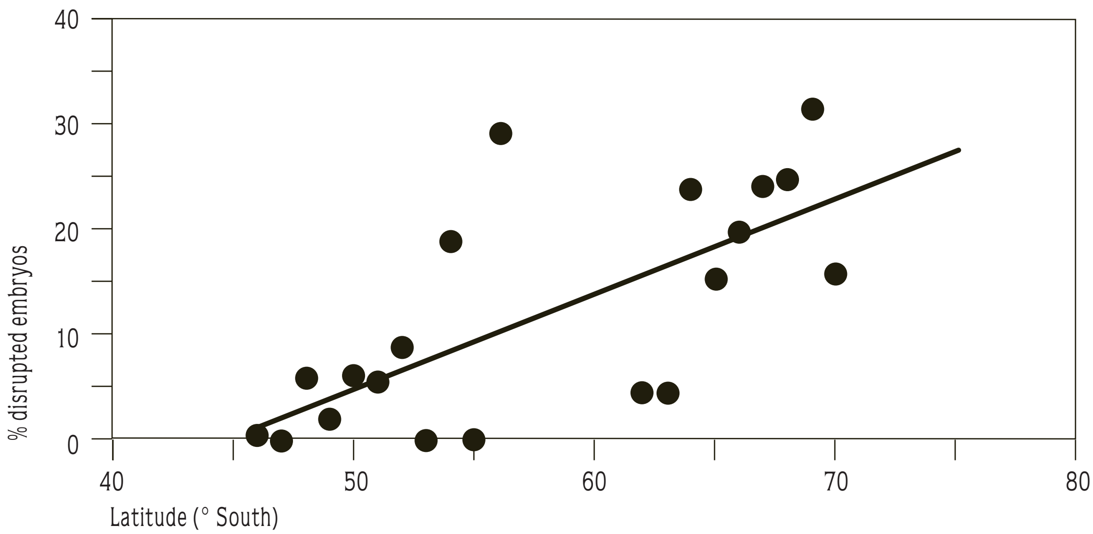


Figure 2

Sea Krill Study" (LAKRIS) SO-GLOBEC investigation. Despite the direction of the LAKRIS towards understanding life-history strategies of Antarctic krill, our group focused on two other important metazoans: the pelagic tunicates *S. thompsoni* and *Ihlea racovitzai* (Fig. 1). Three cruises, fall 2004, summer 2005–06 and winter 2006, have been conducted onboard the RV *Polarstern;* in an area of the Southern Ocean about 800 km wide, stretching from the coast of Dronning Maud Land almost to the Southern Boundary of the Antarctic Circumpolar Current. Atkinson and others (2004) have reported on the spatial distribution of *Salpa thompsoni* in this LAKRIS investigation area and other regions of the Southern Ocean.

It has previously been postulated that under unfavourable conditions *S. thompsoni* could be advected into the Antarctic continental seas and trapped (Pakhomov and others, 2002). It has been observed that these salp populations are composed of small-sized aggregates and to a great extent (up to 100%) may be comprised of individuals with somewhat retarded development. The analysis of a large dataset, collected during eight cruises, indicated that ~ 30% of aggregates at the southernmost locations on average had no embryos (Fig. 2), *e.g.* could not complete their life cycle in these areas. This suggests that, in the coastal Antarctic seas, we may be dealing with 'ghost' populations of *S. thompsoni;* advected into the area by currents, but unable to survive through the winter. The mechanisms of advection and actual survivorship of salps are still under investigation.

Seasonal sampling in the Lazarev Sea has provided a unique opportunity to observe the behaviour of two salp populations year around. Preliminary findings indicate that populations of both salp species were not numerous in the Lazarev Sea during 2004–06, compared to more northern areas. There was a strong interannual variability in the salp species composition and density in the Lazarev Sea. *S. thompsoni* accounted for most of the salp community and had the highest abundances during the fall of 2004, while *I. racovitzai* predominated during the 2006 winter. Most of the *S. thompsoni* found were concentrated in the northern part of the survey and around Maud Rise (Fig. 3). However, during the fall of 2004, high *S. thompsoni* densities were also observed in the southwest part of the survey. The origin of this enhanced salp patch is still unclear. Unlike previous species, *I. racovitzai* was relatively uniformly distributed

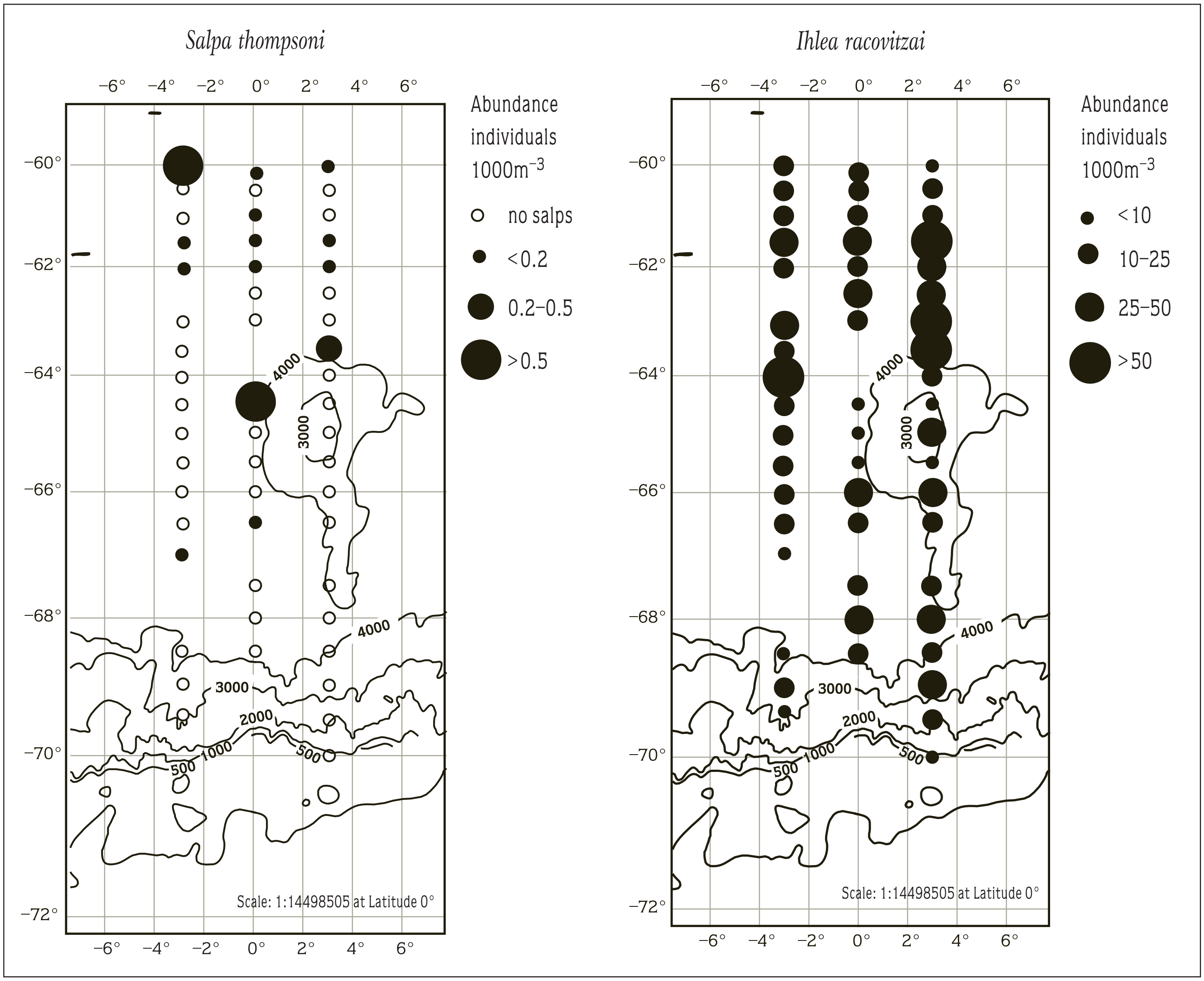


Figure 3

across the Lazarev Sea with slightly elevated densities in the middle part of the area investigated (Fig. 3).

The seasonal cycle in salp populations appeared to be similar between years despite substantial differences in their densities. *S. thompsoni* was represented mainly by aggregate forms (sexual reproducers) during the summer and fall, while only solitary forms (asexual reproducers) were found during the winter. *I. racovitzai*, composed mainly of large specimens (> 40 mm long) year around, produced numerous cohorts of small solitaries (~ 12–15 mm long) just prior to the winter survey. Whether this is normal behaviour for the *I. racovitzai* population is difficult to conclude, due to the absence of prior data on this species, and requires further investigation.

At the moment, salp specimens of *S. thompsoni* and *I. racovitzai* collected in the Lazarev Sea are undergoing various analyses to better understand their elemental and biochemical composition, demography, life-cycle dynamics, feeding ecology and stable-isotope signatures, to determine their ability to survive close to their physiological limits (mainly cold waters) in the high Antarctic seas. However, it is becoming increasingly clear that: (a) the water temperature is the most important environmental parameter affecting salp, particularly *S. thompsoni;* and (b) local hydrology is of critical importance in explaining salp distribution patterns in the high Antarctic.

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Students On Ice – Advancing Polar Education

Chris Ralph

In June 2006, Canada submitted an Information Paper to the XXIX Antarctic Treaty Consultative Meeting (ATCM) on the successful Students on Ice expeditions (SOI). This award-winning educational organization, based in Chelsea, Quebec, has undertaken six expeditions to the Antarctic Peninsula area, and five expeditions to the Arctic regions in successive summer seasons, with approximately 150 students each year since its inception seven years ago.

The philosophy behind the program is to inspire and educate high-school and university students who will soon embark on their adult careers. These future decision-makers are those who will be directly affected by climate change, the consequences of management of natural resources and international politics, and are in a unique and favourable position to benefit from the experiences and perspectives that Antarctica and the polar regions can offer.

The upcoming SOI expeditions to the Antarctic and the Arctic, in 2007–09, have been endorsed by the International Council of Science/World Meteorological Organization (WMO) International Polar Year (IPY) Joint Committee as a prominent and valuable part of the IPY programme. SOI is striving to have youth from around the world, including all Antarctic Treaty nations, participate in these educational expeditions, to raise internationally awareness about IPY, and inspire a next generation of polar researchers and decision-makers: part of a lasting legacy from the IPY.

With the IPY fast approaching, and the world focused on the many extraordinary changes happening in the polar regions, SOI has several IPY youth-related activities planned. The SOI–IPY expeditions will launch in August 2007 to the Arctic and in December 2007 to the Antarctic. These Arctic and Antarctic expeditions will be the largest initiative of their kind in the world taking youth to both the Poles during the IPY years. The educational expeditions are intended to provide exciting and life-changing experiences to over 500 international youth as they explore the polar regions. High-school and university students will journey together with teams of international scientists, polar and environmental experts, educators and journalists on ice-strengthened vessels with about 100 participants per expedition.

As with past SOI expeditions, students will participate in lectures, workshops, and hands-on research. They will focus on subjects such as marine biology, geology, glaciology, earth sciences, environmental issues, deep ecology, politics, polar history, culture, flora and fauna, oceanography, sustainable development, art, traditional knowledge, and

applied technology. A key focus of all the SOI expeditions will be climate change impacts in the polar regions, and the local, national and global solutions needed to reduce our environmental footprints and live a more sustainable lifestyle.

While the expeditions are underway, participants will communicate their experiences through a special expedition website, pod-casting, video-conferencing and other media outreach, which will share the expeditions with audiences of all ages around the world.

SOI is also involved in other IPY initiatives. Communication and outreach activities are an integral part of the IPY mission, and SOI hopes to reach a wide audience by working with many notable and exceptional Canadian and international organizations. These groups include the Canadian Space Agency; Canadian Museum of Nature; EO Wilson Biodiversity Foundation; Royal Canadian Geographical Society (RCGS); IPY International and Canadian Youth Steering Committees; the Stephen R. Bronfman Foundation; First Air; The Explorer's Club, Inuit Tapiriit Kanatami, and more.

One exciting project is the national "Polar Bound" contest with the RCGS. High-school students from across Canada can enter by submitting essays, short films, and artwork that focus on the six IPY themes. The best submissions will be awarded full scholarships to participate in one of the SOI–IPY expeditions to the Arctic or Antarctic. Two contests will be held every year during the IPY.

Together with partners, another IPY goal for SOI is to develop polar curriculum, resources, and accredited high-school courses with a polar focus. Initial plans are to make these available for use in high-school classrooms across Canada during the IPY.

SOI is proud to be partnering with the IPY Canadian and International Youth Steering Committees on several initiatives including the "International Youth Conference on the Poles." This event, supported by the European Polar Consortium, is scheduled for April 2008, and will bring together youth from around the world to discuss the polar regions through roundtables, a research conference, and a polar fair.

SOI is also working closely with the Canadian Space Agency on a program where the CSA will offer five $5000 scholarships each year during IPY for Canadian high-school youth to participate in the SOI–IPY expeditions. Interested youth will need to go through an application and selection process, and demonstrate their interest in, knowledge of, and passion for space technology. The CSA and SOI will work together to integrate a space-related curriculum component into the SOI expedition education program. This will be facilitated by CSA scientists and possibly astronauts participating on the expeditions as members of the education team!

By offering these unique, hands-on educational expeditions to the polar regions, and by embracing the use of emerging technologies, such as pod-casting and video-conferencing, SOI is striving to inspire and excite the next generation of polar scientists, researchers, environmental leaders, and leave an IPY legacy that lasts well beyond 2009.

If you are interested in learning more about the Students on Ice–IPY program, please visit their website at www.studentsonice.com/ipy or call 1-866-336-6423.

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The Argo Armada – Again

Howard Freeland

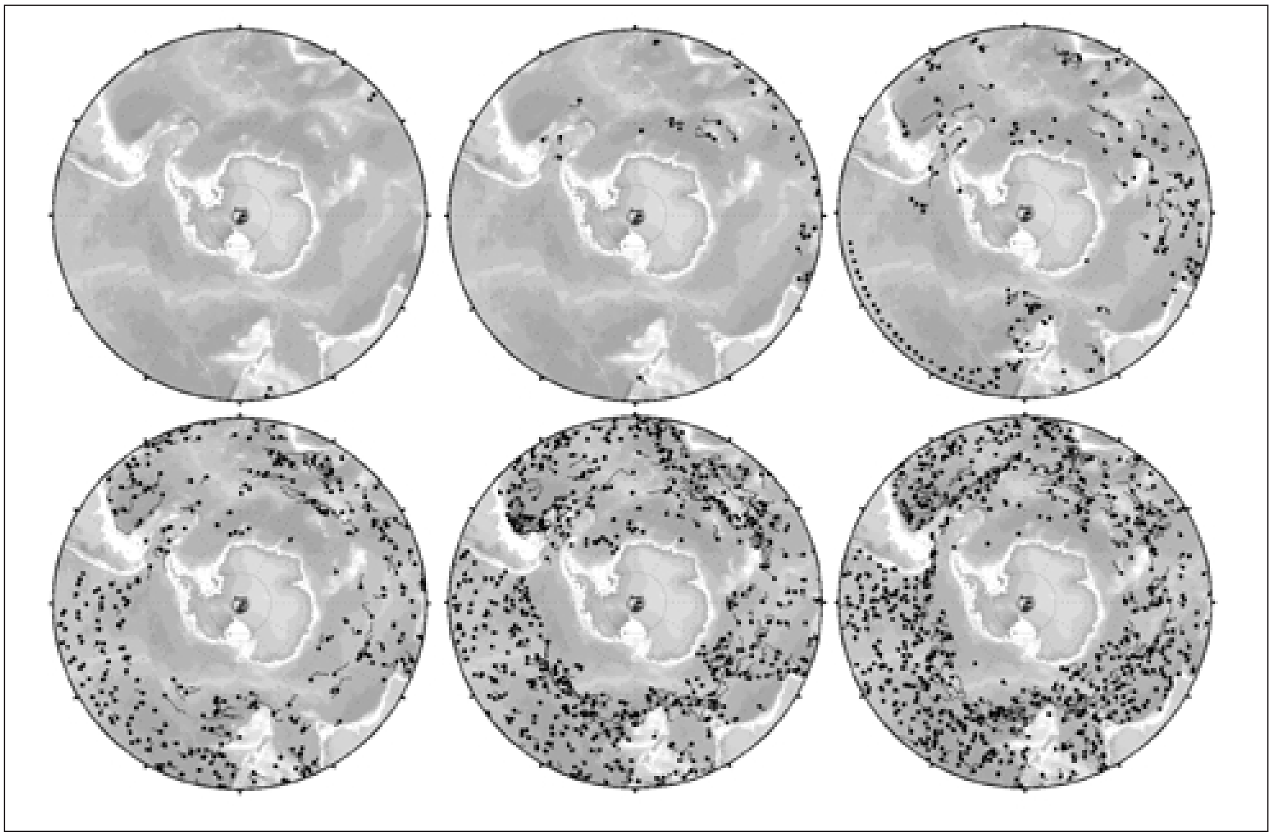

Figure 1
The evolution of the Argo array around Antarctica from 2001 to 2006.

In 2002, Canada launched six Argo floats to investigate deep convection off the coast of Chile as part of a study of the formation of Antarctic Intermediate Water. I wrote a review for the *CARN Newsletter* explaining the objectives and making predictions as to how the Antarctic part of the Argo array would evolve. The purpose of this article is to present you with an update.

First, a brief reminder of the purpose and nature of the Argo armada of profiling floats. An Argo float is a small robotic device that is launched at the sea surface. After a few hours the device adjusts its buoyancy and sinks to a target drift depth of typically 1000 m. After ten days the float adjusts its buoyancy again and dives to the profiling depth, usually 2000 m, then ascends to the sea surface observing a profile of ocean properties. The resulting profile is transmitted to land via a satellite in the Argos constellation. When data transmissions are complete, the float returns to its parking or drift depth. Each float should have energy sufficient for more than 150 cycles and so have a lifetime of four to five years.

There are now 2560 floats in the global ocean reporting profiles. These are fairly evenly distributed over the world oceans offering a uniform glimpse of the climatic state of each of the world's oceans every ten days. This "even coverage" unfortunately does not apply to the Arctic

Ocean. The floats do need to penetrate to the free surface so that their antennas can transmit data to a satellite. Some options for creating systems that will operate in the Arctic are being developed but these are not yet operational.

Figure 1 shows a series of plots of the locations of Argo floats around Antarctica, one map each for each October 1 from 2001 to 2006. Each float location is identified by a dot with a trail behind it of the trajectory over the previous 80 days.

The target originally advertised for Argo was to deploy floats globally with a mean nearest-neighbour distance of about 300 km; to achieve that globally with even coverage over all oceans would require about 3000 floats. At the present time we have 26 nations deploying floats and at the time of writing 2576 floats operating. The target of an even density is a little harder to achieve.

A map of float density on October 9, 2006, *i.e.* the number of floats per unit area normalized by the target number of floats, can be seen at www.pac.dfo-mpo.gc.ca/sci/osap/projects/argo/images/EarthDensity.gif. The objective is to get the map homogenously red, meaning a density of 1.0 over all of the oceans. In general we are approaching the target global density, but some parts of the oceans are easier to instrument than other areas, thus we greatly exceed the target array in the NE Atlantic, the Kuroshio extension region and in the Sea of Japan. There clearly is a distinct absence of instruments in the deep Southern Ocean, because the floats do not fare well under ice. We also see some very significant gaps in the Indian Ocean sector of the Southern Ocean. This deficit is now being addressed.

All 26 nations deploying floats have agreed to a single data policy, meaning that when any float completes a CTD (conductivity, temperature, depth) profile the data can generally be downloaded from one of the Global Argo Data Centres within 24 hours. Several years ago it was estimated that when Argo reached its target density there would be more ocean-climate data gathered by Argo each year from the Southern Ocean than has been obtained by the sum of all previous research missions there. Argo promises then to create a new golden age of ocean research.

The data are uniformly available for anyone to download in near real-time and are freely available to any user without constraint. At the Institute of Ocean Sciences we have a created a utility that allows a user to maintain a permanent mirror of the global Argo archives. The data are yours, please use them and please feel free to contact me if you need advice on the acquisition or use of Argo data.

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News in Brief

Julia Foght, University of Alberta, is co-chairing the 3rd International Polar and Alpine Microbiology Conference, to be held in Banff in May 2008.■

Further to **Olav Loken**'s recent report, readers may be interested in Dian Olson Belanger's new book: *Deep Freeze: the United States, the International Geophysical Year,* and the origins of Antarctica's age of science. Boulder, CO, University Press of Colorado, 544 pp. (ISBN: 0-87081-830-9, Cloth US $29.95).■

Michael Warr, a retired teacher living in British Columbia, who spent two years in the Antarctic with the British Antarctic Survey at Deception and Adelaide Islands, has written of his experiences in: South of Sixty: life on an Antarctic base. Prince George, B.C., Antarctic Memories Publishing (ISBN: 978-0-9738504-0-6, Soft cover, Cdn $26.45). (www.antarcticmemoriespublishing.com)■

Kevin Hall, University of Northern British Columbia, has been appointed to the Editorial Board of *Antarctic Science.*■

Professor Chris Rapley, C.B.E., Director of the British Antarctic Survey and recently elected President of SCAR, paid a fleeting visit to Canada in mid-October, lecturing on global change issues and meeting with scientists and government officials in Ottawa, Toronto and Calgary to promote Antarctic issues and the IPY.■

Following the unfortunate loss of the CryoSat Earth Explorer mission in October, 2005, the European Space Agency Earth Observation Programme Board has approved a proposal for CryoSat-2 to be launched in 2009.■

The University of Canterbury, Christchurch, New Zealand, offers a Graduate Certificate in Antarctic Studies. A 14 week intensive course covers the history, science, political discourse, environmental concerns and future challenges of Antarctica and the Southern Ocean. Details at www.anta.canterbury.ac.nz/courses/ gcas/application.shtml.■

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