

SCOR Meeting on Coordination of International Marine Research Projects

GLOBEC Background information

Data Management Discussion

The SCOR/IGBP Data Management meeting was mentioned at the last GLOBEC SSC meeting but not discussed in detail due to time constraints.

The GLOBEC IPO continues to maintain a metadata catalogue using the DIF format held in the Global Change Master Directory. GLOBEC uses a decentralised data management system where individual projects are responsible for quality control and archiving of their data. At present there are no plans to change this.

GOOS

Active links between GLOBEC and GOOS exist through overlapping membership of committees. The past GLOBEC chair (Roger Harris) was a regular observer at GOOS Coastal Ocean Observations Panel (COOP) meetings to help ensure that COOP plans met GLOBEC's requirements. Dr Coleen Moloney who is a member of the GLOBEC Focus 3 Working Group and Dr Mike Fogarty, the past president of US GLOBEC are also members of the GOOS COOP panel.

Members of the GLOBEC Focus 1 Working Group, Dr Andy Bakun and Dr Takashige Sugimoto were members of the GOOS Living Marine Resources (LMR). Tom Malone, the chair of the COOP implementation panel, has attended meetings of the GLOBEC Focus 3 Working Group to discuss GOOS activities in relation to GLOBEC.

Members of the GLOBEC SSC who are involved in GOOS activities report to the SSC on progress, however, there have been no formal presentations from GOOS members to the GLOBEC SSC.

Other GOOS related activities include: the Continuous Plankton Recorder survey (CPR), operated by the Sir Alister Hardy Foundation for Ocean Science (SAHFOS), which is a contribution towards UK GLOBEC and has also been incorporated into the initial Observing System of GOOS; and the GLOBEC/PICES Climate Change and Carrying Capacity programme intend to conduct a one day workshop on 'North Pacific GOOS: Needs and Activities'.

On-going communication between GLOBEC and GOOS is important to help ensure that information collected by the observations system is useful to researchers, especially in the context of long ecological time series. Also, the modelling studies that are being carried out under the auspices of GLOBEC should enhance the ability to use the observations system to understand (and predict) changes in ecosystems. It was felt by the GLOBEC SSC that monitoring of biological parameters under GOOS are not well defined and that continuous involvement with GLOBEC would be useful in defining those parameters.

Southern Ocean Research

Southern Ocean GLOBEC is an international programme designed to study the year round life cycle of Antarctic zooplankton. The primary objective is to understand the physical and biological factors that contribute to enhanced Antarctic krill growth, reproduction, recruitment and survivorship throughout the year. The focus also includes the predators and competitors of Antarctic krill, such as seal, penguins, whales, fish, seabirds and other zooplankton.

Southern Ocean GLOBEC programmes operate from the UK, Germany, Korea, Australia, the USA and the International Whaling Commission. Field studies have consisted of around 20 multi-national cruises to different parts of the Antarctic to provide an approach for regional comparisons.

Southern Ocean GLOBEC includes studies of:

- Regional differences in over-wintering strategies of Antarctic krill in relation to the physical environment;
- Population dynamics of selected zooplankton species, both sea-ice related and pelagic species;
- Population dynamics of major krill predators, both ice-based and pelagic species;
- Hydrographic, circulation and sea ice distributions; and
- Modelling of circulation, sea ice, and biological processes.

Further information on the GLOBEC Southern Ocean programme can be found from <http://www.pml.ac.uk/globec/structure/regional/so/so.htm> and http://www.ccpo.odu.edu/Research/globec_menu.html

Also see the attached extract from the Report on the GLOBEC National, Multinational and Regional Programme Activities, 2004 on Southern Ocean GLOBEC.

International Polar Year

A new initiative ICCED (Integrated analyses of Circumpolar Climate interactions and Ecosystem Dynamics in the Southern Ocean) is being developed as a joint venture between GLOBEC and IMBER as part of the International Polar Year initiative and is due to start in 2007. ICCED aims to bring together climatologists, oceanographers, biogeochemists and ecosystem scientists to generate unique circumpolar datasets and models and to address two globally important questions:

- How do climate processes affect the dynamics of circumpolar ocean ecosystems?
- How does ecosystem structure affect circumpolar ocean biogeochemical cycles?

Time-Series Stations

There are several time-series stations used for GLOBEC research, including L4 in the English Channel, SAHFOS Continuous Plankton Recorder lines and grids and US GLOBEC Georges Bank. Each of these stations are funded by the individual projects.

Environmental Assessments

Expert advice has been provided for the Millennium Ecosystem Assessment.

Appendix 1. Southern Ocean GLOBEC Section from the GLOBEC Activities Report, 2004

PROGRAMME: SOUTHERN OCEAN GLOBEC

Co-ordinator:

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Project Description:

Although the Antarctic food web is diverse, it is characterized by short trophic linkages that are dominated by fewer than four to six species. These short trophic connections arise because the basic prey types available to predators are limited, with Antarctic krill (*Euphausia superba*) serving as the primary prey. As a result, predators concentrate on a single prey, such as Antarctic krill, or on a core group of species, such as other euphausiids and some fish. Thus, environmental or biological perturbations can potentially affect all components of the Antarctic marine ecosystem irrespective of their initial impact. The knowledge base on which predictions about potential trophic changes that might be expected from climate and population variations is very limited. In particular, little is known about how marine animal populations adapt to austral winter, which is a critical part of many life cycles.

It is the strong linkage to climate and close coupling between trophic levels that resulted in the choice of the Southern Ocean as one of the first study sites for the Global Ocean Ecosystem Dynamics (GLOBEC) program, which has the goal of understanding marine population variability in response to environmental change. The primary objective of the Southern Ocean GLOBEC (SO GLOBEC) program is to understand the physical and biological factors that contribute to enhanced Antarctic krill growth, reproduction, recruitment, and survivorship throughout the year. This objective also includes the predators and competitors of Antarctic krill, such as penguins, seals, cetaceans, fish and other zooplankton. The emphasis by SO GLOBEC on habitat and top predators, as well as Antarctic krill, is a first in international interdisciplinary Antarctic science and reflects the lessons learned from prior multidisciplinary Antarctic research programs, such as the Biological Investigations of Marine Antarctic Systems and Stocks (BIOMASS), the Antarctic Marine Ecosystem Research at the Ice-Edge Zone (AMERIEZ), and the Research on Antarctic Coastal Ecosystem Rates (RACER).

The science questions developed for SO GLOBEC, as a result of four international workshops (U.S. GLOBEC Report No. 5; International GLOBEC Report Nos. 5, 7, 7A), reflect the broadening in scope to take a holistic view of the Antarctic marine ecosystem. As a result, the SO GLOBEC science programs include studies of the habitat, prey, predators and competitors of Antarctic krill, as well as studies specifically focused on Antarctic krill biology and physiology. Moreover, the year-round focus, with an emphasis on winter processes by the U.S. and German SO GLOBEC programs, provides a new and different direction in international Antarctic research.

Southern Ocean GLOBEC includes studies of:

- Regional differences in over-wintering strategies of Antarctic krill in relation to the physical environment;
- Population dynamics of selected zooplankton species, both sea-ice related and pelagic species;
- Population dynamics of major krill predators, both ice-based and pelagic species;
- Hydrographic, circulation and sea ice distributions; and
- Modelling of circulation, sea ice, and biological processes.

Several multidisciplinary field projects have been undertaken as part of SO GLOBEC and others are planned (see listing below). The completed field studies were focused around Marguerite Bay along the western Antarctic Peninsula and at 70°E. The field studies included survey and process-oriented cruises, deployment of surface drifters and moored current meter arrays, deployment of passive

acoustic moored arrays for cetacean sampling, surveys of the distribution and abundance of penguins, seabirds, seals and cetaceans (via collaboration with the International Whaling Commission), deployment of satellite transmitters on seals and penguins, and numerous approaches and methods for studying Antarctic krill physiology and ecology.

Programme Objectives:

The primary science questions that are the focus for Southern Ocean GLOBEC are:

- What key factors affect the successful reproduction of krill between seasons?
- What key physical processes influence krill larval survival and subsequent recruitment to the adult population between seasons?
- What are krill's seasonal food requirements in respect to energetic needs and distribution and type of food?
- What are the geographical variations in krill distribution in relation to the between- and within-season variability in the physical environment?
- How does the winter distribution and foraging ecology of krill-dependent predators relate to the characteristics of the physical environment and the distribution of their prey?
- How does summer breeding season foraging ecology relate to the abundance and distribution of the available krill population?
- How does year-to-year variability in predator population size and breeding success relate to sea ice extent and its possible effects on krill recruitment, availability and distribution?

Achievements and Results:

GLOBEC Report 5: Towards the Development of an International GLOBEC Southern Ocean Programme. Report of the 1st ICES/GLOBEC Working Group, Norfolk, Virginia, USA. June 15-17 1993.

GLOBEC Report 7: International GLOBEC Southern Ocean Programme Implementation Plan. Report of the 2nd Meeting of an International GLOBEC Working Group. Bremerhaven, Germany, June 6-8 1994.

GLOBEC Report 7a: Report of the Meeting of the Southern Ocean Planning Group. San Diego, California, USA, August 1-3 1997.

Second Meeting of Southern Ocean GLOBEC Planning Group. Paris, France, March 17 1998.

Report of US Southern Ocean GLOBEC Planning Workshop. National Science Foundation, Arlington, VA. 30 September – 1 October 1998.

Third Southern Ocean GLOBEC Planning Group Meeting. British Antarctic Survey, UK. August 2-7 1999.

The first special volume of *Deep-Sea Research II* that is devoted to the results of the Southern Ocean GLOBEC program is scheduled for publication in late 2004. The titles, author listing, and abstracts for the papers that are included in the volume are available at: http://www.ccpo.odu.edu/Research/GLOBEC_menu.html.

SO GLOBEC Field Activities:

2001	Jan-Feb	Australian Fine Scale Krill Survey - 70°E
	March-April	U.S. SO GLOBEC mooring deployment cruise – west Antarctic Peninsula
	April-May	German SO GLOBEC cruise to west Antarctic Peninsula
	April-June	U.S. SO GLOBEC survey and process cruises to west Antarctic Peninsula
	July-Sept	U.S. SO GLOBEC survey and process cruises to west Antarctic Peninsula
2002	February	U.S. SO GLOBEC mooring recovery/deployment cruise to west Antarctic Peninsula
	April-May	U.S. SO GLOBEC survey and process cruises to west Antarctic Peninsula
	July-Sept	U.S. SO GLOBEC survey and process cruises to west Antarctic Peninsula
2003	Feb-March	U.S. SO GLOBEC mooring recovery cruise – west Antarctic Peninsula
2004	April-May	German SO GLOBEC cruise to Lazarev Sea
2005	August-Sep	German SO GLOBEC cruise to Lazarev Sea
2006/7	Jan-Feb	German SO GLOBEC cruise to Lazarev Sea (tentative)

Website:

http://www.ccpo.odu.edu/Research/GLOBEC_menu.html

PROGRAMME: SO GLOBEC - USA

Source of Information:

Eileen Hofmann and NSF Awards Abstracts Database, April 2004

Contact:

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Project Title:

US Southern Ocean GLOBEC

Project Description:

The focus of the U.S. Southern Ocean GLOBEC program is on the biology and physics of a region of the continental shelf to the west of the Antarctic Peninsula extending from the northern tip of Adelaide Island to the southern portion of Alexander Island and including Marguerite Bay. The primary goals of the program are:

- To elucidate shelf circulation processes and their effect on sea ice formation and Antarctic krill (*Euphausia superba*) distribution; and
- To examine the factors that govern Antarctic krill survivorship and availability to higher trophic levels, including seals, penguins and whales.

The U.S. Southern Ocean GLOBEC field studies consist of mooring deployment/recovery cruises, process-oriented cruises and survey cruises. During the first mooring cruise, which took place on the ARSV *Laurence M. Gould*, a current meter array was placed along a line extending off Adelaide Island and along a line across the opening of Marguerite Bay. This mooring array remained in place for one year. A second cruise in early 2002 retrieved the first array and redeployed a second current meter array that consisted of three moorings aligned across the opening to Marguerite Bay. These mooring were retrieved in March 2003. The current meter arrays deployed as part of the U.S. SO GLOBEC program provide the first long-term measurements of the current structure on the WAP continental shelf.

Other activities on the mooring cruises consisted of deploying arrays of passive acoustic moorings to obtain information on cetacean distribution and deploying surface velocity drifters. The IWC observers aboard the RV *L.M. Gould* also completed cetacean surveys that established a baseline for cetacean abundance along the Antarctic Peninsula at the start of the austral fall. The cetacean surveys provide observations from regions and seasons that have not been previously sampled and, as such, are important information for the IWC, which has responsibility for management of cetacean resources in this region of the Southern Ocean. Details of the mooring cruises and some preliminary results are given in U.S. SO GLOBEC Report Numbers 1, 4 and 9 (see report listing below).

The U.S. Southern Ocean GLOBEC field program consisted of joint survey and process cruises on board the RVIB *Nathaniel B. Palmer* and ARSV *Laurence M. Gould*, respectively. The region covered by the U.S. cruises overlaps with the region covered by the German SO GLOBEC cruise. The U.S. Southern Ocean GLOBEC cruises provided information from mid to late austral fall and during the austral winter for two years. The German program sampled during late summer to early fall. Thus, the sequence of cruises in the WAP region will provide essentially good coverage for the austral fall, the set-up for austral winter, and the austral winter.

Studies on the RVIB *Nathaniel B. Palmer* survey cruises are based upon data collected from conductivity-temperature-depth (CTD) casts, an Acoustic Doppler Current Profiler (ADCP), a Multiple Opening/Closing Net and Environmental Sampling Sensing System (MOCNESS) with nine 1m² nets, and a Bio-Optical Multifrequency Acoustical and Physical Environmental Recorder (BIOMAPER-II). These data sets provide repeated realizations of hydrographic structure, upper

water column currents, nutrients, phytoplankton, micro-zooplankton and mesozooplankton, and Antarctic krill distributions. Seabird and cetacean surveys were done during the relatively short daylight periods and buoys are deployed for listening to cetacean sounds. Other activities consisted of Remotely-Operated Vehicle (ROV) operations and deployment of surface drifters. The first survey cruise also deployed two Automatic Weather Stations on the Kirkland Islands and the Faure Islands inside of Marguerite Bay. These stations are now providing the first continuous meteorological observations from this region of the Antarctic (data available at <http://amrc.ssec.wisc.edu>). Detailed accounts of the 2001 survey cruises and some preliminary results are given in U.S. SO GLOBEC Report Numbers 2 and 3. Results for the 2002 survey cruises are given in U.S. SO GLOBEC Report Numbers 6 and 8.

The process cruises are based on focused studies of several days duration at specific sites in and around the Marguerite Bay region. The objectives of the process studies were to understand the factors that govern Antarctic krill survivorship, overwintering strategies, and availability to higher trophic levels. Studies on the process cruises consisted of ship-based laboratory experiments of zooplankton and Antarctic krill physiology; under-ice diving to characterize the sea ice habitat, sea ice biota, and to collect animals for experiments; and focused 1m² and 10m² MOCNESS net tows to characterize community assemblages in the water column. In addition ADCP and hydroacoustic measurements were made to complement observations on the survey vessel. Detailed accounts of the 2001 and 2002 process cruises and some preliminary results are given in U.S. SO GLOBEC Reports Numbers 1, 3, 5 and 7.

As part of the process cruise activities Adélie penguins and crabeater seals (*Lobodon carcinophagus*) were instrumented with satellite transmitters. Additional satellite transmitters were placed on Adélie penguins in the colonies near Palmer Station on Anvers Island (64°46'S, 64°04'W) in the early austral fall preceding the cruises. The animal tagging provides insight to where predators go during austral winter, which is still largely unknown. Also, the combination of the tagging studies with the *in situ* and survey data provides a unique opportunity to better understand the foraging strategies used by marine predators in the face of meso- and fine-scale ecological variability.

The sites at which Adélie penguins and seals were tagged during the 2001 and 2002 U.S. SO GLOBEC process cruises ranged from Adelaide Island to the northern part of Alexander Island. As a result, a range of habitats are included in the animal tagging studies. The returned trajectories show that like crabeater seals penguins are moving over large areas and are suggestive that the animals are concentrating in areas that are characterized by fronts where availability of Antarctic krill may be greatest. Therefore, the information on penguin and seal movement will contribute to understanding how these animals select their foraging locations and prey, and how alterations in environmental conditions and Antarctic krill abundance may impact top predator populations. Further details of the crabeater seal tagging program and updates on the seal trajectories can be found at: <http://cwoolf.uaa.alaska.edu/~afjmb4/GLOBEC/Crab.htm>.

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System Types Studied:

Marguerite Bay, Western Antarctic Peninsula, Southern Ocean

Target Organisms:

Euphausia superba (Antarctic krill)

Physical Processes Examined:

Shelf circulation processes

Annual formation and destruction of sea ice

Key Questions, Hypotheses and Issues:

The specific objectives of the U.S. Southern Ocean GLOBEC survey cruises were:

- To conduct a broad-scale survey of the SO GLOBEC study site to determine the abundance and distribution of the target species, *Euphausia superba* and its associated flora and fauna;
- To conduct a hydrographic survey of the region;
- To collect chlorophyll data, nutrient data, and to make primary production measurements to characterize the primary production of the region;
- To collect zooplankton samples with nets at selected locations throughout the broad-scale sampling area;
- To survey the sea birds throughout the broad-scale sampling area and determine their feeding patterns;
- To survey the marine mammals throughout the broad-scale sampling area both by visual sightings and by passive listening techniques;
- To map the bank-wide velocity field using an Acoustic Doppler Current Profiler;
- To collect acoustic, video, and environmental data along the tracklines between stations using a suite of sensors mounted in a towed boy (BIOMAPER-II);
- To collect meteorological data;
- To determine the abundance and distribution of micronektonic krill predators, primarily fishes within the study area;
- To determine rates of metabolism and excretion of all life stages of Antarctic krill;
- To assess the numerical abundances of krill larvae underneath sea ice using SCUBA and videography;
- To capture krill larvae underneath sea ice using SCUBA and hand nets for experimental manipulation;
- To take samples of the surface layer under the sea ice to assess food concentrations;
- To freeze krill of all life stages to assess composition and biochemical indicators of conditions;
- To evaluate the behavioral and physiological overwintering strategies used by different life history stages of the Antarctic krill; and
- To assess the sexual maturity stages of female krill during winter in relation to environmental parameters.

The specific objectives of the process cruises were:

- To measure the optical properties of the predominant sea ice types in the Marguerite Bay area. Quantify what the sea ice types are and measure their physical characteristics, which have direct effect on the optical properties. Deploy drifting ice platforms to measure a long-term mass balance history of the sea ice cover over a 1-2 month period.
- To assess the distribution and activity of the sea ice microbial communities in order to determine the stocks and dynamics of the food reserves for krill over wintering in association with sea ice.
- To link the variability in the biological and physical characteristics of the sea ice habitat with the distribution and abundance of larval krill, and the diet and growth of larval and juvenile krill in winter.
- To apply recently developed biochemical approaches to determine the age and structure of *Euphausia superba* in field populations.
- To investigate specific lipids in *E. superba* as molecular markers of diet history and their potential as markers of trophic transfer.
- To use ARGOS-based satellite transmitters to determine the distribution and movement of important krill predators, Adélie penguins and crabeater seals, relative to features such as bathymetry and sea ice.
- To employ a variety of diet sampling techniques to determine the winter foraging ecology of these predators, and particularly their impacts on krill life history stages and size classes.

Listing of U.S. Southern Ocean GLOBEC Cruise Reports

Reports available from: Southern Ocean GLOBEC Planning Office, Center for Coastal Physical Oceanography, Crittenton Hall, Old Dominion University, Norfolk, VA 23529 USA.

- U.S. Southern Ocean GLOBEC Report No. 1. Reports of R/V *Laurence M. Gould* Cruises LMG01-03 and LMG01-04 to the Western Antarctic Peninsula, 18 March to 13 April 2001 and 23 April to 6 June 2001.
- U.S. Southern Ocean GLOBEC Report No. 2. Report of RVIB *Nathaniel B. Palmer* Cruise 01-03 to the Western Antarctic Peninsula, 24 April to 5 June 2001.
- U.S. Southern Ocean GLOBEC Report No. 3. Reports of RVIB *Nathaniel B. Palmer* Cruise NBP01-04 and R/V *Laurence M. Gould* Cruise LMG01-6 to the Western Antarctic Peninsula, 24 July to 31 August 2001 and 21 July to 1 September 2001.
- U.S. Southern Ocean GLOBEC Report No. 4. Report of R/V *Laurence M. Gould* Cruise LMG02-01A to the Western Antarctic Peninsula, 6 February to 3 March 2002.
- U.S. Southern Ocean GLOBEC Report No. 5. Report of R/V *Laurence M. Gould* Cruise LMG02-03 to the Western Antarctic Peninsula, 7 April to 21 May 2002.
- U.S. Southern Ocean GLOBEC Report No. 6. Report of RVIB *Nathaniel B. Palmer* Cruise NBP02-02 to the Western Antarctic Peninsula, 9 April to 21 May 2002.
- U.S. Southern Ocean GLOBEC Report No. 7. Report of R/V *Laurence M. Gould* Cruise LMG02-05 to the Western Antarctic Peninsula, 29 July to 19 September 2002.
- U.S. Southern Ocean GLOBEC Report No. 8. Report of RVIB *Nathaniel B. Palmer* Cruise NBP02-04 to the Western Antarctic Peninsula, 31 July to 18 September 2002.
- U.S. Southern Ocean GLOBEC Report No. 9. Report of R/V *Laurence M. Gould* Cruise LMG03-02 to the Western Antarctic Peninsula, 12 February to 7 March 2003.

Participating Institutions:

Woods Hole Ocean Institute
University of Wisconsin
Earth and Space Research
University of Maryland
University of Tennessee, Knoxville
University of California, Santa Barbara
University of Alaska, Anchorage
Columbia University
University of California, Berkeley
University of South Florida, Tampa
Old Dominion University
University of Nevada
University of Minnesota
Scripps Institution of Oceanography
University of California, Santa Cruz
USACRREL
Massachusetts Institute of Technology

Funding Agency:

U. S. National Science Foundation Division of Ocean Sciences

Budget:

Approx. \$8.5 million

Funded Projects:

1. Zooplankton Distribution and Abundance

Peter H. Wiebe, pwiebe@whoi.edu, Cabell S. Davis, Carin J. Ashjian, Scott M. Gallager Woods Hole Oceanographic Institution, Woods Hole, MA

This component will focus on juvenile and adult krill and mesozooplankton prey distribution and abundance using a sophisticated instrument package, BIOMAPPER II, which is equipped with an acoustic backscatter sonar system, a video plankton recorder and an environmental sensor system. The system is used in large-scale studies. Additionally, a remotely operated vehicle will be used to map the distribution and behaviour of krill under ice.

Duration: October 1, 2000 - September 30, 2003 (Estimated)

Budget: \$1,203,118 (Estimated)

2. Krill Physiology and Fish Ecology

Joseph J. Torres, Kent A. Fanning, U of South Florida, Tampa, FL

This component will focus on krill physiology, using measures of respiration, excretion, and proximate analysis. Additionally, the distribution and abundance of fishes and squid, which are krill predators, will be investigated using acoustic and net tow methods. This research will be co-ordinated with components studying krill in both the water column and under the ice.

Duration: September 15, 2000 - September 30, 2003 (Estimated)

Budget: \$634,898 (Estimated)

3. Seabird Distribution and Abundance

Christine Ribic, U of Wisconsin

This component will focus on the large-scale distribution, abundance and habitat of seabirds. This will be accomplished using strip-transect surveys and spatial analysis software and models to examine the large-scale data. This research will be co-ordinated with seabird studies that focus on seabird diet composition and small-scale foraging behaviour.

Duration: September 15, 2000 - August 31, 2003 (Estimated)

Budget: \$164,473 (Estimated)

4. Hydrography and Bio-physical Modelling

Eileen Hofmann (hofmann@ccpo.odu.edu), John Klinck, Ricardo Locarnini, Old Dominion University

There are two aspects to this project: the characterisation of the regional hydrography, and the development of a hierarchy of models to organise and integrate the physical and biological observations. The water masses on the continental shelf off Marguerite Bay consist of inflowing Upper Circumpolar Deep Water, which is relatively warm, salty, oxygen-poor, and nutrient-rich. In winter atmospheric processes cool and freshen this water, and recharge it with oxygen to produce Antarctic Surface Water which is diffused seaward, and supports both a sea ice cover and a productive krill-based food web. This project will define these water masses with repeated regional temperature, salinity, nutrients, and oxygen surveys, supplemented by a moored current meter and temperature array, and by acoustic surveys to observe the upper ocean current structure. The modelling effort will provide a mechanism to link water column and sea ice processes with the biology of krill and its predators. It will further help to link these winter observations to similar observations made in summer and elsewhere around Antarctic in the international context of the GLOBEC program. Three major types of models will be used to order the various observations:

- time-dependent biological models - e.g. species interaction models
- depth-time models of both physical and biological characteristics - e.g. effect of snow, ice, and water turbidity on the distribution of light
- three-dimensional and time-dependent models synthesising physical and biological models over the continental shelf.

The specific objective is to develop a comprehensive ecosystem in order to test our understanding of the system, determine its sensitivities, and to provide an organising mechanism for integrating the Southern Ocean GLOBEC observations.

Duration: September 15, 2000 - September 30, 2003 (Estimated)

Budget: \$305,471 (Estimated)

5. Mesoscale Circulation, Tides and Mixing on the Western Antarctic Peninsula Shelf

Laurence Padman, padman@esr.org, Earth and Space Research, Robin Muench, NSF

There are several aspects to this project: One is the collection, analysis, and archiving of Acoustic Doppler Current Profiler (ADCP), and Conductivity-Temperature-Depth (CTD) data in order to characterise mesoscale circulation features and the regional hydrography. Another is to develop an accurate and fully validated model of tidal currents in Marguerite Bay. A third is to provide a data set of small-scale processes such as shear instabilities, tidal stirring, mesoscale eddies, and double diffusion, that are required for the effective parameterisation of the vertical diffusivities of heat, salt, and nutrients. The results of this project will provide a unified data set that satisfies the data requirement of the co-ordinated chemical and biological studies which will link water column and sea ice processes with the biology of krill and its predators. The results further will help to link these winter observations to similar observations made in summer and elsewhere around Antarctic in the international context of the GLOBEC program. The overall objective is to develop a comprehensive ecosystem model that will test our understanding of the system, determine its sensitivities, and to provide an organising mechanism for integrating the Southern Ocean GLOBEC observations.

Duration: November 1, 2000 - November 30, 2003 (Estimated)

Budget: \$369,293 (Estimated)

6. Sea Ice Microbial Communities

Christian H. Fritsen, cfritsen@dri.edu, U of Nevada

This component will focus on the distribution and activities of sea ice microbial communities. This will be accomplished using an integrated combination of sampling (vertical profiles, horizontal surveys, and under-ice surveys) and observational protocols. Experiments will be designed to estimate microbial activity within the sea ice and at the ice-seawater interface. The research will be co-ordinated with components studying the water column productivity and the sea ice habitat.

Duration: September 15, 2000 - September 30, 2003 (Estimated)

Budget: \$301,485 (Estimated)

7. Biochemical Determination of Age and Dietary History in the Krill *Euphasia superba*

H. R. Harvey, Harvey@cbl.umces.edu, U of Maryland

This component will apply new biochemical approaches to determine the population age structure of krill in field populations over seasonal and interannual time scales. Lipids specific to different food resources will be used in parallel with the intent of establishing markers for dietary history. This research will be co-ordinated with components studying krill feeding and growth.

Duration: September 1, 2000 - September 30, 2003 (Estimated)

Budget: \$262,356 (Estimated)

8. Krill Distribution and Abundance in Winter

Meng Zhou, mzhou@d.umn.edu, U of Minnesota

This component will focus on juvenile and adult krill and mesozooplankton prey distribution, using acoustic techniques. Studies will be conducted and krill shrinkage and mortality rates as well as krill aggregation behaviour. The results will be analysed in co-ordination with components involved in physical and biological models.

Duration: September 15, 2000 - September 30, 2003 (Estimated)

Budget: \$251,717 (Estimated)

9. Krill Distribution, Physiology and Predation

Thomas G. Hallam, hallam@tiem.utk.edu, U of Tennessee, Knoxville

Duration: September 1, 2000 - September 30, 2003 (Estimated)

Budget: \$300,000 (Estimated)

10. Winter Ecology of Larval Krill: Quantifying their Interaction with the Pack Ice Habitat

Maria Vernet, U of Cal SD, Scripps Institute, La Jolla

This component will focus on water-column primary production using direct experimental estimates, modelling results from a fast repetition rate fluorometer and modelling of primary production from both optical as well as biophysical models. This research will be co-ordinated with components focused on sea ice production and sea ice habitat.

Duration: September 1, 2000 - September 30, 2003 (Estimated)

Budget: \$300,000 (Estimated)

11. Winter Ecology of Larval Krill: Quantifying their Interaction with the Pack Ice Habitat

Robin M. Ross, Langdon B. Quetin, U of Cal Santa Barbara

This component will focus on the under-ice distribution and abundance of larval and juvenile krill. The physiological condition of the krill associated with sea ice of differing food quality and quantity will be assessed. This research will be co-ordinated with the krill components that focus on adults in the water column, with the goal of understanding the overall age-specific dynamics of krill in winter.

Duration: September 1, 2000 - September 30, 2003 (Estimated)

Budget: \$518,000 (Estimated)

12. Foraging Ecology of Crabeater Seals (*Lobodon Carcinophagus*)

This component will focus on the distribution and foraging behaviour of adult female crabeater seals, using a combination of satellite-linked tracking, specialised diver recorders, and stable isotopic tracers. This research will be co-ordinated with components focused on prey (krill) distribution and the physical environment. The results will be analysed using an optimality model.

Daniel Costa, costa@biology.ucsc.edu, Daniel Crocker, U of Cal Santa Cruz

Duration: September 15, 2000 - September 30, 2003 (Estimated)

Budget: \$183,933 (Estimated)

Jennifer Burns, burns@biology.ucsc.edu, U of Alaska, Anchorage

Duration: September 15, 2000 - January 31, 2004 (Estimated)

Budget: \$116,067 (Estimated)

13. Optical Environment of the Western Antarctic Peninsula (WAP) Region

This project is a contribution to a co-ordinated attempt to understand the interactions of biological and physical dynamics by developing mechanistic links between the evolution of the Antarctic winter ice and snow cover, and biological habitat variability, through modelling the optical properties of the environment. The optical properties of snow and sea ice evolve through the winter and vary greatly both spectrally and spatially. These properties are an important element of the physical environment that strongly influences both the distribution of and the resources available to Antarctic krill. The intensity of incident radiant energy and its distribution within the snow, ice, and water column environment, and the linked physical, optical, chemical, and biological processes that modulate its distribution are generally known but poorly quantified. The optical properties of snow and ice also influence snow algae, ice algae, and water column productivity, as well as visibility for both predator and prey. Furthermore, optical properties play an essential role in satellite observations, as proxy indicators of geophysical sea ice parameters, which permit local observations to be more accurately extrapolated in space and time, thus providing regional coverage that would otherwise not be possible. What is proposed is the deployment of an array of instrumented ice beacons, augmented by periodic ship-based and

satellite observations, along with theoretical studies to create improved quantitative models with which to follow the temporal and spatial evolution of this snow and ice marine ecosystem. The specific objective is to develop a thermodynamic sea ice/ecosystem model through coupling of existing components in order to test our understanding of the system, determine its sensitivities, and to provide an organising mechanism for integrating the Southern Ocean GLOBEC observations.

Raymond Smith, ray@icess.ucsb.edu, U of Cal Santa Barbara

Duration: September 1, 2000 - September 30, 2003 (Estimated)

Budget: \$157,457 (Estimated)

Donald K. Perovich, perovich@crrel.usace.army.mil, USACRREL

Duration: September 1, 2000 - August 31, 2001 (Estimated)

Budget: \$46,056 (Estimated)

Douglas Martinson, dgm@ldeo.columbia.edu, Columbia University

Duration: September 1, 2000 - September 30, 2003 (Estimated)

Budget: \$167,278 (Estimated)

14. Modelling the Effects of Eddies and Mean Flows on Southern Ocean Biology

Glenn Flierl, MIT

This project is an attempt to understand the interactions of biological and physical dynamics by modelling the spatial distribution of Antarctic krill, a small crustacean that forms dense aggregations or patches on the small scale. The spatial distribution of these patches appear to depend on the advance and retreat of the sea ice, the three dimensional movement of water masses from small scale turbulence to the dynamics of the Antarctic Circumpolar Current, as well as on food supply and predation pressure. Prior work has shown that physical processes dominate on the larger scale, while biological processes dominate on the smaller scale, but the relative importance of the two as a function of scale has not been investigated systemically. This work will be carried out in the context of the Southern Ocean Experiment of the Global Ocean Ecosystem Dynamics Study (GLOBEC), a large, multi-investigator study of the winter survival strategy of krill under the Antarctic sea ice. The problem of accurately representing patchiness in a circum-Antarctic model is that of properly representing effects that occur on a scale that is not resolved in the model. The approach that will be used here is to first study a detailed model that can resolve the scale of krill patches and can help to analyse and understand the observations that will be made in the Experiment. These results will allow us not only to make a more quantitative estimation of the errors involved, but also to improve the parameterisation of krill distributions in meso-scale and basin-scale models of the Southern Ocean.

Duration: July 15, 2000 - June 30, 2001 (Estimated)

Budget: \$334,870 (Estimated)

15. Small Scale Mixing and Krill Behaviour

Thomas M. Powell, zackp@socrates.berkeley.edu, U of Cal Berkeley

The objective of this project is to make a quantitative assessment of the small scale temperature and salinity structure of the oceanic surface layer in order to study the effect of stratification and turbulence on the biochemical and biological processes under the winter sea ice. The water masses on the continental shelf off Marguerite Bay consist of inflowing Upper Circumpolar Deep Water, which is relatively warm, salty, oxygen-poor, and nutrient-rich. In winter atmospheric processes cool and freshen this water, and recharge it with oxygen to produce Antarctic Surface Water which is diffused seaward, and supports both a sea ice cover and a productive krill-based food web. The modification processes work through mixing associated with shear instabilities of the internal wave field, double diffusion of salt and heat, and mixing driven by surface stress and convection. These processes will be quantified with two microstructure profilers, capable of resolving the small but crucial vertical variations that drive these processes.

Duration: September 15, 2000 - September 30, 2003 (Estimated)

Budget: \$227,683 (Estimated)

16. Circulation and Water Property Evolution

Robert C. Beardsley, rbeardsley@whoi.edu, Richard Limeburner, Woods Hole Ocean Institute

The objective of this project is to develop and deploy a series of moorings on the continental shelf off Marguerite Bay. These will include current meters, salinity and temperature sensors, zooplankton concentration, upward-looking acoustic sounders to track ice motion, and acoustic doppler current profilers. The proposed mooring design will quantify and characterise the inflowing and outflowing water masses, and provide the physical component for the integrated modelling effort. Instrumented drifters that track surface flow will supplement the mooring data. The water masses on the continental shelf off Marguerite Bay consist of inflowing Upper Circumpolar Deep Water, which is relatively warm, salty, oxygen-poor, and nutrient-rich. In winter atmospheric processes cool and freshen this water, and recharge it with oxygen to produce Antarctic Surface Water which is diffused seaward, and supports both a sea ice cover and a productive krill-based food web. The observations produced by this project will quantify the spatial and temporal variability of the presumed clockwise flow through the bay, and define the tidal and transient flows driven by storms and southward meanders of the Antarctic Circumpolar Current.

Duration: September 15, 2000 - September 30, 2003 (Estimated)

Budget: \$2,082,652 (Estimated)

17. Mysticete Whale Acoustic Census

John A. Hildebrand, jah@mpl.ucsd.edu, Sue Moore, Mark A. McDonald

U of Cal SD Scripps Inst La Jolla, CA

This component will focus on determining minimum population estimates, distribution and seasonality for mysticete whales, especially blue whales. This will be accomplished using passive acoustic recorders deployed on the seafloor for a period of one to two years. The deployment of a large aperture autonomous hydrophone array in the Antarctic will incorporate the use of passive acoustics as a tool for mysticete whale detection and census.

Duration: September 1, 2000 - August 31, 2003 (Estimated)

Budget: \$388,045 (Estimated)

PROGRAMME: SO GLOBEC - GERMANY

**Project Title: Seasonal population dynamics and ecophysiology of Antarctic krill
Euphausia superba in the Lazarev Sea**

Source of Information:

Dr. Uli Bathmann, November 2003

Chief Scientist:

Dr. Uli Bathmann

ubathmann@awi-bremerhaven.de

AWI for Polar and Marine Research

Am Handelshafen 12

Postfach 120161

D-27515 Bremerhaven

Germany

Project Description:

The Antarctic krill (*Euphausia superba*), is a species with increasing commercial interest. It is a key individual in the Antarctic ecosystem, being a major food item for a large number of top predators such as whales, mammals and sea birds. Even their faecal pellets are incorporated in the food web through ingestion by copepods. *E. superba* is very successful in the extreme environment of the Southern Ocean because it is capable of exploiting a food supply that is both patchy and seasonal. However, despite several decades of intensive research the understanding of its life strategy is incomplete. Up to now, most of the information available is based on investigation during the Antarctic summer on adult *E. superba*, and only little is known about its larval ecology. The winter distribution and behaviour of the stocks of Antarctic krill developed during summer months are still unresolved. There is a comparative lack of data on the winter energy budget, particularly for krill larvae. And there is a lack of data from regions around Antarctica especially from the area east of the Weddell Sea (i.e. Lazarev Sea). These data are essential, for developing a model for population dynamics and for a better estimation of krill production.

Therefore the question of increasing interest is how do krill survive during winter, when most of the Southern Ocean is covered by ice and primary production is low?

The study will be carried out in cooperation with our partners during expeditions into the Lazarev Sea. We will focus on early and late winter studies from board the research vessel "Polarstern" (April, May 2004; August, September 2005; January, February 2006 (tentative)) in the area 0°E to 25°E, 64° to 70°S. In addition, in February to July 2005 laboratory experiments are planned in the AAD in cooperation with Dr. Steve Nicol, to investigate regulating mechanisms for metabolic reduction in krill during winter.

Website:

<http://www.awi-bremerhaven.de/Biomeer/zooplankton-top02-e.html>

System Types Studied:

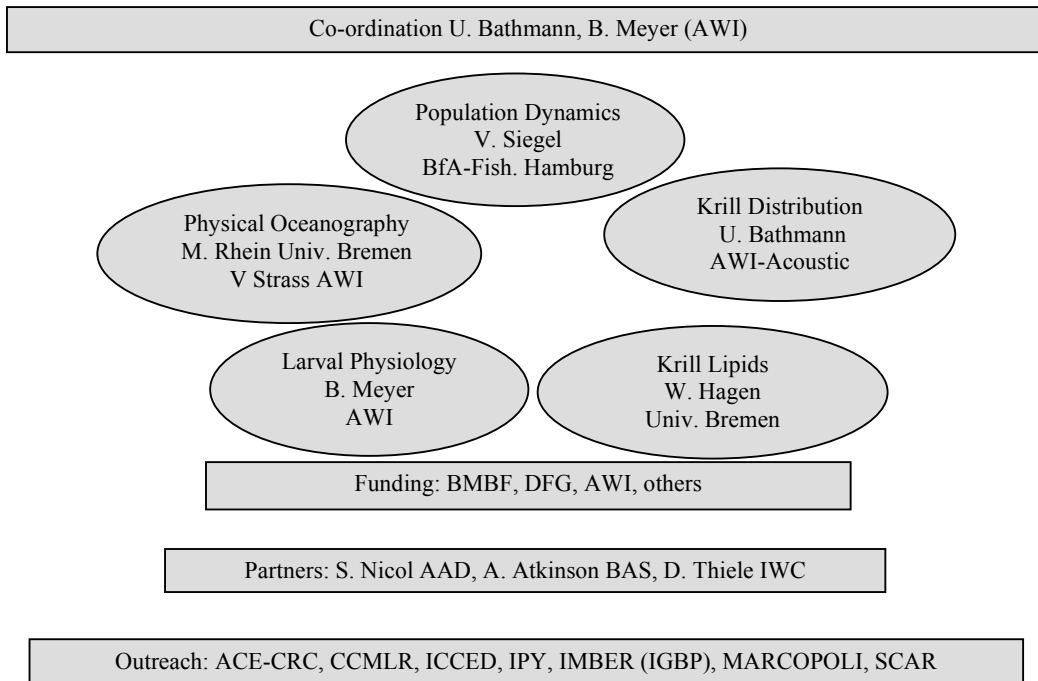
The Atlantic and Indian Sector of the Southern Ocean.

Overwintering regions of krill (pelagial, sea-ice, others).

Target Organisms

Euphausia superba (Antarctic krill)

Structure of the Project:



Key Questions, Hypotheses and Issues:

The main objectives of this research project are to establish:

- If, when and what do larvae and adult krill feed on during late autumn and winter in the Lazarev Sea
- What is krill abundance in the area and do we have one or more populations present?
- What are the available food sources and to quantify specific ingestion and assimilation rates for single developmental stages of *E. superba* present during the time of investigation.

These objectives are essential for a better understanding of the reproduction success and therefore for stock assessment.

To achieve the research objectives for larval and adult krill the project contains the following working steps:

- determination of hydrographic conditions in the Lazarev Sea relevant for krill
- determination the krill abundances in space and time
- determination of quantity and quality of food sources present
- determination of elemental and biochemical composition of larvae and adult krill
- determination of feeding rates on the phytoplankton stock in general and on different autotrophic groups and heterotrophic micro- and mesozooplankton in particular

Number of scientists and fte:

9 senior scientists/post-docs, 5 PhD students, 2 technicians

Participating Institutions:

Alfred-Wegener-Institut für Polar- und Meeresforschung (AWI), Germany
 Marine Zoology, University of Bremen, Germany
 Environmental Physics, University of Bremen, Germany
 Bundesamt für Fischerei (BfF), Hamburg, Germany

Co-operation:

British Antarctic Survey (BAS), Cambridge, UK
Antarctic Cooperative Research Center (ACE-CRC), Tasmania, Australia
ALTERRA, Marine and Coastal Zone Research, Netherlands
International Whaling Commission (IWC), Australia
Laboratory of Aquatic Ecology (LAE), Leuven, Belgium

Duration:

2004-2007

Funding Agency:

Bundesministerium für Bildung und Forschung (BMBF)
Deutsche Forschungsgemeinschaft (DFG)
Alfred-Wegener-Institut für Polar- und Meeresforschung (AWI)

AWI Future Plans:

Draft Ship Schedule: from 2004:

2004	April -May	AWI (Alfred Wegener Institute), Germany
2005	August- September	AWI (Alfred Wegener Institute), Germany
2006/07 tentative	January-February	AWI (Alfred Wegener Institute), Germany

PROGRAMME: SO GLOBEC - INTERNATIONAL WHALING COMMISSION

Project Title:

International Whaling Commission – Southern Ocean Collaboration/ARP's around Antarctic (IWC-SOC/AAA)

Source of Information:

Deborah Thiele, IWC

National Representative/ Contact:

Deborah Thiele

dthiele@deakin.edu.au

Chair, IWC Scientific Committee Working Group

on IWC-Southern Ocean Collaboration

Whale Ecology Group – Southern Ocean (WEG-SO),

School of Ecology and Environment,

Deakin University,

PO Box 423, Warrnambool

Victoria 3280

Australia

Project Description:

The initial collaboration in the Southern Ocean for the IWC under the then IWC - SOWER programme involved research with GLOBEC and CCAMLR. The IWC participated in German and US SO GLOBEC programs in the Western Antarctic Peninsula during 2001 – 2003. On those cruises, visual surveys were run to collect cetacean sightings simultaneous with krill and other physical and biological data. Standard IWC methodology for multidisciplinary studies was used. Data were recorded on a laptop based tracking program, and photo and video records were also obtained for species identification, group size verification, feeding (and other behaviour), ice habitat use and individual identification where possible. Ship and helicopter time were provided to the IWC teams on some cruises to facilitate this work. During these surveys, work was done in partnership with cetacean passive acoustic studies, and this led to the development of a refined project approach for ongoing collaboration in this region.

The development of the AAA/IWC collaborative program is an important component in a circum-Antarctic approach to investigating the connections between whale ecology and the variability and dynamics of Antarctic ecosystems. The main objective of the IWC/AAA is implementing a circum-Antarctic continuous acoustic monitoring system for cetaceans, to investigate connections between cetaceans and variability in ecosystem processes at local, regional and circum-Antarctic scales. The AAA program has been structured to include a variety of novel and historical cetacean research methods whilst simultaneously developing the potential of the new year-round acoustic recording packages (ARP's). While methodologically powerful, passive acoustic technology can currently provide data on call frequency, but cannot, when used remotely in the Antarctic, provide a reliable measure of relative abundance on any temporal or spatial scale, and does not allow an assessment of the number of individual whales calling at any one time, both critical elements in determining seasonal abundance. In order that this tool reaches its potential for application to cetacean conservation and management issues it is essential that means be developed to overcome this limitation as far as possible. Additionally, acoustic research needs to be partnered by studies to develop an ecological context for the analysis of acoustic data. For example, calling rates or spectra may vary with behaviour in response to changes in habitat characteristics. This can only be determined by ship-based research simultaneous with acoustic recordings.

Website:

Full cruise reports, web diaries and images from all of the cruises can be found at: http://www.ccpo.odu.edu:80/Research/GLOBEC/iwc_collab/menu.html or use the link through the IWC website <http://www.iwcoffice.org/> under Recent Additions.

Target Organisms:

Cetaceans

System Types Studied (current and planned):

Marguerite Bay, Western Antarctic Peninsula, Southern Ocean (2001 – 2003 ongoing)
South Orkney Islands, Southern Ocean (2004 – ongoing)
Weddell Sea, Southern Ocean (2003 – 2005)
Ross Sea, Southern Ocean (2004 – 2005 ongoing)
Mawson and Casey, East Antarctica, Southern Ocean (2002 – 2004 ongoing)
Elephant Island, Antarctic Peninsula, Southern Ocean (2003-4)
Amundsen and Bellingshausen Seas (2006 – 2010)

Physical Processes Examined:

Sea ice cover and type

Key Questions, Hypotheses and Issues:

Initial objectives

The long term aim of the programme is to define how spatial and temporal variability in the physical and biological environment influence cetacean species in order to determine those processes in the marine ecosystem which best predict long-term changes in cetacean distribution, abundance, stock structure, extent and timing of migrations and fitness.

Three specific objectives have been identified under the framework of the overall objective:

- Characterise foraging behaviour and movements of individual baleen whales in relation to prey characteristics and physical environment.
- Relate distribution, abundance and biomass of baleen whale species to same for krill in a large area in a single season.
- Monitor interannual variability in whale distribution and abundance in relation to physical environment and prey characteristics.

Expanded objectives with development of AAA program

Our experience in the first two years of SO GLOBEC surveys has led to the development of an additional long-term objective: the development of a cost effective, useful cetacean monitoring system for the Southern Ocean. This system will be developed using year-round passive acoustic recording packages (ARP's) and associated fine scale ecological studies across a number of oceanic regions in the Antarctic.

A major aim of this work is to develop a broad set of categories of association between behaviour, environmental conditions and calling rates for each species. These will be continuously refined until we have a tool that will allow the interpretation of ARP data with remotely sensed environmental data to predict, link and extrapolate whale distribution, and causes at local, regional and circum-Antarctic scales.

Number of scientists and fte:

Variable

Participating Institutions:

IWC
GLOBEC
CCAMLR

Various Institutions associated with Antarctic multidisciplinary research and national programs.

The AAA program is a joint research effort between J. Hildebrand (Scripps), Sue Moore (NOAA), and Deborah Thiele (IWC/WEGSO) and others, and is a core part of the IWC collaborative work in the Southern Ocean.

Duration:

Commenced 2001 and ongoing. Plans for collaborative work under the ICCED initiative beyond 2010

Funding Agency:

International Whaling Commission

Vessel, in kind and monetary support from national programs and other funding bodies