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Editorial

Introduction to dynamics of plankton, krill, and predators in relation to environmental features of the western Antarctic Peninsula and related areas: SO GLOBEC Part II

The objectives of the Southern Ocean Global Ocean Ecosystems Dynamics (SO GLOBEC) program were developed and refined through workshops, discussions, and examination of results of earlier studies, to focus on understanding the physical and biological factors that contribute to Antarctic krill (*Euphausia superba*) growth, reproduction, recruitment, and survivorship throughout the year (Hofmann et al., 2002). Overwintering strategies were highlighted as an important and largely unknown component of the Antarctic ecosystem. The SO GLOBEC science questions required a broad view of the Antarctic marine ecosystem that included studies of the habitat, prey, predators, and competitors of Antarctic krill, as well as studies specifically focused on Antarctic krill biology and physiology (Fig. 1). The science questions have been addressed through field studies in different regions of the Antarctic that used complementary techniques, thereby allowing comparative analyses. The first of the results from the SO GLOBEC program were presented in *Deep-Sea Research II* (Hofmann et al., 2004, vol. 51). This issue continues presentation of SO GLOBEC results and provides a start towards the synthesis of processes and effects from the habitat, through the food web, to top predators.

The extensive multi-disciplinary data sets acquired as a result of the SO GLOBEC studies are providing important new insights into the workings of Antarctic marine ecosystems, underscored by the many articles in this issue. For example, new understanding of the bathymetry and circulation processes of Antarctic coastal waters has been achieved. The role of circulation and sea ice in structuring the environment is better defined at small and large scales, and heat and freshwater budgets developed for parts of the western Antarctic Peninsula (WAP) continental shelf reflect the importance of regional circulation patterns. The SO GLOBEC program has now provided the first description of the Antarctic Peninsula Coastal Current. Another first is the description of upper water-column variability using temperature data collected by instrumented seals. Variability in sea-ice concentration and extent on the WAP continental shelf in 2001 and 2002 translated into marked differences in nutrient fluxes and chlorophyll distributions between the 2 years.

Significant advances in our understanding of winter krill distributions on the WAP shelf were provided by the intensive sampling of SO GLOBEC. The suite of sampling techniques included multi-frequency acoustics, visual imaging, and Multiple Opening/Closing Net And Environmental Sensing Systems (MOCNESS). The spatial coverage provided by the multiple sampling tools allowed meaningful correlation of biological patterns with environmental features. Significant advances were made in acoustic measurements of zooplankton, especially Antarctic krill, which allowed examination of the morphology, internal structure, and vertical position of individual krill aggregations. Robust models of Antarctic krill grouping and aggregation behavior are being developed that ultimately should provide a framework for testing the observations from acoustic and net measurements.

About one-third of the papers in this issue describe predator studies that were integral parts of the overall SO GLOBEC program. A striking feature of those studies is the advances that have been made in understanding relationships between predators, from fish to seals, to habitat structure and prey availability. Many of those studies provide the first winter observations of predator condition, distribution, and habitat use, some of which were unexpected. This work further develops the importance of complex bathymetry such as the Marguerite Trough and the associated influences on physical and biological processes to the winter survival of top predators. The unique hydrographic conditions of the WAP shelf and the accompanying spatial heterogeneity in pelagic ichthyofauna are a striking contrast to the continental margin areas of the Ross Sea, the Weddell Sea, the waters around Davis Station in East Antarctica, and the region around Dumont d'Urville Station in the Adélie Land portion of East Antarctica. Finally, the role of crabeater seals as an important winter krill predator was supported by their increased body condition over the winter period, which indicates successful foraging. The ability to integrate across diverse data sets to understand top predator ecology and biology is a notable strength of the SO GLOBEC program.

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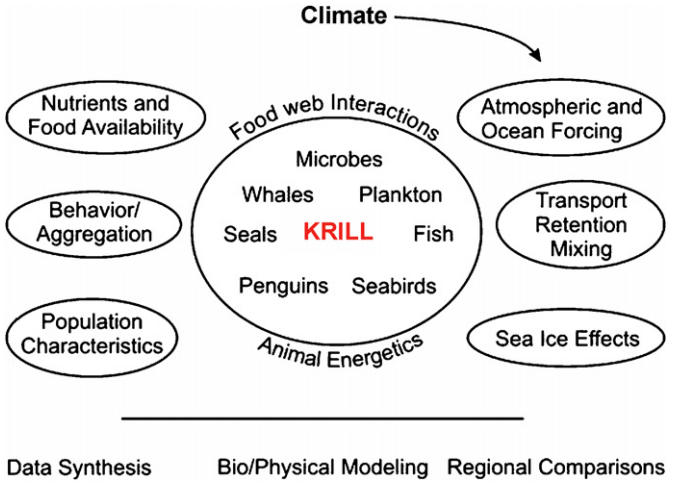

Fig. 1. Schematic of the SO GLOBEC program components and approach. Climate principally affects atmospheric and ocean forcing and directly influences transport, retention, and mixing, and the occurrence and dynamics of sea ice. These in turn influence nutrient and food availability, behavior and aggregation of the biota, and population characteristics. These effects are manifest in the food web interactions between the Antarctic ecosystem biological components and their physiology and biochemistry. Synthesis of the SO GLOBEC data sets includes data integration, biological–physical modeling of the systems, and comparisons among the SO GLOBEC study sites and comparisons with other regions of the Antarctic.

Results from the SO GLOBEC studies are providing a new conceptual understanding for how Southern Ocean marine ecosystems work, which in turn provides the basis for the presently ongoing synthesis, modeling, and integration phase of SO GLOBEC. This phase is part of the larger international GLOBEC synthesis and integration effort (Barange and Werner, 2004). The studies and analyses done to date are already leading to revisions in our understanding of Antarctic food webs, are underscoring the role of sea ice and circulation in ecosystem dynamics, and are highlighting the importance and interconnectivity of top predator populations. The SO GLOBEC synthesis activities will extend those results and provide a basis for comparison with similar activities that are taking place as part of other GLOBEC programs. Such pan-regional synthesis is the focus of ongoing and future research as it allows the results from the regional SO GLOBEC studies to be placed into the context of circumpolar climate and ecosystem dynamics. Understanding variability at a circumpolar scale is basic to understanding ecosystem effects resulting from long-term and large-scale climate change. The knowledge and lessons learned from the SO GLOBEC program provide a strong basis for continuing into this next phase of Southern Ocean research.

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Eileen E. Hofmann
Center for Coastal Physical Oceanography, Old Dominion University, Norfolk, VA 23508, USA
E-mail address: hofmann@ccpo.odu.edu

Peter H. Wiebe
Department of Biology, Woods Hole Oceanographic Institution, Woods Hole, MA 02543, USA

Daniel P. Costa
Department of Ecology and Evolutionary Biology, University of California, Santa Cruz, 100 Shaffer Road, Santa Cruz, CA 95060, USA

Joseph J. Torres
College of Marine Science, University of South Florida, 140 Seventh Avenue South, St. Petersburg, FL 33701, USA