Integrated Analyses of Circumpolar Climate Interactions and Ecosystem Dynamics in the Southern Ocean (ICCED)

A suggestion for an International Polar Year Initiative - 15th December 2003

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Rationale

The International Polar Year (IPY) offers a unique opportunity to mobilise the required international effort to generate a step-change in analyses of polar ocean ecosystem dynamics for input into the next generation of earth system simulations. High-latitude ocean ecosystems are crucial in global biogeochemical cycles, in maintaining global food-security and unique biological diversity. Under the IPY, ICCED will bring together climatologists, oceanographers, biogeochemists and ecosystem scientists to generate unique circumpolar datasets and models 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?

Scientific Background

During the past decade national and international studies of Southern Ocean ecosystems were undertaken with the objective of understanding the processes controlling marine population variability. At the same time the importance of ecosystem structure in determining ecosystem function has been increasingly recognized. So the cycling of carbon through the upper ocean ecosystem, its retention in the surface waters or its export to depth, are a function of the structure of the ecosystem. The need to include ecosystem structure in analyses of biogeochemical cycles has therefore been a major emphasis in the developing IMBER programme under IGBP. These ocean ecosystems programmes have encompassed the whole system, including environmental structure across trophic levels from microbes to whales. Results from these studies will be the focus of synthesis and modelling activities in the coming years, as well as providing the basis for additional focussed studies. Early analyses are producing revised understanding of the

physical and biological factors that control Antarctic food web variability. An emerging result is the importance of circumpolar climate variability and connections in the regional dynamics of Southern Ocean ecosystems. Thus, understanding the causes and consequences of climate change on Antarctic systems has to be an integral focus of future research programmes developed for this region.

The ICCED initiative will develop a coordinated circumpolar approach to understand climate interactions in the Southern Ocean, the implications for ecosystem dynamics and the impacts on biogeochemical cycles. This initiative will be composed of field studies including circumpolar monitoring, sampling along standard transects, and focussed process studies across key regions. The initiative will extend existing circulation and biological models and further develop modelling efforts directed at an integrated circumpolar view of the functioning of the whole ecosystem. An important objective will be to develop international expertise and capability through training courses, workshops, and personnel exchanges. The ICCED initiative directly addresses the questions put forward as a science focus for OCEANS/IMBER. The ICCED initiative will have strong ties with international programmes and organizations with a Southern Ocean focus including CLIVAR, CCAMLR, IMAGES, International GLOBEC, GOOS, SCAR, and the IWC.

Potential field activities/data types

ICCED will facilitate the ***coordination of already planned field efforts*** *to maximise the return from international circumpolar scientific effort. This will include exchange of personnel and expertise. A particular focus will be on ensuring that there is adequate international field effort to give circumpolar coverage of the Southern Ocean. Gaps in the geographical coverage will be identified as priorities for field effort.*

ICCED will build on the current planned CLIVAR/CliC transects and ships-of-opportunity programme to develop ***a network of multidisciplinary ocean transects*** *that traverse the Antarctic Circumpolar Current and the Coastal Current. These will be centred on base supply tracks undertaken by national operators and will be enhanced to include biogeochemical and ecological measurements. These will also be linked to planned paleo-oceanographic activities under the IMAGES programme, to link water column analyses of ecosystem structure and function, to vertical flux and deep water sedimentation processes.*

ICCED will develop, implement and utilise ***a network of circumpolar remote instrumentation****, including oceanographic moorings, drifter deployments (e.g. ARGO). This will also draw on ecosystem monitoring programmes developed as part of CCAMLR. The aim will be to extend the current scientific capacity to include chemical and biological*

monitoring instrumentation. To provide a wider context for these studies ICCED will draw on the available satellite data series including sea-surface temperature, ocean colour for phytoplankton concentration, sea-ice concentration and sea-surface height. These studies will provide the basis for the analyses of interannual and sub-decadal circumpolar variability.

ICCED will undertake **process studies in key regions** associated with the large-scale transect network. These will examine how large-scale climate processes affect the ecosystem dynamics at more regional scales (e.g. mesoscale). These studies will focus on understanding the how large-scale climate processes affect regional physical/chemical regimes, ecosystem structure and biogeochemistry. This will also emphasize mid-water and deep-water processes affecting the transfer of biological material to the deep ocean. This will include shipboard studies of plankton, nekton and predators, nutrient chemistry export processes, use of remotely operated and autonomous vehicles, studies of predator activity and satellite tracking for analyses of behavioural movement.

ICCED will **coordinate a series of circumpolar genetic studies of key species**. These will be used to analyse the dynamic processes of population maintenance and connection in the Southern Ocean. A particular emphasis will be on the role of ocean circulation in dispersing and maintaining populations and oceanic food-webs. These studies will be linked to wider studies of biodiversity and the importance of ecosystem structure in oceanic ecosystems.

*ICCED will undertake **coordinated circumpolar data syntheses and modelling**. The aim will be to bring together existing datasets for model development, validation, and calibration. This will include available distribution and abundance data on all components of the ecosystem, which will be an important contribution to CoML. ICCED will extend existing circulation and biological models to the circumpolar scale. To develop integrated circumpolar ecosystem models that includes nutrient cycling and the dynamics of microbes to higher predators to generate "end-to-end" ecosystem models. The aim will be to generate a hierarchical set of models of varying scale that will be used to examine how climate variation affects regional ecosystems.*

ICCED will stimulate the development of research capacity in the international community by undertaking training courses to develop multidisciplinary science skills, workshops, and a programme of personnel exchange between different international research groups.

ICCED will collaborate with international programmes and organizations

ICCED was initiated by the GLOBEC/JGOFS scientific communities as part of the development of IGBP IMBER. It has wide support in the Southern Ocean GLOBEC community and is seen as a key aspect in the developing IMBER programme. ICCED will build on a range of established international collaborations and will also link to other initiatives that are developing Southern Ocean science, such as the European Polar Board initiative (CIRCLE) and the iAnZone study of shelf regions. ICCED will also link to developing circumpolar Arctic initiatives such as the climate ecosystem studies developing under GLOBEC.

Acronyms

CCAMLR – Convention for the Conservation of Antarctic Marine Living Resources
CIRCLE – Climate, Interactions, Resources and Carbon Links in the Earth System.
CLIVAR – WCRP Climate Variability Programme
CLiC – WCRP Climate and Cryosphere Programme
CoML – Census of Marine Life
GLOBEC – Global Ocean Ecosystem Dynamics - IGBP
GOOS – Global Ocean Observation System
iAnZone - International Antarctic Zone Programme
IMAGES- International Marine Past Global Changes Study - PAGES
IMBER – Integrated Marine Biogeochemistry and Ecosystem Research - IGBP
IWC – International Whaling Commission
SCAR- Scientific Committee Antarctic Research
IGBP- International Geosphere Biosphere Programme