



SOUTHERN OCEAN SENTINEL WORKSHOP, HOBART 20–24 APRIL 2009

CONCLUSIONS

Southern Ocean marine ecosystems, both near to Antarctica and in the subantarctic, are already showing changes due to a warming climate. The manifestations of these climate change impacts now occurring in the Southern Ocean have become obvious long before those reported for other marine ecosystems.

This international workshop was convened to consider how to measure, assess and provide early-warning detection of climate change impacts on the Southern Ocean and how these could be used to signal future impacts on marine and other ecosystems elsewhere in the world. Below is a summary of conclusions from that workshop and the important first steps in establishing a Southern Ocean Sentinel.

Impacts of climate change on Southern Ocean marine ecosystems

Physical changes in the ocean, cryosphere and atmosphere of the Southern Ocean include:

- rising temperatures,
- changes in atmospheric circulation, including increasing winds and modified frequency and intensity of storms,
- changes in ocean state, e.g. increased acidity, freshening of the surface and deep layers, and
- an overall reduction in sea ice extent during the last century.

Climate change impacts are expressed differently around the Southern Ocean, e.g.:

- changes in the South Atlantic sector are different from changes in the Indian and Pacific sectors, and
- the Antarctic Peninsula is the most rapidly warming part of the planet, whereas the Ross Sea is not experiencing such change and may be cooling.

Changes in the state of the marine environment in the Antarctic Peninsula region, such as reduced sea ice, have already impacted that ecosystem:

- poleward movement of Adélie penguin colonies is occurring, and
- a winter fishery for krill has been able to access the region since 1997.

Predictions of future temperature rises (IPCC AR4) are within the range that will potentially have substantive impacts on Southern Ocean ecosystem components. The workshop identified a number of ecosystem components that may be vulnerable to ongoing climate change impacts (including acidification):

- species contributing to ocean productivity, such as foraminiferans and coccolithophores, and benthic habitat structure and function, such as cold water corals
- harvested species, including icefish and krill,
- species recovering from over-exploitation, e.g. whales,
- higher trophic level predators, such as emperor penguins which can only breed in ice habitats,
- species restricted in range, e.g. those inhabiting island shelf systems or requiring cold habitats, and will not have alternative refugia when local conditions change.

Change in the physical environment may be more profound in certain regions of Antarctica and the Southern Ocean and less so in others. The latter regions may provide biota with refuge from climate change and could be used as reference areas for better understanding impacts of climate change.

Role and importance of a Southern Ocean Sentinel

Our ability to make future predictions of ecosystem changes are hampered by a number of large unknowns, including the ability of ecosystem components to adapt to changing sea ice and pelagic environments.

However, sufficient information is now available to identify many aspects of Southern Ocean ecosystems that could be impacted by changes in the physical systems. Despite the uncertainties, tools are also now available to integrate disparate data sources to give coherent assessments of imminent and future change in Southern Ocean ecosystems.

Recent analyses have shown that changes in Southern Ocean ecosystems could indicate changes that may occur in other marine ecosystems across temperate and tropical latitudes – under future climate change scenarios.

Existing tools, combined with long-term measurements of key indicators, should be used to develop assessment and predictive models in order to provide two assessments for use by governments, IPCC and other international forums:

- current climate change impacts on Southern Ocean ecosystems to inform governments of the consequences of climate change on species, populations and ecosystems; and
- predicted future impacts on marine ecosystems, using select indicators of Southern Ocean ecosystems as early warning signals, to inform managers of human activities and ecosystem services that could be impacted by climate change.

These two types of assessments will require the support of a long-term systematic program to differentiate between plausible explanations for change in Southern Ocean ecosystems as well as estimating the changes themselves. Such a program will need to address regional ecosystem variation to ensure that biases are not inherent in measurements and models. At present, the patchy nature (in terms of spatial, temporal and species coverage) of long-term programs means that some changes may be occurring without detection.

This program will necessarily involve:

- long-term multi-decadal measurements of key indicators, and
- shorter-term, multi-year studies to test the plausibility of different models, including comparative studies across regions and, possibly, between the polar seas.

Systematic measurements of change will need to start immediately if climate change impacts are to be properly assessed. Strategies and procedures that distinguish between climate change impacts and impacts from other human activities, such as fishing, are also required.

A Sentinel in Southern Ocean science

Developing and implementing the Southern Ocean Sentinel is, by necessity, an international effort because:

- the problem is globally significant, the outcomes are globally useful and the region is governed by international forums, and
- change needs to be measured across the Southern Ocean and over at least 50 years, involving many nations and scientists and requiring a long-term commitment to sustained resources.

Two existing international programs are:

- Integrating Climate and Ecosystem Dynamics in the Southern Ocean (ICED), part of the Integrating Marine Biogeochemical and Ecosystem Research program of the International Geosphere-Biosphere program, and
- Southern Ocean Observing System (SOOS), an international collaborative monitoring program for the Southern Ocean.

The Southern Ocean Sentinel naturally fits within the objectives of ICED, contributing to developing predictive models and providing a long-term legacy of ICED. The Southern Ocean Sentinel could contribute to science planning in SOOS while the SOOS will be an important body for providing data to the Sentinel.

Mission

The Southern Ocean Sentinel will be an international multidisciplinary scientific effort to provide early warning of climate change impacts on global marine and other ecosystems based on Southern Ocean ecosystem indicators and assessments of climate change impacts in the region.

Vision

To see with clarity and consensus, the consequences of future climate for Southern Ocean marine ecosystems.

Objectives

The Southern Ocean Sentinel will provide information on the impacts of climate change in the Southern Ocean and will:

- establish and utilise methods, including models, for predicting imminent and future change in Southern Ocean ecosystems, locally, regionally and synoptically;
- develop methods and use Southern Ocean ecosystem indicators as early-warning signals for triggering advance planning and response actions in other global regions;
- develop an active, adaptive long-term field program to measure early warning indicators and associated parameters for use in the predictive models; and
- present outcomes (e.g. system assessments), and synthesise, review and regularly update predictions.

For further information:

ICED Program: www.imber.info/ICED.html
Southern Ocean Sentinel:
www.acecrc.org.au/drawpage.cgi?pid=antarctica_climate_change

Initial Milestones

2009 Sentinel Workshop 1: Launch;

Publish proceedings, outcomes and strategic plan; Establish Sentinel within ICED, with a coordinating group.

Assessment 1 (September): qualitative regional impact assessments of current change, prognoses of future change in Southern Ocean ecosystems

2010 Sentinel Workshop 2

- Focus groups to identify tractable/measurable milestones
 - predictive ecosystem models,
 - scenarios of climate change impacts,
 - indicators and design of field programs,
 - utilising Southern Ocean ecosystem indicators in early warning system
- International and institutional collaborations, including ICED and SOOS activities
- Science program
 - estimation of parameters
 - initial field measurements of change
 - pilot work to assist with design

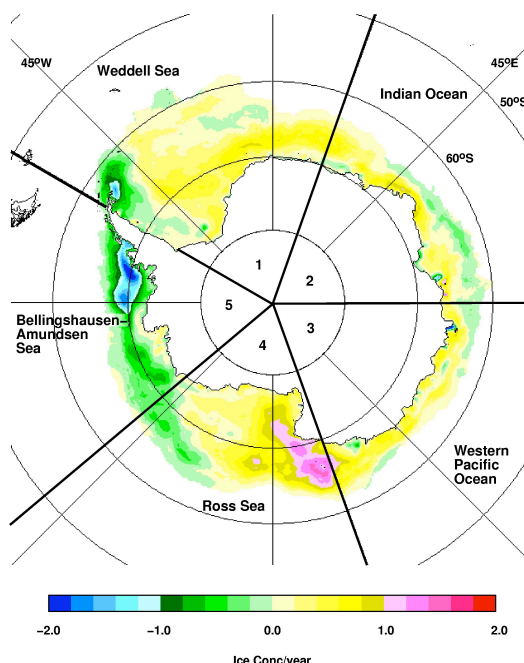
2012 IPCC AR5 contributions

2014 Assessment 2: quantitative assessment of change and predicted change

2017 Long-term science field program established following pilot studies

ICED legacy program; adaptive field program; timetable of reviews, prediction and assessment updates

Southern Hemisphere Ice Concentration Trends, Autumn 1979–2007



Spatial pattern of Autumn sea ice concentration changes 1979–2007 (Figure 2 - Turner et al., 2009. Geophysical Research Letters, Vol 36. L08502).

Workshop Sponsors

