

UNDERSTANDING THE ROLE OF THE SOUTHERN OCEAN IN

Australia is coordinating an international, multi-disciplinary research programme during the International Polar Year that will provide the first circumpolar snapshot of the physical, biogeochemical, atmospheric and ecological environments in the Southern Ocean region.

Southern Ocean processes have a global reach. For example, ocean circulation and water mass formation¹ in the Southern Ocean regulate the storage and transport of heat, freshwater and carbon dioxide throughout the world's oceans. As a result, changes in Southern Ocean currents and sea ice can affect global climate. Thus, if we are to predict future climate change, we must understand how the Southern Ocean will both respond to and drive climate change.

While the past decade has seen a rapidly growing appreciation of the role of the Southern Ocean and Antarctica in the global climate system, a lack of observations continues to hinder attempts to understand how the region drives and responds to climate change and variability.

The International Polar Year (IPY) presents an opportunity to fill this gap. The Climate of Antarctica and the Southern Ocean (CASO) programme, led through the Antarctic Climate and Ecosystems Cooperative Research Centre and CSIRO Marine and Atmospheric Research, aims to obtain the first circumpolar snapshot of the physical environment of the Southern Ocean, and enhance understanding of the role of the Southern Ocean in past, present and future climate.

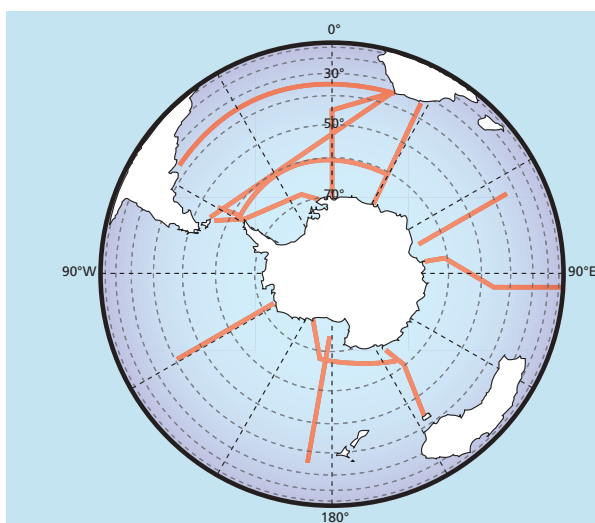
CASO includes 25 individual projects involving scientists from 18 nations, but it will also work closely with other IPY programmes, including studies of ocean circulation and ocean-ice interaction near the Antarctic margin, biogeochemistry, meteorology, ecology and paleoclimate.

Field work will include a range of new technologies such as:

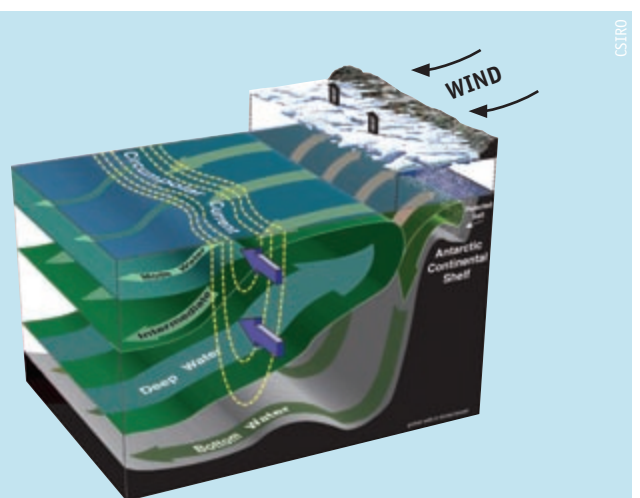
- A circumpolar array of 'sea ice drifters', measuring a range of ice, ocean and atmosphere parameters.
- Ocean profiling floats deployed to measure temperature and salinity throughout the Southern Ocean, including acoustically-tracked floats in ice-covered areas for the first time.
- Current meter moorings and pressure gauges to provide a time series of ocean currents and water mass properties.
- An expanded array of weather stations and atmospheric observations to measure atmospheric variability.
- Oceanographic sensors deployed on marine mammals, which will provide the first measurements of ocean conditions around Antarctica during winter.

Observations from these instruments will be closely integrated with a range of modelling studies.

Through this research, CASO will provide new insights into how the strong east-west flow of the Antarctic Circumpolar Current is linked to the Southern Ocean overturning circulation; determine



Voyage transects for the CASO programme will provide a synoptic circumpolar snapshot of the physical environment of the Southern Ocean that will enhance understanding of the role of the Southern Ocean in past, present and future climate.



The Southern Ocean overturning circulation carries layers of warm near-surface water and cold deep water in alternate directions, resulting in a net transport of heat (and other properties). This circulation is important for climate because it determines how much heat and carbon are stored by the ocean, and therefore the extent to which the ocean can slow the rate of climate change.

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the rate at which surface waters sink into the deep ocean and store heat and carbon dioxide; investigate the coupling between the ocean, atmosphere, sea ice, and ice shelves; and provide a more complete understanding of how Southern Ocean currents influence the carbon cycle, ecology and biodiversity.

As well as leading the programme Australia will make several other contributions to CASO. A major expedition to be carried out between November 2007 and February 2008 will include an oceanographic transect across the Antarctic Circumpolar Current, studies of Antarctic Bottom Water formation, and a survey of continental shelf waters as part of the Census of Antarctic Marine Life (story page 6).

A winter expedition to the sea ice zone (page 10) will improve our understanding of the processes controlling the distribution and thickness of sea ice and of the algae and krill that live within the sea ice zone. Australia will also deploy oceanographic sensors on seals; deploy ocean profiling floats throughout the Australian sector of the Southern Ocean; measure how much carbon dioxide is being absorbed by the Southern Ocean; and contribute to international studies of mixing in the Southern Ocean.

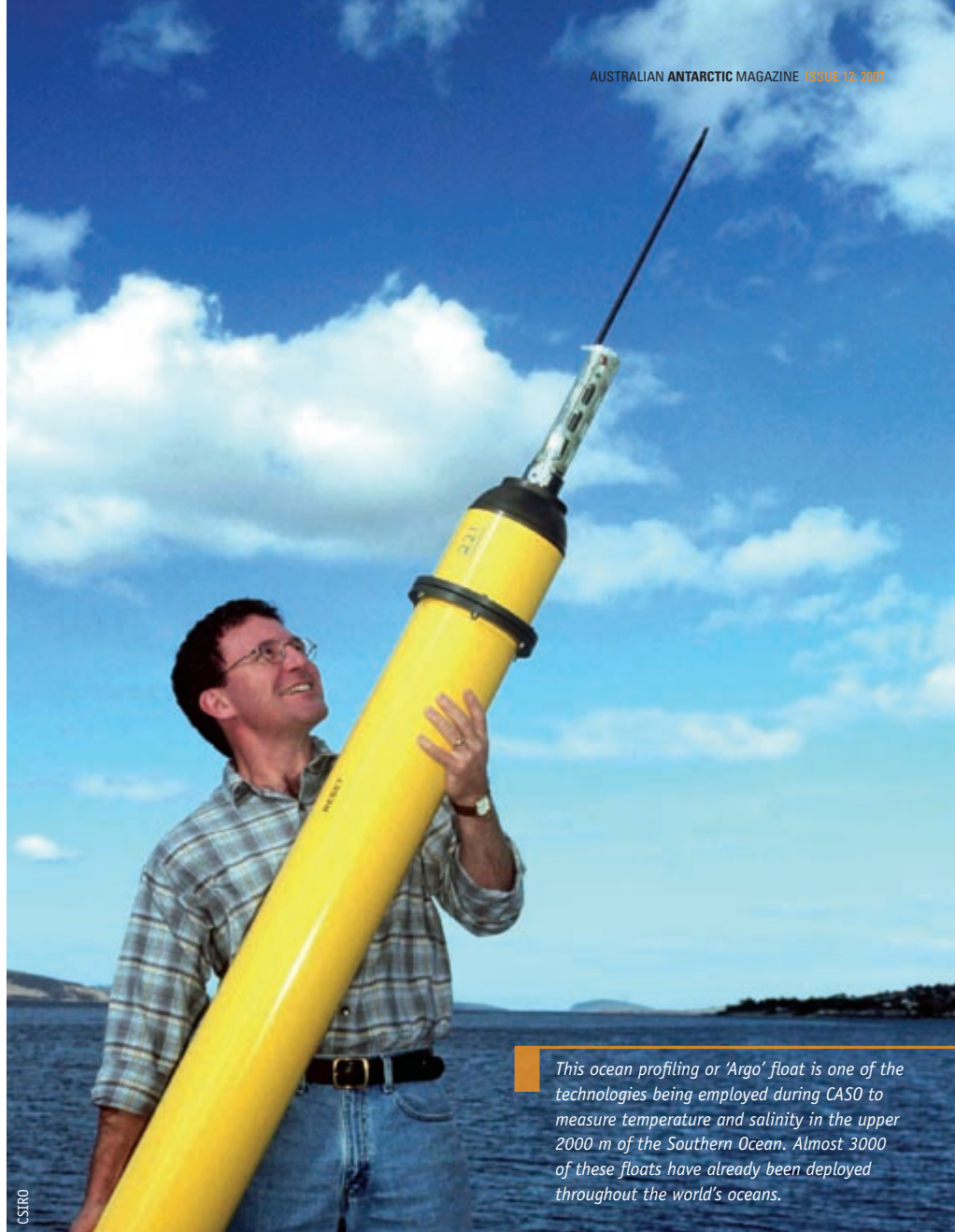
The programme will result in improved climate predictions from models that incorporate a better understanding of southern polar processes. It will also provide a proof of concept of a viable, cost-effective, sustained observing system for the southern polar regions (including the ocean, atmosphere and cryosphere), and a baseline for the assessment of future change.

CASO plans and updated maps of proposed field work can be found on the Southern Ocean panel's web site www.clivar.org/organization/southern.

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¹ Water masses are bodies of water originating from a common source and having similar physical and chemical properties – such as surface waters cooled near the Antarctic continent, which sink to the deep ocean and become 'Antarctic Bottom Water'.



This ocean profiling or 'Argo' float is one of the technologies being employed during CASO to measure temperature and salinity in the upper 2000 m of the Southern Ocean. Almost 3000 of these floats have already been deployed throughout the world's oceans.

The Climate of Antarctic and the Southern Ocean programme is organized into five themes:

1. **Antarctica and the Southern Ocean in the global water cycle** will quantify the high-latitude contributions to the global water cycle; determine the sensitivity of the water cycle to climate change and variability; and identify the impact of changes in the high latitude water cycle on the rest of the globe.
2. **Southern hemisphere teleconnections** will study the climate connections between low and high latitudes; determine the role of air-ice-ocean interactions in southern hemisphere variability and change; and assess the sensitivity of the modes of variability to future change.
3. **Climate processes at the Antarctic continental margin** will improve our understanding and models of ocean-ice-atmosphere interactions and ice shelf stability; obtain a snapshot of the circumpolar distribution of the complex system of coastal, shelf and slope currents; quantify the production rate of Antarctic Bottom Water; and measure the circumpolar volume of sea ice.
4. **Climate–ecosystem–biogeochemistry interactions in the Southern Ocean** will aim to understand the impact of climate variability and change on Southern Ocean ecosystems, including the role of the Southern Ocean in the carbon dioxide cycle.
5. **Records of past Antarctic climate variability and change** will use proxy records from ice cores to determine the natural modes of climate variability on time-scales from years to millennia, and improve our understanding of the mechanisms of abrupt climate change in the past.