

Climate Variability in the Southern Ocean Region



The Southern Ocean region is of fundamental importance to the global climate system. It is also a remote and hostile environment, making it one of the least studied and understood areas in the world.

OBJECTIVES

Through a joint Southern Ocean panel, CLIVAR and its WCRP companion project, CliC (the Climate and Cryosphere project), are endeavouring to:

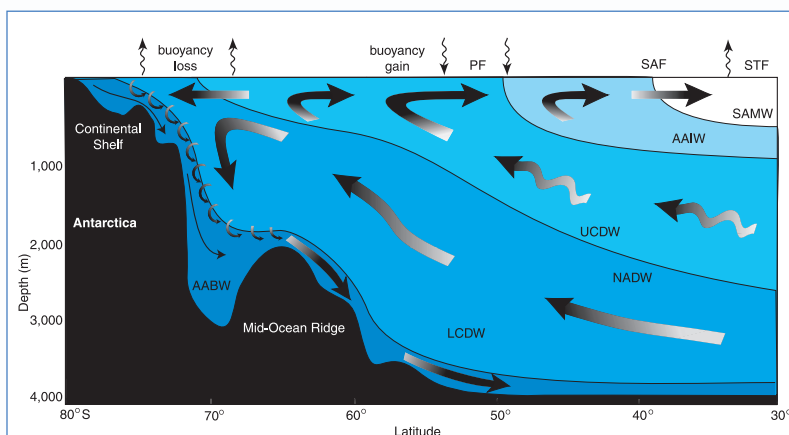
- Design a strategy to assess climate variability and predictability of the coupled ocean-atmosphere-ice system
 - Refine an implementation plan for the Southern Ocean region that defines the process studies, sustained observations and model experiments needed to meet the objectives of CLIVAR and CliC
- Four themes of importance to the Southern Ocean and climate have been identified:
- The "shallow" overturning cell (e.g. formation and circulation of Subantarctic Mode Water (SAMW) and Antarctic Intermediate Water (AAIW); oceanic uptake of heat and anthropogenic CO₂)
 - The "deep" overturning cell (e.g. stability of the deep overturning cell; rate of Antarctic Bottom Water (AABW) formation and sensitivity to change)
 - Inter-basin exchange (e.g. propagation of anomalies between basins and their impact on regional climate)
 - Teleconnections and low-frequency variability (e.g. interannual to centennial time-scales, including, for example, the Southern Annular Mode)

CLIVAR and CliC also work closely with other groups and projects with an interest in climate related studies in the Southern Ocean region.

ACTIVITIES

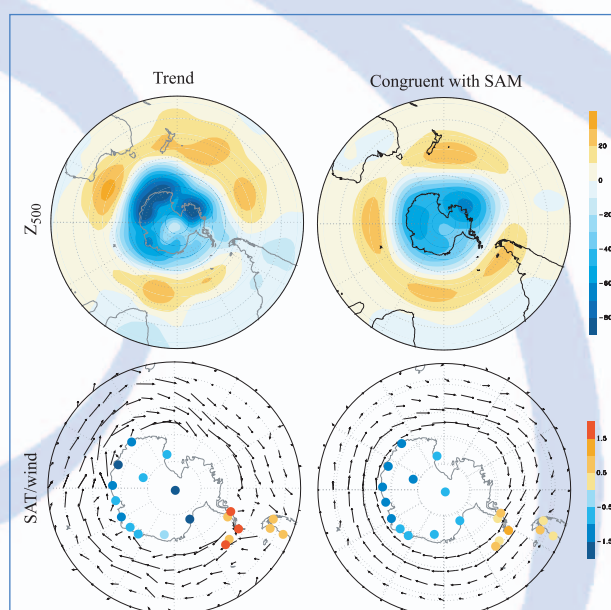
Since its formation in 2002, the Southern Ocean panel has:

- Strengthened our understanding of the Southern Ocean region's role in climate and the research carried out to address this

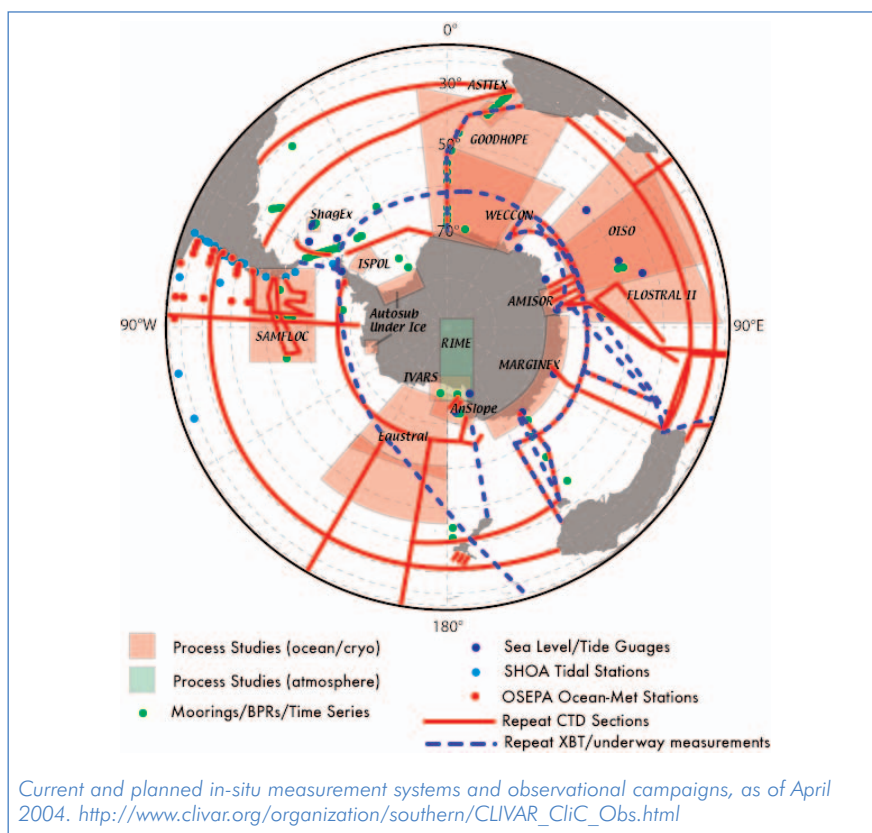


Schematic of the overturning circulation in the Southern Ocean. The "shallow" cell is primarily formed by northward Ekman (wind driven) transport and southward eddy transport in the Upper Circumpolar Deep Water (UCDW) layer. The "deep" cell is primarily driven by dense water formation (mainly AABW) near the Antarctic continent. (From Speer et al., Journal of Physical Oceanography, 2000).

- Enhanced coordination with other programs (e.g. the International Antarctic Zone Programme, the Antarctic Sea-Ice Processes and Climate Project and the International Programme for Antarctic Buoys), other CLIVAR panels, and scientists with an interest in the Southern Ocean region



December-May trends (left) and the contribution of the Southern Annular Mode to the trends (right). Top, 22-year (1979-2000) linear trends in 500-hPa geopotential height. Bottom: 32-year (1969-2000) linear trends in surface temperature and 22-year (1979-2000) linear trends in 925-hPa winds. The longest vector corresponds to ~4 m/s. (From Thompson and Solomon, Science, 2002).



teleconnections and modes of variability such as the Southern Annular Mode and the Antarctic Circumpolar Wave (for example the Southern Annular Mode has been shown to influence rainfall patterns in southern hemisphere countries).

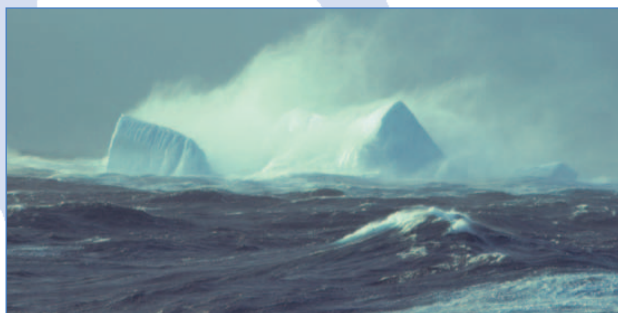
The Southern Ocean plays an important role in natural and anthropogenic climate variability through changes in albedo related to the sea ice cover; changes in heat and carbon storage (the Southern Ocean is thought to be the most important sink for anthropogenic carbon); and its contribution to rising sea levels.

The marine and terrestrial ecosystems in the Southern Ocean region are also particularly sensitive to climate change and variability.

- Played an important role in helping to fill gaps in the observing system (e.g. support of the GOODHOPE project to fill the important 'chokepoint' observational gap south of Africa)
- Been involved with strategic planning for the future (e.g. the proposal for an International Polar Year in 2007/8)
- Developed a Web site that includes an up-to-date overview of Southern Ocean region observational plans and activities, links, relevant publications and meetings etc.

APPLICATIONS

Although remote from the population centres of the world, the Southern Ocean region can influence the climate of southern hemisphere nations through



ISSUES AND CHALLENGES

Commitments now exist for a large fraction of the proposed Southern Ocean observing system, but a number of significant gaps remain. These include: Argo in sea-ice covered water, air-sea flux measurements, Antarctic Circumpolar Current and Bottom Water monitoring, and a sea-ice thickness observations.

Global circulation and climate models show particular weaknesses in the Southern Ocean region. For instance, better parameterisation of sea ice and bottom water formation processes are required.

The CLIVAR/CliC Southern Ocean Panel acts as a focus for national and international collaboration in the Southern Ocean region.



More information on CLIVAR/CliC Southern Ocean Panel activities can be found at :
<http://www.clivar.org/organization/southern/>
 email : icpo@soc.soton.ac.uk