# The CLIVAR/CliC/SCAR Southern Ocean region panel

Sparrow, M.D., K. Speer, I. Renfrew on behalf of the panel and meeting attendees
Corresponding author: m.sparrow@noc.soton.ac.uk

The 4th meeting of the Southern Ocean region panel was held from 14-17 November 2006 in the beautiful Palacio San Martín in Buenos Aires, Argentina.

The first half of the third day was given over to a "Science Morning" consisting of a series of talks and discussions led by local scientists. The subjects of the talks ranged from the influence of the Southern Ocean on climate variability of South America to Glacio-climatic investigations in southern Patagonia and Antarctic Peninsula. This provided a good opportunity for the panel and invited experts to interact with local scientists and students and for everyone to see some of the excellent work being done by scientists in Argentina.

Since the last meeting there have been several changes in membership to reflect a more climate rather than ocean focus to the panel (see http://www.clivar.org/organization/southern/members.php). Thus the panel aimed to build on its past activities and strengths, such as involvement with the International Polar Year (IPY) through e.g. the Climate of Antarctica and the Southern Ocean (CASO) project, but also had a strong emphasis on cross-cutting climate questions such as climate indices, IPCC model runs and focussing on the whole (ocean-atmosphere-cryosphere) observing system (particularly post-IPY). We summarize some of the main themes tackled during the meeting below.

*IPY and the Southern Ocean Observing System*

The International Polar Year provides an unprecedented opportunity to improve the observational capacity and our knowledge of Antarctica and the surrounding oceans (as well as the equivalent northern high latitude system). The panel's involvement in IPY has been mainly through the CASO umbrella project (the lead project in the Ocean Circulation cluster in the south). See: http://www.clivar.org/organization/southern/CASO/index.htm. CASO has several aims:

- To obtain the first circumpolar snapshot of the Southern Ocean, including physical, ecological and biogeochemical properties
- To measure the circumpolar extent and thickness of Antarctic sea ice through an annual cycle for the first time
- To observe the sub-ice ocean circulation, water mass properties and biological distributions

Although it should be possible to achieve many of the original aims, it will not be possible to do as much as was originally envisaged. For example, there will be a lack of zonal lines/moorings in the subtropical Indian and Pacific and, crucially, many sections may not be done on ice breakers. Expanding under-ice Argo was also seen to be a priority: at the moment there is good coverage in the Weddell Sea but little elsewhere. The use of animal-borne CTDs (e.g. the SEaOS project: http://biology.st-andrews.ac.uk/seaos/) is one promising method of helping to fill this gap. The meeting

attendees also noted that there seemed to be no integrated modeling structure within IPY and drafting recommendations for this was seen as a key action item.

The panel felt that a priority was a plan for a post-IPY sustained observing system. This would link strongly with the Southern Ocean Observing System (SOOS) being coordinated by the SCAR/SCOR Oceanography Expert Group. The current state of the observing system is summarised on the panel's website at: http://www.clivar.org/organization/southern/CLIVAR_CliC_Obs.html. Whereas IPY will give the first true snapshot of the Southern Ocean any future sustained observing system is needed to give a measure of the variability in the system. The optimal requirements of any such system are being discussed by the panel, but some initial ideas include:

- Repeat at least six of the shorter sections every 2-5 years
- Moorings/stations on select sections, mainly for properties
- Argo plus sea-ice zone observations
- Meteorological buoys/stations

As well as the sustained observing system, a discussion was held on possible future process studies in the region. Such process studies are required to parameterise certain processes in models. Several suggestions were made, for example process studies to look at the grounding line and shelf slope exchange.

On a related matter, an IPY-era synthesis was also proposed. Groups involved in synthesis noted that they plan to extend the current syntheses through IPY, so the output will be available. What is also suggested is that seed funds for analyses be made available, perhaps along the lines of what was done for the IPCC 4th assessment model runs, in order to fully exploit the new information from polar regions.

*Indices in the Southern Ocean Region*

The use of indices to describe the state of the climate system by examining the connections between the ocean, cryosphere and atmosphere is well known (e.g. ENSO, SAM etc.). Groups such as the Ocean Observations Panel for Climate (OOPC) and the CCI/CLIVAR/JCOMM Expert Team on Climate Change Detection and Indices (ETTCDI) are interested in such indices, especially those that could be used to help give an idea of model skill. One goal of this meeting was to suggest and develop ideas for new indices in the Southern Ocean region, e.g. a scalar index of the state of a feature of the climate system that is known to vary over daily to decadal timescales. A summary of the proposed indices will be made available on the panel's webpage (http://www.clivar.org/organization/southern/southern.php).

*Ice Shelves and Climate Change*

The Panel recognised that one of the largest uncertainties regarding sea level changes in the future come from possible ice shelf movement. Progress could be made in reducing uncertainties of sea-level rise with a concerted effort to monitor the grounding line, representing the boundary between the ice sheet and the ocean. Measuring and modelling the characteristics of convection in ice-shelf cavities, calving, and the intersection of ice streams with the ocean are necessary parts of this effort. As a step in this direction the panel recommended establishing a remotely-sensed "grounding line

index" based, for example, on Rignot et al (1998). Eventually an operational system for monitoring the circumpolar location of the grounding line could be put into place and maintained. Another step is to create ocean and ice-sheet models capable of exchanging mass with one another, i.e., possessing a migrating grounding line capability.

*IPCC Models in the Southern Ocean Region*

The Southern Ocean is one of the regions where the scatter between the results of the different IPCC models is the largest, both for the last 30 years, for which we have relatively good observation data to compare models with, and for future projections. The panel therefore devoted much of an afternoon to discussing how the IPCC models fare in the Southern Ocean region. The text below outlines some of the main points. A full summary will appear in the meeting report.

The climate simulation of the southern extratropics has improved since the Third Assessment Report despite the fact that most coupled models no longer employ flux adjustments. However, large biases in many aspects of the Southern Ocean system in individual models still persist. This bias adversely impacts the westerly wind stress maximum and the location of the Antarctic Circumpolar Current (ACC), which are usually placed too far north in most models. In general, models with sufficient resolution show considerable skill in reproducing extratropical storm tracks. However, simulated storm tracks are often too zonally oriented and many models show deficiencies in the distribution, intensity and number of cyclones.

Both observations and simulations show a trend in the Southern Annular Mode (SAM) towards its positive phase. The associated poleward shift of the storm tracks is accompanied by a similar shift in the midlatitude jets and surface zonal wind stress which in turn is important for driving upwelling in the Southern Ocean and the ACC flow through the Drake Passage.

Despite the large scatter between the various models, the multimodel average sea ice extent is in good agreement with the observations, meaning that there is apparently no systematic bias in the models. On the other hand, the models generally tend to overestimate the variability of the ice extent compared to observations.

Over the 20$^{th}$ century, the multimodel average simulates a stronger warming around the peninsula compared to other regions, which is in qualitative agreement with observations.

The simulated strength of the ACC varies a lot between the different models, ranging from less than 50Sv to more than 200 Sv. Various factors could explain those large inter-model differences. In particular, the strength of the westerly wind over Drake Passage and the salinity gradient across the ACC seem to play a dominant role.

The large variability in the Southern Ocean region on interannual to interdecadal time scales poses problems in the assessment of the quality of model simulations and in the finding of robust signals. Longer times series of surface temperature and sea ice extent, for instance, would be particularly helpful in this framework to have a better estimate of the observed interdecadal variability and trend over the 20$^{th}$ century and to check if models are able or not to simulate the observed characteristics.

Reference:

Rignot, E. J., *Fast Recession of a West Antarctic Glacier Science*, July 1998:
Vol. 281. no. 5376, pp. 549 - 551