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Guest Editorial

The Role of the Southern Ocean in Global Processes

The limits of the Southern Ocean and its importance have been under debate for a long time. However, with growing knowledge, it has become obvious that the circum-Antarctic water belt is the defining limit and that the Southern Ocean plays an active and important role in the physical part of the global climate system, the global carbon cycle and biogeochemical processes.

The powerful Antarctic Circumpolar Current connects the three ocean basins - Atlantic, Indian and Pacific - to form one global ocean system with properties significantly different from three independent basins. And this current is a crucial part of the global oceanic circulation system that transports water, heat, salt and dissolved material as gases and nutrients around the world. Due to the meridional circulation cells in the Southern Ocean, which are dynamically linked to the Antarctic Circumpolar Current, deep water reaches the sea surface around Antarctica and sinks again into intermediate depths where it spreads to the subtropics and tropics to feed the nutrient rich upwelling waters, which are the origin of intensive biological production through all levels of the food chain.

This definition of the Southern Ocean recognises much better its far-reaching effects as the most powerful ocean current on earth. The Southern Ocean bottom waters renew and ventilate the lowest layers of the global ocean well into the North Atlantic. The Mode and Intermediate waters are part of the shallow overturning cells which provide heat transport southward. Their formation is also the origin of another important contribution of the Southern Ocean to global climate - it is one of the major sinks for atmospheric CO_2.

The particular property of the Southern Ocean to be the largest high-nutrient, low-chlorophyll (HNLC) region of the world ocean has drawn the attention to the importance of micro-nutrients, such as iron, for the functioning of the system. The potential effect of iron has suggested to some that manipulation of nutrient status to fix more carbon could balance global emissions of CO_2 and stop the increase of the "greenhouse effect". Experiments indicate a response to added iron but this is far from an answer to continued production of anthropogenic CO_2.

Getting the Southern Ocean into an Earth System Science framework is not easy but essential if we are to make progress with global problems. Increasing observations of the Southern Ocean gave evidence of fluctuations of a wide range of properties on time scales from days to centuries which are reflected in atmospheric properties as sea level pressure and winds, ocean properties as temperature and salinity, and sea ice as well as shelf ice. The fluctuations seem to be linked to global scale processes such as ENSO via the Antarctic Dipole or the Antarctic Circumpolar Wave, or even to stratospheric ozone depletion via the Southern Annular Mode.

The models have already shown that the Southern Ocean is a critical element to predicting future change. Whilst modern technology can do a great deal more ship time is essential to answer many of the questions on fluxes, linkages and process controls and this needs to be more coherently planned with the ships offering international rather than national opportunities for research. The forthcoming International Polar Year offers a real opportunity to move towards this with COMNAP, SCAR and SCOR intimately linked in utilising these expensive assets for the best science achievable. It is surely the role of scientists to explain to governments and funding agencies that this little known 10% of the world's oceans offers a great deal more than 10% importance in global change terms.

EBERHARD FAHRBACH