

Evaluating the ocean as a carbon sink

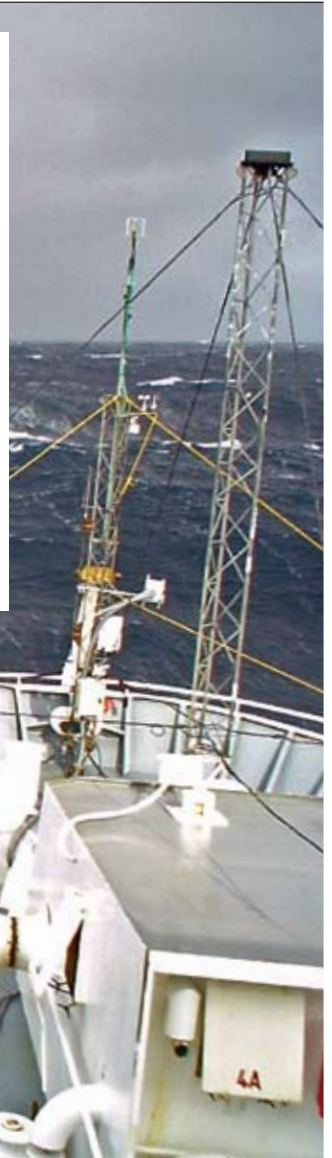
The world's oceans have absorbed nearly half of the carbon dioxide (CO₂) generated by human activities, dampening down global warming. The exchange of gases between air and sea plays an important role by controlling the rate of this CO₂ uptake. Wind enhances air-sea gas exchange, but there have been few measurements at high windspeeds to be certain of its impact on CO₂ uptake.

The notoriously windy Southern Ocean is an important carbon sink. But the magnitude of its contribution to global ocean CO₂ uptake has been uncertain, until now, because data were lacking. Together, NIWA and Colombia University have filled this gap by measuring air-sea gas exchange at high windspeeds in the Southern Ocean.

We found that the high windspeeds and associated wave-breaking in the Southern Ocean do not enhance the air-sea gas exchange to the extent that some scientists had predicted. Our measurements have refined estimates of ocean CO₂ uptake, which will enable more accurate modelling of global climate change.

The research was funded by the Foundation for Research, Science & Technology and the US National Science Foundation.

Tangaroa encounters fierce winds during the Southern Ocean survey.



Peter Minnett, University of Miami



Origins of coastal nutrients

Nutrients in coastal waters sustain important fisheries, aquaculture, and ecosystems. NIWA is using nutrient budgets to help understand the origins and processing of these nutrients in coastal ecosystems.

We have used nutrient budgets to evaluate the balance of terrestrial and oceanic nutrient inputs in the Firth of Thames and Golden and Tasman bays. The Firth of Thames supports New Zealand's largest snapper nursery and biggest mussel farm. We found that about 75% of its nitrogen loading comes from rivers, underlining the importance of runoff water quality and catchment management for the Firth ecosystem.

By contrast, Golden and Tasman bays get 90% of their nitrogen loading from offshore waters in Cook Strait. Understanding the oceanography of Cook Strait is, therefore, key to understanding and predicting nutrient levels in the bays, with implications for scallop fisheries and mussel farms.

Nutrient budgets are also useful in evaluating aquaculture impacts in coastal ecosystems. For instance, we found that very little nitrogen and primary production is lost due to mussel harvest in the Firth of Thames, at both present and projected harvest levels.

Antarctic sea ice and global climate

Sea ice plays a major role in climate through its influence on gas exchange, solar radiation, atmospheric temperature, and ocean salinity. The extent of sea ice in the Southern Ocean varies annually from about 3 million to 20 million square kilometres, effectively doubling the size of Antarctica. This has a major influence on New Zealand's climate.

Average annual sea ice volume in the Southern Ocean is predicted to drop by about 34% over the next century due to global warming. What impact will this have on regional and global climate and on ocean circulation? What oceanic and atmospheric factors influence the formation and break-up of sea ice?

NIWA is undertaking research on these questions in collaboration with Industrial Research Ltd, Victoria University of Wellington, and the universities of Auckland and Otago. We are using McMurdo Sound in the Ross Sea as a natural laboratory to understand the processes controlling sea ice thickness and their impact on local oceanic and atmospheric conditions. This research will then be used in global climate change models.

The 13-year research programme is funded by the Foundation for Research, Science & Technology.



Craig Stevens, NIWA

NIWA's Dr Mike Williams retrieves a current meter from below the McMurdo Sound sea ice.

Exploring the potential of deepsea methane

NIWA has collaborated with several New Zealand and overseas institutions to investigate the unique biology and geology associated with deepsea methane seeps, and their potential as a source of energy and greenhouse gas.

Cold seeps occur where methane-charged fluids percolate through the seafloor from large stores deep below. A 2-year study of a methane seep off the Wairarapa coast by NIWA suggests that insufficient methane reaches the sea surface to be a significant source of greenhouse gas.

Late last year, scientists on *Tangaroa* discovered several new cold seep sites off the east coast of the North Island. They characterised the unique gas-fuelled biota associated with the seeps and their unusual carbonate formations, which include 'donuts' and 'chimneys'. Sediment and water samples were collected to track the fate of the expelled methane. This voyage was led by NIWA and Woods Hole Oceanographic Institution, with funding from the US National Oceanographic and Atmospheric Administration and NIWA.

Following on from this study, a 3-month survey on the German research vessel *Sonne* identified the geological structures and processes which enable transport of methane from beneath the earth's crust. This research was led by IFM-Geomar (Germany), NIWA, and GNS Science.



Craig Stevens, NIWA

Marine tube worms, *Calyptogena* (clam) shells, and carbonate rocks captured at a cold seep by NIWA's Deep Towed Imaging System.

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