

Improved treatment of ice-ocean interactions enhances climate modelling

A new 'coupled' ocean-sea ice model will help researchers more accurately model how different components of the climate system interact, improving their ability to predict the effects of climate change.

One of the greatest challenges facing earth system science (see box) today involves understanding how the global climate system works, so that we can determine how it will respond to climate change and how to predict weather and climate on timescales from months to millennia.

The climate system has numerous components, including the atmosphere, ocean, cryosphere (ice and snow) and the biosphere (part of the Earth where living organisms reside). These components interact with each other at various levels. To advance our understanding of the global climate system, we need to understand the interactions and feedback mechanisms between all these components, by finding answers to questions such as:

- How will global warming affect sea ice and how will this affect the ocean circulation?
- What are the climate variabilities associated with seasonal, annual and decadal timescales, and how will that impact on life on Earth?
- What is the role of Antarctica within the global climate system, how does it interact with the Southern Ocean and how does it affect Australia?

To answer these questions we need a numerical model in which physical processes and their interactions are explicitly simulated. As a first step in this direction, the Australian ocean community has developed the Australian Climate Ocean Model (AusCOM). Model results from the Southern Hemisphere will be used to improve climate predictability by understanding which Southern Ocean processes and feedback mechanisms contribute to climate variability. They will also be used to assess how changes in the Antarctic impact on the global climate and vice versa.

The AusCOM model is a 'coupled' ocean-sea ice model – an ocean model connected with a sea ice model. This coupling allows two of the main components of the climate system to

directly interact. Information from changes in sea ice characteristics, for example, will feed into the ocean model, which then reacts in certain ways and feeds this reactive information back into the sea ice model. This provides a more accurate simulation of the climate system than using stand-alone models in isolation.

AusCOM is a collaborative effort involving scientists from the Tasmanian Partnership of Advanced Computing (TPAC), the Australian Antarctic Division (AAD), the Bureau of Meteorology Research Centre, CSIRO Marine and Atmospheric Research and several universities. Some of the model components were contributed by overseas colleagues, including the Geophysical Fluid Dynamics Laboratory (USA) and the European Centre for Advanced Training in Scientific Computation (France). The sea ice model was developed by the AAD and TPAC and will be integrated into the overall model. It is anticipated that the coupled model will be available to researchers in 2006.

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FURTHER READING:

Griffies SM. Fundamentals of ocean climate models. Princeton University Press, 2004.

Griffies SM, Pacanowski RC, Schmidt M, and Balaji V. Tracer conservation with an explicit free surface method for z-coordinate ocean models. *Mon Weather Rev* 2001;129: 1081-1098.

Roberts JL, Heil P, Murray RJ, Holloway DS, and Bindoff NL. Pole relocation for an orthogonal grid: an analytic method. *Ocean Modelling* in press.

Earth system science aims to understand how the Earth is changing and the consequences for life, with a focus on enabling prediction and thus, allowing room to mitigate undesirable consequences. Earth system science is multidisciplinary, and investigates the processes and interactions among the atmosphere, hydrosphere, cryosphere, biosphere and geosphere, from a global to local point-of-view and across the time scales (minutes to eons) in which these spheres interact. It requires knowledge of physical, chemical and biological processes, and uses mathematics to describe these processes within each sphere and the interactions between the spheres. These descriptions are combined with observations from instruments on the ground, in the atmosphere, at sea, or from space, to construct models through which complex interactions of the spheres are studied. It is through the understanding of these processes that accurate, predictive models are developed. MODIFIED FROM [HTTP://EDUCATION.GSFC.NASA.GOV/ESSPROJECT/ESS_DEFINITION.HTML](http://education.gsfc.nasa.gov/ESSPROJECT/ESS_DEFINITION.HTML)

