Geophysical Research Abstracts,
Vol. 10, EGU2008-A-04543, 2008
SRef-ID: 1607-7962/gra/EGU2008-A-04543
EGU General Assembly 2008

Arctic sea ice in CMIP3 projections

V. Kattsov

Voeikov Main Geophysical Observatory of Roshydromet, St.Petersburg, Russia
(kattsov@main.mgo.rssi.ru / fax: +7 812 2978661)

Results of numerous diagnostic subprojects of the WCRP's Coupled Model Intercomparison experiment, phase 3 (CMIP3) has allowed IPCC (2007) to evaluate advances in developing coupled global atmosphere-ocean general circulation models (AOGCM). The advances include higher resolutions, improved numerical schemes and parameterizations; decreased necessity in flux adjustments; and better simulations of some aspects of current climate and specific modes of variability. In particular, relative to the previous generation of AOGCMs, a major advance is that almost all AOGCMs now have more or less comprehensive sea-ice dynamics components. Although sea ice treatment in AOGCMs has become more sophisticated, improvement in simulating sea ice in these models, as a group, is not obvious. It is difficult to isolate causes of model biases, which might arise both from deficiencies in the representation of sea ice itself and biases in simulation of the atmospheric and oceanic fields in high latitudes, which drive ice movement.

A robust feature of climate models since early simulations of the climate system response to increases in atmospheric concentrations of greenhouse gases has been a poleward retreat of sea ice and the 'polar amplification' of increase of air temperature in the lower troposphere, which is particularly strong in the Arctic. In a few CMIP3 projections, perennial arctic sea ice disappears by the end of the 21^{st} century. The polar amplification is usually attributed to positive feedbacks in the climate system, the cryosphere being of prime importance. While evaluating cryospheric feedbacks in recent years has been marked by a certain progress, substantial uncertainty remains as to their magnitudes, and their representation in AOGCMs. This is one factor contributing to a spread of modelled climate responses in high latitudes. Understanding and evaluating sea-ice feedbacks is complicated by their strong coupling to processes in the high-latitude atmosphere and ocean, particularly to polar cloud processes and ocean heat and freshwater transport. Scarcity of observations in polar regions (e.g. of sea ice thickness) also hampers evaluation.

While the projected changes are relatively large in the Arctic, so are the interannual variabilities. Improved computational strategies, e.g. larger ensembles of simulations, and multi-model ensembles have started to play an increasingly important role in addressing unforced variability, as well as in understanding processes responsible for the range of model results. Having the large inter-model differences in sensitivity to external forcing, a quantitative likelihood weighting of different models in multi-model ensembles should improve credibility of the climate projections. However, defining a robust ‘model metric’ remains a challenge facing the climate modelling community. Further progress in developing observational tests aimed at constraining climate sensitivity is hampered by the scarcity of observational data in the polar regions, sea ice thickness being a particular problem.

I acknowledge the modeling groups, the Program for Climate Model Diagnosis and Intercomparison (PCMDI) and the WCRP’s Working Group on Coupled Modelling (WGCM) for their roles in making available the WCRP CMIP3 multi-model dataset. Support of this dataset is provided by the Office of Science, U.S. Department of Energy. This study was supported by the Russian Federal Target Programme “R&D priority directions of developing Russian science and technology complex in 2007-2012” (state contract No.02.515.11.5032), the US National Science Foundation via the International Arctic Research Center of the University of Alaska Fairbanks (subaward UAF05-0074 of OPP-0327664), the Russian Foundation for Basic Research (Grant 07-05-13594-ofi_ts), and INTAS (03-51-4620).