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Observed and modelled polar climate: regional feedbacks and global links

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Recent observations and climate modeling results have highlighted the Arctic as a region of particular vulnerability to global climate change. To arrive on credible present-day Arctic simulations and estimates of future Arctic climate changes, an improved understanding of Arctic climate processes is necessary. There are uncertainties in current modeling of Arctic climate that must be reduced by improving important process and feedback descriptions in climate models. The current parameterizations of the processes within the climate models can only be improved by a close coordination between model simulations and measurements ands the combined use of high resolution regional and global models. The following 4 topics will be discussed.

1. Arctic regional climate model intercomparison project

The primary ARCMIP activities have focused on coordinated simulations by different Arctic regional climate models and their evaluation using observations from satellites and field measurements. The combination of model intercomparison and evaluation using observations allows to assess strengths and weaknesses of model structures, numerics and parameterizations. The simulation experiments are carefully designed so that each of the models is operating under the same external constraints (e.g. domain, boundary conditions). The ARCMIP experiment has been conducted for the 1997/1998 period of Surface Heat Budget of the Arctic Ocean, which included extensive field observations and accompanying satellite analyses and has been described in Rinke et al. (2006).

2. Coupled regional models of the Arctic climate system

Sensitivity experiments using a coupled regional atmosphere–ocean–ice model of the Arctic has been conducted in order to identify the requirements needed to reproduce observed and measured sea-ice conditions on the basis of station observations and satellite SSMI data and to address uncertainties in Arctic process descriptions. The coupled regional HIRHAM-NAOSIM model was described by *Dorn et al. (2007)*. While summer ice decay is strongly affected by the parameterization of the sea-ice albedo, winter ice growth depends significantly on the parameterization of lateral freezing. A large uncertainty in the model relates to the simulation of long-wave radiation, most likely as a result of overestimated cloud cover. The results suggest that uncertain process descriptions for Arctic clouds, snow and sea-ice albedo, and lateral freezing and melting of sea-ice, including the treatment of snow, are responsible for large deviations in the simulation of Arctic sea-ice in coupled models. Improved descriptions of these processes are needed to reduce model biases and to enhance the credibility of future climate change projections.

3. Global impacts of Arctic feedbacks

Sensitivity runs over 500 years with fixed solar constant and CO_2 and a new ice- and snow albedo scheme for the Arctic has ben carried out by use of the state-of-the-art coupled climate model ECHO-G. The Arctic sea ice coverage within ECHO-G improved, especially the minimum extend and area in summer. The global impact of improved Arctic sea-ice and snow albedo leads to annular mode structures similar to the Arctic Oscillation as shown in Dethloff et al. (2006). This implies an influence on the meridional coupling between the energy sources in the tropics and the energy sink in the Arctic.

4. Expected Arctic climate changes

Future changes of the Arctic climate by the end of the 21st century has been simulated by the regional climate model HIRHAM forced with the ECHAM5/MPI-OM general circulation model, assuming the SRES A1B emission scenario. This assessment provides the regional patterns of future circulation, temperature, and precipitation in the Arctic by the end of the 21st century. The magnitude of winter and summer temperature and precipitation is projected to increase, while their interannual variability is projected to change seasonally and is regionally dependent. The regional-scale response of the temperature and precipitation is associated with changes in storm tracks and atmospheric baroclinicity. During winter, the regions of strongest baroclinicity are shifted northward and strengthened. Changes in the seasonal temperature and precipitation are accompanied by changes in their extremes. Extreme warm and cold events are significantly projected to increase.

Literature

Dethloff, K. et al., 2006, A dynamical link between the Arctic and the global climate system, Geophys. Res. Lett., 33, L03703,DOI: 10.1029/2005GL02524.

Dorn, W. et al., 2007, Sensitivities and uncertainties in a coupled regional atmosphere-ocean-ice model with respect to the simulation of Arctic sea-ice, JGR, in press.

Rinke, A. et al., 2006, Evaluation of an ensemble of Arctic regional climate models. Spatio-temporal fields during the SHEBA year, Climate dynamics, 26, 459-472,DOI: 10.1007/s00382-005-0095-3.

Saha, S. K. et al., 2006, Future winter extreme temperature and precipitation events in the Arctic, Geophys. Res. Lett., 33, L15818, DOI: 10.1029/2006GL026451.