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# Modelling of the ice thickness distribution of the Arctic Ocean

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Global climate models predict a maximum warming in the high latitudes of the Northern Hemisphere. Polar amplification is mainly due to the positive feedback mechanisms related to the insulation and albedo effects of the snow and sea-ice. True magnitude of the feedback effect of the ice/snow surface is still unknown because of the incomplete physical description of snow and ice physics and several others unresolved processes of the Arctic climate. A clear indicator of this is that the projected changes exhibit larges range of warming scenarios in the Arctic. In this talk, the effect of the physical description of the sea-ice on the modelled mean state of the sea-ice conditions are examined with a multi-category sea ice model with the prescribed atmospheric and oceanic conditions. The model has a global coverage, however, the focus is on the Arctic Ocean because it employs orthogonal curvilinear coordinates. The co-ordinate system is equivalent to MPI-OM1 where the poles are located over the Canada and the Western Siberia.

The evolution of the ice pack were simulated with the thermodynamical only model (TDM), free drift model (FDM), viscous-plastic (VPM), viscous-plastic model with island in the North Pole (VP-NPM) and with a multicategory model (MCM). In the multicategory model five underformed and two deformed ice categories were used. All simulations begin from the same initial conditions and a stationary conditions were obtained after ten years integration. It has been found that the modelled annual maximum ice extent is rather insensitive to ice dynamics or ice thickness distribution used. This indicates that the maximum annual ice extent is determined by the thermodynamical growth of new ice and correct modelling of sea surface temperature is the most important factor. In addition to the inaccuracies in the surface heat balance, an overestimation of the modelled ice extent in climate models can be caused due to underestimation of the Atlantic heat transport or vertical mixing. On a contrary, minimum ice extent is sensitive to the modelled ice thickness, which in turn, is highly dependent on the ice dynamics or thickness distribution used. Overestimation/underestimation of the dynamical growth of sea ice leads to overestimation/underestimation of ice mass and to a situation where ice isn't melting/surviving during the summer stage. This clearly shows that a mass-momentum coupling is essential for sea ice and only the plastics models are physically realistic in climate simulations. All other models generate highly unrealistic ice thicknesses which are commonly hidden away introducing a numerical diffusion or an artificial upper limit for ice thickness. Sensitivity experiments show that the response of the sea-ice model to the changes of the thermal forcing depends on the modelled mean state of the control climate and thickness distribution used. In particular, beyond certain degree of warming, two-level model may predict total disappearance of sea ice in the Arctic, but multicategory ice model may predict existence of thick ridged ice also during the summer season.