Abstract

In this thesis the Arctic ice cover is investigated by a suite of model studies. The response of the ice cover to observed changes in the atmosphere and ocean are of particular interest.

Measurements from Arctic Ocean 2001 expedition show that the cold halocline layer has returned to the Amundsen basin, close to the position that was observed at the Oden'91 expedition. Model results suggest that such changes has a relatively large impact on the ice cover with about 0.2 m smaller ice growth in areas with absent halocline.

An important heat source for the Arctic is the poleward energy flux in the atmosphere. Results from a coupled ocean-ice-atmosphere column model show that the poleward energy flux has a major influence on the ice cover. An increase by only 9 W m^{-2} has a dramatic effect on the ice cover, reducing the thickness with more than 2 m. The large thinning is generated by a larger area fraction of thin ice that has a thickness dependent albedo. Ridging activity increases the amount of thick, but also thin ice, which makes the ice cover more sensitive to increased poleward energy flux. Divergence has the opposite effect, making the thickness distribution more linear, and therefore less sensitive to increased poleward energy flux.

Time variability of poleward energy flux computed from the NCEP/NCAR reanalysis data set during the period 1954-2000 generates ice thickness variations in a coupled ocean-ice-atmosphere column model of about 1.0 m. During the period 1978-1986 increased poleward heat flux and increased winter cloudiness observed at the Russian ice drift stations, generates a thinning from 3.2 m down to 2.0 m. It is shown that summer is the most critical period when different model formulations has a large impact on the model result. Forcing with prescribed surface air temperature instead of using a full atmospheric model omits important variability of the downward longwave radiation at the surface.

Forcing the same column model with incoming solar radiation at the top of the atmosphere corresponding to the time period 11,000 years ago with higher insolation decreases the ice thickness down to 1.7 m. Including feedbacks on cloud cover or the water vapor feedback results in ice free summers. The ice cover goes back to a perennial state with ice covered summers if a feedback (related to the air temperature) on the poleward energy flux is included. The annual mean thickness is then about 1.6 m.

Key words: Arctic Ocean, oceanography, sea ice thickness, thickness distribution, poleward energy flux, column model.