B01-O03

REGIONAL AND GLOBAL INTERACTIONS BETWEEN ARCTIC SEA ICE AND THE ATMOSPHERIC CIRCULATION

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Despite progress in recent years, there are still limits of state-of-the-art coupled climate models in reproducing the spatial and temporal characteristics of the observed atmospheric teleconnection patterns. A key process to improve this situation is a better understanding and representation of the nonlinear feedbacks between the planetary waves and synoptic-scale eddies and their changes under different boundary forcing.

In this study, emphasis is put on the influence of Arctic sea ice retreat in late summer and Northern hemisphere snow cover changes in autumn on the baroclinic synoptic systems and the subsequent changes of the planetary waves and atmospheric teleconnection patterns in the following winter. The tropo- and stratospheric response to the observed Arctic sea ice retreat and Northern hemisphere snow cover changes has been analysed on the basis of ERA-Interim data from 1979-2012. The amplified diabatic heating in late summer and autumn leads to enhanced baroclinicity driving synoptic scale systems in the Arctic. The baroclinic signal changes the nonlinear interactions between synoptic-scale and planetary scale and their wave energy fluxes. During low ice phases, this results in large scale circulation changes resembling the negative Arctic Oscillation pattern from the surface up to the stratosphere in the following winter. During periods with enhanced snow cover in particular over Eurasia, the related large scale circulation changes in the following winter resemble the negative Arctic Oscillation pattern and go ahead with a strengthening of the Siberian High. The connection between tropo- and stratospheric processes is maintained via enhanced upward Eliassen-Palm fluxes on planetary scales. The statistical analyses highlighted the importance of the location of the sea-ice and snow-cover changes for the related atmospheric circulation changes.

These results obtained from ERA-Interim reanalysis have been compared with AMIP-style simulations of the atmospheric circulation model ECHAM6 and regional model simulations with the coupled regional model HIRHAM-NAOSIM for the Arctic. The analysis of the regional model results over the Arctic has given deeper insights into the atmospheric changes initiated by regional sea ice changes. The above described chain of reactions, initiated by low sea ice conditions, is partly reproduced by the regional model. The response to the Arctic sea ice retreat, simulated by the global model ECHAM6, shows discrepancies compared to the ERA-Interim results. These shortcomings are supposed to be the result of model deficits in planetary wave propagation in particular from the troposphere to the stratosphere.