The regional climate model HIRHAM is used as a tool for coupled modeling within the Arctic climate system. Various approaches are pursued which will finally be combined into a regional Earth System Model.

The single column climate model HIRHAM5-SCM was used for sensitivity studies concerning Arctic cloud cover. It was found that changing the minimum cloud water content leads to a much better representation of cloud cover.

With the coupled regional model HIRHAM-NAOSIM, ensemble simulations were conducted for the period 1948-2008, showing that the modeled year-to-year variability in Arctic Ocean ice-cover is closely related to differences in atmospheric circulation. It is demonstrated that a realistic simulation of the atmospheric circulation and its internal variability is required to reproduce the observed sea ice extent in summer.

To analyze the influence of vegetation cover and ground conditions, the HIRHAM was coupled with the land-surface model provided by NCAR. A sensitivity study showed that while all examined processes affect air temperature, the highest impact is found due to changes in vegetation cover. Dynamical feedbacks then lead to changes in atmospheric circulation.

In addition, to overcome the deficit of only one-way interactions in regional climate models, an adaptive barotropic model of the atmosphere has been developed. Adaptive grid experiments have been performed with a triangular grid on the sphere. Simulations with a quasi uniform grid and an adaptive grid with a higher resolution at the polar region have been compared. The improved regional grid resolution in polar regions effects the planetary wave structure.