Geophysical Research Abstracts
Vol. 20, EGU2018-6423, 2018
EGU General Assembly 2018


# Impact of snow properties on the simulation of present-day Arctic climate

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Arctic land areas are covered by snow between six and nine months of the year, where snow acts as a mediator between atmospheric and ground conditions. Snow impacts the Arctic climate system via its influence on surface albedo, its thermal properties that modify the heat exchange between atmosphere and soil and its influence on soil hydrology especially through snow melt.

Climate models use a variety of snow models of very different complexity and process representations. This study uses the regional climate model HIRHAM5-CLM4 for the Arctic to analyze the impact of snow properties on the simulated present-day Arctic climate. The addressed questions are: Which properties most prominently change the representation of atmosphere and soil? What do those changes look like spatially and temporally? Are the impacts restricted to the land areas only or are there dynamical 'remote' changes too?

The snow scheme used for this experiment is the standard scheme of the Community Land Model v4 (CLM4). It contains representations of snow aging, complex interaction of vegetation and snow, and aerosol deposition. In a control simulation, the model was run for ten years with all those processes switched on. Then each individual process was disabled separately in sensitivity runs. Impacts of those changes in the model on albedo, snow insulation of ground, shortwave radiation, 2m air temperature, soil temperature and moisture as well as atmospheric circulation were analyzed.

In general, the impact of changing optical properties of snow in the model or changing grid cell albedo via changes in snow-vegetation-interaction are relatively small and mostly not statistically significant for atmosphere and soil simulations. Changing thermal properties however leads to statistically significant changes for the ground. Soil moisture in 20 cm depth is lower for grid cells dominated by bare ground, shrubs and grasses in all months and soil temperatures are lower in spring and summer in 20 cm and 100 cm depth. While the atmospheric circulation (mean sea level pressure) shows no statistically significant differences, all modifications of snow representation in the model lead to similar patterns in changes of cyclone tracks in winter and spring.

In conclusion, the removal of specific processes from the CLM4 snow model lead to small changes in snow properties and mostly statistically insignificant differences in the representation of atmosphere and soil variables. This may indicate that climate models' representations of present-day Arctic climate are relatively insensitive to the complexity of the used snow model as long as there is no focus on specific processes like snow melt and ground temperature which may be less well represented.