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Investigation of the effect of improved frozen soil parameterizations and 'emulated permafrost' on Siberian climate, simulated with the regional climate model REMO

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Permafrost or perennially frozen ground occurs beneath roughly one quarter of the earth's land surface. It is a globally relevant carbon reservoir, but also has an impact on the regional climate and hydrology, since it modifies heat and moisture fluxes at the surface and below ground. It can be seen as a 'long-time memory' of climatic conditions, not only in regard to stored carbon, but also for energy and water.

We would like to study the influence of the large permafrost-underlain areas of Siberia on the regional climate and water cycle.
A possible tool for addressing such questions are regional climate models (RCMs), which compute variables like temperature, moisture and heat fluxes for both atmosphere and land surface, spatially on continental scales, and for time periods from days to centuries.
If one is interested in the interplay between permafrost and climate in terms of the evolution of atmospheric temperature and moisture, it is important to consider the physical effects of permafrost in RCM simulations of the high northern latitudes.
These effects comprise, e.g., altered soil temperature dynamics through an increased thermal conductivity in the presence of soil ice and through the impact of latent heat during freeze or melt, and a changed soil hydrology through a decreased hydraulic conductivity.

We therefore expanded the representation of cold regions' processes in the soil scheme of the RCM of the Max-Planck-Institute for Meteorology, REMO with the following aspects:
Thermal properties now depend on water and ice content; soil moisture movement is resolved vertically and so is freezing and melting; and soil hydrology is influenced by frozen ground.
Moreover, we use 'emulated permafrost' in order to take into account the heat sink effect through existing, deep permafrost, which developed over timescales and to depths which are beyond realistic computing times with RCMs.

We used these tools for simulations on a model domain covering Siberia, with a spatial resolution of 0.5 degree.
Results will be shown for experiments driven with ERA40-reanalysis data for today's climate. These will be validated against observations, and the impact of the above mentioned changes on the simulated climate will be analysed.