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Bridging models for the terrestrial cryosphere and the atmosphere - The CryoMET project

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Predictions of the future climate are generally based on atmospheric models operating on coarse spatial scales. However, the impact of a changing climate on most elements of the cryosphere becomes manifest on much smaller scales, which complicates sound predictions e.g. on glacier and permafrost development. CryoMET is a collaborative project between atmospheric modeling, glacier and permafrost research groups, seeking to bridge the scale gap between coarsely-resolved Earth System Models and the process and impact scales on the ground for the variables snow depth and snow water equivalent for sites in Norway and Svalbard.

Snow is a crucial factor both for the thermal regime of permafrost and the mass balance on glaciers. However, the snow depth and properties can vary considerably on small scales due to wind redistribution, which for instance leads to distinctly different soil temperatures in permafrost areas on distances of tens of meters. CryoMET explores a seamless downscaling procedure to improve the representation in complex terrain: in a first step, we use the regional model PolarWRF to downscale atmospheric variables, including precipitation, air temperature and wind speed, to the so-called interface scale of 1 km to 3 km resolution, where these variables are constant to a good approximation. In a second step, we employ probabilistic downscaling of the average snow water equivalent at the interface scale (as delivered by PolarWRF) using snow redistribution models. With probability density functions of snow depth, the distribution of environmental parameters affected by snow, e.g. of permafrost temperatures, can be inferred for each grid cell at the interface scale. We present here first results demonstrating the capacity of the scheme in delivering the distribution of permafrost-relevant variables.