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The added value of high-resolution climate modeling of the Greenland Ice Sheet

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The local surface mass balance (SMB) of glaciers and ice sheets is to a very high extent related to topography. Subsequently, spatial variability in the SMB is also related to the spatial scales in the topography. The typical topographic length scales on the Greenland Ice Sheet are from several to over hundred kilometers. Therefore, regional climate models with resolutions between 5 and 25 kilometers normally capture the SMB of the Greenland Ice Sheet well.

In this study, we analyze the added value of high-resolution regional climate simulations compared to statistical downscaling. For this aim, the regional climate model RACMO2 has been run for South Greenland for the period 2007-2014 using resolutions of 60, 20, 6.6 and 2.2 kilometer. Modeled and downscaled SMB from these four simulations are analyzed and evaluated against ablation observations.

Our results show that the strong correlation of runoff to elevation makes statistical downscaling a robust tool to refine modeled spatial SMB patterns. However, only high-resolution climate modeling can improve the physical representation of the SMB in lower ablation zone, because the summertime interaction between the warm air over the tundra and the colder air over the ice sheet starts to be resolved. As a result, the runoff in the lower ablation zone is more enhanced compared to lower resolution simulations and statistical downscaled SMB.