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Surface Mass Balance Distributions: Downscaling of Coarse Climates to drive Ice Sheet Models realistically

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The surface mass balance (SMB) is the most import boundary conditions for the state of glaciers and ice sheets. Hence its representation in numerical model simulations is of highest interest for glacier, ice cap and ice sheet modeling efforts. While descent SMB distributions of the current climate could be interfered with the help of various observation techniques and platforms, its construction for older past and future climates relies on input from spatially coarse resolved global climate models or reconstructions. These coarse SMB estimates with a footprint in the order of 100 km could hardly resolve the marginal ablations zones where the Greenland ice sheets, for instance, loses snow and ice. We present a downscaling method that is based on the physical calculation of the surface mass and energy balance. By the consequent application of universal and computationally cheap parameterizations we get an astonishing good representation of the SMB distribution including its marginal ablation zone. However the method has its limitations; for example wrong accumulation rates due to an insufficient precipitation field leaves its imprint on the SMB distribution. Also the still not satisfactory description of the bare ice albedo, in particular, in parts of Greenland is a challenge.

We inspect our Greenland SMB fields' for various forcings and compare them with some widely used reference fields in the community to highlight the weakness and strength of our approach. We use the ERA-Interim reanalyzes period starting in 1979 directly as well as dynamically downscaled by our regional climate model HIRHAM (5 km resolution). Also SMB distributions obtained from the climate model EC-Earth with a resolution of T159 (approx. 125 km resolution in Greenland) are used either directly or downscaled with our regional climate model HIRHAM. Model-based End-of-the-century SMB estimates give an outlook of the future.