A Snow Density Dataset for Improving Surface Boundary Conditions in Greenland Ice Sheet Firn Modeling - DTU Orbit (13/10/2019)

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The surface snow density of glaciers and ice sheets is of fundamental importance in converting volume to mass in both altimetry and surface mass balance studies, yet it is often poorly constrained. Site-specific surface snow densities are typically derived from empirical relations based on temperature and wind speed. These parameterizations commonly calculate the average density of the top meter of snow, thereby systematically overestimating snow density at the actual surface. Therefore, constraining surface snow density to the top 0.1 m can improve boundary conditions in high-resolution firm-evolution modeling. We have compiled an extensive dataset of 200 point measurements of surface snow density from firm cores and snow pits on the Greenland ice sheet. We find that surface snow density within 0.1 m of the surface has an average value of 315 kg m\(^{-3}\) with a standard deviation of 44 kg m\(^{-3}\), and has an insignificant annual air temperature dependency. We demonstrate that two widely-used surface snow density parameterizations dependent on temperature systematically overestimate surface snow density over the Greenland ice sheet by 17–19%, and that using a constant density of 315 kg m\(^{-3}\) may give superior results when applied in surface mass budget modeling.

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