EGU23-9080, updated on 07 Jun 2023
https://doi.org/10.5194/egusphere-egu23-9080
EGU General Assembly 2023

Historical snow and ice temperature compilation documents the recent warming of the Greenland ice sheet

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The Greenland ice sheet mass loss is one of the main sources of contemporary sea-level rise. The mass loss is primarily caused by surface melt and the resulting runoff. During the melt season, the ice sheet's surface receives energy from sunlight absorption and sensible heating, which subsequently heats the subsurface snow and ice. The energy from the previous melt season can also enhance melting in the following summer as less heating is required to bring the snow and ice to the melting point. Subsurface temperatures are therefore both a result and a driver of the timing and magnitude of surface melt on the ice sheet. We present a dataset of more than 3900 measurements of ice, snow and firn temperature at 10 m depth across the Greenland ice sheet spanning the years from 1912 to 2022. We construct an artificial neural network (ANN) model that takes as input the ERA5 reanalysis monthly near-surface air temperature and snowfall for the 1954-2022 period and train it on our compilation of observed 10-meter temperature. We use our dataset and the ANN to evaluate three broadly used regional climate models (RACMO, MAR and HIRHAM). Our ANN model provides an unprecedented and observation-based description of the recent warming of the ice sheet's near-surface and our evaluation of the three climate models highlights future development for the models. Overall, these findings improve our understanding of the ice sheet's response to recent atmospheric warming and will help reduce uncertainties of ice sheet surface mass balance estimates.