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Characteristics of snow structure along Kongsvegen glacier (Svalbard)

Friedrich Obleitner and Maik Brakemeier
Institute for Atmospheric and Cryospheric Sciences, Innsbruck University, Austria

Detailed observations of snow in Arctic regions are scarce while interest in its distribution, properties and seasonal development of Arctic snow is evident in context of climate change, too. We here introduce comprehensive data of end-winter snow physical parameters being observed in snow pits along a height transect at Kongsvegen glacier (Svalbard). Analysis is strongly focused on identifying major structural features (strongly based on high-resolution, SMP derived density profiles), describing their spatial variability (along the glacier and locally) and reproducing their evolution history throughout winter (using the SNOWPACK model driven by input from co-located automatic weather stations).

Applying a layer-wise depth scaling method three outstanding layers can clearly be traced within the accumulation area of the glacier being characterized by maxima in snow hardness and density and mostly rounded grain types. Attributions were comparatively uncertain in the lower section i.e. the ablation area of the glacier due to the higher temperatures and associated melt influences. On the local scale i.e. across decameter distances, the snow hardness profiles were significantly correlated in both regions.

The simulations were skilfully validated by comparison with measured key parameters. Major deficits in simulation skill were reflected in e.g. biases towards too low snow temperature and failure to reproduce fine structures in the vertical density profiles. Concerning the investigated exemplary layers, however, the simulations largely reproduce the observed characteristics. Uncertainties are generally larger at lower sites and a general tendency towards too rapidly evolving snow metamorphosis may be noted. Backtracing individual layers proved feasible and allows estimating the approximate date of deposition and associated meteorological conditions.

Follow up work may concern more detailed analysis of the observed profiles, including parameters and sites which have not yet been considered in this work. Advancing methods for more sophisticated depth attribution of profile data is desirable as well as developing enhanced understanding of processes governing the development of observed physical properties (grain types in particular). Related simulations may mainly be improved concerning their setup and parameterizations (of fresh snow density for example). On the other hand, existing output also hints on interesting new research topics related to e.g. the development of a firn aquifer in the upper regions of the glacier and its dependencies on near-surface snow developments.