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Integrated firn elevation change model for glaciers and ice caps

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We present the development of a firn compaction model in order to improve the volume to mass conversion of geodetic glacier mass balance measurements. The model is applied on the Arctic ice cap Vestfonna. Vestfonna is located on the island Nordaustlandet in the north east of Svalbard. Vestfonna covers about 2400 km^2 and has a dome like shape with well-defined outlet glaciers.
Elevation and volume changes measured by e.g. satellite techniques are becoming more and more popular. They are carried out over observation periods of variable length and often covering different meteorological and snow hydrological regimes. The elevation change measurements compose of various components including dynamic adjustments, firn compaction and mass loss by downwasting.
Currently, geodetic glacier mass balances are frequently converted from elevation change measurements using a constant conversion factor of 850 kg m^{-3} or the density of ice (917 kg m^{-3}) for entire glacier basins. However, the natural conditions are rarely that static. Other studies used constant densities for the ablation (900 kg m^{-3}) and accumulation (600 kg m^{-3}) areas, whereby density variations with varying meteorological and climate conditions are not considered. Hence, each approach bears additional uncertainties from the volume to mass conversion that are strongly affected by the type and timing of the repeat measurements.
We link and adapt existing models of surface energy balance, accumulation and snow and firn processes in order to improve the volume to mass conversion by considering the firn compaction component. Energy exchange at the surface is computed by a surface energy balance approach and driven by meteorological variables like incoming short-wave radiation, air temperature, relative humidity, air pressure, wind speed, all-phase precipitation, and cloud cover fraction. Snow and firn processes are addressed by a coupled subsurface model, implemented with a non-equidistant layer discretisation.
On our poster we present a general view on the model structure, the input data (model forcing) and finally, an exemplary test case with basic approaches of validation.