Firn Model Intercomparison Experiment (FirnMICE) - DTU Orbit (29/12/2018)

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Evolution of cold dry snow and firn plays important roles in glaciology; however, the physical formulation of a densification law is still an active research topic. We forced eight firn-densification models and one seasonal-snow model in six different experiments by imposing step changes in temperature and accumulation-rate boundary conditions; all of the boundary conditions were chosen to simulate firn densification in cold, dry environments. While the intended application of the participating models varies, they are describing the same physical system and should in principle yield the same solutions. The firn models all produce plausible depth-density profiles, but the model outputs in both steady state and transient modes differ for quantities that are of interest in ice core and altimetry research. These differences demonstrate that firn-densification models are incorrectly or incompletely representing physical processes. We quantitatively characterize the differences among the results from the various models. For example, we find depth-integrated porosity is unlikely to be inferred with confidence from a firn model to better than 2 m in steady state at a specific site with known accumulation rate and temperature. Firn Model Intercomparison Experiment can provide a benchmark of results for future models, provide a basis to quantify model uncertainties and guide future directions of firn-densification modeling.

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