EGU2020-15912
https://doi.org/10.5194/egusphere-egu2020-15912
EGU General Assembly 2020

How does the meltwater flow? Retention and refreezing in firn on ice sheets and ice shelves

Ruth Mottram[1], Baptiste Vandecrux[2], Martin Olesen[1], Fredrik Boberg[1], Nicolaj Hansen[1], Peter Langen[1], Robert Fausto[2], and the RetMIP contributors[*]

[1]Danish Meteorological Institute, Research and Development, København, Denmark (rum@dmi.dk)

[2]GEUS - Geological Survey of Denmark and Greenland, København, Denmark

[*]A full list of authors appears at the end of the abstract

Mass loss from glacier surface melt is buffered by percolation and refreezing in the underlying snowpack, processes of particular importance in the percolation zone of the Greenland ice sheet and increasingly in Antarctica under a warming climate. Retention and refreezing is dependent on a number of micro-scale factors such as snow grain size, density and temperature that are heavily parameterized in models. Melt and snowfall in preceding seasons are also important in determining retention rates in the current season due to initialization of the snowpack .

In the retention model intercomparison project (RetMIP) we use a common atmospheric forcing from the HIRHAM5 regional climate model to drive participating models, to study the effect of different internal parameterisations. We compare 9 different 1D models and four 2D models with each other and with observations from 4 key field sites. We show that initialisation of snowpack models is important but evolution of retention through time is strongly determined by melt rates.

Models that explicitly account for deep meltwater percolation tend to overestimate percolation depth and consequently firn temperature at the percolation and ice slab sites although they simulate accurately the recharge of the firn aquifer. Models using Darcy's law and bucket scheme compare favourably to observations at the percolation site but only the Darcy models accurately simulate firn temperature and thus meltwater percolation at the ice slab site. We find that Eulerian models that transfer firn through fixed layers, diffuse over time the gradients in firn temperature and density. No model outperforms all others at our four test sites indicating that all models have potential for development.

A first look at Antarctic firn processes emphasises the importance of long spin-up times to initialise the snowpack and as the ice sheet surface evolves in the future parameterising the specific Antarctic retention process is likely to become more important.

RetMIP contributors: C. Max Stevens, Vincent Verjans, Amber Leeson, Stefan Ligtenberg, Peter Kuipers Munneke6, Sergey Marchenko, Ward van Pelt, Colin Meyer, Ian Hewitt, Sebastian B. Simonsen, Achim Heilig, Samira Samimi, Horst Machguth, Michael MacFerrin, Masashi Niwano,

Olivia Miller, Clifford I. Voss, Jason E. Box, Xavier Fettweis