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Refreezing of melt water in the snow pack of Freya Glacier in North-East-Greenland

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Refreezing of melt water is known to play an important role in both the mass and energy budgets of Arctic glaciers as internal accumulation leads to a systematic error in mass balance calculation if it is not accounted for. Within the firn zone, refreezing incorporates that of percolating meltwater in cold firn during early summer as well as the refreezing of capillary water trapped within firn pore spaces at the end of summer. Below the firnline, meltwater percolating to the base of the annual snow layer will refreeze directly onto the impermeable glacier ice to form superimposed ice. These processes redistribute mass from the surface to the interior of a glacier and are summarized as internal accumulation.

A variety of measurements with the aim of quantification of refreezing of melt water have been performed on Freya Glacier, a 6 km long valley glacier situated on Clavering Island, 10 km southwest of Zackenberg Research Station, situated on the north-eastern coast of Greenland. Its NW-oriented surface area is 6.6 km2, reaching from 330 m to 1250 m a.s.l. Thermistor strings have been drilled into the ice and mounted on poles for collecting ice- and snow temperatures. Furthermore, an automatic weather station has been put up near the equilibrium line altitude in August 2011 to collect all necessary data for energy balance calculations. Shallow ice cores (2 m) serve as additional point information to identify annual layers of superimposed ice. These data served as input and validation for the one-dimensional physical based snow model SNOWPACK to investigate percolation and refreezing of melt water in the snow pack.

In this poster, we present results of data analysis as well as modelling results, focusing on the bias in snow temperature. In the modelled season, a 9 cm layer of superimposed ice was built up because of effective meltwater refreeze upon the glacier surface. This ice layer disappeared during the subsequent summer, thus an ice-pond had been formed at the glacier surface. This corresponds well to the observations in the flat, slush-ice area where the modelling had been performed.