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Greenland subglacial conditions inferred from a hybrid ice sheet/ice stream model: implications for NEEM basal ice

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Subglacial conditions of large polar ice sheets remain poorly understood, despite recent advances in satellite observation. Major uncertainties related to basal conditions, such as the temperature field, are due to an insufficient knowledge of geothermal heat flow. Here, a hybrid method is presented that combines numerical modeling of the ice sheet thermodynamics with a priori information using a simple assimilation technique. Additional data are essentially vertical temperature profiles measured in the ice sheet at selected spots, as well as information on basal reflectors obtained from radar soundings. In this way, geothermal heat flow datasets are improved to yield calculated temperatures in accord with observations in areas where information is available.

In order to achieve statistical robustness, sensitivity experiments are carried out for perturbations in surface accumulation and geothermal heat flow (GHF). This way it is possible to calculate the probability of having ice at pressure melting point and the amount of basal melting associated with this. The analysis focuses on the NEEM drilling site where a deep ice core drilling is being carried out. The influence of basal melting probability on the presence of Eemian ice is discussed.

The steady state basal water flux underneath the Greenland ice sheet was calculated and shows the subglacial water flow concentrated underneath the large outlet glaciers.