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The effect of subglacial hydrology when assessing the impact of geothermal heat flux on sliding and ice dynamics

Silje Smith-Johnsen, Basile de Fleurian, and Kerim Nisancioglu

University of Bergen, Faculty of Mathematics and Natural Sciences, Department of Earth Science, Bergen, Norway (silje.johnsen@uib.no)

The magnitude and spatial distribution of geothermal heat flux (GHF) beneath ice sheets are largely unknown. An increase in GHF may enhance the production of subglacial meltwater, which in turn will affect the basal drag and sliding velocity of an ice stream, thus making it an important boundary condition in numerical models. Sensitivity to variations in GHF on ice dynamics has previously been investigated, but these studies mainly focused on the change in ice rheology with changing ice temperature, and not the effect on friction at the base.
We investigate the impact of a local increase in geothermal heat flux on the ice dynamics of a synthetic glacier (MISMIP+) using the Ice Sheet System Model. By including a two-layered subglacial hydrology model, the coupling between water pressure and basal drag is taken into account through a simple friction law. Results show that the mechanical response arising from changes in rheology is insignificant (2% increase in velocity) compared to the effect arising from the reduction in basal drag (up to 50% increase in velocity) as GHF is doubled. This underlines the importance of including effective pressure when assessing geothermal heat flux sensitivity.