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Assessing the role of subglacial hydrology on the flow of Kamb Ice Stream (Ice Stream C): a numerical modelling approach

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The flow of Antarctic ice streams is known to fluctuate with fast and stagnant phases. It has been assumed that these oscillations have been driven by a basal thermal regime controlled mainly by the ice temperature distribution near the bed. The association of this mechanism with a dynamic flow periodicity on the order of several thousand years conflicts with periodicity estimates derived from surface morphology, which are an order of magnitude faster. This inconsistency may be related to recent findings showing rapid movement of water stored in lakes beneath the Siple Coast ice streams. With the aim to assess the role of subglacial hydrology, we are developing a numerical model where ice motion and subglacial hydrology are integrated.

The HIT flowline model couples Hydrology, Ice thermodynamics and Till rheology. The coupled model is applied to the stagnant Kamb Ice Stream (Ice Stream C). We are currently prescribing a fixed ice stream geometry, a constant surface temperature, and a constant net accumulation rate, but we vary the rate of subglacial water entering the system. The force balance includes longitudinal stresses and till rheology is Coulomb-plastic. The velocity equation allows us to evaluate out-of-plane effects such as stress transfer from bed to shear margins as till weakens in response to the availability of water.

Ice thermodynamics are linked to the hydrology component through basal stress and basal melt or freezing. The hydrology and till components are strongly integrated, where water from upstream and from melt are diffused into the till layer depending on

pressure relationships and till porosity. If freeze is dominant, the water needed to accommodate this is drawn out of the till layer. Preliminary results show that subglacial hydrology is a key control on the evolution of physical properties in the till layer, suggesting that re-activation of Kamb Ice Stream may occur faster than expected.