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The influence of subglacial hydrology on the flow of Kamb Ice Stream

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The West Antarctic ice streams are known to have experienced temporal changes in their flow dynamics, such as the stagnation of Kamb Ice Stream approximately 150 years ago. Although previous studies have identified a strong interaction of ice streams with a weak sedimentary bed, little is known about the influence of the subglacial hydrological system. The latter has only recently become apparent due to the identification of subglacial lakes. A numerical flowline model, the Hydrology, Ice and Till (HIT) model, was developed to investigate whether changes in subglacial water availability could facilitate the slow down or speed up of these ice streams. Ice thermodynamics in the model are coupled to a till layer of Coulomb plastic rheology. The porosity of the till changes with basal melt/freeze and can be augmented by water transported through a subglacial conduit system. The model shows that water availability strongly affects ice flow, as till porosity influences the till failure strength and thereby the basal resistance of the ice stream. Results for Kamb Ice Stream show that the ice stream oscillates between fast and slow velocity states and that hydrological effects influence the temporal character of this activity. Cycles are generated at the ice stream grounding line and the speed of the transition from slow to fast flow is governed by the basal thermal regime and by water availability. The period of oscillation of the cycles experienced by Kamb Ice Stream was found to be several hundred years, which indicates that reactivation of this ice stream could be imminent.