



Dynamic response of ice streams to switches in subglacial water-flow paths

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The main trunk of Kamb Ice Stream (KIS) stagnated ~ 170 years ago (Retzlaff and Bentley, 1993), leading to positive mass balance of the Siple Coast region of West Antarctica (Joughin and Tulaczyk, 2002). We use a numerical flowline model, the Hydrology, Ice and Till (HIT) model (van der Wel, 2013), to investigate whether subglacial water piracy from KIS to neighbouring Whillans Ice Stream (WIS) could have been instrumental in the shutdown of KIS and to investigate the possibility of its reactivation. The model couples ice thermodynamics to a till layer of Coulomb plastic rheology. Water is generated/removed by melting/freezing of the ice base, augmented by water transported through a subglacial conduit system. Subglacial water fluxes rerouted outside of KIS are based on gradients in hydraulic potential (assuming an ice overburden pressure equal to the basal water pressure), which show that it is likely that basal water is transferred from KIS to WIS, particularly from KIS's southern-most upper tributary.

We begin with base runs for KIS and WIS with reasonable modern day surface velocities and ice geometries. We find that both KIS and WIS experience temporal oscillations in flow, due to changes in subglacial conditions at the ice stream grounding lines (van der Wel, 2013). We then investigate the effect that changes in the magnitude of subglacial water present in the lower ice stream have on the flow of both ice streams. Results indicate that a decrease in subglacial water discharged to the lower main trunk of an ice stream causes the mean surface velocity of the lower ice stream to decrease, with shorter periodicity and higher amplitude flow oscillations. If the subglacial water discharged to the lower ice stream is increased, the opposite result occurs. This indicates that a switch in subglacial water-flow paths that directs water, currently routed from KIS to WIS, back to into the subglacial system of KIS could both enhance the current deceleration of WIS and lead to the reactivation of KIS.

References

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