

Tidal Pacing, Stick Slip, and the Slow Down of the Whillans Ice Stream

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The Whillans Ice Stream (WIS) is major route for ice transiting from the interior of the West Antarctic Ice Sheet (WAIS) into the Ross Sea. It has been observed that the WIS has been slowing, contributing to a positive mass balance in the Ross Sea sector of the WAIS. Our examination of the velocity time-series for the ice stream reveals that the deceleration is not occurring at a steady rate, but varies at the sub-decadal time-scale. This unsteady deceleration modulates the temporal evolution of a broad (~50 km across) surface-elevation bulge forming at the junction between the relatively narrow upstream portion of the ice stream and broad ice-plain that constitutes the down-stream end of the WIS. Superimposed on this decadal-scale trend of deceleration, comparison of observations from 2003/04 and 2010/11 reveal significant changes in the tidally modulated stick-slip cycle that regulates motion on the ice plain. We observe that the timing of slip events has become less regular in response to decreased flow speed in the upstream portions of the ice stream. The reduced regularity of slip events has resulted in a less efficient release of stored elastic strain during slip events, increasing the rate deceleration, pointing toward non-linear feedbacks at the daily-scale that influence the decadal time-scale evolution of the ice stream