Geophysical Research Abstracts, Vol. 8, 03217, 2006
SRef-ID: 1607-7962/gra/EGU06-A-03217

Basal mechanics of ice stream stick-slip

J.P. Winberry (1), S. Anandakrishnan (1), R.B. Alley (1), R.A. Bindschadler (2), M. King (3), D. Voigt (1), I. Joughin (4)

(1) Penn State University, (2) NASA Goddard, (3) University of Newcastle, (4) University of Washington

Understanding the dynamics of Whillans ice stream (WIS) is essential for predicting the future stability of the West Antarctic ice sheet, particularly in light of its recent slow-down. However, the observation that motion in the downstream portion is dominated by stick-slip motion has revealed a new complexity in the flow of this ice stream. A comprehensive model of stick-slip motion that can successfully explain the significant variability in slip-event recurrence interval and magnitude is needed for a complete understanding of ice stream dynamics, a critical element in assessing the future behavior of the West Antarctic ice sheet. Our analysis demonstrates that stick-slip variability is not well explained by a plastic model that assumes a constant yield stress. Instead, a time dependent increase in yield strength, or healing, occurs following a slip-event. This healing in combination tidal driven fluctuations in stress on the glacier explain the first order variations observed in slip events.

On three occasions during 110 days of observations during the 2003 and 2004 field seasons only one slip event was observed during a 24 hour period, instead of the normal two. This resulted in a 40% decrease in total motion during the day. If WIS were to switch from its current normal state of two slip events per day to a one slip event mode, shut down of the ice stream may be more rapid than suggested, due to the feedback between reductions in velocity and basal melting. Thus understanding this second mode of stick-slip motion may prove important in predicting the future of WIS. We postulate that these longer recurrence intervals may be associated with additional basal strength gained by basal freeze-on processes.