Decadal dynamics of basal conditions as viewed from the ice bulge on Kamb Ice Stream

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The ice bulge on Kamb Ice Stream (KIS) represents the strongest positive mass balance anomaly in the interior of the Antarctic Ice Sheet (Zwally et al., 2005). This anomaly is caused by internal ice sheet dynamics, i.e. the stoppage of KIS about 150 years ago. High ice sheet thickening rates, up to ~1 m/yr, indicate that this regional imbalance anomaly will not persist for extended time period (e.g. thousands of years) but will force rearrangements in ice drainage to increase mass output from the region.

Here we report results of a GPS-based study aimed at constraining recent dynamics of the KIS ice bulge. In the course of this study (2004/05 and 2005/06 seasons) we conducted GPS measurements of ice surface velocity in ~300 locations, measured deformation of 5 large strain grids, and performed continuous GPS measurements over a small subglacial lake underlying the ice bulge. Repeat velocity measurements indicate that the ice bulge has been moving at relatively steady rates over the last decade, with some localities showing small accelerations and decelerations. Four of the five strain grids were located at the leading edges of the ice bulge, where ice velocity changes from moderately fast (>20 m/yr) to slow (~5 m/yr). Force budget calculations indicate that the faster-flowing areas have lubricated bed (local basal stress < local driving stress). Much of the locally unbalanced driving stress is transferred downstream to the unlubricated bed of slow-moving ice. This stress transfer may be important in enhancing basal shear heating and either slowing down continued bed strengthening or enabling re-lubrication of basal conditions at the leading edge of the ice bulge. One strain grid was located over the small subglacial lake whose existence beneath KIS was inferred from repeat airborne lidar surveys by Gray et al. (2005). This strain grid showed also local force imbalance over the location of the subglacial lake. However, continuous GPS measurements between December 2004 and December 2005 performed over the lake show little clear evidence for 'unusual' vertical displacement patterns, which could be associated with filling or draining of the lake. GLAS altimetry data suggests that the period of our continuous GPS observations may have coincided with a relatively quiescent stage of subglacial lake hydrology, when lake volume changes were relatively small.