

Active sub-glacial lakes beneath two more Antarctic outlet glaciers appear to cause rapid speed and elevation changes

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Recent studies have shown that sub-glacial lake activity can have a significant local effect on the flow speed of major outlet glaciers on the great ice sheets (e.g., Byrd Glacier: L. Stearns et al., 2008 *Nature Geoscience*). Here we present two additional cases where sub-glacial drainage and re-fill appears to be causing significant changes in ice flow speed. However, the two outlet glaciers discussed here show different responses to lake drainage.

MacAyeal Ice Stream in the Siple Coast region of West Antarctica has been shown to contain several active sub-glacial lakes (H. Fricker et al., 2007 *Science*, and H. Fricker et al. in prep.). ICESat repeat profiles and MODIS image differencing allows us to determine the fill-drain status of the lakes. We have examined the largest lake, near the grounding line area, for flow speed changes during fill and drain cycles with several ASTER images. Ice velocity mapping using ASTER image pairs spanning periods when the lake is drained show flow speeds up to 40 m/yr slower than when the lake is filled. We infer that flow speed decreased as a result of increased basal resistance (from zero to non-zero as the ice encountered the basal sediments). The scale of the slowdown is similar to modeled results on nearby ice streams (Sergienko et al., 2007, *Geophys. Res. Lett.*).

Crane Glacier in the Antarctic Peninsula has shown a remarkable increase in speed and decrease in elevation since the break-up of the Larsen B Ice Shelf in 2002. However, during the period November 2004 to November 2005, a portion of the lower glacier showed a sudden, localized increase in the rate of lowering, exceeding 100 m/year for a few months.

The glacier accelerated at a greater rate during and after this period (as determined by a series of satellite image pairs ending with Formosat-2 images in 2008 and 2009), and the surface character of the lower glacier changed significantly to a highly fractured serac field.

Examination of the Crane Glacier fjord bathymetry by multi-beam sonar in regions now exposed due to ice shelf and glacier retreat shows a series of enclosed over-deepened basins. This suggests that a series of sub-glacial lakes existed in the lower trunk prior to ice shelf disintegration. The region of the large Crane elevation change is still ice-covered and therefore unmapped for bathymetry, but may represent an additional lacustrine basin. Changing ice surface slope in the years before the sudden drawdown can be inferred to have significantly changed the sub-glacial pressure field. In the Crane Glacier case, acceleration during drainage may be driven by the large further increase in along-flow surface slope caused by drainage.