Elevation Change Anomalies in West Antarctica - New Windows Into Dynamics of Subglacial Water Flow

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Water flow beneath ice sheets is notoriously difficult to quantify because it is hard to perform direct measurements of subglacial water volume and pressure changes. Monitoring of ice surface elevation changes may provide an important constraint on the relationship between water flux and water pressure wherever subglacial water thickness changes are large enough to be expressed at ice surface.

Elevation Change Anomalies (ECAs) have been recently recognized within the Ross Sea sector of WAIS through remote sensing analysis of ice surface elevation changes (Gray et al., 2005). The ECAs appear as ~5-km-diameter oval areas of anomalously high, up to ±0.5 m, surface elevation rise or drop in RADARSAT interferometric synthetic aperture radar (InSAR) images separated by 24 days in September and October 1997. In addition, two ~10-km diameter ECAs with elevation changes of 3.5-to-6 meters were revealed by repeat laser altimeter (LIDAR) lines from the austral summers 1997/98 and 1999/00.

Here we present the results of a quantitative model, which simulates deformation of an elastic ice layer over a subglacial cavity. The model demonstrates that ECAs may be an expression of cyclic filling and draining of subglacial water from such subglacial cavities. By combining measurements of ice-surface elevation changes over ECAs with our model it is possible to derive constraints on: (1) volume of subglacial water involved in cavity filling/draining, (2) associated water pressure changes, and (3) effective elastic properties of ice overlying the subglacial cavity.