Grounding Zone Heterogeneity on Whillans Ice Stream, West Antarctica

<u>Knut Christianson</u>[1,2], Robert W. Jacobel[1], Huw J. Horgan[3], Sridhar Anandakrishnan[2], Richard B. Alley[2], Benjamin Petersen[4], Benjamin Keisling[1], Lauren Snyder[1], Rebecca Gobel[1], Brian Craig[1], Kevin Dalla-Santa[1]

[1]Physics Department, St. Olaf College, Northfield, MN, USA

[2]Department of Geosciences, The Pennsylvania State University, University Park, PA, USA

[3]Antarctic Research Centre, Victoria University of Wellington, Wellington, New Zealand

[4]Department of Geological and Atmospheric Sciences, Iowa State University, Ames, IA, USA

Grounding zones of ice sheets are critical to understanding marine ice sheet dynamics as processes here determine the mass flux from grounded to floating ice, and thus eventually to the ocean. Furthermore, basal hydrological processes at the grounding zone are critical to understanding inland ice sheet hydrology and the flux of subglacial water and sediment to the ocean. Despite this importance to ice sheet dynamics, comprehensive ground-based geophysical data over ice sheet grounding zones are sparse. Here we present the most comprehensive ground-based geophysical survey ever collected across an ice sheet grounding zone. Our data consist of over 1000 km of kinematic GPS data, over 650 km of ice-penetrating radar data, and approximately 50 km of active-source seismic data collected over the grounding zone of Whillans Ice Stream. These data show that grounding zones that have significantly different surface expressions (in the form of either differing surface slopes, recent grounding line behavior, or grounding zone width) also have significant differences in basal features and processes which are important to capture in ice flow models. Here we contrast a grounding zone embayment (an area where subglacial water from several subglacial lakes is suspected to drain to the ocean) with a grounding zone promontory (characterized by steep surface slopes). Our results indicate that the embayment is characterized by less dramatic surface and basal slopes and less basal reflectivity contrast across the grounding zone. This suggests that there is less of a barrier to seawater intrusion into, and possibly, upstream, of the low-tide grounding line. In contrast, data collected over the promontory depict steep surface slopes, dramatic ice thinning across the grounding line, and a strong contrast in basal reflectivity. This indicates that the grounding zone in this promontory is likely a strong barrier to seawater intrusion and thus to grounding zone retreat. These results suggest the need to include better parameterization of grounding lines into ice sheet models based on the most salient processes operating at the ice/bed interface in a specific geographical area. Thus current ice sheet models that use a single depiction of an ice sheet grounding zone over a wide geographical area are likely inadequate to simulate accurate ice sheet behavior, especially in response to a warming ocean or wind-induced changes in ocean circulation. In addition to presenting these new geophysical data, we also suggest changes to treatment of grounding zones in ice sheet models that may more accurately simulate ice sheet behavior.