Evidence for Ice-Flow-Coupled Subglacial Water Systems Beneath West Antarctica's Potentially Unstable Thwaites Glacier

Dustin M. Schroeder[1], Donald D. Blankenship[1], Duncan A. Young[1]
1: The University of Texas Institute for Geophysics

Subglacial water in various forms has been observed and theorized to accelerate the flow of overlying ice. The acceleration depends on the flux through the subglacial water system and whether the dynamic state is hydrologically "distributed" or "concentrated" . Marine ice sheets with landward-sloping beds are in an unstable configuration for which such accelerations can initiate or modulate grounding line retreat and ice loss. Thwaites Glacier (TG) is one the largest, most rapidly changing glaciers on earth and its landwardsloping bed reaches the interior of the marine West Antarctic Ice Sheet (WAIS) which impounds enough ice to yield meters of sea level rise. Despite the potential instability of this configuration, the subglacial water systems beneath TG and their control on ice flow have not been characterized by geophysical analysis. Although, the size of TG makes airborne radar sounding the only practical means of observation, previous radar analysis approaches have proven inadequate to characterize the dynamic state and geographic extent of its subglacial water systems. We use advanced processing to focus radarsounding data collected over TG and measure the angular distribution of energy returned from the bed. This allows us to characterize the meter-scale geometry and dynamic state of subglacial water systems across TG and validate our interpretations with meter-scale imaging. Our results show substantial water volumes ponding in a system of "distributed" canals upstream of a bedrock ridge that is breached and bordered by a system of "concentrated" channels. The transition between the "distributed" and "concentrated" systems is both co-located and physically consistent with increasing basal shear stress, surface slope, and water flux, indicating a strong feedback between the subglacial water and overlying ice. This feedback raises the possibility that variations in subglacial water flow could trigger a grounding line retreat in TG capable of spreading to the rest of the WAIS.