Geometric constraints on the Thwaites Glacier Catchment and Walgreen Coast of the West Antarctic Ice Sheet from AGASEA radar sounding and laser altimetry

D. A. Young, D. D. Blankenship*, J. W. Holt*, D. L. Morse*, M. E. Peters*, S. D. Kempf*, and D. G. Vaughan†*

**Institute for Geophysics, Jackson School of Geosciences, University of Texas at Austin, Austin TX, USA*
†British Antarctic Survey, Natural Environmental Research Council, Cambridge, UK

The Thwaites Glacier catchment and grounding line have been noted has as zones of potential ice sheet instability, in part due to the deep Byrd Subglacial Basin (BSB) that underlies the catchment and exposure of coastal ice to a warming ocean. We present initial interpretations of new data constraining the geometry of the Thwaites Glacier catchment and the adjacent Walgreen Coast.

Prior to the 2004-05 AGASEA field season, profiles of bedrock topography in the Thwaites catchment region were restricted to three NSF/SPRI/TUD ice penetrating radar flights, two IGY era seismic traverses, and more recently, several NASA/CECS flights and ITASE traverses. We have added over 40,000 km of new flight line with the University of Texas HiCARS 60 MHz coherent radar, and ~3000 km from a new British Antarctic Survey 150 MHz coherent radar. The data was processed using a short unfocused SAR aperture to limit scattering; a focused SAR solution is in progress. Our use of a high-power chirped radar improves both resolution and penetration of the ice volume, allowing more than 90% bed recovery as well as the illumination of deep layer structure within the ice sheet.

A laser altimeter was also flown, which when combined with dual- carrier differential phase GPS positioning, provided sub-meter ice surface elevation resolution. We will also present results of calculations of hydraulic head at the ice/rock interface and ice sheet driving stresses based on our airborne laser/radar observations.

Our radar data confirms the existence of and greatly extends the ~2 km deep trough underlying the Smith-Kohler glacier [Thomas et al 2004], but appears to rule out a direct connection to the Byrd Subglacial Basin. Thwaites Glacier itself appears not to be confined by a distinct bedrock channel, consistent with interpretations of recent lateral expansion [Bamber and Rignot, 2002].

Further inland, the Crary Mountains volcanoes are flanked by two overdeepened, east-trending large valleys, which open into the BSB. The northern valley contains a significant 'dead zone' where ice losses were great enough to obscure the bed.

Longitudinal laser/radar profiles allow us to analyze buoyancy across the Smith Glacier and Thwaites Glacier grounding lines. We use laser altimetry across sea ice to establish local sealevel to within a meter, and using this reference, predict from glacier surface elevations and ice thickness the position of the floating bed. Where the observed bed matches this prediction, we can infer the position of the grounding line. The main trunk of Thwaites Glacier floats at a relatively shallow depth, and a broad lateral sill appears to localize the grounding line. Smith Glacier's grounding line is much deeper, and lacks a sill. Despite the apparent instability implied at Smith Glacier, Thwaites Glacier has higher observed flux variations [e.g, Thomas et al 2004]. Differential access of the subglacial cavity to warm circumpolar deep water [e. g., Shepherd et al. 2004] may in part explain this relationship.