

Mapping West Antarctic subglacial processes using detailed basal morphology: Implications for Thwaites Glacier, based on knowledge gained from the Siple Coast

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We use hectameter to kilometer basal roughness, a property accessible to airborne ice penetrating radar, to examine the dynamics of the West Antarctic Ice Sheet. We quantify roughness through analysis of the along track variability of basal elevation profiles collected over the Siple Coast and the Thwaites Glacier catchment, at length scales of 400 meters, two kilometers, and four kilometers. There are significant differences in the patterns of roughness between catchments and between dynamic zones of the ice sheet. We demonstrate using synthetic data the validity of this technique with both coherent radar data collected in the eighties, incoherent radar data collected in the nineties and coherent radar data collected as part of the more recent ATRS and AGASEA surveys, processed using unfocused synthetic aperture radar (SAR). In particular, we carefully accounted for signal to noise issues in our interpretations of this variability.

A one-to-one correlation between roughness and proposed sedimentary basins identified in potential fields data in the Siple Coast is not apparent. The smoothest regions of grounded ice are the bedrock platforms underlying the interstream ice ridges of the Siple Coast. However, roughness does systematically increase upstream, likely reflecting erosion and downstream redeposition of mobile tills. In the deep interior, near Byrd Station where flow reorganization of tributaries has previously been recognized, basal roughness is greatly reduced at hectameter scales.

Under Thwaites Glacier, smooth areas are more localized, correspond to bedrock depressions and are restricted to the interior. A downstream gradient in roughness is not observed, suggesting that sub-glacial tills play a more restricted role in the Thwaites Glacier catchment.

We plan to extend this analysis to tens of meter length scales by integrating will integrating higher resolution observations obtained using focused SAR techniques over Thwaites Glacier and the Siple Coast.