What Can Radar Scattering Tell Us About the Relative Character of Past and Future Retreats in the Amundsen Sea Embayment?

Dustin Schroeder, Donald Blankenship, Duncan Young

University of Texas Institute for Geophysics

The morphological, lithological, and hydrological basal boundary conditions of ice-sheets and glaciers can exert strong, even dominating, control on their behavior, evolution and stability. However, the scales at which the physical processes and observable signatures of this control occur are typically smaller than the spatial resolutions achievable using ice penetrating radar. Further, the strength of calibrated radar bed echo returns is a combination of both the material (i.e., relative permittivity, conductivity) and geometric (i.e., rms height, rms slope, auto correlation length) properties of the ice/bed interface. This ambiguity in the relative contribution of material and geometric bed properties, along with uncertainty in englacial attenuation from underconstrained ice temperature and chemistry, also makes definitive assessment of basal conditions from echo strengths extremely difficult.

To address these challenges in interpreting geometric and material bed properties at glaciologically relevant scales, we apply a new algorithmic approach to measuring the radar scattering function of the ice/bed interface by performing range-migrated SAR focusing using multiple reference functions spanning different ranges of Doppler frequencies for the bed. We parameterize this scattering function in terms of the relative contribution of angularly narrow specular energy and isotropically scattered diffuse energy. This specularity content of the bed echo is insensitive to englacial attenuation and is a measure of both the angular distribution of returned echo energy and the geometry of the ice/bed interface at the sub-azimuth-resolution scale.

We present the application of this technique to a gridded airborne radar survey over the entire catchment of Thwaites Glacier, West Antactica. We show how this information can be used to constrain the morphology of basal bedforms and infer the distribution of deformable sediments and crystalline bedrocks across the catchment. We compare this distribution to offshore bedforms and sediment records on the deglaciated inner continental shelf of the Amundsen Sea Embayment. We also discuss the potential implications for the processes and timing of previous, contemporary, and potential grounding line retreats in the region.