Characterizing the Location and Extent of the Thwaites Glacier Grounding Zone Using Airborne Radar Sounding

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The impact of warm ocean water on ice sheet retreat and stability is a one of the primary drivers and sources of uncertainty for the rate of global sea level rise. One critical but challenging observation required to understand and model this impact is the location and extent of grounding ice sheet zones. However, existing surface topography based techniques do not directly detect the location where ocean water reaches (or breaches) grounded ice at the bed, which is a significantly factor in ice sheet stability.

Airborne radar sounding is the primary geophysical tool for directly observing the basal properties of ice sheets at the catchment scale. However, uncertainty in englacial attenuation from unknown ice temperature and chemistry can lead to erroneous interpretation of subglacial conditions from bed echo strengths alone (especially in the complicated scattering environment near grounding zones). Recently developed analysis techniques for radar sounding data have overcome this challenge by taking advantage of information in the spatial pattern of radar returns and subglacial water routing. We have developed a similar approach based on the modeled spatial pattern of echo strengths to address the problem of improved grounding zone detection and characterization.

The spatial signal of the transition from an ice-bed interface to an ice-ocean interface is an ~10 dB increase in bed echo strength. However, rapidly changing attenuation (due to variations in temperature and scattering) near the grounding zone prevents the unambiguous interpretation of this signal in typical echo strength profiles and violates the assumptions of existing empirical attenuation correction techniques. We present techniques that treat bed echoes as continuous signals to take advantage of along-profile ice thickness, propagation distance, and echo strength variations to constrain the spatial pattern of attenuation. In this framework, the grounding zone transition can be detected and characterized as a deviation from the spatial pattern of englacial attenuation. We present the application of this technique to a gridded airborne radar sounding survey of the Thwaites Glacier catchment to constrain the location and extent of the grounding zone and compare this characterization with the surface expression of the transition from grounded to floating ice.

Ice-ocean interaction (Surfin' USA): Amundsen Sea (*West Coast Blues)*