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

Dustin M. Schroeder¹, Cyril Grima², Donald D. Blankenship²

¹ Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA
² Institute for Geophysics, University of Texas, Austin, TX

The impact of warm ocean water on ice sheet retreat and stability is 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)