Getting into the Zone: Ice Shelf Margins from ICESat

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Since its launch in January 2003, the ICESat mission has mapped the Antarctic ice sheet to 86 degrees south, well south of the ESA ERS and Envisat satellites, which have maximum latitudes of ~81.5 degrees. ICESat thus extends altimetry coverage to the entire floating portion of the ice sheet, including the southern parts of the Ross and Filchner Ronne ice shelves (RIS and FRIS), for the first time.

We have previously demonstrated that the accuracy and spatial coverage of ICESat over the free-floating interior of ice shelves is sufficient to allow us to identify the optimum ocean tide model for the Ross Ice Shelf (Padman and Fricker, 2005), with crossover data from just one laser operations period of ~40 days duration. Here, we consider another application of ICESat data over ice shelves: the use of repeat-track data across the grounding zones (GZ) to determine the location and characteristics of the GZ. ICESat samples every 172 m along-track with a footprint of ~65 m diameter, thus easily resolving the GZ which is typically several km wide. These characteristics can be used to precisely identify the grounding line (GL) and the seaward limit of the GZ, based on the limits of observed tidal flexure (Figure 1). Here, ICESat repeat-track analyses indicate that the GL is ~3 km further north than indicated in recent coastline databases. By repeating these studies around the perimeter of the RIS and FRIS, we can significantly improve the GL definition, with implications for the quality of models of ocean/ice and ice stream-ice shelf interaction and for mass balance estimates. By defining the characteristics of the GZ, including width and curvature, it will be possible for the first time to apply tidal corrections within the GZ, which is frequently a region of intense basal melt and thus a significant focus of shelf-ice mass balance studies.

References

Padman, L., and H. A. Fricker (2005). Tides on the Ross Ice Shelf observed with ICESat, Geophys. Res. Lett., accepted.

Padman, L., H. A. Fricker, R. Coleman, S. Howard, and S. Erofeeva (2002). A new tidal model for the Antarctic ice shelves and seas, Ann. Glaciol., 34, 247-254.

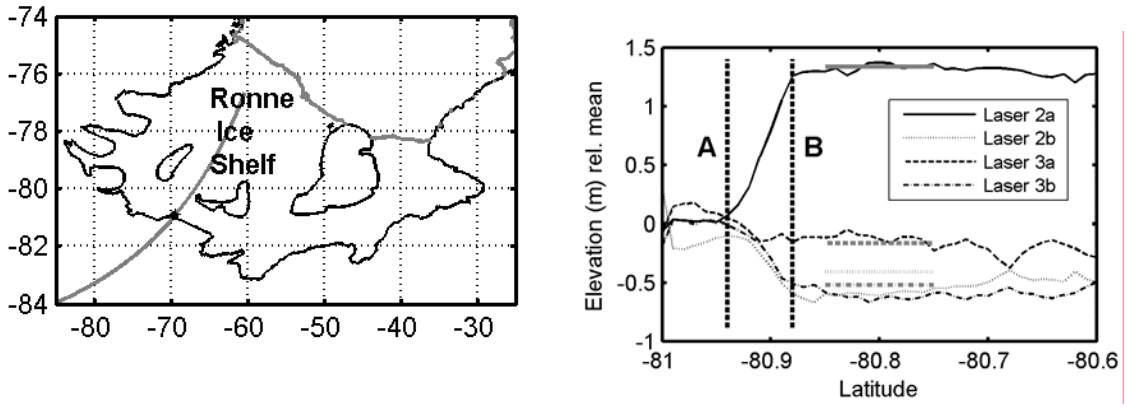

Figure 1: (left) Location of ICESat 91-day Track 1304 (gray arc), which crosses the southern Ronne Ice Shelf grounding line near 81°S, 69.6°W. Coastline (black) and ice front (gray) are from the SCAR database on the GEBCO 2003 CD. (right) Plots of ICESat-derived relative elevations, h'_i, smoothed at about 1 km along-track, for the four available repeat orbits of Track 1304. ICESat data have been "retided", adding back in the ocean tide and ocean tide loading corrections, which are applied during standard processing using the GOT99.2 tide model. Point **A** is the "limit of tidal flexure", slightly inshore of the grounding line. Point **B** is the seaward limit of tidal flexure. The width of the GZ, from A to B, is about 8 km. Horizontal dashed lines indicate tides predicted from CATS02.01 [*Padman et al*., 2002] for a location just inshore of the GZ at the times of respective ICESat passes. A constant offset has been applied to each tide prediction in order to match the model to the offshore height deviation of Laser 2a. This offset accounts for tidal constituents which are aliased by ICESat's orbit to very long or infinite period. CATS02.01 underestimates the offshore tidal range by ~20 cm. The ICESat-derived GL is ~3 km north of the SCAR coastline.