Dynamic Glacier Thinning in the Larsen B Embayment, Antarctica, 2002-2008

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Altimetry data derived from thirteen ICESat operational periods and two long-range aircraft ATM missions acquired between November 2002 and March 2008 quantify significant elevation changes for a glacier flowing into the now-collapsed section of the Larsen B Ice Shelf. Where ICESat's Track 0129 crosses the Crane Glacier, about 12 km from the March 17, 2002 ice edge, little to no elevation change occurred between November 26, 2002 and October 30, 2003 despite an ~11 km retreat in the ice edge location just down fjord; this is due to inland ice moving downstream rapidly to maintain the floating glacier terminus. However, between Oct. 30, 2003 and March 2, 2004, >70 m of elevation lowering occurred at this point, what was a >5 km wide and ~600 m thick glacier became a fjord. The Crane's ice front retreated another ~8 km inland in less than a year and has held a relatively stable position near this point since late 2004 (~65.33°S 297.66°E). However, the combined elevation time series from ICESat and ATM indicates the surface height of the lower Crane Glacier where it was crossed by ICESat Track 0018, about 24 km inland from the March 17, 2002 ice edge, lowered >150 m between November 26, 2002 and March 18, 2007. At this location, an average >40 cm/day elevation loss was observed over ~3 months in late 2004 - early 2005 as the glacier responded dynamically to the collapse. More than 50 km inland, the Crane has shown distinct elevation changes since mid-2006 with >20 m elevation lowering where Track 0390 crosses the upper Crane tributaries. In contrast to the Crane, other glaciers show changes but without clear trends. The nearby but smaller Melville Glacier that also flows into the Larsen B embayment shows >8 m elevation lowering close to its terminus but little change farther inland and similar patterns are observed over the Flask and Leppard Glaciers at the points where the ATM and ICESat data intersect. These latter two glaciers are similar in width and thickness to the Crane (before its dynamic thinning) but are still buttressed by a remnant of the Larsen B Ice Shelf. Bedrock elevations in all cases were derived from available KU/CReSIS radar profiles. The available altimetry data are too limited to resolve seasonal elevation changes associated with velocity variations. These results support early suggestions that ice shelves play a strong role in regulating the dynamics of large outlet glaciers. Although the majority of the mass contributions from the Crane may have already occurred and are a small portion of total sea level rise, its history shows that significant ice mass loss will occur along outlet glaciers with beds well below sea level if their buttressing ice shelves collapse.