Surface Elevation Changes at the Front of the Ross Ice Shelf; Implications for Basal Melting

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Spatial and temporal elevation changes for the front 60 km of the Ross Ice Shelf are examined using GLAS ICESat laser altimetry data. Elevation profiles show a spatial trend of decreasing elevation towards the calving front, which is explained by temporal changes over a 3—4 year period demonstrating ongoing lowering of surface elevations. The constraint of hydrostatic equilibrium, along with assumptions regarding spreading rate, accumulation rate, and firn depth, allow basal melting to be quantified. Melt rates are observed to increase exponentially as the front is approached, from near equilibrium at approximately 40 km from the front to an average of 2.7 m/a within the front kilometer. Melt estimates are best fit by the relationship melt rate = 2.1exp(x/11800) m/a. Spatial averaging along the front indicates that regions which have recently calved large tabular bergs (e.g. icebergs C-19 and B-15) may experience a faster decrease in melt rate with distance from the front compared to a gradual decrease in non-calving regions. This points to the dependence of melt rate on basal profile – the basal profile at the front after calving events is not as conducive for melting at greater distances from the front. The estimated basal-melting is thought to be due to a combination of i) the tidally-induced mixing of near-surface ocean water, and ii) plume ascension and entrainment. We simulate this process using a one-dimensional model of plume-entrainment after initiation with a tidal-mixing melt rate.