Ocean Variability Contributing to Basal Melt Rate Near the Ice Front of Ross Ice Shelf, Antarctica

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Basal melting of ice shelves is an important, but poorly understood, cause of Antarctic ice sheet mass loss and freshwater production. We use data from two moorings deployed through Ross Ice Shelf, ~6 and ~16 km south of the ice front east of Ross Island, and numerical models to show how the basal melting rate near the ice front depends on sub-ice-shelf ocean variability. The moorings measured water velocity, conductivity, and temperature for ~2 months starting in late November 2010. About half of the current velocity variance was due to tides, predominantly diurnal components, with the remainder due to subtidal oscillations with periods of a few days. Subtidal variability was dominated by barotropic currents that were large until mid-December and significantly reduced afterward. Subtidal currents were correlated between moorings but uncorrelated with local winds, suggesting the presence of waves or eddies that may be associated with the abrupt change in water column thickness and strong hydrographic gradients at the ice front. Estimated melt rate was ~1.2±0.5 m/year at each site during the deployment period, consistent with measured trends in ice surface elevation from GPS time series. The models predicted similar annual-averaged melt rates with a strong annual cycle related to seasonal provision of warm water to the ice base. These results show that accurately modeling the high spatial and temporal ocean variability close to the ice-shelf front is critical to predicting time-dependent and mean values of meltwater production and ice-shelf thinning.

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