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Channelized Antarctic ice shelf melting from high-resolution remote sensing

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Antarctic mass loss is the largest source of uncertainty in current sea level rise projections. Ice shelf instability plays a key role in this uncertainty as ice shelves are the floating gatekeepers that surround 75% of Antarctica's coastline and that buttress the contribution of grounded ice to sea level rise. Although basal melting has been identified as one of the key processes for ice shelf instability, the quantitative understanding of this process and how much, how fast it weakens ice shelves is limited as it is determined by fine scale processes (e.g. channelized basal melting) that until recently were difficult to quantify. The recent availability of high-resolution, multi-source satellite imagery (e.g. stereoscopic DEMs from the Reference Elevation Model of Antarctica (REMA) or swath-processing of Cryosat-2), however, offers the opportunity to quantify the role of channelized melting on ice shelf instability across Antarctica.

In this study, we use REMA, Cryosat-2 and IceBridge elevation data to develop high-resolution indicators of basal melt across some major Antarctic ice shelves (Dotson, Pine Island, Larsen C). The methodology consists of processing time series of high-resolution REMA strips in a Lagrangian framework while accounting for tilt and tide corrections.

Comparison of different approaches (e.g. simplified REMA-only approach; combined REMA-Cryosat-2 approach, combined REMA-IceBridge approach) shows that the simplified approach can be applied easily to develop Antarctic wide estimates of basal melting across Antarctica, while the combined REMA-Cryosat-2 shows the highest accuracy. Results of this study, finally, show the potential of using REMA for developing high resolution basal melt products across Antarctica and providing insight in the spatial variability of basal melting due to channelized melting.