Ocean-driven basal melt channels and the stability of Amundsen and Bellingshausen Sea ice shelves

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Basal melt channels carved into floating ice shelves are important both as indicators of sub-shelf oceanic conditions and for their potential direct relationship to ice shelf stability. A survey using MODIS and Landsat imagery of all Antarctic ice shelves reveals extensive basal melt channeling around the continent. The observed channels may be divided into two main categories: those that originate at the grounding line, and those that begin away from the grounding line. Past research has suggested that melt channels starting at the grounding line are driven by freshwater outflow from the ice sheet at the distal end of sub-glacial hydrologic flow. This type of channel appears in many locations around the Antarctic continent (e.g. Le Brocq et al. 2013). In contrast, channels that start away from the grounding line appear mainly in the Bellingshausen and Amundsen Sea regions. IceBridge ice-penetrating radar data show that these channels are ~1-5 km wide and are carved ~50-250 m deep into the base of the shelf. Though they approximately follow the ice flow direction, they are often highly sinuous and may cut directly across ice flow. Because they can start anywhere on the shelf, occur mainly in areas exposed to Circumpolar Deep Water (CDW) intrusions, and frequently terminate in persistent polynyas at the shelf edge, we assume that these channels are formed by melt caused by warm ocean water.

An increase in frequency of CDW intrusions has been observed along a broad area of the northern West Antarctic coastline. In some cases, such as the Pine Island Glacier, the greater presence of CDW has led to enhanced calving and retreat. However, shelves in the region that are more confined by islands and peninsulas, such as the Abbot, Dotson, Getz, and Sulzberger ice shelves, have remained relatively stable to this point despite high rates of basal melt. These are also shelves that exhibit many ocean-driven melt channels carved into their bases, visible in satellite imagery because hydrostatic adjustment over channels creates significant surface depressions. At least one of these channels is visibly growing, indicating that not all channels are in steady state. Additionally, the channels in many locations appear to preferentially form adjacent to islands and peninsulas. At one location on the Getz Ice Shelf, a large crevassed region has developed over the last decade at the tip of a peninsula surrounded by deep channels. We hypothesize that the presence of the channels has weakened the shear margins, leading to the observed fracturing. If channels become large and extensive enough along many of the islands and peninsulas buttressing a confined ice shelf, this mechanism could ultimately lead to reduced back-stress, increased calving rates, and/or break-up. As some of these shelves drain a significant portion of the West Antarctic Ice Sheet, understanding this mechanism is necessary to accurately predict future sea level rise.

Theme: Ice-ocean interaction *(Surfin' USA)*: Amundsen Sea (*West Coast Blues)*