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Antarctic ice discharge due to warm water intrusion into shelf cavities

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Ocean-induced melting below ice shelves is the dominant driver for mass loss from the Antarctic Ice Sheet at present (Pritchard et al., 2012). Observations show that many Antarctic ice shelves are thinning (Paolo et al., 2015) which reduces their buttressing potential and can lead to increased ice discharge from the glaciers upstream (e.g., Gudmundsson et al., 2013).

Melt rates from Antarctic ice shelves are determined by the temperature and salinity of the ambient ocean. In many parts, ice shelves are shielded by clearly defined density fronts which keep relatively warm Northern water from entering the cavity underneath the ice shelves (Jacobs et al., 1992; Alley et al., 2015). Projections show that a redirection of coastal currents might allow these warmer waters to intrude into ice shelf cavities, for instance in the Weddell Sea (Hellmer et al., 2012, 2017), and thereby cause a strong increase in sub-shelf melt rates.

Using the Potsdam Ice-shelf Cavity mOdel (PICO, Reese et al., 2017), we assess how such a change would influence the dynamic ice loss from Antarctica. PICO is implemented as part of the Parallel Ice Sheet Model (PISM, Bueler and Brown, 2009; Winkelmann et al., 2011) and simulates the vertical overturning circulation in ice-shelf cavities. The model is capable of capturing the wide range of melt rates currently observed for Antarctic ice shelves and reproduces the typical pattern of comparably high melting near the grounding line and lower melting or refreezing towards the calving front. Based on regional observations of ocean temperatures, we use PISM-PICO to estimate an upper limit for ice discharge resulting from the potential erosion of ocean fronts around Antarctica.