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Observationally constrained projections of Antarctic ice sheet instability

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Large parts of the Antarctic ice sheet lie on bedrock below sea level and may be vulnerable to a positive feedback known as Marine Ice Sheet Instability (MISI), a self-sustaining retreat of the grounding line triggered by oceanic or atmospheric changes. There is growing evidence MISI may be underway throughout the Amundsen Sea Embayment (ASE) of West Antarctica, induced by circulation of warm Circumpolar Deep Water. If this retreat is sustained the region could contribute up to 1-2 m to global mean sea level, and if triggered in other areas the potential contribution to sea level on centennial to millennial timescales could be two to three times greater.

However, physically plausible projections of Antarctic MISI are challenging: numerical ice sheet models are too low in spatial resolution to resolve grounding line processes or else too computationally expensive to assess modelling uncertainties, and no dynamical models exist of the ocean-atmosphere-ice sheet system. Furthermore, previous numerical ice sheet model projections for Antarctica have not been calibrated with observations, which can reduce uncertainties.

Here we estimate the probability of dynamic mass loss in the event of MISI under a medium climate scenario, assessing 16 modelling uncertainties and calibrating the projections with observed mass losses in the ASE from 1992-2011. We project losses of up to 30 cm sea level equivalent (SLE) by 2100 and 72 cm SLE by 2200 (95% credibility interval: CI). Our results are substantially lower than previous estimates. The ASE sustains substantial losses, 83% of the continental total by 2100 and 67% by 2200 (95% CI), but in other regions losses are limited by ice dynamical theory, observations, or a lack of projected triggers.