Grounding line stability in Antarctic ice sheet models

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The magnitude of the Antarctic ice sheet's contribution to global sea-level rise is dominated by the potential of its marine sectors to become unstable and collapse as a response to ocean (and atmospheric) forcing through a feedback mechanism known as Marine Ice Sheet Instability (MISI). While the theory behind MISI is well understood, resolving grounding-line migration and MISI in contemporary ice-sheet models is generally hampered by the spatial resolution and our understanding of ice-shelf buttressing.

The sensitivity to MISI depends on local bedrock topography (retrograde bed slopes) and may be enhanced through processes that dramatically reduce ice-shelf buttressing, such as cliff instability (MICI; DeConto and Pollard, 2016). However, basal processes near the grounding line also have a major impact on the stability of marine sectors. Here, we show that subglacial sediment deformation translating into a Coulomb friction law increases grounding-line sensitivity and leads to destabilization of marine sectors due to MISI at magnitudes comparable to MICI. Furthermore, this increased sensitivity leads to a smaller dependence on spatial resolution of marine ice-sheet models. High-resolution bedrock irregularities, increasing basal drag and pinning, have therefore less influence on grounding line stability compared to conventional power-law basal sliding. By carrying out sensitivity experiments of the ice sheet to sudden pulses in ice shelf melt, the probability of occurrence of stable grounding-line positions during unstable grounding-line retreat is investigated.

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