

EGU21-1358, updated on 01 Jul 2022

<https://doi.org/10.5194/egusphere-egu21-1358>

EGU General Assembly 2021

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Potential future recovery of Petermann Glacier in northwest Greenland simulated using ISSM

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Ice shelves in Antarctica and Greenland are thinning and breaking up, and marine outlet glaciers are retreating, where the ocean is known to play a key role. This pattern is projected to continue over the next decades to centuries due to ocean warming induced by global carbon emissions. Given that we halt or even reverse the current warming trend and fulfil the Paris agreement, it is unclear whether ice shelves and glaciers can recover from the preceding breakup and retreat. Here, we use the numerical ice sheet model ISSM to assess whether Petermann Glacier in northwest Greenland can recover after future ice shelf breakup and grounding line retreat. Petermann's ice tongue is one of the few remaining in Greenland, where several major calving events occurred over the last decade.

Our experiments suggest that if Petermann's ice shelf collapses due to future ocean warming, the ice shelf will not regrow even if that warming is reversed. Neither an ocean warming reversal nor a more positive surface mass balance help the ice shelf to regrow once it has collapsed. Future ocean warming may thus push Petermann into a new dynamic state from where recovery is exceedingly difficult. Finally, we investigate whether reduced calving activity allows for future grounding line readvance and ice shelf recovery. We discuss our findings in light of both potential future recovery and ice shelf collapse and regrowth in the past.