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The impact of internal variability in ocean-induced melting on Totten Glacier

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The Totten Glacier, located in the Aurora Subglacial Basin of East Antarctica, drains a catchment containing approximately 3.5 m of global sea level rise equivalent ice mass. The This glacier has been losing mass over recent decades, and modelling studies indicate that it is the most vulnerable glacier in East Antarctica to warming oceans and atmosphere over the coming century. Satellite altimetry shows high internal variability in ocean-forced melting of the Totten Ice Shelf; however, the extent to which this variability signal impacts the upstream ice sheet dynamics, and therefore its mass balance, is unknown. Here we use the Ice Sheet System Model (ISSM) combined with a plume and basal melting parameterisation called PICOP to investigate the impact of variability in ocean temperature on the evolution of Totten Glacier. We find that the southernmost portion of the Totten Glacier grounding line - from which the majority of the catchment's ice is channeled - is stable within only a limited range of background ocean temperatures close to present-day values. In the stable simulations, the magnitude of the ice mass flux depends on the extent to which the ice shelf is pinned on a bed topography rumple located approximately 10 km downstream of its grounding line, but the period of the mass flux is decadal to multi-decadal in each simulation, irrespective of the magnitude of the variability in ocean forcing. We further find that the impact of variability in ocean melt rates decreases as the mean background ocean temperature increases, suggesting that the mean state may have a relatively more important role in the evolution of the Totten Glacier than variability in ocean forcing. Our results have implications for detection and attribution of climate change and internal climate variability in modeling studies, and may inform fieldwork campaigns mapping bed topography in the Aurora Subglacial Basin.