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The influence of the solid Earth on the contribution of marine sections of the Antarctic ice sheet to future sea level change

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The future retreat of marine-based sectors of the Antarctic Ice Sheet (AIS) and its consequent global mean sea level (GMSL) rise is driven by various climatic and non-climatic feedbacks between ice, ocean, atmosphere, and solid Earth. The primary mode of ice loss in marine sectors of the AIS is dynamic flow of ice across the grounding line into the ocean. The flux of ice across the grounding line is strongly sensitive to the thickness of ice there, which is in turn proportional to the water depth (sea level) such that sea level rise enhances ice loss and grounding line retreat while sea level fall acts to slow or stop migration of the grounding line. In response to the unloading from removal of ice mass, the underlying bedrock deforms isostatically leading to lower local sea surface which promotes stabilization of the grounding line. In addition to its effect on AIS evolution, solid Earth deformation also alters the shape and size of the ocean basin areas that are exposed as marine areas of ice retreat and influences the amount of meltwater that leaves Antarctica and contributes to global sea-level rise. The solid Earth deformational response to surface loading changes, in terms of both magnitude and timescales, depends on Earth rheology. Seismic tomography models indicate that the interior structure of the Earth is highly variable over the Antarctica with anomalously low shallow mantle viscosities across the western section of the AIS. An improved projection of the contribution from AIS to sea level change requires a consideration of this complexity in Earth structure. Here we adopt a state-of-the-art seismic velocity model to build a high-resolution 3D viscoelastic structure model beneath Antarctica. We incorporate this structure into a high spatiotemporal resolution sea-level model to simulate the influence of solid Earth deformation on contributions of the AIS evolution to future sea-level change. Our sea-level model is coupled with the dynamics of PSU ice sheet model and our calculations are based on a range of future climate forcings. We show that the influence of applying a spatially variable Earth structure is significant, particularly in the regions of West Antarctica where upper mantle viscosities are lower and the elastic lithosphere is thinned.