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The Antarctic response to 1% annual atmospheric CO_2 concentration increase

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The Antarctic Ice Sheet (AIS) holds the largest potential for global sea-level rise (SLR), yet it remains the greatest source of uncertainty in future SLR projections. While the physical processes driving AIS mass loss are qualitatively well understood, significant uncertainties persist due to the challenging representation in models of these processes such as ice-ocean interactions and basal friction at the ice-bed interface. Satellite observations from the last decade reveal accelerated AIS mass loss in regions experiencing enhanced oceanic warming. Such warming thins ice shelves, reducing their buttressing effect and accelerating the flow of grounded ice. This can trigger a retreat of the grounding line into deeper bedrock, activating the Marine Ice Sheet Instability (MISI) feedback mechanism. Understanding the proximity to this tipping point is crucial for accurate sea-level rise projections and for developing effective adaptation strategies. From modeling and paleo-climatic studies it is well established that oceanic warming of 1–3°C in the Amundsen Sea Embayment could instigate MISI in West Antarctica. In addition, the spread and reliability of climate projections in future warming scenarios derived from Earth System Models (ESMs) remains a large source of uncertainty. However, a systematic study of this possible threshold with multiple models is needed. To address this, we conducted simulations of the AIS forced by CMIP6 ESMs under a scenario of 1% annual CO_2 increase until 2300, including simulations that branch off with a constant imposed forcing at different global warming levels. The simulations are run until year 3000 with a constant climate to study committed impacts to ice loss. For this, we use an ensemble produced with the ice-sheet-shelf model Yelmo, initialized with varying configurations to account for key uncertainties, including ice-ocean interactions and basal friction, as well as climatic forcing obtained from various CMIP6 ESMs that were assessed for their performance in Antarctica. This approach provides insights into the differential warming of the Southern Ocean relative to global temperatures, the AIS's committed response, and its proximity to triggering the MISI.