Summary of the Cryosphere v1 Simulation Campaign Overview Manuscript

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Here we present a summary of the overview manuscript for the E3SM v1 Cryosphere Simulation campaign, which concluded earlier this year. As a step towards full ice sheet coupling, the cryosphere configurations in E3SM utilize the capability to simulate ocean circulation and the exchange of heat and freshwater due to ice shelf melting in static ice shelf cavities. In addition, we have implemented a prescribed iceberg melt forcing capability, allowing us to realistically represent the both dominant mass loss processes from the Antarctic Ice Sheet. The cryosphere v1 overview manuscript summarizes results from global, low resolution (i.e. non-eddying ocean) simulations using these new capabilities, in both fully coupled configurations and those with active ocean/sea-ice components and prescribed atmospheric forcing. We find that biased trends in ocean temperature and salinity traverse tipping points in ice shelf cavity circulation, increasing modeled ice-shelf basal melt rates by an order of magnitude. This elevated ice shelf melting seen in some simulations results in unrealistic Antarctic freshwater fluxes under a preindustrial climate and, in turn, an unrealistic global climate. This sensitivity of modeled ocean/ice shelf interactions to ocean state presents a significant challenge to representing the ocean/ice shelf system in coupled ESMs. We show that inclusion of a spatially-dependent parameterization of eddy-induced transport reduces biases in water mass properties on the Antarctic continental shelf. With these improvements, E3SM produces realistic and stable ice-shelf basal melt rates across the continent under preindustrial climate forcing.