



Parameter estimation and model validation of global E3SM simulations focused on Antarctic ice shelf-ocean interactions

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We use global simulations with the U.S. Department of Energy's Energy Exascale Earth System Model (E3SM) to explore ice shelf-ocean interactions and their effect on Antarctic regional climate, focusing on the model's sensitivity to uncertain parameters. We present the results from a large number of simulations at modest resolution (~ 30 km at the poles, ~ 60 km at mid-latitudes), most of which include static ice-shelf cavities. Based on these simulations, we attain a tuned moderate resolution state that we use as a control configuration for a smaller number of (much costlier) sensitivity experiments at higher resolution (~ 10 km in the Antarctic region).

In these simulations, E3SM is configured with active ocean and sea-ice components with CORE-2 interannual forcing. The simulations do not include an active land-ice component, so the ice-shelf topography, derived from the Bedmap2 data set, is held fixed in time. The simulations begin from a common state, spun up for ~ 25 years using a set of control parameter values. We then branch from this run, varying parameters involved in the following processes: ocean horizontal and vertical mixing; melt ponds and sea-ice albedo; sea-ice ridging; ice shelf-ocean boundary conditions; and drag at various component interfaces. From these runs, we determine a subset of parameters that most strongly affect observable properties in the Antarctic and use these parameters to tune the model to better match available observations, including mooring-, float- and ship-based ocean tracers and velocity as well as satellite-derived sea-surface temperature, sea-ice thickness and concentration, and sub-ice-shelf melt rates.