Antarctic Ice Shelf-ocean Interactions in High-resolution, Global Simulations Using the Energy Exascale Earth System Model (E3SM)

Xylar Asay-Davis, Mathew Maltrud, Mark Petersen, Stephen Price, Luke Van Roekel
Los Alamos National Laboratory
xylar@lanl.gov, maltrud@lanl.gov, mpetersen@lanl.gov, sprice@lanl.gov, lvanroekel@lanl.gov

Abstract

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.

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. Following the work of Nakayama et al. (2017) and Urrego-Blanco et al. (2016), we vary 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.

We conclude by presenting some preliminary results from an ongoing effort to implement full ice sheet-ocean coupling in E3SM.

References

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