Objective

New MPAS-Ocean domains include active ocean cells below ice shelves, in order to investigate the interaction between ocean currents and land ice. Warmer ocean currents may speed up ice shelf melting and retreat. Changing land ice fluxes could affect ocean temperature, salinity, and currents below the ice shelf. Modeling these regions is particularly important because these dynamics are poorly understood, and observations are sparse.

Progress since June includes global simulations out to ten years for lower resolution, and successful high-resolution simulations in ACME. These use the EC 60x30km and RRS 30x10km meshes, with grid cells of 30 and 10 km below land ice, respectively. Preliminary analysis shows currents flowing below the ice shelves, ice sheet melting in the same locations as observational estimates, and melting / freezing rates relatively close to observed values. The Ronne-Filchner and Ross ice shelves sit on top of areas of ocean, each at least the size of California. Despite this, ice shelf cavities have not been included in any fully coupled global climate model to date because of the numerical modeling challenges and lack of observational data for validation.

Approach

The following results are from an ACME ocean-sea ice RRS 30x10km simulation with land ice cavities (G case, data atmosphere). Images show a monthly average from April of year one. Ice shelf melt rates in m/yr (a) are of a similar order and have broadly similar patterns to estimates based on altimetry and mass balance models (b, Rignot et al., 2013), though ACME’s melt rates are generally biased high at this early time. The upward heat flux (c) in W/m² due to melting (red indicates ocean cooling). The barotropic speed (d) in m/s shows the vertical average of currents, including those below the ice shelves. MPAS-Ocean has been validated in many idealized and realistic domains (Petersen et al., 2015, Ringler et al., 2013, Reckinger et al., 2015), as well as ice-shelf test cases (Asay-Davis et al., 2015).

Impact

ACME’s capability for representing the coupling between the ice sheet and the oceans in high-resolution, coupled simulations continues to be unique in Earth System Modeling. We are now beginning to validate our simulations against observations and use coupled model output as forcing for Antarctic ice sheet evolution and sea-level rise experiments.

References


