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Projections of ice shelf basal melting in a global finite element sea ice - ice shelf - ocean model

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In the framework of the EU project Ice2sea we utilize a global finite element sea ice - ice shelf - ocean model (FESOM), focused on the Antarctic marginal seas, to quantify heat and freshwater fluxes in the Antarctic ice shelf cavities and to assess ice shelf basal melting in a warmer climate. Ice shelf - ocean interaction is described using a three-equation system with a diagnostic computation of temperature and salinity at the ice-ocean interface. A tetrahedral mesh with a minimum horizontal resolution of 4 minutes and hybrid vertical coordinates is used. Ice shelf draft, cavity geometry, and global ocean bathymetry have been derived from the RTopo-1 data set. Additional simulations were carried out with the circumpolar coarse-scale finite-difference model developed as part of the Bremerhaven Regional Ice Ocean Simulations (BRIOS).

Simulations for present-day climate were forced with the NCEP reanalysis product and the atmospheric output from 20th century simulations of the Hadley Centre Climate Model (HadCM3). The projections for the period 2000-2199 use the output of HadCM3 simulations for the IPCC scenarios A1B and E1. Results from both models indicate a strong sensitivity of basal melting to increased ocean temperatures for the ice shelves in Amundsen Sea. An even stronger impact is found for warm water starting to pulse onto the southern Weddell Sea continental shelf in the middle of the 21st century, originating from a redirected coastal current. As these pulses propagate far into the Filchner-Ronne Ice Shelf (FRIS) cavity, basal melting increases significantly compared to the present value of about 100 Gt/yr. At the end of the 21st / beginning of the 22nd century both models suggest a stabilization of FRIS basal mass loss on a high level.