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Coupled ocean—ice shelf—ice sheet projections for the Weddell Sea Basin, Antarctica

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To study Antarctica's contribution to ongoing and future sea level rise, a coupled ice sheet – ice shelf – ocean model with an explicit representation of ice shelf cavities has been developed. The coupled model is based on a global implementation of the Finite Element Sea ice Ocean Model (FESOM) with a mesh that is substantially refined in the marginal seas of the Southern Ocean. The Antarctic Ice Sheet is represented by a regional setup of the Parallel Ice Sheet Model PISM, comprising the Filchner-Ronne Ice Shelf (FRIS) and the grounded ice in its catchment area up to the ice divides. At the base of the FRIS, melt rates and ocean temperatures from FESOM are applied. PISM returns ice thickness and the position of the grounding line. Buildung on infrastructure developed for the Regional Antarctic and Global Ocean (RAnGO) model, we use a pre-computed FESOM mesh that is adopted to the varying cavity geometry in each coupling step, i.e. currently once per model year. Changes in water column thickness are easily accounted for by the terrain-following vertical coordinate system in the ice shelf cavity. The ice sheet model is run on a horizontal grid with 1 km resolution to ensure an appropriate representation of grounding line processes. Enhancement factors for the approximation of the stress balance, as often used in coarse-resolution ice sheet models, become obsolete at such high resolution. Ice stream flow is well captured by polythermal coupling of the ice flow and a Mohr-Coulomb yield stress criterion that accounts for properties of the till material and the effective pressure on the saturated till. We present results from model runs with a 20th-century climate forcing and projections until the end of the 22nd century. We will show that cavity hydrography, ice shelf basal melt rates and thickness evolution as well as the feedback on grounded ice in the coupled model simulations are very sensitive to the atmospheric forcing scenario applied.