Sensitivity of coupled solid-Earth/ice-sheet modeling of Thwaites Glacier to Earth rheology and coupling timescale

The ability of the solid earth to rebound viscoelastically upon the removal of ice loads has the potential to forestall ice sheet retreat and, consequently, sea-level rise (SLR), particularly for marine ice sheets by inhibiting the marine ice sheet instability (MISI). In this study, we assess the impact of both coupling timescale and earth rheology on model projections of the retreat of Thwaites Glacier and the concomitant SLR by coupling a dynamic ice sheet model (MALI) to a simplified glacial isostatic adjustment (GIA) model. The sensitivity of model projections of ice sheet retreat and SLR is tested by sweeping through a range of coupling intervals from 1 to 32 years for four different earth rheologies. These model parameters are applied to 300-year simulations under current climate conditions. While GIA reduced SLR from Thwaites Glacier by 4% to 70% at 300 years for strong and weak mantles, respectively, insufficiently frequent coupling between the two models substantially biases the result. We find that coupling intervals of 5 to 20 years are required to keep coupled model error in mass loss to less than 5%. We hypothesize that feedbacks between the solid earth - ice sheet system are controlled by a competition between the spatial extent and timescale of bedrock uplift relative to the rate of grounded ice retreat away from the region of most rapid unloading.