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Earth system consequences of a Pine Island Glacier collapse

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An intermediate complexity climate model is used to simulate the impact of an accelerated Pine Island Glacier mass loss on the large-scale ocean circulation and climate. Simulations are performed for pre-industrial conditions using hosing levels consistent with present day observation of 3,000 m^3 s^{-1}, at an accelerated rate of 6,000 m^3 s^{-1}, and at a total collapse rate of 100,000 m^3 s^{-1}, and in all experiments the hosing lasted 100 years. It is shown that even a modest input of meltwater from the glacier can introduce an initial cooling over the upper part of the Southern Ocean due to increased stratification and ice cover leading to a reduced upward heat flux from Circumpolar Deep Water. This causes global ocean heat content to increase and global surface air temperatures to decrease. The Atlantic Meridional Overturning Circulation (AMOC) increases, presumably due to changes in the density difference between Antarctic Intermediate Water and North Atlantic Deep Water. Simulations with a simultaneous hosing and increases of atmospheric CO_2 concentrations show smaller effects of the hosing on global surface air temperature and ocean heat content, which we attribute to the melting of Southern Ocean sea ice. The sensitivity of the AMOC to the hosing is also reduced as the warming by the atmosphere completely dominates the perturbations. Further consequences for oceanic biogeochemical cycles in realistic future warming scenarios are discussed.