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Emplacement of Antarctic ice sheet mass affects circumpolar ocean flow

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During the Cenozoic, the Antarctic continent experienced large fluctuations in ice-sheet volume. We investigate the effects of Glacial Isostatic Adjustment (GIA) on ocean circulation for the first continental scale glaciation of Antarctica ($\sim$ 34 Myr) by combining solid Earth and dynamical ocean modeling. A newly compiled global early Oligocene topography is used to run a solid Earth model forced by a growing Antarctic ice sheet. A regional eddy permitting Southern Ocean zonal isopycnal adiabatic ocean model is run under ice-free and fully glaciated (GIA) conditions.
We find that GIA-induced deformations of the sea bottom on the order of 50 m are large enough to affect the pressure and density variations driving the ocean flow around Antarctica. Throughout the Southern Ocean, frontal patterns are shifted several degrees, velocity changes are regionally more than 100%, and the zonal transport decreases up to 12% in mean and variability.
The results suggest that GIA induced ocean flow variations alone could impact local nutrient variability, erosion and sedimentation rates, or ocean heat transport, and should be considered when analyzing sediment cores. The GIA induced ocean flow variability might be important not only for the Eocene-Oligocene Transition, but for other large-scale ice sheet fluctuations in the Cenozoic as well.
Next steps include running the ocean model globally and adding an atmospheric component to quantify the possible climatic impacts.