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The impact of dynamic topography on the bedrock elevation and volume of the Pliocene Antarctic Ice Sheet

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Reconstructions of the Antarctic ice sheet over long timescales (i.e. Myrs) require estimates of bedrock elevation through time. Ice sheet models have accounted, with varying levels of sophistication, for changes in the bedrock elevation due to glacial isostatic adjustment (GIA), but they have neglected other processes that may perturb topography. One notable example is dynamic topography, the deflection of the solid surface of the Earth due to convective flow within the mantle. Numerically predicted changes in dynamic topography have been used to correct paleo shorelines for this departure from eustasy, but the effect of such changes on ice sheet stability is unknown.

In this study we use numerical predictions of time-varying dynamic topography to reconstruct bedrock elevation below the Antarctic ice sheet during the mid Pliocene warm period ($\sim$3 Ma). Moreover, we couple this reconstruction to a three-dimensional ice sheet model to explore the impact of dynamic topography on the evolution of the Antarctic ice sheet since the Pliocene. Our modeling indicates significant uplift in the area of the Transantarctic Mountains (TAM) and the adjacent Wilkes basin. This predicted uplift, which is at the lower end of geological inferences of uplift of the TAM, implies a lower elevation of the basin in the Pliocene. Relative to simulations that do not include dynamic topography, the lower elevation leads to a smaller Antarctic Ice Sheet volume and a more significant retreat of the grounding line in the Wilkes basin, both of which are consistent with offshore sediment core data. We conclude that reconstructions of the Antarctic Ice Sheet during the mid-Pliocene warm period should be based on bedrock elevation models that include the impact of both GIA and dynamic topography.