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# What do GPS-derived 1-D viscosity models represent given Antarctica's complex 3-D structure?

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The viscoelastic Earth structure beneath the Antarctic ice sheet is an important control on future ice sheet dynamics and a key factor in ice and sea-level reconstructions. However, constraining viscoelastic structure in the mantle beneath the Antarctic is challenging. Relative to other formerly or currently glaciated areas, Antarctica has a paucity of records that constrain local viscosity. Moreover, while seismic studies indicate that three-dimensional mantle structure beneath Antarctica is complex, and includes a low viscosity upper mantle in the West, the conversion from seismic wave speed to viscosity is subject to considerable uncertainty. These challenges have motivated the recent application of Global Position System (GPS) data, in tandem with forward models of crustal deformation due to glacial isostatic adjustment (GIA), to infer 1-D viscoelastic structure beneath various parts of the West Antarctic (Nield et al., 2014; Zhao et al., 2017; Barletta et al., 2018).

However, important questions regarding these GPS-based modeling techniques remain unanswered. What specifically do these 1-D viscosity models represent in an area with complex 3-D mantle structure, and over what geographic length-scale are they applicable (on the scale of a single glacier catchment, the entire West Antarctic, or somewhere in-between)? To investigate these questions, we generate synthetic "observations" of present-day crustal deformation rates using 3-D viscoelastic Earth structure inferred from seismic tomography and a finite volume treatment of GIA (Latychev et al., 2005), and compare these rates with a suite of 1-D forward Earth model predictions. Furthermore, given that horizontal deformation rates are highly sensitive to 3-D Earth structure in this region (Powell et al., 2018), we also test whether and how much their inclusion will improve any inference of 1-D Earth structure. The results have significant implications for analyses of Earth structure in the region and for projections of Antarctic Ice Sheet stability in a progressively warming world.