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Impact of different crustal elastic models on interpreting regional GIA deformation in southeast Alaska

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Centers of rapid glacial isostatic adjustment (GIA) around the world (e.g., southeast Alaska, Iceland, Patagonia, and the North Antarctic Peninsula) are also presently undergoing large-scale deglaciations that elicit an additional elastic response from the Earth. The uplift may be used to estimate rheological parameters of the solid Earth and ice mass balance but requires separating the elastic component from the longer-term viscoelastic GIA. The elastic component is typically modeled using estimates of ice mass balance and a spherically symmetric, layered Earth with 1-D elastic structure defined by the seismically derived global average Preliminary Reference Earth Model (PREM). However, these regions are volcanic, tectonically active settings and feature crustal rheologies that may vary from the global average as well as lateral heterogeneities that may not be well represented by a single 1-D elastic model. These introduce uncertainties into the estimates of elastic uplift rates that have been largely unexplored. We investigate the significance of these uncertainties on previous GIA studies in southeast Alaska using a suite of 42 1-D elastic models derived from density, P- and S-wave velocity estimates available from LITHO1.0. Loading Love numbers are constructed from local 1-D estimates of the elastic structure using the open source Glacial Isostatic Adjustment in Python (giapy) toolkit, and Green's functions and elastic uplift rates are calculated using the Regional ElAstic Rebound calculator (REAR). Elastic uplift rates estimated using the suite of local models are up to 130% higher than those estimated using the global average. Modelling the laterally heterogeneous crustal rheology using 1-D models result in uncertainties up to 2-3x higher than average campaign GPS uncertainties. Both sources of elastic uplift uncertainty become insignificant with distances greater than 2 km from ice covered areas, where most GPS observations were made, but are relevant to studies using InSAR to measure deformation up to the edge of the glaciers. Elastic uplift rate uncertainties are estimated using globally available data and open source tools, and the workflow presented here could be used to optimize GPS deployment locations for other regions with rapid GIA to better constrain rheological parameters and ice mass balance.