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Quantifying the influence of glacial isostatic adjustment on current and future sea-level change using 3-D Earth models

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Ongoing deformation of the Earth in response to past ice-ocean mass exchange is a significant contributor to contemporary sea-level changes and will be an important contributor to future changes. Calibrated models of this process, conventionally termed glacial isostatic adjustment (GIA), have been used to determine its influence on current and future sea-level changes. To date, the majority of these models have assumed a spherically-symmetric (1-D) representation of Earth structure. Here we apply a model that can simulate the isostatic response of a 3-D Earth in order to consider the contribution of lateral structure to model estimates of current and future sea-level change. We will present results from a global analysis based on two independent ice history reconstructions and a suite of 3-D Earth models with viscosity structure constrained using different seismic velocity models and recent estimates of lithosphere thickness variations. The accuracy of these GIA model parameter sets is assessed by comparing model output to a recently published data set of vertical land motion specifically intended to provide a robust measure of the GIA signal (Schumacher et al., Geophysical Journal International, 2018). This comparison indicates that the inclusion of lateral Earth viscosity structure results in an improved fit to the GPS-determined vertical land motion rates although significant residuals persist in some regions indicating that further efforts to improve constraints on this structure are necessary. Using the model parameter sets that best match the GPS constraints to predict the contribution of GIA to contemporary sea-level change indicates that lateral viscosity structure impacts the model estimates by order 1 mm/yr in some regions and that the model uncertainty is of a similar amplitude. Simulations of the GIA contribution to future sea-level change are also significantly affected, with differences, relative to a 1-D Earth model, reaching several decimetres on century timescales and several metres on millennial timescales.