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The inclusion of ice model uncertainty in 3D Glacial Isostatic Adjustment modelling: a case study from the Russian Arctic

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The western Russian Arctic was partially covered by the Eurasian ice sheet complex during the Last Glacial Maximum (~26 ka BP) and is a focus area for Glacial Isostatic Adjustment (GIA) studies. However, there have been few GIA studies conducted in the Russian Arctic due to the lack of high quality deglacial relative sea-level (RSL) data. Recently, Baranskaya et al. (2018) released a quality-controlled deglacial RSL database for the Russian Arctic that consists of ~400 sea-level index points and ~250 marine and terrestrial limiting data that constrain RSL since 20 ka BP. Here, we use the RSL database to constrain the 3D Earth structure beneath the Russian Arctic, with consideration of the uncertainty in ice model ICE-7G_NA, which is assessed via iteratively refining the ice model with fixed 1D Earth model to achieve a best fit with the RSL data. Also, the uncertainties in 3D Earth parameters and RSL predictions are investigated.

We find an optimal 3D Earth model (Vis3D) improves the fit with the deglacial RSL data compared with the VM7 1D model when fixed with the ICE-7G_NA ice model. Similarly, we show improved fit in the White Sea area, where 1D model shows notable misfits, with the refined ice model ICE-7G_WSR when fixed with VM7 Earth model. The comparable fits of ICE-7G_NA (Vis3D) and ICE-7G_WSR (VM7) implies that the uncertainty in the ice model might be improperly mapped into 3D viscosity structure when a fixed ice model is employed. Furthermore, fixed with refined ice model ICE-7G_WSR, we find an optimal 3D Earth model (Vis3D_R), which fits better than ICE-7G_WSR (VM7), and the magnitude of lateral heterogeneity decreases significantly from Vis3D to Vis3D_R. We conclude that uncertainty in the ice model needs to be considered in 3D GIA studies.