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Validating GIA models based on an ensemble of 3D Earth structures with present-day GPS uplift rates

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Glacial-isostatic adjustment (GIA) models simulate the viscoelastic response of the solid earth due to loading. During the last glacial maximum, large areas in the northern and southern hemisphere were covered by km-thick ice sheets. Although most of the ice has been melted already 8,000 year ago, the time-delayed response of the viscoelastic earth is still a significant contribution to present-day uplift rates. The implementation of GIA models in global climate models is an essential part of the current research. Hereby, the choice of an appropriate earth structure in the GIA model plays an important role and has to be constrained by observational data.

Here, we apply present-day uplift data to constrain a set of GIA models that differ in 3D earth structure. To this end, these different GIA models are validated against GPS uplift rates provided by Schumacher et al. (2019). The GPS stations are globally distributed and not necessarily clustered in regions with strong GIA signal. For validation, regions with the largest gradient present in the GIA signal are most crucial. Thus, we use a weighting scheme, where those GPS stations get a higher weight that are less correlated to all other stations. Additionally, uncertainties in the GPS rates appear due to the length of the GPS time series and due to station specifics such as the used GPS receiver, and are provided together with the rates as standard deviations. Thence, the weighting used for the validation is the sum of the correlation derived weights and the uncertainty derived weights.

With this weighting in place, different GIA models can be validated against present day uplift rates by means of root mean square errors or mean absolute error.