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The use of a GNSS surface velocity field in testing GIA models

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Glacial Isostatic Adjustment (GIA) results in lateral and vertical movements of the Earth's surface and is difficult to distinguish from the deformational response to decadal and longer-term changes in continental water storage and the mass of glaciers and ice sheets. The effects of GIA must therefore be modelled. GIA models use an ice sheet history combined with an estimate for Earth rheology, and are tuned to fit evidence for past and present vertical motion, as determined from relative sea-level data and GNSS-derived present-day uplift rates. In contrast, GNSS-derived horizontal rates have not traditionally been used to tune GIA models because it is known that lateral Earth structure can significantly influence horizontal rates, and most GIA models do not account for lateral structure. However, well-modelled horizontal GIA velocities are important for interpreting tectonic plate rigidity and surface mass loading, which affect the realisation of the global reference frame.

The goal of this work is to test and compare a set of GIA model predictions against a GNSS velocity field. We create a GNSS surface velocity field from IGS repro2 data and other similarly processed GNSS datasets and align it to ITRF14. For this, we use the in-house reference frame combination software TANYA. The software has been updated to work with the most recent ITRF2014, including the discontinuity files and post-seismic deformation models. A suite of GIA models are produced by combining three different ice models (ICE-5G, ICE-6G and W12) with a range of 1D and 3D Earth models. By subtracting this ensemble from the velocity field, we identify a tectonic plate rotation model that is insensitive to the details of individual GIA models. The predicted horizontal and vertical velocities of each GIA model are then subtracted from the surface velocity field after removing plate motion. The results will be used to identify robust features of the GIA and residual surface velocity fields, which will reveal the response to contemporary surface mass redistribution.