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Are post-glacial rebound model predictions consistent with the global space-geodetic secular velocity field?

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On global scales the present-day secular velocity field of the Earth's surface is dominated by two processes, namely plate tectonics and post-glacial isostatic rebound. Over the last 15 years, various empirical plate motion models have been derived and constrained by modern space-geodetic observations. Most of these models describe the global horizontal motions for a set of rigid plates distributed over the Earth's spherical surface. For the present-day post-glacial rebound signal (PGS), predictions of both the vertical and horizontal velocity fields are available from geophysical models that have been calibrated against a set of observations including local sea level changes over the last 20,000 years, changes in length of day, and gravity field anomalies. Increasingly, space-geodetic observations of the surface velocities are also used to constrain these models on regional scales.

Here we assess the sensitivity of the observed global surface velocity field to differences in the predicted PGS. For that, we modeled the secular velocity field as a combination of tectonic and post glacial rebound signals. For each tectonic plate, any observed velocity field can be represented as the sum of a rigid body rotation and a velocity field due to intraplate deformation (i.e., post-glacial rebound related deformation). The rigid motion is fully determined by a 3-d rotation vector which fixes the corresponding Euler pole. Traditionally, these vectors are determined in a least squares fit of the predicted angular velocity field of the plates to observed geodetic velocities. The inclusion of modeled intraplate deformations in the least-squares fit does not only improve the separation of the rigid plate motion from the observations but also provides an assessment of the quality of the predicted intraplate deformations.

The surface velocity field used here is the GPSVEL model. The PGS predictions are

those provided by the IERS Special Bureau for Loading (SBL). For some PGS models the inclusion of PGS in the least squares fit improves the Euler vectors particularly for the Eurasian plate and thereby reduces the sensitivity of the Euler vector to the selection of the observed velocity data. However, none of the individual PGS model predictions results in an improvement of the Euler vectors for all plates. The reasons for that can be regional model deficiencies in the PGS predictions, incorrect far-field PGS predictions, the presence of other regionally dominant intra-plate deformation, including sub-divisions of plates, or regional problems in the observed velocity field. For the PGS predictions, inter-model differences are found to be larger than the uncertainties in the velocity field. Consequently, the observed velocity field provides valuable constraints for the geophysical models.