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Mass variations reflected in GRACE products and in crustal deformations from GPS: an intercomparison

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Geophysical mass variations are reflected both in variations of the gravity field sensed by the GRACE satellite mission and in solid Earth deformations observable by GPS. In particular, load variations (e.g. due to the global hydrological cycle) induce an elastic deformation. Hence, GPS observations of crustal deformation are valuable for a cross-comparison with GRACE mass variation datasets. This comparison may validate either dataset and, finally, contribute to the improvement of mass transport estimates.

Concerning GPS-derived deformations, a meaningful geophysical interpretation of these estimated quantities requires both homogeneously processed observations and a stable realization of the terrestrial reference system. Here we use results from a reprocessing of a global GPS network which has been carried out in a joint effort by TU Dresden and TU Munich/GFZ Potsdam with consistent use of the latest processing and modeling strategies.

The GPS reprocessing includes the estimation of low degree deformation terms. We directly compare these results to respective GRACE results and find good agreement.

Our main results concern the comparison of site displacement time series obtained from GPS, on the one hand, and from GRACE gravity variations (interpreted as surface mass variations) converted to load deformations, on the other hand. We do this comparison both for the GRACE background models of short-term atmospheric and oceanic variations and for the final monthly GRACE solutions.

Typically, we find good (sometimes excellent) agreement between the compared independent datasets. Remaining discrepancies between GPS and GRACE contain short-term GPS noise but also some components which appear to have large-scale correlated patterns in space and correlated patterns in time (e.g., seasonal). More detailed analyses indicate that residual errors in the GPS solutions are likely the dominating cause of these discrepancies.

Analyses of regional parts of the GPS network and of their relative deformations are a way to circumvent some of the large-scale systematics of the GPS solution. Indeed, regional analyses, e.g. for Australia or Europe, show good agreement between GPS and GRACE even in the horizontal components.

Overall, our results demonstrate the progress and challenges of combining independent satellite geodetic observations within the GGOS.