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Validating GRACE gravity fields using a global GPS network

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GRACE gravity fields contain both spatially correlated (systematic) and random noise and one of the early GRACE challenges is to determine the averaging radii at which the GRACE signal becomes reliable. We determine this cut-off by comparing vertical crustal deformation estimates from the GRACE fields with those measured using a 63-site global GPS network, about half of which is located on small islands. The GPS data were processed in a fiducial free frame (centre of mass of the whole Earth system; CM) using the Precise Point Positioning approach. Since unmodelled signals at sidereal (K1) and half-sidereal (K2) periods (from mismodelled ocean tide loading or multipath, for example) propagate into 364 and 182 day periods respectively we estimated additional parameters at K1 and K2 in the daily solutions. After removal of the degree-1 and degree-2, order 0 deformation from the GPS time series and averaging the GPS data using the same days present in the GRACE fields, the GRACE and GPS data can be directly compared. We find that GRACE is in good agreement down to a $\sim$300 km averaging radius over continents, with correlations reaching $\sim$0.8 in the Amazon basin, Siberia and Antarctica. Island sites showed much reduced correlations (and signal), with maximum correlations at 1000 km reaching only 0.2-0.4. On average, the GRACE vertical deformation estimates removed 10% of the GPS height time series variability, although this was as high as $\sim$40% at the sites with large signals.