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Combined GRACE-SLR monthly gravity field solutions

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Monthly gravity field solutions from GRACE GPS and GRACE K-Band data provide remarkable information about the mass transport in the system Earth by capturing the temporal variability of the gravity field at long to medium wavelengths. The GRACE solutions suffer, however, from the poor determination of the C20 coefficient from GRACE K-Band data, which describes the Earth's oblateness. C20 and its temporal variability can, on the other hand, be very well determined using satellite laser ranges (SLR) to spherical geodetic satellites such as LAGEOS and LARES. It is common practice to replace the C20 coefficient in GRACE solutions by SLR-derived values. We perform a meaningful combination of GRACE and SLR solutions at the level of normal equations using the SLR-only monthly gravity fields from the combined analysis of up to nine geodetic satellites that capture the temporal variability to degree 10 of the global spherical harmonic expansion.

We present combined monthly GRACE-SLR solutions and compare them to GRACE GPS/K-Band, GRACE GPS-only, and SLR-only solutions. We discuss the relative weighting scheme of the normal equations and evaluate the secular and seasonal periodic time variations of the combined solutions at long wavelengths. We observe a positive influence of the SLR data not only on C20 but also on the formal errors of the other degree-2 spherical harmonic coefficients, which correspond to the excitation of the polar motion. A possible reduction of the influence of aliasing with the S2 tide on some GRACE-derived coefficients using a combination with SLR data will also be addressed. The analysis of SLR-only solutions indicates sensitivity to time variable signal for selected coefficients at even higher degree but special care has to be taken not to corrupt coefficients with the inferior quality in SLR solutions in the combined solutions with GRACE data.

In recent years, K-Band tracking between GRACE satellites was deactivated several times resulting in several gaps in the series of monthly GRACE gravity field solutions. The on-board GPS receivers were, however, active almost all the time providing continuous observations. We investigate to which extent the combined SLR and GRACE GPS-only solutions can fill the gaps of monthly series of gravity field models for the months with none or sparse K-Band observations.