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Recovery of temporal gravity field variations from GRACE data with the range-rate combination approach

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The GRACE mission was launched mainly for the purpose of high-precision mapping the Earth's gravity field with an emphasis on its changes with respect to time. In order to accurately estimate the parameters of the Earth's gravity field, Ditmar and Liu recently proposed a so-called Range-Rate Combination (RRC) approach. In the approach, the functional model explicitly connects gravity field parameters with a linear combination of range-rate measurements at three successive epochs. In the current implementation, we make use of the fast spherical harmonic synthesis and co-synthesis algorithms in combination with the pre-conditioned conjugate gradient scheme. Thanks to this, the computations become much faster than with the traditional dynamic method. A new development with this approach is the detection of temporal gravity field variations. We firstly integrate a purely dynamic orbit using a GRACE mean gravity field model and models of some time-varying phenomena as well as non-gravitational data. The initial state vector and bias in non-gravitational accelerations are simultaneously estimated in order to ensure the best fit with known kinematic or reduced-dynamic orbits of GRACE satellites. The computed purely dynamic orbit is used to obtain residual (observed minus computed) range-rates. Furthermore, the resonants (temporal variations with 1 and 2 cpr as well as some others) are estimated and subtracted. Finally, the residuals are used to form 3-point RRCs. A few months' GRACE data is processed yielding temporal gravity field variations mainly related to hydrological signals.