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Contribution of an accurate determination of GRACE satellite orbits to precise mass transport modeling

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The data acquired by the KBR (K-Band Ranging) system on board the GRACE (Gravity Recovery And Climate Experiment) satellites is currently a valuable source of information for recovery of static and dynamic parts of the Earth's gravity field (particularly, at the global scale). To derive the static part, sufficiently long data spans are needed. On the contrary, the dynamic part is usually recovered on a monthly basis (as a time series of residual gravity solutions). These can be translated into mass transport models which are used to study temporal variations of the Earth's system. An example of such a model is the first release of DEOS Mass Transport (DMT-1) model. The basic steps in the computation of this model are as follows: (i) Purely Dynamic Orbits (PDOs) are integrated based on kinematic orbits and a state-of-the-art force model; (ii) residual inter-satellite ranges are computed as the difference between the KBR data and those derived from PDOs; (iii) residual inter-satellite accelerations are derived with a double numerical differentiation; (iv) sets of residual spherical harmonic coefficients are estimated with a proper frequency-dependent data weighting in order to take care of the colored noise; (v) the statistically optimal Wiener-type filtering is applied.

In our investigation, we identified an increased level of noise at the low frequency part of the spectrum of the residual inter-satellite accelerations which may provide a significant contribution to the error budget of mass transport solutions. According to our findings, the impact of this noise can be mitigated by incorporating GPS tracking data in conjunction with the KBR measurements in a joint inversion as well as by employing orbits of higher quality in the data processing methodology. The latter is the focus of this presentation. We propose a procedure for an advanced orbit determination based on an optimal combination of geometrical and dynamic sources of information. Geometrical information emerges from the GPS and KBR data, whereas the dynamic one is derived from a precise force model. A variance component estimation technique is employed to secure an optimal data combination. The impact of the advanced orbit determination on the mass transport modeling is quantified.