

Semi-Analytic GOCE Gravity Field Analysis from Kinematic Orbits, Energy Integral and Gravity Gradients

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GOCE gravity field determination is based on the combination of the long-wavelength part derived from satellite-to-satellite tracking (SST) between the GPS system and GOCE, and the short-wavelength part computed from satellite gravity gradiometry (SGG). From the high-low GPS to GOCE SST data precise kinematic orbits are derived. This is a purely geometric way of orbit determination where use of any a priori gravity model is avoided. The method has been successfully applied to CHAMP GPS data and yields an orbit precision of a few centimetres in three dimensions.

The kinematic orbits are then employed for the determination of the long-wavelength part of the gravity model. Our approach is the use of the energy integral. It allows the direct derivation of the anomalous gravity potential from orbit velocities. The latter are derived from the kinematic orbits by numerical differentiation. The proper formulation of the stochastic model is currently under investigation. Also non-gravitational forces, as given by the common mode accelerations of the gradiometer need to be taken into account, as well as the direct and indirect gravitational effects of sun, moon and planets.

From the anomalous potential at satellite altitude and from the tensor components measured by the gravity gradiometer a gravity model is deduced using a Semi-Analytical Approach (SA). It is gravity field analysis in the frequency domain taking advantage of certain symmetries in the linear system of equations. This method reduces significantly the computational burden with only little loss in terms of precision. It is in particular suited for quick-look gravity field analysis and is now adopted as part of the official ESA GOCE data processing.