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Assessment of Tscherning-Rapp covariance in Earth gravity modeling using gravity gradient and GPS/leveling observations

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Determination of Earth's gravity field in a high accuracy needs different complementary data and also methods to combine these data in an optimized procedure. Newly invented resources such as GPS, GRACE, and GOCE provide various data with different distribution which makes it possible to reach this aim. Least Squares Collocation (LSC) is one of the methods that help to mix different data types via covariance function which correlates the different involved parameters within the procedure. One way to construct such covariance functions is involving two steps within the remove-compute-restore (RCR) procedure: first, calculation of an empirical covariance function from observations which the gravitational effects of global gravity field (Long-wavelength) and topography/bathymetry have been subtracted from it and then fitting the Tscherning–Rapp analytical covariance model to the empirical one. According to the corresponding studies, the accuracy of LSC is directly related to the ability to localize the covariance function which itself depends on the data distribution. In this study, we have analyzed the data distribution and geometrically fitting factors, on GPS/Leveling and GOCE gradient data by considering the various case studies with different data distributions. To make the assessment of the covariance determination possible, the residual observations were divided into two datasets namely, observations and control points. The observations point served as input data within the LSC procedure using the Tscherning – Rapp covariance model and the control points used to evaluate the accuracy of the LSC in gravity gradient, gravity anomaly, and geoid predicting and then the covariance estimation. The results of this study show that the Tscherning-Rapp (1974) covariance has different outcomes over different quantities. For example, it models accurate enough the empirical covariance of gradient gravity but requires more analysis for gravity anomalies and GPS/Leveling quantities to reach the optimized results in terms of STD of difference between the computed and control points.