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Geoid Determination Using GOCE-Based Models in Turkey

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The maintenance of the vertical datum in tectonically active regions such as Turkey become more of an issue. The distortions in the vertical datum due to geodynamic phenomena necessitate the realization of geoid based vertical datum. The height modernization studies for transition to a "geoid based vertical datum definition" providing practical use of GNSS technologies to obtain orthometric heights in Turkey has accelerated rapidly in recent years and hence in the content of these efforts on-going projects contribute to improvement of quality and quantity of terrestrial gravity dataset as well as selection of the optimal computation algorithm to reach a precise geoid model in the territory. In this manner the assessment of the different methodologies with varying input parameters and referred models is obviously essential to in order to clarify the advantages of the algorithms in terms of providing an optimal combination of different data sets in regional geoid modeling. The performance of recently published GOCE-GRACE gravity field models show significant improvements in the medium frequency. This study investigates the contribution of the recently released Geopotential models with the contribution of GOCE and GRACE missions to the gravimetric geoid modeling specifically from Least squares modification of Stokes' (LSMS) formula point of view in Turkey territory. The algorithm developed by Royal Institute of Technology (KTH) that adopt the least squares modification of Stokes' kernel in order for providing an optimum combination of spherical harmonic expansion model and terrestrial gravity data and hence claims to optimize the drawbacks, may stem from the handicaps (such as low accuracy, sparse distribution etc.) of the terrestrial gravity data in the results. The additive corrective terms in order to account for downward continuation effect, atmospheric effect and ellipsoidal effect are proposed as the superiorities of this algorithm comparing to the conventional Remove-Restore method.
The assessments of the geoid models are done at the homogeneously distributed thirty National Network points in Turkey. The positional accuracy of GNSS/Levelling points (belong the Turkey National Fundamental GNSS Network-TUTGA) are reported as $\pm$1.0 cm in horizontal and $\pm$1.5 cm in vertical components. The orthometric heights of these benchmarks are computed via adjustment of the Turkish National Vertical Control Network (TUDKA). All releases of direct (DIR), time-wise (TIM), space-wise (SPW) and Gravity Observation Combination (GOCO) models are evaluated using spectral enhancement method (SEM). DIR R5, TIM R5 and GOCO05S models, which show the best agreements with the GNSS/Levelling data, are included within the study and their performance are compared with EGM2008 model. In conclusion the GOCE gravity field models performs in the level very close to EGM2008 performance, when the same truncation degree of models are considered. The overall results reveal that the gravimetric geoid model which is computed using DIR R5 model provides the best performance having $\pm$24.1 cm (without de-trending), though there is no significant improvement related with the contribution of GOCE gravity field models to the regional geoid determination based on LSMS approach in Turkey territory.