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Comparison and validation of combined GRACE/GOCE models of the Earth's gravity field

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Accurate global models of the Earth's gravity field are needed in various applications: in geodesy – to facilitate the production of a unified global height system; in oceanography – as a source of information about the reference equipotential surface (geoid); in geophysics – to draw conclusions about the structure and composition of the Earth's interiors, etc. A global and (nearly) homogeneous set of gravimetric measurements is being provided by the dedicated satellite mission Gravity Field and Steady-State Ocean Circulation Explorer (GOCE). In particular, Satellite Gravity Gradiometry (SGG) data acquired by this mission are characterized by an unprecedented accuracy/resolution: according to the mission objectives, they must ensure global geoid modeling with an accuracy of 1 – 2 cm at the spatial scale of 100 km (spherical harmonic degree 200). A number of new models of the Earth's gravity field have been compiled on the basis of GOCE data in the course of the last 1 – 2 years. The best of them take into account also the data from the satellite gravimetry mission Gravity Recovery And Climate Experiment (GRACE), which offers an unbeatable accuracy in the range of relatively low degrees. Such combined models contain state-of-the-art information about the Earth's gravity field up to degree 200 – 250. In the present study, we compare and validate such models, including GOCO02, EIGEN-6S, and a model compiled in-house. In addition, the EGM2008 model produced in the pre-GOCE era is considered as a reference. The validation is based on the ability of the models to: (i) predict GRACE K-Band Ranging (KBR) and GOCE SGG data (not used in the production of the models under consideration), and (ii) synthesize a mean dynamic topography model, which is compared with the CNES-CLS09 model derived from in situ oceanographic data. The results of the analysis demonstrate that the GOCE SGG data lead not only to significant improvements over continental areas with a poor coverage with terrestrial gravimetry measurements (such as Africa, Himalayas, and South America), but also to some improvements over well-studied continental areas (such as North America and Australia). Furthermore, we demonstrate a somewhat higher performance of the model produced in-house compared to the other combined GRACE/GOCE models. At the same time, it is found that the combined models show a relatively high level of noise in the oceanic areas compared to EGM2008. This implies that further efforts are needed in order to suppress high-frequency noise in the combined models in the optimal way.