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A new release of EIGEN-6: The latest combined global gravity field model including LAGEOS, GRACE and GOCE data from the collaboration of GFZ Potsdam and GRGS Toulouse

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High-resolution global gravity field models play a fundamental role in geodesy and Earth sciences, ranging from practical purposes, like precise orbit determination, to scientific applications, like investigations of the density structure of the Earth's interior. We report on a second release of EIGEN-6, the latest combined EIGEN-model (EIGEN = European Improved Gravity model of the Earth by New techniques), jointly developed by GFZ Potsdam and GRGS Toulouse. The initial release of EIGEN-6, published in 2011, was the first global combined gravity field model including GOCE data. It had been computed from a combination of LAGEOS, GRACE and GOCE data, enhanced with the DTU10 surface gravity data and was complete to degree and order 1440 (corresponding to 14 km spatial resolution). The new release is now complete to degree and order 1990 (corresponding to 10 km spatial resolution). Furthermore this new model comprises enlarged measurement time spans for the LAGEOS/GRACE data as well as for the GOCE data.

The combination of GRACE and GOCE data allows the construction of an accurate satellite-only model up to degree and order 240, where the GOCE gradiometer data contribute only for degrees upwards of 100. This is achieved through filtering of the GOCE observation equations, which is necessary because of the degraded gradiometer performance outside the measurement bandwidth. Analyses of gradiometer residuals calculated with ITG10S, EIGEN-5C and EGM2008 as background models revealed considerable model errors in current combined gravity field models caused by the inclusion of low-quality and/or low resolution surface data in particular over South America, Africa, the Himalayas and New Guinea. Therefore, the combination procedure of satellite and surface data was revisited in order to mitigate this error source. In particular, the surface data normal equations are combined with satellite normal equations at a higher degree than presently applied (for instance at degree 70 in EIGEN-5C).

The comparison of test results (orbit computation, GPS leveling) of this latest EIGEN model with a GOCE-only model, EGM2008 and ITG10S demonstrates the gain in accuracy at high degrees, while its performance is identical to a GRACE-only model for the low degrees. Compared to the first release of EIGEN-6 this new release shows a general improvement.

Oceanographic validation of the new EIGEN-model in comparison to other global gravity field models is performed through the analysis of differences between mean geostrophic currents derived from the tested gravity field models and inferred from drifter data as a function of resolution (down to 100 km).