ESA's new satellite-only gravity field model via the direct approach (DIR-R6)

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The recently completely recalibrated and reprocessed Gravity Field and Steady-State Ocean Circulation Explorer (GOCE) gravity gradient data were used by GFZ and CNES/GRGS to generate a new gravity field model via the direct approach (DIR-R6). This work was done on behalf of the European Space Agency (ESA) within the consortium of the GOCE High Level Processing Facility (GOCE-HPF).

DIR-R6 is a satellite-only global gravity field model in terms of spherical harmonics to maximum degree and order 300. It has been inferred by the combination of GOCE gravity gradient data with data from Satellite Laser Ranging (SLR) tracking (LAGEOS 1/2, Stella, Starlette, Ajisai and LARES) and Gravity Recovery and Climate Experiment (GRACE). Due to the instrumental behavior of the GOCE satellite gradiometer, the gravity gradient observation equations must be preprocessed and filtered. Here, within the direct numerical method, the filtering has been done using a low pass filter with a cut-off period of 8 seconds. The GOCE GPS-SST data are only used to geolocate the gradients. The low-to-medium degree spherical harmonic coefficients of the gravity field are determined using GRACE GPS-SST and KBR data as well as SLR data from GFZ's release 6 models. All data are combined at normal equation level, which are solved using Cholesky decomposition. We applied the spherical cap regularization to stabilize the low-order spherical harmonic coefficients for the polar gaps in the GOCE data. Furthermore, Kaula regularization is used at the high degrees. .

When compared to the previous gravity field models based on GOCE data, for instance to the earlier releases of ESA's GOCE models, DIR-R6 is more accurate, especially in its medium to high resolution. This is demonstrated among others by GPS/leveling, orbit determination tests and an oceanographic evaluation.