Gravity field quantities in Antarctica from global Earth gravity models (EGM)
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An Earth gravity model (EGM) is by definition a global model, given in terms of spherical harmonics. That is, an EGM model contains the coefficients for the spherical harmonic expansion. The maximum degree N_{max} of the model defines the halfwidth resolution Δ (in terms of a rough approximation).

Examples: $N_{max} = 360$ $\Delta \approx 55$ km
$N_{max} = 2190$ $\Delta \approx 10$ km

From the EGM any desired functional of the Earth gravity potential can be computed. Normally we are interested in gravity anomaly (the difference between the measured gravity at the geoid, and the normal gravity given at the mean ellipsoid), and in the geoid height (height of the geoid with respect to the mean ellipsoid). The mean (or level) ellipsoid is widely taken from the reference system WGS84 (which is, for our purposes, equal to GRS80).

One of the latest global, high-resolution EGM is the model EIGEN-6C4. It has a maximum resolution of about 10 km ($N_{max} = 2190$), and is calculated from satellite data (GRACE and GOCE satellite gravity missions), satellite altimetry over the ocean, and terrestrial data (see abstract below). Thus, it represents the state-of-the-art of global high-resolution EGM.
The reference (publication and data) as well as an abstract are given below. Like the majority of all other available global EGM, this model is available at http://icgem.gfz-potsdam.de/home, which also provides a calculation service (ICGEM = International Centre for Global Earth Models of the International Association of Geodesy).

Here, the following quantities are computed:

a) GRAVITY DISTURBANCE
The gravity disturbance is calculated by a spherical approximation at the ellipsoid (height = 0). Roughly speaking, it serves as an approximation of the gravity anomaly at the geoid. Regarding permanent tides, it is computed according to the “mean tide” definition.

Value unit: mGal [milliGal]

b) HEIGHT ANOMALY
The height anomaly is also approximately computed at the ellipsoid (height = 0). Roughly speaking, it serves as an approximation of the geoid height. More exactly, it denotes the height of the quasigeoid (a surface which is close to the geoid, and which coincides with the geoid at the ocean area). Regarding permanent tides, it is computed according to the “mean tide” definition. (This means, that the geoid would be equal to a mean sea surface as observed by satellite altimetry).

Value unit: m [Meter]

Over Antarctica, the resolution is worse since terrestrial data are lacked for the global combination. One may compare EIGEN-6C4_GravityDisturbance with ANTGG_FreeAirGravityAnomaly. The latter is a truly terrestrial dataset (see description/metadata there).

Reference for the model EIGEN-6C4:

> Förste, Christoph; Bruinsma, Sean.L.; Abrikosov, Oleg; Lemoine, Jean-Michel; Marty, Jean Charles; Flechtner, Frank; Balmino, G.; Barthelmes, F.; Biancale, R. (2014): EIGEN-6C4 The latest combined global gravity field model including GOCE data up to degree and order 2190 of GFZ Potsdam and GRGS Toulouse. GFZ Data Services. http://doi.org/10.5880/icgem.2015.1

Abstract
(adapted from the model file EIGEN-6C4.gfc, icgem.gfz-potsdam.de)

EIGEN-6C4 is a static global combined gravity field model up to degree and order 2190. It has been elaborated jointly by GFZ Potsdam and GRGS Toulouse. The combination of the different satellite and surface data sets has been done by a band-limited combination of normal equations (to max degree 370), which are generated from observation equations for the spherical harmonic coefficients. A brief description of the applied techniques for the generation of such a combined gravity field model is given in Shako et al. 2014. The resulted solution to degree/order 370 has been extended to degree/order 2190 by a block diagonal solution using the DTU10 global gravity anomaly data grid.
Additional Information

Input Data:
- LAGEOS (deg. 2 - 30): 1985 - 2010
- GRACE RL03 GRGS (deg. 2 - 130): ten years 2003 - 2012
- GOCE-SGG data, processed by the direct approach (Pail et al. 2011, Bruinsma et al. 2014, to deg. 235) incl. the gravity gradient components Txx, Tyy, Tzz and Txz out of the following time spans: 837 days out of the nominal mission time span 20091101 - 20120801 422 days out of the lower orbit phase between 20120901 - 20130524 The GOCE polar gaps were stabilized by the Spherical Cap Regularization (Metzler and Pail 2005) using the combined gravity field model EIGEN-6C3stat
- Terrestrial data (max degree 370): DTU12 ocean geoid data (Anderson et al. 2009) and an EGM2008 geoid height grid for the continents

Parameters:

product_type	gravity_field
modelname	EIGEN-6C4
earth_gravity_constant	0.3986004415E+15
radius	0.6378136460E+07
max_degree	2190
errors	formal
norm	fully_normalized
tide_system	tide_free