RWI_TOPO_2015: An update of the Rock-Water-Ice topographic gravity field model of the Earth

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Method and input data

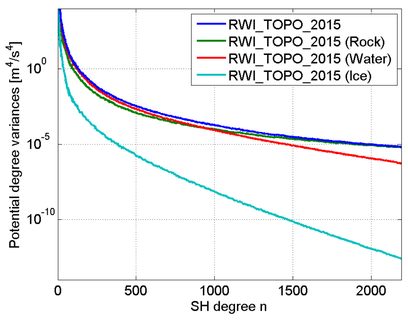
By using high-resolution topographic information the high-frequencies of the gravity field can be determined and utilized in various applications, e.g., smoothing or spectral extension of gravity field-related quantities.

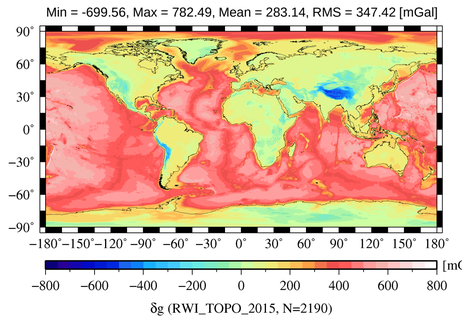
This contribution provides an update of the Rock-Water-Ice (RWI) topographic gravity field model that is characterized by a rigorous separate modeling of rock, water, and ice masses with layer-specific density values. In a first step, gravity forward modelling is performed in the space domain using tesseroid mass bodies (**Grombein et al., 2013**). In the second step, global gridded values of topographic effects are transformed to the frequency domain by applying harmonic analysis (**Abd-Elmotaal et al., 2014**).

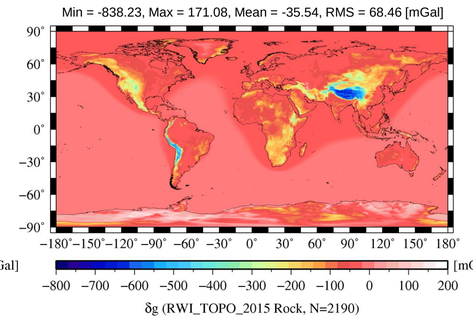
While the former model, **RWI_TOPO_2012** (**Grombein et al., 2014**), was based on the global 5′×5′ DTM2006.0 topographic data base (**Pavlis et al., 2007**), the updated version, **RWI_TOPO_2015**, uses the new 1′×1′ Earth2014 model (**Hirt and Rexer, 2015**) that combines DTM information of SRTM3, SRTM30_PLUS, Bedmap2, and GBT_V3. For comparison, also a consistent rock-equivalent version **REQ_TOPO_2015** has been generated, in which the DTM-heights of water and ice masses are condensed to the constant rock density.

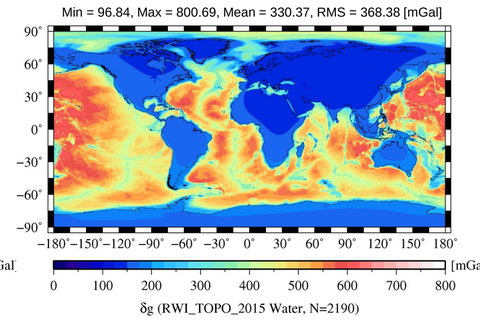
	RWI_TOPO_2012	RWI_TOPO_2015
Topography model	DTM2006.0 (5′x5′)	Earth2014 (1′x1′)
Density values [kg m^{-3}]	Rock: 2670 Water: 1000 (Ocean) 1000 (Inland) Ice: 920	Rock: 2670 Water: 1030 (Ocean) 1000 (Inland) Ice: 917
Mass arrangement	GRS80 ellipsoid	GRS80 ellipsoid + EGM96 geoid
Calculation grid	Sphere (5′x5′, R=a+20 km)	Ellipsoid (4′x4′, h=20 km)
Maximum degree/order	1800	2190

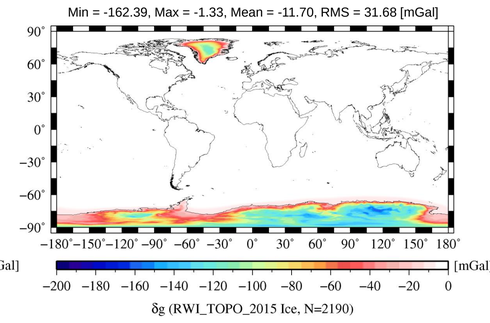
RWI_TOPO_2015 − Model characteristics



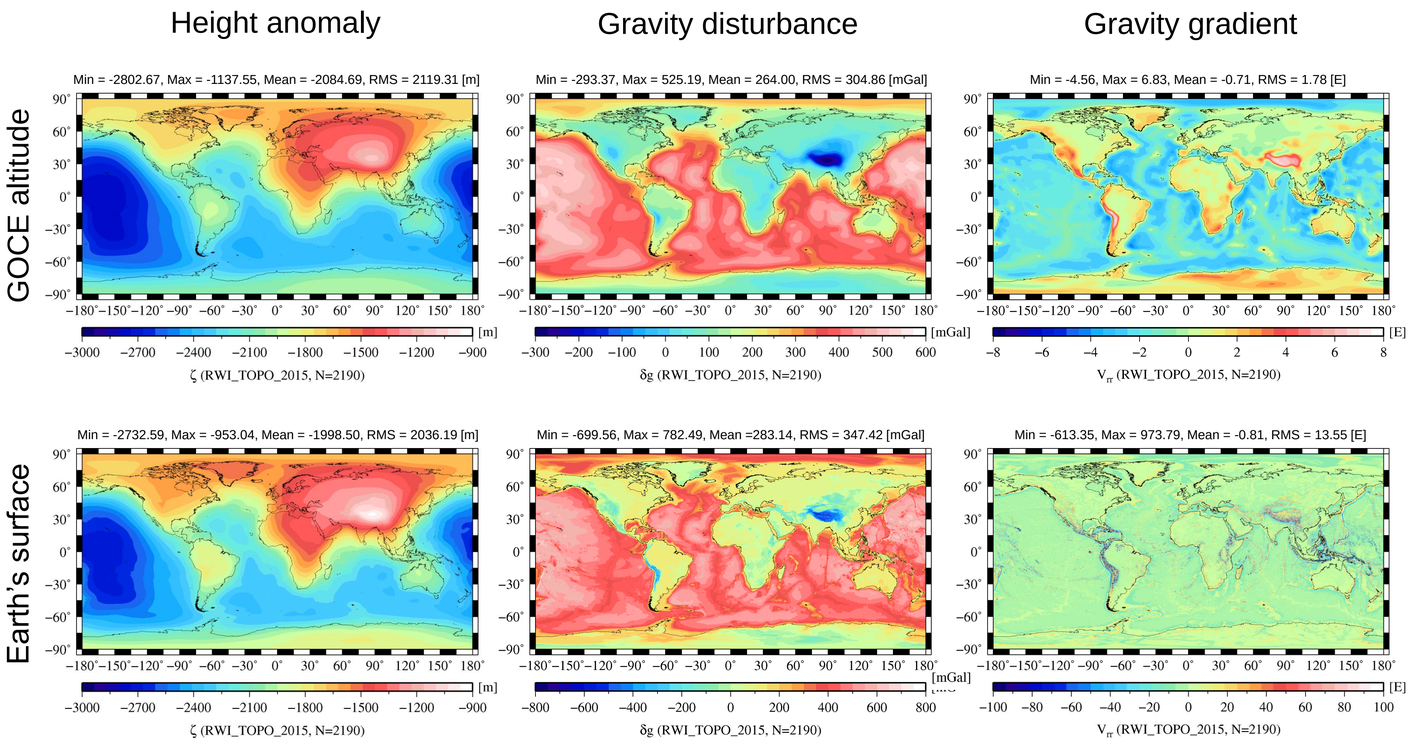




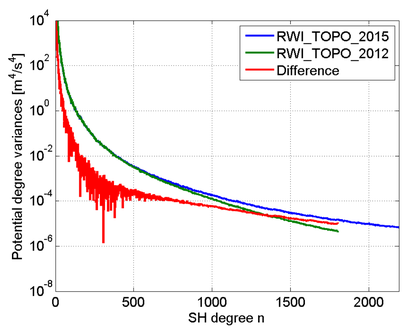


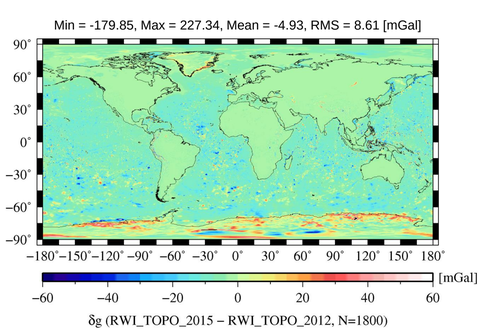


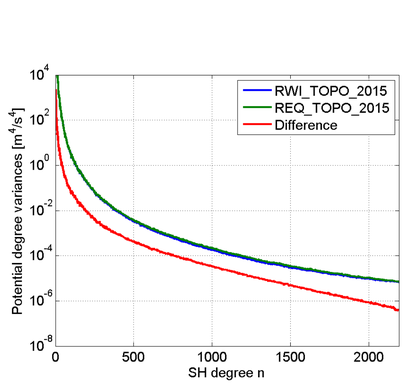
RWI_TOPO_2015 − Meissl scheme

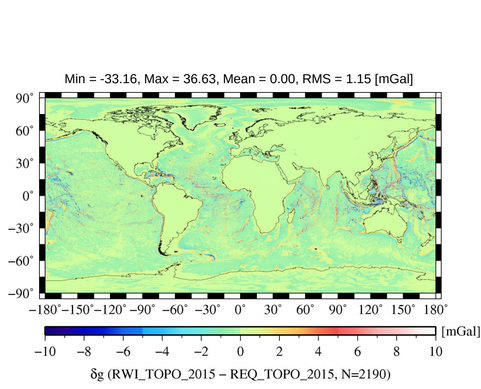


Comparison to RWI_TOPO_2012 / REQ_TOPO_2015









Evaluation by current global gravity field models (GGM)

Performance indicators (**Hirt et al. 2015**):

Reduction rate

$$RR = 100\% \cdot \left(1 - \frac{\mathrm{RMS}(\delta g_{\mathrm{TOPO}} - \delta g_{\mathrm{GGM}})}{\mathrm{RMS}(\delta g_{\mathrm{TOPO}})}\right)$$

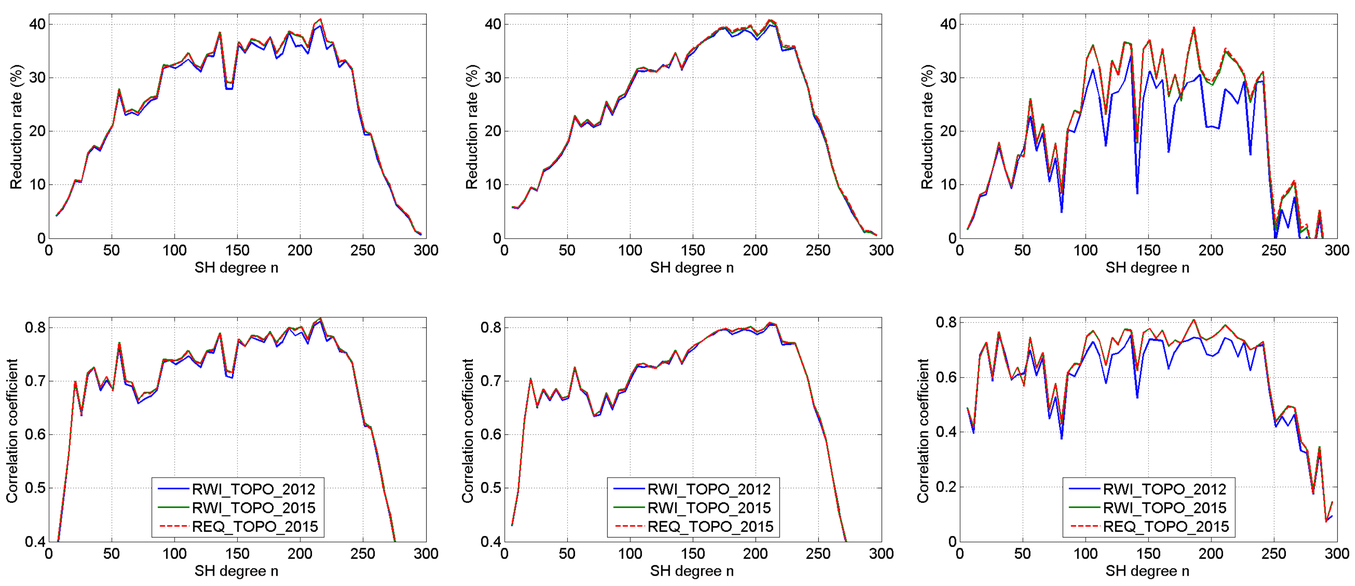
Cross-correlation coefficient

$$CC = \frac{\sum(\delta g_{\mathrm{TOPO}} - \overline{\delta g}_{\mathrm{TOPO}})(\delta g_{\mathrm{GGM}} - \overline{\delta g}_{\mathrm{GGM}})}{\sqrt{\sum(\delta g_{\mathrm{TOPO}} - \overline{\delta g}_{\mathrm{TOPO}})^2 \sum(\delta g_{\mathrm{GGM}} - \overline{\delta g}_{\mathrm{GGM}})^2}}$$

Gravity disturbances are calculated in narrow spectral bands of 5 degrees in terms of geocentric-spherical spaced 10′x10′ global grids (R=a+10 km). In the case of the GOCE GGM, grids are limited to |φ| < 83.3° according to the GOCE satellite inclination.

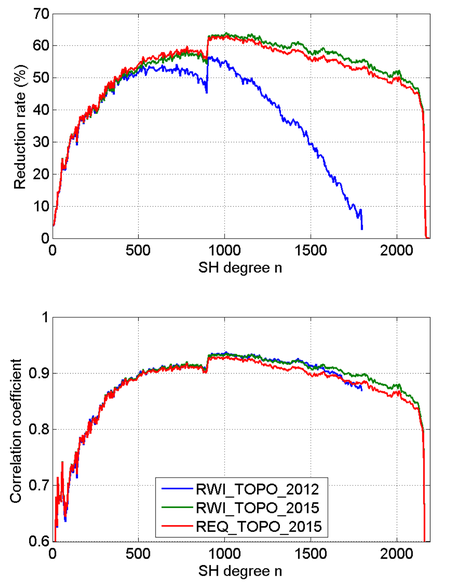
GOCE DIR R5 (**Bruinsma et al., 2014**)

Land, |φ| < 83.3° | Oceans, |φ| < 83.3° | Antarctica, |φ| < 83.3°



EGM08 (**Pavlis et al., 2012**)

Global



Conclusion and Outlook

- A new version of the Rock-Water-Ice topographic gravity field model (RWI_TOPO_2015) has been calculated based on the 1′×1′ Earth2014 topography model.
- SH-coefficients up to d/o 2190 will soon be available at http://www.gik.kit.edu/rwi_model.php.
- An evaluation of the new RWI model by current GGM shows significant improvements over the Oceans and Antarctica as well as much higher reduction rates w.r.t. EGM08 for degrees n > 900.
- A comparison of RWI_TOPO_2015 with Curtin's topographic potential model dV_ELL_RET2014 (**Hirt et al. 2015**), which also relies on the Earth2014 topography, is in progress.

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