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Computation of the gravity gradient tensor due to topographic masses using tesseroids

***Uieda, L**
leouieda@gmail.com
Observatorio Nacional, Rio de Janeiro, Brazil
Ussami, N
naomi@iag.usp.br
Universidade de São Paulo, São Paulo, Brazil
Braitenberg, C F
berg@units.it
University of Trieste, Trieste, Italy

The GOCE satellite mission has the objective of measuring the Earth's gravitational field with an unprecedented accuracy through the measurement of the gravity gradient tensor (GGT). One of the several applications of this new gravity data set is to study the geodynamics of the lithospheric plates, where the flat Earth approximation may not be ideal and the Earth's curvature should be taken into account. In such a case, the Earth could be modeled using tesseroids, also called spherical prisms, instead of the conventional rectangular prisms. The GGT due to a tesseroid is calculated using numerical integration methods, such as the Gauss-Legendre Quadrature (GLQ), as already proposed by Asgharzadeh et al. (2007) and Wild-Pfeiffer (2008). We present a computer program for the direct computation of the GGT caused by a tesseroid using the GLQ. The accuracy of this implementation was evaluated by comparing its results with the result of analytical formulas for the special case of a spherical cap with computation point located at one of the poles. The GGT due to the topographic masses of the Parana basin (SE Brazil) was estimated at 260 km altitude in an attempt to quantify this effect on the GOCE gravity data. The digital elevation model ETOPO1 (Amante and Eakins, 2009) between 40° W and 65° W and 10° S and 35° S, which includes the Paraná Basin, was used to generate a tesseroid model of the topography with grid spacing of 10' x 10' and a constant density of 2670 kg/m^3. The largest amplitude observed was on the second vertical derivative component (-0.05 to 1.20 Eötvos) in regions of rough topography, such as that along the eastern Brazilian continental margins. These results indicate that the GGT due to topographic masses may have amplitudes of the same order of magnitude as the GGT due to density anomalies within the crust and mantle. References: Amante, C., Eakins, B.W., 2009. ETOPO1 1 Arc-Minute Global Relief Model: Procedures, Data Sources and Analysis. *NOAA Technical Memorandum NESDIS NGDC-24*, p. 19. Asgharzadeh, M.F.; Von Frese, R.R.B.; Kim, H.R.; Leftwich, T.E.; Kim, J.W., 2007. Spherical prism gravity effects by Gauss-Legendre quadrature integration. *Geophysics Journal International*, v. 169, p. 1 - 11. Wild-Pfeiffer, F., 2008. A comparison of different mass elements for use in gravity gradiometry. *Journal of Geodesy*, v. 82 (10), p. 637 - 653.

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