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Expected sensitivity of GOCE satellite to detect basement and Moho undulations

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The GOCE satellite is the first mission to carry a gravity gradiometer on board with the goal to improve knowledge of the global Earth gravity field. It has been launched on March 17, 2009 and has been acquiring data since that date, including a several month lasting calibration phase. The satellite is designed to produce a global satellite-only gravity field model in the spherical harmonic expansion up to degree and order n=200-250. Previous missions, including the GRACE satellite, contribute to a maximum degree and order of n=120. Up to now the global field with the highest degree and order of the expansion is EGM2008 (Pavlis et al., 2008), complete to n=2159. The goal of our work is to estimate the geologically relevant structures which can be studied with the GOCE-data and for which we can expect to obtain an improved knowledge with respect to existing models. We base our study on the degree error variances of two existing gravity models (EGM2008 and EIGEN5C) and on simulated errors of the GOCE mission. The error degree variances are tied to the spherical harmonic expansion and consequently we perform the sensitivity study in the spectral domain. We consider in detail two density discontinuities, which can be found everywhere in the crust, and which are the top basement and the Moho. The density discontinuity is expressed as a sheet mass which we can expand in spherical harmonics. We use the relations that tie the sheet mass to the disturbing potential field to determine the smallest mass that can be detected, given the error corresponding to a certain degree of the field. We obtain thus the smallest boundary oscillation that can be detected at the level of the crust-mantle boundary, and at the level of the basement. In our solution available constraints on the Moho stemming from seismic or receiver functions are taken into account. We show under which conditions the GOCE gravity field is bound to improve present knowledge on the boundaries. Our study is accomplished in the frame of different projects as the GOCE-Italy project supported by the Italian Space Agency, responsible Prof. F. Sansò , the FAPESP project, responsible Prof. I. Vittorello, and is part of the ESA GOCE EO project ID 4323, responsible Prof. C. Braitenberg.

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