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Optimal forward calculation method of the Marussi tensor due to a geologic structure at GOCE height.

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The gradient observations of GOCE challenge the geophysical modeler to develop new calculation methods that take into account the sphericity of the earth. The presently available forward modeling tools used for calculating the geoid undulation, the gravity field and gravity gradient field all use a cartesian reference system, which is sufficient for regional studies and for calculating the fields near to the topographic surface, but which are not ideal for calculating the fields at the height of the satellite. We address the problem of discretizing the lithosphere with a series of tesseroids, or spherical prisms. Presently there is no closed formula giving the field of the tesseroid, so approximation methods must be used. We use the Gauss Legendre Cubature (GLC) method, which is an approximation to the mathematical integration of the fields over the volume of the tesseroid. The GLC is characterized by the degree of the expansion, which determines the intrinsic approximation error. Since the computation times with the tesseroids are quite high, it is important to economize the calculation scheme, and therefore optimize the size of the tesseroids used in the discretization of the lithosphere and the degree used in the GLC approximation. The error of the fields calculated with the GLC method depends on the degree of the GLC, the size of the tesseroid and the distance between the tesseroid and the calculation point. We explore these parameters and formulate the criteria by which they can be automatically implemented, allowing the calculation time to be drastically reduced by one order of magnitude or more. The criteria we present also allows us to define the expected calculation error of the GLC with respect to the real tesseroid, a value that we match to the expected error of the GOCE observations. We show further that the correct choice of the size of the tesseroids depends on the particular field we intend to model, and is different for geoid, gravity and gradient field. In this context another issue concerns the estimate of the error when neglecting the sphericity of the earth and making the calculations of the lithospheric structure at GOCE height in the Cartesian system.

Finally we calculate the fields over the Amazon basin with the known geophysical constraints and compare them with the GOCE observations. The Amazon basin is an area difficult to access, with high economic potential of natural resources, where we expect the GOCE observations to pose further constraints on the density variation in the crust and allow a better understanding of the geodynamic formation history. This research is made in cooperation with Valeria C.F. Barbosa from Observatorio Nacional and in the frame of different projects, as PRIN2008, FAPESP, CAPES, GOCE-Italy.