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Formulas of Gravitational Curvatures of Tesseroid Both in Spherical and Cartesian Integral Kernels

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The detailed gravity effects information of topographic mass distributions on the effects of gravity field modeling are fundamental issues in the area of geophysics and physical geodesy. In the spatial domain of gravity forward modeling, we expand the concept of gravity effects, including Gravitational Potential or geopotential (GP), Gravity Vector (GV) and Gravity Gradient Tensor (GGT), of the topographic mass reduction by adding the Gravitational Curvatures (GC). We take the efficient tesseroid model for topographic mass as an example, and derived new GCs of tesseroid formulas both in spherical and Cartesian integral kernels in 3D and 2D integration forms, respectively. Numerical experiments are performed to show the spatial prosperities for gravity effects of tesseroid. Specifically, the numerical efficiency for the gravity effects of tesseroid formulas have been evaluated by 3D and 2D Taylor Series Expansion (TSE) approach with zero-order, second-order and fourth-order, Gauss-Legendre Quadrature method (GLQ) and Newton Cotes Quadrature method (Closed NCQ (CNCQ) and Open NCQ (ONCQ)) with different degree nodes. Moreover, the very-near-area problem and polar singularity problem of the computation point for gravity effects of tesseroid mass body in spherical coordinate system have been discussed based on the numerical method of 3D and 2D TSE approach, GLQ and NCQ methods. Numerical results show that with higher order for TSE and more nodes for GLQ and NCQ, the approximation errors are less whereas the computation time is larger. Among the numerical approaches mentioned in this paper, the GLQ approach is recommended for practical calculation in terms of computation efficiency and time. This study is supported by National 973 Project China (grant Nos. 2013CB733301 and 2013CB733305), NSFCs (grant Nos. 41174011, 41429401, 41210006, 41128003, 41021061)

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