



Comments on Stokes' approach in determining the global gravimetric geoid and its new formulation

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In physical geodesy, in order to determine the global gravimetric geoid, generally, a disturbing potential function, which is the difference between the geopotential and normal gravity potential, is introduced. For instance, by Stokes' approach or Stokes boundary-value problem, given the gravity anomaly on the geoid (as the boundary), a disturbing potential function satisfying some kind of boundary conditions should be solved. A basic requirement is that the disturbing potential function should be harmonic in the region outside the geoid. Besides the well-known disadvantages in the conventional Stokes' approach however, there are some theoretical difficulties. Since the normal gravity potential is not defined inside the reference ellipsoid (taking the WGS 84 ellipsoid as an example), in case that the geoid is below the ellipsoidal surface, the disturbing potential function is not harmonic in the whole region outside the geoid, and neither defined on the whole geoid itself. These are the mentioned theoretical difficulties existing in the conventional Stokes' approach. To take away these difficulties from Stokes' approach, this study provides a new formulation of Stokes' approach. We choose an inner ellipsoid with four fundamental parameters, with its center coinciding with that of the WGS 84 ellipsoid, and completely enclosed by the geoid. Then, the normal gravity potential generated by the inner ellipsoid is determined by requiring that it holds a constant on the surface of the inner ellipsoid or on the surface of the WGS 84 ellipsoid. By this new formulation, the disturbing potential function is harmonic in the whole region outside the geoid, and the difficulties existing in the conventional Stokes' approach do not exist any more. The new formulation proposed in this study is also adequate for analogous geodetic boundary-value problems. This study is supported by Natural Science Foundation China (grant No.40974015; No.41174011).