

Effect of distant topographical masses on geoid determination

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A gravimetric geoid is computed from the solution of the geodetic boundary-value problem. This mathematical approach happens to be relatively straightforward when the unknown function, the earth gravity field potential, is harmonic everywhere above the geoid. This is not the case in reality (because of the presence of topographical and atmospheric masses) and the actual earth body is in practice replaced by a model where all external topographical and atmospheric masses are somehow removed.

In Stokes-Helmert's approach, the actual earth is replaced by the Helmert model where all external topographical and atmospheric masses are condensed on the geoid. This model has, of course, a gravity potential which is different from the original potential and its equipotential surfaces are shifted with respect to the original ones. In the case of the geoid, being one of the equipotential surfaces, this shift is called the "indirect effect" on the geoid. The difference between the actual gravity and its counterpart in the Helmert space, on the surface of the earth, is called the "direct effect" on gravity. The boundary value problem is then formulated and solved in the Helmert space.

This contribution describes the proper evaluation of these two effects taking into account only topographical masses and leaving the atmospheric masses alone. The formulae are derived by adopting a spherical model of the geoid. The involved Newtonian integrals are then evaluated differently for the region close to the point of interest and for the rest of the world. The first integral is evaluated using numerical integration over discrete elevation data. The second, describing the effect of distant topographical masses, is evaluated using a global spherical harmonic representation of topography. Numerical results for the test area in the Canadian Rocky Mountains are presented and their significance from the point of view of the "centimetre geoid" are analysed. It is argued that although the distant-zone contributions to the direct and indirect topographical effects are relatively small, they have to be taken into account when computing precise geoid.