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An approximation of ellipsoidal harmonics and the construction of Galerkin's matrix in studies on Earth's gravitational potential

P. Holota

Research Institute of Geodesy, Topography & Cartography, Department of Geodesy and Geodynamics, 25066 Zdiby 98, Praha-vychod, Czech Republic (e-Mail: holota@pecny.asu.cas.cz, Fax: 00420 284890056)

The concept of the so-called weak solution offers a considerable degree of flexibility in refined studies on Earth gravity potential. It also has a natural tie to variational methods. In this paper the boundary-value problems that govern the determination of the disturbing potential are formulated in a general setting and subsequently interpreted in terms of function bases constructed in the respective Sobolev weight space of functions. Especially, the reciprocal distance and the reproducing kernel were used to produce the function basis. This interpretation is associated with Galerkin's system of linear equations, which yields the coefficients in the approximation of the disturbing potential by means of linear combinations of basis functions. In the paper Galerkin's matrix is constructed for an unbounded solution domain. In case of an ellipsoidal boundary ellipsoidal harmonics come into play and the structure of the elements of the matrix becomes rather complex. For this reason an approximation of ellipsoidal harmonics is applied. A solution of an approximate version of an ordinary differential equation, which results from the use of the method of separation of variables in solving Laplace's equation, is used for this purpose. The construction of Galarkin's matrix based on this idea is discussed and the accuracy of the approximation is examined quantitatively with a particular view to problems in gravity field modeling.