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On determination of regularization parameter in Geoid computations without applying Stokes formula

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Downward continuation of gravity functionals from the surface of the Earth to the surface of reference ellipsoid is a critical step in geoid computations without applying Stokes formula, a geoid computation method, which was proposed by A. Ardalan and E. Grafarend in 2004 (Journal of Geodesy, 78: 138-156) and further developed by A. Safari. A. Ardalan and E. Grafarend in 2005 (Journal of Geodynamics, 39: 545-568). In that method, downward continuation is accomplished via ellipsoidal Abel-Poisson integral and its derivatives. Ellipsoidal Abel-Poisson integral is an integral equation of first kind, i.e. the unknown parameters (disturbing potential on the surface of reference ellipsoid) are under the integral sign, and therefore to determine disturbing potential on the reference ellipsoid, the integral operator must be inverted. It is well known that integral equations of the first kind with Hilbert-Schmidt kernel are ill posed, and as such the inversion of the operator is not continuous, i.e., a small error in the observation is amplified and produce a large error in the unknowns. As any unstable problem the inverse solution of this integral must be regularized by a suitable regularization technique. Successful application of any regularization method depends on correct selection of the regularization parameter. In this paper, 4 methods for determination of regularization parameter, namely (i) L-curve, (ii) GCV, (iii) DP and (iv) Flattest-Slope are studied for regularization of the ellipsoidal Abel-Poisson integral. According to the results of the numerical computations, L-curve method is the most suitable one and as such we recommend that it be used for determination of regularization parameter, in the geoid computation without applying Stokes formula.