A faster algorithm for numerical Stokes's integration

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Abstract

Stokes's kernel is a function of the distance between the point of interest and the dummy point in the integration. Its values thus are obtained from the positions of pairs of points on the geoid. For the integration over the near-zone (in our case, a cap of radius of 6 arc-degrees) it is advantageous to pre-form a matrix of kernel values where each entry corresponds to the appropriate locations of the two points, or equivalently, to the latitude and longitude differences between the point of interest and the dummy point. Thus, for computation points on the same latitude, the matrix of the Stokes kernel values remains the same and can only be evaluated once. Also, only one half of the matrix can be evaluated because of its longitudinal symmetry: the near-zone can be folded along the median of the point of interest. Numerical tests show that the computation speed improves significantly after this algorithm is implemented. For an area of 5 by10 arc-degrees, with the grid of 5' by 5', the computation time reduces from more than 10 hours to half an hour, i.e., twenty times. Compared to the Fast Fourier Transform algorithm, this algorithm is easier to implement. Moreover, the far-zone contribution of the Stokes integration can be precisely defined and evaluated, using the (global) spectral description of the gravity field.