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A comparison between different methods for the determination of the vertical acceleration in mobile gravimetry

M. Abbasi (1), J.P. Barriot (1), J. Verdun (2)

(1) Bureau Gravimétrique International (BGI), 14, Av. E. Belin, UMR5562, Observatoire Midi-Pyrénées, 31400, Toulouse, France (madjid.abbasi@obs-mip.fr , Jean-Pierre.Barriot@cnes.fr),
(2) Ecole Nationale des Sciences Géographiques, 77455, Marne la Vallée, France (verdun@ensg.ign.fr)

Separation of the vehicle induced accelerations (vertical acceleration and Eötvös acceleration) from gravity acceleration is one of the main challenges of mobile gravimetry. Computation of these two kinematic accelerations needs some differentiations of the vehicle's geodetic coordinates time series. But, differentiation is not a bounded operator and amplifies the noises. Considering that accuracies in the order of 1mGal=0.00001m/s^2 are aimed, special precautions should be taken to reduce the impact of the noises. Computation of the Eötvös acceleration is in itself not problematic, because the horizontal accuracy of GPS coordinates is relatively high (a few centimeters accuracy is achievable in kinematic relative positioning). In the opposite, computation of the vertical acceleration is problematic, as the vertical accuracy of the GPS positioning diminishes down to the decimetre level. The common procedure to compute the vertical acceleration is to fit an analytical function to the altitude data series then to double differentiate this function. But the result depends strongly to the choice of the analytical function. We propose another method, based on a transformation of the related second order differential equation giving the vertical acceleration to an integral equation, that is solved for through a least squares procedure. The main advantage is that we obtain vertical acceleration formal error (covariance matrix) as a by product. The aim of this presentation is to describe these two methods of differentiation and to make intercomparison.