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Geoid computation without application of Stokes formula based on very localized gravity data of heterogeneous types Case study: Finland test area

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Local gravity field models and high-resolution geoid models are essential for variety of geodetic, geophysical, geological, and environmental applications. Geoid computation based on Stokes-Helmert method requires access to gravity data from a relatively large area around the area of interest and besides those geoid solutions are always suffering from edge effects, which force to cancel out part of the geoid solution around the computational area. Though there has been different proposals to partially over come the aforementioned problems, however, only limited success has been achieved based on the Stokes-Helmert approach in increasing the accuracy of geoid model in relative sense. Therefore, still computation of highly accurate geoid (in absolute sense) based on localized gravity data is an open question. In this paper, Fixed-Free Two Boundary Value Problem (FFTBVP) is proposed and numerically proved to be the answer to the problems of geoid computation based on gravity observables over the area of interest alone. This investigation has been carried out as a joint research project between Geodesy Division of the University of Tehran and Geodesy and Geodynamic Department of the Finnish Geodetic Institute. The investigation has been performed over a test area of approximate size of $200km \times 200km$ in southwest of Finland. As the boundary values (i) norm of gravity from gravimetry, (ii) astronomical longitude and latitude from astronomical observations, and (iii) geopotential numbers from precise leveling are considered. The selected test area has following properties: (1) Has high quality boundary data of the aforementioned types. (2) Has a geoid model from previous geoid solutions (based on Helmert-Stokes method) with known accuracy. (3) Has reliable GPS/Leveling information which could be used to verify the accuracy of

the computed geoid based on FFTBVP. (4) Has very well known geological structures and it is of interest to know how those structures could be modeled in a high-resolution geoid. The results of the computation have shown possibility of the centimeter geoid computation based on FFTBVP which we call it geoid computation without application of Stokes formula. The theoretical and numerical details are presented in the paper.