Optimal calculation of mean values of topographical effects: Case study for Central Europe

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Abstract: The main topic treated in our contribution is the effectiveness of calculation of mean values of topographical effects in a process of a precise geoid determination. As the geoid height is obtained from gravity values via an integral transformation, the mean values of topographical effects in an integral sense are required to enter the solution. However, the mean values of topographical effects can not be obtained analytically, because the terrain itself is a complicated surface represented by limited amount of elevations called a digital terrain model (DTM). It is obvious that in a rugged terrain it is necessary to calculate the mean value of topographical effects from more point values than in a flat terrain in order to obtain the same accuracy. The aim is to find the optimal density of point values of topographical effects to be averaged to get the mean value with a sufficient accuracy according to terrain roughness. The case study has been performed in six testing areas of 1°×1° with different terrain roughness in Central Europe. In each testing area we computed the mean values of three chosen topographical effects using the program dte_pm of SHGEO software package (Tenzer and Janák, 2002) with 5´×5´ cell size. We performed our calculations in six different modes representing a different amount of point values per averaging cell. The mode 1 represented only 1 point value per averaging cell and thus the lowest density of point values, while mode 6 represented 100 point values per averaging cell which was the highest density of point values. Subsequently, the differences between the mean values of topographical effects computed from neighbouring modes have been calculated and their effects on a geoid have been estimated using the program geofour of GRAVSOFT software package (Tscherning et al., 1992). The criterion for optimal number of point values for one mean value calculation and thus form the

optimal density of point values was a limit value of 1 cm effect on the geoid. This criterion was applied in a sense of the Tsebyshev norm. To generalize the results for all Central Europe we made a graph, which represents the empirical dependency between the terrain roughness represented by standard deviation and the optimal number of point values for 5′×5′ averaging cell. We found out that this empirical dependency is almost linear, so applying the linear regression we estimated the recommended intervals of standard deviation of terrain that correspond to particular densities of point values. Finally we made a map of optimal densities of point values to be used for topographical effects computation in Central Europe. A brief comparison with a similar experiment in Canada (Janák et al., 2011) is discussed.

Key words: Geoid, integral mean value, terrain correction, condensed terrain correction, direct topographical effect, Helmert's condensation

References

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