2011-08-19

NKG Working Group on Geoid and Height Determination

Project #2: Investigation of requirements for a future 5 mm (quasi)geoid model.

Circular letter No. 1

Dear Colleagues,

We are faced with a delicate study project that was formulated as a resolution at the NKG General Assembly 2010. The result should (hopefully) be of interest not only to the NKG community but to most geodesists around the world. Although the major part of the theory and methodology to be used will be general, it is nevertheless reasonable to assume that the resulting simulations and conclusions are mainly valid for Scandinavia alone.

Below I will summarize some introductory thoughts on the project that come to my mind, and I hope that many of you will react to them.

Basic questions and ideas

a) I understand that the task is to study the needed requirements (theory and data) for determining both an accurate geoid and quasigeoid model. Basically we may say that the two models differ by the need for the topographic density in the geoid model (only). But there are some other differences of the two that should also be considered.

b) It should also be cleared out from the beginning what is specifically the purpose of the study, and what do we mean by " the 5 mm geoid". For example, I assume that we are not primarily interested in an absolute geoid model (in the global sense) good to 5 mm, but we will rather think of a regional geoid model with this (relative) accuracy (where we, for instance, do not care about any possible zero- and first-degree terms of the model).

c) One major concern for the study should also be the expected/sought application of the geoid model under consideration. Are we interested in computing a pure gravimetric geoid model to 5mm, independent of GNSS/leveling heights in the area (Alternative A), or are we seeking a geoid model that fits GNNS/leveling to 5mm (or, better, a model that contributes to 5 mm in the fit) (Alternative B)? The answer will help in clarifying the study plan.

d) Actually, I could think of including both alternatives A and B in the study plan. That is, first we should study the error propagtion included in A. Then B can be thought of as a combination of A and GNSS/leveling geoid data.

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e) There is no doubt that the precise gravimetric geoid model (A) should be based on a combination of an EGM (e.g. EGM08) and local gravity data (g-data). According to Pavlis et al. (2005), the global rms commission error of EGM08 (completete to degree 2160) is of the order of 20 cm. To this figure should be added the omission/truncation error of some centimetres (not estimated by Pavlis et al.). These figures look very pessimistic, but the good thing is that we can expect EGM08 to be much better in Scandinavia. Jonas (Ågren, 2010) carried out a Swedish national study of EGM08 vs. GPS/leveling point data, and he got the agreement of 2.7 cm after a 1-parameter transformation. (Some of you may have your own experiences with EGM08; please let us know!) Removing the GPS and levelling uncertainties from the fit, Jonas' study indicates an accuracy of the EGM08 geoid model of slightly more than 10 mm. These studies give a good insight to what EGM08 can do alone for a geoid model in Scandinavia. As one can see from Pavlis and Holme's study, both the commission and the omission errors must be reduced. The former is reduced by some type of spectral weighting of EGM data with g-data, the latter by replacing the omission/truncation error by g-data information.

f) The study group should discuss different alternatives to combine the EGM and g-data (such as LSMS and RCR techniques). Simulated error propagations will help in this study. A crucial point in such a study is the assumed quality of gravimetric data and error covariances (- functions) of the data. This concerns also the signal degree variances of the gravity field, which affect the omission/truncation error. Another problem is systematic errors, mainly in the g-data, which, for example, calls for truncating Stokes integral to a limited area around the computation point. How big area should be choosen?

g) Additional errors to the final geoid model are related with topographic, atmospheric and ellipsoidal corrections. Is there a need for improving the theory for these? Once this is settled the requirements in these corrections can (and should) rather easily be studied by simulations. The atmospheric and ellipsoidal errors are small, but the impact of the quality of the topographic data in the topographic corrections should be carefully studied.

References:

Ågren J (2010) Evaluation of EGM2008 and PGM2007A over Sweden.

Pavlis et al. (2005) A preliminary gravitational model to degree 2160.

I would appreciate to get any reactions from you on these ideas. Also, indicate how you would like to contribute to the study.

Warm regards,

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