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International Geoid Commission

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by

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1. Introduction.

Geoid computations are organized for the Nordic area in cooperation between scientists at the universities and the national mapping organisations, see Tscherning(1990). Special purpose geoid computations are performed ad hoc, as described below. Furthermore research in new or improved methods for geoid computation (gravity field modelling) has also been executed. Extensive software developments have also taken place.

2. Recent geoid computations.

Of major importance has been the new NKG (Nordic Geodetic Commission) geoid (Forsberg, 1990, 1990a). This was based on the OSU89B spherical harmonic model, RTM and the FFT implementation of Stokes integral, see Schwarz et al. (1990). A comparison with the European geoid and GPS traverse showed (see e.g. Forsberg and Madsen, 1990) that 10 cm was achieved for a line of about 2000 km.

Geoid computations of hich resolution for local areas has been computed for smaller areas, e.g. where a new fixed link is being constructed across the Greath Belt (Madsen and Tscherning, 1990, Madsen and Aarestrup, 1990, Forsberg and Madsen, 1990). We are here down in cm uncertainties, where not only the errors in the geoid computation but also in the GPS derived height differences and the levelling plays a role.

Geoid computations have also been performed for larger regions as the Mediterranean and the North Atlantic in order to study sea surface topography and for gravity field mapping (Arabelos and Tscherning, 1988, Knudsen, 1989a, 1990a, 1991, Knudsen et al. 1988). Both pure gravimetric geoids and filtered altimeter - gravity geoids have been computed.

3. Theoretical developments and simulation studies.

Competing methods today are the collocation method and the Stokes method implemented using FFT. These methods have been compared in the Mediterranean (Barzaghi et al., 1988). A very interesting result is that the FFT technique gives excellent results, see also Forsberg and Solheim (1988).

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The handeling of terrain effects is very important, and our experience is, that as much as possible of the terrain must be removed (and later restored) in order to get good results. It is not sufficient to shift the terrain as proposed in older theories. The removal of terrain effects reduces several types of errors and may aid in filling gaps with lacking data. However, terrain effect computations are expensive in terms of computer time. Here many improvements have been made, again using the FFT method, see Forsberg and Sideris (1988, 1989).

Terrain reductions may also be used at sea (see e.g. Knudsen,1989). However, at sea there are several problems due to the low quality of the bathymetry at larger depths, where also gravity observations frequently lack associated depth information.

Global geopotential models have been extremely important for local geoid computations, and we have succesfully used the various OSU models and the tailored models from Hannover (see Basic et al., 1989). The tailored models are inportant, because they may be improved locally for areas where new data has become available since the release of a global geopotential model, but if data is not of good quality problems may occur (see e.g. Kearsley and Forsberg, 1990).

The achievable precision of geoid computations is of interest in connection with the planning of engineering constructions and when evaluating a new instrument like the satellite gradiometer. Such precision estimates are easily made using collocation, and have been published in (Arabelos and Tscherning, 1990, Knudsen, 1990, Tscherning, 1989, 1989a). Also the precision may be lowered if gross errors are present. A method for their detection is described in Tscherning (1990).

4. Software developments.

A program package named GRAVSOFT is maintained and continously improved by the Geophysical Institute, University of Copenhagen and the National Survey and Cadastre. It is commercially available, but has been distributed free of charge to scientists recommended by a member of the commission. (6 copies have been distributed to members, others have received updates). It has succesfully been used for geoid computations in a number of countries. Other developments are under way, especially in the area of satellite altimetry.

4. Future developments.

The challenge for future geoid computations are in 3 areas:

a: computations of "absolute" geoid heights (all our geoids have been good relative geoids)

b: computation of regional geoids of high resolution (project GEOMED, reference geoids for satellite altimetry) c: computation of geoids in high mountains (maximal heights of 2 - 3 km have been used up to now).

We see the issue of precise geoid computation as beeing extremely important not only for the use in connection with GPS (Vermeer,1988), but also for the proper use of satellite radar altimetry. Here, naturally the big problem is the lack of gravity observations in many areas.

A dedicated satellite mission for gravity field determination is very much needed.

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