



# NORDISKA KOMMISSIONEN FÖR GEODESI Nordic Geodetic Commission

## Working Group for Geoid Determination

### Minutes of the meeting of the Working Group for Geoid Determination within the Nordic Geodetic Commission

Finnish Geodetic Institute, Masala, Finland, March 10-11, 2010

#### Participants:

Norway	Dag Solheim (Chairman)	Statens kartverk
	Dagny Lysaker	Statens kartverk
Sweden	Jonas Ågren	Lantmäteriet
Denmark	Gabriel Strykowski	National Space Institute, DTU Space
Estonia	Harli Jürgenson	EMÜ, Estonian University of Life Sciences
	Tõnis Oja	Estonian Land Board
	Andres Rudja	AS Planserik
Latvia	Janis Kaminskis	Latvian Geospacial Information Agency, Riga Technical University
Lithuania	Eimuntas Paršeliunas	Vilnius Technical University
Finland	Mirjam Bilker-Koivula (Secretary)	FGI
	Jaakko Mäkinen	FGI
	Hannu Ruotsalainen	FGI
	Markku Poutanen	FGI
	Martin Vermeer	Aalto University
	Arttu Raja-Halli	FGI
	Jyri Näränen	FGI

#### MEETING DAY 1

##### Opening

Welcome and opening of the meeting by Chairman Dag Solheim. Mirjam Bilker-Koivula was appointed as the secretary.

##### Presentations

*Gabriel Strykowski*: NKG Gravity Data Base and the NKG Geoid

- Overview of the history of the NKG gravity database
- Problems with the database: Epochs sometimes unknown, history of corrections sometimes unknown, national height systems
- Overview of the basics of the NKG geoid determination with NKG2004 as an example
- Points for discussion: Renewal of the database and a systematic procedure for quality checking the data

*Dagny Lysaker*: The marine geoid and its importance to ocean current monitoring

- Altimetry and gravity can be used to determine ocean currents
- Mean Dynamic Topography (MDT) is an important climate parameter
- Mean Sea Surface Heights at high altitude need improvements
- The marine geoid can be improved

*Jonas Ågren*: The need of improved gravity data for the next generation of geoid models in Sweden

- GNSS will get all the time better, which creates a need for better geoid models in the future (5 mm?)
- For Sweden 5 km resolution of gravity data enough
- Error propagation: assuming white noise gives good geoid height RMS results, introducing correlation makes things worse
- Proposed: New gravity system in Sweden, old networks should be properly connected, control with A10
- Significant methodological improvements required
- On Nordic level control measurements across borders required

*Jaakko Mäkinen et al.*: Remeasurement of the First Order Gravity Net with the A10-020 gravimeter and revision of the national gravity net. First experiences 2009

- Present FOGN measured 1962-1963, later readjusted to IGSN71. Control measurements in 1988.
- Future FOGN will be reference for gravity survey, 0.02 mgal (2-sigma) accuracy enough
- Measurements with IGIK A10-020 in 2009-2010. 19 sites measured in 2009, 29 sites in 2010
- Comparisons with FG5 values:  $\overline{\Delta g} = 1 \mu\text{gal}$ ,  $\sigma = 4 \mu\text{gal}$
- Using of results: epoch 2000?, recalculation of surveys connected to FOGN, redo connection of pre-1962 surveys (Fundamental gravity network)

*Tõnis Oja*: Evaluation of historic gravity data in Estonia on the basis of new accurate observations. Calibration of relative gravimeters

- 2 recent geoid models: EST2003 by Harli Jürgenson and BALT2004 by Artu Ellmann
- Checking of level and scale of historic networks, presently many different system realizations, comparison of common points and repeated measurements (2003-2007)
- Project ETF7356 (EstSF grant), 2008-2010: Application of space technologies to improve geoid and gravity field models over Estonia. Leader: Artu Ellmann
- New control measurements 2008-2009
- Conclusion: Historic data should be displaced

## MEETING DAY 2

### Future of NKG and the working group for geoid determination

DS reported from the last meeting of the presidium (November 2009):

The presidium questions whether to keep the current structure and Working Groups or to make changes. One suggestion was to have fewer WG's, with the geoid WG not being one of them, and organize some of the activities in projects, e.g. Ocean Circulation. The working group's opinion is asked.

A discussion followed on the future of the working group. Main topics that came up were: The importance of the WG, would a more saleable name help the WG, should the WG focus more on the marine geoid, whether or not the work of the WG could be done in projects, the importance of improving the theory, the importance of the gravity database, is there an overlap with the WG on geodynamics (g dot, N dot).

### *Main conclusions*

- The members of the working group are strongly in favor of continuing the working group
- Geoid models are getting all the time more important. Geoid models are needed as input for climate change studies.
- Developing the methods and theory is very important. It is ongoing work that is naturally done in a working group; it cannot be done in projects.
- The working group is an excellent forum for making contacts, exchanging experiences and learning from each other. This is very important. We have similar national problems to solve with regards to gravity data and we all profit from the WG with regards to this.
- The working group is needed for keeping up and improving the NKG gravity database. Without the coordination of the data by the WG it would be difficult in the future to calculate geoid models.
- Even if calculating the NKG geoid model would be organized in projects, the WG is needed in between for improving theory and methods, collecting and improving data, and establishing contacts that are a necessary basis for project work.

### *Conclusions on future focus points of the WG*

- Improving theory and methods
- Improving the quality of the (historic) input data. Things to consider are e.g. epoch, systems, system transformations, coordinates, heights.
- Improving the geoid model on land as well as improving the marine geoid (MDT/ocean circulation)
- Strive for yearly WG meetings

### *Conclusions on NKG future*

- The NKG works, we handle things well on a regional basis and with that contribute to others.

### **New NKG geoid model**

DS reported that the presidium has asked about the plans for a new NKG geoid model.

A discussion followed on whether or not to wait for GOCE before calculating a new NKG geoid model.

### *Conclusions*

- We should wait for GOCE results before calculating an official NKG model, but in the mean time we should prepare and improve the input data and investigate calculation methods to be able to calculate a new and better NKG geoid model
- Norway will calculate a new geoid model on a national level in connection with the production of the new height system. Although meant for Norway, the new geoid model will cover the whole Nordic area and can serve as an intermediate NKG model.

### **Presentations (continued)**

*Harli Jürgenson:* Gravity measurements and gravity datasets from the border area with Russia

- Overview of old gravity data
- NKG database data has been checked with old data, irregular differences were removed from NKG DB
- Experiment with water level monitoring by GPS on ferry
- Official geoid model EST\_Geoid2003
- New precise leveling almost finish, >100 GPS points connected to 1<sup>st</sup> order leveling network

### **National Reports**

Denmark by Gabriel Strykowski

- Project to construct 2010 geoid for Faroe Islands

- Construction of Femern Bælt geoid 2010: gravity measurements on windmills to improve near-shore coverage
- BLAST-project, cooperation of countries around the North Sea to harmonize and integrate data from land and sea.

#### Estonia by Tõnis Oja

- New national geoid model to be calculated by end of 2010 or beginning 2011
- Overview of new geodetic networks: leveling almost finished; integration of leveling, GNSS, tide gauges and gravity network; Geodetic reference network; 9 permanent GNSS stations; gravity network, 7 absolute stations form 1<sup>st</sup> order network; calibration of relative gravimeters

#### Finland by Mirjam Bilker-Koivula

- 2 geoid models in use: FIN2000 and FIN2005N00
- Free coordinate transformation service (in Finnish): <http://coordtrans.fgi.fi/>
- 2009-2010 Re-measurement of first order gravity network with Polish A10
- Ongoing modernization of relative gravity database

#### Latvia by Janis Kaminskis

- Ongoing gravity measurements (~4000 new observations) and leveling
- Present GPS-geoid model LV'98
- Comparison of geoid models along cross-section 57° latitude: EGM2008 close to LV'98

#### Lithuania by Eimuntas Paršeliunas

- Overview of the status of the geodetic control of Lithuania
- EUREF2009 implementation, permanent GPS network LitPOS, vertical network finished, 1<sup>st</sup> order gravity network measured, 2<sup>nd</sup> order gravity network measured 2007-2009
- The Baltic Triangulation Ring was measured 80 years ago in 1928
- Future: Adoption of vertical and gravity systems in 2010, 2<sup>nd</sup> order vertical network 2010-2013, 2 more absolute gravity observations

#### Norway by Dag Solheim

- Iterative height reference models, <http://www.geodesi.no/href>
- Focus on marine geoid – filling data gaps
- MAREANO project for sea-floor mapping, Bell BGM3 gravimeter on loan from NGA, example Sognefjorden Survey, <http://www.geodesi.no/href/xing-nmamap.html>, discussion on using airborne gravimetry

#### Sweden by Jonas Ågren

- Updated GNSS/leveling observations
- New gravimetric quasigeoid model KTH08.
- New model adapted to reference system: SWEN08\_RH2000, released 1.2009
- Comparison KTH08 & EGM2008, good agreement
- Comparison SWEN08\_RH2000 & FIN2005N00 along Swedish-Finnish border, good agreement
- Work started to improve Swedish gravity network and systems
- News from KTH: 2 PhD's defended in 2009, 1 ongoing PhD work on estimating crustal thickness using Vening Meinesz-Moritz inverse problem

#### **DEM & data exchange**

- DS reports that a permit was granted for use of the Norwegian DTM in the geoid WG
- MBK reports that the Finnish Land Survey has granted a permit to use the 25 m DTM in the geoid WG for calculating a Nordic geoid
- JM suggests to exchange EUVN-data