Nordiska kommissionen för Geodesi
Nordic Geodetic Commission

Working Group for Geodynamics

Minutes of the 35th meeting of the Working Group for Geodynamics within the Nordic Geodetic Commission

The Norwegian Mapping Authority, Hønefoss, March 7-8, 2011

Participants:

Sweden	Hans-Georg Scherneck	Chalmers/Onsala Space Observatory
	Jonas Ågren	Lantmäteriet
	Andreas Engfeldt	Lantmäteriet
	Per-Anders Olsson	Lantmäteriet
Denmark	Gabriel Strykowski	DTU Space
Finland	Hannu E. Routsalainen	Finnish Geodetic Institute
Germany	Hartmut Wziontek	Bundesamt für Kartographie und Geodäsi
Norway	Bjørn Ragnvald Pettersen	Norwegian University of Life Sciences
	Halfdan P. Kierulf	Norwegian Mapping Authority
	Ove Omang	Norwegian Mapping Authority
	Matthew Simpson	Norwegian Mapping Authority
	Dag Solheim	Norwegian Mapping Authority
	Dagny I. Lysaker	Norwegian Mapping Authority
	Kristian Breili	Norwegian Mapping Authority

1. Introduction

The chair person of the NKG Working Group for Geodynamics (WGG), Dagny I. Lysaker, welcomed all participant to the meeting and to the Norwegian Mapping Authority (NMA) at Hønefoss Norway.

2. Minutes from the last WGG meeting

The participants of the meeting were invited to comment on the minutes from the last meeting. There was no comment to the minutes.

3. Scientific Program

3.1 Presentation by Jonas Ågren and Andreas Engfeldt: Plans for a new gravity system in Sweden

Jonas Ågren presented old and future gravity systems of Sweden. The new system RG 2000 will be based on FG5 absolute gravity measurements and is the fourth fundamental gravity network of Sweden. The work is expected to be finished within 2015 according to Lantmäteriets strategy *Geodesi 2010*.

The presentation turned into a short discussion addressing conventions used to name gravity networks. Gabriel Strykowski suggested that NKG should agree on a common language for gravity networks. Jonas Ågren argued about avoiding the terms zero-order, first-order, etc. These terms are mixed and they make room for confusions. Instead the terms precision, fundamental, connection, and detailed gravity networks should be used. Bjørn Ragnvald Pettersen made a small note about the difference between the reference network established by absolute gravity measurements and the detailed network observed by relative gravimeters. The conclusion of this discussion was that a common language will be most useful!

3.2 Presentation by Halfdan P. Kierulf: GPS velocity field for Norway

Halfdan P. Kierulf informed about the ongoing activities at NMA for establishing a new 3D velocity field for Norway based solely on GPS. The velocity field will include all Norwegian stations providing more than 2.5 years of data. Different noise models have been investigated for calculating realistic standard deviations for the deformation rates. In order to fill the gaps between the stations, statistical methods based on kriging have been developed. When the work is finished, it will be possible to calculate the 3D velocity of any point in Norway.

Hannu E. Routsalainen commented anomalies in the velocity field presented by Halfdan P. Kierulf. Similar anomalies are also seen in the gravity uplift lines crossing through the Scandinavian countries. Halfdan P. Kierulf was encouraged to do further investigations in order to conclude about the origin of the deviating signals.

3.3 Presentation by Matthew Simpson: Can post little ice age glacial retreat on Svalbard explain Halfdan's data-model discrepancies?

The motivation for this presentation was the work published in Kierulf et al. 2009, Geophys. J. Int. 179, 1-13. In this work, the authors report discrepancies between GPS observed uplift rates at Svalbard and predictions calculated from GIA models and observed present day ice mass change. Matthew Simpson presented examples from his compilation of relative sea level observations at

Svalbard. The compilation indicates that current GIA models do a poor job in West Svalbard where the temporal coverage of the data is poor. The next stage will be to run high resolution predictions for the little ice age at Svalbard. A short discussion addressing GIA, earth models and ice models ended this talk.

3.4 Presentation by Hannu E. Routsalainen: Recent observations with the interferometrical tilt meter in Lohja

Hannu E. Routsalainen presented a short historical review of water tilt meters and recent observations from the water tube tilt meters installed in Lohja, Finland. Modern tilt meters are extremely sensitive instruments. They have a sensitivity of 0.1 nanoradians which corresponds to a 1 mm tilt on 10000 km. This allows observations of a broad spectrum of geodynamical signals from microseismic to the free oscillations and tides. As an example, the tilt loading signal from the Baltic Sea observed in Lohja is used for local crustal dynamic studies.

4. National reports

4.1 Finland

The Finnish Geodetic Institute (FGI) report on geodynamics was presented by Hannu E. Routsalainen.

Absolute gravimetry

FGI has in 2010 remeasured 32 sites in the Finnish first order gravity network (FOGN) with an A10. The work was done in cooperation with the Institute of Geodesy and Cartography in Warszawa. As part of this project, the laser of the A10 was calibrated. The calibration showed that the frequency had changed by 1 Mhz from the factory calibration. This is equivalent to 2 microgals. In addition to the gravity observations, supporting measurements were also collected at the FOGN sites, i.e. three level gradients, relative ties, levelling, and 3D coordinates. A terrestrial laser scan of the sites was also planned for 2010, but this work was not done because the instrument was busy elsewhere most of 2010. The remeasurement of FOGN has been presented at EGU2010, at the IAG Symposium in Saint Petersburg, and in a manuscript submitted to Polish Geoinformation Issues.

SG

In Metsähovi several ground water wells were established in the area surrounding the laboratory housing the SG T020. The ambition is to use the test field for verifying and developing hydrological models on spatial scales from regional (Finland) to continental (Europe).

VLBI

FGI has in 2010 participated in IVS-T2, EUROPE geoVLBI, and seven geoVLBI sessions. The VieVS software has been used for analysis of the difference between the crustal movements obtained by using the EUROPE and the IVS-T2 networks.

SLR

The renovation of the SLR station in Metsähovi continues. The electronics are now ready, but the new optics are still under construction.

Plans for 2011

FGI plans to do FG5 comparisons in Metsähovi, Moscow/Saint Petersburg and in Luxembourg. At the end of the year, FGI will also do absolute gravity measurements in Antarctica. In 2011 the remeasurement of FOGN will be finished.

4.2 Denmark

The report of the National Space Institute at the Danish Technical University (DTU Space) was presented by Gabriel Strykowski. In 2010, absolute gravity measurements have been collected in Denmark as part of the new national plan for the gravity reference network based on AG measurements. The new network will include parts of the old precision gravity network and also new stations ensuring adequate geographical distribution. The plan is to do systematic remeasurement of some of these sites on a three year interval. Absolute gravity was also measured at eleven points at Greenland. The work at Greenland was done in cooperation with BKG due to problems with the Danish A10-019. In cooperation with BKG four sites close to the Danish-German border were also observed in 2010.

4.3 Sweden

The report from Lantmäteriet was presented by Andreas Engfeldt. In 2010, the Swedish FG5-233 has been on service at the instrument provider Micro-g. After the service the instrument has been 3 to 4 microgals high.

Lantmäteriet has in 2010 accomplished a comprehensive absolute gravity field work. In total 14 stations was occupied by the FG5-233: Mårtsbo (twice), Smögen, Onsala, Ratan, Lycksele, Kiruna, Skellefteå, Kramfors, Tejn (Denmark), and Vågstranda (Norway). In addition to sites within the Nordic region, Lantmäteriet has observed absolute gravity at the three sites Ohrid, Valandovo, and Skopje in Macedonia. These three points will constitute the Macedonian fundamental gravity network. Comparison with other FG instruments has been accomplished in Onsala in September (FG5-233, FG5-226), and in Wettzell (FG5-233 (LMV), FG5-101 (BKG), FG5-215 (Czech Republic), FG5-220 (IfE), and FG5-301 (BKG)).

For 2011, Lantmäteriet plans to observe Mårtsbo in April and November, Visby in May, Onsala in July, and Arjeplog and Östersund in August or September. There are also plans for establishing and possibly observing the two new stations Uppsala and Kungsholmsfort in 2011. In late February 2011 the FG5-233 was compared to FG5-221 in Metsähovi, a comparison to FG5-225 is planned in Trysil (August ?), and Lantmäteriet will participate in the comparison in Walferdange, Luxemburg (November).

The national report from Chalmers and Onsala Space Observatory was presented by Hans-Georg Scherneck. It was mainly focused on the scientific activities at Onsala Space Observatory during 2010. This includes the analysis of ocean tides by a GNSS tide gauge, calibration and analysis of observations from the SG in Onsala, and the use of InSAR for mapping the Pärve post glacial fault in Sweden. The analysis of SG observations revealed FG5-233 observations from early 2010 too low by 7-8 microgals. However, no plausible explanation for the low AG observations was presented at the meeting.

4.4 Germany

The report of Bundesamt für Kartographie und Geodäsie (BKG) was presented by Hartmut Wziontek. The SG038 in Conception, Chile, was upgraded from June 2008 to December 2009. The upgrade included the installation of a new dewar and a new cooling system. After the upgrade, the SG in Conception was hit by a magnitude 8.8 earthquake at February 27, 2010. During the earthquake, the absolute gravimeter FG5-227 collocated with SG038 fall down. Fortunately, it seems like FG5-227 was not damaged by this accident. The instrument has been validated by FG5-101 and it was concluded that FG5-227 is providing good and reliable data.

At the geodetic observatory Wettzell, a new gravity station has been established. The new gravity laboratory includes four pillars for absolute gravity measurements, one room for the SG030, and one spare pillar. The new laboratory is well suited for instrument comparisons. The first International Regional Comparison of Absolute Gravimeters took place in Wettzell November 2010. The FG5-215 (Czech Republic), FG5-233 (LMV), FG5-220 (IfE), FG5-101 (BKG), and FG5-301

(BKG) participated.

Several hydrological sensors have been installed around the Wettzell gravity laboratory as part of the hydrological project Wettzell. The ambition is to assess and model local water storage changes and the influence on the gravity observations.

Together with DTU Space, BKG took also part in an A10 gravity field campaign at Greenland. The ad-hoc cooperation was initiated by the instrumental problems of the Danish A10. As part of this campaign, BKG observed 10 stations in the south-east of Greenland and two points at the airports Narsarsuaq and Kulsuk.

A database for absolute gravity (Agrav) has now been implemented at the BKG. Presently the database includes metadata and processing results from 26 instruments and 419 AG stations. It was noticed that the Scandinavian region should be better represented in this database, at least by one gravity value for each station. The Agrav database is found at http://agrav.bkg.bund.de and http://bgi.dtp.obs-mip.fr.

Dagny I. Lysaker gave a short summary of the activities at Institut für Erdmessung (IfE). The summary was based on an e-mail from Ludger Timmen. In 2010, IfE has measured absolute gravity in Hannover, Onsala, Wettzell and Braunschweig. For 2011 the plan is to go to Onsala for measuring absolute gravity at both the old and the new gravity pillars. Jurgen Müller at IfE is also working on an application entitled *Evidence on the potential and benefit of transportable spring and atomic gravimeters to register temporal gravity changes*. In short, this project will address the sensitivity of different gravimeters to different frequency bands.

4.5 Norway

On behalf of the Norwegian Mapping Authority (NMA) and the Norwegian University of Life Sciences (UMB), the national report of Norway was presented by Dagny I. Lysaker. Absolute gravity has been observed by FG5-226 at the following stations in 2010: Hønefoss (three pillars), Trysil-AB, Trysil-AC (observed twice), Ås (observed eight times), Trondheim (two pillars), Bodø - Asylhaugen, Andøya, Vågstranda, Ålesund, Kiruna, Honningsvåg, Hammerfest, Kautokeino, Onsala, and Vega (new station). It should be mentioned that 2010 was the last year of funding from UMB for doing comprehensive gravity field work.

UMB and NMA started in 2010 the analyses of the gravity time series from all the Norwegian stations. The work is related to the geometrical velocity field calculated from GPS at the NMA. The work with the geometrical velocity field was presented by Halfdan P. Kierulf in the scientific part of this meeting.

In 2011 NMA and UMB plan to recalculate old gravity data from Norway. The old data will be referenced to the absolute gravity stations. This work involves that some new absolute gravity stations will be established and several of the points in the old detailed network will be revisited in order to check the quality and reliability of the old data. The work is partly motivated by the NOVA GOCE project at UMB. This project addresses validation of the GOCE gravity field by ground data. The idea is to use the recalculated detailed gravity network as an test field for GOCE.

The national report of Norway was followed up by a short discussion. Bjørn Ragnvald Pettersen invited the other NKG countries to contribute to the NOVA GOCE project. A test field stretching across the Nordic countries is desirable. However, it was noticed that this project is run within a limited frame of time since UMB has only two years of funding for the project.

Gabriel Strykowski recommended using an A10 to assess the quality of the old gravity data, at least some of the old points should be occupied by an A10. Hannu E. Routsalainen was also concerned about the accuracy of relative gravity measurements. He suggested doing repeated relative gravity observations between absolute gravity stations in order to assess the accuracy. It was concluded that many error sources make influence on measurements collected by LaCoste & Romberg and Scintrex CG5 relative gravimeters. This should be subject for further investigations.

5. Agreement on exchange of data from absolute gravity observations and conditions for use

The WGG was presented a draft of the agreement. The purpose of the agreement is to establish guide lines for how a common absolute gravity database can be established and used by the members of NKG. It should be stressed that this is not a legal document, but an agreement of cooperation. The WGG discussed the document at the meeting. The following bullet points summarize the debate:

- Gabriel Strykowski commented that the document was easy to read and not too long. He also suggested that a special option should be added for associated members of NKG, i.e. the Baltic countries, BKG and IfE. The agreement and the NKG database should not be restricted to only FG5 data but should also include data from A10 instruments.
- Hannu E. Routsalainen was concerned about which data the agreement will cover. It should be explicitly noticed that the agreement does not cover data covered by other agreements, collected by third parties, or observed outside Fennoscandia. Dagny I. Lysaker and Gabriel Strykowski made it clear that it is up to each party to choose which data to be submitted to the database.
- When formulating the agreement, the parties should be aware that the AG-situation in the Nordic countries may change with time:
  - In the future there will be new types of instruments and new data formats for the raw observations.
  - There may be more AG owners in the future, e.g. maybe the Baltic countries in the future will be able to contribute with observations to the database.
  - At present Lantmäteriet is the host of the database, but this may change with time.
  - The institutions taking part in the AG cooperation may be reorganized in the future.
- Hans-Georg Scherneck added that the agreement should not be too specific. The agreement and the database should be open for all data which might be important in the future. This could include vertical gravity gradients, tidal models, environmental data, and parameters calculated from superconducting gravimeters.
- The design of the database was discussed. It seems like an appropriate solution may be to build a folder tree where each campaign is assigned a separate folder. In this folder the files necessary for processing the data should be stored. For the g-software provided by the FG5 manufacturer, this includes the raw binary observation files, the project file, the ascii set file, and maybe also raw observation files on ascii format. For each station there should also be a folder for ancillary data and metadata.
- Hartmut Wziontek questioned why the database should only include data from the Nordic countries. It was noticed that each party is free to contribute with its own data to other databases, e.g. to Agrav.
- Jaakko Mäkinen conveyed several comments to the agreement by e-mail. The e-mail was discussed at the WGG meeting.

Dagny I. Lysaker will edit the document according to the discussion at the WGG meeting. The revised version of the document will then be sent to the members of WGG and also presented at the NKG Presidium meeting in Masala (March 2011).

6. Proposed NKG project from WGG

The NKG working groups are encouraged to propose projects for the NKG Presidium. However, it is not clear for the members of the WGG how future NKG projects will be organized and implemented. This triggered a small debate. The debate ended with no conclusion. Still, Dagny I.

Lysaker will report to the NKG Presidium that WGG sees the need for projects related:

- absolute gravity measurements in Fennoscandia
- cooperation between the operators of the superconducting gravimeters in Onsala, Metsähovi, and Ny-Ålesund
- a new gravity GIA model for Fennoscandia.

7. The NKG web page

The NKG web page can be found at www.nkg.fi. At this page there are links to pages dedicated the working groups where you can find minutes from the working group meetings, presentations, and national reports. If anyone has anything for the pages, please send it by e-mail to Dagny I. Lysaker and she will upload it for you.

8. Status of AG paper by Jaakko Mäkinen

Hannu E. Routsalainen informed the WGG about the status of the AG paper by Jaakko Mäkinen. Originally this paper was meant for the proceedings of the 2009 GGOS DynaQlim Workshop in Espoo, Finland. However, the deadline was missed, but a new draft is now almost ready. According to Jaakko Mäkkinen, the draft will be sent for circulation among the co-authors before the NKG Presidium meeting in Masala. The finished manuscript will then be submitted to Journal of Geodynamics or another similar journal.

9. Closing of the meeting

The next meeting in WGG will be in Denmark next year.