Nordiska kommissionen för Geodesi
Nordic Geodetic Commission

Working Group for Geodynamics

Minutes of the 30th meeting of the Working Group for Geodynamics within the Nordic Geodetic Commission

University of Life Sciences (UMB), Ås, March 14-15, 2006

Participants:

Denmark	Gabriel Strykowski	DNSC
Finland	Mirjam Bilker-Koivula	FGI
	Hannu Ruotsalainen	FGI
Norway	Björn Engen	Statens Kartverk
	Kristian Breili	UMB
	Jon Glenn Gjevestad	UMB
	Dagny Lysaker	UMB
	Bjørn Ragnvald Pettersen	UMB
Sweden	Hans-Georg Scherneck	Chalmers, Onsala Space Observatory
	Andreas Engfeldt	Lantmäteriet
	Mikael Lilje	Lantmäteriet
	Jonas Ågren	Lantmäteriet
Estonia	Tõnis Oja	Estonian Land Board
Germany	Heiner Denker	IfE
	Olga Gitlein	IfE
	Jürgen Müller	IfE
	Ludger Timmen	IfE
Belgium	Michel Van Camp	Royal Observatory of Belgium

1. Opening

Chairman Hans-Georg Scherneck opened the meeting and Jonas Ågren was appointed as the secretary.

2. Institute reports

All institute reports are available at the home page of the meeting and are therefore not summarised here (see http://www.oso.chalmers.se/~hgs/NKGWG/M2006/PrelProg.html.)

KMS / Danish National Space Center (Gabriel Strykowski)

Finnish Geodetic Institute, FGI (Hannu Ruotsalainen)

University of Life Sciences, UMB (Bjørn Ragnvald Pettersen)

National Land Survey, Sweden (Andreas Engfeldt and Jonas Ågren)

Chalmers, Onsala Space Observatory (Hans-Georg Scherneck)

3. Scientific presentations

No summary is given of each individual presentation. Most of them are available at the website; see http://www.oso.chalmers.se/~hgs/NKGWG/M2006/PrelProg.html.

J. Müller, M. Neumann-Redlin: Determination of gravity variations in Northern Europe from GRACE

O. Gitlein, L. Timmen: The IfE absolute gravimetry campaigns 2003, 2004, 2005: an epilogue.

B.R. Pettersen: Preliminary gravity results and comparison with GPS.

M. Bilker-Koivula, J. Mäkinen: Absolute Gravity in Finland - Measurements 2005 & Time Series

M. Van Camp, T. Camelbeeck: Tectonic deformations inferred from absolute gravity measurements in Belgium and across the Roer Graben

T. Oja: Postglacial rebound in Estonia: Constraints from the measurements of Estonian geodetic networks

L. Timmen, O. Gitlein, J. Mueller, H. Denker: The IfE absolute gravimetry plans for 2006, 2007, 2008, and some additional considerations.

J. Ågren, A. Engfeldt: An absolute gravimeter in Sweden

H. Ruotsalainen: On the water tube tilt meter in geodynamical research of FGI

H.-G. Scherneck, S. Bergstrand, M. Lidberg: Fractals everywhere: Time series analysis and rate uncertainty

M. Ollikainen, J. Ahola: Monitoring Local Crustal Movements Using High Precision GPS Network (Poster)

M. Tervo, M. Bilker-Koivula, H. Koivula, J. Mäkinen, M. Poutanen, H. Virtanen: Surface loading correlation with GPS vertical data (Poster)

H. Virtanen, M. Bilker, J. Mäkinen, M. Tervo, B. Vehviläinen, M. Huttunen, R. Mäkinen, M. Peltoniemi, T. Hokkanen, M. Pirttivaara: Comparison of modelled variation in water storage in Finland with superconducting gravimeter observations and with GRACE (Poster)

4. Business matters

Update of the campaign database

The quality measure that has so far been used in the campaign database is the number of drops. It has been objected by Jaakko Mäkinen that this number (by itself) says nothing of the quality of the observation. The question what should be used instead was discussed and it was concluded that the *internal precision standard deviation* be added to the number of drops.

Some information is missing in the campaign database Excel-sheet. The missing items have been marked by yellow by Hans-Georg Scherneck; see the file "Nordic_absgrav_progress _Upto05.xls" under http://www.oso.chalmers.se/~hgs/NKGWG/M2006/PrelProg.html.
The missing data should be supplied by the observing institutes as soon as possible.

Communications with the NGOS group

Hans-Georg Scherneck gave a short overview of the Nordic Geodetic Observing System (NGOS). It needs to be defined how the NGOS task force relates to the working group for Geodynamics: The working group should be concerned more with the analysis of data, while NGOS should be limited to the handling and distribution of geodetic data.

Structure of the NKG; proposal to appoint the working groups chairpersons to the Presidium

It has been suggested the Presidium that the NKG structure be changed so that the chairperson of each working group is at the same time a member of the Presidium. The working group for geodynamics has been asked to respond to this proposal. The question was discussed and several arguments were considered. The initial idea with the present structure is that the working group and chairperson should be independent of the presidium in order to guarantee the scientific freedom. Today, however, our budgets are more limited, which means that it is more important to do the right thing. To ensure that the working group has funding for its activities, it might also be a good idea that the chairperson is closer to the presidium.

At this point Bjørn Engen emphasised that this does not imply that free discussion is prohibited. Hannu Ruotsalainen stressed that freedom is a very important parameter to the scientist and that we should be careful in delimiting it. Hans-Georg Scherneck summarised the discussion by that saying that it involves the confrontation of two different attitudes and that it is difficult to decide unanimously in either direction.

Decision:

The meeting decided that we support the proposed structure for a 4 year test period.

Proposal to the presidium of a new chairperson 2006—

Since Hans-Georg Scherneck will not continue as chairperson, the working group needs to select a new candidate before the General Assembly. Hans-Georg Scherneck suggested the following procedure to come up with two candidates (one first and one second). First, each working group member at the meeting suggests one candidate in a personal interview with Hans-Georg. After the meeting, all working group members (also the ones not at the meeting) then vote for the nominated candidates using Email. This procedure was accepted.

Decision:

The nominated persons from the interviews were
Martin Lidberg, Sweden (3 votes),
Bjørn Ragnvald Pettersen, Norway (2 votes).

(After the meeting this procedure has been questioned. The objections might be characterised as to converge in a fear that the group might propose names that are not viable together with the other appointments to be made later this year with respect to the represented range of nationalities.)

Key note speaker for the General Assembly

Hans-Georg Scherneck had, without asking the Working Group, already earlier contacted Jacques Hinderer to be the key note speaker at session 4 (Geodynamics) of the General Assembly. This he motivated referring to Hinderer's long and broad work in Gravity and Geodynamics, which might influence our work in positive ways. It was objected that it would be more suitable with a speaker that has at least some kind of connection to the Nordic area and Ludger Timmen's name was put forward. After some discussion, it was decided that we should try and propose both names. (However, after the meeting it has been decided that only the latter is chosen as the key note speaker for the Geodynamics session.)

Decision:

The Working Group for Geodynamics suggests Ludger Timmen to be their key note speaker at the General Assembly in Copenhagen.

Publication policy

The publication policy was discussed, but no conclusion was reached and it was decided to continue the discussion at the next meeting. Gabriel Strykowski promised to investigate the

possibility to publish the absolute gravity results in a special issue of the Journal of Geodynamics. (Gabriel has later discussed this with Kristien van Lunen, the Publishing Editor of Earth and Enviromental Sciences of Elseviere. Gabriel suggests that the WG try to realise such a special issue.)

Proposal for scientific cooperation concerning absolute gravity measurements on the peripheral bulge of the land uplift

Gabriel Strykowski suggested that the WG should engage in international cooperation concerning repeated absolute gravity measurements on the peripheral bulge of the land uplift, as was suggested by Michel Van Camp in his scientific presentation (available at http:// www.oso.chalmers.se/~hgs/NKGWG/ M2006/PrelProg.html). At least, the working group should express its support. It was agreed that the WG for Geodynamics support Michel Van Camp's initiative and that we try to make this a new EU project. It was decided that Gabriel Strykowski and Michel Van Camp write "a proposal of scientific cooperation". This small document should then be officially approved by the Presidium at the general assembly in Copenhagen, which facilitates a possible application for an EU project. (Michel Van Camp and Gabriel Strykowski have already finished this document. It is enclosed in Appendix 2.)

Next meeting

The next working group meeting will be held during the spring 2007.

Decision:

It was decided that Tõnis Oja should investigate whether it is possible to arrange the meeting in Tallinn. If not, it will take place in Copenhagen.

The minutes from the meeting of the Absolute Gravity teams on Wednesday can be found in Appendix 1.

Appendix 1

Notes from the meeting of the Absolute Gravity teams Wednesday, March 15

The publication policy and the proposal for scientific cooperation concerning absolute gravity measurements on the peripheral bulge were discussed at this splinter meeting. Since these topics directly concern the WG for Geodynamics, it was decided to treat them as NKG business; see above.

Absolute Gravity, Stations and Campaigns, planning

The meeting agreed on the following absolute gravity observation plan for 2006:

FGI

- 6 - 10 stations in Finland (Metsähovi, Vaasa, Joensuu, Kuusamo, Sodankylä and Kevo. The rest is uncertain and will be decided later by FGI.)
- 8 stations in the Baltic countries.

IfE

- 3 stations in Finland (Metsähovi, Vaasa, Sodankylä)
- 2 stations in the most Northern parts of Norway (Kautokeino, Honningsvåg)
- Trysil**?**
- The usual route through Sweden (Kiruna, Arjeplog, Skellefteå, Östersund, Kramfors, Mårtsbo, Onsala)
- At least one station in Denmark (Copenhagen).

UMB

- 2 stations in the most Northern parts if Norway (Kautokeino, Honningsvåg)
- 2 Swedish stations (Onsala and either Kiruna or Skellefteå)
- A number of stations in the Southern and middle parts of Norway (Trysil, Trondheim, Vågstranda, Ålesund, Stavanger, Hønefoss (very likely), Ås)
- At least one station in Denmark (stations not yet decided).

Gävle, April 28, 2006

Jonas Ågren

Appendix 2:

Proposal of scientific cooperation

AGILE : Absolute Gravity for Ice and Land Elevation

Tectonic deformations inferred from absolute gravity measurements across the peripheral bulge of the postglacial rebound over Fennoscandia; case study: the Roer Graben.

Michel Van Camp and Gabriel Strykowski
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Spatial geodesy has been furnishing for 10 years data to study crustal movements in Europe and elsewhere. For instance, based on GPS time series, the BIFROST project provided a 3D map of postglacial rebound (PGR) over Fennoscandia (e.g. Milne et al., Science 2001). Moreover, PGR models, that best fit the GPS data in Fennoscandia, predict also subsidence on the peripheral bulge of the PGR deformation extending from 55°N to 43°N, at rates up to -2 mm/yr. Using permanent GPS network, Nocquet et al. (GRL, 2005) detected PGR effects in Western and Central Europe and found good agreement with the surface displacements predicted by Milne et al (2001).
On the other hand, stable gravity observations over long periods can be a useful tool for understanding geodynamic changes related to Earth structure. Therefore absolute gravity (AG) measurements have been undertaken in Fennoscandia to constrain PGR. In particular, since 2003, AG measurements have been performed in Norway, Sweden, Denmark and Finland at about 30 stations, under the coordination of the Nordic Geodetic Commission (NGC) (Timmen et al., 2006). It is hoped to detect the gravity change associated to the PGR and to validate the detection capabilities of GRACE.

Further in the West and the South of Fennoscandia, numerous repeated AG measurements have also been undertaken in Belgium, Luxembourg, the Netherlands, France, Germany, the UK, etc. In the United Kingdom a project aims at determining vertical land movements at tide gauges (Williams et al., GRL, 2003). In Belgium, France and Germany repeated AG measurements are performed to constrain the present-day crustal deformations for the interpretation of the character of the seismotectonics in the Lower and Upper Rhine Embayment (Van Camp et al., Metrologia, 2002; Amalvict, J. Geodyn. 2006). For example, the Royal Observatory of Belgium (ROB) undertook in 1999 an AG profile measurements across the Ardenne and the Roer Graben to infer vertical crustal movements in these two regions. This eight-station profile is 140 km long and is performed twice a year. It should allow one to detect the spatial extension of the uplift expected from the tectonic activity and to discriminate it from long-wavelength phenomena like PGR. The first results of the profile already indicate that there is no detectable movement corresponding to gravity changes higher than 1.3 µGal/yr at a 2σ level. This is equivalent to 6.5 mm/yr as uplift or subsidence would modify the gravity at a rate of about 1 µGal for 5 mm, taking into account the free air and Bouguer corrections.

Quantifying the PGR in the peripheral bulge is important to separate its effect from seismotectonic deformation and to define stable reference frames, which is very important to e.g. monitor mean sea level. However, there are still significant uncertainties on the ice load, the timing of the ice history and the Earth model, which result in large uncertainties in the estimated rates of PGR. So, the profile can also provide useful information on the PGR itself. Study of the PGR provides information on the lower mantle viscosity and consequently, can help constraining present-day ice fluctuations in Greenland or Antarctica. Indeed, for that purpose, one must separate the elastic and the viscous contributions due to the past changes in ice thickness. Wahr et al. (GRL, 1995) determined that, for a wide range of viscosity profiles, the ratio to convert gravity change rate to vertical displacement rates must be $\dot{h}/\dot{g}$ = –6.5 mm/µGal. The viscoelastic crustal motion could be separated using this ratio and collocated GPS and AG measurements. On the other hand, using relative gravity campaigns, Ekman and Mäkinen [GJI, 1996] observed $\dot{h}/\dot{g}$ -5 mm/µGal in Scandinavia.

To summarize, combining AG and GPS measurements, not only in Fennoscandia, but in the whole North-Western Europe, could improve the measurements of PGR effects, in particular:

1) The ratio $\dot{h}/\dot{g}$;
2) The measurements of deformation rates in the peripheral bulge, which are close to or below the accuracy of current space and ground-based geodetic techniques;
3) The models of viscosity in the mantle.

Repeated AG campaigns should allow one to constrain gravity rate of change with an uncertainty of 1 nm/s² (or 0.5 mm of vertical movement) after 15-25 years. AG measurements can constrain vertical deformation only but due to its absoluteness, an absolute gravimeter could go back to any undisturbed measured gravity point even after 100 years and make a measurement that is relevant. No relative geodetic techniques can compete with that.

To ensure that absolute gravimeters remain in good working condition, their calibration needs to be checked regularly at reference stations. In such a place, a superconducting gravimeter should continuously records the gravity with a temporal resolution of 0.1 µGal quite independently of the absolute instrument, as the principle of operation is completely different. This allows any real change in the gravity to be distinguished from any casual instrumental cause and the AG data to be checked over time. Presently SGs are available in Belgium (Membach), Finland (Metsähovi), France (Strasbourg), Germany (Bad-Homburg and Wettzel) and Luxembourg (Walferdange). If different absolute gravimeters are used, they must also be compared regularly with each other, preferably in a reference station.

The ROB has proposed to the NGC to take its AG measurements in Belgium and Germany into account to constrain the deformations along the PGR peripheral bulge. We seek NGC support at the coming General Assembly in Copenhagen for cooperation with other European countries performing repeated AG measurements in Germany, the UK, Luxembourg, the Netherlands and Baltic countries.

If this proposal is approved by the NGC, an EU science project could be considered (7th Framework Programme – global change and ecosystems), in cooperation with the ongoing project in Fennoscandia through the NCG WG on Geodynamics.

The framework of the EU project could be:

Global Change and Ecosystems:

- Mean sea level: Constraining crustal deformation along coastline;
- Changes in ice sheet thickness: Measuring the $\dot{h}/\dot{g}$ ratio in areas only affected past ice fluctuations is important to discriminate between viscoelastic and elastic effects due to past and present ice sheet fluctuations in Greenland and Antarctica;
- Seismic hazard: Constraining deformation rate in intraplate areas.

It is worth mentioning that such a project could refer to the IAG project GGOS (Global Geodetic Observing System).