



# Nordiska Kommissionen för Geodäsi Nordic Geodetic Commission

## Working Group for Geodynamics

### Minutes of the 29<sup>th</sup> meeting of the Working Group for Geodynamics within the Nordic Geodetic Commission

Finnish Geodetic Institute, Masala, May 3-4, 2005

#### Participants:

Sweden	Hans-Georg Scherneck	Chalmers, Onsala Space Observatory
	Anders Olsson	Lantmäteriet
	Andreas Engfeldt	Lantmäteriet
Norway	Bjørn Engen	Statens Kartverk
	Bjørn Ragnvald Pettersen	UMB/IMT
	Ove Omang	UMB/IMT
Denmark	Gabriel Strykowski	DNSC
Finland	Markku Poutanen	FGI
	Mikko Takala	FGI
	Hannu Ruotsalainen	FGI
	Pasi Häkli	FGI
	Hannu Koivula	FGI
	Maaria Tervo	FGI
	Joel Ahola	FGI
	Pekka Lehmuskoski	FGI
	Veikko Saaranen	FGI
	Mirjam Bilker	FGI
	Jaakko Mäkinen	FGI
Lithuania	Romuald Obuchovski	IG
Estonia	Tõnis Oja	ELB
Germany	Olga Gitlein	IfE, University Hanover
	Heiner Denker	IfE, University Hanover
	Ludger Timmen	IfE, University Hanover
	Reinhard Falk	BKG

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#### Opening

Chairman Hans-Georg Scherneck opens the meeting. Mirjam Bilker will act as the secretary. Risto Kuittinen welcomes the participants to the FGI.

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## Institute reports

### *KMS / DANISH NATIONAL SPACE CENTER (Gabriel Strykowski)*

In 2004 KMS hosted absolute gravity measurements in Copenhagen and on Bornholm and the Færø Islands.

In the beginning of 2005 the department of Geodesy and the department of Geodynamics moved from KMS to the Danish National Space Center, NDSC ([www.spacecenter.dk](http://www.spacecenter.dk)). The scope of the work and the structure has remained the same.

In 2005 absolute gravity measurements at two permanent GPS sites in Jutland are wished for.

### *FINNISH GEODETIC INSTITUTE (Jaakko Mäkinen)*

In 2004 Absolute gravity measurements were performed in the Antarctic, South Africa, Finland, Ghana and Poland. An international comparison of absolute gravimeters took place at Metsähovi in July.

Regarding relative gravimetry in 2004, results of the calibration line were studied and the construction of a micro-gravity calibration line is in planning. Processing of the relative land uplift lines is still going on. A paper about the subject will be in the proceedings of the GGSM2004 meeting in Porto.

The superconducting gravimeter has continued its day-to-day operation. Extremely long free-oscillation of the Earth was observed with the SG after the Sumatra earthquake. The emphasis in the study of the time series has been on hydrology. A poster on the subject was presented at the EGU meeting in Vienna, 2005. Local hydrological observations around Metsähovi are starting. Bedrock studies are performed and dense relative measurements have been performed around the site. With levelling local vertical movements have been observed in the bedrock.

Other: The FGI is involved in the Nordic levelling network, reconstruction of the water tube tilt meter is going on and VLBI measurements have started at Metsähovi in cooperation with the Technical University.

### *NATIONAL LAND SURVEY, SWEDEN (Andreas Engfeldt)*

Annual report is enclosed.

In 2004 two new absolute gravity sites were taken into use. Both sites are co-located with mareographs. In addition, 7 absolute sites were measured. A person of Lantmäteriet has assisted the IfE and Ås groups with the absolute measurements.

Relative ties were measured between several absolute sites and the national gravity network. Problems with the LCR-G290 are reported.

Martin Lidberg has calculated a new 3D velocity field.

### *CHALMERS, ONSALA SPACE OBSERVATORY, SWEDEN (Hans-Georg Scherneck)*

At Onsala Space Observatory 4 researchers and 5 PhD students work in the field of atmosphere, technology and solid Earth. eVLBI was started in 2004. 15 normal VLBI measurements were performed. Subjects of study were: noise in GPS time series and air pressure loading on SLR observations.

### *DEPARTMENT OF MATHEMATICAL SCIENCES AND TECHNOLOGY, UNIVERSITY OF ENVIRONMENTAL AND LIFE SCIENCES, [UMB/IMT] (Bjørn Ragnvald Pettersen)*

Note: a new name. Time series analysis of GPS and VLBI is performed. The FG5-226 was acquired and the Absolute gravity laboratory was set up. With the FG5-226, measurements were made at 6 stations in Norway and at Onsala and Smögen in Sweden.

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## Scientific presentations

*Reinhard Falk* talked about the experiences with the redesigned A10 absolute gravimeter. A precision of about 2  $\mu\text{gal}$  was found inside and 7-10  $\mu\text{gal}$  outside. A significant offset was found between A10 and FG5 results. More investigations are needed to see how the A10 reacts to different measuring circumstances to find the optimal setup in the field.

*Hannu Ruotsalainen* showed results of the relative measurements done at the Masala-Vihti calibration line. Old measurements with different instruments were recalculated. The results give no new information to use in the work with the relative uplift lines. Some gravimeters are stables and some are not.

*Tõnis Oja* presented gravity work done in Estonia in the past few years. Measurements were done with LCR gravimeters and later with Scintrex CG5 gravimeters. One of the LCR gravimeters shows big periodical scale errors. The CG5 gravimeters give good results. The 63° uplift line was measured in 2002, the Estonian gravity network in 2003 and the Estonian geodetic GPS network between 2001 and 2004. Ongoing projects include: measurement of the levelling lines and qualification of old Soviet networks and the database of the Geological Survey. Results were shown of network adjustments in which also gravity change is estimated. More tests are needed. Invitation for Absolute gravity teams to come to Estonia. 3 absolute stations exist and a few more are planned.

*Romuald Obuchovski* presented the gravity network of Lithuania. Measurements exist since 1865. In 1994 measurements were made with the JILAg-5. In recent years 51 points of the 1<sup>st</sup> order network were re-measured in cooperation with Poland. An offset of 15  $\mu\text{gal}$  was found between the old 'Potsdam' system and the new IGSN71 system.

*Ludger Timmen* gave an overview of the absolute measurements in 2004. In total 16 stations were measured including the new stations at Bornholm, Visby and Ås. He points out that it is not possible to measure all points every year and calls for a distinction between good points with a long history that should be measured every year and less important points that could be measured less frequently. Groundwater and precipitation are things to take into consideration.

*Olga Gitlein* showed how to deal with the land uplift when looking at the measured gravity changes. When corrected for the height changed due to the land uplift, the gravity disturbances between 2003 and 2004 become all positive. Uncertainties in the calculated rates are big, due to measurement uncertainties and environmental effects. More measurements are needed.

*Ludger Timmen* told about his good experiences with Scintrex relative gravimeters. Over 2.5 years no prove of instability of the instruments was found. Also no range dependence was found over a range of 0.015  $\text{m/s}^2$ . Short ties can be measured with an accuracy of  $\pm 10 \text{ nm/s}^2$ .

*Heiner Denker* showed results of an analysis of the time-varying and static GRACE gravity field models. Analysis of the 22 monthly GRACE models shows that a truncation at degree 50 in combination with a Gaussian averaging kernel with radius 1000 km gives a standard deviation for the gravity of less than 1  $\mu\text{gal}$  and for the gravity change 0.4  $\mu\text{gal/yr}$ . The annual signal is the largest with an amplitude of  $\pm 6 \mu\text{gal}$ . So far, no clear PGR signal is visible for

Fennoscandia. The static GRACE fields show no more tilts over Germany. This means that regional geoid models will improve much from GRACE.

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## Poster presentations

*Reinhard Falk* showed results of absolute gravimeters in Fennoscandia between 1991 and 2003. The main conclusions are that in 10 years the gravity change is visible, combination of different instruments is difficult, seasonal variations should be monitored and studied, and the local gravity field around points should be checked.

He then passed on greetings from Mr. Ihde and advertised the work of the European Combined Geodetic Network, ECGN (more information can be found at <http://www.bkg.bund.de/ecgn>).

*Bjørn Ragnvald Pettersen* presented results of the parallel measurements done in the absolute gravity project. Simultaneous measurements show differences between instruments of less than 2  $\mu\text{gal}$ . Non-simultaneous measurements within one year show similar differences of 2  $\mu\text{gal}$ . Conclusion: Parallel measurements should also in the future be carried out, but not necessarily at the same time.

*Mirjam Bilker* showed results of the comparison between the global CPC hydrological model, the Finnish WSFS hydrological model, monthly GRACE results over Finland and the superconducting gravimeter time series. The global hydrological model fits well to the Finnish model. Clear correlation can be seen between time series from the soil moisture models, local and regional ground water, precipitation, snow and the superconducting gravity changes. First results of GRACE averaged over Finland gives a correlation with the total water storage over Finland.

*Mirjam Bilker* then showed results of absolute gravity measurements at five points in Finland. The gravity change due to PGR is clearly visible. In Vaasa and Metsähovi the trends agree well with the expected trends calculated from uplift models, GPS or levelling. The trends in Sodankylä and Joensuu are bigger than expected.

*Hannu Koivula* gave an overview of the activities of the FGI in Antarctica. A permanent GPS station is operative, absolute gravity is repeatedly measured at three stations (already three epochs at Aboa) and modelling of near-field snow and ice takes place. In the future GRACE and CRYOSAT will play a role and all methods will have to be combined. Absolute gravity measurements will continue in 2006 and 2008.

*Hans-Georg Scherneck* presented work by Martin Lidberg. GAMIT was used to recalculate the time series in the BIFROST network. The regional network is constrained by good stations around the world. The new solution for the 3D rates differ at some places significantly from the BIFROST and Milne solutions.

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## Absolute Gravity, Stations and Campaigns, planning

*Bjørn Ragnvald Pettersen* suggests restarting absolute measurements in Hammerfest because of its long history in geodesy (Struve, Abs. Gravity, Tide gauge). The old absolute point was destroyed, but a relative tie was made to a new point.

*Falk*: There are old Italian absolute measurements from Sicily to Hammerfest. How to bring them to same reference frame as today (air pressure, tidal corrections, etc...)?

*Mäkinen*: It has been done for Swedish stations. Vaasa cannot be used for the correction, because it contains an error. There were a lot of relative measurements done in Hammerfest between 1976 and 1990. Marson's gradients in Hammerfest are wrong. Mäkinen has newer gradient measurements.

*Bjørn Engen* tells that there will be two new sites for absolute gravimetry in Northern Norway: Honningsvåg and Kautoheino. He reports that there are problems in Bodø (it might be good to replace it by two stations, one at the Lofoten and one near the Swedish border) and Trondheim (changes to the building). In Trysil one of the three ground water wells is not behaving normally.

Discussion: It's good to have a station nearby with a relative tie. It would be good to mention extra measurements done at a station (like levelling).

*Jaakko Mäkinen* reports on the status of the relative gravity land uplift lines. Mäkinen and Ruotsalainen are working on the publication. He points out that the lines offer valuable resources. Line 63 is well served with absolute gravimetry. Line 56 was repeated in 2003 and lines 61 and 65 were put to the freezer in 2004. Checking is needed of old relative stations, station descriptions, excenters, ties, and readiness for A10. In Finland lines 61 and 65 are ready for the A10 and would suite very well for a pilot campaign for A10.

A discussion follows on the requirements needed for measurements with the A10. *Falk* remarks that measurements with the A10 will not be possible in 2005 and 2006.

### 2005 campaigns

Main points of the discussion: The Finnish group will measure the points in Finland and optionally the Baltic. The German group will go to Metsähovi, Vaasa and Sodankylä in Finland and the measurements in Sweden and Norway will depend on the Norwegian group. The Norwegian group has several options, but their realisation will depend on the financial situation and manpower.

Not everything can be measured this year. It would be good to re-measure the points that have only one measurement so far. It is good to measure also the points at the border of the uplift area, because there the behaviour of the uplift is not as well constrained as in the middle of the area.

Points in Denmark can be combined with other campaigns when Denmark is on the route.

Conclusion: The discussion will continue after the meeting and a plan for Sweden and Norway will be ready in two weeks.

### 2006 campaigns

*Pettersen*: No funding for absolute measurements in 2006. Help is appreciated for an application to the research council.

Suggestions are made to refer to the NGOS documents in the application.

## **Developments and investments**

Summary of wishes:

### - Bore holes

Discussion: The relation between groundwater level changes and gravity depends on the local situation.

Conclusion: Bore holes are needed at the sites. If this is not possible at a site, any means possible should be used to get information on the ground water.

Conclusion: Study of hydrology signal is needed.

### - Excenter points

Discussion: Excenter points are important for continuation of the time series also in the future. Relative ties and levelling are good to do.

### - A10

Discussion: There is interest among the institutes to purchase an A10, but it is not budgeted. The pros and cons are discussed of having a company/institute that owns an A10 and rents it to others.

*Poutanen* suggests putting up an NGOS consortium to apply for funding from the EU within the 7<sup>th</sup> framework.

Discussion: It would be a lot of work, but it could work.

## **Documents**

Discussion on the campaign database and what data should be archived.

Conclusion: The table with the overview of the measurements will be extended with links to the institutes where the data of the measurements can be obtained.

## **NGOS**

*Poutanen* asks everybody for comments on the NGOS paper.

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## **NKG business matters**

The following response to the previous WG meeting has come from the presidium:

- The Presidium supports the proposal from the Working Group for Geodynamics concerning the phasing out of relative gravity.
- The Presidium asks the Working Group for Geodynamics to develop a proposal for the filing of all gravity observations on the gravity lines and the absolute gravity stations for future analyses to the next meeting of the Presidium in the autumn 2005.

Answer of the meeting:

- The meeting recommends to the presidium to explicitly mention the preservation of the relative lines by securing the observation points.
- The filing of the gravity observations at the gravity lines is for the absolute gravity part covered by the Excel file of the absolute measurements. The metafiles and databases of the absolute measurements are situated at the institutes. The relative part will be covered when the publication on the relative lines will come out. It will include a CD with all measurements. The sub-group for publication consists of *Andreas Engfeldt*, *Björn Geirr Harsson*, *Jaakko Mäkinen*, *Hannu Ruotsalainen*, and *Gabriel Strykowski*.

**Next meeting**

The next meeting will be held in Ås in early spring, preferably in March. Then, the working group will have to choose a new chairman for the next 8 years.

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**Thanks**

The chairman thanks the Finnish Geodetic Institute and the local organizing committee for the hospitality. Thanks go also to the participants.

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Masala, May 26, 2005  
Mirjam Bilker