NORDISKA KOMMISSIONEN FÖR GEODESI

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MINUTES

65th NKG PRESIDIUM MEETING

Time: 3-4 May, 2017, Lunch - Lunch
Place: Umhvørvisstovan, Torshavn, Faroe Island

Item 1)   Opening of the meeting (Niels)
Niels, Stein and Petúr welcomed us to Umhvørvisstovan and Torshavn, Faroe Island. We also noted and thanked Stein for the preparation to ensure that we will have a smooth and productive meeting.

Item 2)   Approval of the agenda (All)
A proposed agenda was sent out before the meeting. Minor adjustment, as e.g. item regarding Lill-chefsmötet and Land Uplift road map was made.

Item 3)   Approval of the Minutes from NKG Presidium meeting No 64 (All)
The minutes from the last meeting were approved. They will be published on our homepage when appropriate.

Item 4)   NKG Web site (Thorarinn)
The web page was discussed at the last meeting. Since that meeting, Thorarinn has asked for and received contact persons from each working group. These persons are supposed to be able to update parts of the webpage when necessary. This is important to ensure that our webpage is updated. The working groups are hoping that they can be able to update their parts instead having to involve Thorarinn every time. Since Landmaelingar Islands and Thorarinn are positive that this can happen we are now in a situation that the working groups are waiting for LMI to set up the webpage so that they can start. However, very little is happening. It is not only text information that we would like to have on the webpage but use it also as a platform to publish some of our products, seminar presentations etc. See e.g. item number 5 in this protocol. An alternative would be that we always use Thorarinn as the webpage but this would probably mean increased workload on both Thorarinn and the working group chairs.

The meeting decided that Niels will contact Thorarinn to ask on how we can move forward. This is an urgent matter.

Item 5)   NKG products and its availability (Matthew)
This item relates to agenda item 4. Matthew raised the issue that there is a need to have a functional web page where we can publish our product. For decision, se agenda item 4.

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Item 6)   Dynamic datum (Per-Erik)

Per-Erik, as "project owner", reported to the Presidium about the progress concerning the study area of Dynamic reference frame and using Iceland as a testbed. From the minutes of Stor-chefsmötet, August 2016 we can read in the minutes that *The NKG is asked to look into dynamic datum and use Iceland as a testbed*.

The study group, led by Halfdan (Kartverket) has had a number of skype meetings as well as a workshop on Iceland. There is progress even though the task is huge. The group is still trying to define the scope and the work needed to come to some results. It involves both geodetic and GIS issues even though the GIS parts probably will be toned down initially. The group is working on a draft project proposal to be presented to the Director Generals.

We can note that a new semi-dynamic datum for Iceland, ISN2016, will be released this year. Currently, the recommendations of the study group is to initiate a Nordic project on dynamic reference frame in Iceland for 2018. The main goal will be implementing the geodetic part of the DRF and facilitate for the implementation of DRF in geospatial data registers and GIS software. The focus, in the proposal, is now on the geodetic and not focus on the GIS part yet.

The study group is identifying some costs that is covering for new CORS stations, upgrade of old CORS stations as well as other geodetic infrastructure. An urgent and important question will be if the other Nordic countries are prepared to cover (some of) these costs? Another option identified is that we perhaps should use the denser networks that we have in the other Scandinavian countries instead of using Iceland as testbed.

The lengthy discussion on this also covered if it is possible to scale the project (and needed investments, and yet get the answers to our questions?

The meeting decided that Per-Erik should talk to Halfdan to prepare a new proposal to be ready early next week for presentation at lill-chefsmötet.

Item 7)   Report on FAMOS Activity 2 and BSHC Chart Datum Working Group (Jonas)
Jonas gave us an update regarding Baltic Sea Chart Datum and the EU-financed project FAMOS.

To overcome the problems with multiple tidal chart datums and facilitate the use of GNSS in the future, the Baltic Sea Hydrographic Commission (BSHC) has decided to introduce the Baltic Sea Chart Datum 2000 (BSCD2000) as new common height reference system for hydrographic surveying, nautical charts and publications from 2020. BSCD2000 is a geodetic height system using an equipotential surface (geoid) as the height reference surface, defined in accordance with EVRS, but with the postglacial land uplift epoch explicitly specified to 2000.0. On land, BSCD2000 will primarily be realised in the same way as the national height systems, i.e. based on precise levelling, given by heights on benchmarks, etc. At sea, BSCD will primarily be realised by GNSS (national networks of

permanent reference stations, land uplift models, transformations, etc.) and a common geoid model (gravimetric model plus a smooth residual surface). The implementation of BSCD2000 is planned, supervised and coordinated by the Chart Datum Working Group (CDWG) of the Baltic Sea Hydrographic Commission (BSHC).

The motivation for FAMOS activity 2; Harmonising vertical datum, Improving vessel navigation for the future is to contribute to future satellite navigation and hydrographic surveying with GNSS based methods by improving the marine geodetic infrastructure. Done mainly by supporting the introduction of Baltic Sea Chart Datum 2000 (EVRS, epoch 2000.0) as the common unified chart datum in the Baltic Sea. Planned 2020. Most important is to improve the Baltic Sea geoid model by making marine gravity measurements on board the FAMOS survey vessels. This would be much more expensive otherwise. A quality controlled FAMOS geoid model with a verified standard uncertainty of 5 cm will be released by the end of the global FAMOS project in 2020. This geoid model will be required for navigation and hydrographic surveying in the future using GNSS to get the heights/depths in BSCD2000. It will be used to realise BSCD2000 at sea. In Odin also shipborne real-time GNSS and UKC aware navigation are included.

The sub-activities in Activity 2 are;
- 2.1 Shipborne gravimetry measurements and processing
- 2.2 Creation/maintenance of databases, gravimetry data analyses/updates and geoid computations
- 2.3 Mean Sea Surface modelling and water level control
- 2.4 Shipborne GNSS for precision navigation and geoid evaluation at sea
- 2.5 Change of chart datum in Sweden and Finland
- 2.6 Vessel routing with optimised UKC and fuel efficiency

The most important achievements in Freja were;
- 8 marine gravimetry campaigns has been measured and processed
- First versions of the FAMOS gravity and GNSS/levelling databases have been set-up, permissions arranged
- A first FAMOS interim geoid model has been computed
- Pilot study finalised of shipborne GNSS to evaluate geoid models at sea showing that GNSS can actually be used for this purpose.
- Reports finalised with "*Initial analysis of the gravity data situation of the Baltic Sea*" and "*Initial validation of geoid models in the Baltic Sea*"
- Written and agreed on the document "*Definition and realisation of Baltic Sea Chart Datum 2000*"
- The initial reference geoid models NKG2015 and bkg2016g have been finalised
- Analysis of existing data using the new marine gravity data have been initiated according to plans.
- An interim Mean Sea Surface model has been computed using satellite altimetry.

Above we have mainly talked about geoid determination and marine gravimetry, which were key tasks in FAMOS Freja (and will be so also in Odin). It should be emphasised that even though a number of results have been reached, the big goal still lies far ahead of us (i.e. to compute a FAMOS geoid model with a verified accuracy of 5 cm to realise Baltic Sea Chart Datum 2000 at sea). It is very important that the Freja efforts continue as planned in the global FAMOS project till 2020. Not before that we will be in a position to compute a FAMOS geoid model (FAMOS height reference surface) with the required accuracy and certainty. Alongside this we will continue to work with testing and developing real-time GNSS at sea, which is obviously another important aspect to make our vision come true... (3D real time navigation, UKC aware navigation, etc.)

Based on the FAMOS pre-study made by LM in 2015, it was decided to procure a Swedish marine gravimeter and to include it in FAMOS Odin. Procurement was finalized without appeals. The winning tender came from Gravity Consult GmbH, the European reseller of the ZLS Corporation, and the gravimeter is the ZLS Dynamic Meter TM for Marine Applications. The contract was signed October 28, 2016, and the gravimeter was delivered by the end of April, 2017. It will then be put into service and a digital production line is developed. An acceptance test will be made at sea in May/June, which will be a 3 days campaigns in a where some smaller structures are measured several times.

Permissions have been obtained to use the data in question in the FAMOS project. Jonas Ågren (as Chairman the NKG WG of GHS) has signed license agreements with the NKG countries + NGU (some countries just gave their permission by e-mail). Gunter Liebsch has obtained permissions from the relevant German Bundesländer. The FAMOS data centers (DTU for gravity, LM for GNSS/levelling) have signed a data center agreement with BKG. Each data user will sign a NKG/BKG data user license, each NKG country has to sign the BKG data user's license to get BKG data, BKG has to sign the NKG data user license to get NKG data. Part of this arrangement is also that at least Sweden and Denmark have to sign bilateral data exchange agreements with Germany/BKG to exchange the data in question also after FAMOS (for geoid studies of a scientific nature or related to national geodetic infrastructure…). To sign such FAMOS bilateral data exchange agreements are encouraged also for the other FAMOS countries (besides Sweden, Denmark and Germany).

BSCD2000 will be realised using the existing national geodetic infrastructure, i.e. the official national vertical and spatial reference frames and the corresponding services. The geodetic infrastructure for the realization of BSCD2000 shall provide a standard uncertainty better than 5 cm over the whole Baltic Sea including the costal zones. To count as realisations the national reference systems/frames have to follow the above definition strictly or agree within a few cm from the official pan-European EVRS realisation with epoch 2000.0 (now EVRF2007). In this way, both the new German DHHN2016 and the Danish DVR90 qualify as realisations of BSCD2000. On land, BSCD2000 is realised by the official national height reference frames, which for the time being are based on levelling. Offshore, BSCD2000 is realised based on GNSS using national CORS networks, national ETRS89 realisations and a consistent model for the BSCD2000 height reference surface. The latter is primarily a gravimetric quasigeoid model, modified to take into account the necessary corrections due to the

existing differences in the definition and realisation of the national reference systems, for instance due to that different tide systems are mixed. It is here the intention to add a smooth correction surface to the gravimetric quasigeoid model. In this way, the land and sea realisations will also be made to agree in the coastal zones (within 1 cm or so). It is recommended that one common height reference surface is decided upon. A model of the height reference surface shall be computed within the EU project FAMOS until 2020. Postglacial land uplift corrections shall be applied in areas with significant land uplift as recommended by the national authorities.

Niels summarized the presentation by saying that this is something very interesting and we should ensure that more people should hear these discussions and decisions. A suggestion would be to present at the ABLOS conference in October, perhaps together with Thomas Hammarklint.

Item 8)   Reports from the working groups.

Positioning and Navigation (chair: Per Knudsen)
The working group had a meeting at the end of January in Riga (Latvia). It was a good meeting but unfortunately neither Per nor Anna Jensen could attend. Hannu Koivula (Finland) acted as chair of the meeting. The working group has attracted more people from the Nordic and Baltic countries.

Focus is on the four projects of which the three has started. They had kick-off at the WG meeting in January and have their first delivery milestones in June. Though the deadline for the first deliverables has not been reached, it was argued that the projects are not progressing as expected and that the communication within the projects is slow. It was mentioned e.g. that responses on emails are few and slow (especially the project *High level guidelines for GNSS-based real-time positioning services and RTK/GNSS surveying* was mentioned). All presidium members was urged to discuss back home about the status and encourage project leaders and members to be active. It was also asked that the working group chair should try to have a closer cooperation with the project leader to find out ambition levels in the projects.

It was questioned, if all projects should have the same priority or if we should already now focus on some of them. The forth project on Galileo may be more important that the three ongoing projects. The forth project, *Preparing for Galileo –hardware, software, organisation* was not among the projects discussed and accepted at last Presidium meeting but has been discussed in emails since then. Anna J has been the leader but has reported that she no longer is available for NKG work. Sweden is expected to take the lead. Mikael to report back as soon as possible if Lantmäteriet has a resource.

Geodynamics (chair: Matthew Simpson)
The working group had a joint meeting with the Geoid and Height Systems WG in Riga earlier in 2017. The agenda included a follow-up of the NKG Joint Land Uplift Workshop, discussion of status and plans for new national gravity networks/systems, sscientific program, national reports and projects/activities.

The progress on the NKG Roadmap for land uplift was discussed and suggestions from the working group that the section on publication on Bifrost Gamit should be included in the publication of NKG2016LU by Olav Vestøl.

The Nordic AG-paper is progressing well and a submission to a journal is expected before NKG GA 2018.

Geoid and height systems (chair: Jonas Ågren)
The working group held its annual meeting in Riga earlier this year together with Geodynamic WG. The next meeting is scheduled to be held in March, 2018 in Helsinki. NKG has a tradition in producing geoid models with the first notable one from 1986. Last year NKG released the quasi-geoid NKG2015 that was prepared and produced by this working group. The work was very much dependent on contributions from the Baltic countries in both geodetic observations as well as computation skill. This meeting discussed of course very much about this important achievement. Among other topics were e.g. discussion about open gravity data (Sweden, Denmark and Norway. Finland later on), the International Height Reference System and stations to be part of the first realisation IHRF xx (Suggestions to add Riga, Reykjavik, 2 stations on Greenland, Faroe Island.)

Left to work on concerning the NKG2015 geoid model are;
      (1) Publication to be written with Jonas as main author
      (2) Computation centres of Finland and Denmark have the possibility to submit new solutions by middle of August.
      (3) SIlja Märdla et al paper accepted in Marine Geodesy

The work in the empirical land uplift modelling project is made according to the roadmap:
    b) Estimation of uncertainties of the empirical model and of NKG2016LU_abs/lev (2017-09).
    c) Publication of NKG2016LU (submission 2018-03)
    d) Olav Vestøl has refined the method for empirical land uplift computation by least squares collocation, so that it is now made with respect to the GIA model in one step (before two steps were used). This is a nice step forward that will facilitate the estimation of standard uncertainties.

Much geoid and height related work is now also going on in the FAMOS project, but this is limited to the Baltic Sea. All the permissions to use Nordic, Baltic and German data in FAMOS have been arranged, and first versions of the FAMOS databases are in place. New Swedish marine gravimeter just delivered. A (in some ways) similar project is on-going in Norway, namely *Felles referanseramme for sjø og land*.

Reference frames (chair: Pasi Häkli)
The Working Group arranged a time series analysis workshop in April 2017 just prior its annual working group meeting. The time series analysis workshop included lectures and exercises on two

software: tsview and Hector. These were considered the most potential ones for the time series analysis and for these there were available expertise from the NKG community (Martin Lidberg and Halfdan Kierulf as the lecturers). The workshop had approximately 20 participants covering all Nordic and Baltic countries.

The agenda of the working group meeting focused on the two projects as well as one study group proposal. The work is now based on the NKG land uplift roadmap that was discussed earlier in the meeting and amendments were accepted. The accepted version can be found in appendix A.

Regarding the project **ITRF – ETRS 89 Transformations** it was noted that the main outcome of the NKG2008 transformation is the methodology. The current transformation (published in 2016) uses the existing 2D+1D deformation model that is already more than 10 years old. A new model is under way in the NKG working groups and consequently, the transformation will be updated to include the forthcoming new model. Most likely also the input ITRF coordinates (now based on the NKG2008 campaign) will be replaced by the coordinates from the NKG GNSS AC project. Moreover, after the resolution of the EUREF symposium 2017 and release of the new ETRF2014 reference frame, consideration on the common Nordic reference frame and frame for the intraplate velocities (now ETRF2000 as previously recommended by the EUREF TWG) is needed.

To make the transformations available to users we need to work towards standardizing models (grids), interpolation and time coordinate in transformations and it has an important role in making transformations available to users. Therefore, the study work project proposal was presented with the title *A NKG proj.4 study group*. The purpose is to **investigate** a potentially fruitful way of *increasing support* for Nordic transformations in GIS, making dynamic reference frames a *practical possibility*, and to *improve documentation*/metadata standard support for Nordic geodetic coordinate systems. Thomas Knudsen (SDFE, DK) to lead.

A report on the status of the **NKG GNSS AC** project was given. The operational analysis is ongoing as well as the first reprocessing of the GNSS data history (Repro1). The repro is planned to be ready by end-of-June. The operational processing includes currently data from 228 stations and seven national LACs are involved. It has been running since June 2014 with daily and weekly solutions. Lithuania will be contributing from week 1934 (already contributing to the repro). After the successful time series analysis workshop and finalizing of the repro, more focus will be given to time series analysis.
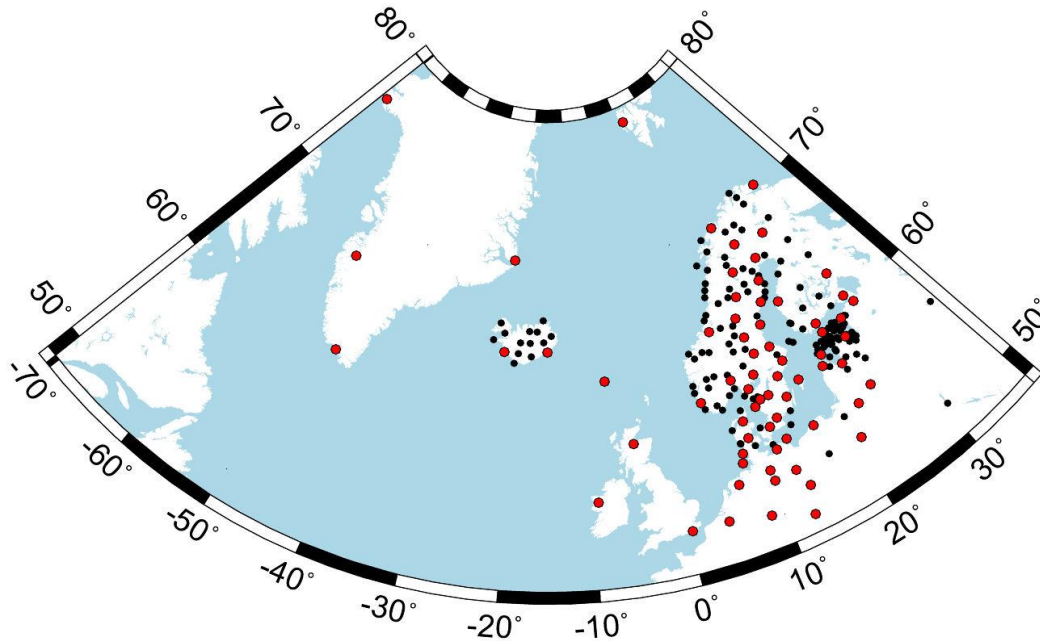
Item 9)   UN-GGIM and UN Resolution on Global Geodetic Reference Frame (Per-Erik), UN GGIM Europe: Geodesy (Markku)

The UNGGIM GRF working group held a meeting in Vienna in conjunction to EGU. The preparations of the UNGGIM Sub-committee on Geodesy is under preparation. It will include members from 40 countries but all others are welcome to be involved. From the Nordic area, Norway and Finland will be members. The inaugural meeting will be held in Mexico City, November 2017. There exists five writing teams working (Governance, Communication, Infrastructure, ETC and Policies) with Nordic representations in all of them. Norway is leading two of these groups (Governance and Communication) and Sweden is leading the ETC.

The regional body, UN GGIM Europe:Geodesy, is not very active since its start early 2016. As Markku noted, we need to start working now.

Item 10)   EUREF (Markku)
Markku reported from the last EUREF Technical WG meeting that was held in Matera. Focus was on the terms of reference as well as ITRF 2014. Also discussions about the upcoming EUREF meeting in Wroclaw in a few week time. About 100 persons registered to that meeting.

Item 11)   Other Business (All)
- NKG General Assembly, 2018 will be held in Helsinki, Finland. Organisation has not yet started.

- Lill-chefsmöte, Norway will present an initiative on stronger cooperation in the Nordic region concerning Geodesy. They would like to start a discussion to identify possible common entities to handle Scandinavian geodesy.

Item 12)   Next meeting of the Presidium (All)

The 66th Presidium Meeting; Iceland in conjunction to the seminar in September. 5-7th September, 2017.

Current order; Iceland – Denmark – Norway – Sweden – Finland

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Invited:

    Denmark: Niels Andersen, DTU Space (Chair)
                                 Per Knudsen, DTU Space
                                 Sören Fauerholm Christensen, SDFE

    Finland: Markku Poutanen, NLS
                                 Jarkko Koskinen, NLS
                                 Pasi Häkli, NLS

    Iceland   Gudmundur Valsson, LMI
                                 Thorarinn Sigurdsson, LMI

    Norway: Torbjørn Nørbech, Kartverket
                                 Per Erik Opseth, Kartverket
                                 Matthew Simpson, Kartverket

    Sweden: Mikael Lilje, LM (Secretary)
                                 Jan Johansson, Chalmers
                                 Jonas Ågren, LM
                                 Anna Jensen, KTH

    Apologies
    Thorarinn Sigurdsson, LMI
    Gudmundur Valsson, LMI
    Anna Jensen, KTH

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APPENDIX A:

NKG Roadmap for land uplift modelling until NKG2018 General Assembly

In the decisions and recommendations of the 3rd NKG Joint WG Workshop on Land Uplift Modelling, held in Gävle in 1-2 December 2016, the main short-term goal was to release a new land uplift model package consisting three models: NKG2016LU_abs/lev, NKG_RF17vel and NKG2016LU_gdot. This roadmap / work plan includes steps required to complete the models until the next NKG General Assembly in autumn 2018 (completed tasks shown in italics, deadlines in bold):

1) NKG2016LU_abs/lev (vertical component):

a) GIA model NKG2016GIA_prel0306: Holger, WGG, 2016-03

b) Bifrost GNSS velocities: Halfdan/Martin, WGG, 2016-03

c) empirical model: Olav, WGGHS, 2016-06

d) semi-empirical model based on empirical model and GIA model NKG2016GIA_prel0306: Jonas, WGGHS, 2016-06 (1c and 1d were made in parallel)

e) uncertainties of NKG2016GIA_prel0306: Holger, WGG, **2017-06**

f) uncertainties of empirical model: Olav, WGGHS, **2017-09**

g) uncertainties of NKG2016LU_abs/lev: Jonas, WGGHS, **2017-09** (1f and 1g will be made in parallel)

h) publication of NKG2016LU_abs/lev (including the 1D GIA modelling leading to NKG2016GIA_prel0306): Jonas, WGGHS/WGG, DL: **NKG2018 GA** (submission **2018-03**)

2) NKG_RF17vel (horizontal and vertical components):

a) GIA model NKG2016GIA_prel0907: Holger, WGG, 2016-09

b) Bifrost GNSS velocities: Halfdan/Martin, WGG, 2016-03

c) horizontal velocity model (based on NKG2016GIA_prel0907): Pasi/Martin, WGRF, **2017-12**

d) transformation/alignment of the velocities: Pasi/Martin, WGRF, **2017-12**

e) uncertainties of BIFROST solution: Halfdan, WGG, 2016-03

f) uncertainties of NKG2016GIA_prel0907: Holger, WGG, **2017-06**

g) * uncertainties of NKG2016LU_abs: Jonas, WGGHS, **2017-09**, *) item 1g (as a part of the NKG_RF17vel)

h) uncertainties of NKG_RF17vel: Pasi/Martin, WGRF, **NKG2018 GA**

i) publication of NKG_RF17vel (including horizontal model based on NKG2016GIA_prel0907): Pasi/Martin, WGRF/WGG, **NKG2018 GA**

3) NKG2016LU_gdot (gravity change):

a) computed gravity values with uncertainties, WGG

*b) * semi-empirical model based on empirical model and GIA model NKG2016GIA_prel0306: Jonas, WGGHS, 2016-06, *) item 1d*

c) linear relation to NKG2016LU_abs: Per-Anders, WGG, **2017-06**

d) * uncertainties of NKG2016LU_abs: Jonas, WGGHS, **2017-09**, *) item 1g

e) uncertainties of NKG2016LU_gdot: Per-Anders, WGG, **2017-09**

f) publication of NKG2016LU_gdot (Absolute Gravity publication by Olsson et al.): Per-Anders, WGG, **NKG2018 GA**

4) GNSS solution

a) publication: The BIFROST Gamit solution used for NKG2016LU and subsequently for the horizontal model: Halfdan/Martin, WGG, **2017-05** (submission)

b) updated BIFROST solution (Gamit, Gipsy, Bernese): Halfdan/Martin/Lotti, WGG/WGRF, **NKG2018 GA**