



NORDISKA KOMMISSIONEN FÖR GEODESI

Nordic Geodetic Commission, Working Group of Reference Frames
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Working Group of Reference Frames

Minutes for the meeting in Gävle, Sweden,

March 25-26, 2015

Participants

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|-----------|---|
| Denmark | Kristian Keller (March 26) Per Knudsen Mette Weber |
| Estonia | Karin Kollo |
| Finland | Pasi Häkli (chairman of the WG) Sonja Nyberg |
| Iceland | Guðmundur Valsson |
| Latvia | Ksenija Kosenko |
| Lithuania | - |
| Norway | Michael Dähnn Oddvar Tangen |
| Sweden | Anders Alfredsson (March 25) Lotti Jivall Tina Kempe (minutes) Martin Lidberg Christina Lilje Jonas Ågren (afternoon March 26) |

In the following, the minutes will not contain technical details. Please, refer to the presentations at the [GST ftp server](#) for further details.

Agenda and minutes of last meeting

The proposed agenda of the meeting was approved, and the minutes from the last meeting in Copenhagen May 2014 were approved.

Scientific presentations

- *Anders Alfredsson, HMK – Handbook for Geodesy*
A project to replace and update existing recommendations, in order to include modern technology.
- *Oddvar Tangen: Bernese L3, L1 and Wasoft on short baselines*
Test of different software and strategies to process short baselines between CORS and nearby bedrock markers.

- *Sonja Nyberg: GPS monitoring at the Olkiluoto nuclear power station*
The monitoring has been going on for almost two decades. Since 2012 a number of CORS have been established, and the main issues relate to the computing strategy.
- *Martin Lidberg et al.: BIFROST solution*
The 2013 BIFROST solution was presented. A new solution is planned, focusing on velocities and uncertainties for geophysical studies.
- *Martin Lidberg: Models of crustal deformations – from the European perspective*
Models of crustal deformation can improve prediction of time evolution of coordinates, and overcome limitations of the use of ETRS89, instead of more frequent updates of national realizations of ETRS89.

National reports

Denmark

A new strategy for geodetic reference will be developed during 2015, as an update of the 2012 version. This is done in cooperation with DTU Space.

The development of a strategy for geodetic reference for Greenland is on-going.

Maintenance of some permanent GNSS stations has started, because the antenna fell off one station (FERR), due to burst of the bolts.

The transformation software GNSSTrans light will be released for users.

During 2015-2016/2017 there will be a pilot project for mapping of Greenland, regarding maps of scales 1:100' – 1:25'. The project is funded by a private company. GST is preparing ground control points and specification for an EU tender.

Estonia

There are 20 permanent stations in ESTPOS (owned by Estonian Land Board). An RTK service is now running in test mode.

Today the Baltic Height system 1977 is used, but as it is associated with many uncertainties, a new EVRS height system will be established, probably in 2016-2017.

Finland

The abbreviation FGI remains, but now stands for the Finnish Geospatial Research Institute – a part of Maanmittauslaitos (National Land Survey) since January 2015.

The work with the new SLR telescope in Metsähovi is on-going. The new building and the dome were installed in the beginning of 2015. The telescope will be installed this year.

FinnRef consists of 20 CORS and runs the Geo++ software for their free-of-charge DGNS service. Despite the sparse network, the software is said to be capable of RTK accuracy. Network RTK performance has been tested and studies will be made in 2015 to see how FinnRef should be improved to fulfil the requirements of the NLS (~10 cm).

FGI participates in a European metrology research project, to demonstrate the potential and to analyse the limitation of GNSS-based distance measurements.

Iceland

A third re-measure of the reference network was planned for 2015, but was postponed to 2016 due to lack of funds.

An extra module for the network RTK software GNSMART was bought, to allow for using a deformation model. There is on-going work on a preliminary deformation model, based on all CORS and the two previous ISNET campaigns. It is planned to test this in IceCORS this summer.

The next version of the deformation model will include all CORS and the three ISNET campaigns, and maybe also GNSS/levelling points. Some open questions are: Which kind of model is most suitable? How to deal with episodic events?

Latvia

A new height system was implemented in December 2014 (normal heights, epoch 2000.5.), together with a new quasigeoid model. Height transformation is built in to the map service.

A height connection project with Belarus is started, and a meeting with Belaerocosmo-geodesia is planned in April.

On-going GNSS surveys on benchmarks. Plans to further develop zero order GNSS network (5 more CORS). No bedrock: Large concrete foundation underground. Steel grid pyramid on top.

Norway

The densification of the permanent geodetic stations (PGS) goes on, to obtain station inter-distances of c. 35 km. At the moment there are 184 stations, and 20 new stations are planned for 2015.

GNSS receivers are updated at 40 stations per year, to prepare for Galileo. Since 2012 individually calibrated antennas are used at all stations.

150 municipalities have finished the implemented the new height system. Southern Norway will be completed in 2016 and northern Norway in 2017.

Combinations of SLR and VLBI observations, using the Geosat software, have started. The aim is to be able to combine SLR, VLBI and GNSS observations in 2018.

Sweden

The SWEPOS densification continues by ~40 stations per year until 2015. There will be a price cut for the network DGNSS service in 2015, and 2016 it will be free of charge. At the moment there are 341 stations and 3145 network RTK users.

The CLOSE III project runs from July 2014 to June 2015, in cooperation between Lantmäteriet, Onsala Space Observatory and SP, the Swedish Research and Testing Institute. The work packages include e.g. a comparison of VRS, MAC and PPP, as well as analysis of local effects at the SWEPOS stations.

Twin telescopes are being built at Onsala, for which permanent GNSS stations are needed. These stations are now used as a test field.

Lantmäteriet has developed a new radome, OSOS, which is similar to OSOD but directly attached to the antenna.

NKG Working Group for Reference Frames

Summary of 2010-2014

Pasi gave a brief overview of the activities during 2010-2014. Two projects (transformation ITRS-ETRS89, NKG GNSS AC) were started – both were presented at the General Assembly (GA).

The future – 2014-2018

The keywords for the WG were presented by Pasi. “Dense velocity fields” and “time series” are new ones.

Some of the previous tasks within positioning have been moved to the new WG of Positioning and Navigation. The keywords for this new WG are: Real-time positioning (dGPS, RTK, PPP), Positioning/navigation services, New GNSSs and modernization, Quality checking / monitoring, and Making reference frames and vertical reference systems available to users. The chairman (Per Knudsen) does not expect the new WG to be working on positioning for realization of reference frames. Hence, that is still a task for the WG of Reference Frames.

There was a discussion with some WG members at the GA, where the conclusion was that the current projects are enough also for the coming period. Related to these is also the new topic of time series analysis/velocities.

Also in the current WG meeting there was consensus: Lots of work need to be done with the continuation of the two projects. We also need to discuss how to work with time series. However, it was postponed to the next meeting to decide if a common NKG realization of ITRF2013-4-5 should be included as a task for the WG.

Pasi encourages everyone to give other proposals.

Project NKG GNSS AC

Overall status

Now, 5 of 8 LAC's are contributing with solutions on a regular basis. There are two combination centres (LM_ and FGI), and totally 230 stations in NKG network. Ksenija will investigate to see if 4-5 Lithuanian stations bordering Latvia can be included.

The outcome of a project meeting at the GA was e.g. that guidelines for inclusion of EPN stations in the sub-networks have been developed, as well as guidelines for the processing and draft guidelines for re-processing. Re-processing will be done using GPS-only.

The combination centres had a Lync meeting in October, where outlier rejection in the combination was discussed. It was also decided to do a check of SNX file content against EPN STA file.

Some relevant information has been uploaded to the GST ftp server. It has been noticed that there might be a need for scripts for automatic uploading of solutions to the ftp server. Script examples are now available at the GST ftp.

Since the last meeting, there have been a few updates in the Bernese software. The major ones are new orbit modelling (OBGEN) and a bug-fix regarding the VMF grid interpolation.

The next steps will be additional LAC's contributing with solutions, as well as re-processing and time series analysis.

Status reports from LAC's

- *Sweden:* The network consists of 66 stations. Today, the LM_NKG solution is run separately, but the aim in the future is to extract the solution as a sub-set from the ordinary SWEPOS processing.
Re-processing has not started yet, but the data download was fortunately made before the archive crash in the end of January.

- *Denmark*: Bern 5.2 has been installed on a new server, as well as the March release. The LAC is working on having the automatic processing running soon. There are technical problems regarding the ftp server. Technical problems have occurred because the folder structure was created before the new logins. Normally it's the other way round. The new logins will be created on a new ftp server, and the data structure will be moved there. The new ftp server will also be backed-up.
- *Iceland*: The benchmark test has been completed. The LAC is now in a process of deciding which stations to process, and is applying for DOMES no. Hopefully the LAC will be up and running soon.
- *Finland*: Weekly processing is scheduled every Sunday and essential results are collected automatically to a local website. The re-processing has started, using CODE repro products. With 35-37 stations, it takes 3 days to process a year. No outliers are excluded in the re-processing, because it would be too laborious.
- *Latvia*: The LAC is operational, but re-processing has not started. The LAC processes 7 LATPOS stations, but the possibility to include some Lithuanian stations will be investigated (see above).
- *Estonia*: Produces weekly solutions and solutions also for EUPOS. The re-processing will not be started before the autumn.
- *Norway*: The LAC has tested VMF, after the Bernese bug-fixing, on a 250 station network split into four clusters (Lotti's clustering method). The repeatability is better with VMF than GMF, especially in height. Should we consider using VMF for the repro?

Combinations

- *LM_*: Uses SNX files from the GST ftp server and check them against the EPN STA file. The repeatability is also checked. After combination, a check for outliers is done and then the combination is re-run if necessary. The summary and SNX files are uploaded to the GST ftp server. The limits for outlier rejection were decided at a meeting with FGI in October 2014. Obvious outliers should also be rejected from the weekly solutions by each LAC. Some development is needed, regarding automatic outlier rejection for re-processing, as well as some visualization to get a quick overview.
- *FGI*: The processing starts with a regular check for new files at the GST ftp server. If so; the SNX files are checked and the combination is run and some results are plotted. The constraints are removed and an MC solution over 7 parameters is run. FGI uses in principle the same outlier rejection criteria as LM_, and the combination is re-run if there are outliers. FGI has started to look into time series analysis.

In general there are very few outliers, both for LM_ and FGI combinations.

Re-processing

Re-processing was discussed in Copenhagen, but still there are some open questions. The decision on final guidelines can be done later, via e-mail.

The main option for handling the troposphere is now VMF, after Berne has made the bug-fix.

Weekly combinations are probably needed. E.g. Ambrus Kenyeres (the EPN densification project) wants weekly solutions, if we are going to submit solutions to him. If so, a routine for

automatic outlier rejection is needed. However, no decision of submitting NKG GNSS AC solutions has been taken yet.

Troposphere solutions is not the main interest at the moment, but will be produced anyway, since it takes little time to compute if it is included in same script.

The reference frame alignment was discussed. We should think of pros and cons of aligning to either IGS or EPN solutions. The meeting could not come to a decision right away. Lotti will start a document, where pros and cons are considered, circulation. This will be done in a month or so.

According to the time schedule, the re-processing should be finalized in June (decided at the project meeting in connection with the GA), but is now delayed. The data for finalizing the re-processing must be postponed until autumn – the schedule as adjusted to November. There is no real deadline or request from other users, but it is important that we continue the progress. Some time is needed then for stacking of time series – the schedule as adjusted to February 2016.

There is an idea to have a time series analysis workshop, where people with experience of such analysis are invited. This will be suitable when re-processing has started, when the participants have gained some own experience. It could be suitable to schedule the time series analysis workshop for next spring, but we need to talk to the Geodynamics WG. Maybe it could be held in connection to the next WG meeting.

Project ITRS-ETRS89 transformations

Status

Pasi presented his and Martin's work with the transformations based on the NKG2008 campaign. The manuscript for the NKG GA paper "*The NKG2008 GPS Campaign – final transformation results and a new common Nordic reference frame*" to the Journal of Geodetic Science along with reviewers' comments had been distributed to the co-authors before the meeting.

There were some considerations for the choice of transformation: Should it be based on the ITRF2005 or the ITRF2008 solution? In which reference frame should the NKG03RF intra-plate corrections be applied? Use ITRF plate motions models or not? Which common NKG reference frame and epoch should be used?

ITRF2008 was chosen because it works better with EPN solutions @2000.0 and because NKG03RF fits well with ITRF2008-PMM (plate motion model).

A questionnaire has been sent out to get opinions and comments on the different transformation approaches (see presentation). Some corrections and comments were made, but no objections. Therefore, the decision was to use the common frame ETRF2000 ep. 2000.0, and two sets of transformations:

- ITRF2008 → ETRS89(tr), tr = reference epoch for national realization
- ETRS89(tr) → ETRF2000(2000.0)

A Helmert fit from ITRF2008 to the national ETRS89 realizations showed good agreement for most countries, but with slightly worse results in the up component for Latvia and Lithuania.

There were a discussion on reviewers' (of the NKG GA paper) comments, but the conclusions were: Stick to the common ep. 2000.0, because it is the common epoch for height systems and

geoid model in the Nordic countries.

Two Nordic reference frames are presented: The recommendation from the authors is to use ETRF2000 ep. 2000.0 within the Eurasian plate and ITRF2008 at the epoch of observation elsewhere.

It could also be possible to call the frame “NKG2008” instead of ETRF2000.

Reference frame for crustal deformation models should be ETRF2000, since it is the conventional frame for ETRS 89.

If we want to tell EUREF that transformations can be done in another way than they suggest, now is the time to do it because the Memo will be updated with ITRF2014/5.

Summary: The decisions of the authors are justified, because we need something that EUREF cannot provide at the moment.

The paper will be revised according to the comments from the meeting and from the reviewers. Any further comments are also welcome before the deadline March 30.

Evaluation of NKG empirical land uplift model NKG2014LU_test

Pasi has re-run the NKG2008 transformation with new land uplift (LU) model, resulting in small differences to old model, except for Norway, where rms increased. In general, residuals are already at the level of the accuracy of the national ETRS89 realizations, implying that no big improvements are to be expected with any models?

In comparison to the EPN velocities, the new LU model gives an improvement in Denmark and southern Norway, compared to the old LU model. In comparison to the FinnRef velocities, the new LU model gives slightly worse results than the old model, close to the land uplift maximum, but it gives an improvement in southern Finland.

Jonas presented the computation of the new LU model (see Vestøl’s presentation from GA), as well as briefly some different tests.

A new LU model will be computed by the end of 2015 (including the new Bifrost solution, a new GIA model, tide gauge data from Baltic countries, and levelling data from Lithuania).

The future

The WG RF sees a need also for a new horizontal model for intraplate deformations. Pasi will bring the request to the presidium.

Next meeting

The next meeting will be held around the same time next year, possibly in Finland.

Closing of the meeting

The meeting ended on Thursday at 15:45.