NORDISKA KOMMISSIONEN FÖR GEODESI

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

Minutes of the working group meeting online on 22–23 March 2021

Place: Online

Participants:

DK: Thomas Knudsen, Mette Weber, Per Knudsen, Kristian Evers, Majbritt Sørensen

EE: Karin Kollo, Jaanus Metsar, Tarmo Kall, Andres Rüdja

FI: Pasi Häkli, Sonja Lahtinen (secretary)

IS: Guðmundur Valsson, Dalia Prizginiene

LT: Eimuntas Kazimieras Paršeliūnas

LV: Ivars Liepins, Inese Vārna, Jānis Kaminskis

NO: Per Christian Bratheim, Oddvar Bråvold Tangen, Sveinung Himle, Karoline Arnfinnsdatter Skår, Hans Sverre Smalø, Michael Dähnn

SE: Holger Steffen, Faramarz Nilfouroushan, Christina Lilje, Per-Anders Olsson, Tong Ning, Tobias Nilsson, Lotti Jivall, Tina Kempe, Rebekka Steffen, Martin Lidberg, Henrik Bryskhe

The slides of the presentations will be available at the SDFE's FTP server.

Session 1: Scientific presentations

- **Review and update of SWEREF99:** Lotti presented the work related the SWEREF 99 update. They had computed three weeks campaign solutions for the years 1999, 2015 and 2019 with different setups, and estimated the effects due to different changes during the years. The new coordinates are based on the 2019 campaign, being in line with the current processing setup. They were taken into use in Feb 2021.
- **Update of EUREF-FIN:** Pasi presented the update of the EUREF-FIN coordinates of the FinnRef stations. The antenna model corrections from igs05 to igs08 were applied to the original FinnRef stations that are mostly decommissioned but still used in transformations. The highest order E1 coordinates were determined for the newer stations using the NKG2020 transformation.
- **New 3D velocity model of Estonia from GNSS measurements:** Tarmo presented a 3D GNSS velocity model for Estonia. It bases on PPP solutions of the CORS stations

and campaign data. A good fit to the NKG models were achieved. The results have been accepted to be published in in Estonian Journal of Earth Sciences (https://doi.org/10.3176/earth.2021.08).

- **EUREF velocity model:** Rebekka presented the status of the EUREF velocity model. It bases on the velocities of the latest EPN densification solution (D2100). Smooth velocity fields were achieved for many areas.
- **DynPos - dynamic coordinates in FINPOS positioning service:** FGI has tested the use of the dynamic coordinates in FINPOS positioning service. It was possible to set up both dynamic and semi-dynamic services using the GNSMART. The different coordinate setup produced almost the same results, but the semi-dynamic approach can be considered as a more correct method than the static coordinates.

Session 2: National reports

Some main points listed here; for all project and details, see the slides.

Iceland

- The main focus has been on IceCORS network. Four new stations have been set up.
- The ongoing unrest in Reykjanes peninsula has caused lots of actions at NLSI. They have been coordinating all sorts of monitoring work in the area. The re-measurement of the geodetic infrastructure in the area will be needed.

Denmark

- One more CORS station will be set up this year, SDFE having in total 14 stations.
- Four nationwide commercial RTK service providers are operating in Denmark. The SDFE approves the services for the use in the cadastral work.
- SDFE is working towards an active height reference system to reduce the need of levelling.
- Tests on the usability of InSAR technique are going on, equipment has been installed at CORS stations.
- A new geodetic data management system FIRE has been taken into use. Also actions towards better distribution of the GNSS data have been undertaken.
- The PROJ development has been going on, and work on update of ISO standards related to coordinates and reference systems.
- Development of GNET in Greenland, and related GR96 frame, has continued.

Estonia

- There has been no changes in ESTPOS network. The number of users is increasing.
- Re-measurement of national benchmarks going on.

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- The responsibility of the maintenance of the local network points will be changed from Land Board to local authorities.
- Measurements at Vääna baseline have continued, and a process of getting a legal status is under work
- Maintenance of first and second order geodetic benchmarks finished at the end of 2020
- Estonian-Latvian co-operation is going on to harmonize the geodetic systems in the border areas
- There is a national satellite data centre called ESTHub that can be used to download Copernicus programme data

Finland

- The FGI has been involved a lot in the NKG related work; NKG GNSS AC, NKG_RF17vel and NKG transformations, as it supports national needs very well
- The precise levelling of the FinnRef stations have been continued. The aim is to get all done by the end of 2025.
- Project on Preparing for the renewal of the Finnish national reference frames is ongoing.
- The TIN support has been added to PROJ 7.2.0. Now it is possible to do all the Finnish national transformation using PROJ.
- The work on the new control point register has been continued and is almost ready.
- Several activity going on at Metsähovi, see the details in the slides.
- The NLS has a new organizational structure since March, 2021. Now the production unit is responsible of the reference frames, and FGI provides the scientific base for work.
- Maybe not mentioned in meeting, but the FINPOS service was taken into operational use at NLS on Feb 2021.

Latvia

- Work for modernization of the Latvian geodetic coordinate system has started.
- Development of the LATPOS network is going on.
- The benchmark inventory has been continued mainly in (south)eastern region of Latvia.
- InSAR transponders have been tested at Riga.
- Struve Geodetic Arc exhibition room in Jekabpils museum.

Lithuania

- A few new stations are planned to LITPOS network, but the setup has been delayed due to the current situation.
- The 0 and 1st order benchmarks have been re-measured during 2018-19 and the computations have been finished.

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- Lots of gravity points measured during recent years with CG-5 gravimeter
- The determination of the heights for 1st and 2nd order points is going on.

Norway

- Not presented, the slides will be shared after the meeting.

Sweden

- The update of SWERE99; see the notes and slides from the Session 1.
- Local tie measurements have been done at Swepos stations. This was the second time for the mast stations.
- LM participates in the ESA project on Geodetic SAR. The Baltic Sea serves as a target area.
- Also other InSAR project going on, where the need of Swedish ground motion service is investigated.
- The VLBI data analysis have been done in co-operation with colleagues at Onsala. Solutions have been submitted to the IVS for ITRF2020.
- The re-measurement of the national boundary between Sweden and Norway is going on.

Session 3: Project NKG GNSS AC

- **BIFROST 2020:** Holger presented the background of the NKG2016LU model, where the GNSS data is coming from the latest BIFROST solution computed several years ago. Significant improvements in both data and modelling can be seen. The latest BIFROST solution has been computed with GAMIT, but now it could be possible to combine or at least to compare the Bernese and Gipsy solutions as well. We discussed on the schedule of the work, the stations to be included and the processing capabilities. Holger has collected a large data set of GNSS stations in both Germany and Poland which has not been included in BIFROST before. The processing will be coordinated with the next NKG GNSS AC Repro. Volunteers for processing the additional German and Polish stations with the Bernese software were asked for and Karin Kollo showed interest in processing (at least a subset) of the Polish network. The processing will not start before the release of ITRF2020 and igs20 antenna models, so we have good time to plan the work and start to prepare the RINEX data during this year.
- **Current status in NKG GNSS AC:** Lotti presented the current status of the NKG GNSS AC. We have roughly 300 stations operational now. There has been delays in submission of the operational solutions for some LACs. The LACs have also continued to contribute to EPN densification project lead by Ambrus Kenyeres. Additionally, Joaquin Zurutuza has requested solutions for an alternative EPN densification solution, so some of the LACs have been contributing to that (sub-)project as well. Lotti will resend the request to the LACs, as some may have missed it. The cumulative solution

(NKG_Repro1_update_2020) has been a major activity in autumn. All the LACs have been pre-analysing their time series. Lotti has asked about the interest towards our troposphere solution outside our group. The EPN (or Rosa Pascione) is interested in them, especially from our coming reprocessing. It was emphasized that station meta data is essential for the usability of our products.

- **Status of Repro1 update 2020:** Sonja presented the status of the velocity and uncertainty estimation of the Repro1_update_2020. The velocities are almost ready. The uncertainties need to be re-run after finishing the velocity solution. Some further studies may be needed to decide on the power spectral model to be used. So far, it looks that the powerlaw plus white noise model would describe our time series quite well. Sonja has already worked for a more automatic offset detection method to be utilized in the next updates.
- **Status of LACs**: Five LACs have submitted the solutions on schedule (three weeks after end of week) at the moment. The rest promised to catch up the schedule soon. EST has excluded the commercial stations from their solution. ISS have submitted also their extended solution to be tested in the combination since GW 2091. SK is planning to add some good quality newly installed stations to their solution. LAT will introduce a new person to the LAC analysis to catch up with the delay.
- **FTP server:** Mette reminded about the access rights of the SDFE FTP server. Please contact Mette for any changes or issues.
- **Plans and development:**
    - **Cumulative solutions:** We will finalise the Repro1_update_2020 hopefully in April. We will try to communicate with EPN/Juliette about the offsets we have detected in our time series. It would increase the number of usable datum points in the EPN cumulative solution. The next cumulative update depends on the schedule of the Repro2 activity.
    - **Next reprocessing:** We will start the preparations for the next Repro2 effort in co-operation with the BIFROST activity.
    - **Global solution:** We will try the combination of the extended ISS solution with our other LAC solutions.
    - **Rapid solution:** The LACs are encouraged to develop their current operational processing, and we are not aiming for rapid solutions now.
    - **Development of data quality routines:** Hans-Sverre will organize a separate meeting/work-shop at the end of April to exchange the experience on the data quality monitoring and analysis. The colleagues working with the real-time services can be invited as well. Each country informs their people who might be interested in to participate.

Session 4: NKG transformations

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- **Status of NKG_REF17vel:** Pasi presented the status of the NKG_RF17vel model. The velocities have been finalized already earlier, and now the determination of the uncertainties has been going on. Pasi has followed the same method that Vestøl et al. used for the vertical model. The uncertainties need still some finalizing. The plan is to document the velocity as a peer-reviewed journal article, as the model is widely used. Pasi will take the lead. The planning of the next steps of the models will be done by email.

- **NKG2020 transformation:** Pasi presented the updated transformation. The national coordinates were changed for some of the countries. Pasi demonstrated the differences between the old NKG2008 and the new transformation. The differences were mostly on sub-cm level, and due to the changes in the national coordinates. The differences increase with time especially in the areas, where better GIA model is now in use. Pasi asked each country to report on their status of the NKG transformation: is it used or recommended to be used, who is the contact person, any plans for updated etc. Pasi aims to document the transformation as a research paper.

- **NKG2020 transformation in Norway:** Sveinung presented the developed adaptation of the NKG2020 transformation for Norway. The standard Helmert transformation did not give sufficient accuracy, and therefore a transformation grid was developed. The related tools will be published in Github so that they can be utilised by others as well. They will continue the study of the method with the Landsnet (2^{nd} order network).

- **NKG2020 transformation in PROJ:** Kristian presented the development of the PROJ, and the implementation of the NKG2020 transformation. The aim is to go towards standardised licencing, file formats and EPSG database codes. The naming of the transformation has been changed so that they are more intuitive to use now. The NKG2020 transformation is included since PROJ version 7.2.1, but it is recommended to use the version 8. The final step is to add the NKG transformations into EPSG database. It was decided that NKG will input the initial information to the system, and each country is responsible for the maintenance of the information. Kristian will invite people to this work.

Session 5: AOB

- **EPOS-GNSS:** Kristian presented the EPOS-GNSS concept that has been developing during recent years. Its services consist of the M3G metadata registry, and GNSS data and product gateways. We discussed on the possibilities of each country to contribute to EPOS-GNSS. The NKG GNSS AC could potentially contribute to the products in the future. However, the concept was rather new for many participants. We will follow the topic and keep it on the agenda in the next meetings.

- **Next meeting:** In Riga in March 2022, but not overlapping with the other WG meetings of NKG.