

NORDISKA KOMMISSIONEN FÖR GEODESI

Nordic Geodetic Commission, Working Group of Reference Frames
Chairman
PASI HÄKLI
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National Land Survey of Finland
Geodeetinrinne 2
FI-02430 MASALA
Finland

NKG Working Group of Reference Frames

Minutes of the working group meeting in Helsinki, Finland, April 5–6, 2017

Place: National Land Survey, Office Centre
Opastinsilta 12, Helsinki

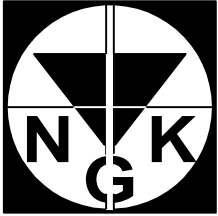
Participants:

Denmark	Thomas Knudsen, Finn Bo Madsen, Mette Weber
Estonia	Tarmo Kall, Karin Kollo
Finland	Pasi Häkli, Sonja Lahtinen, Maaria Nordman, Markku Poutanen, Mikko Takalo
Iceland	Dalia Prizginiene, Gudmundur Valsson
Latvia	Ksenija Kosenko
Lithuania	Rimvydas Baniulis, Karolis Galinauskas
Norway	Michael Dähnn, Halfdan Kierulf, Torbjørn Nørbech, Oddvar Tangen
Sweden	Lotti Jivall, Christina Kempe, Martin Lidberg, Christina Lilje

The slides of the presentation are available at the SDFE's FTP server.

Session 1: Scientific presentations

- **Halfdan, Dynamic Reference Frame Iceland:** Halfdan presented a pre-study project on “Dynamic reference frame for Iceland” that is carried out within NKG. The first meeting was held in Iceland this spring and both geodesists and GIS experts participated. Many challenges have been recognised related to the implementation of a dynamic reference frame into the GIS software and services (WMS, WFS). A draft of the project proposal will be prepared by May, 2017.
- **Gudmundur, ISNET2016:** Gudmundur presented the ISNET2016 that will be released in summer 2017. The data has been processed with Bernese using the NKG GNSS AC setup. The final results were aligned to IGS14 that worked better than IGB08. There has been a clear distortion of the old systems (ISN93, ISN2004) mainly due to two major episodes between 2004 and 2016. The next steps will be re-measuring and re-processing of the GNSS levelling network and modelling of a secular velocity field.



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- **Thomas, PROJ.4:** PROJ.4 is a C library of map projections that is widely used within the GIS software (QGIS, Esri products etc.). PROJ.4 is under development to be utilised also for the geodetic transformations that can be determined as pipelines of multiple tasks. The NKG transformations could be also delivered for the users using a PROJ.4 and a NKG PROJ.4 repository. The support from then NKG community was asked and discussed later in Session 4.
- **Michael, Where:** Where is a software package developed at Norwegian Mapping Authority that build on ideas and experiences from the former Geosat software. It is a geodetic analysis and combination program written in Python. The program consists of processing of individual techniques (VLBI, SLR, GNSS and DORIS) plus the combination module. The VLBI processing part of the software is almost ready, the SLR and GPS need still some more work. There is no estimated schedule for finishing the project.
- **Mikko, Comparator to Moscow:** Mikko presented the project of developing and building a levelling comparator to the Russian colleagues. The project started already in December, 2012, but it was delayed several times before the final installation in December, 2016, in Moscow. The comparator works for all types of rods and levelling systems. The more technical description of the system can be found in Mikko's slides.

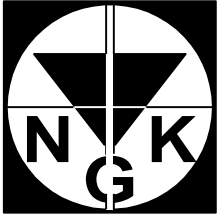
Session 2: National reports

Denmark

- Denmark is planning to establish new permanent GNSS stations close to the tide gauges at the coast line and also Galileo capable twin stations at existing sites.
- They aim to improve their geoid model to 5 mm accuracy by re-evaluating existing data (gravity, GPS, levelling) and by carrying out additional measurements at the areas needed.
- The PROJ.4 will replace the in house developed transformation software and routines.
- They have developed new software (GNU Gama) for adjustment of levelling data. They have also developed the routines of the motorized levelling so that it requires only two persons, two instruments and 2 cars, and 2-3 km per hour speed can be achieved.
- New geoid and height system has been released for Greenland in Dec, 2016 by DTU Space. There are altogether over 50 permanent GNSS stations in GNET currently.

Estonia

- Estonia has 28 permanent GNSS stations. All but the EPN stations observes Galileo, and antenna changes have been planned for those stations.
- The new height system will be released in Jan, 2018. The measurements have been carried out between 2004 and 2016. An 8 mm geoid accuracy has been achieved. They



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still plan to carry out more gravity measurements, to re-measure the 12 first order points and to connect them to the GNSS stations.

- Estonia participated the FAMOS project in spring 2016. Gravity data was collected from the Estonian coastal area.

Finland

- The FinnRef network has currently 20 GNSS stations and four GPS-only stations (old EPN-stations). Nine GPS-only stations from 90's were shut down in Nov, 2016. All 20 stations were proposed to EPN. So far 11 of them have been accepted. MET3 and SOD3 were proposed and accepted to IGS as well in March, 2017.
- The FinnRef network will be densified to 40-50 stations for the NLS's operational use. The stations will be high class stations suitable for the needs of reference frame maintenance as well. The implementation has started this year and scheduled to be ready in the end of 2018 or mid-2019.
- Measurement of GNSS levelling points was started in 2016 and will be continued this year. Roughly 50 points are measured both years. FinnRef stations will be connected to the precise levelling network also.
- Geodesy Strategy for 2017-2026 has been prepared and is about to be published in the near future. It is currently available only in Finnish. A summary of the goals can be found in the slides of Finland's national report on FTP-server.
- FGI is participating the FAMOS activities as full partner since beginning of this year.
- The renewal of SLR in Metsähovi has delayed due to the delays in the delivering of the parts of the system. The VGOS (VLBI Global Observing System) project has advanced during the year. The telescope has been ordered and it will be installed in summer, 2018. The design of the signal chain is under way.

Iceland

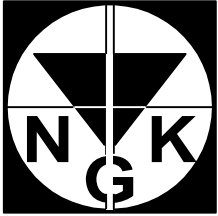
- Defining the ISNET2016 has been the major task within the last year. The details were presented in Session 1.

Latvia

- Latvia has carried out inventory of the 600 geodetic points last year in order to find, mark and protect the points for the future use.
- 90 km of second order levelling was carried out last year.
- Control measurements were carried out for the lidar data.
- One zero order permanent GNSS stations will be established in 2017, another one in 2018.

Lithuania

- There are currently 40 LitPos stations in the network. All equipment of the network has been changed in 2014.



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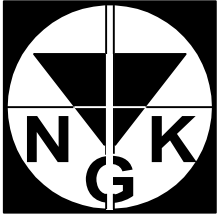
- Lithuania has submitted their weekly GNSS solutions (Lithuanian station only) to the EPN densification project.

Norway

- Norway provides new web services. SeHavniva provides information about sea level, tide tables, reference levels and land uplift for the Norwegian coast. SeSolstorm shows the ionospheric activity observations and predictions.
- The development of the Where software continues. The details were presented in Session 1.
- Norway has ongoing ESA projects related to the EGNOS monitoring and to the Galileo.
- The geometric reference frame is defined by 206 GNSS stations. The processing is carried out in ITRF and the coordinates are transformed to ETRS89 and other passive frames.
- The height reference frame (HREF) is almost finished. It will be further developed by improving the geoid modelling and related gravity measurement, and by improving the levelling data and the adjustment methods.
- A new twin VGOS station is under construction at Ny Ålesund in Svalbard.

Sweden

- Sweden will release this summer a new geoid model SWEN16 that is an adaptation of NKG2015 geoid model. The consolidation point measurements have been reprocessed using GAMIT, and Bernese processing will follow.
- Sweden has participated in the Close 3b project that aims to analyse different aspects of maintaining permanent GNSS stations (design of a CORS, antenna calibrations) and related positioning services (SWEPOS PPP service, positioning across Baltic Sea). A project report will be finalised soon.
- The implementation of reference systems SWEREF 99 and RH 2000 has continued. Almost all municipalities are using the SWEREF 99 and increasing number also RH 2000 (209 + 21 of 290). Extra support has been offered to municipalities to speed up implementation of the RH 2000.
- New national Geodata Strategy has been launched for 2016-2020. The main message is that geodata is open, usable, accessible and highly advanced. The work for new strategy for geodesy has also started.
- European Navigation Conference ENC 2017 will be held in Göteborg in May, 2018, hosted by Chalmers University.

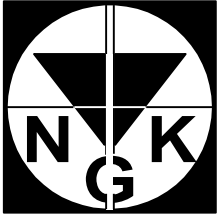


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Session 3: Project NKG GNSS AC

- **Major actions during last period:** Lithuania (LIT) joined the reprocessing part of the project in 2016. The FTP server has been moved to a new server at SDFE (DK). The operational solutions were switched to the IGS14 frame since GPS week 1934 (Jan 2017).
- **Status of LACs:** We have now 7 LAC submitting regularly solutions and the EPN_NKG backbone solution processed by LM. Lithuania (LIT) will soon join to the operational part of the project starting from GW 1934. All LACS (inc. LIT) has also contributed to the reprocessing of time series. The finalisation of the repro solutions is still going on.
- **Combination centres:** Both NKL (LM with Bernese) and NKF (FGI with CATREF) has continued the combination of the operational solution. The combination goes mostly smoothly and the solutions fit well together. The number of issues in the LAC solution has decreased during the year thanks to the SNX check script implemented by LACs themselves.
- **FTP-server:** The FTP server has been moved to a new SDFE server. Technical logins for the data submissions and personal logins for other tasks have been created for the LACs and project members, respectively. There is also possibility to create read-only logins to specific directories if needed in the future eg. for sharing the results. We did not yet decide on the sharing of the products. Please contact Mette if any issues with the FTP server.
- **Declaring the NKG GNSS AC operational:** We concluded that we have developed the routines of the NKG GNSS AC to the level that enables routinely produce highly consistent solutions within the Nordic and Baltic area, and so we declared the NKG GNSS AC as fully operational.
- **Need for common combined coordinates:** The need for common combined coordinates in addition to the stations velocities was discussed. This hasn't been discussed yet but one obvious need comes from the transformation project where new input coordinates in latest ITRF is needed when transformation will be updated. For example, the work load is quite unclear. We will come back to the question when we have progressed first with the time series analysis.
- **Next steps:** The NKG GNSS AC work will now focus on finalising the repro results for the remaining parts and combining of the repro results. We decided that each LAC makes a pre-analysis of their own solutions (especially the stations within own country) using eg. TSVIEW. After we get more experienced in the time series analysis, we will decide the information we will share from our pre-analysis.
- **Schedule for the repro and time series analysis:** We will aim to get the repro finalised and the time series pre-analysed by each LAC by the end of June, 2017. We will exchange experiences on time series by mail or Skype by June and agree on common strategy and limits for further time series analysis. We will have the combined daily and weekly results ready by the end of August, 2017, expecting that



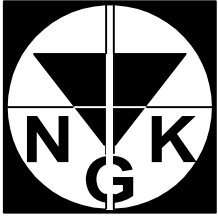
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all the LAC's have submitted the solutions by June. After this final time series analysis can be performed.

Session 4: ITRS-ETRS89 Transformation project

- **Transformations available through PROJ.4:** The possibility of delivering the NKG transformation within the PROJ.4 was discussed. The main idea of providing the transformations easily available for the users was supported, but also many open questions raised related to the version handling and how to ensure that the users are using the transformations correctly etc. The WG recognized that there is a need for a small study group to deepen the knowledge of the subject. Martin, Pasi and Thomas will prepare a proposal for starting such a study group to the presidium and a project may be proposed later if needed.
- **EUREF questionnaire on ETRS89 realization:** A questionnaire on ETRS89 realisations has been sent to director generals of the national authorities in March 2017. The main idea behind the questionnaire is the proposal of having a new conventional frame for the ETRS89, namely ETRF2014. With the questionnaire EUREF TWG wants to find out the opinions, needs and concerns of possible new ETRF2014 realization. Martin gave background of the questionnaire and presented some challenges of realising the ETRF2014. The way of realizing the ETRF2014 will influence on consistency of different ETRS89 realizations. Two proposed ways lead to about 2cm or 7cm differences compared to existing conventional frame ETRF2000. One advantage of replacing ETRF2000 with an ETRF2014 is that the vertical velocities will be identical for ETRF2014 and ITRF2014 (vertical velocities of ETRF2000 differ about 1mm/yr compared to post-ITRF2000 velocities). Martin presented an alternative way to realize ETRF2014 with slightly modified parameters for the 3 translations (T_x , T_y , T_z) that have the properties to minimize the differences at the coordinate level between ETRF2014 and ETRF2000. Martin will also work on a second new alternative where the translations are replaced by an Euler pole rotation (three rotations). The advantage of such a realization of ETRF2014 is that also the vertical positions will be identical to ITRF2014 which is beneficial in e.g. work on geoid models.
- **Land uplift modelling works within NKG:** A land uplift workshop was held in Gävle in December 2016 to coordinate the land uplift modelling related work within NKG. The output of the workshop can be found at SDFE FTP server. The conclusions and recommendations of the workshop were later formulated to a road map by the request of the presidium. The aim of the work is to release the whole land uplift model kit (including both vertical and horizontal components, gravity change and GNSS solution) latest in NKG General Assembly in 2018. Finalizing the horizontal land uplift model using the NKG2016GIA_prel0907 GIA model and latest BIFROST GNSS velocities is a task of our WG. A new NKG_RF17vel model (2D+1D where vertical part is the NKG2016LU_abs model) is to be released in the transformation



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project. A Skype meeting will be arranged in June, 2017 to agree on the further action on this.

- **Update the NKG (NKG2008) transformation:** The update of the NKG transformation (parameters) comes topical with the new NKG_RF17vel model. Following the NKG2008 transformation methodology, the velocities of the NKG_RF17vel would need to be in the conventional frame of the ETRS89 (to be decided, see section ETRS89 questionnaire). Together with the new model and possible new conventional frame, also input coordinates in the latest ITRF might be updated and to be based on time series instead of the NKG2008 campaign.