



Nordiska kommissionen för Geodesi Nordic Geodetic Commission

Working Group for Geodynamics and Earth Observations
(WGGE0)

Minutes of the 48th meeting of the Working Group for Geodynamics and Earth Observations, within the Nordic Geodetic Commission

The hybrid WGGE0 meeting was hosted by Landmaelingar Íslands in conjunction with the NKG Science Week on 14 March 2024. It was organized together with the hybrid Workshop on “Geodesy Redefined? - Quantum & AI Insights” on 12 March 2024 and the hybrid meeting of the Working Group of Height and Geoid (WGHE) on 13 March 2024. WG meetings were held in room Hvammur at the Hotel Reykjavík Grand in Reykjavík, Iceland. Combined National Reports for the WG meetings were given at the WGHE meeting.

Participants (51, 26 in person (p), 25 online (o), *Guests in italics*):

Denmark	Bjørnar Dale (p), Joanna Balasis-Levinsen (p), Rene Forsberg (p), Kristian Keller (Secretary II, p), Biao Lu (p), Aslak Meister (p), Malte Nordmann Winther-Dahl (o), Gabriel Strykowski (p)
Estonia	Karin Kollo (p), Andres Rüdja (o), Sander Varbla (o)
Finland	Mirjam Bilker-Koivula (p), Jaakko Mäkinen (o), Maaria Nordman (p), Veikko Saaranen (o), Timo Saari (o)
<i>Germany</i>	<i>Alexey Kupriyanov (o), Mohsen Romeshkani (o), Matthias Weigelt (p)</i>
<i>Hungary</i>	<i>Ambrus Kenyeres (p)</i>
Iceland	Greta Bellagamba (p), Guðmundur Valsson (p)
Latvia	Janis Kaminskis (o), Ivars Liepiņš (p), Jānis Sakne (p), Lubova Sulakova (o), Inese Varna (o), Madara Znotiņa (o), Vents Zuševics (Secretary I, p)
Lithuania	Jānis Šteinbergs (o)
Norway	John Dehls (p), Knut Gjerde (o), Halfdan Pascal Kierulf (p), Ove Christian Dahl Omang (p), Vegard Ophaug (o), Olav Vestøl (p)
<i>Poland</i>	<i>Przemysław Dykowski (o), Damian Godlewski (o), Małgorzata Szelachowska (o), Monika Wilde-Piórko (p), Dariusz Ziolkowski (o)</i>
Sweden	Anders Alfredsson (p), Mohammad Bagherbandi (p), Andreas Engfeldt (o), Nureldin Gido (o), Faramarz Nilfouroushan (p), Tobias Nilsson (o), Per-Anders Olsson (o), Chrishan Puwakpitiya Gedara (o), Holger Steffen (Chair, p), Rebekka Steffen (o)

1. Introduction

The Chair welcomed all participants to the meeting.

The updated Agenda, version 8 March 2024, was approved unanimously.

The participants of the meeting were invited to comment on the Minutes from the previous 47th hybrid meeting hosted by Aalto University in Otaniemi, Finland, 14 and 15 March 2023. There were no comments and thus the Minutes were approved unanimously. The Chair uploaded the Minutes to the WG's website: <https://www.nordicgeodeticcommission.com/working-group-of-geodynamics/reports-and-documents/>

Vents Zuševics (Latvia) was appointed as Secretary. In appreciation of the Groundhog Day the Chair noted once more that the secretary duty should be shared among the countries. Unfortunately, participants from Lithuania are missed in the Working Group, thus after Latvia's turn this year, it will be very likely be Norway's turn next year. Due to some unforeseen double-booking, the Secretary had to leave at noon. Kristian Keller from Denmark kindly stepped in as Secretary II for the afternoon. This was warmly acknowledged by the Chair and the audience.

The Chair repeated WGGE0's vision and goals, as well as its milestones for the 2022–2026 period. Regarding the latter, the agenda was adjusted to accommodate each milestone and sufficient time for discussion. The following news were forwarded from the NKG Presidium:

- The NKG Summer School 2025 is planned in Estonia, probably somewhere on Saaremaa Island, in late summer 2025. Artu Ellmann and Aive Liibusk are in charge.
- The next NKG General Assembly in 2026 was only loosely discussed to date.
- NKG Awards are coming. A designated WG is discussing the nomination guidelines. NKG will try to follow EGU guidelines on inclusion and Early Career Scientist recognition. First awardee is expected at the Summer School 2025.
- The Presidium is discussing the matter of national points of contact for NKG. Latvia founded a national NKG group with own bylaws. Other countries are supposed to investigate how they would like to organize. Some more examples can be expected at the next WG meeting.
- Rebekka Steffen was elected IAG Commission 3 President and thus is a Nordic contact in the IAG Executive Committee – if there are any ideas or wishes to be forwarded to IAG, feel free to contact her.
- Martin Lidberg continues his EUREF Presidency.
- Next presidium meeting is planned tentatively in June 2024, online.

2. InSAR

- Joanna Balasis-Levinsen: “EGMS - what's new and how you can be involved?”

An overview of the European Ground Motion Service (EGMS) was given – what's happening now and can be expected in the future. There will be a new release October 2023 and a new 5-year sliding window on data releases. Previous data will be available for download, but not visible in the browser viewer – it's a matter of resources. The visualization of the basic layer has been added to the EGMS Explorer. The aim with the 5-year sliding window is to capture quickly moving phenomena like landslides or new infrastructure. The Ortho product is available as 100-m-x-100-m grid. Other colour scales can be picked from a drop-down menu in the legend box. The next update includes data from 2019-2023. How national data providers can help:

- Act as data providers
 - Precision leveling and corner reflector data
 - Type of data: Coordinates, height, time series, etc.
 - Data preferably fully free and open
- Define standard for delivering corner reflector data, e.g., regarding coordinate system,

reference frame for height, etc.

Additional webinars will be organised in May and June to support the practical use of the EGMS products. As previously, recordings, slides, and Q&A will be published on the CLMS portal afterwards.

- Ambrus Kenyeres: “InSAR integration for serving heighting reference”

First, the status of EPN Densification was introduced and some fresh details of the EPND Iceland densification was shown; it includes 160+ stations provided by the National Land Survey of Iceland. Non-linear parts were modelled and removed with the tool also used for ITRF solutions. However, there is no chance to model linear velocities at the Reykjanes Peninsula because of the frequent volcanic events. EPND Iceland could be used for better velocity modelling and validation of the EGMS solutions. Second, the ESA-supported heighting infrastructure developments in Hungary were presented. New integrated GNSS-InSAR reference benchmarks with CORS and CR are installed and a semi-kinematic height reference surface based on geoid+GNSS+InSAR is generated. This represents the start of a new era, where the role of the classical levelling benchmarks is gradually decreasing and alternatively the field heighting works and height reference maintenance are taken over by satellite-based technologies. In the project detailed descriptions and guidelines are published later in 2024 and will be available for the international community.

- Aslak Meister: “A comparison of the European Ground Motion Service with GNSS”

EGMS is of interest to national mapping agencies as one can recognize stable areas for point establishment. Also, local deformation can be included into deformation models. The presentation discussed the correlation analysis between EGMS and GNSS. Class B stations are not included in the analyses since they are possessed irregularly (around every two years). A small bias of -0.4 mm/a is found in the up and east directions, which is a great result given the accuracy.

- Faramarz Nilfouroushan, Chrishan Puwakpitiya Gedara & Nureldin Gido: “Seasonal Effects and Performance Analysis of Compact Active Transponders and Passive Radar Corner Reflectors in Sweden: Utilizing Multi-Year Sentinel-1 SAR Data”

The performance of corner reflectors was reviewed, i.e., CR vs ECR vs GNSS. Which is the best size, shape, and form? For what can it be applied and what is the level of accuracy we can reach? Currently 3 ECRs (2 working, 1 for repair) and 16 CRs are installed in Sweden. Five more are supposed to be installed in 2024. Snow cover protection is needed, otherwise the quality drops in CRs during snow season. CRs and ECR data sets are at a good agreement. Overall ECRs perform as good as CRs, which was not expected in the beginning.

- Mahnoor Fatima, Marius Schlaak & Maaria Nordman: “Case study of two corner reflectors in Finland”

Does snow depth correlate with InSAR data? To answer this question, two CRs, one in the city and one in a forest clearing, were installed. A bad signal pattern was found in the forest clearing where snow depth and signal-to-clutter ratio agree. Snow impacts the signal! It is discouraged to install a heating system on CRs to deal with snow because a CR is a passive instrument, thus introducing electricity complicates the whole infrastructure. Based on Norway’s experience, plexiglass as snow cover works fine. Only during certain weather snow can stick to the glass. It was noted that some

GNSS stations in Sweden have heaters installed and stations work much better. There is a need to stress the importance of good coordinates for CRs – like when the reflection signal is not so easily distinguishable. It was emphasized that the backscatter of an area should be analysed before and after installation of new CRs.

Discussion

Reflector database. An NKG/EGMS/EPOS reflector database should be developed. This is because InSAR could be used for more frequent updates of geodetic products than GNSS. InSAR also has a validation function, despite its main usage for landslide control in Norway. It is unclear yet at which level such database should be pursued, e.g., if it should be an NKG Product or a part of the EGMS? (Or should there be an EPOS product in the far future?) It is mentioned that the database needs to relate to GNSS. As a start, we should collect the information from NKG countries but already get in touch with whole European community, perhaps use EUREF as a tool. The following steps are suggested as a start:

1. Inform EUREF President Martin Lidberg.
2. Start collecting reflector information at Lantmäteriet (tbd if Faramarz or someone else). People in NKG member states will be contacted. Basic information like coordinates, site description, reflector description, measurement method, etc. should be collected. The format of the database is tbd – likely an Excel spreadsheet which can later be expanded or reformatted.
3. Announce initiative at EUREF.

Status of the two NKG InSAR reports of the WG's Milestones list. Nothing has been done so far. Two reports might be too ambitious, so the topics should be discussed in one report on, e.g., “Enhancing national geodetic infrastructures with InSAR – An NKG perspective”. The report should describe the progress of installations and preliminary results, share experiences and best practices, and present some validations. It may be influenced by a Lantmäteriet report from 2023: https://www.lantmateriet.se/globalassets/geodata/gps-och-geodetisk-matning/rapporter/lantmaterirapport_2023-1.pdf. A new such report is planned for this year. The report can also reflect SDFI's findings presented earlier, and their hopeful future, newer results. The InSAR experts think they should be able to put something together until Summer 2026, before the next NKG General Assembly. The writing should be led by NMAs; SDFI and LM agreed to support this. Finland doesn't have many activities. The EEA, and hopefully NGU, will support.

3. Geodynamics

- Halfdan P. Kierulf: “Ice scale, and reference frame”

Can climate change influence VLBI scale? Seasonal variations in Ny Ålesund in height and uplift rates almost doubled over the 21st century. There is a wide range of possible causes from viscoelastic response to tectonic activity in the Atlantic rift system. One should investigate if the elastic signal in Reykjavik is increasing. Another part of the presentation reviewed potential GIA-related tectonic activities in North Europe. GNSS data for the Stuoragurra postglacial fault show no movement in the last 25 years. InSAR investigations did not detect anything either, but seismometers did for the subsurface.

- Yohannes G. Ejigu & Maaria Nordman: “Analyzing the 3D deformation induced by non-tidal loading in GNSS time series in Finland”.

In some of time series differences of up to half a millimetre are visible when non-tidal loading is corrected, thus it is not insignificant. However, each station must be corrected individually – but stations, for example in activities like BIFROST, are so many, that workload would likely increase too much. The processing of all stations together will be a few months with the help of scripts. Perhaps individual correction can just be done for key stations.

- Elisa Kropsu, Havu Pellikka, Terhi Rytteri, Tomi Heilala & Maaria Nordman: “Impacts of future sea level rise on meadows and sandy beaches on the Finnish coast”.

The presentation determined percentages of coastal habitats and their flooding risks due to rising sea level in different future projections. There is a coastal squeeze effect, but also the possibility of habitat migration as reaction to inundation. Extreme weather events in conjunction with sea level rise were not considered as they do not affect habitats so much as people. Some small meadows might have been omitted from project’s input data; it depends how they were defined in the databases that were provided.

- Rebekka Steffen, Holger Steffen & Pingping Huang: “Development of a new GIA modelling code”

The theory behind the GIA and the sea level equation was elaborated and how its terms potentially affect the results. The new code is designed to include lateral and vertical structural variations of the Earth, which is rarely included in previous models. Benchmark tests are described in Huang et al. (2023). Some small differences can be attributed to the Centre of Mass implementation in the FEMIB(S)F code. Overall, the differences are very small, thus the model fits perfectly, and the code is working. Global results for horizontal velocity will be available. Regarding the uncertainty of the GIA model, the goal is to have a range of models that are suitable to explain the observations, not to pick one. All input models have some uncertainties which could theoretically be used.

Discussion

- Holger Steffen et al.: “NKG2022GIA - Status March 2024”

The idea behind the NKG2022GIA activity is reviewed. A fancy feature of the new GIA code is the adaptive resolution to areas of interest. The current runs have constant resolution of 0.5 degrees. Smaller resolution is currently time-consuming but can be considered for the final model. The code is parallelized and thus can use multiple servers for modelling. The ice model input was delivered by Lev Tarasov in form of regional ice models. Picking the best ice model combination could take up to 5 years when using the new 3D code. Some smaller glaciers (New Zealand) are not included in Lev’s models but can be taken from, e.g., ICE-7G. The influence is minimal, much less than 1 m sea level change. Ice model testing will take place using the simpler 1D model as used for NKG2016LU. Regarding constraining observations, GNSS data are not equally distributed globally which may lead to misleading fit interpretations. Similarly, RSL data have different target times – data from 9-6 ka BP are many while before and after they are limited. Studies towards the best subsurface models (3D lithosphere and mantle) are in progress. Ice model testing will start right after NKG. The first result to be distributed for tests will just be hard numbers.

4. Gravimetry

Discussion

NKG Absolute Gravity Database. For 9 years, there haven't been significant updates in the database except a recent delivery by our Danish colleagues. The Chair has encouraged the colleagues in an email in early fall last year to submit data. This is because there exists a signed agreement from 2012 "NKG AG DATABASE Guidelines/Agreement" which states that data should "be delivered 1 year after observation". The current host is Andreas Engfeldt while Mirjam Bilker-Koivula receives a copy of the data. It seems that some potential contributors are no longer aware the agreement. Also, there is different reasoning in which form new data should be delivered: unprocessed (and thus actually being unusable) or processed with gradients, but what if the gradients change due to bad data earlier? There is consensus that the database is important and should be continued, but it is unclear in which form. The agreement was written and signed by non-experts more than a decade ago when data flow was in its infancy. Many things have changed so that parts of the contract can be considered impractical. Therefore, the Chair proposes that the AG experts come up with new guidelines for the data delivery and potential changes or amendments to the agreement. Deadline is the next WG meeting in 2025. It is expected that this issue is solved then. The current agreement will be shared. The Chair will also investigate if it can be put on the NKG website.

- Mirjam Bilker Koivula: "On the comparison of AG observations: NKG CAG 2022"

Mirjam has recalculated the results and compared her results with those performed by Hartmut Wziontek (BKG Germany). Agreement has been reached. From the initial four different solutions, the simple solution has been cancelled. The three other calculations are ICN initial, final and KCN. A10 and AQC (Quantum) instruments have higher off-sets. The draft report is on its way now.

- Jaakko Mäkinen & Andreas Engfeldt: "Fennoscandian Land Uplift Gravity Lines, (FLUGL...) status report"

First, a brief historic introduction was given. The latest publication by Mäkinen (2005) includes data 1966-2005. There has been successful data rescue with both the files of the published tables (Reports of the FGI 85:4, observations until 1984) and of later observations preserved. Currently, work deals with data upgrading, in a second phase various models of loading and other models will be used for data correction. As the latter is very ambitious, the focus will be on getting data out in public, and then the more sophisticated corrections are handled later.

5. Business Matters

Invited presentations. We had invited presentations a few years ago, a tradition that Matt Simpson started in 2015. Recently, there was no need for an invited speaker as we had the SAR workshop in 2023 and the Science Week in 2024. In 2025, we expect to have a "normal" meeting and thus the Chair will consider inviting (a) speaker(s).

G-ET Symposium in Strasbourg, 25-30 August 2024. This conference is held every 4 years and there are many interesting sessions that cover topics of WGGE0. There is a session on time-variable gravity with Maaria Nordman and the Chair as conveners. Abstract deadline is 19 April 2024. Link to the conference website: <https://g-ets2024.sciencesconf.org/>

Status of the NKG website and mailing list. Both text and documents of the [NKG website](#) have been updated. More to come after the meeting. Dalia in Iceland will help to update it if you send her the documents. The Chair will investigate why the NKG logo disappeared. Sign up on the mailing list if you haven't already: https://www.freelists.org/list/nkg_wggeo. It is possible to post job advertisements!

Registration problems this year. There was some miscommunication in the Scientific Committee of the Science Week. Next year the two WG Chairs promise only one registration form.

6. Closing of the meeting

The next meeting in 2025 (week 11) will be held in Norway, likely Oslo. A wish to explore a potential meeting in Svalbard was expressed.

The Chair thanked the hosts and participants and closed the meeting.