

# NKG

# Nordic Geodetic Commission

Past, Present and Future

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President of the NKG



# Long tradition of co-operation in geodesy: Baltic Geodetic Commission 1924 – 1948

- Finland, Sweden, Denmark, Germany, Poland, Lithuania, Latvia, Estonia, Soviet Union
- To research and advance first order triangulation, baseline measurements, gravity measurements, astronomical positioning in the Baltic Sea region
- Greatest achievement: **adjustment of the Baltic Ring**, triangulation chain around the Baltic Sea. Basis for unified gravity and coordinates in the region
- Results best in the world of its time
- More than 30 scientific publications



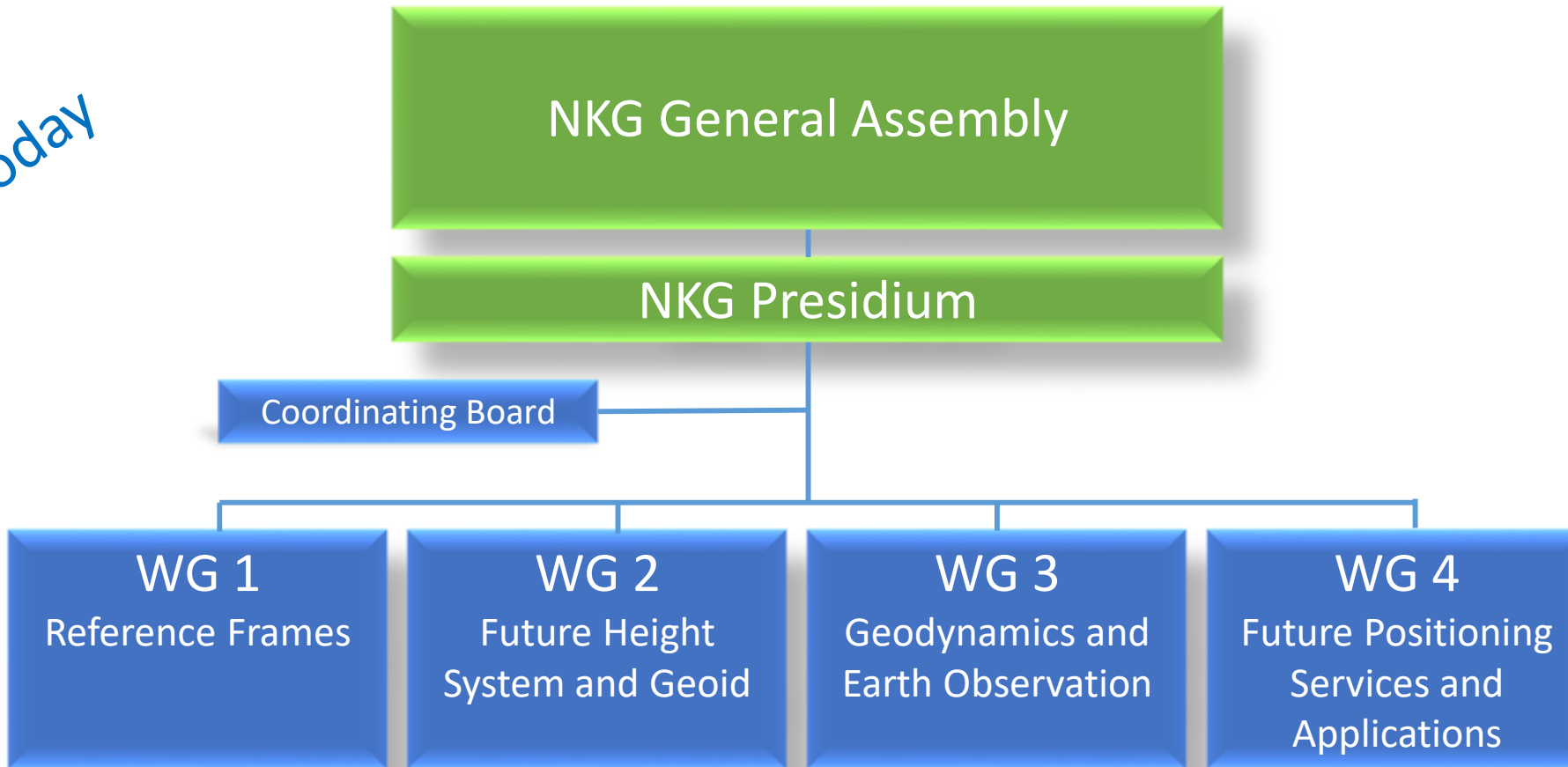


# Nordic Geodetic Commission NKG 1953 – A Need for Nordic Co-operation in Geodesy

- Initiative of Prof. Lars Asplund: Geodetic co-operation, joint research, NKG presents proposals to the National Mapping Authorities for joint work and projects
- Members: Finland, Sweden, Norway, Denmark, Iceland
- Since early 1990's Baltic States have participated actively in the work of NKG
- National Mapping Authorities, Universities and Research Institutes



NKG Today

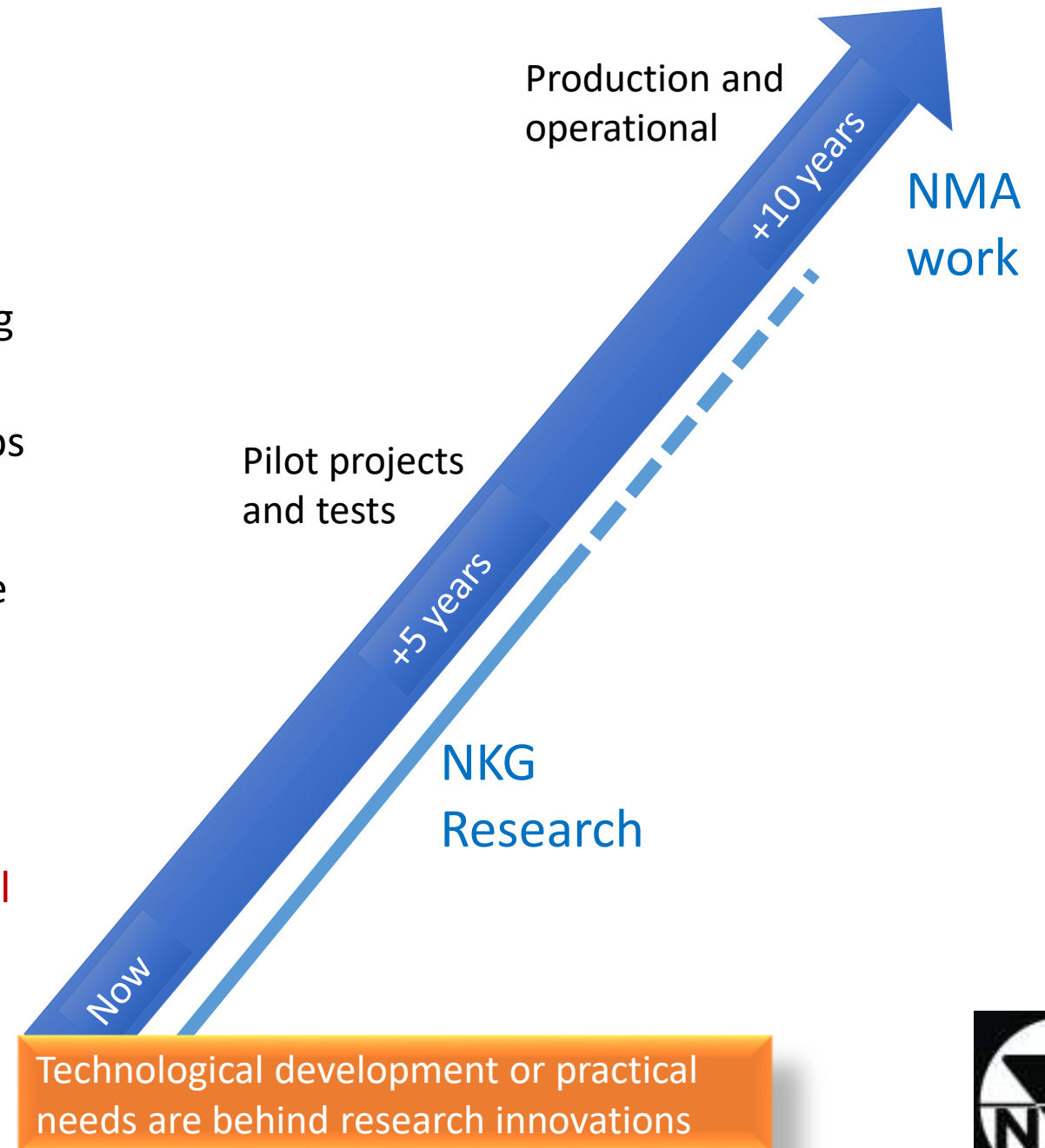


- General Assembly is the **highest decision-making body**, meeting every 4th year
- Presidium is the permanent body, having regular meetings (currently 2-3 times/year)
- Working groups are performing actual research in tasks and projects
- Coordinating board deals with large multi-WG projects (example Dynamic Reference Frames)



# NKG Success Stories

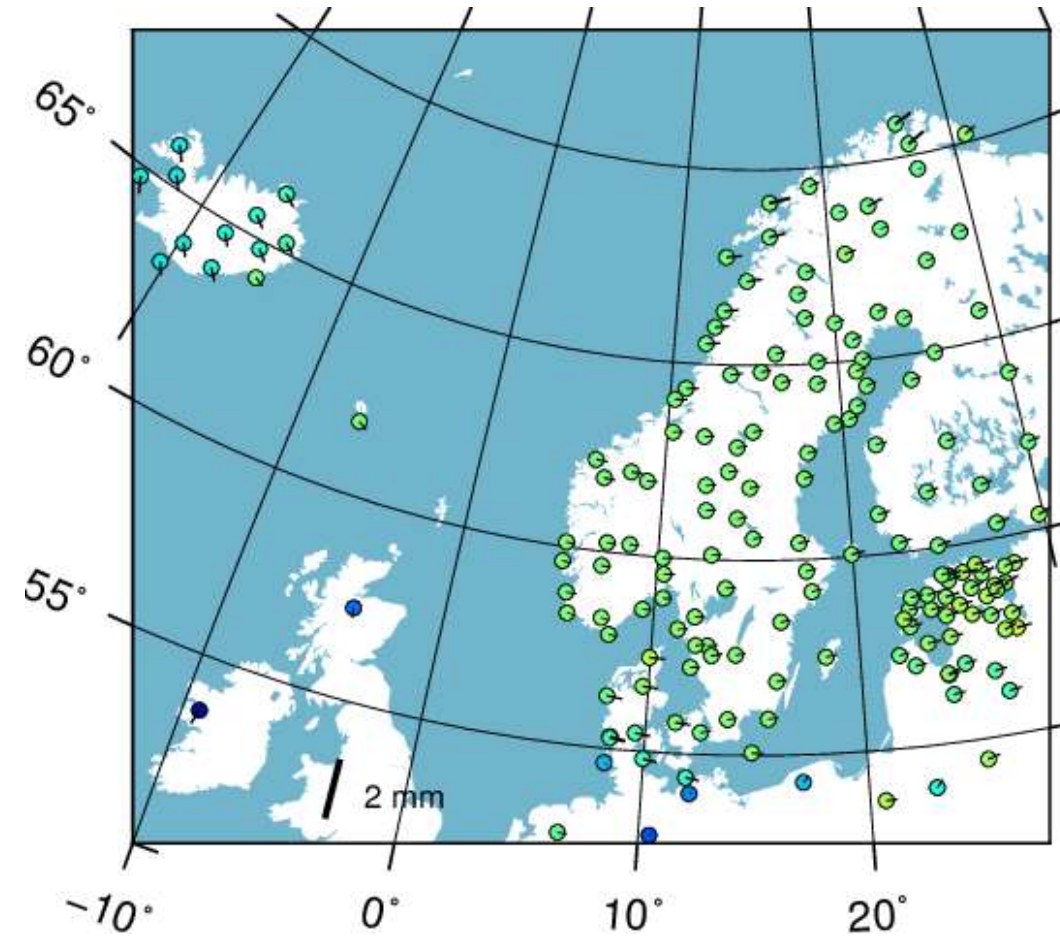
- Common problems to be solved
- Focus areas and key research are changing during years; defined by Resolutions
- Projects and tasks jointly made in Working Groups
- Support by participating organizations
- Most successful cases have been those which are
  - Actual
  - Common to most Nordic Countries
  - Challenging topics, scientific excellence
  - Beneficial to the NMAs
- Research is typically 10-5 years ahead of practical solutions or operational work





# Permanent GNSS-network → NKG Analysis Centre

- Started early 1990's as a NKG research to study crustal deformation with GPS (BIFROST-project)
- Mid-1990's **establishment of first permanent GPS stations**; synergy in planning and construction; share of information and data
- Compatible navigation services
- Joint analysis of data, common data banks
- **New national coordinate systems are compatible**
- **NKG Analysis centre** to compute the daily solution of the Baltic Sea area + Iceland; part of EUREF European network; contributes to the common European and global coordinate system and scientific research
- Precise **NKG crustal motion model** developed here will be needed for future dynamic coordinate systems
- **Backbone for all National surveying and cadastral work**

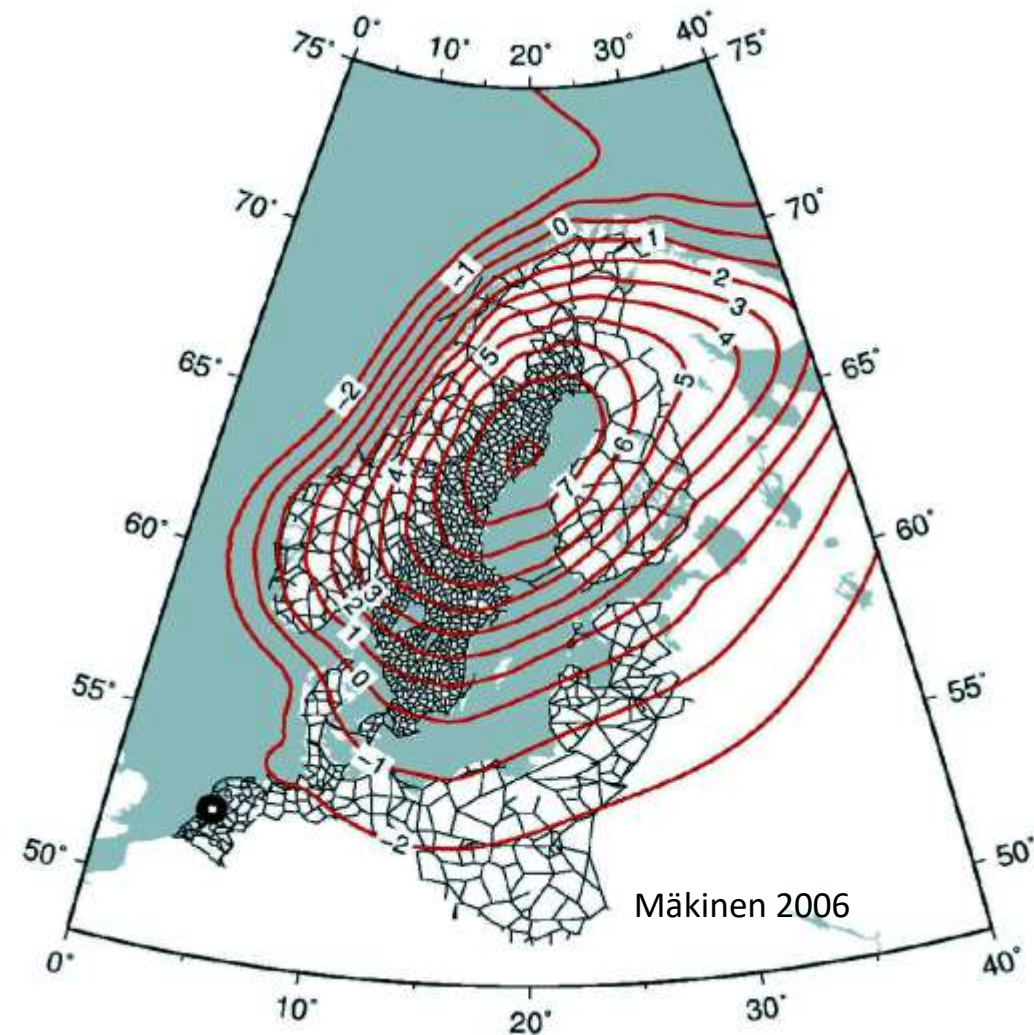


Lahtinen et al 2018



# Height → Height system and uplift model

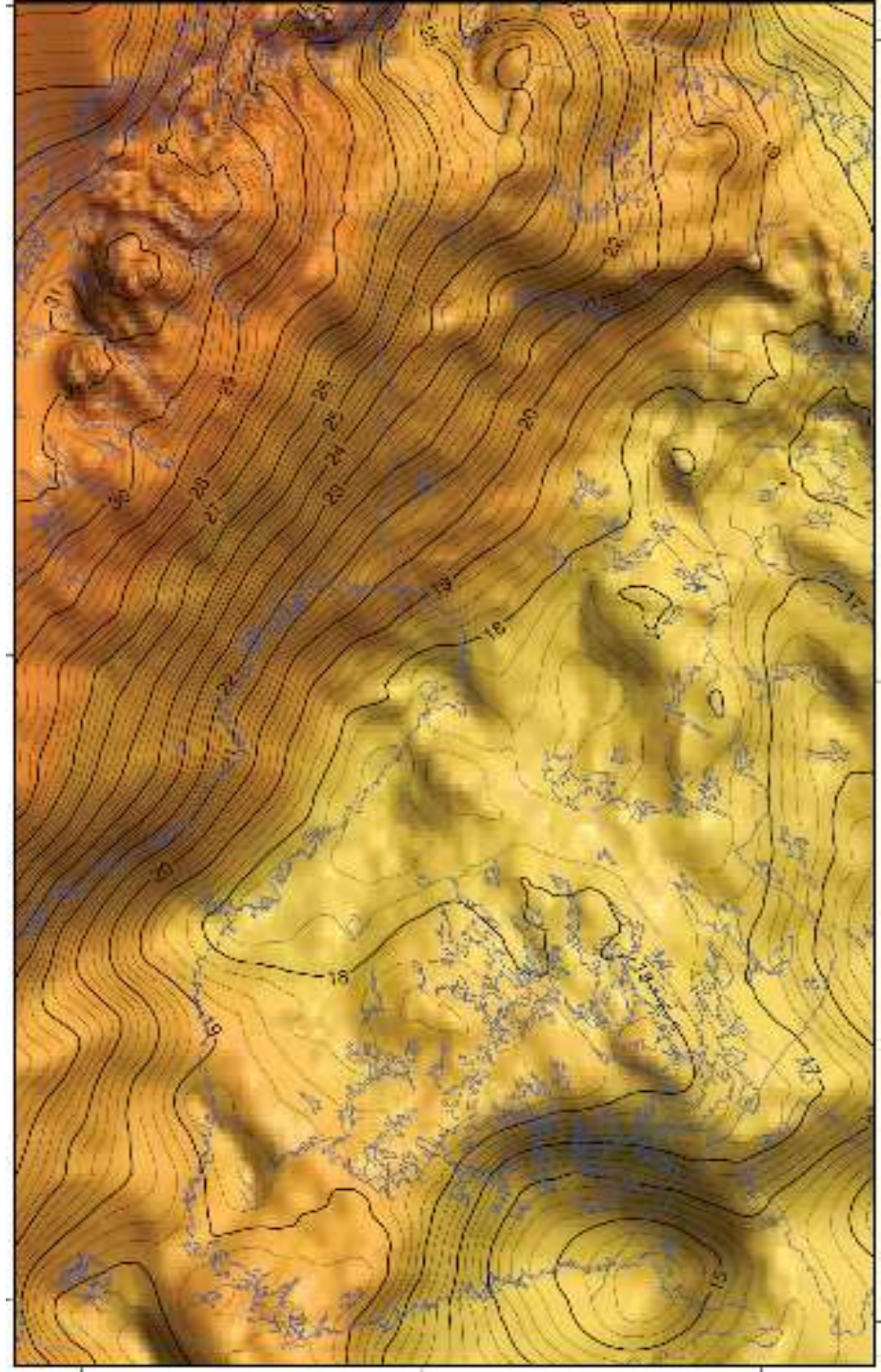
- Long tradition (since 1950's) in co-operation in levelling
- **Connection of national levelling networks**
- Early 2000's readiness for common adjustment of levelling networks around the Baltic Sea
- NKG joint adjustment to create a **unified height system** based on Amsterdam zero and INSPIRE requirements
- National height systems based on the NKG adjustment; compatible to each other; common epoch for land uplift correction (2000), common treatment of data
- **NKG land uplift model** created based on joint levelling network
- Common height system for the Baltic Sea for maritime applications (**Baltic Sea Chart Datum 2000**) by the Baltic Sea Hydrographic Commission
- NKG solution as a part of joint European levelling network and European height system





# Gravity and geoid

- Joint NKG gravity measurement campaigns since beginning of NKG
- Land uplift-gravity line measurements 1960's – 1990's to get the connection between gravity change and land uplift
- Absolute gravity measurements at permanent GNSS stations from 1990's as NKG joint projects
- Joint **gravity data bank for geoid computation** (hundreds of 1000s of points in Fennoscandian area)
- **NKG geoid models** computed since 1980's, needed especially for height determination with GPS. Current goal towards cm-accuracy
- Accurate digital height model needed for computation
- Norway is most difficult case due to mountainous areas





# **Resolutions adopted in the General Assembly, Helsinki 2018**

(Prepared and formulated by the Plenary members and the NKG Presidium, and endorsed unanimously as the program of NKG for next four years)

*Res no 1: Dynamic Reference frames*

*Res no 2: NKG bylaws*

*Res no 3: Relation to the International Height Reference Frame*

*Res no 4: Long term support for fundamental geodetic observatories*

*Res no 5: Future positioning services*

*Res no 6: Outreach*



## *Res no 1. Dynamic reference frame*

### **The Nordic Geodetic Commission (NKG)**

**Recognising** the potential benefit of high precision GNSS services for the societies in general,

**recognising** the joint efforts in the NKG GNSS Analysis Centre, the NKG working groups and the *Dynamic Reference Frame (DRF) Iceland* projects, and the achieved findings and results

**noting** the rapid development in geodetic observing techniques, especially the satellite positioning and their applications

**recognising** the increased user needs for accuracy, timeliness and reliability and further **noting** the divergence between recent ITRF and ETRS89 based national reference frames affecting seamless use of GNSS based positioning tools, satisfying the end users' needs

**recommends** NKG to continue the DRF activities in close cooperation with the NKG working groups and further make recommendations for future dynamic reference frames in the NKG area of interest.



*Res no 2. NKG bylaws*

## **The Nordic Geodetic Commission (NKG)**

**Recognising** the development in the field of geodesy, and the importance of geodesy being part of the national infrastructure and the increased need for cross border cooperation

**recognising** the existing bylaws of the NKG

**recognising** the active participation of the Baltic countries in the NKG activities for a long time

**noting** the Baltic countries are invited as observers at the NKG presidium meetings in the coming 4 year period

**requests** the NKG Presidium to prepare revised bylaws for discussion and adoption by the General Assembly of the NKG in 2022.





### *Res no 3. Relation to the International Height Reference Frame*

#### **The Nordic Geodetic Commission**

**Recognising** that IAG defined the International Height Reference System (IHRs) in resolution #1 at the IUGG General Assembly 2015 in Prague and are now working hard with the first International Height Reference Frame (IHRF)

**noting** the high quality of and good agreement between the present Nordic/Baltic height systems including the Baltic Sea Chart Datum 2000

**noting** the future needs to transform between the IHRF and the Nordic/Baltic height systems

**asks** the working group on *Future height systems and geoid* to closely follow the international development of IHRs and IHRF

**and** derive a Nordic/Baltic realization of IHRs and based on this derive transformations between IHRF and the Nordic/Baltic height systems.



*Res no 4. Long-term support for fundamental geodetic observatories*

## **The Nordic Geodetic Commission (NKG)**

**Recognising** the great efforts of NKG countries in maintaining and modernising the fundamental geodetic observatories in Ny-Ålesund, Onsala and Metsähovi,

**noting** the UN General Assembly 2015 resolution on global geodetic reference frame for sustainable development,

and further **noting** the ultimate importance of such multi-technique sites for fulfilling the UN resolution,

also **noting** the benefit of cooperation on development, correlation, analysis and operations

**encourages** National Mapping Authorities, universities and research institutes to work for sufficient support for long-term operation and development of such facilities.



## 5: Future positioning services

### The Nordic Geodetic commission

**Recognising** the rapid development of advanced real-time positioning applications like autonomous platforms, and the interest for such applications in society

**recognising** the on-going development of the digital maritime traffic management (e-navigation)

**noting** the modernisation of existing GNSS (GPS and GLONASS), and the foreseen finalising of new GNSS (e.g. Galileo and BeiDou) as well as the interest for new positioning techniques like precise point positioning (PPP)

**noting** the existing mature technology for real-time positioning available in the Nordic/Baltic countries (Network-RTK) and the associated infrastructure

also **noting** the importance of information about reference frame to be included in real-time data streams from both positioning service and source of geospatial information, as well as noting the on-going standardisation initiatives (e.g. 3GPP and RTCM) regarding real-time positioning services

**encourages** the related organisations to *prepare* for the foreseen future, including *strategies* for how to benefit from the existing infrastructure and know-how, and to perform appropriate *research* and *development* of the geodetic infrastructure, in order to achieve efficient use of existing investments and know-how in this wider development.





*Res no 6: Outreach*

## **The Nordic Geodetic Commission**

**Recognising** that geodesy is an important part of modern society as well as sciences about studies of the planet Earth and climate change

**noting** that geodesy is unknown for the wider community

**noting** a general decrease in the number of students in natural sciences

**noting** the need for qualified geodetic expertise in the future

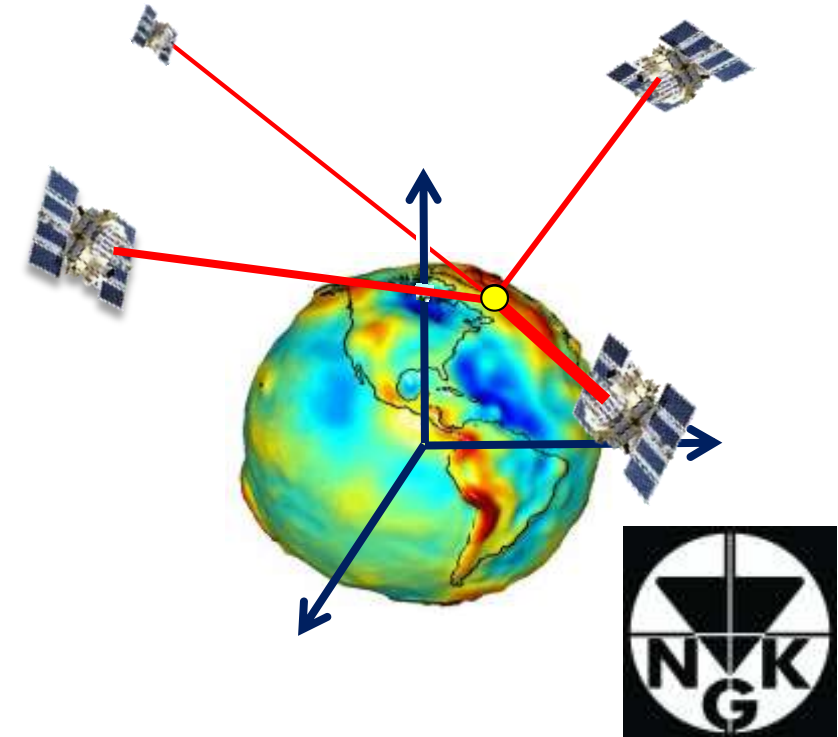
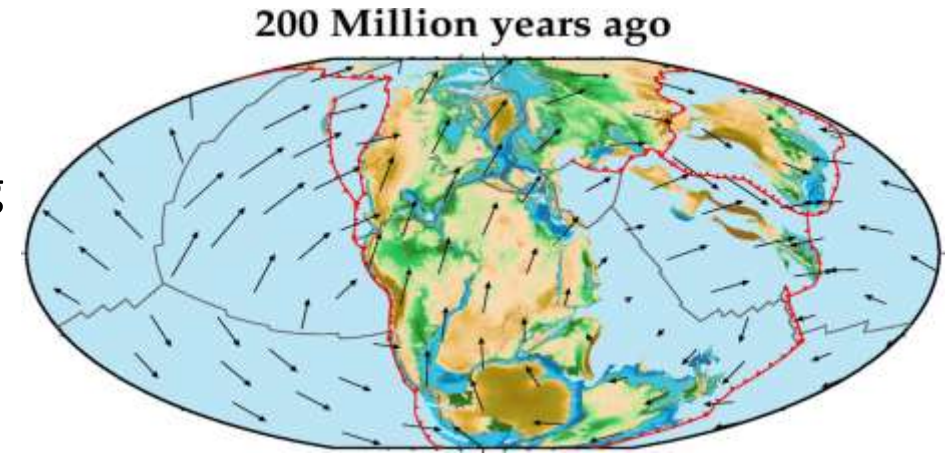
**noting** the benefit of exchanging outreach experience and material

**encourages** the geodetic community to improve its ability in outreach activities towards society in general and young people in particular.



# A Way to Future

- NKG General Assembly 2018 identified and adopted the following focus areas:
  - **Dynamic reference frames**
  - **Future positioning services**
- Dynamic Reference Frames needs continuously
  - Permanent GNSS network over the whole Nordic area
  - Joint data analysis (NKG Analysis Center)
  - Crustal deformation model (NKG models)
  - Precise geoid model (NKG model)
  - Seamless connection to global and European geodetic networks
- Future positioning service needs
  - Better deformation models due to cm-accuracy real-time requirements, maintenance of reference frames in real time
  - Solving possible mismatches between countries for seamless transition across borders
  - Study of accuracy, error sources, jamming, spoofing
  - Use of e.g. Galileo Public Service signal, authorized use &c.
- **Research related to these are realized in four working groups**



# A Way to Future, expansion of NKG

- Estonia, Latvia, and Lithuania will become full members of NKG after adoption of the new by-law in 2022 General Assembly (as given in the resolution #2 of the 2018 General Assembly)
- Three NMA's, several Universities will be added in the NKG -> implies changes on the NKG administrative level
- Only a minor impact on science environment because Baltic researchers have already been active in NKG Working Groups
- Increasing interest in the Baltic Sea area
- Geophysically covers most of the Fennoscandian postglacial area and the Baltic Shield
- Most countries share common interests and challenges – bases of good co-operation





# A Way to Future, Development and Challenges

- **Adoption of new techniques** and related research on applications.
- In 2020's and beyond 2030 new techniques/new models are taken in use
- Increased demands on accuracy and real time delivery of products
- Diversity of users
- Practical needs of NMAs and high-level research

60° 13' 3,390"  
24° 23' 51,028"



# A Way to Future, developing landscape of geodesy

Courtesy Martin Lidberg / modified MP

## ***Evolving reference frames***

- ETRS89/ETRF
- EVRS/EVRF
- ITRS/ITRF
- Galileo reference frame

## ***Evolving networks/resources***

- EPN
- EPND
- Other CORS
- UELN
- NKG

## ***New developments***

- IHRS/IHRF
- Global/regional PPP-based services (Galileo HAS – High accuracy service, SAPCORDA, etc)

- Dynamic reference frames
- SAR in geodesy
- Lidar (airborne...), surface models
- Height determination techniques
- Improved geoid models

## ***Organizations***

- IAG
- EUREF
- IAG Services (e.g. IGS)
- GGOS
- EPOS
- FIG
- UNGGIM
- SCoG
- GGCE (Global Geodetic Center of Excellence)

The environment is evolving rapidly; reference frames, related networks, new techniques and changes on the organizational level (both scientific level (e.g. IAG) and political level (e.g. UN))

Keeping close connections to IAG and other scientific organizations :  
Markku Poutanen – Secretary

General / IAG

Niels Andersen – Treasurer / IUGG

Martin Lidberg – President / EUREF

Mikael Lilje – Vice President / FIG



# A Way to Future, Threats

- Ignorance of NKG (by commercial services, untrusted sources, inappropriate models, ...); -> outreach and communication more and more important
- Challenge of NKG is to keep track on development, stay in the forefront, and offer solutions and products which are up-to-date, precise, and available to all users
- Challenge of Presidium and Working Group members to introduce achievements and projects to the directors of NMAs to keep them informed; equally bring the needs on NMAs to the Presidium
- External funding is needed for Universities to participate in projects; this implies that NKG must conduct world-class research to successfully compete in funding
- Seamless co-operation to avoid duplication or double work in countries (few people, small resources)



# A Way to Future, Strengths and Opportunities

- NKG has been **one of the most successful scientific organization in the world** when looking results and benefits
- **Long-term co-operation**, numerous success stories and joint projects have **saved a lot of work and money** among the Nordic NMAs, and at the same time produced **one of the best geodetic infrastructure in the world**. This is reflecting in all fields of Geoinformatics in Nordic countries as reliable and accurate reference systems
- The most successful projects have been born in the **combination of scientific excellence, technological development and practical needs** of the NMAs. Close connection to the front-line research is the prerequisite for this.
- **Combination of NMAs and Universities offers unique opportunity to continue the work**
- **New by-law and strategy** under preparation (and to be adopted by the next General Assembly in 2022) will strengthen NKG, and improve possibilities for research and practical applications in the future.

