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FGI

NKG Working Group of Reference Frames (WGRF)

Status report

NKG General Assembly 14-17 September 2026

Pasi Häkli (Chairman of the Working Group of Reference Frames)

+all participants of the WG

WG Reference Frames

1(2)

Vision and goals:

A common, harmonized, densified, continuous and up-to-date ITRFyy coordinate and velocity solutions are in a key role for maintaining/monitoring of the national reference frames (ETRS89) in the Nordic and Baltic countries. The GNSS solutions together with associated velocity/deformation models and transformations form the basis for high-quality national reference frames in the long term. The GNSS velocities are essential data especially for Glacial Isostatic Adjustment (GIA) and deformation modelling and up-to-date coordinates for accurate transformations from global to national reference frames. We produce and constantly improve the GNSS solutions, deformation models and transformations for the maintenance of national reference frames.

- 1. NKG GNSS Analysis Centre (NKG GNSS AC):** We produce operational daily GNSS solutions for the Nordic and Baltic countries through local analysis centres (LAC) and combine the LAC subnets to NKG daily solutions. Subsequently these solutions are stacked and analyzed to obtain multiyear solution (coordinates, velocities and their uncertainties). We produce regular cumulative solutions (and necessary reprocessings) to keep solutions up-to-date.
- 2. NKG transformations:** We create and maintain accurate links between global and national reference frames. Together with the transformation parameters we develop and/or incorporate existing crustal motion models to account for the deformations caused e.g. by the GIA. Furthermore, we make NKG transformation available to users, e.g. through PROJ transformation software.

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Input from the NKG General Assembly 2022

- NKG focus areas:
 - ...
 - dynamic reference frames
 - Identifiers for Geodetic Reference Frames (EPSG, ISO register...)
- Resolution 1:
 - ...
 - recommends to continue developing transformations and associated products and
 - encourages its member countries to address standardization of reference frames and transformations.

WGRF plan 2022-2026

Milestones 2022-2026:

NKG GNSS Analysis Centre (NKG GNSS AC)

- Operational processing and combined NKG solutions continuously, switching to ITRF2020/IGS20
- Continue development of cumulative NKG solutions towards regularly updated solutions
- New NKG GNSS reprocessing(NKG Repro2), coordinated with IGS/EPN and BIFROST
- Improving codebase needed for the LAC operations, e.g. Github

NKG transformations

- Continuing registrations to EPSG (and ISO registry) to facilitate the use of existing transformations
- Updated NKG deformation model (2D+1D), coordination with WGGeo and WGHG (e.g. NKG Repro2/BIFROST, GIA, NKG202XLU)
- Updated NKG transformations and implementations (after new NKG deformation model)
- Developing/securing codebase needed for the transformations, e.g. Github

Working Group of Reference Frames (WGRF) 2022-2026

- **WG meetings** (hybrid, 1-2 days):
 - 2023/03/30–31: Tallinn, Estonia
 - 2024/03/13–14: Reykjavik, Iceland
 - Half-day introduction to Git and Github
 - 2025/03/27–28: Gävle, Sweden
 - 2026/03/24–25: Helsinki, Finland
 - Minutes and presentations (partly) available in the NKG webpage:
<https://www.nordicgeodeticcommission.com/reference-frames/meetings/>
- Online meetings on specific subjects
- Main communication via mailing list:
https://www.freelists.org/list/nkg_wgrf



Nordic Geodetic Commission

NKG

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MEETINGS

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OTHER MATERIAL

Meetings

Reference Frames – M

Next meeting will be held

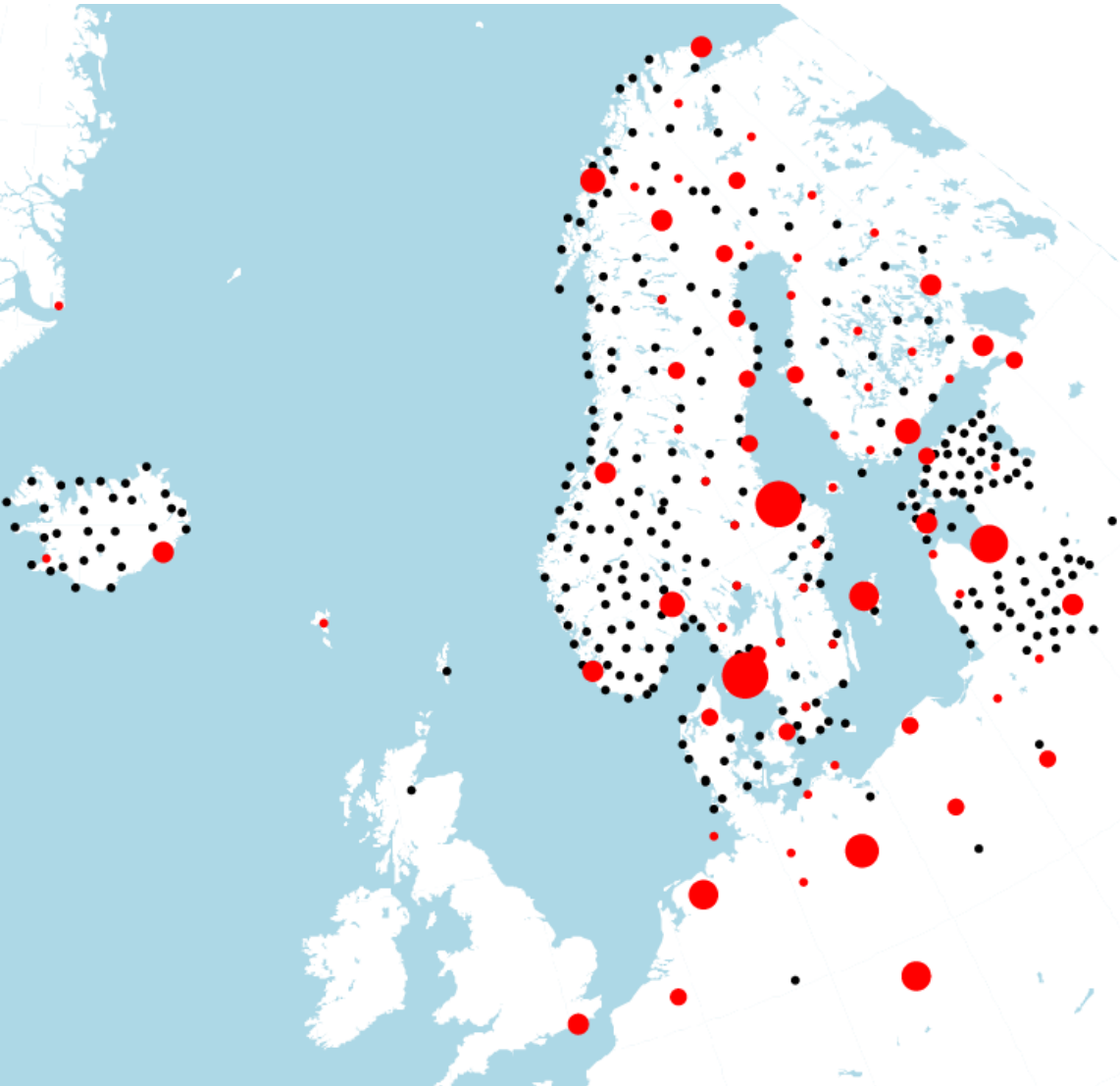
- 2026/03/24–25: Helsinki, Finland (minutes, presentation)
- 2025/03/27–28: Gävle, Sweden (minutes, presentation)
- 2024/03/13–14: Reykjavik, Iceland (minutes, presentation)
- 2023/03/30–31: Tallinn, Estonia (minutes, presentation)

- 2022/05/19–20: Riga, Latvia (minutes, presentation)
- 2021/03/22–23: Online (minutes, presentations)
- 2020/03/10–11: Reykjavik, Iceland (minutes, presentation)
- 2019/03/25–26: Copenhagen, Denmark (minutes)

NKG GNSS AC

Project leader: Sonja Lahtinen
(2022-2024), Tobias Arnell
(2024-)

NKG GNSS Analysis Centre (NKG AC)



Operational processing

- 8 national networks and the NKG_EPN-solution as backbone, >400 stations
- Switch to IGS20 – some delays to get started with the new version Bernese 5.4

Cumulative solution C2237 was released in June 2023

- Last solution in IGB14
- crd+vel solution with data up to Nov 2022

NKG Repro2 project

- Reprocessing of GNSS data 1997.0-2022.9
- Consistent with EPN, extra solution for BIFROST

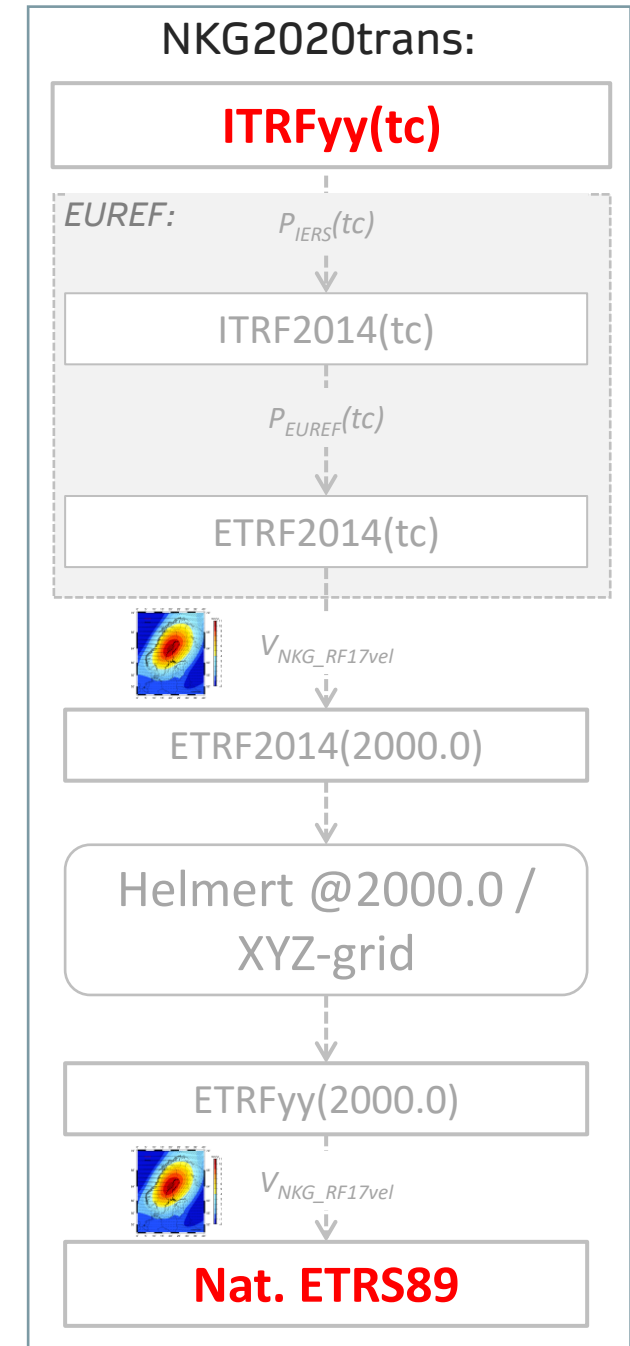
See more in the presentation by Tobias Arnell

NKG transformations

Project leader: Pasi Häkli

NKG2020 transformation

- NKG2020 transformation
 - **Uncertainty estimation:** 1.7 mm +/- 0.1 mm/yr, 1.8 mm +/- 0.1 mm/yr and 3.6 mm +/- 0.3 mm/yr in North, East and Up components, respectively (1σ)
 - **Documentation:** <https://doi.org/10.1515/jogs-2022-0155>
- NKG2020 transformation **update for Latvian LKS-2020** in 2025
- **Standardization:** geodetic registries
 - NKG2020 transformation added to the EPSG dataset v12.021 (2025-08-24)
 - Several new coordinate operation and CRS codes added, see <https://epsg.org/search/by-name/?query=NKG>
 - Swedish NKG2020 transformation added also to [ISO geodetic registry](#)



NKG transformations

- **Modernizing** current NKG transformation **code: transformo**
 - Python and maintained in Git/Github:
<https://github.com/NordicGeodesy/Transformo>
 - Reads various data formats, derives Helmert parameters and produces reports that help evaluate the results
 - More info: <https://transformo.xyz/>
- Will be used for the future NKG transformations

Use cases

Search Ctrl+K

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Getting Started

Installation

Using Transformo

Architecture

Use cases

Examples

DataSources

Comma Separated Values

Bernese CRD files

Operators

PROJ Operator

Helmert 3-Parameter

Transformo Components

Source DataSource

ProjOperator(helmert)

Intermediate result 1

ProjOperator(deformation)

Intermediate result 2

ProjOperator(deformation)

Intermediate result 3

NKG2020 Method

ITRF2014@2015.0

P_{EUREF}

ETRF2014@2015.0

$V_{NKG_RF17vel}$

ETRF2014(2000.0)

$V_{NKG_RF17vel}$

ETRF2014(2015.829)

On this page

Transformation parameters for Nordic and Baltic ETRS89 realisations

References

Transformo

Transformo is a generalized software package for estimating geodetic transformation parameters and models.

Transformo seeks to provide a framework that lets the user focus on determining the best transformation model. To achieve that, the burden of reading coordinate data from various sources, (re)implementing algorithms and delivering the results in a useful accessible form has been removed.

Note

Transformo is currently being developed. It is functional but no guarantees regarding the internal architecture or user interface are given at this point.

Transformo

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PROJ Operator

Helmert 3-Parameter Transformation

7-Parameter Helmert Transformation

7-Parameter Helmert Transformation (Small Angle Approximation)

Presenters

DataSource Presenter

Coordinate Presenter

Residual Presenter

Topocentric Residual

Rationale

The rationale behind Transformo is to create a framework that removes the tedious work of reading input data and presenting the results after transformation parameters has been determined. In particular, this approach is meant to be a service to researchers that develop new for methods geodetic coordinate transformations, as they can focus on the core algorithms and not the supporting scaffolding.

Problem

The main problem Transformo tries to solve can be presented on the idealized form

$$y = f(\beta, x)$$

Where x and y are the source and target coordinates, f is a transformation model and β is the parameters for the chosen model.

The real world is rarely simple so a more realistic form would be

$$y = f(\beta, x) + r$$

Where r is the transformation residuals.

The primary function of Transformo is to provide a set of parameters β that minimizes the residual r . In some cases that might involve a transformation model consisting of several steps:

$$y = f_3(\beta_3, f_2(\beta_2, f_1(\beta_1, x))) + r$$

With transformo we can easily specify the x , y and f_1 , f_2 and f_3 using the built-in constructs, which leaves only the parameters, β_1 , β_2 and β_3 , to be determined. Transformo will do that based on the specified model and present the results in a suitable format.

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WGRF status 9/2026

WGRF status 2026

Color coding:

Done or ongoing according to plan

Partly done or in the pipeline

Not done or postponed

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BIG thanks to all WGRF participants!



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