

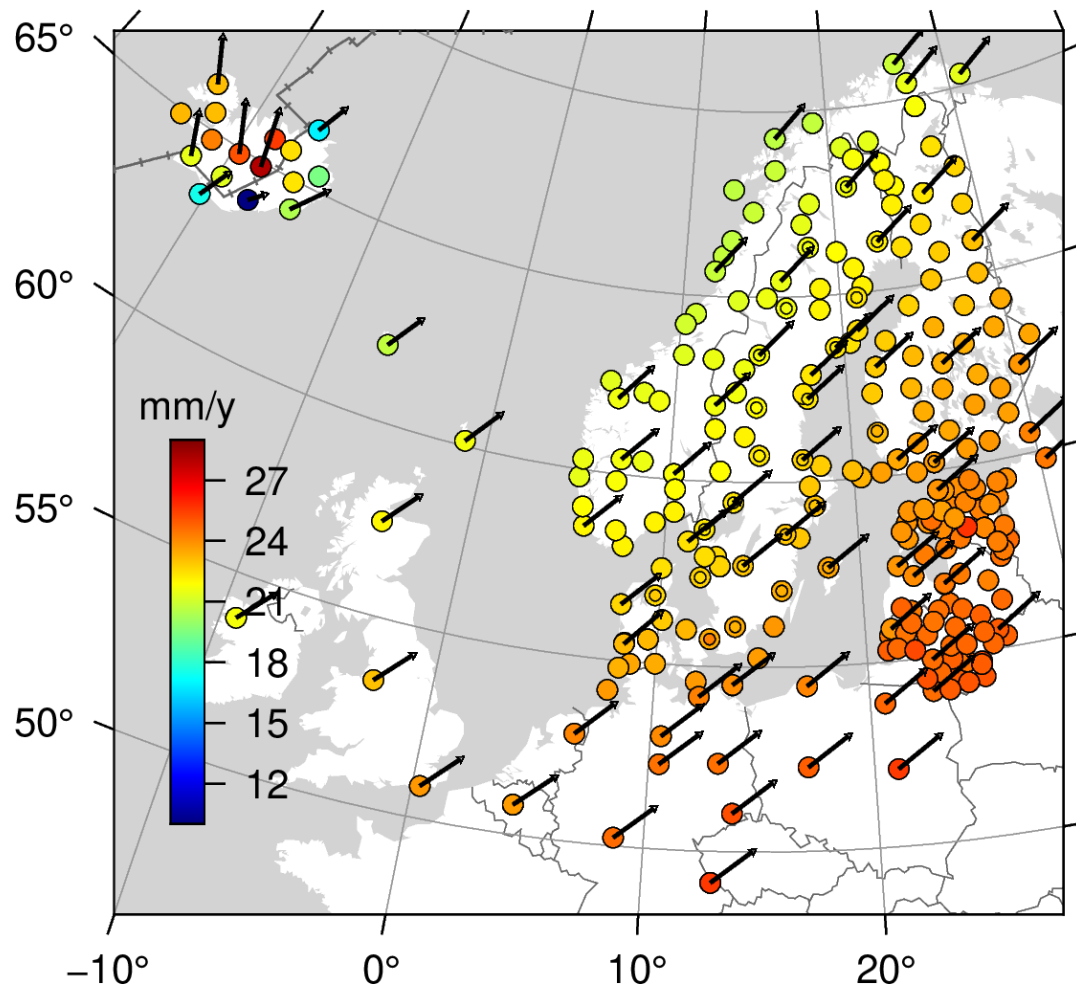
NKG GNSS Analysis Centres

Operational Processing,
Reprocessing 2 and BIFROST

Status 2022–2026

Tobias Arnell, on behalf of the NKG GNSS AC contributors

NKG General Assembly, 16 September 2026



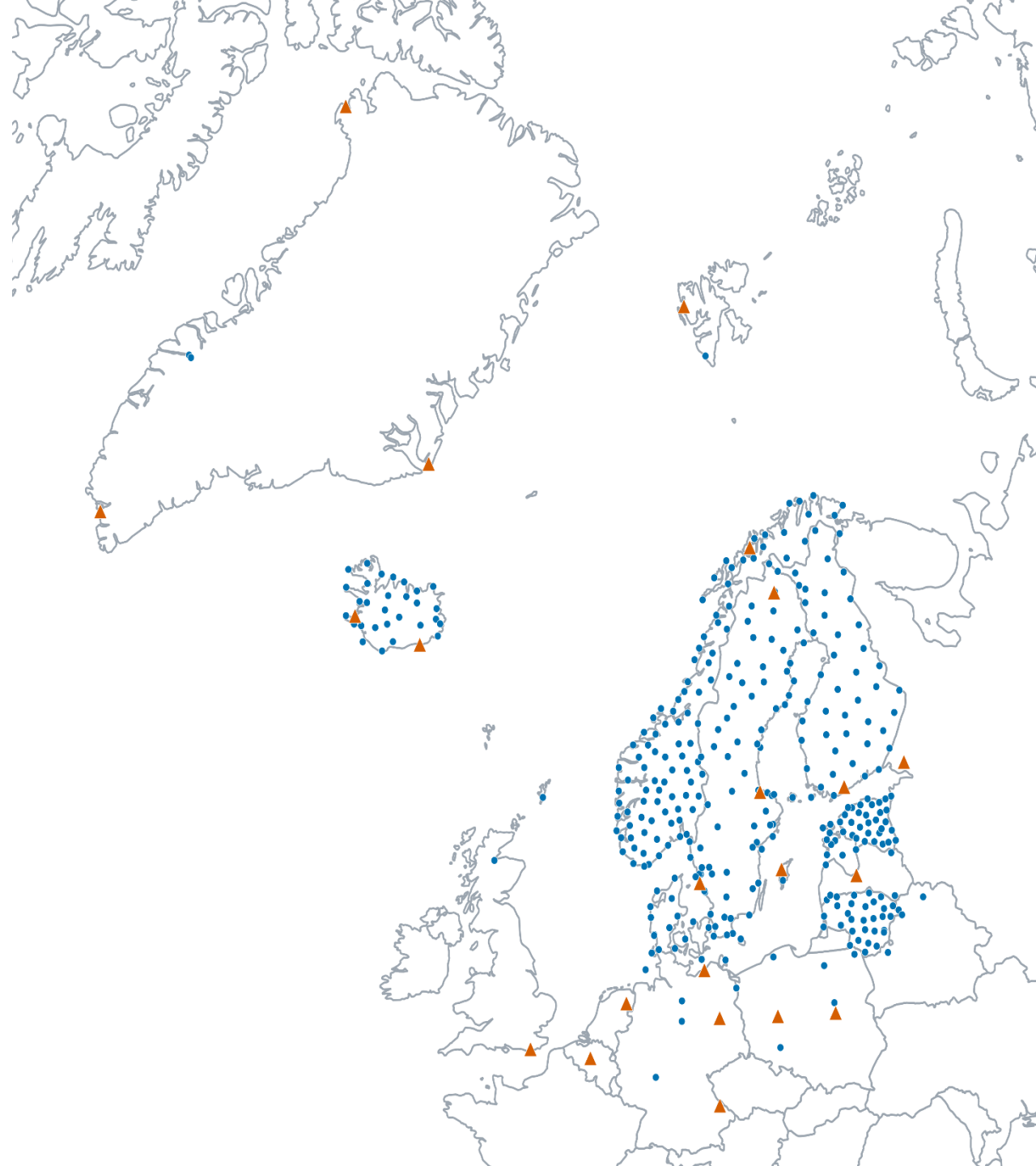
NKG C2237 Horizontal Velocities

Objectives

- Produce consistent station positions and velocities across the Nordic-Baltic region
- Combine national subnetworks into a common regional GNSS solution
- Support the maintenance of national ETRS89 realisations
- Provide positions and velocities for NKG transformation and deformation modelling

Network

- Eight national subnetworks, with the NKG EPN solution providing the backbone
- More than 400 stations
- National station selection based on stability, data quality and geographical coverage
- Common stations connect the subnetworks and enable inter-solution comparisons



Operational Processing

Software	Bernese 5.4
Constellations	GPS, GLONASS and Galileo, subject to antenna-calibration availability
Antenna model	IGS20.atx, with specified epnc_20.atx exceptions
Orbits, ERPs, and OSBs	Final products from CODE
Elevation cut-off angle	3°, with elevation-dependent weighting
Troposphere model	VMF3, 1° × 1° grid
Ionosphere model	CODE global ionosphere model
Ocean loading	FES2014b
Ambiguity resolution	Bernese Advanced or QIF

Operational Processing

LAC Quality Control

- Validate station metadata and SINEX files before submission
- Assess daily repeatability, ambiguity resolution and solution residuals
- Exclude stations with large outliers from the affected solutions and investigate their impact on other stations in the network.
- Remove clear daily outliers from the weekly combination

CHANGE

Antenna or receiver

DAILY SOLUTION

Exclude affected station-day

WEEKLY SOLUTION

Exclude station for affected week

Operational Processing

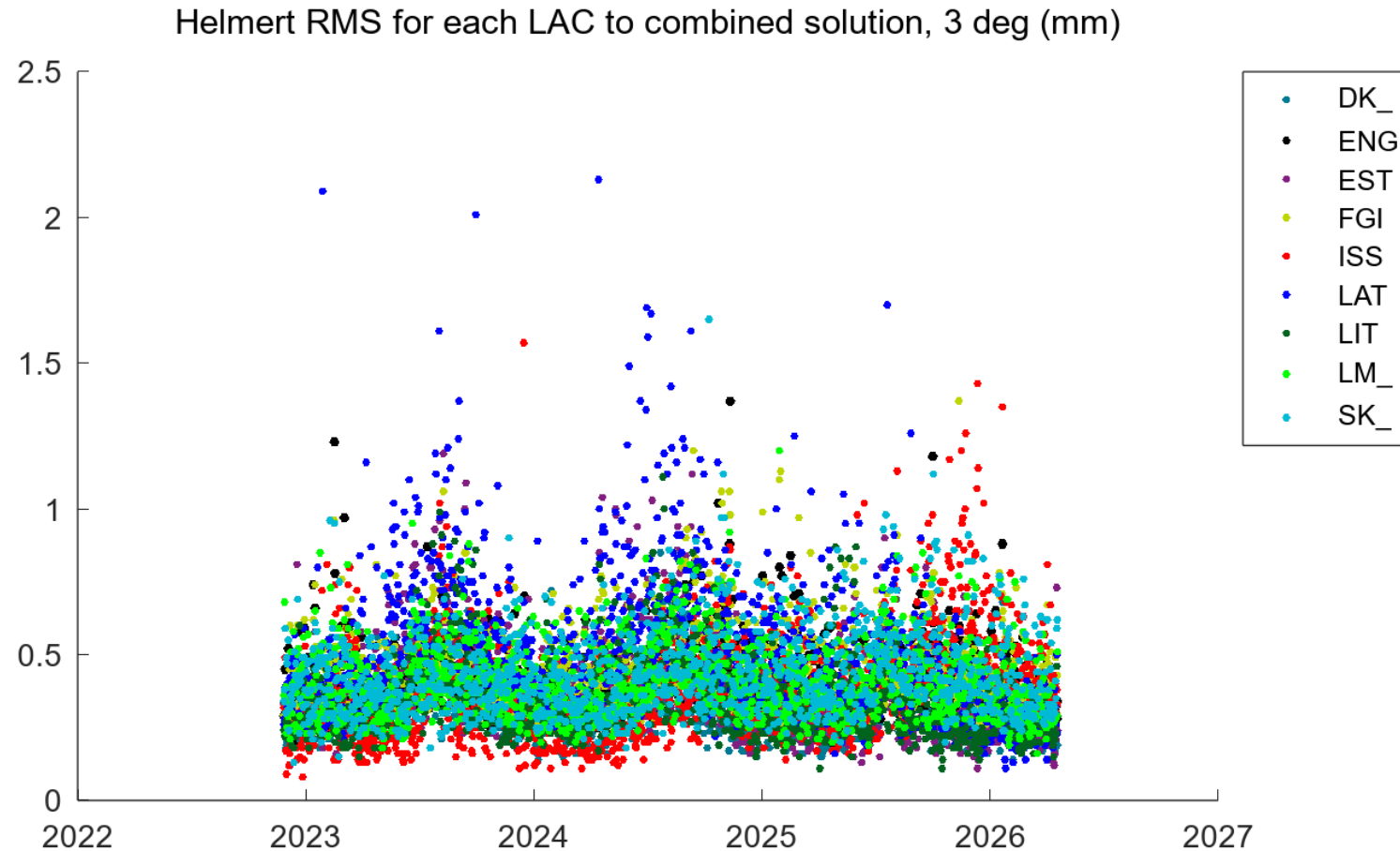
Combination

- Check submitted SINEX files and reconstruct normal equations.
- Combine LAC contributions separately for daily and weekly solutions using ADDNEQ2.
- Apply no-net-translation minimum constraints.

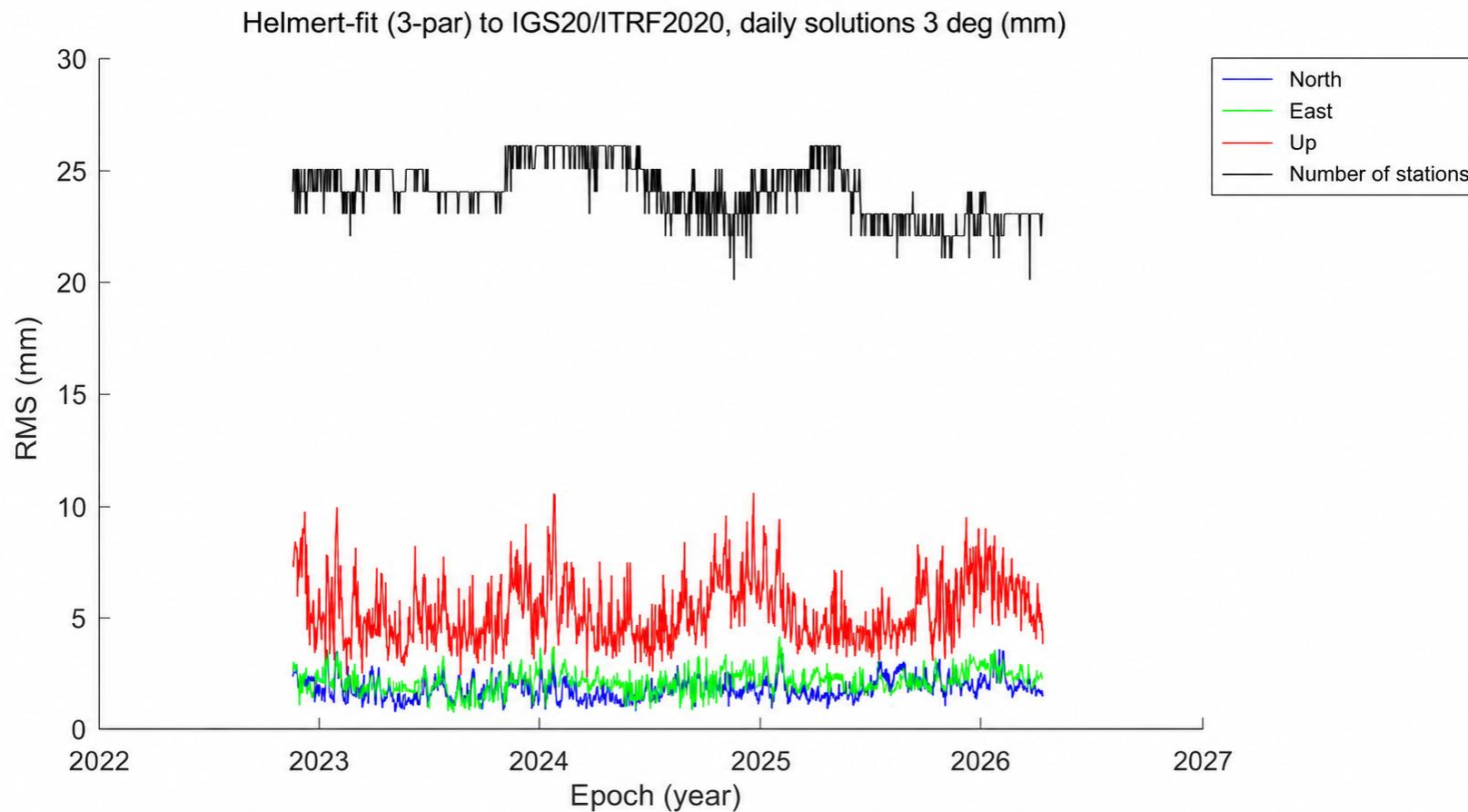
Validation

- Compare daily LAC coordinates and their mean with the weekly solution
- Fit LAC solutions to the corresponding NKG EPN solution
- Investigate N/E/U residuals exceeding 5/5/10 mm
- Exclude selected contributions and repeat the combination

Operational Results: GPS weeks 2238-2414



Operational Results: GPS weeks 2238-2414



Repro2 and BIFROST Processing

Shared processing basis

- Bernese GNSS Software 5.4
- CODE Repro3 orbits and ERPs; CODE global ionosphere model
- EPN historical observations and Repro3 antenna/station information

PARAMETER	REPRO2	BIFROST
Constellations	Multi-GNSS when available	GPS only
Elevation cut-off	3°	7°
Troposphere	VMF3_E1: 1997–2007; VMF3_OP: from 2008	VMF1

Repro2 Processing

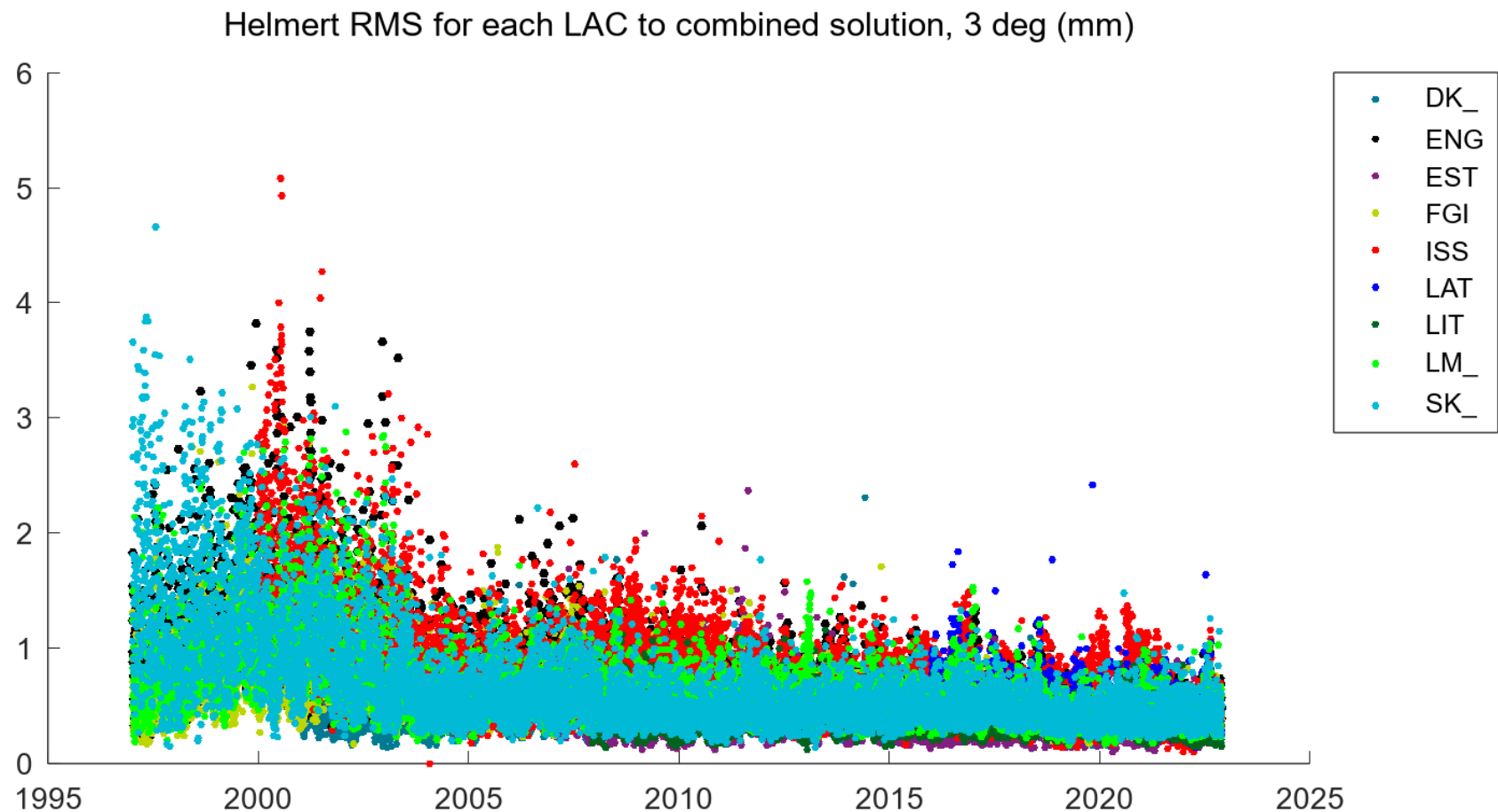
The NKG Repro2 combination is complete

- Reprocessed interval: 5 January 1997–26 November 2022
- Operational solutions extend the historical record
- Time-series analysis is underway

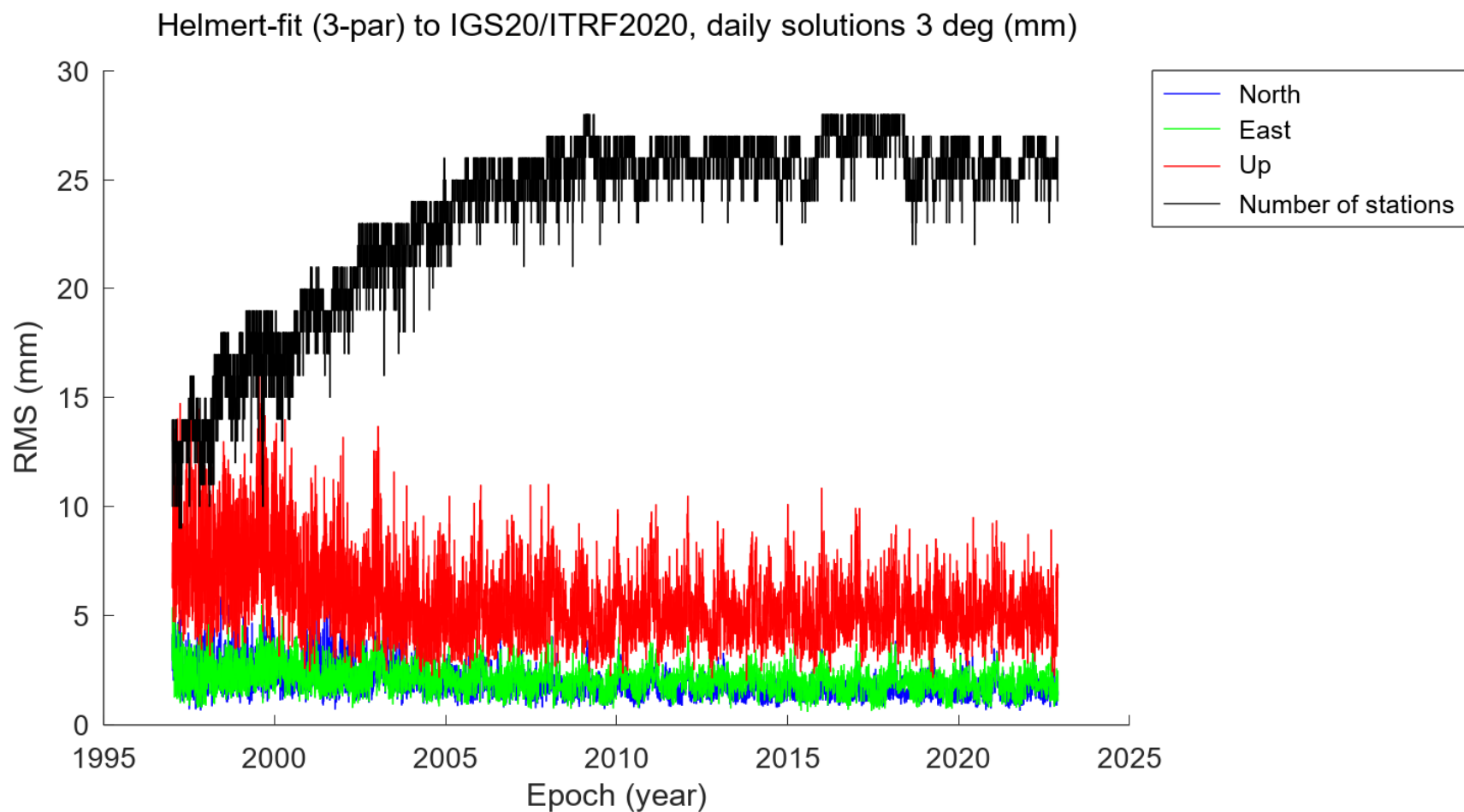
NETWORK COVERAGE	REPRO2	REPRO2 + OPERATIONAL
Total stations	439	459
Locations after grouping stations within 8 km*	375	390

*Distance-based grouping used to describe geographical coverage.

Repro2 Results: GPS weeks 887 - 2237



Repro2 Results: GPS weeks 887 - 2237



Progress and Next Steps

Progress

- Transition from Bernese 5.2 to 5.4, including extensive testing and adjustments
- Operational processing following EPN guidelines and NKG requirements
- Repro2 processing designed for consistency with EPN Repro3
- Additional BIFROST solutions produced
- Repro2 combination completed
- 50% of LACs have completed their Repro2 time-series analysis

Next

- BIFROST combination
- Complete remaining Repro2 time-series analysis: target autumn 2026