



Federal Agency for
Cartography and Geodesy



Status of EUREF Working Group “European Unified Height Reference”

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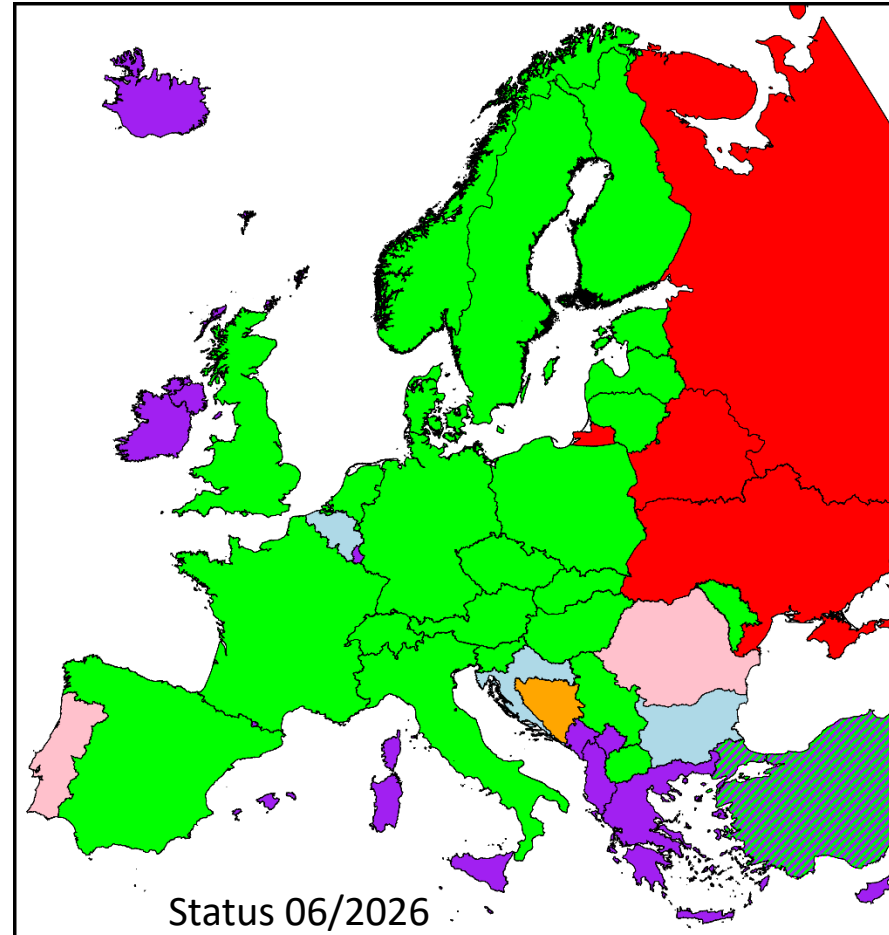
EUREF Symposium 2026, Paris, 23 – 25 June 2026

Working Group „European Unified Height Reference“

- Major goal is the development and provision of a height reference surface (fitted quasigeoid model)
 - to enable the transformation between current ETRS and EVRS realizations
 - thus facilitate GNSS-based height determination, e.g. across borders or for mapping (→ INSPIRE)
→ *European Height Reference Surface (EHRS)*
- This depends on an updated harmonized GNSS/levelling dataset
→ *European Height Reference Surface – Control Points (EHRS_CP)*
- Recently: Focus on the final preparations for the release of the first version
 - Initial or updated GNSS/levelling data received from a few more countries
 - Test computations based on the available gravimetric quasigeoid model EGG2015 (*Denker 2015*)
→ WG Online meeting 18 May 2026

Status of GNSS/levelling dataset (EHRS_CP)

- **HU:** Dataset added
- **CZ:** additional points
- **Serbia:** Constrained connection to EVRF2019 (Sep 2025)
- **DK, LV:** Final datasets (ETRF2020)
- **DE:** Updated GNSS coordinates
- **PT, RO:** New GNSS data but only national heights (transformation to EVRF2019 by grid)
- **BE, BG, HR:** EUVN-DA GNSS data retained, but with specific ETRFxx and epoch and with EVRF2019 heights assigned
- **First version of dataset now (almost) ready for publication process**



EHRS_CP

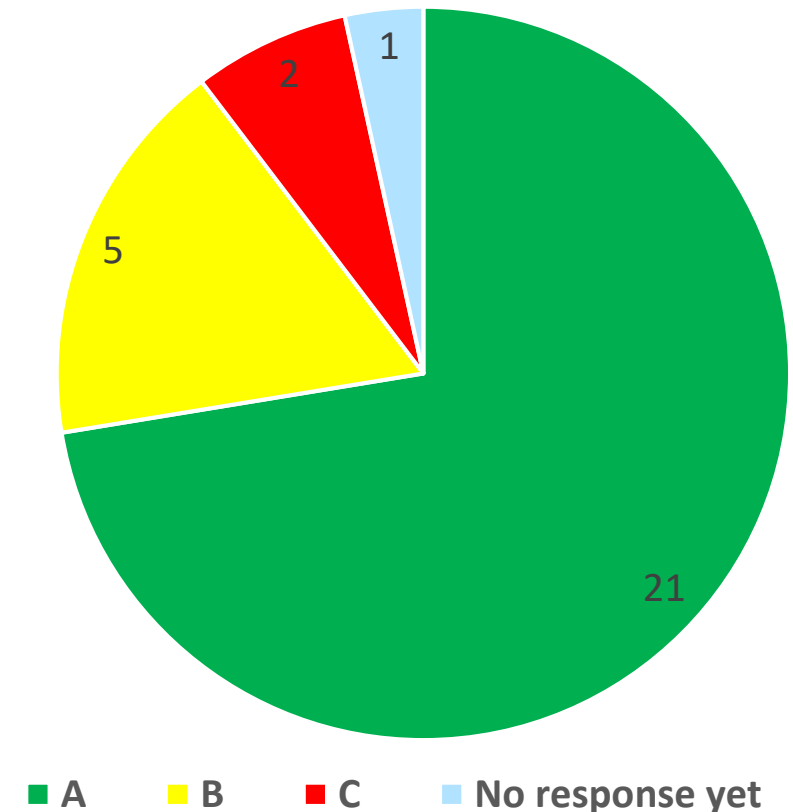
- Data received
- GNSS coordinates of EUVN-DA dataset retained, EVRF2019 heights assigned
- EVRF2019 heights computed by transformation
- EVRF2019 heights computed by offset
- Vertical reference undergoing revision (timeline unknown)
- Not in UELN
- Status unclear

The border of Kosovo is used without prejudice to positions on status and is in line with UNSC 1244 and the ICJ Opinion on the Kosovo declaration of independence.

Publication of EHRS_CP dataset

- Dataset now ready for finalization, documentation and publication
- Data licensing to be selected by country from three options (*see presentation at EUREF 2025*)
 - A. Make available on EVRS website with DOI as open data (CC-BY 4.0)
 - B. Make available by email after request to WG chair (yearly report of requests via EUREF Newsletter)
Terms of use: non-commercial use only, no further distribution, attribution
 - C. No publication
(possibly direct application to national point of contact)

Turnout
(as of 9 June 2026)



Homogenization of national reference frames to ETRF2020

1) Continental Europe (incl. GB) except nordic countries

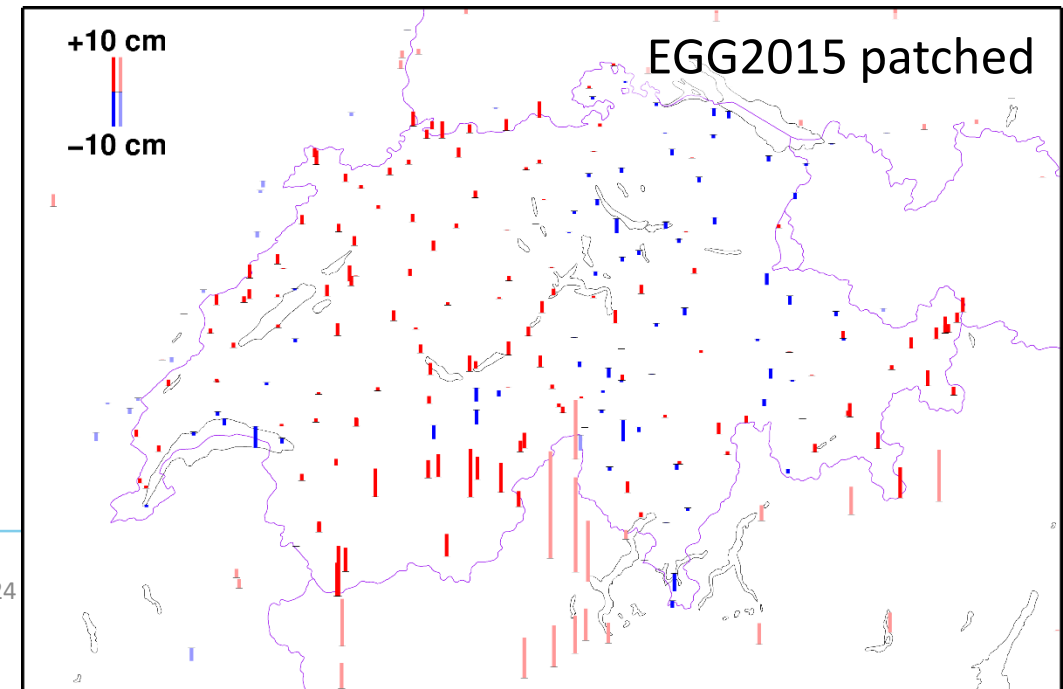
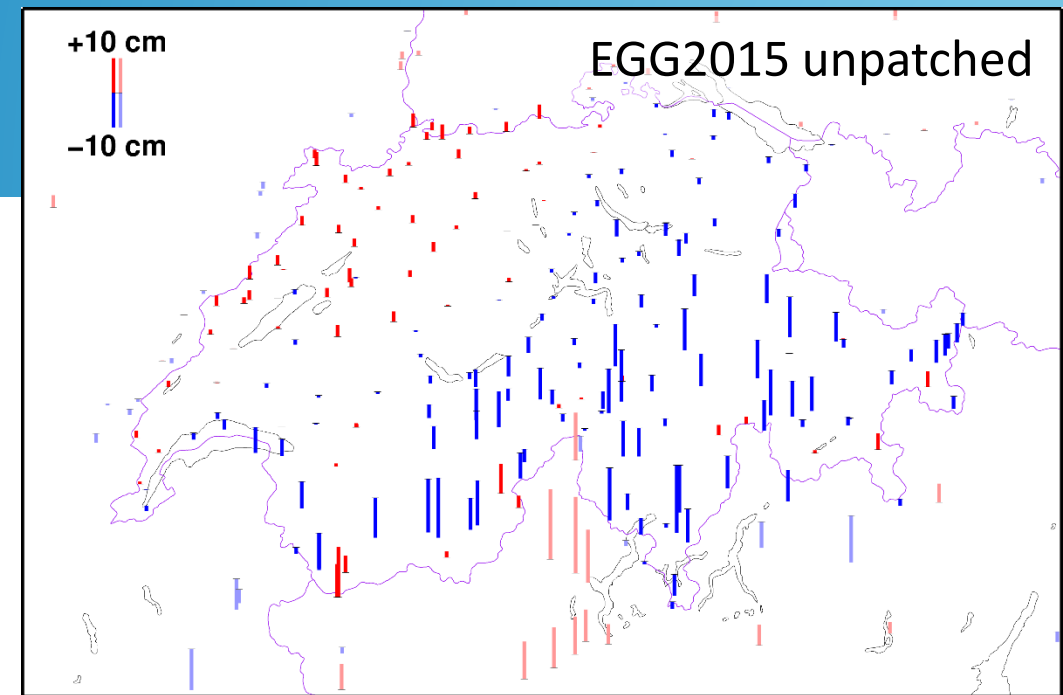
- Transformation from specified ETRFxx (epoch yyyy) to ETRF2020 (epoch yyyy) according to **EUREF Technical Note 1**
- National transformation parameters to ETRFxx, if applicable (e.g. DE)
- No reduction to common epoch with velocity model (since also not used in EVRF2019)
- Conversion of coordinates to zero-tide = mean-tide

2) Nordic countries

- **NKG Transformation 2008 or 2020** (depending on countries' recommendations)
 - National epoch to 2000 via NKG Transformation velocity model (*)
 - National parameters from national frame to ETRF2000 resp. ETRF2014 valid for epoch 2000 (**)
 - Transformation from ETRF2000 resp. ETRF2014 to ETRF2020 according to EUREF Technical Note 1
- Conversion of GNSS coordinates to zero-tide convention
- (*) *This is consistent with EVRF2019, which uses the same epoch and velocity model like NKG Transformation 2020*
- (**) *DK and LV provided newer data in ETRF2020 → Application of NKG Transformation 2020 modified accordingly*

Patching EGG2015 with simulated RTM harmonic correction

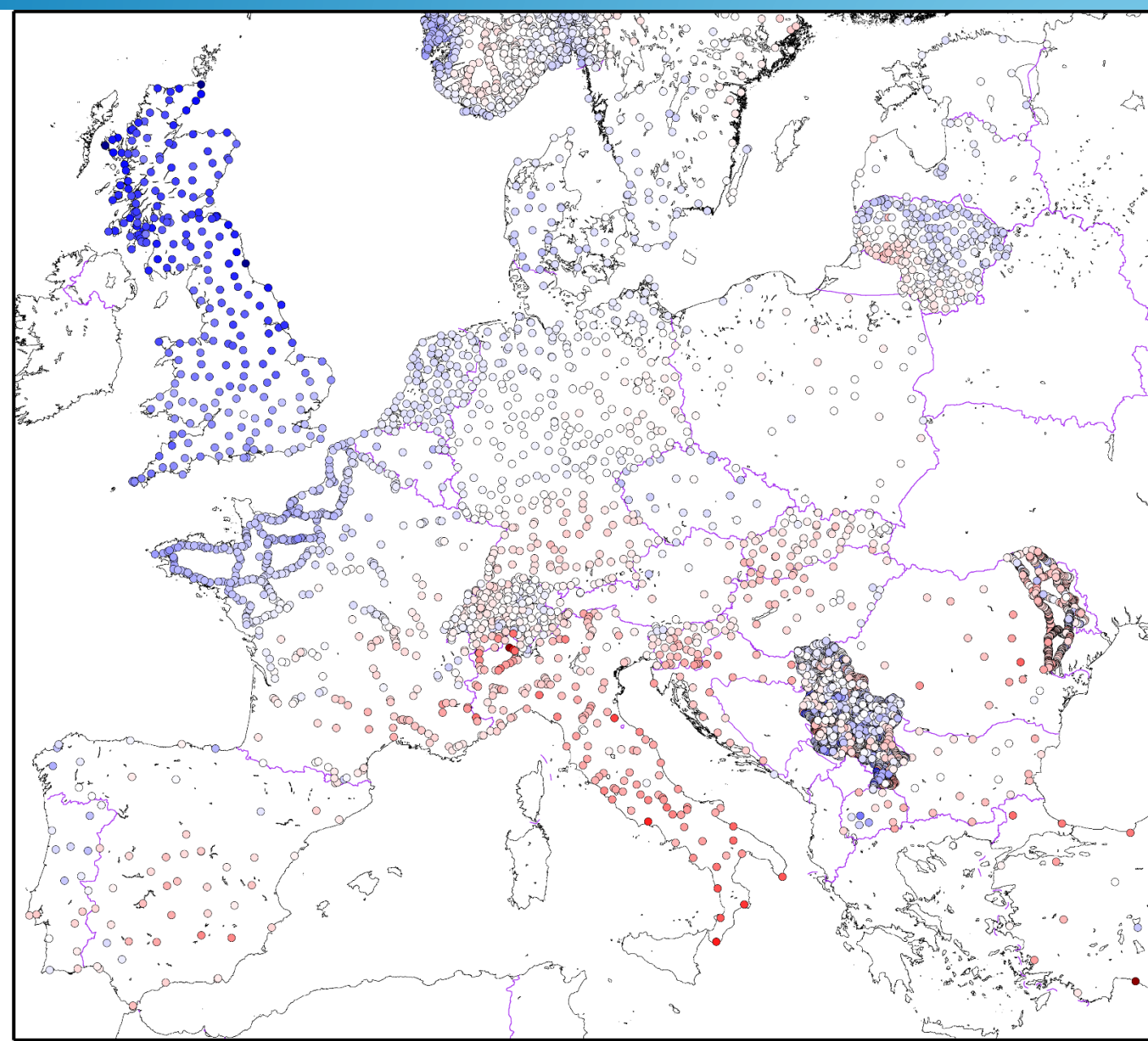
- EGG2015 uses RTM concept, but does not apply a harmonic correction for the potential
- Studies in the Alps have shown the HC to be significant (up to 20 cm)
see [Schwabe et al. \(2024\), J Geod](#) or slides of [EUREF2025](#)
- Original RTM data of the EGG2015 in order to compute a fully consistent patch are currently not available
- An experimental patch, based on a simulation of the HC with the EuroDEM, was tried with success
→ proposed use for EHRS
 - **CH** Reduction of SD from 5.0 cm to 2.8 cm
 - **SI, FR, IT, HR, MK** Slight improvements
 - **Elsewhere** no significant impact



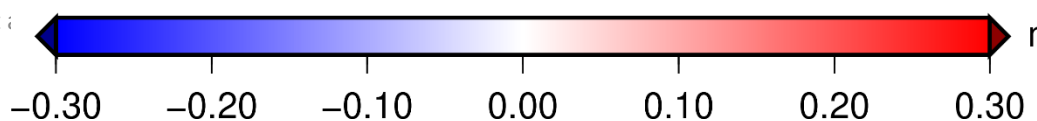
Some statistics vs. EGG2015 (HC)

Europe except nordic countries

- Currently only 12 obvious outliers removed in the numbers and figures presented on the next slides
- Larger variations in
 - Turkey
 - Parts of Italy
 - Moldova
 - North Macedonia
 - Serbia* (*update foreseen, see talk by Jonas Ågren*)
 - Romania
- Could be both outliers or residual geoid signal due to limitations of input gravity data in EGG2015



Schwabe et al.



The border of Kosovo is used without prejudice to positions on status and is in line with UNSC 1244 and the ICJ Opinion on the Kosovo declaration of independence.

Some statistics vs. EGG2015 (patched for harmonic correction)

Europe except nordic countries

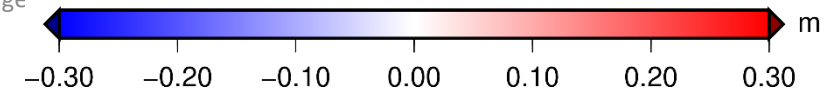
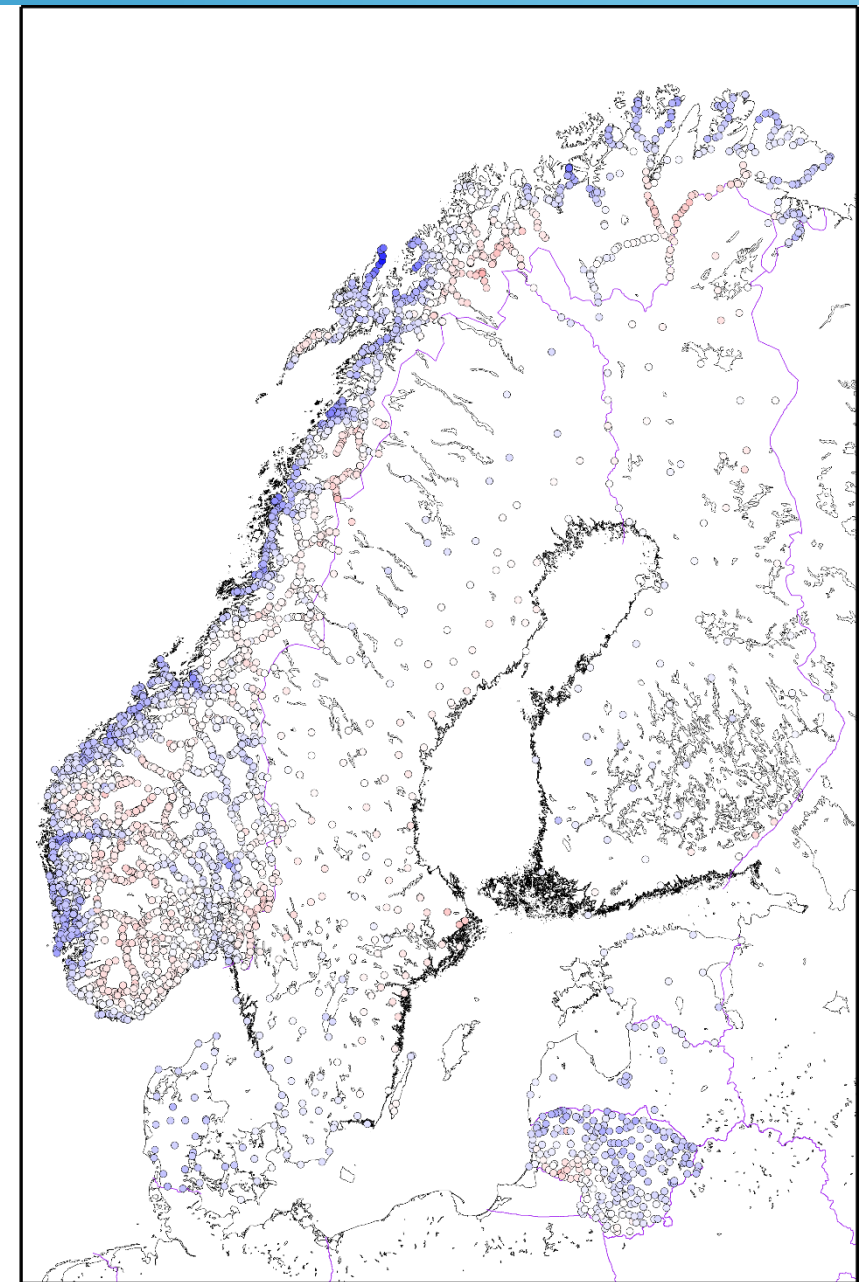
CC	No.	1-par SD	1-par 95%	3-par SD	3-par 95%
AT	20	3.5	7.4	3.4	7.3
BE	9	2.5	4.2	2.3	4.2
BG	19	3.2	4.8	2.9	4.4
CH	209	2.8	5.6	2.7	5.5
CZ	22	2.2	3.8	1.9	3.1
DE	306	2.2	4.3	1.4	2.6
ES	53	4.9	11.0	3.9	7.7
FR	463	4.7	9.7	2.4	4.9
GB	242	6.0	11.6	3.7	7.2
HR	20	3.5	4.2	2.9	5.8
HU	32	3.5	7.4	2.4	4.5

CC	No.	1-par SD	1-par 95%	3-par SD	3-par 95%
IT	148	5.9	12.0	5.2	9.9
MD	405	4.3	8.2	4.2	8.1
MK	13	8.0	16.1	6.9	12.4
NL	82	0.9	1.6	0.8	1.2
PL	38	1.5	2.8	1.5	2.8
PT	16	4.8	7.3	3.8	5.6
RO	18	5.1	8.5	4.9	9.6
RS	1986	5.4	11.4	5.4	11.4
SI	46	3.7	6.9	2.3	4.8
SK	63	2.3	4.2	1.9	4.2
TR	12	11.1	20.7	11.0	21.3

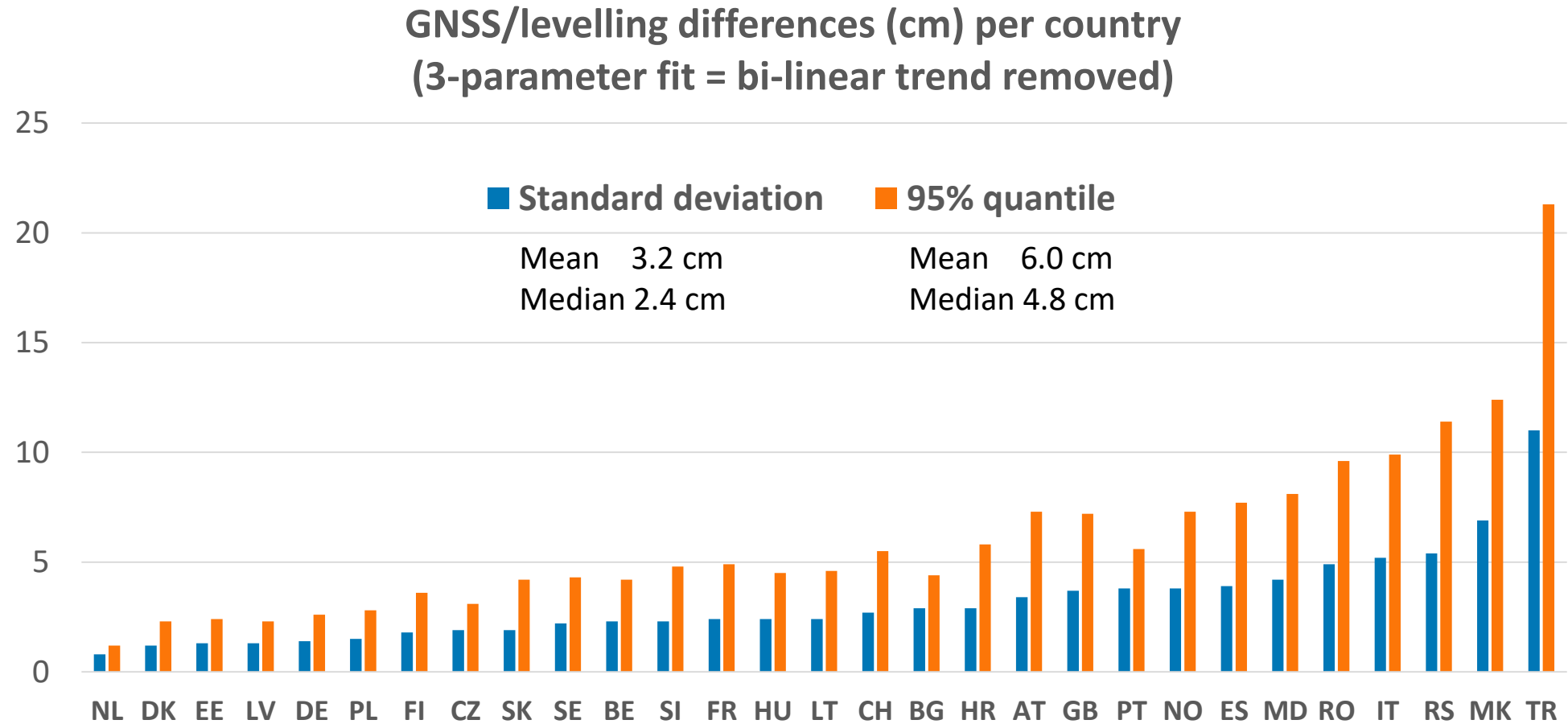
Some statistics vs. EGG2015 (patched for HC) Nordic countries (using NKG Transformation)

CC	No.	1-par SD	1-par 95%	3-par SD	3-par 95%
DK	37	1.9	3.6	1.2	2.3
EE	11	1.4	2.4	1.3	2.4
FI	74	2.1	4.2	1.8	3.6
LT	243	3.3	6.4	2.4	4.6
LV	18	1.7	2.9	1.3	2.3
NO	3222	4.1	8.3	3.8	7.3
SE	185	2.3	4.6	2.2	4.3

Comparison with quasigeoid models NKG2015 and FAMOS (2023) even better, especially in Norway (ca. 25%)
(*not shown here*)



Summary statistics of GNSS/levelling differences



Test computations of corrector surface with EHRS_CP dataset

Contribution of S. Varbla (TalTech, now TUM)

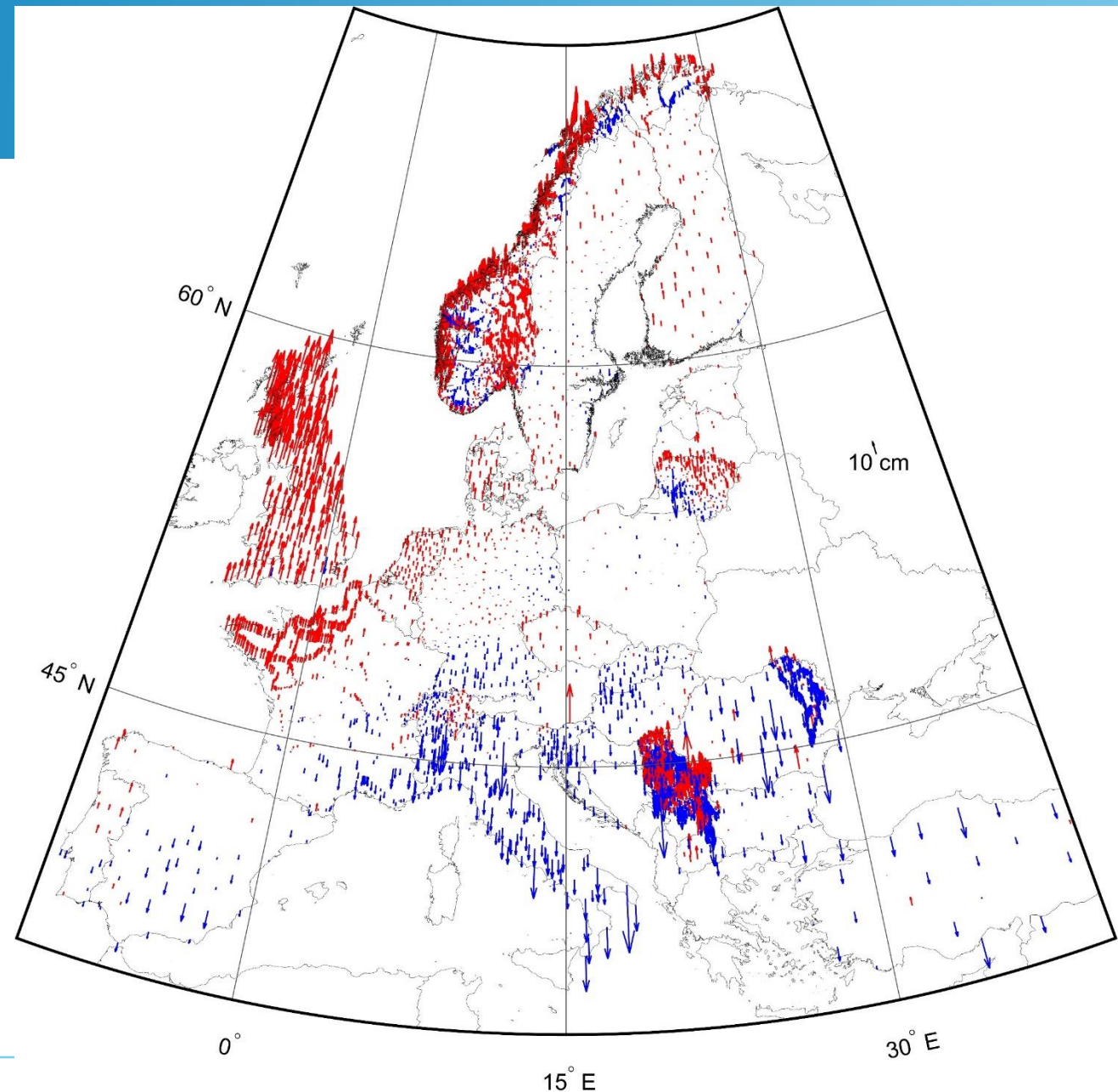
Based on:

Preliminary GNSS/levelling dataset
(status **04/2026**)

EGG2015 quasigeoid model (**patched for HC**)

Updated approach using
2nd-order Gauss Markov interpolation with
locally adapted covariance model

GNSS/levelling – quasigeoid differences ►
(no outliers removed here for testing purposes)



Schwabe et al.: Status of

Test computations of corrector surface with EHRS_CP dataset

Contribution of S. Varbla (TalTech, now TUM)

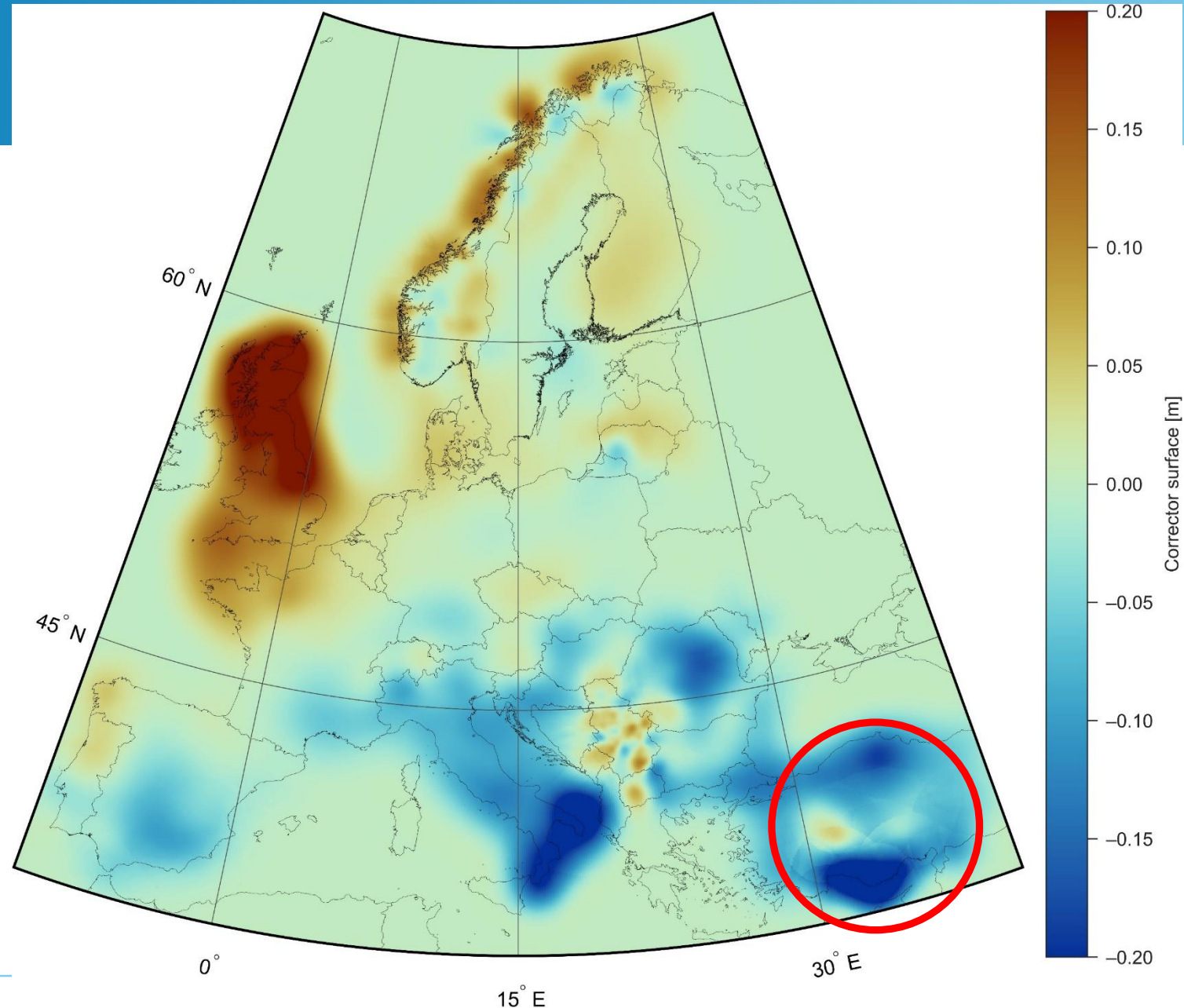
Based on:

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Corrector surface ►



Schwab

Test computations of corrector surface with EHRS_CP dataset

Contribution of S. Varbla (TalTech, now TUM)

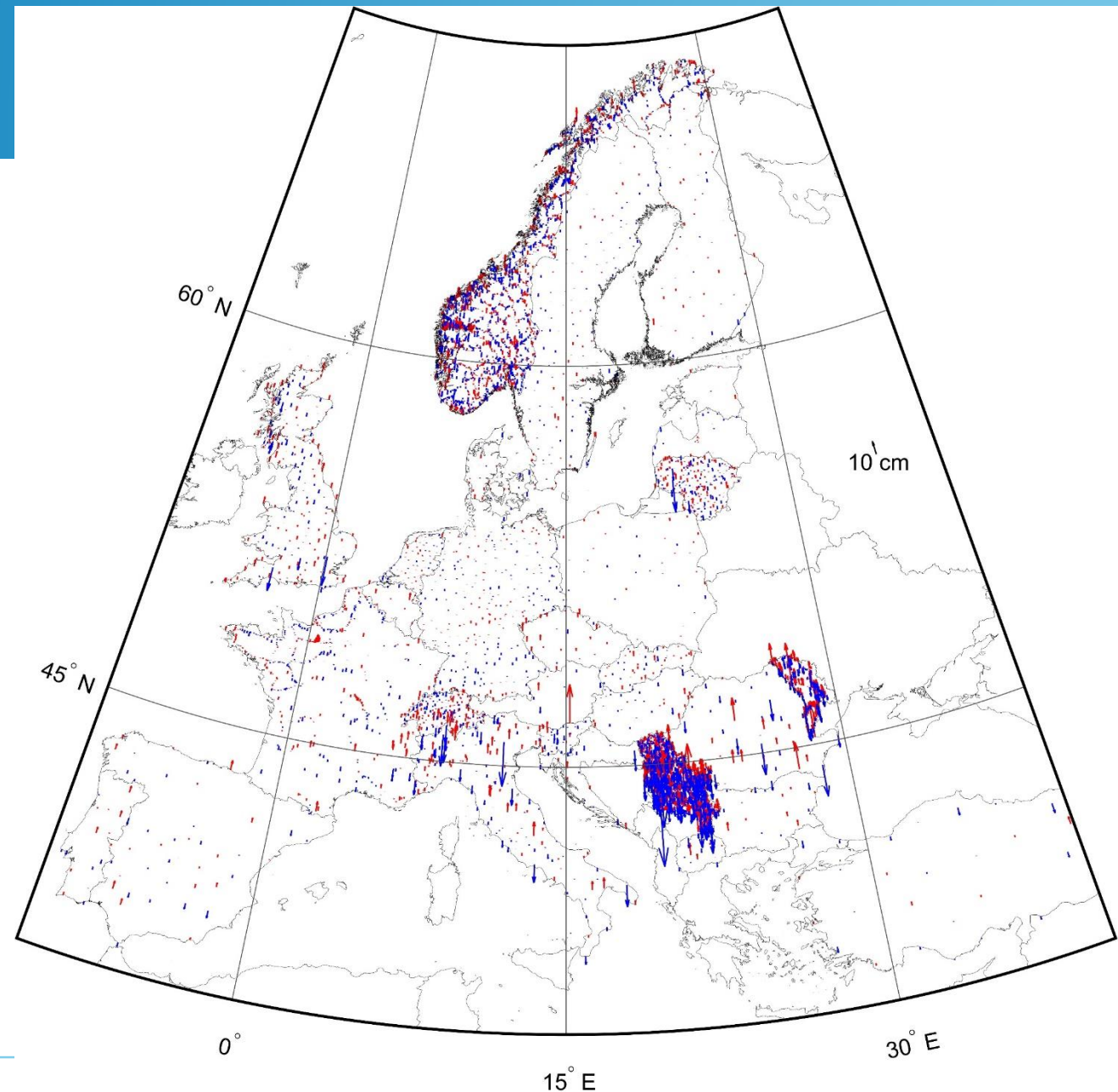
Based on:

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Residuals of corrector surface (SD 3 cm) ►
(no outliers removed here for testing purposes)



Schwabe et al.: Status of

Summary

- EHRF_CP GNSS/levelling dataset (almost) ready for publication process (*update from Serbia?*)
- Provides basis to compute EVRS height reference surface for GNSS-based height determination across borders with RTK accuracy (i.e., a few centimeters standard deviation) → *INSPIRE*
 - In a few countries, accuracy is limited to ca. 5 cm due to noisy GNSS/levelling data or limitations of the current European gravimetric quasigeoid model
- Valuable also for scientific studies (validation of global geopotential models or regional models)

Next steps

- Finalization of GNSS/levelling dataset and of EHRF corrector surface
- New goal for release: EUREF Newsletter (December 2026)

Outlook

- New EVRF version in 2027/2028 → *see talk by Tobias Bauer*
- Groundwork for new European gravimetric quasigeoid model (earliest ~2030) → *EUREF Resolution 2025/2*



Federal Agency for
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Thank you for your kind attention!

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