GFZ
Helmholtz Centre
POTSDAM

HELMHOLTZ
RESEARCH FOR GRAND CHALLENGES

AN UPDATE OF GFZ'S CONTRIBUTION TO EUREF

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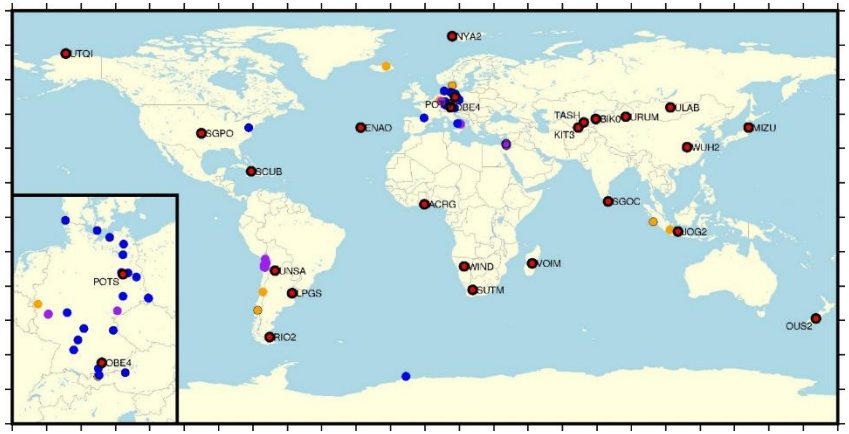
GNSS activities at GFZ

- Station network
  - 25 stations with global coverage (IGS contribution)
  - 75+ for specific purpose (e.g., tectonics, troposphere …)
  - Hardware development (tinyBlack receiver)
- Analysis centre of the International GNSS Service: operation product lines, MGEX, contribution to reprocessing
- EPOS.P8, gfzrnx

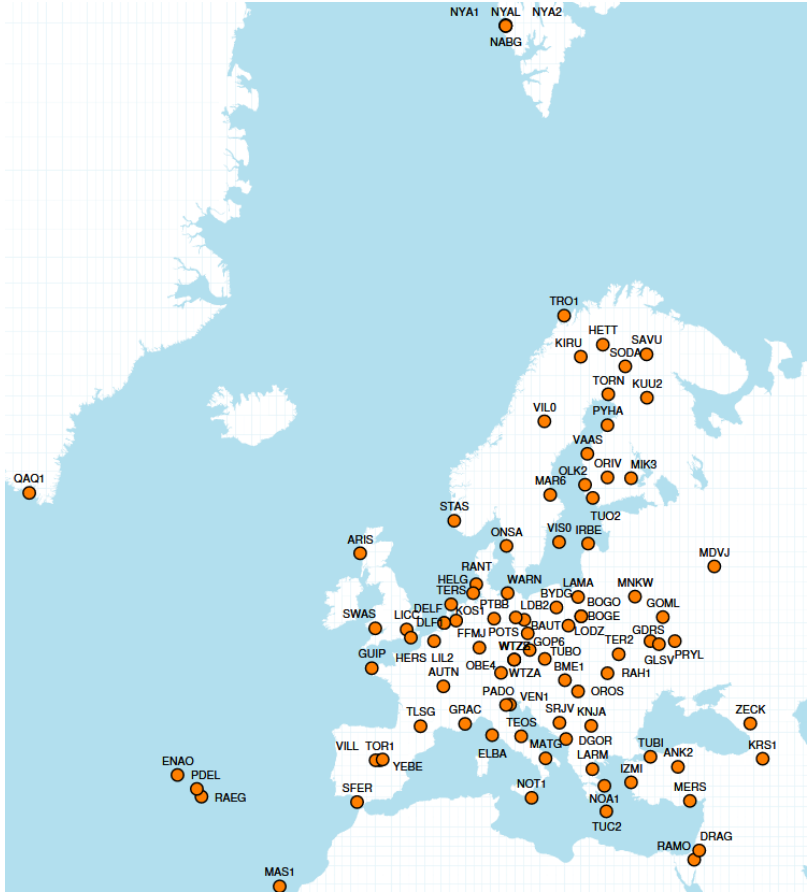


Product	Ultra-rapid line	Rapid line	Final line	MGEX	Repro3
Availability	every 6h	daily	weekly	daily	reprocessing
Systems	GRE	GRE	GR	GRECJ	GRE
Satellite orbits	x	x	x	x	x
Satellite clock corrections		x	x	x	x
Station coordinates			x		x

More information

gnss.gfz-potsdam.de

Stations selected for GFZ's AC contribution



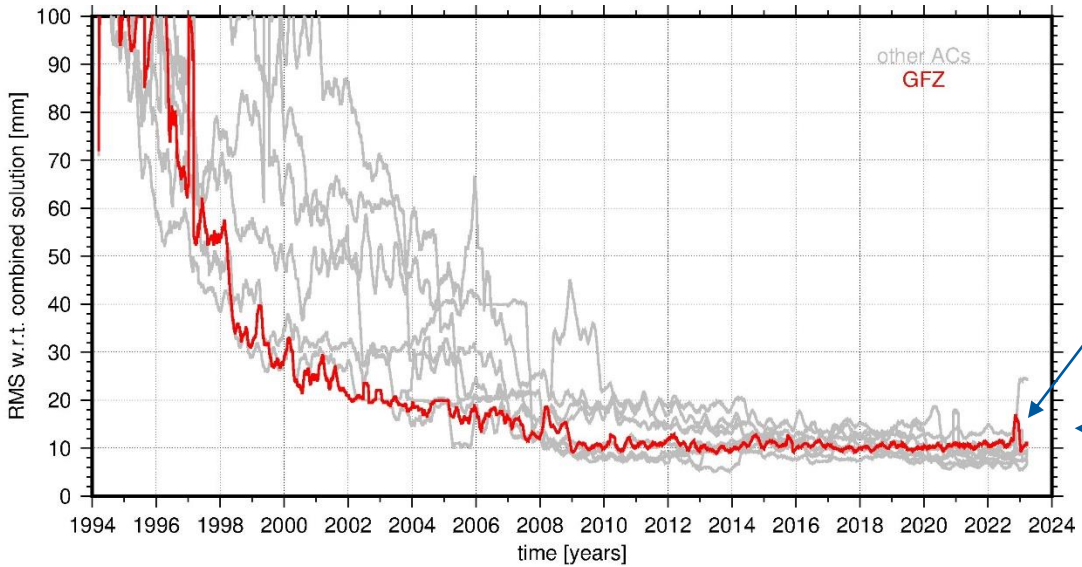
- Station recommendation provided by T. Liwosz
- Considerations:
  - number of EPN ACs presently processing each station
  - number of EPN ACs which are going to process the station in EPN repro3 project
  - Stations included in the IGS20 solution
  - stations included in GFZ's IGS solution
  - stations operated by GFZ

Processing strategy

Observations	Ionosphere-free linear combination formed by undifferenced GPS, GLONASS, Galileo observations; 300s sampling rate (30s for pre-cleaning); 3° elevation cutoff-angle, elevation-dependent weighting applied
Modelling	➢ GFZ orbit & clock products (operational, repro3) ➢ GPT2 meteo values mapped with VMF3 (Landskron & Böhm et al. 2018) ➢ Second-order ionospheric correction applied ➢ EPN20 antex (type-mean) & IGS20 reference frame ➢ Gravity field: GOCO6s (Kvas et al., 2019) ➢ Ocean tides: FES2014b (Carrere et al. 2016) ➢ HF-EOP: Desai-Sibois model (Desai and Sibois 2016) ➢ Mean pole tide according to IERS 2018
Ambiguities	Resolved for GPS and Galileo
Estimated parameters	Station coordinates (minimum constraint w.r.t. IGS20), 1h troposphere delay (no re-computation for weekly solution) and 24h gradients, receiver clocks
Software	EPOS.P8, metadata management via semisys.gfz-potsdam.de

Orbit and clock products

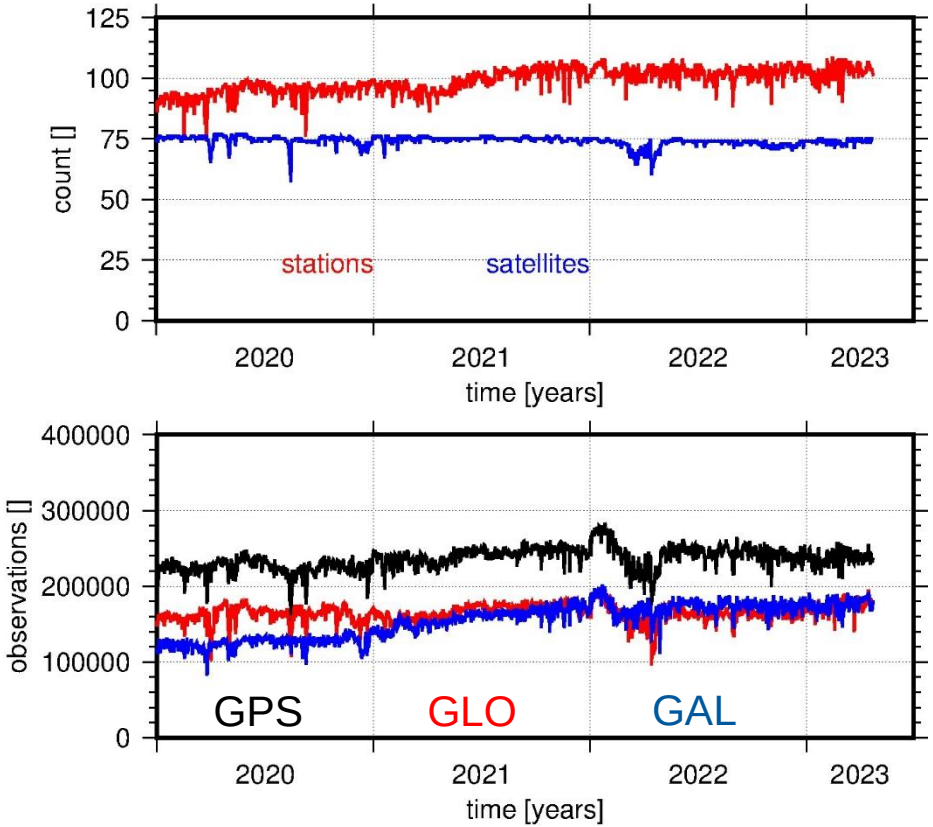
- GFZ final products (since week 2238 GPS, GLONASS, Galileo)
- GFZ repro3 products (GLONASS since 2012, Galileo since 2014; extended until week 2237)
- Orbits & clock products computed with same software (EPOS.P8)



Inconsistency in ocean tide model, products are re-computed and re-submitted

RMS of ~ 10mm w.r.t. combined solution

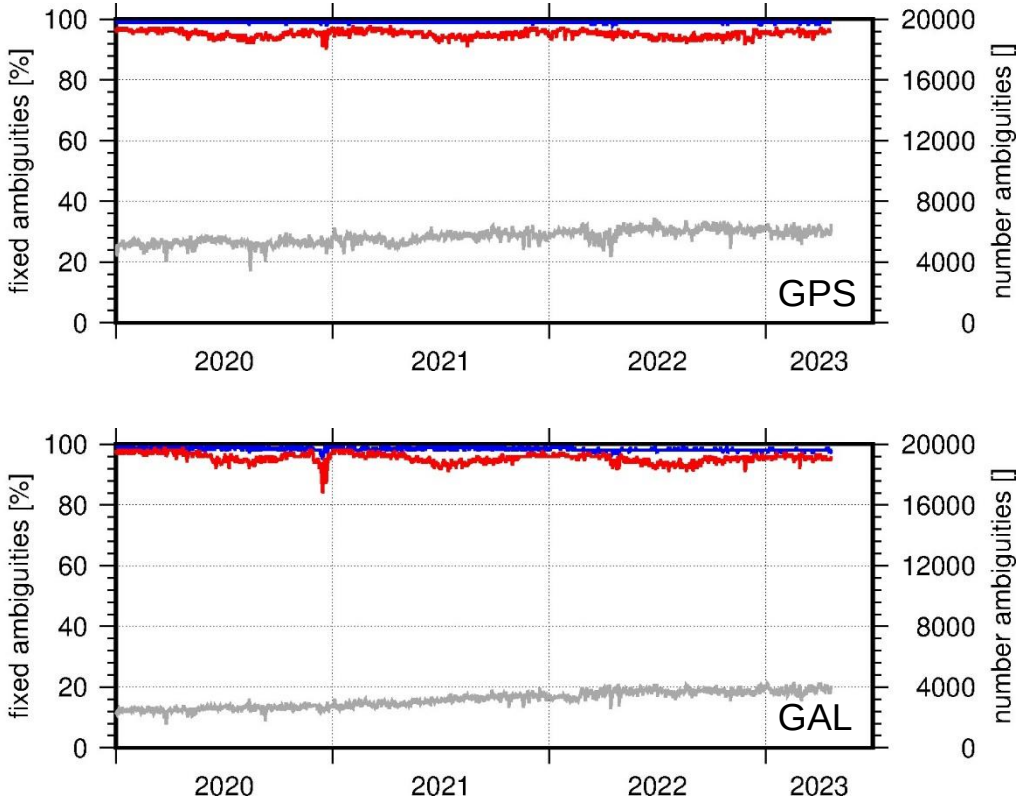
Stations and satellites



For testing purpose the operational configuration was used to process 2020-2023

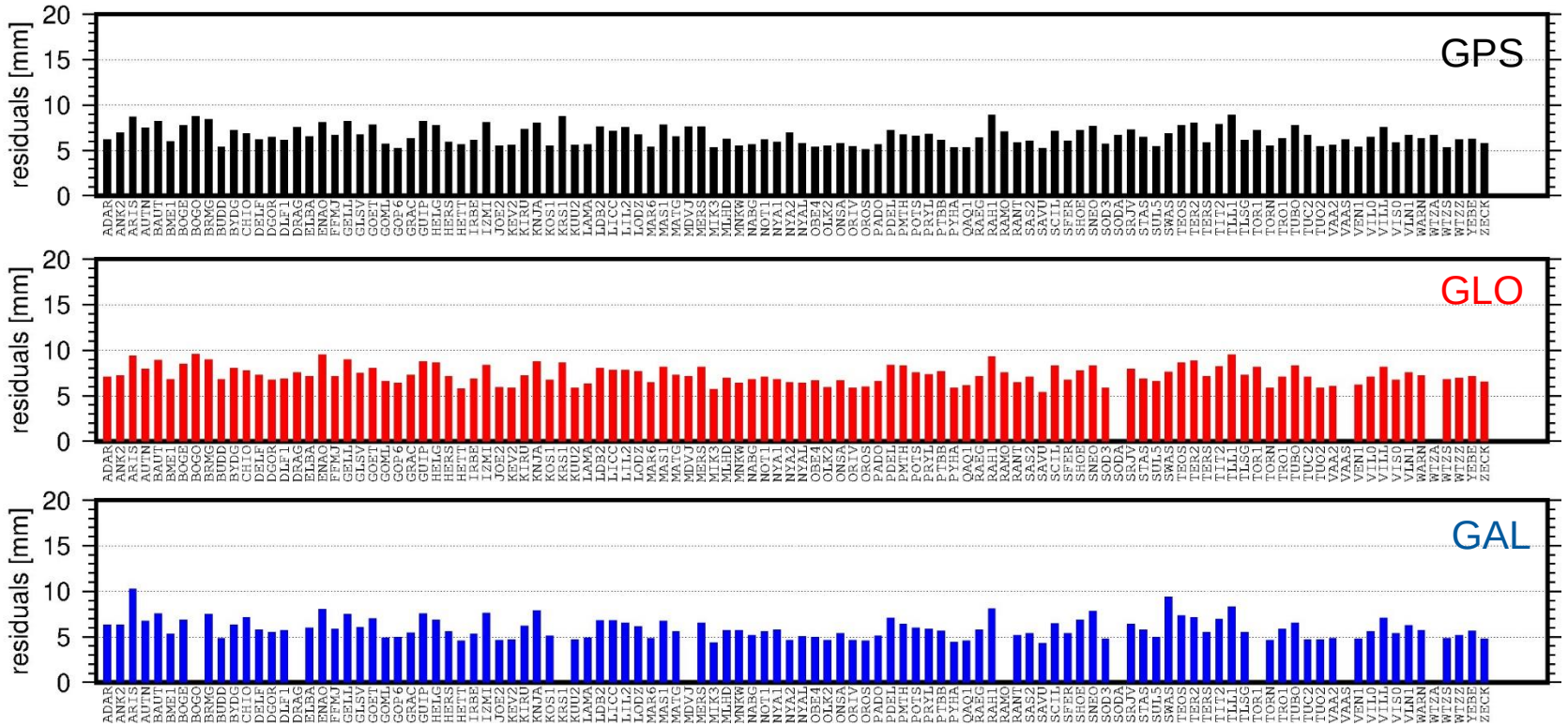
- Between 90 and 110 stations per day contained, mostly 75 satellites
- Satellite drop in 2022 needs further checks (not related to single constellation)
- Number of observations reflects increase in station number
- Variations in 2022 need some further investigations

Ambiguity resolution

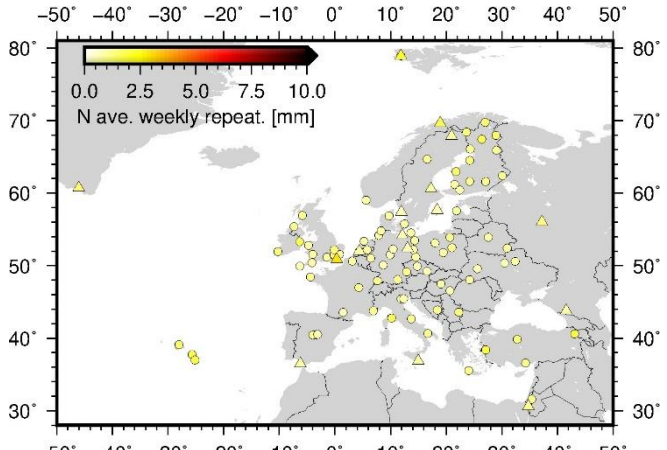


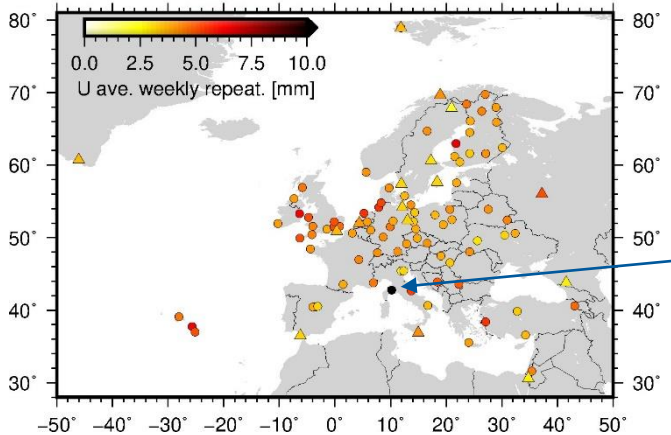
- Ambiguities (grey) and ratio of fixed widelane (blue) and narrowlane (red) ambiguities
- GPS: always > 95% except few days end of 2020
- Galileo: always > 95% except few days end of 2020
- Time dependency in ratio of fixed narrowlane ambiguities

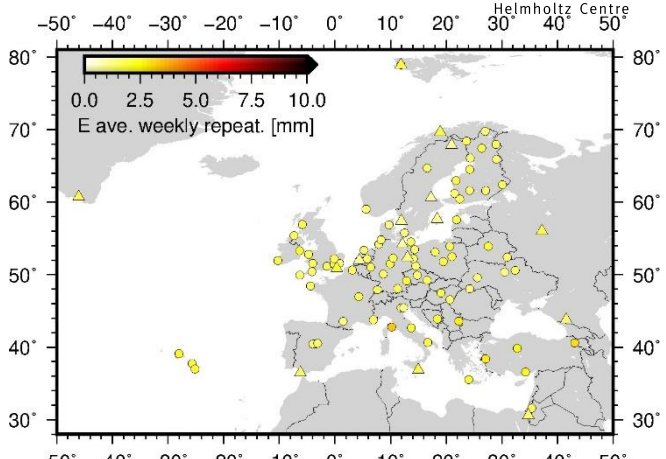
Observation residuals (w2238 – 2259)

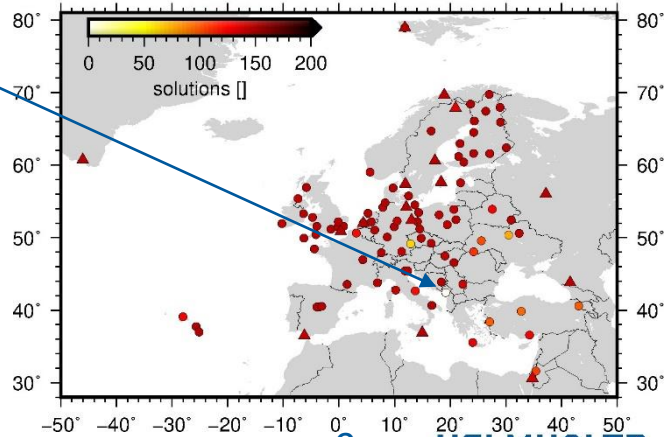


Coordinate repeatabilities (w2238 – 2259)





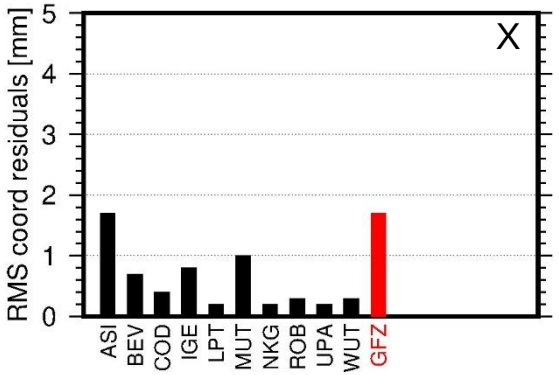


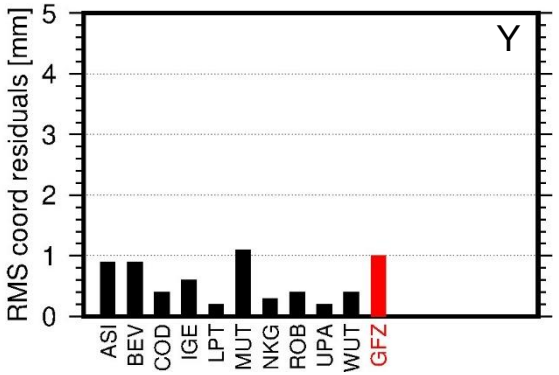


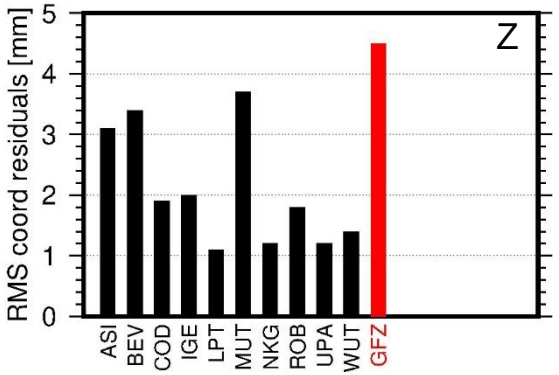
DGOR: automatically excluded for most days (to be checked)

ELBA: significant variations in the up component

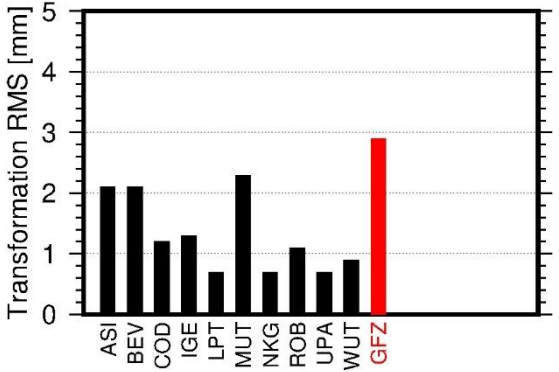
Preliminary combination I (w2244 – 2245)



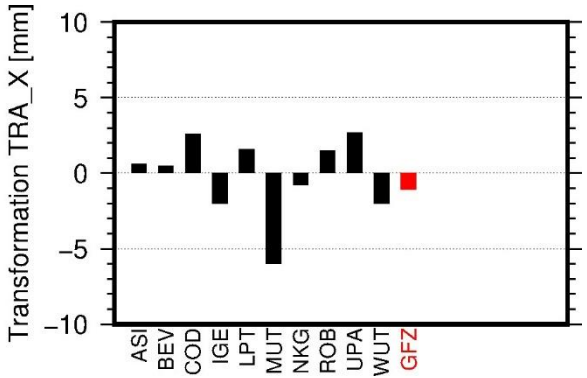


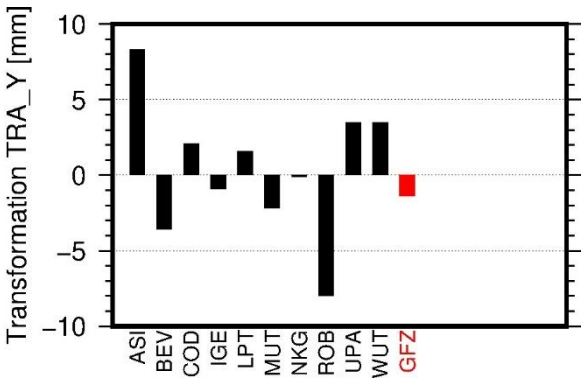


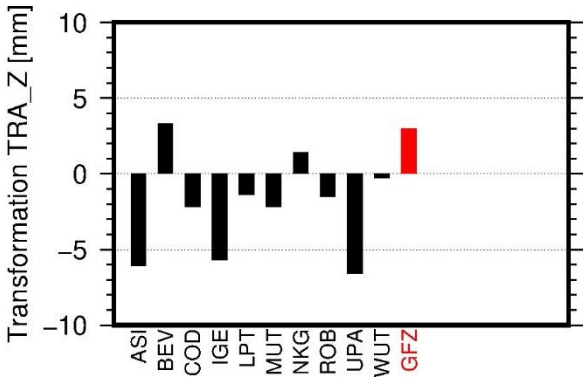
- Unweighted RMSs of station position residuals computed with respect to each contributing AC solution
- Larger values for AC not using Bernese (ASI, MUT)
- RMS of Helmert transformation parameters between each AC solution and the final combined solution.



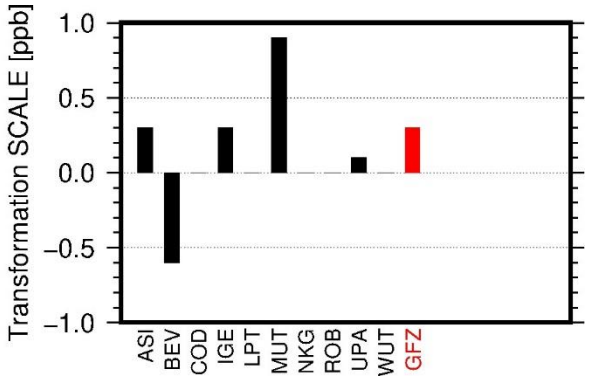
Preliminary combination II (w2244 – 2245)



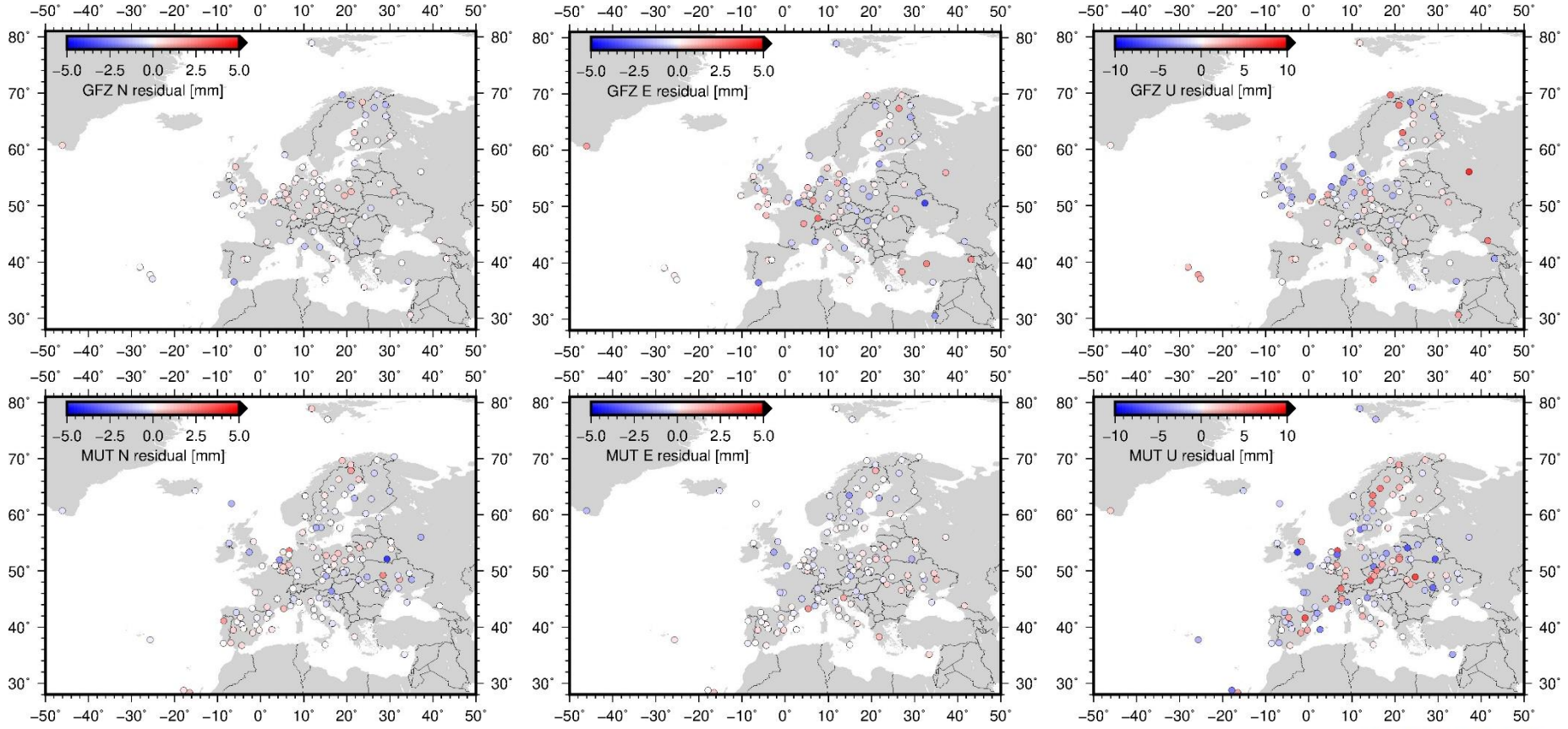




- Helmert transformation parameters between each AC solution and the final combined solution (parameters were determined using all stations)



Preliminary combination III (w2244 – 2245)



Summary

- GFZ will join EUREF as AC with final products, processing up to 114 stations
- Processing based on an additional software package (EPOS.P8)
- Still some minor updates needed to follow analysis guidelines (e.g., 180s sampling rate, apriori delays from VMF3, troposphere re-computation in weekly solution)

- GFZ will participate also in the EPN Repro3 using the same station network

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