EPN Repro2: A Reference Tropospheric Dataset over Europe

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and the EPN Repro2 team

Outline

- EPN Repro2 Campaign (1996-2013 with extension to 2014)
  - Features of the delivered solutions
- Homogeneously reprocessed long-term tropo products
  - Preliminary & Final Combined ZTD Solution
  - Horizontal Gradient Evaluation
- EPN Repro2 end-user
- Summary

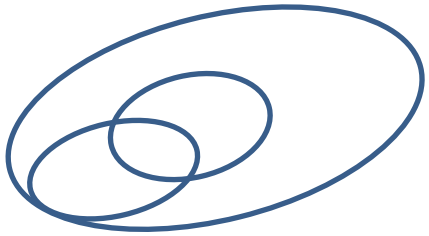
GNSS Solutions: SW & Network coverage

- **5 ACs**: ASI GOP IGE LPT MUT
- **5 (+3)** input solutions available
- Tropospheric Parameters: **ZTDs & Gradients**

5 (+3) Solutions

- ASI (GIPSY, Full EPN)
- GOP (Bernese, Full EPN)
- LPT (Bernese, EPN sub-net)
- IGE (Bernese, EPN sub-net)
- MUT (GAMIT, Full EPN)

- **Different software**
- **Different networks**



3 Bernese Solutions

- GOP (Full EPN network)
- LPT (EPN Sub-network)
- IGE (EPN Sub-network)

- **Same software**
- **Different networks**

3 Solutions (Full EPN)

- ASI (GIPSY)
- GOP (Bernese)
- MUT (GAMIT)

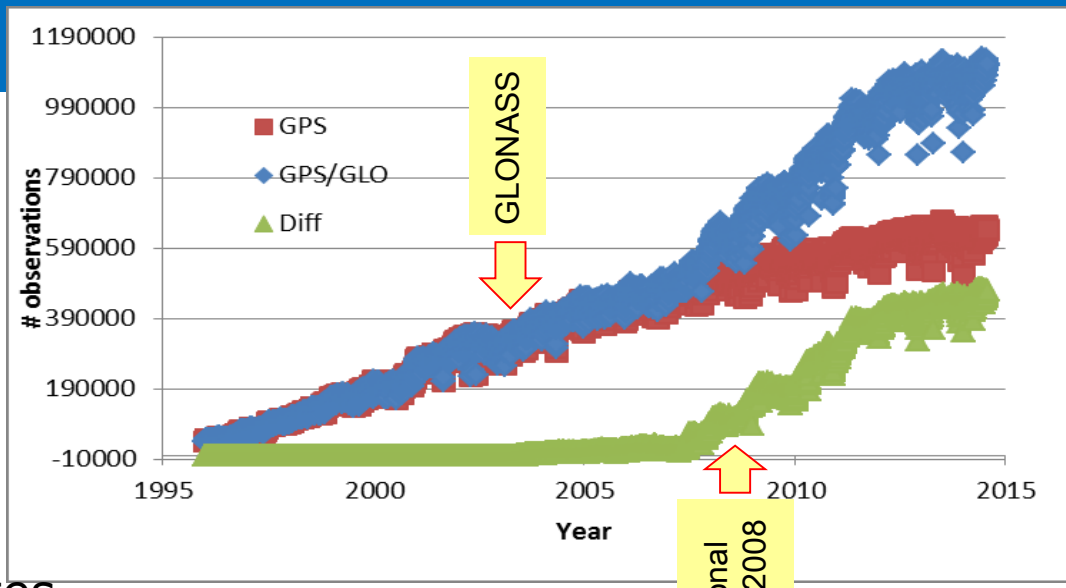
- **Different software**
- **Same network**

Features of the solutions

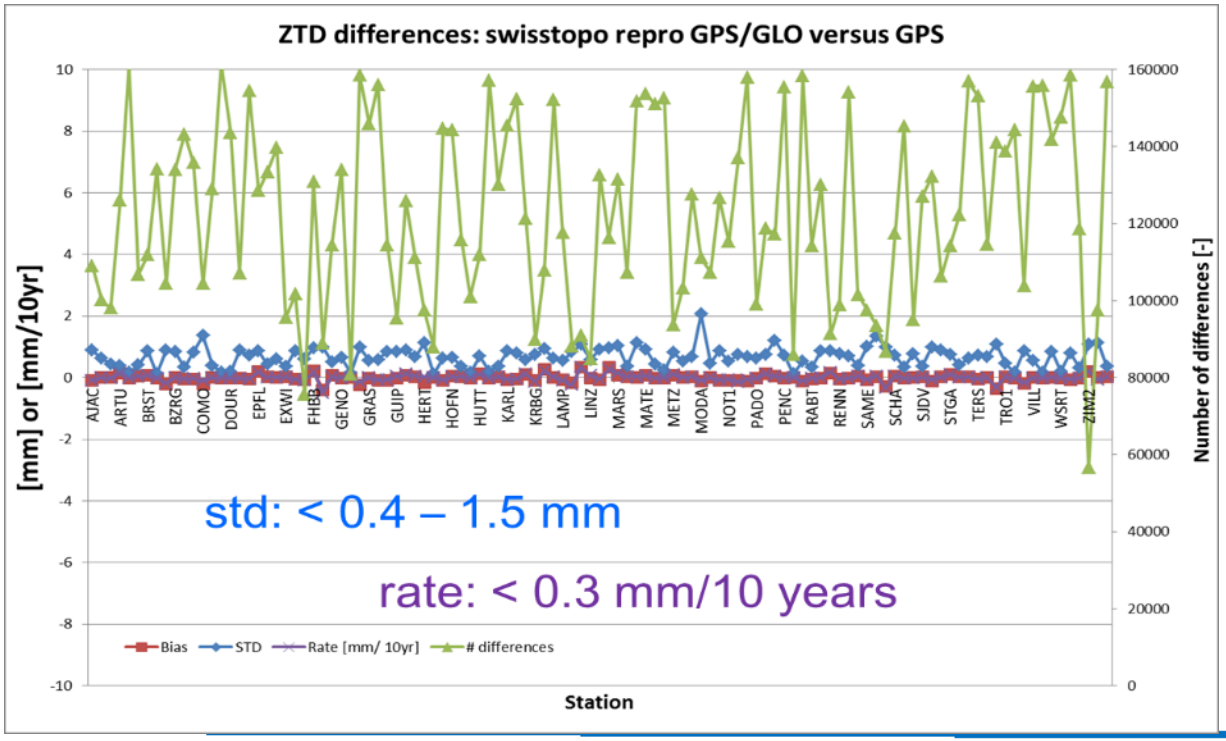
- **GLONASS**
  - available since 2003, very few stations at the beginning
  - only used LPT and IGE solutions
- Different PCV corrections used: **'type mean'** & **'type mean + individual'**
- Non Tidal Atmospheric Loading: **Yes/No**
- **Orbits**
  - CODE reprocessed: IGE, GOP, LPT, MUT
  - JPL reprocessed: ASI
- Different MF used: **GMF** & **VMF1**

Impact of GLONASS

LPT processing, Courtesy E. Brockmann



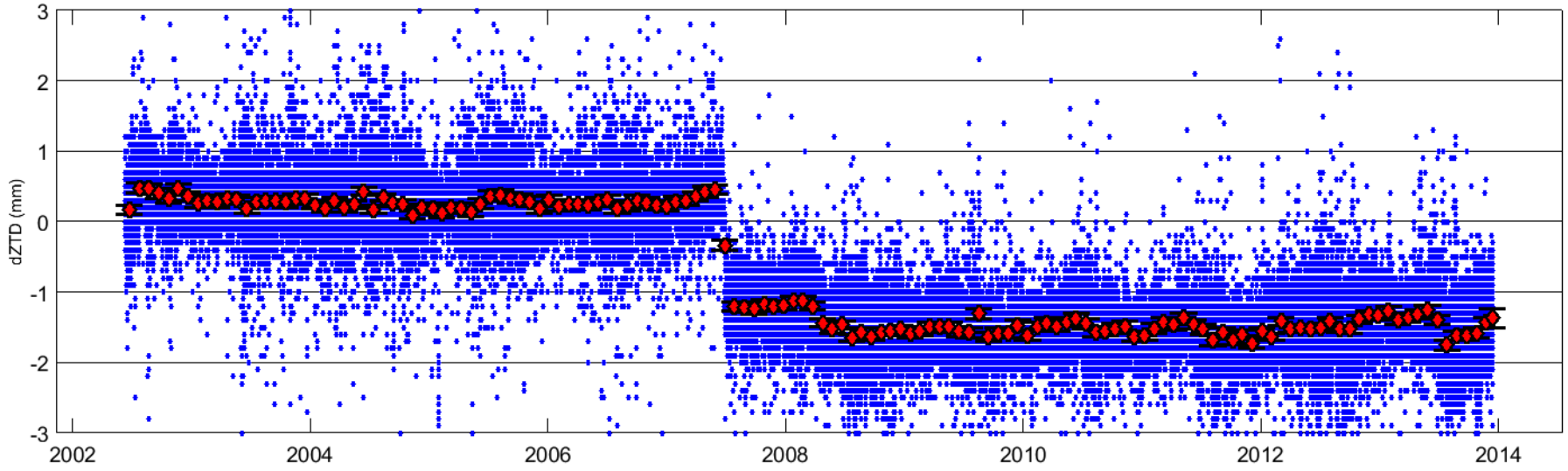
ZTD trend computed over 111 sites



Individual versus Mean Type calibration

KLOP00DEU (KLOP): differences between 'individual' & 'type mean' calibration

PERIOD	Diff . Up	Diff. ZTD	Antenna + Radome	
2007-06-27 : 2013-06-28	8.7 mm	- 1.3 mm	TRM55971.00	TZGD

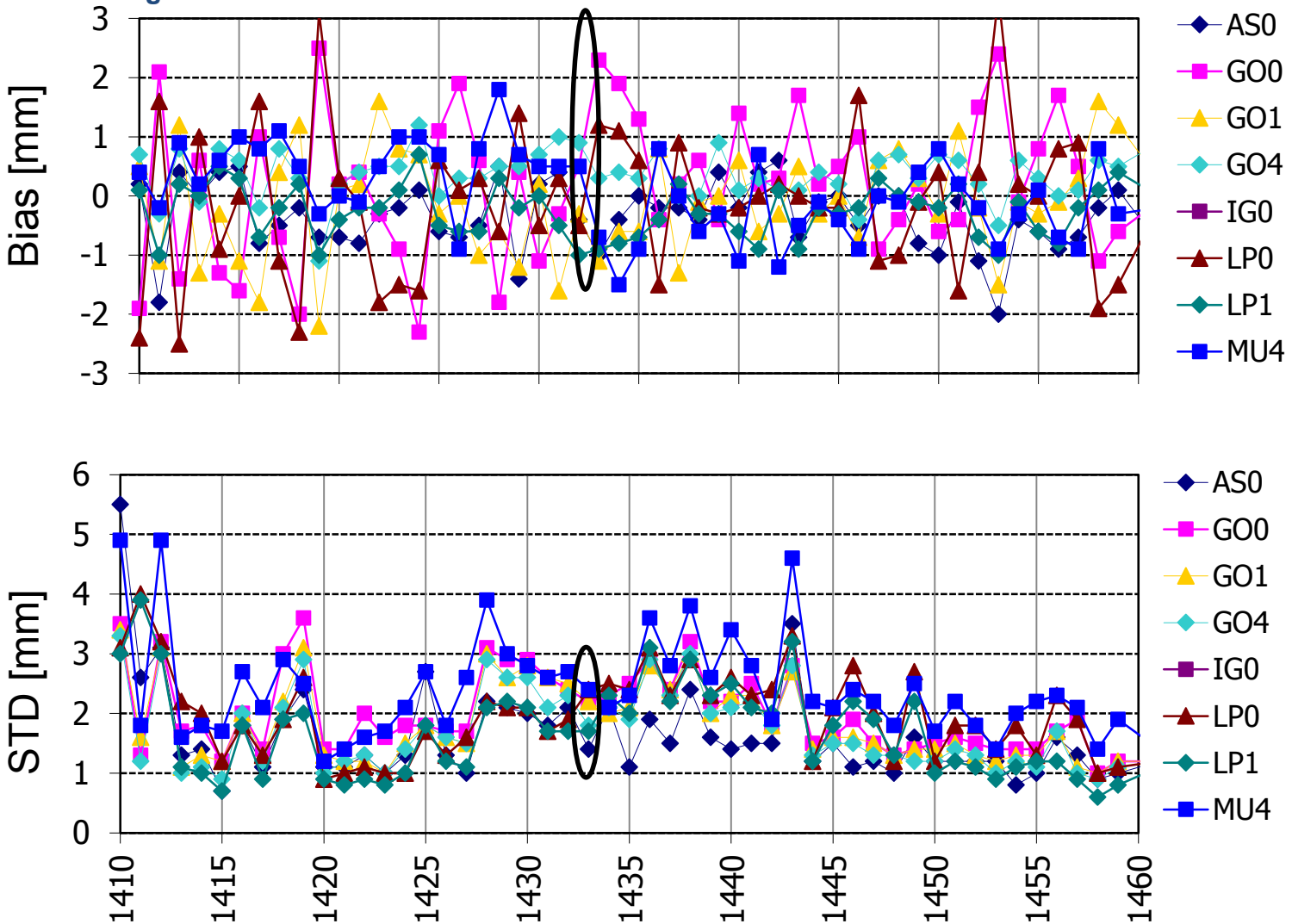


MUT processing, Courtesy A. Araszkiewicz

Individual vs Mean Type calibration

KLOP00DEU (KLOP): AC Bias & STD w.r.t. the combination for 2007

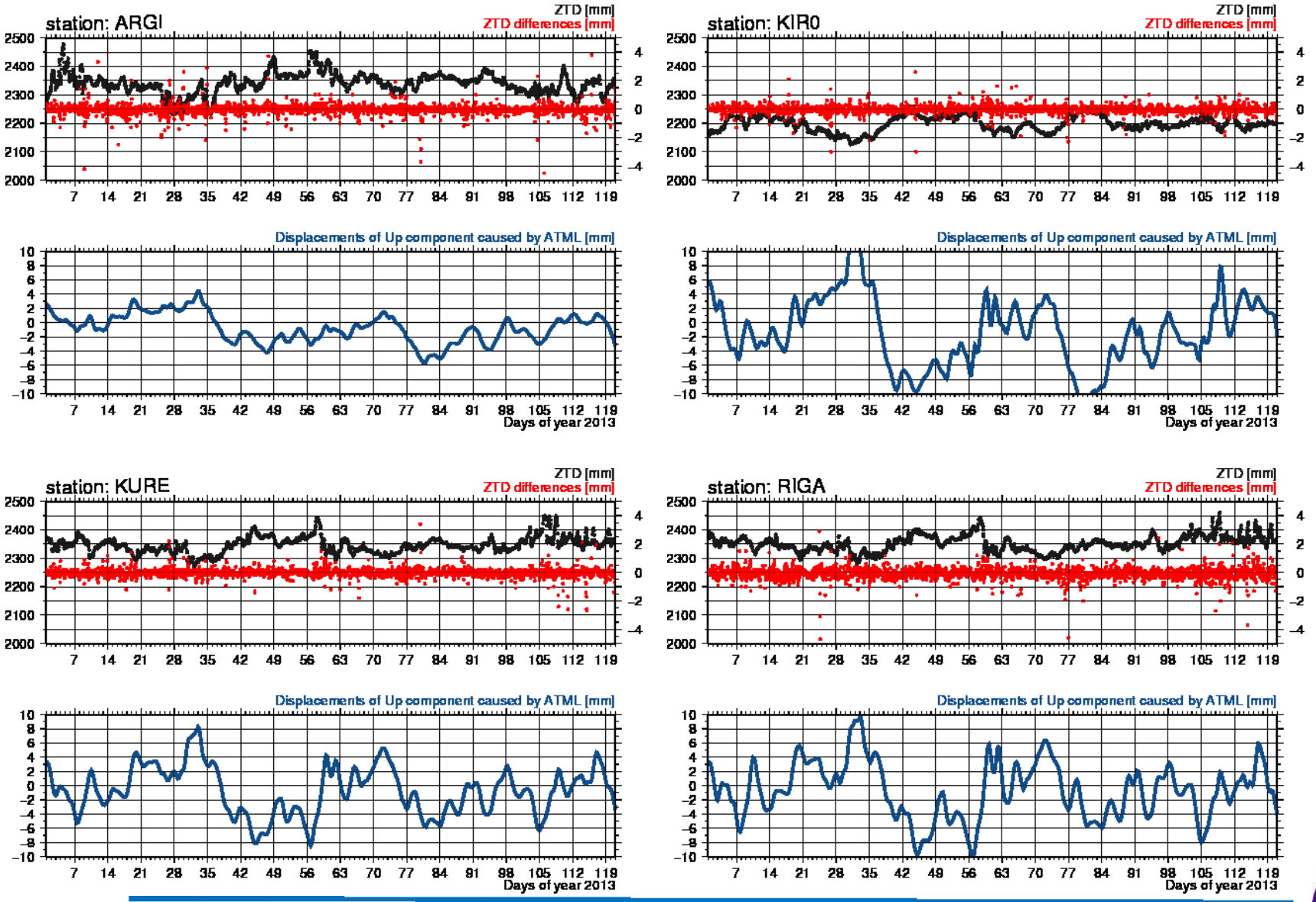
1433 KLOP antenna change



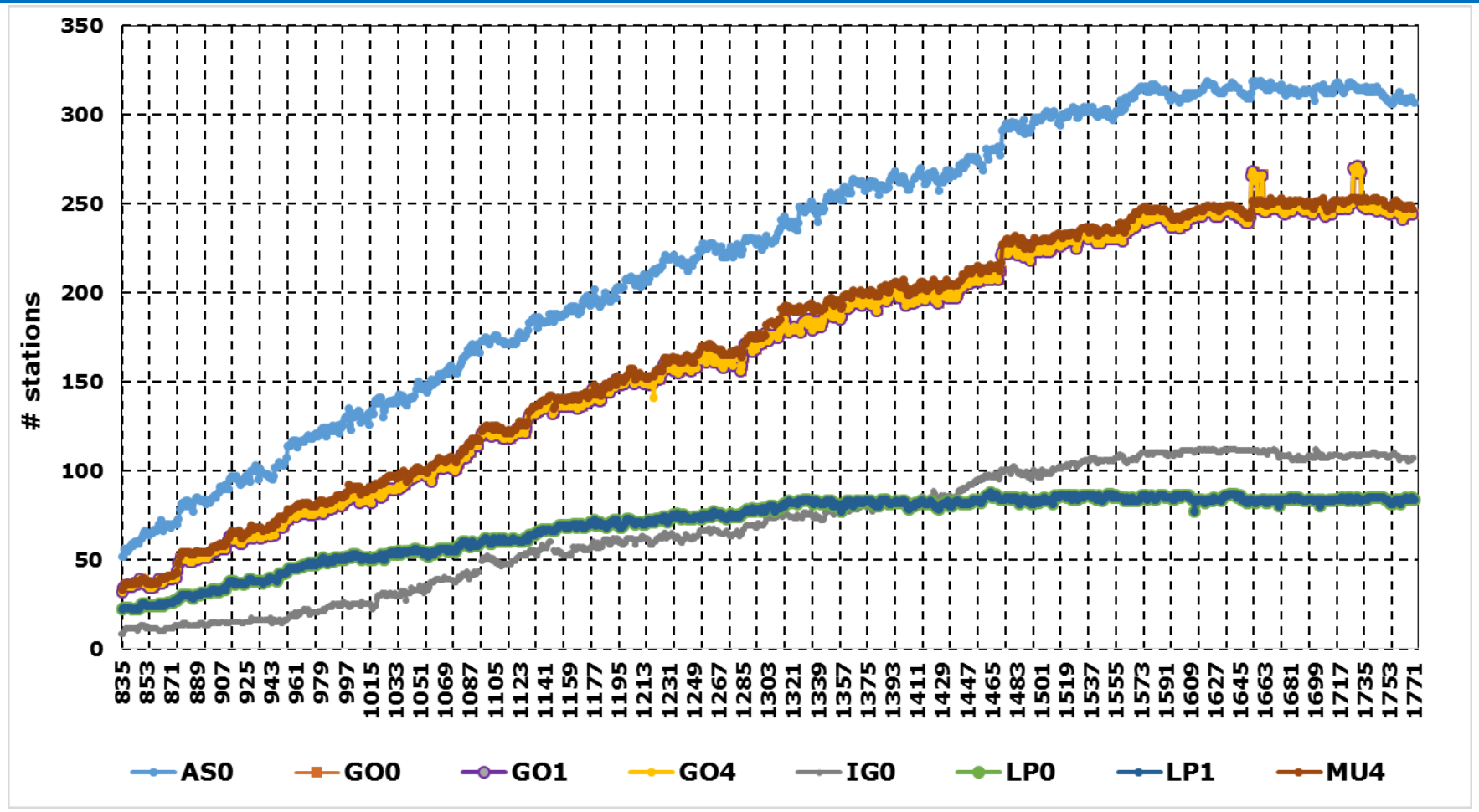
Results from the combination

Impact of NT-ATL on ZTD and Height

MUT processing, Courtesy A. Araszkiewicz

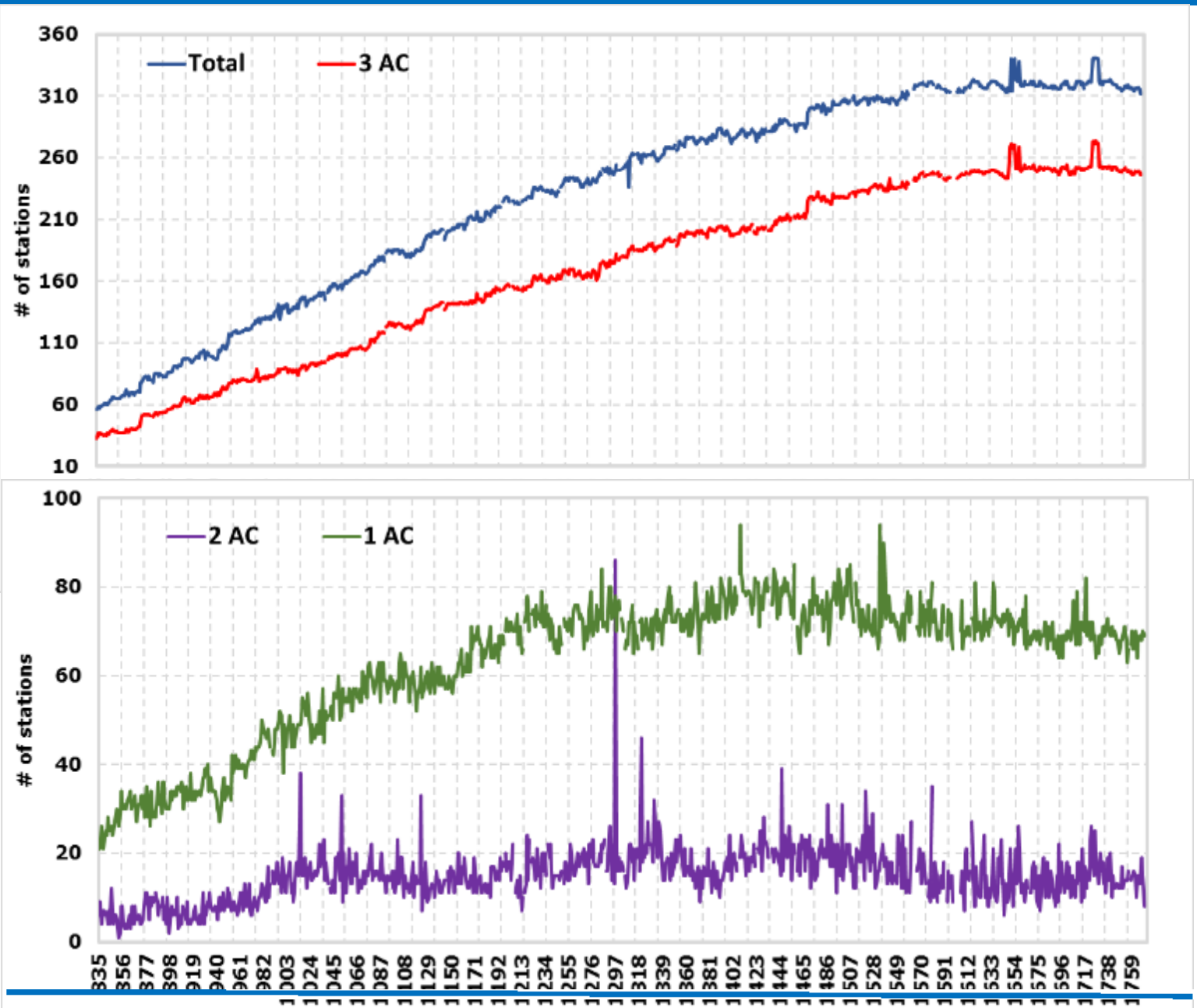


EPN-Repro2: Available Sites



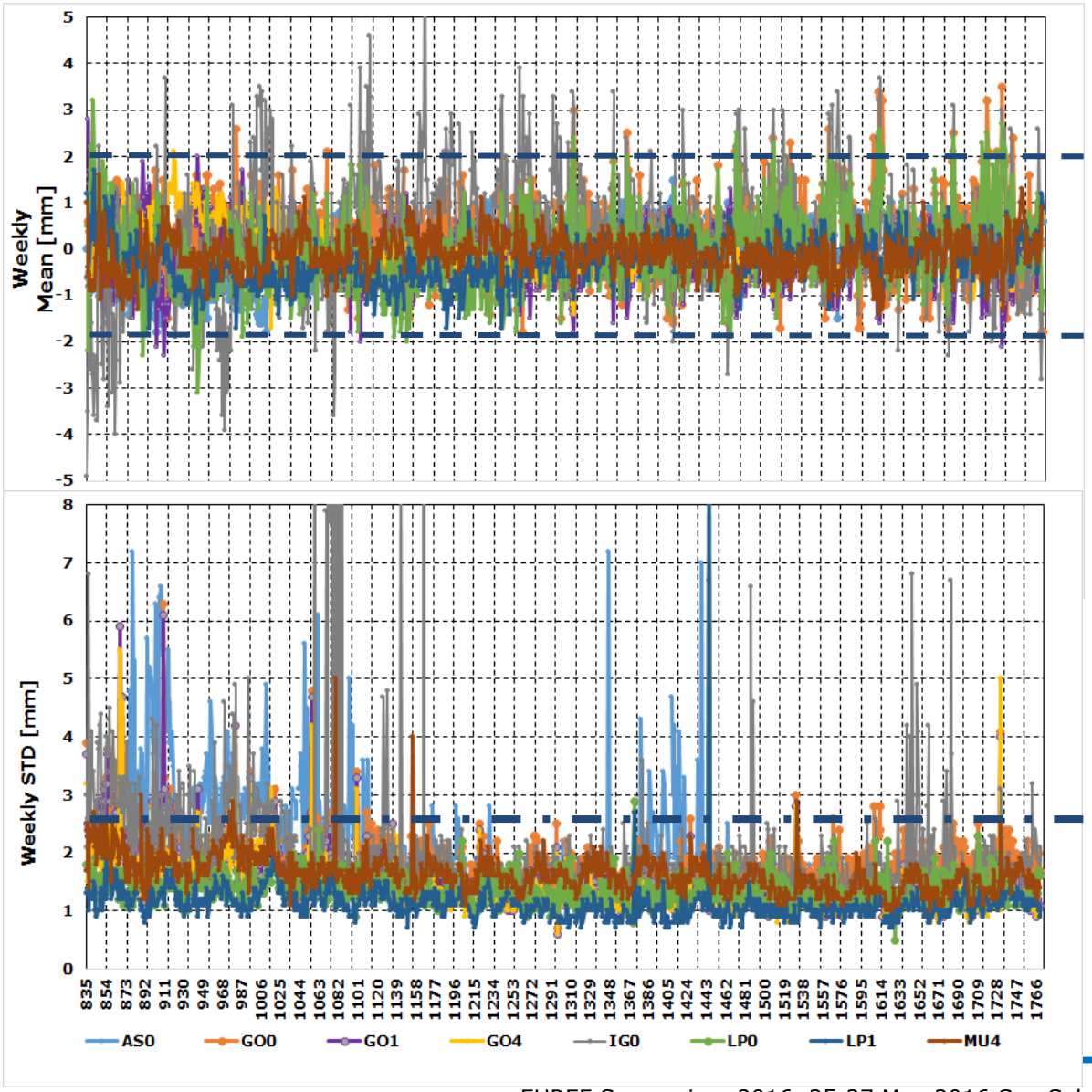
IGS Core + Full EPN | Full EPN | EPN sub network | EPN sub network | Full EPN

EPN-Repro2: Sites Redundancy



Preliminary Repro2 ZTD Combination

- **8 input solutions: AS0, GO0, GO1, GO4, LP0,LP1, MU4**



Purpose:

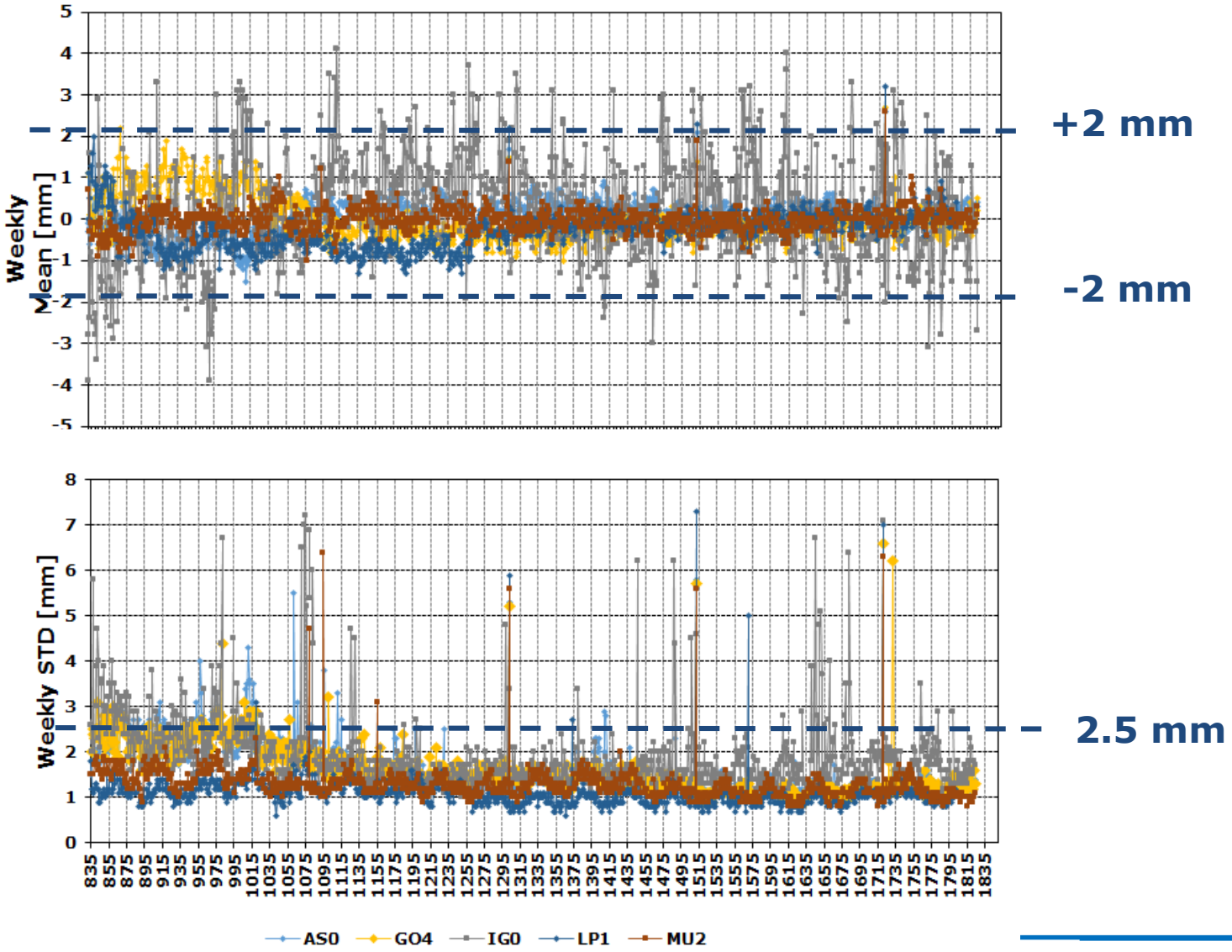
- test all the available solutions
- flag the outliers
- send feedback to the ACs

IWV Accuracy for Regional Climate
(E-GVAP II Product Requirements Document)

Threshold	3 kg/m^2
Breakthrough	1.5 kg/m^2
Goal	1 kg/m^2

Final Repro2 ZTD Combination

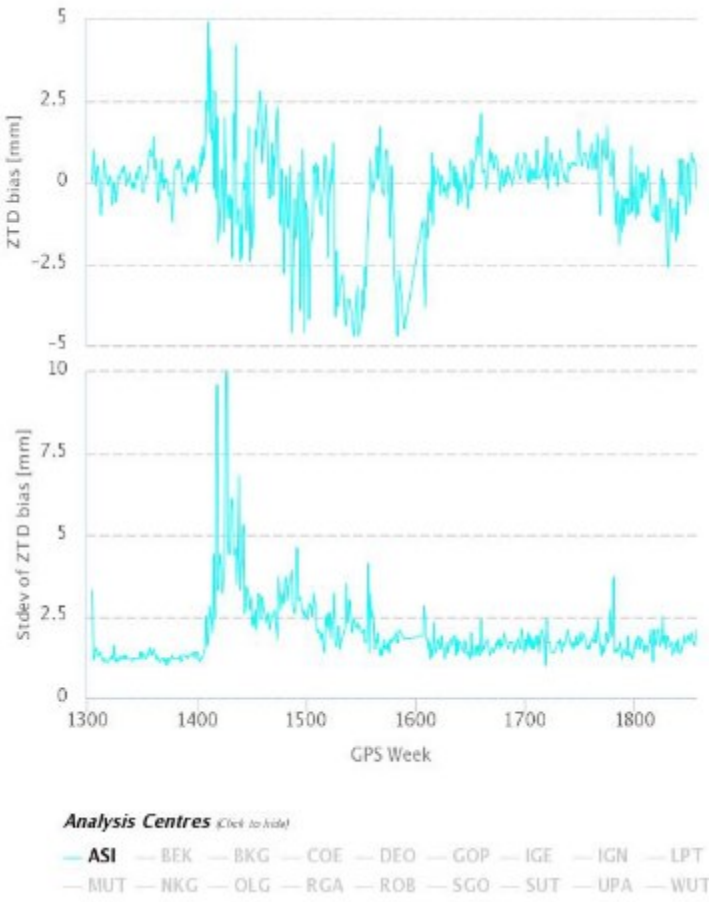
- **5 input solutions: AS0, GO4, IG0, LP1, MU2**



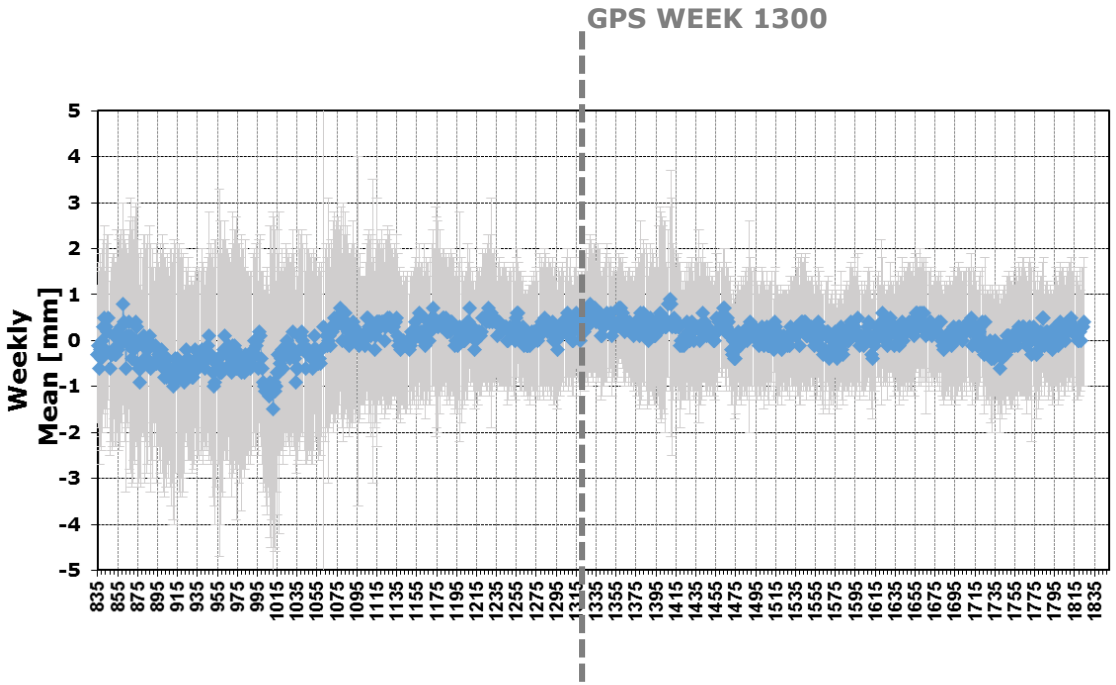
ASI: Repro2 vs Repro1+Operational

Repro1 & Operational

http://www.epncb.oma.be/_productsservices/sitezenithpathdelays/

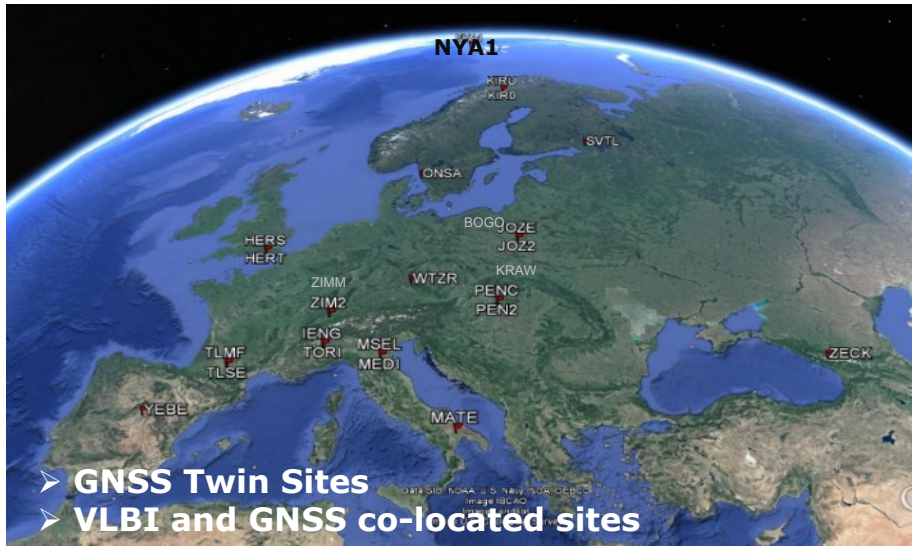


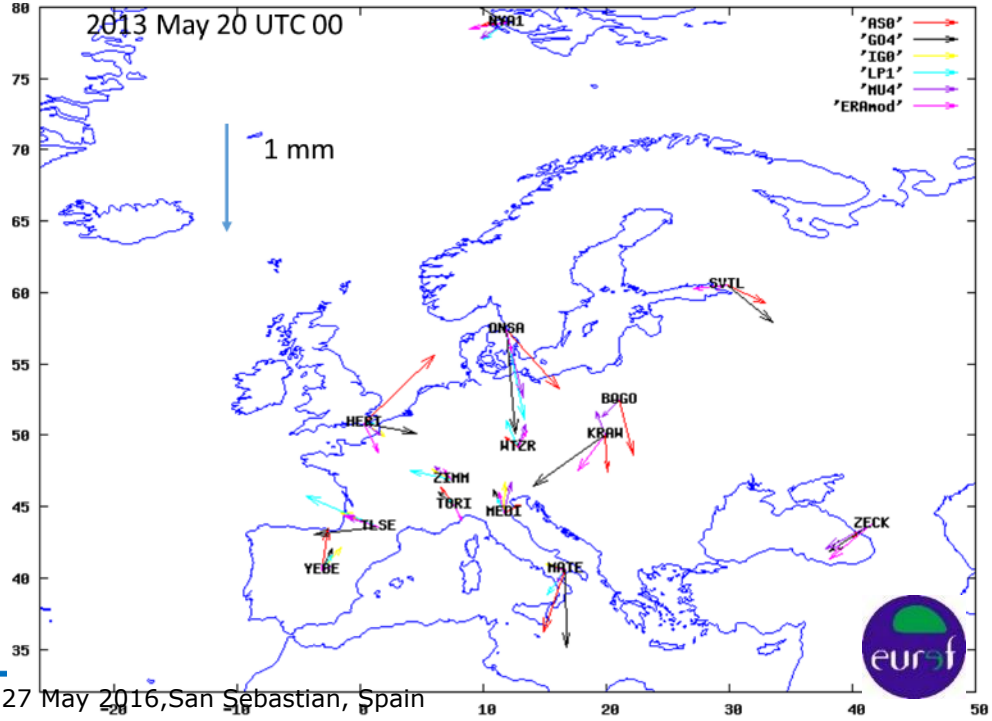
Repro2



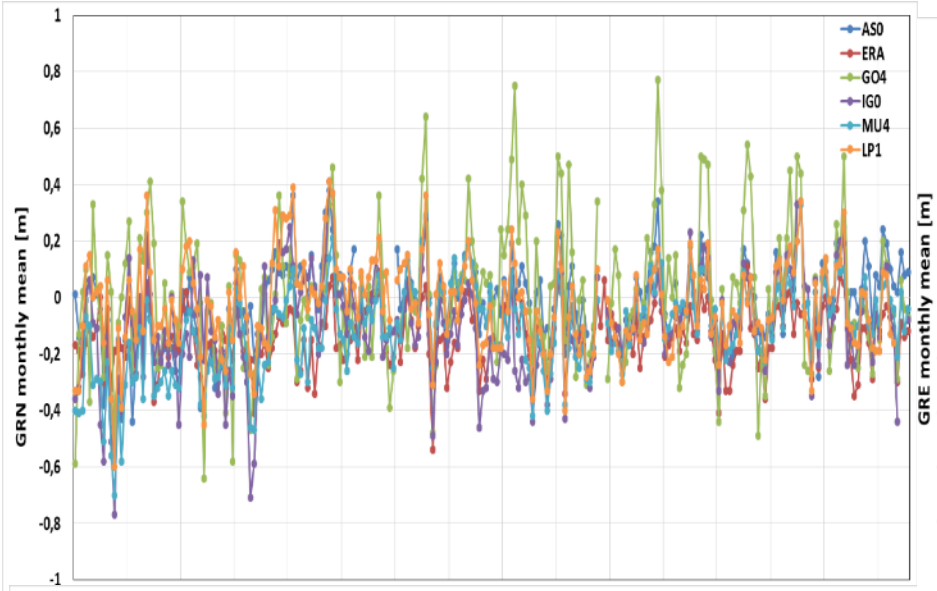
Evaluation of Horizontal Gradients

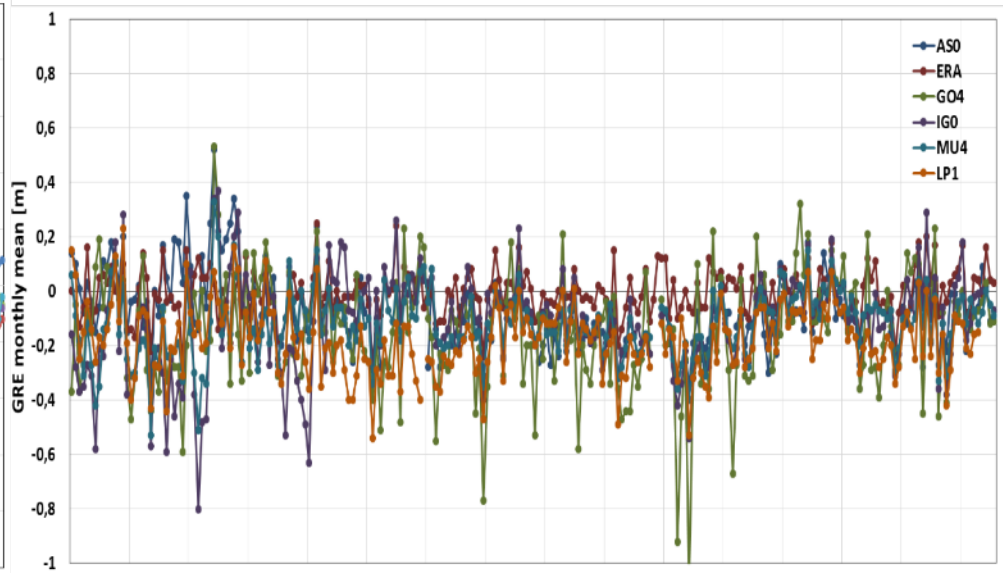
	AS0	GO4	IG0	LP1	MU2
TROPOSPHERE Estimated Param	ZTD (5min) GRAD (5min)	ZTD (1h) GRAD (6h)	ZTD (1h) GRAD (6h)	ZTD (1h) GRAD (24h)	ZTD (1h) GRAD (24h)
Cut-off angle	3	3	3	3	5
MAPPING FUNCTION	VMF1	VMF1	GMF	VMF1	VMF1
ZTD/GRAD time stamp	hh:30 24 estimates/day	hh:30 (and hh:00) 24(+24) estimates/day	hh:30 24 estimates/day	hh:30 (and hh:00) 24(+24) estimates/day	hh:30 24 estimates/day

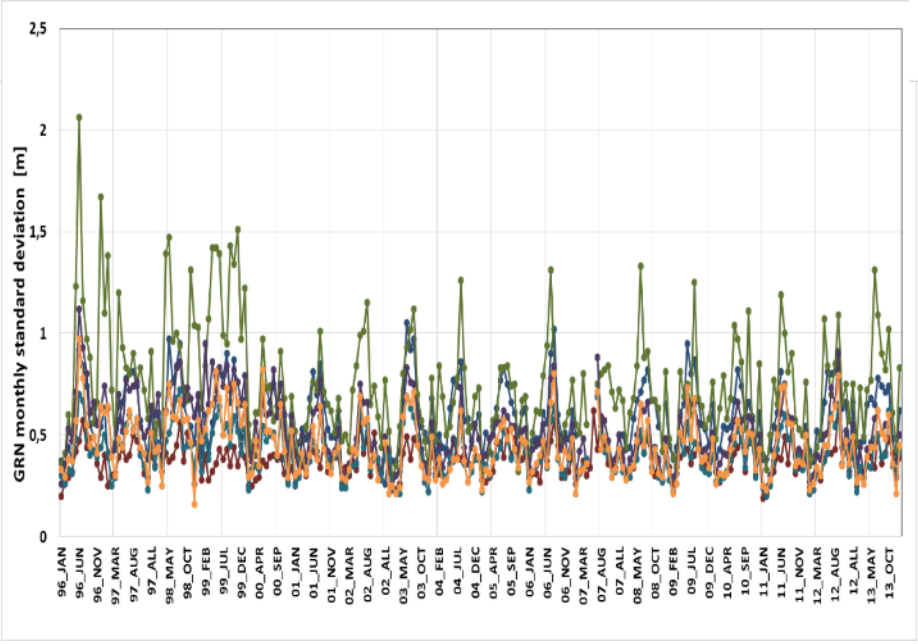


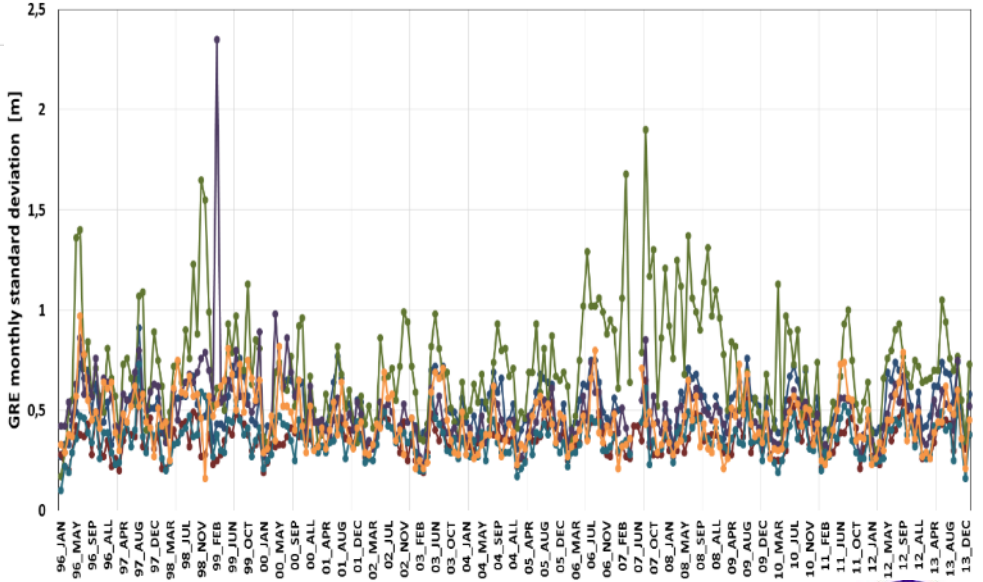


MEDI East, North Gradients: Monthly Mean&Std



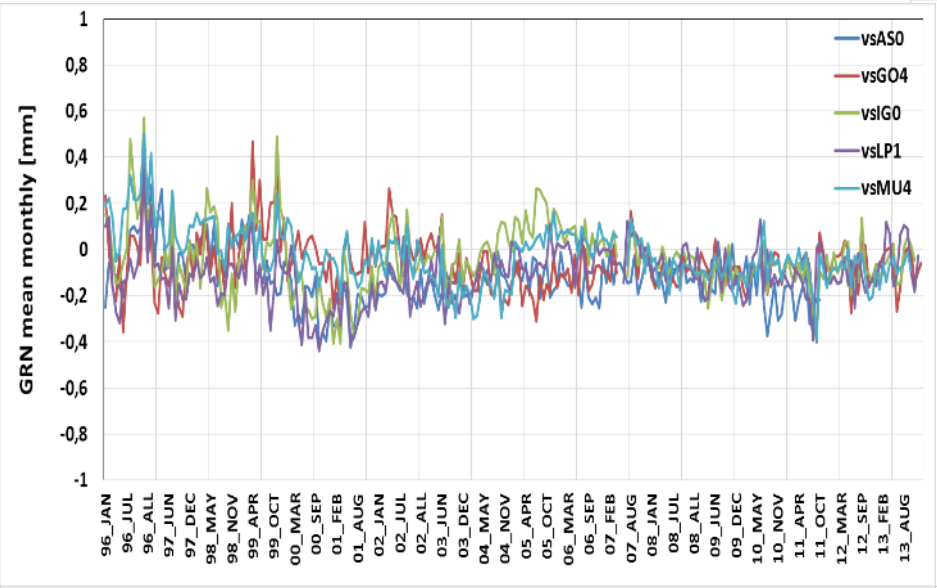


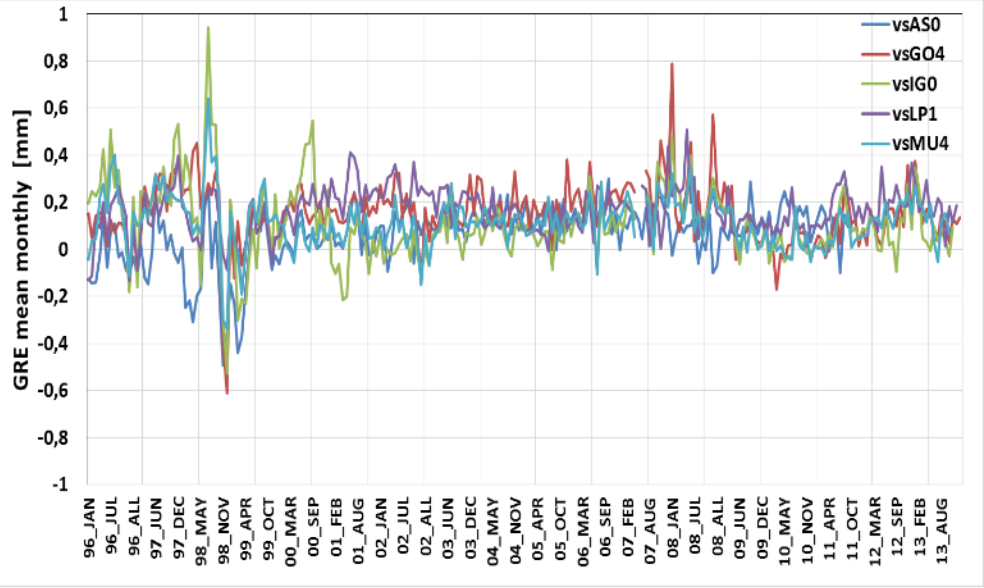


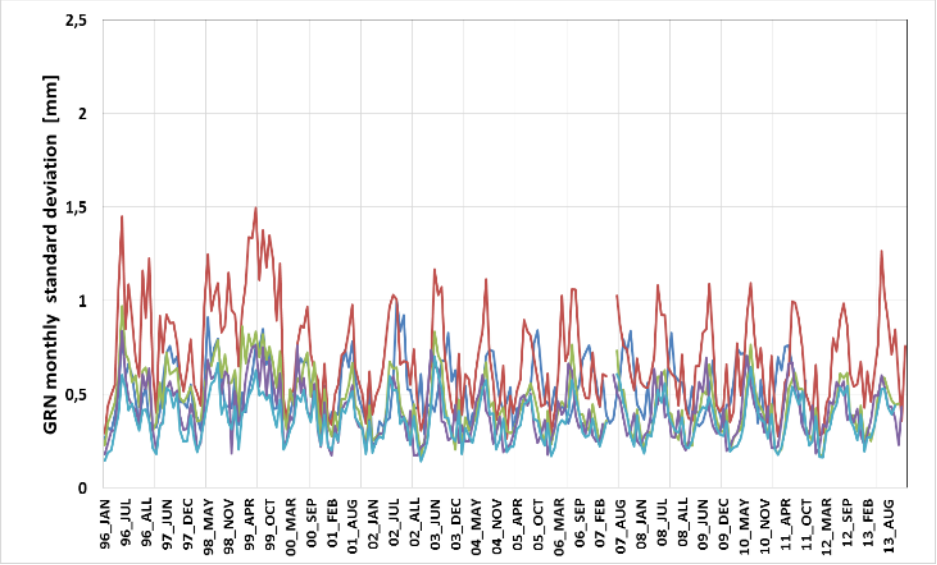


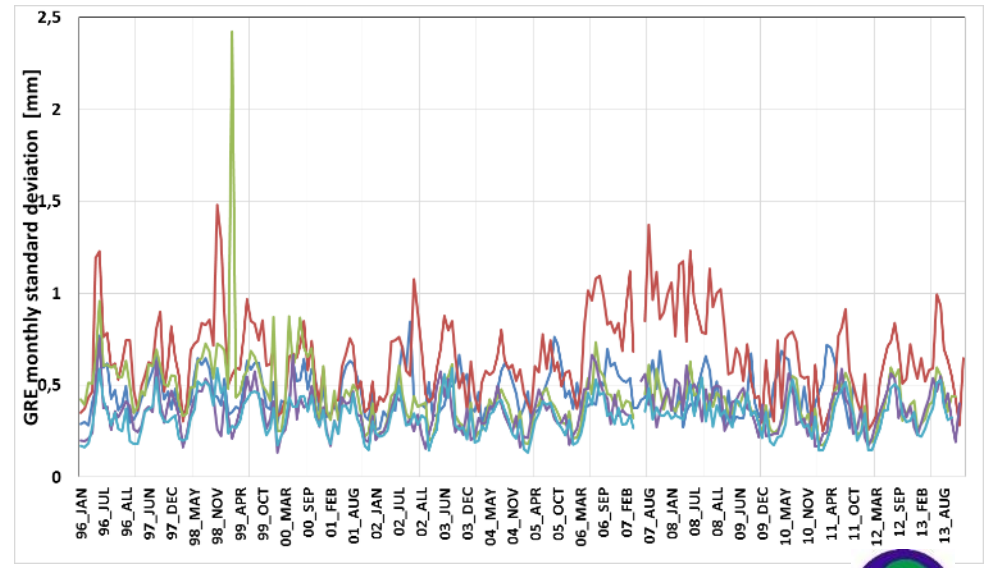
MEDI East, North Gradients

ERA-Interim as reference





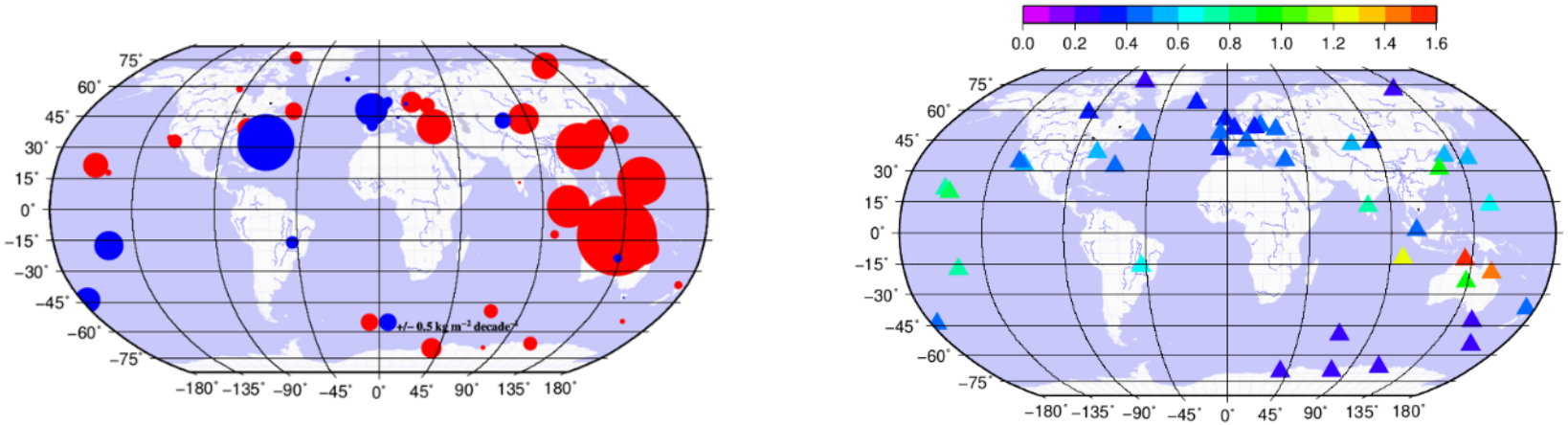




EPN Repro2 end-user

Water vapour is under-sampled in the current **meteorological and climate observing systems**.

Climate community only now starting to use GNSS tropospheric products.

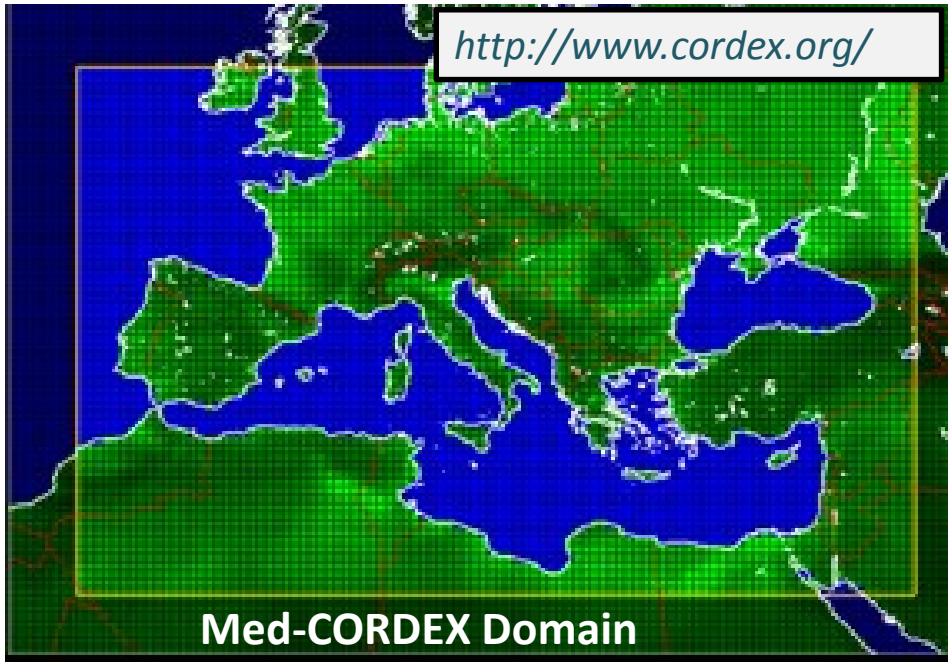


Ning 2012, GPS Meteorology with focus on Climate Applications, Ph.D. Thesis

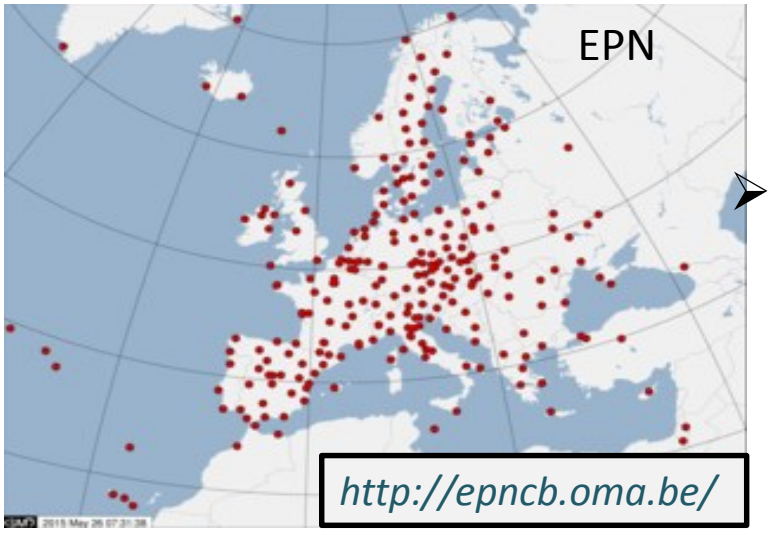
COST ACTION GNSS4SWEC
WG3: GNSS for climate monitoring

J. Jones at al. '*COST ACTION ES1206: Advanced GNSS Tropospheric Products for Monitoring Severe Weather Events and Climate (GNSS4SEC)*'

GNSS IWV Trends and Variability



- Assessment of Med-CORDEX, Euro-CORDEX climate model simulation using GNSS IWV long time series.
- IGS Repro1 (1996-2010) used as reference reprocessed GPS solution.



→ **Data after 2010 are required!**

- The climate groups expressed the need for more spatially dense GPS ZTD/IWV data over Europe.

→ **EPN Repro2 compliant to both requirements!**

Summary

- **EPN Repro2 Campaign**: 1996-2013/2014 homogeneously reprocessing tropospheric products from **5 EPN ACs.**
- Impact of the features of the contributing solutions evaluated prior to the combination.
- **Preliminary** EPN Repro2 ZTD **combination** based on 8 input solutions (**AS0, GO0, GO1, GO4, IG0, LP0,LP1, MU4**) done to test them, to flag the outliers, to send feedback to the Acs.
- **Final** EPN Repro2 ZTD **combination** based on 5 input solutions (**AS0, GO4, IG0,LP1, MU2**) done. Same solutions used by the EPN ACC in the final combination of the EPN positions.
- **Horizontal Gradients** evaluation, both intra-technique and inter-technique, on a EPN sub-network.
- Comparison with respect to radiosonde data is on-going.
- Products will be available to the user community.

Acknowledgment

EPN Repro2 Working Group

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Dousa Jan	GOP
Figurski Mariusz	MUT
Ineichen Daniel	LPT
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Pacione Rosa	ASI/CGS
Sánchez Sobrino José Antonio	IGE
Szafranek Karolina	MUT
Soehne Wolfgang	BKG
Valdés Pérez De Vargas Marcelino	IGE
Völksen Christof	BEK

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