Federal Agency for
Cartography and Geodesy

Reference Frame Specification of the Combined EPN Solution

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Questions

- Do the ETRF2000 station coordinates of EPN stations change, when we apply Memo V8 parameters for the ITRF2008 to ETRF2000 transformation?
- Is it possible to change the scale of a NEQ system through applying minimum constraint conditions?
- Is it possible to stack NEQs of different scale following the “Bernese ADDNEQ” approach?
- How performs the EPN Repro1 benchmark test?
- Should we use ITRF2008 or IGS08 for EPN reference frame specification?

Transformation ITRF200[5,8] to ETRF2000

Scope

- Validation of ETRF2000 continuity
  - Transformation ITRF2005 to ETRF2000
  - Transformation ITRF2008 to ETRF2000
- Test of Memo V8 transformation parameters

Approach

- Apply formulas on published ITRF2005/2008 coordinates
  - Computation for different epochs

Processing
- Input -

- Input Coordinates ITRF2005
  - Master: EPN05.CRD, EPN05.VEL (Epoch 2000-01-01)
  - Epoch 1995.0: EPN05I_95.CRD
  - Epoch 2000.0: EPN05I_00.CRD, effectively a copy of master file
  - Epoch 2005.0: EPN05I_05.CRD
  - Epoch 2010.0: EPN05I_10.CRD
  - Epoch 2015.0: EPN05I_15.CRD
- Input Coordinates ITRF2008
  - Master: EPN08.CRD, EPN08.VEL (Epoch: 2005-01-01)
  - Epoch 1995.0: EPN08I_95.CRD
  - Epoch 2000.0: EPN08I_00.CRD
  - Epoch 2005.0: EPN08I_05.CRD, effectively a copy of master file
  - Epoch 2010.0: EPN08I_10.CRD
  - Epoch 2015.0: EPN08I_15.CRD

Processing
- Output in ETRF2000 -

- Output coordinates from ITRF2005
  - Epoch 1995.0: EPN05E_95.CRD
  - Epoch 2000.0: EPN05E_00.CRD
  - Epoch 2005.0: EPN05E_05.CRD
  - Epoch 2010.0: EPN05E_10.CRD
  - Epoch 2015.0: EPN05E_15.CRD
- Output coordinates from ITRF2008
  - Epoch 1995.0: EPN08E_95.CRD
  - Epoch 2000.0: EPN08E_00.CRD
  - Epoch 2005.0: EPN08E_05.CRD
  - Epoch 2010.0: EPN08E_10.CRD
  - Epoch 2015.0: EPN08E_15.CRD

Selection of Suitable Sites

- Limit geographical region
  - Longitude -20° to 40° East
  - Latitude 30° to 70° north
- Site belongs to stable part of Europe
  - ETRF2000 coordinate comparison of 5 Epochs within time interval of 20 years
  - Limit RMS of horizontal movement to less than 1.4 mm
- Consistency between ITRF2005 and 2008
  - Residuals after 7 P Helmert transformation smaller than 5 mm horizontal and 10 mm height component
    - 17 sites fulfill the consistency check at epoch 2005.0
    - 9 sites fulfill the consistency check for all 5 epochs
- Finally, 9 sites fulfill such requirements

ITRF2005 vs. ITRF2008 (Files EPN05lyy vs. EPN08lyy)

Epoch	RMS Trans.	RMS North	RMS East	RMS UP	TX mm	TY mm	TZ mm	RX "10^{-3}	RX "10^{-3}	RZ "10^{-3}	Scale ppb
1995	2.7	0.9	1.6	3.8	-8.8	16.4	-6.4	-0.20	-0.01	-0.57	-0.2
	2.6	1.3	1.8	4.0	-5.6	0.8	-8.4	-	-	-	-
2000	1.7	0.3	0.8	2.6	-10.7	10.2	-0.20	-0.10	-0.25	0.39	0.2
	1.8	0.7	0.9	2.9	-2.4	0.5	-5.3	-	-	-	-
2005	1.5	0.3	0.5	2.3	-12.7	4.0	2.3	-0.01	-0.42	0.22	0.7
	1.7	0.4	0.7	2.8	0.7	0.1	-2.3	-	-	-	-
2010	2.3	1.0	1.1	3.3	-14.7	-2.2	6.7	0.08	-0.59	0.04	1.1
	2.5	0.9	1.4	3.9	3.8	-0.3	0.8	-	-	-	-
2015	3.5	1.6	2.0	4.9	-16.6	-8.5	11.1	0.17	-0.76	-0.13	1.5
	3.6	1.6	1.3	5.8	6.6	-0.1	3.9	-	-	-	-

- Using 9 sites that passed the consistency check
- Correlations between 7 Helmert parameters → more than 3 parameters not meaningful

ETRF2000
(Files EPN05Eyy vs. EPN08Eyy)

Epoch	RMS Trans.	RMS North	RMS East	RMS UP	TX mm	TY mm	TZ mm	T North mm	T East mm	T Up mm
1995	6.4	1.8	2.7	11.2	-	-	-	-	-	-
	2.7	1.5	1.9	4.0	-5.7	1.0	-8.3	-0.9	2.1	-9.8
2000	4.2	0.8	1.7	7.5	-	-	-	-	-	-
	1.8	0.8	1.1	2.8	-4.1	0.6	-5.3	-0.3	1.4	-6.5
2005	2.5	0.5	1.0	4.5	-	-	-	-	-	-
	1.7	0.5	0.5	2.8	-2.5	0.3	-2.2	0.5	0.7	-3.2
2010	2.4	1.3	1.2	4.0	-	-	-	-	-	-
	2.4	0.9	1.2	3.9	-0.9	-0.1	0.8	1.2	0.0	0.1
2015	4.0	2.3	2.2	6.7	-	-	-	-	-	-
	3.5	1.5	2.1	5.5	0.8	-0.6	3.9	2.0	-0.7	3.4

- Significant translation for all epochs, aside from epoch 2010.0
- Trend in height component of translation, which is at a minimum for epoch 2010.0

Differences

ITRF2005–2008 (Epoch 1995.0)

Differences

ITRF2005–2008 (Epoch 2000.0)

Differences

ITRF2005–2008 (Epoch 2005.0)

Differences

ITRF2005–2008 (Epoch 2010.0)

Differences

ITRF2005–2008 (Epoch 2015.0)

Differences

ETRF2000 (Epoch 1995.0)

GMT 2011 Jan 21 13:32:26

Differences

ETRF2000 (Epoch 2000.0)

GMT 2011 Jan 21 13:33:05

Differences

ETRF2000 (Epoch 2005.0)

Differences

ETRF2000 (Epoch 2010.0)

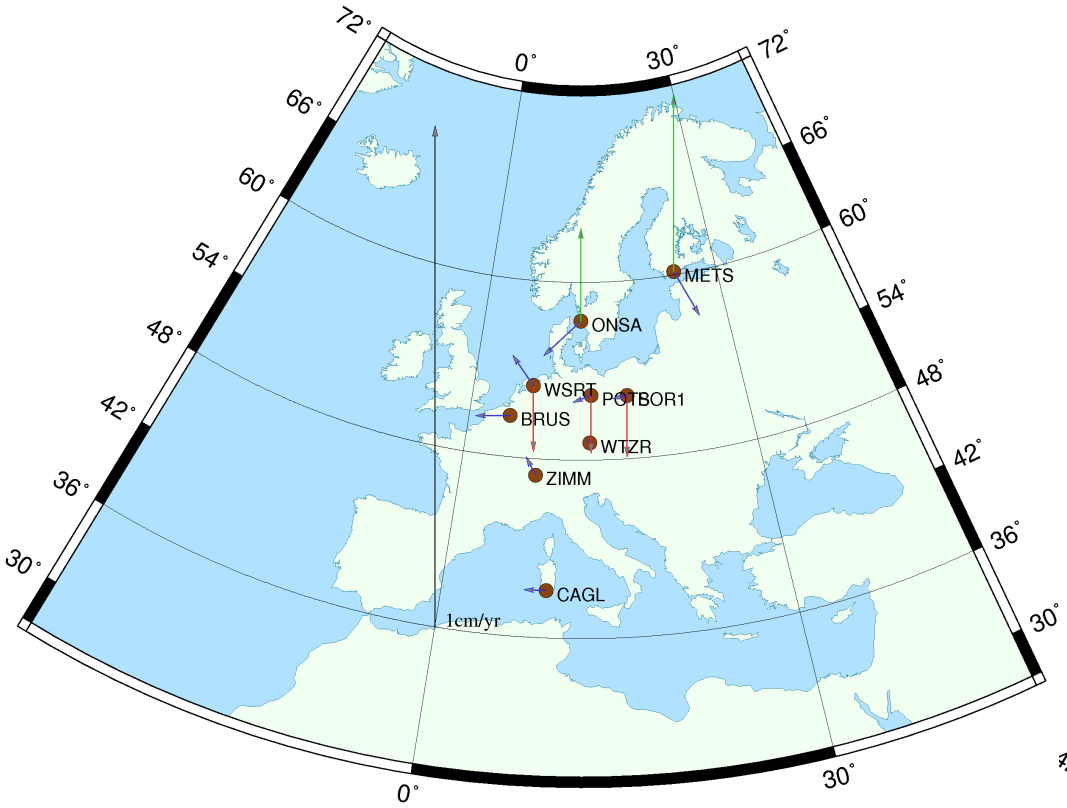
Differences

ETRF2000 (Epoch 2015.0)

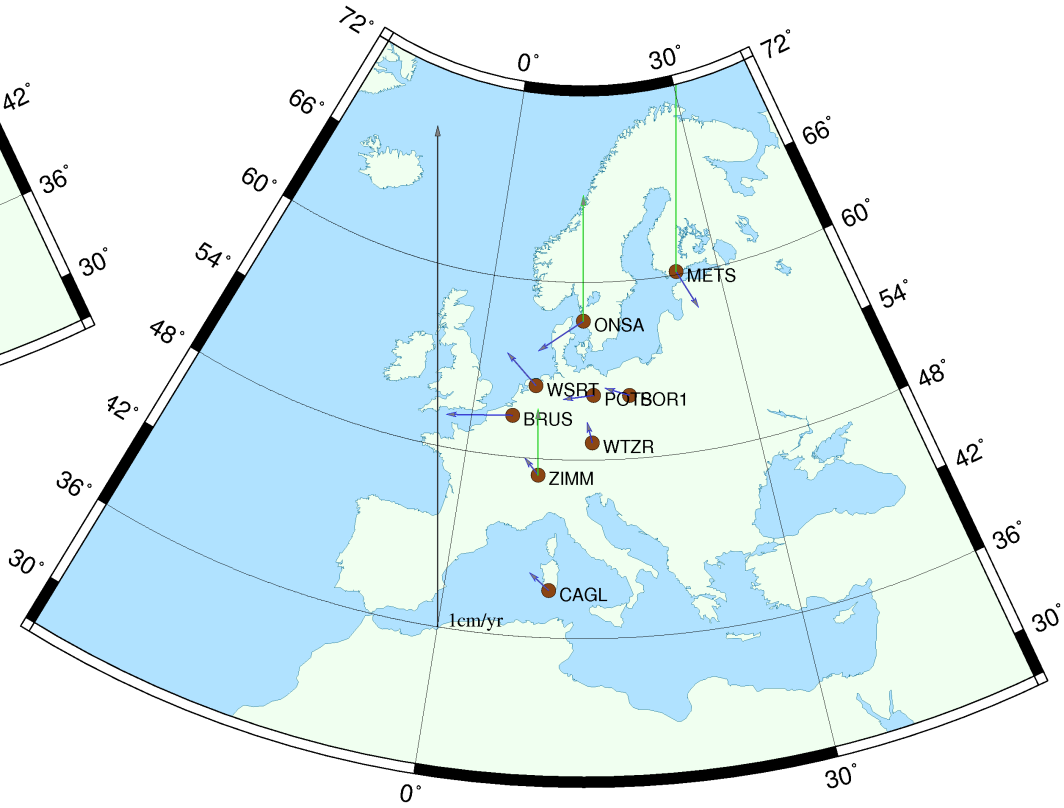
GMT 2011 Jan 21 13:34:31

ETRF2000 Velocity

ETRF2000(R08) Velocity



ETRF2000(R05) Velocity



Conclusion ITRF200x to ETRF2000

- Change from ITRF2005 to ITRF2008 close to epoch 2010.0
  - will not change ETRF2000 coordinates,
  - no jump for current epoch, but “silent” change for the future
  - Trend in height component in ITRF and ETRF2000 differences
  - ETRF2000(R05) and ETRF2000(R08) velocities show slightly different behaviour
  - height differences in 10 years in the order of a few mm and not critical for primary interest of ETRS89 (that is horizontal)
- 9 sites have been selected to represent the EPN network and may be insufficient for a general statement
- Vertical movement not considered in ITRFyy-to-ETRF2000 transformation ?

Minimum Constraint Condition Validation

Scope

- Question: Is it possible to apply a datum definition for solving a NEQ system, which is different to the datum applied in the GNSS analysis steps?
- Relation to EPN: IGS orbits in IGS05 are fixed during data analysis. Is datum definition for solving NEQs through applying MCC on ITRF2008 reference coordinates successful?
- Note: The NEQs are not completely unconstrained due to, e.g., fixed IGS orbits. Thus the described datum "definition" includes a datum "transformation".

Approach

- Comparison of estimated coordinates vs. reference coordinates by usage of HELMR1 program of Bernese Software
  - Specify 3 translation and 1 scale parameter to consider ITRF2005 to ITRF2008 differences
- Note: A-priori sigma for MCC specified to 0.01 mm within Bernese Software panel

Step 1
MCC validation in ITRF2005

- Solve NEQ for re-processed EPN solution of week 1356 (epoch 2006.0), and apply MCC for 18 reference sites
- Confirm MCC for reference sites in ITRF2005
  - 4 P Helmert transformation of estimated coordinates of reference sites to the original ITRF2005 numbers
  - estimated Helmert parameters result to zero in sub-millimeter level

Step 2
MCC validation in ITRF2008

- Transformation of reference coordinates of 18 sites from ITRF2005 to ITRF2008,
  - considered as “simulated” ITRF2008 coordinates, but strictly conform to the published transformation parameters
  - such coordinates are “close” to published ITRF2008 numbers, which is sufficient here
- Solve NEQ for re-processed EPN solution of week 1356 (epoch 2006.0), and apply MCC for 18 reference sites
- Confirm MCC for reference sites in ITRF2008
  - 4 P Helmert transformation of estimated coordinates of reference sites to the original ITRF2005 numbers
  - estimated Helmert parameters result to zero in sub-millimeter level

Step 3
Coordinate Comparison

- Compare estimated coordinates of step 1 and step 2 through 4 P Helmert transformation
- 18 reference sites
  - 4 Helmert parameters as applied for "simulated" ITRF2008 coordinates re-covered
- total 193 sites
  - 4 Helmert parameters as applied for "simulated" ITRF2008 coordinates NOT STRICTLY re-covered, difference in translation and scale

Step 4
Back-Transformation

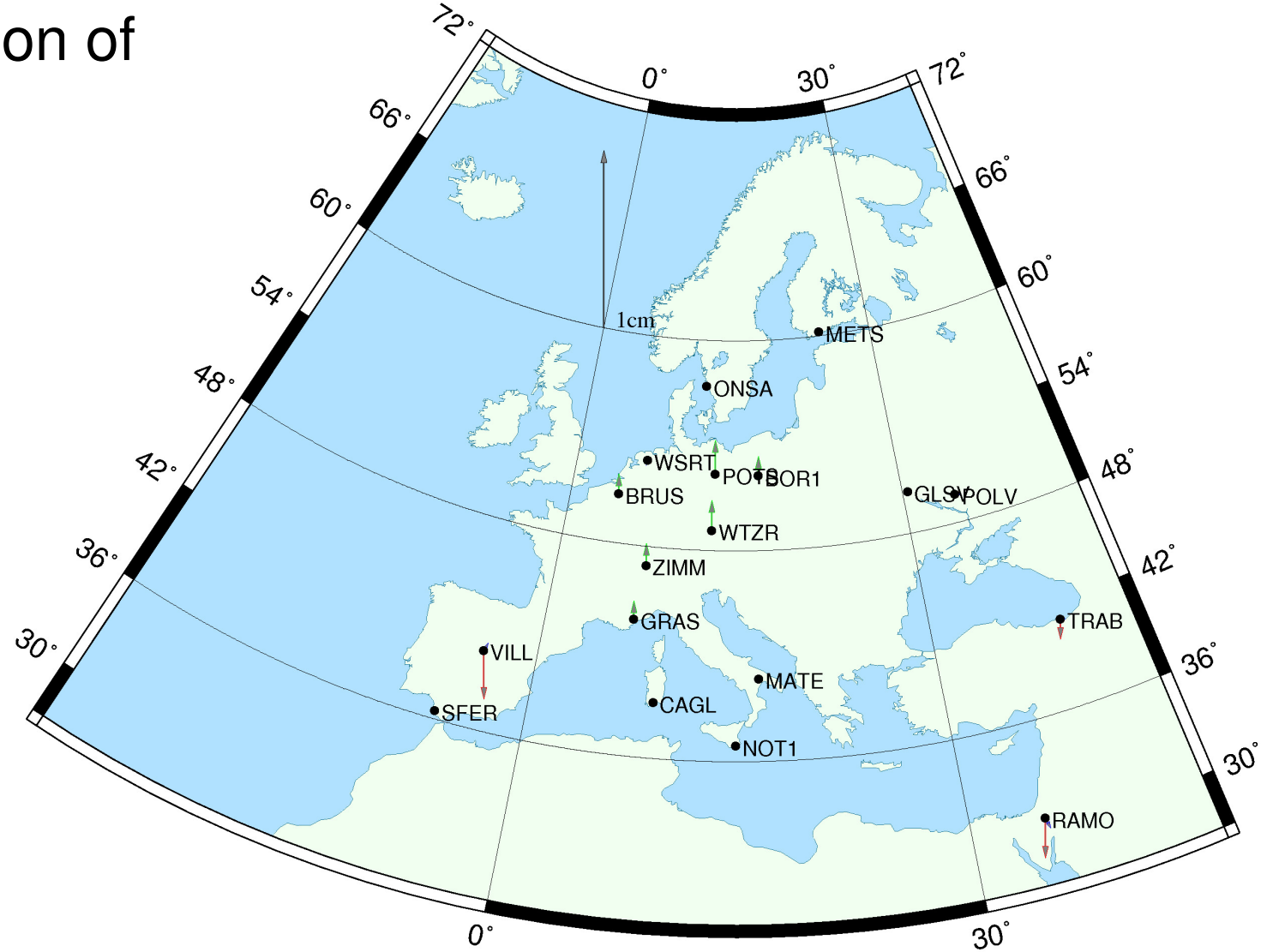
- Estimated coordinates in the “simulated” ITRF2008 are back-transformed to ITRF2005 and compared to estimated coordinates in ITRF2005
- Residuals and estimated Helmert parameters of this comparison show the success of the MCC in defining a new datum

Transf. Type	TX mm	TY mm	TZ mm	Scale 10^{-9}	T North mm	T East mm	T UP mm
4 P	-1.9	-0.5	-2.2	0.8	0.1	-0.2	**1.9**
3P	1.2	0.0	1.5	-	0.1	-0.2	**1.9**

Residuals after Back-Transformation - Reference Sites -

- Based on 4 P Helmert Transformation of Step 4
- "Zero mean" according to MCC

MCC Validation

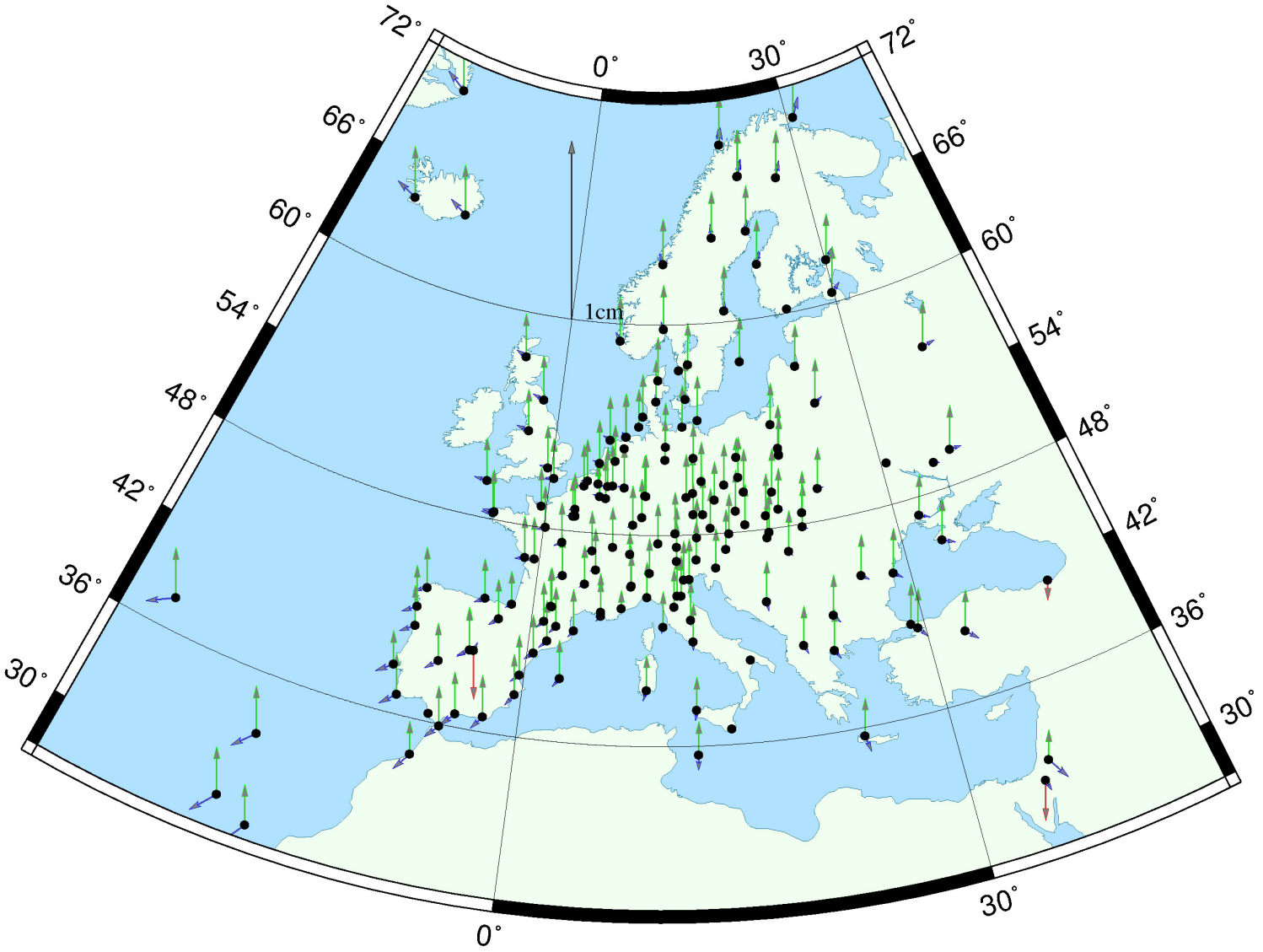


Residuals after Back-Transformation - All Sites -

MCC Validation

- Not shown in map:

  THU3
  NYA1
  NYAL
  KELY
  QAQ1
  STJO
  ARTU



MCC Validation
- Conclusion -

- **Only reference sites follow** the changed datum definition in the mean after applying changed MCC (i.e., reference coordinates in changed reference frame)
- Remaining constraints in the NEQ prevent that non-reference sites follow the changed MCC
- Horizontal residuals in radial directions and a common vertical shift indicate scale difference that remains in the network after applying changed MCC
- But, significance of 1.9 mm may be questionable
- **ITRF2008 coordinate tests** based on analysis using **fixed IGS orbits in IGS05 not meaningful**

Scale Parameter in NEQ Stacking
- Background -

- The sub-network solution as processed with “Microcosm” software shows significant larger RMS and scale parameters as “Bernese” software solutions in the comparison against the combined solution (see table for week 1610).
- Test solutions with “GIPSY” software showed even larger scale parameters, but mostly smaller RMS values.
- Solving the normal equations separately and comparing the resulting coordinates confirmed the scale difference.
- The reason for the scale difference has not been recovered and will be accepted for the time being.
- The adjustment of the scale in the normal equation stacking approach will be discussed.

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Helmert Transformation Parameters of LACs w.r.t. Combined Solution

		Translation (m)			Rotation (")				
Sol	Rms (m)	X	Y	Z	X	Y	Z	Scale (ppm)	
1	**0.00350**	0.0018	0.0115	-0.0223	-0.0002	0.0005	0.0003	**0.00162**	Microcosm
2	0.00079	-0.0015	-0.0033	-0.0026	0.0001	-0.0001	-0.0000	0.00011	
3	0.00129	0.0023	0.0004	0.0001	-0.0000	0.0001	0.0000	0.00022	
4	0.00050	-0.0004	0.0070	-0.0051	-0.0002	-0.0000	0.0001	0.00014	
5	0.00117	0.0003	0.0101	-0.0042	-0.0002	-0.0000	0.0001	0.00008	
6	0.00055	0.0053	-0.0025	0.0005	0.0000	0.0001	-0.0000	-0.00032	
7	0.00073	-0.0003	-0.0007	-0.0000	0.0000	-0.0000	-0.0000	-0.00006	
8	0.00056	-0.0017	0.0009	0.0011	-0.0000	0.0000	0.0000	0.00004	
9	0.00120	-0.0013	0.0025	0.0033	0.0000	-0.0001	0.0000	-0.00042	
10	0.00056	-0.0042	0.0025	-0.0006	-0.0001	-0.0000	0.0001	0.00025	
11	0.00155	0.0043	0.0127	0.0075	-0.0002	-0.0001	0.0002	-0.00042	
12	0.00086	-0.0014	0.0002	0.0076	-0.0000	-0.0001	0.0001	-0.00009	
13	0.00073	-0.0053	-0.0066	-0.0041	0.0000	-0.0001	0.0000	0.00015	
14	0.00056	0.0037	-0.0051	-0.0027	0.0002	0.0001	-0.0001	0.00005	

Week 1610

Scale Parameter in NEQ Stacking - Some Details -

- Normal equations (NEQs) of EPN sub-network solutions are not completely free of constraints, e.g., satellite orbit parameters are fixed all the time.
- Caused by remaining constraints in the NEQs the degree of freedom is not equivalent to 7 Helmert parameters, and it is smaller. Thus it is recommended to define the datum by 3 translation parameters.
- Under such conditions the stacking of NEQs with difference scales couldn't adjust the scale difference. The estimation of 7 additional Helmert parameters for each solution may overcome that deficiency.

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ASI: Operational (Microcosm) vs. Test Solution (GIPSY)

M=Microcosm, G=GIPSY

Sol		Rms (m)	Translation (m) X	Y	Z	Rotation (") X	Y	Z	Scale (ppm)
1601	M	**0.00346**	-0.0274	-0.0229	0.0129	0.0006	-0.0010	-0.0003	**0.00171**
	G	**0.00246**	-0.0242	0.0134	0.0030	-0.0003	-0.0007	0.0005	**0.00205**
1602	M	**0.00371**	-0.0396	-0.0092	0.0375	0.0004	-0.0018	0.0000	**0.00089**
	G	**0.00337**	-0.0130	0.0090	-0.0125	-0.0001	-0.0001	0.0002	**0.00277**
1603	M	**0.00353**	-0.0076	-0.0055	-0.0009	0.0001	-0.0002	-0.0000	**0.00031**
	G	**0.00252**	-0.0306	0.0074	0.0040	-0.0002	-0.0009	0.0003	**0.00249**
1604	M	**0.00349**	-0.0039	-0.0212	-0.0173	0.0003	0.0003	-0.0005	**0.00239**
	G	**0.00252**	-0.0165	-0.0113	0.0003	0.0002	-0.0005	-0.0002	**0.00197**
1605	M				EXCLUDED				
	G	0.00269	-0.0219	-0.0128	0.0028	0.0003	-0.0006	-0.0002	**0.00215**
1606	M	**0.00358**	-0.0239	0.0150	-0.0164	-0.0004	-0.0002	0.0005	**0.00402**
	G	**0.00258**	-0.0143	-0.0139	-0.0091	0.0002	-0.0002	-0.0003	**0.00234**
1607	M	**0.00367**	-0.0122	-0.0025	-0.0060	-0.0000	-0.0002	-0.0001	**0.00180**
	G	**0.00257**	-0.0099	-0.0201	-0.0148	0.0004	0.0000	-0.0004	**0.00226**
1608	M	**0.00429**	-0.0046	0.0113	-0.0029	-0.0003	-0.0001	0.0003	**0.00025**
	G	**0.00267**	-0.0068	-0.0147	-0.0054	0.0003	-0.0001	-0.0003	**0.00152**
1609	M	**0.00282**	-0.0347	0.0082	0.0094	-0.0000	-0.0011	0.0004	**0.00214**
	G	**0.00281**	-0.0134	-0.0077	-0.0026	0.0002	-0.0004	-0.0001	**0.00180**
1610	M	**0.00350**	0.0018	0.0115	-0.0223	-0.0002	0.0005	0.0003	**0.00162**
	G	**0.00217**	-0.0071	-0.0142	-0.0087	0.0003	-0.0000	-0.0003	**0.00147**
1611	M	**0.00337**	-0.0053	0.0123	-0.0110	-0.0001	0.0001	0.0005	**0.00138**
	G	**0.00262**	-0.0128	-0.0167	-0.0089	0.0004	-0.0001	-0.0003	**0.00211**

ASI: Operational (Microcosm) vs. Test Solution (GIPSY)

- For 10 tested weeks the RMS is smallest for the GIPSY
- For 6 tested weeks the scale was smallest for GIPSY
- For 4 tested weeks the scale was smallest for Microcosm
- The **resulting combined station coordinates are identical on the 0.1 mm level** for both approaches
  - detailed coordinate comparison for week 1611
  - RMS and estimates of 7 Helmert parameters confirmed
  - equivalence of combined coordinate solution confirmed

Coordinate Comparison for Week 1611 Combined vs. GIPSY solution

Type	RMS Trans.	RMS North	RMS East	RMS UP	TX mm	TY mm	TZ mm	RX "10^{-3}	RX "10^{-3}	RZ "10^{-3}	Scale ppb
0 P	4.0	2.7	1.7	6.2	-	-	-	-	-	-	-
3 P	2.8	1.4	1.5	4.5	1.9	0.2	4.5	-	-	-	-
4 P	2.7	1.1	0.8	4.5	11.6	2.3	13.5	-	-	-	-2.1
7 P	2.6	1.1	0.8	4.2	12.9	16.6	8.9	-3.7	1.3	3.1	-2.1

- RMS of 3P, 4P and 7P similar
- Scale compensates "overestimated" part of translation and rotation

Conclusion: Scale problem does not exist

  - But, why for Microcosm/GIPSY solution only? Why larger RMS?

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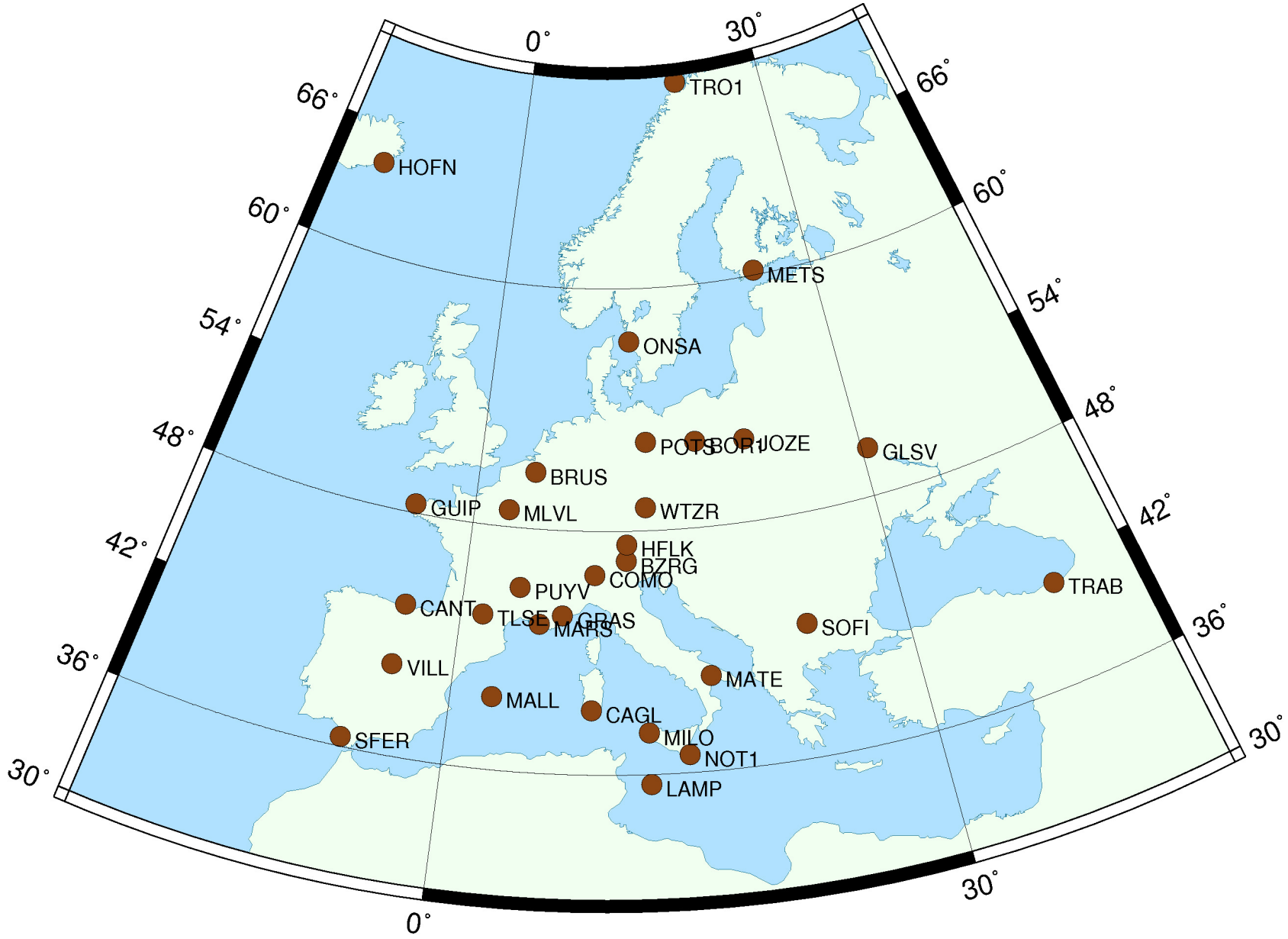
EPN Repro1 “Benchmark Test”



Version V03 Intermediate Combination Solution (11 LACs)

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================================================================================
EPN RE-PROCESSING 1 - BENCHMARK SOLUTION
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 Version V03 2011-02-15: MUQ and UPQ solutions added

 Contributing solutions (equvalent order as used in subsequent summary/tables):

 A_Q - Italian Space Agency/Centro di Geodesia Spaziale, Matera - Italy
 BEQ - Bayerische Kommission fuer die Internationale Erdmessung - Germany
 BKQ - Bundesamt fuer Kartographie und Geodaesie - Germany
 GOQ - Geodetic Observatory Pecny, Pecny - Czech Republic
 IGQ - Instituto Geografico Nacional / Centro de Obs. Geodesicas - Spain
 MUQ - Military University of Technology - Poland
 M_Q - Military University of Technology - Poland (GAMIT solution)
 NKQ - Nordic Geodetic Commission / Lantmaeteriet / Onsala Space Obs. - Sweden
 SUQ - Slovak University of Technology, Bratislava - Slovakia
 UPQ - University of Padova, Padova - Italy
 WUQ - Warsaw University of Technology, Warsaw - Poland
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Consistency of Solutions

weekly solutions

Station	#Days	Weekday 0123456	Repeatability (mm) N	E	U	
BOR1 12205M002	10	XXXXXX	0.31	0.15	1.28	XXXX
BRUS 13101M004	11	XXXXXXX	0.21	0.29	0.46	XXXX
BZRG 12751M001	11	XXXXXXX	0.80	1.43	1.47	XXXX
CAGL 12725M003	11	XXXXXXX	0.85	0.11	1.14	XXXX
CANT 13438M001	11	XXXXXXX	0.67	0.31	1.40	XXXX
COMO 12761M001	11	XXXXXXX	0.87	1.33	1.09	XXXX
GLSV 12356M001	11	XXXXXXX	0.32	0.59	2.37	XXXX
GRAS 10002M006	11	XXXXXXX	0.78	0.22	1.32	XXXX
GUIP 10004M501	11	XXXXXXX	0.55	1.44	0.98	XXXX
HFLK 11006S003	11	XXXXXXX	0.53	0.49	0.85	XXXX
HOFN 10204M002	11	XXXXXXX	0.62	2.19	1.07	XXXX
JOZE 12204M001	11	XXXXXXX	0.96	0.26	1.52	XXXX
LAMP 12706M002	11	XXXXXXX	0.95	0.29	0.94	XXXX
MALL 13444M001	11	XXXXXXX	0.83	1.20	0.96	XXXX
MARS 10073M008	11	XXXXXXX	0.28	0.66	3.58	XXXX
MATE 12734M008	11	XXXXXXX	0.26	0.35	1.04	XXXX
METS 10503S011	11	XXXXXXX	0.61	0.26	1.45	XXXX
MILO 12758M001	11	XXXXXXX	0.29	0.63	1.05	XXXX
MLVL 10092M001	11	XXXXXXX	0.35	0.34	1.13	XXXX
NOT1 12717M004	11	XXXXXXX	0.48	0.83	0.87	XXXX
ONSA 10402M004	11	XXXXXXX	0.26	0.53	0.57	XXXX
POTS 14106M003	11	XXXXXXX	0.24	0.26	1.28	XXXX
PUYV 10065M001	11	XXXXXXX	0.58	0.47	0.74	XXXX
SFER 13402M004	11	XXXXXXX	0.92	0.49	1.29	XXXX
SOFI 11101M002	11	XXXXXXX	0.81	0.25	2.47	XXXX
TLSE 10003M009	11	XXXXXXX	0.57	1.06	1.52	XXXX
TRAB 20808M001	10	XXXXXX	0.55	0.47	1.80	XXXX
TRO1 10302M006	11	XXXXXXX	0.21	0.41	0.64	XXXX
VILL 13406M001	11	XXXXXXX	0.22	0.35	1.16	XXXX
WTZR 14201M010	11	XXXXXXX	0.17	0.53	2.03	XXXX
Total	**328**		**0.59**	**0.77**	**1.45**	

Comparison grouped by software packages planned

Consistency of LACs

weekly solutions

Helmert Transformation Parameters With Respect to Combined Solution:

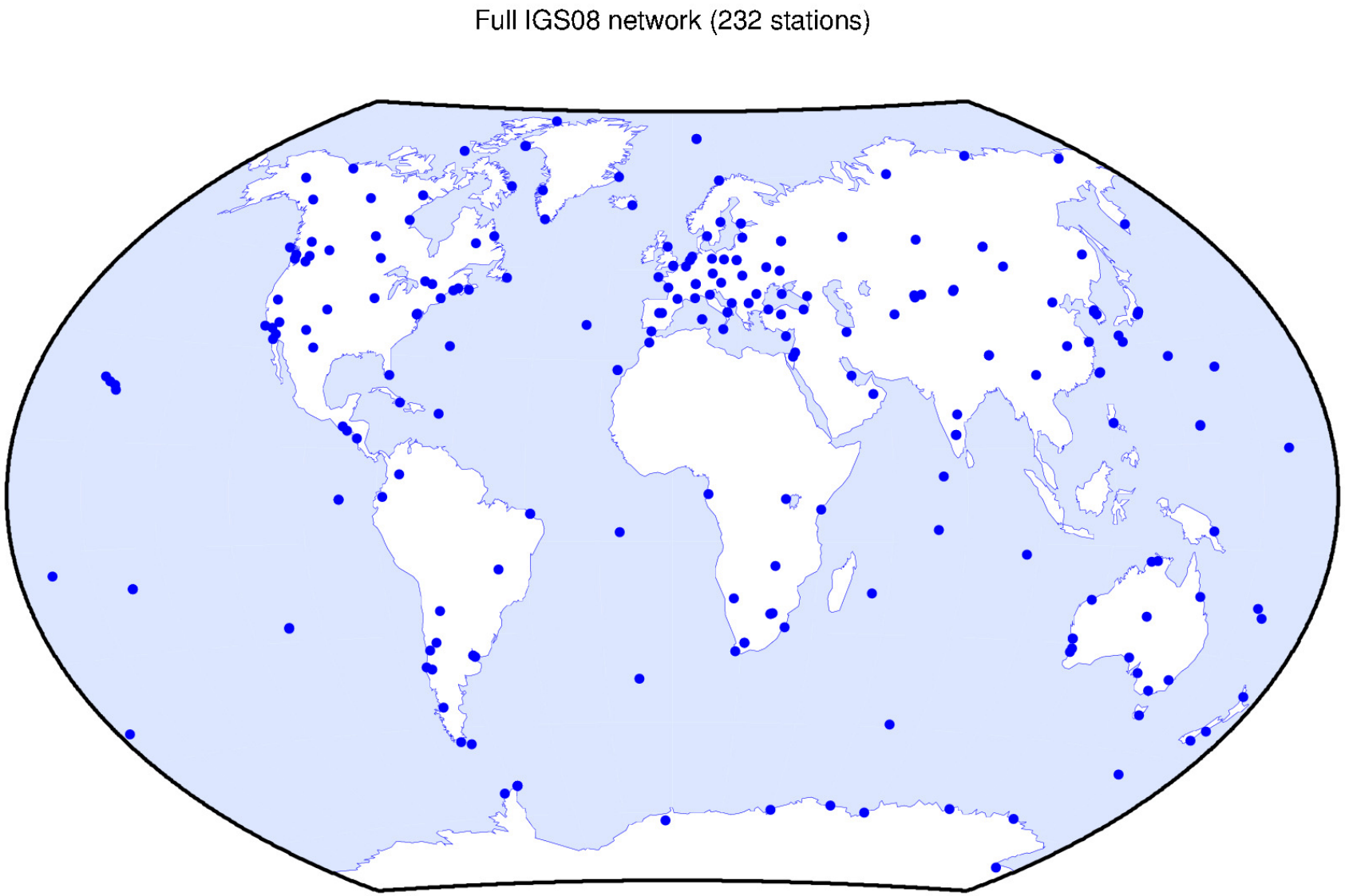
Sol	Rms (m)	Translation (m) X	Y	Z	Rotation (") X	Y	Z	Scale (ppm)	
1	0.00262	-0.0023	-0.0105	-0.0081	0.0003	0.0001	-0.0001	0.00120	**GIPSY**
2	0.00053	0.0026	-0.0035	-0.0018	0.0000	0.0001	-0.0001	0.00004	
3	0.00082	0.0011	0.0039	-0.0019	-0.0001	0.0001	0.0001	-0.00004	
4	0.00040	0.0002	0.0015	-0.0000	-0.0000	0.0000	0.0000	-0.00004	
5	0.00027	-0.0009	0.0020	0.0013	-0.0000	-0.0000	0.0001	-0.00008	
6	0.00041	-0.0016	0.0008	0.0015	0.0000	-0.0001	0.0000	-0.00004	
7	0.00147	-0.0029	-0.0006	-0.0063	0.0000	0.0001	0.0001	0.00112	**GAMIT**
8	0.00026	-0.0001	0.0000	0.0006	0.0000	-0.0000	0.0000	-0.00006	
9	0.00080	-0.0027	-0.0016	0.0024	0.0001	-0.0001	-0.0000	-0.00002	
10	0.00054	0.0023	-0.0022	-0.0039	0.0000	0.0001	-0.0001	0.00031	
11	0.00033	-0.0018	0.0004	0.0022	0.0000	-0.0001	0.0000	-0.00007	

IGS08 Reference Coordinates and Velocities

Scope

- Question:
  - ITRF2008 or IGS08 for EPN reference frame specification?
- Remark 1:
  - IGS08 must be considered as interaction of IGS08.snx and IGS08.atx (satellite and receiver antenna PCOs and PCVs)
- Remark 2:
  - IGS08 is a subset of 232 stable, well-performing IGS stations from ITRF2008 (in total 580 stations)

Dense Coverage to Satisfy Regional Users



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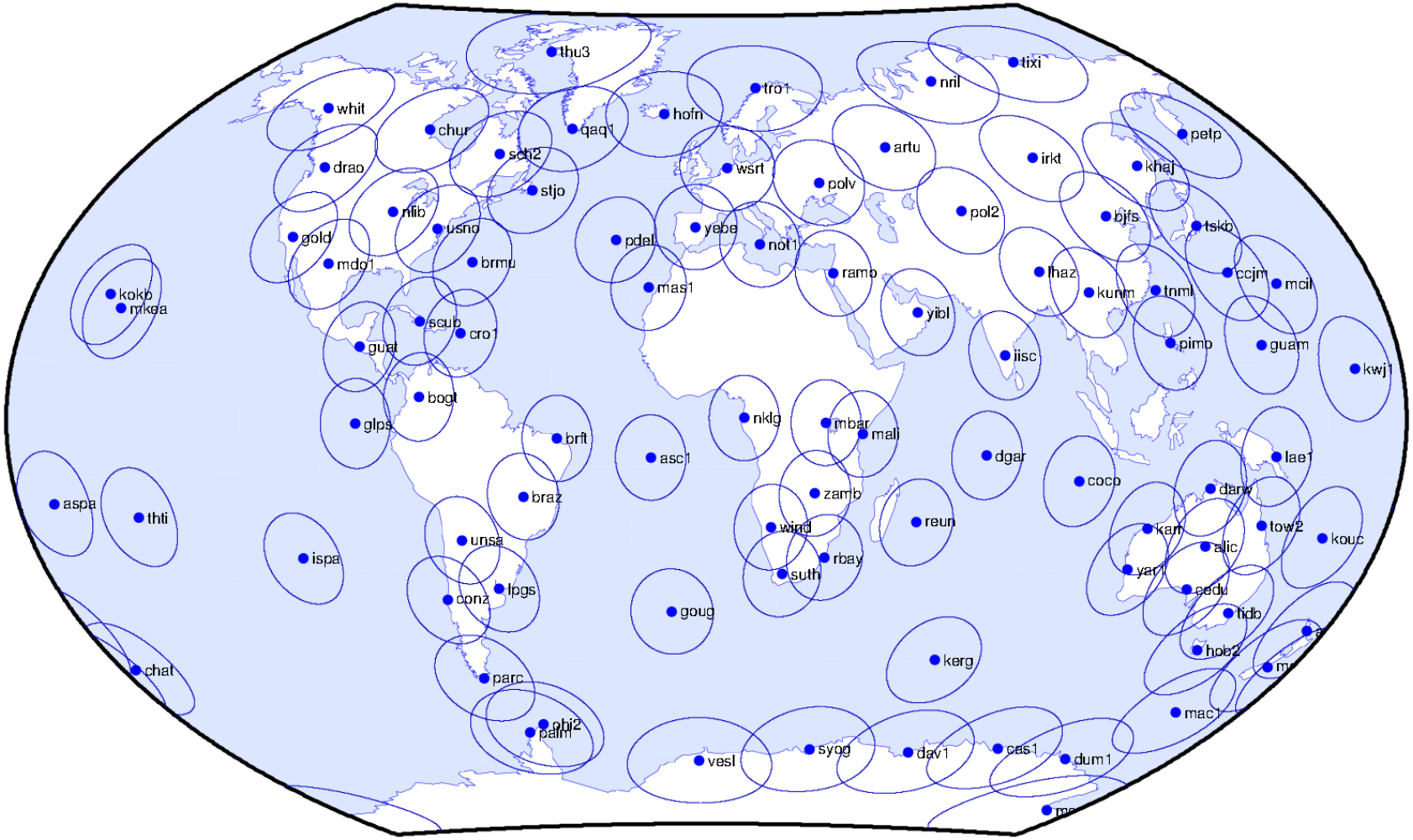
Homogeneous Sub-Network for Alignment of Global Frames

The 91 primary stations of the IGS08 core network



Definition of IGS08

Update of receiver antenna corrections in IGS08.atx

Impact of calibration update of station coordinates assessed by PPP strategy and applied to ITRF2008 coordinates

a) non-significant impact: IGS08=ITRF2008
b) significant impact: IGS08=ITRF2008+correction

Significant impact for 35 EPN stations belonging to IGS08 detected

Satellite PCO re-estimated consistently with IGS08 scale (~1 ppb difference to IGS05 scale)

SINEX Header Information IGS05.SNX and IGS08.SNX

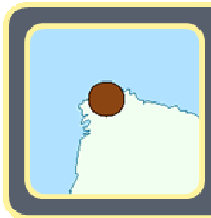
- IGS realization of ITRF2005 using 132 selected stations.
  1) Coordinates extracted from ITRF2005_IGS-TRF.SNX
  2) Applied the relative to absolute phase center corrections to 1)
  3) Realigned (7-parameters Transformation) 2) to 1)

- IGS realization of ITRF2008 using 232 selected stations
  1) Coordinates extracted from ITRF2008-TRF-IGS.SNX
  2) Corrections due to antenna calibration changes from igs05.atx to igs08.atx applied to the ITRF2008 coordinates of some stations

ITRF2008 stations of EPN

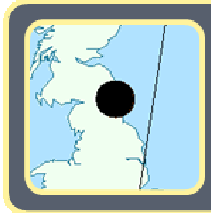
- Group of EPN stations included in ITRF, but **not** in IGS08
  - impact of IGS08.atx update not verified by IGS, do be done by …(?)
  - reliability and acceptance of any results for coordinate corrections to be discussed
  - How may EPN station of that group are involved? Action started by EPN-CB?

ITRF2008 versus IGS08



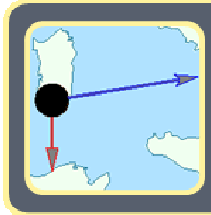
ITRF2008 station

- Not included in IGS08
- Consistency with IGS08.atx unclear



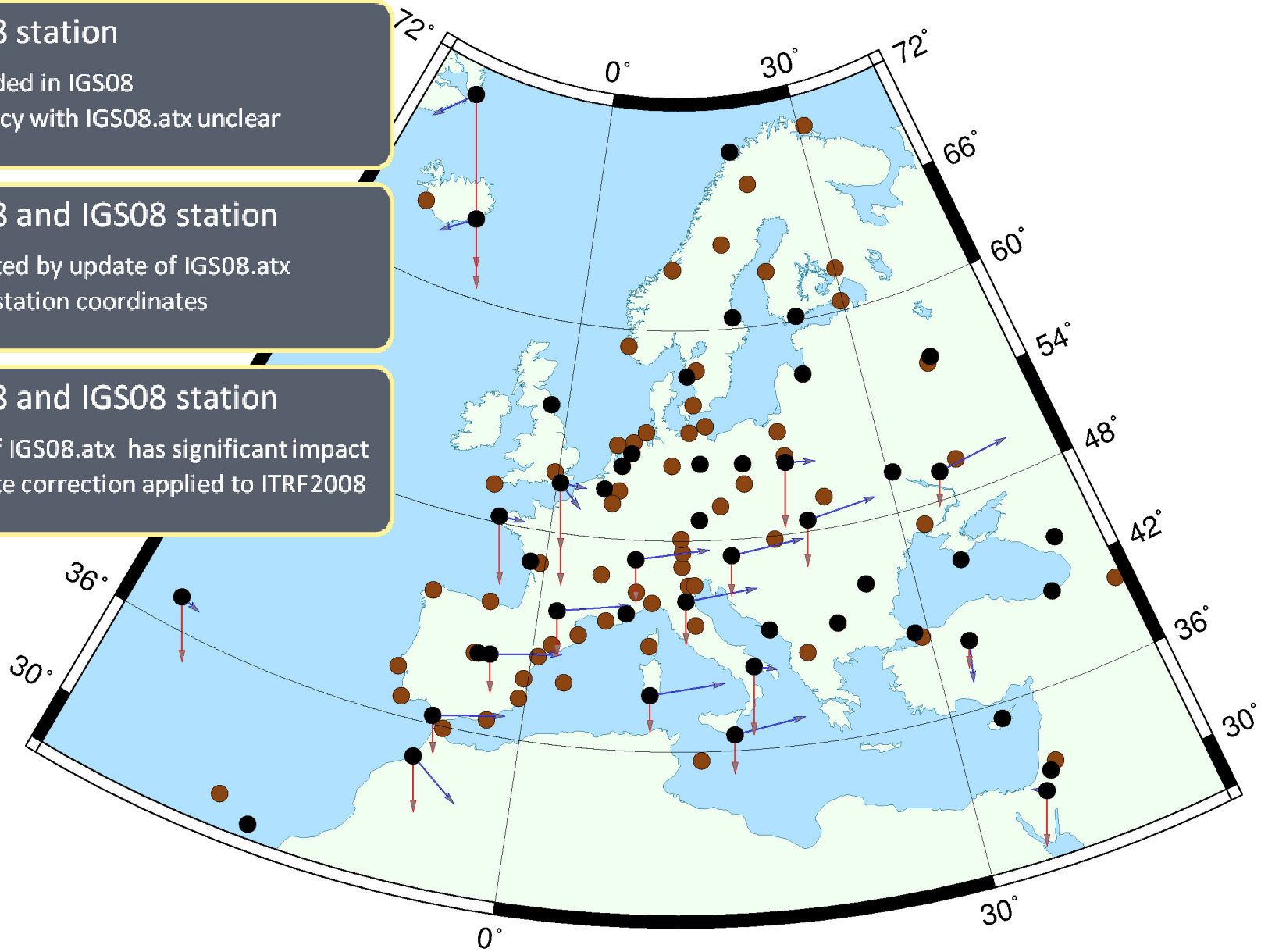
ITRF2008 and IGS08 station

- Not affected by update of IGS08.atx
- Identical station coordinates



ITRF2008 and IGS08 station

- Update of IGS08.atx has significant impact
- Coordinate correction applied to ITRF2008



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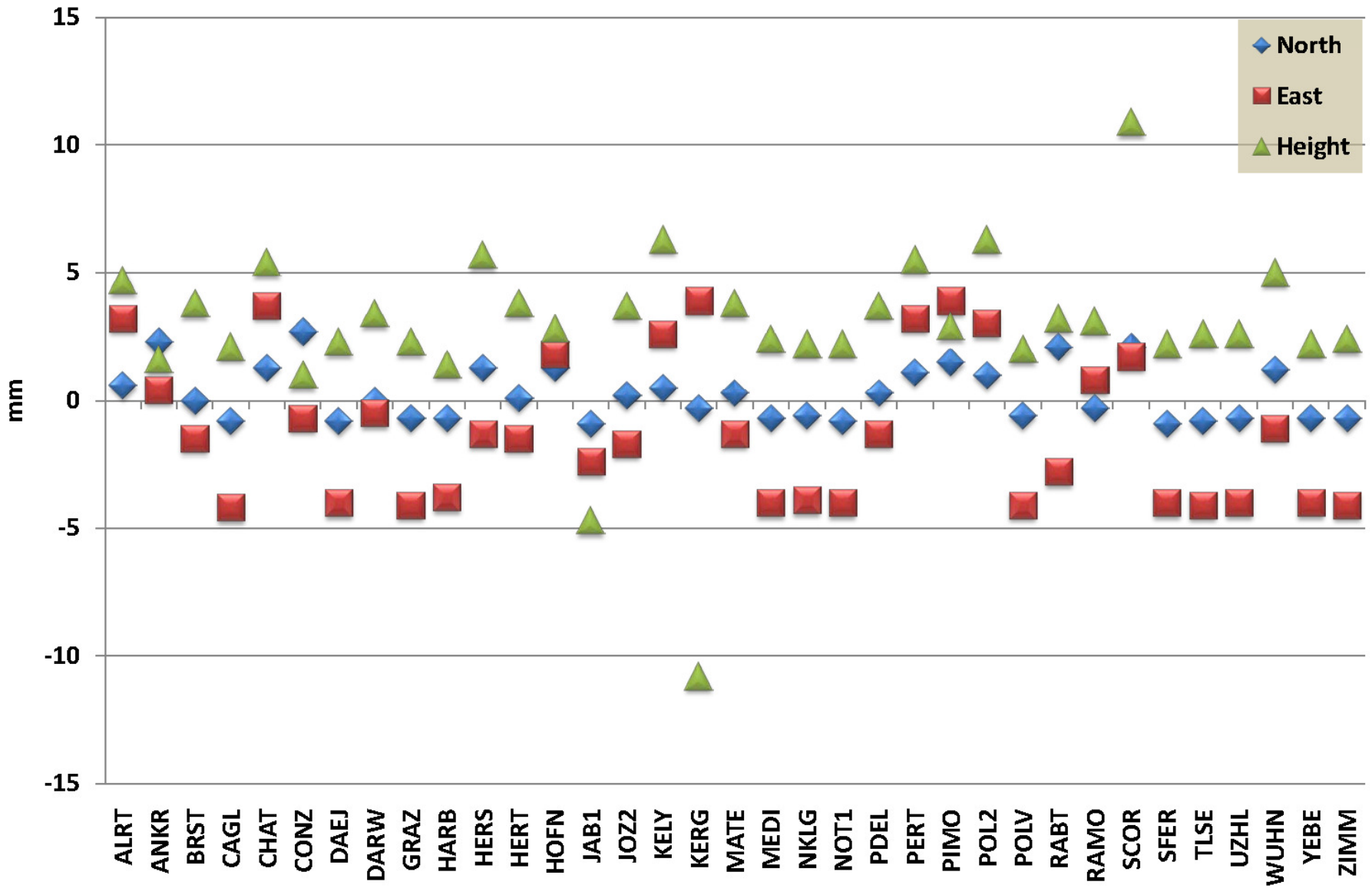
ITRF2008 to IGS08 Coordinate Coordinates of Affected EPN Stations



Conclusion for EPN Analysis

- Switch to IGS08.snx (crd and vel) and IGS08.atx for all EPN analysis steps simultaneously with the change for IGS product generation
- EPN reference frame specification:
  - Option 1: Use ITRF2008 station coordinates of EPN stations that belong to ITRF2008 and are not affected by IGS08.atx update (IGS08 coordinates of 35 EPN station will not be used)
    Open Issue: Verify ITRF2008 station not included in IGS08!
  - Option 2: Use IGS08 station coordinates for all EPN stations that belong to ITRF2008 (coordinates differ to ITRF2008 for 35 stations) **What about unused ITRF2008 stations of EPN?**
- Global transformation between ITRF2008 and IGS08 is considered as zero. Transformation parameters of “Memo” are to be used both options given above