CEGRN reprocessing using repro2 products

Motivation and Goals (extract from the EUREF CEGRN MoU signed in Chisinau, 2011)

3. Objectives

- The objective of this Memorandum of Understanding is, in general, to create the conditions to facilitate the data exchange and to promote the increase in the co-operation between the two parties, for the benefit of both, and in particular, to facilitate the densification of the European GNSS network for reference frame definition and geokinematical applications.
- It is expected that a closer co-operation between EUREF and CEGRN will increase the level of support to the IAG Dense Velocity Field Project, and the availability of a combined solution with respect to a denser network.
- Moreover, the co-operation will contribute to:

✓ provide better and more consistent data for geokinematics, by the optimization of guidelines for approval of networks with position and velocities and the improvement of offset treatment in time series;

✓ stimulate reprocessing of old EPN data, taking into account the foreseen realization of CEGRN 2011 and the completion of the reprocessing of the EPN;

✓ involve more nations into the INSPIRE initiative, in particular with the CRS (Coordinate Reference Systems) Implementing Rules.

CEGRN overview

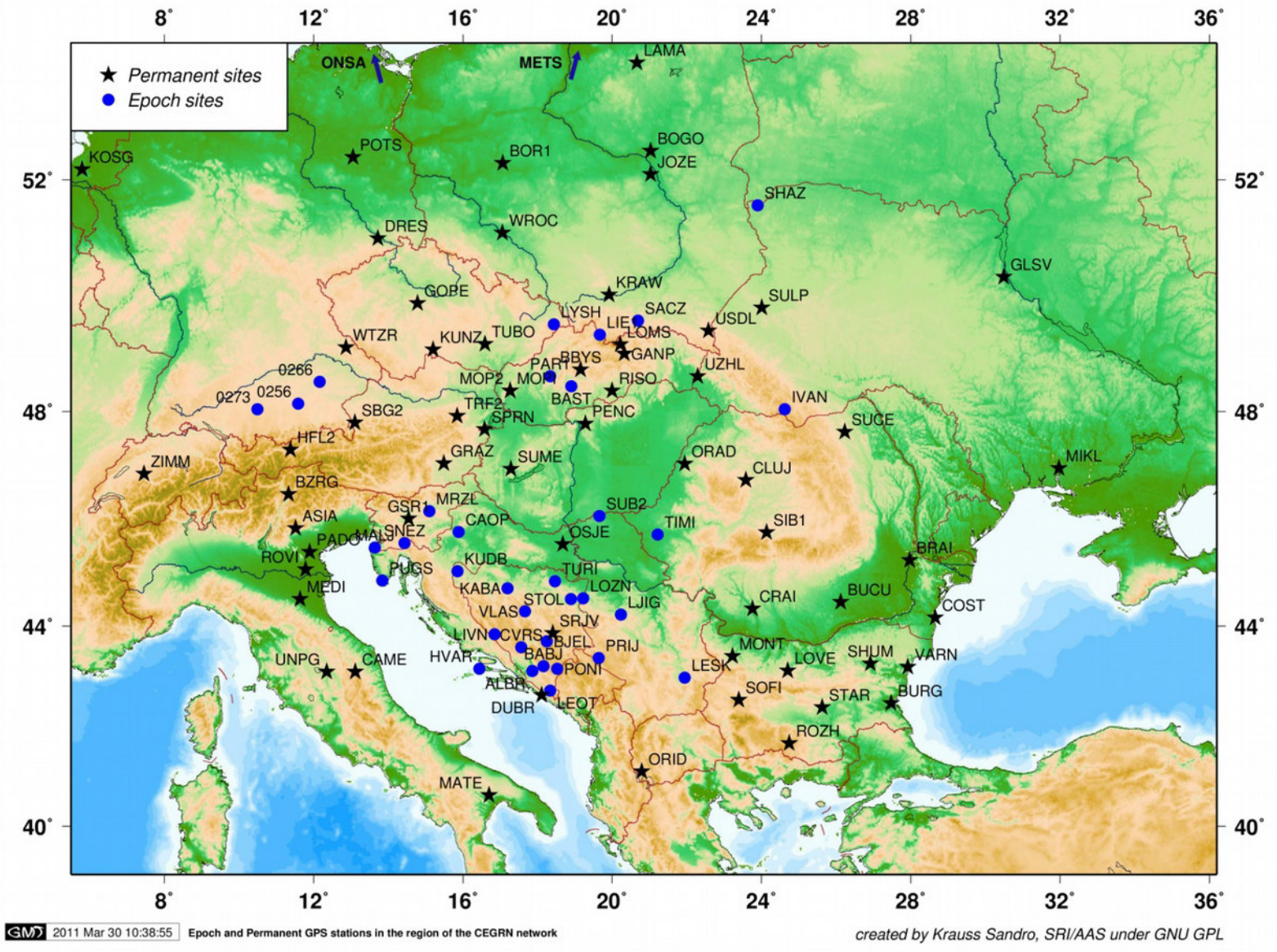
CEGRN 2013

Country	Total	EPN	CEGRN	SAPOS
AUT	4	3	1	
BIH	24	1	23	
BUL	7		7	
CRO	5	5		
CZE	3	3		
GER	6	3		3
HUN	4	4		
ITA	7	5	2	
POL	8	7	1	
ROM	9	2	7	
SRB	9		9	
SVK	6	4	2	
SLO	1	1		
UKR	3	3		

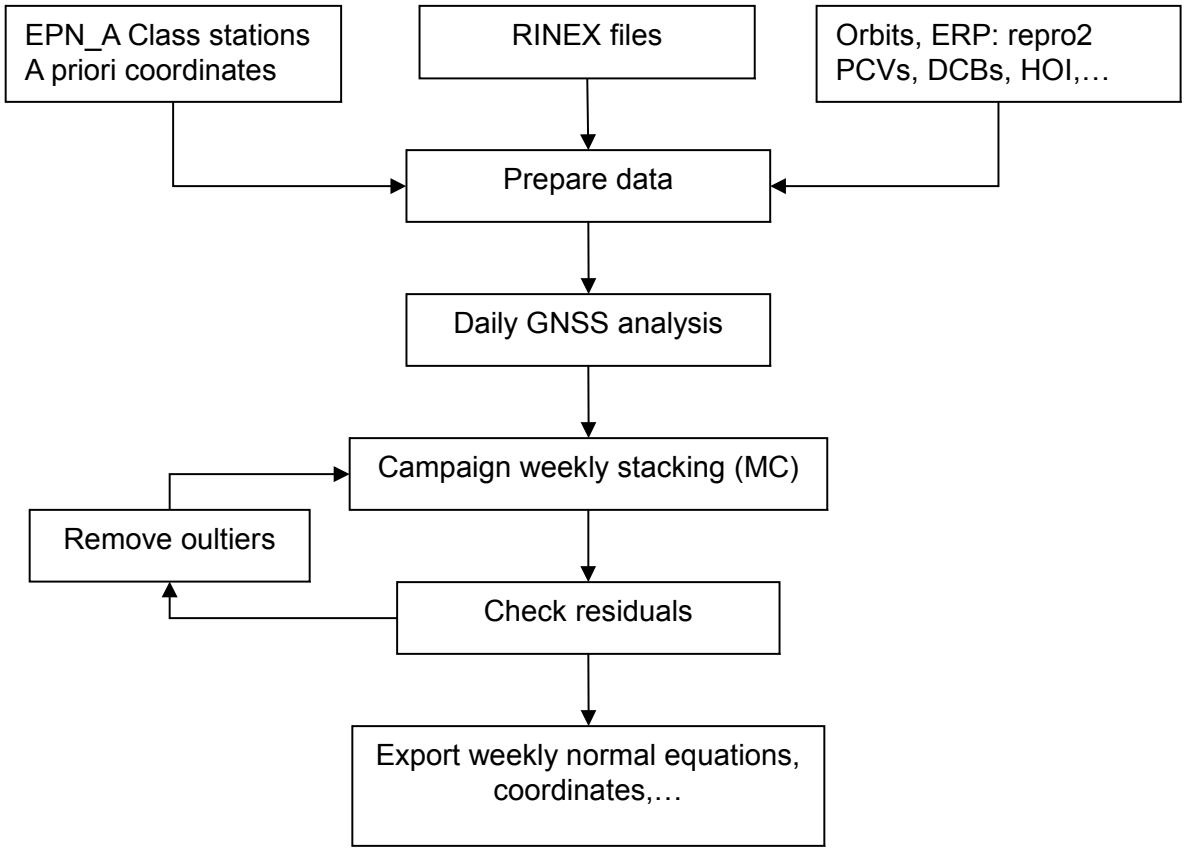
SUMMARY

CAMPAIGN	PERIOD	COUNTRIES	SITES
CERGN'94	2-6 May, 1994	10	30
CERGN'95	29 May- June 3, 1995	11	36+5
CERGN'96	10-15 June, 1996	11	35+6
CERGN'97	04-10 June, 1997	12	35+10
CERGN'99	14-19 June, 1999	13 (extended network)	57 (29P+38E)
CERGN'01	17-23 June, 2001	13 (extended network)	51 (28P+23E)
CERGN'03	16-21 June, 2003	13 (extended network)	51 (28P+23E)
CERGN'05	20-25 June, 2005	14 (extended network)	94
CERGN'06	12-18 June, 2005	Only CGPS	44P
CERGN'07	18-23 June, 2007	14 (extended network)	95
CERGN'09	22-27 June, 2009	14 (extended network)	85
CERGN'11	20-25 June, 2011	14 (extended network)	74
CERGN'13	16-22 June, 2013	14	96

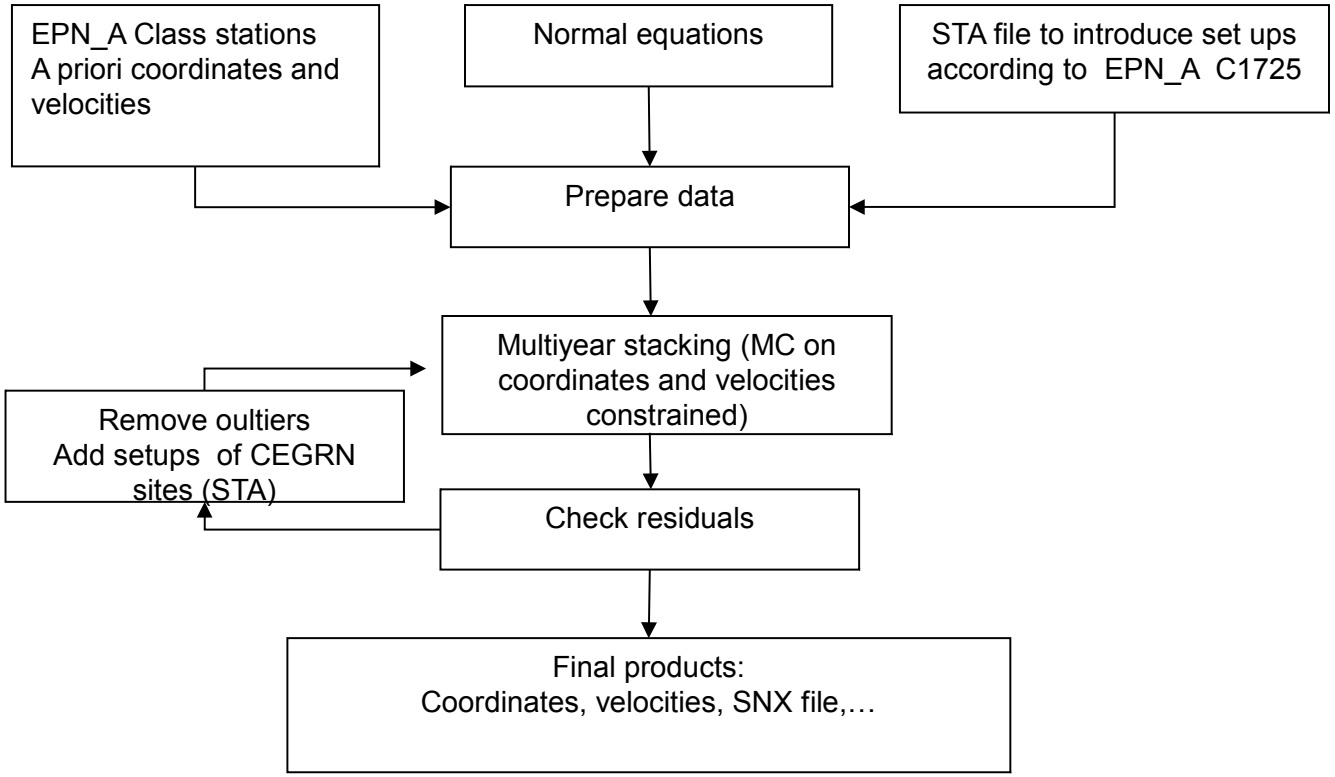
CEGRN overview



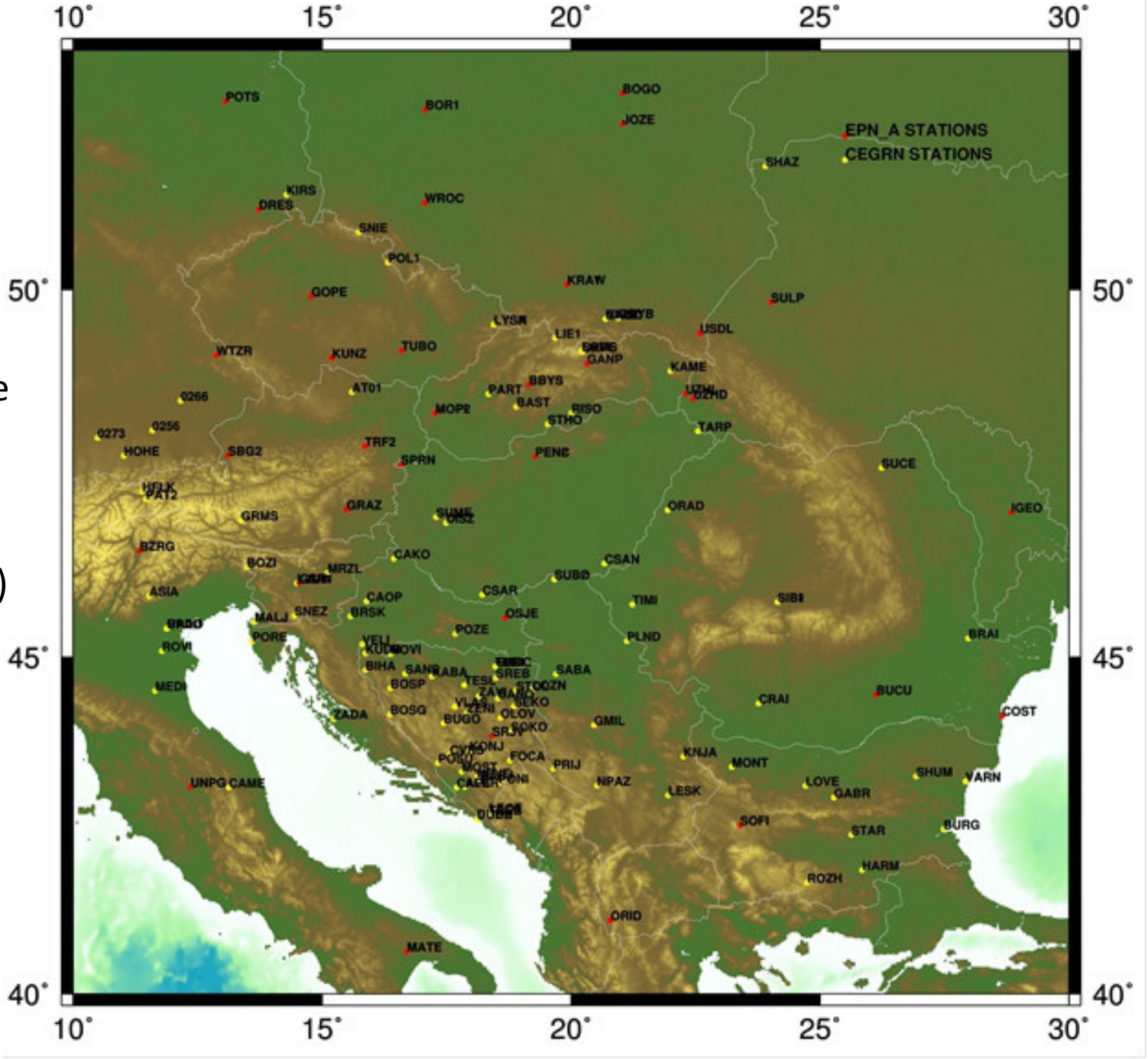
Processing of a weekly campaign (EUREF guidelines)



Stacking of weekly campaigns (EUREF guidelines)



CEGRN sites in the context of the EPN_A sites used for alignment to ETRF2000 (C1725)



Summary of the considered parameters (BSW52*)

- Orbits, ERP, Iono…
  - All needed products: IGb08 orbits, ERPs,… used. Source: CODE (repro2).
- Loading:
  - FES2004 ocean loading.
  - Atmospheric loading applied. Coeffs. for each site obtained from a gridded model (computed with GRDS1S2, from BSW52).
- Following the latest recommendations:
  - Cutoff angle: 3 deg.; elevation dependent weighting
  - ZTD parameters are estimated using WET GMF mapping function and CHENHER gradient estimation model.
  - Iono: No a priori model. Ionospheric effect removed by the “iono-free” linear combination. CODE’S Ionospheric data used to compute 2nd and 3rd order ionospheric corrections.
- Add discontinuity if the difference in coordinates is :
  - 6 mm in N or E,
  - 10 mm in U

  Note: no specification in the Guidelines
- Final solution: MC to EPN_A class sites (EPN_A C1725): threshold 10 mm in any component, as specified in the Guidelines
- Antennas: G. Stangl prepared a file with the PCVs for all the antennas used.

(*) the analysis (repro2 +stacking) was originally done with BSW50 and repeated with BSW52 which was released in the meantime

Weekly results (repeatibilities)

Computed Sites	Repeatibility (mm) N	E	U	
50	1.54	1.16	3.82	CEGRN 1996
44	1.34	1.01	3.40	CEGRN 1997
62	1.46	0.97	3.73	CEGRN 1999
57	1.16	0.83	3.77	CEGRN 2001
77	1.20	0.93	3.19	CEGRN 2003
105	1.14	0.91	3.74	CEGRN 2005
95	1.37	1.23	4.06	CEGRN 2007
85	1.18	0.98	3.83	CEGRN 2009
60	0.82	0.90	3.24	CEGRN 2011
101	1.02	1.15	3.90	CEGRN 2013

- Outlier thresholds for the daily and weekly solutions are:
  - 6 mm for the E, N components,
  - 10 mm for the U component.
- Any value exceeding any of those thresholds has been considered as an outlier and removed from the daily stacking.
- Regarding the weekly solutions, an EPN_A class site used for MC has been considered as a non-fixed site in the yearly stacking if the residual wrt the published value is >10 mm in any component. This is to be reported, according to the Guidelines

Combined results: individual vs combined Helmert 7D for all sites (EPN_A/MC+CEGRN)

		Translation (m)			Rotation (")			
Sol	Rms (m)	X	Y	Z	X	Y	Z	Scale (ppm)
1	0.00216	-0.0033	-0.0209	0.0057	0.0005	-0.0003	-0.0005	0.00004
2	0.00203	-0.0016	0.0366	-0.0083	-0.0009	0.0001	0.0008	0.00018
3	0.00235	-0.0078	0.0006	0.0053	0.0001	-0.0003	0.0002	0.00024
4	0.00158	0.0081	-0.0296	-0.0003	0.0007	0.0002	-0.0006	0.00016
5	0.00146	-0.0091	-0.0031	0.0088	0.0001	-0.0004	-0.0000	-0.00016
6	0.00212	-0.0025	0.0211	-0.0043	-0.0006	0.0000	0.0004	-0.00015
7	0.00269	0.0005	0.0075	0.0023	-0.0001	-0.0000	0.0002	-0.00087
8	0.00199	0.0050	-0.0106	-0.0038	0.0002	0.0002	-0.0003	0.00029
9	0.00153	-0.0018	-0.0049	-0.0003	0.0001	-0.0000	-0.0001	0.00038
10	0.00122	0.0028	-0.0001	-0.0012	-0.0000	0.0001	-0.0001	-0.00014

Remarks:

-This table shows how close the epoch realizations of the ETRF2000 are to the combined frame

Request for validation

We identify three groups of results:

- i) **Epoch sites**: these are sites observed in one weekly campaign only. We request validation of the coordinates at the epoch of the campaign. Residuals of the daily estimates to the weekly value are presented, to highlight that the requirement of Class B is met.
- ii) **Sites observed for 2 or more campaigns, without validated velocity**: sites with two epochs only , or sites with three or more epochs but with discontinuities are requested for validation at the individual epochs. Velocities were estimated in the multiyear adjustment, as mandatorily requested by the Guidelines, but to our judgment are insufficiently constrained to be submitted for validation. These sites should qualify as class B at the individual campaign epochs.
- iii) **Sites observed three or more campaigns (hence for more than three years) with continuous time series.** For these sites qualify for class A (10 mm and 1 mm/yr precision in position resp. velocity at all epochs).

STATION	YEARS OBSERVED	WEEKLY REPEATIBILITY (SOLS.,REP. NEU MM)					REMARKS
ALBR	2005	ALBR 00000M000	1	0.05	0.06	0.58	
BABJ	2005	BABJ 00000M000	1	0.08	0.04	0.68	
BANO	2013	BANO 00000M000	1	0.04	0.05	0.16	
BIHA	2013	BIHA 00000M000	1	0.00	0.06	0.19	
BOSA	2013	BOSG 00000M000	1	0.02	0.07	0.22	Refers to BOSG (Bosansko Grahovo)
BUGO	2013	BUGO 00000M000	1	0.03	0.07	0.21	
CAPL	2013	CAPL 00000M000	1	0.06	0.09	0.28	
CVRS	2005	CVRS 00000M000	1	0.01	0.11	0.50	
FOCA	2013	FOCA 00000M000	1	0.07	0.07	0.23	
GRDC	1999	GRDC 00000M000	1	0.27	0.19	0.58	
KABA	2005	KABA 00000M000	1	0.12	0.03	0.21	
KNJA	2013	KNJA 12113M001	1	0.08	0.06	0.37	EPN candidate
KONJ	2013	KONJ 00000M000	1	0.05	0.07	0.23	
LEOT	2005	LEOT 00000M000	1	0.12	0.02	0.66	
MOST	2013	MOST 00000M000	1	0.06	0.08	0.26	
NEVE	2013	NEVE 00000M000	1	0.07	0.08	0.28	
NOVI	2013	NOVI 00000M000	1	0.00	0.05	0.19	
NPAZ	2013	NPAZ 12110M001	1	0.09	0.08	0.19	
OLOV	2013	OLOV 00000M000	1	0.05	0.05	0.18	
PLND	2013	PLND 12111M001	1	0.09	0.02	0.03	
PONI	2005	PONI 00000M000	1	0.07	0.04	0.56	
POSU	2013	POSU 00000M000	1	0.05	0.08	0.26	
SABA	2013	SABA 12112M001	1	0.07	0.01	0.03	
SANS	2013	SANS 00000M000	1	0.01	0.06	0.18	

Sites observed in one campaign only, meeting the requirements for class B) : validation of the coordinates at the campaign epoch (= minimum variance epoch)

SABA	2013	SABA 12112M001	1	0.07	0.01	0.03	EPN candidate
SANS	2013	SANS 00000M000	1	0.01	0.06	0.18	
SEKO	2013	SEKO 00000M000	1	0.05	0.05	0.16	
SOKO	2013	SOKO 00000M000	1	0.06	0.06	0.19	
SREB	2013	SREB 00000M000	1	0.04	0.04	0.14	
STOL	2005	STOL 00000M000	1	0.04	0.08	0.12	
TESL	2013	TESL 00000M000	1	0.03	0.05	0.17	
TREB	2013	TREB 00000M000	1	0.09	0.09	0.33	
TURI	2005	TURI 00000M000	1	0.02	0.01	0.16	
VELI	2013	VELI 00000M000	1	0.01	0.06	0.17	
VLAS	2005	VLAS 00000M000	1	0.03	0.03	0.49	
ZAVI	2013	ZAVI 00000M000	1	0.04	0.05	0.17	
ZENI	2013	ZENI 00000M000	1	0.04	0.06	0.19	

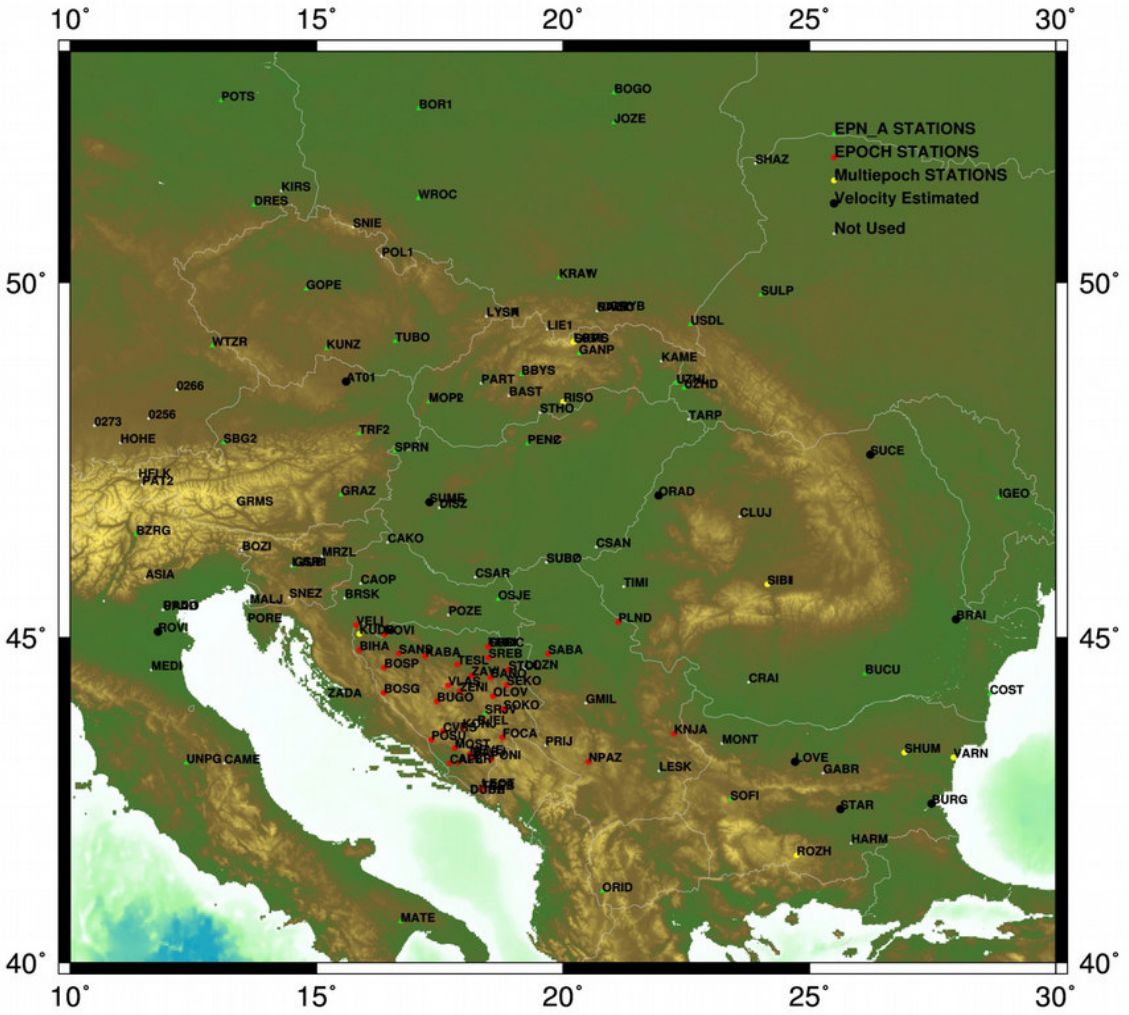
STATION	YEARS OBSERVED	WEEKLY REPEATIBILITY (SOLS.,REP. NEU MM)					REMARKS
BRAI	2003-2007, 2009, 2013	BRAI 00000M001	4	0.80	1.33	0.55	
BURG	2009-2013	BURG 00000S001	3	1.09	0.61	0.67	
CLUJ	2003, 2005, 2007, 2009-2013	CLUJ 00000M000A	1	0.16	0.03	0.04	
		CLUJ 00000M000B	1	0.12	0.05	0.46	
		CLUJ 00000M000C	1	0.13	0.28	0.15	
		CLUJ 00000M000D	2	0.17	0.18	3.05	
HFLK	1996-1997, 1999-2007	HFLK 11006S003A	2	2.45	0.74	7.16	Former EPN site, identical to HFL2 if different antenna height applied
		HFLK 11006S003B	4	1.68	1.24	9.67	
		HFLK 11006S003C	2	1.97	0.25	17.45	
HOHE	1996-2003, 2005, 2007	HOHE 00000M000A	4	0.70	1.61	3.10	
		HOHE 00000M000B	1	0.16	0.13	1.84	
		HOHE 00000M000C	1	0.09	0.37	1.84	
KOSG	1996-2001, 2003-2009, 2013	KOSG113504M003	4	0.63	0.58	0.78	EPN A site
		KOSG213504M003	4	1.71	0.62	3.73	
		KOSG513504M003	1	0.21	0.11	0.70	
LOMS	2005-2009, 2013	LOMS 00000M000A	3	1.46	0.62	1.22	
		LOMS 00000M000B	1	1.48	0.07	9.34	
LOVE	2009-2013	LOVE 00000S001	3	0.76	0.34	0.73	
RISO	2005, 2013	RISO 00000S001A	1	0.03	0.04	0.00	
		RISO 00000S001B	1	0.04	0.13	0.05	
ROZH	2005-2011, 2013	ROZH 00000S001A	4	0.55	0.61	1.62	
		ROZH 00000S001B	1	0.18	0.04	0.70	
SBGZ	1999, 2001-2005, 2007	SBG2 11031M002A	2	4.22	8.22	2.62	
		SBG2 11031M002B	3	2.10	4.34	1.5	
		SBG2111031M002	3	0.83	1.21	0.86	
SBGZ	1999, 2001-2005, 2007	SBG2 11031M002A	2	4.22	8.22	2.62	EPN A class site
		SBG2 11031M002B	3	2.10	4.34	1.5	
		SBG2111031M002	3	0.83	1.21	0.86	
SIB1	2009, 2013	SIBI 00000M001	3	1.68	0.91	2.56	
		SIB1 00000M002A	1	0.00	0.24	1.71	
		SIB1 00000M002B	1	0.01	0.01	0.67	
SUCE	2003-2009, 2013	SUCE 00000M001A	4	1.22	2.91	2.28	
		SUCE 00000M001B	1	0.16	0.12	0.39	
SULP	1997, 1999-2001, 2003-2013	SULP 00000M000A	1	0.05	0.07	5.50	
		SULP 00000M000B	2	5.34	3.81	4.99	
		SULP212366M001	6	0.39	1.07	2.44	
SUME	2005-2007, 2009-2013	SUME 11215M001A	2	1.28	1.09	2.90	
		SUME 11215M001B	2	0.66	0.44	1.73	
VARN	2005, 2011, 2013	VARN 00000S001A	1	0.39	0.17	3.11	
		VARN 00000S001B	1	0.07	0.20	2.56	
		VARN 00000S001C	1	0.05	0.15	1.46	

Sites with two epochs, or three or more epochs with discontinuous time series
Coordinates are to be validated at the campaign epochs. Velocity was estimated but is not submitted for validation

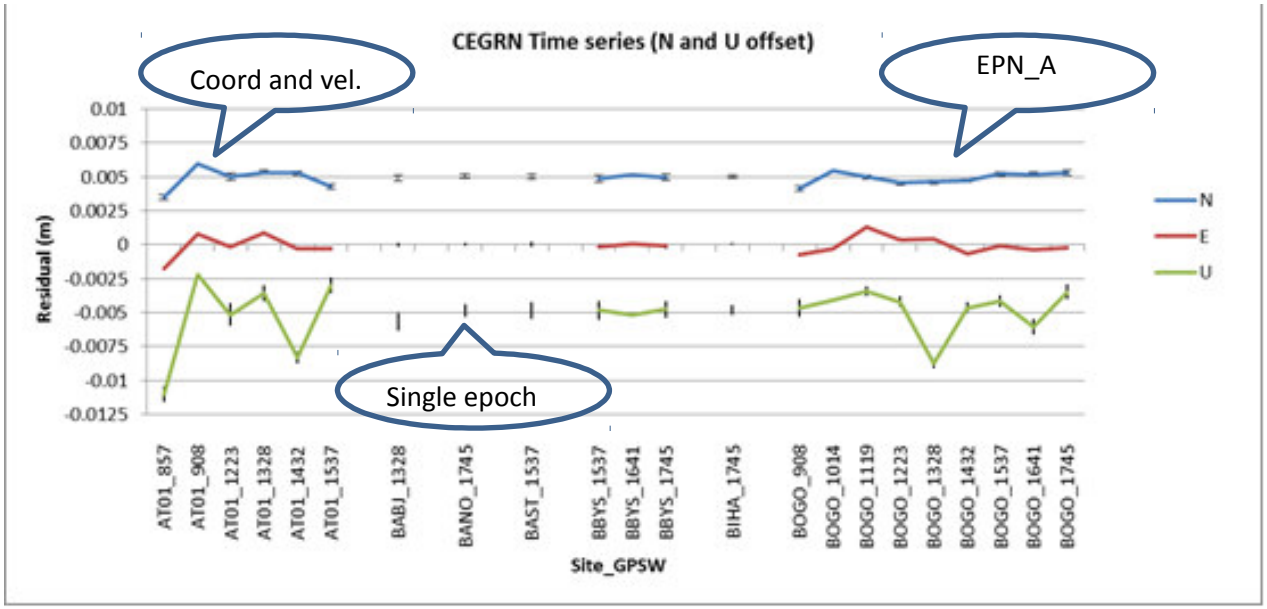
Sites observed three or more campaigns (i.e. typically > 6 years) with continuous time series: vaidation of coordinates and velocities

STATION	YEARS OBSERVED	WEEKLY REPEATIBILITY (SOLS.,REP. NEU MM)				REMARKS
AT01	1996-2009	AT01 11027M002A	2	1.81	1.90 6.63	Identical with HUTB
		AT01 11027M002B	4	0.45	0.61 2.41	
KUDB	2005-2007	KUDB 00000M000	2	0.35	0.08 0.22	
ORAD	2007-2013	ORAD 00000M001	3	1.14	0.15 2.51	
ROVI	2005-2013	ROVI 12769M001	4	0.90	0.23 2.22	
SHUM	2009-2013	SHUM 00000S001	2	0.37	0.12 0.43	
STAR	2009-2013	STAR 00000S001	3	0.27	0.67 1.31	
TRFB	2005-2007	TRF2 11047M002	2	2.60	1.33 35.21	Former EPN site, identical to TRF2
		TRF2111047M002	3	1.01	0.97 9.98	if different antenna height applied

EPN_A sites, single epoch sites, multiple epoch sites, sites with coords and velocity



Examples


CEGRN Time series (N and U offset)
Coord and vel.
EPN_A
Single epoch
Residual (m)
0.01
0.0075
0.005
0.0025
0
-0.0025
-0.005
-0.0075
-0.01
-0.0125
N
E
U
AT01_857
AT01_908
AT01_1223
AT01_1328
AT01_1432
AT01_1537
BABJ_1328
BANO_1745
BAST_1537
BBYS_1537
BBYS_1641
BBYS_1745
BIHA_1745
BOGO_908
BOGO_1014
BOGO_1119
BOGO_1223
BOGO_1328
BOGO_1432
BOGO_1537
BOGO_1641
BOGO_1745
Site_GPSW


40
30
20

Last remarks

- We are presenting the CEGRN multiyear combination for its approval by the TWG
- Repro2, GPS+Glonass
- Being a series of campaigns, the ETRF2000 has been realized in several epochs. Also the coordinates of some stations may be defined at different epochs.
- Within each realization, the sites apply for class B
- Some sites apply for velocity validation (Class A, according to the Guidelines)
- Full list available at the next TWG/Symposium