
EUREF-CEGRN MoU: repro2 of CEGRN campaigns and densification of EPN in Central Europe

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Why repro2?

■ Objectives of repro2

- ❑ Compute CEGRN data from 1996 to 2013
- ❑ Combine the solutions with EPNA_IGb08
- ❑ Contribute to WG 'Dense Velocity Fields' (Bruyninx, Kenyeres)
- ❑ Contribute to WG on 'Deformatin Models' (Lidberg)

■ Methodology

- ❑ Repro2 with BSW5.0 as intermediate step/benchmark
- ❑ Repro2 with BSW5.2 as final step
- ❑ EUREF's guidelines, SOLn's of reference sites

■ This means

- ❑ Consistent IGb08 orbits, PCV's and ERPs are used

Orbits and other files...

- The IGS08 orbits were retrieved from the CODE (created for the repro2 campaign) (Note: second reprocessing done in response to BSW mail on zero quality code issues)
- Some P1P2*.DCB needed files were missing, mainly DCB files (source: <ftp://ftp.unibe.ch/aiub/CODE/YYYY/>):
 - P1P2YYMM.DCB started being generated on 1997/10.
- 2013 reprocessed to embody Croatian stations

Old receivers

- Receiver related errors (*** SR GETRCV: RECEIVER TYPE NOT FOUND). These missing receivers were manually added to the \${X}/GEN/RECEIVER. file:
 - ❑ E_GGD, copied from JPS E_GGD
 - ❑ GB1000, copied from TPS GB-1000
 - ❑ GEOTRACER 100, copied from SPP GEOTRACER100
 - ❑ LEICA SR399, copied from LEICA SR399E
 - ❑ NET-G3, copied from TPS NETG3
 - ❑ ROGUE SNR-12 ACT, copied from ROGUE SNR-12
 - ❑ SR399, copied from LEICA SR399E
 - ❑ TPS HIPER_GGD, copied from TPS EGGDT
 - ❑ TRIMBLE 4400, copied from TRIMBLE 4700
 - ❑ TRIMBLE 4800, copied from TRIMBLE 4700

Antennas/campaigns

- 1996 Campaign (GPS week 0857, from dow 1 to 6). Wrong/non-existing antennas replaced with the antenna in the STA file:
 - DORNE MARGOLIN TNONE replaced in RINEX header by AOAD/M_T NONE in BOR1
 - TR GEOD L1/L2 GPNONE replaced in RINEX header by TRM22020.00+GP NONE in BRSK
 - 4000ST L1/L2 GEOD replaced in RINEX header by TRM14532.00 NONE in GOPE
 - DORNE MARGOLIN TNONE replaced in RINEX header by AOAD/M_T NONE in GRAZ
 - TR GEOD L1/L2 GPNONE replaced in RINEX header by ***** in HUTB: NOT USED.
 - 4000ST L1/L2 GEOD replaced in RINEX header by TRM14532.00 NONE in JOZE
 - DORNE MARGOLIN TNONE replaced in RINEX header by AOAD/M_B DUTD in KOSG
 - DORNE MARGOLIN TNONE replaced in RINEX header by AOAD/M_T NONE in LAMA
 - DORNE MARGOLIN TNONE replaced in RINEX header by AOAD/M_B NONE in METS
 - DORNE MARGOLIN TNONE replaced in RINEX header by AOAD/M_B DUTD in ONSA
 - 4000ST L1/L2 GEOD replaced in RINEX header by TRM14532.00 NONE in PENC
 - DORNE MARGOLIN TNONE replaced in RINEX header by AOAD/M_T NONE in POTS
 - 4000ST L1/L2 GEOD replaced in RINEX header by TRM14532.00 NONE in SOFI
 - 4000ST L1/L2 GEOD replaced in RINEX header by TRM14532.00 NONE in VAT1
 - 4000ST L1/L2 GEOD replaced in RINEX header by TRM14532.00 NONE in VRN1
 - DORNE MARGOLIN TNONE replaced in RINEX header by AOAD/M_T NONE in WTZR
 - 4000ST L1/L2 GEOD replaced in RINEX header by TRM14532.00 NONE in ZIMM

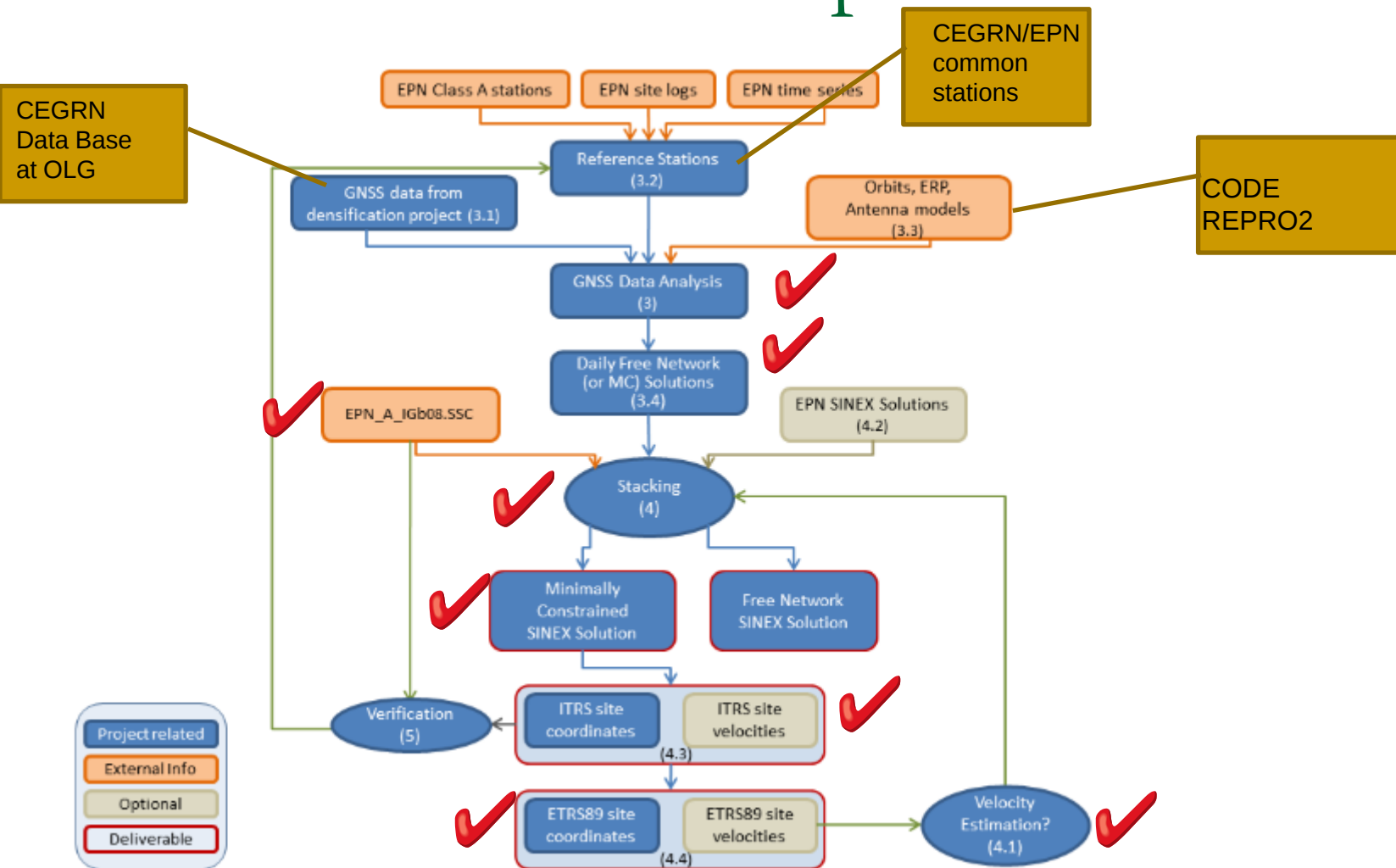
CEGRN Campaigns

Campaigns	Period	Country	Sites
CEGRN'94	2-6 May 1994	10	30
CEGRN'95	29 May-3 June 1995	11	36+5
CEGRN'96	10-15 June 1996	11	35+6
CEGRN'97	4-10 June 1997	12	35+10
CEGRN'99	14-19 June 1999	13 (extended network)	57 (19P+38E)
CEGRN'01	18-23 June 2001	13 (extended network)	51 (28P+23E)
CEGRN'03	16-21 June 2003	13 (extended network)	51 (28P+23E)
CEGRN'05	20-25 June 2005	14 (extended network)	94
CEGRN'06	12-18 June 2006	Only CGPS	44P
CEGRN'07	18-23 June 2007	14 (extended network)	
CEGRN'09	22-27 June 2009	14 (extended network)	85
CEGRN'11	20-26 June 2011	14 (extended network)	74
CEGRN'13	15-22 June 2013	14	96

Contributing Countries

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		

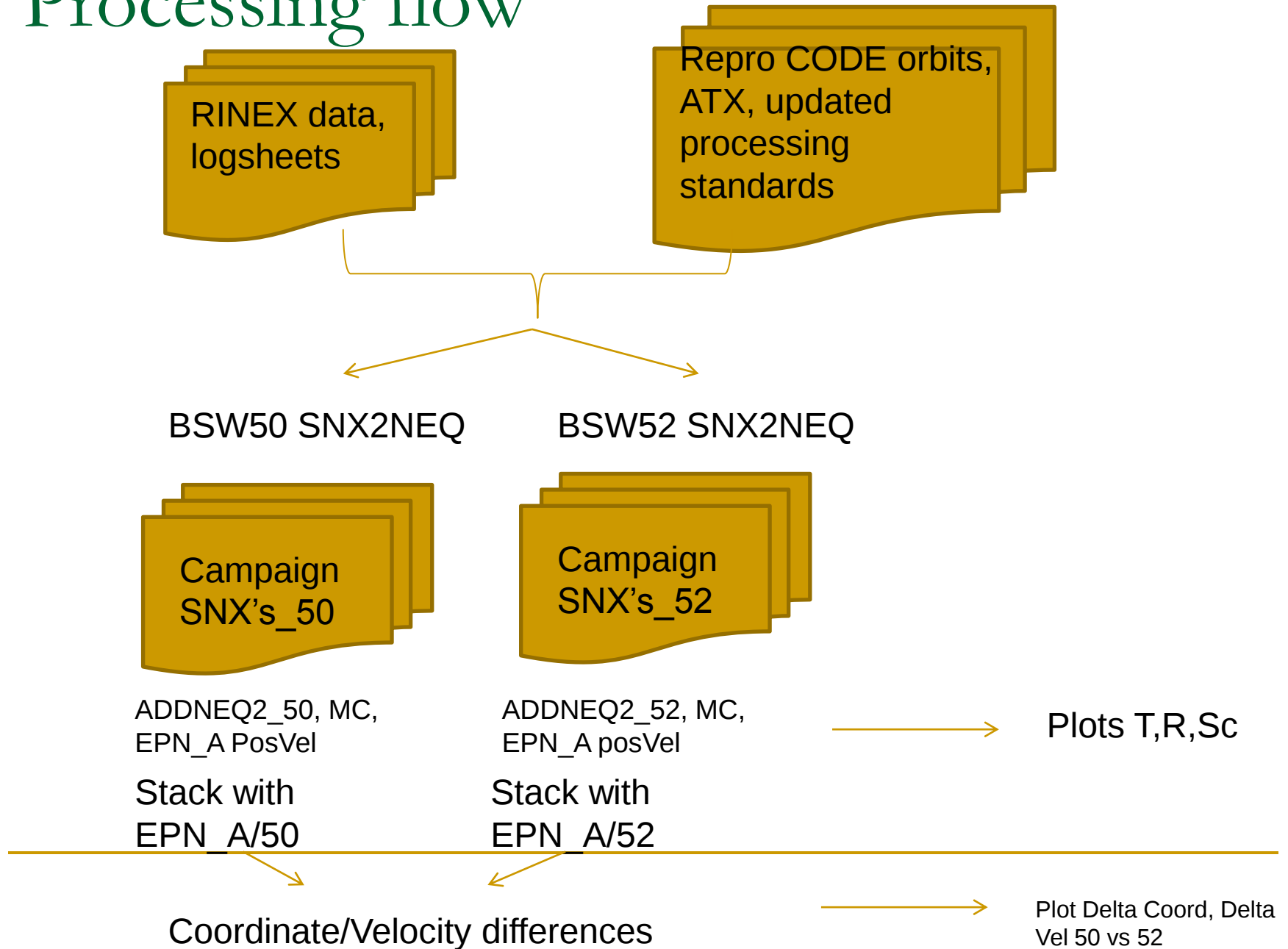
Review of standard procedure

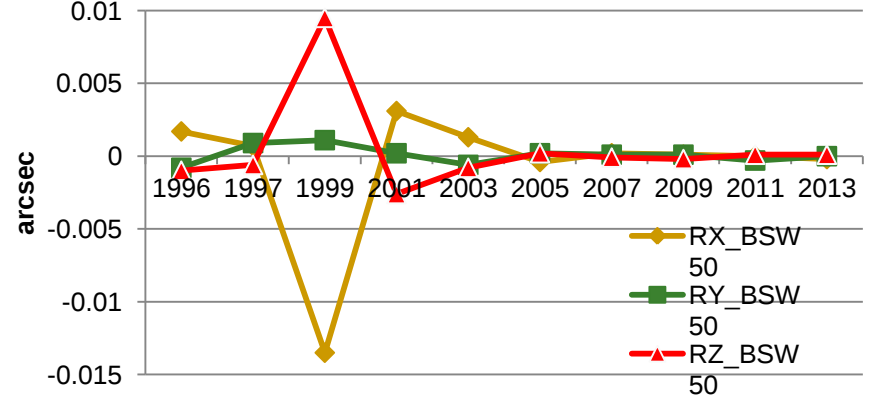
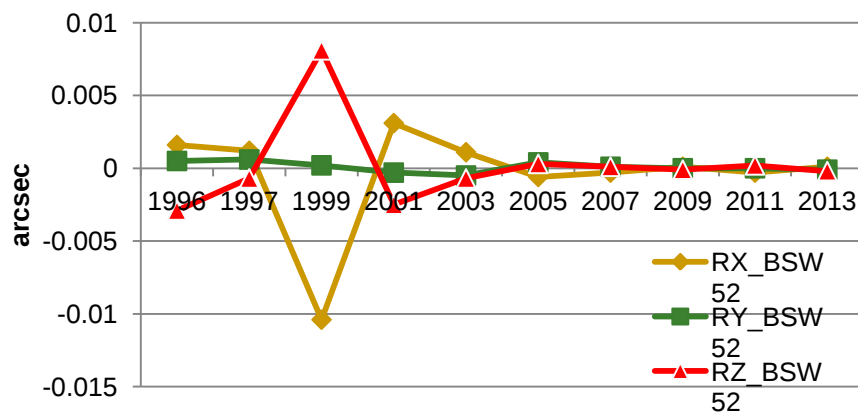
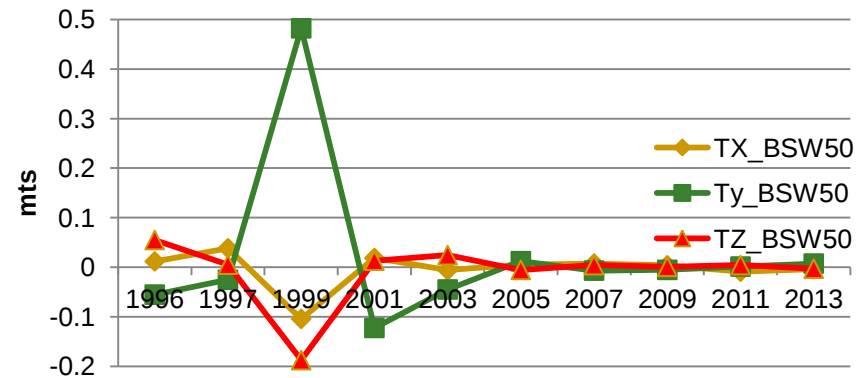
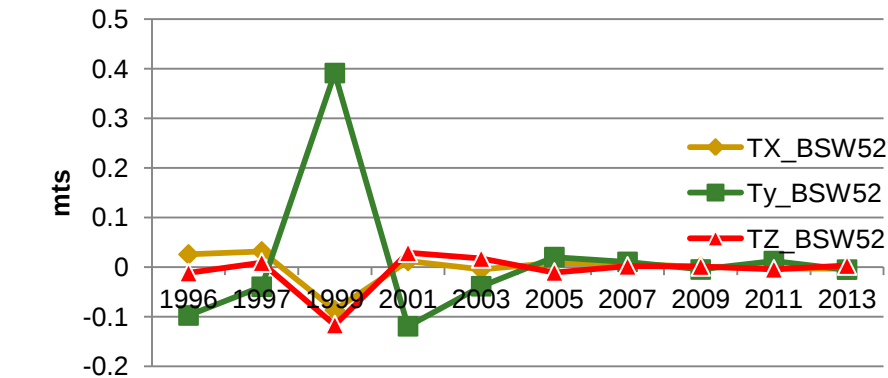
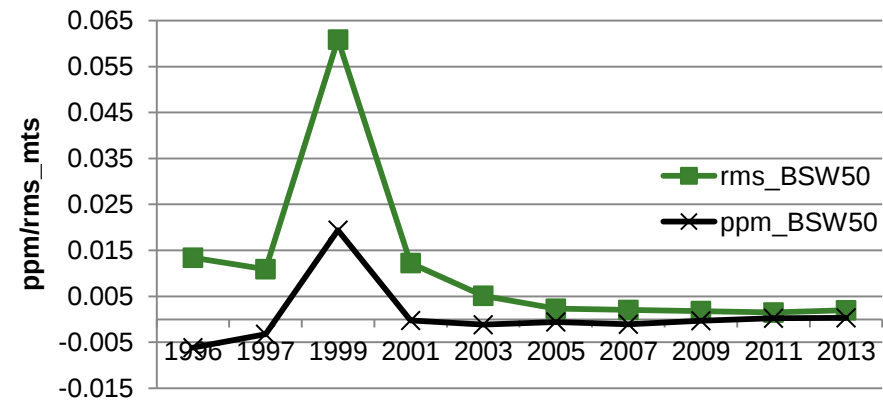
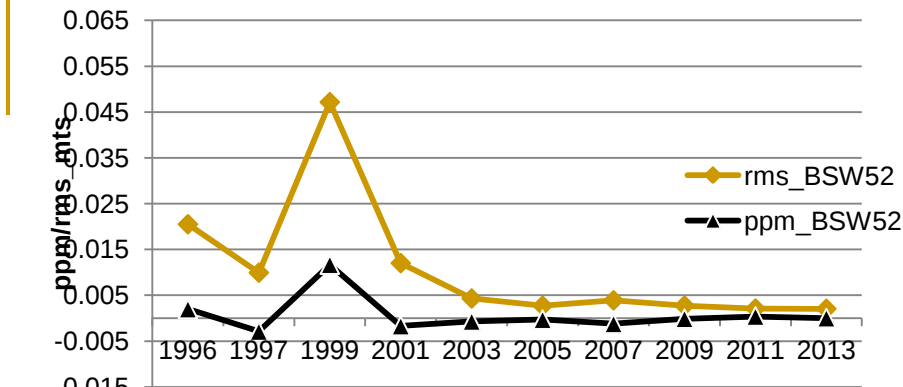


Normal Equation Adjustment: basic statistics

From	To	observations		parameters		degree of freedom	
		BSW50	BSW52	BSW50	BSW52	BSW50	BSW52
1 1996-06-10	6/15/1996	471271	471348	9630	8745	461641	462603
2 1997-06-04	6/10/1997	621722	615813	11126	10024	610596	605789
3 1999-06-14	6/19/1999	843008	824523	14218	12320	828790	812203
4 2001-06-17	6/23/2001	1062448	1035665	15341	14770	1047107	1020895
5 2003-06-16	6/21/2003	1247662	1244321	17204	15848	1230458	1228473
6 2005-01-01	2/3/2013	3390	3390	3390	3390	0	0
7 2005-06-20	6/25/2005	1849283	2593865	26435	30543	1822848	2563322
8 2007-06-18	6/23/2007	1790100	1556809	24775	25506	1765325	1531303
9 2009-06-22	6/27/2009	1635430	1660575	22525	26977	1612905	1633598
10 2011-06-20	6/25/2011	1237224	1905504	16811	27049	1220413	1878455
11 2013-06-16	6/22/2013	2106379	3284905	28939	47184	2077440	3237721
		12867917	15196718				

Processing flow

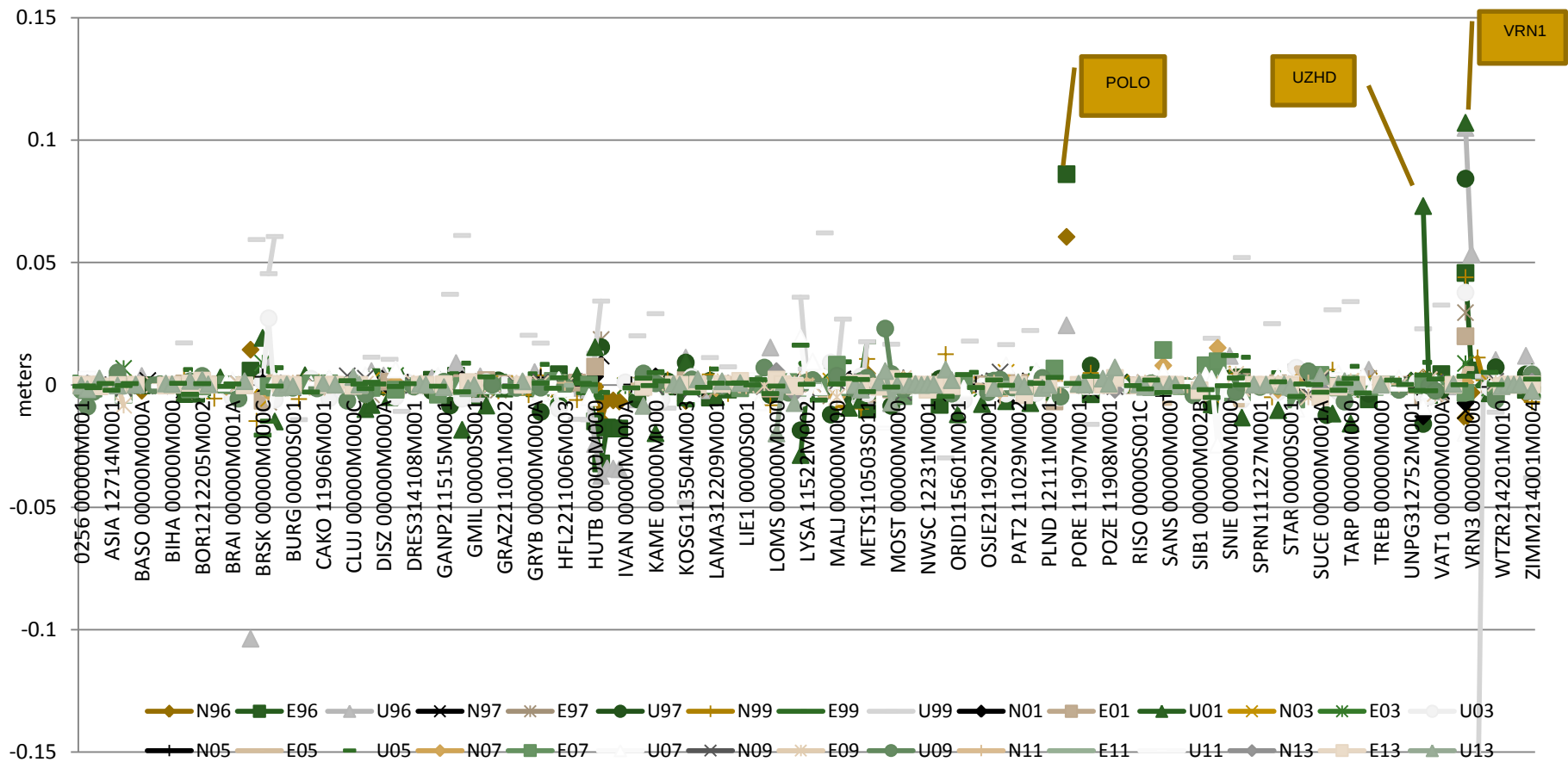




Helmert comparison BSW50 vs BSW52 cumulative solutions

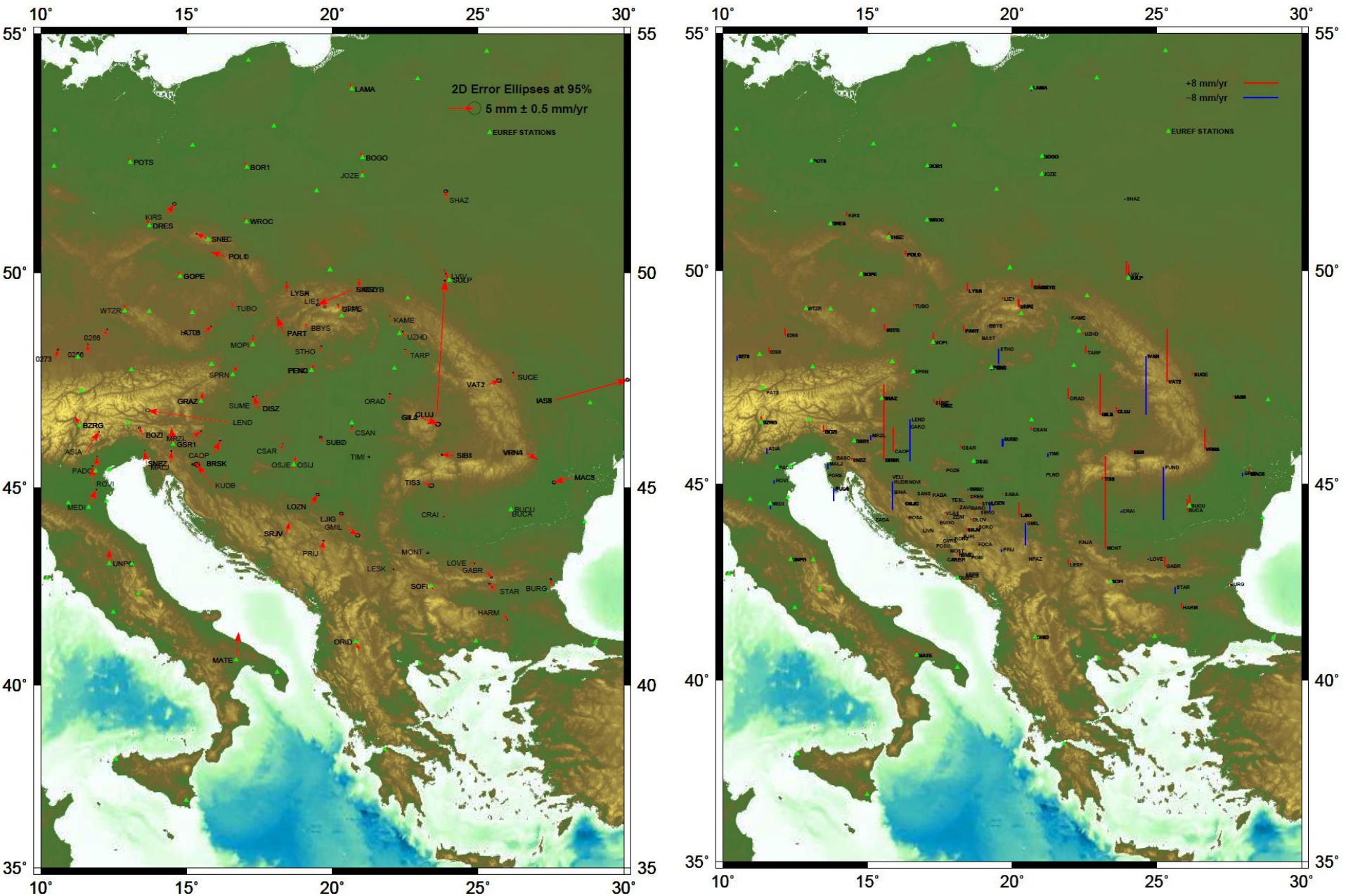
Repeatability of epoch solutions (1996 to 2013)

BSW52 cummulative solution (MC on EPN_A common sites)



1996, 1997 and 1999 tend to be noisier than more recent solutions

Velocity Map ETRF2000



Comparison of CEGRN repro 2

BSW50 vs. BSW52 (ADDNEQ2_52 for backward compatibility)

File Name

1 \${P}/R/CEGRN52/SOL/CEGRN50.NQ0
2 \${P}/R/CEGRN52/SOL/CEGRN52.NQ0

Main characteristics of normal equation files:

File	From	To	Number of observations / parameters / degree of freedom		
1	1996-06-10 00:00:00	2013-06-22 23:59:30	13006265	187987	12818278
2	1996-06-10 00:00:00	2013-06-22 23:59:30	18961221	232362	18728859
Total	1996-06-10 00:00:00	2013-06-22 23:59:30	31967486		

Helmert Transformation Parameters With Respect to Combined Solution:

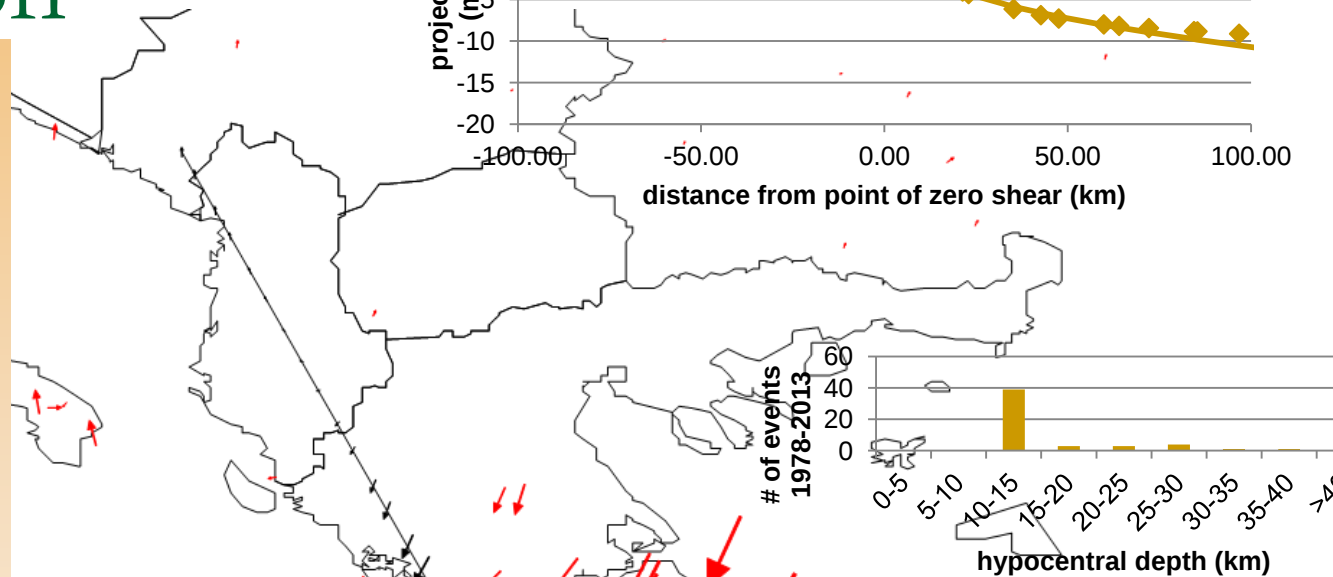
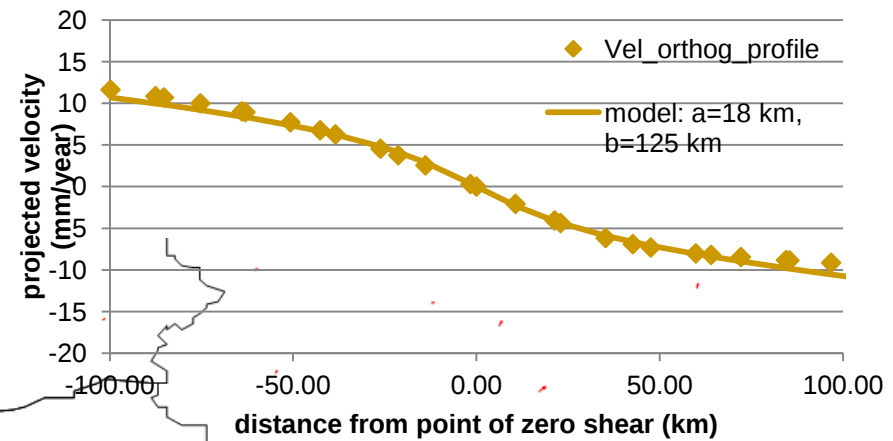
Sol	Rms (m)	Translation (m)		Rotation (")			Z	Scale (ppm)
		X	Y	Z	X	Y		
1	0.04711	0.0880	-0.0841	0.0875	0.0029	0.0003	-0.0018	-0.01655
2	0.01330	0.0259	-0.0406	-0.0001	0.0011	0.0007	-0.0009	-0.00148

Statistics of individual solutions:

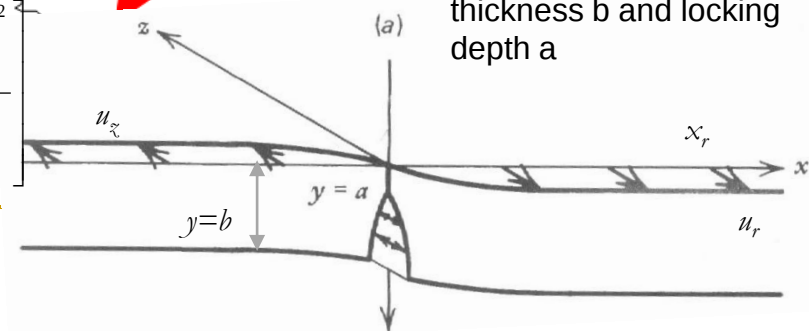
-- File	RMS (m)	DOF	Chi**2/DOF	#Observations	authentic / pseudo	#Parameters	explicit / implicit / singular
1	0.00279	12818909	7.78	13006265	603	1322	186637 2
2	0.00261	18729463	6.83	18961221	576	1280	231054 11

Modeling the deformation

- Combine CEGRN-EPN with data of Chousianitis et al. 2013 J. of Geod. And Italian Dense Network
- Interpolate to one or more profiles
- Fit projected velocities to a model of elastic deformation of a half space
- Solved for parameters:
 - Locking depth $a=18$ km: agrees with mean hypocentral depth
 - Thickness of elastic lithosphere $b=125$ km



$$u_z = \frac{bu_r}{\pi x_r} \ln \left[\frac{\sinh \frac{\pi x}{2b} + \left(\sinh^2 \frac{\pi x}{2b} + \sinh^2 \frac{\pi a}{2b} \right)^{1/2}}{\sin \frac{\pi a}{2b}} \right]$$



Model: deformation of an elastic half space of thickness b and locking depth a

Conclusions

- Densification of the EPN in central Europe using CEGRN campaign data, following guidelines.
- Repro2 of all CEGRN campaigns 1996-2013
- BSW50 and BSW52
- Geophysical modeling in a selected area
- Remarks:
 - The rms repeatabilities are:
 - N: 1.53 mm
 - E: 1.62 mm
 - Up: 3.55 mm
- Major problems:
 - Including EPN_A_IGb08.SNX into the stacking with BSW52: very high coordinate residuals and Helmert parameters in the EPN solution
 - Reconstructing soln's in STA file format out of EPN snx

CLUJ

CLUJ's 2D velocity is anomalously high. However, if we go through the outputs, everything seems to be fine (2 sites defined: CLUJ 00000M000A (CEGRN03) and CLUJ 00000M000B (other campaigns)):

