EUREF2019 MAA-AMET

Wednesday, May 22, 2019 to Friday, May 24, 2019 in Tallinn, Estonia

Present Day Geokinematics of Central Europe Part 1: the Central European GNSS Research Network (CEGRN)

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Outline

1. Introduction: EUREF CEGRN MoU.
2. Stations and Countries Involved in the CEGRN cumulative Solution.
3. Results.
4. Conclusions.

CEGRN 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.

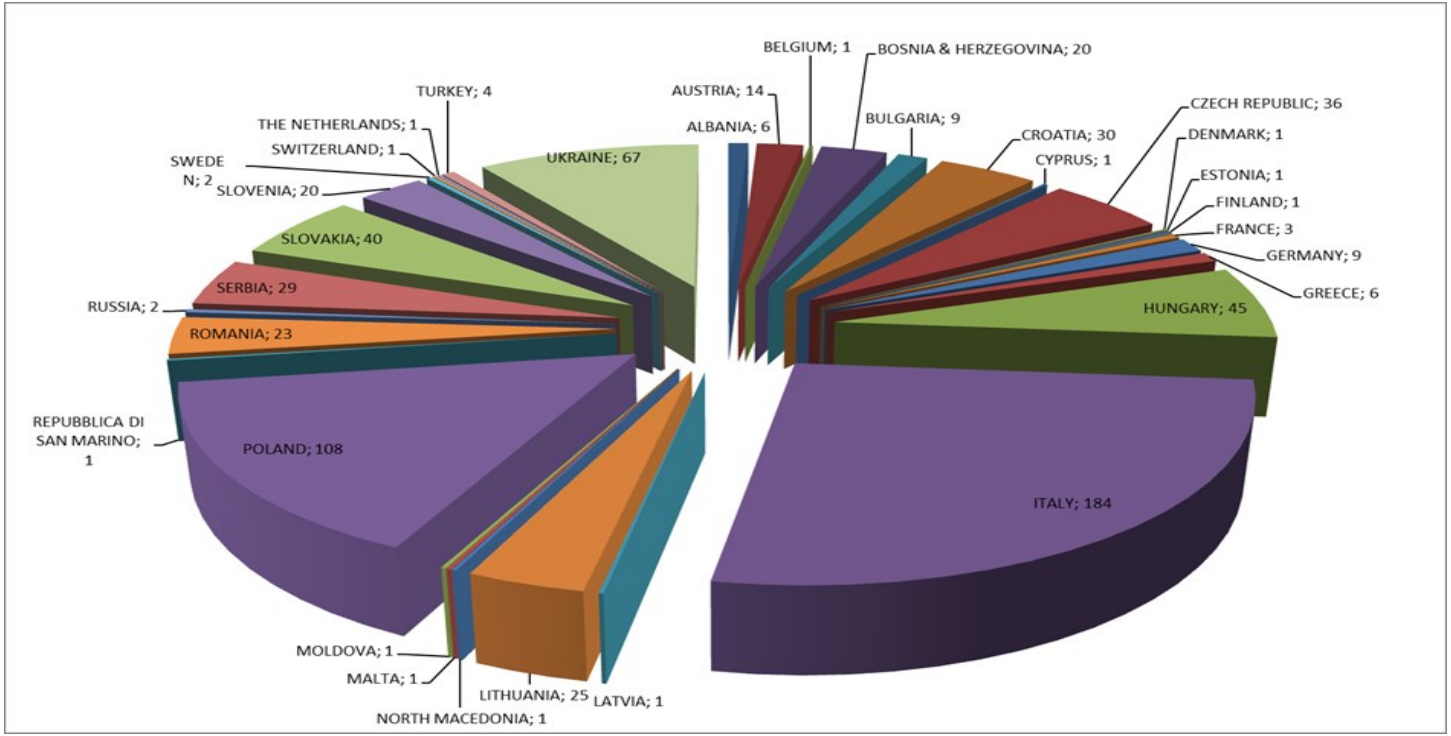
It is expected that a closer co-operation between EUREF and CEGRN will increase the level of support to the IAG Dense Velocity Field Project, and the availability of a combined solution with respect to a denser network.

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.

Campaign	From	To	Number of sites
CEGRN 1996	1996-06-10	1996-06-15	51
CEGRN 1997	1997-06-04	1997-06-10	44
CEGRN 1999	1999-06-14	1999-06-19	62
CEGRN 2001	2001-06-17	2001-06-23	57
CEGRN 2003	2003-06-16	2003-06-21	77
CEGRN 2005	2005-06-20	2005-06-25	106
CEGRN 2007	2007-06-18	2007-06-23	95
CEGRN 2009	2009-06-22	2009-06-27	85
CEGRN 2011	2011-06-20	2011-06-25	89
CEGRN 2013	2013-06-16	2013-06-22	178
CEGRN 2015	2015-06-14	2015-06-20	184
CEGRN 2017	2017-06-11	2017-06-17	1104

At present **CEGRN consists of 1229** different sites covering Central Europe from Lithuania to Makedonia and from Switzerland to Ukraine. The data, from raw data files to final velocities, are made available to the relevant Working Groups of the EUREF ('European Dense Velocities', 'EPN Densification' and 'Deformation Models') for validation and comparison with independent analyses.



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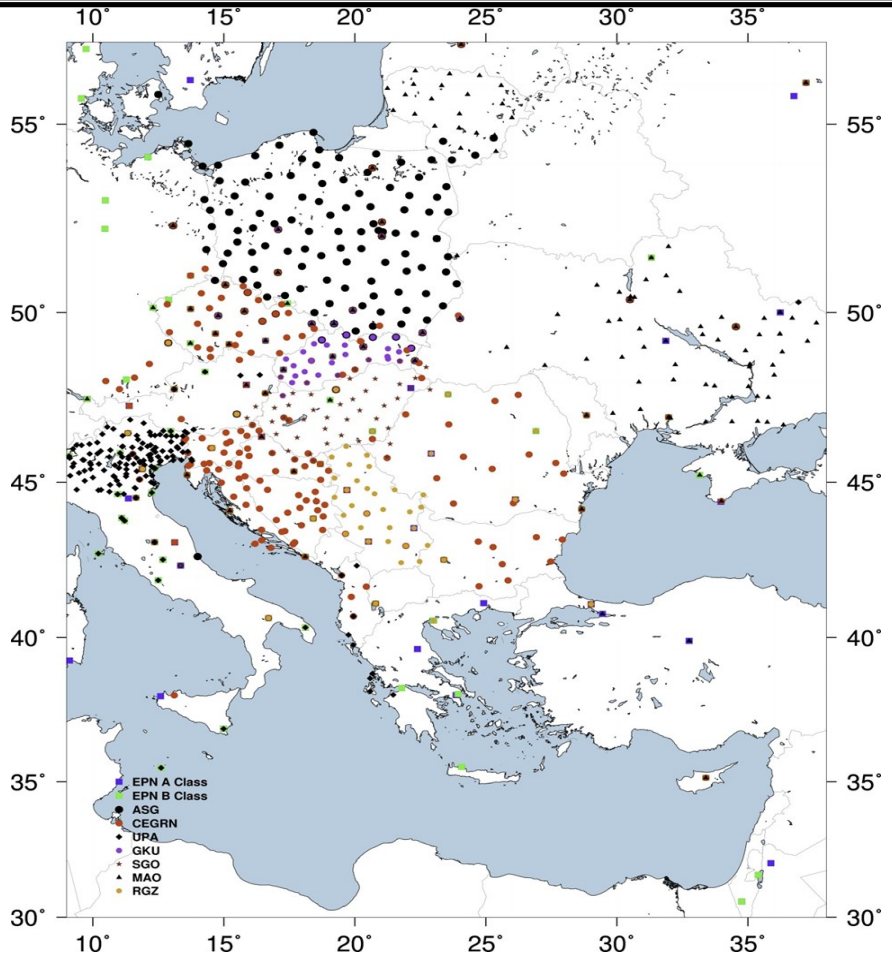
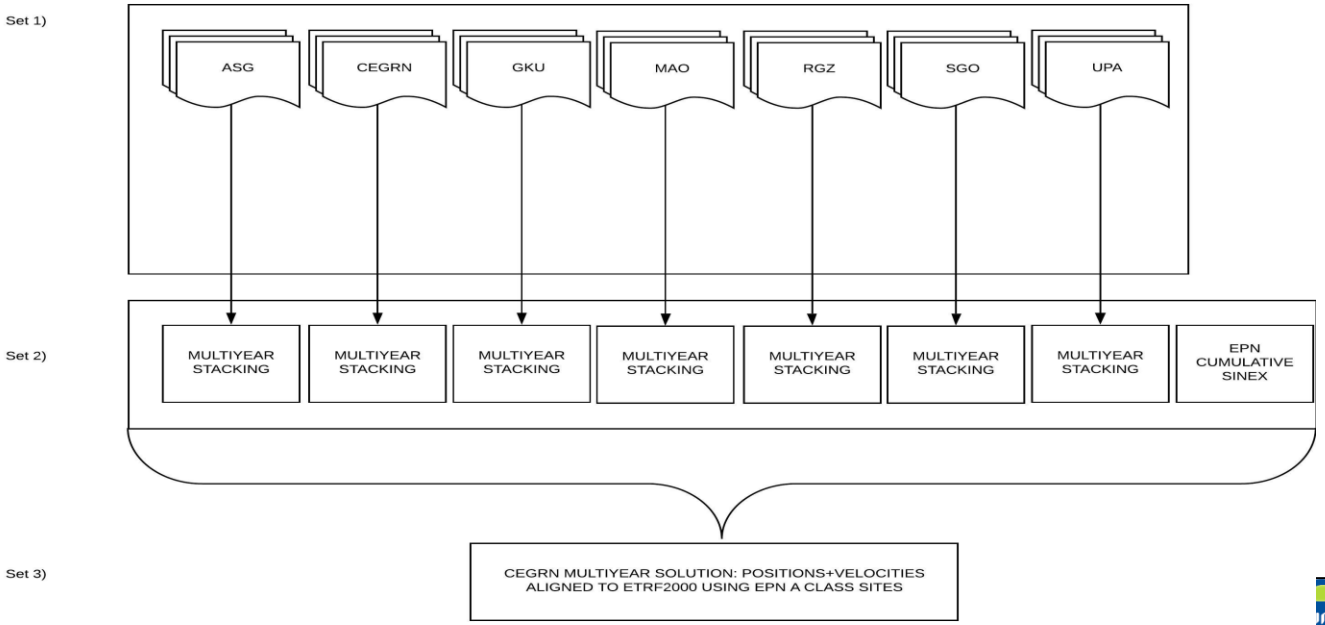


CEGRN Network, sites with more than 4 years of data. EPN = European Permanent Network; ASG = Glowny Urzad Geodezji i Kartografii, Poland; GKU = Geodetický a Kartografický Ústav, Slovakia; MAO = Main Astronomical Observatory, National Academy of Sciences of Ukraine, Ukraine; RGZ = Republicki geodetski zavod, Serbia; SGO = Satellite Geodetic Observatory, Hungary; UPA = University of Padova, Italy. EPN A Class are used for frame alignment; EPN B Class are complementary sites not used for frame alignment.

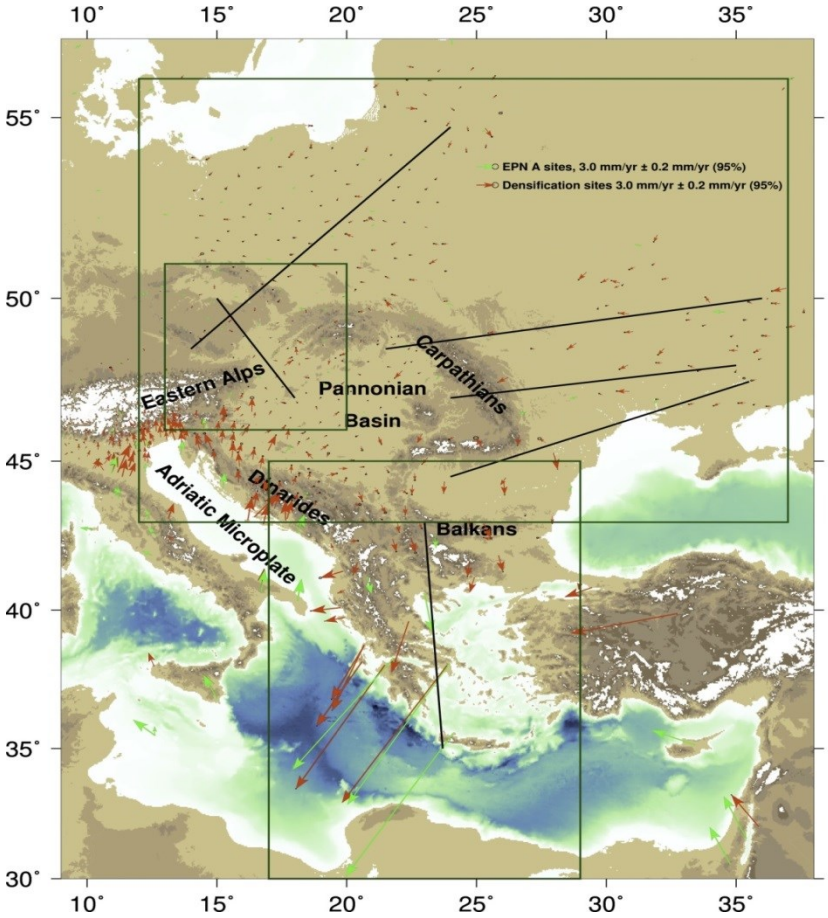
The following Analysis Centers contributed to the CEGRN analysis with weekly **SINEX** files computed according to the EPN Guidelines (http://epncb.oma.be/_documentation/guidelines/):

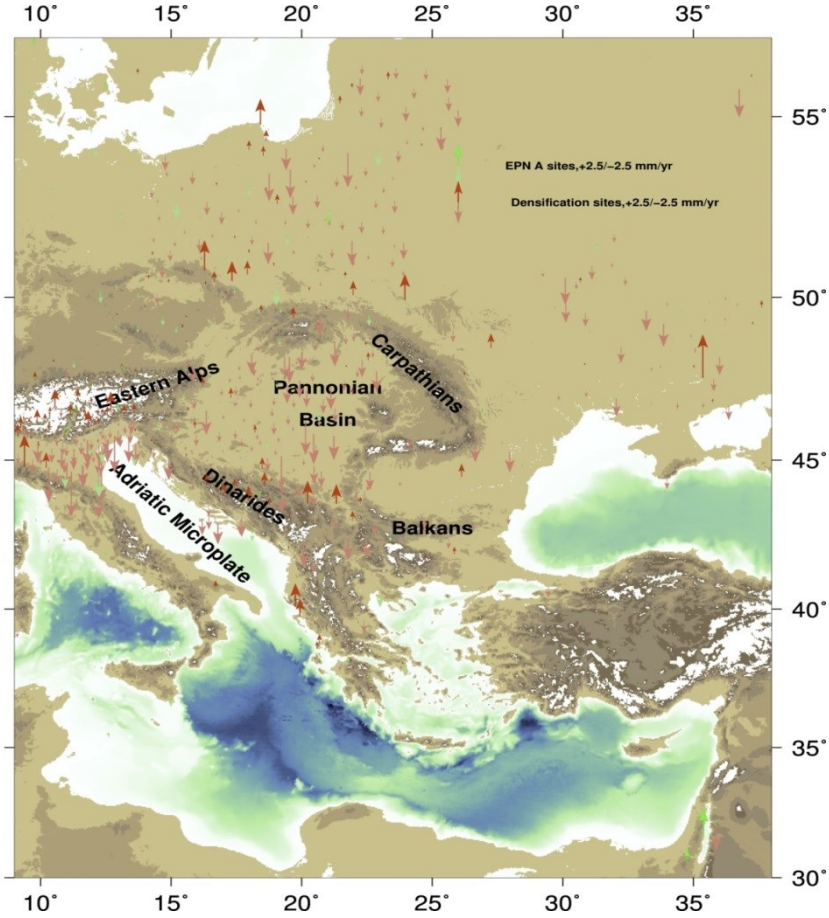
- ASG (*Glowny Urzad Geodezji i Kartografii*, Poland): solutions from 2009 to 2015.
- GKU (*Geodetický a Kartografický Ústav*, Slovakia): solutions from 2007 to 2017.
- MAO (Main Astronomical Observatory, National Academy of Sciences of Ukraine): solutions from 2001 to 2017.
- EPN (European Permanent Network): solutions from 1996 to 2018.
- RGZ (*Republicki Geodetski Zavod,* Serbia): solutions from 2009 to 2015.
- SGO (Satellite Geodetic Observatory, Hungary): solutions from 2011 to 2017.
- UPA (University of Padova, Italy): solutions from 2011 to 2017.



	Class A Sites	Rms (mm)	TX (mm)	TY (mm)	TZ (mm)	RX (mas)	RY (mas)	RZ (mas)	Scale (ppb)
EPN	234	0.8	-0.2	-0.3	0.1	0.0	0.0	0.0	0.0
CEG	50	4.8	-13.4	6.7	14.7	0.0	-0.6	0.2	-0.6
MAO	71	3.8	-0.5	-3.5	8.7	0.2	-0.2	-0.1	-0.7
GKU	15	4.4	16.7	-29.0	-2.5	0.6	0.4	-0.9	0.9
ASG	35	2.0	5.3	-17.4	7.1	0.5	0.0	-0.5	-0.2
RGZ	17	3.4	56.5	-44.7	-21.0	1.1	1.8	-1.1	-1.8
UPA	22	1.1	-3.0	3.0	6.2	0.0	-0.2	0.0	0.0
SGO	19	2.6	20.0	-7.4	-5.6	0.2	0.6	-0.3	-0.3

Helmert transformation parameters of the individual solutions with respect to the combined CEGRN at epoch 2010.0. For each individual solution, the number of reference stations (Class A sites) is provided. Rms is the root mean square of the common coordinate differences at the reference epoch. TX, TY, TZ are the translations of the origin of each subnetwork relative to the combined network; likewise, RX, RY and RZ represents rotations about the X, Y and Z axis and scale is the scale difference, in parts per billion (ppb).


EPN A sites, 3.0 mm/yr ± 0.2 mm/yr (95%)
Densification sites 3.0 mm/yr ± 0.2 mm/yr (95%)
Eastern Alps
Pannonian Basin
Carpathians
Adriatic Microplate
Dinarides
Balkans
10°
15°
20°
25°
30°
35°
55°
50°
45°
40°
35°
30°


EPN A sites,+2.5/−2.5 mm/yr
Densification sites,+2.5/−2.5 mm/yr
Eastern Alps
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10°
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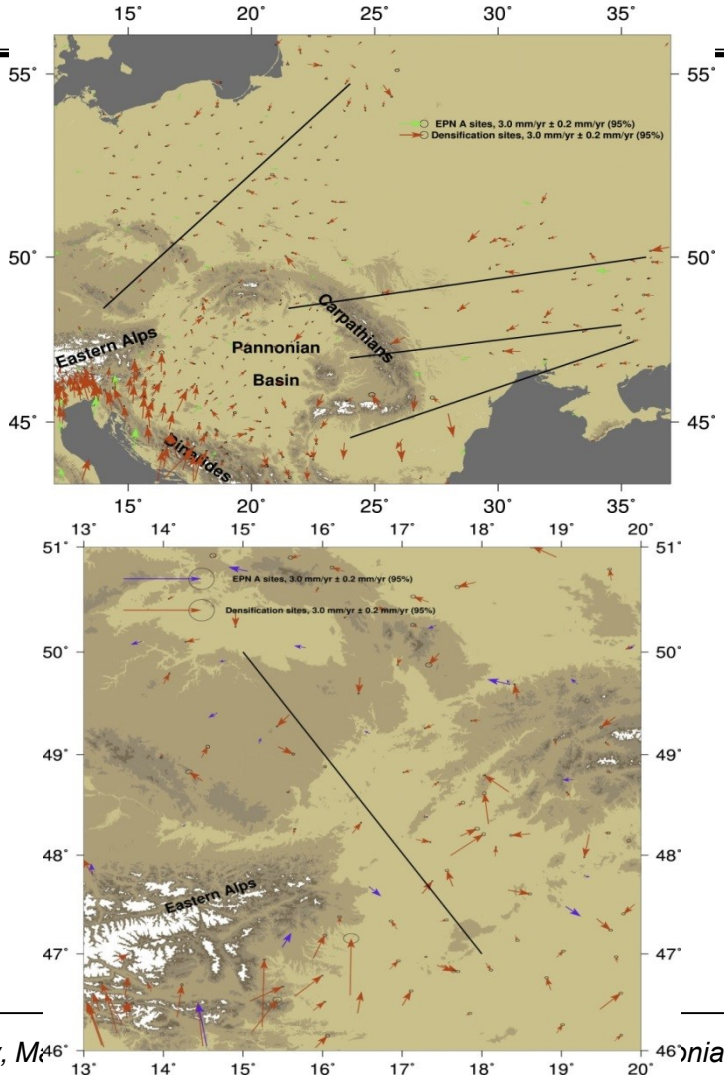
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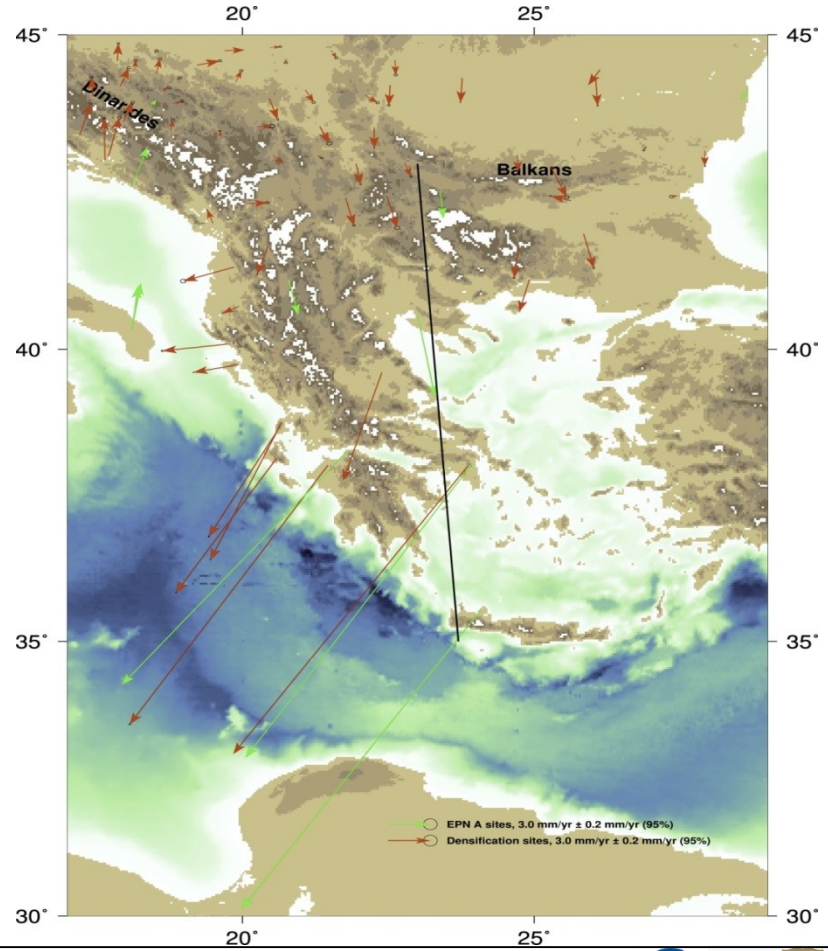
Dinarides
Balkans
EPN A sites, 3.0 mm/yr ± 0.2 mm/yr (95%)
Densification sites, 3.0 mm/yr ± 0.2 mm/yr (95%)

RMS (mm)	TX (mm)	TY (mm)	TZ (mm)
1.8	-1.17 ± 0.07	-1.60 ± 0.07	-2.05 ± 0.07

Helmert Parameters (only translations) between the computed values (CEGRN 1996-2017) and the nominal values (C1980) of the EPN class A sites, at epoch 2010.0. RMS is the root mean square difference in the coordinates of the 234 Class A sites (690 if solution numbers are considered at the reference epoch 2010.0.

N (mm)	E (mm)	Up (mm)	Vn (mm/yr)	Ve (mm/yr)	VUp (mm/yr)
0.0 ± 1.1	0.5 ± 1.0	0.1 ± 2.7	0.06 ± 0.13	-0.07 ± 0.12	0.38 ± 0.28

Statistic of the residuals, after applying the Helmert Parameters between the CEGRN multiyear adjustment (CEGRN 1996-2017) presented in this paper and the nominal values (C1980) of the 234 EPN class A sites (690 if solution numbers are considered), at epoch 2010.0, for position and velocities.

Conclusions

- We have proven that the combination of cumulative solutions (positions and velocities) is possible and leads to high quality results.
- Cumulative solutions that span over different periods of time can be stacked, but: the normal equations must be very carefully handled and the discontinuities must be exactly the same for all the normal equation sets being considered.
- Again, we must emphasize the need of accurate and updated log-sheets to be able to detect problems/discontinuities,… Handling +1.000 stations becomes difficult when no metadata but the RINEX header is available
- We look forward including new data (e. g. LIT and Polish VRSNET).
- The next CEGRN campaign has been scheduled from June 9th to June 15th, 2019.
- The results shown here have been accepted for its publication and will be published in the upcoming weeks in the Journal of Geodynamics.

- We must express our most sincere gratitude to all the people, Agencies and Institutions that re involved in the CEGRN.

Thank you for your attention