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IGS vs EPN as the backbone to align GNSS network densifications

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Agenda

1. Introduction
2. EPN vs IGS20 REFERENCE station distribution in Central Europe
3. Bulgaria and Slovakia GNSS Network
4. Conclusions

Introduction

In this presentation we show the problems of stacking normal equations (P+V) in areas with lack of reference stations.

At the European level, we will usually use a certain EPN Cxxxx release, aligned to the IGS in a certain reference frame.

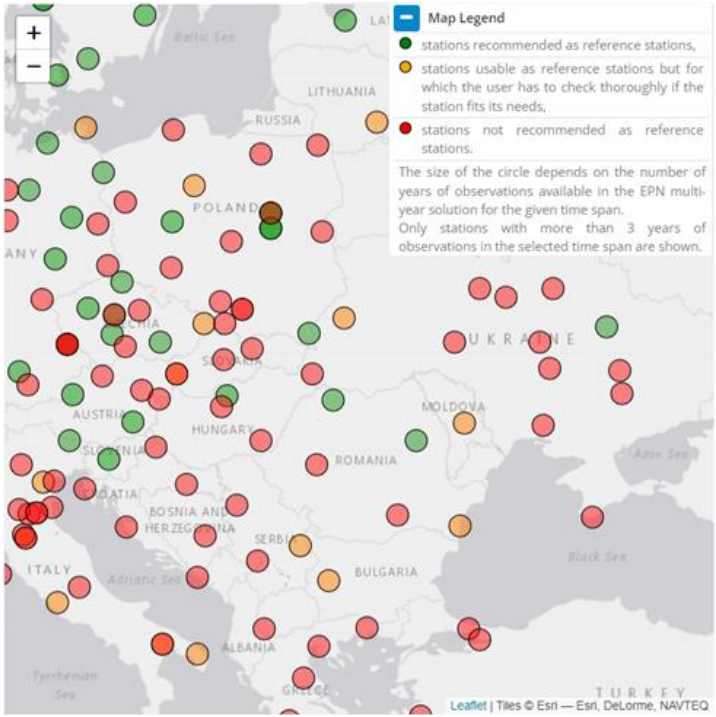
It can happen that we have a lack of reference stations or that the solutions are not available (Cxxxx in the IGS20 frame).

The alignment to IGS can be a problem for small networks/areas, where the reference stations are not enough to properly align our solution to the IGS.

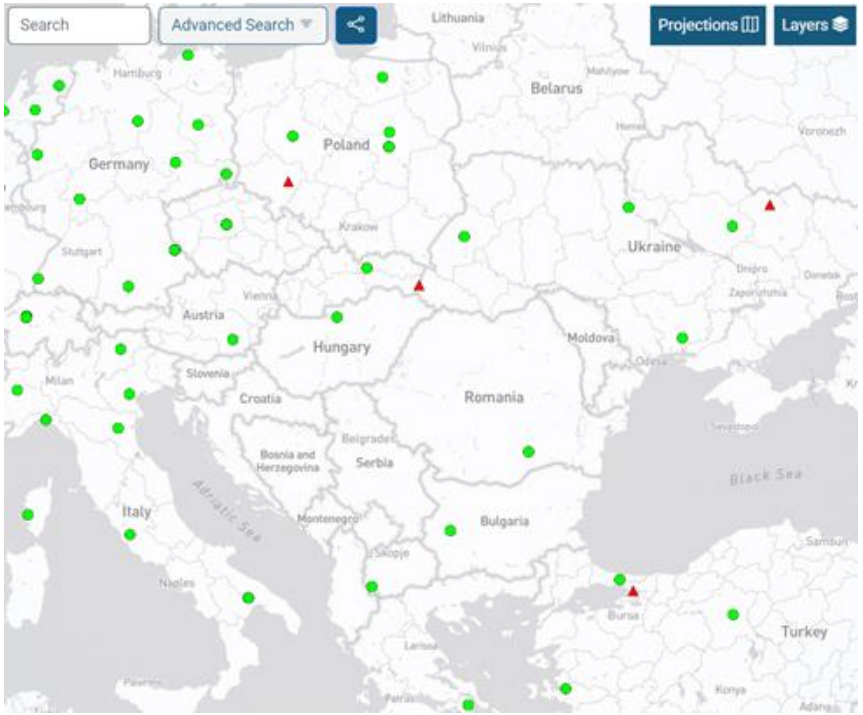
We show the solutions of 2 national solutions that are aligned to the IGS using the P+V available at the IGS20 frame (https://network.igs.org/)

EPN vs IGS20 REFERENCE station distribution in Central Europe

EPN release (C2235, IGb14)



IGS20 frame



EPN vs IGS20 REFERENCE station distribution in Central Europe

EPN C2235

- The number of reference sites of the EPN is remarkable in Europe
- The available EPN sites will easily embody any GNSS network at the country level
- However, we have no IGS20-compliant solutions

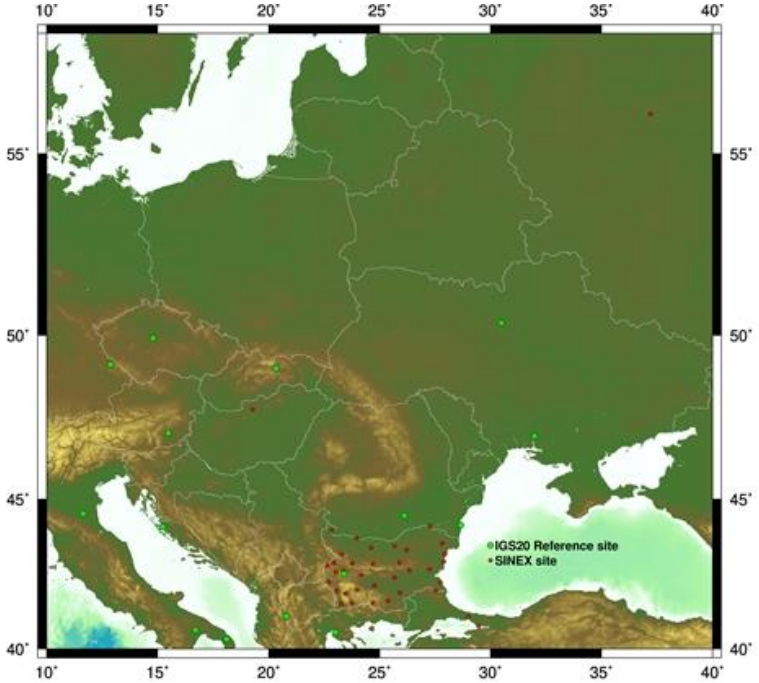
IGS20 frame

- The number of reference sites is limited and can be a proble in small areas
- IGS20 available sites might be far from the area and including them in the solutions implies computing very large baselines
- On the other hand, we have no other way to use and produce IGS20-compliant solutions

Bulgaria GNSS Network

BAS SINEX files

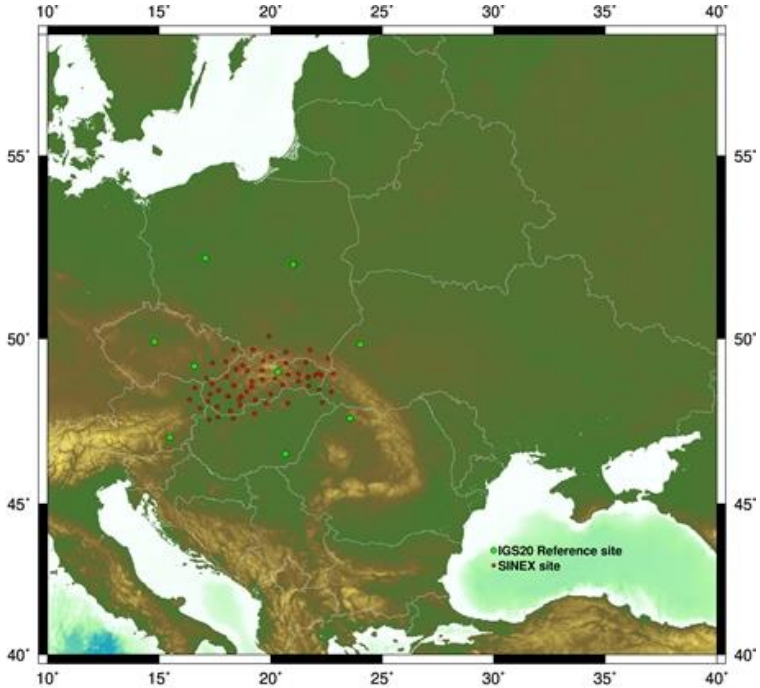
- + 4 years of data
- 20 IGS20 sites



Slovakia GNSS Network

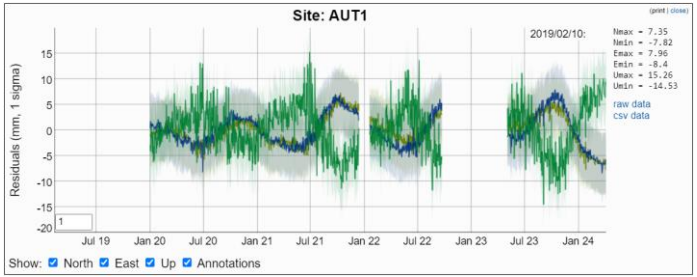
GKU SINEX files

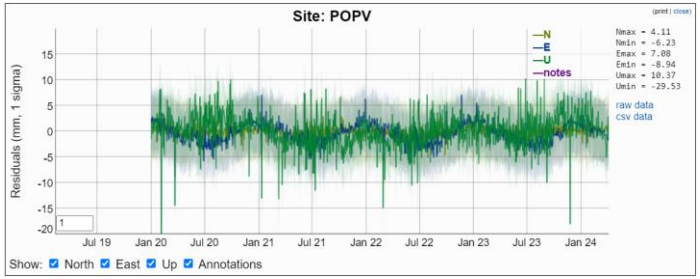
- + 4 years of data
- 10 IGS20 sites

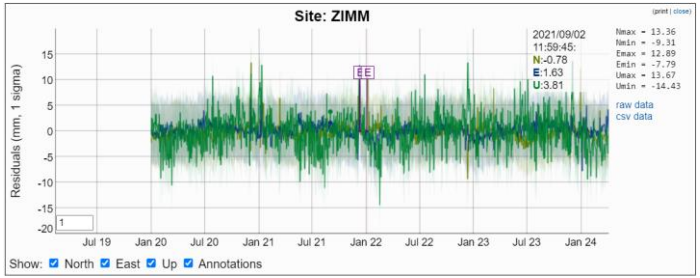


Some time series (daily solutions; no jumps due to frame switches)

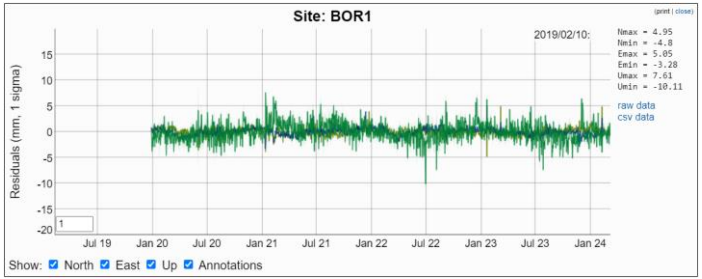
BAS (GAMIT)

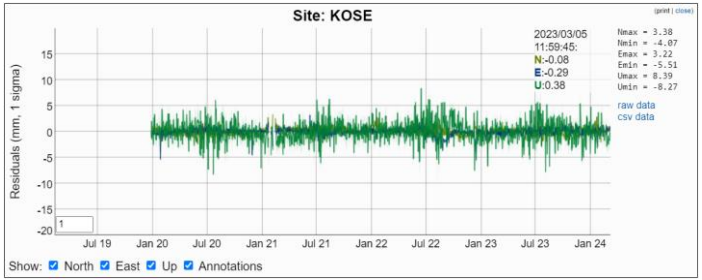


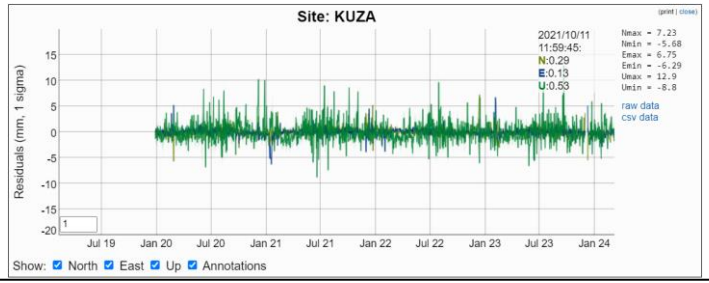




GKU (BSW54)







Bulgaria GNSS Network

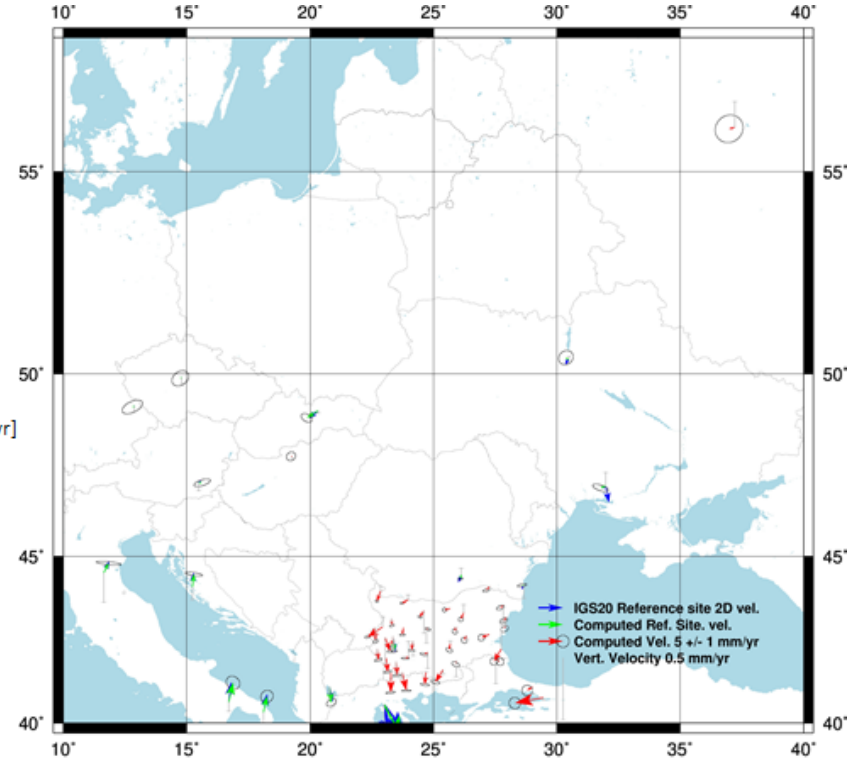
Alignment to IGS20 (20 sites, 5 have discontinuities: 25 sites)

Positions (at epoch 2022.0):

	N (mm)	E (mm)	Up (mm)
RMS / COMPONENT	0.59	1.18	3.87
MEAN	-0.34	-0.13	0.01
MIN	-3.55	-2.95	-5.40
MAX	2.29	2.92	8.27

Velocities:

	DVX[mm/yr]	DVY[mm/yr]	DVZ[mm/yr]	DVN[mm/yr]	DVE[mm/yr]	DVUp[mm/yr]
Max.	0.71	0.33	1.07	1.28	0.44	1.14
min.	-1.11	-0.43	-1.98	-1.94	-0.51	-0.78
Average	-0.01	0.00	0.00	-0.02	0.01	0.02
std. Dev.	0.48	0.26	0.65	0.59	0.28	0.55



Slovakia GNSS Network

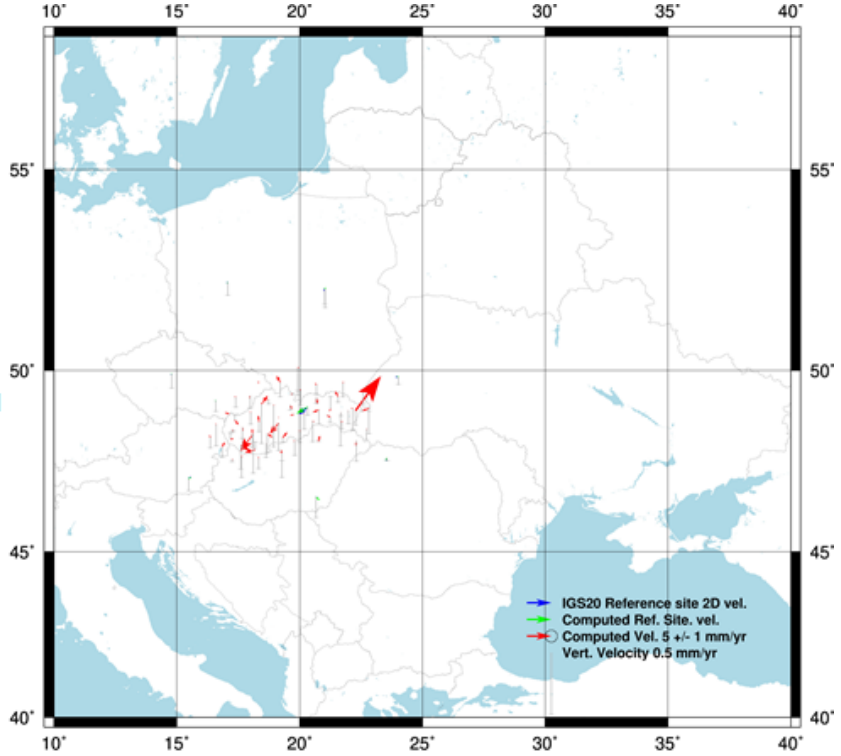
Alignment to IGS20 (10 sites, 1 has discontinuities: 11 sites)

Positions (at epoch 2022.0):

	N (mm)	E (mm)	Up (mm)
RMS / COMPONENT	0.34	0.51	1.64
MEAN	-0.1	-0.17	0.82
MIN	-0.62	-1.35	-1.02
MAX	0.56	0.43	3.24

Velocities:

	DVX[mm/yr]	DVY[mm/yr]	DVZ[mm/yr]	DVN[mm/yr]	DVE[mm/yr]	DVUp[mm/yr]
Max.	-0.01	0.47	0.14	0.44	0.46	0.09
min.	-0.78	-0.52	-0.75	-0.60	-0.46	-0.94
Average	-0.26	-0.02	-0.21	0.06	0.07	-0.32
std. Dev.	0.29	0.25	0.31	0.26	0.24	0.35



Bulgaria and Slovakia GNSS Network

If we consider the 2 solutions using IGS20 frame, individually:

- Both solutions align to the IGS20 within a few mm (positions) and less than 1 mm/year (velocities)
- Lack of reference sites: the available EPN reference sites would easily embody any of the provided solutionsa nd we would have more sites to validate the solutions

- We can have more IGS20 reference sites if we combine the two solutions

Bulgaria and Slovakia COMBINED GNSS Network

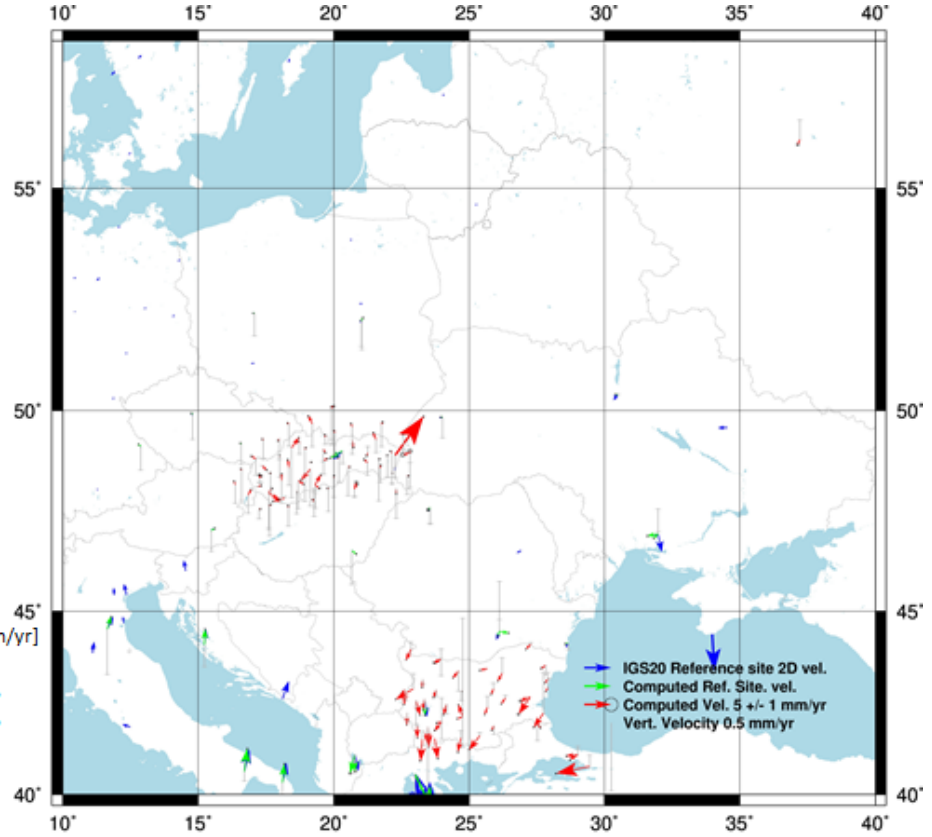
Reference sites: 33
Common IGS20 sites: 3

Positions:

	N (mm)	E (mm)	Up (mm)
RMS / COMPONENT	1.03	1.37	4.43
MEAN	-0.2	-0.13	0.22
MIN	-1.69	-3.76	-6.79
MAX	2.22	5.08	11.25

Velocities:

	DVX[mm/yr]	DVY[mm/yr]	DVZ[mm/yr]	DVN[mm/yr]	DVE[mm/yr]	DVUp[mm/yr]
Max.	2.21	2.58	3.00	1.48	2.24	3.02
min.	-1.29	-1.31	-1.53	-2.17	-1.49	-1.63
Average	-0.11	0.00	-0.12	0.05	-0.06	-0.15
std. Dev.	0.95	0.69	0.95	0.71	0.60	1.19



Conclusions

- We have presented 2 examples of country-wise solutions where IGS20 sites have been used as reference sites
- The combined solution degrades, in terms of rms, related to the individual solutions: both countries are not neighbouring and the number of common reference sites is very small (only 3)
- Having more common and better distributed reference sites should help to improve combined solutions
- IGS20 sites can be an excellent alternative for EPN reference sites
- The size of the area/network is determinant: the larger the area, the more reference sites are needed.
- On the other hand, the larger the are, the more IGS20 stations available.

Thank you