

The EUREF Poland 2015 Campaign

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A network of permanent reference stations called ASG-EUPOS (Active Geodetic Network – EUPOS), is the primary national geodetic network in Poland maintained by the Head Office of Geodesy and Cartography (GUGiK).

This network was processed together with selected EPN stations, to establish a new ETRF2000 realization related to IGb08.

Observations period is between 17 April 2011 (GPSWeek 1632 0) and 31 December 2014 (1825 3). In total – 3.7 years.







Densification network consists of:

- 43 EPN stations (40 class A)
- 91 non-EPN ASG-EUPOS permanent reference stations
- 22 non-EPN neighbouring permanent reference stations





GNSS data was processed using Bernese GNSS Software ver. 5.2

Option	Value
GNSS Orbits and ERPs	IGS (final, fixed)
GNSS observations	GPS, GLONASS
Elevation mask	3°
Baselines creation	maximum common observations
Ambiguity resolution strategies	$200 < L \le 2000$ km: L6/L3+QIF
depending on baseline length (L)	$20 < L \le 200$ km: L5/L3+QIF
	$L \leqslant 20$ km: direct L1&L2
A priori troposphere model	Saastamoinen $+$ GMF, dry part
Mapping function for corrections	wet GMF
Time resolution for ZTD	1 hour
Interval for troposphere horizontal gradients	24 hours
lonosphere model	CODE global
Higher order ionosphere corrections	applied
Antenna calibrations	igs_08.atx + individual calibrations (EPN, ASG)
Reference frame	IGb08 (EPN cumulative solution)





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On average, it was possible to resolve 83% of GPS ambiguities, and 63% of GLONASS ambiguities.





Long-term solution was obtained by stacking daily normal equations in ADDNEQ2 (BSW 5.2)

- velocities estimated for stations with more than 2.7 years of observations
- ▶ velocities before and after discontinuity in position, constrained to the same value ($\sigma = 10^{-3}$ mm)
- discontinuities for EPN stations used from EPN_discontinuities.snx file
- identification of outliers: 10 mm in North or East, or 20 mm in Up component (and time series check)
- stations with observations shorter than 2.7 years were expressed at the epoch of minimum position variance and eliminated from final solution (10 sites)





Reference frame: cumulative EPN solution (C1815)

- ► Coordinates : NNT minimum constraints: 40 Class A stations
- Velocities : NNT minimum constraints

Veryfication in 3 epochs:

- solution excluded if residuals exceeded 4 mm horizontally and 5 mm vertically
- 40 stations (49 solution numbers) used for final reference frame realization

	Beginning (2011.29)			Middle (2013.14)			End (2015.00)		
	Δ <i>N</i> (mm)	Δ <i>E</i> (mm)	ΔU (mm)	Δ <i>N</i> (mm)	Δ <i>E</i> (mm)	Δ <i>U</i> (mm)	Δ <i>N</i> (mm)	Δ <i>E</i> (mm)	Δ <i>U</i> (mm)
Min: Max:	-1.48 3.91	-1.92 1.94	-4.59 4.33	-1.19 3.52	-1.23 1.65	-3.88 2.58	-1.38 3.13	-2.30 1.64	-3.81 4.75





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Final coordinates were transformed from IGb08 to ETRF2000(08):

- ▶ 14-parameter one-step transformation (Memo ver. 8, Table 5)
- transformation parameters extrapolated to the mean epoch of observations: 2013.14 (or to the epoch of minimum position variance for stations with short observation time-span)



Position repeatability





 Repeatability (mm)
 N
 E
 U
 RMS

 1.09
 1.04
 3.23
 1.48

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Comparison with EPN C1815





Differences of ETRF2000 positions from campaigne cumulative solution and EPN cumulative solution C1815

Left: horizontal velocities. Right: vertical velocities.

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ETRF2000 velocities from campaigne cumulative solution

Left: horizontal velocities. Right: vertical velocities.

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Comparison with EPN C1815



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Differences of ETRF2000 velocities from campaigne cumulative solution and EPN cumulative solution C1815

Left: horizontal velocities. Right: vertical velocities.





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Because of no comparable position sets of previous EUREF campaign, this campaign solution is compared to the offcial, currently adopted ASG-EUPOS catalogue.

This catalogue, named PL-ETRF2000 was established during national GNSS campaigns preformed between 2008 and 2011. Besides the reference stations it also included also ground points from networks such as: EUREF-POL, POLREF and EUVN.

Its final output comes from cumulative solution expressed in the ETRF2000 at the epoch 2011.00.

It should be noted that this solution was based on IGS05 frame.



Map of position differences between new solution and the official PL-ETRF2000 expressed at common epoch 2011.00.

Left: horizontal differences. Right: vertical differences.

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Map of position differences at epoch 2011.00 between new solution and the official PL-ETRF2000 after Helmert transformation (7P)

Left: horizontal differences. Right: vertical differences.

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	vl	ocities o	nly	with velocities and transformation			
	Δ <i>N</i> (mm)	ΔE (mm)	ΔU (mm)	Δ <i>N</i> (mm)	Δ <i>E</i> (mm)	Δ <i>U</i> (mm)	
RMS MEAN MIN MAX	$1.41 \\ -0.35 \\ -4.09 \\ 3.25$	2.51 - 2.09 -5.20 2.72	6.69 6.11 -0.73 15.02	$1.36 \\ -0.00 \\ -3.64 \\ 3.43$	$1.38 \\ -0.00 \\ -3.08 \\ 4.65$	2.41 -0.00 -5.24 7.34	

Statistical summary of comparison between the new ETRF2000 with the PL-ETRF2000. (epoch 2011.00)





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- Campaign was presented to EUREF Technical Working Group for validation for 81 non-EPN reference stations
- Comparison with current ASG-EUPOS catalogue shows good agreement of data sets (eaven with height shift)
- Further monitoring of ASG-EUPOS network will be continued (cooperation with Warsaw University of Technology WUT).
- Daily SINEX files also contribute to the EPN densyfication project (also known as EUPOS CC).