EPN Analysis Coordinator Status Report

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Analysis Combination Centre

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The EPN Analysis Coordinator combines and analyses GNSS solutions computed by the EPN Analysis Centres (AC)

- 16 analysis centres regularly process GNSS data from 300+ EPN stations (distributed processing)
- Each AC provides solutions for its subnetwork in SINEX format
 final weekly and daily (available with a delay of ~ 2 weeks)
- Some ACs in addition also provide rapid daily (9 ACs) and ultra-rapid solutions (3)
- AC solutions are combined on a normal equation level using Bernese software
 - before combination, metadata (antennas, receivers, PCOs, eccentricities) provided in AC SINEX files are checked, and problematic stations are excluded
 - detected outliers are iteratively removed from AC solutions
- Weekly combined solutions are official EUREF solutions

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AC	Agency
ASI	Italian Space Agency, Space Geodesy Center, Italy
BEK	Kommission fuer Erdmessung und Glaziologie, Germany
BKG	Bundesamt fuer Kartographie und Geodaesie, Germany
COE	Center for Orbit Determination in Europe, Switzerland
IGE	Instituto Geografico Nacional, Spain
IGN	Institut Geographique National, France
LPT	Federal Office of Topography swisstopo, Switzerland
MUT	Military University of Technology, Poland
NKG	Nordic Geodetic Commision, Sweden
OLG	Austrian Academy of Sciences, Austria
RGA	Republic Geodetic Authority, Serbia
ROB	Royal Observatory of Belgium, Belgium
SGO	FOMI Satellite Geodetic Observatory, Hungary
SUT	Slovak University of Technology, Slovakia
UPA	University of Padua, Italy
WUT	Warsaw University of Technology, Poland

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EPN Analysis Centres – characteristics

AC	Software	Solu	# sites	GNSS		
ASI	GIPSY 6.2	Weekly/Daily	Rapid	NRT	52	G
BEK	Bernese 5.2	Weekly/Daily	Rapid	_	96	GR
BKG	Bernese 5.2	Weekly/Daily	Rapid	NRT	117	GR
COE	Bernese 5.2	Weekly/Daily	_	_	43	GR
IGE	Bernese 5.2	Weekly/Daily	Rapid	_	89	GR
IGN	Bernese 5.2	Weekly/Daily	_	_	64	G
LPT	Bernese 5.2	Weekly/Daily	Rapid	NRT	60	GREC
MUT	Bernese 5.2	Weekly/Daily	_	_	144	GR
NKG	Bernese 5.2	Weekly/Daily	-	-	88	GR
OLG	Bernese 5.2	Weekly/Daily	_	_	106	GR
RGA	Bernese 5.2	Weekly/Daily	_	_	56	GR
ROB	Bernese 5.2	Weekly/Daily	Rapid	-	98	GR
SGO	Bernese 5.2	Weekly/Daily	Rapid	-	42	GR
SUT	Bernese 5.2	Weekly/Daily	-	-	59	GR
UPA	Bernese 5.2	Weekly/Daily	Rapid	_	57	GR
WUT	Bernese 5.2	Weekly/Daily	Rapid	-	119	GR

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Recent activities include:

- 1 Change of the combination strategy for creating weekly combined solutions
- 2 Switch to the new reference frame IGS14/epn_14.atx

Change of combination strategy for weekly combined solutions

Since GPS week 1925 (November 27, 2016), the combination strategy for creating final weekly combined solutions has been changed (LACMAIL-2134)

Methodology used up to and including GPS week 1924:

- 1 Weekly AC solutions were combined into weekly solutions
- Daily combined solutions also created but independently of weekly solutions (solutions less consistent); not all ACs were providing daily solutions;

Methodology used since GPS week 1925:

- **1** All daily AC solutions are iteratively combined into daily solutions
- 2 Clean (without outliers) daily combined solutions are stacked into weekly solution
- Weekly combined solutions fully consistent with daily combined solutions; outlier detection possible with higher (daily) resolution

Change of combination strategy: Comparison of both approaches

Motivation for changing the combination approach were position inconsistenices observed between weekly AC solutions

■ Both approaches were compared for a period of 70 weeks (1831–1900)



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Differences of coordinates: old minus new approach



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	Daily/V	Veekly RM		Ratio			
AC	N	Е	U	N	Е	U	
ASI	1.6/1.2	1.3/1.0	5.2/4.0	1.34	1.40	1.29	
BEK	0.5/0.3	0.6/0.4	2.0/1.4	1.35	1.42	1.42	
BKG	0.4/0.3	0.5/0.3	1.8/1.4	1.35	1.46	1.28	
COE	0.5/0.8	0.6/0.6	2.3/2.2	0.60	0.88	1.04	
IGE	0.4/0.3	0.4/0.3	1.5/1.2	1.30	1.44	1.28	
IGN	1.1/0.9	1.5/1.2	6.0/5.5	1.31	1.31	1.08	
LPT	0.3/0.2	0.3/0.2	1.3/1.2	1.15	1.27	1.11	
MUT	0.6/0.5	0.7/0.4	2.9/2.0	1.42	1.51	1.51	
NKG	0.4/0.3	0.3/0.3	1.6/1.2	1.36	1.37	1.33	
OLG	1.0/0.8	0.9/0.7	3.9/3.3	1.24	1.29	1.18	
RGA	0.4/0.3	0.4/0.3	2.7/2.4	1.22	1.37	1.11	
ROB	0.4/0.3	0.4/0.3	1.6/1.4	1.19	1.24	1.15	
SGO	0.4/0.3	0.5/0.4	2.4/2.0	1.28	1.50	1.20	
SUT	0.9/0.7	0.8/0.6	3.0/2.4	1.26	1.40	1.26	
UPA	0.4/0.3	0.5/0.3	1.5/1.1	1.43	1.65	1.35	
WUT	0.4/0.3	0.4/0.3	1.6/1.2	1.29	1.27	1.29	
Mean:	0.6/0.5	0.6/0.5	2.6/2.1	1.26	1.36	1.24	

Expected increase of RMS of daily solutions: $\sqrt{7} \approx 2.6$ times

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Starting with GPS week 1934 (January 29, 2017), IGS switched the framework for its products generation from IGb08/igs08.atx to IGS14/igs14.atx (IGSMAIL-7399 and IGSMAIL-7414)

To maintain consistency in EUREF products, EPN ACs switched to IGS14/epn_14.atx at the same time as IGS did (IGS orbits and ERPs used by EPN ACs during GNSS data processing)

epn_14.atx is a combination of igs14.atx and a new release of the EPN individual antenna calibration model, epnc_14.atx

The new individual antenna model, epnc_14.atx, was released by the EPN CB and it contains updated individual callibrations for ground antennas for some EPN stations. The epnc_14.atx model should be used together with the IGS14/igs14.atx framework

Switch from epnc_08.atx to epnc_14.atx (LACMAIL-2142)

Individual calibration replaced by another individual calibration (more calibrated signals)

Site	#	From	То	Antenna	Radome	epnc_08 s	tatus	epnc_14 s	tatus
DOUROOBEL	3	2015-03-02		LEIAR25.R3	NONE	Indiv.	ROBOT	Indiv.	CHAMBER
ISTAOOTUR	2	2016-05-09		LEIAR25.R4	LEIT	Indiv.	ROBOT	Indiv.	CHAMBER
WRLGOODEU	1	2015-03-17		LEIAR25.R3	LEIT	Indiv.	ROBOT	Indiv.	CHAMBER

Individual calibration replaced by type calibration (calibration facility not recognized)

Site	#	From	То	Antenna	Radome	epn_08 status	epn_14 status
KLOPOODEU	4	2007-06-27	2013-06-28	TRM55971.00	TZGD	Indiv.	Туре

 Type calibration replaced by individual calibration (calibration made available after inclusion of antenna to EPN)

Site	#	From	То	Antenna	Radome	epn_08 status	epn_14 status
CLIBOOCZE	2	2011-08-31		LEIAR25.R4	LEIT	Туре	Indiv.
COMOOOITA	2	2005-12-15	2017-02-07	TPSCR3_GGD	CONE	Туре	Indiv.
CPAROOCZE	2	2011-10-25		LEIAR25.R4	LEIT	Туре	Indiv.
CRAKOOCZE	2	2011-05-11		LEIAR25.R4	LEIT	Туре	Indiv.
CTABOOCZE	2	2011-09-13		LEIAR25.R4	LEIT	Туре	Indiv.
POTSOOCZE	4	2011-02-15		JAV_RINGANT_G3T	NONE	Туре	Indiv.

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- IGS14 includes coordinates and velocities at epoch $t_0 = 2010$ for 51 EPN stations
- due to discontinuities, only 45 stations used for reference frame definition in current combined daily and weekly solutions (and rapid and ultra-rapid)
 - not used stations: BOR100POL, FUNC00PRT, GRAZ00AUT, HERT00GBR, MEDI00ITA, TLSE00FRA
- 1 station with post seismic deformation (PSD) model (BUCU00ROM, Bucarest, Romania)
 - $X(t) = X_0(t_0) + V \cdot (t t_0) + \delta_{PSD}$, where δ_{PSD} denotes PSD correction (exponential model for Bucarest)

Switch to IGS14 reference frame: alignment of weekly solutions

Starting with week 1934 all combined solutions are aligned to IGS14 reference frame using MC NNT approach.

- left: number of used/rejected stations from reference realization in weekly solutions. Stations are rejected from reference frame realizations if residuals exceed 8/15 mm in horizontal/vertical components
- right: RMS of residuals between reference and combined weekly coordinates



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Switch to IGS14 reference frame: RMS of AC residuals



- New combination approach was implemented for creating weekly combined solutions
 - outliers may be better handled in both AC and combined daily solutions. More data can be preserved; only rejection of single daily outliers and not a whole week
 - consistency of daily and weekly combined products
 - both weekly and daily combined solutions available at the EPN product center (BKG)
- The switch to the IGS14/epn_14.atx framework has been succesfully done in routine analysis centres' and combined solutions

Additional information on daily and weekly combinations of AC solutions can be found at:

- summary reports from combinations
 - available at the BKG data & product center: igs.bkg.bund.de
 - sent via EUREFMail and LACMail
- the EPN Analysis coordinator webpage: www.epnacc.wat.edu.pl
 - maps and plots of information given in summary reports