Report of the EPN Analysis Centres Coordinator

Status of EPN coordinate products and preparation for the switch to IGS20

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EPN Analysis Centres Workshop

November 3, 2022

Overview

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

- New EPN analysis centre
- Status of AC solutions
- Preparations for the switch to IGS20 and new standards
- Update of the guidelines for EPN Analysis Centres
- Summary

EPN Analysis Centres description

AC	Agency
ASI	Centro di Geodesia Spaziale G. Colombo, Matera, Italy
BEK	Bavarian Academy of Sciences and Humanities, Germany
BEV	Federal Office of Metrology and Surveing, Austria
BKG	Bundesamt für Kartographie und Geodäsie, Germany
COE	Astronomical Institute, University of Bern, Switzerland
IGE	Instituto Geográfico Nacional, Spain
IGN	L'Institut national de l'information géographique et forestière, France
LPT	Federal Office of Topography swisstopo, Switzerland
MUT	Military University of Technology, Poland
NKG	Nordic Geodetic Commision, Lantmäteriet, Sweden
RGA	Republic Geodetic Authority, Serbia
ROB	Royal Observatory of Belgium, Belgium
SGO	Lechner Knowledge Center, Hungary
SUT	Slovak University of Technology, Slovakia
UPA	University of Padova, Italy
WUT	Warsaw University of Technology, Poland

GeoForschungsZentrum (GFZ) – new EPN analysis centre

GeoForschungsZentrum, Germany (GFZ) agreed to become a new EPN analysis centre. GFZ is also one of the IGS ACs.

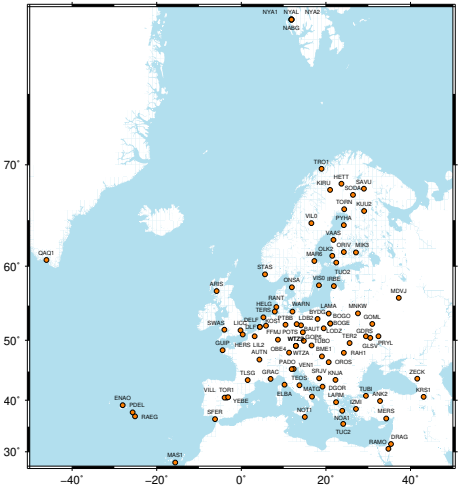
GFZ AC will contribute with:

- repro3 solutions
- operational solutions since week 2238

GFZ subnetwork of GNSS stations:

- 114 EPN stations selected

More information on GNSS analysis at GFZ and used software will be given by Benjamin Männel on Monday (Nov. 7)



Stations selected for GFZ network

EPN Analysis Centres characteristics

AC	Software	Solutions			# sites (new)	GNSS[1]
ASI	GipsyX 1.6	Final	Rapid	NRT	96 (17)	GRE
BEK	Bernese 5.2	Final	Rapid	–	130 (19)	GRE
BEV	Bernese 5.2	Final	–	–	177 (1)	GRE
BKG	Bernese 5.2	Final	Rapid	NRT	149 (5)	GRE
COE	Bernese 5.5	Final	–	–	39 (0)	GR
IGE	Bernese 5.2	Final	Rapid	–	92 (2)	GRE
IGN	Bernese 5.2	Final	Rapid	–	62 (0)	GR
LPT	Bernese 5.3	Final	Rapid	NRT	59 (0)	GRE
MUT	GAMIT 10.71	Final	–	–	151 (1)	GE
NKG	Bernese 5.2	Final	Rapid	–	104 (2)	GRE
RGA	Bernese 5.2	Final	–	–	64 (6)	GRE
ROB	Bernese 5.2	Final	Rapid	–	110 (1)	GRE
SGO	Bernese 5.2	Final	–	–	51 (1)	GRE
SUT	Bernese 5.2	Final	Rapid	NRT	64 (3)	GRE
UPA	Bernese 5.2	Final	Rapid	–	86 (8)	GRE
WUT	Bernese 5.2	Final	Rapid	–	144 (3)	GRE

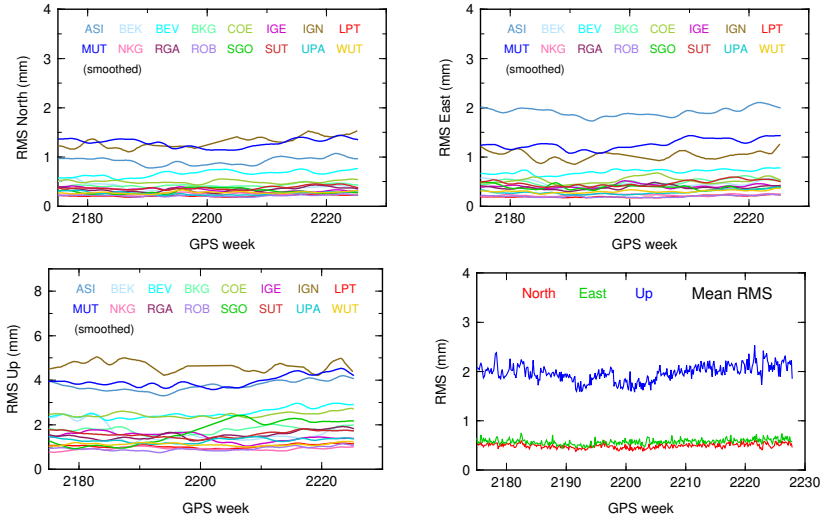
[1] GNSS: G – GPS, R – GLONASS, E – Galileo

- Distribution of EPN stations (396) according to the number of processing ACs:

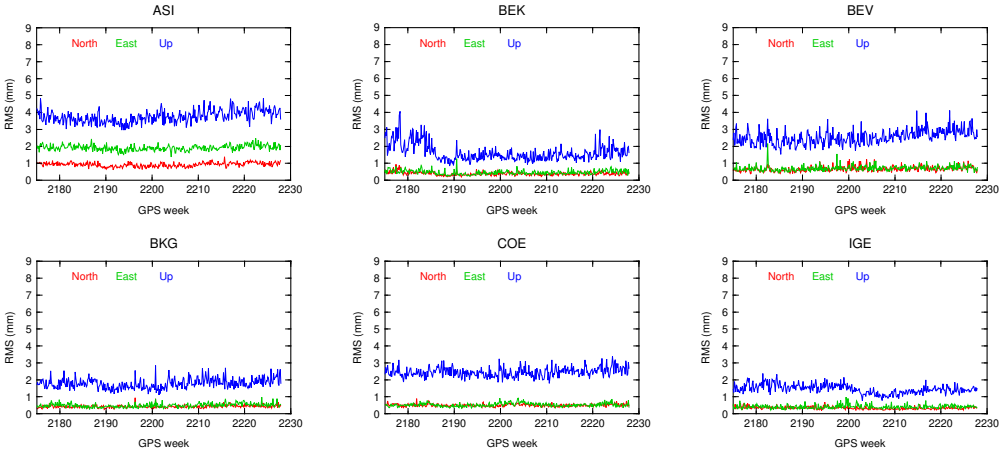
#ACs	#sites	#sites w. GFZ
2	1	0
3	87	31
4	231	234
5	71	123
6	6	8

Combined solutions: AC solutions agreement (last year)

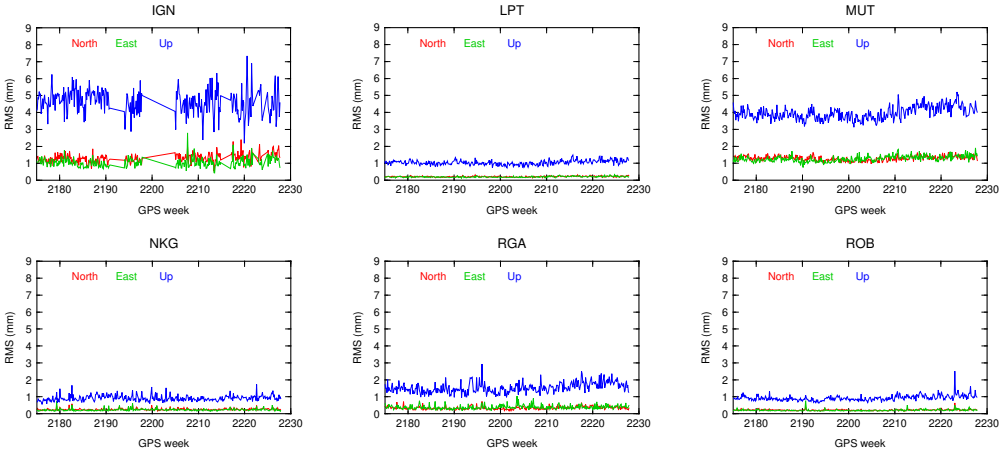
- RMSs of position residuals between each AC solution and combined solution



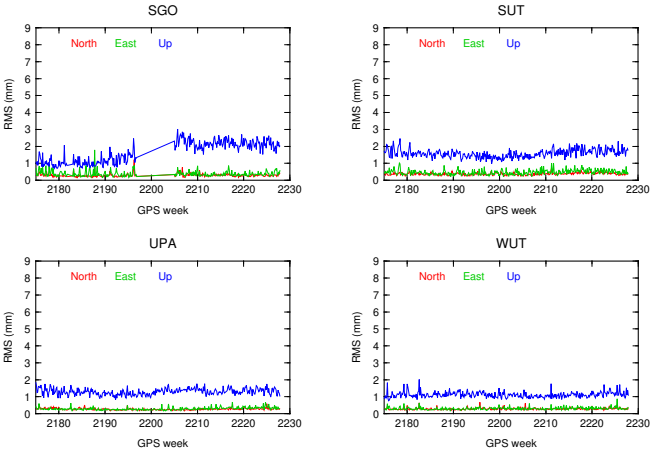
RMS of AC residuals wrt. combination (1/3)



RMS of AC residuals wrt. combination (2/3)



RMS of AC residuals wrt. combination (3/3)



New stations included and reincluded to EPN

- Since the last EUREF Symposium 19 new EPN stations included to EPN:
  - AGRN00ITA, ASIR00ITA, BIRG00ITA, BSVZ00ITA, ENZA00ITA, FRNE00ITA, GALH00ITA, ISRN00ITA, LIGN00ITA, RIVO00ITA, SART00ITA, SPT700SWE, SVLL00ITA, TEOS00ITA, TREU00ITA, TRMI00ITA, UBEN00ITA, VIRG00ITA, ZZON00HUN
- 4 IGS stations reincluded to EPN:
  - MAD200ESP – processed by BEK, IGE, WUT
  - MADR00ESP – processed by BEK, BKG, IGE, WUT
  - NYAL00NOR – IGS20 station, processed by GFZ (since week 2238), NKG, WUT
  - TROM00NOR – IGS20 station (former)

Upcoming switch to IGS20 reference frame

The IGS20/igs20.atx reference frame was published on July 26, 2022 (IGSMAIL-8238)

- IGS will switch from IGb14/igs14.atx to the new reference framework and repro3 standards starting with GPS week 2238, November 27, 2022 (IGSMAIL-8256)
- As EPN follows IGS standards we need to switch to the IGS20/igs20.atx framework and new standards at the same time

Some of the new repro3 standards are:

- processing of Galileo satellites (in addition to GPS and GLONASS)
- correcting antenna misalignments from true north
- new naming convention for product files
- use of latest generation ocean tide loading model
- adoption of new secular pole model

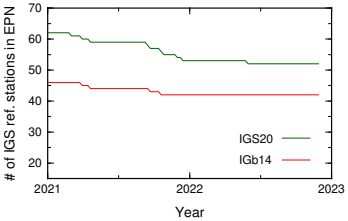
IGS20 reference frame files

IGS20 related files can be downloaded from the IGS RFC server at IGN:

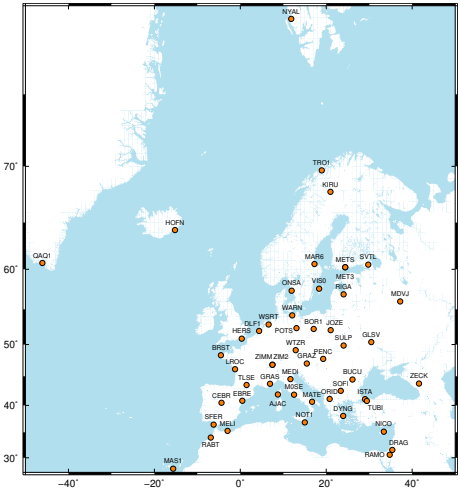
- station coordinates (at epoch 2015.0) and velocities
  - `ftp://ign-rf.ign.fr/pub/IGS20/IGS20.SNX.gz`
  - `ftp://ign-rf.ign.fr/pub/IGS20/IGS20.SSC`
- post seismic deformation (PSD) model (log, exp or exp+log):
  - `ftp://ign-rf.ign.fr/pub/IGS20/psd_IGS20.snx`
- discontinuity file:
  - `ftp://ign-rf.ign.fr/pub/discontinuities/soln_IGS20.snx`

IGS20 stations in EPN

- 74 EPN stations (62 active, 12 former) included in IGS20
- presently 52 usable EPN IGS20 stations (due to discontinuities)



- 3 stations with PSD model (ISTA00TUR, REYK00ISL, TUBI00TUR)



52 EPN IGS20 stations

The igs20.atx model and individual calibrations

The `igs20.atx` antenna model is available at the IGS:

`https://files.igs.org/pub/station/general/igs20.atx`

- New IGS antenna model `igs20.atx` officially supports GPS, GLONASS and Galileo signals for receiver antennas, therefore
- It was agreed within EUREF (GB, ACs) to use only type-mean model in EPN analysis (some individual calibrations in EPN model without GLONASS or Galileo)
  - better consistency of multi-GNSS analysis in EPN
  - better consistency with IGS analysis
- It was also decided to allow for individual calibration exceptions
  - BEV proposed to use individual calibrations for `LEIAR25.R3_BEVA` antennas (installed at SBG200AUT and TRF200AUT)

Individual calibrations exceptions

Individual antenna calibration exceptions could be allowed, e.g., in the following cases:

- multi-GNSS calibration for antenna-radome pair not included in igs20.atx model
- station not in IGS network (and not included in IGS20 solutions)
- other?

In present EPN model (274 indiv. calib.) the following individual calibrations could be potential exceptions:

Antenna type		Ant. SN	GNSS	Station	Remark
LEIAR25.R3	BEVA	09400005	GRE	SBG200AUT	
LEIAR25.R3	BEVA	09470003	GRE	TRF200AUT	
TPSCR.G5	OSOS	76212004	GRE	VAE600SWE	GR calib. for NONE in igs20.atx

EPN individual calibrations, EPN model files

Currently the following individual calibrations were requested and accepted as exception:

- `LEIAR25.R3_BEVA`, SN: 09400005, installed at SBG200AUT
- `LEIAR25.R3_BEVA`, SN: 09470003, installed at TRF200AUT

The new EPN model with individual calibrations will be maintained by Andrzej Araszkiewicz (MUT).

The following files can be now accessed (presently available from MUT server):

- `http://gnss.wat.edu.pl/euref/station/general/epnc_20.atx`
- `http://gnss.wat.edu.pl/euref/station/general/epn_20.atx` (merge of `epnc_20.atx` and current `igs20.atx`)

Antenna north misalignments for EPN stations

Antenna misalignments in EPN as of October 31, 2022:

No.	Station	Antenna type		Azimuth (°)	Analysis Centers
1	ARA200SVN	LEIAR20	LEIM	1	BEV, BKG, RGA, SGO, UPA
2	GSR100SVN	LEIAR20	LEIM	1	BEK, BEV, MUT, RGA, UPA
3	JOEN00FIN	ASH700936A_M	SNOW	10	COE, MUT, NKG, WUT
4	KDA200SVN	LEIAR20	LEIM	1	BEV, BKG, RGA, SGO, UPA
5	KHAR00UKR	NOV702GG	NONE	45	BEV, SGO, UPA, WUT
6	KRAW00POL	ASH701945C_M	SNOW	180	BEV, MUT, SUT, WUT
7	PZA200SVN	LEIAR20	LEIM	1	BEV, BKG, RGA, SGO, UPA
8	SODA00FIN	AOAD/M_T	DUTD	9	BEV, COE, NKG, RGA
9	SVTL00RUS	JAVRINGANT_DM	JVDM	5	BEV, NKG, SUT, WUT
10	UZHL00UKR	NOV702GG	NONE	180	BEV, MUT, SGO, WUT
11	VAAS00FIN	ASH700936A_M	SNOW	5	BEV, COE, MUT, NKG
12	WUTH00NOR	SEPCHOKE_B3E6	SPKE	15	BEV, BKG, MUT, WUT

- EUREF mail (no. 11208) sent by C. Bruyninx, C. Völksen, T. Liwosz to ask EPN station managers about possible antenna misalignements not reported in station log files

Long product filenames in the IGS

New filenames for IGS repro3 and operational products expressed in IGS20 (`http://acc.igs.org/repro3/Long_Product_Filenames_v1.0.pdf`):

`AAAVPPPTTT_YYYYDDDHHMM_LEN_SMP_CNT.FMT[.gz]`

where:

AAA	analysis/combination center abbreviation
V	version/solution (0-9). Increased e.g., for resubmitted solutions
PPP	campaign/project specification (e.g. OPS, R03)
TTT	solution type identifier (e.g. FIN, RAP, NRT, SNX)
YYYYDDDHHMM	product intended nominal start epoch
LEN	product period (e.g. 01D, 07D)
SMP	temporal product sampling resolution (e.g. 01D, 07D)
CNT	content type (e.g. CLK, CRD, ERP, ION, ORB, SOL, TRO)
FMT	file format (e.g. CLK, ERP, IOX, SNX, SP3, SUM, TRO)

IGS products

IGS ACs and coordinators provide test solutions for weeks 2222-2238 at:

`ftp://igs-rf.ign.fr/pub/test_20/WWWW/`
`https://cddis.nasa.gov/archive/gnss/products/WWWW/igs20/`

Examples for CODE and ESA solutions (week 2232, day 0; 289 day of 2022):

```
COD0OPSFIN_20222890000_01D_01D_ERP.ERP.gz
COD0OPSFIN_20222890000_01D_15M_ORB.SP3.gz

ESA0OPSRAP_20222890000_01D_01D_ERP.ERP.gz
ESA0OPSRAP_20222890000_01D_15M_ORB.SP3.gz

ESA0OPSULT_20222890000_02D_01D_ERP.ERP.gz
ESA0OPSULT_20222890000_02D_15M_ORB.SP3.gz
```

- date in `ULT` filenames corresponds to the start of used observations and not to the start of predicted part (as presently)!

Long filenames for EPN AC final and rapid products

As EPN follows IGS standards, we should also adopt the new filenames for EPN products.
The filenames for EPN operational final AC coordinate products could be as follows.
Examples for week 2238 (year 2022; days 331-337; November 27 – December 3):

- final daily product files, day 6:

  `AAA0OPSFIN_20223370000_01D_01D_SOL.SNX.gz`
  `AAA0OPSFIN_20223370000_01D_01D_SUM.SUM.gz`

- final weekly product files:

  `AAA0OPSFIN_20223310000_07D_07D_SOL.SNX.gz`
  `AAA0OPSFIN_20223310000_07D_07D_SUM.SUM.gz`

- rapid daily product file, day 6:

  `AAA0OPSRAP_20223370000_01D_01D_SOL.SNX.gz`

where `0`: version/solution (0-9), `OPS`: operational product, `FIN`: final product, `RAP`: rapid product, first `01D/07D` - product length, second `01D/07D`: product resolution

Long filenames of EPN NRT products

The format for NRT solutions:

`AAA0OPSNRT_YYYYDDDHH00_??H_??H_SOL.SNX.gz`

According to the IGS document (*Long product filenames in the IGS*):

- the epoch in the new long filenames corresponds to the starting date of used data
- EPN ACs use different session lenghts

AC	Software	Time span
ASI	GIPSY OASIS II	24 h
BKG	Bernese 5.2	4 h
LPT	Bernese 5.3	27 h
SUT	Bernese 5.2	8 h

  - solutions with the same end date would have different names
- how to proceed?
  - should we use in the filename the end date (as presently)?
  - should we agree on a common session length in hourly solutions? How long?

Long names for EPN combined products

For combined coordinate products, the new names would be:

- Daily final:

  `EUR0OPSSNX_YYYYDDD0000_01D_01D_SOL.SNX.gz`
  `EUR0OPSSNX_YYYYDDD0000_01D_01D_SUM.SUM.gz`

- Weekly final:

  `EUR0OPSSNX_YYYYDDD0000_07D_07D_SOL.SNX.gz`
  `EUR0OPSSNX_YYYYDDD0000_07D_07D_SUM.SUM.gz`

  - For final solutions `SNX` used as solution type, instead of `FIN` as in case of AC files

- Rapid daily:

  `EUR0OPSRAP_YYYYDDD0000_01D_01D_SOL.SNX.gz`
  `EUR0OPSRAP_YYYYDDD0000_01D_01D_SUM.SUM.gz`

- NRT:

  - according to conclusions on AC solutions

Changes of processing options: Guidelines for EPN ACs

With the change to IGS20/igs20.atx the Guidelines for EPN Analysis centres will need to be updated.
Selected processing options from the Guidelines include:

Processing option	Present value	New value
Reference frame	IGb14	IGS20
Antenna model	`epn_14.atx`	`igs20.atx` + indiv. exceptions
Orbits and ERPs for final solutions	IGS, AC, CODE rapid	IGS, AC
GNSS observations	GPS, GLONASS, Galileo	GPS, GLONASS, Galileo
Troposphere modelling	VMF1	VMF1 or VMF3?
Antenna misalignment from north	—	corrected
Product filenames	short	long
Ocean tide loading	FES_2004	FES_2014b[1]
Atmospheric tidal loading	recommended	?

[1] new model for all EPN stations available at the EPN CB server:
`ftp://ftp.epncb.oma.be/pub/station/general/FES_2014b.BLQ`

Preparations for switch to IGS20

- EPN data centers at BEV and BKG are ready for receiving EPN products with long filenames
- ACs are asked to start preparations for the switch since week 2238 (November 27)
  - the IGS test products can be used for preparatory analysis in IGS20
  - for ACs using Bernese software it would be recommended to upgrade to version 5.4 for best consistency with new standards and models
- ACs are asked to provide rapid and NRT solutions for testing new filenames (e.g. for weeks 2236-2237)
  - the test solutions could be prepared in IGS20 or present solutions could be uploaded with new names

Summary and discussion

- New EPN analysis centre at GFZ
- Type mean antenna model adopted in EPN with individual exceptions
  - rules for the individual calibration exceptions need to be specified
- New filenames for EPN products
  - how to proceed with NRT solutions?
  - testing phase for rapid and NRT solutions proposed
- Processing options
  - atmospheric tidal loading, VMF1 or VMF3?
- Update of the guidelines (ACC can start the update, and send the new version to ACs for further changes, additions, comments)