EPN-Repro3

Activities of the working group on EPN reprocessing

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Introduction to EPN-Repro3

- The global AC of the IGS have conducted their 3rd reprocessing campaign to provide consistent products that have been the input data for the computation of the ITRF2020
- Based on this new reference frame the EPN ACs had to switch in GPS week 2238 (27. Nov 2022) to the IGS20 for the operational computation of the EPN
- Consequently, previous operational products no longer match the actual analysis
- In order to obtain consistent products for the period from 1996 to the current generated products, a repeated processing of the old data is necessary
- This lead to the decision to initiate a new reprocessing campaign - ***EPN-Repro3***

IGS repro3

IGS repro3 covers the period from 1994 until the end of 2020

Items to observe in IGS repro3 in relation to IGS14/IGb14 (incomplete list) :

- **Ground antenna calibrations**: igs14.atx was replaced by new multi-GNSS calibrations containing absolute antenna calibration for all frequencies: **igsR3.atx**
- **Satellite z-PCOs**: update of the radial phase center offsets (z-PCOs) of all GPS and GLONASS satellites (Galileo Z-PCOs were provided by EUSPA [PCO estimated in an anechoic chamber])
- **IGSR3 reference frame**: IGS repro3 solutions are not aligned to the IGS14 reference frame but to a reference frame called IGSR3

IGS repro3 Products

https://cddis.nasa.gov/archive/gnss/products/WWWW/repro3/

AC	Reference Frame	PCV ATX	OL	AL	CLOCKS	Systems
COD	IGS14_FIT	IGS14R3	FES2014b	NONE	05S/30S	GRE
ESA	IGS14_BHN	IGSR3_2077	EOTA11a	NONE	30S	GRE
GFZ	UNDEF_FIT	IGSR3_2077	FES2014b	NONE	30S	GRE
GRG	IGSR3 FIT	IGSR3_2077	FES2014	NONE	30S	GRE
JPL	IGSR3_FIT	IGSR3_2077	GOT4.8AC	NONE	30S	G
MIT	IGSR3_FIT	IGSR3_2135/ IGSR3_2107	FES2014B	NONE	5M	G_E
NGS	IGS14_FIT	IGSR3_2077	FES2004	NONE	-	G
TUG	IGSR3_FIT	IGSR3_2135	FES2014b	AOD1B_R6	30S	GRE
WHU	IGS14_FIT	IGSR3_2077	EOTA11a	NONE	05M	GR

Preparations for EPN-Repro3

A first teleconference with all ACs of the EPN has taken place in February 2022 with a first discussion:

- The determination of the analysis strategy should be based in particular on the strategies used by the IGS
- It was decided that EPN-Repro3 shall be as consistent as possible with the operational EPN analysis in the IGS20
- Therefore, the Analysis Centre workshop and the EPN-Repro3 workshop have often been merged in recent months to harmonize the standards for the two analyses (operational and reprocessing)
- The last teleconference took place on 11 May 2023

Standards for EPN-Repro3

Reference frame	IGSR3~IGS20
GNSS observations to be used	GPS, GLONASS, Galileo
Orbits and ERPs for EPN-Repro3	Reprocessed products with GPS, GLONASS, and Galileo (e.g. COD, GFZ, ESA,….)
Ocean tide loading model	FES2014b
Product filenames	Long filenames according to new IGS convention
Atmospheric mapping function	The Vienna mapping function VMF1 was suggested (*)
Format of the troposphere products	Troposphere SINEX 2.0 (hourly products optimally given for the half hour and not for the full hour)
Atmospheric tidal Loading (ATL)	Atmospheric tidal loading will not be applied for the coming analysis of EPN operational and reprocessed products. The insufficient accuracy of the existing models is not enough to get a significant gain. Existing correction models still differ too much even among themselves

EPN-Repro3 Set-Up

- Only 12 out of now 17 EPN AC have announced to participate in EPN-Repro3
- Therefore, a redistribution of EPN-sites to other ACs was necessary to optimize the sub-network configuration (at least three (3) ACs process one site)
- The GeoFoschungsZentrum Potsdam (GFZ) is a new AC for the EPN
- The GNSS analysis software shall fulfil the requirements used in IGS repro3
  - a new version of the Bernese (5.4) is now released
  - EPOS (GFZ), GAMIT and GIPSY fulfil the requirements
- Solutions computed by Bernese, EPOS, and GAMIT will be combined

Re-design of the subnetworks for 12 ACs

LAC	#Sites	New Sites in EPN-Repro3
BEK	131	LAMP00ITA
BKG	153	GRAC00FRA, IZMI00TUR, RVNE00UKR
GFZ	**114**	**114 new sites**
IGE	97	DOUR00BEL, FRNE00ITA, HERS00GBR, SART00ITA, ZIM200CHE
IGN	62	
MUT	159	DNMU00UKR, GWWL00POL, ISRN00ITA, KLNK00BLR, MOGI00BLR, SMLA00UKR, SWKI00POL, VITR00BLR
NKG	104	
ROB	113	GRAS00FRA, WTZR00DEU, ZIMM00CHE
SGO	64	BISK00CZE, BRTS00BLR, BSVZ00ITA, DGOR00MNE, DVCN00SVK, ENZA00ITA, KNJA00SRB, MNSK00BLR, MOP200SVK, MOPI00SVK, PFA300AUT, RIVO00ITA, VIRG00ITA, ZZON00HUN
SUT	81	AGRN00ITA, BME100HUN, BUTE00HUN, CFRM00CZE, CLIB00CZE, CPAR00CZE, CTAB00CZE, GALH00ITA, GOP600CZE, KATO00POL, KRA100POL, LINZ00AUT, PENC00HUN, SVLL00ITA, UBEN00ITA, VACO00CZE,
UPA	101	AGRN00ITA, ASIR00ITA, BIRG00ITA, BSVZ00ITA, GOPE00CZE, GRAZ00AUT, LIGN00ITA, MATG00ITA, MEDI00ITA, PENC00HUN, SART00ITA, SVLL00ITA, UBEN00ITA, UCAG00ITA, VIRG00ITA
WUT	153	BBYS00SVK, KUNZ00CZE, MARP00UKR, NOVP00BLR, PINS00BLR, PSTV00BLR, SODA00FIN, TREU00ITA,TRMI00ITA

Antenna calibration used for EPN-Repro3

- EPN-Repro3 will be using absolute antenna calibrations for multi-frequencies (GPS, GLONASS and Galileo)
- EUREF GB and the EPN ACs decided to rely on **type mean calibrations** only for the EPN operational analysis and EPN-Repro3 (no individual calib.)
- Only observations shall be analysed where corrections for the PCV and PCO are available (no mixing of antenna calibration e.g. GPS for GLONASS)
- The multi-frequency calibration for the EPN operational analysis are currently based on the recent file igs20_2247.atx with some additions (e.g. radome type BEVA and Topcon TPSCR.G5)
- This file has been frozen on May 11, 2023 as **epn_20_r3.atx** and will remain unchanged for the entire analysis of EPN-Repro3

http://epncb.oma.be/ftp/station/general/epn_20_r3.atx

GNSS data for analysis and meta-data

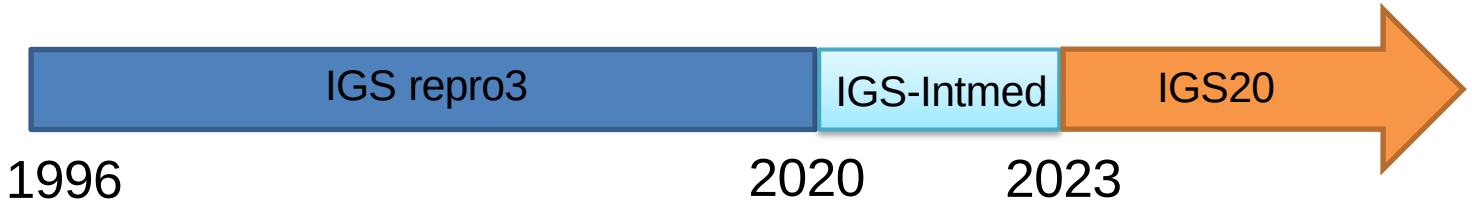
- The station to be analyzed belong exclusively to the EPN (>350 sites)
- Due to the already performed intensive checks of RINEX data by ROB, consistency checks of the header and logfiles, the **Historical Database of the EPNCB** was chosen to simplify access and ensure consistency
- Work on the data basis for GNSS observations @ ROB continues and is constantly updated
- Nevertheless, the current status can be considered as completed

Meta-data:

- Meta-data with the relevant information are available from **EUREF54_R3.STA** (*Bernese Station Information File* with status May 11, 2023)

http://epncb.oma.be/ftp/station/general/EUREF54_R3.STA

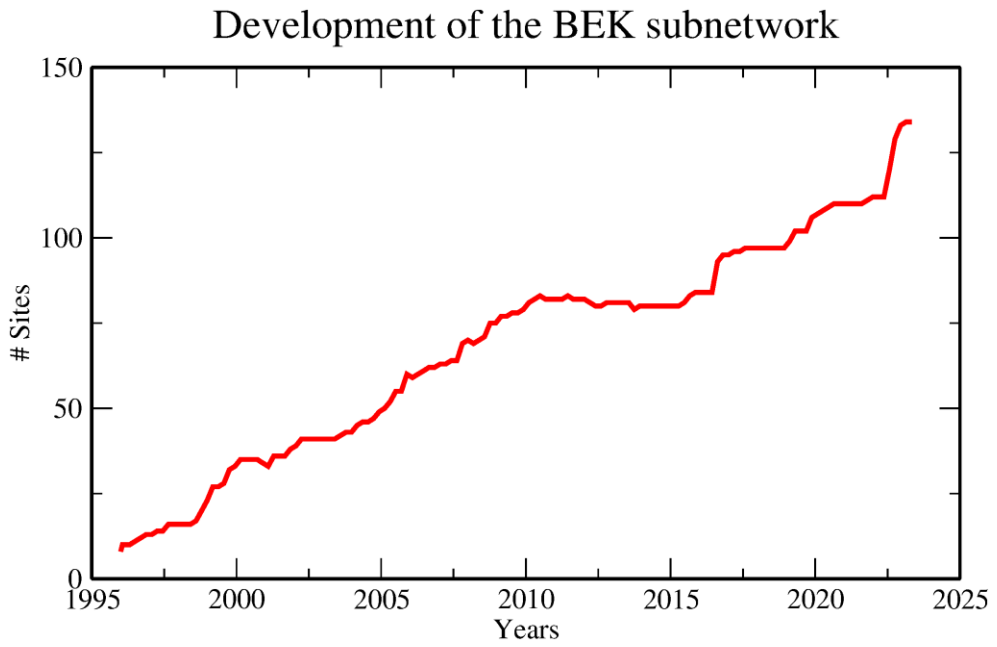
Benchmark



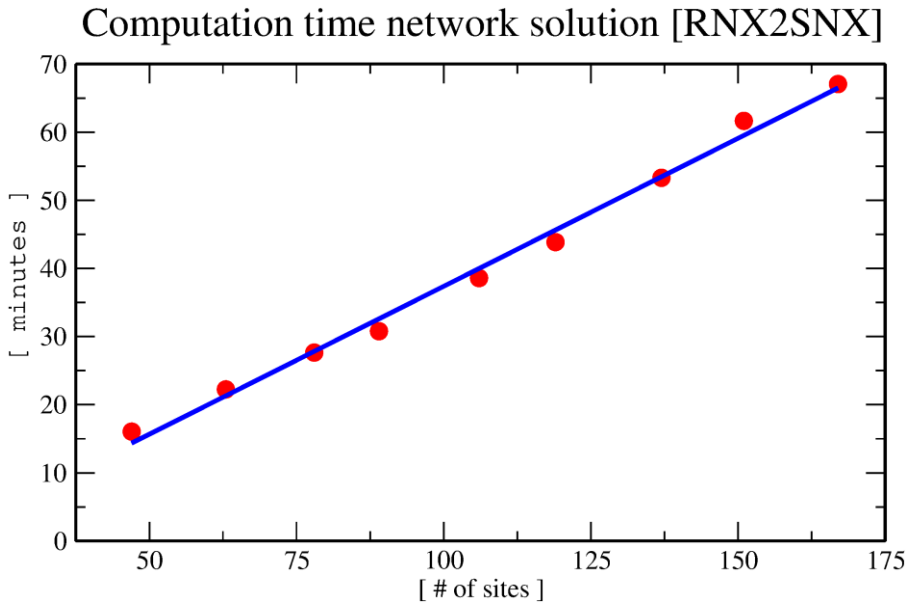
- A benchmark test is proposed for consistency check
- Data from four (4) GPS weeks 2236 to 2239 are to be analyzed by each AC
- This period describes the transition (GPS week 2238) from the reprocessed analysis to the operational analysis.
- Test the effect caused be redesigning different sub-networks for the operational (17 ACs) and EPN-Repro3 (12 ACs)
- Allows to study the impact of tropospheric mapping function VMF1 (to be used in the reprocessing) and VMF3 to be used in the operational analysis

Schedule

- Data analysis can start just after this symposium (e.g. benchmark test)
- A number of AC want to start as soon as possible
- But, not every AC can begin immediately since the switch to Bernese 5.4 delayed
- Almost 27 years of data have to be analysed
- Especially the latter years require more effort (more satellite systems, more stations)



Outlook



Computed with:
Software: Bernese 5.4 (gfortran)
CPU: Intel ® Core i7-8700 / 6 cores
6 Clusters formed
OS: Ubuntu 22.04

GNSS-Analysis requires 25 seconds per site in a network analysis (GPS/GLONASS/Galileo)

Results in ~205 days of computation time

- EPN-Repro3 spans a period of almost 27 years (9828 days)
- Not every AC is ready to start with EPN-Repro3 soon, possible delay
- Of all the reprocessing campaigns carried out so far, EPN-Repro3 presents the greatest challenge in terms of effort

Product names for EPN-Repro3

Long Product file names: (see http://acc.igs.org/repro3/Long_Product_Filenames_v1.0.pdf)

Example: AAAVPPPTTT_YYYYDDDHHMM_LEN_SMP_CNT.FMT[.gz]

AAA:	3 characters: Analysis Center/Combination abbreviation; e.g. COD, GFZ, …		
V:	1 character: Version/Solution identifier (0-9)		
PPP:	**3 characters: Campaign/Project specification**		**E03 (reprocessed R, EPN: E)**
TTT:	3 characters: Solution type identifier		FIN
LEN:	3 characters: intended (nominal) products period		01D
SMP:	3 characters: temporal product sampling resolution		SOL: 01D, TRO:01H
CNT:	3 charcaters: content type		SOL, TRO
FMT:	3 characters: fileformat	SNX	

EPN-Repro3 products (example):

MUT0E03FIN_19992340000_01D_01D_SOL.SNX[.gz]	Daily solution
MUT0E03FIN_19992340000_01D_01H_TRO.SNX[.gz]	Daily troposphere 1H-sampling
MUT0E03FIN_19992340000_07D_07D_SOL.SNX[.gz]	Weekly solution