ROYAL OBSERVATORY OF BELGIUM

EUREF Symposium Wroclaw, May 17-19, 2017

Enhanced Assessment of EPN Station Performance

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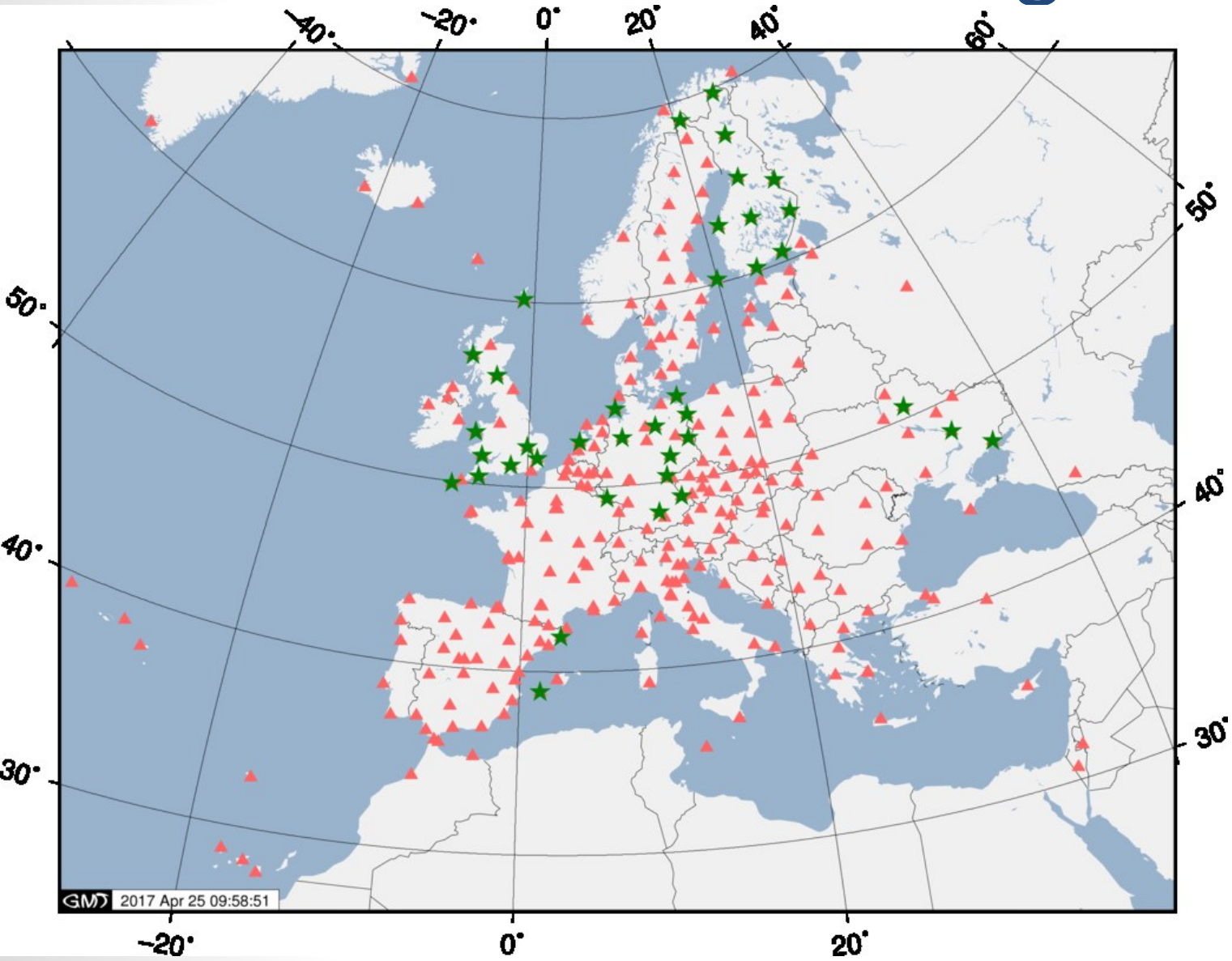
EPN Central Bureau, Royal Observatory of Belgium

http://www.epncb.eu/

Special thanks to D. Mesmaker and A. Moyaert

Evolution of the Tracking Network



320 EPN stations

2 inactive (MOPS, RABT)

280+ tracking GLONASS

150+ tracking Galileo

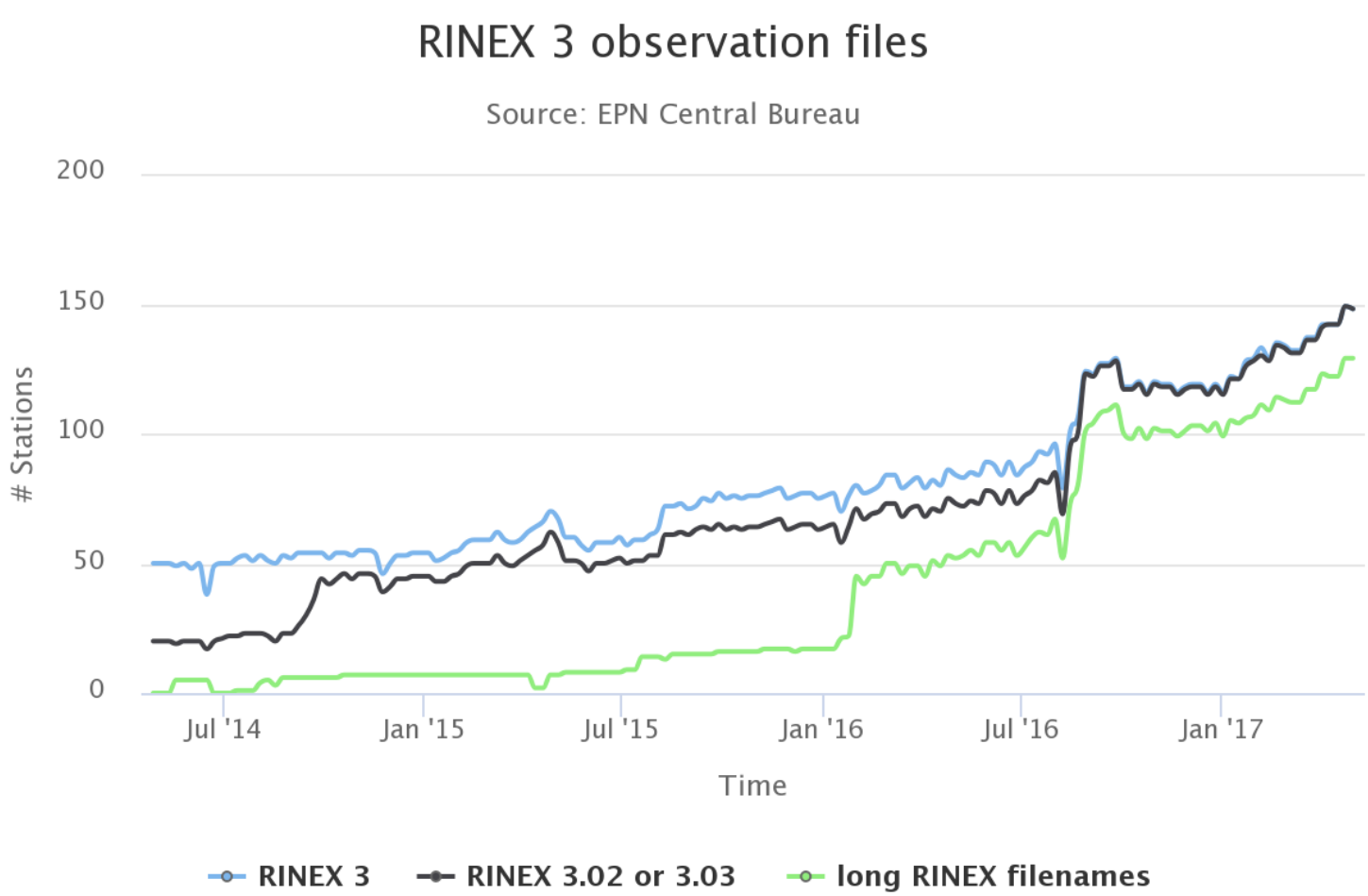
39 new EPN stations since last EUREF symposium :

- Antenna calibrations
  - Type mean 8 stations
  - Individual 31 stations
- Multi-GNSS
  - GPS+ GLO 15 stations
  - GPS+GLO+GAL+.. 24 stations
- Networks

  8 stations included in ITRF2014

  3 stations included in IGS network

RINEX 3



On May 12, 2017:
~150 stations providing RINEX 3 (all RINEX 3.02 or 3.03)

129 stations providing RINEX 3 with long filenames

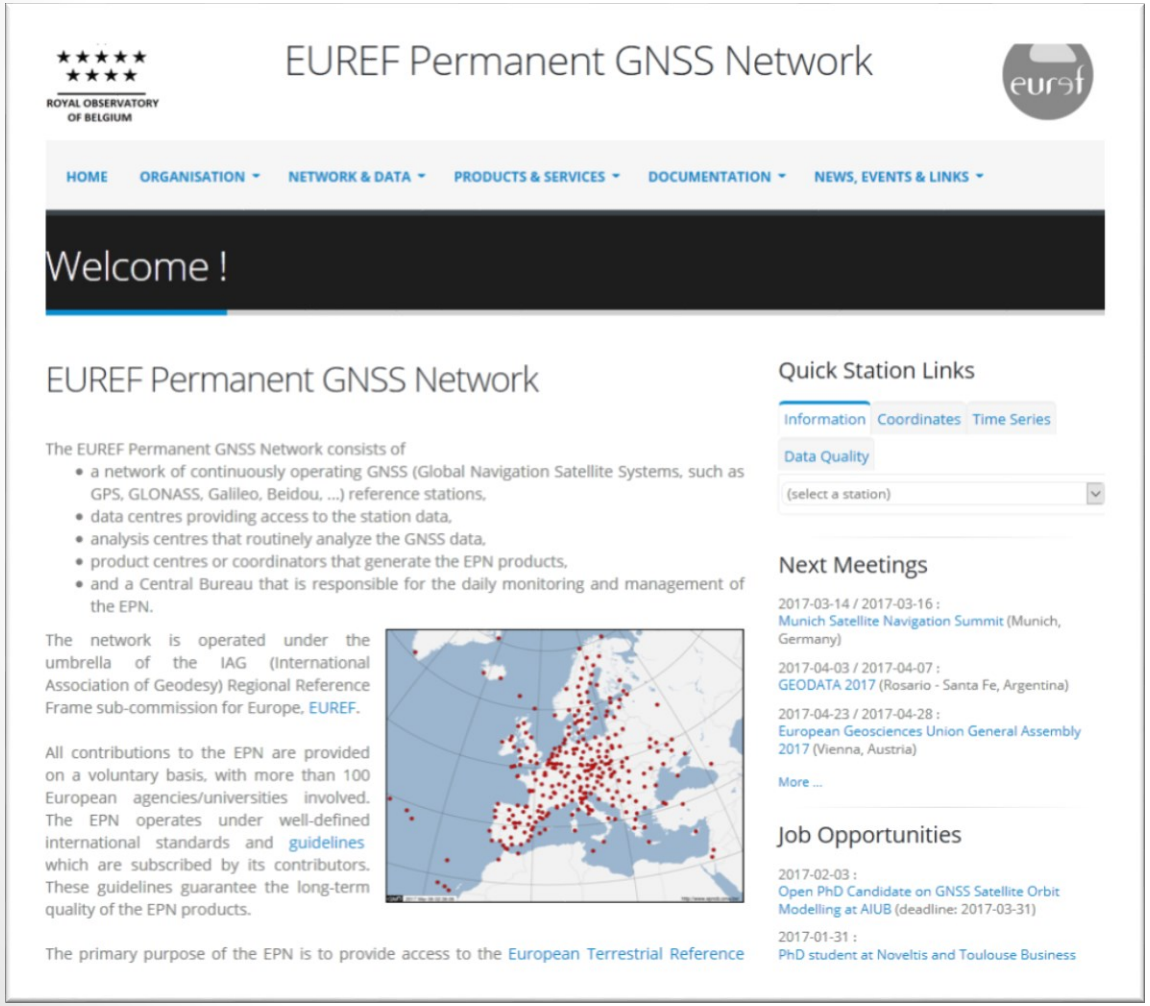
Providing RINEX 3 with short filenames:
BPDL BUTE* BYDG CASC FLRS FUNC GAIA GWWL KATO KLOP LAGO LINZ LODZ M0SE* PDEL REDZ SWKI USDL VAIN VLNS WROC ZYWI

RINEX 3 in both short and long format (short at BKG, long at OLG/BEV)

New EPN Central Bureau web site

Nov. 2016

http://www.epncb.oma.be/ or http://www.epncb.eu/



Redesign of frontend

- ✓ More intuitive menu structure to navigate through the web site
- ✓ Dynamic plots (data latency, data quality, time series)

Backend

- ✓ GNSS data availability and data latency
- ✓ GNSS data quality checks
- ✓ Extended real-time data monitoring
- ✓ Administrator tools – still developing

Data Availability & Latency

OLG will stop operations end of 30/06/2017
Station managers are asked to switch data upload from OLG to BEV (Bundesamt für Eich- und Vermessungswesen, Vienna)
EUREF mail 8976 (10/04/2017), reminder EUREF mail 9001 (02/05/2017)

Scans of content of regional data centers BEV, OLG, BKG and historical data center ROB

New functionality to FLAG files:

- Invalid RINEX 3 (No GPS L1/L2), Isolated RINEX 3 (tests)
- RINEX 3 converted from RINEX 2 ⚠
- Cannot uncompress data
- RINEX 3 data found in RINEX 2 directory
- Incorrect filename
- …

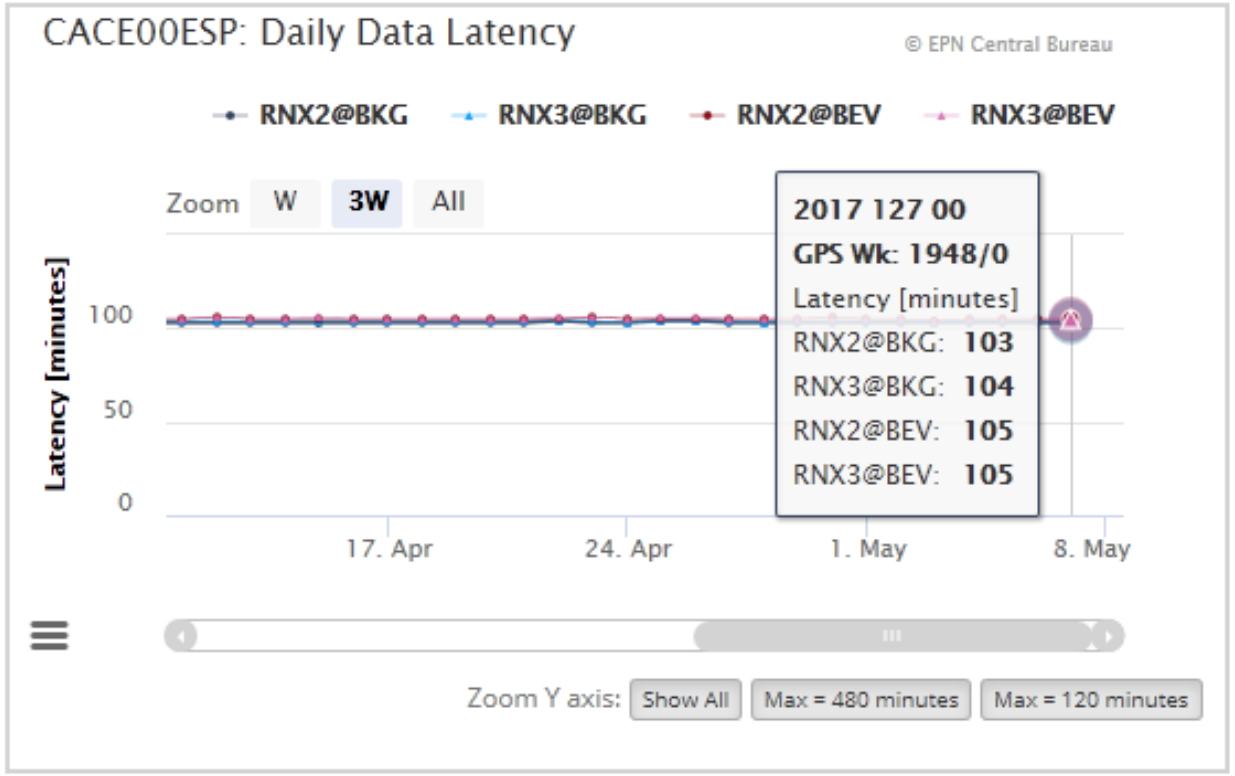
→ In preparation of EPN-REPRO2 input for additional flagging of data files in historical data center (moving to separate directory)

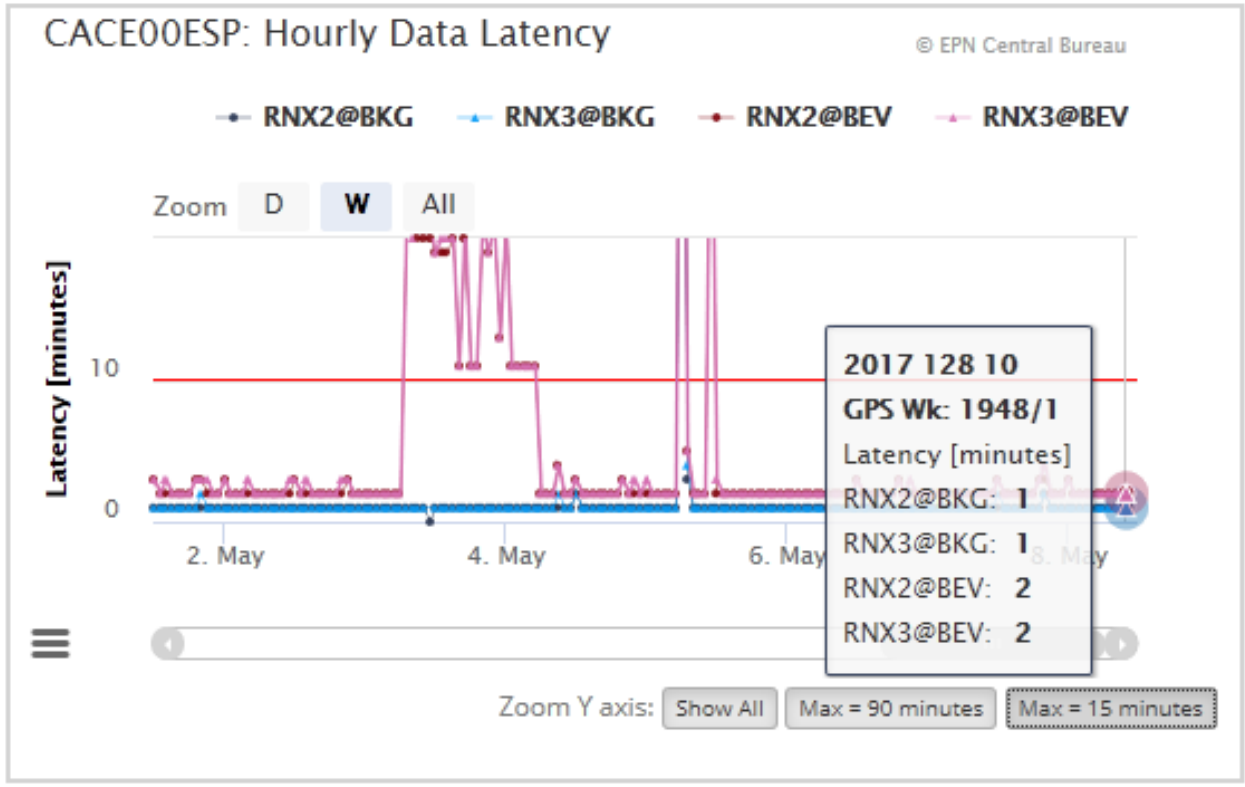
INPUT FROM STATION MANAGERS AND USERS IS IMPORTANT!

Data Availability & Latency RESULTS

http://www.epncb.eu/_networkdata/data_access/dailyandhourly/latency/

Dynamic plots available for each station





Data Quality METHOD

- Focus on daily RINEX 2 & 3 data
- Daily: G-nut/Anubis*
  - Once with navigation messages
  - Rerun, when precise orbits become available
  - Dynamics plots → web site (1 year, full history can be viewed)
- Once a month: G-nut/Anubis* runs with higher verbosity
  - Monthly snapshots (skyplots)
- Store multiple key metrics in database

*Václavovic P, Dousa J (2016)

Satellite constellations RESULTS

Satellite constellations vs. site log → Mails to station manager

From administrator tools:

Station Name	Station Log	RINEX 2 data file	RINEX 3 data file
ARGI00FRO	GPS+GLO	GPS+GLO+GAL (127/2017)	
BOGI00POL	GPS+GLO+GAL	GPS+GLO (127/2017)	
BRST00FRA	GPS+GLO+GAL+BDS+SBAS	GPS+GLO+GAL (128/2017)	GPS+GLO+GAL+BDS (128/2017)
DRAG00ISR	GPS+GLO+BDS	GPS+GLO (128/2017)	
HELG00DEU	GPS+GLO+GAL+SBAS	GPS+GLO+SBAS (128/2017)	GPS+GLO+GAL+BDS+SBAS (128/2017)
INVR00GBR	GPS+GLO	GPS (128/2017)	
MATG00ITA	GPS+GLO+GAL+BDS+SBAS	GPS (92/2017)	GPS+GLO+GAL+SBAS (92/2017)
NEWL00GBR	GPS+GLO+GAL	GPS+GLO (125/2017)	
SULP00UKR	GPS+GLO+SBAS	GPS+SBAS (126/2017)	

Status May 9, 2017

QZSS inconsistencies are neglected

Elevation cut off RESULTS

Elevation cut off vs. site log → Diff > 3° → Mails to station managers

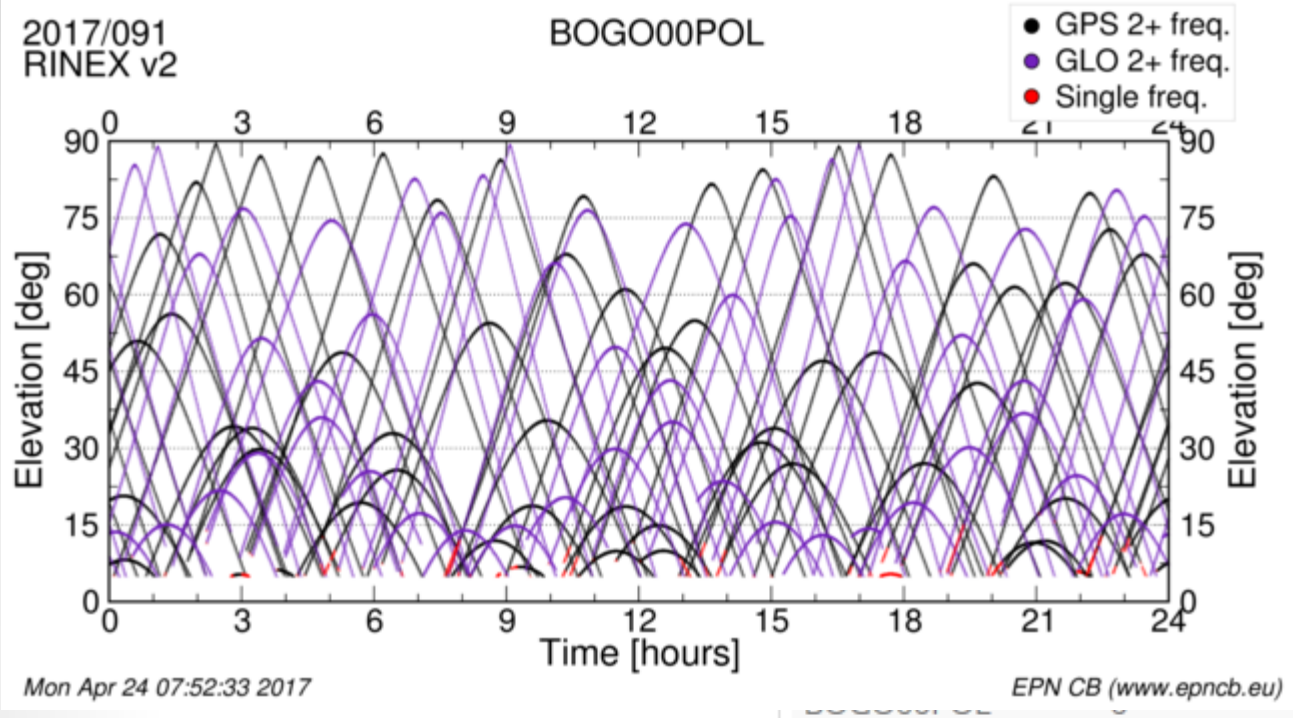
From administrator tools:

Station Name	Station Log	RINEX 2 data	RINEX 3 data	
BOGI00POL	0	5 (2017-05-02)		inconsistency
BOGO00POL	0	4 (2017-05-02)		inconsistency
BRST00FRA	0	10 (2017-05-02)	4 (2017-05-02)	inconsistency
JOZE00POL	0	3 (2017-05-02)		obstruction/old
MOPI00SVK	0	3 (2017-05-02)		obstruction/old
MORP00GBR	0	3 (2017-05-02)		obstruction
ROVE00ITA	0	3 (2017-05-02)		obstruction
SASS00DEU	0	4 (2017-05-02)		inconsistency
SULP00UKR	0	4 (2017-05-02)		inconsistency
TRF200AUT	0	4 (2017-05-02)		obstruction
TUBI00TUR	0	6 (2017-05-02)		obstruction

Obstruction/old:
includes older receivers with 8/10 channels
TRIMBLE 4000SSE/SSI

Status May 3, 2017

RESULTS



to station managers

		RINEX 2 data	RINEX 3 data	
		5 (2017-05-02)		inconsistency
		4 (2017-05-02)		inconsistency
BRST00FRA	0	10 (2017-05-02)	4 (2017-05-02)	inconsistency
JOZE00POL	0	3 (2017-05-02)		obstruction/old
MOPI00SVK	0	3 (2017-05-02)		obstruction/old
MORP00GBR	0	3 (2017-05-02)		obstruction
ROVE00ITA	0	3 (2017-05-02)		obstruction
SASS00DEU	0	4 (2017-05-02)		inconsistency
SULP00UKR	0	4 (2017-05-02)		inconsistency
TRF200AUT	0	4 (2017-05-02)		obstruction
TUBI00TUR	0	6 (2017-05-02)		obstruction

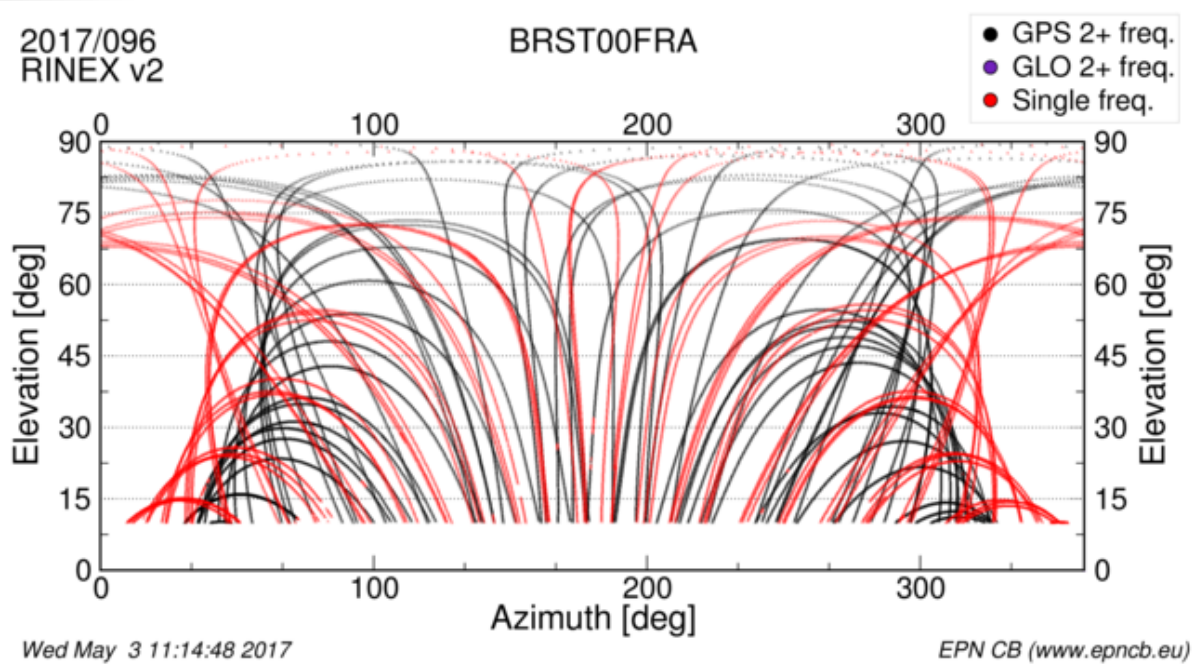
Obstruction/old:
includes older receivers with
8/10 channels
TRIMBLE 4000SSE/SSI

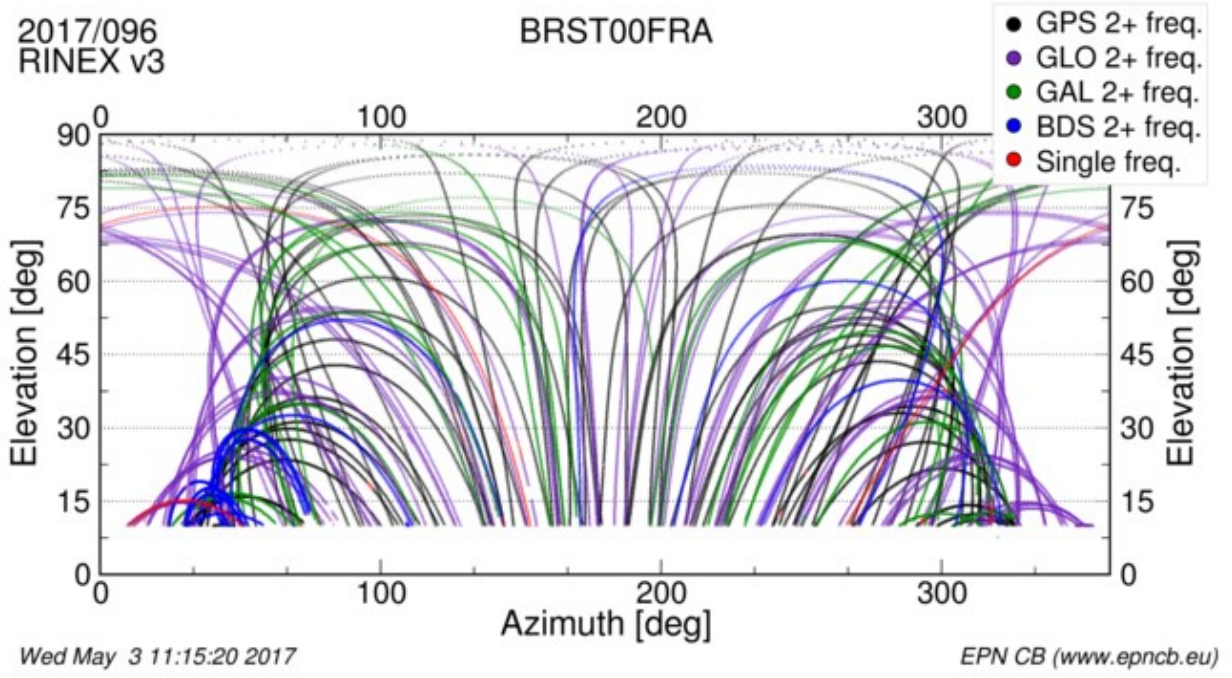
Status May 3, 2017

Data Quality - Snapshots RESULTS

http://www.epncb.eu/_networkdata/data_quality/skyplots/

Plots also available for all data in EPN historical data center at ROB





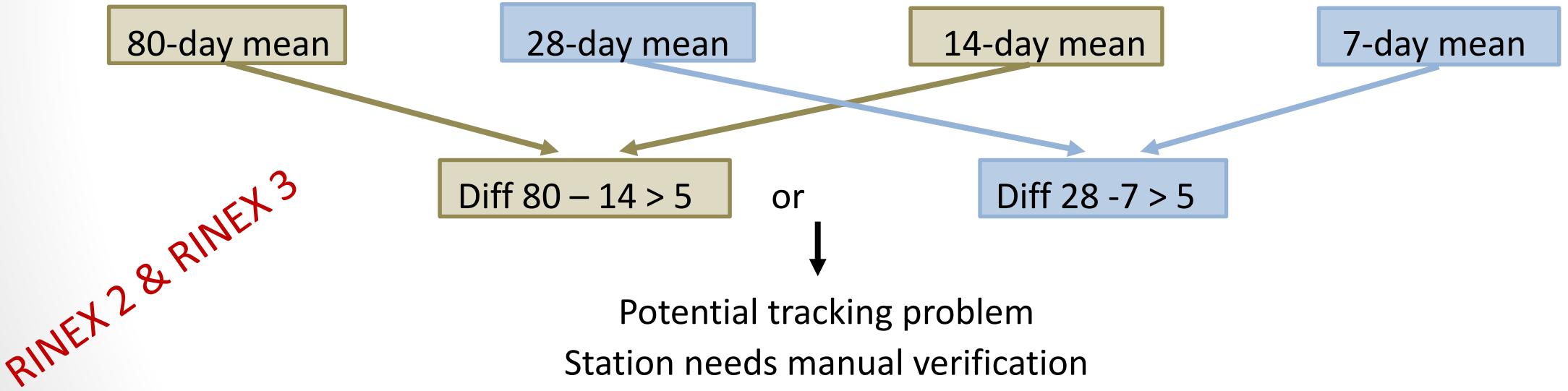
RINEX 2: GLONASS dual freq. tracking
RINEX 3: affected differently

Data Quality METHOD

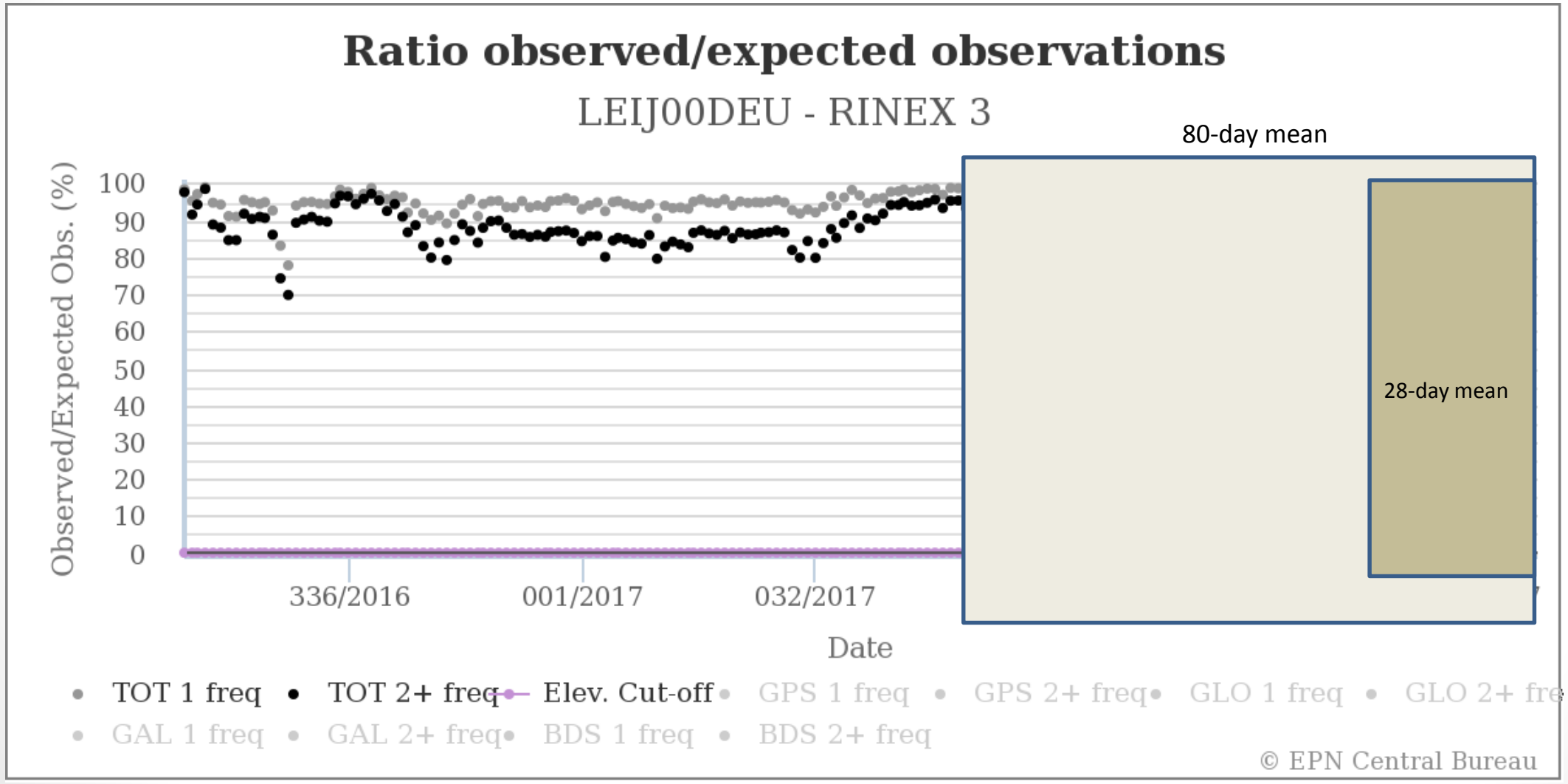
To detect stations with RECENT tracking problems

Administrator tools:

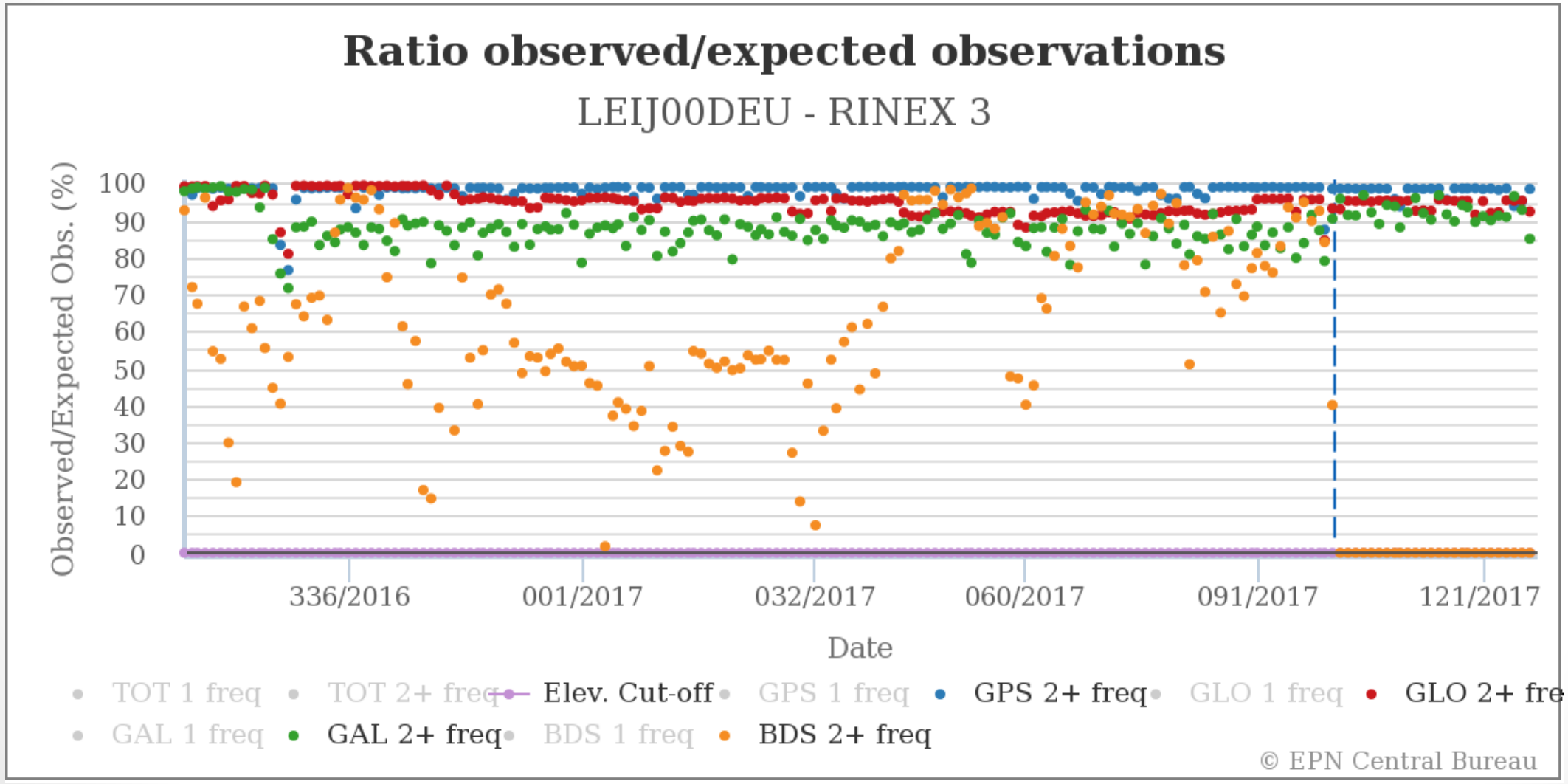
Evolution of daily computed % observed/expected dual+ frequency data (G-nut/Anubis)



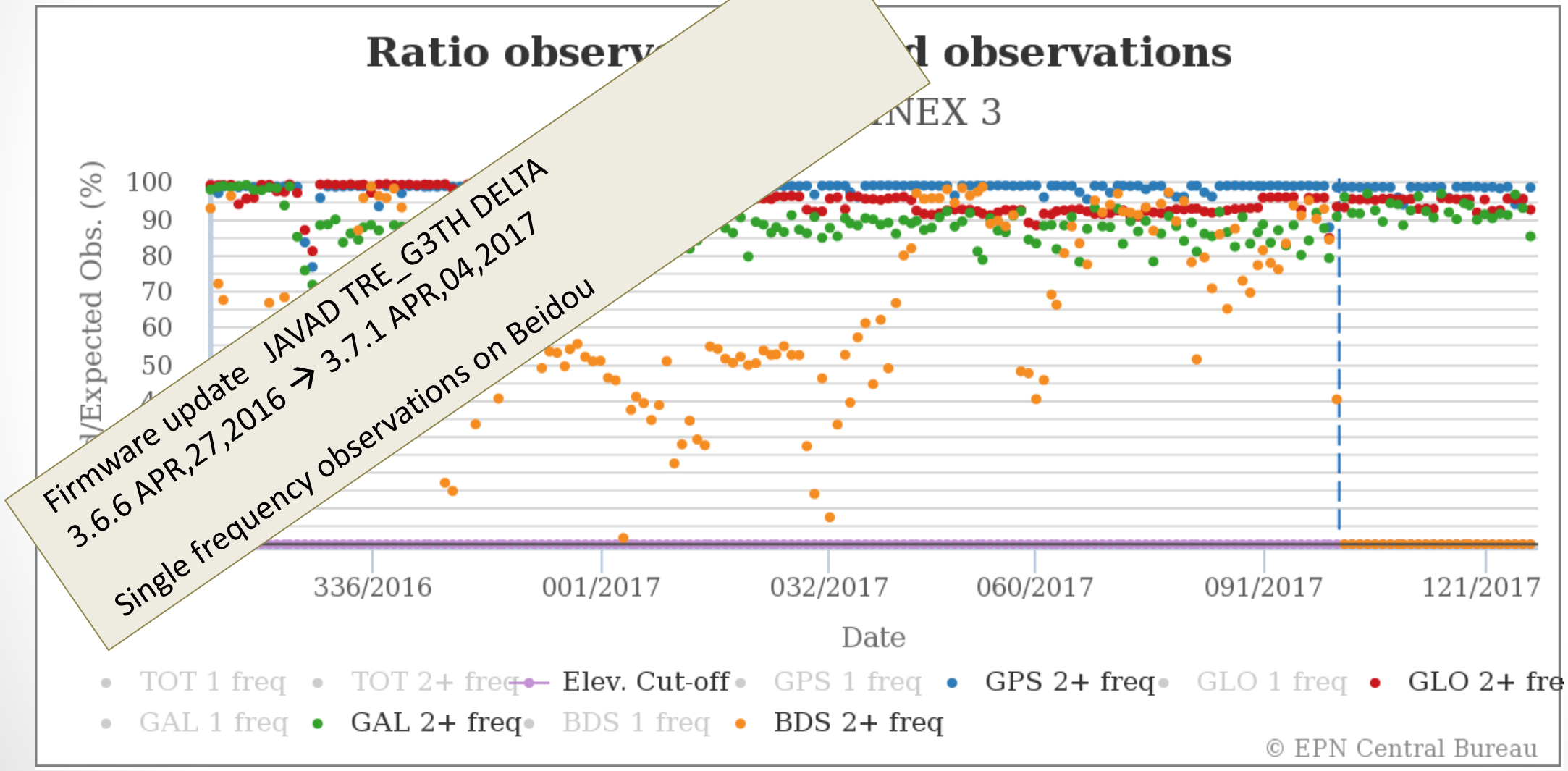
Data Quality – time series RESULTS



Data Quality – time series RESULTS



Data Quality – time series RESULTS



RESULTS

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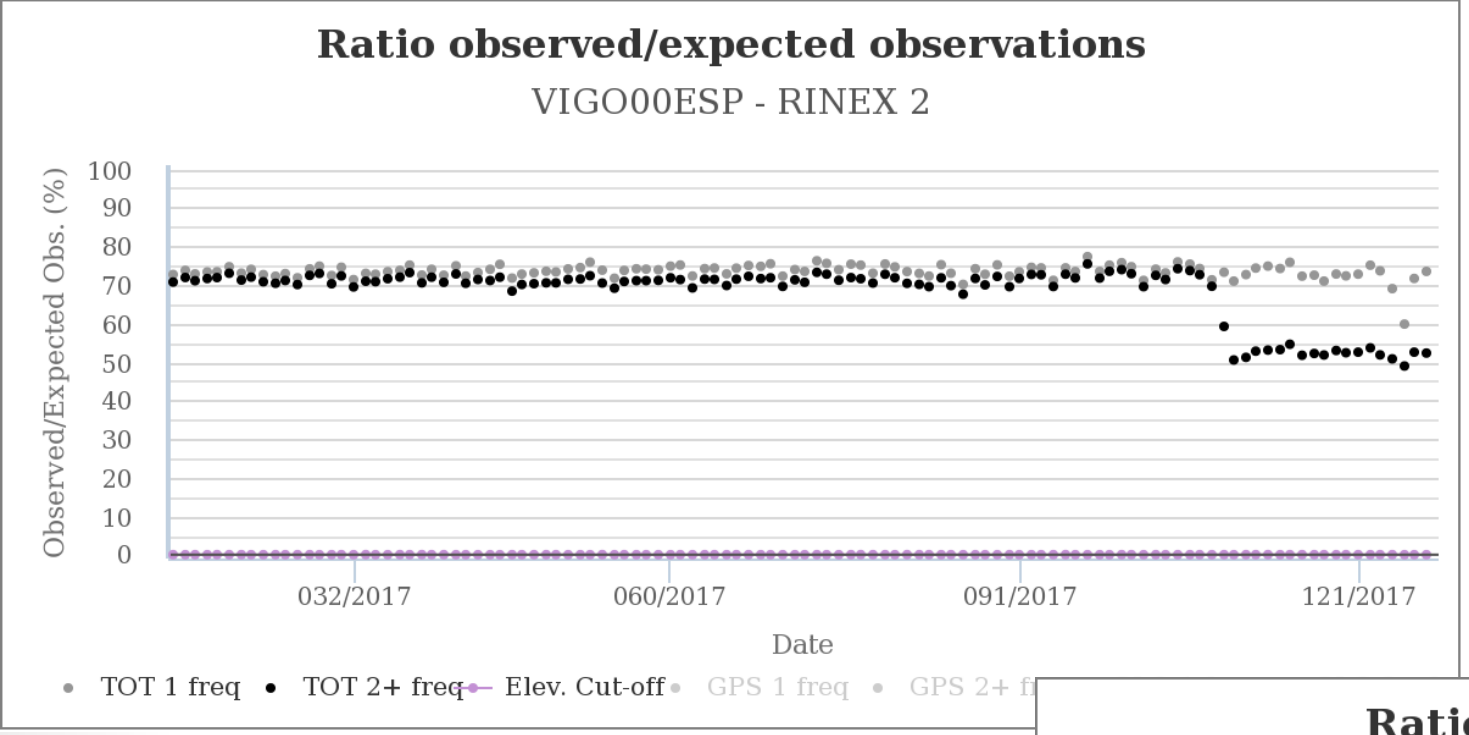
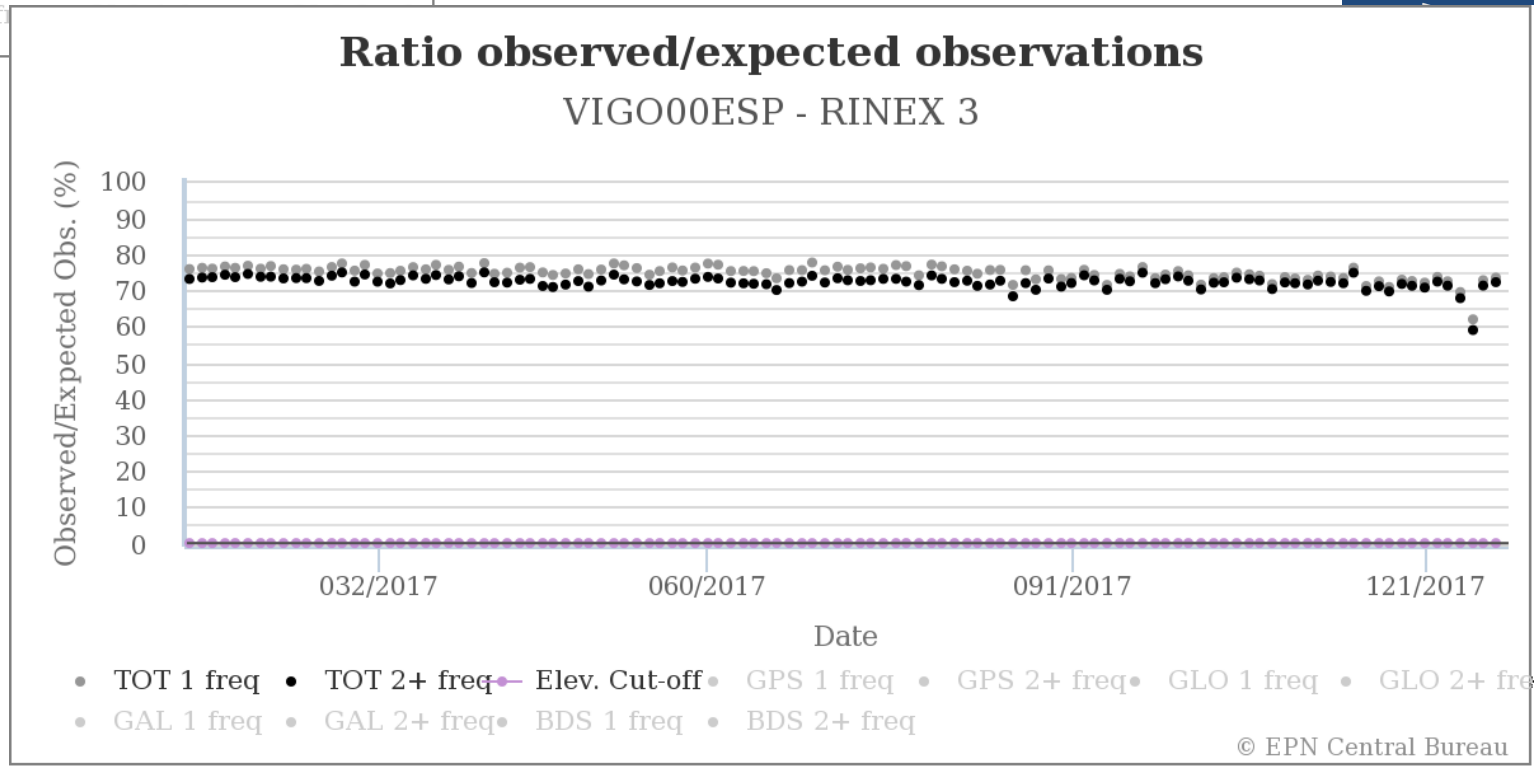
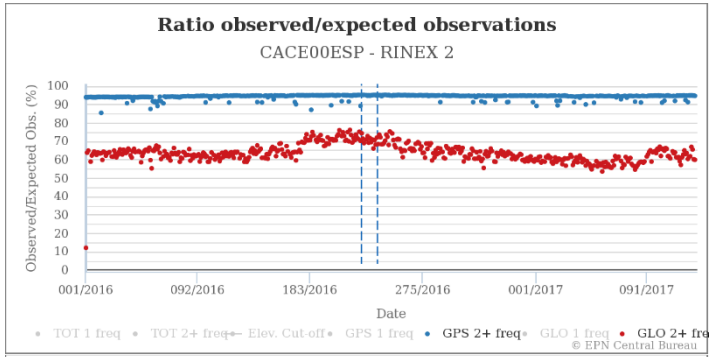


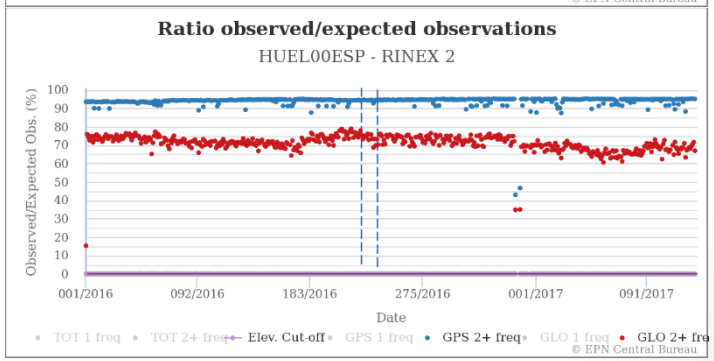


Da

RESULTS

TRIMBLE NetR9/TRM29659.00
RINEX 2/3: reduced low elevation GLONASS tracking
Antenna pre-amplifier not designed for GLO?
But RINEX 3: not affected by last sudden jump





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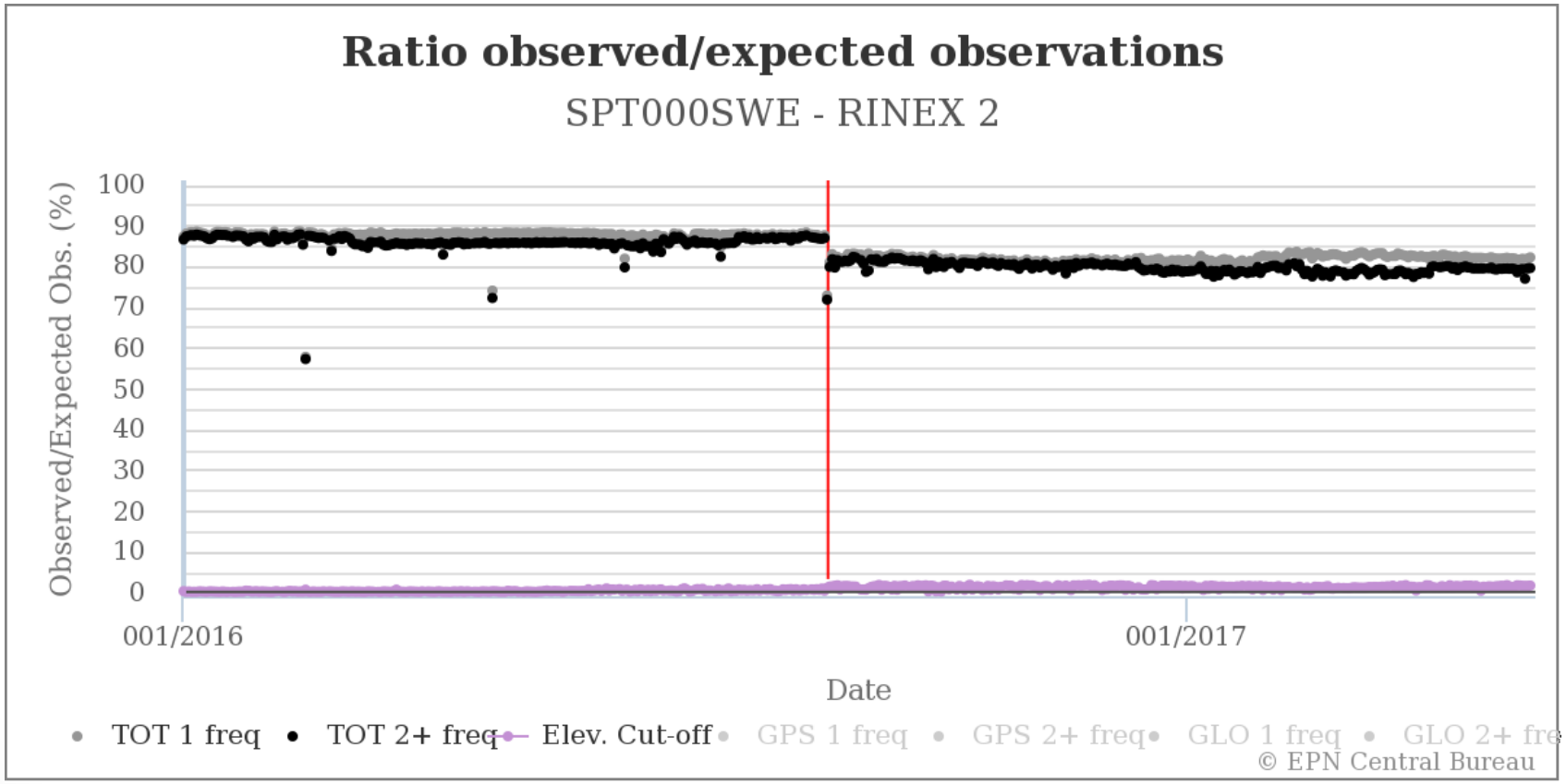
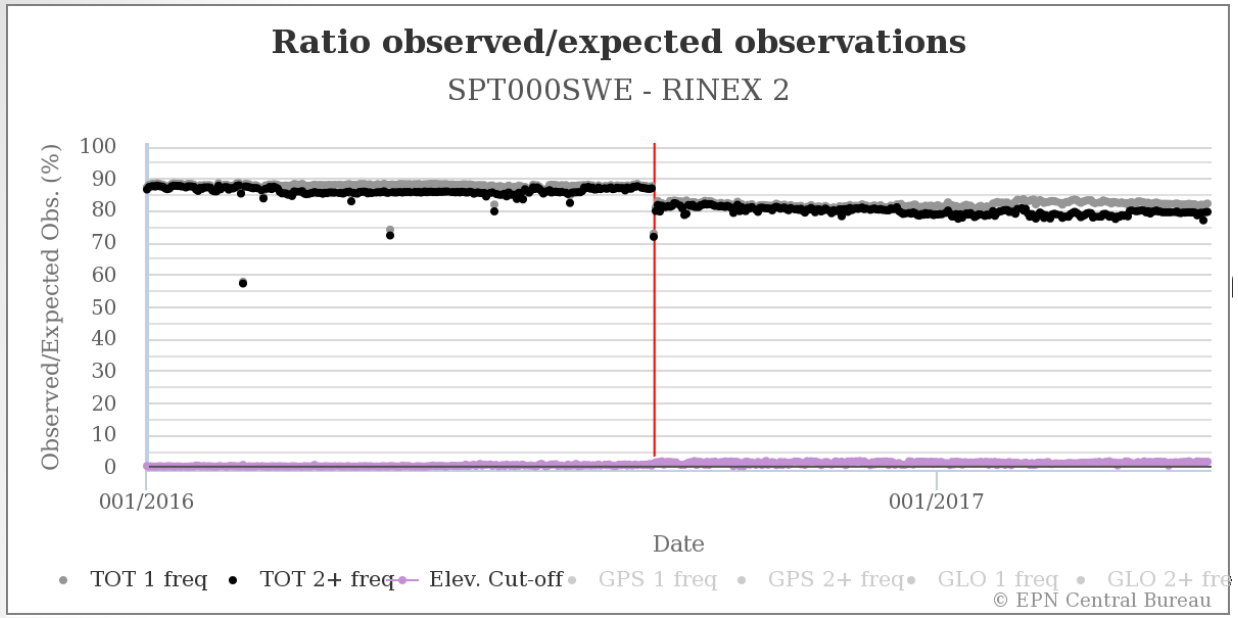
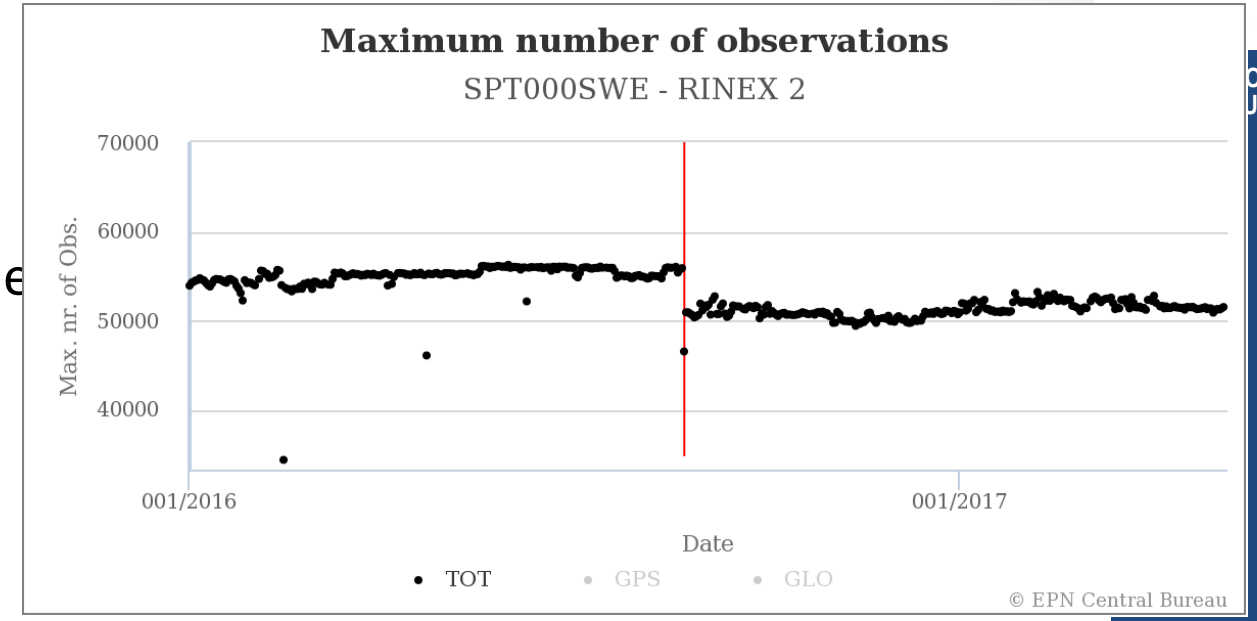
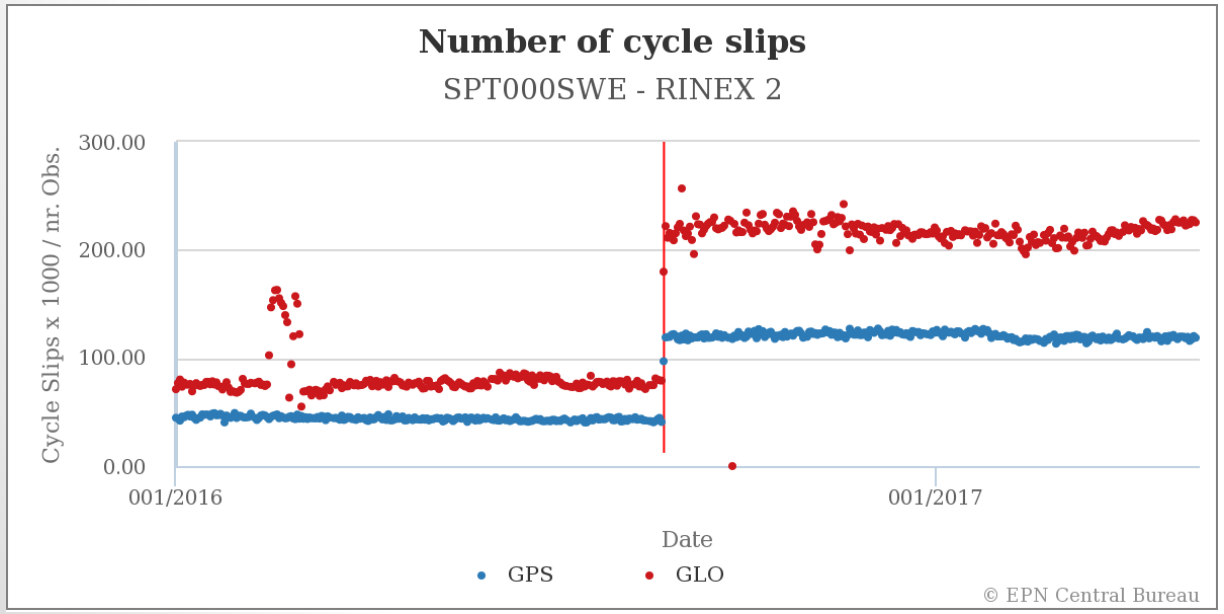
Data Quality RESULTS

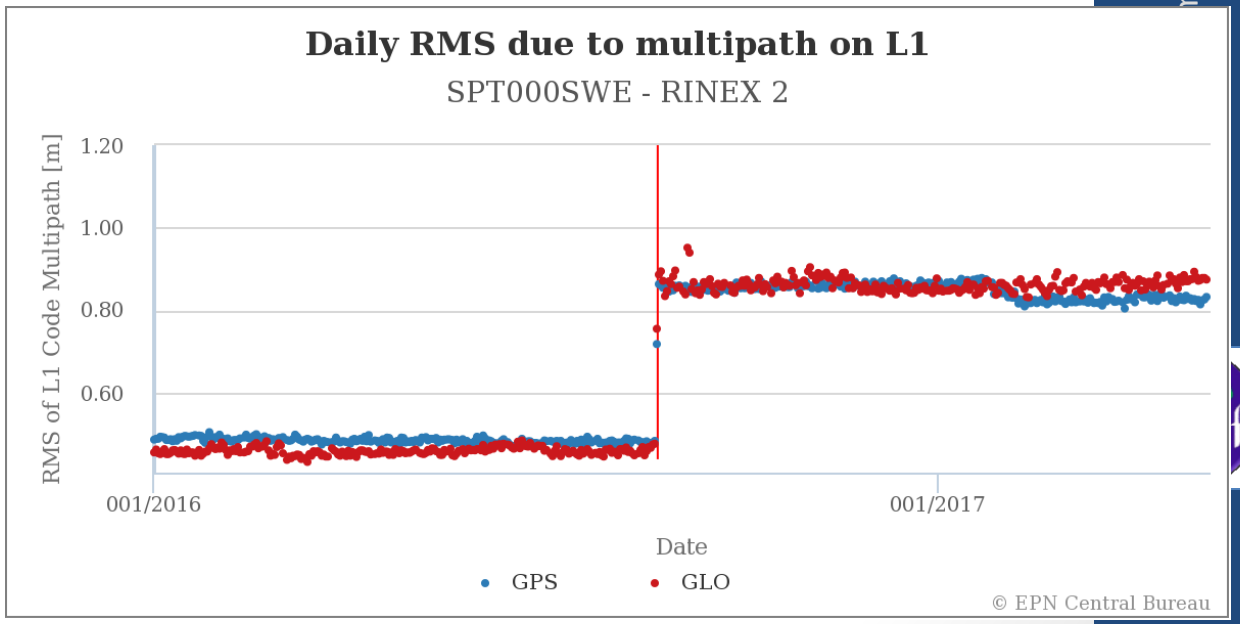
Too many interesting things to show. A last one….

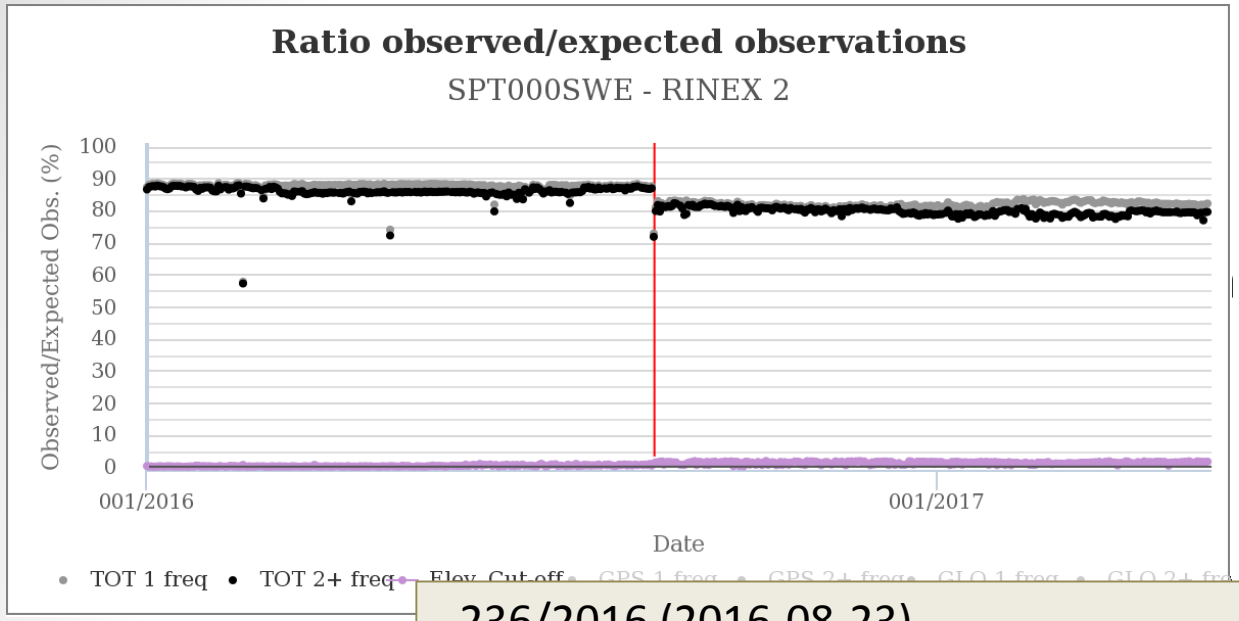


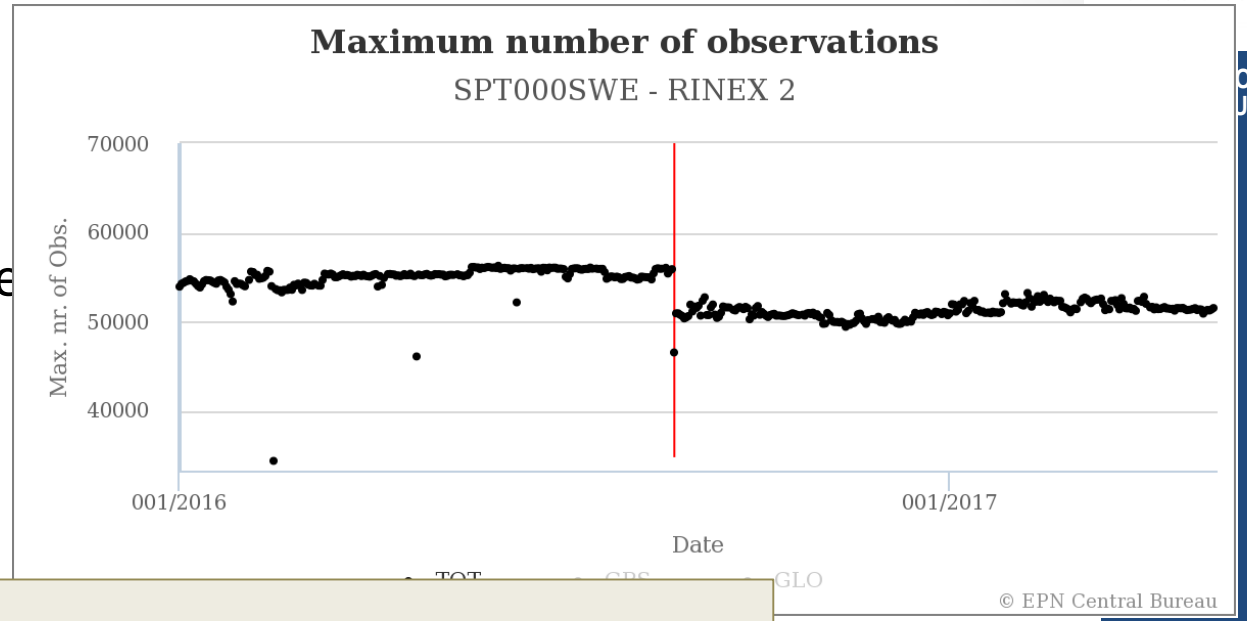

Ratio observed/expected observations
SPT000SWE - RINEX 2
Observed/Expected Obs. (%)
100
90
80
70
60
50
40
30
20
10
0
001/2016
001/2017
Date
TOT 1 freq
TOT 2+ freq
Elev. Cut-off
GPS 1 freq
GPS 2+ freq
GLO 1 freq
GLO 2+ fre
© EPN Central Bureau


Maximum number of observations
SPT000SWE - RINEX 2
Max. nr. of Obs.
70000
60000
50000
40000
001/2016
001/2017
Date
TOT
GPS
GLO
© EPN Central Bureau

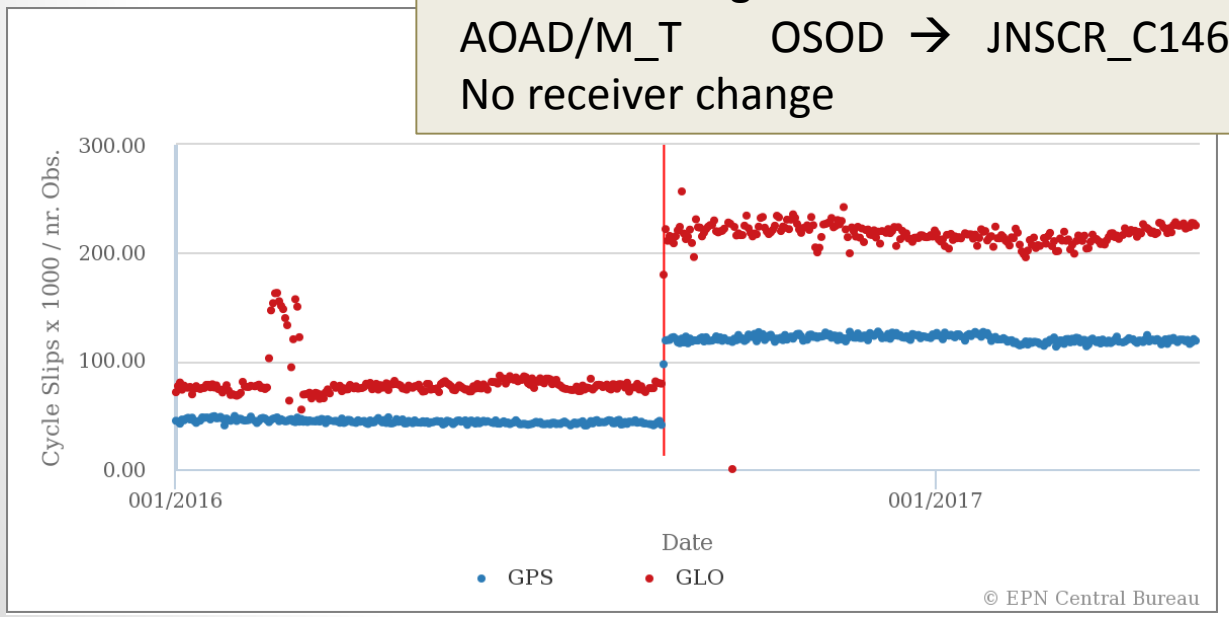

Number of cycle slips
SPT000SWE - RINEX 2
Cycle Slips x 1000 / nr. Obs.
300.00
200.00
100.00
0.00
001/2016
001/2017
Date
GPS
GLO
© EPN Central Bureau

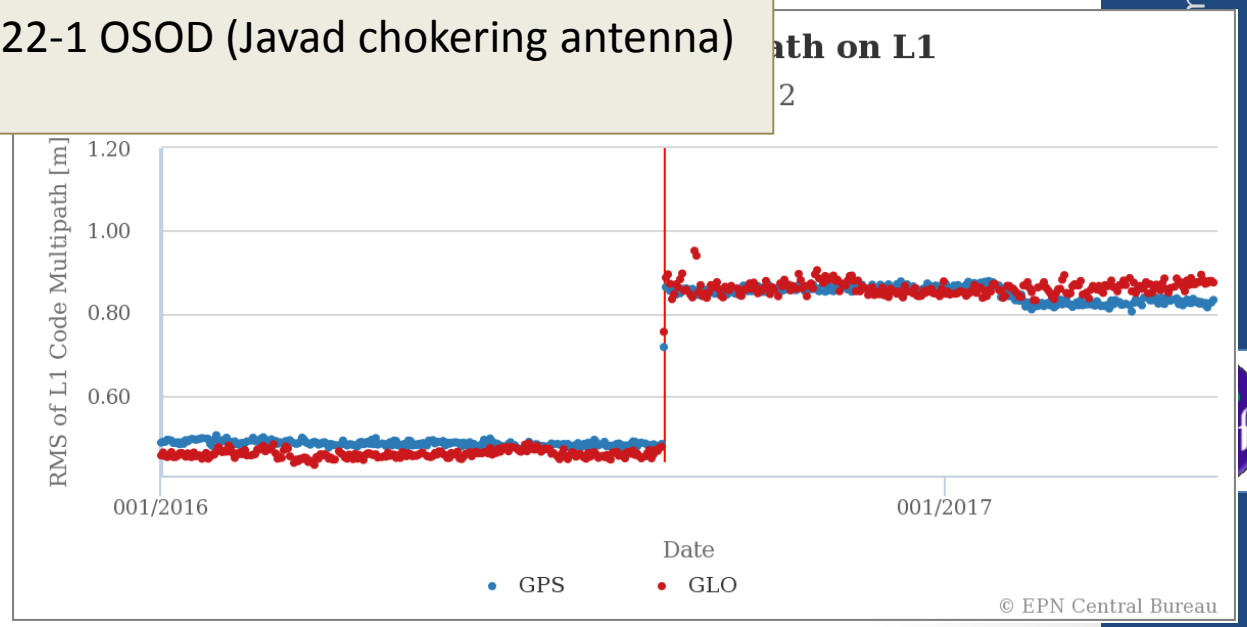

Daily RMS due to multipath on L1
SPT000SWE - RINEX 2
RMS of L1 Code Multipath [m]
1.20
1.00
0.80
0.60
001/2016
001/2017
Date
GPS
GLO
© EPN Central Bureau





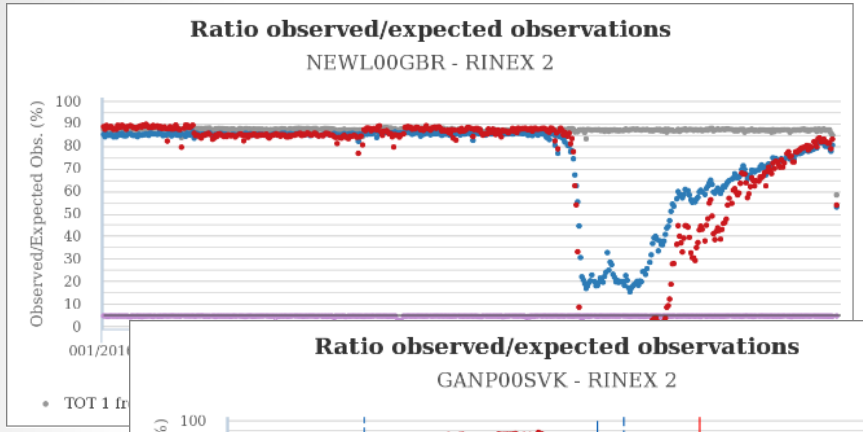
236/2016 (2016-08-23)
Antenna change
AOAD/M_T OSOD → JNSCR_C146-22-1 OSOD (Javad chokering antenna)
No receiver change

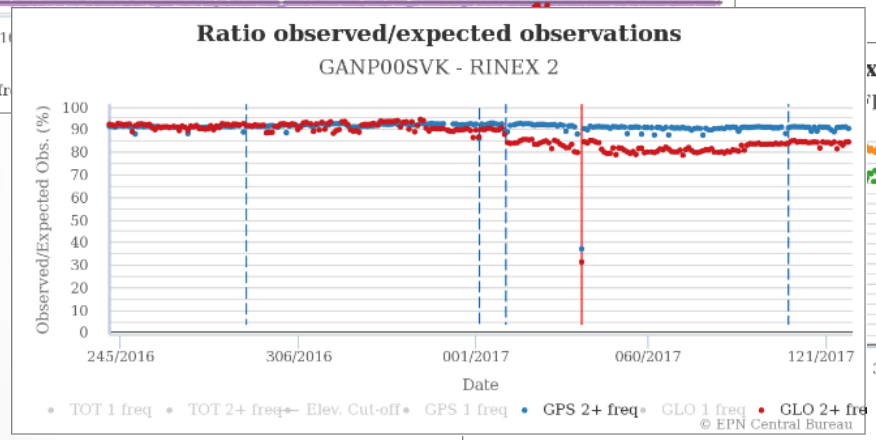


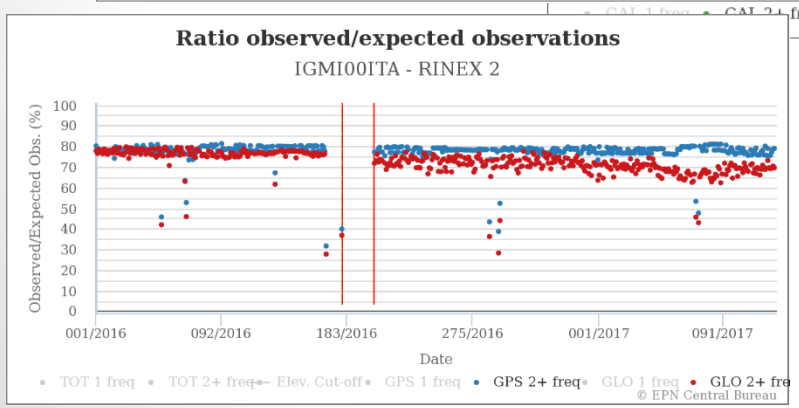


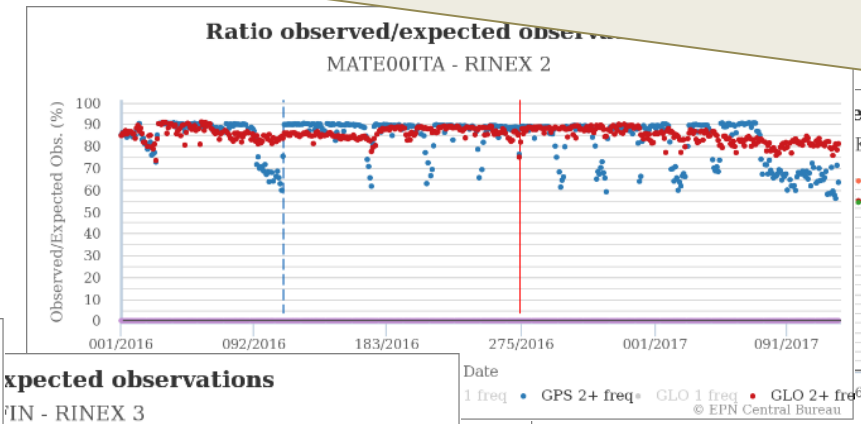
Other Stations

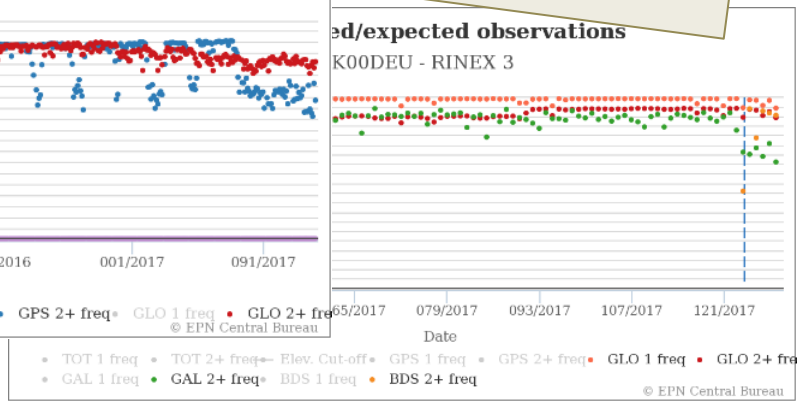
http://www.epncb.eu/_networkdata/data_quality/
Plots also available for all data in EPN historical data center at ROB

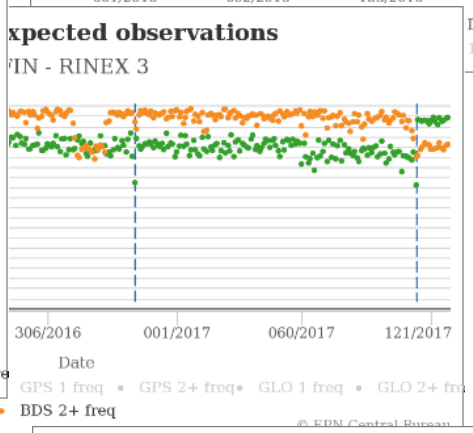


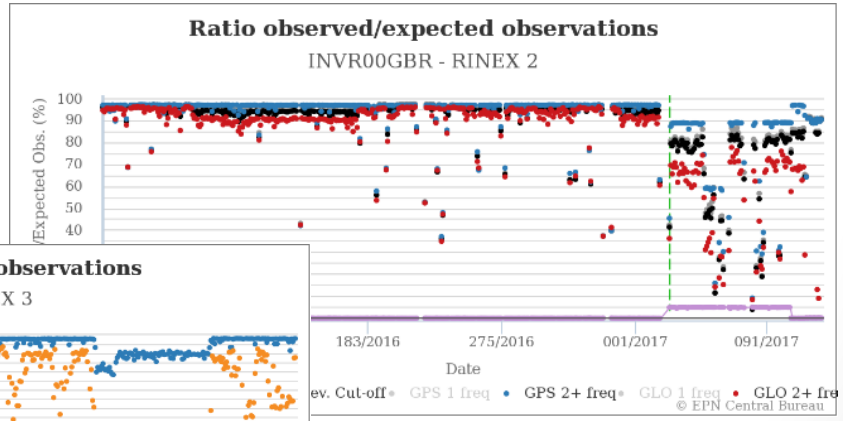


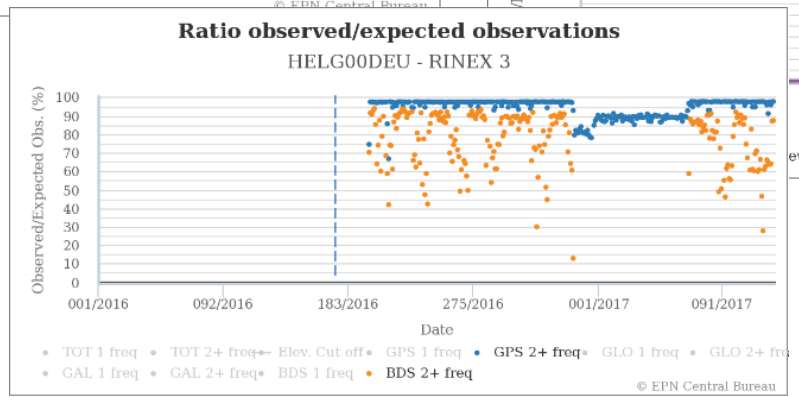












EPN Time Series

http://www.epncb.eu/_productsservices/timeseries/

Input for the time series are

- Official cumulative EPN solution, released each 15 weeks by Reference Frame coordinator
- Extended cumulative solution= official cum. solution + more recent final and rapid combined EPN solutions
  - based on cumulative solution computed at EPN CB

For both solutions, time series with

- position residuals after estimation of position/velocity and introduction of discontinuities
- positions (ITRS, ETRS89)

EPN Time Series RESULTS

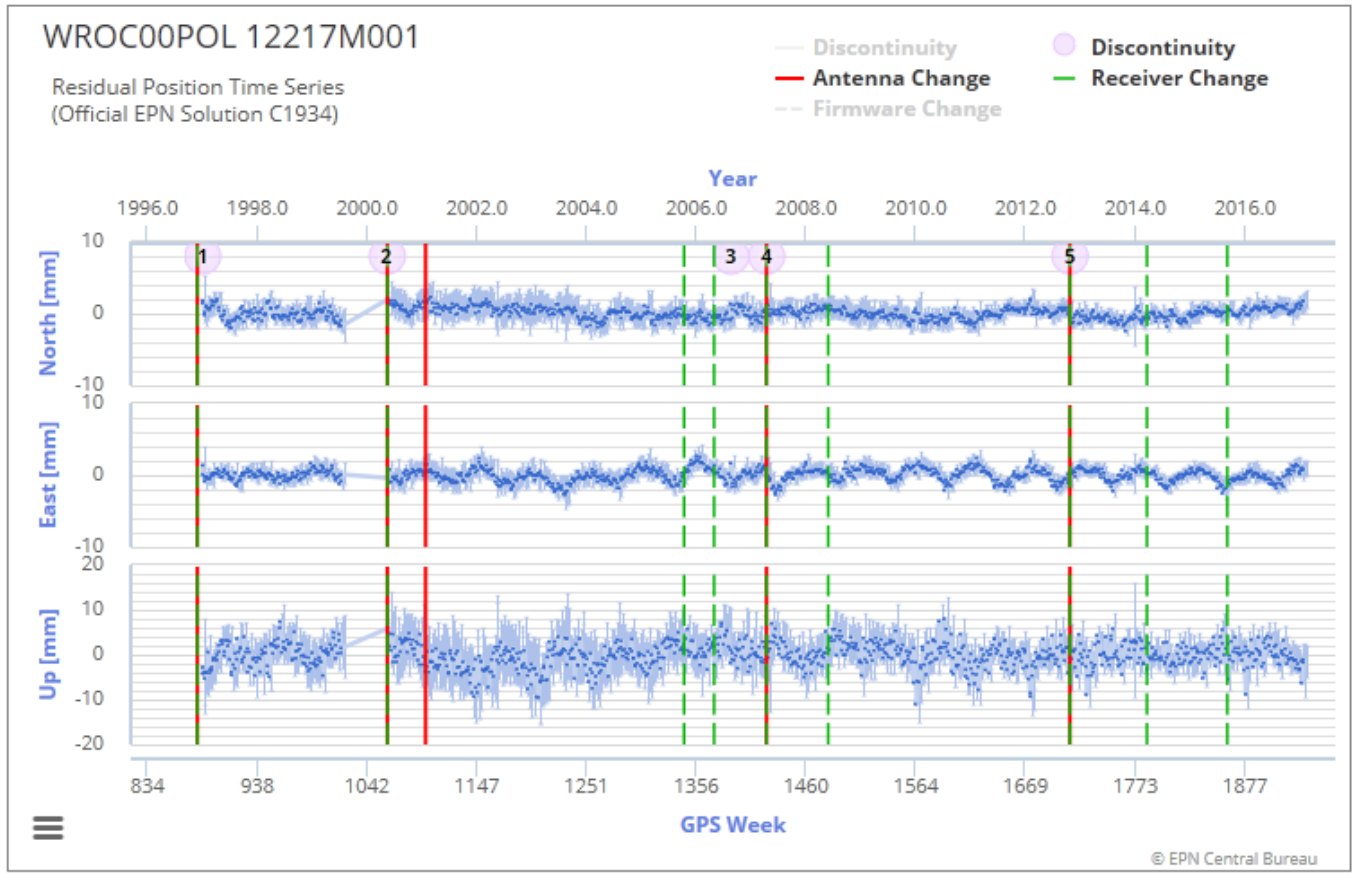
MULTI-YEAR EPN SOLUTION

EPN station position time series:

WROC00POL (Wroclaw,Poland) [Class A]

Other residual position time series: ITRF2014, IGS, Nevada Geodetic Laboratory

OFFICIAL, SOLUTIONS INCLUDED UP TO 04-02-2017 (GPS WK 1934) (READ MORE)



Download Residual Position Time Series data

Official Time Series up to week 1934

Extended Time Series up to week 1947/1

Residual Position Time Series

Position Time Series in ITRS (IGb08)

Position Time Series in ETRS89 (ETRF2000)

Official Station Velocities published by EUREF:

Frame	V_{North} [mm/yr]	V_{East} [mm/yr]	V_{Up} [mm/yr]
IGb08	14.9 ± 0.03	20.2 ± 0.02	0.2 ± 0.08
ETRF2000	0.0 ± 0.03	-0.4 ± 0.02	-0.7 ± 0.08

EPN Time Series RESULTS

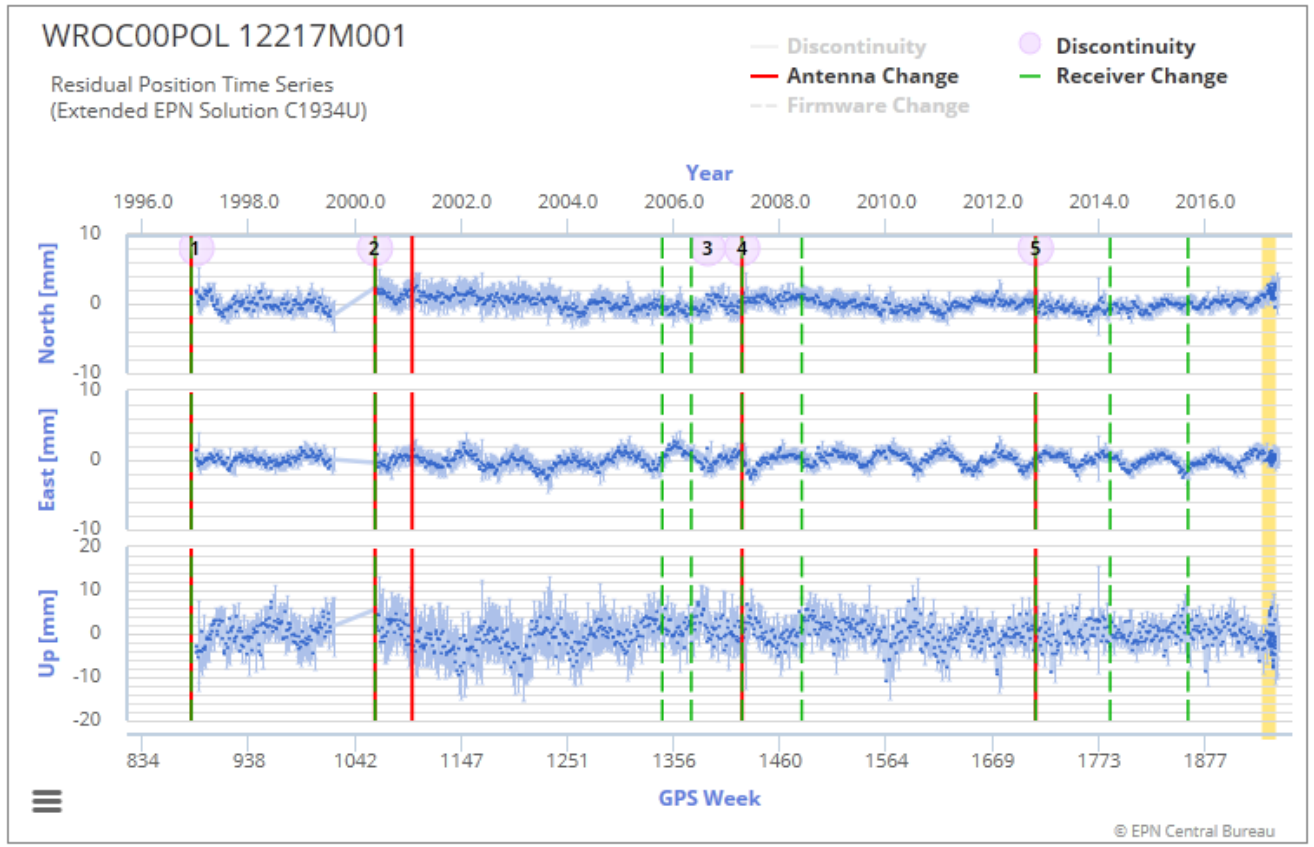
MULTI-YEAR EPN SOLUTION

EPN station position time series:

WROC00POL (Wroclaw,Poland) [Class A]

Other residual position time series: ITRF2014, IGS, Nevada Geodetic Laboratory

EXTENDED, SOLUTIONS INCLUDED UP TO 01-05-2017 (GPS WK 1947) (READ MORE)



Official Time Series up to week 1934

Extended Time Series up to week 1947/1

Residual Position Time Series

Position Time Series in ITRS (IGb08)

Position Time Series in ETRS89 (ETRF2000)

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Dynamic plots

EPN Time Series

MULTI-YEAR EPN SOLUTION

EPN station position time series:

WROC00POL (Wroclaw,Poland) [Class A]

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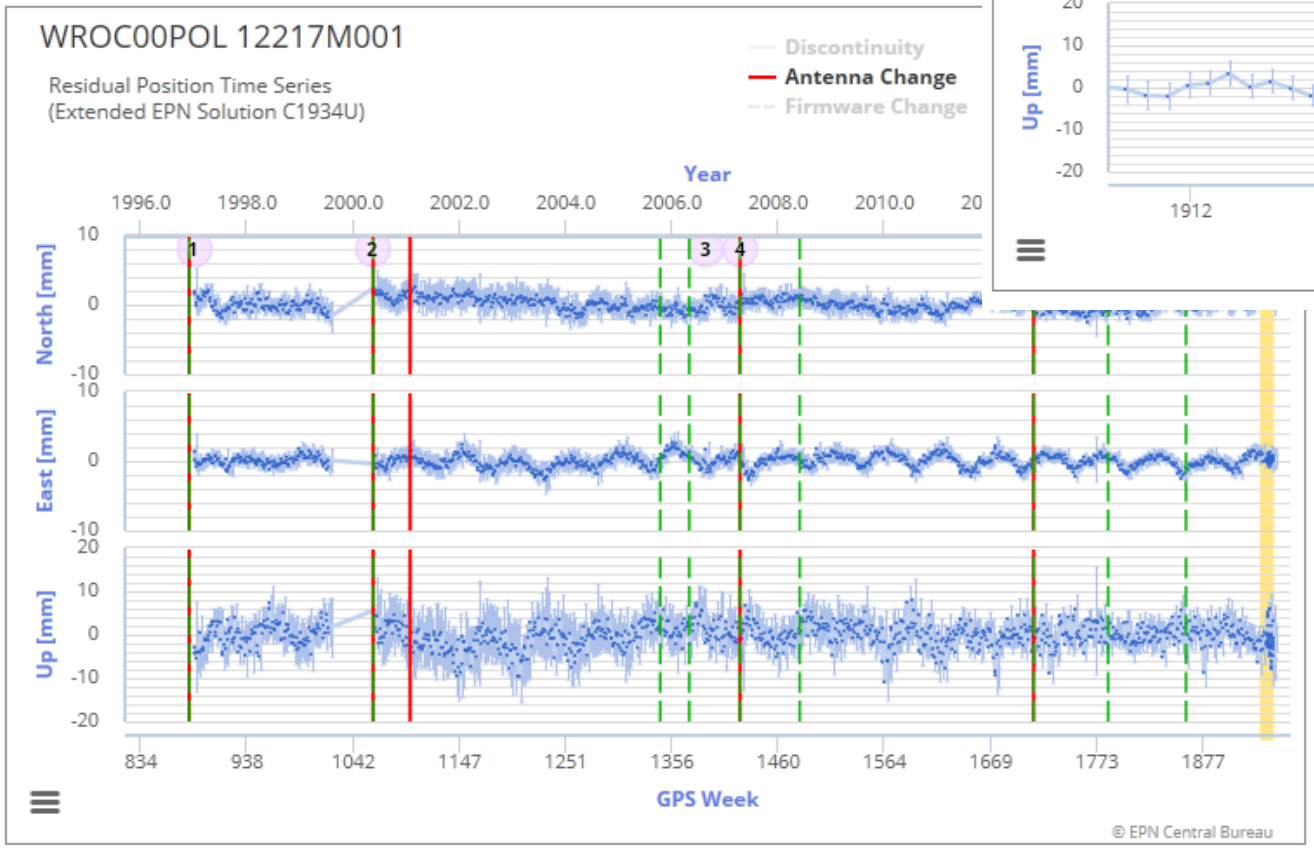
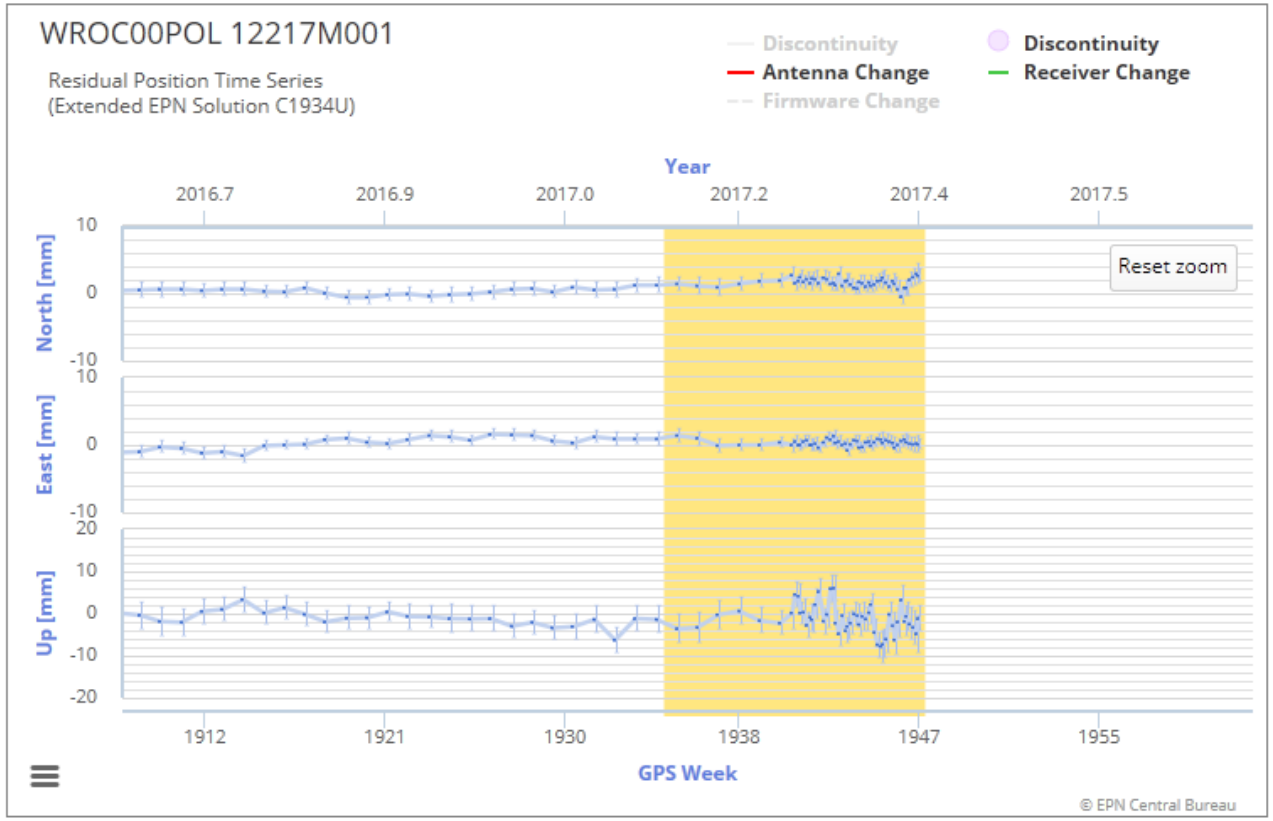




Official Station Velocities published by EUREF:

Frame	V_{North} [mm/yr]	V_{East} [mm/yr]	V_{Up} [mm/yr]
IGb08	14.9 ± 0.03	20.2 ± 0.02	0.2 ± 0.08
ETRF2000	0.0 ± 0.03	-0.4 ± 0.02	-0.7 ± 0.08

Dynamic plots

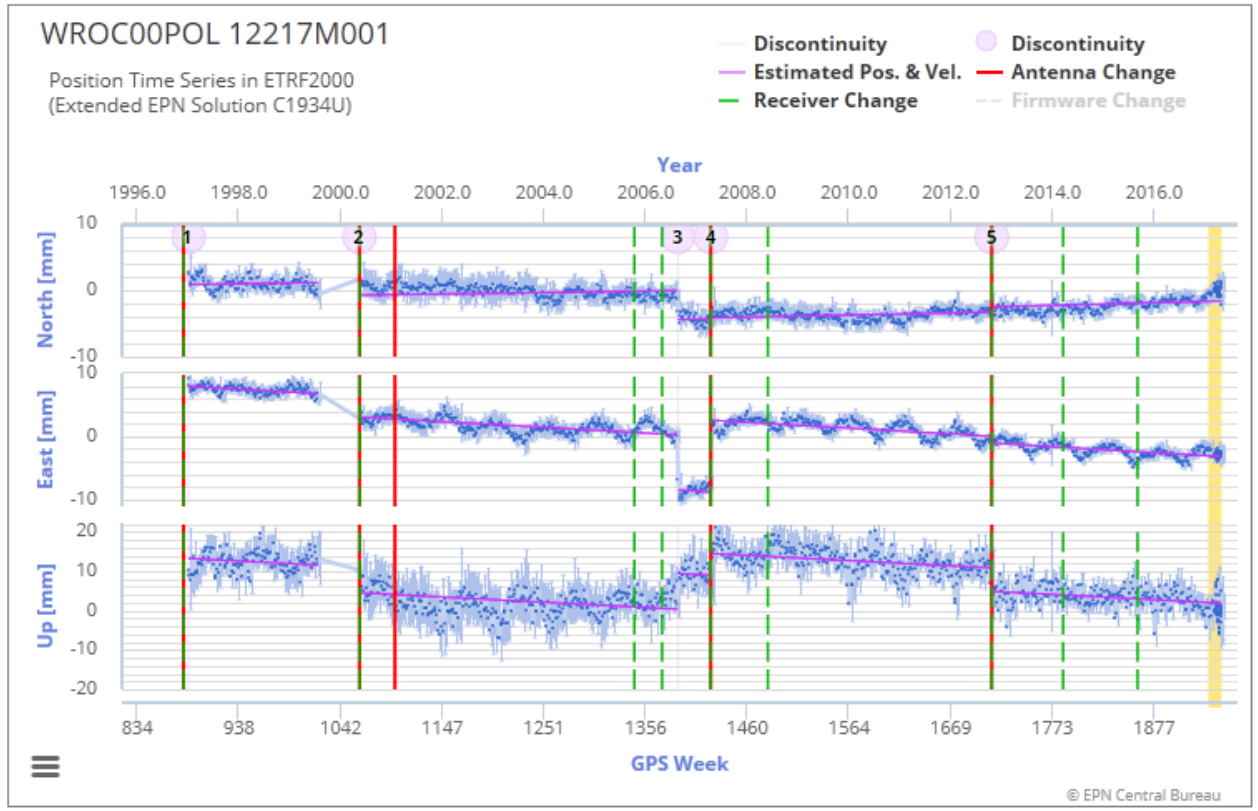
ROYAL OBSERVATORY OF BELGIUM

EUREF Symposium Wroclaw, May 17-19, 2017

EPN Time Series

RESULTS

EXTENDED, SOLUTIONS INCLUDED UP TO 01-05-2017 (GPS WK 1947) (READ MORE)



Official Time Series up to week 1934

Extended Time Series up to week 1947/1

Residual Position Time Series

Position Time Series in ITRS (IGb08)

Position Time Series in ETRS89 (ETRF2000)

Official Station Velocities published by EUREF:

Frame	V_{North} [mm/yr]	V_{East} [mm/yr]	V_{Up} [mm/yr]
ETRF2000	0.0 ± 0.03	-0.4 ± 0.02	-0.7 ± 0.08

1. POSITIONS/VELOCITIES PUBLISHED BY EUREF

EUREF has classified WROC00POL (Wroclaw, Poland) as a **class A station** which means that it can used as fiducial station for EUREF densifications.

LATEST RELEASE

EPN_A_ETRF2000_C1934.SSC - EPN_A_IGb08_C1934.SSC (March 25, 2017)

ETRF2000	epoch t_0	Position (m)			Velocity (m/y)		
		X	Y	Z	V_X	V_Y	V_Z
302/2012 - 035/2017	001/2005	3835751.622 ± 0.000	1177249.745 ± 0.000	4941605.050 ± 0.001	-0.0003 ± 0.0000	-0.0006 ± 0.0000	-0.0005 ± 0.0001
111/2007 - 301/2012	001/2005	3835751.626 ± 0.000	1177249.747 ± 0.000	4941605.054 ± 0.000	-0.0003 ± 0.0000	-0.0006 ± 0.0000	-0.0005 ± 0.0001
232/2006 - 103/2007	001/2005	3835751.627 ± 0.000	1177249.736 ± 0.000	4941605.050 ± 0.001	-0.0003 ± 0.0000	-0.0005 ± 0.0000	-0.0005 ± 0.0001
146/2000 - 232/2006	001/2005	3835751.616 ± 0.000	1177249.742 ± 0.000	4941605.045 ± 0.000	-0.0003 ± 0.0001	-0.0005 ± 0.0000	-0.0005 ± 0.0001
002/1997 - 200/1999	001/2005	3835751.618 ± 0.000	1177249.746 ± 0.000	4941605.052 ± 0.000	-0.0003 ± 0.0001	-0.0005 ± 0.0000	-0.0005 ± 0.0001

Position Time Series in ETRS89 (ETRF2000)

Official Station Velocities published by EUREF:

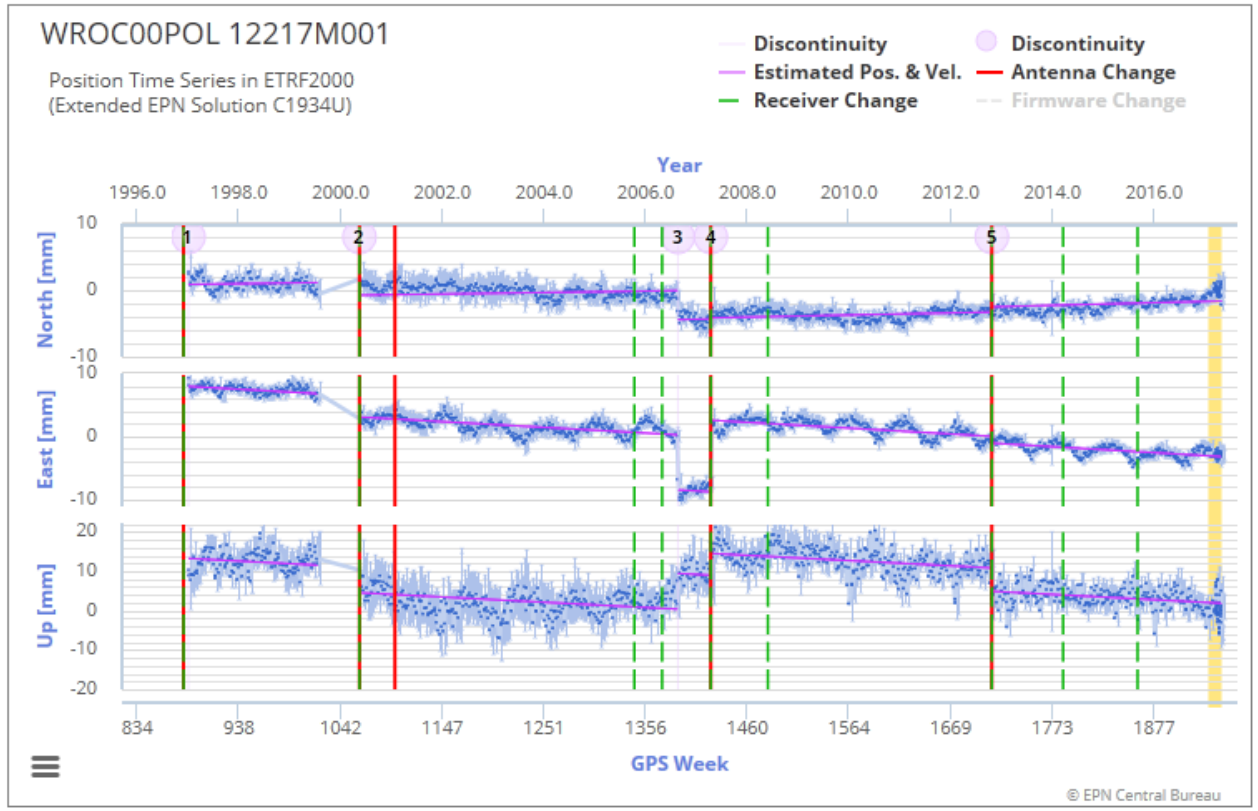
Frame	V_{North} [mm/yr]	V_{East} [mm/yr]	V_{Up} [mm/yr]
ETRF2000	0.0 ± 0.03	-0.4 ± 0.02	-0.7 ± 0.08

Estimated ETRF2000 pos/vel
(taking validity epochs into account)
+ Residual position time series
⇒ Variation of the position of the station in ETRF2000

EPN Time Series

RESULTS

EXTENDED, SOLUTIONS INCLUDED UP TO 01-05-2017 (GPS WK 1947) (READ MORE)



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Position Time Series in ITRS (IGb08)

Position Time Series in ETRS89 (ETRF2000)

Official Station Velocities published by EUREF:

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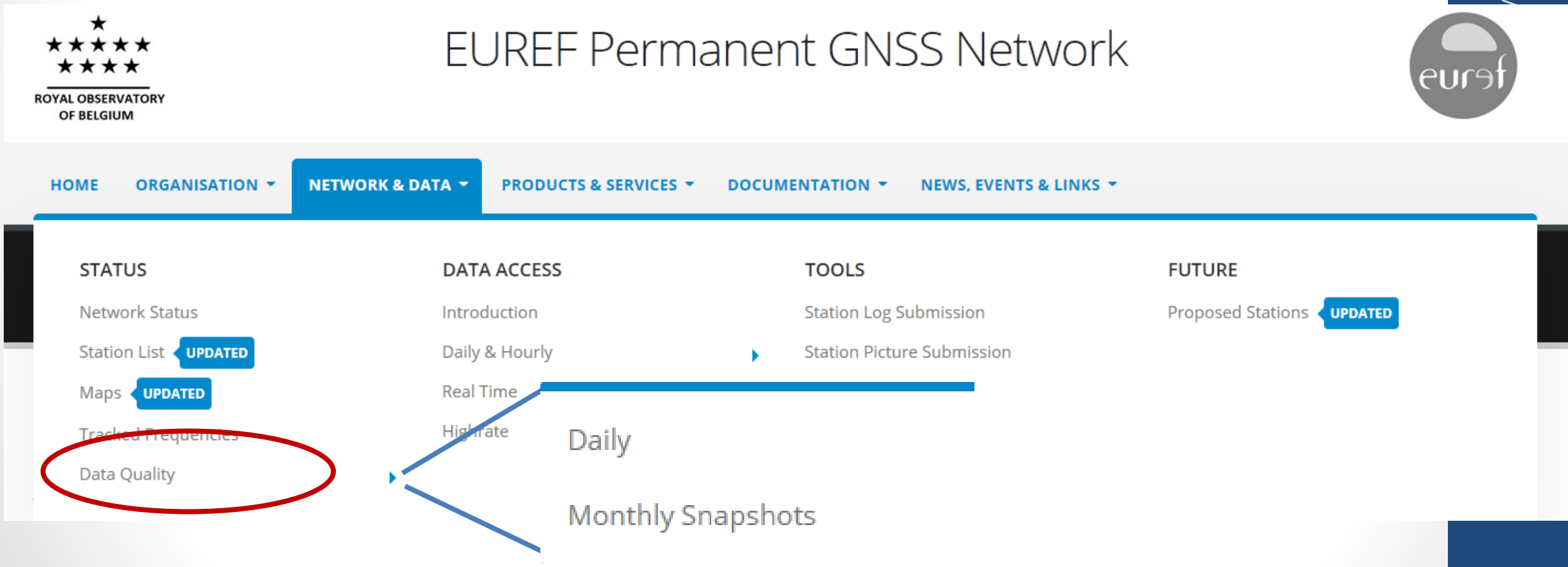
Estimated ETRF2000 pos/vel
(taking validity epochs into account)
+ Residual position time series
⇒ Variation of the position of the station in ETRF2000

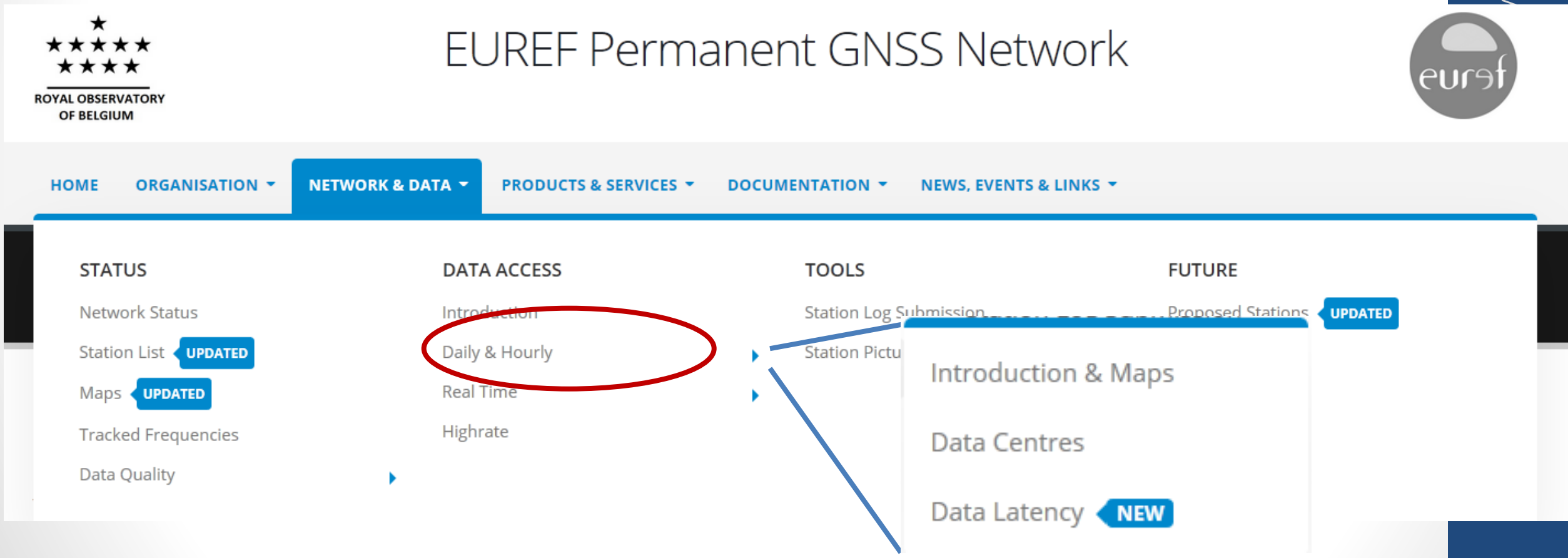
Where to find all this info on EPN CB?

EPN Data Quality



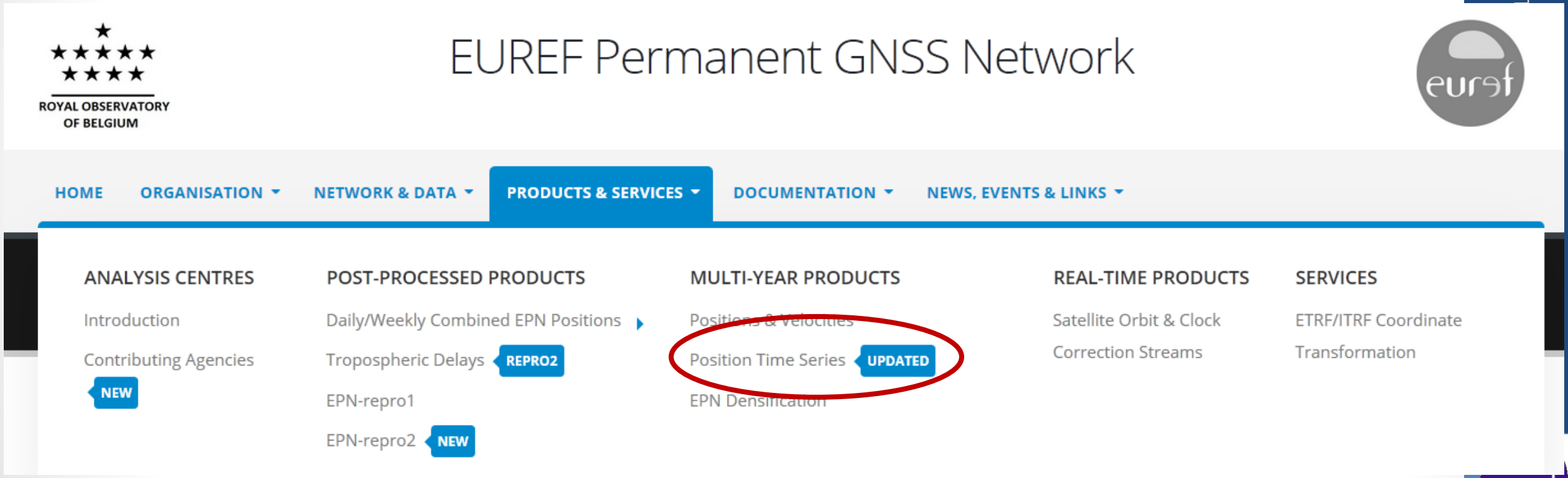
Where to find all this info on EPN CB?

EPN Data Availability & Latency



Where to find all this info on EPN CB?

EPN Time Series



Summary

- Upgraded tools to monitor EPN station performance → data bases
  - Availability, latency
  - Data quality
  - Integration of RINEX 3
- Full exploitation of the data bases is ongoing
  - Correlations of all types of time series
  - Additional administrator tools are under development
- More results next year!

Other ideas/requests?

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