Experience with GNSS Data Quality Monitoring of the SKPOS Reference Stations

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SKPOS®

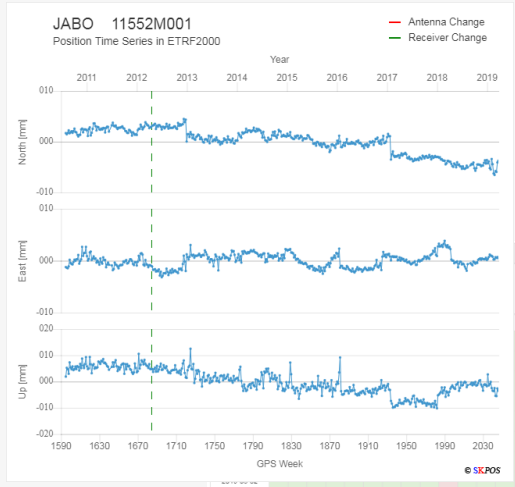
- 33 Slovak stations (GPS+GLO+GAL+BDS)
- 21 foreign stations (APOS, gnssnet.hu, CZEPOS, ASG-EUPOS, ZAKPOS)

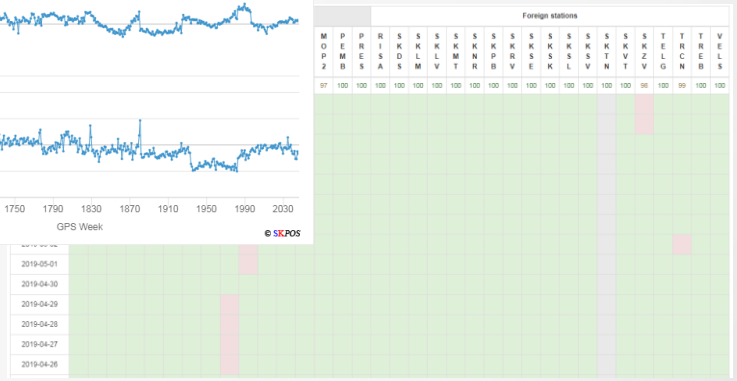
SKPOS Quality Control

- new web application developed at GKÚ Bratislava for tracking, monitoring and analyzing:
  - Time Series
  - Data Quality:
    - Number and percentage of observations
    - Cycle slips
    - Multipath errors
    - Skyplots
  - RINEX availability
  - Real-time data delay (station -> control software)

SKPOS Quality Control

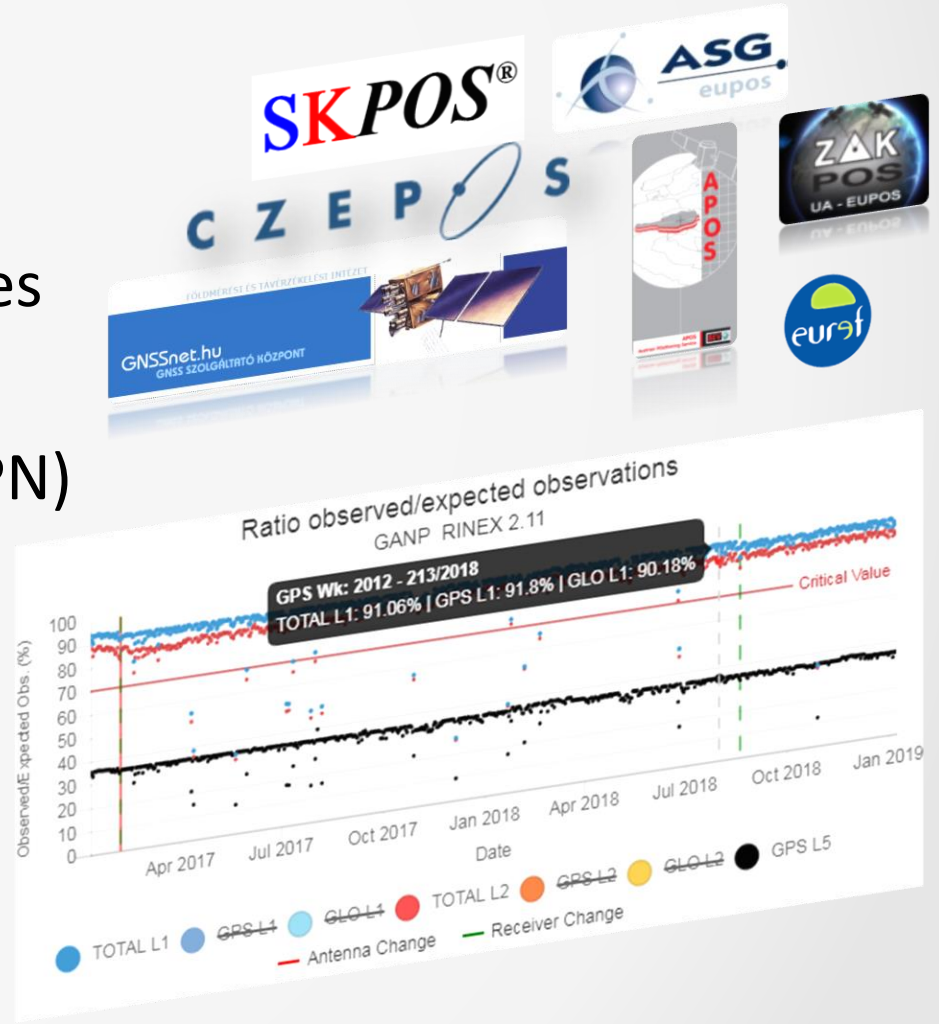
- Input data:
  - SINEX (Bernese GNSS Software 5.2)
  - RINEX (G-Nut/Anubis 2.2.2)
  - Real-time data (Trimble Pivot Platform)
- Output data:
  - Plots
    - Time Series
    - Observations, cycle slips, multipath errors
    - Skyplots
  - Tables
    - RINEX availability
    - Real-time data delay





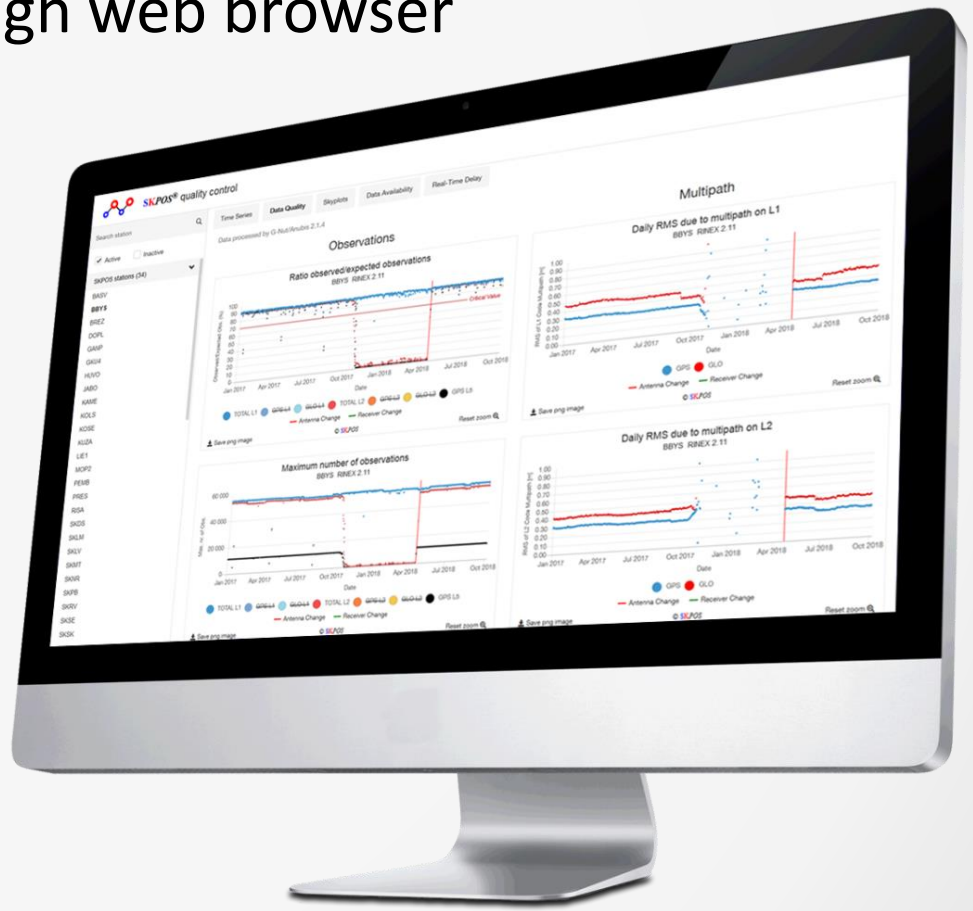
SKPOS Quality Control

- App features:
  - automatic data processing / data updating
  - e-mails alerts
  - interactive plots with marked GNSS HW changes
  - zoom-in/out, direct export to PNG
  - data of 86 stations (SKPOS / foreign SKPOS / EPN)
  - quality data of GPS & GLONASS observations



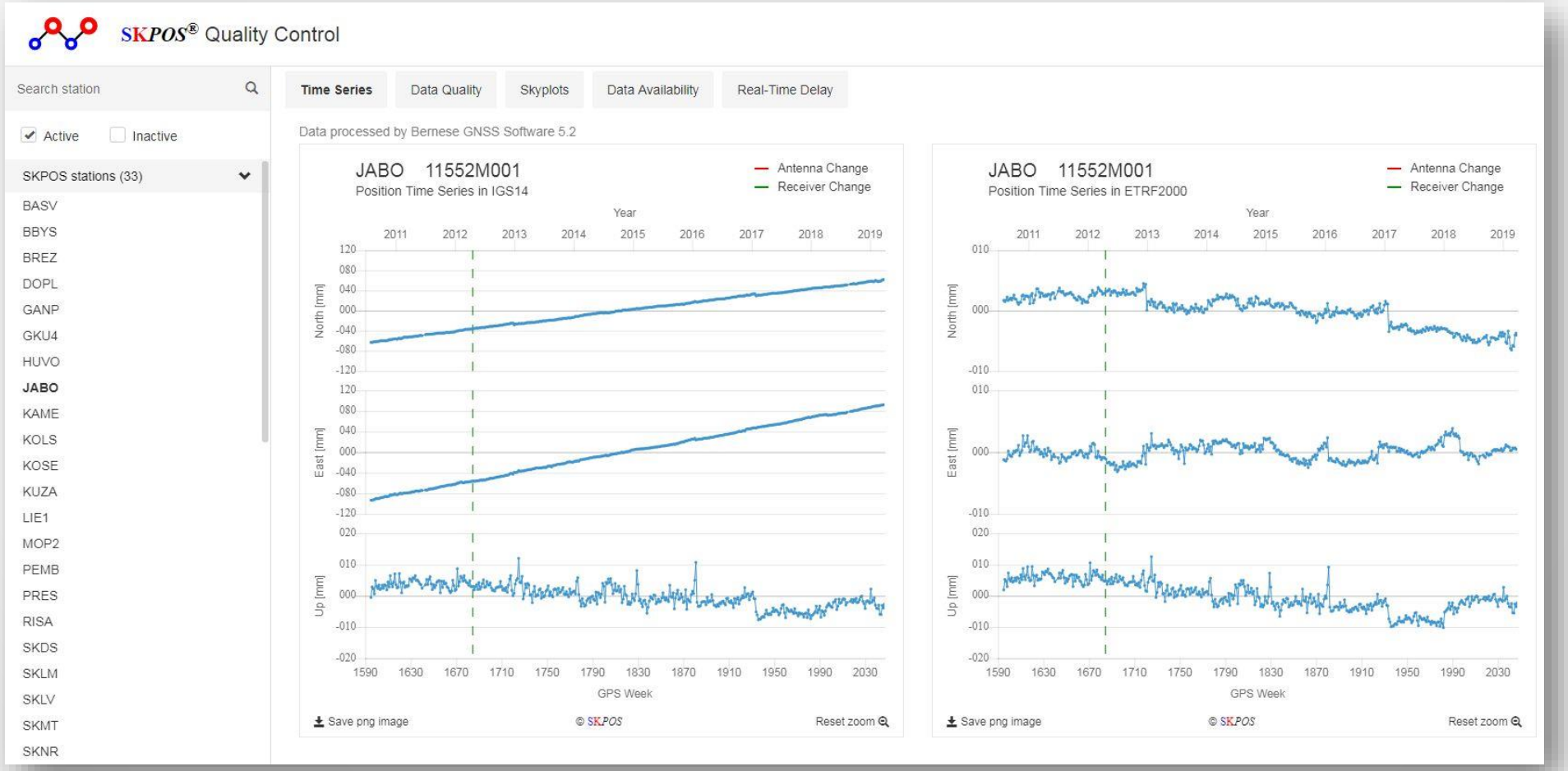
SKPOS Quality Control

- User Interface:
  - client-server application available through web browser
  - only for SKPOS administrators
  - programming languages:
    - HTML
    - CSS
    - Javascript (Angular 5)
    - PHP
    - MySQL
    - Batch



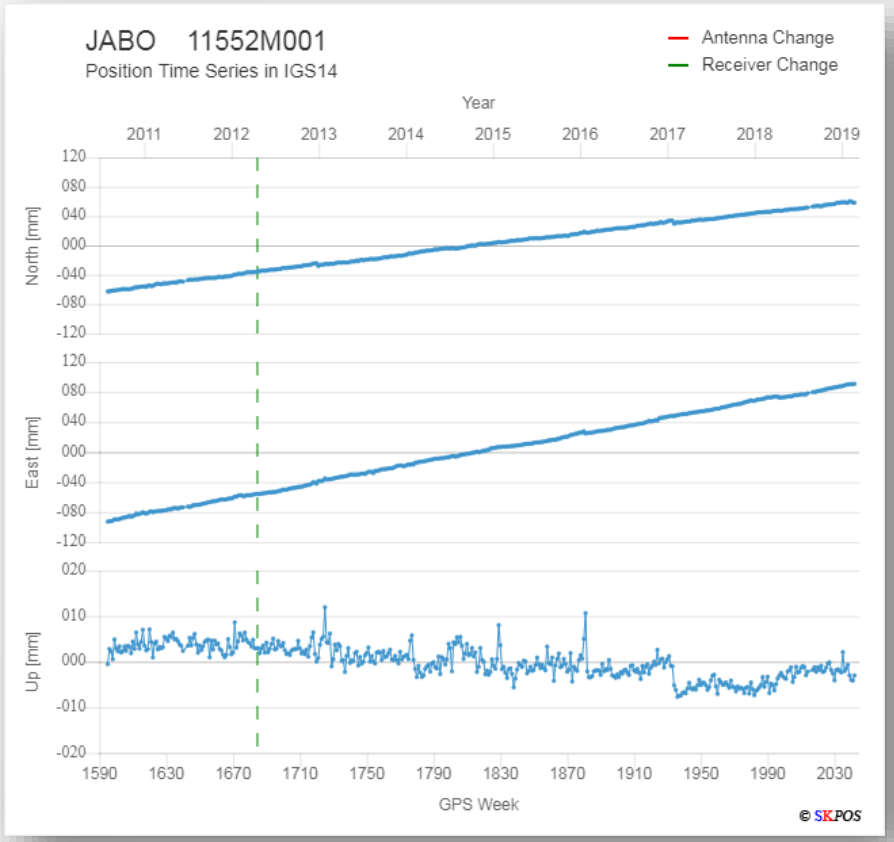
SKPOS Quality Control

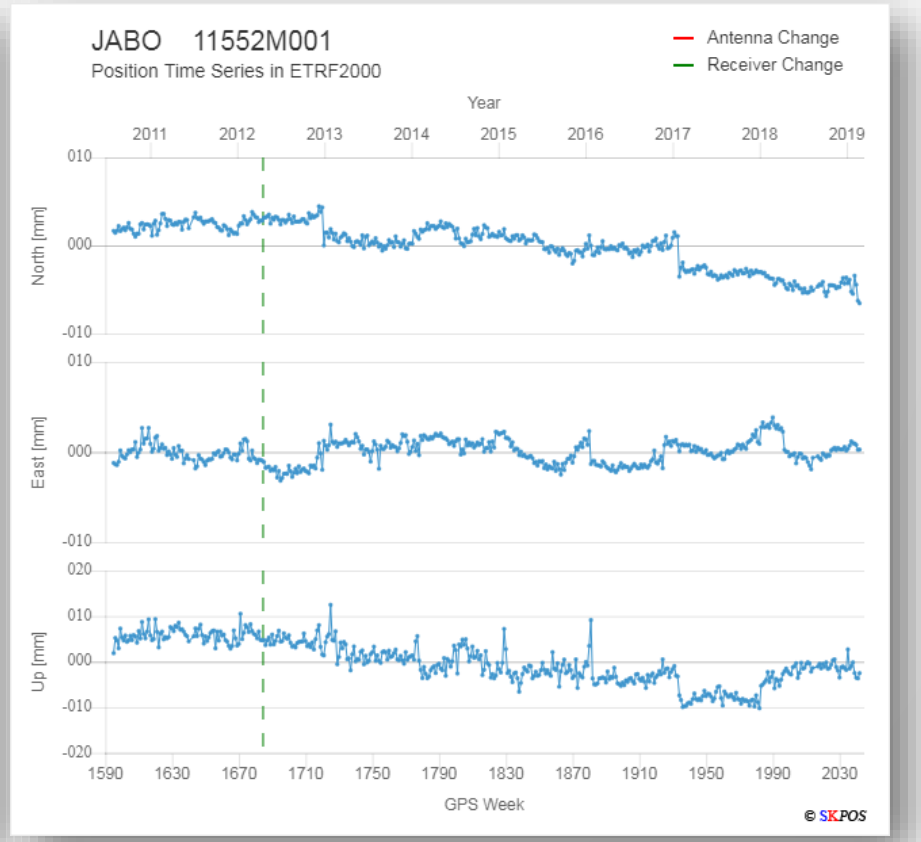
- Graphic User Interface:



Data Quality Monitoring

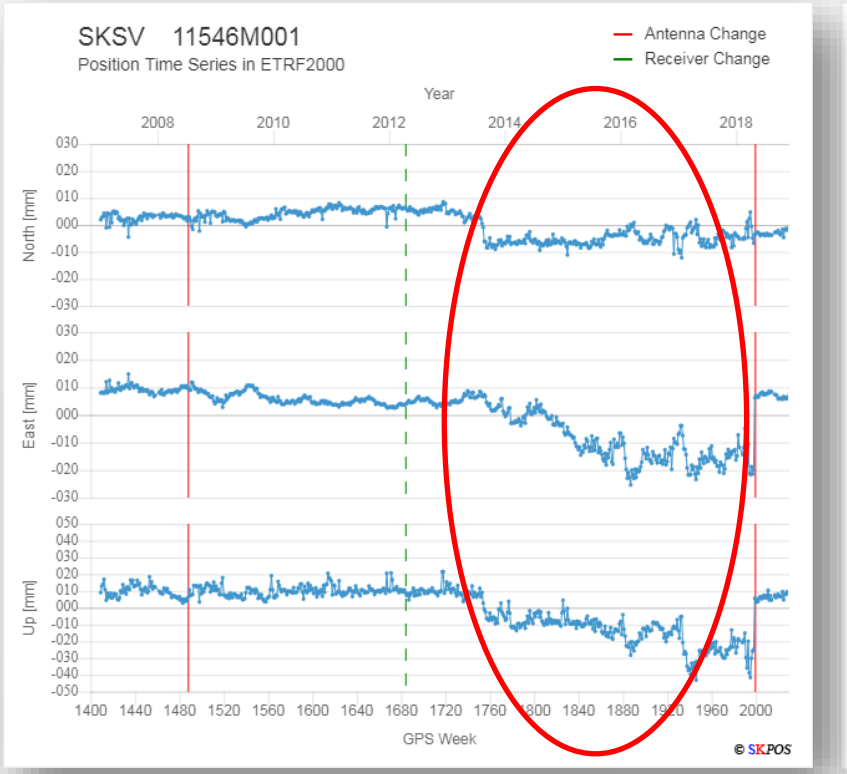
- Time Series:
  - „RAW“ time series of permanent stations in IGS14 & ETRF2000

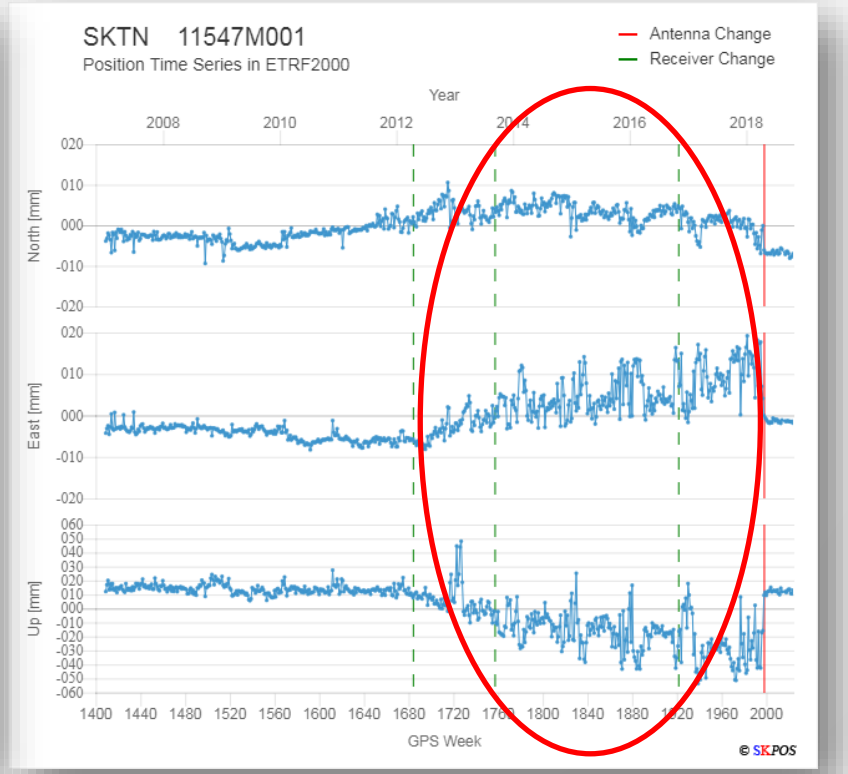




Data Quality Monitoring

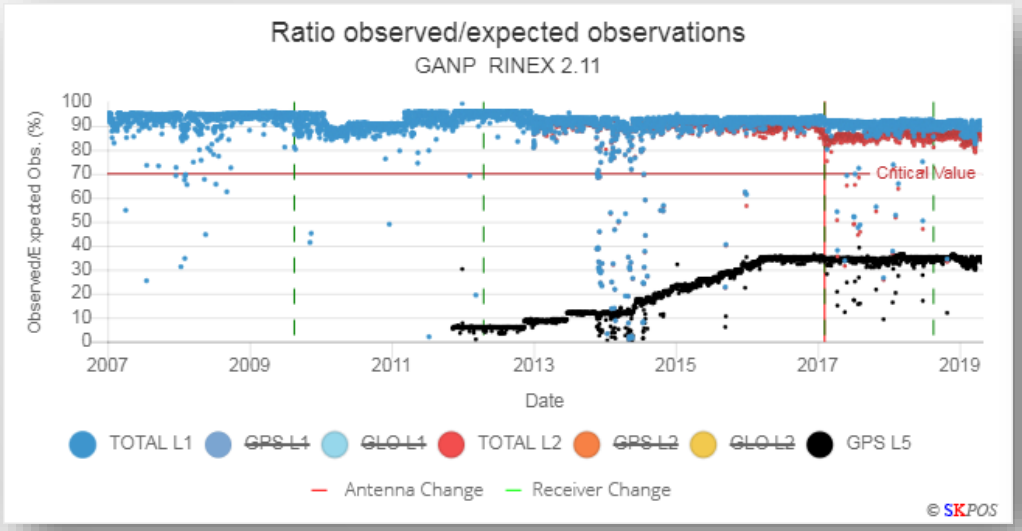
- Time Series:
  - identified problem with Trimble Zephyr Geodetic Model 2 GNSS antenna (S/N: 3013) – GANP, GKU4, KUZA, SKLV, SKVK

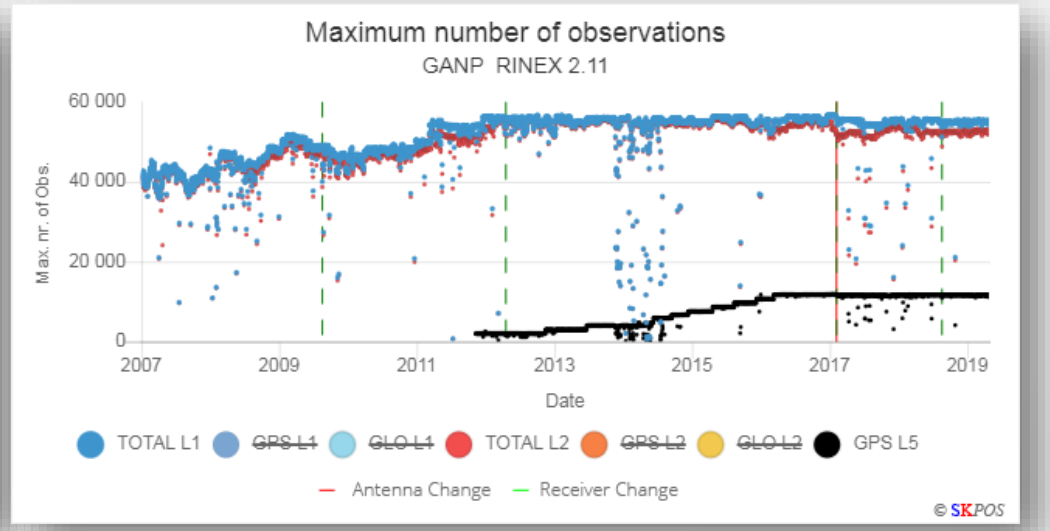




Data Quality Monitoring

- Data Quality:
  - quality of GNSS data in RINEX v2.11 files since 2007:
    - **percentage & number of observations (L1, L2, L5)**
    - multipath errors (L1, L2, L5)
    - cycle slips





Data Quality Monitoring

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  - quality of GNSS data in RINEX v2.11 files since 2007:
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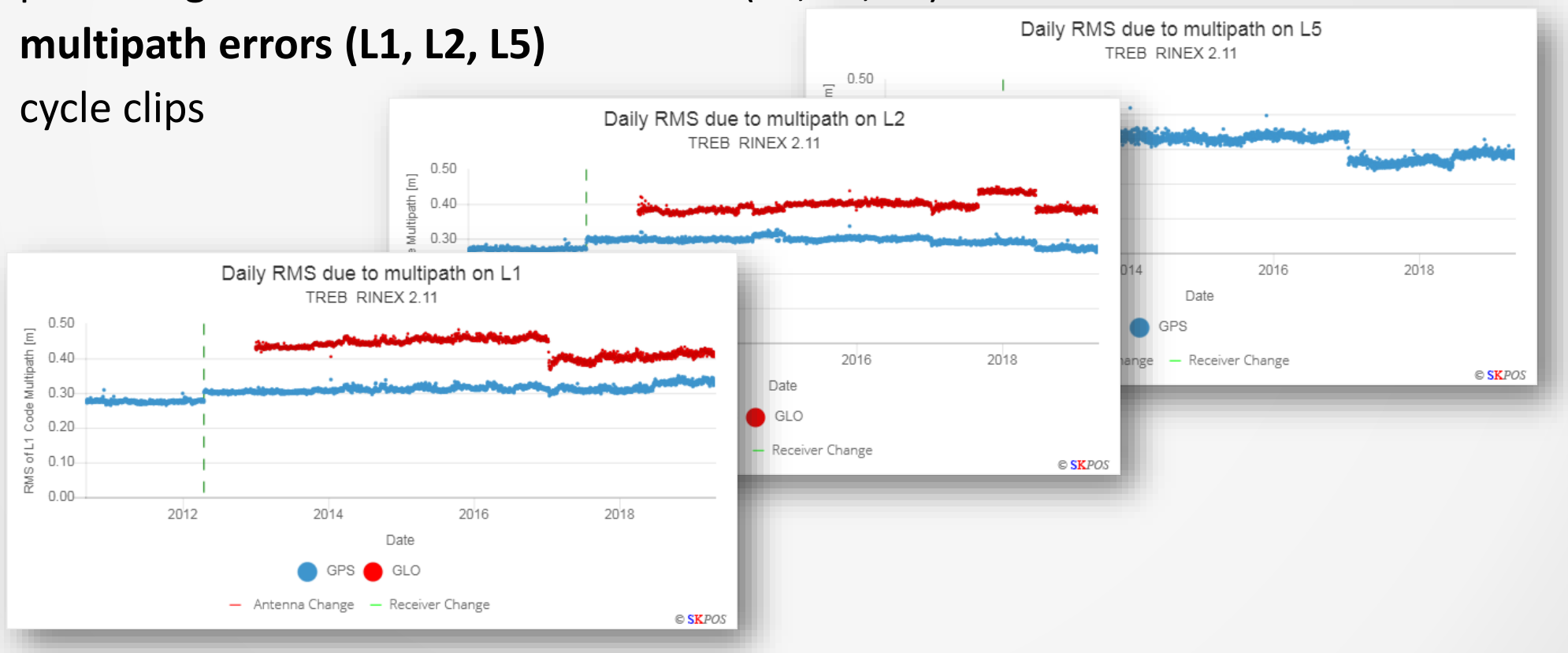
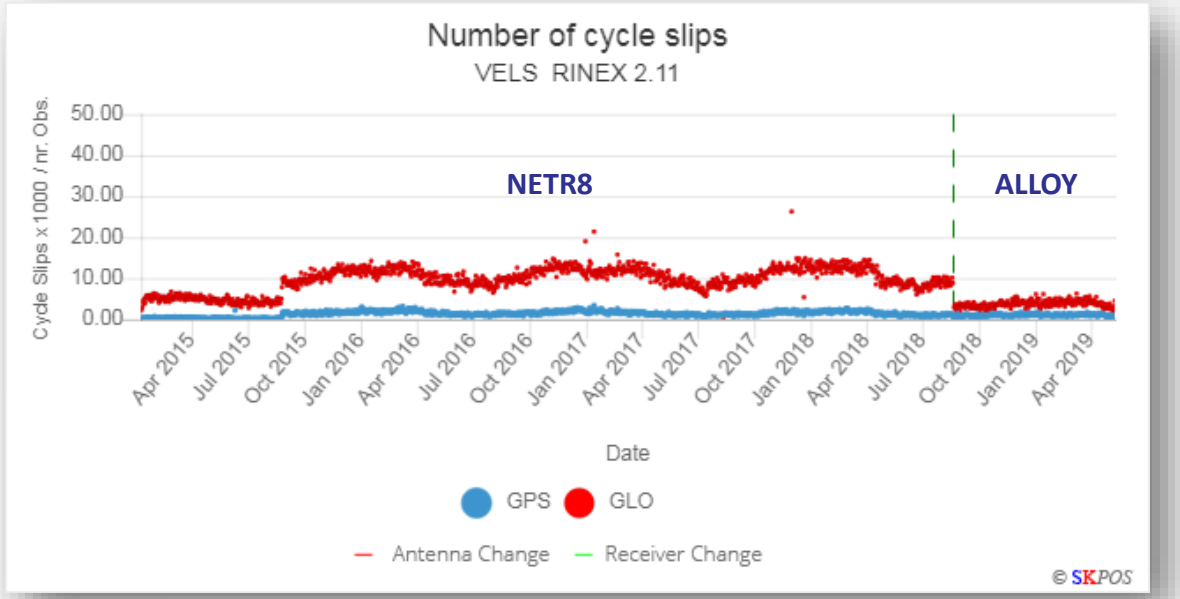
    - cycle clips



Data Quality Monitoring

- Data Quality:
  - quality of GNSS data in RINEX v2.11 files since 2007:
    - percentage & number of observations (L1, L2, L5)
    - multipath errors (L1, L2, L5)
    - **cycle slips**



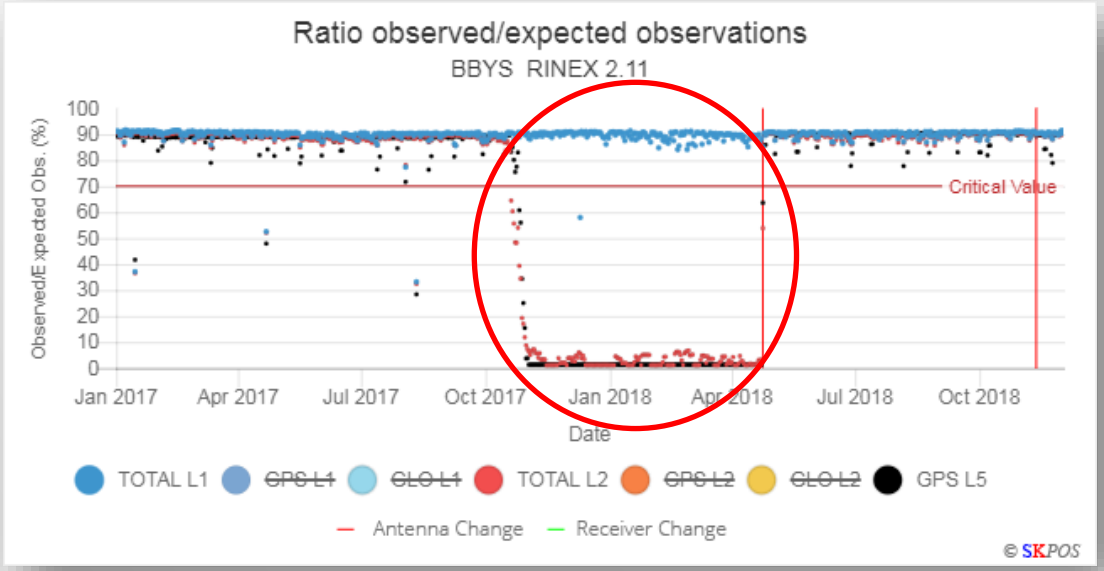
Data Quality Monitoring

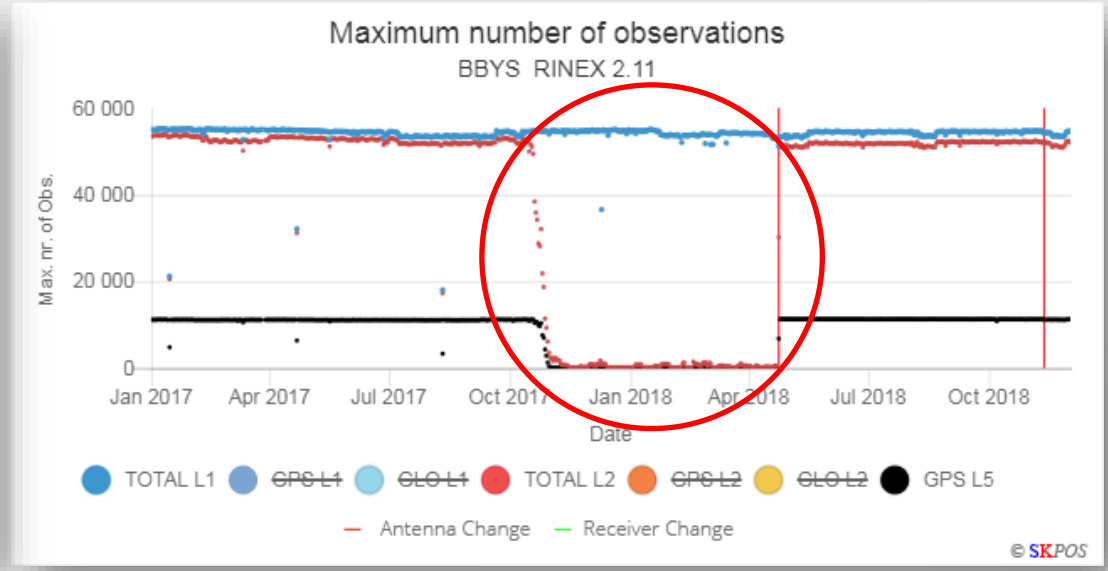
- Data Quality:
  - lost signals at L2, L5 frequencies at Trimble Choke Ring antennas
    - BASV, BBYS, KAME, KOSE

Satellite Tracking | Skyplot | Receiving Info | Multipath | Raw Data Analysis | Storage Integrity

Sat	El [°]	Az [°]	SNR (CA/P1/E1)	SNR (L2/L2C/L2C...	SNR (L5/E5/
C02	8	108	- / - / - / 31	-	-
C05	23	131	- / - / - / 35	-	-
C08	28	40	- / - / - / 40	-	-
C10	1	103	-	-	-
C11	34	49	- / - / - / 46	-	-
C13	43	66	- / - / - / 45	-	-
E02	50	97	- / - / 48	-	-
E07	17	255	- / - / 41	-	-
E11	11	33	- / - / 38	-	-
E14	66	111	- / - / 50	-	-
E19	0	348		-	-
E20	17	308	- / - / 36	-	-
E30	70	310	- / - / 50	-	-
G02	29	123	46	-	-
G06	30	76	45	-	-
G12	79	347	52	-	-
G14	16	321	40	-	-
G17	11	44	44	-	-
G19	29	48	44	-	-
G24	57	156	50	-	-
G25	41	276	49	-	-
G29	12	213	43	-	-
G32	30	294	46	-	-

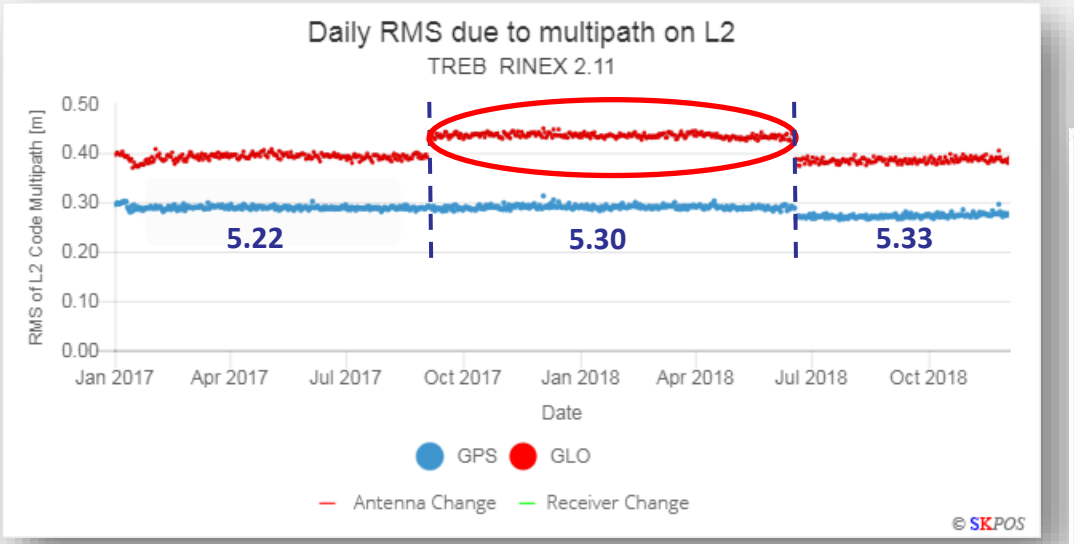
Problem!
No L2, L5 data!

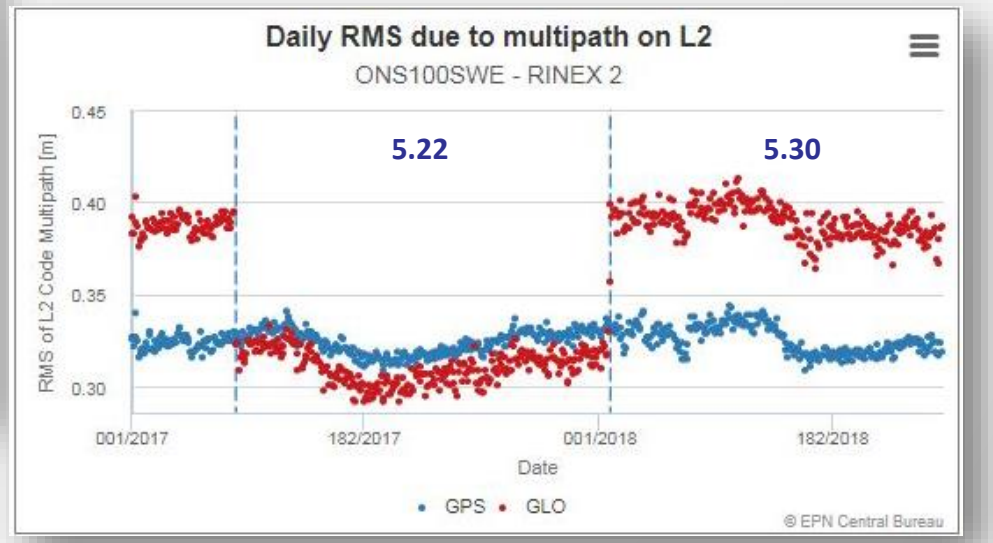




Data Quality Monitoring

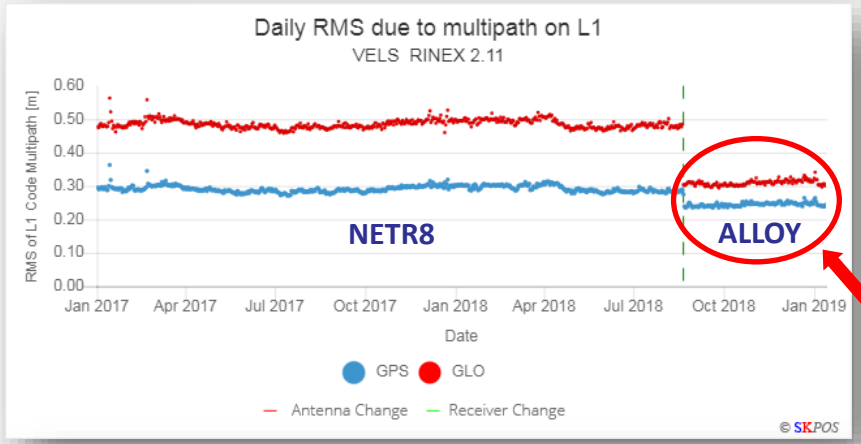
- Data Quality:
  - identified problem with firmware version 5.30 (Trimble NETR9)
  - detected jump in multipath errors (GLONASS L2)

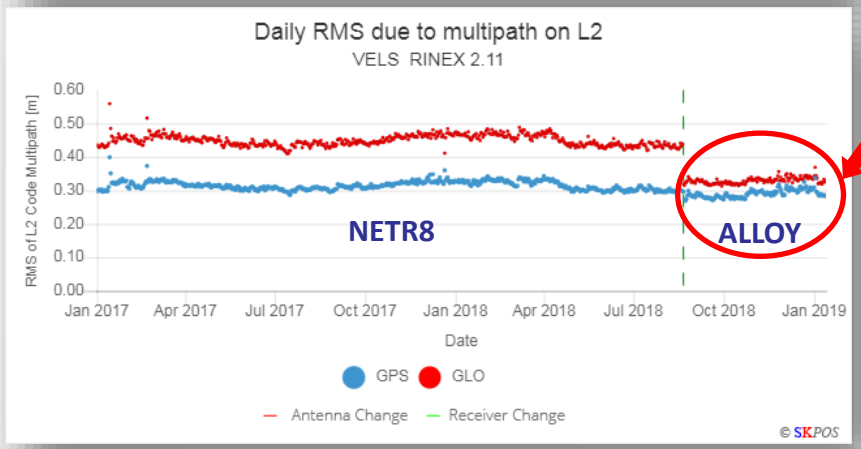


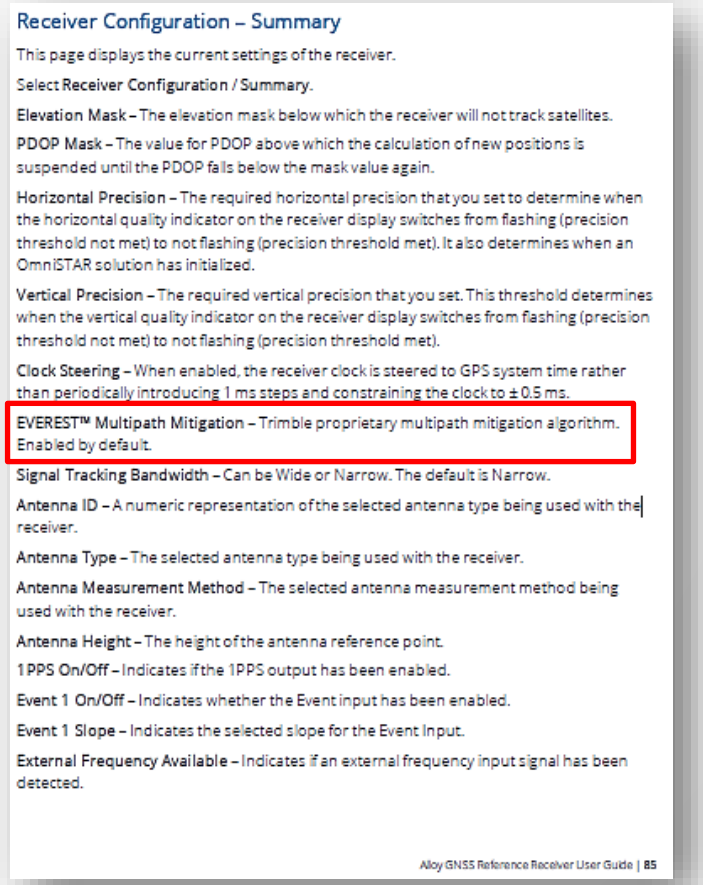


Data Quality Monitoring

- Data Quality:
  - reduced multipath errors (Trimble NETR8 -> Trimble ALLOY)







Receiver Configuration – Summary

This page displays the current settings of the receiver.

Select Receiver Configuration / Summary.

Elevation Mask – The elevation mask below which the receiver will not track satellites.

PDOP Mask – The value for PDOP above which the calculation of new positions is suspended until the PDOP falls below the mask value again.

Horizontal Precision – The required horizontal precision that you set to determine when the horizontal quality indicator on the receiver display switches from flashing (precision threshold not met) to not flashing (precision threshold met). It also determines when an OmniSTAR solution has initialized.

Vertical Precision – The required vertical precision that you set. This threshold determines when the vertical quality indicator on the receiver display switches from flashing (precision threshold not met) to not flashing (precision threshold met).

Clock Steering – When enabled, the receiver clock is steered to GPS system time rather than periodically introducing 1 ms steps and constraining the clock to ± 0.5 ms.

EVEREST™ Multipath Mitigation – Trimble proprietary multipath mitigation algorithm. Enabled by default.

Signal Tracking Bandwidth – Can be Wide or Narrow. The default is Narrow.

Antenna ID – A numeric representation of the selected antenna type being used with the receiver.

Antenna Type – The selected antenna type being used with the receiver.

Antenna Measurement Method – The selected antenna measurement method being used with the receiver.

Antenna Height – The height of the antenna reference point.

1 PPS On/Off – Indicates if the 1PPS output has been enabled.

Event 1 On/Off – Indicates whether the Event input has been enabled.

Event 1 Slope – Indicates the selected slope for the Event Input.

External Frequency Available – Indicates if an external frequency input signal has been detected.

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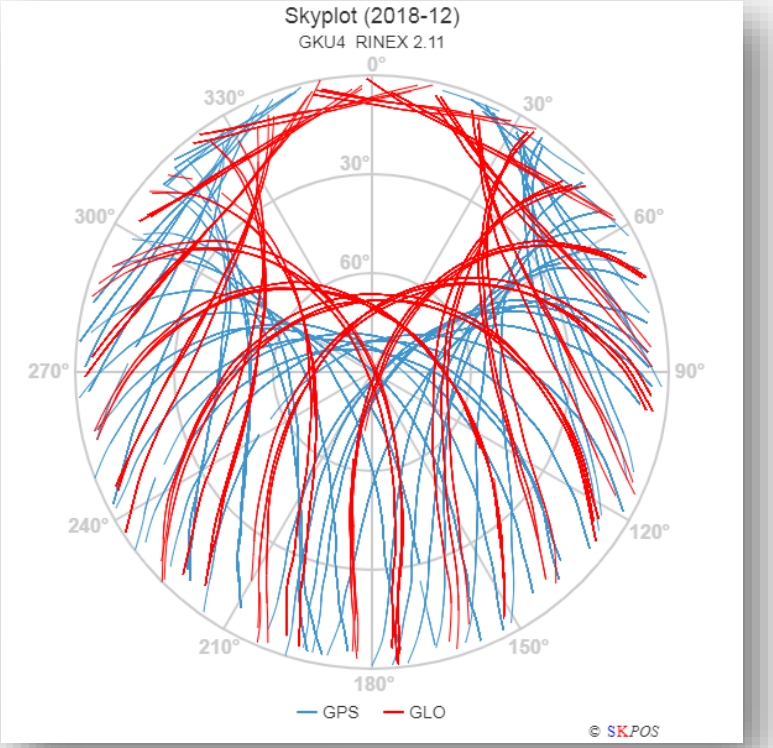
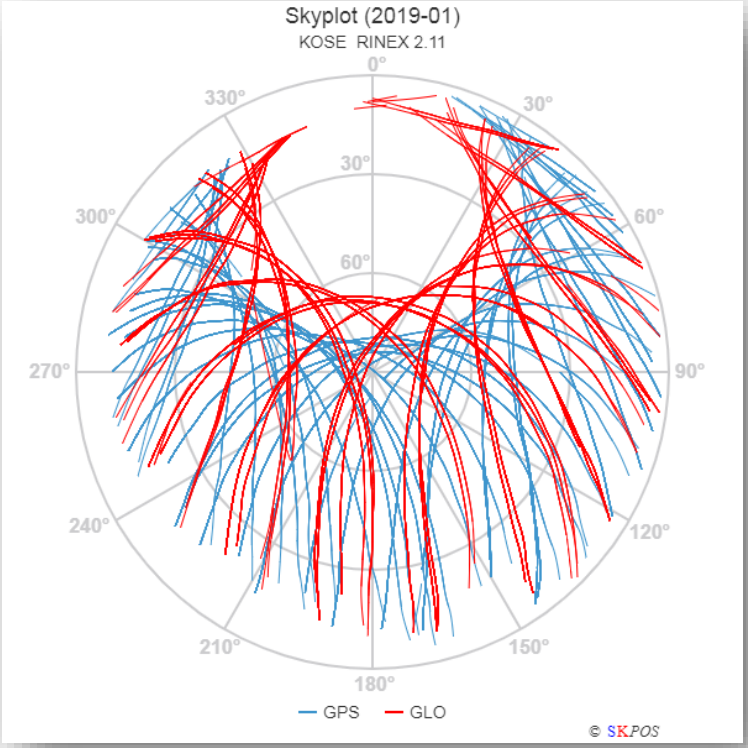
Data Quality Monitoring

- Skyplots:
  - trajectory of visible GPS and GLONASS satellites
  - identification of objects that cause GNSS signal blockage

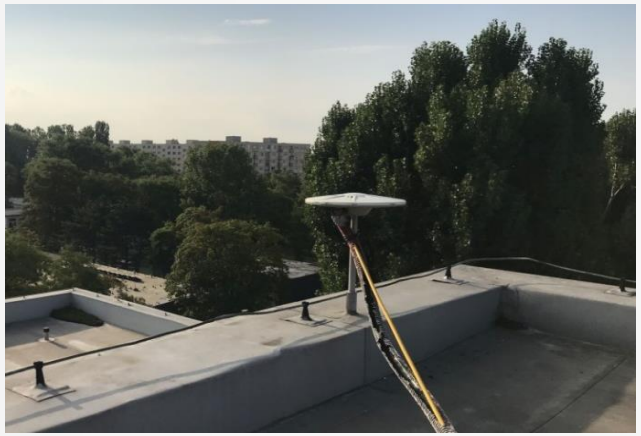


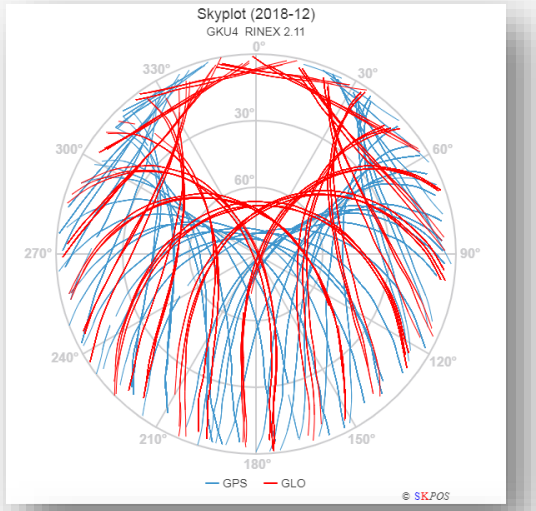


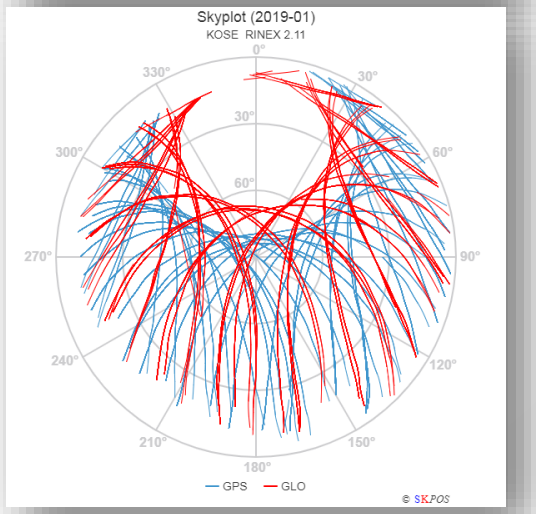
Data Quality Monitoring

roof vs. monument (pillar) stabilization

- Skyplots:

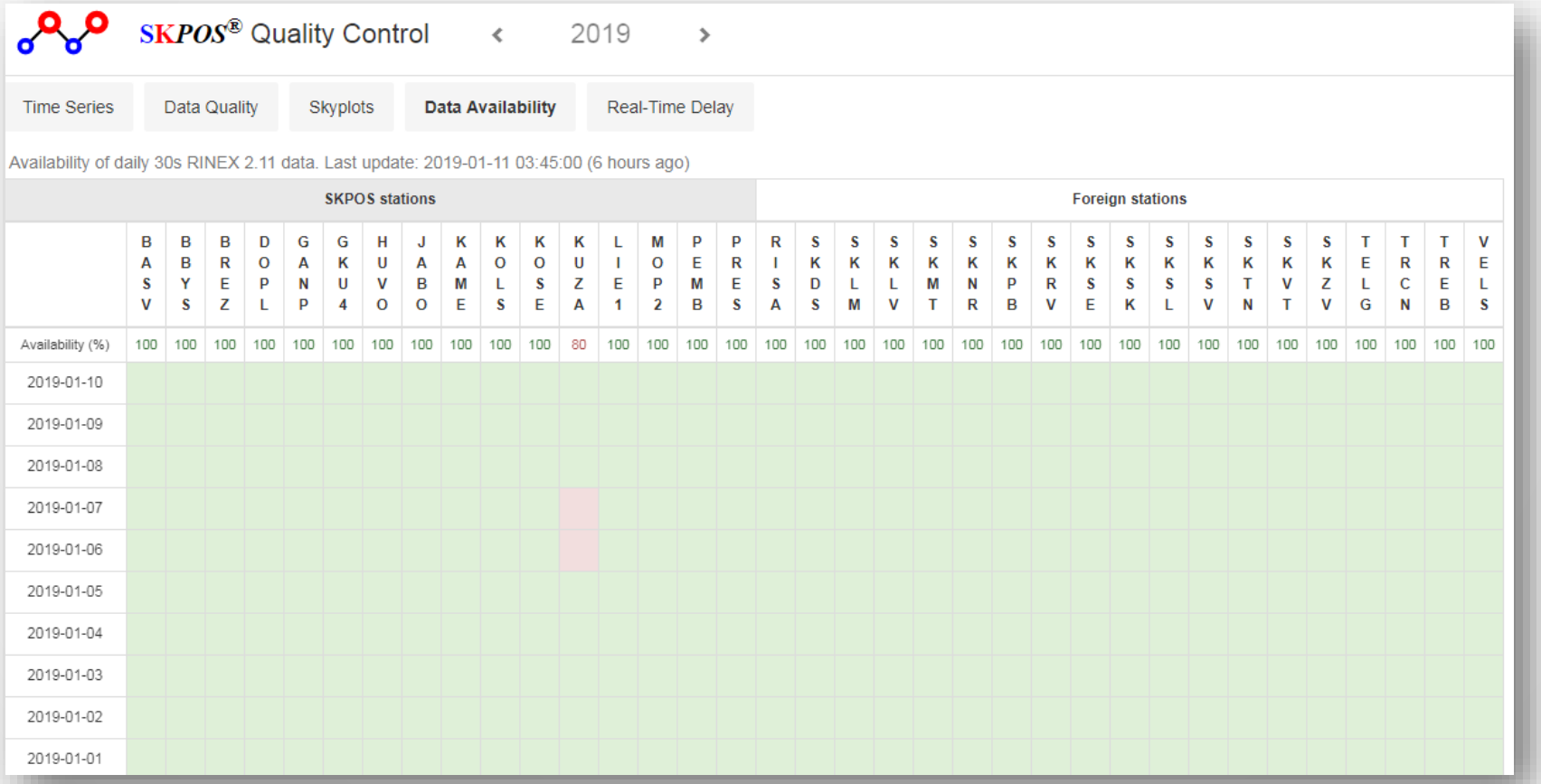






Data Quality Monitoring

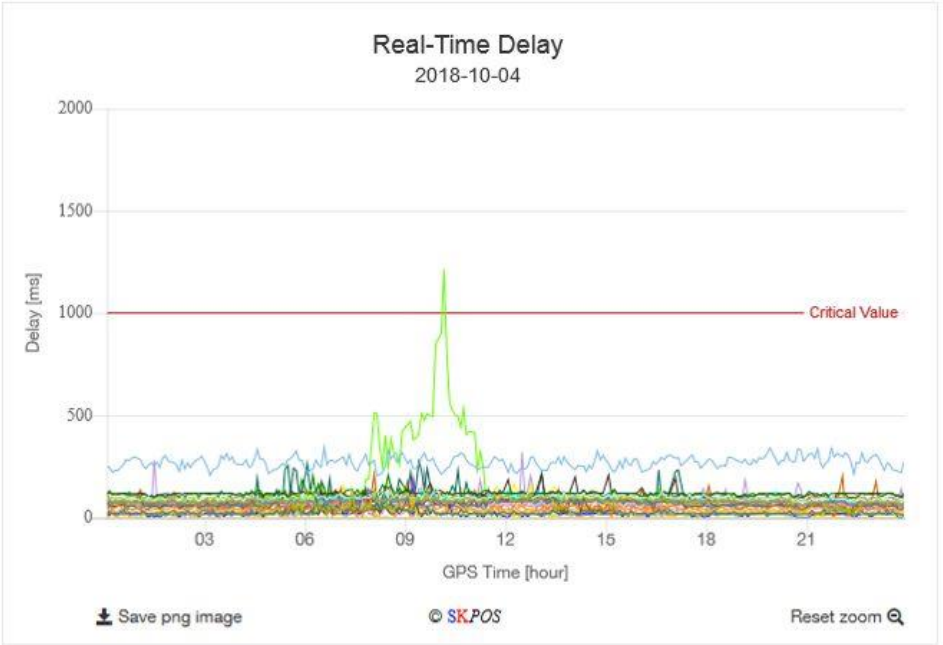
- Data Availability:
  - availability of daily 30s RINEX 2.11 files



Data Quality Monitoring

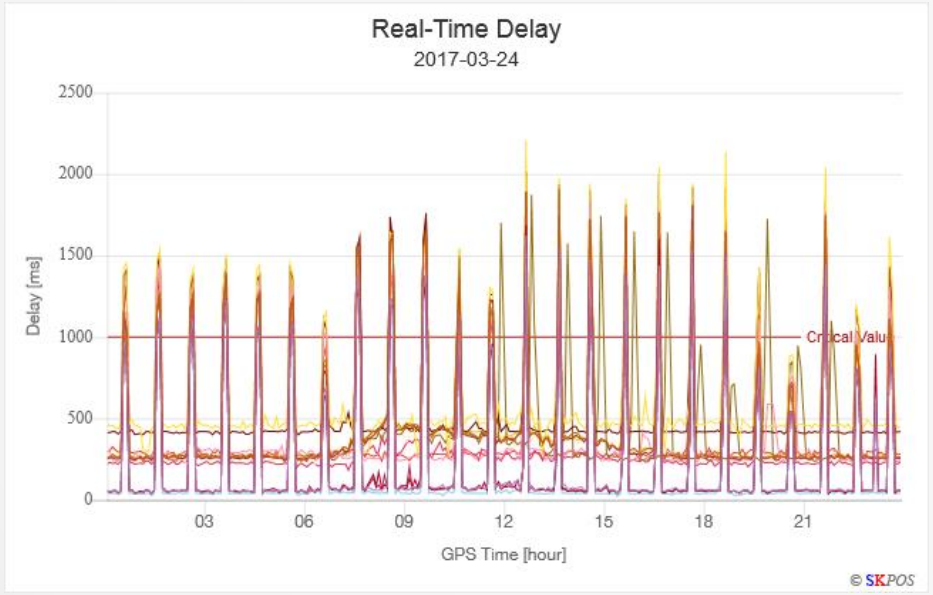
- Real-time Delay:
  - data flow delay from SKPOS and foreign stations to Trimble Pivot Platform
  - delays: actual, average, maximum

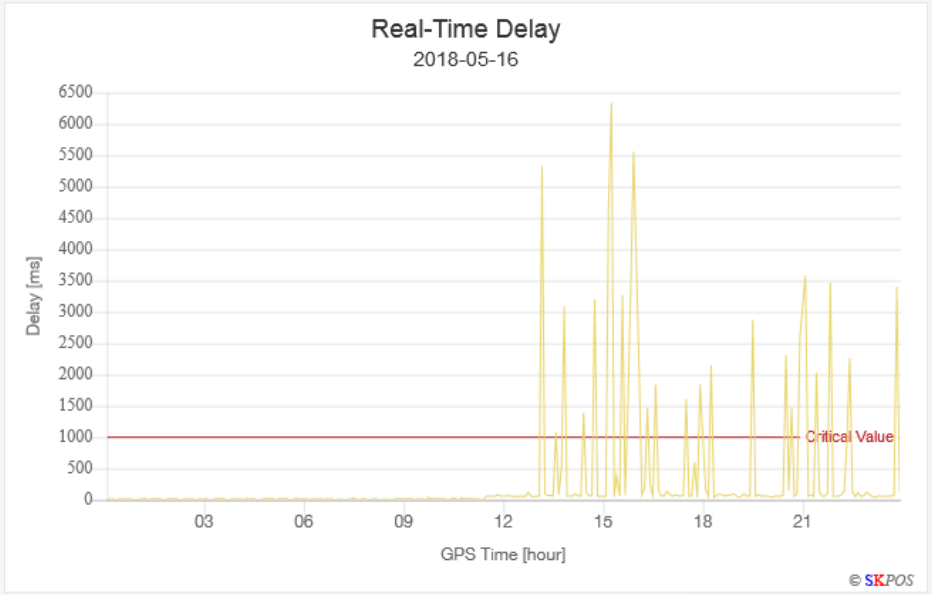
SKPOS stations			Foreign stations	
Station	Last Delay	Average Delay	Maximum Delay	Show in chart
BASV	50 ms	137 ms	88 554 ms	☑
BBYS	239 ms	72 ms	87 266 ms	☑
BREZ	63 ms	187 ms	70 032 ms	☑
DOPL	39 ms	110 ms	6 891 ms	☑
GANP	0 ms	159 ms	58 090 ms	☑
GKU4	2 ms	129 ms	52 150 ms	☑
HUVO	36 ms	119 ms	24 040 ms	☑
JABO	33 ms	182 ms	58 274 ms	☑
KAME	81 ms	216 ms	48 113 ms	☑
KOLS	50 ms	183 ms	46 956 ms	☑
KOSE	63 ms	185 ms	60 973 ms	☑
KUZA	23 ms	105 ms	153 571 ms	☑



Data Quality Monitoring

- Real-Time Delay:
  - detected data flow delay from foreign stations
  - detected problems with internet





Summary

- Present:
  - ✓ effective and automatic data quality monitoring
  - ✓ ability to detect GNSS SW/HW problems
  - ✓ reverse analysis of historical quality data
- Future:
  - add new quality parameters (healthy satellites, ...)
  - add data availability of RINEX v3 files
  - extend quality monitoring for Galileo and BeiDou

Thank you for your attention

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