Development of EPOS-GNSS data monitoring: web portal and alarms

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INTRODUCTION

The Royal of Belgium (ROB) monitors the availability and quality of EPOS-GNSS data by developing a new web portal (https://gnssquality-epos.oma.be) and alarms

EPOS-GNSS data distribution:

- EPOS-GNSS data are stored in distributed EPOS data repositories.
- Data repositories are maintained by data nodes and synchronized to the data gateway (DGW).
- GNSS data can be accessed by the public via an Application Program Interface (API) and a web portal.

EPOS-GNSS data quality assurance:

- Each data node is responsible for generating GNSS data quality metrics using G-Nut/Anubis[1] software.
- Ten EPOS-GNSS data nodes have been installed (three of them are still in the pre-operational phase).
- The quality metrics are retrieved by ROB to be assessed by alarms and published on the web portal.

Challenge:

- Number of GNSS stations that are integrated into EPOS expands every day.
- Robust systems in handling the erroneous GNSS data quality metrics received on a daily basis.
- Maintain the web portal to be user-friendly and have an adequate response time.
- Discrepancies between stations and data variability affect alarms accuracy.

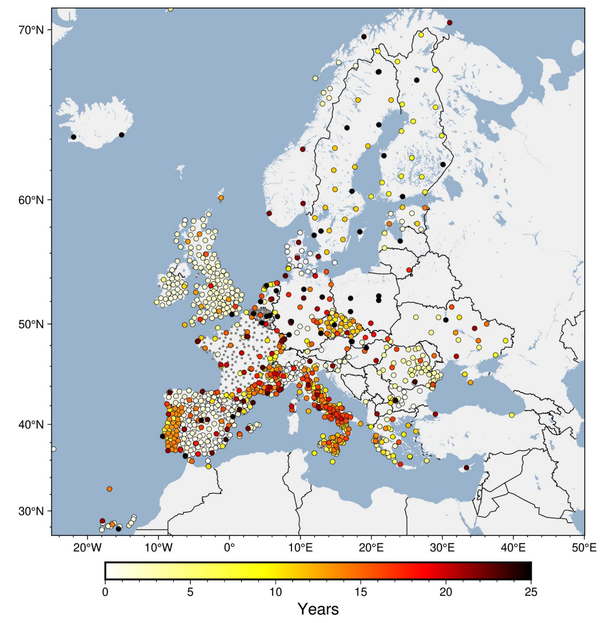


Figure 1. The distribution of 1299 stations from 1663 proposed stations at EPOS. Colormap shows the length of data quality metrics retrieved. EPOS-GNSS stations without data are depicted by gray points.

WEB PORTAL

- Allows users to check the distribution and the availability of the EPOS-GNSS station data by GNSS network, data node, or operational center
- Provides plots of several GNSS data quality indicators, such as:
  - The observed vs. expected observations
  - The number of missing epochs
  - The number of observed satellites
  - The maximum number of observations
  - The number of cycle slips
  - The Standard Point Positioning results
  - The multipath values on code observations

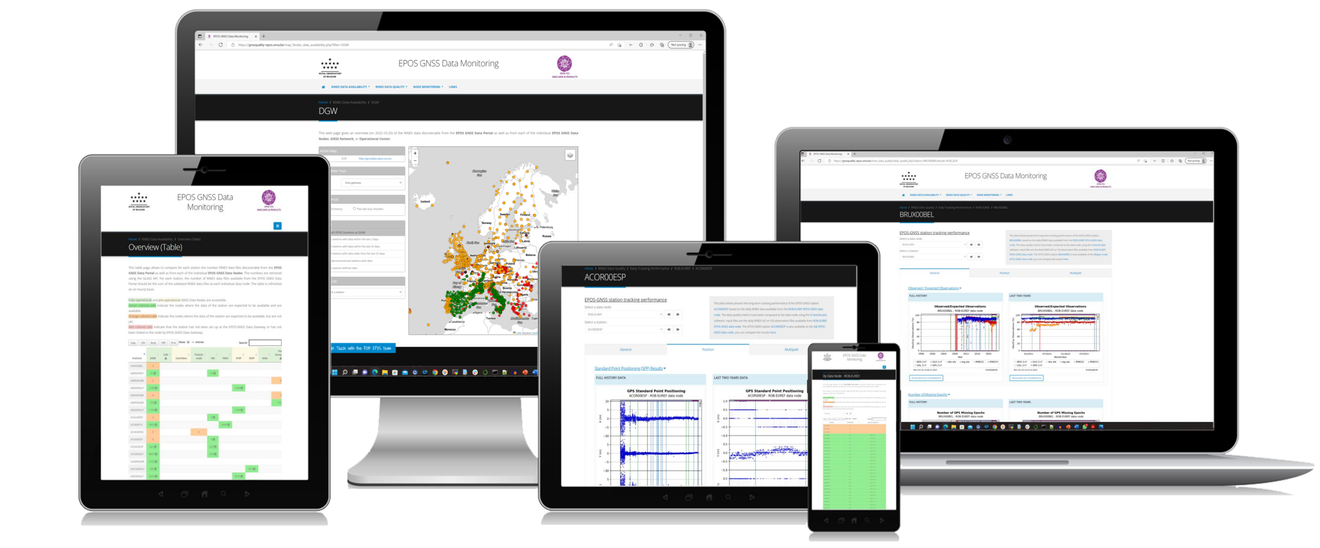
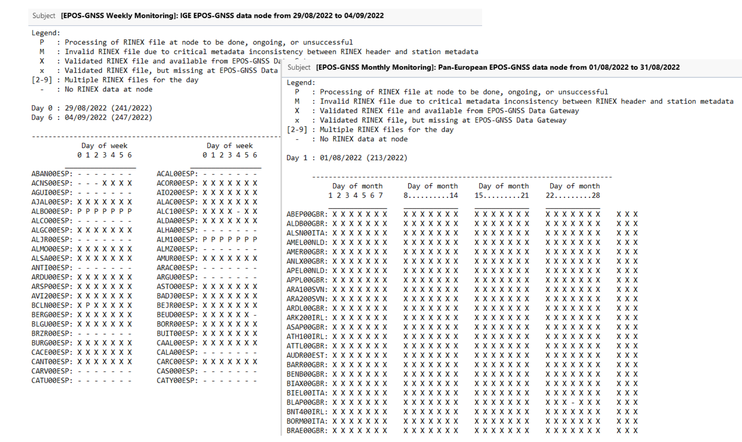


Figure 2. The interface of GNSS Data Monitoring web portal

ALARMS

- Are designed to warn data nodes when the GNSS data expected to show up at their node are not available
- Are sent automatically on a weekly and monthly basis



Subject [EPOS-GNSS Weekly Monitoring]: IGE EPOS-GNSS data node from 29/08/2022 to 04/09/2022

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Legend:
  P   : Processing of RINEX file at node to be done, ongoing, or unsuccessful
  M   : Invalid RINEX file due to critical metadata inconsistency between RINEX header and station metadata
  X   : Validated RINEX file and available from EPOS-GNSS Da
  x   : Validated RINEX file, but missing at EPOS-GNSS Data
[2-9] : Multiple RINEX files for the day
  -   : No RINEX data at node

Day 0 : 29/08/2022 (241/2022)
Day 6 : 04/09/2022 (247/2022)

                Day of week
                0 1 2 3 4 5 6

ABAN00ESP: - - - - - - -
ACNS00ESP: - - - X X X X
AGUI00ESP: - - - - - - -
AJAL00ESP: X X X X X X X
ALBO00ESP: P P P P P P P
ALCO00ESP: - - - - - - -
ALGC00ESP: X X X X X X X
ALJR00ESP: - - - - - - -
ALMO00ESP: X X X X X X X
ALSA00ESP: X X X X X X X
ANTI00ESP: - - - - - - -
ARDU00ESP: X X X X X X X
ARSP00ESP: X X X X X X X
AVI200ESP: X X X X X X X
BCLN00ESP: X P X X X X X
BERG00ESP: X X X X X X X
BLGU00ESP: X X X X X X X
BR2R00ESP: - - - - - - -
BURG00ESP: X X X X X X X
CACE00ESP: X X X X X X X
CANT00ESP: X X X X X X X
CARV00ESP: - - - - - - -
CATU00ESP: - - - - - - -
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Subject [EPOS-GNSS Monthly Monitoring]: Pan-European EPOS-GNSS data node from 01/08/2022 to 31/08/2022

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Legend:
  P   : Processing of RINEX file at node to be done, ongoing, or unsuccessful
  M   : Invalid RINEX file due to critical metadata inconsistency between RINEX header and station metadata
  X   : Validated RINEX file and available from EPOS-GNSS Data Gateway
  x   : Validated RINEX file, but missing at EPOS-GNSS Data Gateway
[2-9] : Multiple RINEX files for the day
  -   : No RINEX data at node

Day 1 : 01/08/2022 (213/2022)

                Day of month                Day of month                Day of month                Day of month
                1 2 3 4 5 6 7               8.........14                15.........21               22.........28

ACOR00ESP: X X X X X X X   X X X X X X X   X X X X X X X   X X X X X X X   X X X
ACOR00ESP: X X X X X X X   X X X X X X X   X X X X X X X   X X X X X X X   X X X
AIO200ESP: X X X X X X X   X X X X X X X   X X X X X X X   X X X X X X X   X X X
ALAC00ESP: X X X X X X X   X X X X X X X   X X X X X X X   X X X X X X X   X X X
ALC100ESP: X X X X - - X   X X X X X X X   X X X X X X X   X X X X X X X   X X X
ALDA00ESP: X X X X X X X   X X X X X X X   X X X X X X X   X X X X X X X   X X X
ALHA00ESP: - - - - - - -   - - - - - - -   - - - - - - -   - - - - - - -   - - -
ALM100ESP: P P P P P P P   X X X X X X X   X X X X X X X   X X X X X X X   X X X
ALM200ESP: - - - - - - -   - - - - - - -   - - - - - - -   - - - - - - -   - - -
AMUR00ESP: X X X X X X X   X X X X X X X   X X X X X X X   X X X X X X X   X X X
ARAC00ESP: - - - - - - -   - - - - - - -   - - - - - - -   - - - - - - -   - - -
ARGU00ESP: - - - - - - -   - - - - - - -   - - - - - - -   - - - - - - -   - - -
AST100ESP: X X X X X X X   X X X X X X X   X X X X X X X   X X X X X X X   X X X
BAD300ESP: X X X X X X X   X X X X X X X   X X X X X X X   X X X X X X X   X X X
BEJR00ESP: X X X X X X X   X X X X X X X   X X X X X X X   X X X X X X X   X X X
BEUD00ESP: X X X X X X X   X X X X X X X   X X X X X X X   X X X X X X X   X X X
BORR00ESP: X X X X X X X   X X X X X X X   X X X X X X X   X X X X X X X   X X X
BUIT00ESP: X X X X X X X   X X X X X X X   X X X X X X X   X X X X X X X   X X X
CAAL00ESP: X X X X X X X   X X X X X X X   X X X X X X X   X X X X X X X   X X X
CALA00ESP: - - - - - - -   - - - - - - -   - - - - - - -   - - - - - - -   - - -
CARC00ESP: X X X X X X X   X X X X X X X   X X X X X X X   X X X X X X X   X X X
CAS000ESP: - - - - - - -   - - - - - - -   - - - - - - -   - - - - - - -   - - -
CATY00ESP: - - - - - - -   - - - - - - -   - - - - - - -   - - - - - - -   - - -
ABEP00GBR: X X X X X X X   X X X X X X X   X X X X X X X   X X X X X X X   X X X
ALDB00GBR: X X X X X X X   X X X X X X X   X X X X X X X   X X X X X X X   X X X
ALSN00ITA: X X X X X X X   X X X X X X X   X X X X X X X   X X X X X X X   X X X
AMEL00NLD: X X X X X X X   X X X X X X X   X X X X X X X   X X X X X X X   X X X
AMER00GBR: X X X X X X X   X X X X X X X   X X X X X X X   X X X X X X X   X X X
ANLX00GBR: X X X X X X X   X X X X X X X   X X X X X X X   X X X X X X X   X X X
APEL00NLD: X X X X X X X   X X X X X X X   X X X X X X X   X X X X X X X   X X X
APPL00GBR: X X X X X X X   X X X X X X X   X X X X X X X   X X X X X X X   X X X
ARA100SVN: X X X X X X X   X X X X X X X   X X X X X X X   X X X X X X X   X X X
ARA200SVN: X X X X X X X   X X X X X X X   X X X X X X X   X X X X X X X   X X X
ARDL00GBR: X X X X X X X   X X X X X X X   X X X X X X X   X X X X X X X   X X X
ARK200IRL: X X X X X X X   X X X X X X X   X X X X X X X   X X X X X X X   X X X
ASAP00GBR: X X X X X X X   X X X X X X X   X X X X X X X   X X X X X X X   X X X
ATH100IRL: X X X X X X X   X X X X X X X   X X X X X X X   X X X X X X X   X X X
ATTL00GBR: X X X X X X X   X X X X X X X   X X X X X X X   X X X X X X X   X X X
AUDR00EST: X X X X X X X   X X X X X X X   X X X X X X X   X X X X X X X   X X X
BARR00GBR: X X X X X X X   X X X X X X X   X X X X X X X   X X X X X X X   X X X
BEN000GBR: X X X X X X X   X X X X X X X   X X X X X X X   X X X X X X X   X X X
BIAX00GBR: X X X X X X X   X X X X X X X   X X X X X X X   X X X X X X X   X X X
BIEL00ITA: X X X X X X X   X X X X X X X   X X X X X X X   X X X X X X X   X X X
BLAP00GBR: X X X X X X X   X X X X X X X   X X X X X X X   X X X - X X X   X X X
BNTA00IRL: X X X X X X X   X X X X X X X   X X X X X X X   X X X X X X X   X X X
BORM00ITA: X X X X X X X   X X X X X X X   X X X X X X X   X X X X X X X   X X X
BRAE00GBR: X X X X X X X   X X X X X X X   X X X X X X X   X X X X X X X   X X X
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Figure 3. Weekly and monthly alarm e-mails

In development:

An alarm based on the statistical behavior of GNSS data quality indicators

- To automatically detect degraded metrics
- To find the root cause of the degradation

GEOPHYSICAL APPLICATION

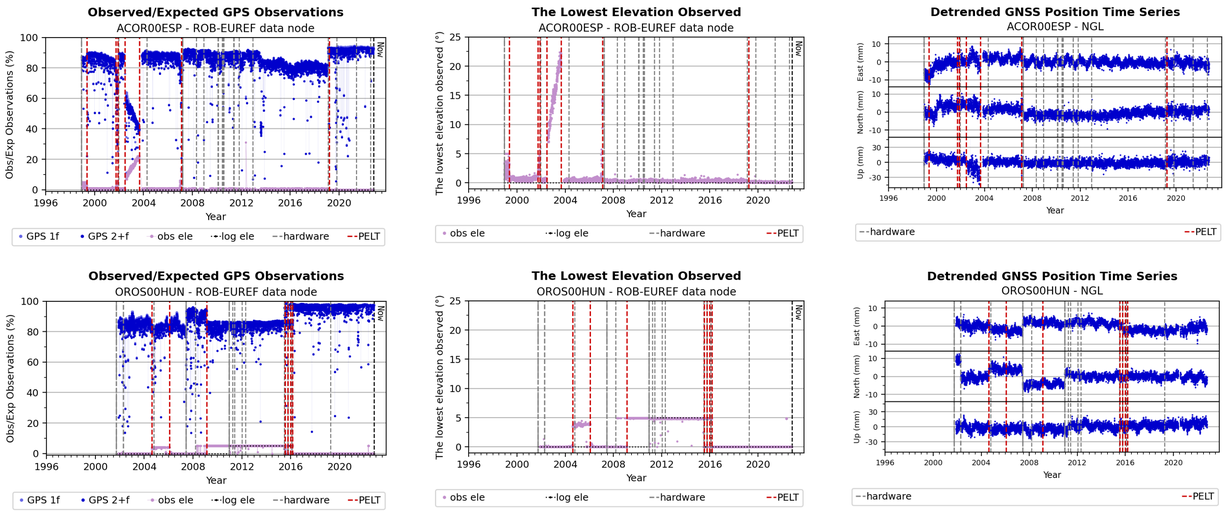

Figure 4. The Obs/Exp GPS observations (a), with a zoom on the cut-off angle (b) and NGL position time series[2] (c) detrended GNSS position time series for ACOR00ESP (top) and OROS00HUN (bottom).

- Degradation of the data quality can impact the accuracy of products like the GNSS position time series (For example, the lowest elevation observed can have an impact and change points need to be detected).
- For this reason, we look for un-documented changes in the lowest elevation observed that can impact the time series.
- Red-dashed line is automatic change point based on the lowest elevation observed using Pruned Exact Linear Time (PELT) Algorithm[3].

REFERENCES

[1] Václavovic P. and Douša J. (2016). G-Nut/Anubis - open-source tool for multi-GNSS data monitoring. IAG Symposia Series, Springer, Vol. 143, pp. 775-782, doi:10.1007/1345_2015_157.

[2] Blewitt, G., W. C. Hammond, and C. Kreemer (2018), Harnessing the GPS data explosion for interdisciplinary science, Eos, 99, https://doi.org/10.1029/2018EO104623.

[3] Killick, R., Fearnhead, P., & Eckley, I. (2012). Optimal detection of changepoints with a linear computational cost. Journal of the American Statistical Association, 107(500), 1590–1598.

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