Toward long-term data quality monitoring of EPOS-GNSS stations

Fikri Bamahry, Juliette Legrand, Carine Bruyninx
Royal Observatory of Belgium

Introduction

The European Plate Observing System (EPOS) is a European research e-infrastructure that aims to enhance the integration, accessibility, and utilization of multi-disciplinary datasets (such as GNSS) and services for Solid Earth research.

The Royal Observatory of Belgium (ROB) developed a new EPOS community web portal (https://gnssquality-epos.oma.be) accompanied by alarms that monitor the availability and quality of GNSS data distributed through EPOS. This web portal presents the tracking performance of 1700+ EPOS-GNSS stations.

This unique set of GNSS data quality indicators provides helpful information that can be used to detect a potential degradation of the quality of the GNSS observations.

EPOS-GNSS data quality monitoring portal

allows users to check the distribution and the availability of the EPOS-GNSS station data by GNSS network, data node, or metadata maintainer.

provides plots of several GNSS data quality indicators, such as:

- the % of observed vs. expected observations. (Figure 7a).
- 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.

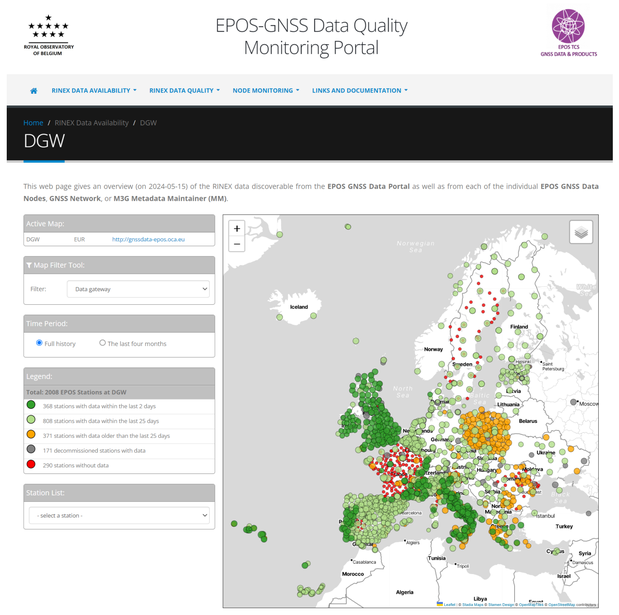


Figure 2. *GNSS Data Quality Monitoring web portal: RINEX Data Availability.*

Available data

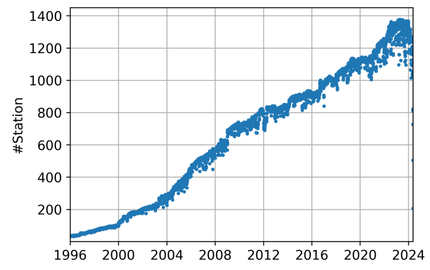


Figure 3. *Number of daily RINEX files discoverable from the EPOS-GNSS Data Gateway as function of the time.*

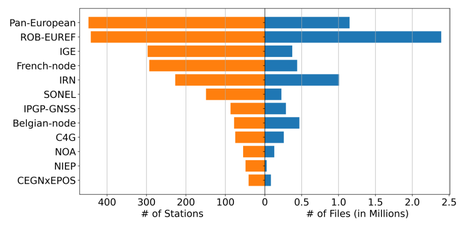


Figure 4. *Number of daily RINEX files discoverable from the 12 active GNSS data nodes.*

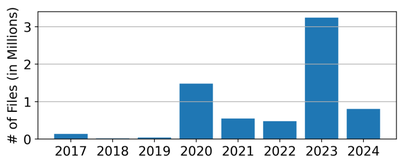


Figure 5. *Number of new daily RINEX files published by EPOS-GNSS per year.*

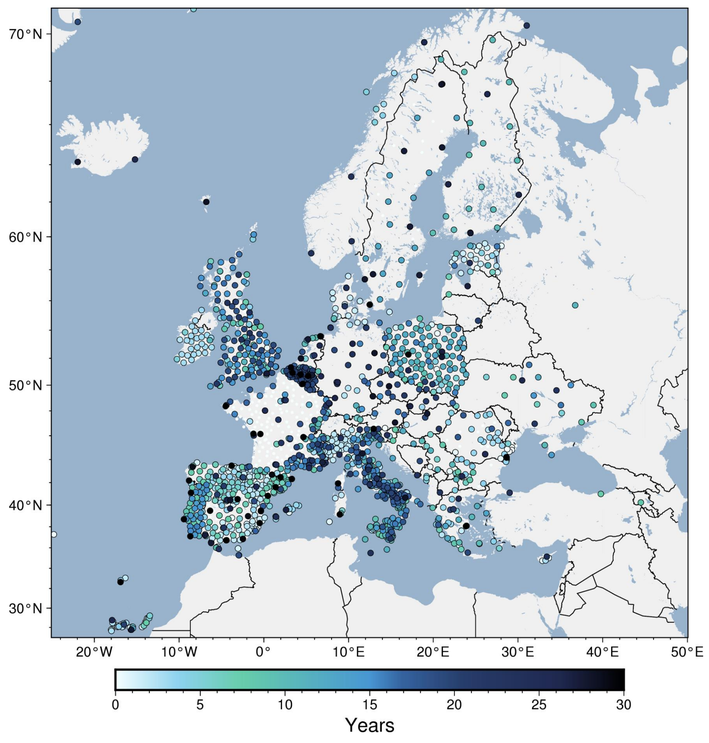


Figure 6. *Map of the 1718 EPOS stations with data at DGW ; the colour code shows the number of days with quality metrics (converted in years). 290 EPOS-GNSS stations without data are shown in grey. Some nodes are still populating.*

References and links

EPOS-GNSS data quality monitoring web portal: https://gnssquality-epos.oma.be/
EPOS Data Portal: https://www.ics-c.epos-eu.org/
EPOS-GNSS Data Gateway: https://gnssdata-epos.oca.eu/
EPOS-GNSS Product Portal: https://gnssproducts.epos.ubi.pt/
M³G: https://gnss-metadata.eu/
G-Nut/Anubis Software: https://gnutsoftware.com/software/anubis

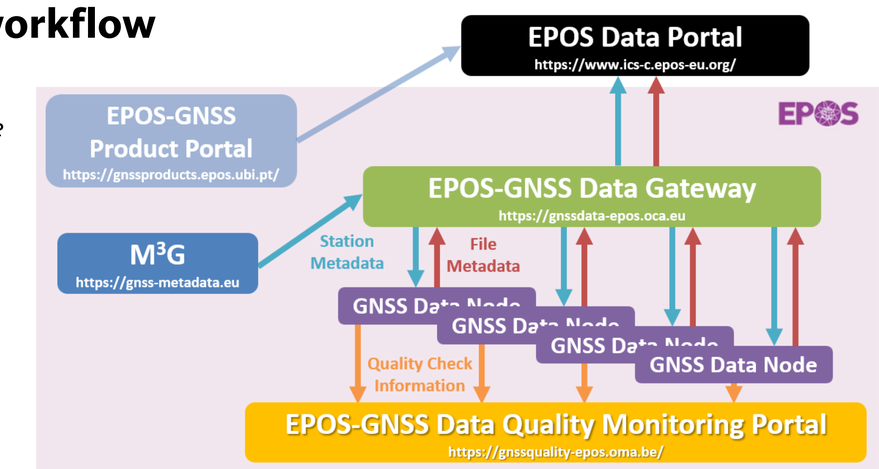
[1] Adams, R.P., MacKay, D.J.C. (2007): Bayesian Online Changepoint Detection. arXiv 0710.3742. https://doi.org/10.48550/arXiv.0710.3742

[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] Vaclavovic, P., Dousa, J. (2015). G-Nut/Anubis: Open-Source Tool for Multi-GNSS Data Monitoring with a Multipath Detection for New Signals, Frequencies and Constellations. In: Rizos, C., Willis, P. (eds) IAG 150 Years. International Association of Geodesy Symposia, vol 143. Springer, Cham. https://doi.org/10.1007/1345_2015_97

EPOS-GNSS workflow

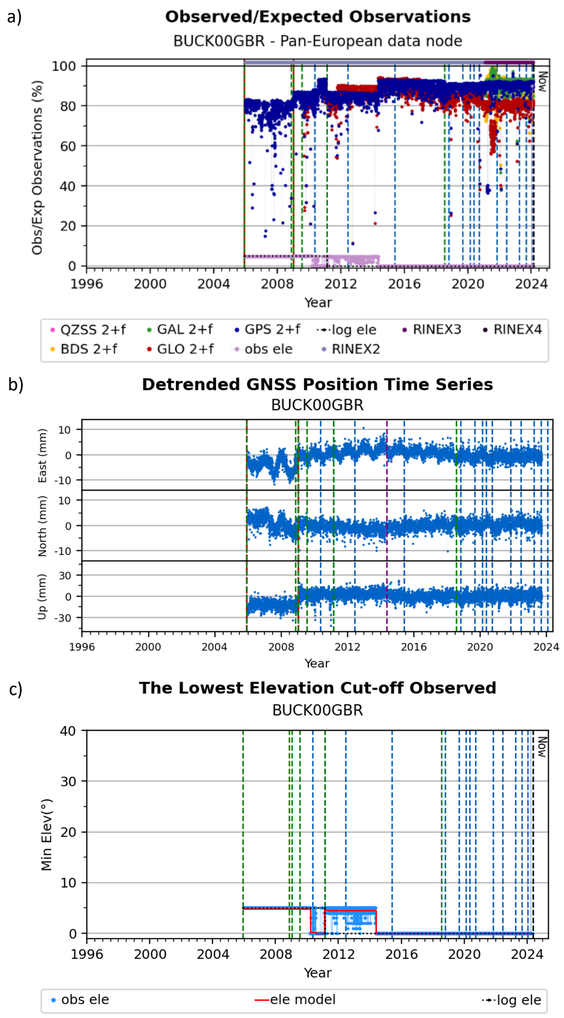
Figure 1. *Schema of the EPOS-GNSS workflow.*



- **EPOS data portal**: provide access to (meta)data and products from the EPOS-GNSS and other thematic core services.
- **EPOS-GNSS Data Gateway** (DGW): provide access to GNSS RINEX data from a distributed infrastructure of twelve GNSS data nodes.
- Station metadata are inserted in **M³G** (Metadata Management and Distribution System for Multiple GNSS Networks) and are synchronized to the DGW and then from the DGW to the nodes.
- **GNSS data nodes**: RINEX files are checked using the G-Nut/Anubis software[3] and inserted at the node level. The metadata of the validated RINEX files are synchronized to the DGW to make them discoverable through the DGW and the EPOS data portal.
- **EPOS-GNSS data quality monitoring portal**: provide access to the plots of GNSS data quality indicators retrieved from the nodes.
- **EPOS-GNSS Product Portal**: provide access to the EPOS-GNSS products.

Example of GNSS data quality indicators usage

When processing GNSS data using a low elevation cut-off angle, changes in the elevation cut-off angle of the observation data will affect the estimated GNSS position, and especially the height component. Therefore, it is important to keep track of all elevation cut-off changes at the receiver so that we can correctly interpret and model detrended GNSS position time series. For this reason, we developed an algorithm that models the cut-off angle (and its evolution in time) set up in the receiver or maybe caused by degraded data quality.



Figures 7. *Example of an undocumented change affecting the cut off angle in 2014 for the station BUCK00GBR.*

a) % of observed/expected observations, minimum elevation is shown in purple.
b) Detrended position time series from Nevada Geodetic Laboratory (NGL[2]), a purple vertical line in 2014-05-16 shows an un-documented change of the cut off angle observed by Anubis Software.
c) ECA model is shown in red.

The EPOS-GNSS data quality monitoring portal provides, for all EPOS-GNSS stations, plots the Estimated Cut-off Angle (ECA) set up in the receiver over time. The estimation is based on a model that uses as input the lowest elevation cut-off angles observed by the station each day and uses a Bayesian online change point detection algorithm[1] (see Figure 8) to detect the epochs at which the elevation cut-off angle set up in the receiver is most likely to have changed.

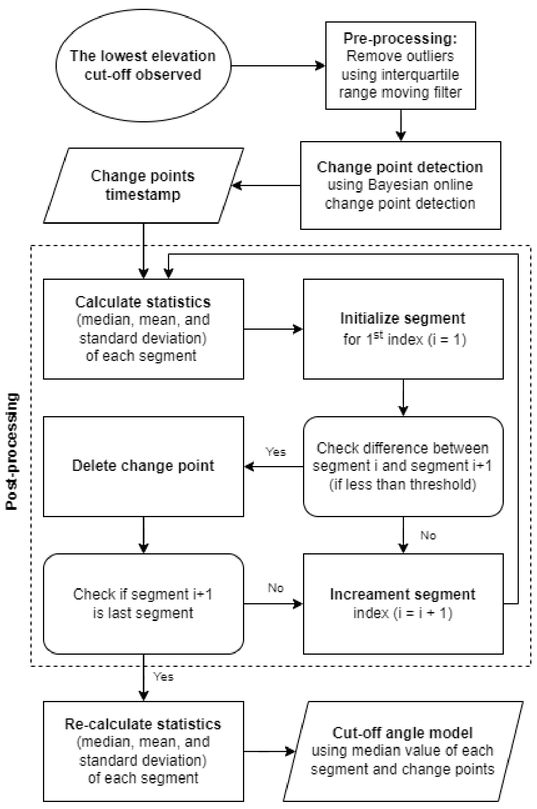


Figure 8. *Flowchart illustrates the process for estimating the model of cut-off angle.*

By comparing the ECA model with the cut-off angles documented in the site logs, it is possible to identify cut-off angle changes that were not documented in the site logs. However, the ECA model cannot be used to blindly complete site logs. Instead, it should be considered as an additional tool for station managers to manually verify and complete the site logs of their stations.

EUREF Symposium 2024
Barcelona, Catalonia, Spain
6th June 2024

This work was funded by the Belgian Federal Science Policy Office (BELSPO) through the ESFRI-FED program.