

Combination strategy of EPN Analysis Centres coordinate solutions

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The EUREF combined coordinate solutions are created on the basis of daily GNSS solutions generated by the EPN Analysis Centres (AC). Each EPN AC regularly processes GNSS data from an assigned subnetwork of EPN stations and generates daily coordinate solutions in SINEX format. Each EPN station is processed by at least three ACs. Every week, the AC solutions are combined by the EPN Analysis Centres Coordinator in order to obtain daily and weekly combined positions for all EPN stations. This document describes the combination methodology used for the creation of the EPN daily and weekly combined positions.

1 Metadata checking

Before the combination of AC solutions, metadata included in AC daily SINEX files from a particular week are checked for a consistency with respect to information provided in station log files and in the EPN antenna calibration file (presently `e pn_14.atx`). The correctness of the following metadata is checked: receiver types, antenna types, antenna radomes, eccentricities of the antenna reference point (ARP) with respect to a station mark, and the mean antenna phase center offsets with respect to the ARP. In addition, it is also checked if all stations for which RINEX files are available at the EPN data centers are included in AC SINEX files. In case of detected inconsistencies, notification emails are sent to ACs. To ensure the highest agreement between station positions computed by different ACs, stations for which the inconsistencies in metadata have been found are excluded from the affected AC solutions. Also, the following stations are excluded from AC daily solutions: (1) stations for which an antenna or receiver was changed during the considered day (according to daily excluded files provided by the EPN Central Bureau), (2) EPN stations which do not belong to a subnetwork of a particular AC, and (3) non-EPN stations. All stations excluded in this step are reported in daily and weekly summary reports submitted to the BKG data center (section 3).

2 Combination strategy

The combination strategy consists of several steps. At first, AC daily solutions provided in SINEX files are deconstrained and transformed into normal equations. Then, the solutions are iteratively combined using Bernese GNSS Software [*Dach et al., 2015*]. After the combination, each AC solution is compared to the resulting combined solution by means of a 7-parameter transformation using all stations included in AC solutions. Stations for which coordinate residuals between an individual AC solution and the combined solution exceed the threshold of 5 mm in horizontal components, or 12 mm in the vertical component are eliminated from the AC solution. The combination process is repeated until no station coordinate residuals exceeding the mentioned threshold are detected.

In the next step, each daily combined solution is stacked together with previous 10 weekly solutions and compared to the resulting solution by using a 7-parameter transformation. Stations for which coordinate residuals between the daily combined solution and the stacked solution are larger than 15 mm in horizontal components, or 25 mm in the vertical component are eliminated

from the daily combined solution. In the last step, clean daily combined solutions are stacked into a weekly solution. Stations for which an antenna or receiver was changed during the week are excluded from the weekly solution (according to weekly excluded files).

The daily and weekly combined coordinate solutions are aligned to the latest realization of the IGS terrestrial reference frame (presently IGS14) using no-net-translation minimum constraint conditions. The minimum constraints are imposed over usable IGS stations, i.e., for which no position discontinuities were observed after the introduction of the IGS14 reference frame (according to file ftp://igs-rf.ign.fr/pub/IGS14/soln_IGS14.snx). The combined station coordinates are also compared to the IGS coordinates propagated to a reference epoch of the combined solution; stations for which coordinate differences exceed the threshold of 8 mm in horizontal components, or 15 mm in the vertical component are not used for the final reference frame alignment of the combined solution.

3 Availability of the combined solutions

Each week, EPN daily and weekly combined coordinate solutions and summary reports are submitted to the BKG data center (<ftp://bkg.bund.de/EUREF/products/WWW/>, where WWW is a GPS week). The following files can be accessed:

- `eurWWWWD.snx.Z` – daily combined coordinate solutions in SINEX format ($D = 0, \dots, 6$),
- `eurWWW7.snx.Z` – a weekly combined coordinate solution in SINEX format,
- `eurWWWWD.sum.Z` – daily summary reports,
- `eurWWW7.sum.Z` – a weekly summary report.

The combined coordinate solutions are available also at the EPN (<ftp://ftp.epncb.oma.be/epncb/product/combin/WWW>) and CDDIS (<ftp://cddis.gsfc.nasa.gov/gps/products/WWW>) data centers. In addition, weekly summary reports are distributed via EUREF mail service operated by the EPN Central Bureau.

References

Dach, R., S. Lutz, P. Fridez, and P. Walser (2015), *Bernese GNSS Software, Version 5.2*, Astronomical Institute, University of Bern.