Quality check procedures of EPOS products derived from EUREF Densification and EPOS DD and PPP product combination

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1. Introduction

This document concisely describes the quality check procedures performed during the generation of the combined EUREF and EPOS SINEX products.

The main tool used for the combination is the CATREF software (Altamimi et al, IGN, France) supported by in-house developped small tools facilitating and supporting data preparation, checks and evaluation.

2. Input files

2005/001 - 2015/365: INGV, UGA-CNRS pan-European daily SINEX solutions and EPN-repro2 daily and weekly combined SINEX files for the same period, all consistent with IGb08/epn_08.atx.

The daily SINEX solutions are used for the

- EPOS.Combined SINEX series and
- generation of weekly SINEX series, which then may used for the EUREF Densification.

The weekly SINEX solutions are exclusively used for the EUREF Densification.

3. Quality checks

3.1 Input SINEX level checks

Each daily/weekly SINEX series stemming from single networks are first combined separately by the CATREF software. The multi-year combination allows the detection of station metadata inconsistencies, outliers, possible processing issues (remaining constraints) and give and overall

estimation of the solution quality. The pre-processing is being done iteratively until the quality parameters are getting satisfatory.

At this stage only the station naming (4 character ID and DOMES numbers are checked. Station equipment information (antenna/radome type, antenna serial number, antenna offset) have not been compared yet, but few equipment inconsistencies at Greek stations in EPN Densification had been identified and eliminated.

Conflicting station namings (between solutions and the database maintained by IERS had been resolved by renaming of such stations and keeping those cases in a database. A simple tool is also developed to make the renaming unique and reproducible. The same holds for the DOMES numbers. If a station still has no official DOMES identifier then a virtual DOMES number is assigned temporarily until the official identifier is published.

The relevant station information, including naming and solution number definition is collected and stored in the standard EDV_solution.snx file, which was regularly updated. At this combination stage no geodetic datum is defined, only intrinsic datum definition is used.

The quality checks of the single network multi-year solutions are being based on the indicators provided by the different CATREF outputs. Similarly to the EUREF.Combined.Positions DDSS the following internal checks are performed:

1. Time series of the weighted root mean square of the residual position time series
2. Time series of the Helmert transformation parameters
3. Station position timeseries: outliers are iteratively removed when they exceed a threshold of 15 mm for the horizontal components and 25 mm for the vertical component. However there are several stations, where the general noise level higher or exhibit high seasonal variations, where ourliers exceeding the given threshold are not eliminated.
4. Position discontinuities and velocity changes are being checked and in case of clear indication the respective information is saved in the discontinuity file and the vcontr.dat file. One unique discontinuity file is maintained.

At all checking stages graphical representation is also prepared and visual inspection is performed. If needed as annex examples of the plots can be provided.

3.2 Preliminary SINEX combinations

As the daily/weekly SINEX solutions are coming from various sources – especially at the EUREF Densification - the metadata in the SINEX files should be carefully checked and intercompared at overlapping stations. The testing is being done in two phases:

1. daily or weekly combination of the network solutions day-by-day (EPOS) or week-by-week (EUREF densification). This combination may reveal unnoticed metadata issues on daily/weekly level and they can be corrected iteratively if needed,
2. test multiyear combinations using the combined daily/weekly SINEX series still without datum definition. This is the final level of checking metadata issues and test outliers and unnoticed discontinuities.

3.3 Final SINEX combinations

This step comprises the final combination of the daily SINEX series for the EPOS.Combined product and the weekly level combination of the EUREF.Densification product. These combinations are already use datum definition based on the MC approach preferred by CATREF.

The datum SINEX is an extraction of the IGSyy SINEX, where IGSyy must be in agreement with the reference frame and atx file used by the input SINEX solutions.

In the current situation IGb08 is used at both the EPOS.Combined and at the EUREF.Densified solutions. However if the next generation EPOS pan-European solutions will be prepared in the IGS14 frame and atx then of course the product will be expressed in IGS14.

The quality of the final combined products will be tested based on the CATREF combination outputs:

- 4 quality measures as described in 3.1 under the points 1-4,
- additionally the quality of the MC datum realization is tested computing the 14 Helmert transformation parameters between the selected subset of the IGSyy SINEX and the same stations in the combined solution - the parameters should be zero if MC is correctly realized. The IGSyy datum SINEX should be modified if pos/vel outliers (bigger than 3 mm in the horizontal and 5 mm in the vertical positions and 0.2mm/yr in the horizontal and 0.4 mm/yr in the vertical velocities) and significant transformation parameters are observed. This could be a time consuming iterative procedure.
- the velocity uncertainties should also be checked and more realistic estimates should also be provided e.g. using the Hector software. This option is not yet implemented, but planned to be done until Summer 2018.