



European Position Determination System

Guideline for EUPOS Reference Frame Fixing

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Fehrbelliner Platz 1
D - 10707 Berlin, Germany

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1. Preamble

The IAG Subcommission for the European Reference Frame (EUREF), following its resolution No. 1 of the Firenze 1990 meeting, recommends that the terrestrial reference system to be adopted by EUREF is coincident with ITRS at the epoch of 1989.0 and fixed to the stable part of the Eurasian plate. It is named European Terrestrial Reference System 89 (ETRS89).

In 2003 the European Commission accepted the ETRS89 as an obligatory reference system for referencing spatial information for all applications done in EU's interests. The ellipsoidal coordinates related to ETRS89 represent an obligatory system of geographical coordinates.

The EuroGeographics, which is an association representing European Mapping and Cadastral Agencies of 42 European countries, has been developing its main projects, like ESDI (European Spatial Data Infrastructure), on the basis of ETRS89. Therefore, ETRS89 should be underlying to the EUPOS GNSS positioning system currently developed in Central and Eastern Europe.

2. ETRS89 realization

The ETRS89 is maintained by the IAG Subcommission EUREF and is accessed through the EUREF Permanent Network (EPN), a science-driven network of continuously operating GNSS reference stations with precisely known coordinates in ETRS89 see e.g. <http://www.epncb.oma.be/>. The EPN represents the ETRS89 first-order realization on international (continental) level. On national level the ETRS89 has been realized by a stepwise densification and improvement of the original EUREF reference frame carried out by individual European countries making full use of existing operational EPN stations. At present (March 2007) the EPN consists of about 200 operational tracking stations. In the years 1989 – 2002 EUREF densification observation campaigns were carried out in almost all European countries, in some of them repeatedly. These campaigns, along with EPN stations, constitute national ETRS89 realizations. The realization of a system is called reference frame, which is represented by a number of markers on the earth surface, with known coordinates and (sometimes) velocities.

Like each system, ETRS89 has been evolving in time and each evolution stage is represented by a corresponding realization. The most recent realization is always an improvement with respect to the previous one. The reliability of the EPN site coordinates depends on the length of its operation and on the possibility to link the GPS-based coordinates to the coordinates determined by other space observation techniques. EPN coordinates are available in two reference systems – ITRS and ETRS89. With respect to the history of observations and processing three types of EPN site coordinates can be distinguished:

(1) **weekly coordinates**, computed by the EPN combination centre,
(2) site coordinates and velocities computed within the **EPN project „Time series monitoring“** and

(3) **official coordinates** and velocities issued by the **IERS** as a result of a combination of the multi-year coordinate solutions obtained by several space geodetic techniques.

Coordinates (1) are not suitable for reference frame definition, this is only for rough coordinate monitoring.

Coordinates (2) are the most up-to-date and most accurate crd and vel. solution for the EPN stations. They are useful when a permanent station is running for years but not yet included into the latest ITRF solution (between 2 consecutive ITRF realizations). If a non-ITRF EPN station have 1-2 years observation history the quality of its crd solution is equivalent or comparable to the ITRF (the velocity needs longer observation set). They fully rely on (1).

Coordinates (3) are official coordinates/velocities issued by IERS,.

Recommended usage:

- If the spacing of EPN stations is less than 300 km and if no coordinate discontinuity appears, use (3),
- If (3) not available, use (2) especially when you want to involve as much permanent stations as possible,
- If (3) or (2) not available, use (1).

3. ETRS89 implementation in EUPOS

The ETRS89 coordinates of EUPOS stations should be basically determined following the guidelines agreed by the TWG EUREF, see Gurtner et al., 1996 and Boucher and Altamimi, 2007 (see also Annex – Memo: Specifications for reference frame fixing in the analysis of a EUREF GPS campaign, issued March 27, 2007). The goal is to process the observation data in ETRS89 taking full benefit of the most recent realization of the reference frame represented by fiducial stations and of the final IGS orbits. It is recommended the EUPOS coordinates should be related exclusively to the reference frame represented by the EPN and should represent the national ETRS89 realization.

The EUPOS member countries are encouraged not to accommodate the EUPOS coordinates to the the "old" national realizations, but to recompute the national realization to most recent realization of the ETRS89. using EPN. The aim of this approach is to ensure:

- nationwide consistency of the passive and active networks,
- consistent reference system realization between EUPOS countries (important for cross-border networking).

3.1 Using EPN

The ETRS89 coordinates of EUPOS reference stations should be determined following the EUREF specifications and relevant EUREF TWG guidelines.

- Use high precision GNSS data processing software like Bernese, GIPSY-OASIS, Geodyn, Geonap, etc.
- Select properly several EPN stations distributed inside and outside the corresponding national EUPOS segment
- Avoid EPN stations with the history shorter than 1 year, check their observation time series visiting http://epncb.oma.be/_dataproduts/products/index.php, avoid stations with unexplained trends and periodicities, prefer IGS stations if any
- Define a campaign lasting at least 3 – 4 weeks, operating the EUPOS stations simultaneously with the EPN stations
- Process the campaign, generate a loosely constrained SINEX solution
- Regularize the solution fixing the ITRF-YY coordinates of EPN stations
- Convert the results into ETRS89 at tc following the formulas and numerical values of parameters given in Boucher and Altamimi, 2007 (see Annex)

In the processing of the corresponding GNSS observation campaigns antennas phase centre variations from individual phase center calibrations should be used if they exist. Using this approach a consistency with the actual ETRS89 realization on the level of 1 mm horizontally and 3 mm vertically can be achieved for the defined observation period.

References

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Boucher C., Z Altamimi: Memo: Specifications for reference frame fixing in the analysis of a EUREF GPS campaign. Issue March 27, 2007, see <http://lareg.ensg.ign.fr/EUREF/>