Guidelines for the EPN Analysis Centres

Prepared by the EPN Coordination Group and the EPN Central Bureau
Contact: epn_acc@wat.edu.pl

Changes

28-01-2010
- Complete revision of the guidelines (all sections)
- Moving separate EPN Processing Option Table as addendum into the guidelines

19-11-2013
- Final daily coordinate solutions became mandatory
- Recommendation for troposphere gradients submission
- Update of processing options (e.g. mapping functions)
- Minor changes to keep the Guidelines up-to-date

05-12-2016
- Minor changes to keep links up to date after switch to new EPN CB web site

12-07-2018
- Update of combination strategy (using daily AC solutions)
- Update of processing options (tropospheric mapping functions)
- Submission of troposphere gradients became mandatory
- Introduction of new daily excluded files
- Minor changes to keep the Guidelines up-to-date

01-10-2021
- Update of processing options (e.g., using Galileo observations)
- Changes in EPN antenna model
- Minor changes to keep the Guidelines up-to-date

18-05-2022
- Adding BEV RDC as EPN product centre

This document comprises the guidelines for EPN Analysis Centres specifying the analysis procedure and submission of the results. The reader is introduced into the EPN analysis method and the connection between the sub-network analysis and the combination. But this document gives no detailed explanation of the last item. All steps for becoming an Analysis Centre are explicitly listed and the processing instructions include the processing scheme as well as the required options. The submission guidelines give the file naming convention and address the upload of the analysis results. It is also explained, how the Analysis Centres could check their performance against the combination. The addendum holds detailed information about processing options and the history, which could be helpful to understand inconsistencies in coordinate time series.

1. EPN Analysis Components

The strategy to analyse EPN observations is in accordance with the so-called distributed processing approach. **Analysis Centres (ACs)** process the observations of a dedicated sub-network of EPN stations. The **EPN Central Bureau (CB)** assigns stations to the particular sub-networks following proposals from the **Analysis Combination Centre (ACC)** and the ACs as far as appropriate, ensuring that each station will be processed by at least 3 ACs, and considering further aspects that will be explained below. The ACs submit their sub-network coordinate solutions to the ACC, who processes the EPN combined solutions. EPN products are published at the EPN CB and **Regional Data Centres (RDCs).** Each component of the EPN analysis will be described separately in the following.

1.1 Analysis Centre Solutions

The ACs process the observations of the assigned sub-network (https://epncb.eu/_productsservices/analysiscentres/dataprocessingdistribution.php shows the distribution of the sub-networks). There is no explicit requirement for the analysis software to be used. It is by default in the responsibility of the ACs to meet the scientific state-of-the-art analysis methods, and to select proper processing options. Some processing options, however, have been defined for the EPN analysis explicitly and will be noted in the following paragraphs. A detailed description and the history of these options are given in the addendum.

Each AC compiles a "description form" (blank form from ftp://epncb.oma.be/pub/center/analysis/BLNKFORM.AC) that holds information about models and parameters treated in the analyses and sends it to the CB (ftp://epncb.oma.be/pub/center/analysis/). It is the ACs responsibility to keep the information in this form up to date.
In the following, the different solutions submitted by the ACs to EUREF are described.

Final Daily Coordinate Solution (mandatory)
The ACs generate and submit daily solutions of station coordinates based on final products (or rapid, see **Satellite Orbits** options in the Addendum) prepared by one of the IGS AC or the IGS itself. Solutions in SINEX formatted files are passed to the ACC. The deadline for submission of that product is 5 weeks after end of observations of the analysed week. This product is suitable for high frequency spectral analysis of coordinate time series, due to seven times higher resolution of available solutions w.r.t. the weekly solutions.

Final Weekly Coordinate Solution (mandatory)
The ACs generate a weekly solution of the station coordinates based on daily coordinate estimates. They submit the solutions in the SINEX format to the ACC. The deadline for upload of that product is 5 weeks after the end of observations of the analysed week. This product is mandatory for generation of the tropospheric solution (see Section 3.2, 4a).

Rapid Daily Coordinate Solution (recommended)
The ACs are asked to submit daily solutions of station coordinates based on rapid products prepared by one of the IGS AC or the IGS itself. Since this solution is not mandatory it may not be provided by all ACs, and therefore not all EPN stations may be included in the submitted AC solutions and eventually monitored (see Rapid Daily Coordinate Solution part in section 1.2). To increase the number of monitored EPN stations (and the redundancy), it is allowed that the ACs providing rapid solutions include in their solutions not only stations from the dedicated sub-networks but also additional ones. Solutions in SINEX formatted files are passed to the ACC. The deadline for submission of that product is 22 hours after the end of observations of the analysed day.

Hourly Coordinate Solution (recommended)
The ACs are asked to submit hourly solutions of station coordinates based on ultra-rapid products prepared by one of the IGS AC or the IGS itself. Many ACs are already providing hourly solutions for numerical weather forecast projects (e.g. EUMETNET) or perform an hourly coordinate stability validation check for their national networks. These results are also very helpful for the EPN identifying possible station problems as quickly as possible. Since the hourly solution is not mandatory it may not be provided by all ACs, and therefore not all EPN stations may be included in the submitted AC solutions and eventually monitored (see Hourly Coordinate Solution part in section 1.2). To increase the number of monitored EPN stations (and the redundancy), it is allowed that the ACs providing hourly solutions include in their solutions not only stations from the dedicated sub-networks but also additional ones. However, in case of insufficient data processing capacity to provide these solutions within a specified deadline (see below), it is also allowed that ACs include in hourly solutions only a subset of EPN stations from their sub-networks. Solutions in SINEX formatted files are passed to the ACC. The interval of observations of this solution includes the past hour and possibly observations before the past hour to stabilise the solution. The total length of the observation interval is not yet fixed and may differ for individual ACs. The deadline for submission of that product is 50 minutes after end of observations of the analysed hour.

Final Daily Zenith Path Delays Parameters and gradients (mandatory)
The ACs estimate mandatory (mostly hourly) tropospheric site zenith path delays and gradients for the EPN stations included in their sub-network. These zenith path delay estimates are submitted in daily troposphere files in the "Troposphere SINEX" format. It is also mandatory to estimate and submit in addition tropospheric gradients. The deadline for submission of that product is 5 weeks after end of observations of the analysed week.

1.2 Coordinate Combination

The ACC combines the SINEX files of the sub-networks as provided by the ACs into the EPN combined solution. This combination is performed for final daily, rapid daily and hourly coordinate solutions.

Final Daily Coordinate Solution
The ACC combines the daily sub-network solutions of the ACs into the EPN daily combined solution. The final daily coordinate solution is mandatory for all ACs and thus the resulting combination includes all EPN stations. A full description on this solution is available at https://epncb.eu/_productsservices/analysiscentres/combinedeurefsolution.php, while detailed comparisons and

statistics from the combination procedure at http://www.epnacc.wat.edu.pl/epnacc/. The combined solution is generated in an iterative way: after a first combination, each individual solution is crosschecked against the combination and stations exhibiting a significant coordinate difference with respect to the combined solution are eliminated. In a second step the solutions are combined again, but with the outliers removed.

Final Weekly Coordinate Solution
The ACC combines the final daily combined solutions into the EPN weekly combined solution. A full description on this solution is available at https://epncb.eu/_productsservices/analysiscentres/combinedeurefsolution.php.

Rapid Daily Coordinate Solution
The ACC combines the rapid daily sub-network solutions of the ACs on a daily basis. This solution is suitable to monitor the EPN station performance with a time delay of less than 24 hours. This product type is a recommendation and does not necessarily include all EPN sites.

Hourly Coordinate Solution
The ACC combines the hourly sub-network solutions of the ACs on an hourly basis. This solution is suitable to monitor the EPN station performance with a time delay of less than 1 hour. This product type is a recommendation and does not necessarily include all EPN sites.

1.3 Troposphere Combination

The combination of the troposphere solutions of the ACs falls under responsibility of the **Troposphere Coordinator (TC)**. Daily SINEX TRO files, delivered on weekly basis by the EPN ACs along with the Final Daily and Weekly coordinates, are used to generate each week the combined EPN troposphere solution containing the combined troposphere estimates (ZPD only) with an hourly sampling rate. The coordinates, as a necessary part of this file, are taken from the EPN weekly combined SINEX file. Hence, stations without estimated coordinates in the weekly SINEX file are not included in the combined troposphere solution.
More details on this activity are available from https://epncb.eu/_productsservices/troposphere/.

1.4 Cumulative Position/Velocity Solution

The daily combined EPN solutions are used to maintain the ETRS89 and monitor the EPN station performance by means of the regular computation of EPN cumulative position/velocity solutions. This task is performed by the **EPN Reference Frame Coordinator (RFC).** The RFC publishes the positions and velocities of EPN stations with at least 3 years of observations and only the positions for the stations with less than 3 years of observations. This product is available from https://epncb.eu/_productsservices/coordinates/. The RFC also publishes the list of position and velocity discontinuities in the IGS discontinuity SINEX format (https://epncb.eu/ftp/station/coord/EPN/EPN_discontinuities.snx), the residual position time series (https://epncb.eu/_productsservices/timeseries/) and a station categorization (https://epncb.eu/_productsservices/ReferenceFrame/).

2. Becoming an EPN Analysis Centre

Candidate ACs must be able to contribute to the EPN on a long-term basis. The sub-network solutions that are submitted to the ACC and the derived EPN combined solutions will be freely available for everyone. This data policy must be approved by new ACs. The used analysis software must have the capacity to process the assigned sub-network and to fulfil the required EPN analysis standards. To avoid overlapping of the activities and solutions, some ACs can contribute through specific tasks related to their main interests (see section 2.1).

2.1 Keeping up-to-date

According to new challenges that EPN faces, current Analysis Centers are invited to contact EPN CB and ACC to discuss a possible re-orientation of their contribution to the EPN. The most urgent necessities are related to, among others, the real-time analysis, control analysis using different types of software and analysis made for the purpose of testing new strategies and models.

2.2 Initial Steps

1. Contact the EPN CB at epncb@oma.be and the ACC at epn_acc@wat.edu.pl to declare your desire to become an EPN AC. Give the name and address of the representative of your AC.
2. Add a proposal for a European region you intend to analyse or a specific task you want to perform. New EPN ACs are encouraged to perform specific tasks, which would fulfil current EPN requirements. In the case the AC wishes to contribute to the EPN through a standard data analysis, then take into account, that each station has to be processed by at least 3 ACs, but it is not allowed that a single station is processed by nearly all ACs (in general not more than 5 ACs are accepted for one EPN station, some exceptions can be allowed for twin stations). The final list of processed stations has to be verified by the EPN CB and ACC.
3. Add a proposal for the 3-character identifier of your planned AC, e.g., "COE" for the Centre for Orbit determination in Europe at the Astronomical Institute University Bern.
4. Give a description of the analysis software you plan to use as well as the planned data analysis strategy. For this purpose an AC form can be completed (see ftp://epncb.oma.be/pub/center/analysis/BLNKFORM.AC). It is the AC's responsibility to keep this form up to date.
5. Add a proposal for the first GPS week you plan to start the EPN analysis.

2.3 Acceptance procedure

1. The CB requests an **AC description form** that has to be filled out and to be submitted to the CB.
2. The EPN CB and ACC assign a sub-network to the candidate AC taking into account the stations proposed by the AC and the need for additional AC for some EPN stations. Both EPN CB and ACC decide what the most urgent EPN needs are, concerning the tasks performed by the new AC (see section 2.1).
3. The EPN CB contacts the new AC after acceptance of the proposal by the **GB**, represented by the **EPN Coordination Group (CG)**.

3. Processing Instructions

Daily and hourly observation files in RINEX format of EPN stations are publicly available at the two **RDCs** (refer to https://epncb.eu/_documentation/guidelines/guidelines_data_centres.pdf).

3.1 Preparation

1. Download the RINEX observation files of your sub-network for the period to be processed. The data of all EPN stations are available at the EPN data centres that are listed at the CB (see https://epncb.eu/_networkdata/data_access/dailyandhourly/datacentres.php).
2. Download the orbit and Earth Rotation Parameter (ERP) files from the IGS or one of its ACs. IGS final, rapid or ultra-rapid products have to be used depending on the solution to be generated (for more details see **Satellite Orbits** options in the Addendum). For information about access to IGS products see https://igs.org/.
3. Download the coordinates and velocities of the actual IGS realisation of the ITRF (e.g. IGb14), if not already done, from the IGS CB at https://files.igs.org. In the case of the IGb14 realisation, also a post-seismic deformation model may be necessary for some stations.
4. Prepare a table of ocean loading displacements for each involved EPN site either by using the online computation service at http://holt.oso.chalmers.se/loading/index.html or through downloading the table from the CB at ftp://epncb.oma.be/pub/station/general/.
5. Prepare the receiver and satellite antennae calibration table using individual calibrations (when available) and IGS antenna type mean calibrations, from a file in ANTEX format that is provided from the CB (see https://epncb.eu/_documentation/equipment_calibration/).
6. Get and apply the list of excluded stations provided by EPN CB (e.g. inactive, excluded stations, see ftp://epncb.oma.be/pub/station/general/excluded/). Use daily excluded files (excluded.wwwwd, where wwww is a GPS week, and d is the day of the week) to exclude stations from daily coordinate solutions, and weekly excluded files (excluded.wwww) to exclude stations from weekly coordinate solutions and troposphere solutions.
7. Make sure the correct meta-data (provided in ftp://epncb.oma.be/pub/station/general/euref.snx) is used during all steps of the data analysis, independent of the information in the RINEX header.

3.2 Processing

1. Process the observation files of the assigned sub-network
    a. Write the estimated station coordinates into the resulting SINEX file.
    b. Align the solution to the valid ITRF at the current epoch, e.g., through applying "minimum-constraint-conditions" to the reference sites (do NOT "fix" any reference coordinates).

    Comment: It is recommended to use the actual IGS realisation of the ITRF (e.g., IGb14 instead of ITRF2014) to reach the best possible consistency with IGS products (IGS satellite orbits, clock corrections and EOP) for all processing steps. Users must be aware that the published ITRFyyyy to ETRF2000 (and to ETRF2014) transformation parameters are also valid for the actual IGS realization.
2. The following SINEX data blocks are mandatory:
    a. +SOLUTION/STATISTICS
    b. +SOLUTION/EPOCHS
    c. +SOLUTION/APRIORI
    d. +SOLUTION/ESTIMATE
    e. +SOLUTION/NORMAL_EQUATION_VECTOR and
    +SOLUTION/NORMAL_EQUATION_MATRIX L
    or
    +SOLUTION/MATRIX_ESTIMATE L COVA and
    +SOLUTION/MATRIX_APRIORI L COVA,

    although it is recommended to submit normal equation solutions if possible (first option in subsection e).
3. ACs are requested to keep the ACC and CB posted about disturbances noticed in solutions (e.g. large outliers resulting in stations elimination)
4. Generation of tropospheric zenith path delays
    a. Re-substitute the final weekly coordinates in the daily solutions and constrain them heavily while solving for the hourly station specific troposphere parameters.
    b. Write these final estimates of the troposphere parameters (zenith path delays and gradients) into daily SINEX Troposphere format files (final troposphere result).
    c. To accommodate for the gradients, the fields 'TGNTOT, TGETOT' are introduced in the SINEX TRO format.

3.3 Processing Options

Processing should be done in accordance with IERS Conventions 2010.

1. Use the suitable IGS products (combined or from one of the IGS ACs) corresponding to the solution to be processed (for more details see **Satellite Orbits** options in the Addendum). Select from "final", "rapid" and "ultra-rapid". IGS provides satellite orbits, satellite clock corrections and Earth orientation parameters. Take in particular care of the usability of orbits for unhealthy satellites.
2. Introduce ocean-loading corrections for the stations. Make sure to use the same model for all stations. Optionally introduce atmospheric tidal loading corrections.
3. Use a 3° elevation cut-off angle. Apply elevation dependent weighting of observations.
4. Use state-of-the-art tropospheric mapping functions (MF) to map the tropospheric delay in zenith direction. Use an a priori model for zenith hydrostatic delay (ZHD) together with a hydrostatic MF and estimate corrections to the model using wet MF.
5. Estimate hourly station specific troposphere parameters.
6. Fix the initial phase ambiguities to integer numbers.
7. Recommendation: Use GPS as well as GLONASS and Galileo observations.

Further details on processing options and their history are given in the Addendum.

4. Submission Guidelines

1. Submit your solutions to the RDCs at BKG and BEV. Contact BKG at BKG-GDC@bkg.bund.de and BEV at gnss@bev.gv.at to get the required login and account information. File naming conventions are described below. For the time being it is recommended to apply z-compression before submission that will add the extension ".Z" to each file.
2. Notation:
   ccc = AC abbreviation,

wwww = GPS week,
d = day of week 0, …, 6,
hh=hour 00, ..., 23,

3. Final weekly coordinate solution: cccwwww7.SNX
4. Final daily coordinate solution: cccwwwwd.SNX
5. Rapid daily coordinate solution: cccwwwwdR.SNX
6. Hourly coordinate solution: cccwwwwd_hh.SNX
7. Final daily troposphere zenith path delays: cccwwwwd.TRO

5. AC Performance Control

Each AC needs the information how well his/her single solution fits into the combined solution to check the quality of his/her analysis. There are various sources of such kind of information:

1. The weekly EUREF AC report as distributed to the ACs by E-Mail includes a list of the stations which have been explicitly excluded from single AC solutions in the combination of station coordinates. This report also includes a list of stations excluded due to metadata inconsistencies found in AC daily solutions (with reference to the euref.snx file, available at https://epncb.eu/ftp/station/general/). The EUREF AC report shows in addition un-weighted RMS values of each daily AC solution with respect to the combined solution.
2. The EUREF Mail exploder distributes a weekly EUREF combination report. It includes a list of stations which have been explicitly excluded in the combination of station coordinates. It is marked, whether the station was excluded for a single or for all ACs. This report also includes a list of stations excluded due to metadata inconsistencies found in AC daily solutions (with reference to the euref.snx file).
3. The summary reports on daily combinations available at BKG and BEV RDCs. The report for each day includes a direct comparison of the station coordinates from the individual solutions with respect to the combined solution. Thus, it reflects the alignment of the individual solutions, which is important for the reduction of the troposphere parameter biases. The report also includes a list of stations which have been explicitly excluded in the combination of station coordinates. It is marked, whether the station was excluded for a single or for all ACs. The report shows moreover un-weighted RMS values of each daily AC solution with respect to the combined solution.
4. The EPN ACC webpage (http://www.epnacc.wat.edu.pl/epnacc/) presents graphs and statistics about combination with information about excluded sites and comparison between the individual and combined solutions.
5. A weekly EUREF troposphere combination report (EURwwww7.TSU) is distributed to the ACs by E-Mail and is available at BKG and BEV RDCs. It provides statistics for the differences of the individual AC estimates with respect to the combined product. Statistics, in terms of mean and standard deviation, are provided for each AC and for each station/AC pair. They are computed without any outlier removal. The information contained in these mails is available in graphical form from the EPN Central Bureau at https://epncb.eu/_productsservices/troposphere/mean_zpd_biases.php.

Addendum

EUREF Permanent Network Processing Options

Ambiguity Fixing
It is *recommended since week 0860* to fix the ambiguities in the final solution (Ref.: a) Minutes of EUREF Analysis Workshop, Brussels, April 10 - 11, 1997, b) Minutes of 3rd EUREF AC Workshop, Warsaw, May 31- June1, 2001).

Antenna Phase Centre Corrections
It is *mandatory since week 1400* to apply absolute antenna phase centre corrections as provided by the EPN Central Bureau (Ref.: Conclusions of the EPN AC Workshop, March 15 - 16, 2006, Padua, Italy).
Since the end of 2019, EPN CB is not including Galileo E5 calibrations in the official EPN ANTEX file (Ref.: Minutes of EPN Analysis Centres Workshop, Warsaw, October 16-17, 2019).
Since May 14, 2020 EPN CB includes in the EPN ANTEX file repeated individual calibrations for antennas with the same serial number that were calibrated several times (Ref.: Minutes of EPN Analysis Centres Workshop, Warsaw, October 16-17, 2019).

> It was *mandatory* for *weeks 0860 – 1399* to apply elevation dependent phase centre correction values adopted by IGS (Ref.: Minutes of EUREF Analysis Workshop, Brussels, April 10 - 11, 1997).

GLONASS Observations
It is *recommended since week 1400* to add GLONASS observations to the GPS data analysis
(Ref.: Conclusions of the EPN AC Workshop, March 15 - 16, 2006, Padua, Italy).

Galileo Observations
It is *recommended* since week 2044 to add Galileo observations to the GPS (and GLONASS) data analysis
(Ref.: Decision of the EUREF Governing Board and EPN Coordination Group, 2019).

Observation Cut-Off Angle
It is *recommended since week 1765* to set the elevation cut-off angle to 3° (Ref. Discussion within ACs during 8th EPN AC Workshop, Brussels, May, 2013).

> It was *recommended for weeks 1550-1764* to use the lowest cut off angle that is reasonable w.r.t. the applied troposphere mapping function and for which absolute antenna phase centre variation corrections are available (Ref.: Discussion within EPN Coordination Group in November 2009).
>
> It was *mandatory* for *weeks 1130 – 1549* to set the elevation cut-off angle to 10°, provided an elevation-dependent weighting of observations is performed as well (Ref.: Minutes of 3rd EUREF AC Workshop, Warsaw, May 31- June1, 2001).
>
> It was *recommended for weeks 0860 – 1129* to set the elevation cut-off angle to 15° (Ref.: Minutes of EUREF Analysis Workshop, Brussels, April 10 - 11, 1997).

Observation Weighting
It is *mandatory since week 1130* to apply elevation dependent weighting to the observations (Ref.: Minutes of 3rd EUREF AC Workshop, Warsaw, May 31 – June 1, 2001).

Observation Sampling Rate
It is *recommended since week 0860* to use an observation sampling rate of 180 sec for the final parameter estimation (Ref.: Minutes of EUREF Analysis Workshop, Brussels, April 10 - 11, 1997).

Satellite Orbits
It is *recommended since week 1765* to use orbits and clocks consistent with the analysis options and software used by the AC. Alternatively the combined IGS products may be used. (Ref.: Discussion within ACs during 8th EPN AC Workshop, Brussels, May, 2013). It *is mandatory since week 1765* to exclude defective satellites. For ACs processing Galileo observations, it is *mandatory* since week 2082 (December 1, 2019) to use CODE rapid orbits for final analysis (Ref.: Minutes of EPN Analysis Centres Workshop, Warsaw, October 16-17, 2019).

It was *recommended* for weeks 2044 (March 10, 2019) to 2081 (November 30, 2019) to use CODE MGEX (Multi-GNSS Experiment) orbits for final analysis if Galileo observations were processed.

It was *mandatory for weeks 1130* to 1764 to use IGS final orbits in EPN analysis (Ref.: Minutes of 3rd EUREF AC Workshop, Warsaw, May 31- June1, 2001).

It was *mandatory for weeks 0860 to 1129* to use IGS or CODE orbits in EPN analysis (Ref.: Minutes of EUREF Analysis Workshop, Brussels, April 10 - 11, 1997).

Orbits and Earth Orientation Parameter Consistency
It is *mandatory since week 0860* to use consistent products (Ref.: Minutes of EUREF Analysis Workshop, Brussels, April 10 - 11, 1997).

Tidal Displacements
It is *mandatory since week 1130* to apply ocean tide loading corrections for the stations (Ref.: Minutes of 3rd EUREF AC Workshop, Warsaw, May 31 – June 1, 2001).

Tidal Displacements Model
It is *mandatory since week 1400* to use FES2004 model for tidal displacement (Ref.: Conclusions of the EPN AC Workshop, March 15 - 16, 2006, Padua, Italy).

Atmospheric Tidal loading corrections
It is *recommended since week 1765* to apply atmospheric tidal loading corrections (Ref. Discussion within ACs during 8th EPN AC Workshop, Brussels, May, 2013).

A priori troposphere
It is *mandatory since week 1980* to use a priori ZHD from the Vienna Mapping Functions (VMF1) model.

It was *mandatory for weeks 1765 – 1979* to use a priori ZHD either from VMF1 model or, alternatively, computed on the basis of GPT or GPT2 global pressure models.

Troposphere Mapping Function
It is *mandatory since week 1980* to use the VMF1 (Ref.: Minutes of EPN AC Workshop, Brussels, October 25-26, 2017).

It was *mandatory for weeks 1765 – 1979* to use the Global Mapping Function or the VMF1 (Ref. Discussion within ACs during 8th EPN AC Workshop, Brussels, May, 2013).

It was *mandatory for weeks 1130-1764* to use the Niell Mapping Function (Ref.: Minutes of 3rd EUREF AC Workshop, Warsaw, May 31 – June 1, 2001).

Number of Troposphere Parameters
It is *mandatory since week 1765* to estimate hourly troposphere parameters for each station (Ref. Discussion within ACs during 8th EPN AC Workshop, Brussels, May, 2013).

It was *recommended for weeks 1130 – 1764* to estimate hourly troposphere parameters for each station. (Ref.: Minutes of 3rd EUREF AC Workshop, Warsaw, May 31 – June 1, 2001).

It was *recommended for weeks 0860 – 1129* to estimate one troposphere parameter for every 2 hours for each station (Ref.: Minutes of EUREF Analysis Workshop, Brussels, April 10 - 11, 1997).

Troposphere Parameter Reference
It is *recommended since week 1130* to save the estimated troposphere parameters in the daily normal equation files. Generate a weekly coordinate solution. Re-generate the daily troposphere parameter solutions with the weekly coordinates fixed; so-called coordinate “re-substitution” (Ref.: Minutes of 3rd EUREF AC Workshop, Warsaw, May 31- June1, 2001).

Global Troposphere Parameters
It is *recommended since week 1130* to not introduce global troposphere parameter estimates (Ref.: E-Mail discussion within the EPN Coordination Group in February 2002).

A Priori Weight of Troposphere Parameters
It is *recommended since week 0860* to use 5 m a priori weight for the absolute and relative troposphere parameters (Ref.: Decision of EPN Coordination Group, 2000).

Tropospheric Gradient Parameters
It is *mandatory since week 1400* to estimate tropospheric gradient parameters (Ref.: Conclusions of the EPN AC Workshop, March 15 - 16, 2006, Padua, Italy). It is *recommended since week 1765* to use Chen-Herring model or an adequate model for the estimation of gradient tropospheric parameters. It is *mandatory since week 1980* to submit the estimated gradients in the "Troposphere SINEX" format.

> It was *recommended for weeks 1765 – 1979* to submit the estimated gradients in the "Troposphere SINEX" format.

Ionosphere Corrections
It is *mandatory since week 1765* to apply higher-order ionospheric corrections.