

GUIDELINES FOR EUREF DENSIFICATIONS



EUREF 2009 Symposium
Florence, Italy
May 27-30, 2009

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BACKGROUND

- ✖ EUREF symposium Warsaw 1994:
 - + The use of IGS Products for the Densification of Regional/Local Networks, Gurtner W.
 - + Computation in ITRFyy + datum definition by fix coord. of ITRFyy sites → ETRFyy (Memo)
- ✖ TWG 1995
 - + Deliverables for EUREF Campaigns, Van der Marel H.
 - + List of items to be delivered to TWG
- ✖ TWG 1997
 - + The use of the IGS/EUREF Permanent Network for EUREF Densification Campaigns, Gurtner W. et al
 - + Take advantage of EPN: combine campaign SINEX with EPN SINEX and datum definition by fixing coordinates of larger nr available ITRFyy sites in EPN

BACKGROUND

Datum definition needed update

- ✖ Fix, Constraints → Minimal constraints
 - + optimal datum definition together with preserving the original characteristics of the solution
- ✖ ITRF → EPN
 - + Previous guidelines mainly use ITRF sites as reference (fiducial) stations for datum definition
 - + Now: reliable (and up-to-date) coordinates for EPN stations in ITRFyy
 - + Use EPN for datum definition !



GNSS DATA AND DATA ANALYSIS



GNSS DATA



GNSS data from the densification sites in project

- + Equipment should comply with requirements for EPN stations, see “Guidelines for EPN Stations and Operational Centers”
- + Antenna/radome with absolute antenna calibrations
- + At least 3 days / 24 hours observations

STATIONS USED FOR DATUM DEFINITION

× Criteria

- + EPN class A stations (1 cm – 1mm/yr) - last EUREF realization: (EPN_A_ITRF2005.SSC, POS+VEL)
- + During the time frame of the densification project:
 - × Available
 - × In case equipment change, check if included in last EUREF realization
 - × Avoid stations with noisy time series or large periodic signals
- + Estimated coordinates agree with last EUREF realization better than 5 (eventually 10) mm for positions

× How many?

- + At least 5 reference stations around the densification area
- + All EPN stations in the densification area which fulfil the criteria

GNSS PROCESSING OPTIONS

- ✕ Conform with procedure used by EPN Analysis Centers
 - + IGS orbits and ERP
 - + Absolute antenna calibrations
 - + Guidelines for EPN Analysis Centres:
http://epncb.oma.be/organisation/guidelines/proc_opt.pdf
- ✕ Produce daily free network solutions



STACKING AND DATUM DEFINITION

VELOCITY ESTIMATION

- ✖ Stacking of daily free network solutions
→ positions (& velocities?)
- ✖ Densification sites - permanent tracking stations
→ possibility to have densification projects of long-duration
- ✖ If 3+ years → velocity estimation
- ✖ If 3- years:
 - + Velocity estimation if station coordinates in ETRS89 change due to intraplate deformations by more than 1 cm over project duration

COMBINATION WITH EPN SINEX

Take advantage of full EPN

- + Large geographical area
- + More potential reference stations

Depending on available processing capabilities:

combine free network solutions from densification project
with weekly SINEX solutions from EPN

Advantage:

extended European-wide combined network can be used
for datum definition → higher stability

Consistent GNSS analysis!



STACKING AND COMPUTATION OF ITRS COORDINATES



- ✖ Start from daily free network solutions
 - + Or weekly if densification project is combined with EPN
- ✖ Stack daily (weekly) free network solutions to estimate site coordinates in ITRFyy (positions, velocities)
- ✖ Tie network to ITRFyy using EPN reference stations fulfilling criteria
- ✖ Use minimal constraints

TRANSFORMATION TO ETRS89

- ✕ Convert estimated
 - + ITRFyy positions at t_{obs}
 - + ITRFyy positions and velocities

- ✕ to ETRS89 (Memo by Boucher and Altamimi)
 - + ETRF2000 for new projects
 - + ETRFyy of a previous national frame
 - ✕ Reduce jumps



VERIFICATION

- ✕ Ambiguity resolution
- ✕ Daily repeatability (in North, East, Up)

Compare with weekly summary files of the EPN LAC (at BKG).

- ✕ Agreement of estimated positions (and velocities) of the EPN reference stations with EPN_A_ITRF2005.SSC
- ✕ Variation of ETRS89 positions in time. If more than 1 cm, then site velocities should have been estimated.
- ✕ Compare estimated ETRS89 coordinates with the coordinates obtained from previous EUREF densification campaigns.



VALIDATION BY TWG AND DELIVERABLES



VALIDATION BY TWG AND DELIVERABLES



- ✕ Announce to TWG chair one month prior to TWG
- ✕ Submit written report 2 weeks prior to TWG
- ✕ Present results at TWG

REPORT TO EUREF TWG

✖ Description of the densification project

- + List of densification stations (full names, 4-char ID, domes numbers, map), Observation period (permanent, campaign type)
- + GNSS equipment (IGS standard names for receiver and antenna/radome), Monument description

✖ Description of other data used in the processing

- + List of fiducial stations and list of verification performed to check their performance during the densification project
- + If used, list of EPN SINEX solutions
- + Orbits, ERP, Antenna calibration models

✖ Description of processing strategy

- + Software (and version), Schematic processing method, Elevation cut off, Positioning mode (double difference network mode, ...), Modeling of loading effects, Ambiguity resolution strategy, Modeling of troposphere (e.g. a priori model, mapping function, constraints, gradients, ...), Modeling of ionosphere (e.g. higher order corrections)
- + Alternative strategies for test purposes
- + Method for combining daily free network solutions in one densification solution, Parameters used in minimal constraints

✖ Results from the processing

- + Daily mean ambiguity resolution percentages
- + Comparison of the daily coordinates solutions (repeatability in North, East and Up). Outliers should be identified, explained and eliminated.
- + Comparison between estimated ITRFYYYY coordinates and latest EUREF densification of ITRS (indicate which one was used)
- + Transformation to the ETRS89 (including parameters used)
- + Comparison between new ETRS89 coordinates and ETRS89 coordinates from previous ETRS89 densifications



DELIVERABLES (CAMPAIGN DATA BASE)

- ✕ Site description forms
- ✕ Free network solution in the SINEX format
- ✕ Minimally constrained solution in the SINEX format
- ✕ List of positions for all stations in the network in the ITRFyy at epoch of observation
or
List of positions & velocities for all stations in the network in the ITRFyy (for densification projects requiring velocity estimation)
- ✕ List of positions for all stations in the network in the ETRS89 (indicate the frame used) at epoch of observation
or
List of positions & velocities for all stations in the network in the ETRS89 (indicate the frame used)
- ✕ List of fiducial sites
- ✕ ITRFyy coordinates and velocities used for the fiducial sites



PAPER PRINT AVAILABLE !

QUESTIONS?