

Development Process of EPN Analysis

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Statement

EPN Analysis is a *continuous effort*...

...of Local Analysis Centres (LACs) in European countries

...to realize an European Reference Frame in the most accurate manner

...and thus requires to question the applied methods and strategies all the time.





Outline

Status of Local Analysis Centres

- Status of sub-network combination
- Local Analysis Centre Workshop 2006 in Padua, Italy
- Planned changes in the EPN analysis
- ITRF 2005 Densification
- TIGA co-operation





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Status of Local Analysis Centres - Software Week 1369 (April 2006) -



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Status of sub-network combination

Indication of Precision

Precision between LACs

Day to Day Repeatability



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Note

- The formal error of the least squares adjustment is not suitable as indicator of the precision in GPS analysis, because correlations between observations are not correctly modelled.
- We may use residuals between sub-network solutions or day-to-day repeatability of the stations as alternative indicator for the achieved precision.





5th LAC Workshop

- Date and Venue: University of Padua, Italy, March 15 16, 2006
- 37 registered participants from 15 European Nations
- 15 LACs represented, 1 LAC not represented after short-term cancellation
- **5** Working Sessions:
 - Session 1: Reports from the EPN Coordination Group
 - Session 2: Local Analysis Centres reports
 - Session 3: Experiences with new processing strategies
 - Session 4: Site, receiver and antenna issues
 - Session 5: Wrap-up and closing session



"Inspiration" from Galileo's Chair



LAC Workshop Conclusions (1/7) - Absolute Phase Centre Variations -

- Absolute phase centre variations (APCV) will be introduced simultaneously with the IGS
- At the same time switch to ITRF2005

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- APCVs will be taken from IGS ANTEX file. For Bernese Software users:
 - Use converter programme to generate Bernese files from ANTEX, or
 - Use Bernese satellite/receiver files as provided by CODE
- EPN will preferable use APCV from robot calibrations of GEO++ company in Hannover, Germany for stations that are missing in IGS ANTEX file.
- Use "NONE" as ball-back for antenna without radome codes
- Perform a "preparation step" (relative PCV, but new format and radome codes), detailed instructions will be given by CODE



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Remark

New results of APCV have been presented at the IGS workshop in May 2006:

- Frequency dependent receiver PCV for GLONASS signals
- Update of IGS ANTEX file expected!





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LAC Workshop Conclusions (2/7) - Tropospheric Gradients -

- Estimation of tropospheric gradients simultaneously with the introduction of APCV
- Pre-elimination of gradients before submission of TROP SINEX files (not supported by format)





LAC Workshop Conclusions (3/7) - GLONASS -

- LACs are authorised to add GLONASS observations to their GPS analysis, provided the results are not degraded
- LACs recommend
 - to replace obsolete GPS equipment with GPS/GLONASS/GALILEO equipment and
 - propose to assess the recommendation with a EUREF symposium resolution





LAC Workshop Conclusions (4/7) - Re-Processing -

General agreement between LACs on EPN reprocessing of all observations since the beginning of the EPN

Action is postponed until re-processed final IGS orbits are available





LAC Workshop Conclusions (5/7) - Real-Time Strategies -

Discussion about strategies for real-time (RT) data analysis postponed until RT software becomes available



LAC Workshop Conclusions (6/7) - Near Real-Time Processing -

Objective:

- Near real-time (NRT) processing is useful for monitoring of station coordinates.
- Concept:
 - LACs already doing NRT processing submit hourly SINEX files to a "central place"
 - Coordinate check and alert generation at "central place"
- Actors and details to be determined
- LACs are asked to cooperate with NMAs and to contribute with dense national networks to meteorological applications (TOUGH/E-GVAP)





LAC Workshop Conclusions (7/7) - *Divers* -

- Switch from GOT002 to FES2004 ocean loading model simultaneously with APCV and ITRF2005
- Proposal for a "rapid EPN combination product".
 - Providing coordinates with significant reduced delay
 - Strict time table without waiting for missing LAC contributions
 - Details to be discussed in the near future



Planned Changes in the EPN Analysis

APCV, ITRF2005 and tropospheric gradients *simultaneously*

- IGS ANTEX file as reference for APCV, but
 - Completion for EPN sites required,
 - Book keeping of radome types, and if necessary individual series number (with time stamps ?)
 - Geo++ data base access
 - Legal restrictions
 - Disadvantages caused by updates
 - Update of GLONASS numbers expected
 - Open questions, e.g., maintenance of official EPN phase file?





Relative vs. Absolute PCV - BKG Sub-Network Week 1374 -

Analysis by Peter Franke



Note

- The BKG sub-network was analysed with relative and absolute PCV numbers. The so-called "preparation step" for relative PCV has been carried out before.
- Nearly 50 % of the stations experience height changes of larger than 5 mm
- It should be considered that minimum constraints have been applied to selected reference sites. This will restrict changes for the reference site coordinates.







Note

- The height changes evoked by the APCV have been ordered by antenna/dome types.
- For some types we observe common height changes, whereas other types shows several changes.
- The minimum constrained condition for the reference stations may affect this result.





Contribution of EPN to ITRF2005

- December 16, 2004: Call for "weekly" SINEX files for ITRF2004
- Combination of time series of station positions and EOPs from all techniques
- EPN contributes to GPS technique
 - with weekly SINEX files
 - IGS (NRCan) combines weekly solutions
 - only IGS stations of EPN will be included
- EUREF was asked to check the discontinuity table used by NRCan
 - Done by Ambrus Kenyeres on the part of Time Series SP
 - Check will performed by Heinz Habrich (EPN AC) too



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Densification of ITRF2005

- Initiative within IAG sub-commission 1.3 "Regional Reference Frames" in responsibility of Zuheir Altamimi
- Time-integrated solutions (positions and velocities) of 6 regional sub-commissions have been inquired
- EPN contributes to regional European network
 - computation of corresponding a multi-year solution





New EPN Multi-year Solution 2005 - Strategy -

- Conversion of all EPN weekly SINEX files into normal equations (NEQs) without option "reconstruction of original NEQ" (coordinate=observation).
- Inconsistency file from time series SP as a-priori information, but additional editing because of singularities in ADDNEQ2.
- Minimum constraint conditions (MCC) for datum definition (2 step approach to store SINEX file).
- Setup of stations velocities.
- Observations of weeks 860 (30 Jun 1996) 1355 (31 Dec 2005)





New EPN Multi-year Solution - Processing Statistics-

		MCC	Quasi Fixed
Dati	um Definition	Minimum Constraint for 21 sites	0.1 mm Constraint for all sites
۲ paramet	lumber of ers/observations	1596/151758	1596/151758
А-рс	osteriori RMS	3.42 mm	3.42 mm
Numl (+ solu	oer of stations ution numbers)	266	266
Proce A	ssing Time for DDNEQ2	30 min	3 h
Coordir	nate comparison	RMS = ().1 mm



Excluded EPN Solutions (14 weeks)

EUR08617.SNX	Internal station number MATE	
EUR8707.SNX, EUR8717.SNX, EUR8727.SNX	?	
EUR8737.SNX	Internal station number GRAS	
EUR8977.SNX	?	
EUR131 17.SNX, EUR13127.SNX, EUR131 47.SNX, EUR13157.SNX, EUR131 67.SNX, EUR13177.SNX, EUR131 87.SNX	No "solution epoch" in SINEX	
EUR13347.SNX	?	
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Helmert Transformation - Weekly Networks vs. Combined -



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The variation of the RMS for the Helmert transformation may lead to the assumption of a changing analysis accuracy. But it will be shown later that it depends on the reference station selection.







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Note

- The <u>following two plots</u> show the periods for which each reference station contributes to the datum definition of the multiyear solution.
- New "solution numbers" of a station become mandatory after a coordinate change with the consequence that ITRF2000 coordinates are no longer valid.
- The setup of new solution numbers for reference stations leads to a loss of reference sites over the years.
- The number of reference stations for each week is highly correlated to the RMS of weekly Helmert parameters as mentioned before.





Reference Sites Contribution



Number of Reference Sites in Weekly Networks

Estimated Station Velocity

Height

Note

Significant velocities for stations...

- ...not located on stable part of European plate
- ...new stations having just a little solutions
- ... other reasons??

Note

- Shown are the differences between estimated station velocities and the a-priori quantities. A-priori velocities are ITRF2000 solutions and alternatively results from the Nuvel model.
- Velocity corrections for height components are mostly identical to the absolute velocity estimation, because Nuvel 1A-NNR model applies only horizontal motions.

ITRF2005 Densification - Next Steps -

- Comparison of jumps and outliers with IGS (for IGS stations of EPN) and Time Series SP (for remaining EPN sites)
- Investigation of residuals for coordinates and velocities
- Check for Remaining outliers
- Investigation of the variation of weekly Helmert transformation parameters
- Apply additional reference coordinates/velocities from ITRF2005 as soon as available

TIGA Cooperation

- GFZ started recently working on a weekly combined solution of AUT, DGF, ETG, GFT, ULR and CTA contributions.
- Problems concerning correct station names and DOMES numbers have been identified.
- Combination for the period of 2002 has been performed for test purposes.
 - Slightly improvement in height component compared to single AC solution,
 - but large variation in scale parameter for regional solutions (AUT, DGF and ETG).
- Magnitude of scale variation for ETG complies with quantity of most recent EPN multi-year solution.

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Graphics of previous slight

- Upper left:
 - EPN sub-network that was submitted to TIGA for week 1368 (April 2006).
- Bottom left:
 - Scale parameter between individual TIGA AC and combined solution for year 2002.

Upper right:

Scale parameter between weekly and multi-year EPN solution

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- Bottom right:
 - Zoomed scale parameter for year 2002

For any suggestions and questions related to EPN analysis please contact

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