Some Reports from EPN Analysis

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Outline

- Report from Local Analysis Centre (LAC) Workshop 2006 in Padua, Italy
- Status of EPN multi-year solution for ITRF2005 densification
- Proposal for near real-time EPN monitoring from Poland

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

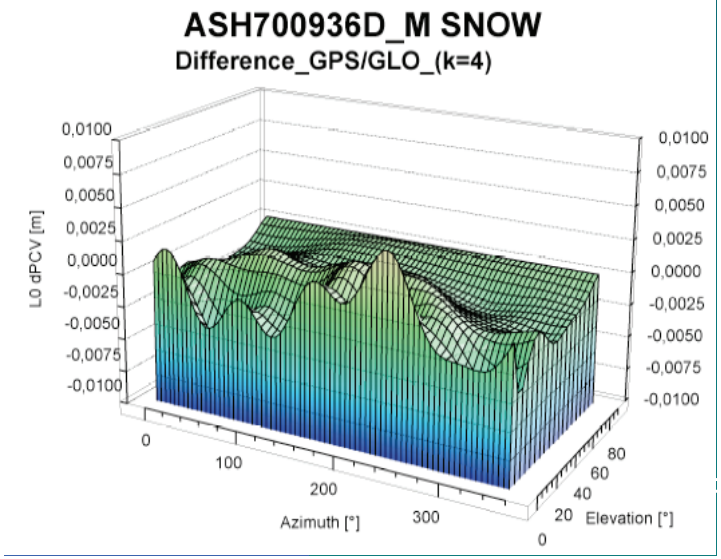
„Inspiration“ from Galileo‘s Chair

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
- 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

Remark

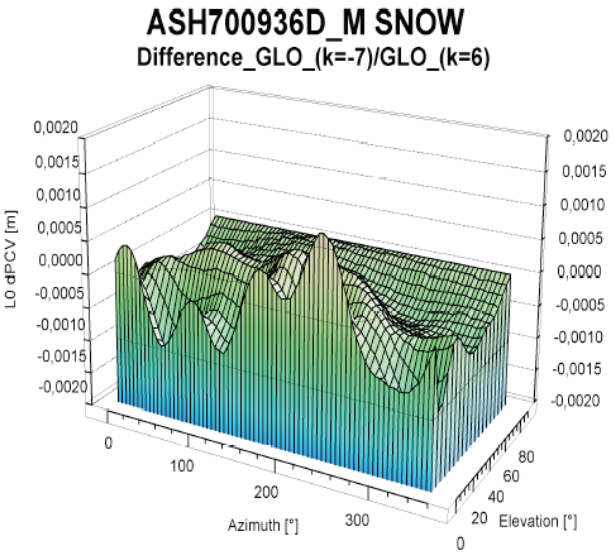
- New results of APCV have been presented at the IGS workshop in May 2006:
  - Frequency dependent receiver PCV for GLONASS signals
  - Update of IGS ANTEX file expected!



Presented by ***Geo++*** at IGS 2006 Workshop

◂ GPS – GLONASS

GLONASS-GLONASS ▸



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 re-processing 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 -

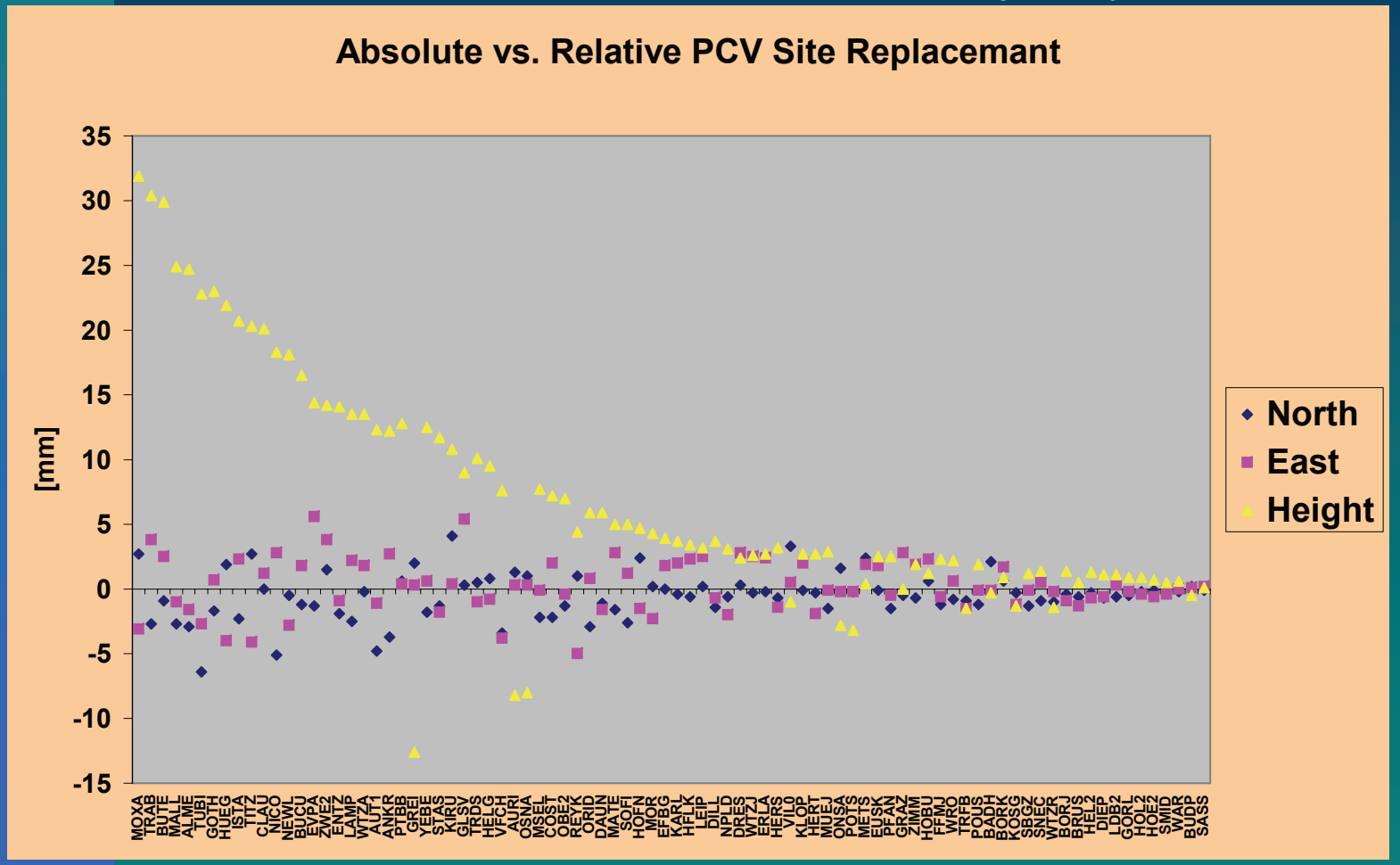
- Switch from GOT002 to FES2004 ocean loading model simultaneously with APCV and ITRF2005
- Proposal for a „rapid EPN combination product“.
  - Providing coordinates with significant reduced delay
  - Strict time table without waiting for missing LAC contributions
  - Details to be discussed in the near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

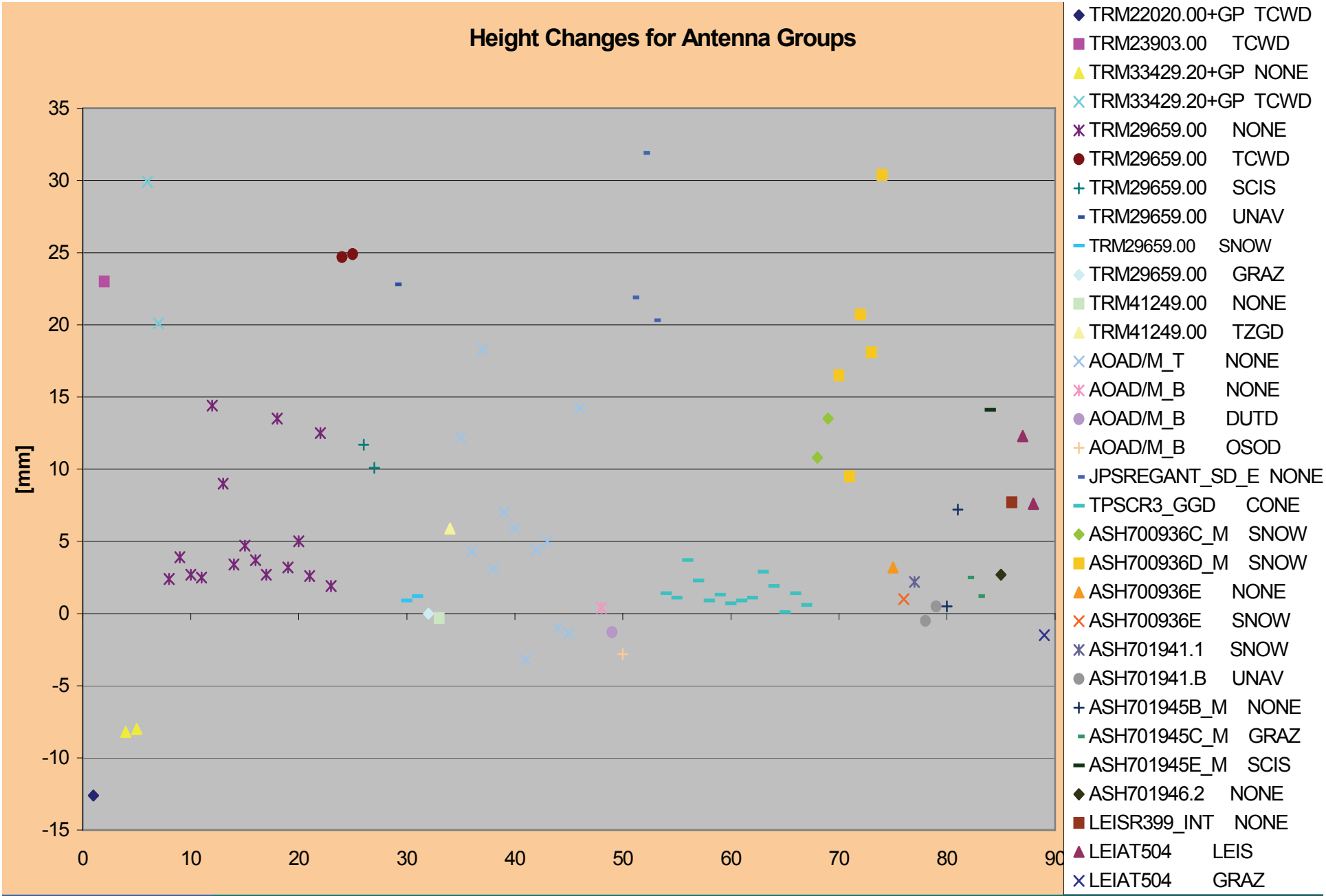
Relative vs. Absolute PCV
- BKG Sub-Network Week 1374 -

- 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.


Height Changes for Antenna Groups
[mm]
35
30
25
20
15
10
5
0
-5
-10
-15
0
10
20
30
40
50
60
70
80
90
TRM22020.00+GP TCWD
TRM23903.00 TCWD
TRM33429.20+GP NONE
TRM33429.20+GP TCWD
TRM29659.00 NONE
TRM29659.00 TCWD
TRM29659.00 SCIS
TRM29659.00 UNAV
TRM29659.00 SNOW
TRM29659.00 GRAZ
TRM41249.00 NONE
TRM41249.00 TZGD
AOAD/M_T NONE
AOAD/M_B NONE
AOAD/M_B DUTD
AOAD/M_B OSOD
JPSREGANT_SD_E NONE
TPSCR3_GGD CONE
ASH700936C_M SNOW
ASH700936D_M SNOW
ASH700936E NONE
ASH700936E SNOW
ASH701941.1 SNOW
ASH701941.B UNAV
ASH701945B_M NONE
ASH701945C_M GRAZ
ASH701945E_M SCIS
ASH701946.2 NONE
LEISR399_INT NONE
LEIAT504 LEIS
LEIAT504 GRAZ

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

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)

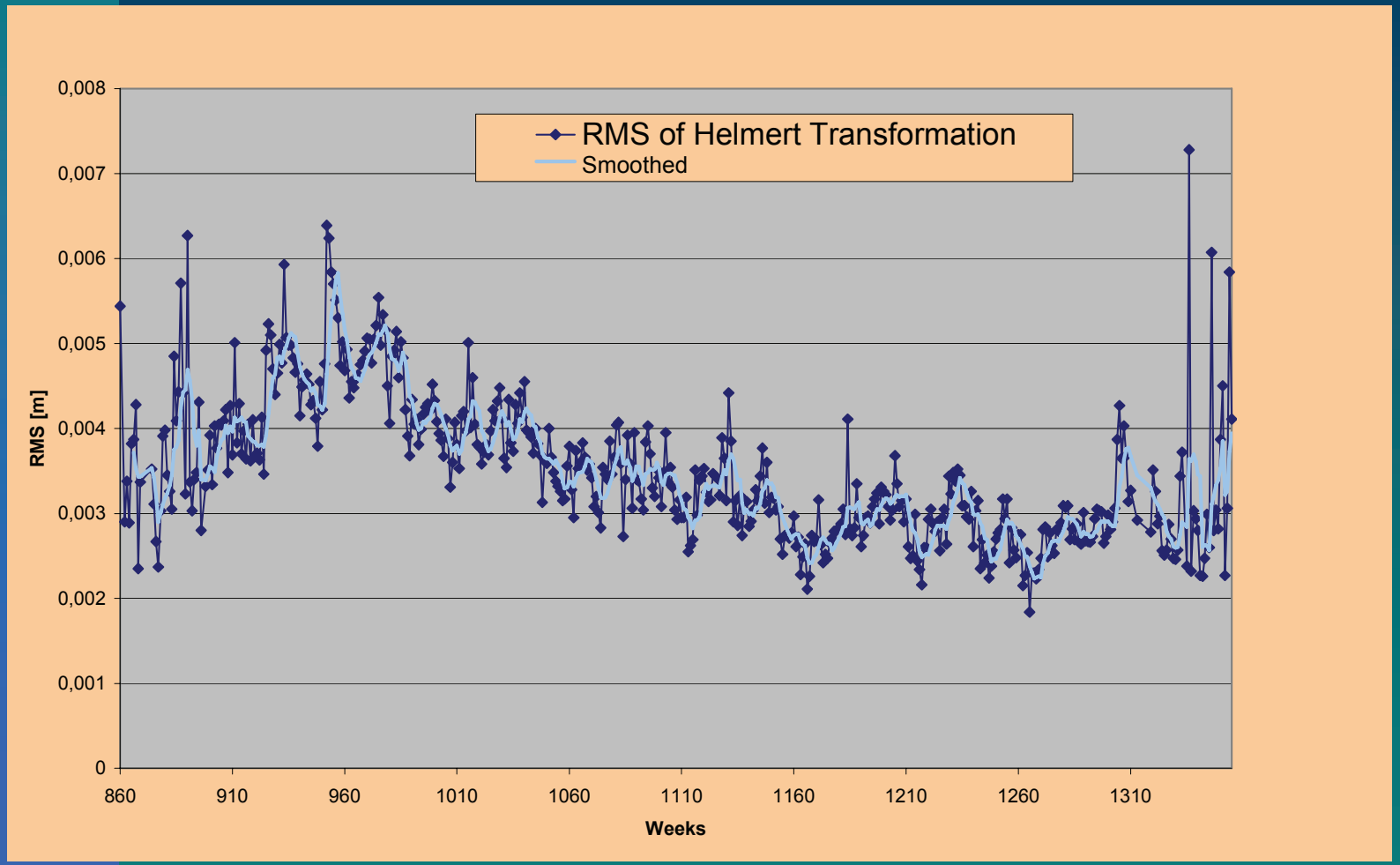
New EPN Multi-year Solution
- Processing Statistics-

	MCC ➡	Quasi Fixed
Datum Definition	**Minimum Constraint for 21 sites**	**0.1 mm Constraint for all sites**
Number of parameters/observations	1596/151758	1596/151758
A-posteriori RMS	3.42 mm	3.42 mm
Number of stations (+ solution numbers)	266	266
Processing Time for ADDNEQ2	30 min	3 h
Coordinate comparison	RMS = 0.1 mm	

Excluded EPN Solutions (14 weeks)

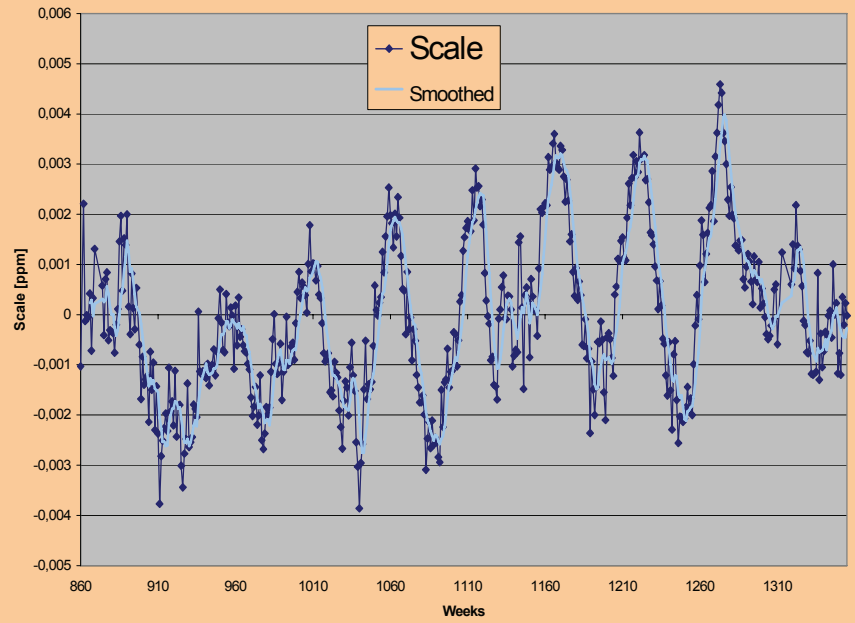
EUR08617.SNX	Internal station number MATE
EUR8707.SNX, EUR8717.SNX, EUR8727.SNX	?
EUR8737.SNX	Internal station number GRAS
EUR8977.SNX	?
EUR13117.SNX, EUR13127.SNX, EUR13147.SNX, EUR13157.SNX, EUR13167.SNX, EUR13177.SNX, EUR13187.SNX	No „solution epoch“ in SINEX
EUR13347.SNX	?

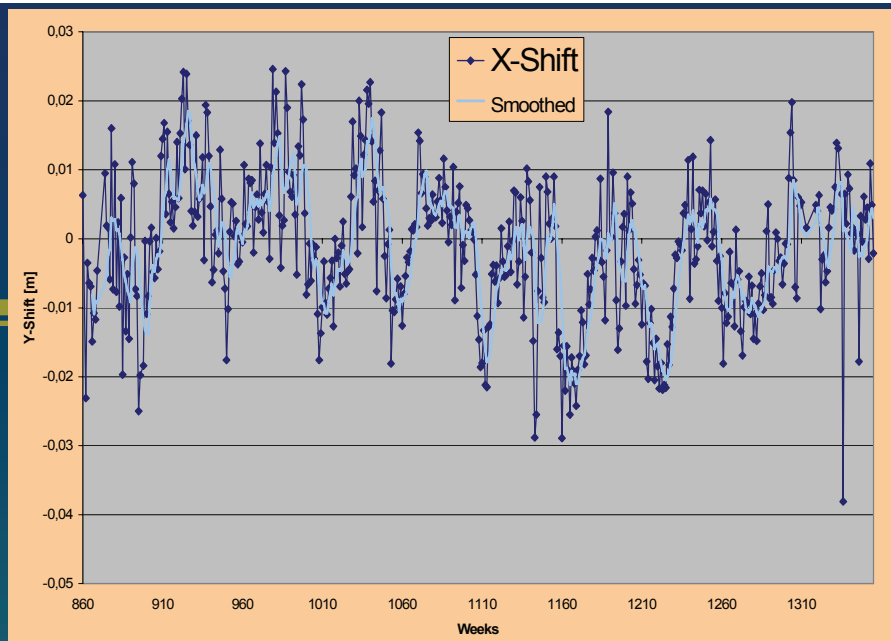
Helmert Transformation
- *Weekly Networks vs. Combined* -

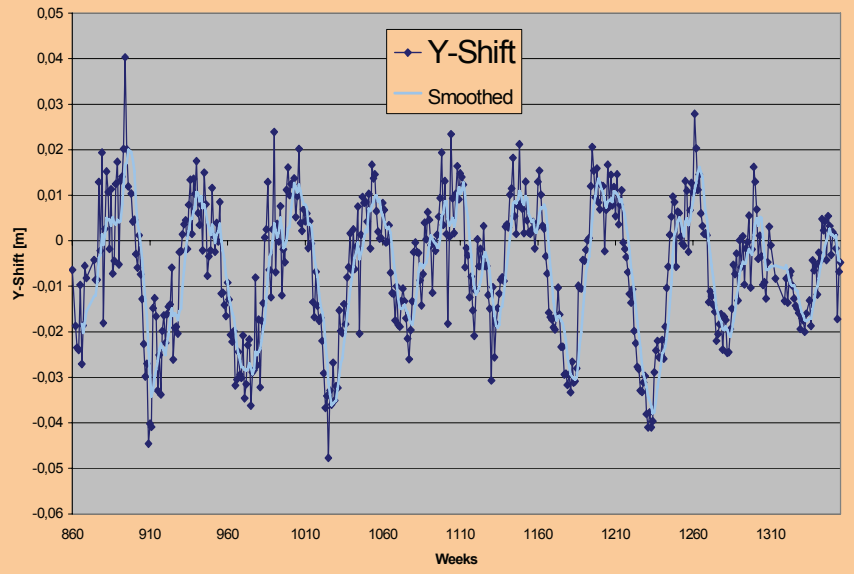


Note

- 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.


Scale
Smoothed
Scale [ppm]
0,006
0,005
0,004
0,003
0,002
0,001
0
-0,001
-0,002
-0,003
-0,004
-0,005
860
910
960
1010
1060
1110
1160
1210
1260
1310
Weeks


X-Shift
Smoothed
Y-Shift [m]
0,03
0,02
0,01
0
-0,01
-0,02
-0,03
-0,04
-0,05
860
910
960
1010
1060
1110
1160
1210
1260
1310
Weeks


Y-Shift
Smoothed
Y-Shift [m]
0,05
0,04
0,03
0,02
0,01
0
-0,01
-0,02
-0,03
-0,04
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-0,06
860
910
960
1010
1060
1110
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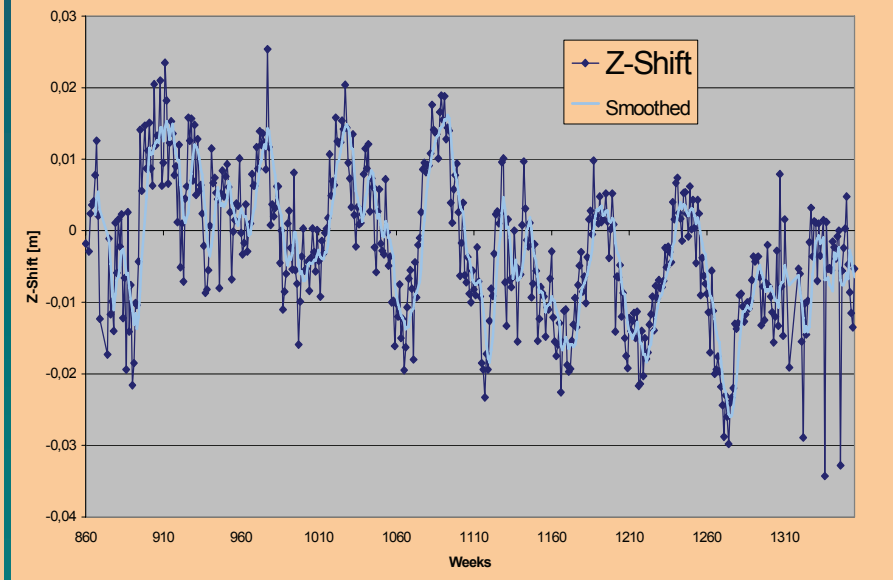
1210
1260
1310
Weeks


Z-Shift
Smoothed
Z-Shift [m]
0,03
0,02
0,01
0
-0,01
-0,02
-0,03
-0,04
860
910
960
1010
1060
1110
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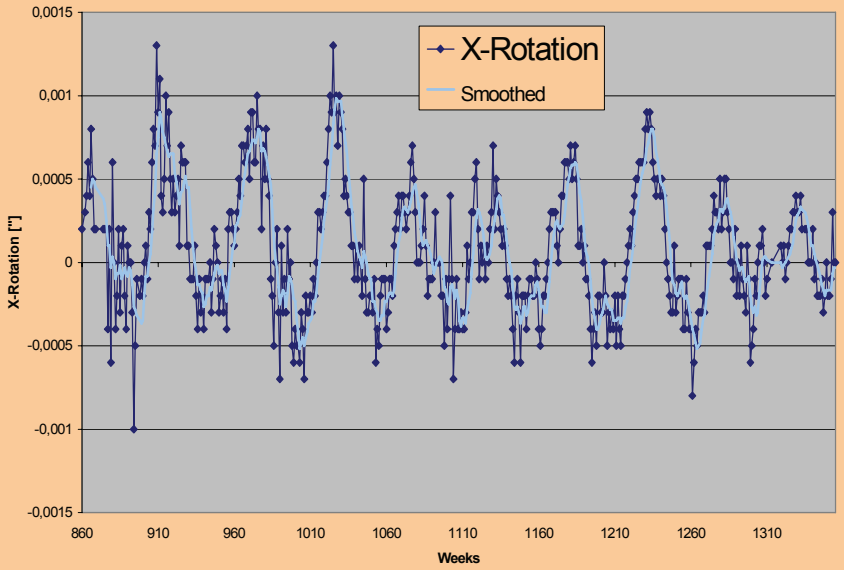
1210
1260
1310
Weeks


X-Rotation
Smoothed
X-Rotation ["]
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860
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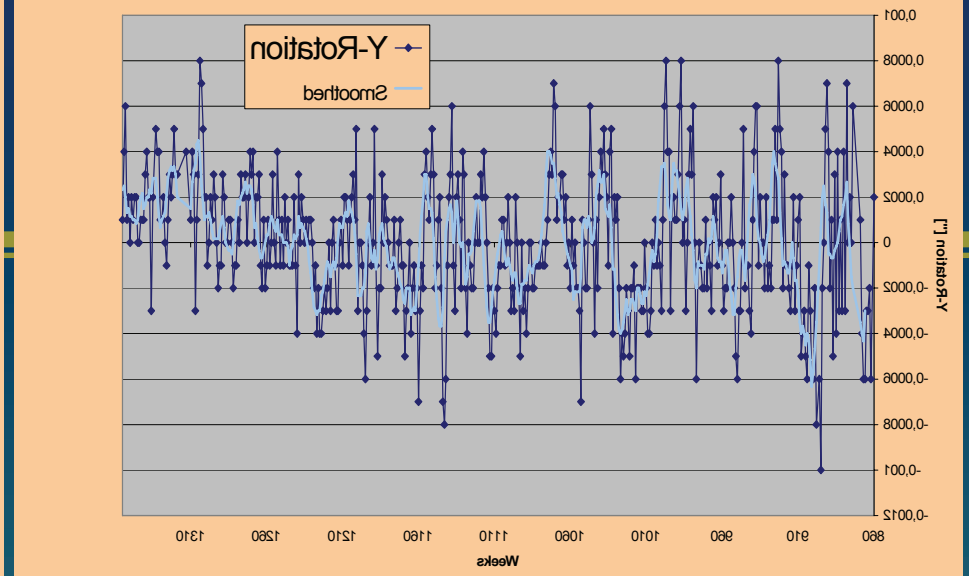
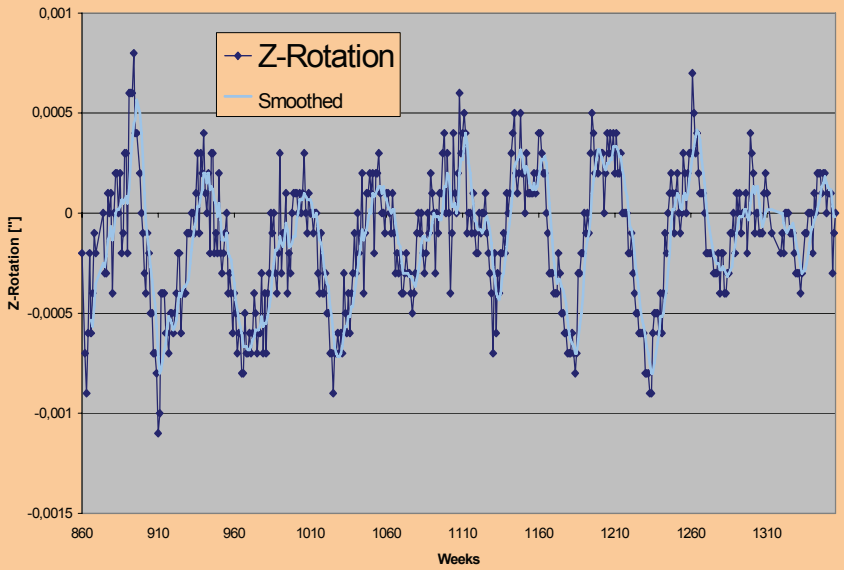
Weeks

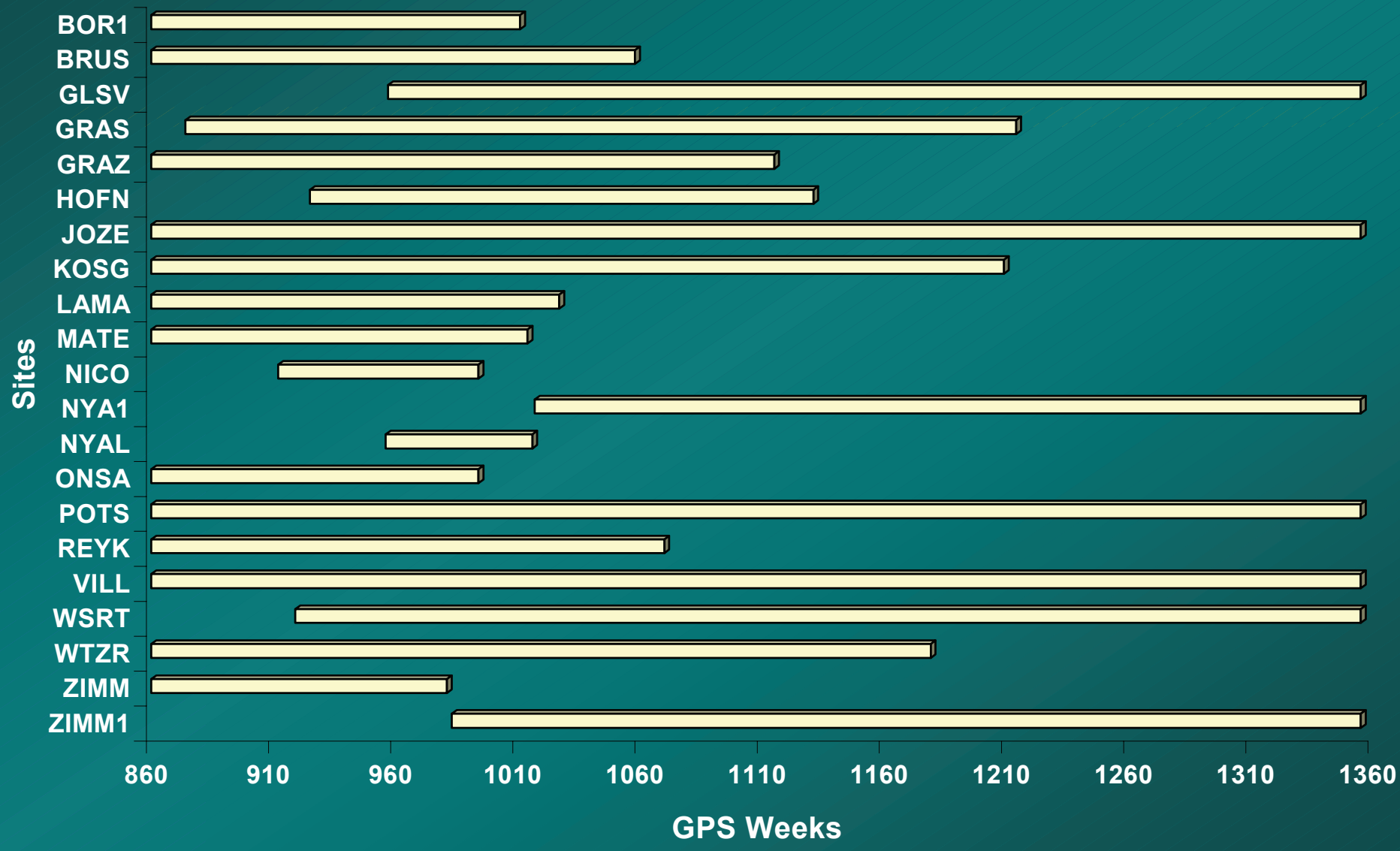

Y-Rotation
Smoothed
Weeks


Z-Rotation
Smoothed
Z-Rotation ["]
0,001
0,0005
0
-0,0005
-0,001
-0,0015
860
910
960
1010
1060
1110
1160
1210
1260
1310
Weeks

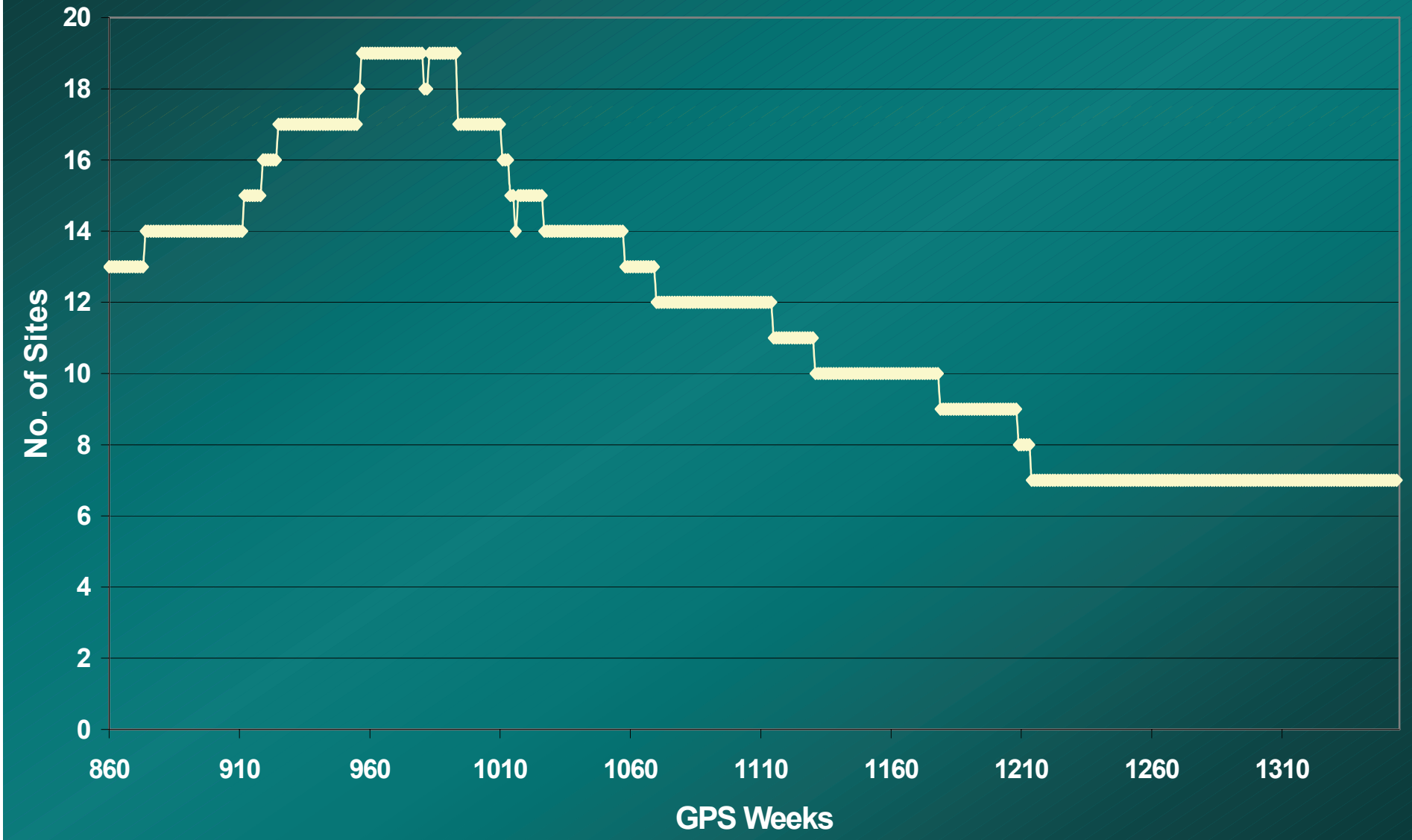
Note

- The following two plots 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.

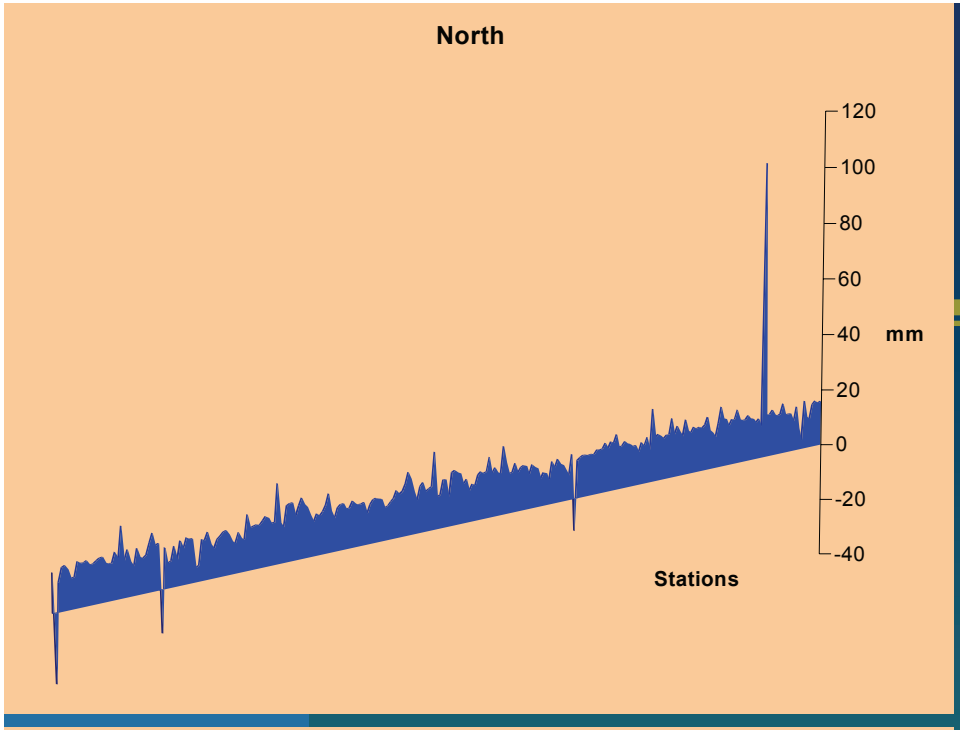
Reference Sites Contribution

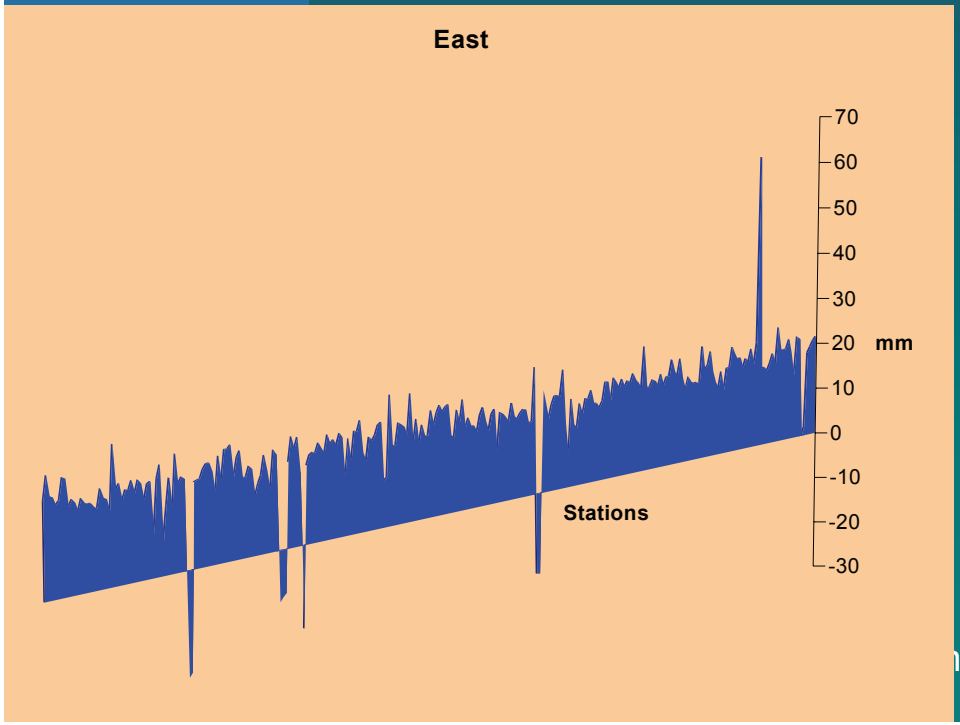


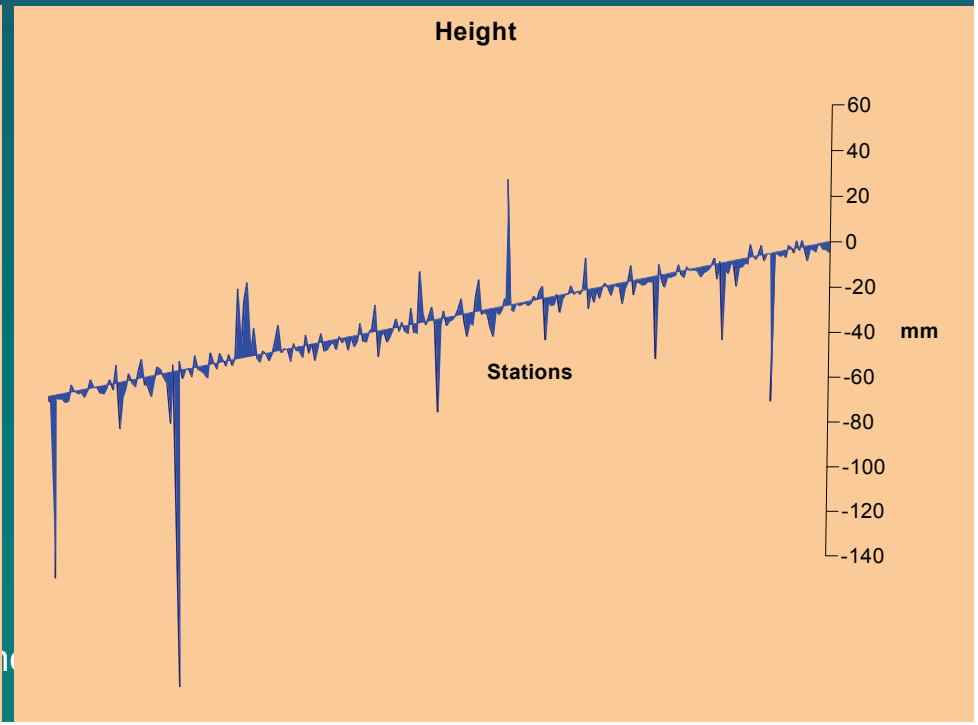
Number of Reference Sites in Weekly Networks



Estimated Station Velocity



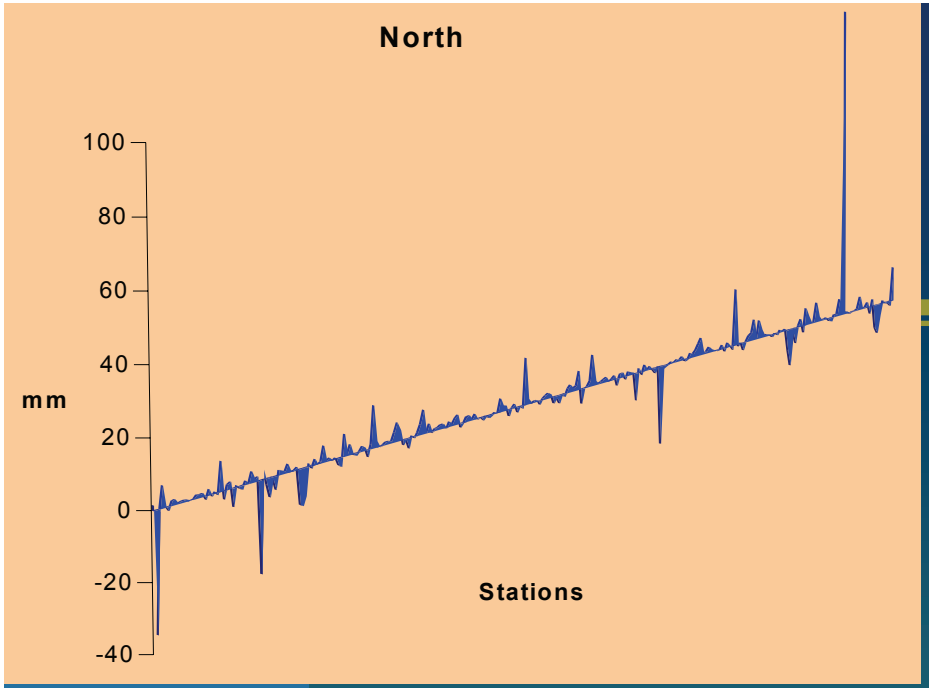


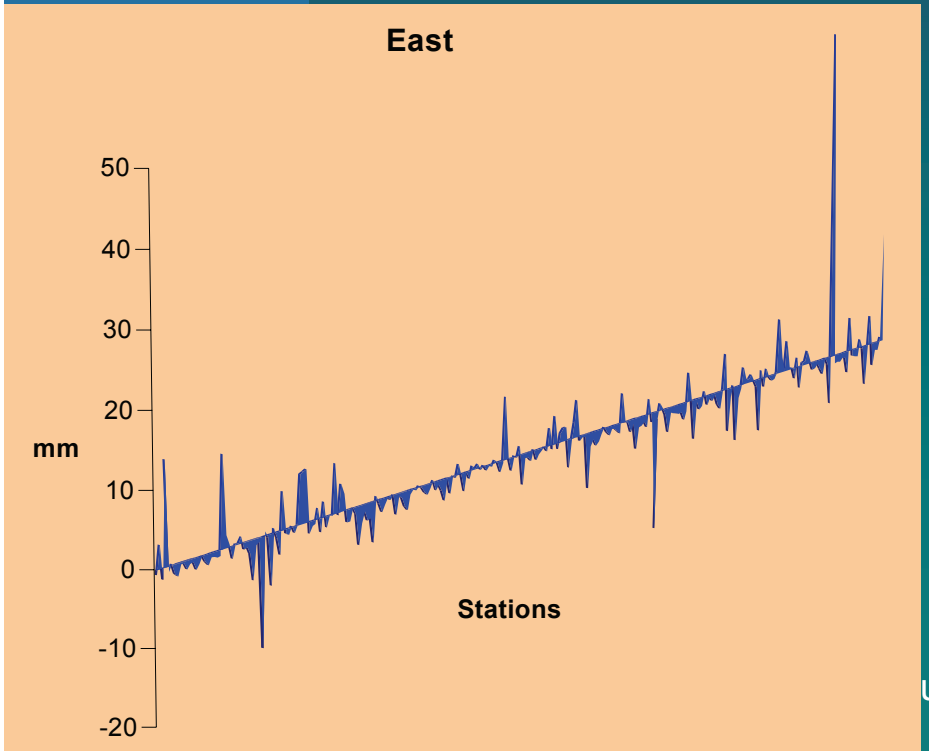


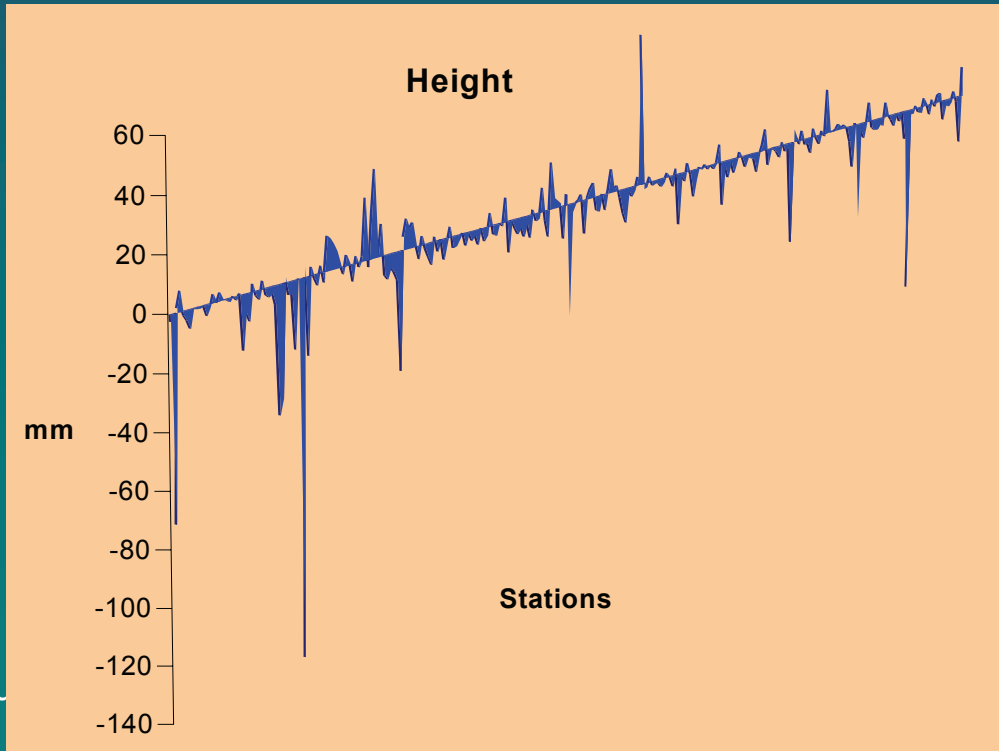
Note

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

Velocity Correction to a-priori







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

Proposal for EPN Near Real-Time Monitoring, *-Background -*

- One of the conclusions of the LAC Workshop 2006 in Padua is
  - to establish a near real-time (NRT) processing for monitoring the EPN station coordinates,
  - to cooperate with dense national GPS networks, e.g., from meteorological projects.
  - Details for realization have to be discussed.
- Kind offer from Warsaw University of Technology to run a „rapid EPN service“ at new (and fast) computer facilities of the Military University of Technology.

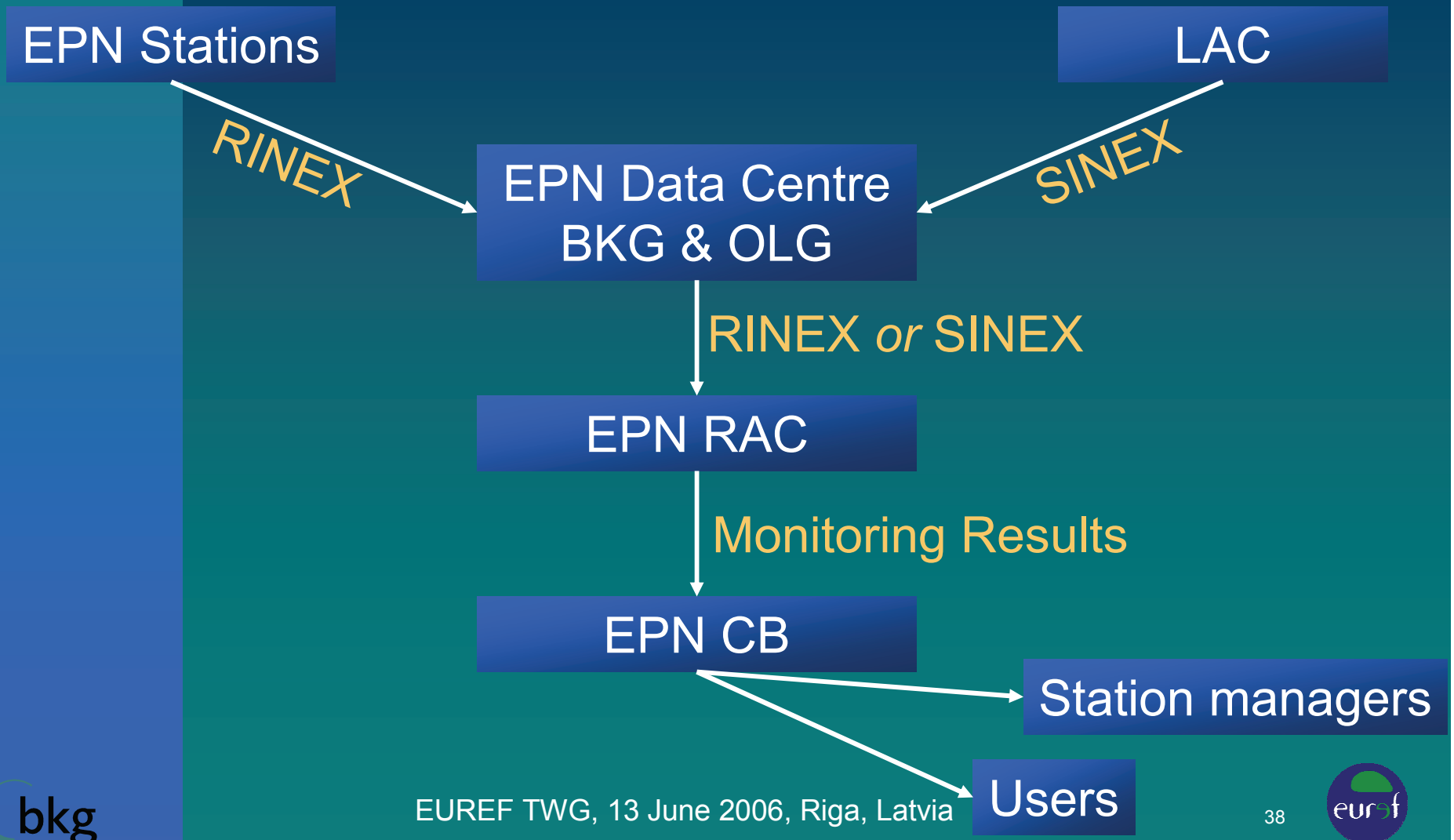
Details of Proposal

- Initial question: WUT plans to re-process EPN network
  - Daily solution of WUT network lasts 8 minutes on new computer.
  - WUT asked EPN-AC for co-operation, but EPN has already decided to postpone re-processing until new IGS orbits are available
- Suggestion to WUT for playing an active role in EPN monitoring
- Proposal for ***„Military University of Technology Rapid Analysis Centre (MUTRAC)“***
  - RINEX analysis ? Network design ?
  - Distribution of observations and products ?
  - Combination of NEQs at MUTRAC ?
  - Delay of products, 24 h or 1 h ?

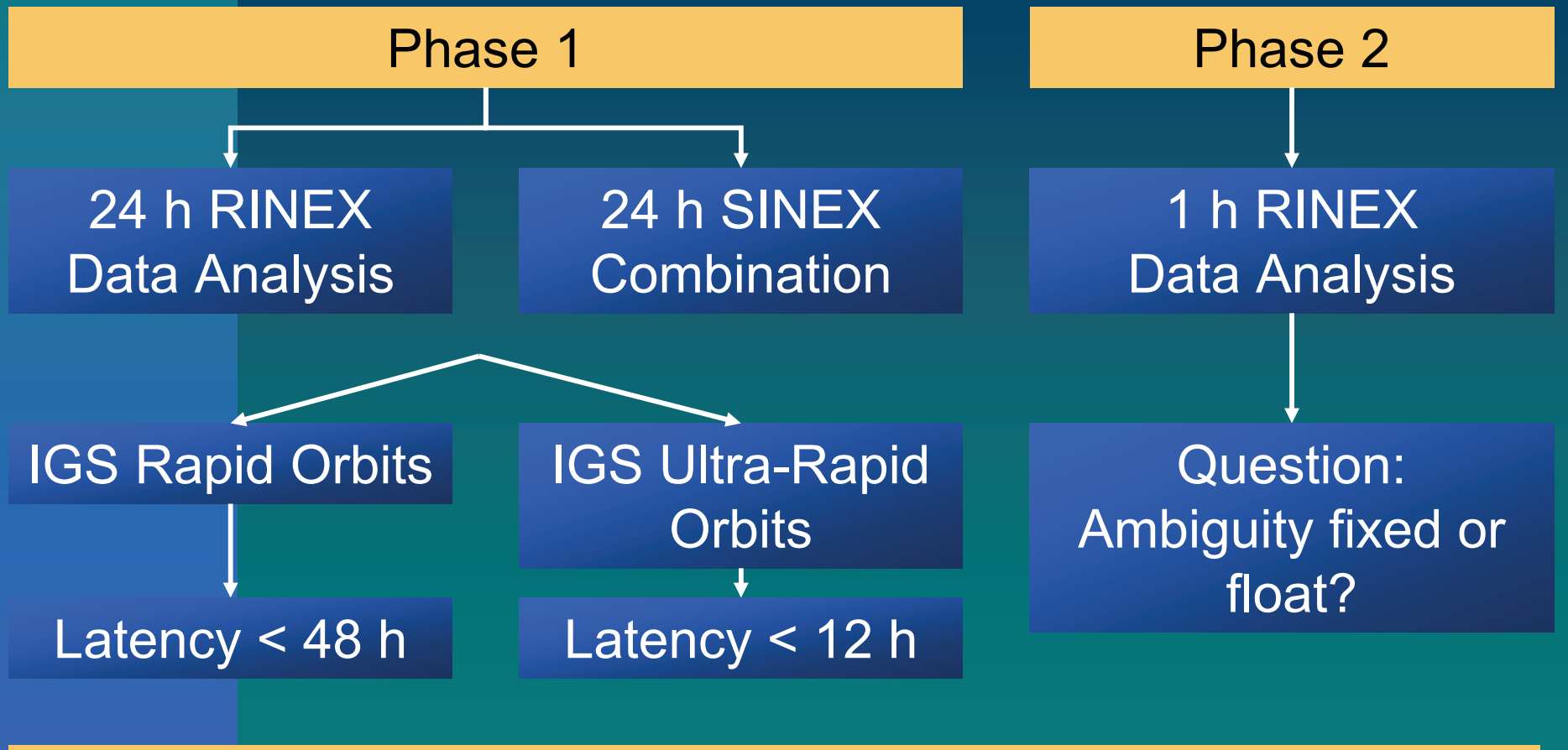
Some Ideas about EPN Monitoring...

- Goal: Providing status information of EPN stations to users and station managers
- 2 aspects may be considered:
  - Is the station operational and delivers suitable observations?
    - Process 1 hour (float) or 1 day observations with „standard processing scheme“
  - Is the station performance degrading?
    - Need for ambiguity resolution.Thus special analysis scheme for 1 hour observations (standard for daily) required.
- 2 basis concepts:
  - Hourly and/or daily SINEX combination as provided from LACs
    - Pro: Redundancy
  - Separate Rapid Analysis Centre starting from RINEX
    - „MUTRAC“ offer

EPN Monitoring Scheme (Option)



E-Mail from WUT, 6 June 2006



Products: SINEX (Coor.) and Troposphere SINEX

How could we proceed?

- Questionnaire to LACs:
  - Could they provide hourly and daily SINEX files?
  - What is the analysis strategy for hourly/daily products (ambiguity fixed/float, rapid/ultra-rapid orbits,..)?
- Ask WUT for writing a detailed proposal in close cooperation with EPN coordination group or the EPN-AC
  - What are the planned products?
  - Is an operation on long term basis possible?
- Decision about proposal at next TWG

Thank You