Bundesamt für
Kartographie und Geodäsie

EPN Analysis Update

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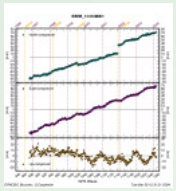
Introduction

- Report on the 4th EPN LAC Workshop, September 18-19 Graz, Austria

4th LAC Workshop

- Comparison of coordinate time series and datum



- Station inconsistency in DEO solution

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- ETRS89 coordinates of the EPN

- Other activities

Other Goodies

Venue and Participants

- Venue:
  - Space Research Institute, Department Satellite Geodesy Austrian Academy of Sciences
  - Local organizers: Peter Pesec and Günter Stangl

- Participants
  - 28 participants
  - 13 nations
  - 14 of the 16 local analysis centers represented
  - Non LAC institutions, e.g., Technical University of Civil Engineering, Bucharest, Romania and University of Federal Armed Forces, Munich, Germany

Workshop Objective

- Review of the last 2 years work by reports of all contributors
- Discussion about the participation in current and future projects
- Improvement of processing strategy and options
- Examination of current and future direction of the EPN (development of a roadmap for the next 2 years)

Workshop Schedule

- Session 1: LACs reports
- Session 2: EPN special projects reports
- Session 3: Processing strategies
- Session 4: Discussion

» All contributions are available at the EPN-CB (pdf-files)

» The topics of the discussions, each summary and the resulting recommendations are available at the EPN-CB

Datum definition

Motivation:

- Minimal constraint approach is less sensitive to errors of reference stations.

Recommendation 1:

- To fix the datum of the weekly EPN solutions, as well as the individual LAC solutions, the minimal constraint approach is better than the fixed-station approach. Using the present version of Bernese, it is not possible to apply this minimal constraint approach and to write the results into a SINEX file. This topic will be re-discussed when the next Bernese version will be released.

➢Action: Minimum constraint approach with Version 5 of Bernese GPS Software

Combination of daily SINEX files

Motivation:

- Contribution to study daily consistency of LACs and shorts periodic effects in the coordinate time series.

Recommendation 2:

- In order to evaluate the use of daily SINEX submission by the LACs, H. Habrich will invite the LACs to participate to a test campaign (~8 weeks).
- The final decision on the daily SINEX submission is delayed until the results of the test campaign are available and the datum definition of the sub-networks has improved.

➢Action: Test for daily SINEX combination.

ETRS time series

Motivation:

- Who is using the weekly ETRS89 solutions? Should we recommend a pre-transformation from ITRFxx to ITRF2000 before the transformation to ETRS89 to prevent the rotation in the ETRS89 which becomes visible since the usage of ITRF2000?

Recommendation 3:

- Discuss these topics at the next meeting of the EUREF Technical Working Group.

➢Action: The discussion is going on within the TWG

EUREF contribution to ECGN

Motivation:

- How can the EPN improve the height component to better support ECGN, TIGA and ESEAS?

Recommendation 4:

- Contact the IERS Special Bureau for the Atmosphere and inform them about EUREFs interest for the modeling of the atmospheric loading.
- Other methods to improve the height component can only be implemented when using the Bernese V5.0.

➢Action: Improvement of height component in EPN Analysis.

Receiver/satellite PCV

Motivation:

- Satellite antenna PCV parameters are now available.

Recommendation 5:

- Absolute receiver and satellite antenna PCVs will improve the EPN solutions. However, their implementation should be coordinated with the IGS and will therefore at least be postponed until the next IGS workshop in Berne, March 2004.

➢ Action: Coordinate receiver and satellite antenna PCV with IGS.

GLONASS observations

Motivation:

- GLONASS observations are now part of the IGS and EUREF data centers.
- Precise GLONASS orbits and analysis software are available.
- Study of GNSS combination prepares the usage of GALILEO.

Recommendation 6:

- H. Habrich will invite the LACs to participate to some test computations adding GLONASS data to their sub-network solution.

➢Action: GLONASS test analysis within the EPN.

Update of Analysis Options Table

- Should we allow solving for tropospheric gradients?

Recommendation 7.1:

- It is to soon now to know what to do. Better is to wait and gather experience with the new Bernese software version.

- Are there any alternatives to the weighting scheme that is presently used to create the EPN Combined Solution?

Recommendation 7.2:

- H. Habrich will look into how the IGS is doing the waiting and investigate whether it can be used for the EPN combination.

Update of Analysis Options Table

- Should we introduce satellite dependent weights, e.g., the accuracy codes as given in the IGS orbits?

Recommendation 7.3:

- Presently, the use of satellite dependent weights needs further testing and should be re-discussed in the future.

- Should we reprocess the EPN?

Recommendation 7.4:

- Although a complete reprocessing of the EPN would improve the overall consistency of the time series, it is recommended to wait for a final decision on the absolute PCVs and the new Bernese V5.0, which will include new processing options that will improve the overall quality of the computations.

Update of Analysis Options Table

- Should we use the radom-dependent receiver antenna calibration values that IGS issues into the EPN processing? (20 character code not fully supported by Bernese Version 4.2)

Recommendation 7.5:

- The EPN LACs that use software other than Bernese should test the radom-dependent calibration values and inform the Analysis Coordinator about this, so that he can test for inconsistencies between the different solutions.

Proposal for LAC in Bucharest:

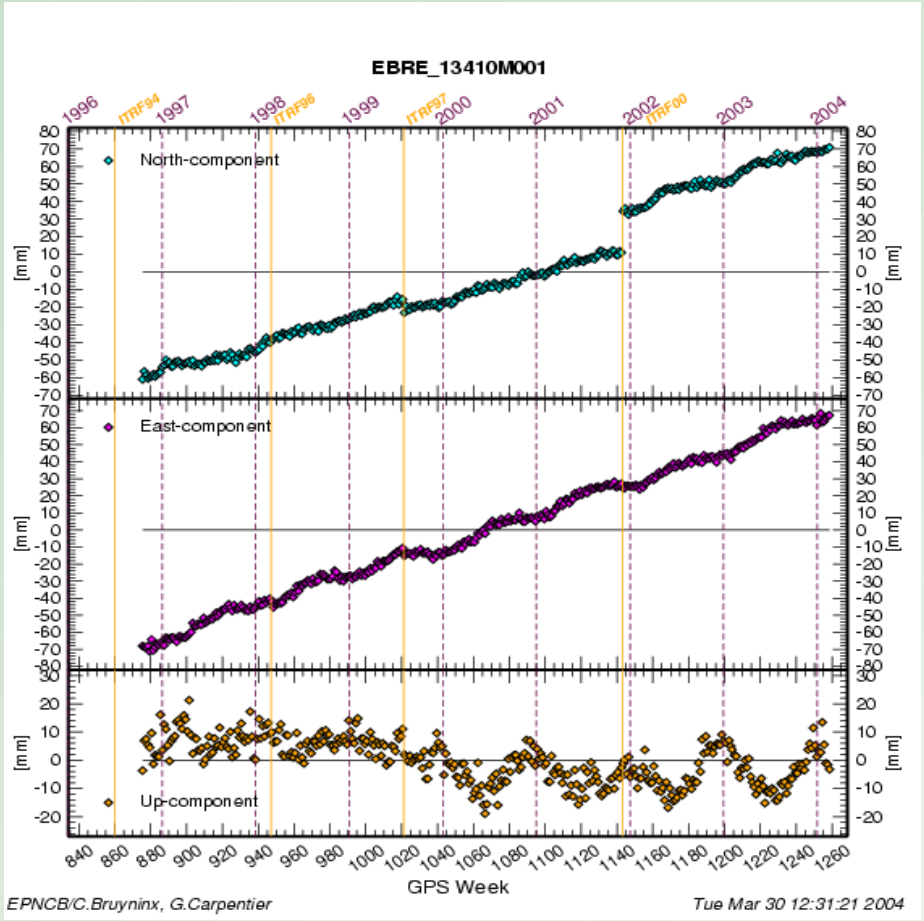
Recommendation 8:

- The proposal for a new LAC in Bucharest at FGB (Faculty of Geodesy Bucharest) was generally accepted. The plenum of the Workshop became convinced to favor the distribution of the EPN analysis to many European nations against the scientific aspect of a common solution. FGB will contact the EPN-CB if it is prepared to start with the analysis. After that, a sub-network will be designed.

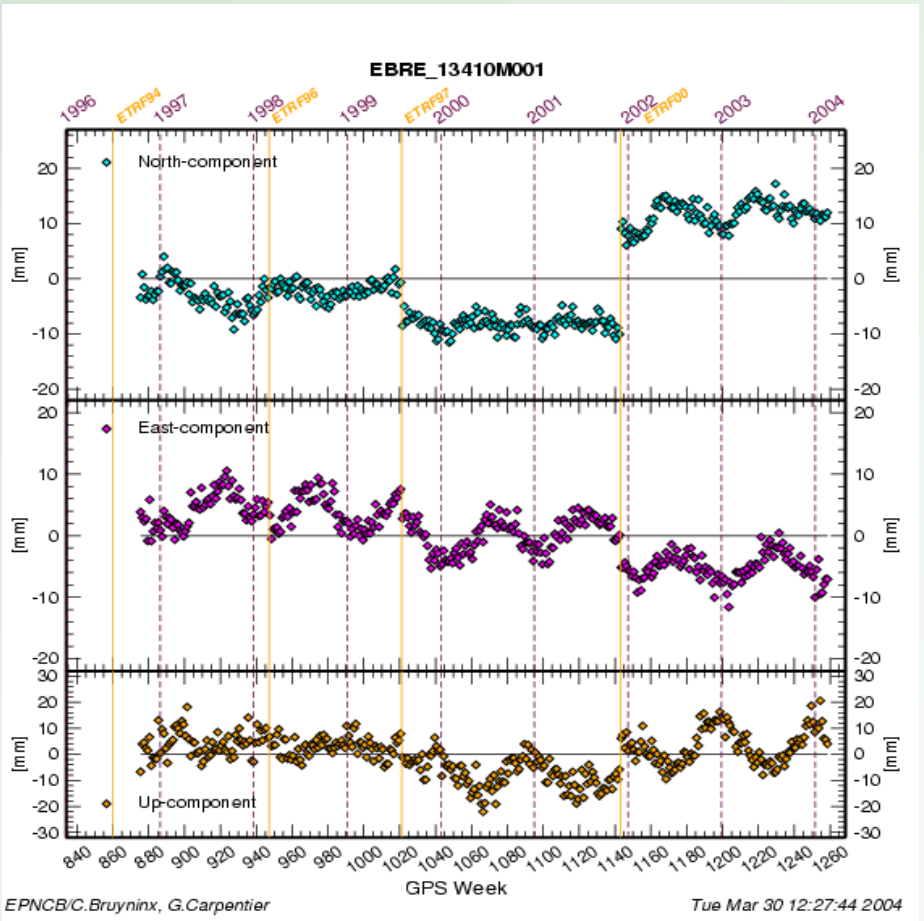
➢ Action: Proposal for new LAC accepted.

Comparison of Time Series

- ITRF

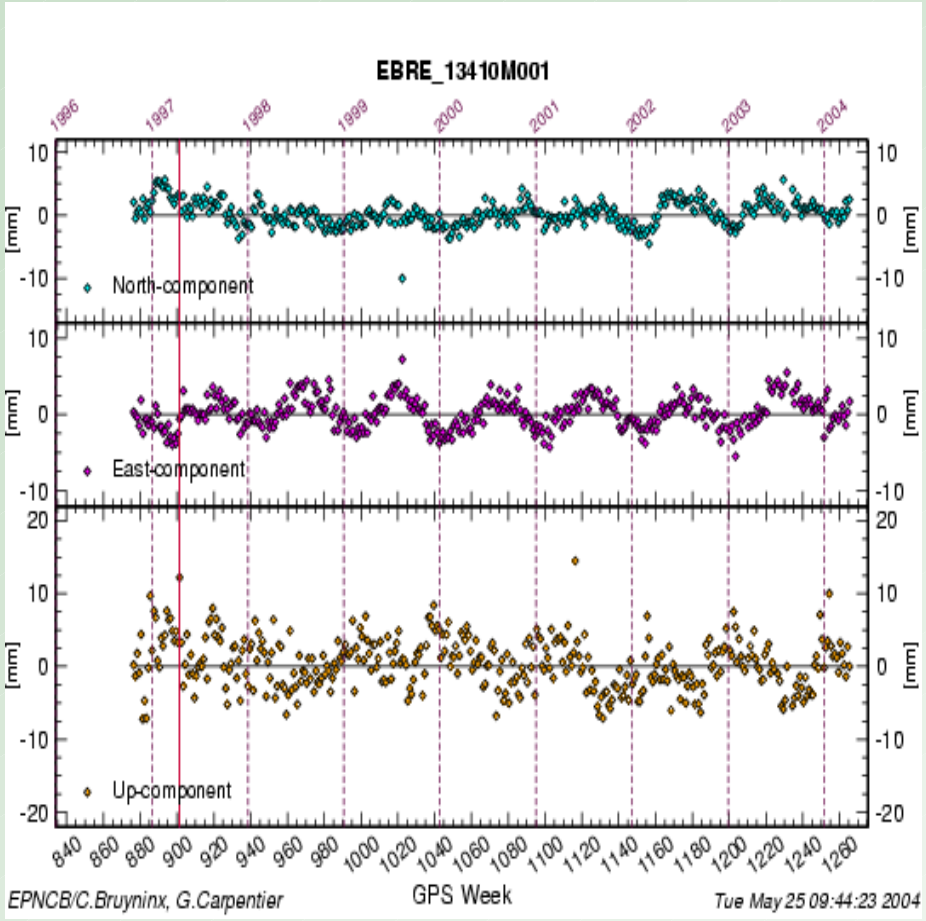


- ETRS89

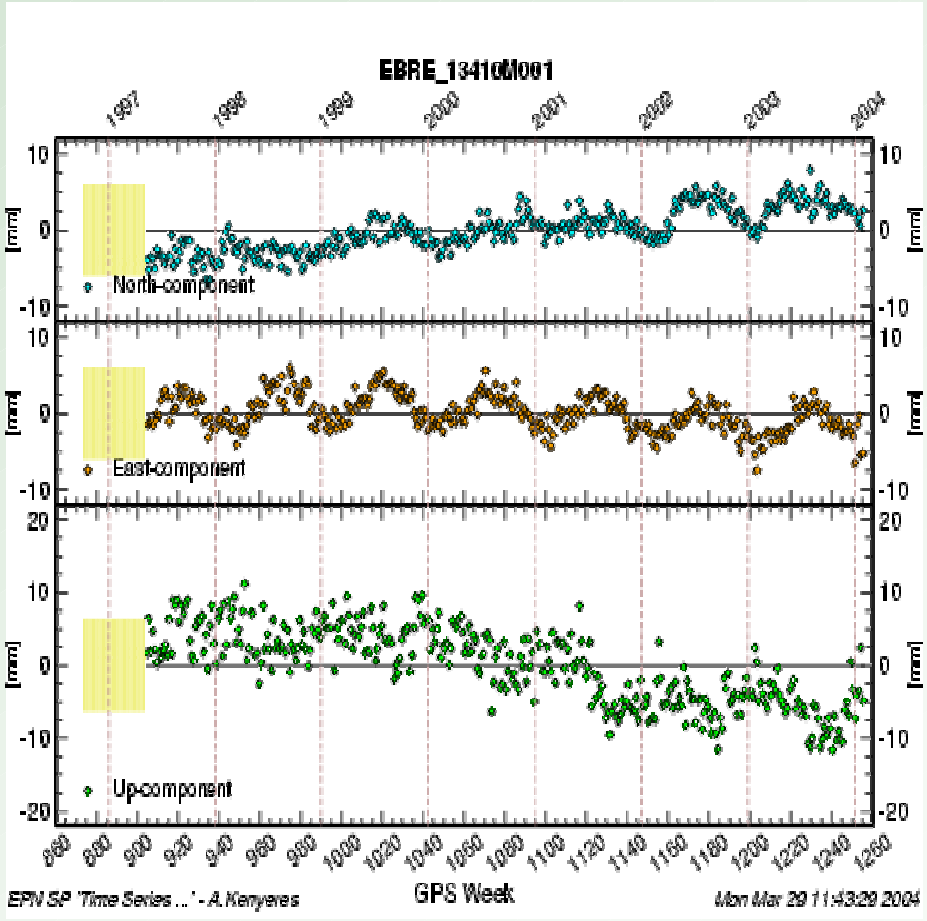


Comparison of Time Series

- Raw (former Standard)

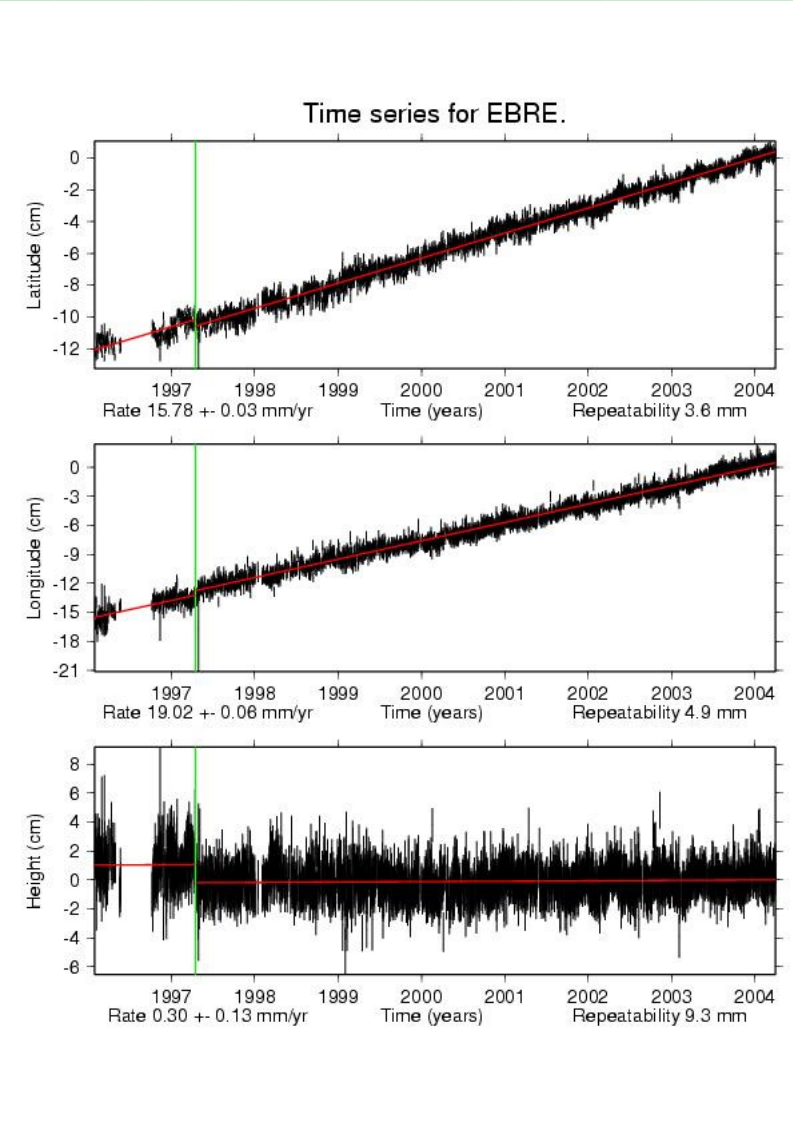


- Improved

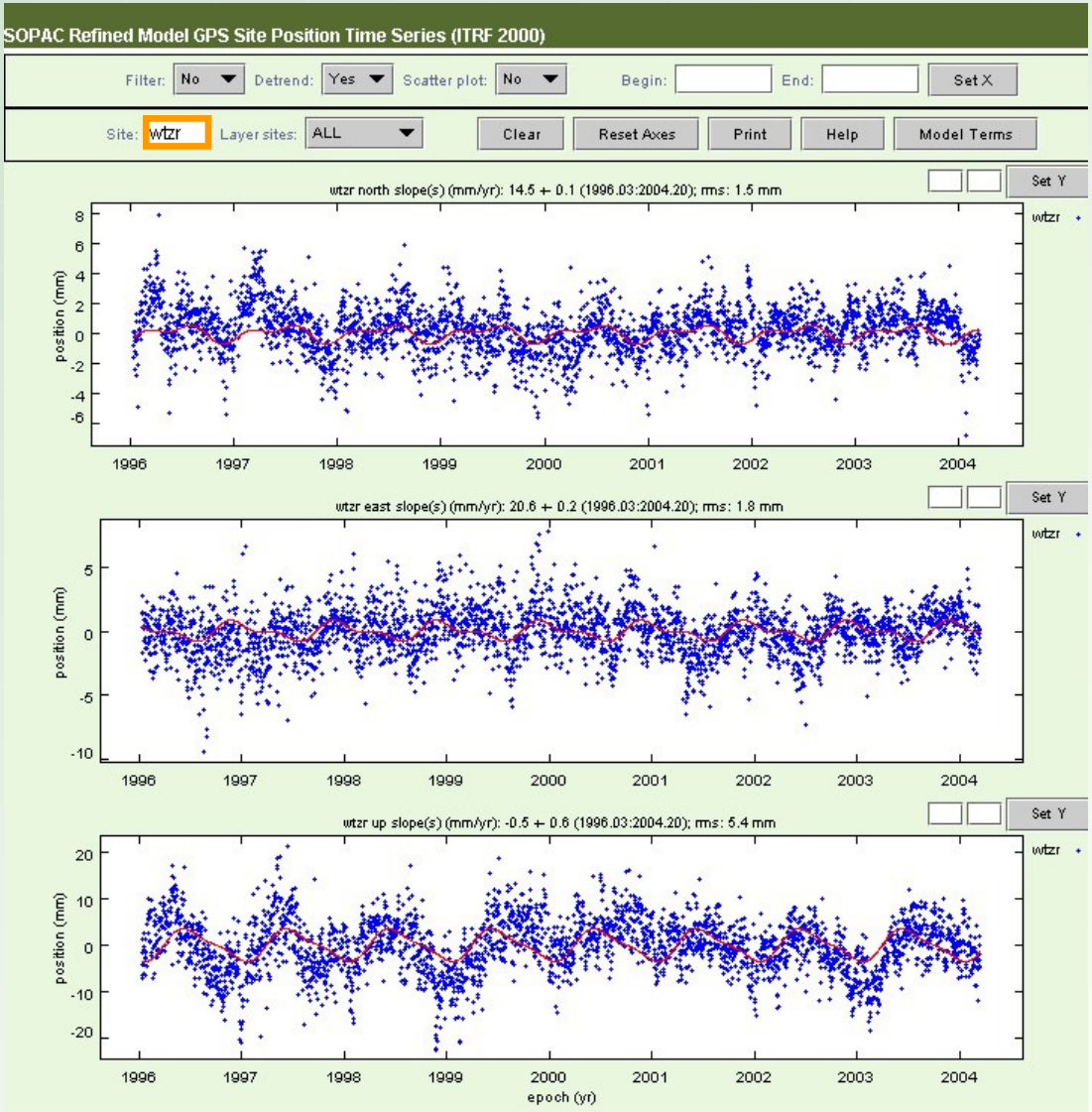


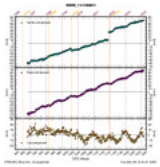
Comparison of Time Series

- JPL



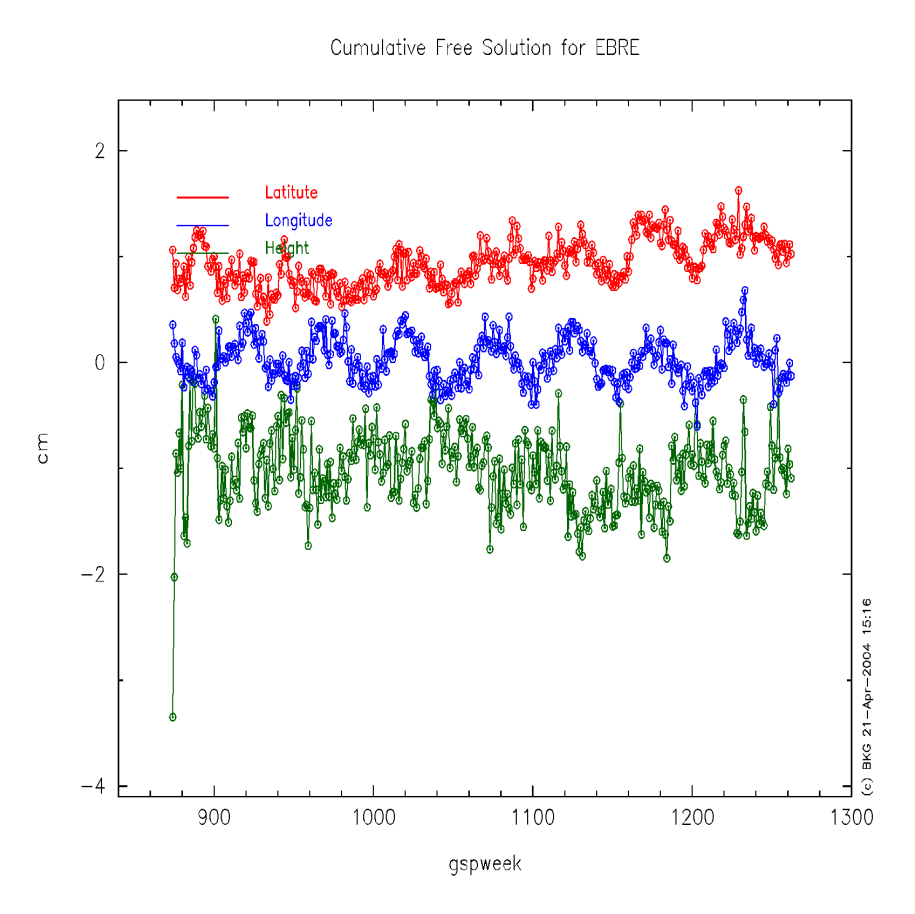
SOPAC

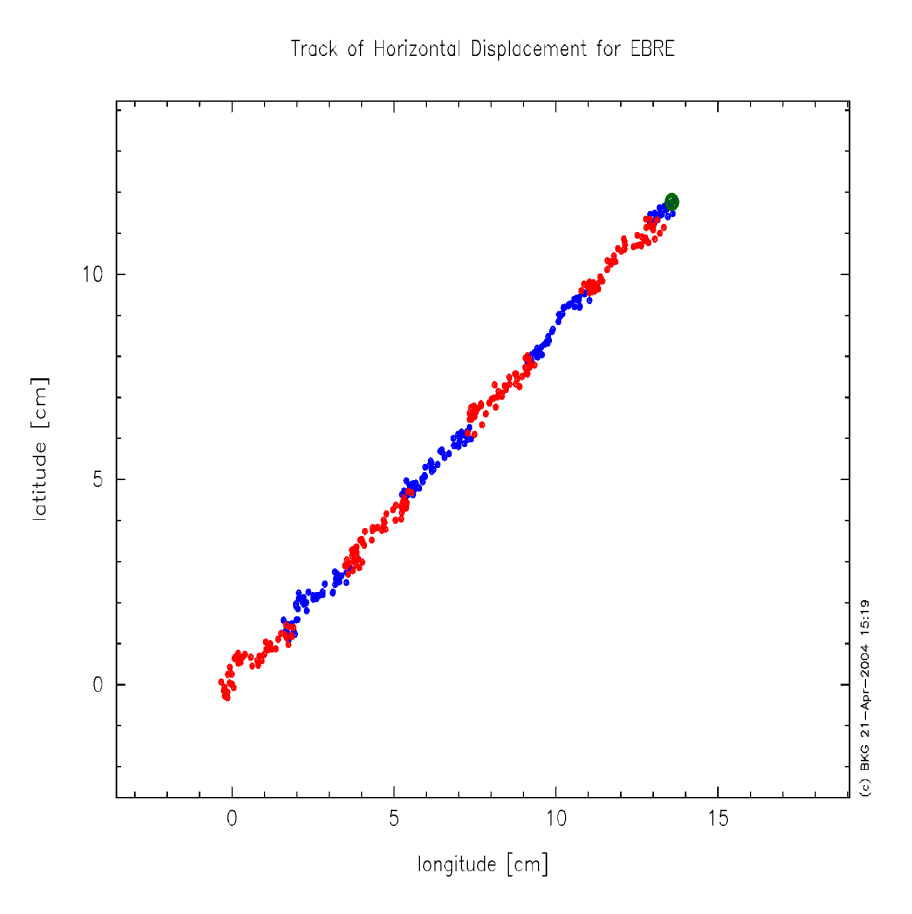


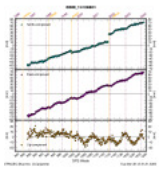


Comparison of Time Series

- BKG



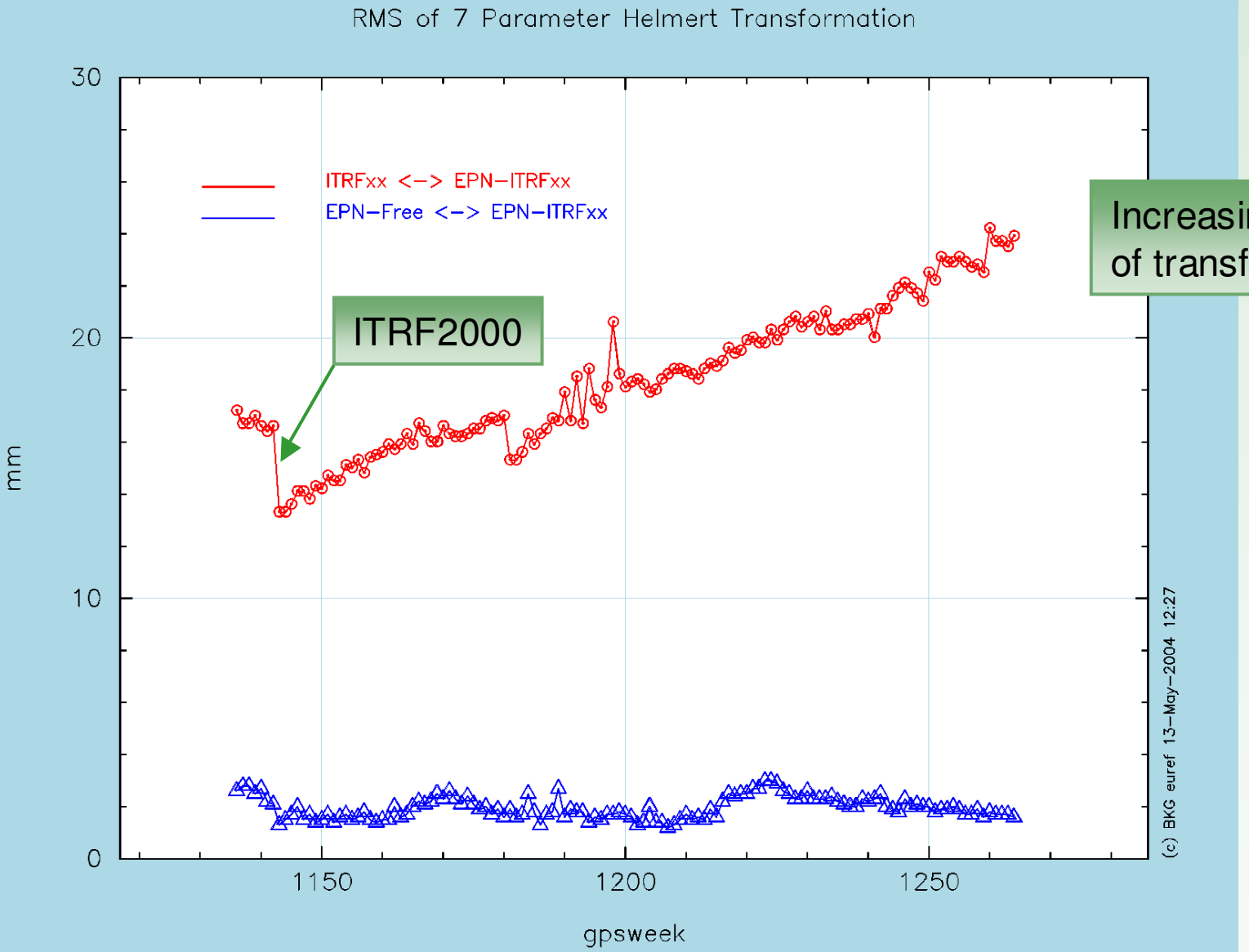




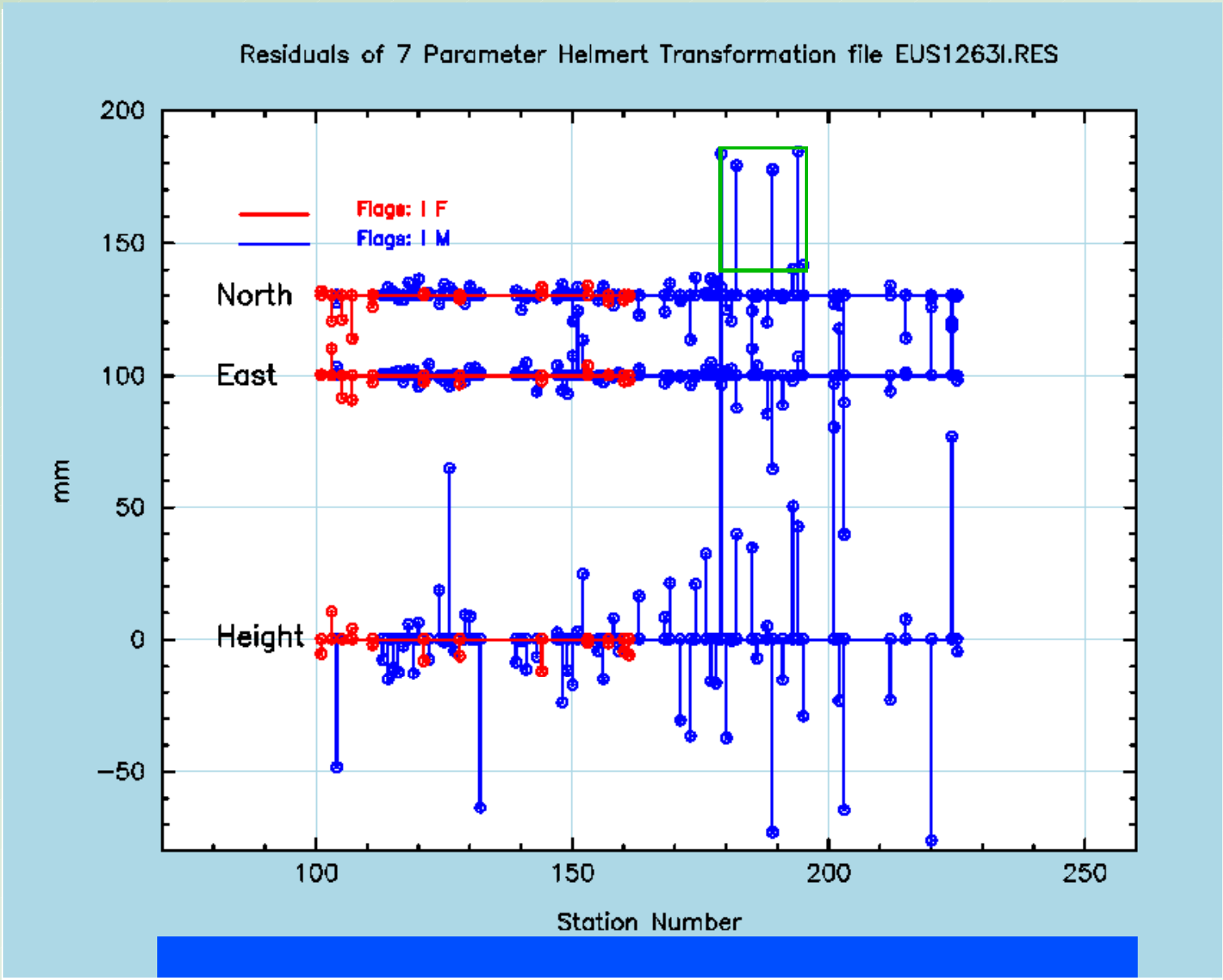
Summary and Tasks

- What could we conclude from the comparisons?
  - Various time series have to be interpreted differently, where the 4 EPN time series are well explained at the EPN-CB.
  - There exist jumps because of various ITRF realizations.
  - There are annual signals which are not yet explained and accounted for.
  - Some annual horizontal signals disappear in the lat/lon plot.
  - Note: There is per definition no annual signal for the reference stations.
- Tasks
  - The existence of annual periods in the time series of nearly all EPN stations put the question whether a linear model (ITRF) for the reference stations is sufficient.
  - The resulting inconsistency between reference and non-reference stations should be corrected (apply Loading?).

Datum

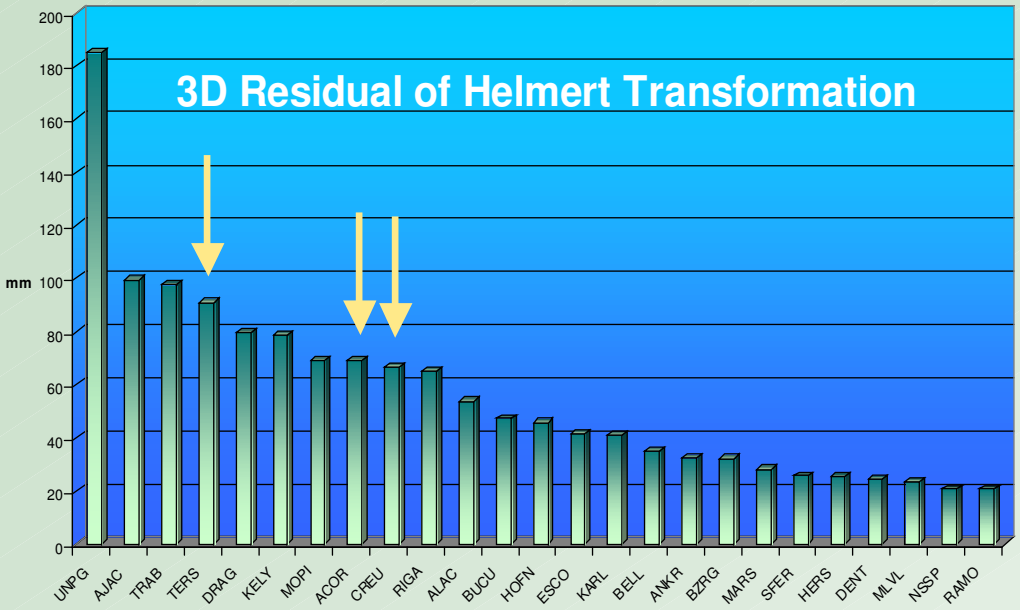

RMS of 7 Parameter Helmert Transformation
ITRFxx <-> EPN-ITRFxx
EPN-Free <-> EPN-ITRFxx
ITRF2000
Increasing RMS
of transformation
30
20
10
0
mm
1150
1200
1250
gpsweek
(c) BKG euref 13-May-2004 12:27

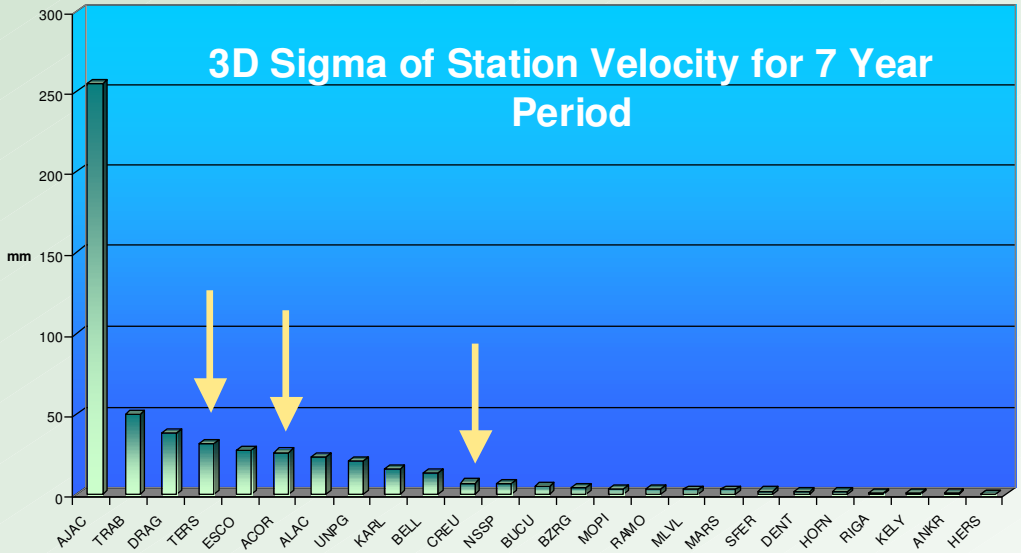
Datum



- ACOR
  (A Coruna)
- TERS
  (Terschelling)
- CREU
  (Cadaques)

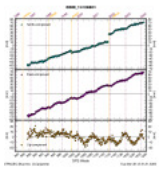
Correlation: Residual and Velocity





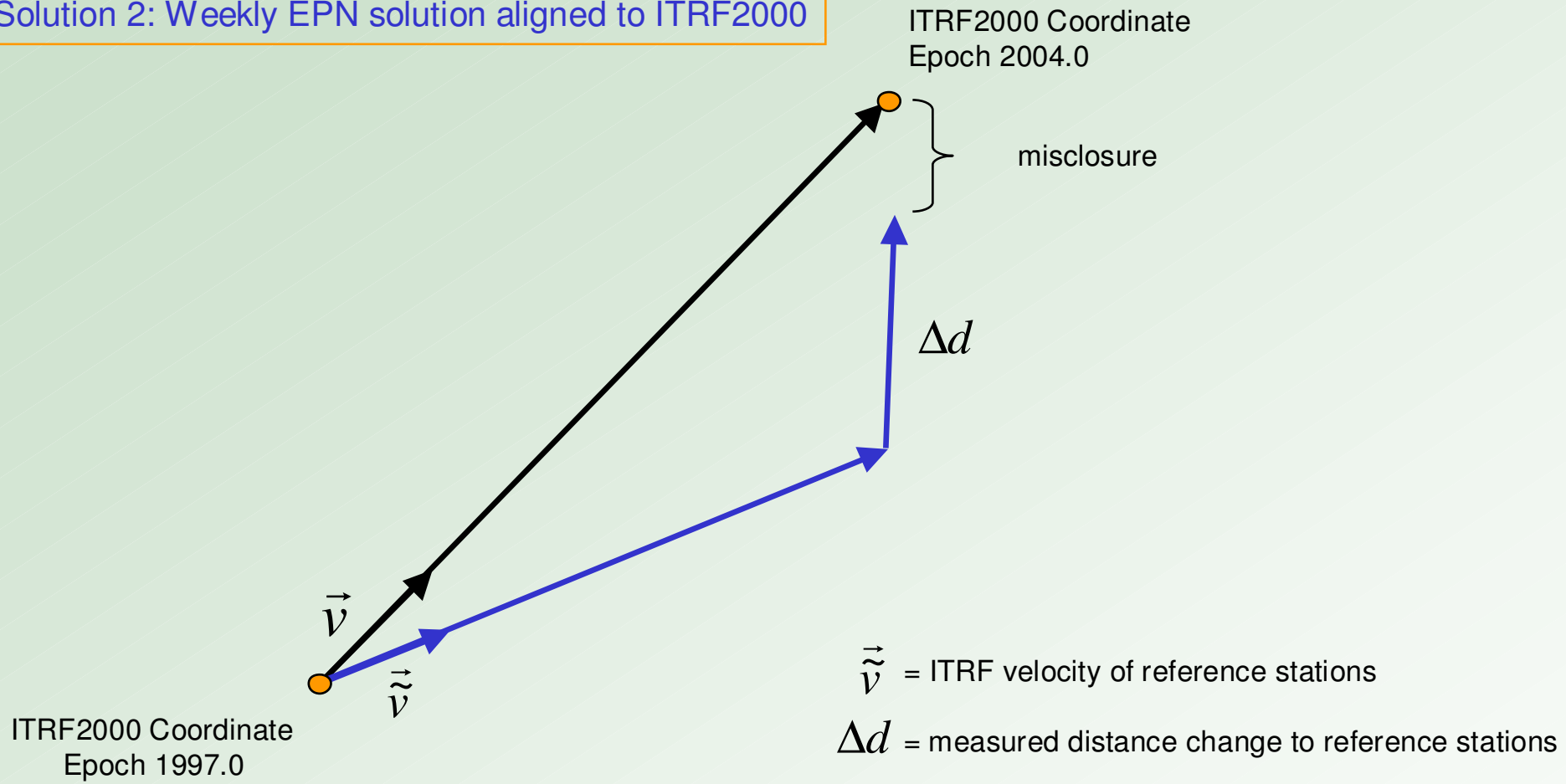
- „Top 25“ stations are shown
- The stations ACOR, TERS and CREU belong to the „top 10“ of
  - Helmert residual **as well as**
  - ITRF velocity sigma

  numbers.
- ITRF velocity is the reason for increasing Helmert residuals

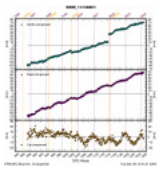


Movement of a Non-Reference Station

Solution 1: ITRF coordinates and velocities
Solution 2: Weekly EPN solution aligned to ITRF2000



- Misclosure is mainly determined by poor quality of ITRF velocity of non-reference stations
- Quantity up to 1 cm for the period of 2 years



Datum

- Conclusions
  - A new ITRF realization will „reset“ the misclosure.
  - It is recommended to use the weekly EPN solutions expressed in ITRF for such stations, which have large sigma for the ITRF velocity.

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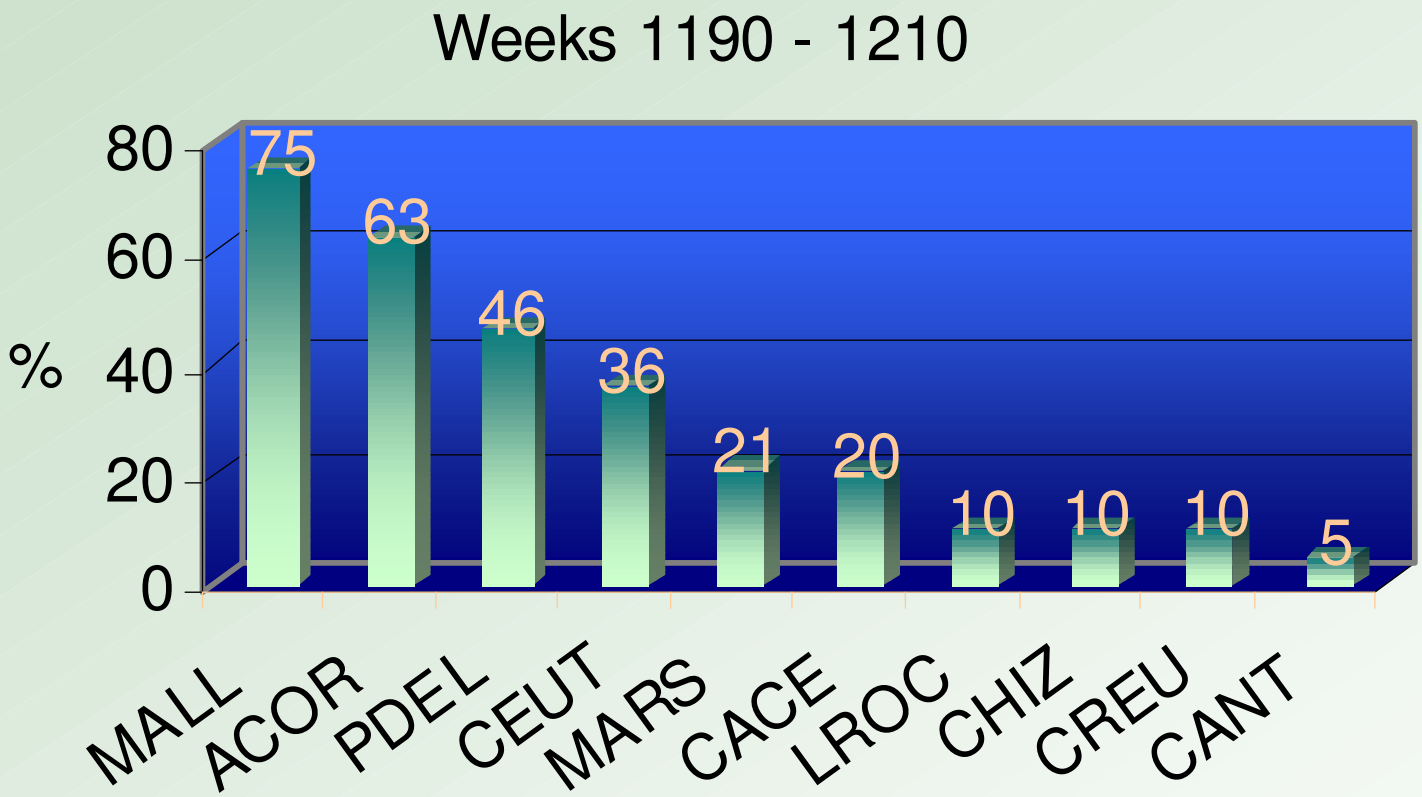
Station Inconsistency in DEO Solution

- Objective and History
  - A certain group of stations of the DEO sub-network show significant discrepancy in the comparison to the EPN combined solution on regularly basis.
  - This phenomena could not yet be explained.
  - DEO uses GIPSY compared to the majority of the LACs that use Bernese GPS Software.
  - Lina Ferraro from ASI offered to analyze the particular stations with MicroCosm software for comparison (results for weeks **1235 to 1241** available).
  - This report includes an updated study of the outstanding stations and includes the test results from ASI.

History

- Exclusions of some stations of the DEO sub-network



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Graphics of the Comparison

- 3 types of graphics have been generated:
  - Comparison of a single sub-network solution to the combined solution
  - Time series of a-priori coordinates as given in the SINEX file of the sub-network solution
  - Time series of the estimated coordinates in the sub-network solution.

- LAC versus Combination
  - A threshold of 5 mm for longitude/latitude and 10 mm for height is roughly used in the weekly combination. Exceeding station are excluded in the combined solution.
  - The corresponding graphics are on top of the following slights at the left site for solution from DEO and at the right site from ASI (if available).
  - Grey bars indicate the exclusion for a particular week.

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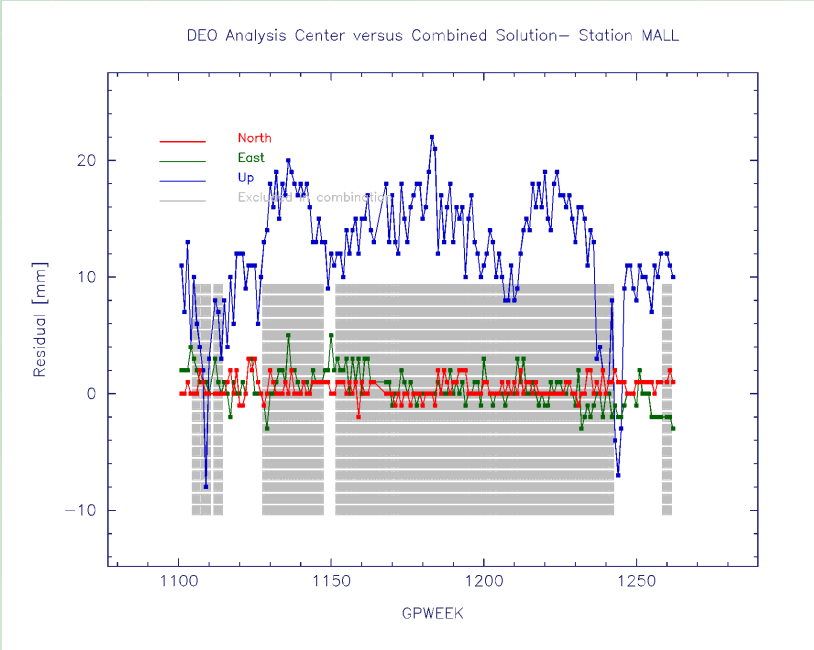
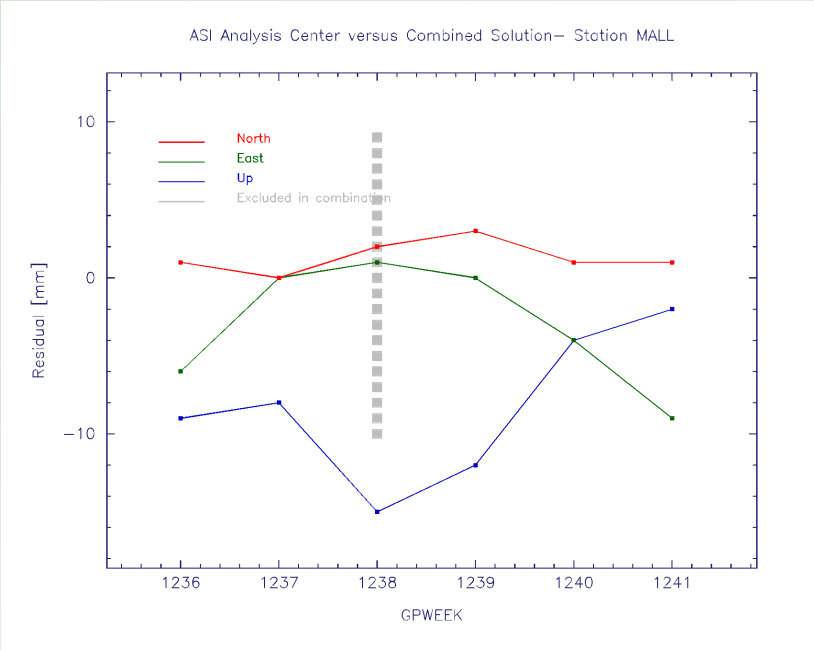
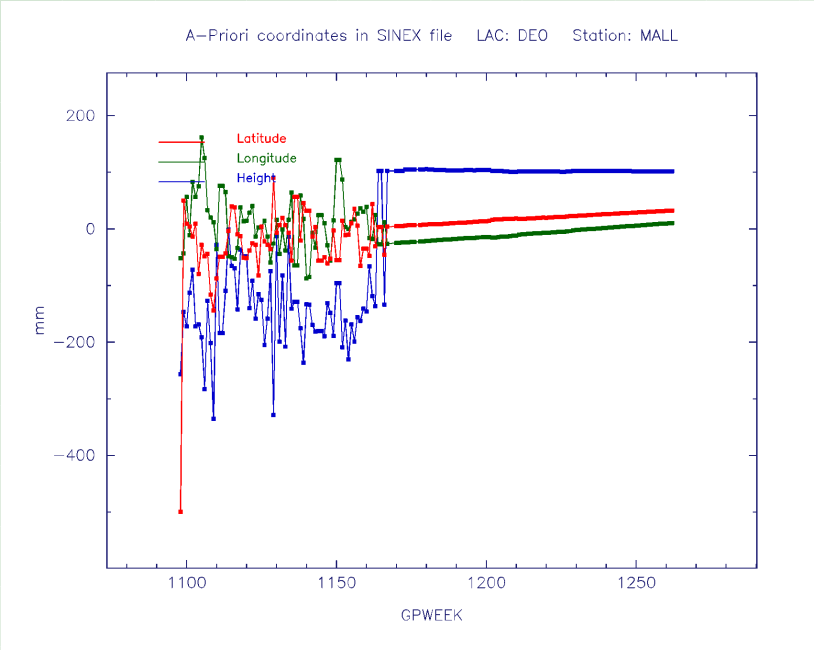
Graphics of the Comparison

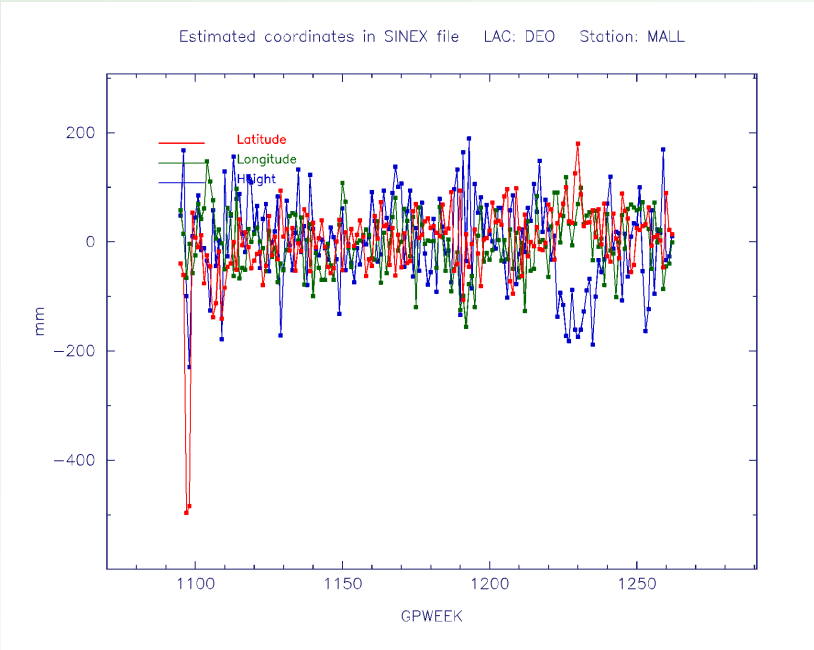
- A-Priori Coordinates
  - The graphics on the bottom left site show the a-priori coordinates that have been used in the DEO analysis and that are given in the SINEX files.
  - A-priori coordinates may affect the results and for this reason they are shown here.
  - Large residuals are reduced to 1000 mm and appear in this way.
- Estimated Coordinates
  - The graphics on the bottom right site show the estimated coordinates as given in the resulting SINEX files from DEO.
  - The residuals refer to the mean value of the DEO solutions for the given period.

Station: MALL

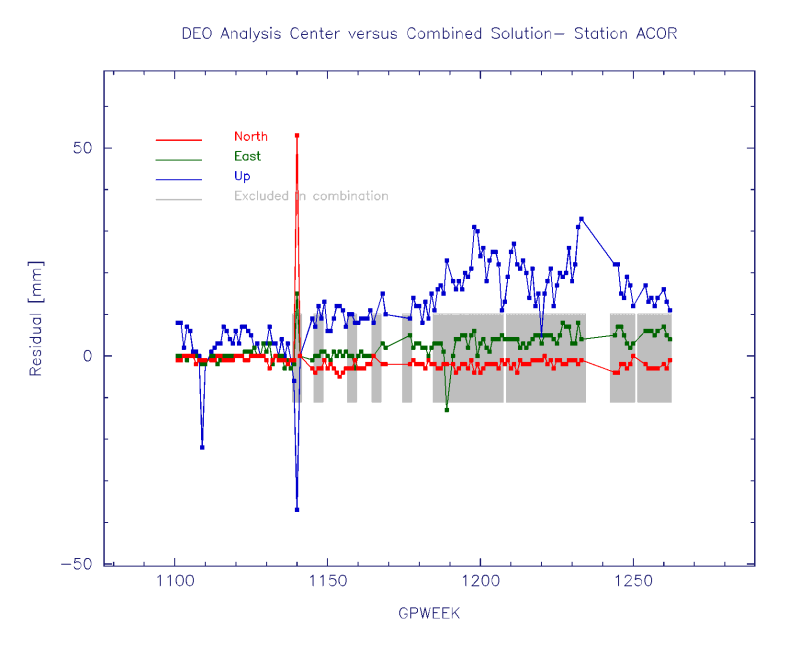


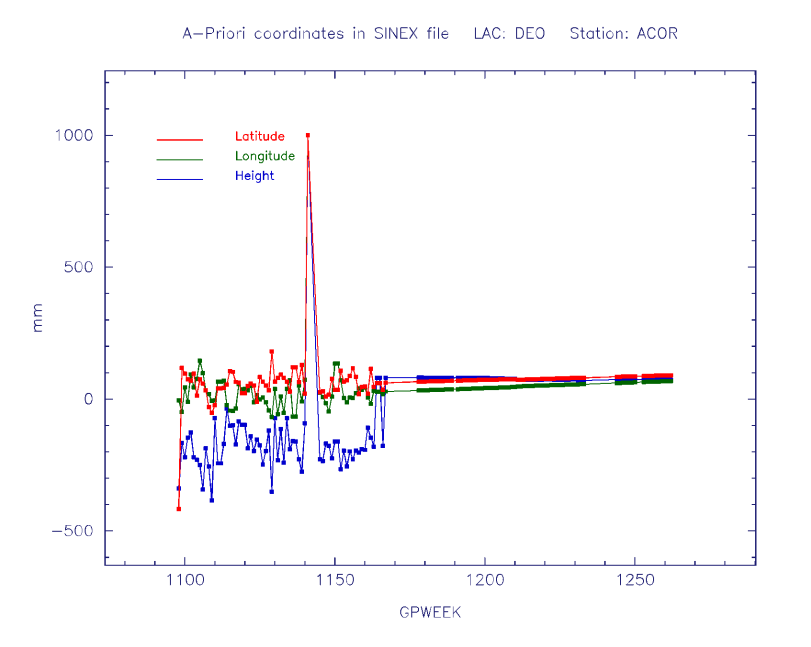


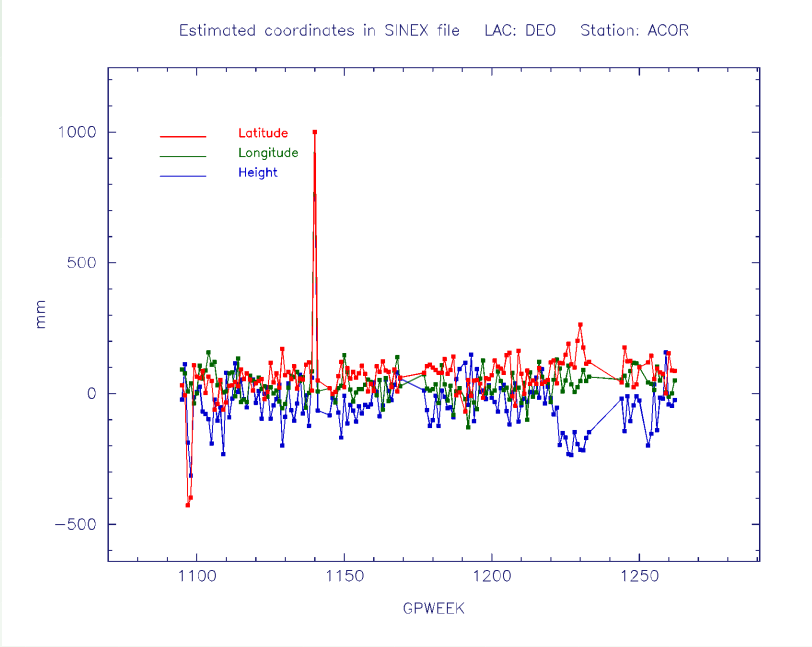




Station: ACOR







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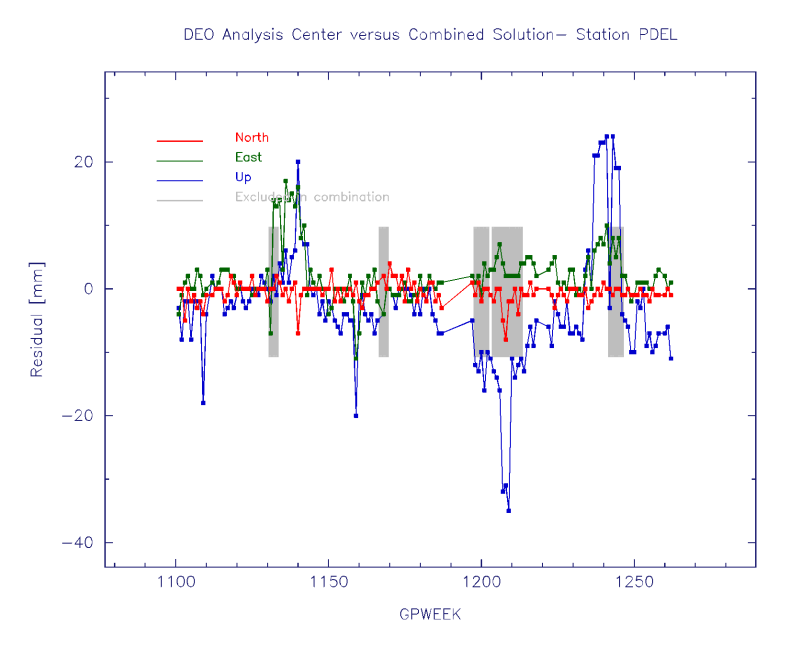
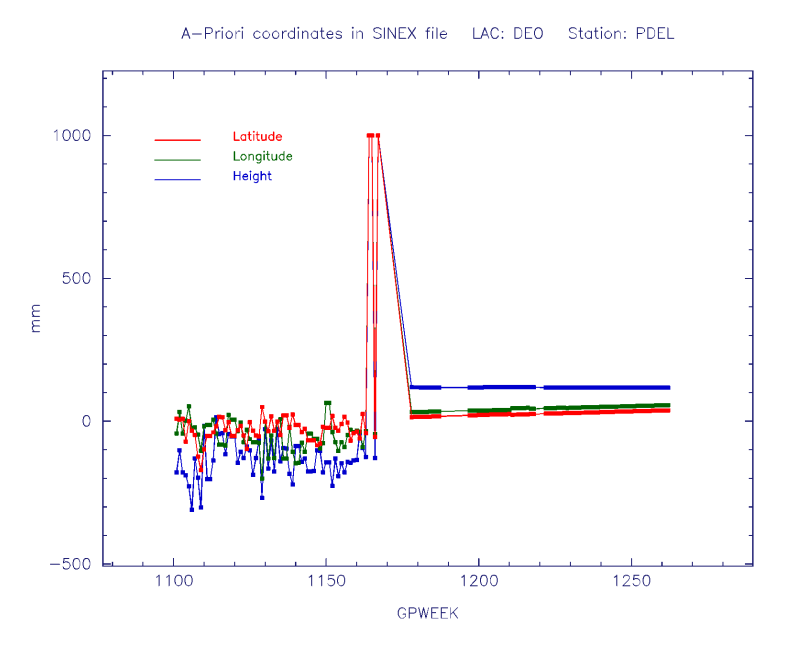
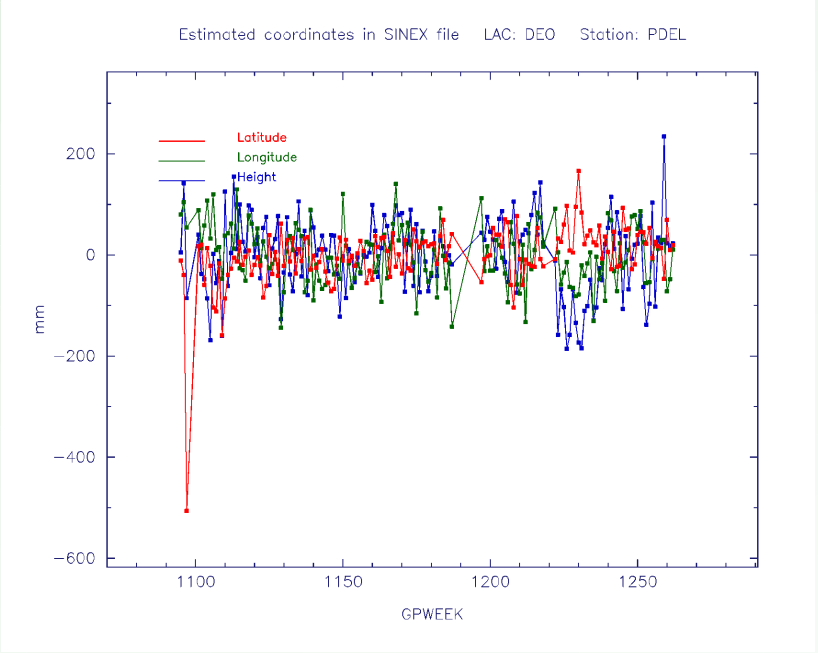
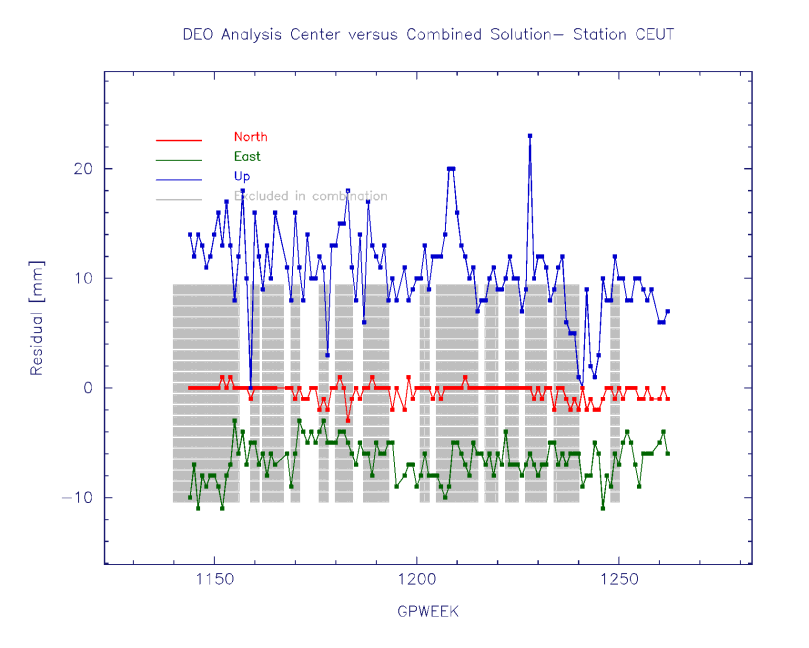
Station: PDEL

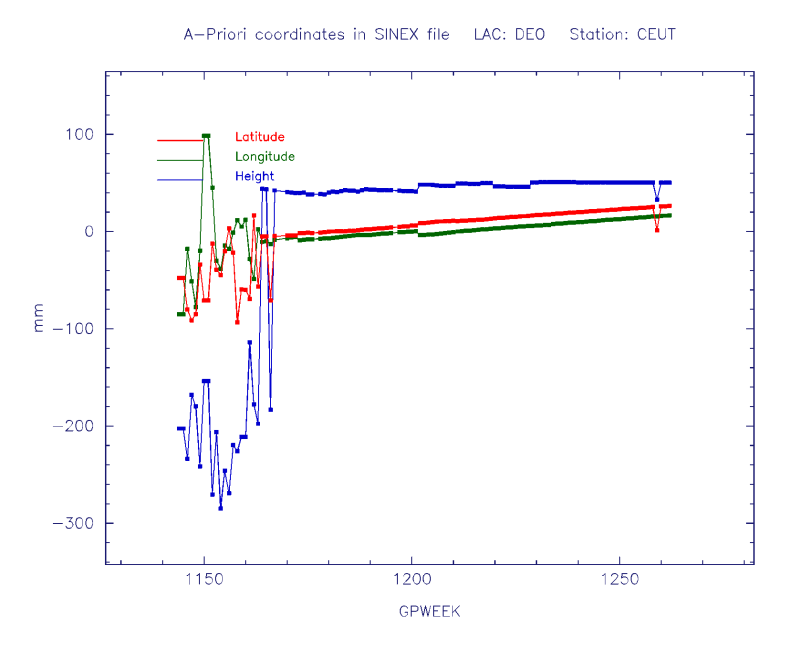


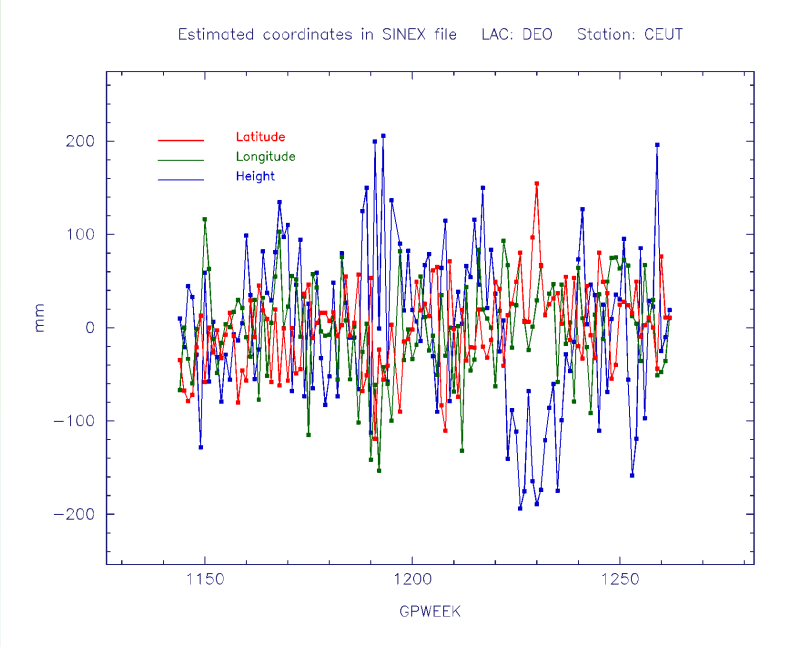




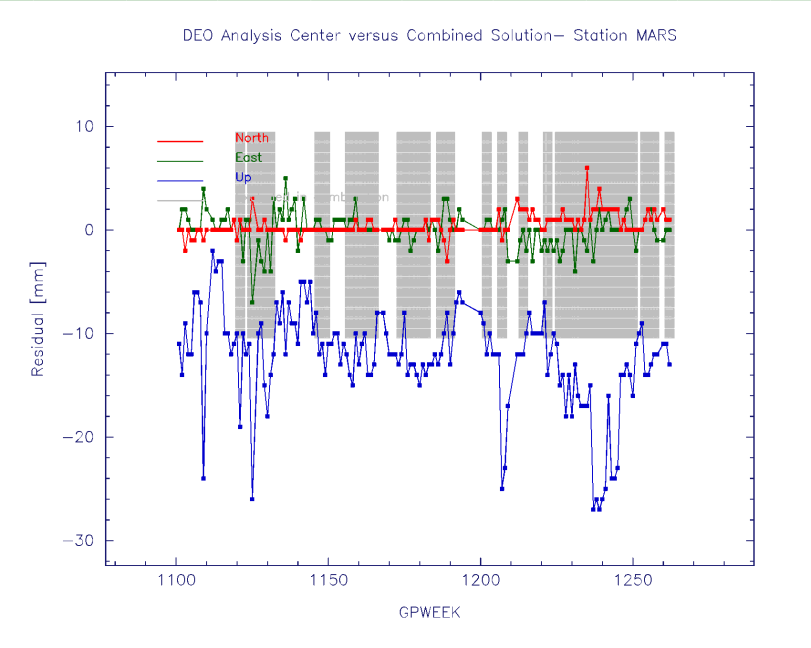
Station: CEUT

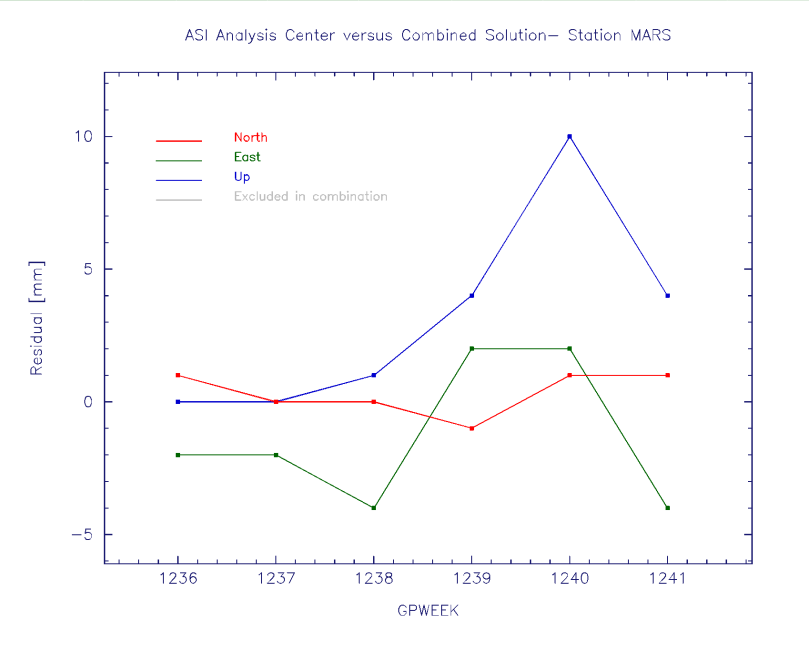


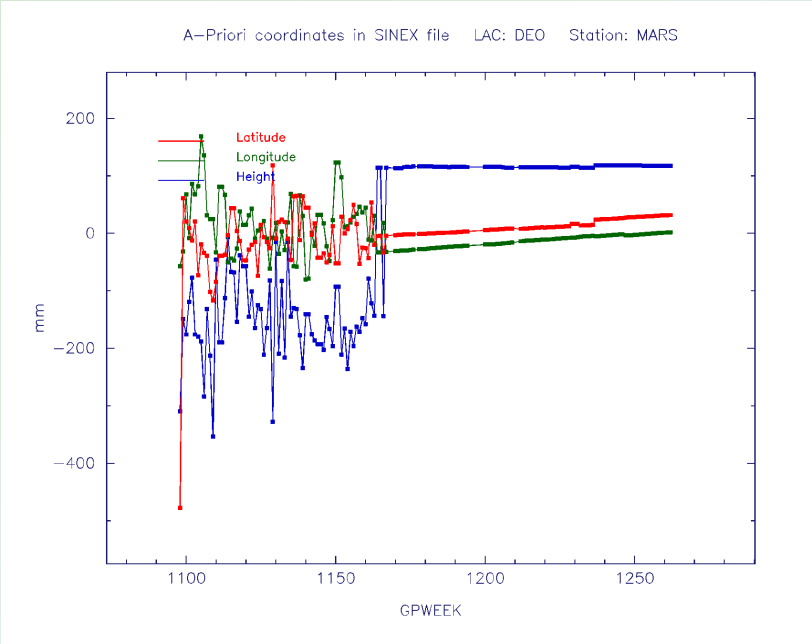


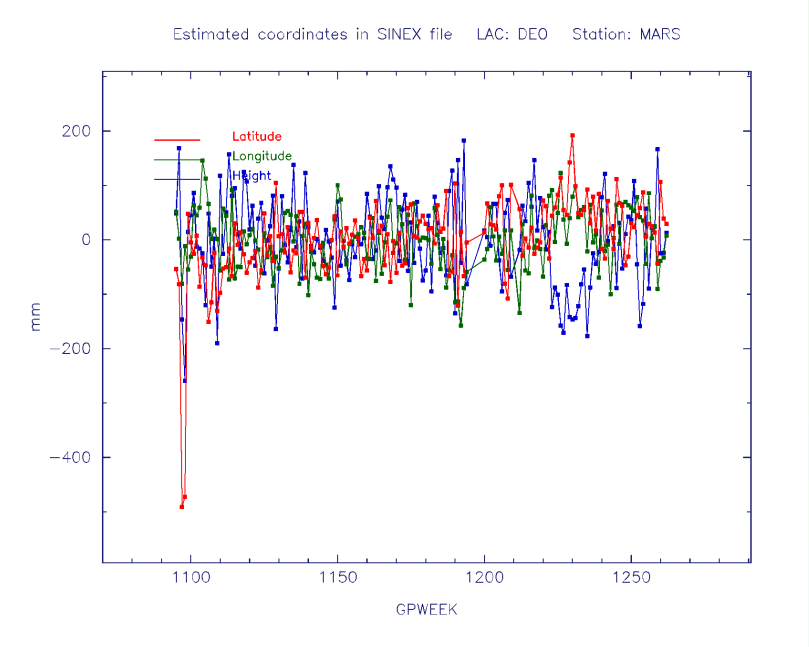


Station: MARS









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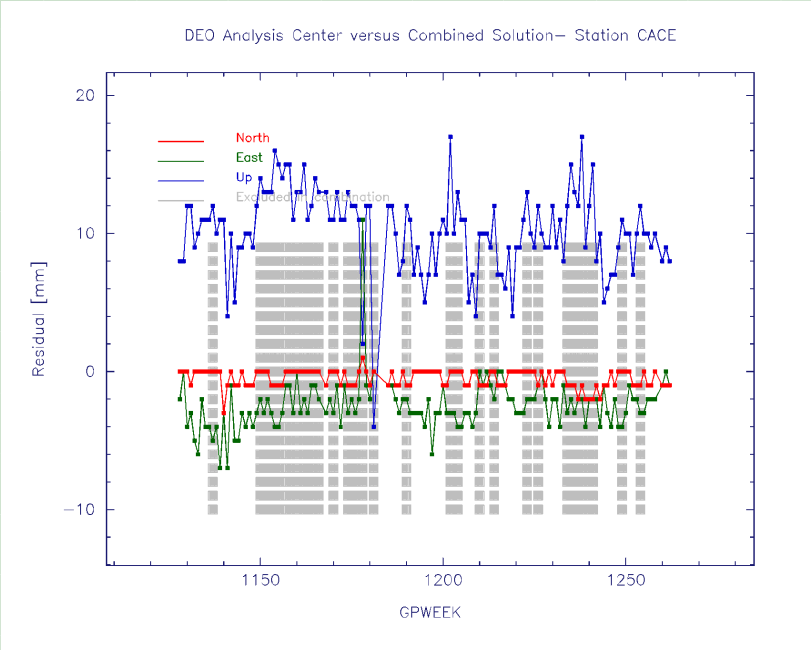
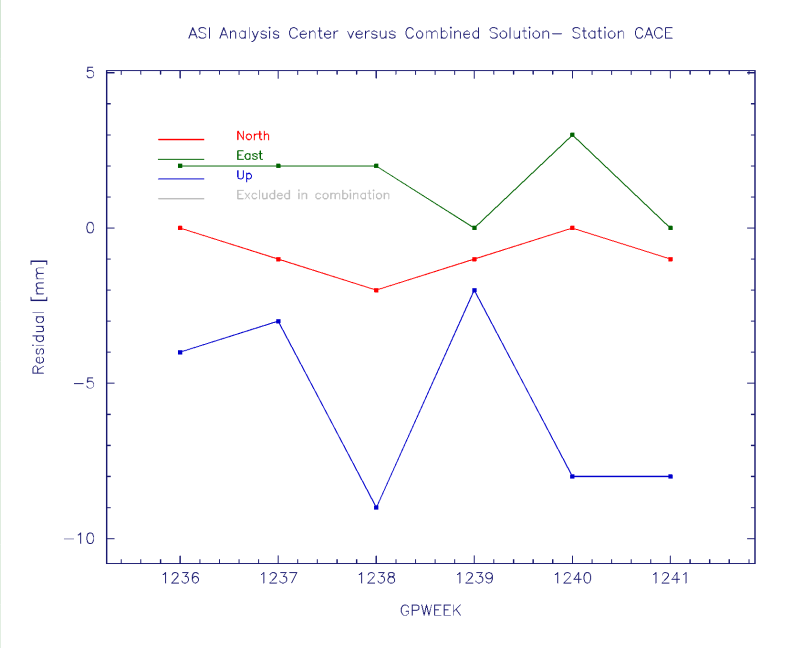
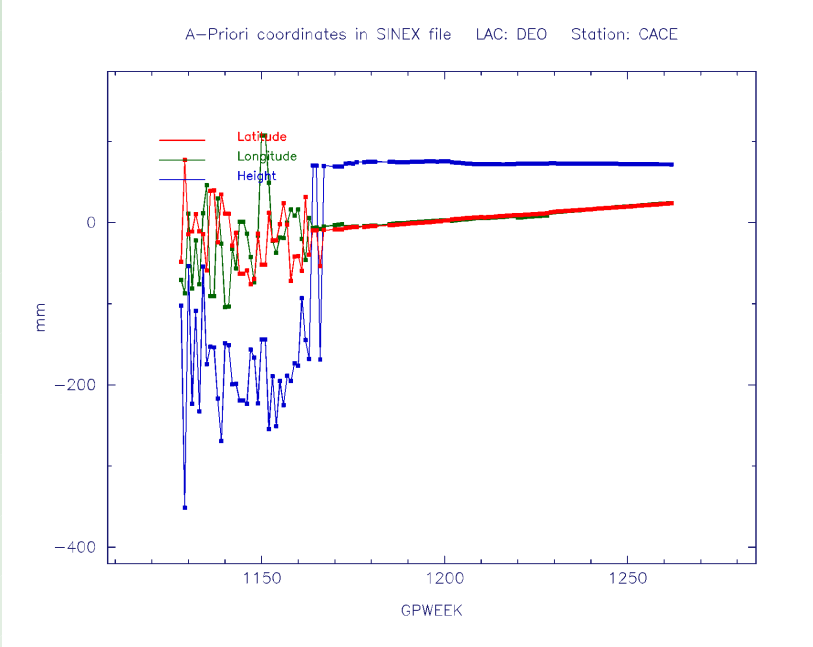
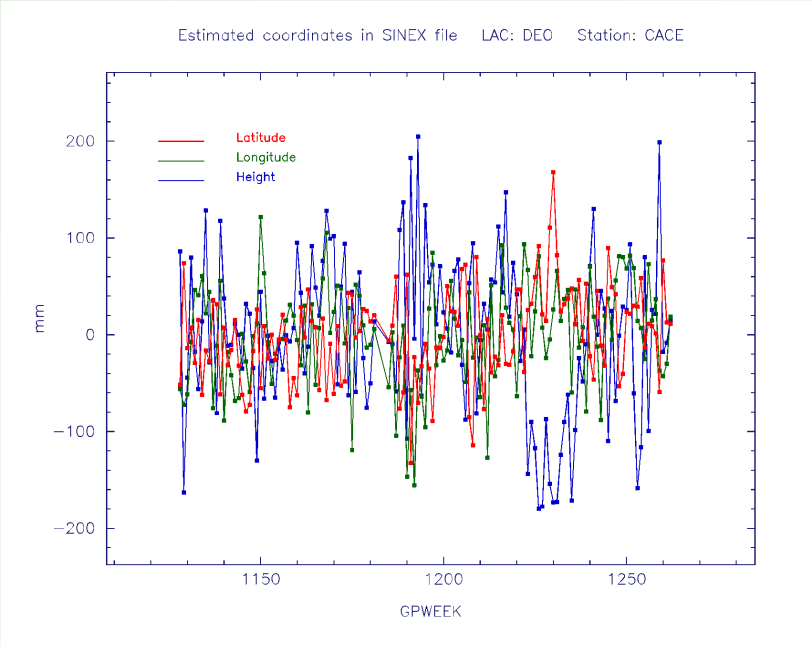
Station: CACE

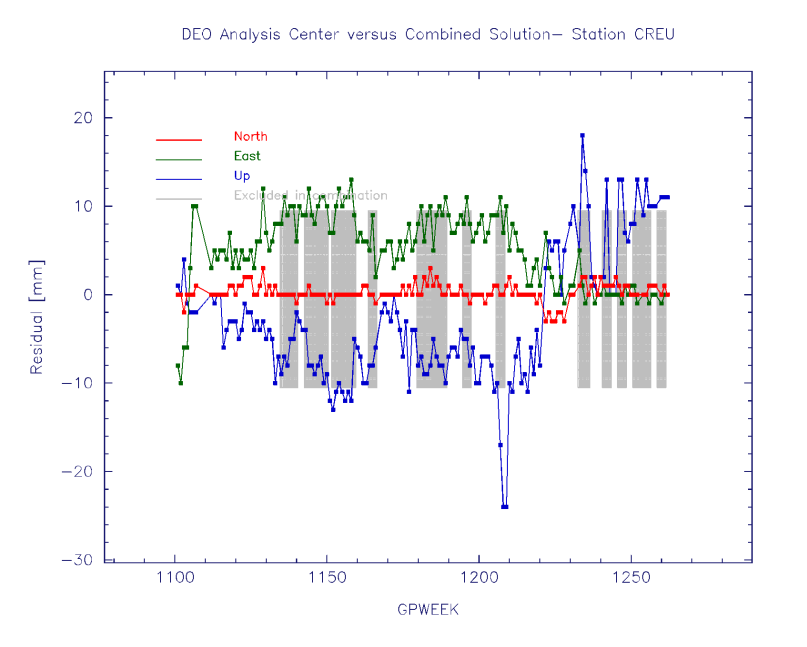


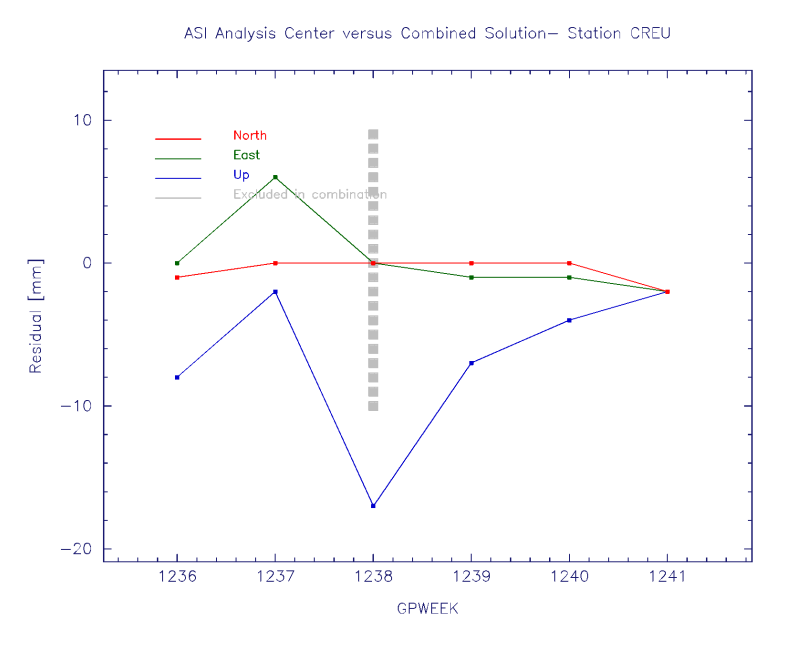


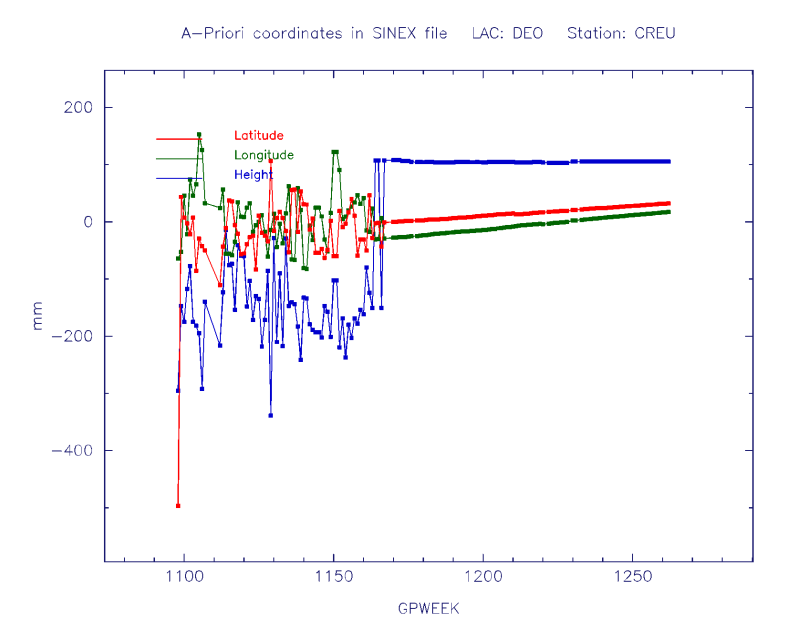


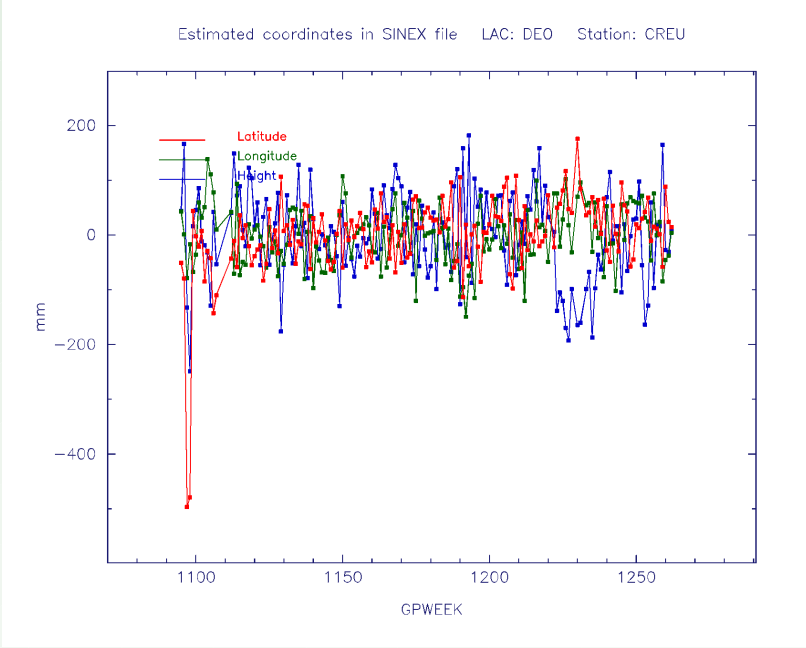


Station: CREU









Comparison Results

- DEO versus Combined:
  - It seems worthwhile to look at each coordinate component separately.
  - There are periods where the height component does not fit to the combined solution but other periods where it does.
  - The north component is in very good agreement to the combination for all stations studied.
  - The east component shows a small but stable offset for the stations CEUT and CACE.
  - The majority of stations use the „TRM29659.00 + DOME“ antenna, but CREU is contrary this rule
- DEO versus ASI:
  - The solutions of the period from week 1236 to 1241 from ASI do mainly not exceed the threshold of 5 resp. 10 mm.
  - The inconsistency in the DEO solution could not be confirmed by the ASI results.
  - Many thanks to Lina Ferraro for the test computation and her remarks to the results.

Comparison Results

- A-Priori Coordinates in DEO SINEX Files:
  - The a-priori coordinates are obviously constrained since week 1164.
  - No correlation between the modified strategy since week 1164 and the results becomes visible.
- Estimated Coordinates in DEO SINEX Files:
  - The week to week repeatability is in the order of 10 to 15 cm according to the datum definition of the DEO sub-network, which changes from week to week in the same order.
- Summary:
  - The inconsistency for some stations in the DEO sub-network could not yet be explained.
  - The analysis of the corresponding stations with MicroCosm Software is in good agreement with the Bernese Software solutions.
  - „Different causes behind the common problem“

ETRS89 Coordinates of EPN

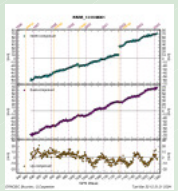
- ***Motivation:***
  - Official ETRS89 coordinates are only available through ITRF realizations, recently ITRF/ETRF2000
  - Current ETRS89 coordinates may be requested by the users.
- Discussion at LAC workshop Graz, September, 2003
- Discussion at TWG Frankfurt, December 2003
- This issue is closely connected to the question of an EUREF product catalogue, which will be presented in the EuroGeographic session of this symposium.
- ***Status of discussion (TWG):***
  - Datum definition of the weekly EPN solutions will be re-viewed before publishing weekly ETRS89 coordinates.

Other Activities

- EPN contribution to TIGA:
  - Weekly submission of a EPN sub-network to TIGA since October 2002
  - Backwards extraction of the sub-network to week 1021 (August 1999) was processed in May 2004
  - Sub-network consists of 18 stations, 7 of it are reference stations for connection to ITRF
  - Solution filename ETGwwww7.SNX
  - Map of sub-network
- New BKG Data Center Server in Test Phase:
  - A new server structure has been developed in 2003 and is now in the test phase.
  - The concept had been presented at the IGS Workshop 2004 in Berne.
  - Example: Internet Connectivity

Instead of summary.....

4th LAC Workshop



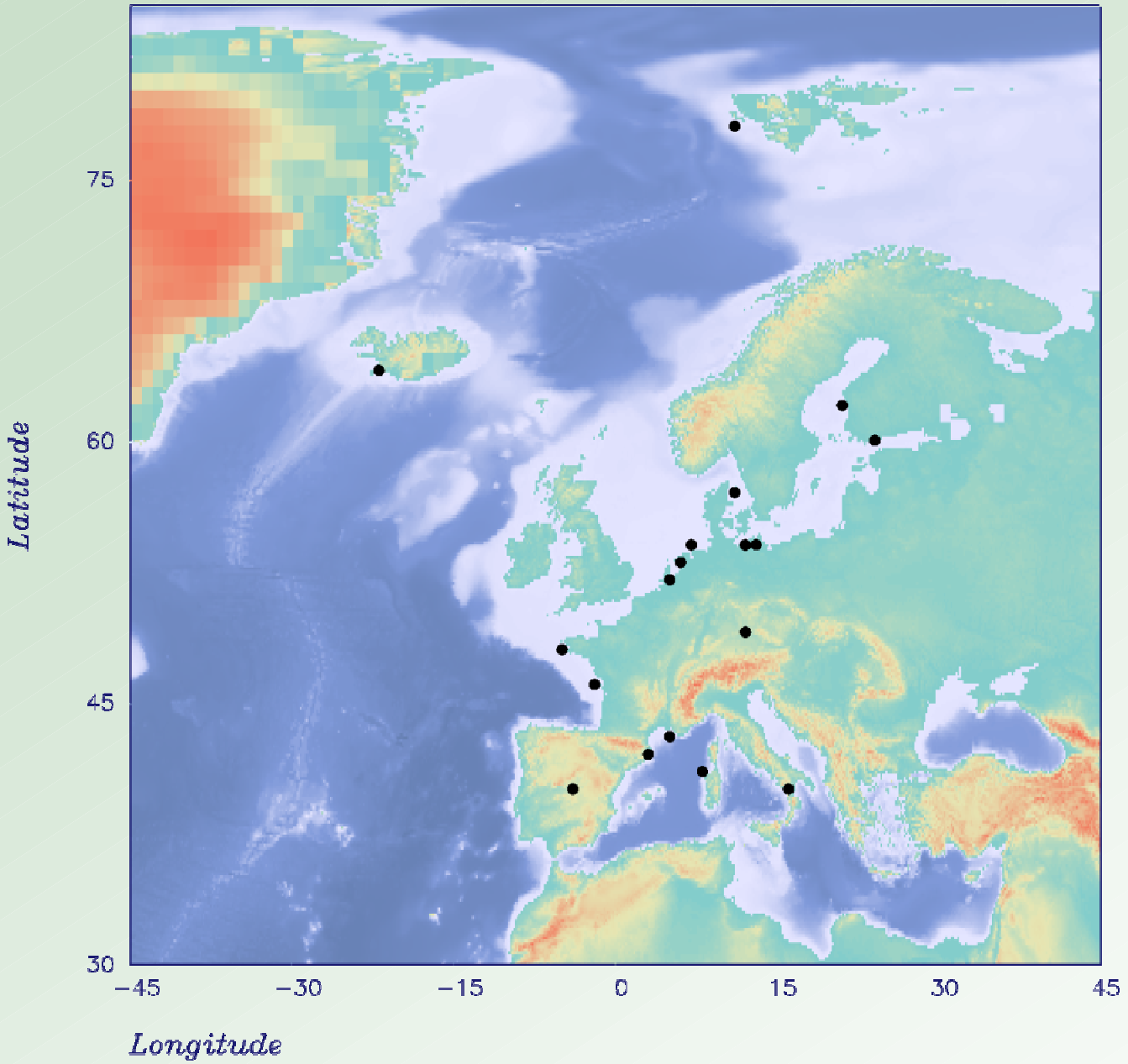
TU Delft
Technische Universiteit Delft

Thank you

ETRS89

Other Goodies

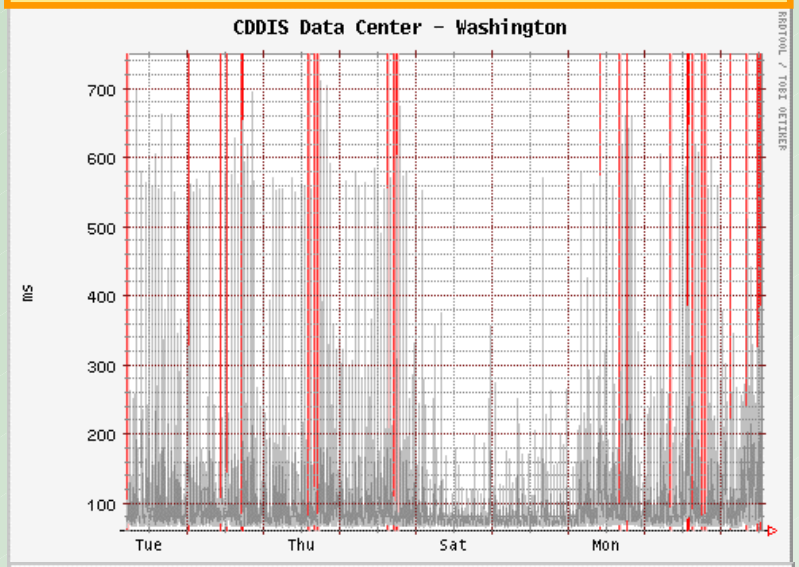
Contribution to TIGA

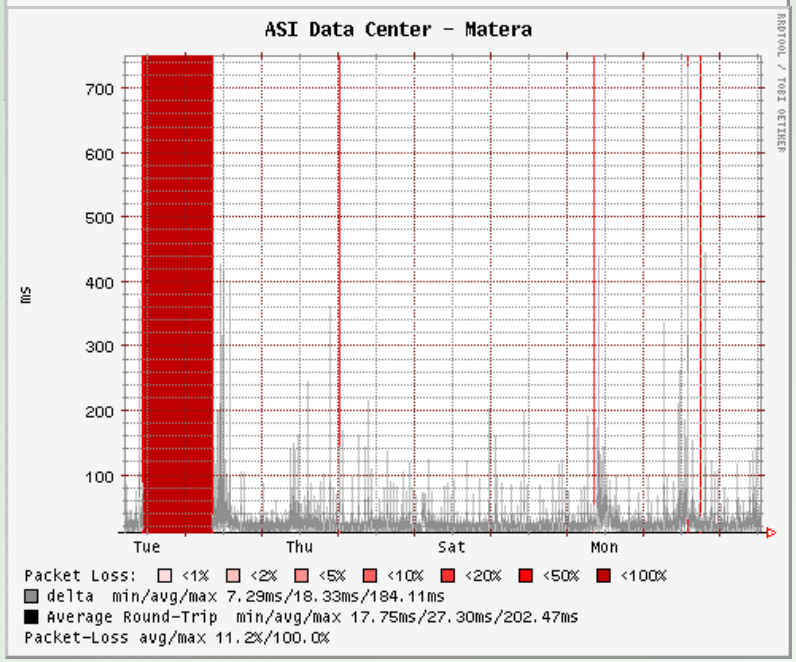


Other Goodies

New BKG Data Center Server

Weekly





Monthly