

ITRF densification – datum definition

J. Douša

(jan.dousa@pecny.cz)

*Geodetic observatory Pecný
Research Institute of Geodesy, Topography and Cartography*

EUREF TWG, February 3-4, 2010, Padua

Motivation

- **EUREF Serbia 2010 campaign (EUREF TWG Lisbon)**
 - small N-S tilt observed
 - medium network at the SE Europe only
 - → check the datum of EPN cumulative solution (EPNC)
- **EUREF IE/UK 2009 campaign**
 - significant N-S tilt observed
 - large network extent
- **EUREF Czech 2009 campaign**
 - insignificant N-S tilt
 - large network, but data from 2004-2008 processed

Testing datum of EPNC

- EPNC datum is tested in a long-term period
 - period 1996-2010
 - comparisons using Helmert transformation between weekly CRD w.r.t reference CRD+VEL
 - NEU | XYZ
 - TRA | TRA+ROT+SC
- Main interest is to compare datum with recent observations
 - after 2005, datum is realized almost based on predicted velocities (and coordinates for ,unchanged' stations)
- To access 'datum' – selection of fiducials starting from all common stations iterated after eliminating outlier

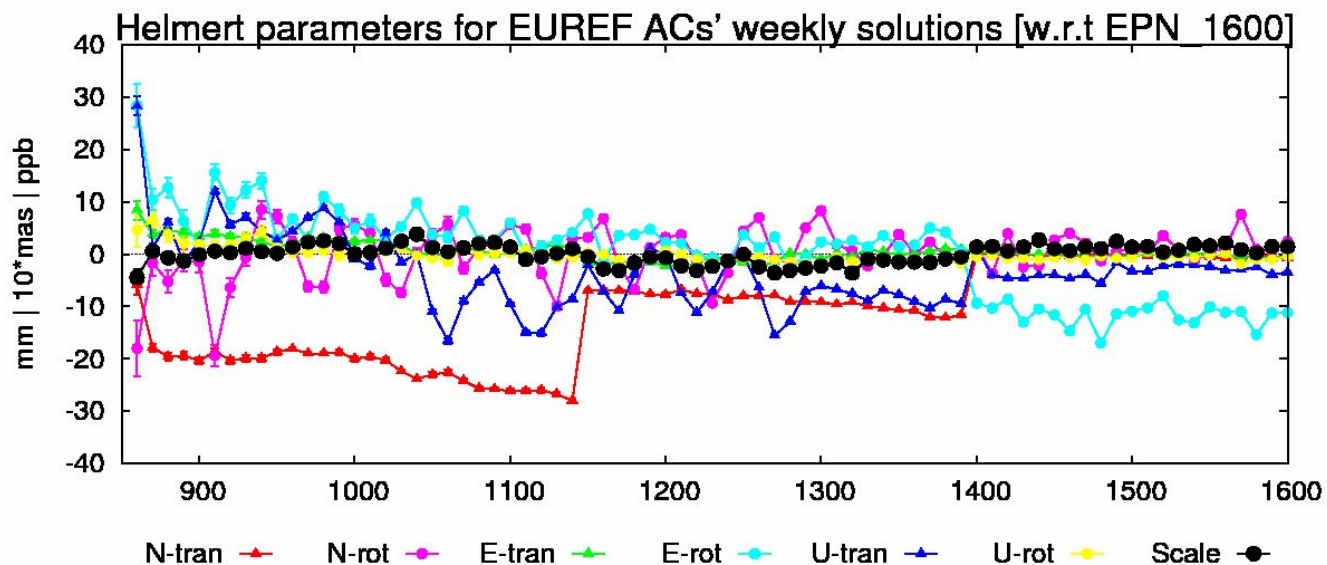
Testing datum of EPNC (cont)

- Compared solutions (weekly CRD – new observations)
 - EUR ACs weekly
 - GOP repro1 weekly
 - ... converted to corresponding 'solution' number
 - ... 'original': datum realization
- Reference solutions (CRD+VEL in refer. epoch)
 - EPN_C1600 - 'latest' EPN cumulative solution
 - EPN_C1355 = European ITRF2005 densification
 - ITRF2005
 - ITRF2008

Outputs of tests

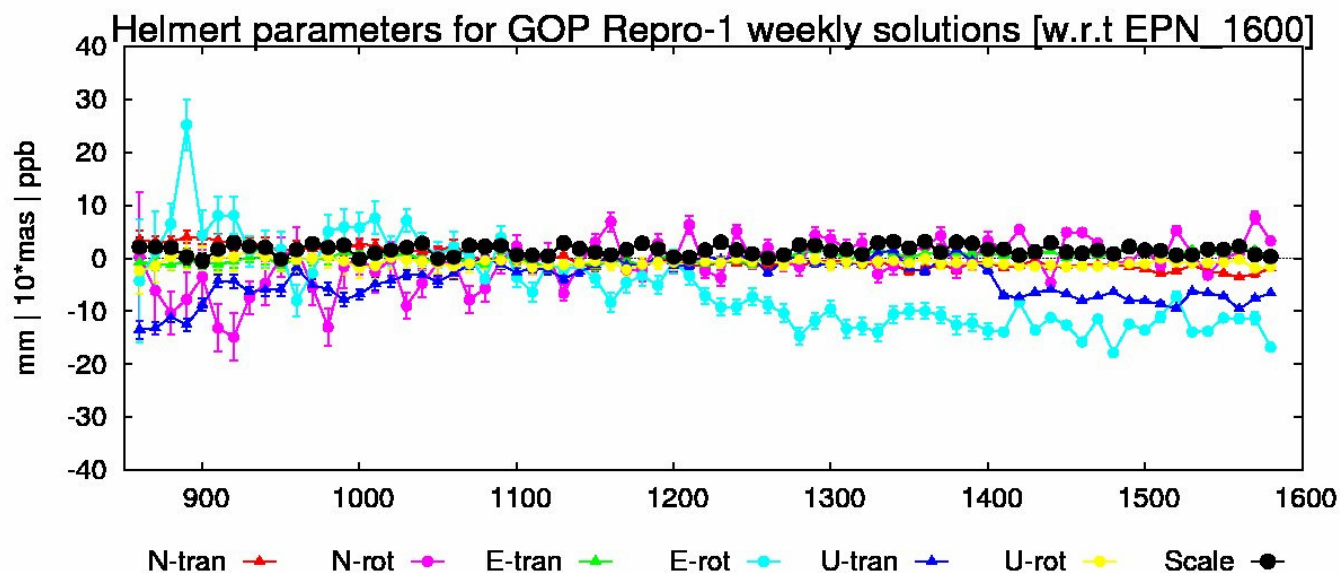
- **Helmert parameters**
 - XYZ using TRA+ROT+SC
 - NEU using TRA+ROT+SC
 - plotted as time-series
- **Residuals from Helmert**
 - NEU using TRA or TRA+ROT+SC
 - plotted as map for each comparison
 - plotted as time-series for all stations

Helmert parameters (NEU)

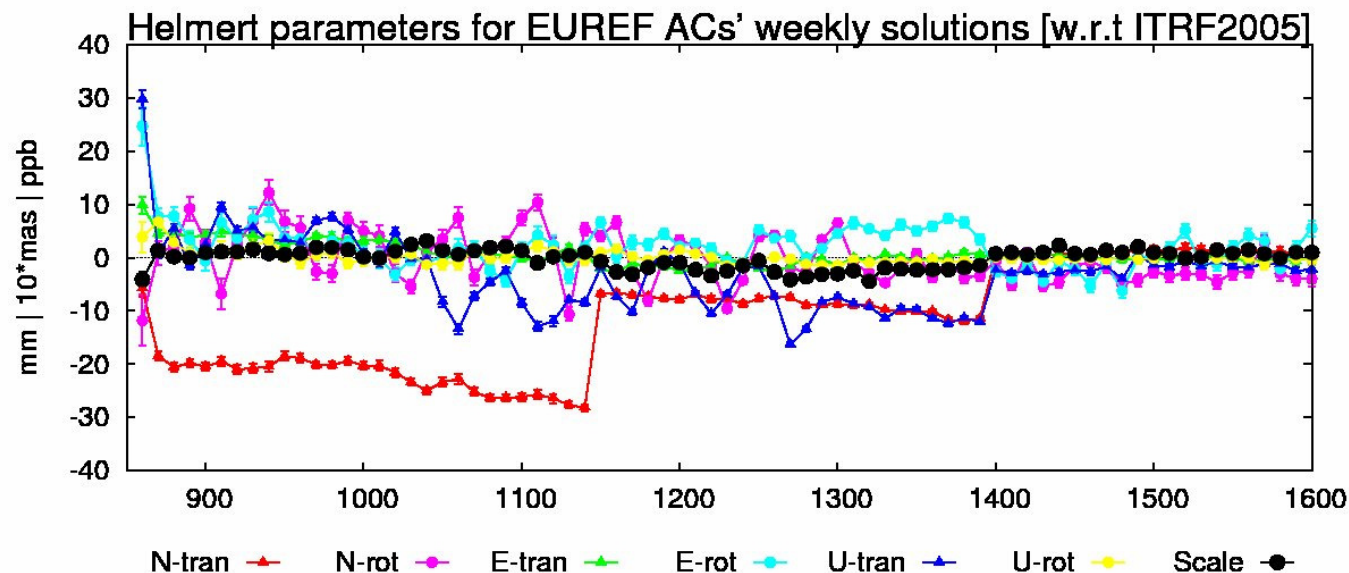


EUREF ACs
x
EPN_C1600

GOP repro-1
x
EPN_C1600

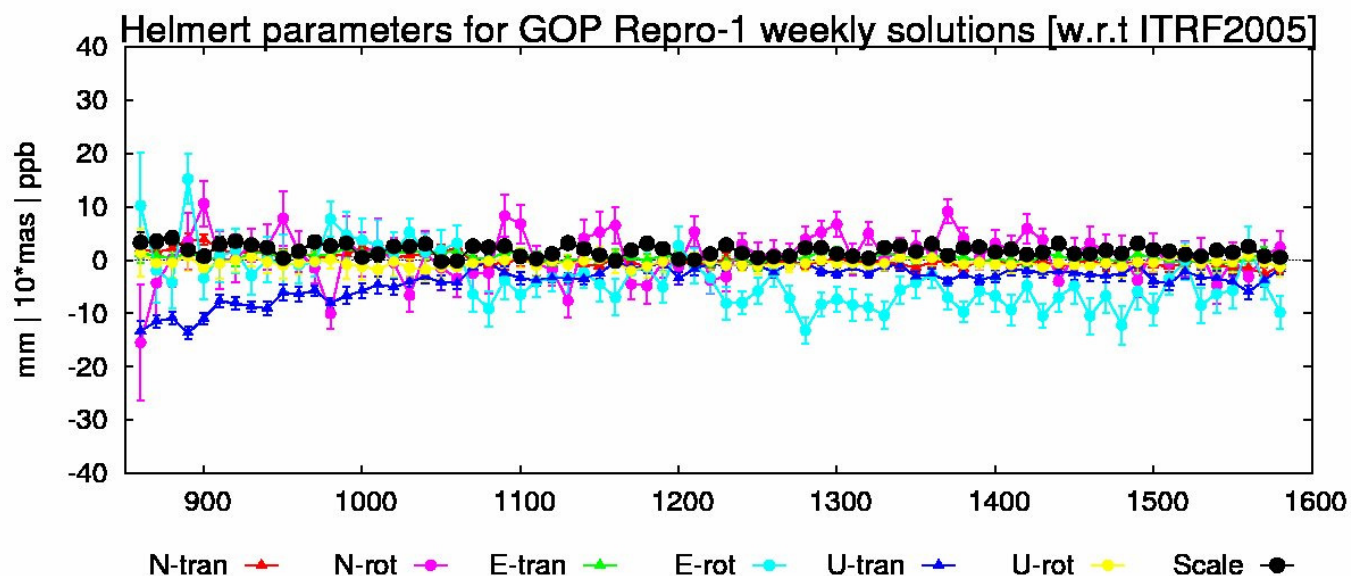


Helmert parameters (NEU)

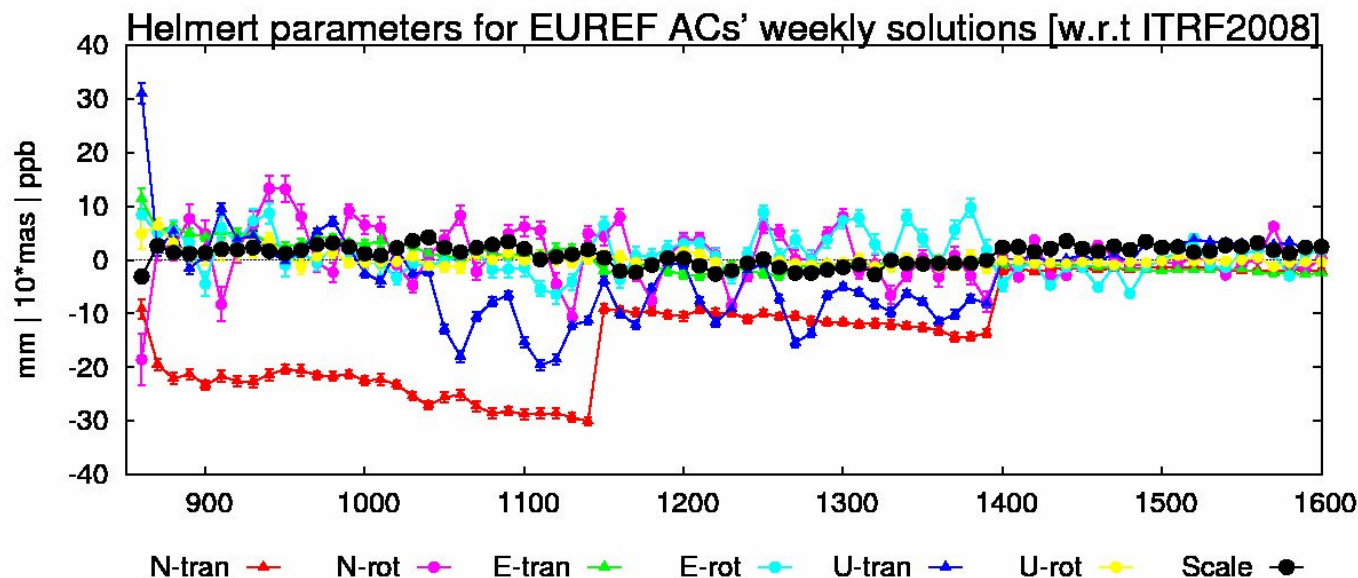


EUREF ACs
x
ITRF2005

GOP repro-1
x
ITRF2005

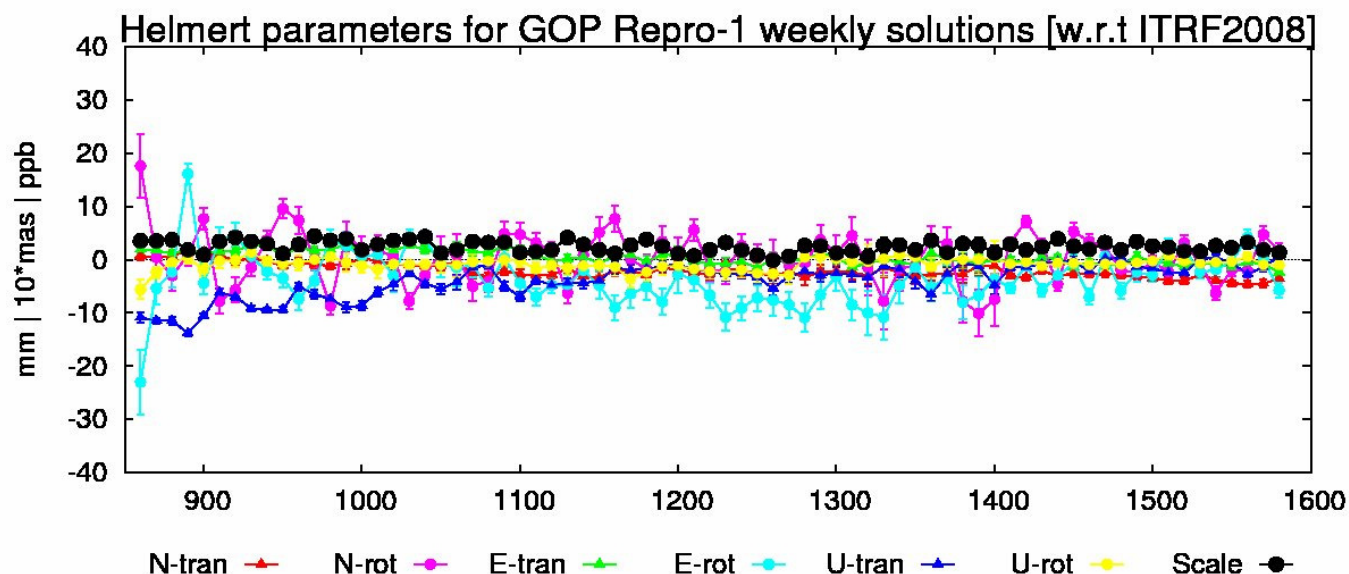


Helmert parameters (NEU)

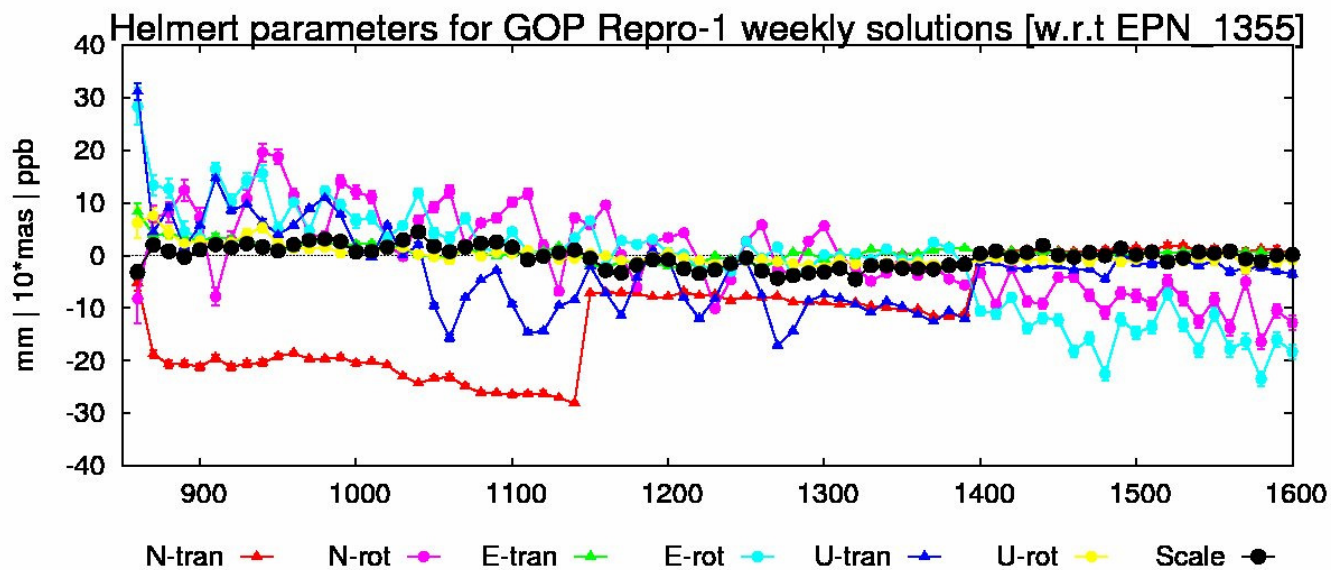


EUREF ACs
x
ITRF2008

GOP repro-1
x
ITRF2008

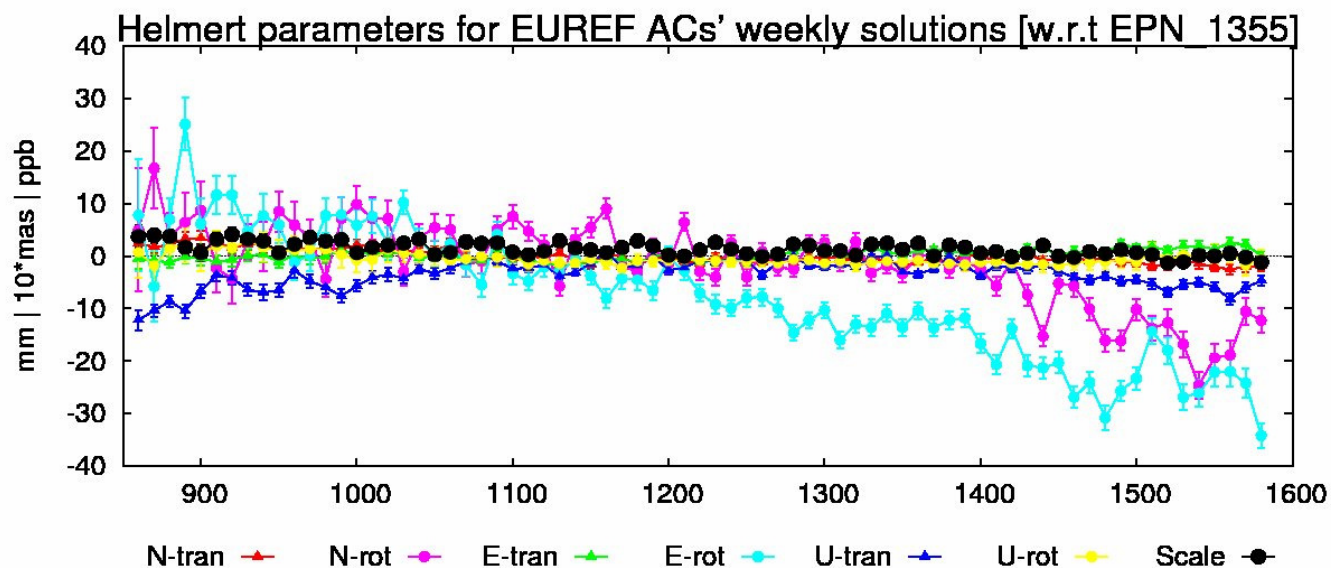


Helmert parameters (NEU)



EUREF ACs
x
EPN_C1355

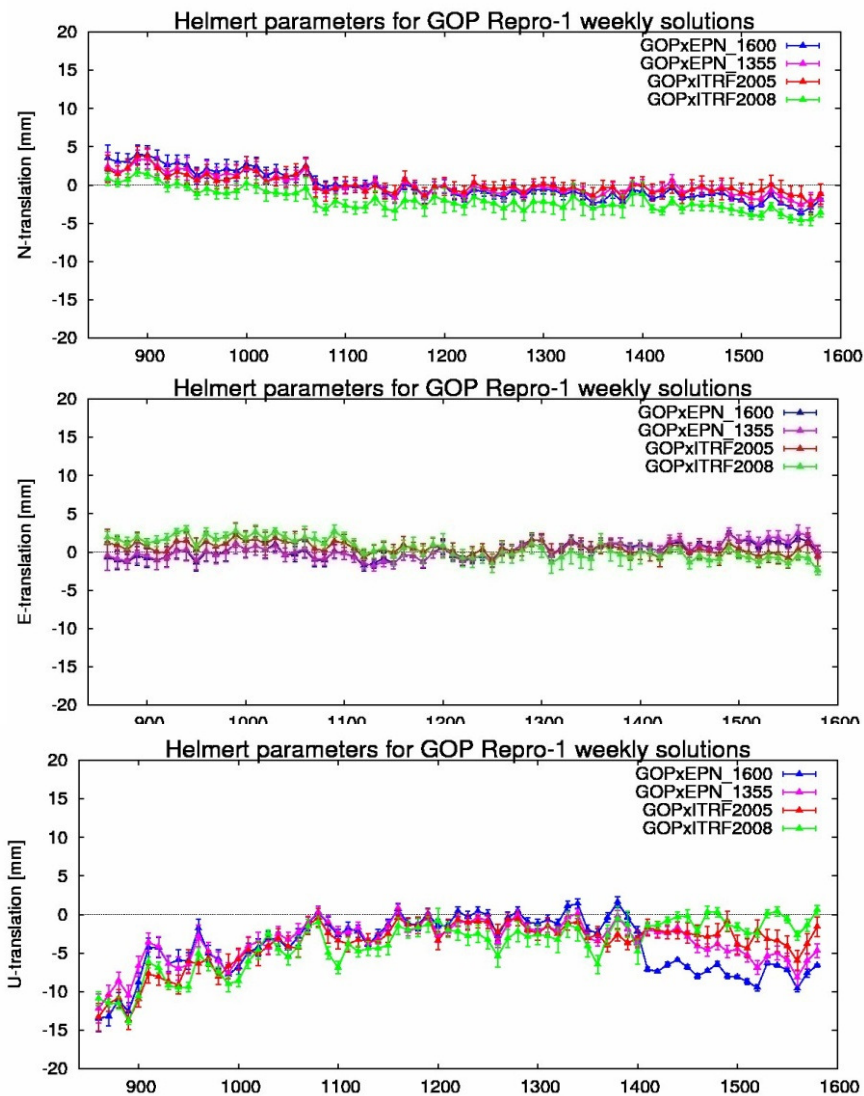
GOP repro-1
x
EPN_C1355



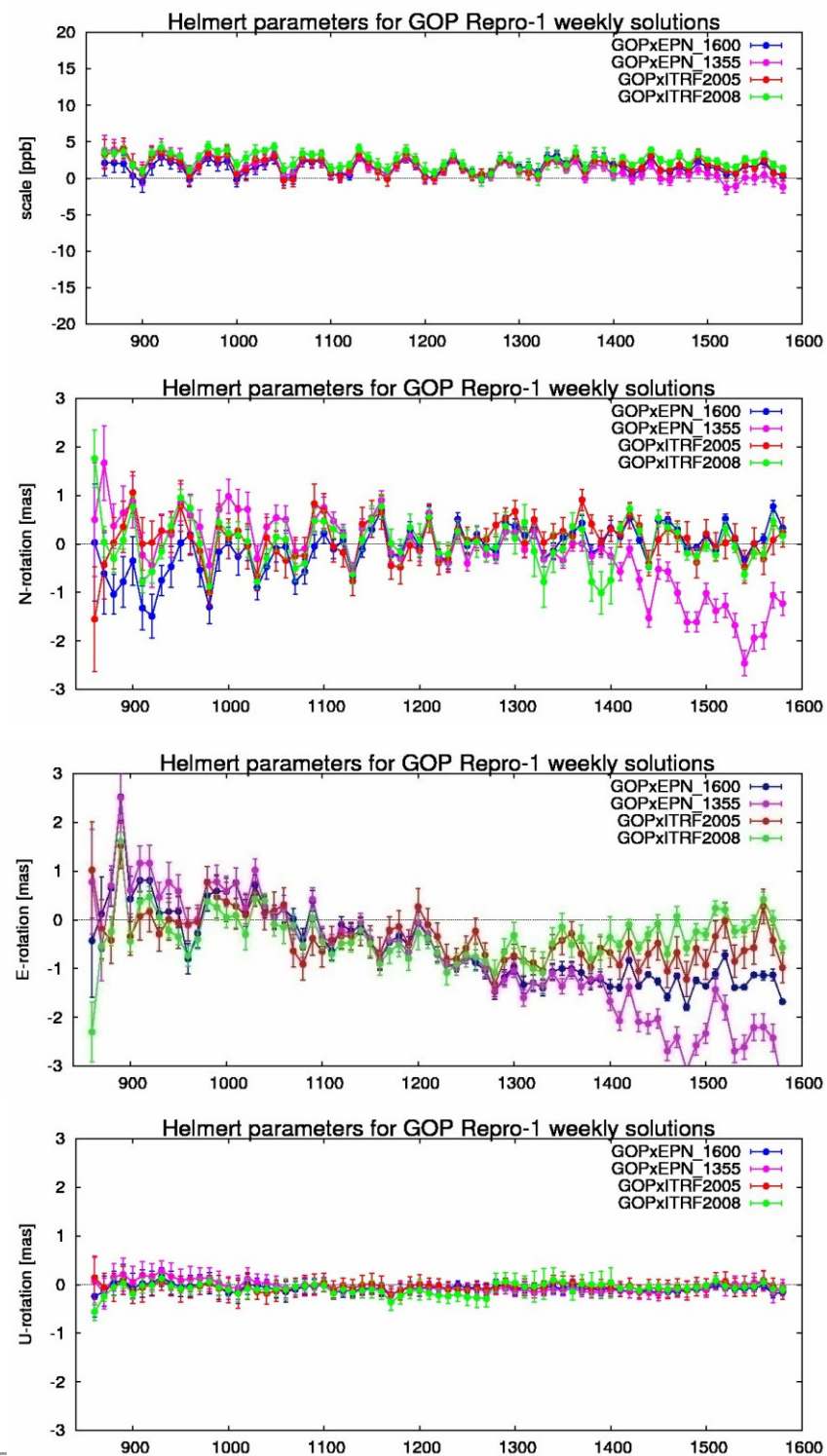
Helmert parameters

GOP x EPN_1600, EPN_1355, ITRF2005, ITRF2008

N, E, U - translations



N, E, U, rotations + scale

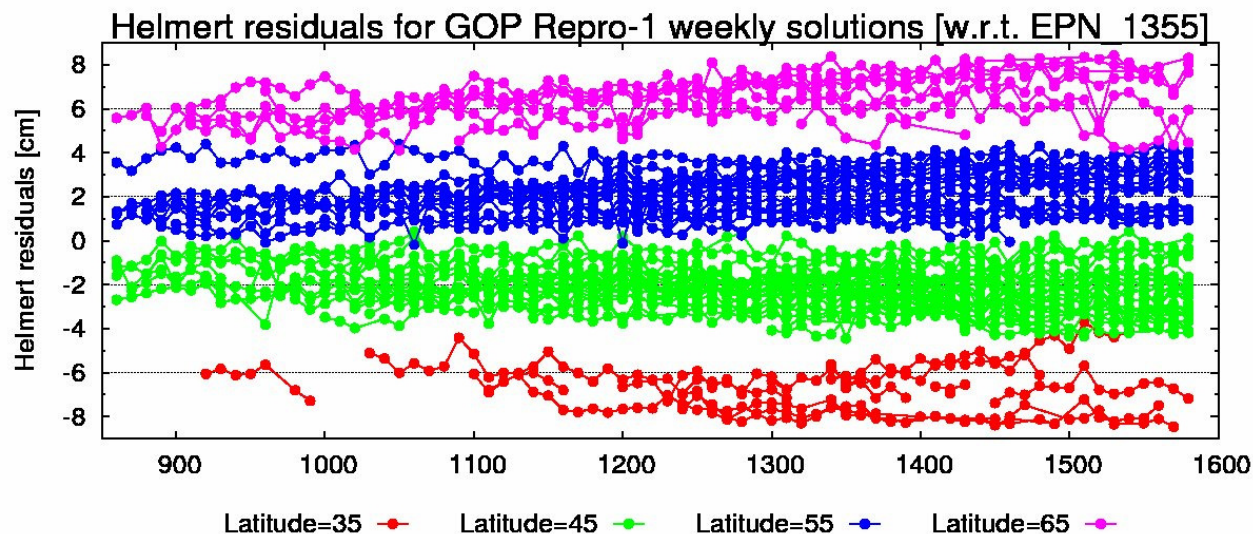


EUREF ITRF densification

- $T_x = T_y = T_z = R_x = R_y = R_z = S_c = 0.0$
- $dT_x = -1.23 \text{ mm/yr}$ $\Rightarrow 12.3 \text{ mm/10yrs}$
- $dT_y = +0.39 \text{ mm/yr}$
- $dT_z = +0.76 \text{ mm/yr}$ $\Rightarrow 7.6 \text{ mm/10yrs}$
- $dR_x = +0.008 \text{ mas/yr}$
- $dR_y = +0.046 \text{ mas/yr}$ $\Rightarrow 0.46 \text{ mas/10yrs}$
- $dR_z = -0.012 \text{ mas/yr}$
- $dS_c = +0.038 \text{ ppb/yr}$

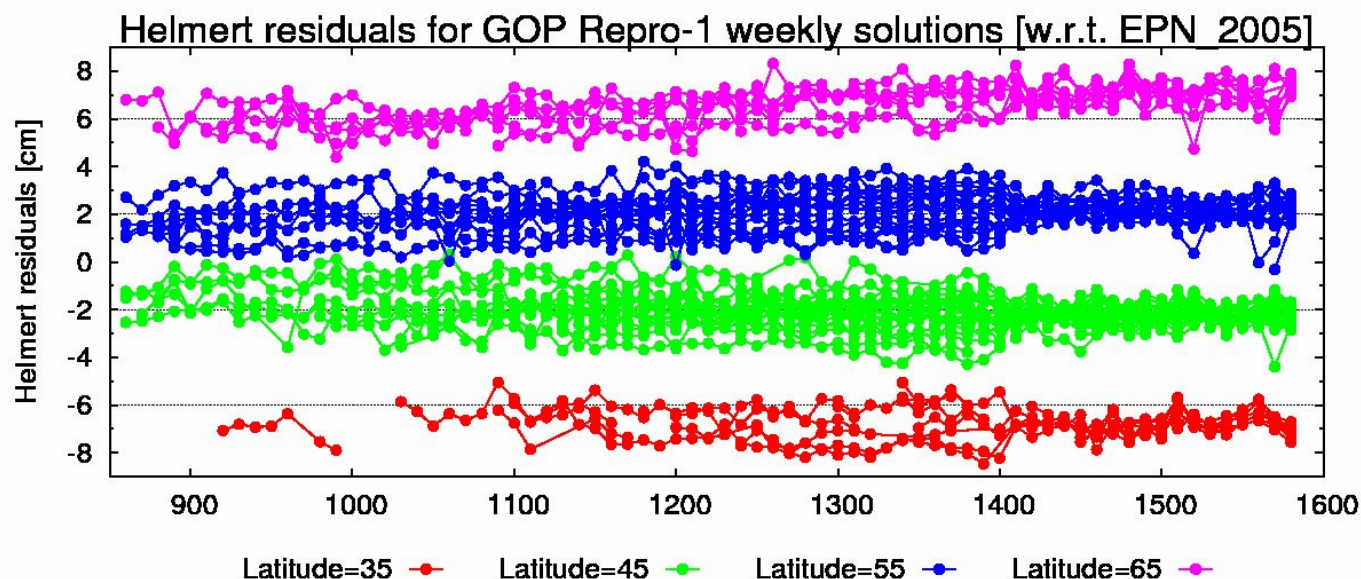
Observed $\sim 2 \text{ mas/10yrs}$ in East-rotation (N-S tilt)

Coordinates UP residuals

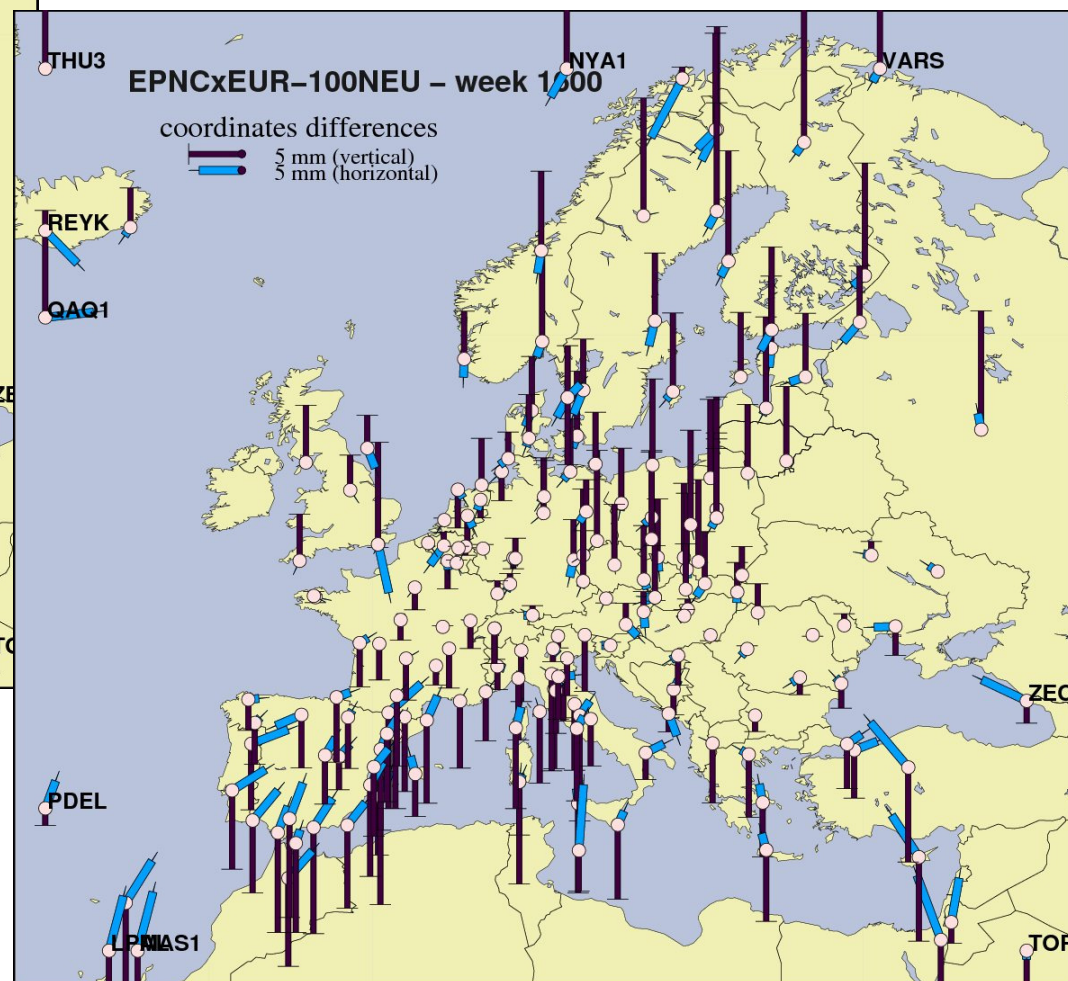
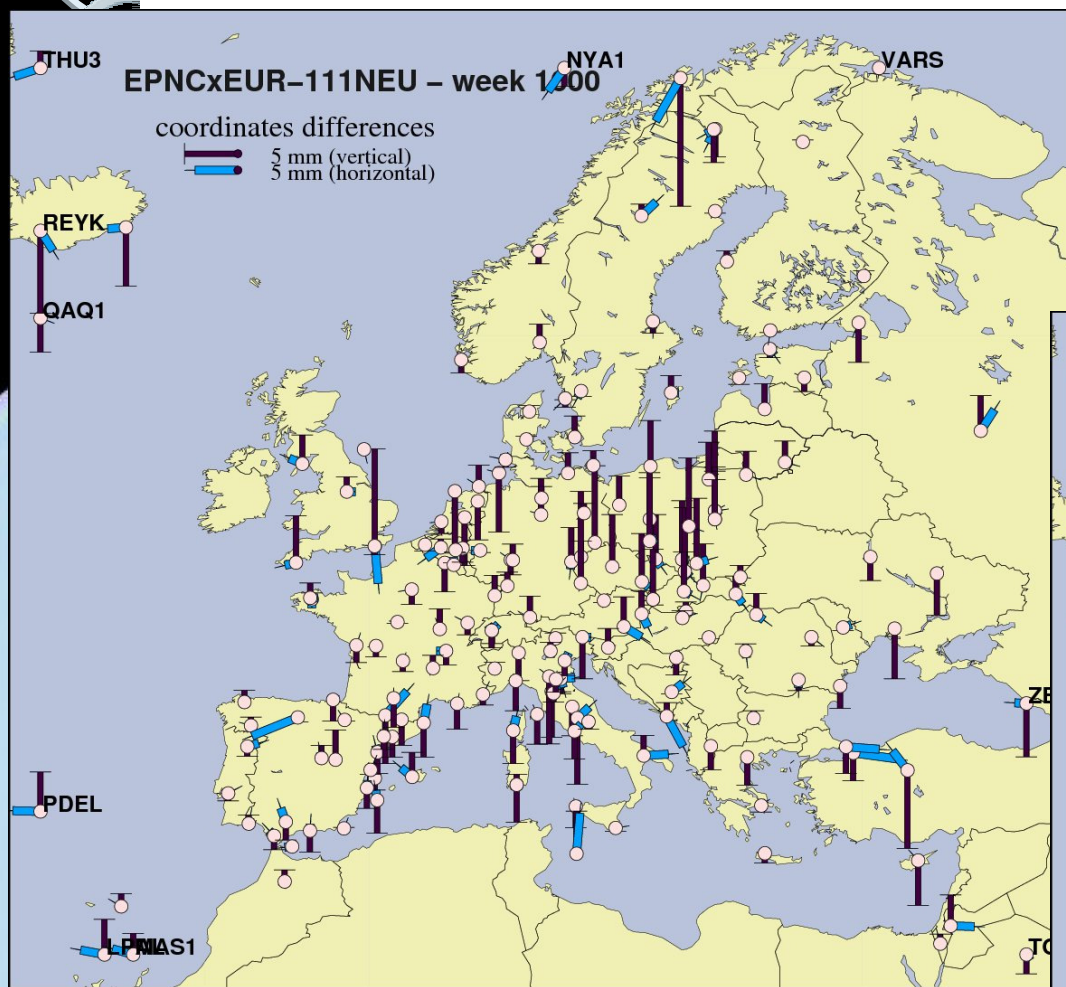


GOP repro-1
x
EPN_C1355

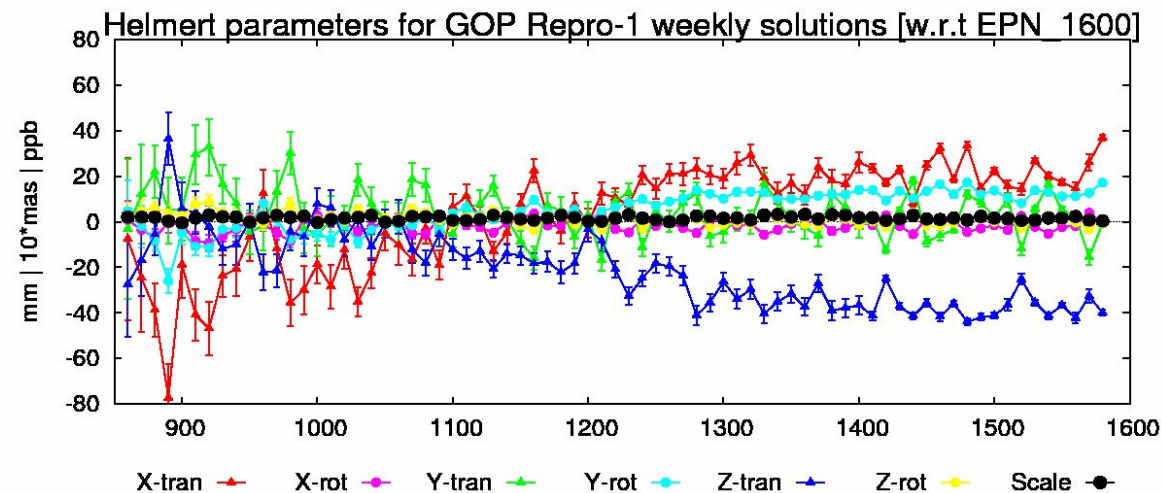
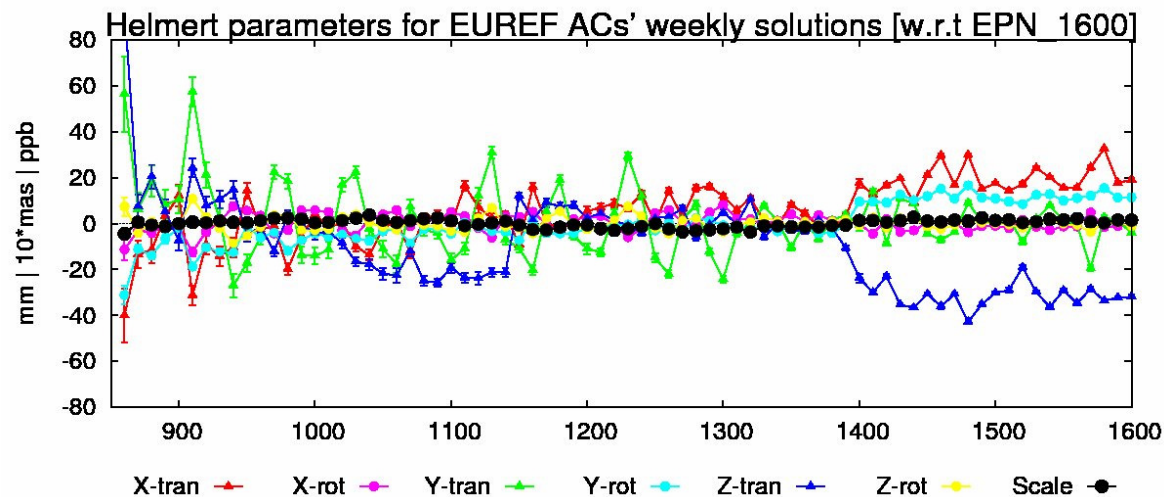
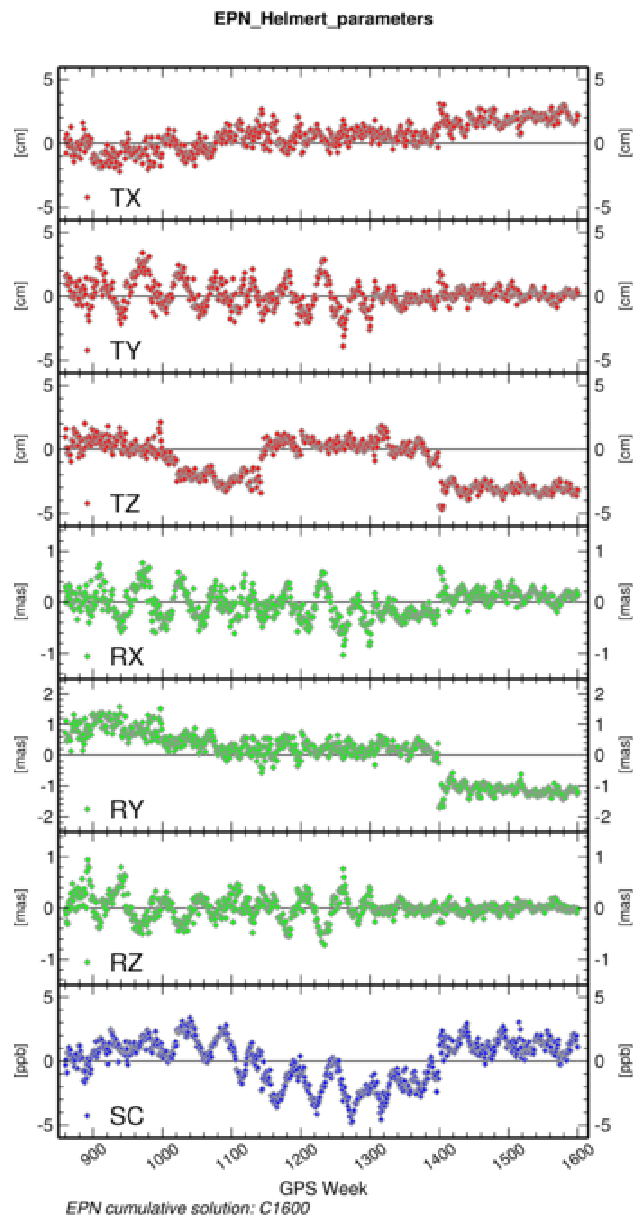
GOP repro-1
x
EPN_C1600



Coordinate residuals



Helmert parameters (XYZ)



Improvement of Ref frame

Additional observation in **space-domain**

- **DENSIFICATION** – the improvement of RF realisation in space CRD(!)+VEL

Additional observation in **time-domain**

- **UPDATE** – the improvement of RF realisation in time CRD+VEL(!)

European RF densification

~ 5 year coordinate prediction required !?

=> extrapolation mainly based on velocity datum

EPN_1355 – regional GPS densification of ITRF2005

- currently datum derived using NNT+NNR+NNS

EPNC solution (e.g. EPNC_1600) – regional GPS densification and update (new observations in time)

- currently datum derived using NNT+NNR+NNS

National densification

- Densification usually based on the latest data
- Using short periods and neglecting velocities
- Datum definition – coordinates
 - NNT or NNT+NNR+NNS ?
 - *smaller networks than European densification*
 - *if up-to-date models are used in campaign (usually not newer models are used in RF datum), then there is probably no reason for using more than NNT constraints*
- Using:
 - EPNC_1355 (original densification)
 - EPN cumulative (more up-to-date, thus should be more precise in time domain !)

Summary

- 2010 - observed N-S tilting represented by E-rot (NEU) $\sim 0.2\text{mas/year}$ (or equivalent Y-rot + X-tra + Z-tra) for EPN cumulative solution.
- The table (report) comparing ITRF2005 x EPNC_1355 shows 0.046mas/year (dRY), which seems to be small to explain the observed tilt. However, according to the datum definition (NNT+NNR+NNS) should be zero. Additionally, dRY is clearly correlated with dTX+dTZ in Europe.
- NNT+NNR+NNS datum definition is sensitive for cases like QAQ1 and comparison with NNT datum solution could be an indicator of a problem with fiducials set or datum.
- The detail report on the densification is interesting, but finally more questions came out after careful reading.