

## *ILRSA CC*

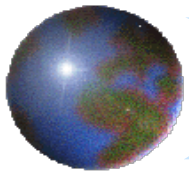
# *Status of the orbit combination products*



**C. Sciarretta, V. Luceri**  
**eGEOS S.p.A., CGS – Matera**

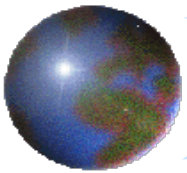


**G. Bianco**  
**Agenzia Spaziale Italiana, CGS - Matera**



# Contents

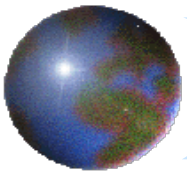
- SP3c combination



# AC weekly orbit - present status

|             |            |   | Comments/notes           |
|-------------|------------|---|--------------------------|
| <b>ASI</b>  | <b>L51</b> | X | OK                       |
|             | <b>L52</b> | X |                          |
|             | <b>L53</b> | X |                          |
|             | <b>L54</b> | X |                          |
| <b>BKG</b>  | <b>L51</b> | x | OK                       |
|             | <b>L52</b> | X |                          |
|             | <b>L53</b> | X |                          |
|             | <b>L54</b> | X |                          |
| <b>DGFI</b> | <b>L51</b> | x | OK                       |
|             | <b>L52</b> | X |                          |
|             | <b>L53</b> | X |                          |
|             | <b>L54</b> | X |                          |
| <b>ESA</b>  | <b>L51</b> | X | <b>L53, L54 every 5'</b> |
|             | <b>L52</b> | X |                          |
|             | <b>L53</b> | X |                          |
|             | <b>L54</b> | X |                          |
| <b>JCET</b> | <b>L51</b> | X | OK                       |
|             | <b>L52</b> | X |                          |
|             | <b>L53</b> | X |                          |
|             | <b>L54</b> | X |                          |

|             |            |   | Comments/notes |
|-------------|------------|---|----------------|
| <b>GFZ</b>  | <b>L51</b> | X | OK (01/10/13)  |
|             | <b>L52</b> | X |                |
|             | <b>L53</b> | - |                |
|             | <b>L54</b> | - |                |
| <b>NSGF</b> | <b>L51</b> | X | OK (01/10/13)  |
|             | <b>L52</b> | X |                |
|             | <b>L53</b> | X |                |
|             | <b>L54</b> | X |                |

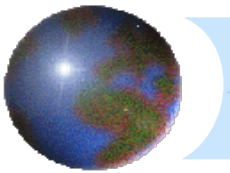


# SP3c data evaluation

- L51/L52/L53/L54 SP3c files available at CDDIS and EDC – march 2013
- cross-evaluate their consistency (RAC)
- Try a preliminary combination among the more coherent ones

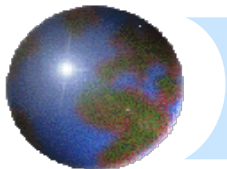
## *Product Features*

- EF frame tied to SLRF2008
- UTC
- SP3c format
- 2' POS/VEL L51/L52
- 15' POS/VEL L53/L54



## SP3c files - remarks

- L51/L52 asi, bkg, dgfi, gfz, jcet, nsgf
- L53/L54 asi, bkg, dgfi, jcet, nsgf
- Format check
  - nok esa: L53/L54 5'
- asi, bkg, gfz, nsgf coherent ( $\sim 2-4\text{cm}$  C-A L51/L52)
- dgfi shows discrepancies in A component
- *jcet shows big differences in C component*
- Evident differences in the dynamic modelling
- Test combination for L51 using asi, bkg, gfz, nsgf



# L51 – summary (sample 24/2 -3/3/2013)

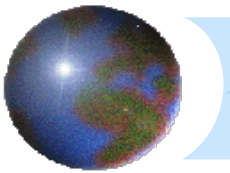
|                 |   |                  |
|-----------------|---|------------------|
| GFZ – BKG<br>cm | R | $-0.01 \pm 0.75$ |
|                 | C | $-0.05 \pm 2.30$ |
|                 | A | $-0.87 \pm 2.61$ |
| GFZ – ASI<br>cm | R | $-0.06 \pm 0.77$ |
|                 | C | $-0.10 \pm 3.55$ |
|                 | A | $-0.52 \pm 3.57$ |
| ASI-BKG<br>cm   | R | $+0.05 \pm 0.43$ |
|                 | C | $+0.05 \pm 4.34$ |
|                 | A | $-0.09 \pm 3.59$ |

|                  |   |                  |
|------------------|---|------------------|
| GFZ – DGFI<br>cm | R | $-0.08 \pm 0.97$ |
|                  | C | $-0.08 \pm 2.78$ |
|                  | A | $+1.57 \pm 4.24$ |
| DGFI – ASI<br>cm | R | $+0.02 \pm 0.91$ |
|                  | C | $-0.01 \pm 3.96$ |
|                  | A | $-2.29 \pm 5.30$ |
| DGFI-BKG<br>cm   | R | $+0.07 \pm 0.74$ |
|                  | C | $+0.03 \pm 2.13$ |
|                  | A | $-2.44 \pm 4.71$ |

|                  |   |                  |
|------------------|---|------------------|
| GFZ – DGFI<br>cm | R | $-0.08 \pm 0.97$ |
|                  | C | $-0.08 \pm 2.78$ |
|                  | A | $+1.57 \pm 4.24$ |
| DGFI – ASI<br>cm | R | $+0.02 \pm 0.91$ |
|                  | C | $-0.01 \pm 3.96$ |
|                  | A | $-2.29 \pm 5.30$ |
| DGFI-BKG<br>cm   | R | $+0.07 \pm 0.74$ |
|                  | C | $+0.03 \pm 2.13$ |
|                  | A | $-2.44 \pm 4.71$ |

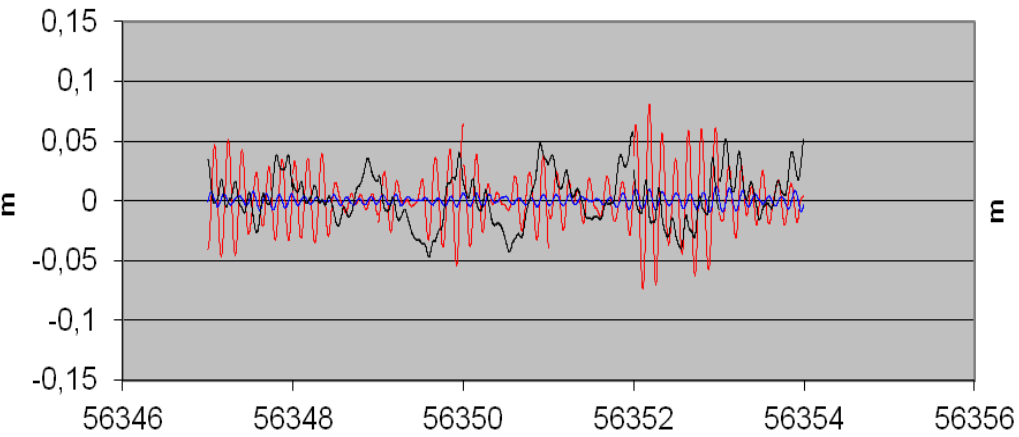
|                  |   |                  |
|------------------|---|------------------|
| ESOC-ASI<br>cm   | R | $+0.04 \pm 0.62$ |
|                  | C | $-0.58 \pm 9.66$ |
|                  | A | $+4.77 \pm 3.44$ |
| ESOC-BKG<br>cm   | R | $+0.09 \pm 0.30$ |
|                  | C | $-0.53 \pm 8.98$ |
|                  | A | $+4.62 \pm 1.51$ |
| GFZ - ESOC<br>cm | R | $-0.10 \pm 0.67$ |
|                  | C | $+0.48 \pm 7.59$ |
|                  | A | $-5.49 \pm 3.15$ |

|                  |   |                  |
|------------------|---|------------------|
| ASI-NSGF<br>cm   | R | $+0.05 \pm 0.67$ |
|                  | C | $+0.08 \pm 4.05$ |
|                  | A | $+0.28 \pm 3.30$ |
| NSGF-BKG<br>cm   | R | $+0.01 \pm 0.60$ |
|                  | C | $-0.03 \pm 2.55$ |
|                  | A | $-0.36 \pm 2.78$ |
| GFZ - NSGF<br>cm | R | $-0.02 \pm 0.62$ |
|                  | C | $-0.01 \pm 2.49$ |
|                  | A | $-0.51 \pm 2.37$ |

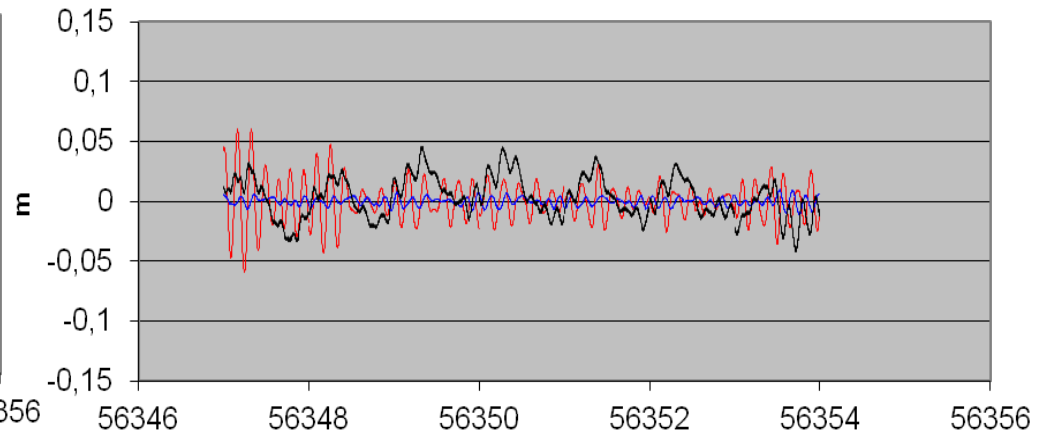


# L51 NSGF-ASI-BKG-GFZ vs Combination

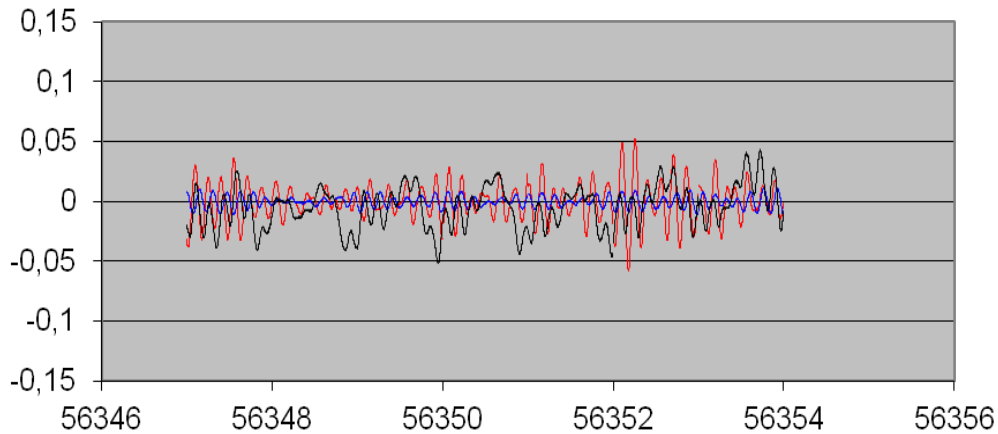
ASI-C



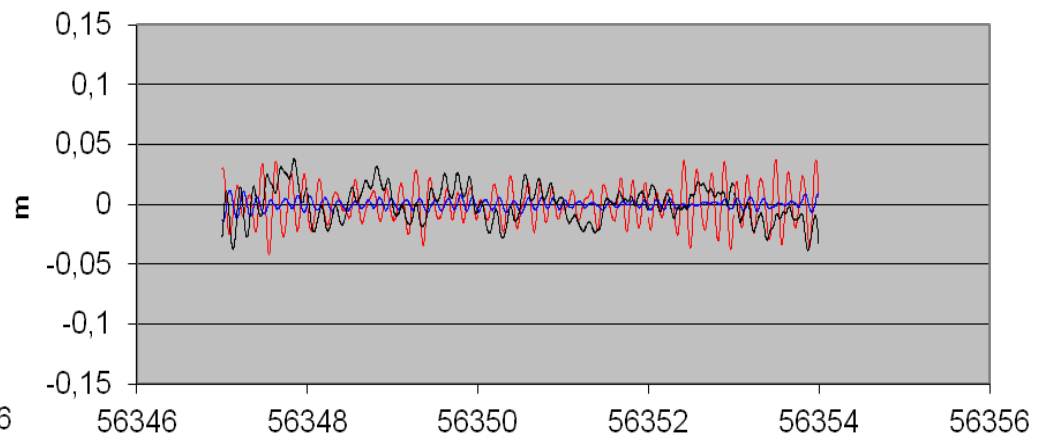
BKG-C

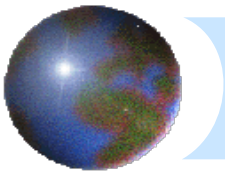


GFZ-C



NSGF-C



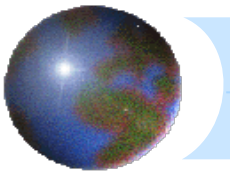


# L51 NSGF-ASI-BKG-GFZ vs Combination

|                      |          |                     |
|----------------------|----------|---------------------|
| <b>ASI - C</b><br>cm | <b>R</b> | <b>+0.04 ± 0.38</b> |
|                      | <b>C</b> | <b>+0.06 ± 2.42</b> |
|                      | <b>A</b> | <b>+0.20 ± 2.10</b> |
| <b>GFZ - C</b><br>cm | <b>R</b> | <b>-0.02 ± 0.47</b> |
|                      | <b>C</b> | <b>-0.04 ± 1.61</b> |
|                      | <b>A</b> | <b>-0.52 ± 1.77</b> |

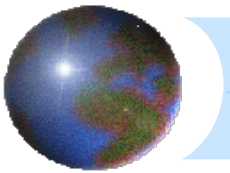
|                       |          |                     |
|-----------------------|----------|---------------------|
| <b>BKG - C</b><br>cm  | <b>R</b> | <b>-0.01 ± 0.34</b> |
|                       | <b>C</b> | <b>+0.01 ± 1.70</b> |
|                       | <b>A</b> | <b>+0.35 ± 1.71</b> |
| <b>NSGF - C</b><br>cm | <b>R</b> | <b>-0.01 ± 0.37</b> |
|                       | <b>C</b> | <b>-0.02 ± 1.57</b> |
|                       | <b>A</b> | <b>-0.02 ± 1.46</b> |





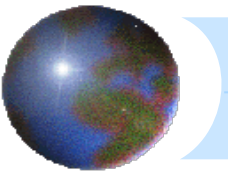
# Combination evaluation, weighting, etc.

- As a first step, the combination has been computed as a simple mean of the contributing solutions SVs
- We can associate to each series a formal error given by the 3D discrepancy wrt combination (RSS of the R, C, A residuals RMS)
  - **ASI: 3.23 cm**
  - **GFZ: 2.49 cm**
  - **BKG: 2.46 cm**
  - **NSGF: 2.18 cm**
- and we can associate to the combination the formal error propagating the contributing solutions formal error
  - **C: 1.26 cm**



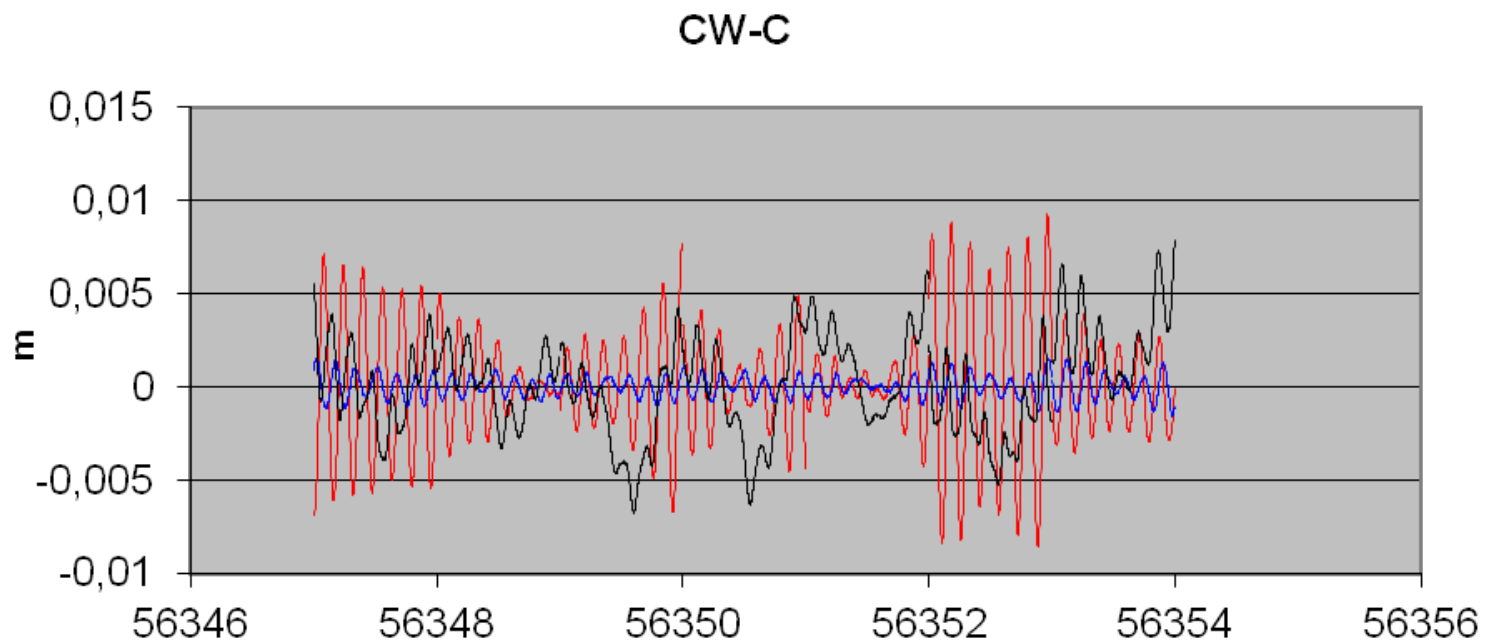
# Combination evaluation, weighting, etc.

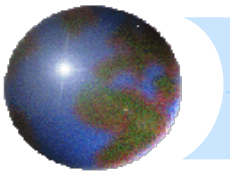
- As a second step, we can compute a combination  $C'$  as a weighted mean of the contributing solutions SVs, using as weights  $w_i = 1/\sigma_i^2 / \Sigma(1/\sigma^2)$
- In that case, the 3D discrepancies wrt combination (RSS of the R, C, A residuals RMS) are
  - **ASI: 3.63 cm**
  - **GFZ: 2.35 cm**
  - **BKG: 2.39 cm**
  - **NSGF: 1.95 cm**
- and the propagated formal error
  - **C: 1.20 cm**



# Combination evaluation, weighting, etc.

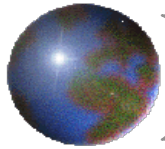
- i.e., as expected, the combination 'awards' the best solutions (the closer ones), even if the overall benefit appears to be small





## Next steps

- Start on 2014.0 the routinary production (not public) of the combined orbit files for L51 and L52, using gfz, bkg, asi, and nsgf 'bulk' solutions (all 4 solutions available?)
- Apply a 2-step combination scheme, deriving weights
- Evaluate the quality and stability of this 'pilot' solution for a couple of months, deriving corrective actions, in particular to remove periodic signals evident in the series
- Integrate the other solutions when available, using the weighted combination and the outcomes of the evaluation of the 'bulk' combination



# *Update of the ILRS Data handling file and SLRF2008*



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**e-GEOS S.p.A., CGS – Matera**



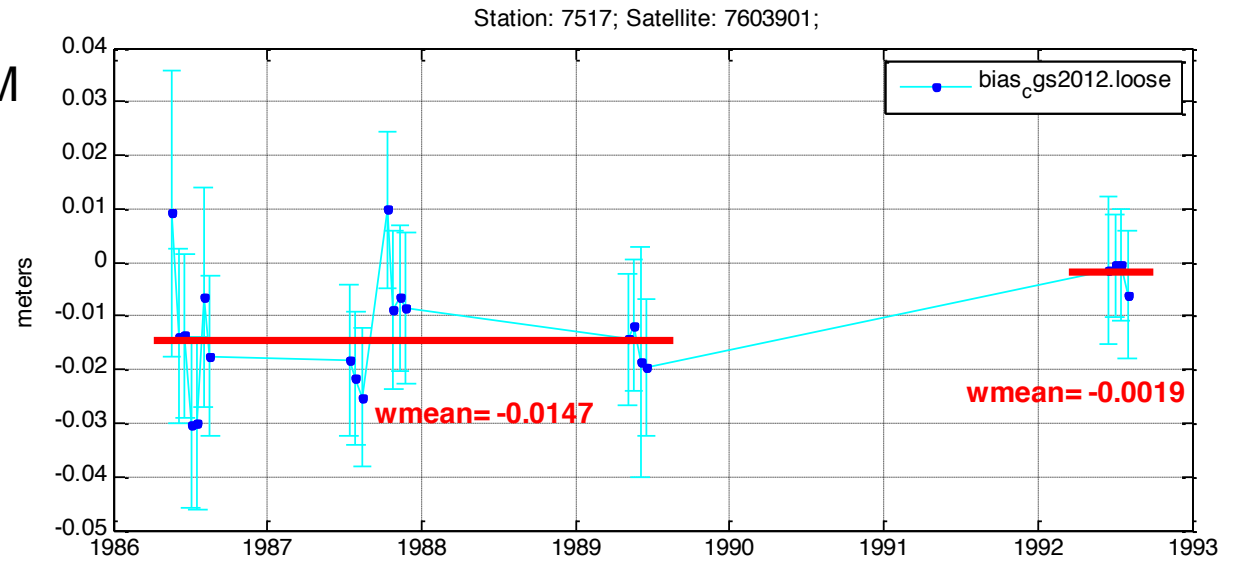
**G. Bianco**  
**Agenzia Spaziale Italiana, CGS - Matera**

# Data Handling Update

|      | OLD  | NEW  | Note  |
|------|--|--|---|
| 7517 | 92:153:00000 To 92:245:00000<br>Bias -94.00  | <b>Change</b><br>92:153:00000 To 92:245:00000<br><b>Bias -80.00</b>      |   |
| 7544 | 92:245:00000 To 93:001:00000<br>Bias -85.00  | <b>Change</b><br>92:245:00000 To 93:001:00000<br><b>Bias -60.00</b>      |   |
| 7811 | 93:201:00000 To 98:139:00000<br>Bias -50.00<br>--<br>98:139:00000 To 02:126:00000<br>Bias -30.00 | <b>Change</b><br>93:201:00000 To<br>02:126:00000<br><b>Bias -30.00</b>   |   |
| 7838 | 04:183:00000 To 00:000:00000<br>Bias +10.00  | <b>Remove bias</b>   | ILRS/AWG 09/01/18<br>No information found in the distributed biases               |
| 7840 |  | <b>Insert bias</b><br>85:001:00000 To 88:254:00000<br><b>Bias -10.00</b> | The bias was neglected in the first estimation but the time series confirms it is |
| 7841 |  | <b>Insert bias</b><br>11:182:00000 To 00:000:00000<br><b>Bias +10.00</b> | New system  |
| 7845 |  | <b>Insert bias</b><br>08:182:00000To 00:000:00000<br><b>Bias -14.00</b>  | New system  |

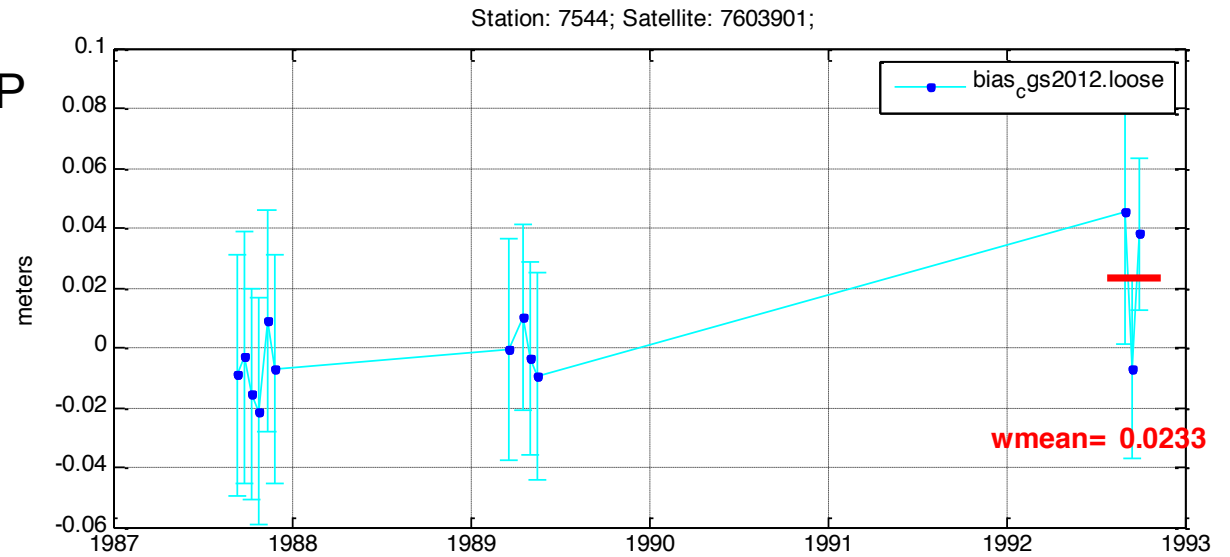
|      |                                      |
|------|--------------------------------------|
| 1873 | Delete from 01/09/2009 to 01/01/2012 |
| 8834 | Delete from 15/02/2009 to 15/11/2010 |

# 7517 - ROUM



7517 --- mm A 92:153:00000 92:245:00000 R -94.00  
to be changed in -80

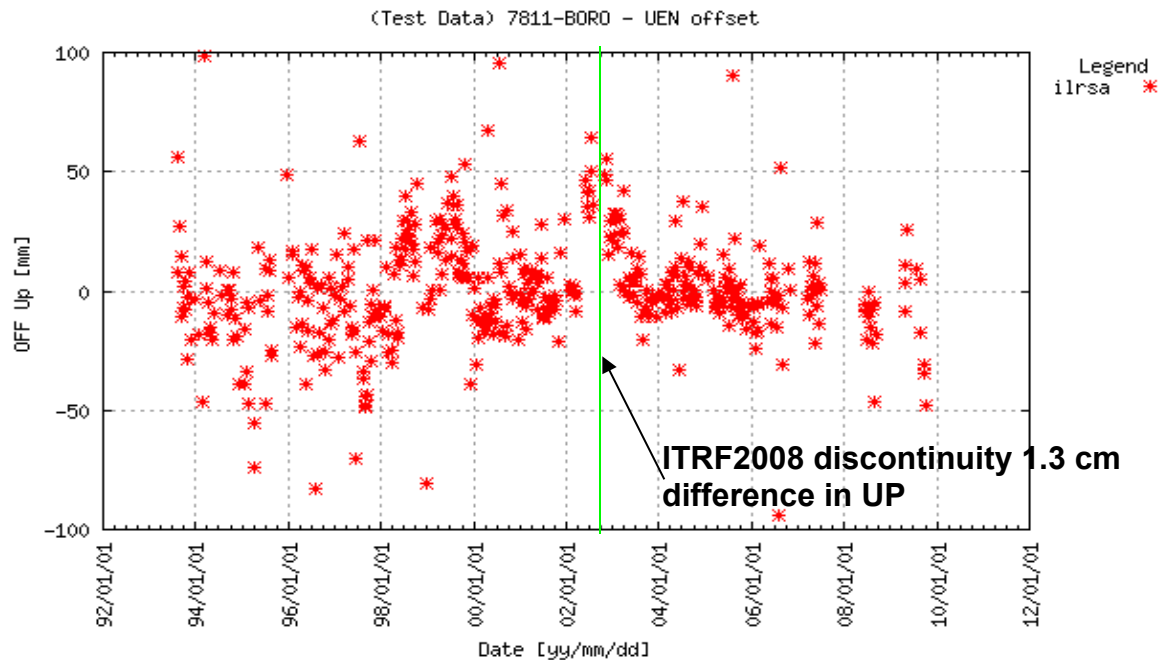
# 7544 - LAMP



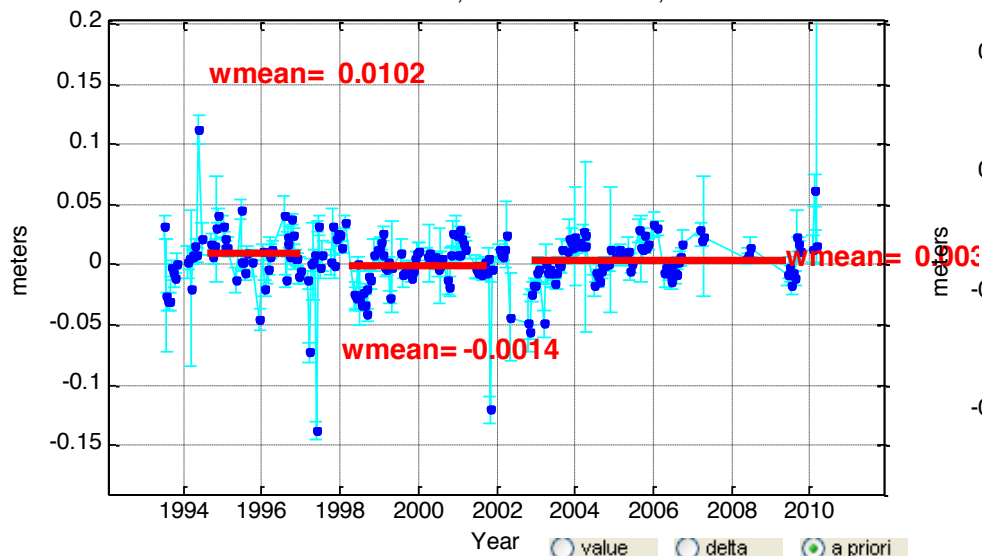
7544 --- mm A 92:245:00000 93:001:00000 R -85.00  
to be changed in -60

# 7811 - BORO

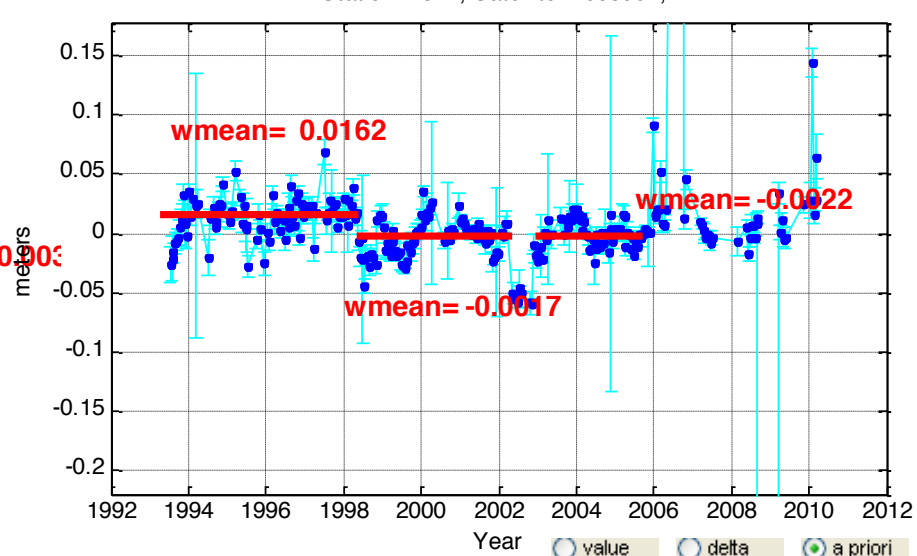
93:201:00000 98:139:00000 R -50.00  
 98:139:00000 02:126:00000 R -30.00  
 to be changed in  
 93:201:00000 02:126:00000 R -30.00



Station: 7811; Satellite: 9207002;



Station: 7811; Satellite: 7603901;





## 7838 - SIMO

7838 --- mm A 04:183:00000 00:000:00000 R +10.00 ILRS/AWG 09/01/18

- The bias is defined in the Stanford correction list  
[http://ilrs.gsfc.nasa.gov/network/site\\_information/nsgf\\_stanfordcorrections.html](http://ilrs.gsfc.nasa.gov/network/site_information/nsgf_stanfordcorrections.html)
- A discontinuity is defined in ITRF2008 at 03:177

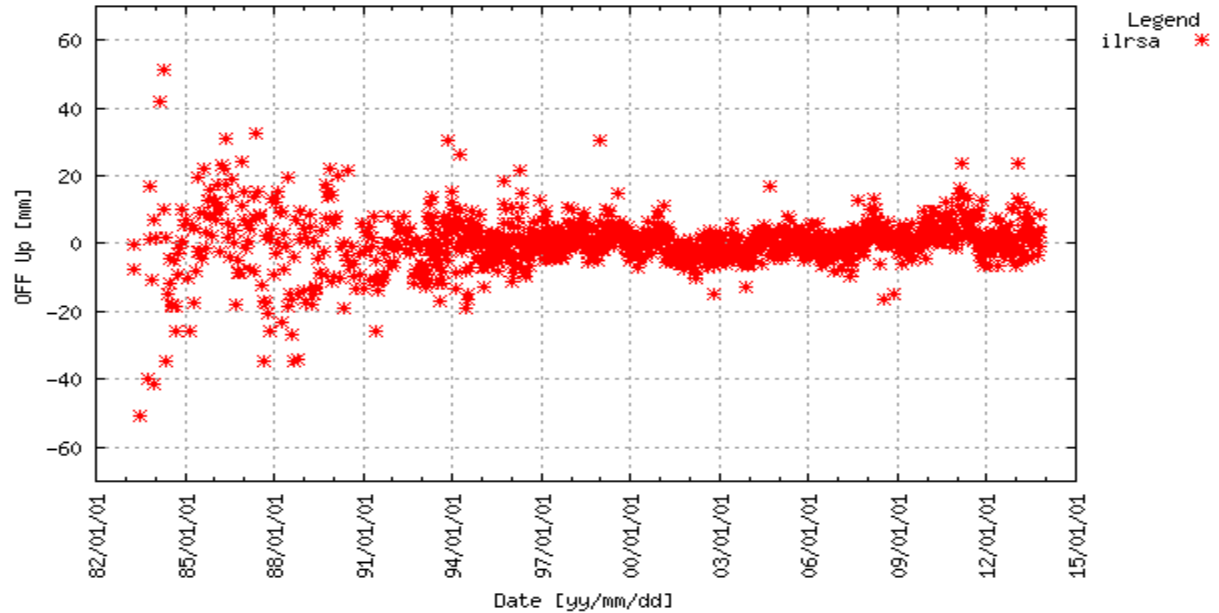
# 7840 - HERST

## AWG biases

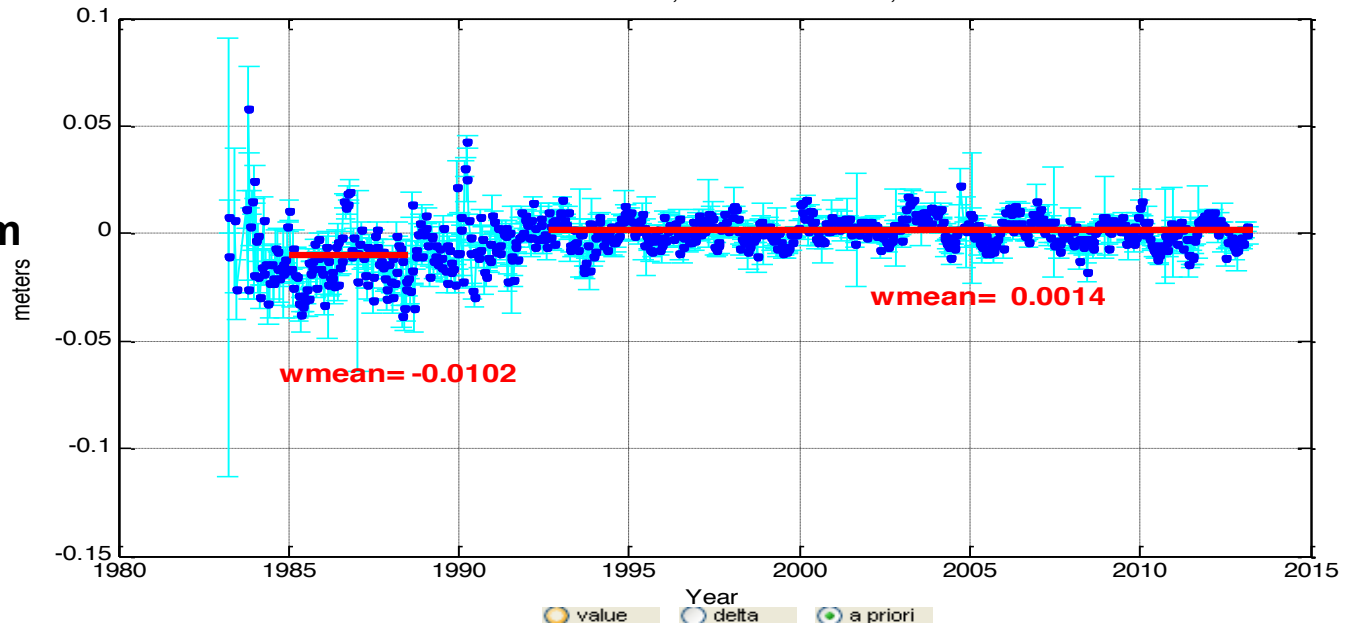
83:244:00000 84:136:00000 R 40.00  
84:136:00000 85:001:00000 R 20.00  
88:254:00000 88:269:00000 R 32.00  
88:269:00000 88:284:00000 R 31.00

**Suggestion:**  
**Insert 1 cm bias from**  
**85:001 to 88:254**

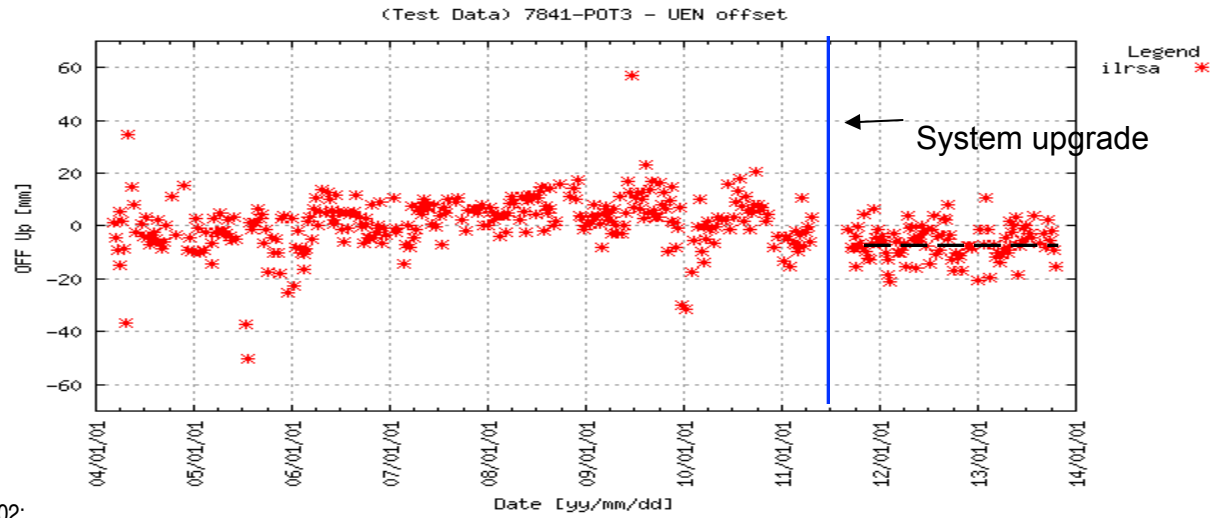
(Test Data) 7840-HERS - UEN offset



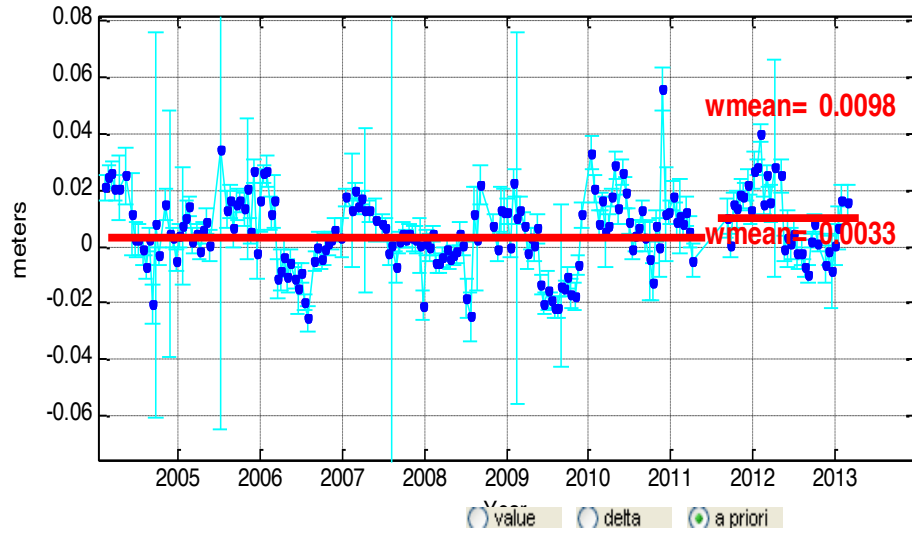
Station: 7840; Satellite: 7603901;



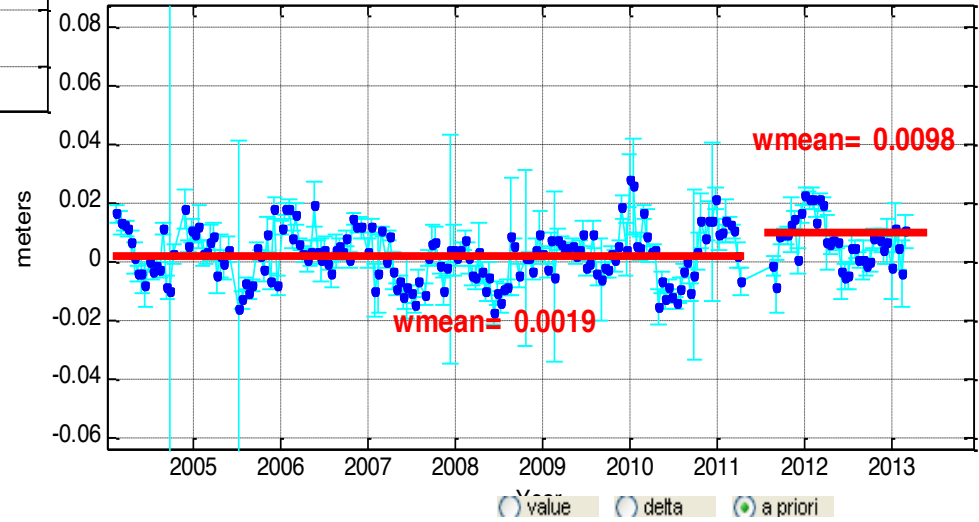
# 7841 - POTS : discontinuity



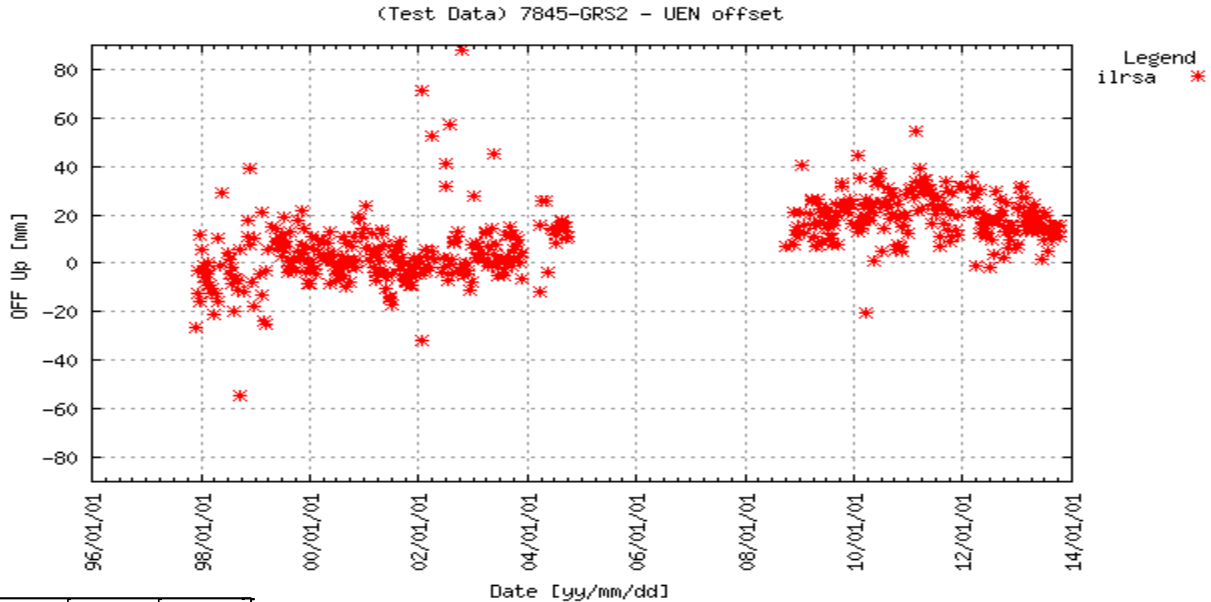
Station: 7841; Satellite: 9207002;



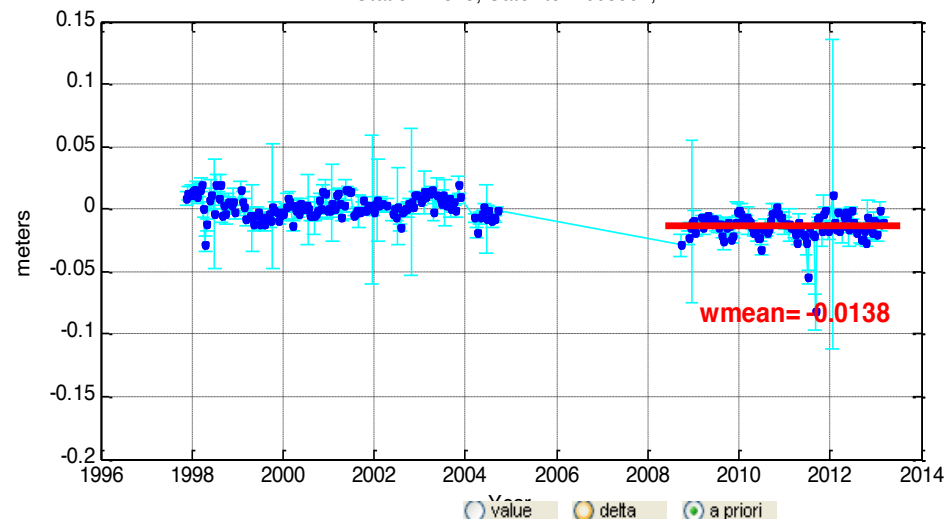
Station: 7841; Satellite: 7603901;



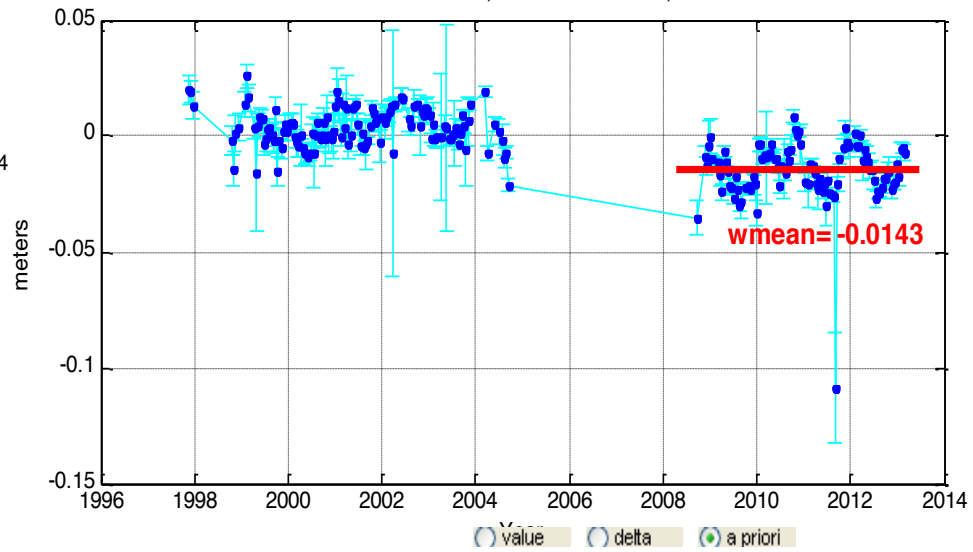
# 7845 - GRS



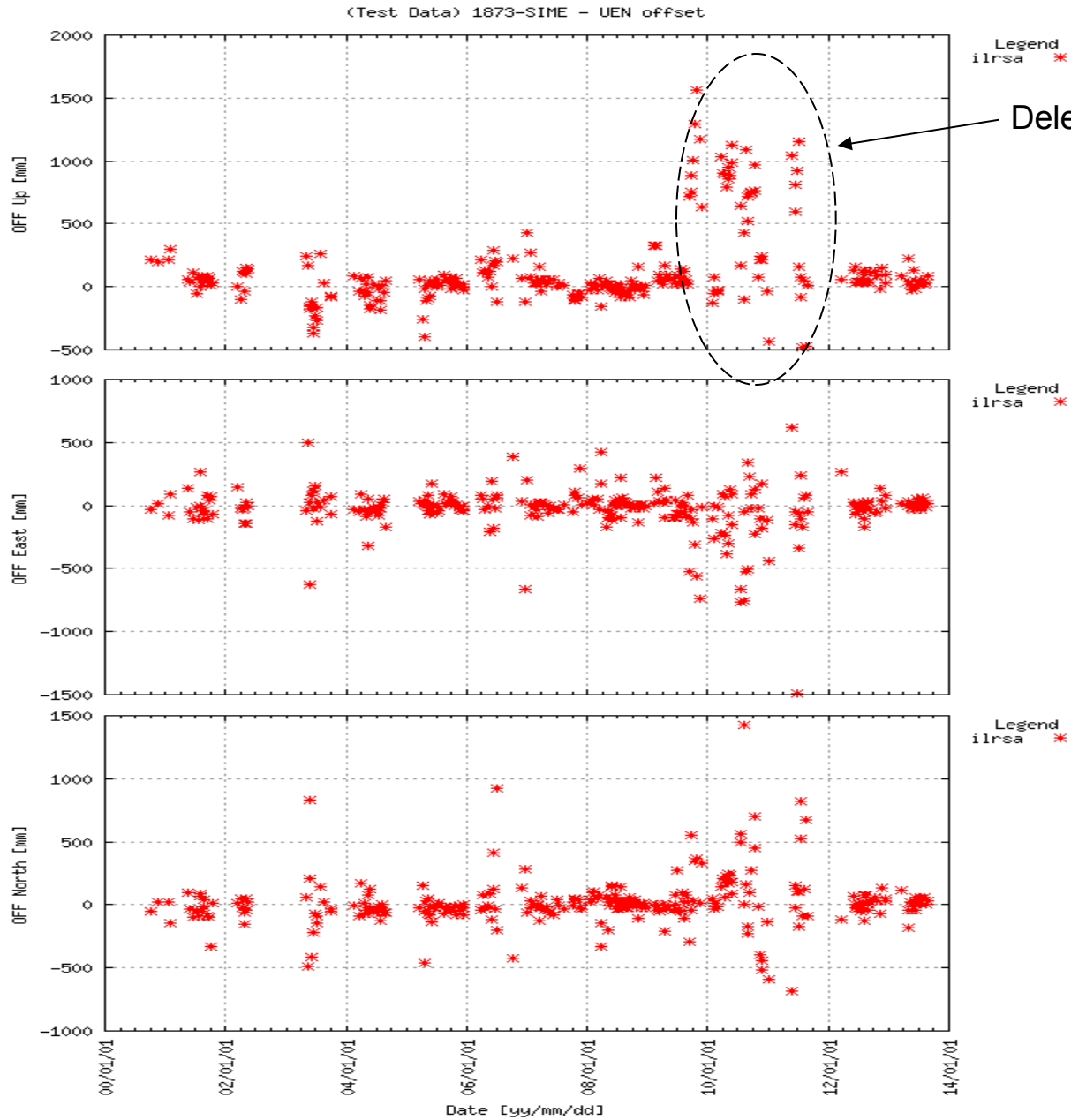
Station: 7845; Satellite: 7603901;



Station: 7845; Satellite: 9207002;

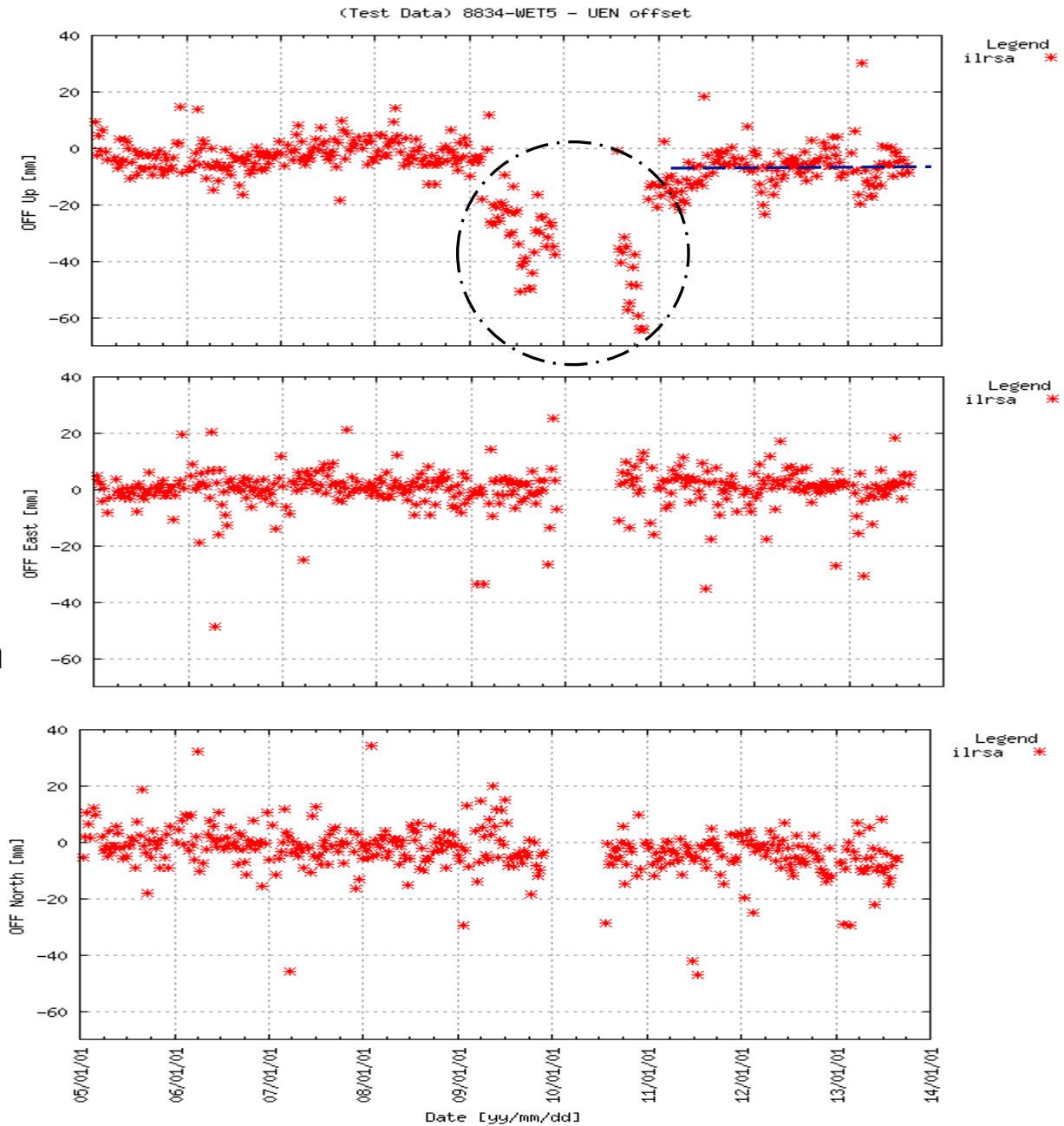


# 1873 - SIME: data problem



Delete from 1/9/2009 to 1/1/2012

# 8834 - WETT : data problem

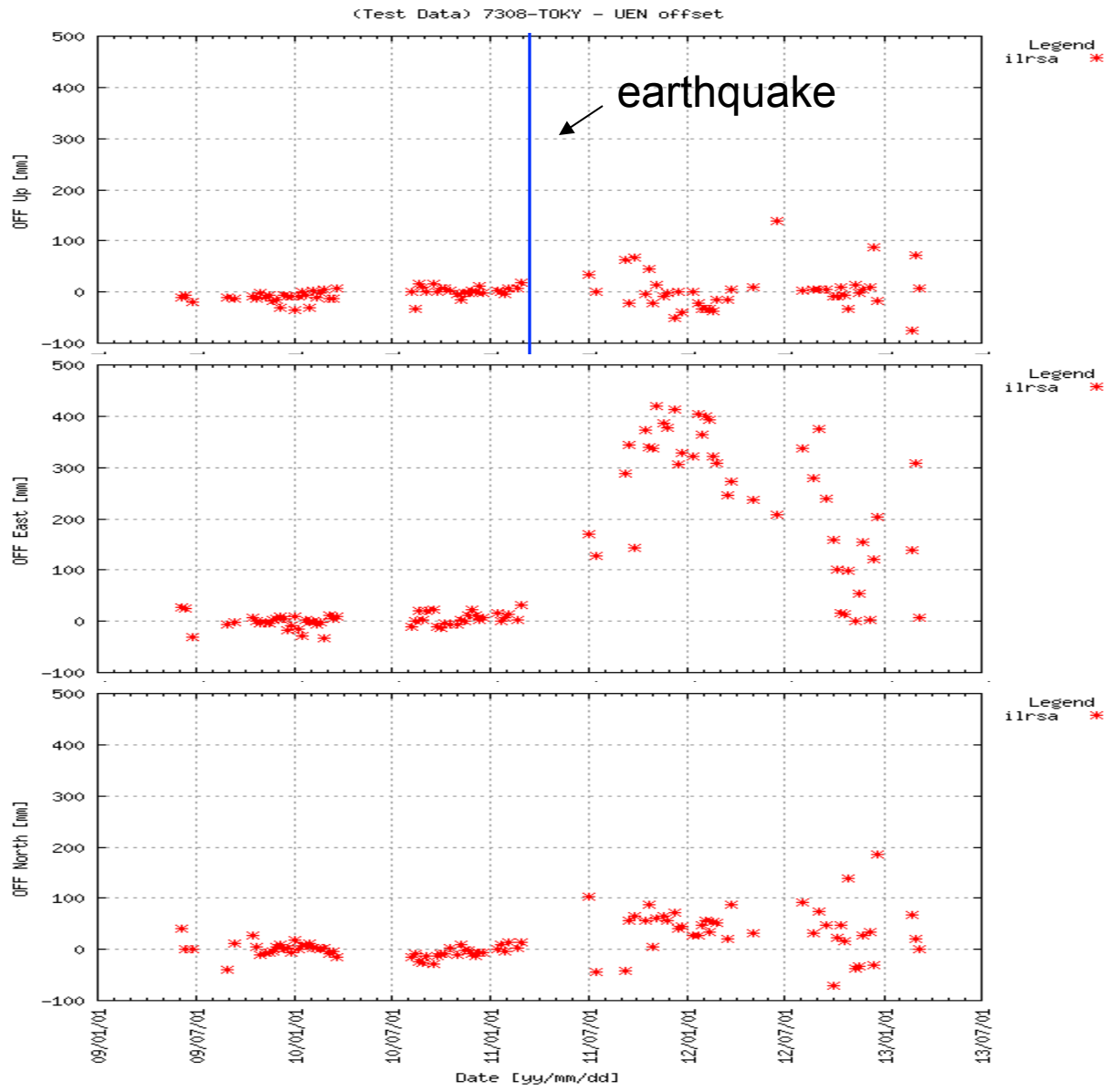


Delete data from  
15/2/2009  
To  
15/11/2010

## *SLRF2008 update*

|      |      |              |     |                |           |
|------|------|--------------|-----|----------------|-----------|
| STAX | 1879 | 05:001:00000 | m   | 543405.9563    | 1.60E-02  |
| STAY | 1879 | 05:001:00000 | m   | 3955302.3666   | 2.20E-02  |
| STAZ | 1879 | 05:001:00000 | m   | 4957821.0360   | 1.50E-02  |
| STAX | 7308 | 05:001:00000 | m   | -3942019.8927  | 4.00E-02  |
| STAY | 7308 | 05:001:00000 | m   | 3368097.7844   | 6.40E-02  |
| STAZ | 7308 | 05:001:00000 | m   | 3702190.9161   | 3.80E-02  |
| STAX | 7405 | 05:001:00000 | m   | 1492030.29807  | 2.00E-02  |
| STAY | 7405 | 05:001:00000 | m   | -4887946.53044 | 1.10E-02  |
| STAZ | 7405 | 05:001:00000 | m   | -3803566.40380 | 1.40E-02  |
| STAX | 7406 | 05:001:00000 | m   | 1984104.3319   | 1.30E-02  |
| STAY | 7406 | 05:001:00000 | m   | -5068867.2450  | 1.10E-02  |
| STAZ | 7406 | 05:001:00000 | m   | -3314482.5720  | 1.10E-02  |
| VELX | 1879 | 05:001:00000 | m/y | -0.0292        | 2.66E-03  |
| VELY | 1879 | 05:001:00000 | m/y | -0.0104        | -2.33E-03 |
| VELZ | 1879 | 05:001:00000 | m/y | -0.0006        | -2.48E-03 |
| VELX | 7308 | 05:001:00000 | m/y | -0.0689        | 3.49E-02  |
| VELY | 7308 | 05:001:00000 | m/y | -0.0603        | 5.37E-02  |
| VELZ | 7308 | 05:001:00000 | m/y | 0.0204         | 3.30E-02  |
| VELX | 7405 | 05:001:00000 | m/y | -0.0406        | 3.50E-04  |
| VELY | 7405 | 05:001:00000 | m/y | -0.0107        | 2.90E-04  |
| VELZ | 7405 | 05:001:00000 | m/y | 0.0166         | 2.70E-04  |
| VELX | 7406 | 05:001:00000 | m/y | 0.0069         | -1.87E-04 |
| VELY | 7406 | 05:001:00000 | m/y | -0.0012        | -1.76E-04 |
| VELZ | 7406 | 05:001:00000 | m/y | 0.0117         | -1.84E-04 |

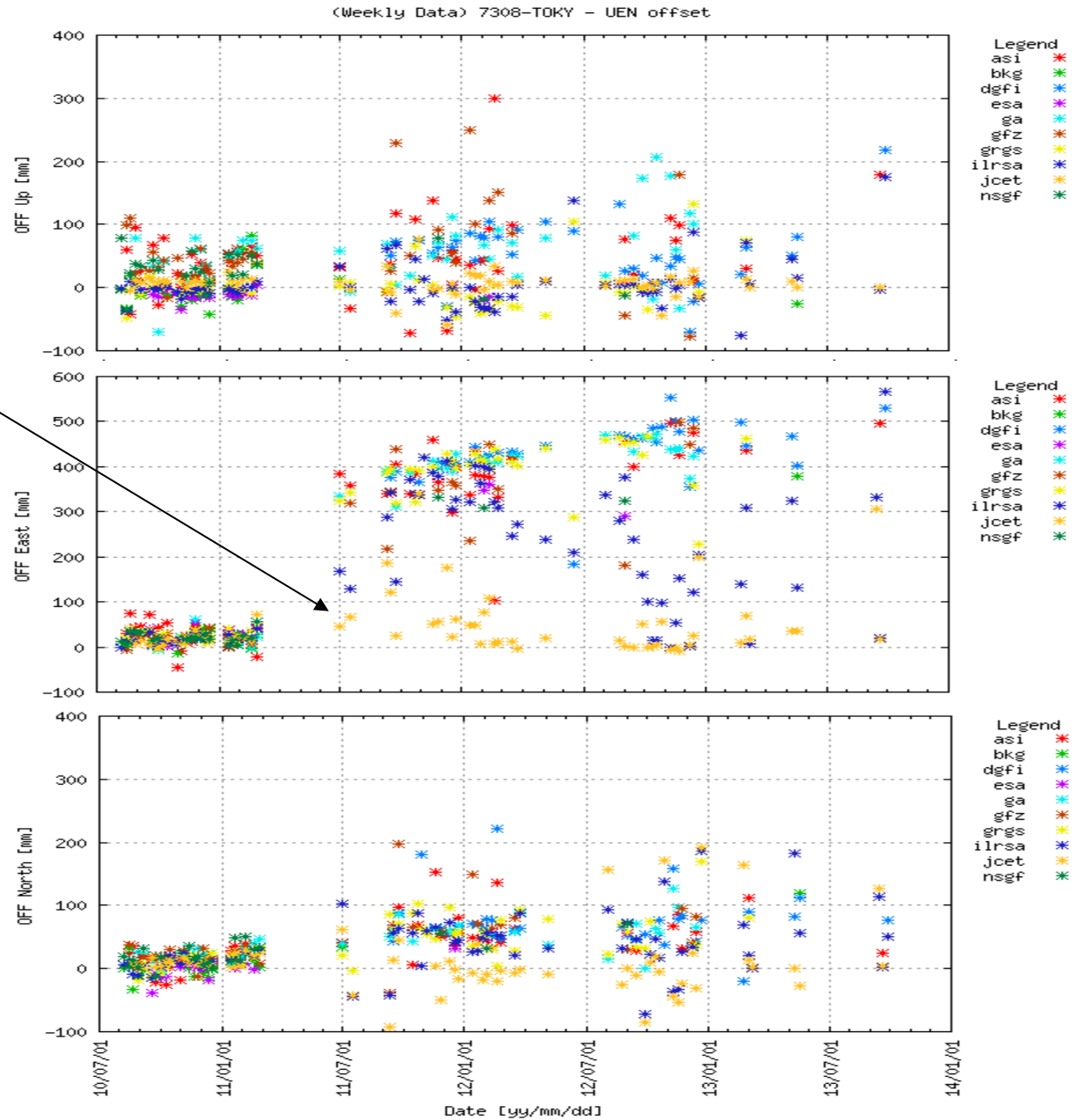
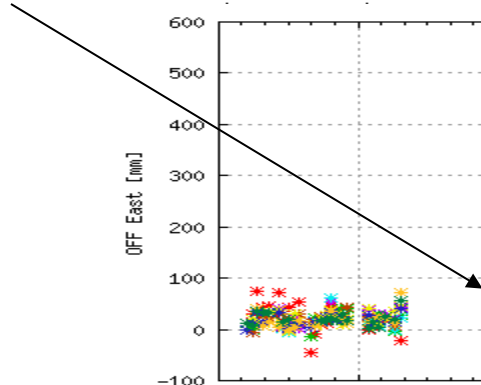
# 7308 : earthquake on 11 March 2011



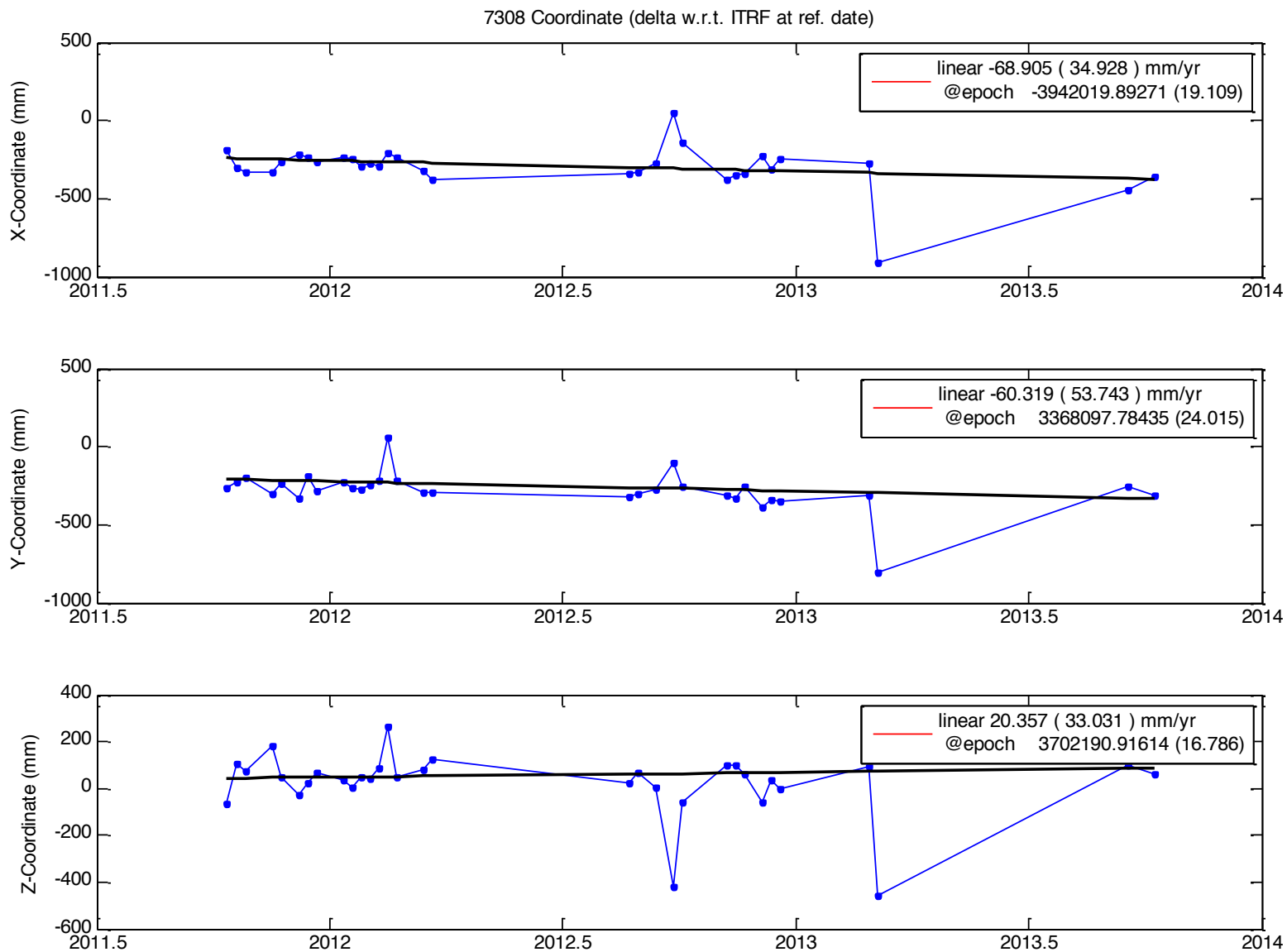


# 7308 : earthquake

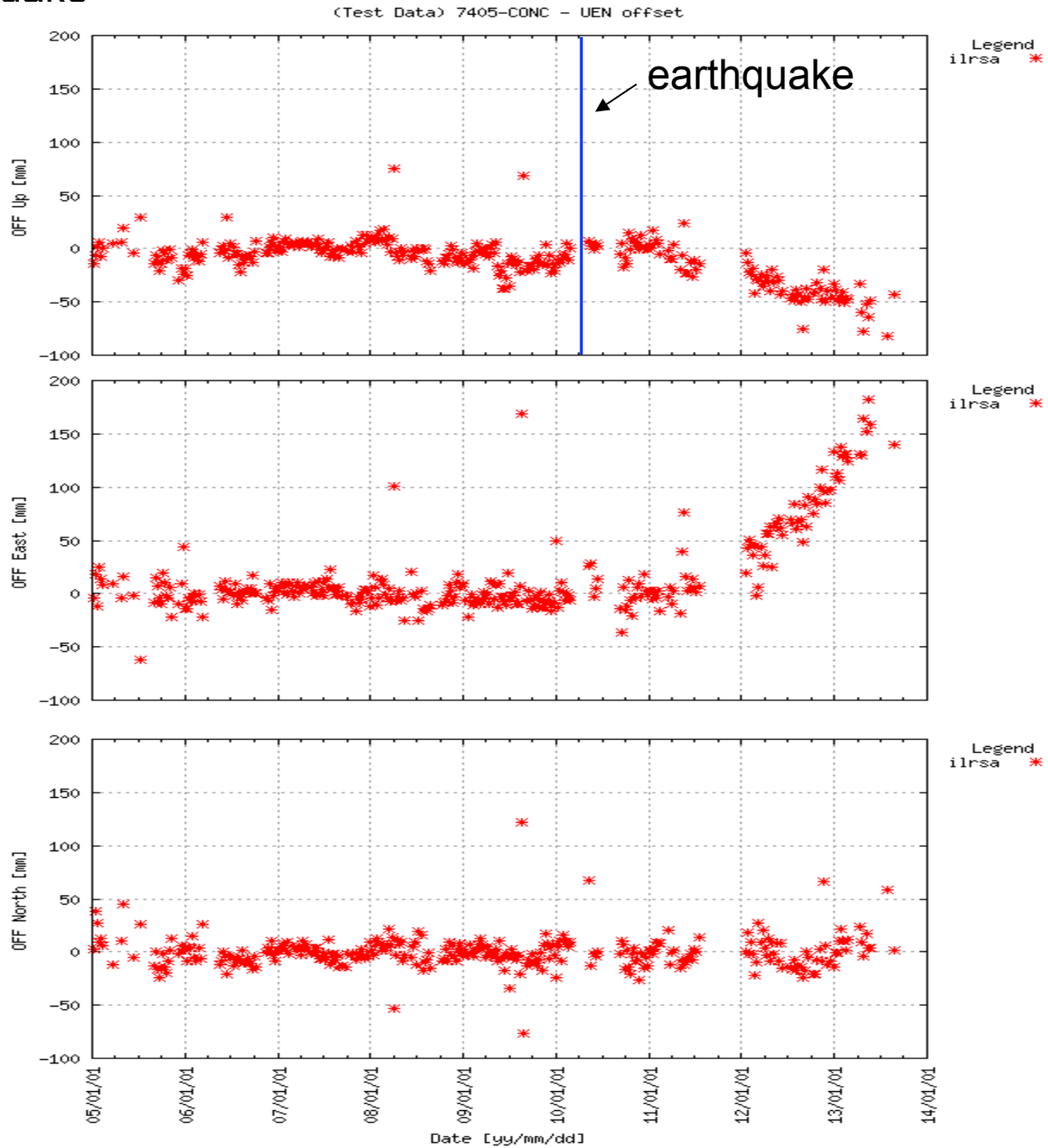
JCET



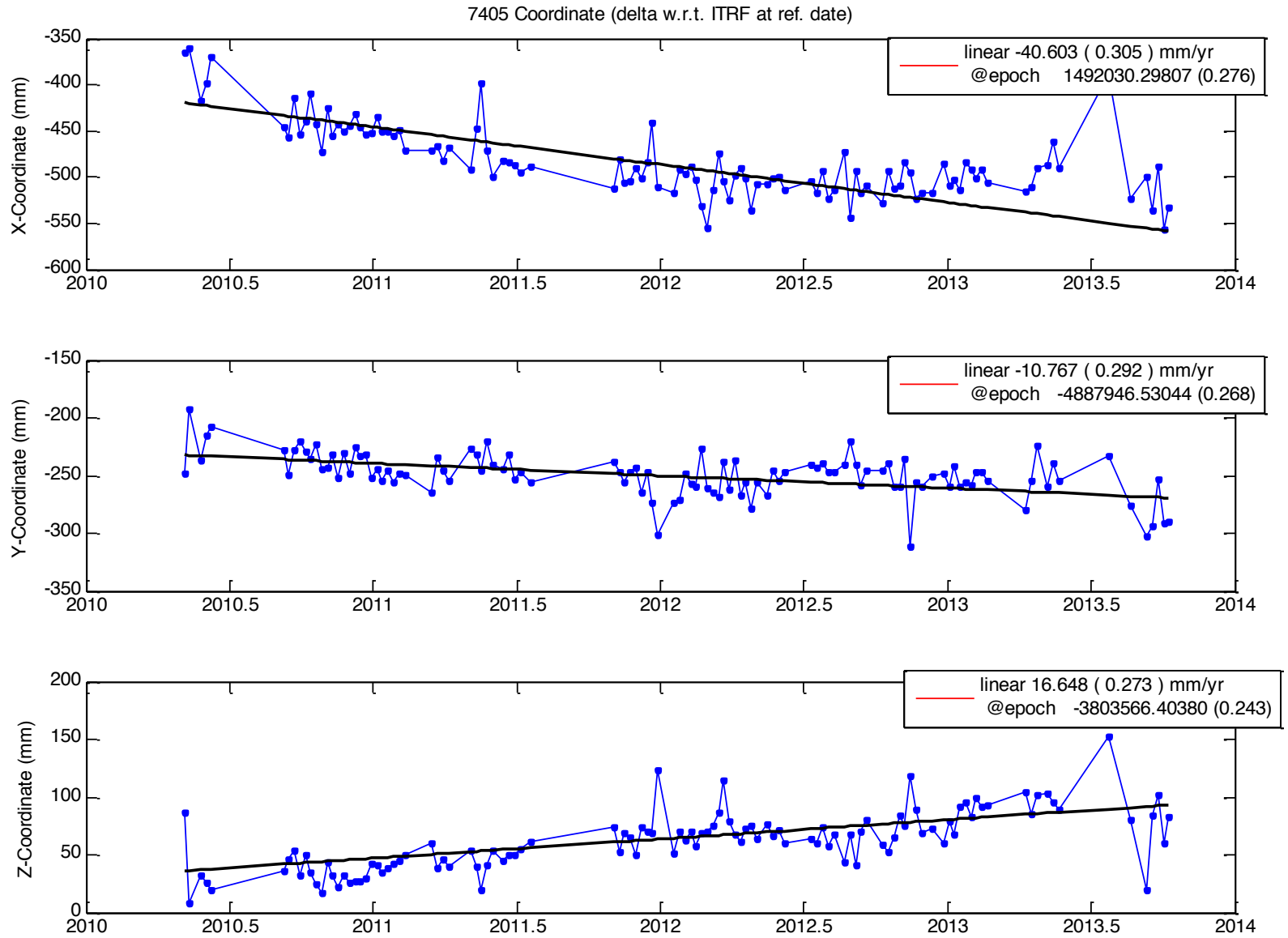
# 7308 : earthquake



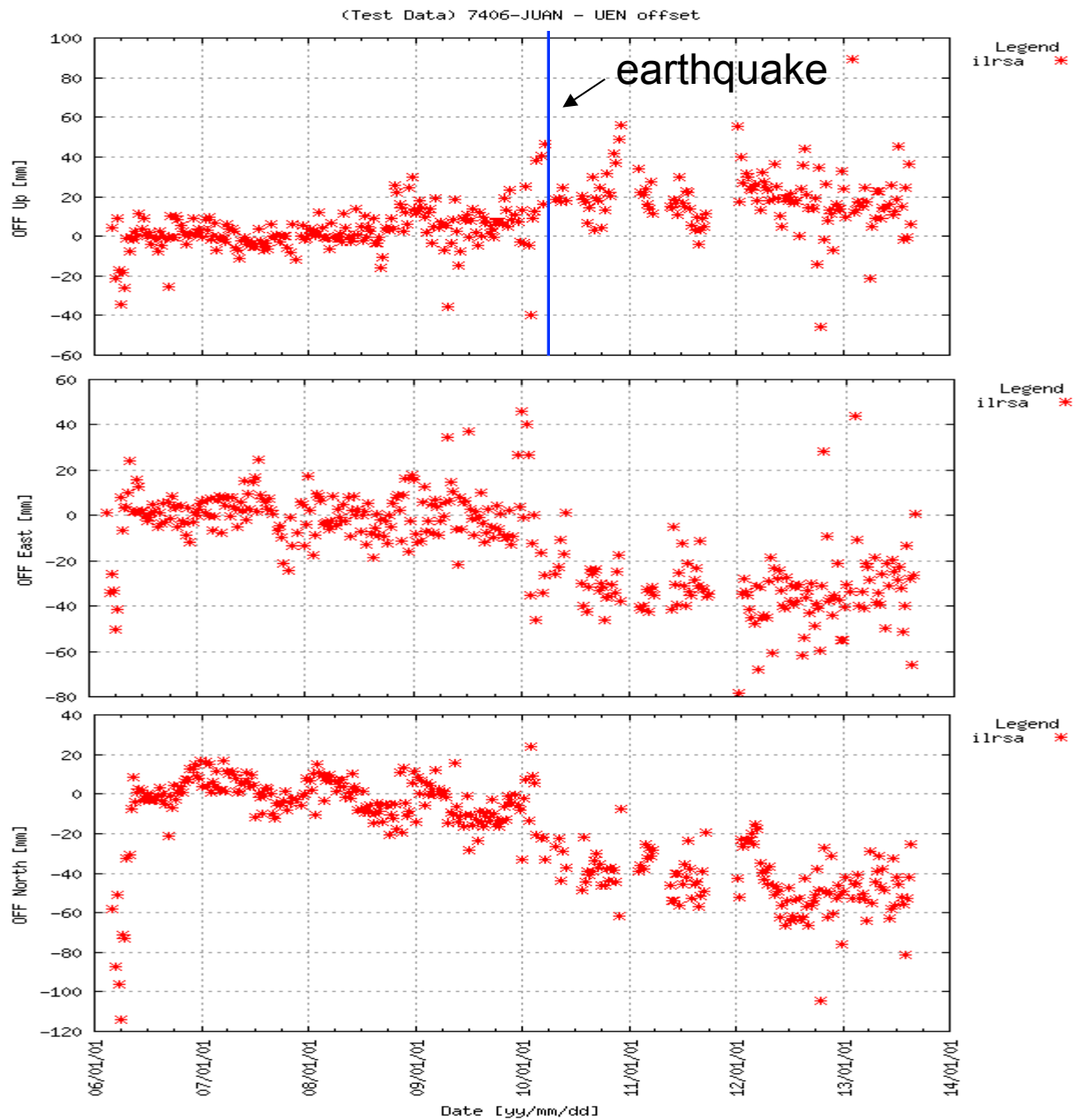
# 7405 : earthquake



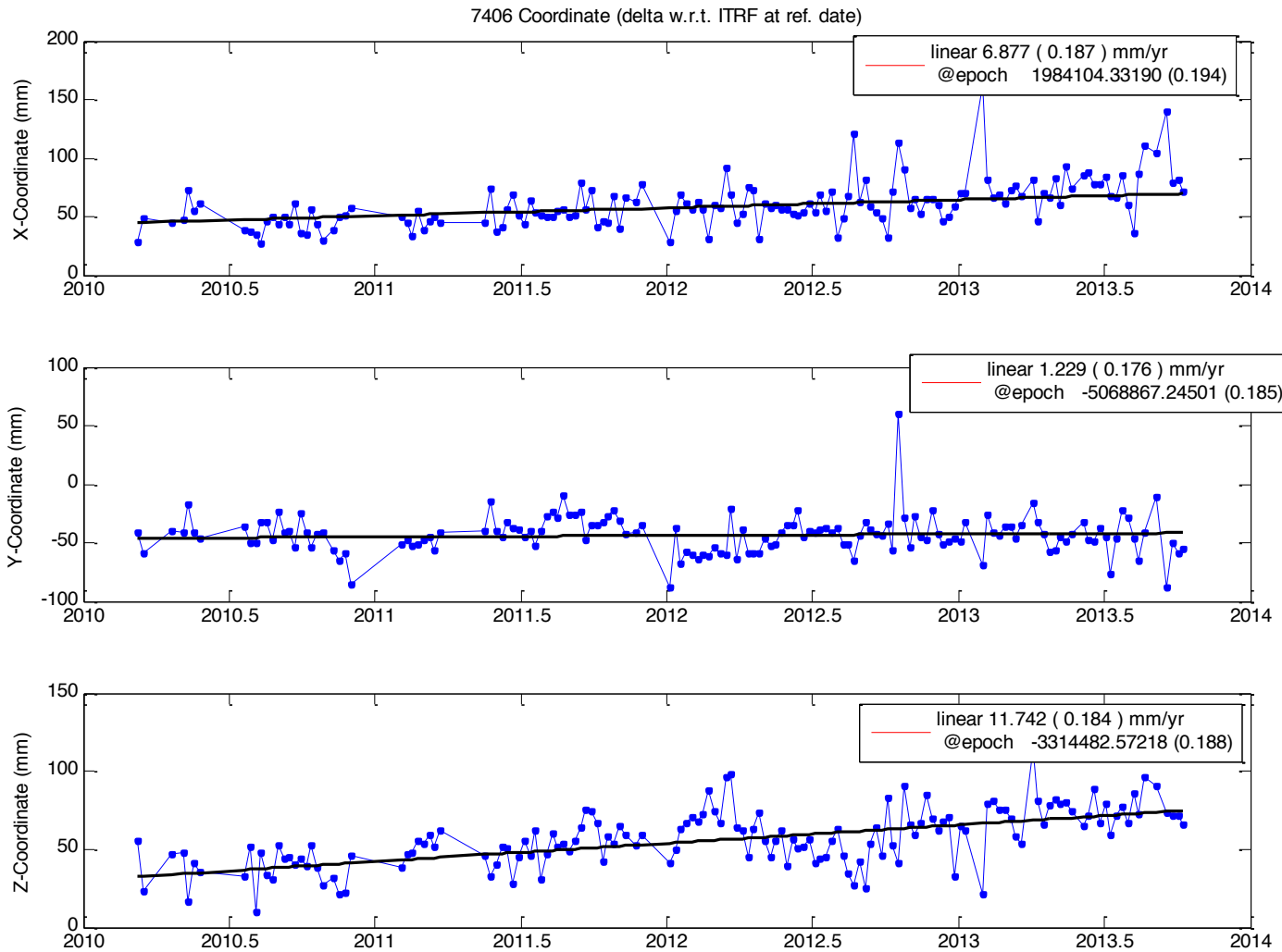
# 7405 : earthquake



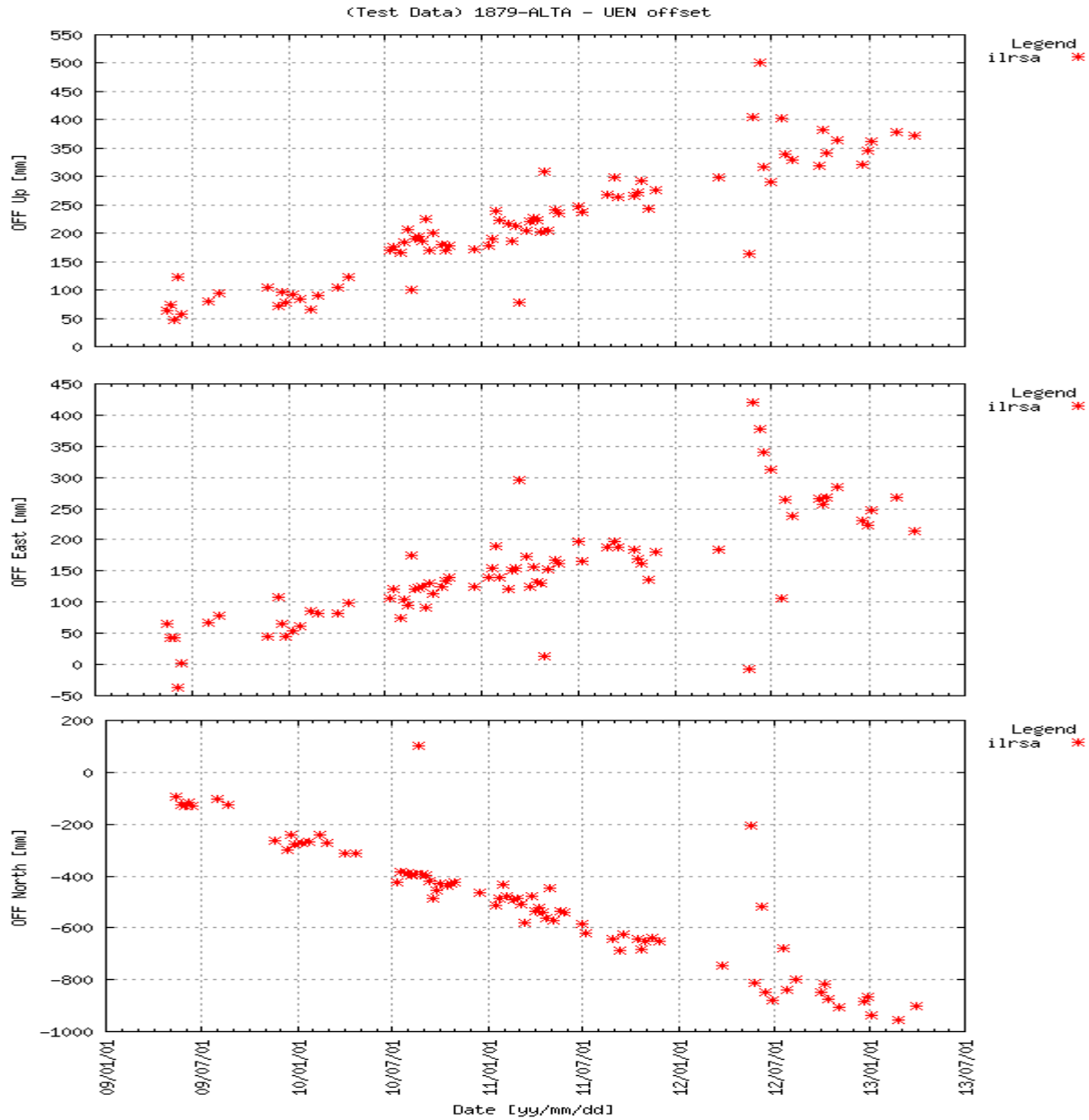
# 7406 : earthquake



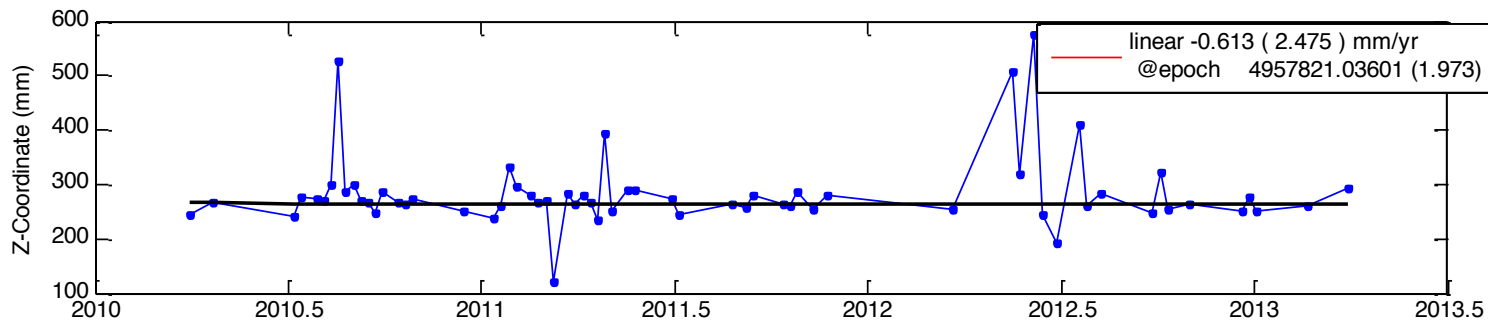
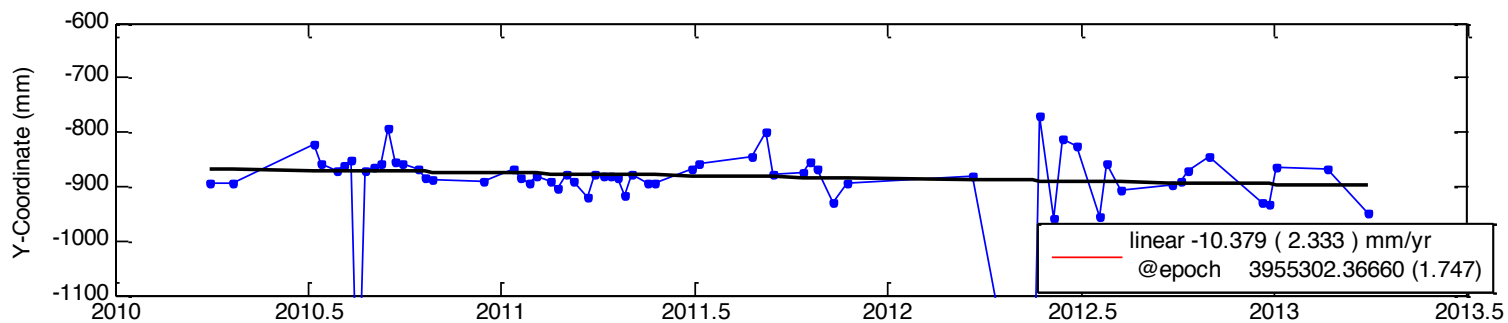
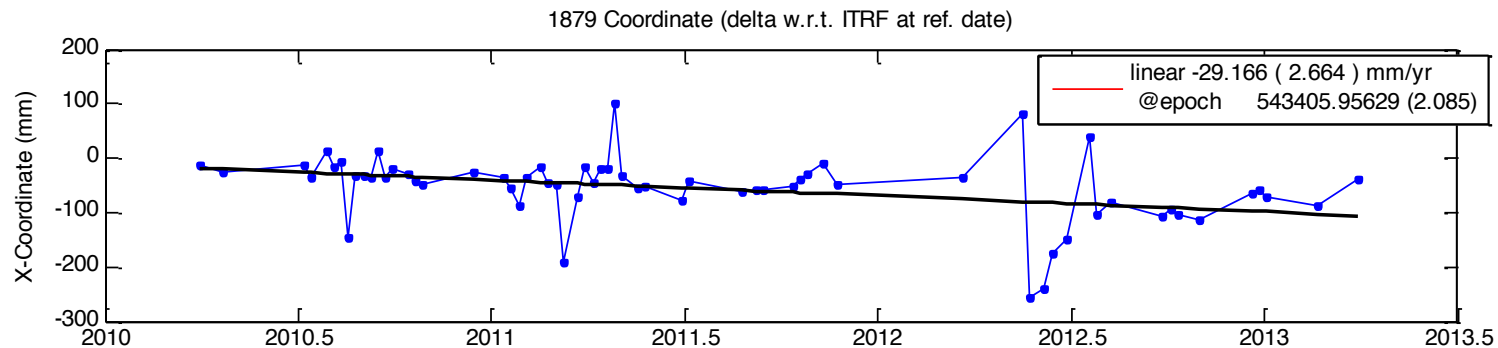
# 7406 : earthquake



# 1879 : bad coordinates/velocities



# 1879 : bad coordinates/velocities





# Report DGFI AC

ILRS Analysis Working Group Meeting  
Fujiyoshida, Japan, Nov. 9, 2013

**Horst Müller**

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# Products

- Delivered regularly daily v130
  - Problems with new stations (DGFI is not solving for biases, follows rules given in the data handling file), some other AC solve for biases
  - Editing of observation is differs to other centers, eventually harmonization or comparison of data editing, or at least edit criteria. For stations with only few observations this has big influence on the coordinates solved.
- Weekly products v35
  - Lageos and Etalon orbits for version v35 delivered in sp3 format, along track problem not yet solved.
- DOGS status
  - current version 5.2 includes non tidal atmospheric loading and station dep. CoM as standard.
  - DOGS-OC 5.2 follows IERS 2010 conventions,
  - Products use eigen6c2 gravity field and FES2004 ocean tides, estimation of low-degree SH of the gravity field is possible

# Biases

Biases are critical especially for stations with poor station coordinates

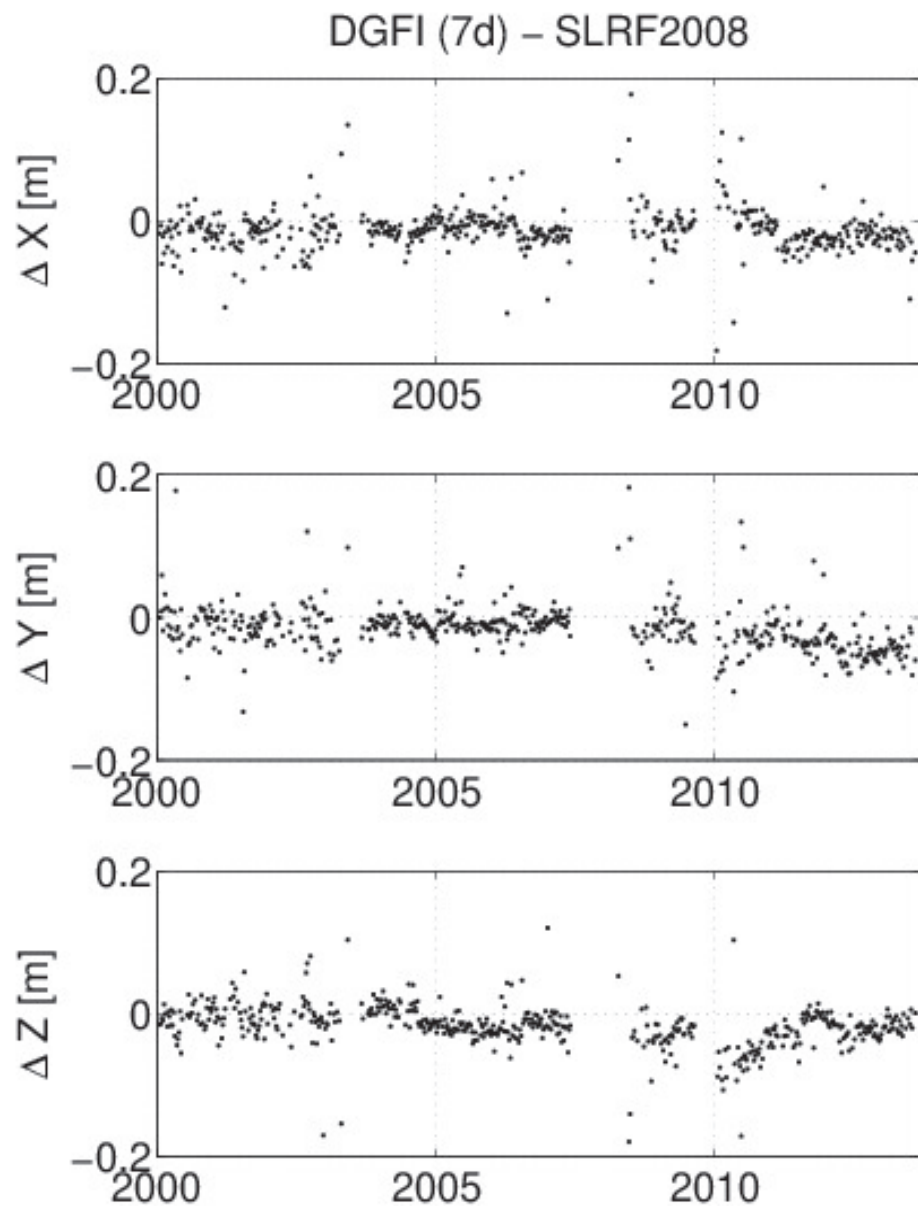
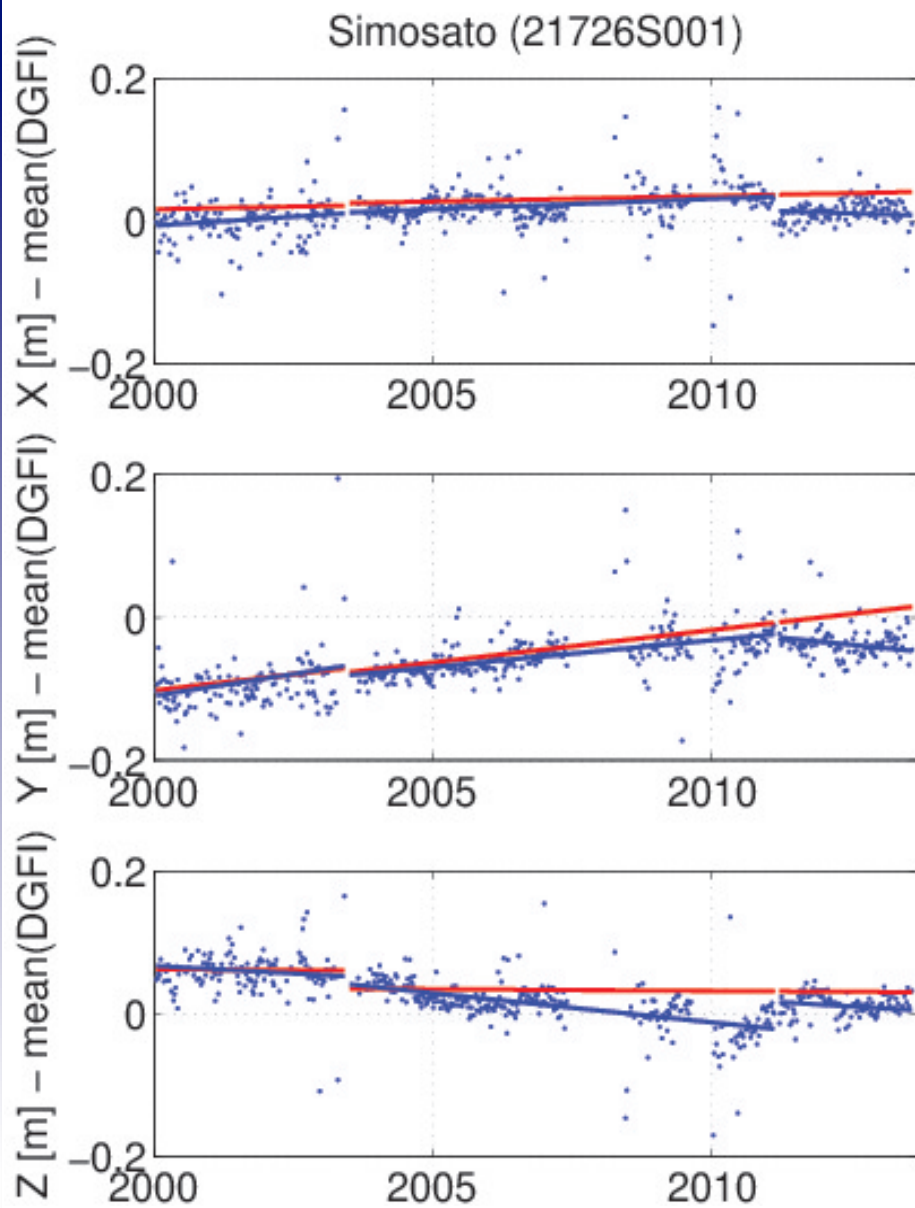
The problem with can only be solved if all ACs use the same set bias parameters *and* the station coordinates are good enough. For a number of stations, either new or in tectonic regions, SLRF2008 needs an update.

For harmonization all ACs should follow rules defined by the data handling file.

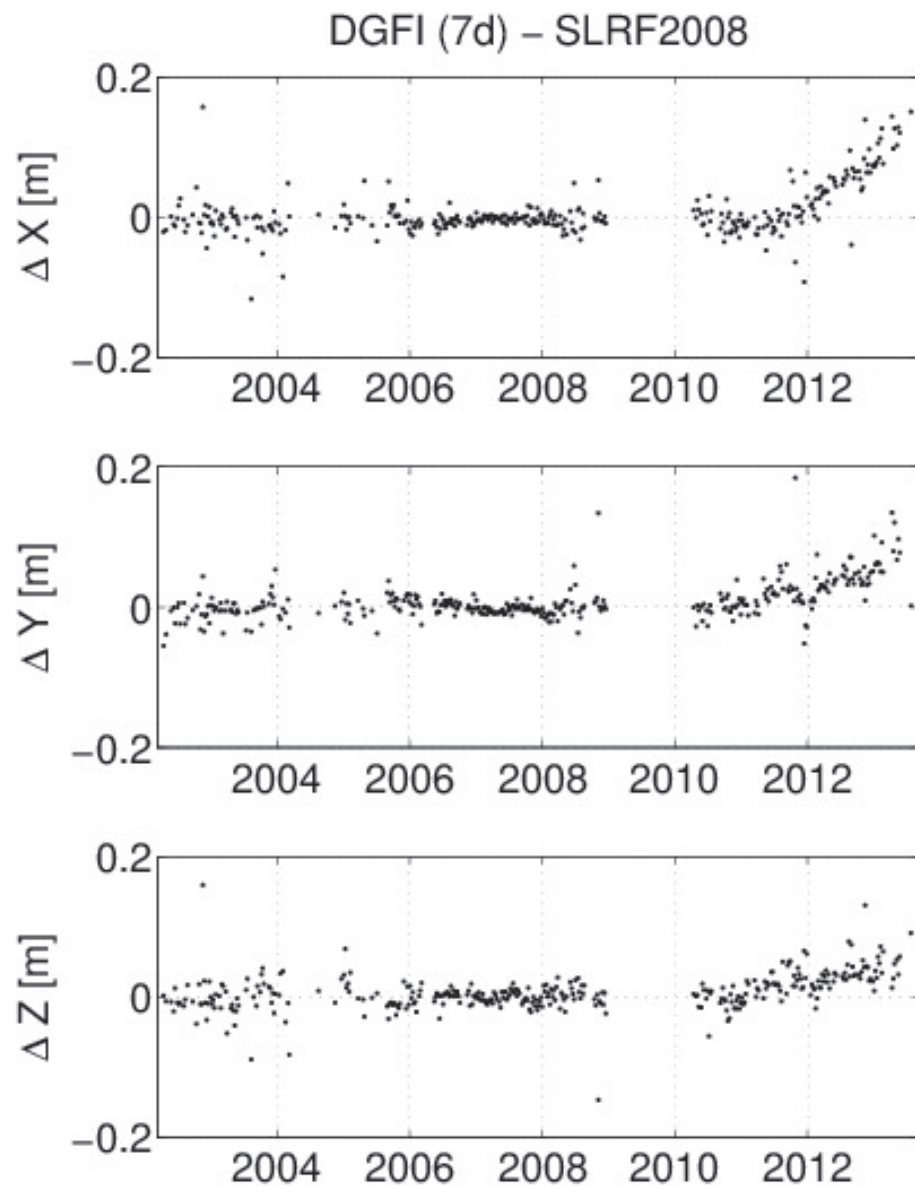
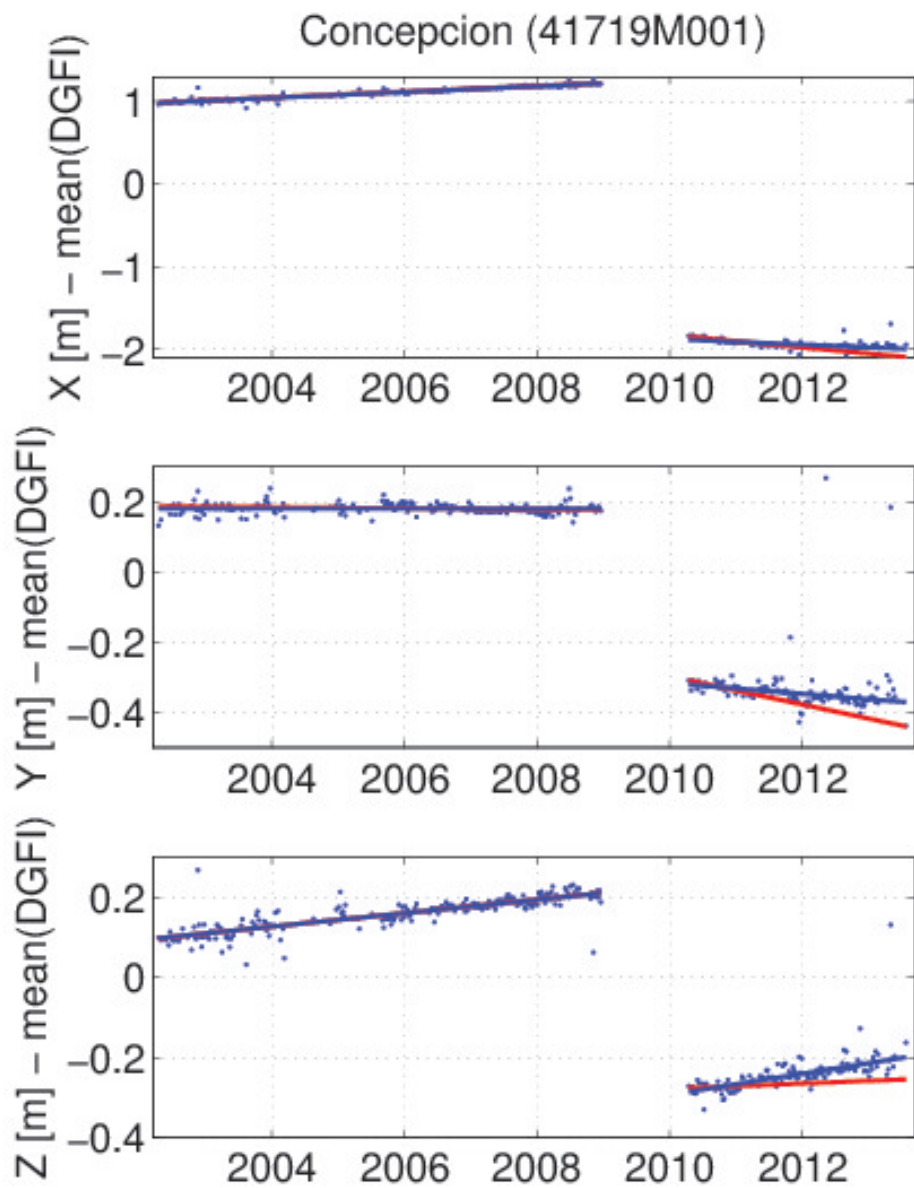
A new bias parameters as used for the combined solution, and for the ITRF2008 computaion, should be estimated with good coordinates (common bias for Lageos1 and Lageos2 ?) New set of bias parameters were delivered by Cinzia. These updates are not yet implemented, needs approval at AWG meeting.

New set of station coordinates delivered by Mathis Blossfeld, DGFI. Good improvement for a few stations.

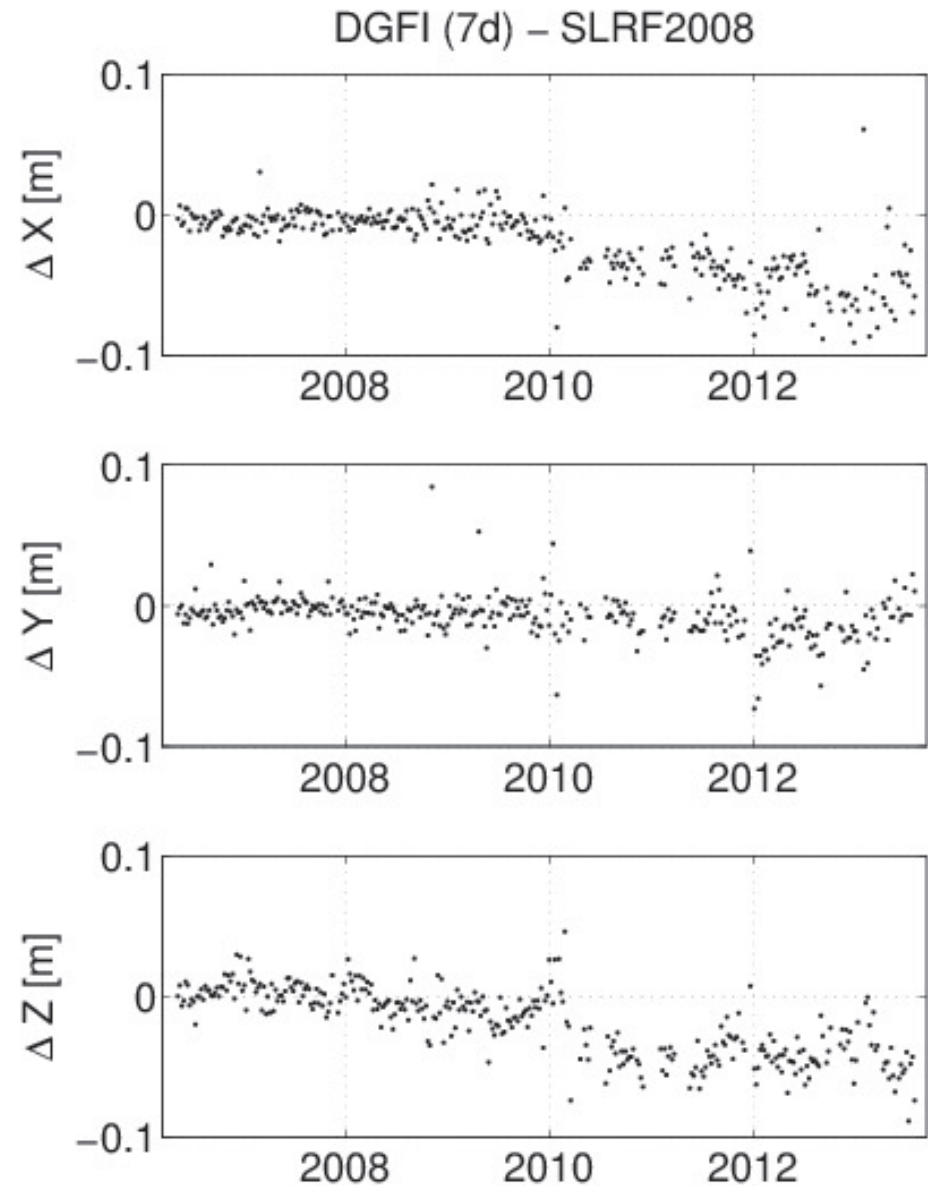
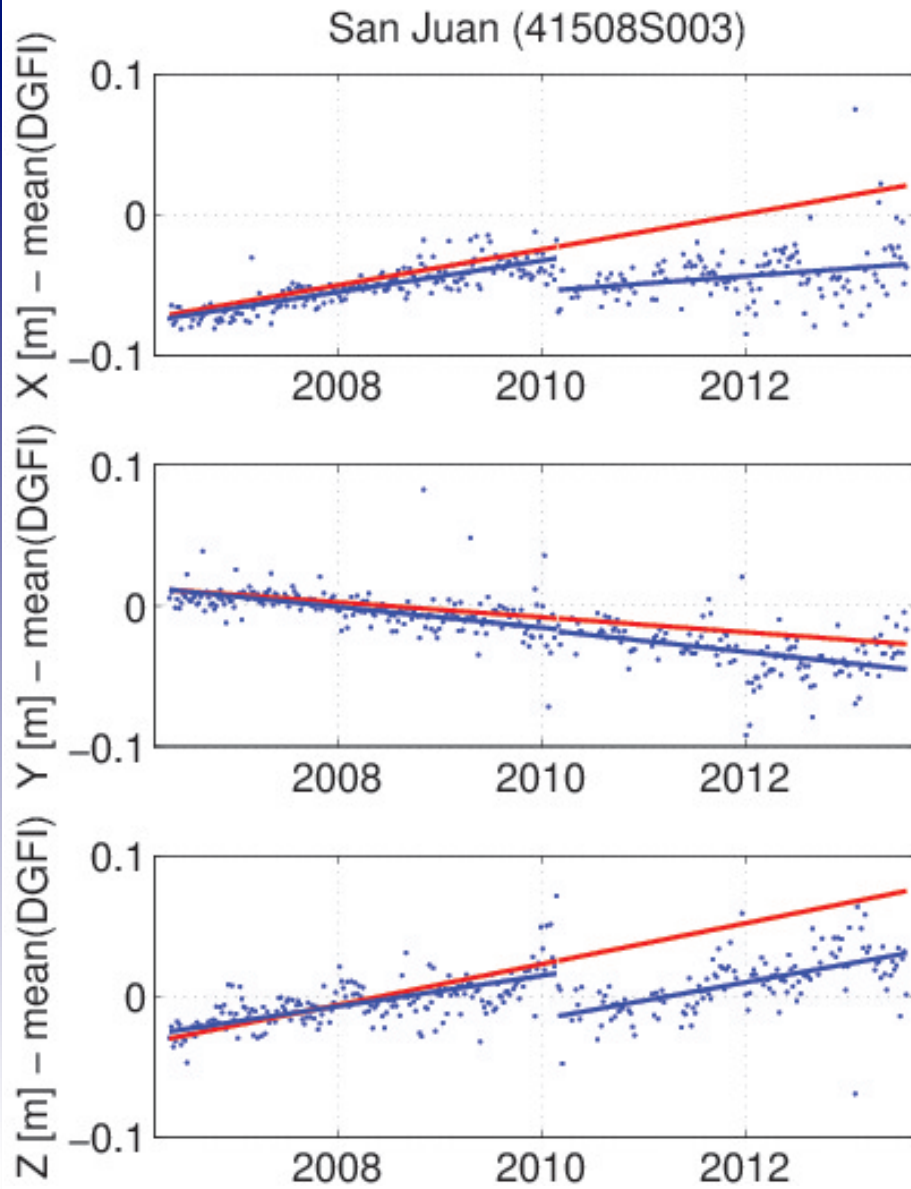
# Biases



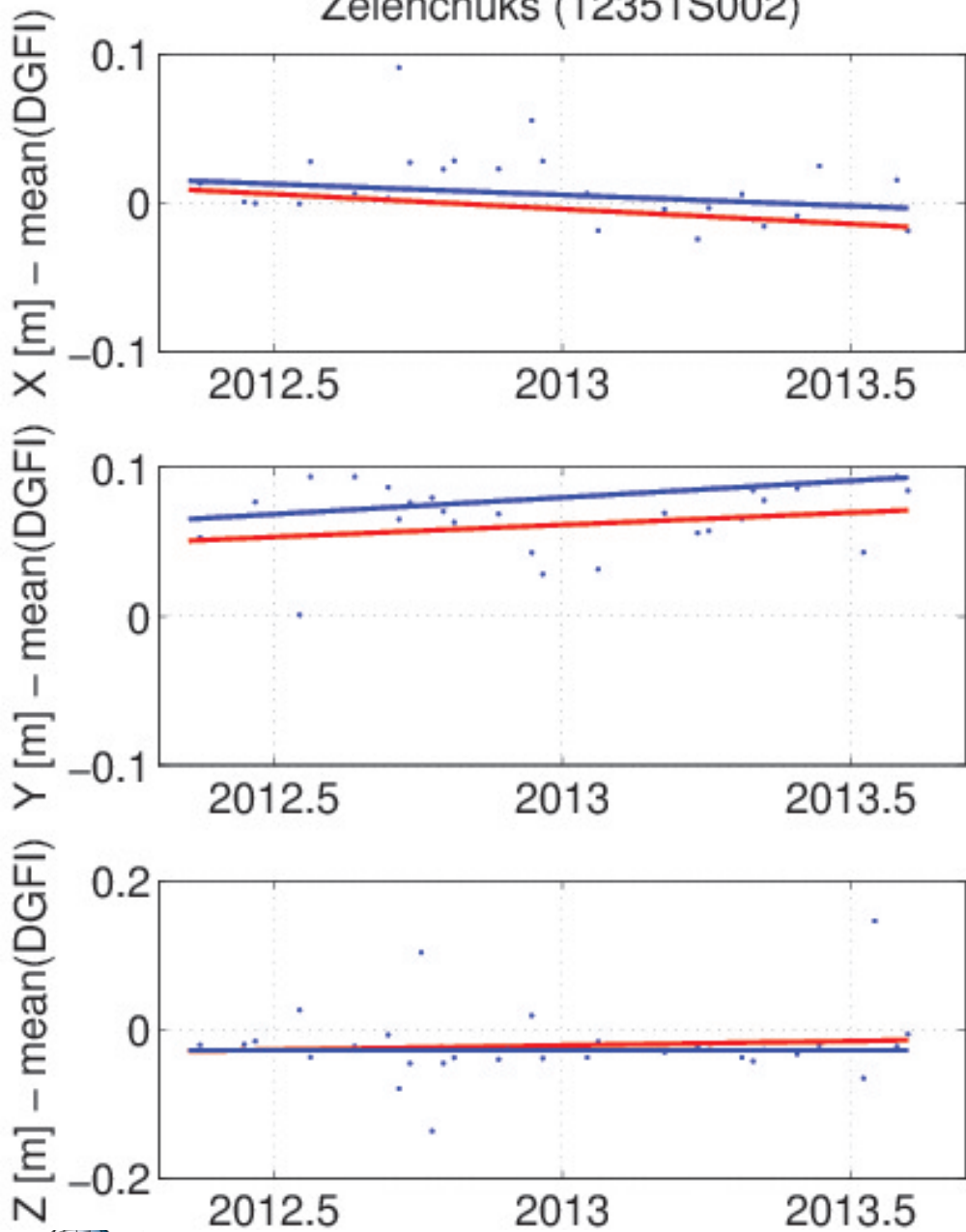
# Biases



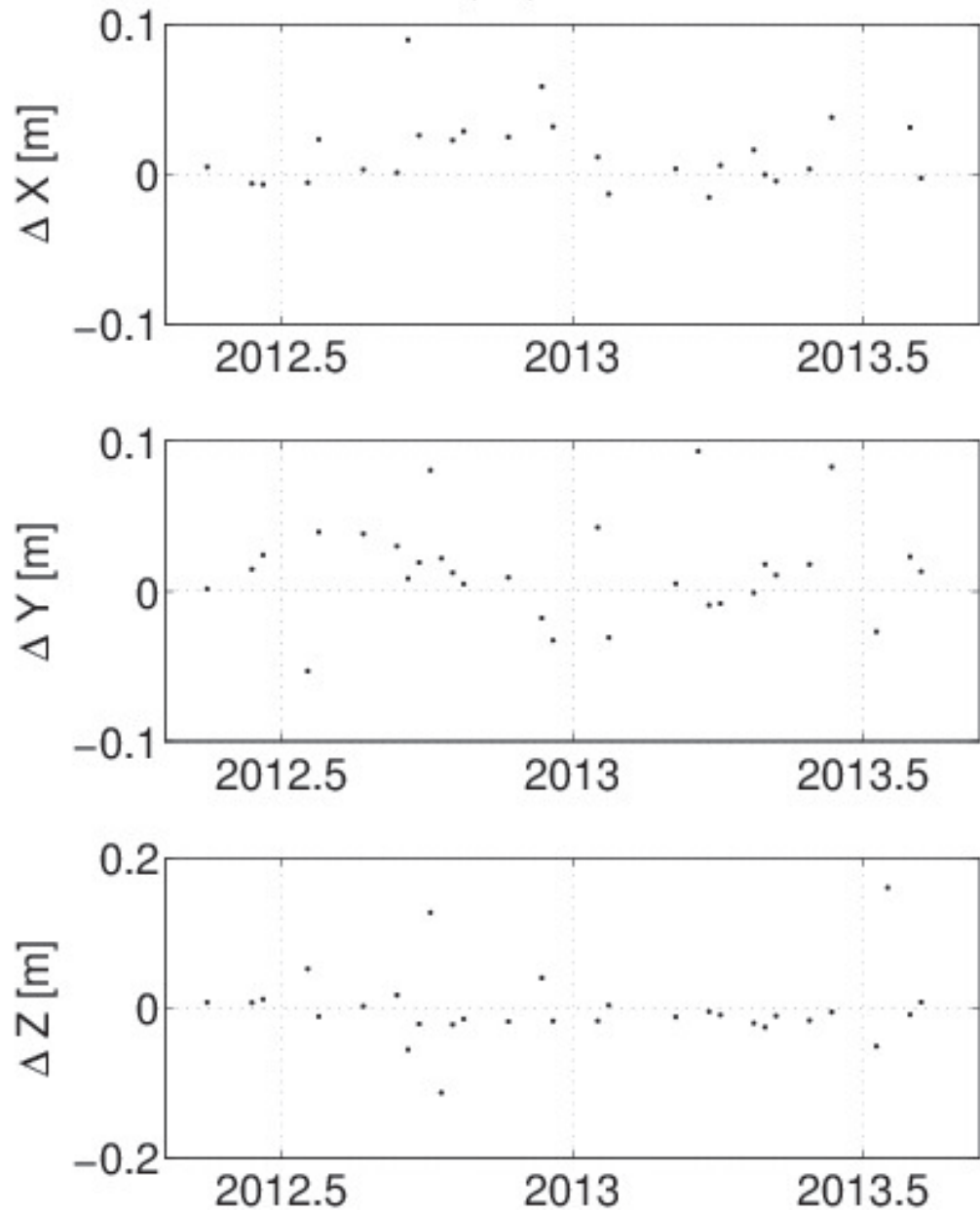
# Biases



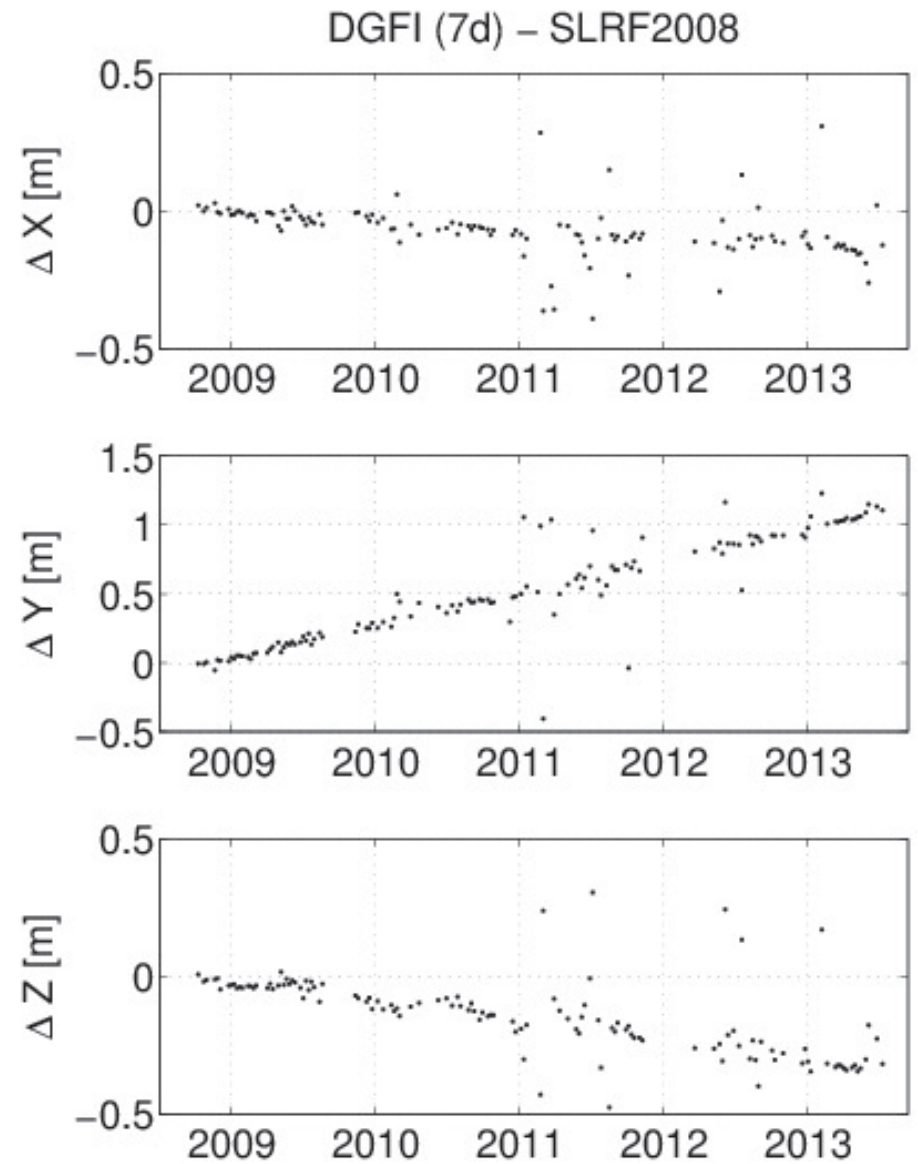
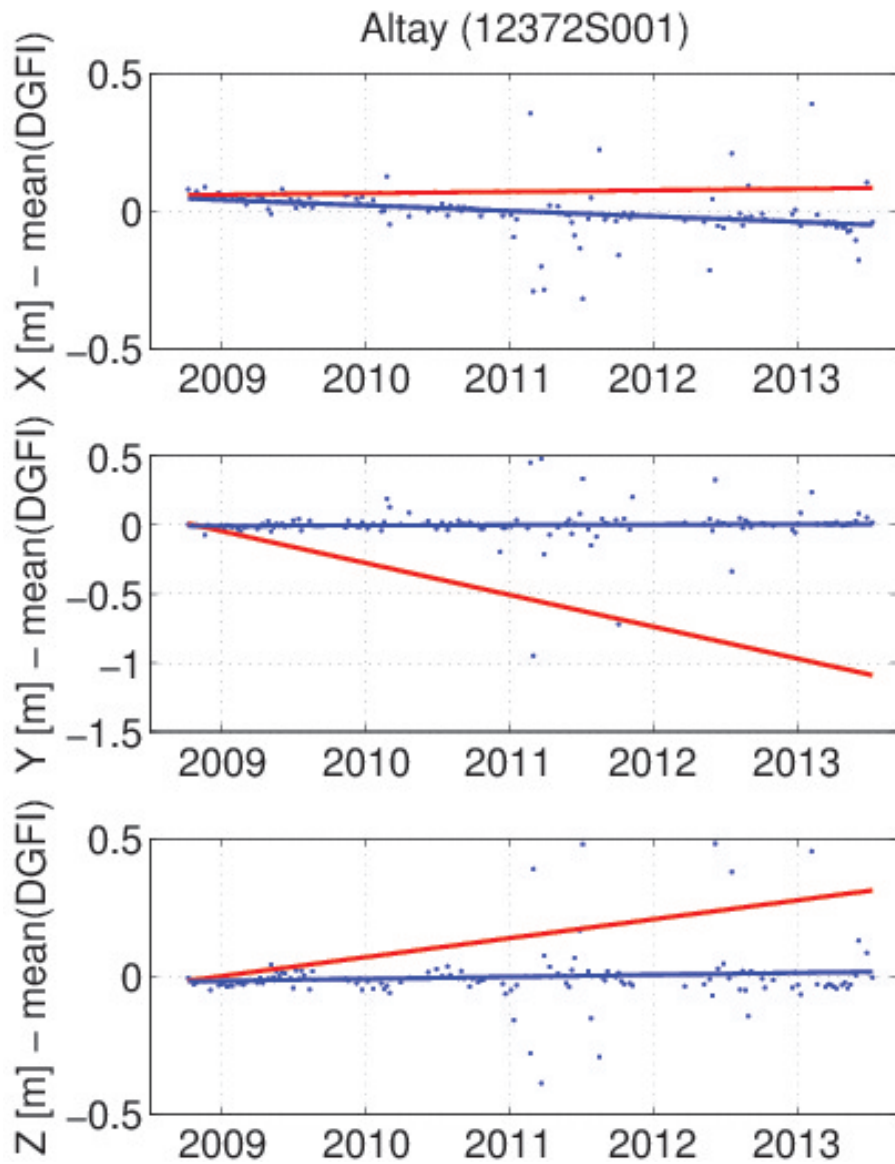
Zelenchuks (12351S002)



DGFI (7d) – SLRF2008



# Biases

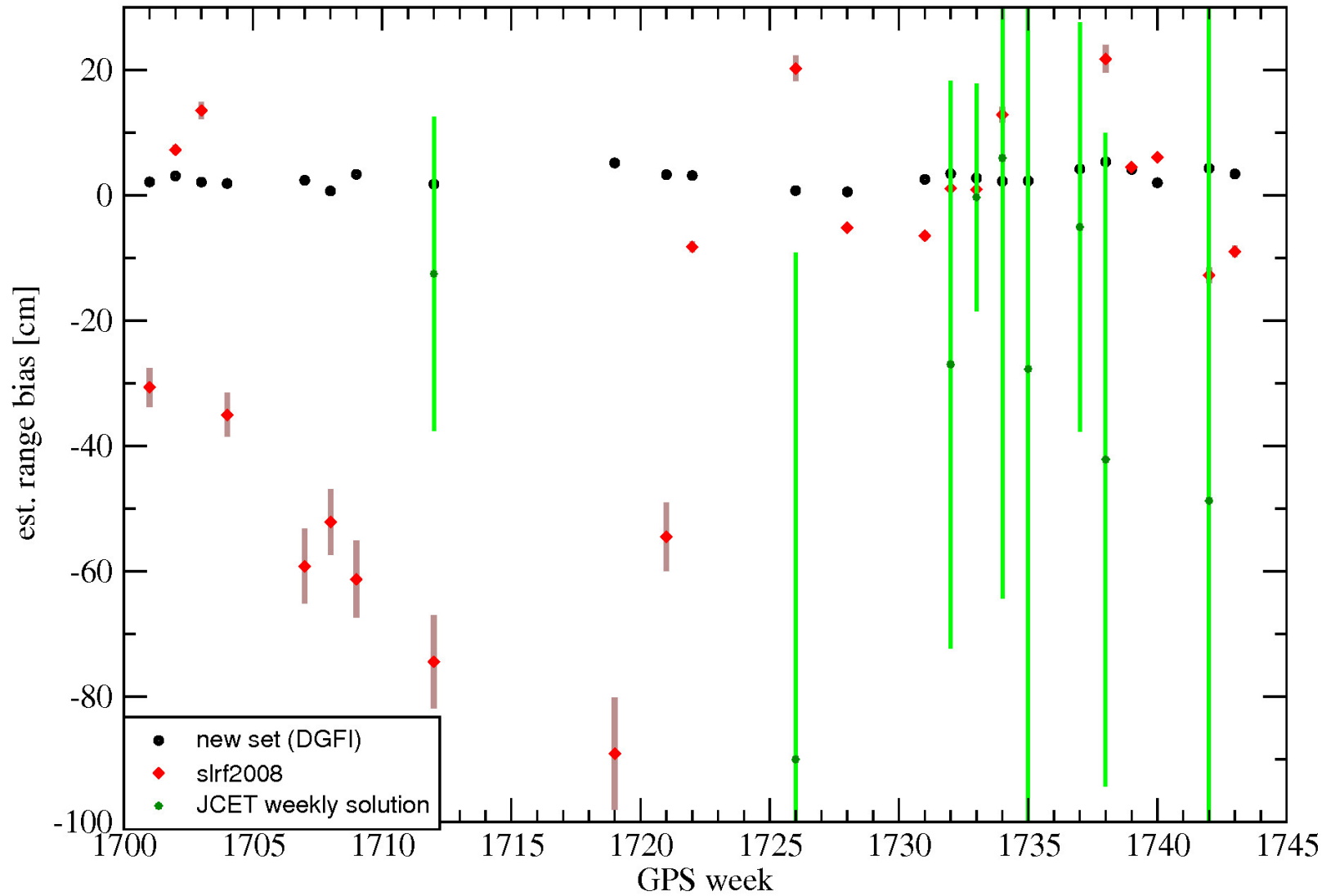




# Biases

## Altay (1879) range bias estimation

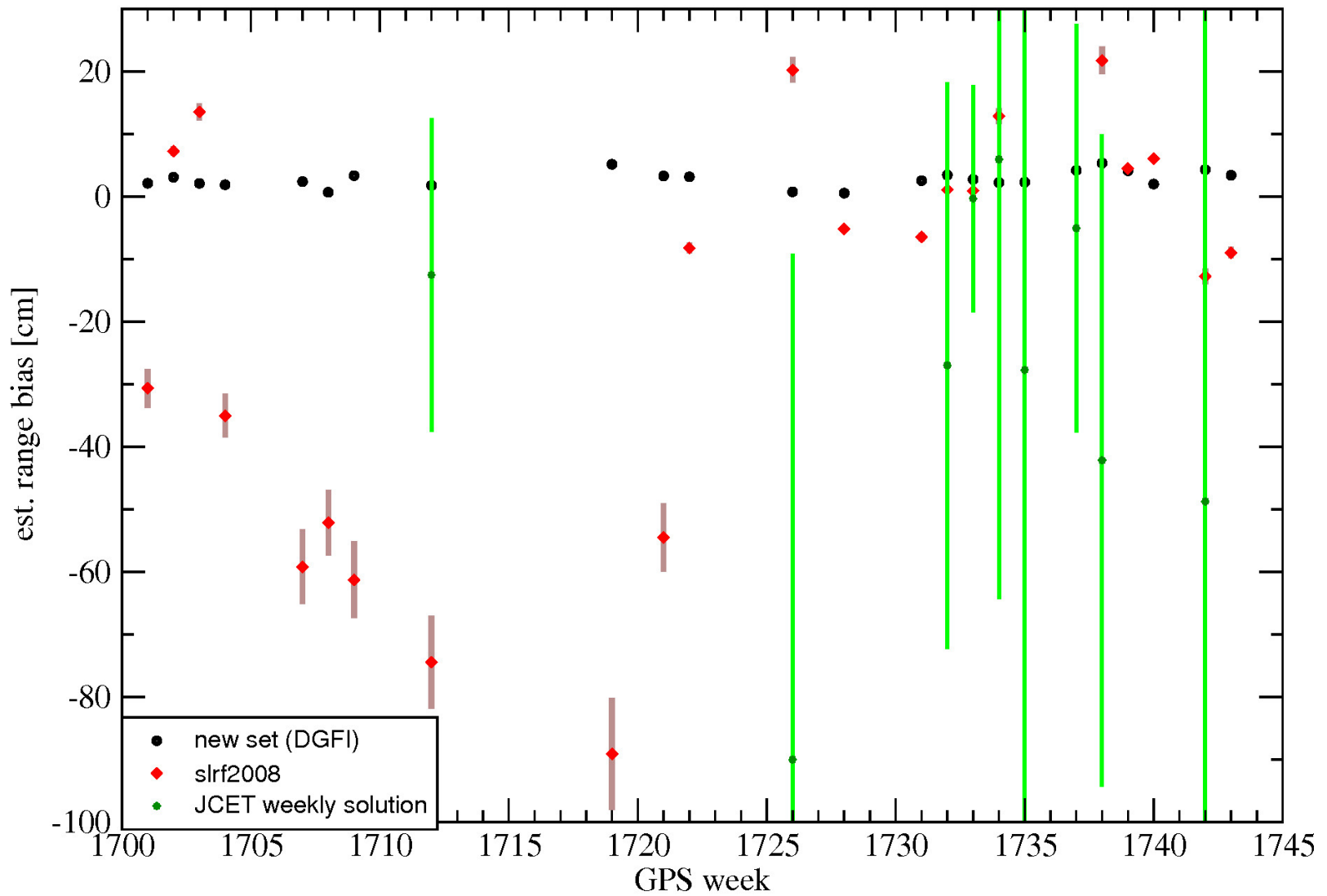
Lageos2



# Biases

## Altay (1879) range bias estimation

Lageos2



# ILRS Data Handling File

The ILRS data handling file maintained at DGFI should be mandatory for all ACs, to have a homogenous product. But the files need some updates and addenda.

- New flag **Q** for stations in quarantine
- New flag **N** for „not reliable“ stations, like Simeiz (1873) or San Juan (7406), which should not be used for standard products but can be used for other analysis
- New flag **P** for stations with only preliminary coordinates, for these stations it is not recommended to solve for biases and they should not be used in the official products until a coordinate update is possible.

At the moment San Juan, Simeiz seem to have problems with the data they deliver and should not be used. New stations Kunming and Daedok are now in Quarantine, like Wettzell and Greenbelt.

The bias values listed in the file need a revision for the ILRS contribution to ITRF2013..

# Data Handling File

\* -----  
\* list of unreliable sites, sites in Quarantine or with preliminary coordiantes  
\* -----

|      |     |    |   |              |              |   |             |
|------|-----|----|---|--------------|--------------|---|-------------|
| 1831 | --- | mm | A | 00:000:00000 | 00:000:00000 | Q | quarantine  |
| 1873 | --- | mm | A | 00:000:00000 | 00:000:00000 | N | not stable  |
| 1874 | --- | mm | A | 00:000:00000 | 00:000:00000 | Q | quarantine  |
| 1879 | --- | mm | A | 00:000:00000 | 00:000:00000 | P | new station |
| 1884 | --- | mm | A | 00:000:00000 | 00:000:00000 | Q | quarantine  |
| 1887 | --- | mm | A | 00:000:00000 | 00:000:00000 | P | new station |
| 1888 | --- | mm | A | 00:000:00000 | 00:000:00000 | P | new station |
| 1889 | --- | mm | A | 00:000:00000 | 00:000:00000 | P | new station |
| 1890 | --- | mm | A | 00:000:00000 | 00:000:00000 | P | new station |
| 7358 | --- | mm | A | 00:000:00000 | 00:000:00000 | Q | quarantine  |
| 7359 | --- | mm | A | 00:000:00000 | 00:000:00000 | Q | quarantine  |
| 7406 | --- | mm | A | 00:000:00000 | 00:000:00000 | N | not stable  |
| 7811 | --- | mm | A | 00:000:00000 | 00:000:00000 | Q | quarantine  |
| 7820 | --- | mm | A | 00:000:00000 | 00:000:00000 | Q | quarantine  |
| 7825 | --- | mm | A | 00:000:00000 | 00:000:00000 | Q | quarantine  |
| 7832 | --- | mm | A | 00:000:00000 | 00:000:00000 | Q | quarantine  |
| 8834 | --- | mm | A | 00:000:00000 | 00:000:00000 | Q | quarantine  |

# Lares

Lares, launched Feb. 2012 is a good target to improve the quality of the ILRS products

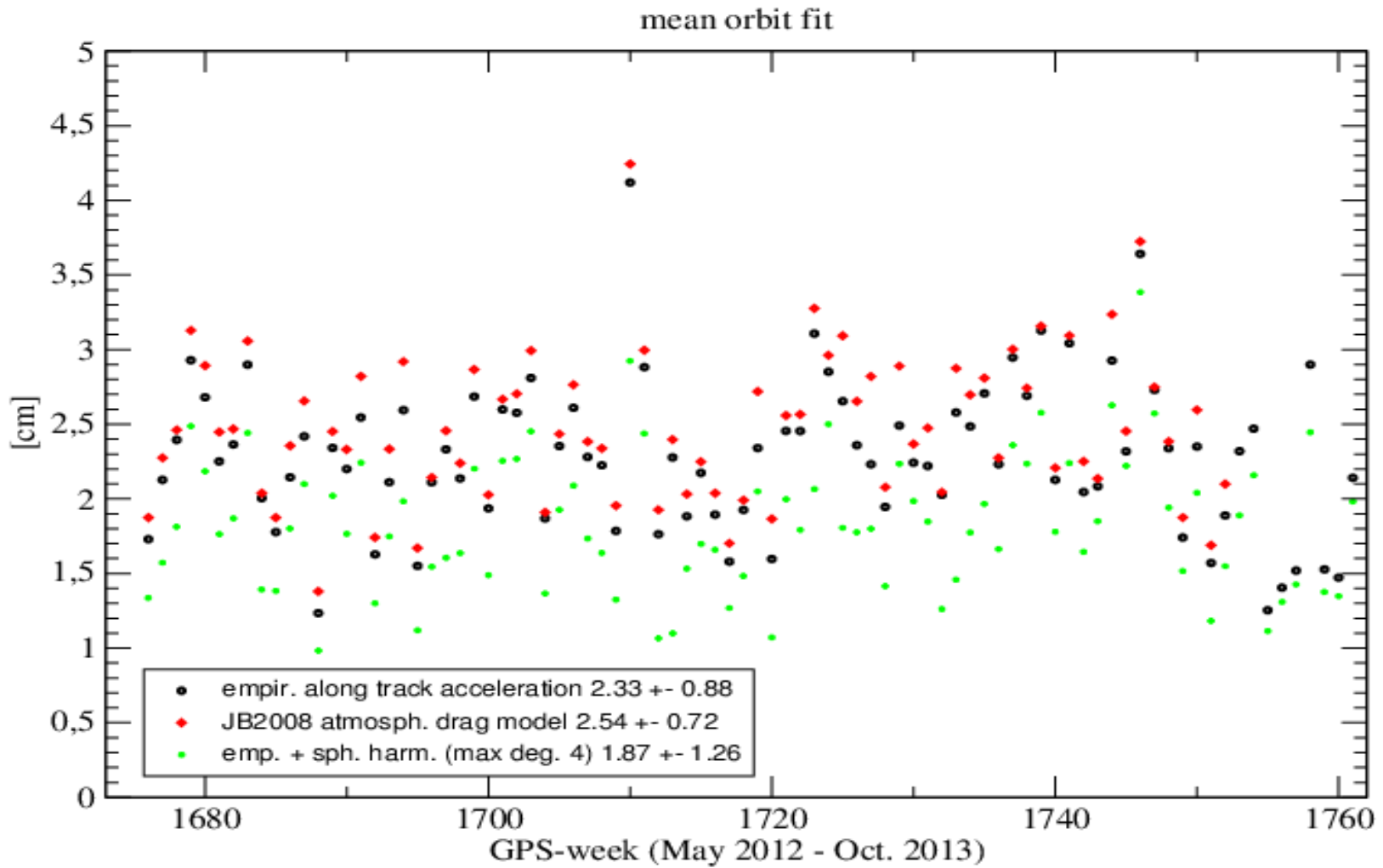
- Heavy satellite > small  $a/m$  value
- No need to model drag force of the high atmosphere, simple empirical force is sufficient
- Low enough to solve for low degree harmonics
- Good number of observation, mean 1750 per week, sometime > 2000, and more than Lageos1
- Good orbital fit  $\sim 2.5$  cm without solving for spherical harmonic coefficients (see graph)

Etalon1/2 have a decreasing number of observations  $\sim 200$  Etalon1 and  $\sim 150$  Etalon2 presently. Sometimes  $< 100$  observations/week. This does not allow a good and reliable orbit computation. (see graph)

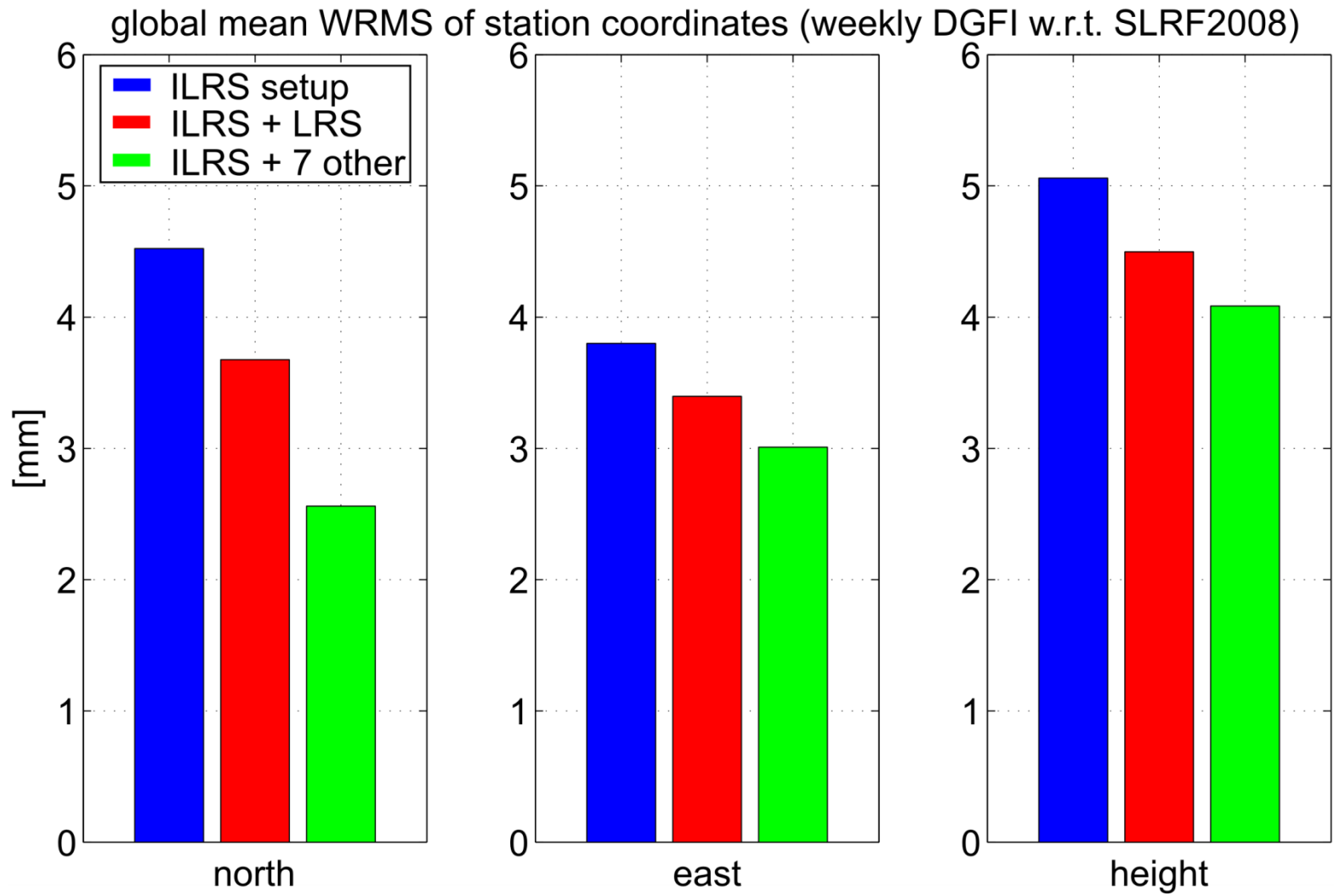
Either we get more etalon observations or we should remove Etalon from the satellites used for the ILRS products.

# Lares

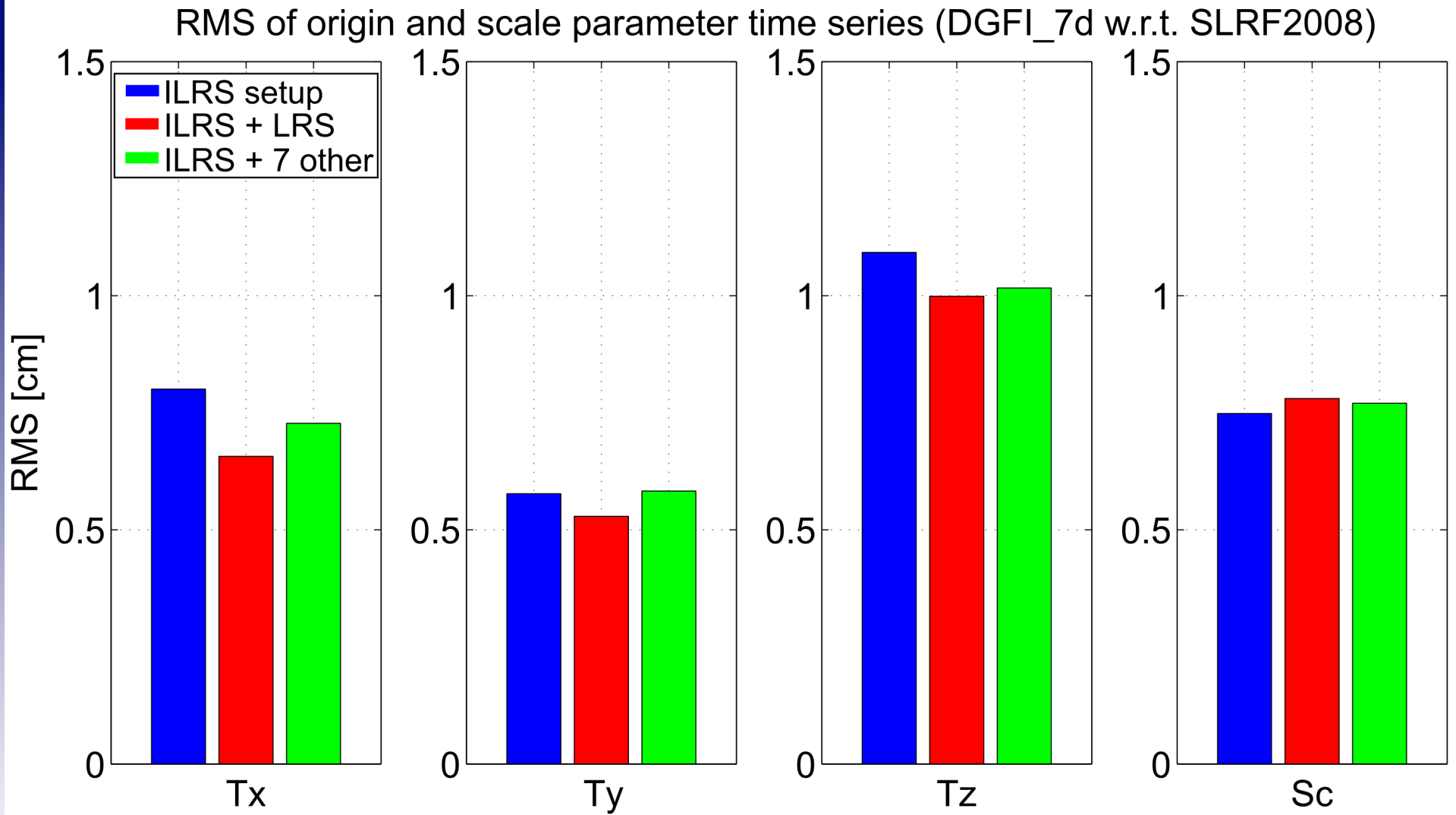
## Lares orbit tests, various force models



# Lares

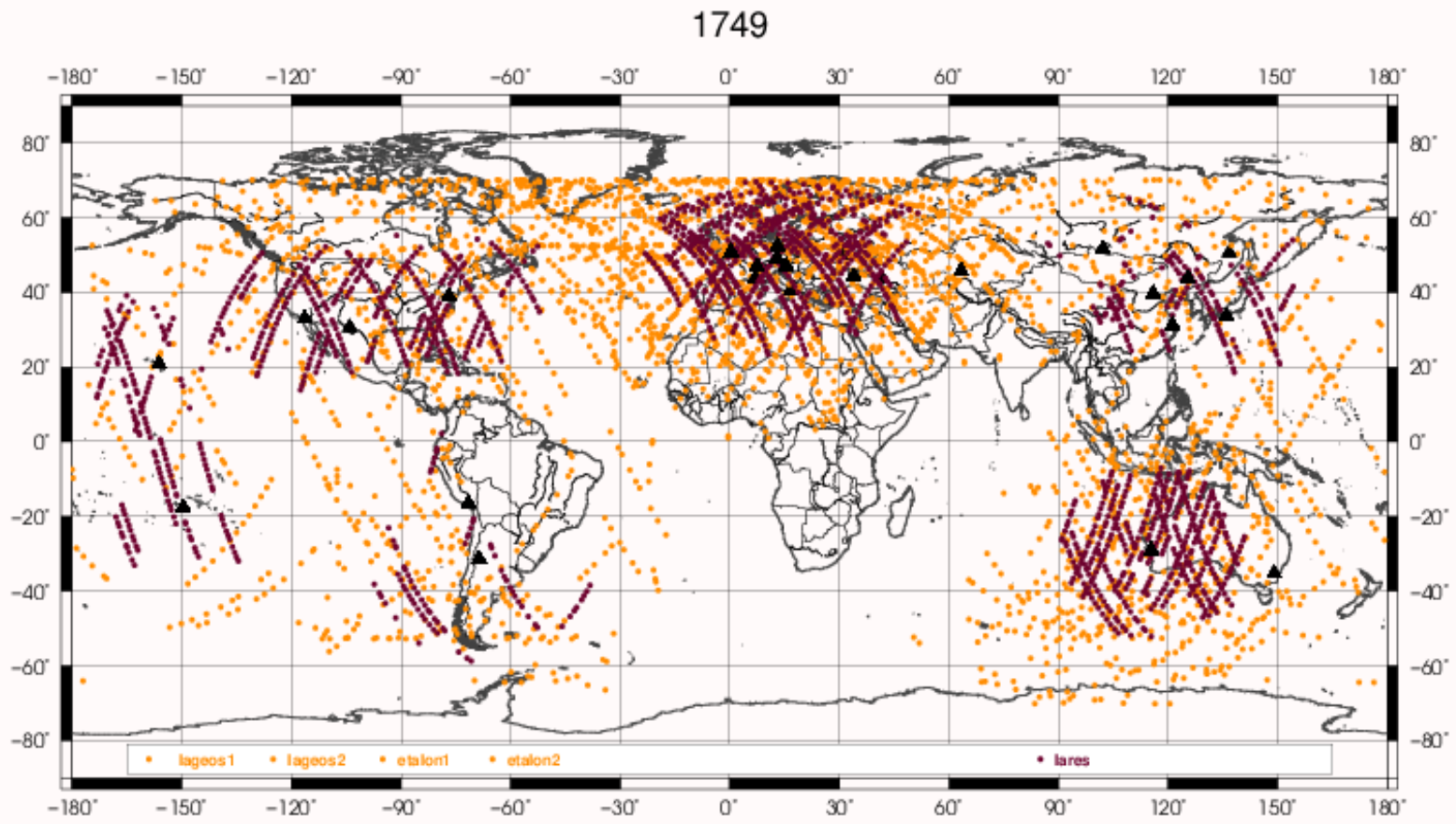


# Lares

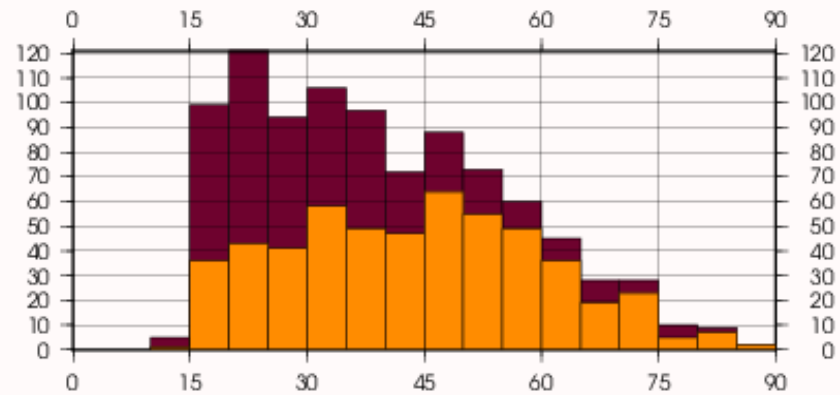
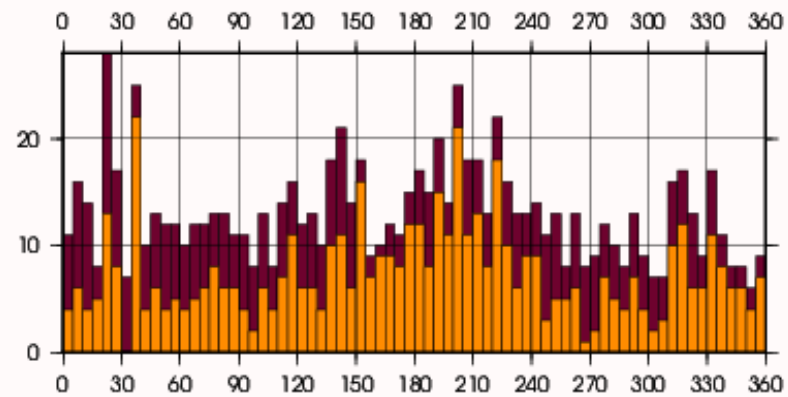
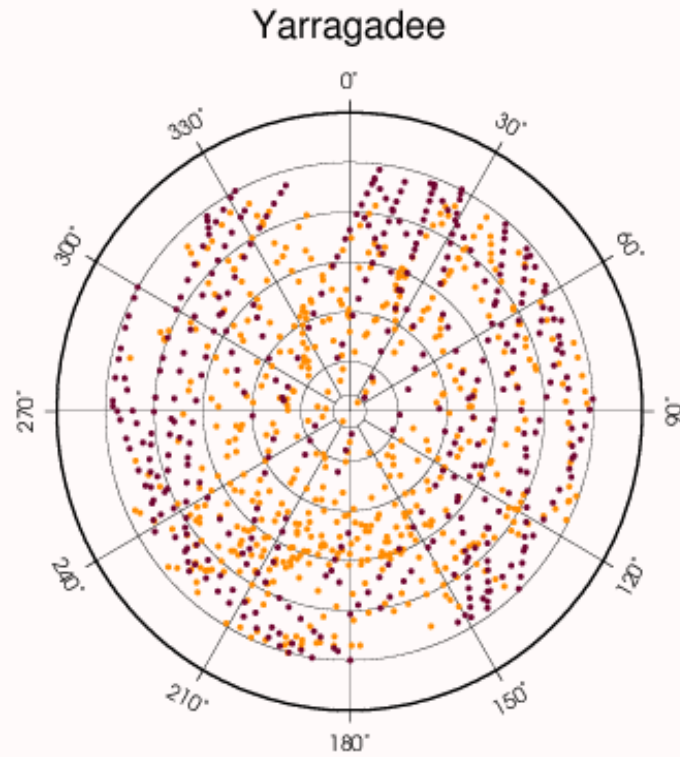




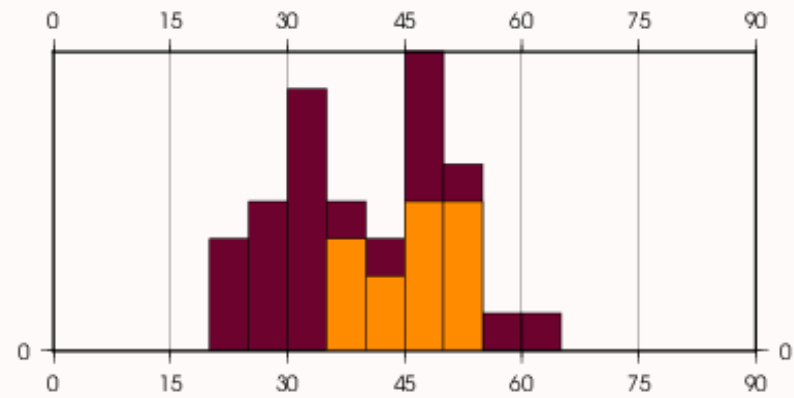
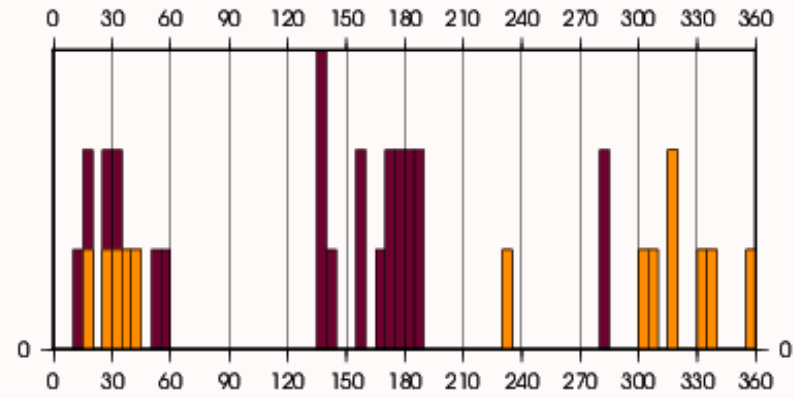
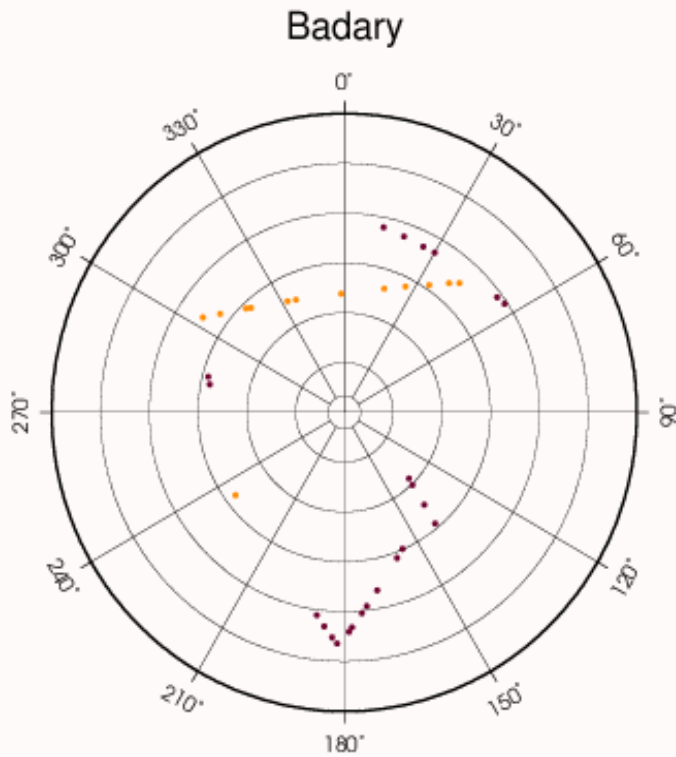
# Lares



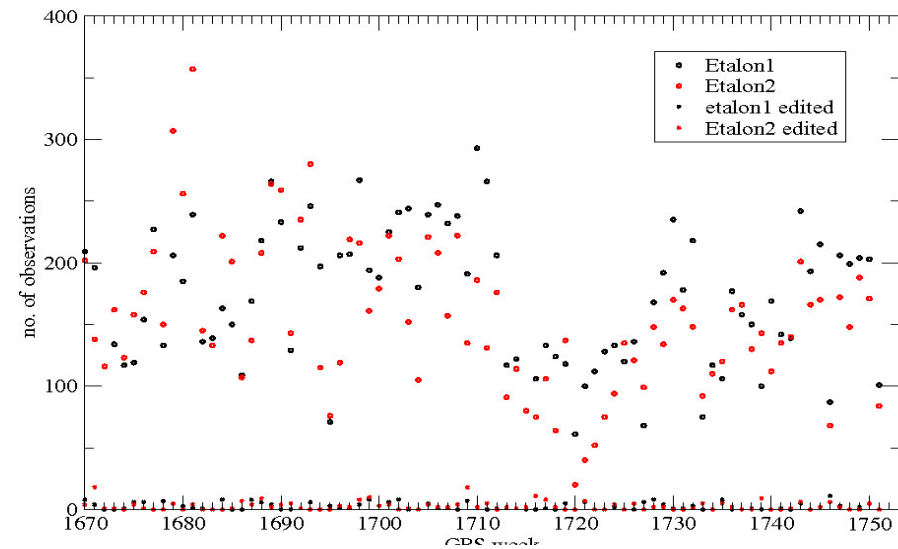
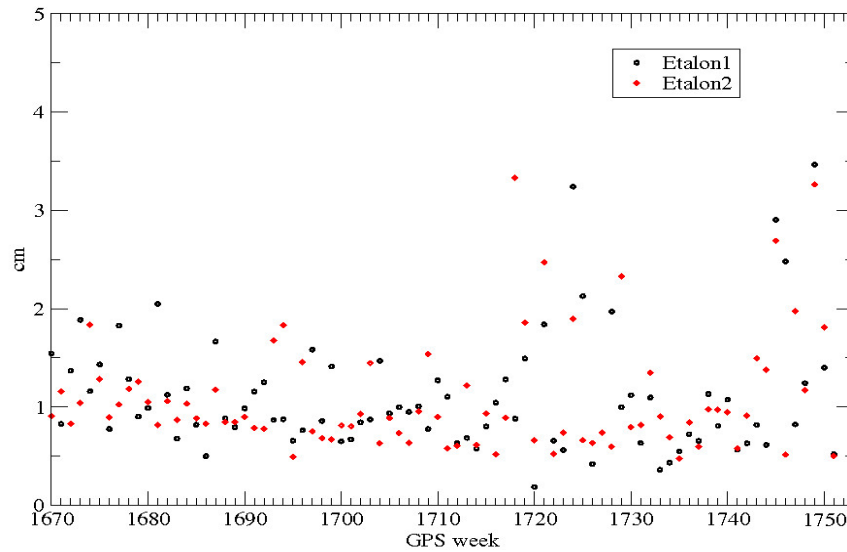
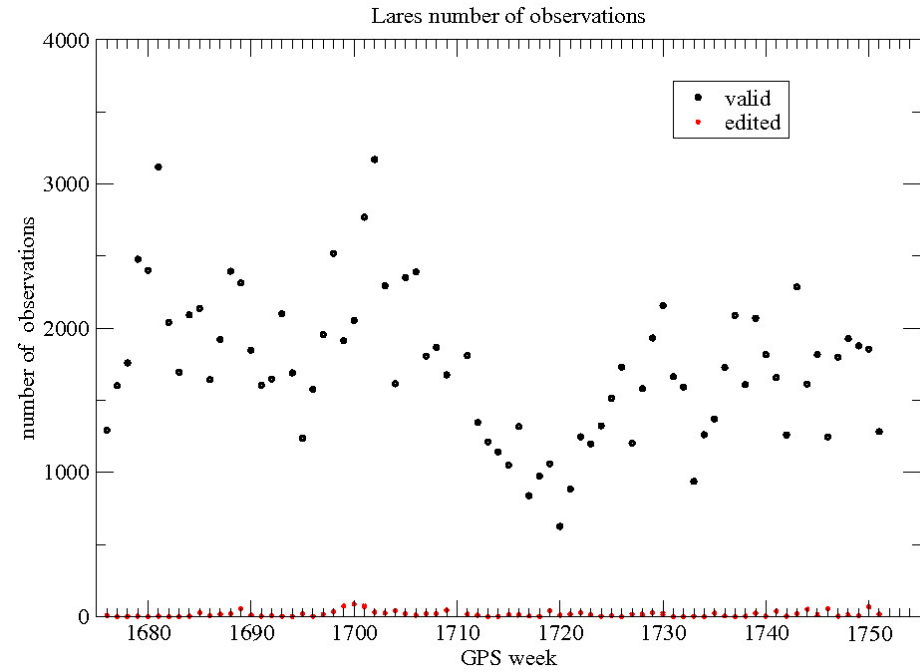
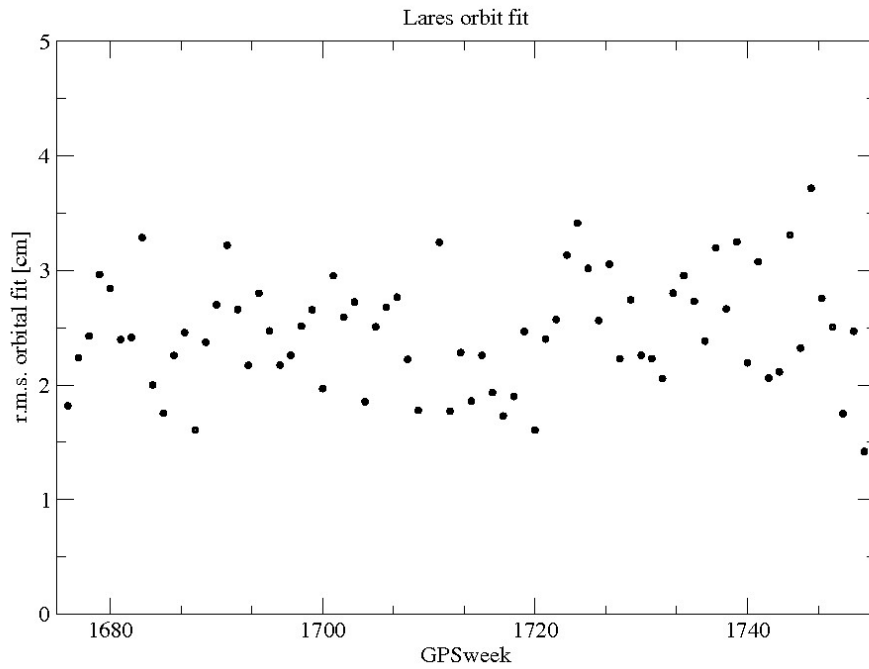
# Lares



# Lares



# Lares vs. Etalon



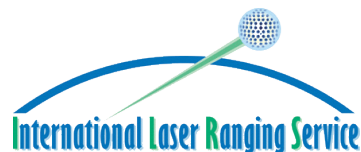
# Inclusion of LRS as a 5<sup>th</sup> satellite in the POS+EOP ILRS products

**Mathis Bloßfeld<sup>1</sup>, Horst Müller<sup>1</sup>**

<sup>1</sup>Deutsches Geodätisches Forschungsinstitut (DGFI)  
Centrum für Geodätische Erdsystemforschung (CGE)

Munich

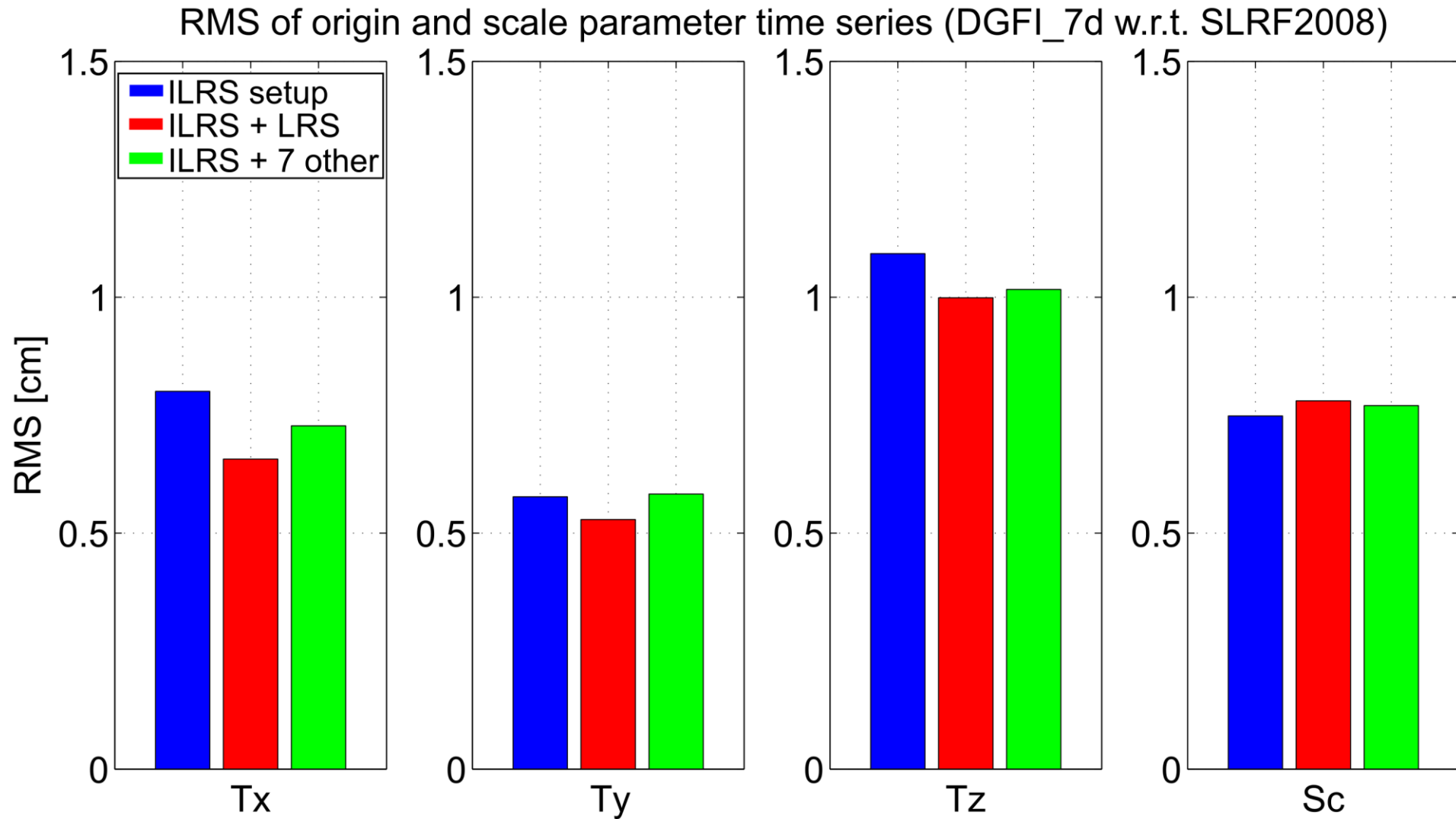
email: [blossfeld@dgfi.badw.de](mailto:blossfeld@dgfi.badw.de)



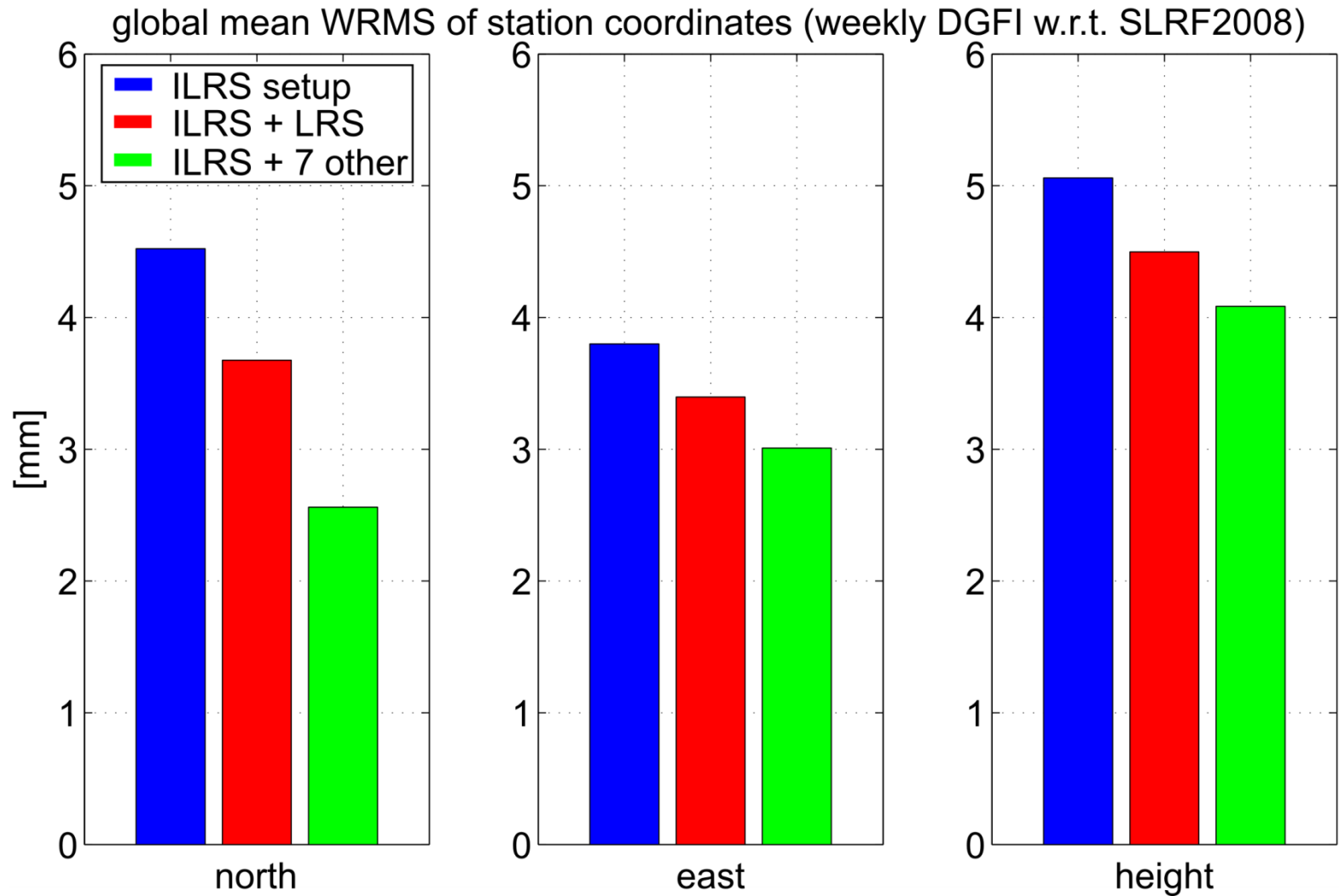
# Solution setup

- weekly solutions:
  - LA1, LA2, ET1, ET2 (ILRS setup)
  - LA1, LA2, ET1, ET2, LRS (ILRS + LRS setup)
  - LA1, LA2, ET1, ET2, STA, STE, LTS, LRS, AJI, BEC, BTS
- estimated parameters:
  - station coordinates
  - EOP
  - GFC of degree/order 2,3,4
- test of station coordinates
  - 4-parameter transformation of DGFI (7d) w.r.t. SLRF2008
  - global mean WRMS of transformation residuals
- EOP comparison w.r.t. IERS 08 C04

# RMS of internal SLR datum parameters



# WRMS of station coordinates





# 7-parameter trafo w.r.t. SLRF2008 (week 1749)

## 4 satellites

---- positions ----

```
tx [cm]:      0.13 +-      0.27
ty [cm]:     -1.32 +-      0.26
tz [cm]:     -0.14 +-      0.26
rx [urad]:   0.00142 +-   0.00048 [cm]:   0.91
ry [urad]:   0.00034 +-   0.00060 [cm]:   0.22
rz [urad]:   0.00038 +-   0.00056 [cm]:   0.24
sc [ppm]:    0.00354 +-   0.00041 [cm]:   2.26
```

parametername, Phi- Lamda-, Height- coordinate in [cm]

|                 |       |       |        |
|-----------------|-------|-------|--------|
| 10002S002 A02 * | 0.08  | 0.23  | 5.17   |
| 11001S002 A03 * | 0.79  | -0.44 | 2.12   |
| 12337S003 A01 * | 10.96 | 6.56  | 1.53   |
| 12338S004 A01 * | -7.49 | 3.85  | 10.85  |
| 12351S002 A01 * | 38.08 | 52.04 | -13.54 |
| 12356S001 A01 * | -4.33 | -3.12 | 1.90   |
| 12734S008 A01 * | -2.71 | -4.95 | 2.15   |
| 14106S011 A01 * | -0.36 | -1.61 | 2.52   |
| 14201S018 A02   | 0.24  | -0.30 | -0.08  |
| 21601S004 A02 * | 10.90 | 6.35  | -10.18 |
| 21605S010 A01 * | 1.79  | 2.00  | -5.66  |
| 21611S001 A01 * | 1.77  | 3.85  | 6.28   |
| 25603S001 A01 * | 2.95  | 3.28  | 5.53   |
| 40445M004 A01 * | 1.23  | 2.92  | -0.87  |
| 40497M001 A01   | 0.25  | 0.18  | -0.19  |
| 42202M003 A06 * | 5.14  | 4.56  | 0.87   |
| 50107M001 A01   | -0.08 | 0.05  | 0.27   |
| 92201M007 A02 * | -0.21 | 2.43  | 1.23   |

mean rms coordinates: 0.00429 velocities: 0.00000  
 estimated standard deviation [cm]: 0.42946

## 5 satellites

---- positions ----

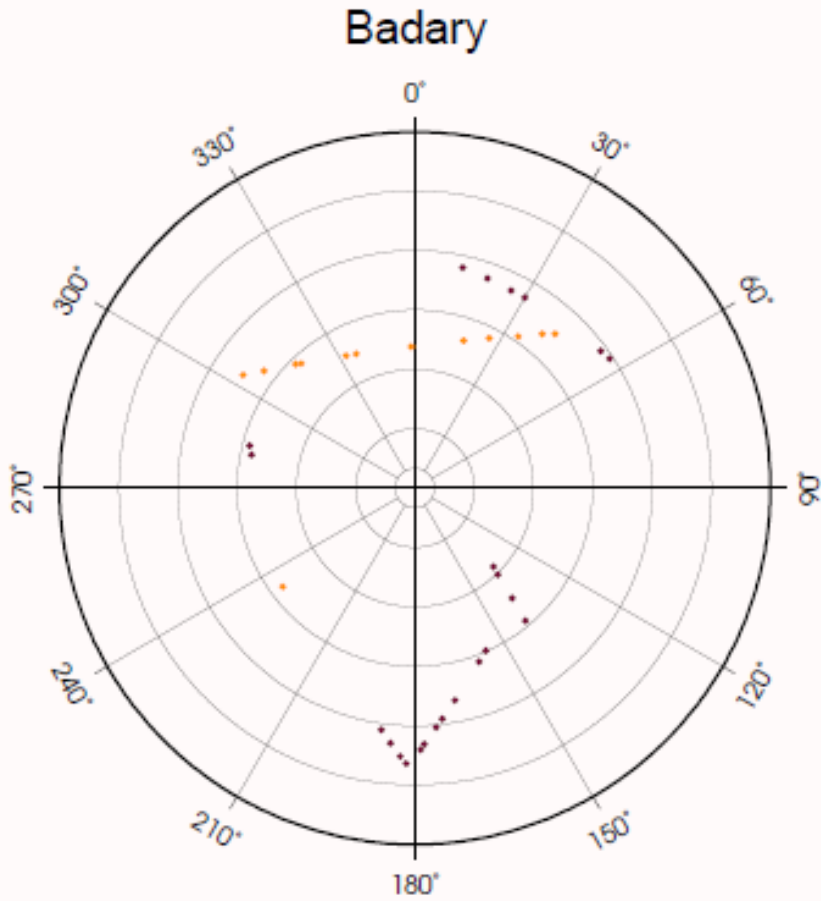
```
tx [cm]:      0.52 +-      0.13
ty [cm]:     -1.30 +-      0.13
tz [cm]:      0.21 +-      0.13
rx [urad]:   0.00092 +-   0.00024 [cm]:   0.58
ry [urad]:   0.00120 +-   0.00029 [cm]:   0.76
rz [urad]:   -0.00010 +-  0.00028 [cm]:  -0.06
sc [ppm]:    0.00366 +-   0.00020 [cm]:   2.33
```

parametername, Phi- Lamda-, Height- coordinate in [cm]

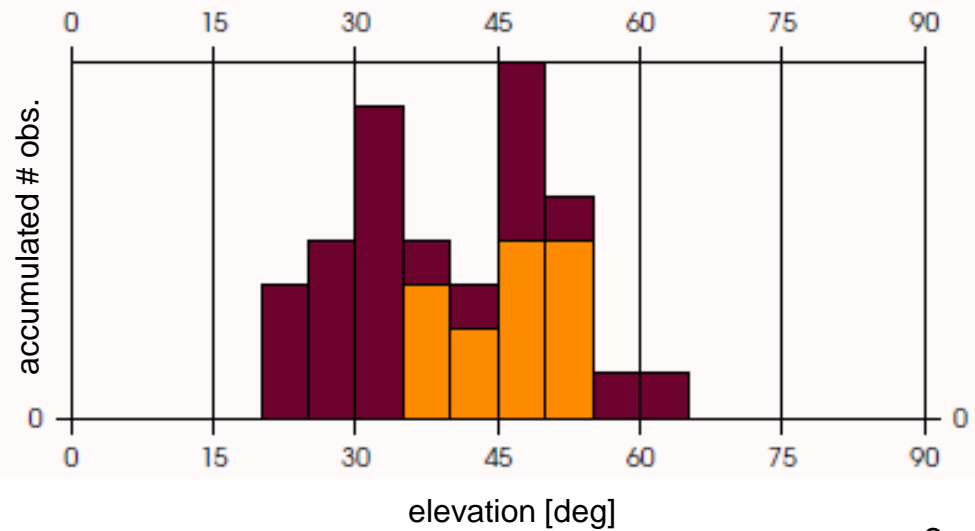
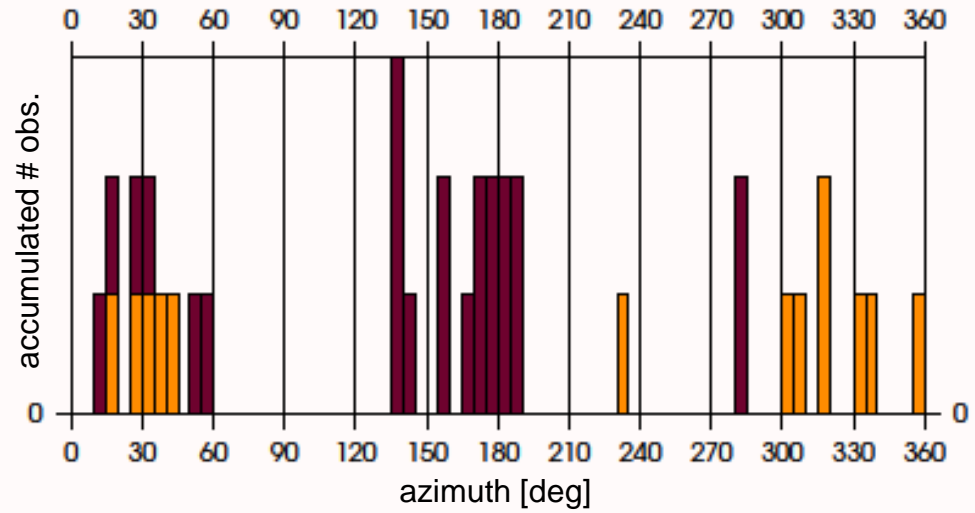
|                 |       |       |        |
|-----------------|-------|-------|--------|
| 10002S002 A02 * | -0.73 | 0.01  | 5.51   |
| 11001S002 A03 * | -0.08 | -0.54 | 2.34   |
| 12337S003 A01 * | 9.95  | 5.52  | 2.16   |
| 12338S004 A01 * | 0.14  | 2.42  | 3.70   |
| 12351S002 A01 * | 39.52 | 53.15 | -13.91 |
| 12356S001 A01 * | -4.91 | -3.00 | 1.60   |
| 12734S008 A01 * | -0.66 | -3.66 | 1.81   |
| 14106S011 A01 * | 1.04  | -0.94 | 1.62   |
| 14201S018 A02   | 0.01  | 0.07  | -0.18  |
| 21601S004 A02 * | 2.62  | 2.98  | 0.92   |
| 21605S010 A01 * | -0.57 | -0.54 | -6.32  |
| 21611S001 A01 * | -0.65 | 2.65  | 5.16   |
| 25603S001 A01 * | 3.78  | 3.85  | 4.18   |
| 40445M004 A01 * | 1.94  | 2.18  | -0.13  |
| 40497M001 A01   | 0.04  | 0.09  | 0.15   |
| 42202M003 A06 * | 4.62  | 5.02  | 5.07   |
| 50107M001 A01   | 0.04  | -0.13 | 0.03   |
| 92201M007 A02 * | -1.19 | 2.63  | 0.33   |

mean rms coordinates: 0.00211 velocities: 0.00000  
 estimated standard deviation [cm]: 0.21125

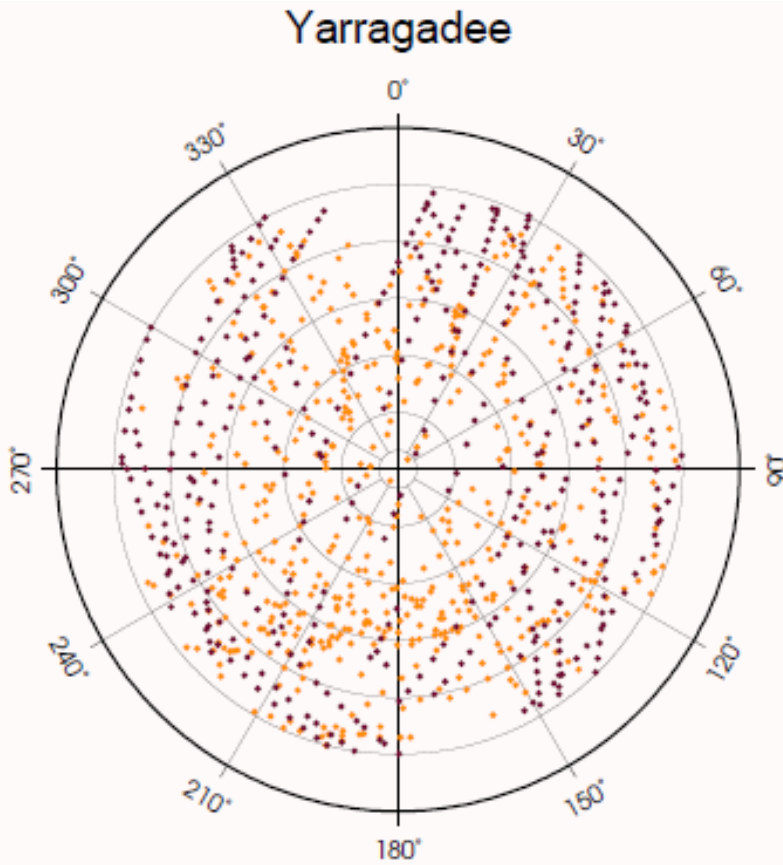
# Badary



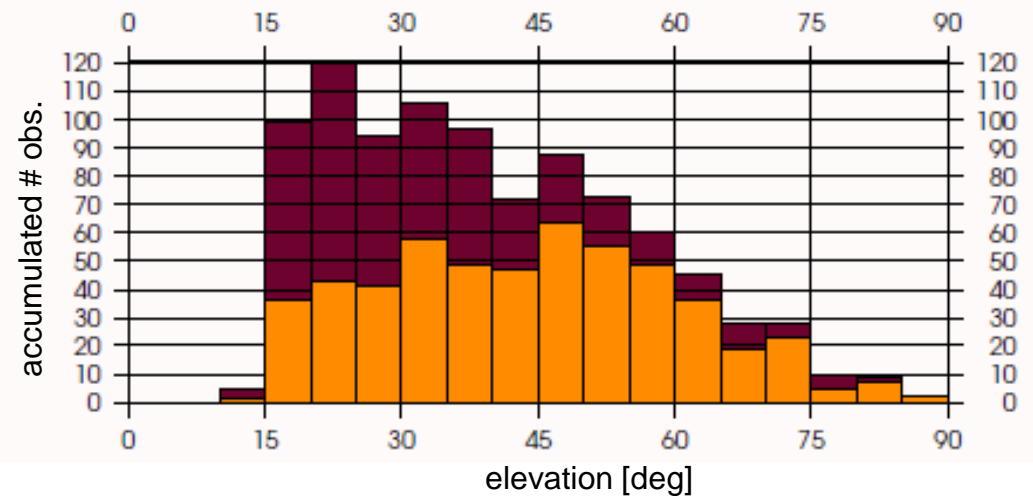
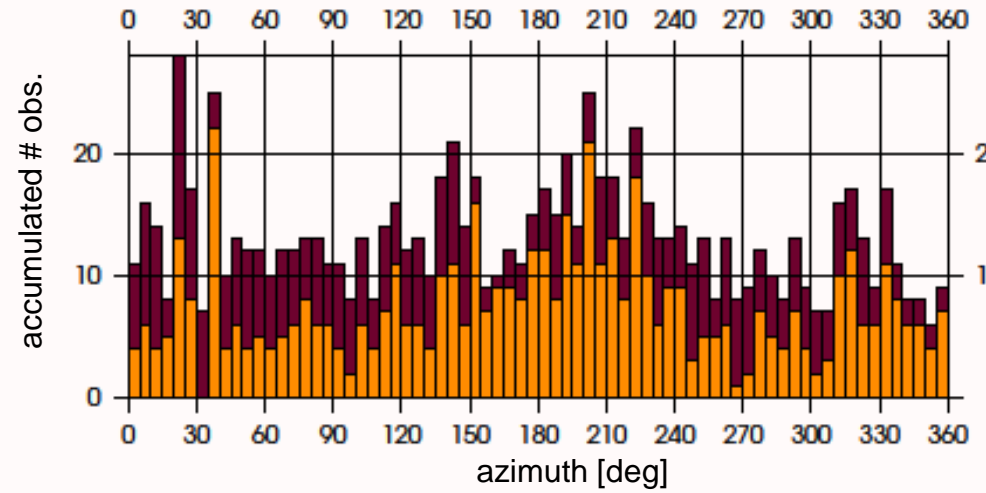
■ LA1/2, ET1/2  
■ LRS



# Yarragadee

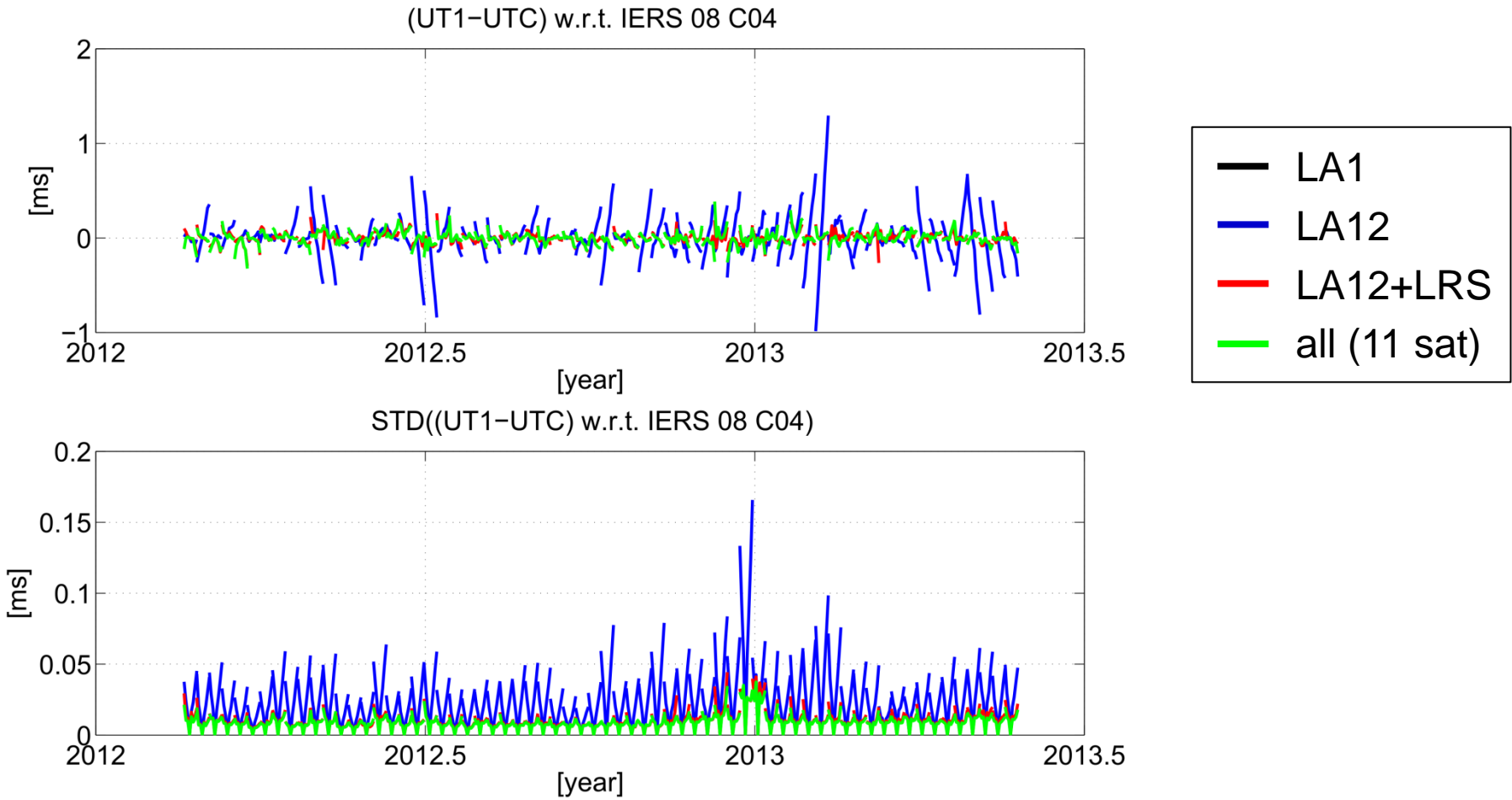


LA1/2, ET1/2  
LRS



# EOP I

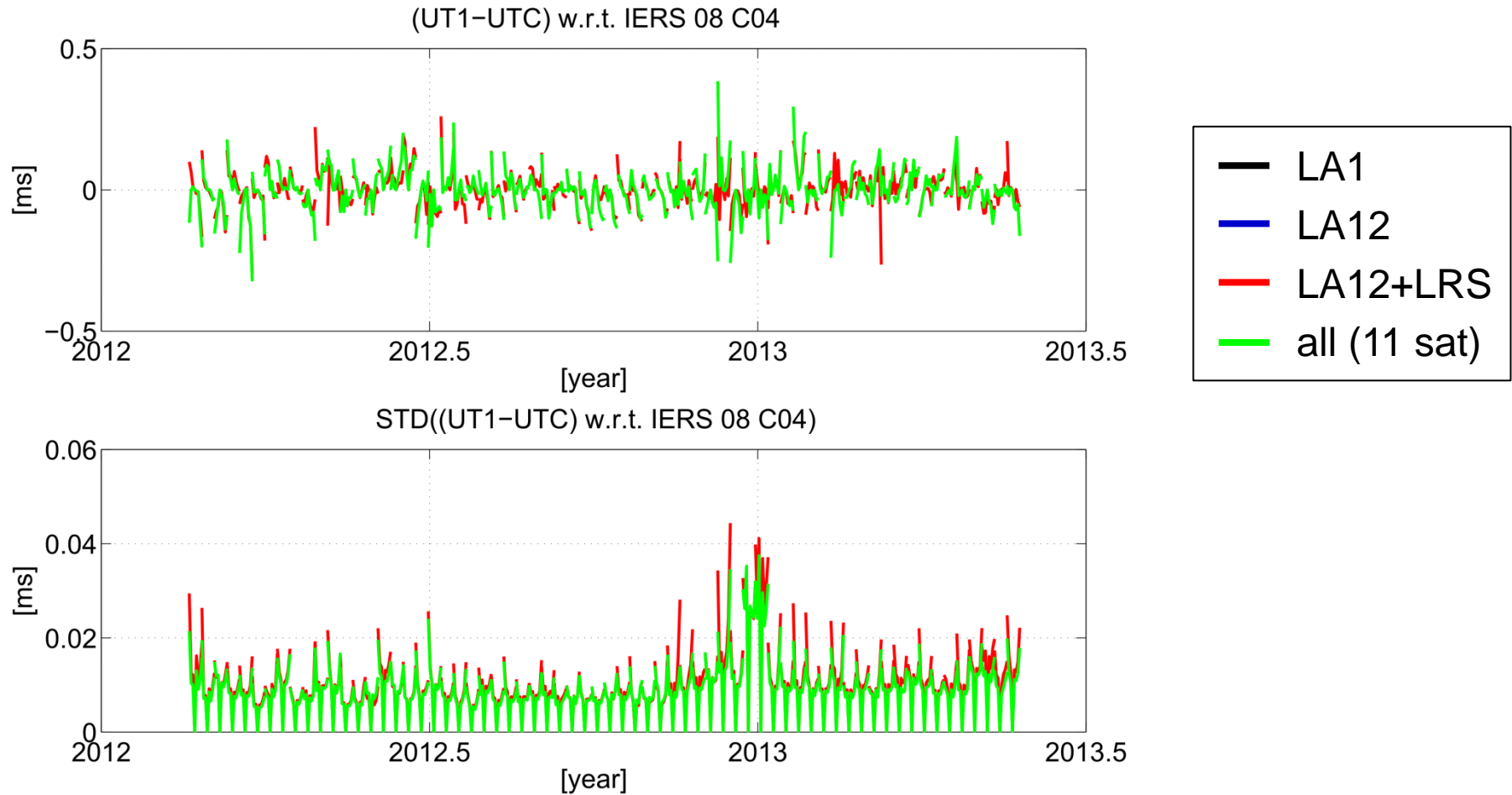
weekly solution between Feb. 2012 and May 2013 (LARES period)



|  |      |      |  |  |
|--|------|------|--|--|
| <b>RMS <math>\Delta</math> x-pole [<math>\mu</math>as]</b> | 39.2 | 15.1 |  |  |
| <b>RMS <math>\Delta</math> y-pole [<math>\mu</math>as]</b> | 50.0 | 16.1 |  |  |

# EOP II

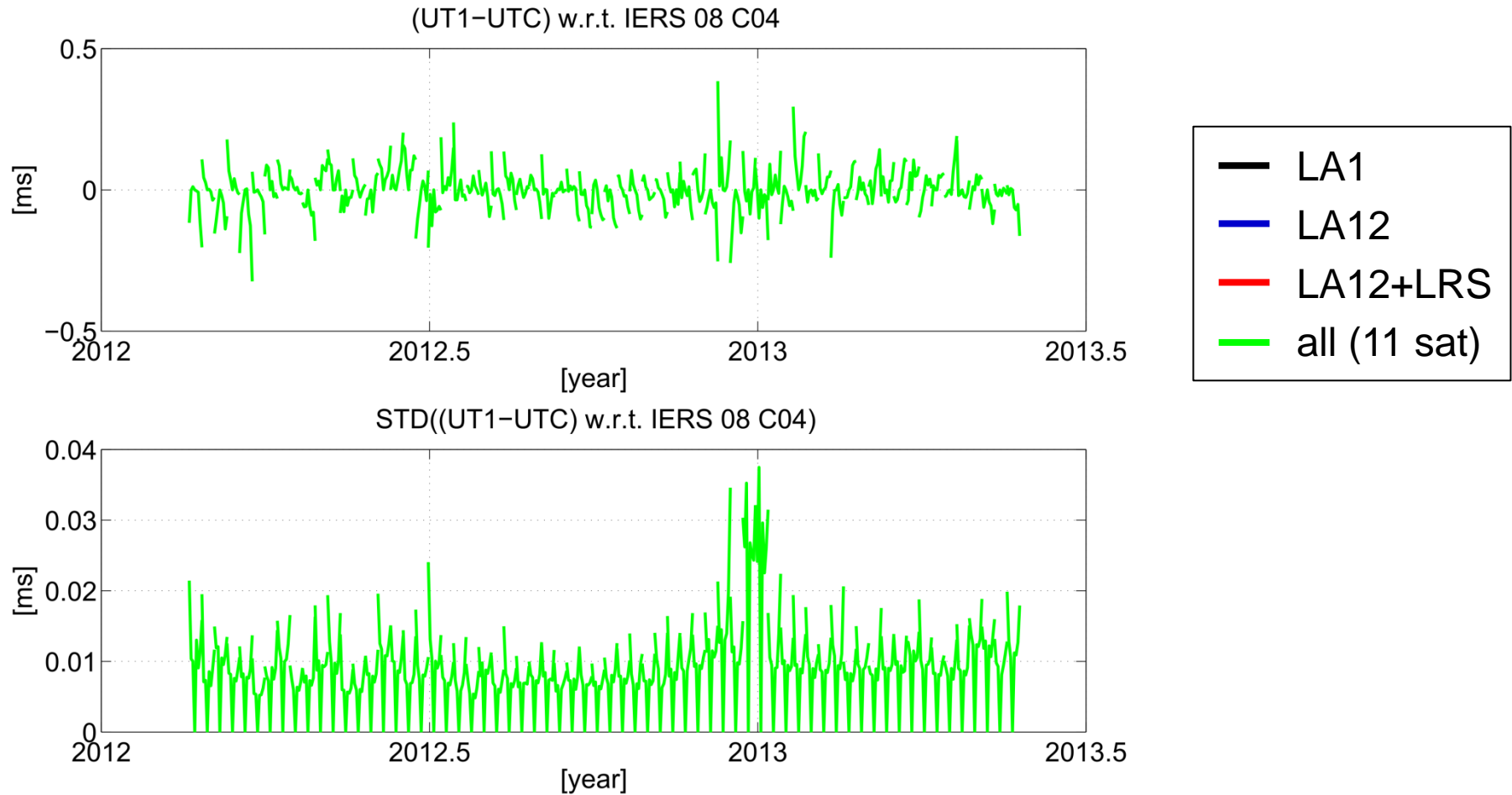
weekly solution between Feb. 2012 and May 2013 (LARES period)



|  |      |      |      |  |
|--|------|------|------|--|
| <b>RMS <math>\Delta</math> x-pole [<math>\mu</math>as]</b> | 39.2 | 15.1 | 15.3 |  |
| <b>RMS <math>\Delta</math> y-pole [<math>\mu</math>as]</b> | 50.0 | 16.1 | 15.8 |  |

# EOP III

weekly solution between Feb. 2012 and May 2013 (LARES period)



|  |      |      |      |      |
|--|------|------|------|------|
| <b>RMS <math>\Delta</math> x-pole [<math>\mu</math>as]</b> | 39.2 | 15.1 | 15.3 | 14.6 |
| <b>RMS <math>\Delta</math> y-pole [<math>\mu</math>as]</b> | 50.0 | 16.1 | 15.8 | 14.7 |

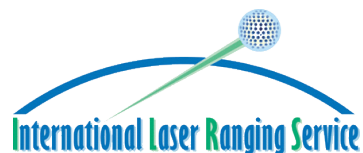
# SLRF2008 coordinate updates

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# New coordinates for ...

- [12372S001](#) A01 Altay (18799401) → incorrect velocity (typo in SLRF2008)
- [12373S001](#) A01 Arkhyz (18869601) → new site
- [25603S001](#) A01 Baikonur (18879701) → new site
- [12350S002](#) A01 Svetloe (18889801) → new site
- [12351S002](#) A01 Zelenchuksaya (18899901) → new site
- [12338S004](#) A01 Badary (18900901) → new site
- [21749S001](#) A01 Tanegashima (73588901) → new coord. due to earthquake
- [41719M001](#) A02 Concepcion (74057904) → new coord. due to earthquake
- [41508S003](#) A01 San Juan (74068801) → new coord. due to earthquake
- [21609S002](#) A02 Kunming (78208201) → (new) site
- [21605S010](#) A01 Shanghai (78212801) → only few obs. in SLRF2008
- [21726S001](#) A02 Simosato (78383603) → new coord. due to earthquake



# New coordinates for ...

```
123383004 OA01 :: Badary (1) at reference epoch: 4748.5 (2013/01/01)
      DGFI(7d) [m]          DGFI(7d) [m/a]          SLRF2008 [m]          SLRF2008 [m/a]          delta [m] delta [m/a]
-----
x:   -838300.0491 +- 0.0070 | -0.03259 + 0.01944 | -838300.0495 +- 0.0197 | -0.03130 +- 0.00241 | -0.00044 | 0.00129
y:   3865738.8699 +- 0.0057 | 0.04043 + 0.01572 | 3865738.8459 +- 0.0246 | -0.00010 +- 0.00304 | -0.02399 | -0.04053
z:   4987640.8734 +- 0.0062 | -0.00373 + 0.01710 | 4987640.8694 +- 0.0205 | -0.00440 +- 0.00251 | -0.00399 | -0.00067
```

--> new reference epoch!

```
123723001 OA01 :: Altay (1) at reference epoch: 4070.5 (2011/02/23)
      DGFI(7d) [m]          DGFI(7d) [m/a]          SLRF2008 [m]          SLRF2008 [m/a]          delta [m] delta [m/a]
-----
x:   543405.7808 +- 0.0076 | -0.01994 + 0.00513 | 543405.8539 +- 1.8272 | 0.00533 +- 0.25136 | 0.07312 | 0.02528
y:   3955302.2988 +- 0.0130 | 0.00257 + 0.00880 | 3955301.7583 +- 1.6811 | -0.23125 +- 0.23120 | -0.54057 | -0.23382
z:   4957821.0404 +- 0.0084 | 0.00730 + 0.00566 | 4957821.1896 +- 1.3784 | 0.06876 +- 0.18956 | 0.14919 | 0.06146
```

--> new reference epoch

--> maybe error in SLRF2008 y-velocity (-23cm/a is much too large!)

```
123733001 OA01 :: Arkhys (1) at reference epoch: 4511.5 (2012/05/09)
      DGFI(7d) [m]          DGFI(7d) [m/a]          SLRF2008 [m]          SLRF2008 [m/a]          delta [m] delta [m/a]
-----
x:   3466773.3154 +- 0.0084 | -0.02147 + 0.01077 | 3466773.3277 +- 0.4768 | -0.02014 +- 0.02097 | 0.01231 | 0.00133
y:   3059757.9112 +- 0.0159 | 0.02030 + 0.02048 | 3059757.9235 +- 0.3407 | 0.01523 +- 0.02012 | 0.01227 | -0.00507
z:   4381456.8167 +- 0.0112 | 0.03540 + 0.01441 | 4381456.7985 +- 0.2165 | 0.00530 +- 0.01820 | -0.01826 | -0.03010
```

--> new reference epoch

```
256033001 OA01 :: Baikonur (1) at reference epoch: 4641.5 (2012/09/16)
      DGFI(7d) [m]          DGFI(7d) [m/a]          SLRF2008 [m]          SLRF2008 [m/a]          delta [m] delta [m/a]
-----
x:   2001873.2769 +- 0.0057 | -0.03427 + 0.01129 | 2001873.3043 +- 0.5255 | -0.02345 +- 0.02097 | 0.02740 | 0.01082
y:   3987633.4155 +- 0.0036 | 0.00161 + 0.00722 | 3987633.3686 +- 0.5235 | 0.01077 +- 0.02012 | -0.04688 | 0.00916
z:   4542477.6941 +- 0.0032 | 0.00149 + 0.00632 | 4542477.6727 +- 0.5193 | 0.00088 +- 0.01820 | -0.02139 | -0.00061
```

--> new reference epoch

```
123503002 OA01 :: Svetloe (1) at reference epoch: 4725.5 (2012/12/09)
      DGFI(7d) [m]          DGFI(7d) [m/a]          SLRF2008 [m]          SLRF2008 [m/a]          delta [m] delta [m/a]
-----
x:   2730138.8656 +- 0.0087 | -0.00998 + 0.02305 | 2730138.8383 +- 0.0195 | -0.01840 +- 0.00241 | -0.02733 | -0.00842
y:   1562328.8019 +- 0.0085 | 0.00461 + 0.02260 | 1562328.7936 +- 0.0245 | 0.01250 +- 0.00304 | -0.00825 | 0.00789
z:   5529998.6769 +- 0.0060 | 0.00089 + 0.01581 | 5529998.6745 +- 0.0203 | 0.00840 +- 0.00251 | -0.00247 | 0.00751
```

--> new reference epoch

# New coordinates for ...

```
123518002 OA01 :: Zelenchuksaya (1) at reference epoch: 4738.5 (2012/12/22)
      DGFI(7d) [m]          DGFI(7d) [m/a]          SLRF2008 [m]          SLRF2008 [m/a]          delta [m]          delta [m/a]
-----
x:    3451135.9311 +- 0.0206 | -0.01471 + 0.05856 | 3451135.9217 +- 0.1672 | -0.02000 +- 0.02097 | -0.00930 | -0.00529
y:    3060335.2665 +- 0.0071 | 0.02243 + 0.02025 | 3060335.2483 +- 0.1605 | 0.01640 +- 0.02012 | -0.01821 | -0.00603
z:    4391970.3355 +- 0.0181 | 0.00035 + 0.05144 | 4391970.3416 +- 0.1452 | 0.01160 +- 0.01820 | 0.00611 | 0.01125
```

--> new reference epoch

```
217498001 OA01 :: Tanegashima (1) at reference epoch: 1826.5 (2005/01/01)
      DGFI(7d) [m]          DGFI(7d) [m/a]          SLRF2008 [m]          SLRF2008 [m/a]          delta [m]          delta [m/a]
-----
x:   -3607651.5333 +- 0.0111 | -0.03135 + 0.00288 | -3607651.5073 +- 0.0039 | -0.03372 +- 0.00143 | 0.02606 | -0.00237
y:    4147873.9460 +- 0.0099 | -0.01032 + 0.00258 | 4147873.9774 +- 0.0041 | -0.00850 +- 0.00148 | 0.03145 | 0.00181
z:    3223722.8692 +- 0.0080 | -0.02133 + 0.00208 | 3223722.8851 +- 0.0037 | -0.02019 +- 0.00134 | 0.01592 | 0.00114
```

```
217498001 OA02 :: Tanegashima (2) at reference epoch: 4515.5 (2012/05/13)
      DGFI(7d) [m]          DGFI(7d) [m/a]          SLRF2008 [m]          SLRF2008 [m/a]          delta [m]          delta [m/a]
-----
x:   -3607651.7624 +- 0.0333 | -0.07359 + 0.03665 | -3607651.7555 +- 0.0112 | -0.03372 +- 0.00143 | 0.00693 | 0.03987
y:    4147873.9206 +- 0.0271 | -0.07307 + 0.02979 | 4147873.9148 +- 0.0116 | -0.00850 +- 0.00148 | -0.00575 | 0.06456
z:    3223722.7508 +- 0.0270 | -0.06854 + 0.02966 | 3223722.7364 +- 0.0105 | -0.02019 +- 0.00134 | -0.01431 | 0.04835
```

--> new jump due to Tohoku Earthquake (April2011) introduced

--> new reference epoch for Tanegashima (2)

--> velocities in Tanegashima (2) very bad! --> maybe use of new station coordinates but old SLRF2008 velocity

```
41719M001 OA01 :: Concepcion (1) at reference epoch: 1826.5 (2005/01/01)
      DGFI(7d) [m]          DGFI(7d) [m/a]          SLRF2008 [m]          SLRF2008 [m/a]          delta [m]          delta [m/a]
-----
x:    1492033.0270 +- 0.0015 | 0.03534 + 0.00068 | 1492033.0314 +- 0.0007 | 0.03489 +- 0.00022 | 0.00434 | -0.00045
y:   -4887946.0777 +- 0.0013 | -0.00015 + 0.00057 | -4887946.0756 +- 0.0008 | -0.00151 +- 0.00020 | 0.00213 | -0.00136
z:   -3803565.8972 +- 0.0017 | 0.01677 + 0.00077 | -3803565.8972 +- 0.0006 | 0.01691 +- 0.00018 | 0.00001 | 0.00013
```

```
41719M001 OA02 :: Concepcion (2) at reference epoch: 4353.5 (2011/12/03)
      DGFI(7d) [m]          DGFI(7d) [m/a]          SLRF2008 [m]          SLRF2008 [m/a]          delta [m]          delta [m/a]
-----
x:    1492030.0089 +- 0.0031 | -0.03366 + 0.00344 | 1492029.9785 +- 0.0126 | -0.07540 +- 0.00140 | -0.03033 | -0.04174
y:   -4887946.6044 +- 0.0023 | -0.01534 + 0.00258 | -4887946.6331 +- 0.0126 | -0.04010 +- 0.00140 | -0.02870 | -0.02476
z:   -3803566.2824 +- 0.0017 | 0.02627 + 0.00192 | -3803566.3052 +- 0.0126 | 0.00660 +- 0.00140 | -0.02288 | -0.01967
```

--> new reference epoch for Concepcion (2)

# New coordinates for ...

```

415083003 OA01 :: San Juan (1) at reference epoch: 1826.5 (2005/01/01)
                DGFI(7d) [m]          DGFI(7d) [m/a]          SLRF2008 [m]          SLRF2008 [m/a]          delta [m] delta [m/a]
-----
x:  1984104.3223 +- 0.0021 | 0.01116 +- 0.00062 | 1984104.3225 +- 0.0015 | 0.01268 +- 0.00050 | 0.00027 | 0.00152
y: -5068867.1897 +- 0.0037 | -0.00737 +- 0.00108 | -5068867.1926 +- 0.0015 | -0.00532 +- 0.00048 | -0.00287 | 0.00205
z: -3314482.5340 +- 0.0039 | 0.01087 +- 0.00113 | -3314482.5439 +- 0.0011 | 0.01450 +- 0.00039 | -0.00991 | 0.00363
415083003 OA02 :: San Juan (2) at reference epoch: 4336.5 (2011/11/13)
                DGFI(7d) [m]          DGFI(7d) [m/a]          SLRF2008 [m]          SLRF2008 [m/a]          delta [m] delta [m/a]
-----
x:  1984104.3664 +- 0.0017 | 0.00534 +- 0.00177 | 1984104.4097 +- 0.0038 | 0.01268 +- 0.00050 | 0.04324 | 0.00734
y: -5068867.2428 +- 0.0015 | -0.00784 +- 0.00154 | -5068867.2291 +- 0.0036 | -0.00532 +- 0.00048 | 0.01366 | 0.00252
z: -3314482.4860 +- 0.0015 | 0.01306 +- 0.00151 | -3314482.4442 +- 0.0029 | 0.01450 +- 0.00039 | 0.04176 | 0.00144

--> new jump due to Chile-Maule Earthquake (February2010) introduced
--> new reference epoch for San Juan (2)

216093002 OA01 :: Kunming (1) at reference epoch: 3983.5 (2011/11/28)
                DGFI(7d) [m]          DGFI(7d) [m/a]          SLRF2008 [m]          SLRF2008 [m/a]          delta [m] delta [m/a]
-----
x: -1281275.8393 +- 0.0080 | -0.04709 +- 0.01542 | -1281275.8277 +- 0.0141 | -0.03052 +- 0.00279 | 0.01163 | 0.01657
y:  5640727.2156 +- 0.0034 | -0.00226 +- 0.00646 |  5640727.2250 +- 0.0109 | -0.00683 +- 0.00216 | 0.00943 | -0.00457
z:  2682925.7980 +- 0.0071 | -0.01119 +- 0.01360 |  2682925.8180 +- 0.0120 | -0.00820 +- 0.00237 | 0.02008 | 0.00299
216093002 OA02 :: Kunming (2) at reference epoch: 3136.5 (2008/08/03)
                DGFI(7d) [m]          DGFI(7d) [m/a]          SLRF2008 [m]          SLRF2008 [m/a]          delta [m] delta [m/a]
-----
x: -1281276.1292 +- 0.0104 | -0.02454 +- 0.00419 | -1281276.1500 +- 0.0242 | -0.03052 +- 0.00279 | -0.02078 | -0.00598
y:  5640727.2615 +- 0.0085 | -0.01608 +- 0.00344 |  5640727.3010 +- 0.0190 | -0.00683 +- 0.00216 | 0.03945 | 0.00925
z:  2682925.6742 +- 0.0133 | -0.02766 +- 0.00540 |  2682925.7063 +- 0.0211 | -0.00820 +- 0.00237 | 0.03216 | 0.01945

--> new reference epoch for Kunming (1)
--> new reference epoch for Kunming (2)

216053010 OA01 :: Shanghai (1) at reference epoch: 3569.5 (2009/10/10)
                DGFI(7d) [m]          DGFI(7d) [m/a]          SLRF2008 [m]          SLRF2008 [m/a]          delta [m] delta [m/a]
-----
x: -2830744.5874 +- 0.0034 | -0.03107 +- 0.00155 | -2830744.5885 +- 0.0019 | -0.03004 +- 0.00011 | -0.00113 | 0.00103
y:  4676580.2275 +- 0.0043 | -0.01019 +- 0.00197 |  4676580.2366 +- 0.0018 | -0.01174 +- 0.00013 | 0.00907 | -0.00156
z:  3275072.7820 +- 0.0031 | -0.01070 +- 0.00141 |  3275072.7863 +- 0.0016 | -0.01192 +- 0.00011 | 0.00434 | -0.00122

--> new reference epoch
    
```

# New coordinates for ...

```

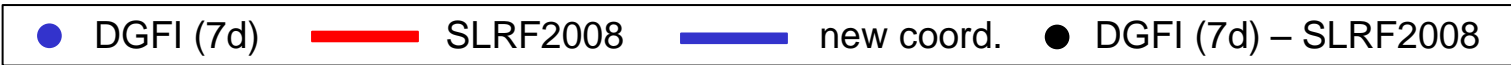
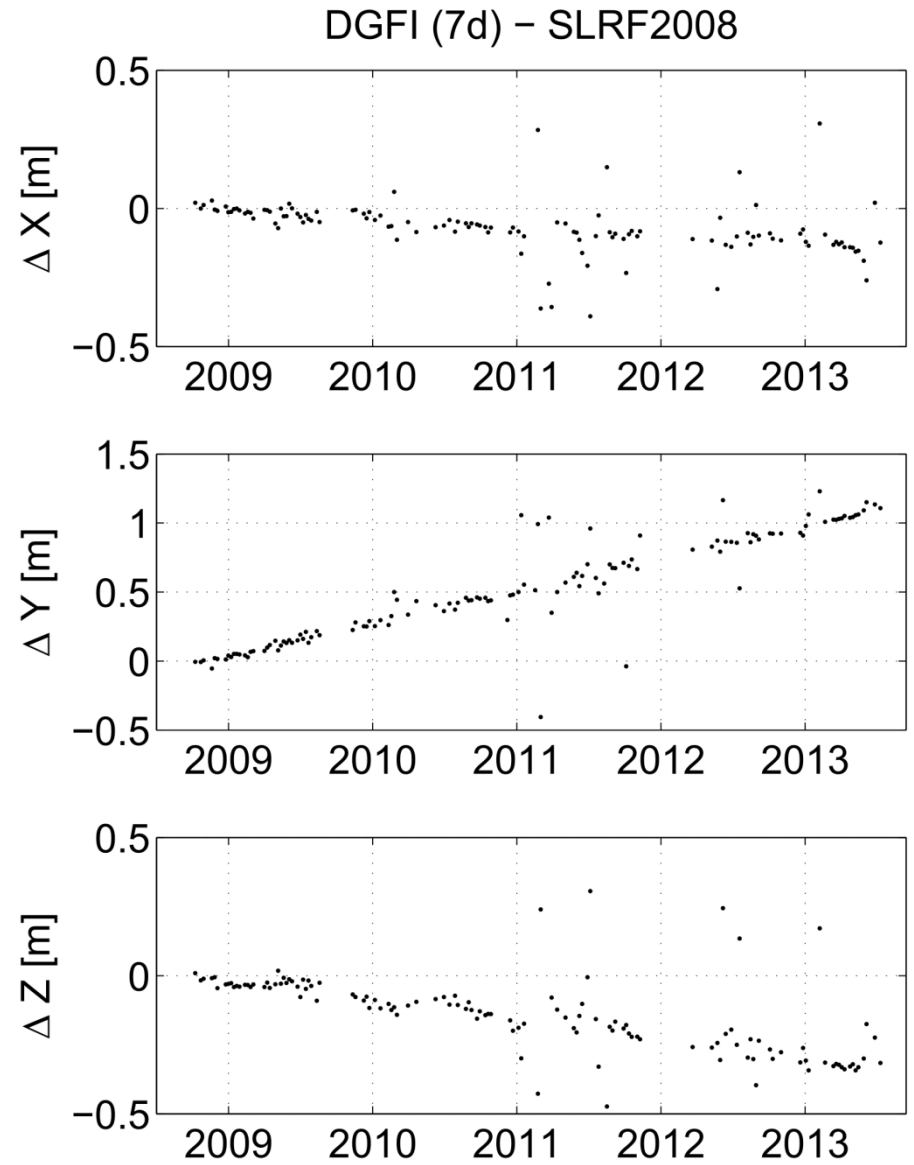
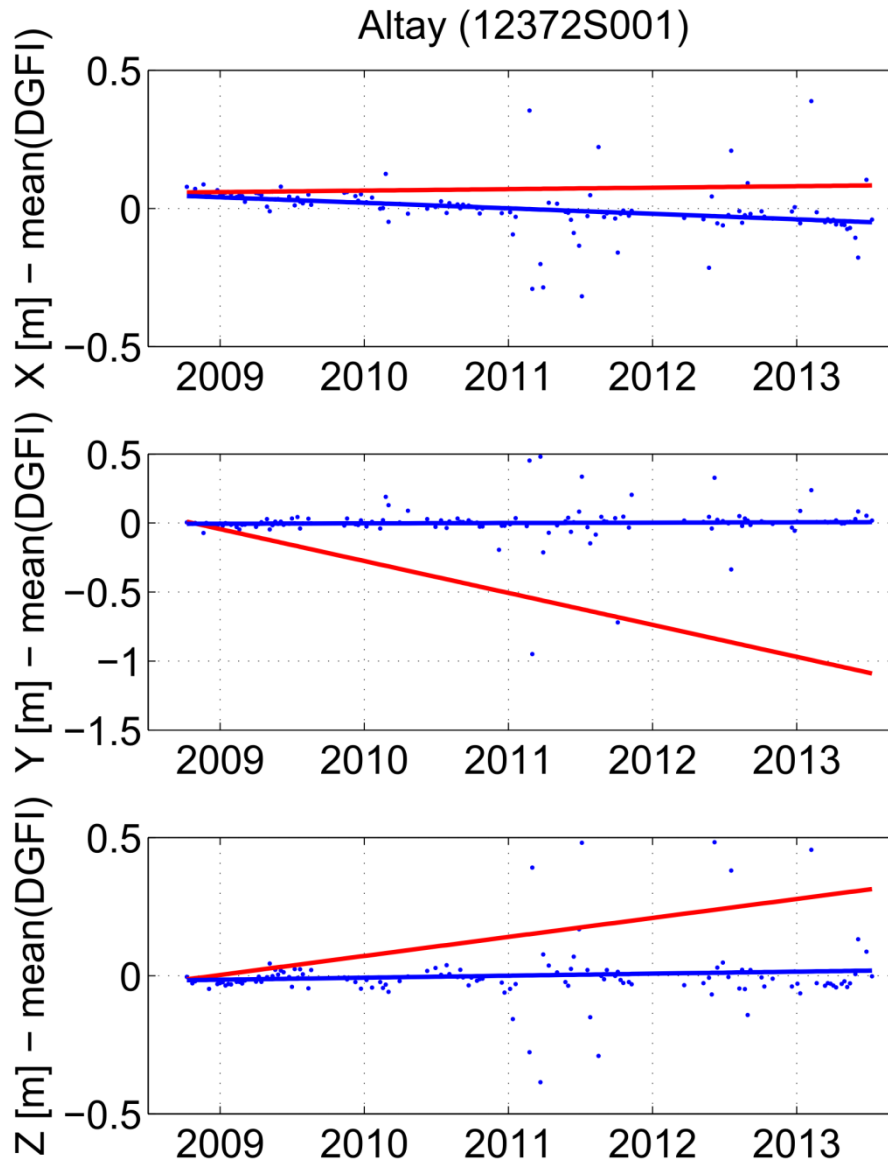
217263001 0A01 :: Simosato (1) at reference epoch: 633.5 (2001/09/26)
                DGFI(7d) [m]          DGFI(7d) [m/a]          SLRF2008 [m]          SLRF2008 [m/a]          delta [m] delta [m/a]
-----
x:  -3822388.3424 +- 0.0040 | 0.00500 +- 0.00410 | -3822388.3255 +- 0.0013 | 0.00155 +- 0.00013 | 0.01688 | -0.00345
y:  3699363.5782 +- 0.0057 | 0.01221 +- 0.00584 | 3699363.5802 +- 0.0013 | 0.00907 +- 0.00013 | 0.00194 | -0.00314
z:  3507573.1063 +- 0.0039 | -0.00424 +- 0.00403 | 3507573.1080 +- 0.0011 | -0.00049 +- 0.00012 | 0.00169 | 0.00374

217263001 0A02 :: Simosato (2) at reference epoch: 1826.5 (2005/01/01)
                DGFI(7d) [m]          DGFI(7d) [m/a]          SLRF2008 [m]          SLRF2008 [m/a]          delta [m] delta [m/a]
-----
x:  -3822388.3282 +- 0.0028 | 0.00293 +- 0.00093 | -3822388.3172 +- 0.0008 | 0.00155 +- 0.00013 | 0.01093 | -0.00138
y:  3699363.5974 +- 0.0033 | 0.00750 +- 0.00107 | 3699363.6038 +- 0.0009 | 0.00907 +- 0.00013 | 0.00643 | 0.00157
z:  3507573.0755 +- 0.0030 | -0.00821 +- 0.00098 | 3507573.0809 +- 0.0007 | -0.00049 +- 0.00012 | 0.00545 | 0.00771

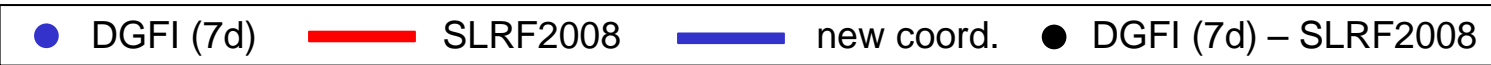
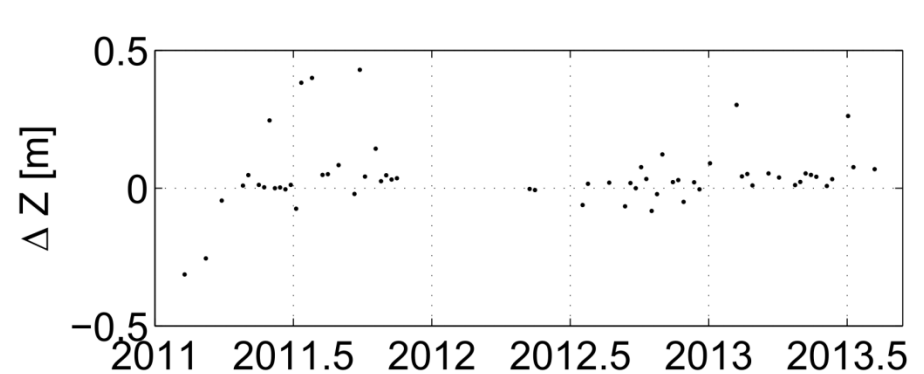
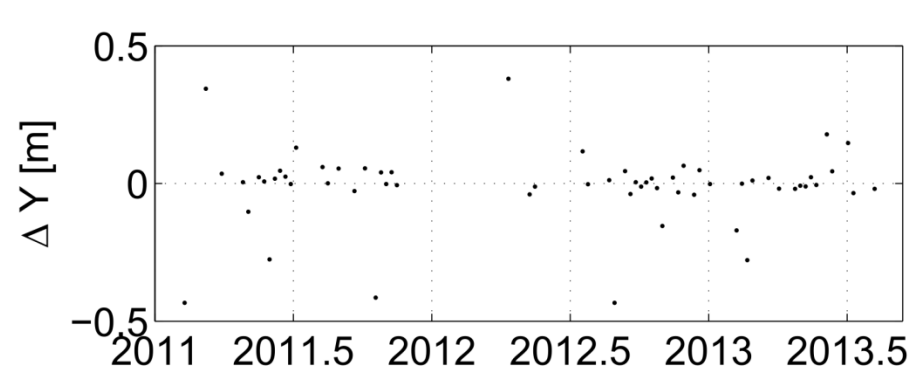
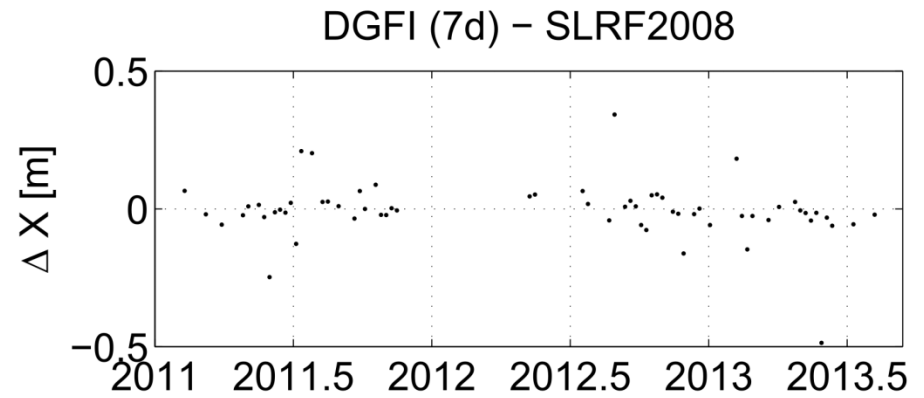
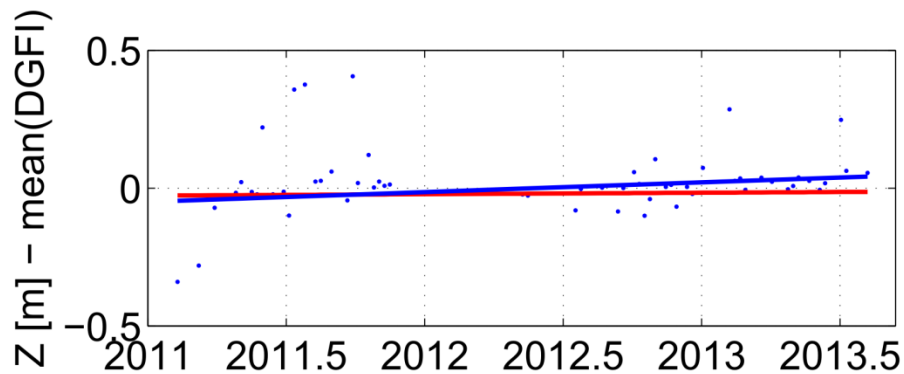
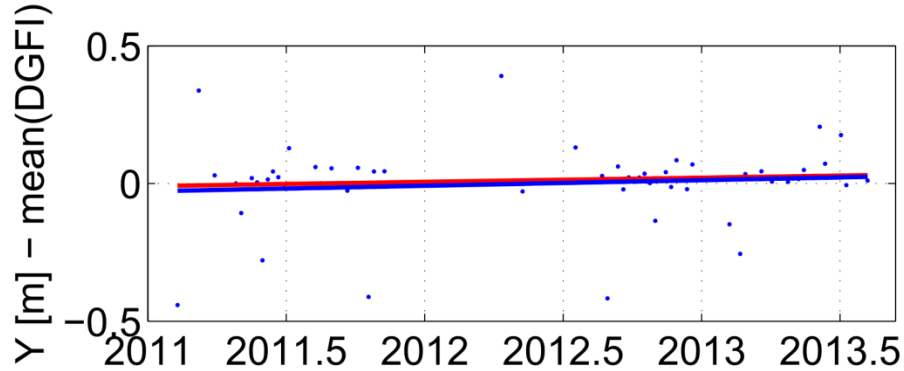
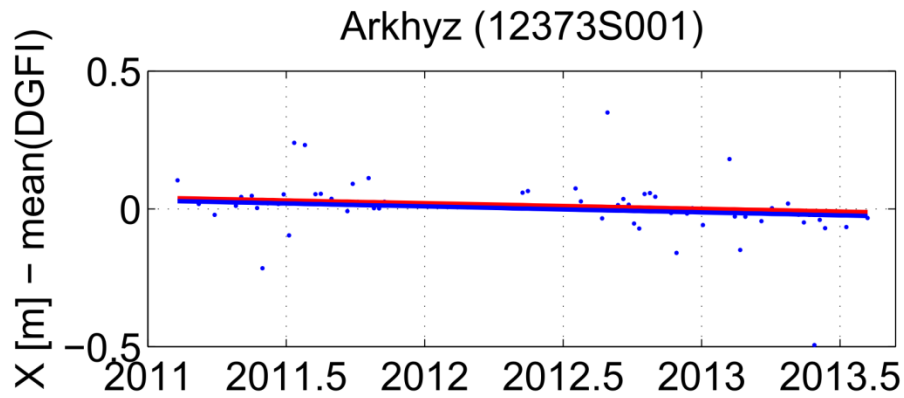
217263001 0A03 :: Simosato (3) at reference epoch: 4532.5 (2012/05/30)
                DGFI(7d) [m]          DGFI(7d) [m/a]          SLRF2008 [m]          SLRF2008 [m/a]          delta [m] delta [m/a]
-----
x:  -3822388.3336 +- 0.0034 | -0.00257 +- 0.00500 | -3822388.3058 +- 0.0013 | 0.00155 +- 0.00013 | 0.02784 | 0.00412
y:  3699363.6295 +- 0.0029 | -0.00786 +- 0.00427 | 3699363.6710 +- 0.0013 | 0.00907 +- 0.00013 | 0.04144 | 0.01693
z:  3507573.0573 +- 0.0026 | -0.00466 +- 0.00392 | 3507573.0773 +- 0.0011 | -0.00049 +- 0.00012 | 0.01996 | 0.00417

--> new reference epoch for Simosato (1)
--> new jump due to Tohoku Earthquake (April2011) introduced
--> new reference epoch for Simosato (3)
    
```

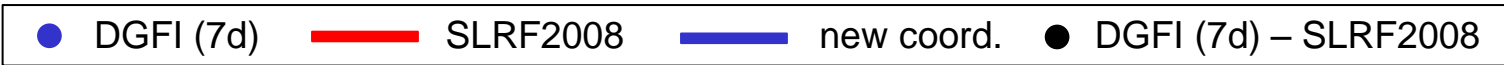
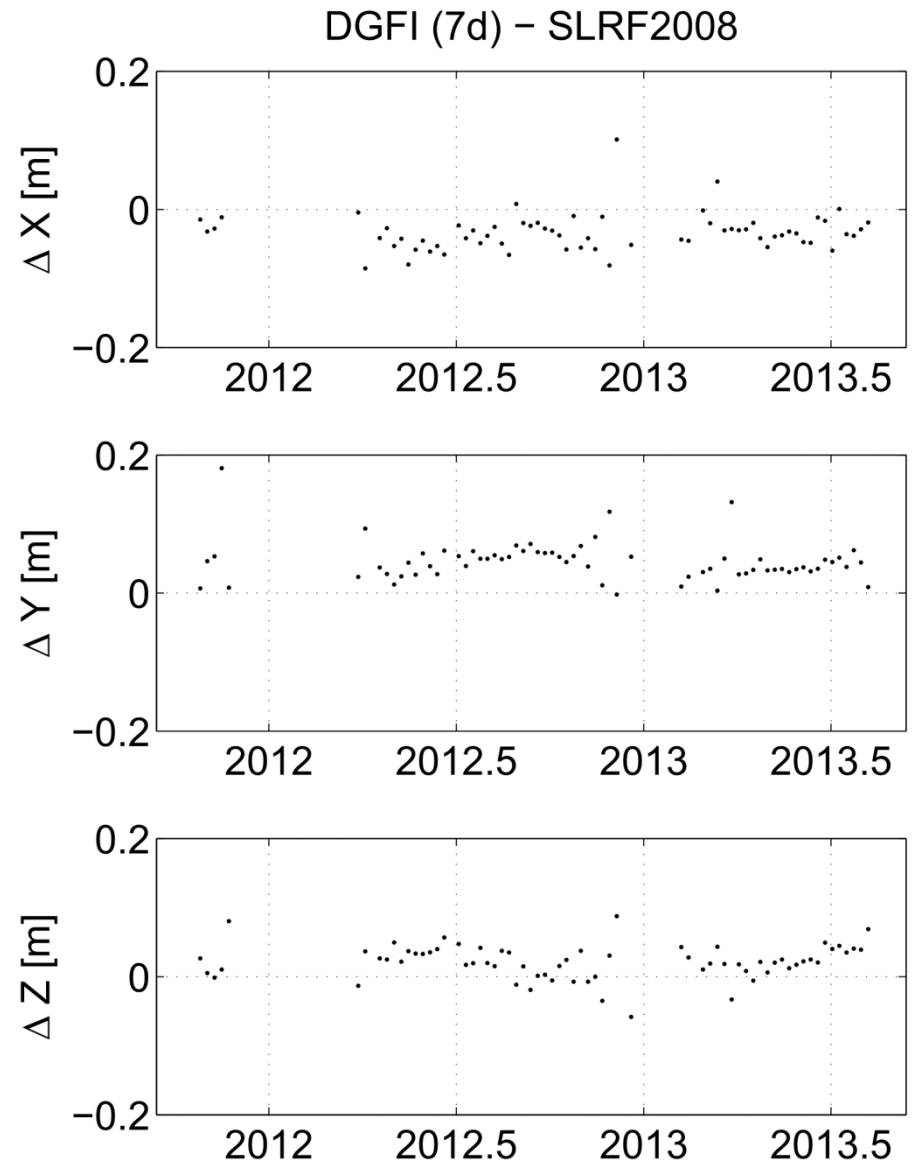
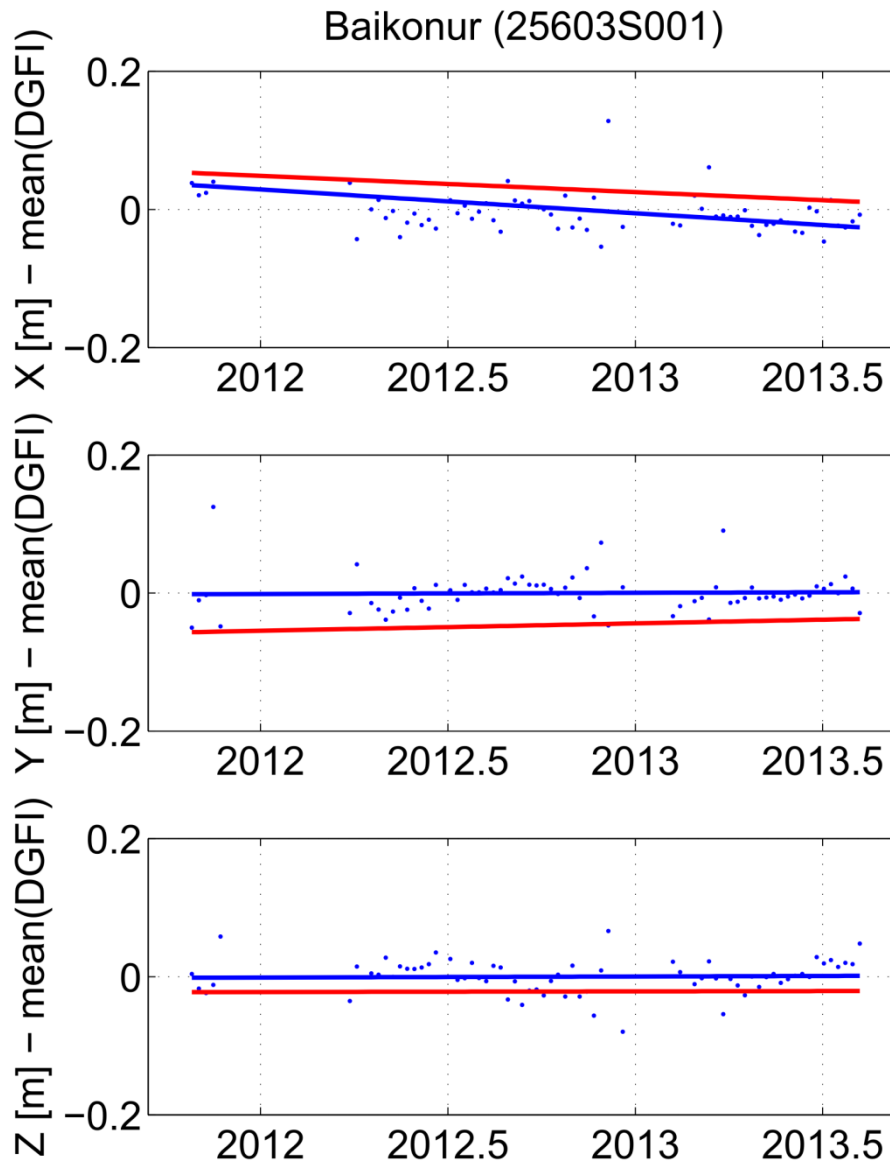
# Altay



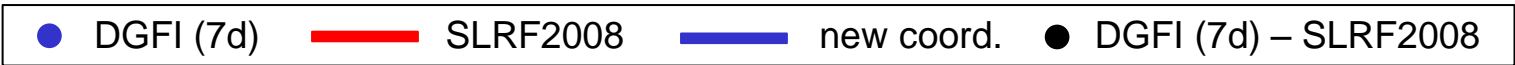
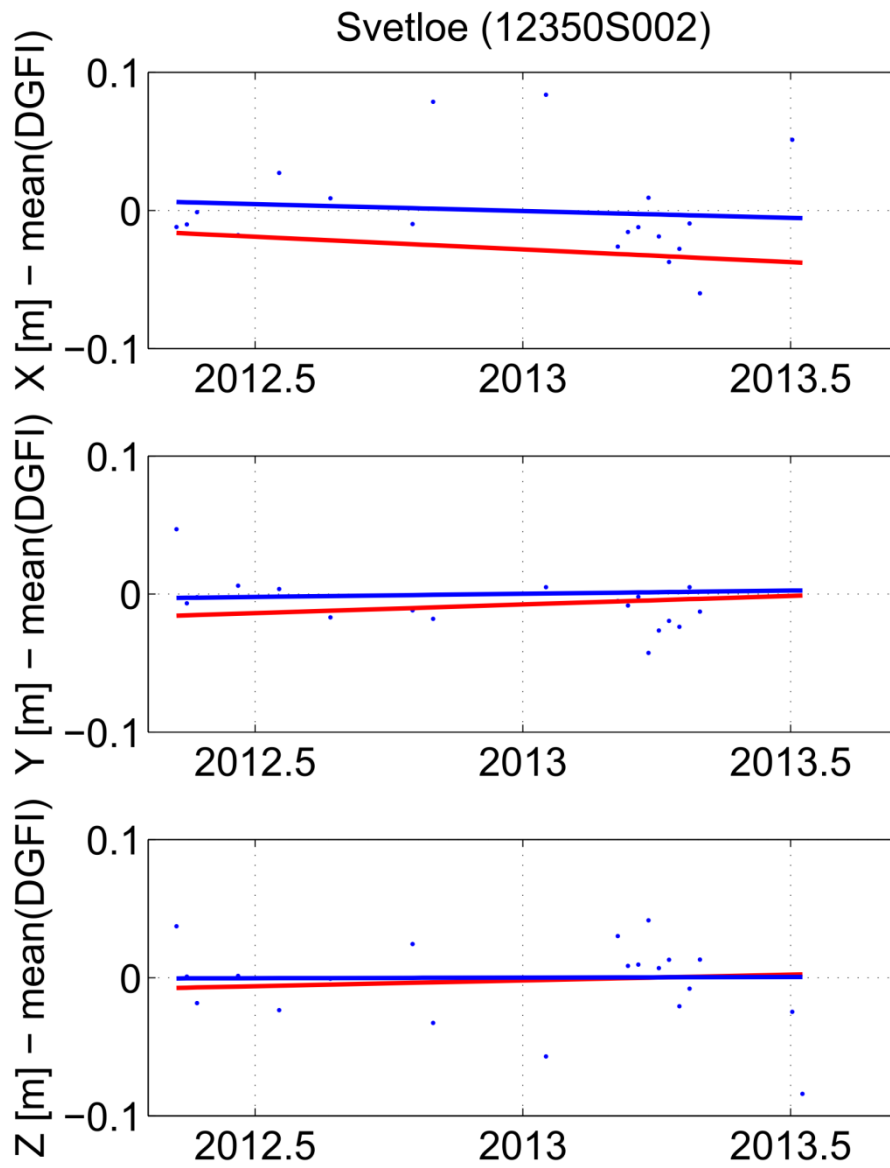
# Arkhyz



# Baikonur



# Svetloe

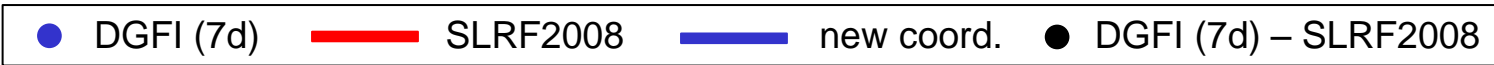
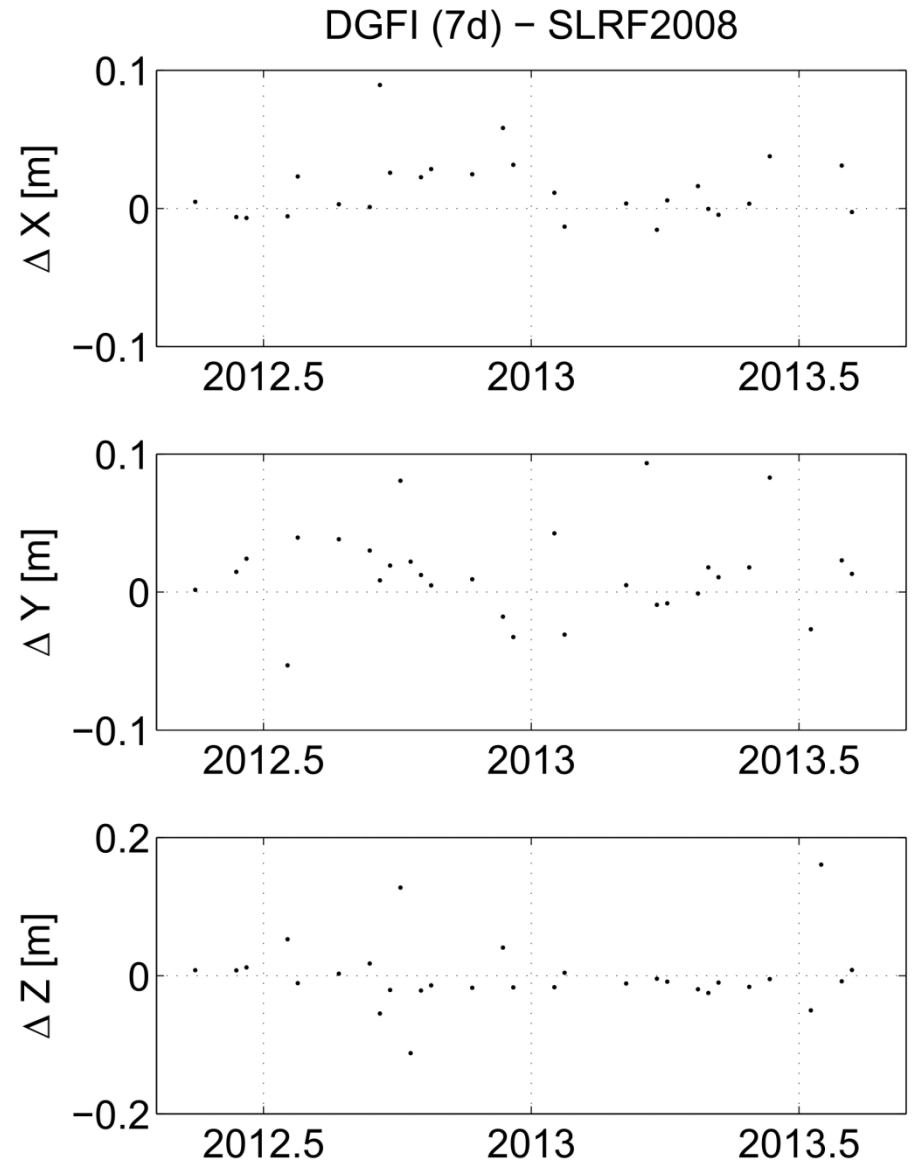
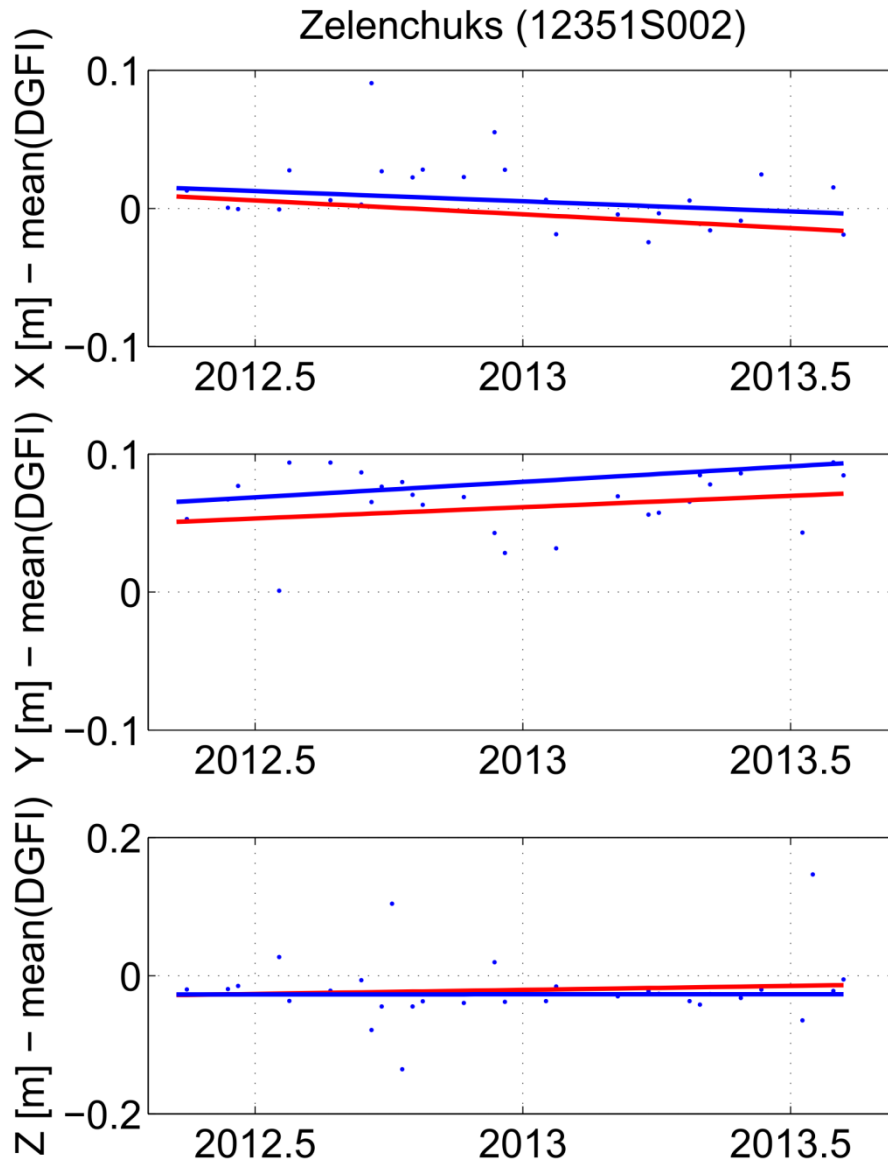




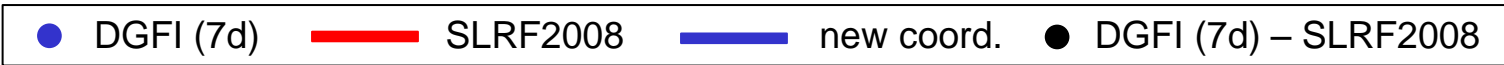
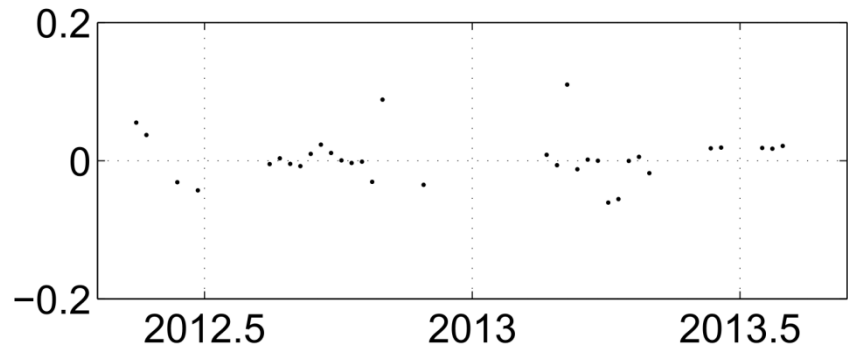
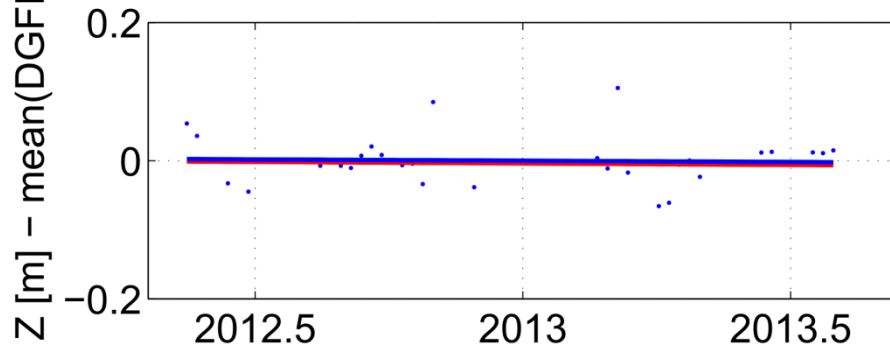
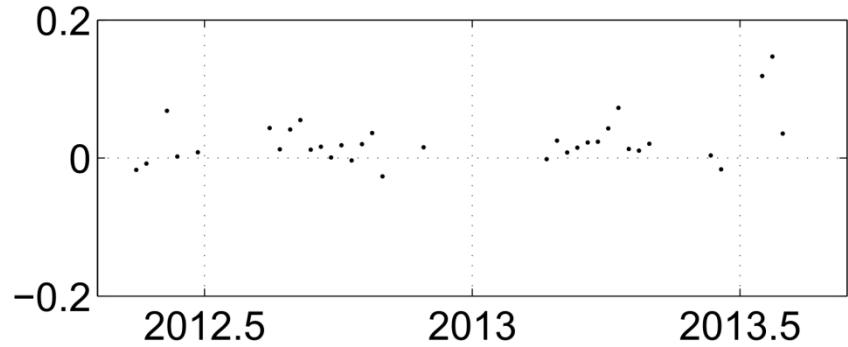
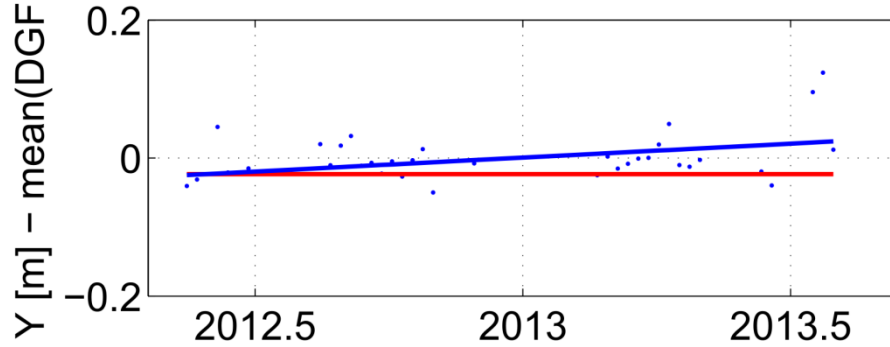
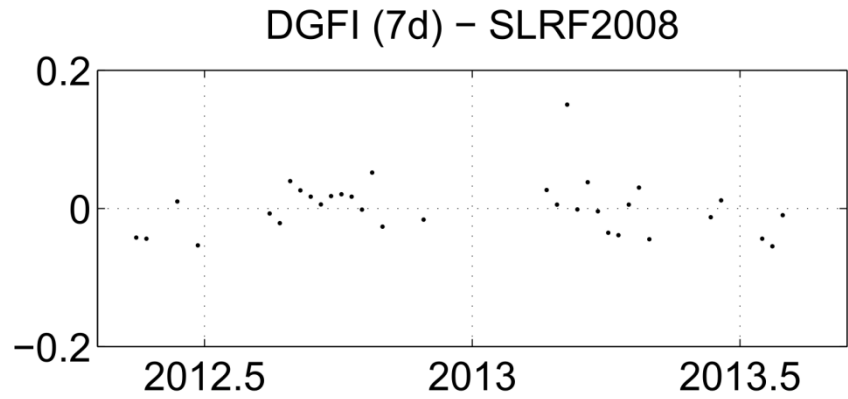
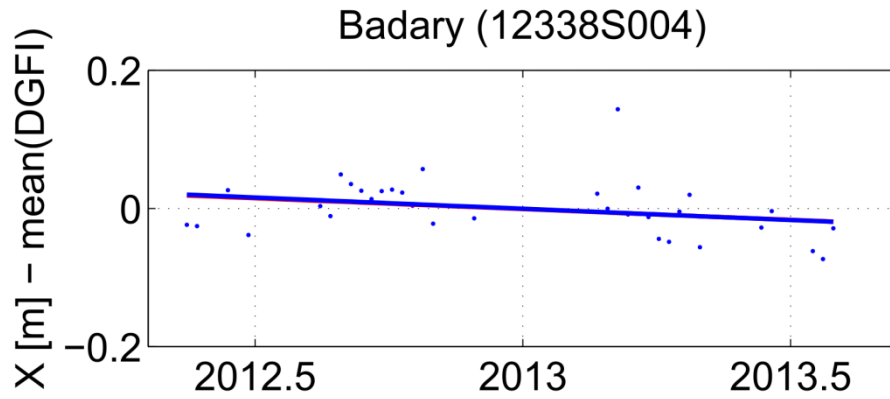
# Zelenchuksaya



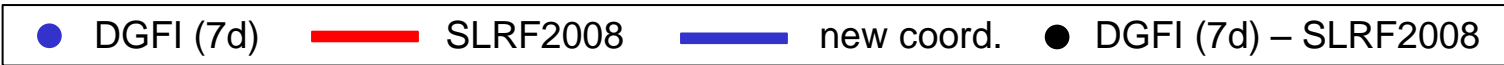
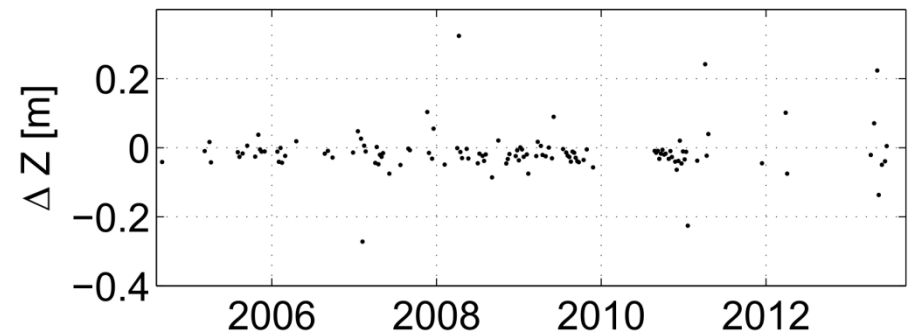
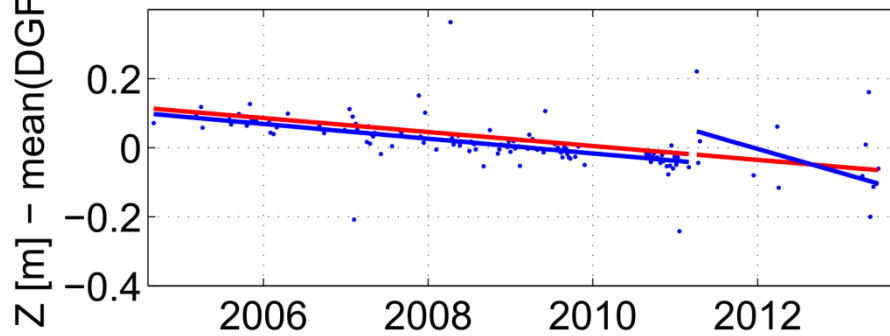
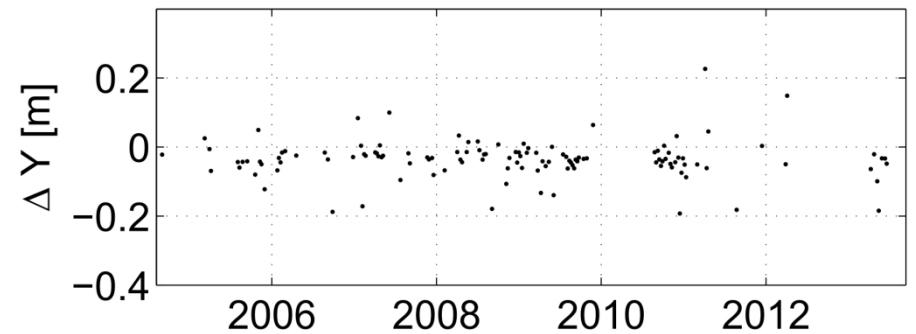
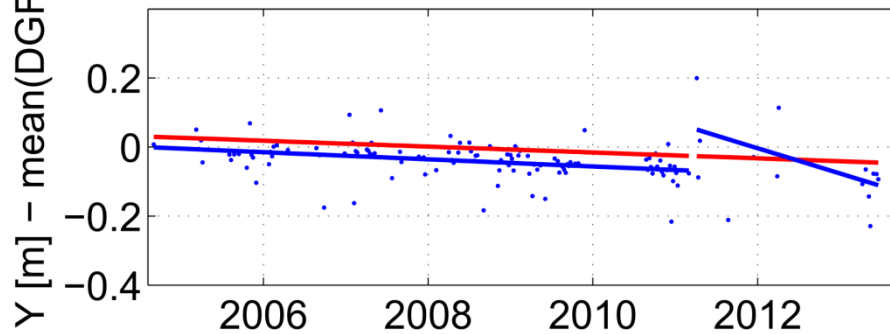
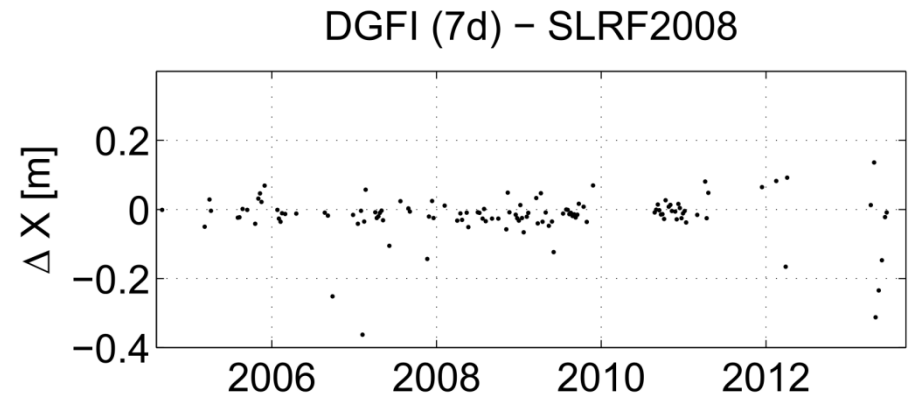
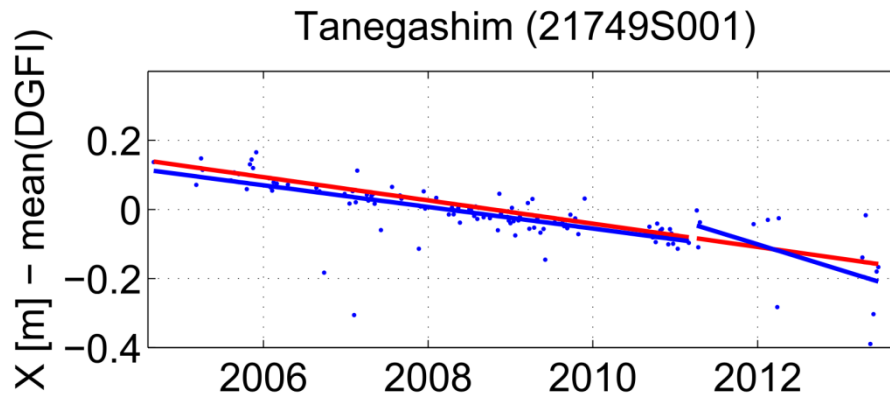
AWG Meeting, 09.11.2013



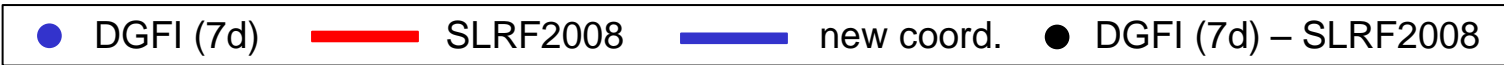
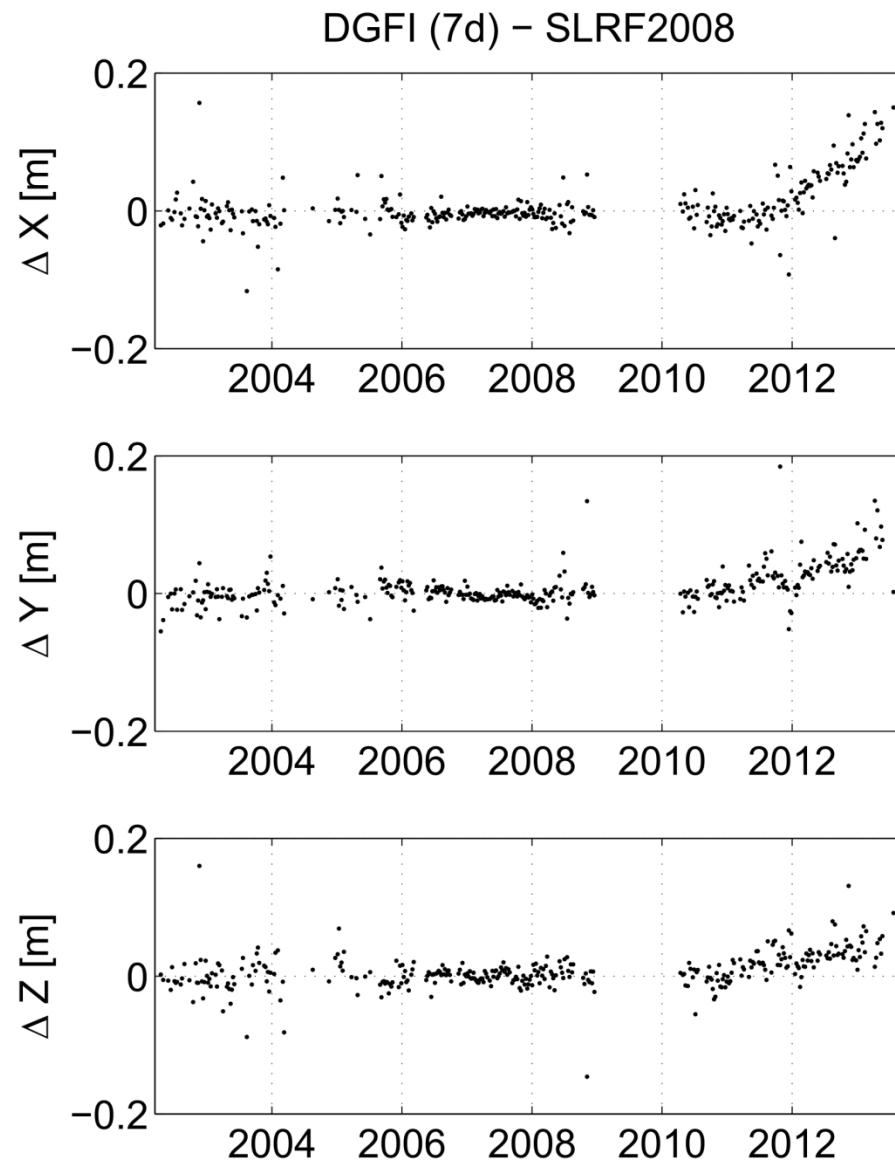
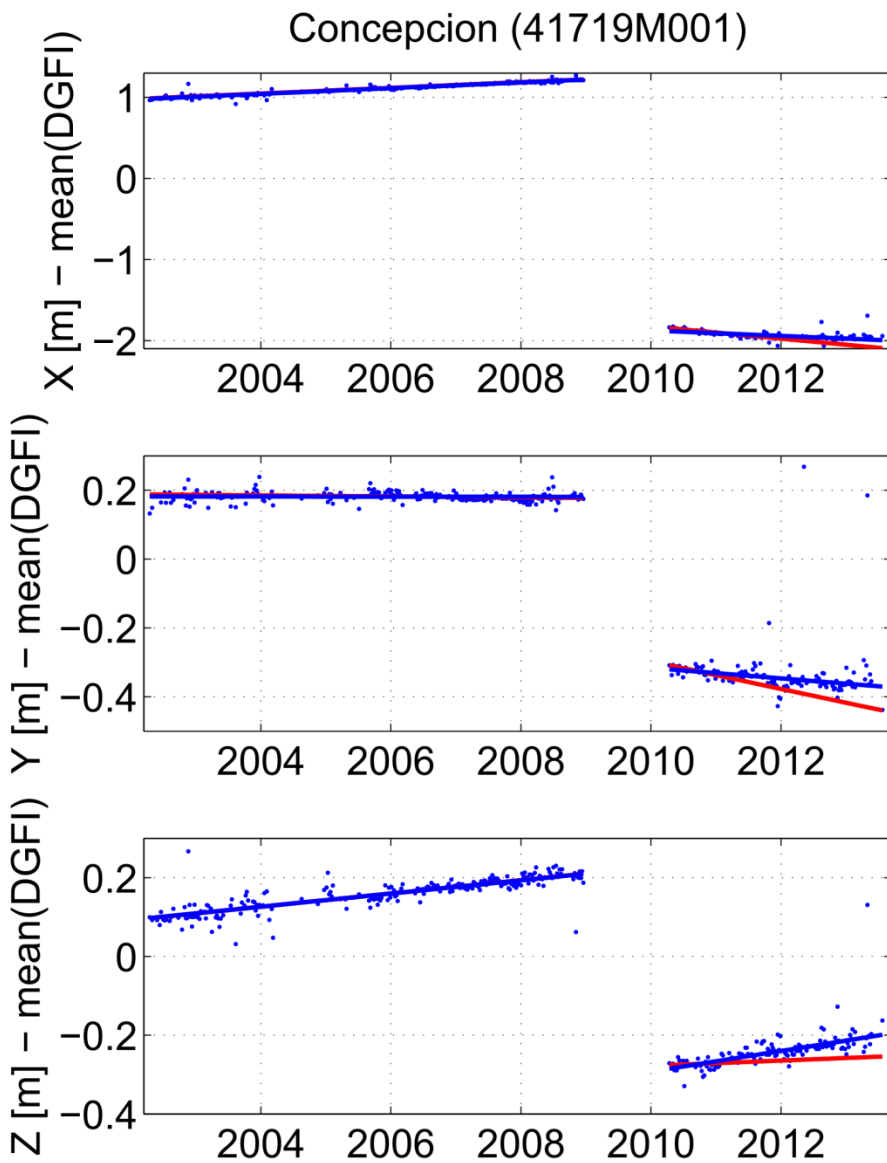
# Badary



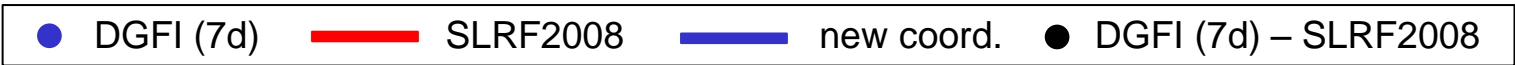
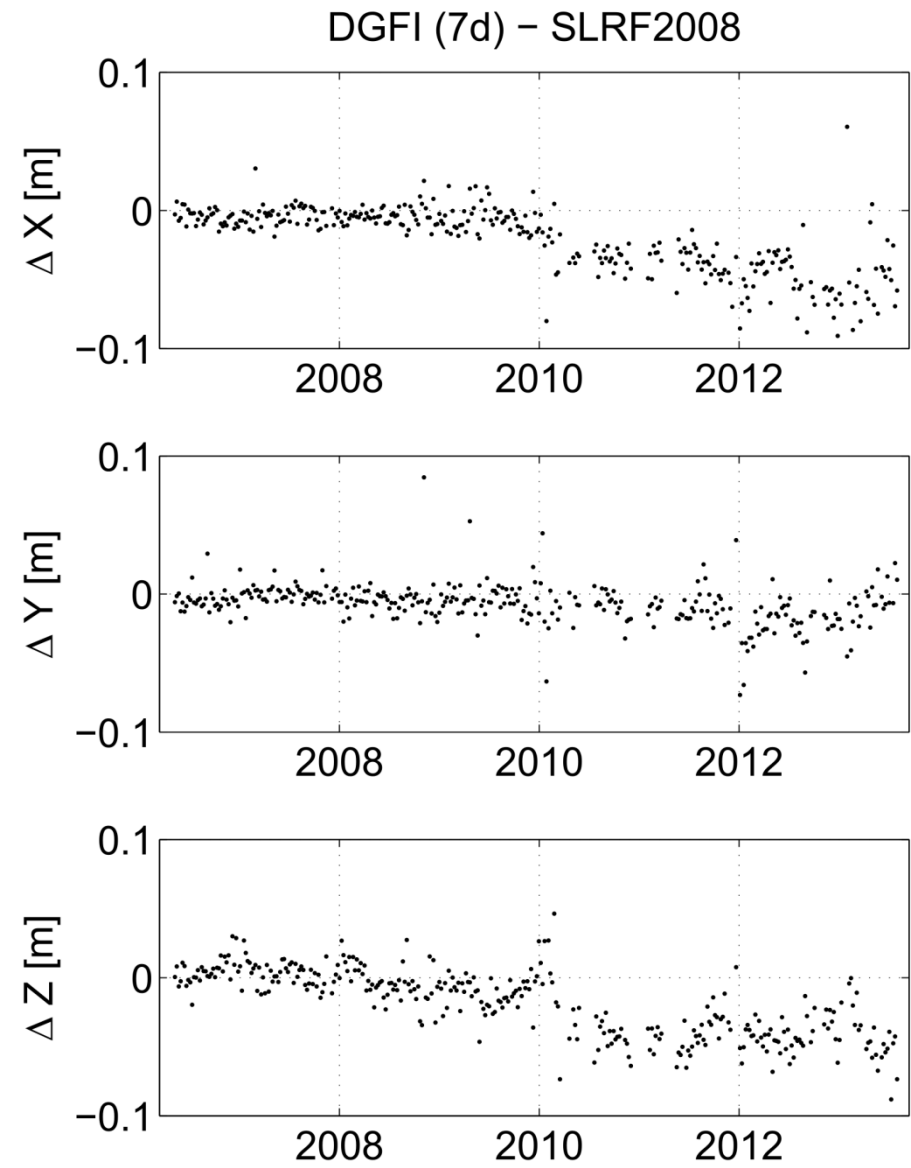
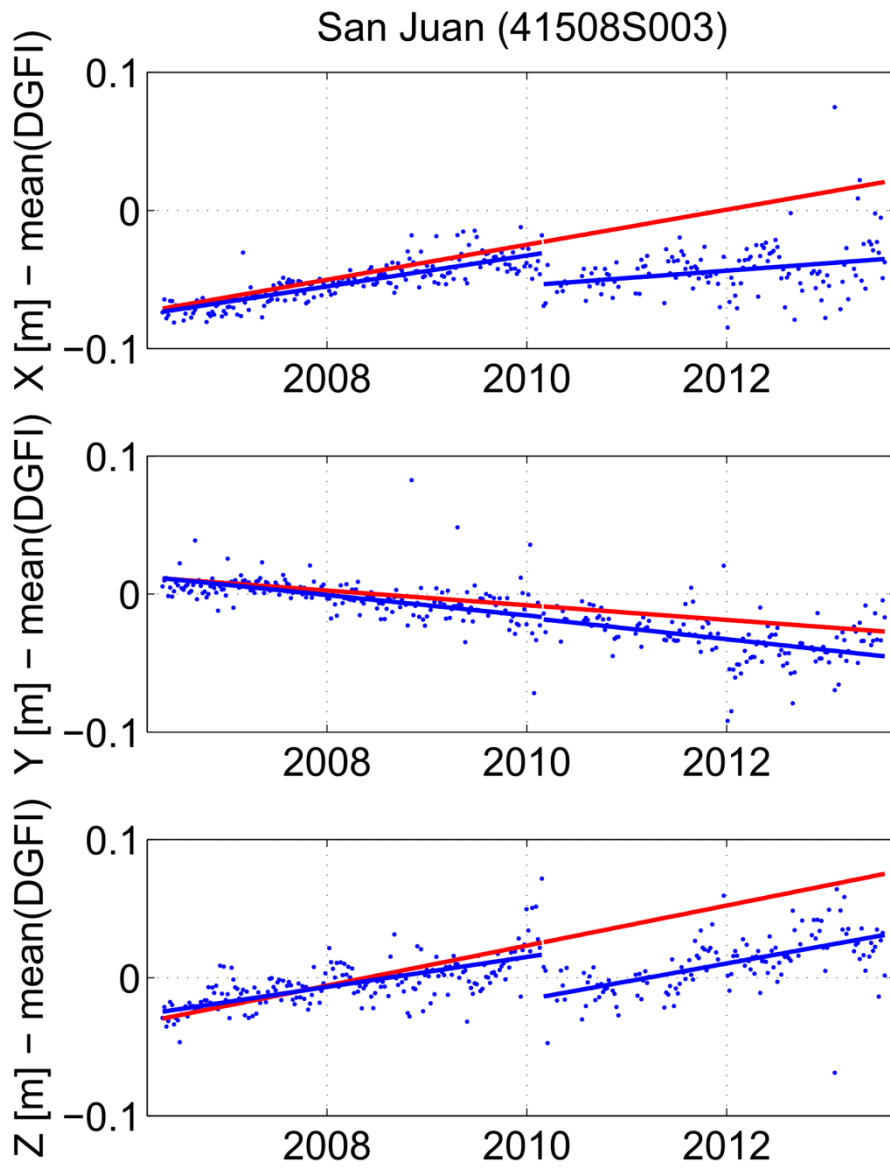
# Tanegashima



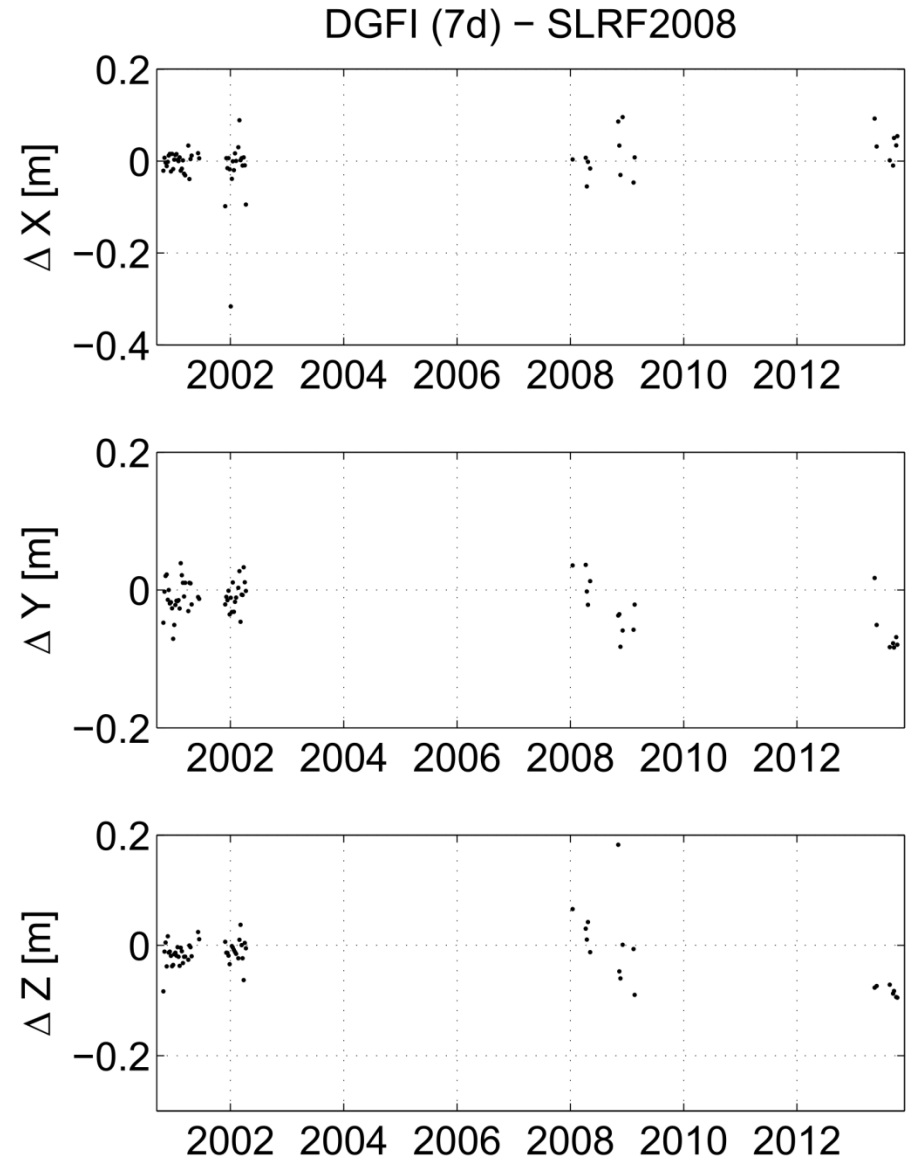
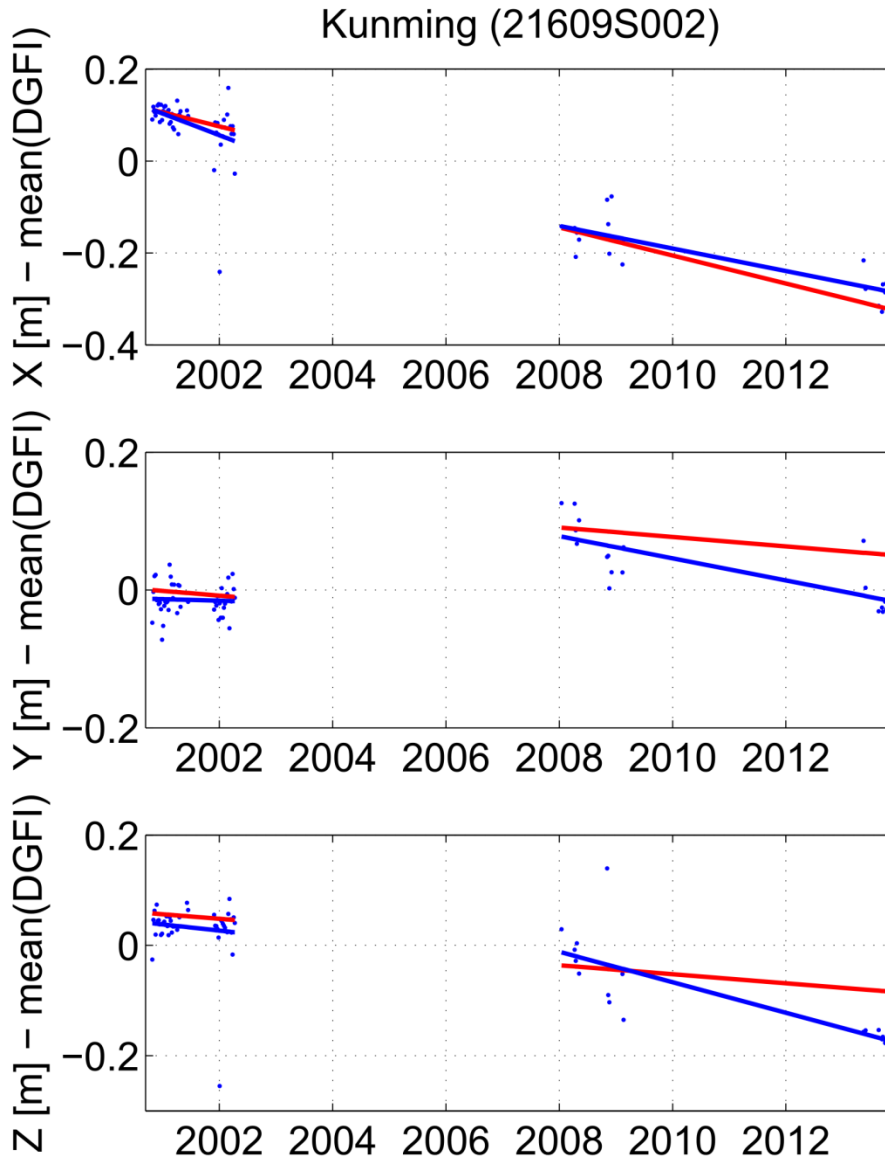
# Concepcion



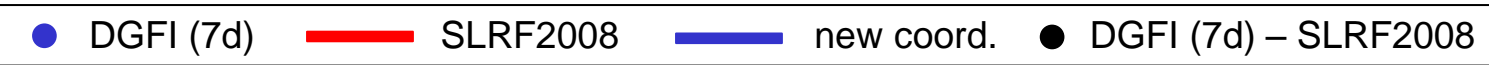
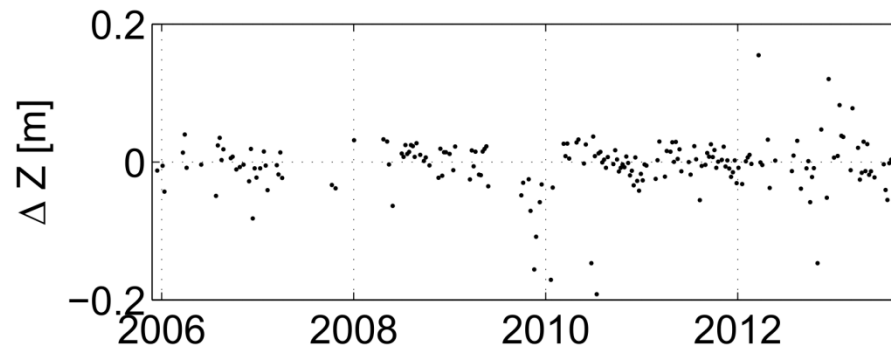
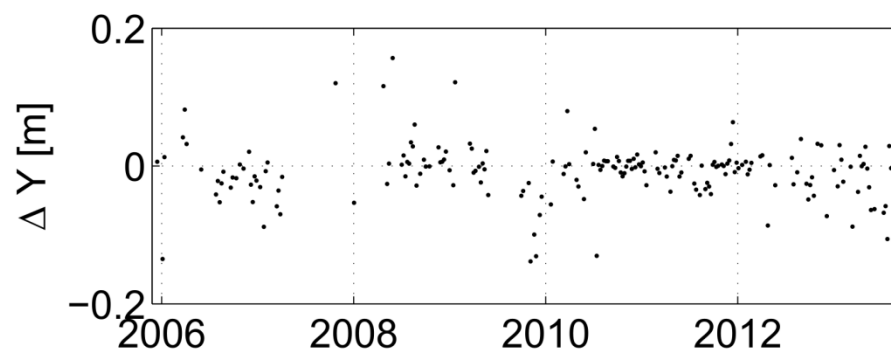
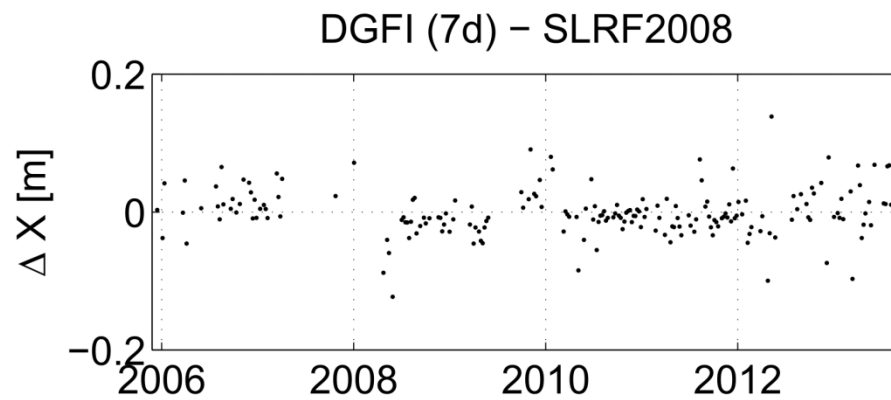
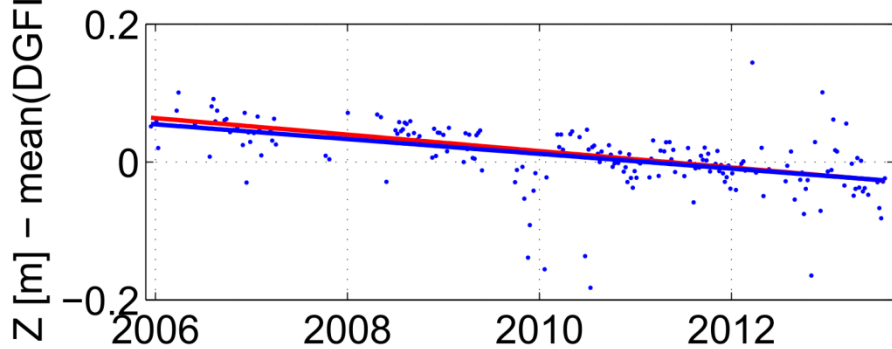
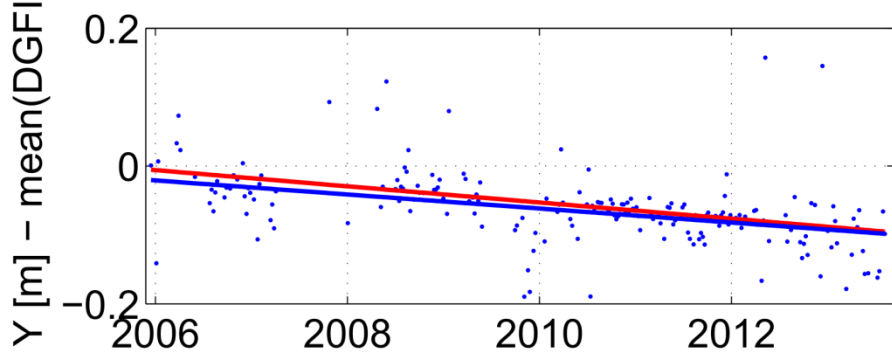
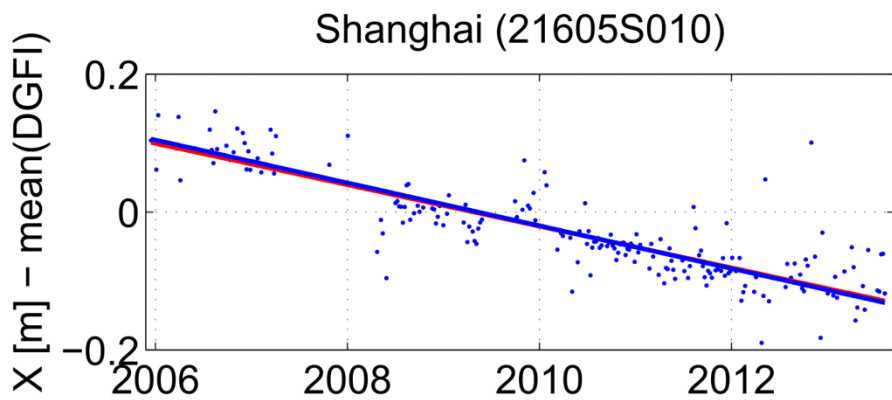
# San Juan



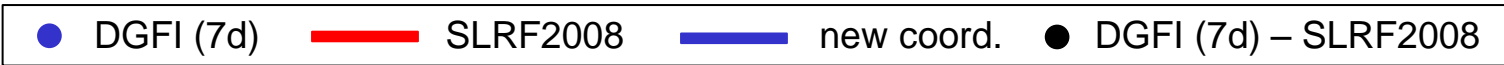
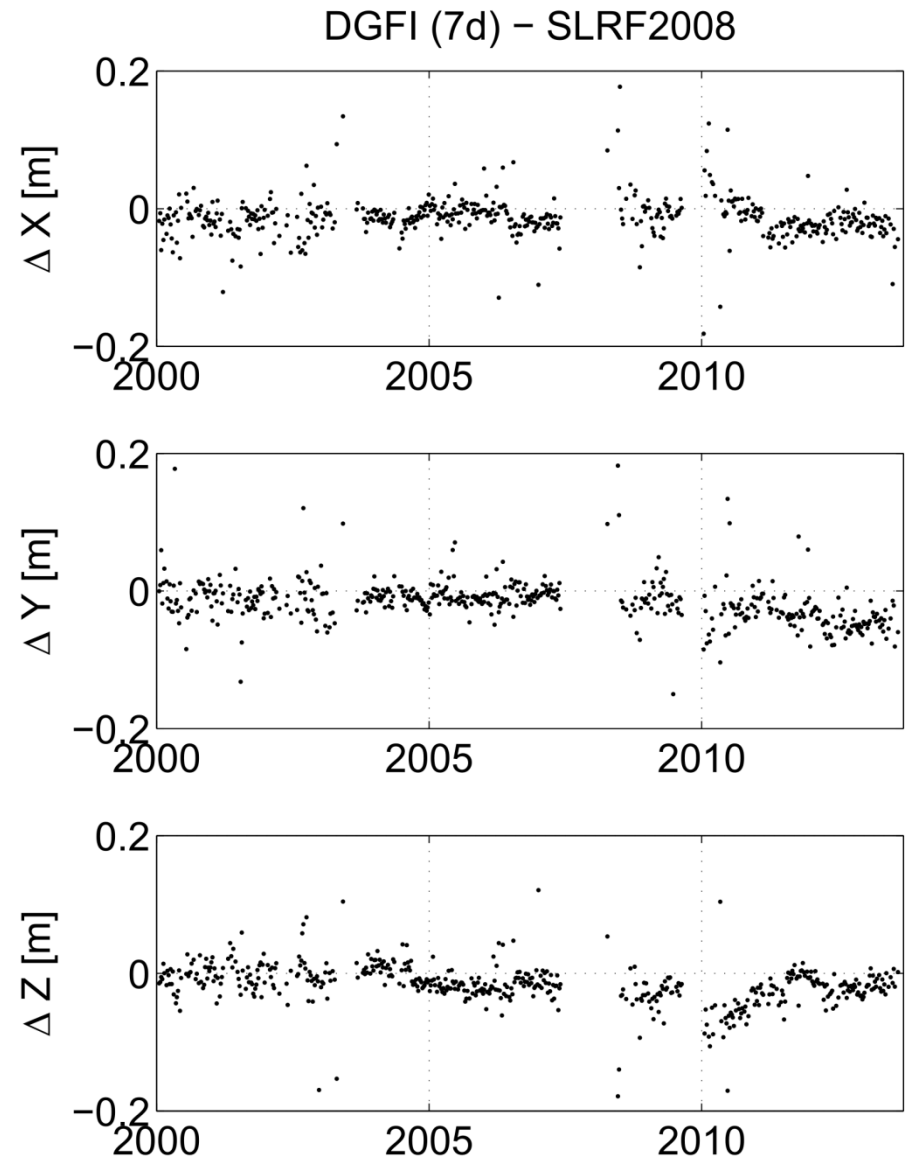
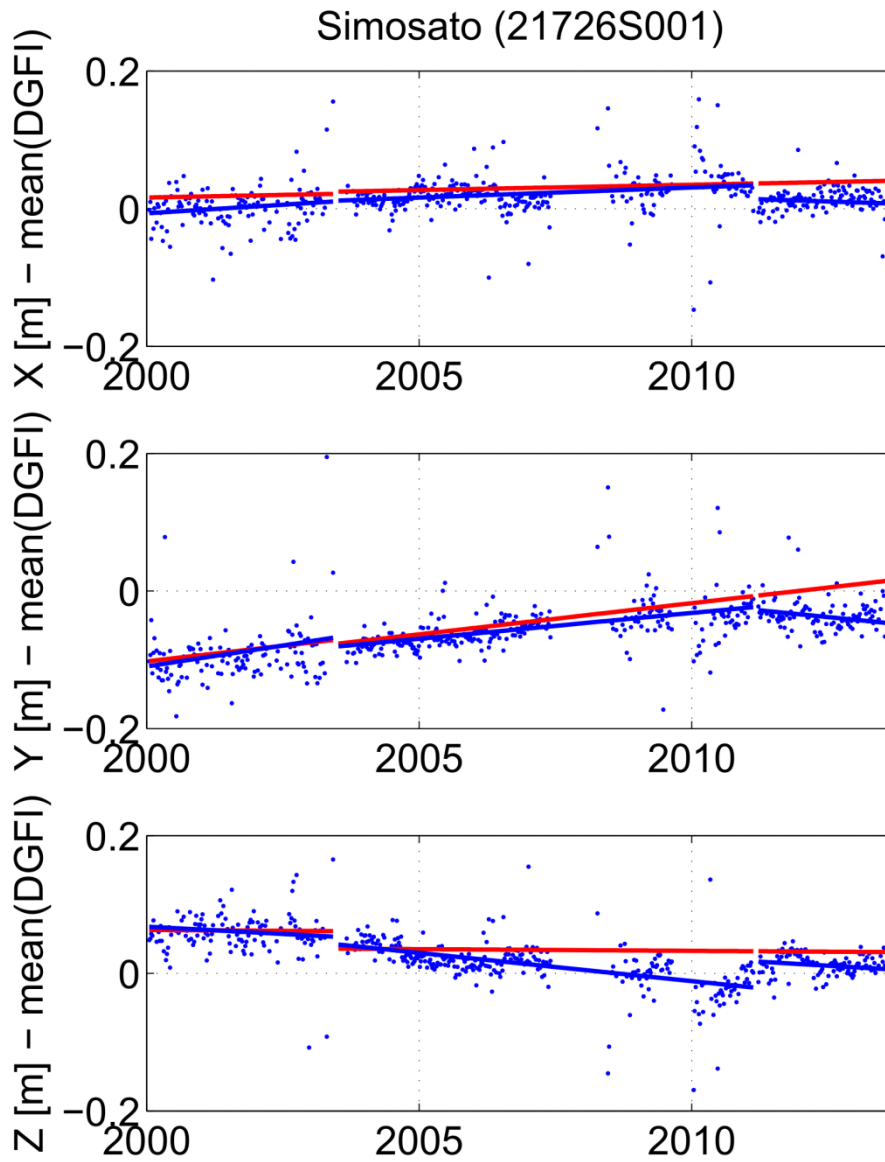
# Kunming



# Shanghai



# Simosato

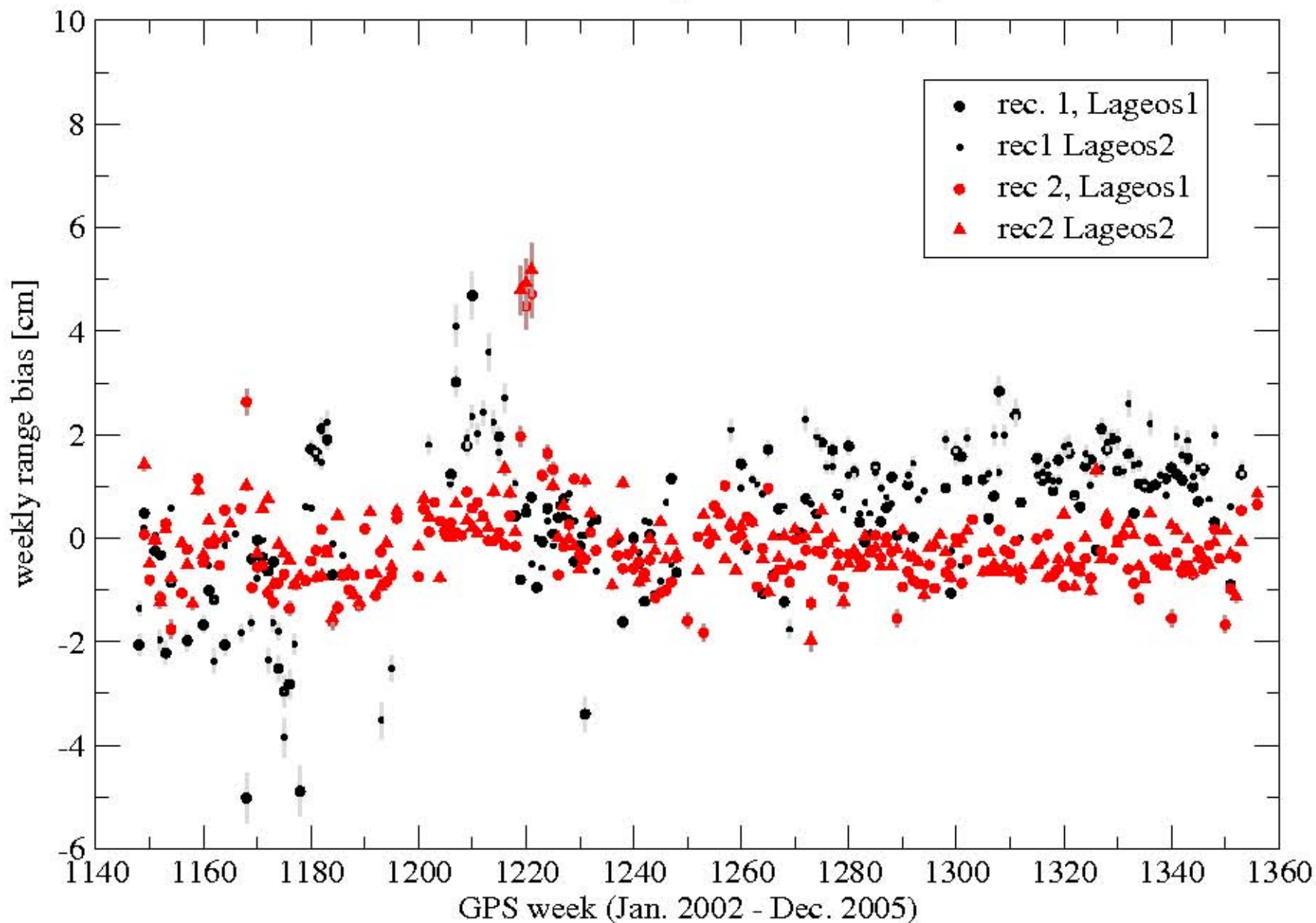






# Wettzell bias test weekly biases rec. dependend

Rec.1 0.51 +- 2.86, rec. 2 -0.17 +- 3.29



# Report to ILRS DF&P WG

Randall Ricklefs  
University of Texas  
Center for Space Research

# Need for Change to System Configuration Tracking

- 1) Must track changes to prevent discontinuities and errors in data and data products
- 2) Without tracking system changes, our data will not be competitive with other space geodesy techniques
- 3) Few stations posted changes in old SCH/SCI formats
- 4) Some stations found requirements confusing
- 5) SCI (system baseline) is redundant with site log

# New System Configuration Tracking Procedure

- 1) Keep the site log up-to-date
- 2) Keep CRD configuration records up-to-date
- 3) Submit an email with the entire history log and new entries to ILRS at EDC whenever there is a significant change to the system
- 4) Follow quarantine procedures when a significant change to the measurement path is made

**See** [http://ilrs.gsfc.nasa.gov/network/site\\_procedures/configuration\\_files.html](http://ilrs.gsfc.nasa.gov/network/site_procedures/configuration_files.html)

# Implementing New Procedure

- 1) one time: Convert SCH file to history log, removing sequence number (which was rarely up to date) and adding subsystem ID (from site log)
- 2) One time: Discard SCH, SCI files and the CRD “60” (compatibility) record holding the SCH and SCI values.
- 3) When there is a change: Email entire change history log in email body or as an attachment to EDC every time there is a significant change – this could be automated at the station

# Fields in New Change History Log

- Site Occupation Designator (SOD)
- Year, Day of Year, Hour and Minutes when change became active
- Estimated Chance of Data Impact: 0=none, ..., 3=needs quarantine
- Subsystem number of changed component from site log (or 99 for those not in site log)
- Text – to the end of the line describing change so that station and analyst can locate and identify

# New Normal Point Definition

- 1) Allows high rep-rate systems to move to a new target once they have “enough” data, even if in much shorter time than the normal point bin size.
- 2) Allows station to more effectively interleave passes, with the attendant increase in data yield
- 3) Mainly pertains to high (HEO) and the LAGEOS satellites, which have long normal point bins
- 4) Went into effect May 2012
- 5) Possibly implemented at 13+ stations
  - Graz – real-time feedback, 1000 points/npt
  - Herstmonceux – real-time feedback on precision
- 6) Chart on next page shows the number of stations with  $> 1000$  returns/npt. There is much potential for better interleaving with the new npt definition



# New Normal Point Definition

## High Return NPs – Sept 2013

| Station | SOD      | Mean # of returns per NP | Median # of returns per NP | MAX # of returns per NP | # NP's with >=1000 returns | Total # of NPs | Percent of NP's with >= 1000 returns | Number of Passes with 1-1000 returns | Total Number of Passes (TP) | Percent of Passes with >=1000 returns | Max. Rep. Rate (Hz) |
|---------|----------|--------------------------|----------------------------|-------------------------|----------------------------|----------------|--------------------------------------|--------------------------------------|-----------------------------|---------------------------------------|---------------------|
| ALTL    | 18799401 | 1,743.18                 | 1,600.00                   | 4,572.00                | 87.00                      | 289.00         | 30%                                  | 14                                   | 31                          | 45%                                   | 300                 |
| ARKL    | 18869601 | 1,265.75                 | 1,117.50                   | 1,788.00                | 4.00                       | 287.00         | 1%                                   | 3                                    | 49                          | 6%                                    | 300                 |
| BAIL    | 18879701 | 1,492.46                 | 1,303.50                   | 3,103.00                | 28.00                      | 901.00         | 3%                                   | 19                                   | 105                         | 18%                                   | 300                 |
| CHAL    | 72371901 | 6,529.10                 | 3,919.00                   | 51,337.00               | 1,067.00                   | 1,496.00       | 71%                                  | 194                                  | 223                         | 87%                                   | 10000               |
| CONL    | 74057904 | 1,356.45                 | 1,239.50                   | 2,189.00                | 44.00                      | 876.00         | 5%                                   | 13                                   | 80                          | 16%                                   | 100                 |
| GRZL    | 78393402 | 13,647.98                | 9,336.00                   | 113,981.00              | 755.00                     | 857.00         | 88%                                  | 76                                   | 77                          | 99%                                   | 2000                |
| HERL    | 78403501 | 4,570.26                 | 3,075.50                   | 22,600.00               | 554.00                     | 1,164.00       | 48%                                  | 76                                   | 110                         | 69%                                   | 2000                |
| KOML    | 18685901 | 1,574.04                 | 1,417.00                   | 3,047.00                | 25.00                      | 88.00          | 28%                                  | 10                                   | 16                          | 63%                                   |                     |
| MATM    | 79417701 | 1,023.56                 | 1,023.00                   | 1,070.00                | 9.00                       | 2,116.00       | 0%                                   | 7                                    | 249                         | 3%                                    | 10                  |
| POT3    | 78418701 | 2,793.18                 | 2,125.00                   | 10,397.00               | 308.00                     | 1,056.00       | 29%                                  | 43                                   | 70                          | 61%                                   | 2000                |
| SHA2    | 78212801 | 3,861.12                 | 2,740.50                   | 15,630.00               | 166.00                     | 257.00         | 65%                                  | 42                                   | 49                          | 86%                                   | 1000                |
| SVEL    | 18889801 | 1,028.00                 | 1,028.00                   | 1,028.00                | 1.00                       | 83.00          | 1%                                   | 1                                    | 14                          | 7%                                    | 300                 |
| ZIML    | 78106801 | 1,180.67                 | 1,186.50                   | 1,406.00                | 472.00                     | 2,221.00       | 21%                                  | 73                                   | 165                         | 44%                                   | 110                 |

By Justin Woo, Excelis

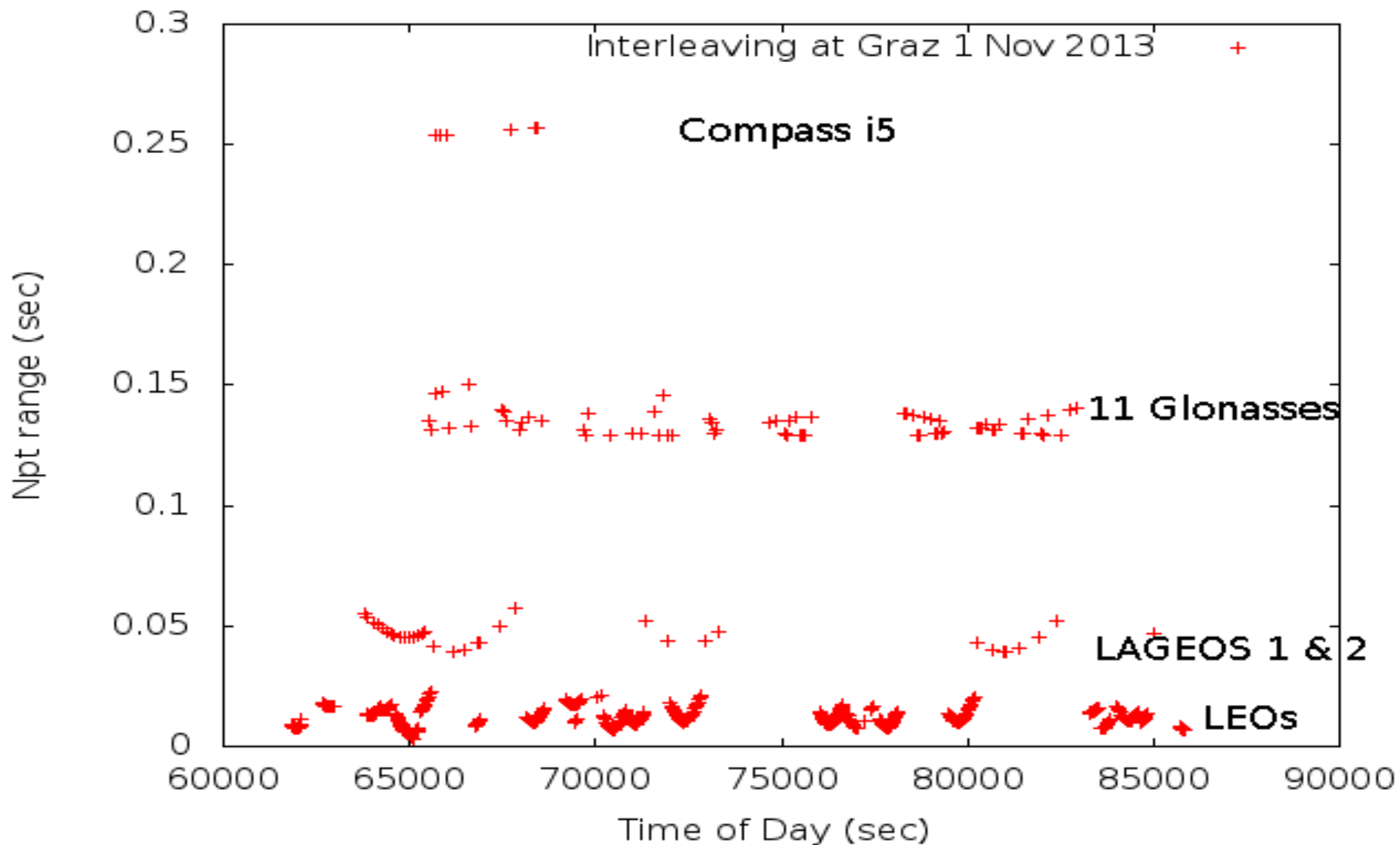
- Many stations have a high enough return rate to implement the new npt definition

November 9-15, 2013

Ricklefs DF&P WG Fujiyoshida

7

# Recent Example of Interleaving Passes (Graz)



# Software Library

- 1) Software is listed on new ILRS web site under the Technology menu
- 2) Would like to include Eurostat software. Contacting AIUB.
- 3) Do not yet have a normal point program, which would be useful for new stations
- 4) Have mount model fit program, but must replace a routine it uses from a copyrighted book
- 3) Concern about software licenses on new deposits on ILRS web site and any NASA constraints

# System Change History Tracking Backup Slides from presentations in Frascati

# System Change Reporting - I

- System change and station log files are needed by analysts to locate origin of data issues
- Problem: Stations are not updating their System CHange indicators and/or files (SCH):
  - Only 11 stations have updated their “sch” configuration file since 2003 and only 6 since 2008
  - Of 31 stations recently checked, 10 did not have “sch” files on CDDIS, 12 did not have SCH in CRD data, and 5 had SCH in CRD file that did not match “sch” file, and only 7 had it “right”
  - Station log files are not up-to-date

# System Change Reporting - II

- Stations find current method of tracking station changes confusing and complex
- ILRS needs to find a better method of tracking changes. e.g.
  - Simplify
  - Possibly upload station maintenance files regularly
  - Possibly add software, meteorological, and other subsystems to CRD configuration section
  - Frequently remind stations to update information
- A proposal will be circulated to the ILRS N&E W/G soon

# Configuration and Change Primer -I

- Need to track station changes and configuration so analysts can easily locate sources of changes in station performance
- SCH (System CHange) : indicator + description
  - This indicator is incremented whenever there is a “significant” change to the station's measurement chain
- SCI (System Conflguration) : indicator + description
  - The indicator and file entry are different for each standard operating configuration
  - Indicator implies changes in data characteristics
- The indicators are available in the old cstg format and the new CRD format
- Indicators and descriptions are kept in separate files on the ILRS web site for each monument/pad ID
- Station log and CRD configuration records contain much of the change information organized by sub-subsystem

# Configuration and Change Primer -II

- When a station makes a change, according the to ILRS web site, in addition to possible requirement to quarantine and validate data, they must
  - Change the SCH indicator in normal points/full rate files
  - Add the new SCH and description to ILRS data base for via an email message
  - Change the SCI indicator in normal points/full rate files (if baseline changes)
  - Add the new SCI and description to ILRS data base for via an email message
  - Change CRD configuration records (if needed)
  - Update the station log (if needed)
- "It is up to the judgement of the station what should be included in this baseline description of the system, and what constitutes a significant change to the system."
- There is confusion at some stations about these files



# Issues

- Stations are not updating their system configuration indicators or files (SCH):
  - Only 11 stations have updated their “sch” change file since 2003 and only 6 since 2008
  - Of 31 stations checked,
    - 10 did not have “sch” files on CDDIS;
    - 12 did not have SCH in CRD data (record 60);
    - 5 had SCH in CRD file that did not match “sch” file; and
    - only 7 had all information available and in sync

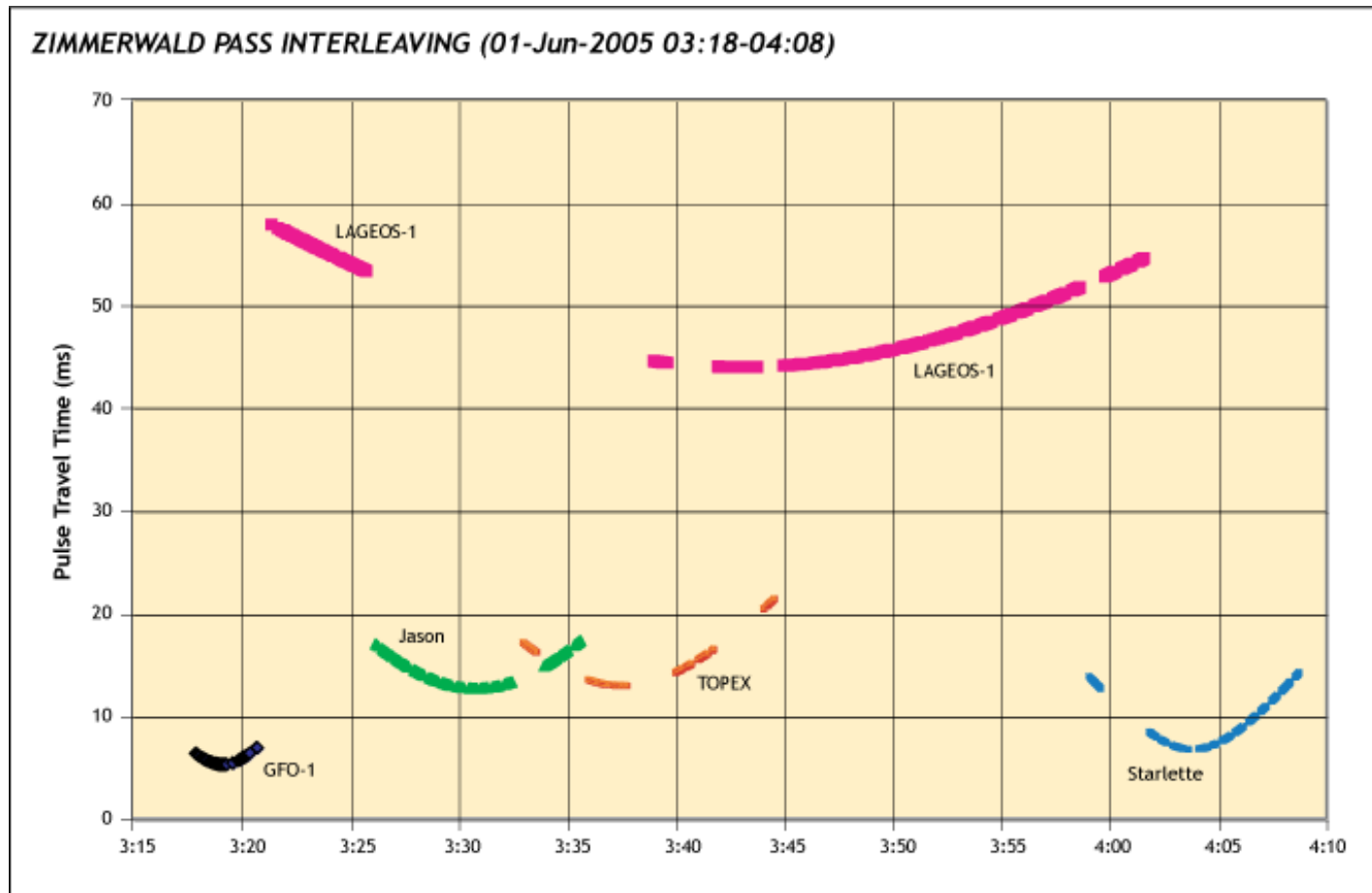
# SCH/SCI in CRD

- Format was intended to end need for SCI/SCH by adding configuration records, but provided a location for indicators ("60" record); not fully implemented
- SCI: (alternate configurations) can, in principle, be handled properly by CRD configuration records
- SCH:
  - Some sub-systems are not in configuration records, like meteorological sensors and software (add?)
  - Some types of station changes can not be recorded in CRD or system log (e.g., cable changes, mirror recoating)
  - May not need SCH in CRD format if there is a way to deal with changes inserted and removed for testing

# What do we do now?

- Remind stations to follow existing procedures, including use of CRD SCH/SCI ("60") record?
- Abandon SCI/SCH in favor of station log and CRD configuration records? (Loose some changes)
- Augment subsystems in CRD configuration records (e.g., met systems, telescope/mount, software, personnel :-) )?
- Abandon CRD SCH/SCI record in favor of CRD configuration records; require SCH file update?

# An early example of interleaving passes – from Zimmerwald



# Quality assessment of SLR data-related products

Florent Deleflie<sup>1</sup>, Jean-Michel Lemoine<sup>2</sup>,  
Franck Reinquin<sup>2</sup>, and David Coulot<sup>3,1</sup>

<sup>1</sup> Institut de Mécanique Céleste et de Calcul des Ephémérides, GRGS/Paris

<sup>2</sup> Centre National d'Etudes Spatiales, GRGS/Toulouse

<sup>3</sup> IGN/LAREG/GRGS, Université Paris Diderot, Paris

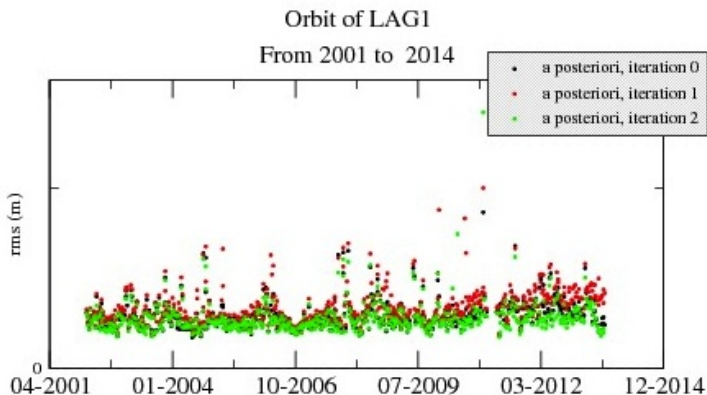
9th Nov. 2013



## GRGS AC status

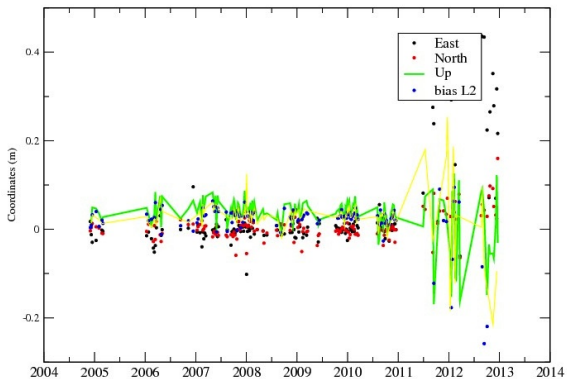
- fully operational
- New website: <http://vo.imcce.fr/slr-ac/>
  - operational solution
  - reanalyses
- test: change the weight of stations to evaluate the impact.  
Impact very small except for LOD.
- Updates:
  - reanalysis in view of ITRF2013
  - on time for most of tasks
  - still to be done: SP3c format, data prior to 1992 period

# LAG1 post fit residual level



# ITRF2008 feature

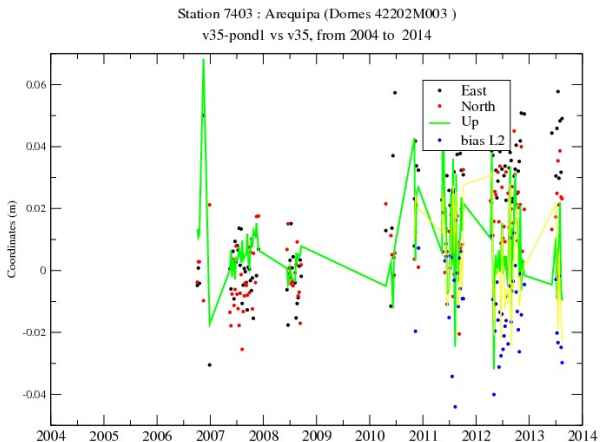
Station 7308 : Koganei (Domes 21704S002 )  
v35-pond1 vs v35, from 2004 to 2014



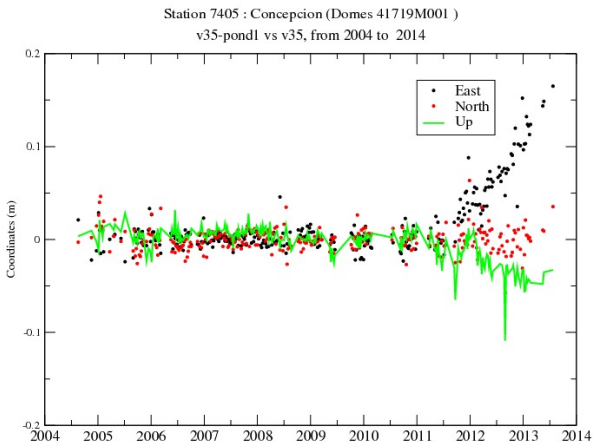
Discretary Rhude (c) IOD/CROD, generated Wed Nov 6 20:00:32 CEST 2013



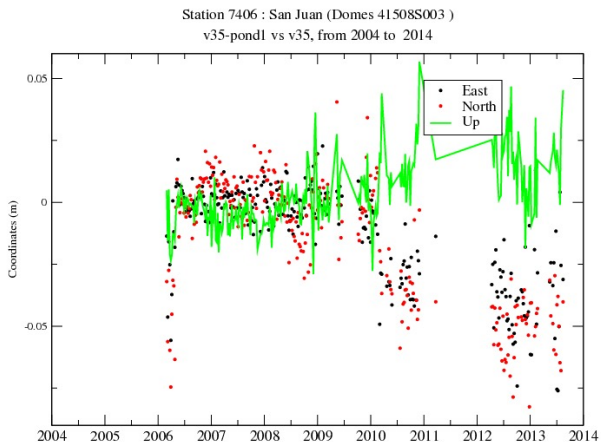
# ITRF2008 feature



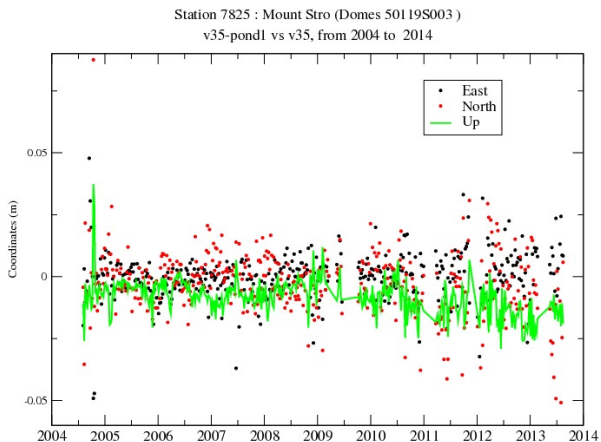
## ITRF2008 feature



## ITRF2008 feature



## ITRF2008 feature



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# JCET AC/CC REPORTS

Erricos C. Pavlis  
GEST/UMBC

Magda Kuzmicz-Cieslak, Keith Evans and Daniel König  
GEST/UMBC

ILRS AWG Meeting at 18<sup>th</sup> ILW, Fujiyoshida, Japan  
Nov. 9, 2013

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# Activities since last AWG

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- Analysis products submitted for DAILY (v135) & WEEKLY (v35) series
  - Combination products for corresponding DAILY & WEEKLY series continues with no major issues
  - Site information updates:
    - SCH-SCI database – NOW HISTORICAL !!!
    - We have a new data base which incorporates the historical information from the SCH-SCI database & continues seamlessly with the new records as provided since last month
    - We are working on incorporating the information in a visual manner on our webpages that display the products from each AC and CC, to help correlate the events with any anomalies in the data
  - We evaluated new coordinate solutions for a number of sites
-

## Activities since last AWG (cont.)

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- Station coordinate evaluation for ASI and DGFI solutions for several sites that required updates in SLRF2008, testing both over the period 1.1.2013 to present
  - We need to agree here TODAY on which of these should be adopted so that SLRF2008 can be updated prior to the reanalysis for the ITRF2013 contribution
    - NGSLR co-location data were evaluated and a separate talk during the workshop will cover that successful story
    - Yarragadee (7090) – Height change (~1 cm) in early 2010 seems to be more complex than earlier thought, showing a variety of different levels over significant amounts of time, without a clear explanation available from the local tests
-

# Ocean Loading for SLR Sites

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- GSFC's GOT4.7 tide model used
  - New file can be downloaded from:
    - [http://geodesy.jcet.umbc.edu/OLOAD\\_4\\_220\\_SLR\\_sites.got4p7.iers.gz](http://geodesy.jcet.umbc.edu/OLOAD_4_220_SLR_sites.got4p7.iers.gz)
    - Need to be maintained as new sites show up (e.g. Daedeok, Korea - 7359).
  - Same info available in Geodyn format also
    - [http://geodesy.jcet.umbc.edu/OLOAD\\_4\\_220\\_SLR\\_sites.got4p7.gdyn.gz](http://geodesy.jcet.umbc.edu/OLOAD_4_220_SLR_sites.got4p7.gdyn.gz)
-



## Activities since last AWG (cont.)

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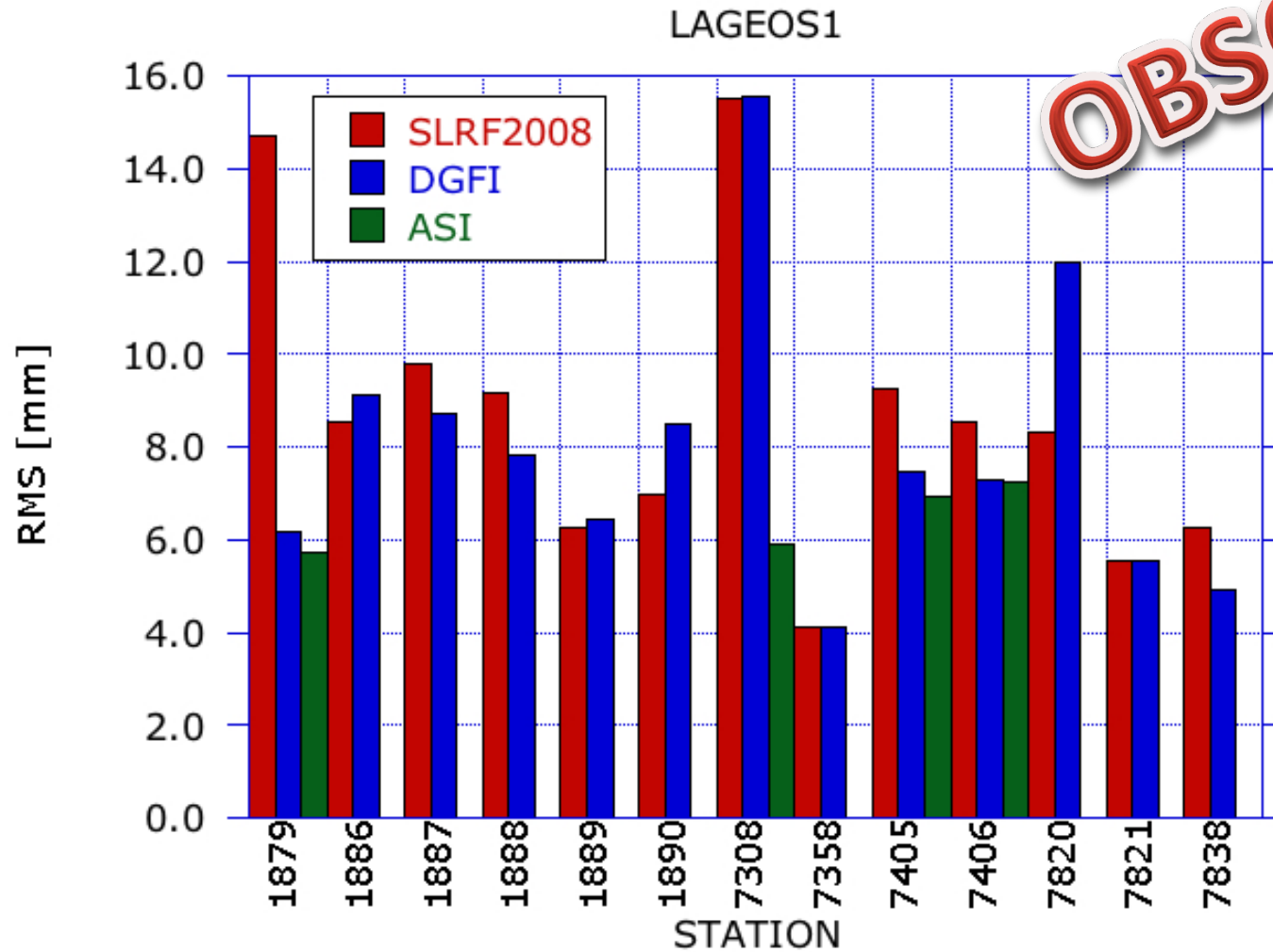
- We have invested significant effort in looking into the issues associated with LARES' response to ranging in the early days after launch, especially from kHz systems
    - Compared almost all available kHz FR data to NPs from the same stations
    - Graz FR data are not available at EDC, so these cannot be checked, and we are still working on the Changchun data due to the huge amounts compared to all other sites
    - So far, none of the stations checked has revealed a different response (range bias) at the same period as the satellite rotation (or any other period for that matter)
    - We would like to arrange with Graz to obtain some of their data, in part from just after the launch, a few passes a couple of months later and some in the recent months (if the entire data set is unavailable)
-

# JCET QC Viewer

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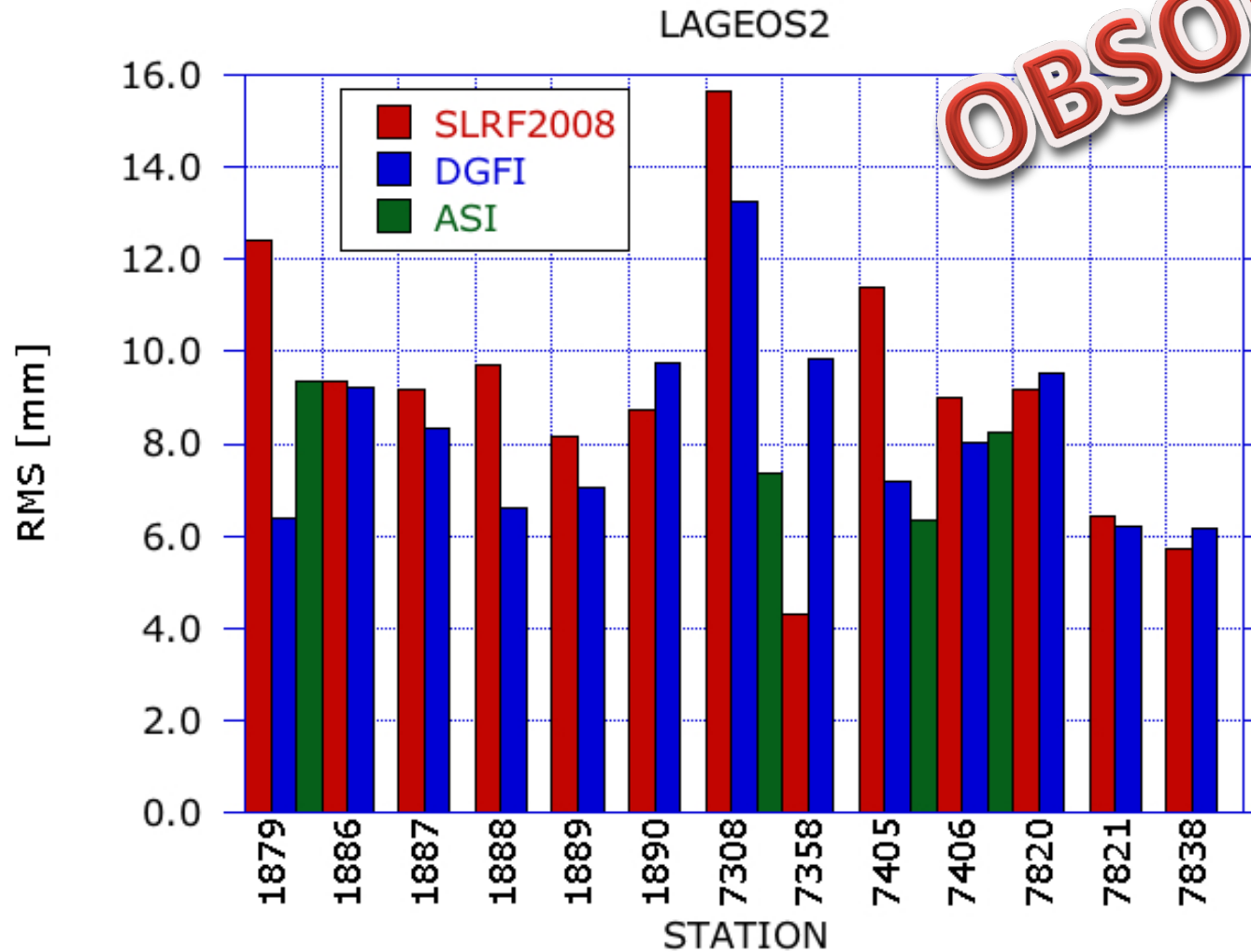
- The QC reports from each of the contributing ACs are in general formatted in a very tailored manner, containing different information, in different order, units, etc.
    - The information in these reports should be easily compared across AC, satellites, stations, evaluation metrics, etc., for these to be useful to the teams managing the various stations
    - In the past, the Graz team had devised a PC-based plotting package that was tailored to work with the UT/CSR reports, the only ones available at the time
  - JCET's MATLAB-based QC viewer works with ALL reports from DGFI, HITU, MCC, JCET, SHAO and (legacy) UT/CSR
    - The package will run on Mac★, Linux and Windows environments and it will be distributed with examples, a historical QC report data base (up to a certain date) and a simple user's manual (see poster at 18ILW)
- ★Needs some work to make it possible for all Mac OS X flavors
-

# RMS of Fit by Station – LAGEOS 1



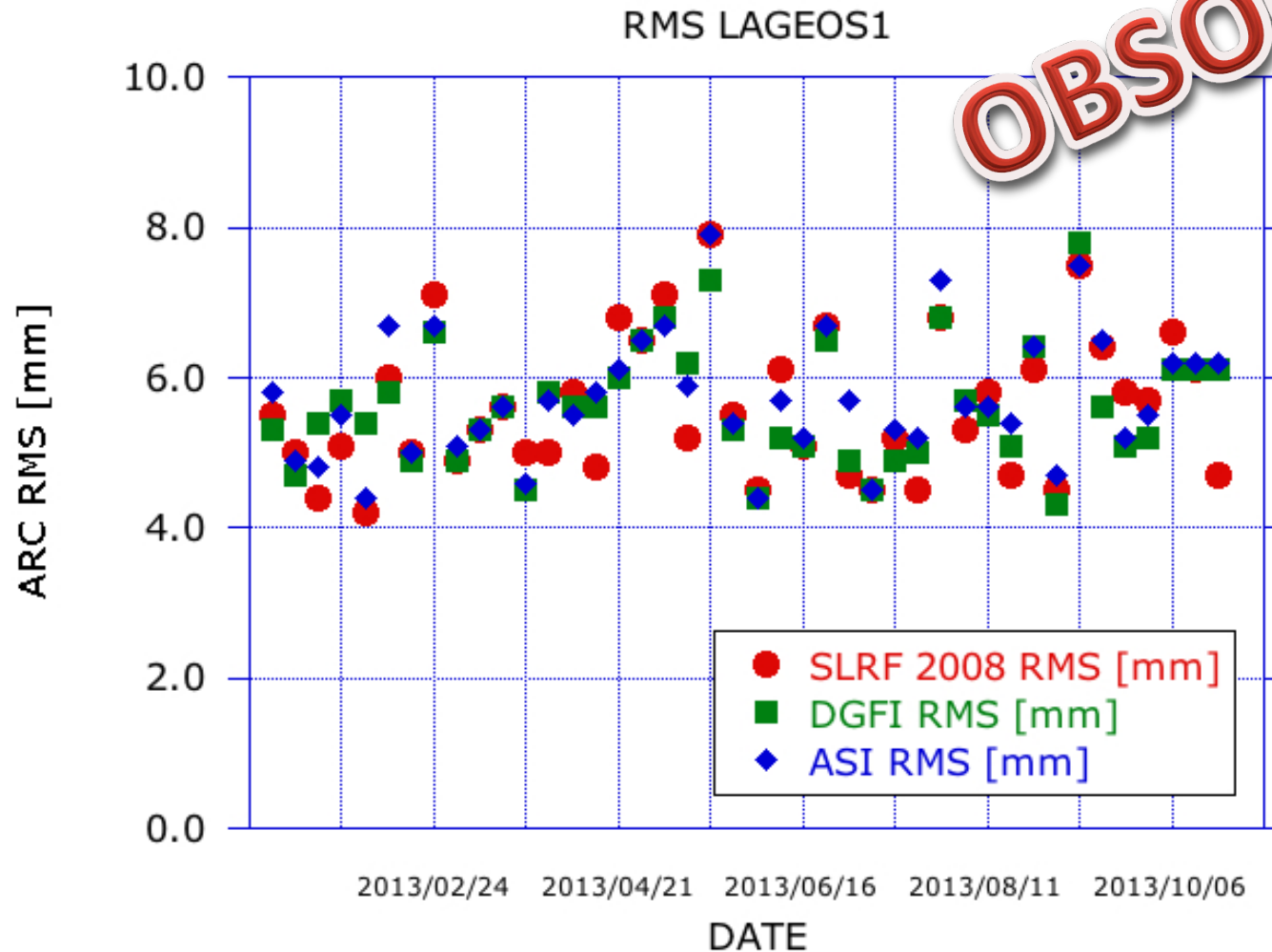
**OBSOLETE**

# RMS of Fit by Station – LAGEOS 2

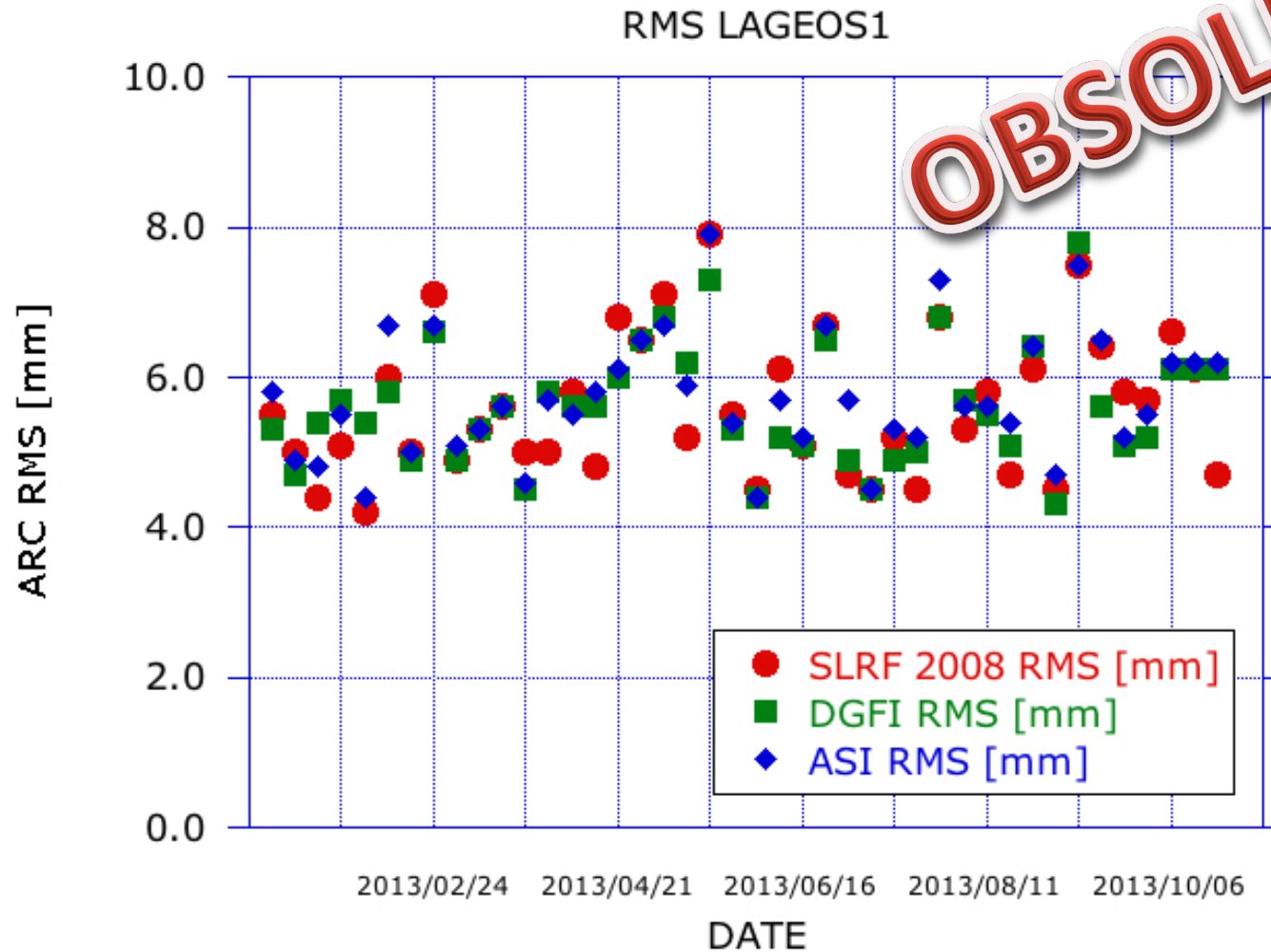


**OBSOLETE**

# RMS of Orbital Arc Fit – LAGEOS 1



# RMS of Orbital Arc Fit – LAGEOS 2

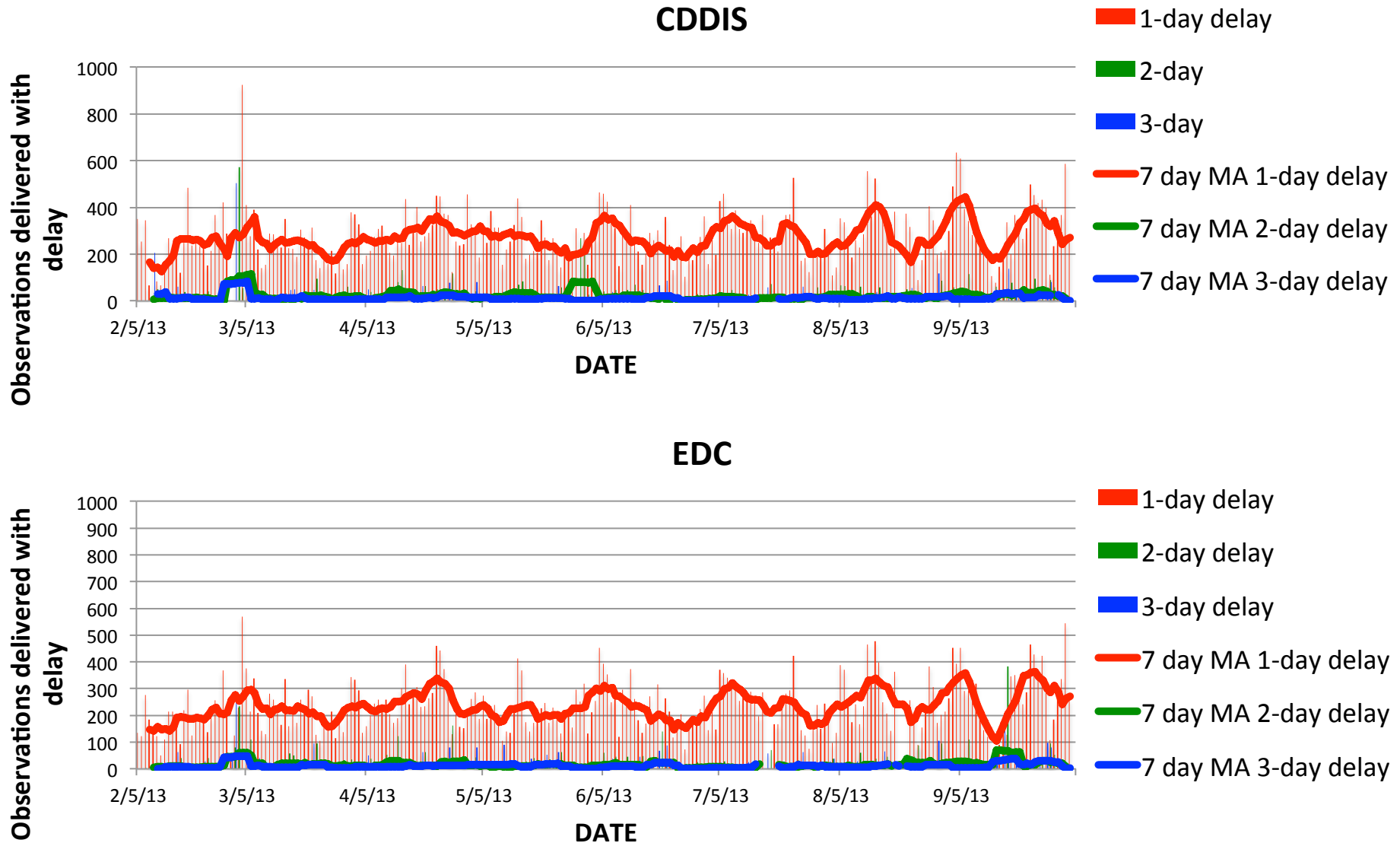


# Proposed Selection of Solutions for Update

| STATION        |      | SLRF2008 | ASI Solution | DGFI Solution |
|----------------|------|----------|--------------|---------------|
| Altay          | 1879 |          |              | X             |
| Arkhyz         | 1886 |          |              | X             |
| Baikonur       | 1887 |          |              | X             |
| Svetloe        | 1888 |          |              | X             |
| Zelenchukskaya | 1889 |          |              | X             |
| Badary         | 1890 | X        |              |               |
| Koganei        | 7308 |          | X            |               |
| Tanegashima    | 7358 | X        |              |               |
| Concepcion     | 7405 |          | X            |               |
| San Juan       | 7406 |          |              | X             |
| Kunming        | 7820 | X        |              |               |
| Shanghai       | 7821 | X        |              |               |
| Simosato       | 7838 | X        |              |               |

**OBSOLETE**

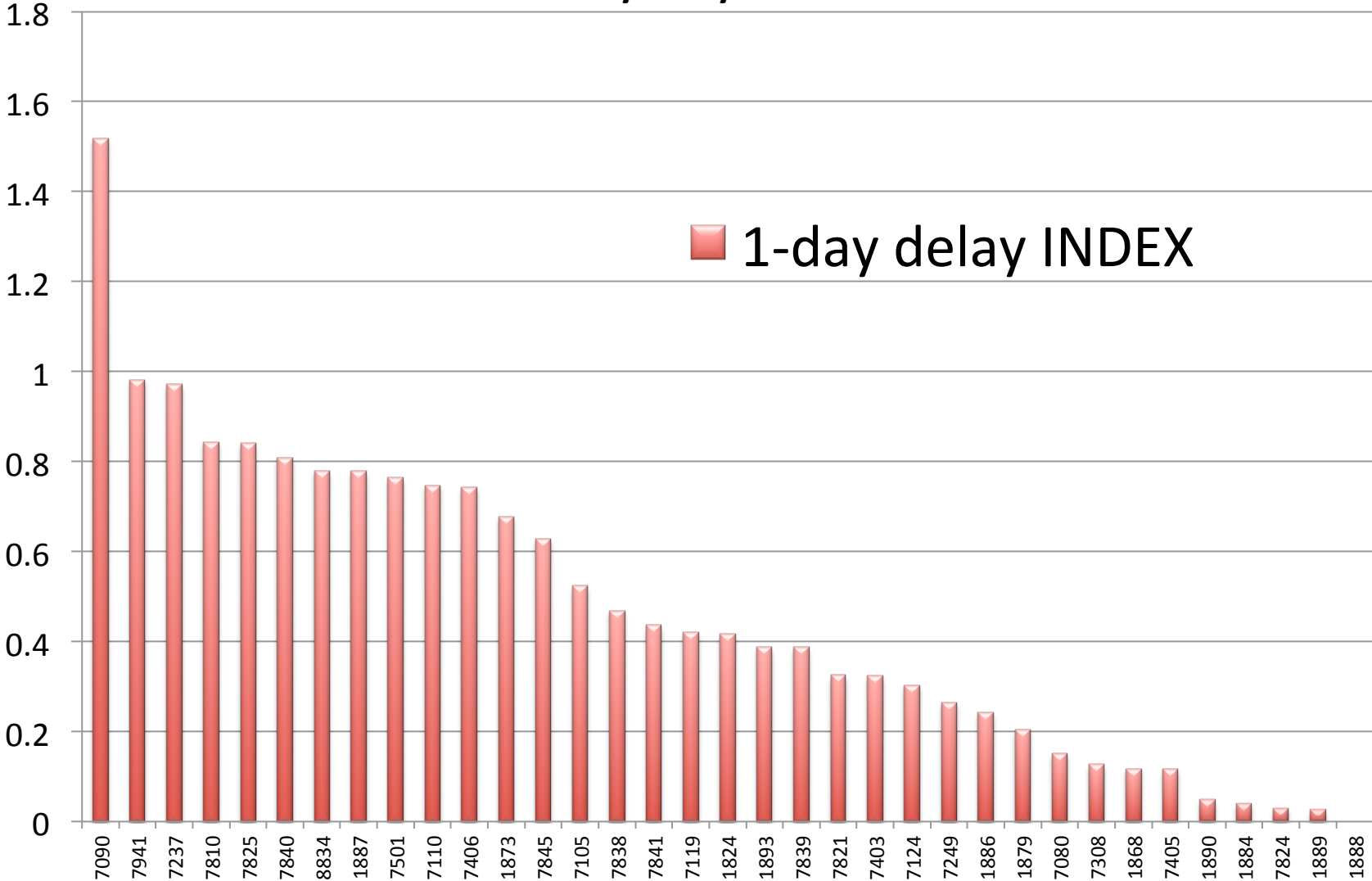
# Data Delivery Delays CDDIS & EDC





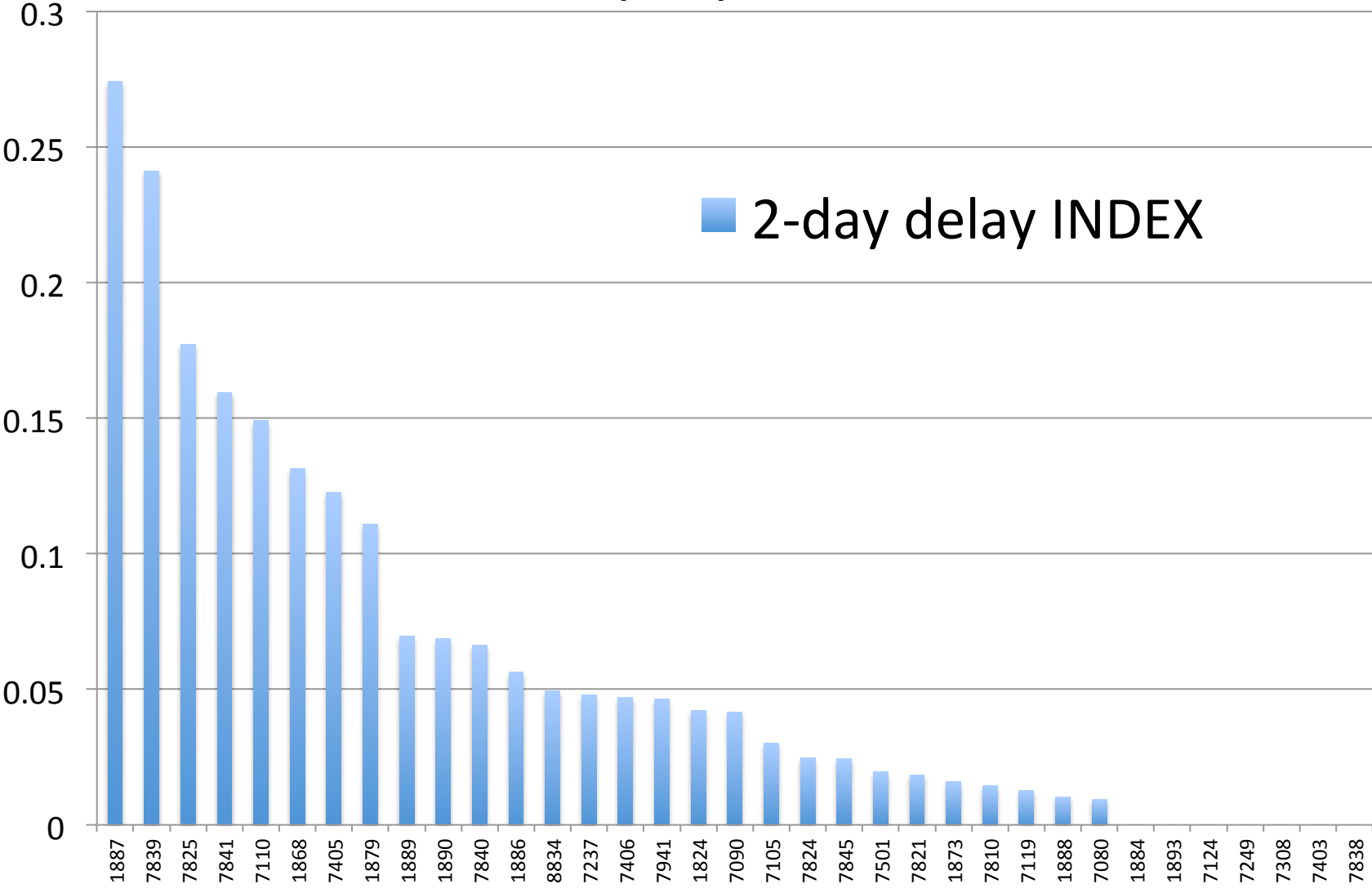
# CDDIS

## 1-day delay INDEX



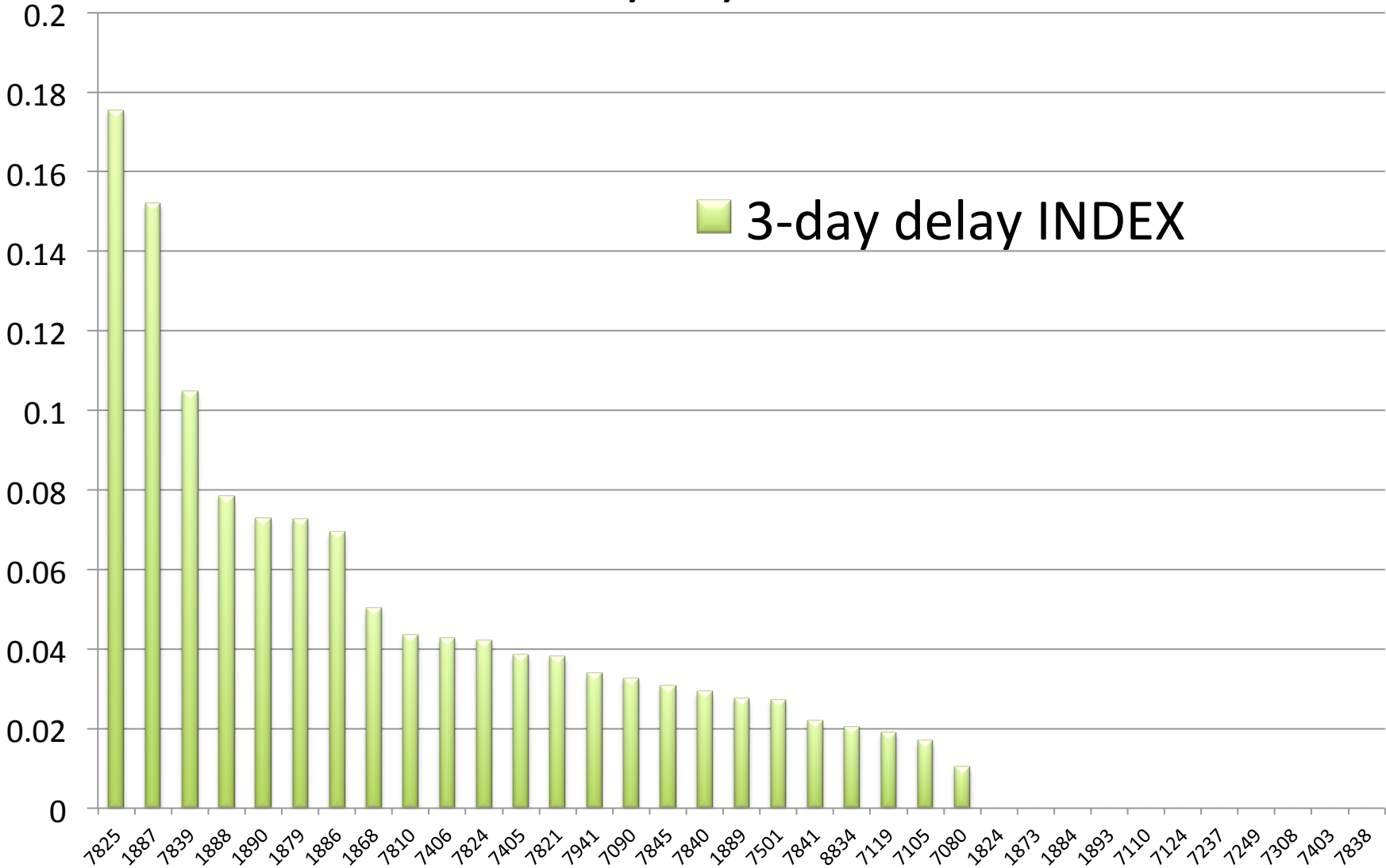
# CDDIS

## 2-day delay INDEX



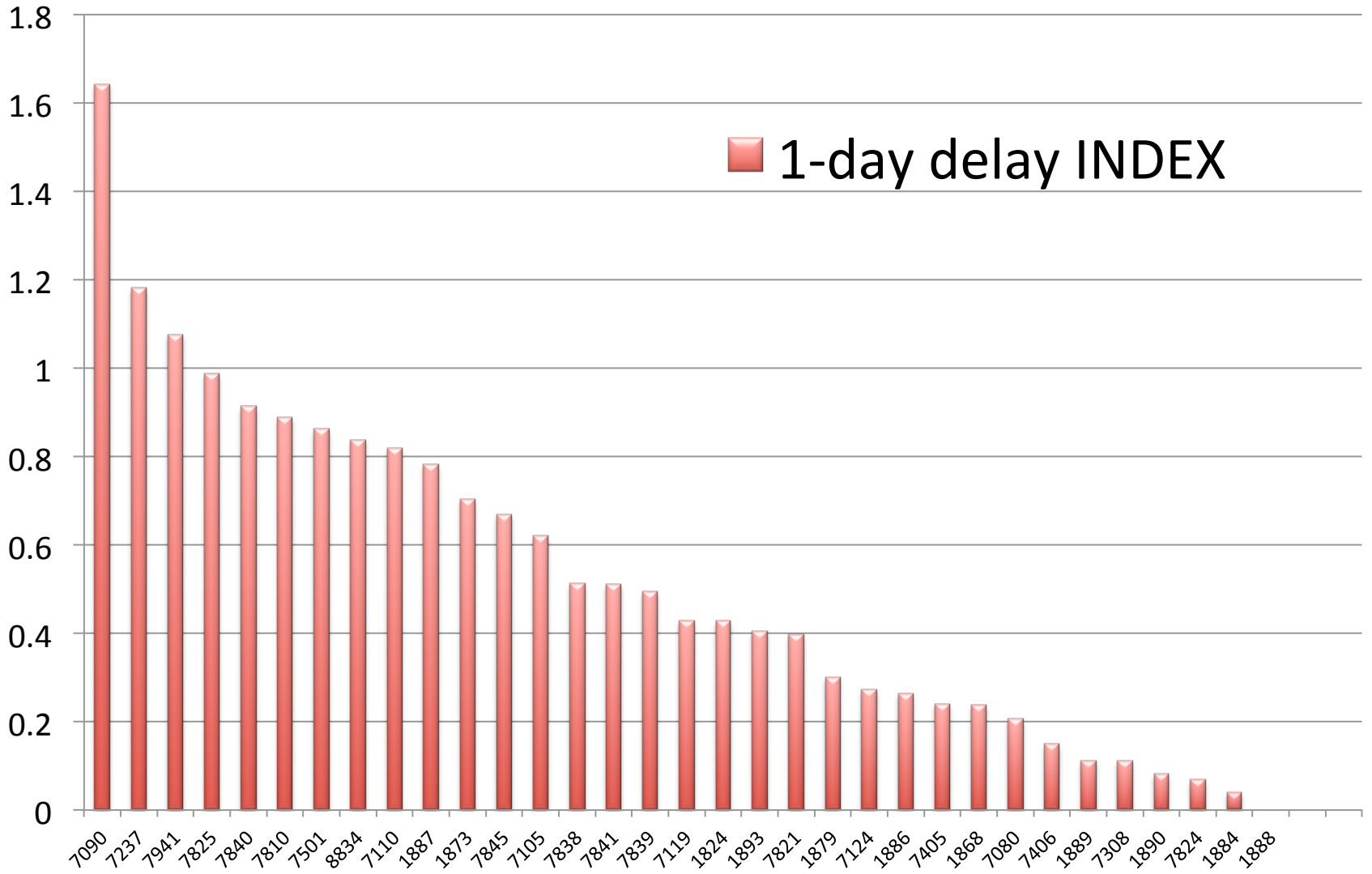
# CDDIS

## 3-day delay INDEX



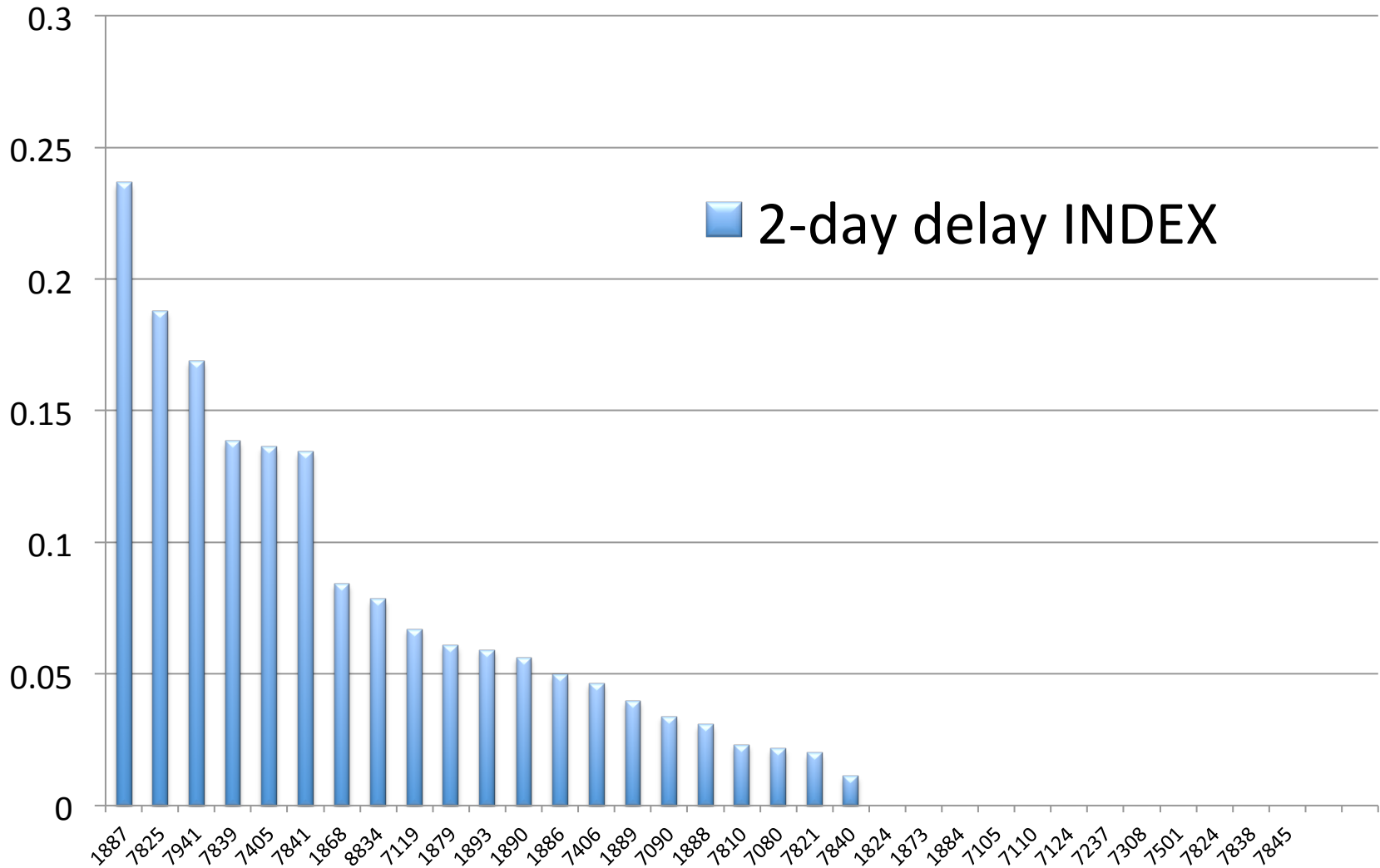
# EDC

## 1-day delay INDEX



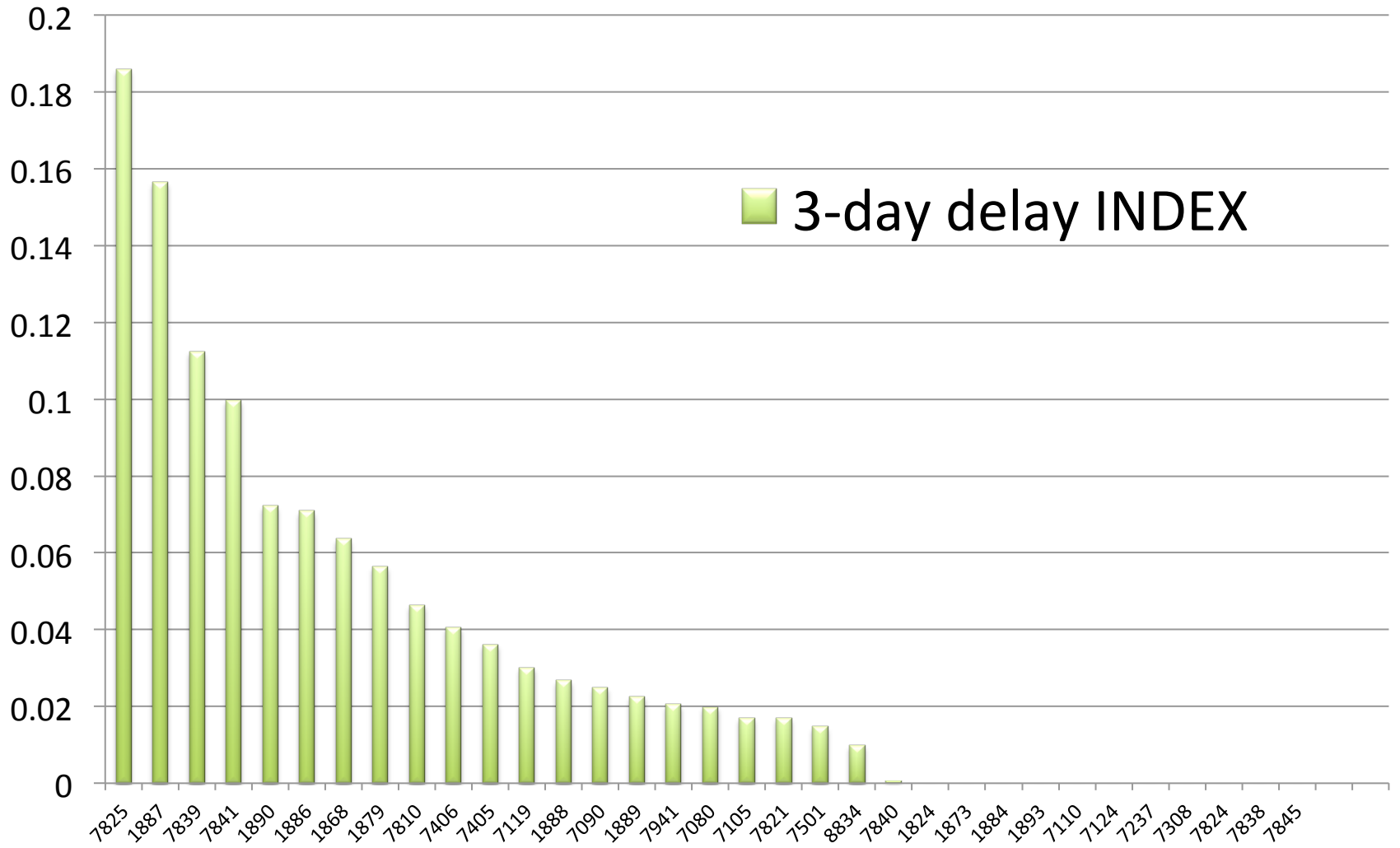
# EDC

## 2-day delay INDEX



# EDC

## 3-day delay INDEX



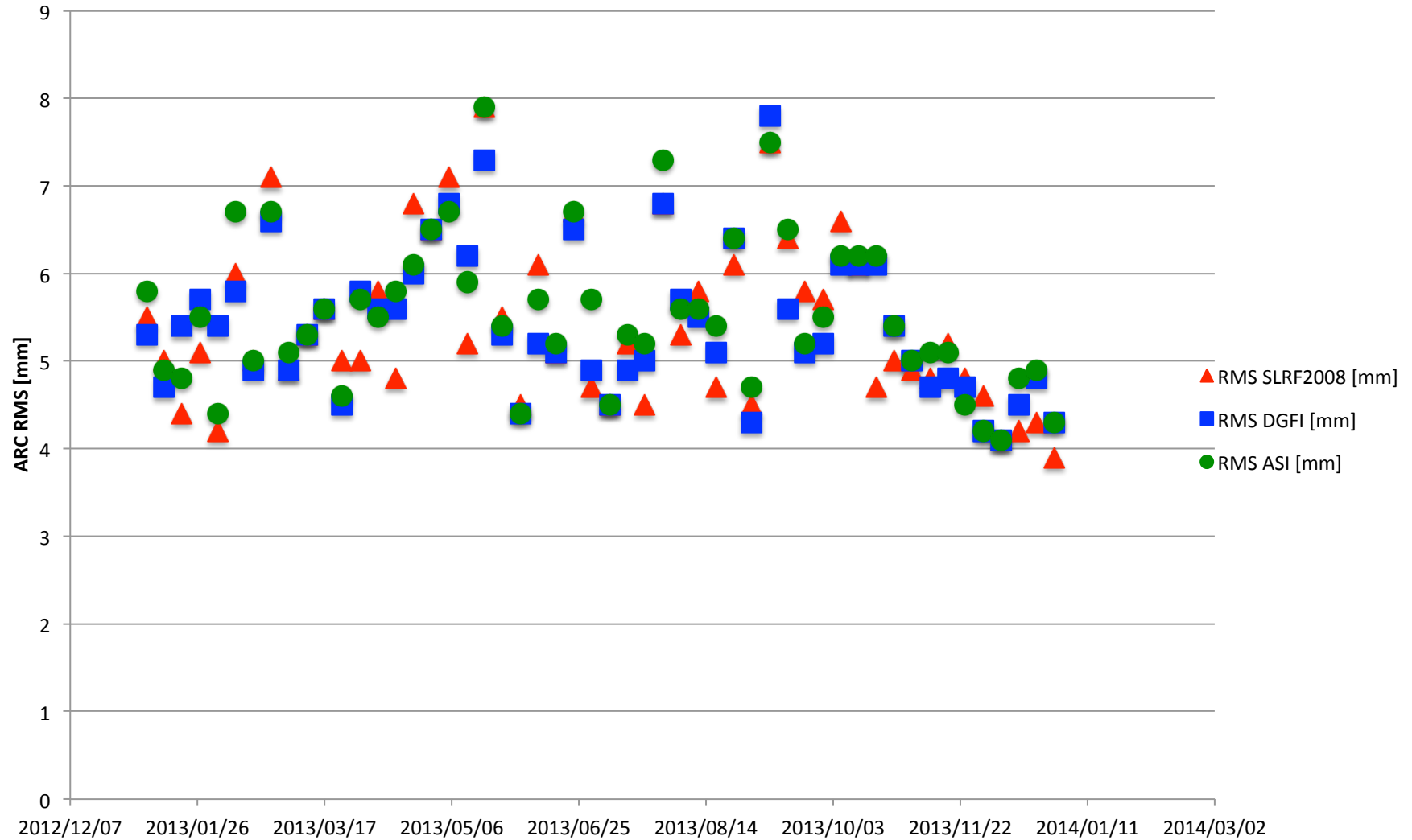
# SLRF2008

## Position and Velocity Updates

Magda Kuzmicz-Cieslak and Erricos C. Pavlis

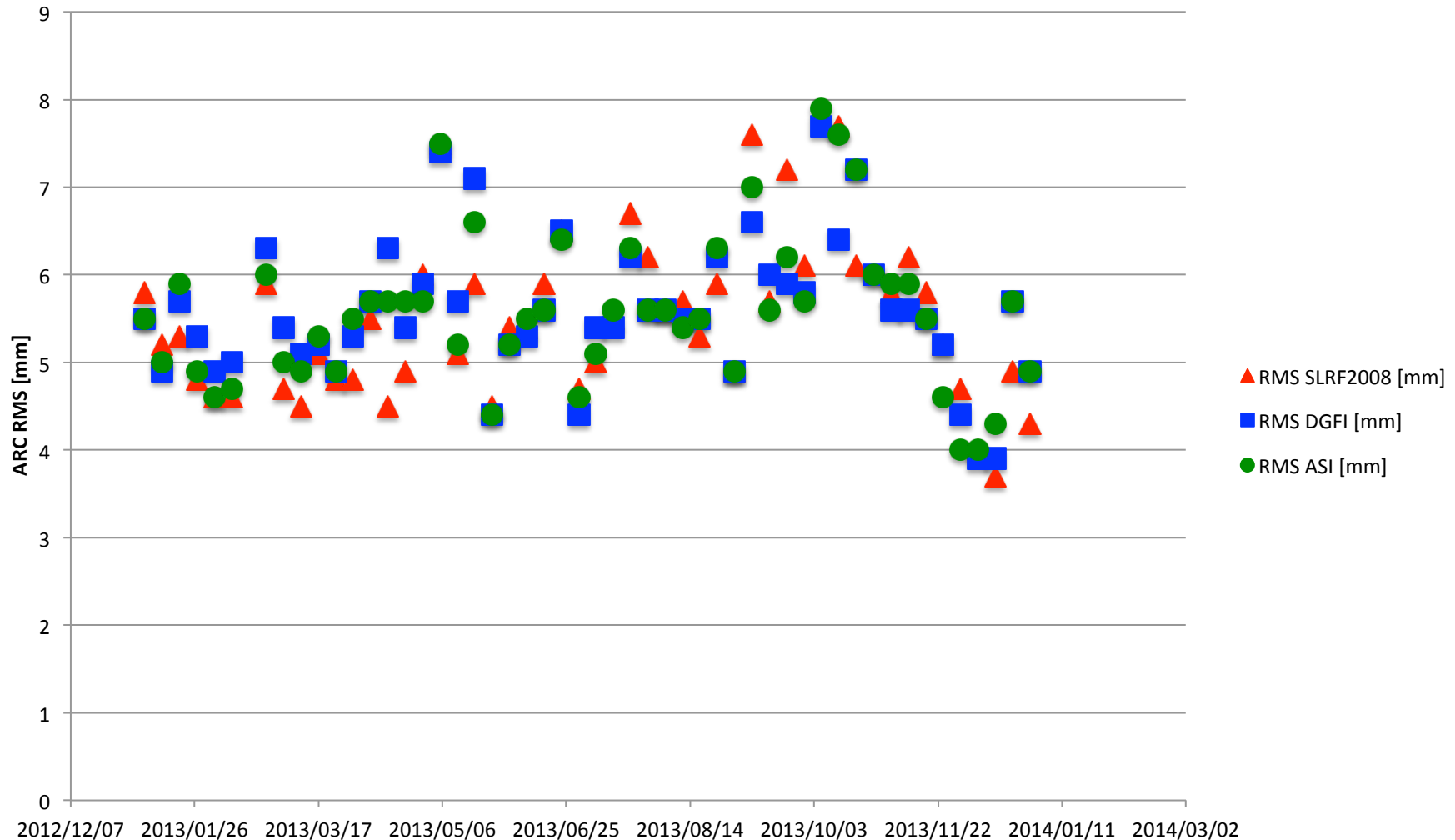
2014/02/03

# RMS of Orbital Arc Fit – LAGEOS 1



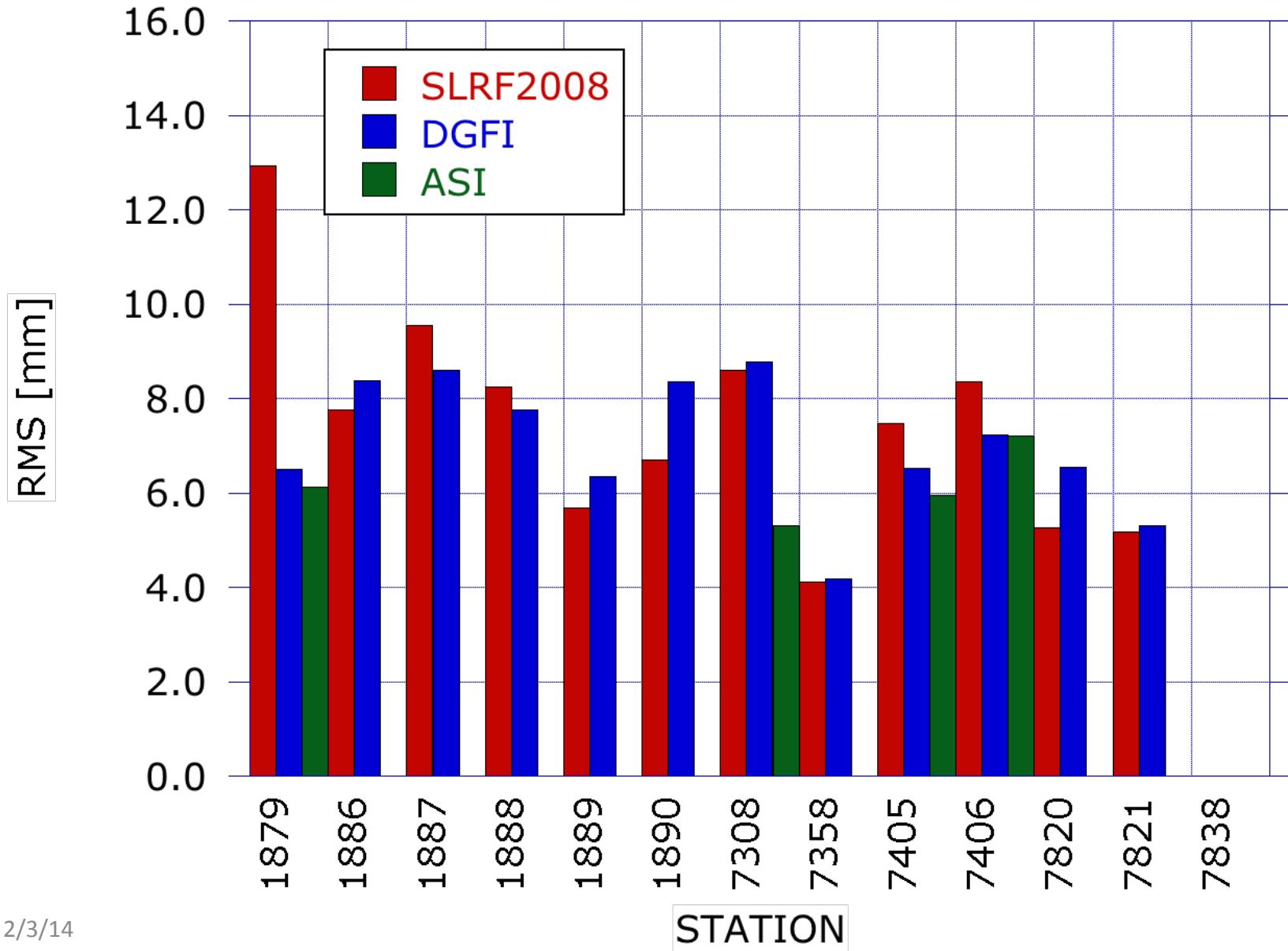


# RMS of Orbital Arc Fit – LAGEOS 2



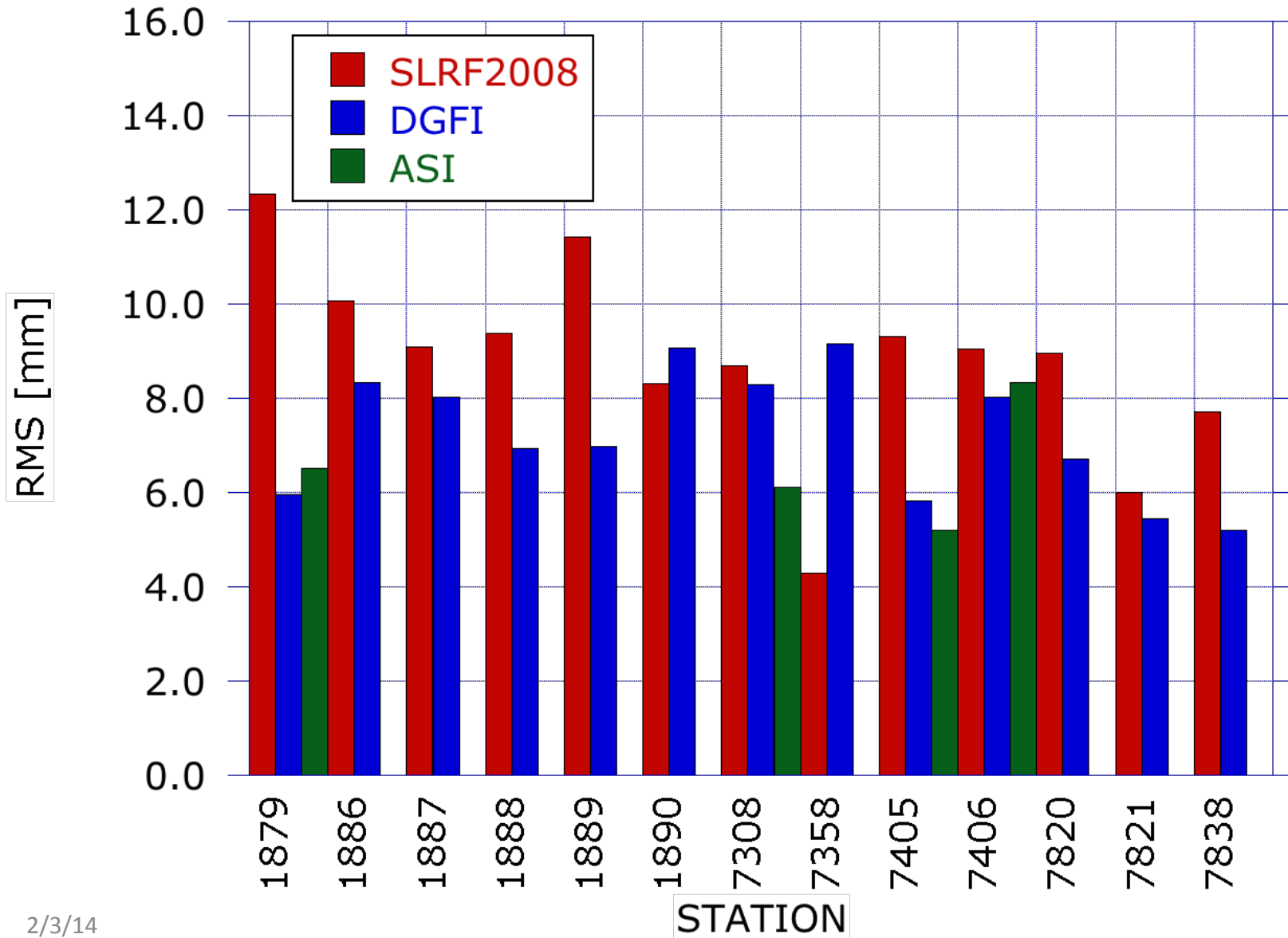
# RMS of Fit by Station – LAGEOS 1

LAGEOS1 201301-201312 NEW



# RMS of Fit by Station – LAGEOS 2

LAGEOS2 201301-201312 NEW



# Station Solutions Which are Updated

| STATION        |      | SLRF2008 | ASI Solution | DGFI Solution |
|----------------|------|----------|--------------|---------------|
| Altay          | 1879 |          | X            |               |
| Arkhyz         | 1886 |          |              | X             |
| Baikonur       | 1887 |          |              | X             |
| Svetloe        | 1888 |          |              | X             |
| Zelenchukskaya | 1889 |          |              | X             |
| Badary         | 1890 | X        |              |               |
| Koganei        | 7308 |          | X            |               |
| Tanegashima    | 7358 | X        |              |               |
| Concepcion     | 7405 |          | X            |               |
| San Juan       | 7406 |          |              | X             |
| Kunming        | 7820 |          |              | X             |
| Shanghai       | 7821 |          |              | X             |
| Simosato       | 7838 |          |              | X             |

# **LLR Status Report**

## **- 2013 -**

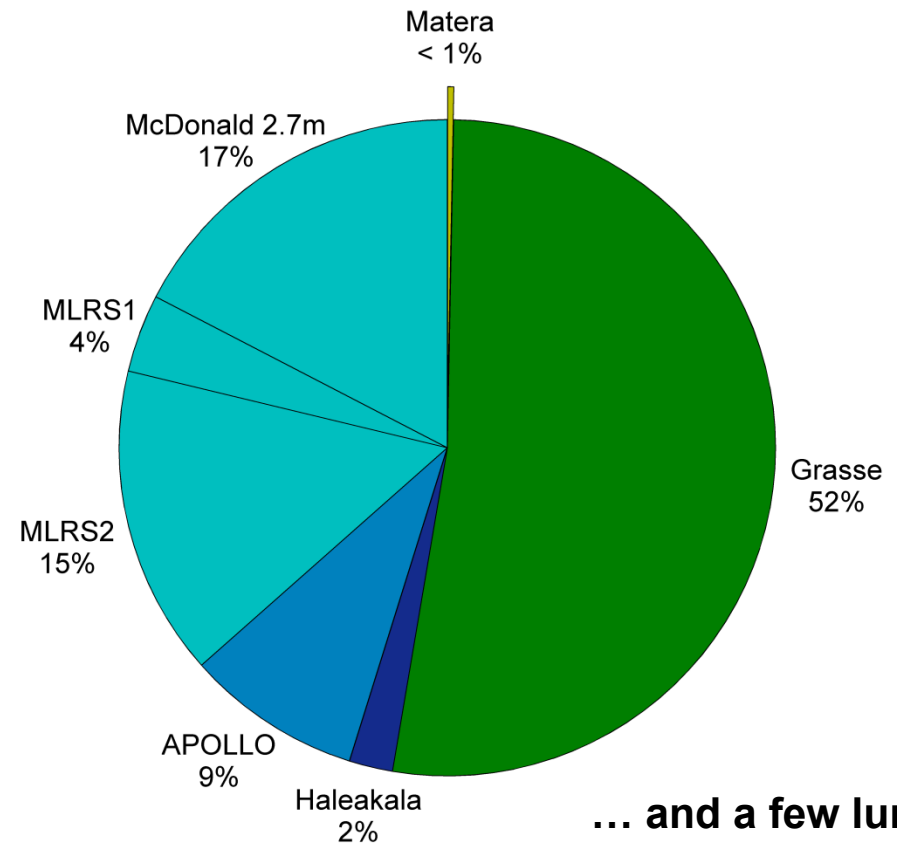
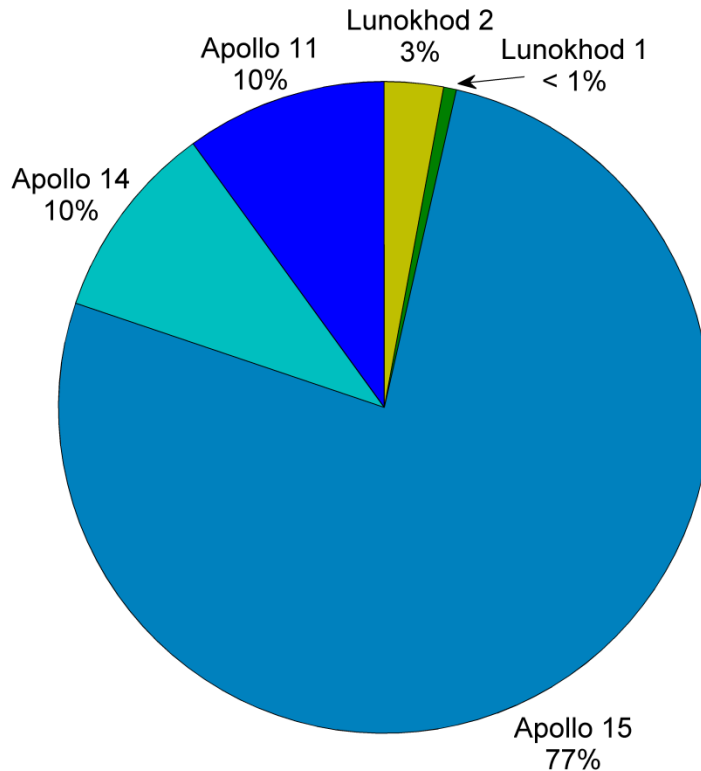
**Jürgen Müller**

**Institut für Erdmessung (Institute of Geodesy) and  
Center of Excellence QUEST  
(Quantum Engineering and Space-Time Research)**

**Leibniz Universität Hannover (University of Hannover)**

# Statistics – retro-reflectors and observatories

Time span **1970-2013**



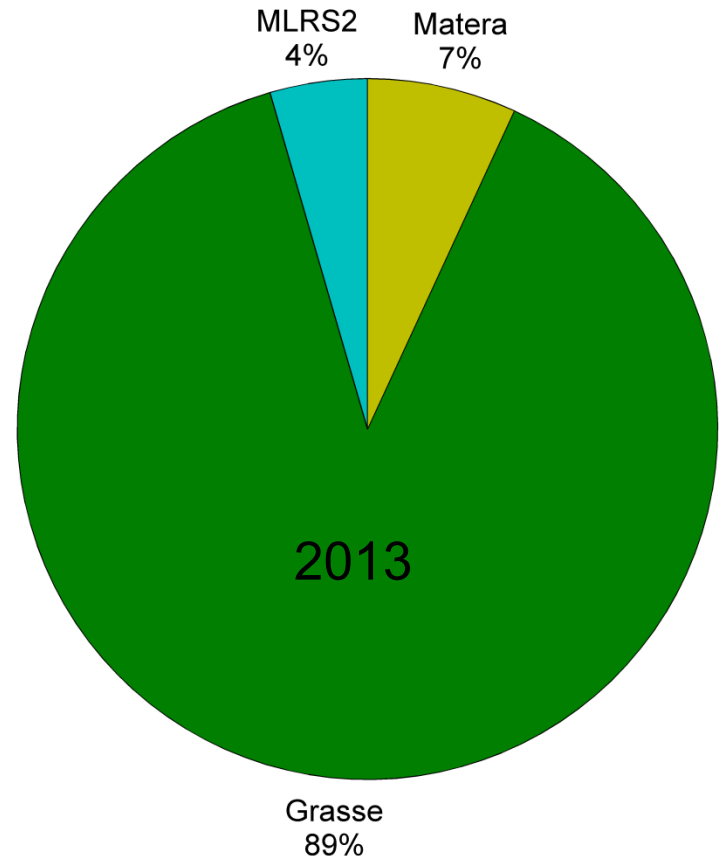
about 18,100  
normal points

... and a few lunar  
tracks from

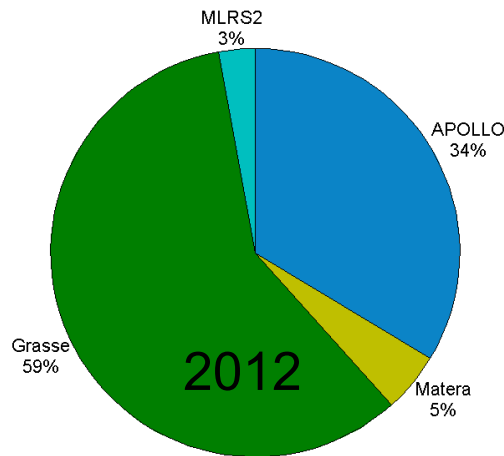
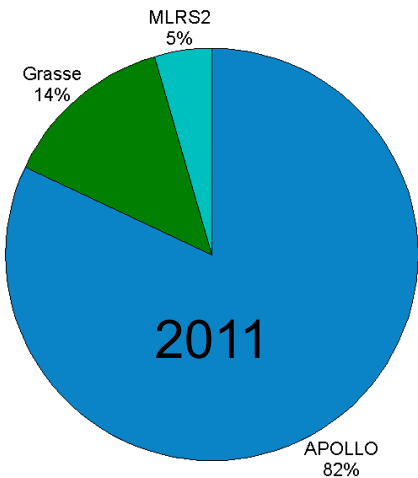
- Orroral
- Wettzell

# Statistics – observatories 2013

| Normal points   | 2012       | 2013       |
|-----------------|------------|------------|
| APOLLO          | 201        | 0*         |
| McDonald        | 17         | 15         |
| Grasse          | 351        | 296        |
| Matera          | 28         | 23         |
| <b>In total</b> | <b>597</b> | <b>334</b> |



\*APOLLO data of last year not released yet



# Status, perspective at the LLR sites

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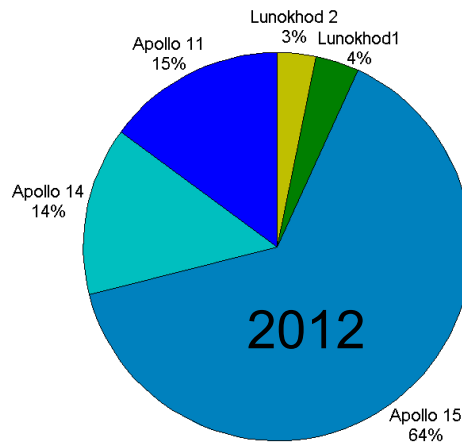
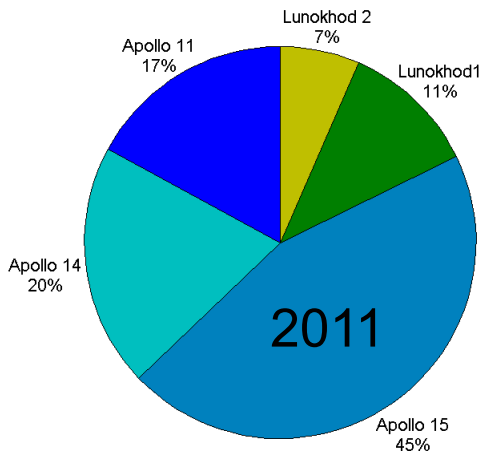
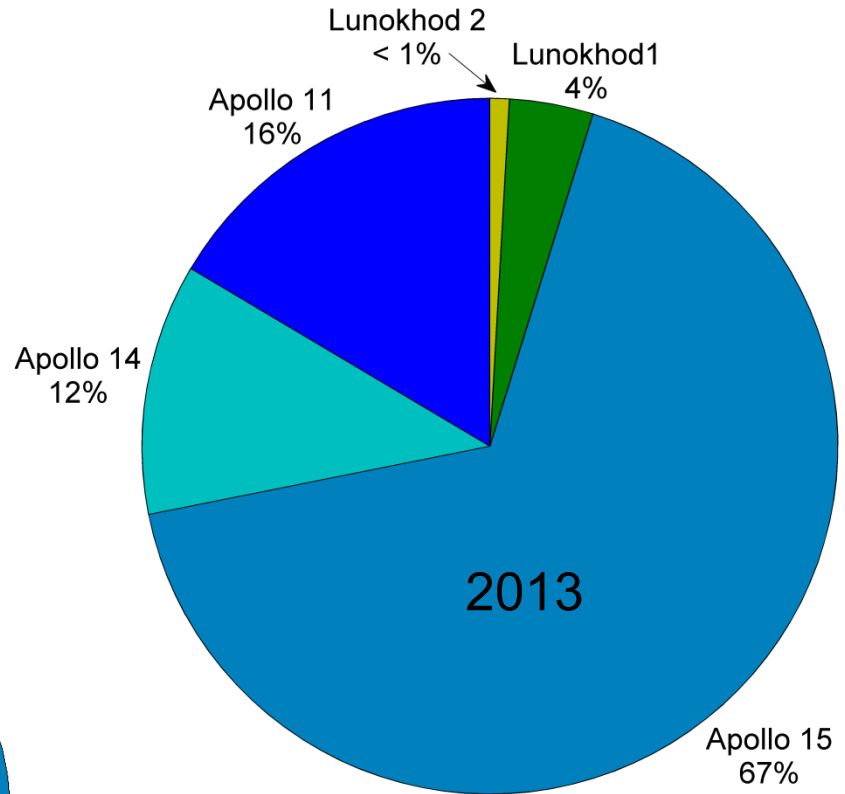
- McDonald - lunar tracking at low level
- Matera re-started in spring 2010 - lunar tracking at low level
- APOLLO - good LLR data until end of 2010 (new detector required refined processing → reduced accuracy, i.e. cm instead of mm level, problem fixed in 2012), pre-processing and release of 2013 data delayed
- Grasse re-started by end of 2009, good performance since end of 2011, more publications needed
- Wettzell LLR tracking is still pending



# Statistics – retro-reflectors 2013

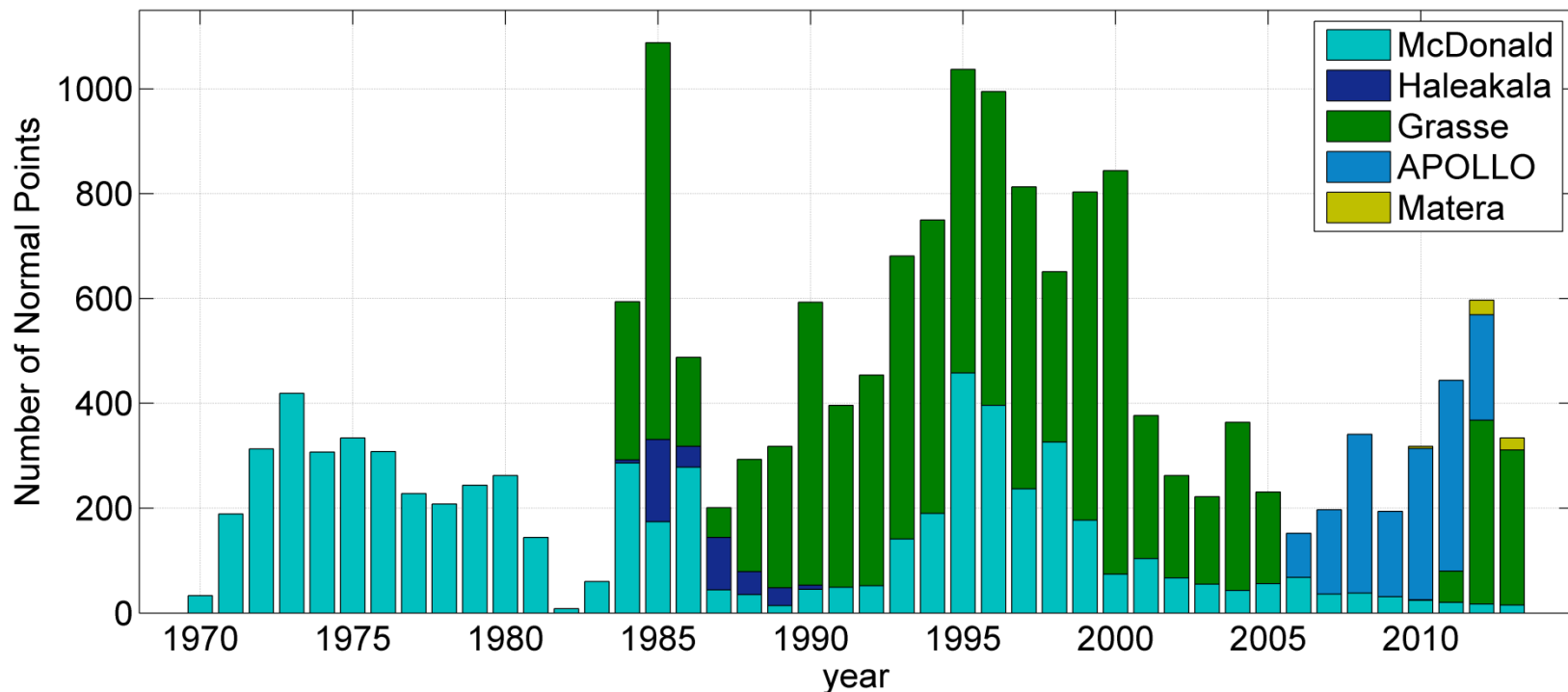
## Normal points 2012 2013

|                 |            |            |
|-----------------|------------|------------|
| Apollo 11       | 89         | 55         |
| Apollo 14       | 84         | 39         |
| Apollo 15       | 383        | 224        |
| Lunokhod 1      | 22         | 13         |
| Lunokhod 2      | 19         | 3          |
| <b>In total</b> | <b>597</b> | <b>334</b> |



# Number of normal points

1970 - 2013: ca.18,100 normal points

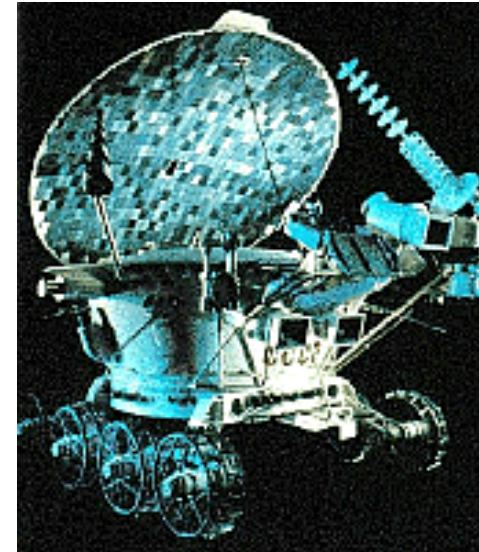
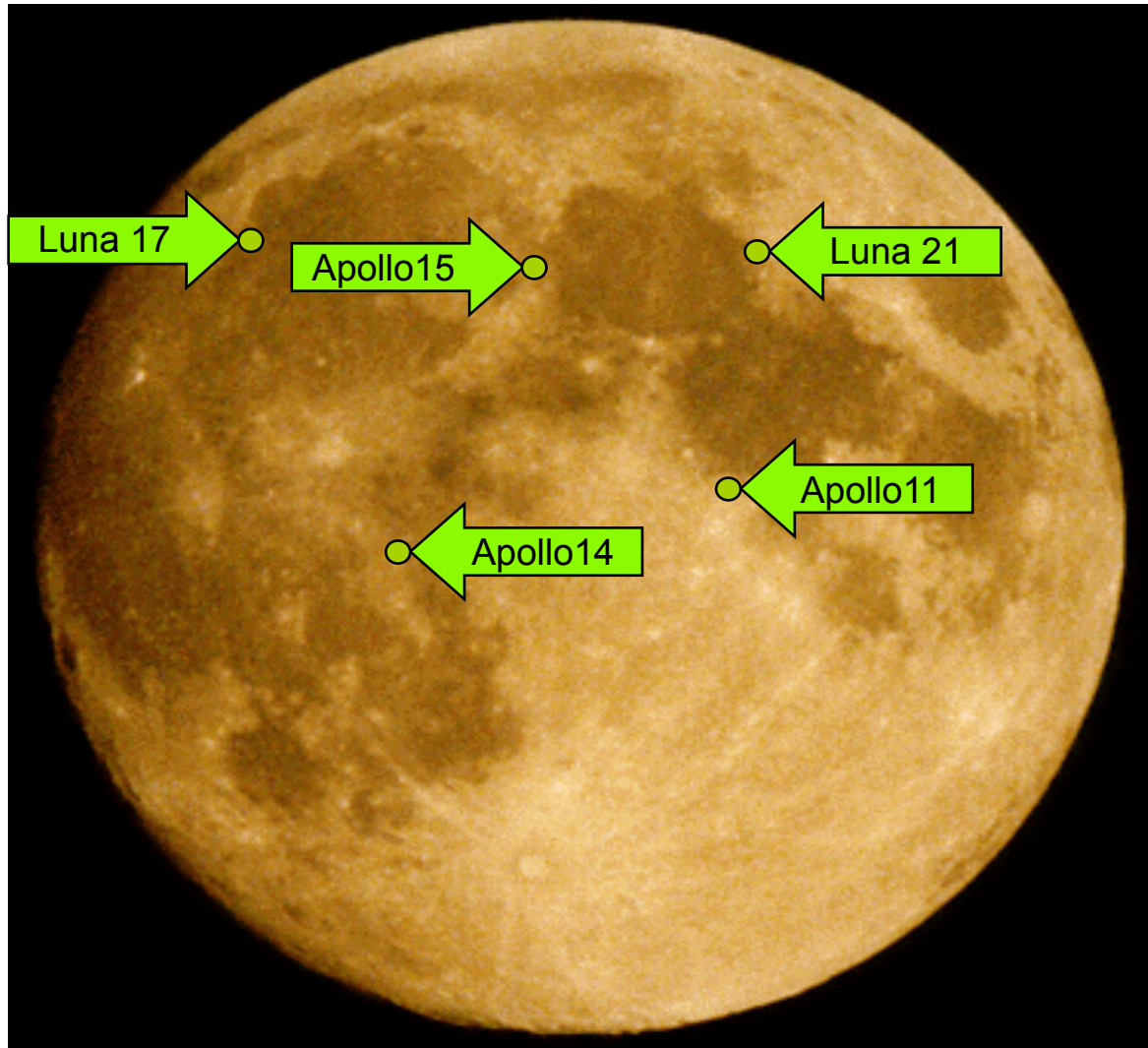


# Major LLR-related activities

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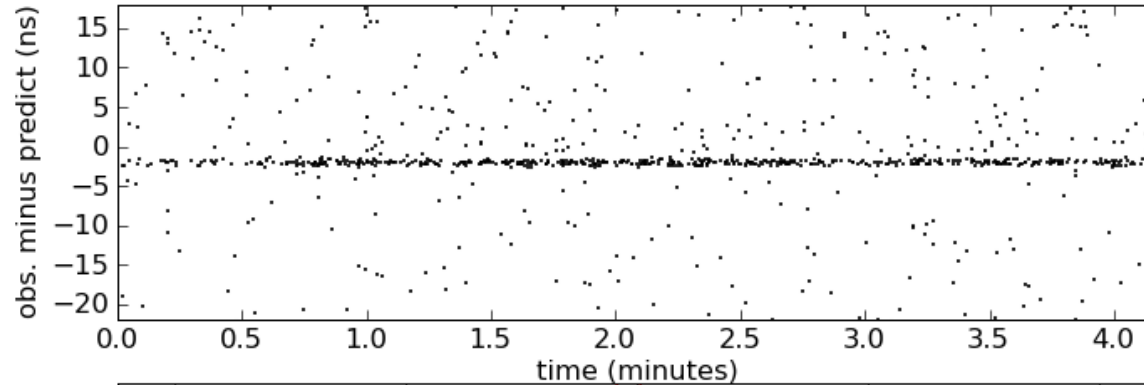
- Comparison of LLR software ongoing work between CfA (PEP)\*, Paris (INPOP) and Hannover
- LLR part on ILRS website shall be updated
- Some debate about correctness of Lunokhod 2 range data (see next three slides)
- Data screening, homogenization of archived LLR data is still in progress
- Many LLR-related talks (IAG, EGU, GR20 ....) and papers (CQG, IAG symposia series, Brumberg book ...) in the past years

# Retro-reflectors on the Moon

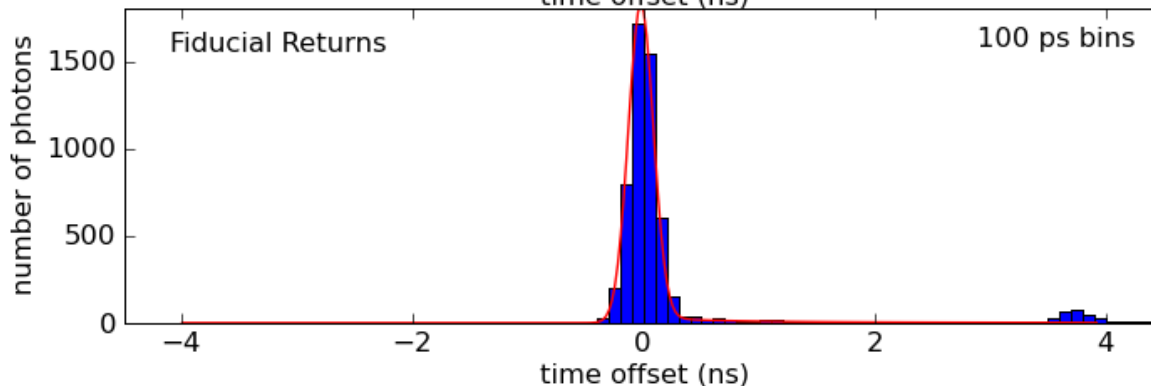
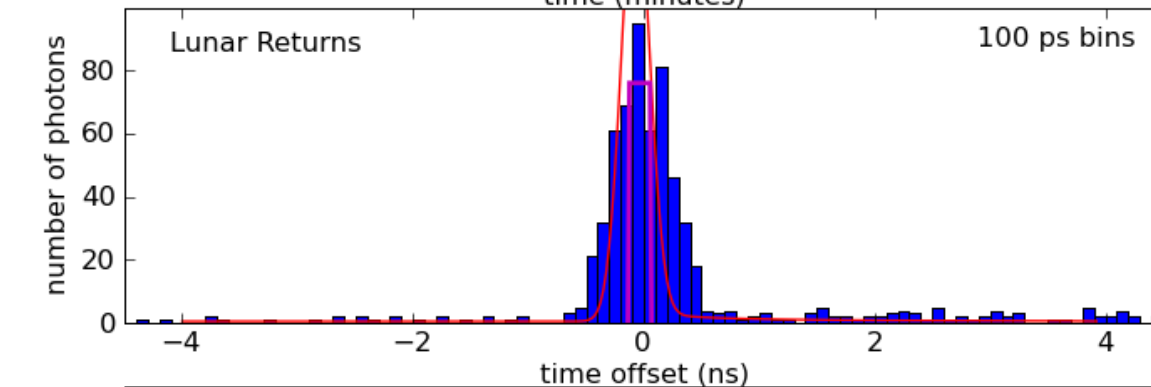


Lunokhod 2  
at Luna 21 position,  
tracked for 40 years

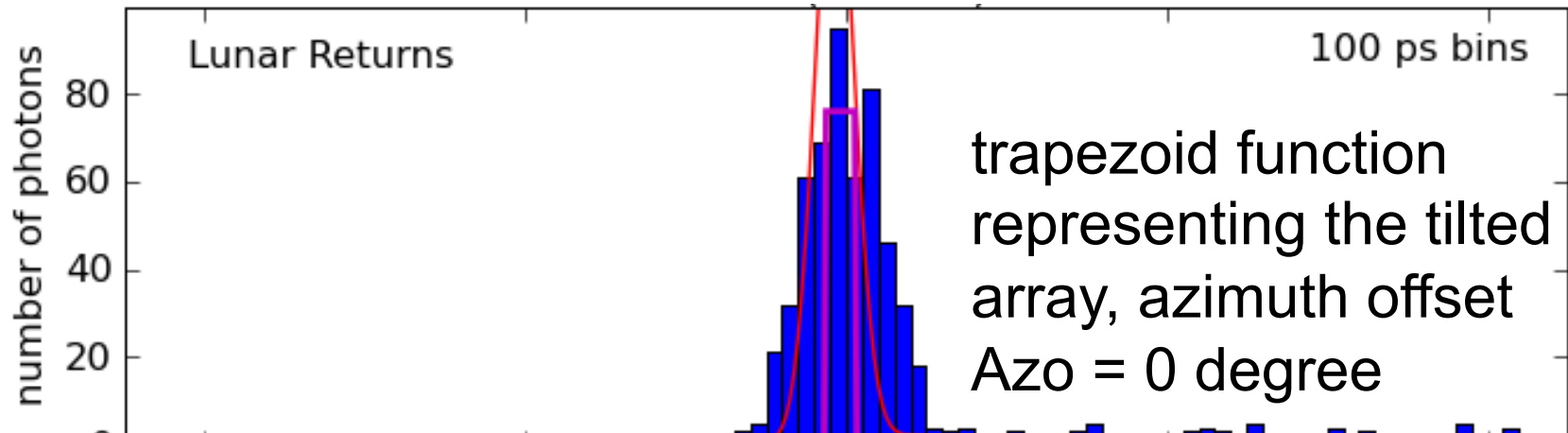
# Study on Lunokhod 2 orientation by T.Murphy



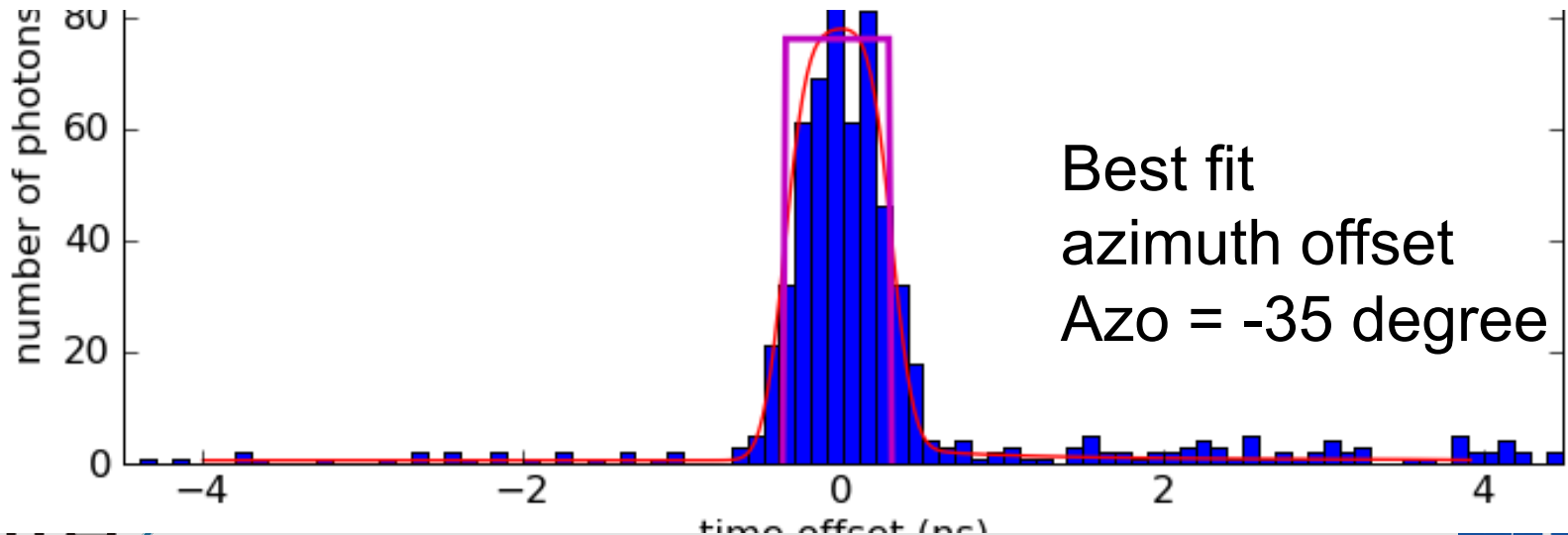
APOLLO  
tracking of  
Lunokhod 2  
at 2008-08-22



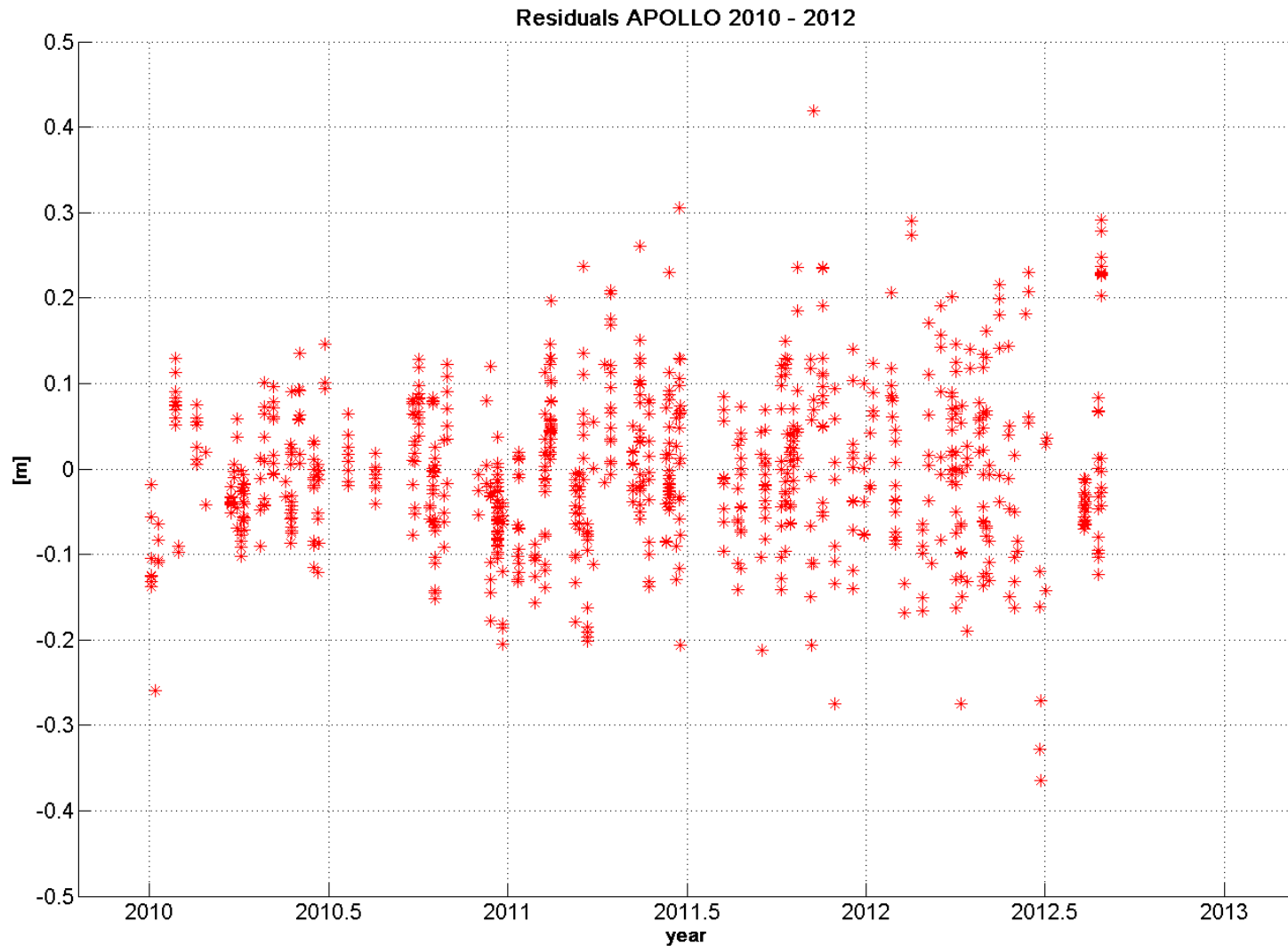
# Study on Lunokhod 2 orientation by T.Murphy



For more information see <http://physics.ucsd.edu/~tmurphy/apollo/l2-is-real.html>



# Residuals of APOLLO



# Weighted annual residuals

weighted residuals (observed - computed Earth-Moon distance), annually averaged

