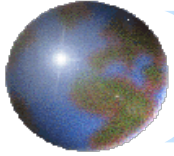# *ILRSA CC*
ITRF2008P preliminary evaluation

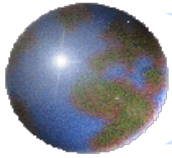**C. Sciarretta, V. Luceri**
eGEOS S.p.A., CGS – Matera

G. Bianco
Agenzia Spaziale Italiana, CGS - Matera
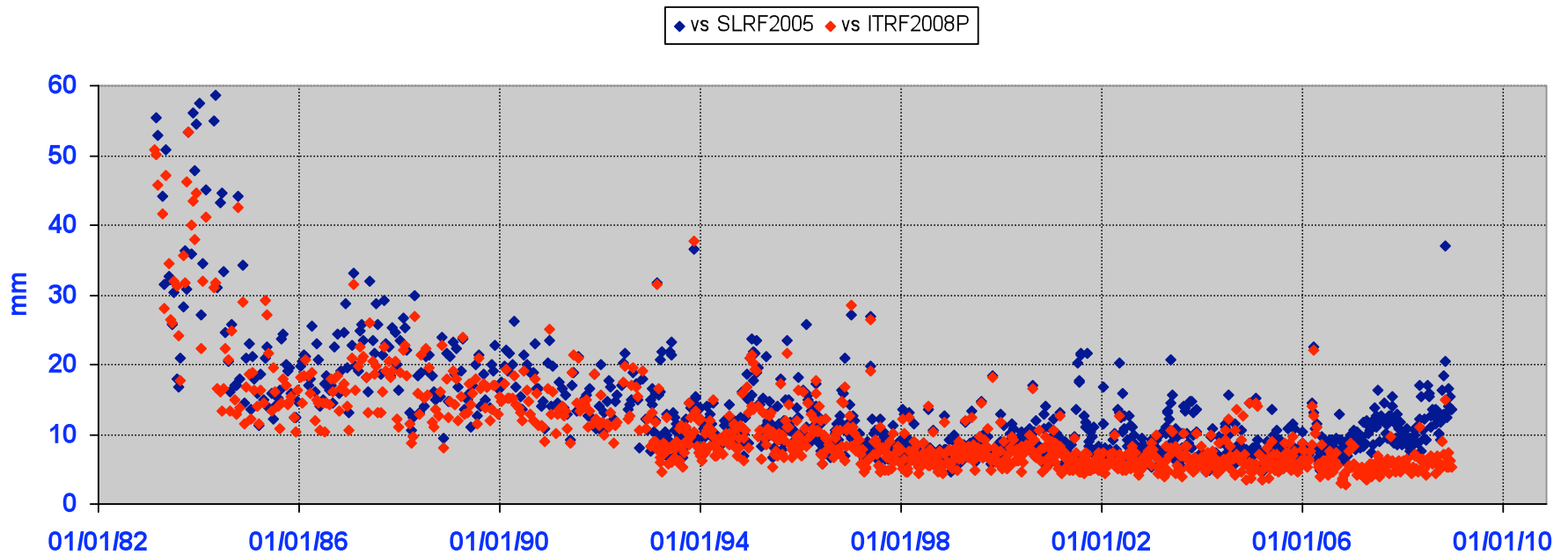
ILRS AWG Meeting, 8 May 2010, Wien

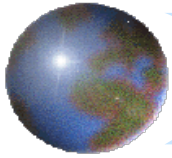# Contents

- 1983-2008 ILRSA v24 transformed into **ITRF2008P (IGN)**

  (transformation into SLRF2005 already available)

- analysis of SSC residuals

- analysis of Helmert parameters (Translations&Scale)

Site Coordinate Residuals

All Sites - 3D Residuals WRMS wrt Terrestrial Reference Frame

Site Coordinate Residuals

Core Sites - 3D Residuals WRMS wrt Terrestrial Reference Frame
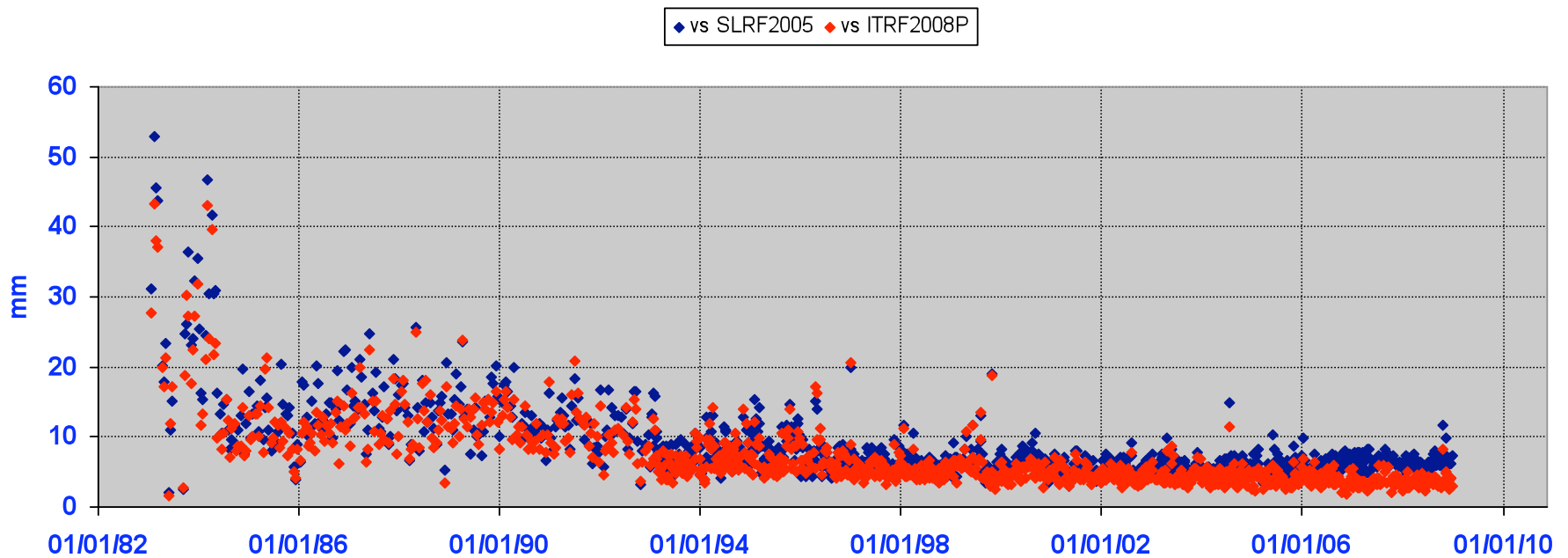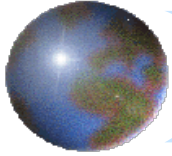
Site Coordinate Residuals - Statistics

::
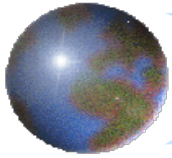
	vs SLRF2005		vs ITRF2008P	
	<WRMS> [mm]	σWRMS [mm]	<WRMS> [mm]	σWRMS [mm]
All Sites	13.21	18.80	10.88	18.89
Core Sites	8.44	5.79	7.01	5.15
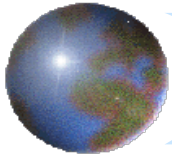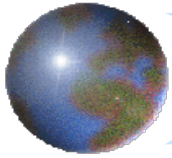
Helmert Translations: Tx
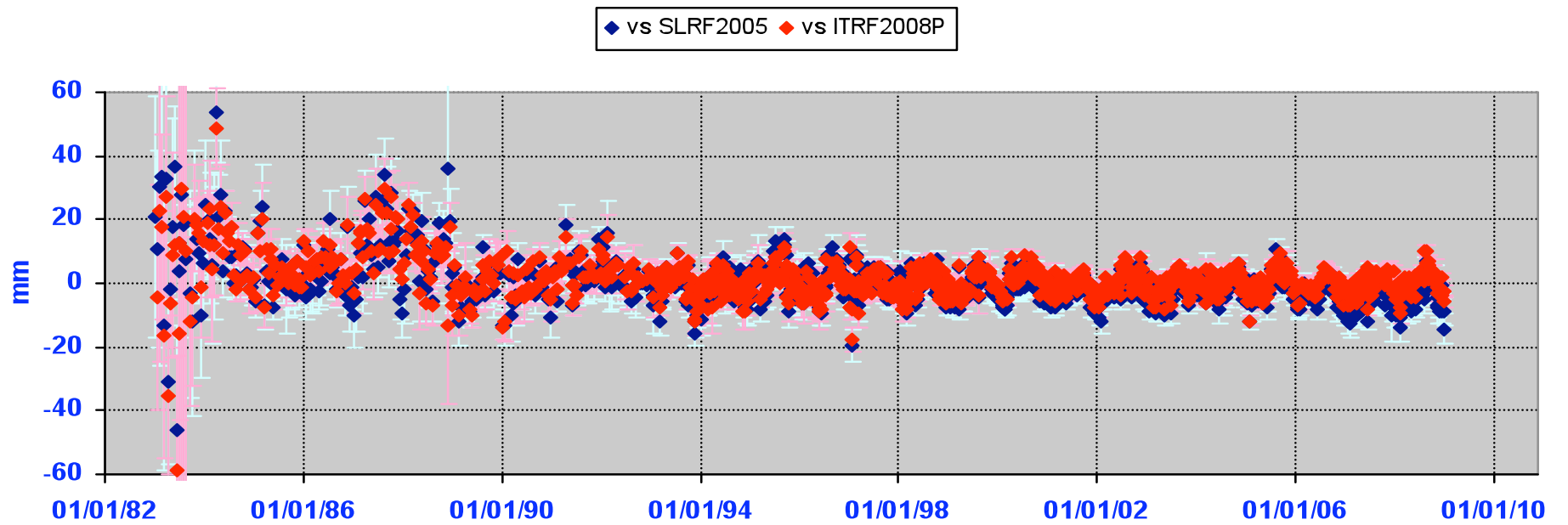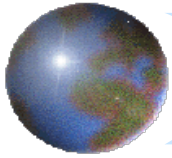
Helmert Translations: Ty
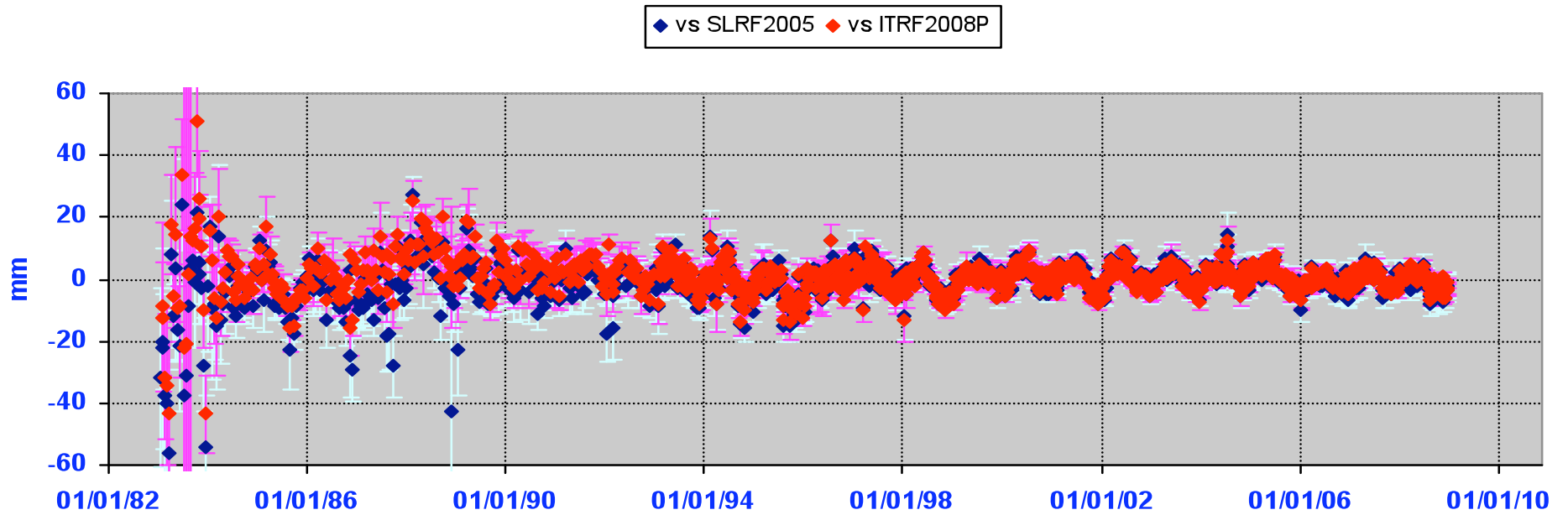
Helmert Translations: Tz
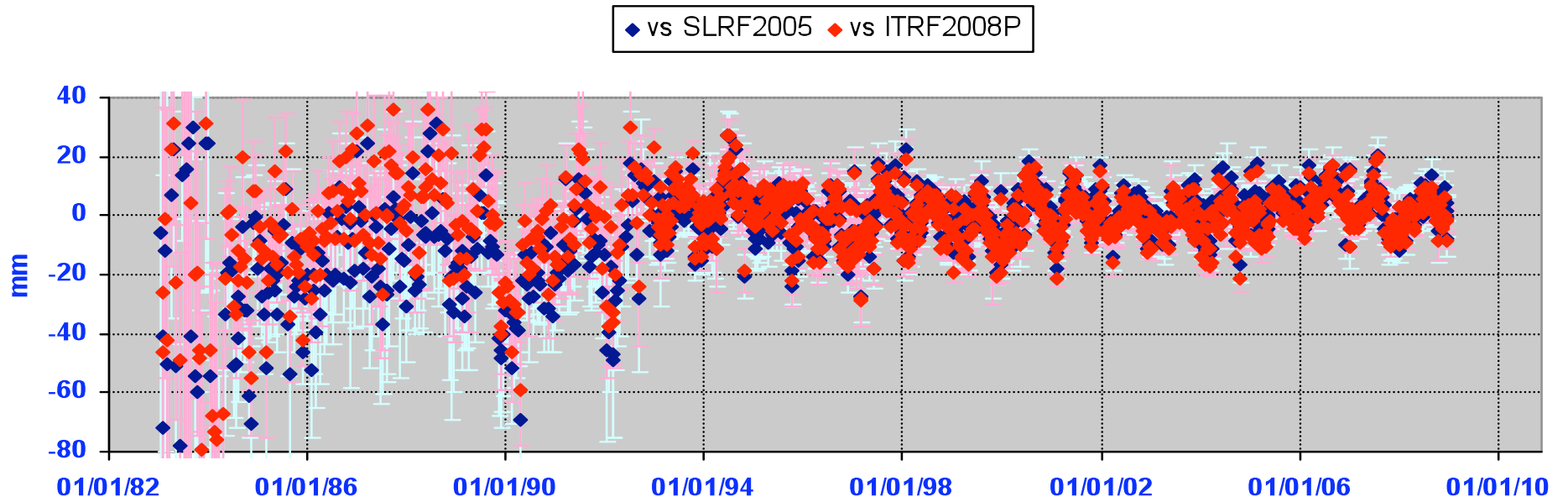
Helmert ∆Scale
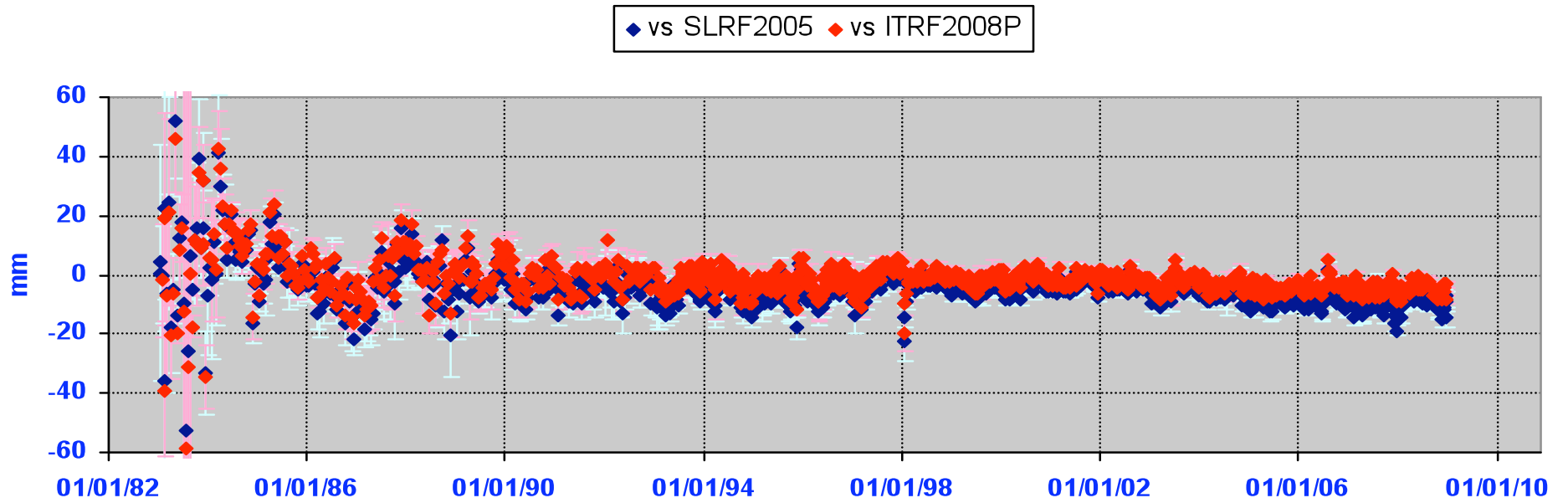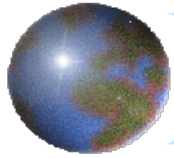
Helmert Parameters comparison

A linear (weighted) fit has been computed over the Helmert parameters time series; beyond the estimated slope values, their std and the post fit residuals are of key importance.

::

	vs SLRF2005			**vs ITRF2008P**		
	Slope [mm/yr]	σslope [mm/yr]	Res wrms [mm]	Slope [mm/yr]	σslope [mm/yr]	Res wrms [mm]
Tx	-0.29	0.02	4.16	-0.11	0.01	3.76
Ty	+0.06	0.02	3.82	-0.05	0.01	3.54
Tz	+0.38	0.03	7.45	+0.07	0.02	7.17
Sc	-0.30	0.01	3.15	-0.30	0.01	2.65

Weekly product: 2009 performance

Core Sites - 3D Residuals WRMS wrt Terrestrial Reference Frame

Legend: ◆ vs SLRF2005 ◆ vs ITRF2008P

7.32+/-1.38 mm

5.43+/-1.74 mm
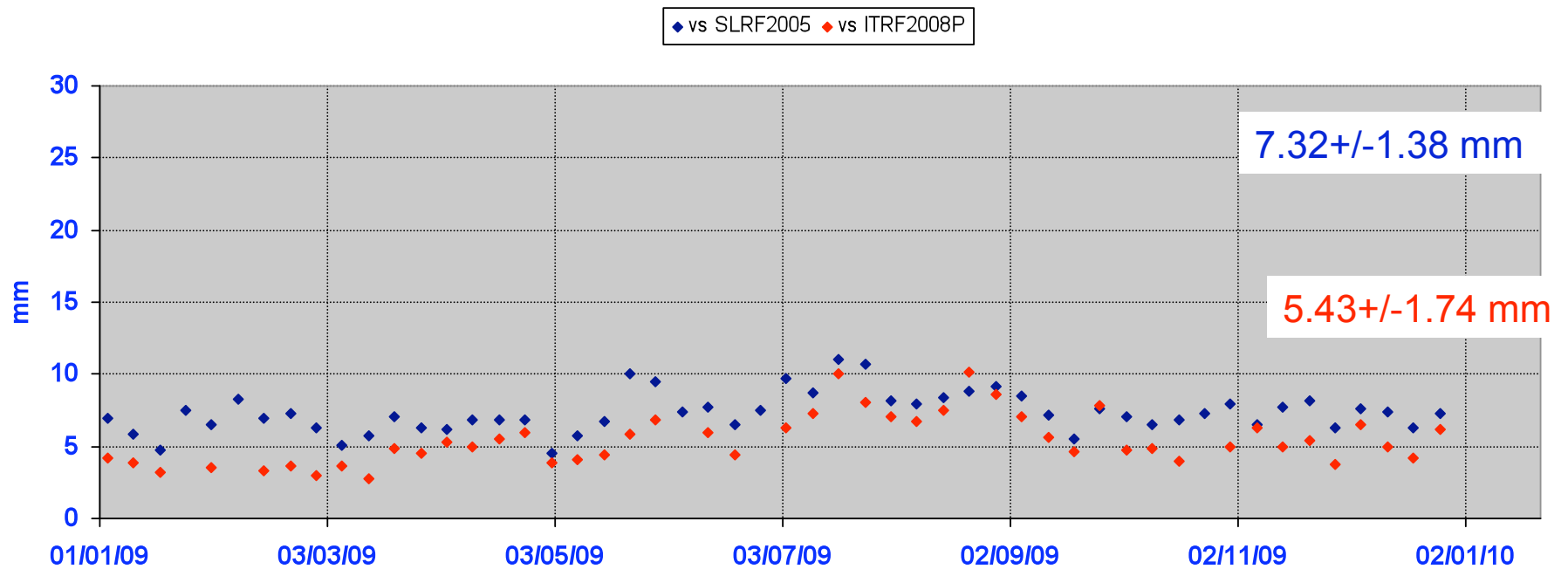
Weekly product: 2009 performance

All Sites - 3D Residuals WRMS wrt Terrestrial Reference Frame

◆ vs SLRF2005   ◆ vs ITRF2008P

11.95+/-2.39 mm

8.75+/-3.38 mm
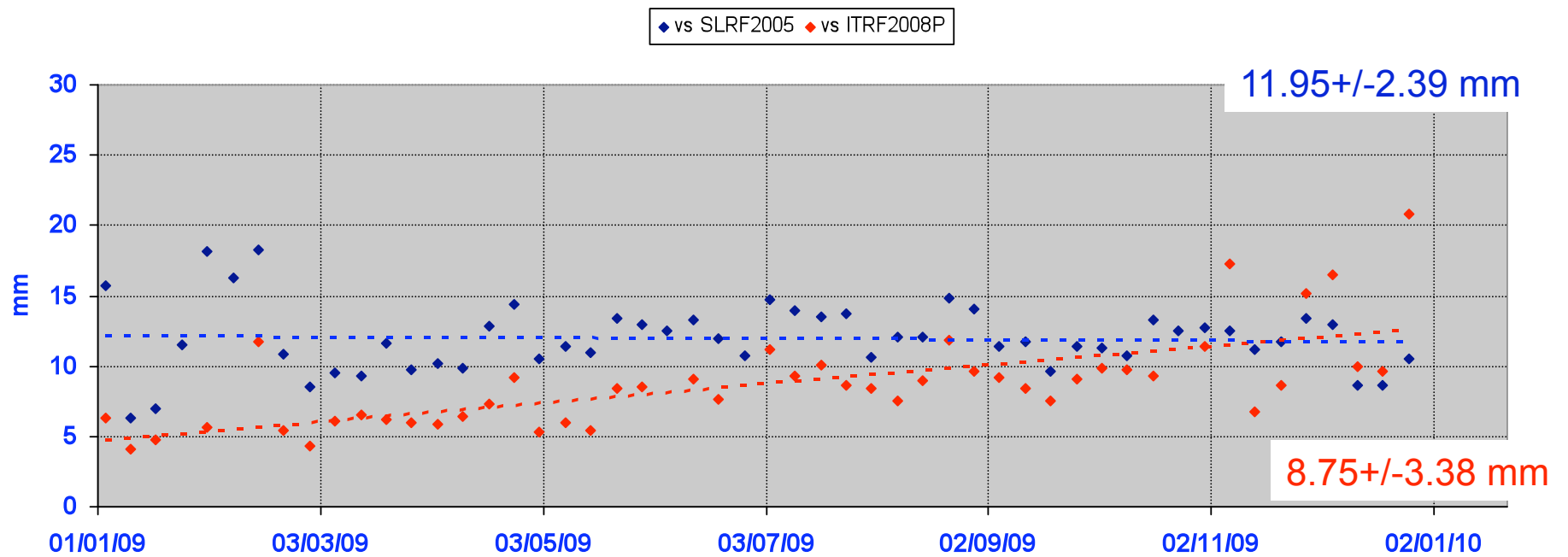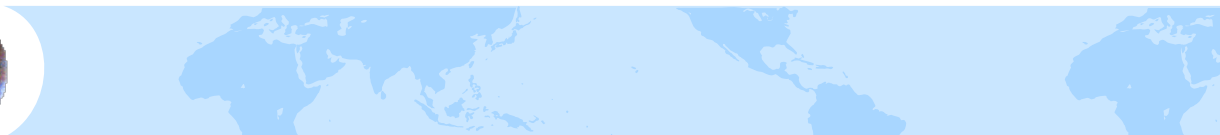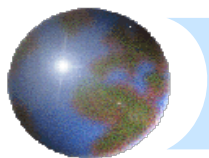
ILRSA CC
Status of the products

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

G. Bianco
Agenzia Spaziale Italiana, CGS - Matera

ILRS AWG Meeting, 8 May 2010, Wien
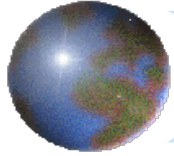
Contents

- Applying "lessons learned" (loosening and LOD issues) from ILRSA v24 for ITRF2008 to weekly and daily products: ILRSA v25, v125

- analysis of the weekly product performance: 2009-10 solutions

- EOP product: performance evaluation and operational remarks

- Additional analysis on ILRSA v24 for ITRF2008: looking for periodic component in Helmert Translations & Scale
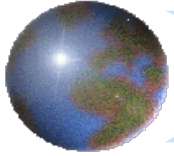
An evaluation of the 2009-2010 (feb) weekly AC & CC operational solutions has been performed:

- to fix issues known during the preparation of the ITRF2008 contribution in the operational solutions (*loosening*, LOD)
- to issue a re-worked version of the 2009 weekly solutions to connect the ILRSA v24 to the updated operational weekly/ daily solutions: -> v25, v125
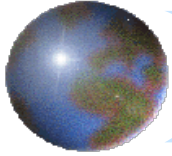
LOD issue

All the operational AC solutions have been evaluated to assess the LOD parameter; LOD parameters from GA and DGFI solutions show a poor performance, so they will be not included in the current combined solutions.

GA eop (LOD) - Weekly Mean of residuals wrt USNO "finals.data"

DGFI eop (LOD) - Weekly Mean of residuals wrt USNO "finals.data"
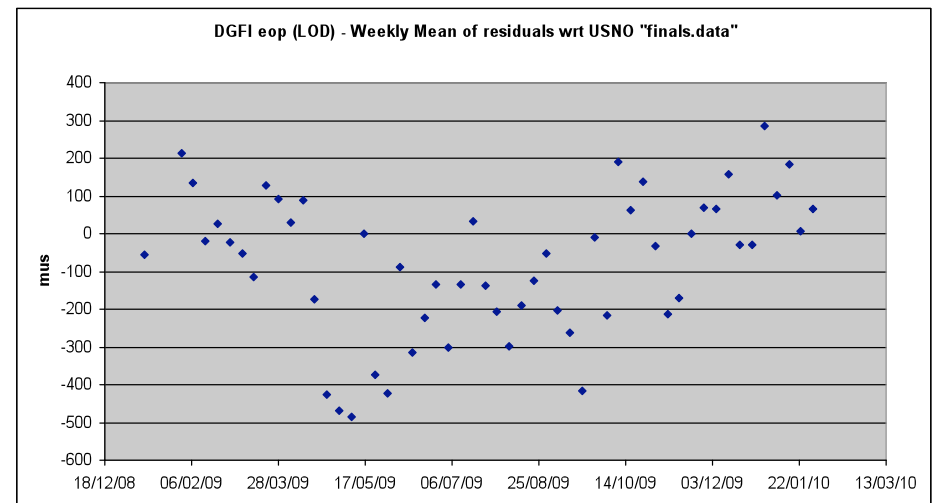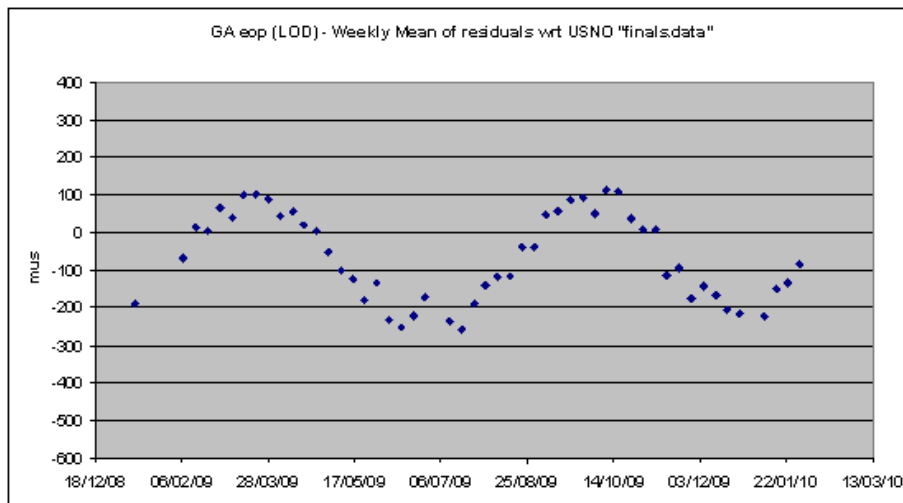
Loosening issue

The operational AC solutions have been re-assessed to evaluate the current looseness degree of each one; additional loosening to NSGF, BKG, DGFI, GRGS solutions has been included in the operational combination processing to guarantee the final combined solution be loose enough.
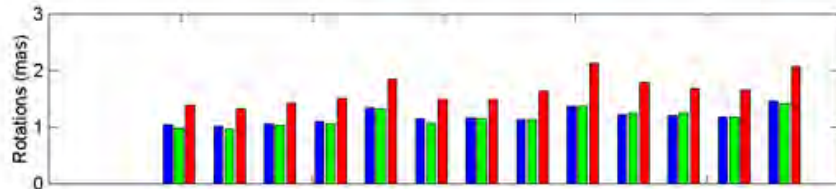
NSGF – 2009/11-2010/01
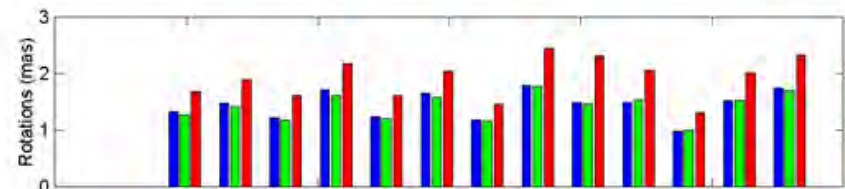
BKG – 2009/11-2010/01
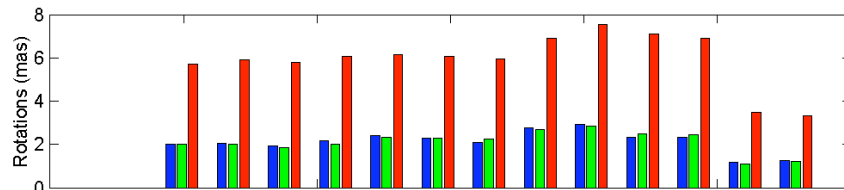
DGFI – 2009/11-2010/01
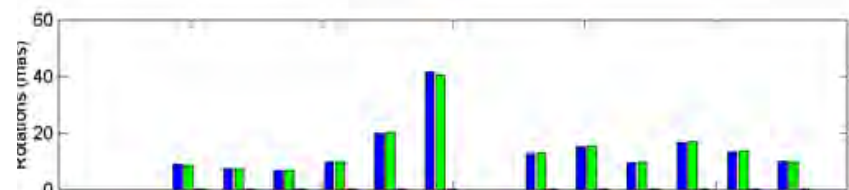
GRGS – 2009/11-2010/01
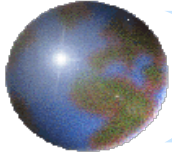
ILRSA v25, v125

According to the previous analysis, the current operational combined solution is the ILRSA v25 (v125) that includes

- additional loosening for BKG, DGFI (no daily), NSGF, GRGS
- GA and DGFI LOD excluded from combined weekly solutions

A backward re-combination (ILRSA v25) for the period 2009 – 2010 (feb) has been performed on the weekly solutions and uploaded to the archives; it implements the above corrections and uses the following available AC solutions:

ASI	**V23**
BKG	**V20**
DGFI	**V25**
GA	**V22 (up to 30/05/2009); V23**
GFZ	**V20 (up to a 30/05/09); V23**
GRGS	**V24**
JCET	**V23**
NSGF	**V20 (even if available V24)**
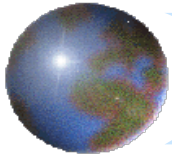
Weekly product: 2009- 2010 performance

SLRF2005
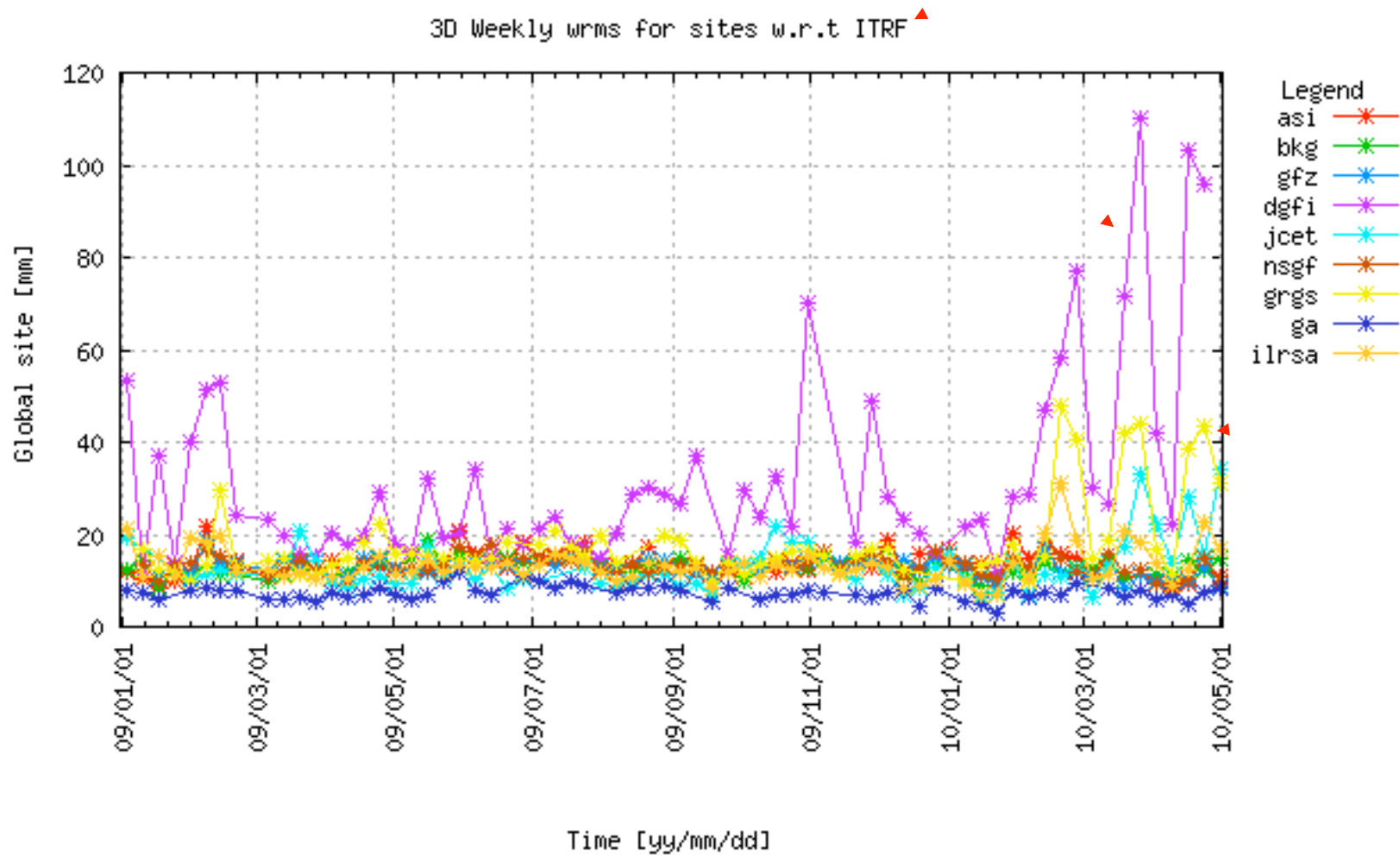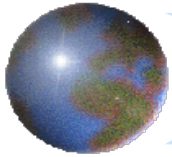
3D Weekly wrms for sites w.r.t ITRF

Weekly product: 2009- 2010 performance

3D Weekly wrms for sites w.r.t ITRF

3D Weekly wrms for sites w.r.t ITRF
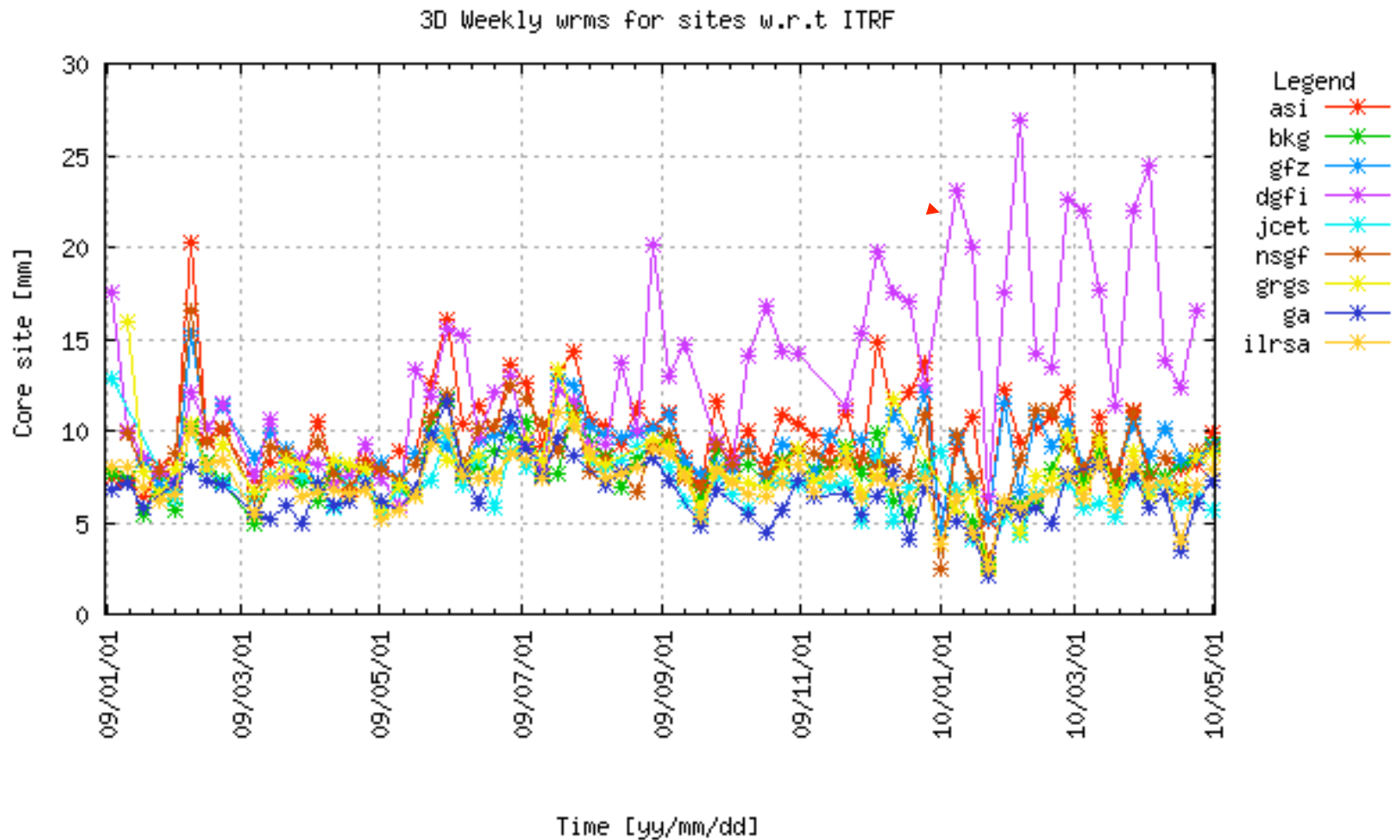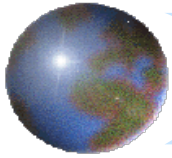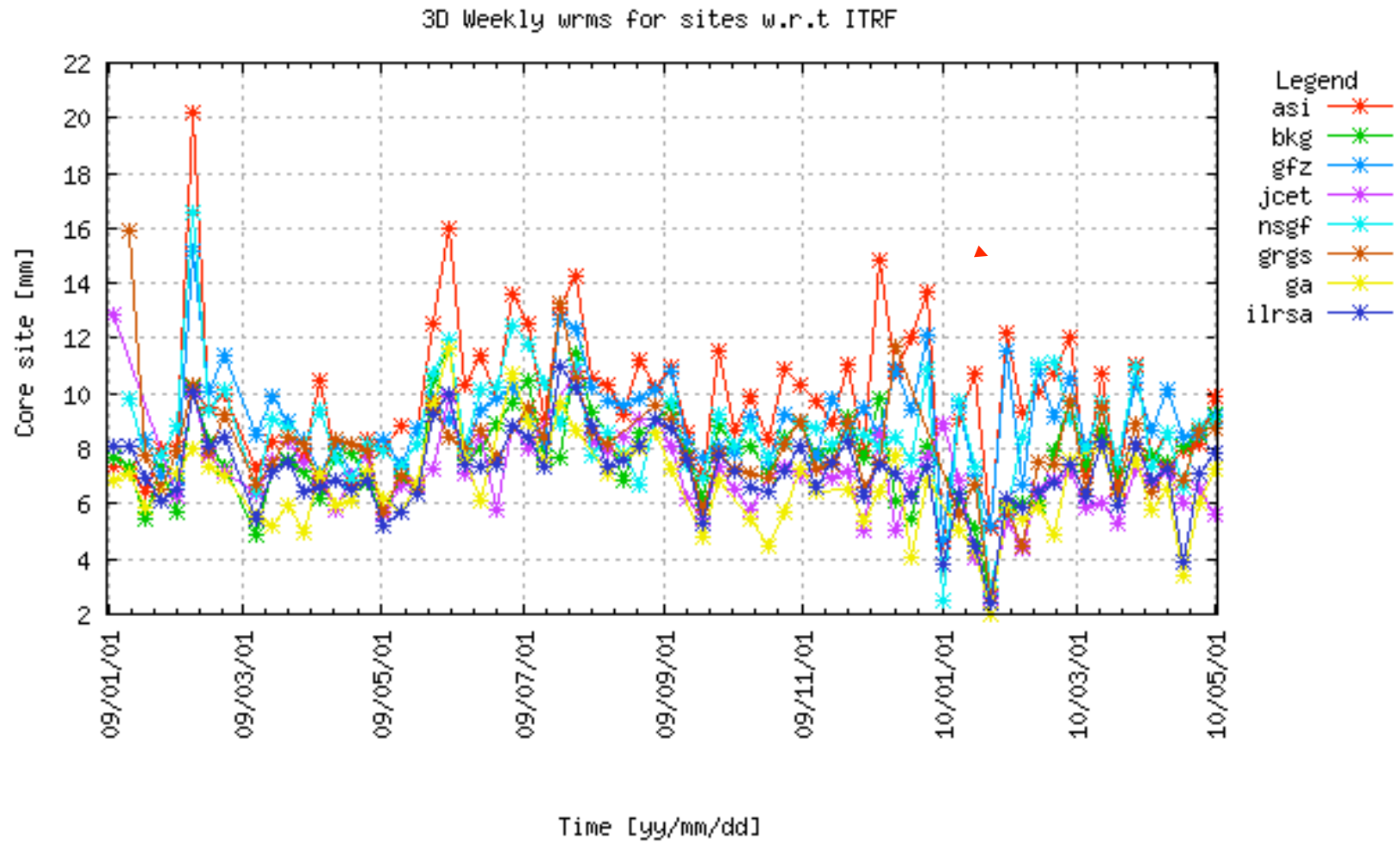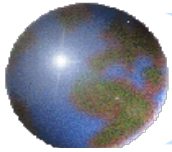
Weekly product: ILRSA EOP performance
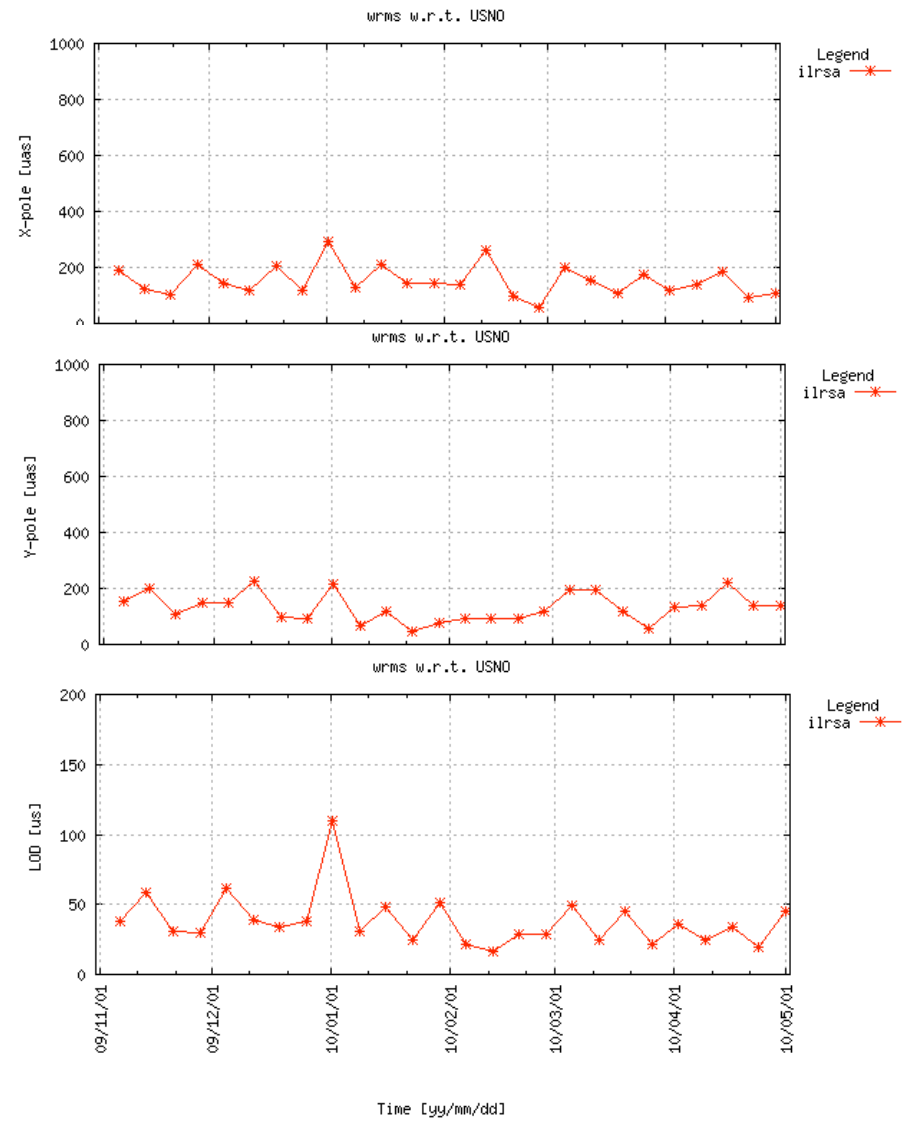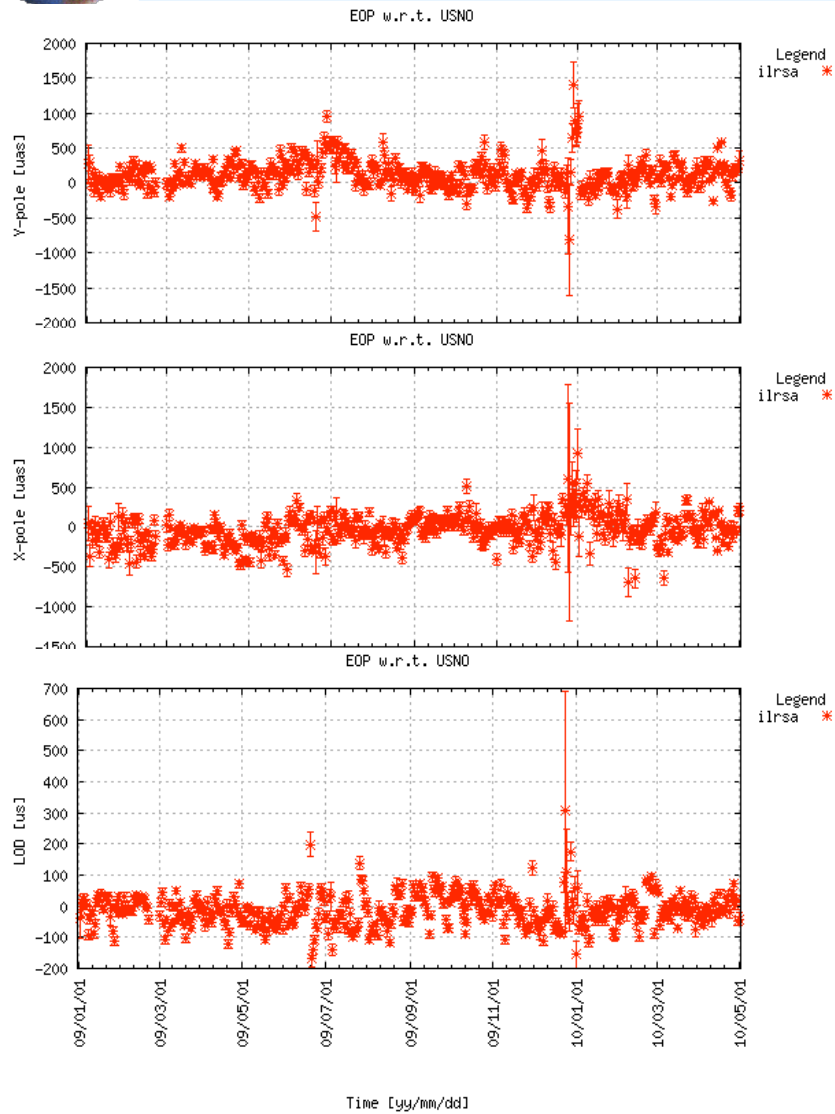
BKG
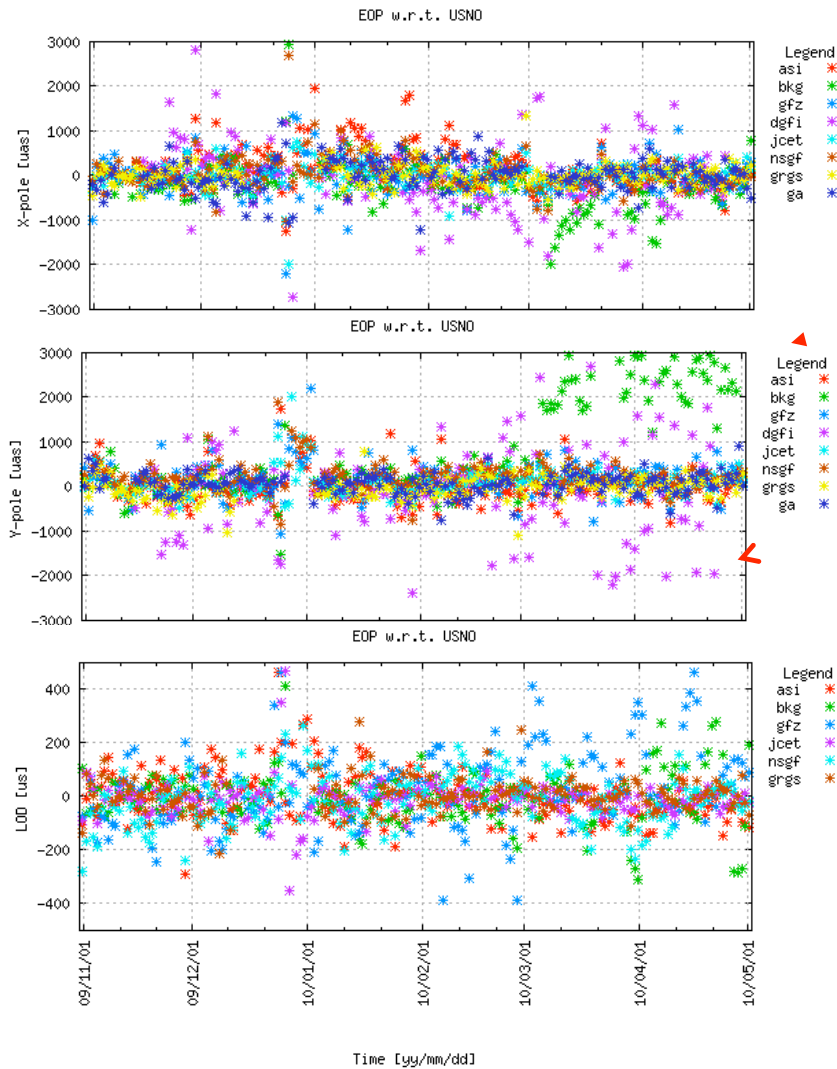
DGFI
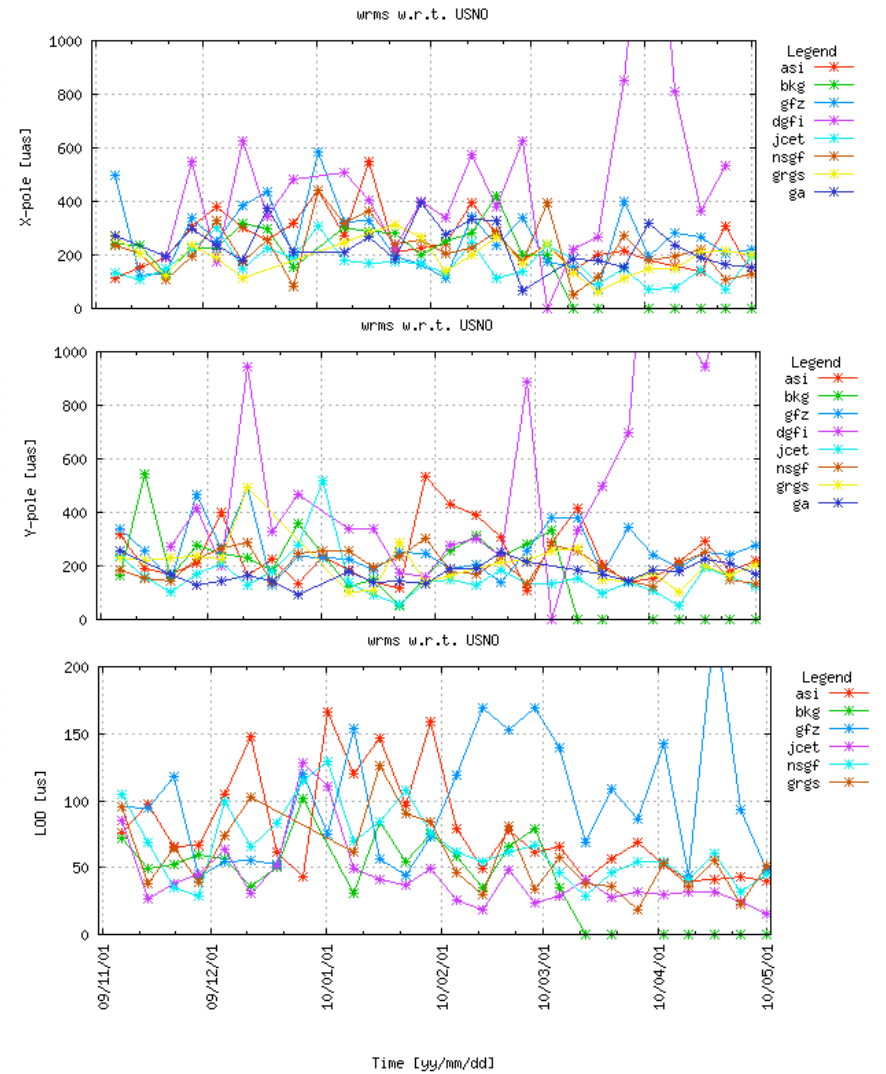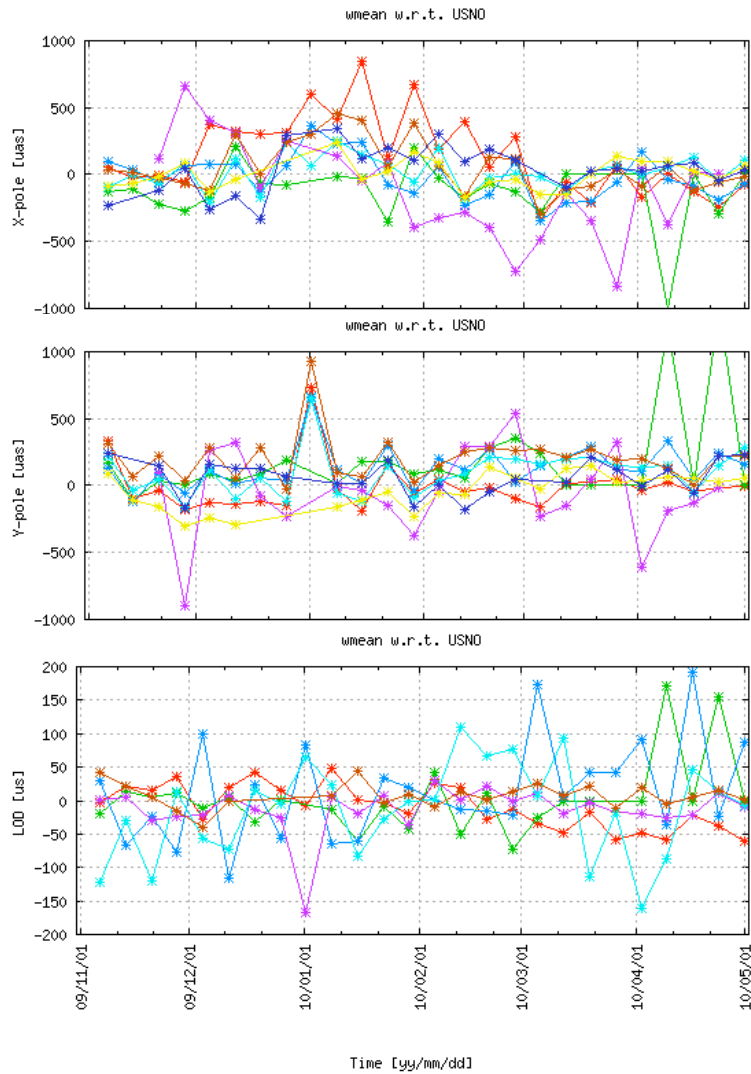
ILRSA v24 Helmert parameters analysis
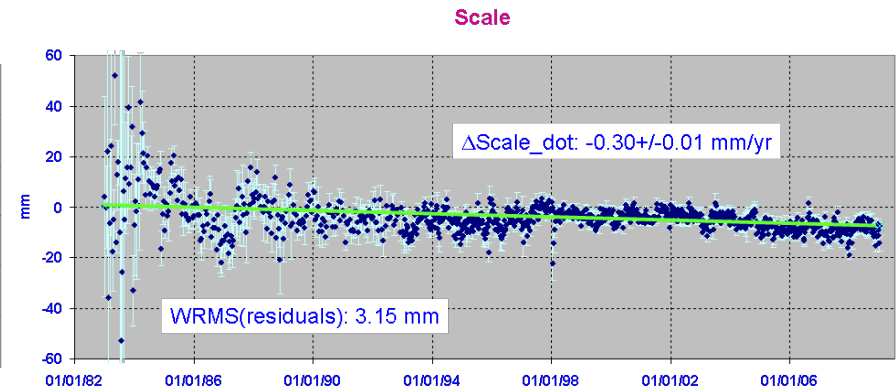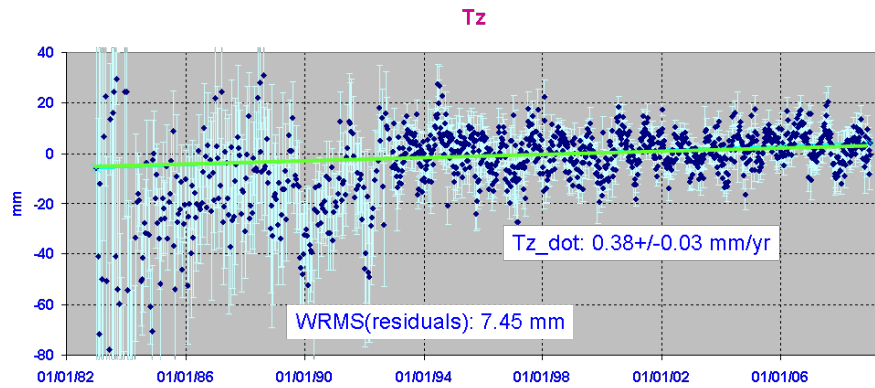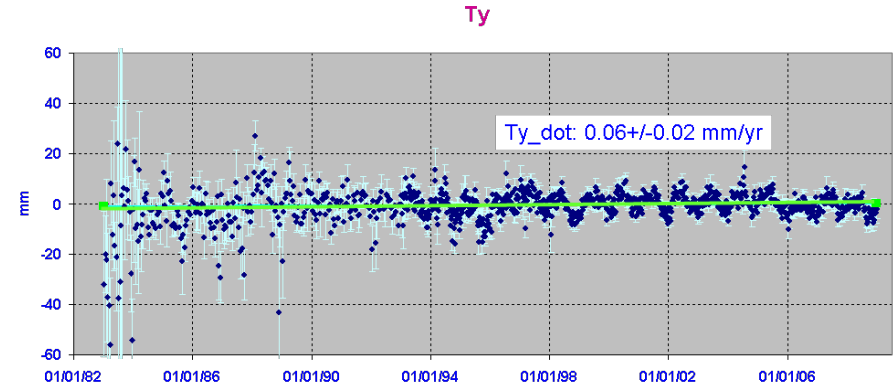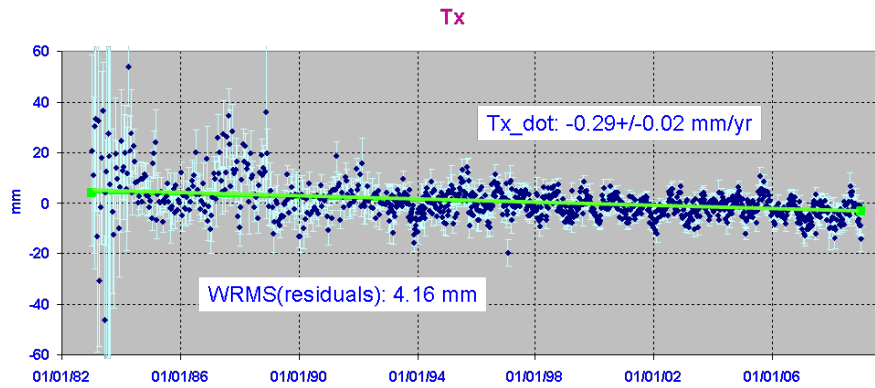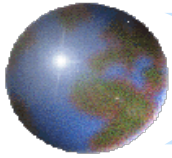
ILRSA v24 Helmert parameters analysis

detrended Helmert parameters
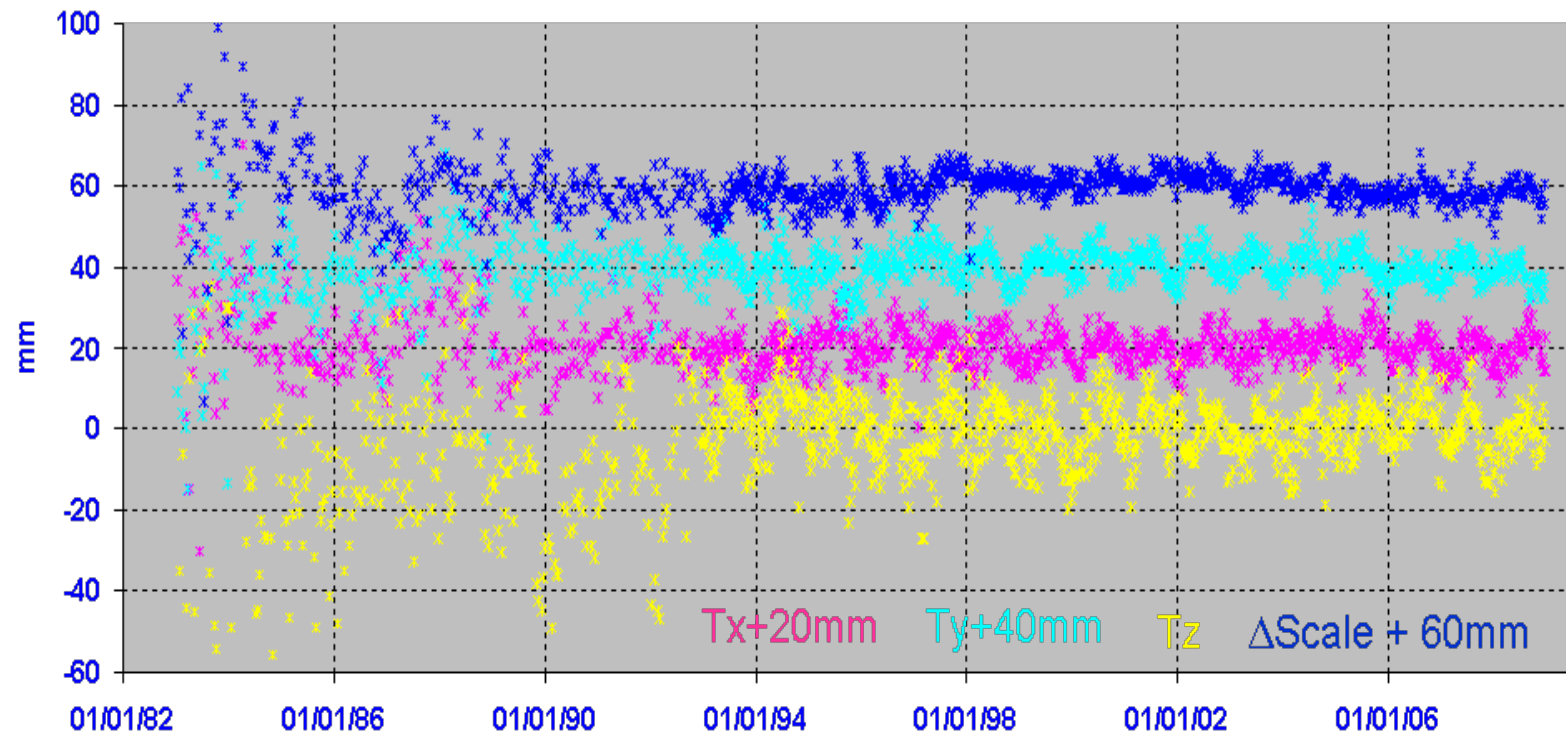
ILRSA v24 Helmert parameters analysis
SLRF2005

single-Sided Amplitude Spectrum of Tx, Ty, Tz

single-Sided Amplitude Spectrum of ΔScale
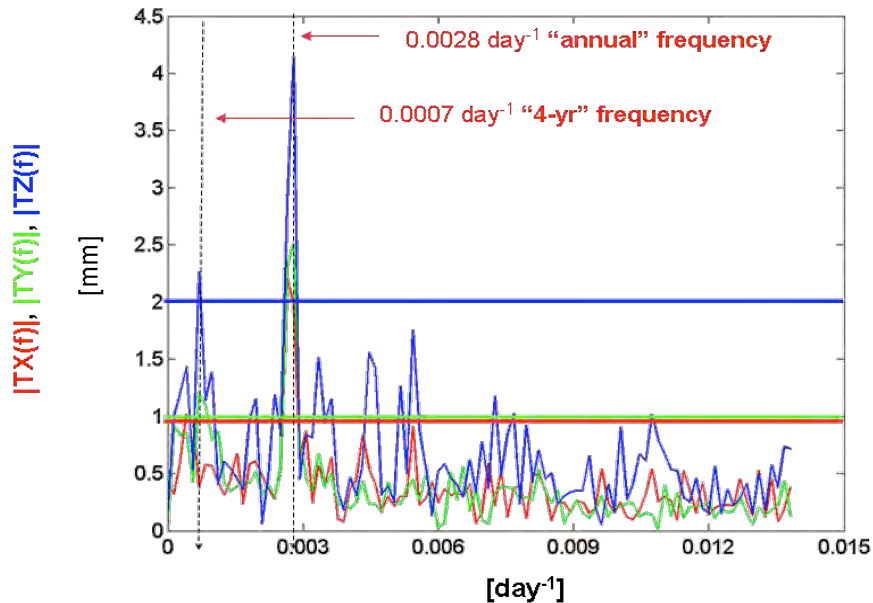
Freq. terms w Amplitude > thresholds
(1mm Tx, Ty; 2mm Tz)

freq [day^{-1}]	Tx [mm]	Ty [mm]	Tz [mm]
0.00056	1.0158	-	-
0.00070	-	1.2082	2.2643
0.00084	-	1.1012	-
0.00265	2.2067	2.3187	2.8636
0.00279	1.9856	2.5139	4.1424
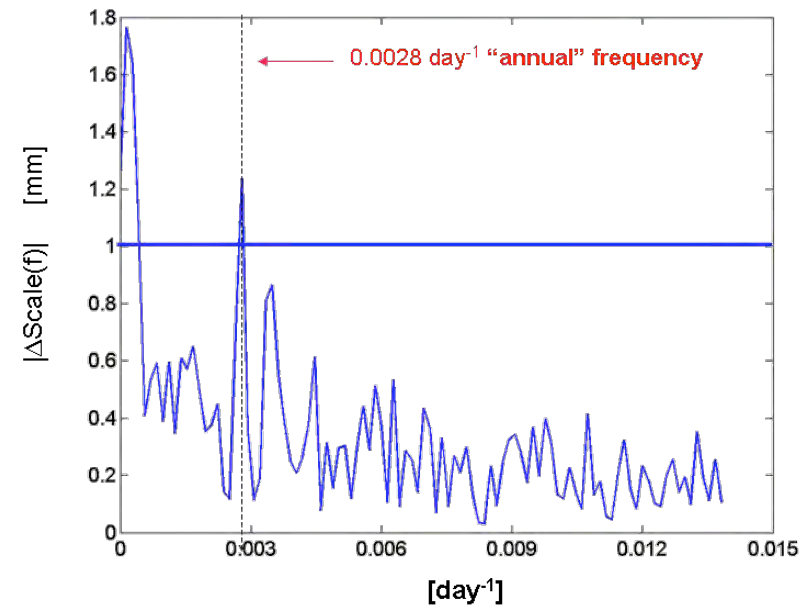
- 1993-2008
- Evident annual term in translation residuals
- Secular/long-periodic terms in scale residuals
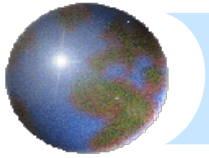
ILRSA v24 Helmert parameters analysis
SLRF2005
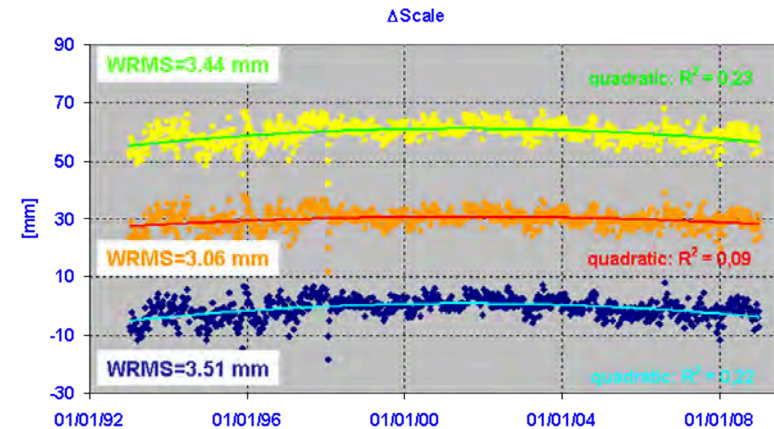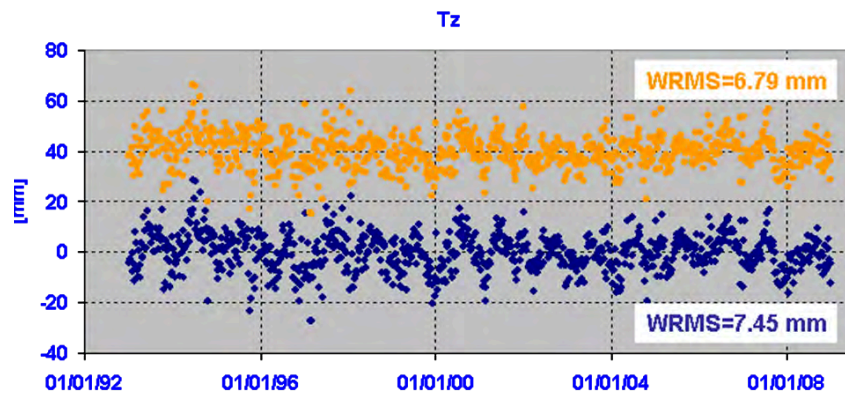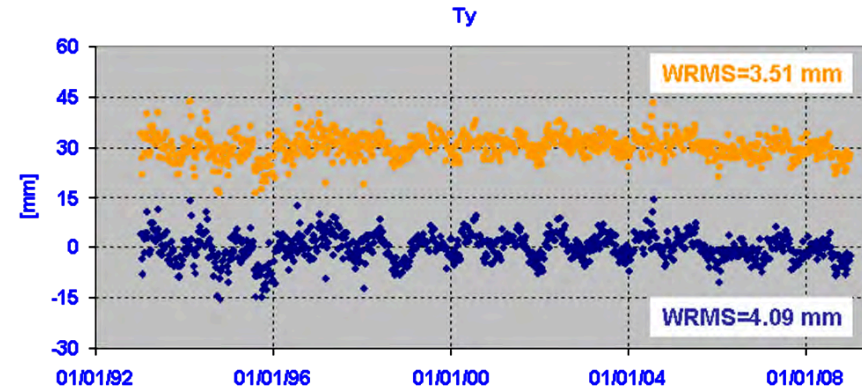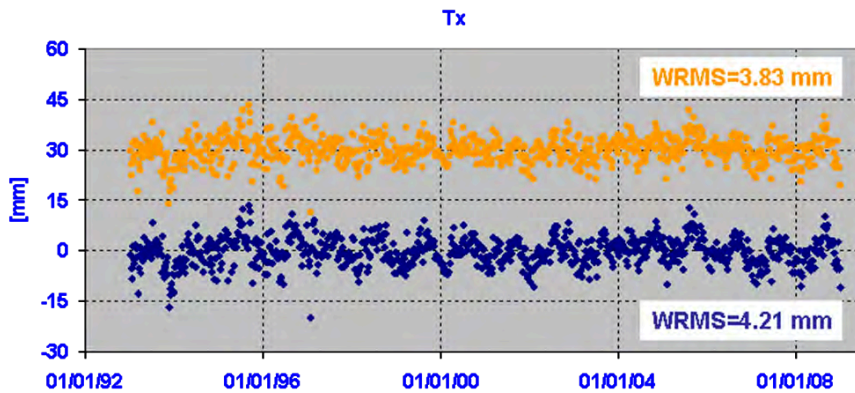
The residual WRMS of the series with maxima removed (IFT) are significantly lower (10-15%) than the correspondent values of the old series.

UT/CSR Release-04 Degree-2 Time Series

M.K. Cheng, J.C. Ries

Monthly degree-2 time series from 5 SLR satellites
using complete GRACE RL04 background model
(AOD1B, tides, pole tides, except NO rates for C20, C21, S21)

ftp://ftp.csr.utexas.edu/pub/slr/degree_2

C20

(Atmosphere-Ocean De-aliasing applied)
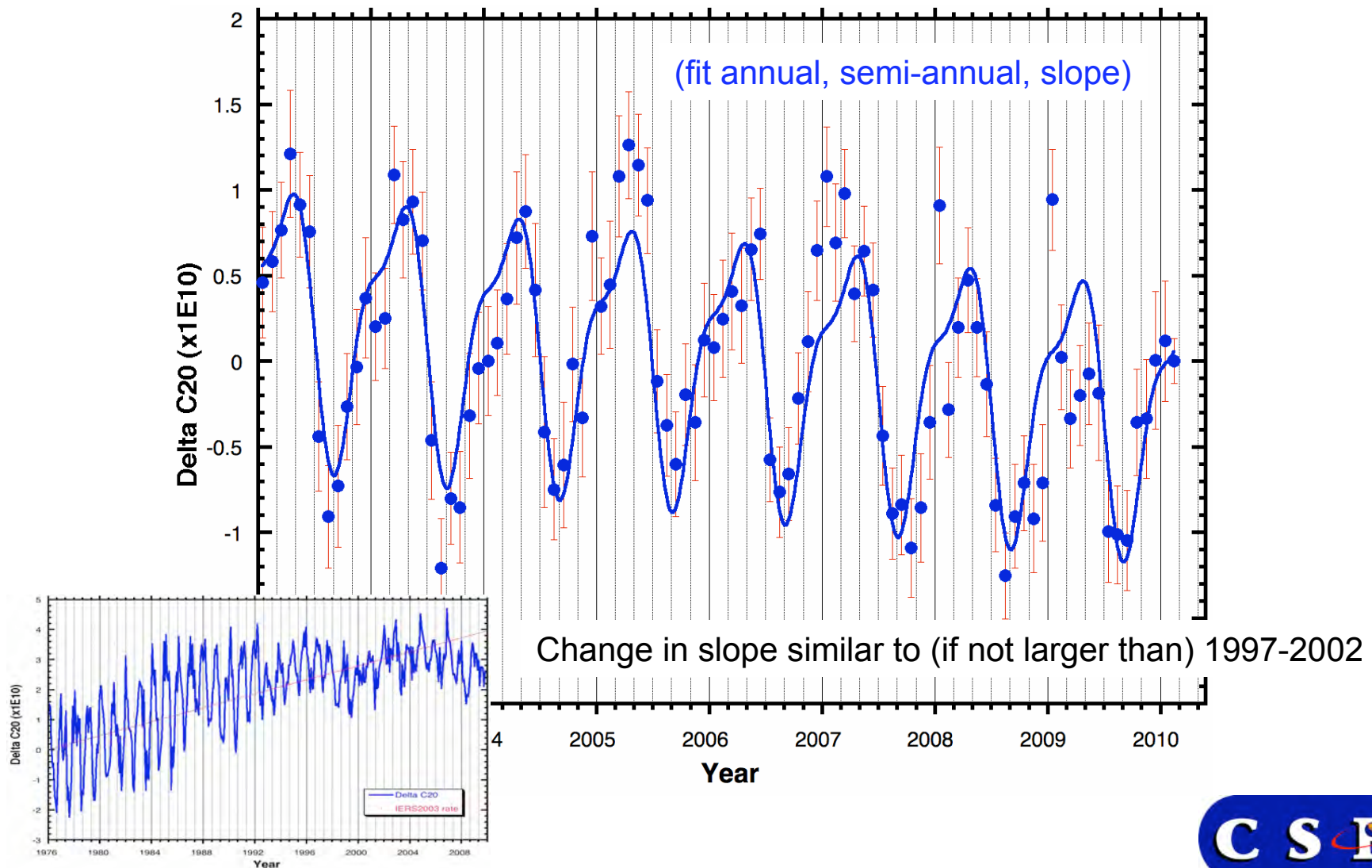
C21

(Atmosphere-Ocean De-aliasing applied)

Change in slope due to change in mean pole drift

(fit annual, quadratic)

C21 proportional to $-\overline{X}p$

S21

(Atmosphere-Ocean De-aliasing applied)

Change in slope due to change in mean pole drift

S21 proportional to $+\overline{Y}p$

(fit annual, quadratic)
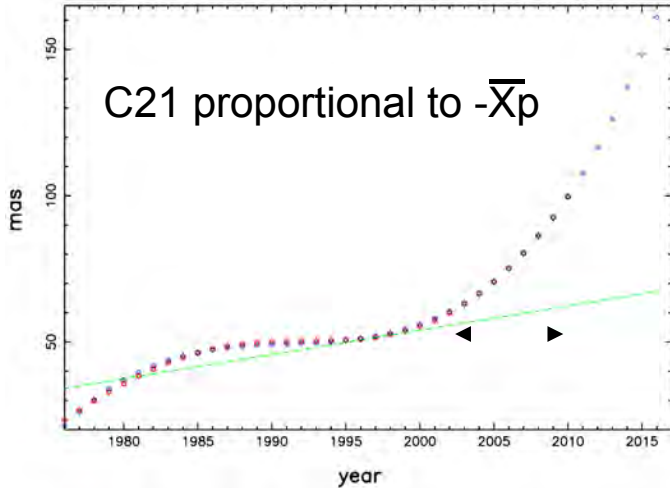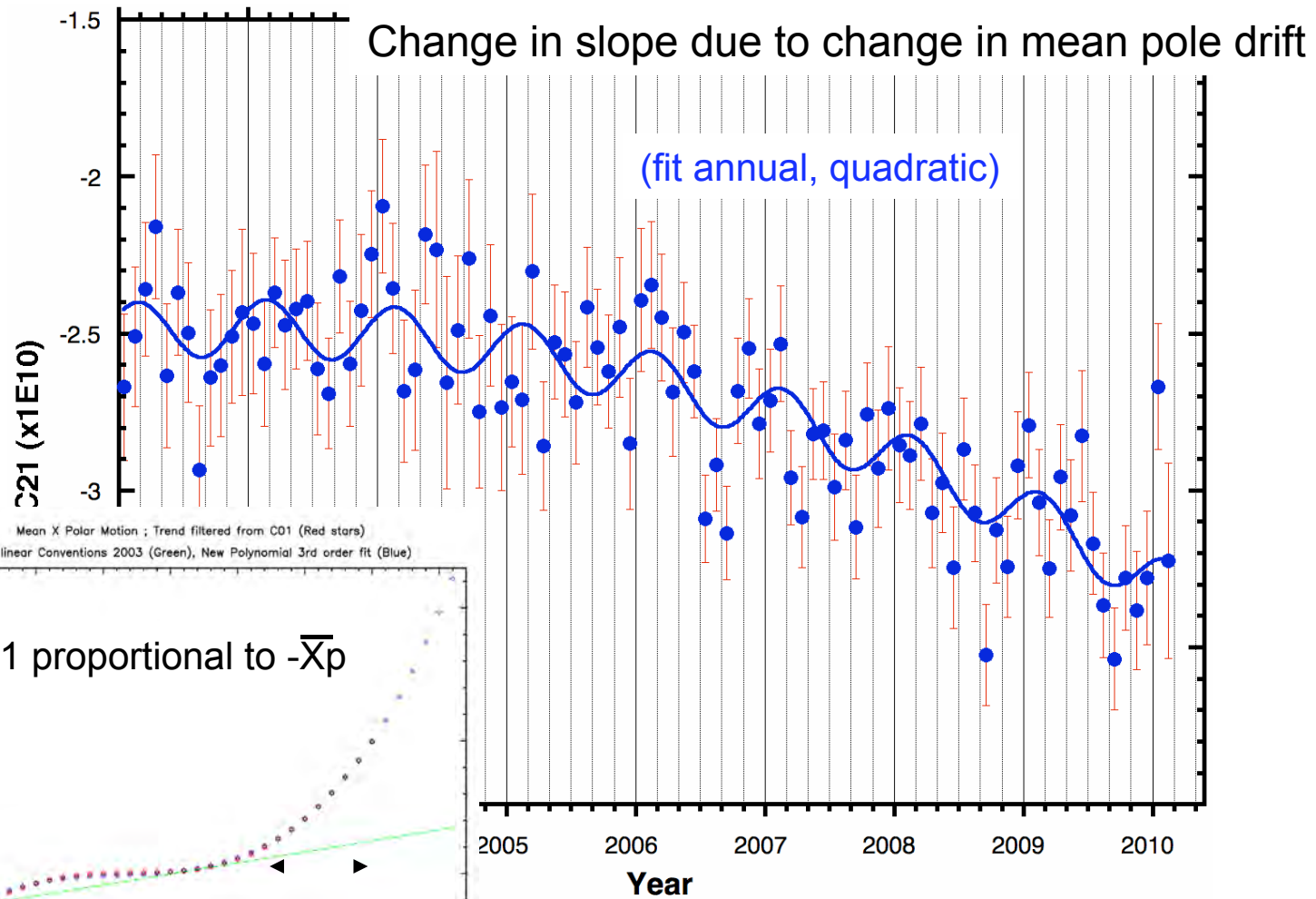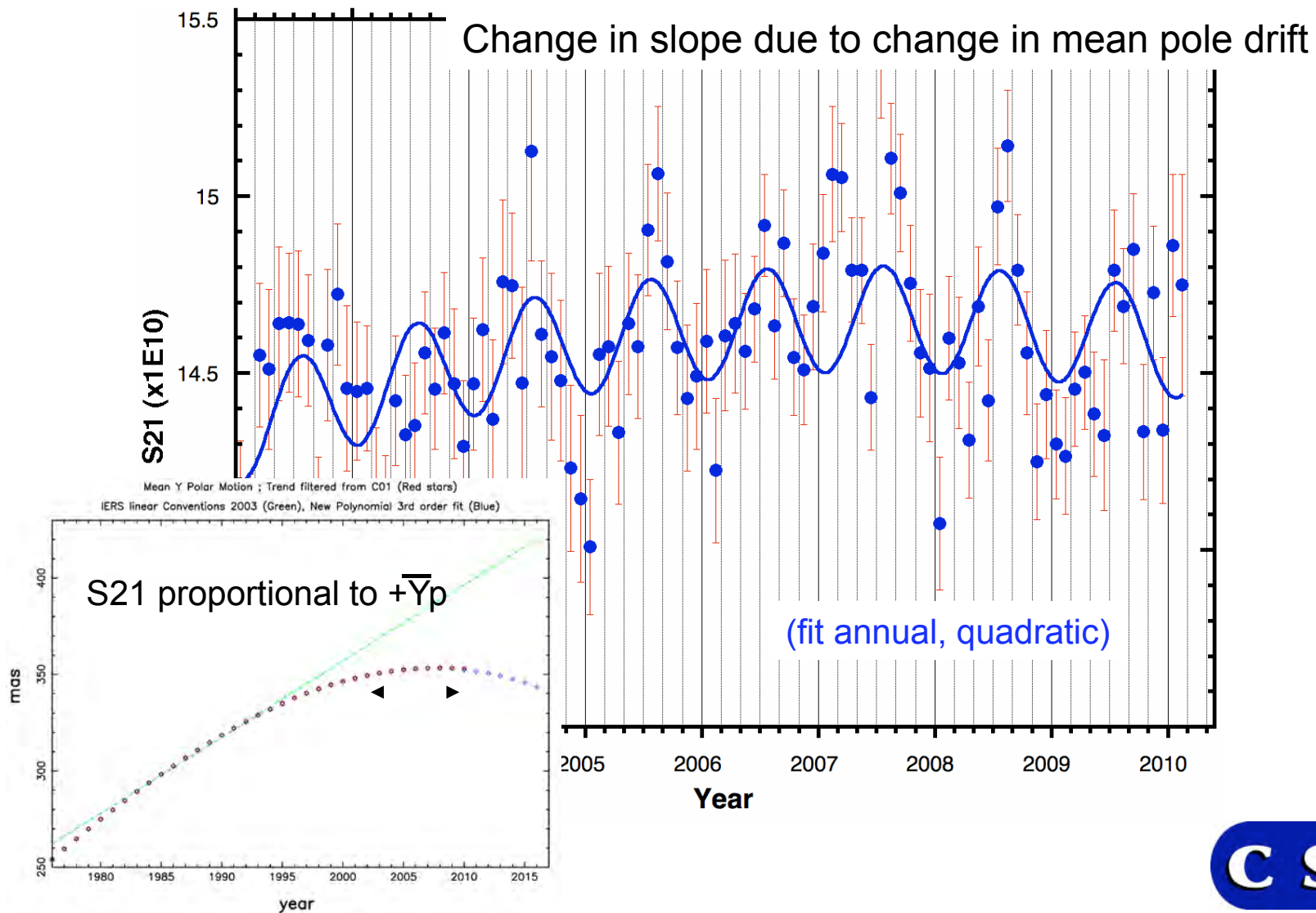
C22

(Atmosphere-Ocean De-aliasing applied)
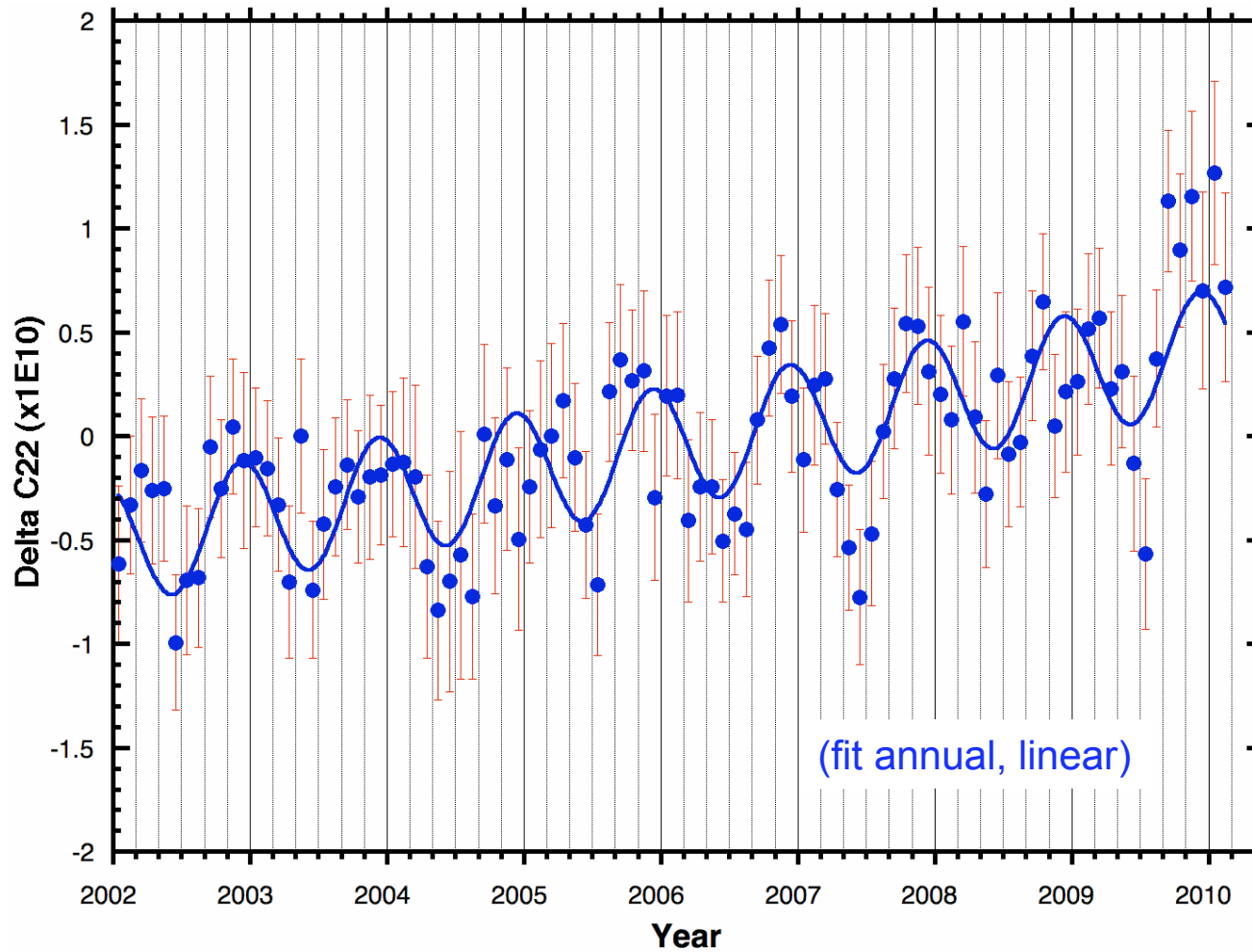
S22

(Atmosphere-Ocean De-aliasing applied)
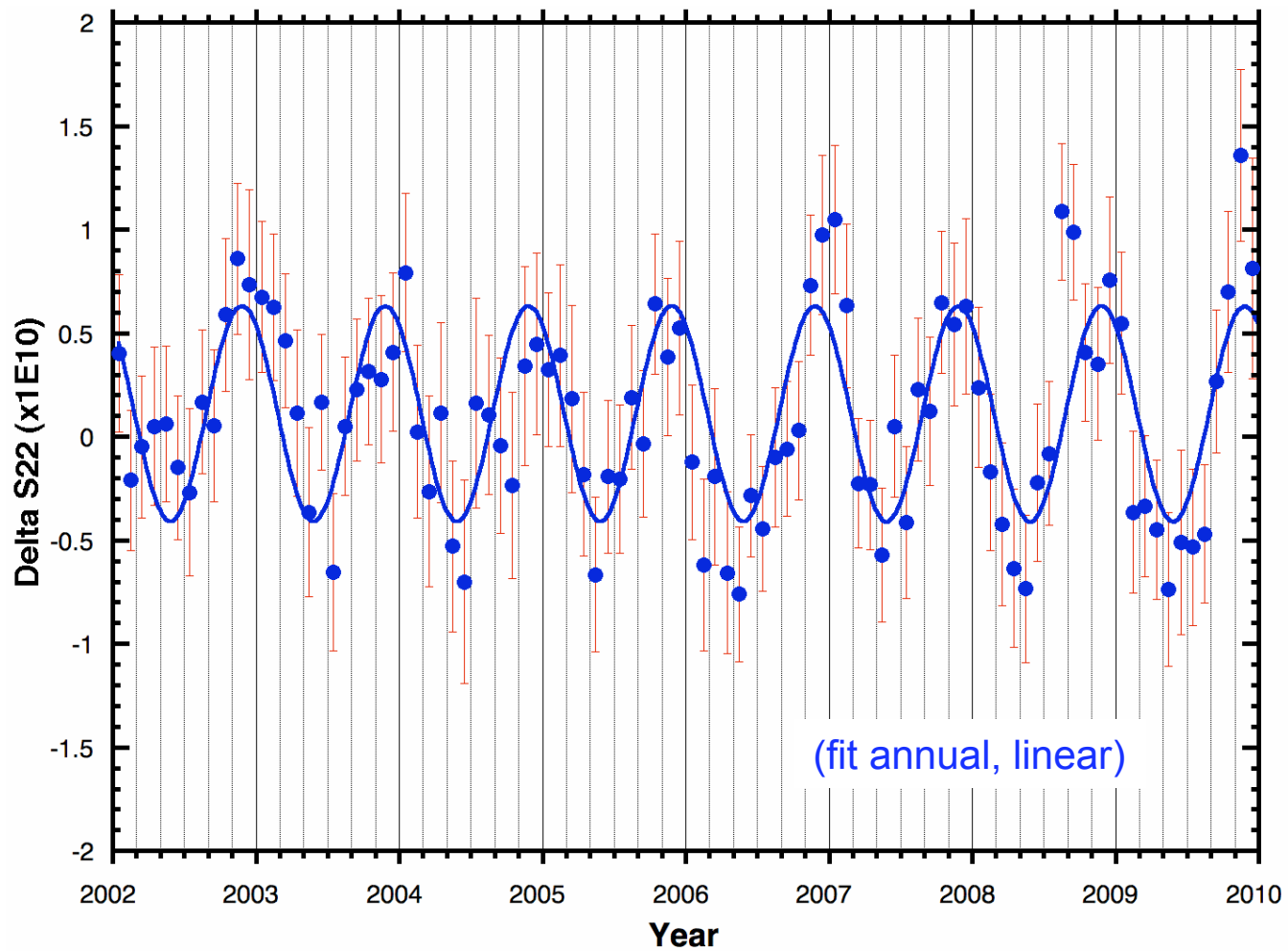
ITRF2005 vs ITRF2008p

-

comparisons through
LA1 & LA2 weekly orbital arcs

GRGS ILRS Analysis Center

April 2010

I. Orbital modelling

- Gravity field: EIGEN-GL04s_annual
- Pole: IERS C04
- Terrestrial frame :
  - So-called « ITRF2005 »: ITRF2005 SLR rescaled, eccentricities and data corrections provided by ILRS AWG
  - So-called « ITRF2008p »: ITRF2008p, eccentricities and data corrections provided by ILRS AWG (release april 2010), to ensure compatibilities with ITRF2008p
- Empirical parameters:
  - Radial : 0
  - Tangential:bias + 1/rev.
  - Normal : 1/rev
  - 1 SRP
- Range bias adjusted for 7 stations

Order of weekly residuals
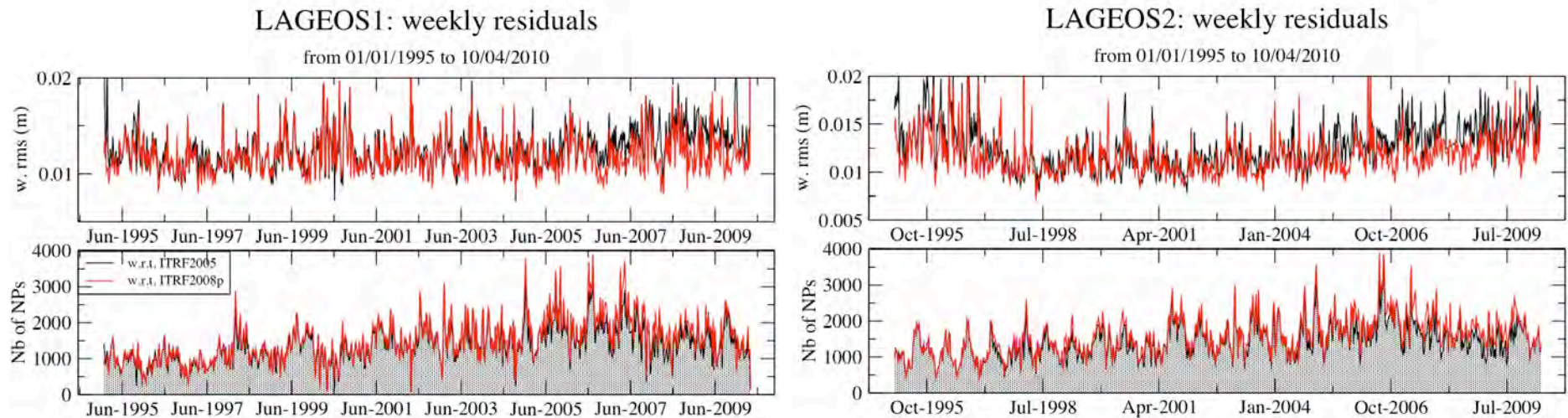
LAGEOS1: weekly residuals from 01/01/1995 to 10/04/2010

LAGEOS2: weekly residuals from 01/01/1995 to 10/04/2010

- Slight difference: 2007-2009
- LA1:
  – ITRF2005: mean 0.0127m, std. dev. 0.00247m
  – ITRF2008p: mean 0.0118m, std. Dev. 0.00202m
- LA2:
  – ITRF2005: mean 0.0126m, std. Dev. 0.00247m
  – ITRF2008p:mean 0.0117m; stf. Dev. 0.00216m

II. Overlap differences

- Two consecutive orbital arcs have two days in common
- Differences plotted in local frame RTN

Overlap differences:LA1, *RTN*

- Radial:
  - Mean: 0.000022m
  - Std. Dev.: 0.004954m
- Tangential:
  - Mean: 0.5 10-6m
  - Std. Dev.: 0.000609m
- Normal:
  - Mean: -0.0253m
  - Std. Dev.: 0.6530m
- Rms 3d: 0.05804m

- Radial:
  - Mean: 0.000023m
  - Std. Dev.: 0.004956m
- Tangential:
  - Mean: 0.8 10-6m
  - Std. Dev.: 0.000588m
- Normal:
  - Mean: -0.0254m
  - Std. Dev.: 0.6544m
- Rms 3d: 0.05699m

Overlap differences:LA2, *rtn*

- Radial:
  - Mean: 8.72 10-5
  - Std. Dev.: 0.00059m
- Tangential:
  - Mean: 0.88 10-5m
  - Std. Dev.: 0.00078m
- Normal:
  - Mean: 0.0018m
  - Std. Dev.: 0.02036m
- Rms 3d:

- Radial:
  - Mean: 0.874 10-7m
  - Std. Dev.: 0.0058m
- Tangential:
  - Mean: 0.6 10-5m
  - Std. Dev.: 0.000777m
- Normal:
  - Mean: -0.0011583m
  - Std. Dev.: 0.0198776m
- Rms 3d: 0.035m

III. Differences induced by the change of ITRF

- Differences must not be interpreted interms of change of ITRF
- Mean differences, in meter

- LA1, ITRF2005/ITRF2008p
  - Radial: $0.74874 \cdot 10^{-7}$
  - Tangential: $0.18593 \cdot 10^{-6}$
  - Normal: 0.00301926
  - a: 0.000106643
  - e: 0.000976438
  - i: 0.00519879
  - ω: 0.234001
  - Ω: 0.00810794
  - M   0.0149883
  - Rms 3d: 0.0107906

- LA2, ITRF2005/ITRF2008p
  - Radial: $0.47177 \cdot 10^{-6}$
  - Tangential: $0,16562 \cdot 10^{-6}$
  - Normal: 0.00575594
  - a: $0.23225 \cdot 10^{-5}$
  - e: 0.000834982
  - i: 0.00390287
  - ω: 0.05957
  - Ω: 0.00786668
  - M   0.0129344
  - Rms 3d: 0.00972865

LA1 orbit differences
w.r.t. ITRF2005 and ITRF2008p (unit: m)
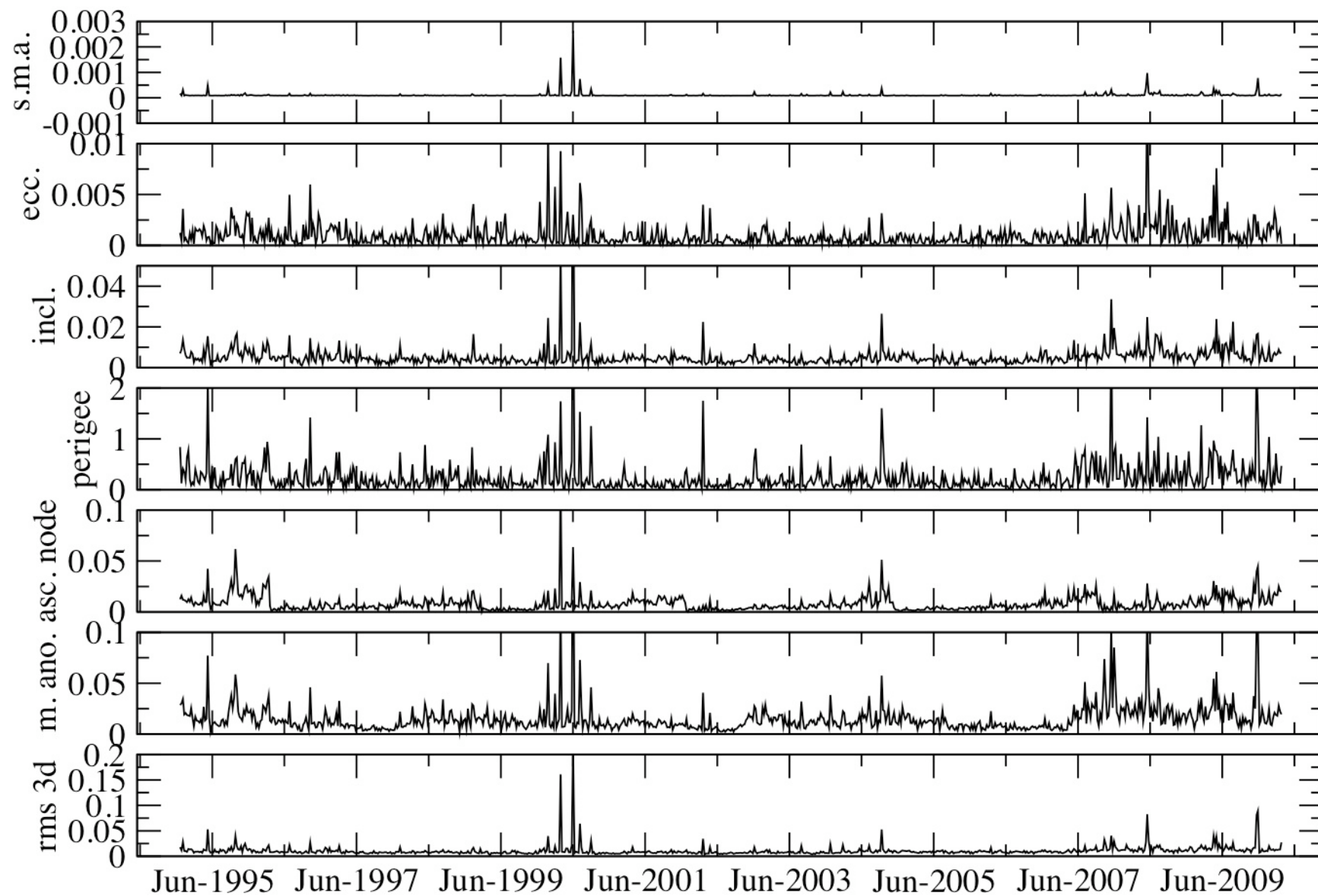
LAGEOS-1 weekly orbital arc differences
differences between ITRF2005 and ITRF2008p
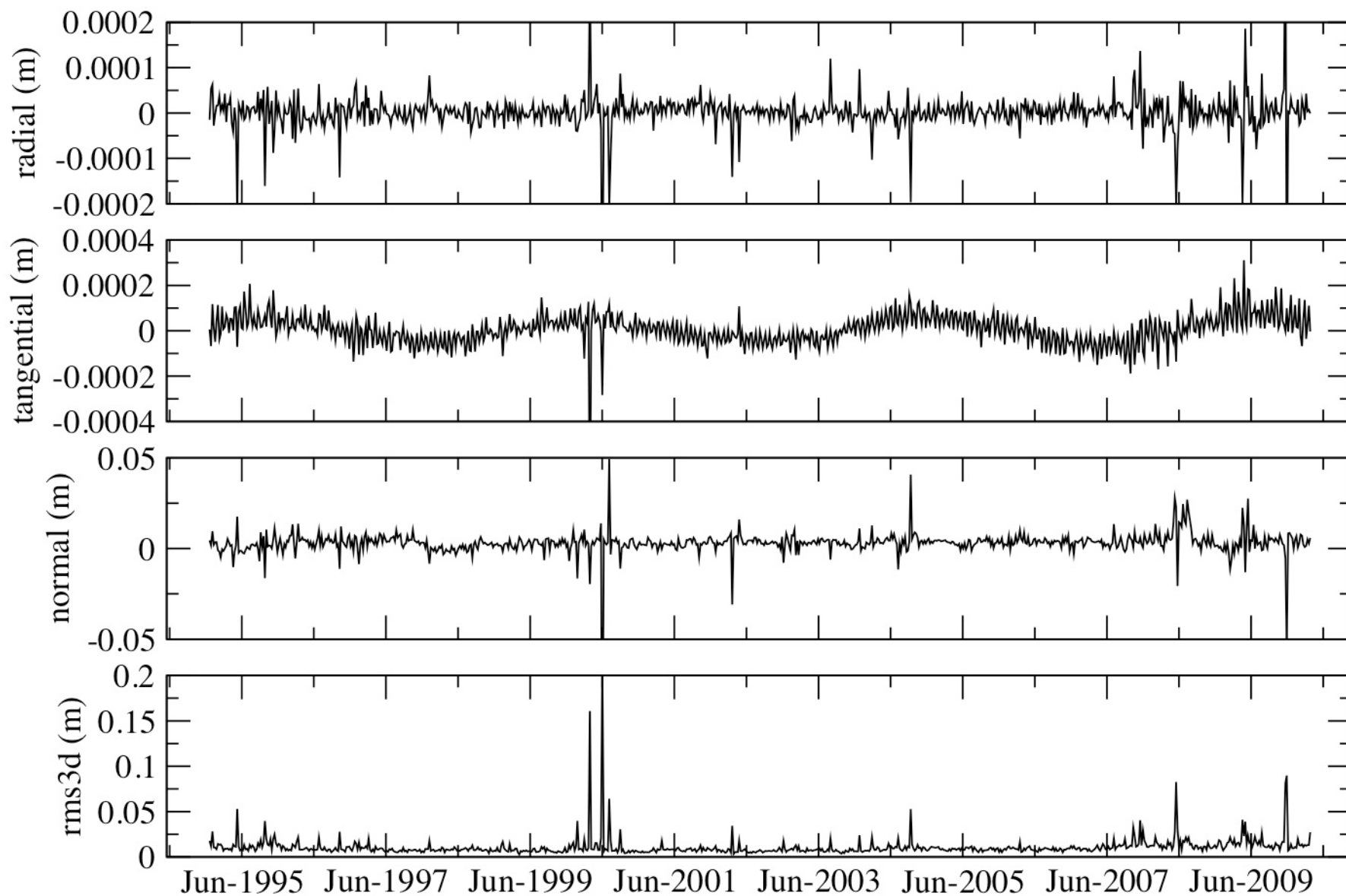
LA2 orbit differences
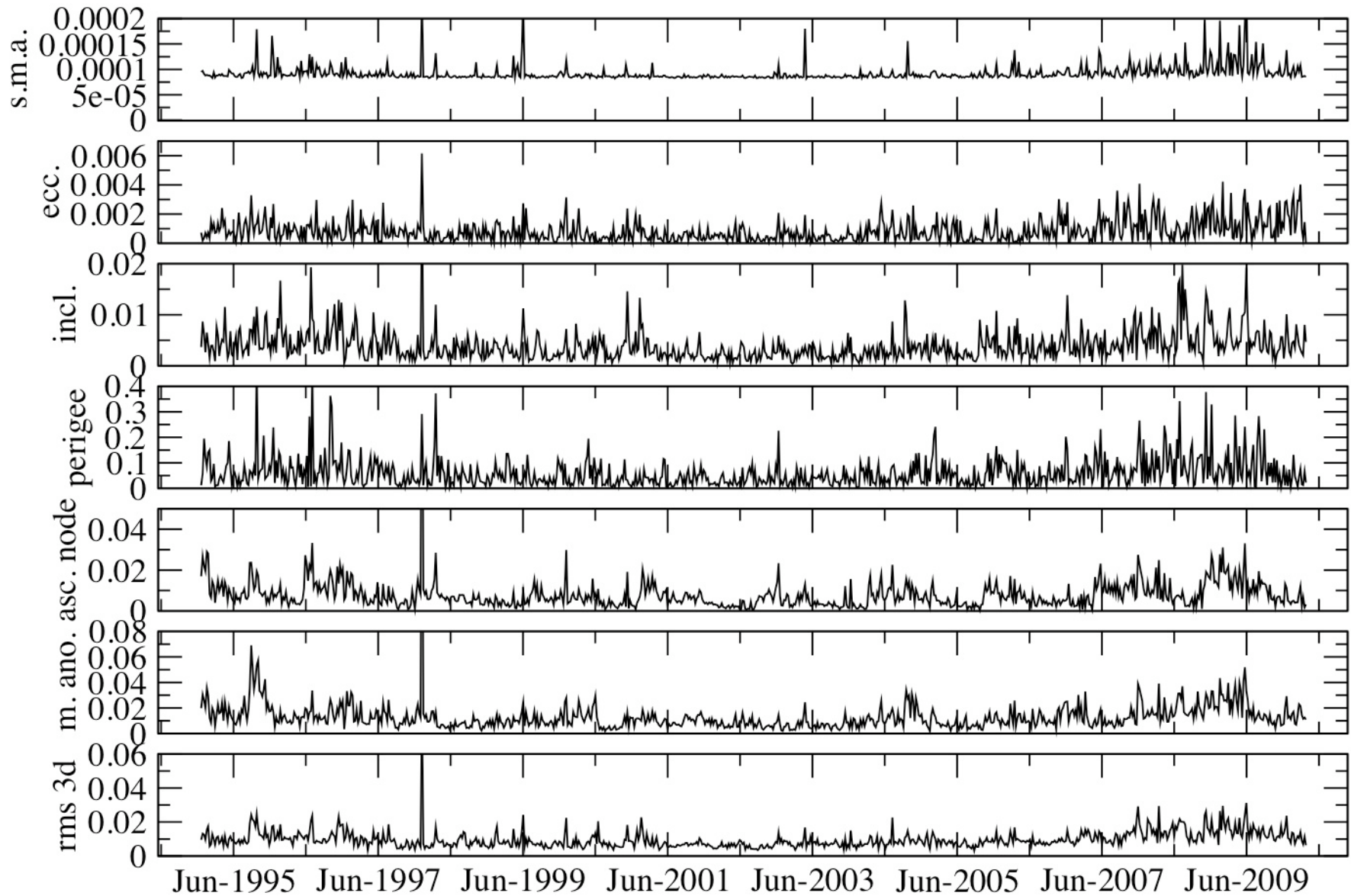
w.r.t. ITRF2005 and ITRF2008p (unit: m)

LAGEOS-2 weekly orbital arc differences

differences between ITRF2005 and ITRF2008p
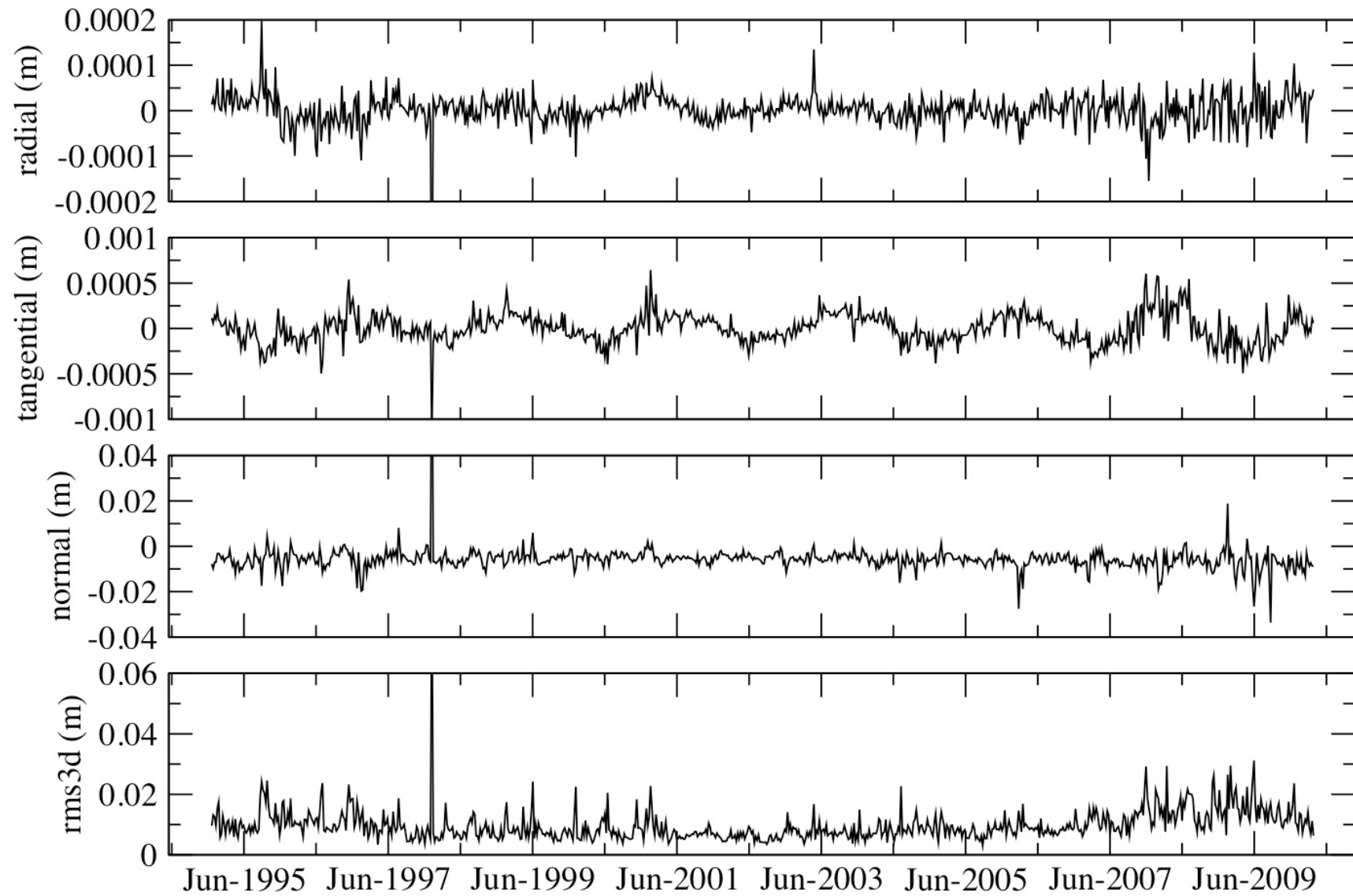
IV. Range differences example for two stations

LA1 range rate residuals for two stations
orbit computation with ITRF2005 or ITRF2008p
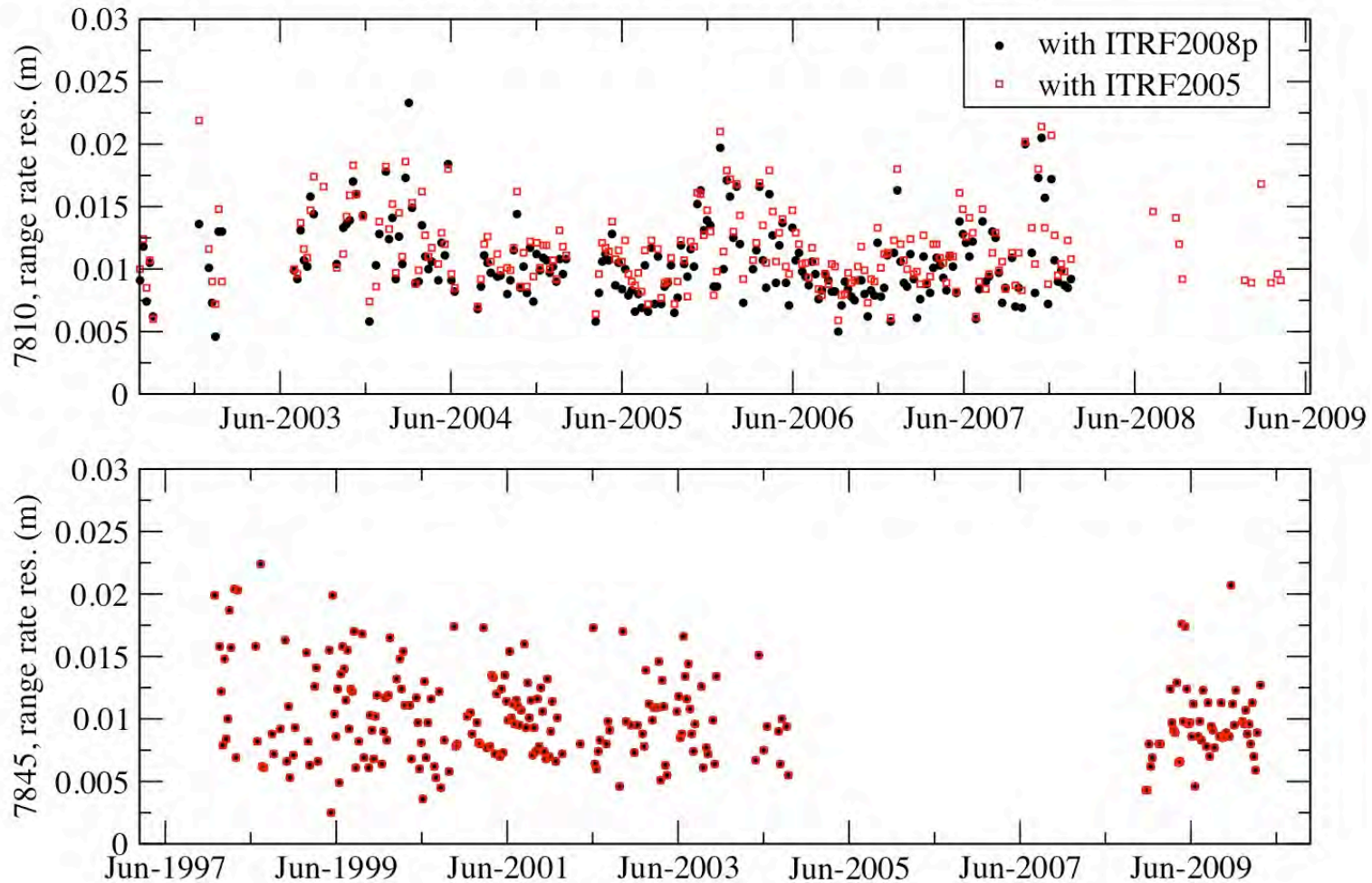
Conclusion for this part

- Very small differences for both LA1 LA2 satellites

- Similar analysis to be done for LEO ?

- Analysis to be continued in the second part: *Helmert parameters, station positions, Earth Orientation Parameters, and a priori residual time series*.

Helmert parameters, station positions,
Earth Orientation Parameters,
and a priori residual time series.

I - Analyses for the ILRS combined v24 solution over the time period 1993.0 - 2009.9

* Computation of transformations between ILRS solution and ITRF2005/ITRF2008P

* For each computation
    - Projection of the variance-covariance matrix
    - Raw residuals rejected at 10 cm and then normalized residuals at 4
    - For the statistics after transformation, all the position residuals are considered

Weekly Helmert transformations (1/5)

w.r.t. ITRF2005

Results for TX translation (mm)

Weighted mean = -0.83
Weighted standard deviation = 3.97
WRMS = 4.05

Results for TY translation (mm)

Weighted mean = -0.13
Weighted standard deviation = 3.76
WRMS = 3.76

Results for TZ translation (mm)

Weighted mean = 1.29
Weighted standard deviation = 7.35
WRMS = 7.46

Results for scale (ppb)

Weighted mean = -1.91
Weighted standard deviation = 0.69
WRMS = 2.03

w.r.t. ITRF2008P

Results for TX translation (mm)

Weighted mean = -0.05
Weighted standard deviation = 3.50
WRMS = 3.50

Results for TY translation (mm)

Weighted mean = 0.05
Weighted standard deviation = 3.35
WRMS = 3.35

Results for TZ translation (mm)

Weighted mean = 0.76
Weighted standard deviation = 7.03
WRMS = 7.07

Results for scale (ppb)

Weighted mean = -0.45
Weighted standard deviation = 0.42
WRMS = 0.62

Reduction of all biases and WRMS → better consistency with ITRF2008P

Daily polar motion series (2/5)

w.r.t. ITRF2005

Results for X_p (µas)

Weighted mean = 40
Weighted standard deviation = 228
WRMS = 232

Results for Y_p (µas)

Weighted mean = 43
Weighted standard deviation = 222
WRMS = 226

w.r.t. ITRF2008P

Results for X_p (µas)

Weighted mean = -2
Weighted standard deviation = 203
WRMS = 203

Results for Y_p (µas)

Weighted mean = -5
Weighted standard deviation = 204
WRMS = 204

Better stability of the series achieved with ITRF2008P

Weekly station position series WRMS (3/5)

w.r.t. ITRF2005
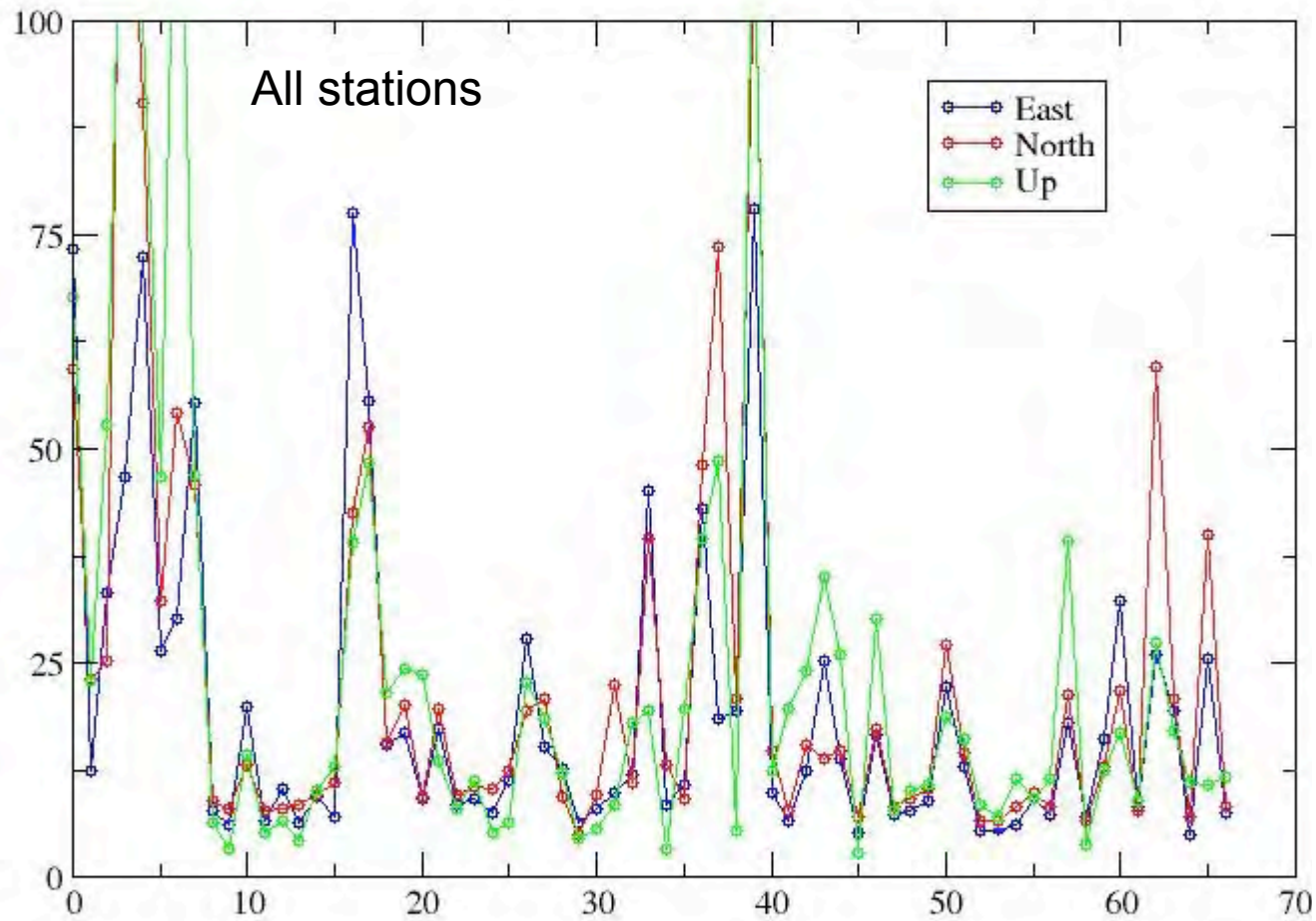
Median value for East component = 12.3 mm

Median value for North component = 13.2 mm

Median value for Up component   = 13.6 mm

Weekly station position series WRMS (4/5)

w.r.t. ITRF2008P

Median value for East component = 11.8 mm

Median value for North component = 11.4 mm

Median value for Up component   = 9.7 mm

Weekly station position series WRMS (5/5)

Comparison between ITRF2005 and ITRF2008P

All stations

East component
- Improvement for 73 % of the stations
- Median improvement = 0.7 mm

North component
- Improvement for 81 % of the stations
- Median improvement = 1.0 mm

Up component
- Improvement for 87 % of the stations
- Median improvement = 3.5 mm

20 core stations

East component
- Improvement for 90 % of the stations
- Median improvement = 0.6 mm

North component
- Improvement for 100 % of the stations
- Median improvement = 0.7 mm

Up component
- Improvement for 95 % of the stations
- Median improvement = 2.2 mm

Better stability of the series for the three components achieved with ITRF2008P

II - Analyses for the ILRS combined v24 solution over the time period 1982.9 - 1993.0

* Computation of transformations between ILRS solution and SLRF2005/ITRF2008P

* For each computation
- Projection of the variance-covariance matrix
- Raw residuals rejected at 10 cm and then normalized residuals at 4
- For the statistics after transformation, all the position residuals are considered

Helmert transformations (1/5)

w.r.t. SLRF2005

Results for TX translation (mm)

Weighted mean = 4.92
Weighted standard deviation = 8.65
WRMS = 9.95

Results for TY translation (mm)

Weighted mean = 0.31
Weighted standard deviation = 7.79
WRMS = 7.80

Results for TZ translation (mm)

Weighted mean = -14.55
Weighted standard deviation = 21.39
WRMS = 25.88

Results for scale (ppb)

Weighted mean = -0.15
Weighted standard deviation = 1.23
WRMS = 1.24

w.r.t. ITRF2008P

Results for TX translation (mm)

Weighted mean = 3.91
Weighted standard deviation = 6.75
WRMS = 7.81

Results for TY translation (mm)

Weighted mean = 2.36
Weighted standard deviation = 6.66
WRMS = 7.07

Results for TZ translation (mm)

Weighted mean = -4.55
Weighted standard deviation = 19.95
WRMS = 20.47

Results for scale (ppb)

Weighted mean = 0.17
Weighted standard deviation = 1.15
WRMS = 1.16

Better WRMS and reduction of the TZ bias with ITRF2008P

Polar motion series (2/5)

w.r.t. SLRF2005

Results for Xp (µas)

Weighted mean = 348
Weighted standard deviation = 700
WRMS = 782

Results for Yp (µas)

Weighted mean = 84
Weighted standard deviation = 738
WRMS = 743

w.r.t. ITRF2008P

Results for Xp (µas)

Weighted mean = 325
Weighted standard deviation = 683
WRMS = 756

Results for Yp (µas)

Weighted mean = -209
Weighted standard deviation = 692
WRMS = 723

Better stability of the series achieved with ITRF2008P in spite of the larger bias for Yp

Station position series WRMS (3/5)

w.r.t. SLRF2005
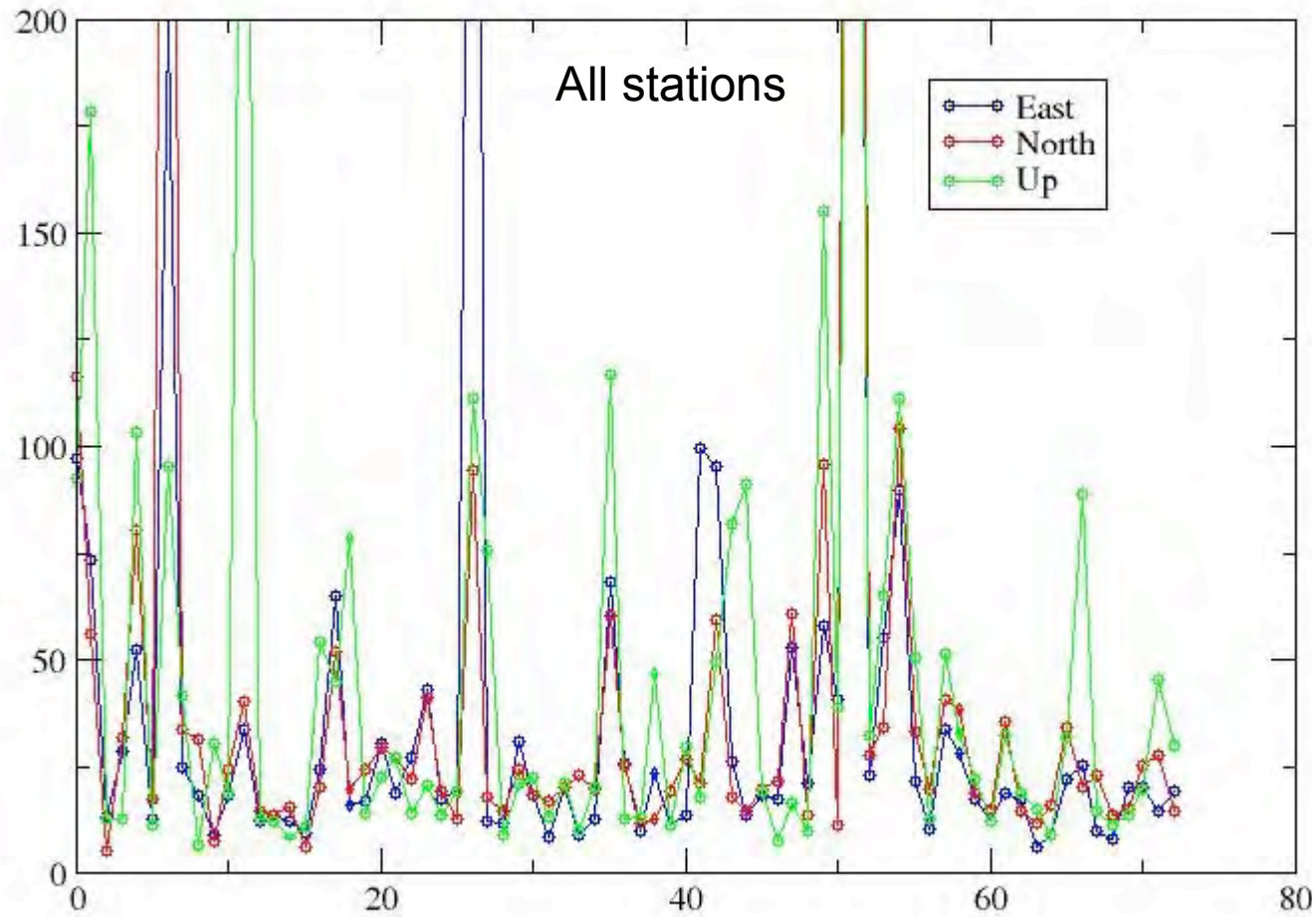
Median value for East component = 19.5 mm

Median value for North component = 21.3 mm

Median value for Up component   = 21.3 mm

Station position series WRMS (4/5)

w.r.t. ITRF2008P

Median value for East component = 15.7 mm

Median value for North component = 20.4 mm

Median value for Up component   = 15.7 mm

Station position series WRMS (5/5)

Comparison between SLRF2005 and ITRF2008P

All stations

East component
- Improvement for 72 % of the stations
- Median improvement = 3.7 mm

North component
- Improvement for 69 % of the stations
- Median improvement = 2.8 mm

Up component
- Improvement for 82 % of the stations
- Median improvement = 5.7 mm

13 core stations

East component
- Improvement for 85 % of the stations
- Median improvement = 1.1 mm

North component
- Improvement for 85 % of the stations
- Median improvement = 1.5 mm

Up component
- Improvement for 92 % of the stations
- Median improvement = 1.1 mm

Better stability of the series for the three components achieved with ITRF2008P

III - Computations with the MATLO software
over the time period 1995.0 - 2010.3

* MATLO software computes the SLR a priori residuals (Observed minus Computed)

* Two computations are carried out :
    - LAGEOS orbits computed with SLRF2005 and SLRF2005 as a priori TRF
    - LAGEOS orbits computed with ITRF2008P and ITRF2008P as a priori TRF

* The first solution is called 'GRGS V05' and the second one 'GRGS V08'

* For both computations, only the TRF changes. All the models, the EOP a priori series, the measurement corrections (range biases, etc.) and the eccentricities are the same

A priori residual RMS values per satellite (1/3)

GRGS V05 solution
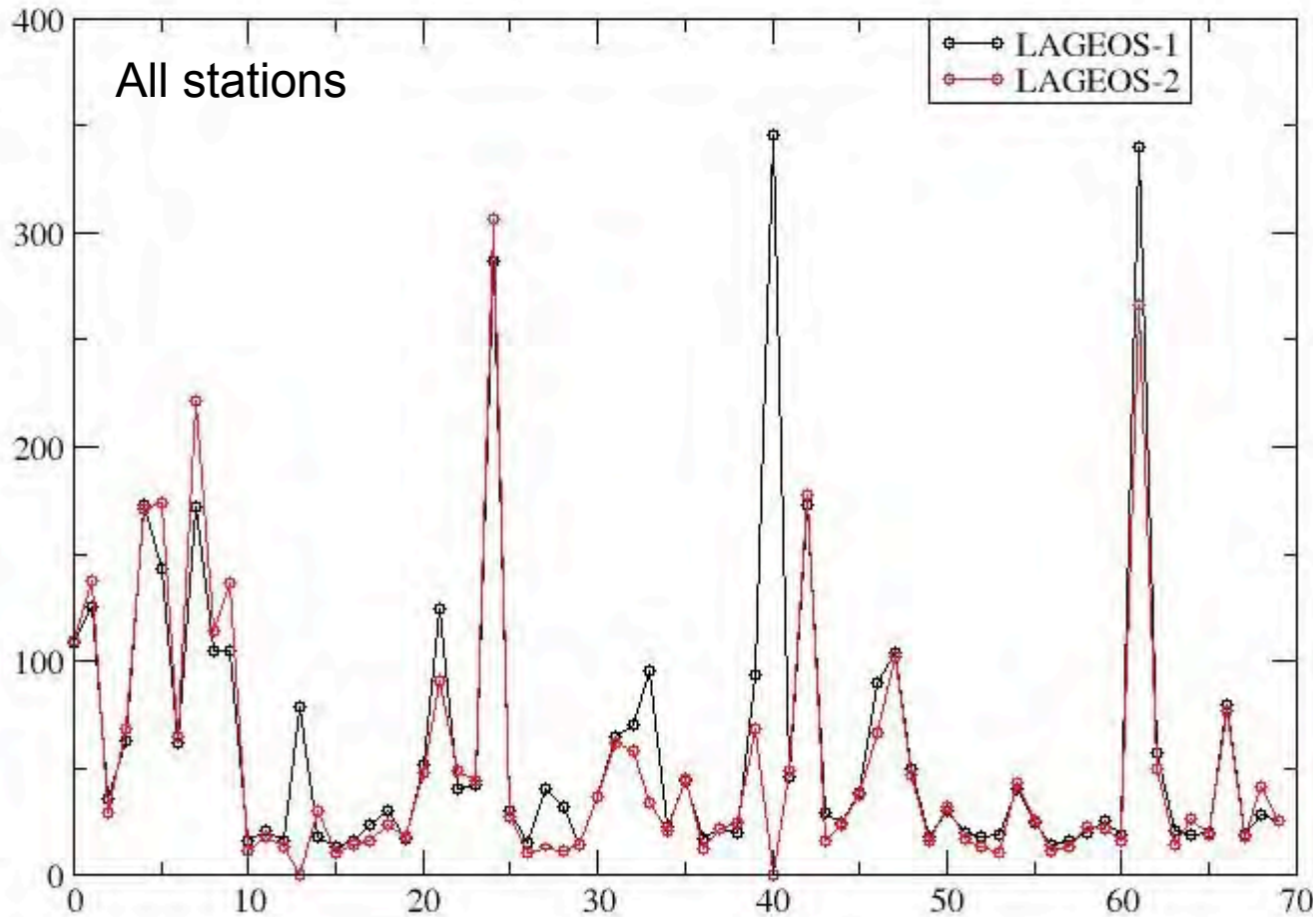
All stations

Median value for LAGEOS-1 = 30.2 mm

Median value for LAGEOS-2 = 27.2 mm

20 core stations

Median value for LAGEOS-1 = 17.8 mm

Median value for LAGEOS-2 = 15.7 mm

A priori residual RMS values per satellite (2/3)

GRGS V08 solution
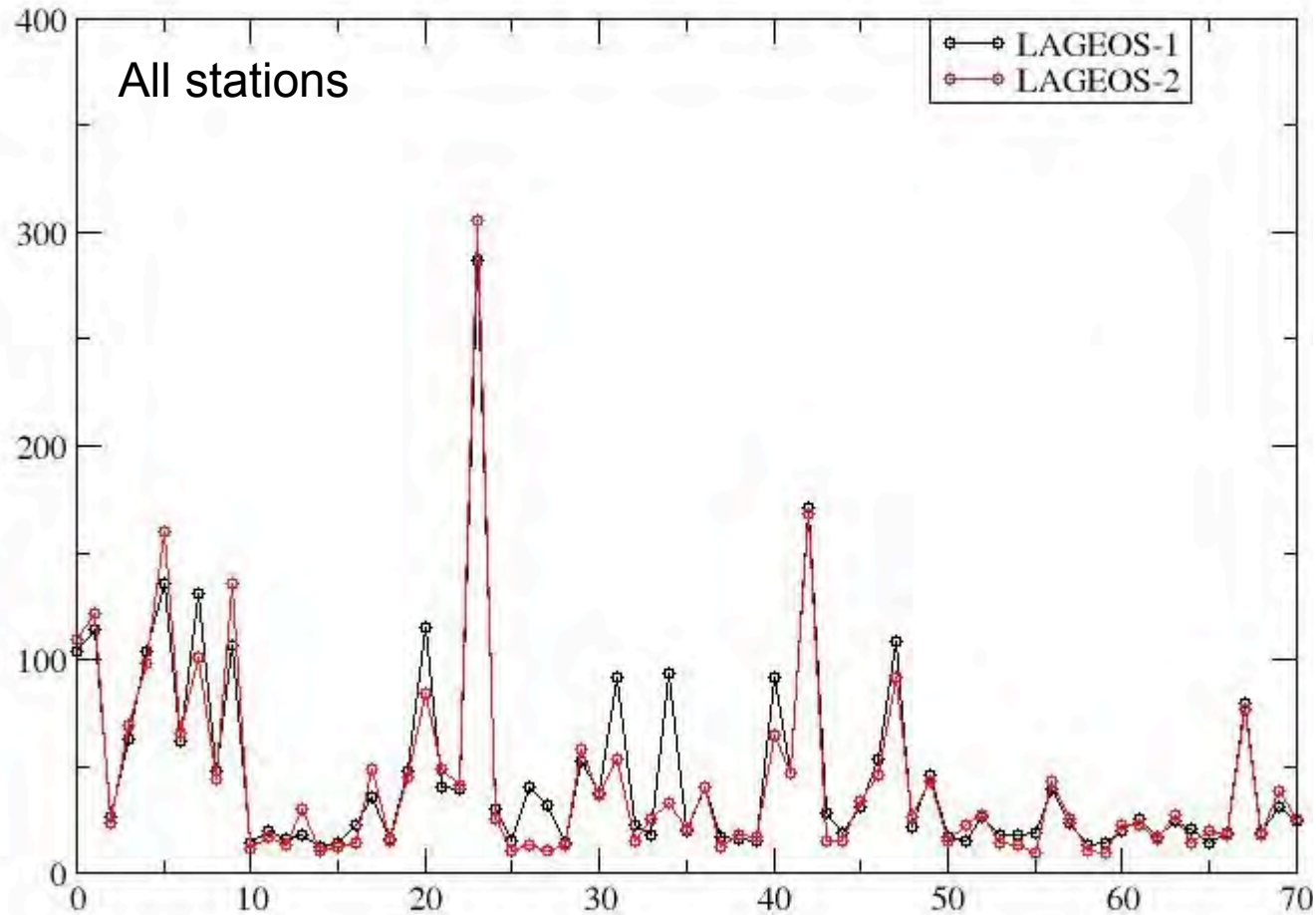
All stations

20 core stations

Median value for LAGEOS-1 = 25.0 mm

Median value for LAGEOS-2 = 25.4 mm

Median value for LAGEOS-1 = 17.7 mm

Median value for LAGEOS-2 = 14.4 mm

A priori residual RMS values per satellite (3/3)

Comparison between the GRGS V05 and V08 solutions

All stations

For LAGEOS-1
- Improvement for 82 % of the stations
- Median improvement = 1.5 mm

For LAGEOS-2
- Improvement for 87 % of the stations
- Median improvement = 2.0 mm

20 core stations

For LAGEOS-1
- Improvement for 75 % of the stations
- Median improvement = 0.6 mm
- Improvement of 5.7 mm for 7810
- Improvement of 53.1 mm for 7403

For LAGEOS-2
- Improvement for 85 % of the stations
- Median improvement = 0.5 mm
- Improvement of 7.8 mm for 7810
- Improvement of 32.4 mm for 7403

Improvement of a priori residuals for the great majority of the stations

ITRF2005 vs ITRF2008p

-

comparisons through LA1 & LA2 weekly orbital arcs

GRGS ILRS Analysis Center

April 2010

I. Orbital modelling

- Gravity field: EIGEN-GL04s_annual
- Pole: IERS C04
- Terrestrial frame :
  - ITRF2005 »: ITRF2005 SLR (rescaled) or ITRF2008p
  - eccentricities and data corrections provided by ILRS AWG (release april 2010)
- Empirical parameters:
  - Radial : 0
  - Tangential:bias + 1/rev.
  - Normal : 1/rev
  - 1 SRP

Order of weekly residuals
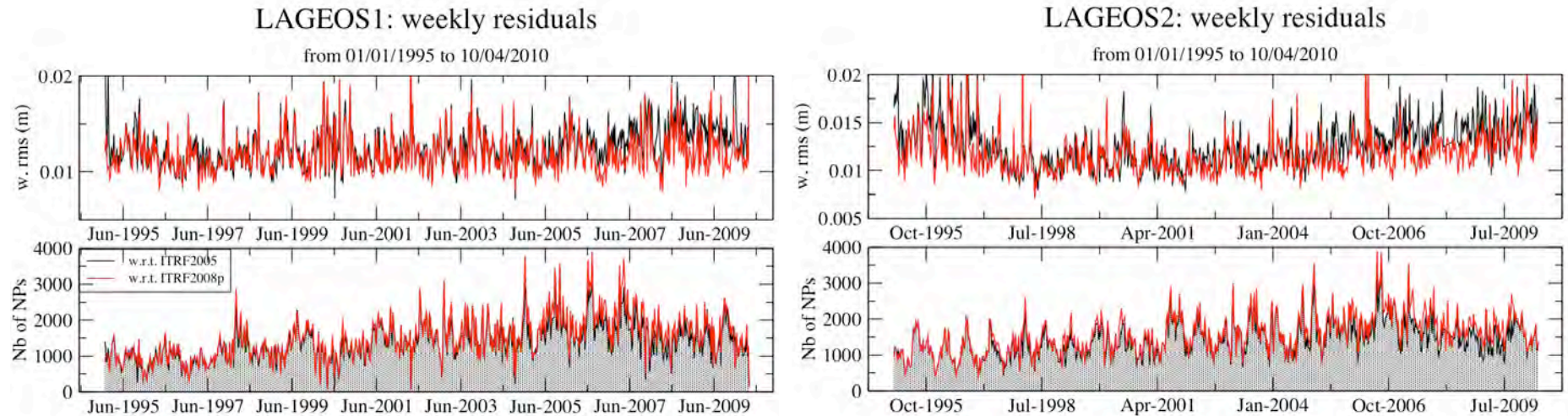
- Slight difference: 2007-2009
- LA1:
  - ITRF2005: mean 0.0127m, std. dev. 0.00247m
  - ITRF2008p: mean 0.0118m, std. Dev. 0.00202m
- LA2:
  - ITRF2005: mean 0.0126m, std. Dev. 0.00247m
  - ITRF2008p:mean 0.0117m; stf. Dev. 0.00216m

LAGEOS-1 weekly orbital arc differences

differences between ITRF2005 and ITRF2008p
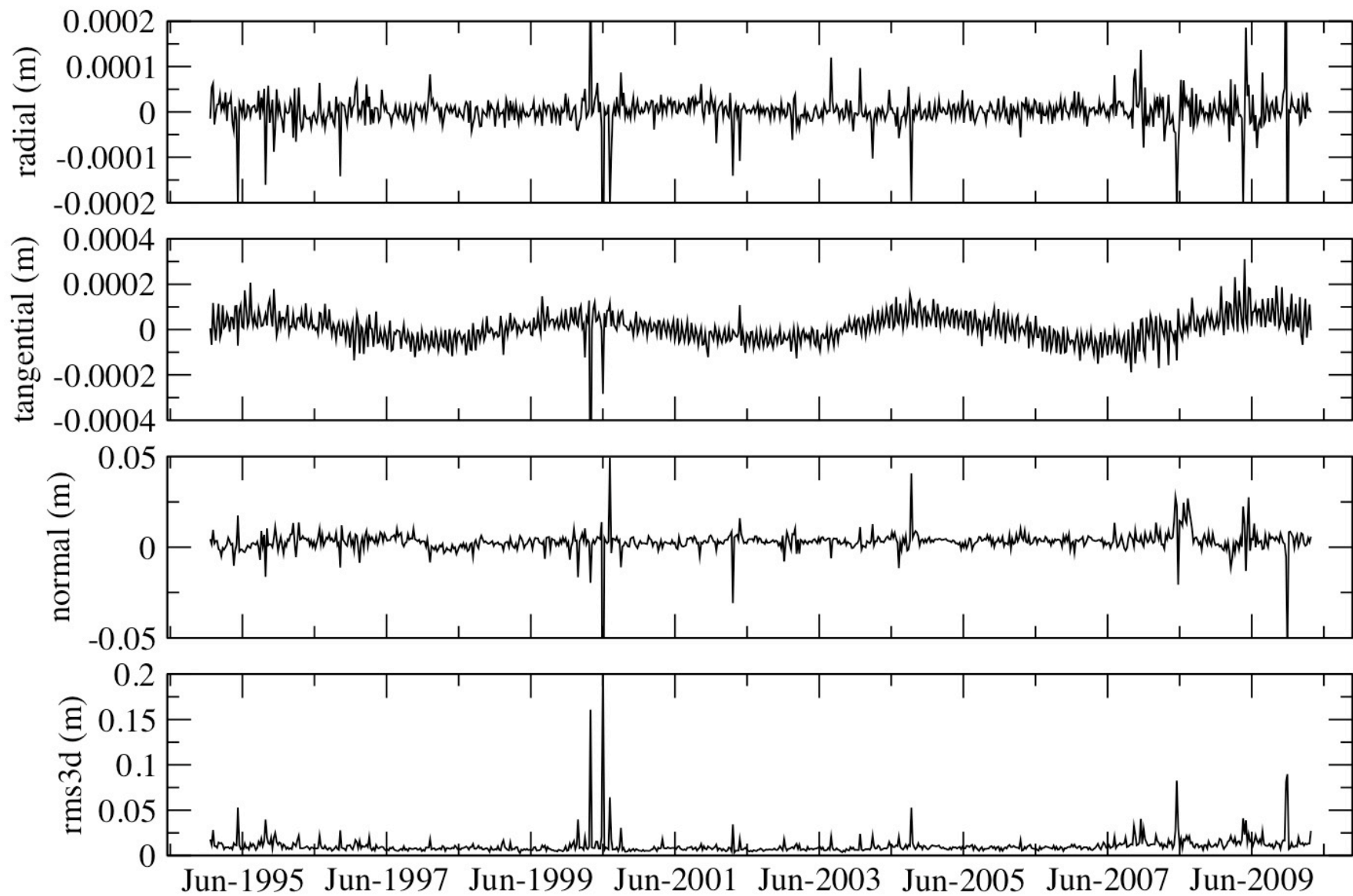
LA1 orbit differences
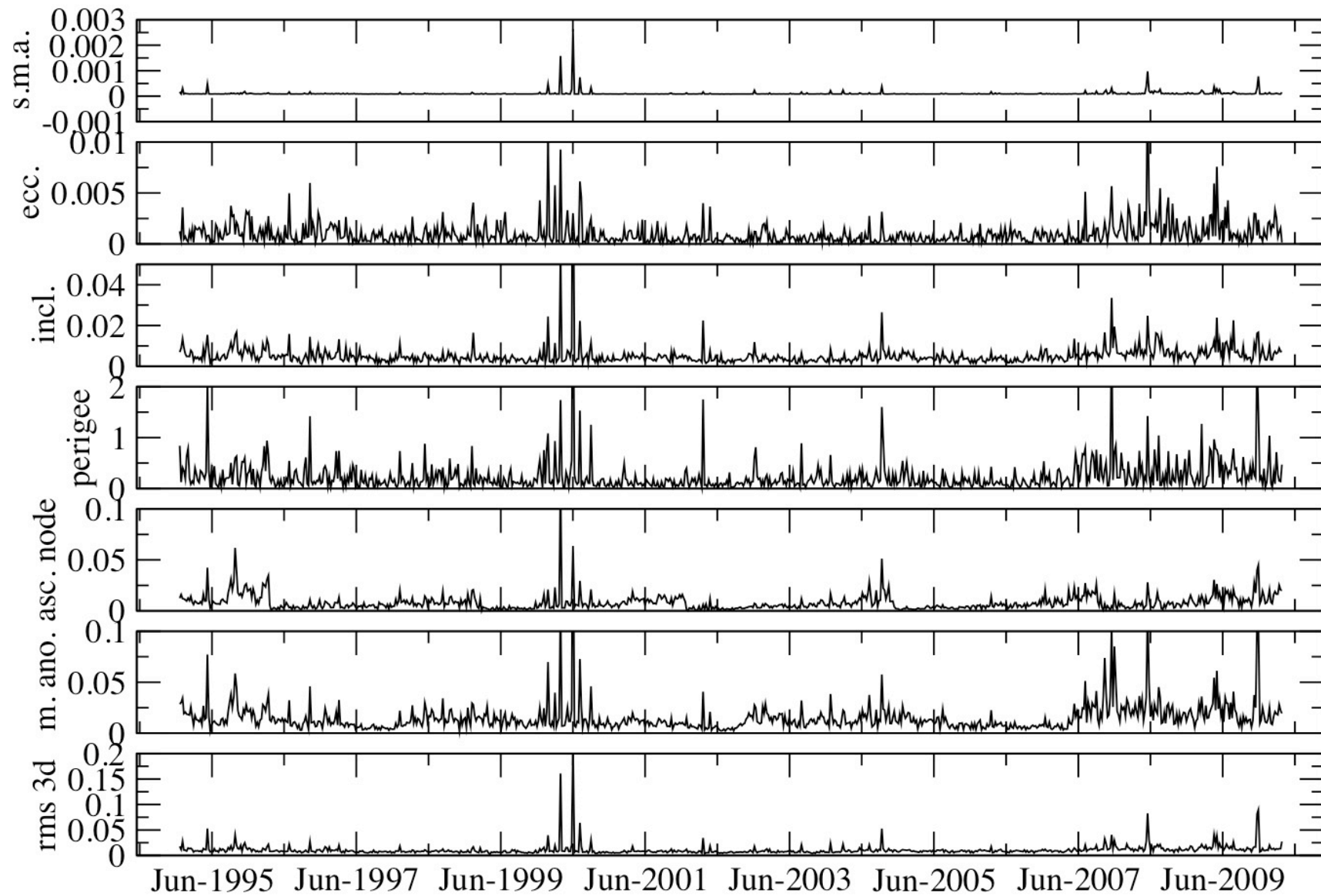
## w.r.t. ITRF2005 and ITRF2008p (unit: m)

LA2 orbit differences
w.r.t. ITRF2005 and ITRF2008p (unit: m)
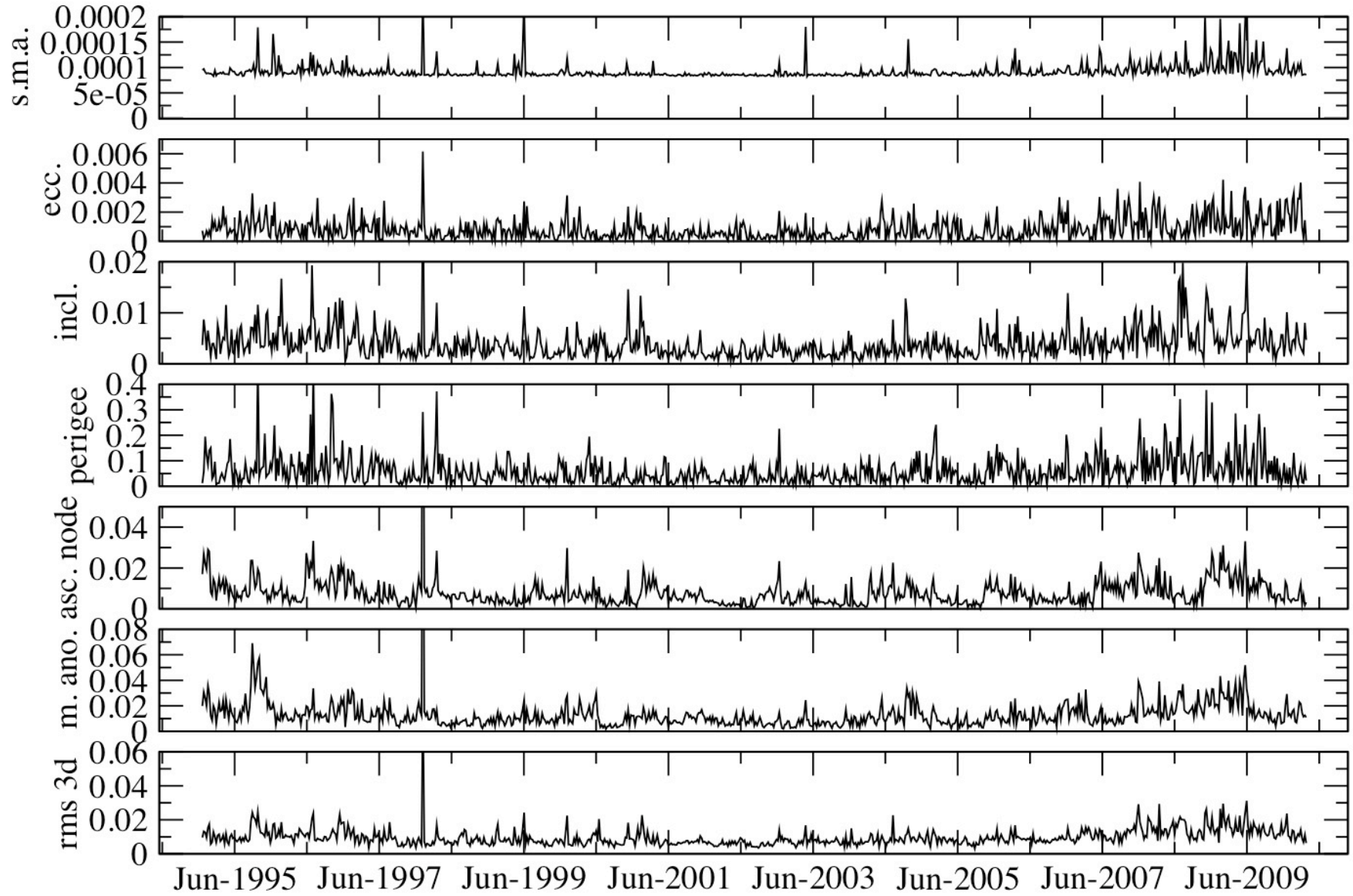
LAGEOS-2 weekly orbital arc differences

differences between ITRF2005 and ITRF2008p
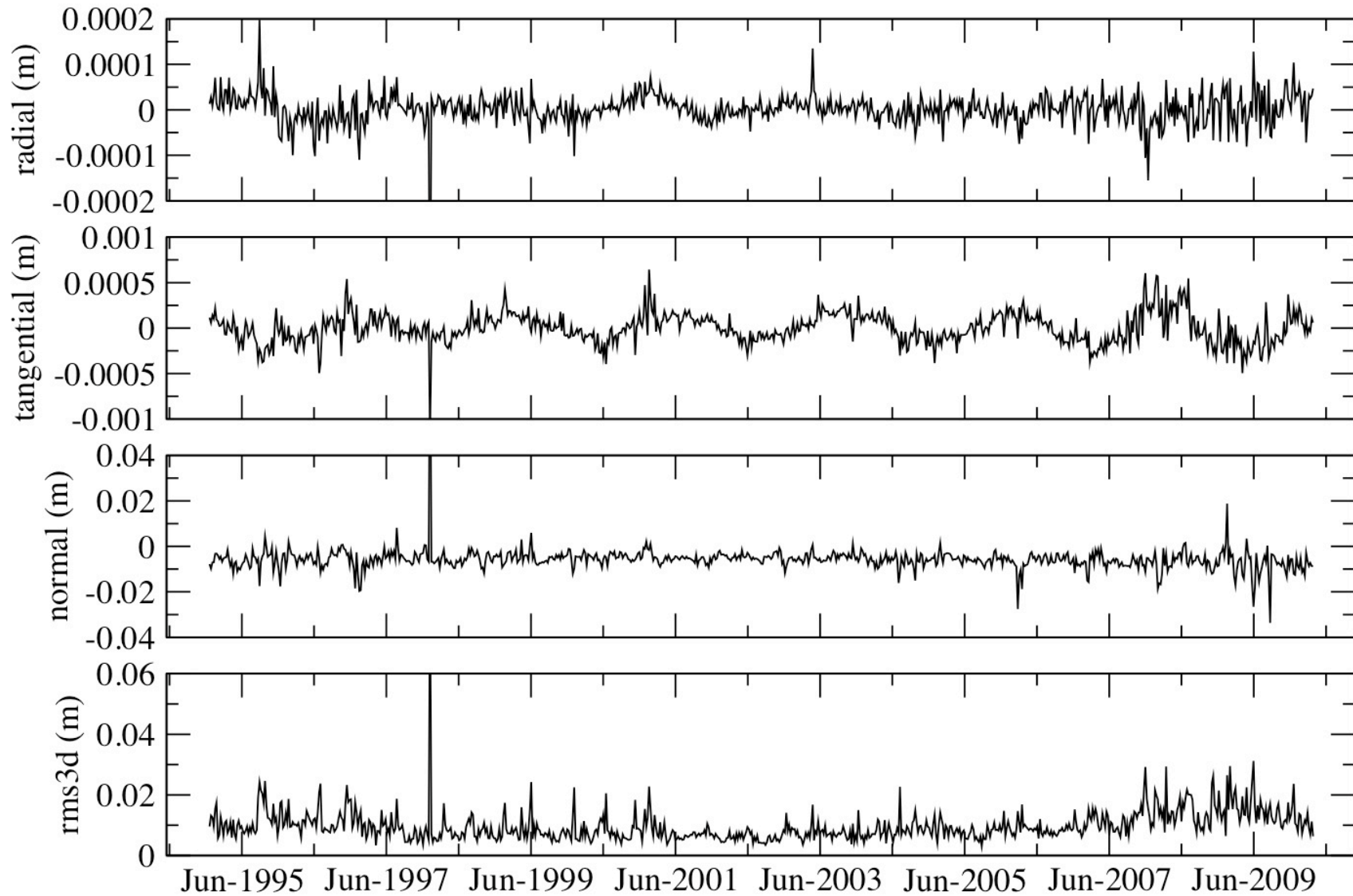
IV. Range differences example for two stations

LA1 range rate residuals for two stations
orbit computation with ITRF2005 or ITRF2008p

I - Analyses for the ILRS combined v24 solution over the time period 1993.0 - 2009.9

* Computation of transformations between ILRS solution and ITRF2005/ITRF2008P

* For each computation
  - Projection of the variance-covariance matrix
  - Raw residuals rejected at 10 cm and then normalized residuals at 4
  - For the statistics after transformation, all the position residuals are considered

Weekly Helmert transformations (1/5)

w.r.t. ITRF2005

Results for TX translation (mm)

Weighted mean = -0.83
Weighted standard deviation = 3.97
WRMS = 4.05

Results for TY translation (mm)

Weighted mean = -0.13
Weighted standard deviation = 3.76
WRMS = 3.76

Results for TZ translation (mm)

Weighted mean = 1.29
Weighted standard deviation = 7.35
WRMS = 7.46

Results for scale (ppb)

Weighted mean = -1.91
Weighted standard deviation = 0.69
WRMS = 2.03

w.r.t. ITRF2008P

Results for TX translation (mm)

Weighted mean = -0.05
Weighted standard deviation = 3.50
WRMS = 3.50

Results for TY translation (mm)

Weighted mean = 0.05
Weighted standard deviation = 3.35
WRMS = 3.35

Results for TZ translation (mm)

Weighted mean = 0.76
Weighted standard deviation = 7.03
WRMS = 7.07

Results for scale (ppb)

Weighted mean = -0.45
Weighted standard deviation = 0.42
WRMS = 0.62

Reduction of all biases and WRMS → better consistency with ITRF2008P

Daily polar motion series (2/5)

w.r.t. ITRF2005

Results for X_p (µas)

Weighted mean = 40
Weighted standard deviation = 228
WRMS = 232

Results for Y_p (µas)

Weighted mean = 43
Weighted standard deviation = 222
WRMS = 226

w.r.t. ITRF2008P

Results for X_p (µas)

Weighted mean = -2
Weighted standard deviation = 203
WRMS = 203

Results for Y_p (µas)

Weighted mean = -5
Weighted standard deviation = 204
WRMS = 204

Better stability of the series achieved with ITRF2008P

SSC

w.r.t. SLRF2005
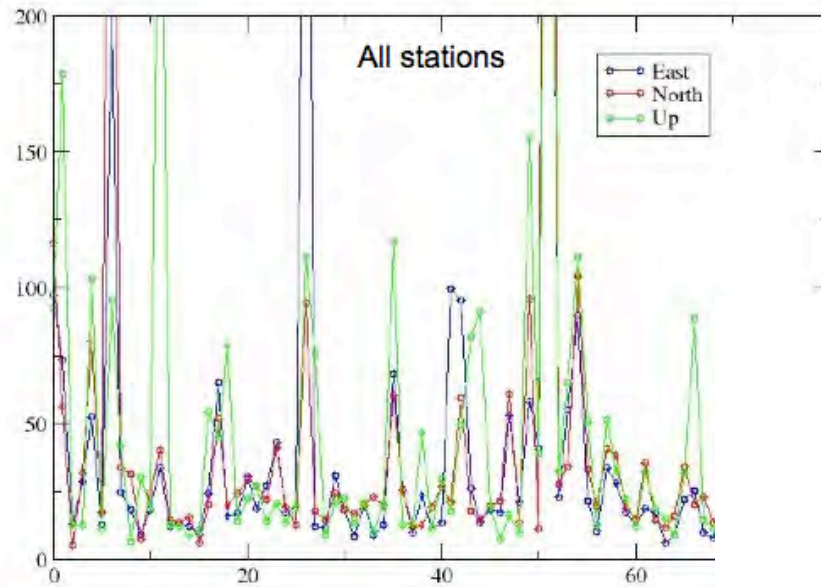
All stations

Median value for East component = 19.5 mm
Median value for North component = 21.3 mm
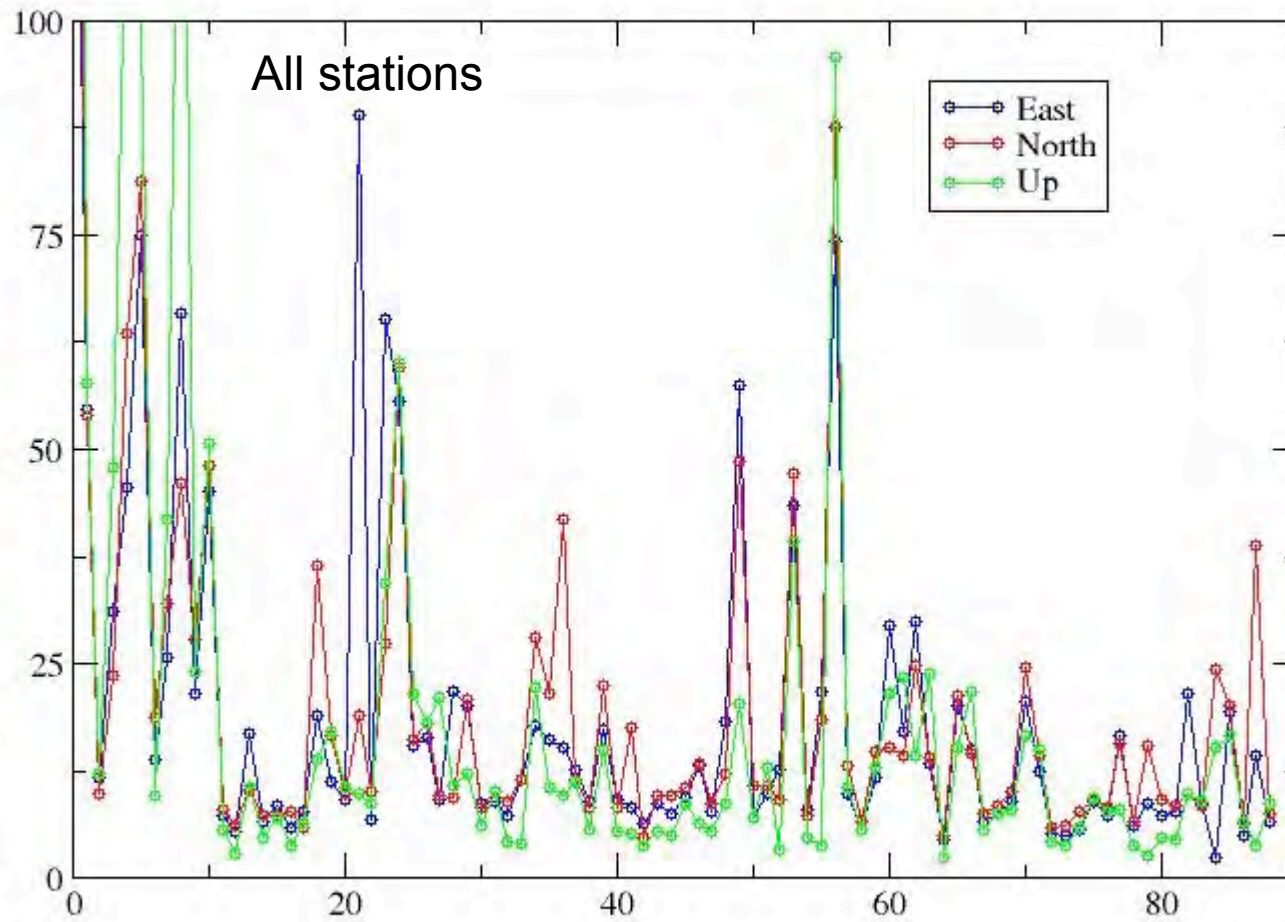Median value for Up component = 21.3 mm

w.r.t. ITRF2008P

All stations

Median value for East component = 15.7 mm
Median value for North component = 20.4 mm
Median value for Up component = 15.7 mm

Station position series WRMS (5/5)

Comparison between SLRF2005 and ITRF2008P

All stations

East component
- Improvement for 72 % of the stations
- Median improvement = 3.7 mm

North component
- Improvement for 69 % of the stations
- Median improvement = 2.8 mm

Up component
- Improvement for 82 % of the stations
- Median improvement = 5.7 mm

13 core stations

East component
- Improvement for 85 % of the stations
- Median improvement = 1.1 mm

North component
- Improvement for 85 % of the stations
- Median improvement = 1.5 mm

Up component
- Improvement for 92 % of the stations
- Median improvement = 1.1 mm

Better stability of the series for the three components achieved with ITRF2008P

A priori residual RMS values per satellite (3/3)

Comparison between the GRGS V05 and V08 solutions

All stations

For LAGEOS-1
- Improvement for 82 % of the stations
- Median improvement = 1.5 mm

For LAGEOS-2
- Improvement for 87 % of the stations
- Median improvement = 2.0 mm

20 core stations

For LAGEOS-1
- Improvement for 75 % of the stations
- Median improvement = 0.6 mm
- Improvement of 5.7 mm for 7810
- Improvement of 53.1 mm for 7403

For LAGEOS-2
- Improvement for 85 % of the stations
- Median improvement = 0.5 mm
- Improvement of 7.8 mm for 7810
- Improvement of 32.4 mm for 7403

Improvement of a priori residuals for the great majority of the stations

Overlap differences:LA1, *RTN*

- Radial:
  - Mean: 0.000022m
  - Std. Dev.:   0.004954m
- Tangential:
  - Mean: 0.5 10-6m
  - Std. Dev.:   0.000609m
- Normal:
  - Mean: -0.0253m
  - Std. Dev.:   0.6530m
- Rms 3d: 0.05804m

- Radial:
  - Mean: 0.000023m
  - Std. Dev.:   0.004956m
- Tangential:
  - Mean: 0.8 10-6m
  - Std. Dev.:   0.000588m
- Normal:
  - Mean: -0.0254m
  - Std. Dev.:   0.6544m
- Rms 3d: 0.05699m

Overlap differences:LA2, *rtn*

- Radial:
  - Mean: 8.72 10-5
  - Std. Dev.: 0.00059m
- Tangential:
  - Mean: 0.88 10-5m
  - Std. Dev.: 0.00078m
- Normal:
  - Mean: 0.0018m
  - Std. Dev.: 0.02036m
- Rms 3d:

- Radial:
  - Mean: 0.874 10-7m
  - Std. Dev.: 0.0058m
- Tangential:
  - Mean: 0.6 10-5m
  - Std. Dev.: 0.000777m
- Normal:
  - Mean: -0.0011583m
  - Std. Dev.: 0.0198776m
- Rms 3d: 0.035m

III. Differences induced by the change of ITRF

- Differences must not be interpreted interms of change of ITRF
- Mean differences, in meter

- LA1, ITRF2005/ITRF2008p
  - Radial: $0.74874\ 10^{-7}$
  - Tangential: $0.18593\ 10^{-6}$
  - Normal: 0.00301926
  - a: 0.000106643
  - e: 0.000976438
  - i: 0.00519879
  - ω: 0.234001
  - Ω: 0.00810794
  - M 0.0149883
  - Rms 3d: 0.0107906

- LA2, ITRF2005/ITRF2008p
  - Radial: $0.47177\ 10^{-6}$
  - Tangential: $0,16562\ 10^{-6}$
  - Normal: 0.00575594
  - a: $0.23225\ 10^{-5}$
  - e: 0.000834982
  - i: 0.00390287
  - ω: 0.05957
  - Ω: 0.00786668
  - M 0.0129344
  - Rms 3d: 0.00972865

II. Overlap differences

- Two consecutive orbital arcs have two days in common
- Differences plotted in local frame RTN

Analysis Working Group Report

JCET AC

2010 EGU, Vienna, Austria, Saturday, May 8, 2010

Erricos C. Pavlis

GEST/UMBC - NASA Goddard

ITRF2008P Tests at JCET AC

E. C. Pavlis and M. Kuzmicz-Cieslak

Goddard Earth Sciences and Technology Center - GEST and NASA Goddard, USA

epavlis@umbc.edu

LAGEOS 1 RMS of Fit
1993 - 2010
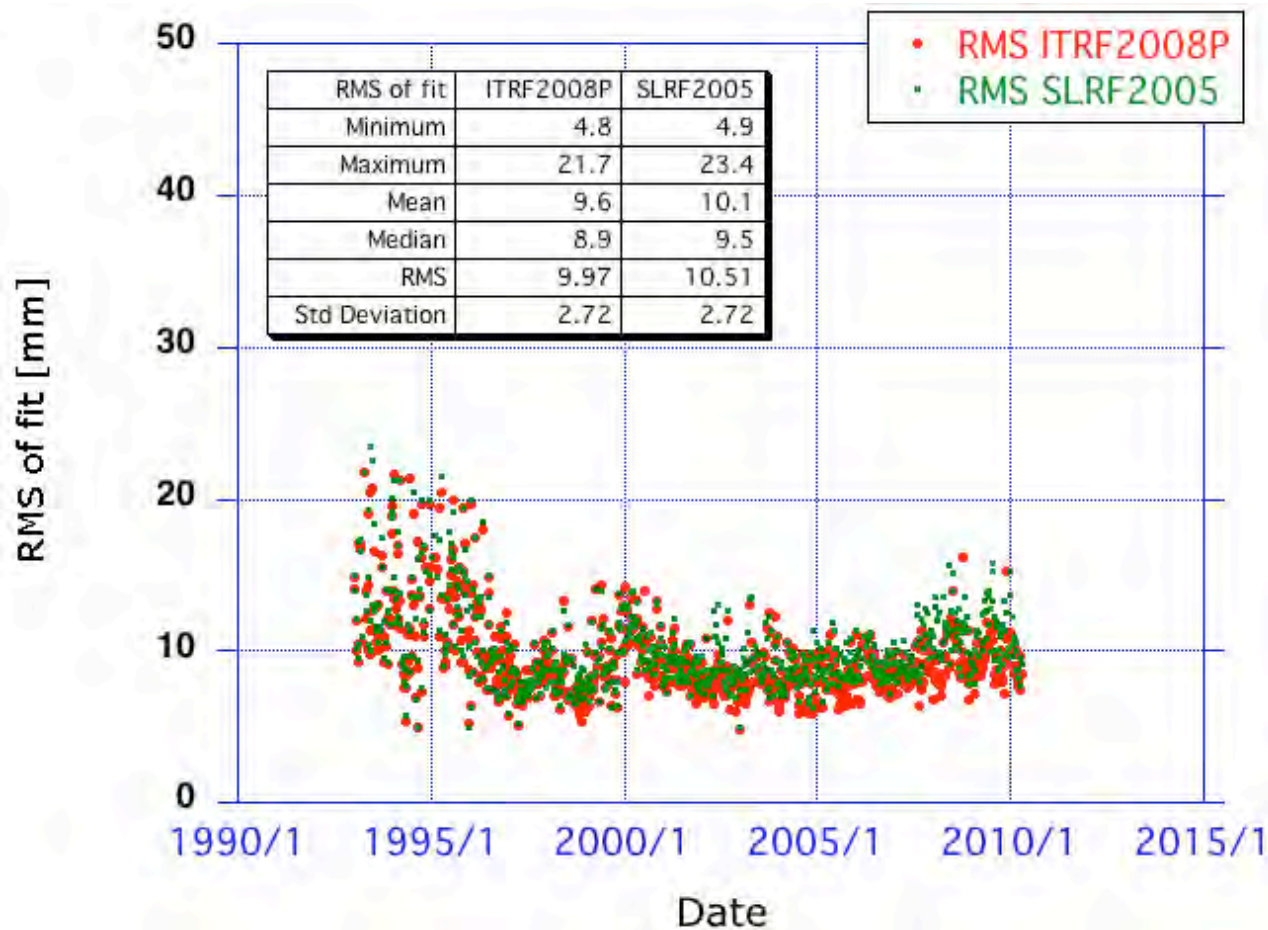
LAGEOS 1 RMS of Fit
2006 -2010
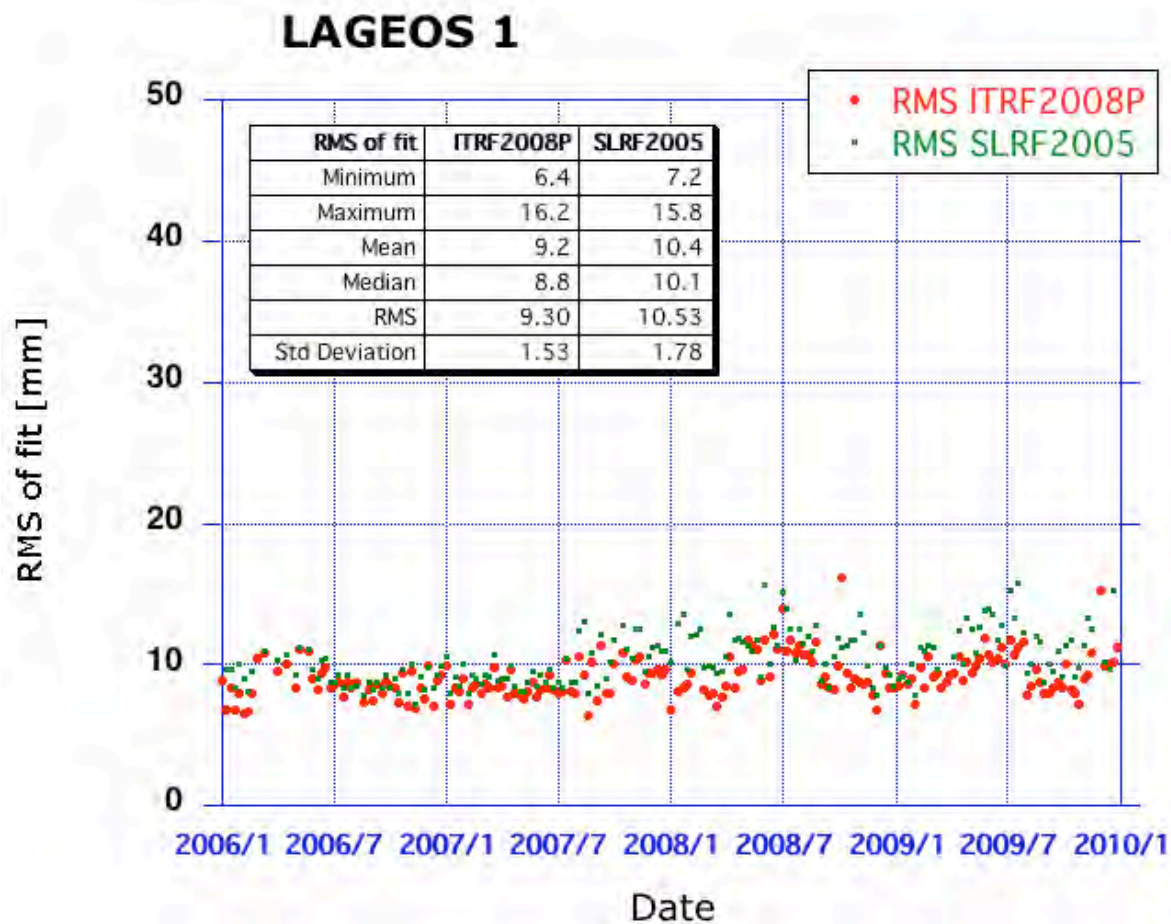
LAGEOS 2 RMS of Fit
1993 - 2010
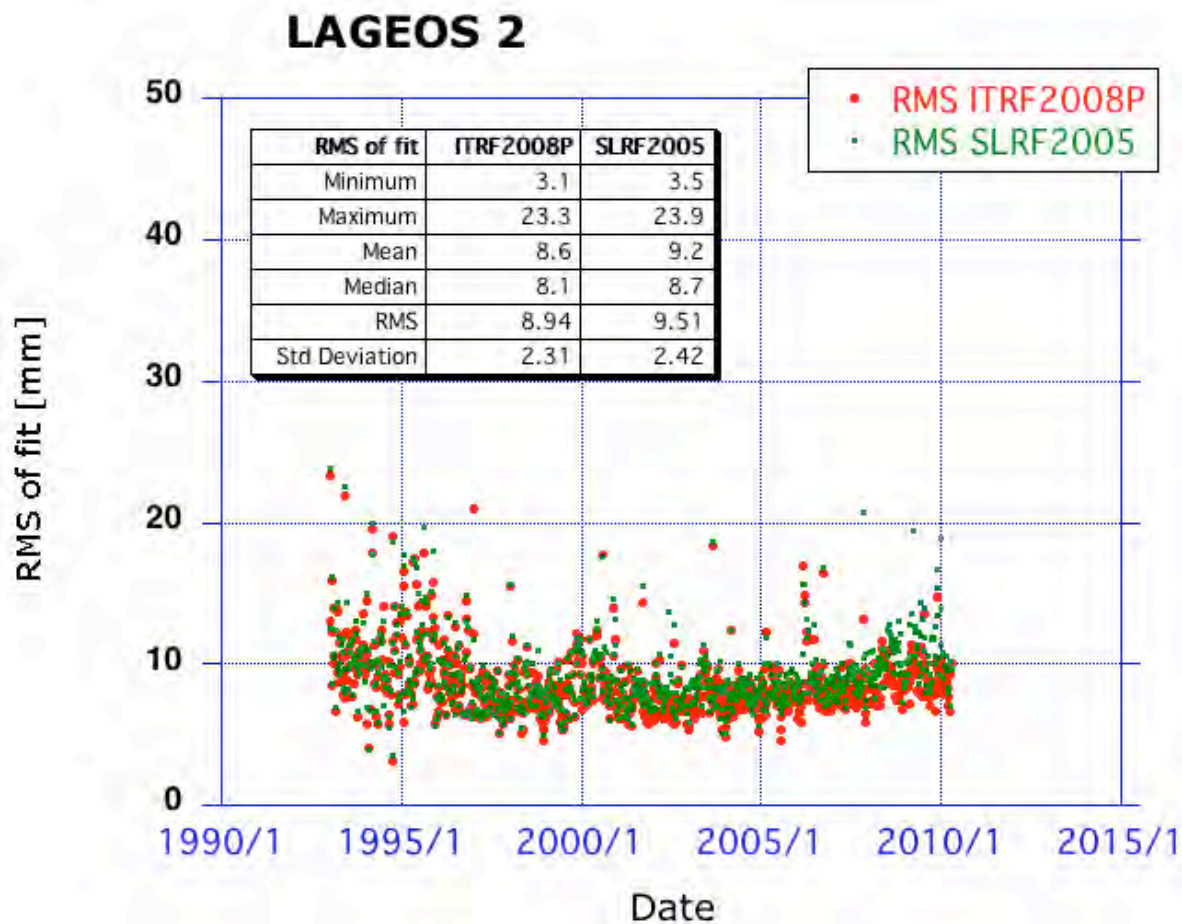
LAGEOS 2 RMS of Fit
2006 -2010
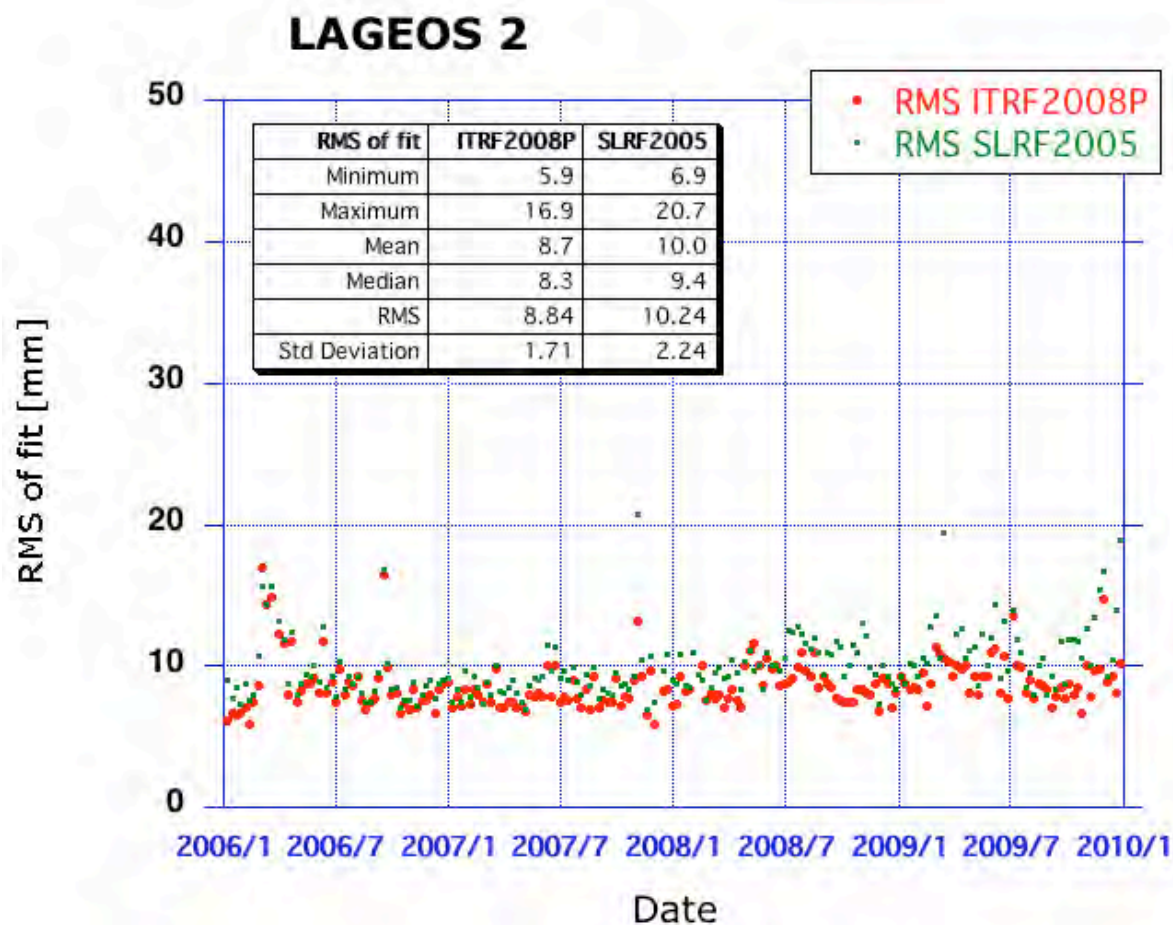
Summary

- The ITRF2008P combination improves the *a priori* fits of the two LAGEOS data sets in its entirety

- When we look at the fits over the period 2006 to 2010, when the collected data did not contribute to the ITRF2005, we see significant overall improvement

- If we focus on the last year 2009, data which are not contributing in either combination, then the improvement is even more significant

San Fernando 7824 Pressure Drift

Pressure [hPa]
Mean : 1011.04
Std Dev: 4.95
Min: 992.4
Max: 1029.7

7824 San-Frenando

San Fernando 7824 Pressure Drift

presion media mensual rota - roa 2006 - 2009 (nov)

San Fernando 7824 Pressure Drift

Comparativa NCEP-ROTA-ROA (niveles medios anuales)
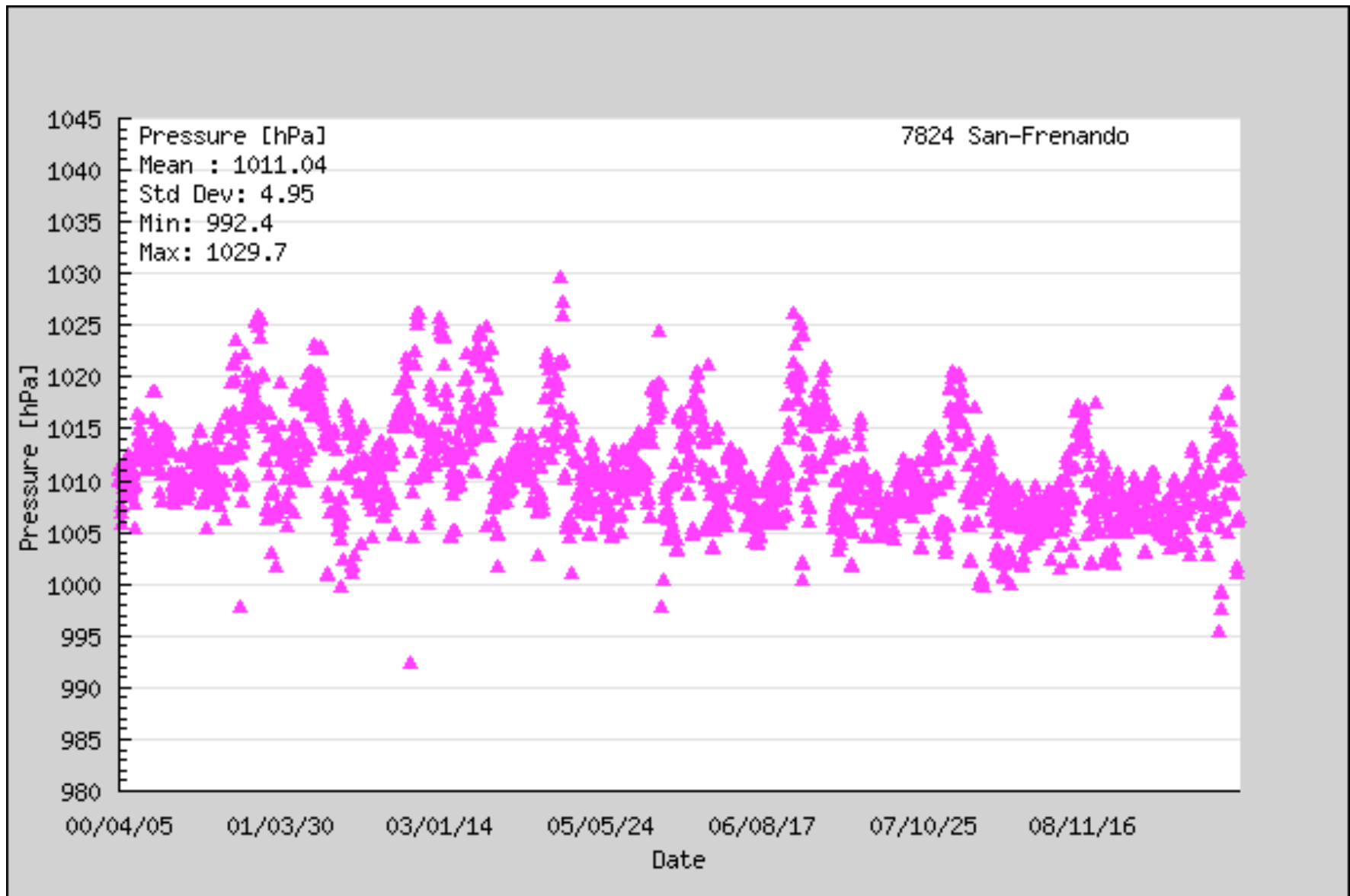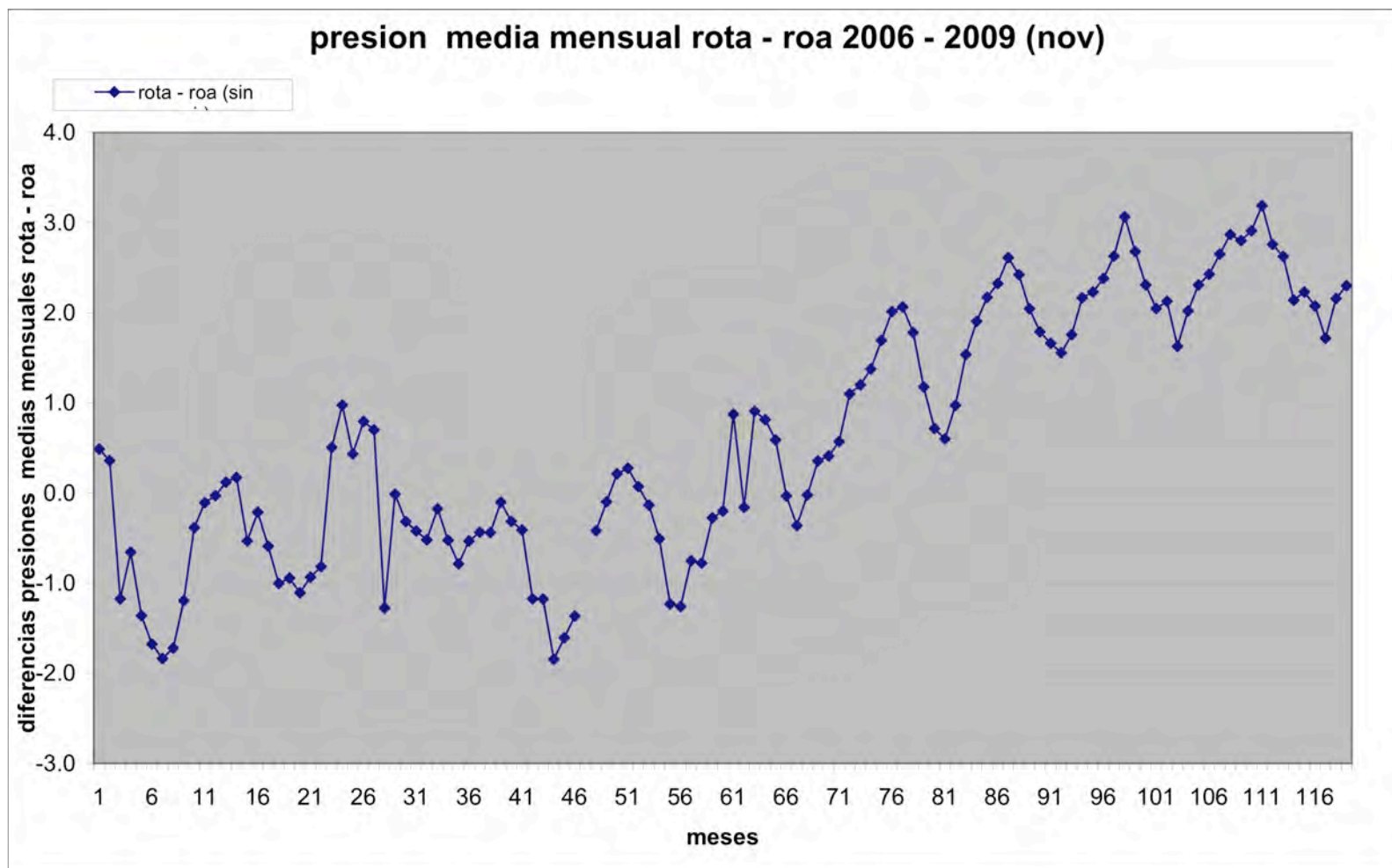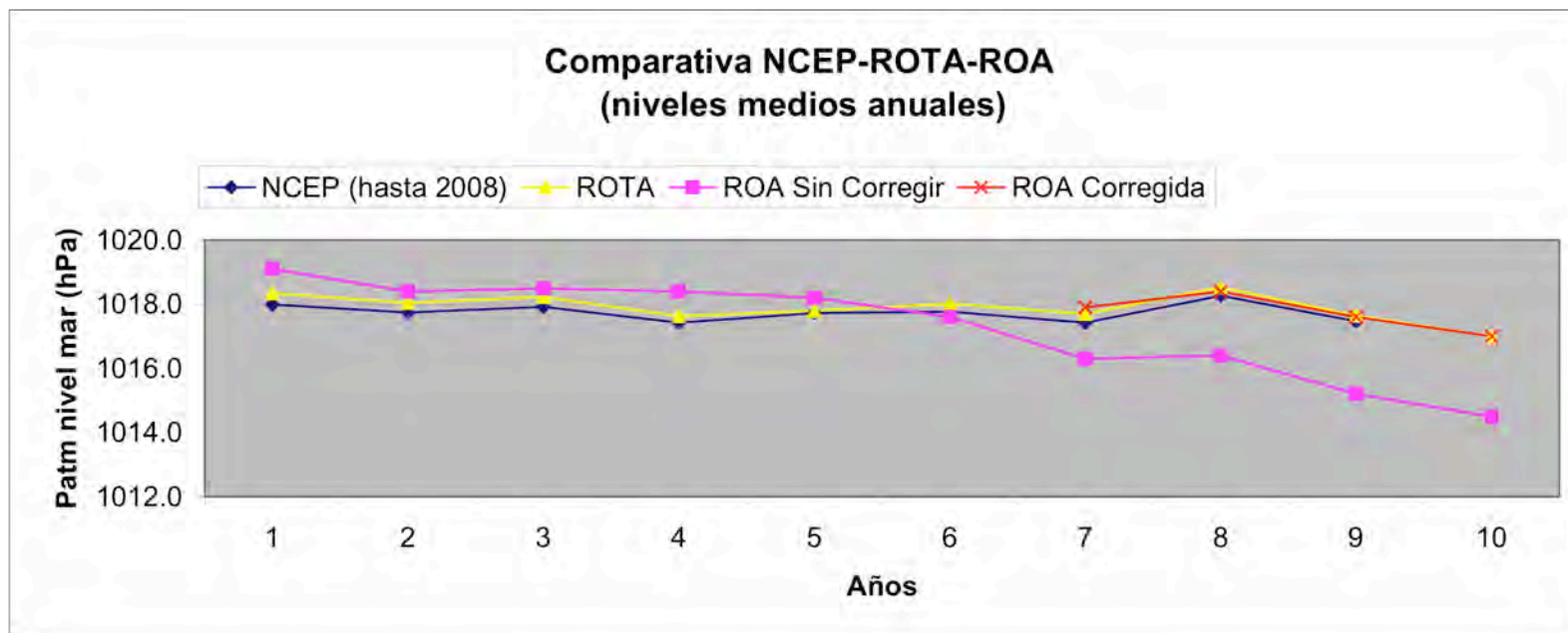
	ROA			DIF	DIF	DIF	ROA
	Sin corregir	ROTA	NCEP	ROA-ROTA	ROA-NCEP	ROTA-NCEP	Corregida
2000	1019.1	1018.3	1018.0	0.8	1.1	0.3	
2001	1018.4	1018	1017.7	0.4	0.7	0.3	
2002	1018.5	1018.2	1017.9	0.3	0.6	0.3	
2003	1018.4	1017.6	1017.4	0.8	1.0	0.2	
2004	1018.2	1017.8	1017.7	0.4	0.5	0.1	
2005	1017.6	1018	1017.8	-0.4	-0.2	0.2	
2006	1016.3	1017.7	1017.4	-1.4	-1.1	0.3	1017.9
2007	1016.4	1018.5	1018.3	-2.1	-1.9	0.2	1018.4
2008	1015.2	1017.6	1017.5	-2.4	-2.3	0.1	1017.6
2009(nov)	1014.5	1017		-2.5			1017

San Fernando 7824 Pressure Drift

PRESION MEDIA MENSUAL Enero 2006 - Noviembre 2009

- roa sin corregir
- rota

PRESION MEDIA MENSUAL Enero 2006 - Noviembre 2009

- roa corregida
- rota
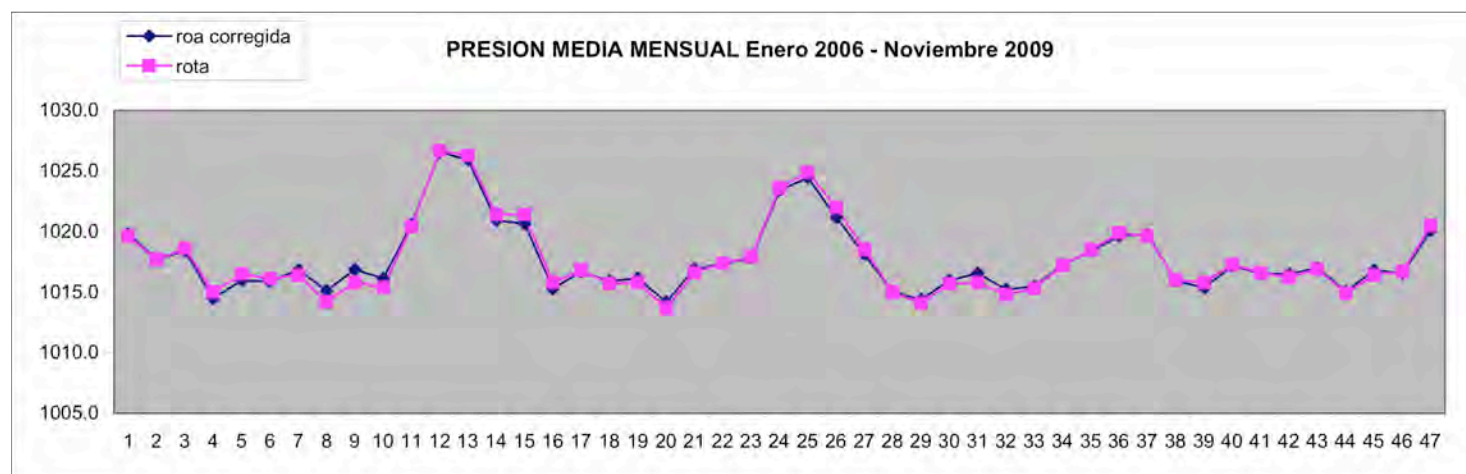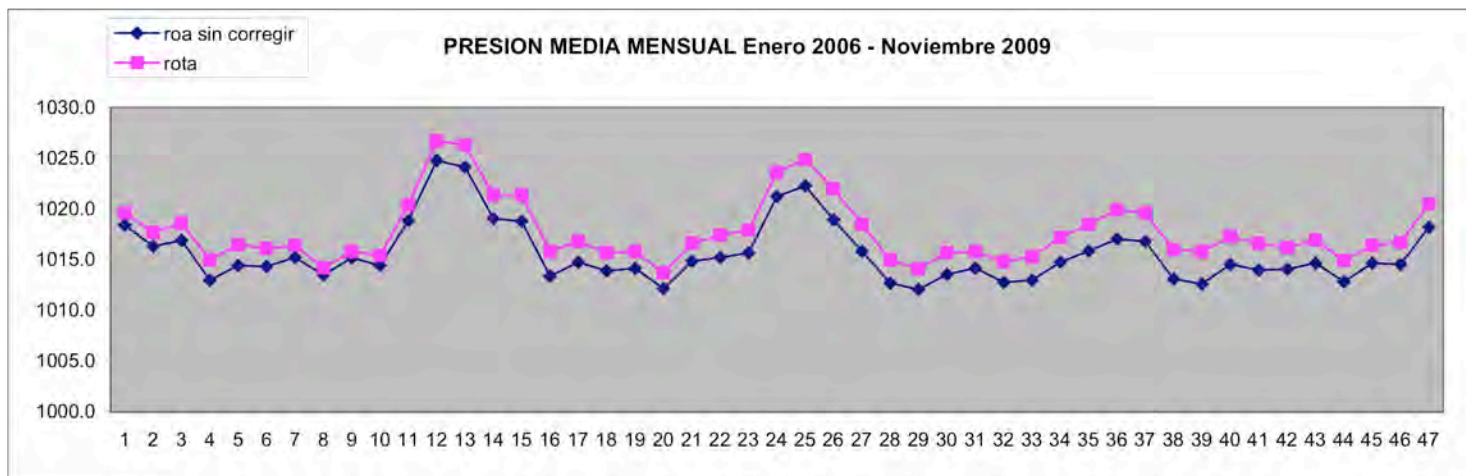
San Fernando 7824 Pressure Drift

Barometer correction

- T = year + (day of the year)/365   day of the year from 1 to 365

- **Since January 1st, 2006 until the end of 2008:**

- Correction = 0.40402 x (T - 2006) + 1.38412

- Correct value = Old value + Correction

- **Since January 1st, 2006 until December 9th 2009:**

- Correction = 1.2658 x (T - 2009) + 3.007838412

- Correct value = Old value + Correction

ILRS DAILY vs USNO - X

ILRS DAILY vs USNO - Y
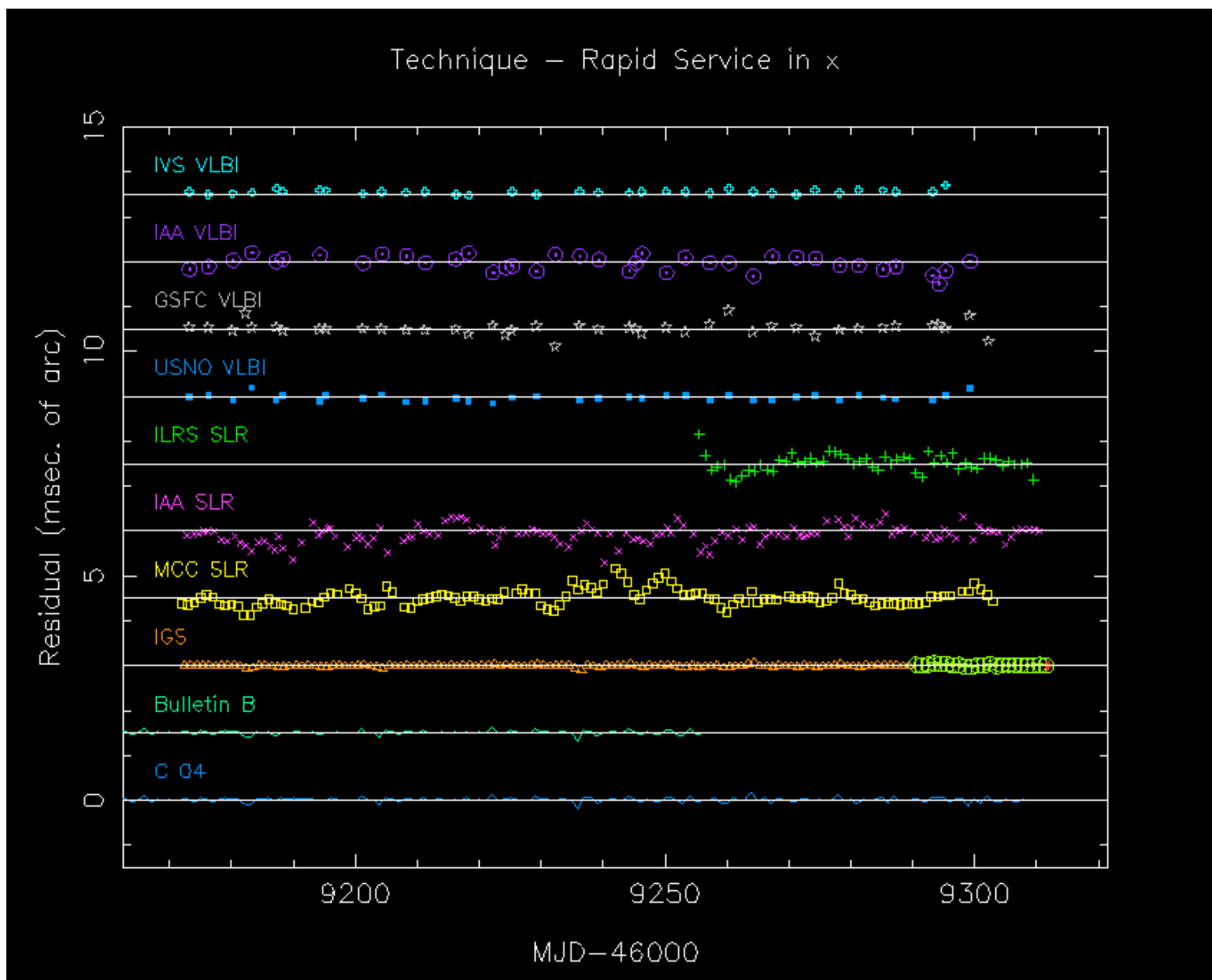
Technique — Rapid Service in y
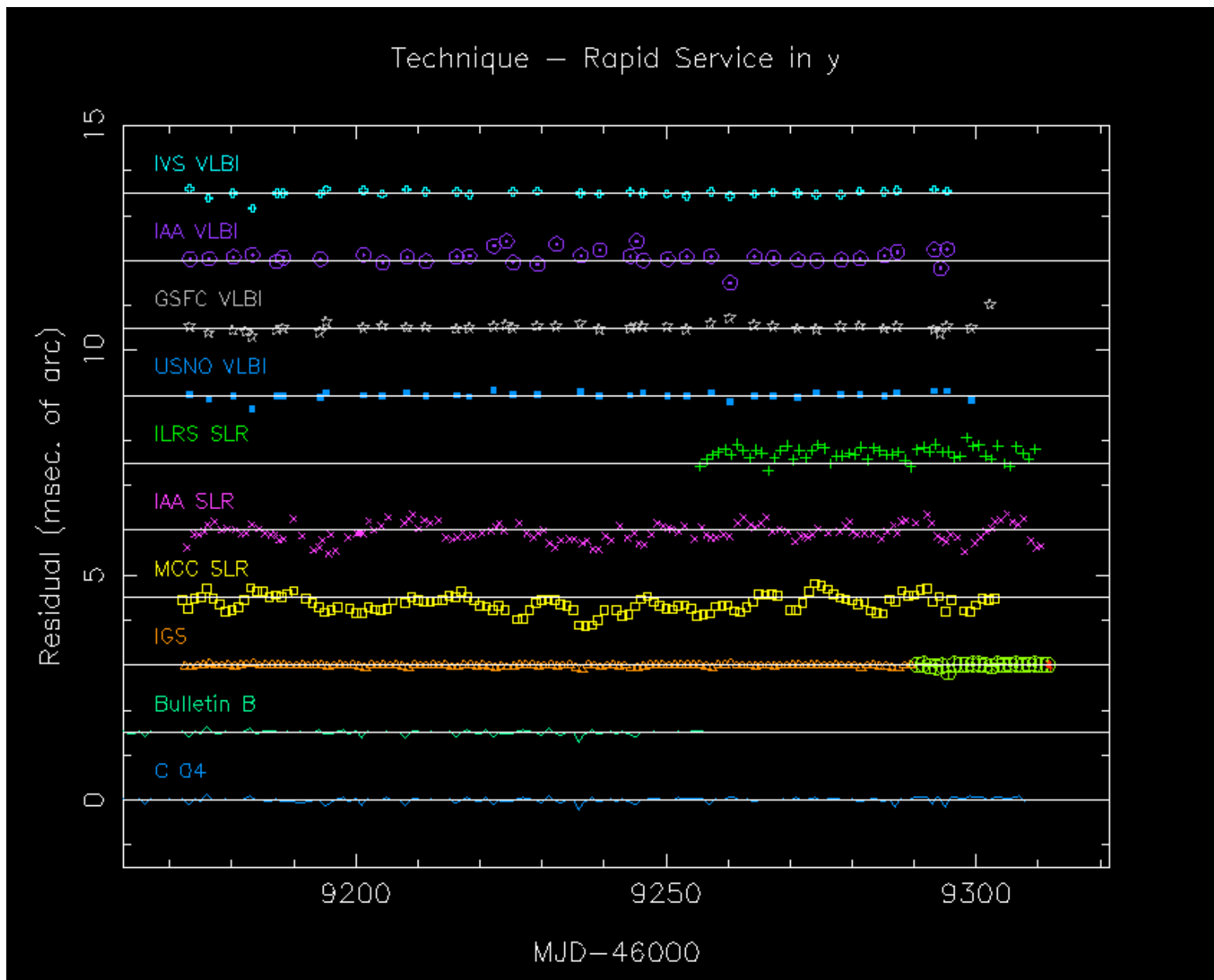
ILRS DAILY & WEEKLY vs USNO - X

ILRS DAILY & WEEKLY vs USNO - Y

CRD Validation Status

CRD Implementation and Validation Schedule - 100503

SITE	ID	Code	Coding	Testing	OC Validated	AC Validated					Operational
						ASI	DGFI	GFZ	GRGS	JCET	
Golosiiv	1824	GLSL									
Lviv	1831	LVIV	X	X	P						
Maidanak 1	1863	MAID									
Maidanak 2	1864	MAIL									
Komsomolsk	1868	KOML									
Mendeleevo	1870	MDVL									
Simeiz	1873	SIML	X	X	X				P	P	P
Riga	1884	RIGL	X	P							
Katsively	1893	KTZL	X	X	X				P	P	P
McDonald	7080	MDOL	X	X	X	X	X	X	X	X	X
Yarragadee	7090	YARL	X		X						P
Greenbelt	7105	GODL	X	X	X	X				X	X
Monument Peak	7110	MONL	X	X	X						P
Haleakala, HI	7119	HA46	X	X	X						P
Tahiti	7124	THTL	X	X	X						P
Wuhan	7231	WUHL									
Changchun	7237	CHAL	X	X	X	X			X	X	X
Beijing	7249	BEIL	X	P							
Koganei	7308	KOGC	X	X	X	X				X	X
Tanegashim	7358	GMSL	X	P							
Arequipa	7403	AREL	X	X	P						
Concepcion	7405	CONL	X	X	X	X	X		X	X	X
San Juan	7406	SJUL	P								
Hartebeesthoek	7501	HARL	X	X	X						P
Metsahovi2	7806	METL									
Zimmerwald	7810	ZIML	X	X	X	X	X			X	X
Borowiec	7811	BORL	X	X	X						P
Kunming	7820	KUNL	X	X	P						
Shanghai	7821	SHA2	X	X	X	X			P	P	P
San Fernando	7824	SFEL	X	X	X				P	P	P
Mt. Stromlo	7825	STL3	X	X	X	X	X		X	X	X
Helwan	7831	HLWL									
Riyadh	7832	RIYL									
Simosato	7838	SISL									
Graz	7839	GRZL	P	P							
Herstmonceux	7840	HERL	X	X	X	X	X		X	X	X
Potsdam	7841	POT3	X	X	X					X	X
Grasse (MeO)	7845	GRSM	X	X	X	X			X	X	X
Matera	7941	MATM	X	X	X		X	X	X	X	X
Wettzell	8834	WETL	X	X	X	X	X			X	X
FTLRS	--	--	X								
TROS	--	--									

ORBEX by IGS

ORBEX

The Orbit Exchange Format

Draft Version 0.08

Stephen Hilla
National Geodetic Survey, NOAA
Silver Spring, Maryland, USA

Steve.Hilla@noaa.gov

7 May 2010

J of G Guest EB

- *J of Geodesy Editor contacted*
- *Procedures of JoG provided (suggested list of topics)*
- *ILRS Special Issue Guest Editors:*
  - *Pavlis, Luceri, Pearlman, Appleby*
- *Delayed due to higher priority for the development of the ILRS contribution to ITRF2008 (which will form the basis for this issue)*
- *Realistic time-table for soliciting papers: within less than a month*

Proposed TOC

TITLE	Lead Author(s)
Foreword	The Guest EB
The International Laser Ranging Service (ILRS): **the first decade** or **ten years of success**	The ILRS GB
ILRS Electronic Documentation Service: Mission Details, Data and Product Archives, Formats and Information for the Users	Noll, Torrence, Seemuller, Ricklefs
Past, Present and Future of the ILRS Global Tracking Network	Wetzel, Horvath, EUROLAS, WPLTN, ???
The Next Generation Satellite Laser Ranging Systems	McGarry, Degnan, Kirchner, Jäggi, Appleby, Fumin, ???
The Geodetic Sateliite Missions	Pearlman, Arnold, Barlier, Biancale, Vasiliev, (?)
Lunar and Planetary Laser Ranging	Shelus, Luck, Torre, McGarry, J. Müller, Murphy, Bianco, ???
Target Signature Systematic Errors for Geodetic Sateliites	Appleby, Otsubo, Arnold
Data Quality Control Service	Otsubo, H. Müller, Pavlis, Glotov
Systematics in SLR Data: Documentation and Discussion of Errors and their Sources	Luceri, Appleby, Pavlis and H. Müller
Weekly and Daily Products of the ILRS Analysis Working Group	Sciarretta, Kelm, Luceri and Pavlis
Monitoring Mass Redistribution in the Earth System with SLR	Pavlis
The ILRS Contribution to the International Terrestrial Reference Frame (ITRF)	The AWG ACs and CCs

Contributions from solicitation announcement

NORMAL POINT CONSTRUCTION
FOR OPTIMAL TRACKING

- Original Concept from Werner Gurtner AIUB
  Use satellite multiplexing capability at high
  repetition rate stations to improve tracking efficiency

- Response from ILRS CB
  Proposes a protocol to move to a new target after 100 returns
  see
  http://terra.sgt-inc.com/~pdunn/trackmore/NormalPointConstruction.doc

NORMAL POINT CONSTRUCTION
FOR OPTIMAL TRACKING

(*To be reviewed and validated by the Analysis Working Group)*

ASSUMPTIONS
- The quality of a normal point depends only on the number of single shot contributors.
- The primary application of the SLR Network tracking LAGEOS I and II is station location.
- The primary applications of the SLR network tracking GNSS are (1) orbit definition and (2) reference frame definition (geocenter, scale and orientation) which has similar pass geometry requirements to orbit definition.
- Stations should strive for precision as close to one mm as possible for all applications of SLR data.
- Normal Point distribution during a satellite pass should be determined by the requirements of the most stringent application for that satellite.

RECOMMENDATION:
- A normal point should be terminated when 100 full rate data points have been accumulated or the maximum normal point interval (i.e. 2 minutes for LAGEOS) is complete, whichever comes first.

Highlights of Feedback from High Rep Stations

- **Graham Appleby NERC**: Single-photon noise levels are higher than 10 mm and depend on the satellite. Engineering issues dictate single shot quota.

- **Philip Gibbs NERC:** Is normal point interval negotiable?

- **Georg Kirchner IWF/OEAW:** Useful only for HEO satellites 100 point minimum currently used at Graz.

- **Jan McGarry NASA:** Eyesafe system has higher single shot noise. NGSLR signal processing allows timely single shot quota assessment.

- **Adrian Jaeggi AIUB:** Burdensome on-line processing required

Highlights of Feedback from Analysis Community

John Ries CSR: Higher rate normal points may be useful for analysis off-line.

Erricos Pavlis JCET: Data yield could significantly increase with this recipe. We should ponder tracking choreography later (supported by Juergen Mueller IFE).

Proposal

If a station can interleave satellite tracks, with a goal of 1mm normal point precision, range to a target until that goal is achieved, then track another target. Return to the first target only after the "normal point" interval has elapsed from the first acquisition.

Normal Points from kHz systems: comments from Herstmonceux

Graham Appleby, Philip Gibbs

Test observation runs- principle:

- If the real-time tracking software can detect the returns:

- Can inform the observer when enough returns obtained to improve NP precision to 1mm

- Based on improvement by root(n) of single-shot precison

Test observation runs- principle:

- Single-shot precision is target-dependent:

- For LAGEOS ~15mm, ETALON ~50mm;

- For GNSS, dependent on elevation (impact angle to the flat arrays)

- Tests being carried out at Herstmonceux:

  - The observer is informed about numbers of returns per NP interval and resulting RMS

  - No satellite-dependent scaling yet

Observing on April 14th with kHz
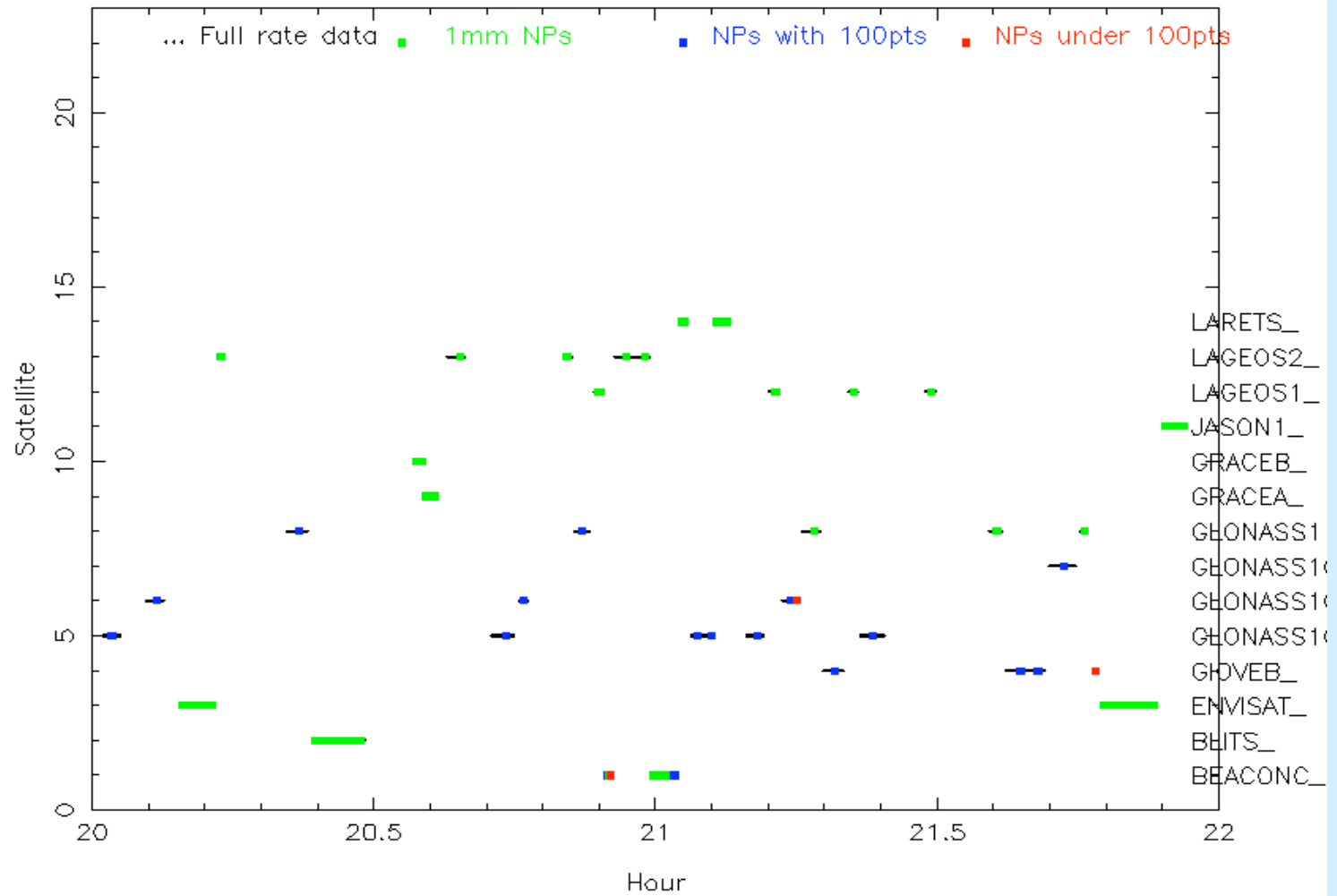
Unified Analysis Workshop 2009

Date: December 11, 2009, 09:00 – December 12, 2009, 18:00
Location: Gran Hyatt, San Francisco

Action Items

AI	Description	Responsible	Deadline
	General Remarks		
	Position Paper should be prepared well ahead of time for the next UAW workshop		
	GGOS SC should motivate participation from gravity and from IGS		
	UAW 2011 will be at ETH Zürich, Switzerland		
5 5a	**SINEX format update (Version 2.10):** Distribute new version 2.10 of the SINEX format containing: - Reference frame block (mandatory) - Header line "Solution content": allow "X", "X V", "V" (description) - Information on time system (Urs Hugentobler) - Discontinuities block to be made official - Metadata block (mandatory; defined by IERS CB) - Extended parameterization (optional); important also for IERS WG on Combination - GLONASS receiver phase center corr. block (mandatory). Galileo is already in. Note: LAT/LON/HEIGHT coordinate representation will not be included in SINEX for the time being. It can be discussed again in the IERS WG on SINEX to be created. Make new description available at IERS web pages and	M. Rothacher, D. Thaller	31-JAN-10

	distribute it to all analysis centers Implementation of mandatory blocks by the Analysis Centers and Combination Centers		
5b		IERS CB	31-JAN-10
5c		All ACs	30-APR-10
12	**IERS WG on Parameterization and Modeling for IERS201x (ITRF/EOP/ICRF):** WG to discuss and converge on specifications for IERS201x, e.g.: - Common ERP parameterization for all techniques - Add quasar coordinates to the SINEX files (to be discussed in IVS) - Add nutation to the SINEX files - Add low-degree harmonics of the gravity field to SINEX files (to be discussed by ILRS, next AWG Meeting) - Mapping Functions ? - Atmospheric loading ? - Other loading effects ? - Seasonal signal treatment ? etc. Members: All ACoo, ITRS PC/CCs, EOP PC, ICRF WG Chair, Combination WG Chair. Prepare charter etc. according to IERS ToR.	Lead: open M. Rothacher All services IVS IVS ILRS/IDS	31-MAR-10
13 13a 13b 13c	**Documentation of AC modeling and parameterization standards:** Generation of a unified form for the description of AC standards, models parameterization. (Check also standards sheet by GGOS-D for completeness) and distribution to all ACs. Comments by Technique Analysis Coordinators Form distributed to all ACs (or make a internet version ?). Forms filled and returned by all ACs Start the homogenization of the models and parameterizations	GGOS BSC (U. Hugentobler) GGOS BSC Analysis Coo GGOS BSC	 28-FEB-10 15-MAR-10 15-APR-10

13d		All ACs	31-MAY-10
13e		GGOS BSC	31-MAY-10
17	**Combination of SLR Range Biases:** SLR range biases could be combined at the ILRS Combination Centers. This would improve the consistency of the combined solutions of the ILRS Combination Centers. This is just a recommendation.	ASI, DGFI /CC	Open
18	**EOP Parameterization:**		
18a	Recommendation to have consistent parameterization (daily offsets and rates) for the weekly SINEX files for all techniques. Parameterization of Nutation (de, dpsi ☾ X,Y): Recommendation	IDS, ILRS (for the next ITRF realization)	Next ITRF realization
18b	to start to move towards X,Y parameterization	All ACs	open
20	**SLR Tracking of GLONASS:** Recommendations whether to get a lot of observations for a few satellites or to get few observations for a lot of satellites. Simulations necessary.		
20a	Collect information on GLONASS retro-reflectors.	T. Springer, G. Appleby	31-DEC-10
20b		ILRS	31-DEC-10

Unified Analysis Workshop 2009

Date: December 11, 2009, 9:00 – December 12, 2009, 18:00
Location: Grand Hyatt San Francisco, 345 Stockton Street,
San Francisco, California, USA 94108

Detailed Programme
(Version December 6, 2009)

Friday, December 11, 2009:

08:30 – 09:00 Registration
09:00 – 09:10 **ROTHACHER M., RICHTER B.**
Welcome
09:10 – 09:25 **ROTHACHER M.**
Overview of UAW Goals 2009 and Outcome of UAW 2007

Session 1 Products by the Services, GGOS Portal and Metadata
Chair: **NEILAN R.**
Co-Chairs: **RICHTER B.**, **NOLL C.**

PRESENTATIONS SERVICES (IVS, ILRS, IGS, IDS, IERS, IGFS):
09:25 – 09:35 **NOTHNAGEL A., SCHUH H.**
IVS – Present and Future Products
09:35 – 09:45 **PAVLIS E., PEARLMAN M.**
ILRS Official Products - Current and Future
09:45 – 09:55 **SPRINGER T.**
IGS – Latest Development, Reprocessing
09:55 – 10:05 **WILLIS P., LEMOINE F.**
IDS – Latest Developments and Perspectives
10:05 – 10:15 **MA C., ROTHACHER M.**
IERS - Products and Future

10:15 – 10:25   **BARTHELMES F., FORSBERG R.**
                IGFS – Status and Future

10:25 – 10:45   *Coffee Break*

10:45 – 11:15   Discussion, Action Items

11:15 – 11:30   **RICHTER B., NOLL C.**
                Position Paper "GGOS Portal, Meta Data"

                PRESENTATIONS (PORTAL, METADATA, …):
11:30 – 11:40   **HUGENTOBLER U.**
                Standards and Conventions
11:40 – 11:50   **ROTHACHER M.**
                Updates to the SINEX format

11:50 – 12:30   Discussion, Action Items

12:30 – 13:30   *Lunch*

Session 2   Modeling Deficiencies and Modeling Based on External Data (Atmosphere, Ocean, ...)
                Chair: **BÖHM J.**
                Co-Chair: **VAN DAM T.**

13:30 – 13:45   **BÖHM J., VAN DAM T.**
                Position Paper "Modeling Deficiencies and Modeling based on External Data"

                PRESENTATIONS:
13:45 – 14:00   **VAN DAM T.**
                Restructured GGFC
14:00 – 14:15   **HOBIGER T., ICHIKAWA R., KOYAMA Y., KONDO T.**
                Ray-traced troposphere slant delays from numerical weather models as corrections on the observation level - status and outlook
14:15 – 14:30   **SCHUH H., WIJAYA D., BÖHM J.**
                Various methods for the definition of reference pressure
14:30 – 14:45   **DACH R. BÖHM J., STEIGENBERGER P., LUTZ S., BEUTLER G.**
                Evaluation of Atmospheric Loading Modelling Using GNSS Data
14:45 – 15:00   **KÖNIG R., FLECHTNER F., RAIMONDO J.C.**
                Atmosphere/ocean dealiasing and loading products and some effects

(some additional slides of E. Pavlis and T. van Dam)

15:00 – 15:15 **VAN DAM T.**
Non-tidal ocean loading models

15:15 – 15:30 **GROSS R.**
Improving geodetic/geophysical models used to estimate EOPs

15:30 - 15:50 *Coffee Break*

PRESENTATIONS:

15:50 - 16:05 **PAVLIS E.**
SLR Data Analysis Standards

16:05 - 16:20 **SARTI P., ABBONDANZA C., PETROV L., NEGUSINI M.**
Effect of antenna gravity deformations on VLBI estimates of site positions

15:50 - 16:45 **LUCERI C.**
Measurement Bias Estimation and Modeling - Data QC

15:50 - 16:45 **APPLEBY G.**
CoM for Geodetic SLR Targets - Current Accuracy and Prospects

16:45 - 18:00 Discussion, Action Items

Saturday, December 12, 2009:

Session 3   Combination Strategies, Common Parameters and Combined Products
Chair: **SCHUH H.**
Co-Chair: **BIANCALE R.**, **ALTAMIMI Z.**

INTRODUCTION:

08:45 – 09:00 **BIANCALE R.**
Objectives and workplan of the IERS WG on combination at the observation level

09:00 – 09:15 **ALTAMIMI Z., COLLILIEUX X., METIVIER L.**
Discussion on the combination strategies at the normal equation level

PRESENTATIONS:

09:15 – 09:30 **GAMBIS D., RICHARD J.Y., BIZOUARD C.**
Combination strategies for Earth orientation monitoring

09:30 – 09:45 **SCIARRETTA C.**
Combination Strategies for ILRS Products

09:45 – 10:00 **FÖRSTE CH., BARTHELMES F., BIANCALE R.**

Comparison and Combination of Global Gravity Field Models
10:00 – 10:15 **KÖNIG R., KÖNIG D.**
Integrated solutions from the GPS-GRACE-CHAMP constellation

10:15 – 10:35 *Coffee Break*

PRESENTATIONS:
10:35 – 10:50 **THALLER D., DACH R., SEITZ M., BEUTLER G., MAREYEN M., RICHTER B.**
Combined Analysis of GNSS and SLR data
10:50 – 11:05 **KÖNIG R., MICHALAK G., NEUMAYER H.K.**
On space ties for some LEOs
11:05 – 11:20 **SPRINGER T.**
Space-Ties
11:20 – 11:35 **HEINKELMANN R., SEITZ M., BÖHM J., SCHUH H.**:
Troposphere ties

11:35 – 12:30 Discussion, Action Items

12:30 – 13:30 *Lunch*

Session 4   Network Simulations and Analyses
Chair: **PEARLMAN M.**
Co-Chair: **RIES J., PAVLIS E.**

13:30 – 13:45 **PAVLIS E., PEARLMAN M.**
Position Paper "Network Simulation and Analyses"

PRESENTATIONS:
13:45 – 14:00 **PAVLIS E.**
GGOS Network Scoping Simulations
14:00 – 14:15 **PAVLIS E.**
SLR Tracking of GNSS Constellations

14:15 – 14:45 Discussion, Action Items

Discussion, Wrap-up and Action Items
Chair: **ROTHACHER M.**

14:45 – 15:40   Additional Discussion of the Sessions, Action Items
(if time allows: first ideas on integrated GGOS products)

15:40 – 16:00   *Coffee Break*

16:00 – 17:00   Discussion of how to proceed, Action Items

17:00 – 17:30   Summaries of Workshop and Action Items

17:30   *Closing of Workshop*

Session Descriptions

General Remarks:

As in the case of the Unified Analysis Workshop (UAW) of 2007, the participation in the UAW 2009 is based on invitation, i.e., the Services decide on the persons to represent them during the workshop.

Sessions 1-4: For each of these sessions a chair and co-chairs are proposed to cover all the required expertise and to guarantee the input from all services. The chair, together with the co-chairs is responsible for the session organization. There should be a presentation of the position paper and there can be additional presentations on various topics if considered useful. A call for presentations is issued to the participants. Authors an titles can be supplied through the web pages of the workshop. The chair and co-chairs are responsible to get/collect additional useful input/comments/ideas from their respective Services concerning the session topic. A position paper (it can be in the form of keywords) containing

(1) the major problems and issues
(2) the solution strategies and approaches
(3) action items with deadlines and responsible people

should be ready before the Workshop, namely by Friday

    December 2, 2009

Each of the sessions should reserve time for at least 30-45 minutes of discussion.

Session 1   Products by the Services, GGOS Portal and Metadata

Description: In this session each of the Services should present its present status of product generation, i.e., the products themselves, the standards, models, parameterizations, and processing strategies used. A list of the deficiencies and problems encountered by the various techniques is of special importance here and the Service should describe, how they are intending to improve these issues and what new strategies are considered to improve the technique and products in general. In addition, the metadata flow from the services to the GGOS Portal (meta data format) will have to be an important topic. Also an updated version of SINEX including necessary updates will be considered.

Goals:
- Understand the processing details and problems of the individual techniques
- Information about the improvements planned by each of the techniques
- Discuss ways to improve the deficiencies and cure problems in the future
- Define formats, data structures and data flows for metadata for the GGOS Portal
- New version of SINEX

Session 2   Modelling Deficiencies and Modelling Based on External Data (Atmosphere, Ocean, ...)

.

Description: The geodetic/geophysical models used in data analyses still show significant deficiencies and are not really fully consistent among techniques and analysis centers. The various modeling problems (antenna effects, atmosphere, loading effects, etc.) should be addressed and possible solutions/improvements should be discussed. Of special importance is the fact, that in the future, the modeling of the observations will depend more and more on large amounts of external data (e.g., meteorological models for mapping functions and a priori delays, ocean models for non-tidal loading effects, hydrological models for hydrological loading, etc.). This can be considered a paradigm change in reference system definition and realization, because these external data sets will have to be available for all high-precision realizations of the frame, be it in post-processing or (near) real-time applications. The benefit from corrections based on external data and the implications thereof should be addressed.

Goals:
- Improve the accuracy and consistency of the geodetic/geophysical models used
- Assess the benefits of correction models based on large external data sets
- Discuss the implications of the paradigm change (from corrections based on "simple" mathematical formulas and corrections based on large amounts of external data

Session 3   Combination Strategies, Common Parameters and Combined Products

Description: One topic of this session are combination strategies to be used for various combined products of the IERS or GGOS (e.g., including troposphere parameters, quasar coordinates, gravity field coefficients, clocks, …). Important issues are, among others, the weighting of the observations and variance component estimation, constraining of parameters, rank deficiencies, datum definition strategies, combination of UT1 and LOD, nutation offsets and rates (VLBI + satellite techniques), definition of the parameterization for parameters common to more than one technique, standards for a priori values/models to be used for these parameters as well as standards for the time resolution (weekly, daily, sub-daily, ...) and reference epochs of parameters. Combination on the observation level will also be considered.

Goals:
- Improve common understanding of combination strategies
- Understand the singularities and correlations between different parameter groups and their impact
- Define parameter types to be provided in SINEX and their unique parameterizations and time resolution
- Concepts for UT1/LOD and nutation offsets/rates combination
- Steps towards new combined products (daily, weekly combined products; troposphere; …)
- Benefits of observation level combination

Session 4   Network Simulations and Analyses

Description: One of the GGOS recommendations (see GGOS2020 book) is the establishment of a global, well-distributed network of core sites, where all the major observation techniques are co-located. Simulations and analyses are therefore important to assess the number of sites necessary, some reasonable locations and what results are to be expected if, e.g., new observation techniques are implemented (kHz-SLR, twin telescopes, combined GPS/GLONASS/GALILEO receivers).
Goals:
- Assess network characteristics required to fulfill demanding requirements (e.g., 1 mm reference frame, 0.1 mm/y stability)
- Identify improvements to be achieved with technological innovations (technique-specific and local ties)

Mission T2L2 sur Jason-2 :
Bilan d'exploitation et perspectives

	Visa	Date
Préparé par : Philippe GUILLEMOT DCT/ME/EU Pierre EXERTIER OCA/GéoAzur Etienne SAMAIN OCA/GéoAzur		
Approuvé par : Etienne SAMAIN PI de la mission T2L2		

Pour												
application à												
Model												

Document géré en configuration	OUI/NON	par : CCM	à dater du :

Réf.	: T2L-RP-JA2EXP-1179-CNES	
Edition : 1	Révision :	D3
Date : 19/03/10	Page :	8

Titre : Mission T2L2 sur Jason-2 : Bilan d'exploitation et perspectives

L'instrument T2L2 est constitué de deux sous-ensembles, les boîtiers optiques d'un part, installés au bout d'un mat à côté du LRA, et le boîtier électronique situé dans le module charge utile à côté de l'instrument DORIS. L'ensemble pèse environ 11 kg pour une consommation d'un peu moins 50 W.
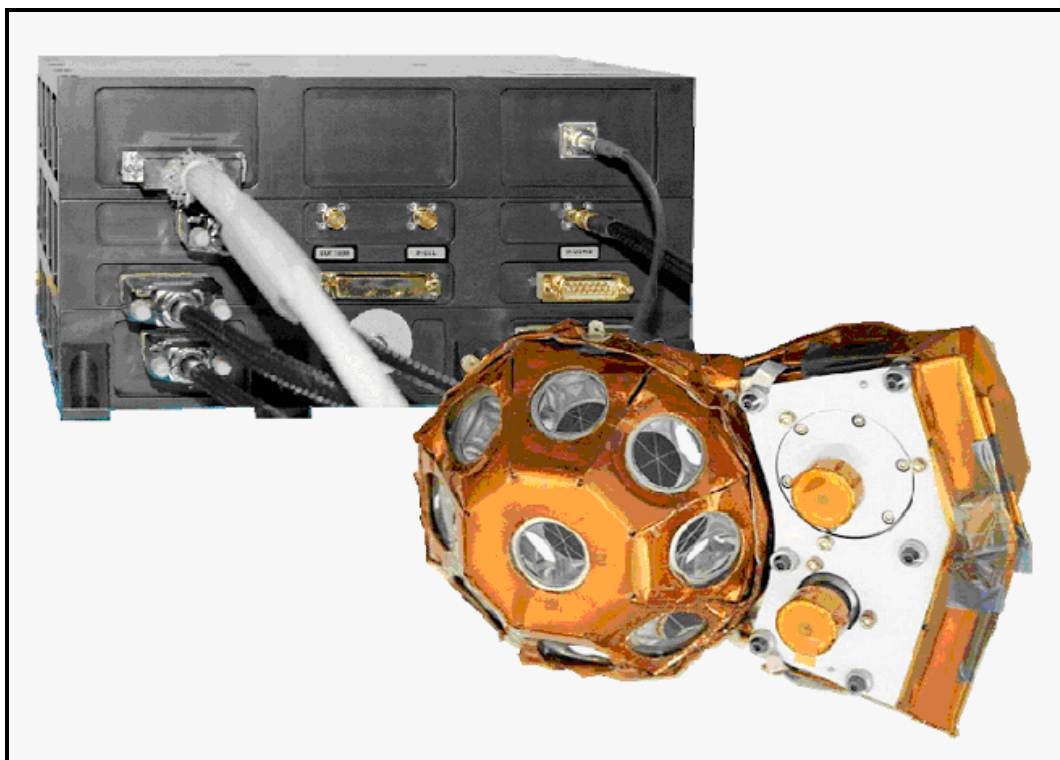
Figure 2-4 : *L'instrument T2L2 sur Jason-2 (avec le LRA)*

2.4.3 LE CENTRE DE MISSION INSTRUMENT

Le Centre de Mission Instrument s'interface d'un coté avec SSALTO, qui assure l'interface avec le segment sol Jason-2, et de l'autre coté avec le Centre de Mission Scientifique. Il assure les services suivants :

- Il émet vers SSALTO, qui se charge de les relayer vers le segment sol Jason-2, les télécommandes nécessaires au pilotage de l'instrument (ajustement de la configuration, gestion des autorisations de datation),

- Il reçoit via SSALTO les télémesures constituées des mesures de datation (TM scientifique) et d'informations sur le bon fonctionnement de l'équipement (TM servitude) et effectue les traitements de niveau 1, jusqu'au calcul des dates grossières,

- Il dispose d'un dispositif de contrôle de premier niveau permettant de réagir en cas d'anomalie sur l'instrument afin de le préserver au mieux,

- Il transmet les données d'expériences au Centre de Mission Scientifique.

			Réf.	: T2L-RP-JA2EXP-1179-CNES
			Edition : 1	Révision : D3
			Date : 19/03/10	Page : 34

Titre : Mission T2L2 sur Jason-2 : Bilan d'exploitation et perspectives

id <	1	1	0-9	1	>1m	1
id <	1	1	1	1	1	2->3
pas prévu <	1	0	1	1	1	1
triplet synth. <	1	1	0	1	-	-
pas prévu <	0	0	0	-	-	-

Tableau 5-2 : *???*

Ainsi, il est possible d'utiliser par la suite, des dates laser avec ou sans écho, ou avec des échos dont le résidus ne passe pas les critères de performances de l'orbite. Ceci permet d'avoir accès, ensuite, 10-20% de triplets supplémentaires, pour les stations qui émettent une date même sans écho (mesure de temps aller-retour).
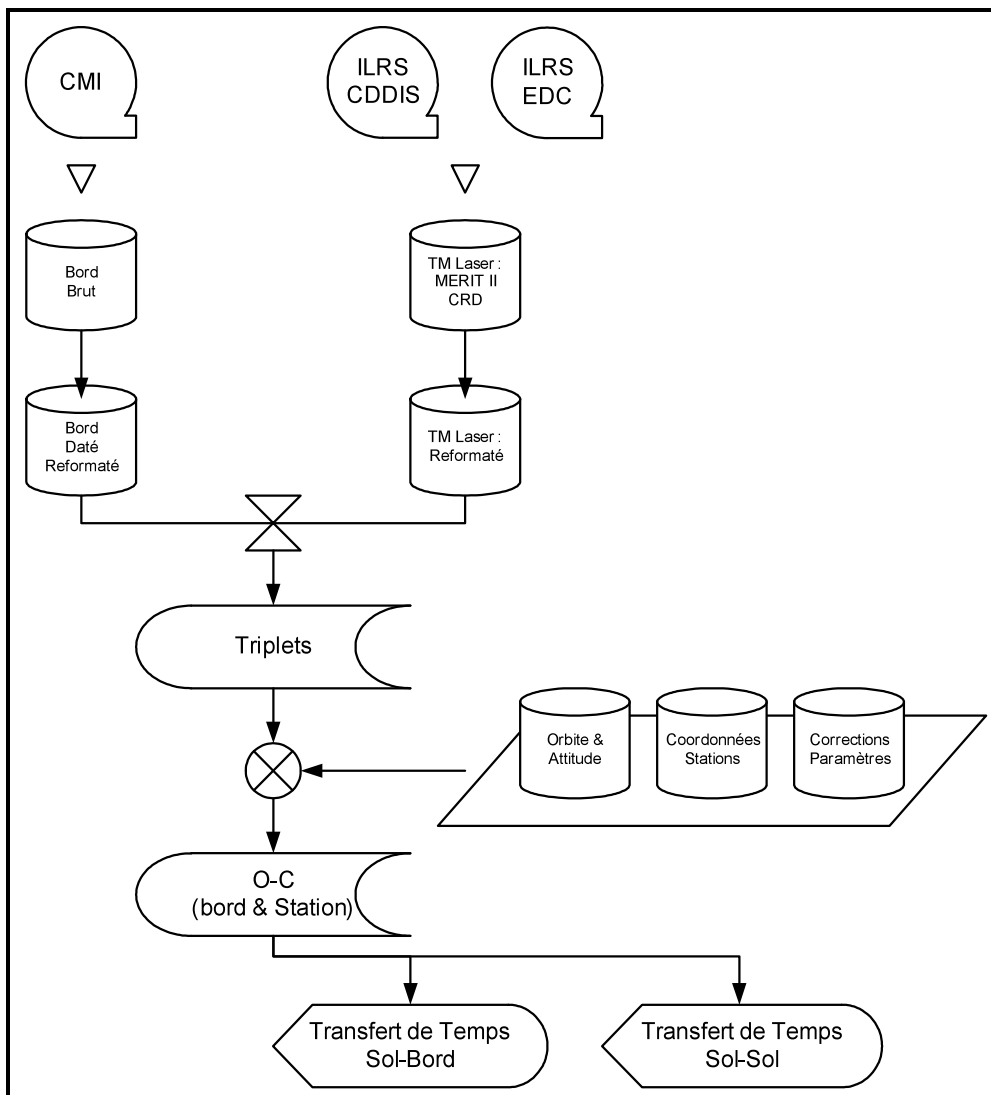
Figure 5-2 : *Schéma des traitements du CMS*

			Réf.	: T2L-RP-JA2EXP-1179-CNES
			Edition : 1	Révision : D3
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Titre : Mission T2L2 sur Jason-2 : Bilan d'exploitation et perspectives

type global, après une régression linéaire (uniquement) effectuée sur chaque passage de transfert de temps sol bord est de 0.085 ns et 0.102 ns, respectivement.
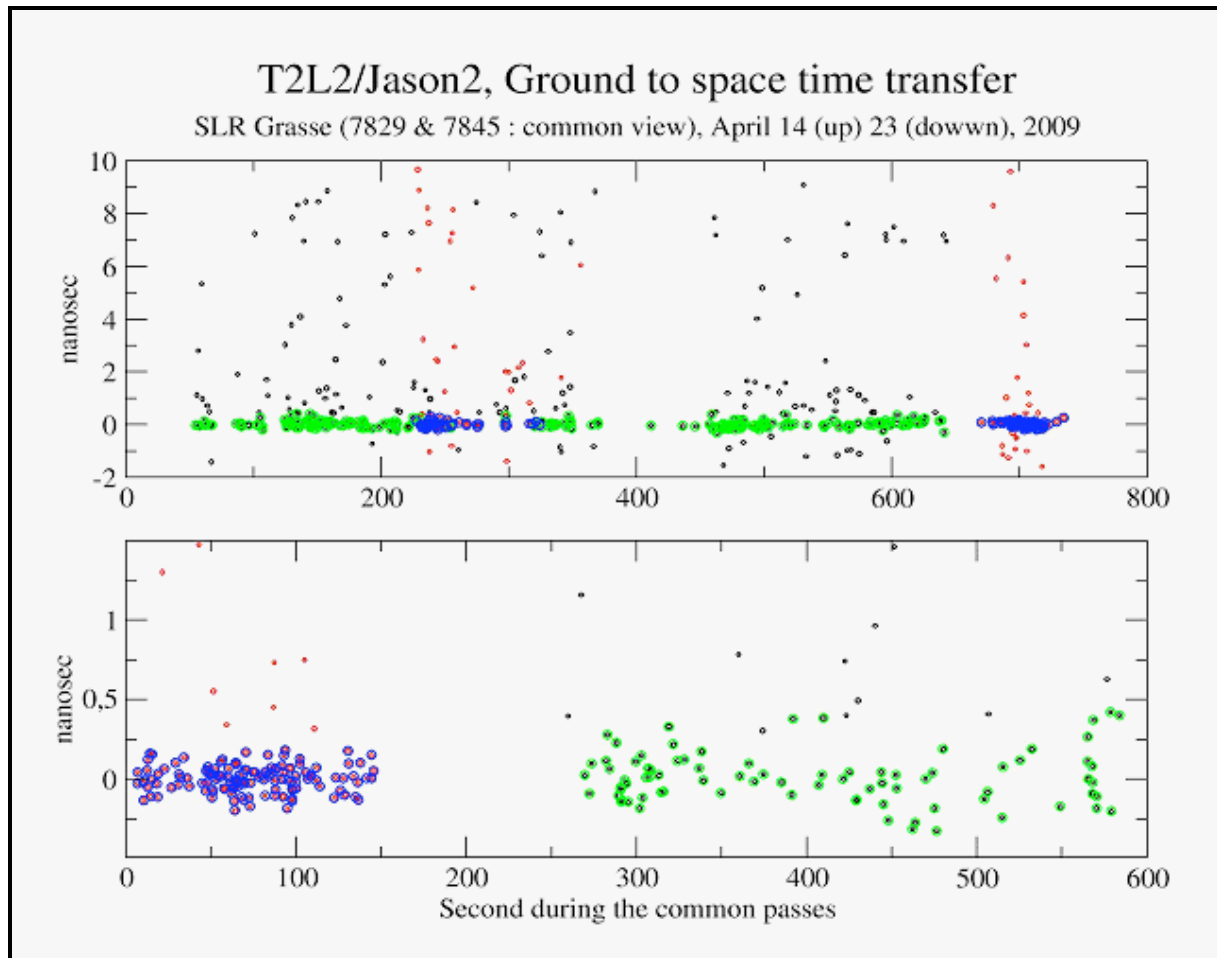
Figure 5-3 : *Exemple de Transfert de Temps sol-bord corrigé :*
MéO (7845) et FTLRS (7829) à Calern en vue commune

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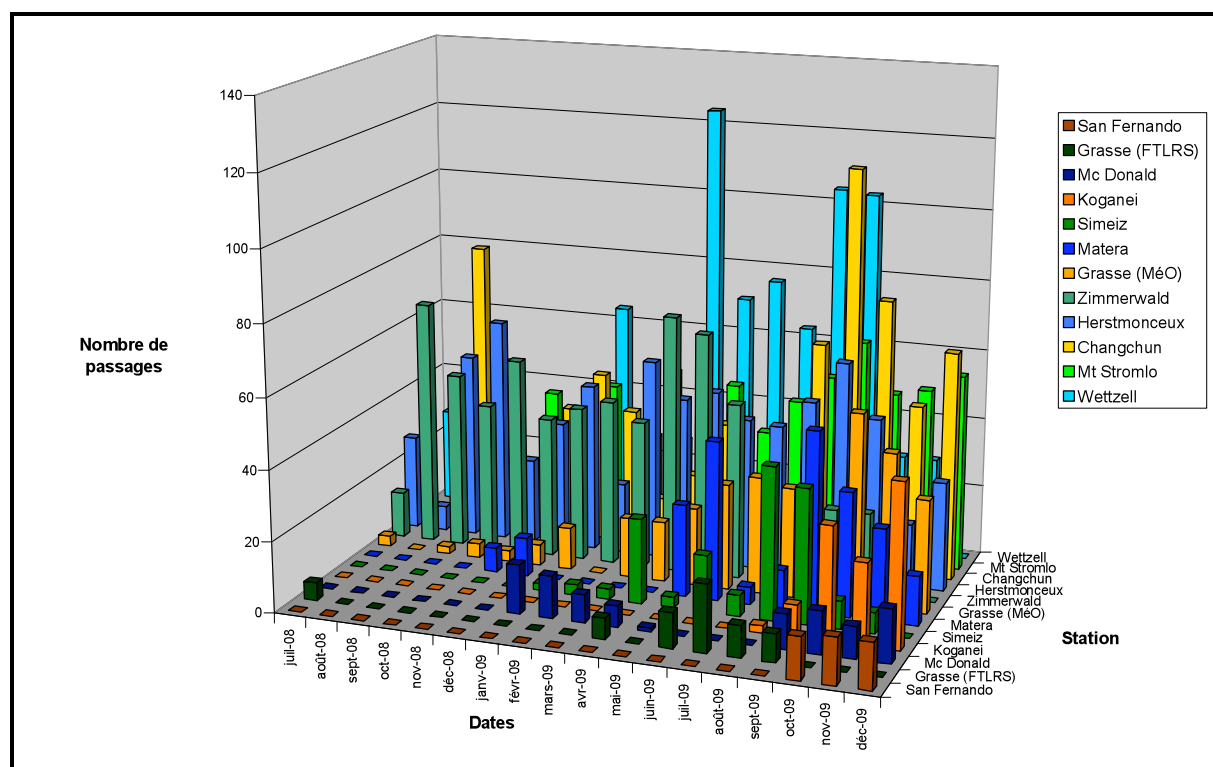
Figure 6-6 : *Bilan de l'activité laser pour les stations*
fournissant des données au format CRD

Station	Periode [mois]	Nombre total de passages	Nombre moyen de passages	Nombre moyen d'écho sol par passage	Pourcentage moyen de triplets par passages	Estimation de la précision du transfert de temps [ps]
Matera (Italie)	2	18	9	600	89	100
Wettzell (Allemangne)	6	132	22	400	79	20 000
Grasse-MeO (France)	5	18	4	1700	28	200
Grasse-FTLRS (France)	1	5	5	3000	14	800
Zimmerwald (Suisse)	6	271	45	1700	48	25 000
Changchun (Chine)	5	195	39	500	9	600
Mt Stromlo (Australie)	4	103	26	400	9	2 000
Herstmonceux (Angleterre)	6	211	35	1400	37	2 00
Ajaccio-FTLRS (France)	6	110	18	1600	13	3 000

Tableau 6-1 *: Bilan d'activité des stations laser pour T2L2 :*
2008 (6 mois seulement), format CRD.

Station	Periode [mois]	Nombre total de passages	Nombre moyen de passages	Nombre moyen d'écho sol par passage	Pourcentage moyen de triplets par passages	Estimation de la précision du transfert de temps [ps]

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Mc Donald (USA)	6	28	5	164	64	30 000
Yarragadee (Australie)	6	417	70	417	93	60 000
Greenbelt (USA)	6	170	28	483	88	55 000
Monument Peak (USA)	5	61	12	446	82	60 000
Tahiti (Polynésie)	6	18	3	565	90	55 500
Arequipa (Pérou)	6	63	11	78	97	37 500
Hartebeesthoek (Af. du Sud)	6	40	7	317	43	24 000

Tableau 6-2 *: Bilan d'activité des stations laser pour T2L2 :*
2008 (6 mois seulement), format MERIT.

Station	Periode [mois]	Nombre total de passages	Nombre moyen de passages	Nombre moyen d'écho sol par passage	Pourcentage moyen de triplets par passages	Estimation de la précision du transfert de temps [ps]
Matera (Italie)	8	213	27	825	90	100
Wettzell (Allemangne)	12	712	59	583	67	100
Koganei (Japon)Japan	5	112	22	1360	54	120
Grasse-MeO (France)	12	311	26	1700	21	220
Grasse-FTLRS (France)	5	52	10	3000	7	600
Zimmerwald (Suisse)	12	426	36	2542	28	8 500
Mc Donald (USA)	9	87	10	404	56	16 500
Changchun (Chine)	12	555	46	9438	7	550
Mt Stromlo (Australie)	12	568	47	350	12	2 000
Herstmonceux (Angleterre)	12	515	43	11667	20	2 750
San Fernando (Espagne)	3	38	13	600	23	15 000
Simeiz (Ukraine)	12	152	13	101	4	50 00

Tableau 6-3 *: Bilan d'activité des stations laser pour T2L2 :*
2009, format CRD.

Station	Periode [mois]	Nombre total de passages	Nombre moyen de passages	Nombre moyen d'écho sol par passage	Pourcentage moyen de triplets par passages	Estimation de la précision du transfert de temps [ps]
Yarragadee (Australie)	12	896	75	1042	93	57 000
Greenbelt (USA)	12	453	38	1375	88	55 000
Monument Peak (USA)	11	136	12	905	86	59 000
Tahiti (Polynésie)	4	22	6	800	94	55 000
Arequipa (Pérou)	8	59	7	54	100	30 000
Hartebeesthoek (Af. du Sud)	12	179	15	573	21	10 000
Simosato (Japon)Japan	4	21	5	166	15	20 000

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Tableau 6-4 : *Bilan d'activité des stations laser pour T2L2 :*
2009, format MERIT.

6.3 TRANSFERT DE TEMPS SOL-ESPACE

Les équipements mis en jeu au sein de l'ensemble des stations laser participantes sont très différents. Le tableau ci-dessous résume la situation pour quelques stations.

Country	Clock	Time Transfer
MéO (France)	HM + Cesium	TWSTFT-GPS
FTLRS (France)	_	_
Wettzell (Allemagne)	HM + Cesium	GPS
Herstmonceux (Angleterre)	Rubidium	GPS
Matera (Italie)	HM	GPS
Koganei (Japon)	Fontaine Atomique	TWSTFT-GPS
Zimmerwald (Suisse)	Osc GPS	GPS
Mt Stromlo (Australie)	Cesium	GPS
Changchun (Chine)	Rubidium HM	GPS-LTT

Tableau 6-5 : *Equipement des principales stations laser*
contribuant à la mission T2L2.

Le bruit du transfert de temps sol espace est gouverné par le bruit du lien T2L2, le bruit de l'horloge sol et le bruit de l'oscillateur DORIS. Les figures ci-dessous sont une illustration des résidus du transfert de temps sol-espace obtenue par 2 stations lasers l'une connectée à une horloge au Cesium, l'autre un maser à hydrogène
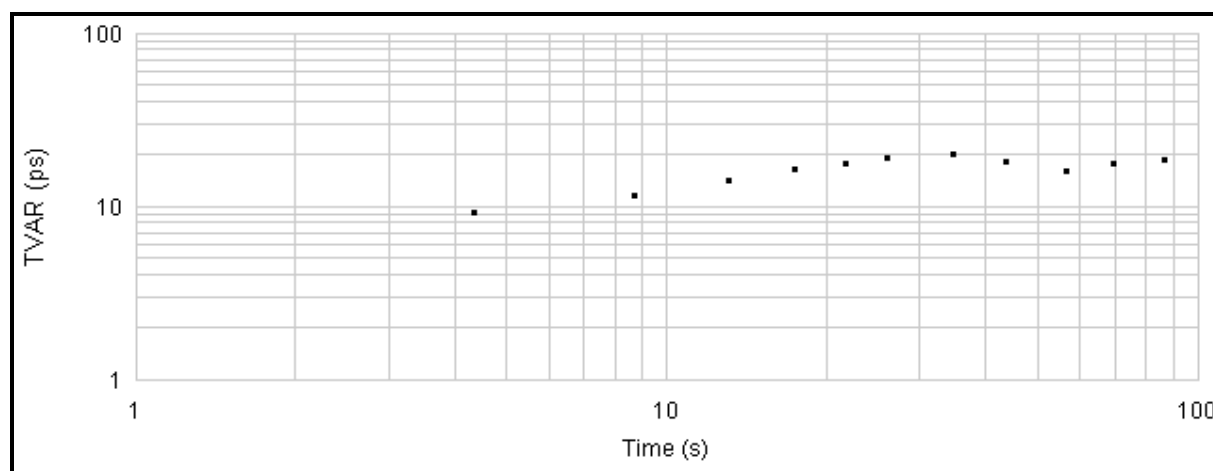
			Réf.	: T2L-RP-JA2EXP-1179-CNES
cnes CENTRE NATIONAL D'ÉTUDES SPATIALES	GeoAzur TERRE - OCÉAN - ESPACE	T2L2	Edition : 1	Révision : D3
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Figure 6-11 : *Stabilité par TVAR du transfert de temps en vue commune FTLRS - MeO*

6.5 TRANSFERT DE TEMPS ENTRE GRASSE, KOGANEI ET PARIS

6.5.1 CONTEXTE

Le laboratoire SYstème de Référence Temps Espace (SYRTE) de l'Observatoire de Paris est le laboratoire national de métrologie du temps et des fréquences, dépendant du Laboratoire National d'Essais (anciennement Bureau National de Métrologie). Il a parmi ses missions la recherche et le développement d'horloges toujours plus performantes et leurs utilisations pour la réalisation et la diffusion d'échelles de temps et pour la recherche fondamentale. Il possède aujourd'hui les horloges parmi les meilleures au monde et est équipé de tous les moyens actuels d'émission et de réception dans le domaine radiofréquence : système américain GPS, système européen EGNOS, système russe GLONASS et système 2 voies TWSTFT (Two Way System Time and Frequency Transfer) qui représente le meilleure outils de transfert de temps radio électrique opérationnelle aujourd'hui.

Le projet consiste à mettre en place une expérience de transfert de temps entre l'Observatoire de Paris et l'Observatoire de la Côte d'Azur pour comparer des signaux des meilleures horloges distantes de 800km par la méthode T2L2 et réaliser en parallèle des comparaisons avec les méthodes de transfert de temps radio électrique couramment utilisées. Elle constituera une première scientifique et technique dans le domaine de la métrologie du temps et des fréquences et de la physique fondamentale.

Le projet prévoit également d'inclure 2 autres stations équipées d'horloge ultra stable et du transfert de temps TWSTFT. Il s'agit des laboratoires de Borowiec en Pologne et de Koganei au Japon. Cette architecture permet notamment d'envisager les comparaisons de transfert TWSTFT entre l'Europe et l'Asie grâce au double lien TwoWay Europe-Asie dont dispose l'observatoire de Paris.

Outre l'inter calibration de tous les types de liens, l'expérience doit permettre l'obtention de nouvelles informations sur les délais atmosphériques puisque les signaux ne sont pas dans le même domaine de fréquence.

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- Permettre aux stations laser participante à T2L2 de s'équiper d'un dispositif de chronométrie capable de dater de façon exacte les événements laser

- Permettre d'étalonner les équipements de télémétrie laser et de transfert de temps radio électrique avec un instrument unique

Un premier contrat de collaboration de recherche pour mettre au point le prototype de cet instrument a été signé courant 2009 entre le CNRS, l'université et la société Phusipus Intégration. Un deuxième contrat de recherche a été signé début 2010 pour la réalisation de 2 modèles récurrents.

Figure 6-15 : *Kit T2L2. De gauche à droite :*
Face arrière avec les modules de métrologie et les entrées sorties réseaux, USB,... ;
Vue de dessus avec alimentation et PC embarqué ;
Logiciel embarqué

L'instrument est contenu dans un châssis 4U. Il intègre 2 dateurs, une synthèse de fréquence, les alimentations et un PC embarqué chargé de transformer les données brutes en date, de piloter différents types de mesures, de mettre à disposition un interface utilisateur et une interface réseaux pour le pilotage à distance. Le châssis est conçu pour accueillir jusqu'à 4 dateurs, un module d'horloge et une synthèse de fréquence.

Les caractéristiques de cet instrument sont les suivantes :

- erreur de répétabilité : 0.6 ps rms

- temps mort 120 ns

- bande passante des entrées commune 8 GHz

- fréquence de la synthèse 500 MHz

- fréquence d'entrée 1 à 250 MHz

- bande passante de l'entrée optique 20 GHz.

Un module de photo détection vient compléter cet équipement. Il est constitué :

- Un photo détecteur NewFocus ayant une bande passante de 20 GHz et une étendue spectrale étendue de 500 à 1600 nm.

- Une fibre optique mono mode (= 532 nm)

- Une optique de couplage libre-fibre