International Laser Ranging Service
Analysis Working Group

Minutes of AWG Meeting
Vienna, Austria
April 14, 2007

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e-GEOS, S.p.A. - ASI
AWG Coordinators

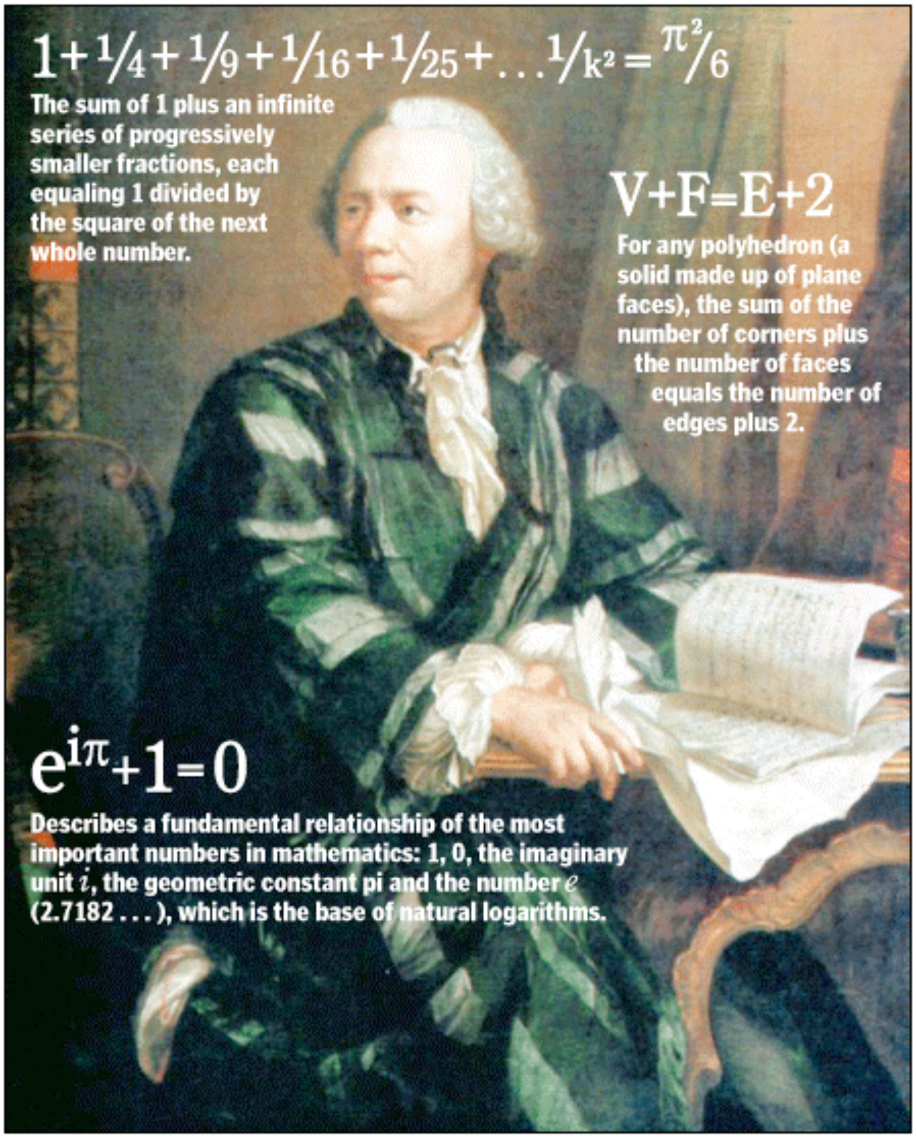
JCET-ISG-2007-02

Joint Center for Earth Systems Technology
University of Maryland Baltimore County
Baltimore, Maryland, 21250

May 20, 2007

AWG Spring meeting – TU Wien, April 14, 2007

Starting at: 9:00 am SEM124



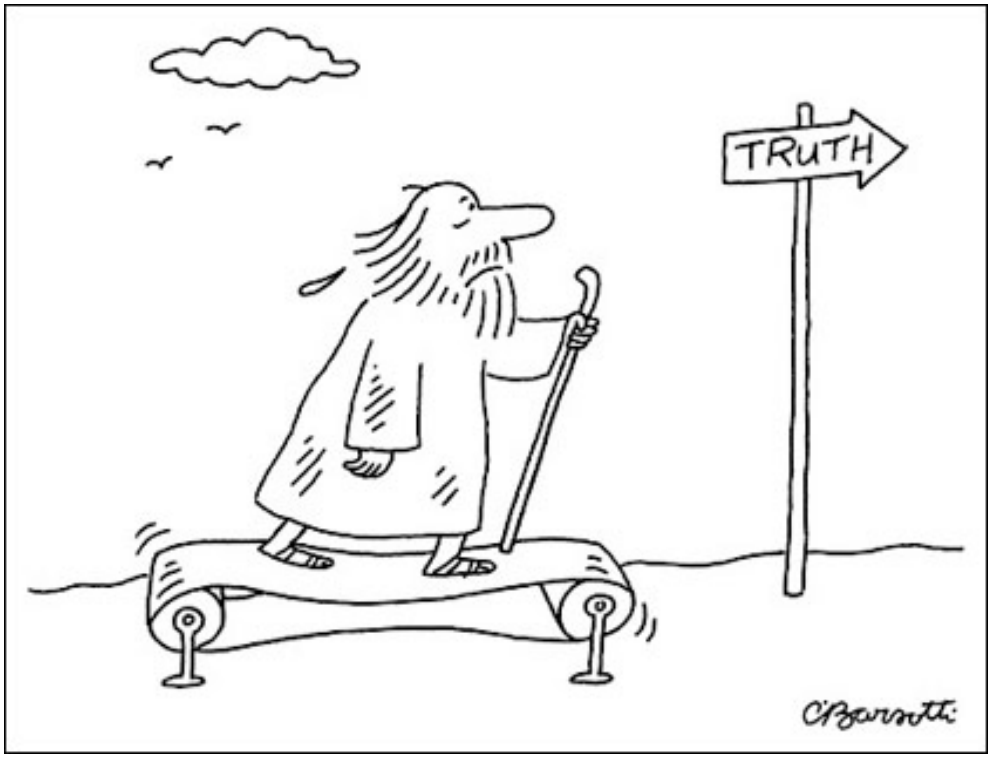
1737 Portrait by Johann Georg Brucker

Leonhard Euler was born in Basel, Switzerland, called the "Mozart of Mathematics," Euler published more than 800 papers of pure and applied mathematics before his death in 1783 (Sunday, April 15, 2007, marked the 300th anniversary of his birth).

Opening – Agenda review and adjustment & announcements

Old topics:

- ***Benchmark project: status***



- GA : completed successfully, official ILRS AC again.
- GRGS : A problem exists in the submitted orbit for the benchmark. After orbit comparisons with BKG, the problem has been isolated in the transformation from the inertial to the terrestrial reference frame. GRGS will send to Pavlis the inertial state vectors and the transformation matrices, to be checked within may 15th (or two weeks after receiving them). After that date, they will start to submit the weekly files to the CC for preliminary tests.
- NCL : submitted case is being examined now.

- ***Operational product "positioning + earth orientation"***
  - ITRF2005 & ITRF200X: ILRS 1983-1992 reports on analysis progress
    - ASI - time series 1983-1992 delivered. Plots with EOP and SSC comparison w.r.t. EOPC04 and ITRF2000 respectively. time series 1993-2006 delivered.
    - BKG - None
    - DGFI - Time series 1981-1992 delivered. Differences in the estimated orbits when using NASA and DGFI normal points. Time series 1993-2006 delivered. Check of DOGS versions undergoing, DGFI seems to be worse that others in estimation of the station UP component.
    - GA – Frank Lemoine reported for Ramesh that: time series 1983-1992 in processing and time series 1992-2006 delivered.
    - GFZ - Time series pre-1993 not delivered. Reported problems with the use of the normal points, probably due to the flags for the tropospheric correction. Joint effort DGFI-GFZ to fix the problem. Time series 1993-2006 delivered.
    - JCET – Reprocessed 1993-2007 time series submitted. Historical data analysis in 15—day arcs completed and submitted for the period 1976-1993. 5-day EOP solved for up until mid-1979, followed with 3-day EOP after the SINEX with date 790715.
    - NSGF - Time series 1983-1992 delivered. Plots on the height time series for a few stations, reasonably good results. Stanford corrections to be included. Time series 1993-2006 delivered.
    - GRGS - Plots on the high correlation between range biases and UP component were shown. The estimation of biases over long period decreases the correlation. A website exists with the database of the official ILRS solutions at:

      http://www.obs-azur.fr/gemini/donnees/index.html. Presentation on the status of the MEO telescope (1 year for the first observations to geodetic satellite and the moon) and the FTLRS laboratory.
  - operational product: ILRS-A/B technique issues, quality/refinement of products (e.g. weekly geocenter)

- JCET – presentation of the QC/QA site and the new additions in terms of weekly reports for each AC/CC to help monitor the quality of the submitted products. Follow the link:

  http://geodesy.jcet.umbc.edu/ILRS_QCQA

- Operational product enhancements – several suggestions:

  - Generation of a SLR-only TRF ala IGS00, etc.

  - Investigate the benefits of implementing atmospheric signals in SLR

- Pavlis suggests the application of the atmospheric loading and atmospheric gravity to the analysis for the ILRS products. The adherence to the IERS standards will be checked. A test on a couple of months will be done. Pavlis will send an e-mail with the months to be reprocessed.

  - Adoption of an ITRF2000 replacement timetable (ITRF2005SLR?)

- Adoption of a new ITRF. ITRF2000 and ITRF2005 are not suitable for SLR products and thus a new ITRF will be prepared using the rescaled ITRF2005, ITRF2000 roto-translated to ITRF2005 and the new stations in the ITRF2005 frame. The new ITRF will be named SLR05 and will be available within mid-may (Pavlis and Luceri).

  - Generation of daily EOP ala NEOS:

- Pavlis suggests the production of daily solutions. It is accepted to generate each day a 7 day arc solution with the same characteristic of the actual products. The time delay between the solution generation and the last analyzed data could be reduced after a check of the data delivery times (HTSC). The new timeline will be defined before the next meeting in Perugia.

  - Generation of a “geocenter” product:

- Luceri had suggested to deliver the weekly similarity parameters as official ILRS geocenter. It is decided to deliver the geocenter, in SINEX format, together with the new combined time series, after modelling update and Stanford corrections fixed.

- ***System bias studies (present and future):***

  - Stanford ET status report (Appleby & Gibbs)

    Presentation of the work on the Stanford calibration. Center of mass correction. List of corrections for most sites, plots of post fit range residuals as a function of returns per normal points.

    Appleby had circulated in 2006 December a table of corrections to be applied to range data from stations using Stanford counters. Most of the corrections were estimates (probable uncertainty ~5mm) based on characteristics of the Stanfords in use at Herstmonceux. Corrections of up to 10 or 15mm in range were indicated by this work. It is planned to examine at Herstmonceux as many as the operational Stanford counters as possible, in order to improve the estimated range errors due to the devices.

    Luceri reported that the Stanford corrections have introduced an artefact in the series. The UP component of the stations, affected by those corrections, is smaller and, since some of them are core stations, the SLR scale is shortened. The difference w.r.t. ITRF2000 and ITRF2005 is increased by 4 mm. Some stations had a jump in the range residuals caused by the introduction of the Stanford counter corrections and they seem to be larger after applying the corrections. This evidence suggests an incorrect sign in the adopted corrections.

    Koenig showed results of the new series using the new standards: M-P model and Stanford corrections. His results indicated a general deterioration of his solutions.

    After discussion on the adopted Stanford corrections, it was agreed that:

    - Appleby will check and report back on the corrections for Herstmonceux and for the estimates for the other Stations.
    - No Stanford correction will be applied to other stations. Gurtner underlined that corrections based on assumptions can be dangerous. ACs will remove those corrections from their modelling starting from the first week of May.
    - A systematic analysis of the biases to be applied to the stations will be done and a list of biases will be produced. The new re-analysis will apply those corrections. (Pilot project?)

  - CoM corrections for all targets, sites and time periods/configurations

    Considering that 6.4 mm correspond to ~1 ppb in scale change of the TRF, CoM corrections are becoming a major error source for SLR. The table that Appleby has generated for the LAGEOS CoM corrections will be examined to decide which “fixed” values should be adopted for each site, based on the range of values provided in that table (sometimes up to 10 mm).

  - Core site bias characterization in view of ILRS’ mm-SLR goal

    A study of the Eastbourne list will be done in order to revise the sites for which biases will be allowed to solve-for or to model a priori. Target date for discussion: Perugia

- ***Quality assessment of new SLR systems/sites (H. Müller)***

  The assessment of new stations will be based on: data quality, reliability, stability. The new data will be processed by two designared ACs that will generate range biases for all passes and will compute weekly coordinates. Close coordination and contact between the new site and the two ACs will be a prerequisite.

- ***Station performance card (ASI CC & DGFI CC)***

  The original idea of generating a "station performance card" based on the official weekly ILRS products is still not settled. The two CCs need to coordinate their activities and to generate reports for the sites that seem to under-perform on a given week or have an abrupt change in their coordinates or bias estimates.

  Dunn reported new web pages on products and station performance charts at the ILRS website. He also discussed and explained the Simosato height changes and their explanation based on system changes verified through discussions with the local team.

- ***Precise orbital product project (SP3c)***

  - Status report (ECP & Müller and CC reps)

  Pavlis showed the newly adopted (multi-technique) table with the official satellite codes to be used in the generation of SP3c files. The exchange of test SP3c files will be done prior to the Perugia meeting.

- ***Project "harmonization"*** *Status report (Mareyen)*

  None

NEW topics:

- ***GGOS and ILRS, establishing a closer tie with GGOS and maintaining a "live" link to GGOS, providing input for the studies and support documents that GGOS requires***

  Pavlis suggested that the AWG members should start to interact with GGOS more closely and monitor the areas of GGOS interests central to SLR. Suggested that AWG members attend the various GGOS meetings that were planned during the EGU week.

- ***Independent validation of SLR height variations and bias estimates with a routine AG survey of the core sites over time (1 to 4 times per year - baseline, once a month - goal)***

  Pavlis suggested the use of absolute gravimetry in the form frequent site surveys at SLR sites in order to place bounds in the SLR biases. ASI and NSGF possess AGs and could make them available in principle. NSGF reported that they are running their system on-site now.

- ***Report of the new WG on the evaluation/validation effort for site-ties between SLR and other techniques (GB & CL)***

  No major progress. A team has been formed, but the Networks & Engineering Group has not submitted a candidate yet. Julie Horvath/HTSI was suggested as a good candidate and Pavlis suggested also Detlef Angermann/DGFI.

- ***Generation of "clean" observational data set with known biases applied? (for use by POD groups)***

  Pavlis suggested the formation of a "clean" set of observations in the form of validated biases and data rejections to be made available to the wider SLR user community. The file that Müller is generating can perform this function if it is maintained and extended to past years. Action on this was postponed until we have clarified site biases further.

Miscellanea:

- SLR tracking network (status, weekend effect) – no news
- consistency of QC reports (ILRS CB) – no news
- documentation of analysis (ECP & CL) -- DONE
- special issue Journal of Geodesy (Noomen) – Ron is working on it
- other topics ???

Next meeting(s):

- 2-day meeting at Perugia (IUGG/IAG, July) ?
  The AWG tentatively agreed on a 2-day workshop in Perugia, during the IAG/IUGG. NOTE ADDED 07/05/08: The workshop length was later revised to 1-day with a much more focused agenda on urgent topics and an attempt to ensure that all open issues are on-track, keeping in mind the need for final results for the December workshop.

- 1-day meeting at Grasse Tech. Workshop (September)?
  The 1-day workshop during the Grasse meeting in September will serve as a final review and planning meeting for the program that the AWG will present at the December MTW.

- N-day IAG Services' workshop prior to Fall AGU (San Francisco, December '07)
  Pavlis reported the invitation/request from Rotacher for participation in a Multi-Technique Workshop (MTW), to discuss issues, practices and common topics associated with the analysis of space geodetic data.

Action items

- **Open action items from past AWG meetings**

ACs	prepare for new format SLR data (***see attachment***)
ACs	include conversion of orbit solutions into SP3c format (step-size 2 minutes for LAGEOS; 15 minutes for Etalon)
AWG	re-assess AWG core stations status + general ILRS classification
AWG	make overview of station activities 1993-present, based on eccentricity file and “pos+eop” info
CCs	prepare for combination of SP3c files
Mareyen	develop 2-day analysts get-together in Frankfurt(???)
Mareyen	investigate reasons for degradation of NKG(???) contribution to operational product
Müller (Horst), Pavlis	exchange and compare orbits in SP3c format
Müller	develop slr_discontinuities file further (1992-2006)
Müller (Jürgen)	develop validation plan for (new) LLR stations
Noomen, Pearlman, Gurtner	homogenization of QC reports
Noomen	get letter expressing general support for ILRS activities from IERS chairman
Noomen, Luceri, Gurtner	develop report with pos+eop use for stations and managers
Noomen	organize guest editorial board for JoG special issue
Noomen	check IERS procedure for station documentation after earthquakes and such
Noomen	get Delft QC procedure running again
Pearlman	remind Simosato to become IGS station

- **New action items**

Pavlis	dataset for the test on the models of atmospheric loading and gravity
Pavlis, Luceri	new ITRF for SLR analysis
HTSI	check of the station data delivery time
GRGS	inertial state vectors and transformation matrices to Pavlis
Pavlis	check of the GRGS orbits and transformation matrices
Appleby	check the Stanford corrections for Herstmonceux
ACs	remove Stanford corrections from the routine weekly analysis
Pavlis Luceri	pilot project for the generation of a bias list, etc.
CCs	start combination from pre-1993 time series, after GFZ submission
ACs and CCs	work on generating daily submission of weekly solutions

Closing comments

See you all in Perugia.

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ANNEX

Presentations at AWG meeting of 07/04/14

- ASI_awg_07_comb.ppt
- ASI_ILRS_AWG_Wien_0407_post93.ppt
- ASI_ILRS_AWG_Wien_0407_pre93.ppt
- DGFI_ILRS_awg_wien07_2.ppt
- DGFI_ILRS_awg_wien07_1.ppt
- DGFI_ilrs_awg_vienna_2007.pdf
- DUNN_Yarg_lclt_rng.pdf
- DUNN_station_front_page.pdf
- DUNN_official_products.pdf
- DUNN_2007_qrt1.pdf
- GFZ_egu_070417_rk.pdf
- GRGS_AWG_Wien_2007.ppt
- ITRS_ILRS-AWG-vienna-April-14-2007.ppt
- Lageos_com.xls
- NSGF_AWG_CoM.ppt
- NSGF_Stanford_calib.ppt
- NSGF_back_soln.ppt

New SLR data format

- crd_v0.26.pdf

SP3c Satellite Code list

- ALL_MISSIONS_TABLE_070201.pdf

Eastbourne accords bias list (discussed briefly but not shown)

- Bias List 2 Update 070414 .pdf

Status of ILRSA Weekly Solution

G. Bianco, C. Sciarretta, V. Luceri

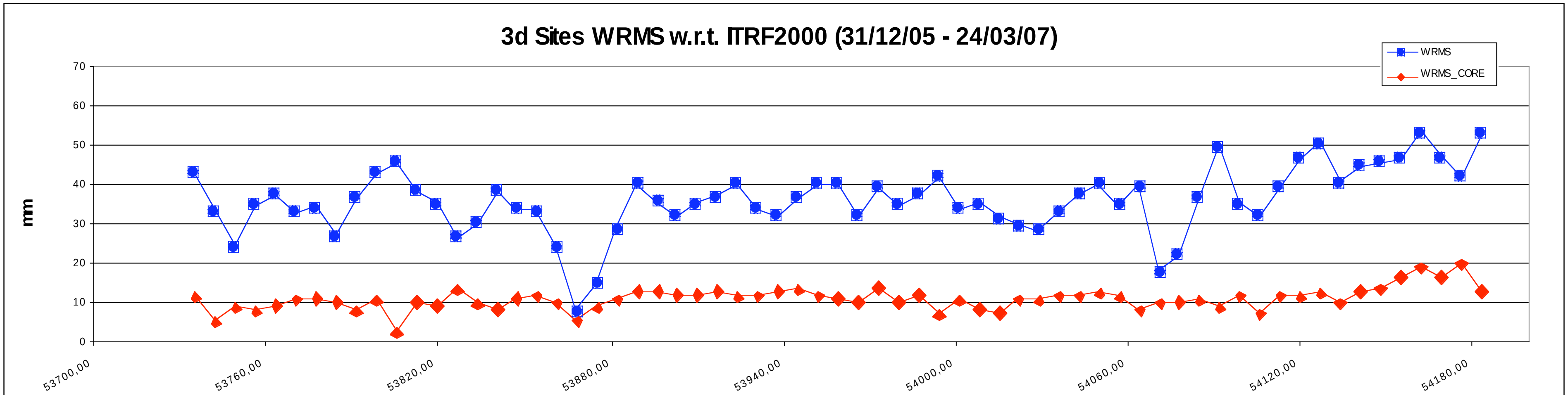
ILRSA consistency w.r.t. ITRF2000

Hereafter the plot showing the 3d differences of ILRSA **weekly solutions** for the period 31/12/05 – 24/03/07 is shown.

The combined solutions include solutions from **asi, bkg, dgfi, gfz, jcet, nsgf** as provided weekly.

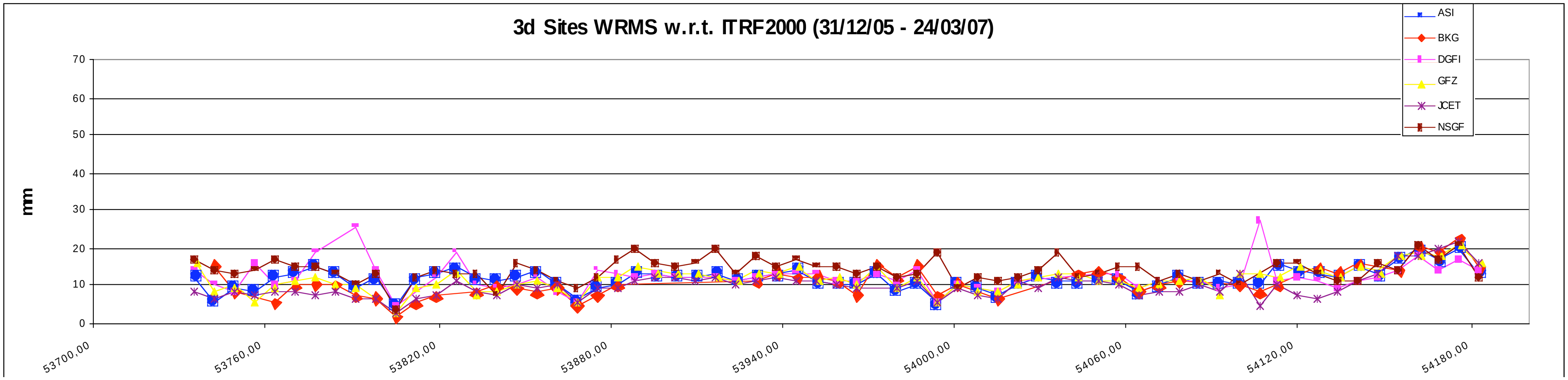
Only five weeks have been reprocessed for the period: they are available as **“v2”** in the archives.

The agreement for the Core Sites is at one cm level; from week 060107, different corrections have been applied: they turn into an increased 3d WRMS of the analysed differences.



ILRSA consistency w.r.t. ITRF2000

The single solution behavior (**Core Sites**) is similar, showing the same trend from 060107 onwards

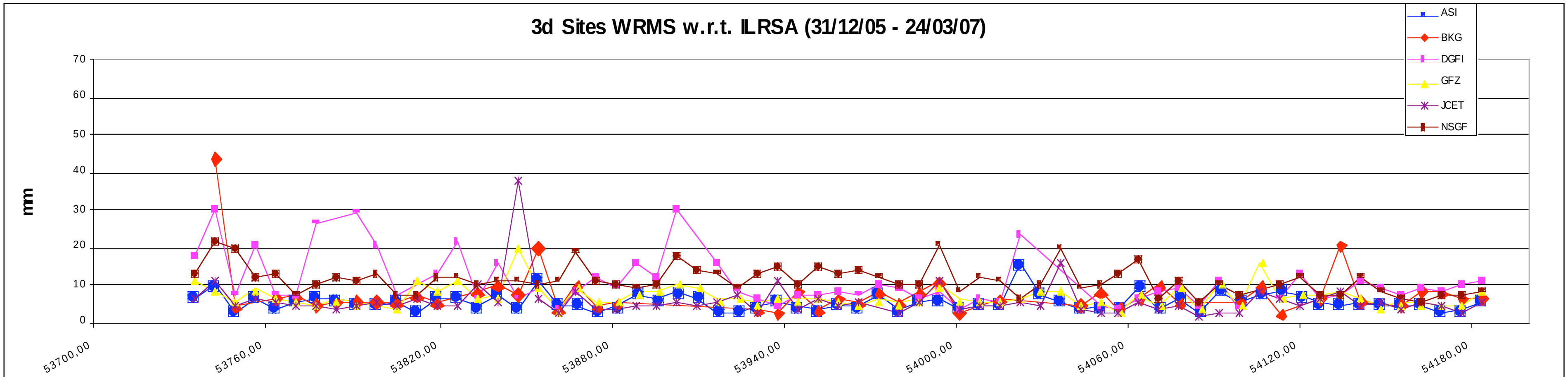


On the right, the average 3d WRMS (mm) for each solution (Core Sites) is reported

ASI	11.9
BKG	11.1
DGFI	12.4
GFZ	12.1
JCET	10.0
NSGF	14.2

ILRSA internal consistency

Moreover, the agreement of each solution w.r.t. the combined ILRSA is shown (**all sites**)

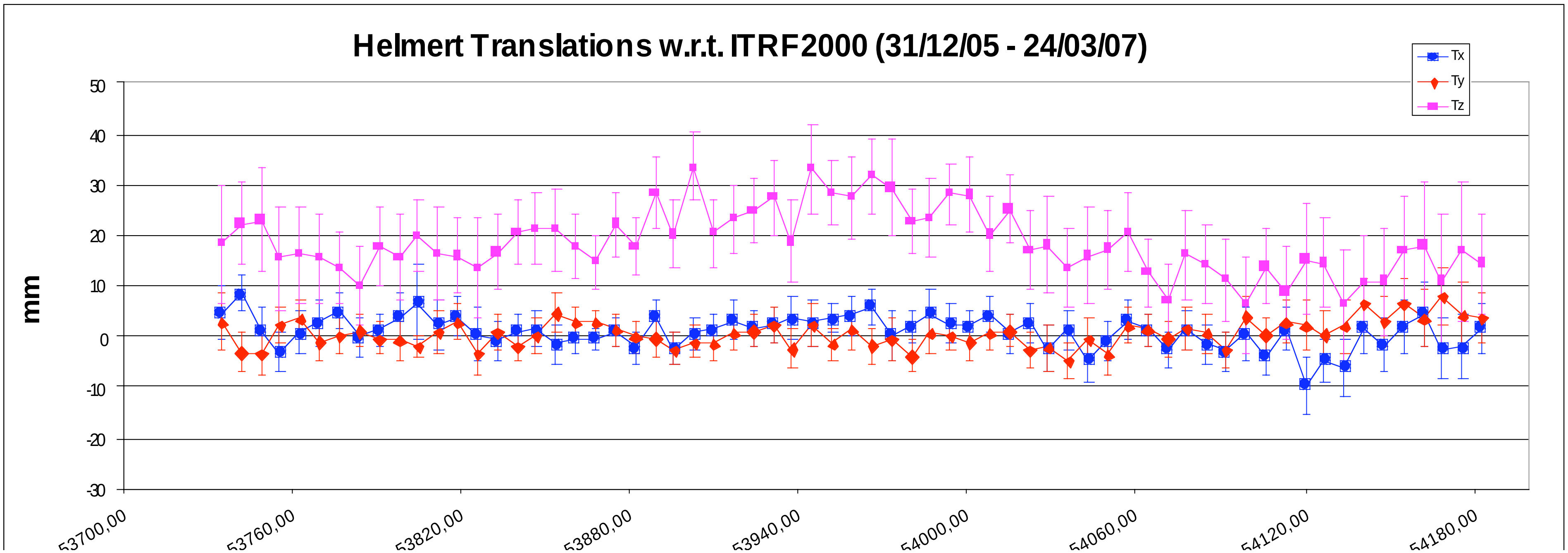


On the right, the average 3d WRMS (mm) for each solution w.r.t. ILRSA (all sites) is reported; ASI and JCET agree to ILRSA at 5 mm level, DGFI and NSGF agree at 1 cm level.

ASI	5.5
BKG	7.5
DGFI	10.8
GFZ	7.0
JCET	5.8
NSGF	11.3

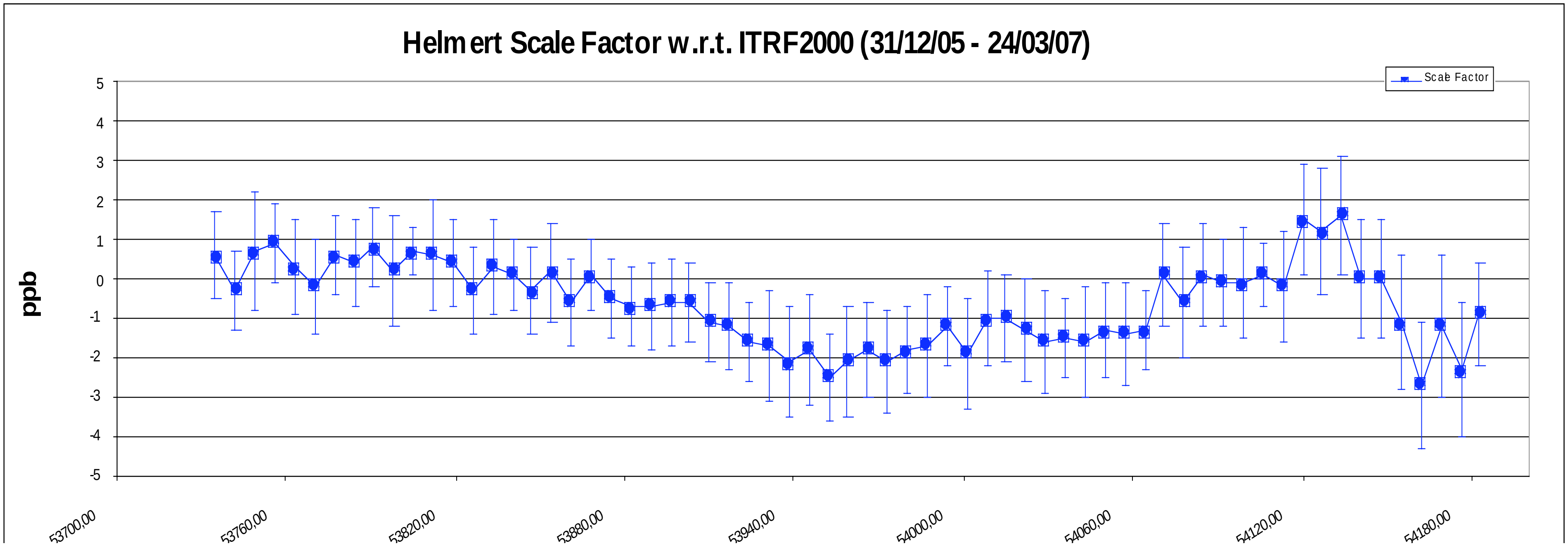
ILRSA Helmert Parameters

The usual plot for the Helmert Translation is shown for the analysed period (31/12/05-24/03/07); some different behaviors can be detected, again, after week 060107 (mjd>54106): Tz seems to be closer to 0, a slightly variability seems to appear in Tx and Ty; more data in the time series are needed!!



ILRSA Helmert Parameters

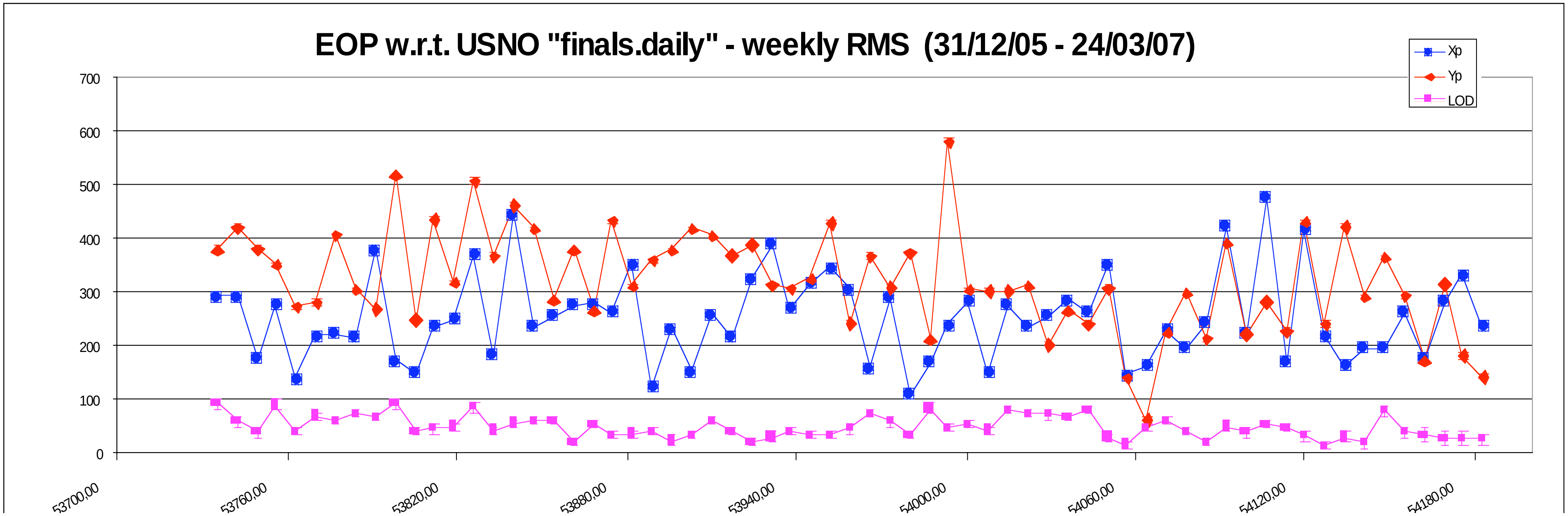
The usual plot for the Scale Factor is shown for the analysed period (31/12/05-24/03/07); again, after week 060107 (mjd>54106): a greater variability and a different trend seems to appear



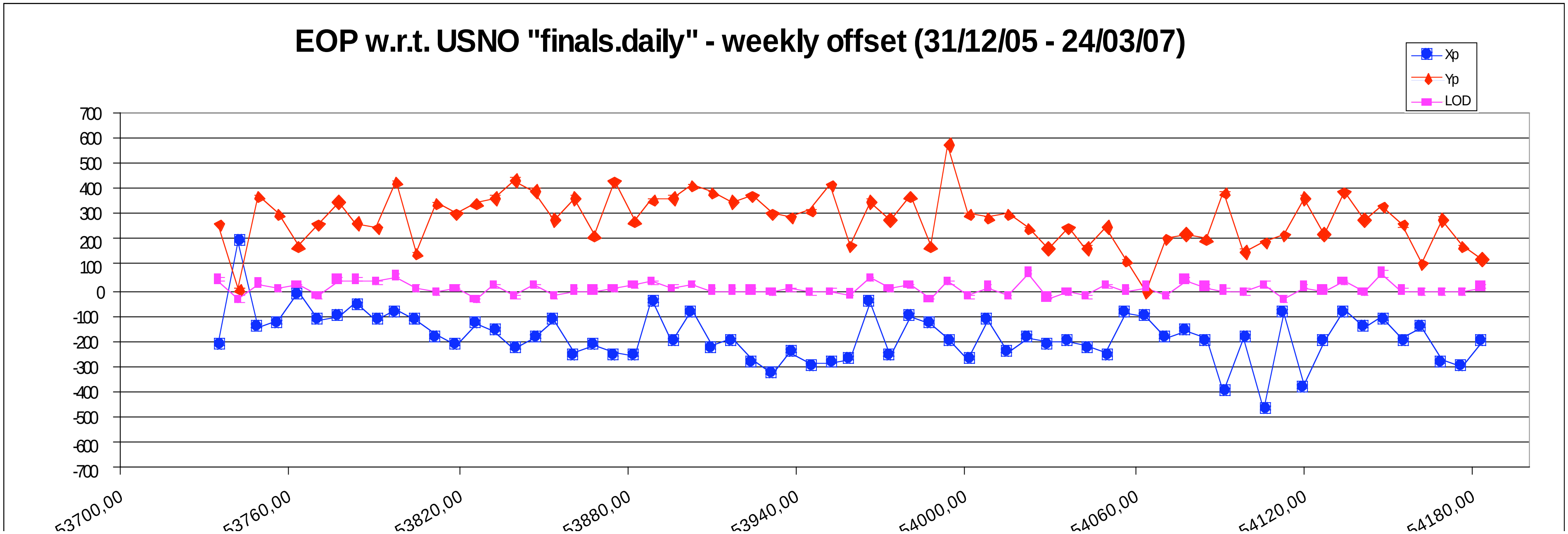
ILRSA EOP

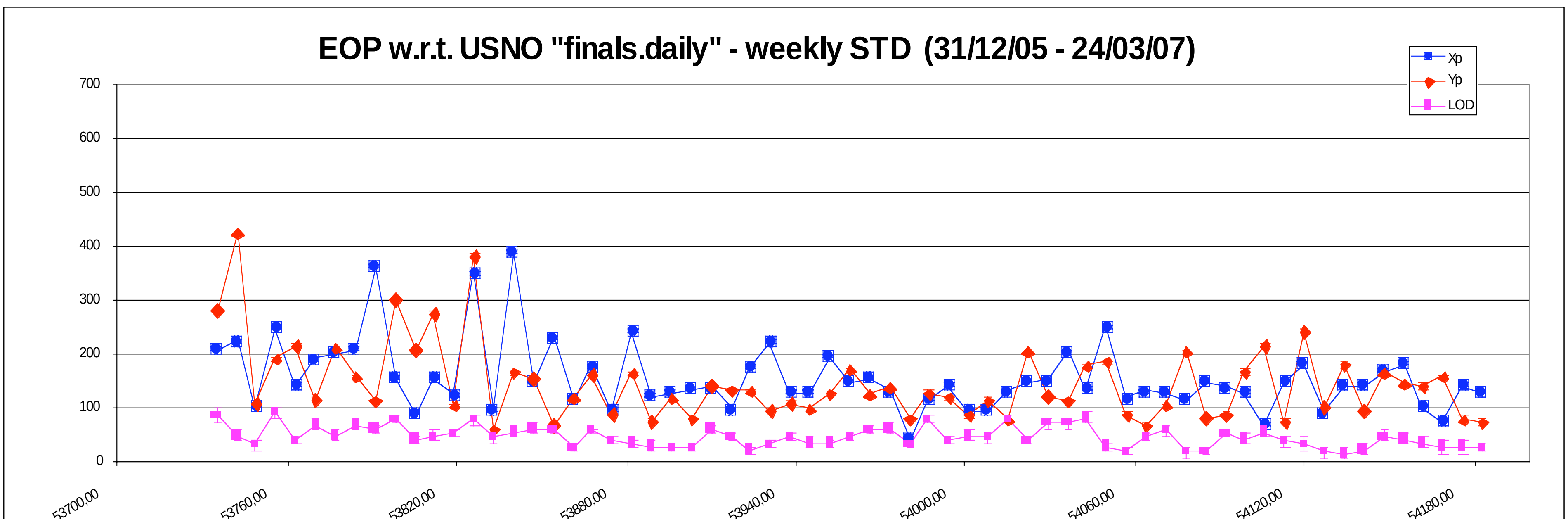
Above, the ***RMS*** values of the differences between ILRSA and USNO "finals.daily" (as used in the weekly report) are plotted; units are μas (xp, yp) and μs (lod).

In the next slide the differences are reported in terms of ***offset*** and ***STD***.



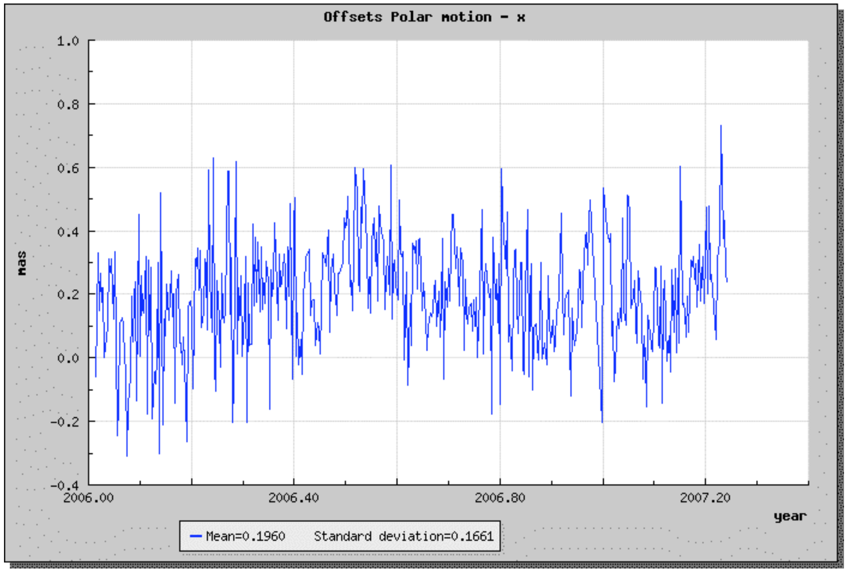
ILRSA EOP

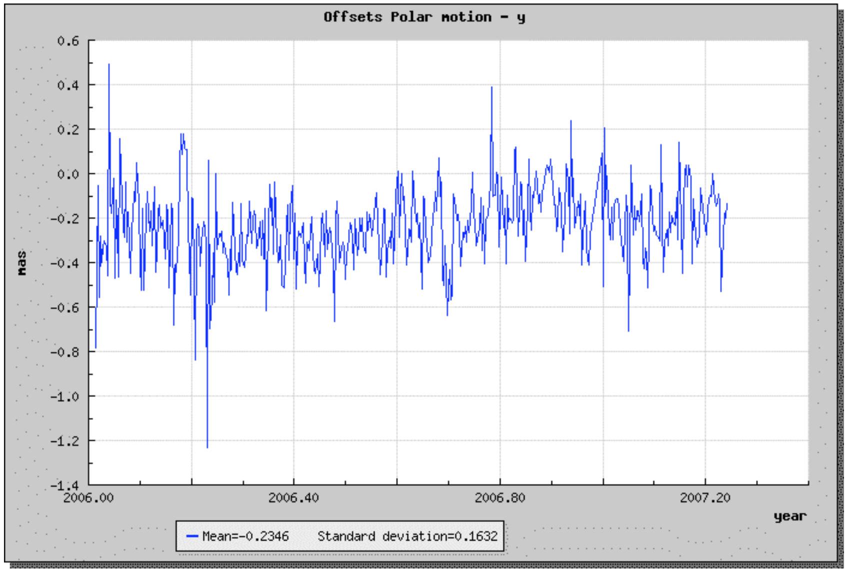

EOP w.r.t. USNO "finals.daily" - weekly offset (31/12/05 - 24/03/07)
Xp
Yp
LOD
700
600
500
400
300
200
100
0
-100
-200
-300
-400
-500
-600
-700
53700,00
53760,00
53820,00
53880,00
53940,00
54000,00
54060,00
54120,00
54180,00

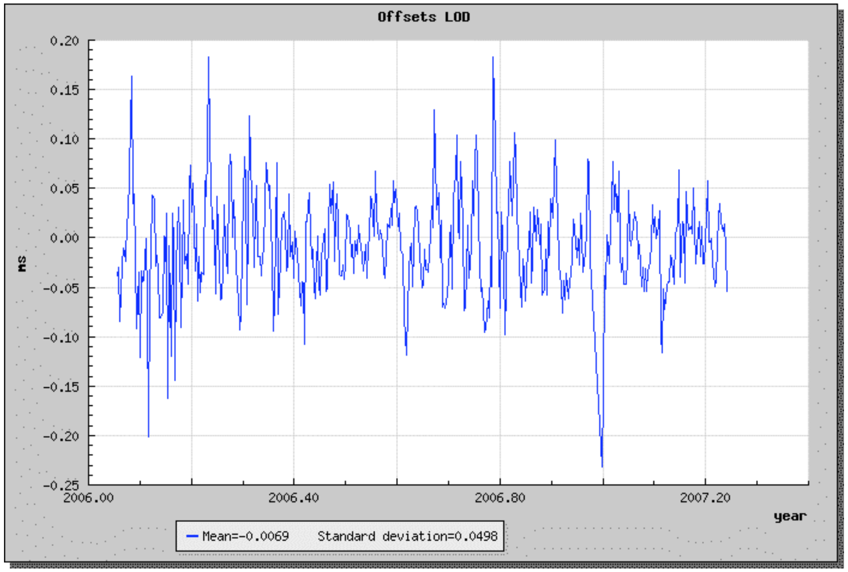

EOP w.r.t. USNO "finals.daily" - weekly STD (31/12/05 - 24/03/07)
Xp
Yp
LOD
700
600
500
400
300
200
100
0
53700,00
53760,00
53820,00
53880,00
53940,00
54000,00
54060,00
54120,00
54180,00

ILRSA operational solution for IERS EOP

IERS provided values (2006 ->) for operational series compared to EOP C04







ILRSA Status Summary

- The operational production of ILRSA weekly solutions **continues regularly**
- **6 ACs** have been contributing regularly since 2006.0
- All the ACs individual solutions share a **common good level of quality**
- **GA AC** has just started (week **070407**) the regular contribution after having successfully passed the benchmark test
- **ITRF2000** is still adopted in the combination solutions production and reported in the summary files
- ILRS combined solutions are used regularly in the production of **EOPC04** series; IERS allows a continuous monitoring of the quality of our ILRS solution and of its performance w.r.t. to the other contributors

ASI operational products: 1993-2007 series (version 6)

G. Bianco - Agenzia Spaziale Italiana

V. Luceri – e-GEOS S.p.A.

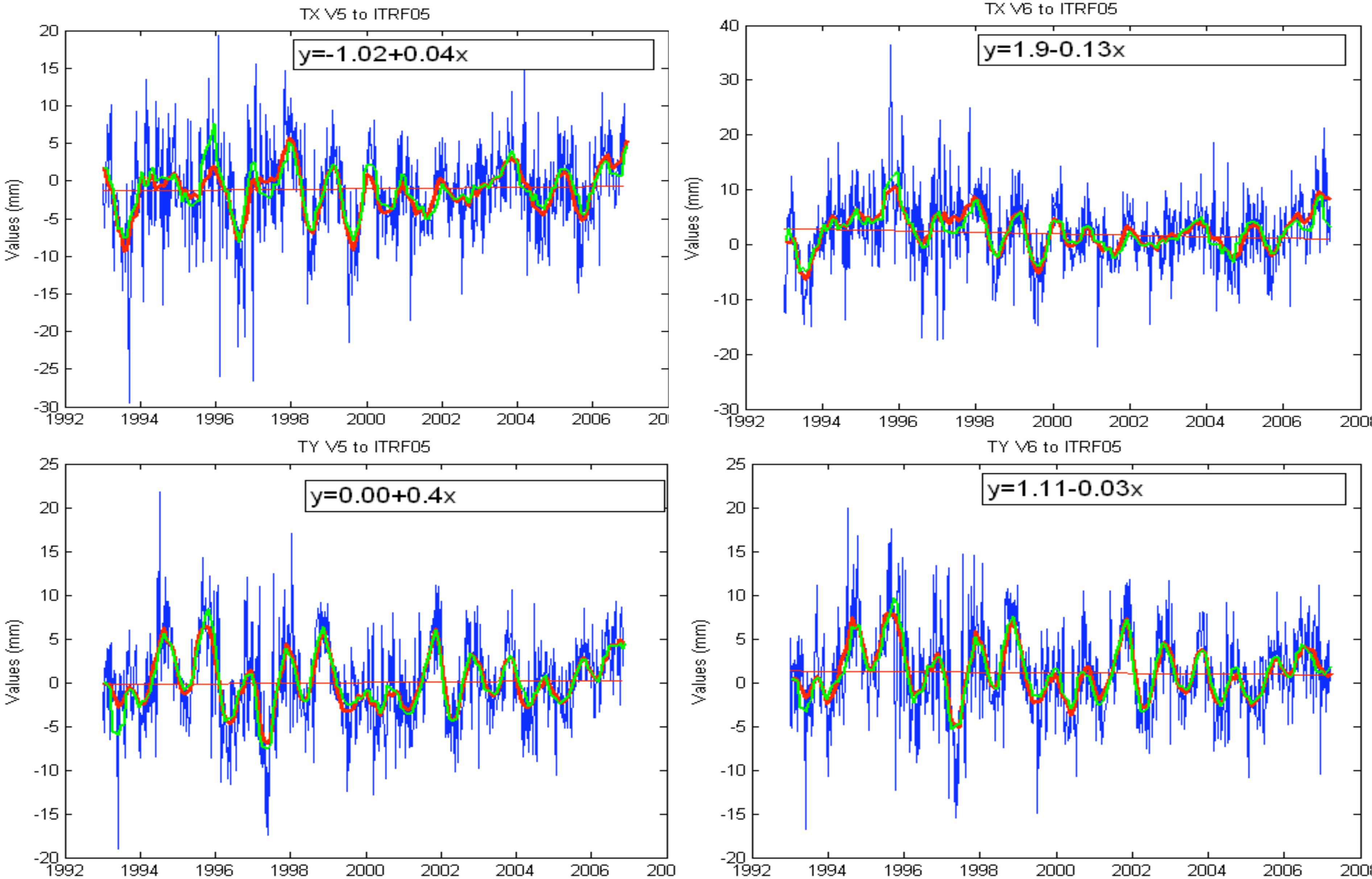
Core stations

AWG core site for 1993 -2007

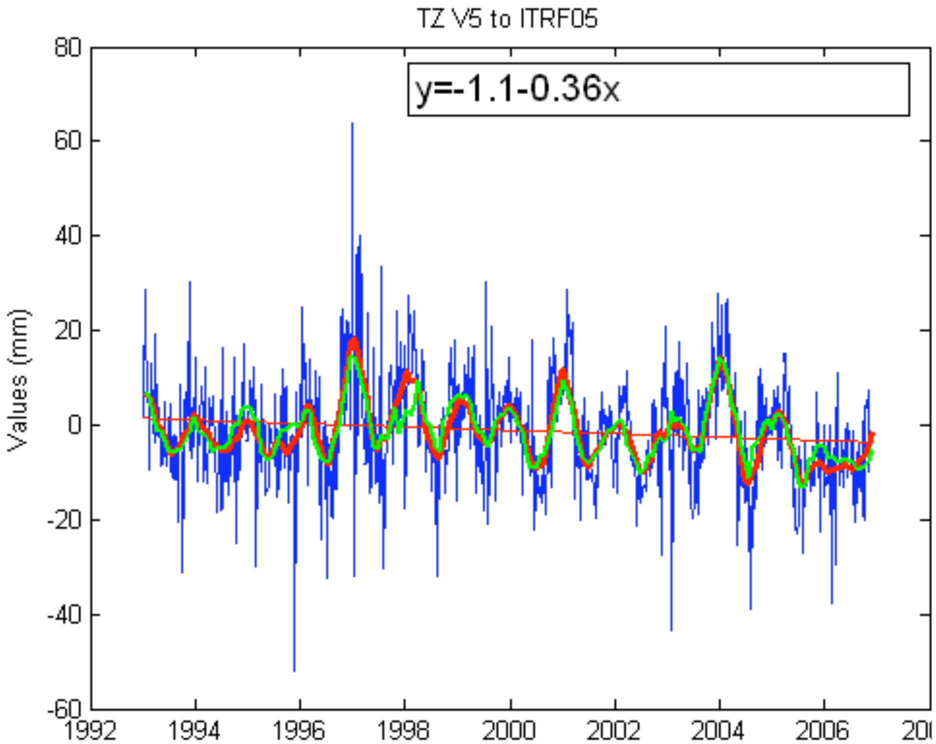
11001S002 7839 Graz 96:268:55735
40451M105 7105 Greenbelt 93:018:15434
13212S001 7840 Herstmonceux 92:362:04637
40442M006 7080 McDonald 93:011:47264
40497M001 7110 Monument Peak 93:004:12732
14201S018 8834 Wettzell 93:012:46468
50107M001 7090 Yarragadee 92:362:54751
14001S007 7810 Zimmerwald new 96:353:62813
10002S002 7845 Grasse 97:327:55006 04:265:02443
40445M001 7210 Haleakala 94:026:20235 04:156:47280
30302M003 7501 L HART(coo/vel JCET) 00:221:73541
12205S001 7811 Borowiec 93:200:54797
14106S009 7836 Potsdam 93:004:15930 04:164:75988
21605S001 7837 Shangai 93:025:51341

ASI Translation w.r.t. ITRF2005

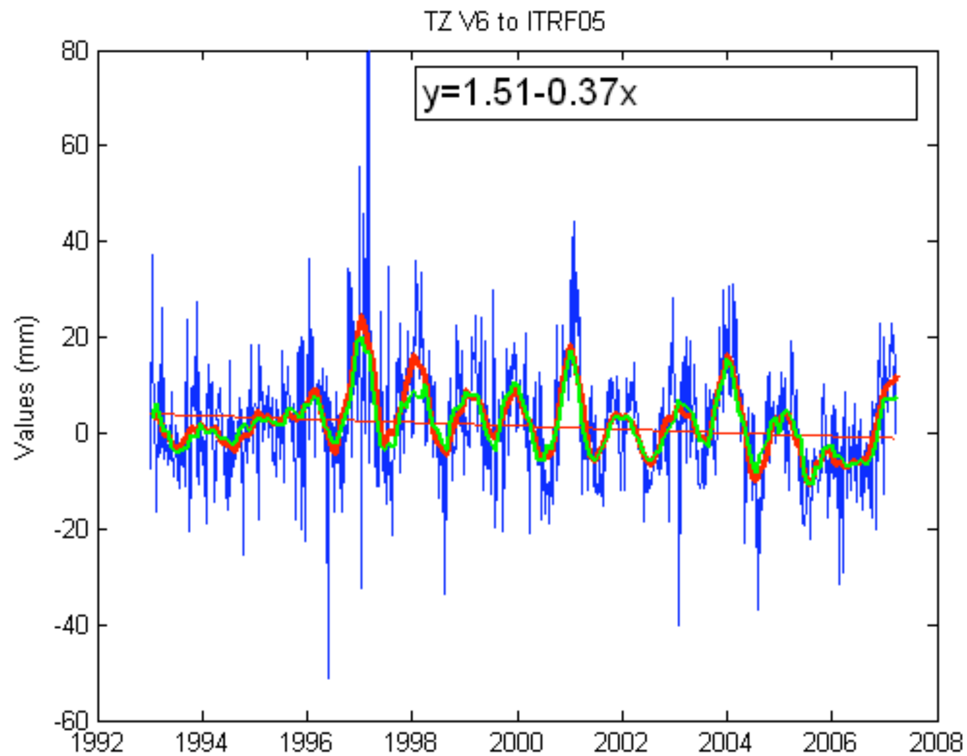
NEW



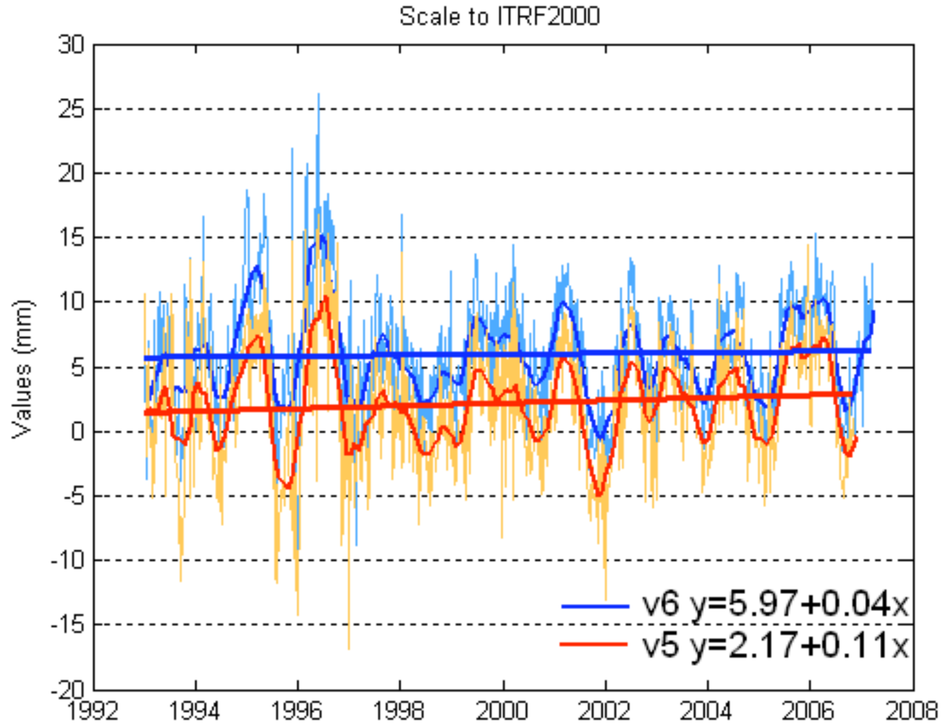
ASI Translation w.r.t. ITRF2005

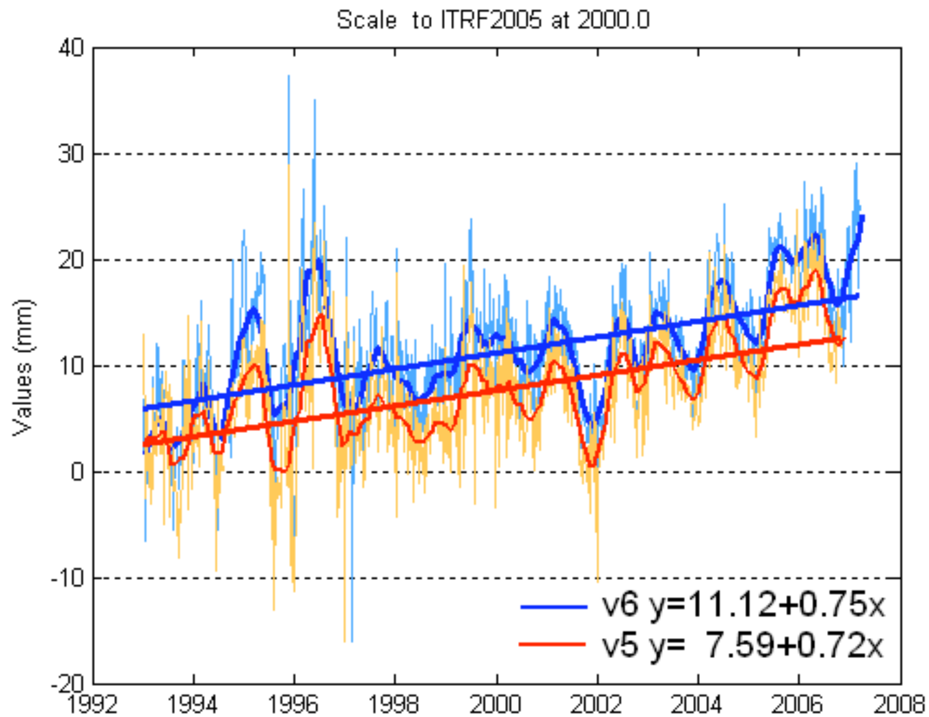


NEW

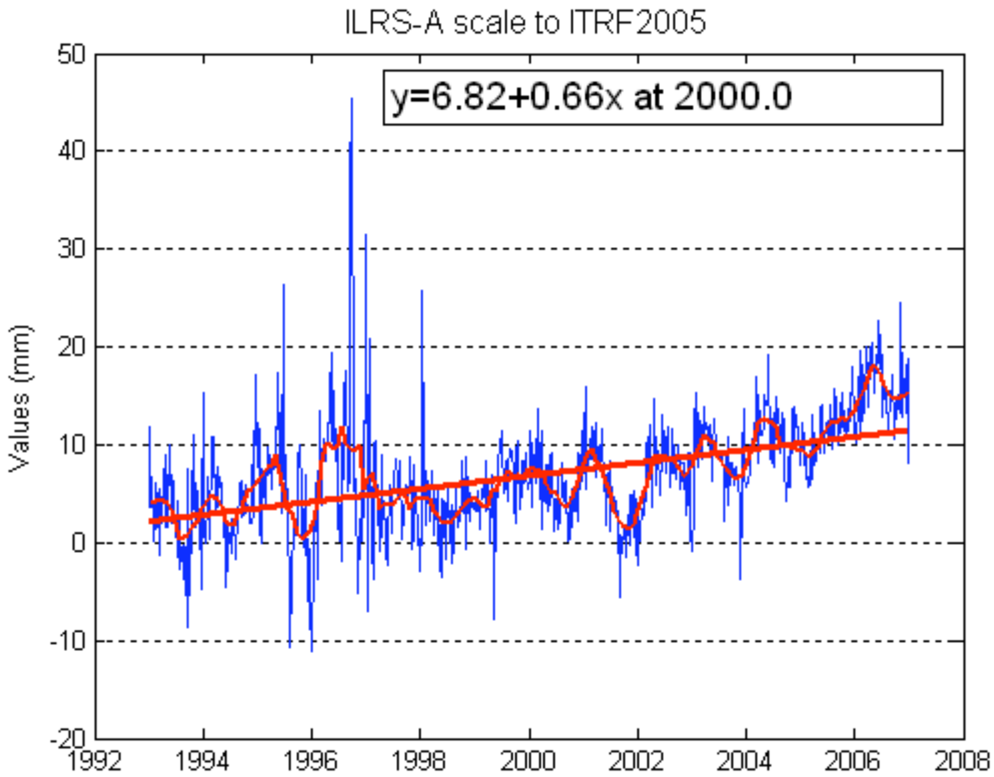


ASI Scale w.r.t. ITRF





ILRSA Scale w.r.t. ITRF2005



Stanford correction effect (ASI sol.)

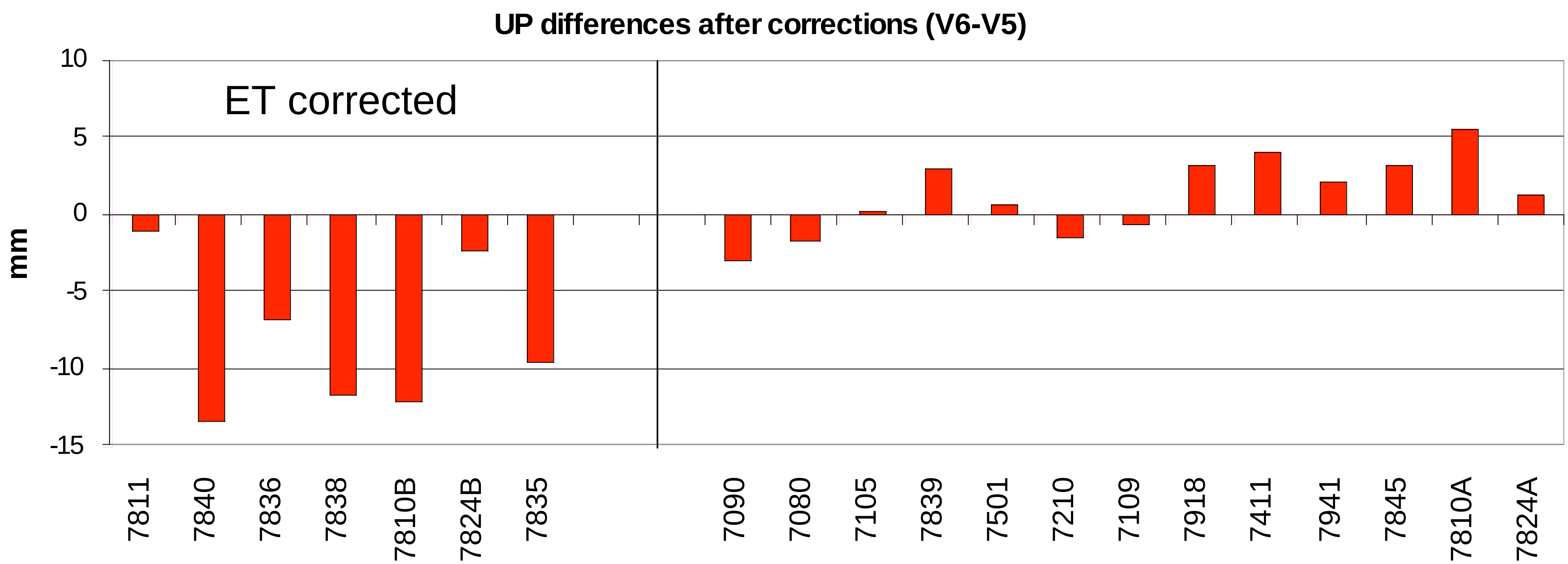
UP(mm) V5 w.r.t. ITRF2000

	wmean	wrms
7811	-3.765	22.331
7840	2.005	7.076
7836	-5.03	9.46
7838	-21.248	24.642
7810B	2.627	13.352
7824B	-46.588	32.581

UP(mm) V6 w.r.t. ITRF2000

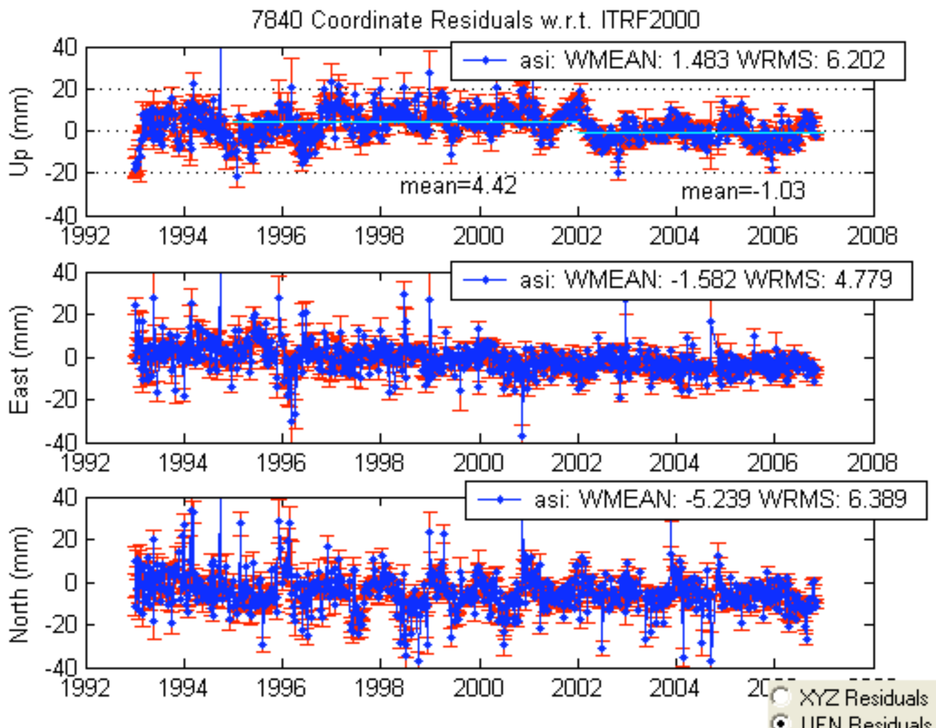
	wmean	wrms
7811	-4.809	25.955
7840	-11.326	6.694
7836	-11.803	9.262
7838	-32.966	26.829
7810B	-9.406	14.594
7824B	-48.934	36.57
7835	-17.545	12.596
7249	-132.394	84.236

without scale transformation



Stanford correction effect (ASI sol.)

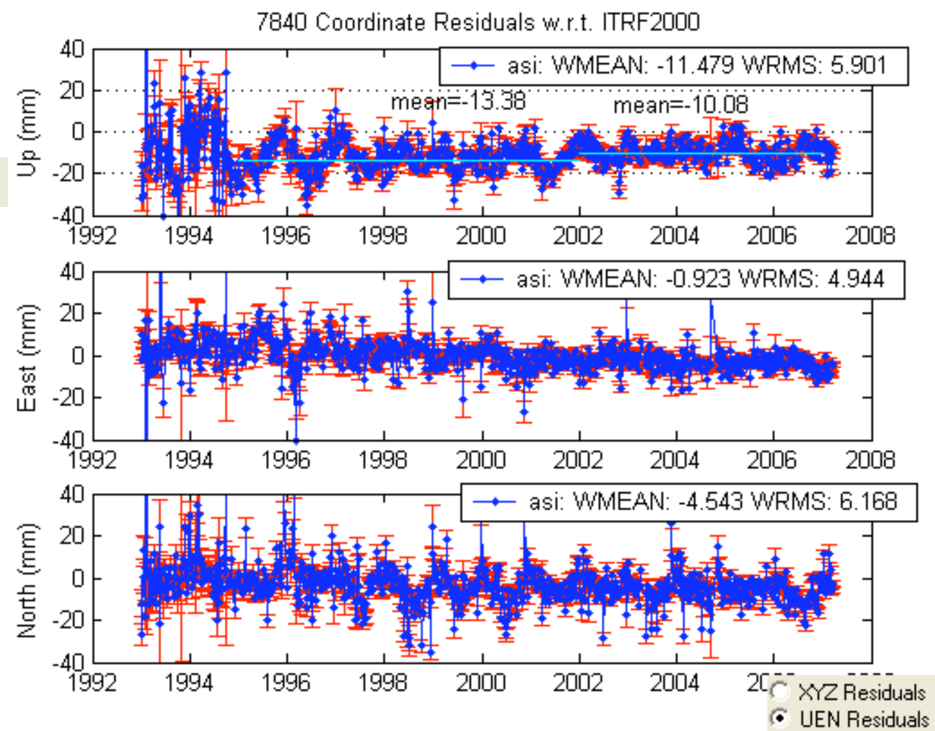
Site 7840 Hers



without scale transformation

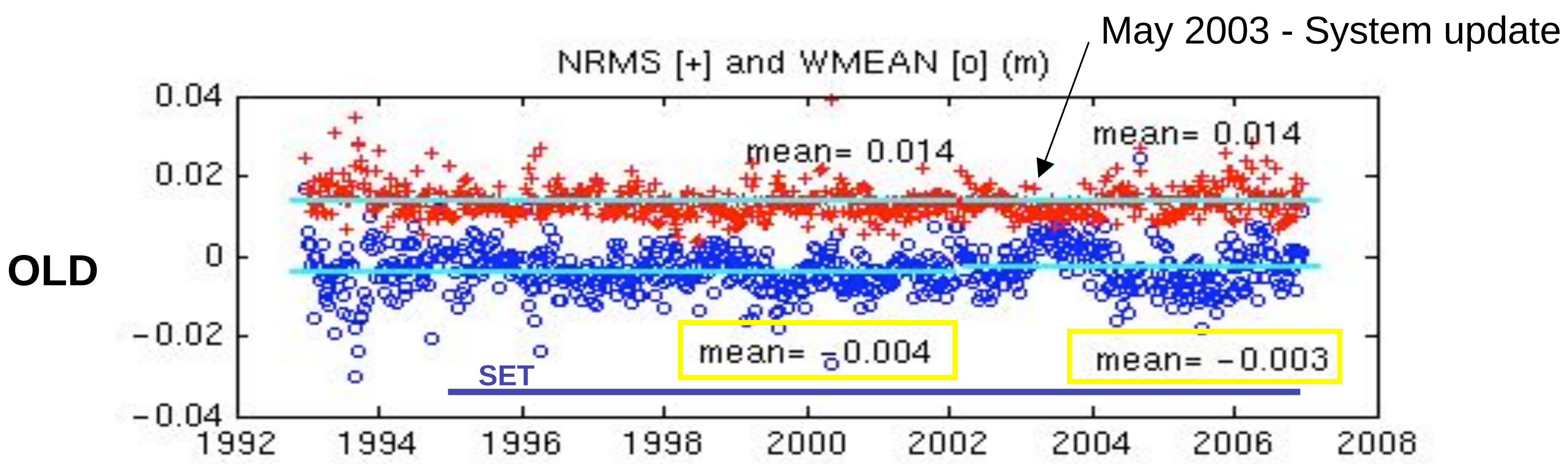
OLD

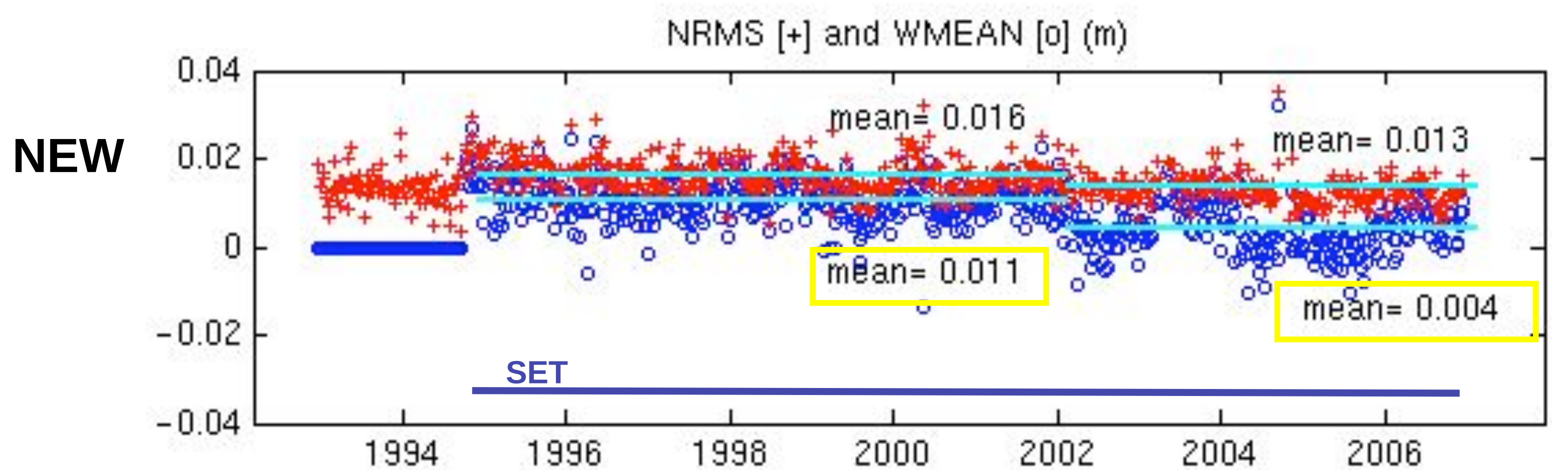
NEW



Stanford correction effect (ASI sol.)

Site 7840 Hers – Lageos1 Range residuals (ITRF2000 coordinates)

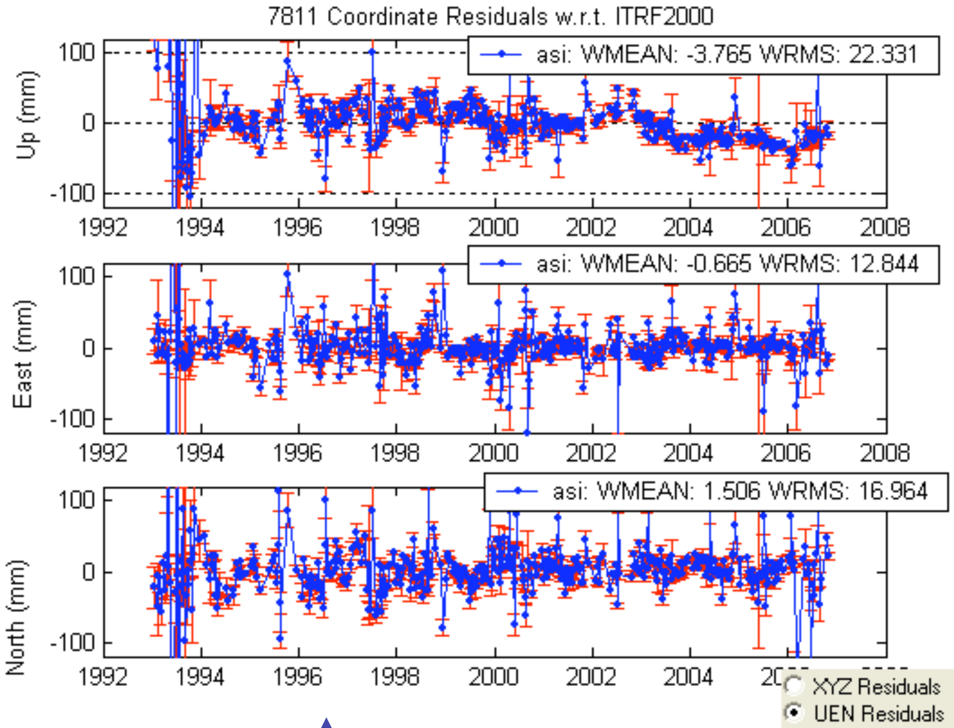




Stanford correction effect (ASI sol.)

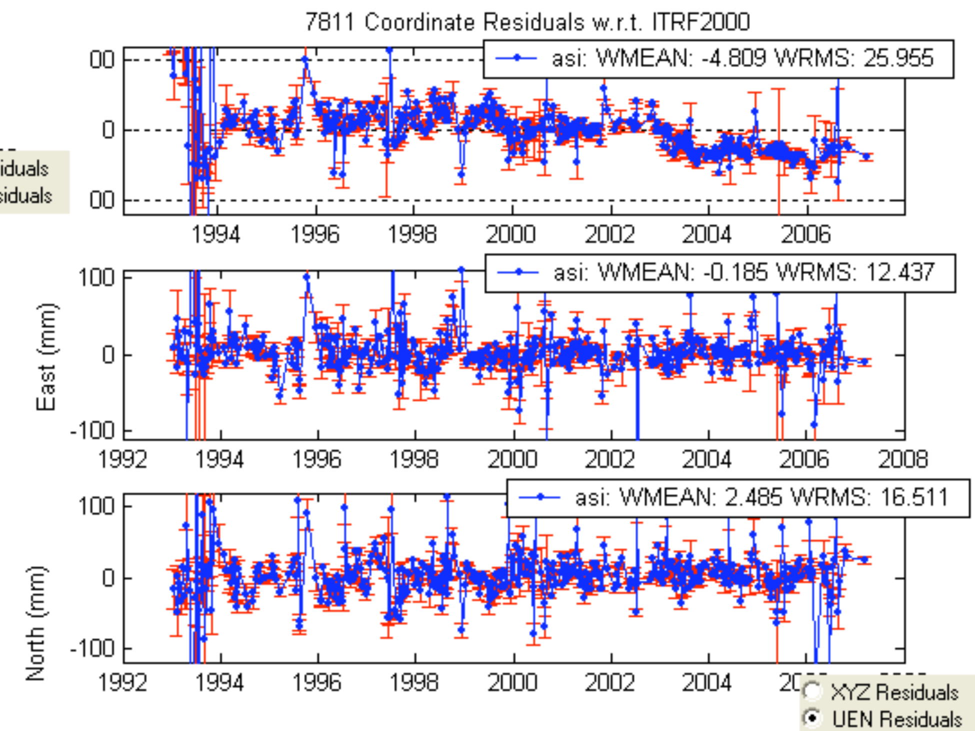
Site 7811 Boro

without scale transformation



OLD

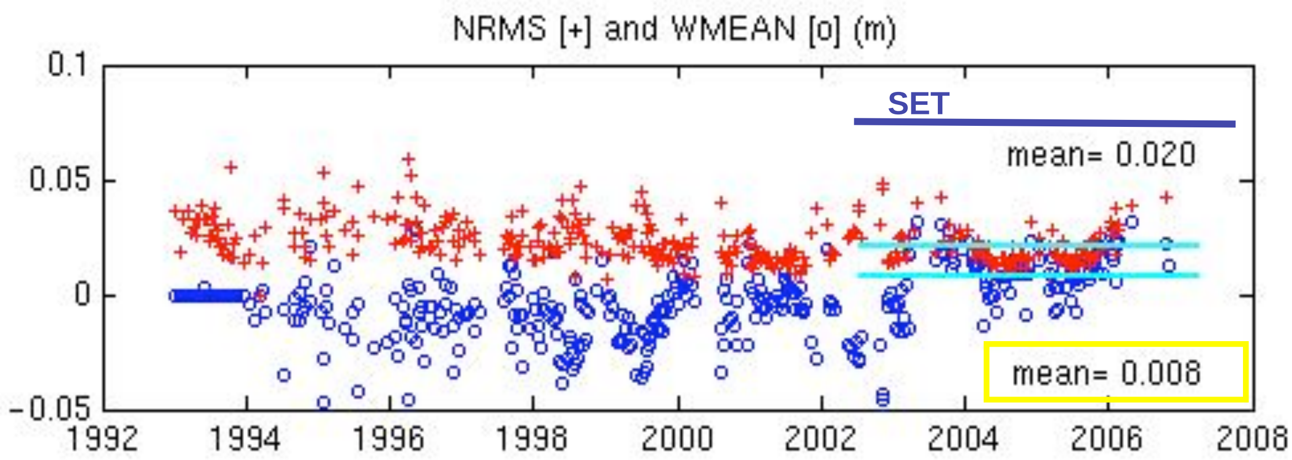
NEW



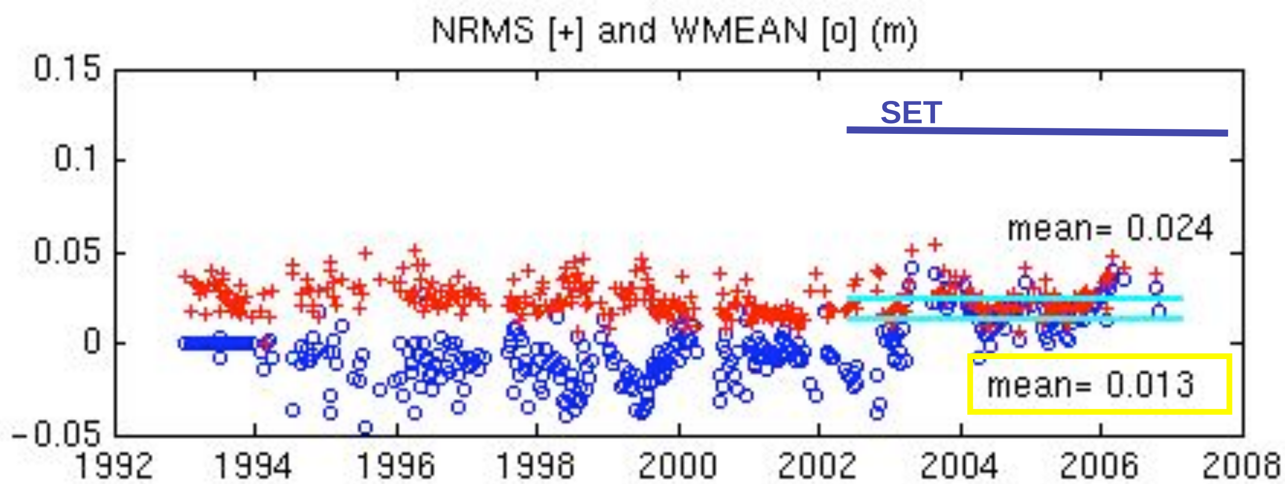
Stanford correction effect (ASI sol.)

Site 7811 Boro – Lageos1 Range residuals (ITRF2000 coordinates)

OLD



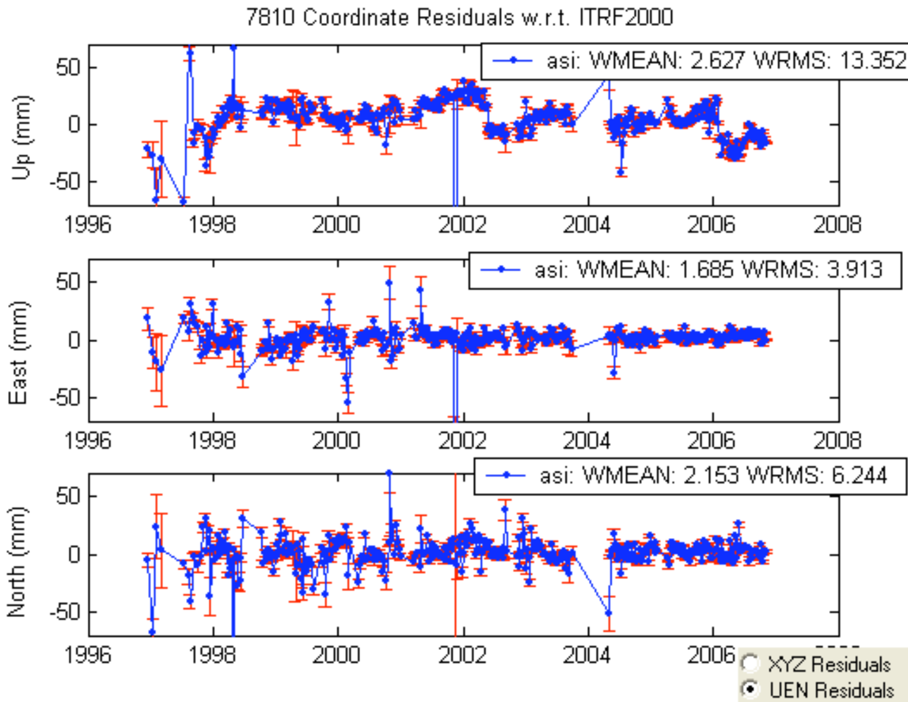
NEW



Stanford correction effect (ASI sol.)

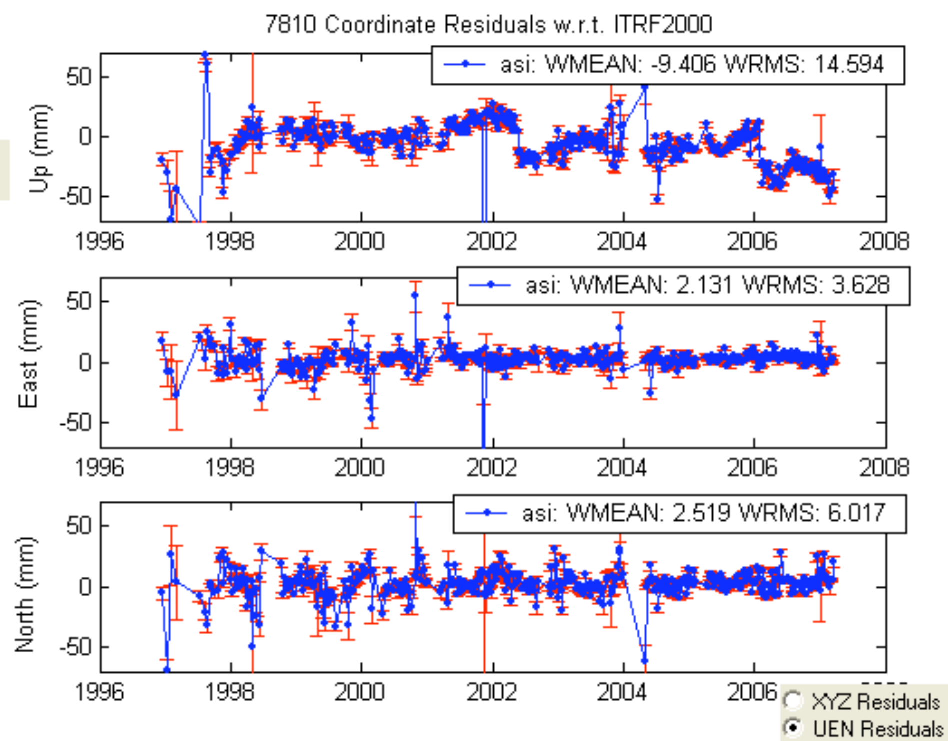
Site 7810 Zimm

without scale transformation



OLD

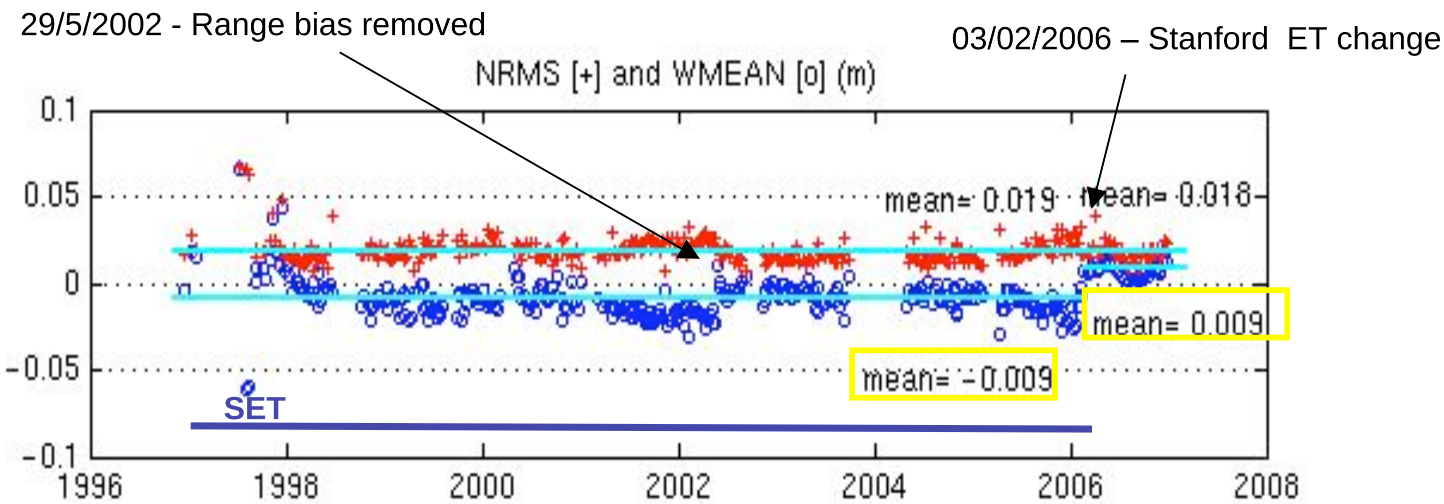
NEW



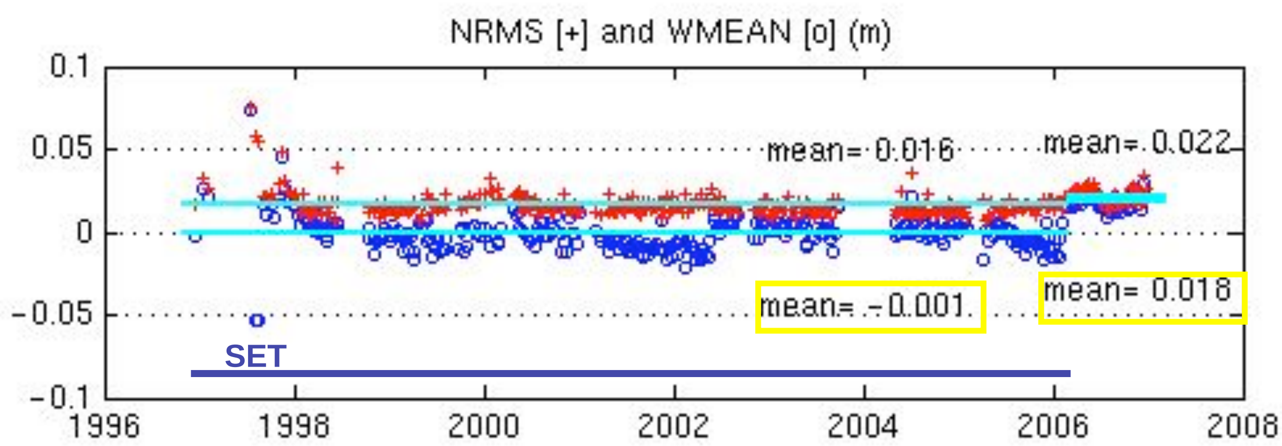
Stanford correction effect (ASI sol.)

Site 7810 Zimm (423 nm) – Lageos1 Range residuals (ITRF2000 coordinates)

OLD



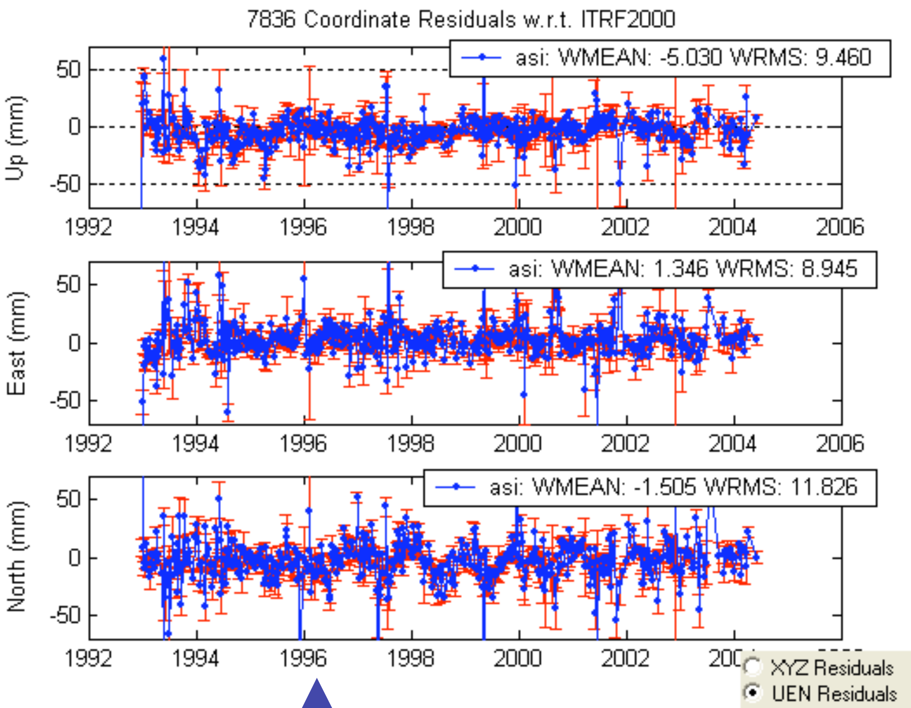
NEW



Stanford correction effect (ASI sol.)

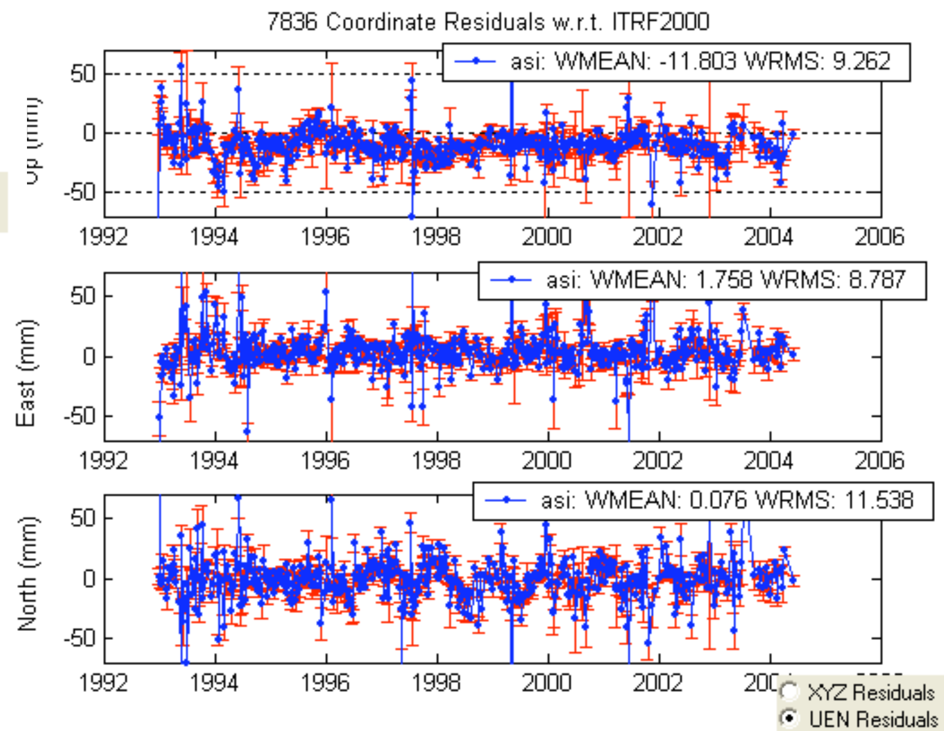
Site 7836 Pots

without scale transformation



OLD

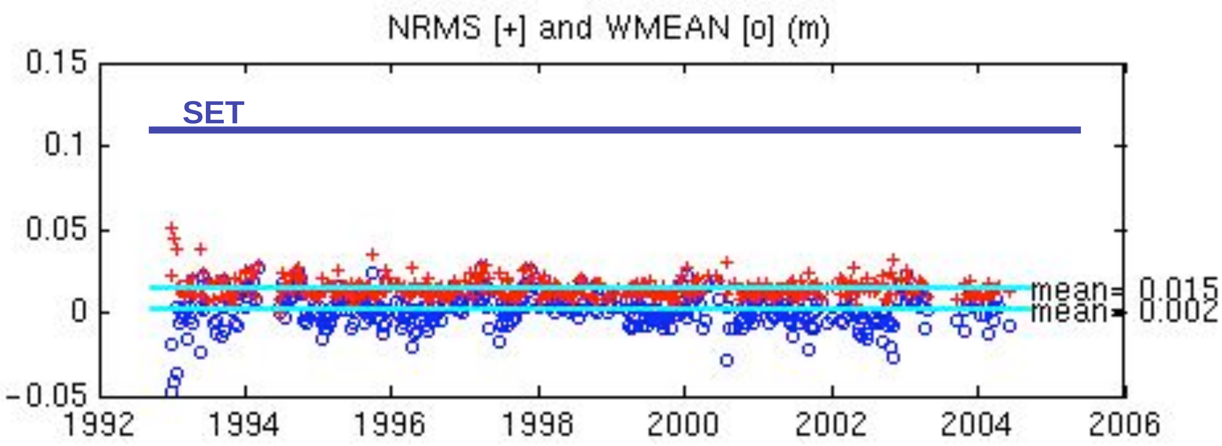
NEW



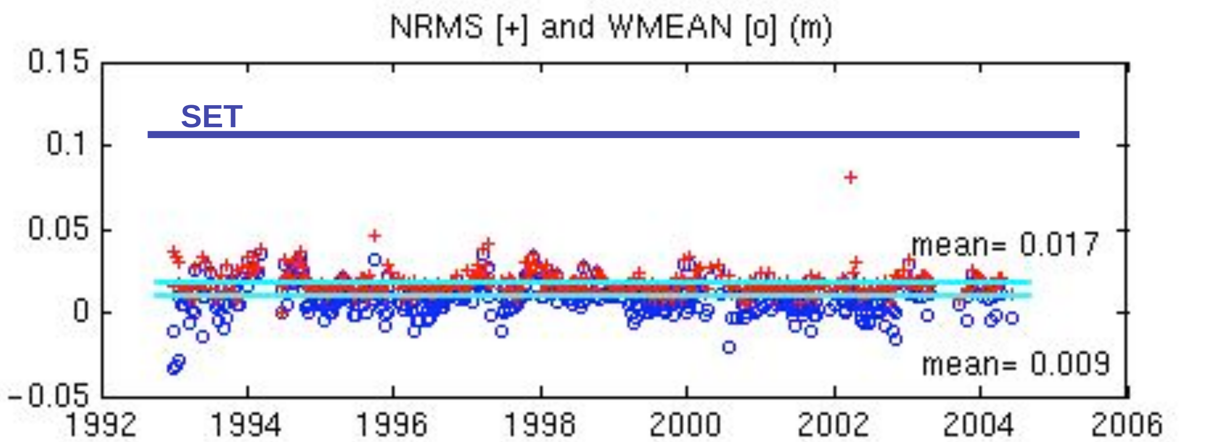
Stanford correction effect (ASI sol.)

Site 7836 Pots – Lageos1 Range residuals (ITRF2000 coordinates)

OLD



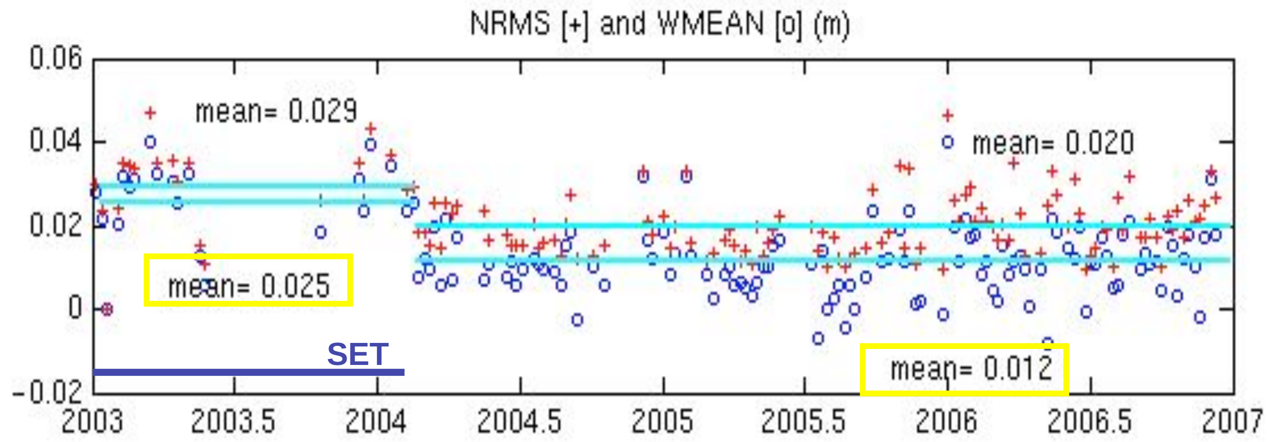
NEW



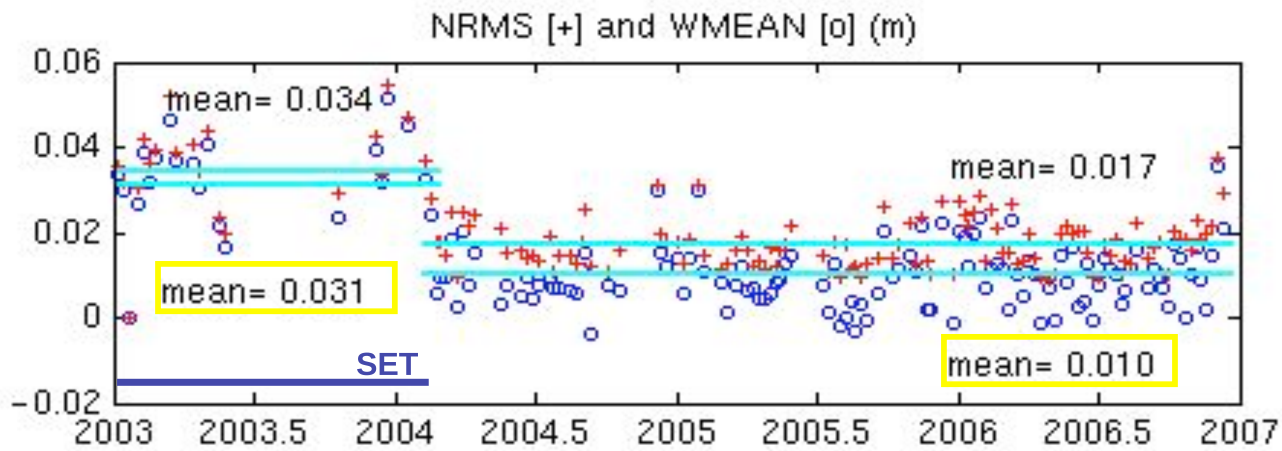
Stanford correction effect (ASI sol.)

Site 7841 Pots – Lageos1 Range residuals (ITRF2000 coordinates)

OLD



NEW



Open Points

- **Scale effect of Stanford event timer corrections?**

ASI operational products: 1983-1992 series (version 2)

G. Bianco - Agenzia Spaziale Italiana

V. Luceri – e-GEOS S.p.A.

Analysis setup

- Standards agreed within the AWG, in particular: 15 day arc, 3-day EOP and LOD, Marini-Murray
- Biases applied as indicated by Erricos Pavlis
- Biases estimated for

site	from(yymmdd)	to(yymmdd)
1864	all arcs	
1884	all arcs	
7210	all arcs	
7237	all arcs	
7811	880101	940101
7835	830101	980103
7839	910301	960928
8834	910101	961228
7080	830101	930101
7112	830101	850101
7122	830101	870120
7843	850101	920101
7838	830101	840205
7517	920601	920730

Core stations

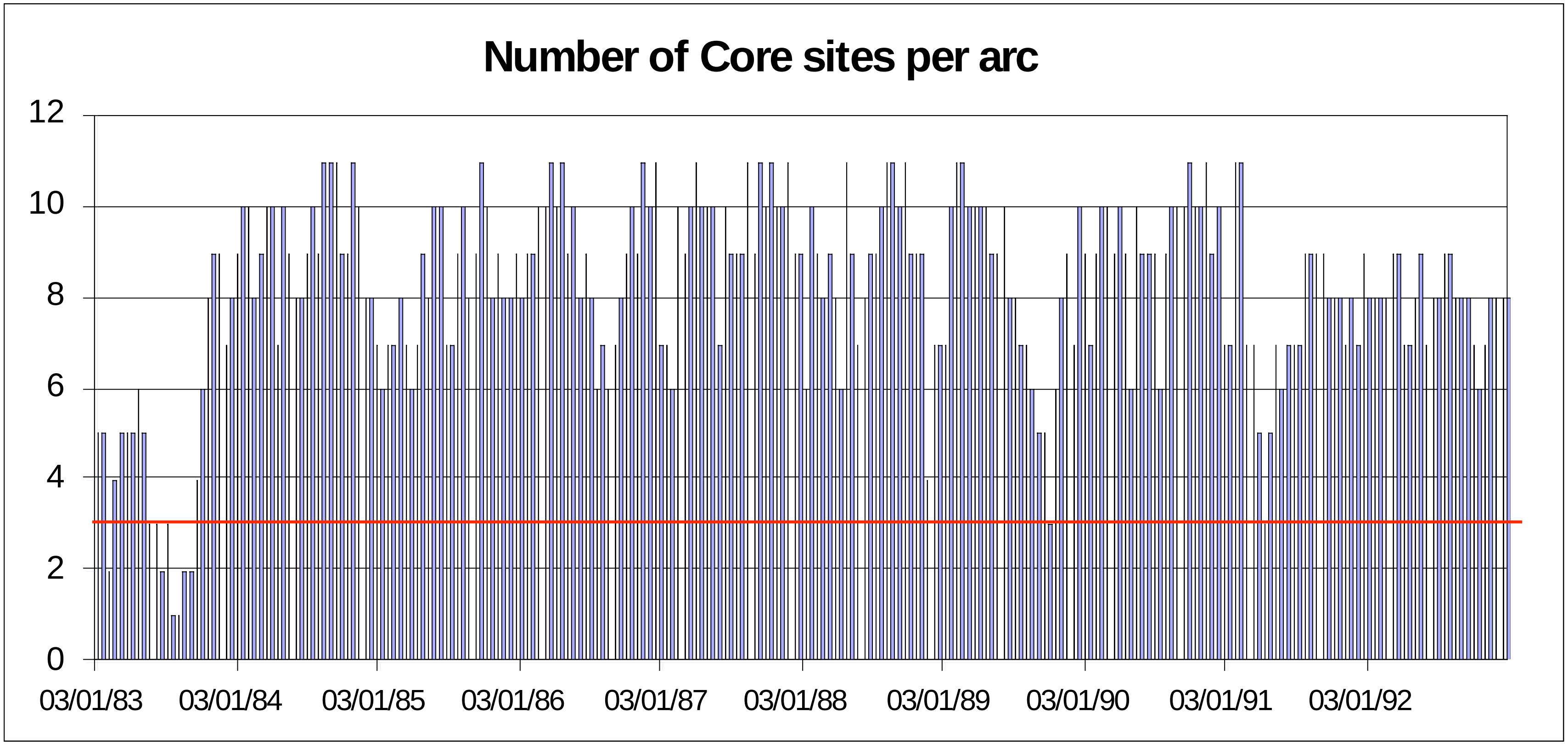
AWG core site for 1993 -2007

11001S002 7839 Graz
40451M105 7105 Greenbelt
13212S001 7840 Herstmonceux
40442M006 7080 McDonald
40497M001 7110 Monument Peak
14201S018 8834 Wettzell
50107M001 7090 Yarragadee
14001S007 7810 Zimmerwald new
10002S002 7845 Grasse
40445M001 7210 Haleakala
30302M003 7501 L HART(coo/vel JCET)
12205S001 7811 Borowiec
21726S001 7838 Simosato(coo/vel JCET)
14106S009 7836 Potsdam
21605S001 7837 Shangai

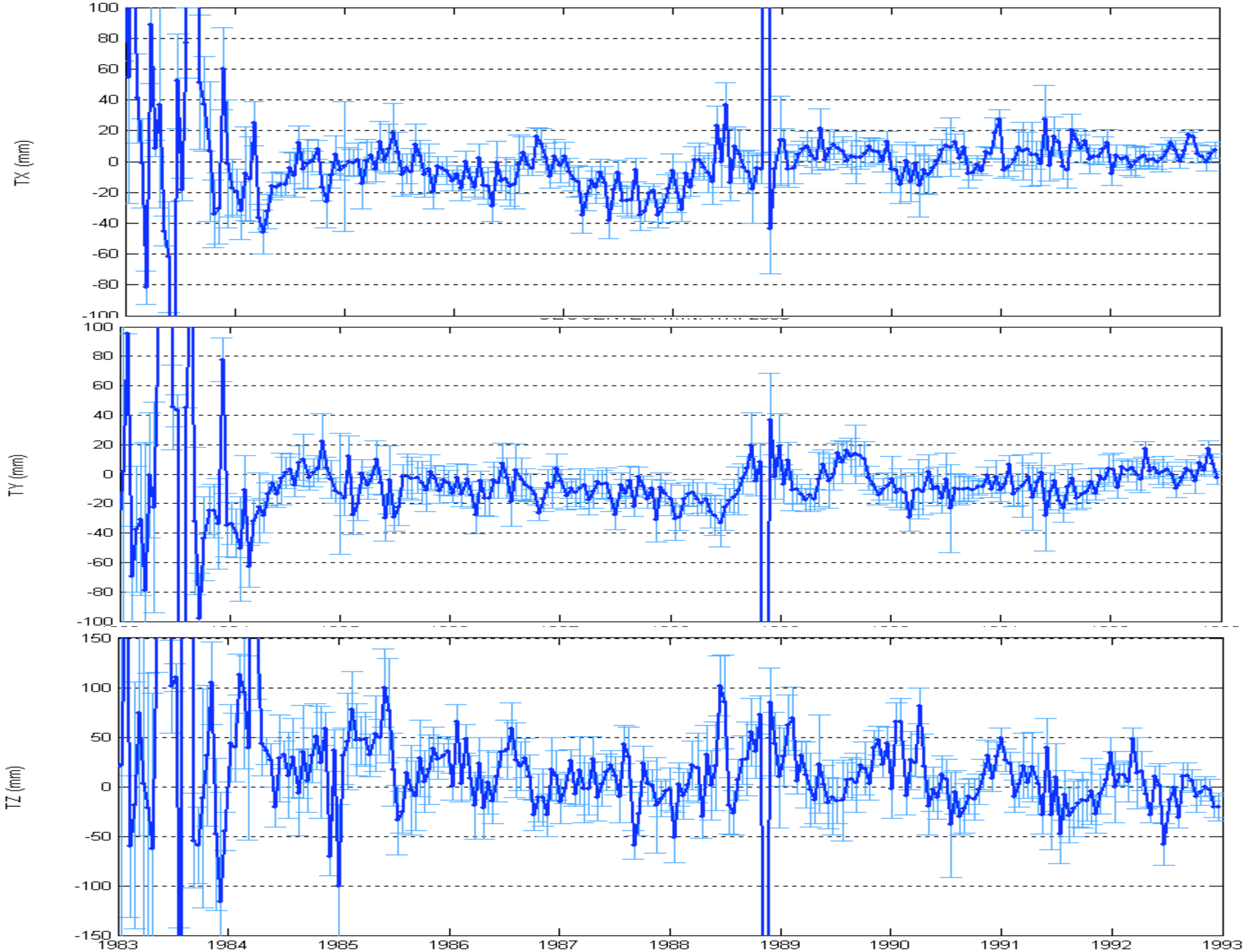
Core site for 1983-1992 **used in these tests**

14106S001 1181 Potsdam
11001S002 7839 Graz
40451M105 7105 Greenbelt
13212S001 7840 Herstmonceux
40497M001 7110 Monument Peak
50107M001 7090 Yarragadee
14001S001 7810 Zimmerwald old
21726S001 7838 Simosato(coo/vel JCET)
12734S001 7939 Matera SAO
40433M002 7109 Quincy
14201S002 7834 Wettzell

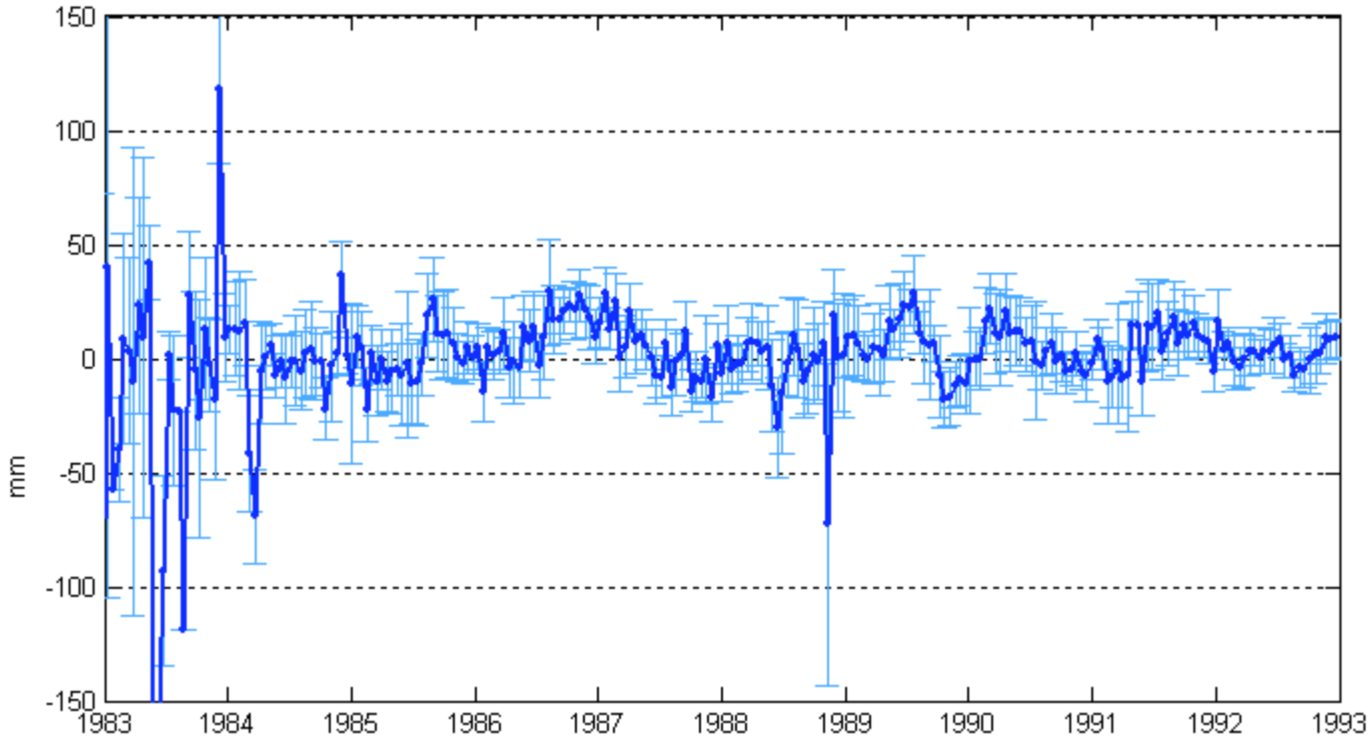
Core stations



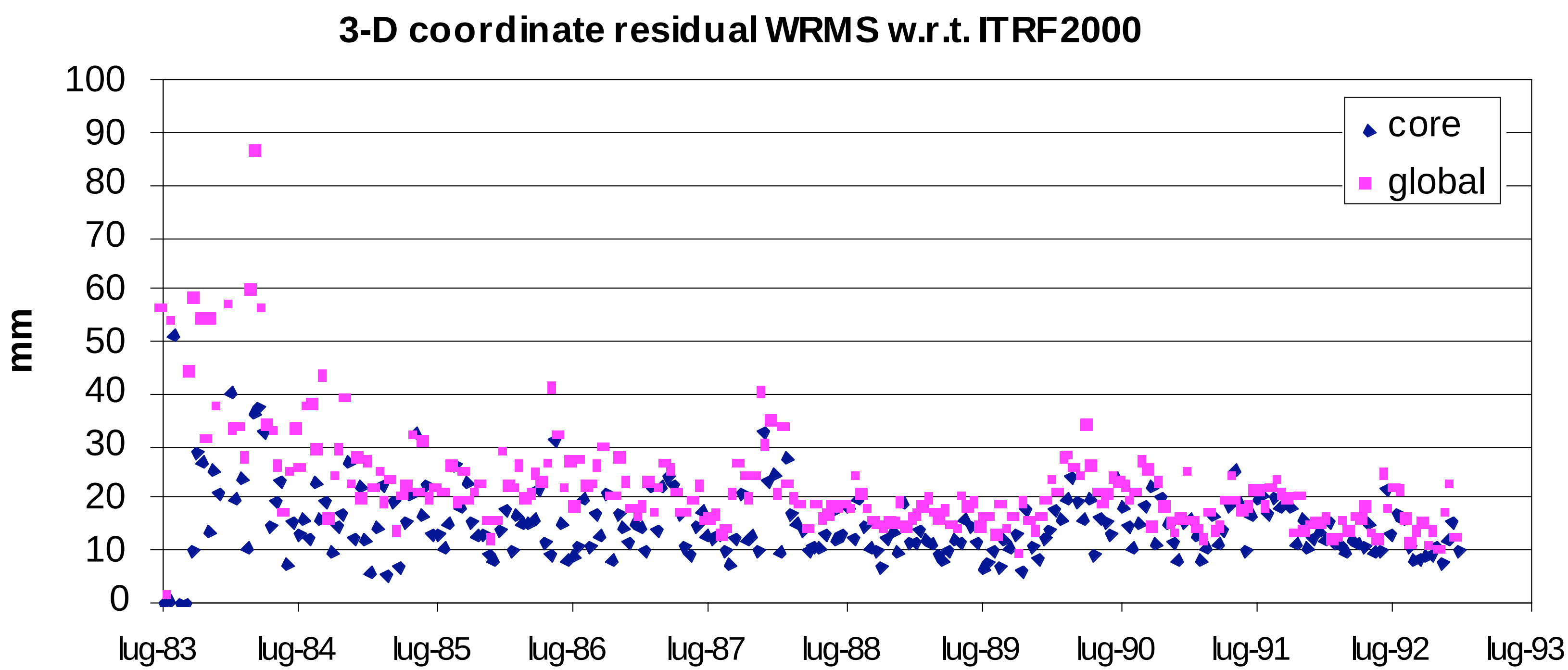
1983-1992: Translation w.r.t. ITRF2000



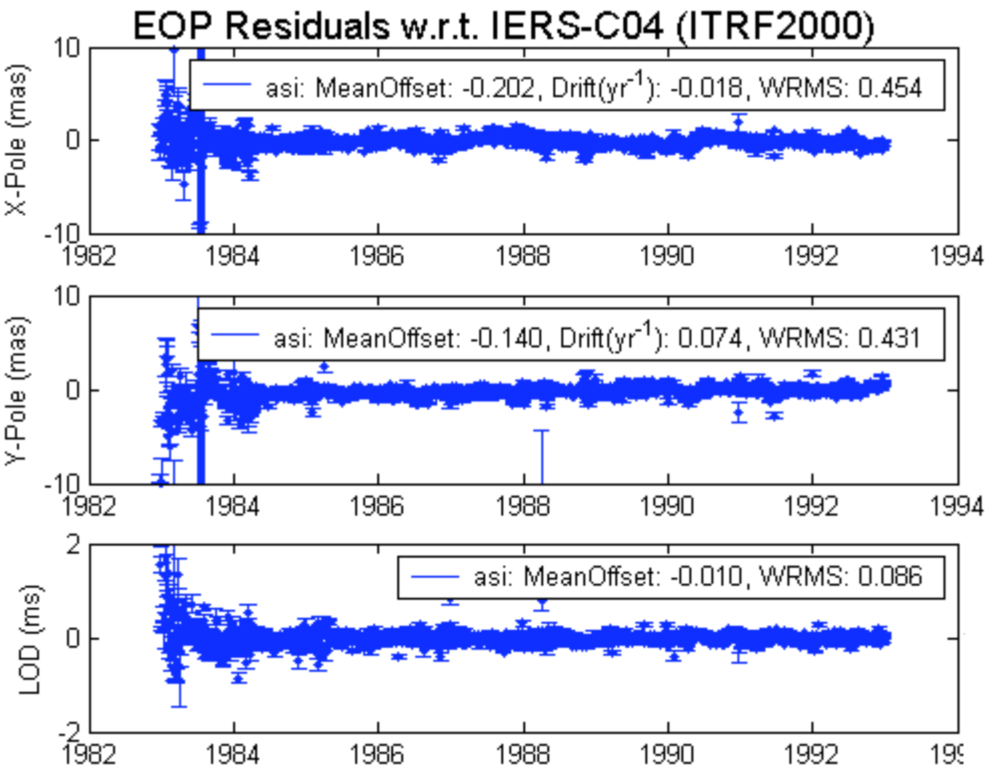
1983-1992: Scale w.r.t. ITRF2000

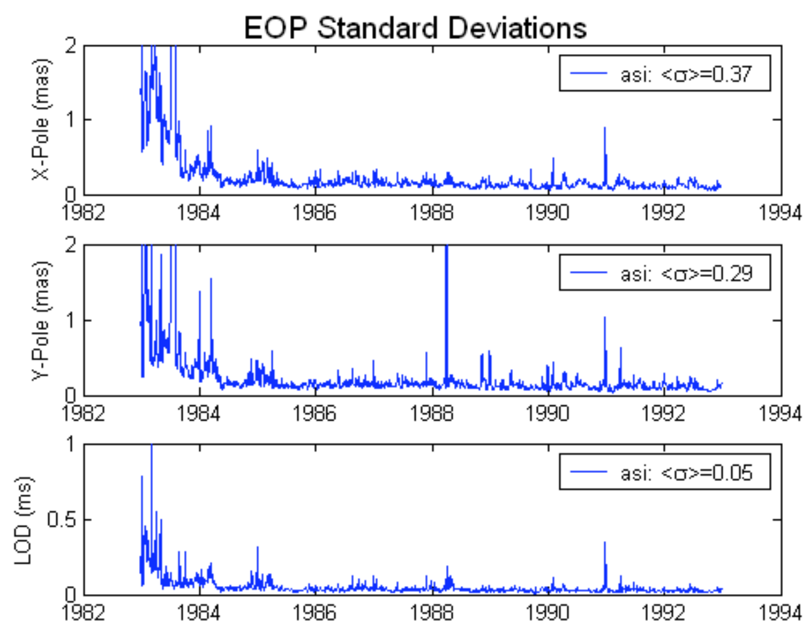


1983-1992: site coordinates

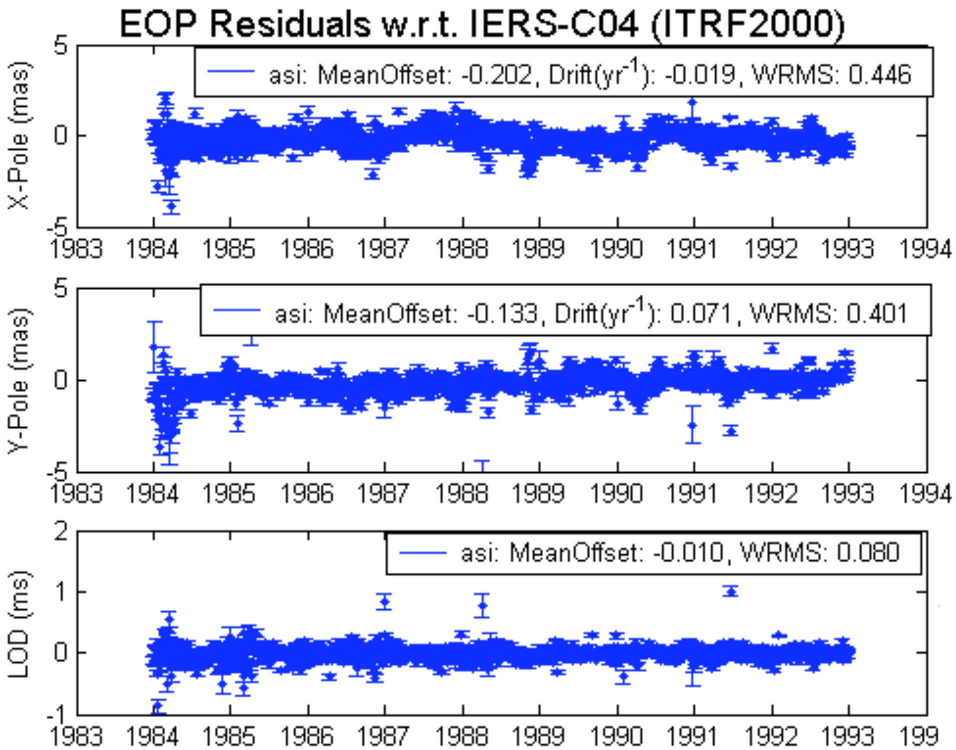


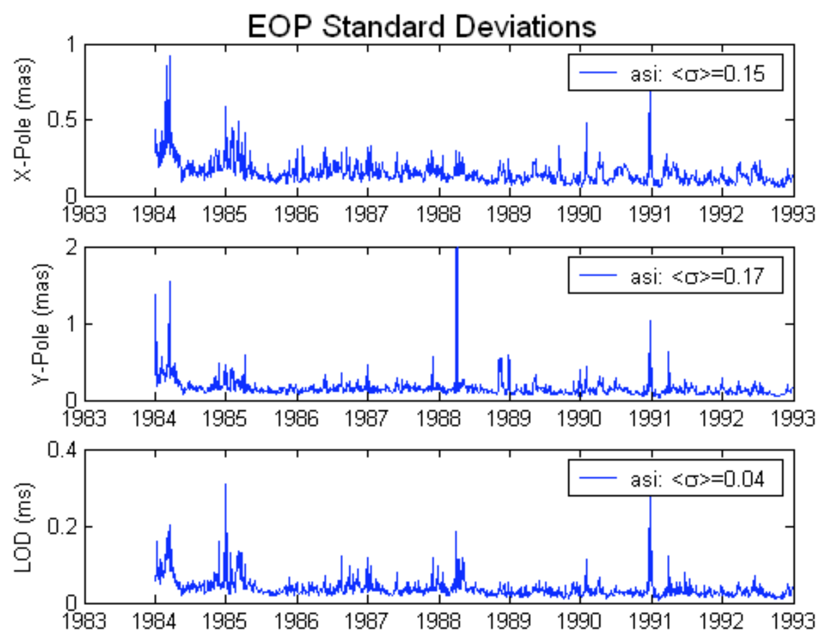
1983-1992: EOP





1984-1992: EOP





Open Points

- **EOP only products to extend the IERS Operational series?**
- **List of core sites for ITRF constraints (i.e. quality check)**
- **Range biases to be estimated**

Status of the
ILRS 1983-1992 processing

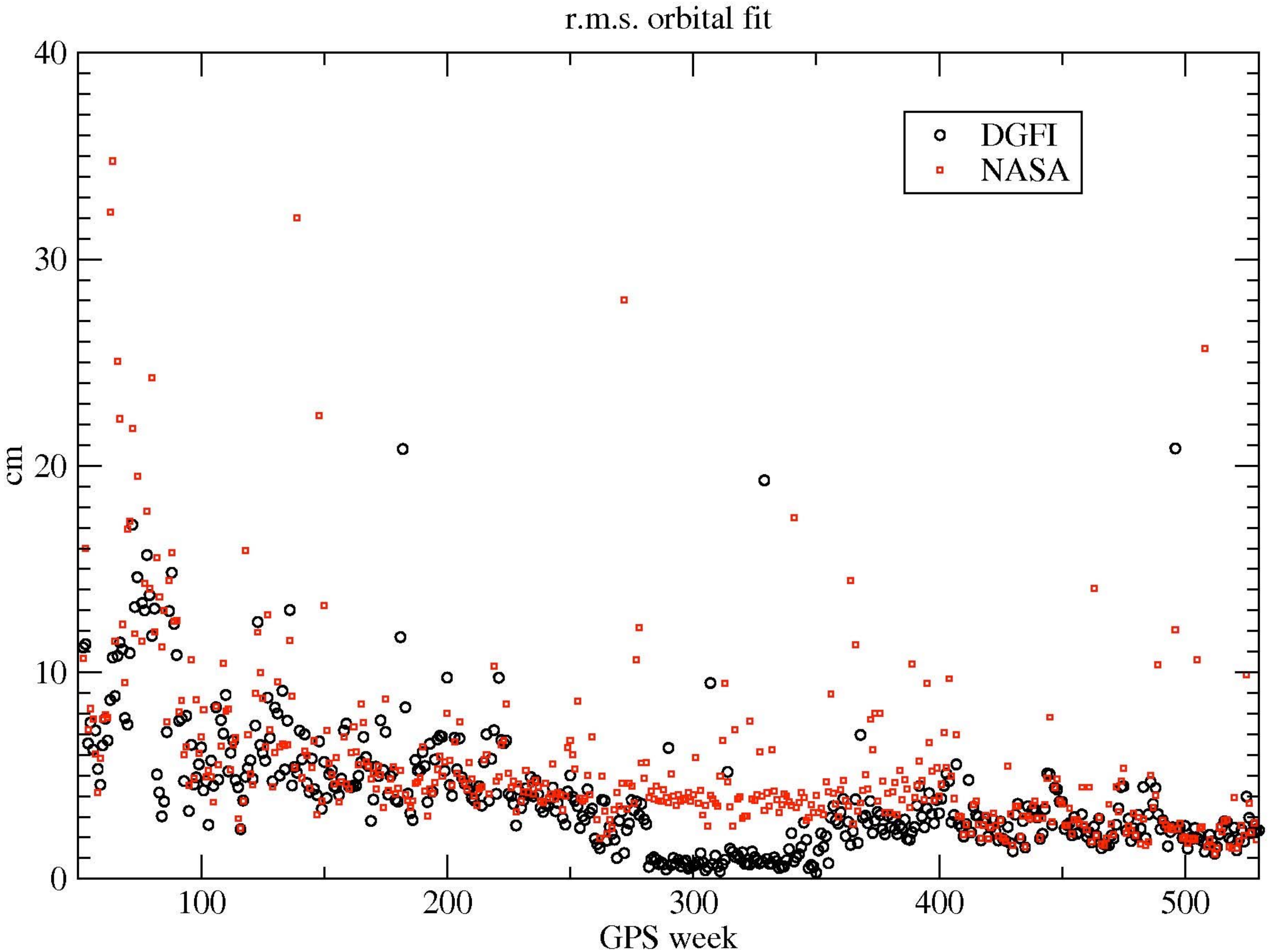
Horst Müller

Deutsches Geodätisches Forschungsinstitut, München
E-Mail: mueller@dgfi.badw.de

DGFI

- Period 1993-2006 reprocessed and delivered
- NASA NP's corrected to new CoM
- Processing of all arcs 1981 – 1992 finished
- Comparison with DGFI-NP solution shows differences
- Evaluation of these discrepancies is in progress
- Use of the slr_data_corrections.snx file foreseen next
- Check of the new DOGS version (diff. to older versions)
- Final delivery expected for the end of April

Comparison of normal points



Quality assessment of new SLR systems/sites

Horst Müller

Deutsches Geodätisches Forschungsinstitut, München
E-Mail: mueller@dgfi.badw.de

General Aspects

- Data Quality
  - single shot precission
  - *no* systematic errors (no biases, system calibration)
- Reliability
  - certain number of passes per week (tbd)
  - tracking of most targets
- Stability
  - station should operate for a longer time span (tbd)

Procedures

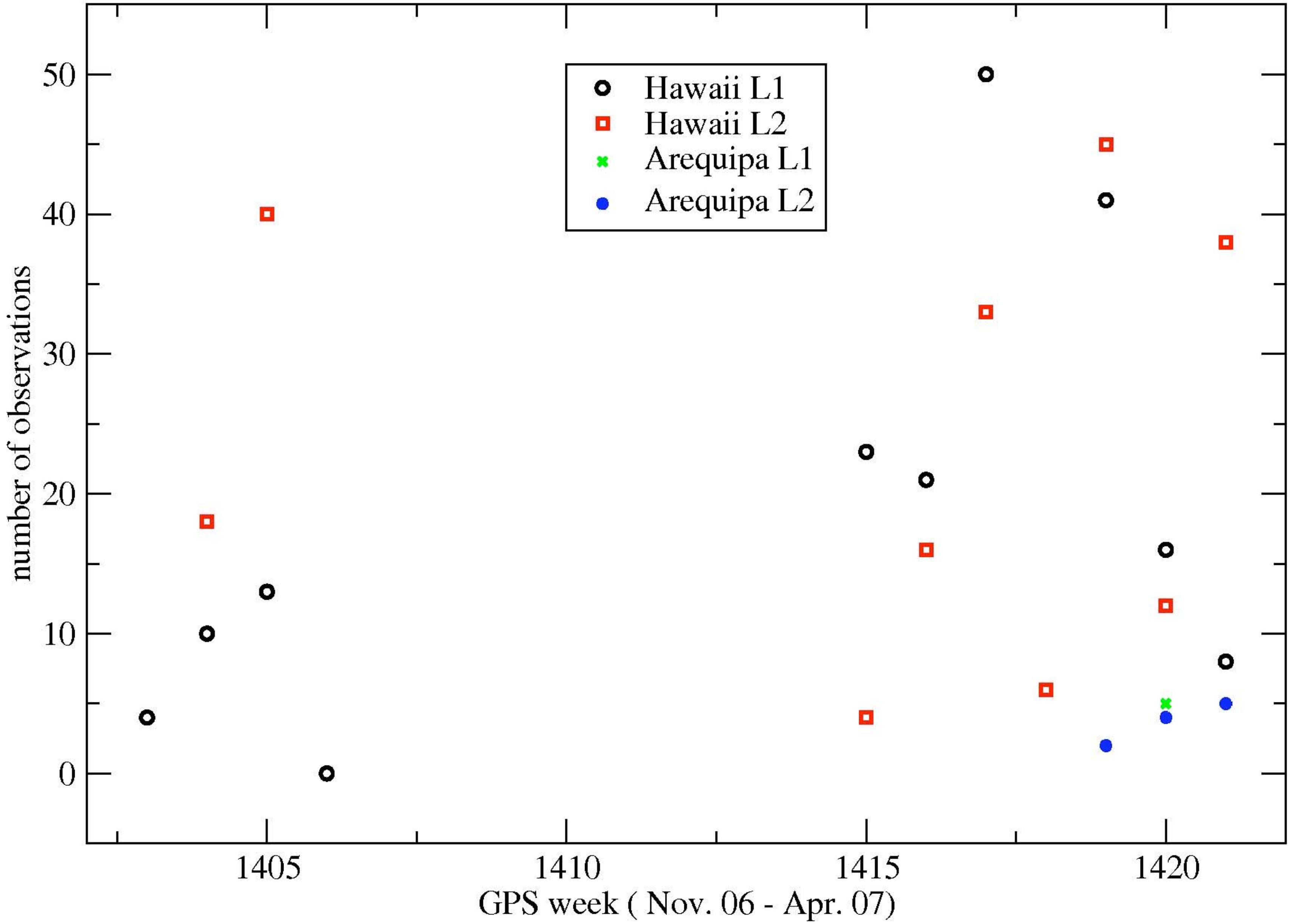
- Data Quality
  - processing of satellite arcs
  - computation of range biases during the processing
- Reliability
  - fulfil station qualification from ILRS
  - statistics at data centres
- Stability
  - ?

Proposal

- Regular (weekly) processing of the station by at least two analysis centres (one for LEOs)
- Generation of range biases for all passes
- Computation of weekly coordinate series (L1/2)
- Close cooperation
- Feedback to stations (report on detected problems and positive results)

New SLR stations

number of observations per week



First results on Haleakala coordinates 398 obs. ITRF2000 Ref. Frame

X	-5466067.710	± 0.041
Y	-2404339.593	± 0.051
Z	2242109.090	± 0.054

Very preliminary results for Arequipa 16 obs.

X	1942807.793	± 0.442
Y	-5804069.912	± 0.240
Z	-1796915.488	± 0.523

Conclusion

- Problem not easy to solve
- Some aspects still to be defined
- Close cooperation with stations to investigate their needs
- ?

Status of ILRSB

Rainer Kelm
Deutsches Geodätisches Forschungsinstitut

Actual combination

Reanalysis 1993

Proposals

Actual combination (1)

ilrsb.pos+eop.070407.v1.sum
############################

Summary file Version 1.2 (2006-06-30): solution from Wed Apr 11 07:23:10 2007
****

AC Deutsches Geodaetisches Forschungsinstitut Muenchen
OUTPUT ILRS Combination Center: DGFI
CONTACT kelm@dgfi.badw.de
SOFTWARE DOGS_AS
HARDWARE PC (LINUX)
INPUT Global SLR data via CDDIS or EDC

Input solutions:
----
asi.pos+eop.070407.v1.snx
bkg.pos+eop.070407.v1.snx
dgfi.pos+eop.070407.v5.snx
ga.pos+eop.070407.v6.snx
gfz.pos+eop.070407.v5.snx
jcet.pos+eop.070407.v6.snx

Actual combination (2)

E^T*N*E = 0?

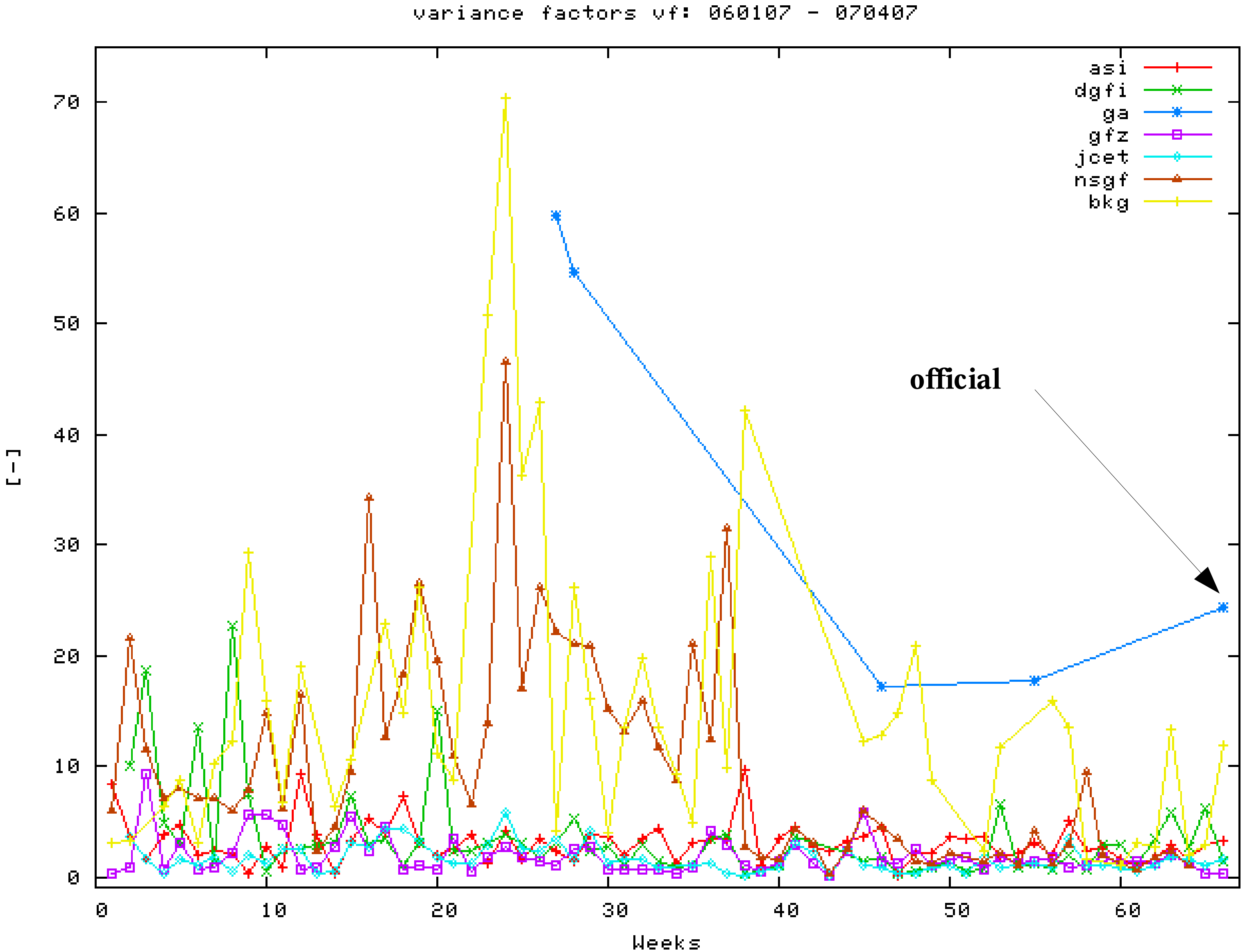
AC	tx [m]	ty [m]	tz [m]	rx [m]	ry [m]	rz [m]	sc [ppb]
asi	5.4e+06	5.89e+06	7.25e+05	16.4	16.5	0.908	1.02e+07
bkg	3.97e+06	4.27e+06	5.23e+05	1.08e-07	4.61e-08	0.00631	7.26e+06
dgfi	2.39e+06	2.12e+06	2.22e+05	46	54.9	-24	3.45e+06
ga	6.62e+06	7.52e+06	1.01e+06	39.3	40.9	18	1.2e+07
gfz	8.51e+06	8.19e+06	9.52e+05	225	201	0.00649	1.32e+07
jcet	9.45e+06	1.04e+07	1.3e+06	29.1	29	0.605	1.76e+07

Actual combination (3)

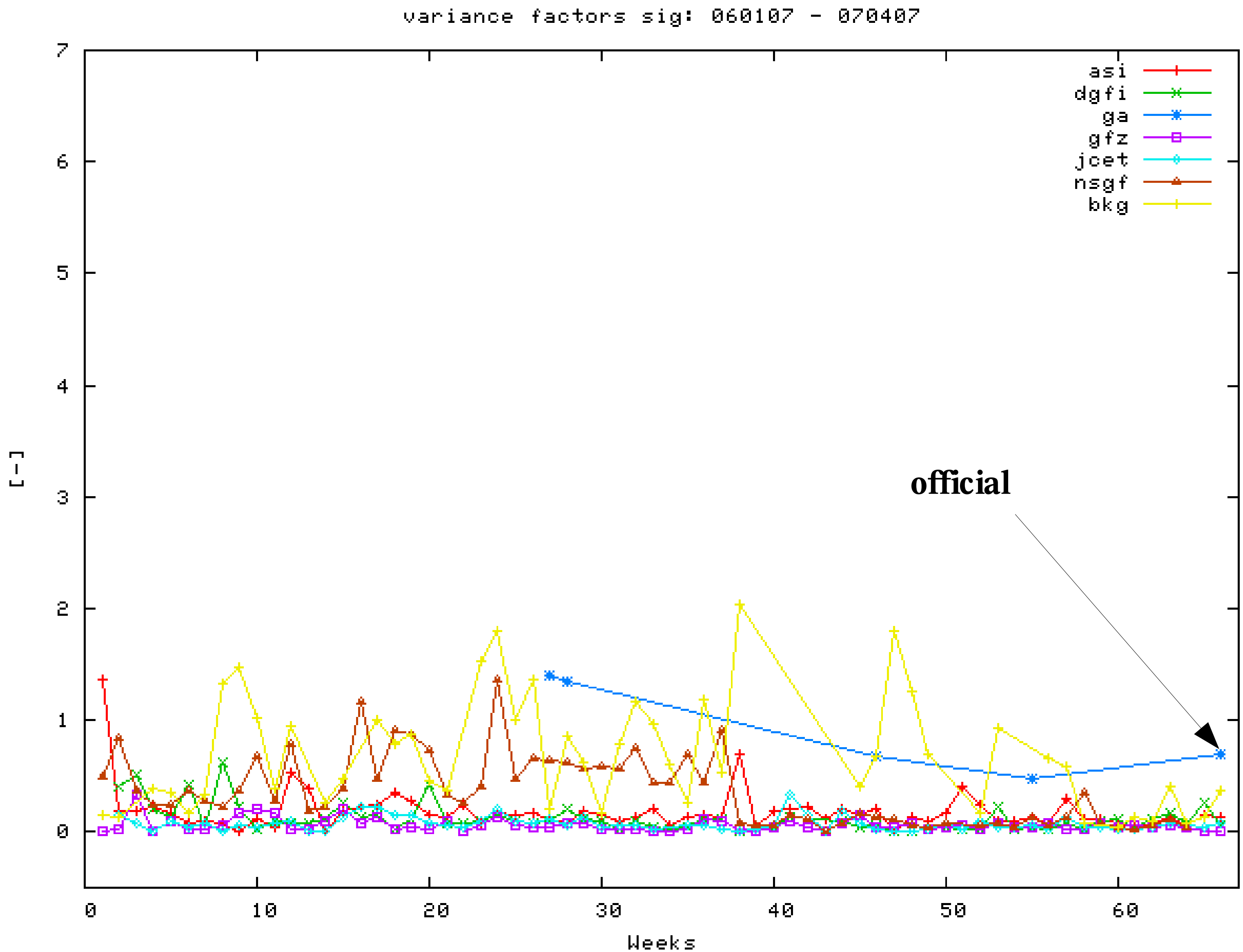
Variance factors and their variances (VCE)
****

asi.pos+eop.070407:	3.21294	0.13082
bkg.pos+eop.070407:	11.79487	0.37012
dgfi.pos+eop.070407:	1.36680	0.06136
ga.pos+eop.070407:	24.41183	0.69992
gfz.pos+eop.070407:	0.35350	0.01154
jcet.pos+eop.070407:	1.58929	0.08698

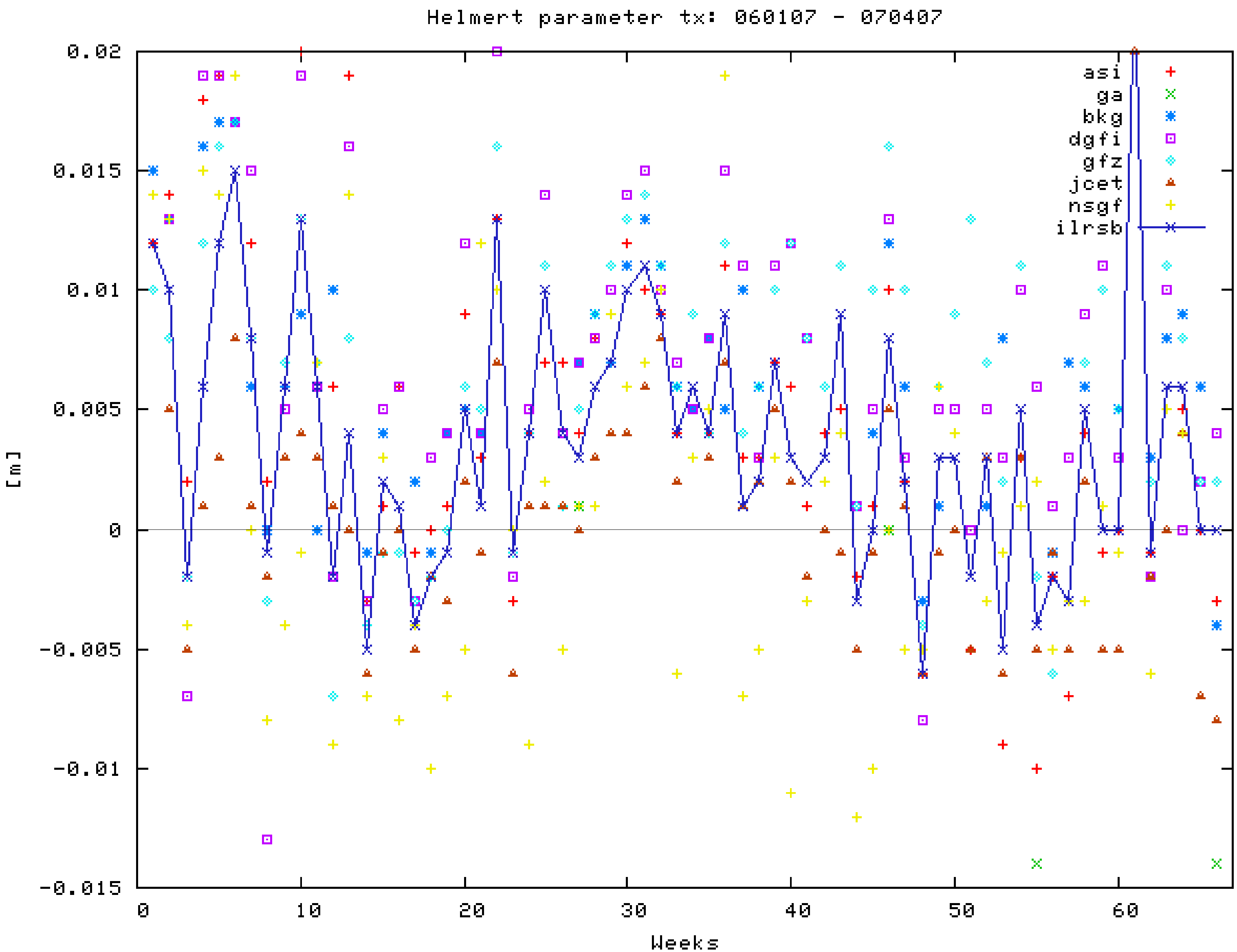
Actual combination (4)



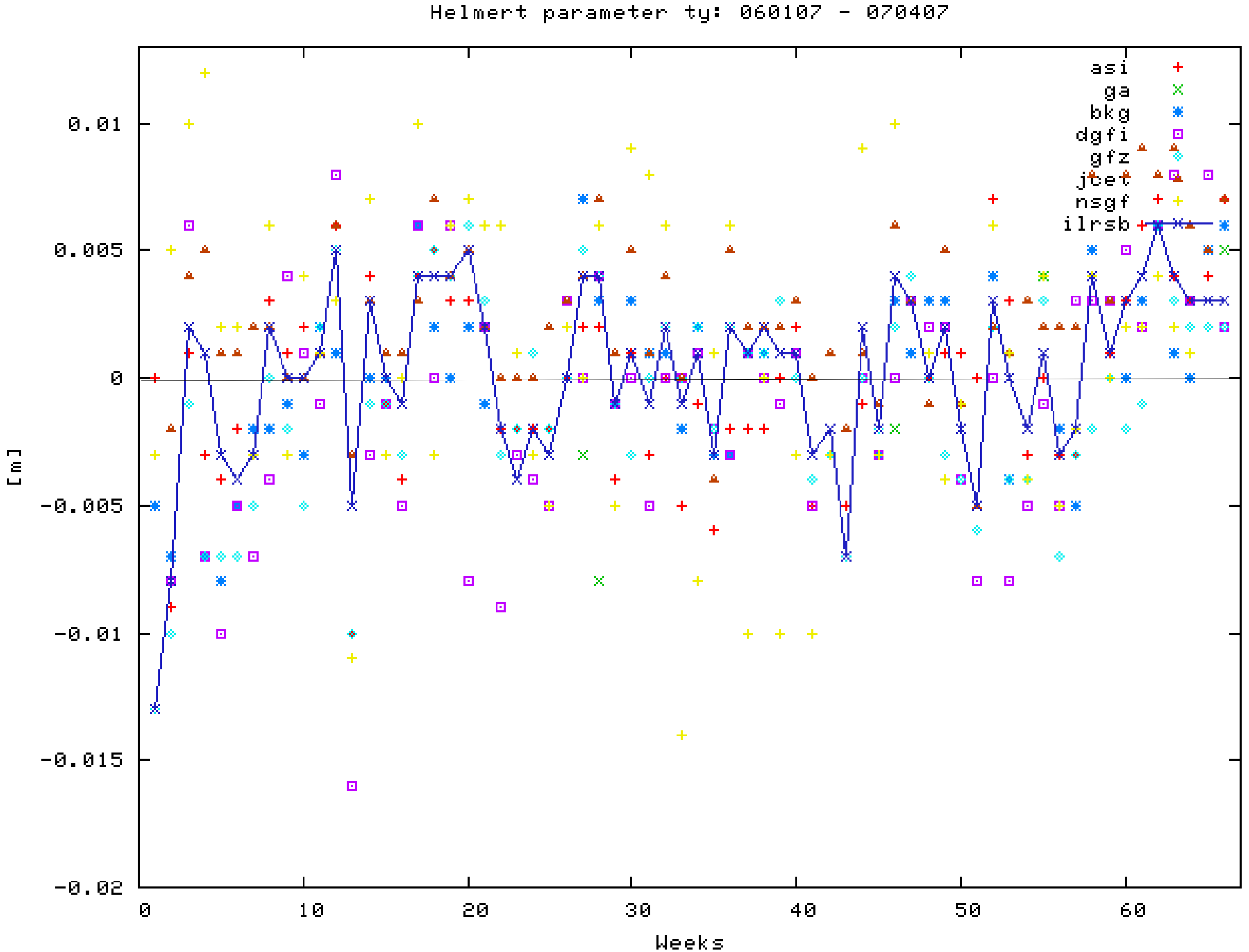
Actual combination (5)



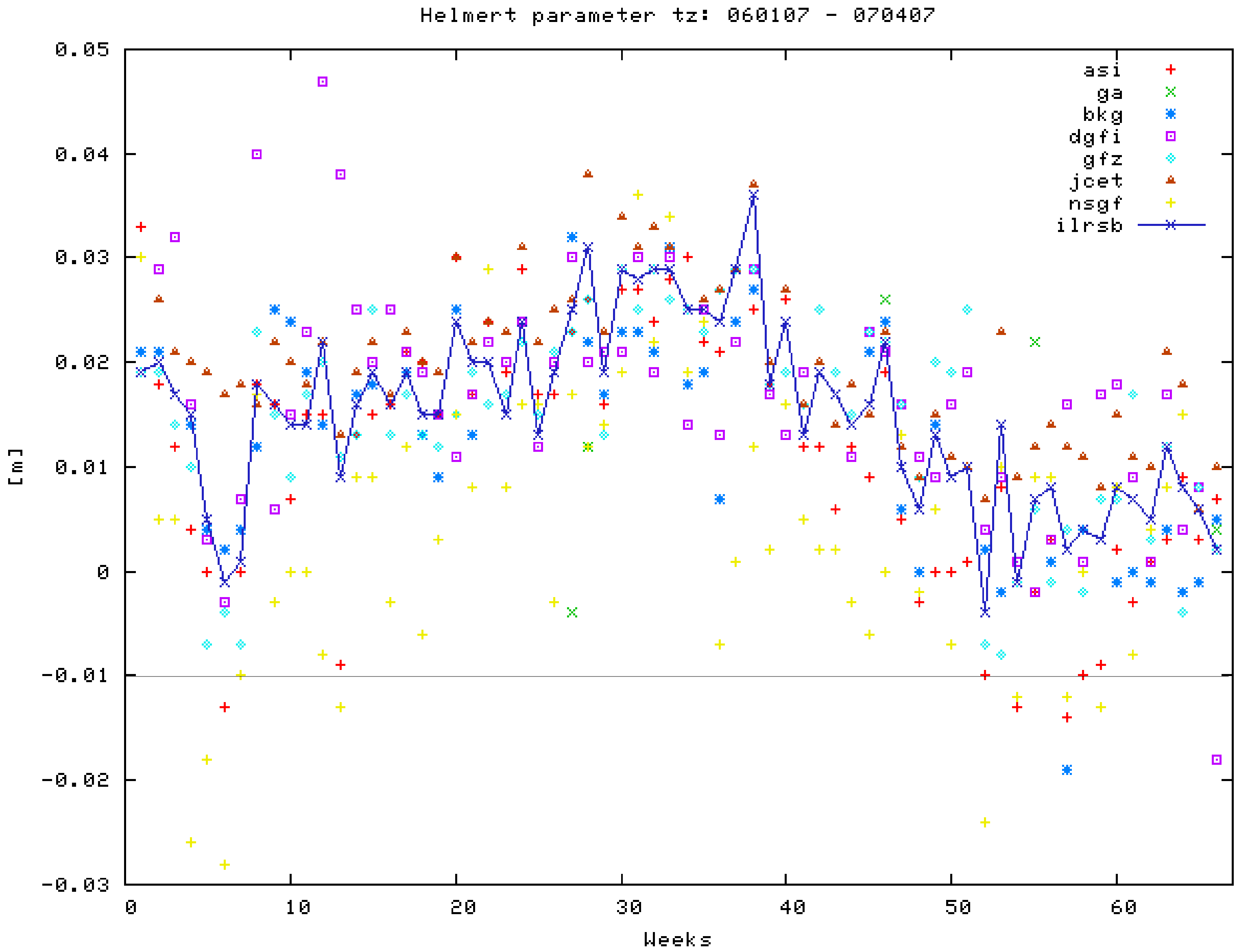
Actual combination (6)



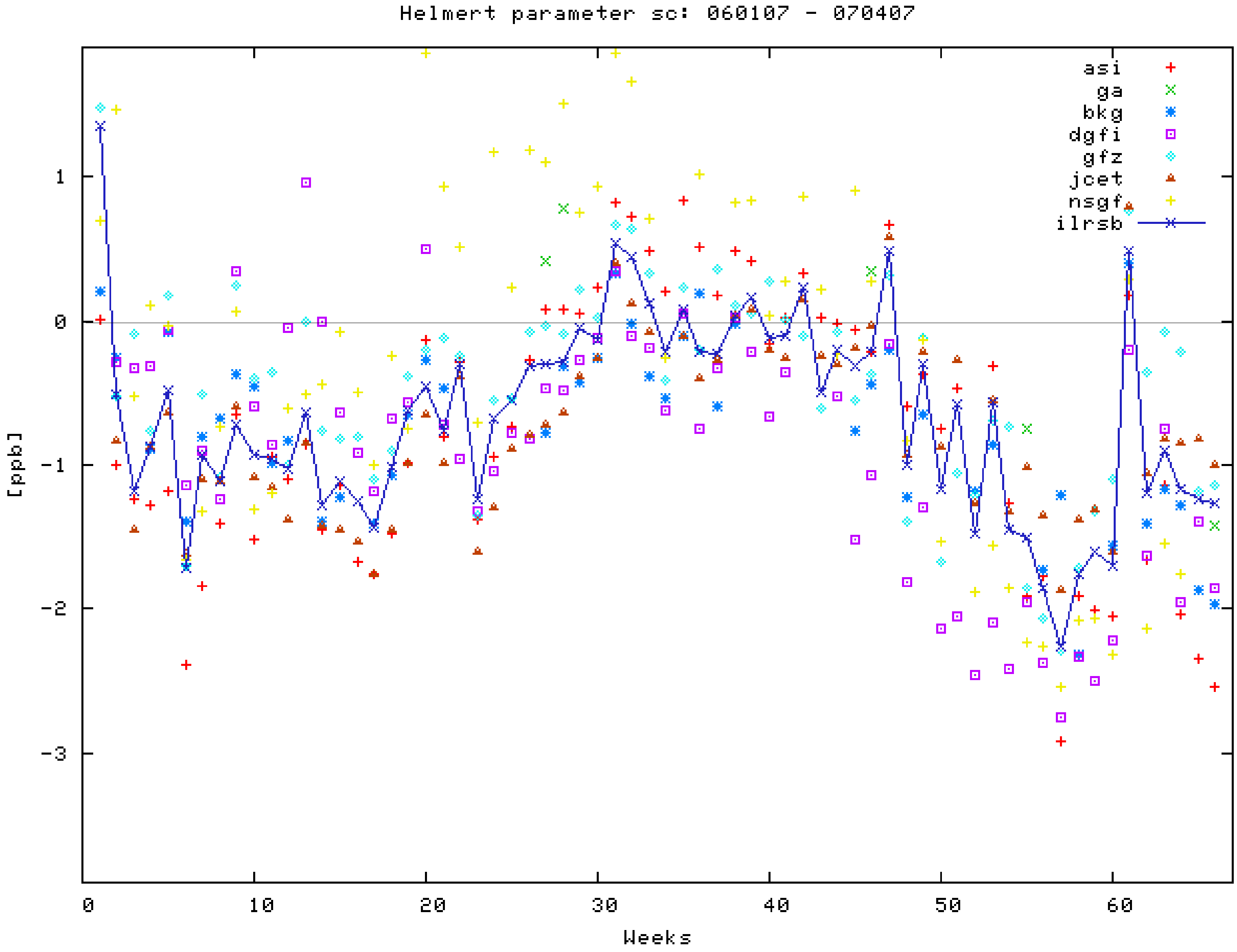
Actual combination (7)



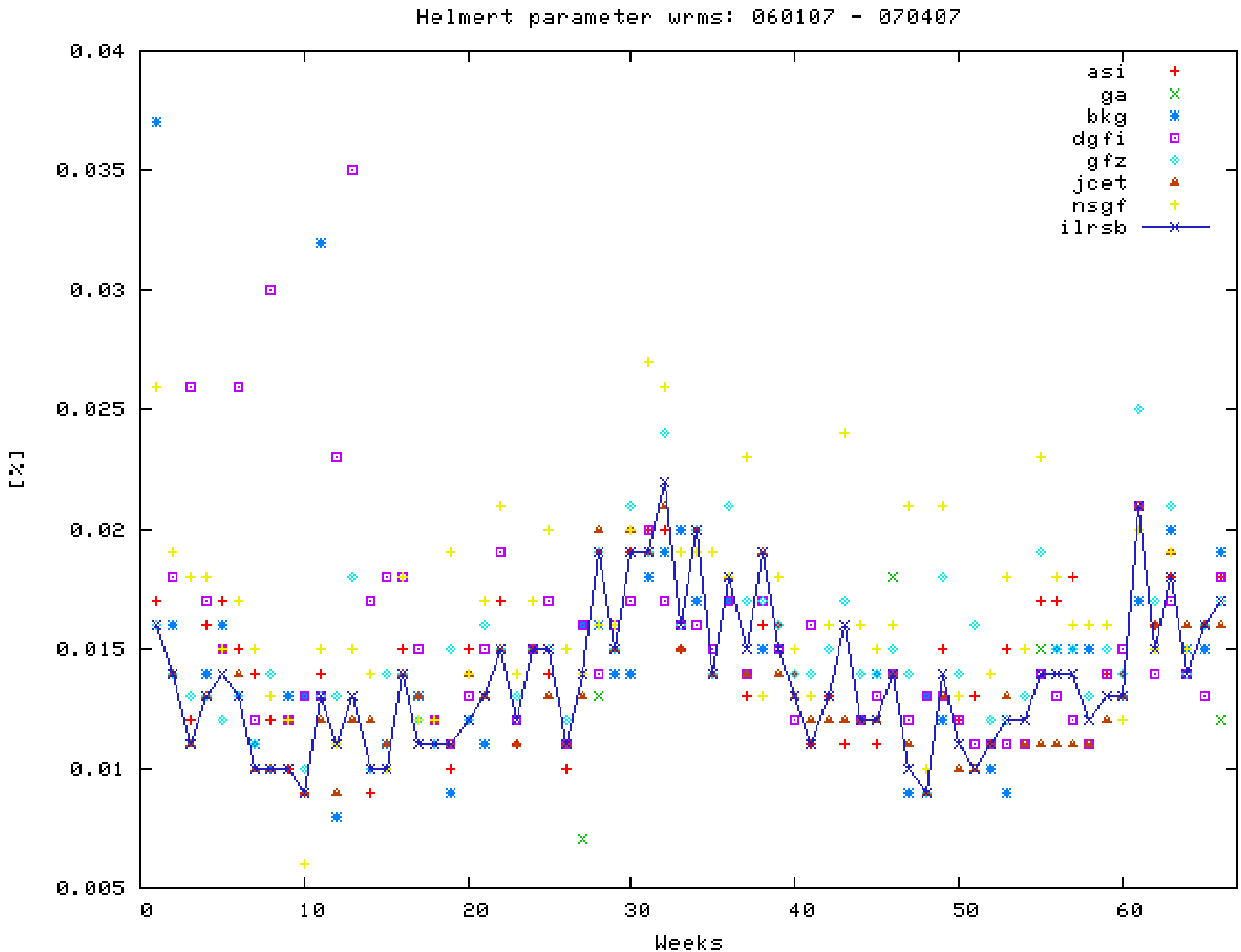
Actual combination (8)



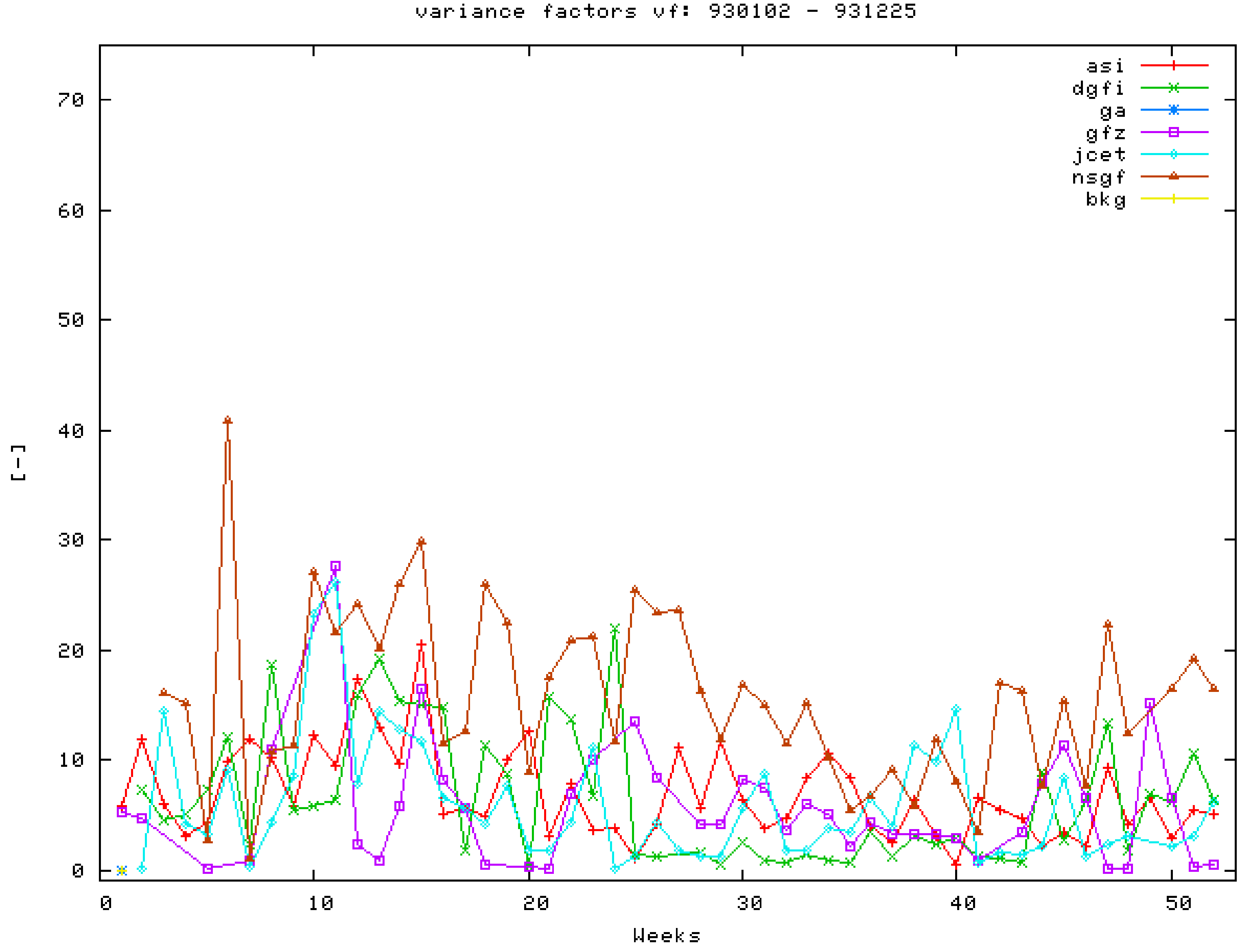
Actual combination (9)



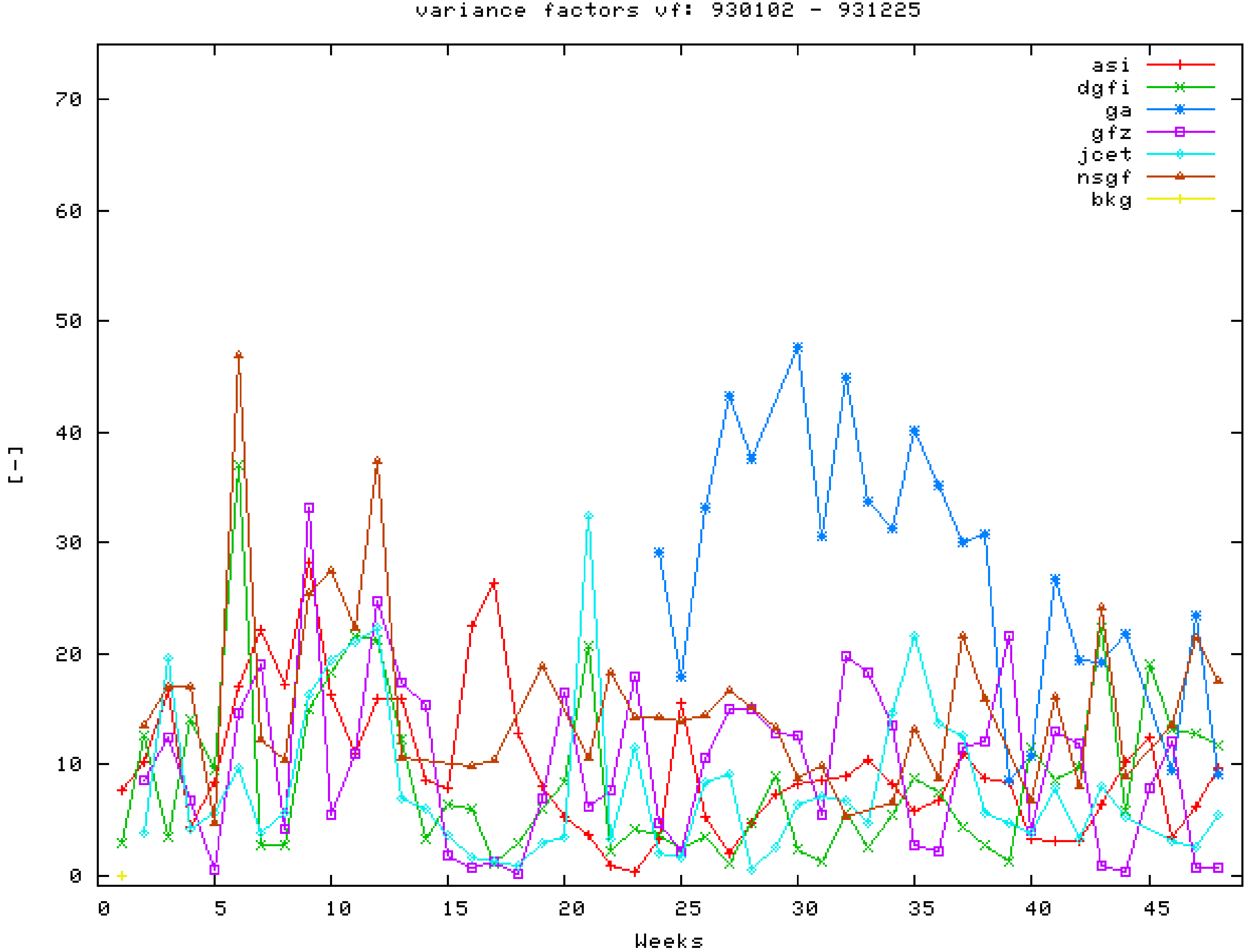
Actual combination (10)



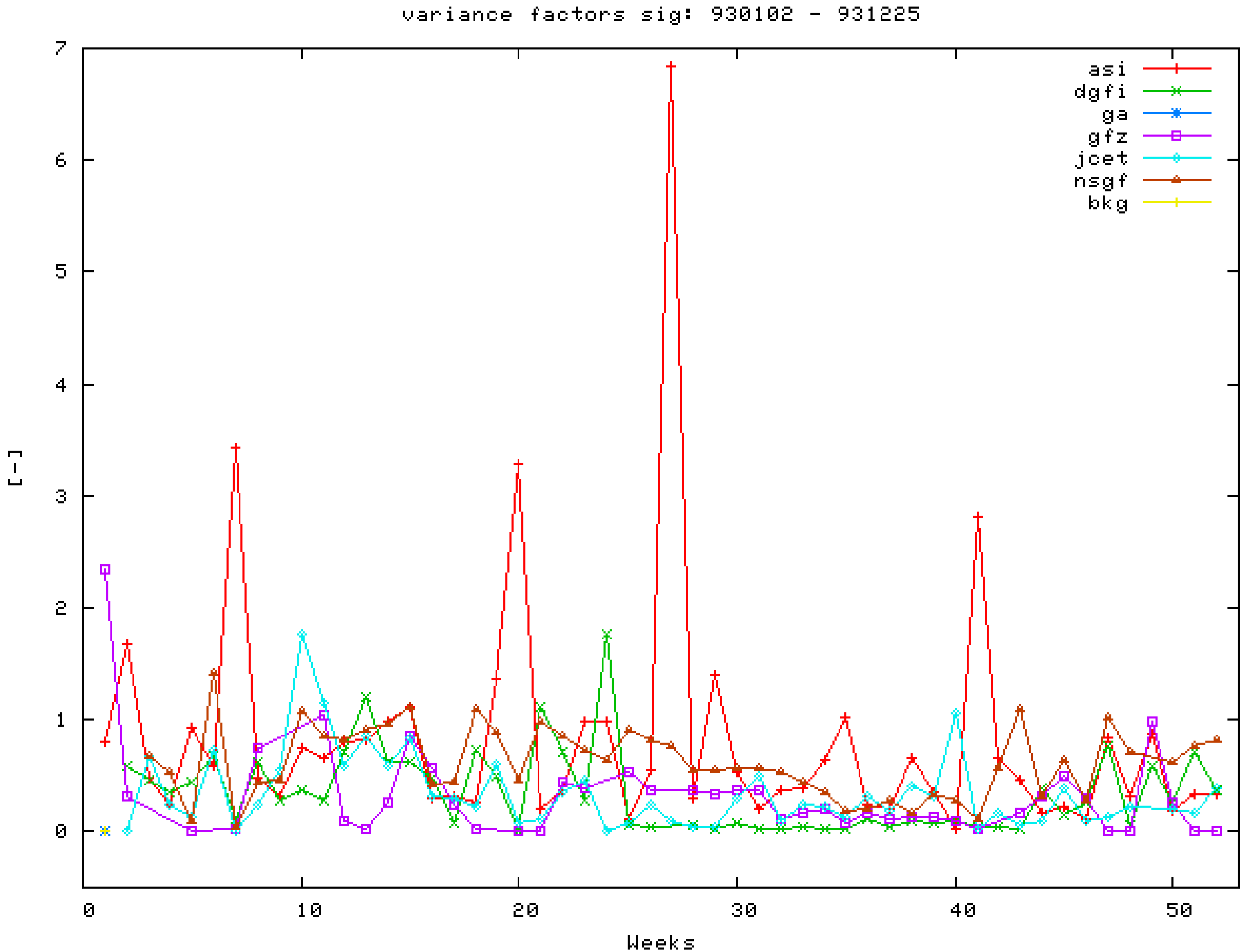
Reanalysis 1993_v7 (old)



Reanalysis 1993_v6 (new)

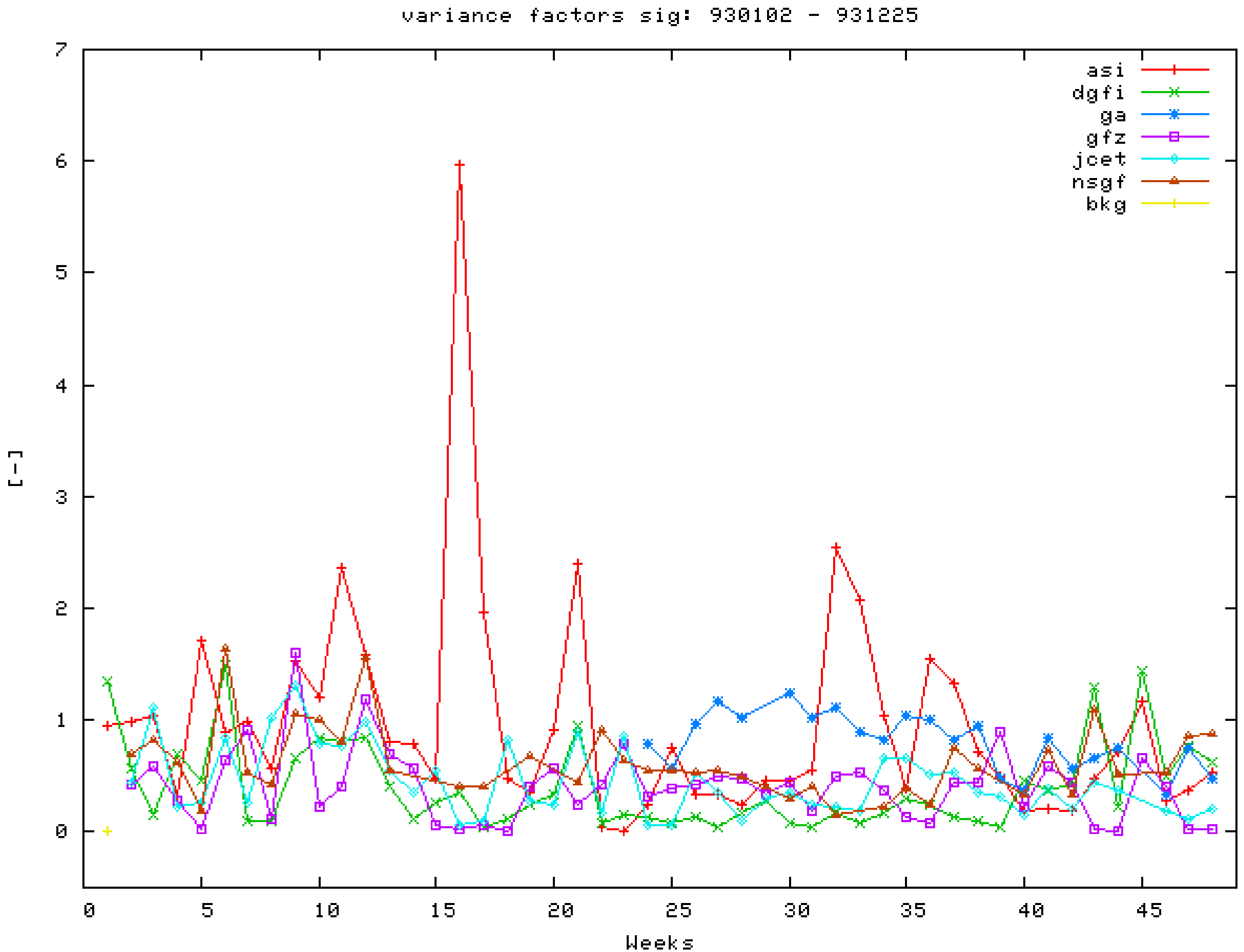


Reanalysis 1993_v7 (old)

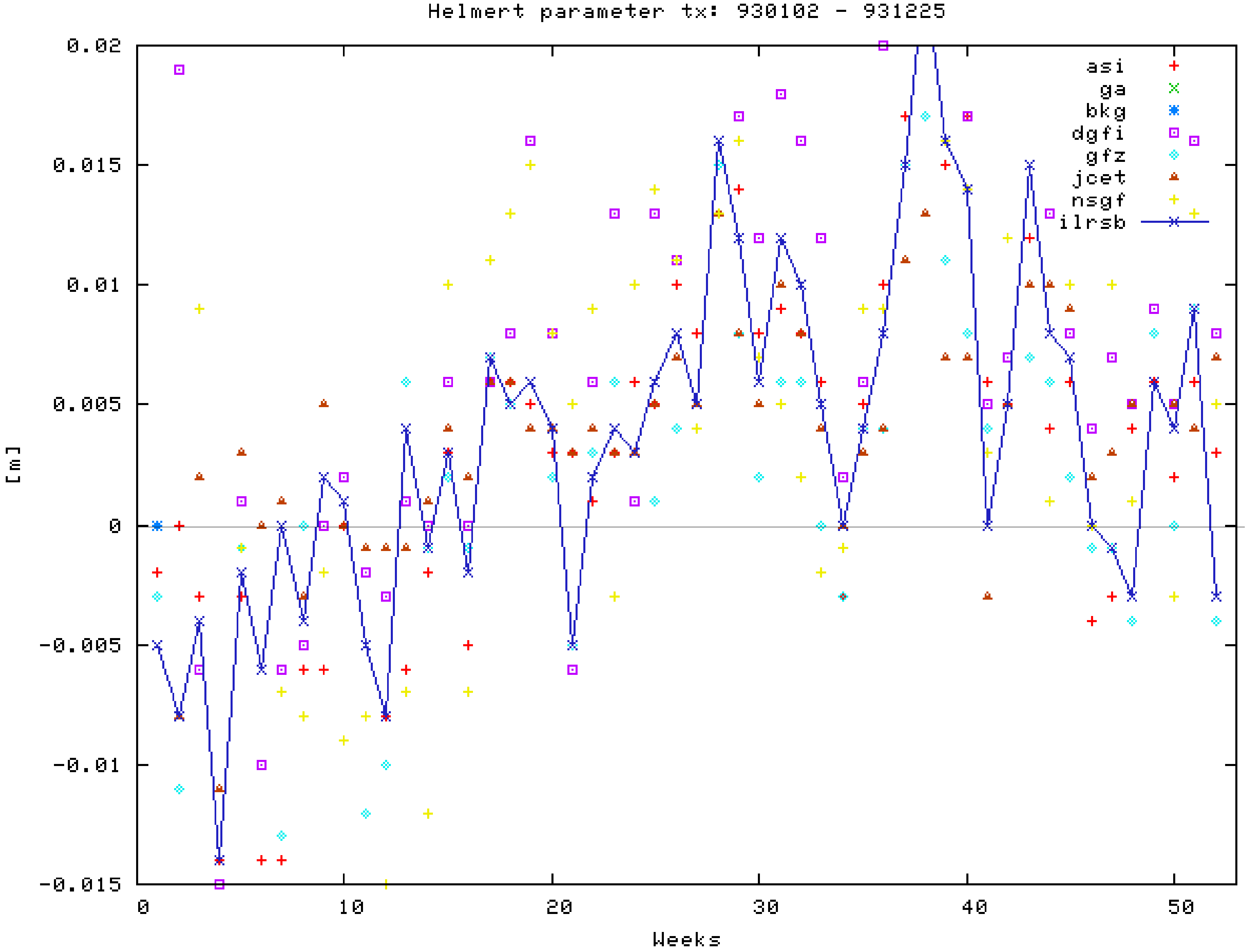


ILRS AWG Meeting Vienna,April 14, 2007

Reanalysis 1993_v6 (new)



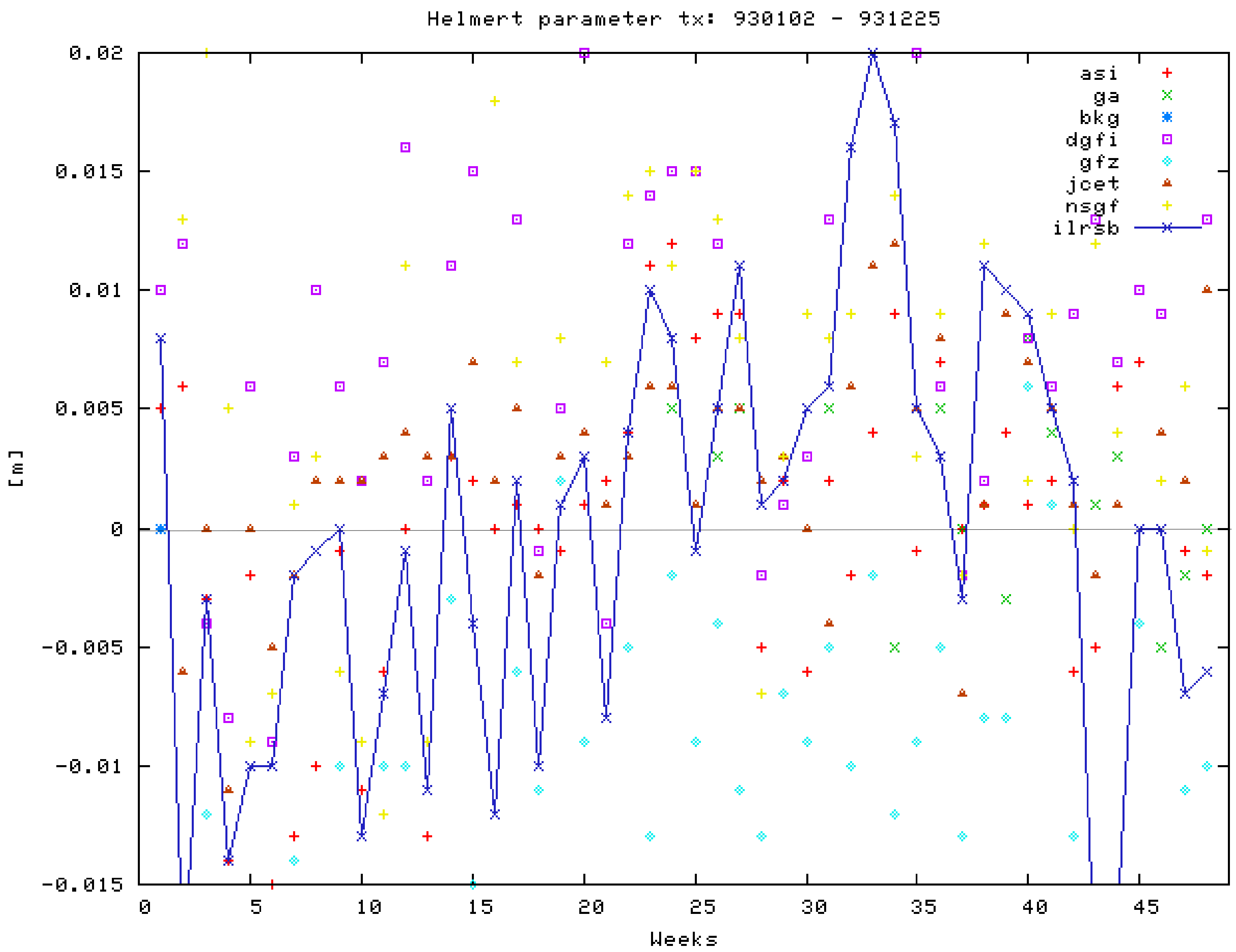
Reanalysis 1993_v7 (old)



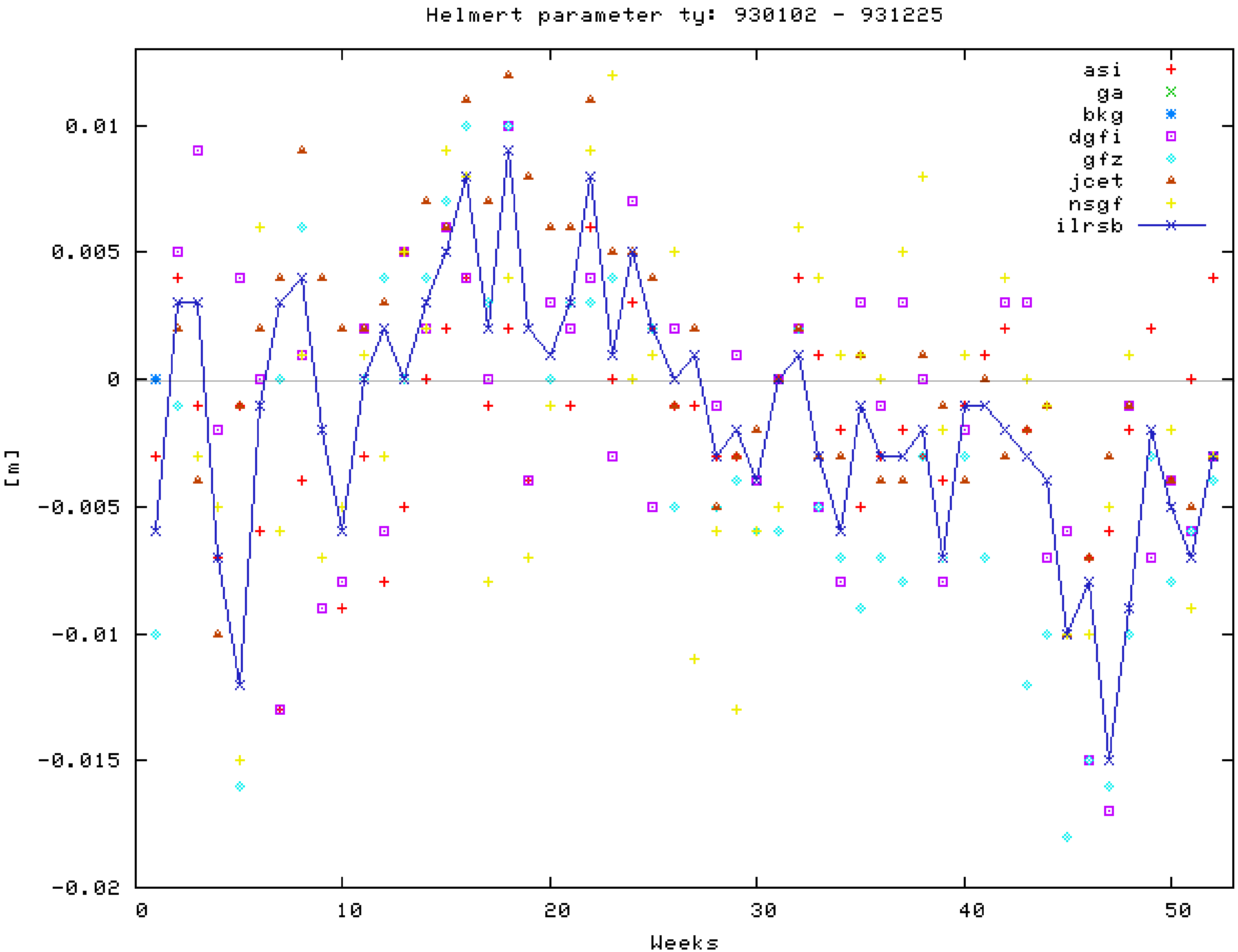
ILRS AWG Meeting Vienna,April 14, 2007

DGFI Forschungsgruppe Satellitengeodäsie

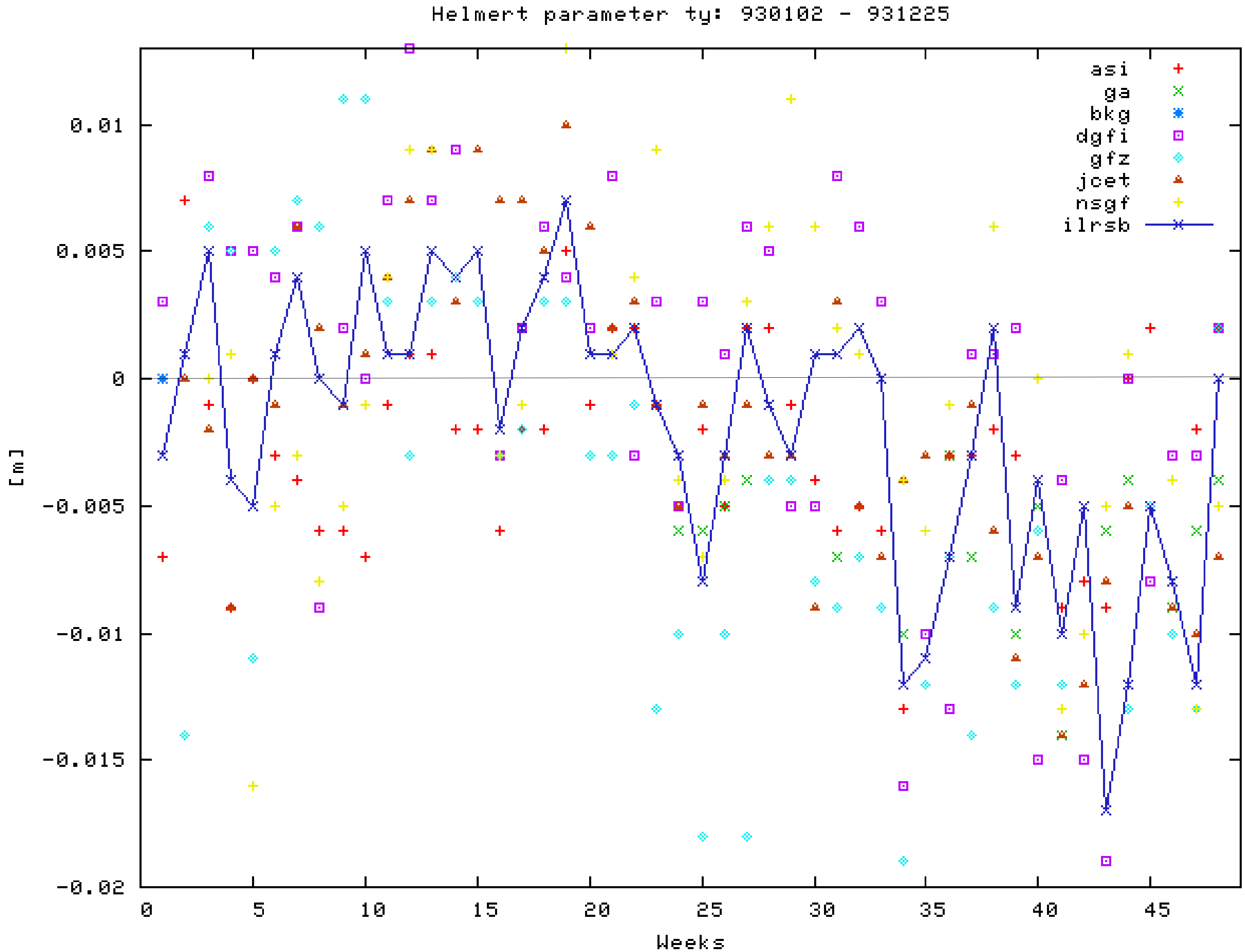
Reanalysis 1993_v6 (new)



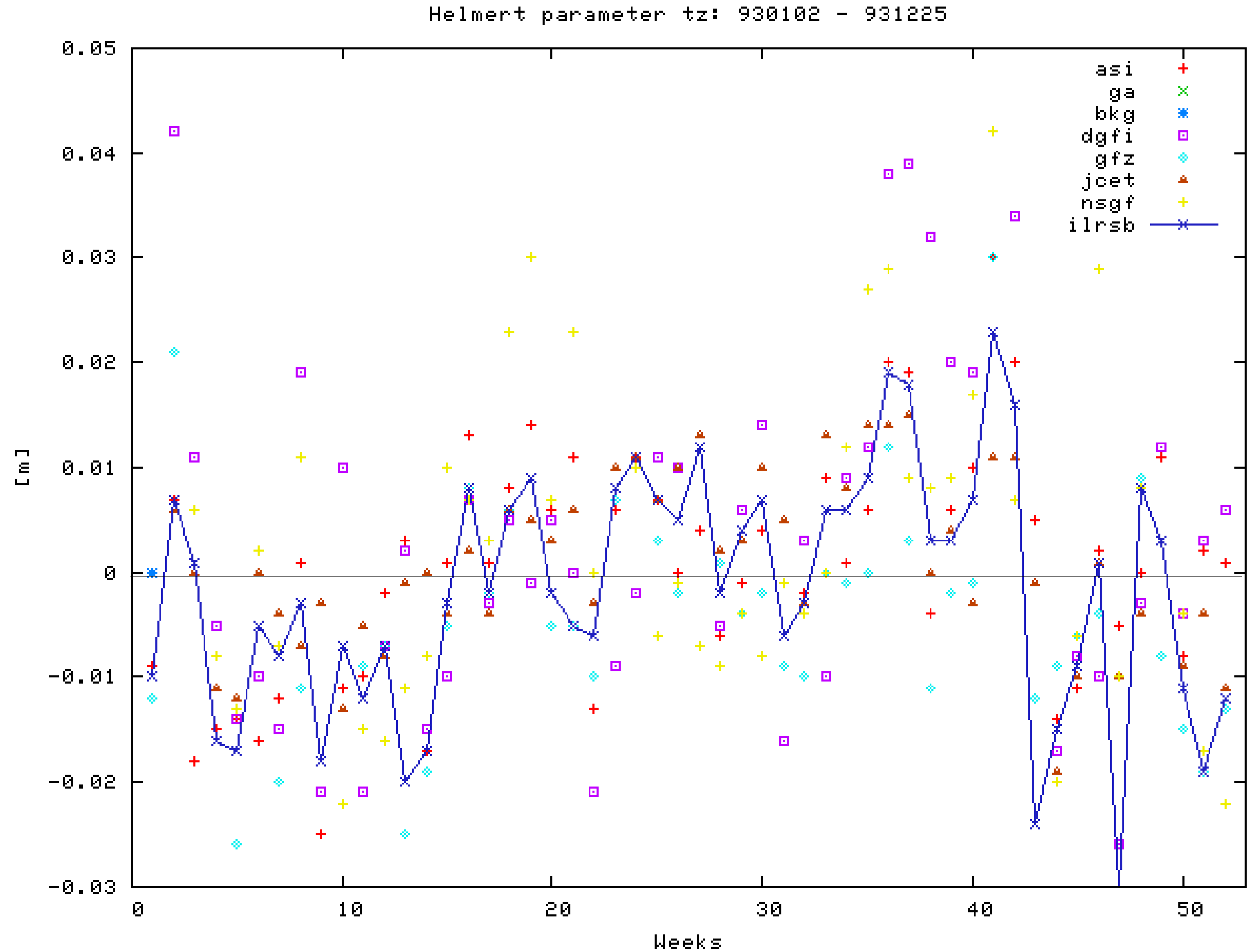
Reanalysis 1993_v7 (old)



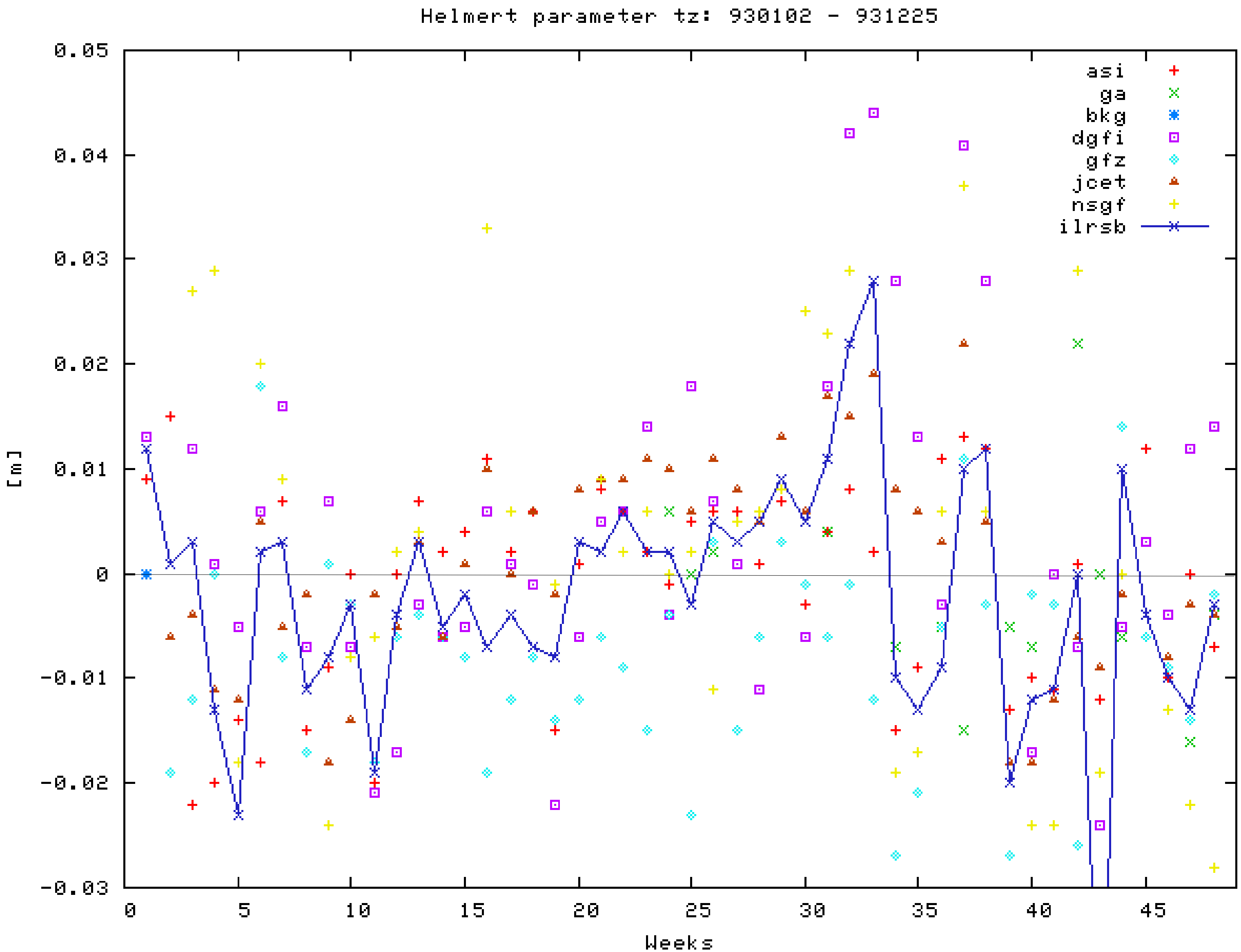
Reanalysis 1993_v6 (new)



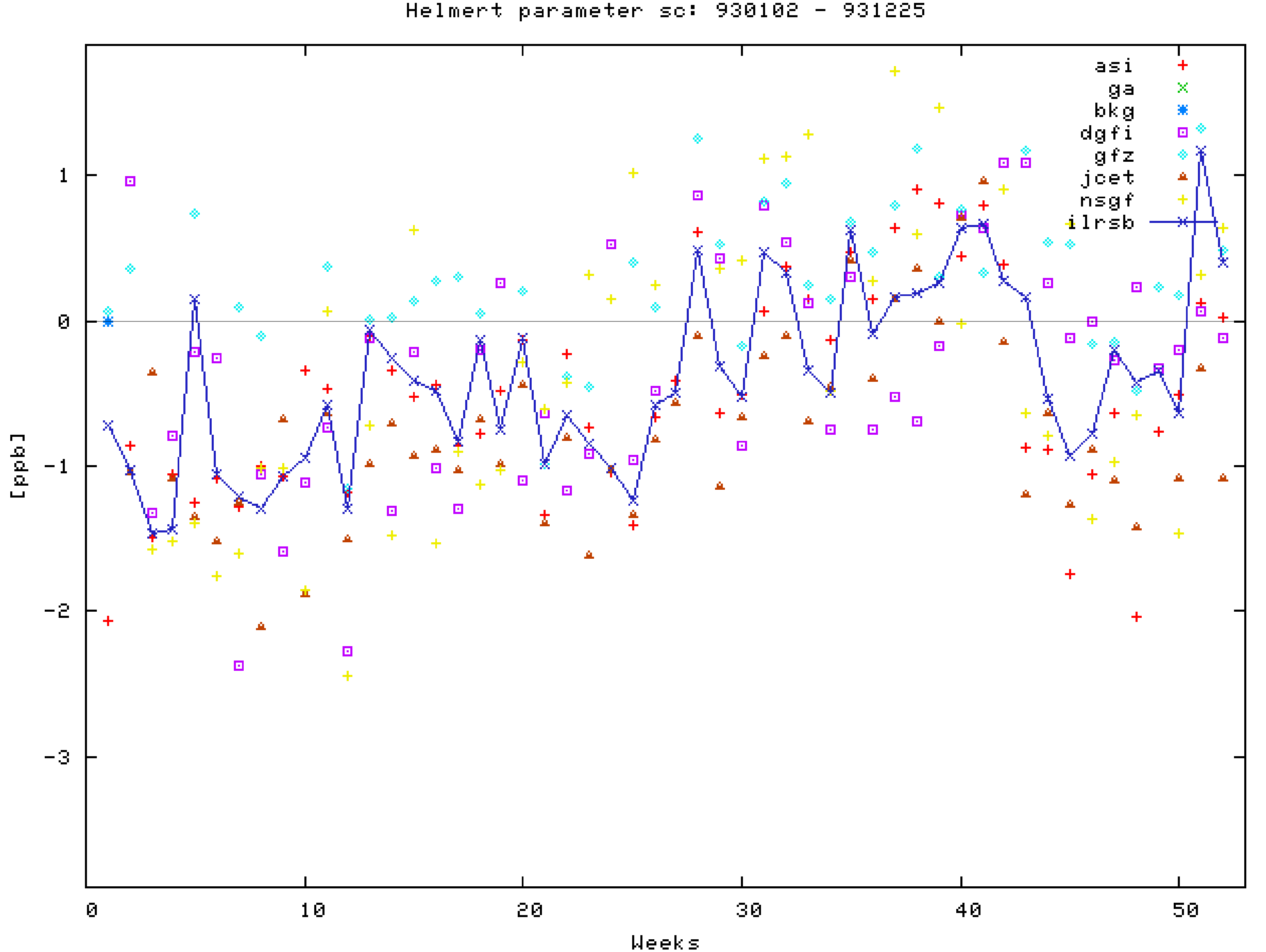
Reanalysis 1993_v7 (old)



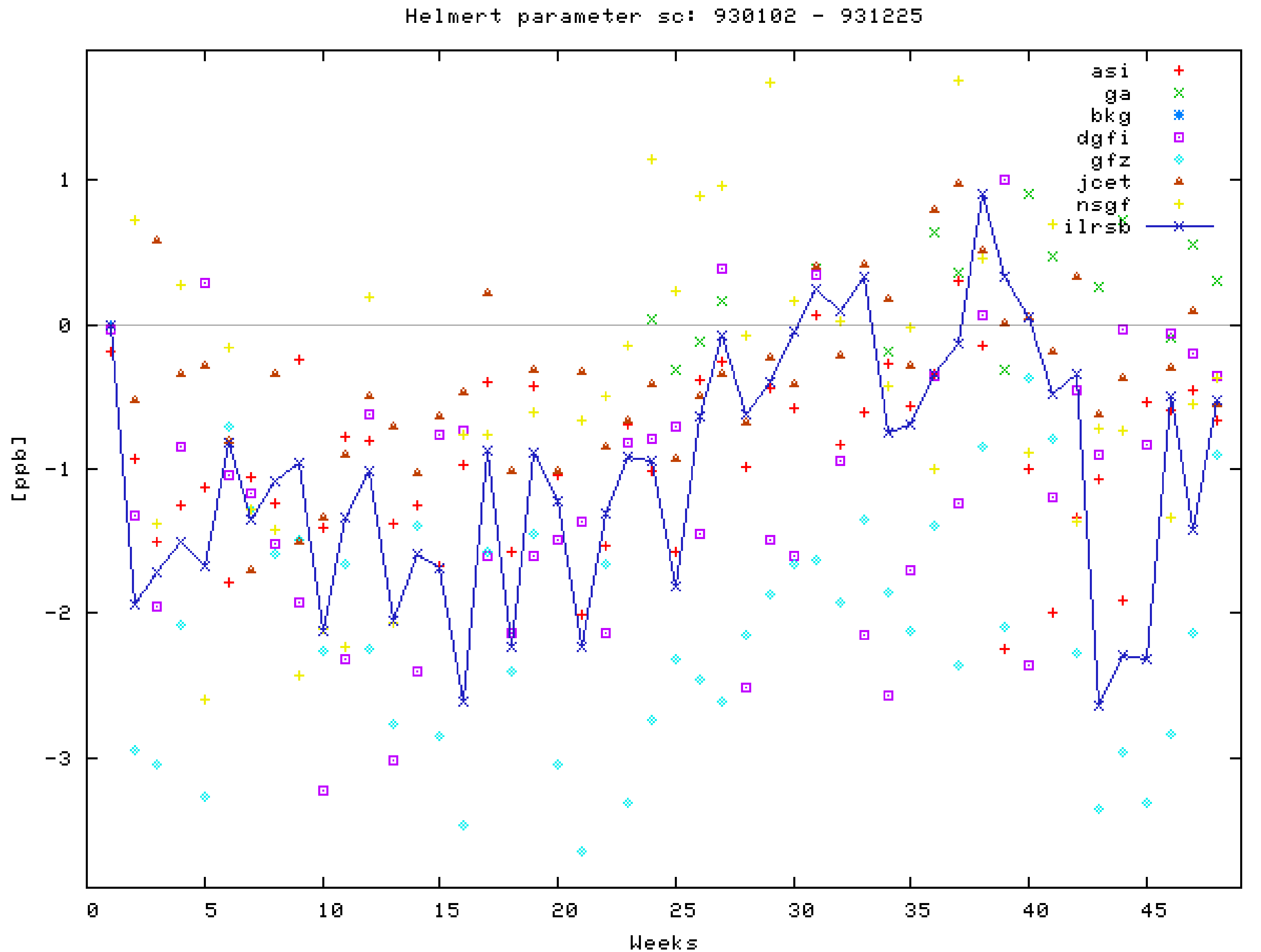
Reanalysis 1993_v6 (new)



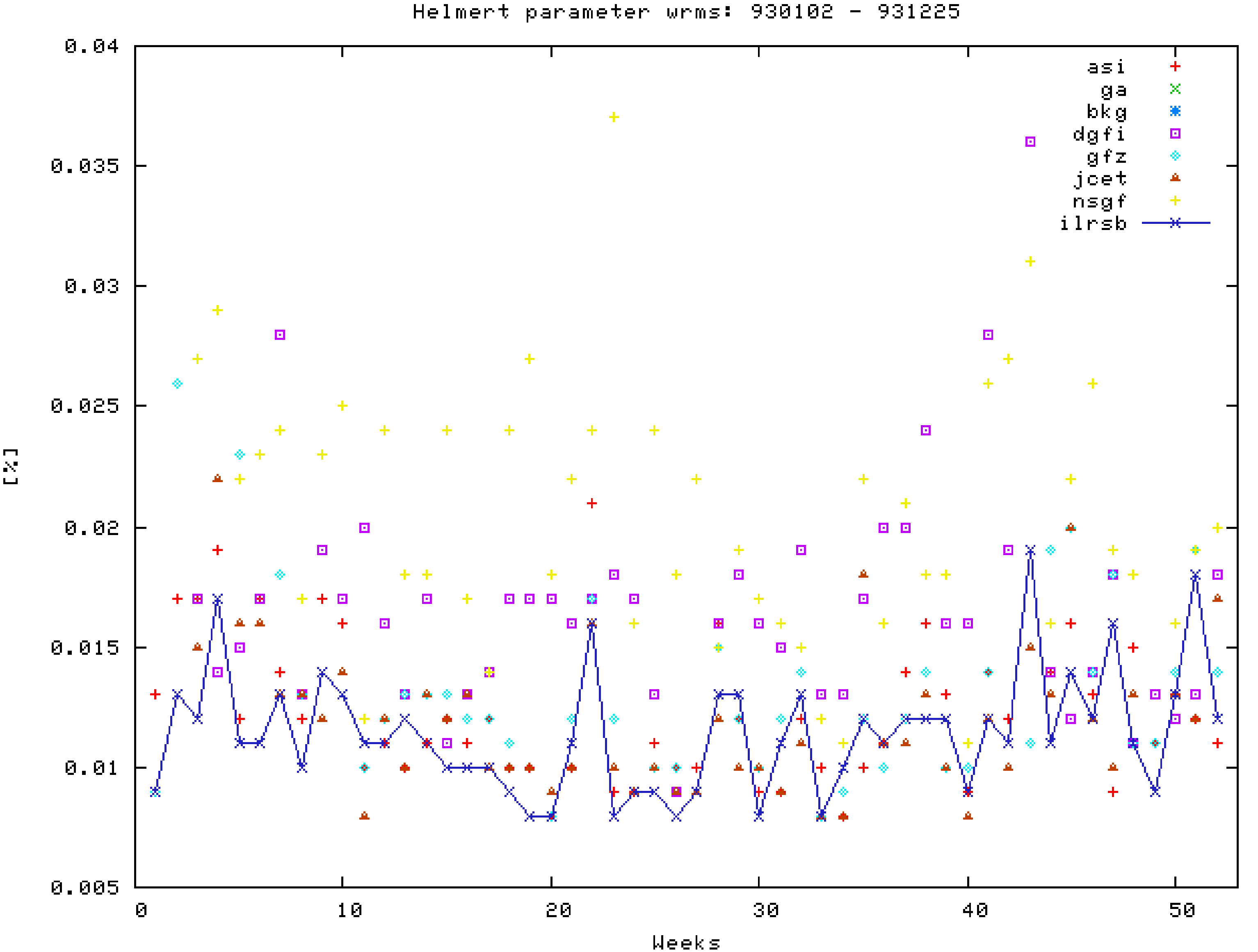
Reanalysis 1993_v7 (old)



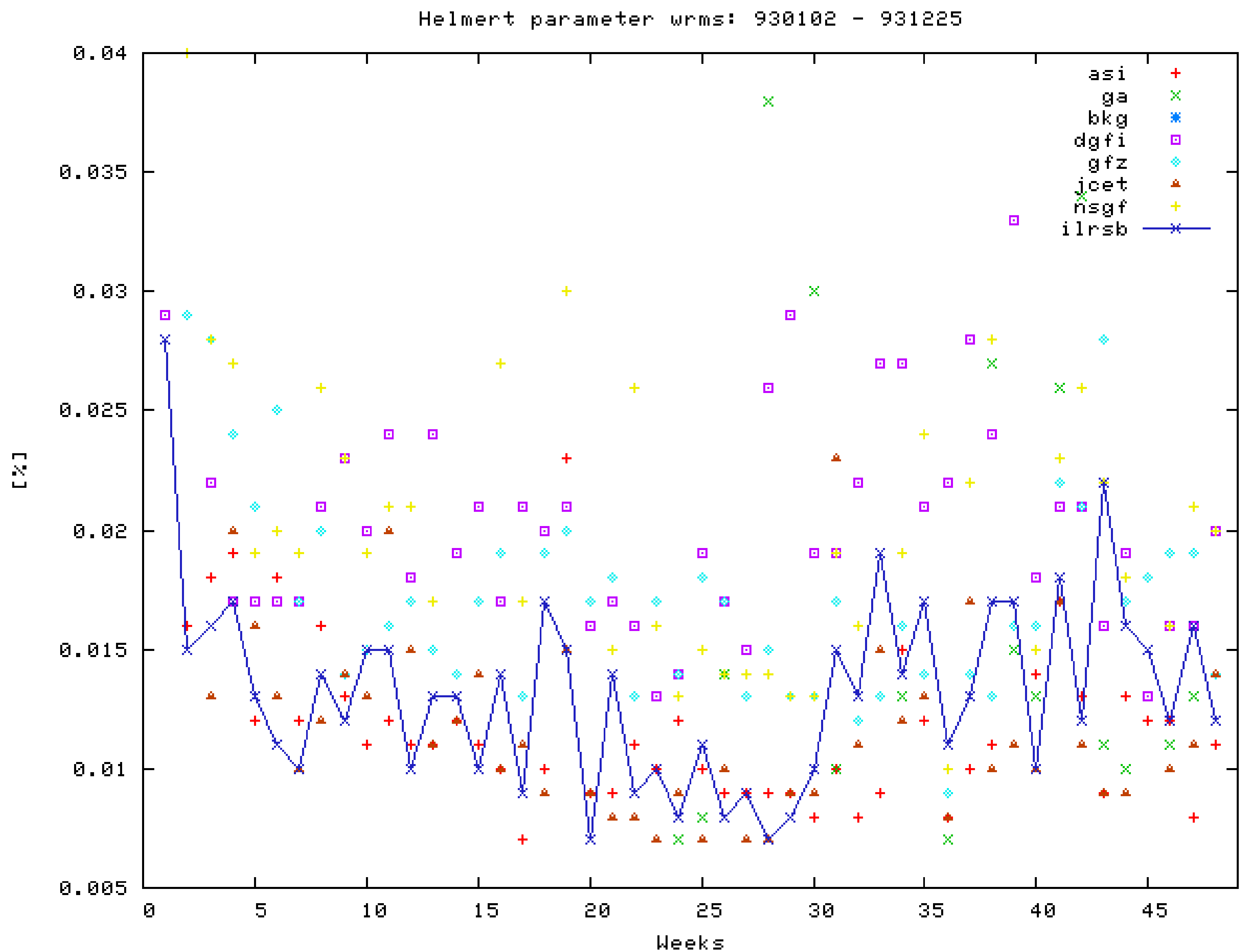
Reanalysis 1993_v6 (new)



Reanalysis 1993_v7 (old)



Reanalysis 1993_v6 (new)

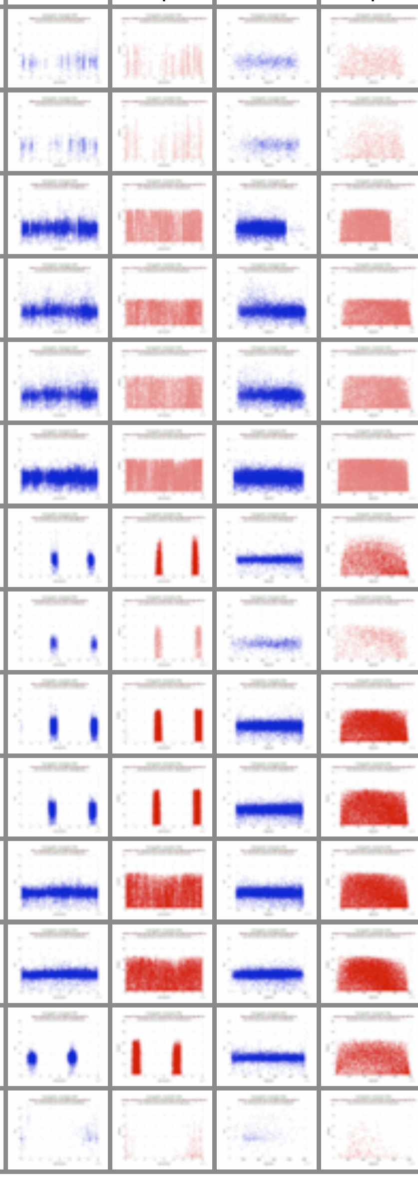


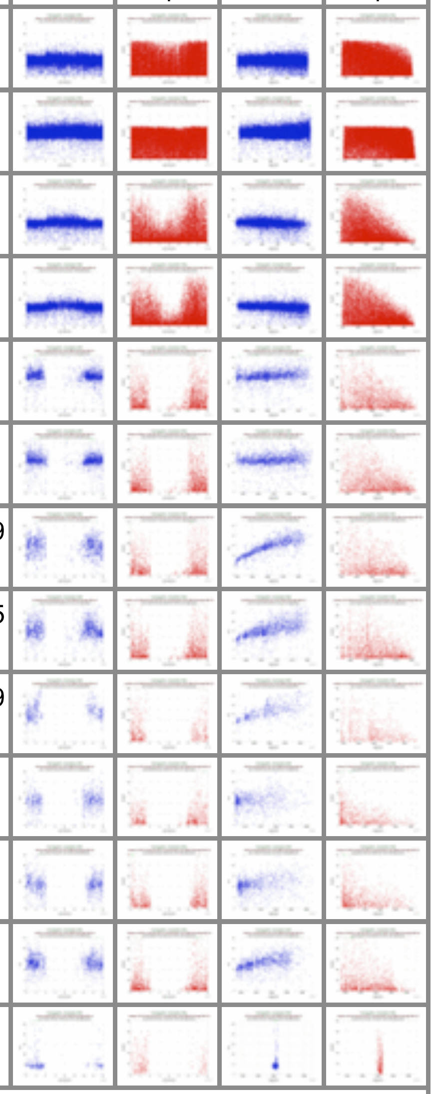
Proposals

* newest version in actual directory at CDDIS and EDC
* two-digit version numbering: 10, 11, 12, ... (proposal of Cecilia a long time ago)

Yarragadee, Australia satellite information as a function of local time and satellite range timespan begins April 1, 2006 and ends March 31, 2007

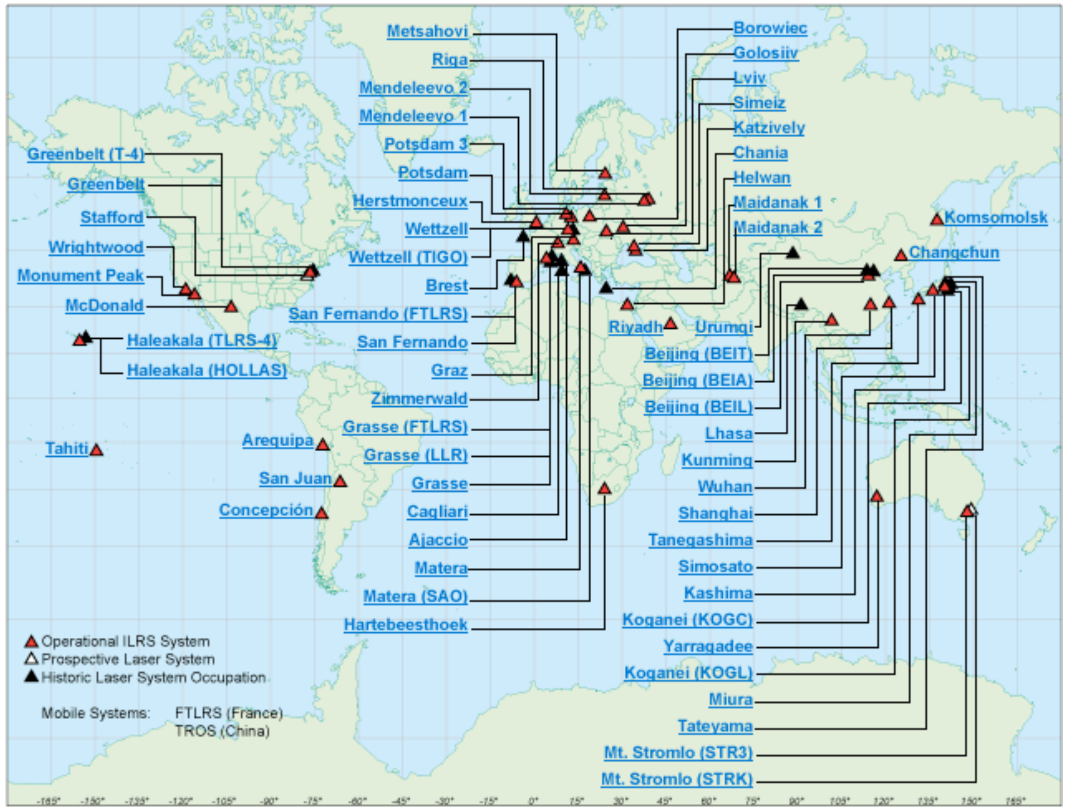
satellite	local time		range		satellite	local time		range	
	npt rms	numFR /npt	npt rms	numFR /npt		npt rms	numFR /npt	npt rms	numFR /npt
ANDE-Act 5 sec					Jason-1 15 sec				
ANDE-Pas 5 sec					Ajisai 30 sec				
CHAMP 5 sec					LAGEOS-2 120 sec				
GRACE-A 5 sec					LAGEOS-1 120 sec				
GRACE-B 5 sec					Etalon-1 300 sec				
ICESat 5 sec					Etalon-2 300 sec				
Larets 30 sec					GLONASS-89 300 sec				
ALOS 15 sec					GLONASS-95 300 sec				
ERS-2 15 sec					GLONASS-99 300 sec				
Envisat 15 sec					GPS-36 300 sec				
GFO-1 15 sec					GPS-35 300 sec				
Starlette 30 sec					GIOVE-A 300 sec				
Stella 30 sec					ETS-8 300 sec				
Beacon-C 15 sec									





this page made Apr. 11, 2007

Stations



Operational and Associate stations as of latest ILRS quarterly report card
(following ILRS station qualification criteria)

Responsible Government Official: Carey Noll
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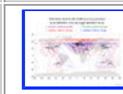
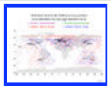
Send us your comments

Last modified date: Thursday, January 11, 2007
Author: Carey Noll
Maintained by: Carey Noll

ILRS Products

Official ILRS products consist of solutions for station coordinates and Earth Orientation Parameters (EOPs). The ILRS generates weekly, unconstrained solutions for station coordinates (valid for the mid-point of each 7-day interval) and EOPs (x-pole, y-pole and Length-Of-Day (LOD), all at 1-day intervals). These results are stored in subdirectories "pos+eop/YYMMDD", where "YYMMDD" is the date (YY=2 digit year, MM=2 digit month, and DD=2 digit day) of the end of each 7-day interval. Within each subdirectory, are the solutions from the combination centers and individual analysis centers.

click on the thumbnail to view a larger image of the location of the tacking data, click on the links to download the solution file via ftp

Solution end date, gps week, and data location		combination solution *	analysis center contributions						
			asi	bkg	dgfi	ga	gfz	jcet	ngsf
20070331 **1420**		pos+eop: sum snx; eop: snx	snx	snx	snx	snx	snx	snx	snx
20070324 **1419**		pos+eop: sum snx; eop: snx	snx	snx	snx	snx	snx	snx	snx
20070317 **1418**		pos+eop: sum snx; eop: snx	snx	snx	snx	snx	snx	snx	snx
20070310 **1417**		pos+eop: sum snx; eop: snx	snx	snx	snx	snx	snx	snx	snx
20070303 **1416**		pos+eop: sum snx; eop: snx	snx	snx	snx	n/a	snx	snx	snx

* *pos+eop:* *__SUM__mary file assessing the quality of solution and a __SiNeX__ format solution file for combination __POS__ition and __E__arth __O__rientation __P__arameter solution*

eop: *a __SiNeX__ format solution file for the __EOP__ combination product*

The official primary ILRS combination products are formed by ASI Space Geodesy Center. The ILRS's official backup combination center is Deutsches Geodatisches Forschungsinstitut (DGFI). The combination products, and the individual ILRS analysis center contributions to the official combination pos+eop and eop product can be downloaded from the ILRS ftp archive labeled as:

> ftp://cddis.gsfc.nasa.gov/pub/pub/slr/products/pos+eop/ YYMMDD/CENTER.pos+eop.YYMMDD.vN.sum
> ftp://cddis.gsfc.nasa.gov/pub/pub/slr/products/pos+eop/ YYMMDD/CENTER.pos+eop.YYMMDD.vN.snx
> ftp://cddis.gsfc.nasa.gov/pub/pub/slr/products/pos+eop/ YYMMDD/CENTER.eop.YYMMDD.vN.snx

Here, "CENTER" is replaced by either "ilrsa", or "ilrsb", or the abreviated name of the analysis center. The version number "N" for first solution that is generated for this period is labeled as "1". If re-computations are necessary, the version number, "N", will be increased by one. The results are stored in the SINEX format (".snx"). The reader is refered to the COMMENTS section of each solution (in the file itself) or more general explanations of SINEX for further details of the solution and/or the format.

The individual analysis center solutions as well as the combination solutions are monitored on a weekly basis with a graphical and a statistical presentation of these time series available at: site hosted by the JCET analysis center http://geodesy.jcet.umbc.edu/ILRS_QCQA

For more information and/or suggestions, please contact the CDDIS/EDC Data Center representatives (Carey Noll or Wolfgang Seemueller respectively) or the ILRS Analysis Coordinators (Erricos Pavlis or Cinzia Luceri).

NOTICE: It is **important** that you **acknowledge** the ILRS in your papers and presentations that rely on SLR and results. Please **reference** the following citation:

> Pearlman, M.R., Degnan, J.J., and Bosworth, J.M., "The International Laser Ranging Service", Advances in Space Research, Vol. 30, No. 2, pp. 135-143, July 2002.

Furthermore, please include SLR as a keyword in your papers. The SLR community relies on these acknowledgements and references to strengthen its requests for continued support from its funding organizations. The Central Bureau asks that you provide a link to and/or bibliographic reference of any SLR/LLR-related papers or presentations.

SLR Global Performance Report Card

April 1, 2006 through March 31, 2007

The performance report card is divided into three tables for readability. Table 1 contains performance parameters based on data volume, on-site processing statistics and operational compliance issues. Table 1 L contains information about Lunar Laser Ranging during the past year. Table 2 contains performance parameters based on various Ananlysis Cente's rapid orbital analysis results.

Below are the detailed descriptions of each column in Table 1 *plots of the columns are linked in this description and in Table 1:*

- ***Column 1*** *is the station location name.*
- ***Column 2*** *is the monument marker number.*
- ***Column 3*** *is the LEO pass total during the past 12 months.*
- ***Column 4*** *is the LAGEOS pass total during the past 12 months.*
- ***Column 5*** *is the high satellite pass total during the past 12 months.*
- ***Column 6*** *is the pass total (i.e., all satellites) during the past 12 months.*
- ***Column 7*** *is the LEO NP total during the past 12 months.*
- ***Column 8*** *is the LAGEOS NP total during the past 12 months.*
- ***Column 9*** *is the high satellite NP total during the past 12 months.*
- ***Column 10*** *is the NP total (i.e., all satellites) during the past 12 months.*
- ***Column 11*** *is the total tracking minutes (i.e., all satellites) during the past 12 months. This is computed by the summation of the number of normal points multiplied by its bin size in minutes.*
- ***Column 12*** *is the average single-shot calibration RMS, in millimeters, during the last quarter.*
- ***Column 13*** *is the average single-shot Starlette RMS, in millimeters, during the last quarter.*
- ***Column 14*** *is the average single-shot LAGEOS RMS, in millimeters, during the last quarter.*

The first entry in each table is for the performance baseline goal. Note: There are no baseline goals for NP data quantities, single shot RMS's.

Additional Notes: Blanks in any columns implies either that there was no data or that there was insufficient data. Only stations that have supplied data within the last year are included in the table. The table is sorted in descending order by total passes.

Table 1

Site Information		Data Volume									Data Quality		
Column 1	2	3	4	5	6	7	8	9	10	11	12	13	14
Location	Station Number	LEO pass Tot	LAGEOS pass Tot	High pass Tot	Total passes	LEO NP Total	LAGEOS NP Total	High NP Total	Total NP	Minutes of Data	Cal. RMS	Star RMS	LAG RMS
Baseline		1000	400	100	1500								
Yarragadee	7090	9048	1996	1368	12412	176336	26510	13753	216599	85814	4.8	8.4	9.4
Zimmerwald_423 Zimmerwald_846	7810	5448 5415	1184 1202	860 820	7492 7437	89862 89751	15996 18098	5740 5809	111598 113658	41355 43478	11.9 24.5	14.9 24.3	16.8 25.8
San_Juan	7406	4806	1171	1178	7155	66823	13458	6047	86328	39337	6.5	9.2	11.9
Mount_Stromlo_2	7825	5154	1403	578	7135	68060	15755	4626	88441	39664	3.4	6.4	9.1
Graz	7839	5200	855	572	6627	103813	9597	4863	118273	32220	2.4	3.9	8.0
Riyadh	7832	4279	1093	821	6193	56690	9971	4628	71289	29563	9.5	19.4	18.7
Wettzell	8834	4523	990	555	6068	56898	8095	3158	68151	24616	5.0	13.5	18.6
Monument_Peak	7110	4378	945	341	5664	86396	10532	3312	100240	27591	4.9	13.2	14.4
Herstmoncex	7840	3833	985	419	5237	61558	12960	2017	76535	23582	7.9	12.1	15.1
Changchun	7237	3607	510	393	4510	45778	4292	2068	52138	14885	9.2	12.9	14.1
Matera_MLRS	7941	2586	864	199	3649	35622	9961	1599	47182	19581	1.8	4.4	5.7
Hartebeesthoek	7501	2455	681	200	3336	37645	7186	1883	46714	17495	5.1	7.9	9.5
Simosato	7838	2023	515	7	2545	38577	7705	67	46349	12745	5.3	5.6	8.6
Potsdam_3	7841	2055	313		2368	39130	3902		43032	6856	12.4	17.2	20.6
San_Fernando	7824	2002	316		2318	30735	2558		33293	5646	6.0	11.2	15.4
Greenbelt	7105	1840	315	66	2221	38709	3339	399	42447	7580	4.8	9.3	9.5
McDonald	7080	1253	419	291	1963	14328	3911	1226	19465	8637	12.6	12.0	12.5
Beijing	7249	1386	199	66	1651	17614	1797	425	19836	5427	13.2	34.0	20.3
Shanghai_2	7821	1314	123	10	1447	16316	1201	69	17586	3288	15.1	25.7	33.6
Maidanak_1	1864	757	191	234	1182	7771	1688	909	10368	5256		63.0	69.7
Riga	1884	1061	93	8	1162	20409	1113	44	21566	2360	7.3	10.6	12.2
Katzively	1893	761	105	30	896	12693	839	178	13710	2693	32.2	44.1	41.6
Borowiec	7811	642	94	4	740	9808	932	15	10755	1981	19.1	20.8	24.2
Papeete	7124	518	131		649	7679	1168		8847	1993	4.4	7.6	
Koganei	7308	406	104	108	618	6364	1205	762	8331	4478	8.9	11.8	14.6
Simeiz	1873	477	108	2	587	5595	982	13	6590	1796		98.6	54.5
Arequipa	7403	390	42		432	3524	301		3825	819	5.4	7.4	5.0
Haleakala	7119	264	46		310	3915	437		4352	990	4.8	11.5	9.6
Tanegashim	7358	204	23	19	246	2723	220	78	3021	755	2.9	4.0	5.5
Concepcion_423 Concepcion_847	7405	122 1647	33 766	 149	155 2562	1320 22747	304 8953	 1128	1624 32828	626 16562	4.2 7.3	10.3 31.9	11.5 61.7
Lviv	1831	47			47	738			738	101			
NRL	7865	9			9	131			131		19.5		
Helwan	7831	9			9	92			92	4			
Kiev	1824	1			1	12			12	4	47.4		

Below are the detailed descriptions of each column in Table 1 L:

- ***the first column, L1****, is the station location name.*
- ***the second column, L2****, is the monument marker number.*
- ***the third column, L3****, is the number of nights during the past 12 months in which there were Lunar ranging measurements*

- ***the fourth column, L4***, *is the number of Lunar Laser Ranging normal points during the past 12 months*
- ***the fifth column, L5***, *is the number of Lunar Laser Ranging normal points during the past 3 months*
- ***the sixth column, L6***, *is the average Lunar Laser Ranging normal points rms 3 months in mm*

Table 1 L

Site Information		Data Information			
Column L1	L2	L3	L4	L5	L6
Location	Station Number	num nights tracking last 12 mon	num npt last 12 mon	num npts last 3 mon	ave npt rms last 3 mon
McDonald	7080	72	116	26	61.4

Below are the detailed descriptions of each column in Table 2:

- ***the first column*** *is the station location name.*
- ***the second column*** *is the monument marker number.*
- *following columns are in grouped by analysis center with four columns for each*
  - ***the first AC column*** *is the average LAGEOS normal point RMS, in millimeters, during the last quarter*
  - ***the second AC column*** *is the measure of short term bias stability, in millimeters, during the last quarter. The short term stability is computed as the standard deviation about the mean of the pass-by-pass range biases (minimum number of passes in quarter is 10)*
  - ***the third AC column*** *is the measure of long term bias stability, in millimeter, during the past year. The long term stability is the standard deviation of the monthly range bias estimates.* A station must have tracked LAGEOS (1,2) in at least 8 of the last 12 months in order to compute this metric.
  - ***the fourth AC column*** *is the percentage of LAGEOS normal points that were accepted in the analysis.*

The first entry in each table is for the performance baseline goal.

Additional Notes: Blanks in any columns implies either that there was no data or that there was insufficient data. Only stations that have supplied data within the last year are included in the table. The table is sorted in descending order by total data volume.

Table 2

Site Information		NICT Orbital Analysis				MCC Orbital Analysis				SHAO Orbital Analysis			
Station Location	Station Number	LAG NP RMS (mm)	short term (mm)	long term (mm)	% good LAG. NP	LAG NP RMS (mm)	short term (mm)	long term (mm)	% good LAG. NP	LAG NP RMS (mm)	short term (mm)	long term (mm)	% good LAG. NP
Baseline		**10.0**	**20.0**	**20.0**	**95**	**10.0**	**20.0**	**20.0**	**95**	**10.0**	**20.0**	**20.0**	**95**
Yarragadee	7090	2.0	9.1	1.3	100.0	2.3	12.6	6.8	98.5	2.2	16.1	2.0	95.2
Zimmerwald_423 Zimmerwald_846	7810	2.7 3.7	9.7 5.8	3.3 2.9	99.9 100.0	3.2	8.1	10.4	96.2	2.9 3.1	11.3 11.0	2.6 3.2	94.2 94.1
San_Juan	7406	2.6	19.7	13.2	98.8	3.8	11.9		99.5	2.7	23.6		95.6
Mount_Stromlo_2	7825	3.8	12.3	1.5	98.7	4.3	18.1	3.1	92.8	3.5	17.9	2.2	94.6
Graz	7839	1.2	5.3	2.9	100.0	1.8	5.7	5.1	99.2	1.3	11.3	2.0	95.7
Riyadh	7832	2.7	12.2	3.6	99.8	3.7	13.9	4.8	96.6	3.0	21.8	3.7	95.8
Wettzell	8834	3.3	11.4	3.7	100.0	3.1	14.6	9.2	97.1	3.3	15.7	3.1	96.3
Monument_Peak	7110	2.0	11.2	1.5	100.0	2.2	14.1	3.5	98.4	2.1	13.5	2.6	95.7
Herstmoncex	7840	1.6	7.3	1.6	100.0	2.7	9.8	3.8	98.7	2.2	11.7	3.1	96.6
Changchun	7237	7.0	22.0	6.9	99.9	7.1	19.9	17.3	96.0	6.0	27.6	8.1	96.1
Matera_MLRS	7941	2.7	13.9	7.5	100.0	2.4	15.3	10.3	97.7				
Hartebeesthoek	7501	2.2	10.5	4.5	100.0	2.1	10.2	3.7	97.5	3.3	15.8	4.3	98.0
Simosato	7838	3.0	13.0	8.4	99.8	4.8	13.1	9.8	99.6	5.0	19.1	9.2	95.5
Potsdam_3	7841	4.1	12.8	4.2	99.5	5.0	15.5	13.1	90.0				
San_Fernando	7824	2.6	14.1	9.2	100.0	3.9	14.9	15.1	99.6	3.7	19.1	14.8	95.2
Greenbelt	7105	1.7	8.5	5.5	100.0	2.0	15.7	10.8	98.7	2.2	15.1	3.9	94.8
McDonald	7080	2.3	10.2	4.7	99.9	3.0	11.7	7.6	96.7	2.2	15.4	6.4	94.9
Beijing	7249	9.9	21.3	7.6	91.8	13.8	16.8	18.4	88.3	8.9	23.1	9.4	85.9
Shanghai_2	7821	9.9	25.2	12.0	100.0	11.2	22.6		98.9	9.6	29.4	18.2	95.8
Maidanak_1	1864	22.9	24.7	11.3	90.0	21.9	32.6	9.2	80.4	25.1	24.5	10.2	69.8
Riga	1884	6.5	25.8	23.8	100.0	6.8	29.7	27.4	94.2	5.1	14.8	21.4	94.0
Katzively	1893	7.0	21.9	7.3	98.9	6.7	23.4	8.9	94.5	7.6	26.5	28.0	92.9
Borowiec	7811	9.9	11.5	5.8	100.0								
Koganei	7308	3.3	18.8	18.1	99.9	4.8	21.7	13.4	97.8	4.2	22.7	17.9	95.8
Simeiz	1873	73.1	48.4	46.0	95.0	44.5	50.9	48.3	78.1	37.6	27.3	28.3	70.4
Haleakala	7119	1.8	11.1		100.0								
Concepcion_423 Concepcion_847	7405	 2.1	 11.3	 4.2	 99.9	 3.3	 14.4	 6.7	 99.4	2.6	23.3		96.4

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Last modified date: Tuesday, April 3, 2007
Author: Mark Torrence
Maintained by: Carey Noll

GFZ POTSDAM

Some Effects of Data Handling and Background Models on the SLR Dynamical and Geometrical Reference Frame

R. König, K.H. Neumayer, M. Vei

EGU General Assembly
Vienna, 15-20 April, 2007

GFZ POTSDAM

Motivation

- Effect of
  - individual stations / network configuration
  - systematic corrections to range observations
  - a priori coordinates
- on the
  - dynamic
  - geometric
- reference frame

GFZ POTSDAM

Introduction

- 2 Solutions:
  - SLR test solution for year 2004 within GGOS-D
  - 14-year series 1993-2004 within ILRS reanalysis
- GGOS-D standards different than for ILRS AC duties for pos&eop
  - EIGEN gravity model
  - FES2004
  - Corresponding ocean tide loading site displacements
- Recently introduced systematic corrections within ILRS ACs for pos&eop
  - Stanford counter range biases for individual stations and periods
  - Tropospheric range correction model change
- ITRF2000 / ITRF2005(rescaled)

Parametrization

- Solved for parameters in weekly solutions from LAGEOS-1 and -2

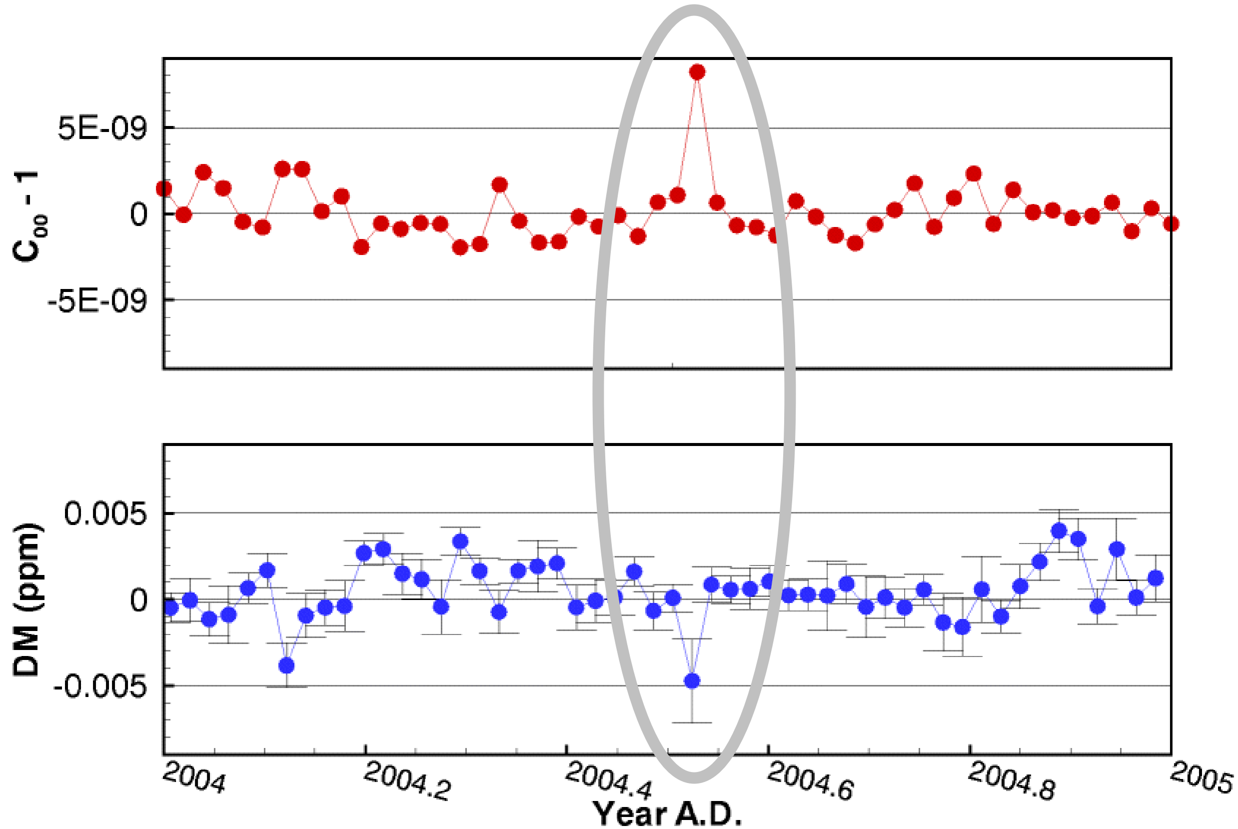
GGOS-D:	ILRS AC:
Station coordinates, a priori sigma 1 m	dto.
X-, Y-pole, UT1; @0:00; a priori sigma 1 m	dLOD; @12:00
Degree 0 to 2 harmonics, a priori sigma 1 m	NO
Range biases for a few stations, free	dto.
Initial states of LAGEOS-1 and -2, free	dto.
Empirical accelerations for LAGEOS-1 and -2, free	dto.

- Rank deficiency without a priori sigmas = 3

the rotations need a datum	dto.

Spurious Stations

- **Peak in C(0,0) and in HT (Helmert transformation) scale (DM) time series**
  - **Standard data screening and processing sees no spurious station**

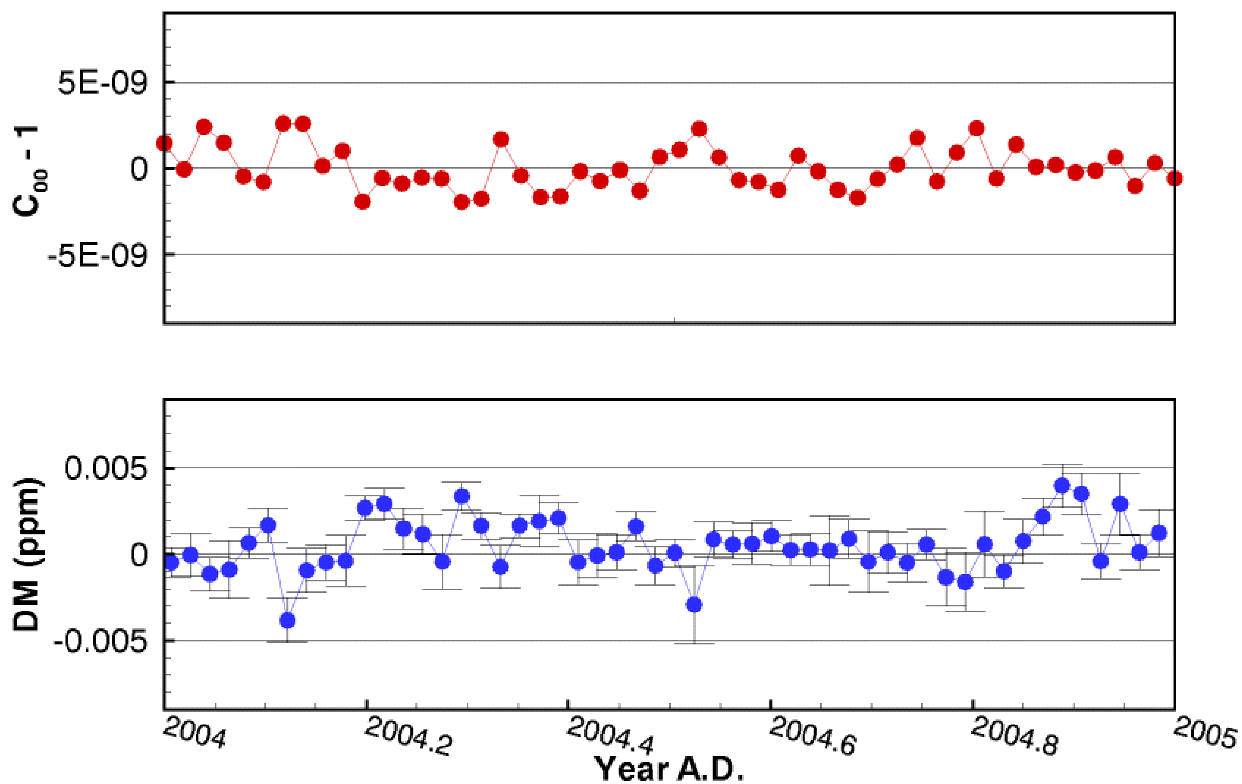


Spurious Stations, II

- **Empirical remove-restore search for peak driving station**
  - **Spurious from C(0,0):**

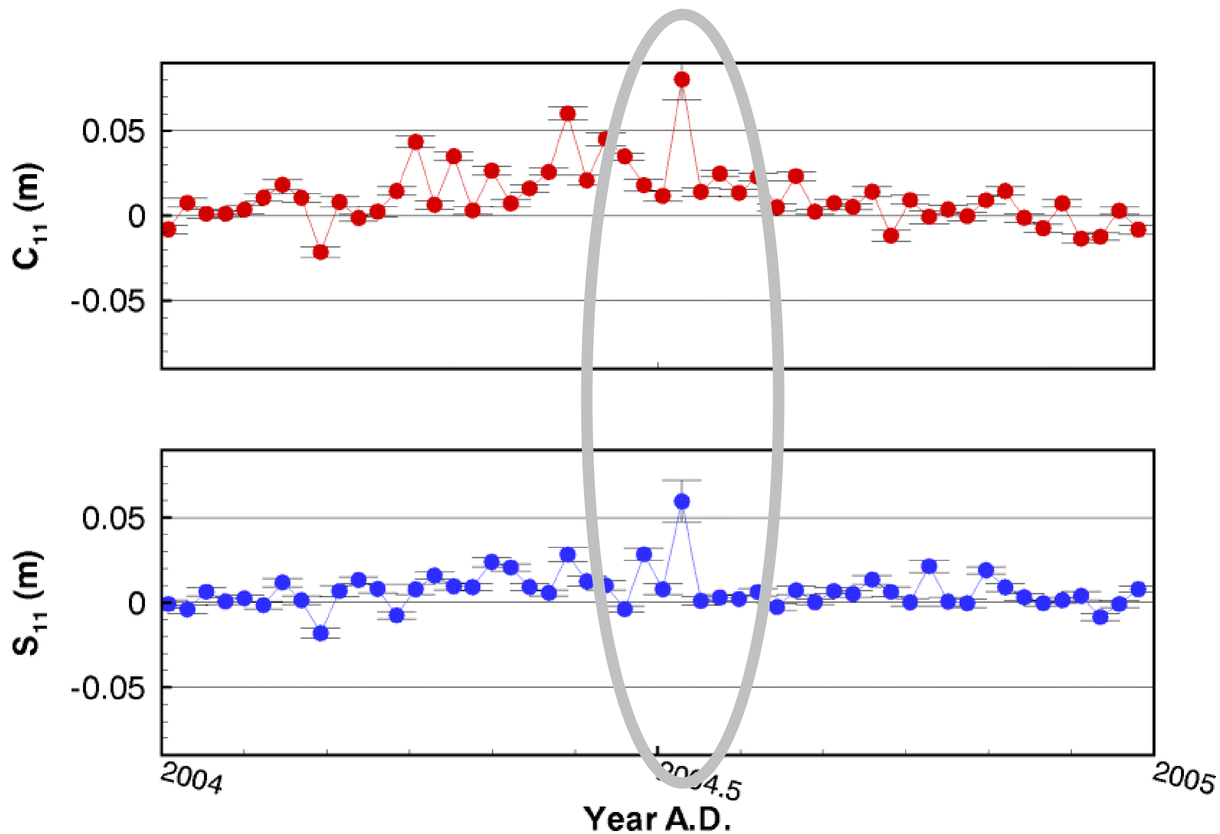
    7355 Urumqi
  - **dto. from HT scales:**

    7249 Beijing
  - **=> both removed**



Spurious Stations, III

- **BUT: peaks in C(1,1), S(1,1), TX, TY and other series, e.g. S(2,2), remain**



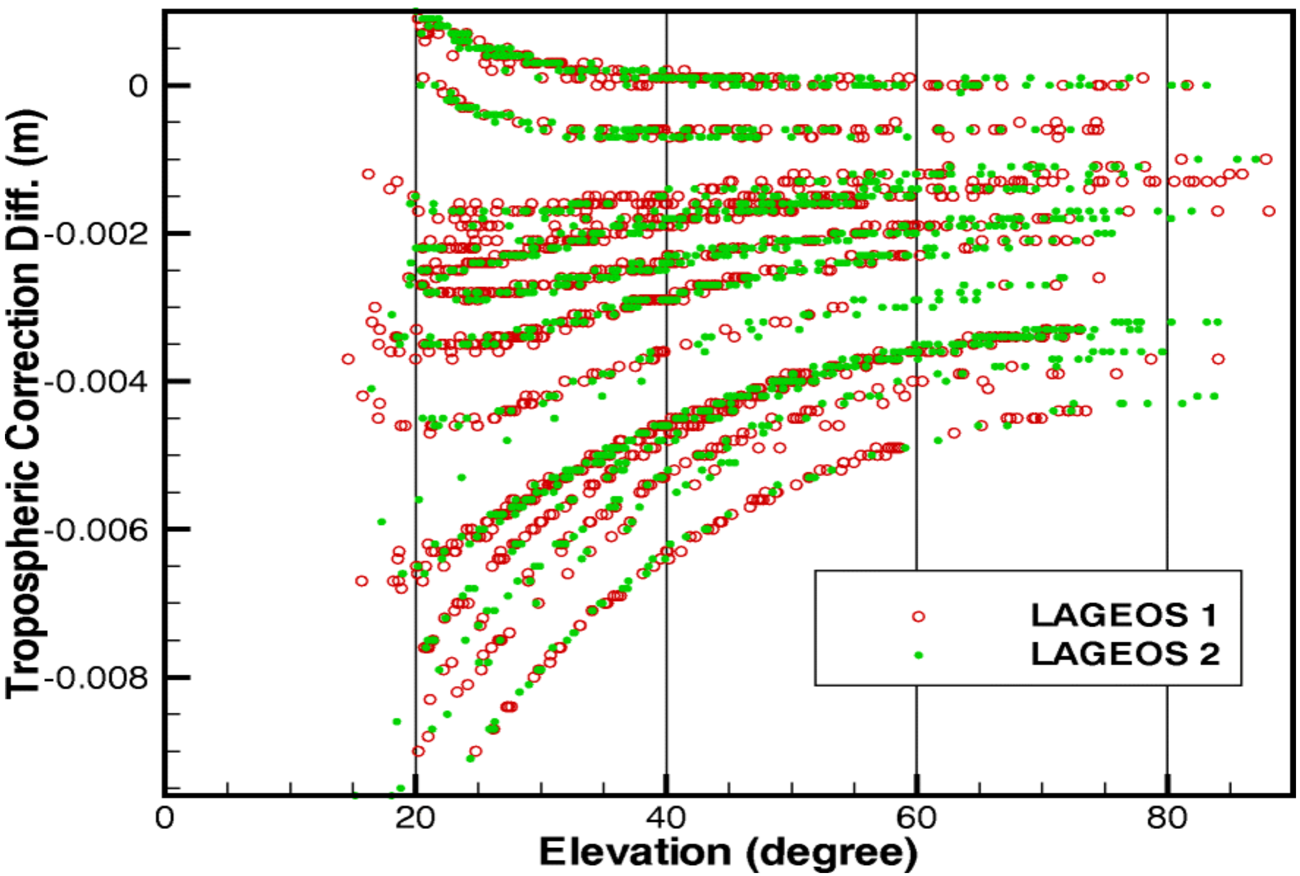
GFZ POTSDAM

Stanford Counter Range Bias Corrections

1824 San Fernando	16 mm	since 99:314
1893 Katsively	10 mm	since 98:171
7231 Wuhan	10 mm	since 99:001
7249 Beijing	22 mm	since 01:020
7406 San Juan	10 mm	since 06:020
7810 Zimmerwald	11 mm	since 97:001
...		
7840 Herstmonceux	18.5 mm	from 93:001 to 02:032
	8.5 mm	from 02:032 to 07:042
...		

Tropospheric Range Correction

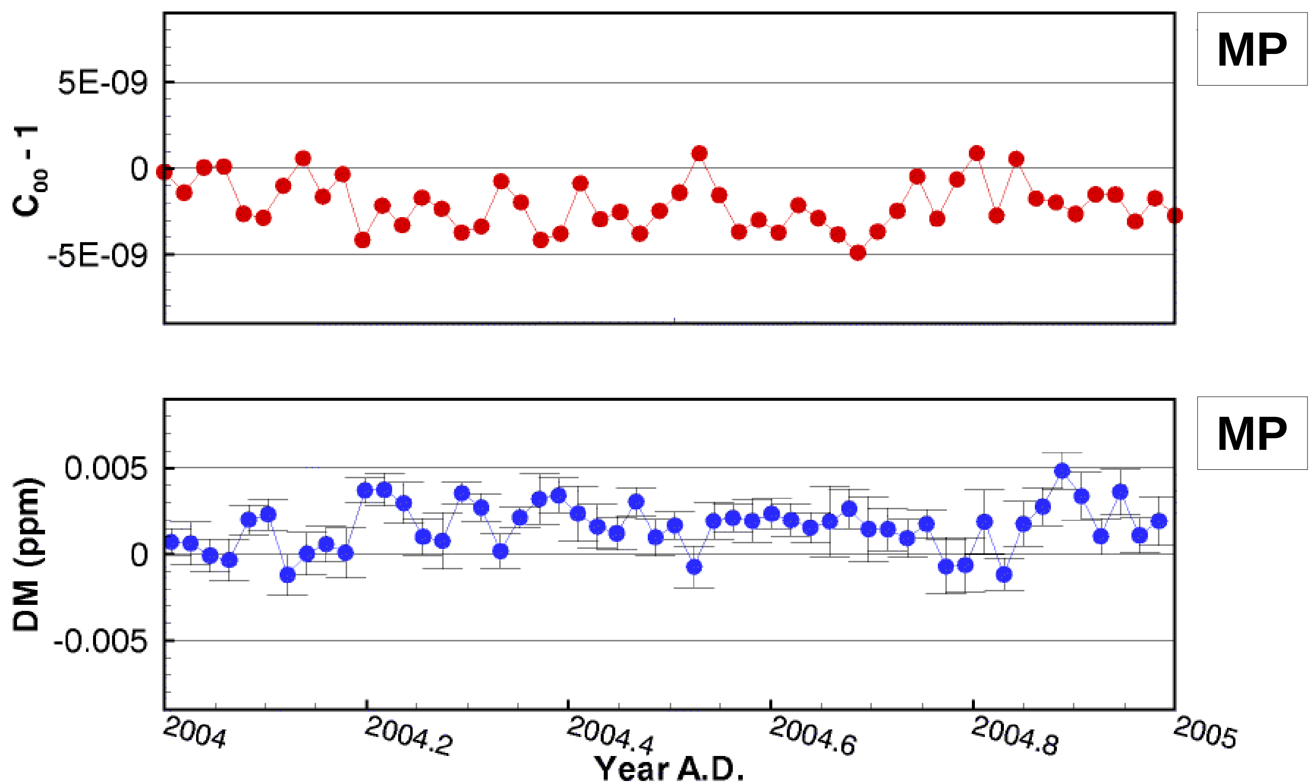
Difference of the Mendes-Pavlis model to Marini-Murray for a one-week arc



Tropospheric Range Correction, II

- **Impact on scale:**

	MM [ppb]	MP [ppb]	MM–MP [ppb]
C(0,0)	**-0.4**	**-2.5**	**2.1**
s	*0.1*	*0.2*	*0.2*
DM	**0.8**	**1.8**	**-1.0**
s	*0.2*	*0.2*	*0.3*
Dorbit			**-0.6**
s			*0.02*

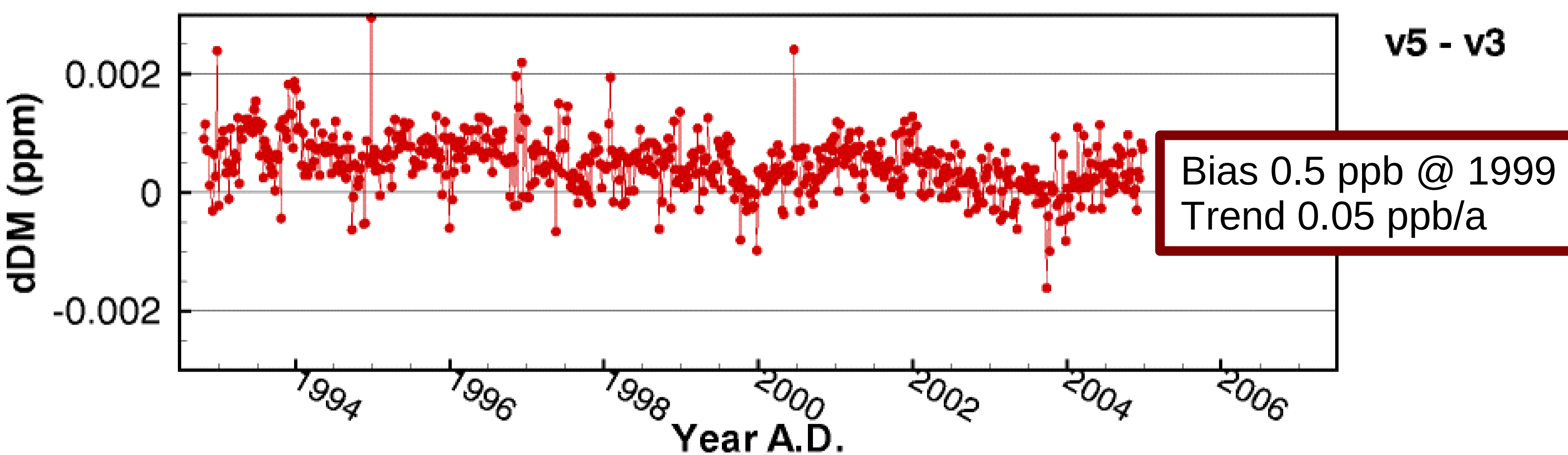


- **Missing 0.5 ppb:**

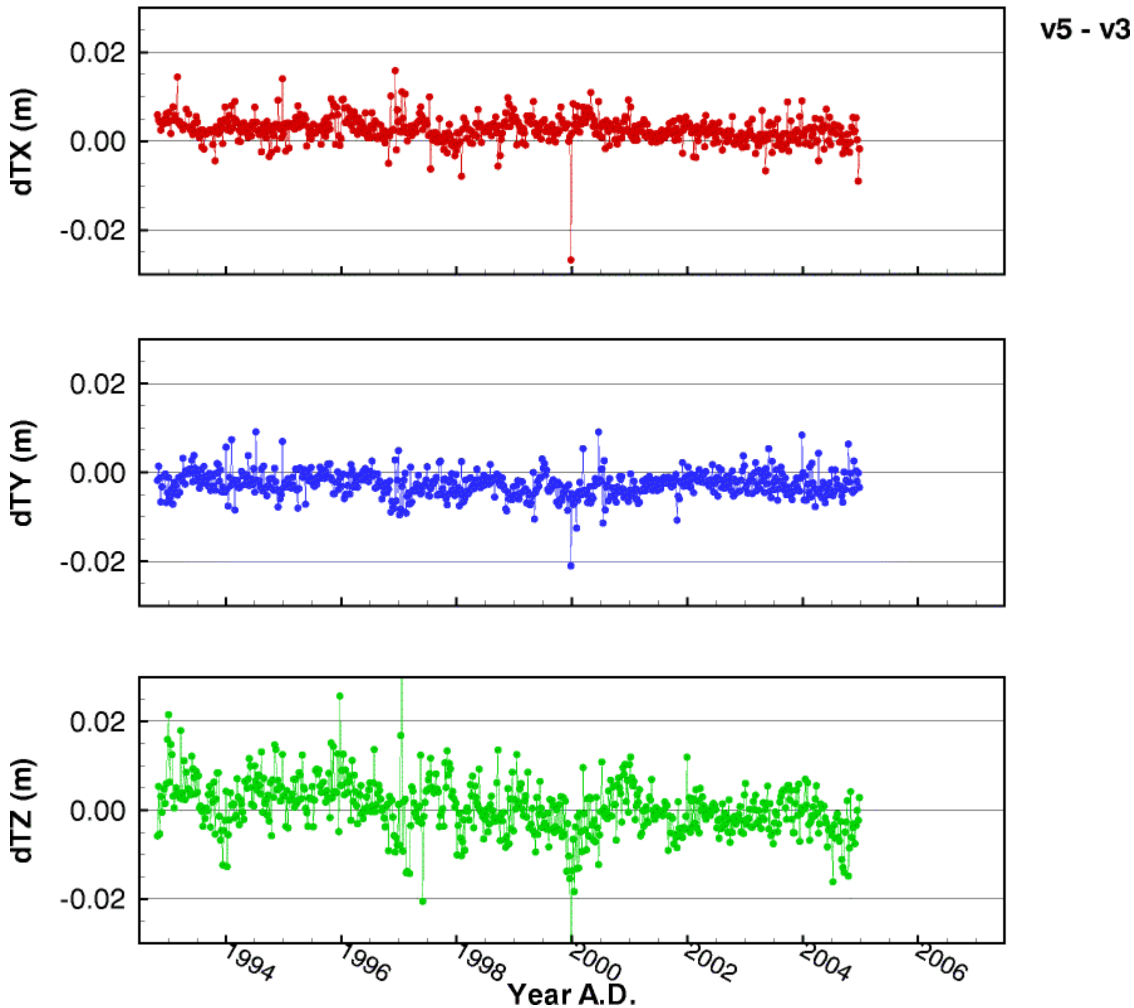
3 mm / 6,000 km = 0.5 ppb

Long Series ILRS Reanalysis

- **Pos&eop standards: (low degree harmonics not solved for !!)**
  - **v5 - v3:**
    - **Stanford counter range biases applied**
    - **Mendes-Pavlis tropospheric correction applied**



Long Series ILRS Reanalysis, II



Bias 2.5 ± 0.1 mm
Trend -0.2 ± 0.03 mm/a

Bias -2.6 ± 0.1 mm
Trend -0.1 ± 0.03 mm/a

Bias 0.6 ± 0.2 mm
Trend -0.6 ± 0.07 mm/a

ITRF2000 / ITRF2005(“rescaled”) as A Priori

- **Impact on scale:**

	ITRF2000 [ppb]	ITRF2005r [ppb]	2000-2005r [ppb]
C(0,0)	**-2.5**	**-2.5**	**0.0**
s	*0.2*	*0.2*	*0.3*
DM vs. ITRF2000	**1.8**	**1.4**	**0.4**
s	*0.2*	*0.2*	*0.3*
DM vs. ITRF2005r	**1.5**	**1.1**	**0.4**
s	*0.2*	*0.2*	*0.3*
Dorbit			**0.0**
s			*0.0*

- **Difference ITRF2000 vs. ITRF2005_rescaled amounts to 0.4 ppb in 2004**

Ocean Loading Site Displacements

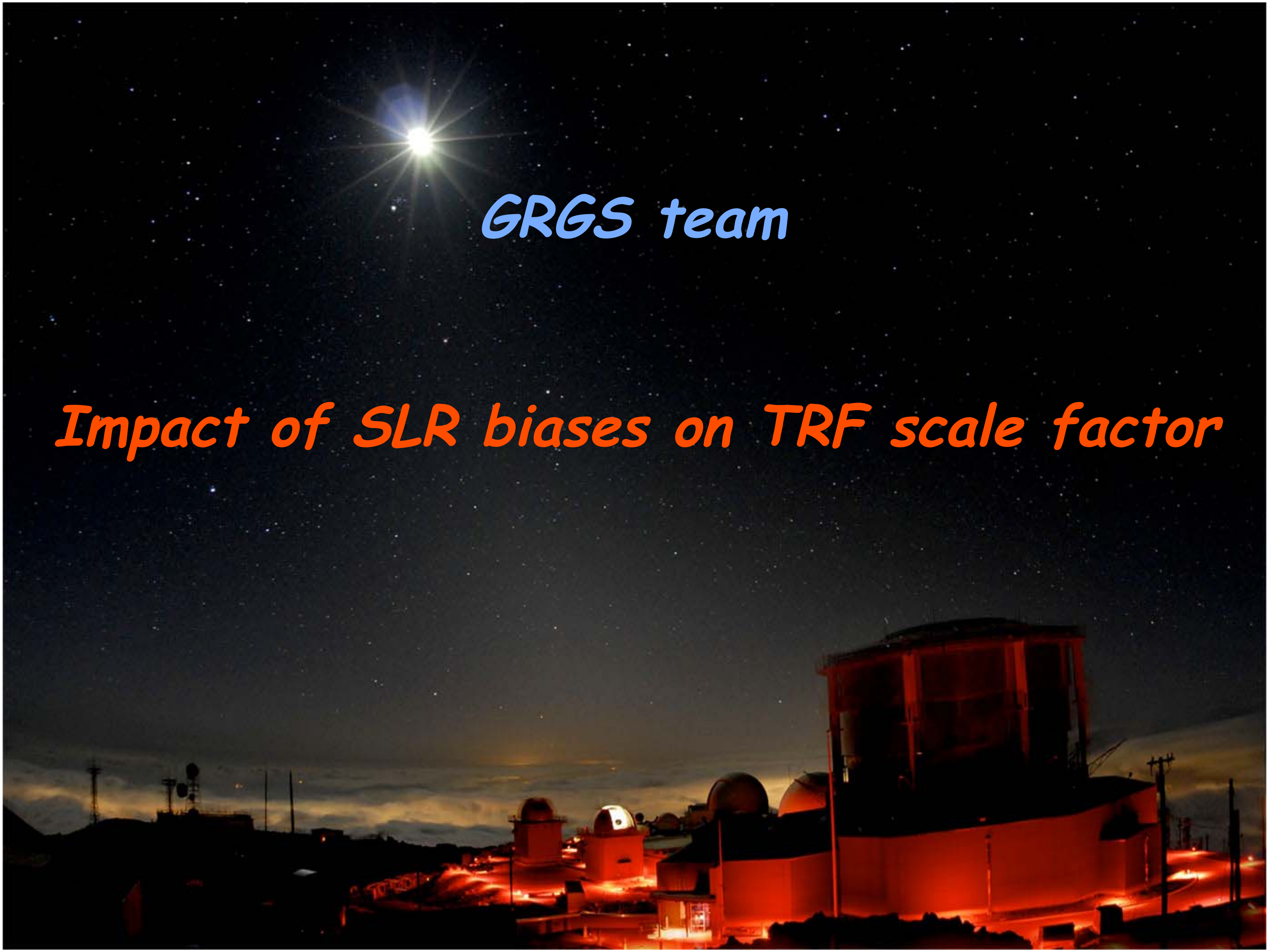
- Old: Scherneck/Schwidersky, hard-coded (not all stations)
- New: Scherneck, FES2004, Earth CoM considered

	Old	New
Orbital Fit	1.06 cm / 134,638	0.96 cm / 134,638
C(1,1)	0.89 ± 0.18 cm	0.19 ± 0.11 cm
S(1,1)	0.49 ± 0.11 cm	0.18 ± 0.08 cm
TX	-1.27 ± 0.26 cm	-0.24 ± 0.18 cm
TY	-0.90 ± 0.17 cm	-0.49 ± 0.12 cm

- Orbital fit improves considerable
- Geocenter X and Y series move closer to E{ . } = 0 and become more stable

Summary

- Weak network (<15 stations, <1000 observations / week) could produce spurious results
- Systematic corrections of the range observations have influence on scale and origin of the reference frame:
  - Tropospheric range correction change: ~0.5 ppb
  - Long term: 0.5 ppb / 10 a in geometric scale
  - Significant biases in the millimeters and trends in the sub-millimeters per year for the geometric origin
- ITRF2000 to ITRF2005r changes geometric scale by 0.4 ppb in 2004
- Up-to-date ocean loading site displacement models improve dynamic and geometric origin and more


GRGS team
Impact of SLR biases on TRF scale factor

Temporal de-correlation method

→ Range biases directly linked to SLR station instrumentations and SLR instrumentations do not change all the time.

→ We can suppose range biases constant over given periods of time.

→ Estimation of range biases over "long" periods of time together with weekly station positions.

→ Correlation between biases and station vertical components decreases.

→ Limits of the time intervals over which the range biases are supposed to be constant correspond to station instrumental changes. The corresponding times are found in station log files, in SLR mails and in the ILRS official eccentricity file.

→ See http://maestro.obs-azur.fr/cgi-bin/query_mrb.pl.

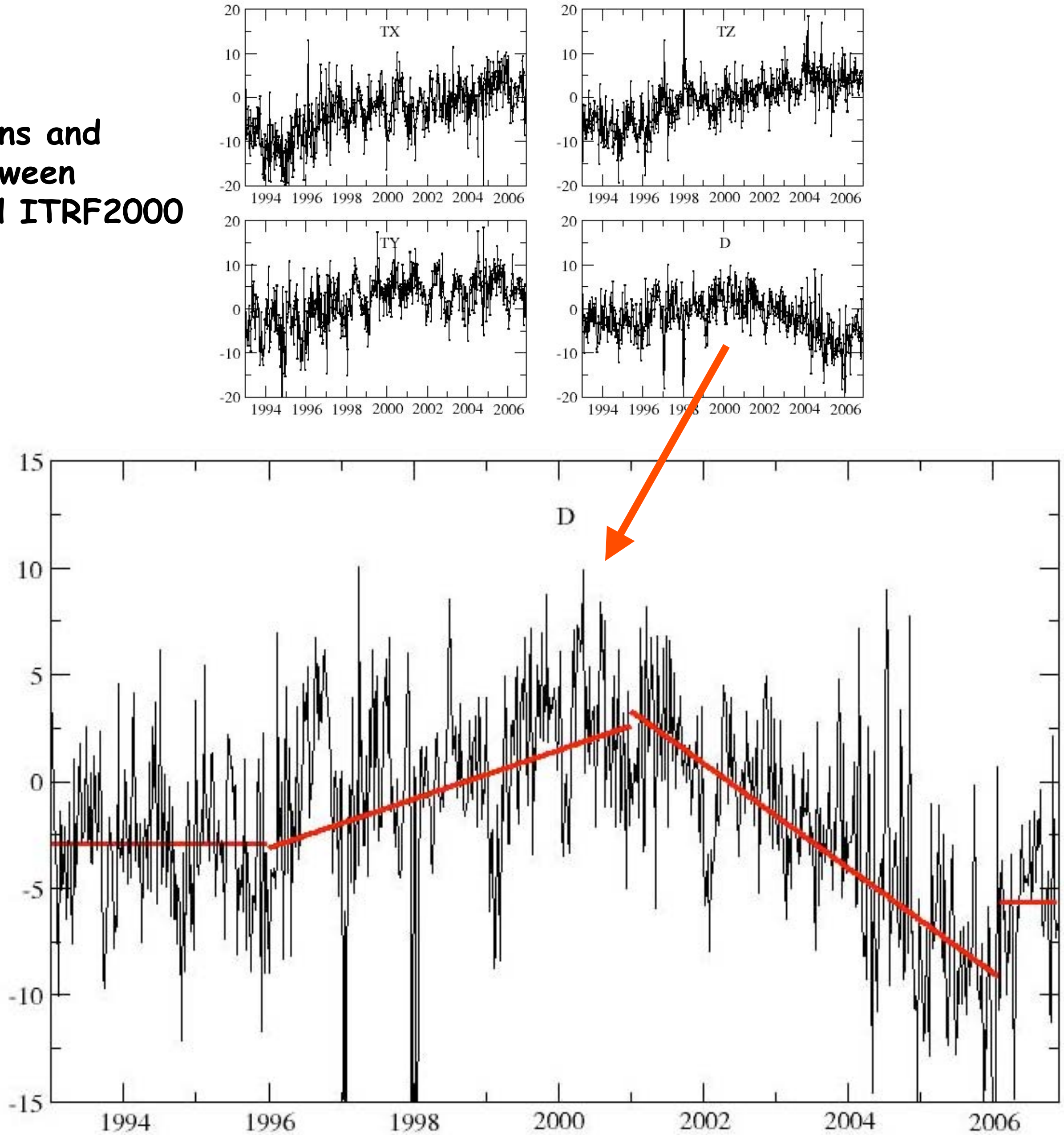
Two opposite strategies

1- No bias is estimated nor applied during the SLR data processing.
2- Measurements are corrected by the biases estimated with the temporal de-correlation method during the SLR data processing.

→ Weekly SINEX derived by the two strategies are stacked with CATREF software.

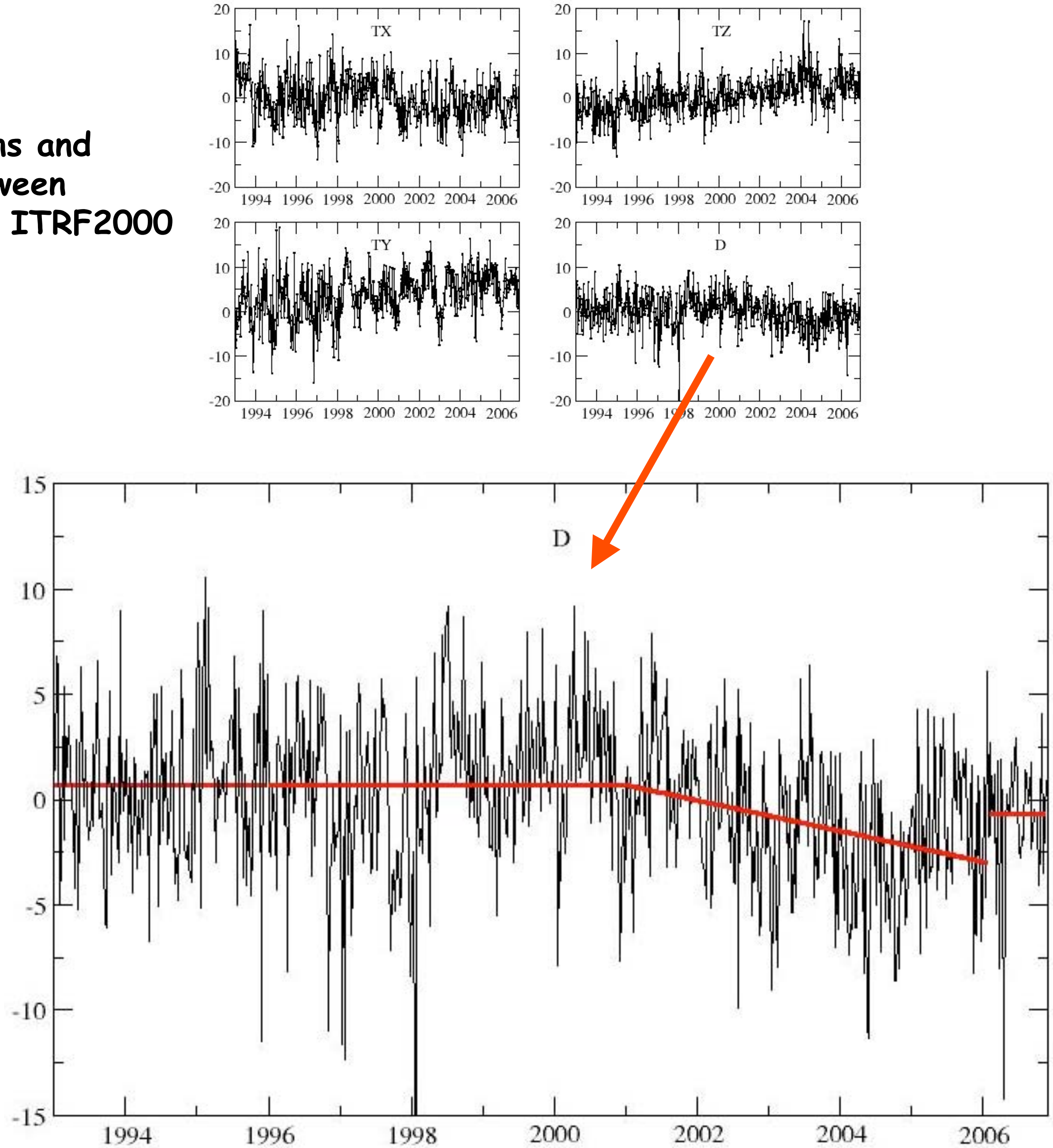
Strategy 1 (No bias)

Three translations and scale factor between weekly TRFs and ITRF2000 (mm).



Strategy 2 (Biases estimated with our method)

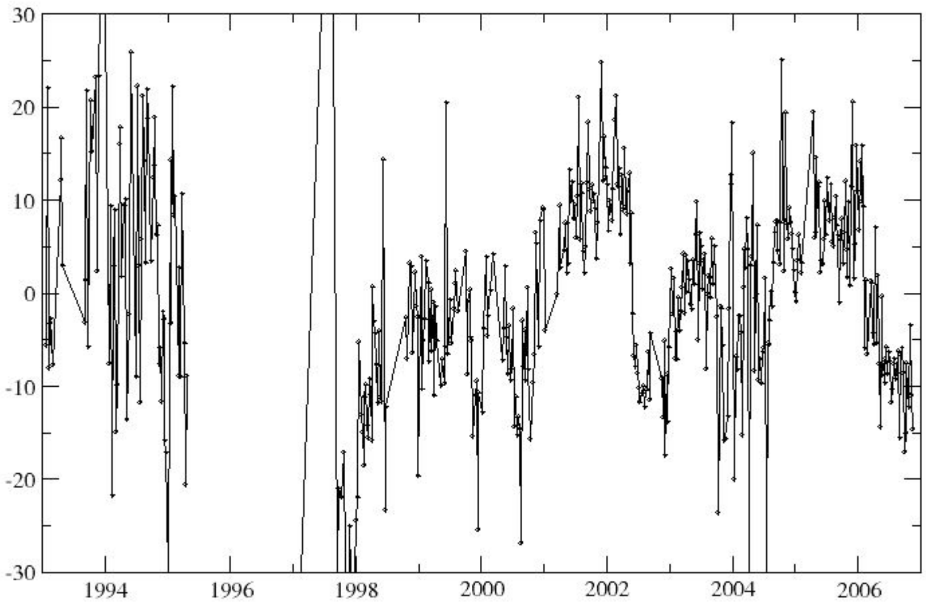
Three translations and scale factor between weekly TRFs and ITRF2000 (mm).



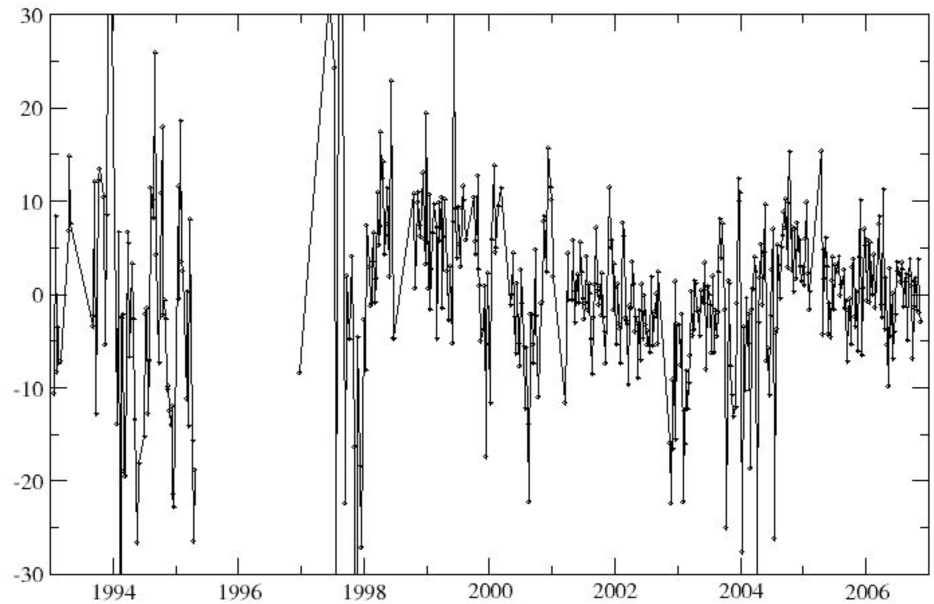
Comparisons between the two strategies

Time Interval	Without Any Bias (Strategy 1)	With Biases (Strategy 2)
XXXX.X-XXXX.X	Mean Value (mm) Drift +/- St. Dev. (mm/yr)	Mean Value (mm) Drift +/- St. Dev. (mm/yr)
1993.0-1996.0	-2.9 -0.3 +/- 0.3	0.7 0.3 +/- 0.3
1996.0-2001.0	0.4 *1.0 +/- 0.2*	0.7 0.3 +/- 0.2
2001.0-2006.0	-2.9 *-2.5 +/- 0.2*	-1.1 *-0.7 +/- 0.2*
2006.0-2006.9	-5.7 2.2 +/- 1.8	-0.9 0.0 +/- 1.6
1993.0-2006.9	-1.9 *-0.5 +/- 0.05*	-0.05 *-0.2 +/- 0.04*

Strategy 1



Strategy 2



Zimmerwald (7810) station vertical component time series in ITRF2000 (mm)

See our poster "Satellite Laser Ranging biases and Terrestrial Reference Frame scale factor" by Coulot et al., abstract n°EGU2007-A-07027, session G1, Tuesday, 17 April 2007.

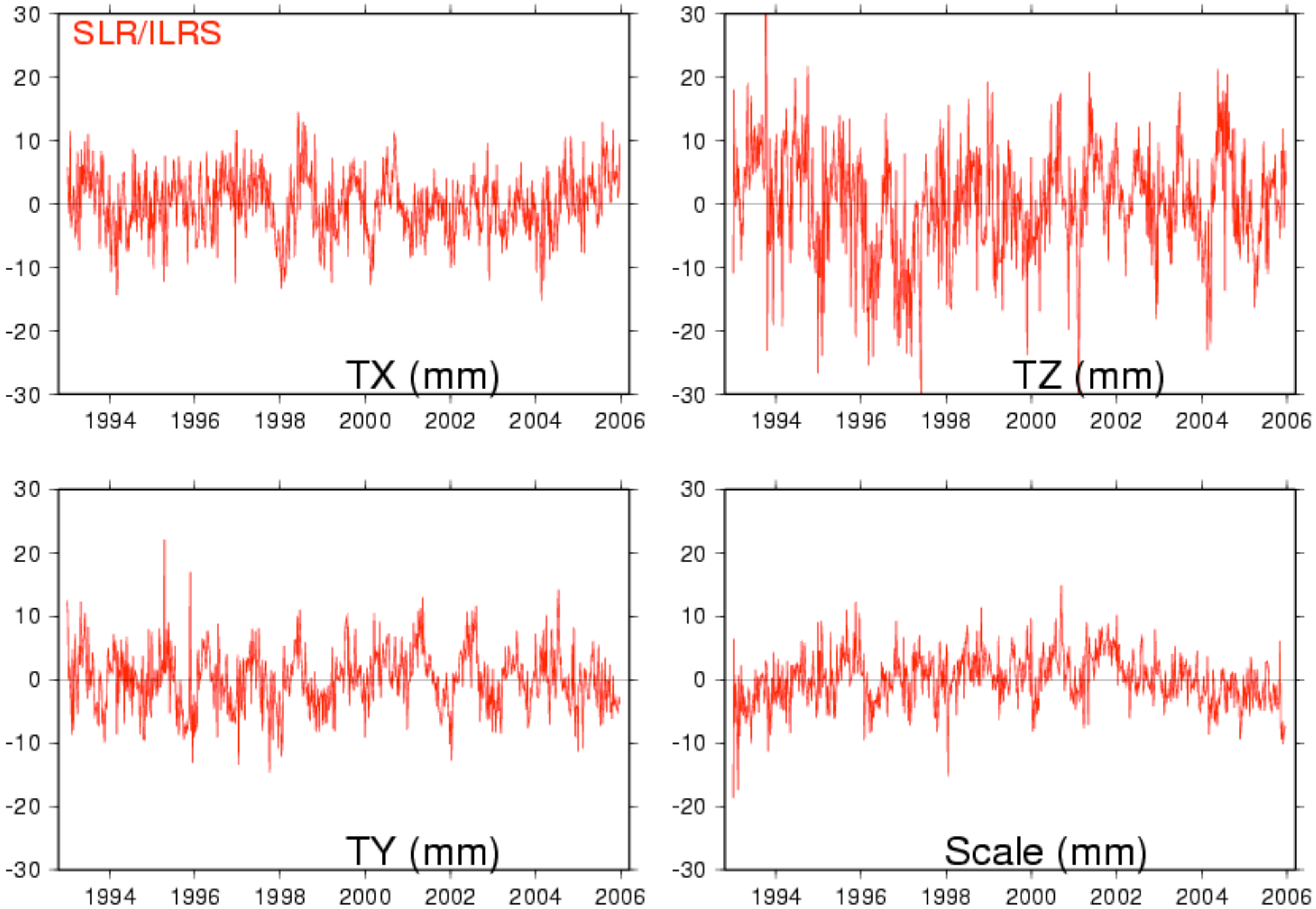
Slides Presented by

Zuheir Altamimi

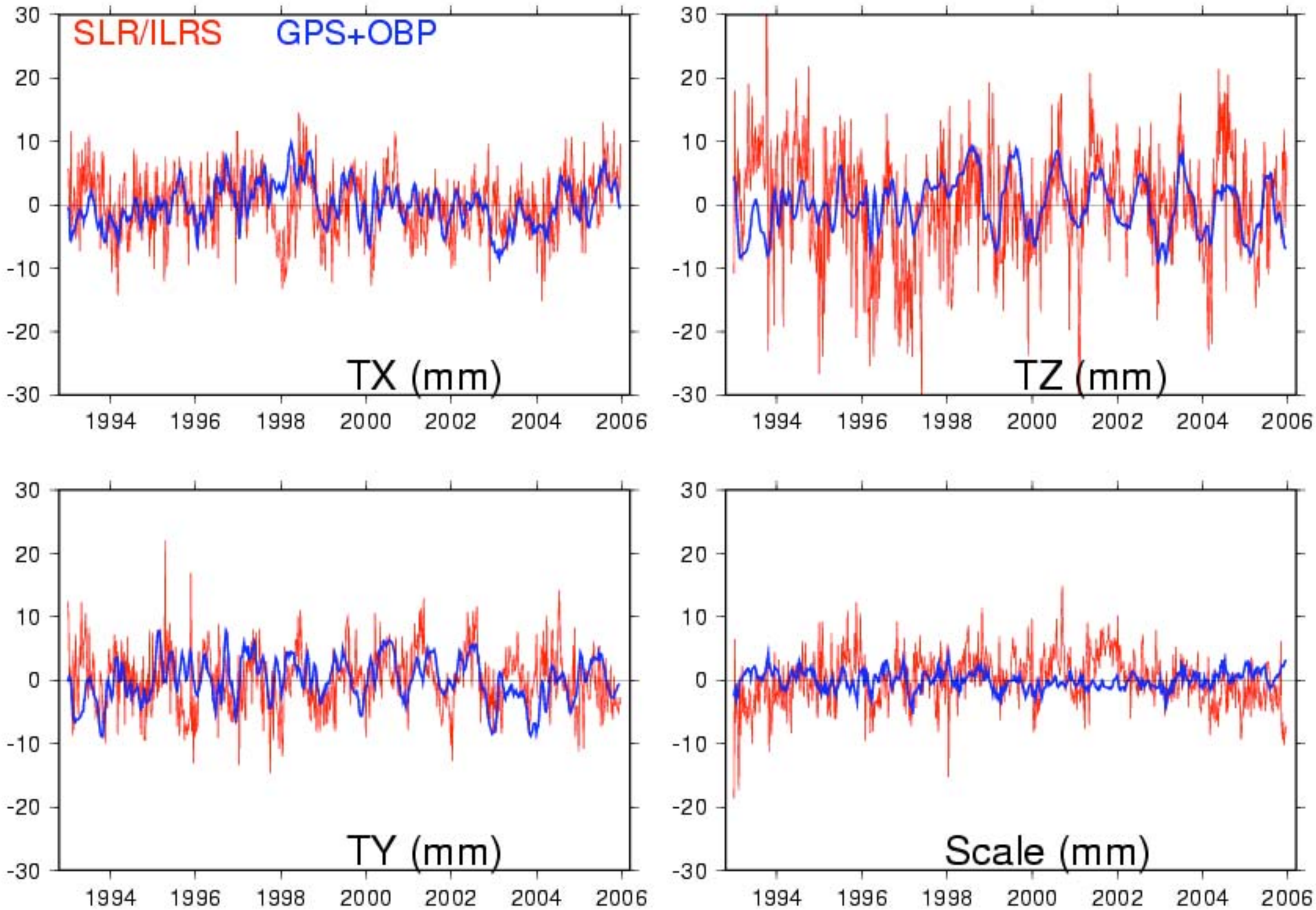
Vienna ILRS AWG

April 14, 2007

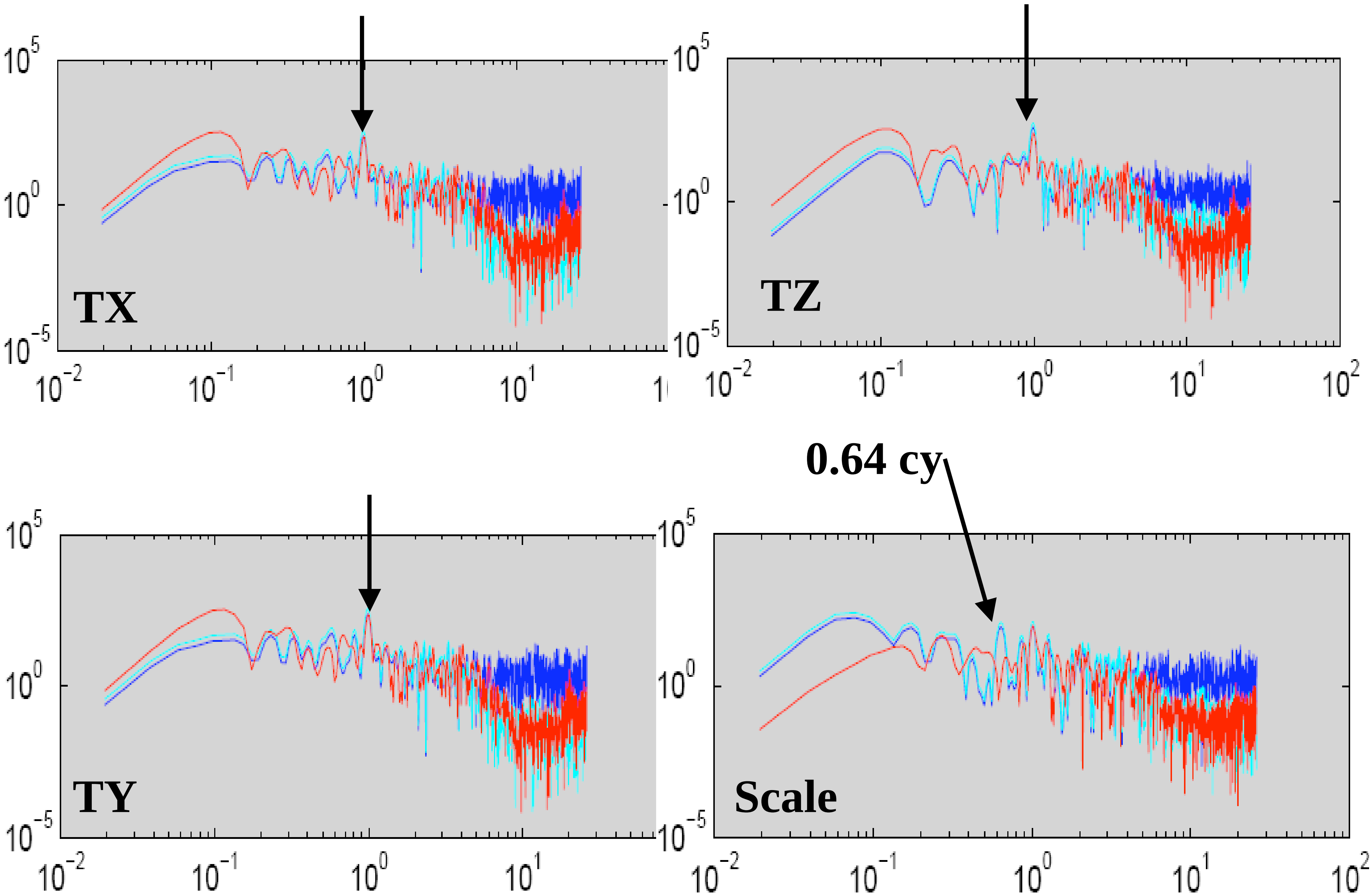
Geocenter ILRS SLR vs models



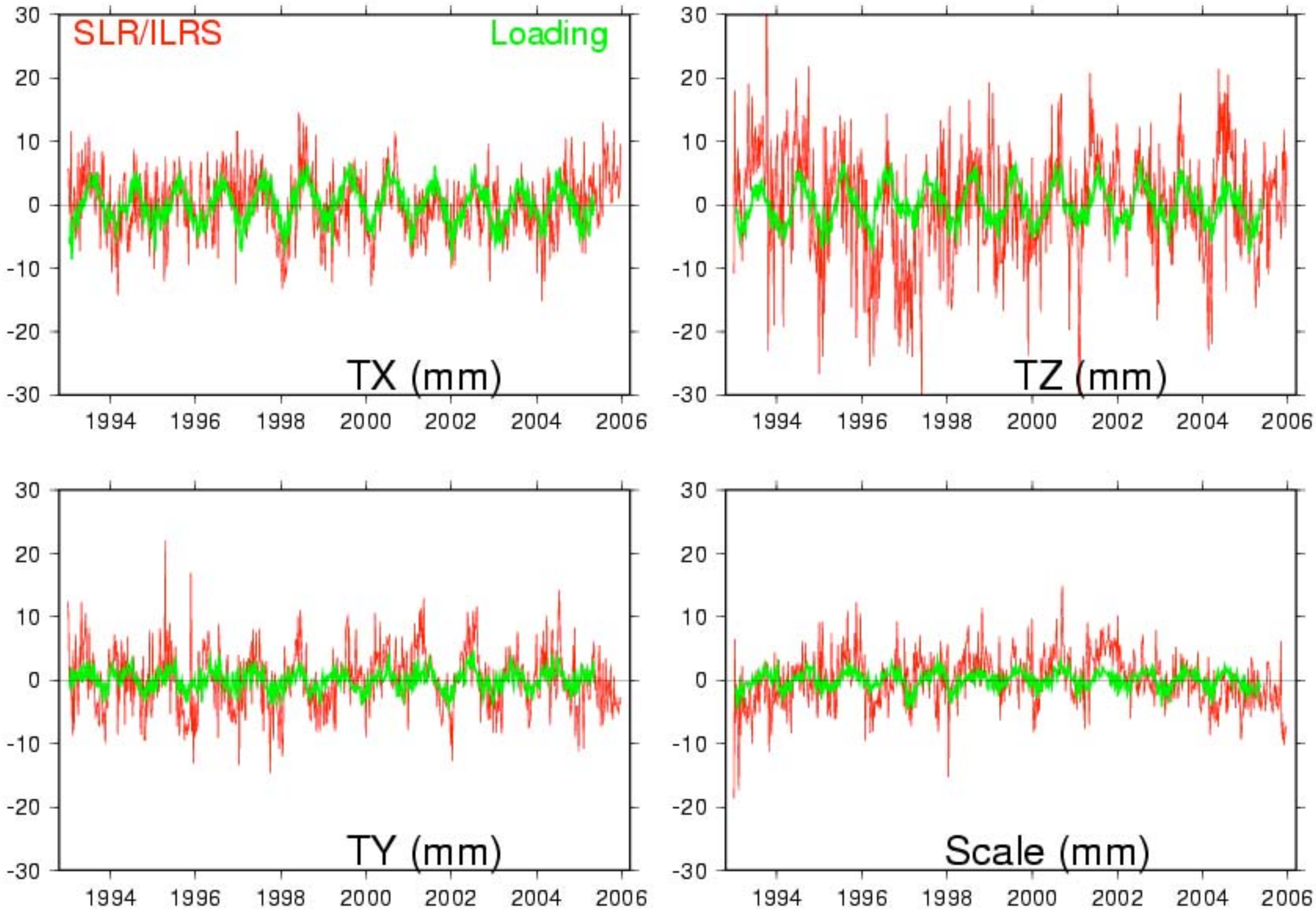
Geocenter ILRS SLR vs GPS+OBP model



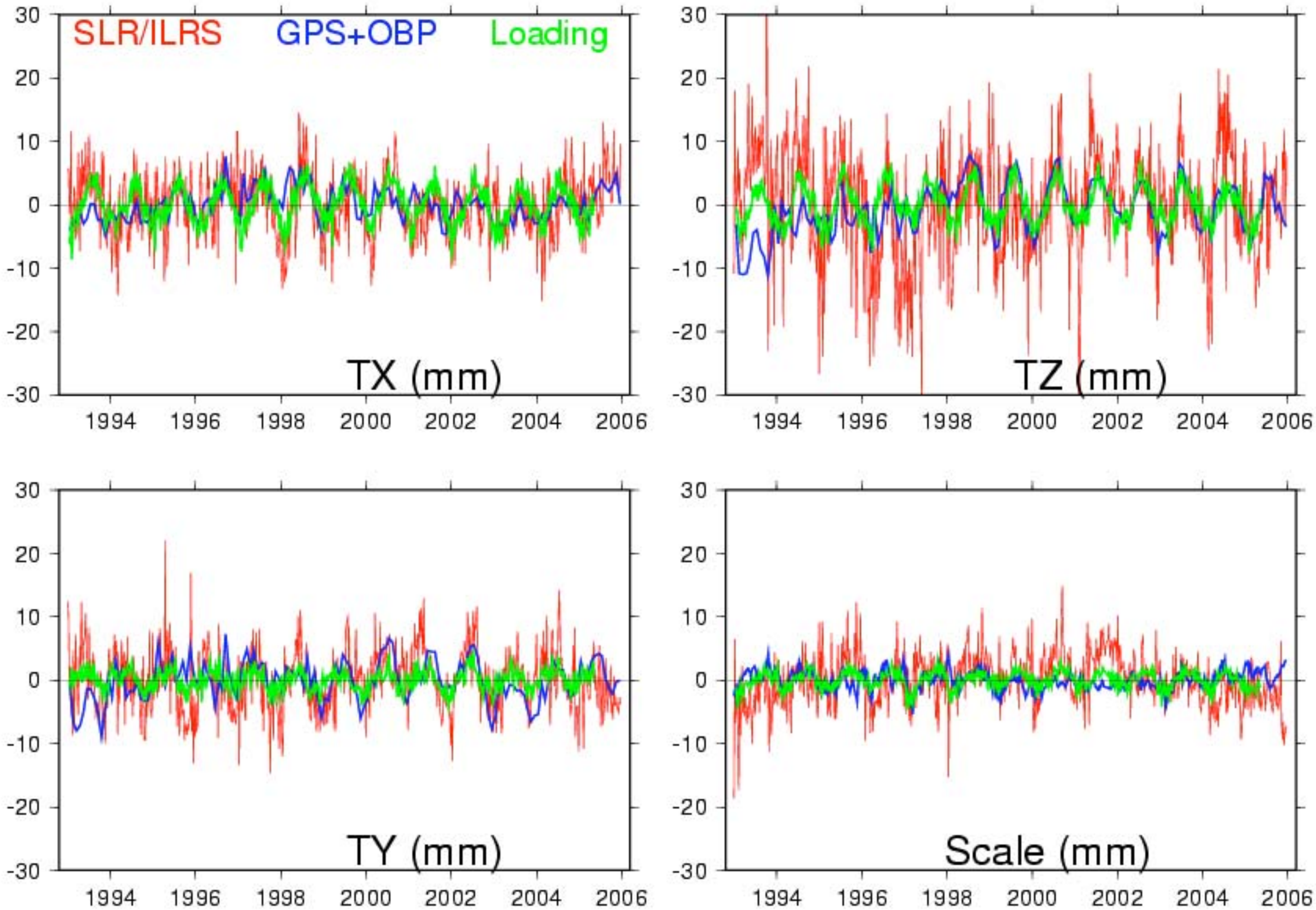
ILRS SLR & GPS+OBP Power Spectrum



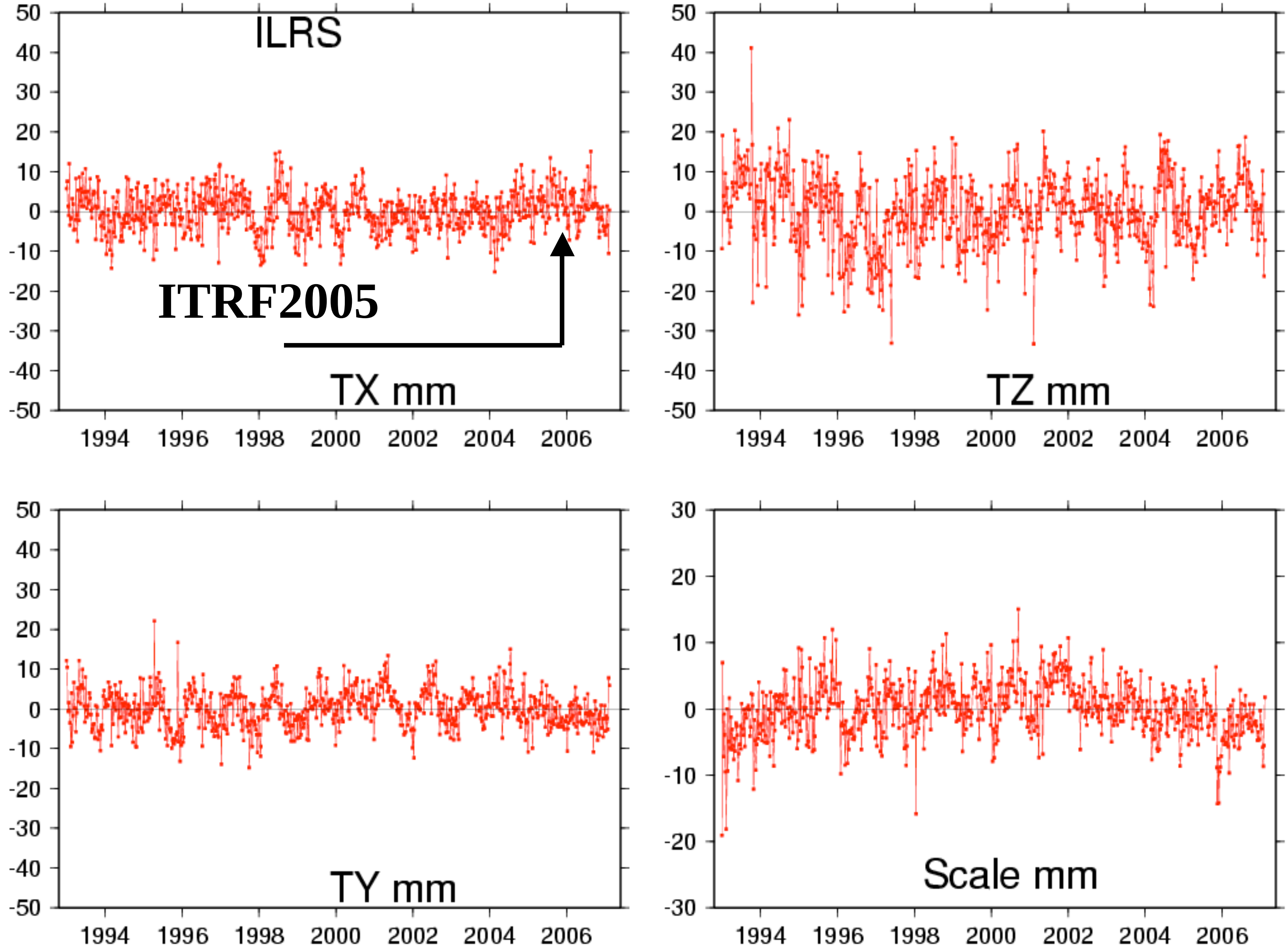
Geocenter ILRS SLR vs Loading model



Geocenter ILRS SLR vs GPS+OBP and Loading models

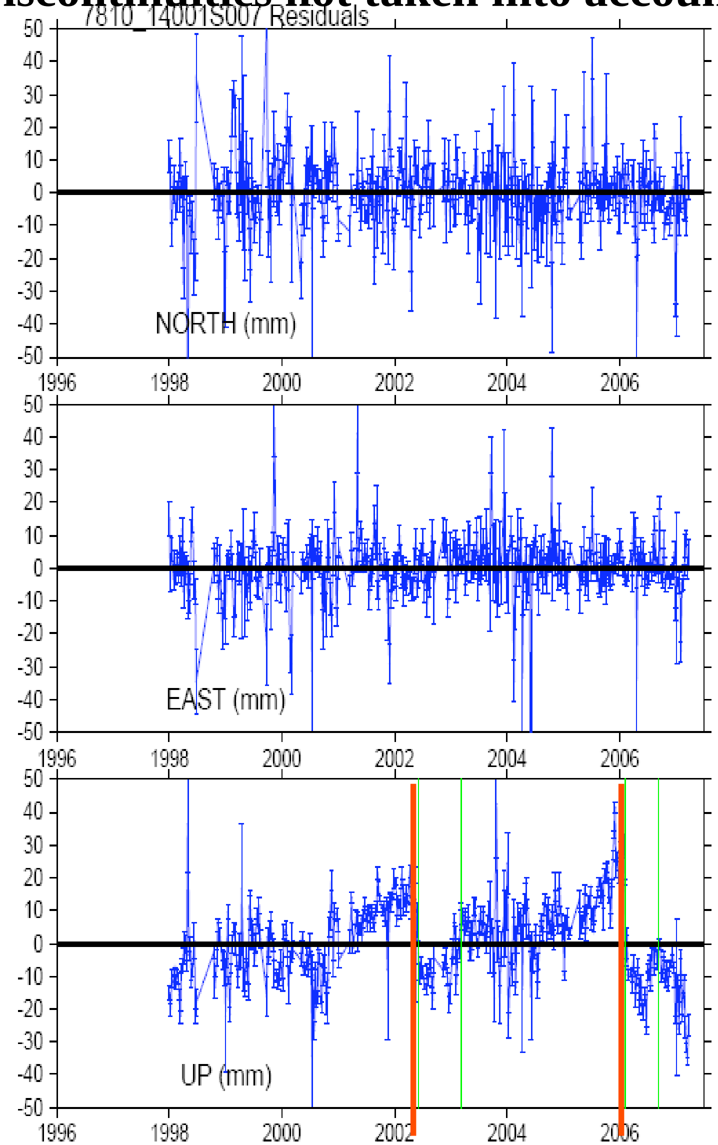


ILRS SLR Intrinsic origin and scale (ITRF2005 + 64 weeks)



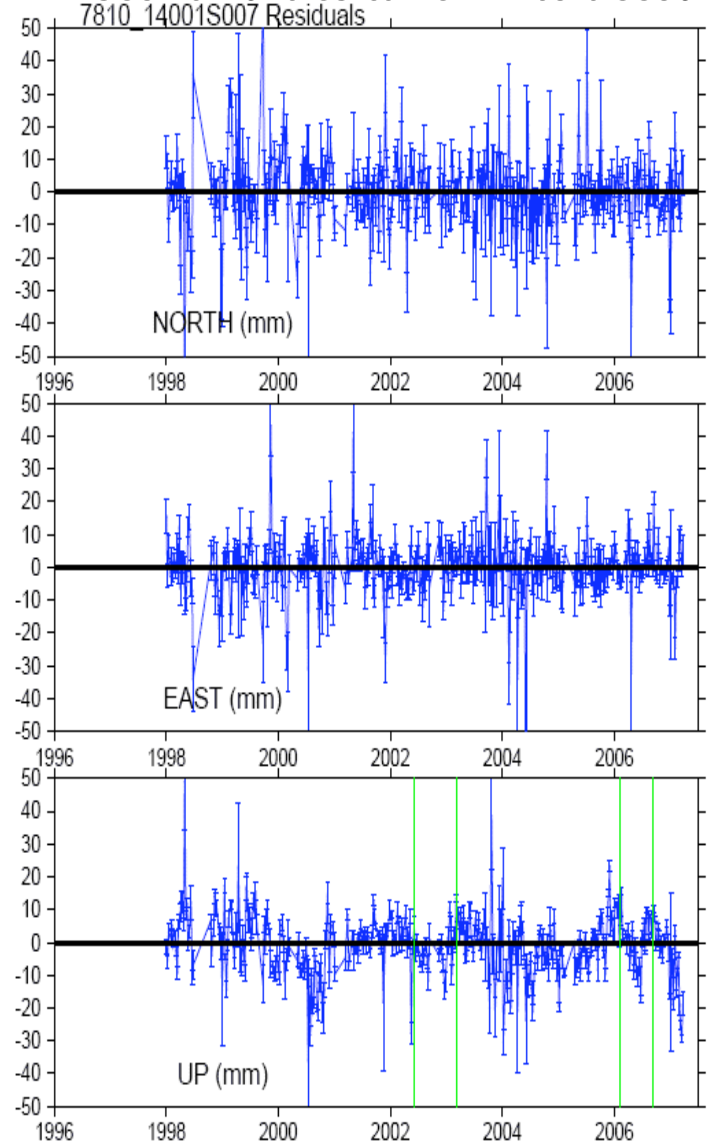
Zimmerwald SLR Station

Discontinuities not taken into account

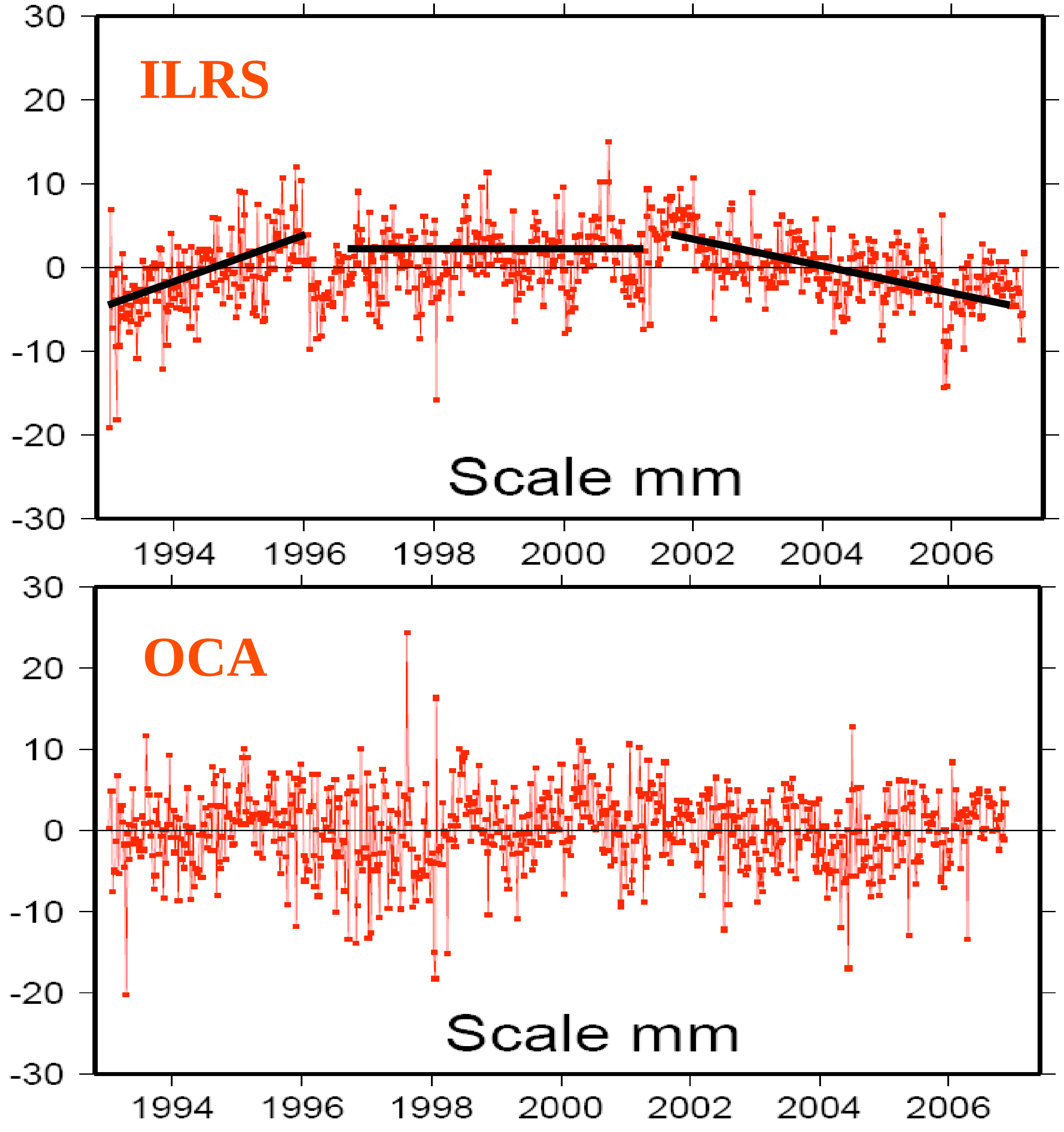


Range Bias events

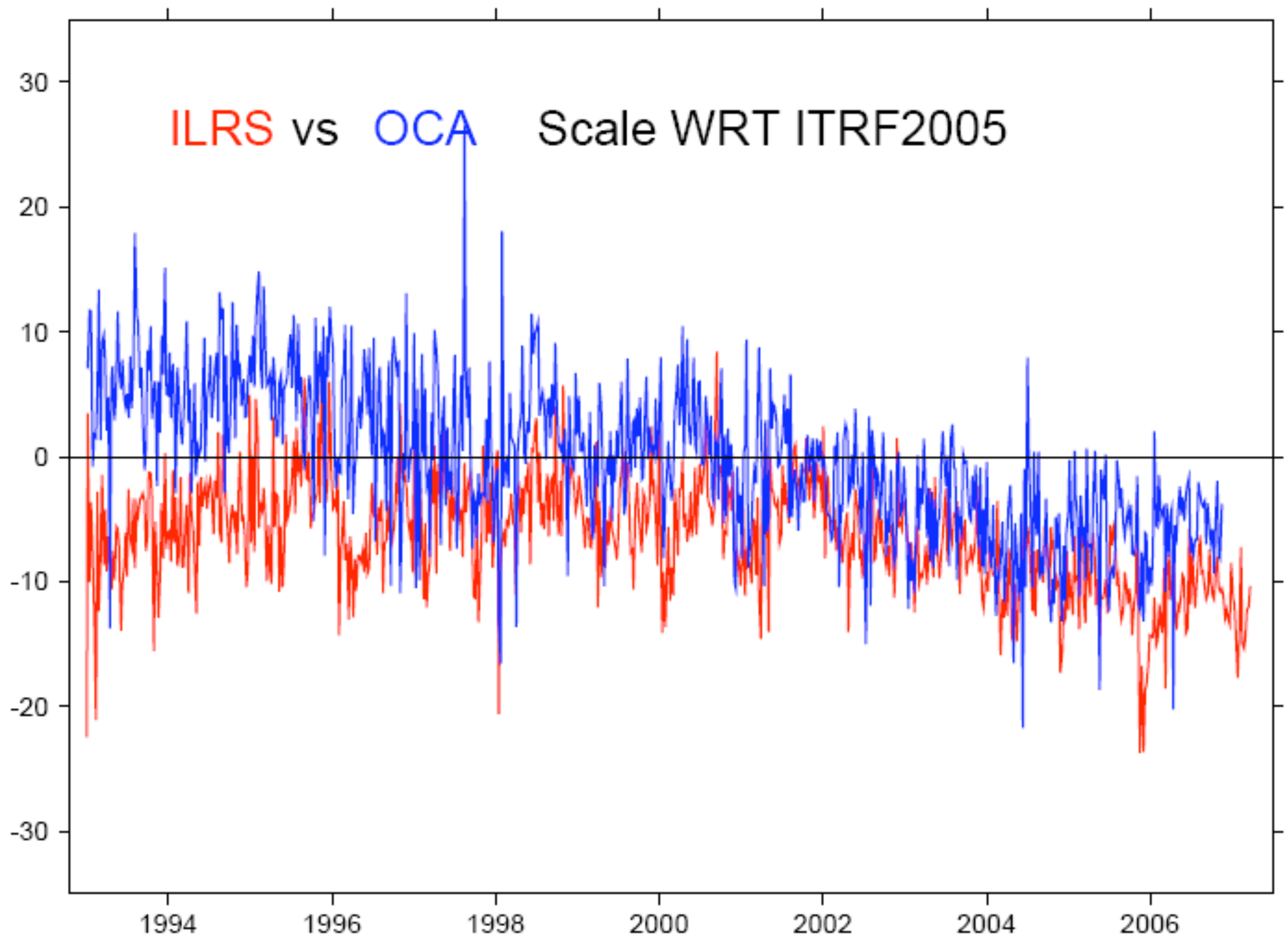
Discontinuities taken into account



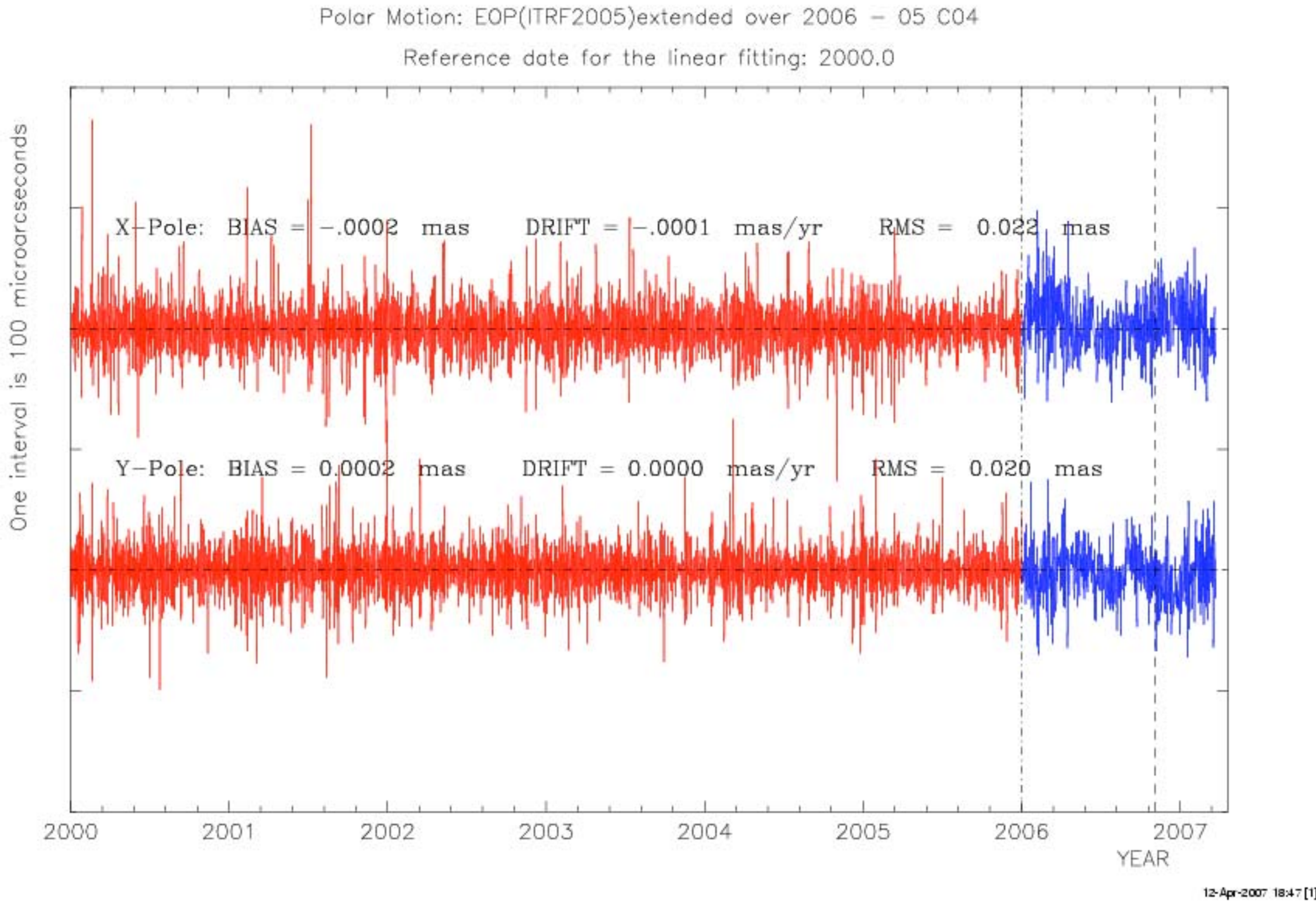
Intrinsic ILRS vs OCA scales



ILRS vs OCA scales wrt ITRF2005



EOP Differences 05 C04 – CATREF



Further Improvements in Understanding CoM Effects in Laser Ranging Observations

Graham Appleby [1] and Toshi Otsubo [2]

1: Space Geodesy Facility, Herstmonceux, UK;

2: Hitotsubashi University, Tokyo, Japan

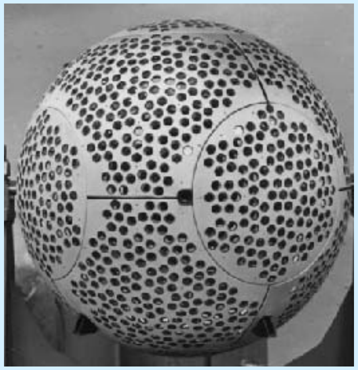
ILRS Spring AWG 14th April 2007, TUW, Wien, Austria

NATURAL ENVIRONMENT RESEARCH COUNCIL

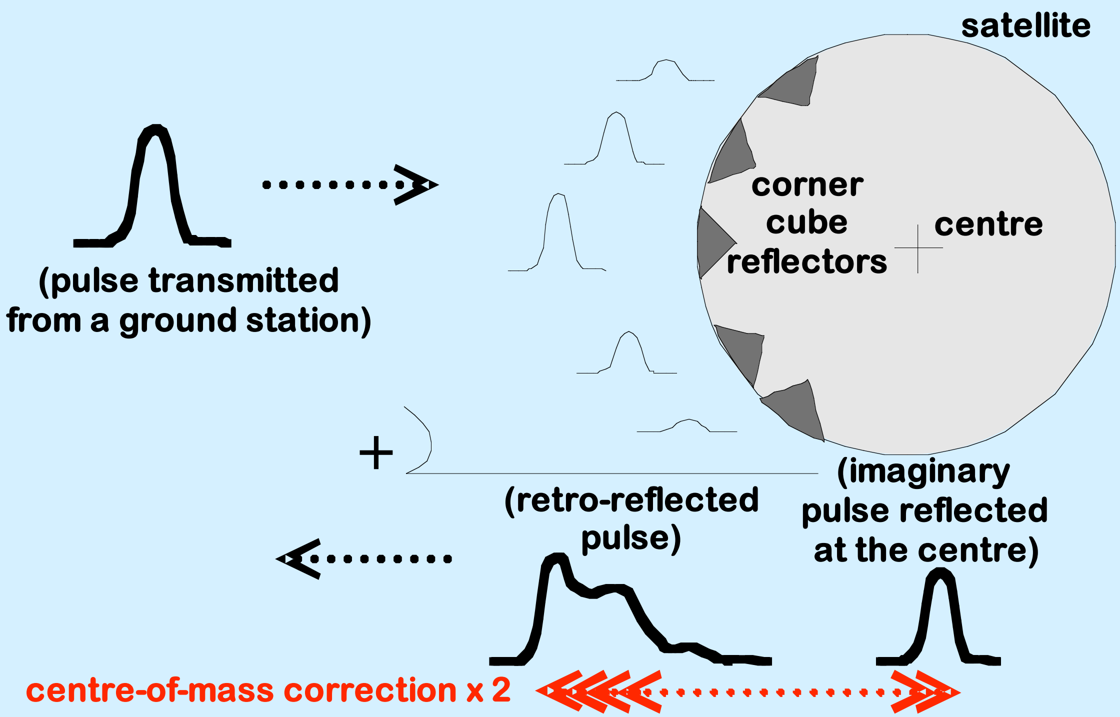
BNSC BRITISH NATIONAL SPACE CENTRE

Outline of work

- SLR technique is capable of making extremely *precise* range measurements to retro-reflector clusters on geodetic satellites
  - Short-pulse lasers, high-precision counters=>
  - mm-level 'Normal point' precision, 0.2ppb in range to LAGEOS
- To realise same accuracy, three key features:
  - Linearity of range measuring devices;
  - **Correct ranges for 'size' of satellite, CoM value;**
  - Accurate atmospheric refraction model.



Satellite ‘signature’ contribution



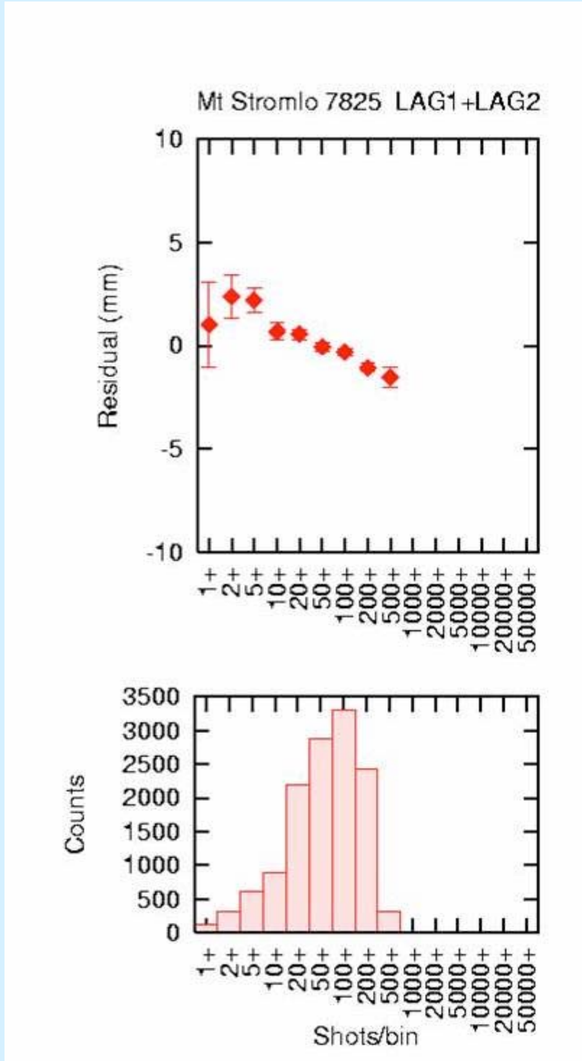
Magnitude of effect

- Depending upon the stations' technologies:

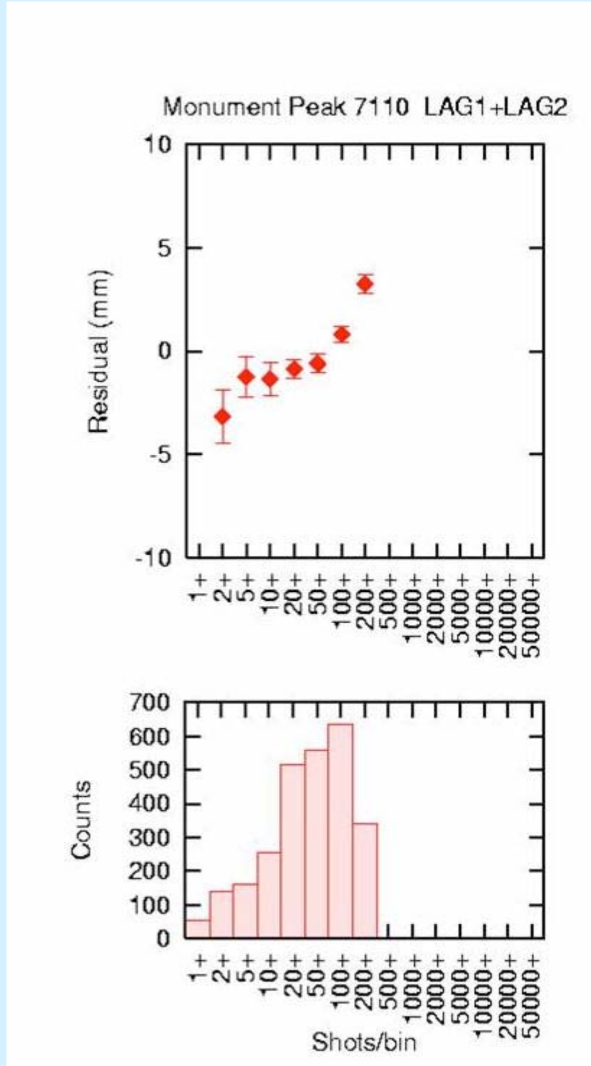
  - there is a range of appropriate CoM values;
  - for LAGEOS the total range is ~8mm

- Station technology:
  - multi-photon returns:
    - photomultiplier or first-photon detection
  - single photon return

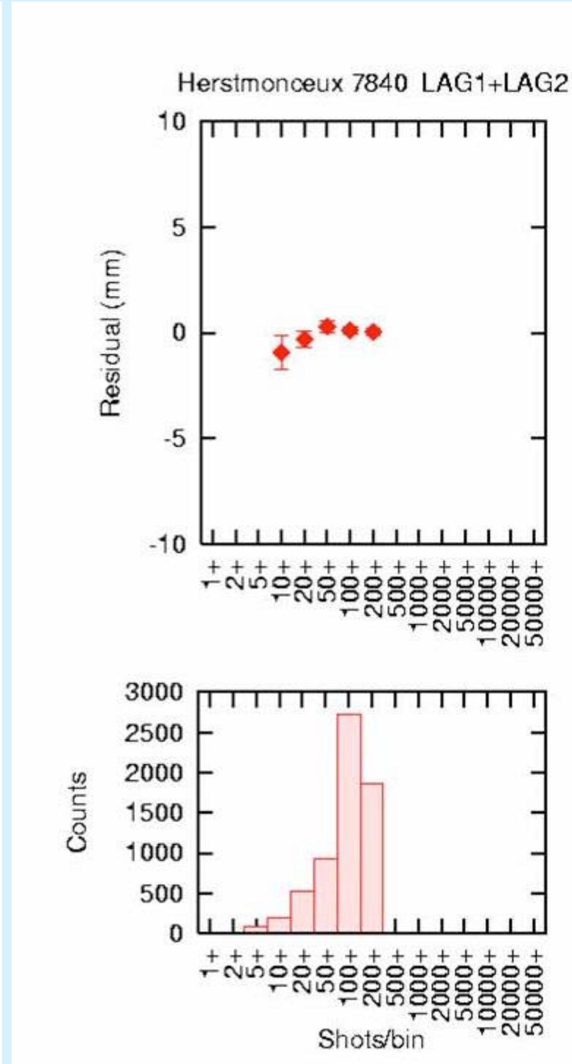
- For a **given station**, there is a return-energy dependence too:



Multi photon



Multi photon



Single photon

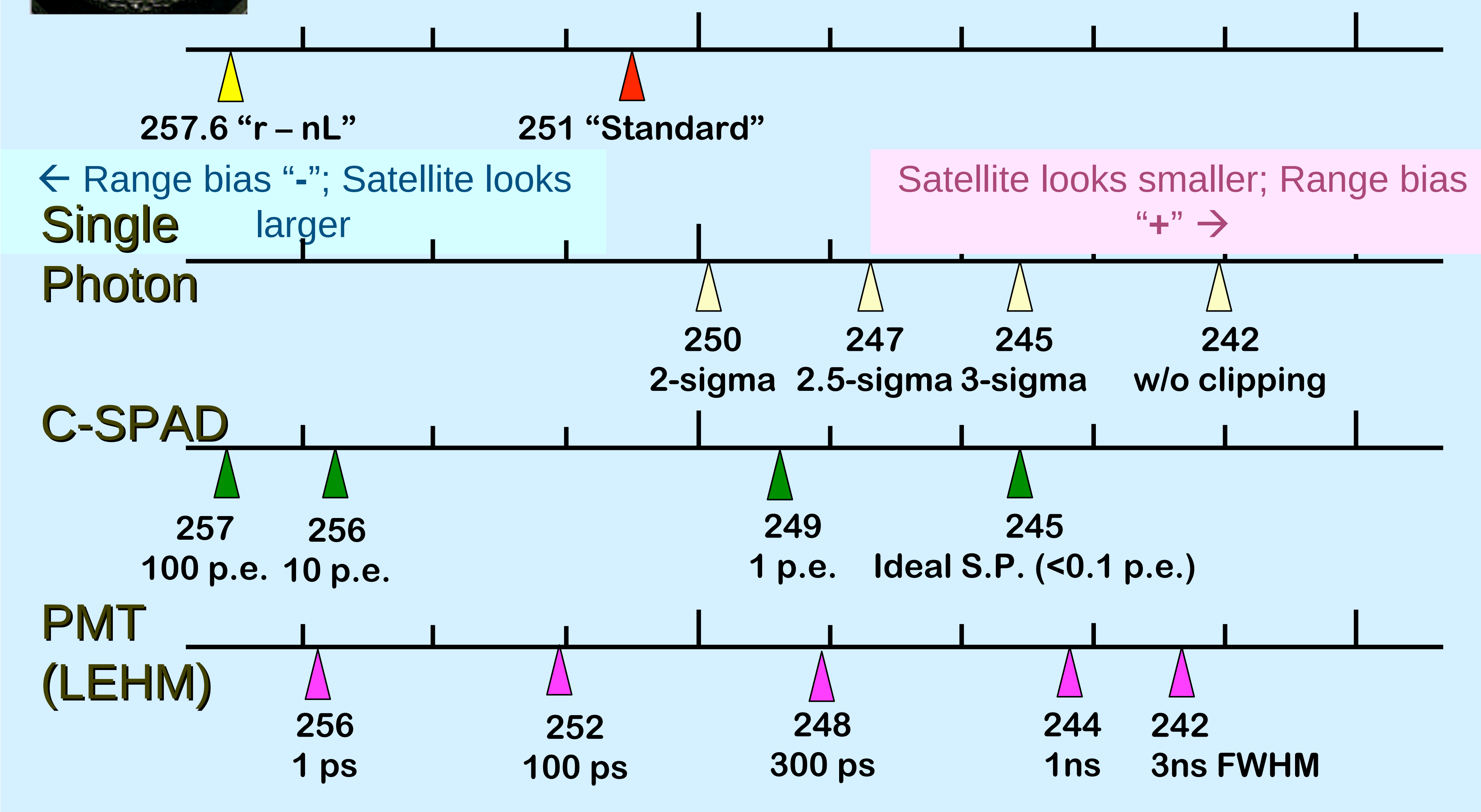
Example post-fit range residuals as a function of returns per normal point (a proxy for return energy variation)

LAGEOS

Diameter 600 mm

Centre-of-mass correction

Otsubo & Appleby, JGR, 2003



Theoretical LAGEOS CoM values based on stations' characteristics

Stn pad ID	Name	Pulse (ps)	Detector	Regime (single, few, multi)	Processing level	LAGEOS CoM (mm)
1873	**Simeiz**	350	PMT	No Control	2.0 sigma	**244-248**
1884	**Riga**	130	PMT	Controlled s->m	2.0 sigma	**248-252**
7080	**Mc Donald**	200	MCP	Controlled s->m	3.0 sigma	**244-250**
7090	**Yaragadee**	200	MCP	Controlled f->m	3.0 sigma	**244-250**
7105	**Greenbelt**	200	MCP	Controlled f->m	3.0 sigma	**244-250**
7110	**Monument Peak**	200	MCP	Controlled f->m	3.0 sigma	**244-250**
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7237	**Changchung**	200	CSPAD	Controlled s->m	2.5 sigma	**245-250**
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7355	**Urumqui**	30	CSPAD	No Control	2.5 sigma	**247-255**
7405	**Conception**	200	CSPAD	Controlled s	2.5 sigma	**245-246**
7501	**Harteb.**	200	PMT	Controlled f->m	3.0 sigma	**244-250**
7806	**Metsahovi**	50	PMT	?	2.5 sigma	**248-254**
7810	**Zimmerwald**	300	CSPAD	Controlled s->f	2.5 sigma	**244-250**
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7824	**San Fernando**	100	CSPAD	No Control s->m	2.5 sigma	**246-252**
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7836	**Potsdam**	35	PMT	Controlled s->m	2.5 sigma	**252-256**
7838	**Simosato**	100	MCP	Controlled s->m	3.0 sigma	**248-252**
7839	**Graz**	35	CSPAD	No Control m	2.2 sigma	**250-255**
7839	**Graz kHz**	10	CSPAD	No Control s->f	2.2 sigma	**?**
7840	**Herstmonceux**	100	CSPAD	Controlled s	3.0 sigma	**244-246**
7841	**Potsdam 3**	50	PMT	Controlled s->f	2.5 sigma	**248-254**
7941	**Matera**	40	MCP	No Control m	3.0 sigma	**248-254**
8834	**Wettzell**	80	MCP	No Control f->m	2.5 sigma	**248-252**

In close-up, for the example stations

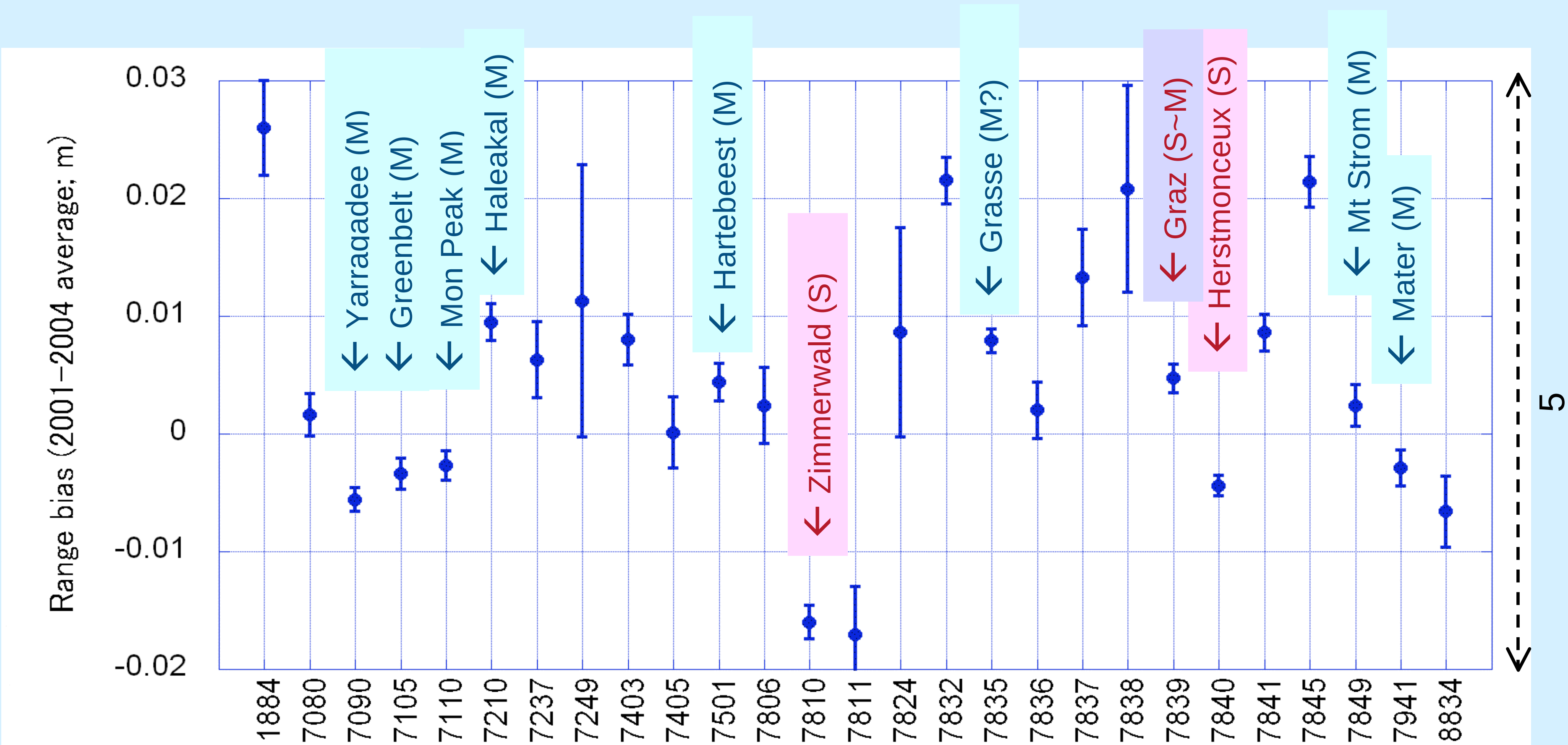
Stn pad ID	Name	Pulse (ps)	Detector	Regime (single, few, multi)	Processing level	**LAGEOS CoM (mm)**
7110	**Monument Peak**	200	MCP	**Controlled f->m**	3.0 sigma	**244-250**
7825	**Stromlo**	10	CSPAD	**Controlled s->m**	2.5 sigma	**247-257**
7840	**Herstmonceux**	100	CSPAD	**Controlled s**	3.0 sigma	**244-246**

We are left with a band of CoM values, the size of which is dependent on the stations' technology.

- Single photon systems have tightest band;
- MCP systems' results appear counter-intuitive in terms of bias wrt energy regime and do not agree in sign with the theoretical band.
- Answer is strictly to maintain a particular regime during ranging.

Range bias estimates (LAGEOS1+LAGEOS2)

Standard CoM correction 251 mm applied



(M) = Multi photon system, (S) = Single photon system

Station dependence NOT always agrees with prediction at sub-cm region.

… Due to error sources such as timer, calibration, etc?

Conclusion

- With improved
  - calibration of counters;
  - knowledge of band of appropriate CoM values:
- Can re-estimate stations' mean bias and return-energy effects in a full solution to include
  - Constrained RB;
  - Coordinates;
  - GM

Progress with counter non-linearity effects

Graham Appleby and Philip Gibbs

Space Geodesy Facility, Herstmonceux, UK;

NATURAL ENVIRONMENT RESEARCH COUNCIL

ILRS Spring AWG meeting, 14th April 2007, TUW

BNSC BRITISH NATIONAL SPACE CENTRE

Outline of work

- SLR technique is capable of making extremely *precise* range measurements to retro-reflector clusters on geodetic satellites
  – Short-pulse lasers, high-precision counters=>
  – mm-level ‘Normal point’ precision, 0.2ppb in range to LAGEOS
- To realise same accuracy, three key features:
  – **Linearity of range measuring devices**;
  – Correct ranges for ‘size’ of satellite, CoM value;
  – Accurate atmospheric refraction model.

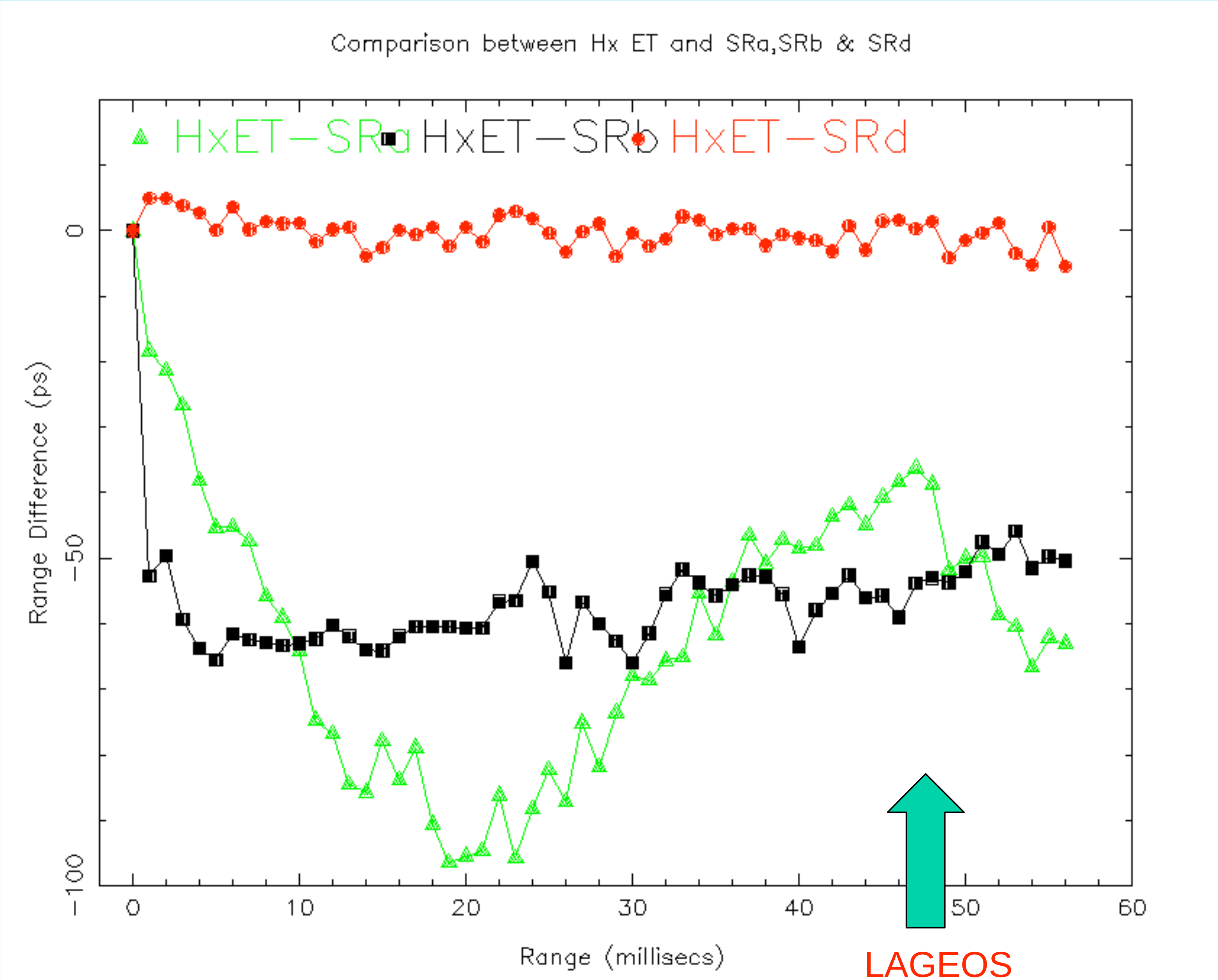
Tests on counter linearity

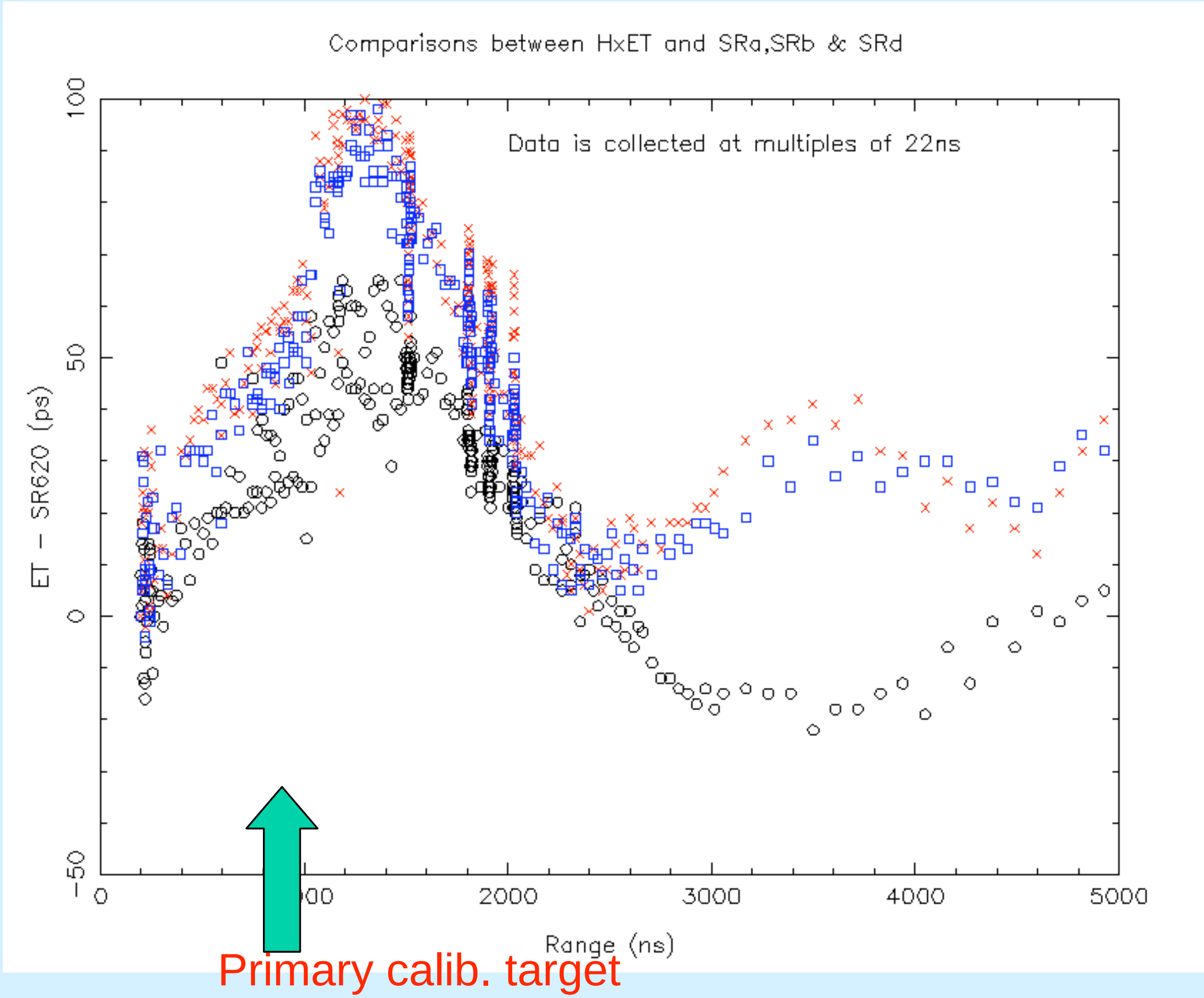
- Work was started by a careful examination of *Stanford* (SR) counters in use at Herstmonceux, UK, relative to a high-spec, ps-level event timer.
- Studied effects at LAGEOS and at local calibration target distances.
- Moved on to estimate effects in ILRS network:
  - Relative to a 'perfect' time-of-flght counter, what are the characteristics of the SR counters in common use over the last 15+ years?

Herstmonceux counters

- A ps-level event timer (HET) has been built in-house from *Thales* clock units;
- A prerequisite for the upcoming kHz operations.

- Extensive use of HET to calibrate existing cluster of *Stanford* counters prior to routine use of HET;
- In particular **back-calibrate** Hx data 1994-present.
- Look at effect on range accuracy and station height in ITRF2000/05.


Comparison between Hx ET and SRa,SRb & SRd
HxET−SRa
HxET−SRb
HxET−SRd
Range Difference (ps)
0
−50
−100
0
10
20
30
40
50
60
Range (millisecs)
LAGEOS

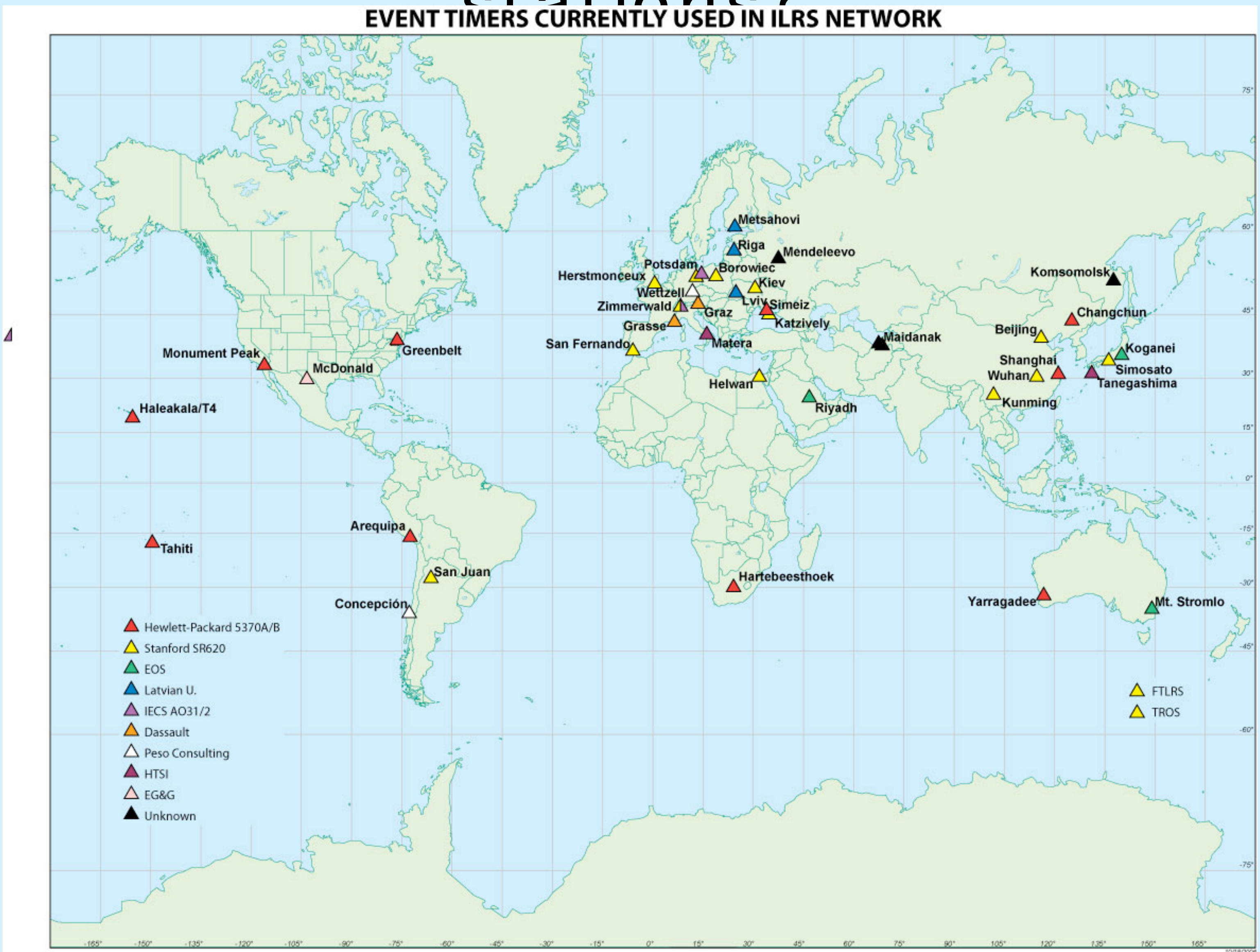


Test runs between HET and the Stanfords at 0-5000ns range (calibration boards' distances);
Behaviour very similar to spec;
Errors up to 100ps, with some systematic detailed structure

Summary of effect on range measurements at Herstmonceux (1992-2006)

- The non-linearity of the Stanfords:
- imparts an average of ~+7±2mm error onto the observed calibration range;
- Value is dependent on the target range and on the particular Stanford;
- At distance of LAGEOS, range error is between zero and ~-8±2mm;
- **So total range error was up to -15mm**
- **Currently error is ~zero, with new event timer**

Effect present in other ILRS stations?



Effect present in other ILRS stations?

- At this stage, we confine our investigation to Stanford counters;
  - Our limited experience with *e.g.* HP timers suggests they do not have problem – used by NASA network
- We have made 'worst case' estimates of calibration error and total range error at LAGEOS for all 'Stanford stations'
- Largest error is ~20mm, frequent error 10mm
- Uncertainty in these **estimates** is ~5mm

Worse-case error estimates (mm)

Station		ID	Calibration error	LAGEOS error	Total error
BEIL	Beijing	7249	12	10	22
BORL	Borowiecz	7811	9	0 meas	9
BREF	Brest	7604	10	10	20
GLSV	Kiev	1824	6	10	16
HELW	Helwan	7831	0	10	10
HERL	Herstmonceux	7840	8 meas	0 meas	8
KTZL	Katzively, Ukraine	1893	0	10	10
KUNL	Kunming, China	7820	9	10	19
POT3	Potsdam	7841	0	10	10
POTL	Potsdam	7836	0	5 meas	10
SFEL	San Fernando	7824	0	8 meas	8
SISL	Simosato, Japan	7838	-1	10	9
SJUL	San Juan	7406	0	10	10
WUHL	Wuhan	7231	0	10	10
ZIML	Zimmerwald	7810	3	8 meas	11
Closed sites					
GRSL	Grasse	7835	1	10	11

meas = measured on particular Stanford counter

Summary/outlook

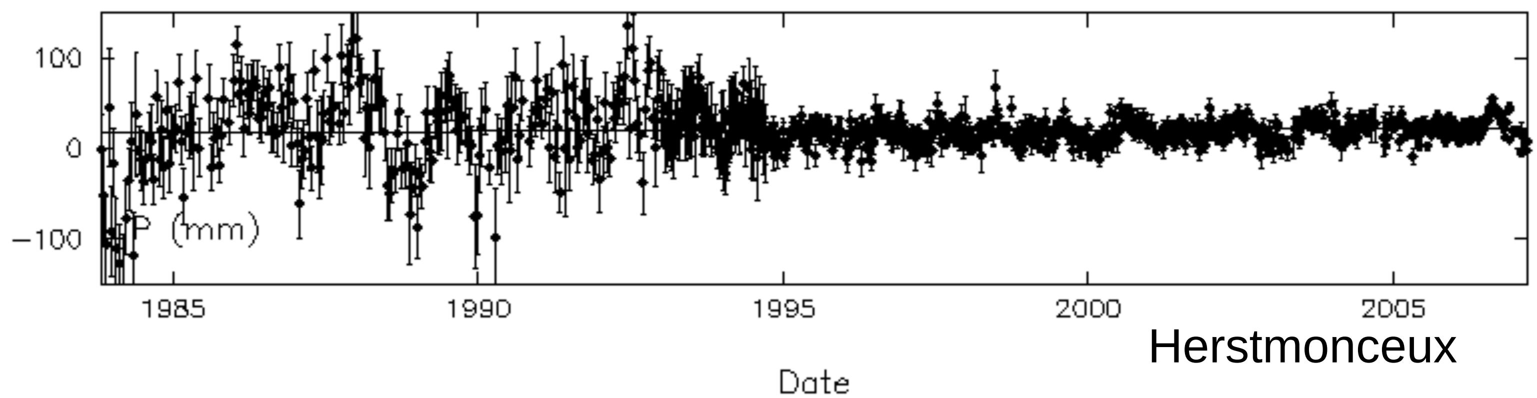
- We emphasize that:
- These stations are a subset of the full ILRS network, with a high proportion of non-core;
- The counters can be calibrated (ongoing) and past data reprocessed;
  - SGF have started this work, by inviting EUROLAS stations to send their counters to Hx – one so far.
- Several of the stations have already upgraded to higher-quality counters.

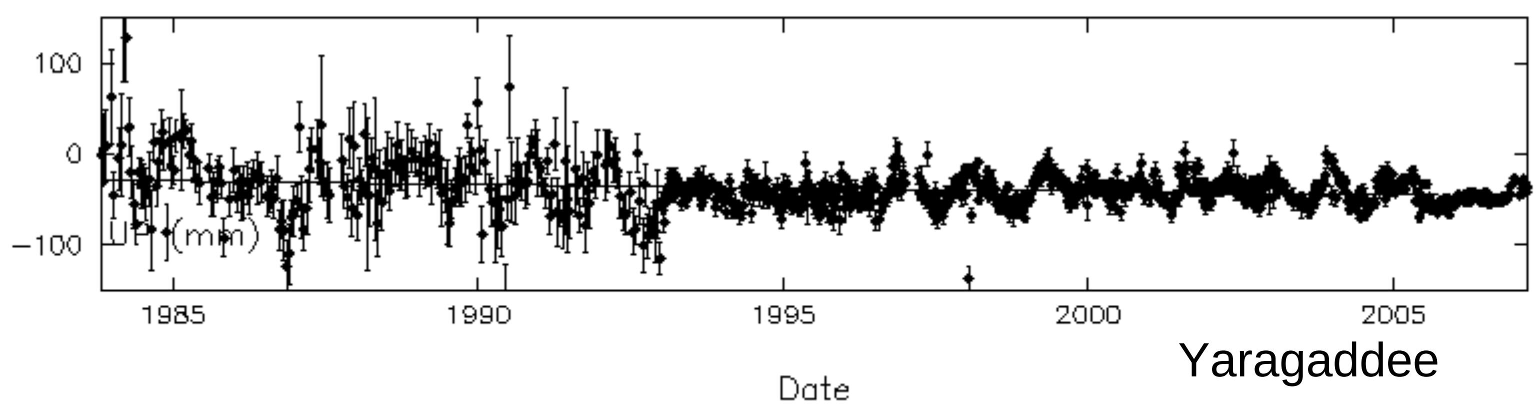
ILRS Pilot Project 'back solutions' – NSGF AC

Graham Appleby, Matt Wilkinson

- Preliminary testing using 1983 -1985 MERIT II NP data (DEOS, DGFI)
- Currently using official ILRS MERIT II LAGEOS NP data via CDDIS
- SATAN package used unchanged wrt operational solutions:
- Decided upon 15-day arcs with 3-day eops (xp, yp, LoD)
- .1cpr terms at 7.5 day intervals, RB for selected stations;
- Solutions completed for 1983 – 1992;
- continuity with date of start of 'current' 7-day V6 solutions
- not yet included ILRS-recommended corrections to data

Height time-series 1983-2007





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7836	**Potsdam**	35	PMT	Controlled s->m	2.5 sigma	**252-256**
7838	**Simosato**	100	MCP	Controlled s->m	3.0 sigma	**248-252**
7839	**Graz**	35	CSPAD	No Control m	2.2 sigma	**250-255**
7839	**Graz kHz**	10	CSPAD	No Control s->f	2.2 sigma	**?**
7840	**Herstmonceux**	100	CSPAD	Controlled s	3.0 sigma	**244-246**
7841	**Potsdam 3**	50	PMT	Controlled s->f	2.5 sigma	**248-254**
7941	**Matera**	40	MCP	No Control m	3.0 sigma	**248-254**
8834	**Wettzell**	80	MCP	No Control f->m	2.5 sigma	**248-252**

Consolidated Laser Ranging Data Format (CRD)

Version 0.26

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Abstract

Due to recent technology changes, the existing International Laser Ranging Service (ILRS) formats for exchange of laser fullrate, sampled engineering and normal point data are in need of revision. The main technology drivers are the increased use of kilohertz firing-rate lasers which make the fullrate data format cumbersome, and anticipated transponder missions, especially the Lunar Reconnaissance Orbiter (LRO), for which various field sizes are either too small or non-existent. Rather than patching the existing format, a new flexible format encompassing the 3 data types and anticipated target types has been created.

Introduction

The purpose of the Consolidated Laser Ranging Data Format (CRD) is to provide a flexible, extensible format for the ILRS fullrate, sampled engineering, and normal point data. The primary motivations for creating a new format at this time is to allow for transponder data, and to handle high-repetition-rate laser data without unnecessary redundancy. This format is based on the same features found in the ILRS Consolidated Prediction Format (CPF), including separate header and data record types assembled in a building block fashion as required for a particular target.

There are 3 separate sections to the data format: 1) the header section which contains data on the such topics as station, target, and start time; 2) the configuration section containing an expanded version of data previously described by the System Configuration Indicator (SCI) and system CHange Indicator (SCH) fields; and 3) the data section containing laser transmit and receive times, and other highly dynamic information. The data headers are fixed format and similar in content to those of the CPF files. The configuration and data records are free format with spaces between entries. Records can be added as needed for the specific data types and at frequencies commensurate with the data rate. For example, at a 2 kHz ranging rate, meteorological data and pointing angles are commonly read far less frequently than the ranges. Note that 1 way out-bound, 1 way in-bound, and 2 way ranges could all appear within one file. Also note that multiple colors could appear in one file.

Advantages of this format over the current ILRS formats are as follows;

Flexibility. The data files can be simple and compact for kiloHertz ranging or comprehensive for more complex data structures, as appropriate.

The building block structure with multiple record type allows for including and omitting certain records types as needed by a station or target.

Configuration descriptions are addressed in a more explicit, logical and extensible manner than the current format.

A single integrated format can be used for current and future data and target types.

Multiple color data, multiple ranging modes (transponder one- and two-way ranges) and multiple configurations can be included naturally within a single data file.

The format can be expanded in the future as needs expand without abandoning the entire format.

All data types (full rate, sampled engineering, and normal point) can be managed in a single file if desired, e.g., for archival and reference purposes.

Extensibility to the eXtensible Markup Language (XML) is provided for in the design.

Fields in the Configuration sections are compatible with the SLR Engineering Data File (EDF) format.

When data is converted from an old format to the CRD format, there will be fields (such as skew and kurtosis) that do not exist in the old format. In these cases, unless noted otherwise, numerical fields in the new format should be set to “-1” to indicated “no information”. Character fields without information should be filled with “na” for “Not Available”.

In the following pages, sections 1 – 3 provide a description and discussion of the specific file sections and record types. Following that, section 4 gives examples of the file structure for various types of data. Section 5 addresses file naming conventions. Section 6 provides some real-world examples of the new format, while section 7 provides web references to formats and “official lists.” Finally, Section 8 provides definitions of abbreviations.

1. Header Records

Fields in header records are defined according to the following format specifications (in contrast to data records which will have free format fields that are delimited by white space). Upper and lower case characters are both acceptable: e.g., “H1” or “h1”; “CRD” or “crd” in H1.

White spaces are allowed (where appropriate) in header record fields since these are fixed format.

1.1. Format Header

The format header describes information relating to the file: e.g. the version of the format used, time of production etc.

1.1.1. Format:

1-2	A2	Record Type (= "H1")
4-6	A3	"CRD" (Consolidated Ranging Data format)
8-9	I2	Format Version
11-14	I4	Year of file production
16-17	I2	Month of file production
19-20	I2	Day of file production
22-23	I2	Hour of file production (UTC)

1.1.2. Notes

There must be one and only one format header record in the file and it must be the first record.

1.2. Station Header

The station header describes information relating to the station or site collecting this laser data.

1.2.1. Format:

1-2	A2	Record Type (= "H2")
4-13	A10	Station name from official list(e.g., "MOB7 ", "MLRS ")
15-18	I4	Crustal Dynamics Project Pad Identifier
20-21	I2	Crustal Dynamics Project 2-digit system number
23-24	I2	Crustal Dynamics Project 2-digit occupancy sequence number
26-27	I2	Station Epoch Time Scale - indicates the time scale reference. 4 = UTC (GPS) 7 = UTC (BIH) 1-2, 5-6, 8-9 = reserved for compatibility with earlier data using obsolete time scales.

10 and above = UTC (Station Time Scales)

1.2.2. Notes

For station-created files, there must be one and only one station header record in the file and it must be the second record. Data centers may combine files.

The “Station Time Scales” option is needed to describe the time scale that accommodates the added precision of fire and return times for transponder ranging. The other time scales are not (yet) good to 1 picosecond, so some other ad hoc time scale must be used. Since the time scale techniques will evolve with time, there are many indicators (10-99) available to describe which time scale is used. In fact, these indicators may be station or experiment dependent.

The Crustal Dynamics Project Pad, site, and occupancy sequence number are often combined into the “CDDIS SOD” found in the official pad and code list mentioned in the introduction to this document.

1.3. Target Header

The target header describes static information relating to the target, whether it is a satellite, lunar or spacecraft target.

1.3.1. Format:

1-2 A2 Record Type (= "H3”)

4-13 A10 Target name from official list(e.g., "Ajisai", "GPS35")

15-22 I8 ILRS Satellite Identifier (Based on COSPAR ID)

24-27 I4 SIC (Satellite Identification Code)

29-36 I8 NORAD ID

38-38 I1 Spacecraft Epoch Time Scale (transponders only)

0 = Not used.

1 = UTC

2 = Spacecraft Time Scale

1.3.2. Notes

There must be at least one target header (and associated child records) in a file but there could possibly be more, e.g. for accumulating normal point data for many targets over a period (e.g. one day) for transmission to data centres.

COSPAR ID to ILRS Satellite Identification Algorithm:
COSPAR ID Format: (YYYY-XXXA)

YYYY is the four digit year of when the launch vehicle was put in orbit
XXX is the sequential launch vehicle number for that year

A is the alpha numeric sequence number within a launch
Example: LAGEOS-1 COSPAR ID is **1976-039A**
Explanation: LAGEOS-1 launch vehicle was placed in orbit in 1976; was the 39th launch in that year; and LAGEOS-1 was the first object injected into orbit from this launch.

ILRS Satellite Identification Format: (YYXXXAA), based on the COSPAR ID

Where YY is the two digit year of when the launch vehicle was put in orbit
Where XXX is the sequential launch vehicle number for that year
AA is the numeric sequence number within a launch
Example: LAGEOS-1 ILRS Satellite ID is **7603901**

1.4. Session (Pass) Header

The session/pass header describes information relating to the period over which the data is collected. For normal satellite targets this is generally each pass, but could be associated with pass segments. For geostationary satellites and distant targets, it must be related to time segments as defined by the station. It will be necessary to specify and hence enforce that certain parameters or conditions remain constant or static during a session.

The session header is the place to indicate what type of data records follow – this will enforce data records to be provided in blocks of consistent data rather than allowing sampled engineering, full rate and normal point records to be randomly intermingled.

Hence there must be a Session Header preceding each block of data and there may be more than one Session Header for a given pass or segment if different types of data follow.

1.4.1. Format:

1-2	A2	Record Type (= "H4”)	
4-5	I2	Data type	
		0 = full rate	
		1 = normal point	
		2 = sampled engineering	
7-10	I4	Starting Year	
12-13	I2	Starting Month	
15-16	I2	Staring Day	
18-19	I2	Starting Hour (UTC)	
21-22	I2	Starting Minute (UTC)	
24-25	I2	Starting Second (UTC)	
27-30	I4	Ending Year	(Set ending date and time fields to “0” if not available.)
32-33	I2	Ending Month	
35-36	I2	Ending Day	

38-39 I2 Ending Hour (UTC)

41-42 I2 Ending Minute (UTC)

44-45 I2 Ending Second (UTC)

47-48 I2 A flag to indicate the data release:
- 0: first release of data
- 1: first replacement release of the data,
- 2: second replacement release, etc

50-50 I1 Tropospheric refraction correction applied indicator
- 0 = False (not applied)
- 1 = True (applied)

52-52 I1 Center of mass correction applied indicator
- 0 = False (not applied)
- 1 = True (applied)

54-54 I1 Receive amplitude correction applied indicator
- 0 = False (not applied)
- 1 = True (applied)

56-56 I1 Station system delay applied indicator
- 0 = False (not applied)
- 1 = True (applied)

58-58 I1 Spacecraft system delay applied (transponders) indicator
- 0 = False (not applied)
- 1 = True (applied)

60-60 I1 Range type indicator
- 0 = No ranges (i.e. transmit time only)
- 1 = 1 way ranging
- 2 = 2 way ranging
- 3 = Receive times only
- 4 = Mixed (for real-time data recording)

Important: If Range type indicator is **not** set to two-way (2), all corrections must be written as one way quantities. Specifically, this applies to range, calibration, refraction correction, center of mass correction, as well as all RMS and other statistical fields.

1.4.2. Notes

For normal point records, stations generating the file must set the Centre of Mass and Refraction Applied flags to false and provide data consistent with these flags. The format however allows data to be provided where normal point data have these corrections applied e.g. for special purpose users or for use by data centres themselves.

Ending time may be cumbersome to compute if data is being written directly into the CRD format in real-time. In this case the ending date and time fields may be zero-filled.

1.5. End of Session Footer

1.5.1. Format

1-2 A2 Record Type (= "H8")

1.5.2. Notes

Include even if it is immediately followed by end of file footer.

1.6. End of File Footer

1.6.1. Format

1-2 A2 Record Type (= "H9")

1.6.2. Notes

If an end-of-file footer is missing the implication is that the file has been truncated and has therefore been corrupted. One response could be to request a retransmission of the file.

2. Configuration Records

Configuration records will hold static data that represents station specific configuration information used while collecting the data stored in this file. All fields must be separated by spaces, and white spaces are not allowed within record fields. These records are free format and rely on white spaces for parsing. The field types (e.g., I5, F12.5) are suggestions, and should be sized according to the stations' needs.

While detailed configuration records are strongly encouraged and are a vital part of the CRD format, the minimum requirement is a "C0" record containing the Transmit Wavelength and the System Configuration ID, and the "60" Compatibility Record. The "60" record is not required if records C1-C3 are included, although it may be useful until the format is fully implemented. Record "C4" is always required for transponder data.

The "detail type" field in the configuration records allows for future expansion of the configuration record format. At this time, this field will always have the value "0".

2.1. System Configuration Record

The system configuration record provides a means for identifying all significant components of a system in operation during collection of the data records contained within this file. This record will be an extensible list of configuration records of components deemed necessary to characterize the system at any given time during which data records are collected.

2.1.1. Format:

A2(1-2)	Record Type (= "C0").
A1(3)	Detail Type (= "0").
F10.3	Transmit Wavelength (nanometers)
A4	System Configuration id (unique within the file)
A4	Component A configuration id (e.g. detector configuration id)
A4	Component B configuration id (e.g. laser configuration id)
A4	Component C configuration id (e.g. local timing system configuration id)
A4	Component D configuration id (e.g. transponder configuration id)

Repeat as required.

2.1.2. Notes

The use of configuration records replaces the current SCI and SCH (but not the station site log) files. To access information currently contained in the SCH file, one should use the date and time as a key and extract the information from station site log files which should be maintained to provide such data. The SCI file is totally replaced by the records in the current file.

The Transmit Wavelength represent the wavelength of the laser beam as transmitted to the atmosphere and is thus common to many of the station subsystems. Hence it is included explicitly in this record.

One advantage of this is that the association of data records to wavelength used is more direct.

The file ***must*** contain at least one Configuration Header. If there are multiple system configurations used when generating the data records contained within the file, then there should be multiple system configuration headers in the file. These should appear after the associated component configuration records have all been defined.

A standard enumerated list of components for many of the configuration fields needs to be maintained. This includes, for example, detector type, laser type, timer. Any input would be appreciated!

2.2. Laser Configuration Record

The file should contain at least one Laser Configuration record. If multiple wavelengths are used or there are significant changes to any of the other parameters within the data sets in the file, then there must be appropriate Laser Configuration records for each wavelength or configuration used.

2.2.1. Format:

A2(1-2) Record Type (= "C1").

A1(3) Detail Type (= "0").

A4 Laser Configuration id (unique within the file)

A10 Laser Type (e.g. “Nd-Yag”)

F10.2 Primary wavelength (nm)

F10.2 Nominal Fire Rate (Hz)

F10.2 Pulse Energy (mJ): record when this fields changes by 10%

F6.1 Pulse Width (ps): record when this fields changes by 10%

F5.2 Beam Divergence (arcsec)

I4 Number of pulses in outgoing semi-train

2.2.2. Notes

Note that the primary wavelength is used here, e.g. use 1064 for a Nd-Yag laser even though only 532 is used.

Most fields are expected to be static for a given laser. Pulse energy and width should trigger the writing of a new record whenever they change by 10%.

2.3. Detector Configuration Record

The file should contain at least one Detector Configuration record. If multiple wavelengths are used or there are significant changes to any of the other parameters within the data sets in the file, then there must be an appropriate Detector Configuration record for each wavelength or configuration used.

2.3.1. Format:

A2(1-2) Record Type (= "C2").

A1(3) Detail Type (= "0").

A4 Detector Configuration id (unique within the file)

A10 Detector Type (e.g.”SPAD”, “CSPAD”, “MCP”, “APD”, GeDiode” …)

F10.3 Applicable wavelength (nm)

F6.2 Quantum efficiency at applicable wavelength (%).

F5.1 Applied voltage (V)

F5.1 Dark Count (kHz)

F5.1 Output pulse type (ECL, TTL, photon-dependant, …)

F5.1 Output pulse width (ps)

F5.2 Spectral Filter (nm)

F5.1 % Transmission of Spectral Filter

F5.1 Spatial Filter (arcsec)

A10 External Signal processing

2.3.2. Notes

Most fields are expected to be static for a given detector. Spatial and spectral filters changes should be recorded when they change by 10% (for continuously variable filters), or whenever they change (for discrete filters).

2.4. Timing System Configuration Record

The file should contain at least one station Timing System Configuration record. If multiple timing systems are used, then there must be an appropriate Timing System Configuration record for each system used.

2.4.1. Format:

A2(1-2) Record Type (= "C3").

A1(3) Detail Type (= "0").

A4 Timing System Configuration id (unique within the file)

A20 Time Source (e.g.”Truetime XLi”, “Truetime XL-SD”, “Datum 9390”, “HP 58503A”, “TAC”,…..)

A20 Frequency Source (e.g. “Truetime OCXO”, “CS-4000”,)

A20 Timer (e.g. “MRCS”, “SR620”, “HP5370B”, “Dassault”, ”Other” …)

A20 Timer Serial Number (for multiple timers of same model)

F6.1 Epoch delay correction (ps).

2.4.2. Notes

Most of the fields in this record should effectively be pointers to items in the Station Log File where associated static data on each device can be found. The epoch delay correction provides a measure of the propagation delay between the Time Source output and the point at which the timing epochs are registered. For example, in some systems, a 1PPS signal is used to latch second boundaries, However there must be some correction applied for the transmission delay between the source of the 1PPS signal and the timer system.

2.5. Transponder (Clock) Configuration Record

The transponders header describes static information relating to certain transponders

2.5.1. Format:

A2(1-2) Record Type (= "C4").

A1(3) Detail Type (= "0").

A4 Transponder Configuration id (unique within the file)

F20.3 Estimated Station UTC offset (nanoseconds)

F11.2 Estimated Station Oscillator Drift (UTC/station clock) in parts in 10^{15}.

F20.3 Estimated Transponder UTC offset (nanoseconds)

F11.2 Estimated Transponder Oscillator Drift (UTC/spacecraft clock) in parts in 10^{15}

F20.12 Transponder Clock Reference Time. (seconds, scaled or unscaled)

I1 Station offset and drift applied indicator.

- 0 = False (not applied)
- 1 = True (applied)

I1 Spacecraft offset and drift applied indicator.

- 0 = False (not applied)
- 1 = True (applied)

I1 Spacecraft time simplified

- 0 = False
- 1 = True

2.5.2. Notes

Note that standard sense used in all time and frequency metrology must be followed, e.g. local station offset is (UTC – local station).

A transponder configuration record is required only if the target contains a transponder or time transfer equipment.

To convert from spacecraft master clock units and timescale,

$$t_{UTC} = t_{master} + (t_{master} - t_o) * 10^{-15} * \text{Oscillator Drift} + \text{UTC offset}$$

where t_o is Transponder Clock Reference Time, the time at which master clock was calibrated against

UTC (somehow), and the UTC offset is (UTC-master) at time t_o.

For the space craft time simplified mode (used for LRO), t_o has already been removed from t_{master} to allow passing of a much smaller number. The Transponder Clock Reference Time field is filled but only used for reference. The equation then becomes

$$t_{UTC} = t_{master} + (t_{master}) * 10^{-15} * \text{Oscillator Drift} + \text{UTC offset}.$$

The conversion for the station clock is analogous.

A new record should be written whenever a field changes value.

3. Data Records

Data records contain non-static data and hence they all will contain a timestamp field. All fields ***must*** be separated by spaces, and white spaces are not allowed within data fields. These records are free format and rely on white spaces for parsing. The field types (e.g., I5, F12.5) are suggestions, and should be sized according to the target's needs and the station's precision. There will be no unused or undefined fields.

3.1. Range Record (Full rate, Engineering)

The full rate range record contains single-shot measurement data. Generally only accepted signal data will be included but engineering data and low-quality (see quality and filter flags) may contain noise data as well. The file will contain blocks of one or more range records corresponding to a consistent format and system configuration.

3.1.1. Format:

A2(1-2) Record Type (= "10")

F18.12 Fire time seconds of day (typically to 100 ns for SLR/LLR or 1 picosecond for transponder/T2L2). For transponders, station clock correction may be applied.

F18.12 Range in seconds (none, 1-, or 2-way depending on range type indicator); or (for Epoch Event 5) spacecraft receive time in units of the spacecraft master clock, or seconds if “Spacecraft offset and drift applied indicator” is true. Range may be corrected for station system delay; receive time may be corrected for spacecraft system delay and/or clock correction.

A4 System configuration id.

I1 Epoch Event - indicates the time event reference.

Currently, only 1 and 2 are used for laser ranging data.

0 = Ground receive time (at System Reference Point - SRP) (2 way)

1 = Spacecraft bounce time (2 way)

2 = Ground transmit time (at SRP) (2 way)

3 = Spacecraft receive time (1 way)

4 = Spacecraft transmit time (1 way)

5 = Ground transmit time (at SRP) and spacecraft receive time (1 way)

6 = Spacecraft transmit time and ground receive time (at SRP) (1 way)

I1 Filter Flag

0=unknown

1=noise

2=data

I1 Detector channel

0 = not applicable or “all”

1-4 for quadrant

1-n for many channels

I5 Receive Amplitude - a positive linear scale value.

3.1.2. Notes

Receive signal strength is not in the current normal point format, but is left in this record for compatibility with engineering quick look and full rate data.

Format allows multiple color data to be included in the same file, with separate normal point statistics, etc.

As noted above, transmit time only, receive time only, 1-way, and 2-way ranges etc. can appear in the same file, to accommodate transponders.

Note that station transmit and receive times are nominally with respect to the system reference point (SRP) which will in many cases be the telescope invariant point. This requires a knowledge of both the transmit delay and receive delay, which is critical for transponder ranging. It is less critical for normal satellite (two-way) ranging since errors in distributing the system delay to these components will cancel.

It should be remembered that full rate data should include a swathe of data around the station assessed signal, and assessed noise and signal data be indicated using the filter flag. The noise/data flag should initially be set based on on-site processing.

3.2. Range Record (Normal Point)

The normal point range record contains accepted measurement data formed into normal point bins. The file will contain blocks of one or more range records corresponding to a consistent format and system configuration.

3.2.1. Format:

A2(1-2) Record Type (= "11")

F18.12 Seconds of day (typically to < 100ns for SLR/LLR or <1 ps for transponders). Station clock corrections should be applied for all targets.

F18.12 Range in seconds (none, 1-, or 2-way depending on range type indicator); or (for Epoch Event = 5) spacecraft receive time in units of the spacecraft master clock, or seconds if “Spacecraft offset and drift applied indicator” is true. Range should be corrected for station system delay; receive time may be corrected for spacecraft system delay and/or clock correction.

A4 System configuration id.

I1 Epoch Event - indicates the time event reference.

Currently, only 1 and 2 are used for laser ranging data.

0 = Ground receive time (at SRP) (2 way)

1 = Spacecraft bounce time (2 way)

2 = Ground transmit time (at SRP) (2 way)

3 = Spacecraft receive time (1 way)

4 = Spacecraft transmit time (1 way)

5 = Ground transmit time (at SRP) and spacecraft receive time (1 way)

6 = Spacecraft transmit time and ground receive time (at SRP) (1 way)

I4 Normal point window length (seconds)

I6 Number of raw ranges (after editing) compressed into the normal point.

F9.1 Bin RMS from the mean of raw accepted range values minus the trend function (ps)

F7.3 Bin skew from the mean of raw accepted range values minus the trend function.

F7.3 Bin kurtosis from the mean of raw accepted range values minus the trend function.

F9.1 Bin peak – mean value (ps)

F5.1 Return rate (%) for SLR or signal to noise ratio, in units of 0.1 for LLR.

3.2.2. Notes

Note that station transmit and receive times are nominally with respect to the system reference point (SRP) which will in many cases be the telescope invariant point. This requires a knowledge of both the transmit delay and receive delay, which is critical for transponder ranging. It is less critical for normal satellite (two-way) ranging since errors in distributing the system delay to these components will cancel.

If there are too few data points to assess pass rms, skew, or kurtosis, put “-1” in the field. It is left to the station’s discretion, subject to ILRS directives, whether to include normal points having few data points.

3.3. Range Supplement Record

The range supplement range record contains optional range data and will be interspersed with range data to which it is associated. If this record is used, then it should be created whenever there is a ***significant*** change to one or more fields.

3.3.1. Format:

A2(1-2) Record Type (= "12")

F18.12 Seconds of day.

A4 System configuration id.

F6.1 Tropospheric refraction correction (picoseconds)

F6.4 Target Center of Mass Correction (meters)

F5.2 Neutral Density (ND) filter value

F8.4 Time bias applied (seconds)

3.3.2. Notes

None.

3.4. Meteorological Record

This data record contains a minimal set of meteorological data. At least one record must appear in the data file.

3.4.1. Format:

A2(1-2) Record Type (= "20")

F18.12 Seconds of day (typically to 1 milllisec)

F7.2 Surface Pressure (mbar).

F6.2 Surface Temperature in degrees Kelvin.

F4.0 Relative Humidity at Surface in %

3.4.2. Notes

Meteorological records should only be written when one of the fields changes "significantly". The criteria should be at least 2 times the least significant bit of the sensor, to prevent noise in the lowest bit from constantly producing new records. In addition the criteria should require new records whenever pressure changes by 0.1 mb, temperature changes by 0.1 K, or humidity changes by 5%.

3.5. Meteorological Supplement Record

This data record contains an (optional) supplement set of meteorological data. A file must contain at least one meteorological record and may contain one or more meteorological supplement records.

3.5.1. Format:

A2(1-2) Record Type (= "21")

F18.12 Seconds of day (typically to 1 milllisec)

F5.1 Wind speed (m/s)

F5.1 Wind direction (degrees azimuth, north is zero)

A4 Precipitation type ("rain", "snow", "fog", "fine" ...TBD)

I3 Visibility (km)

I3 Sky Clarity (ie zenith extinction coefficient)

I2 Atmospheric seeing (arcsec)

I2 Cloud cover (%)

3.5.2. Notes

Meteorological records should only be written when one of the fields changes "significantly". The criteria should be at least 2 times the least significant bit of the sensor, to prevent noise in the lowest bit from constantly producing new records.

Please comment on the choice of fields here!

3.6. Pointing Angles Record

This record contains telescope or beam director pointing (azimuth and elevation) angles, and is optional for normal point data sets. If it is used, the source and nature of this data must be provided.

3.6.1. Format:

A2(1-2) Record Type (= "30")

F18.12 Seconds of day (typically to 1 milllisec)

F8.4 Azimuth in degrees

F8.4 Elevation in degrees

A1 Direction flag

0 = transmit & receive

1 = transmit

2 = receive

A1 Angle Origin Indicator

0 = unknown

1 = computed

2 = commanded (from predictions)

3 = measured (from encoders)

A1 Refraction corrected

0 = False (in vacuo angles ie angles if no atmosphere is assumed)

1 = True (apparent angles with refraction included)

3.6.2. Notes

Point angle records should only be written when one of the angles changes “significantly”, which means a change of at least 0.001 degrees.

Is 0.001 degrees too fine?

3.7. Calibration Record

The calibration record contains statistics of accepted calibration measurements. It may be associated with calibrations at the station or target. The file will contain as many calibration records as required, but there must be at least one station calibration record in the file at the station level. Each calibration record is applicable to the subsequent block(s) of range records.

3.7.1. Format:

A2(1-2) Record Type (= "40")

F18.12 Seconds of day (typically to < 100ns for SLR/LLR or <1 ps for transponder ranging). Station clock corrections should be applied for all targets.

I1 Type of data

- 0=station
- 1=target (e.g. transponder)

A4 System configuration id

I8 Number of data points recorded (= -1 if no information)

I8 Number of data points used (= -1 if no information)

F7.3 One way target distance (meters, nominal) (= -1 if no information)

F10.1 Calibration System Delay (picoseconds)

F8.1 Calibration Delay Shift - a measure of calibration stability (picoseconds).

F6.1 Root Mean Square (RMS) of raw system delay (ps). If pre- and post- pass calibrations are made, use the mean of the two RMS values, or the RMS of the combined data set.

F7.3 Skew of raw system delay values from the mean. If pre- and post- pass calibrations are made, use the mean of the two skew values, or the skew of the combined data set.

F7.3 Kurtosis of raw system delay values from the mean. If pre- and post- pass calibrations are made, use the mean of the two kurtosis values, or the kurtosis of the combined data set.

F6.1 System delay peak – mean value (ps)

I1 Calibration Type Indicator

- 0 = Not used or undefined
- 1 = Nominal (from once off assessment)
- 2 = External cals
- 3 = Internal cals
- 4 = Burst cals
- 5 = Other

I1 Calibration Shift Type Indicator

- 0 = Not used or undefined
- 1 = Nominal (from once off assessment)
- 2 = Pre – to Post- Shift
- 3 = Minimum to maximum
- 4 = Other

3.7.2. Notes

Nominal calibrations are intended for generally low accuracy systems that do not have access to high precision system delay measurements, but rather depend on fairly static and infrequent assessments of system delay. For example, use nominal calibrations for engineering data while a station is being developed, or for other special purposes.

It is expected that one calibration record is expected for a normal point data block, but this record could be used to also provide single shot measurements or indeed averaged blocks ("normal points") of internal calibrations for example.

3.8. Session (Pass) Statistics Record

The session (pass) statistics record contains averaged statistics derived from measurements taken during the session (or over the duration of a pass). The file will contain blocks of one or more range records corresponding to a consistent format. One session statistics record should be associated with each of these data blocks.

3.8.1. Format:

A2(1-2) Record Type (= "50")

A4 System configuration id.

F6.1 Session RMS from the mean of raw, accepted range values minus the trend function (ps).

F7.3 Session Skewness from the mean of raw accepted range values minus the trend function.

F7.3 Session Kurtosis from the mean of raw accepted range values minus the trend function.

F6.1 Session peak – mean value (ps)

I1 Data quality assessment indicator. For SLR and LLR data:

- 0 = Undefined or no comment.
- 1 = Clear, easily filtered data, with little or no noise.
- 2 = Clear data with some noise; filtering is slightly compromised by noise level.
- 3 = Clear data with a significant amount of noise, or weak data with little noise. Data are certainly present, but filtering is difficult.
- 4 = Un-clear data; data appear marginally to be present, but are very difficult to separate from noise during filtering. Signal to noise ratio can be less than 1:1.
- 5 = No data apparent.

3.8.2. Notes

This record is only required in combination with a number of normal point records. It is optional with full rate or engineering data records.

3.9. Compatibility Record

This record is provided primarily to allow reformatting of old data from the ILRS normal point and full-rate data to this format, without losing existing data.

3.9.1. Format:

A2(1-2) Record Type (= "60").

A4 System configuration id.

I1 System CHange indicator (SCH)

A flag to increment for every major change to the system (hardware or software). After the value '9' return to '0', and then continue incrementing. The station and data centers should keep a log in a standard format of the value used, the date of the change, and a description of the change.

I1 System Configuration Indicator (SCI)

A flag used to indicate alternative modes of operation for a system (e.g., choice of alternative timers or detectors, or use of a different mode of operation for high satellites). Each value of the flag indicates a particular configuration, which is described in a log file held at the station and at the data centers. If only a single configuration is used then use a fixed value. If a new configuration is introduced then use the next higher flag value. If value exceeds '9' then return to '0', overwriting a previous configuration flag (it is not likely that a station will have 10 current possible configurations).

3.9.2. Notes

None

3.10. User Defined Record

This record is provided to allow special interest users or groups to add non-standard data records. Other uses must be able to ignore such records (if they exist in a file) without any impact. Record types outside this range will be reserved for future standard format use.

3.10.1. Format:

A2(1-2) Record Type (= "9X", X = 0…9).

3-80 User defined format

3.10.2. Notes

None

3.11. Comment Record

Comment records are optional, and allow users to insert comments or notes as deemed necessary and appropriate.

3.11.1. Format:

A2(1-2) Record Type (= "00").

A80 Free format ASCII comments (terminated by an end-of-line character).

3.11.2. Notes

To ensure line lengths do not become excessive, a limit of 80 characters is set. Lines exceeding this limit may be truncated. Multiple comment lines are encouraged. Comment lines can occur anywhere within a file.

4. Record Structure

The records as defined should have the potential for storing a quite complex mix of data types while maintaining data integrity. The format must support a consistent, unambiguous data set that can be readily parsed for currently used and expected data sets, and for data sets that are possible in the future. The data stored in a CRD file should be capable of being stored in a normalized database and/or expressed in the XML language. The definitions of the records have kept this in mind.

It is important that, unless totally unavoidable, data fields are not repeated as this has the potential for undermining the requirement for unambiguous and consistent data. It is also efficient in terms of file sizing and storage.

Consider a number of cases. The first is simple case where the station is performing basic satellite tracking and is creating full rate and normal point files. In practice, this will probably represent the majority of files most of the time, at least for the present.

A more complex case where a station is performing two-colour ranging and wants to store both full rate and normal point data in the one file, or when a site is publishing full rate data from experiments in time transfer using target transponders.

4.1. Case 1

Two files containing full rate for one target and normal point data for one period (for example, one day). This is typical for existing normal point (.qld) and fullrate (.fr) files being generated at many stations. (Comment records are not considered here.)

Full rate file for 1 target, single system configuration.

Format Header

Station Header

Target Header

Laser Configuration Record

Detector Configuration Record

Timing System Configuration Record

System Configuration Record

Calibration Record

    Session Header

        Calibration Record (if required)

        Pointing Record / Mets Record

        Data Record (Full rate) (repeated)

        Calibration Record / Pointing Record / Mets Record (as required)

        Data Record (Full rate) (repeated)

        Calibration Record (if required)

Pointing Record / Mets Record

End Of Session Header

Session Header

Calibration Record (if required)

Pointing Record / Mets Record

Data Record (Full rate) (repeated)

Calibration Record / Pointing Record / Mets Record (as required)

Data Record (Full rate) (repeated)

Calibration Record (if required)

Pointing Record / Mets Record

End of session Header

…… (as many session as required)

End of file header

Normal point file for many targets, single system configuration.

Format Header

Station Header

Laser Configuration Record

Detector Configuration Record

Timing System Configuration Record

System Configuration Record

Calibration Record

Target Header

Session Header

Calibration Record (if required)

Mets Record

Data record (normal point) (repeated)

Mets Record

Data record (normal point) (repeated)

Mets Record

Pass Record

End of session header

….. other sessions for this target as required

Target Header

…. Repeat as above for as many targets as required

End of session header

End of file header

This would correspond to files having a record sequence such as

H1 H2 C0 C1 C2 C3 40 H3 H4 20 30 40 10 10 10...20 10 10...30 10 10...40...10 10 20 H8 H4 20 30 40 10 10 10...20 10 10...30 10 10...40...10 10 20 H8 H4...H8...H9

and

H1 H2 C0 C1 C2 C3 40 H3 H4 40 20 11 11 11...20 11 11...20.12 H8 H4 40 20 11 11 11...20 12 H8 H3 H4 40 20 11 11 11...20 11 11...20 12 H8 H4 40 20 11 11 11...20 12 H8...H8...H9

4.2. Case 2

One file containing full rate and normal point data for one target for one period (for example, one day) from a station performing two-colour ranging (or any other dual configuration) ranging.

Full rate and normal point file for 1 target, two system configurations.

Format Header

Station Header

Target Header

Laser Configuration L1 Record

Laser Configuration L2 Record

Detector Configuration D1 Record

Detector Configuration D2 Record

Timing System Configuration (TS) Record

System Configuration S1 Record (L1-D1-TS)

System Configuration S2 Record (L2-D2-TS), or whatever is appropriate

Calibration (system S1) Record C1

Calibration (system S2) Record C2, or whatever is appropriate.

Session Header (full rate)

Calibration Records C1 and/pr C2 (if required)

Pointing Record / Mets Record

Data Record for S1 (Full rate) (repeated)

Data Record for S2 (Full rate) (repeated)

Calibration Records / Pointing Record / Mets Record (as required)

Data Records for S1 (Full rate) (repeated)

Data Records for S2 (Full rate) (repeated)

Calibration Records (if required)

Pointing Record / Mets Record

End of session Header

Session Header (normal point)

Mets Record

Data Record for S1 and/or S2(normal point) (repeated)

Mets Record

Data Record for S1 and/or S2 (normal point) (repeated)

Mets Record

End of session Header

Session Header (full rate)

…. (Repeat as above for as many sessions as required)

End of session Header

End of file header

This would correspond to files having a record sequence such as

H1 H2 H3 C0 C0 C1 C1 C2 C2 C3 H4 20 30 40 40 10 10 10 10...20 10 10 10 10...30 10 10 10 10...40...10 10 20 H8 H4 20 11 11 11 11...20 11 11 11 11...11 11 11 11...11 11 20 H8 H4 20 30 40 40 10 10 10 10...20 10 10 10 10...30 10 10 10 10...40...10 10 20 H8 H4 20 11 11 11 11...20 11 11 11 11...11 11 11 11...11 11 20 H8…H8 H9.

4.3. Case 3

One file containing full rate data for one target from a station performing experiments in time transfer via a transponder in association with another station.

Full rate 1 target, two system configurations.

Format Header

Station Header

Target Header

Laser Configuration Record

Detector Configuration Record

Timing System Configuration Record

Transponder Configuration Record

System Configuration Record

Calibration Record (Site)

Calibration Record (Target)

Session Header (full rate)

Calibration Record (Site) (if required)

Calibration Record (Target) (if required)

Pointing Record / Mets Record

Data Record (Full rate, range and transmit epoch) (repeated)

Data Record (Full rate, receive epoch only) (repeated)

Pointing Record / Mets Record

End of session Header

End of file header

4.4. Case 4

In this case, several fullrate or normalpoint sessions from one station are sent in a single file from the station to a data center. There are two ways of doing this:

4.4.1. Preferred method

H1 H2 H3 H4 ... H8

H3 H4 ... H8

...

H3 H4 ... H8 H9

This ordering is more hierarchical and is more compatible with parsing into XML.

4.4.2. Acceptable, but not preferred, method

H1 H2 H3 H4 ... H8

H1 H2 H3 H4 ... H8

...

H1 H2 H3 H4 ... H8 H9

This ordering is syntactically correct, and may be easier to implement when converting data in the old format to CRD.

5. File Naming

Since the proposed data format is so flexible and a file could contain many data types and cover any number of periods, file naming becomes a real issue. Therefore there must be a number of conventions adopted. Proposed conventions are:

1. File names and file naming conventions do not form the basis for file processing except for files that have well defined and specific file extensions (such as .Z for extraction purposes).
2. File names ending in ".NPT", ".FRD", or ".QLK" contain single data types, but possibly multiple satellites and stations.
3. File names ending in ".CRD" may contain multiple data types.
4. Files are delivered to specific file repositories in which it has been agreed and understood that certain file operations will be performed. Hence the onus is on the supplier to provide the appropriate type of file to the repository.
5. Published files will always have a unique file name. (Pertains to station naming conventions.)
6. Release versions are maintained within the data file headers. Data center files names will not include release information.
7. File processing will require files to be opened and parsed to determine what operations, if any, are to be performed.

5.1. Station Naming Convention

This naming convention is for use with files transmitted from the station to the data***THIS CONVENTION IS UNDERGOING REVISION***

date[_station-name][_target-name][_mjd][_type][_other].crd

where the [] indicates optional fields and

- Date is the date and time of production/transmission in format yyyymmddhhmmss.
- Station-name is the station name with no white spaces, if the file contains only data from that station,
- Target-name is the target name with no white spaces, if the file contains only data for that target,
- Mjd is the integral modified julian date if the file contains data for that one day only,
- Type is one of the following if the file contains only data of that type,

  "np" for normal point data,

  "fr" for full rate data, and

  "ql" for engineering, quick look data.
- Other is a suitable string without white spaces, if none of these options are appropriate.

Files may contain the ".Z", ".z", or ".zip" extension indicating a particular type of file compression.

5.2. Data Center Naming Convention

Data centers (e.g. CDDIS and EDC) will use these file names at their ftp and web sites. These are the file names the users will see when retrieving data for their analysis work. Each file will contain only one type of data.

satname_yyyymmddhh.typ (hourly)
satname_yyyymmdd.typ (daily)
satname_yyyymm.typ (monthly)
satname_yyyy.typ

where

- satname is from a standard ILRS list of spacecrafts;
- yyyy is the 4-digit year,
- mm is the 2-digit month,
- dd is the 2-digit day,
- hh is the 2-digit hour, and
- typ is
  - frd – full-rate data,
  - qlk – engineering sampled engineering data,
  - npt – normal point data.

Examples: starlette_2006091011.frd
lro_200810.npt

Files may contain the ".Z" or ".z" extension indicating file compression.

5.3.

6. Sample Files

This section includes passes and samples of passes represented in the CRD format. Note that record lengths were kept short by using "%.*x*f" c language formats for most floating point fields.

6.1. Fullrate

Filename: lageos2_7080_crd_20061113152300_01.frd

```
H1 CRD  1 2007  3 20 14
H2 MLRS       7080 24 19 4
H3 LAGEOS2     9207002 5986    22195 0
H4  0 2006 11 13 15 23 52 2006 11 13 15 45 35  1 1 1 1 0 0 2
C0 0 532.000 std1
60 std1 5 2
10 55432.0414338     0.047960587856 std1 2 0 0 0
12 55432.0414338 std1 20735.0 1601.0000 0.00 0.0000
20 55432.0414338  801.80  28.21   39
30 55432.0414338 297.2990  38.6340 0 2 1
40 55432.0414338 0 std1       -1       -1 0.000 -913.0 0.0 56.0 -1.000 -1.000 -1.0 3 3
10 55435.6429746     0.047926839980 std1 2 0 0 0
12 55435.6429746 std1 20697.0 1601.0000 0.00 0.0000
30 55435.6429746 297.4480  38.7190 0 2 1
...
10 56735.8021609     0.046094881873 std1 2 0 0 0
12 56735.8021609 std1 18092.0 1601.0000 0.00 0.0000
30 56735.8021609  15.2330  45.7100 0 2 1
H8
H9
```

6.2. Normal Point

File name: lageos2_7080_crd_20061113152300_01.npt

```
H1 CRD  1 2007  3 20 14

H2 MLRS       7080 24 19 4

H3 LAGEOS2     9207002 5986    22195 0

H4  1 2006 11 13 15 25  4 2006 11 13 15 44 40  0 0 0 0 1 0 2


C0 0 532.000 std1

60 std1 5 2

11 55504.9728030 0.047379676080 std1 2  120     18      94.0 -1.000 -1.000 -1.0 0.0

20 55504.9728030  801.80 282.10   39
```

```
40 55504.9728030 0 std1       -1       -1 0.000 -913.0 0.0 56.0 -1.000 -1.000 -1.0 3 3
11 55988.9809589 0.044893190432 std1 2  120     19      83.0 -1.000 -1.000 -1.0 0.0
20 55988.9809589  801.50 282.80   39
11 56141.8467215 0.044635017248 std1 2  120     28      66.0 -1.000 -1.000 -1.0 0.0
11 56223.2817254 0.044605221903 std1 2  120     25      87.0 -1.000 -1.000 -1.0 0.0
20 56223.2817254  801.50 282.60   39
11 56373.5463612 0.044746486398 std1 2  120     25      78.0 -1.000 -1.000 -1.0 0.0
20 56373.5463612  801.50 282.10   39
11 56439.9749454 0.044889147842 std1 2  120     25      99.0 -1.000 -1.000 -1.0 0.0
11 56565.2288146 0.045288773098 std1 2  120     25      92.0 -1.000 -1.000 -1.0 0.0
11 56680.8785419 0.045804632570 std1 2  120     10      55.0 -1.000 -1.000 -1.0 0.0
20 56680.8785419  801.50 282.00   39
50 std1 86.0 -1.000 -1.000 -1.0 0
H8
H9
```

6.3. Sample Engineering (Quicklook)

File name: lageos2_7080_crd_20061113152300_01.qlk

```
H1 CRD  1 2007  3 20 14
H2 MLRS       7080 24 19 4
H3 LAGEOS2     9207002 5986    22195 0
H4  2 2006 11 13 15 24 17 2006 11 13 15 44 59  0 0 0 0 0 0 2
C0 0 532.000 std1
60 std1 5 2
10 55457.0521861     0.047753624332 std1 2 0 0 0
20 55457.0521861  801.80 282.10   39
30 55457.0521861 298.3470  39.2230 0 0 0
10 55482.4631214     0.047552685849 std1 2 0 0 0
30 55482.4631214 299.4370  39.8100 0 0 0
...
10 56589.0390552     0.045383653062 std1 2 0 0 0
20 56589.0390552  801.50 282.00   39
30 56589.0390552   6.7380  47.9120 0 0 0
10 56623.4538362     0.045531247776 std1 2 0 0 0
```

```
30 56623.4538362   8.8120  47.4510 0 0 0
10 56657.6685552     0.045690091816 std1 2 0 0 0
30 56657.6685552  10.8230  46.9570 0 0 0
10 56699.7866762     0.045901952309 std1 2 0 0 0
30 56699.7866762  13.2310  46.3060 0 0 0
50 std1 86.0 -1.000 -1.000 -1.0 0
H8
H9
```

6.4. *Sample 2-Color Normal Point file*

File Name: lageos1_7810_crd_20061230073543_01.npt

```
H1 CRD  1 2007  3 20 14
H2 ZIMMERWALD 7810 68  1 7
H3 LAGEOS1     7603901 1155     8820 0
H4  1 2006 12 30  7 35 34 2006 12 30  8 12 29  0 0 0 0 1 0 2
C0 0 846.000 std1
C0 0 423.000 std2
60 std1 9 0
60 std2 9 1
11 27334.1080890 0.051571851861 std1 2  120     36     154.0 -1.000 -1.000 -1.0 0.0
20 27334.1080890  923.30 275.40   43
40 27334.1080890 0 std1       -1       -1 0.000 113069.0 0.0 138.0 -1.000 -1.000 -1.0 2 2
11 27343.5080895 0.051405458691 std2 2  120     28      79.0 -1.000 -1.000 -1.0 0.0
11 27372.6080888 0.050895050517 std2 2  120     30      76.0 -1.000 -1.000 -1.0 0.0
11 27373.1080893 0.050886342010 std1 2  120     17     158.0 -1.000 -1.000 -1.0 0.0
11 28003.8080894 0.042252027043 std1 2  120     19     170.0 -1.000 -1.000 -1.0 0.0
20 28003.8080894  923.40 275.50   42
11 28008.7080899 0.042208378233 std2 2  120     85      71.0 -1.000 -1.000 -1.0 0.0
11 28402.1080897 0.040251470202 std1 2  120      6     183.0 -1.000 -1.000 -1.0 0.0
11 28406.5080897 0.040247878310 std2 2  120     45      78.0 -1.000 -1.000 -1.0 0.0
11 28620.0080896 0.040574433849 std1 2  120     18     163.0 -1.000 -1.000 -1.0 0.0
20 28620.0080896  923.50 275.50   42
```

11 28627.6080899 0.040603966534 std2 2 120 114 71.0 -1.000 -1.000 -1.0 0.0

11 29151.2080895 0.045287136931 std2 2 120 7 65.0 -1.000 -1.000 -1.0 0.0

11 29156.7080892 0.045360524908 std1 2 120 7 134.0 -1.000 -1.000 -1.0 0.0

20 29156.7080892 923.50 275.80 42

11 29225.6080889 0.046314735294 std1 2 120 45 164.0 -1.000 -1.000 -1.0 0.0

11 29237.7080892 0.046488750878 std2 2 120 50 78.0 -1.000 -1.000 -1.0 0.0

11 29326.8080894 0.047825380133 std1 2 120 49 152.0 -1.000 -1.000 -1.0 0.0

11 29334.2080895 0.047940570614 std2 2 120 73 85.0 -1.000 -1.000 -1.0 0.0

11 29461.4080892 0.050011219353 std2 2 120 29 76.0 -1.000 -1.000 -1.0 0.0

11 29477.2080896 0.050279566397 std1 2 120 25 187.0 -1.000 -1.000 -1.0 0.0

11 29544.4080897 0.051445695153 std1 2 120 19 164.0 -1.000 -1.000 -1.0 0.0 11 29549.5080897 0.051535764981 std2 2 120 14 87.0 -1.000 -1.000 -1.0 0.0

50 std1 165.0 -1.000 -1.000 -1.0 0

50 std2 78.0 -1.000 -1.000 -1.0 0

H8

H9

6.5. Sample Configuration Segment

The previous examples were converted from existing data files. For new data where configuration information is available while forming the CDR, the following could replace the C0 and 60 records for MLRS tracking a lunar transponder. (The values are not necessarily realistic.)

C0 0 532.0 std1 slrd las1 tim1 lro

C1 0 las1 Nd-Yag 1064.0 10.0 100 200 20 1

C2 0 slrd MCP 532.0 8 1300 1 TTL 10 1.0 50 10 none

C3 0 tim1 TAC na MLRS na 0

C4 0 lro 100 5 325 8 12345678m1 0 1

7. Resources

The official list of satellite names and numerical identifiers can be found at:

http://ilrs.gsfc.nasa.gov/products_formats_procedures/satellite_names.html .
The satellite numerical identifiers can be found at:

http://ilrs.gsfc.nasa.gov/satellite_missions/list_of_satellites/index.html .

The official list of station names can be found at:

TBD .

The official list of station monument (pad) numbers and codes can be found at:

http://ilrs.gsfc.nasa.gov/stations/sitelist/index.html .

Find information on site files at:

http://ilrs.gsfc.nasa.gov/stations/site_procedures/site_logs/site_log_procedure.html .

Find formats for the pre-CRD data formats at:

http://ilrs.gsfc.nasa.gov/products_formats_procedures/normal_point/np_format.html

and

http://ilrs.gsfc.nasa.gov/products_formats_procedures/fullrate/fr_format_v3.html .

The latest official version of this document can be found at:

http://ilrs.gsfc.nasa.gov/products_formats_procedures/crd.html .

8. Common Abbreviations

CRD	Consolidated laser Ranging Data Format
COSPAR	Committee on Space Research, a Committee of ICSU, the International Council for Science.
CPF	Consolidated laser ranging Prediction Format
ILRS	International Laser Ranging Service
LLR	Lunar Laser Ranging
LRO	Lunar Reconnaissance Orbiter
ND	Neutral Density, which describes opacity of a broad band optical filter.
NORAD	The North American Aerospace Defense Command
ns	nanoseconds
ps	picoseconds
RMS	Root Mean Square. Same as standard deviation.
SLR	Satellite Laser Ranging
SCH	Station Change Indicator
SCI	Station Configuration Indicator
SIC	Satellite Identification Code, a 4 digit satellite descriptor.
SRP	System Reference Point, usually described as the first non-moving point in the telescope light path.
UTC	Coordinated Universal Time, formerly known as Greenwich Mean Time (GMT).
XML	eXtensible Markup Language.

Spacecraft ID Correspondence Table for Orbit Exchange Files (SP3c)

International Association for Geodesy (IAG) Inter-Service Document

Version 2007.02.01

Procedure for a request of code assignment: see note at bottom of table

MISSION NAME	SP3c Code	ILRS SI	NORAD #	Altitude [km]	Inclination °	Tracking Status
General group						
TOPEX/Poseidon	L01	9205201	22076	1350	66	Off
GPS-MET	L02	9501703	23547	740	69.9	Off
GFO-1	L03	9800701	25157	800	108	
Ørsted	L04	9900802	25635	630	96.1	Off
SUNSAT	L05	9900803	25636	400	93	Off
CHAMP	L06	0003902	26405	474	87	
SAC-C	L07	0007502	26620	682	98.2	Off
Jason-1	L08	0105501	26997	1336	66	
GRACE-A	L09	0201201	27391	485-500	89	
GRACE-B	L10	0201202	27392	485-500	89	
ICESat	L11	0300201	27642	600	94	
CryoSat	L12	--	--	--	--	--
TerraSAR-X	L13			514	97.4	
METOP-2	L14	0604401	29499	817	98.7	
GOCE	L15			250	96.5	
Beacon-C	L16	6503201	1328	927	41	
DIADEME-1C	L17	6701101	2674	545	40	Off
DIADEME-1D	L18	6701401	2680	585	40	Off
IRS-P5 (CARTOSAT-1)	L19	0501701	28649	620	97.9	
	L20					
COSMIC-1 (FM-1)	L21	0601101	29047	815	72.0	
COSMIC-2 (FM-2)	L22	0601102	29048	815	72.0	
COSMIC-3 (FM-3)	L23	0601103	29049	815	72.0	
COSMIC-4 (FM-4)	L24	0601104	29050	815	72.0	
COSMIC-5 (FM-5)	L25	0601105	29051	815	72.0	
COSMIC-6 (FM-6)	L26	0601106	29052	815	72.0	
	L27					
GEOS-3	L28	7502701	7734	841	115	Off
Seasat	L29	7806401	10967	805	108	Off
GEOSAT	L30	8502101	15595	760 x 817	108.1	Off
ERS-1	L31	9105001	21574	780	99	Off
ERS-2	L32	9502101	23560	800	99	
Envisat	L33	0200901	27386	800	98	
Meteor-3M	L34	0105601	27001	1000	99.6	Off
	L35-L49					
Ajisai	L50	8606101	16908	1485	50	
LAGEOS-1	L51	7603901	8820	5850	110	
LAGEOS-2	L52	9207002	22195	5625	53	
Etalon-1	L53	8900103	19751	19105	65	
Etalon-2	L54	8903903	20026	19135	65	
Starlette	L55	7501001	7646	815x1100	50	
Stella	L56	9306102	22824	815	99	
GFZ-1	L57	8601795	23558	385	52	Off
WESTPAC	L58	9804301	25394	835	98	Off
Larets	L59	0304206	27944	691	98.2	
	L60-L90					
SPOT-2	L91	9000501	20436	786	98.7	
SPOT-3	L92	9306101	22823	832	98.7	Off
SPOT-4	L93	9801701	25260	802	98.7	
SPOT-5	L94	0202101	27421	777	98.7	
	L95-L99					
GPS group*						
GPS-35	G05	9305401	22779	20195	54	
GPS-36	G06	9401601	23027	20030	55	
GLONASS group*						
GLONASS-87	R03	0105302	26988	19140	65	
GLONASS-86	R06	0105303	26989	19140	65	Off
GLONASS-95	R07	0405302	28509	19140	65	
GLONASS-89	R22	0206001	27617	19140	65	
GLONASS-99	R24	0505002	28916	19140	65	
GALILEO group*						
GIOVE-A	E01	0505101	28922	23916	56	

LEGEND

Codes in **RED BOLD**: Next available slots for assignment

SP3c Code: A letter and a 2-digit number assigned by the list-keeper in consultation with the IERS Services

L	For all s/c other than GPS, GLONASS, and GALILEO
G	For GPS s/c
R	For GLONASS s/c
E	For GALILEO s/c

ILRS Satellite ID†: **YYXXXAA** where:

YY: last two digits of launch-vehicle launch year,
XXX: launch vehicle number in year YY, and
AA: payload sequence number for the specific launch XXX

NORAD #: The ID number assigned to each item in orbit by NORAD

NOTES:

* This list contains **only** GPS, GLONASS and GALILEO satellites **currently (Feb. 2007) and historically tracked by ILRS**. The SP3c codes of all GNSS satellites are identical to the codes used in the RINEX data and navigation message files. For more information on all of these s/c, please visit the **IGS Antex file**, which resides on the IGSCB ftp site.

† ***COSPAR ID to ILRS Satellite Identification Algorithm***

COSPAR ID Format: (YYYY-XXXA)

YYYY is the four digit year of when the launch vehicle was put in orbit
XXX is the sequential launch vehicle number for that year
A is the alpha numeric sequence number within a launch
Example: LAGEOS-1 COSPAR ID is 1976-039A
Explanation: LAGEOS-1 launch vehicle wasplaced in orbit in 1976; was the 39th launch in that year; and LAGEOS-1 was the first object injected into orbit from this launch.

ILRS Satellite Identification Format: (YYXXXAA), based on the COSPAR ID

Where YY is the two digit year of when the launch vehicle was put in orbit
Where XXX is the sequential launch vehicle number for that year
AA is the numeric sequence number within a launch
Example: LAGEOS-1 ILRS Satellite ID is 7603901

Requesting assignment of a code for new s/c:

New missions can obtain a code assigned to them by submitting a request via email to Carey Noll (carey.noll@nasa.gov) who is responsible for the maintenance of this list. The request will then be forwarded immediately to the Analysis coordinators of the three satellite services, IGS, ILRS and IDS for approval. If there is no objection for a valid reason, the list-keeper assigns the code, posts the change on the web, notifies the requesting party and sends out an email to the three services' mailing lists announcing the new entry. The rules followed in assigning codes are very simple: "intelligent" satellites occupy the lowest entry numbers, cannonballs are above 50, and DORIS-only s/c in the 90s. GPS, GLONASS and GALILEO s/c are in all cases handled separately and solely the responsibility of IGS.

Groups of sites	Site No.	Wavelength	Core/NonCore	Solve ?	Model ?	Relevant period	REMARKS
CORE SITES	7080	G	C	NO	NO	__	
(NO BIASES)	7090	G	C	NO	NO	__	
	7105	G	C	NO	NO	__	
	7110	G	C	NO	NO	__	
	7501	G	C	NO	NO	__	
	7810	B	C	NO	NO	__	
	7810	I	C	NO	NO	AFTER_June_21,_2006	
	7825	G	C	NO	NO	__	
	7832	G	C	NO	NO	__	
	7839	G	C	NO	NO	AFTER_October_1996	
	7840	G	C	NO	NO	__	
	8834	G	C	NO	NO	AFTER_1997.0	
NON-CORE SITES	1864	G	NC	YES	--	1993.0 - 2006.0	
(BIASES)	1868	G	NC	YES	--	1993.0 - 2006.0	
	1884	G	NC	YES	--	1993.0 - 2006.0	
	7210	G	NC	YES	--	1993.0 - 2006.0	
	7237	G	NC	YES	--	1993.0 - 2006.0	
	7810	I	C	YES	--	~8 mm TO_June_20,_2006	
	7811	G	NC	YES	--	1993.0 -1994.0	
	7835	G	NC	YES	--	1993.0 - 1998.0	
	7839	G	NC	YES	--	1993.0 end of September 1996	
	8834	G	NC	YES	--	1993.0 - 1997.0	
NON-CORE SITES	1824	G	NC	NO	NO	--	
(NO BIASES)	1831	G	NC	NO	NO	--	
	1863	G	NC	NO	NO	--	
	1873	G	NC	NO	NO	--	
	1885	G	NC	NO	NO	--	
	1893	G	NC	NO	NO	--	
	1953	G	NC	NO	NO	--	
	7097	G	NC	NO	NO	--	
	7106	G	NC	NO	NO	--	
	7109	G	NC	NO	NO	--	
	7122	G	NC	NO	NO	--	
	7123	G	NC	NO	NO	--	
	7124	G	NC	NO	NO	--	
	7130	G	NC	NO	NO	--	
	7231	G	NC	NO	NO	--	
	7236	G	NC	NO	NO	--	
	7249	G	NC	NO	NO	--	
	7295	G	NC	NO	NO	--	
	7307	G	NC	NO	NO	--	
	7308	G	NC	NO	NO	--	
	7328	G	NC	NO	NO	--	
	7335	G	NC	NO	NO	--	
	7337	G	NC	NO	NO	--	
	7339	G	NC	NO	NO	--	
	7355	G	NC	NO	NO	--	
	7356	G	NC	NO	NO	--	
	7357	G	NC	NO	NO	--	
	7358	G	NC	NO	NO	--	
	7403	G	NC	NO	NO	--	
	7404	G	NC	NO	NO	--	
	7405	G	NC	NO	NO	--	
	7410	G	NC	NO	NO	--	
	7411	G	NC	NO	NO	--	
	7502	G	NC	NO	NO	--	
	7505	G	NC	NO	NO	--	
	7520	G	NC	NO	NO	--	
	7525	G	NC	NO	NO	--	
	7530	G	NC	NO	NO	--	
	7541	G	NC	NO	NO	--	
	7543	G	NC	NO	NO	--	
	7545	G	NC	NO	NO	--	
	7548	G	NC	NO	NO	--	
	7589	G	NC	NO	NO	--	
	7597	G	NC	NO	NO	--	
	7805	G	NC	NO	NO	--	
	7806	G	NC	NO	NO	--	
	7820	G	NC	NO	NO	--	
	7823	G	NC	NO	NO	--	
	7824	G	NC	NO	NO	--	
	7830	G	NC	NO	NO	--	
	7831	G	NC	NO	NO	--	
	7836	G	NC	NO	NO	--	
	7837	G	NC	NO	NO	--	
	7838	G	NC	NO	NO	--	
	7841	G	NC	NO	NO	--	
	7843	G	NC	NO	NO	--	
	7845	G	NC	NO	NO	--	
	7847	G	NC	NO	NO	--	
	7848	G	NC	NO	NO	--	
	7849	G	NC	NO	NO	--	
	7850	G	NC	NO	NO	--	
	7882	G	NC	NO	NO	--	
	7883	G	NC	NO	NO	--	
	7884	G	NC	NO	NO	--	
	7907	G	NC	NO	NO	--	
	7918	G	NC	NO	NO	--	
	7920	G	NC	NO	NO	--	
	7939	G	NC	NO	NO	--	
	7941	G	NC	NO	NO	--	
	8833	G	NC	NO	NO	--	