Status of the ASI time series

V. Luceri – e-GEOS S.p.A.

C. Sciarretta – Telespazio S.p.A.

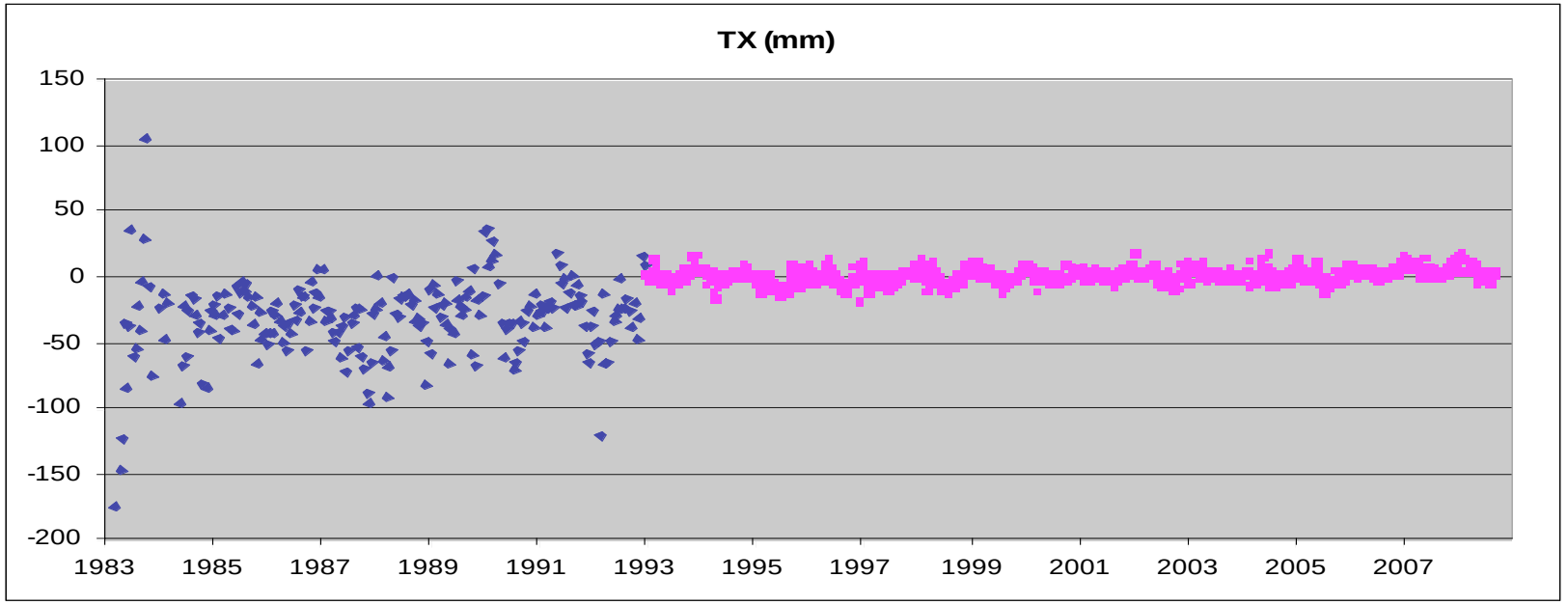
G. Bianco – ASI

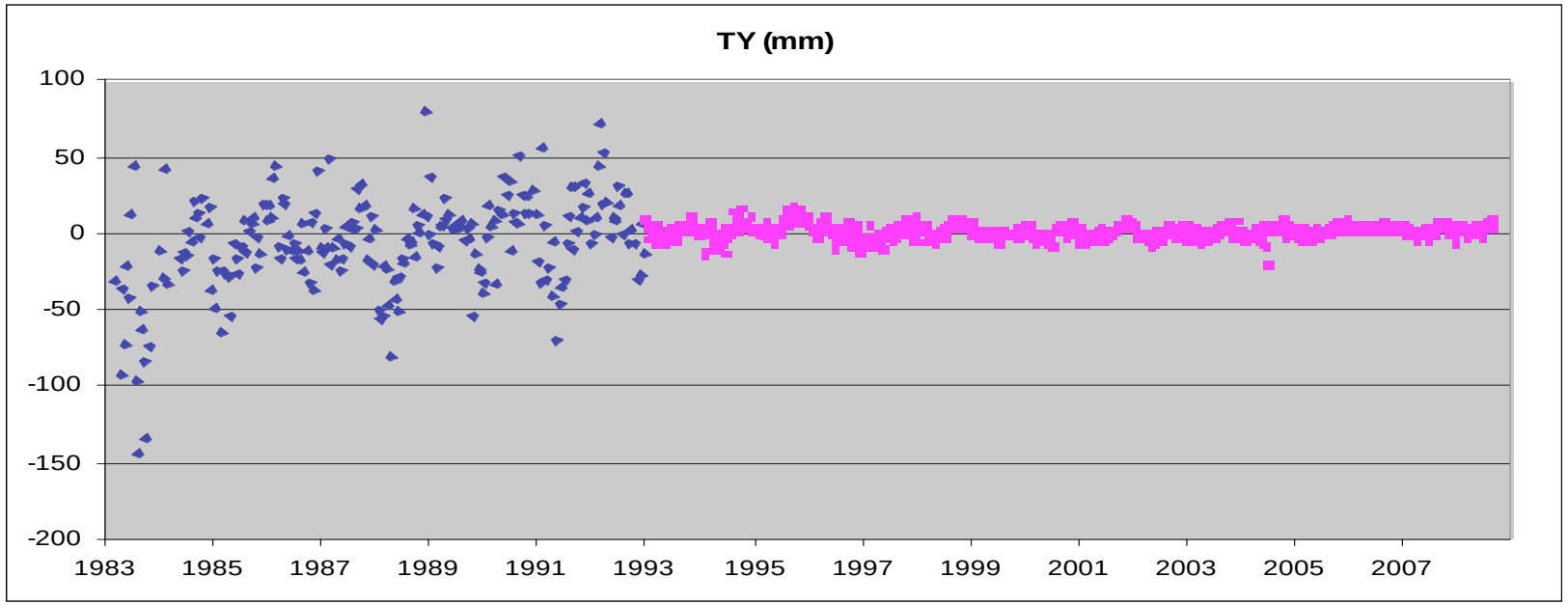
ASI latest time series

Period	1983-1992
Version	v12

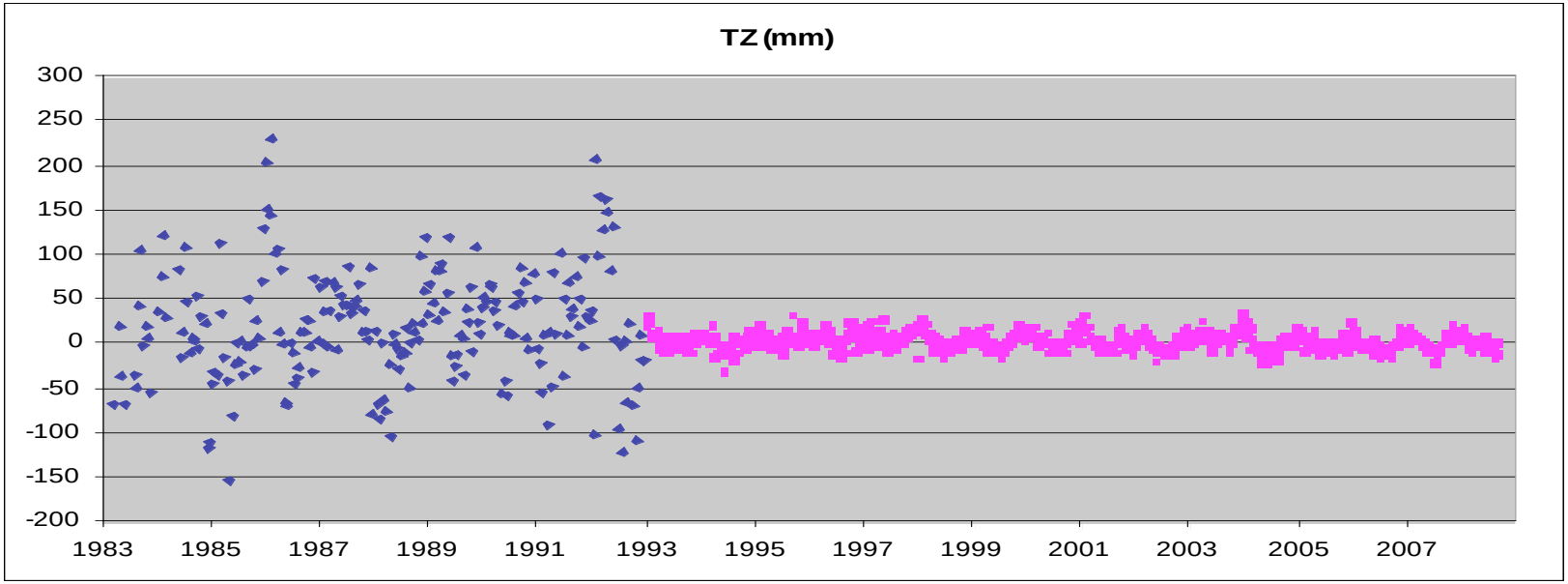
Period	1993 – Feb 2007	Feb 2007 – Oct 2007	Oct 2007 – may 2008	may 2008 – now (weekly solutions)
Version	v12	v13	v12	v10

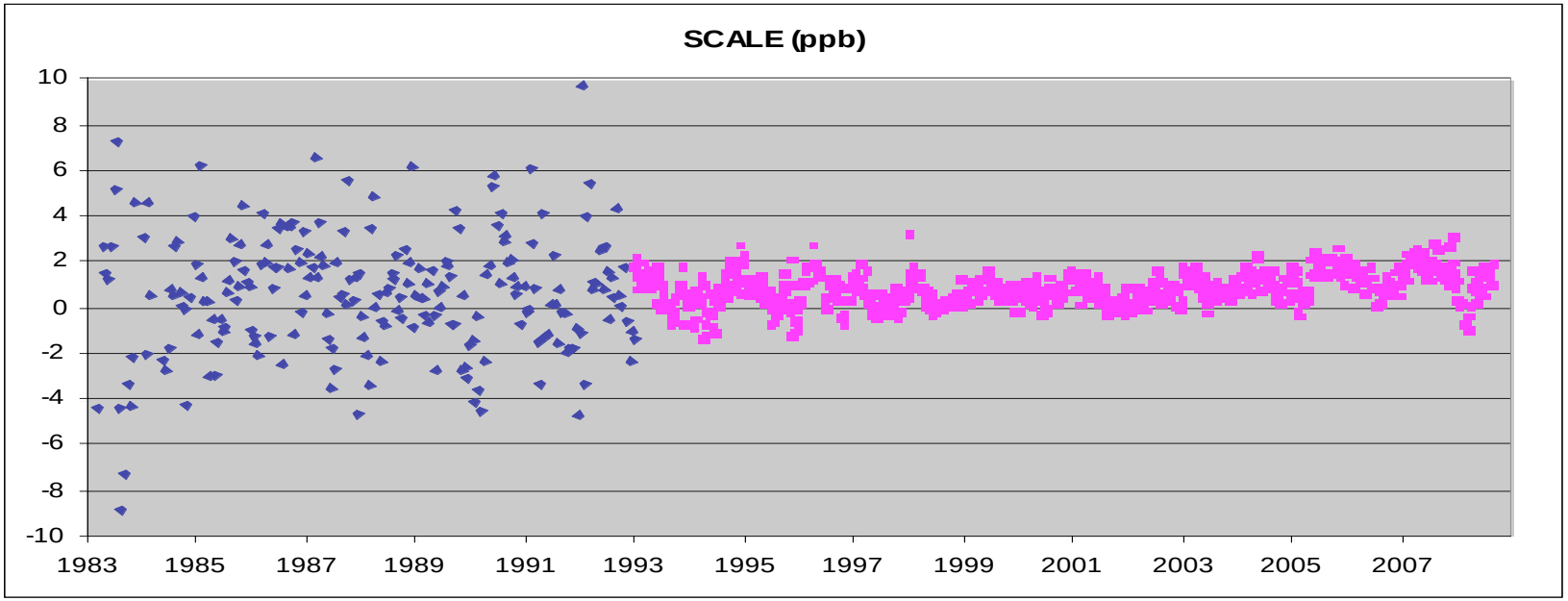
Transformation to SLRF2005



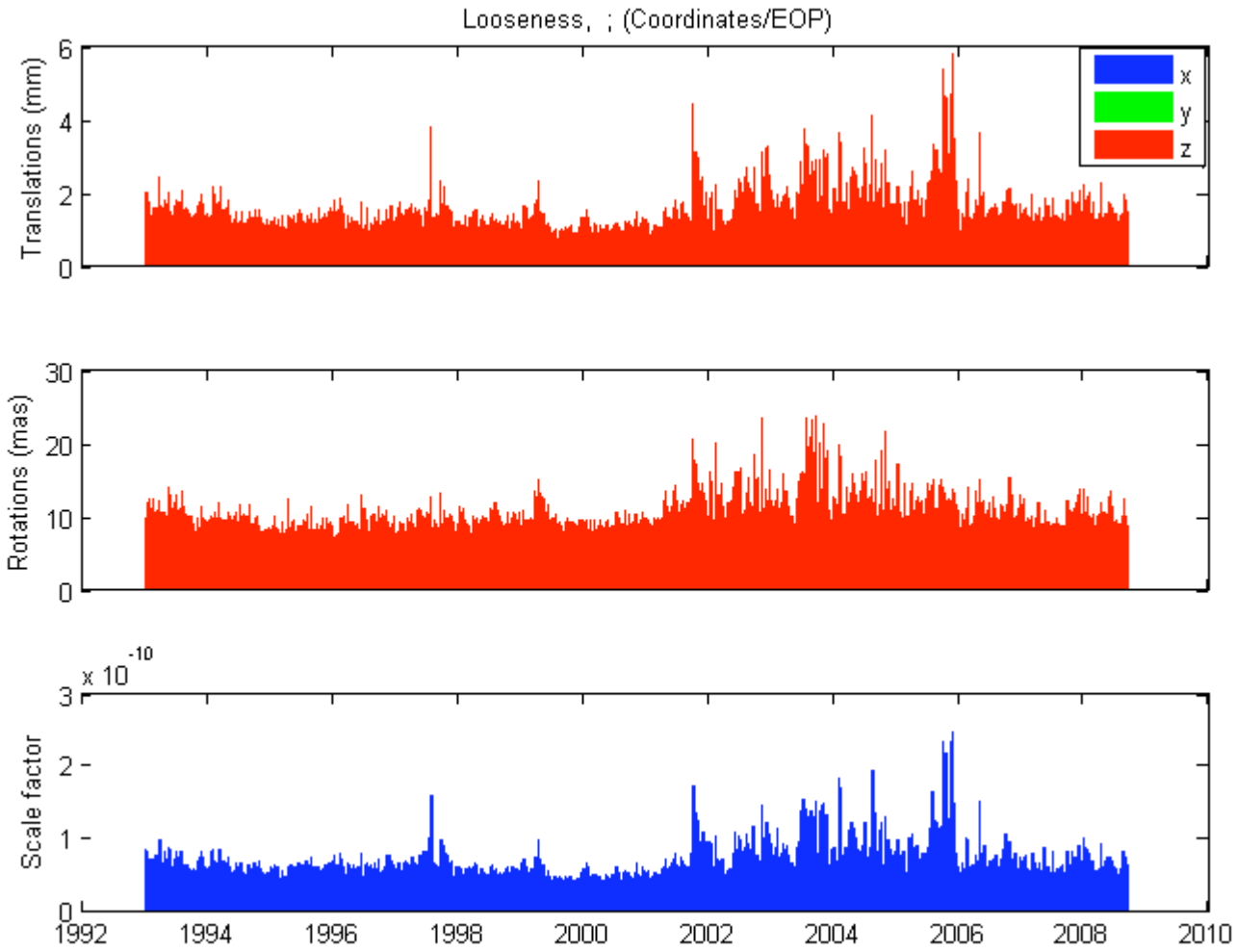


Transformation to SLRF2005

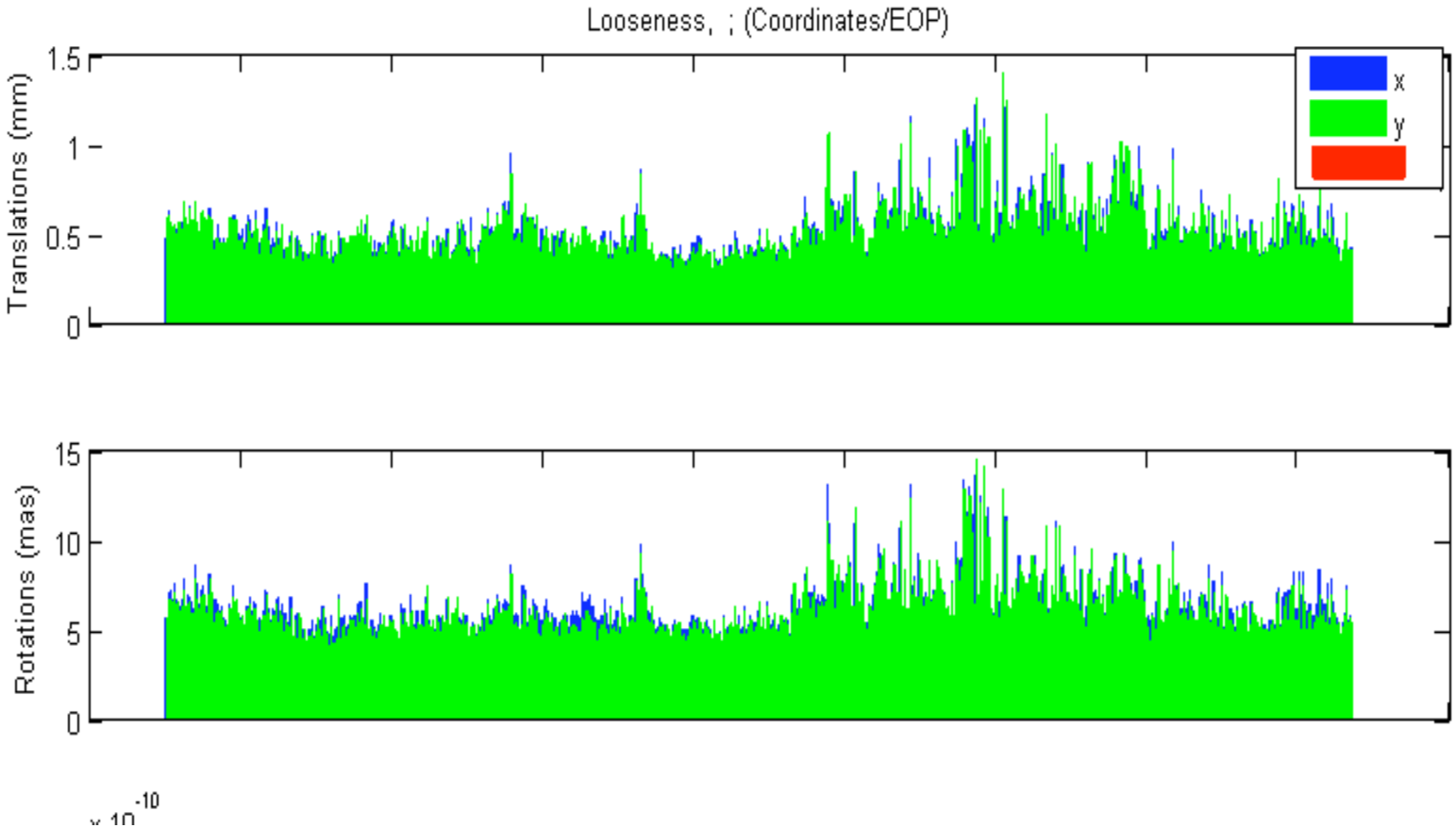




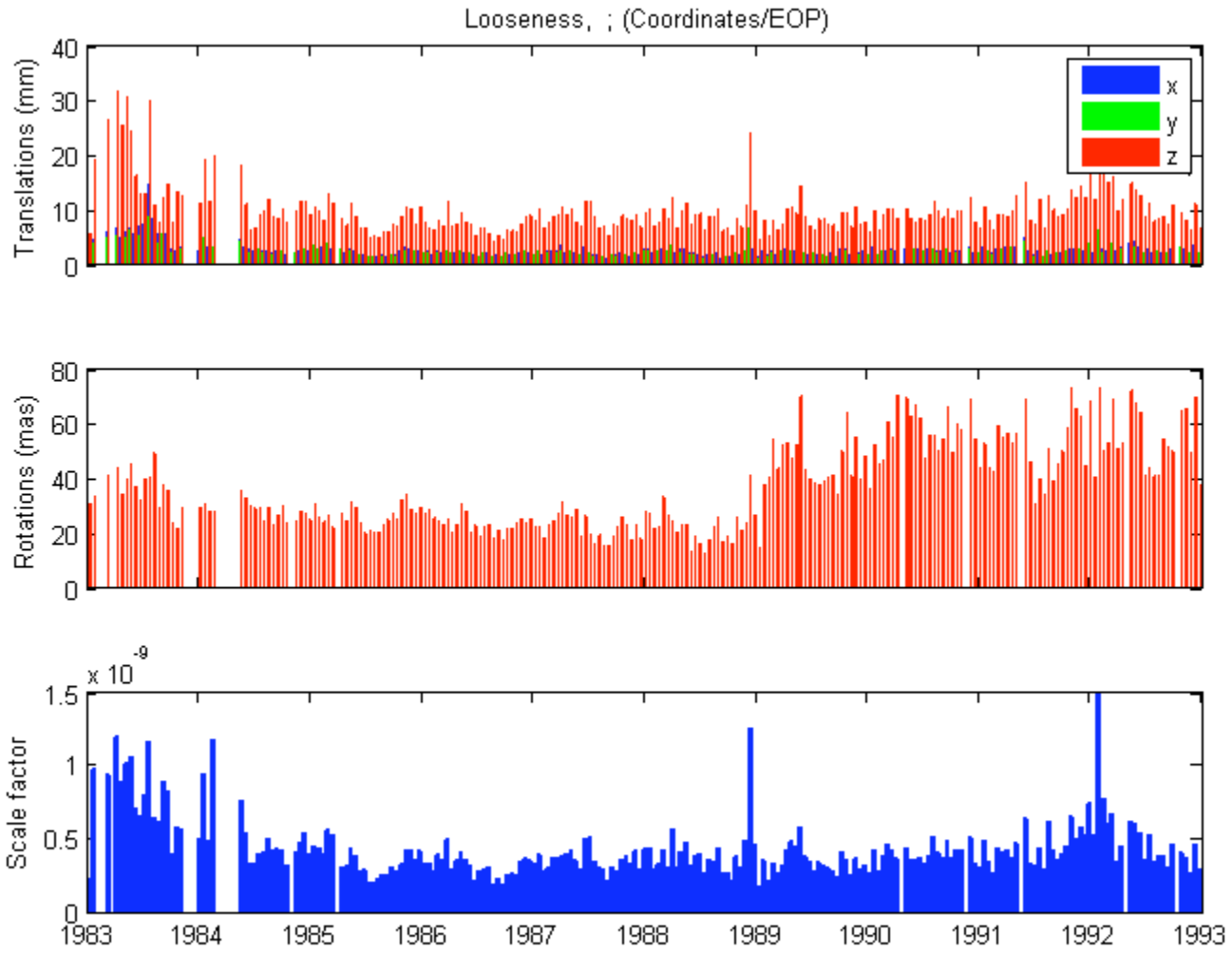
Looseness (1993-2008)



Looseness (1993-2008)



Looseness (1983-1992)



ILRSA CC
Status of the products

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G. Bianco
Agenzia Spaziale Italiana, CGS - Matera

ILRS AWG Meeting, 12 October 2008, Poznan (Poland)

Contents

- 1993-2007 Re-analysis
- 1983-1992 Re-analysis
- Daily Solution
- Orbit Combination

1993-2007 Re-analysis

Presently, 4 ILRS contributing solutions are available, obtained according the latest recommendations:

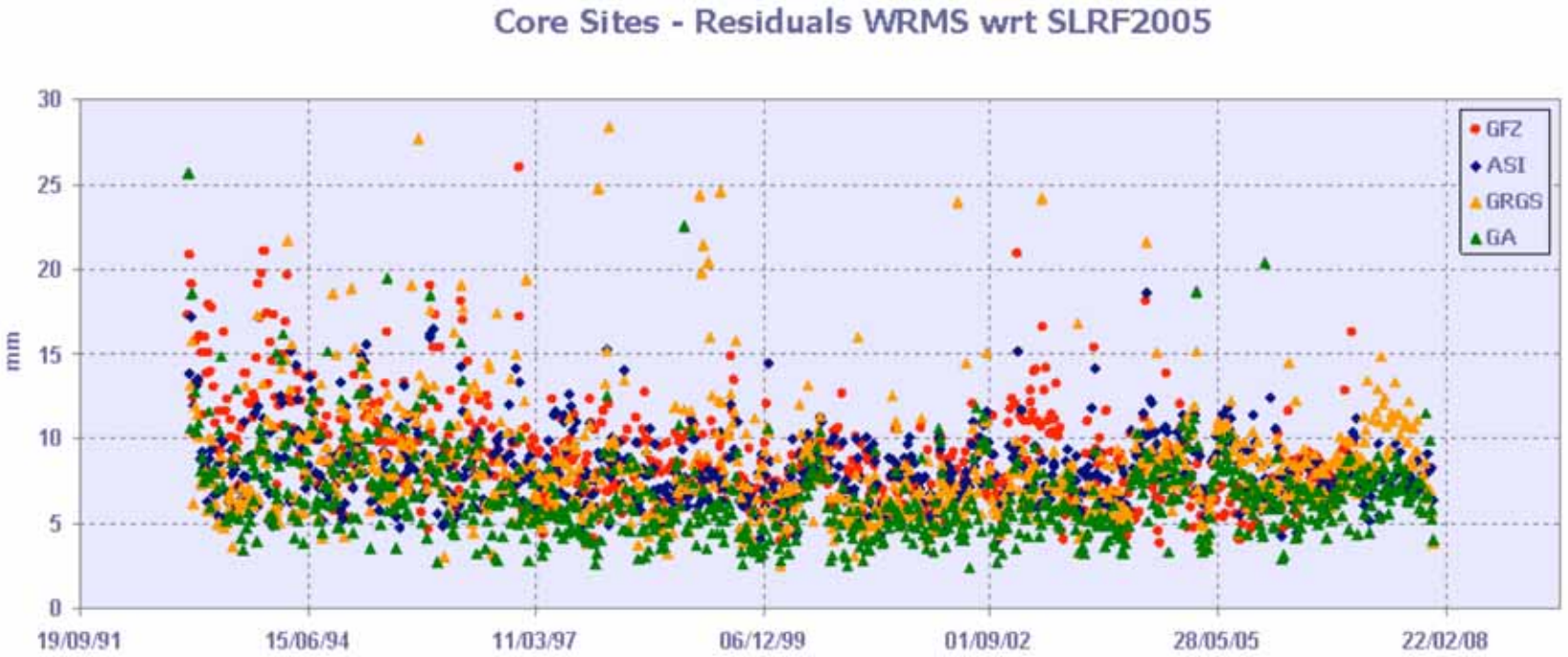
ASI	v12	June 08
GA	v11	August 08
GFZ	v10	January 08
GRGS	v11	June 08

A preliminary quality assessment has been performed on the submitted time series to

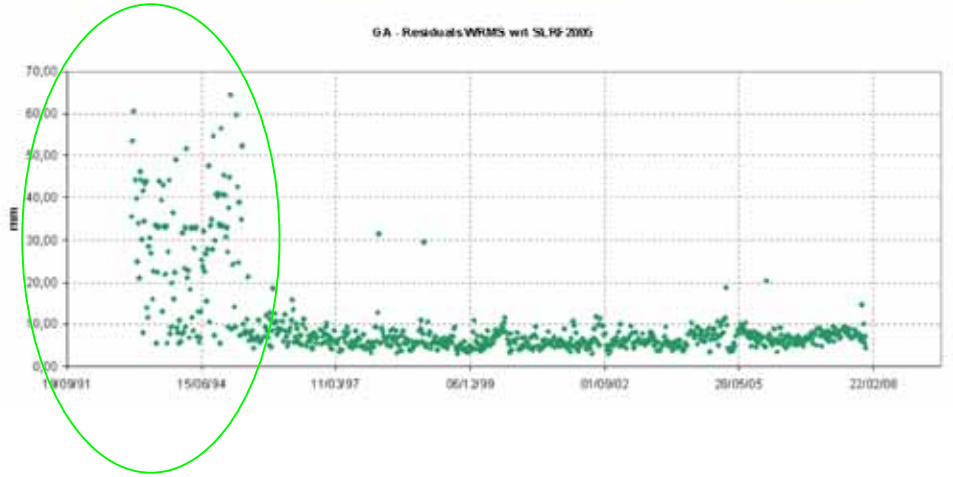
- check the correct implementation of the AWG decisions (data to be deleted, bia estimated/applied)
- draw an overall quality assessment

Each contribution solution has been framed into SLRF2005 and the site time series has been analys coordinate estimates are provided for a wrong period (i.e. data to be deleted), they are rigor removed a-posteriori from the solution. Thus, for this kind of problems, solutions don't need resubmitted.

1993-2007 Re-analysis

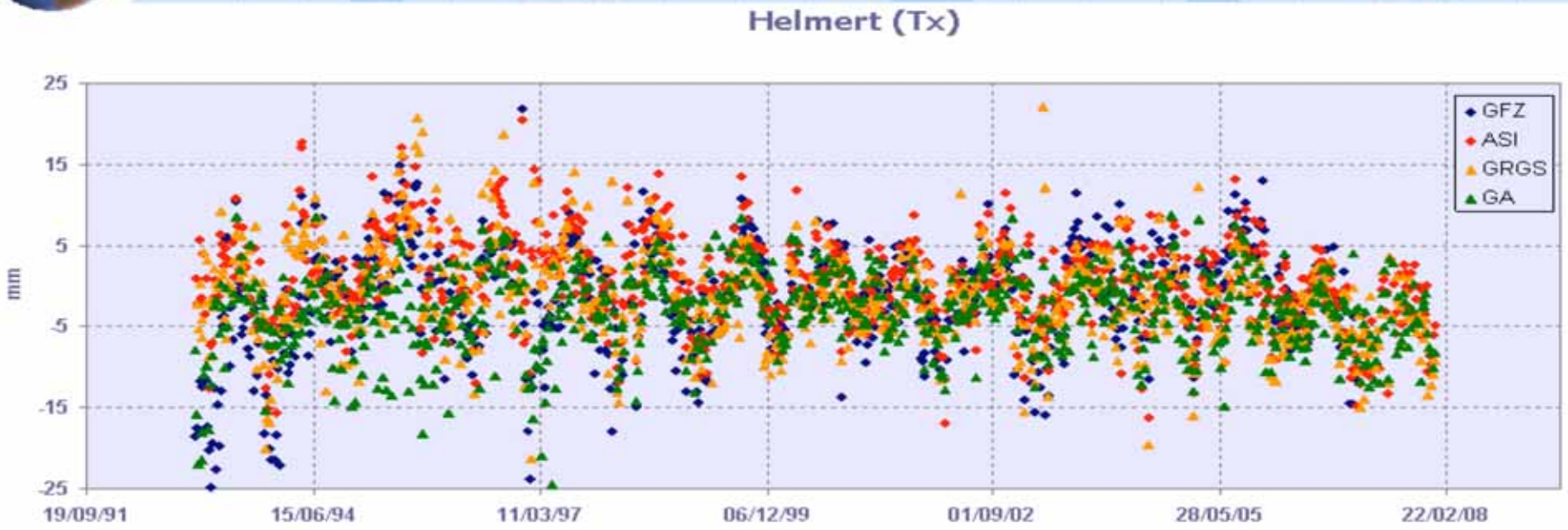


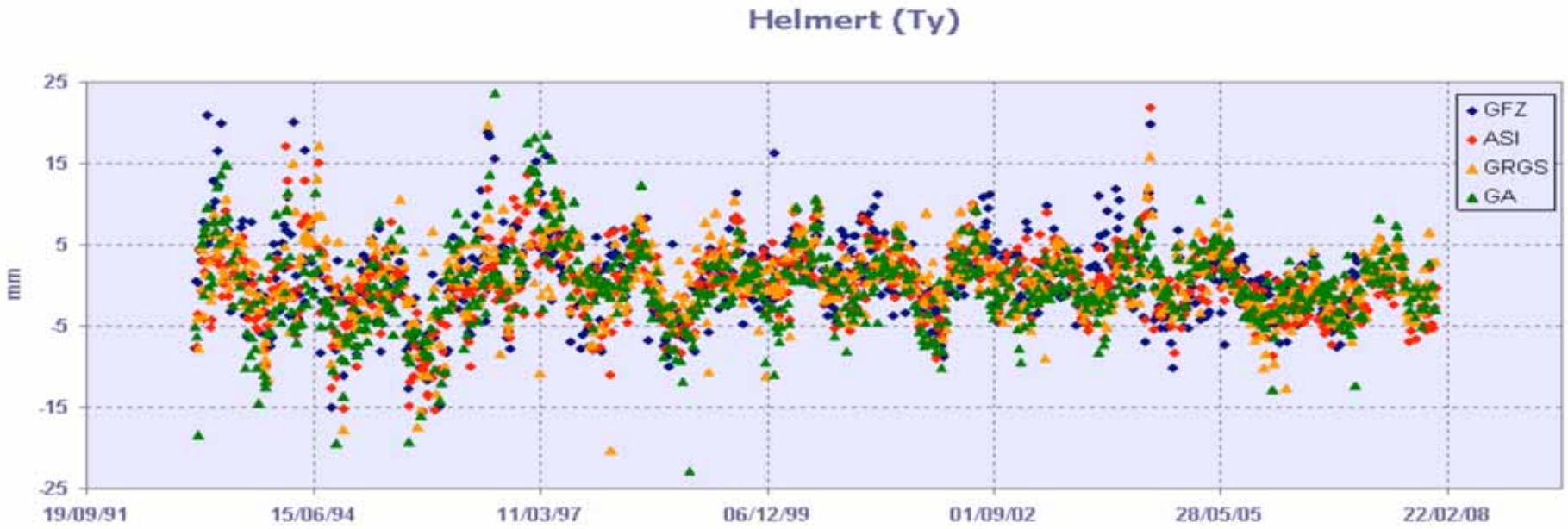
	Core Sites (mm)	All Sites (mm)
GFZ	9.0+/-3.0	13.6+/-6.2
ASI	8.3+/-2.1	10.0+/-2.6
GRGS	8.6+/-3.9	14.2+/-6.8
GA	6.9+/-5.2	10.5+/-13.7



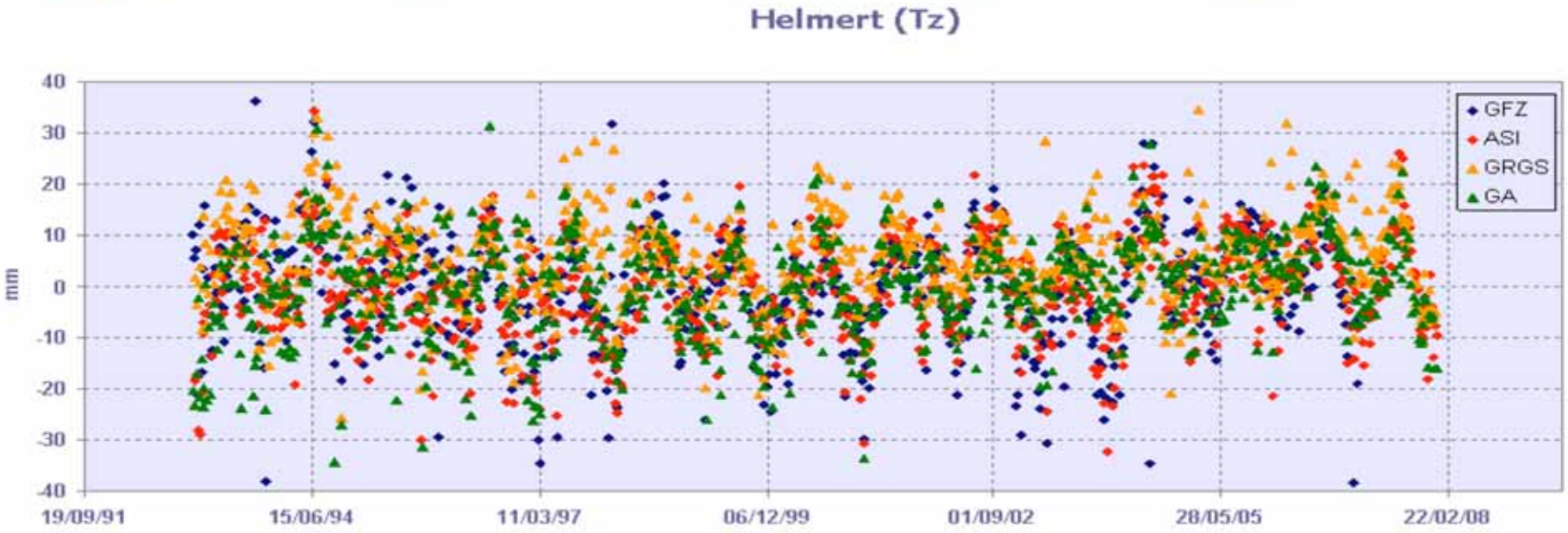
7810?

1993-2007 Re-analysis



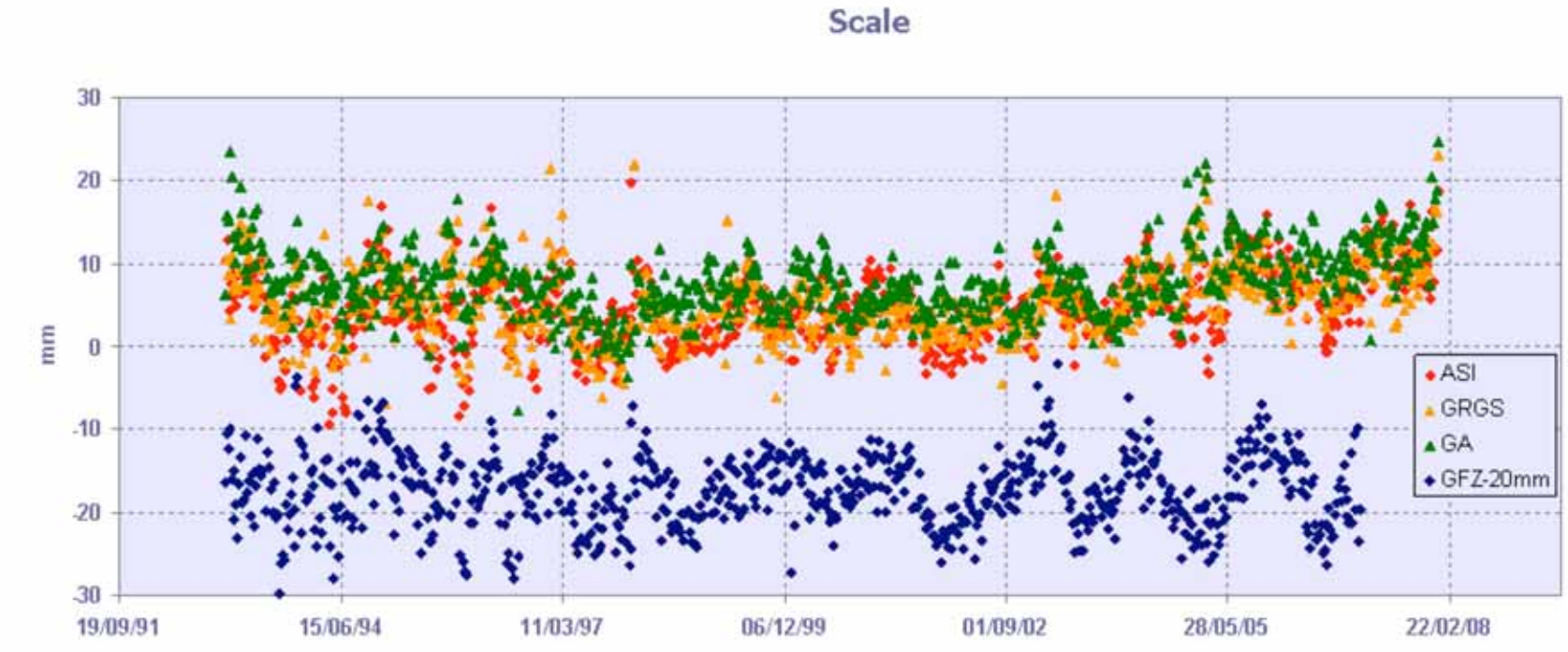


1993-2007 Re-analysis

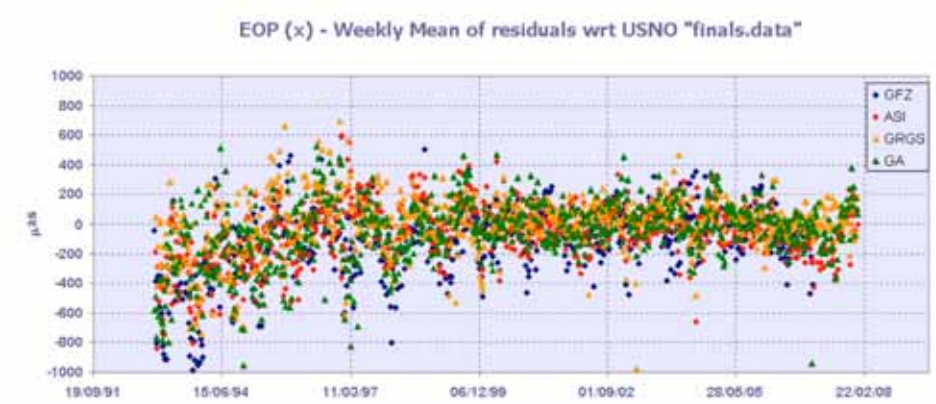


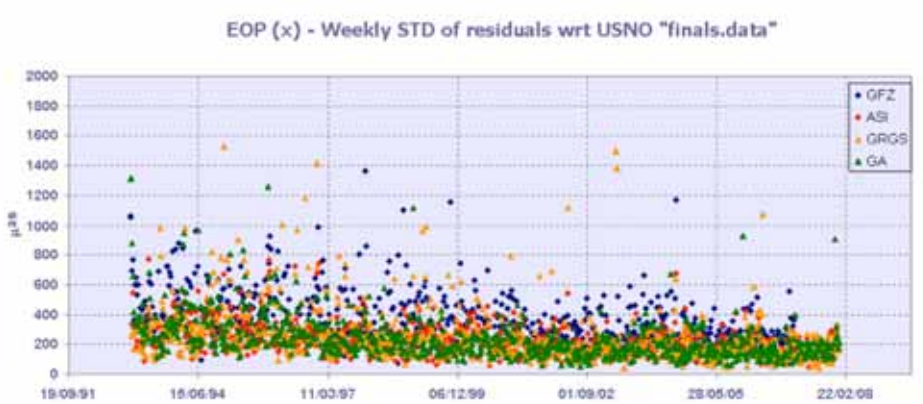
	Tx (mm)	Ty (mm)	Ty (mm)	Scale (mm)
GFZ	-1.4 +/ -6.6	0.8 +/ -5.2	-0.2 +/ -10.8	2.6 +/ -4.3
<σ>	4	4	10	4
ASI	0.5 +/ -5.5	0.1 +/ -4.6	-0.5 +/ -9.6	4.5 +/ -4.5
<σ>	4	4	9	3
GRGS	-1.3 +/ -5.8	0.6 +/ -5.1	5.5 +/ -9.3	5.4 +/ -5.2
<σ>	4	4	4	3
GA	-3.2 +/ -6.1	-0.3 +/ -5.9	-0.1 +/ -11.1	7.6 +/ -4.7
<σ>	3	3	8	2

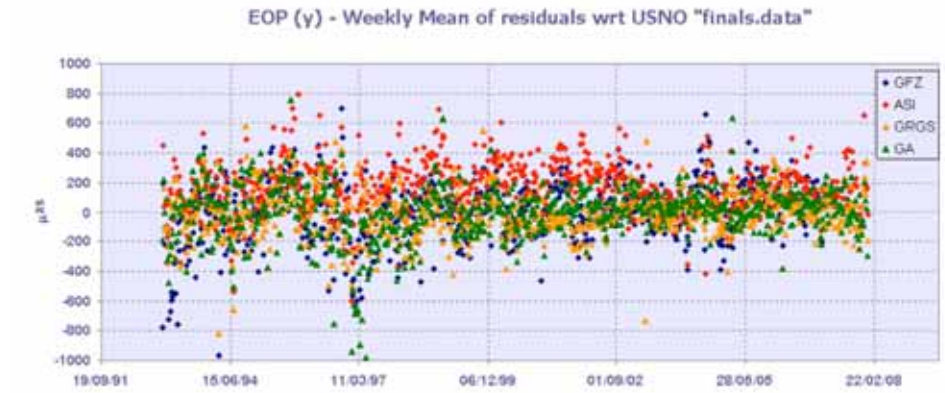
1993-2007 Re-analysis

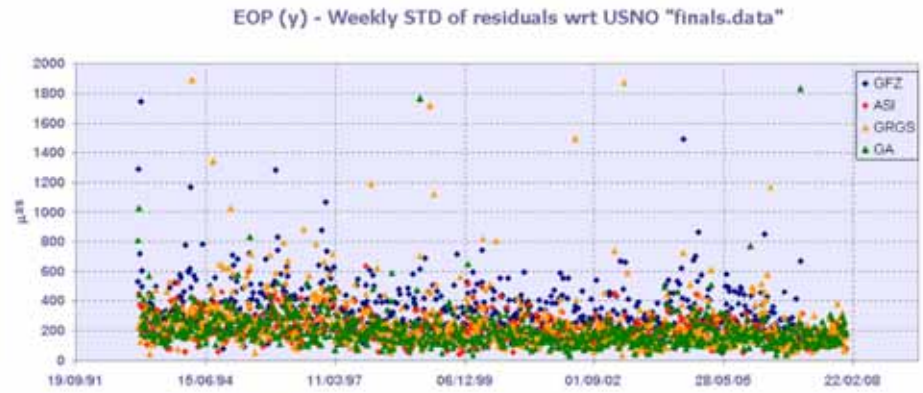


1993-2007 Re-analysis









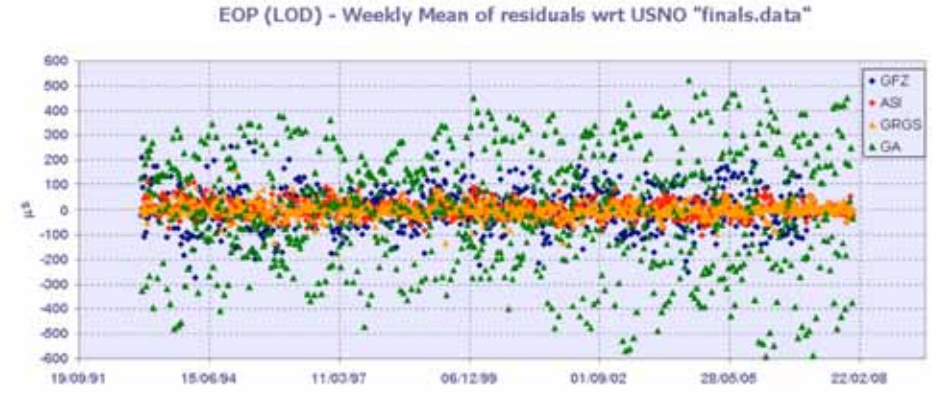
Average of the weekly mean of differences

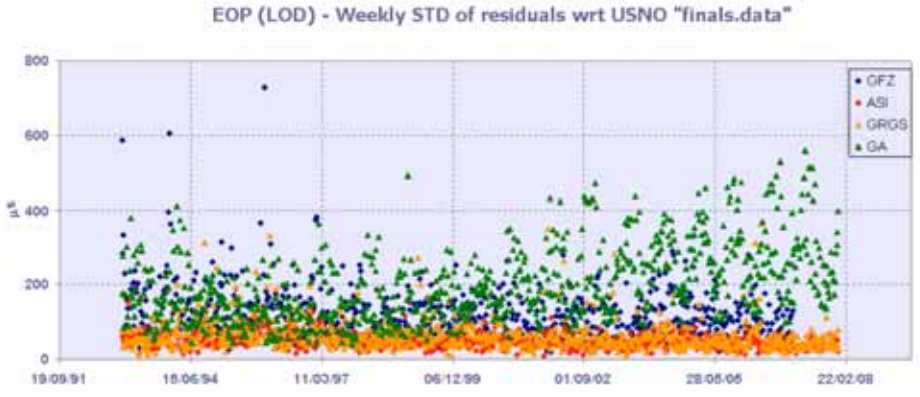
STD of the weekly mean of differences

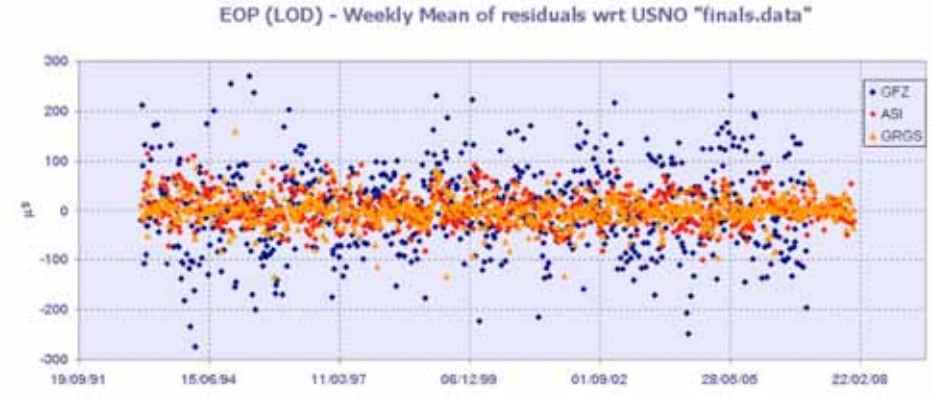
Average of the weekly STD of differences

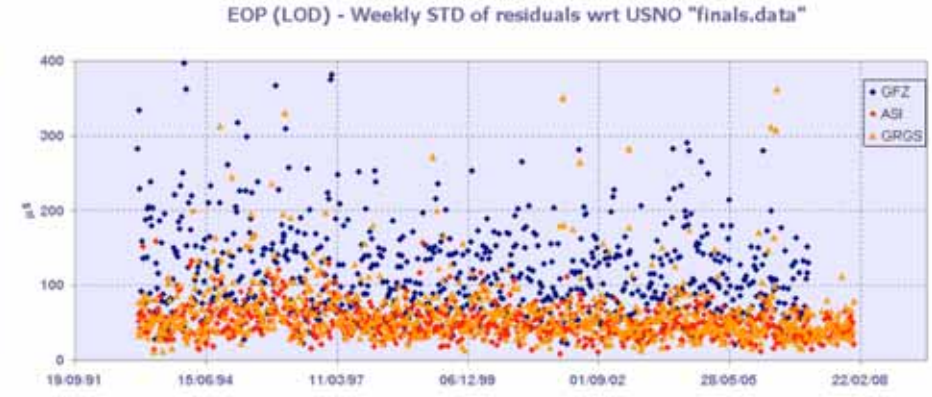
	X (μas)	Y (μas)	LOD (μs)
GFZ	-102 +/ -235	5 +/ -206	3.7 +/ -80.6
<σ>	358	335	120
ASI	-58 +/ -198	157 +/ -196	3.6 +/ -31.0
<σ>	228	210	51
GRGS	1 / -187	-12 +/ -166	0.3 +/ -27.9
<σ>	258	252	65
GA	-48 +/ -218	-13 +/ -351	3.6 +/ -235
<σ>	272	215	205

1993-2007 Re-analysis





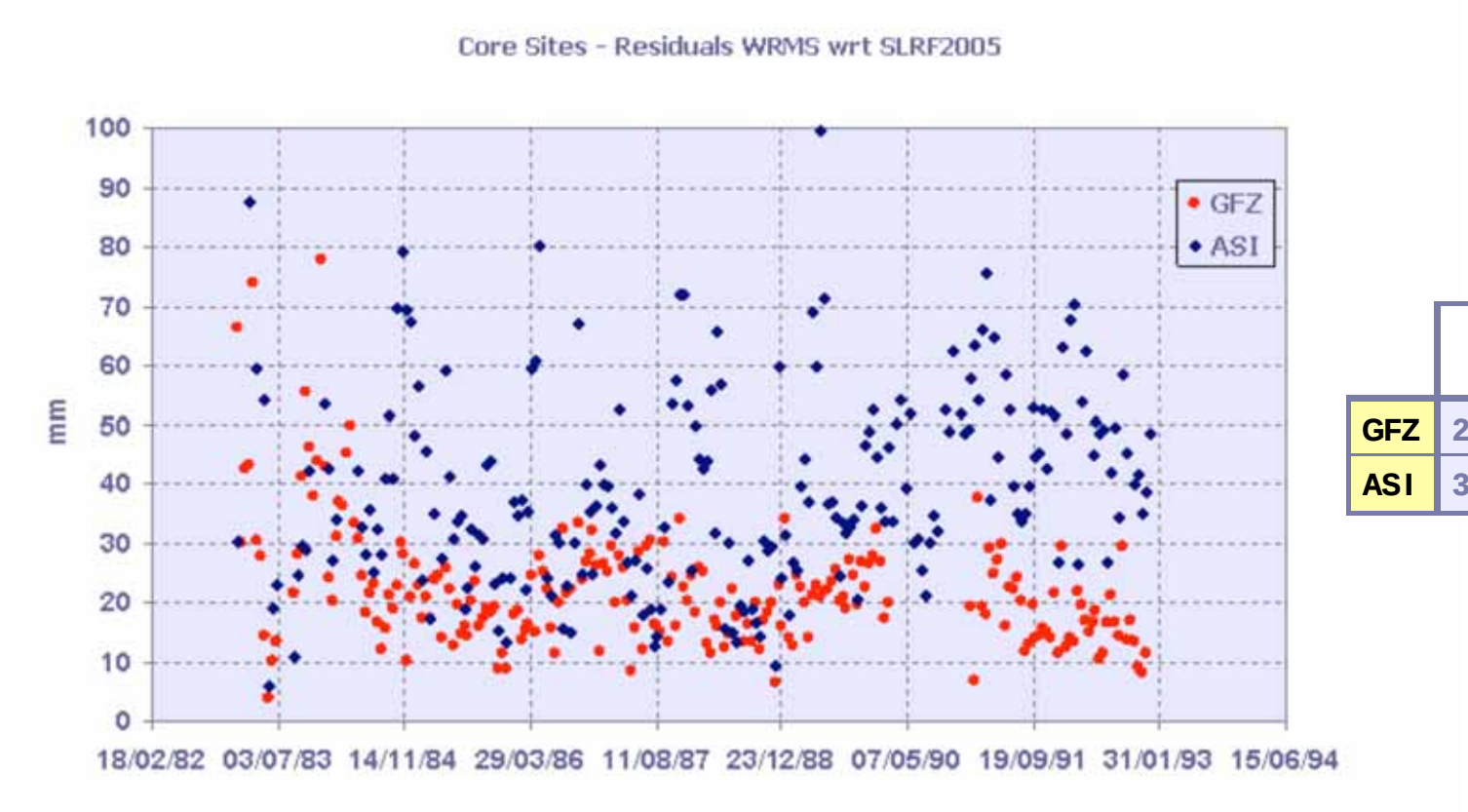




1983-1992 Re-analysis

Presently, 2 contributing solutions are available obtained according the latest AWG recommendation

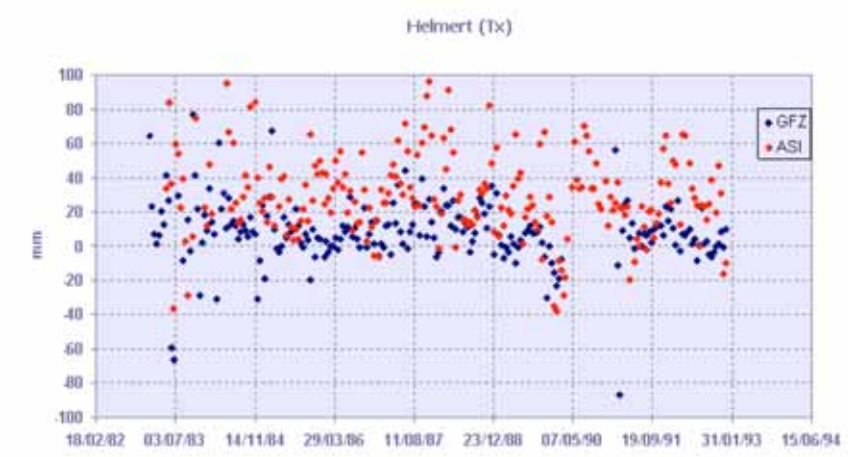
ASI	v12	September 08
GFZ	v10	September 08

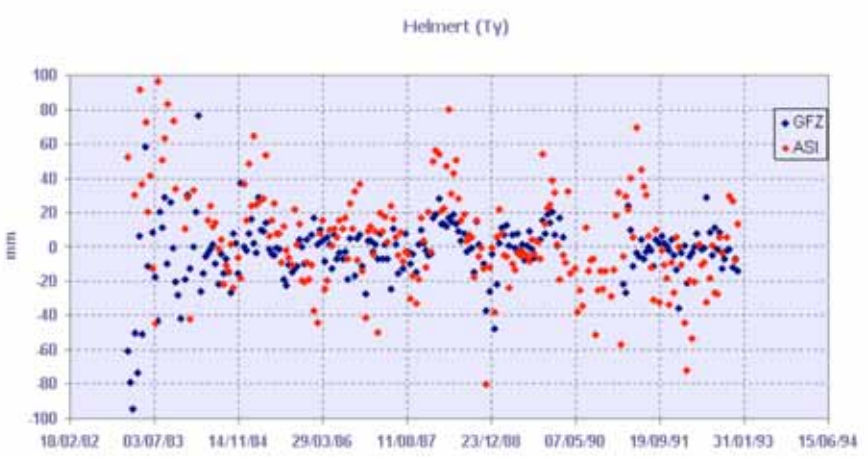


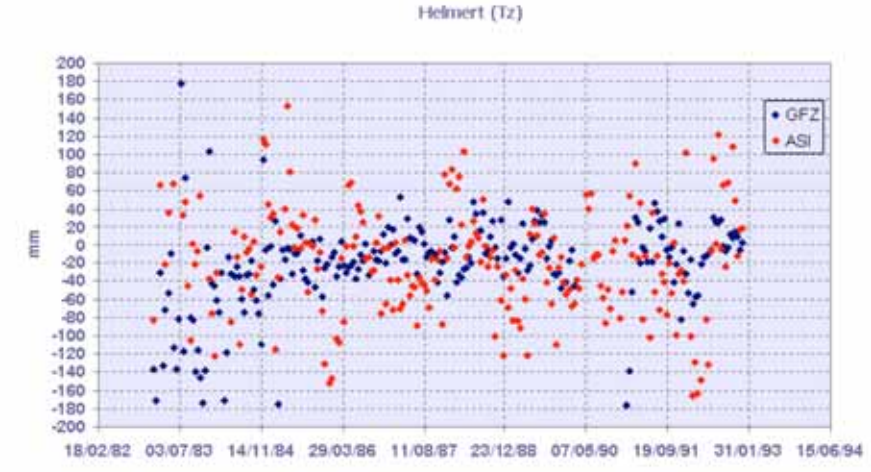
	Core Sites (mm)	All Sites (mm)
GFZ	22.0 + / -10.3	28.2 + / -13
ASI	39.9 + / -16.0	49.0 + / -17

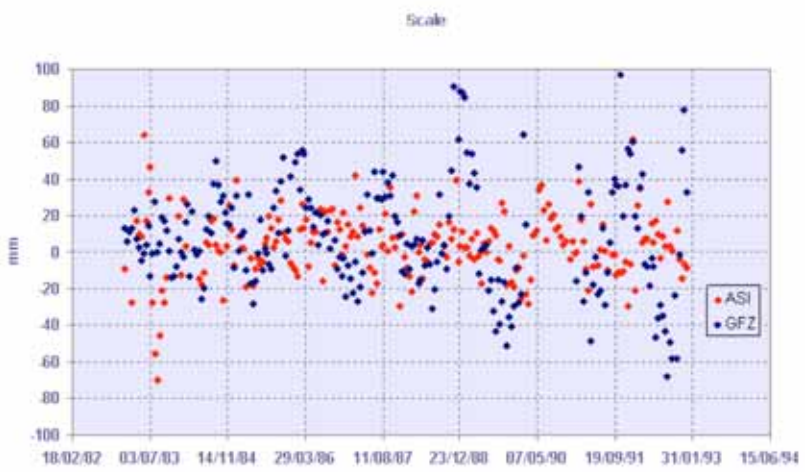
?

1983-1992 Re-analysis

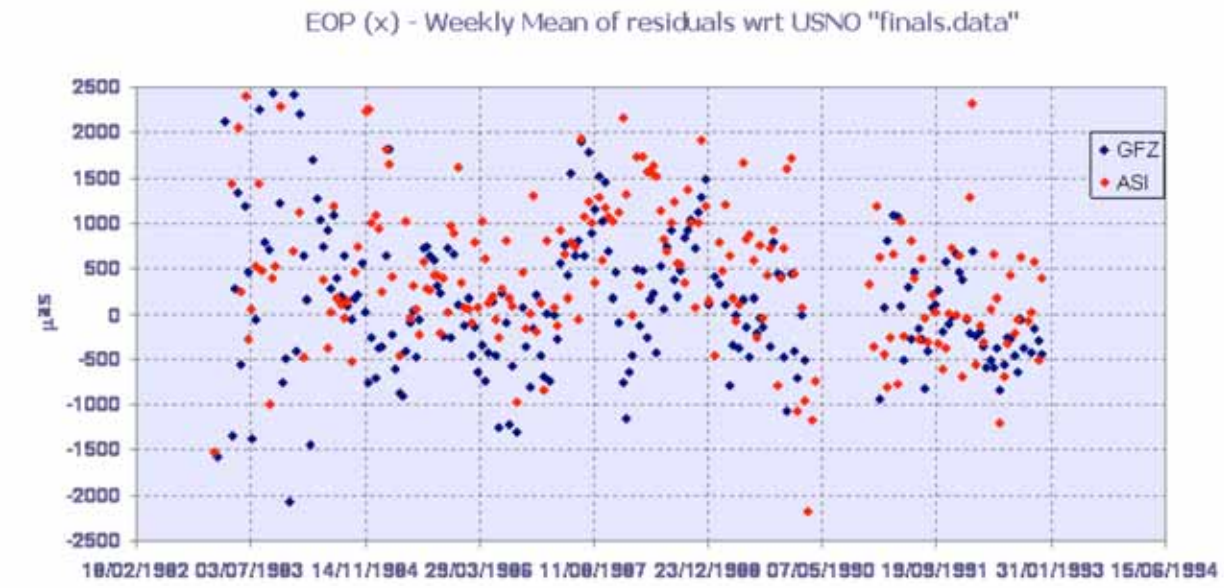


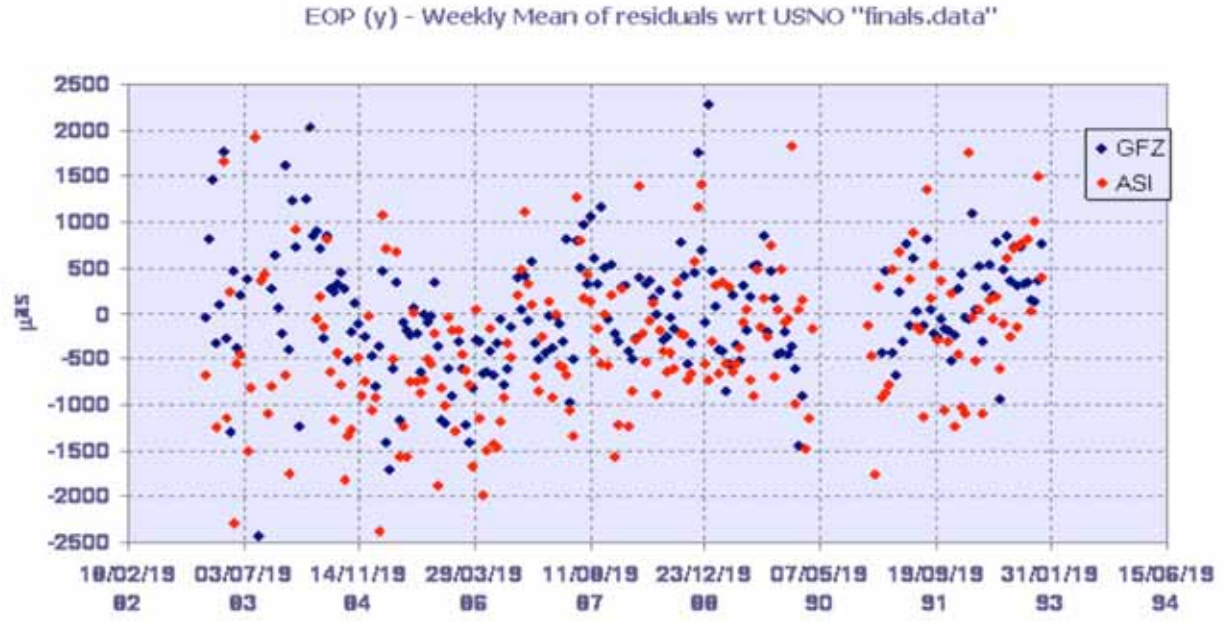






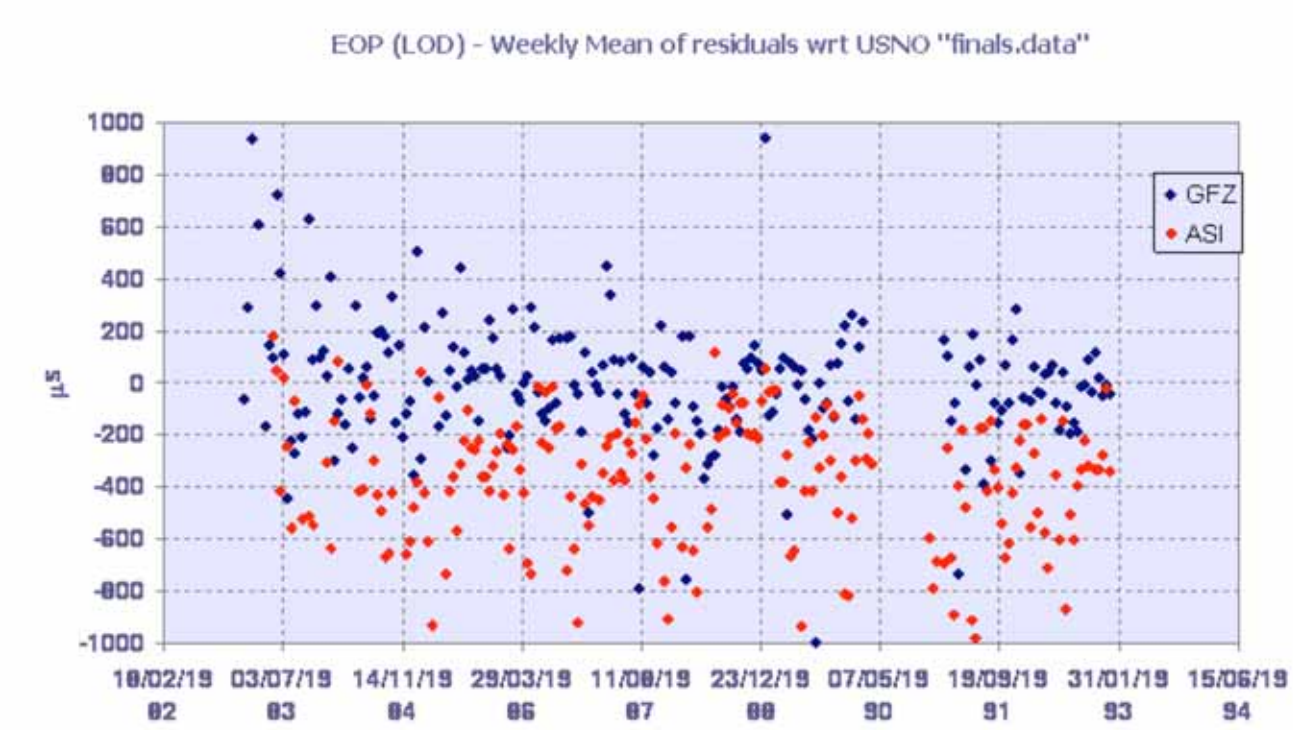
1983-1992 Re-analysis





$\langle\sigma\rangle \sim 750\mu as$

1983-1992 Re-analysis



$\langle\sigma\rangle$ ~250 µs

Daily solution

Since February 25, 5 ILRS ACs have been contributing steadily to the pre-operational phase of
"daily" solution generation: ASI, BKG, GFZ, JCET, NSGF.

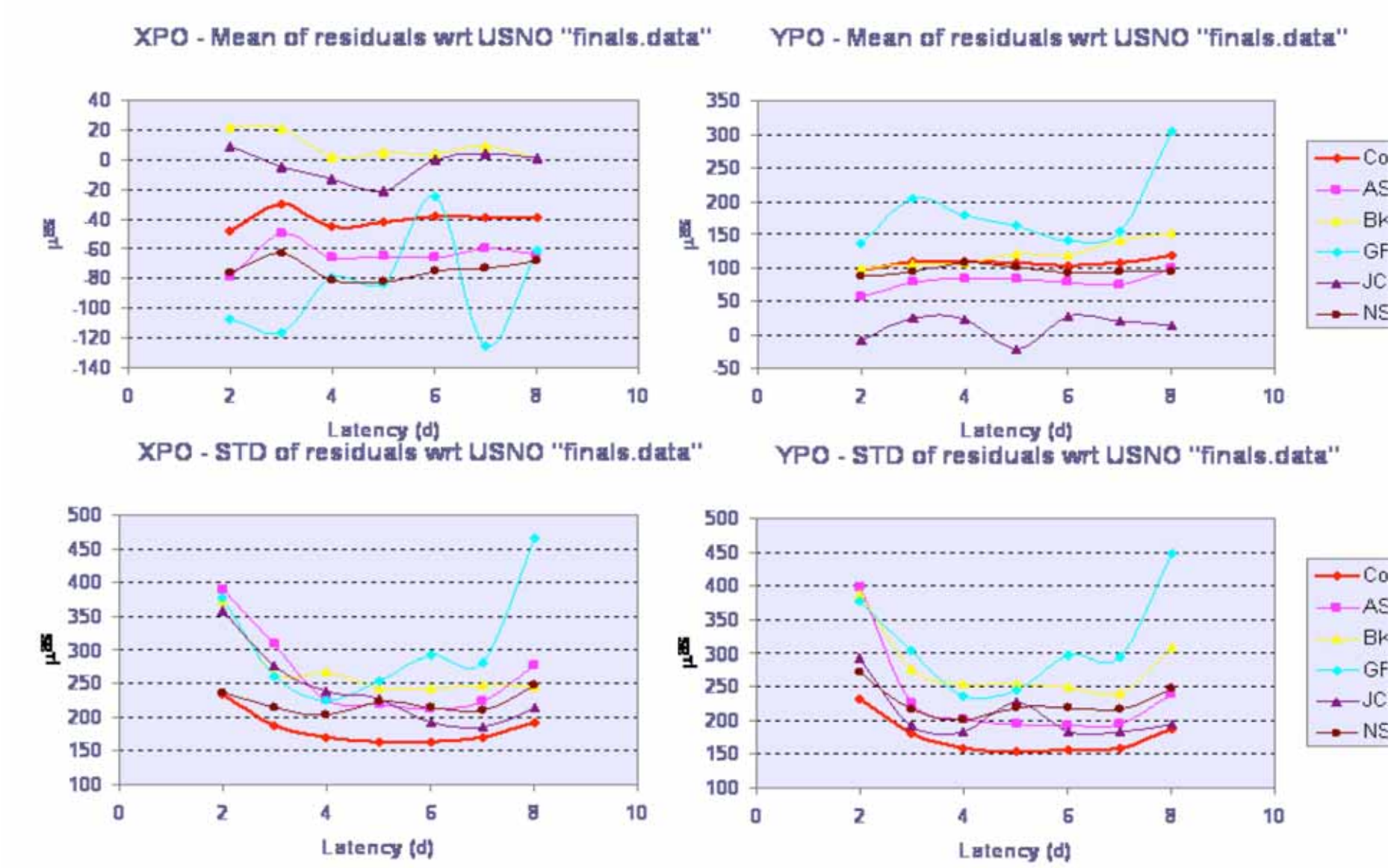
Daily solution main features

Data batch	7 days
Generation frequency	1/day
Age of estimates	2-8 days

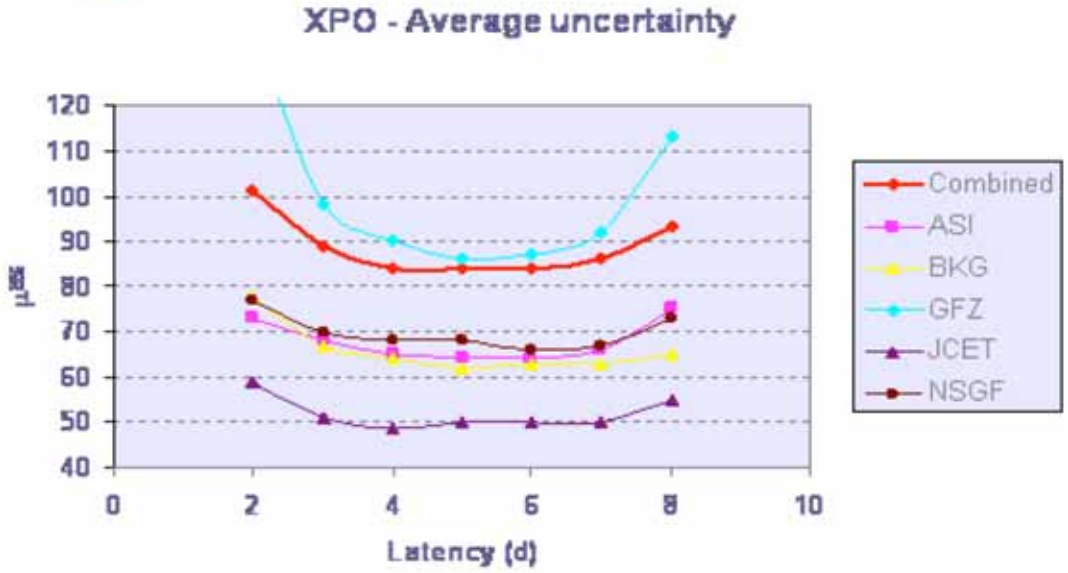
The ILRSA combination is performed automatically and seems to be robust: only a specific probl
arose in August (few solutions were not timely issued) but that was expected as related to
present HW configuration still not included in the Matera ASI/CGS operational environment.

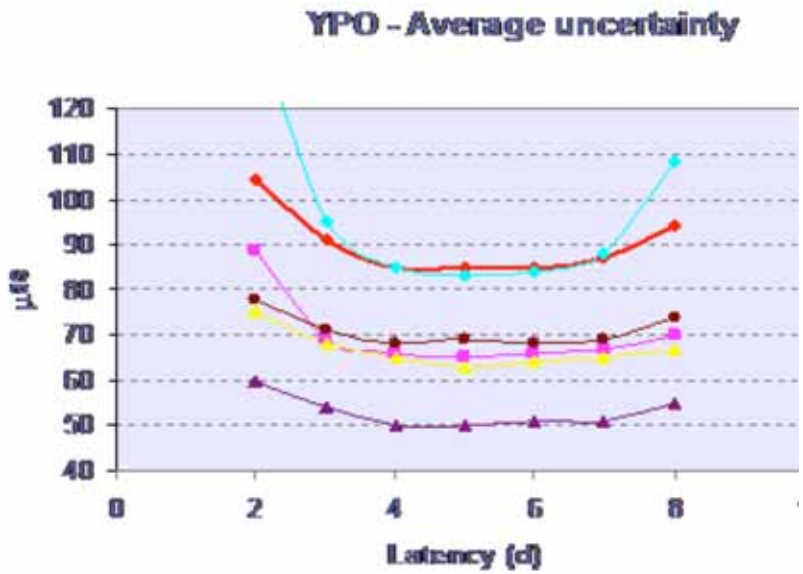
A dedicated analysis has been performed to evaluate the quality (accuracy/precision) of the solut
vs the single estimates "age": from each daily solution "same age" estimates have be
arranged in time series and compared to EOP reference values (USNO "finals.data")

Daily solution



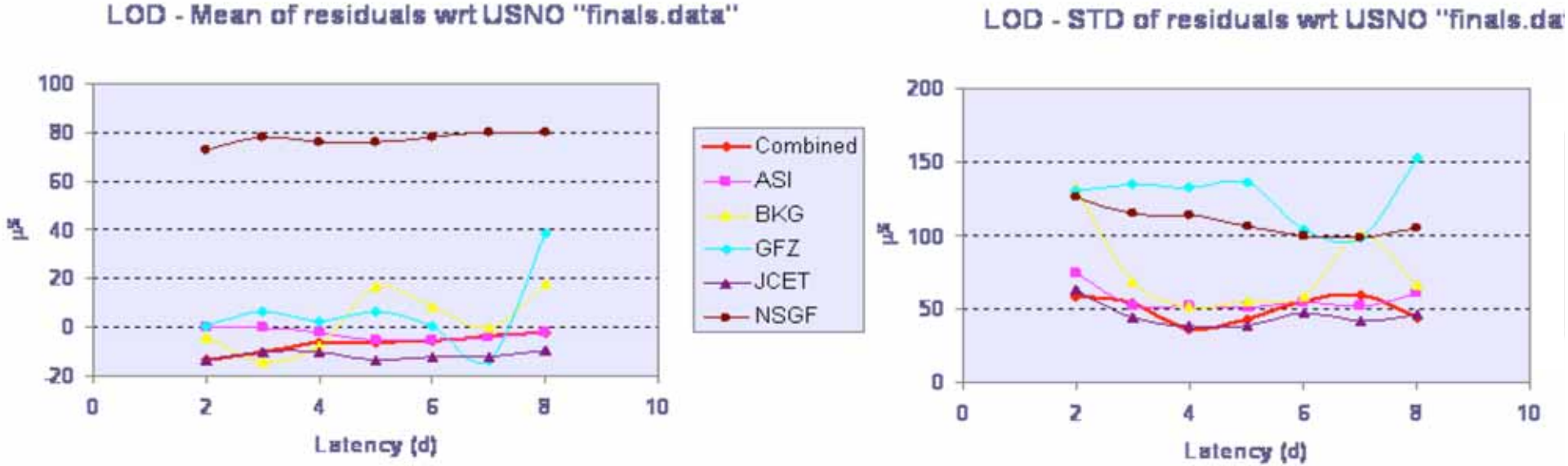
Daily solution

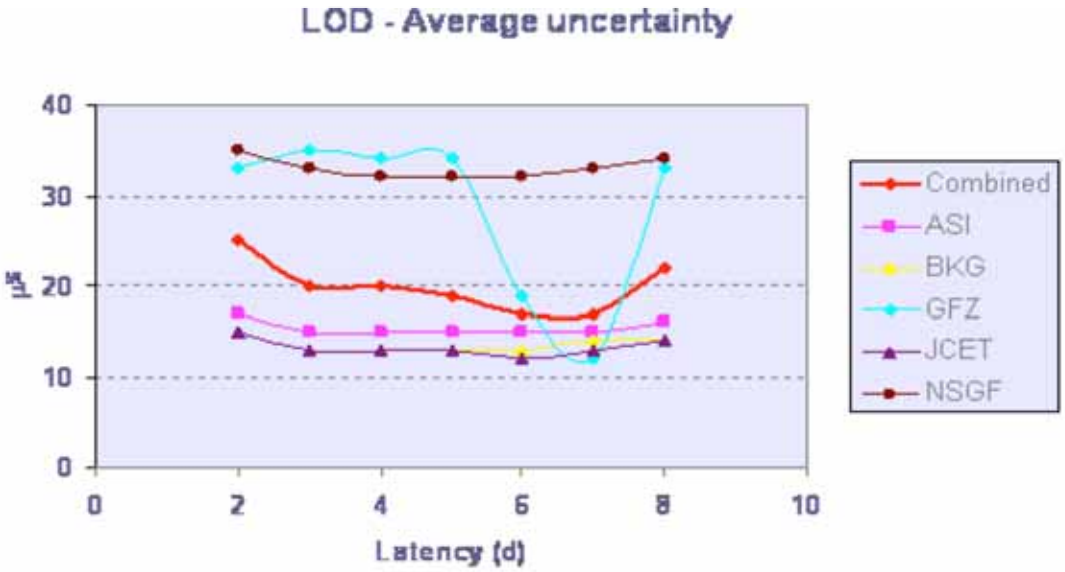




An "arc edge" effect is evident for all the contributing solutions, each one with a specific level c sensitivity. As the main objective of the Dailly solution is to provide EOPs with low latency (i.e always on the "edge"), that imposes the necessity of a careful evaluation of each solutio parametrization and of the fastest as possible data availability. Besides, the higher th difference among the solutions, the higher the uncertainty of the combined values.

Daily solution





Combined Orbit product

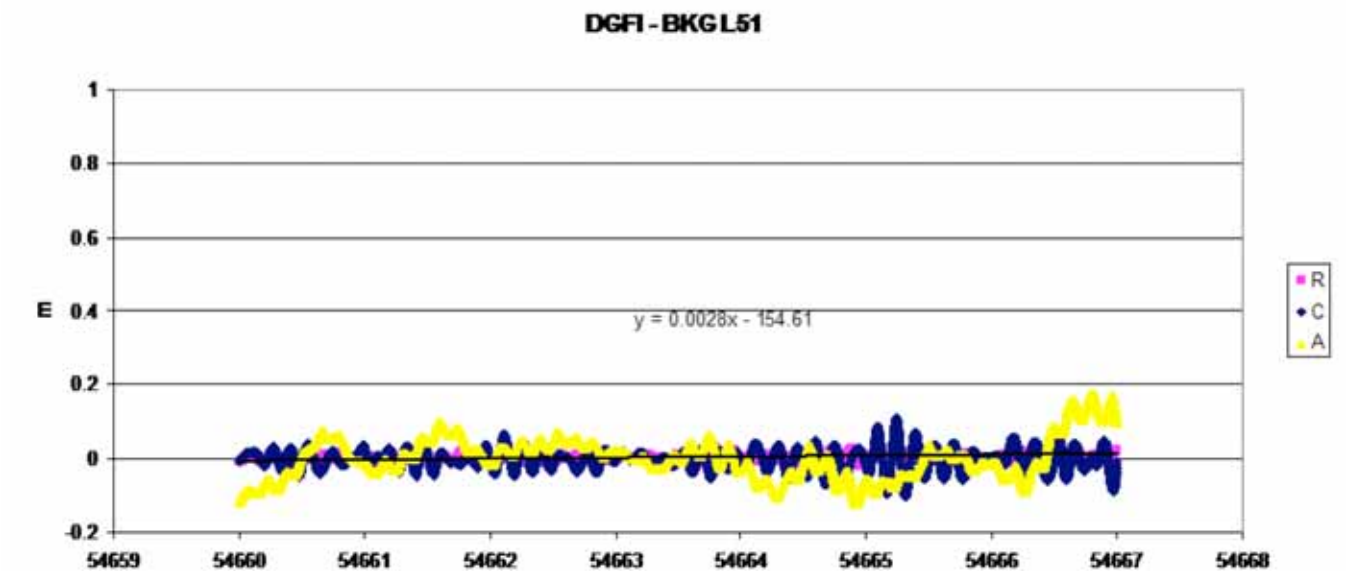
The purpose is to issue a new ILRS product providing a combined set o SVs for **Lageos I/II**, **Etalon I/II** aligned with the EOP/SSC weekly product

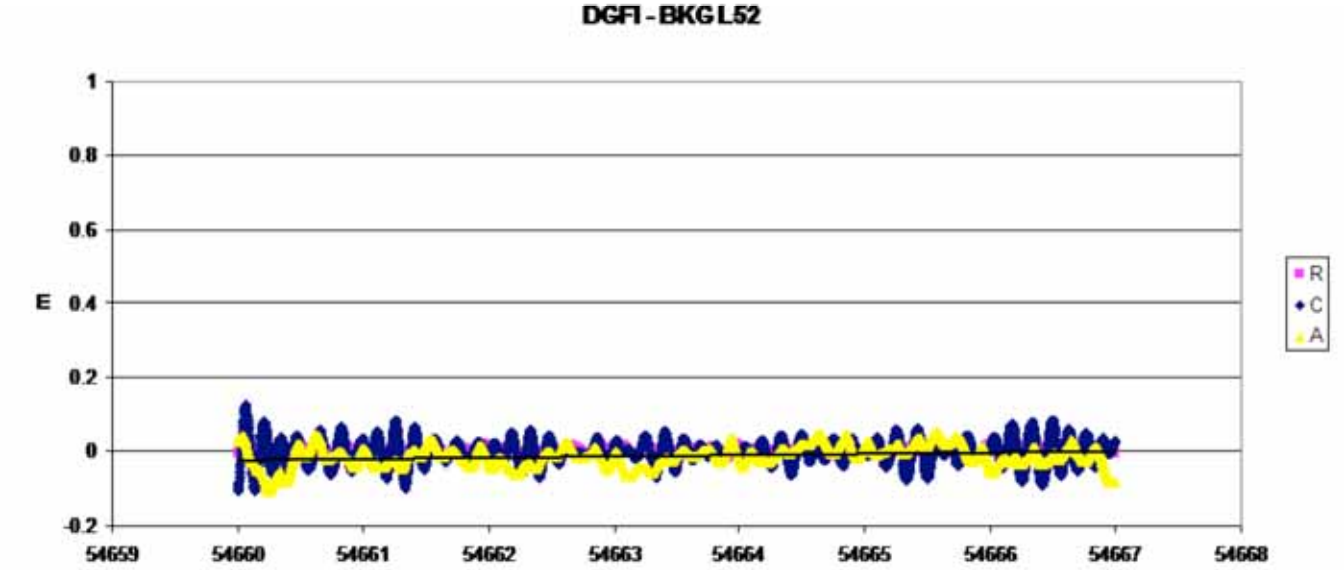
ACs are requested to provide their orbital solution as **SP3** files, in the same ECE they provide the 'loose' SSC/EOP solutions, with state vectors every **2' (Lageos** and every **15' (Etalon)**, covering the whole week.

The combination procedure has been prototyped; it includes

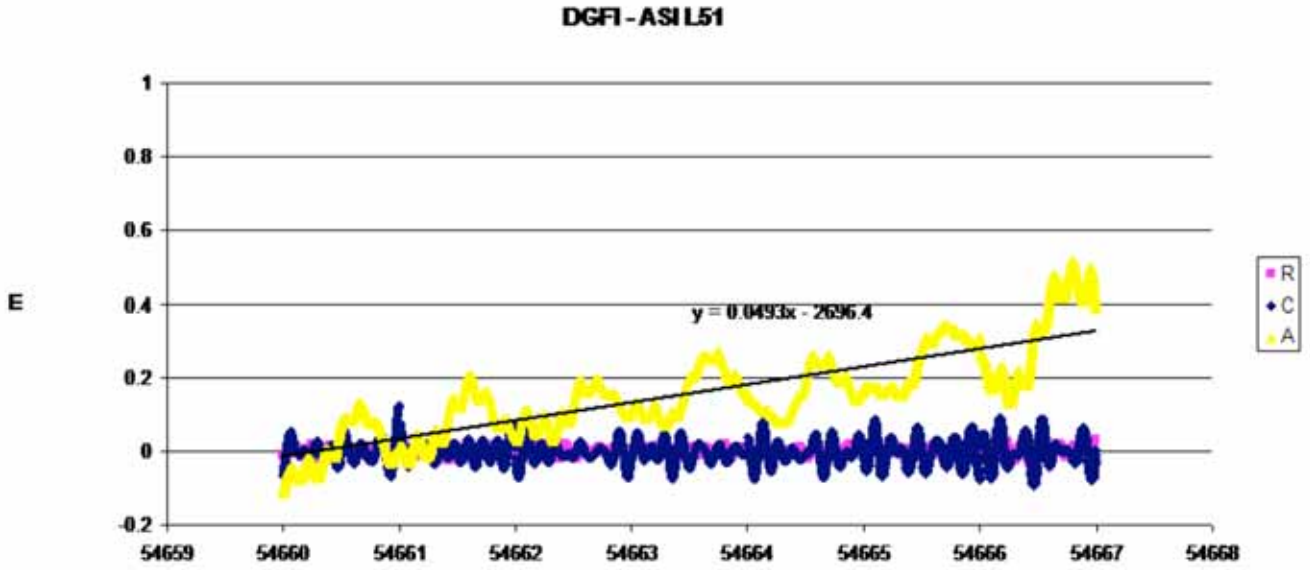
- SP3 files transformation to the ITRF of reference, by using the Helmert parameter estimated in the SSC/EOP combination (no scale) and reported in the weekly summary report
- a weighted average of the state vectors, based on a unique weekly weight for each AC solution reflecting the agreement of each solution to the reference ITRF (3d WRMS of SSC residuals)
- An alternative version includes the contemporary estimation of the rototranslation parameters and the combined SVs

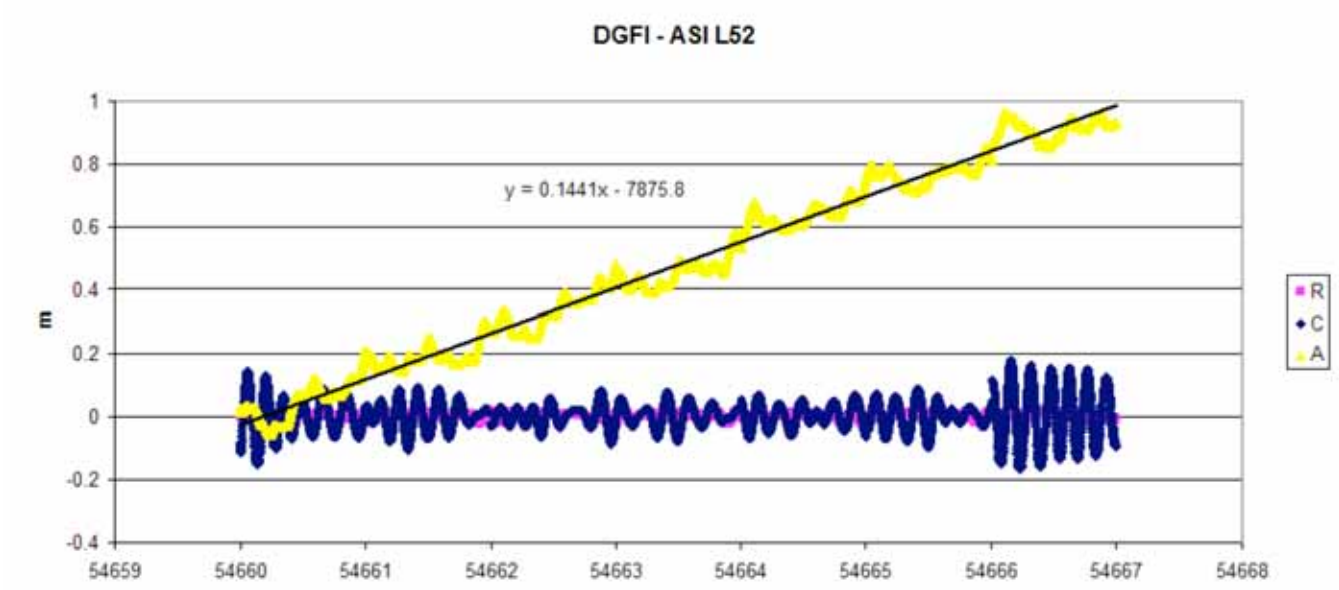
Combined Orbit product



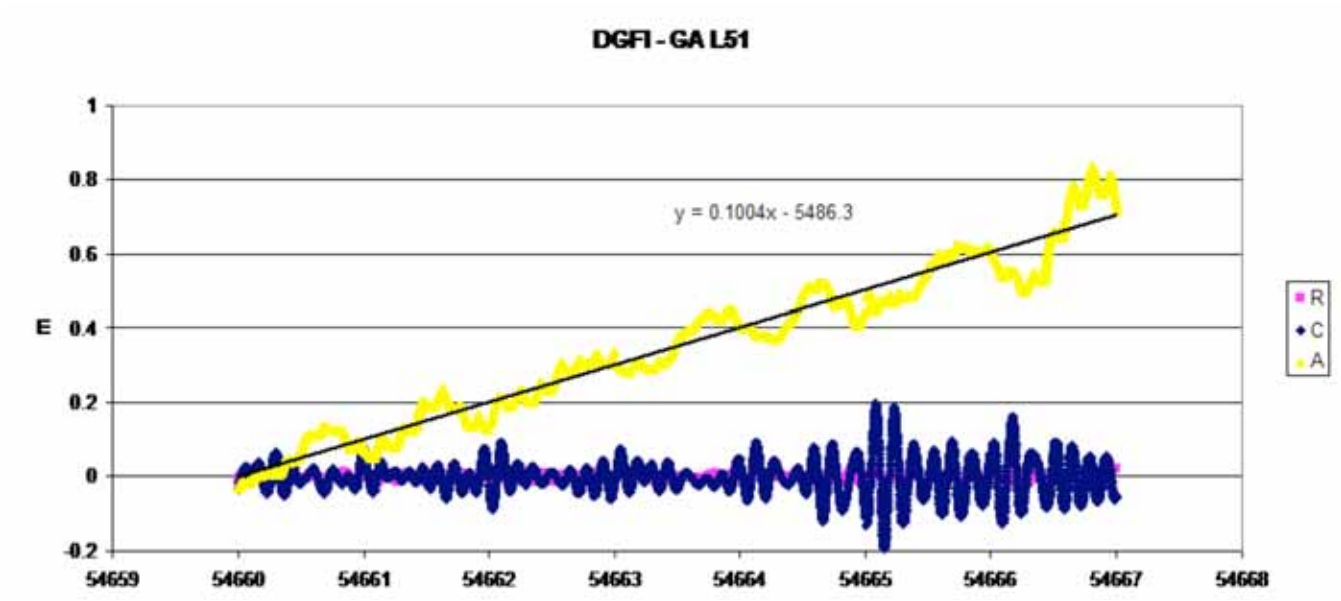


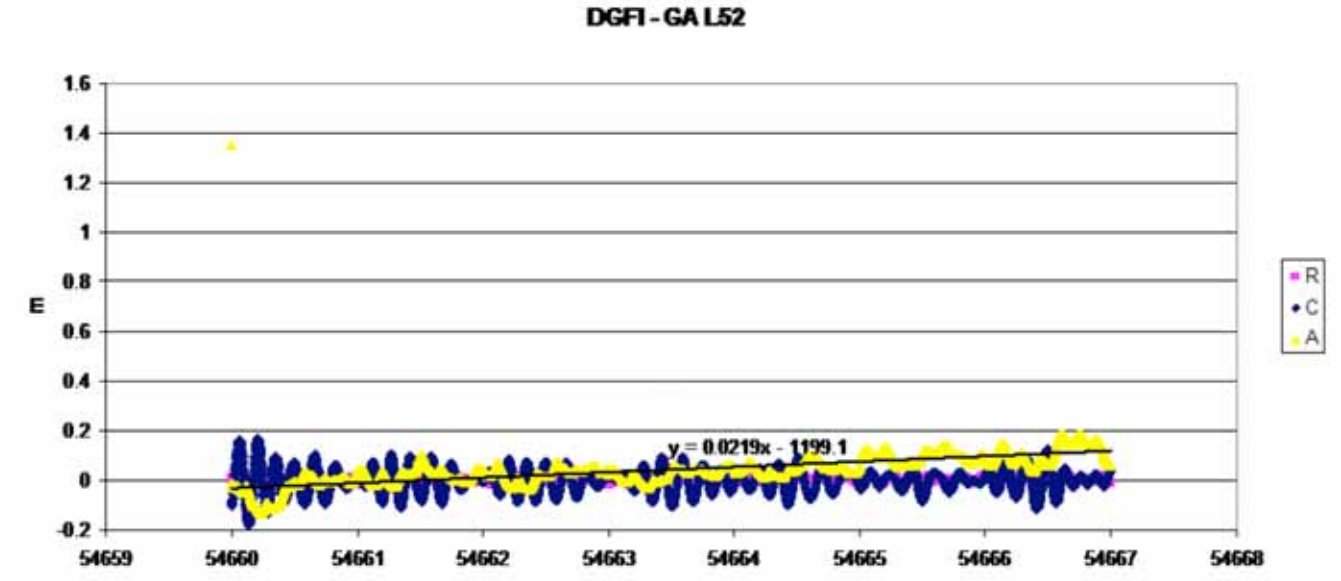
Combined Orbit product





Combined Orbit product

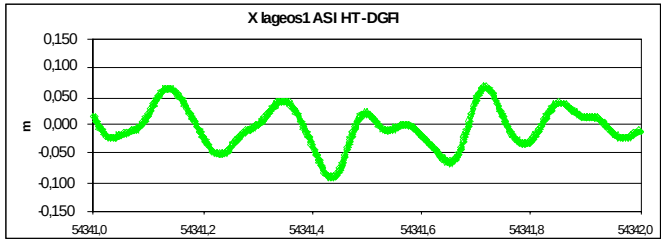


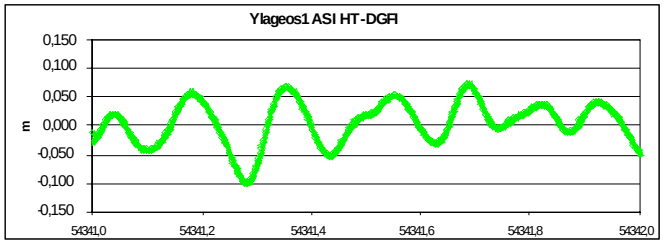


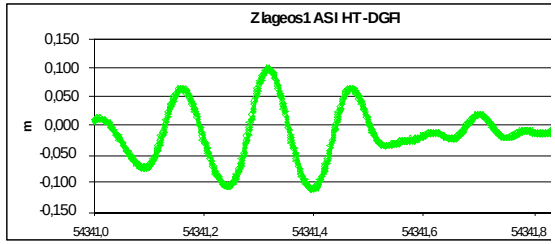
Combined Orbit product

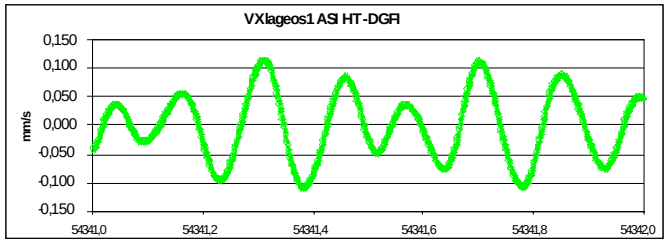
Comparison tests (ASI, DGFI) show a **5-cm level** position agreement (see ta and plots) in the Lageos1 orbit after the proper similarity transformation.

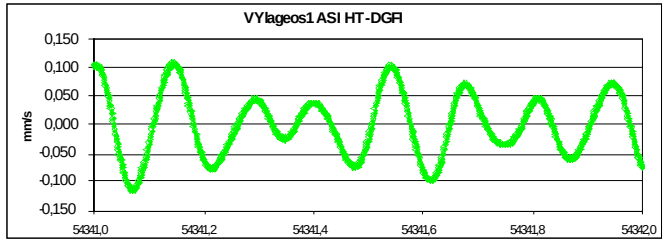
SAT	X mean std	Y mean std	Z mean std	VX mean std	VY mean std	VZ mean std
LAGEOS 1	**m**	**m**	**m**	**mm/s**	**mm/s**	**mm/s**
6 days	**0,001**	**0,004**	**-0,010**	**-0,001**	**0,001**	**0,001**
	0,053	**0,060**	**0,055**	**0,062**	**0,061**	**0,034**
1 day	**-0,003**	**0,006**	**-0,012**	**0,001**	**0,001**	**-0,001**
	0,035	**0,037**	**0,044**	**0,058**	**0,054**	**0,026**

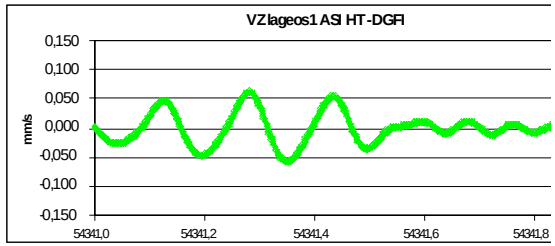












DGFI Analysis Report

Horst Müller

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

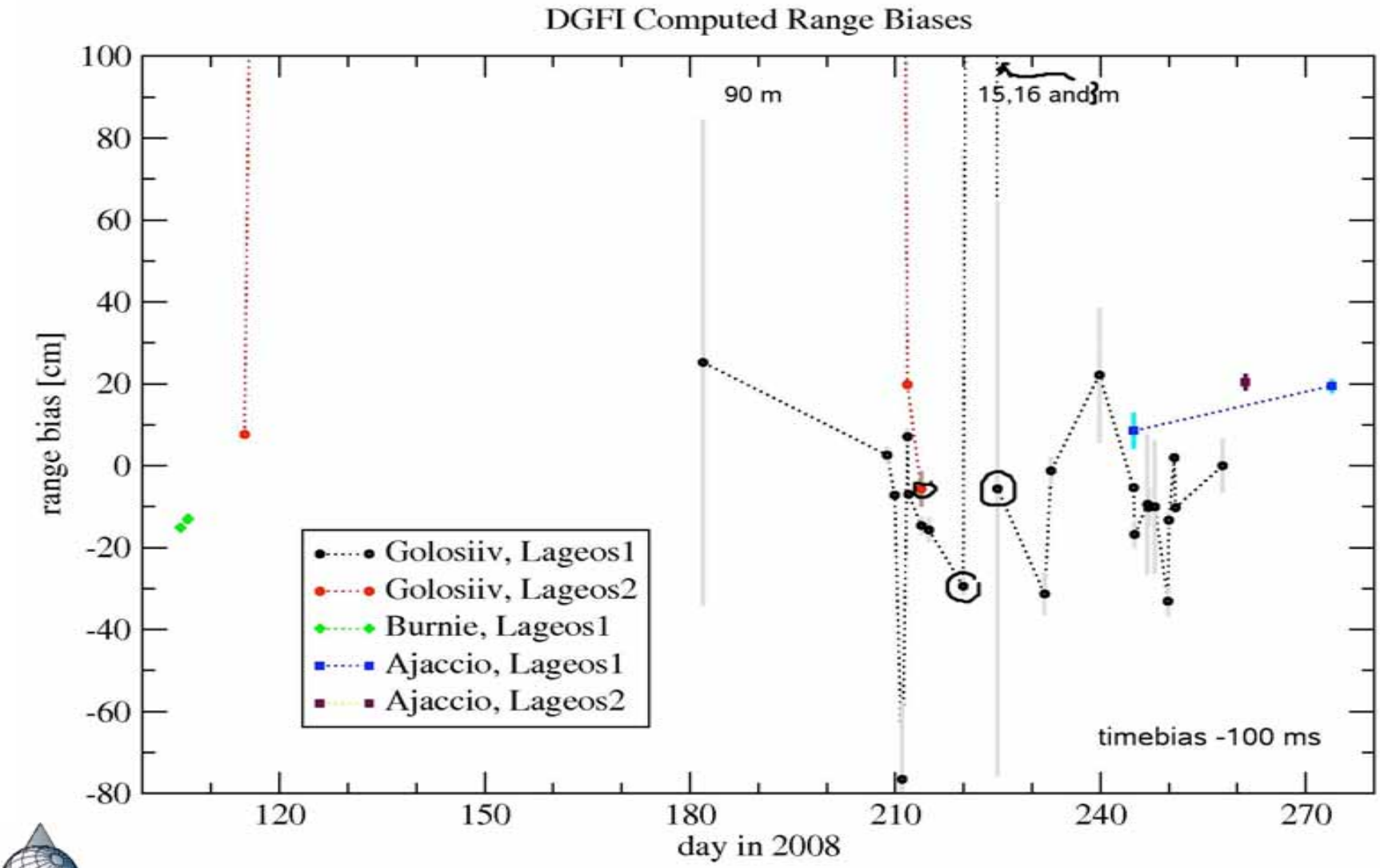
Quality assessment of new SLR systems/sites

Status of new stations since last meeting

- Stations
  - Burnie only 2 Lageos1 passes
  - Ajaccio 4th occupation, eccentricty missing operation since July 15
  - Golosiiv, Ukraine
- FTLRS
  - Mainly used for Jason calibration
  - Ajaccio coordinates in SLRF2005,
  - observations can be used as soon as eccentricities are available
  - statement on data quality not yet possible
- Hawaii and Arequipa
  - are used in the routine processing

DGFI

- Golosiiv
  - Coordinates from John Ries LPOD2005
  - Used in daily bias reports
  - 27 Lageos1 and 4 Lageos2 passes until then
  - No new data since Sep. 14
- Problem
  - Still relatively large range biases
  - End July to Aug. 8 –100 ms time bias
- Better station coordinates
  - because of the problem the LPOD2005 are still the best coordinates weekly solution do not improve the values
  - combined solution not yet availble


DGFI Computed Range Biases
range bias [cm]
day in 2008
90 m
15,16 and 3m
Golosiiv, Lageos1
Golosiiv, Lageos2
Burnie, Lageos1
Ajaccio, Lageos1
Ajaccio, Lageos2
timebias -100 ms
100
80
60
40
20
0
-20
-40
-60
-80
120
150
180
210
240
270

Weekly Golosiiv station coordinates

Corr. to LPOD2005 in cm after sim. transf.

Time	Lat..	Lon.	Hight	obs.
July 27	-1.80	-0.21	-2.53	59
Aug. 31	20.23	-6.96	6.94	28
Sep. 7	15.61	5.25	-1.29	20

Station not yet ready for routine processing

validation for new stations

- Station reports to ILRS
- specific analysis centres cooperates with the station
  - centre and backup centre to be appointed from the AWG
  - local surveys are desirable at that point, prel. Coordinates
- If no problem happens in a period of about 8(?) weeks and sufficent passes are availble the station can be used as non core station in weekly analysis
  - better coordinates

- Core station qualification
  - fulfil ILRS station qualification
  - proofs to be stable (no sig. biases)
  - common decision from AWG

Proposal

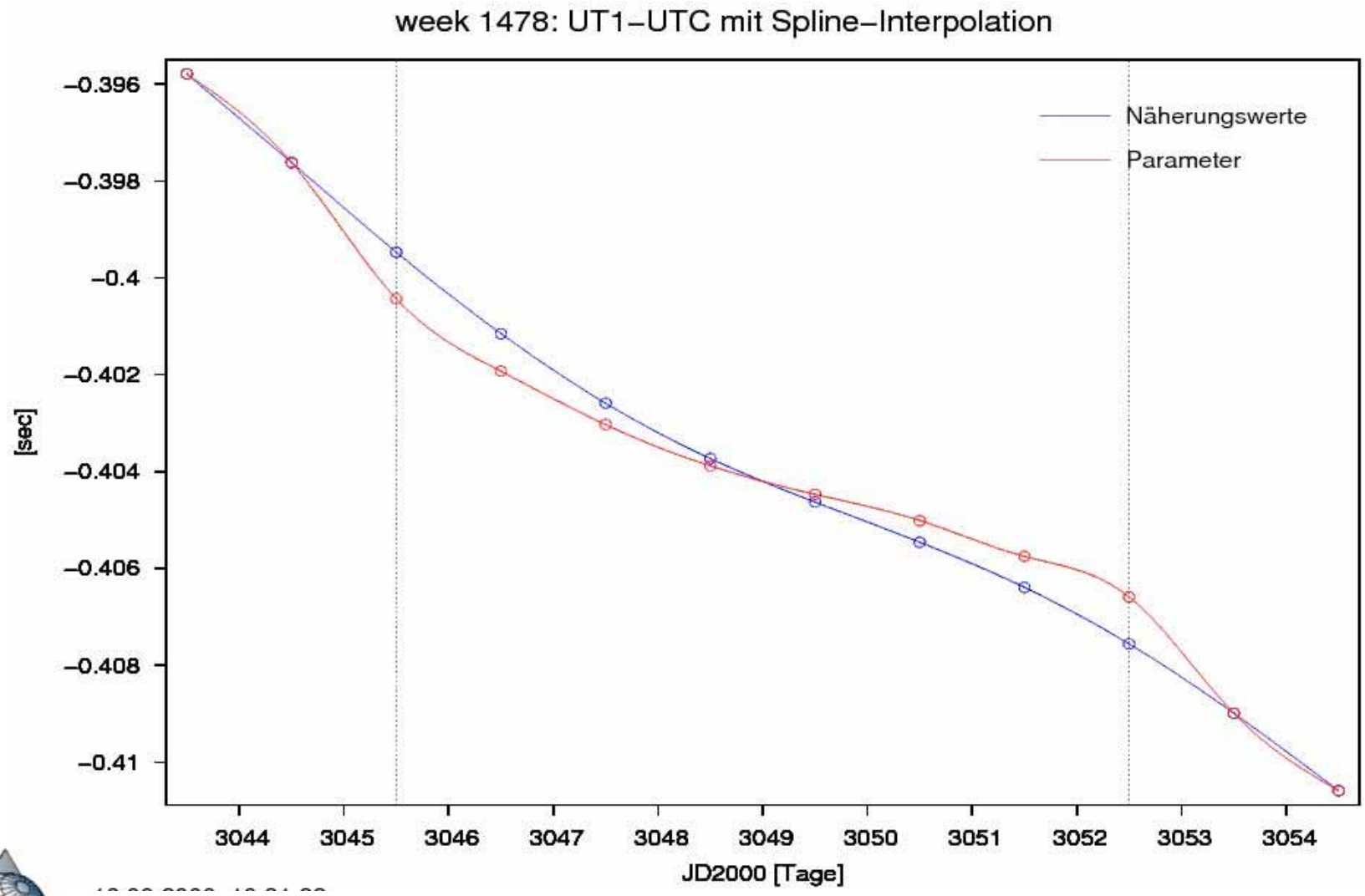
- New concept, better cooperation
- better information to central bureau
- contact with stations in case of problems detected

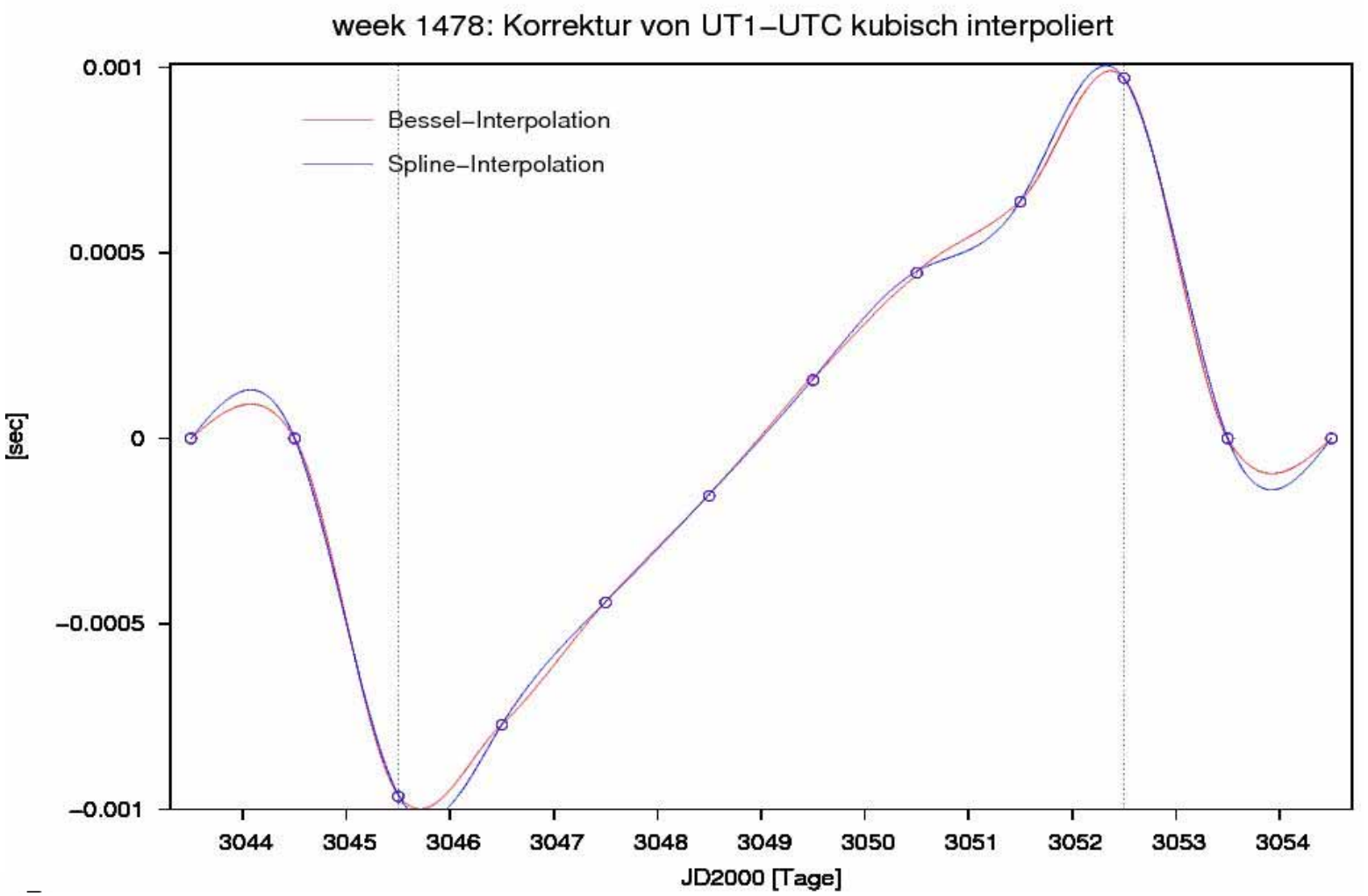
  station was informed on the –100ms time bias

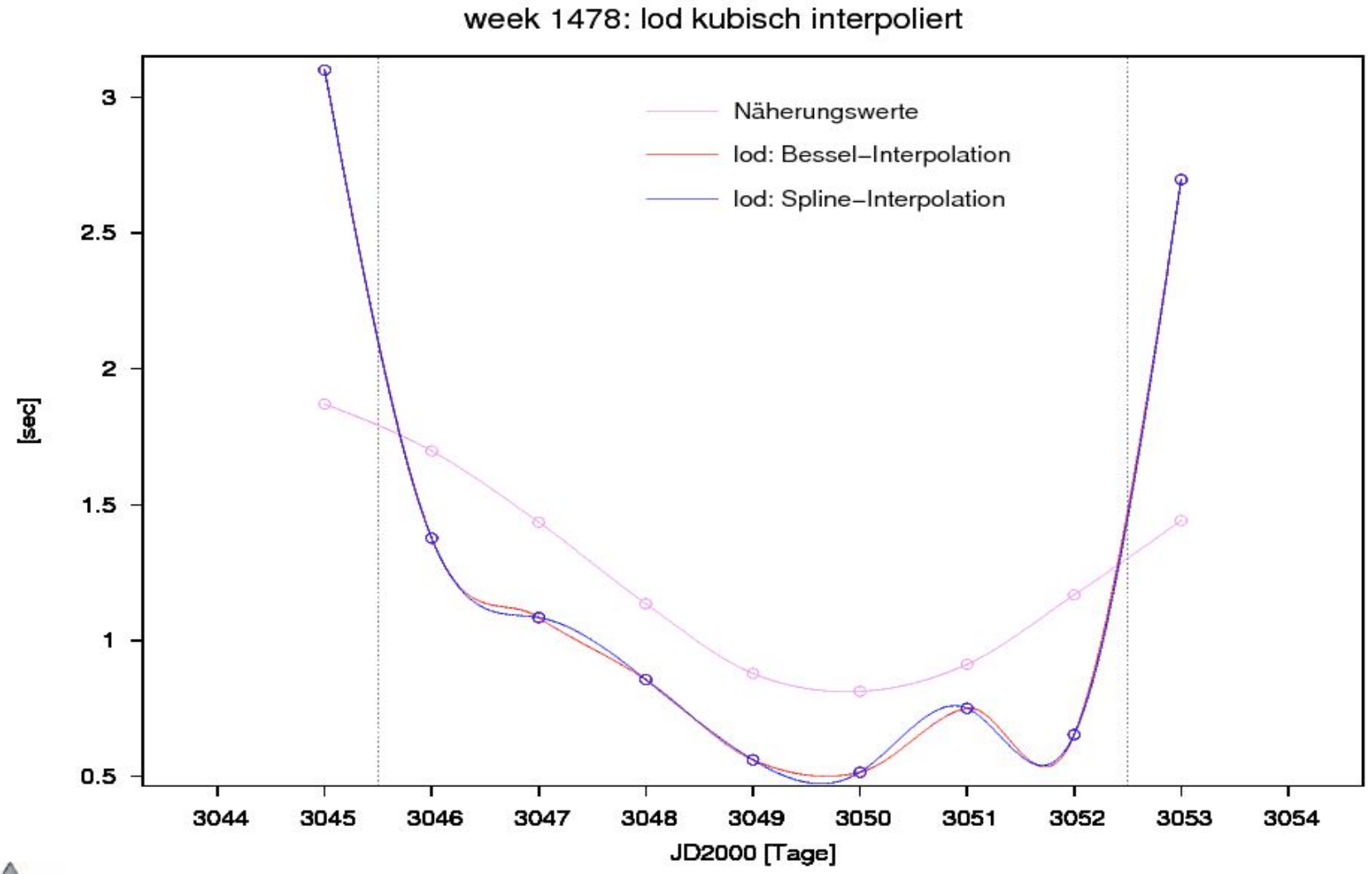
Standardized proceedure to informe the station in case of detected biases or other problmes (e.g. San Juan wrong day number in np record)

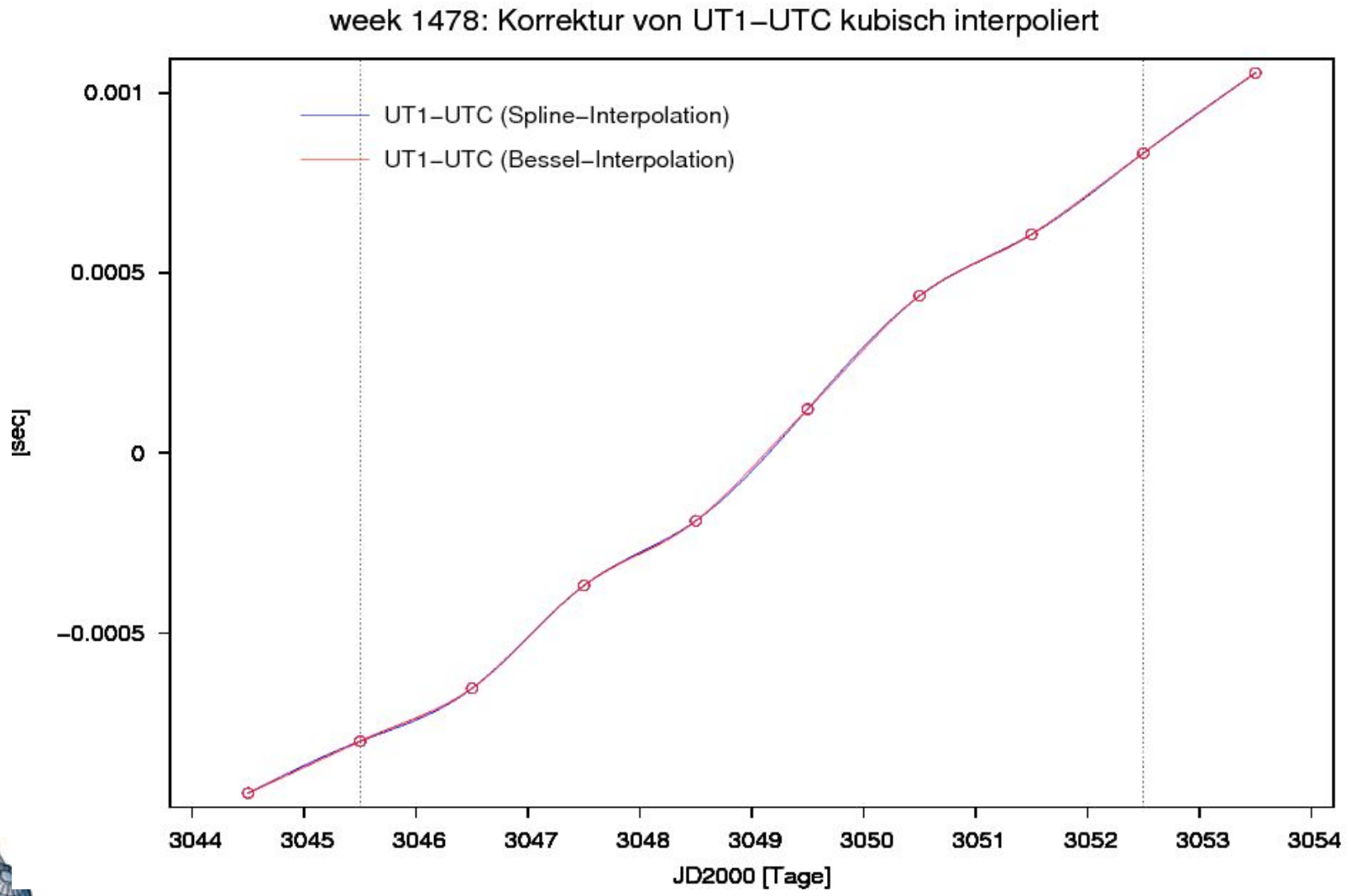
Routine Processing

- Weekly solution
  - Operational, but problems with EOPs
    - values on the borders are wrong
    - interpolation problem, DOGS computes EOP-values at 0:00 UTC and interpolates to 12:00 in an extra step, using full covariance matrix
  - a new interpolation routine is being test in the last weeks, situation is getting better.
- Daily processing
  - can start as soon as problem is solved
  - daily bias reports are availble


week 1478: UT1–UTC mit Spline–Interpolation
Näherungswerte
Parameter
[sec]
–0.396
–0.398
–0.4
–0.402
–0.404
–0.406
–0.408
–0.41
3044
3045
3046
3047
3048
3049
3050
3051
3052
3053
3054
JD2000 [Tage]


week 1478: Korrektur von UT1–UTC kubisch interpoliert
Bessel–Interpolation
Spline–Interpolation
0.001
0.0005
0
–0.0005
–0.001
[sec]
3044
3045
3046
3047
3048
3049
3050
3051
3052
3053
3054
JD2000 [Tage]


week 1478: lod kubisch interpoliert
Näherungswerte
lod: Bessel–Interpolation
lod: Spline–Interpolation
[sec]
3
2.5
2
1.5
1
0.5
3044
3045
3046
3047
3048
3049
3050
3051
3052
3053
3054
JD2000 [Tage]


week 1478: Korrektur von UT1–UTC kubisch interpoliert
UT1–UTC (Spline–Interpolation)
UT1–UTC (Bessel–Interpolation)
0.001
0.0005
0
–0.0005
[sec]
3044
3045
3046
3047
3048
3049
3050
3051
3052
3053
3054
JD2000 [Tage]

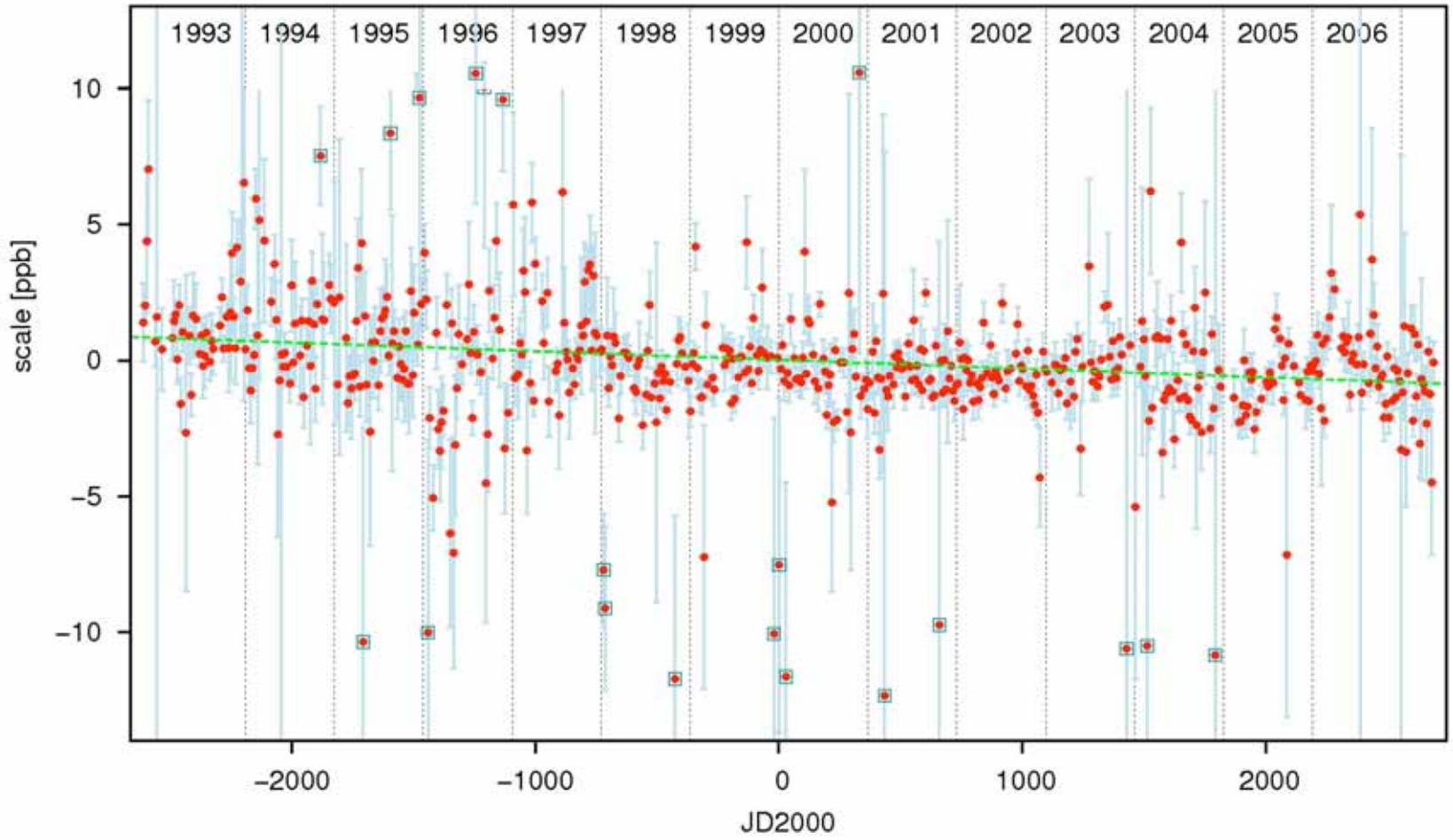
ITRF processing

- Reprocessing 1992 - present
  - prepared to deliver data as soon as interpolation problem is solved .
- Backward processin 1983- 1992
  - solutions are ready
  - same interpolation problem
  - a new iteration is foreseen
    - small problems end of 1992
    - bad orbits in 1983/84 (too many stations edited?)

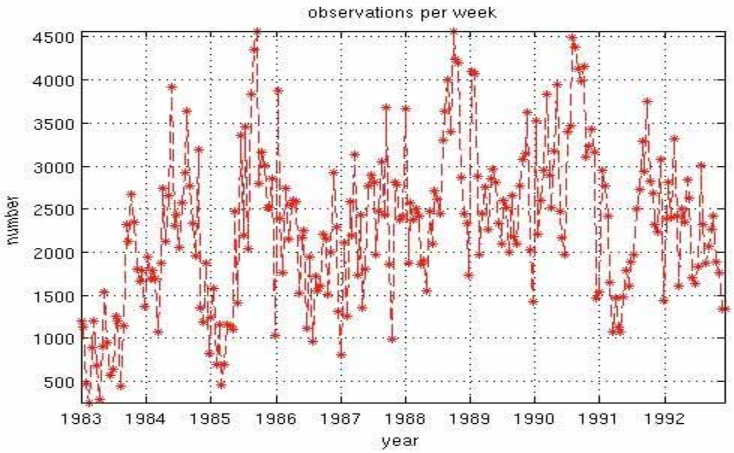
ILRS Analysis Working Group Meeting, Poznan, October 12, 2008

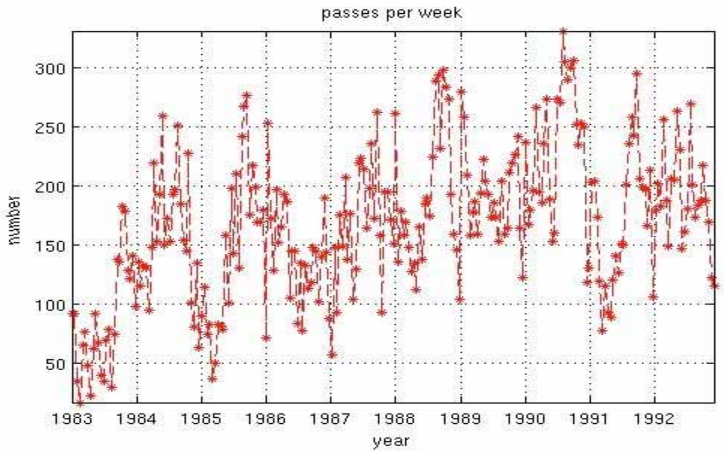
Scale between reprocessed SLR solution and ITRF solution

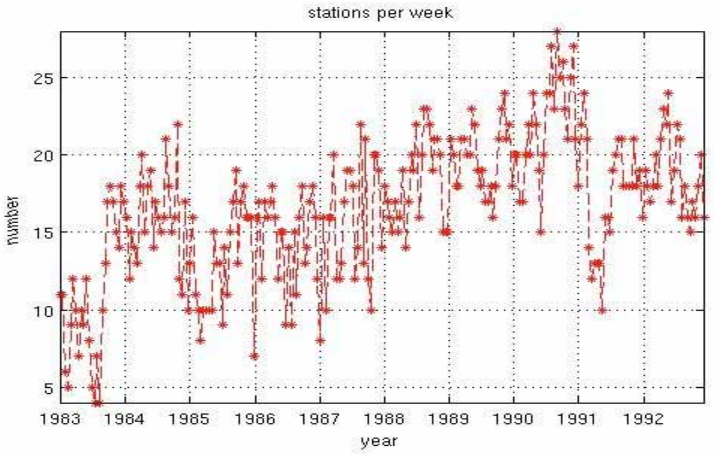
Offset: 0.0 ± 0.1 ppb , drift –0.1 ± 0.03 ppb

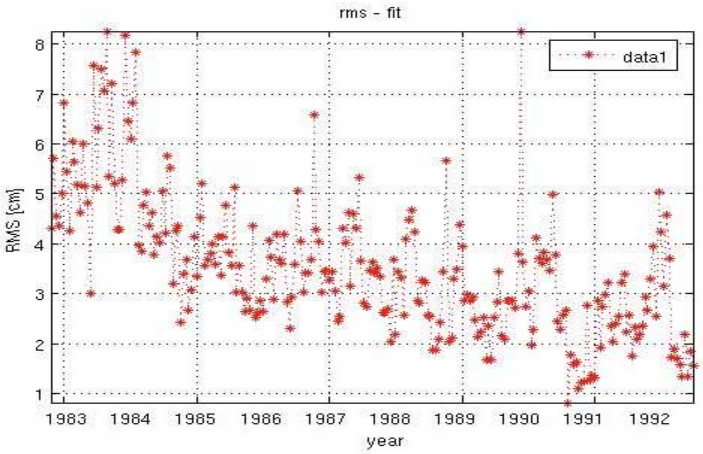


ILRS Analysis Working Group Meeting, Poznan, October 12, 2008



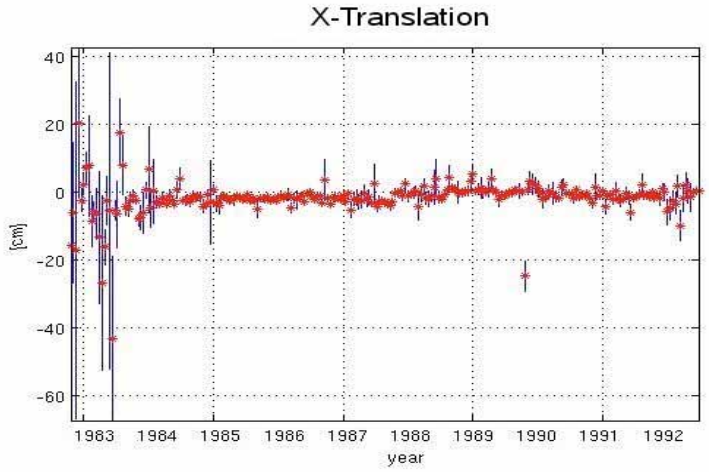


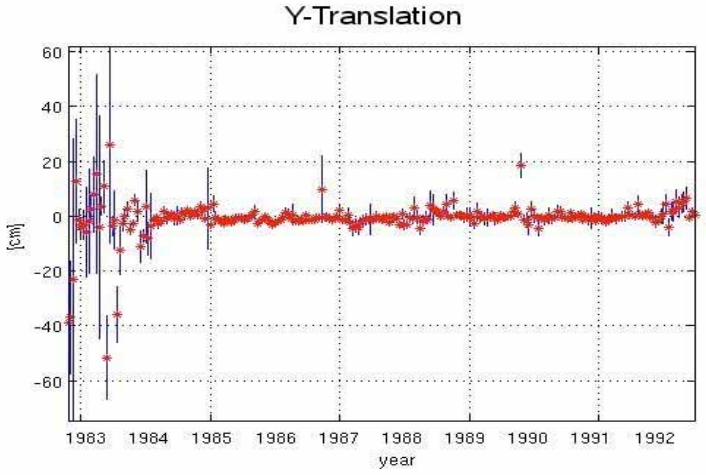


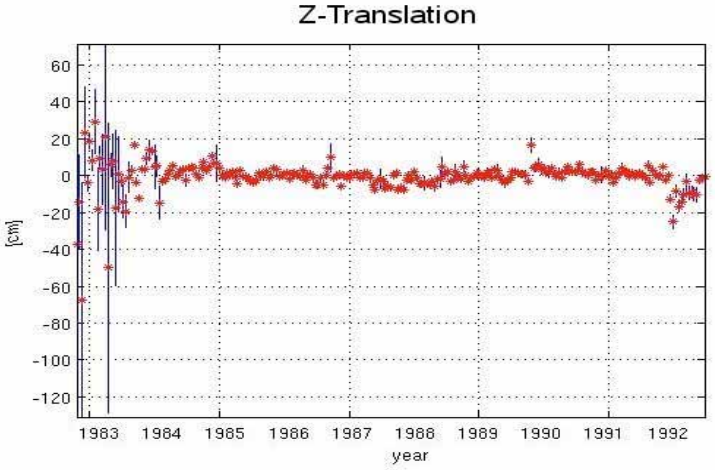


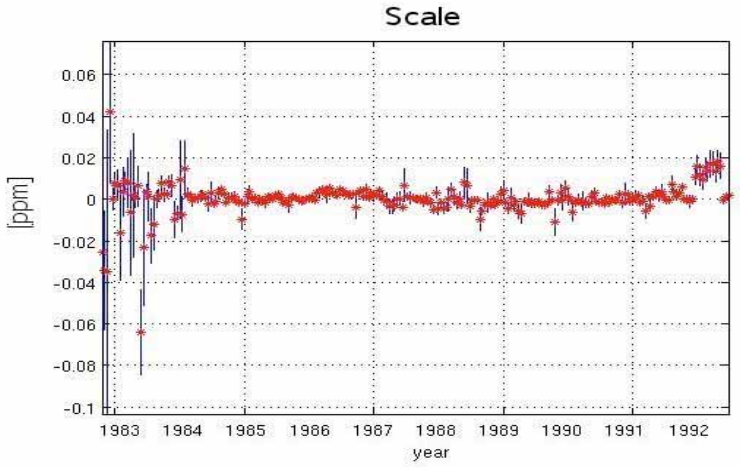
ILRS Analysis Working Group Meeting, Poznan, October 12, 2008

Transformation parameters to SLRF2005









SP3 Orbit Products

- Status
  - Weekly orbits from DGFI are available
  - Datum SLRF2005
  - Orbits in DGFI loose frame not yet present (DGFI computers single arc orbits, EOPs and Coor. Combination in an extra step.
- Future Plans
  - Orbits in loose frame
  - More satellites

CRD Format

- Only first tests with reformated CRD data
- Direct use of CRD-Format data is not yet implemented in DOGS
  - planed for end of the year
  - Not enough CRD data availble
    - mix of old format and CRD is not foreseen in DOGS

Discontinuity file

- A new file, including the old data correction files from CDDIS is ready
- But its not very handy, too big
- file is sorted by station
  - sorted by date better?
- Porposal
  - Split file in two separate files
    - Discontinuity part, like ITRF
    - Data handling part, for analysts only
  - Install automatic update proceedure
    - either Web-based
    - or email system

Discontinuity file

- some information is missing
  - one should distiguish between biases solved for and biases to be applied and not
- How to handle two colors
- CoM correction to be included in the file?
- Satellite codes for group of satellites
  - e.g. LC- for both Lageos satellites
  - LEO/HEO for all leos/heos
  - new columns?
    - laser color
    - ??

Status of ILRSB

Rainer Kelm
Deutsches Geodätisches Forschungsinstitut

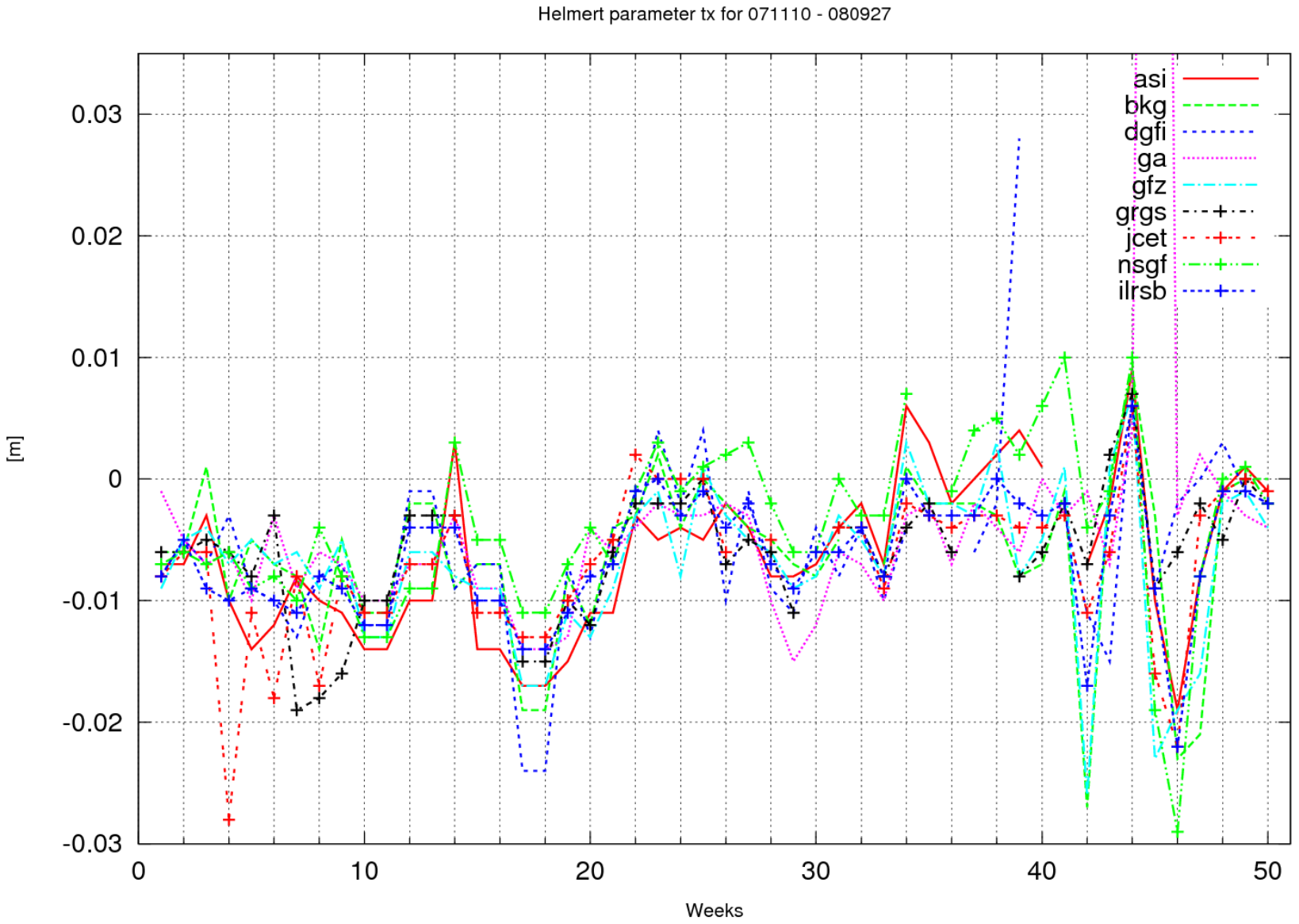
Weekly combination v10

Daily combination v100

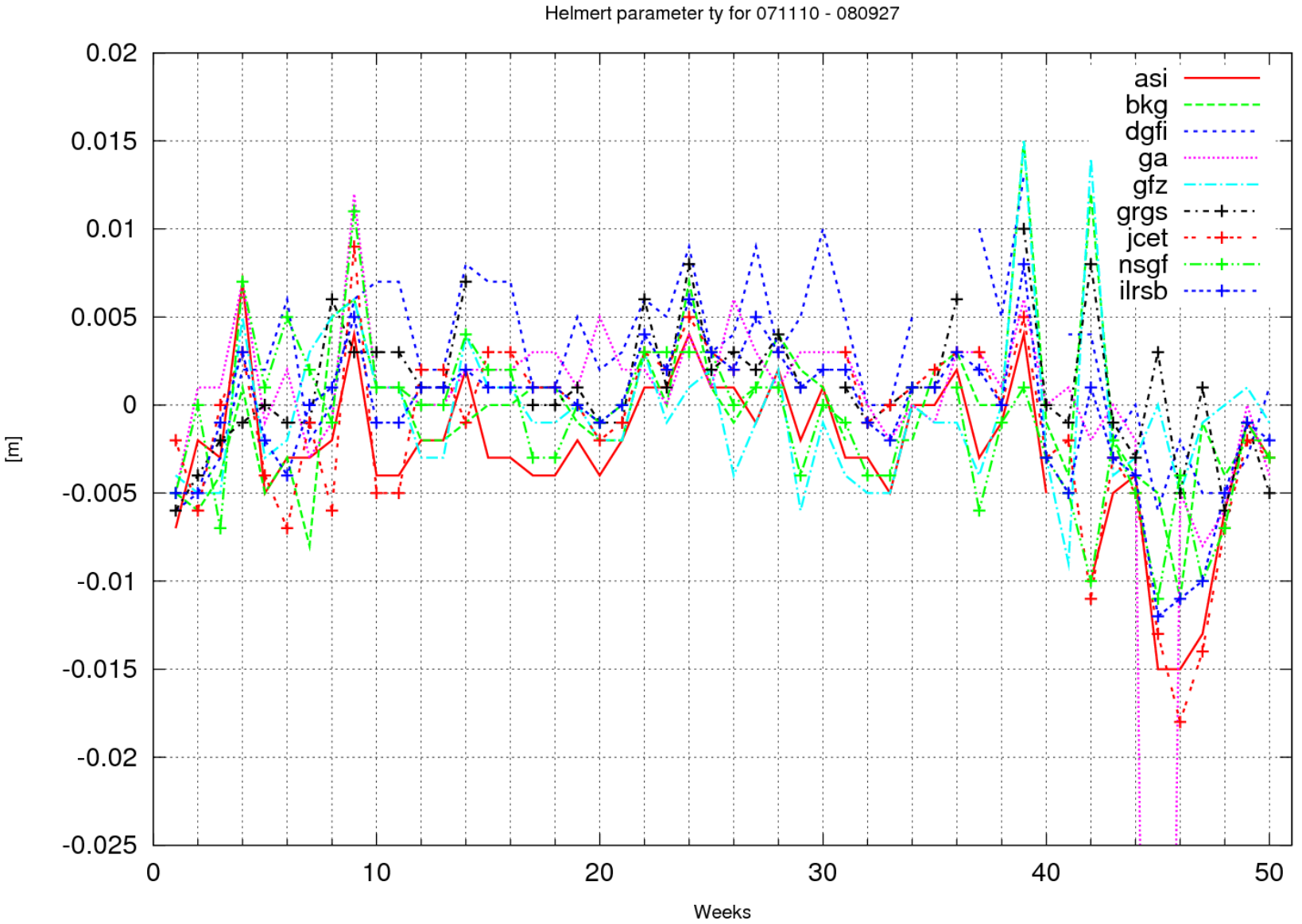
Orbit combination SP3C

ILRS AWG Meeting Poznan, October 12, 2008

Weekly combination v10 (1)

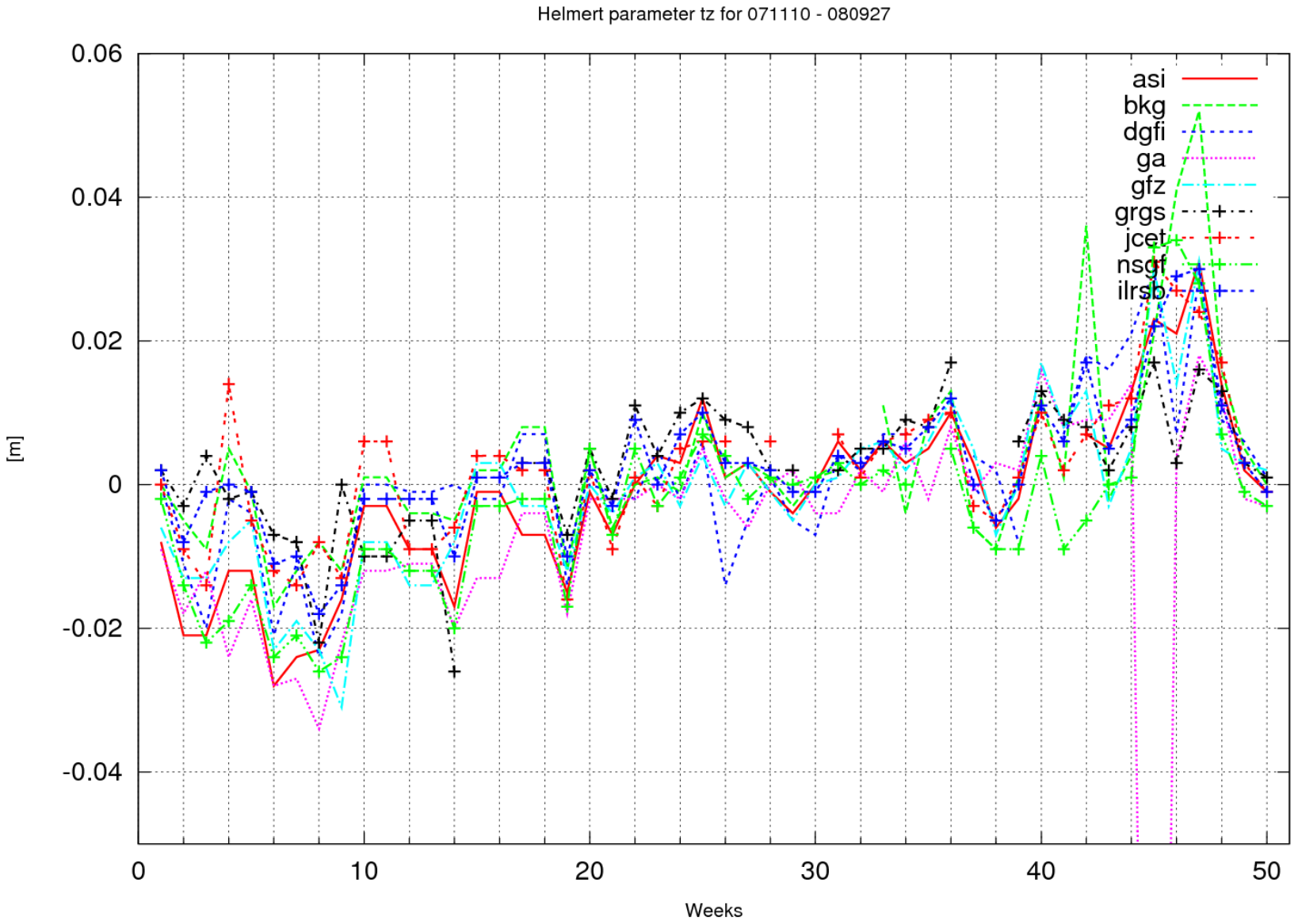


Weekly combination v10 (2)



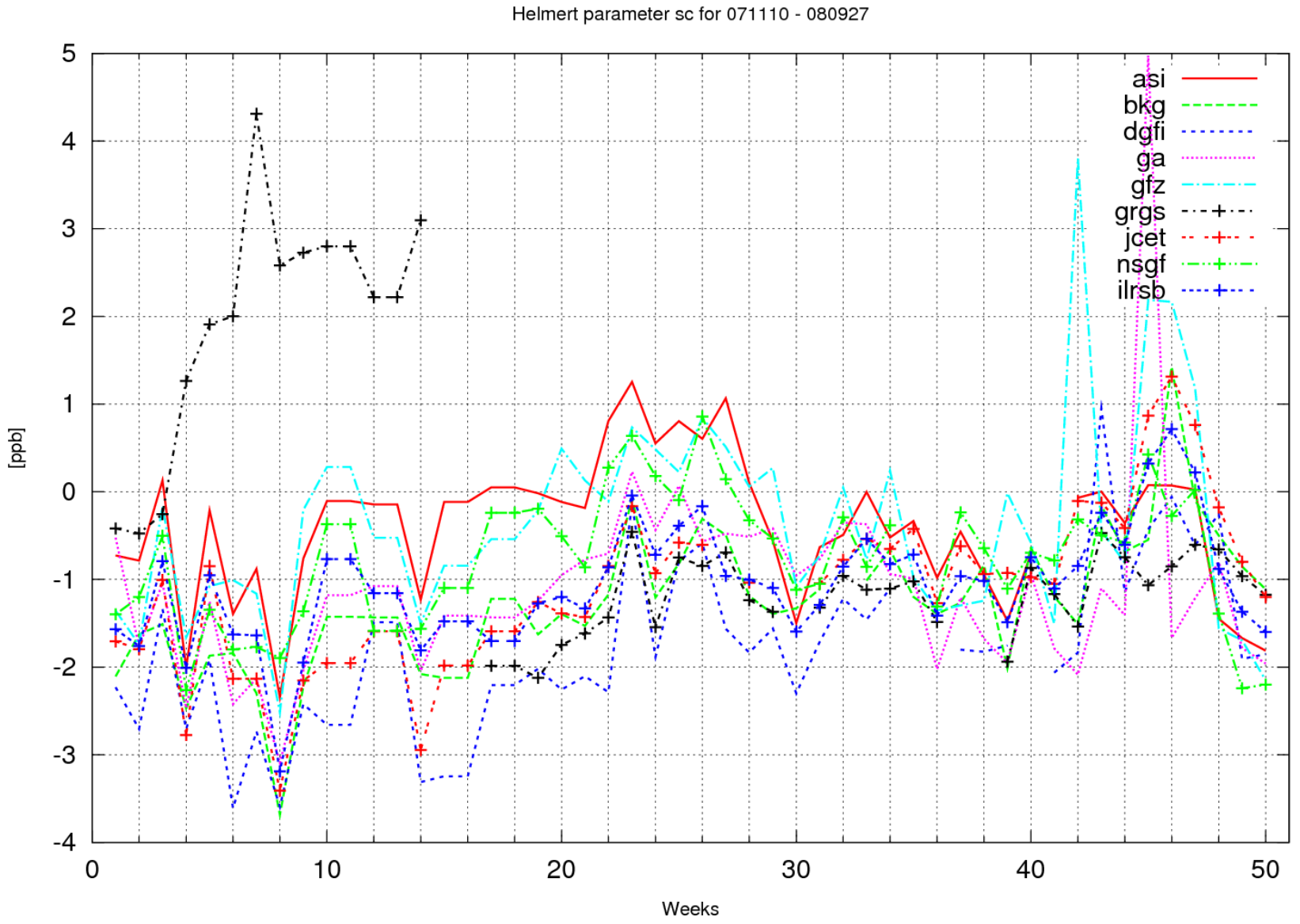
DGFI FGS Forschungsgruppe Satellitengeodäsie

Weekly combination v10 (3)



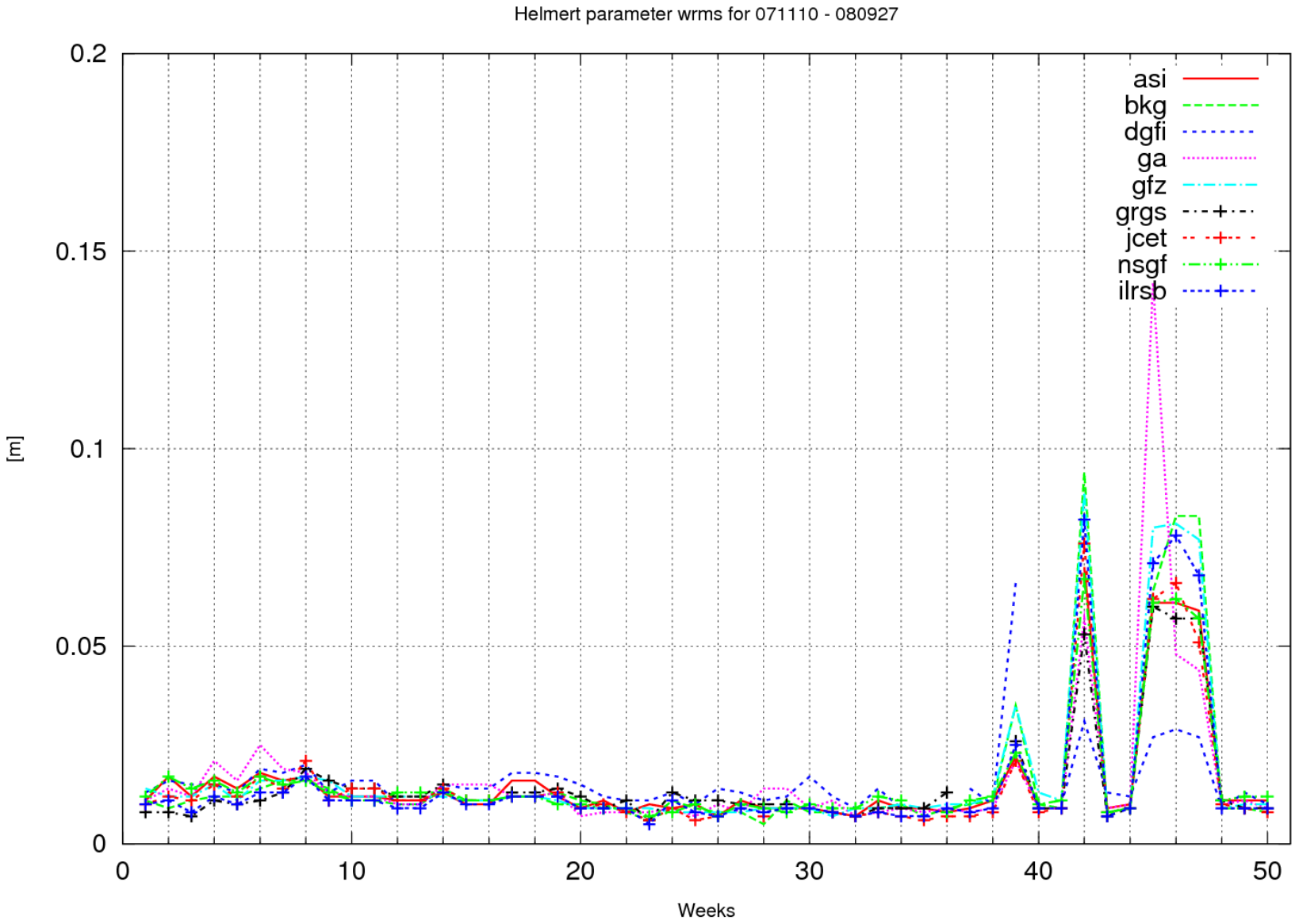
DGFI FGS Forschungsgruppe Satellitengeodäsie

Weekly combination v10 (4)

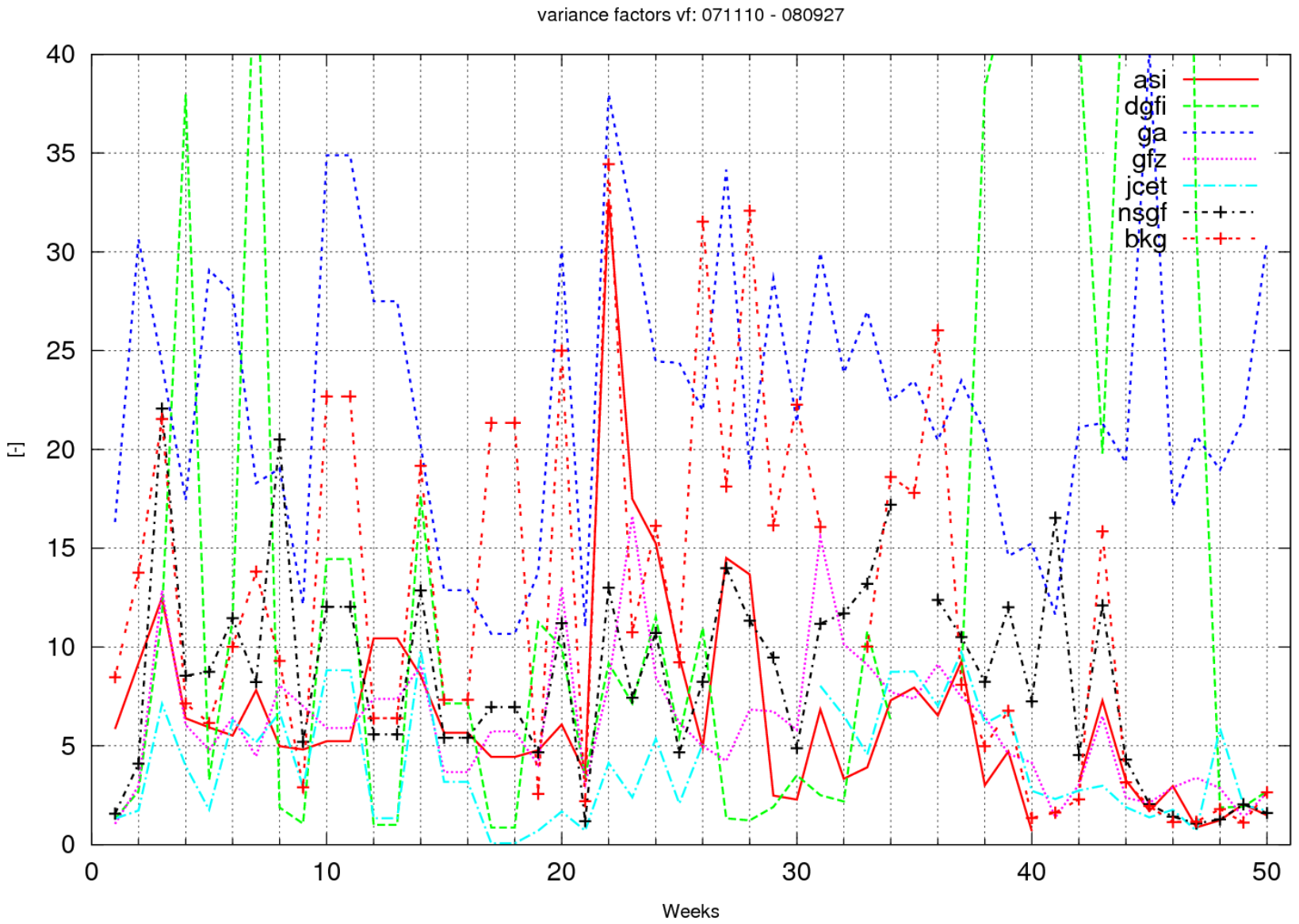


DGFI FGS Forschungsgruppe Satellitengeodäsie

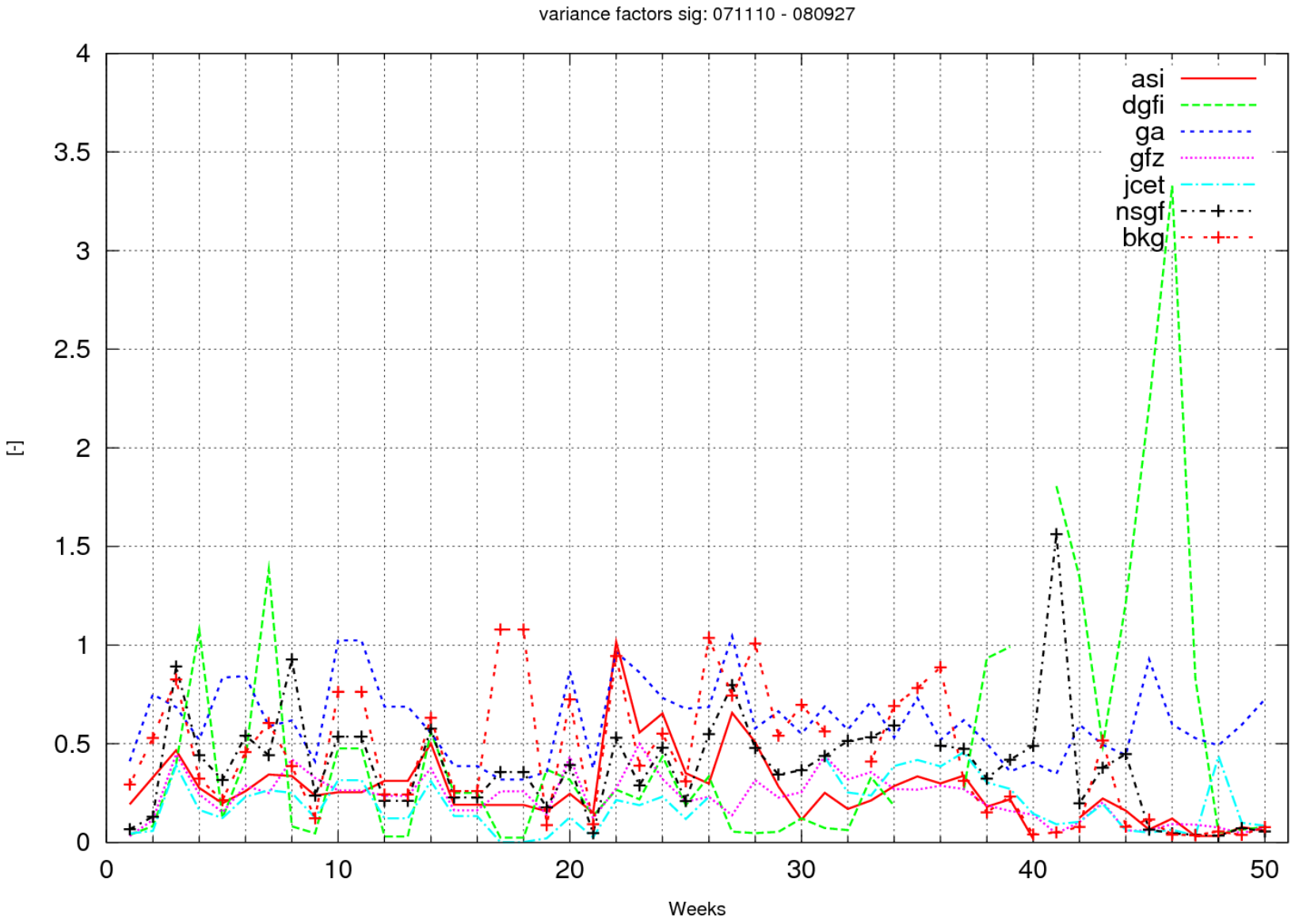
Weekly combination v10 (5)



Weekly combination v10 (6)

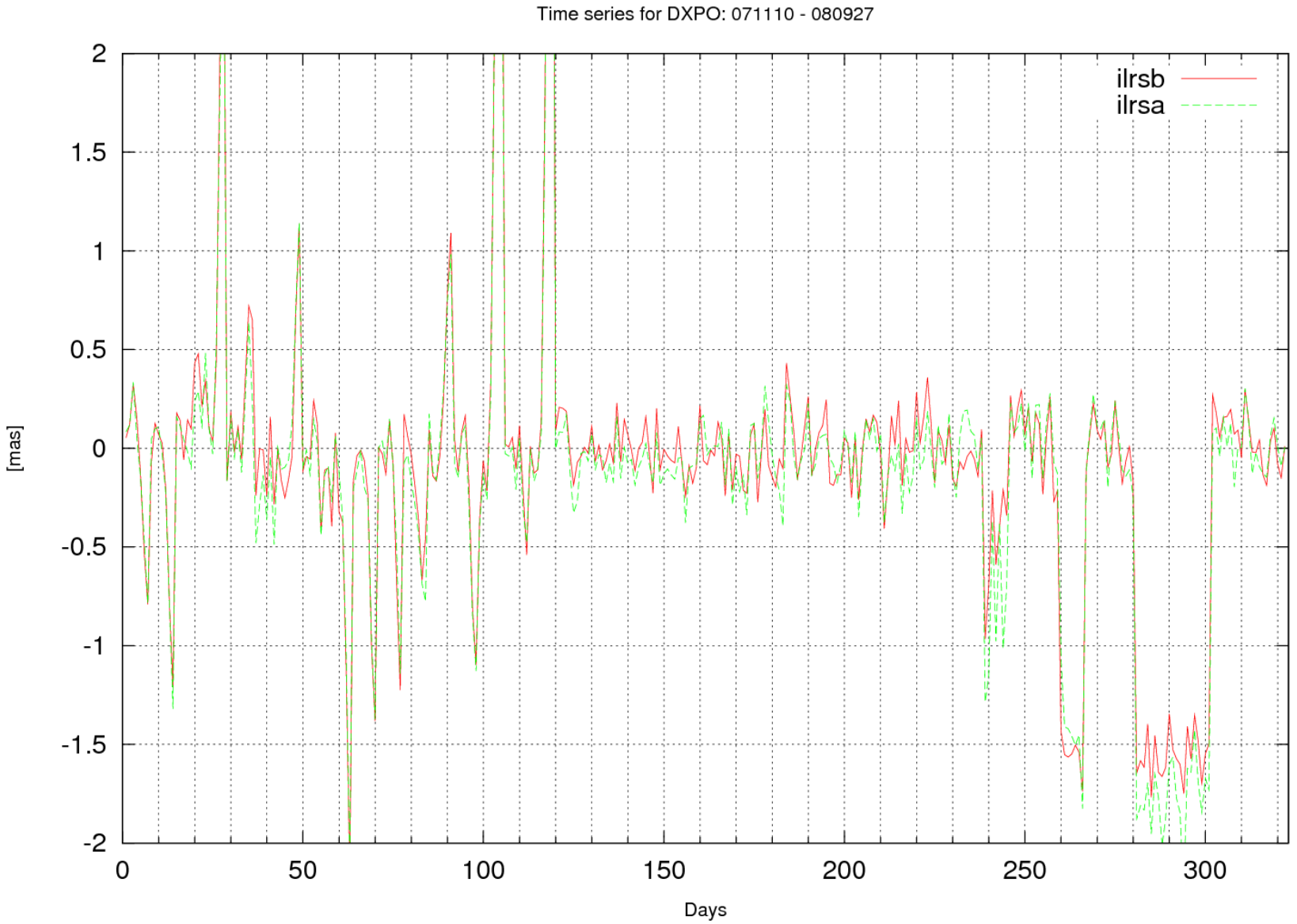


Weekly combination v10 (7)



DGFI FGS Forschungsgruppe Satellitengeodäsie

Weekly combination v10 (8)

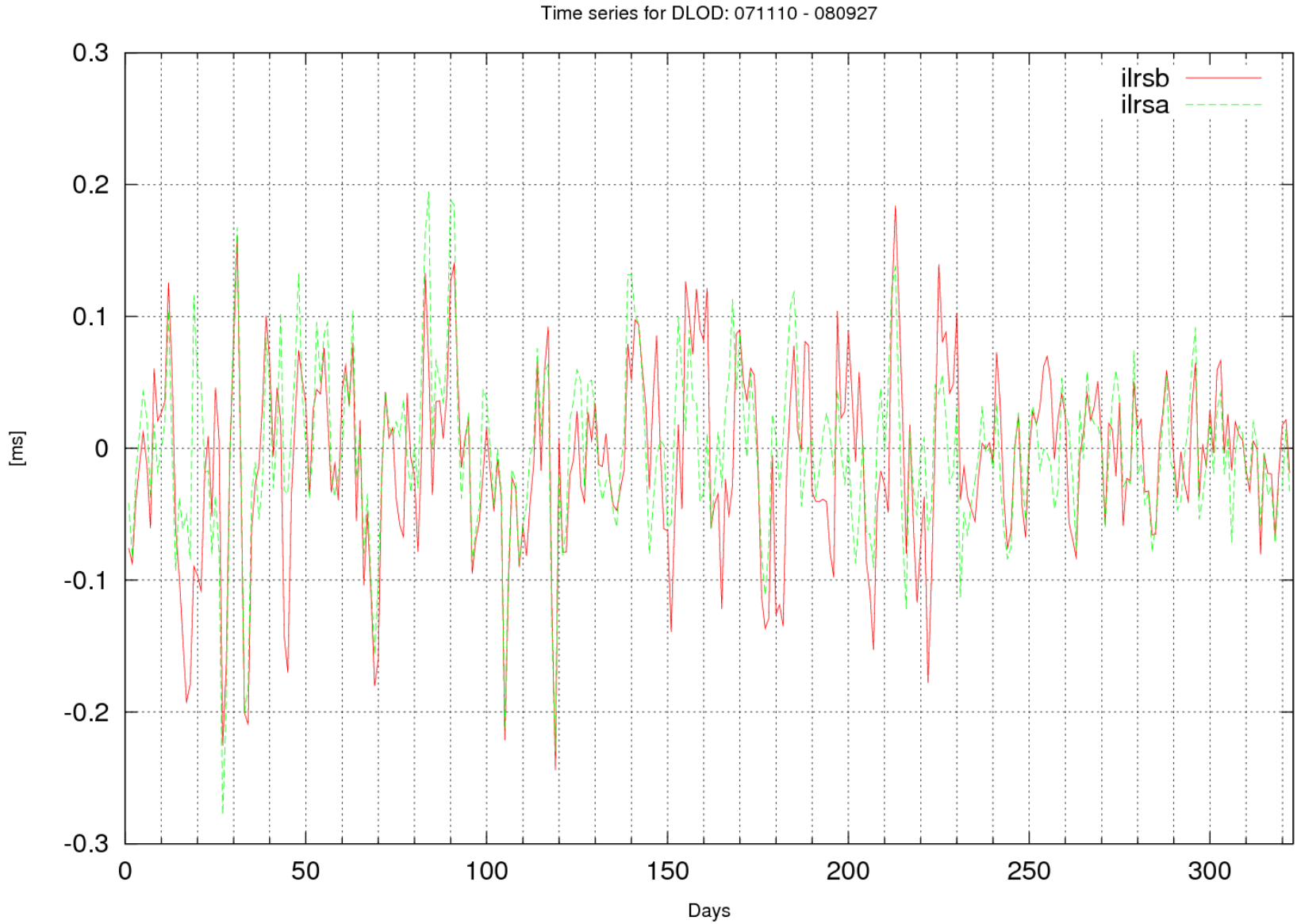


DGFI FGS Forschungsgruppe Satellitengeodäsie

Weekly combination v10 (9)

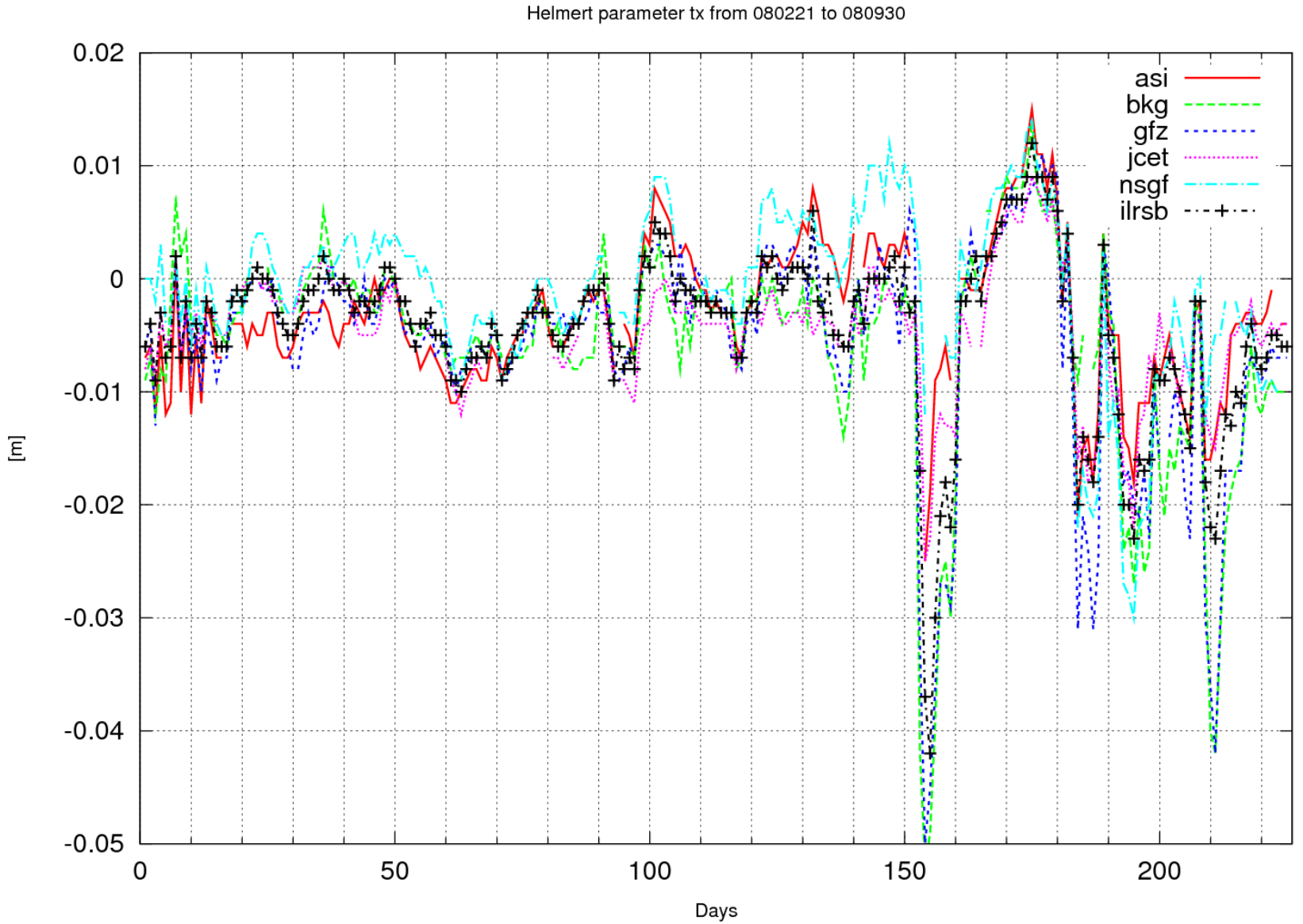
DGFI FGS Forschungsgruppe Satellitengeodäsie

Weekly combination v10 (10)



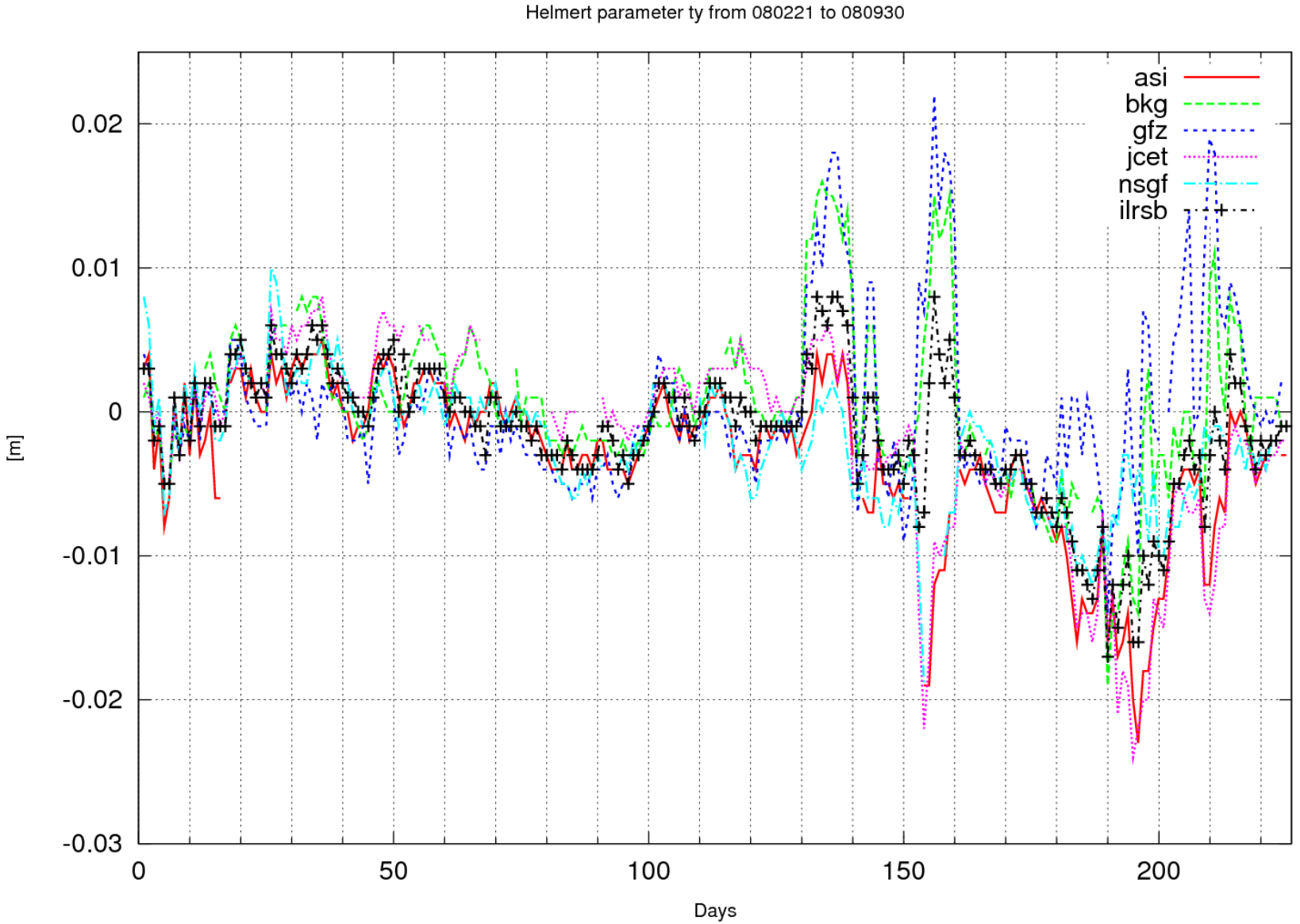
DGFI Forschungsgruppe Satellitengeodäsie

Daily combination v100 (1)



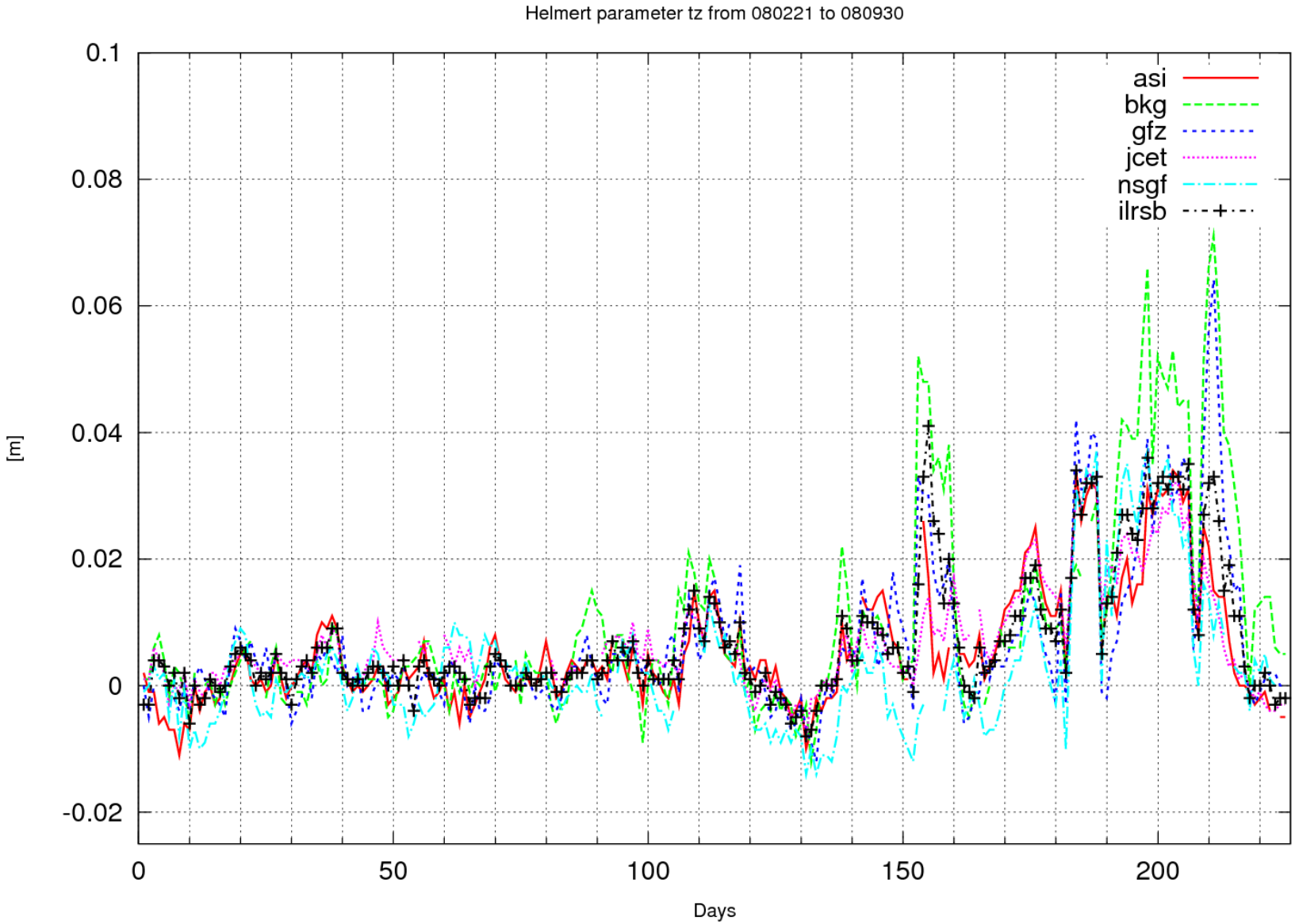
DGFI Forschungsgruppe Satellitengeodäsie

Daily combination v100 (2)

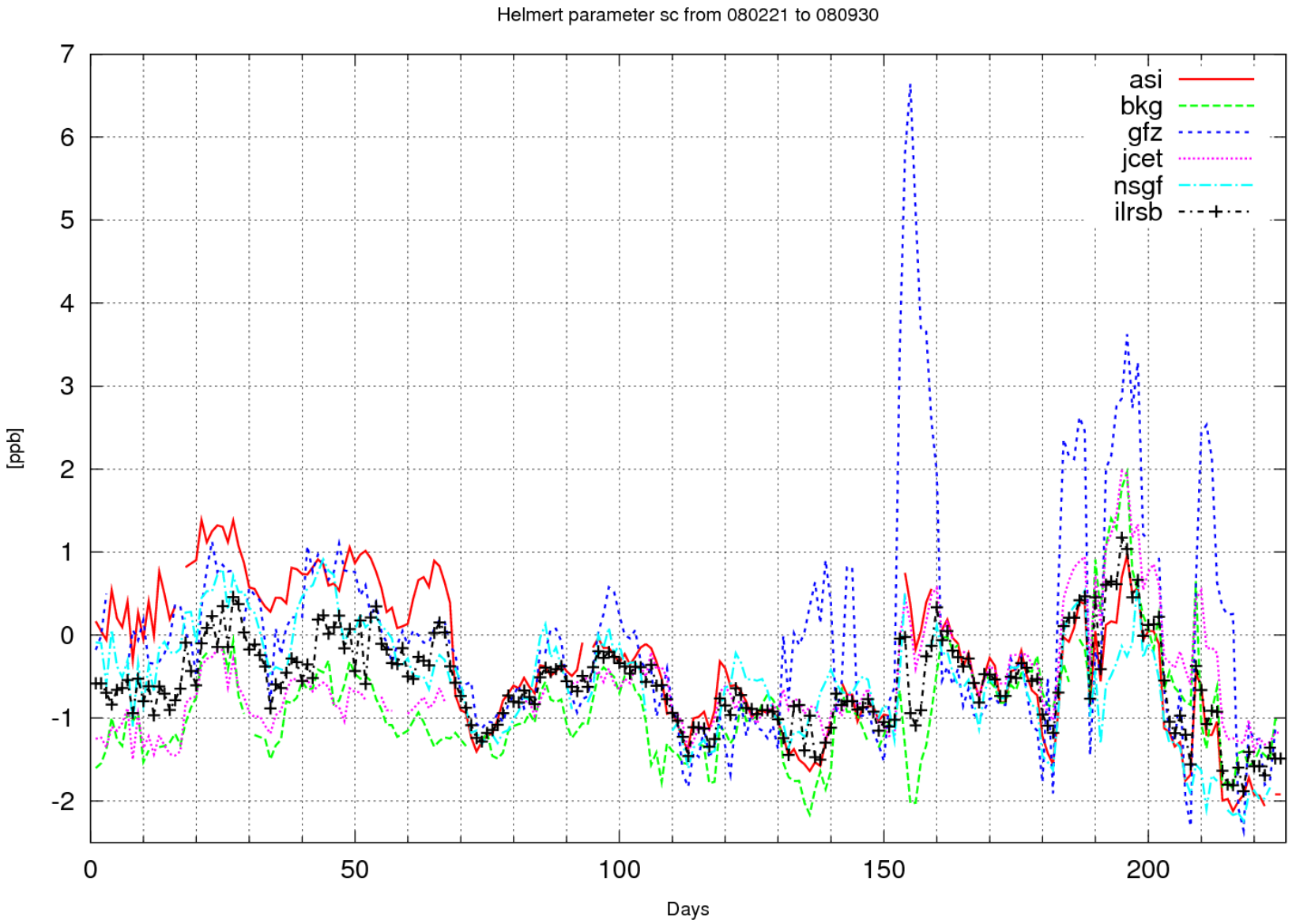


DGFI FGS Forschungsgruppe Satellitengeodäsie

Daily combination v100 (3)



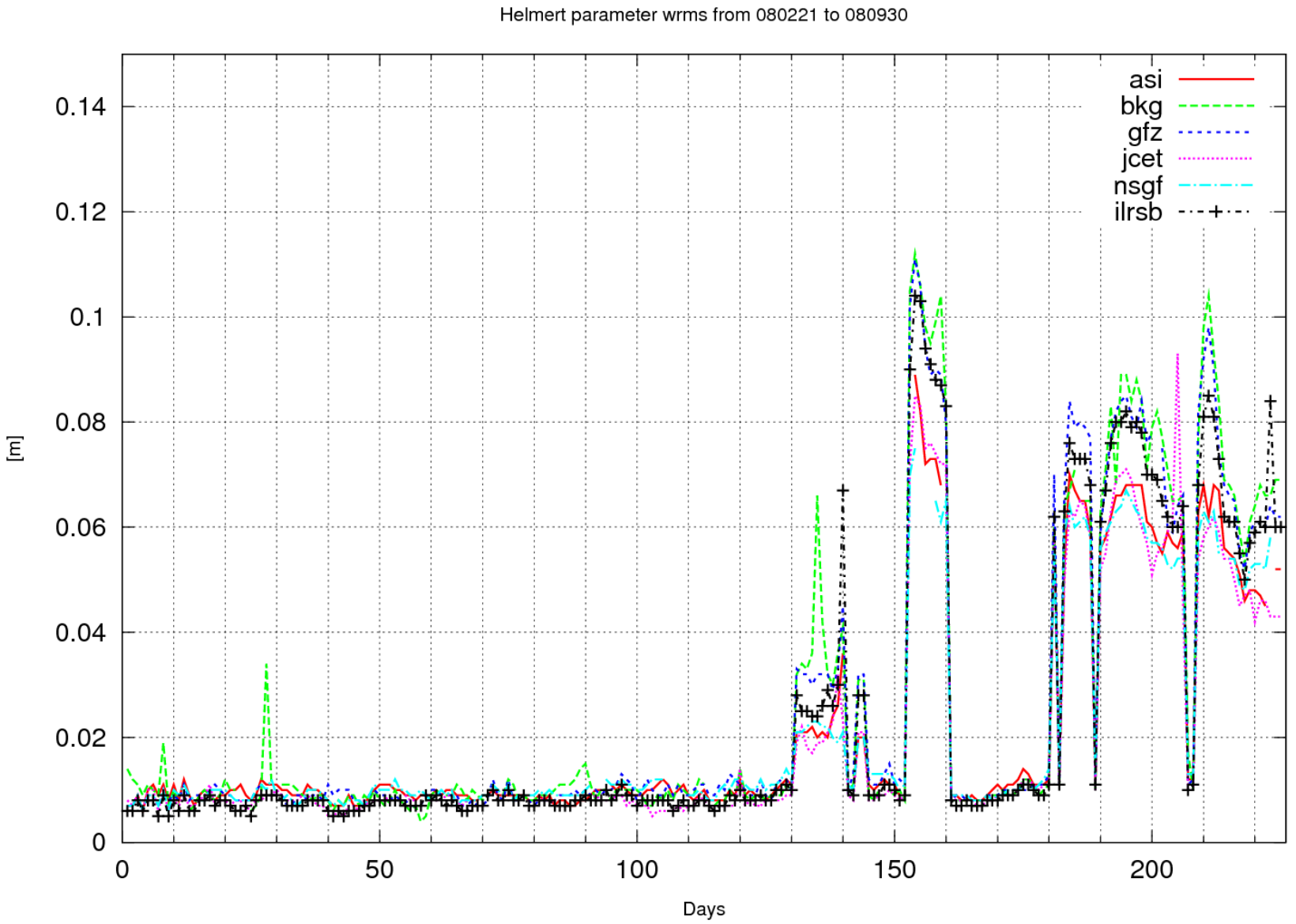
Daily combination v100 (4)



ILR

DGFI Forschungsgruppe Satellitengeodäsie

Daily combination v100 (5)

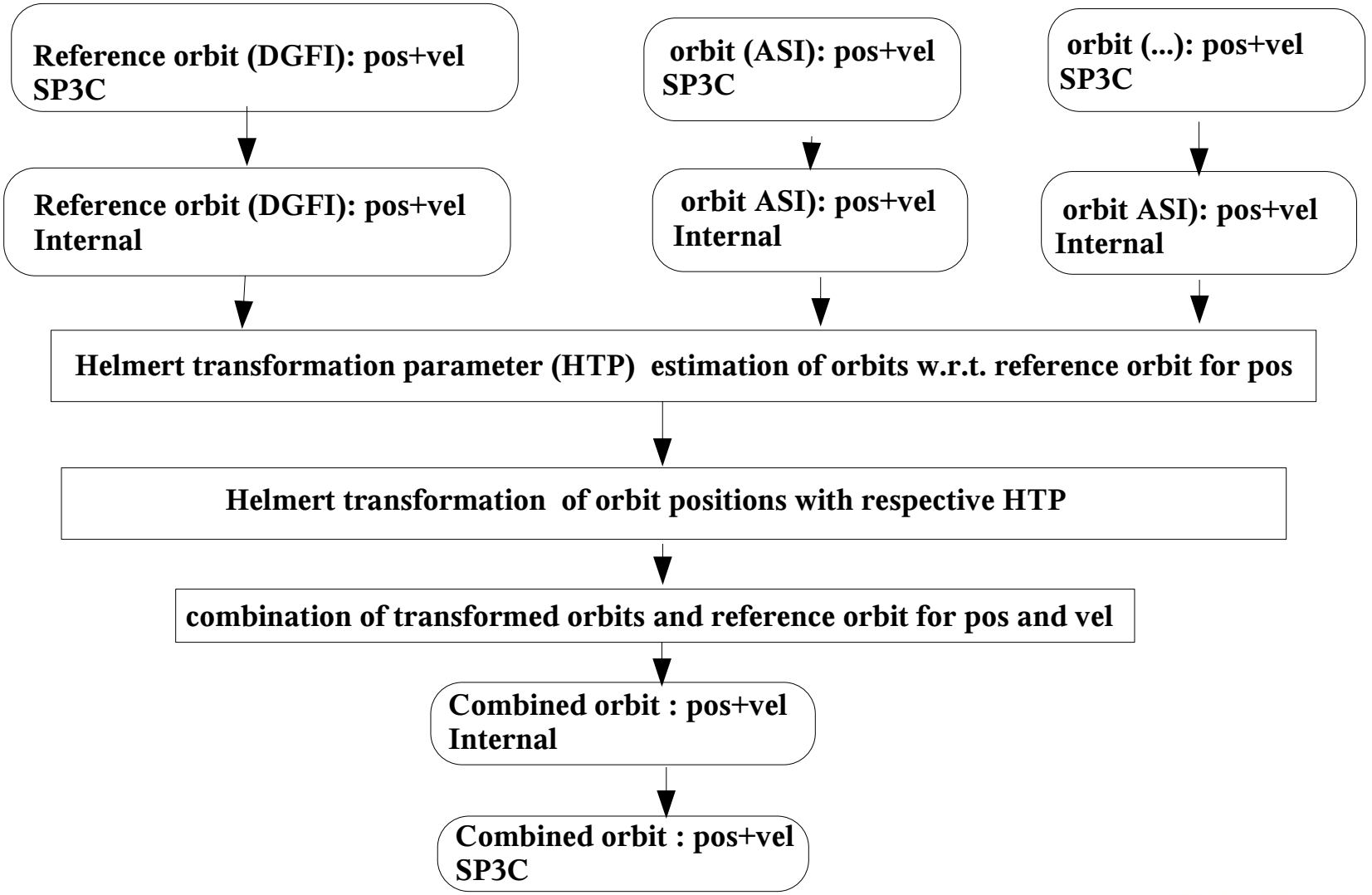


ILR

DGFI Forschungsgruppe Satellitengeodäsie

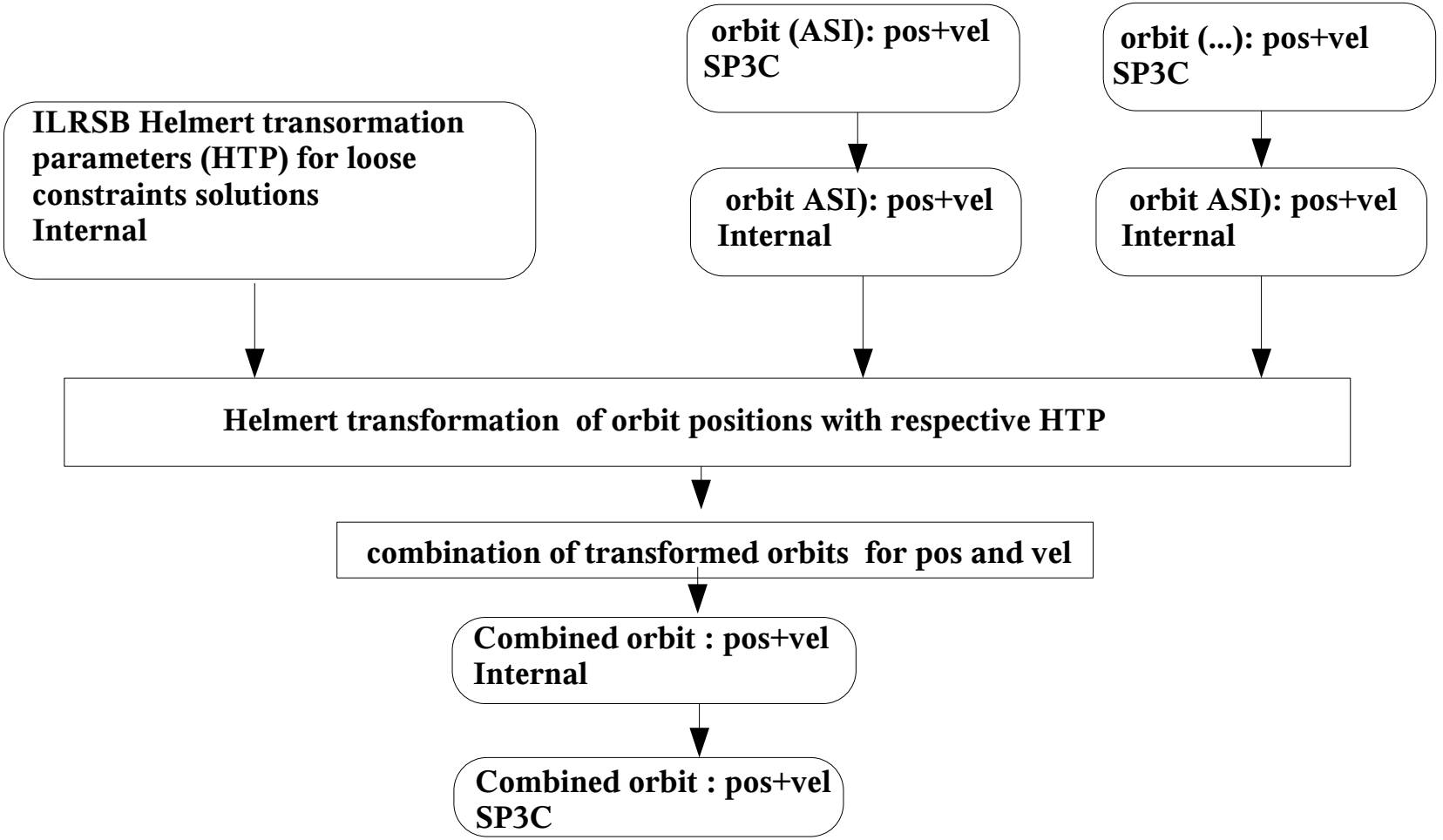
Orbit combination SP3C (1)

Processing flow of version 1



Orbit combination SP3C (2)

Processing flow of versiion 2



Australian Government

Geoscience Australia

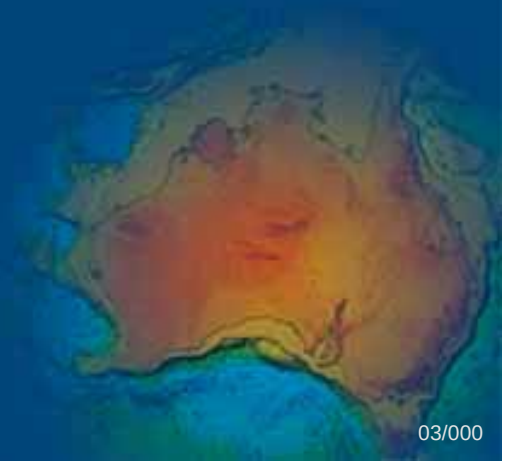
Activity Report to ILRS AWG

Ramesh GOVIND

ILRS AWG Meeting

12th October 2008

Poznan



Current Status and Activities

- Upgraded from Geodyn0511 to Geodyn0712 and GOT4.7 Ocean tides and Ocean Loading
- Lageos-1 & Lageos-2 recomputed with new version for the period beginning 1993 to mid-2008 – Weekly SINEX files submitted
- Continue to submit the weekly SINEX product and SP3c ephemerides comprising Lageos-1, Lageos2, Etalon-1 and Etalon-2

LAGEOS range of center-of-mass correction & proposed values to be adopted by ACs & AACs

Stn pad ID	Name	Pulse length (ps)	Detector	Regime (single, few, multi)	Editing Level (×σ)	Calib. St. error (mm)	LAGEOS St. error (mm)	LAGEOS CoM range (mm)	LAGEOS CoM ADOPTED (mm)
1873	Simeiz	350	PMT	No CNTL	2.0	60	70	248-244	246
1884	Riga	130	PMT	CNTLD s->m	2.0	10	15	252-248	250
7080	McDonald	200	MCP	CNTLD s->m	3.0	8.5	13	250-248	249
7090	Yaragadee	200	MCP	CNTLD f->m	3.0	4.5	10	250-248	249
7105	Greenbelt	200	MCP	CNTLD f->m	3.0	5	10	250-248	249
7110	Mon. Peak	200	MCP	CNTLD f->m	3.0	5	10	250-248	249
7124	Tahiti	200	MCP	CNTLD f->m	3.0	6	10	250-248	249
7237	Changchung	200	CSPAD	CNTLD s->m	2.5	10	15	250-245	248
7249	Beijing	200	CSPAD	No CNTL, m	2.5	8	15	255-247	251
7355	Urumqui	30	CSPAD	No CNTL	2.5	15	30	255-247	251
7405	Conception	200	CSPAD	CNTLD s	2.5	15	20	246-245	246
7501	Harteb.	200	PMT	CNTLD f->m	3.0	5	10	250-244	247
7806	Metsahovi	50	PMT	?	2.5	15	17	254-248	251
7810	Zimmerwald	300	CSPAD	CNTLD s->f	2.5	20	23	246-244	245
7811	Borowiec	40	PMT	No CNTL f	2.5	16	23	256-250	253
7824	San Fernando	100	CSPAD	No CNTL s->m	2.5	30	25	252-246	249
7825	Stromlo	10	CSPAD	CNTLD s->m	2.5	4	10	257-247	252
7832	Riyadh	100	CSPAD	CNTLD s->m	2.5	10	15	252-246	249
7835	Grasse	50	CSPAD	CNTLD s->m	2.5	6	15	255-246	250
7836	Potsdam	35	PMT	CNTLD s->m	2.5	10	20	256-252	254
7838	Simosato	100	MCP	CNTLD s->m	3.0	20	40	252-248	250
7839	Graz	35	CSPAD	No CNTL m	2.2	3	9	255-250	252
7839	Graz kHz	10	CSPAD	No CNTL s->f	2.2	3	9	255-250?	252
7840	Herstmonceux	100	CSPAD	CNTLD s	3.0	6	15	246-244	245
7840	Hx kHz	10	CSPAD	CNTLD s	-1.5,+2.5	3	9	245	245
7841	Potsdam 3	50	PMT	CNTLD s->f	2.5	10	18	254-248	251
7941	Matera	40	MCP	No CNTL m	3.0	1	5	252-248	250
8834	Wettzell	80	MCP	No CNTL f->m	2.5	10	20	252-248	250

MERIT from QL

```
760390108151233635623984708024190516697578770000079532008009292904200-0000927000000004770011240111652100
760390108151234293907088708024190509355295320000091532008009292904200-0000927000000004770012240111652100
760390108151236286764986708024190489977299680000103532008009292904200-0000927000000004770006240111652100
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```

MERIT from CRDX

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760390108151023363562398359369000000802419000000000000005166975787700000008000532000080088292950420000000000000000000-0000926800000000467001124011165230
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760390108151023848570794909108000000802419000000000000004742912087700000008000532000080088292950420000000000000000000-0000926800000000467002524011165230
```

Difference in the RMS of fit of weekly arcs of LAGEOS SLR for 2001 & 2006 and four Atmospheric loading treatments (one being NO loading)

Variable	Points	Mean	Median	RMS	Std Deviation
ΔRMS v0-NO	52	3.4	2.7	4.45	2.87
ΔRMS v1-NO	104	2.9	2.1	4.31	3.16
ΔRMS v2-NO	52	2.7	1.7	4.09	3.08
ΔRMS v1-v0	52	0.4	0.0	0.92	0.82
ΔRMS v2-v1	52	1.7	1.4	2.58	1.96

"v0": 1970/01 - 2002/08: ECMWF Reanalysis (ERA40), with a spatial resolution of 1.125 degrees

"v1": 2000/12 - 2006/12: ECMWF Operational, with a spatial resolution of about 0.350 degrees

"v2": 2005/10 - now: ECMWF Operational, with a spatial resolution of about 0.250 degrees

Rethinking the Definition of NPs

Erricos C. Pavlis with input from Werner Gurtner

- The additional information content of the large number of returns per normal point is certainly not significant at all, the formal errors are unreasonably small and have nothing to do with the actual error situation (systematic errors).
- There are several questions to examine:
  - Should one **reduce the bin length** of the normal points of many of the satellites to pass at least some additional information to the analysis?
  - Should one **limit the number of returns** per normal point, i.e. should the station stop tracking if it reaches this maximum number before the end time of the normal point - and do something else?
  - Should one **adjust the position of the normal point bins** to the actual data, i.e. forget about the "worldwide" synchronization of the start and end times of the normal points? This "synchronization" (of no use at all for the analysts/analysis), often leads to normal points that are formed by a just few returns at the edge of the normal point bin.

Zimmerwald NP Example (GLONASS)

Bin Number	Number of Obs per Bin	Residual (ns)	RMS	Residual (mm)	RMS
1	575	0.007	0.007	1.0	1.1
2	1348	0.000	0.005	0.0	0.7
3	1320	0.003	0.005	0.5	0.7
4	786	-0.018	0.006	-2.8	0.9
5	1312	-0.001	0.003	-0.2	0.5
6	2434	-0.002	0.002	-0.3	0.4
7	970	-0.003	0.004	-0.5	0.7
8	1918	0.003	0.003	0.5	0.4
9	3884	0.001	0.002	0.2	0.4
10	3577	-0.002	0.002	-0.3	0.4
11	3769	0.002	0.002	0.4	0.3
12	3074	-0.001	0.002	-0.2	0.4
13	2217	0.004	0.003	0.7	0.4
14	3302	0.001	0.002	0.1	0.3
15	2832	-0.002	0.002	-0.4	0.3
16	3040	0.000	0.002	0.0	0.3
17	1703	0.003	0.003	0.4	0.4
18	1589	-0.006	0.003	-0.9	0.4
19	1691	-0.002	0.003	-0.2	0.4
20	3460	0.005	0.002	0.7	0.3
21	2594	-0.009	0.002	-1.3	0.3
22	2699	0.001	0.002	0.1	0.3
23	475	0.003	0.005	0.5	0.7

23 normal points stored. Bin width: 300 sec

Basic Reasons Requiring New Orbit Format

Erricos C. Pavlis

- **The main things that folks wanted to see in a new orbit format were:**

1. capability to handle any number of satellites
2. allow for unlimited comments (both in the header and at any epoch)
3. irregularly spaced epochs (to allow for LEO receiver clock error, or missing positions in a kinematic solution of a LEO satellite)
4. make it okay to have a variable number of satellites at an epoch (this goes hand-in-hand with #3 above)
5. design a more flexible, SINEX-like header (this is critical to handle any/all future SVs; GEO/MEO/LEO and future GNSS constellations)
6. allow for 0.1 mm precision (for GRACE, for GEOs, and for computing velocities from positions)
7. Attitude information (this could be an attitude model in the header, quaternions at each epoch, or the vector from the center-of-mass to a certain point of interest -- antenna phase center, retro-reflector, center-of-sensor, center-of-transmitter, etc.)

The Consultative Committee for Space Data Systems

Draft Recommendation for
Space Data System Standards

ORBIT DATA MESSAGES

DRAFT RECOMMENDED STANDARD

CCSDS 502.0-P-1.1

PINK BOOK

July 2008

SGF Analysis Centre Report to AWG

Graham Appleby, Philip Gibbs, Matthew Wilkinson, Vicki Smith

Space Geodesy Facility, Herstmonceux, UK

AWG at16th International Workshop on Laser Ranging, Poznan Sunday 12th October 2008

NATURAL ENVIRONMENT RESEARCH COUNCIL

International Laser Ranging Service

Regular analysis products

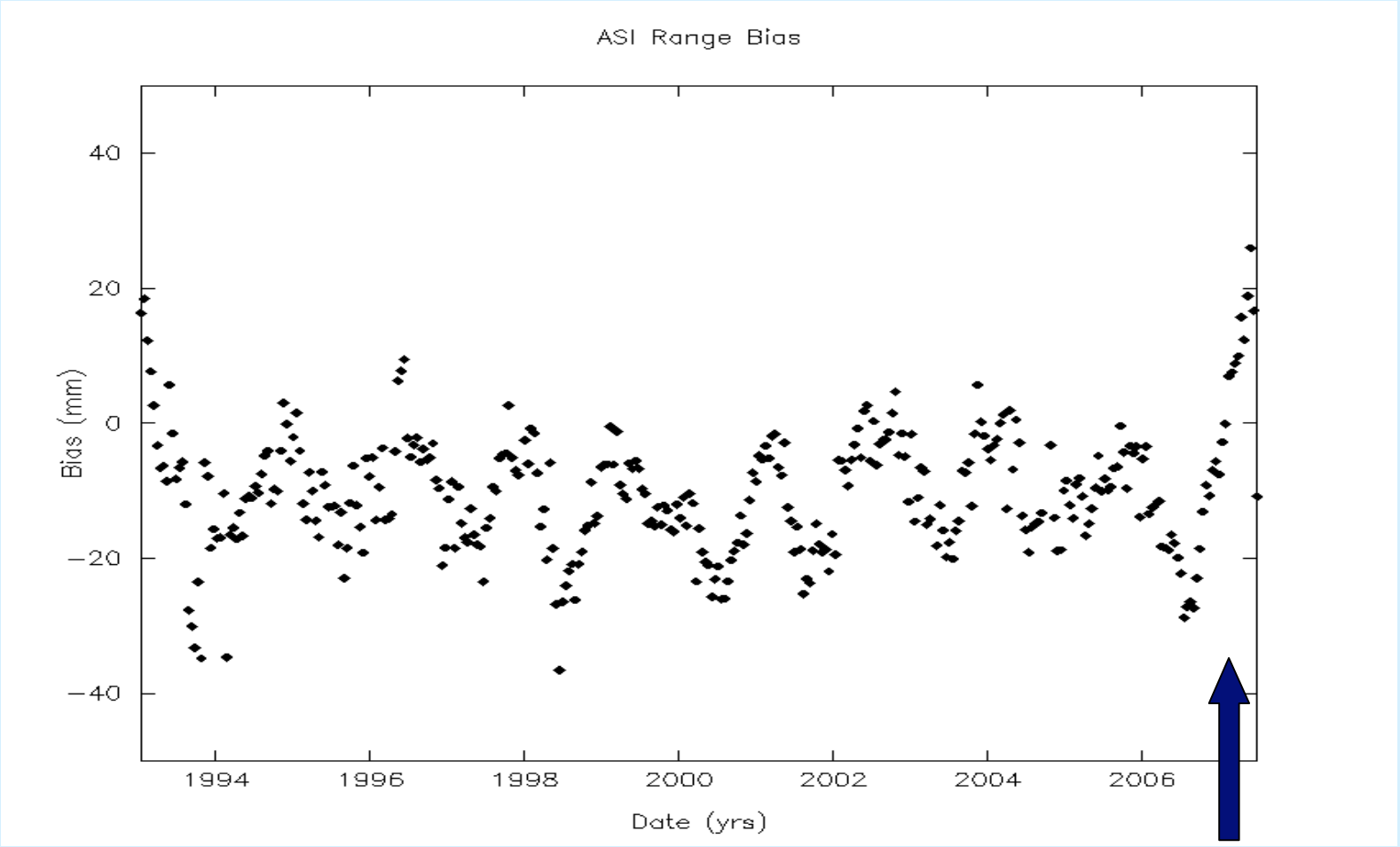
- Weekly 'v10' solutions delivered on Tuesdays
- Daily 'v100' solutions delivered every day
- Progress on generating orbit products and low degree and order gravity field coefficients
- New daily web-based QC 'long-arc' and 'short-arc' on new : **http://sgf.rgo.ac.uk**

1993-2007 re-analysis

- Transferred s/w to new Linux machine
- Implemented bias correction series
- Expect to deliver series by end 2008

Herstmonceux RB problem

LAGEOS-2



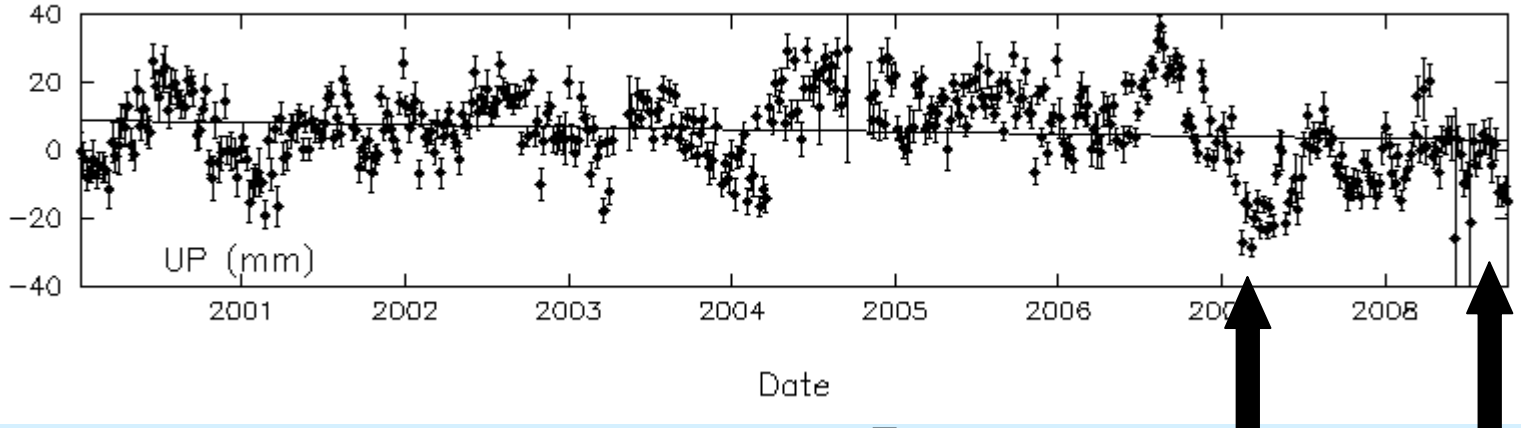
Stanford counter era

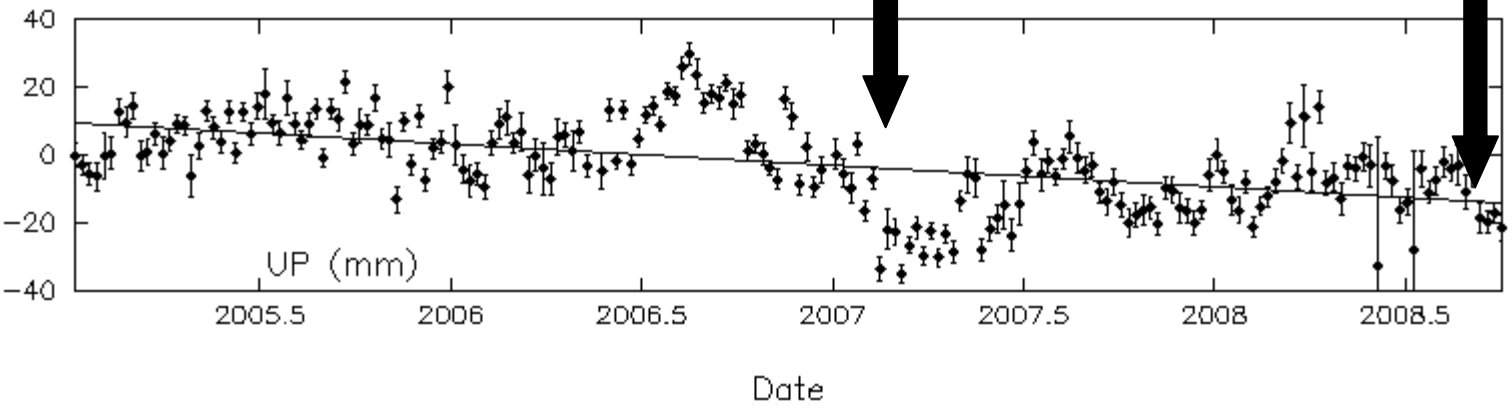
Start Thales event timer era

High-quality event timer

- Based on high-spec Thales units, ps-level linearity
- Introduced 2007 Feb 11 (doy 41)
- From that date, system should be bias-free at mm-level
- However, ‘jump’ in LAGEOS-2 RB series starts 2007 ~ doy 21 and again 2008 ~ doy 245 ?

Height time series for Herstmonceux from LAGEOS and ETALON (SGF and ASI solutions)

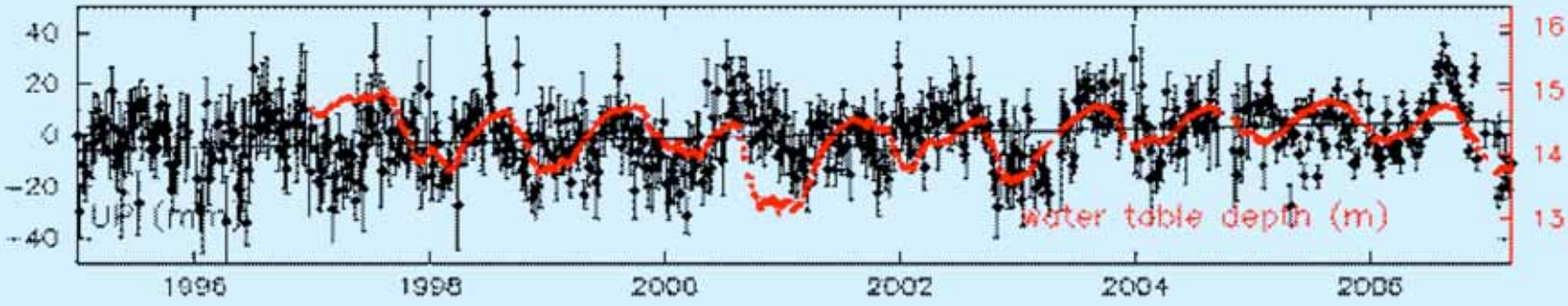




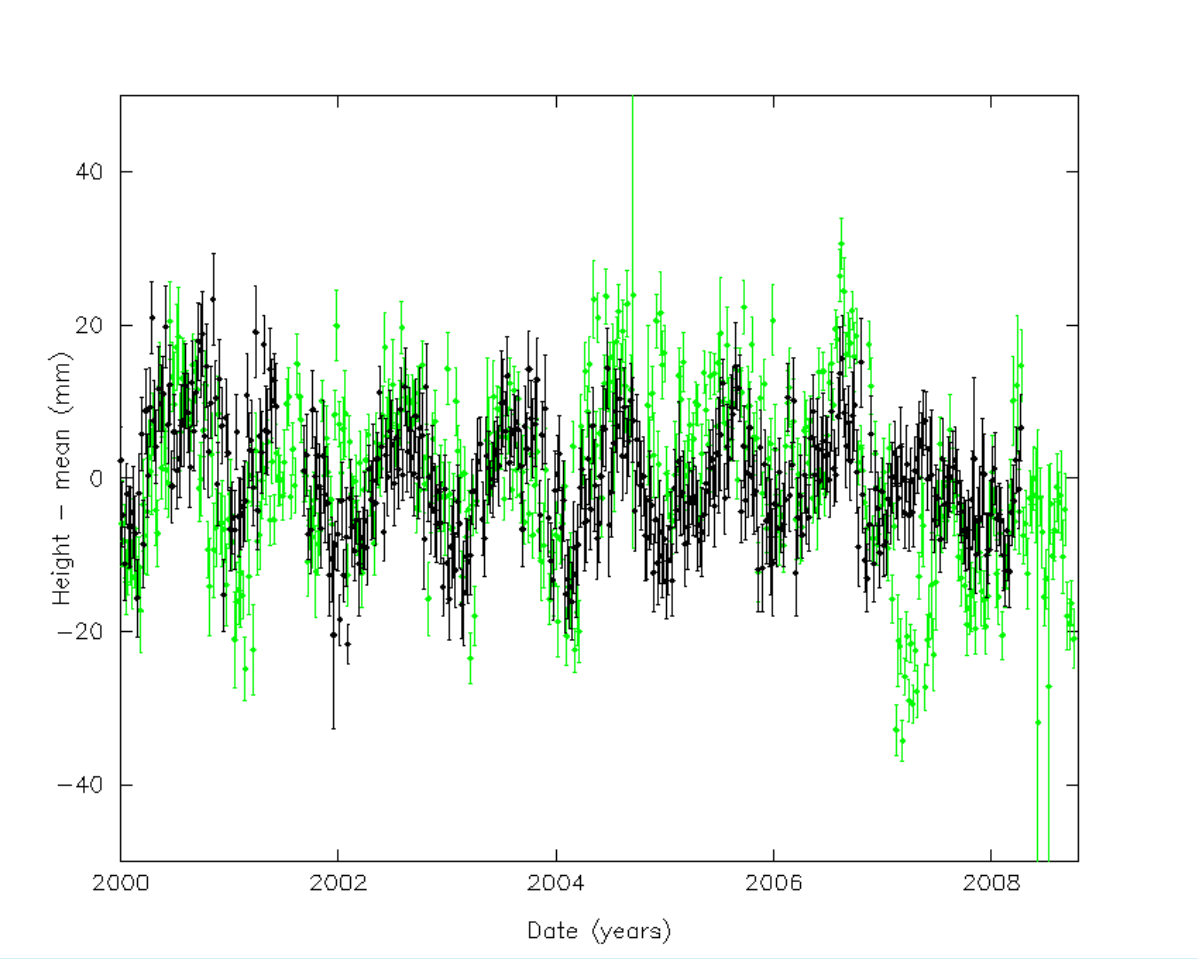
arrows mark RB ‘jumps’ dates

RB or local deformation?

- From this height series, it was not immediately apparent that there was a 2007 ‘jump’, RB problem.
- Previously-observed correlation between seasonal water-table level and height – loading or soil moisture driven:

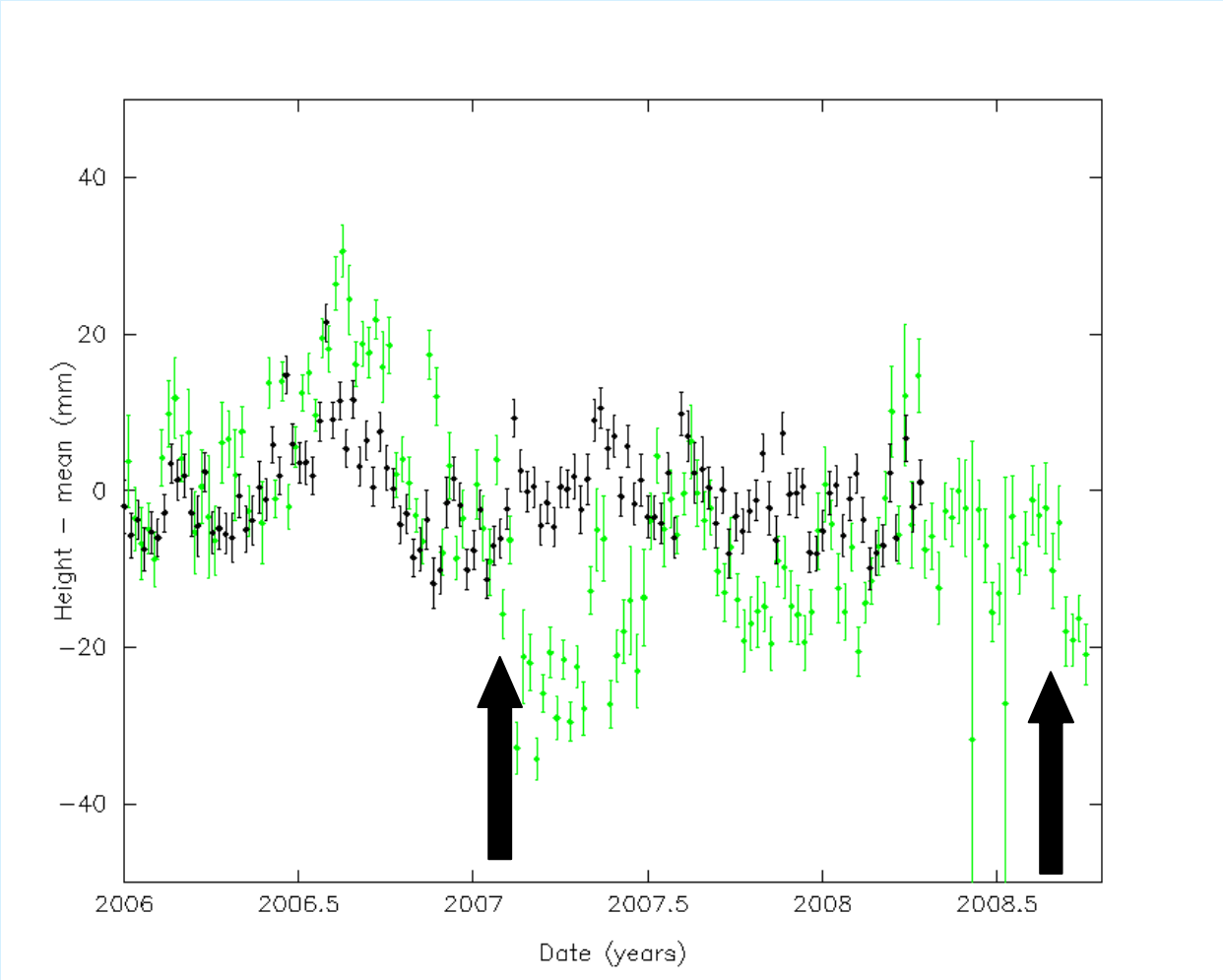


Comparison with HERS GPS system, close to laser ranger



Laser series (green), GPS (black)

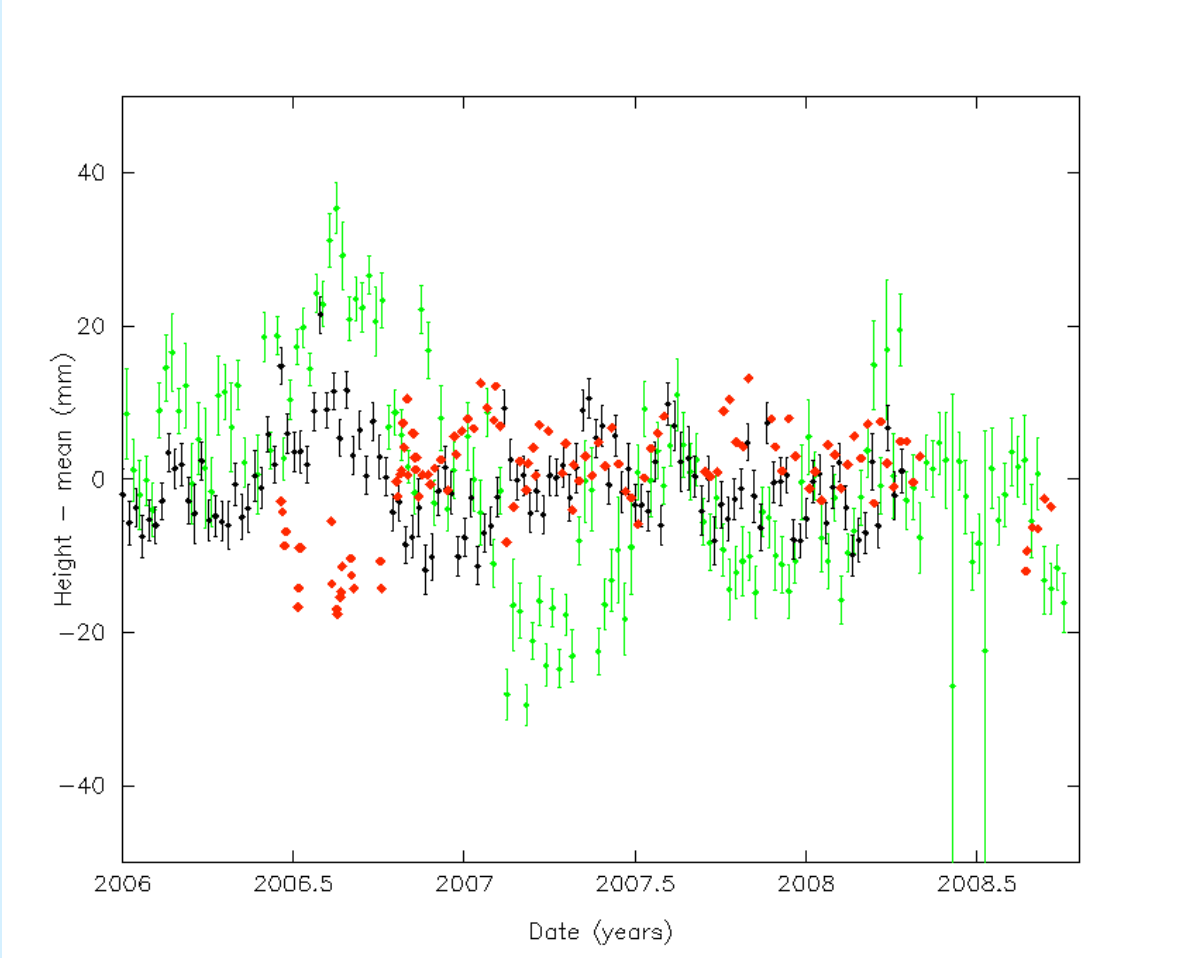
In close-up, from 2006 to date



Addition of absolute gravity measurements

- From early 2006, an FG5 absolute gravimeter has been operated on site
- From late 2006, weekly, 24-hour observing sessions
- Average gravity variations converted to equivalent height changes using estimated 1μGal = - 4.5mm (following Zerbini *et al*, 2007)
  - Conversion to be refined in future via seasonal signals
- Precision of average values ~4mm

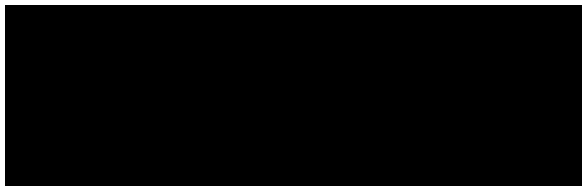
Laser (green), GPS (black) and height-from-gravity (red)



Lunar Laser Ranging Validation Plan for New LLR Sites

Jürgen Müller

Institut für Erdmessung, Leibniz Universität Hannover, Germany

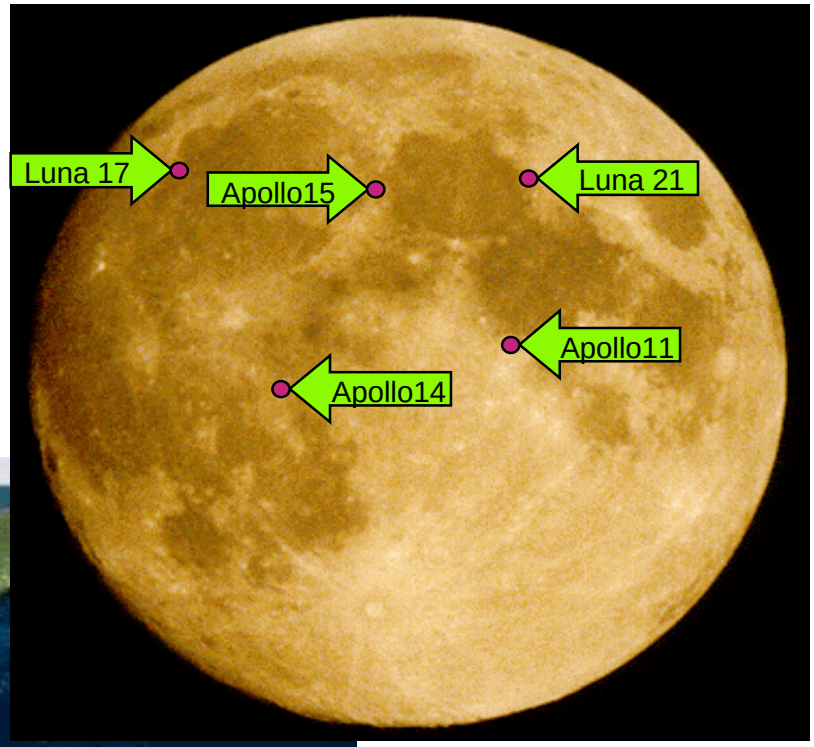


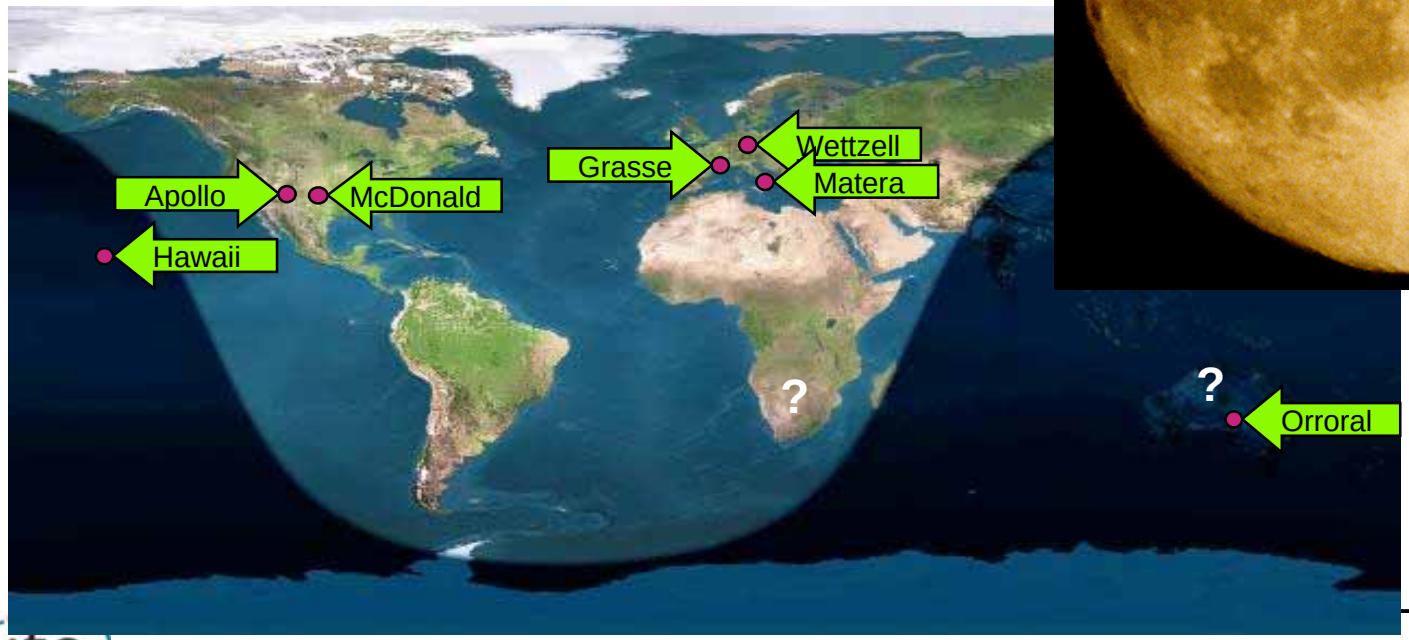
Background

„We are happy with each single LLR measurement at all.“

Most data have been collected

- from old OCA site, Grasse
- to reflector array of Apollo 15





Current LLR Network

- McDonald: routine operation, but reduced priority (and reduced quality – no system upgrades)
- APOLLO: restricted Geodesy application, high (internal) quality, but some systematics wrt. „LLR system“ to be solved
- OCA: new system installation ready by end of 2008?
- Other sites:
  - Wettzell: plans to re-start in 2009 …
  - Matera: very low priority
  - ?

Science Requirements

(input also from Pete Shelus)

- Lunar interior (sub-cm NPs, 1 hour, 5 times per month)

- Spacecraft navigation, ephemeris (sub-cm NPs, homogeneous distribution througout the month)

- General relativity (sub-cm NPs, as often as possible, i.e. covering all lunar phases, every lunation)

- ...

Validation Plan for (New) LLR Sites

Test phase (1 year)

- Collect as many data as possible
- Check quality in close cooperation with a LLR AC (biases, systematics, internal/external accuracy)

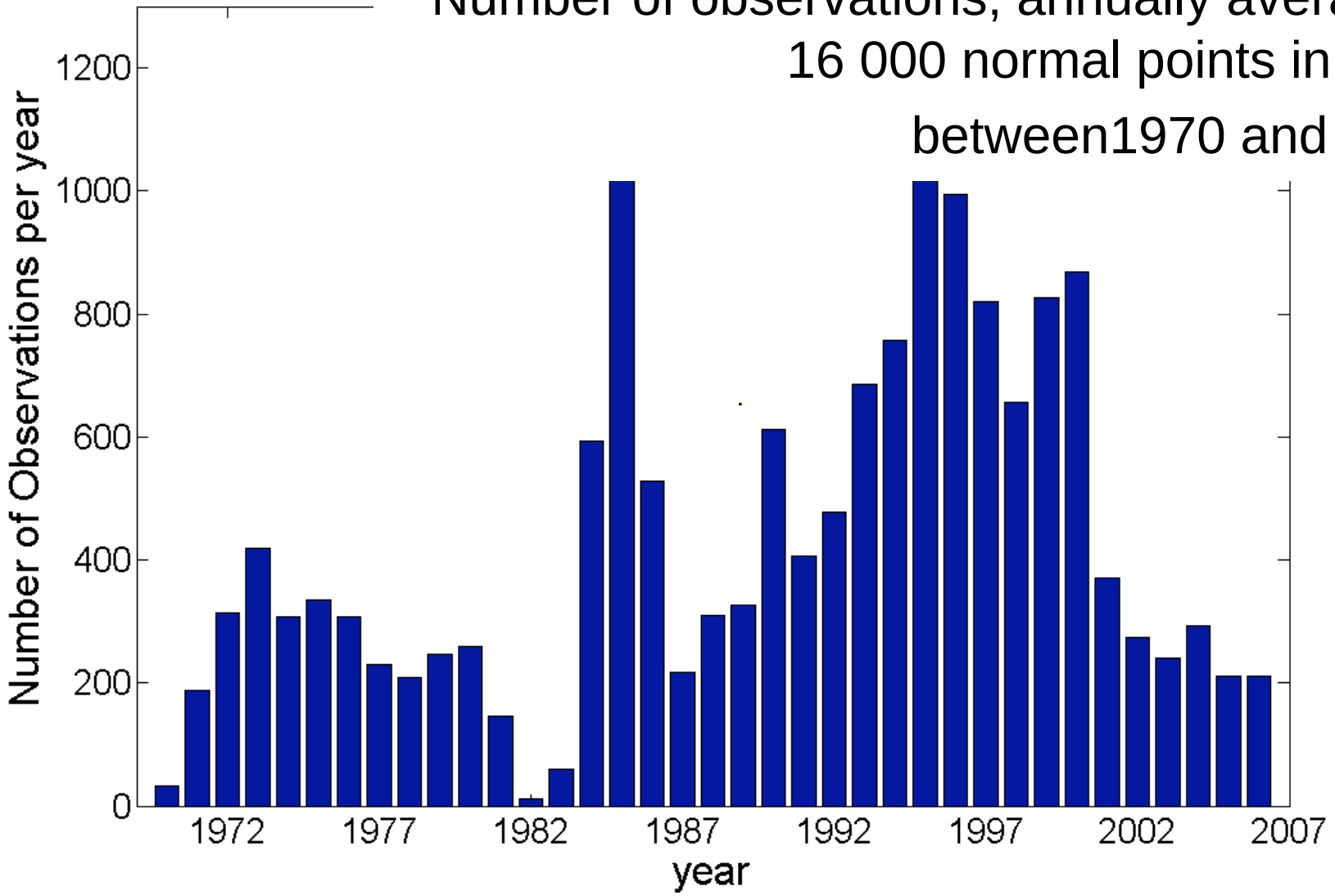
Routine operation (TBC)

- carry out observations to all (four) reflector arrays
- successful observation days/nights per month: **> 4**
- normal points per year: **> 240**
- normal point accuracy: **< 0.1 ns** (goal **< 0.05 – 0.01 ns**)
- post-fit residual of single NP to global solution: **< 1 ns**

Consequences in case of failure?

LLR Observations per Year

Number of observations; annually averaged;
16 000 normal points in total,
between1970 and 2007



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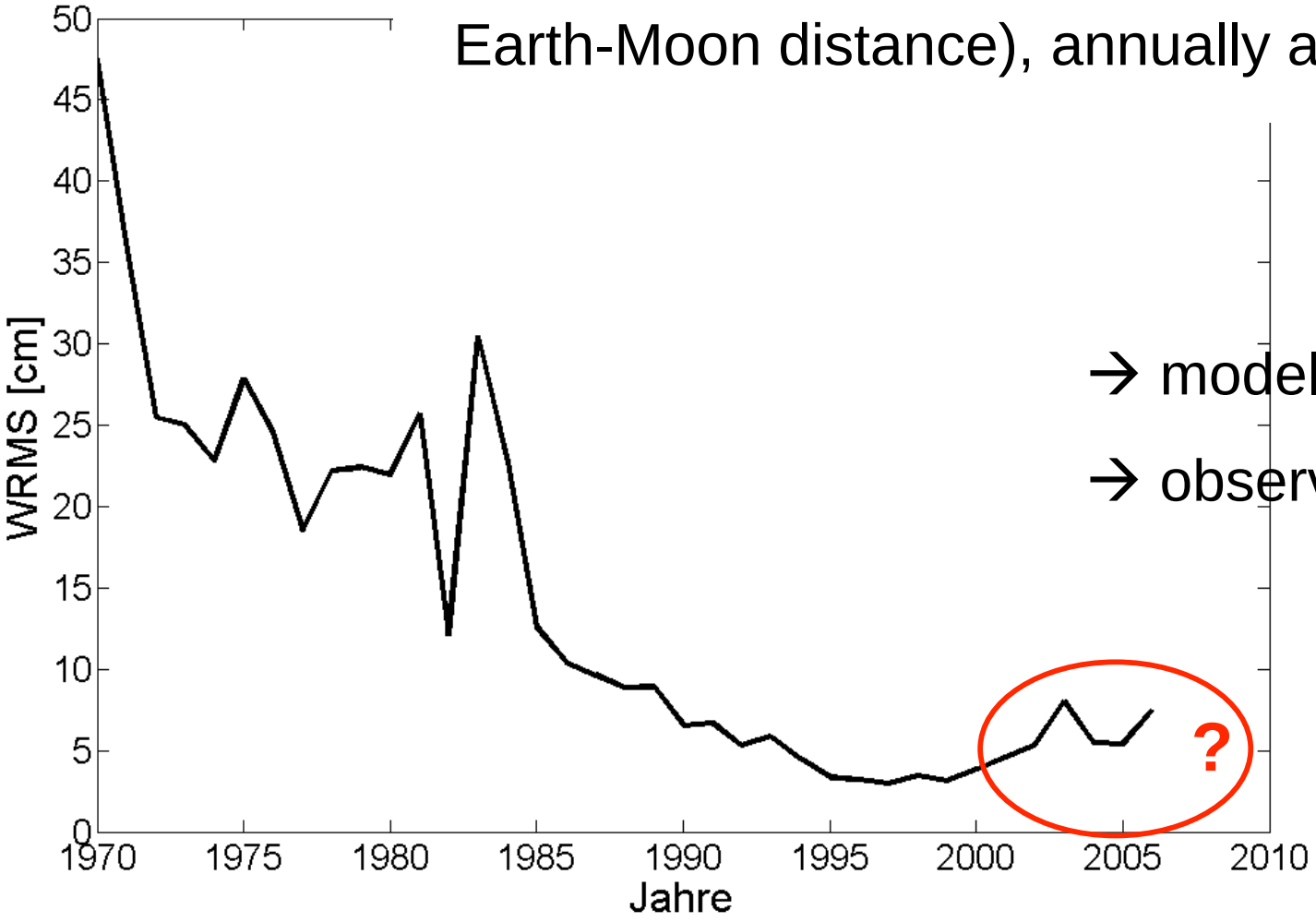
Weighted Annual Residuals

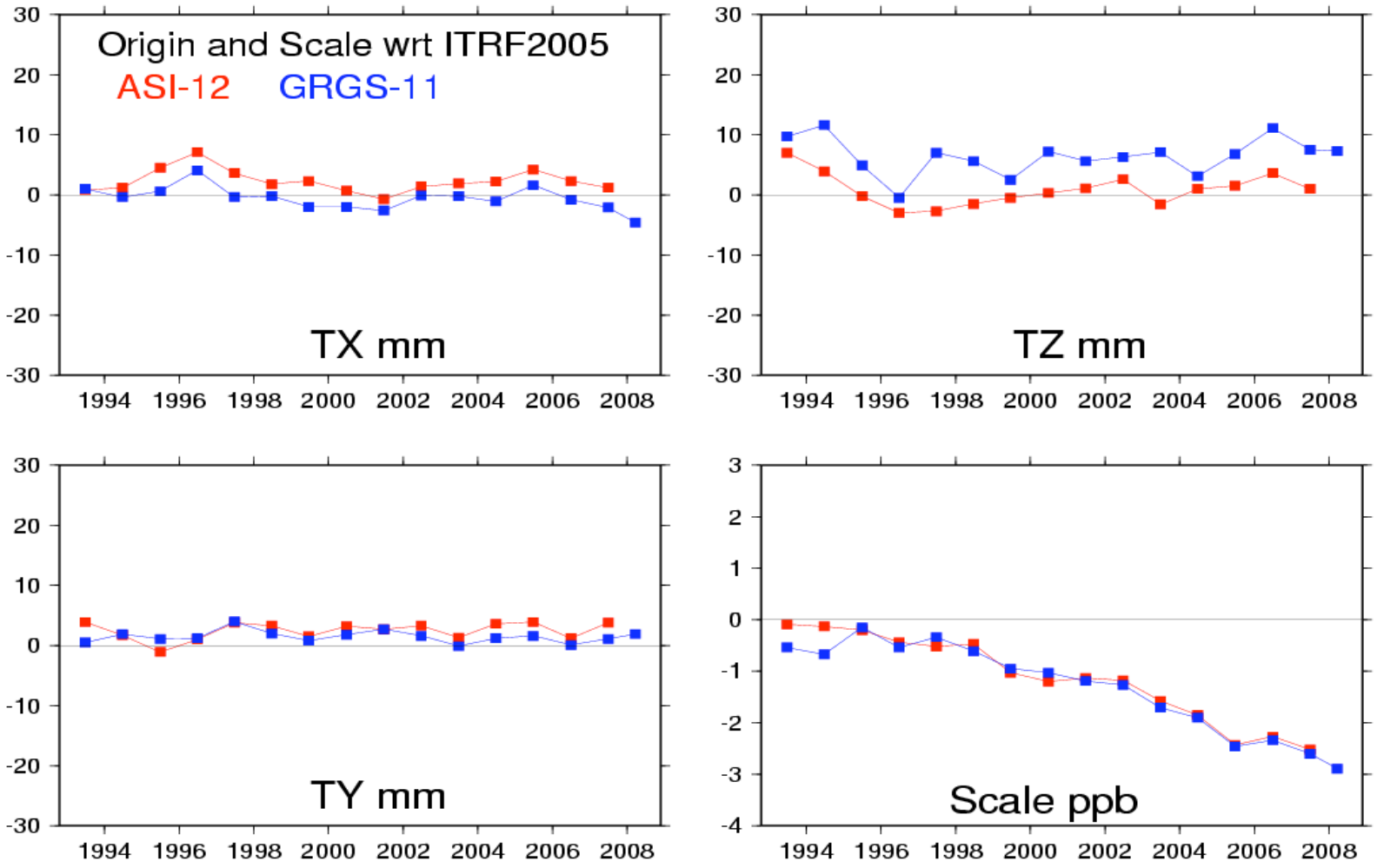
weighted residuals (observed - computed Earth-Moon distance), annually averaged



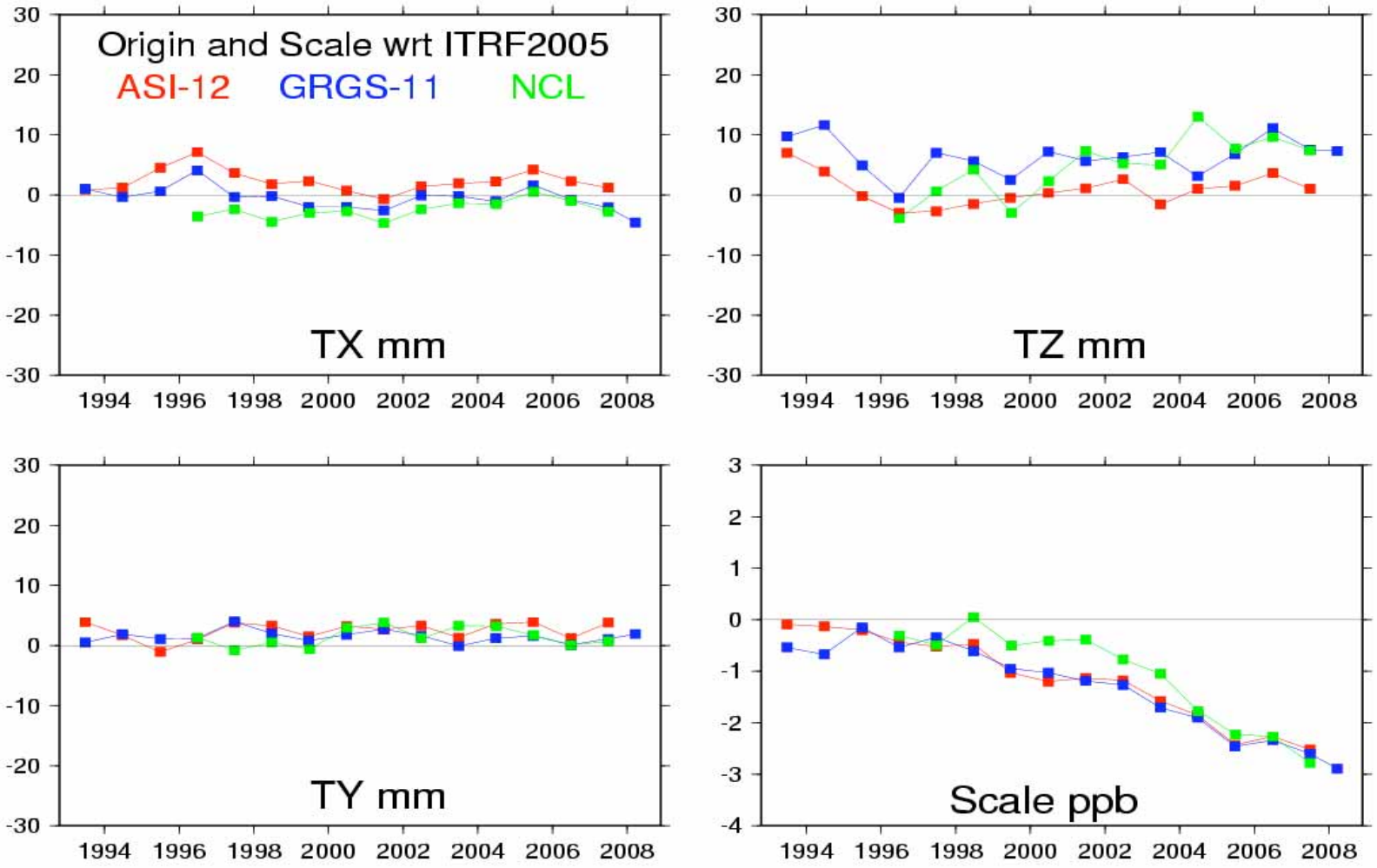
→ model?

→ observations?

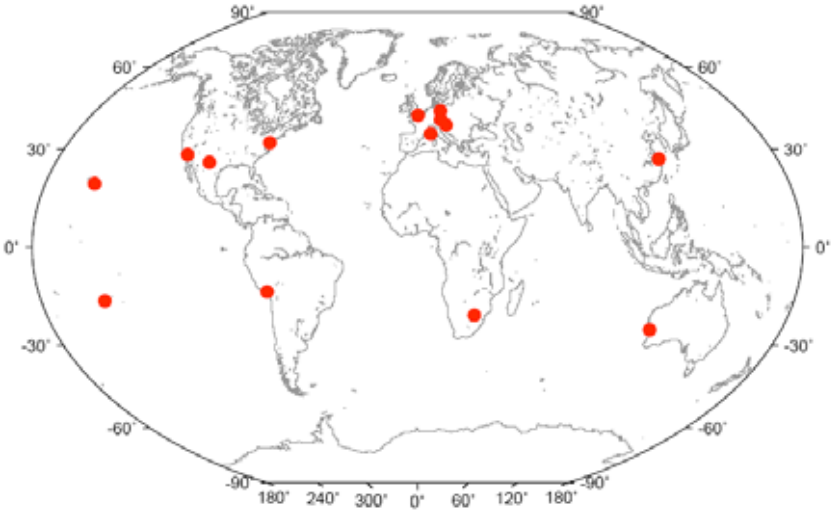
Origin and Scale wrt ITRF2005

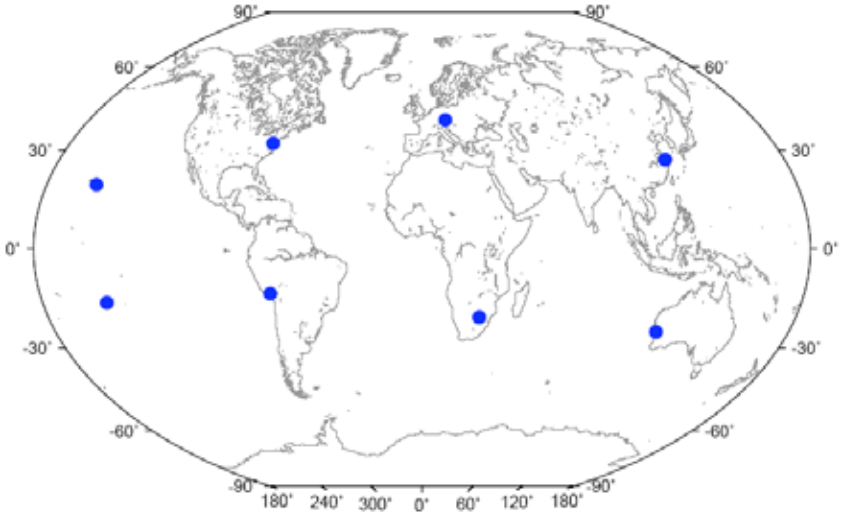


Origin and Scale wrt ITRF2005



ILRS RF Sites





ASI-12 RF Origin & Scale