Deutsches Geodätisches Forschungsinstitut (DGFI-TUM)
Technische Universität München

2023/2 ILRS Analysis Standing Committee meeting

Mathis Bloßfeld[(1)] and Cinzia Luceri[(2)]

(Conveners)

(1) DGFI-TUM

(2) ASI/e-geos

Thursday, October 26th, 2023, Zoom, 1 to 4 PM (UTC)

Today's agenda (order changed; 1 point more…)

0)	Last meeting + open Action Items (AIs)	(MB, CL)	10 minutes
1)	**Short reports of ACs/CCs; status of the new operational products (v180,v80,v280)**	**(all)**	**40 minutes**
2)	LARES-2	(JR)	10 minutes
3)	Stanford counter issue	(AS, GA)	10 minutes
	break (optional)		20 minutes
3)	**ITRF2020 update**	**(CL, MB)**	**50 minutes**
4)	LARES-PP (gravity field estimates)	(MB)	10 minutes
5)	ILRS ASC analysis document website	(MB)	10 minutes
6)	New ACs (CNES and GRGS)	(EP, CL, MB)	10 minutes
7)	Update of DSC files	(all)	10 minutes

Open AIs from the last meeting

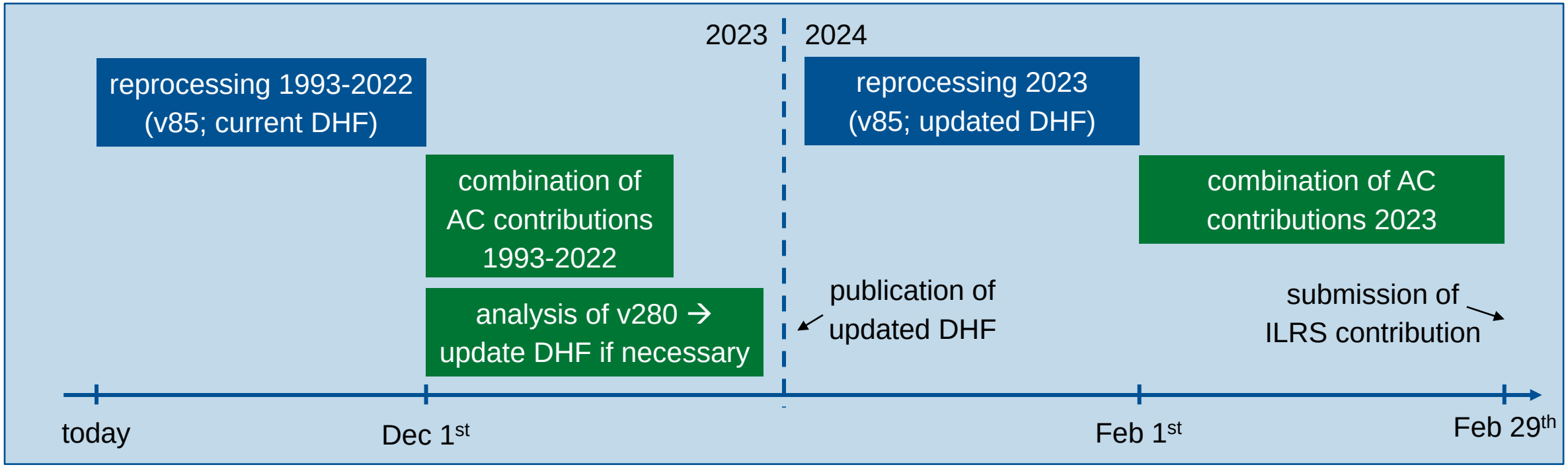
	NEW ACTIONS		
# AI	**Description**	**AC/person**	
1_apr2023	Large scatter of LOD w.r.t. USNO	GFZ	→ status?
2_apr2023	LARES-2 target signature model	José Rodriguez	→ done; cf. 2)
3_apr2023	Publication on ILRS contribution to ITRF2020	Erricos Pavlis	→ status?
4_apr2023	LARES-PP submission folder and SINEX NEQ example	Mathis Bloßfeld	→ (partly) done
5_apr2023	New strategy for the processing of arcs before 1993	Cinzia Luceri, Mathis Bloßfeld	→ not yet done
6_apr2023	Differences in the WRMS time series between the CCs for BKG, DGFI and GFZ	ASI/JCET/DGFI	→ not yet done

	OLD OPEN ACTIONS		
# AI	**Description**	**AC**	
1_nov2022	Daily&Weekly products from 07-08/2022 to be investigated (3D wrms too high)	DGFI/BKG/GFZ	→ not yet done
4_nov2022	daily&weekly Scale from 09/2022 to be investigated	NGSF	→ status?
6_nov2022	Implement v180 daily operational products	BKG/ESA/GFZ/JCET	→ done
7_nov2022	Implement v80 weekly operational products	BKG/ESA/GFZ/JCET	→ done
8_nov2022	Implement v280 weekly operational products then switch-off v230 (date TBD)!	BKG/DGFI/ESA/GFZ /JCET	→ (partly) done
9_nov2022	Complete Re-Analysis 1993-2022 (SLRF2020, new DHF & IERSEOPC04 20), v85 series	ALL ACs	→ ongoing

ITRF2020 update

- Z. Altamimi plans to frequently update the ITRF2020 on a yearly basis. The current plan is to update the ITRF2020 in the first half of 2024, meaning that the **IAG Services should provide input to the IERS ITRS CCs until February 2024**
- For the ILRS ASC, that means we have to provide three additional years of data (2021-2023). Since we also plan to do a complete **reprocessing of the SLR data (1982-2020; v85)** based on most recent standards and models, we can extend this reprocessing until the end of 2023 and provide the CCs this data set to be combined and send to the ITRS CCs. This means the extra workload for the ACs is limited! For the CCs, some additional workload is expected
- Plan so far: start of the **reprocessing of 1982-2020 right now**
- Before the reprocessing of the most recent three years, we have to update the ILRS DHF until the end of 2023 based on the operational products v280
  - this might be done in **December 2023 or January 2024 by ASI**
  - **after the new DHF is available, all ACs can reprocess the last three years (January 2024)**
  - **the settings to be used for the reprocessing should be the same as for the operational weekly v80 processing**
  - after the AC contributions are complete, CCs can combine the last three years and provide the ILRS contribution to the ITRF update end of February 2023
  - from my current point of view I would suggest not to include the new ACs in the contribution to the ITRF2020 update since the time is too limited to do everything now (in the next 4 months)

ITRF2020 update



- v85 repro will be based on DHF (230621); this version is based on the v230 product which itself is based on the old models (e.g., SLRF2014, IERS 14C04, IERS mean pole) → inconsistency hopefully not causes significant changes in the biases…
- Any problems with this strategy? Schedule too tight for **ACs**/**CCs**?

LARES-PP

- I have to apologize that I was not able to provide you some information on this issue before!
- For the PP, one should estimate **TRF, ERP, and Stokes coefficients up to d/o 6 into the SINEX files based on LA-1/-2, ET-1/-2 and LARES only**
- Examples:
  - Daniela's email from July 24th on the SINEX description document as well as example SINEX file with Stokes coefficients up to d/o 90.
  - SINEX file I've send around yesterday including TRF, EOP, Stokes coefficients of d/o 2
  - SINEX files should contain datum-free NEQs!

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*_ESTIMATED/REDUCED_PARAMETERS_____________________________________________
 - Keplerian elements                6 per arc at initial epoch          (reduced)
 - station coordinates               X/Y/Z offsets at mid-arc epoch      (estimated)
 - station-dependent range biases    1 per arc at mid-arc epoch          (reduced)
 - x-/y-pole coordinate offsets      1 per day at 12h epochs             (estimated)
 - LOD offsets                       1 per day at 12h epochs             (estimated)
 - solar rad. pres. scaling factor   1 per arc at mid-arc epoch          (reduced)
 - Earth rad. pres. scaling factor   1 per arc at mid-arc epoch          (reduced)
 - empirical acc. (along-track)      1 per day at 0h epochs (LA/ET-1/2)  (reduced)
                                     1 sine/cosine at mid-arc epoch      (reduced)
 - empirical acc. (cross-track)      1 per day at 0h epochs              (reduced)
                                     1 sine/cosine at mid-arc epoch      (reduced)
 - atm. pres. scaling factor         2 per day at 0h/12h epochs          (reduced)
 - Earth grav. par. (d/o 2)          1 per arc at mid-arc epoch          (estimated)
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*_APPLIED_CONSTRAINTS______________________________________________________
 - station coordinates               1 m at the Earth's surface (loose constr.)
 - range biases                      0.1 m at the Earth's surface (loose constr.)
 - other orbit parameters            0.01 [-, m/s^2] (loose constr.)
*_WEIGHTING_OF_THE_SATELLITES______________________________________________
 - weighting technique               Iterative Variance Component Estimation
                                     (VCE) based on minimum constraint solutions
       LAGEOS-1 ( 1337 obs.):          1.790182158410E+00
   +   LAGEOS-2 ( 1198 obs.):          9.776592245607E-01
   +   Etalon-1 (   79 obs.):          4.982399625988E-02
   +   Etalon-2 (   95 obs.):          2.850827820646E-01
   +      LARES ( 1657 obs.):          3.283991970276E-01
   +     Stella ( 1049 obs.):          4.496789510609E-02
   +  Starlette ( 1583 obs.):          2.743457864438E-02
   +     Ajisai ( 2340 obs.):          3.078724376982E-02
   +     Larets (  447 obs.):          1.426351821169E-03
   +    LARES-2 ( 1526 obs.):          3.618397145858E-01
```

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 45 RBIAS  7110 55  501 23:284:43200 m    1  0.00000000000000E+00 1.00000E-01
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 60 CN        2 --    2 23:281:00000      2  2.43945626036470E-06 1.00000E-06
 61 SN        2 --    1 23:281:00000      2  1.65990057109164E-09 1.00000E-06
 62 SN        2 --    2 23:281:00000      2 -1.40025345430514E-06 1.00000E-06
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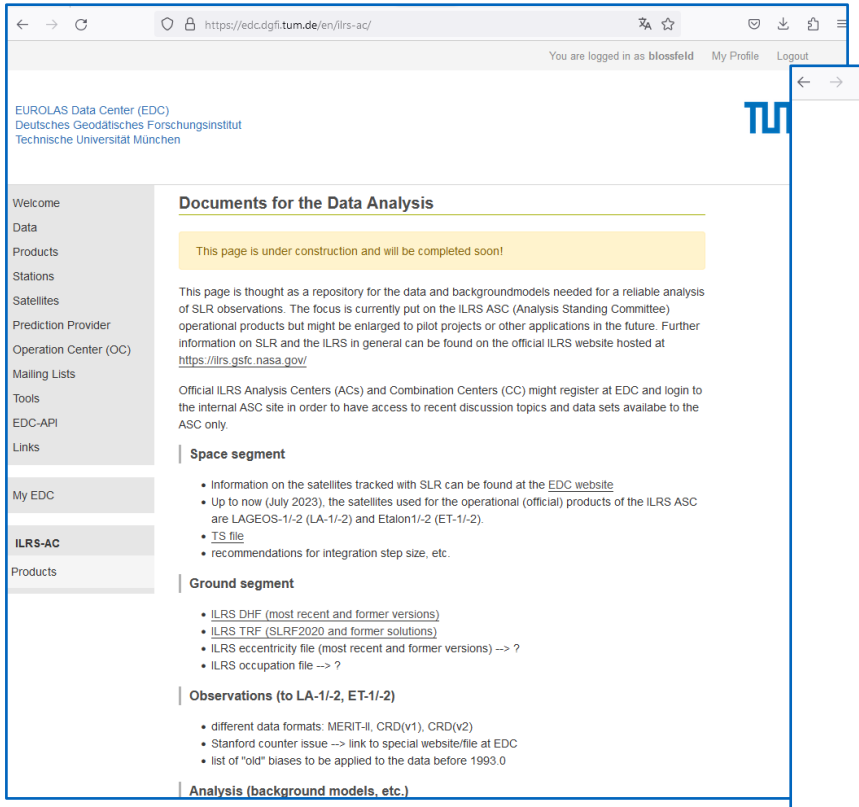
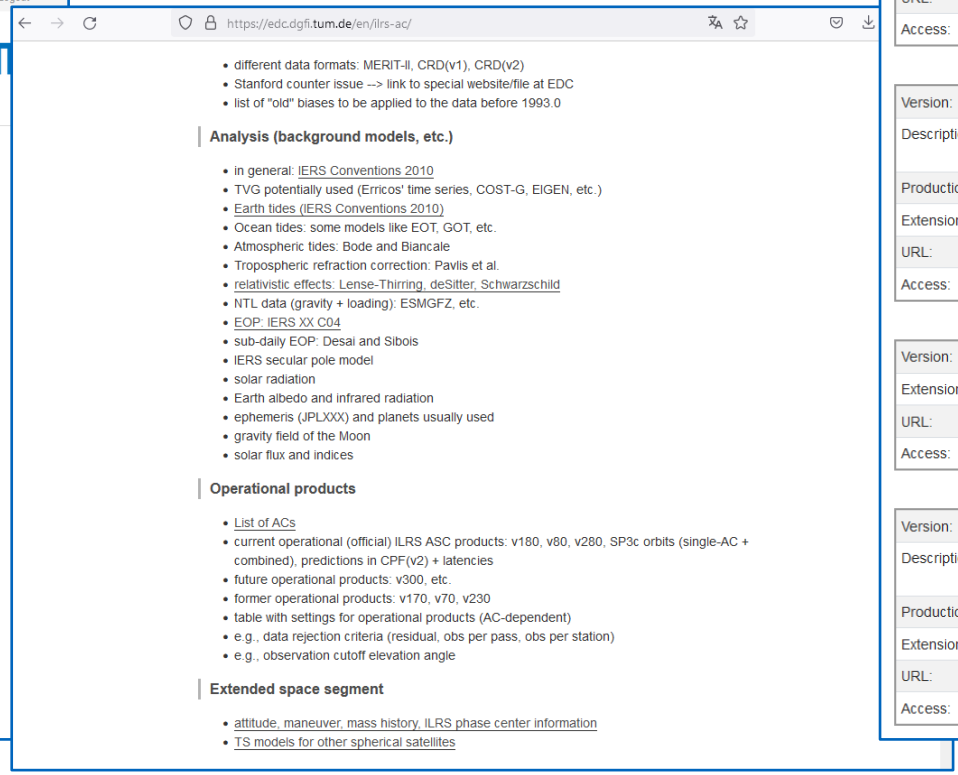
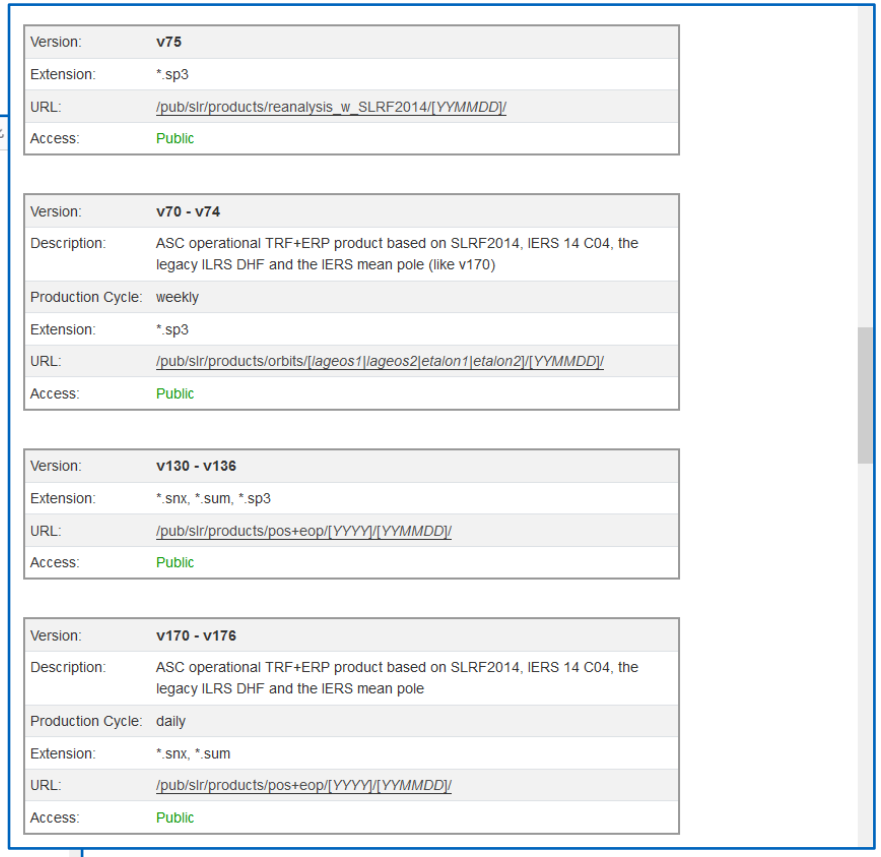
ILRS ASC analysis document website

- Public area https://edc.dgfi.tum.de/en/ilrs-ac/
- Internal area https://edc.dgfi.tum.de/en/ilrs-ac/products/
  - access to the internal area requires a registration at EDC (approval by C.Schwatke and me; only AC responsible persons)







Version:	**v75**
Extension:	*.sp3
URL:	/pub/slr/products/reanalysis_w_SLRF2014/[YYMMDD]/
Access:	Public

Version:	**v70 - v74**
Description:	ASC operational TRF+ERP product based on SLRF2014, IERS 14 C04, the legacy ILRS DHF and the IERS mean pole (like v170)
Production Cycle:	weekly
Extension:	*.sp3
URL:	/pub/slr/products/orbits/[/ageos1|/ageos2|etalon1|etalon2]/[YYMMDD]/
Access:	Public

Version:	**v130 - v136**
Extension:	*.snx, *.sum, *.sp3
URL:	/pub/slr/products/pos+eop/[YYYY]/[YYMMDD]/
Access:	Public

Version:	**v170 - v176**
Description:	ASC operational TRF+ERP product based on SLRF2014, IERS 14 C04, the legacy ILRS DHF and the IERS mean pole
Production Cycle:	daily
Extension:	*.snx, *.sum
URL:	/pub/slr/products/pos+eop/[YYYY]/[YYMMDD]/
Access:	Public

New ILRS ACs → benchmark tests

- Organization of the benchmark tests for the two new ACs must be done by the ASI CC and me. Erricos explained me how the benchmark testing of a CNES and a GRGS solution might look like…

a) GRGS uploaded so far from 2021 onwards the operational v70 and v170 solutions
   - Antonio (ASI CC) might check some of their SINEX files if the format is OK
   - after confirmation, 1-2 months of daily/weekly v180/v80 solutions should be submitted and the ASI CC should try a combination with them
   - both ACs should make sure that their SINEX file COMMENT block contains a detailed description of their processing strategy including settings and standards used as precise as possible (good examples by other ACs available!)
   - in addition, the SP3c files for LA-1/2 and ET-1/2 should be provided together with the weekly solution

b) CNES should directly provide one v180 SINEX test file to ASI CC for format checking... after approval, they should also submit 1-2 months of v180 and v80 solutions

c) After the benchmark is passed
   - both ACs should provide the v180 and v80 on a solid operational basis
   - both ACs should work on providing the v280 and v320 (including LARES-2) on an operational basis
   - as well as providing the v85 reprocessing solutions afterwards.

- From my current point of view I would suggest not to include them in the contribution to the ITRF2020 update since the time is too limited to do everything now (in the next 4 months). Anyway, for future ITRF updates and ILRS pilot projects, these ACs will provide a valuable extension to our ASC products... Other opinions?

Update of DSC files

- Every AC should update their respective DSC files stored at CDDIS. All DSC files are very old but are mandatory by the ILRS (https://cddis.nasa.gov/archive/slr/products/ac/).
- Before, I will update the blanc form ;-)

dgfi.dsc - Editor

Datei Bearbeiten Format Ansicht Hilfe

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                INTERNATIONAL LASER RANGING SERVICE

            Deutsches Geodaetisches Forschungsinstitut (DGFI)

                    Analysis Strategy Summary


================================================================================
ANALYSIS CENTRE    | Deutsches Geodaetisches Forschungsinstitut (DGFI)       |
                   | Munich, Germany                                         |
--------------------------------------------------------------------------------
CONTACT PERSONS    | H. Mueller (mueller@dgfi.badw.de; tel +4989230311277)   |
                   | D. Angermann (angerman@dgfi.badw.de; tel +4989230311217)|
--------------------------------------------------------------------------------
SOFTWARE USED      | DOGS-OC 5.2  DOGS-CS 4.9                                |
--------------------------------------------------------------------------------
ILRS PRODUCTS      | weekly solution for coordinates of global SLR stations  |
                   | and daily Earth Orientation Parameters (x,y-pole,       |
                   | LOD, UT1-UTC) (SINEX format) daily resoltuion           |
                   | weekly orbits for Lageos1/2 and Etalon1/2 (sp3c format) |
--------------------------------------------------------------------------------
PREPARATION DATE   | effective since June 1, 2003                            |
================================================================================




--------------------------------------------------------------------------------
|                        MEASUREMENT MODELS                                    |
|------------------------------------------------------------------------------|
| Satellites used  | LAGEOS-1, LAGEOS-2, ETALON-1, ETALON-2                    |
|------------------------------------------------------------------------------|
```

Parent Directory

archive

aas.dsc	2015:01:12 14:44:48	13.11KB
asi.dsc	2014:04:08 17:20:10	13.43KB
bkg.dsc	2014:11:06 12:34:33	13.54KB
blank.dsc	2006:10:25 14:36:15	8.67KB
code_qc.txt	2008:08:18 12:31:23	1.37KB
csr.dsc	2013:11:05 15:52:28	13.66KB
dgfi.dsc	2013:08:28 12:58:34	12.78KB
dgfi_qc.txt	2017:10:17 12:55:46	13.09KB
esa.dsc	2015:04:16 13:00:01	19.75KB
ga.dsc	2007:11:27 04:57:25	12.9KB
gfz.dsc	2017:11:13 15:11:32	12.19KB
gld.dsc	2022:03:10 17:51:34	13.89KB
grgs.dsc	2013:10:01 12:44:22	9.45KB
hitu_qc.txt	2008:08:18 12:31:17	12.26KB
infn.dsc	2014:12:02 17:11:44	9.53KB
jcet.dsc	2012:10:19 20:38:29	13.36KB
jcet_qc.txt	2008:08:18 12:31:10	14.69KB
kasi.dsc	2014:09:25 11:46:30	14.65KB
larase.dsc	2014:10:08 17:30:51	10.63KB
mcc_qc.txt	2014:02:28 14:54:02	11.63KB
nsgf.dsc	2007:11:14 15:04:13	13.05KB
pul.dsc	2010:04:28 13:11:43	10.4KB
shao.dsc	2017:11:07 20:07:14	13.11KB
shao_qc.txt	2017:11:07 20:07:14	12.98KB

ILRS ASC MEETING

CNES « AC CANDIDATE » STATUS

2023/10/26

Franck Reinquin – CNES
Adrian Baños-Garcia - CLS

What's new?

System

- The CNES cluster underwent a major overhaul, starting in June : new CPU's (AMD), new storage appliances, operating system upgrade, new tools (load leveller, …).
  The GNSS people are happy with the increase in computing power. We are happy to have a stable platform again.

Software

- Upgrade to GINS 23.1 : handles different station biases for different laser colours
- Upgrade to SLRF2020 (+ DHF, target signature files) and the latest models (IERS 20 C04 EOP, Desai-Sibois…)
- Daily production of v180 solutions, weekly production of v80 solutions. Checked against other CA's.
- No v280 solution so far.

Status

- Ready to have our solutions evaluated. Waiting for instructions.

ESOC ILRS AC Status

Tim Springer and Erik Schoenemann

26/10/2023

ESA ILRS AC Status (1/2)

- V230 (V231) solutions still running manual
  - Never anticipated the ITRF2020 switch to take so long….
  - Hopefully, parallel submissions not too much longer now….
- ITRF2020 (v80/v180/v280) solutions running routinely since June 2023
  - Did a resubmission after the first couple of weeks due to an error in our interpretation of the bias handling file
- ITRF2020 solution with LARES-2 (v320) running also since June 2023
  - Reported on this briefly

ESA ILRS AC Status (2/2)

- LARES
  - LARES is included in our initial 21-day cleaning step since Feb 2012
  - Ready for fully including LARES
    - Need to check and validate our gravity field SINEX implementation
    - (thanks for SINEX example Mathis)

ASI AC&CC report

A. Basoni , D. Sarrocco, V. Luceri
e-GEOS S.p.A., ASI/CGS - Matera

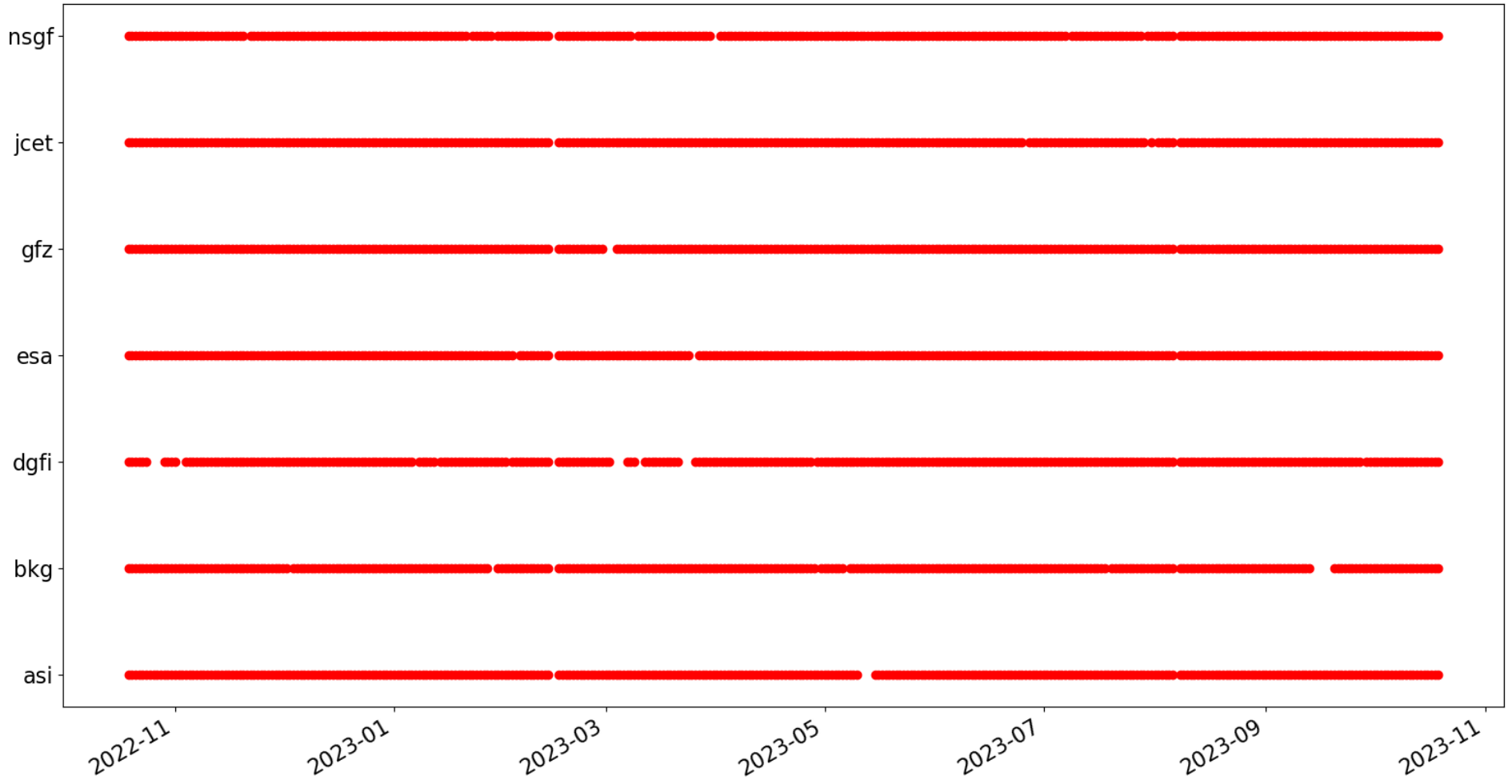
G. Bianco
Agenzia Spaziale Italiana, CGS - Matera

ASI/CGS Activities since last ASC meeting

- ACs performance check
    - Product submissions
    - 3D wrms of the residuals w.r.t. SLRF (daily and weekly)
    - Scale
    - Geocenter motion
    - LOD
    - Orbits: RMS of residuals w.r.t. combination
    - ILRS ACs orbit agreement
- Activities to control systematic error.
- Check of products to be launched as new operational

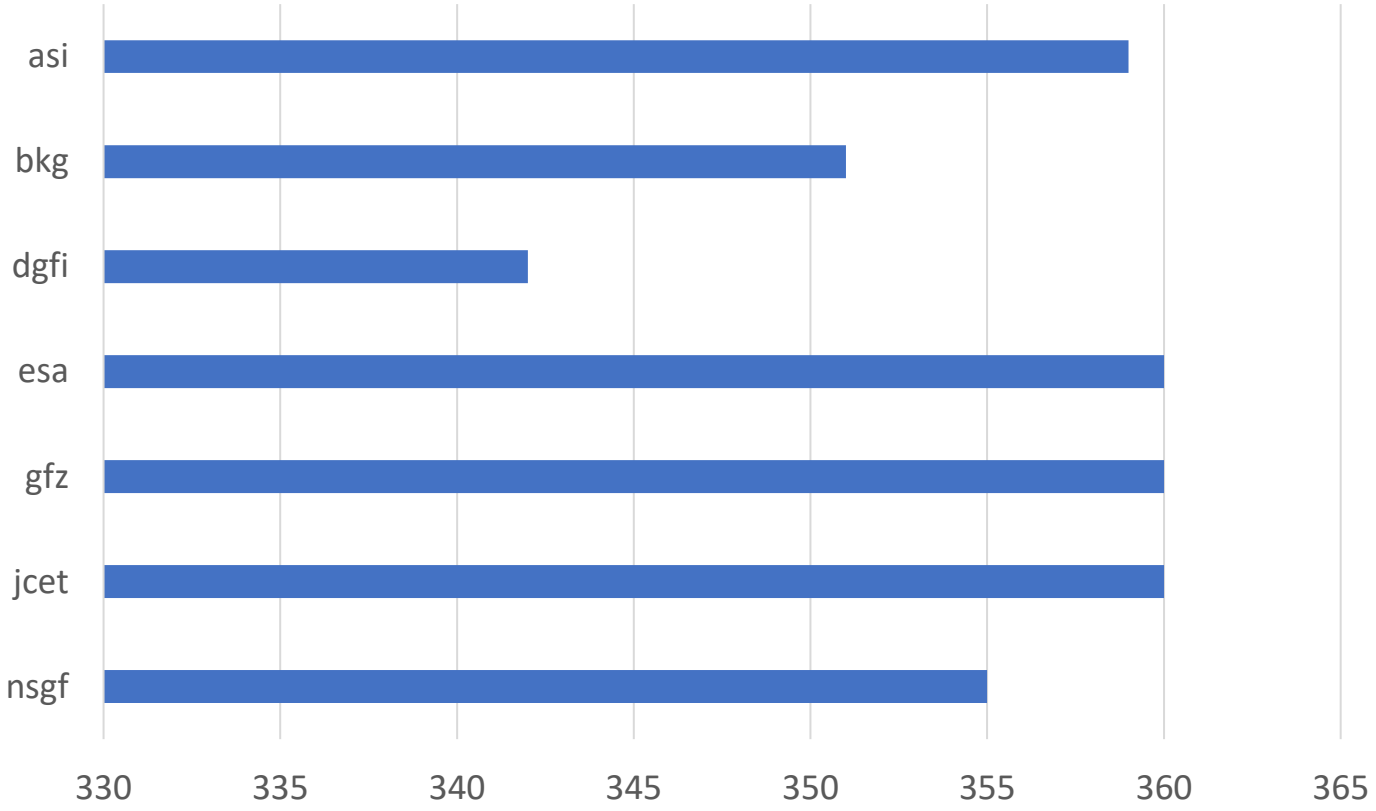
Solution submissions

Daily v170 ACs contribution to ILRSA solution 2022/10/19 – 2023/10/19



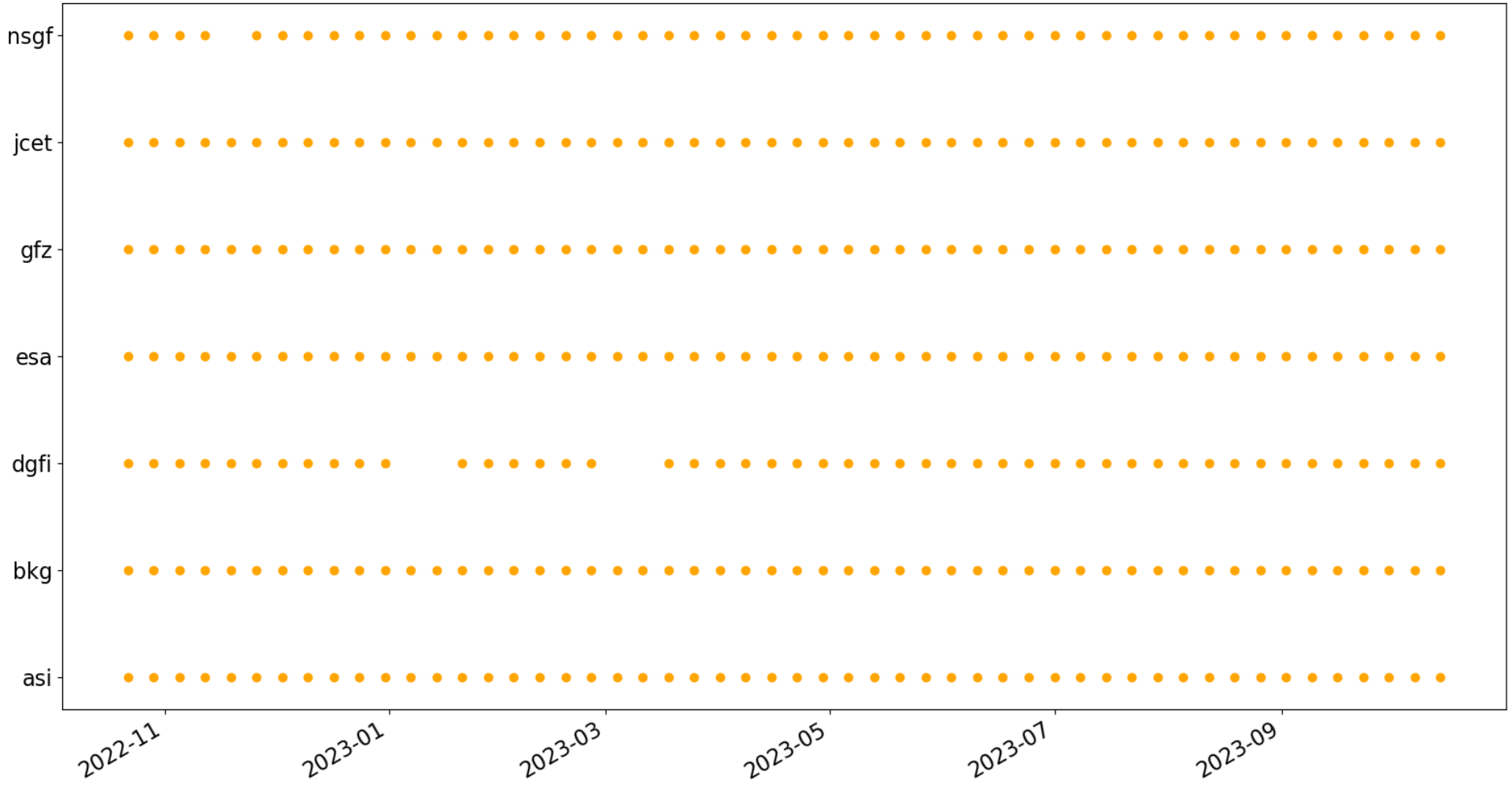
Solution submissions

Daily v170 ACs contribution to ILRSA solution (only valid SINEXs)
2022/10/19 – 2023/10/19



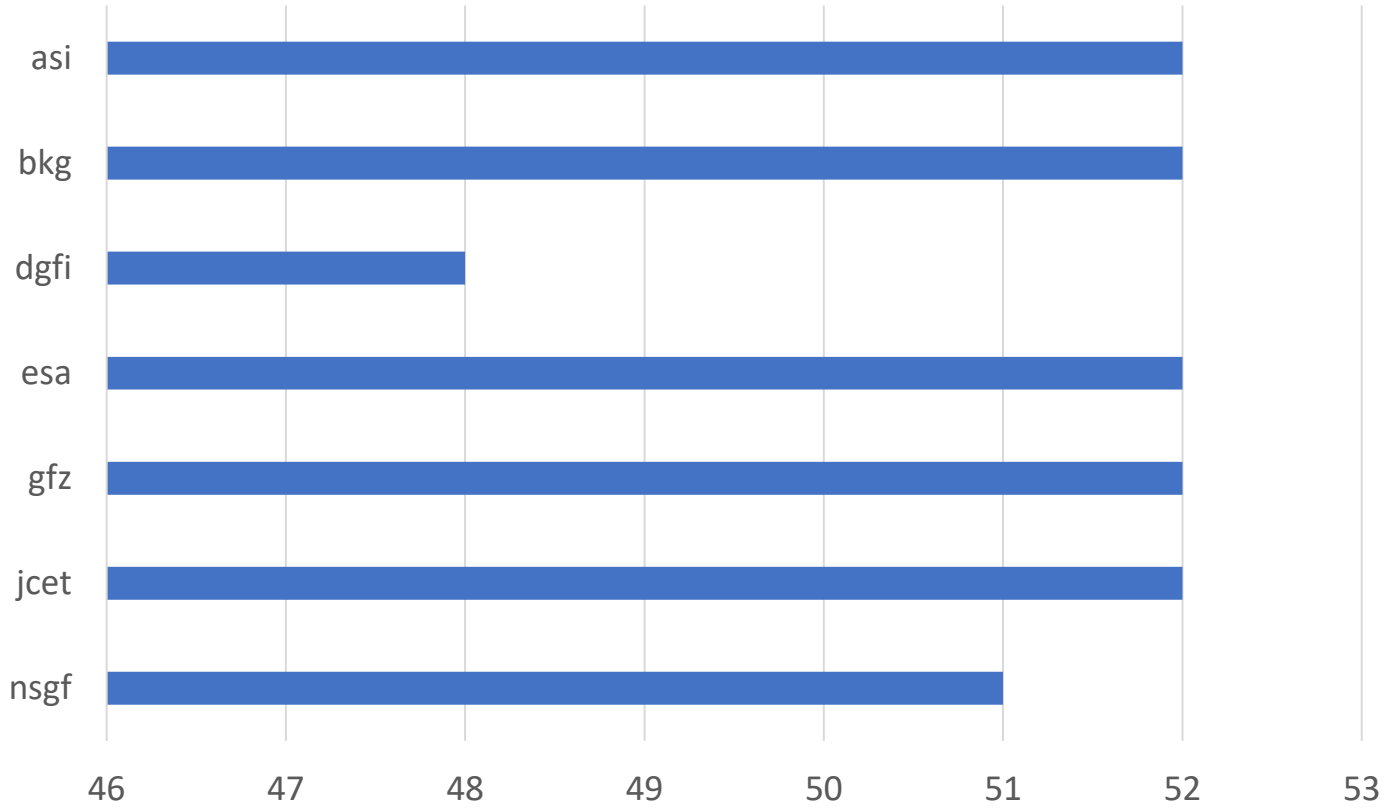
Solution submissions

Weekly v70 ACs contribution to ILRSA solution
2022/10/19 – 2023/10/19

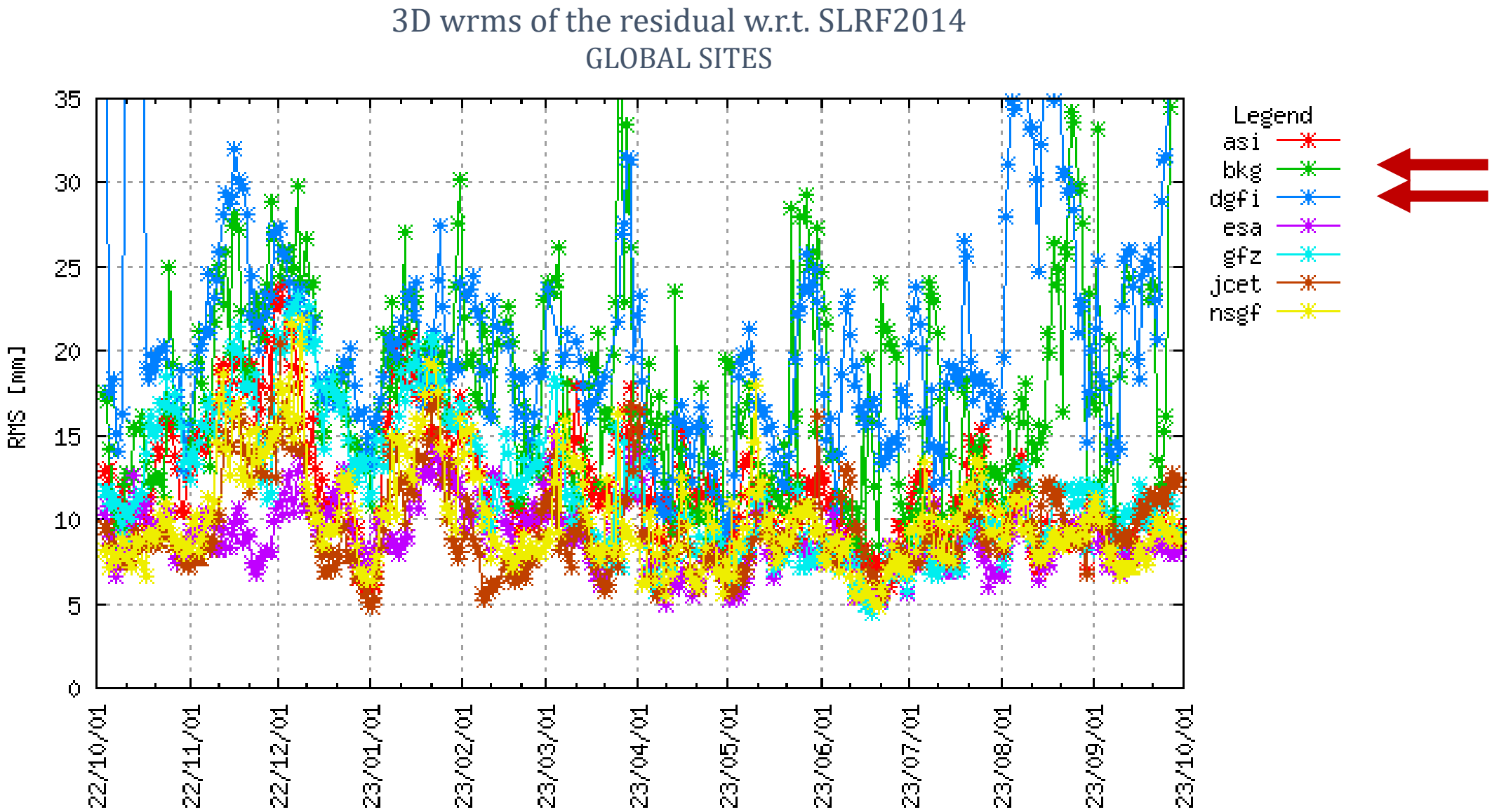


Solution submissions

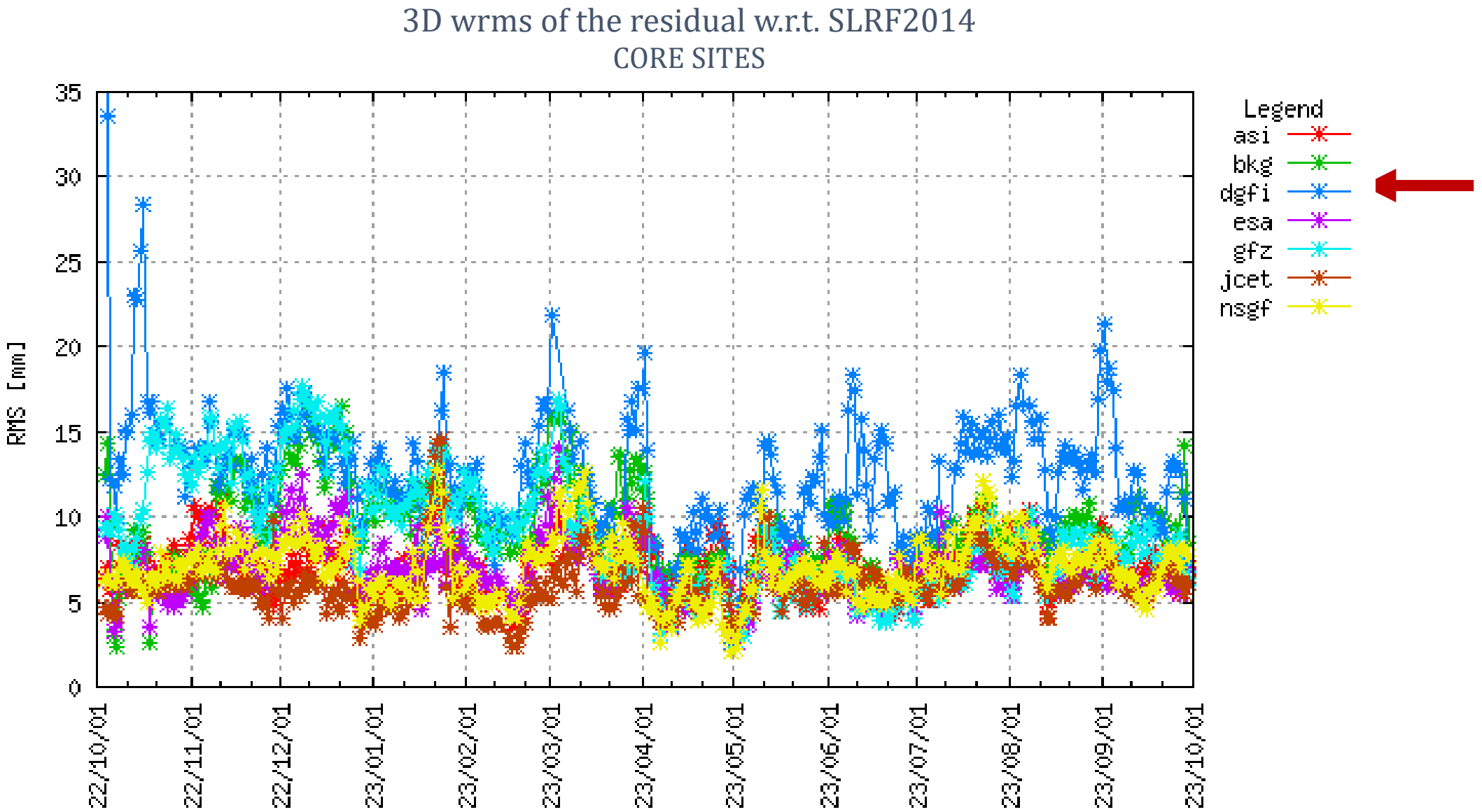
Weekly v70 ACs contribution to ILRSA solution (only valid SINEXs)
2022/10/19 – 2023/10/19



Stations coordinates from daily solutions



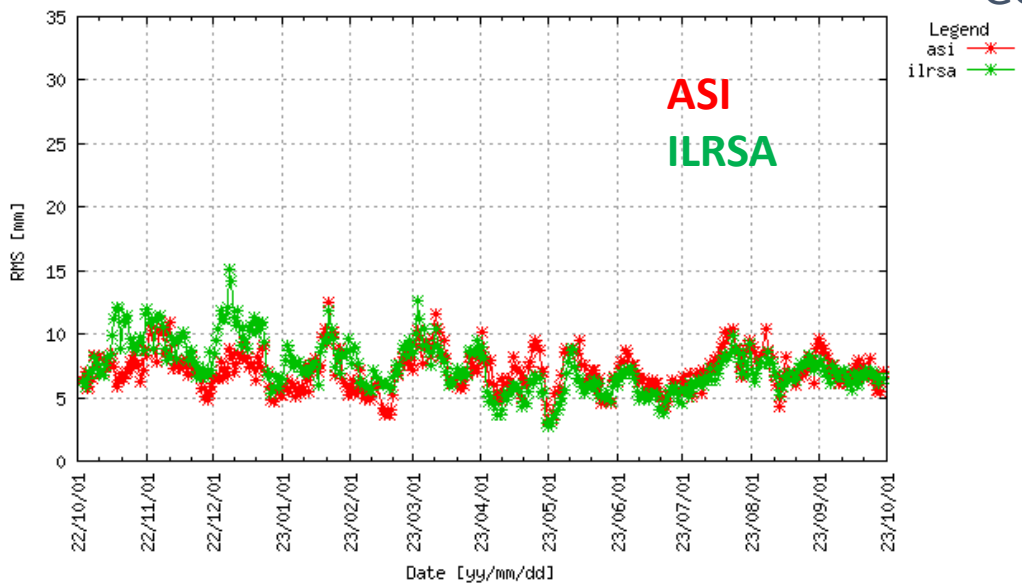
Stations coordinates from daily solutions

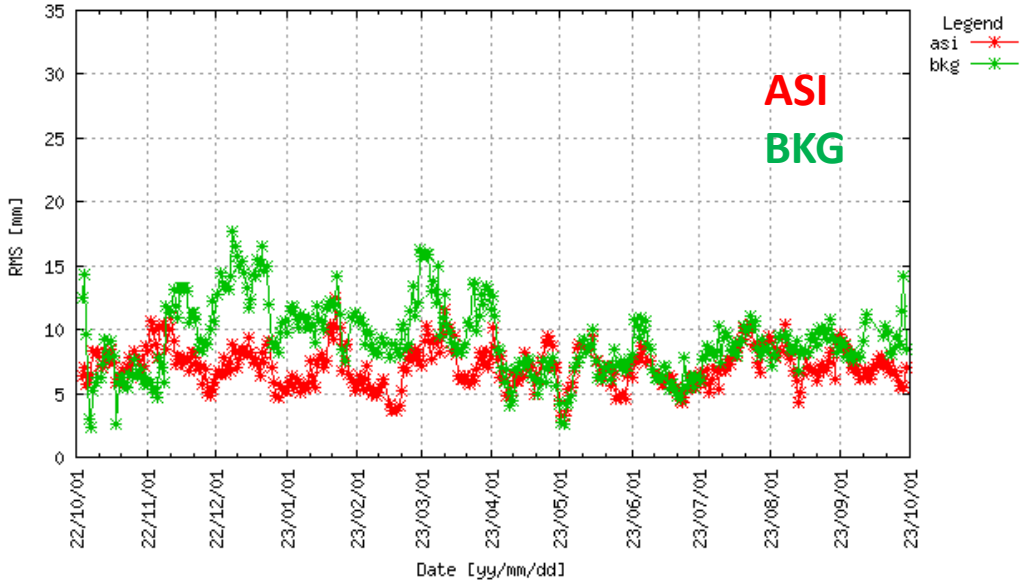


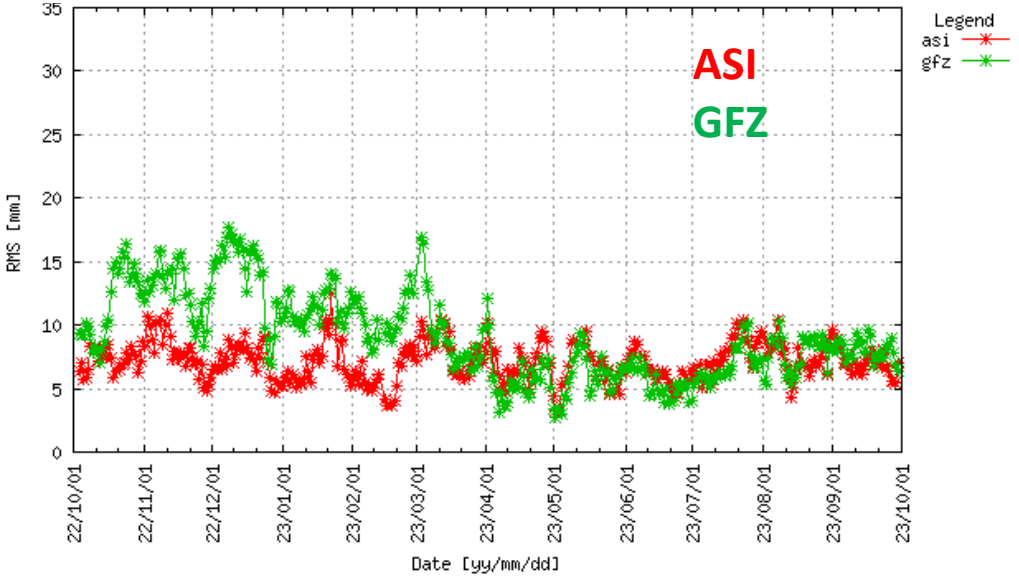
Stations coordinates from daily solutions

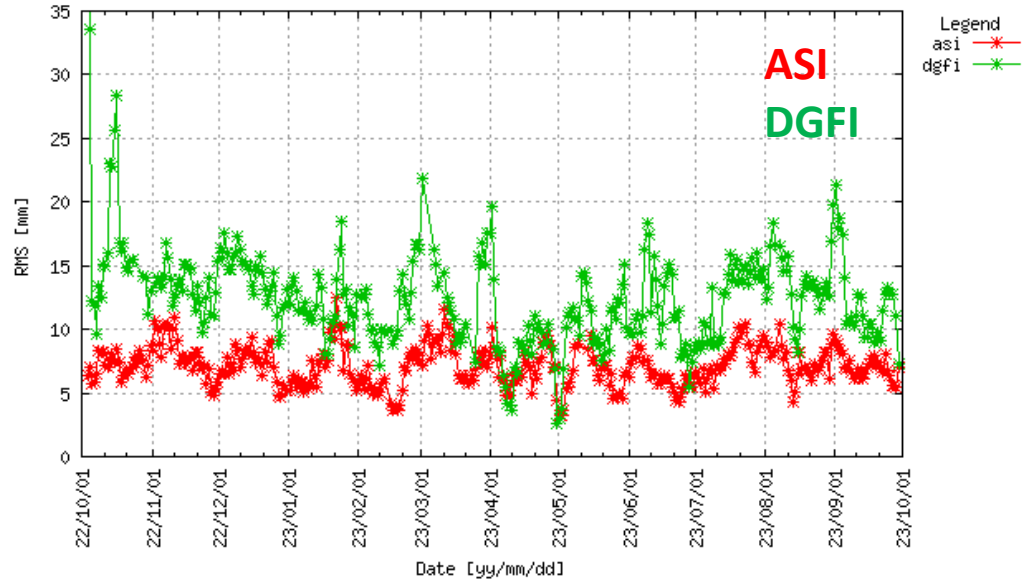
3D wrms of the residual w.r.t. SLRF2014

CORE SITES



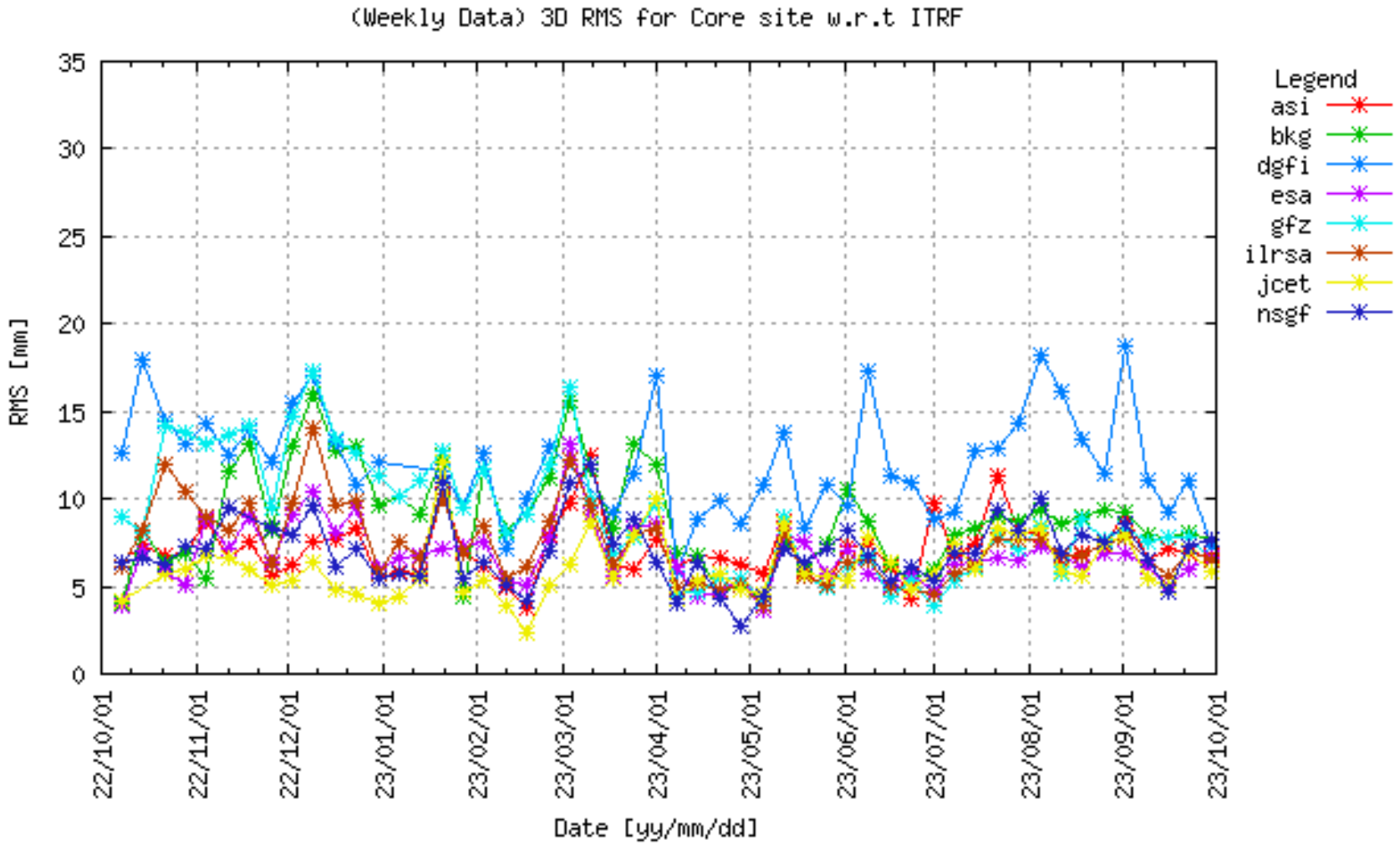




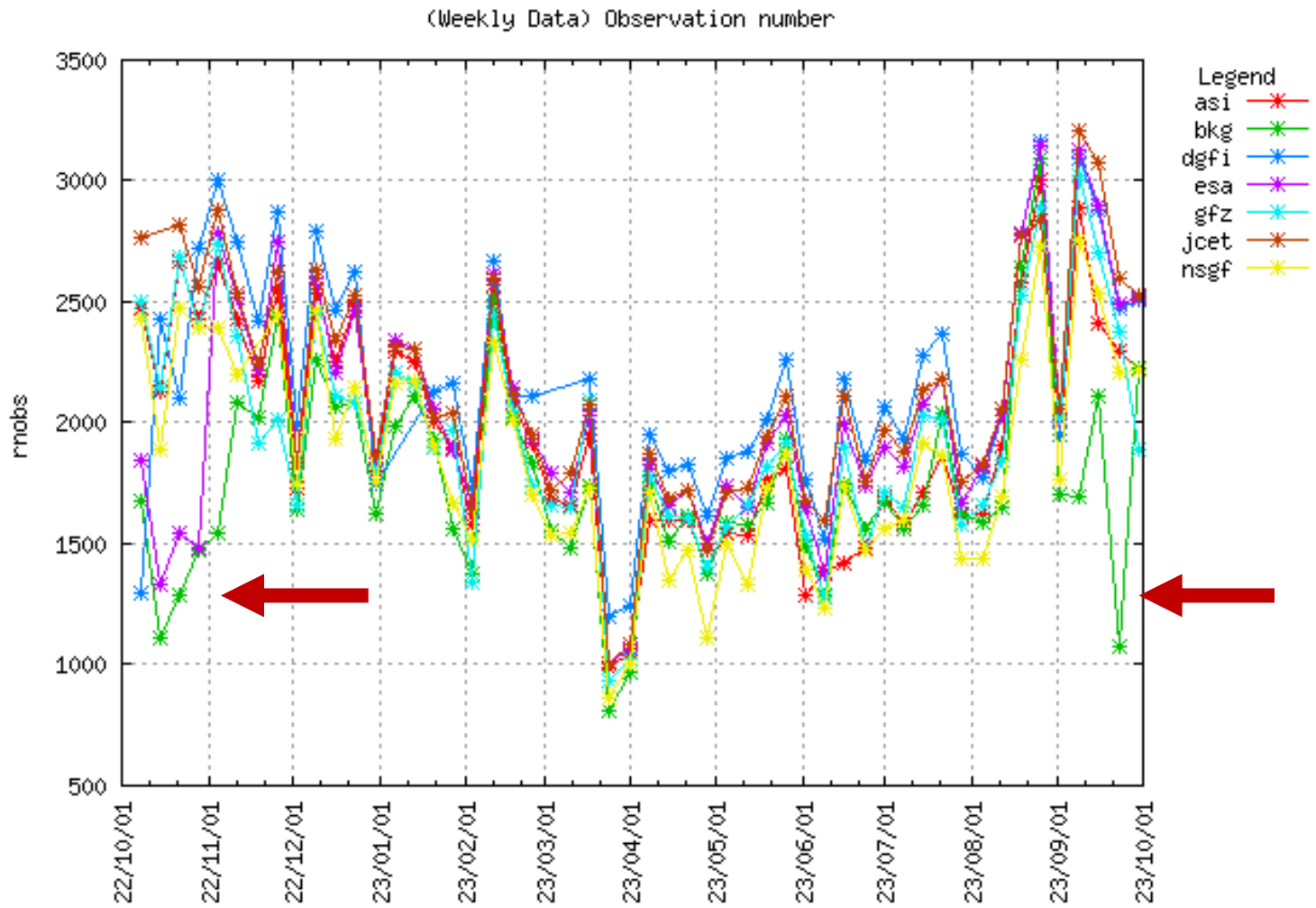


Stations coordinates from weekly solutions

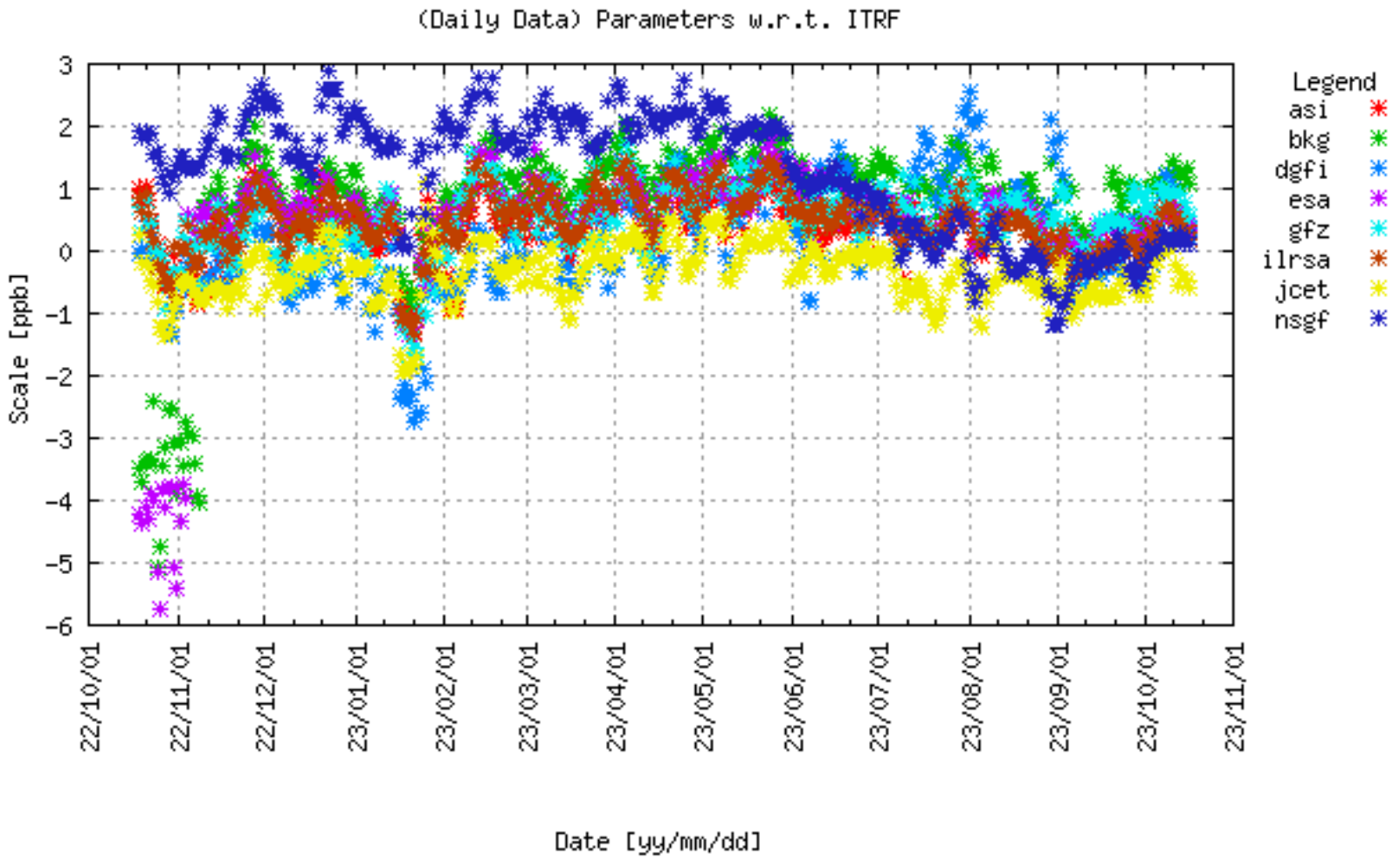
3D wrms of the residual w.r.t. SLRF2014
CORE SITES



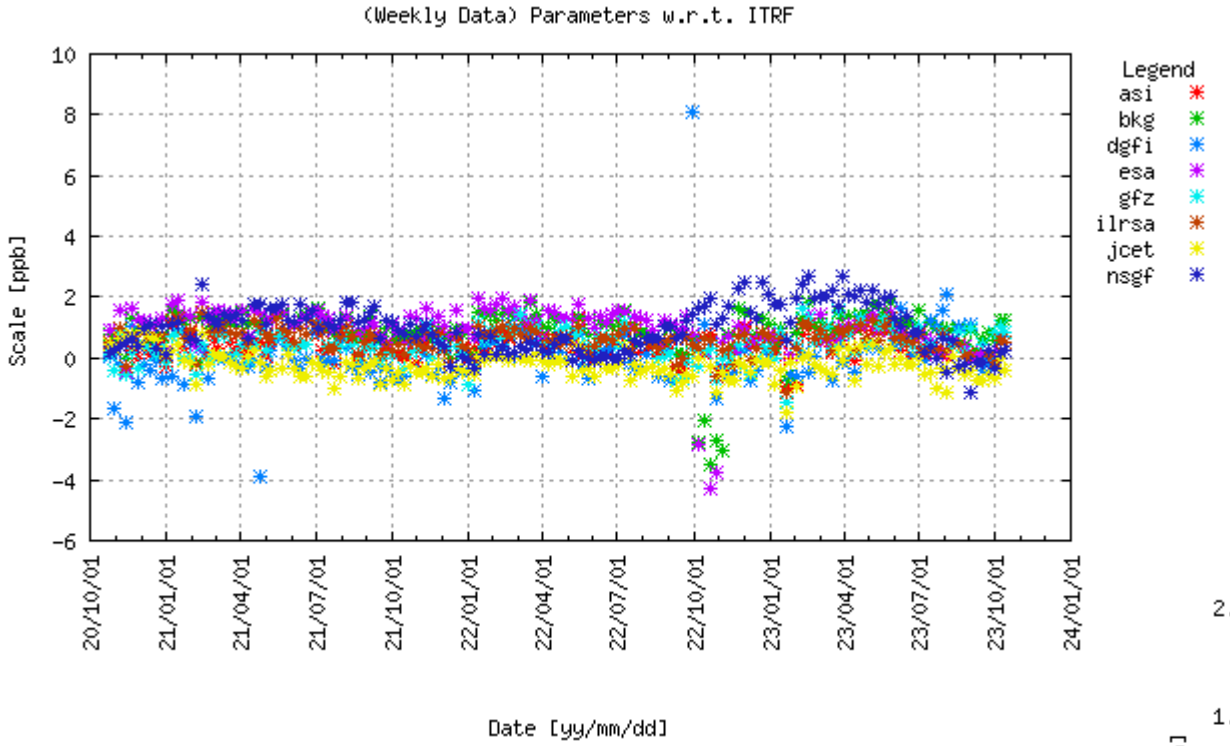
Weekly -Number of observations for ACs

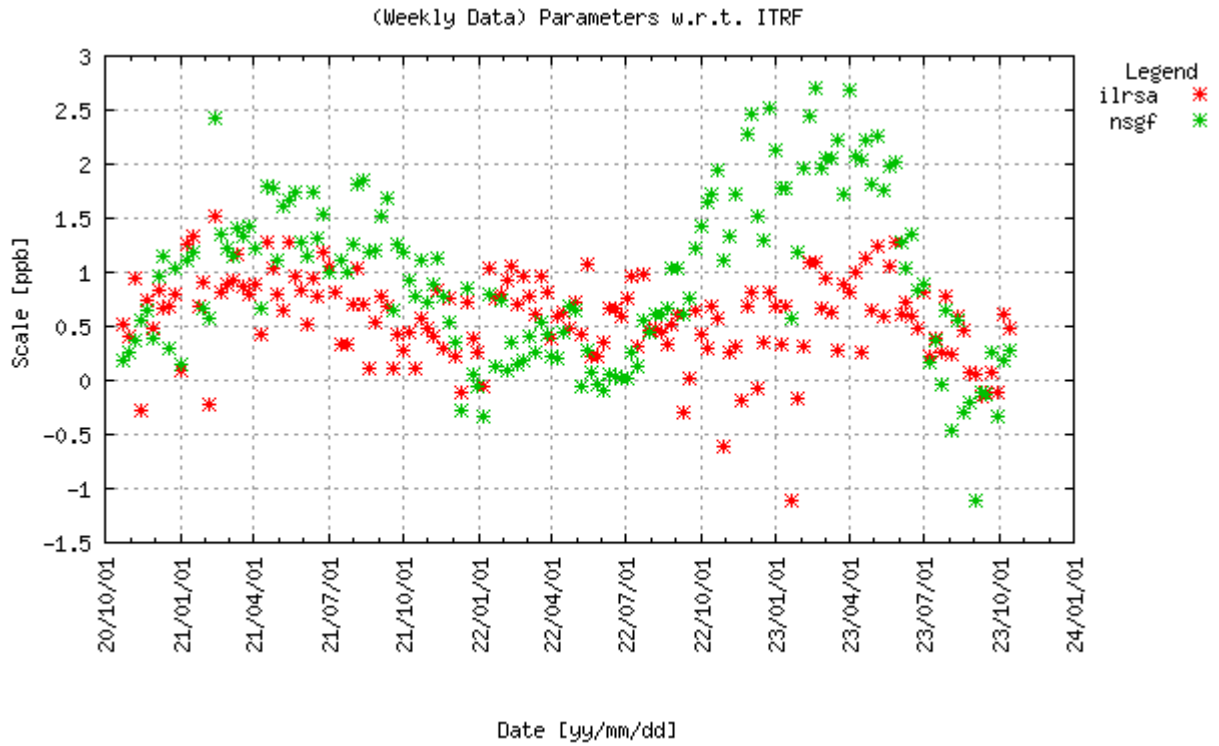


Scale from daily solutions

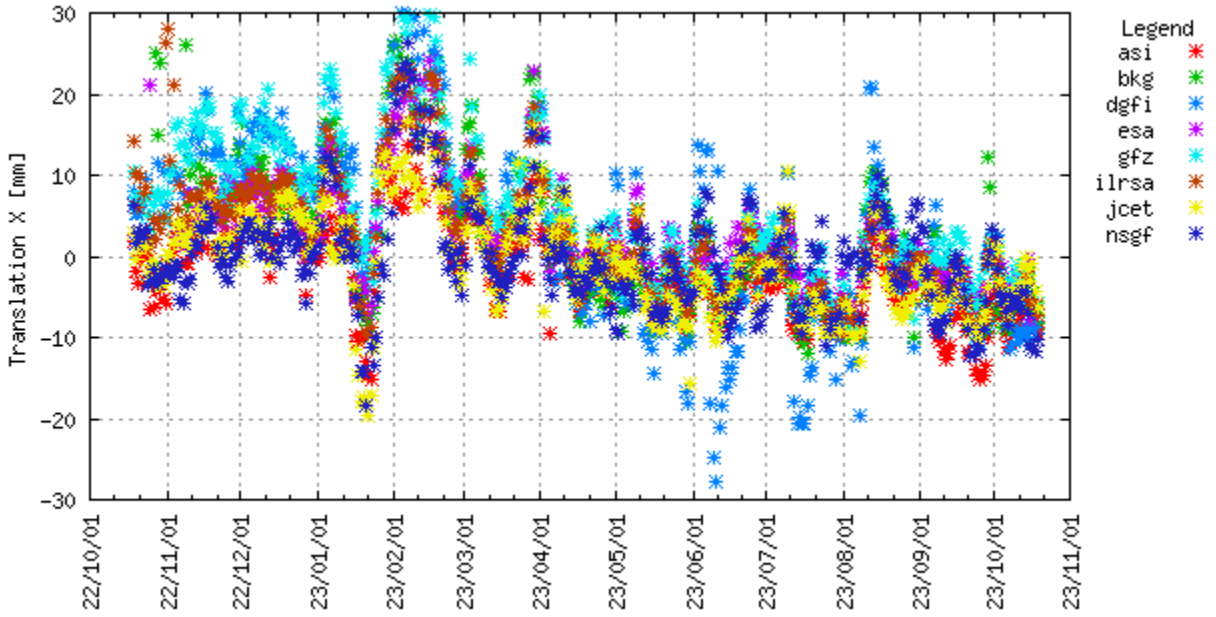


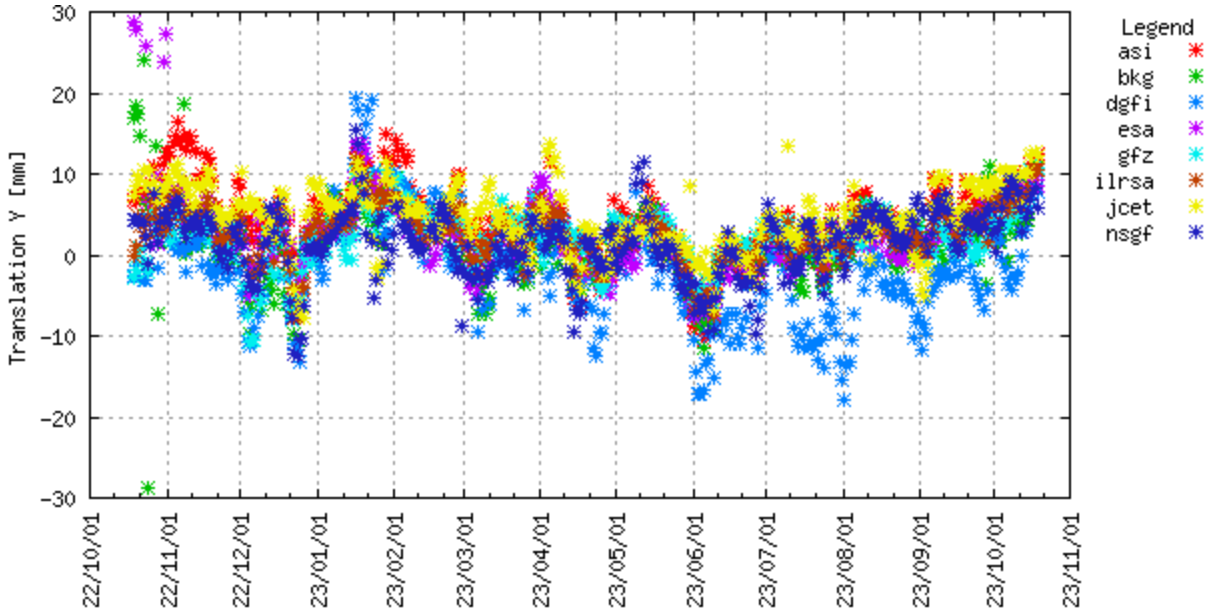
Scale from weekly solutions

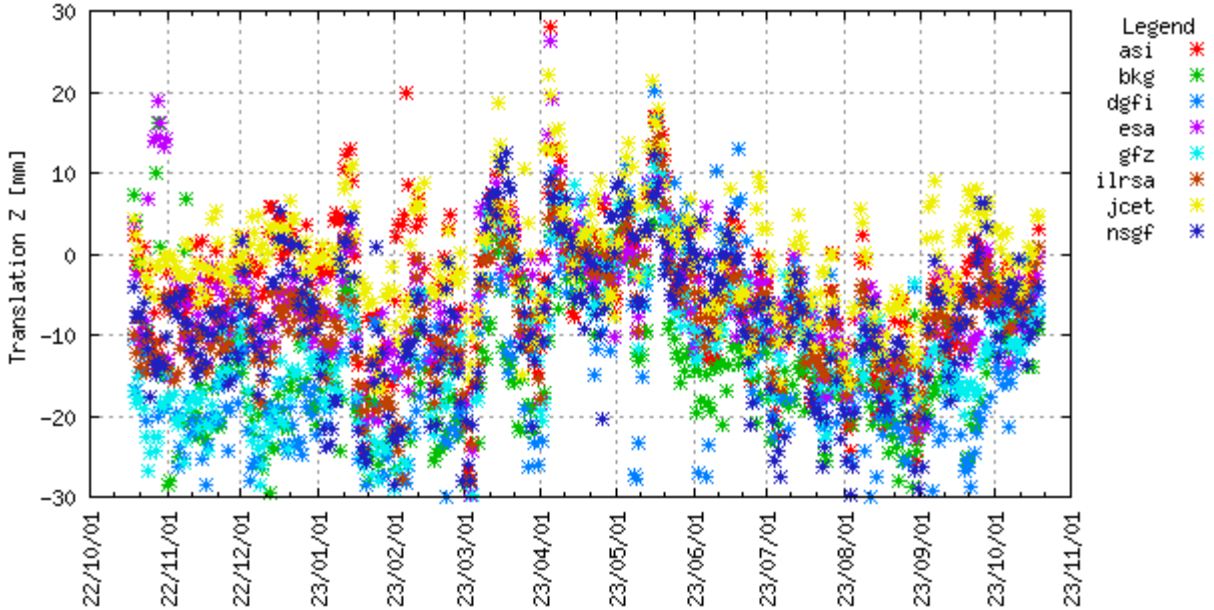




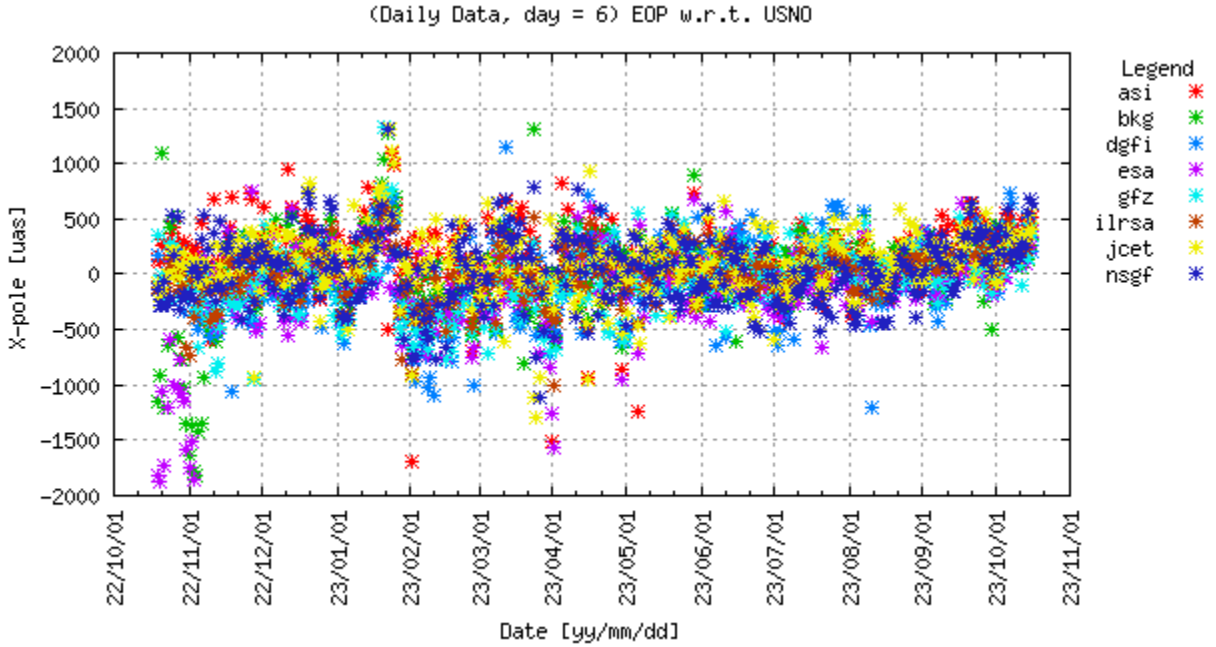
Geocenter motion from daily solutions

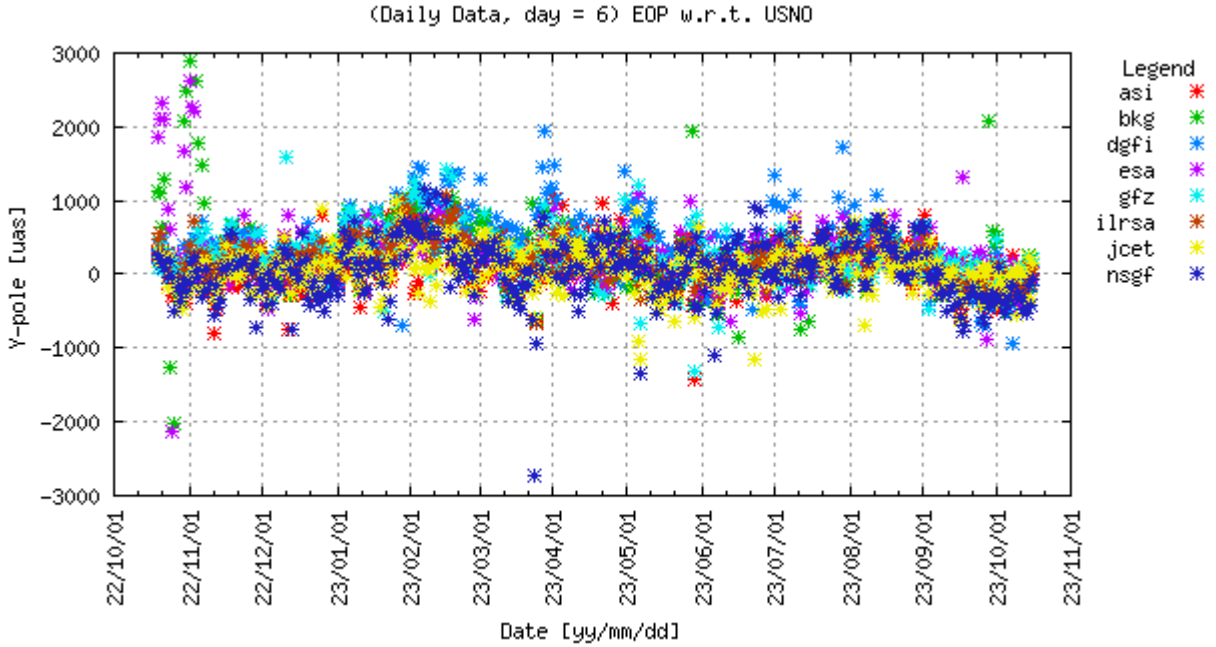


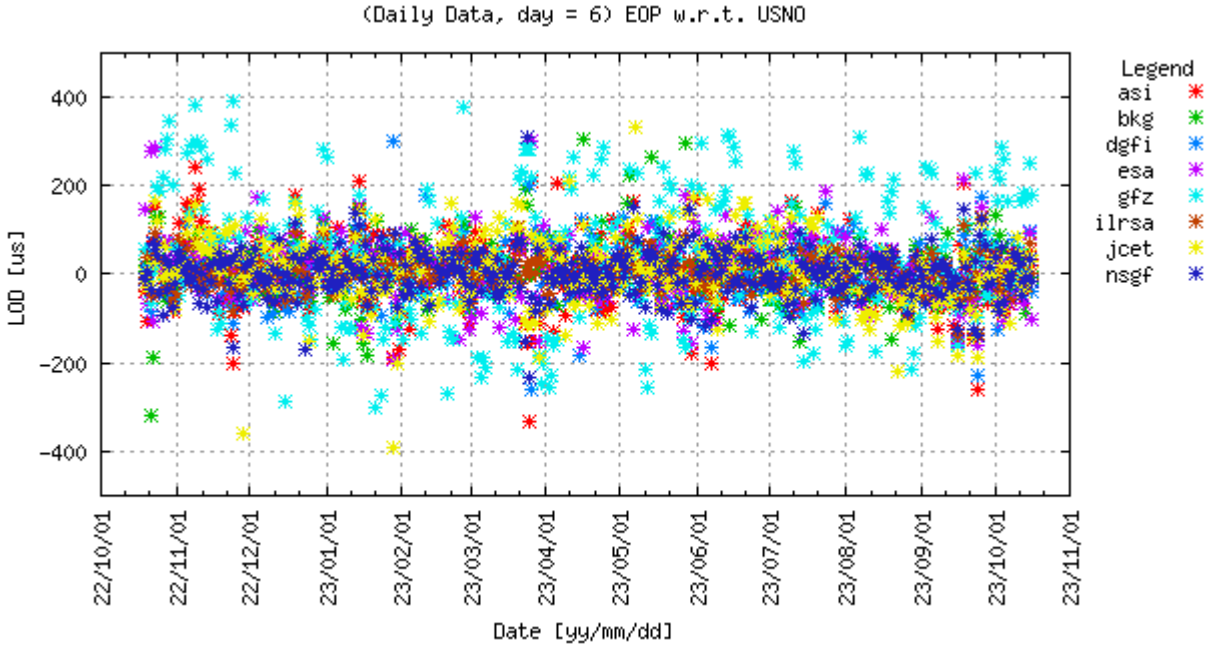


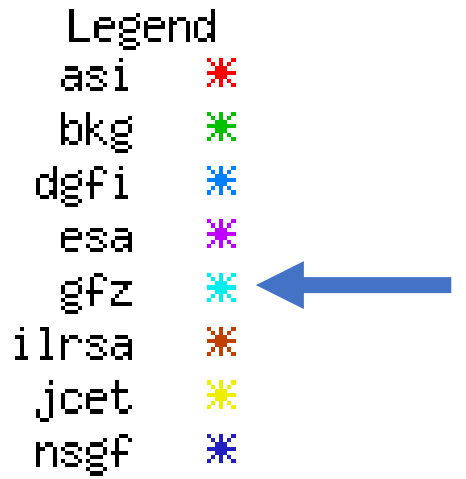


EOP from daily solutions

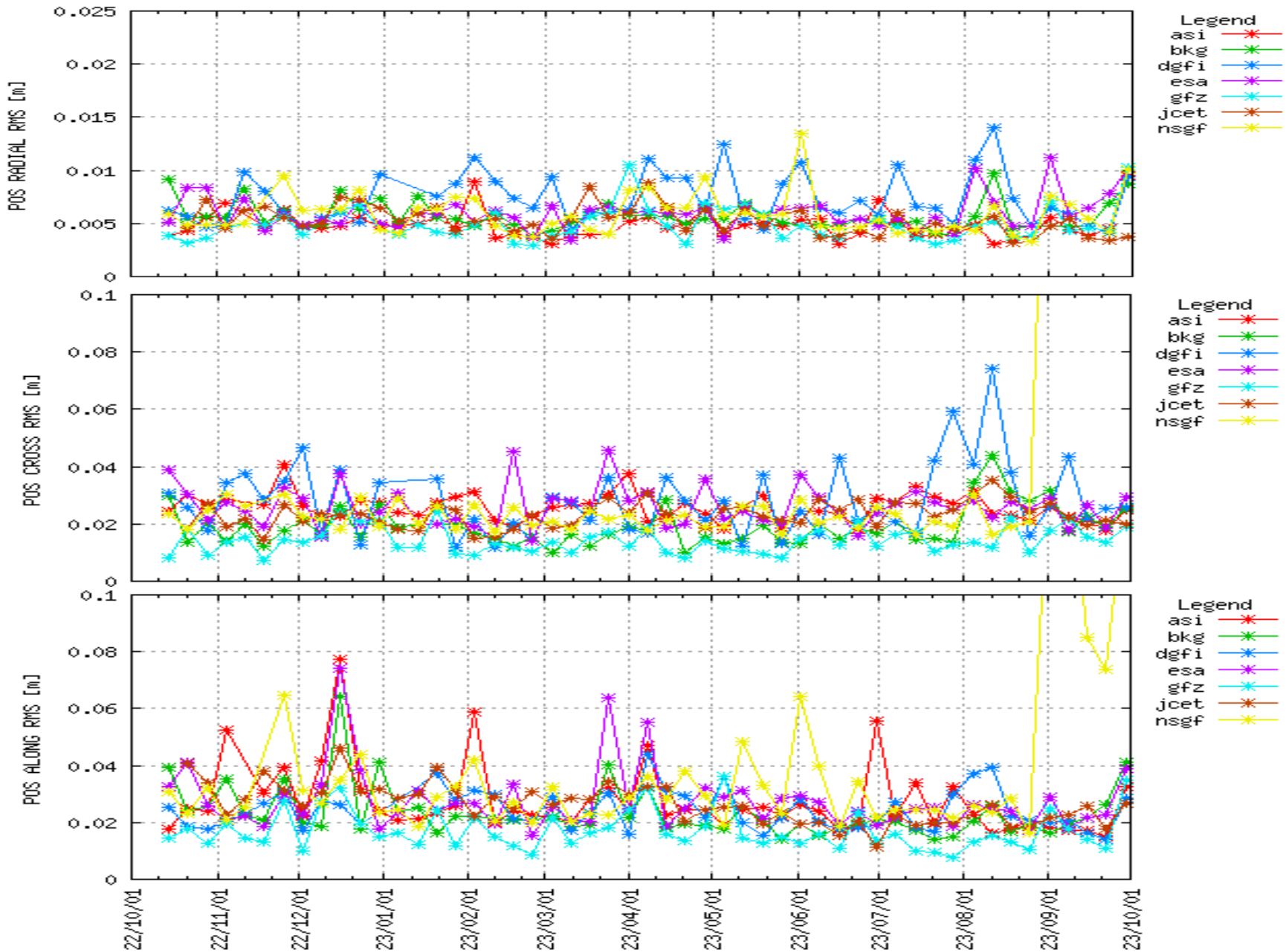




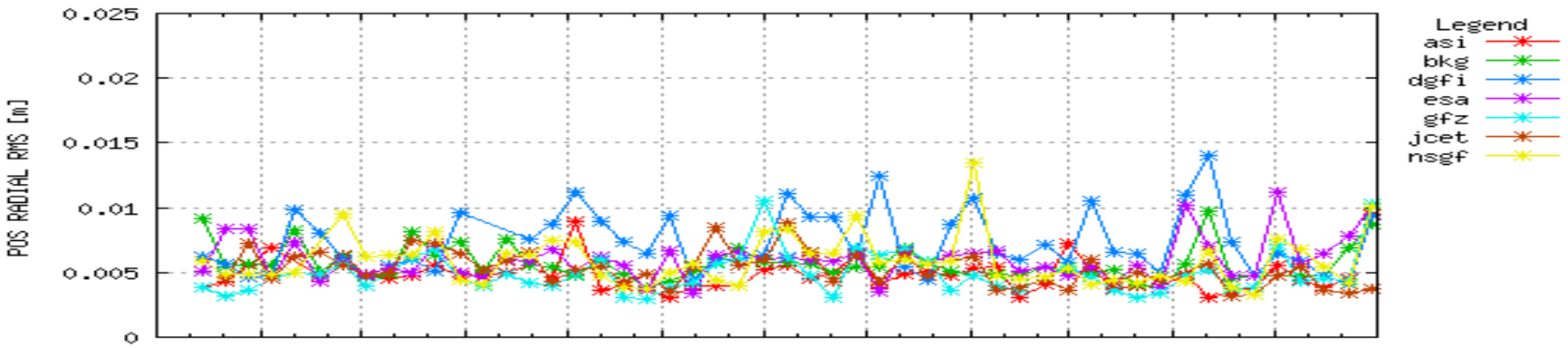


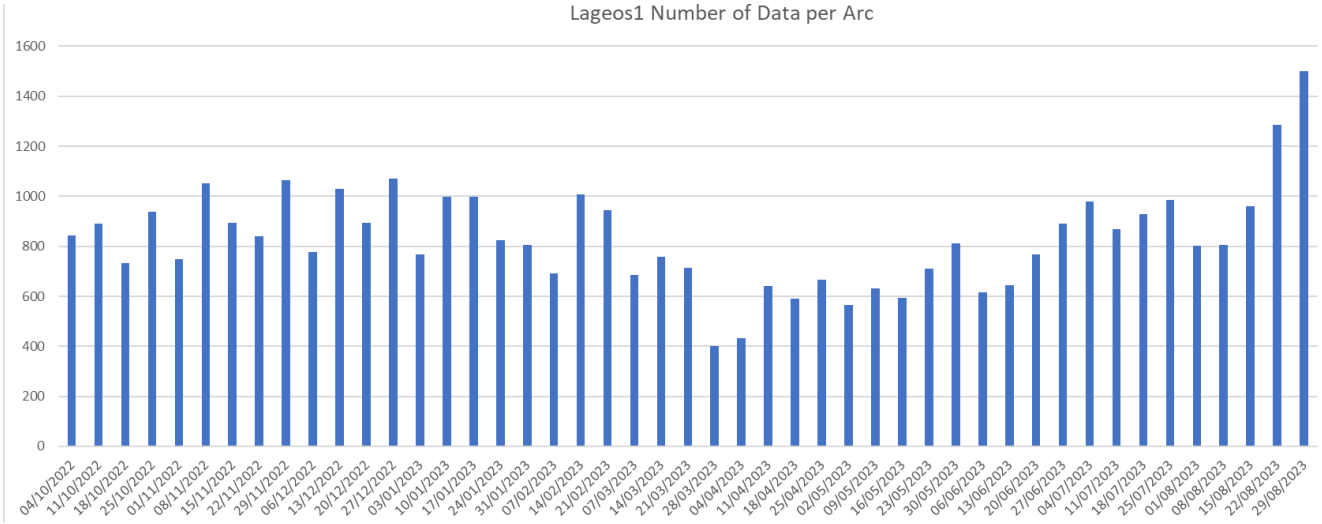


LAGEOS1 orbits – RMS of residuals w.r.t. combination

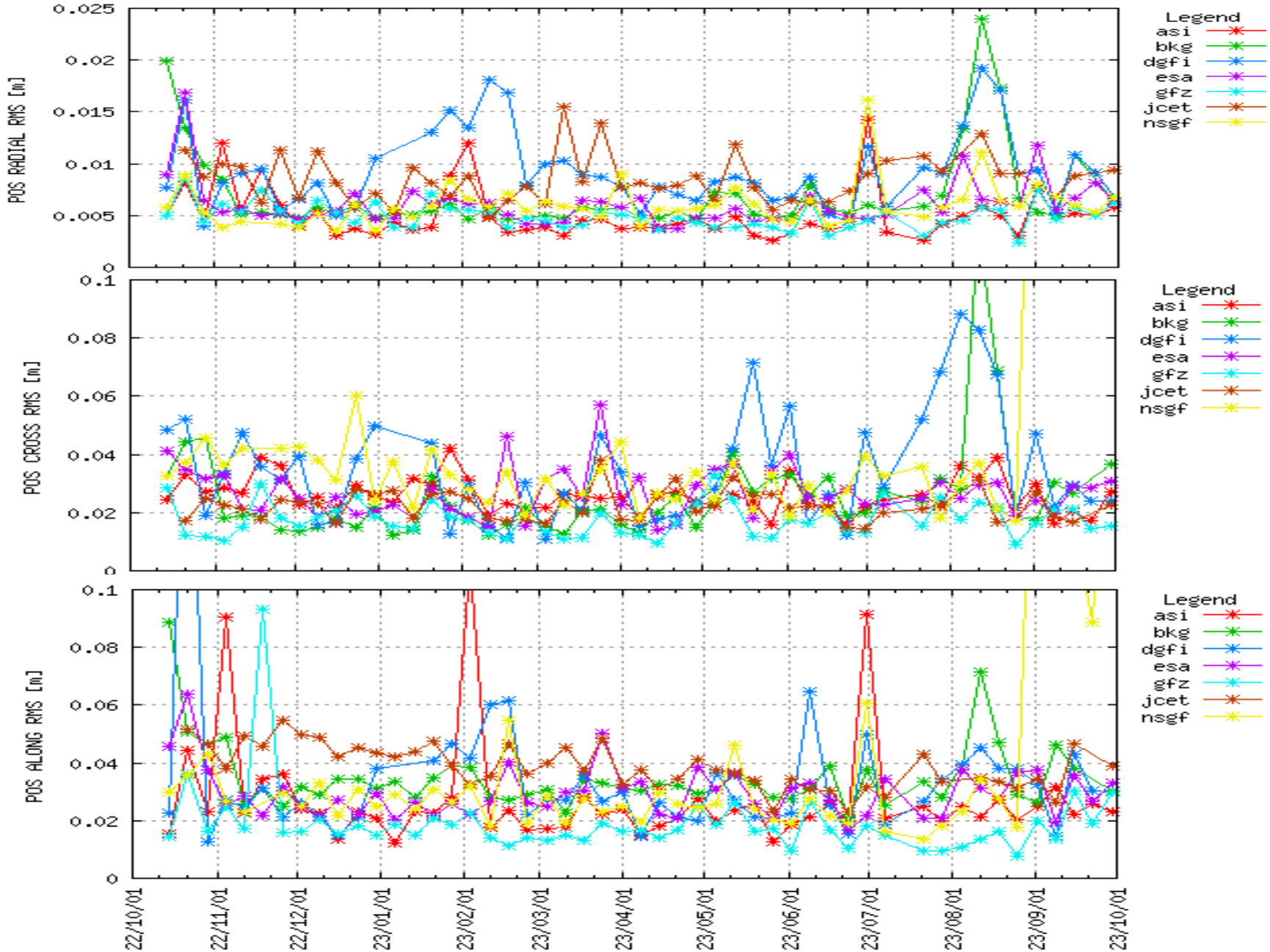


LAGEOS1 orbits – RMS of residuals w.r.t. combination

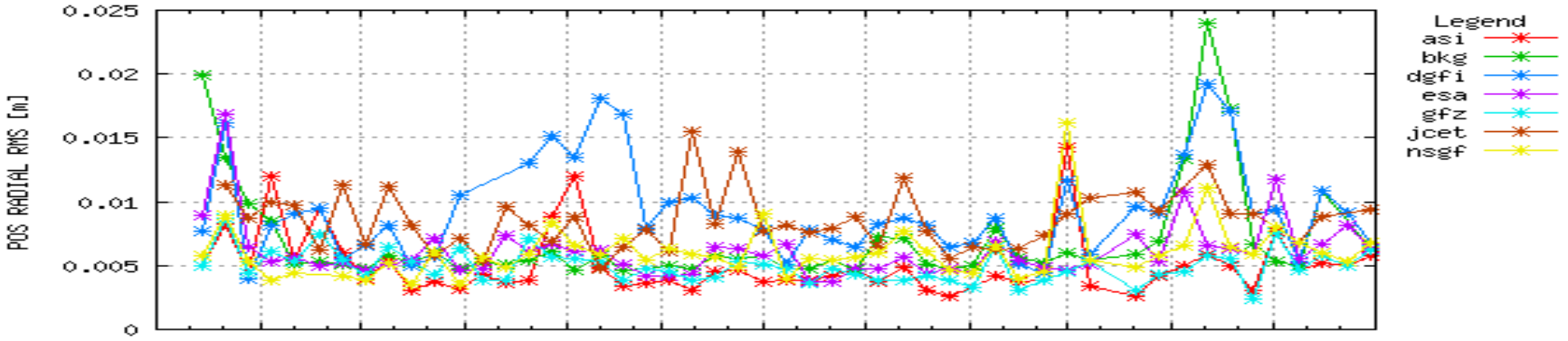


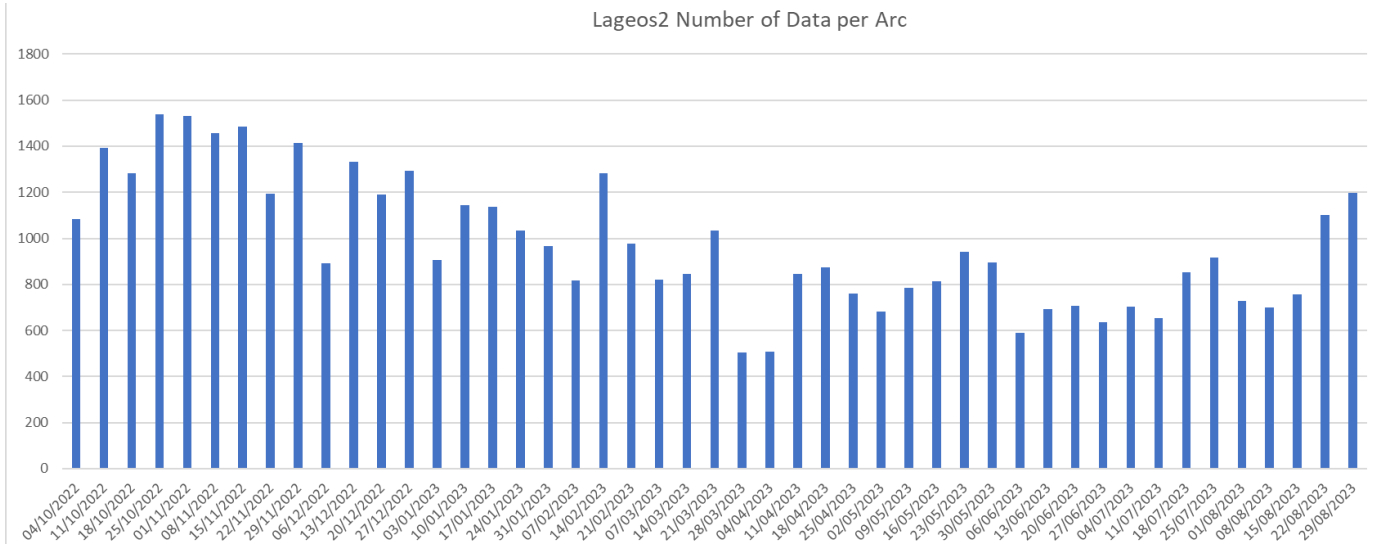


LAGEOS2 orbits – RMS of residuals w.r.t. combination

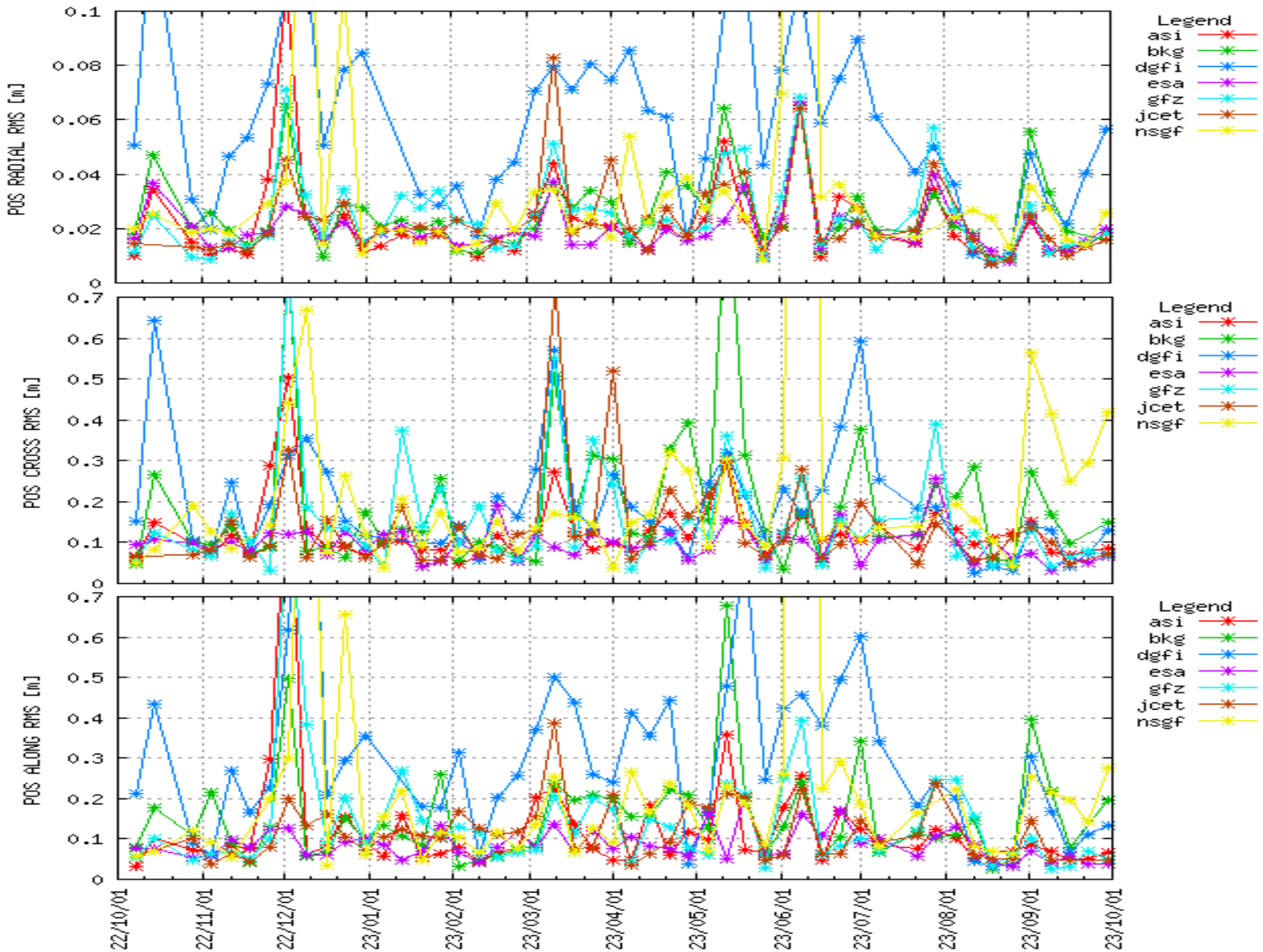


LAGEOS2 orbits – RMS of residuals w.r.t. combination

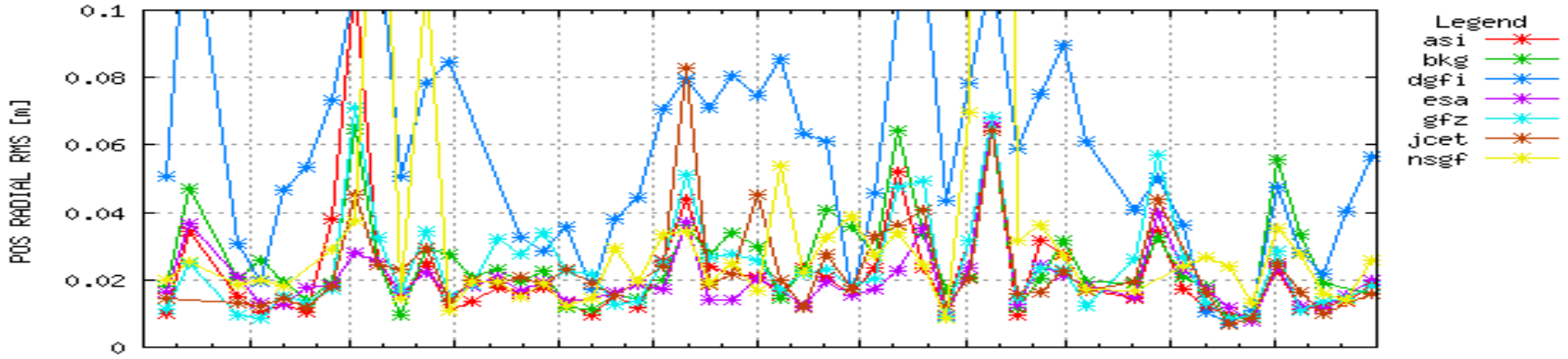


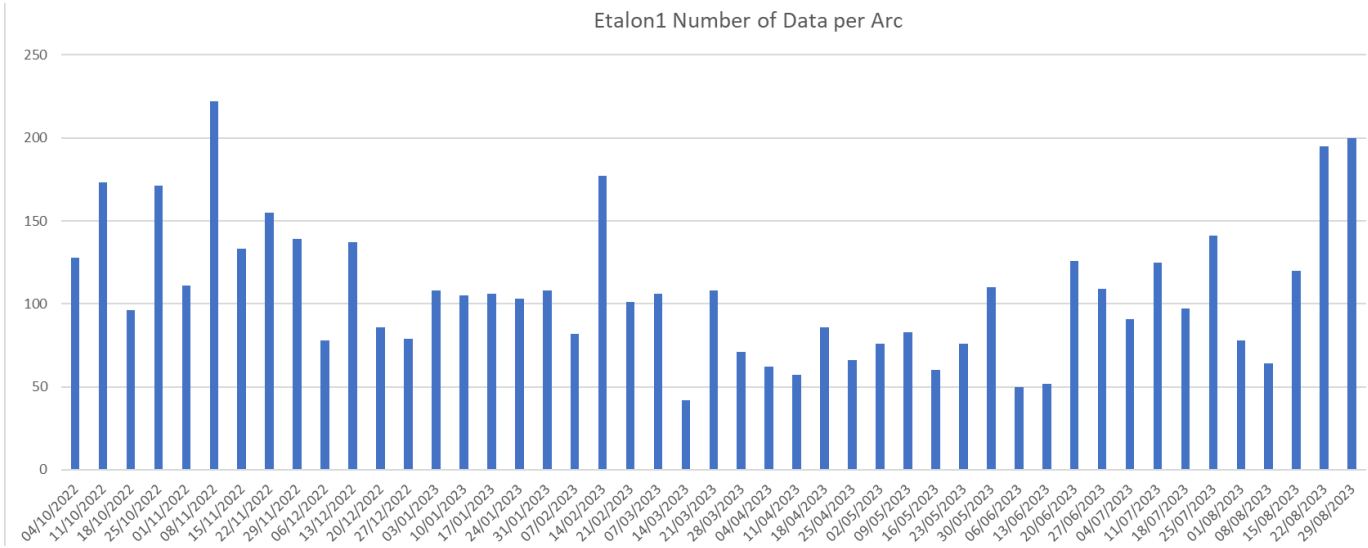


ETALON1 orbits – RMS of residuals w.r.t. combination

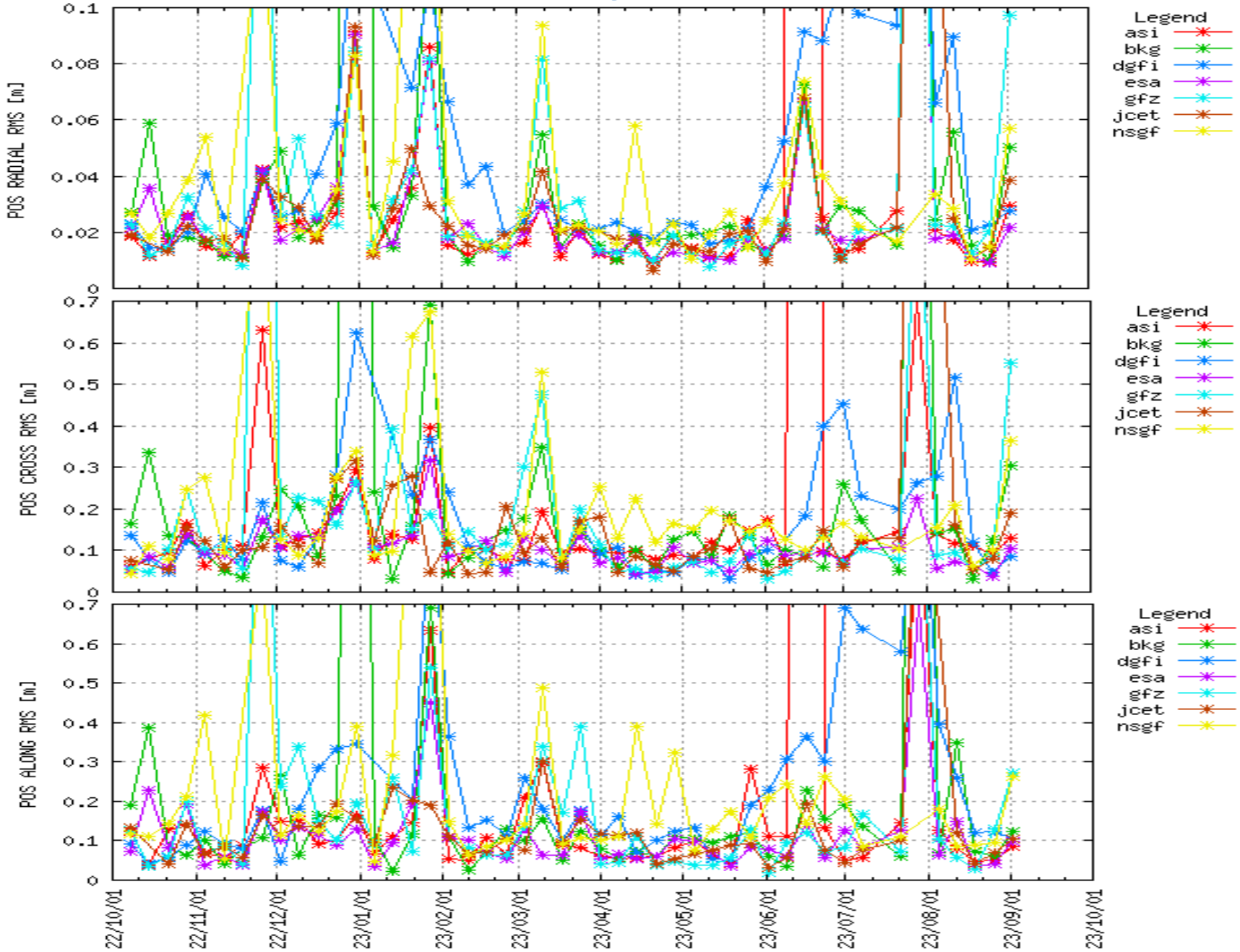


ETALON1 orbits – RMS of residuals w.r.t. combination

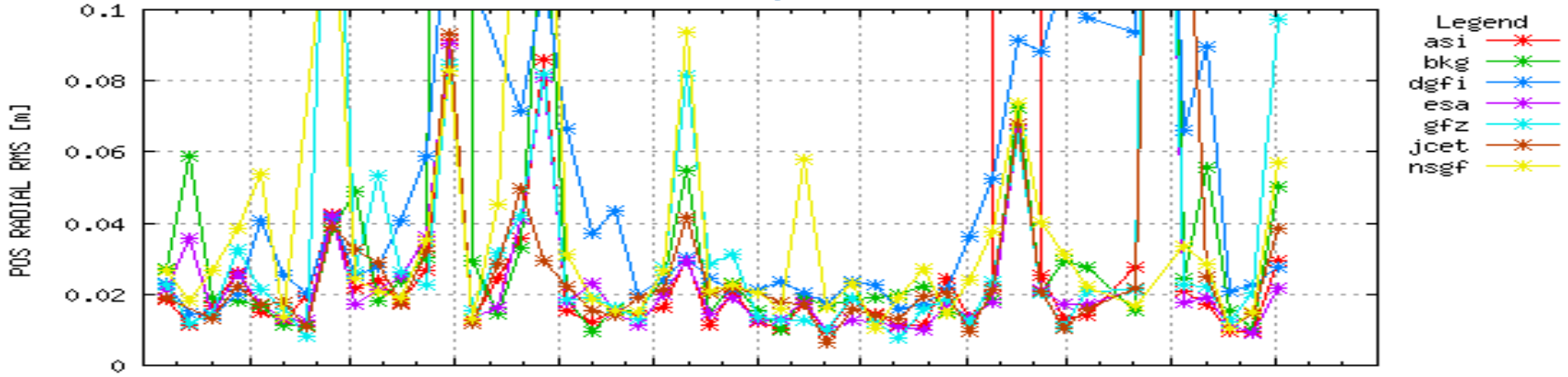


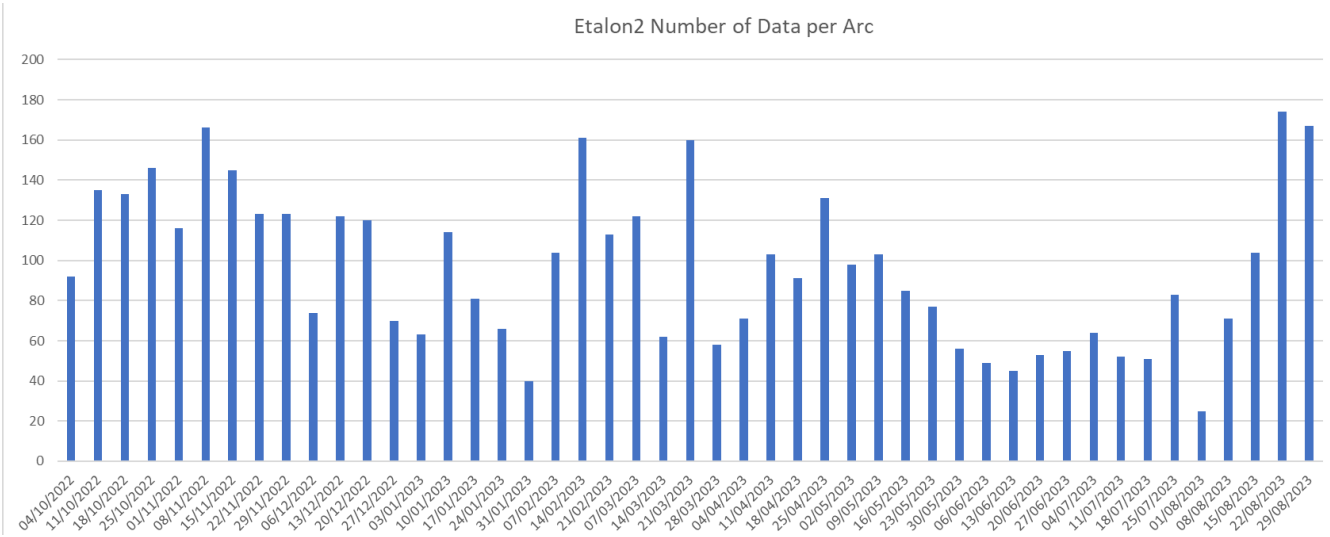


ETALON2 orbits – RMS of residuals w.r.t. combination



ETALON2 orbits – RMS of residuals w.r.t. combination



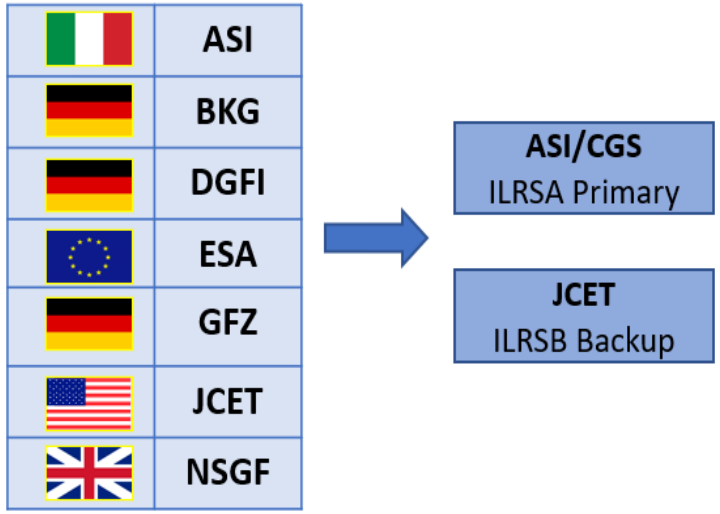


ILRS ACs orbit agreement

Satellite	Radial [mm]	Cross-track [mm]	Along-track [mm]
LAGEOS1	5.7	23.2	25.9
LAGEOS2	6.6	26.8	29.9
ETALON1	29.0	132.4	127.6
ETALON2	34.7	124.9	123.1

Mean RMS over the period 2022/10/01-2023/10/01

Station Systematic Error Modeling



In 2015 ILRS launched a multi-year effort to address and resolve the SLR scale issue: Station Systematic Error Modeling Pilot Project (**SSEM PP**) to estimate RBIAS simultaneously with the station positions.

- Analysis since **01/1993.**
- Weekly estimation of coordinates, EOP and range biases RB
- Time frame for the Pilot Project: 1993 – 2020 for ITRF2020
- Data: LAGEOS , LAGEOS 2, ETALON1-2
- Time series with separate range biases for LAGEOS, combined for ETALON

Operational Data Handling file

- Data Handling File (DHF) used for ITRF2020 was the version **210416** (yymmdd), from January 1993 to December 2020.
- The DHF was extended to the end of 2022 as a result of the SSEM-X project, version **230328**.
- An updated version of the DHF file was released to include a paragraph that is directed to general POD users of SLR data, not necessarily linked to the ASC, version **230621**: http://geodesy.jcet.umbc.edu/ILRS_ASC_RESOURCES/SLRF2020/ILRS_Data_Handling_File_2023.06.21.snx

- All ACs are delivering WEEKLY SINEXs to extend the time series (v23* series) to the current epoch.
- A weekly production chain of SSEM-like SINEXs file to routinely extend the RB time series (v230) was set by the ILRSA CC to check if any update of the DH file is needed.
- ILRSA CC is testing a change-point detection (CPD) algorithm, e.g. based on Pruned Exact Linear Time to support the analysts in their search for a potential new discontinuity in range bias series. A preliminary test to set parameters was performed on v230 series.

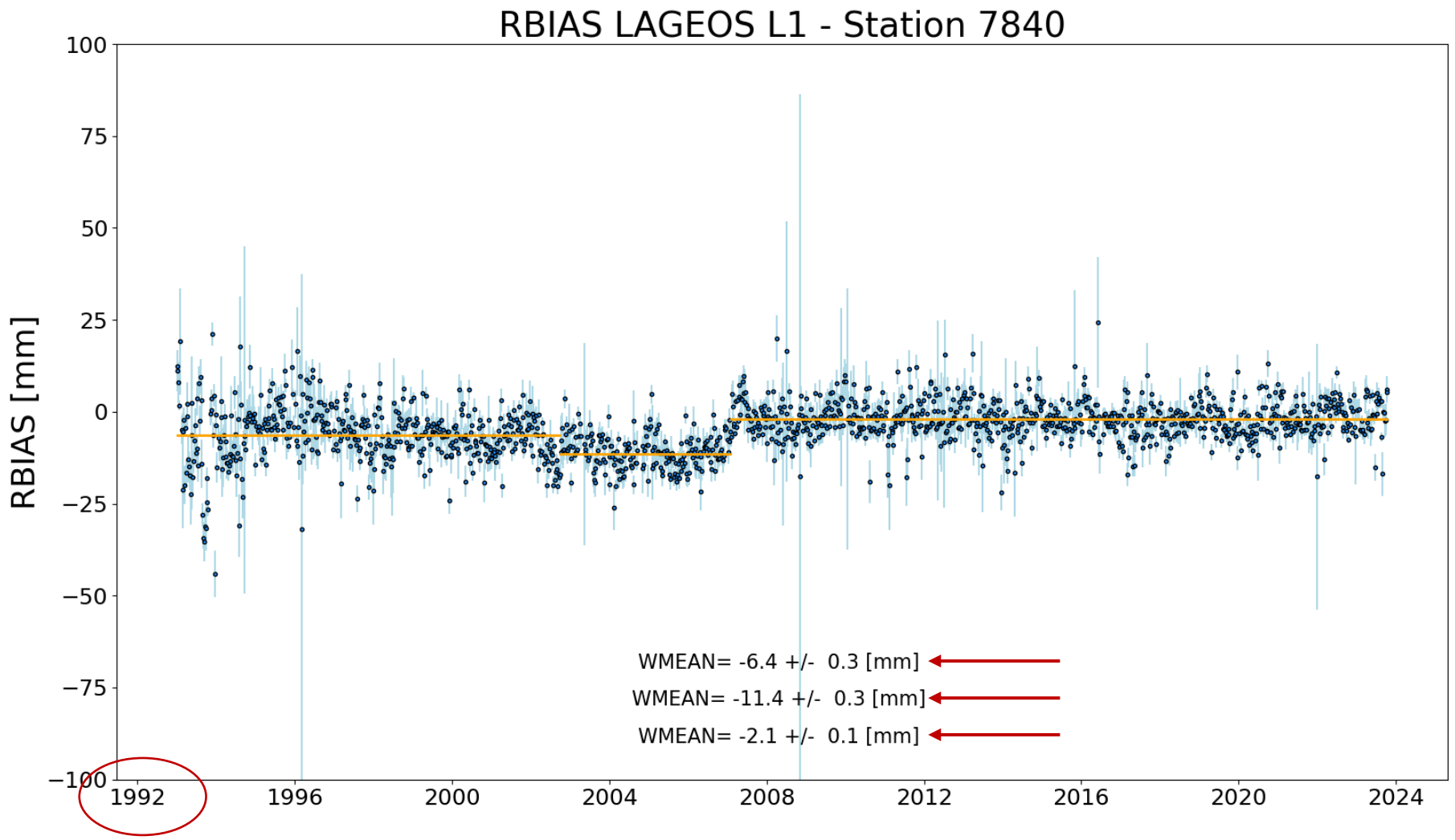
SSEM-X solutions – v230

AC	# SINEXs v23*	Start date	End date
ASI	1735	930109	231014
BKG	1654	930109	231014
DGFI	3112	930109	231014
ESA	2994	930109	231014
GFZ	1657	930109	231014
JCET	1752	930109	231014
NSGF	1754	930109	231014
Expected	1605	930109	231014

All ACs to the current date 19/10/23 are delivering v230 product routinely to EDC server (with some discontinuities in the operations).

DHF extension

Herstmonceux, United Kingdom (HERL)

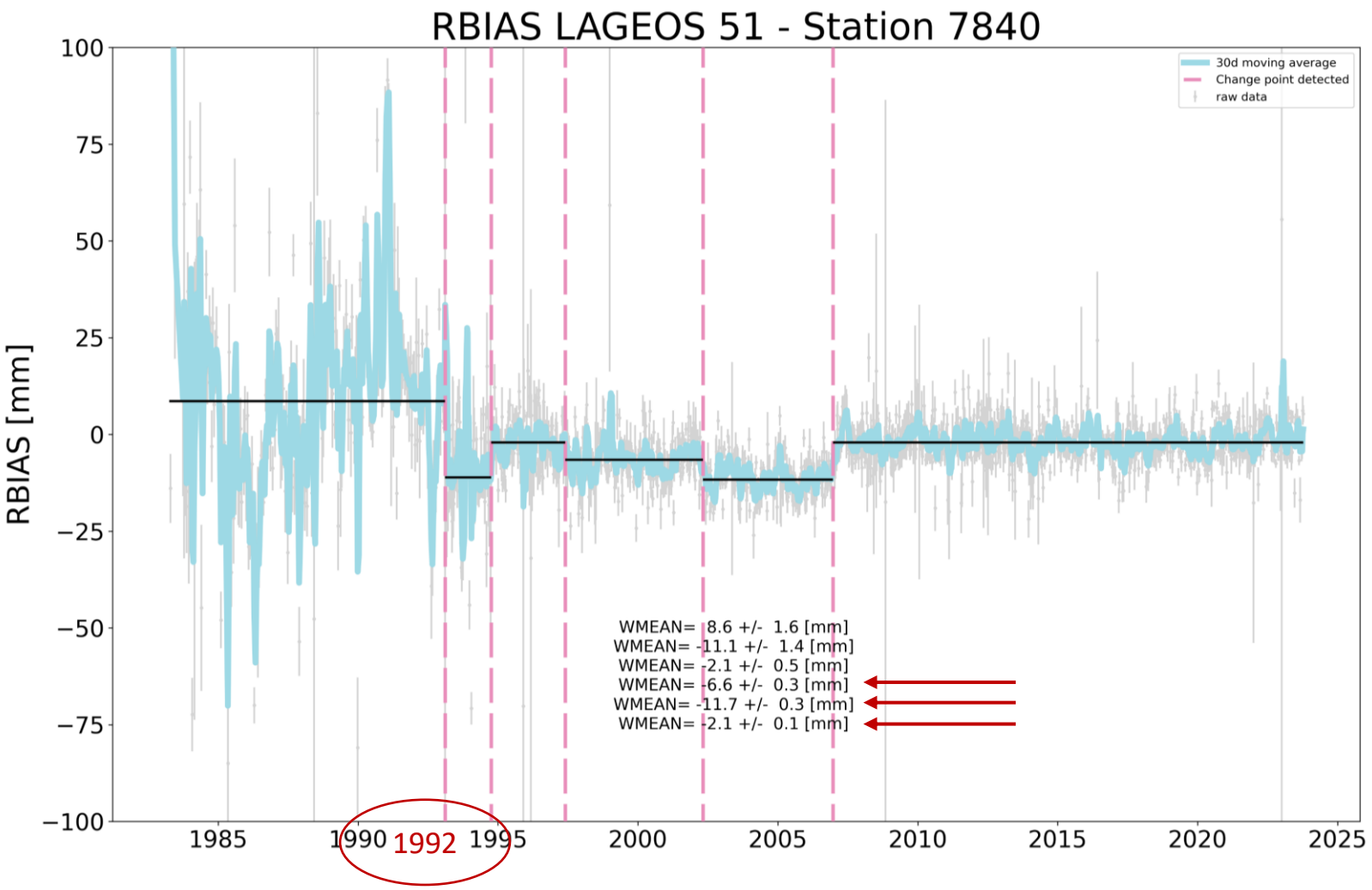


7840	2007-02-07 2022-12-21	-2.2	0.1 mm (DHF)
7840	2007-02-07 2023-10-08	-2.1	0.1 mm

*Considering v230 to 231014.

CPD test

Herstmonceux, United Kingdom (HERL)



ILRS_Data_Handling_File_2023.06.21.snx

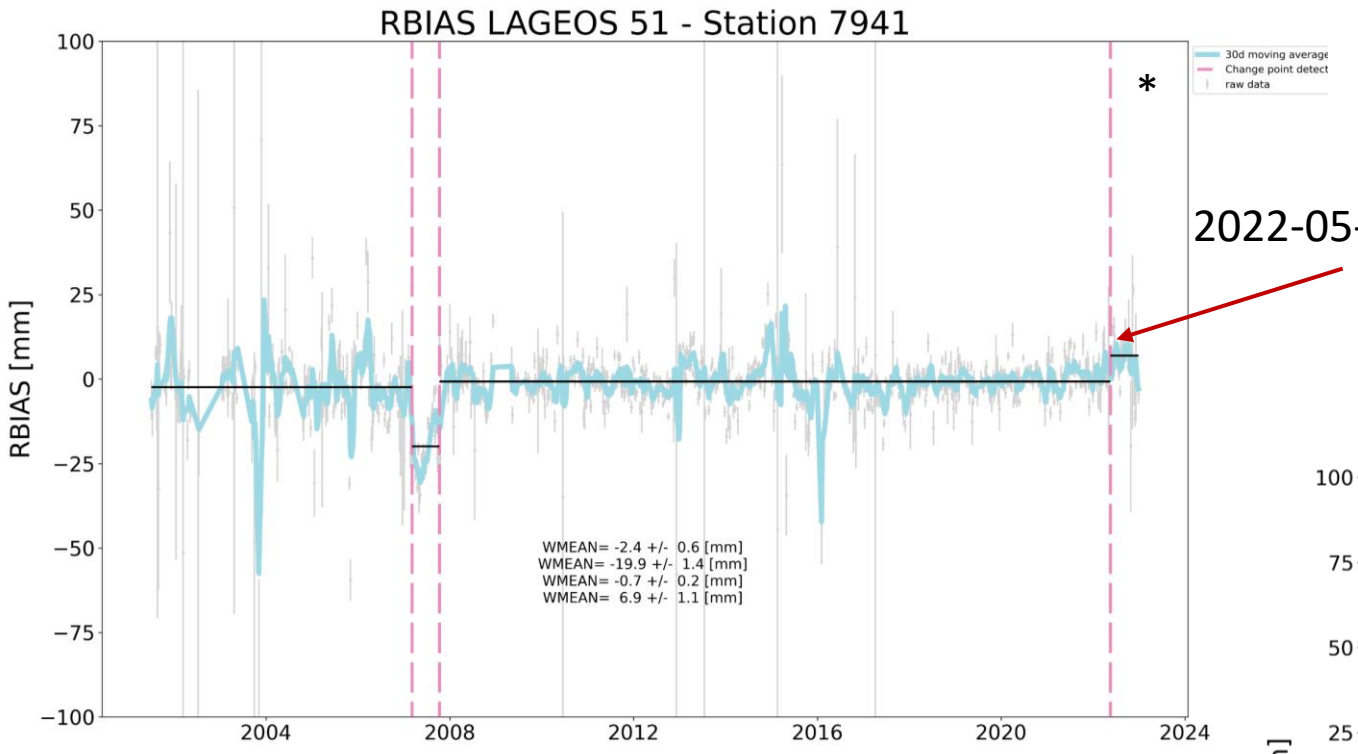
7840	**1993-01-06 2002-09-25**	**-6.4**	**0.3 mm**
7840	**2002-10-02 2007-01-31**	**-11.4**	**0.3 mm**
7840	**2007-02-07 2022-12-21**	**-2.2**	**0.1 mm**

CPD algorithm

1993-02-10 1994-10-05	-11.1	1.4 mm
1994-10-05 1997-05-28	-2.1	0.5 mm
1997-05-28 2002-05-01	**-6.6**	**0.3 mm**
2002-05-01 2006-12-20	**-11.7**	**0.3 mm**
2006-12-20 2023-10-11	**-2.1**	**0.1 mm**

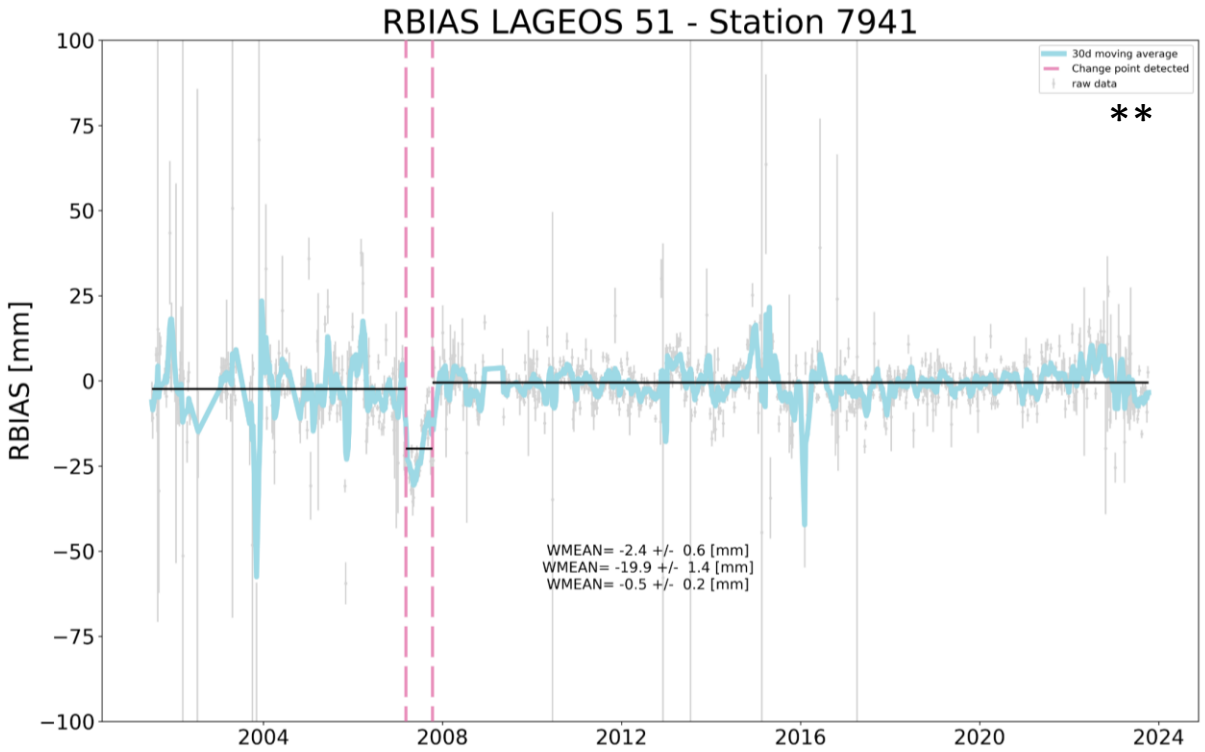
CPD test

Matera (MLRO)



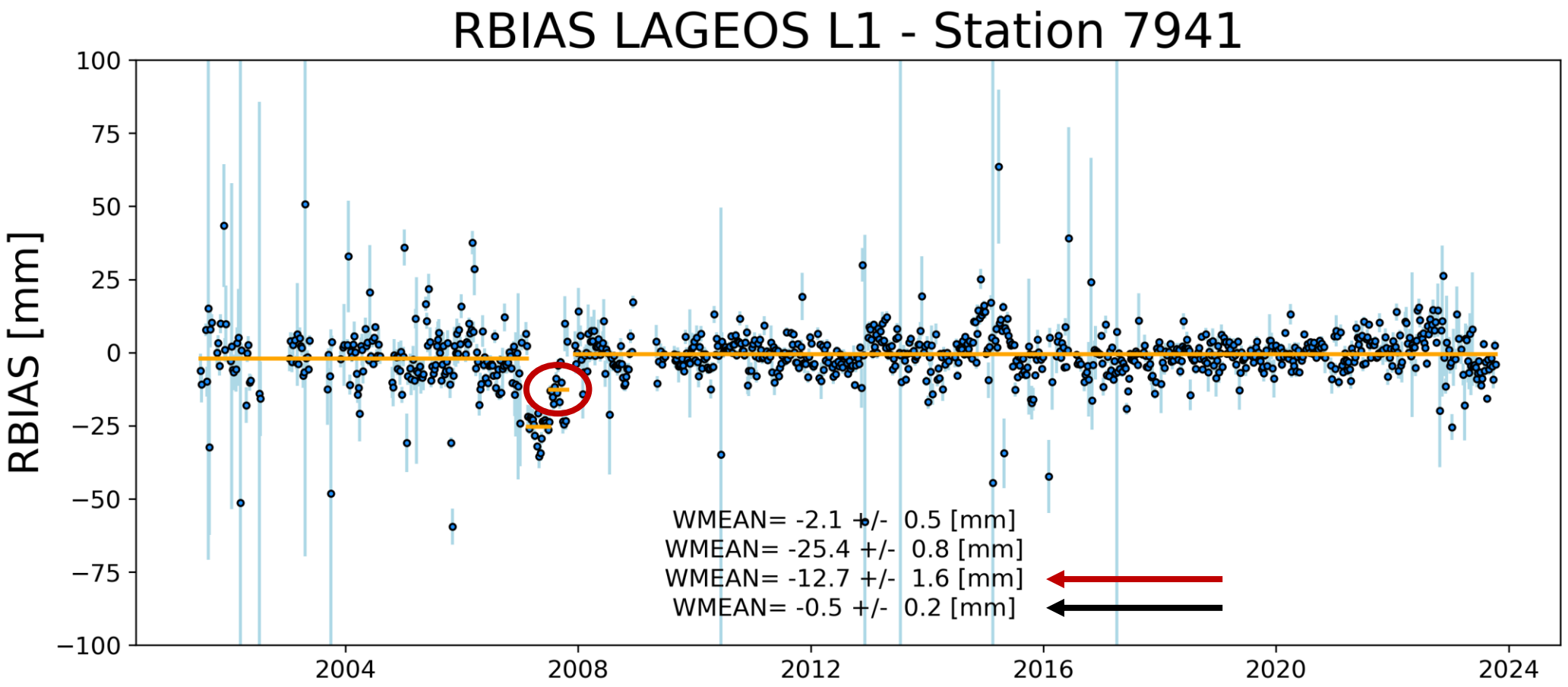
2022-05-18

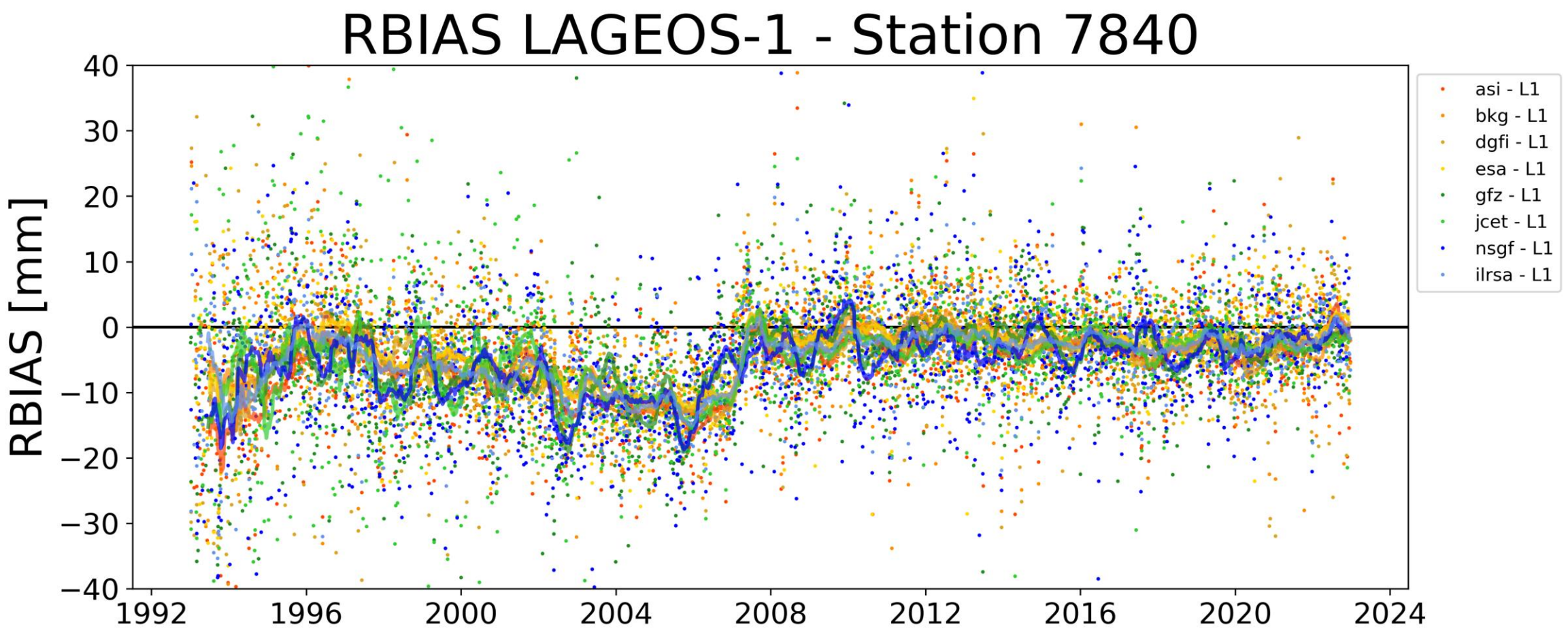
*CPD Considering v230 to 221031.



**CPD Considering v230 to 231014.

Matera (MLRO)


RBIAS LAGEOS L1 - Station 7941
RBIAS [mm]
100
75
50
25
0
−25
−50
−75
−100
2004
2008
2012
2016
2020
2024
WMEAN= -2.1 +/- 0.5 [mm]
WMEAN= -25.4 +/- 0.8 [mm]
WMEAN= -12.7 +/- 1.6 [mm]
WMEAN= -0.5 +/- 0.2 [mm]



No ACs is handling the error imposed by the Stanford counter (?!) for HERL station for period 1995-2007 (as suggested by NSGF in 26/04/2023 ASC meeting)

New ILRS routine products

- The SLRF2020 and associated DHF were sent to the 7 ACs involved in REPRO2020 (28/03/2023) as input for the new products (v80, v180 & v280):

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

- v80, v180 and v280 products are produced in parallel with the current operational ones in order to check the new solutions.

- **All ACs with the exception of BKG** to the current date 19/10/23 are routinely delivering v180, v80 (including orbits) and v280 products to EDC server:

  /pub/slr/products/test/daily_v180
  /pub/slr/products/test/weekly_v80
  /pub/slr/products/test/ssem_v280

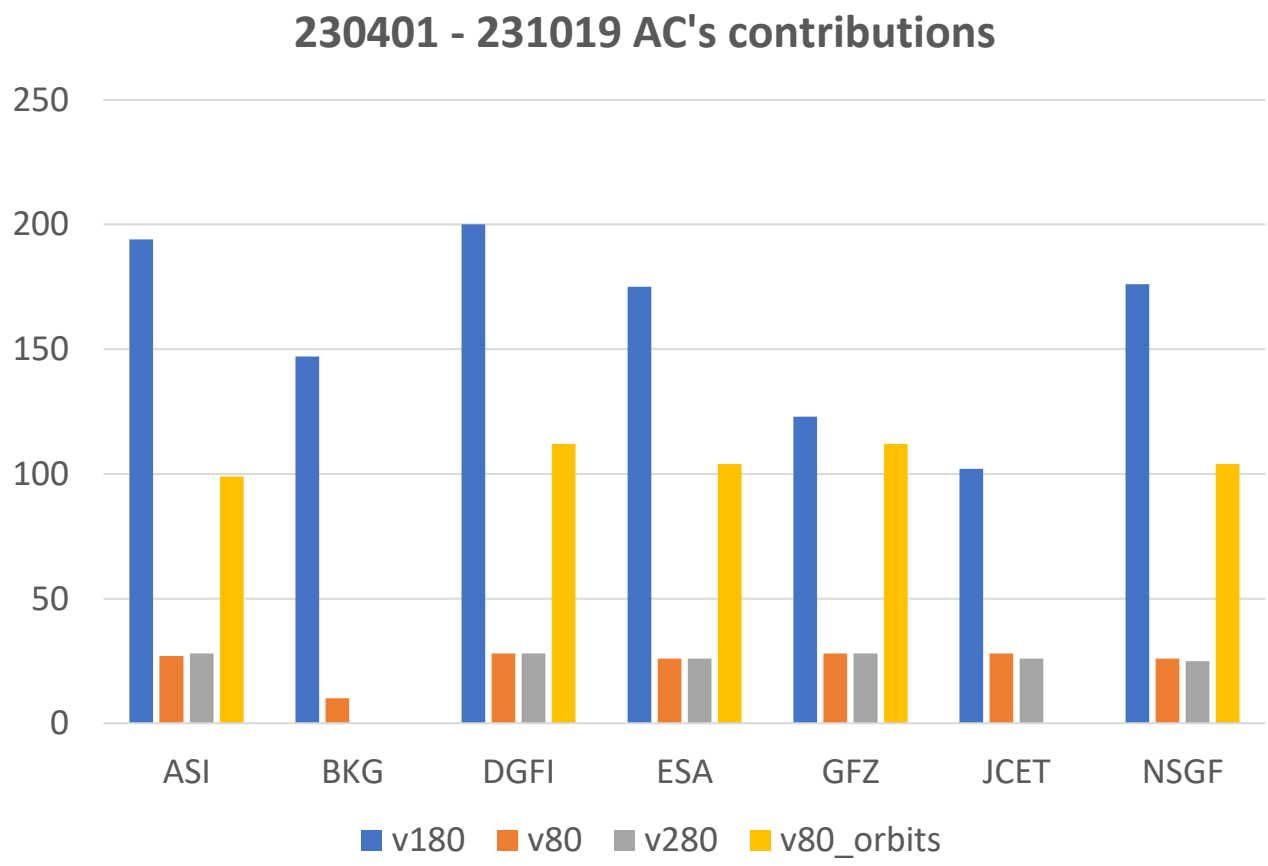
- Latency for v80 and v280:

sunday 1	.....	sat 7	sun 8	...	sat 14	sun 15	mon 16	tue 17	wed 18	.....
Data arc from 1 to 7								AC V80 V280 arc 1-7	CC V80V280 arc 1-7	

- ILRSA CC carried out test combinations and provided feedback to the ACs on their solutions to quickly arrive at convergence on new products.
- ILRSA v180, v80 and v280 series were computed (230401 – 230930).
- ILRSA CC computes routinely the combined solution for all the products. The proposed date for the release of the new operational products can be set.

230401 – 231019 - # of files				
	v180	v80	v280	v80_orbits
ASI	194	27	28	99
BKG	*127	*10		
DGFI	200	28	28	112
ESA	175	26	26	104
GFZ	123	28	28	112
JCET	102	28	26	**112
NSGF	176	26	25	104

*uploaded on 23/10, at this stage not considered in ILRSA (need fix)
**uploaded on 19/10, at this stage not considered in ILRSA



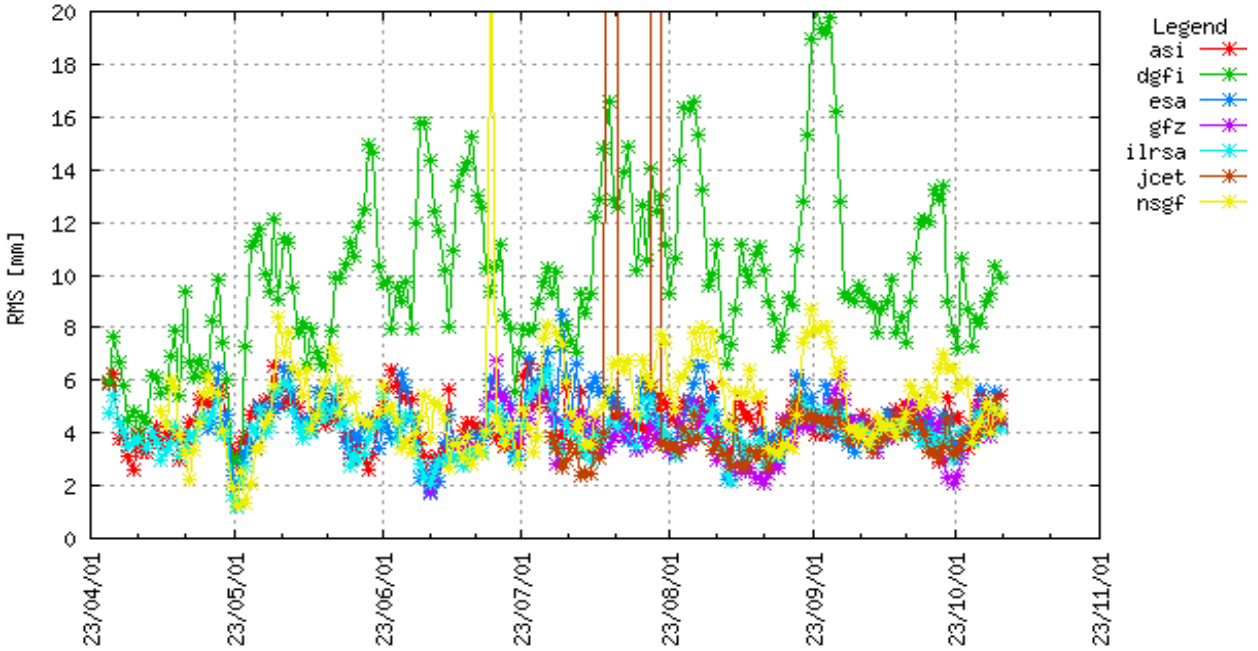
Current Operative Products
(v170/v170/v230)

VS

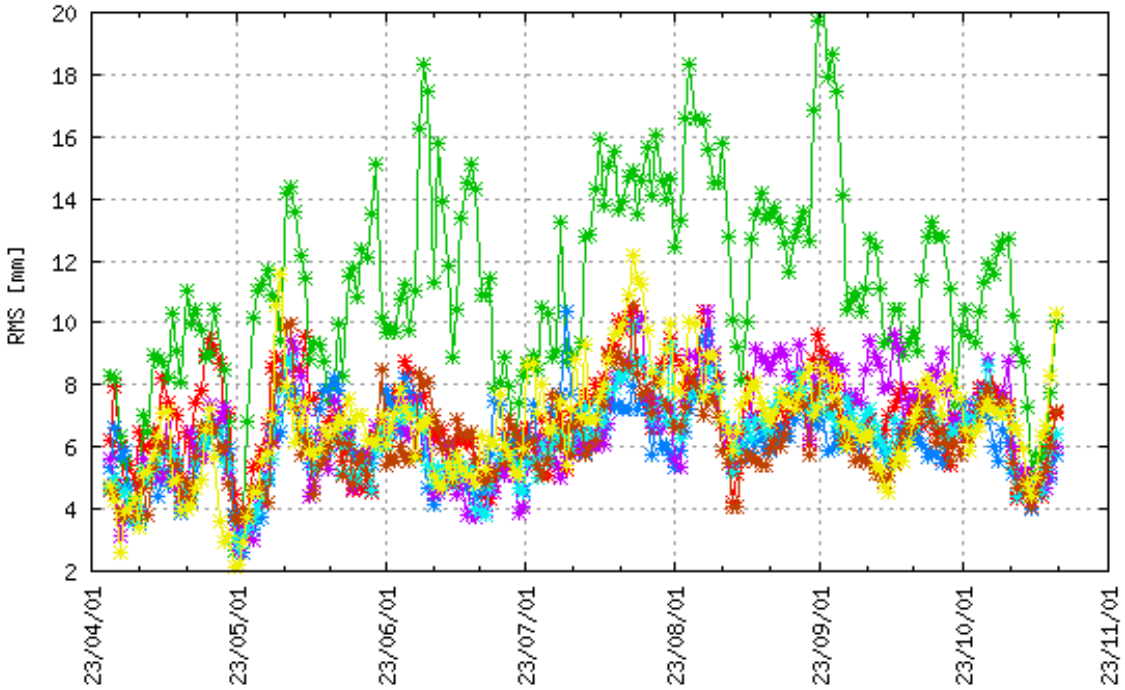
New Operative Products
(v180/v80/v280)

Stations coordinates from daily solutions (v180/v170)

3D wrms of the residual
CORE SITES



w.r.t ITRF2020: v180



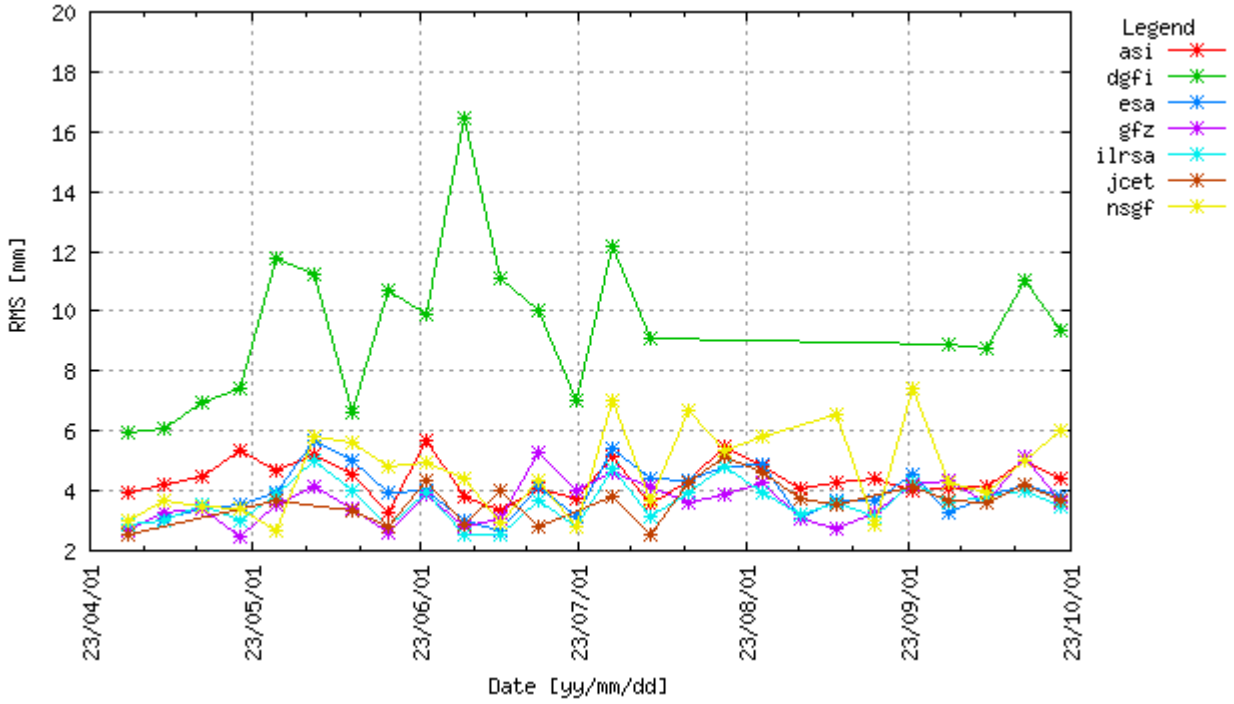
w.r.t ITRF2014: v170

DGFI*: same behaviour for v170/v180 daily station coordinates 3D-WRMS*

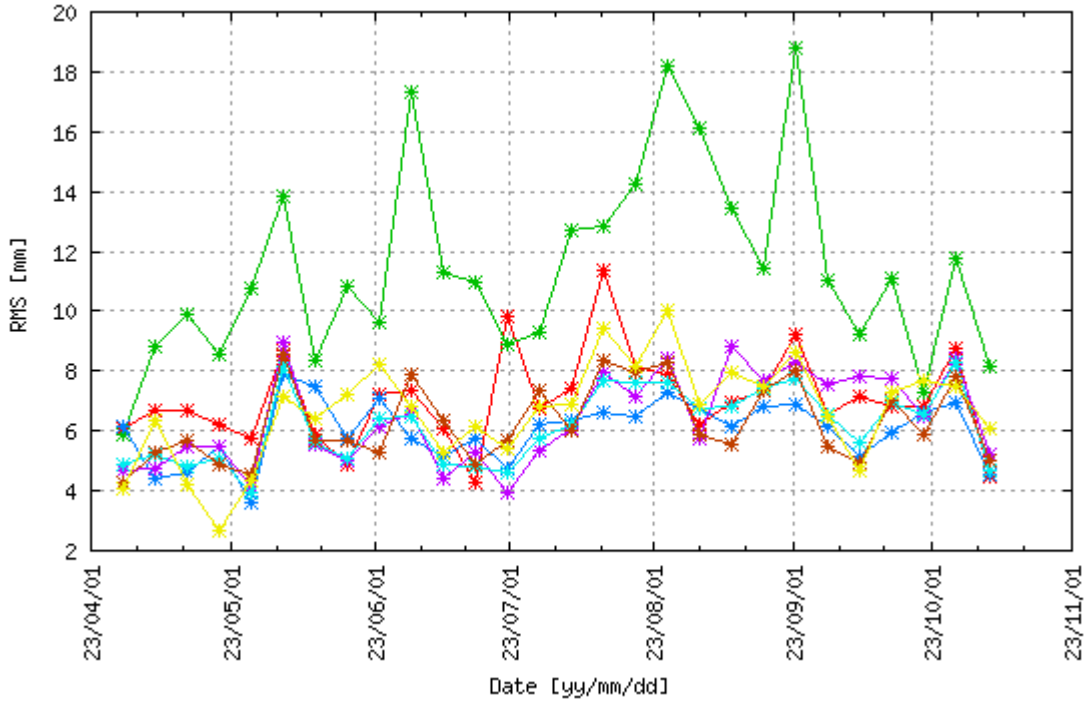
** on 03/10 JCET uploaded a new set of SINEXs after a fix (v181), to be considered in next ILRSA series*

Stations coordinates from weekly solutions (v80/v70)

3D wrms of the residual
CORE SITES



w.r.t ITRF2020: v80

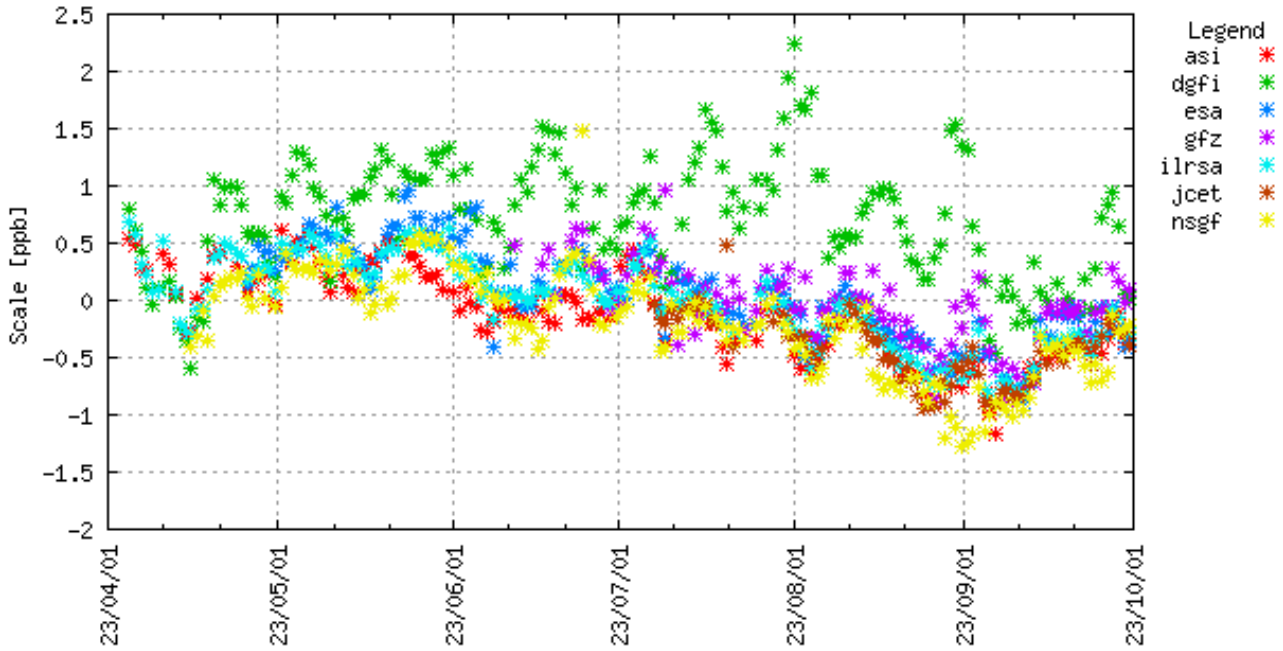


w.r.t ITRF2014: v70

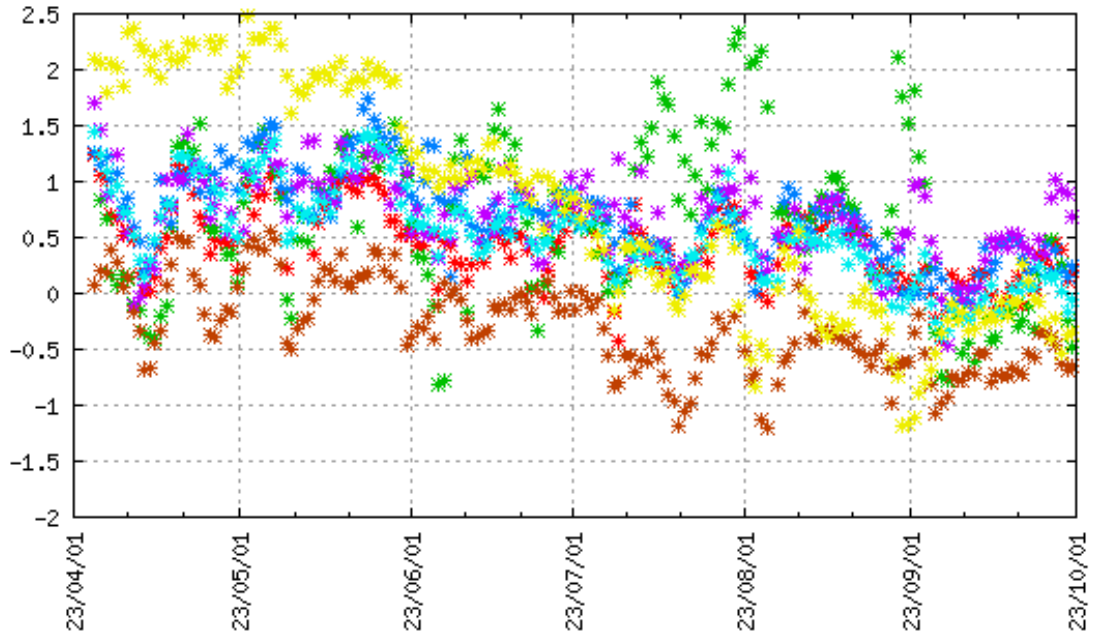
DGFI*: same behaviour for v70/v80 weekly station coordinates 3D-WRMS*

** on 03/10 JCET uploaded a new set of SINEXs after a fix (v81), to be considered in next ILRSA series*

Scale from daily solutions (v180/v170)



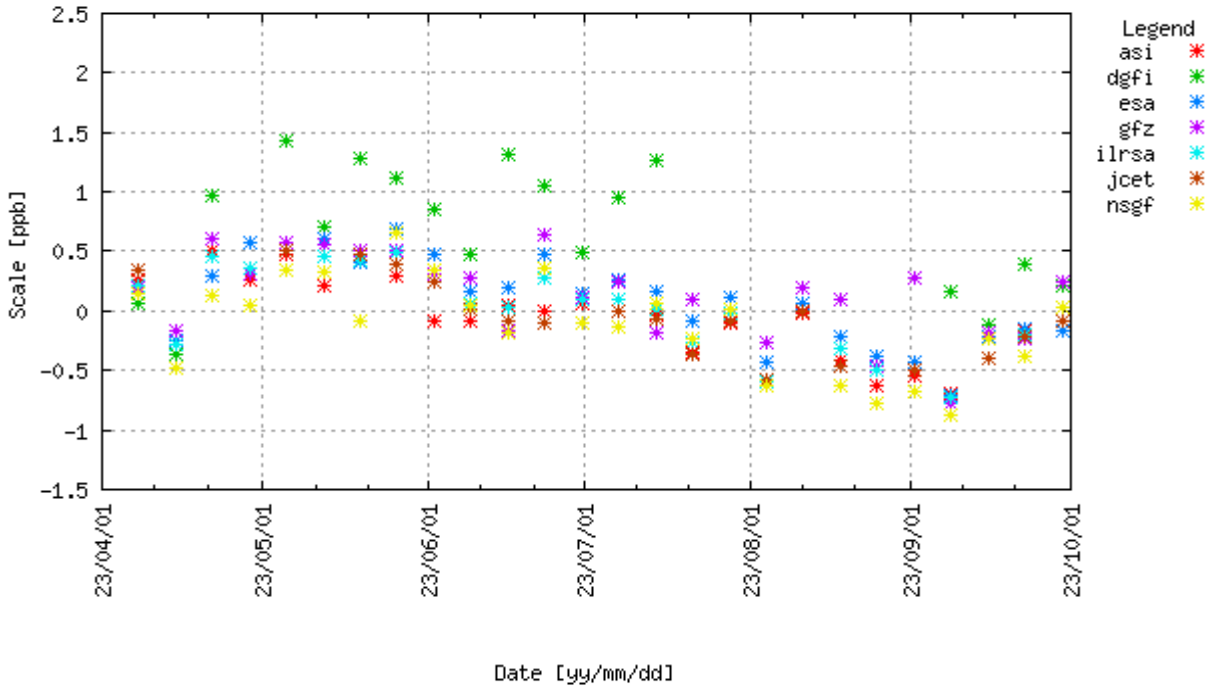
w.r.t ITRF2020: v180



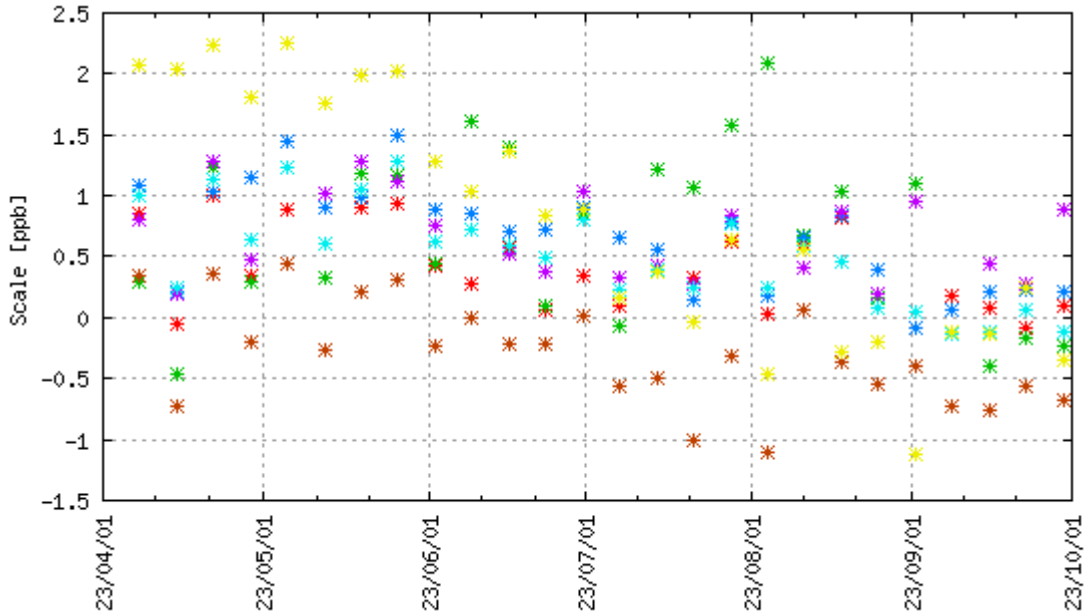
w.r.t ITRF2014: v170

DGFI*: not aligned with others ACs on v180 daily Scale*

Scale from weekly solutions (v80/v70)



w.r.t ITRF2020: v80

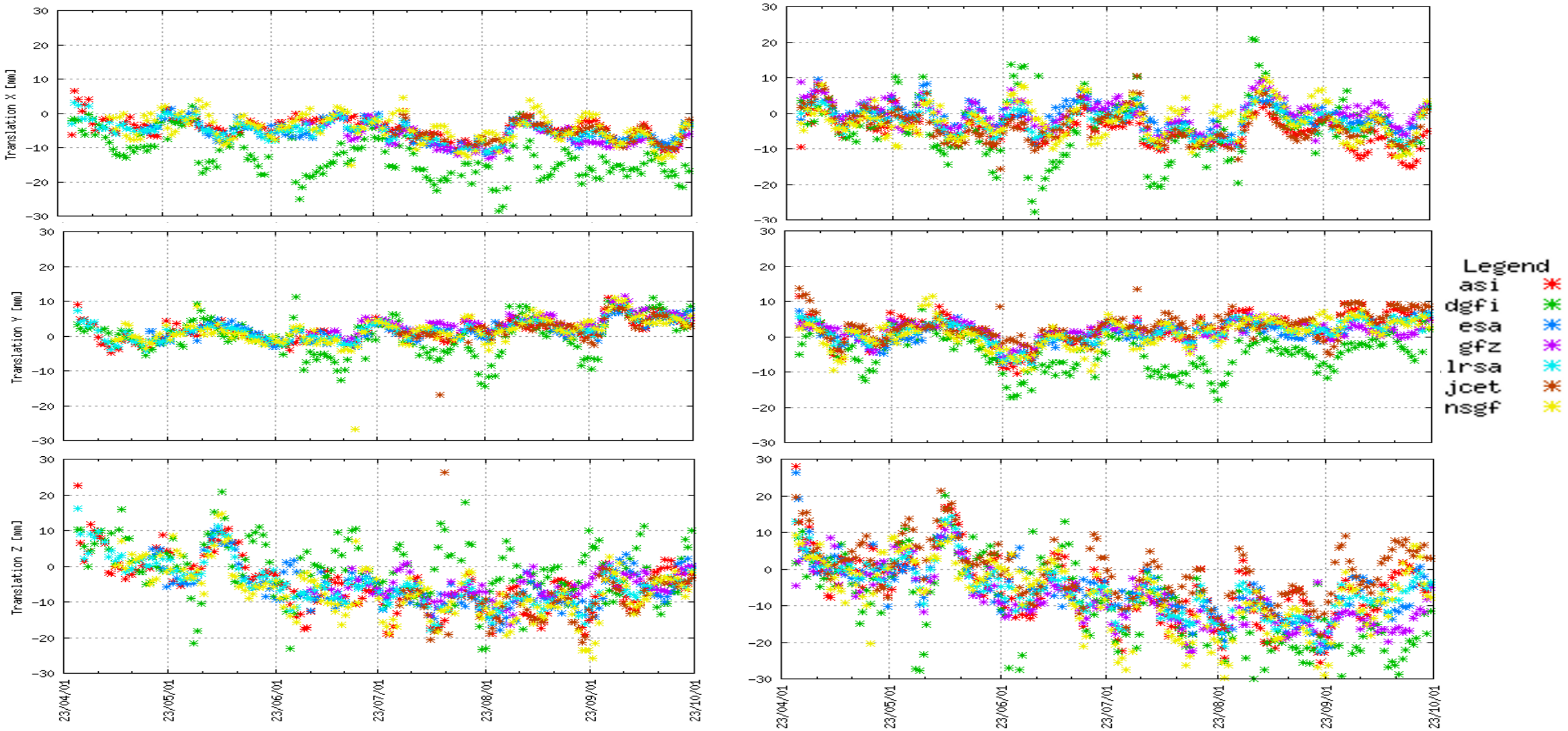


w.r.t ITRF2014: v70

***DGFI**: not aligned with others ACs on v80 weekly Scale untill Mid-July*

Geocenter motion from daily solutions (v180)

v180 **v170**

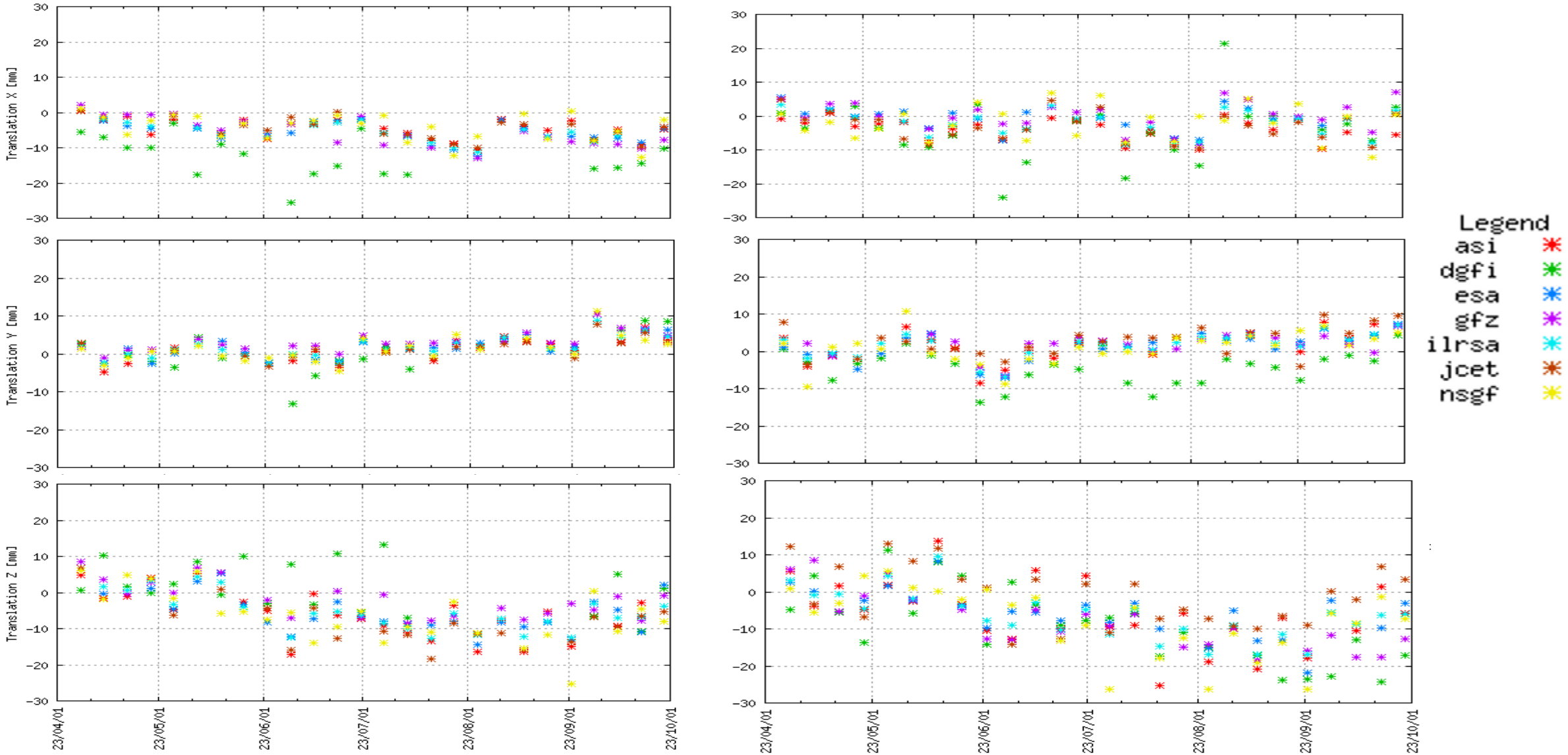


***DGFI**: not aligned with others ACs on v180 daily Geocenter values*

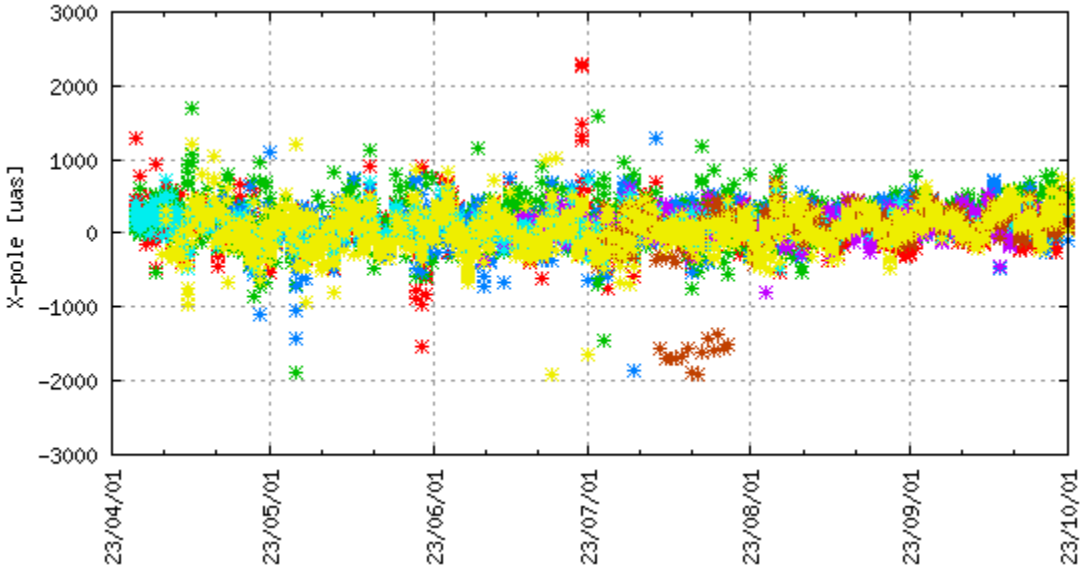
Geocenter motion from weekly solutions (v80)

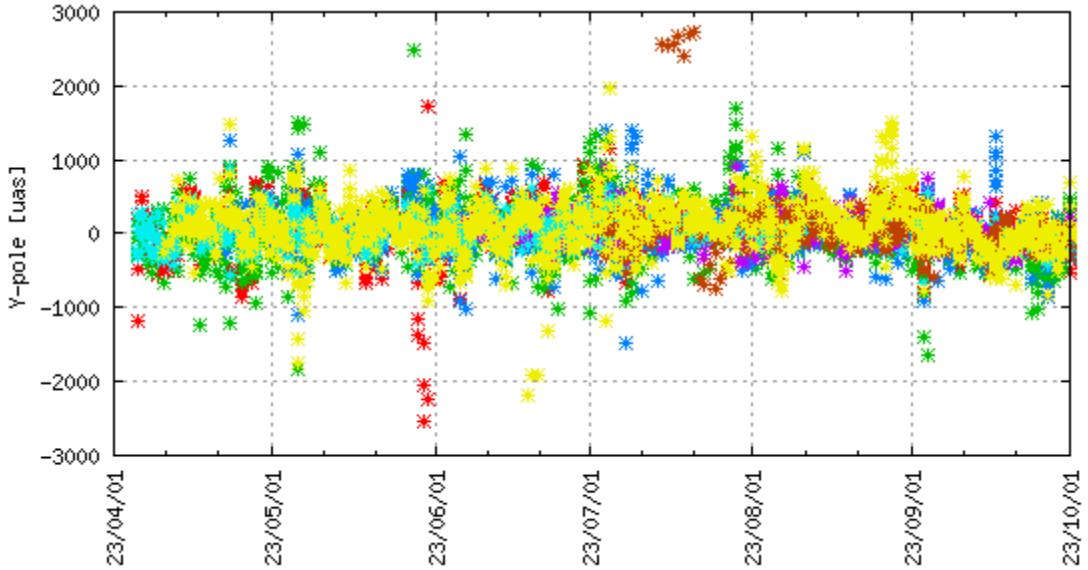
v80

v70

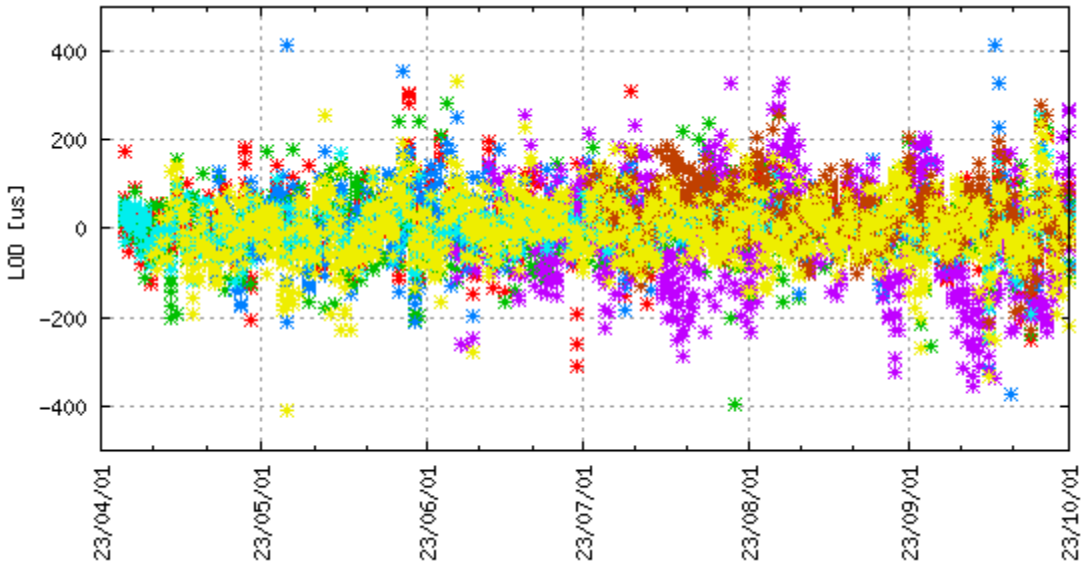


EOP from daily solutions (v180)

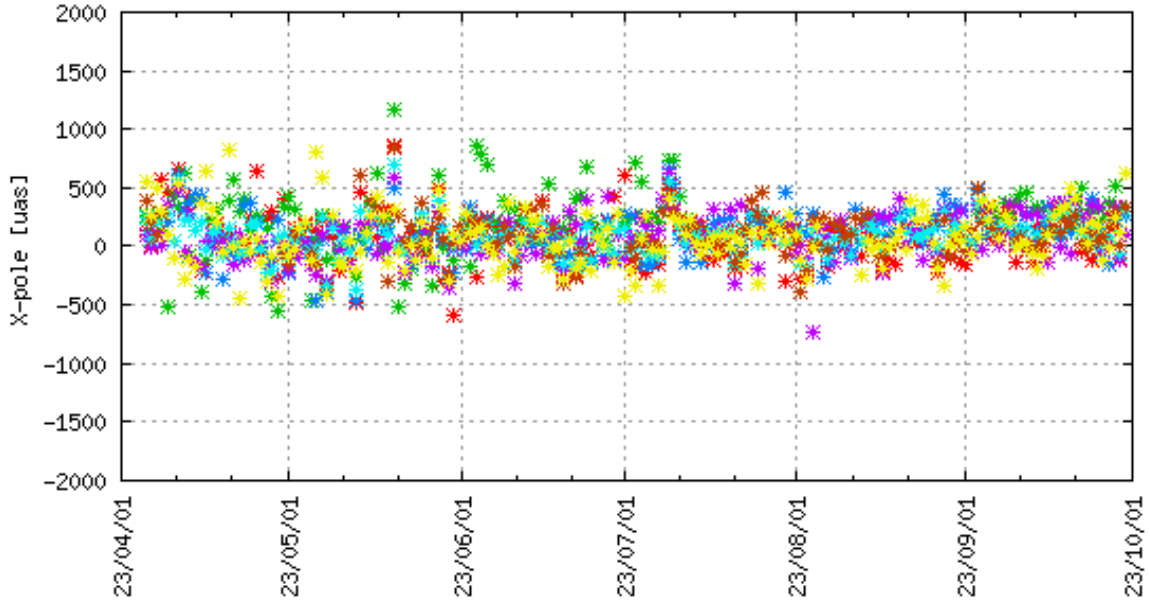


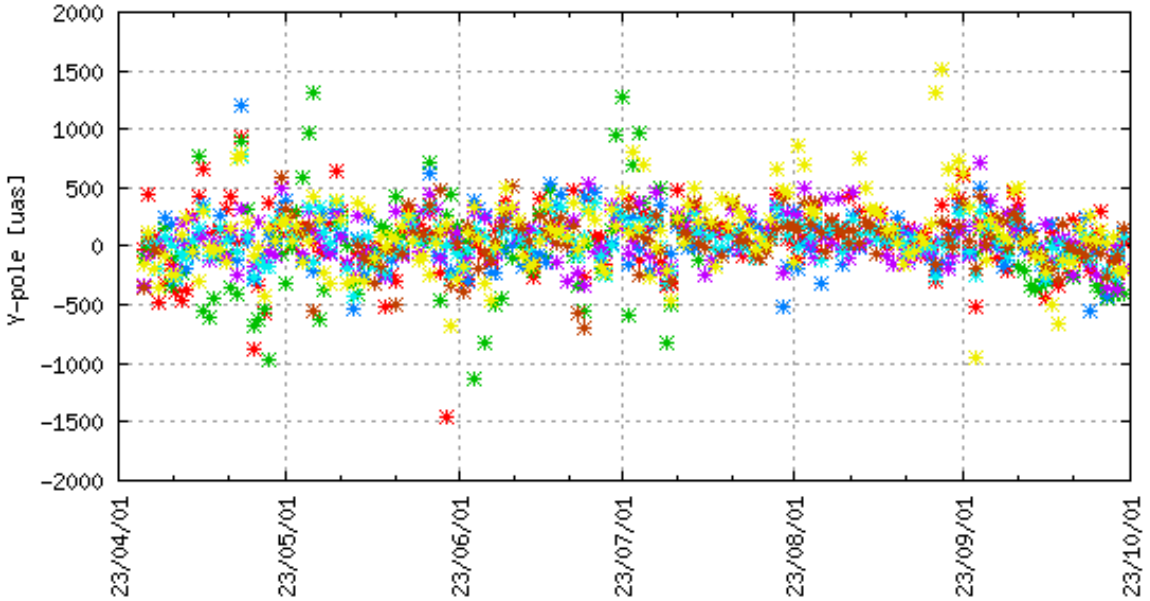


***GFZ**: daily (v180) LOD a bit more scattered*

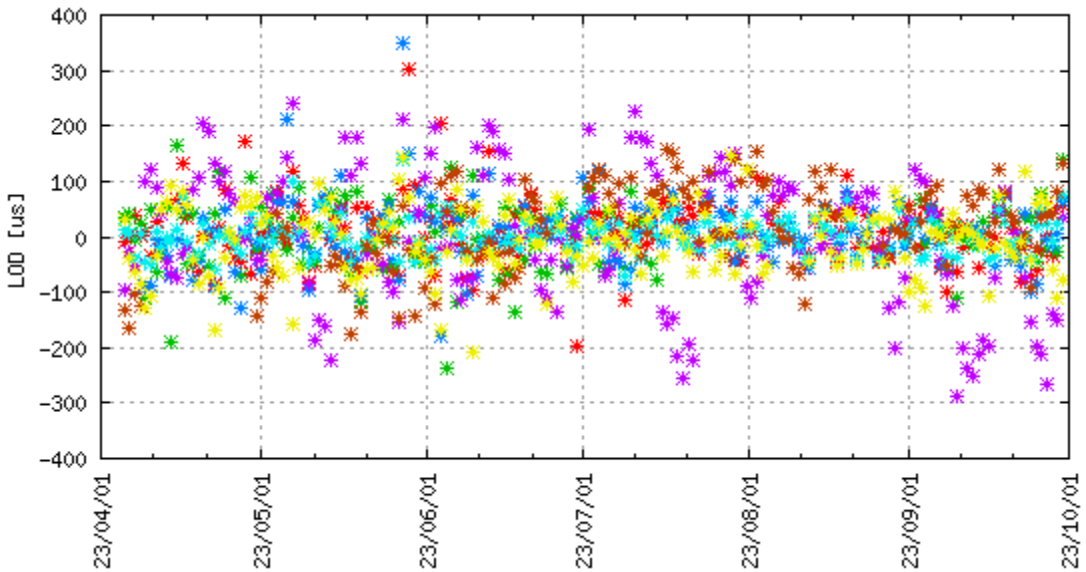


EOP from weekly solutions (v80)

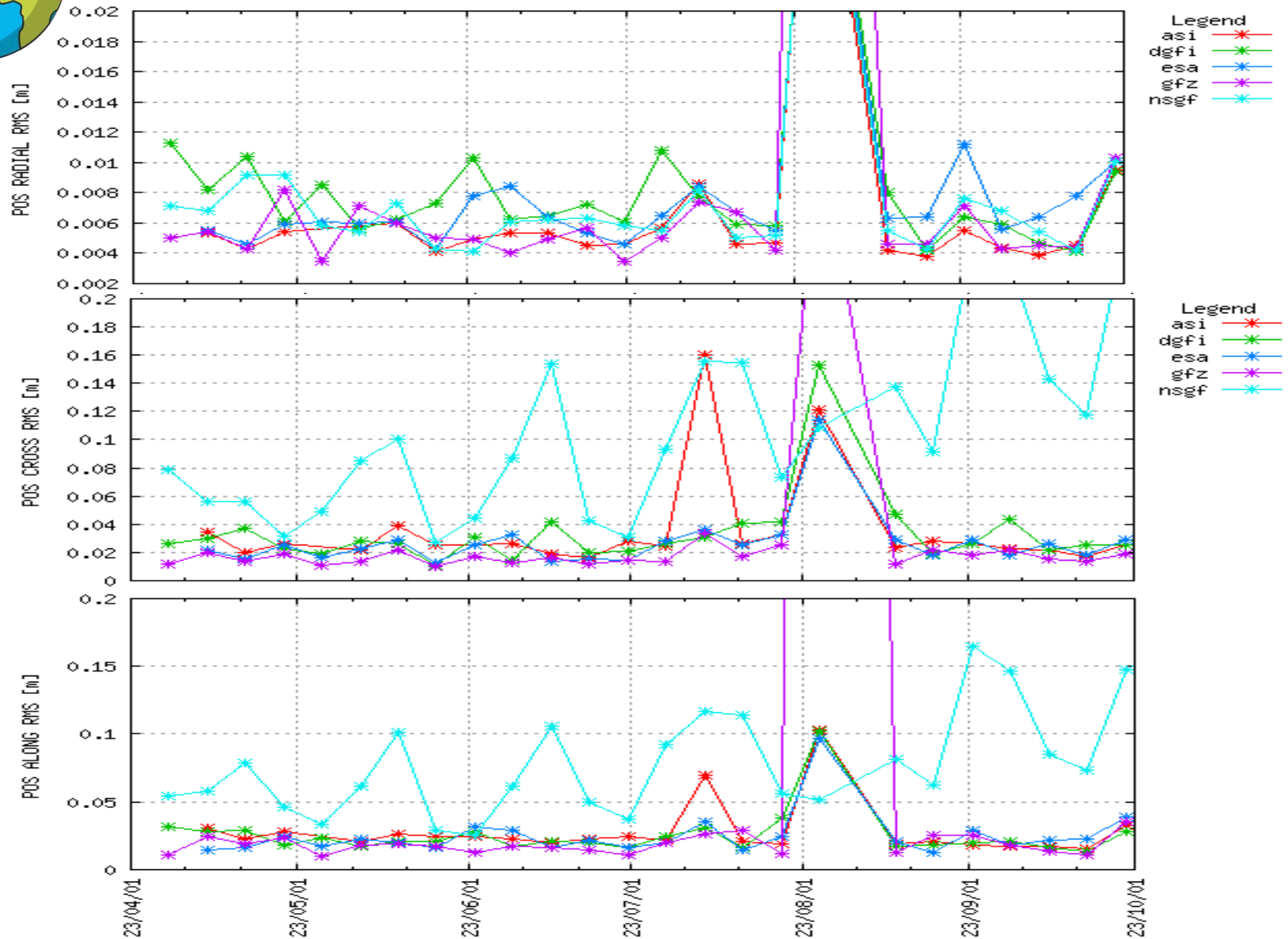




***GFZ**: weekly (v80) LOD a bit more scattered*



LAGEOS1 orbits (v80) – RMS of residuals w.r.t. combination

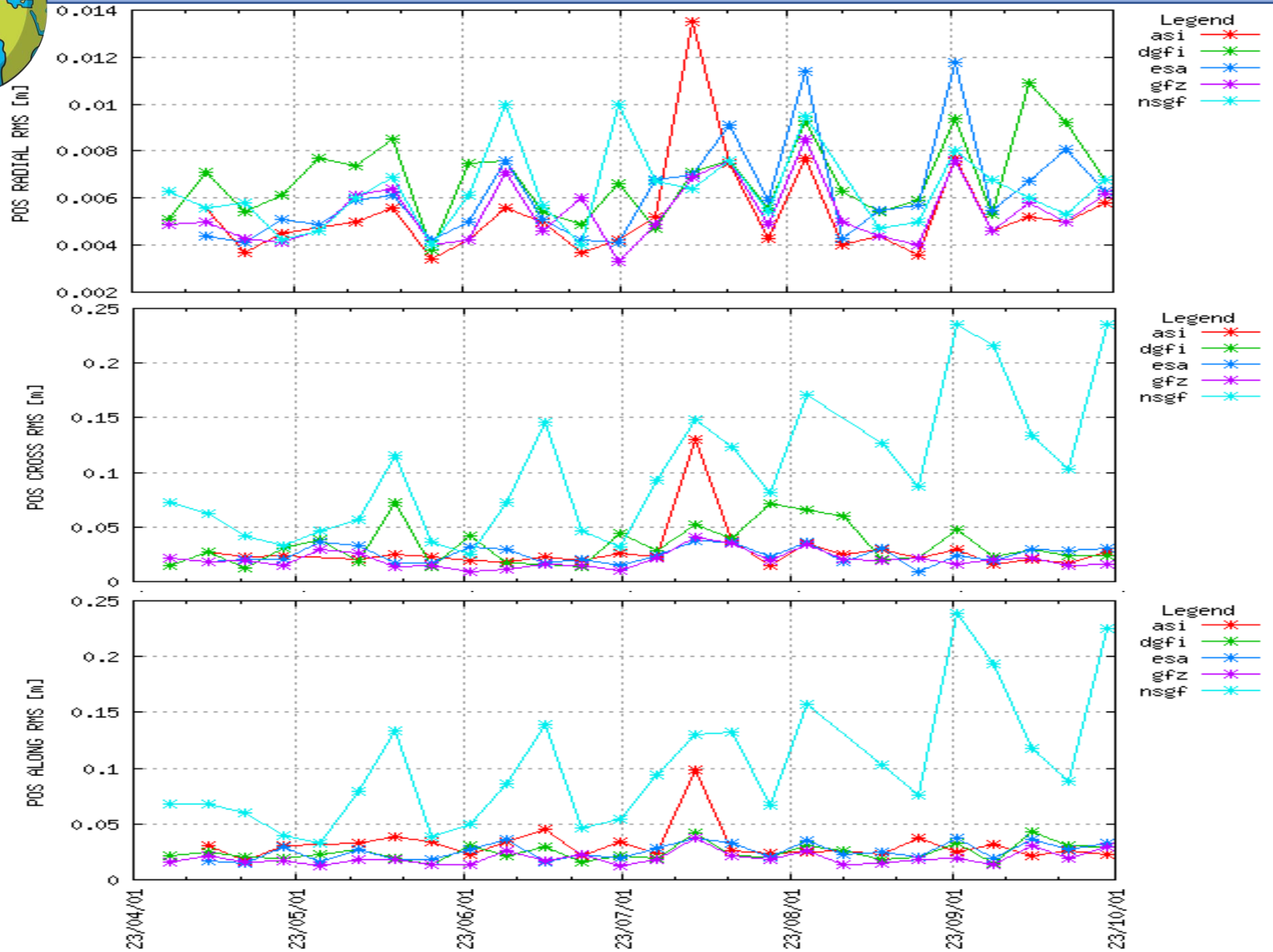


NSGF:
Cross&Along RMS w.r.t. ILRSA divergency

ASI:
Anomalous outlier

ALL:
single outliers w.r.t con ILRSA

LAGEOS2 orbits (v80) – RMS of residuals w.r.t. combination



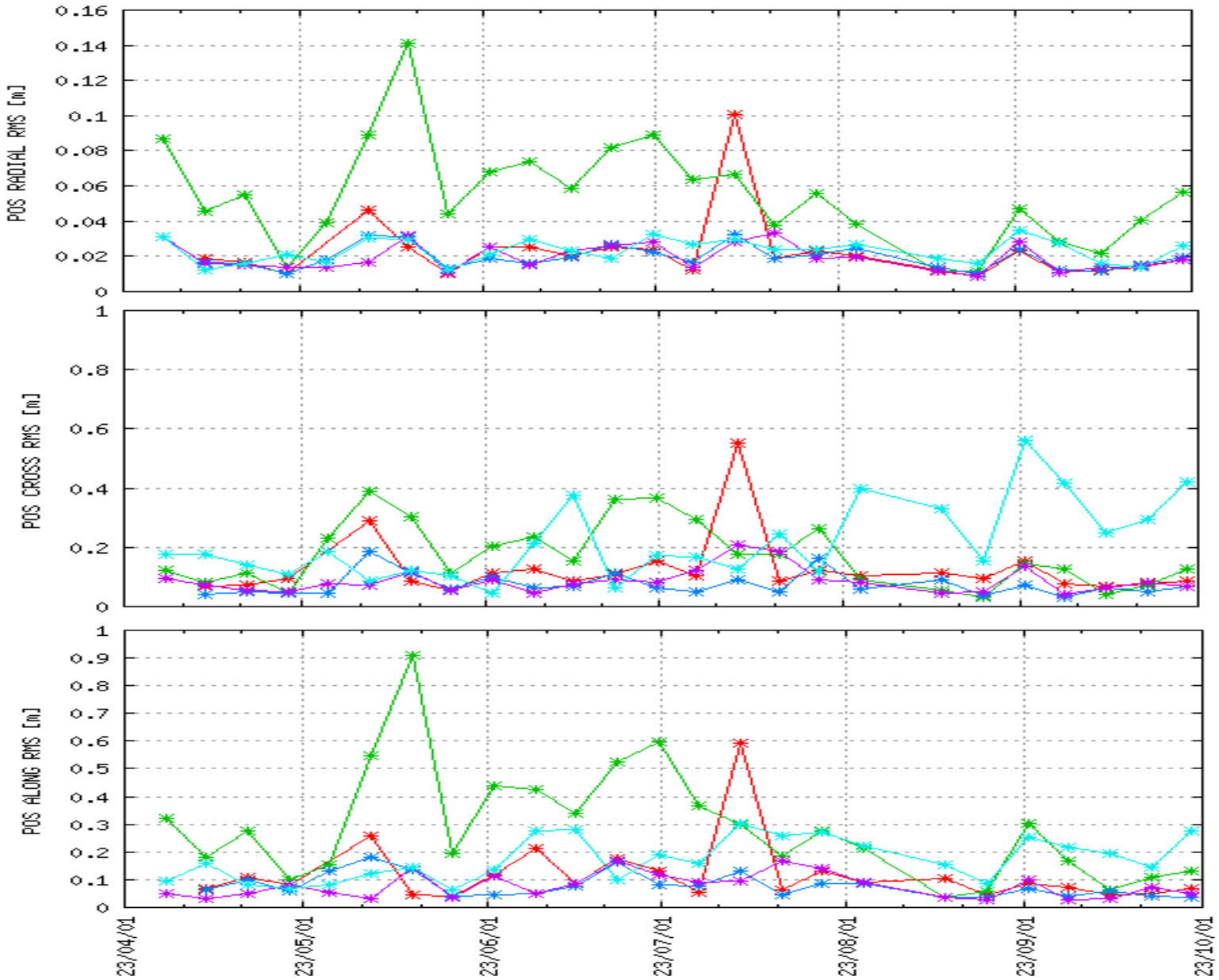
NSGF:

Cross&Along RMS w.r.t. ILRSA divergency

ASI:

Anomalous outlier

ETALON1 orbits (v80) – RMS of residuals w.r.t. combination

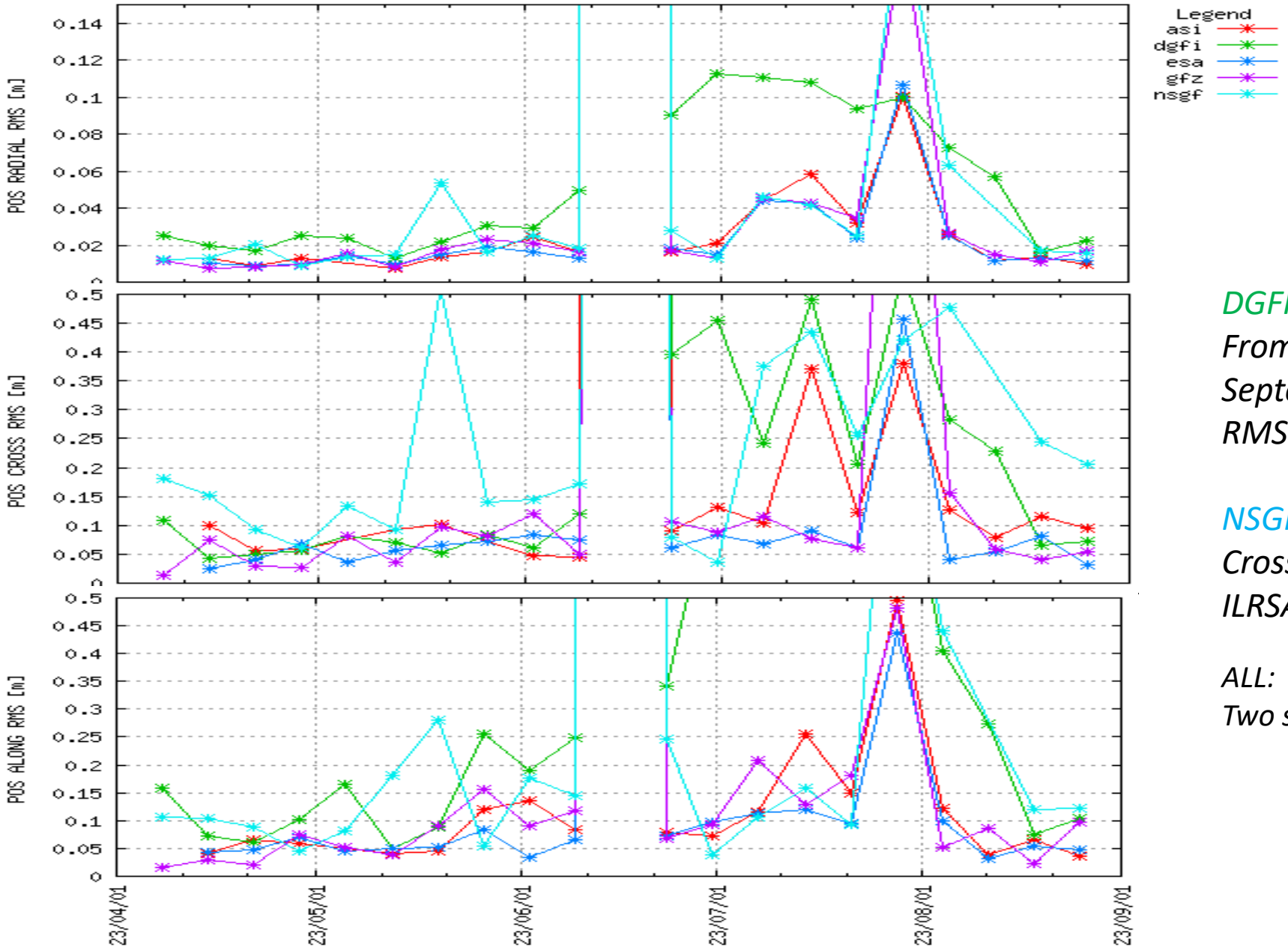


DGFI:
From April to August higher RMS

NSGF:
Cross RMS w.r.t. ILRSA divergency

ASI:
Anomalous outlier

ETALON2 orbits (v80) – RMS of residuals w.r.t. combination



DGFI:

From August to September higher RMS

NSGF:

Cross RMS w.r.t. ILRSA divergency

ALL:

Two single outliers w.r.t ILRSA

ILRS ACs orbit agreement

v80

Satellite	Radial [mm]	Cross-track [mm]	Along-track [mm]
LAGEOS1	6,16	41,25	33,31
LAGEOS2	5,95	40,67	39,55
ETALON1	27,38	132,51	144,59
ETALON2	30,70	137,01	154,82

All Five ACs (ASI/DGFI/ESA/GFZ/NSGF)

v80

Satellite	Radial [mm]	Cross-track [mm]	Along-track [mm]
LAGEOS1	6,16	24,78	21,66
LAGEOS2	5,86	25,47	24,25
ETALON1	28,49	110,27	137,16
ETALON2	29,88	116,03	147,19

Without NSGF

Mean RMS over the period 2023/04/01-2023/10/01
(after outliers exclusion)

ILRS ACs orbit agreement

v80

Satellite	Radial [mm]	Cross-track [mm]	Along-track [mm]
LAGEOS1	6,16	41,25	33,31
LAGEOS2	5,95	40,67	39,55
ETALON1	27,38	132,51	144,59
ETALON2	30,70	137,01	154,82

v80

Satellite	Radial [mm]	Cross-track [mm]	Along-track [mm]
LAGEOS1	5,75	23,57	21,43
LAGEOS2	5,54	22,71	24,17
ETALON1	19,28	88,33	83,69
ETALON2	22,02	91,31	94,65

Mean RMS over the period 2023/04/01-2023/10/01
(after outliers exclusion)

All Five ACs (ASI/DGFI/ESA/GFZ/NSGF)

Without NSGF & Without DGFI

ILRS ACs orbit agreement

v70

Satellite	Radial [mm]	Cross-track [mm]	Along-track [mm]
LAGEOS1	5,9	23,8	25,8
LAGEOS2	6,3	28,0	26,9
ETALON1	31,7	133,4	130,6
ETALON2	36,9	124,0	129,0

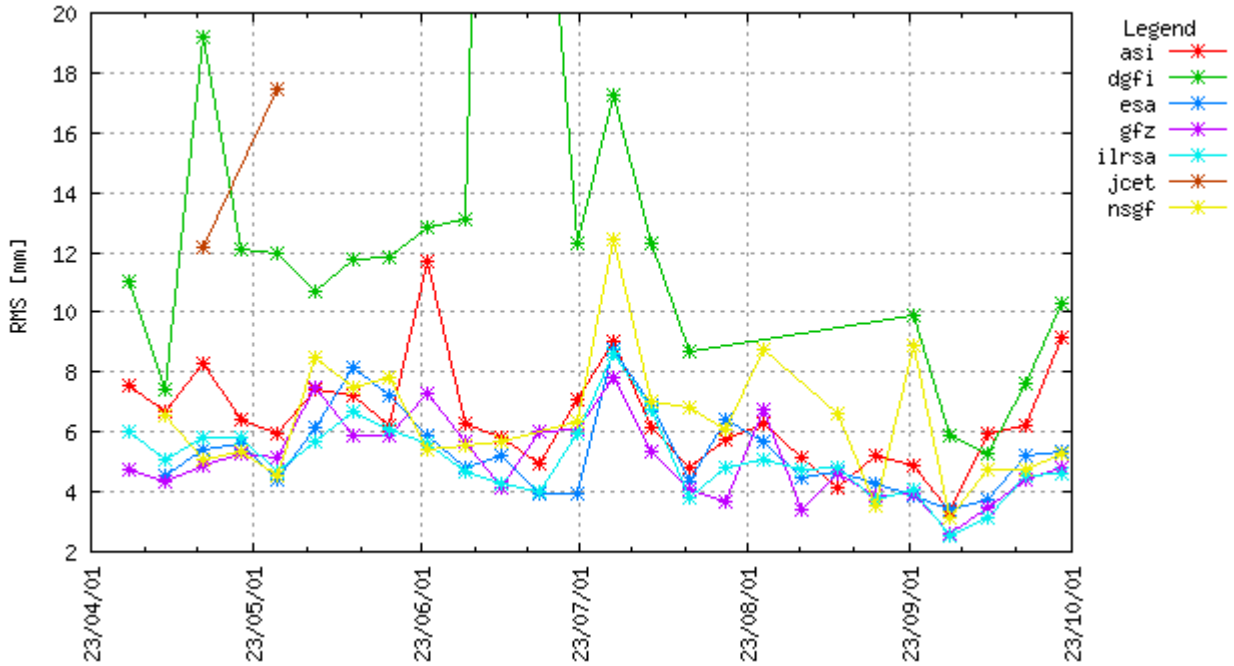
v80

Satellite	Radial [mm]	Cross-track [mm]	Along-track [mm]
LAGEOS1	5,75	23,57	21,43
LAGEOS2	5,54	22,71	24,17
ETALON1	19,28	88,33	83,69
ETALON2	22,02	91,31	94,65

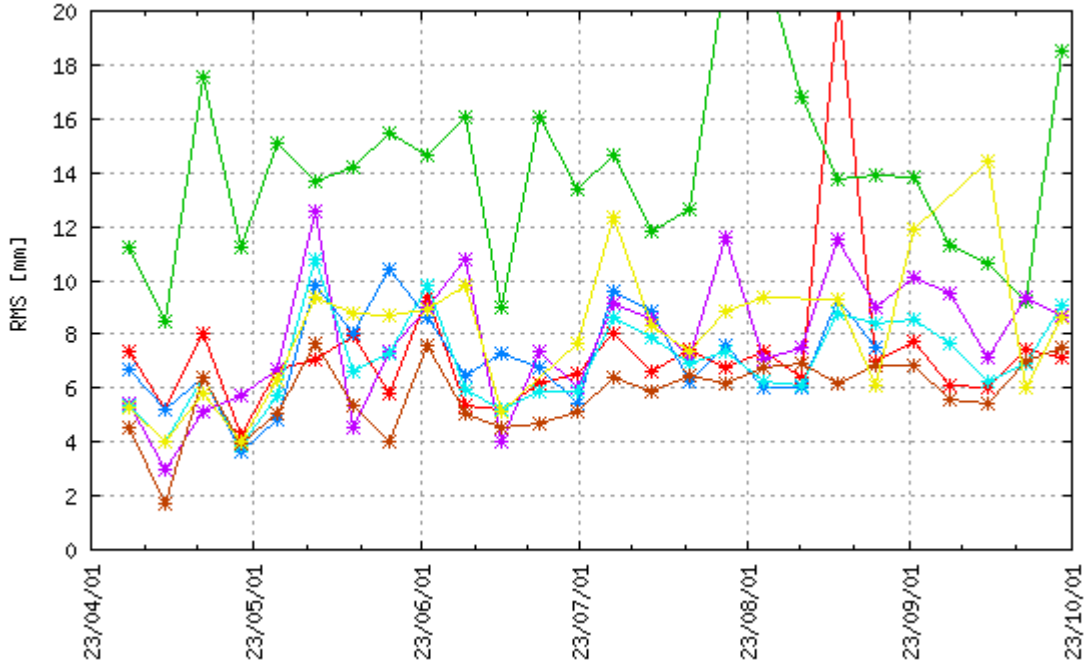
Mean RMS over the period 2023/04/01-2023/10/01
(after outliers exclusion)

SSEM Project – Stations coordinates

3D wrms of the residual
CORE SITES



w.r.t ITRF2020: v280



w.r.t ITRF2014: v230

***DGFI**: same behaviour for v280/v230 weekly station coordinates 3D-WRMS*

** on 18/10 JCET uploaded a new set of SINEXs after a fix (v280), to be considered in next ILRSA series*


e-geos
AN ASI / TELESPAZIO COMPANY


International Laser Ranging Service


ASI
Agenzia Spaziale Italiana

Thank you

Federal Agency for
Cartography and Geodesy

BKG
Wir geben Orientierung.

BKG Report 10-2023

D. Koenig, U. Meyer (AIUB), D. Thaller

Status of new Operational Series

- Installation of BSW 5.5 with largely renewed processing scheme (in view of adding LARES)
- Considerable time needed to get BSW 5.5 running at BKG‘s SLR AC

- v180: running since 07-26-2023
  upload to be implemented these days
- v80 : running since 08-21-2023
  upload to be implemented these days
- v280: not yet implemented
  coming soon

- v85 : considerable time invested
  ready to be processed from 1993 on

Report of the DGFI-TUM ILRS AC

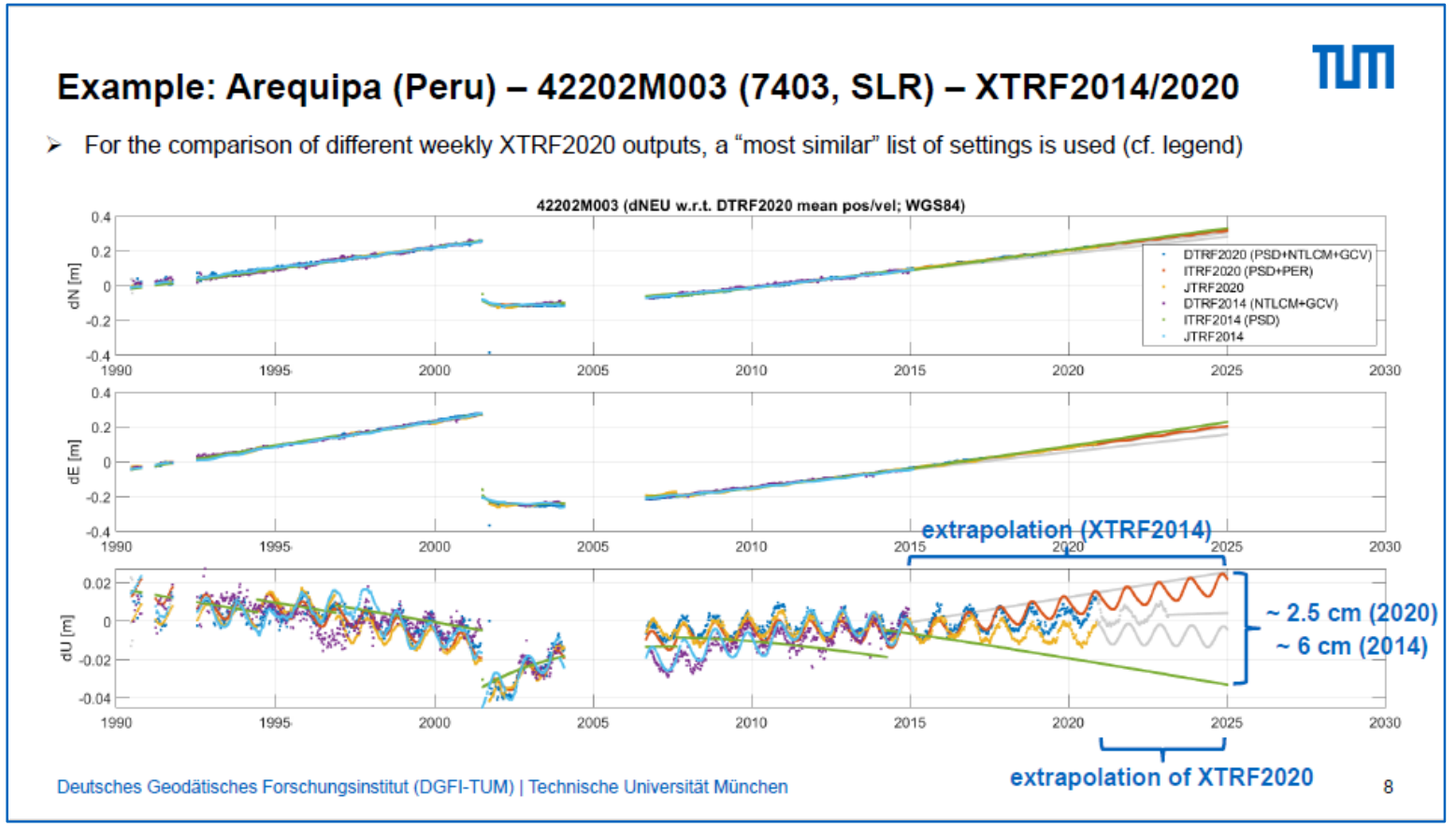
Mathis Bloßfeld, Alexander Kehm

Deutsches Geodätisches Forschungsinstitut, Technische Universität München (DGFI-TUM)

ILRS ASC meeting – 2023-10-26

Implementation of new analysis models

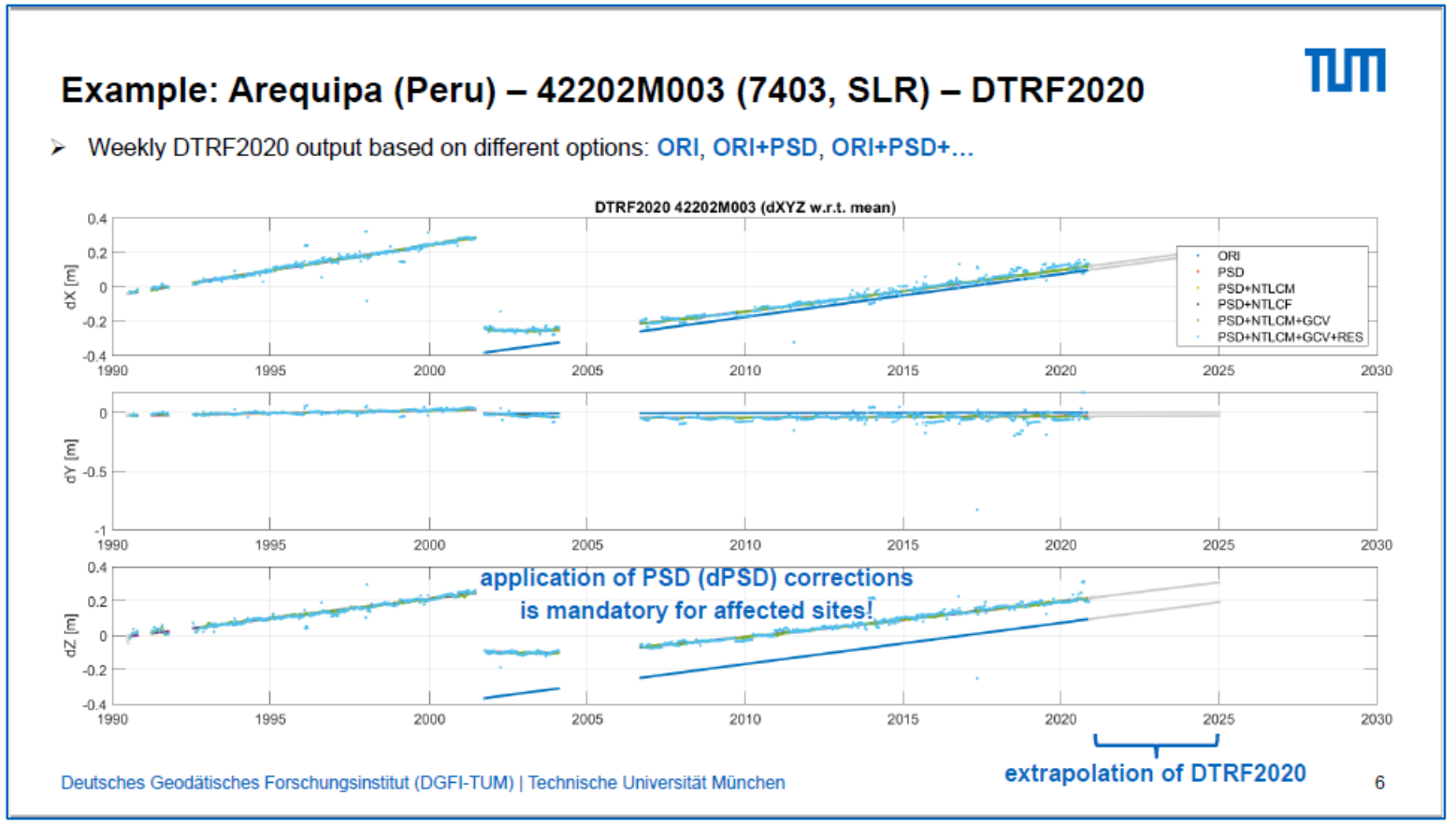
- New ITRS realizations (**Bloßfeld et al., 2023, VIWLR**)
  - **ITRF2020** (Altamimi et al., 2023) **+ respective metadata**
  - **DTRF2020** (Seitz et al., 2023) **+ respective metadata**
  - **JTRF2020** (Abbondanza et al., 2023)



Implementation of new analysis models

- New ITRS realizations (**Bloßfeld et al., 2023, VIWLR**)
  - **ITRF2020** (Altamimi et al., 2023) **+ respective metadata**
  - **DTRF2020** (Seitz et al., 2023) **+ respective metadata**
  - **JTRF2020** (Abbondanza et al., 2023)

- For the new products, one should use **SLRF2020** (231002; Pavlis et al., 2023) **+ PSD models for 7110, 7237, 7308, 7328, 7358, 7403, 7405, and 7838!**



Implementation of new analysis models

- New handling of ocean tidal models implemented in DOGS-OC (motivated by implementation problems of FES2014b)
  - for details, please see **Kehm et al. (2023, VIWLR)** and **Mayer-Gürr et al. (2023, EGU)**

Results: Impact of tidal admittance and resolution

- Applying tidal admittance reduces the arc RMS by multiple millimetres:

	EOT11a with	*18 main 0 secondary*	*18 main 63 secondary (IERS 2010)*	*18 main 335 secondary*
Satellite	**altitude**	**arc rms of SLR fits** [cm]		
LAGEOS-1	5850 km	1.2108	1.1931	1.1928
LARES	1450 km	3.1290	2.7630	2.7546
Jason-3	1336 km	2.5687	2.4275	2.4263

- For the satellites used in this study, the maximum degree/order (30, 90, or 180) has no significant impact on the results

	EOT20 with	*19 main 0 secondary*	*19 main 335 secondary*
Satellite		**arc rms of SLR fits** [cm]	
LAGEOS-1		1.2111	1.1939
LARES		3.1388	2.7751
Jason-3		2.5658	2.4254

- Small differences between the results for EOT11a and EOT20
  - EOT20 long-period tides could contain non-tidal loading effects which are not present in EOT11a
  - We expect that these cause the changes in SLR RMS fits

Deutsches Geodätisches Forschungsinstitut (DGFI-TUM) | Technische Universität München

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https://ifg.tugraz.at/ocean-tides

Ocean tides

- FES2014b
- EOT20, EOT11a
- TiME22
- .. Further models follow

Atmospheric tides

- TiME22
- …

Reference implementations

- MATLAB, Python, Fortran

Skripts for converting ocean tide models

- from gridded NetCDF grids to spherical harmonics
- generating all necessary files
- based on GROOPS
- https://github.com/groops-devs/groops

ILRS product array at DGFI-TUM

ILRS label	description	file format
v170	daily LA-1/2 and ET-1/2 TRF and ERP solution	SINEX
v70	weekly LA-1/2 and ET-1/2 TRF and ERP solution	SINEX
v70-sp3c	weekly LA-1/2 and ET-1/2 (reduced dynamic) orbit solution	SP3c
---	daily orbit predictions for LA-1/2 and ET-1/2	CPF(v2)
v230	weekly LA-1/2 and ET-1/2 TRF and EOP solution (including RBs for all stations)	SINEX
v180	daily LA-1/2 and ET-1/2 TRF and ERP solution (based on most recent standards and files)	SINEX
v80	weekly LA-1/2 and ET-1/2 TRF and ERP solution (based on most recent standards and files)	SINEX
v80-sp3c	weekly LA-1/2 and ET-1/2 orbit solution (based on most recent standards and files)	SP3c
v280	weekly LA-1/2 and ET-1/2 TRF and EOP solution (including RBs for all stations; based on most recent standards and files)	SINEX
v85	Reprocessing 1982-2023 of LA-1/2 and ET-1/2 TRF and EOP solution (based on most recent standards and files)	SINEX
v320	weekly LA-1/2, ET-1/2 and LR-2 TRF and EOP solution (including RBs for all stations; based on most recent standards and files)	SINEX
v300	weekly LA-1/2, ET-1/2 and LR-1 TRF, EOP and SH deg2-6 solution	SINEX
---	daily 10-satellite TRF and EOP solution	SINEX
---	weekly 10-satellite TRF and EOP solution	SINEX
---	weekly 10-satellite GM solution	SINEX
---	weekly 10-satellite SH deg1 solution	SINEX
---	weekly 10-satellite SH deg2 solution	SINEX
---	weekly 10-satellite (reduced dynamic) orbit solution	SP3c
---	weekly 10-satellite TRF, EOP and SH deg2-20 solution	SINEX
---	daily orbit predictions for LA-1/2, Ajisai, Stella, Starlette and Larets	CPF(v2)

Future plans at DGFI-TUM

- Revisit **NTL application at observation level** in DOGS
- Further tests on the **refined tide handling:**
  - test *'combined' ocean tide models*, e.g. replace long-period tides in EOT20
  - test alternative *tidal admittance* methods
  - test *alternative atmospheric tide models* with more main tides (e.g. AOD1BRL06, TiME22, etc.)
  - *site displacements* not yet consistent!
- Work on **pilot project for the inclusion of LARES**
  - test series nearly finished
- Implementation of **Sentinel satellites** (TOPEX and Jason-1/-2/-3 already implemented)
  - focus on combined SLR/DORIS POD

NSGF AC report

ILRS Analysis Standing Committee Meeting, 26 October 2023 online

Andreja Susnik (1), Graham Appleby (2)

(1) BGS Space Geodesy Facility, Herstmonceux Castle, UK; (2) BGS Honorary Research Associate, SGF;

British Geological Survey

Natural Environment Research Council

NSGF AC activities

- Finished, ongoing

Solution	Submission	Status
v80	weekly (with 10-day delay; snx + orbits)	(routinely since 18 April 2023)
v180	Daily	(routinely since 18 April 2023)
v230	weekly	(routinely since January 2023)
v415	two submissions (on 22/12/2022 and end of February);	√
v280	weekly (with 10-day delay)	(routinely since July 2023)
v85	weekly	√ (1993-2023)

- LARES 2 – solutions (LG1/LG2/ET1/ET1/LA2) between August 2022 up to the end of September 2023 generated and provided to Jose for CoM related work
- Evaluation of DTRF2020 – implemented PSD corrections in SATAN, just finished processing of 20 years…
- Analysis of data from other stations that used Stanford counters

Revisiting the ‘Stanford’ systematics issue - progress report

Graham Appleby, Andreja Susnik

NSGF AC, SGF Herstmonceux

Analysis Standing Committee virtual meeting, 26th October 2023

Background

- Given the long timespan of geodetic solutions beginning from the two-LAGEOS era of 1993 onwards:

- It's important to minimise systematic measurement error to realise the full potential of the results
- A major advance towards this aim is the ILRS ASC-developed SSEM technique
  This technique effectively removes systematic range error from all stations' data; **but**:

- Stanford time-of-flight counters (SR) were in common use, particularly at the European stations, in the 1990s and 2000s
- The discovery at Herstmonceux of a ***range-dependent*** systematic measurement error:

- Provoked extensive tests being carried out on the SGF counters using a borrowed high-accuracy event timer

Submission from SGF for ITRF2020

- Seven-day orbital solutions using the two LAGEOS and two Etalon satellites:
  - SATAN code;
  - Updated CoM values from Rodriquez *et al, J Geod,* 2019
  - ASC Data Handling File for mean RB values to be applied and not solved

- But the range-dependent errors imposed by the Stanford counters:
  - Were **regrettably NOT** taken into account in these or the previous SSEM solutions
  - Will have impacted the validity of the handling file mean value RBs for HERL

Counters were in use 1994-2007

Extensive measurements of range-dependent (satellite) plus fixed (calibration) bias

-reported in LR Workshop #15 (Gibbs) and in SLRMail 0891, Appleby & Gibbs, Jan 2002.

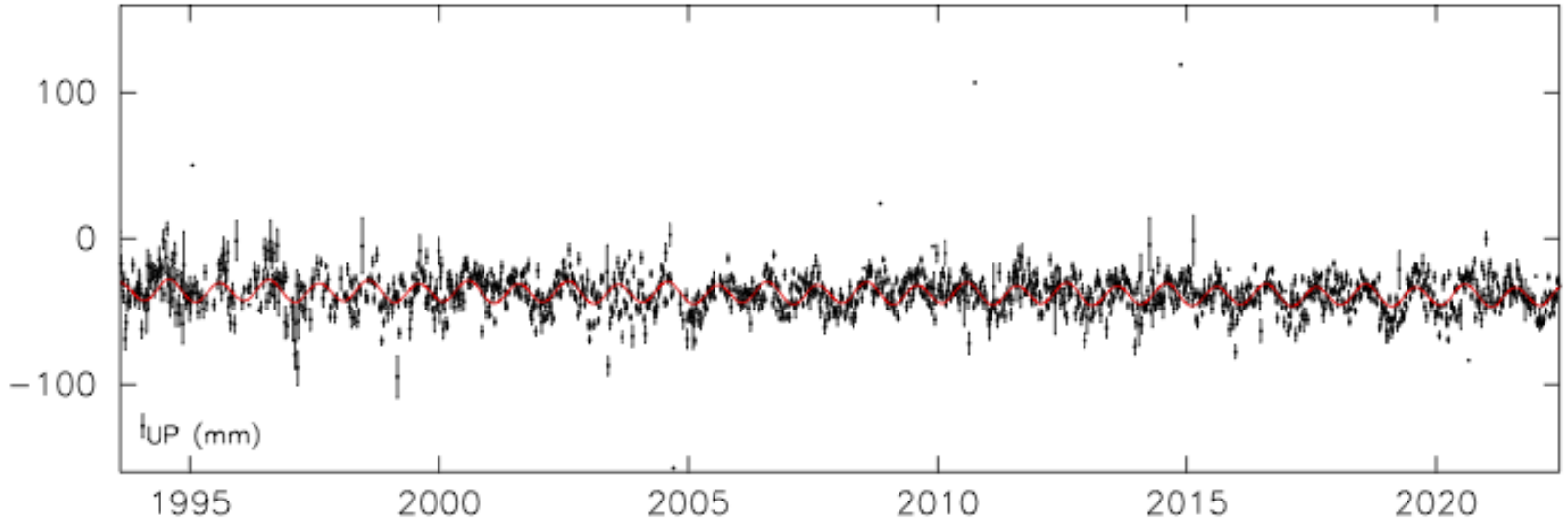
Reprocessing

This omission of the Stanford corrections by the NSGF (and all other) ACs for ITRF2020 submissions was discussed in detail by Susnik et al at the LR workshop in Spain in November 2022, where a scheme was developed:

To accommodate Stanford systematics in re-evaluation solutions:

- cancel a-priori RB for SR stations from the data-handling file;
- application of range-dependent and fixed-value correction to NPs as appropriate;
- estimating RB for every 7-day arc for all SR stations along with reference frame.

Example - Corrected height time series for Herstmonceux 1993-2022



- Stanford corrections applied to each NP
- RB solved-for along with reference frame

At the expense of some increase in noise, essentially bias-free

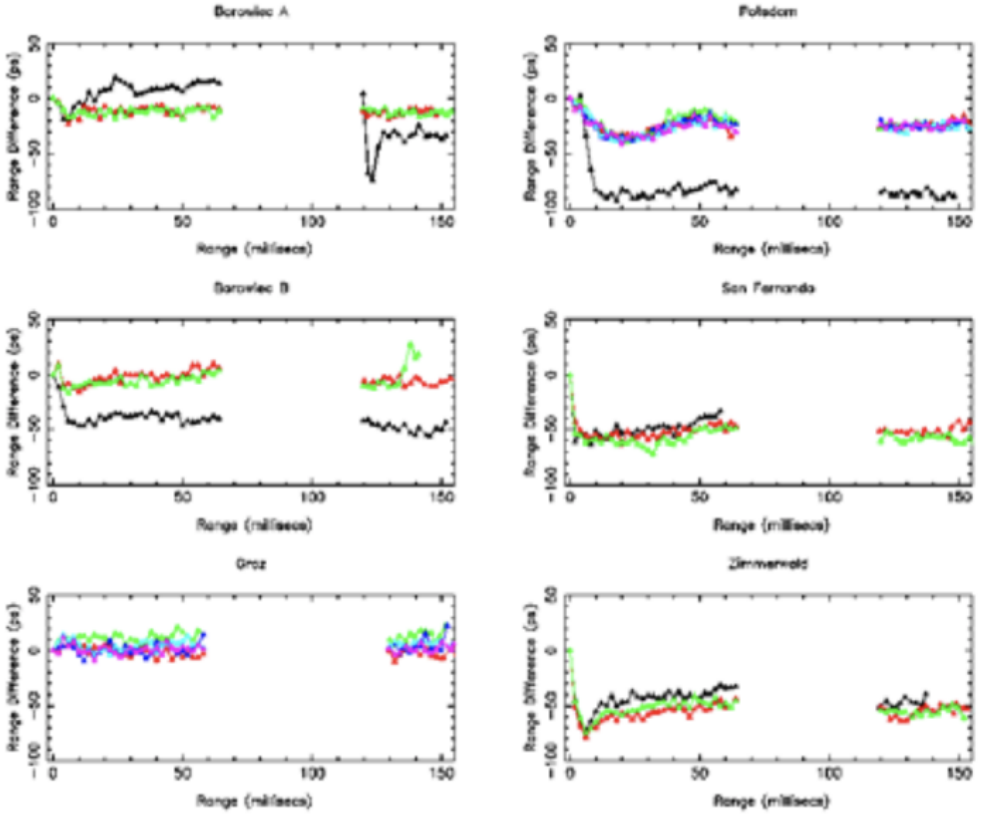
Linear and annual fit gives slope of -0.12 +/- 0.04 mm yr^{-1}

Stanford counters at ILRS stations

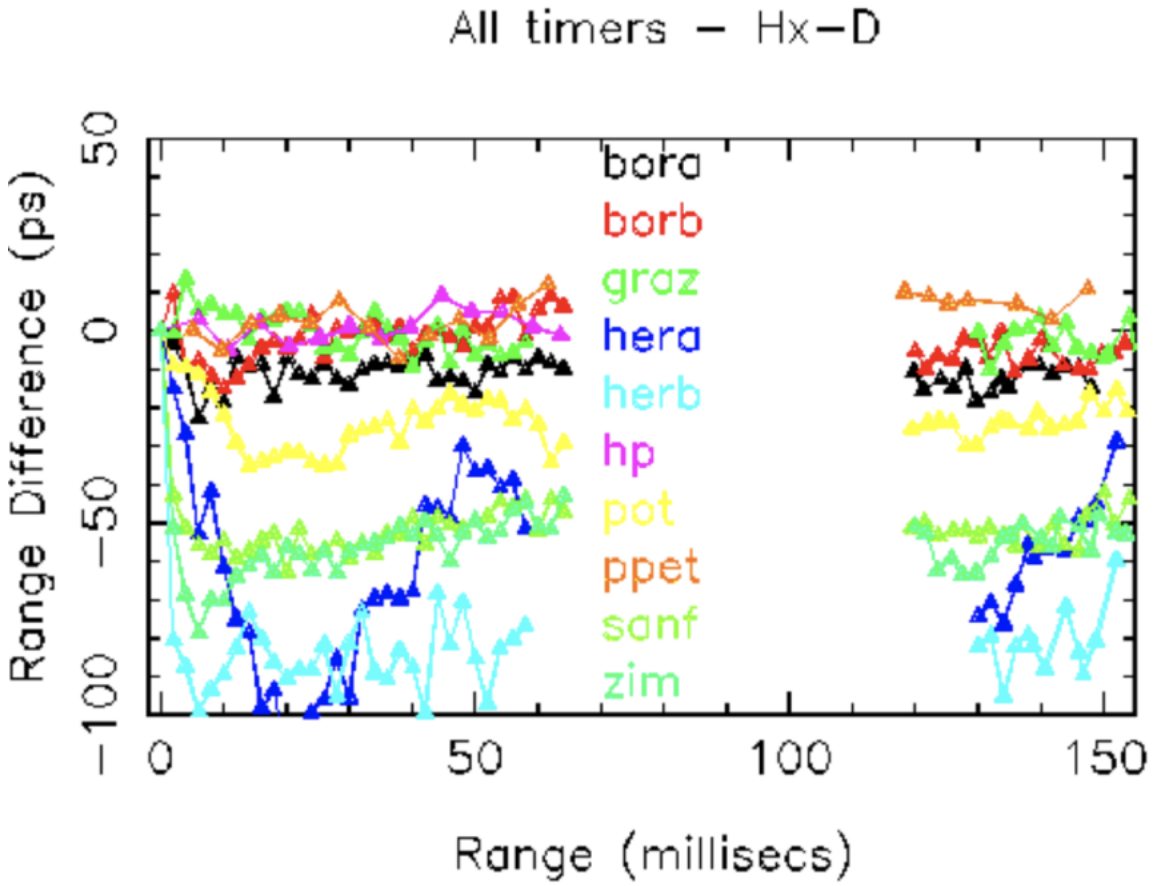
- The success of this effort to use Stanford ‘calibrations’ to improve Hx geodetic height solutions:
- Particularly the realization that SSEM does not fully remove this problem:
- Prompted a re-visit to the work done at Herstmonceux (1) to calibrate a number of other counters from European stations
- Counters assessed at the time were from Borowiec, Potsdam, San Fernando, Graz, Zimmerwald

(1) Gibbs, P., 2002. Stanford Counter Comparison Results, Proceedings of EUROLAS Workshop ‘Detecting and eliminating errors in the EUROLAS network’, Herstmonceux, UK. http://ilrs.gsfc.nasa.gov/reports/special_reports/eurolas_workshop.html

Results from the EUROLAS Comparisons of 2002



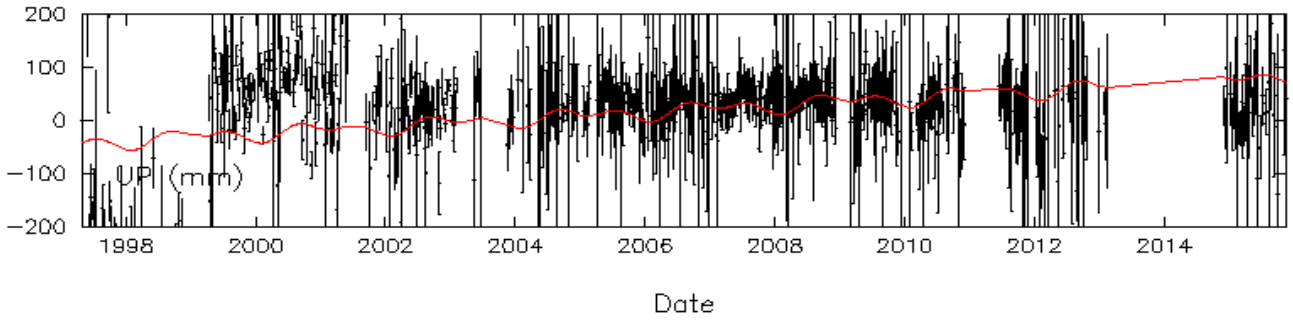
Results from the EUROLAS Comparisons of 2002



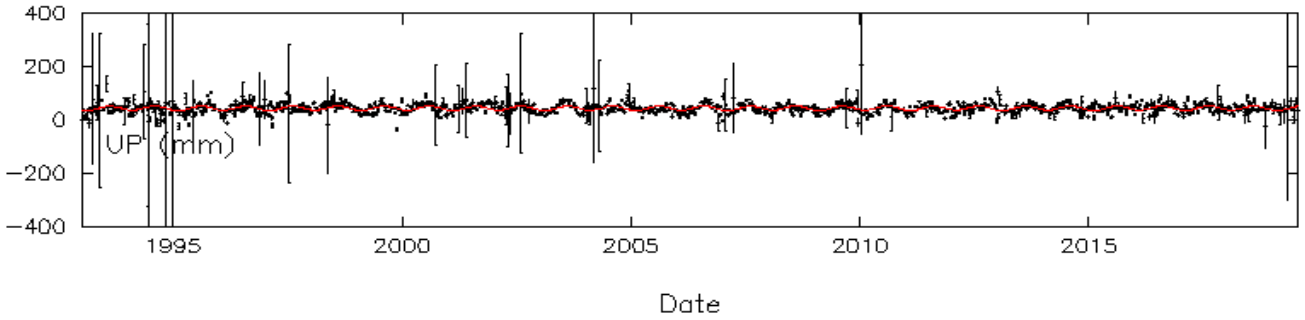
Dates of applicability

Station	SR installed	SR removed	Notes
Borowiec	2002 May 07	-	
Potsdam	2001 May 20	2011 Apr 19	
San Fernando	2001 Aug 10	2022 Aug 30	
Graz	1982	2001 Aug 01	3*SR in cluster
Zimmerwald	1997 Jan 01	2006 Feb 03	
Herstmonceux	1995 Jan 01	2007 Feb 01	Actually 4 diff SRs

Examples of height time series from stations using SRs



San Fernando. Stanford installed in 2001 August – note ht jump.



Graz. Stanfords (in a cluster) until 2001 August

Next steps

For dates of applicability:-
Make range-dependent table of corrections (format tbd)
Share with all ACs
Use in re-processing as per the Herstmonceux work
Note – any impact of SR error on target-board calibration at the stations is not retrievable
Error is specific to set-up at the station
But will be removed by RB solution as per SSEM