Deutsches Geodätisches Forschungsinstitut (DGFI-TUM)
Technische Universität München

2025/2 ILRS Analysis Standing Committee meeting

Mathis Bloßfeld[(1)], Cinzia Luceri[(2)]
(Conveners)

(1) DGFI-TUM
(2) ASI/e-geos

Thursday, 1st May, 2025, hybrid, 12:30 to 3:30 PM (UTC)

ILRS ASC meeting – 2025-05-01

Today's [draft] agenda

0)	Last meeting + open Action Items (AIs)	(MB)	10 minutes
1)	Status reports of SLR ACs and CCs	(all)	90 minutes
2)	LARES-2 as 5th satellite in ILRS ASC operational products	(AB, DS, MB)	20 minutes
3)	Fundamental ILRS files for the SLR analysis	(MB, AS)	10 minutes
4)	LARES and the SH pilot project	(MB)	15 minutes
5)	ESA's Genesis mission	(MB)	10 minutes
6)	ILRS core stations	(MB, tbd)	10 minutes
7)	Publications (of the ILRS ASC)	(MB, CL, DS)	10 minutes
8)	AOB and next ASC meeting	(MB)	5 minutes

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Last meeting + open Action Items (AIs)

	NEW ACTIONS		
# AI	Description	AC/person	
2025_feb01	Send ASC meeting minutes + SLRF2020 (21.02.2025) to ACs	MB	Done
2025_feb02	Compile and distribute report on ILRS contribution to ITRF2020-u2024	ASI CC	Done
2025_feb03	Set up folder at EDC for ILRS contribution to ITRF2020-u2024	MB	Done
2025_feb04	v320 reprocessing of 2024	All ACs	Done
2025_feb05	Finalization of DHF including LR-2 entries	ASI CC	Done
2025_feb06	Reprocessing and operational submission of v90 solutions	All ACs	Done
2025_feb07	Processing and operation submission of v190 solutions	All ACs	(partly) done
2025_feb08	Combination of processed and operationally submitted v190/v90 solutions	ASI and JCET CC	(partly) done

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Status reports of SLR ACs and CCs

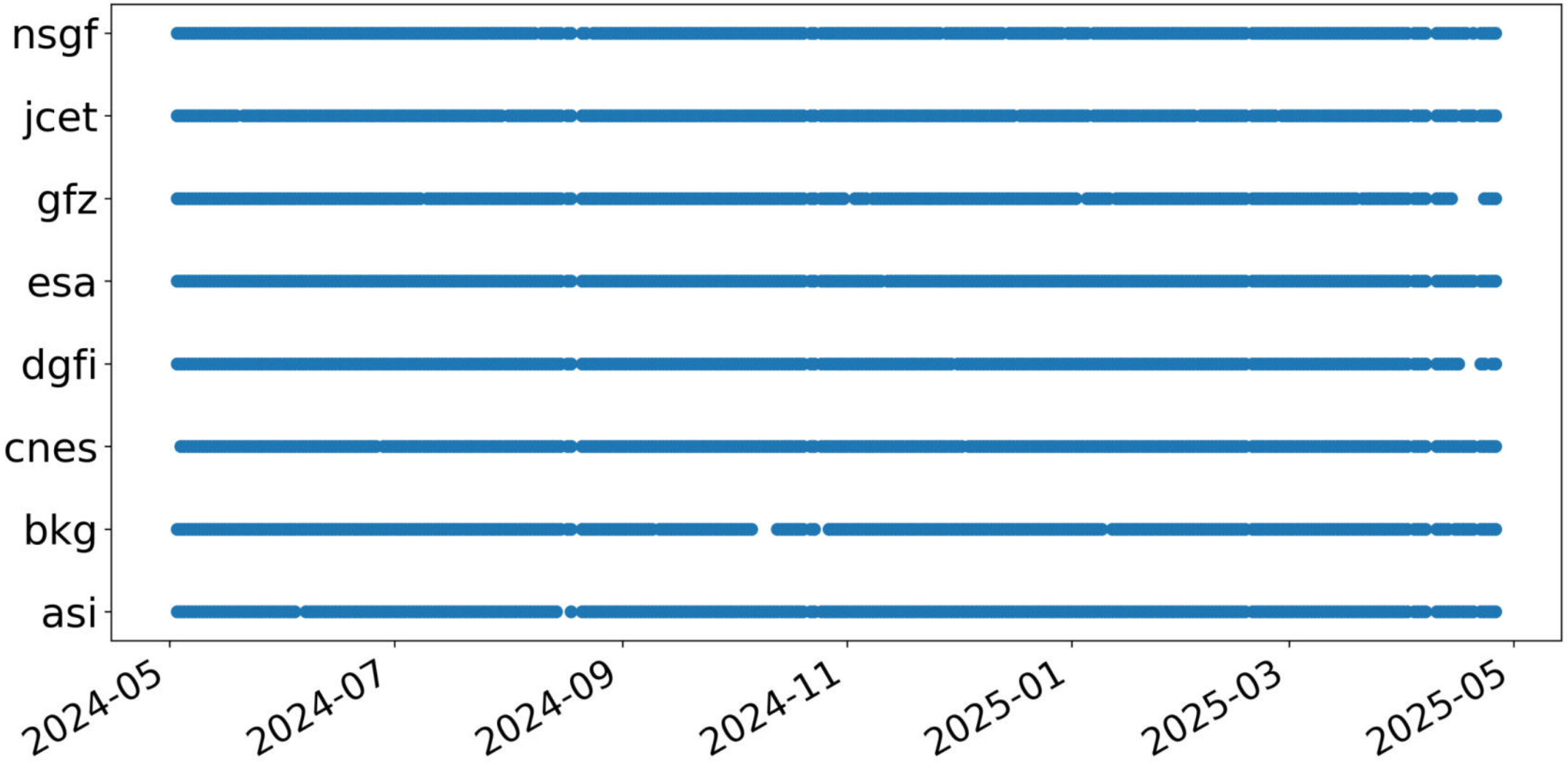
- cf. slides by
  - ASI
  - BKG
  - CNES
  - DGFI
  - ESA
  - GFZ
  - (GRGS)
  - JCET
  - NSGF
  - GSFC

ASI AC and CC report

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

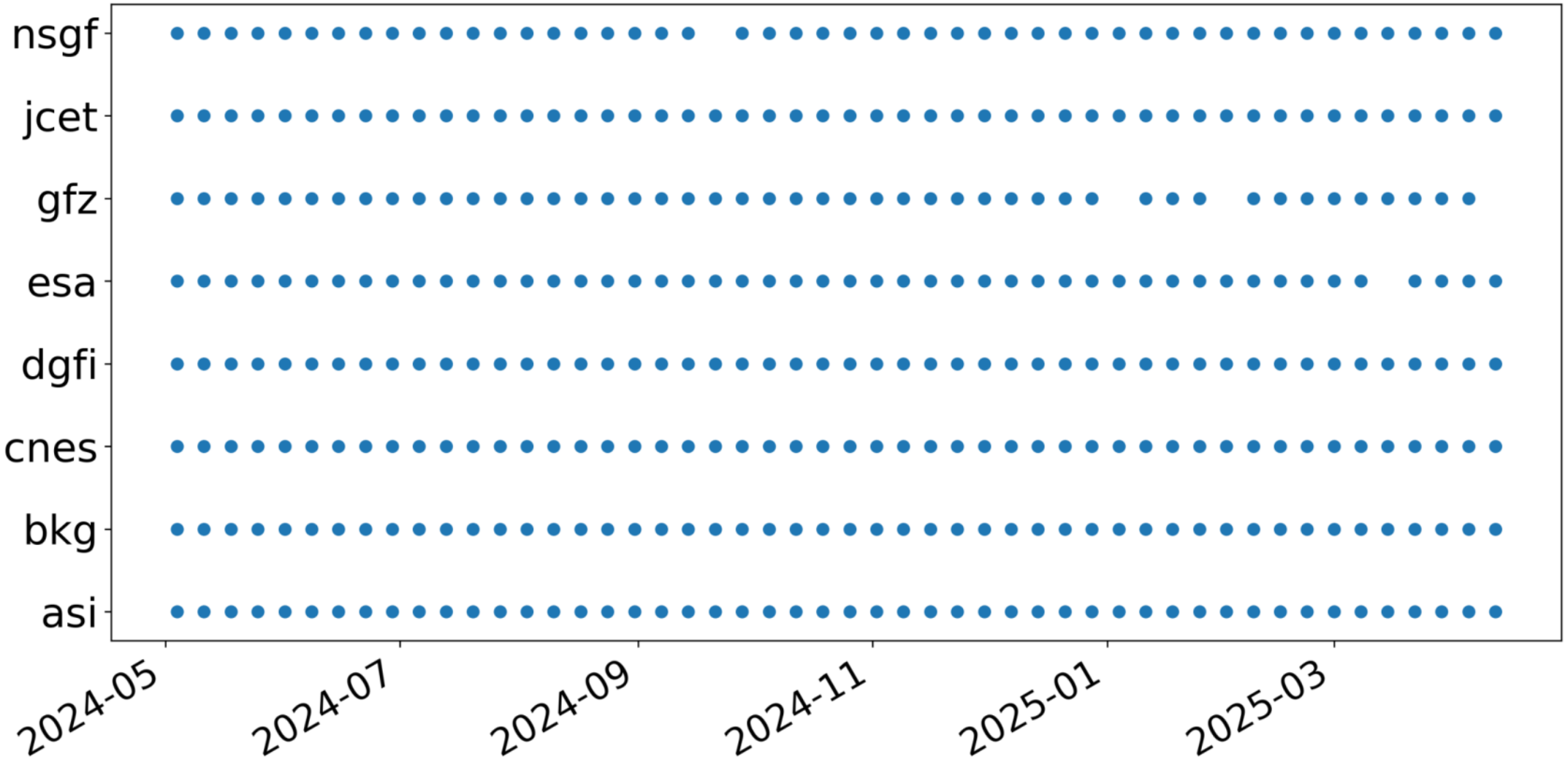
Vespe F.
Agenzia Spaziale Italiana, CGS – Matera, Italy

Daily v180 deliveries (only valid SINEX)



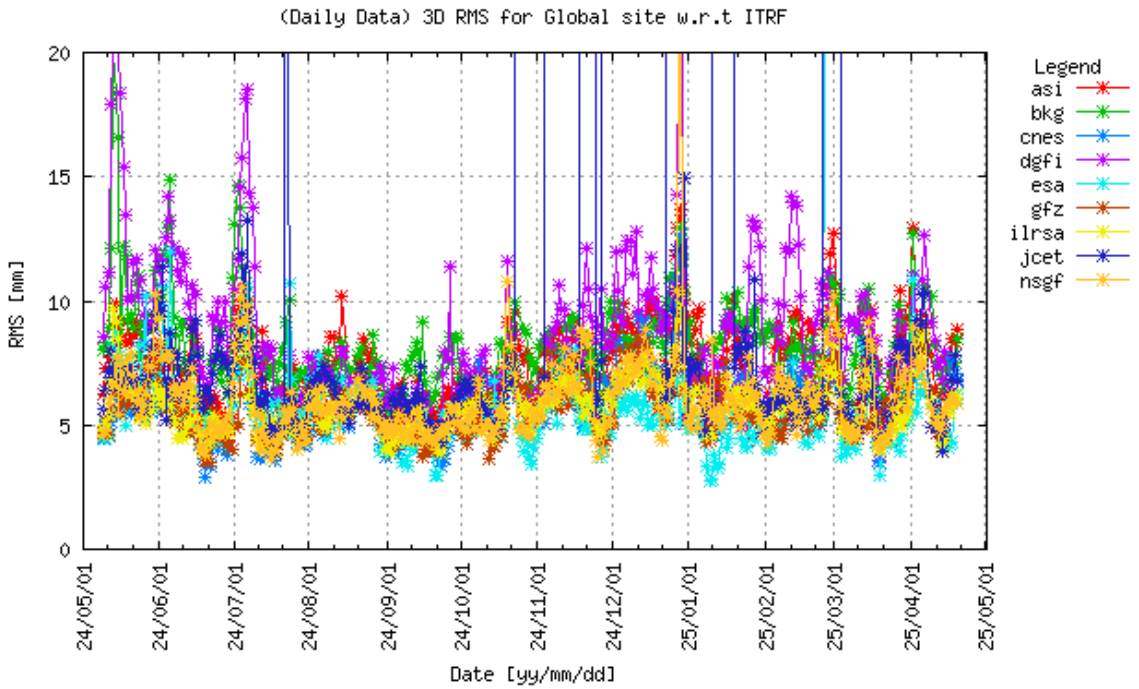
*updated on 29/04/2025

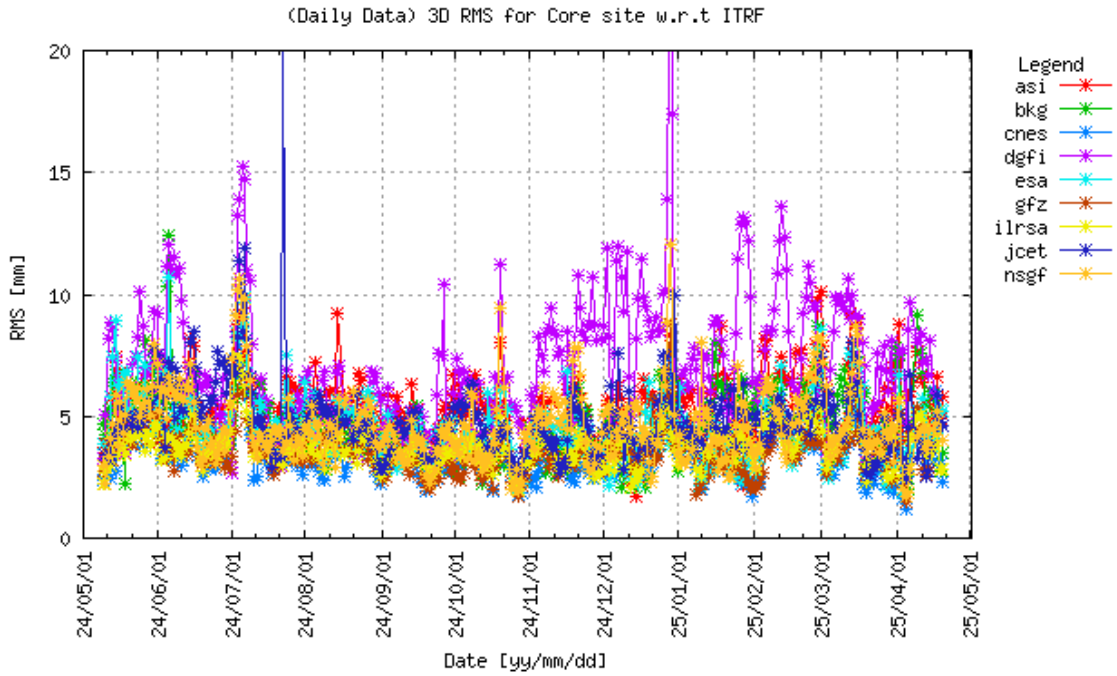
Weekly v80 deliveries (only valid SINEX)



*updated on 29/04/2025

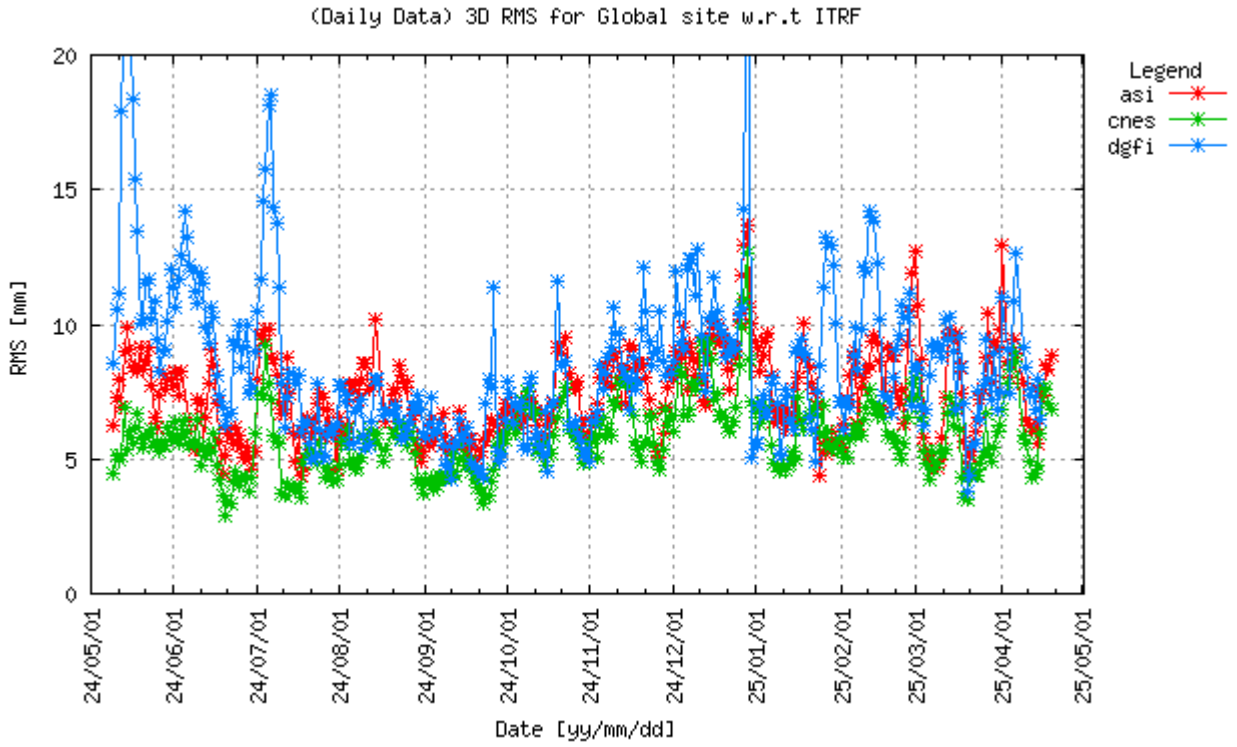
Stations coordinates from daily solutions

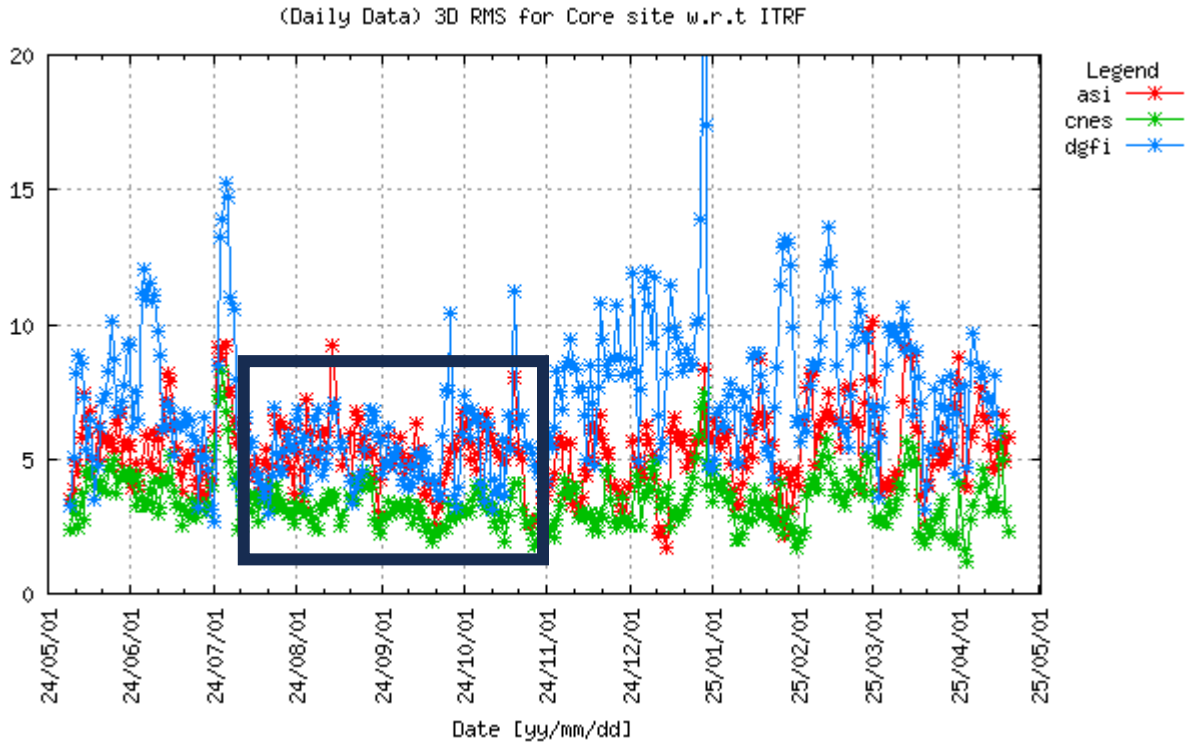




ALL ACs (selected Acs on next slides)

Stations coordinates from daily solutions





DGFI good agreement w.r.t other Acs/ILRSA between mid-July 2024 and November 2024.

After November 2024, Core Site values appear to be similar to Global ones: maybe some changes and uncorrect set of/for Core Stations?

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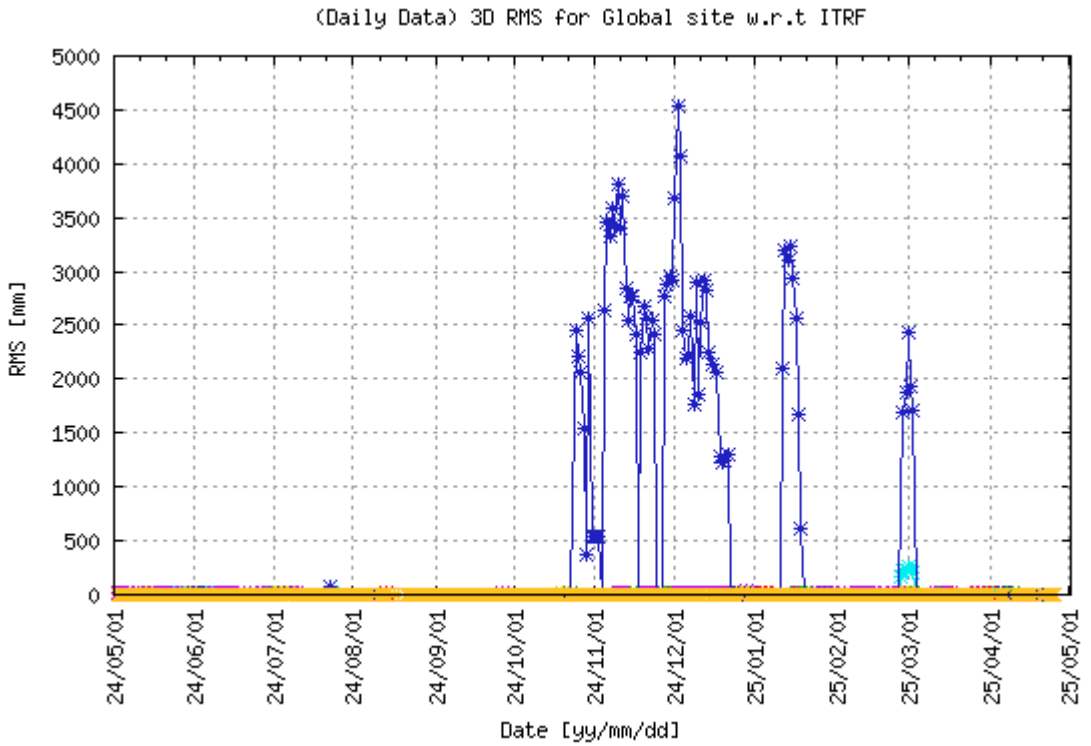
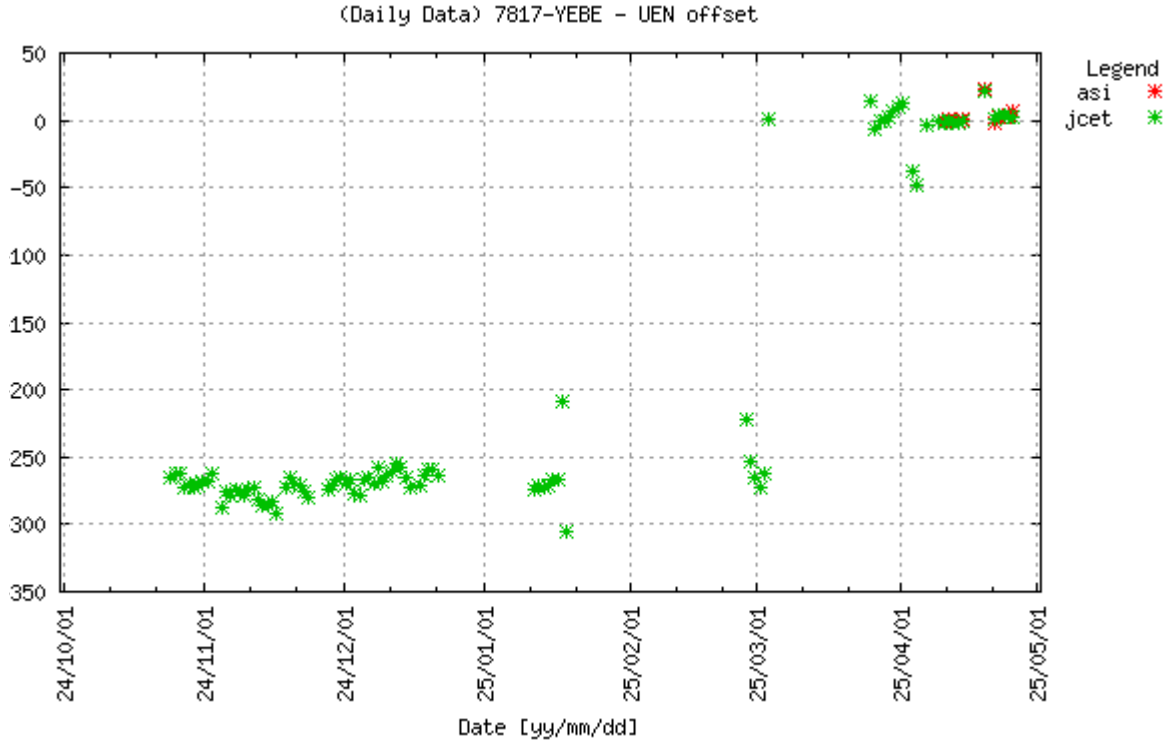


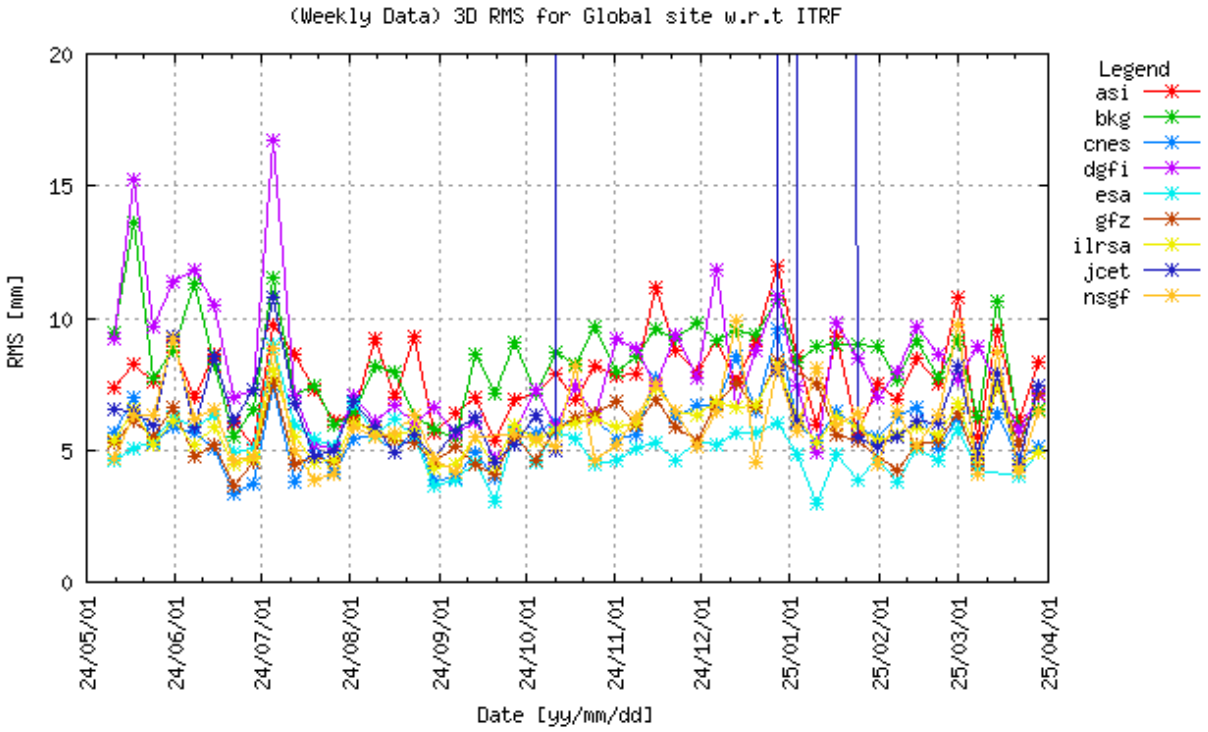


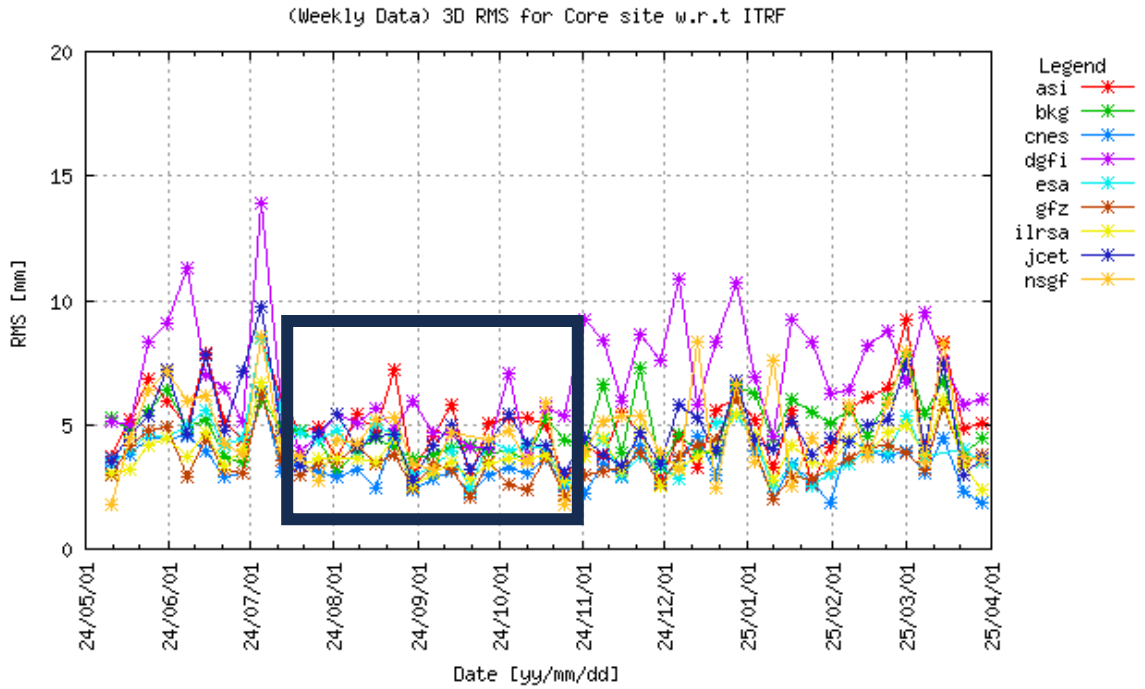
7817 (JCET): EAST/UP/North out of scale in this period

JCET: Global 3D RMS, anomalous from 10/24 to 03/25

Stations coordinates from Weekly solutions

Same Consideration for Weekly





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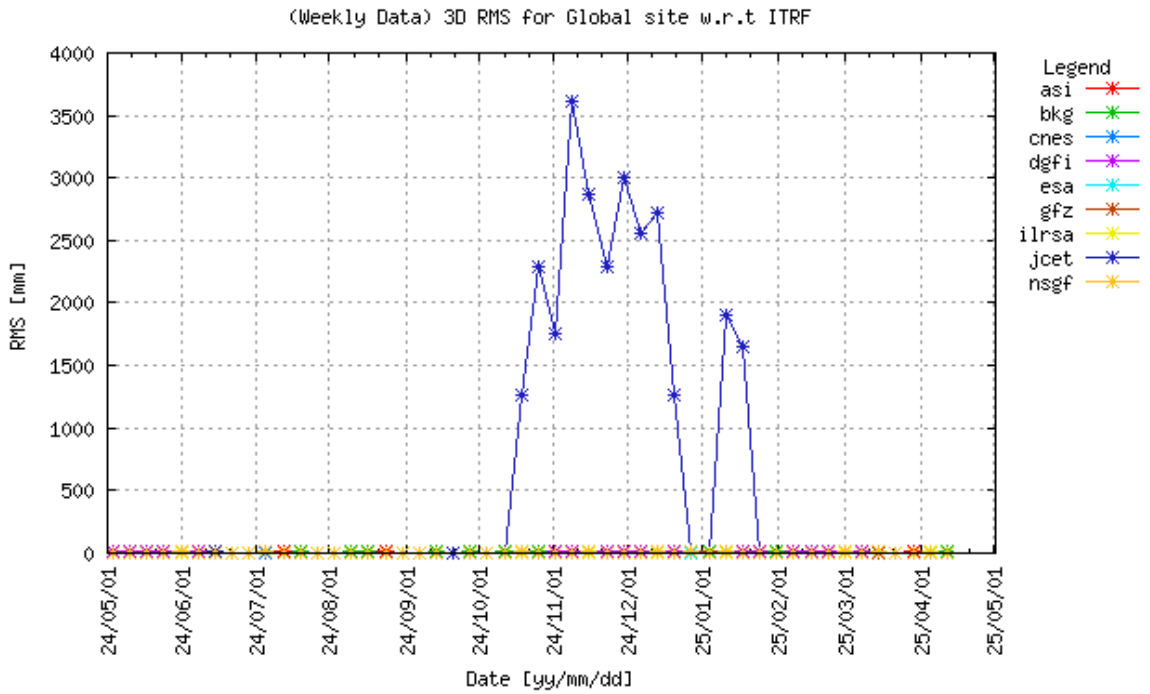
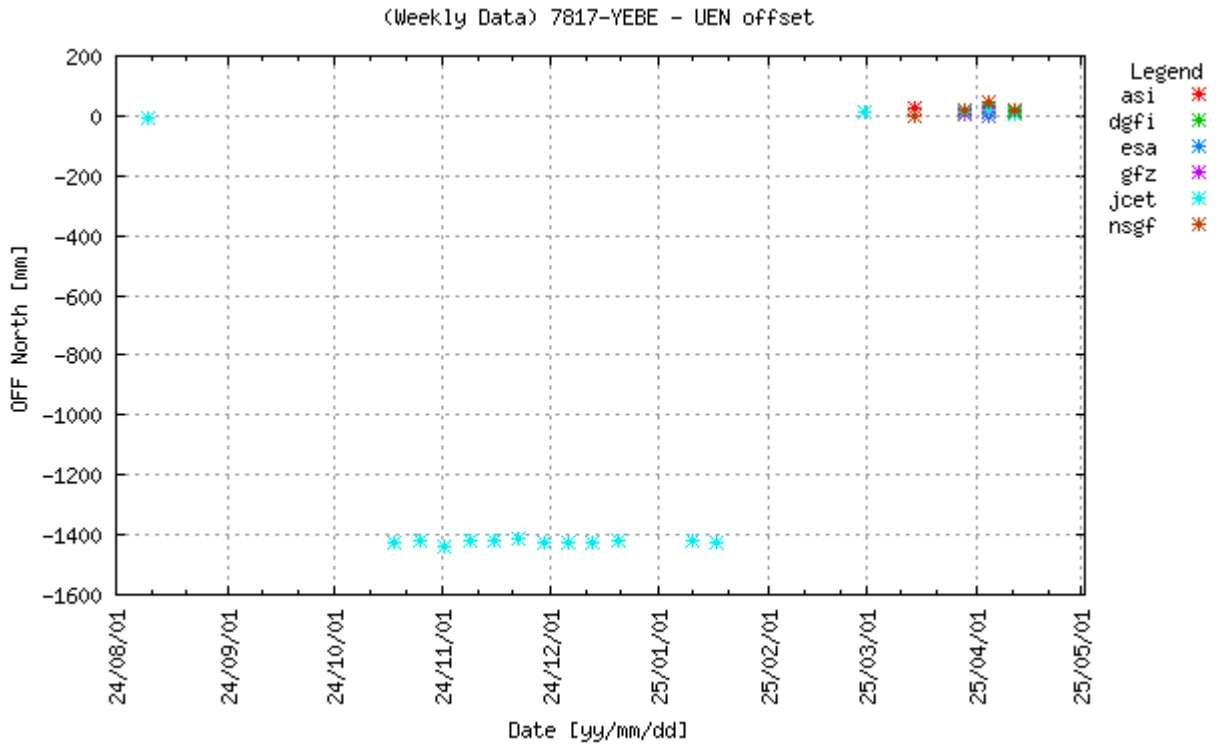
After November 2024, Core Site values appear to be similar to Global ones: maybe some changes and uncorrect set of/for Core Stations?

JCET: Global 3D RMS, anomalous from 10/24 to 03/25 [next slide]

Stations coordinates from Weekly solutions (v80)





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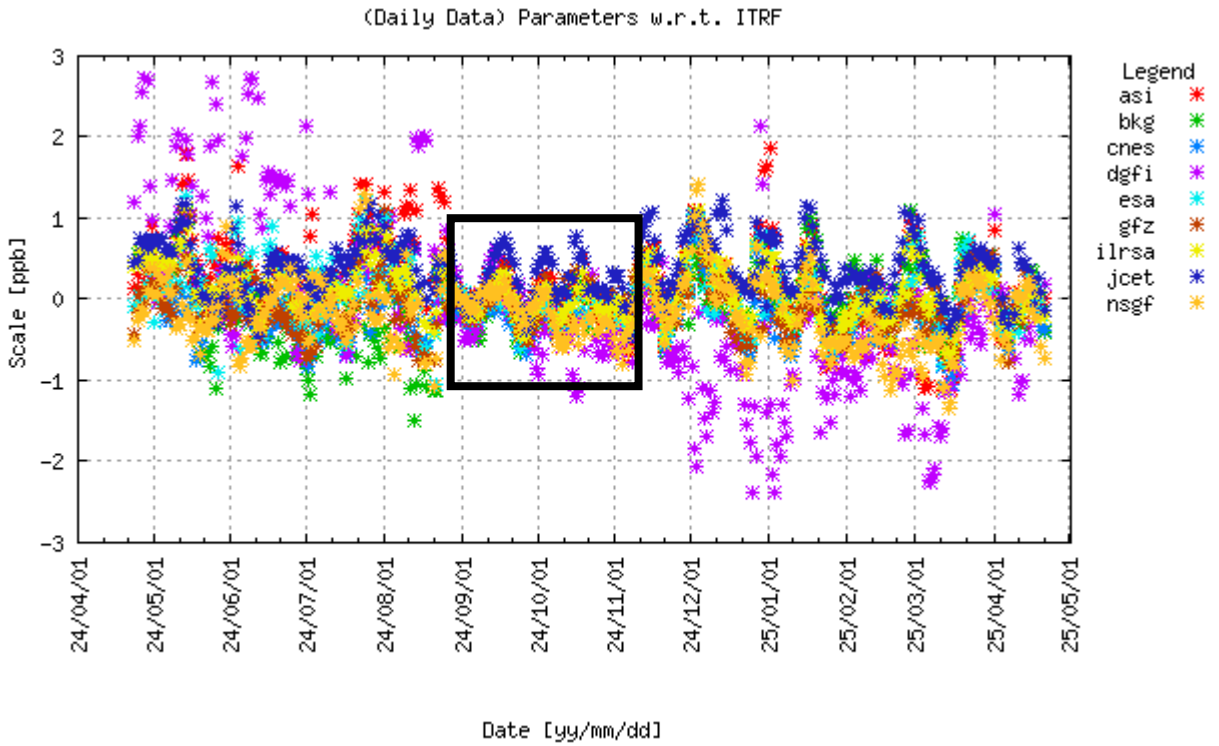
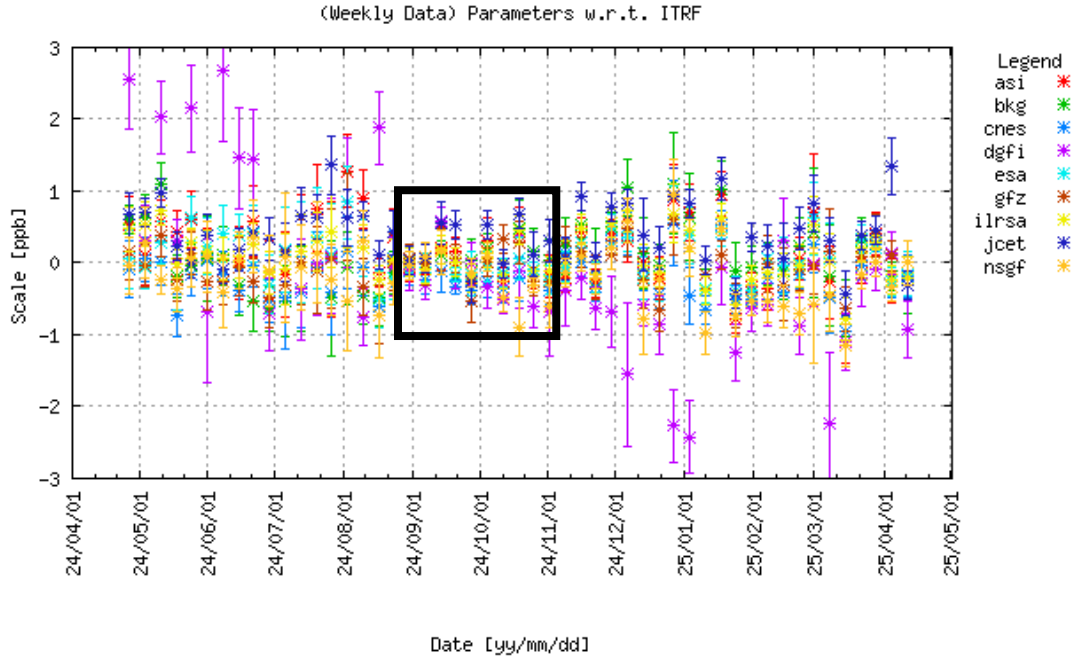
Scale from daily and weekly solutions





ASI: some outlier are reported

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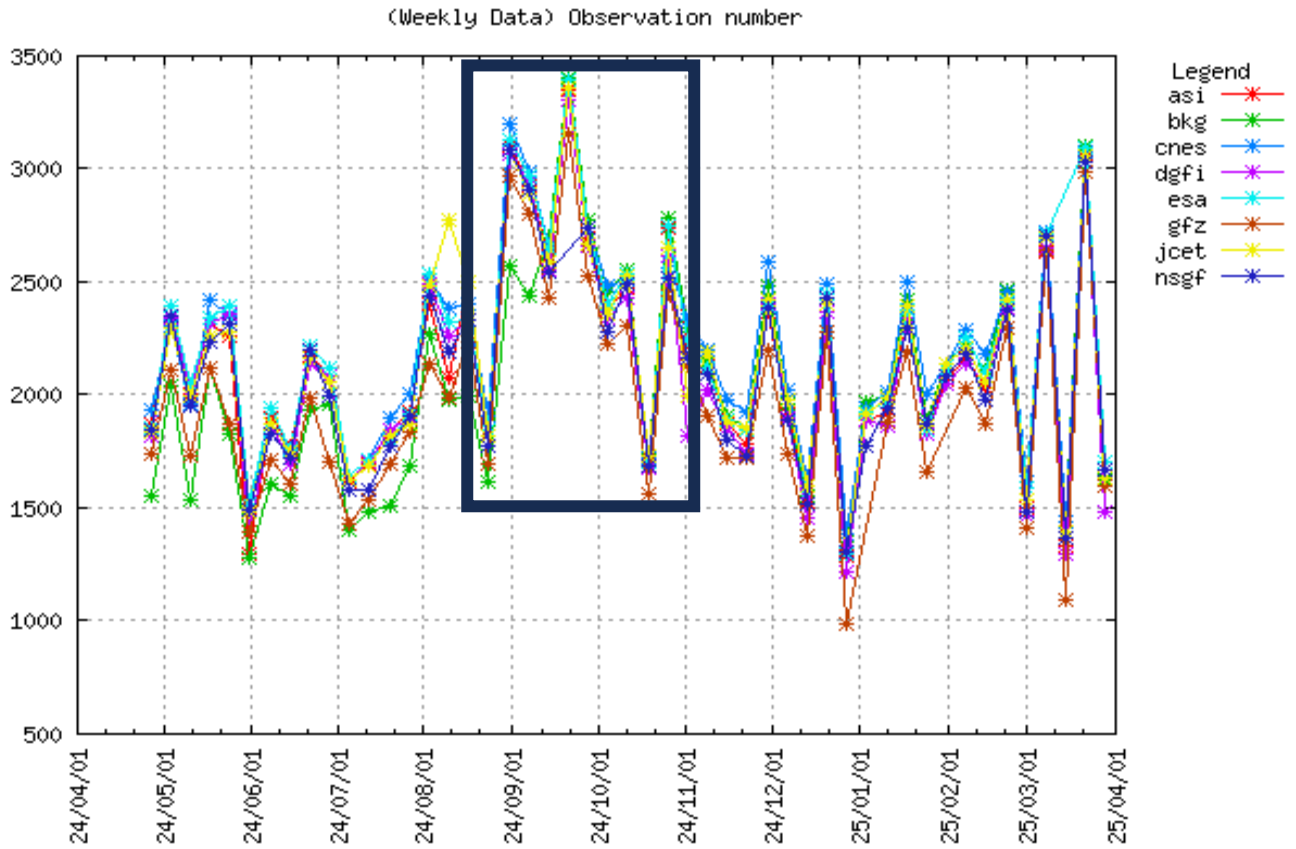
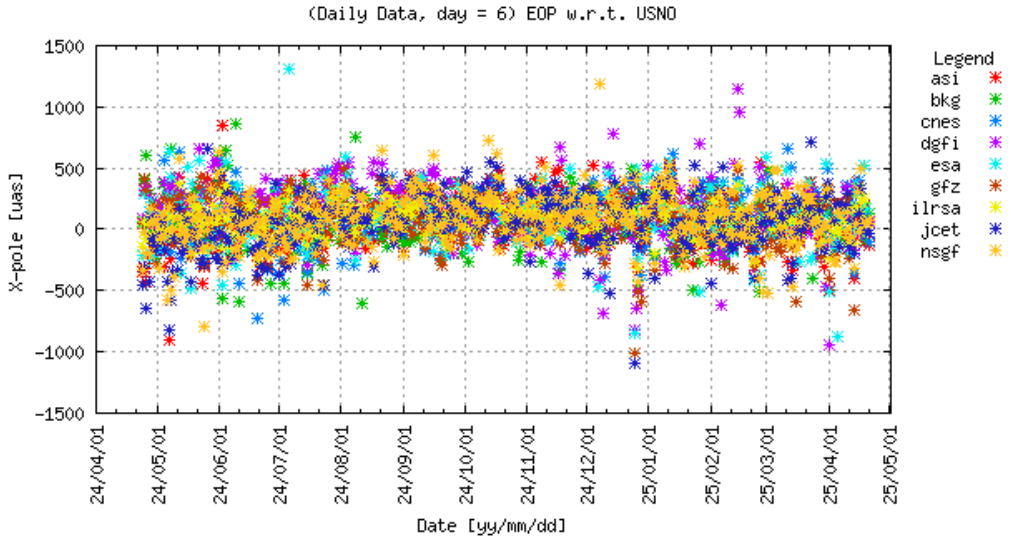
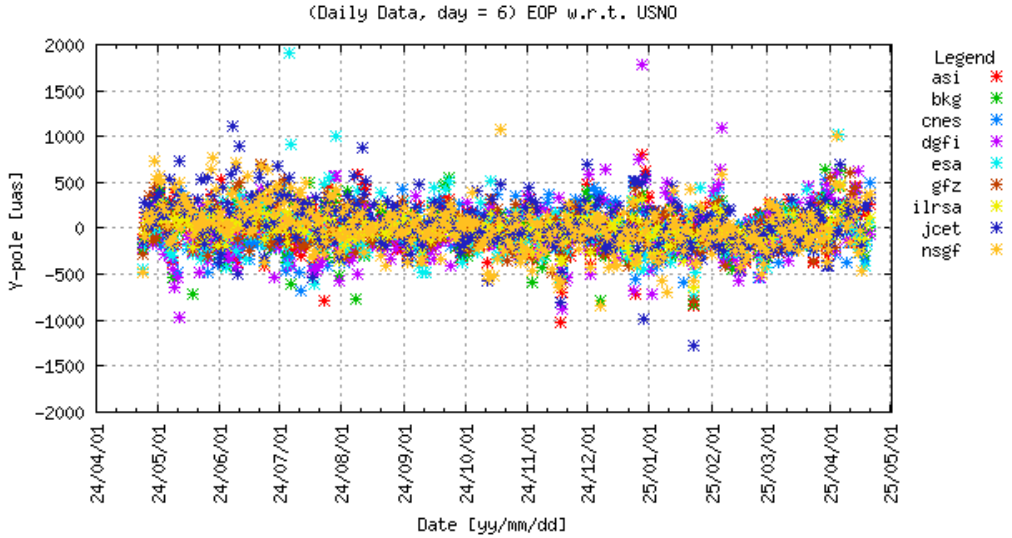
Stations coordinates from Weekly solutions

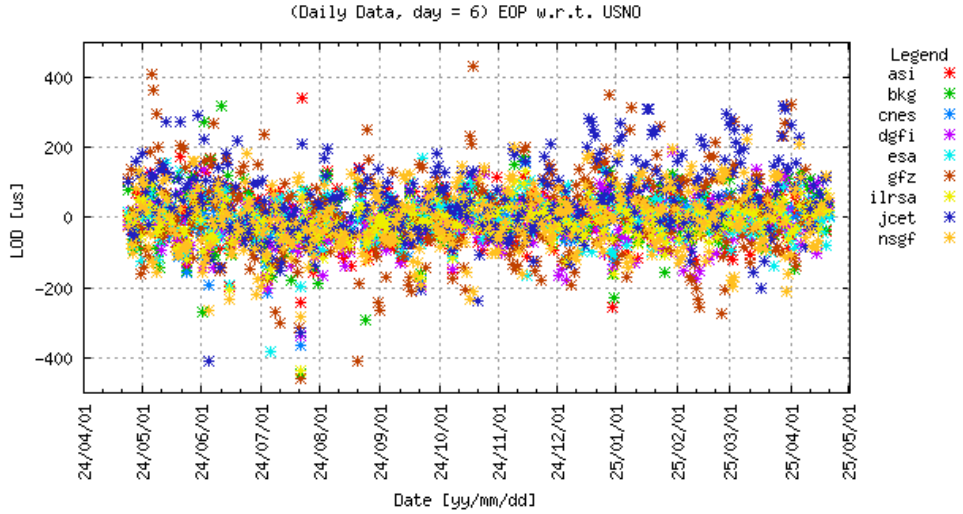


Between mid-Sept to November: +15/20% more of data

EOP from daily v180

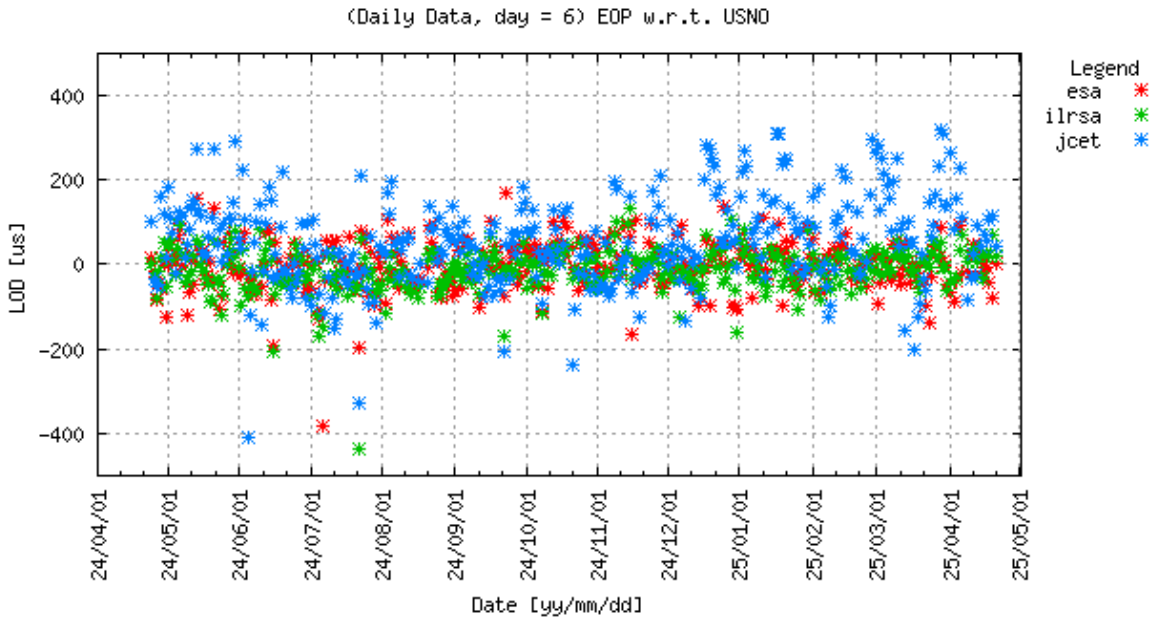


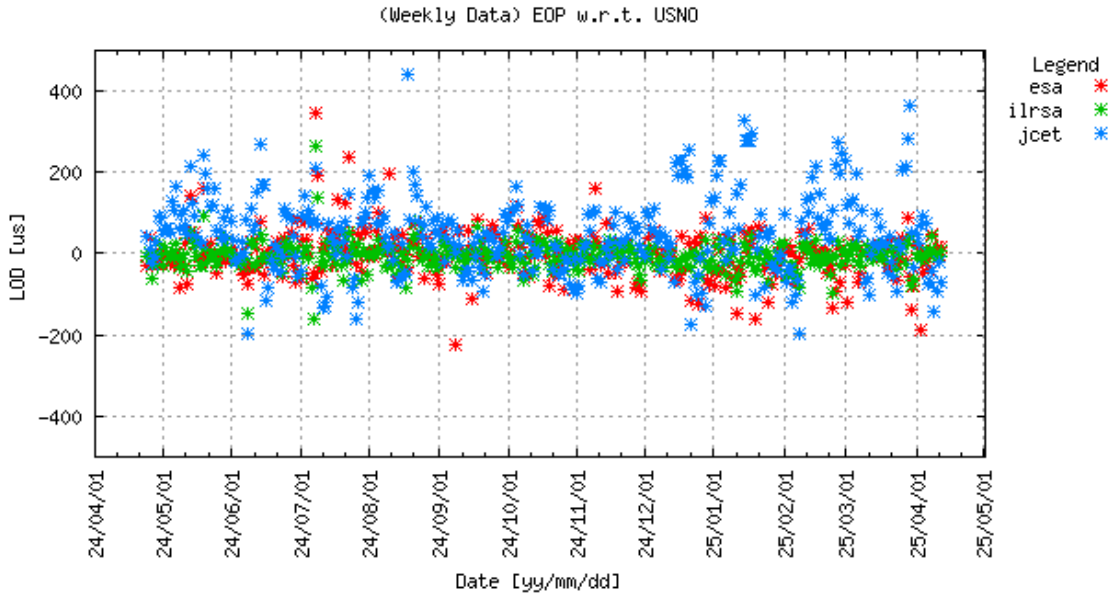




JCET: Lod shows larger deviation from ILRSA (next slide)

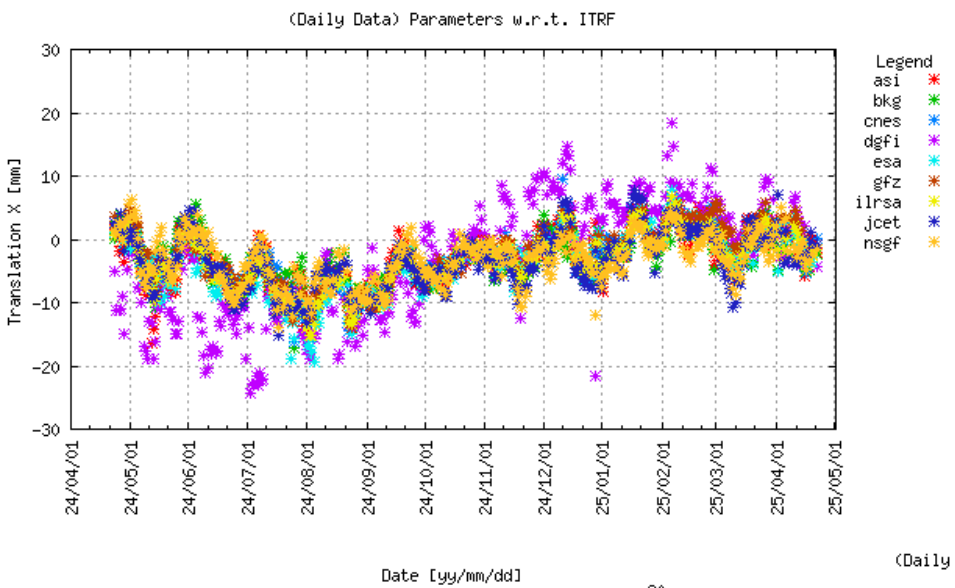
LOD from daily & weekly

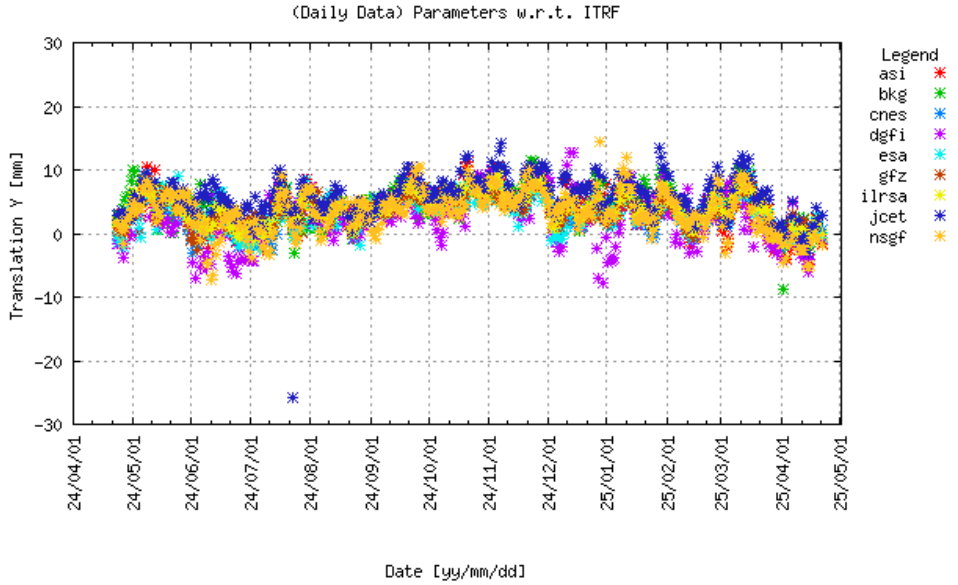


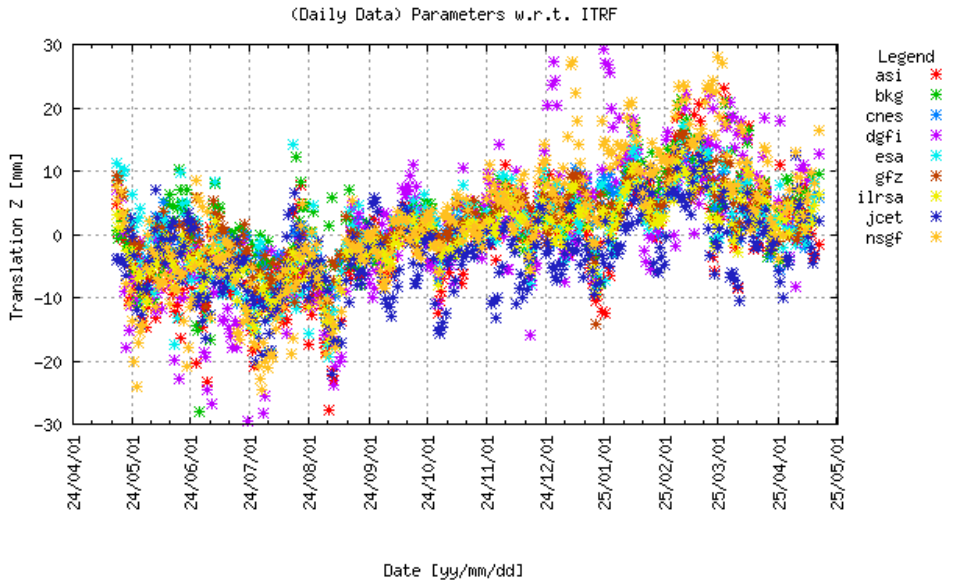


JCET: Lod shows larger deviation from ILRSA

Geocenter motion from daily v180

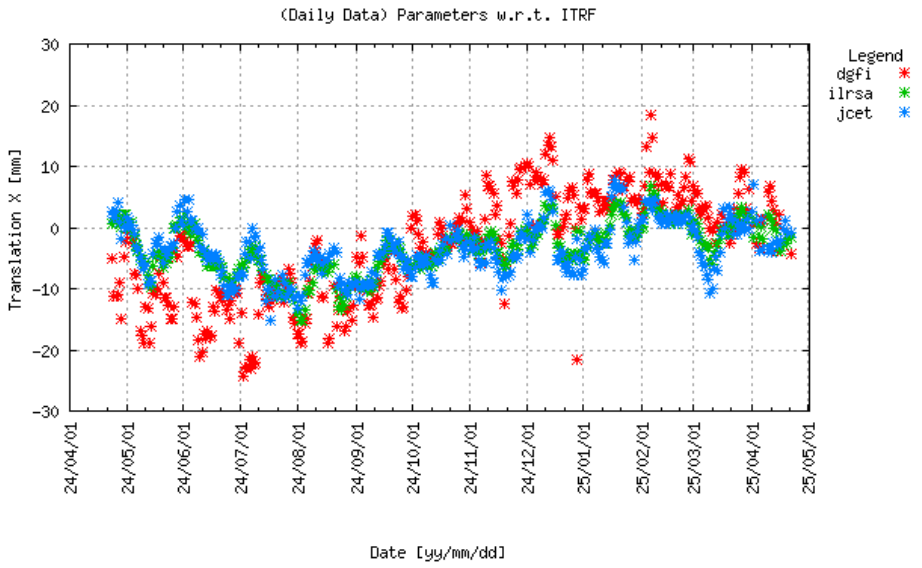


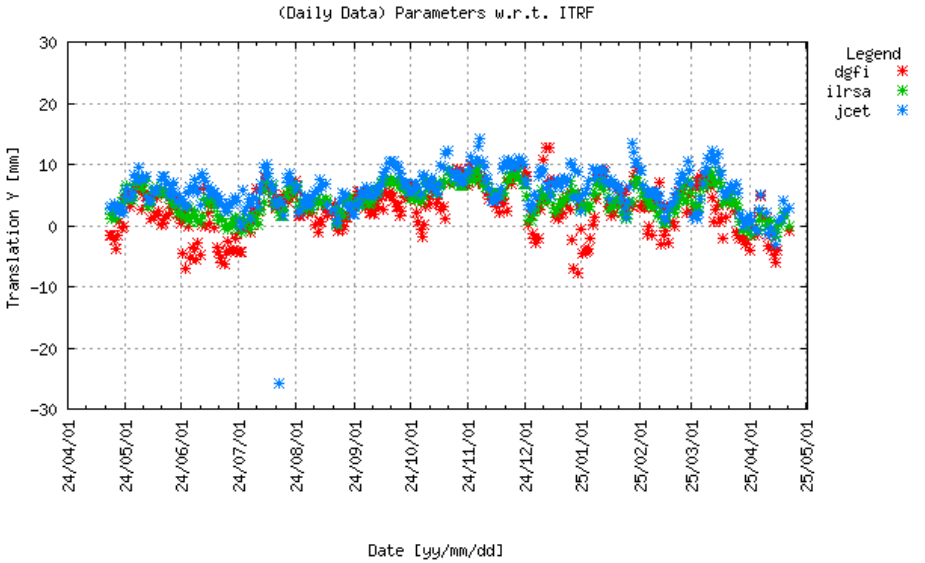


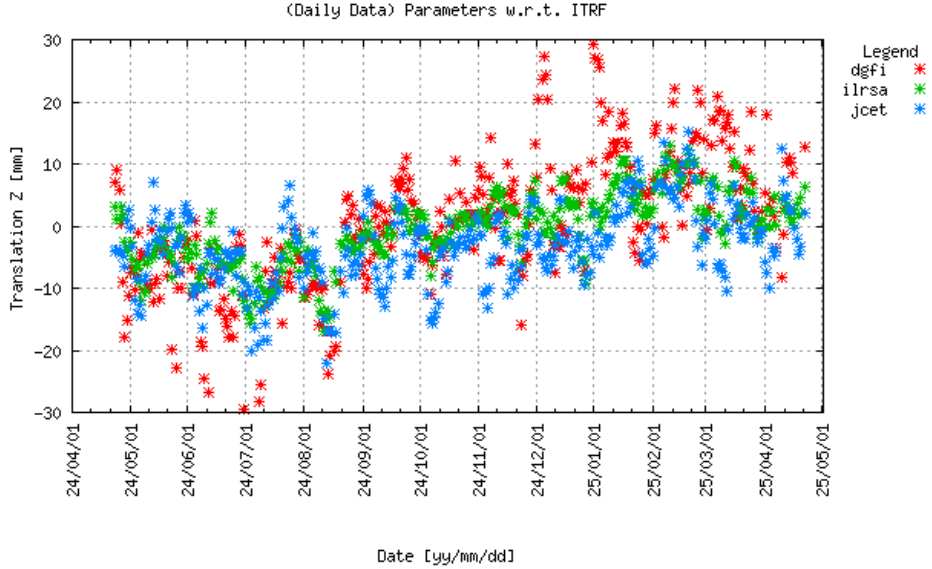


DGFI: larger deviations w.r.t ILRSA (next slide)

Geocenter motion from daily v180

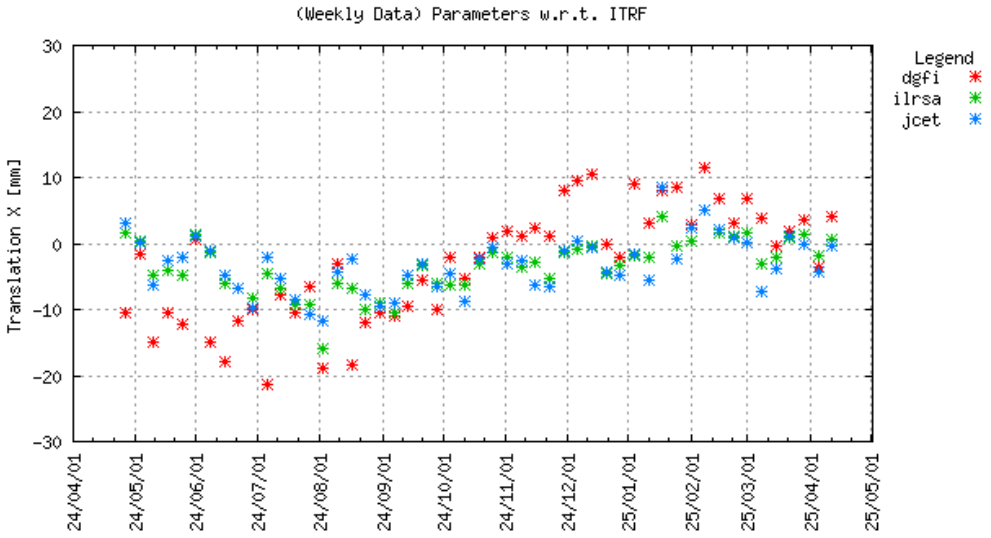


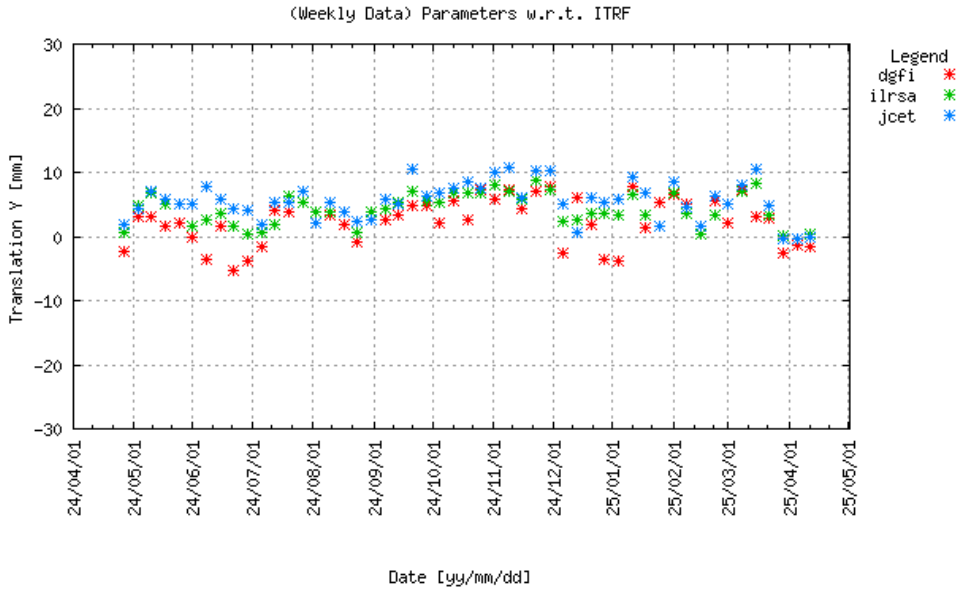


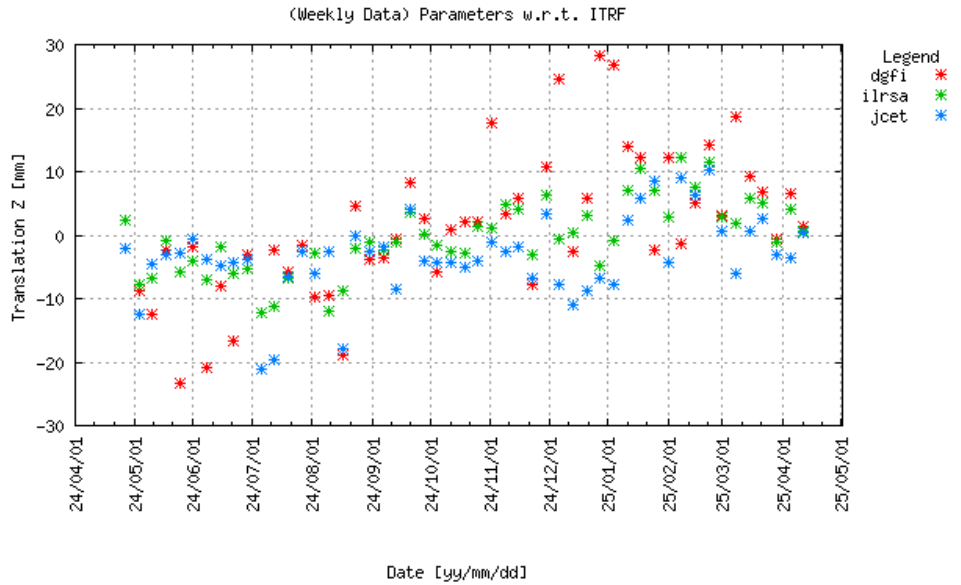


DGFI: larger deviations w.r.t ILRSA, especially on X-Z component

Geocenter motion from Weekly v80

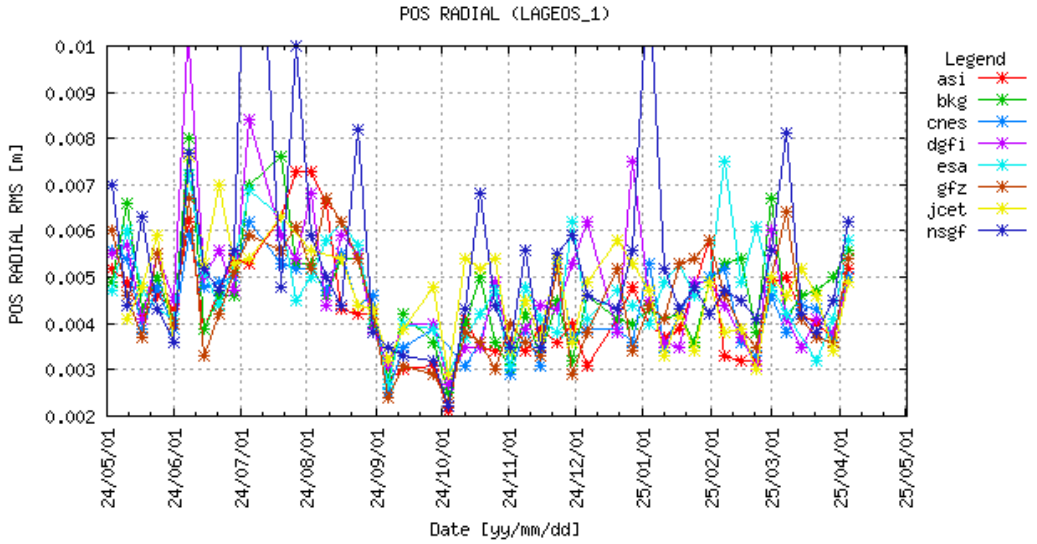


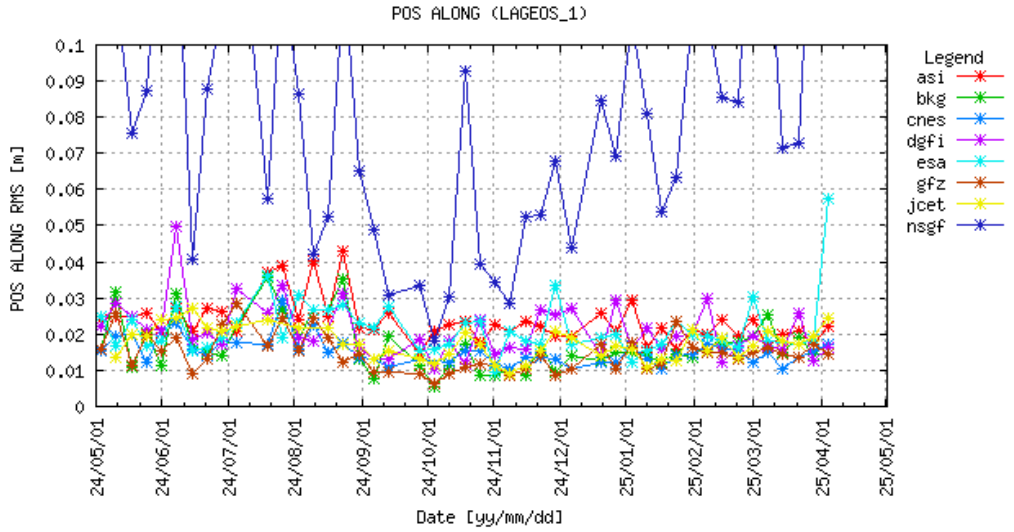


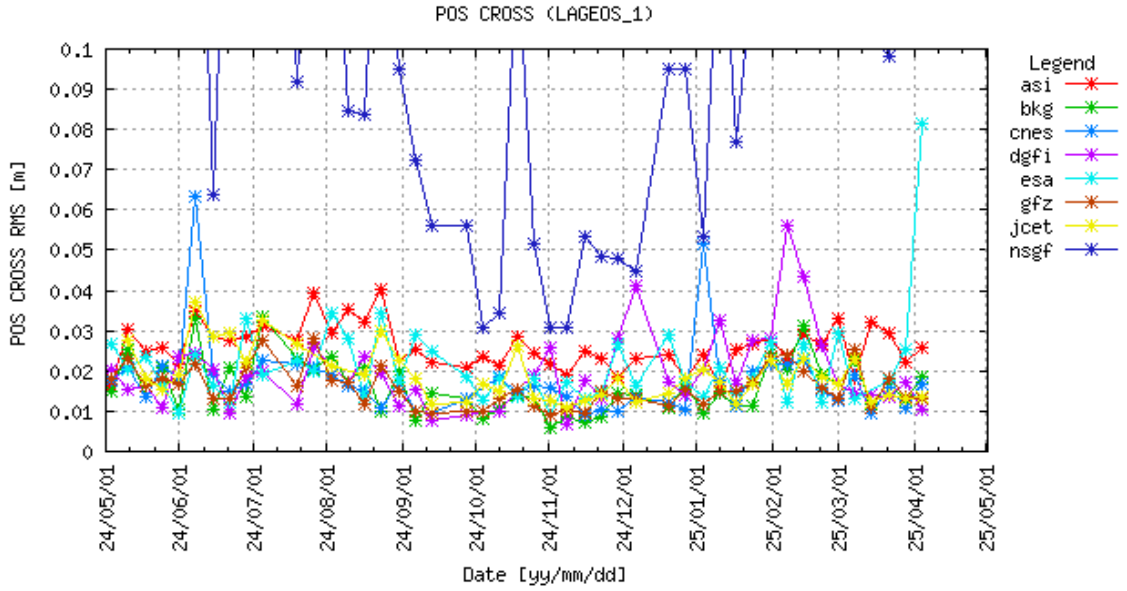


DGFI: larger deviations w.r.t ILRSA, especially on X-Z component

LAGEOS-1 orbit – RMS of residuals w.r.t. combination

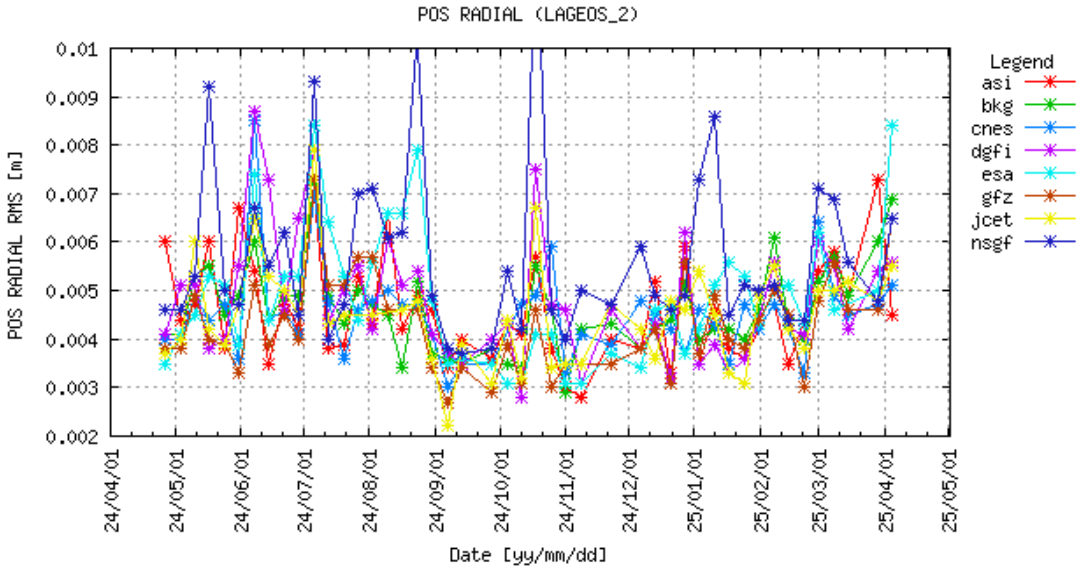


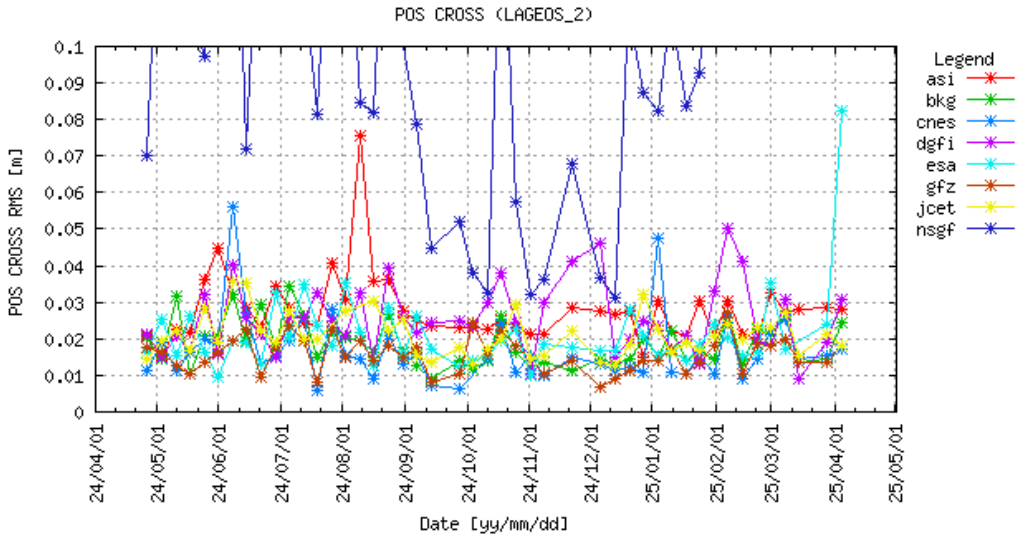


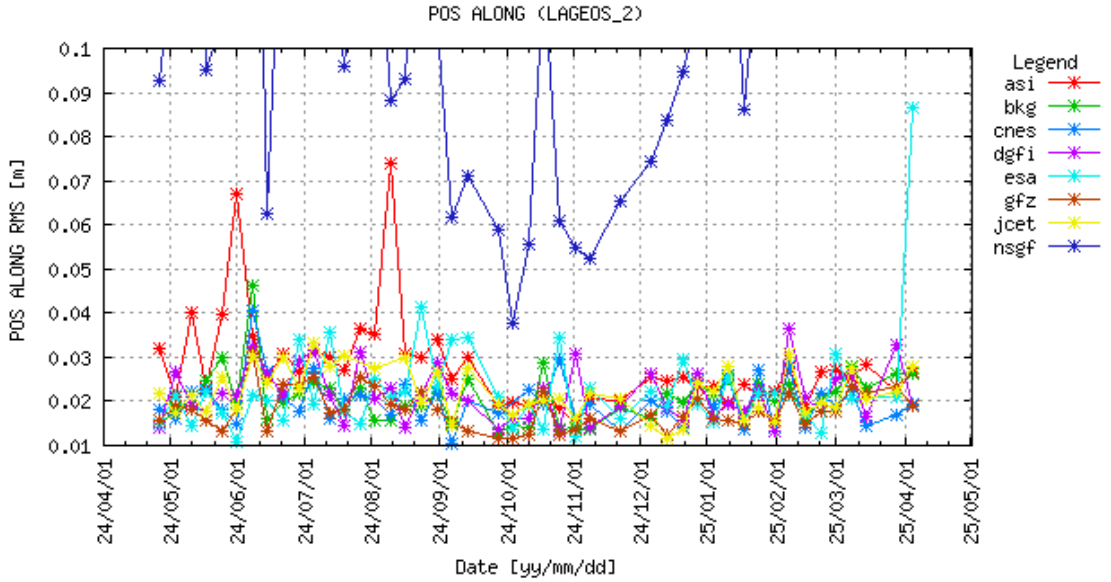


NSGF: larger deviations w.r.t ILRSA on ALONG and CROSS components

LAGEOS-2 orbit – RMS of residuals w.r.t. combination







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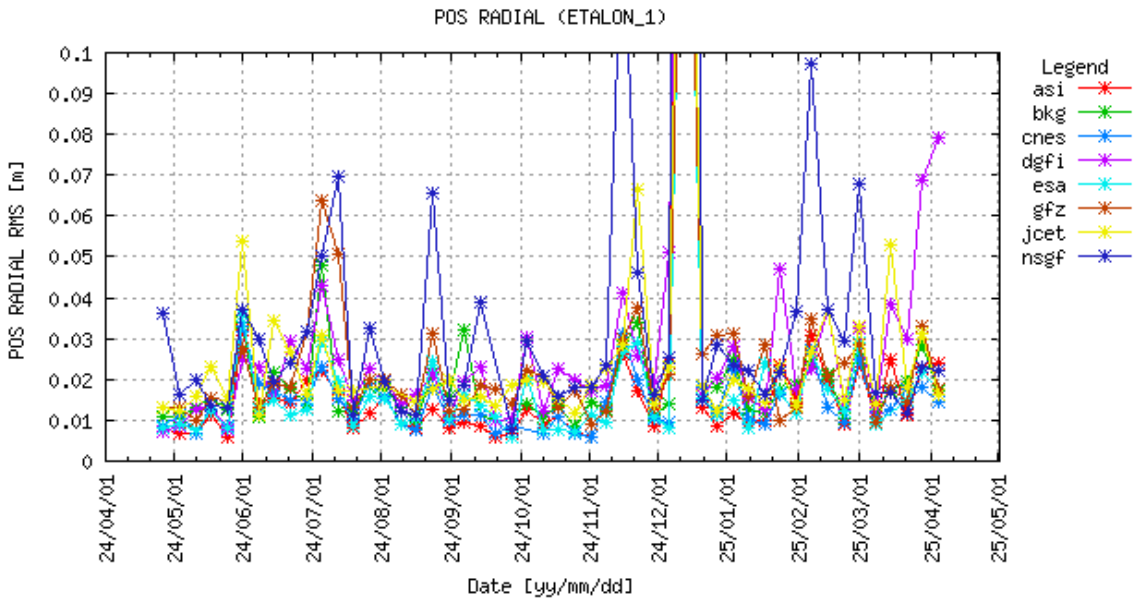
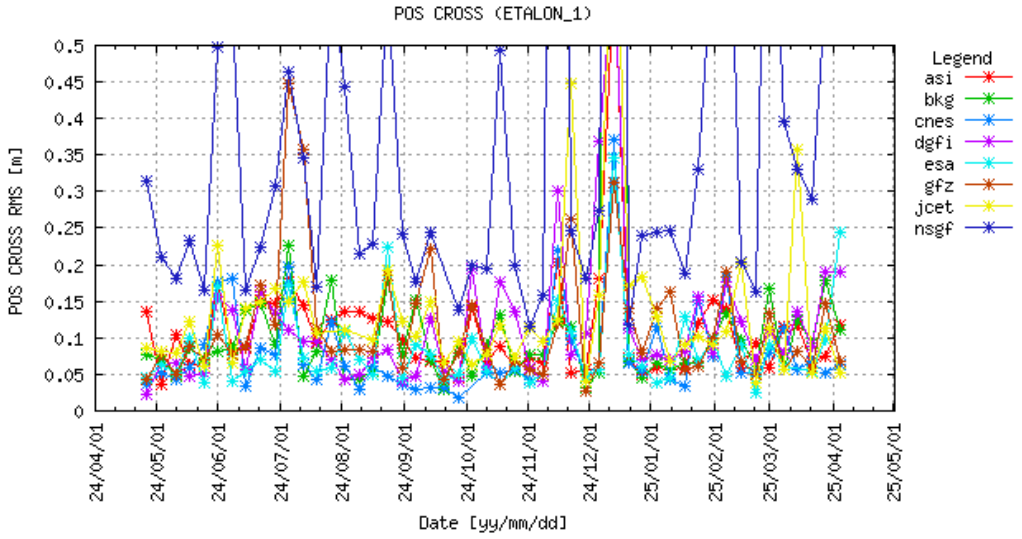
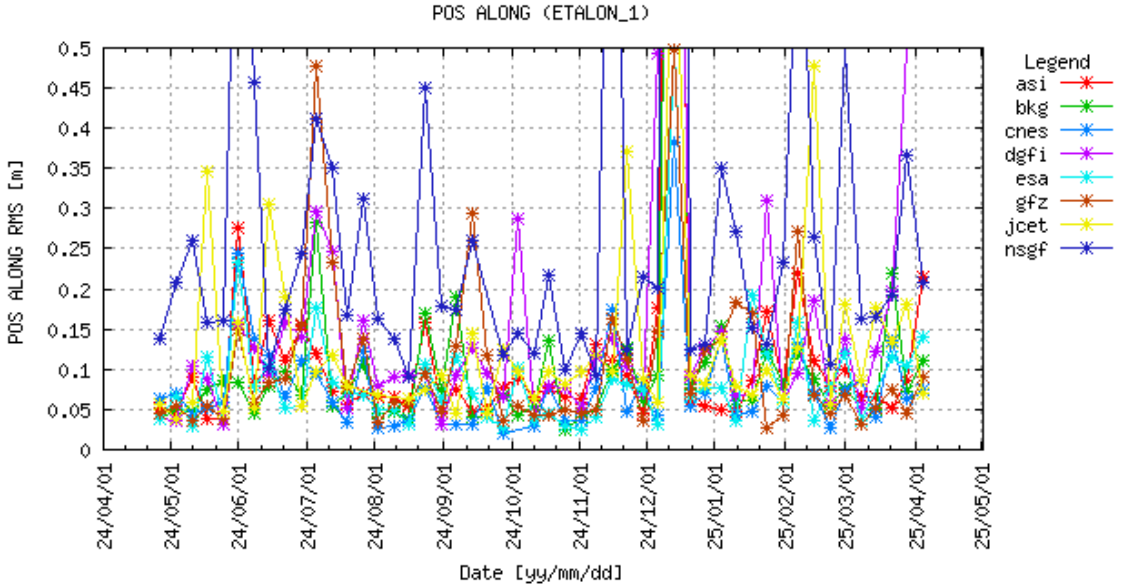
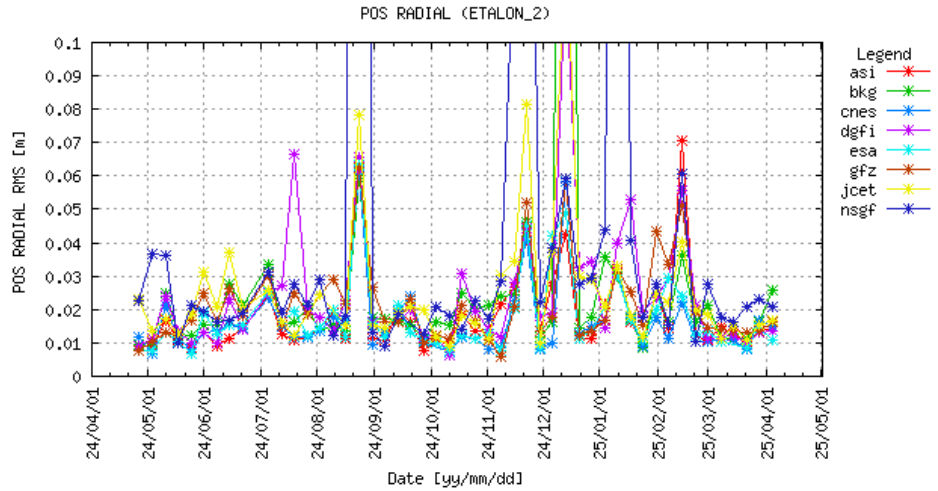
Etalon1 orbit – RMS of residuals w.r.t. combination

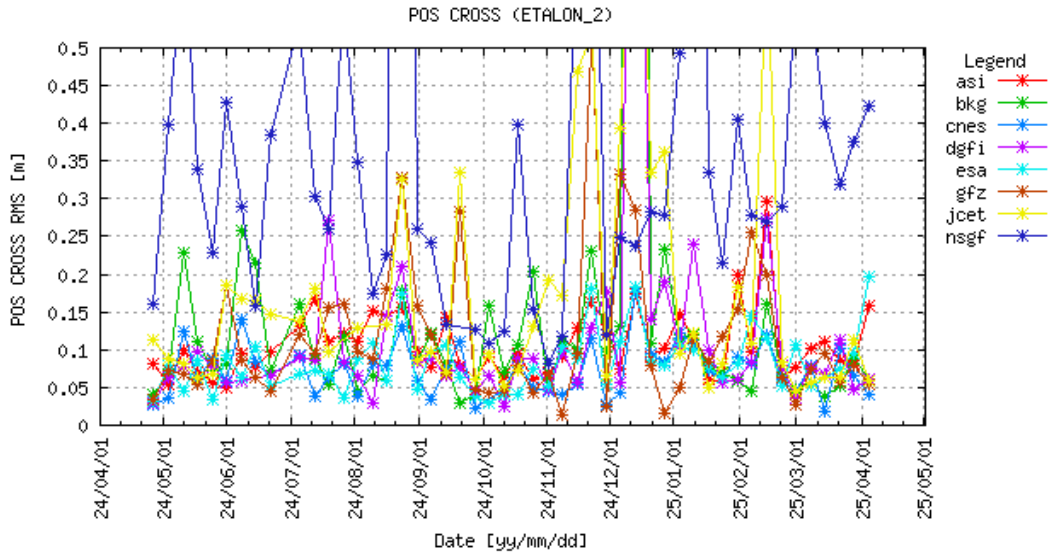


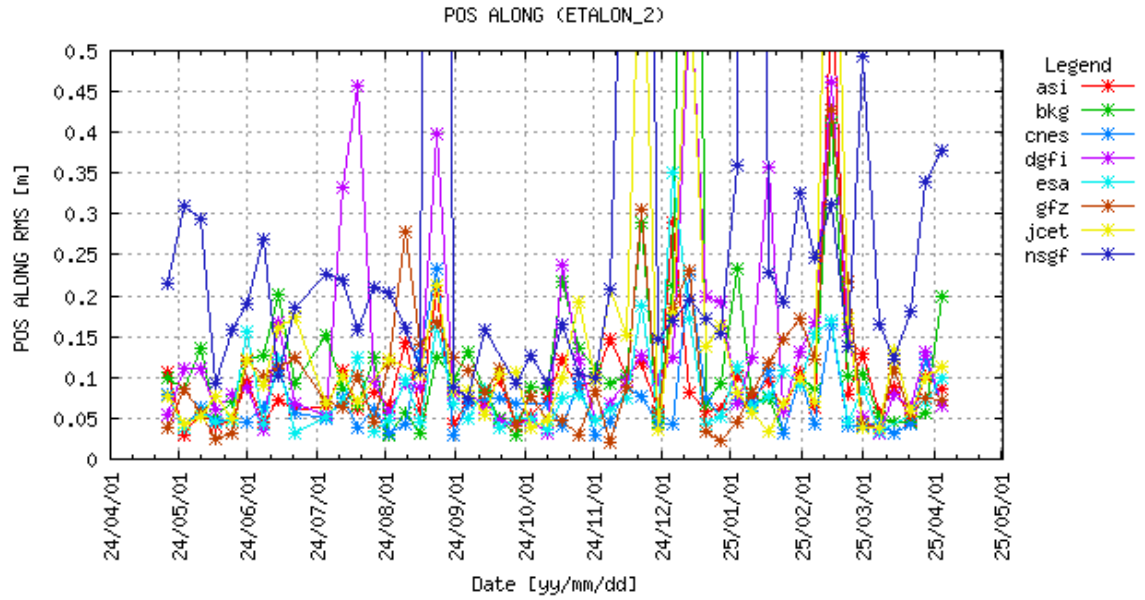




Etalon2 orbit – RMS of residuals w.r.t. combination







Federal Agency for Cartography and Geodesy

BKG
Wir geben Orientierung.

BKG Report 2025-05

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

Status of Series

Operational Series

- v180: running stable
- v190: running stable
- v80 : running stable
- v90 : running stable
- v280: running stable
- v320: running stable

Reprocessings

- v90 (2022/09-2025/04, incl. orbits): done and uploaded

Remarks

- -

Work Done

Operational Series

- v90 & v190: re-designed to v80 type, upload to EDC activated
- Presentation of results on webpage: work ongoing
- Master thesis written at BKG-G1 by M. Hillig (TU Darmstadt)
  - behavior of time series of estimated EOP series investigated
  - time series used: SLR-DAILY, VLBI-intra-comb., VLBI-GNSS-comb., IERS-C04
  - one aspect: exact frequency of max. amplitude in frequency spectrum (see following slide)

Work Done

Master thesis of M. Hillig (in German)

Aspect:
Exact frequency of max. amplitude

Analyse von ERP-Zeitreihen

Ergebnisse: Peak-Algorithmus

TECHNISCHE UNIVERSITÄT DARMSTADT

- Schrittweite der Perioden der DFT/ FFT zu groß, maximale Amplitude wird nur annähernd gefunden
- Peak-Algorithmus und Goertzel-Algorithmus um die maximale Amplitude zu finden
  - Lokale Algorithmen -> können auf verschiedene lokale Maxima angewendet werden

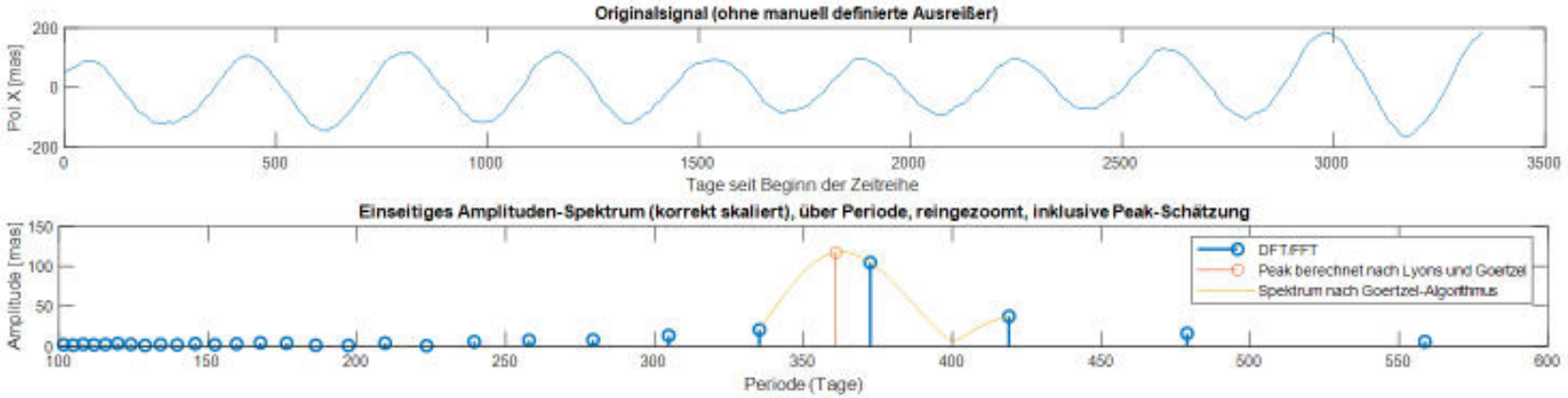


Abbildung 19: Frequenzanalyse der X-Polkoordinaten, oben: Originaldaten (manuell definierte Ausreißer wurden entfernt und die Datenlücken interpoliert); unten: Ausschnitt aus Amplitudenspektrum über die Periode mit Peak-Algorithmus; SLR-Zeitreihe, Tag 4

29.04.2025 Masterarbeit | Mariane Hillig 22

Work Planned

Internal Series

- Evaluating min.-constr. versions of operational ILRS series
- Multi-satellite solution on operational basis

Personnel

BKG (operational ILRS-AC)

- Daniela Thaller
- Daniel Koenig

AIUB (development Bernese for SLR processing)

- Ulrich Meier

ILRS ASC MEETING

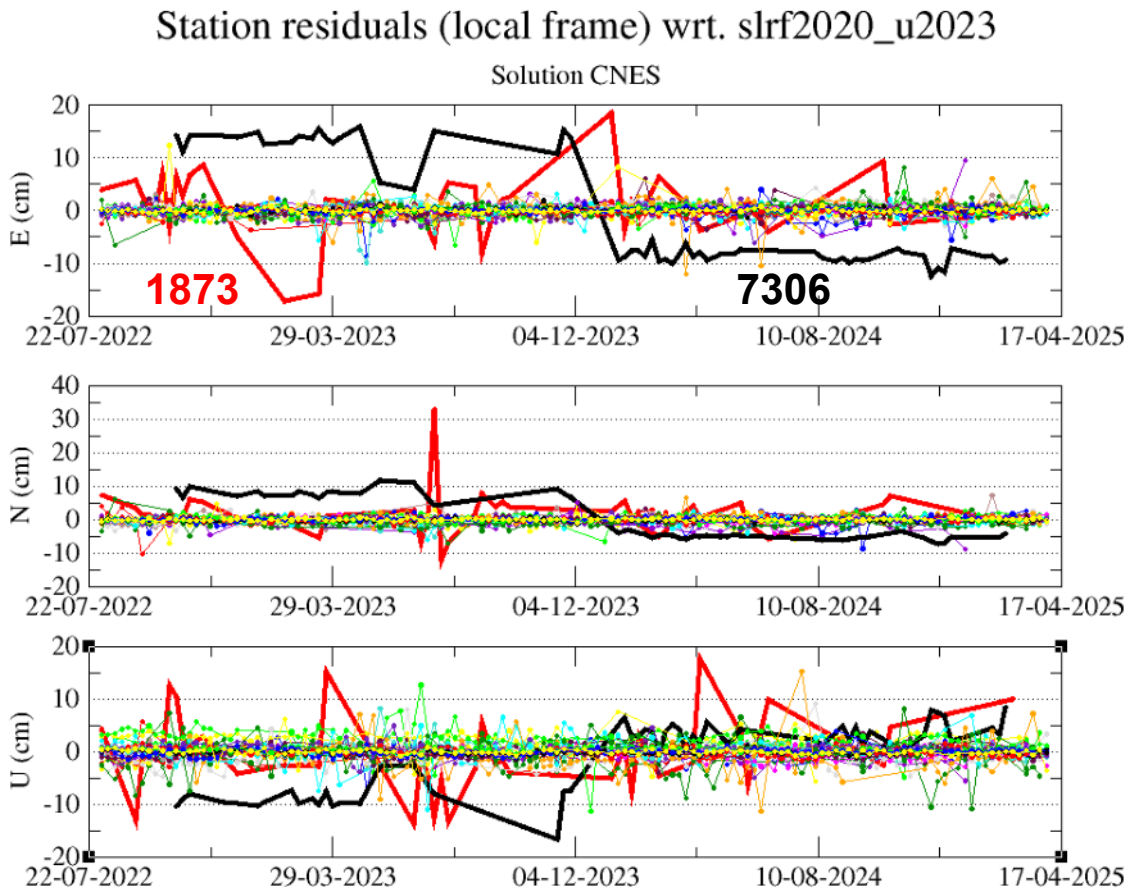
CNES/CLS AC STATUS

01/05/2025

Franck Reinquin - CNES
Adrian Baños Garcia - CLS

Operational status

- Contribution to the v85 reprocessing for the ILRS contribution to ITRF2020-u2024 with the latest inputs and data released at the time.
- Contribution to the 320, v90 and v190 reprocessings for the incorporation of Lares-2 into the operational products. In our internal evaluation, the inclusion of Lares-2 is positive. Although not everything is perfect on our side…
- Daily (v180, v190) and weekly (v80, v280, v320, v90) routinely delivered to CDDIS and/or EDC. Ready to decomission v180, v80 and v280.



Pilot projects and studies (1)

Lares/SH Pilot Project

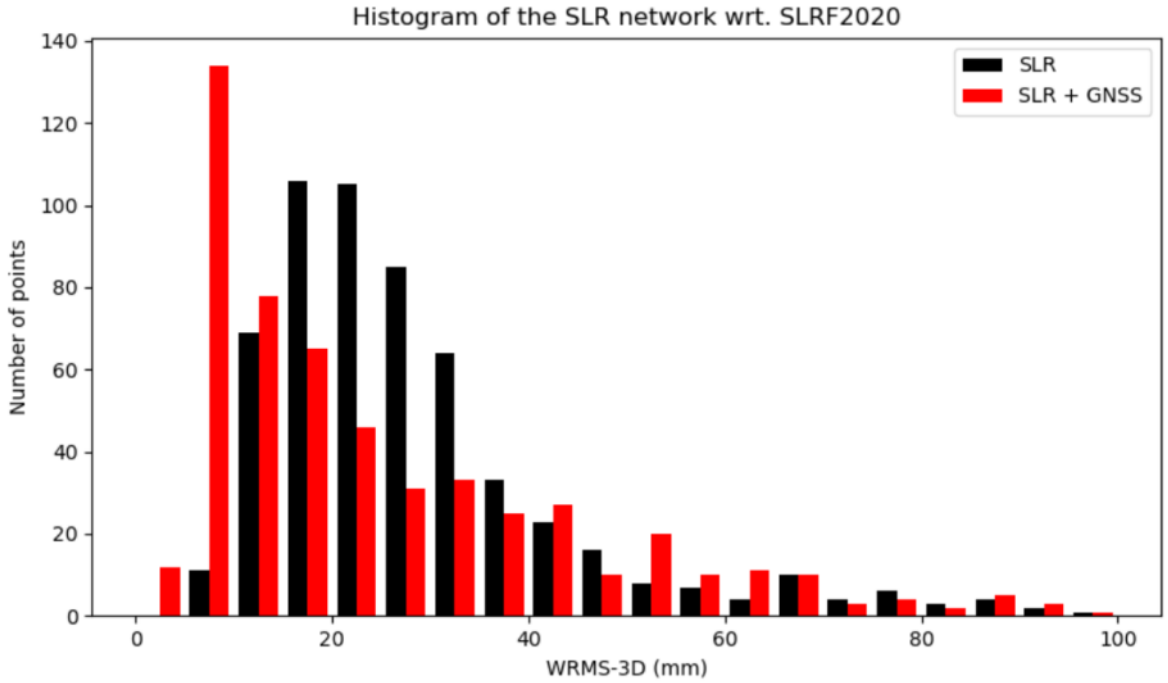
- Lares is already available and tested in the AC.
- Generation of SINEX for SH coefficients to be coded.

Happy to participate !

GENESIS

- Single SLR LEO processings as well as combinations of NEQs with GNSS and DORIS are already taking place within the AC. These combinations are possible thanks to a LEO common orbit between techniques (Sentinel-6A).

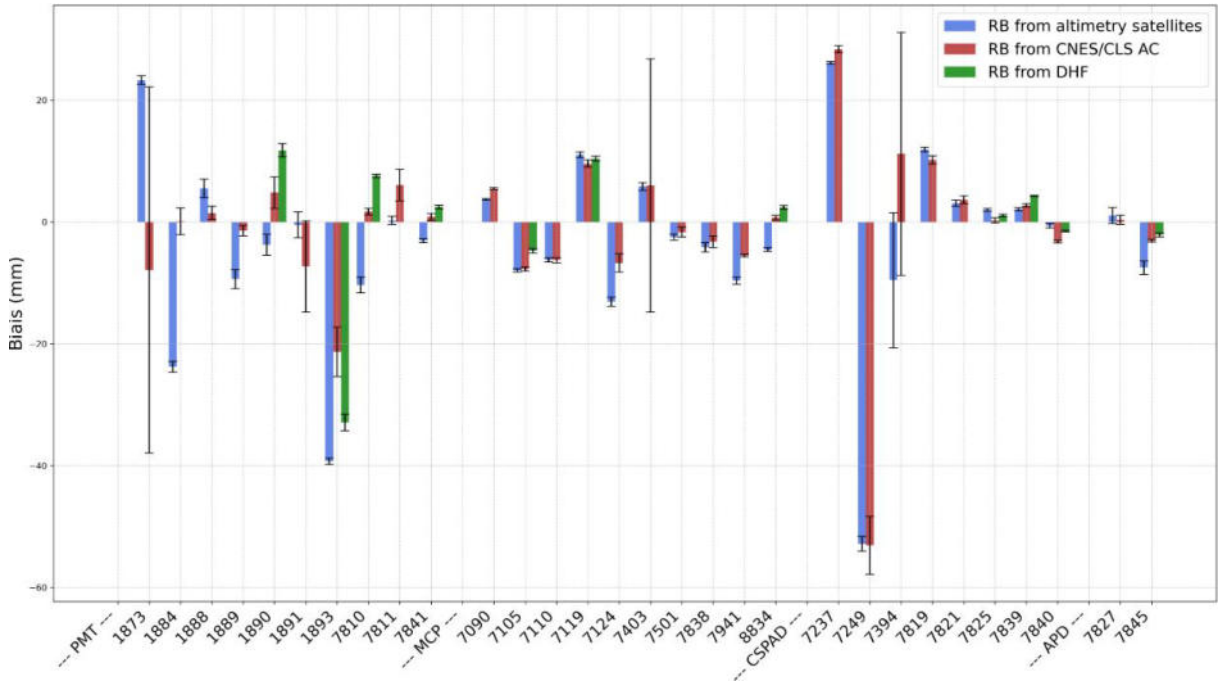
- Participation in the GENESIS WG for SLR, GNSS and DORIS techniques.

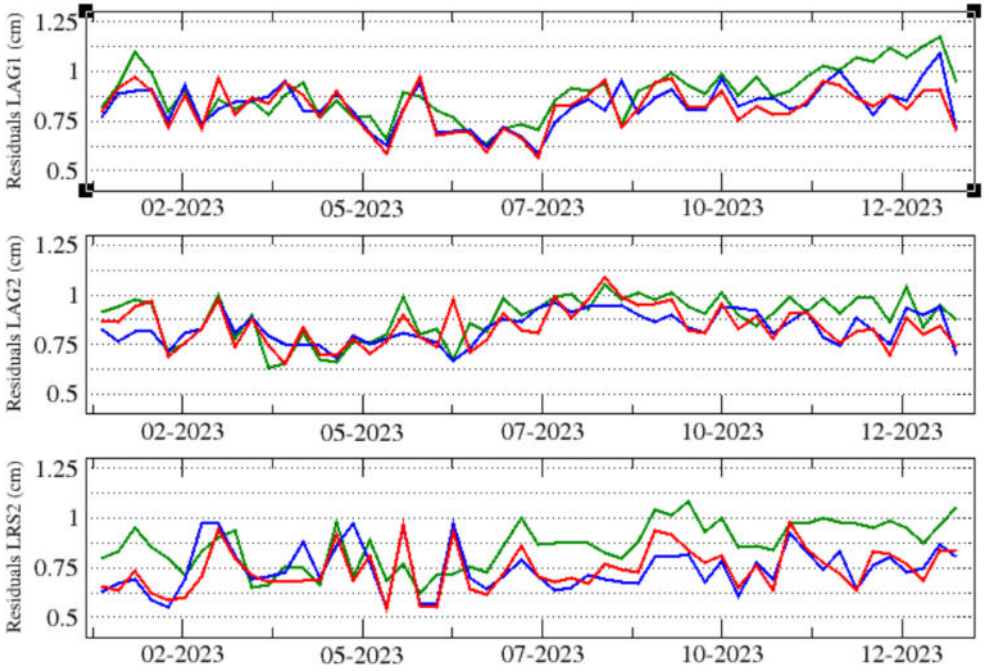


Pilot projects and studies (2)

Range biases with altimetry LEO satellites

- As shown in Saquet et al. (2023), range biases from SLR stations can be precisely derived from altimetry LEO satellites observations.
- Validation with the help of the AC: comparison of RB estimates and SLR residuals of three solutions: Altimetry satellites, CNES/CLS AC and DHF. RB estimates show great agreement, specially for the core stations. LEO observations can help with stations that tracked poorly the spherical satellites. The more properly estimated RB, the better the SLR measurement residuals.
- Poster on site : « Clearing systematic range biases from SLR observations: assessment and outlook » (Wed, 30 Apr, 10:45)





Report of the DGFI-TUM ILRS AC

Mathis Bloßfeld, Julian Zeitlhöfler

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

ILRS ASC meeting – 2025-05-01

ILRS product array at DGFI-TUM

ILRS label	description	file format
v180	daily LA-1/2 and ET-1/2 TRF and ERP solution	SINEX
v80	weekly LA-1/2 and ET-1/2 TRF and ERP solution	SINEX
v80-sp3c	weekly LA-1/2 and ET-1/2 orbit solution	SP3c
---	daily orbit predictions for LA-1/2 and ET-1/2	CPF(v2)
v280	weekly LA-1/2 and ET-1/2 TRF and EOP solution (including RBs for all stations)	SINEX
v190	daily LA-1/2, ET-1/2 and LR-2 TRF and ERP solution	SINEX
v90	weekly LA-1/2, ET-1/2 and LR-2 TRF and ERP solution	SINEX
v90-sp3c	weekly LA-1/2, ET-1/2 and LR-2 orbit solution	SP3c
---	daily orbit predictions for LA-1/2, ET-1/2, LR-2	CPF(v2)
v320	weekly LA-1/2, ET-1/2 and LR-2 TRF and EOP solution (including RBs for all stations)	SINEX
v300	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

- Primary focus will be on coordination of ASC project within the next 6 months
  - Details will be provided during the ASC meeting
- Elaborate improvement due to consistent NTL corrections (grav. + loading)
- SLR-/DORIS-based POD of altimetry (LEO) satellites

ESOC ILRS AC Status

Tim Springer, Frank Zimmermann and Erik Schoenemann

01/05/2025

ESOC ILRS AC Status (1/2)

- ITRF2020 (v80/v180/v280/v320) solutions running routinely since June 2023
  - v180: Daily solution, v80: Weekly solution,v280: Weekly solution with biases for all stations-satellites pairs
    - But combined bias for Etalon-1 and -2
  - v320: Weekly solution like v280 but including LARES-2
  - We switched from NAPEOS to EPNS but for ILRS that should not have had a significant effect

- New solutions **including LARES-2** (v190/v90/v290)
  - Now based on:
    - (new) SLRF2020_POS+VEL_2025.04.08.snx
    - (new) slrecc.250408.ILRS.xyz.snx
    - (new) ILRS_Data_Handling_File_2025.04.08.snx
    - com231128
  - v190: Daily solution, v90: Weekly solution, v290: Weekly solution with biases for all stations-satellites pairs
    - Combined bias for Etalon-1 and -2

ESOC ILRS AC Status (2/2)

- LARES
  - LARES is included in our initial 21-day cleaning step since February 2012
  - Ready for including LARES
    - Still need to check and validate our gravity field SINEX implementation
      - Based on the examples from Mathis

Effect of LARES-2 on the ERP Estimates

- This is important because of our ESA EOP solutions

	X-Pole		Y-Pole		LOD	
	(mas)		(mas)		(ms/day)	
	Mean	Sigma	Mean	Sigma	Mean	Sigma
V80	0.090	0.225	0.010	0.260	-0.001	0.052
V90	-0.013	0.164	-0.078	0.210	-0.002	0.038
GNSS	0.002	0.047	0.029	0.033	-0.010	0.028

- LOD improvement very significant. Most likely now better then GNSS in an absolute sense
  - GNSS LOD suffers from correlations with the dynamical orbit parameters

Solar Radiation Scale Factor

- Just a quick check of our adopted values

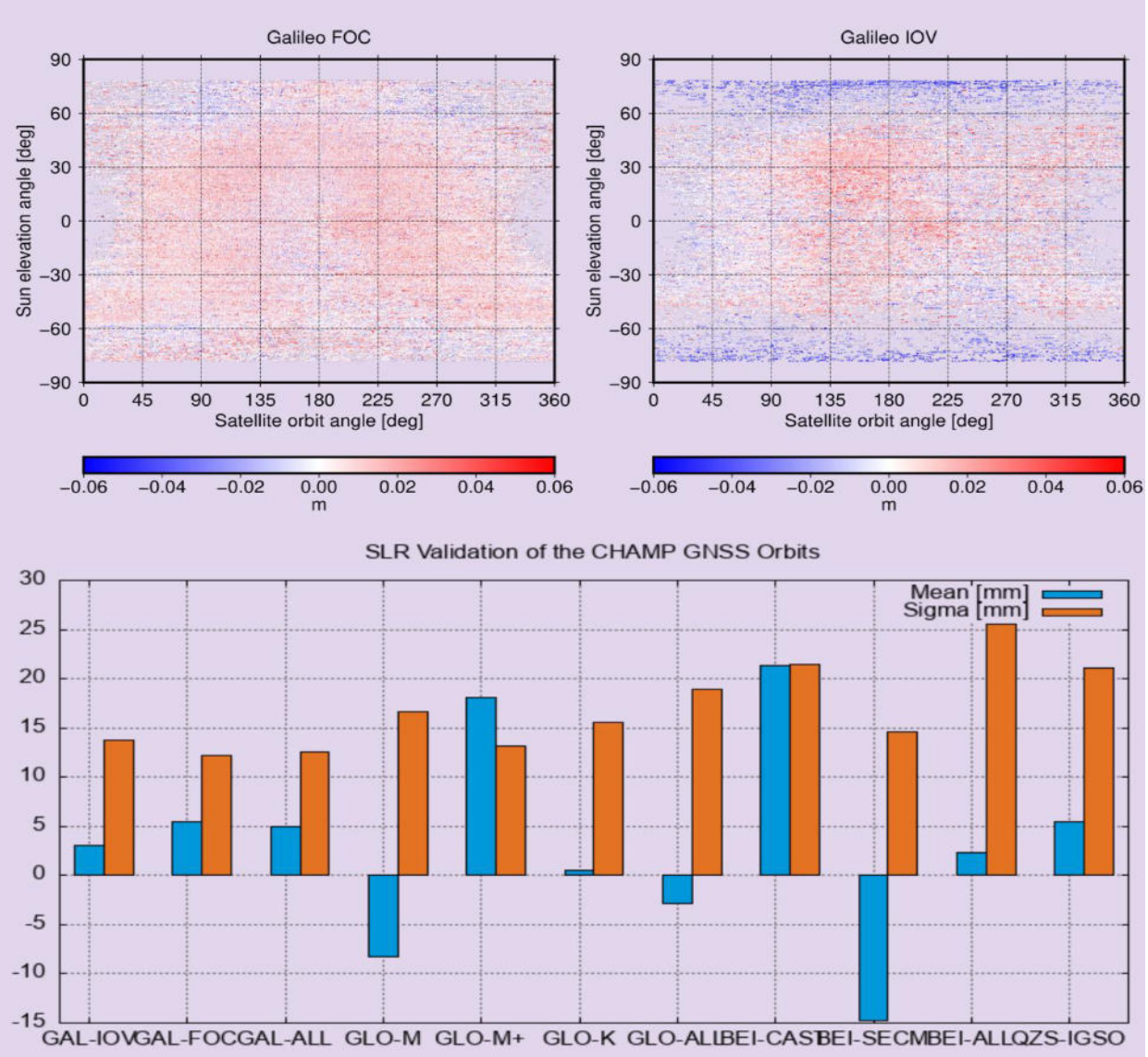
	ILRS	Estimate		ILRS-Est.
		Mean	Sigma	Diff
LARES	1.000	1.020	0.092	-0.020
LARES-2	1.100	1.094	0.035	0.006
LAGEOS-1	1.130	1.149	0.064	-0.019
LAGEOS-2	1.130	1.113	0.048	0.017
ETALON-1	1.250	1.254	0.030	-0.004
ETALON-2	1.280	1.277	0.024	0.003

- Differences are well within the standard deviation of the estimates!

GNSS Validation

Tim Springer

SLR O-C Two-Way Residuals of GNSS Orbit Validation



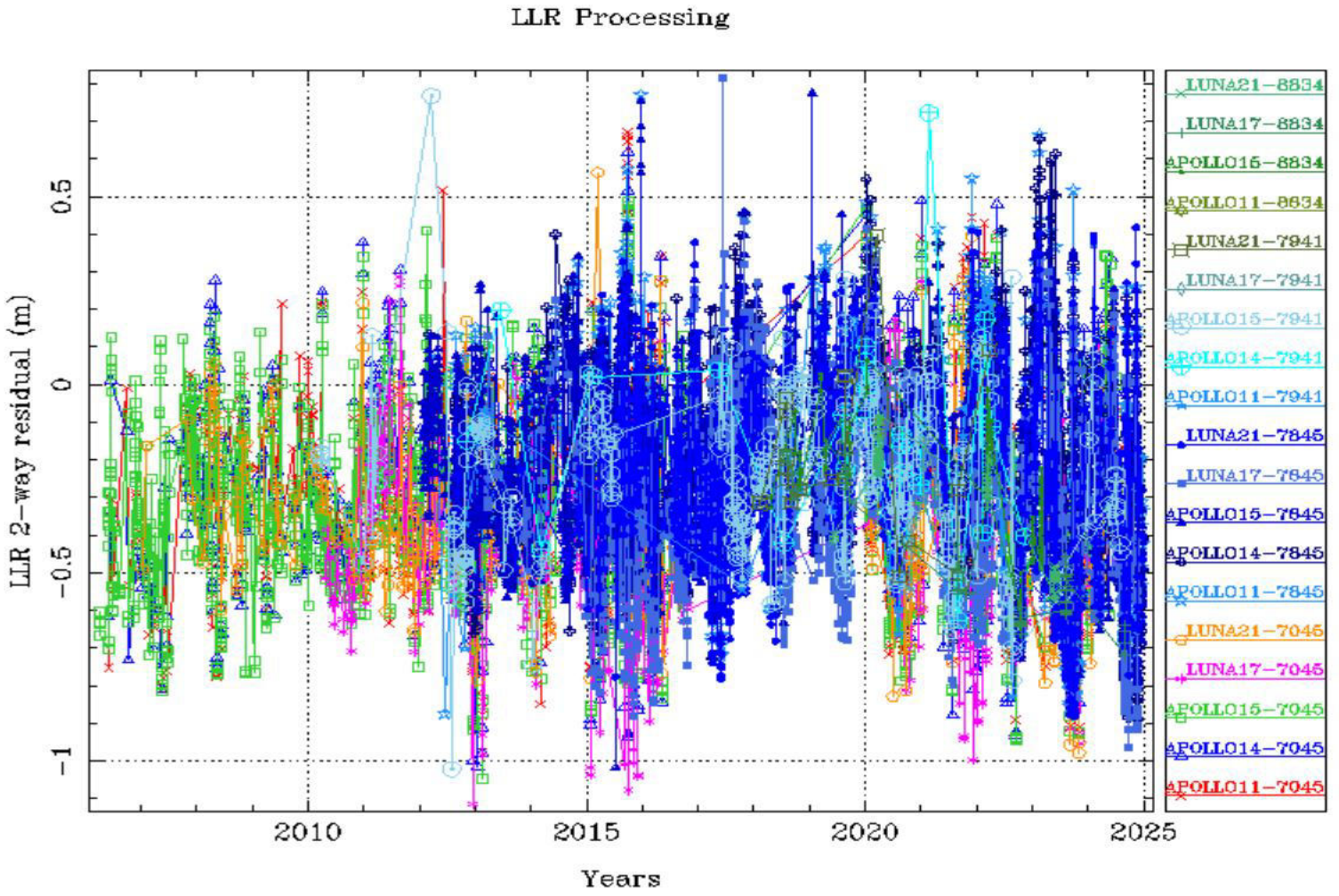
Validation of our operational IGS products:

- Using the ETALON biases where available
- Using the ILRS Data Handling file to determine for which stations to estimate biases
- When needed we estimate 1 bias per station for all GNSS over the whole time
- For stations 7110 and 7825 the ETALON biases did not work
- Station 1886 showed a HUGE bias of -90mm. Most likely station coordinate problem.
- All other biases below the 20mm level
- Mean and RMS (2-way) below the 20mm
  - For Galileo below the 15mm
  - Which is very close to the SLR noise level

LLR Work in preparation of Moon Missions

Tim Springer

LLR O-C Two-Way Residuals (nothing estimated!)

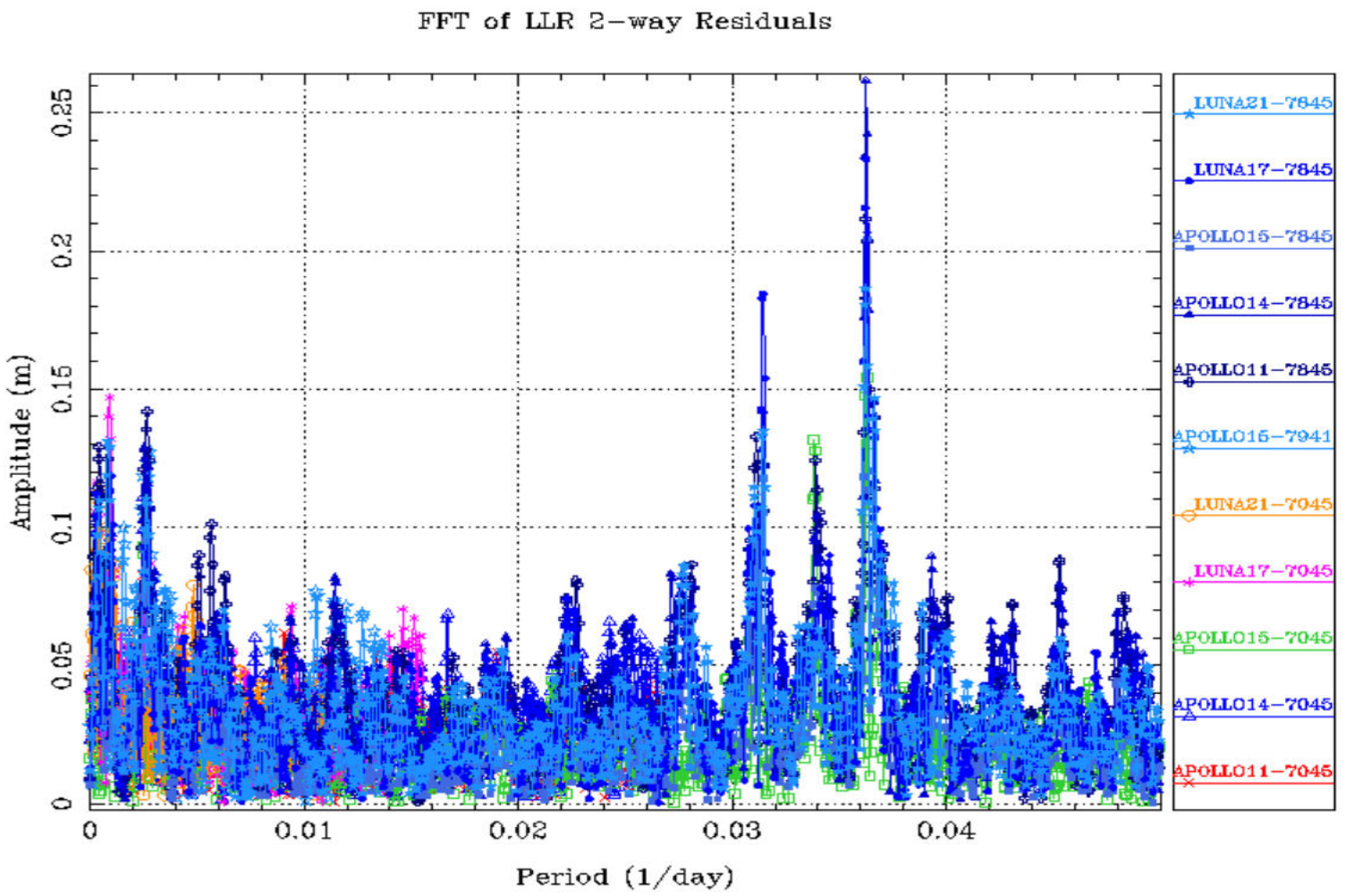


Two-way LLR Residual statistics

Mean: -0.2581 m
RMS: 0.3585 m
Sigma: 0.2436 m

Clear mean in the residuals

Fourier spectrum of the O-C residuals.



No results for 8834 (Wettzell) due to lack of data for FFT

0.0363 ~ 27.586 days
0.0311 ~ 32.119 days?

Draconic: 27.2122 days
Sidereal: 27.322 days
Anomalistic: 27.55 days
Synodic: 29.530 days

Clear period of around 27.6 days visible. Corresponds to Moon period around the Earth. Clear indication of some remaining modelling issues. But only at the 26 cm (two-way) level

Thank you!

Status report of the ILRS AC at GFZ

Anton Reinhold [1], Ahmad Desai [1], Margarita Vei [1], Patrick Schreiner [1]

[1] GFZ Helmholtz Centre for Geosciences, Potsdam, Germany
(anton.reinhold@gfz.de)

ILRS – ASC Meeting 2025
Vienna, 1 May 2025

GFZ Helmholtz Centre for Geosciences

HELMHOLTZ

Current Status ILRS AC at GFZ

Operational Processing:

- All products (v80,v180,v320) are nominal
- Missing daily v180 products: 25.04.17-25.05.24 due IT issues

Miscellaneous:

- Reprocessing of v80 and v180 with the new DHF and current SLRF2020 realization including Lares2 done
- Orbits for v90 uploaded to ECD
- SINEX File syntax has been corrected and will be available in operational v90 and v190

Staff Situation:

- Additional AC Support from Margarita until June 2025

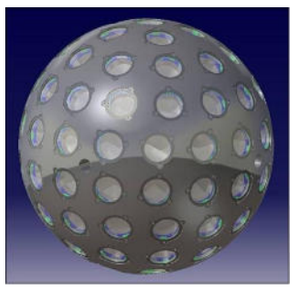
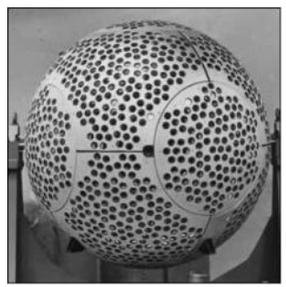
Outlook

- Operational v90 and v190 solutions
- Investigations for known LOD abnormalities

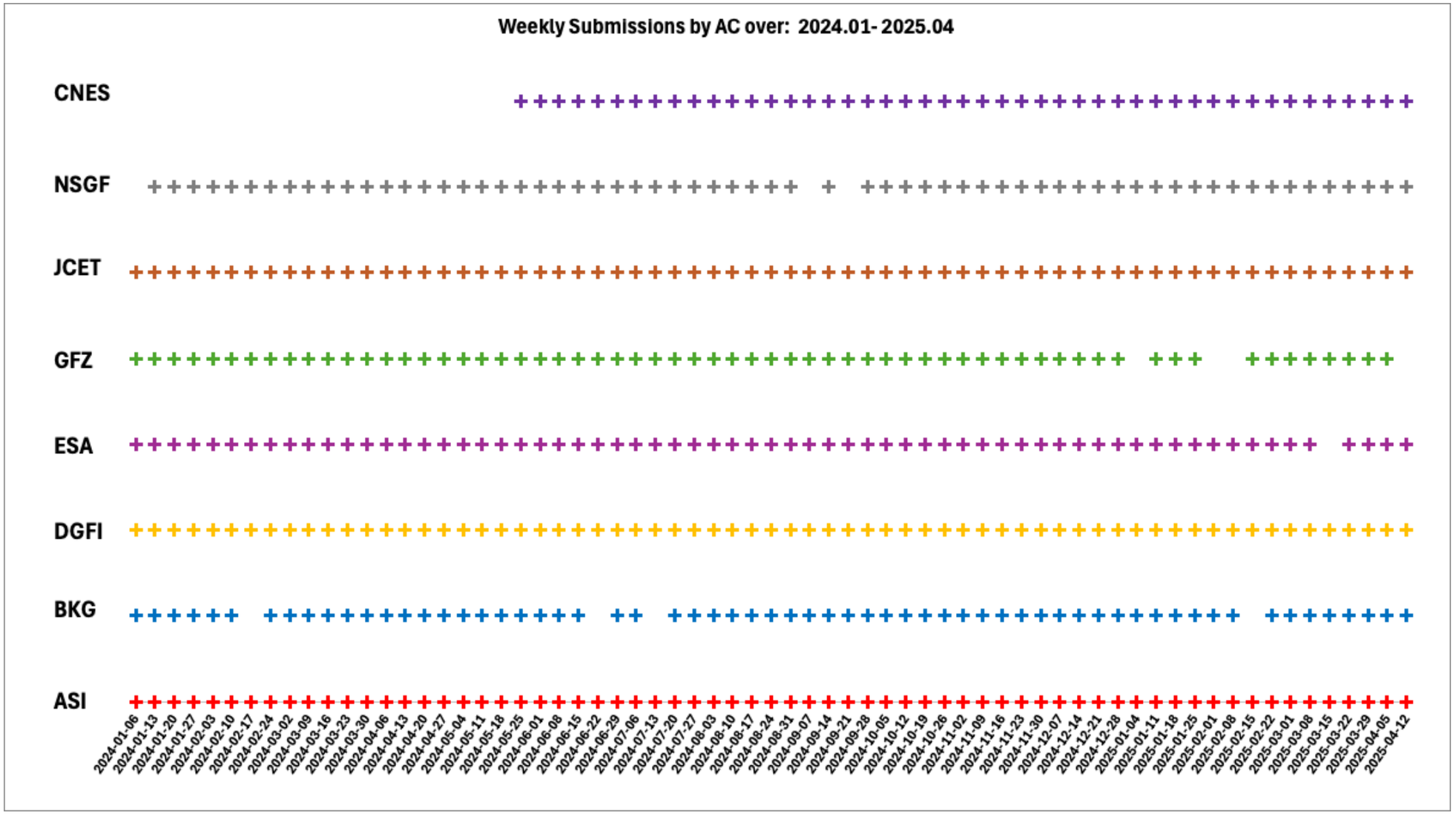
NASA GSFC/JCET & ILRSB Update, 2025/05

ILRS Analysis Standing Committee Meeting (2025/05)
Vienna, Austria
May 1, 2025

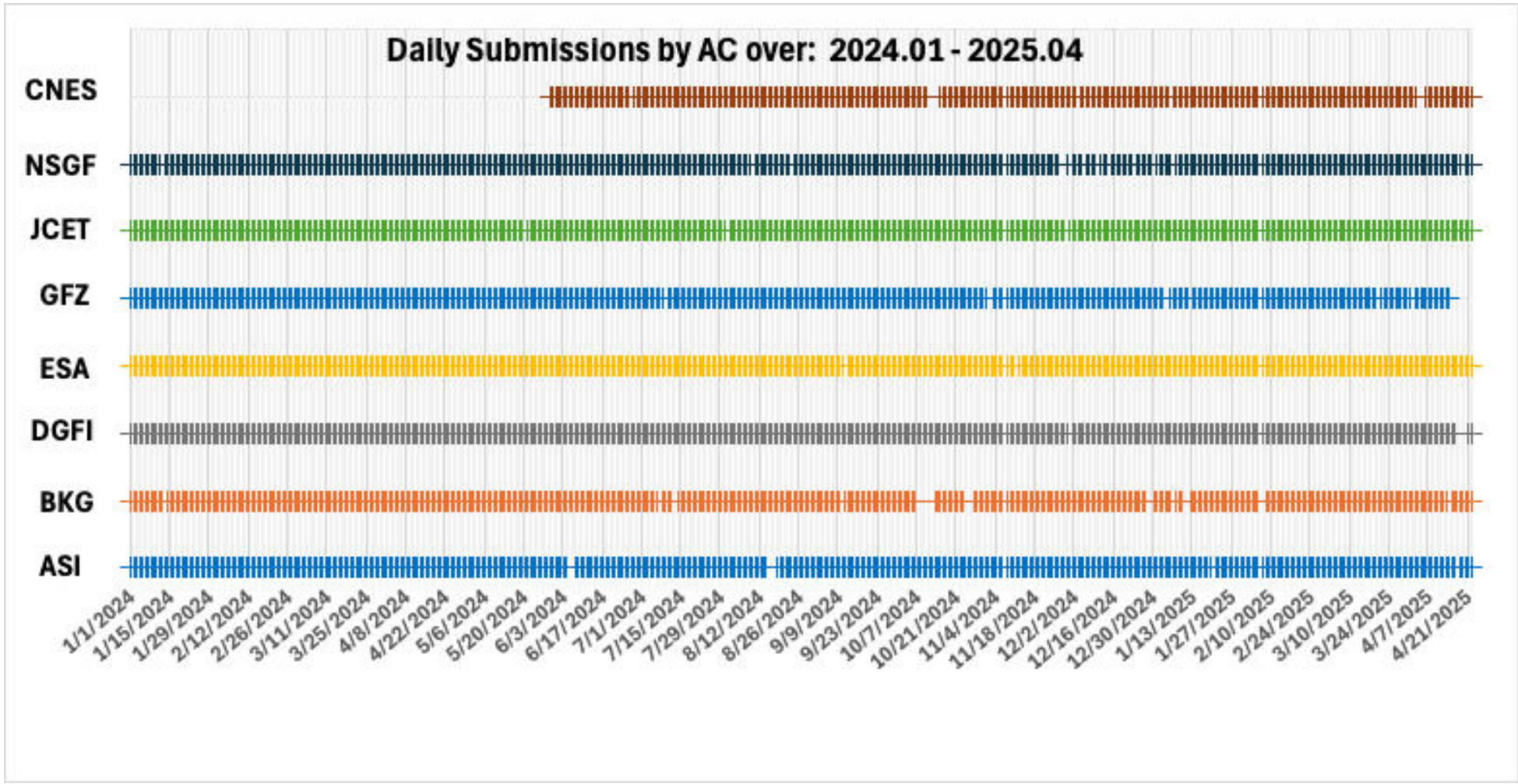
F.G. Lemoine (1), M. Kuzmicz Cieslak (2,1), K.D. Evans (2,1), A. Belli (3)
(1) NASA GSFC, Greenbelt, Maryland, U.S.A.
(2) GESTAR II, Univ. of Maryland, Baltimore County, Baltimore, Maryland, U.S.A.
(3) SSAI Inc., Greenbelt, Maryland, U.S.A.

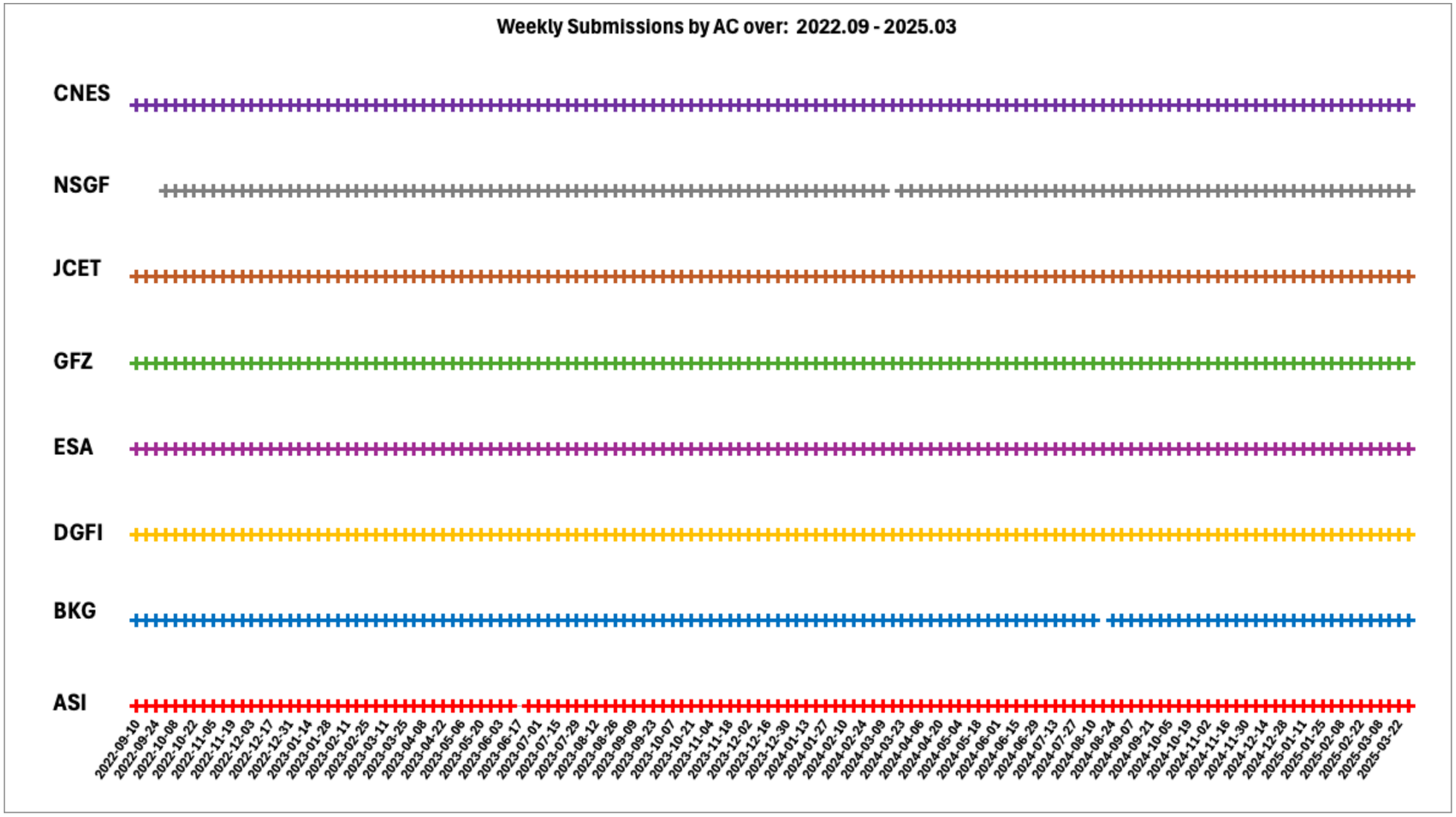
ILRSB Status v80: Solution availability by AC (*since 2024.01*)



ILRSB Status v180: Solution availability by AC (*since 2024.01*)



ILRSB Status v90: Solution availability by AC (*since 2022.09*)

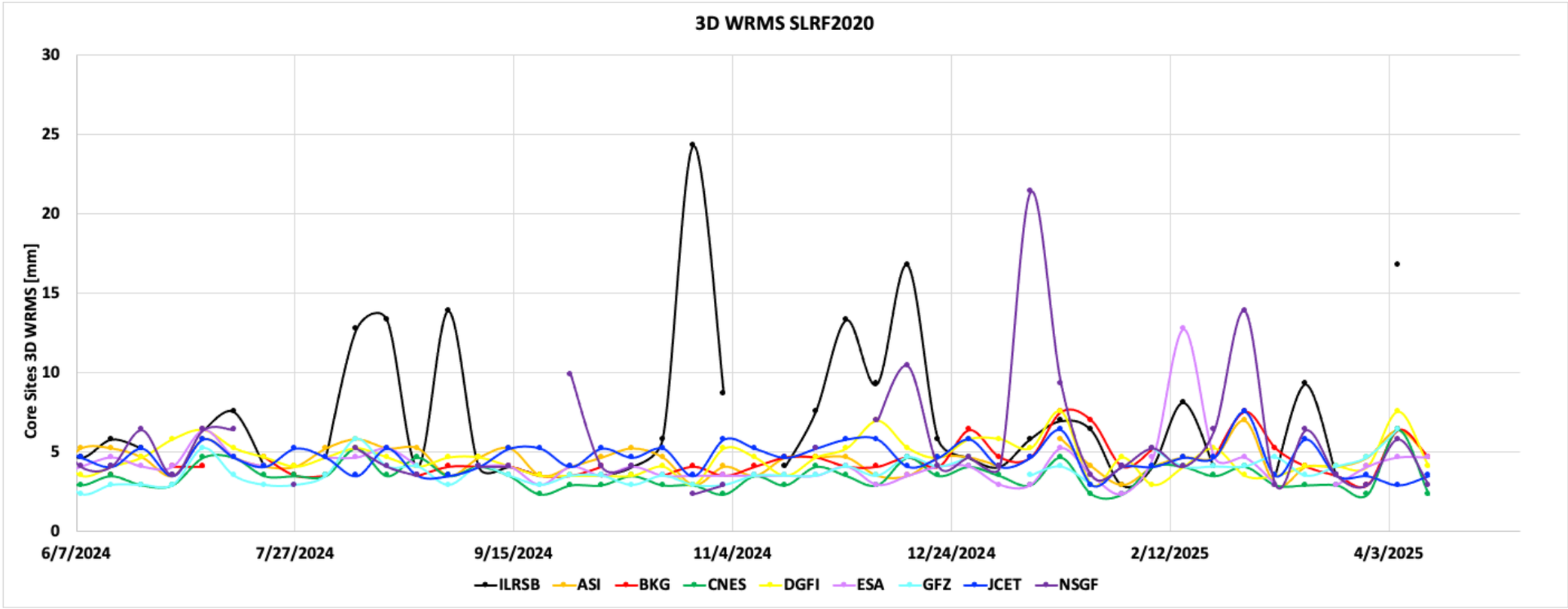


ILRSB Status v80: Core WRMS (since ~July 1, 2024)

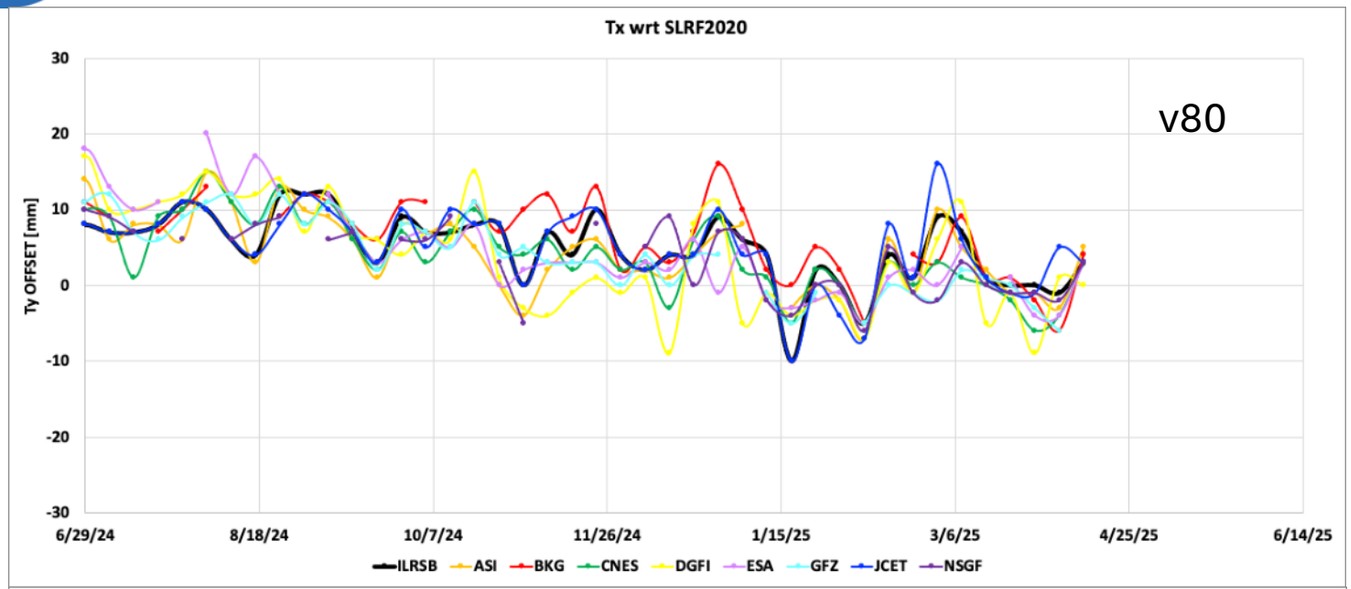
- **A number ILRS-B solutions had anomalous core WRMS: should have been re-run.**

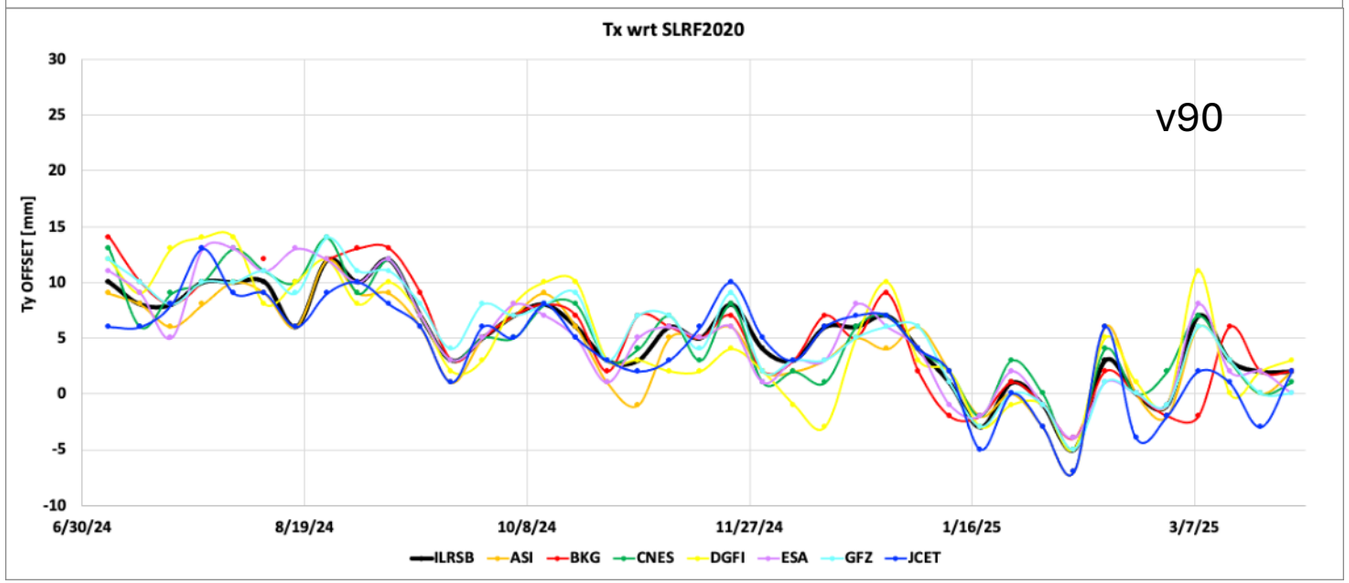
Other anomalies:

NGSF: **01/11/2025** (21.36 mm); **03/15/2025** (9.24 mm); **ESA**: **02/15/2025** (12.70 mm);



ILRSB Status: Tx. v80 vs. v90 (*since 7/1/2024*)



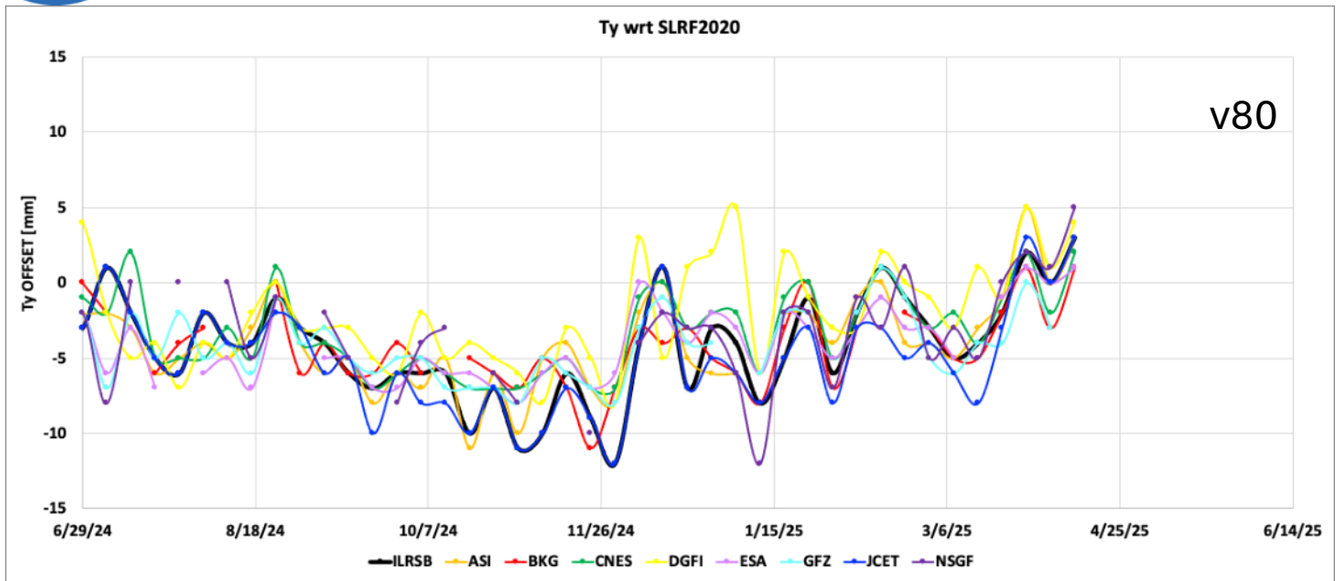


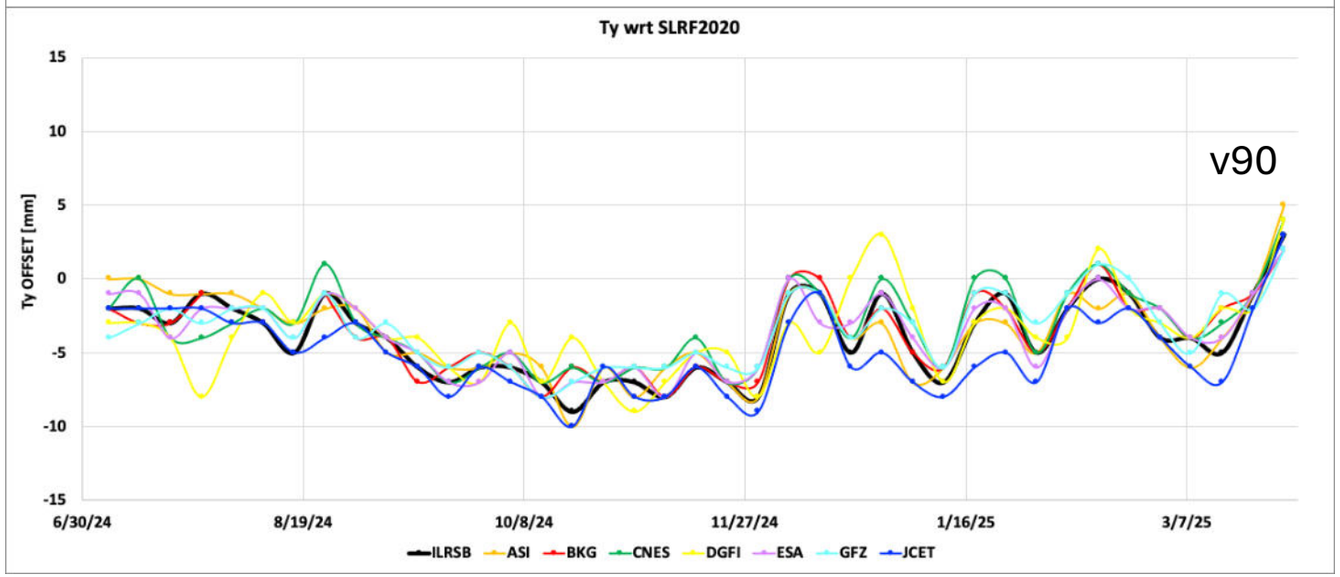
v80

AC	Mean ± StdDev
ILRSB	4.3±4.7
ASI	4.3±4.8
BKG	5.4±5.2
CNES	4.1±4.9
DGFI	3.7±6.6
ESA	4.0±5.8
GFZ	2.3±5.6
JCET	4.8±5.0
NSGF	3.1±4.7

AC	Mean ± StdDev
ILRSB	5.0±4.0
ASI	4.2±4.1
BKG	5.0±4.8
CNES	5.2±4.4
DGFI	4.9±5.2
ESA	5.1±4.6
GFZ	5.3±4.6
JCET	4.1±4.5

ILRSB Status: Ty. v80 vs. v90 (*since 7/1/2024*)



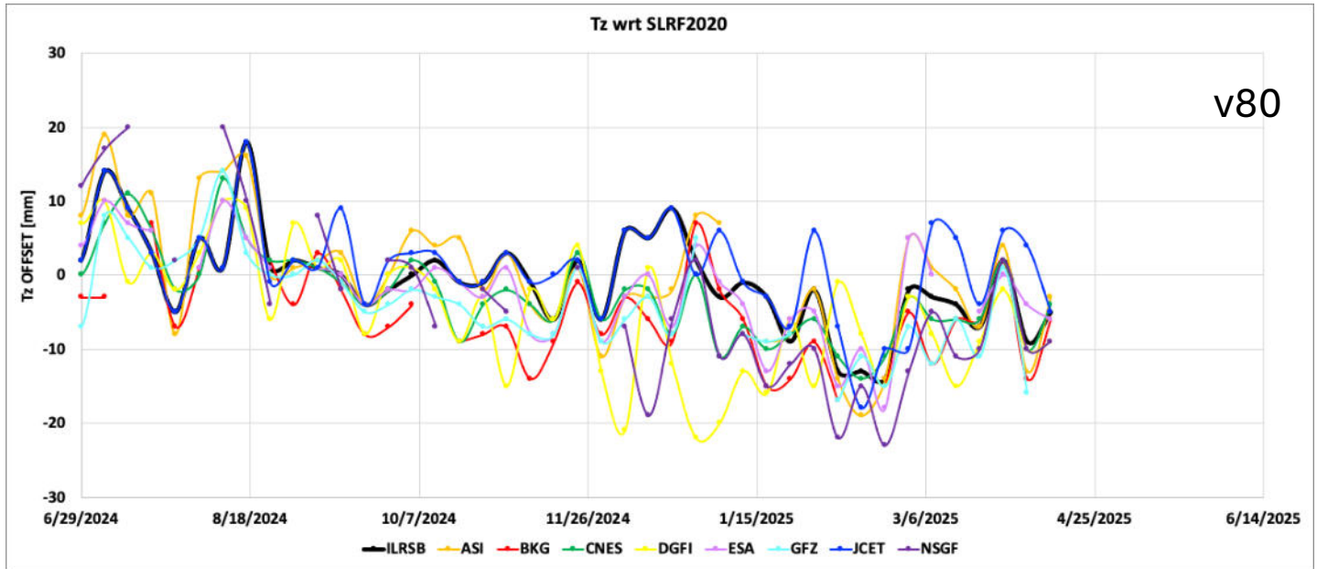


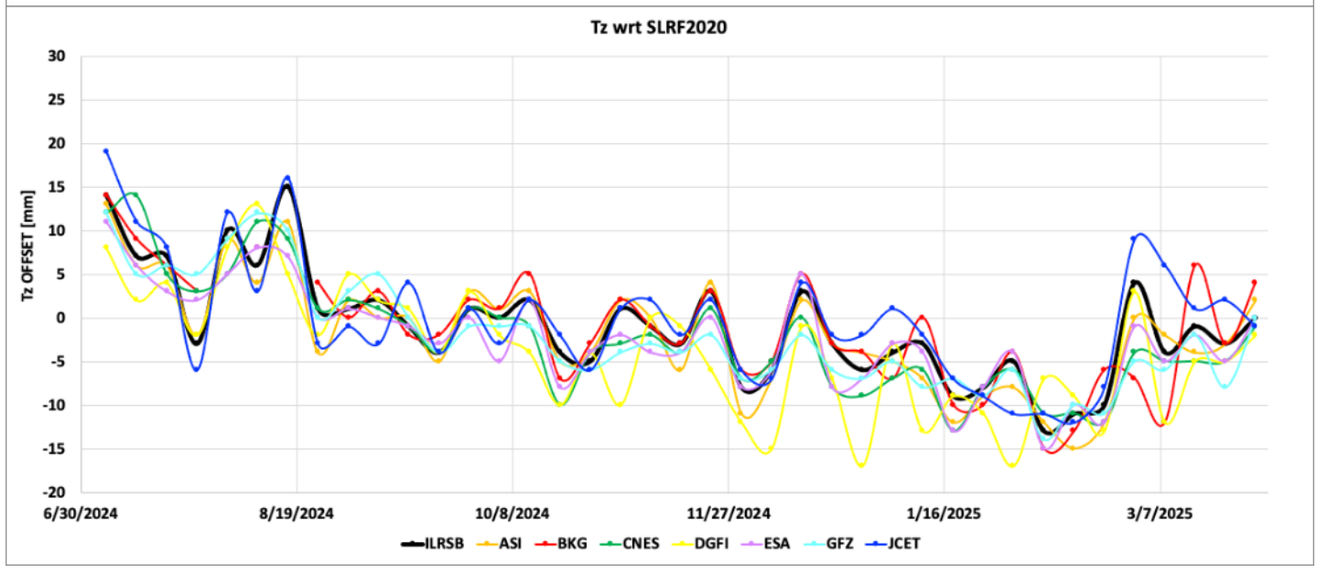
v80

AC	Mean ± StdDev
ILRSB	-4.3±3.1
ASI	-4.3±3.0
BKG	-5.1±2.8
CNES	-3.1±2.7
DGFI	-2.8±3.5
ESA	-4.4±2.5
GFZ	-4.3±2.1
JCET	-4.7±3.1
NSGF	-3.6±3.4

AC	Mean ± StdDev
ILRSB	-3.9±2.8
ASI	-3.6±2.9
BKG	-3.6±2.6
CNES	-3.1±2.7
DGFI	-3.6±2.9
ESA	-3.6±2.5
GFZ	-3.4±2.4
JCET	-4.9±2.7

ILRSB Status: Tz. v80 vs. v90 (*since 7/1/2024*)



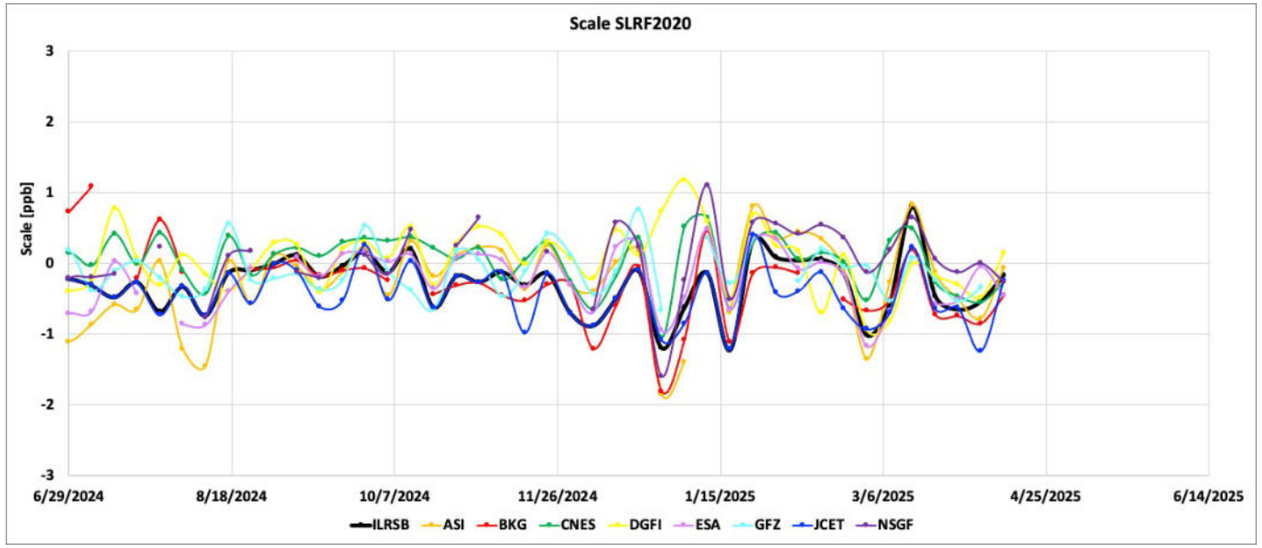


v80

AC	Mean ± StdDev
ILRSB	-0.5±6.3
ASI	1.5±8.3
BKG	-4.7±6.5
CNES	-2.1±5.9
DGFI	-0.7±10.2
ESA	-1.3±6.1
GFZ	-3.0±6.8
JCET	-0.1±6.5
NSGF	-0.6±10.9

AC	Mean ± StdDev
ILRSB	-1.0±6.3
ASI	-1.8±6.5
BKG	-1.3±6.5
CNES	-2.2±6.5
DGFI	-3.8±7.2
ESA	-2.4±5.8
GFZ	-2.1±6.3
JCET	-0.1±7.1

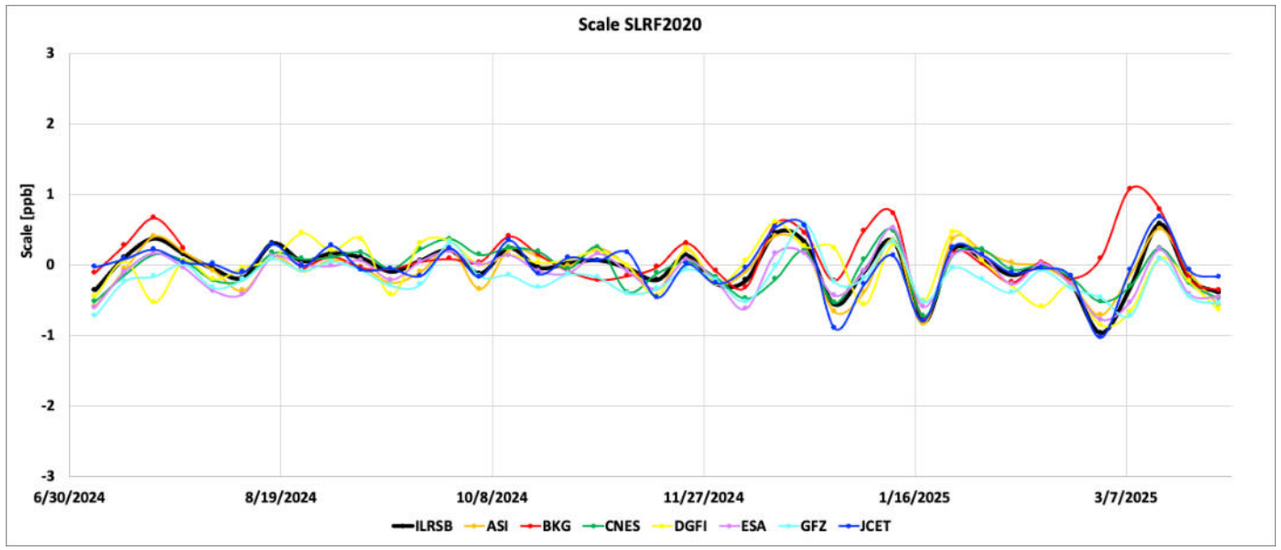
ILRSB Status: Scale. v80 vs. v90 (*since 7/1/2024*)



v80

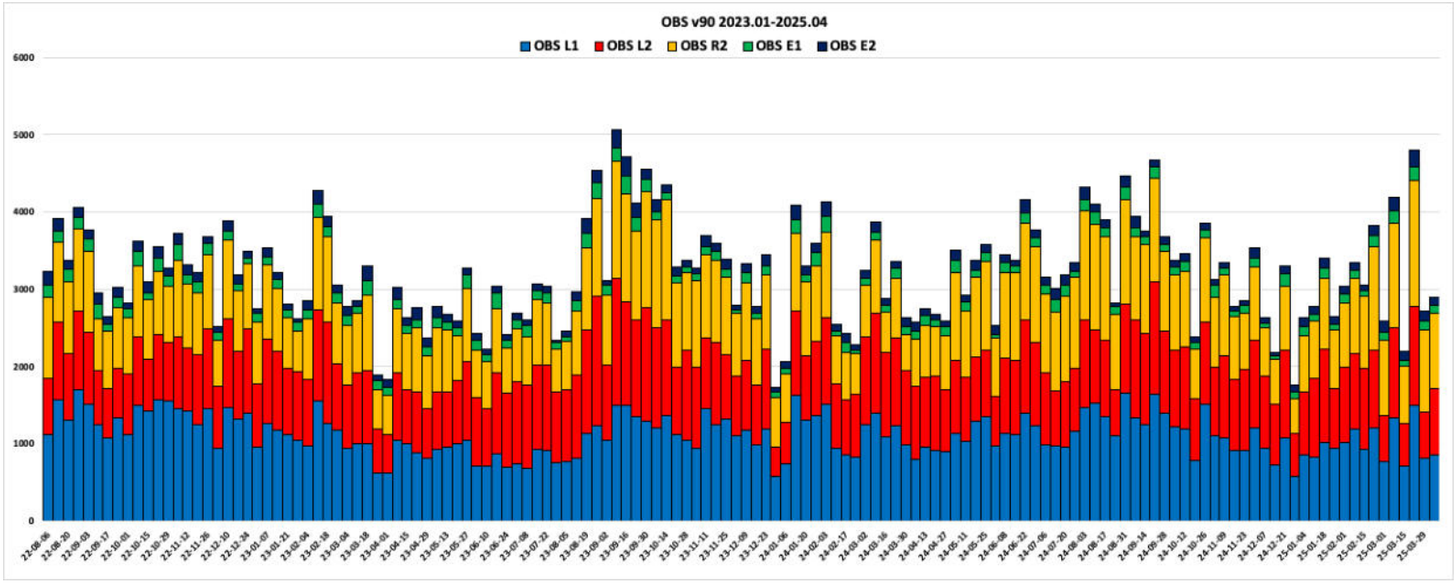
v80

AC	Mean ± StdDev
ILRSB	-0.4±0.4
ASI	-0.4±0.6
BKG	-0.4±0.5
CNES	0.0±0.4
DGFI	-0.2±0.6
ESA	-0.3±0.4
GFZ	-0.3±0.5
JCET	-0.5±0.4
NSGF	-0.1±0.5



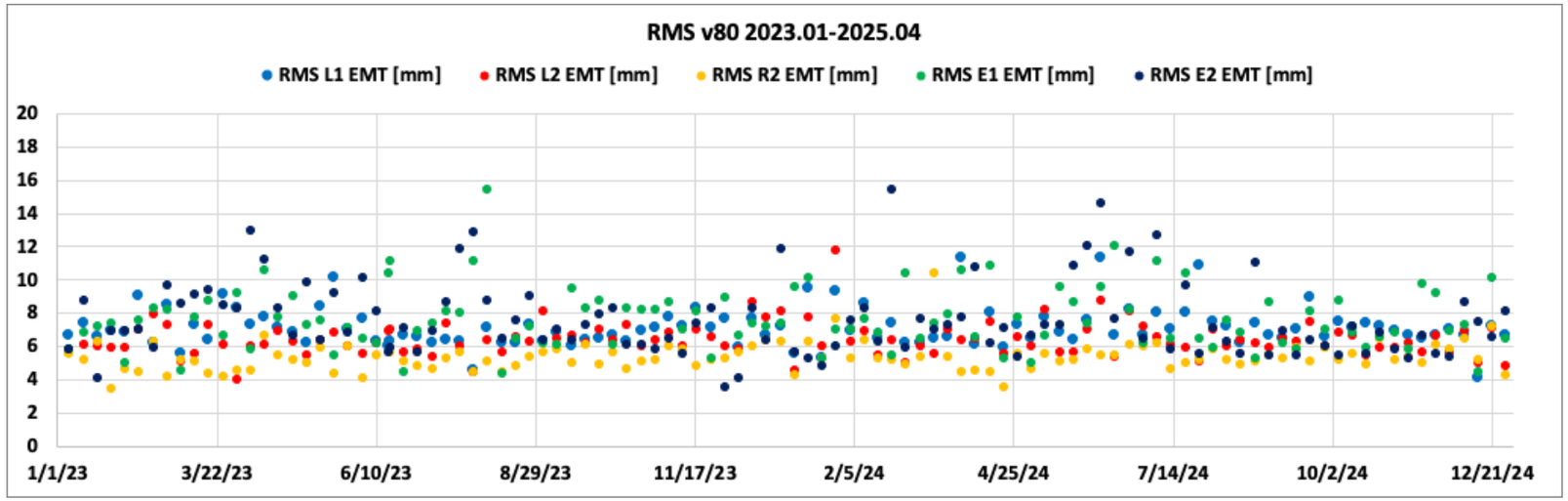
AC	Mean ± StdDev
ILRSB	0.0±0.3
ASI	-0.1±0.3
BKG	0.1±0.4
CNES	-0.1±0.3
DGFI	-0.1±0.4
ESA	-0.1±0.3
GFZ	-0.2±0.3
JCET	0.0±0.3

JCET/NASA v90 status



OBS	L1	L2	R2
Mean	1078	964	921
Total	127158	113786	108697

OBS	E1	E2
Mean	117	109
Total	13779	12842



<u>V90/V190 status:</u>

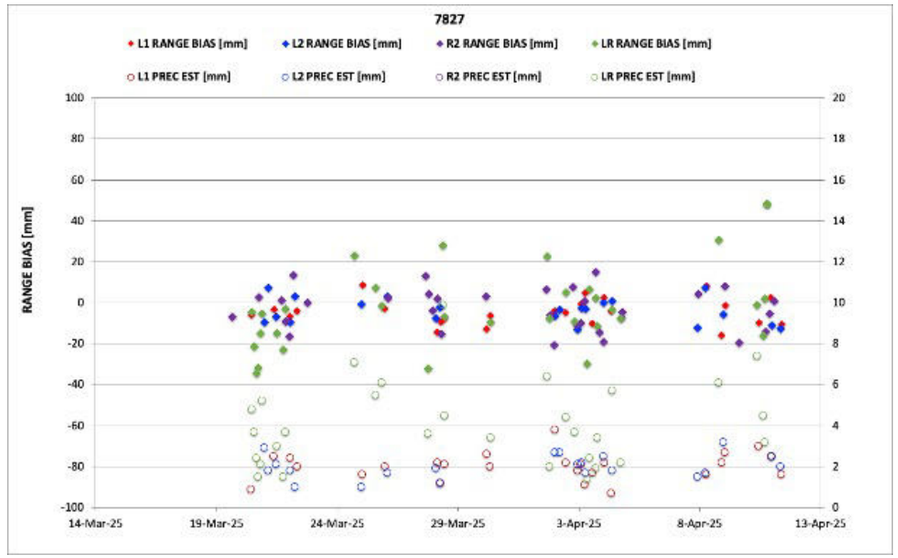
1. Made first pass through entire set of data (08/2022 – 04/2025) including LARES2 (v90) with new DHF.
2. Need to check implementation, as RMS of fit is higher than we expected.

Recent ILRS Station Validations (7827 & 7810)

Wettzell (SOSW, 7827)

	Station 7827 (Wettzell) (*data for March & April 2025*)		
Satellite	**Precision**	**Range bias**	**N passes***
LAGEOS-1	2.0 ± 0.7	-4.8 ± 6.6	25
LAGEOS-2	2.0 ± 0.6	-4.1 ± 6.3	21
LARES-2	2.9 ± 1.4	-3.1 ± 10.0	32
LARES	4.4 ± 2.8	-3.6 ± 19.3	31

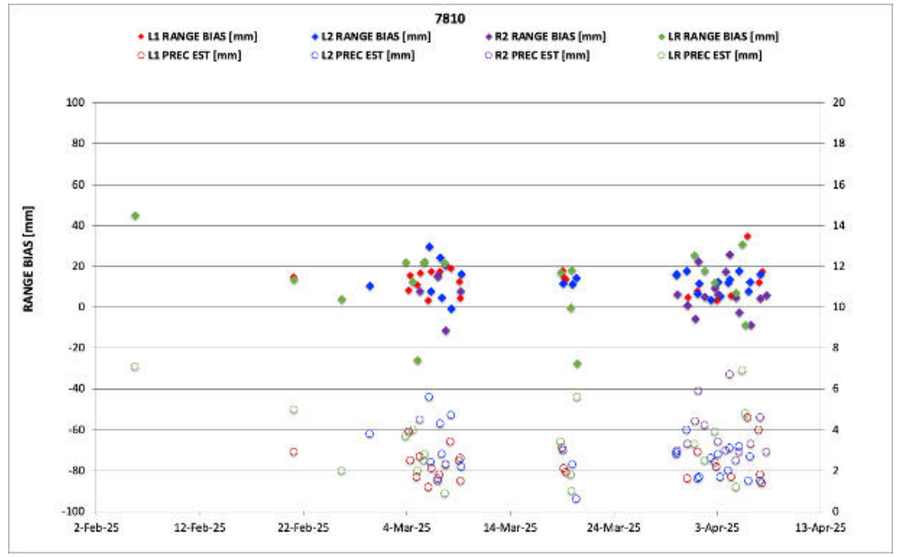
* Number of passes after editing, where we require passes to have 5 or normal points of unedited data.



Zimmerwald (ZIML, 7810)

	Station 7810 (*data for March & April 2025*)		
Satellite	**Precision**	**Range bias**	**N passes***
LAGEOS-1	2.4 ± 0.9	13.1 ± 7.1	22
LAGEOS-2	2.7 ± 1.1	12.4 ± 6.6	24
LARES-2	3.4 ± 1.3	7.3 ± 10.1	20
LARES	3.4 ± 1.8	12.0 ± 17.9	19

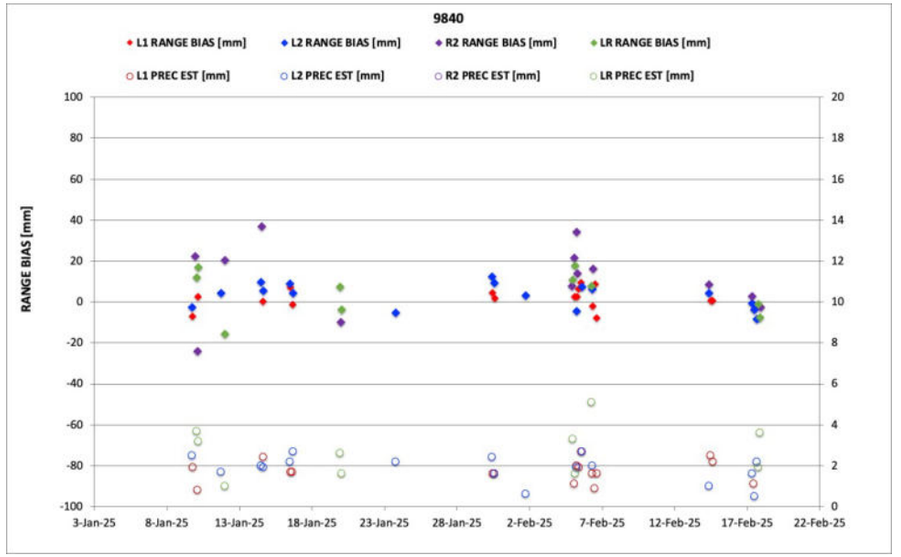
* Number of passes after editing, where we require passes to have 5 or normal points of unedited data.



Recent ILRS Station Validations: Herstmonceux, *new laser*

Herstmonceux
New laser “9840” (Jan-Feb 2025)

	New Laser	
Satellite	**Precision**	**Range bias**
LAGEOS-1	1.7 ± 0.5	2.2 ± 5.4
LAGEOS-2	1.9 ± 0.7	3.9 ± 6.1
LARES-2	4.4 ± 1.7	9.9 ± 16.0
LARES	2.9 ± 1.5	3.4 ± 11.2



Herstmonceux
Old laser “7840” (2024 data)

Old Laser (2024)		
Precision	**Range bias**	**N passes**
2.0 ± 0.9	-3.7 ± 9.5	382
2.0 ± 0.9	-2.7 ± 10.3	236
2.4 ± 1.4	-5.8 ± 12.7	341
3.4 ± 2.2	-5.2 ± 18.8	255

Adjustment of Coordinates for TKBL “pre240101”

TKBL Coordinates from L1, L2, Lares, Lares-2 estimations (pre-240101)

Iteration	Solutions (Epoch 2015.0)	X (m)	Y (m)	Z (m)	Δ from a priori X (m)	Δ from a priori Y(m)	Δ from a priori Z (m)	Δ from a priori lat (s)	Δ from a priori lon(s)	Δ from a priori h (m)
1	**SLRF2020 a priori, pre-240101**	-3961640.9245	3308774.6771	3734291.4734	-	-	-	-	-	-
1	L1+L2	-3961640.9264	3308774.4967	3734291.4757	-0.0019	-0.1804	0.0023	0.0022	0.0056	-0.0910
1	L1+L2+Lares2	-3961640.9278	3308774.4994	3734291.4753	-0.0033	-0.1777	0.0019	0.0022	0.0055	-0.0889
1	L1+L2+Lares2+Lares	-3961640.9263	3308774.4937	3734291.4746	-0.0018	-0.1834	0.0022	0.0057	0.0056	-0.0932
1	J3+S6A	-3961640.9192	3308774.4694	3734291.4845	0.0053	-0.2077	0.0111	0.0029	0.0062	-0.1044
2	**JAXA2022 a priori**	-3961640.9446	3308774.4052	3734291.4970	-	-	-	-	-	-
2	L1+L2+Lares2	-3961640.9323	3308774.4848	3734291.4914	0.0123	0.0796	-0.0056	-0.0009	-0.0028	0.0304
2	L1+L2+Lares2+Lares	-3961640.9305	3308774.4781	3734291.4774	0.0141	0.0730	-0.0196	-0.0012	-0.0026	0.0175
3	**L1+L2+Lares2+Lares A priori (from Iteration 2)**	**-3961640.9305**	**3308774.4781**	**3734291.4774**	-	-	-	-	-	-

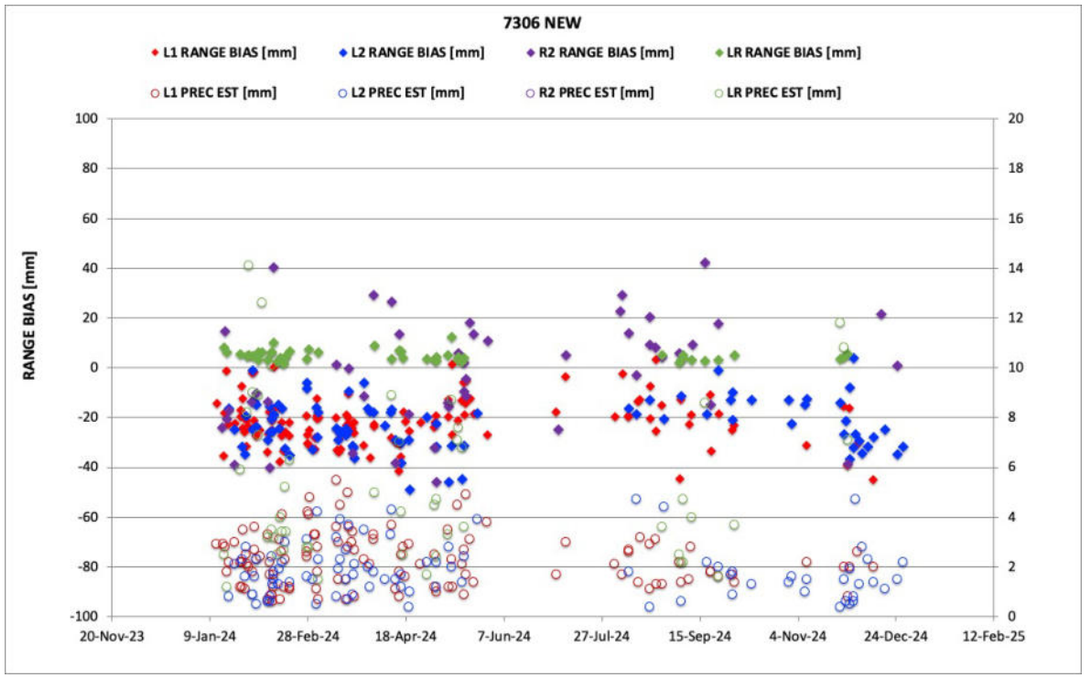
Adjustment of Coordinates for TKBL “post240101”

TKBL Coordinates from L1, L2, Lares, Lares-2 estimations (post-240101)

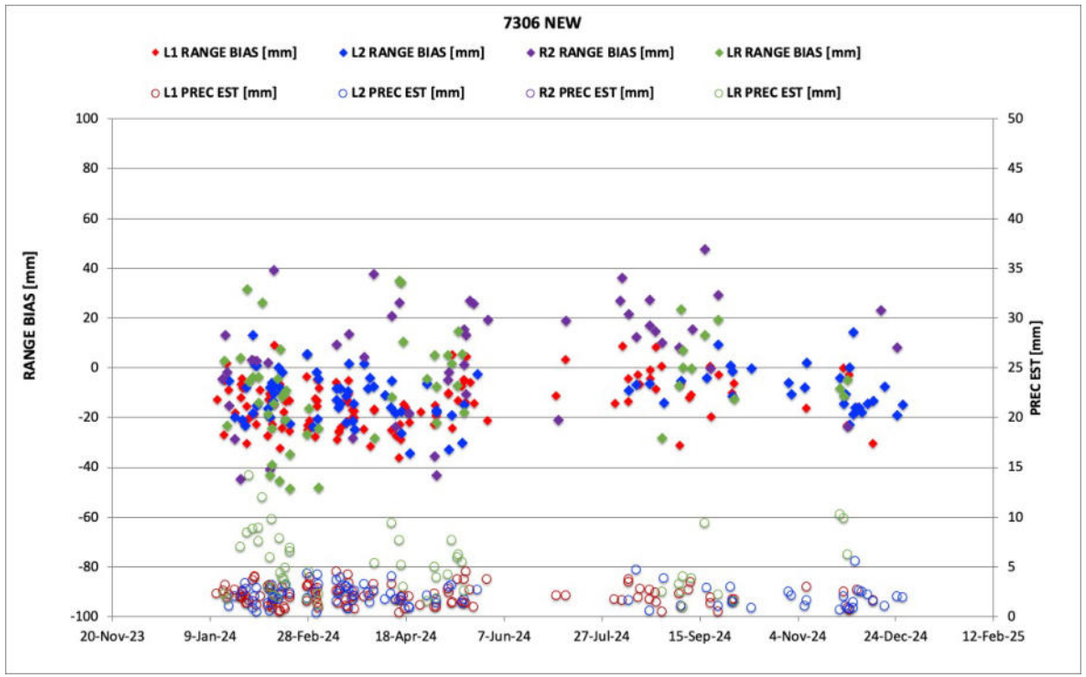
Iteration	Solutions (Epoch 2015.0)	X (m)	Y (m)	Z (m)	Δ from a priori X (m)	Δ from a priori Y(m)	Δ from a priori Z (m)	Δ from a priori lat (s)	Δ from a priori lon(s)	Δ from a priori h (m)
1	**SLRF2020, post-240101**	**-3961640.9321**	**3308774.3897**	**3734291.5058**	-	-	-	-	-	-
1	L1+L2	-3961640.9275	3308774.4808	3734291.4880	0.0046	0.0911	-0.0178	-0.0015	-0.0029	0.0339
1	L1+L2+Lares2	-3961640.9283	3308774.4808	3734291.4897	0.0038	0.0911	-0.0161	-0.0015	-0.0029	0.0353
1	L1+L2+Lares2+ Lares	-3961640.9275	3308774.4773	3734291.4936	0.0046	0.0877	-0.0122	-0.0013	-0.0028	0.0354
2	**JAXA2022 a priori**	**-3961640.9446**	**3308774.4052**	**3734291.4970**	-	-	-	-	-	-
2	L1+L2+Lares2	-3961640.9323	3308774.4848	3734291.4914	0.0123	0.0796	-0.0056	-0.0009	-0.0028	0.0304
2	L1+L2+Lares2+Lares	-3961640.9367	3308774.4951	3734291.4960	0.0079	0.0899	-0.0010	-0.0010	-0.0030	0.0411
3	**L1+L2+Lares2+ Lares A priori (from Iteration 2)**	**-3961640.9367**	**3308774.4951**	**3734291.4960**	-	-	-	-	-	-

Validation tests for TKBL New coordinates (2024)

Using “Iteration-1 L1+L2+LR2” coordinates



Using Jaxa2022 coordinates



Ignore green dots in above figure

ADDENDUM

Test of TKBL coordinates (2023-2025) [L1+L2+Lares+Lares-2, Iteration-2)

Year	Satellite	Station	Narcs	Total Obs	Avg. RMS (cm)	Std. Dev. (cm)	Avg. Mbias (cm)	Std. dev Mbias (cm)
2023	J3	TKBL-532	13	222	0.27	0.32	-0.15	0.457
2024	J3	TKBL-532	25	801	0.49	0.47	1.03	1.280
2025	J3	TKBL-532	8	495	0.44	0.44	0.09	1.047
2023	S6A	TKBL-532	16	360	0.23	0.12	-0.74	0.58
2024	S6A	TKBL-532	28	958	0.55	0.56	0.98	2.069
2023	LS2	TKBL-532	20	258	0.28	0.28	-0.36	1.013
2024	LS2	TKBL-532	35	383	0.27	0.24	0.13	0.89
2025	LS2	TKBL-532	7	215	0.57	0.45	0.25	0.81

NSGF Analysis Center report

Update on current NSGF activities

Personnel:

- 90% Andreja Susnik – lead of the NSGF AC, main developer of SATAN software, responsible for operational products (v80, v180, v280), reprocessing, test solutions (v90, v320), predictions etc.…
- 10% Graham Appleby, Jose Rodriguez - scientific and technical support

Future outlook:

Urgent – resubmission of v90 solution

– submission of v190 solution

– fixing any other problems that I am not aware of yet….

Update on current NSGF activities

Future outlook:

- Short term?
- Long term – LARES incorporation into software (we have it, but we have a problem with estimation of gravity field coefficients)

  – incorporation of other geodetic satellites into operational version

Achievements:

- Stanford counters – tables/corrections and subroutine for treating them properly is ready to be shared with other AC's

  – Opens the relevant Stanford correction file based on station number. Filenames of form timer_xxxx.dat. File has mjd span of corrections and range (ms) and corresponding Stanford correction (ps)

Status reports of SLR ACs and CCs

- Does the current setup of the ASC meet the needs of the ILRS and other users?
- Product portfolio:
  - v180/v190 (ILRSA, 1-day latency) used by USNO for BulletinA computation
  - v80/v90 (9-day latency) used ASC-internally for monitoring of stations (valuable for ITRF updates!)
  - v80/v90 orbits (9-day latency) : not clear who uses them
  - v280/v320 (9-day latency) used ASC-internally for DHF updates
  - (NSGF, DGFI, ESA compute predictions which are used by stations to track satellites)
- Do we need other ACs to gain expertise in POD (non-spherical sat.)
- Global coverage of ASC not good (4x Germany, 3x other Europe, 1x USA) → advertise participation? Asia?

Today's [draft] agenda

0)	Last meeting + open Action Items (AIs)	(MB)	10 minutes
1)	Status reports of SLR ACs and CCs	(all)	90 minutes
2)	**LARES-2 as 5th satellite in ILRS ASC operational products**	**(AB, DS, MB)**	**20 minutes**
3)	Fundamental ILRS files for the SLR analysis	(MB)	10 minutes
4)	LARES and the SH pilot project	(MB)	15 minutes
5)	ESA's Genesis mission	(MB)	10 minutes
6)	ILRS core stations	(MB, tbd)	10 minutes
7)	Publications (of the ILRS ASC)	(MB, CL, DS)	10 minutes
8)	AOB and next ASC meeting	(MB)	5 minutes

LARES-2 as 5th sat. in ILRS ASC operational products

- cf. slides by DS et al., at EGU and ILRSA

LARES-2 as 5th satellite in the ILRS operational products

Verification of LARES-2 impact

A test comparison v280/v320 for LAGEOS-1, data starting from 2022-08-03, was set to check the impact of LARES-2 introduction.

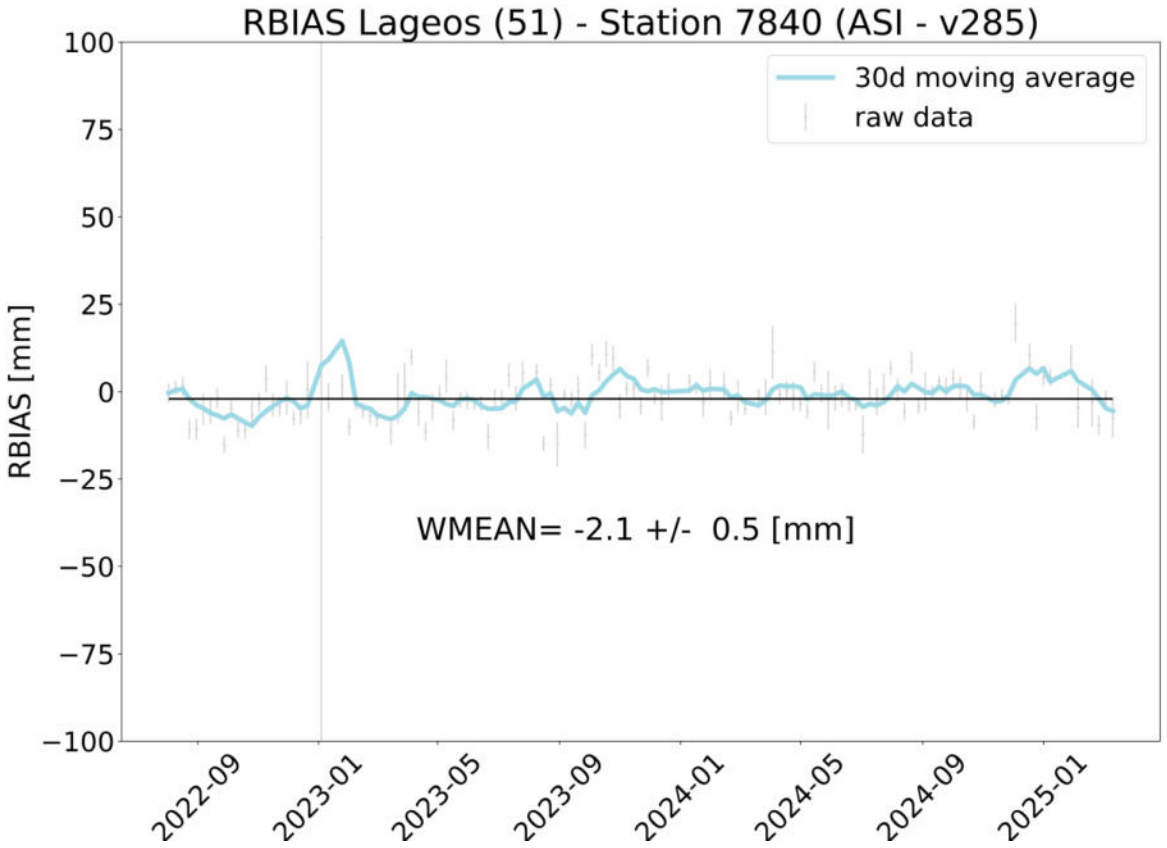
Difference in input data v280/v320:

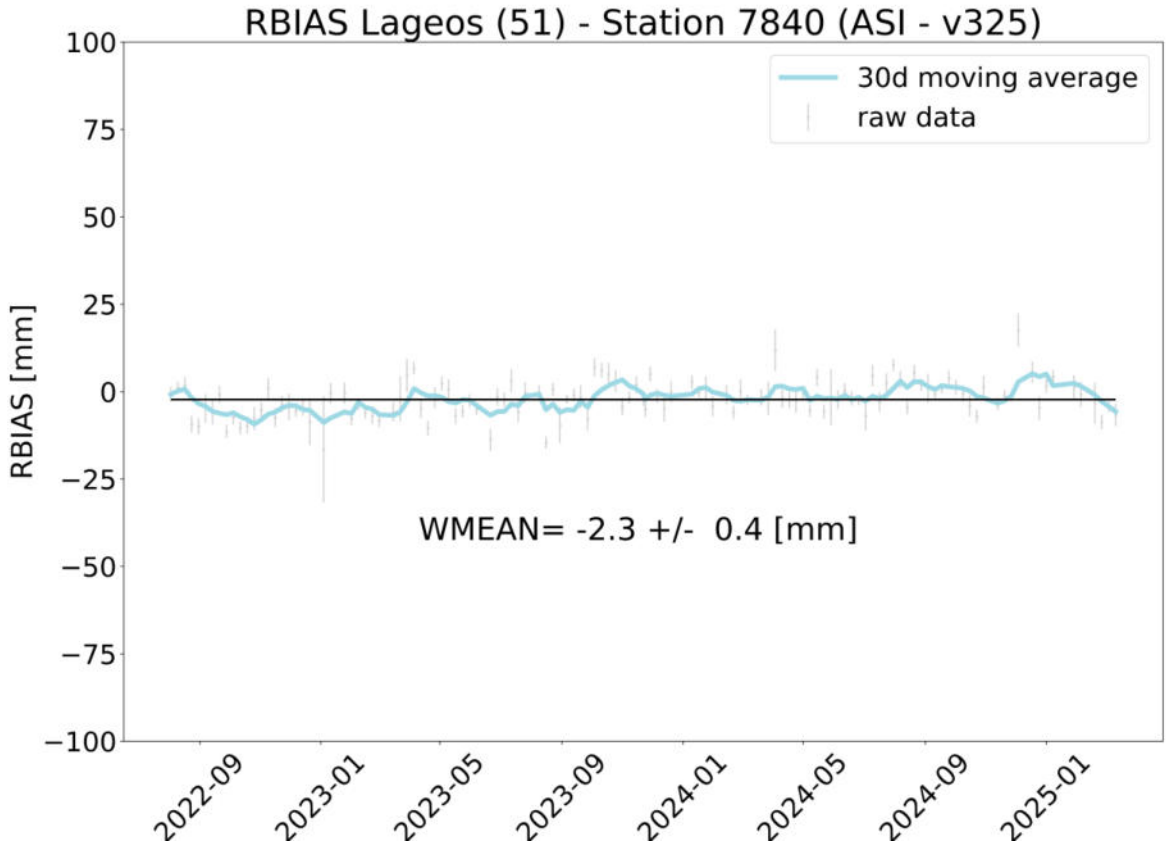
- v320 product was entirely reprocessed (last delivery 13.03.2025) with the most recent version of SLRF+DHF
- v280 operative from 03.2024

- CNES from SINEX 240427 in v280
- CNES from SINEX 220806 in v320

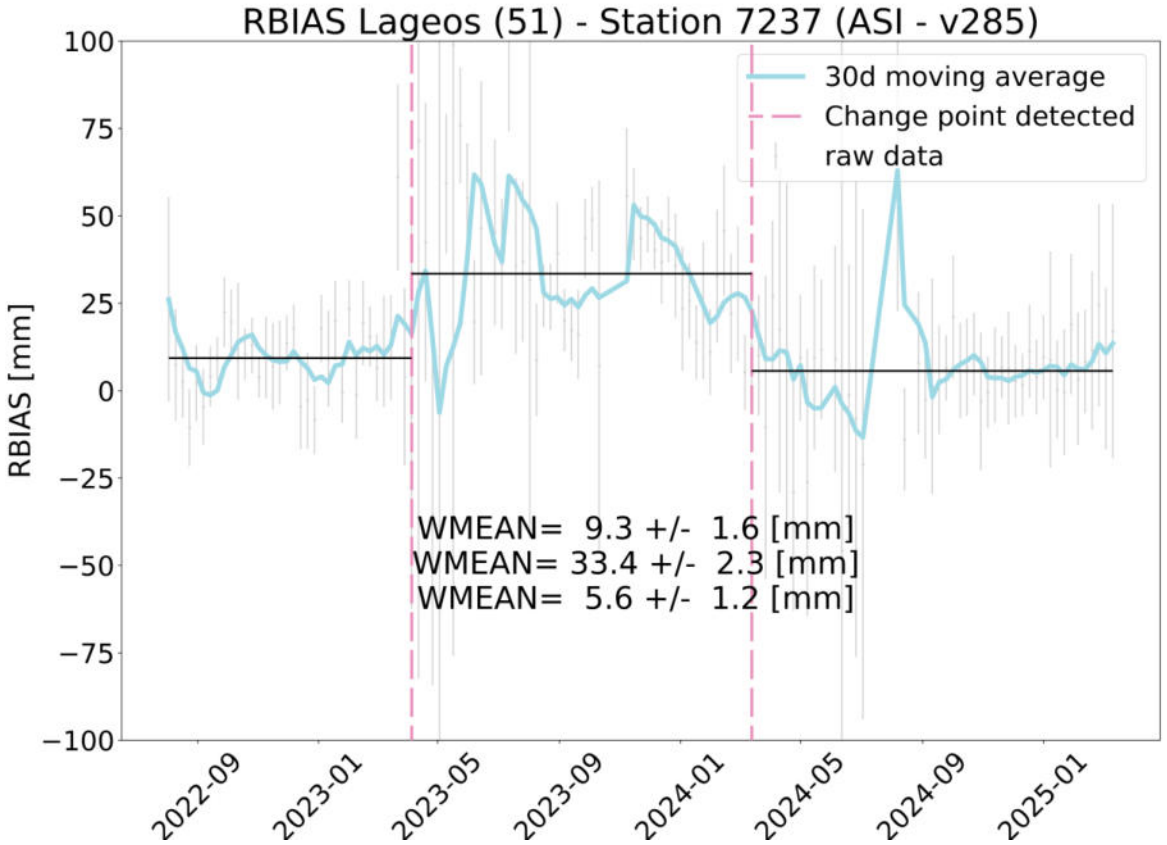
Verification of LARES-2 impact

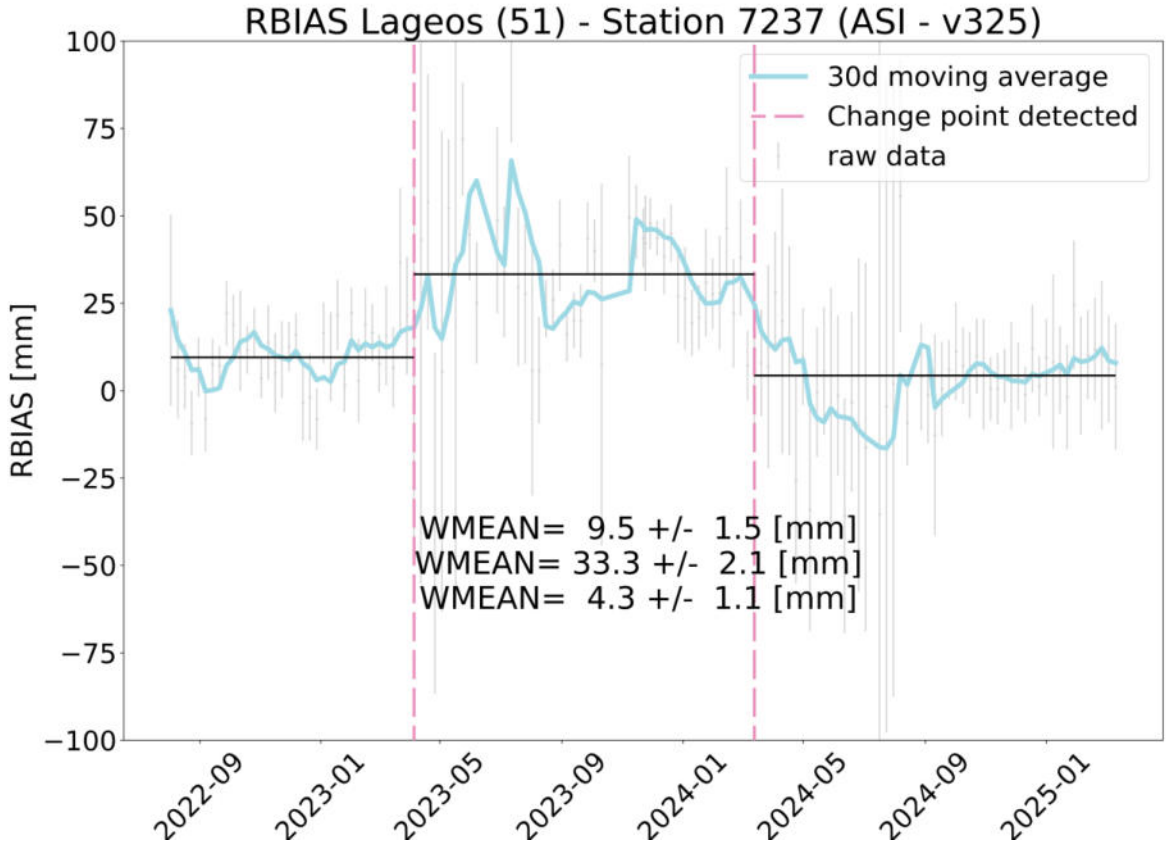
An internal verification was performed reprocessing a **v285 (v280-like)** and a **v325 (v320-like)** considering the same dataset (since v280, being an operational product, may not include some data despite the 10-days delay).



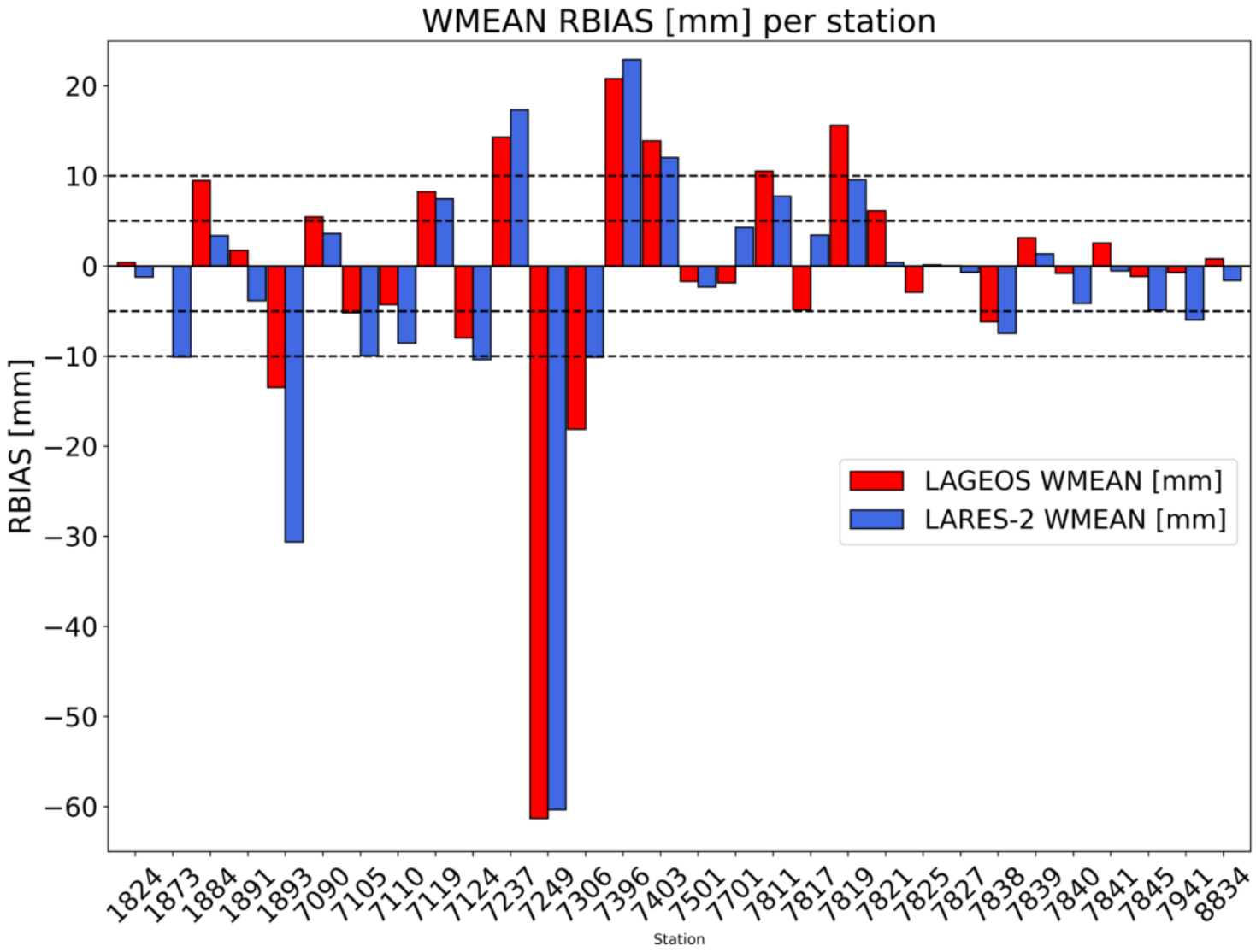


Verification of LARES-2 impact

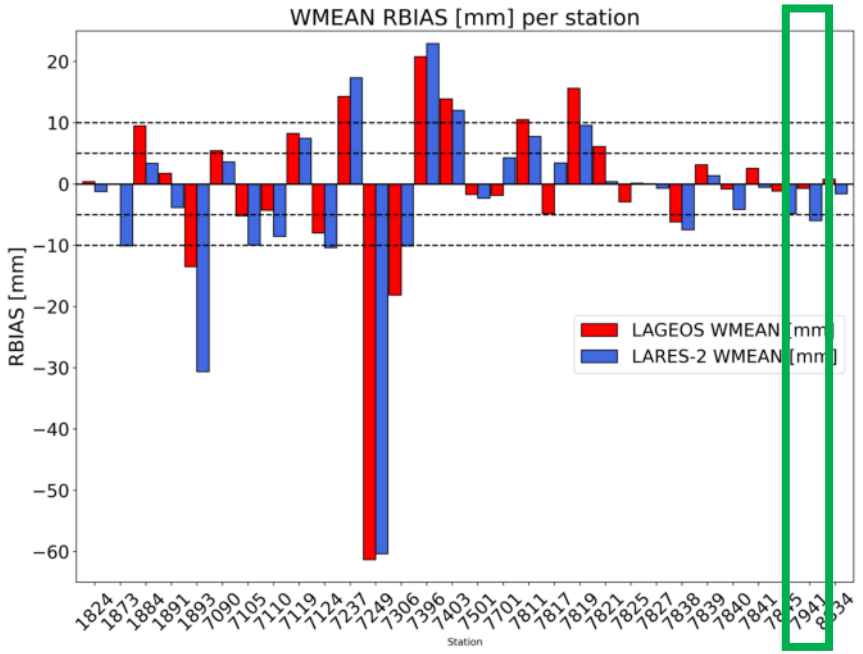




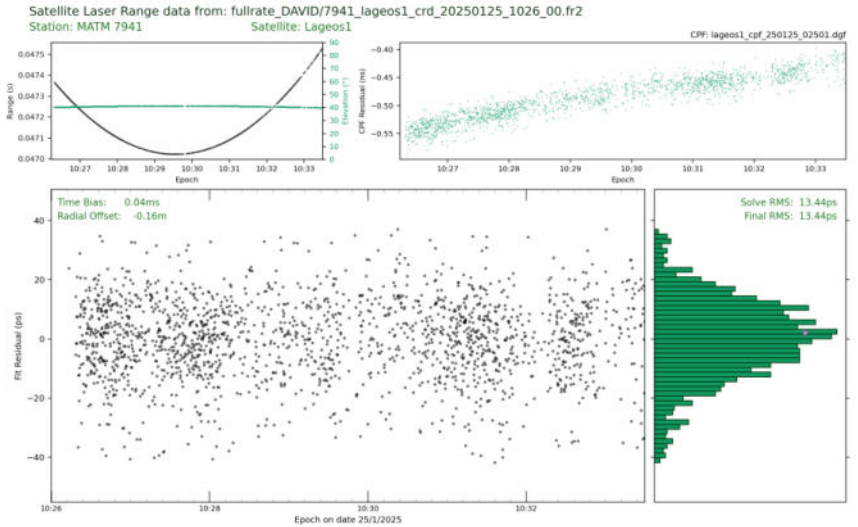
Determination of long-term rbias for LARES-2



Determination of long-term rbias for LARES-2



Very first investigation for 7941 (Matera)



1 Month of Fullrate data (January 2025)

- Station (7941) Fullrate RMS: comparable with Lageos
- RX energy: comparable with Lageos
- Skewness & Kurtosis: negligible differences with Lageos

Going to involve QCB to investigate

Determination of long-term rbias for LARES-2

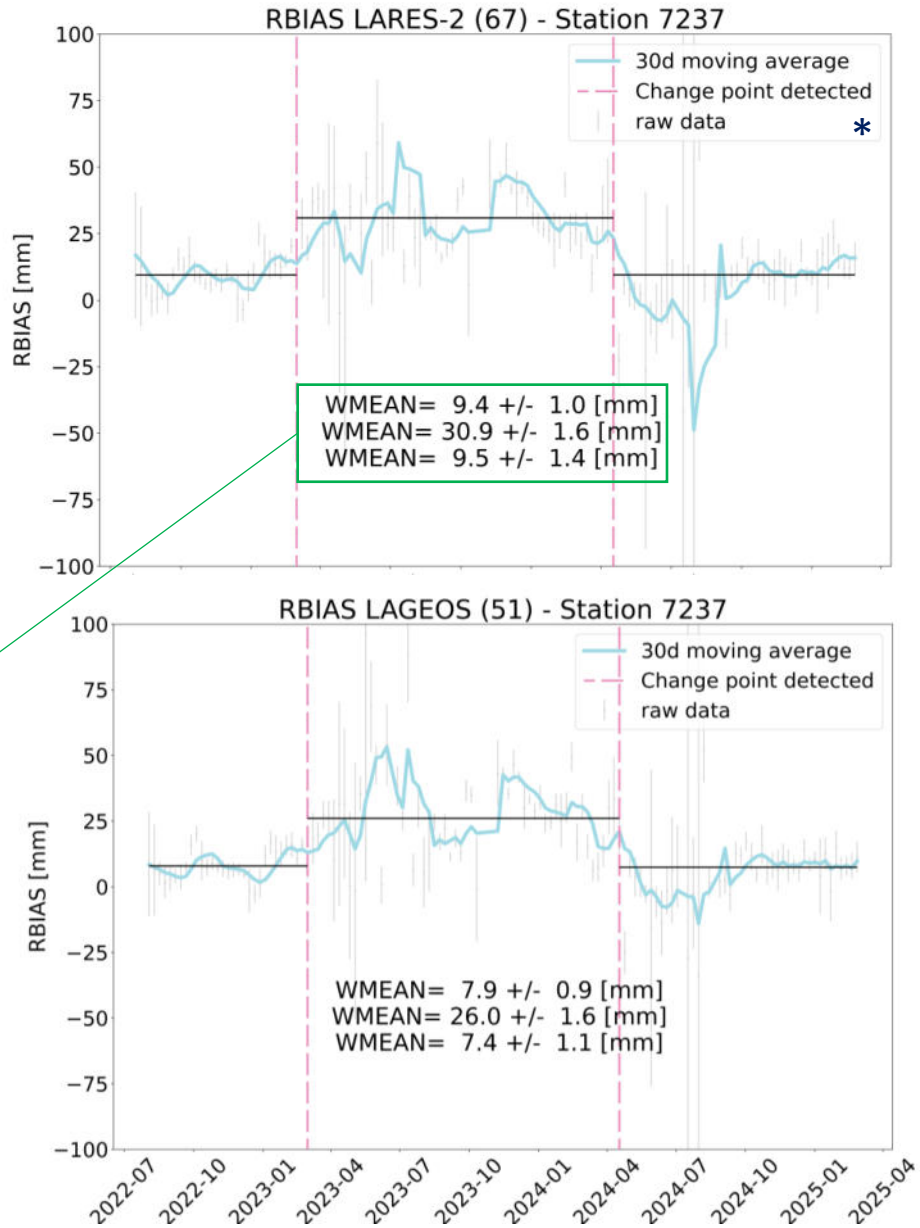
- **Range Bias Estimation**

Example for **7237 station**:

- 9.4 mm before first discontinuity
- 30.9 mm after first discontinuity
- 9.5 mm after second discontinuity

Data Handling File Extract:

```
.....
7237 67  501 A 24:105:00000 00:000:00000 R      9.5    1.4          mm
7237 67  501 A 23:064:00000 24:105:00000 R     30.9     1.6          mm
7237 67  501 A 22:212:00000 23:064:00000 R      9.4    1.0          mm
.....
```



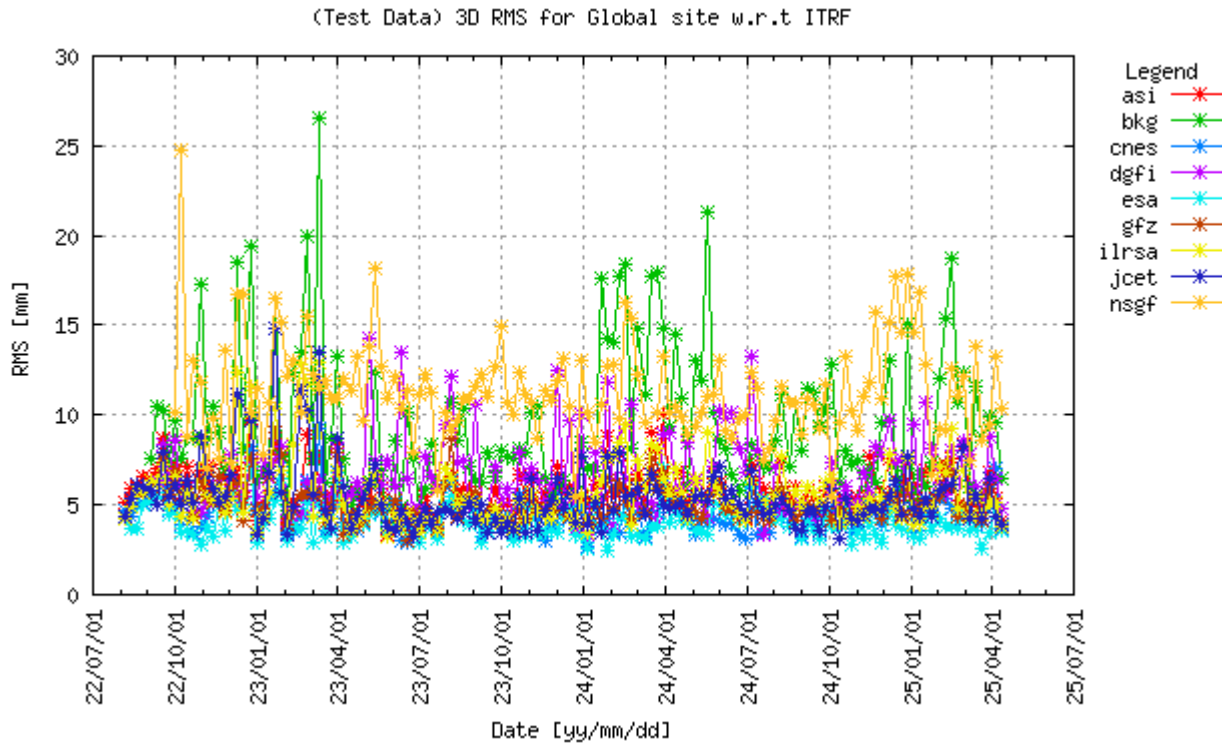
*using an automatic Algorithm for break identification

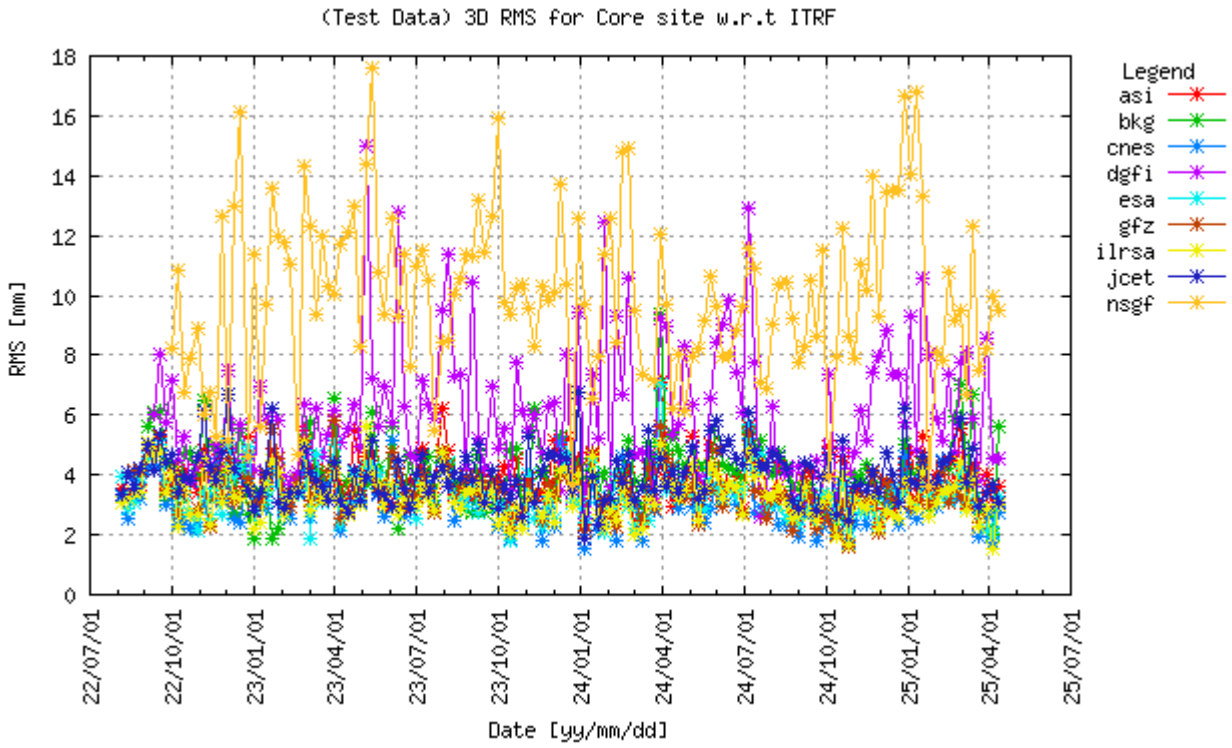
v90/v190 Submission Status

Analysis Center	V90 [2022-2025]	v190 [from 01/01/2024]
ASI	✓	✓
CNES	✓	✓
BKG	✓	✗
DGFI	✓	✓
ESA	✓	✓
GFZ	✓	✗
JCET	✓	✗
NSGF	✓ (waiting new version) [Next slides]	✗

-

v90 Submission Status

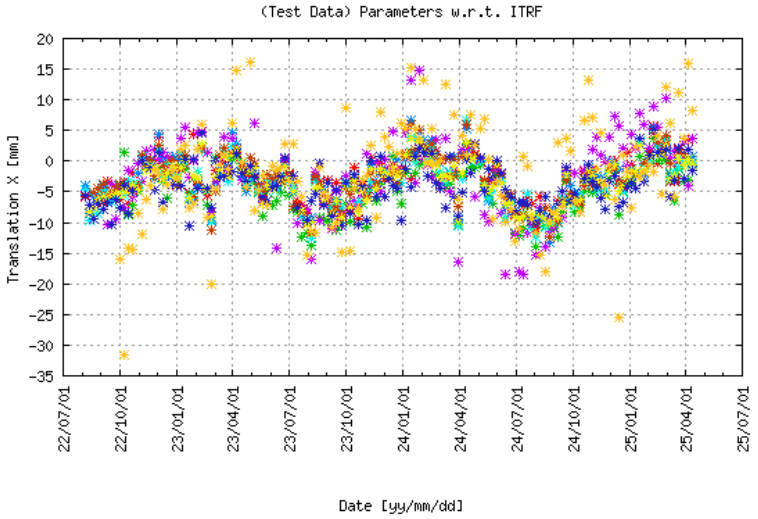


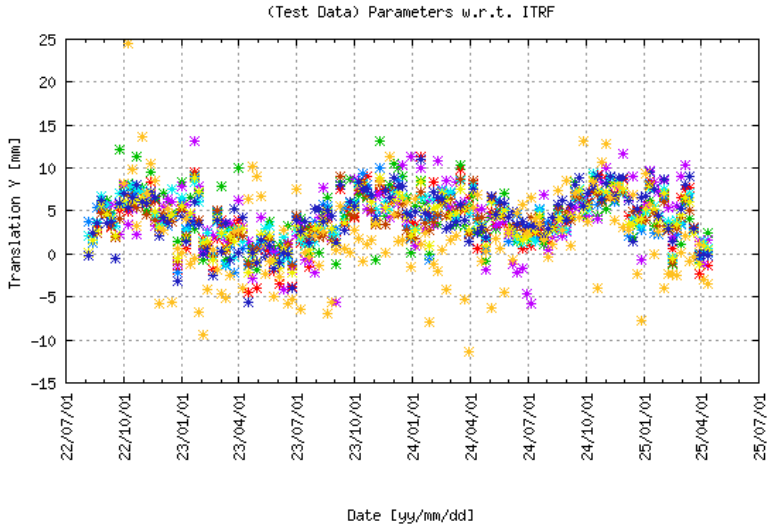


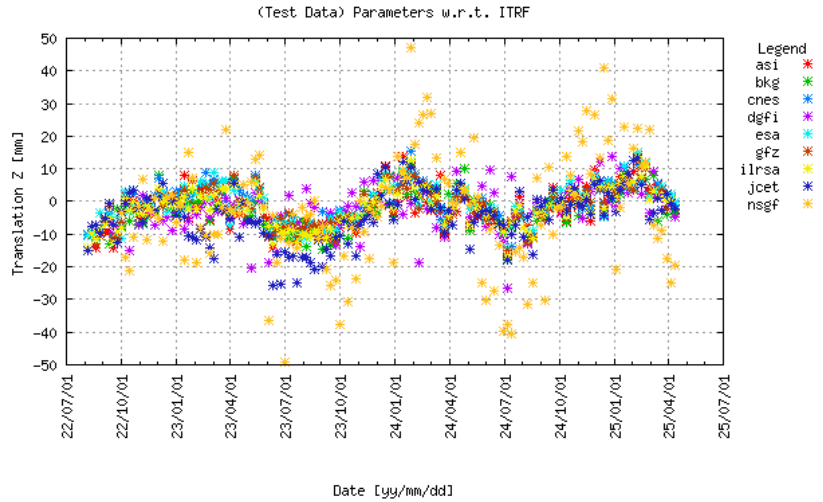
NSGF: very high values

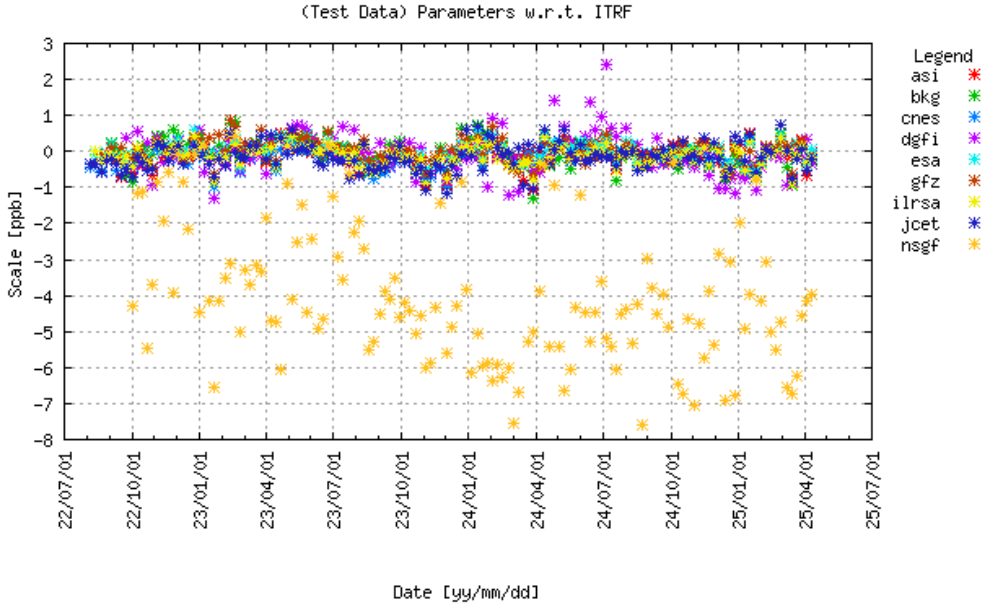
DGFI: higher values w.r.t. to other AC (core values similar to global ones)

v90 Submission Status







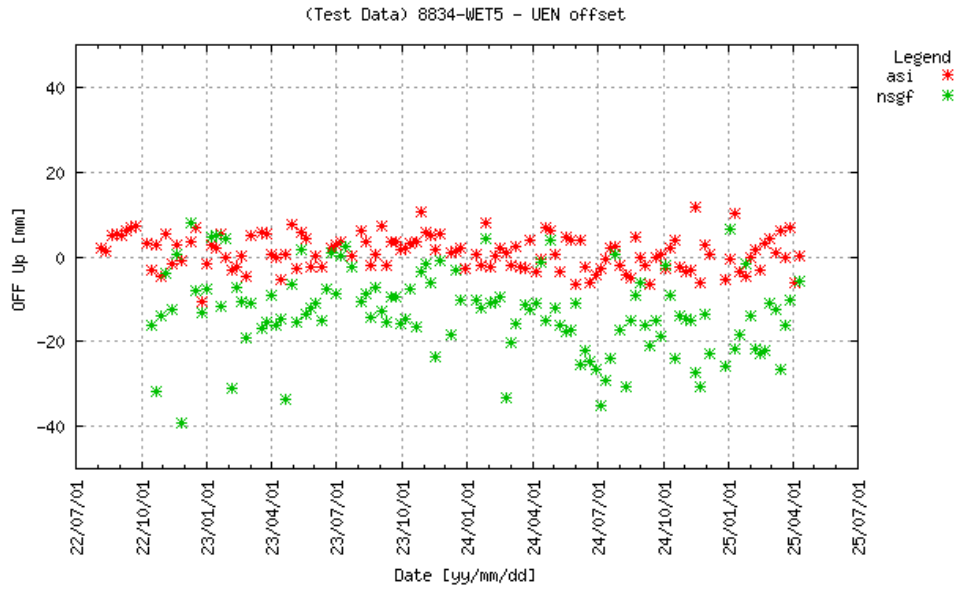


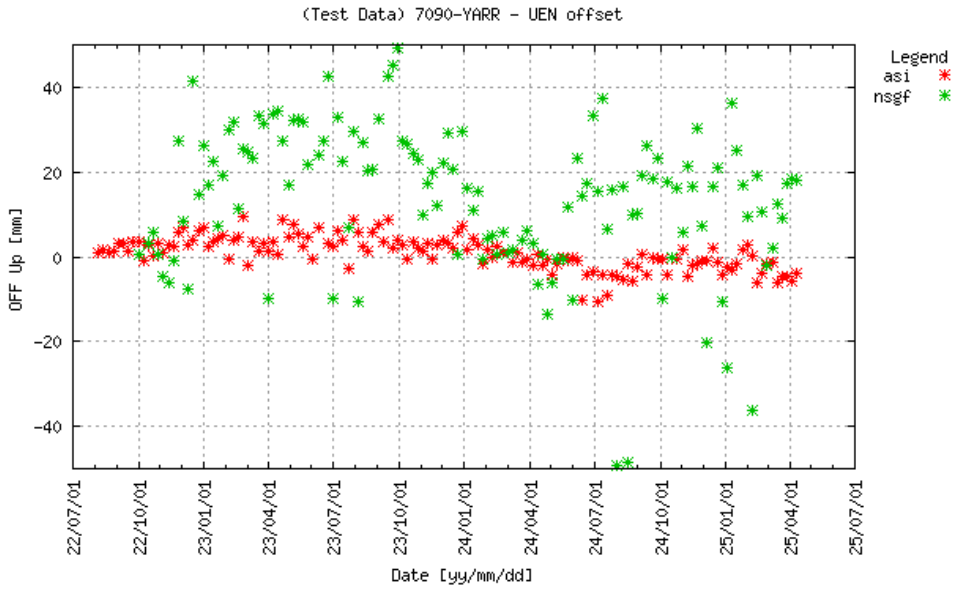
NSGF

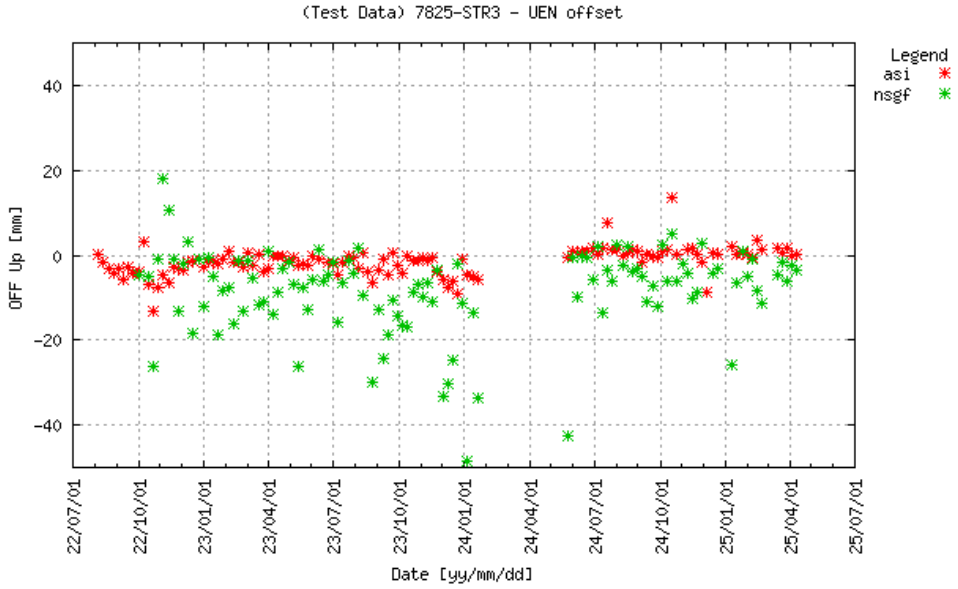
- Geocenter: higher oscillation very high value w.r.t. ACs and ILRSA

- Scale: very higher (absolute) values w.r.t. ACs and ILRSA

v90/v190 Submission Status



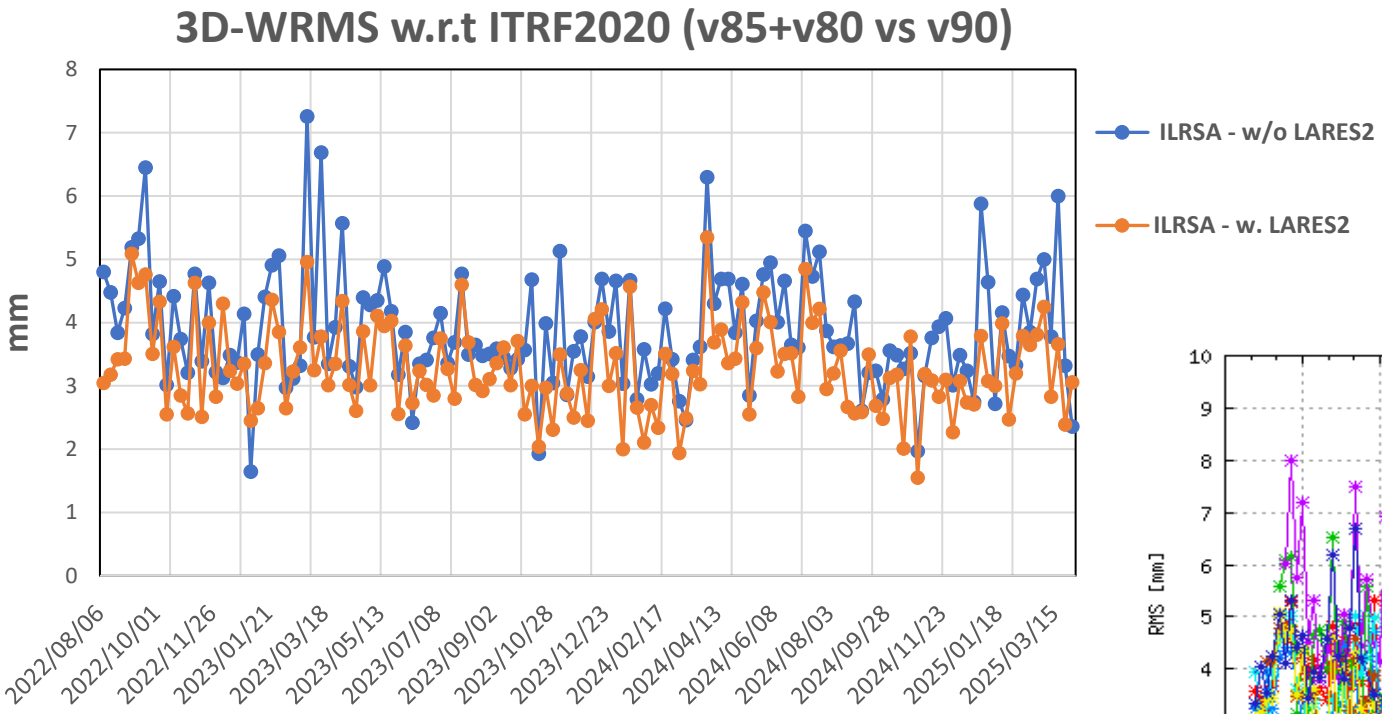


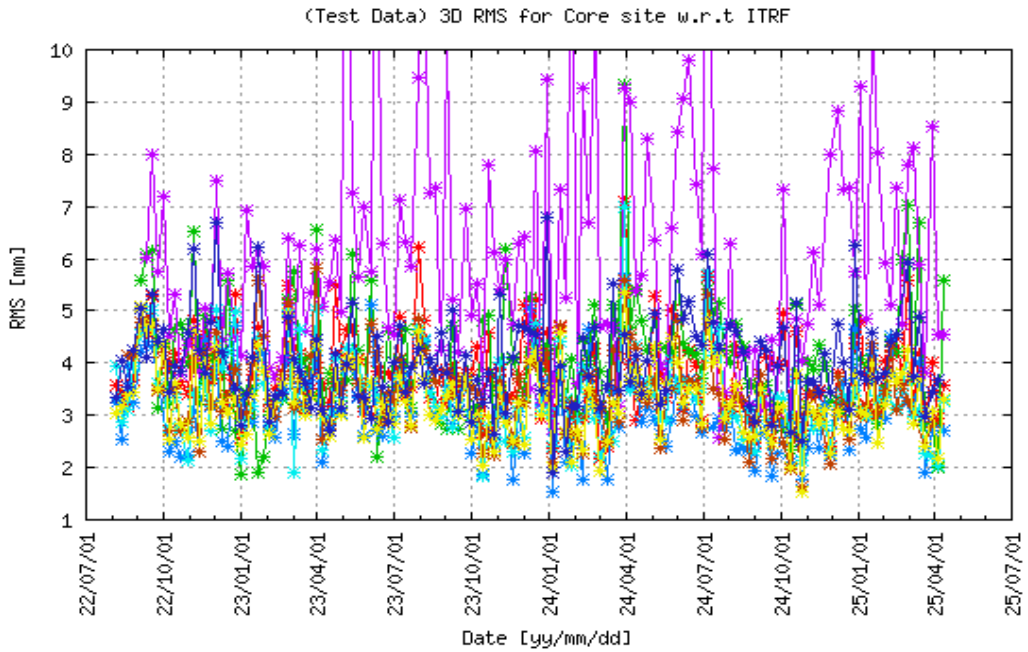


NSGF: Impact on UP components.

Example for 8834/7090/7825

LARES-2 Analysis *

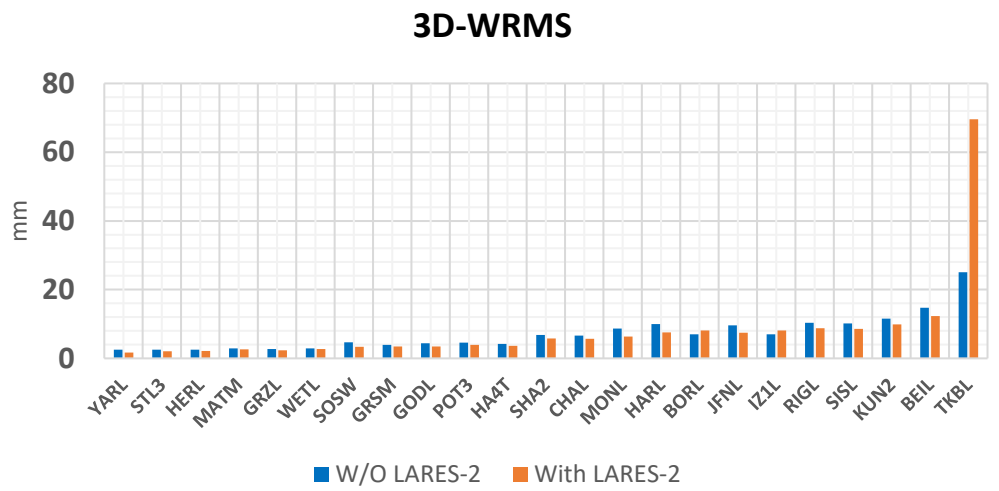


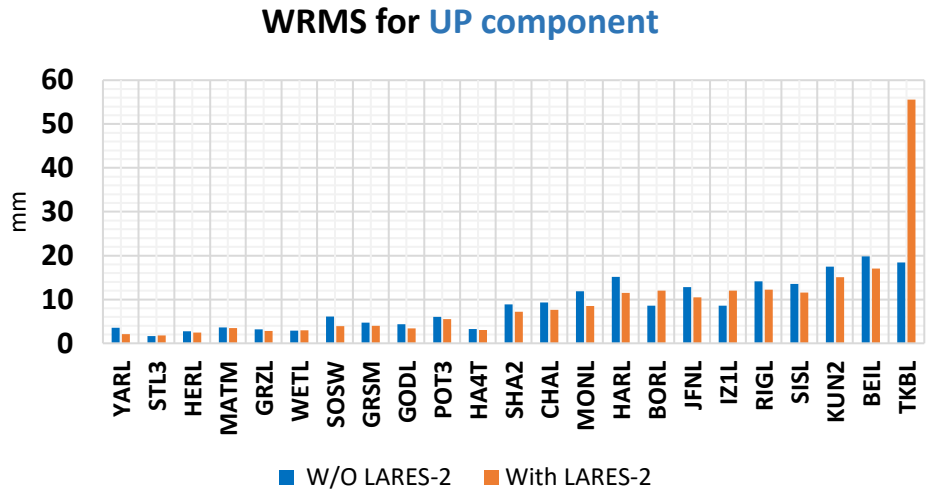


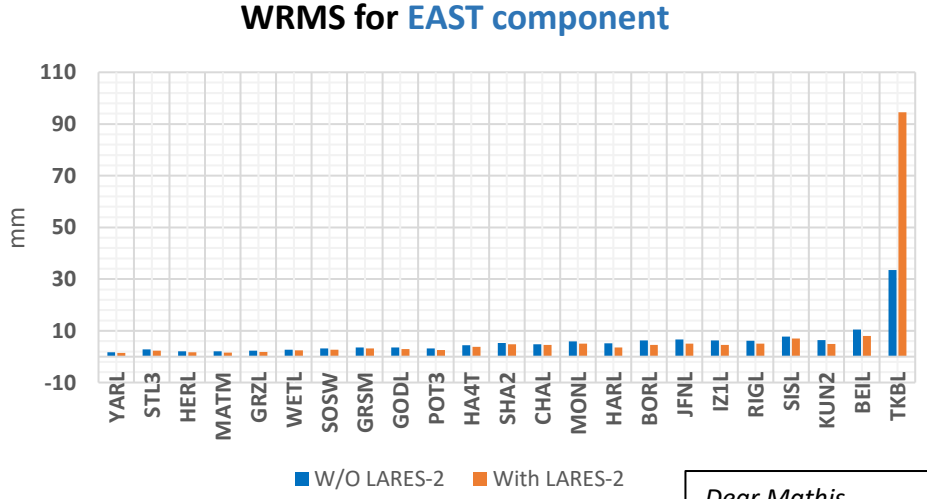
Solution	Mean [mm]
ILRSA w/o Lares2	3,89
ILRSA w. Lares2	3,29

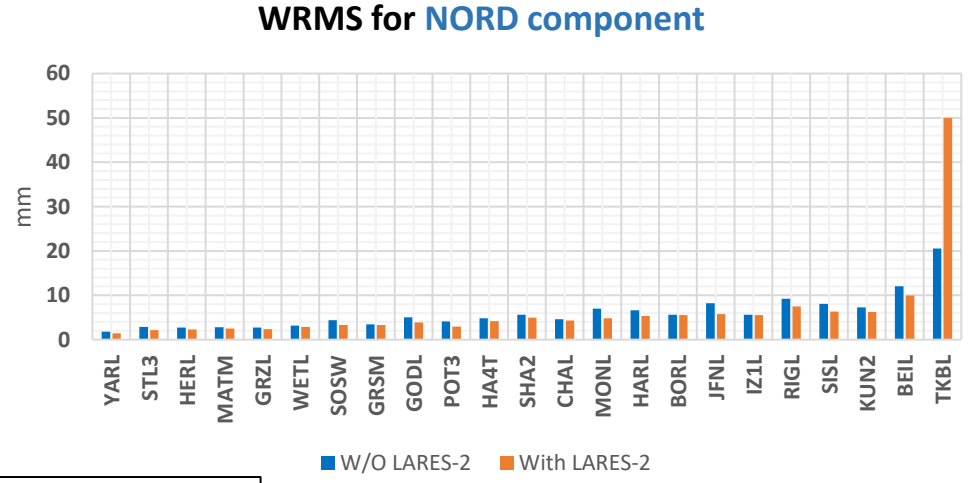
*NSGF not included

LARES-2 Analysis









7306 (TKBL): WRMS worse for v90.

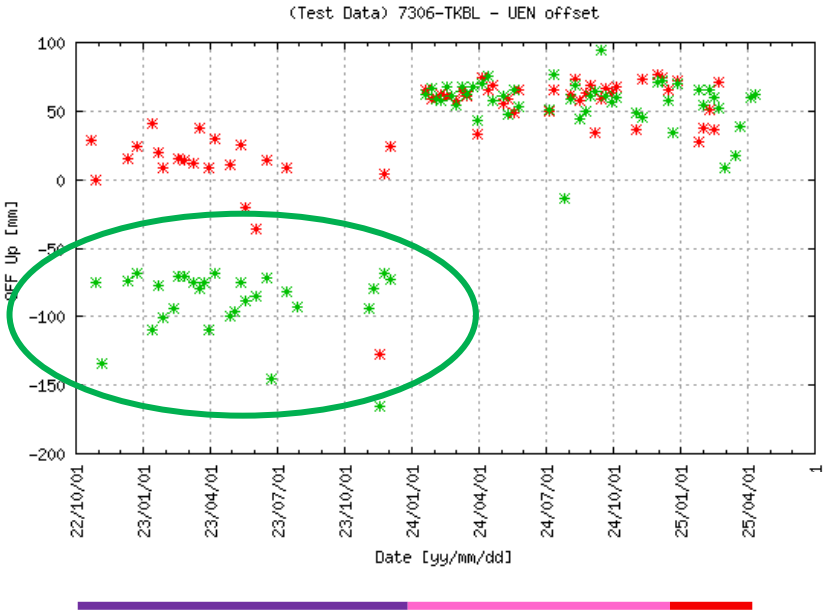
F. Lemoine

Dear Mathis,
*[…] we have recently completed a recomputation of the coordinates of **Tsukuba***
*[….]because we noticed in the **SLRF2020 (Feb2025)** [.....] a displacement of 19 cm in Y [……] which is unrealistic*

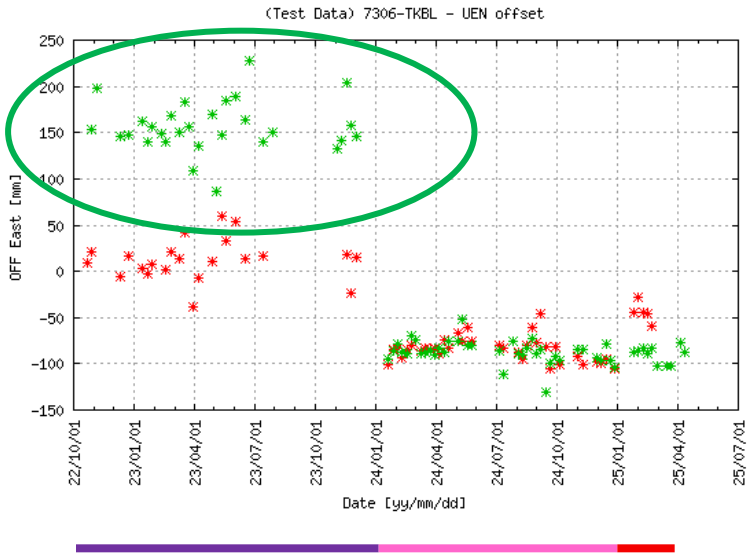
New Coordinates for 7306 in SLRF2020 ……?

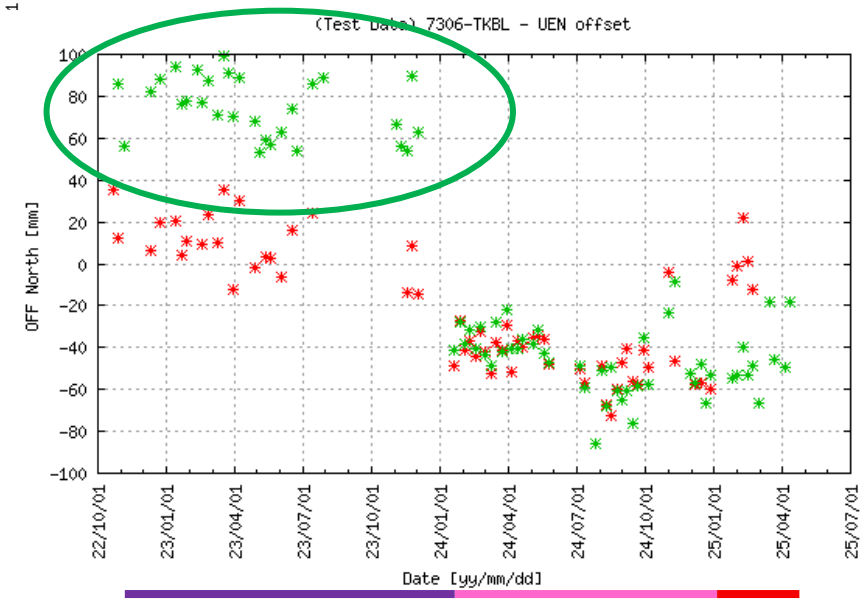
LARES-2 Analysis (7306)

v90: used the latest SLRF distribuited



ILRSA v90
ILRSA: v85 first subm. [before 2024]
+v85 second subm. [only 2024]
+ v80 [after 2025]





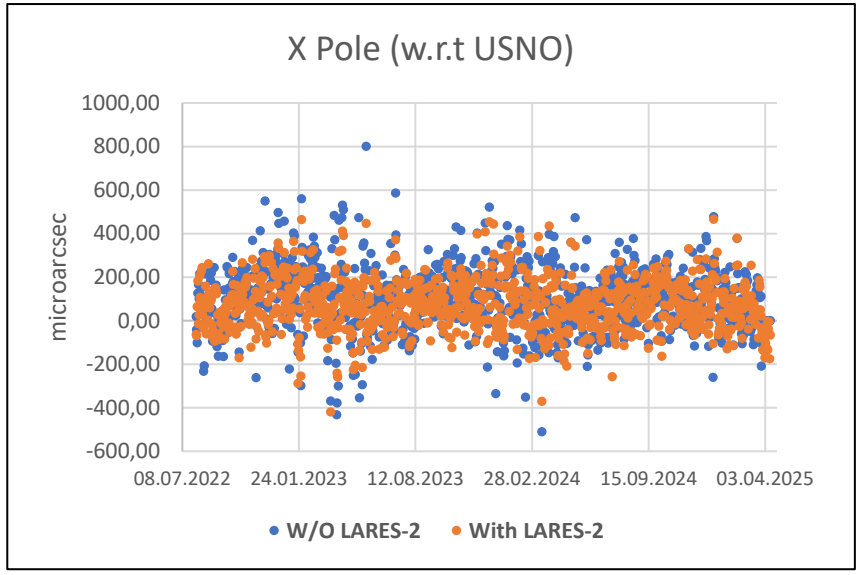
7306 (TKBL): WRMS worse for v90.

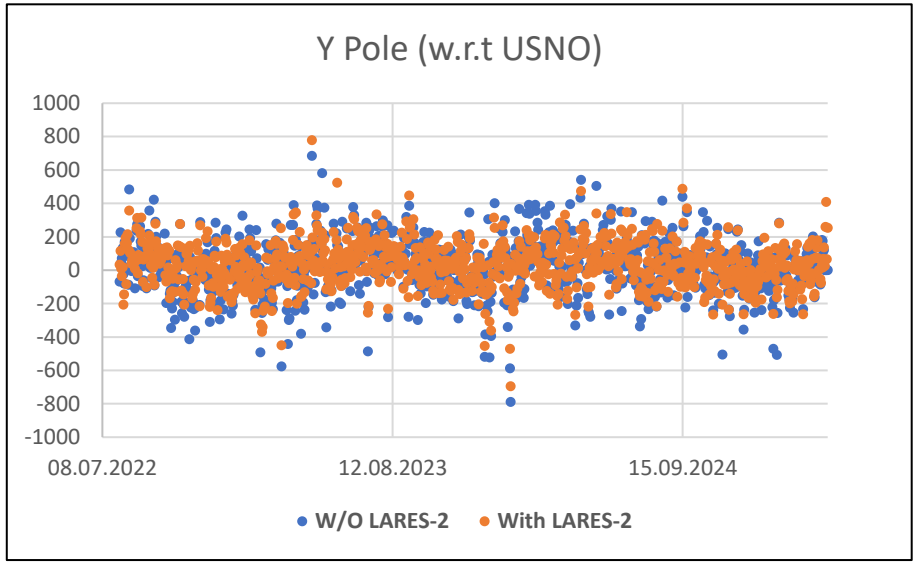
F. Lemoine

Dear Mathis,
*[…] we have recently completed a recomputation of the coordinates of **Tsukuba***
*[….]because we noticed in the **SLRF2020 (Feb2025)** […..] a displacement of 19 cm in Y [……] which is unrealistic*

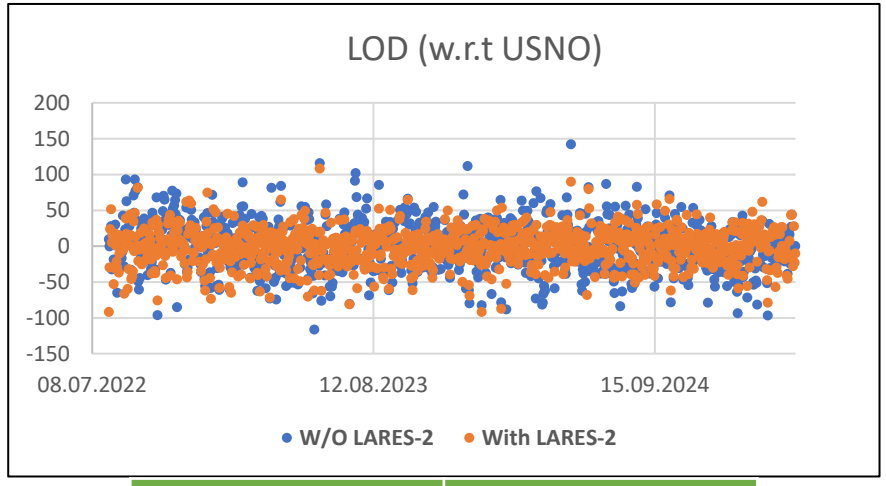
New Coordinates for 7306 in SLRF2020 ……?

LARES-2 Analysis (Polar Motion)





Solution	Mean [microarcsec]
ILRSA w/o Lares2	**103,64**
ILRSA w. Lares2	**79,39**



Solution	Mean [microarcsec]
ILRSA w/o Lares2	**2,51**
ILRSA w. Lares2	**-0,05**

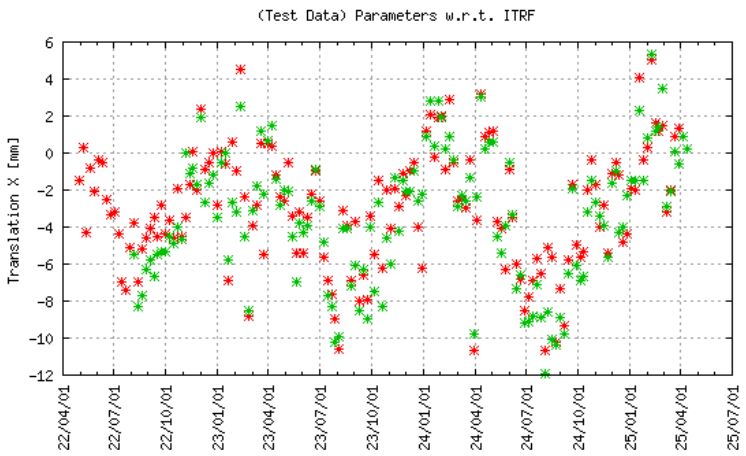
Solution	Mean [microarcsec]
ILRSA w/o Lares2	**27,02**
ILRSA w. Lares2	**27,12**

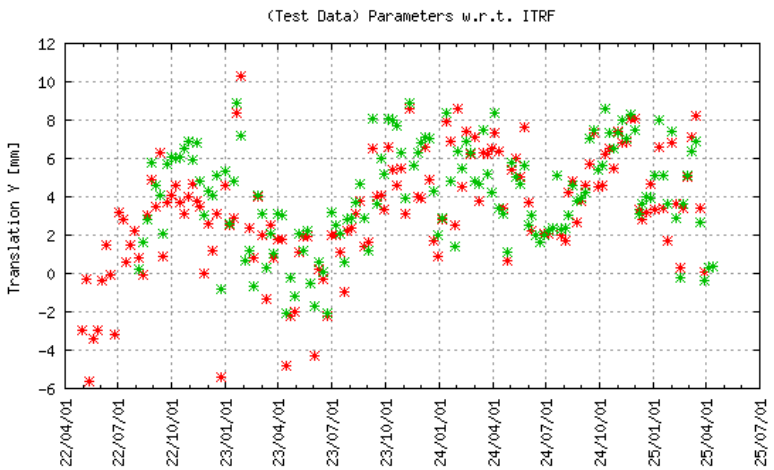
ILRSA v90

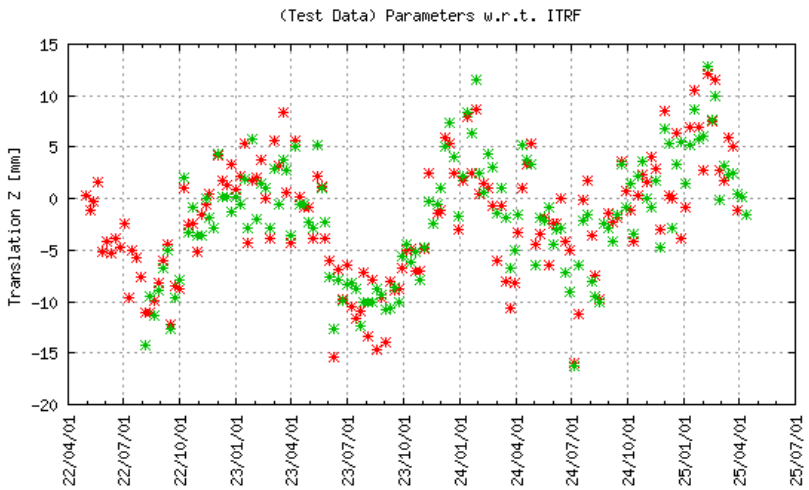
ILRSA : v85 first subm. [before 2024]
+ v85 second subm. [only 2024]
+ v80 [after 2025]

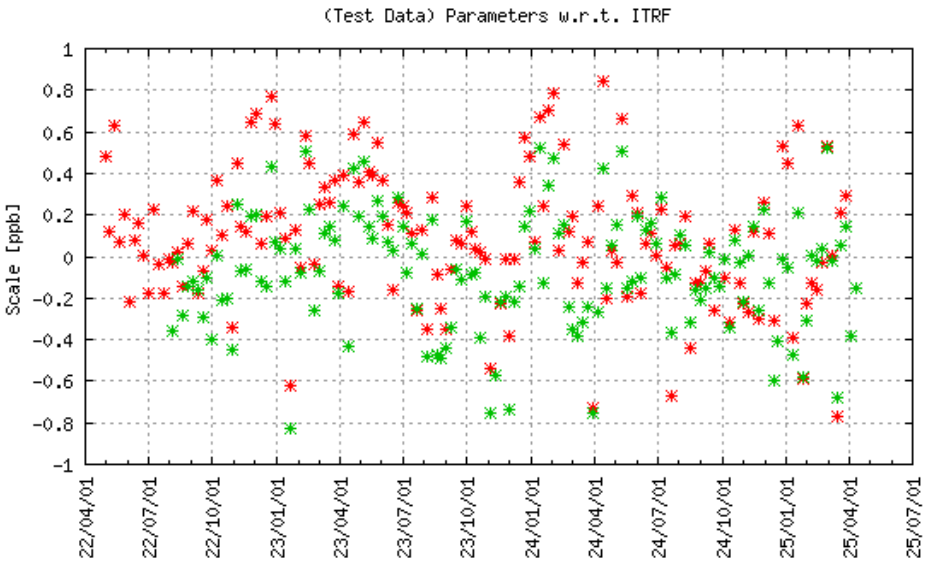
LARES-2 Analysis (Geocenter)

ILRSA SCALE & TX/TY/TZ









ILRSA v90

ILRSA: v85 first subm. [before 2024]

+ v85 second subm. [only 2024]

+ v80 [after 2025]

	Scale WMean
ILRSA v85	**0.07 ppb**
ILRSA v90 =	**-0.11 ppb**

LARES-2: Next Steps

- Combination for v91 (with new NSGF)

- Combination for v190 (after submission completed)

- Decide (now? next ASC?) the official switch to v90/v190/v320

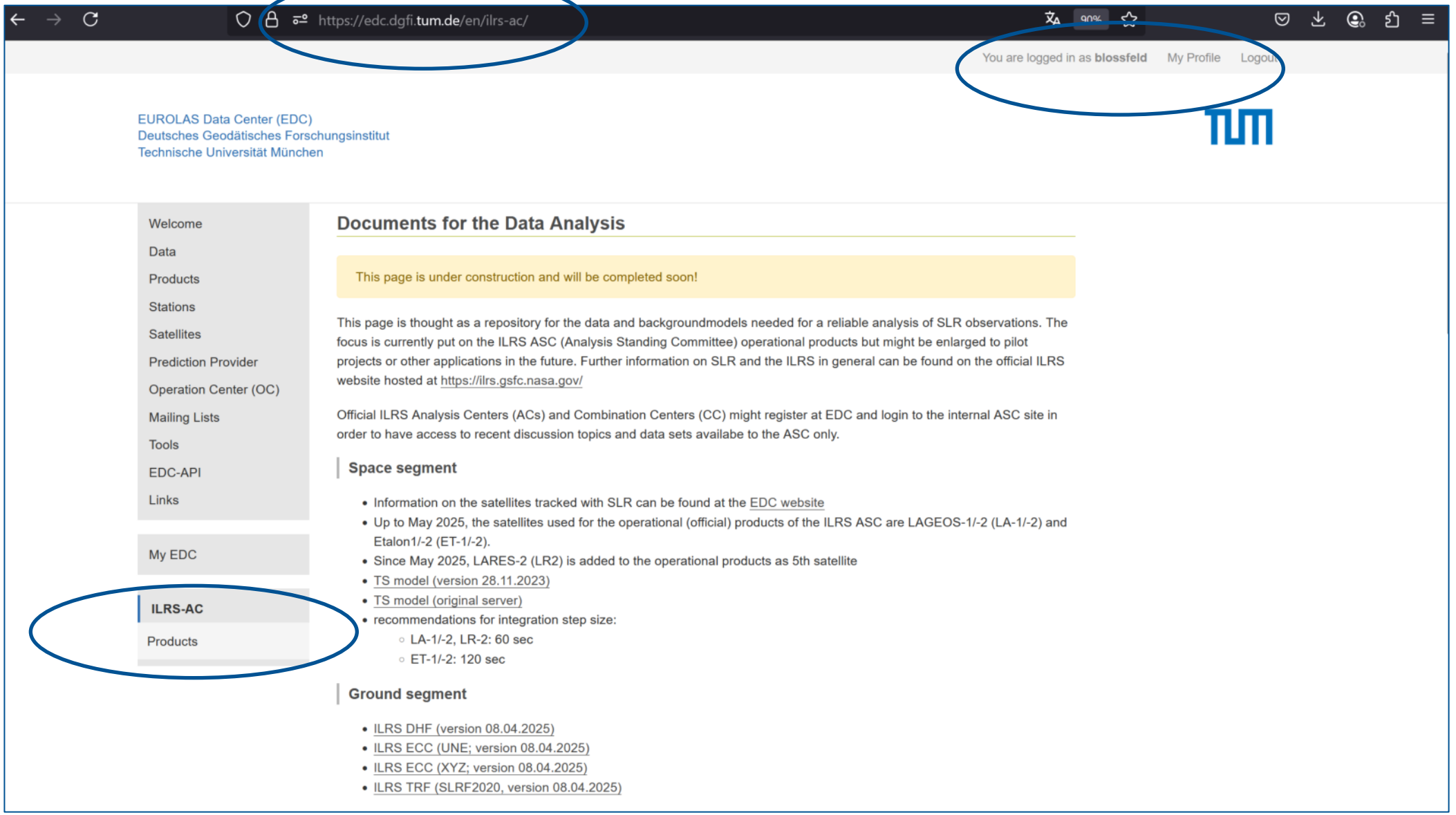
Today's [draft] agenda

0)	Last meeting + open Action Items (AIs)	(MB)	10 minutes
1)	Status reports of SLR ACs and CCs	(all)	90 minutes
2)	LARES-2 as 5th satellite in ILRS ASC operational products	(AB, DS, MB)	20 minutes
3)	**Fundamental ILRS files for the SLR analysis**	**(MB)**	**10 minutes**
4)	LARES and the SH pilot project	(MB)	15 minutes
5)	ESA's Genesis mission	(MB)	10 minutes
6)	ILRS core stations	(MB, tbd)	10 minutes
7)	Publications (of the ILRS ASC)	(MB, CL, DS)	10 minutes
8)	AOB and next ASC meeting	(MB)	5 minutes

Fundamental ILRS files for the SLR analysis (1)

- For the ILRS contribution to the ITF2020-u2023 update, essential files for the analysis of SLR obs. had been updated:
  - **ILRS ECC file (UNE, XYZ) – version: 08.04.2025**
    - New/missing eccentricities added (Greenbelt, Xian)
  - **SLRF2020 file – version: 08.04.2025**
    - New coordinates for Tsukuba after quarantine release and earthquake; coordinates for new station Xian
  - **ILRS DHF – version: 08.04.2025**
    - LR-2 RBs added
- Any problems with the new files?
  - Frank reported Tsukuba offset seems to be unrealistic
  - Franck reported missing ECC for Koganei for the 2010-2011 period
    → this marks an important point in our data analysis! **SLRF2020 vs. ECC vs. ILRS mails vs. "internal knowledge"**
- How should we handle these problems and the versioning of these files in the future?
  - Files are currently stored at CDDIS, ILRS website, and EDC
  - Metadata (how to handle the data) stored there as well?

Fundamental ILRS files for the SLR analysis (2)



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LARES and the SH pilot project (1)

- After 32 years, ASC managed it to include a 5th satellite into its official TRF+EOP products
- Several other geodetic spheres are in orbit (LR1, AJI, STE, STA, LTS, BTS, WPC)
- Now, the situation to proceed within this pilot project is good since no ITRF update is on the list and LR2 is included
- Other trigger points: Adrian, Krzysztof and Mathis proposed a new IERS initiative to compare degree-1/-2 solutions of different groups/techniques

LARES and the SH pilot project (2)

- SH combined product based on ILRS ASC input NEQs
- Combination done at DGFI at NEQ level
  - Task for ACs:
    - 1) provide information on reduced-dynamic orbit model for each satellite (emp. acc., etc.; survey will be prepared by MB)
    - 2) unification of orbit models and adaption of sophisticated parameterization (e.g., not estimate OPR N SIN)
    - 3) v320-like settings (5-sat., RBs estimated) + SH deg 2-6 (preferably 1-6)
    - 4) T > 2024.0 (since GPS week 2296)
    - 5) Hidden path at EDC: https://edc.dgfi.tum.de/pub/slr/products/test/v500/ (example file provided with minutes: dgfi.pos+eop.250419.v500.snx; only LA-1/-2, ET-1/-2 and LR-2 included, LR-1 missing)
    - **Schedule: 1)-2) until mid of June; 3)-5) until end of June**
    - Next steps: include LR-1 in pilot project (v510)

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ESA's Genesis mission

- cf. slides of Genesis WG5 report at IAG JWG 1.1.1 meeting
  - **T1**: Clarify what is needed for Genesis data analysis (to incorporate Genesis SLR obs. into a TRF+EOP product?)
- The idea is to build a taskforce (few persons only) which should
  - Identify points how ASC can approach this topic
    - What is necessary to include Genesis obs. in ASC products?
    - Topical meeting of ASC and AACs and other groups doing SLR to LEOs?

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6)	**ILRS core stations**	**(MB, tbd)**	**10 minutes**
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ILRS core stations

- The currently used list of ILRS core stations is partly out of date and should be revisited/updated
- I have the file “ILRS_core_sites_231215”, ASCII format

```
40442M006 7080 -7305.50000 17897.50000
50107M001 7090 -7670.50000 17897.50000
40451M105 7105 -6939.50000 17897.50000
40433M002 7109 -6939.50000  -731.50000
40497M001 7110 -6939.50000  3286.50000
40445M004 7119  4168.50000 17897.50000
40445M001 7210 -2160.50000  1825.50000
21611S001 7237  4382.50000 17897.50000
42202M003 7403 -3652.50000   365.50000
30302M003 7501    -0.50000 17897.50000
14001S007 7810  -730.50000  2960.50000
14001S001 7810  3022.50000 17897.50000
50119S003 7825  1460.50000 17897.50000
20101S001 7832   365.50000 17897.50000
14201S002 7834 -8766.50000 -2923.50000
10002S001 7835 -4109.50000  2190.50000
14106S009 7836 -2556.50000  1825.50000
21605S001 7837 -1095.50000  2190.50000
11001S002 7839 -6209.50000 17897.50000
13212S001 7840 -6209.50000 17897.50000
14106S011 7841  1491.50000 17897.50000
50119S001 7849  -730.50000  1459.50000
42202S001 7907 -8766.50000 -2558.50000
12734S001 7939 -6209.50000   364.50000
12734S008 7941   365.50000 17897.50000
14201S018 8834 -1340.50000  3336.50000
```

- The idea is to build a small team (2-3 persons: NN, NN and me) to
  - Revisit the list
  - Compile a list of criteria which can be used to identify core stations
    - long obs. history, small biases, no large differences between biases, no/few discontinuities, good station repeatability, etc.
  - Screen the combined v280/v320 data to identify core stations
  - Produce guidelines and a recommendation
    (core site list + description how they had been identified)
  - Volunteers?

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7)	**Publications (of the ILRS ASC)**	**(MB, CL, DS)**	**10 minutes**
8)	AOB and next ASC meeting	(MB)	5 minutes

Publications (of the ILRS ASC)

- ILRS contribution to ITRF2020
  - Leading author: CL
- Inclusion of LARES-2 ILRS ASC products
  - Leading author: DS
- The ILRS ASC – scientific products and future perspectives
  - Leading author: MB

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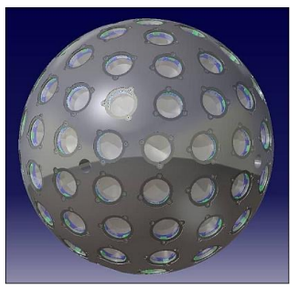
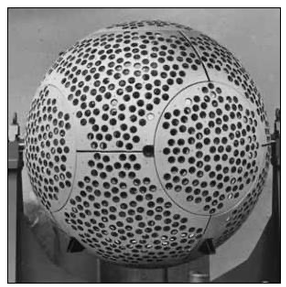
Next ILRS ASC meeting

- 3rd ILRS ASC meeting 2025 (online): 4th week in September 2025 (i.e., **Mo., 22.09. – Fr., 26.09.**)
- Optional: intermediate ASC meeting during ILRS Technical Workshop in Arequipa (Peru): **Su., 19.10. – Fr., 24.10. 2025**
- 4th ILRS ASC meeting 2025 (online): **beginning of December 2025**

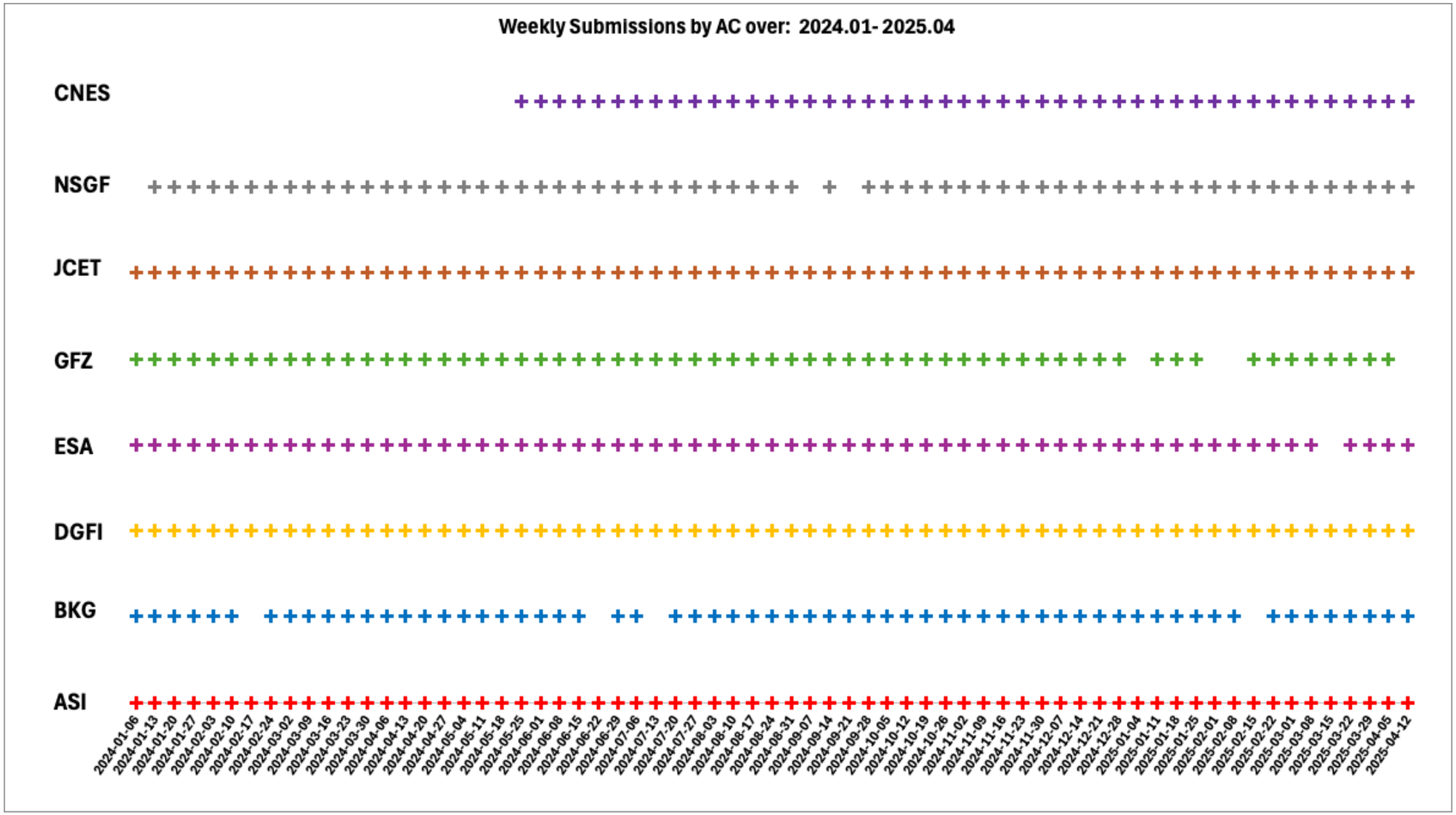
NASA GSFC/JCET & ILRSB Update, 2025/05

ILRS Analysis Standing Committee Meeting (2025/05)
Vienna, Austria
May 1, 2025

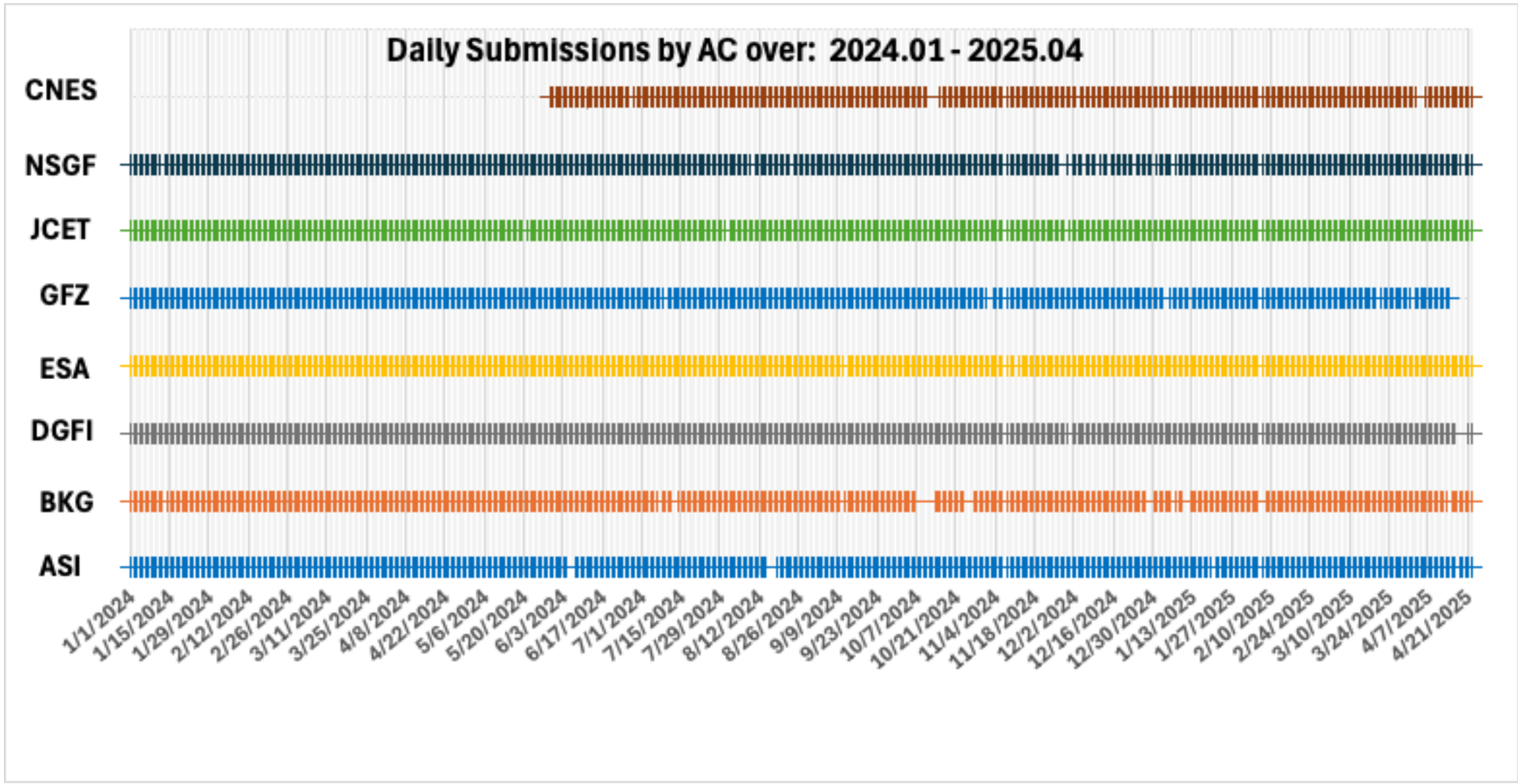
F.G. Lemoine (1), M. Kuzmicz Cieslak (2,1), K.D. Evans (2,1), A. Belli (3)
(1) NASA GSFC, Greenbelt, Maryland, U.S.A.
(2) GESTAR II, Univ. of Maryland, Baltimore County, Baltimore, Maryland, U.S.A.
(3) SSAI Inc., Greenbelt, Maryland, U.S.A.

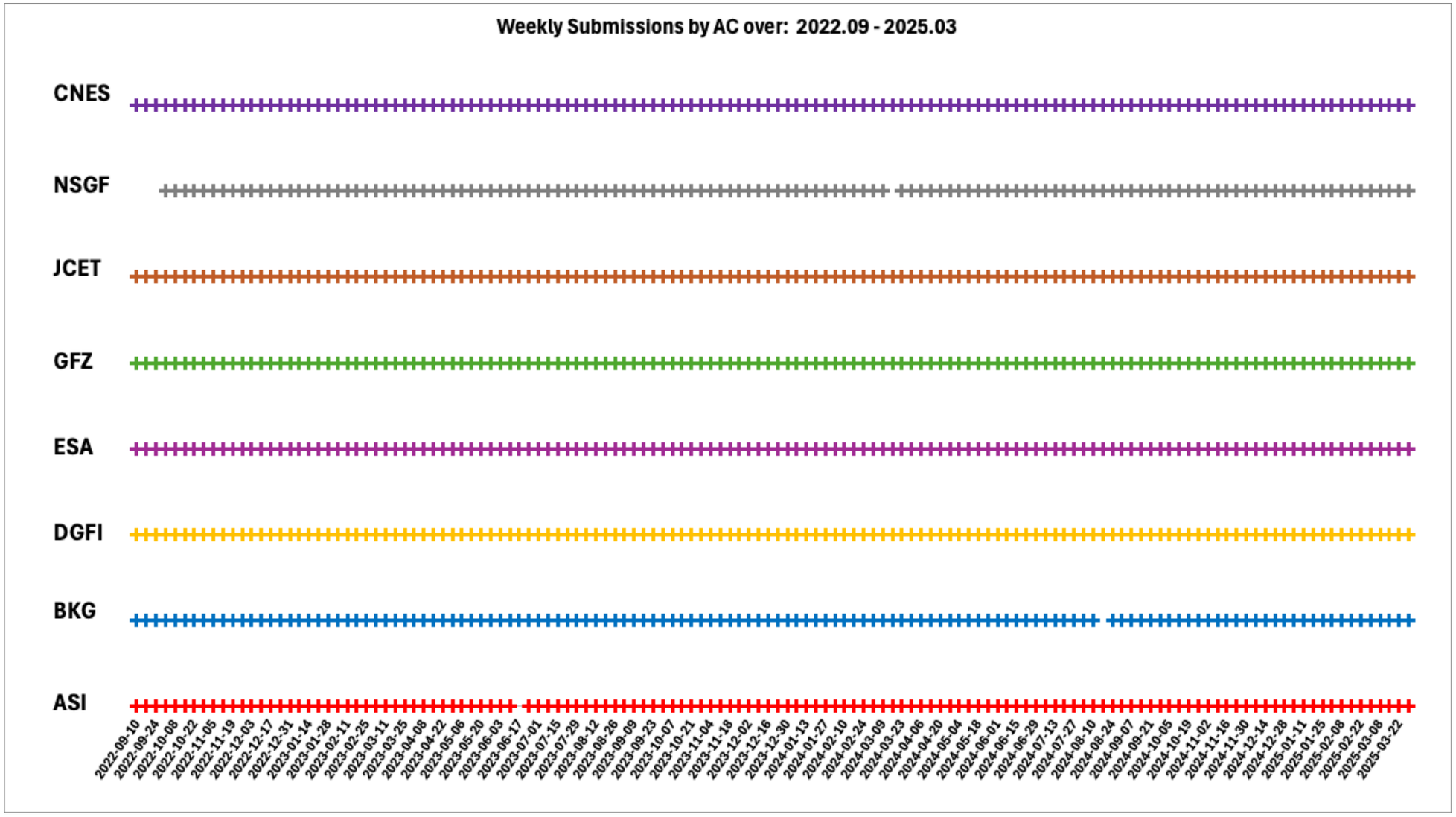

ILRSB Status v80: Solution availability by AC (*since 2024.01*)



ILRSB Status v180: Solution availability by AC (*since 2024.01*)



ILRSB Status v90: Solution availability by AC (*since 2022.09*)

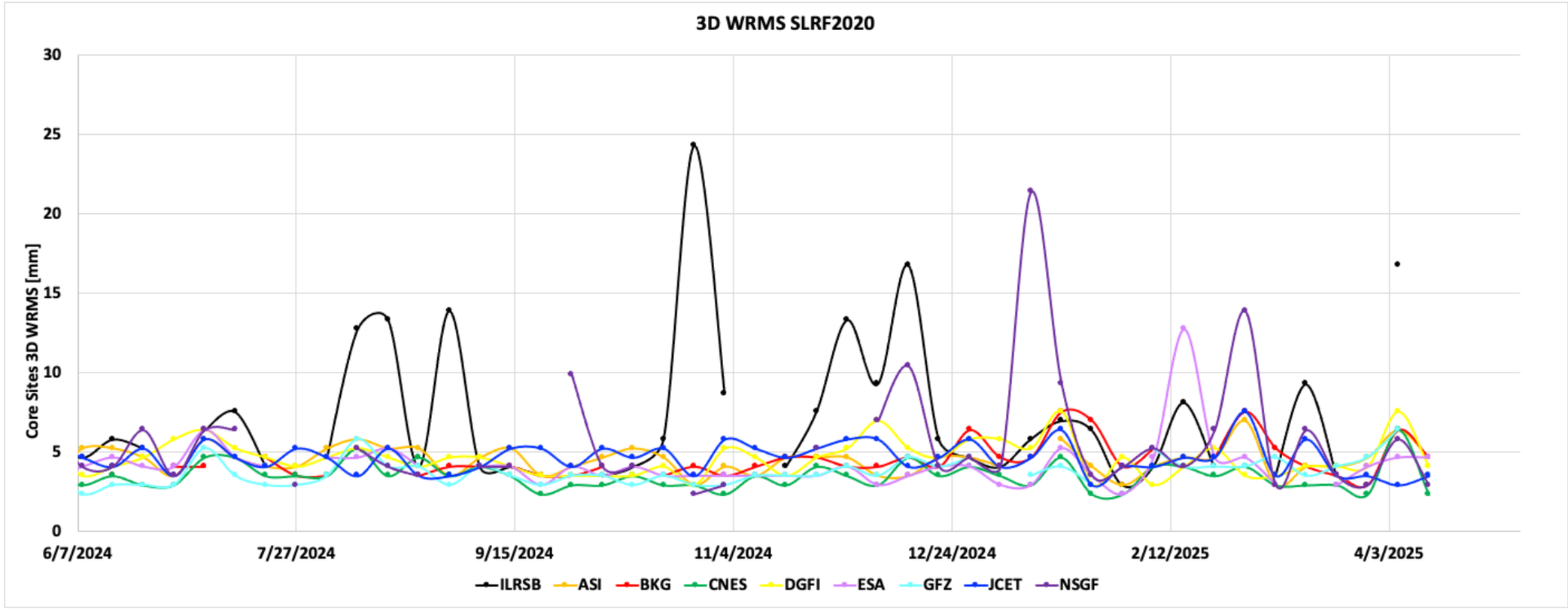


ILRSB Status v80: Core WRMS (since ~July 1, 2024)

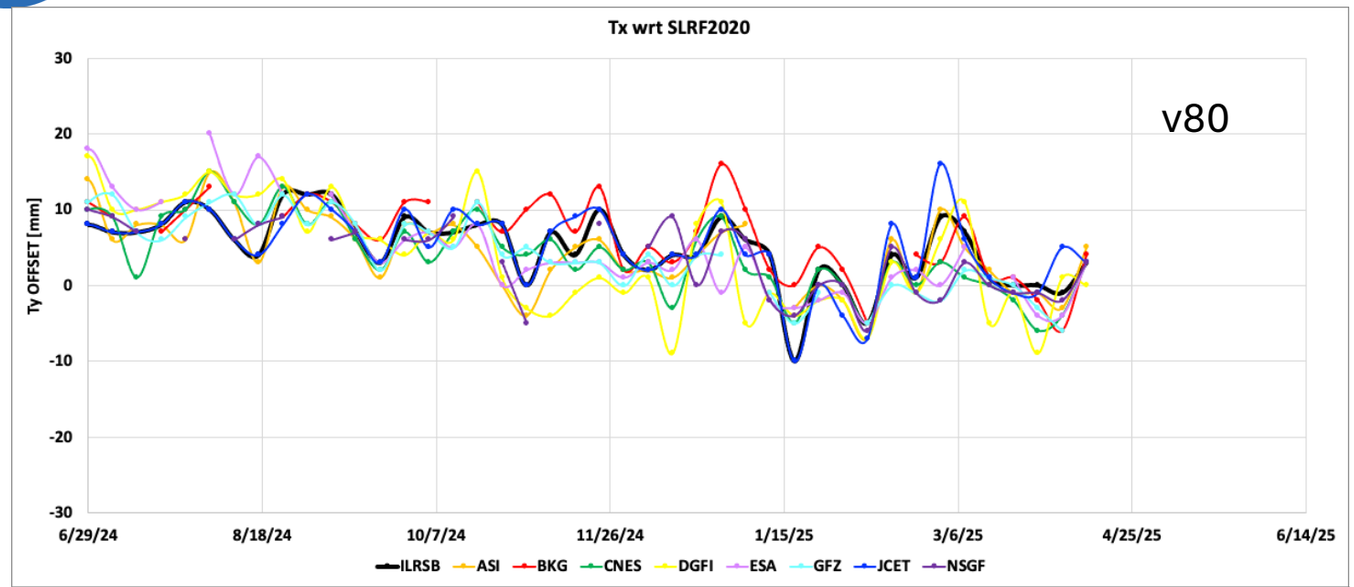
- **A number ILRS-B solutions had anomalous core WRMS: should have been re-run.**

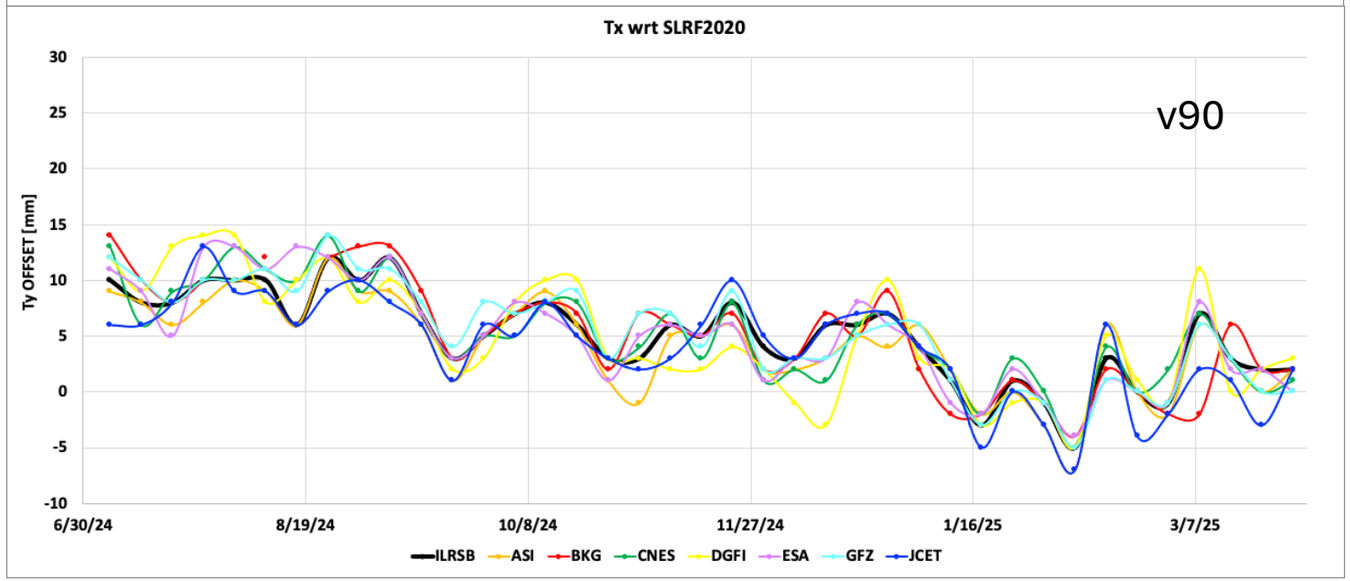
Other anomalies:

NGSF: **01/11/2025** (21.36 mm); **03/15/2025** (9.24 mm); **ESA**: **02/15/2025** (12.70 mm);



ILRSB Status: Tx. v80 vs. v90 (*since 7/1/2024*)



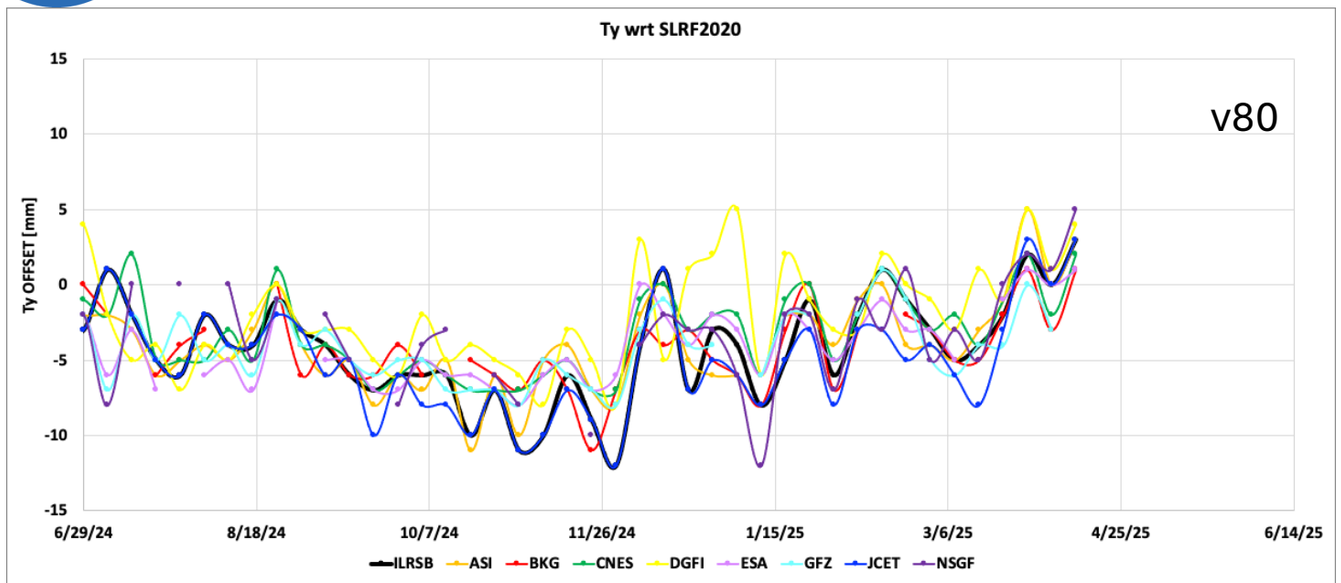


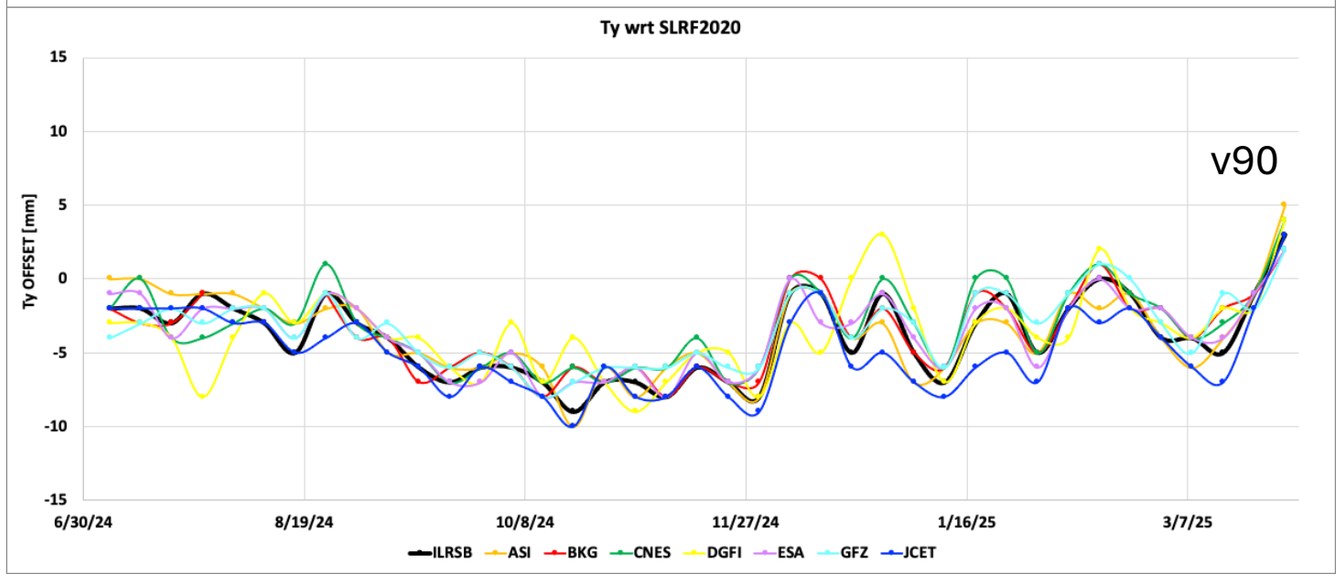
v80

AC	Mean ± StdDev
ILRSB	4.3±4.7
ASI	4.3±4.8
BKG	5.4±5.2
CNES	4.1±4.9
DGFI	3.7±6.6
ESA	4.0±5.8
GFZ	2.3±5.6
JCET	4.8±5.0
NSGF	3.1±4.7

AC	Mean ± StdDev
ILRSB	5.0±4.0
ASI	4.2±4.1
BKG	5.0±4.8
CNES	5.2±4.4
DGFI	4.9±5.2
ESA	5.1±4.6
GFZ	5.3±4.6
JCET	4.1±4.5

ILRSB Status: Ty. v80 vs. v90 (*since 7/1/2024*)



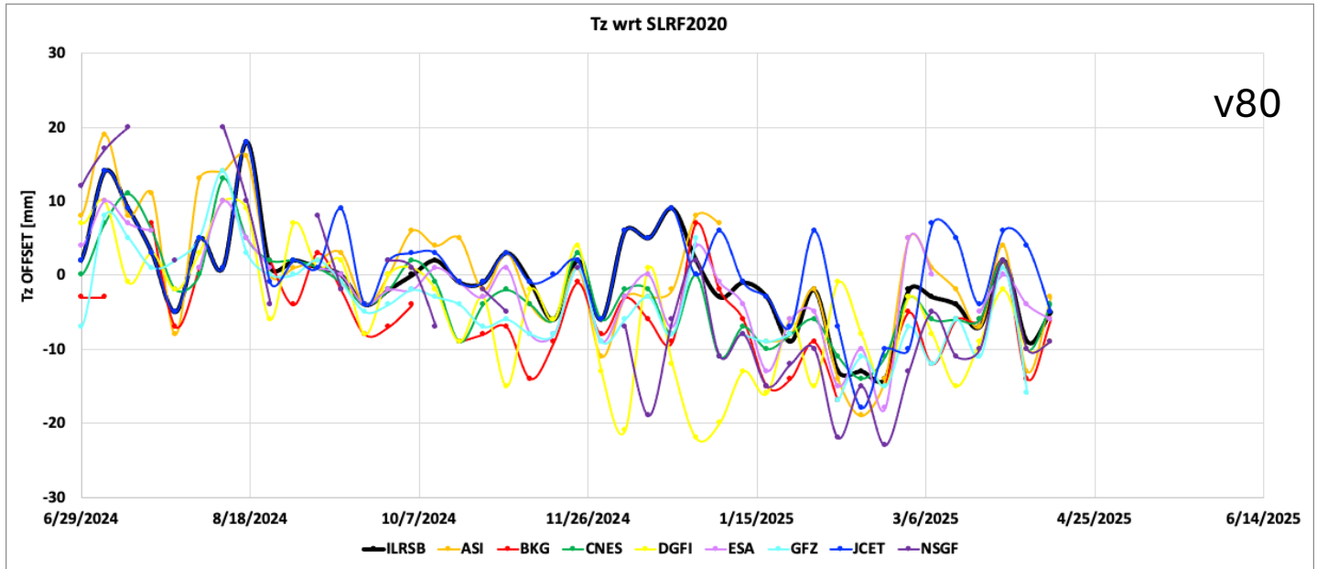


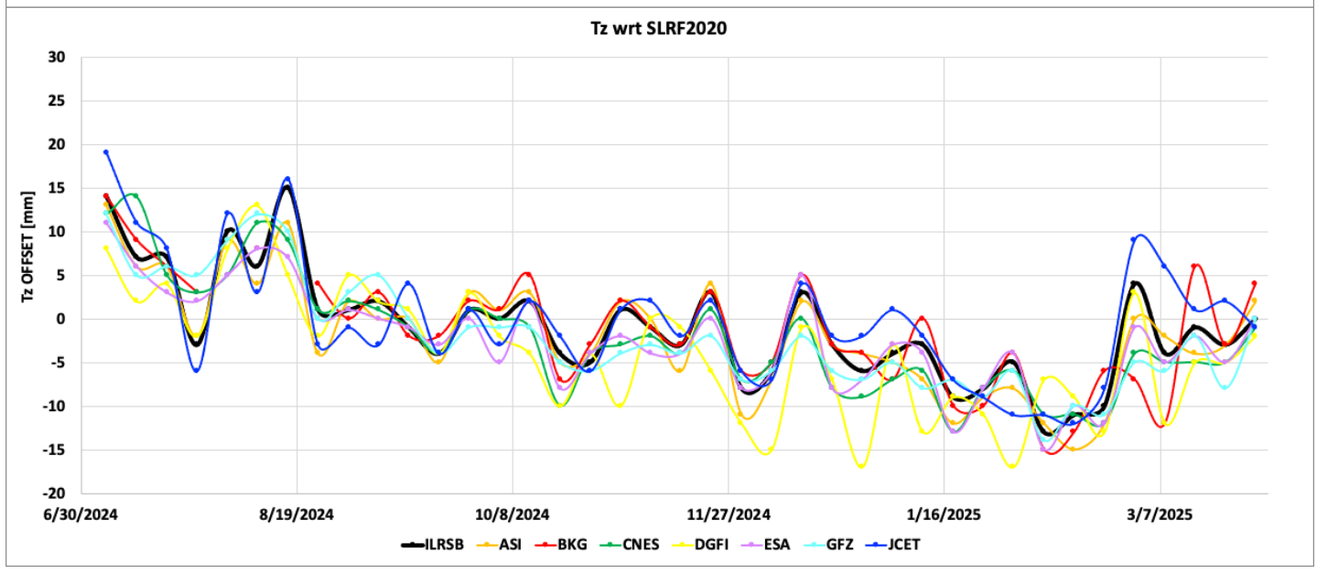
v80

AC	Mean ± StdDev
ILRSB	-4.3±3.1
ASI	-4.3±3.0
BKG	-5.1±2.8
CNES	-3.1±2.7
DGFI	-2.8±3.5
ESA	-4.4±2.5
GFZ	-4.3±2.1
JCET	-4.7±3.1
NSGF	-3.6±3.4

AC	Mean ± StdDev
ILRSB	-3.9±2.8
ASI	-3.6±2.9
BKG	-3.6±2.6
CNES	-3.1±2.7
DGFI	-3.6±2.9
ESA	-3.6±2.5
GFZ	-3.4±2.4
JCET	-4.9±2.7

ILRSB Status: Tz. v80 vs. v90 (*since 7/1/2024*)



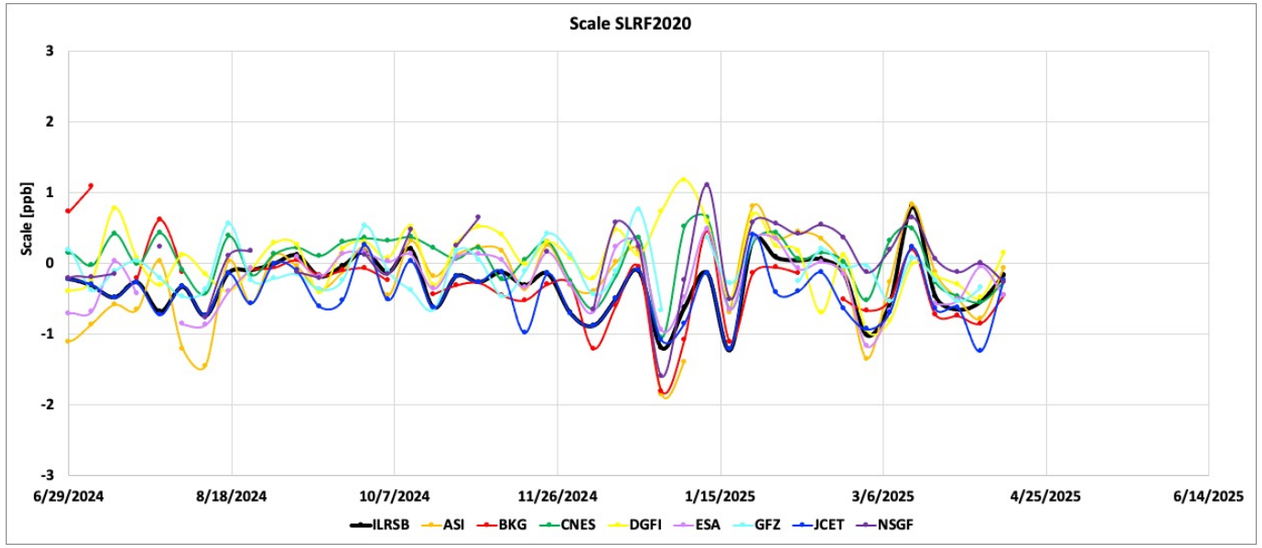


v80

AC	Mean ± StdDev
ILRSB	-0.5±6.3
ASI	1.5±8.3
BKG	-4.7±6.5
CNES	-2.1±5.9
DGFI	-0.7±10.2
ESA	-1.3±6.1
GFZ	-3.0±6.8
JCET	-0.1±6.5
NSGF	-0.6±10.9

AC	Mean ± StdDev
ILRSB	-1.0±6.3
ASI	-1.8±6.5
BKG	-1.3±6.5
CNES	-2.2±6.5
DGFI	-3.8±7.2
ESA	-2.4±5.8
GFZ	-2.1±6.3
JCET	-0.1±7.1

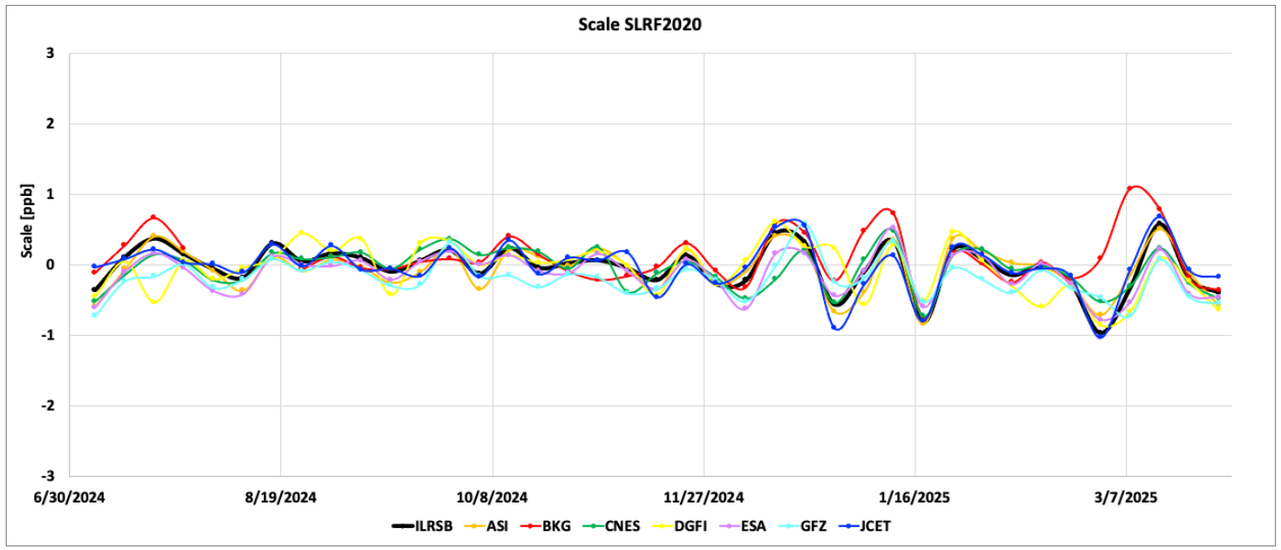
ILRSB Status: Scale. v80 vs. v90 (*since 7/1/2024*)



v80

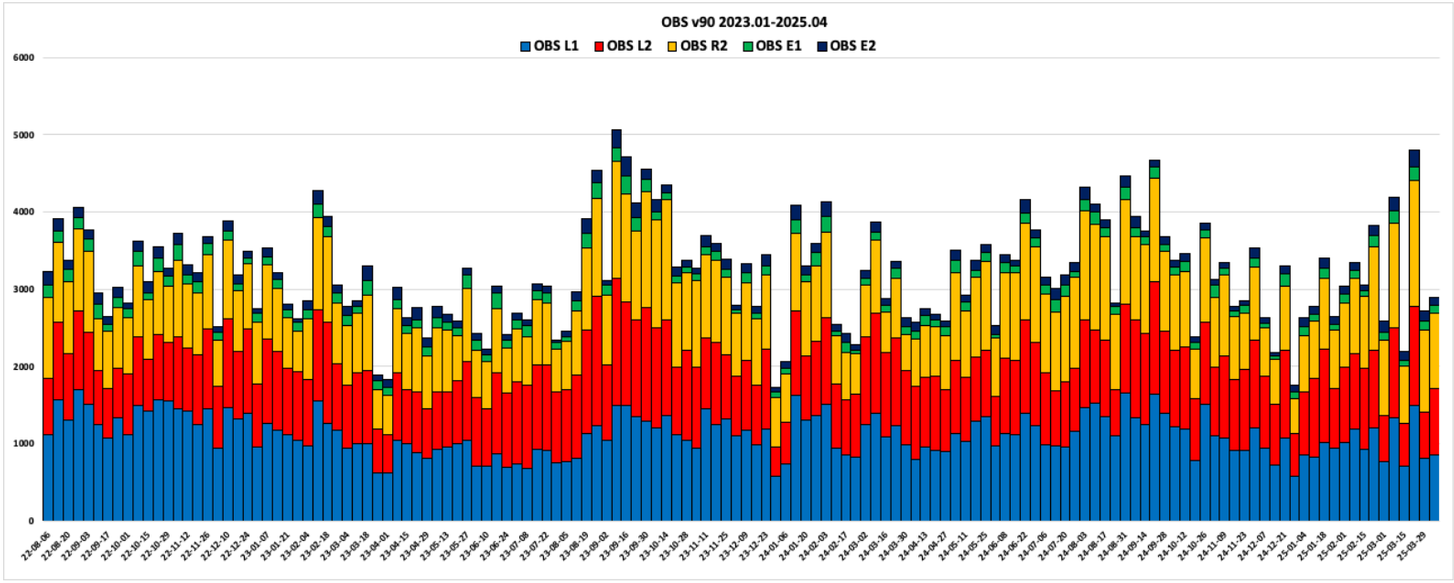
v80

AC	Mean ± StdDev
ILRSB	-0.4±0.4
ASI	-0.4±0.6
BKG	-0.4±0.5
CNES	0.0±0.4
DGFI	-0.2±0.6
ESA	-0.3±0.4
GFZ	-0.3±0.5
JCET	-0.5±0.4
NSGF	-0.1±0.5



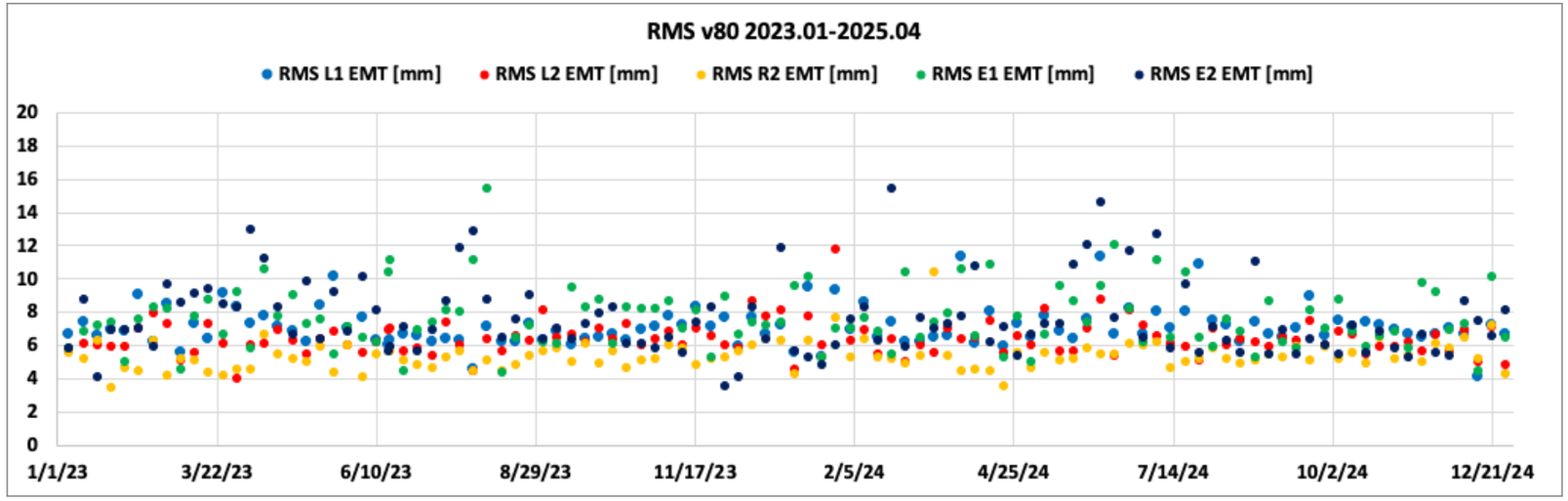
AC	Mean ± StdDev
ILRSB	0.0±0.3
ASI	-0.1±0.3
BKG	0.1±0.4
CNES	-0.1±0.3
DGFI	-0.1±0.4
ESA	-0.1±0.3
GFZ	-0.2±0.3
JCET	0.0±0.3

JCET/NASA v90 status



OBS	L1	L2	R2
Mean	1078	964	921
Total	127158	113786	108697

OBS	E1	E2
Mean	117	109
Total	13779	12842



<u>V90/V190 status:</u>

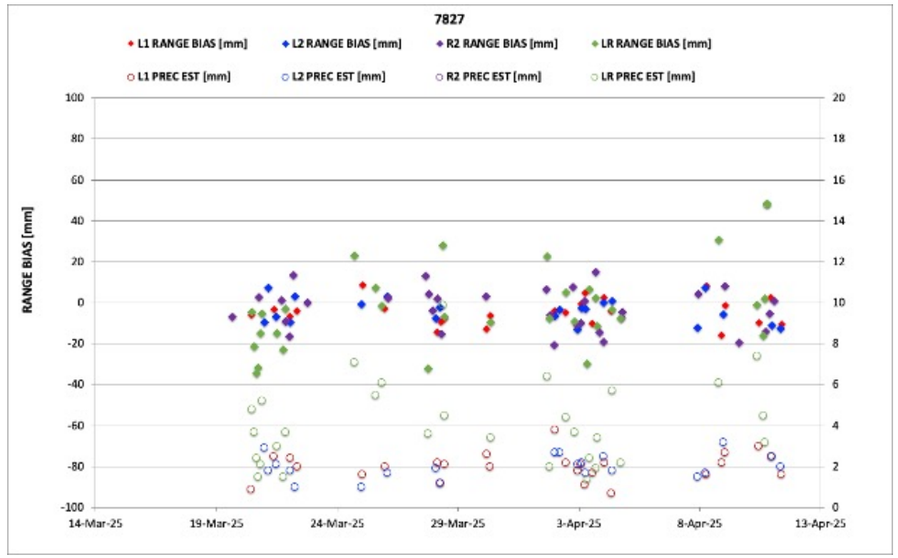
1. Made first pass through entire set of data (08/2022 – 04/2025) including LARES2 (v90) with new DHF.
2. Need to check implementation, as RMS of fit is higher than we expected.

Recent ILRS Station Validations (7827 & 7810)

Wettzell (SOSW, 7827)

	Station 7827 (Wettzell) (*data for March & April 2025*)		
Satellite	**Precision**	**Range bias**	**N passes***
LAGEOS-1	2.0 ± 0.7	-4.8 ± 6.6	25
LAGEOS-2	2.0 ± 0.6	-4.1 ± 6.3	21
LARES-2	2.9 ± 1.4	-3.1 ± 10.0	32
LARES	4.4 ± 2.8	-3.6 ± 19.3	31

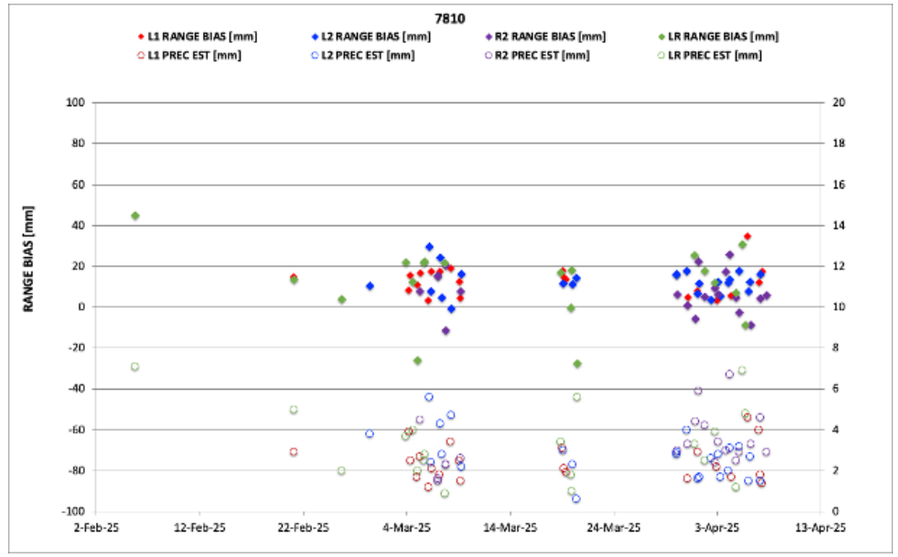
* Number of passes after editing, where we require passes to have 5 or normal points of unedited data.



Zimmerwald (ZIML, 7810)

	Station 7810 (*data for March & April 2025*)		
Satellite	**Precision**	**Range bias**	**N passes***
LAGEOS-1	2.4 ± 0.9	13.1 ± 7.1	22
LAGEOS-2	2.7 ± 1.1	12.4 ± 6.6	24
LARES-2	3.4 ± 1.3	7.3 ± 10.1	20
LARES	3.4 ± 1.8	12.0 ± 17.9	19

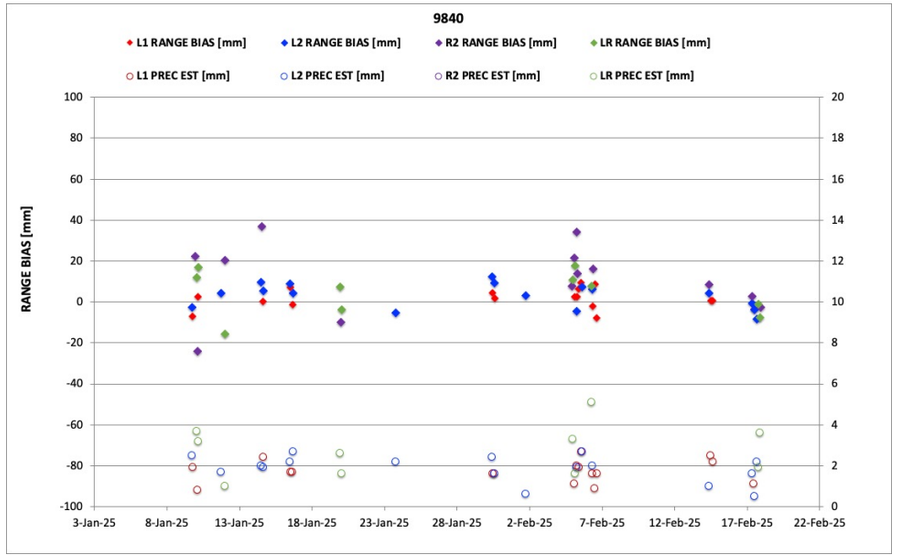
* Number of passes after editing, where we require passes to have 5 or normal points of unedited data.



Recent ILRS Station Validations: Herstmonceux, *new laser*

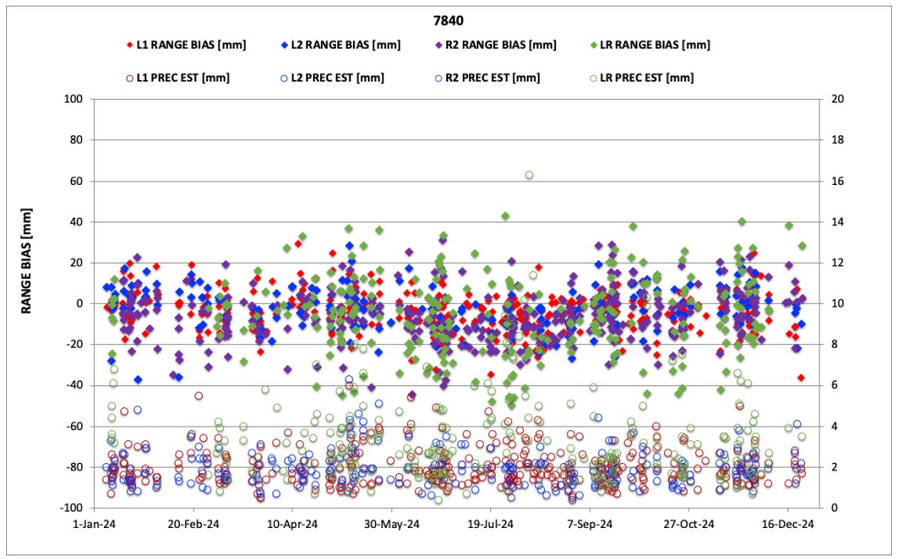
Herstmonceux
New laser “9840” (Jan-Feb 2025)

	New Laser	
Satellite	**Precision**	**Range bias**
LAGEOS-1	1.7 ± 0.5	2.2 ± 5.4
LAGEOS-2	1.9 ± 0.7	3.9 ± 6.1
LARES-2	4.4 ± 1.7	9.9 ± 16.0
LARES	2.9 ± 1.5	3.4 ± 11.2



Herstmonceux
Old laser “7840” (2024 data)

Old Laser (2024)		
Precision	**Range bias**	**N passes**
2.0 ± 0.9	-3.7 ± 9.5	382
2.0 ± 0.9	-2.7 ± 10.3	236
2.4 ± 1.4	-5.8 ± 12.7	341
3.4 ± 2.2	-5.2 ± 18.8	255



Adjustment of Coordinates for TKBL “pre240101”

TKBL Coordinates from L1, L2, Lares, Lares-2 estimations (pre-240101)

Iteration	Solutions (Epoch 2015.0)	X (m)	Y (m)	Z (m)	Δ from a priori X (m)	Δ from a priori Y(m)	Δ from a priori Z (m)	Δ from a priori lat (s)	Δ from a priori lon(s)	Δ from a priori h (m)
1	**SLRF2020 a priori, pre-240101**	-3961640.9245	3308774.6771	3734291.4734	-	-	-	-	-	-
1	L1+L2	-3961640.9264	3308774.4967	3734291.4757	-0.0019	-0.1804	0.0023	0.0022	0.0056	-0.0910
1	L1+L2+Lares2	-3961640.9278	3308774.4994	3734291.4753	-0.0033	-0.1777	0.0019	0.0022	0.0055	-0.0889
1	L1+L2+Lares2+Lares	-3961640.9263	3308774.4937	3734291.4746	-0.0018	-0.1834	0.0022	0.0057	0.0056	-0.0932
1	J3+S6A	-3961640.9192	3308774.4694	3734291.4845	0.0053	-0.2077	0.0111	0.0029	0.0062	-0.1044
2	**JAXA2022 a priori**	-3961640.9446	3308774.4052	3734291.4970	-	-	-	-	-	-
2	L1+L2+Lares2	-3961640.9323	3308774.4848	3734291.4914	0.0123	0.0796	-0.0056	-0.0009	-0.0028	0.0304
2	L1+L2+Lares2+Lares	-3961640.9305	3308774.4781	3734291.4774	0.0141	0.0730	-0.0196	-0.0012	-0.0026	0.0175
3	**L1+L2+Lares2+Lares A priori (from Iteration 2)**	**-3961640.9305**	**3308774.4781**	**3734291.4774**	-	-	-	-	-	-

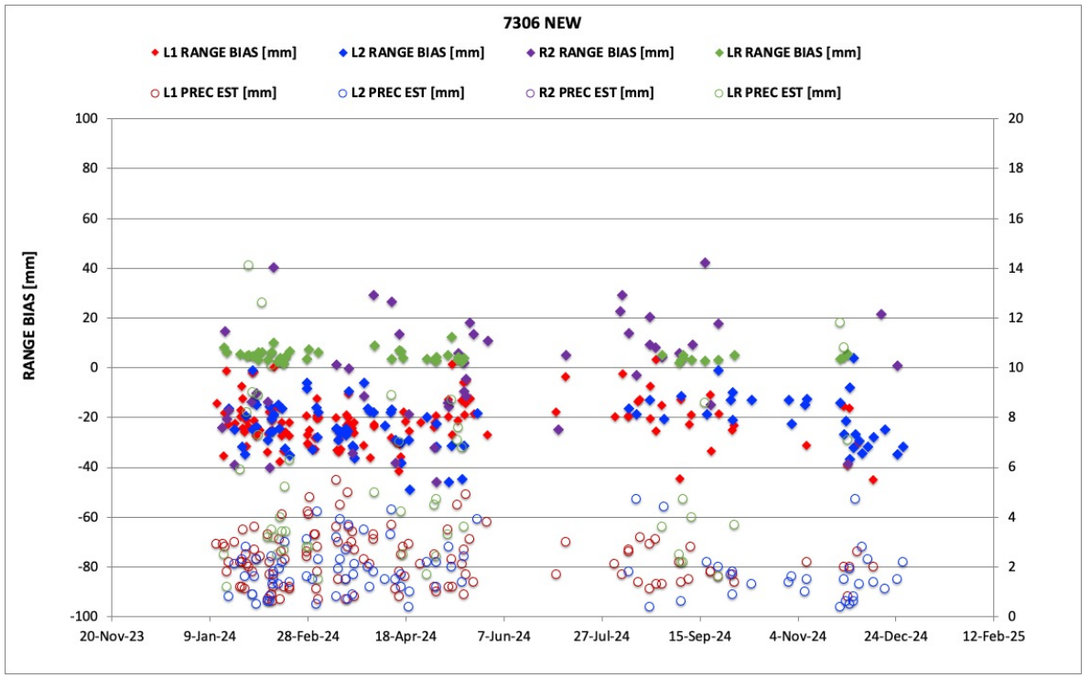
Adjustment of Coordinates for TKBL “post240101”

TKBL Coordinates from L1, L2, Lares, Lares-2 estimations (post-240101)

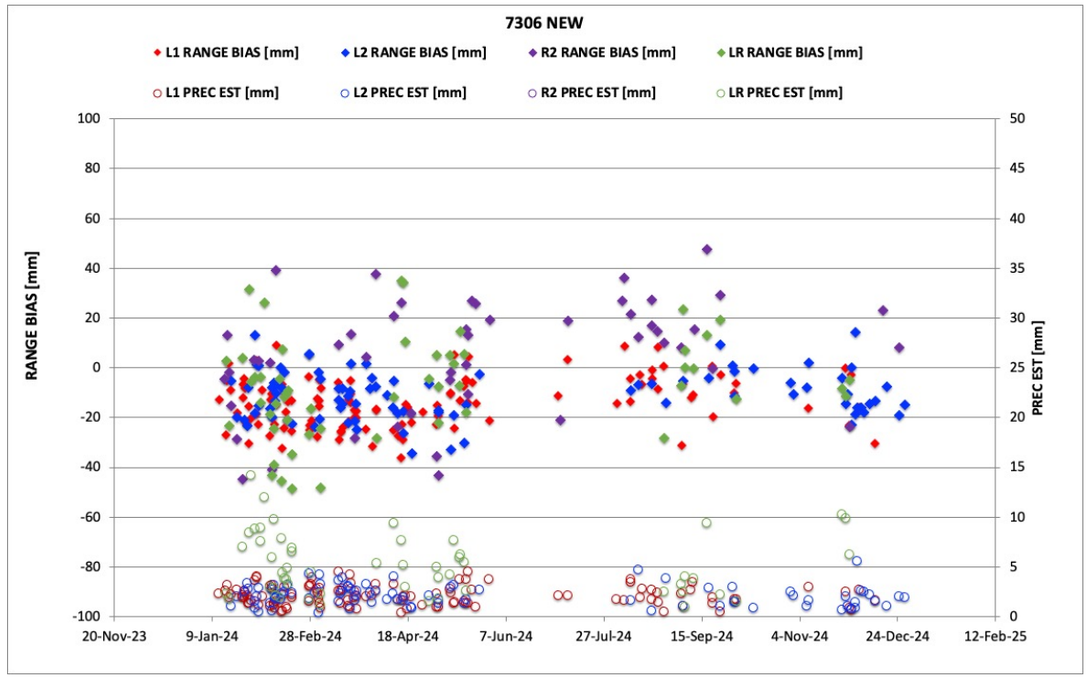
Iteration	Solutions (Epoch 2015.0)	X (m)	Y (m)	Z (m)	Δ from a priori X (m)	Δ from a priori Y(m)	Δ from a priori Z (m)	Δ from a priori lat (s)	Δ from a priori lon(s)	Δ from a priori h (m)
1	**SLRF2020, post-240101**	**-3961640.9321**	**3308774.3897**	**3734291.5058**	-	-	-	-	-	-
1	L1+L2	-3961640.9275	3308774.4808	3734291.4880	0.0046	0.0911	-0.0178	-0.0015	-0.0029	0.0339
1	L1+L2+Lares2	-3961640.9283	3308774.4808	3734291.4897	0.0038	0.0911	-0.0161	-0.0015	-0.0029	0.0353
1	L1+L2+Lares2+ Lares	-3961640.9275	3308774.4773	3734291.4936	0.0046	0.0877	-0.0122	-0.0013	-0.0028	0.0354
2	**JAXA2022 a priori**	**-3961640.9446**	**3308774.4052**	**3734291.4970**	-	-	-	-	-	-
2	L1+L2+Lares2	-3961640.9323	3308774.4848	3734291.4914	0.0123	0.0796	-0.0056	-0.0009	-0.0028	0.0304
2	L1+L2+Lares2+Lares	-3961640.9367	3308774.4951	3734291.4960	0.0079	0.0899	-0.0010	-0.0010	-0.0030	0.0411
3	**L1+L2+Lares2+ Lares A priori (from Iteration 2)**	**-3961640.9367**	**3308774.4951**	**3734291.4960**	-	-	-	-	-	-

Validation tests for TKBL New coordinates (2024)

Using “Iteration-1 L1+L2+LR2” coordinates



Using Jaxa2022 coordinates



Ignore green dots in above figure

ADDENDUM

Test of TKBL coordinates (2023-2025) [L1+L2+Lares+Lares-2, Iteration-2)

Year	Satellite	Station	Narcs	Total Obs	Avg. RMS (cm)	Std. Dev. (cm)	Avg. Mbias (cm)	Std. dev Mbias (cm)
2023	J3	TKBL-532	13	222	0.27	0.32	-0.15	0.457
2024	J3	TKBL-532	25	801	0.49	0.47	1.03	1.280
2025	J3	TKBL-532	8	495	0.44	0.44	0.09	1.047
2023	S6A	TKBL-532	16	360	0.23	0.12	-0.74	0.58
2024	S6A	TKBL-532	28	958	0.55	0.56	0.98	2.069
2023	LS2	TKBL-532	20	258	0.28	0.28	-0.36	1.013
2024	LS2	TKBL-532	35	383	0.27	0.24	0.13	0.89
2025	LS2	TKBL-532	7	215	0.57	0.45	0.25	0.81