International Laser Ranging Service

Agenda for the Fall 2018 ILRS Analysis SC Meeting

Erricos C. Pavlis and Cinzia Luceri

ILRS Analysis Coordinators

November 4, 2018

21st IWLR

Mt. Stromlo, Canberra, Australia

Operational Products: Status Reports & Future Plans

- AC & CC Reports (*<u>including one from the new IAA LLR AC</u>*)
- ACs must report on the status of:
  - *Adopting of the revised analysis procedures and modeling standards (per ITRF2014 reanalysis, secular pole, T2L2 T_Bs, etc.) for the re-analysis products*
  - *Results from testing various High Frequency EOP models under the IERS Pilot Project*
- Re-analysis (weekly series) with ITRF2014 (i.e. the updated SLRF2014 version) plan:
  - *CoM model update status: what is available? when do we expect the final version?*
  - *SINEX products requirements for submission to the next ITRF development effort*
    - *We need to adopt the format for inclusion of the applied systematics model*

Operational Products: Status Reports & Future Plans

- Presentation by Randy Ricklefs on upcoming CPF and **CRD** Formats' update process:
  - *Discussion and plans for testing (and later adopting) the new CRD Format v2.0*
    - Which ACs have reviewed the new format?
    - Who will participate in testing data delivered in the new format and by when?
    - Plan for the adoption of the new format in the near future?

Station Systematic Error Monitoring Project
—The Operational Phase

- Comments on the combination results of the currently available series
- Reports of delinquent ACs on their status and ability to deliver operational products - **DEADLINE**
- Results from the so-far submitted series and the schedule for operational product delivery:
  - Identify the stations worth to study, eliminate stations with very brief occupations (e.g. MEDLAS campaign sites, etc.) and eliminate them from our ITRF submissions;
  - Adopt "operational" delivery schedule: deliver weekly arcs with freely adjusted systematics;
  - Delay product delivery to benefit from a more stable SLR NP data set and better EOP;
  - Discussion of the averaging process, the identification of breaks, validation, testing, etc.
- Can we have this service online and operational by March 1, 2019?
- Implementing timing errors by means of T2L2 tracking on Jason-2 in our Data Handling File beyond 2016 – **T2L2 is now PERMANENTLY turned off!!!**

Planning for the Development of ITRF20XX

- *Can we start our reanalysis soon, assuming that the latest and best CoM estimates for the targets we use for ITRF development are now* **available** **(are they** *?)* *?*
- *Can we complete the LARES and low degree gravity PP by the summer of 2019?*
- *This will take us to end of 2019 before the CCs will have a stable set of contributions to start the initial combination process for ITRF2020;*
- *The CCs estimate they need 6-8 months to complete this process based on the ITRF2014 experience (and the prior models);*
- *This implies that we should be able to include most all of 2019 in the reanalysis, so we can fine-tune our contribution to the new model ITRF2020 over the next year and include 2020 in the final delivery;*
- *This plan assumes that all of the LARES data will also be part of this analysis this time around.*

Planning the next Pilot Project and launch date:

- *We had agreed in Vienna to deliver one year as a test, but nothing happened:*
  - *Estimation of low-degree SH of the gravity field plan: ???*
  - *Inclusion of LARES as a 5th satellite in our operational products plan: ???*

- *Revisit NT Atm. Loading & Gravity changes implementation as an internal PP (eventually to be used operationally for new series—<u>NOT for ITRF use</u>)*

- *Discussion of a plan for the expansion of the targets used in operational products, with the intent to produce higher quality EOP in a shorter timeframe (e.g. the day after the data were collected)*
  - *This can be running in parallel with the reanalysis, since it is a PP and we will not have strict delivery deadlines; most of the work will be to coordinate between ACs and make sure we all use the same or similar/equivalent modeling.*

Special Issue of the Journal of Geodesy Status

No.	Article Title	Status Date
1	The SAO and the CNES contributions to the International Laser Ranging Network	18 October 2018
2	Information Resources Supporting Scientific Research for the International Laser Ranging Service	12 October 2018
3	Modernizing and Expanding the NASA Space Geodesy Network to Meet Future Geodetic Requirements	21 September 2018
4	Assessment of the impact of one-way laser ranging on orbit determination of the Lunar Reconnaissance Orbiter	11 September 2018
5	Rapid Response Quality Control Service for the Laser Ranging Tracking Network	1 September 2018
6	The Next Generation of Satellite Laser Ranging Systems	1 September 2018
7	NASA's Satellite Laser Ranging Systems for the 21st Century	17 August 2018
8	Time and laser ranging: A window of opportunity for geodesy, navigation and metrology	8 July 2018
9	Laser and Radio Tracking for Planetary Science Missions - A Comparison	8 July 2018
10	The NASA Space Geodesy Network	5 June 2018
11	Satellite Laser Ranging to Low Earth Orbiters - Orbit and Network Validation	30 March 2018

8 additional articles are currently under review and a small number are yet to be submitted

Other topics, next meeting…

- Next ASC meeting at EGU 2019
- TENTATIVE DATE/TIME: April 6 or 7, (*depends on IERS DB date*) 9:00 – 17:00

International Laser Ranging Service

ASI AC&CC report

e-geos
UNA SOCIETÀ ASI/TELESPAZIO

M. Pirri, V. Luceri
e-GEOS S.p.A., CGS – Matera

agenzia spaziale italiana

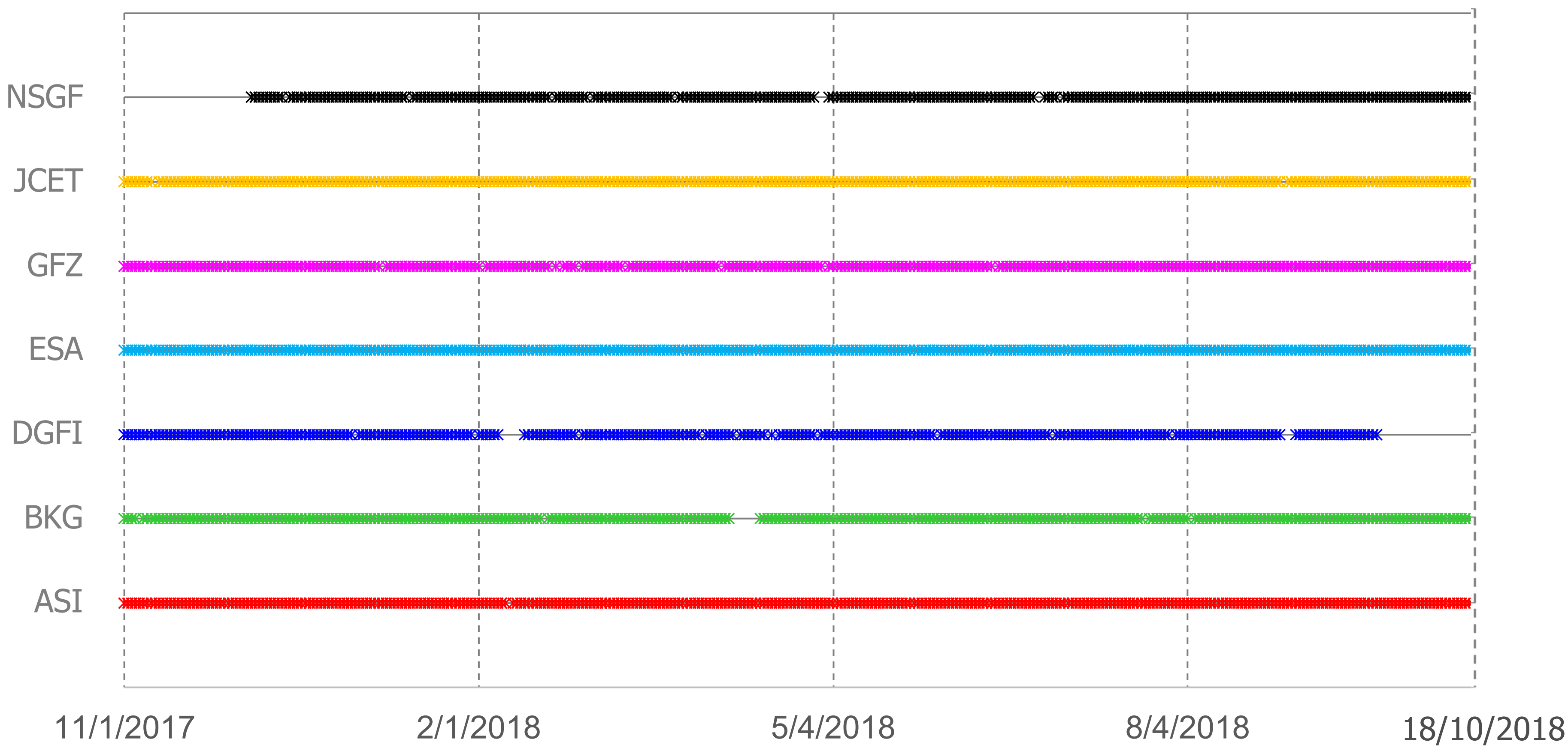
G. Bianco
Agenzia Spaziale Italiana, CGS - Matera

Activities since last ASC meeting

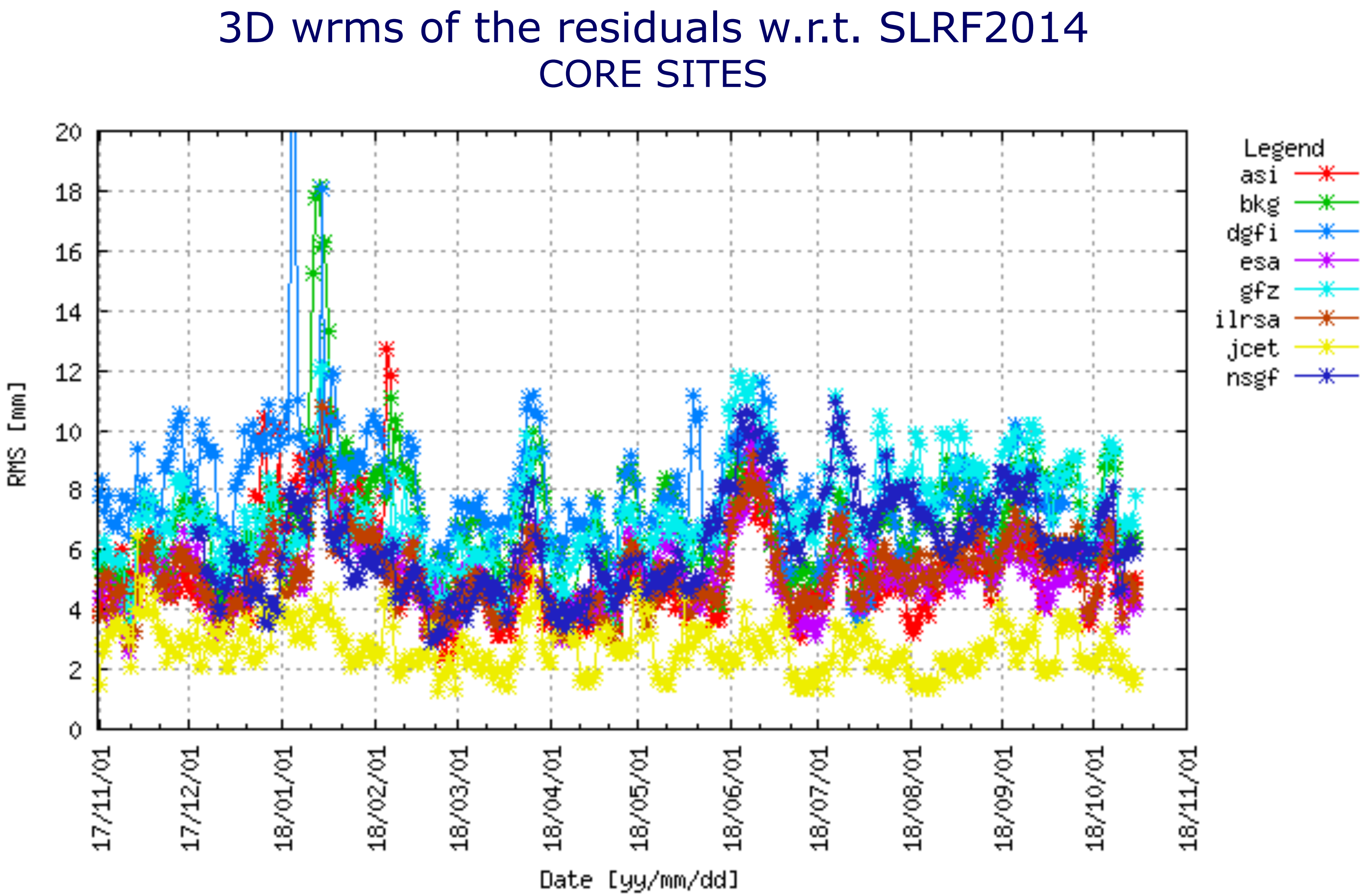
- ACs performance check
  - Data submissions
  - 3D wrms of the residuals w.r.t. SLRF (daily and weekly)
  - Scale factor
  - Geocenter motion
  - LOD
  - Combination scale factor
  - Orbits: RMS of residuals w.r.t. combination
  - ILRS ACs orbit agreement
- Systematic Error Pilot Project
  - Range Bias time series for Core Stations
  - Remarks

ACs submissions

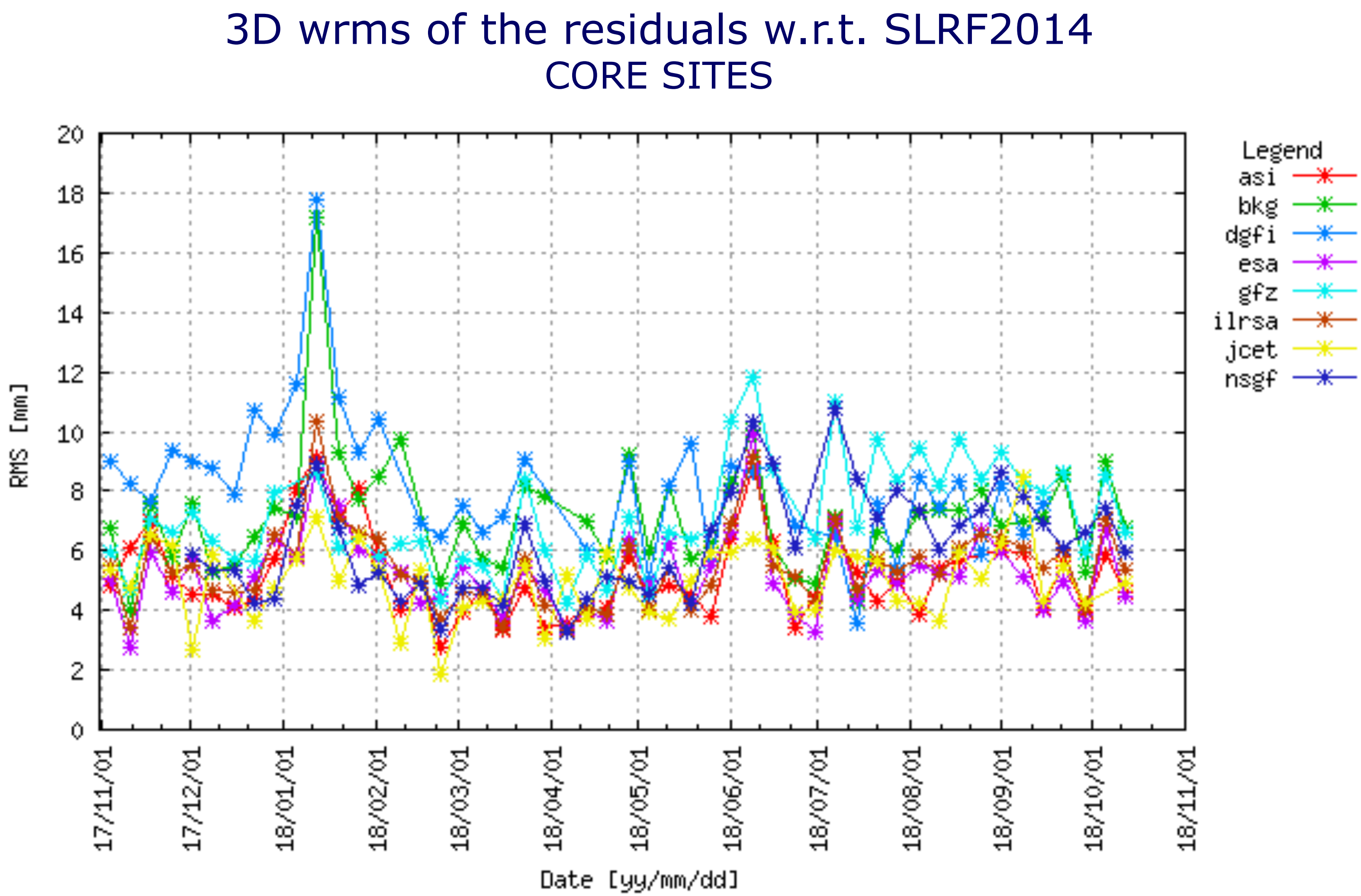
Daily (v170) and weekly (v70) ACs time series.



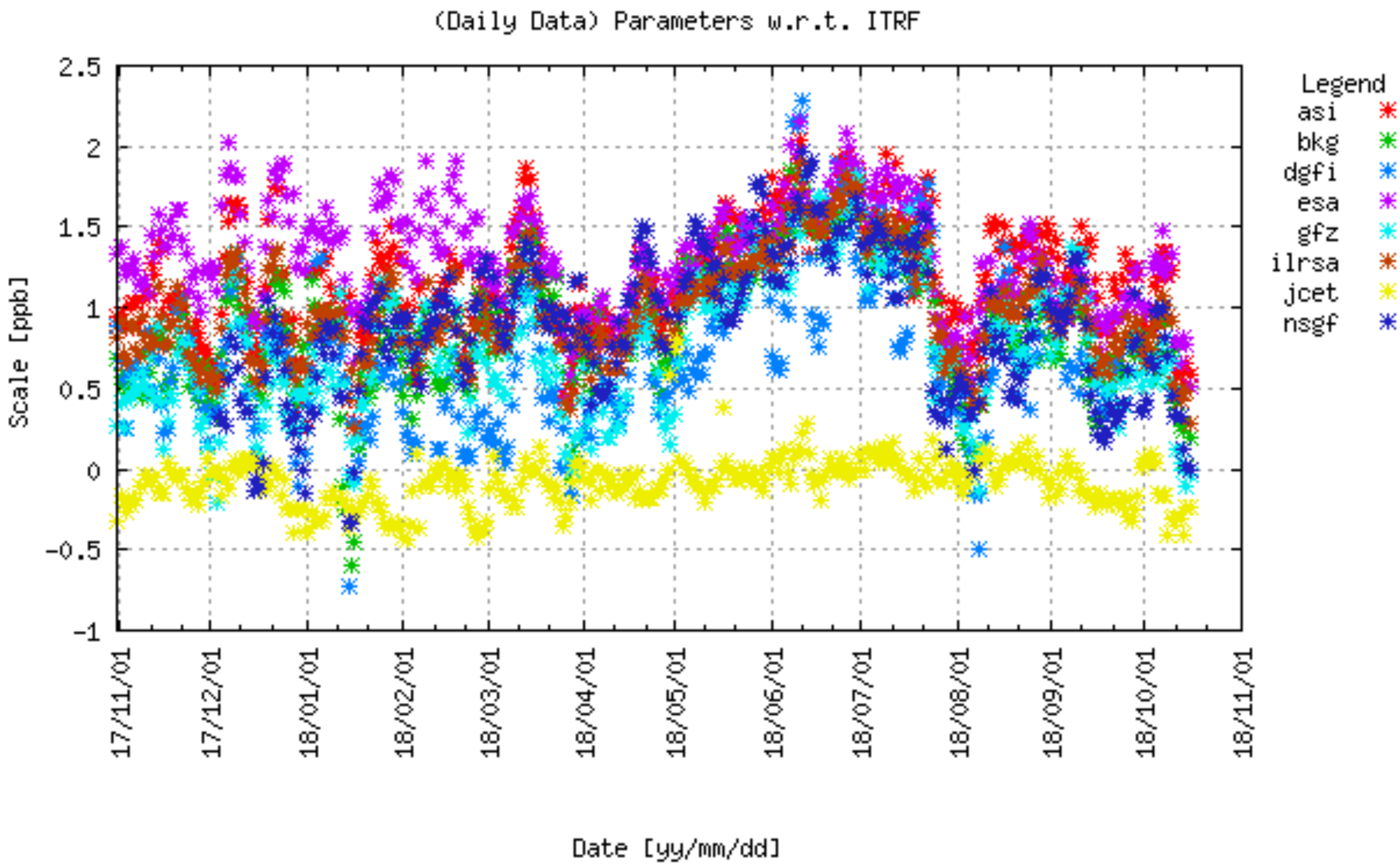
Daily solutions



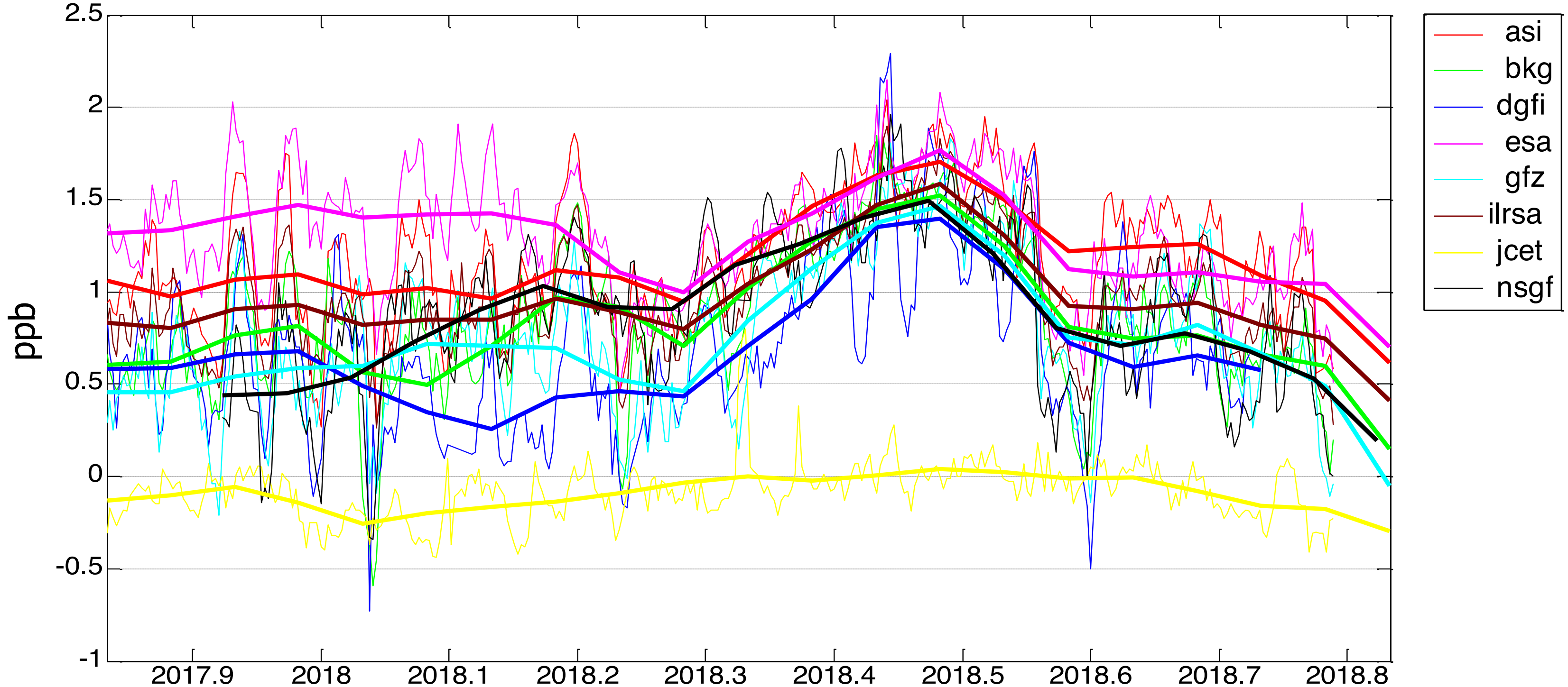
Weekly solutions



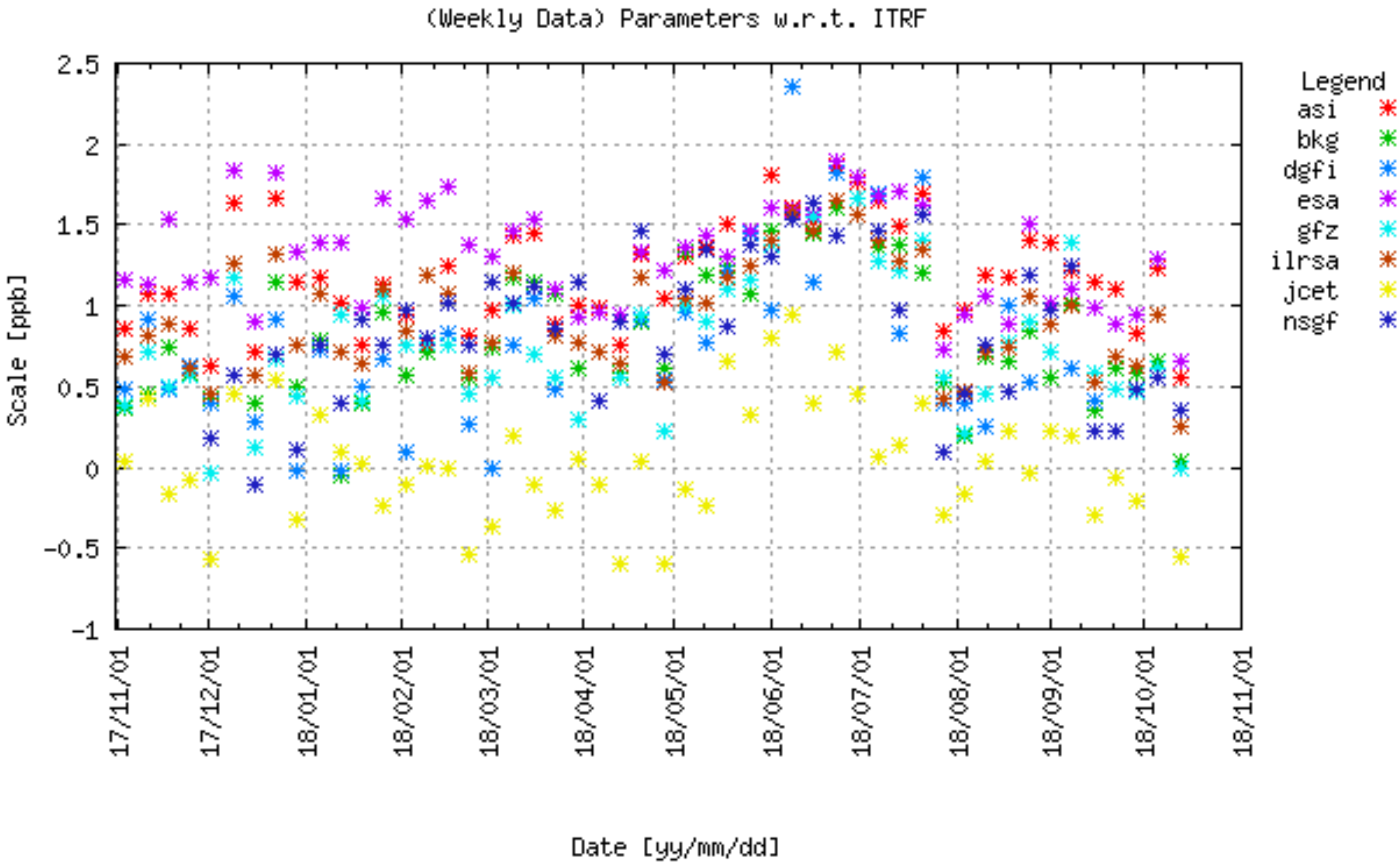
Scale from daily solutions



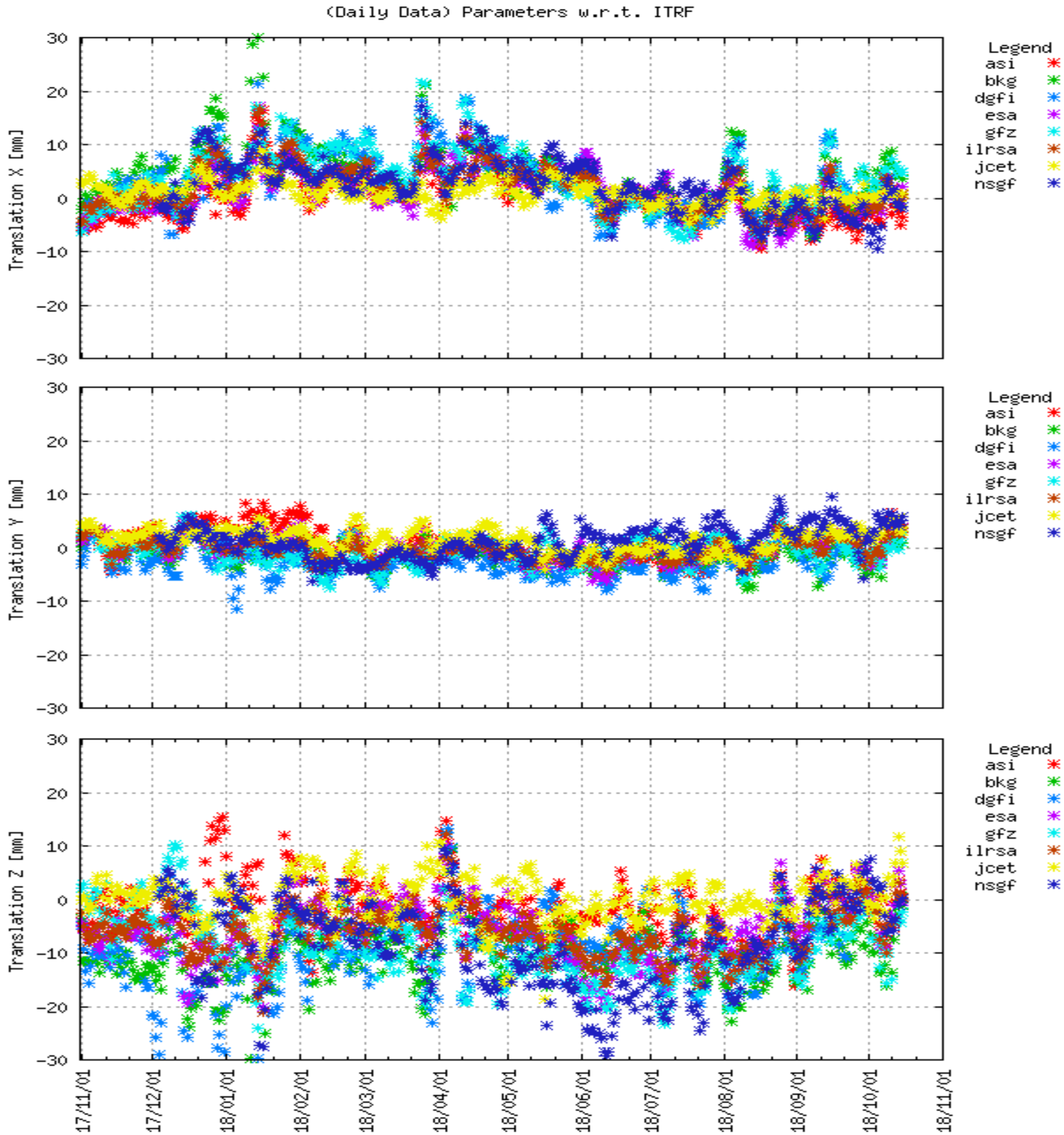
Scale from daily solutions



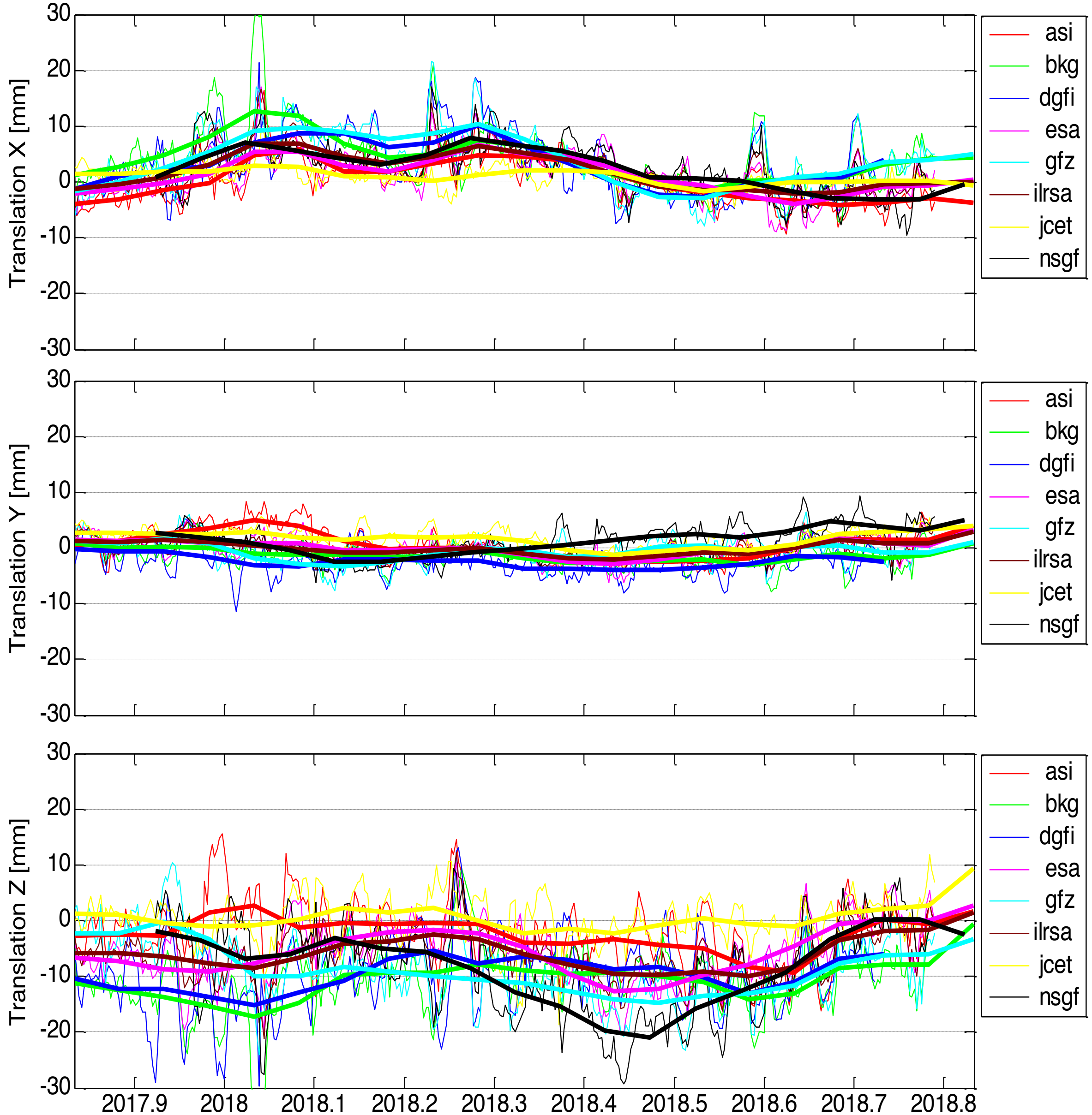
Scale from weekly solutions



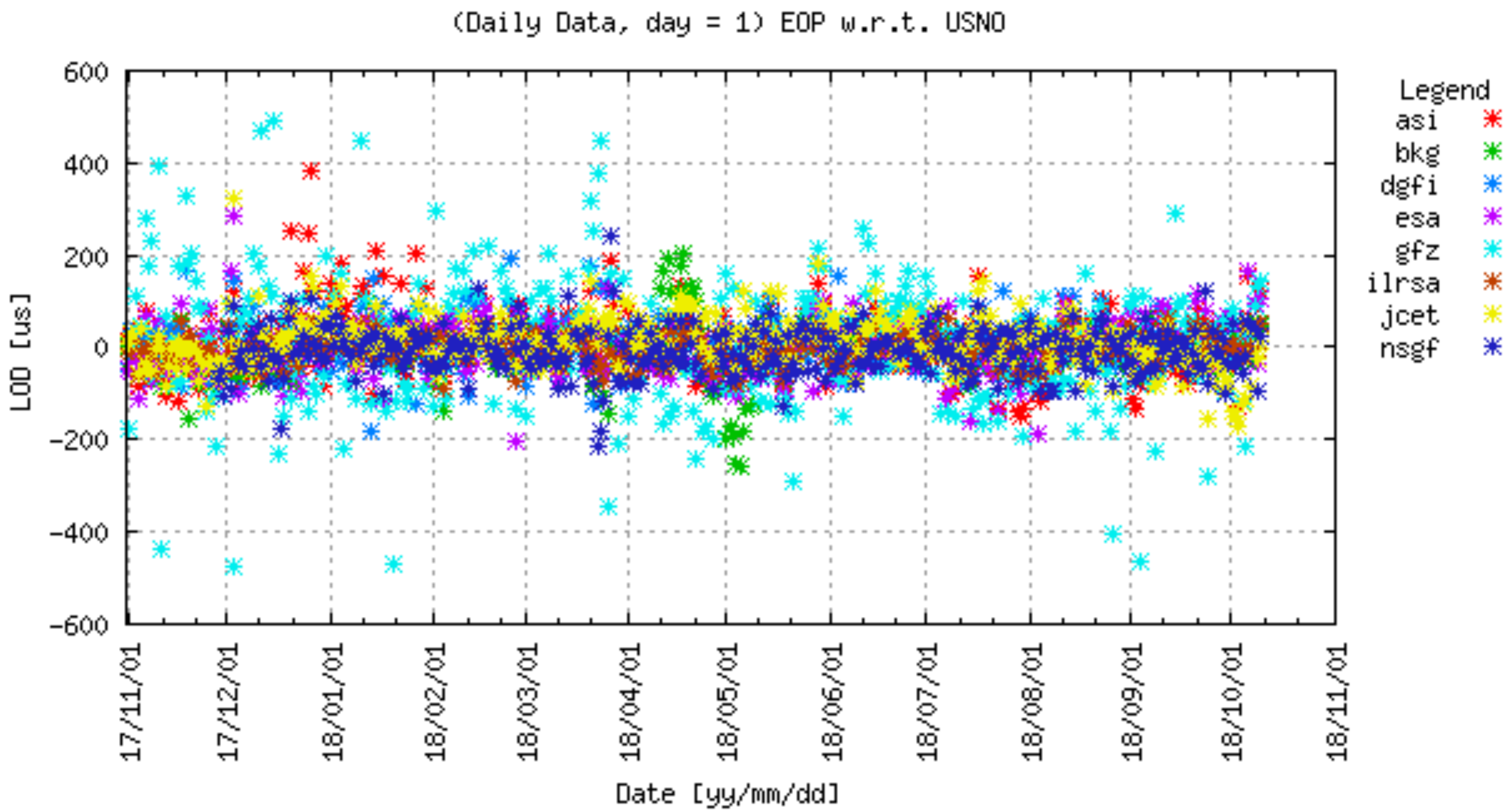
Geocenter motion from daily solutions



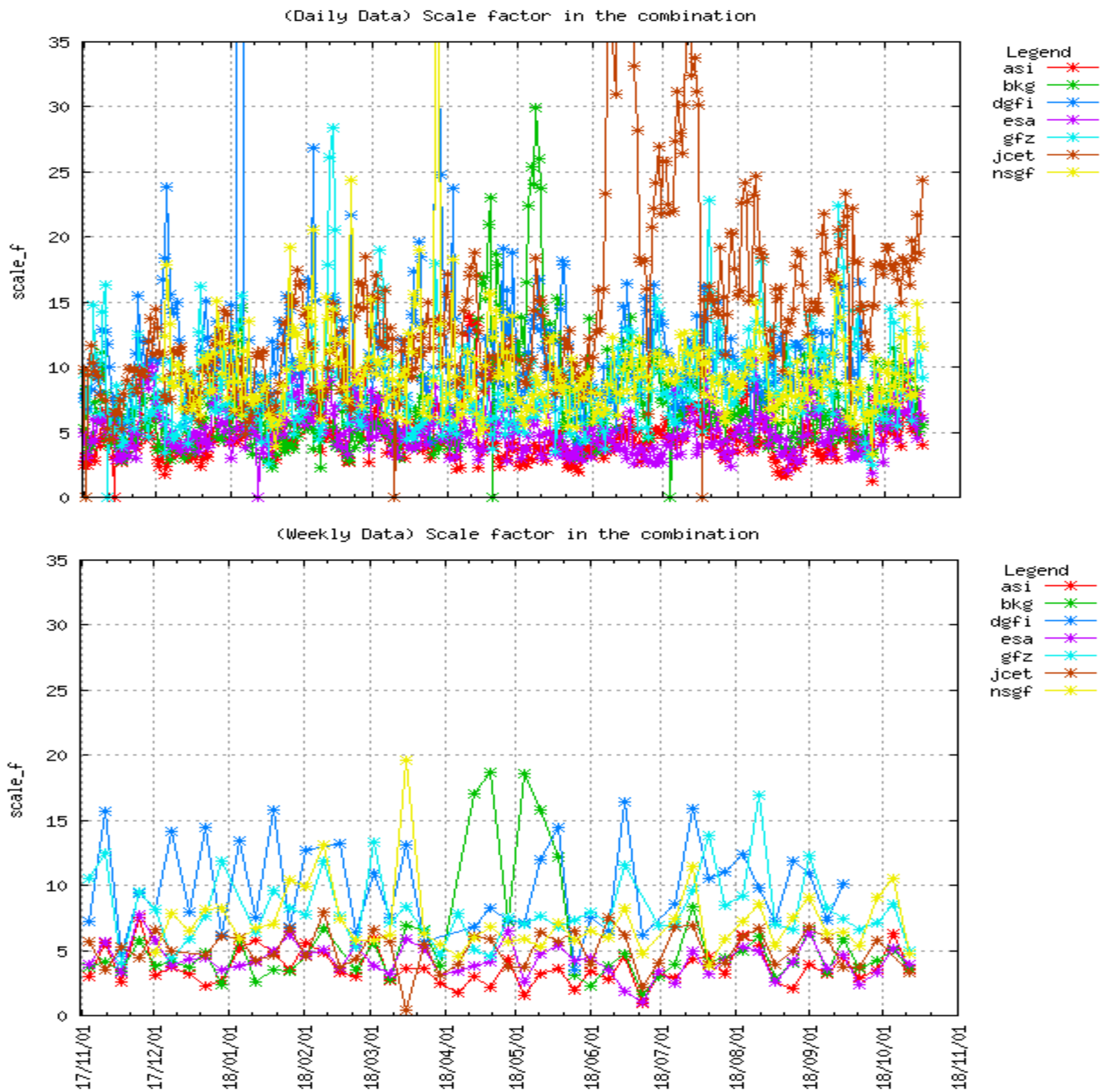
Geocenter motion from daily solutions



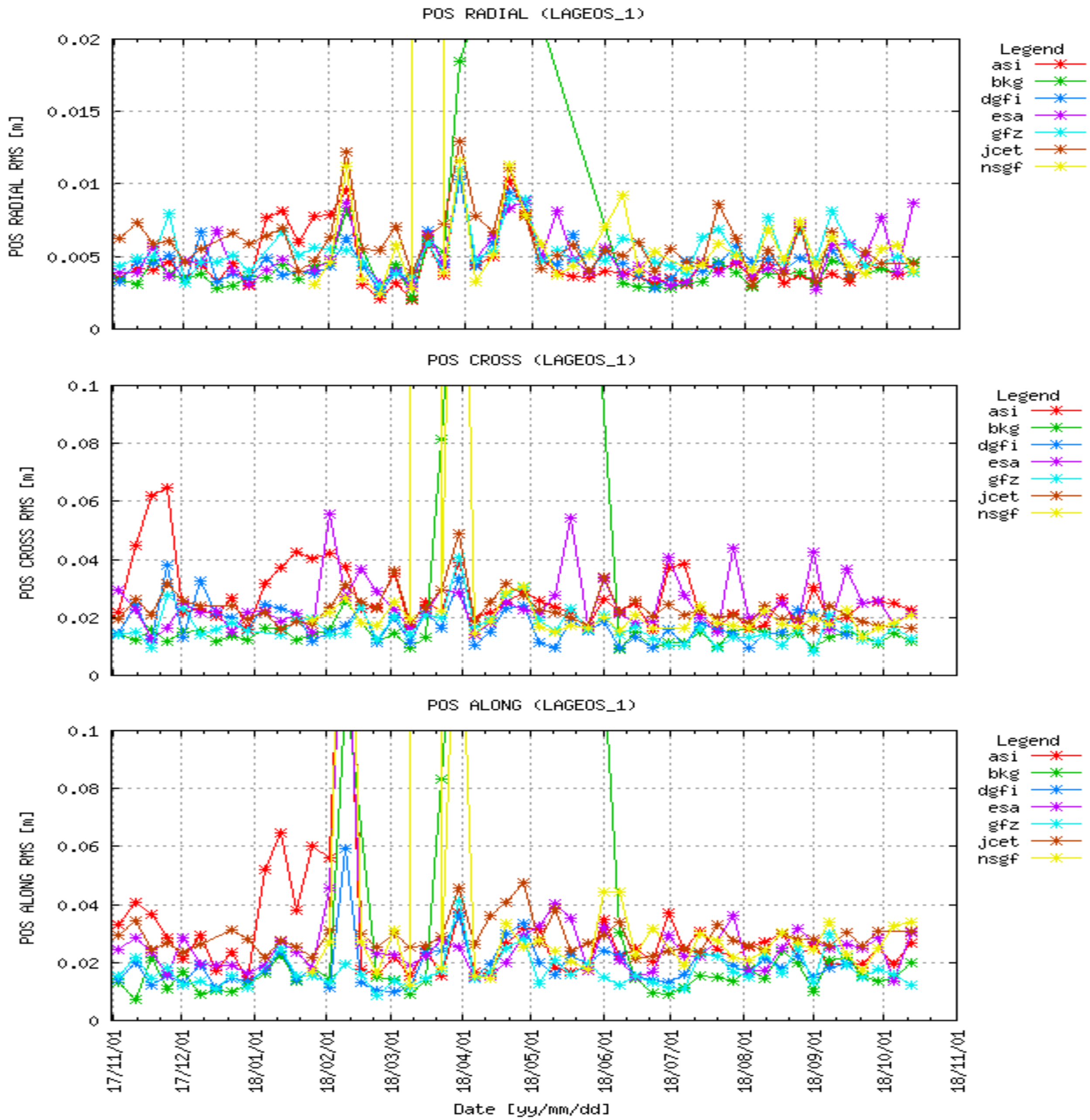
LOD from daily solutions



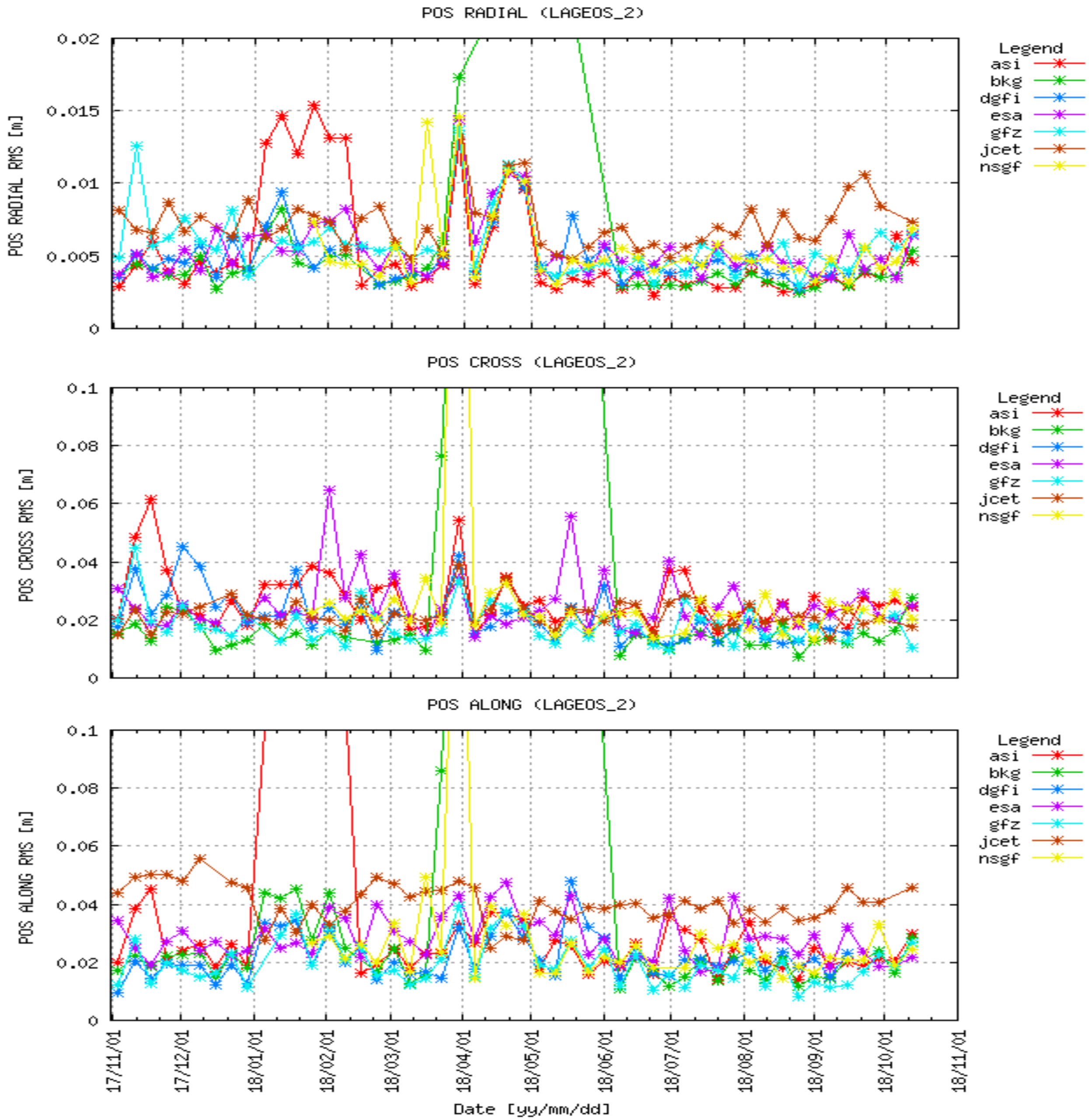
Combination scale factor



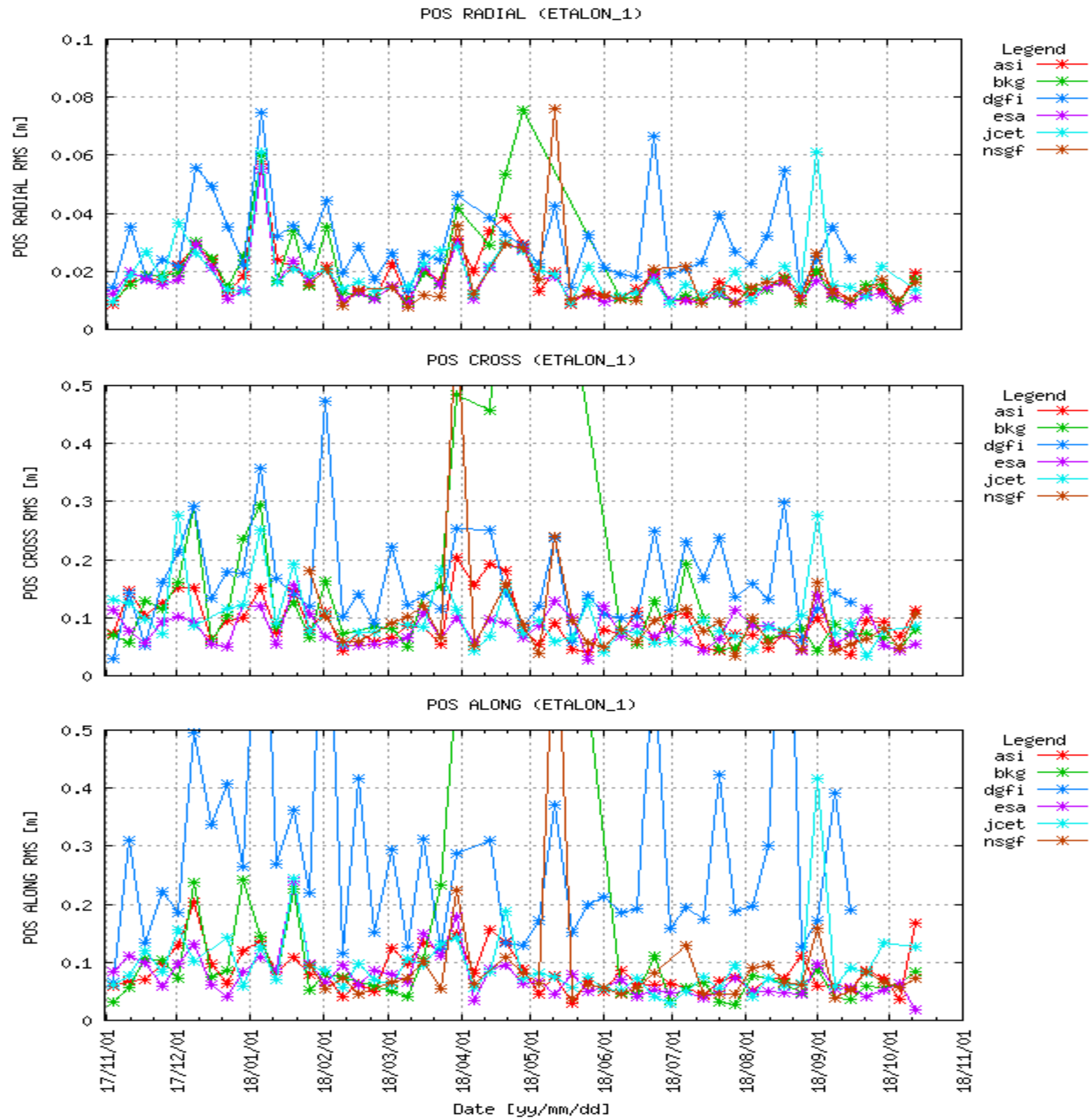
LAGEOS1 orbits – RMS of residuals w.r.t. combination



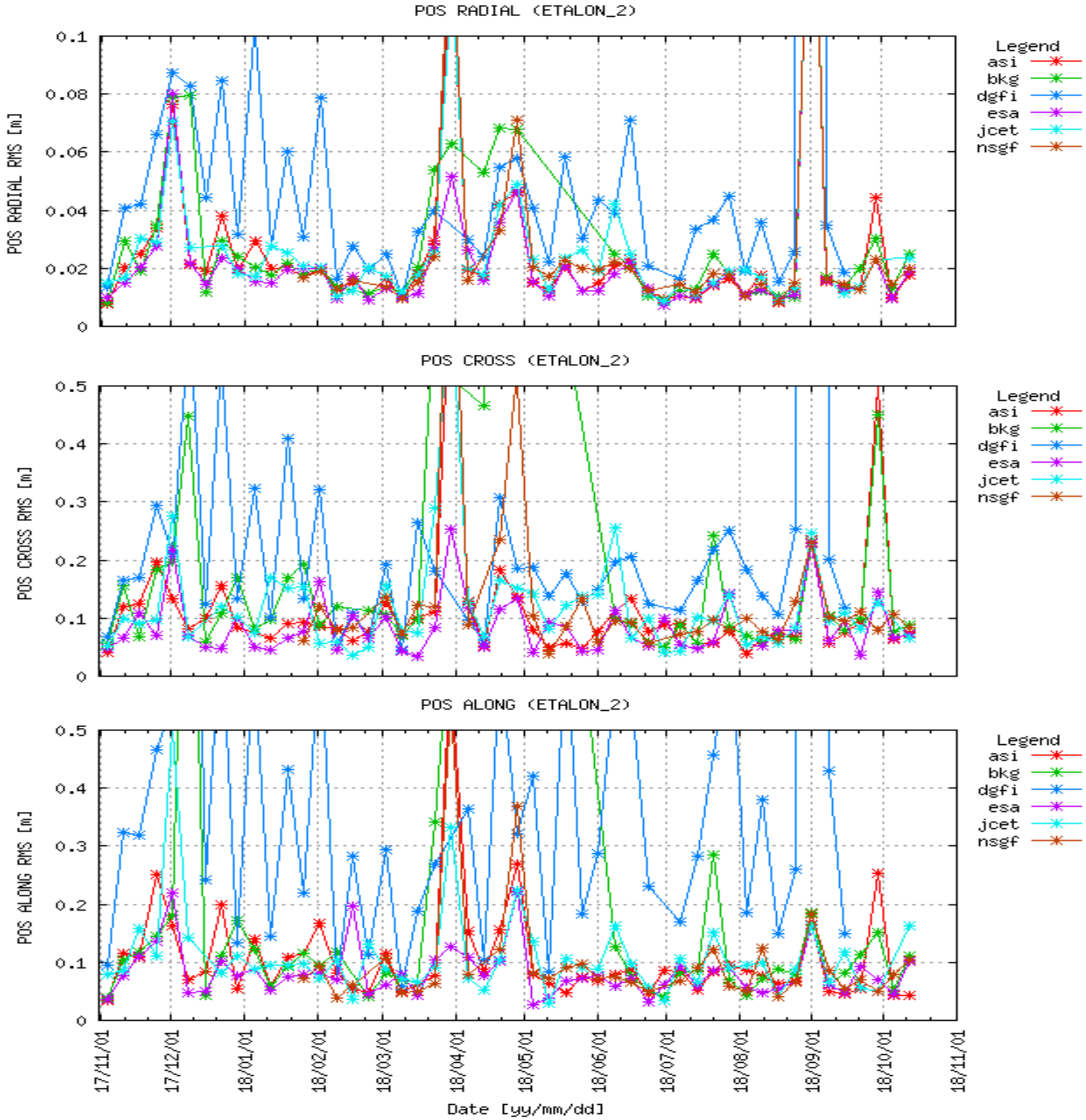
LAGEOS2 orbits – RMS of residuals w.r.t. combination



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



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



ILRS ACs orbit agreement

Satellite	Radial [mm]	Cross-track [mm]	Along-track [mm]
LAGEOS1	5	24	26
LAGEOS2	6	25	31
ETALON1	19 17*	100 91*	104 82*
ETALON2	24 23*	106 99*	111 90*

Mean RMS over the period 2017/11/01-2018/10/18

* DGFI not included

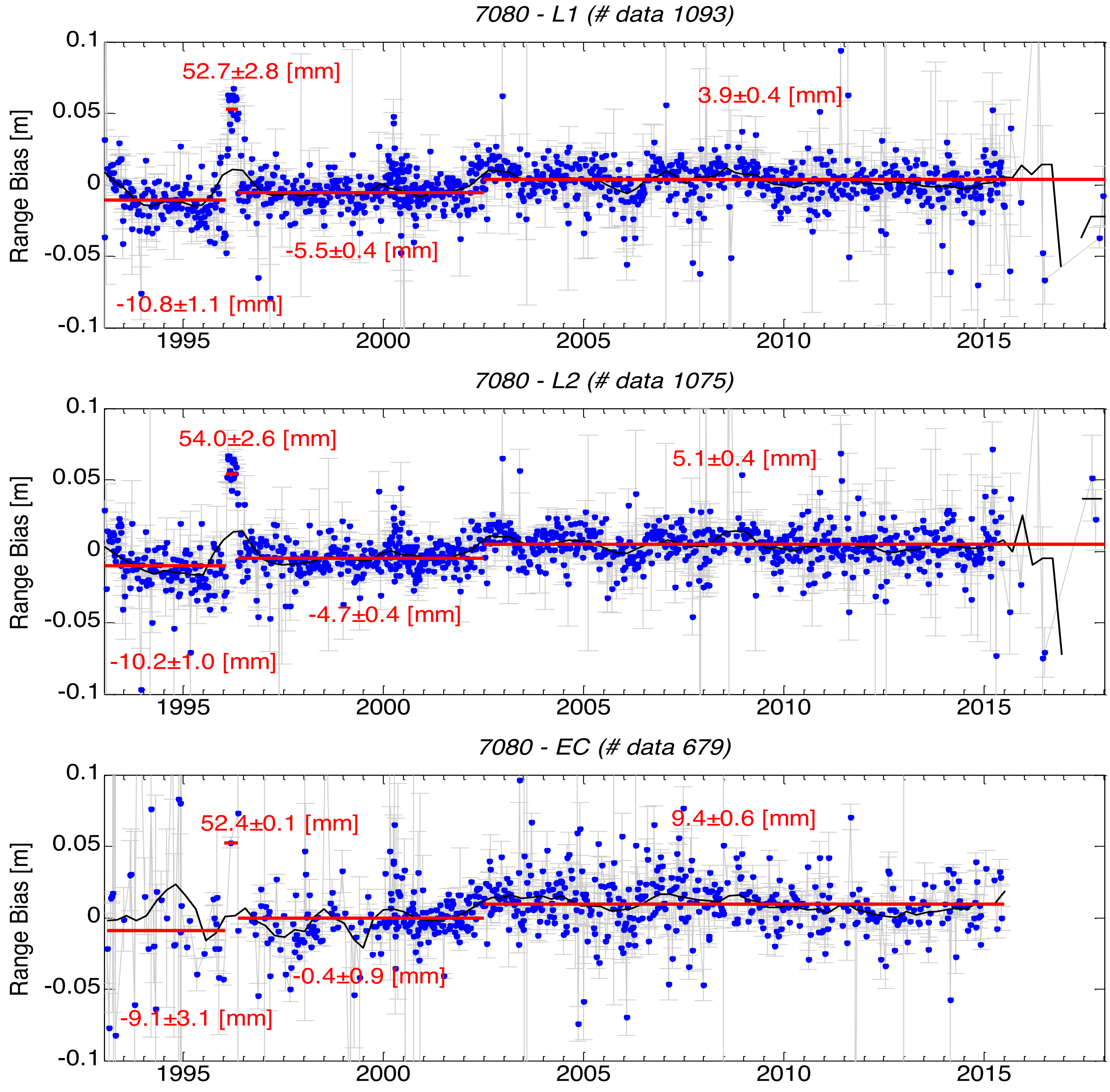
SYSTEMATIC ERROR PILOT PROJECT

ILRS Pilot Project on systematic errors

- Weekly estimation of coordinates, EOP and biases
- Time frame: 1993-2018 (25 years, 1305 weeks)
- Data: L1, L2 and EC
- New convention for solution identication number SOLN in the SINEX files (the hundreds of the wavelength in nm is added to the solution number)
- Combination
- Site by site investigation (out of 107) to detect discontinuities in the time series for L1, L2 and EC

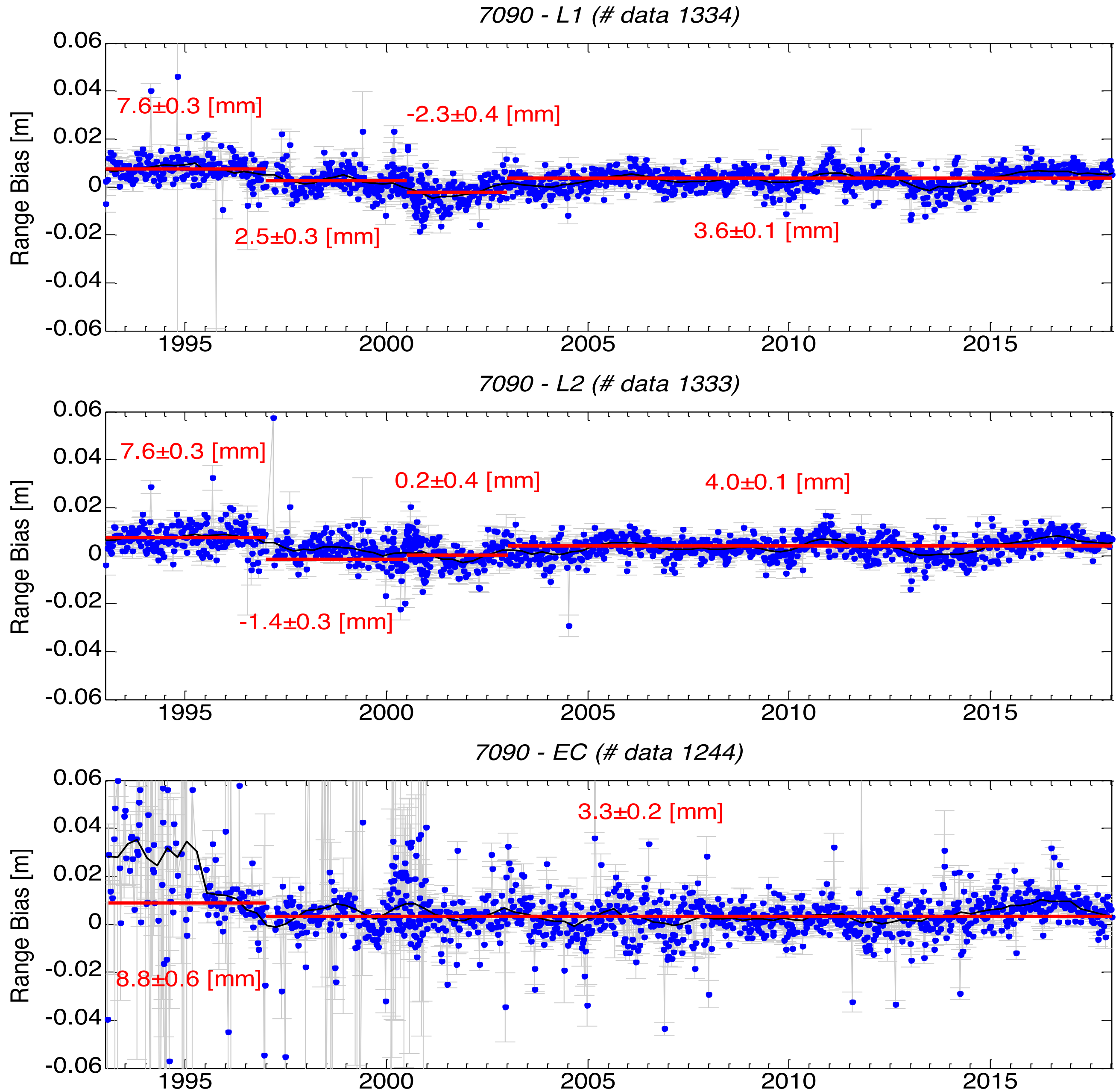
Range Bias time series for Core Stations

7080
McDonald Observatory
Texas, USA
Operational



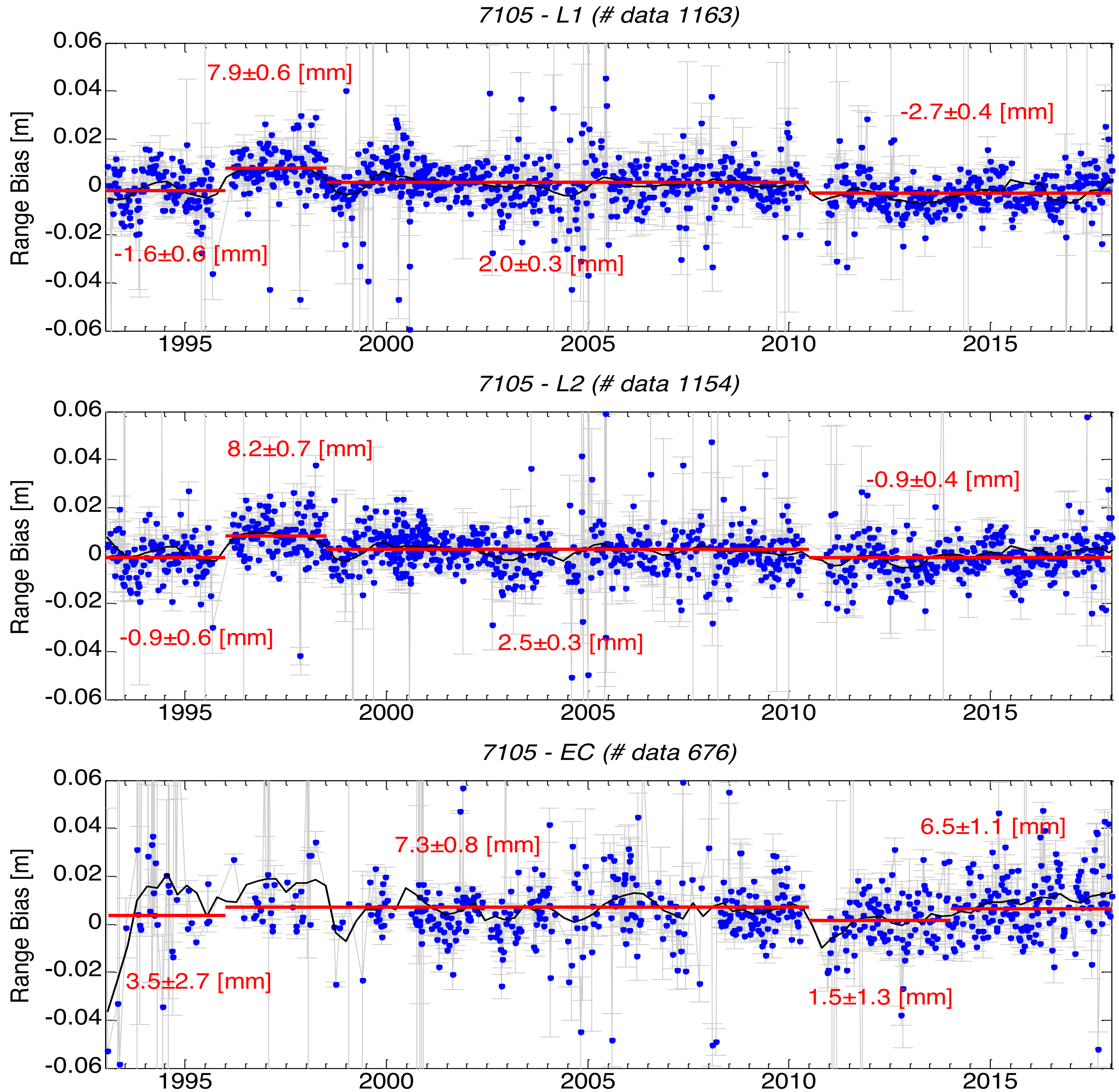
Range Bias time series for Core Stations

7090
Yarragadee
Australia
Operational



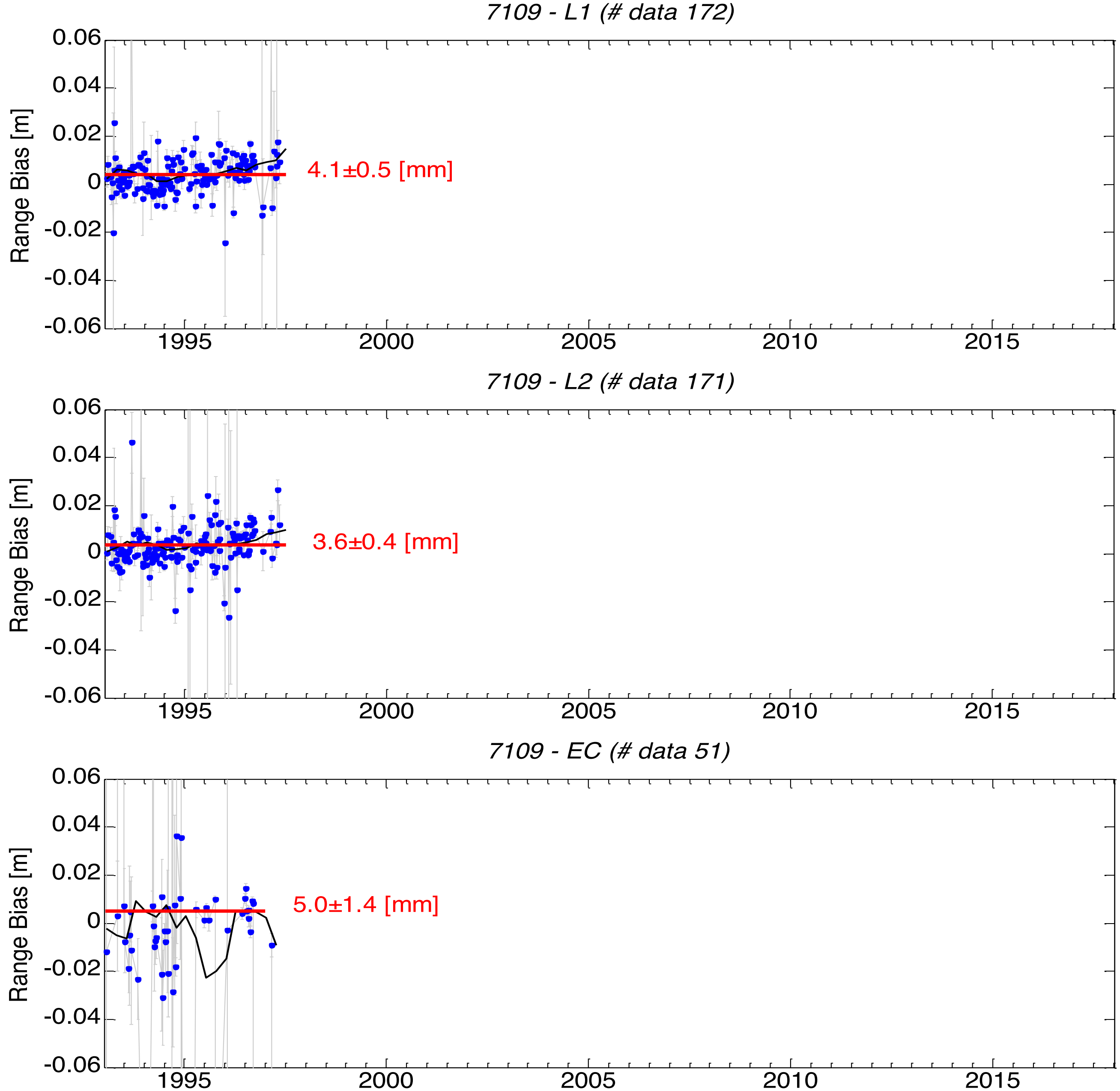
Range Bias time series for Core Stations

7105
Greenbelt
Maryland, USA
Operational



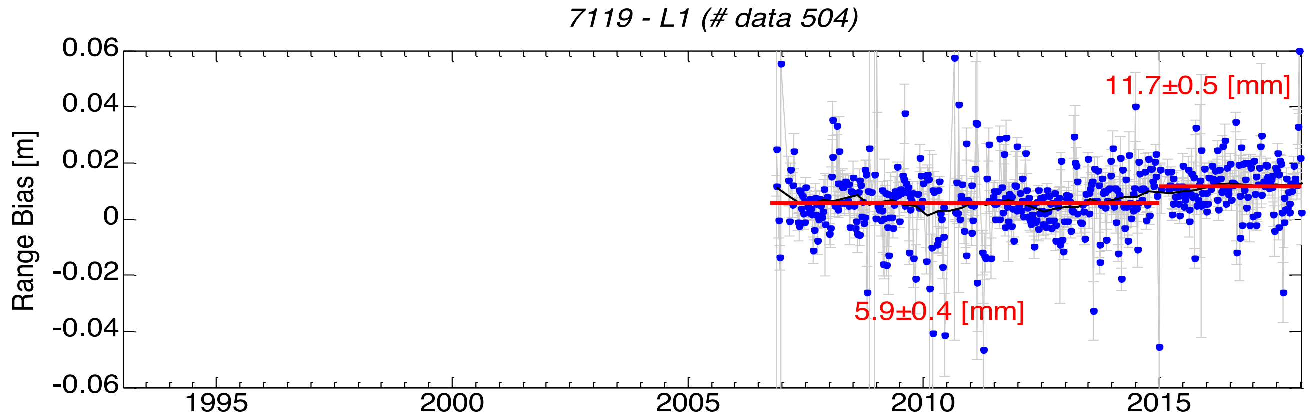
Range Bias time series for Core Stations

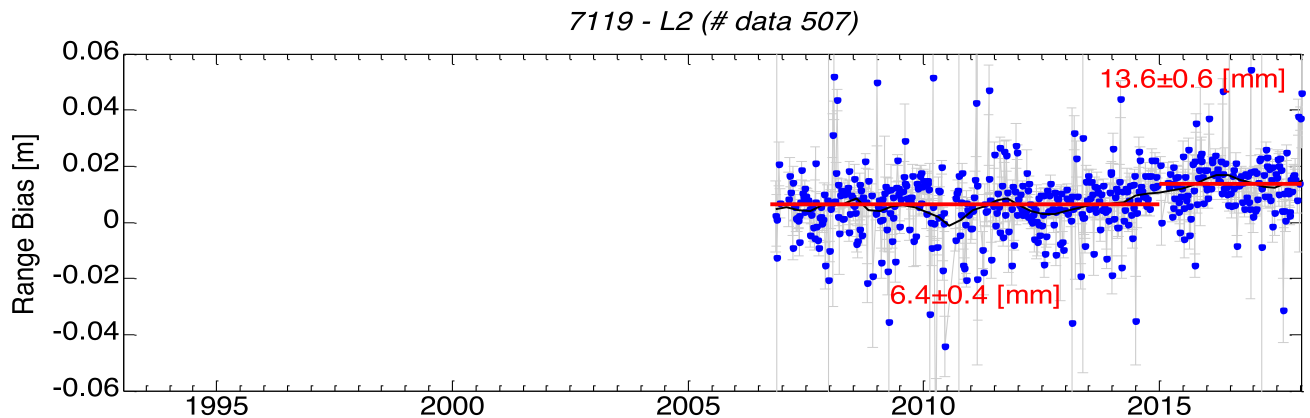
7109
Quincy
USA
pre-ILRS



Range Bias time series for Core Stations

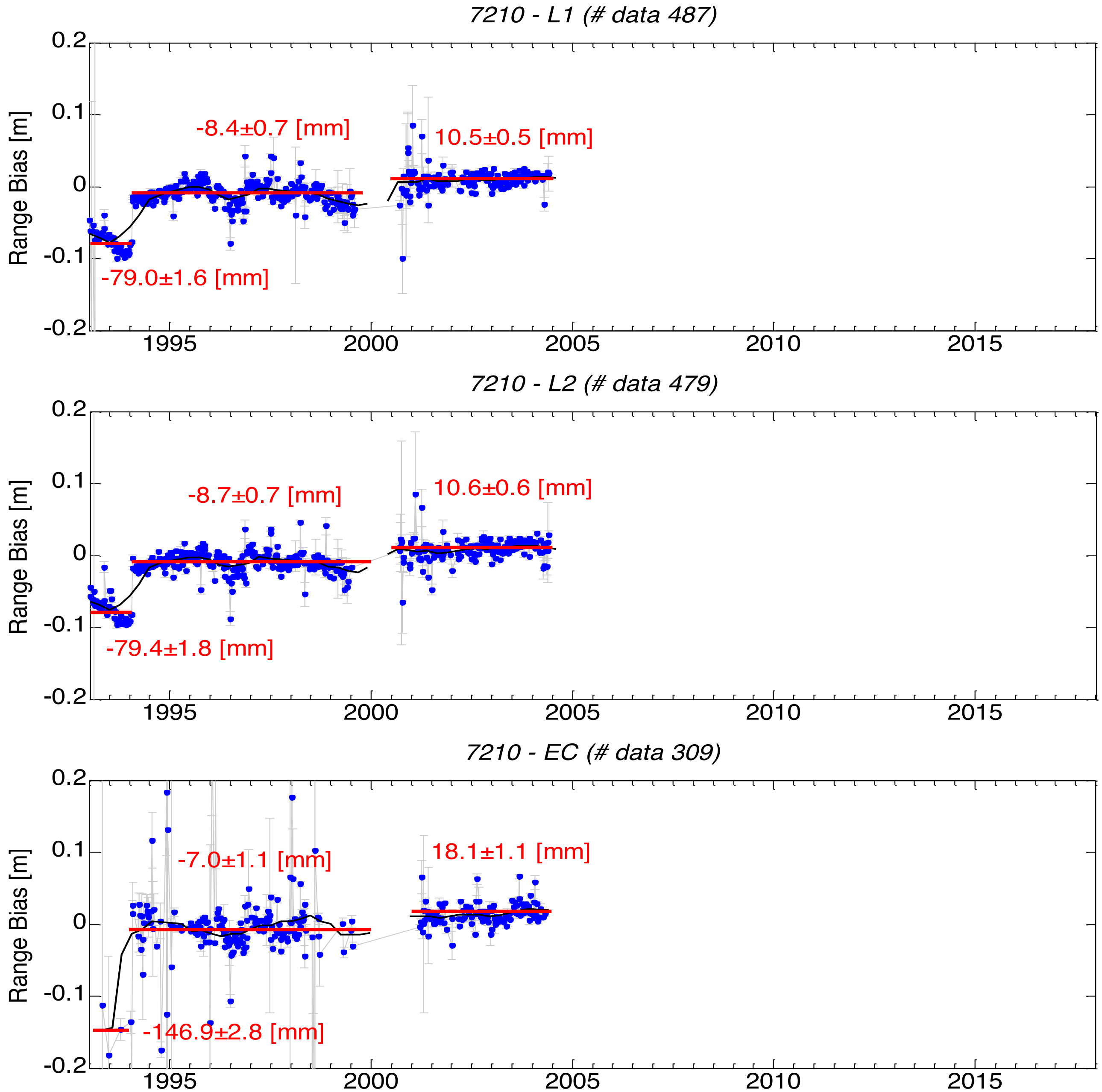
7119
Haleakala
Hawaii, USA
Operational





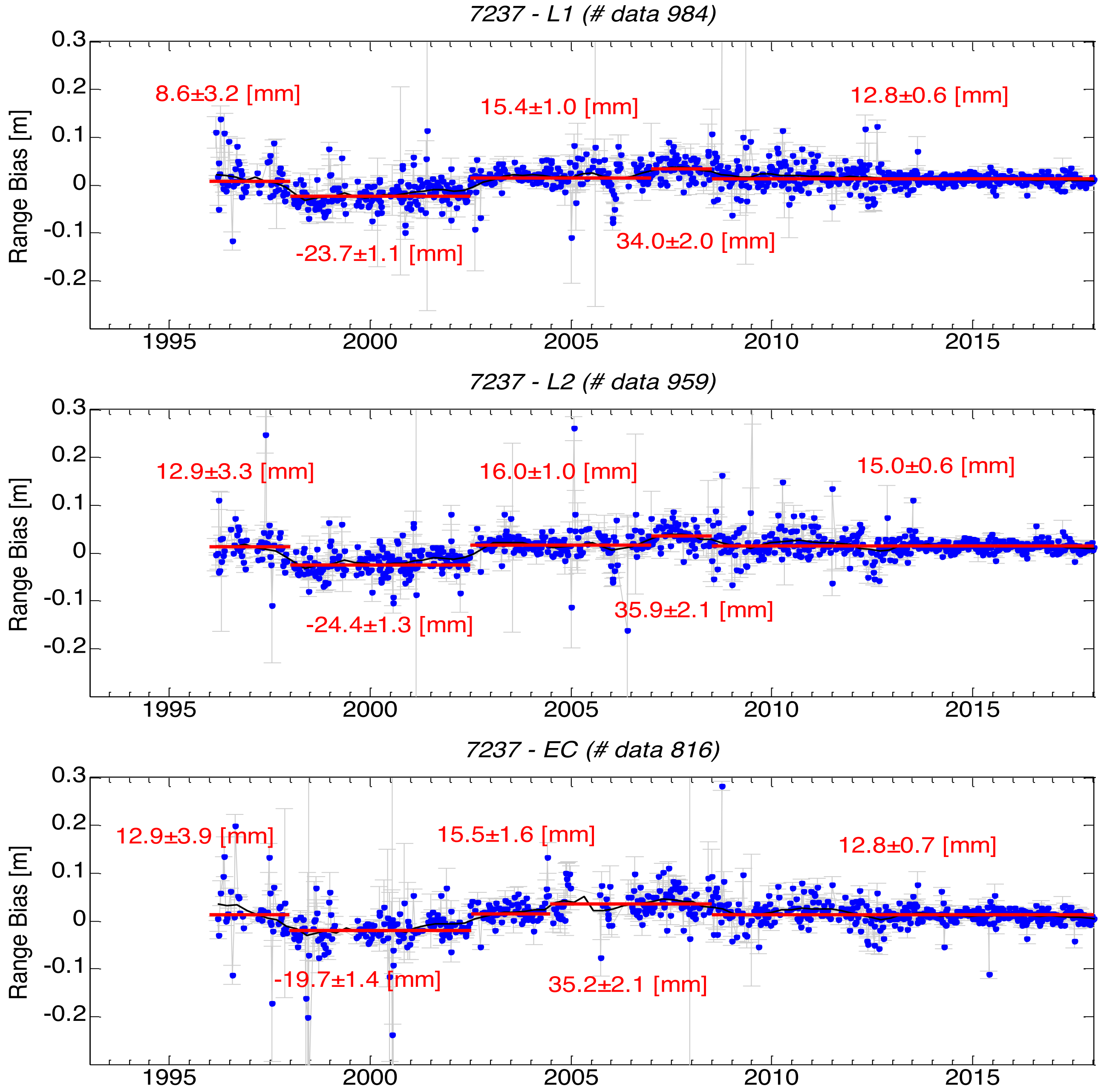
Range Bias time series for Core Stations

7210
Haleakala
Hawaii (USA)
Closed/Inactive



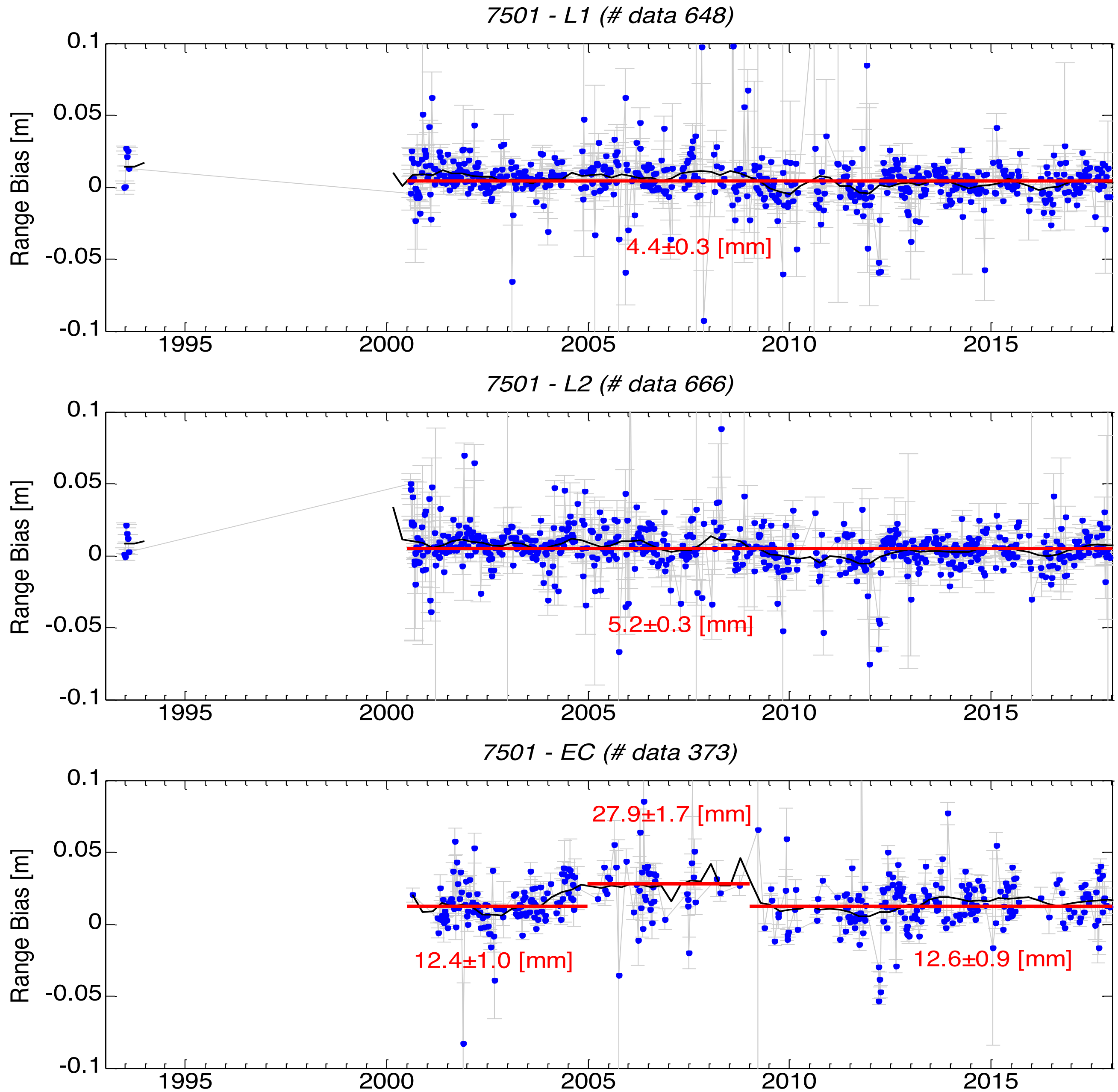
Range Bias time series for Core Stations

7237
Changchun
China
Operational



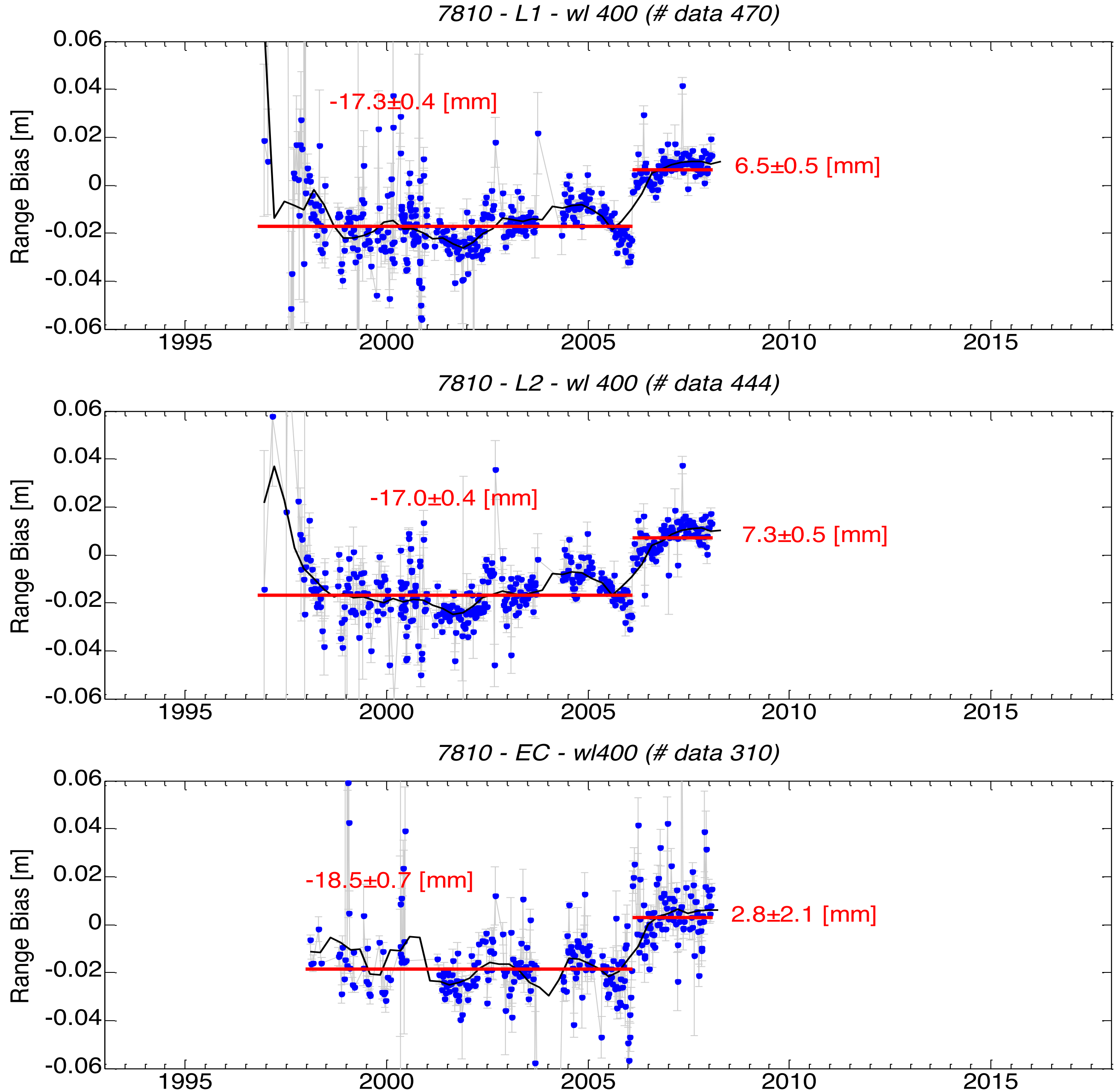
Range Bias time series for Core Stations

7501
Hartebeesthoek
South Africa
Operational



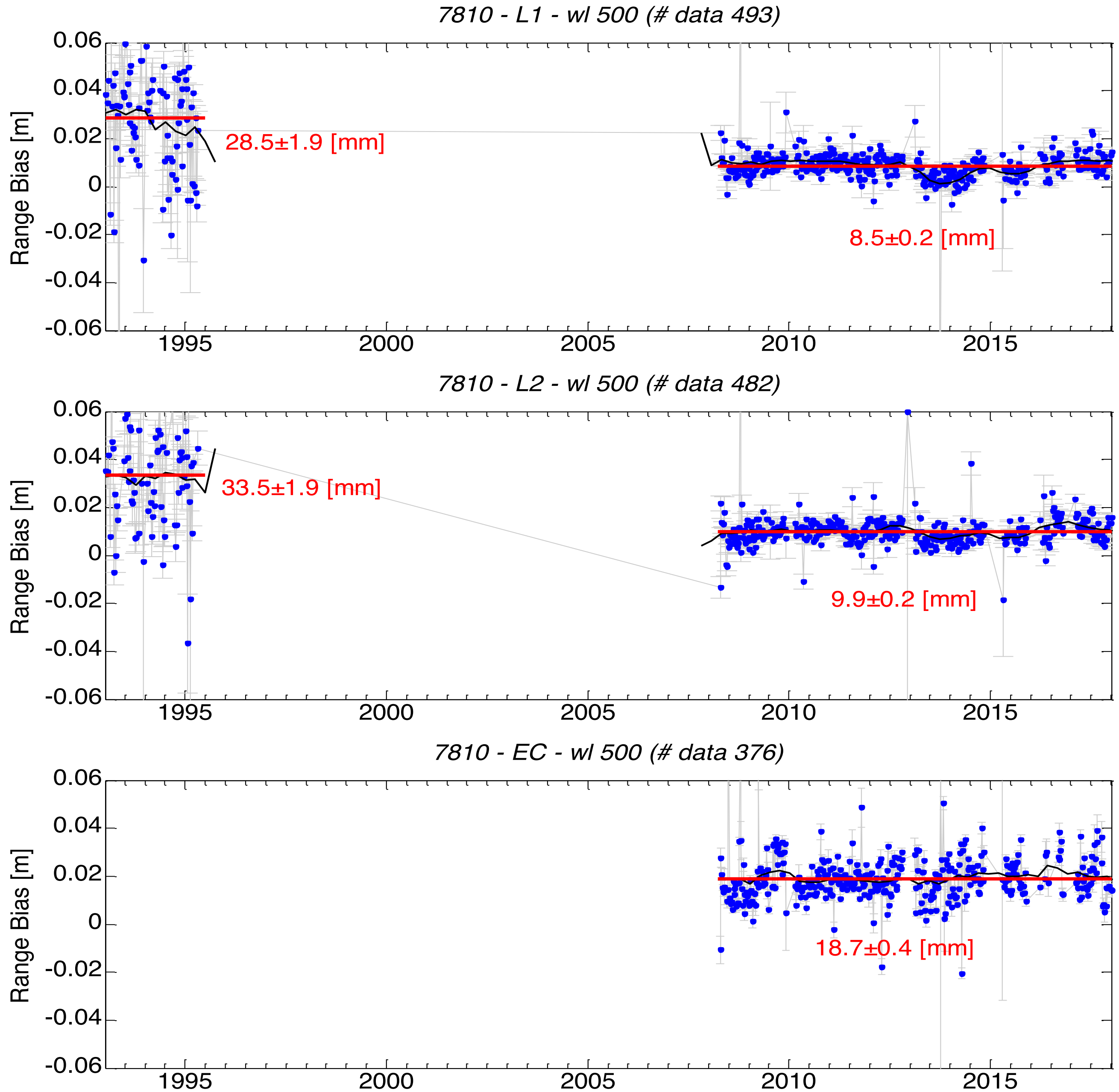
Range Bias time series for Core Stations

7810 - λ 400
Zimmerwald
Switzerland
Operational



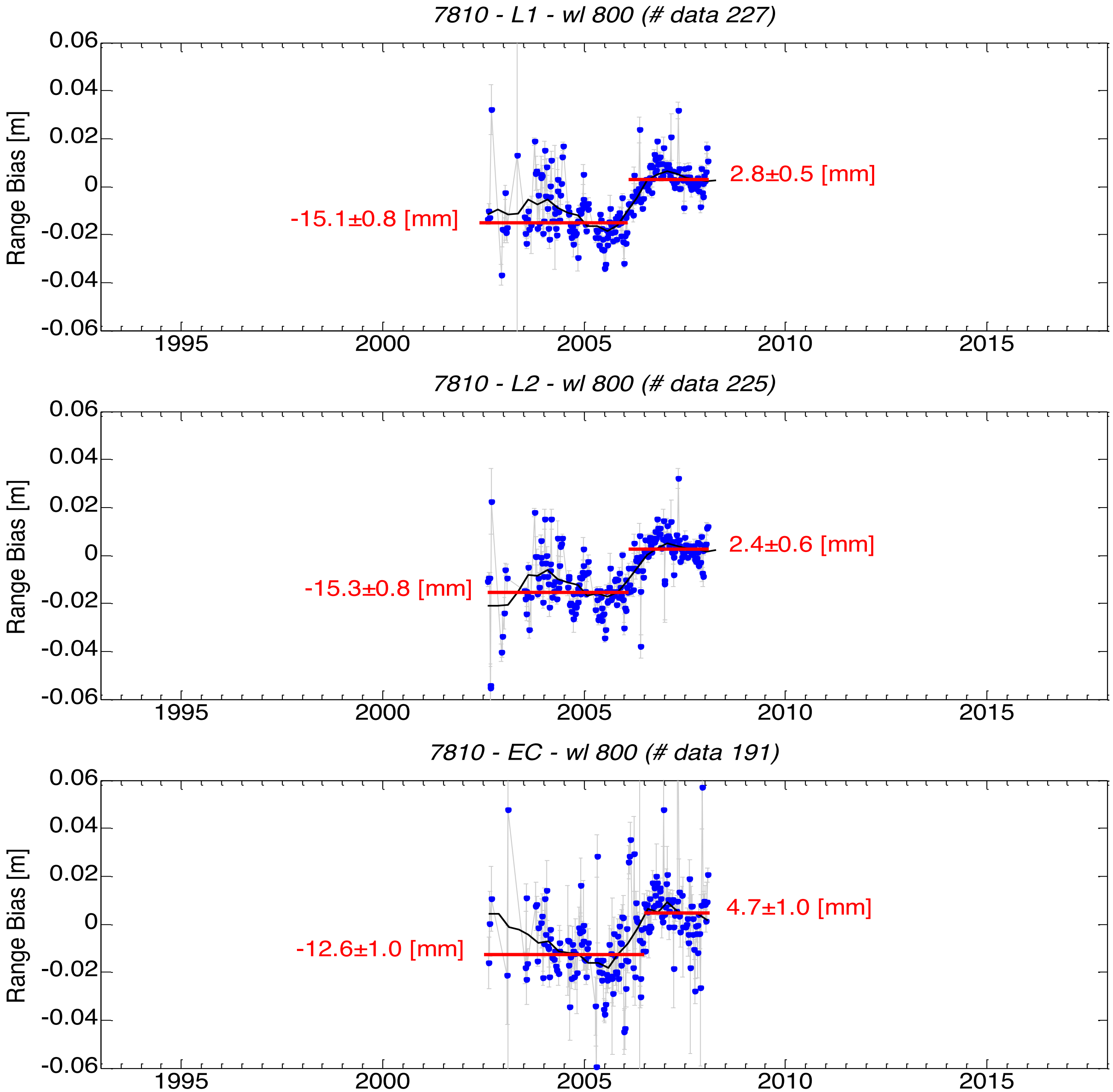
Range Bias time series for Core Stations

7810 - λ 500
Zimmerwald
Switzerland
Operational



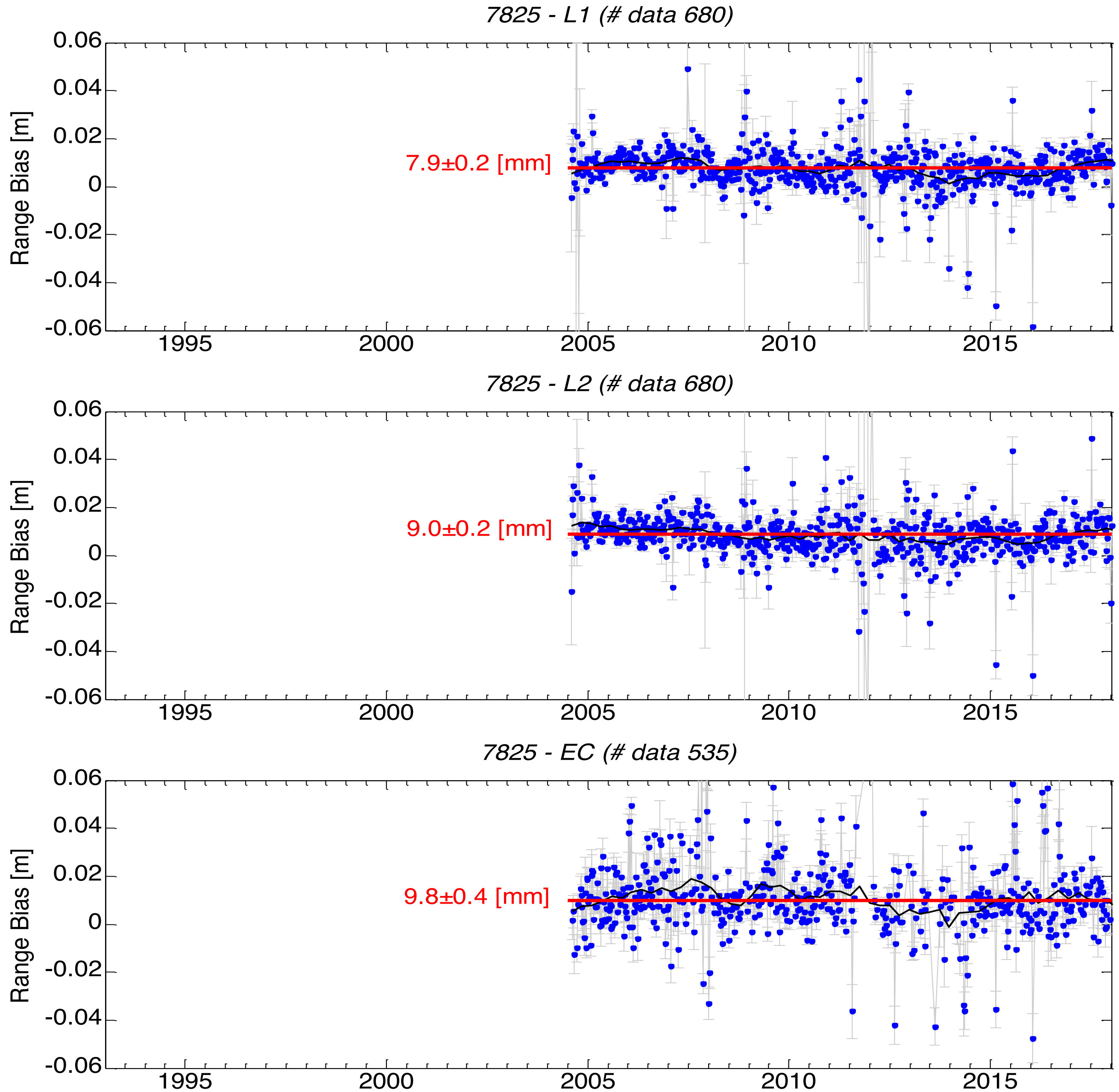
Range Bias time series for Core Stations

7810 - λ 800
Zimmerwald
Switzerland
Operational



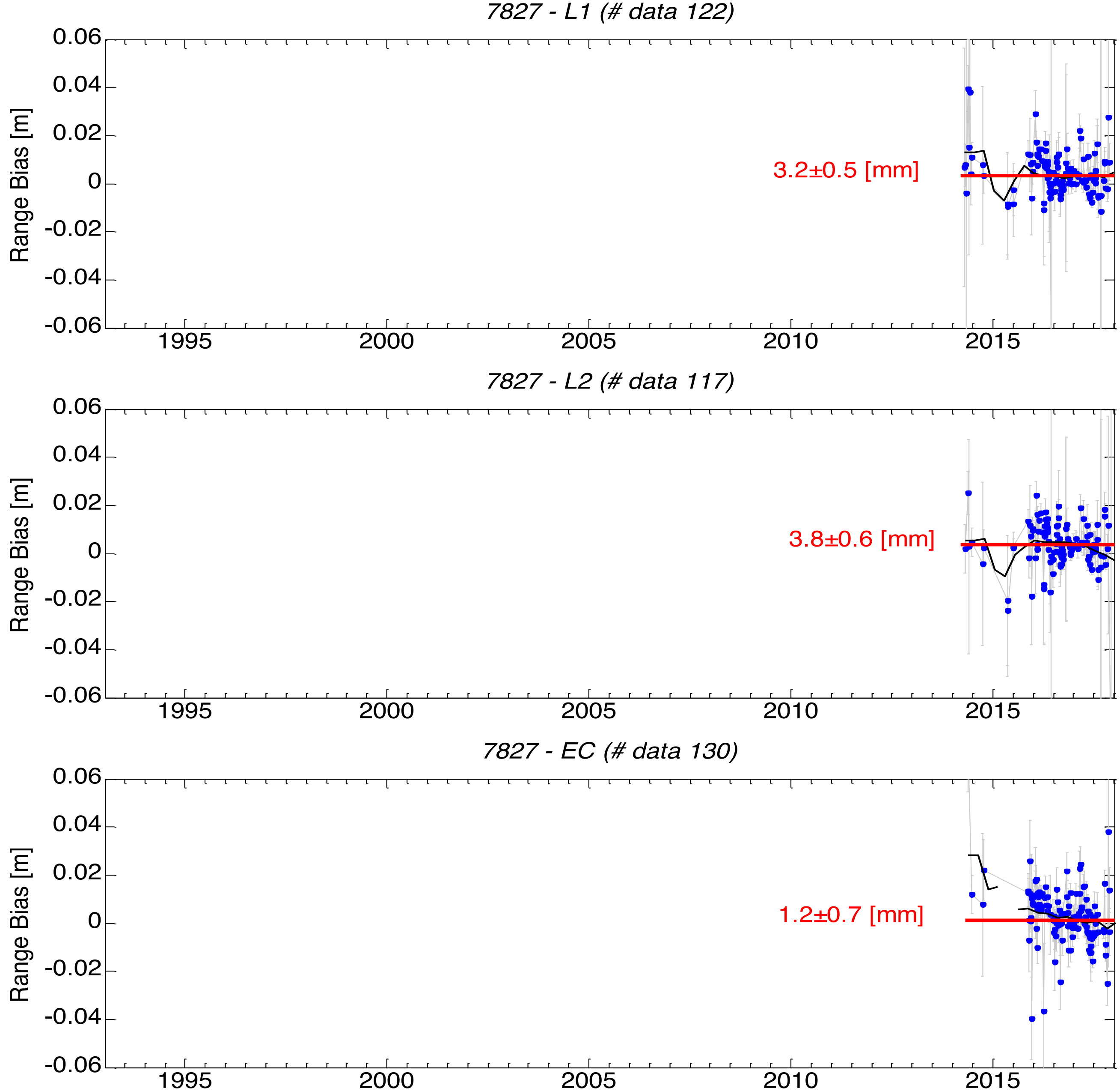
Range Bias time series for Core Stations

7825
Mt. Stromlo
Australia
Operational



Range Bias time series for Core Stations

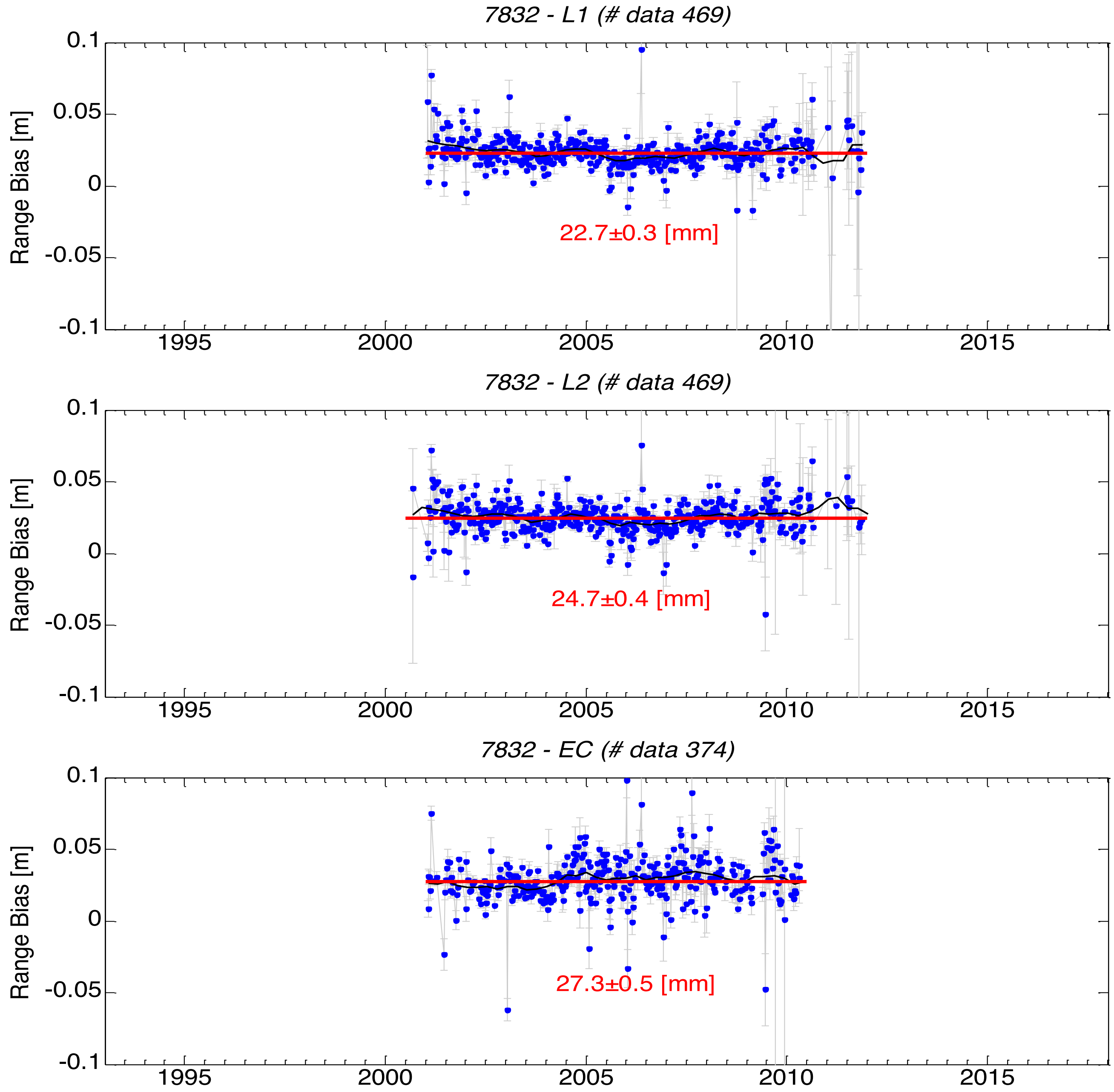
7827 (not a core station)
Wettzell
Germany
Operational



Warning for DGFI
wrong wavelength
in the SINEX
(500 instead of 800)

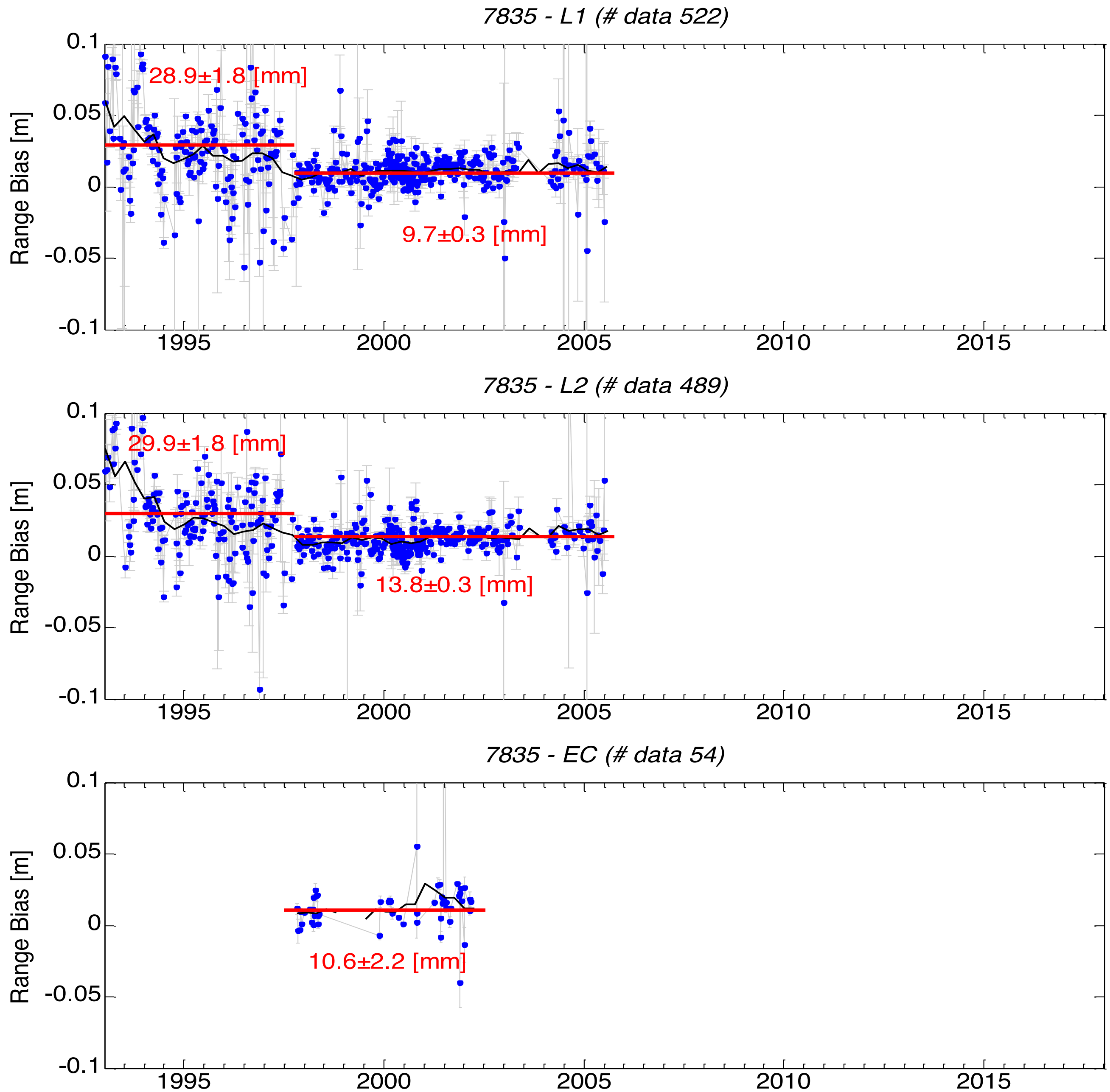
Range Bias time series for Core Stations

7832
Riyadh
Saudi Arabia
Closed/Inactive



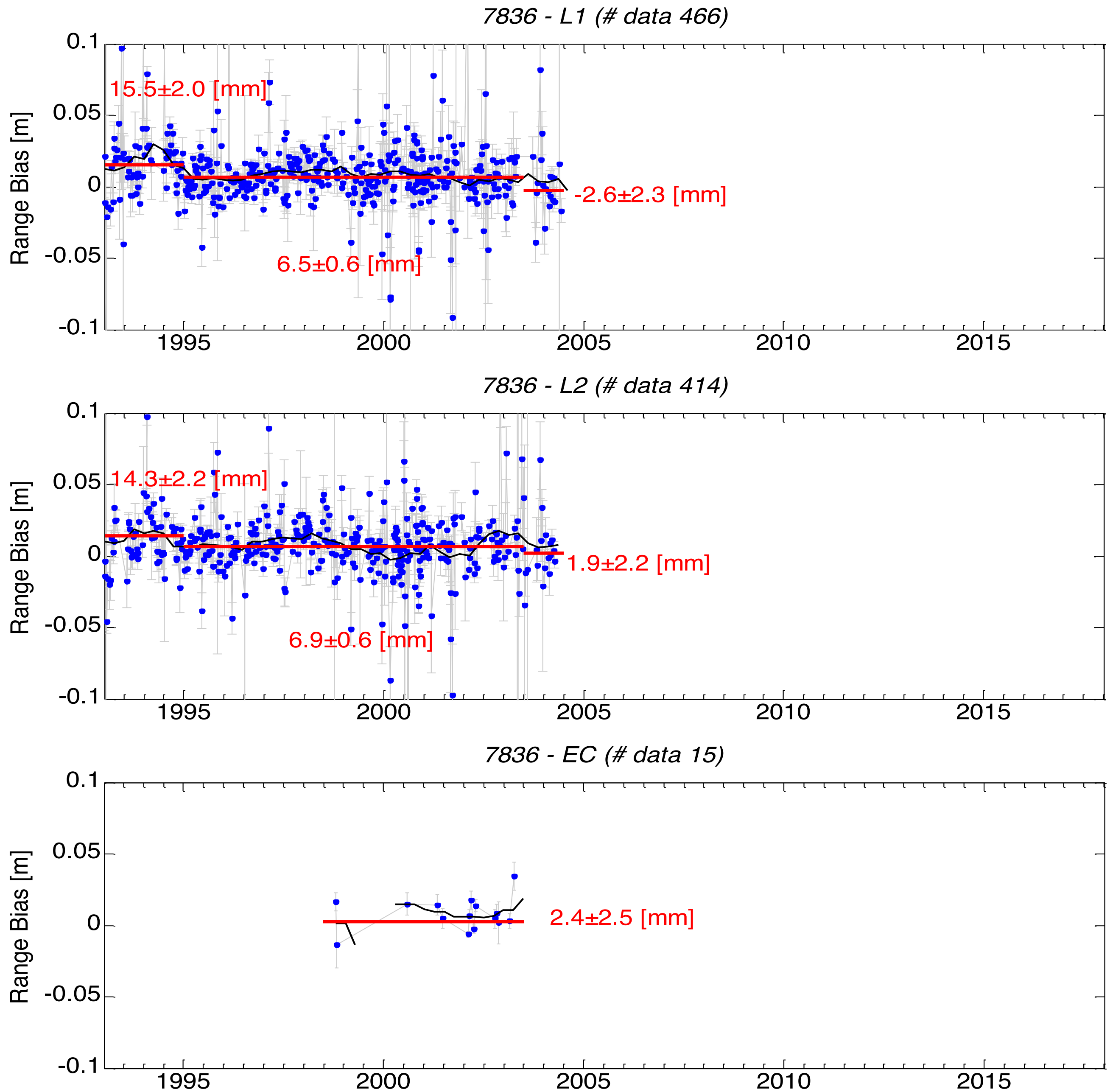
Range Bias time series for Core Stations

7835
Grasse (SLR)
France
Closed/Inactive



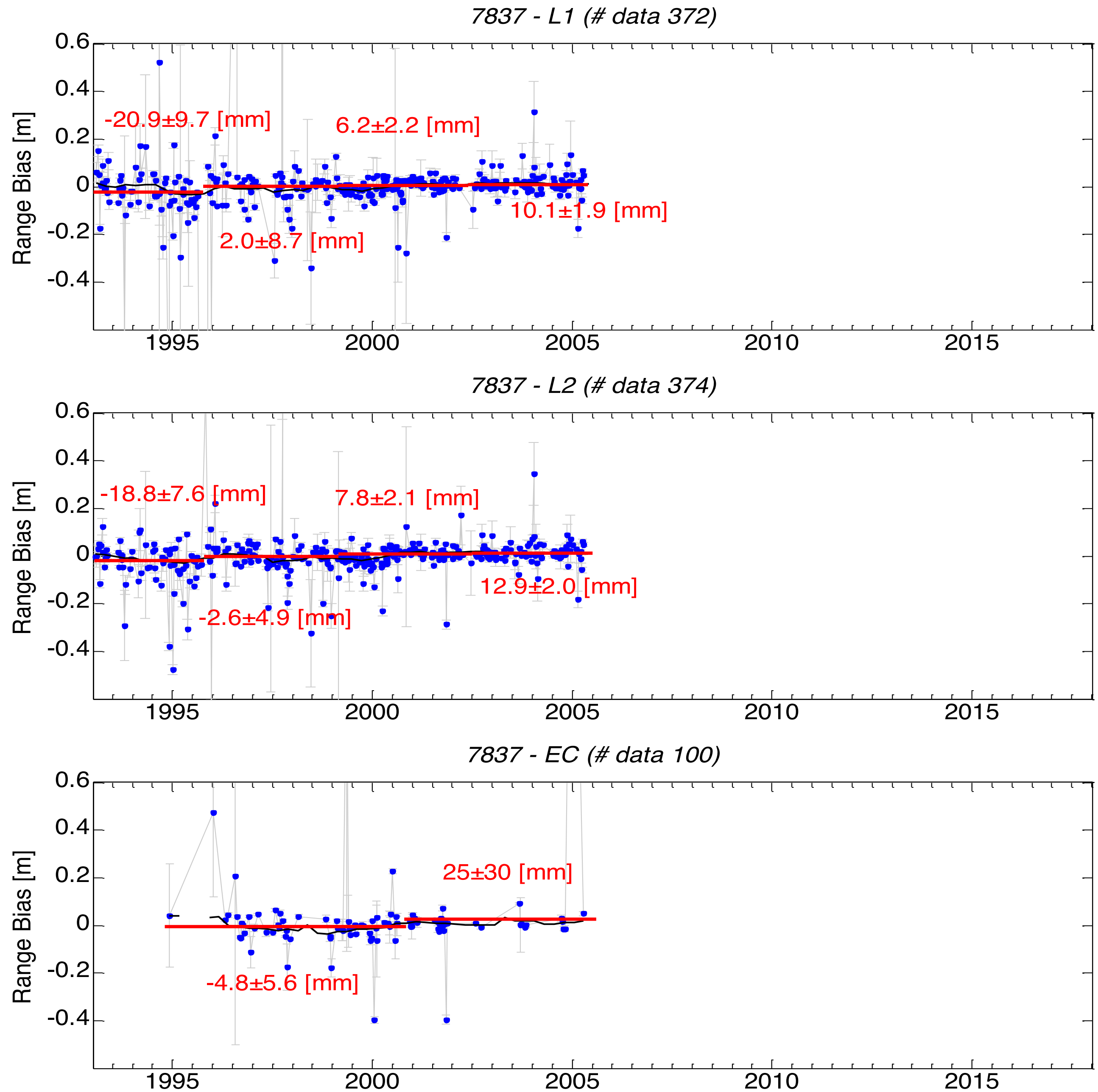
Range Bias time series for Core Stations

7836
Potsdam
Germany
Closed/Inactive



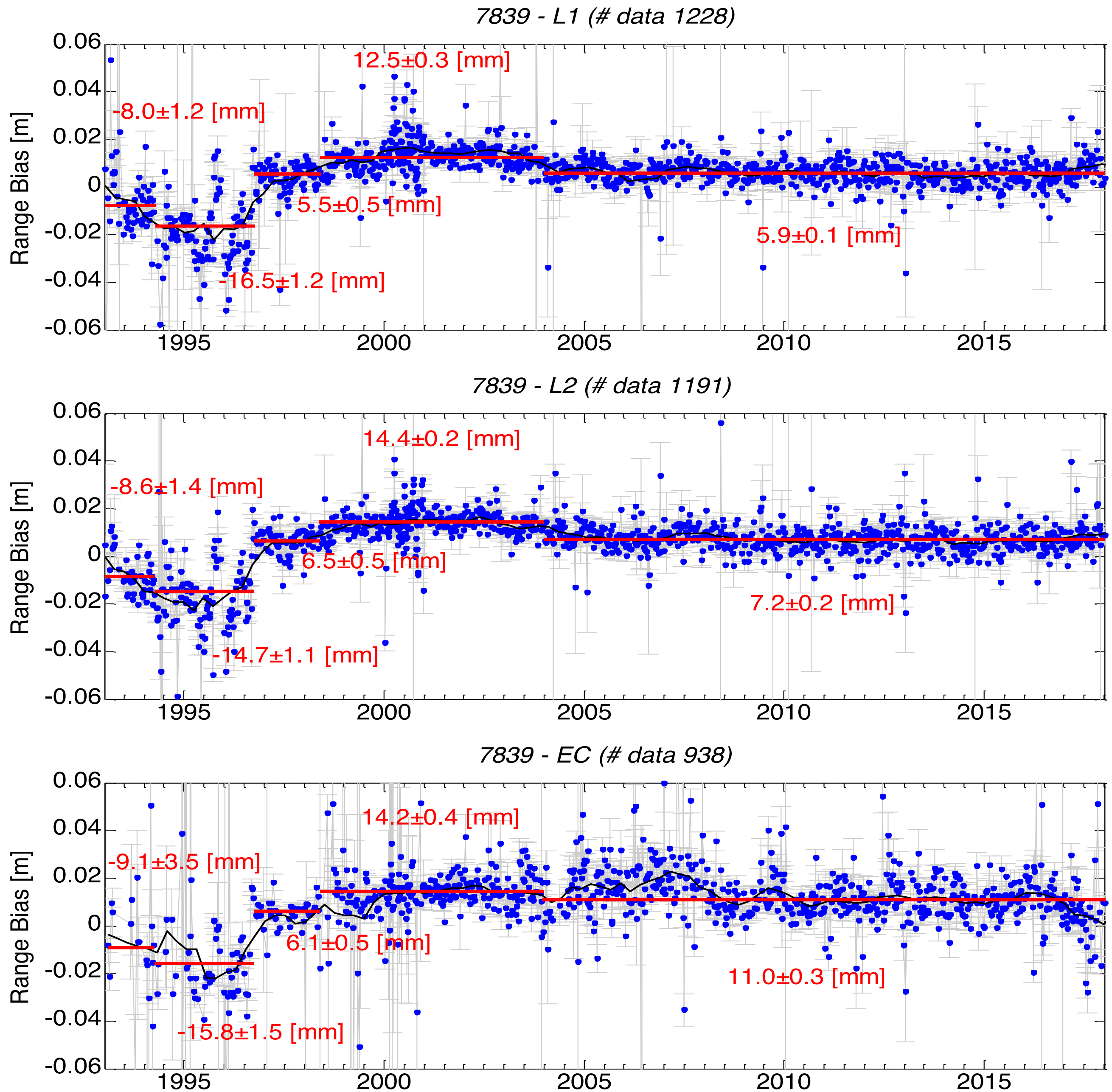
Range Bias time series for Core Stations

7837
Shanghai
China
Closed/Inactive



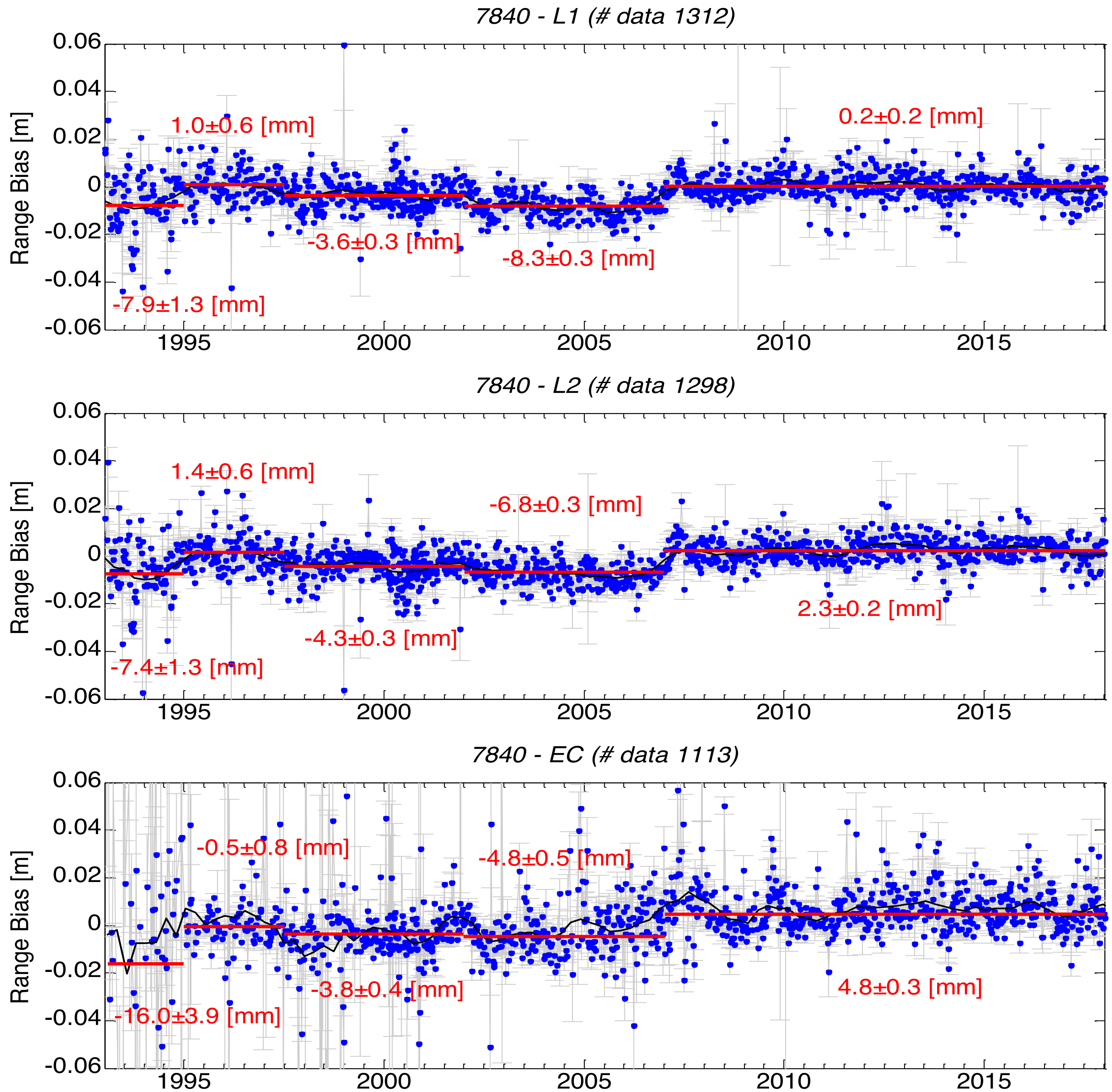
Range Bias time series for Core Stations

7839
Graz
Austria
Operational



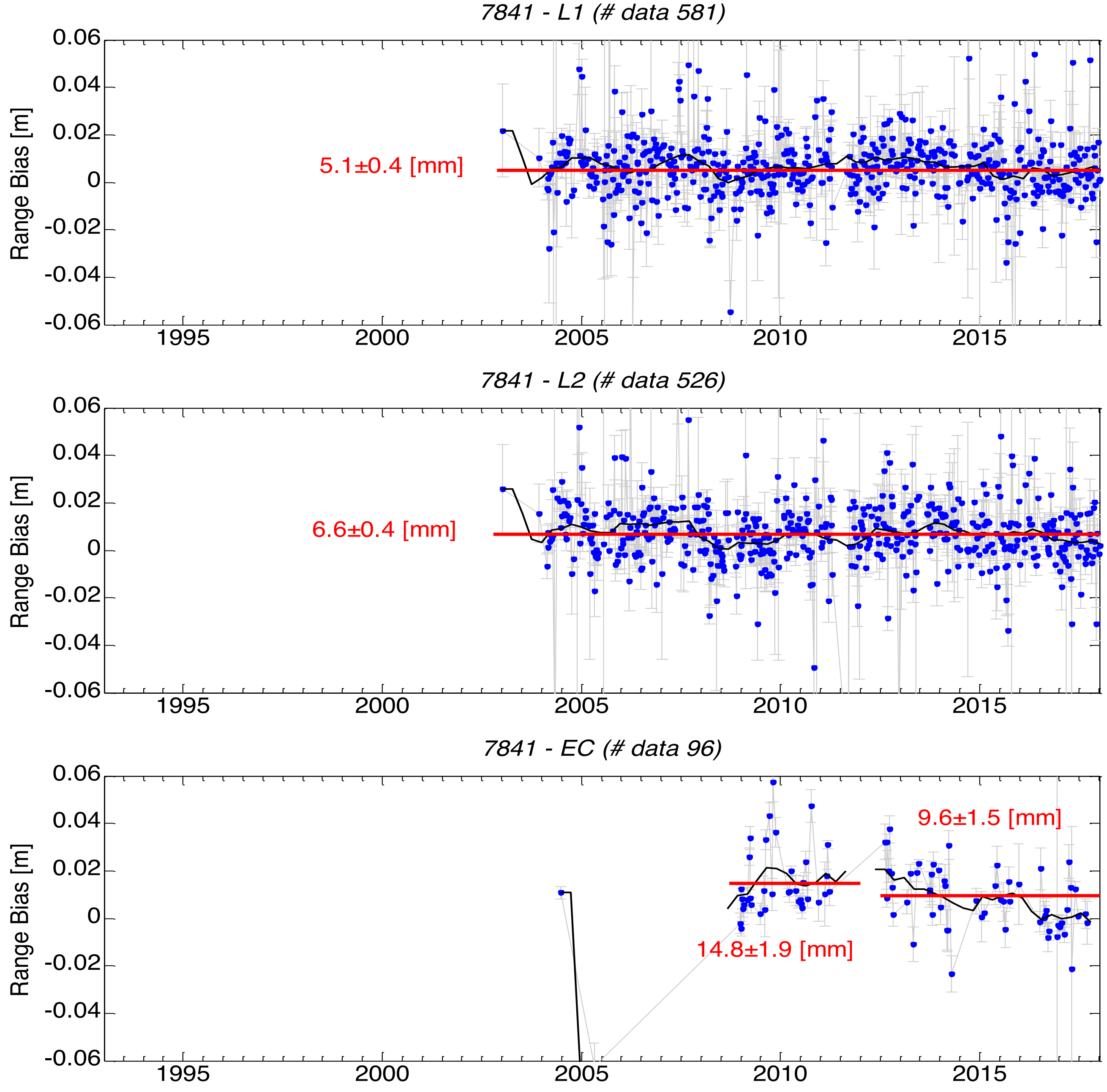
Range Bias time series for Core Stations

7840
Herstmonceux
United Kingdom
Operational



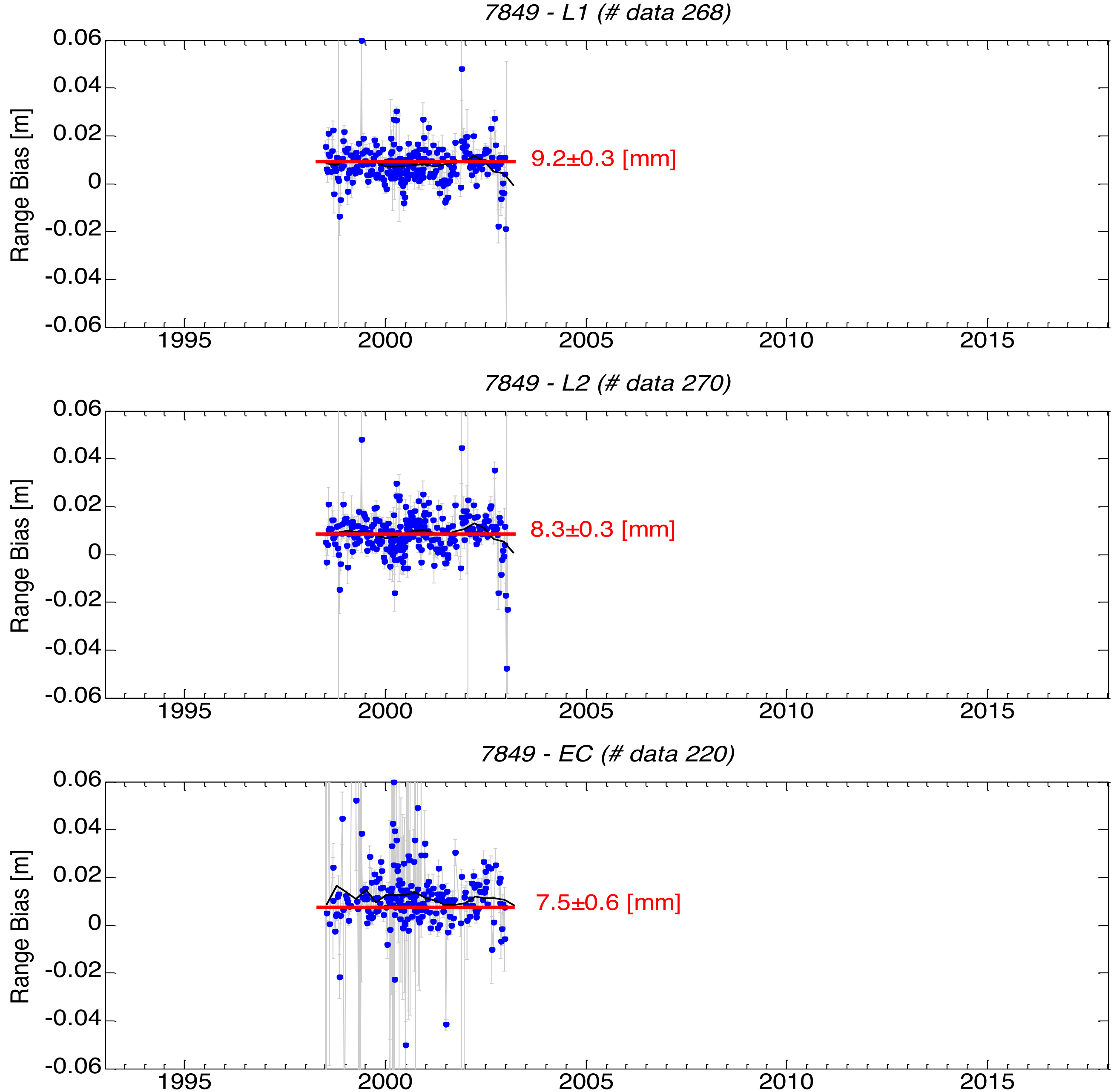
Range Bias time series for Core Stations

7841
Potsdam
Germany
Operational



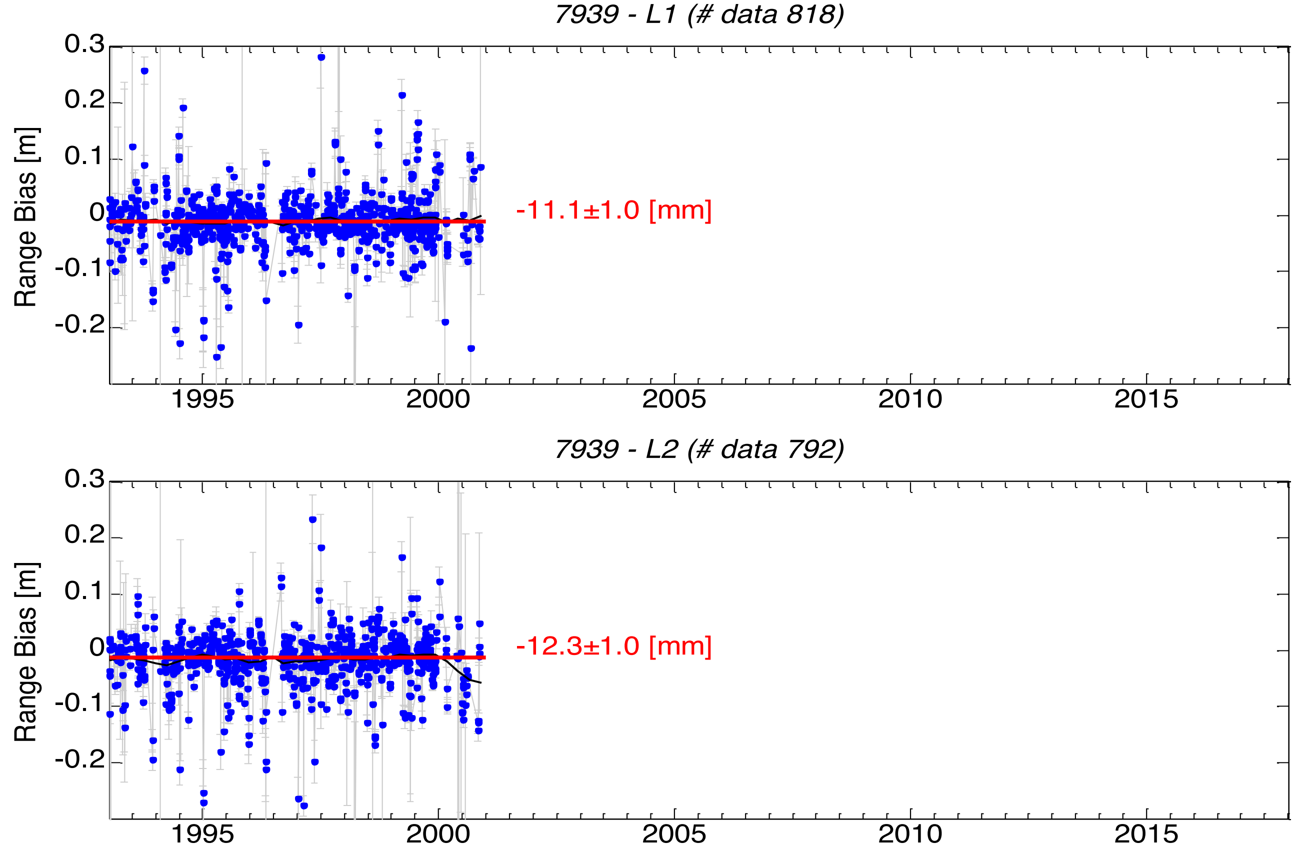
Range Bias time series for Core Stations

7849
Mt. Stromlo
Australia
Closed/Inactive



Range Bias time series for Core Stations

7939
Matera SAO
Italy
Closed/Inactive



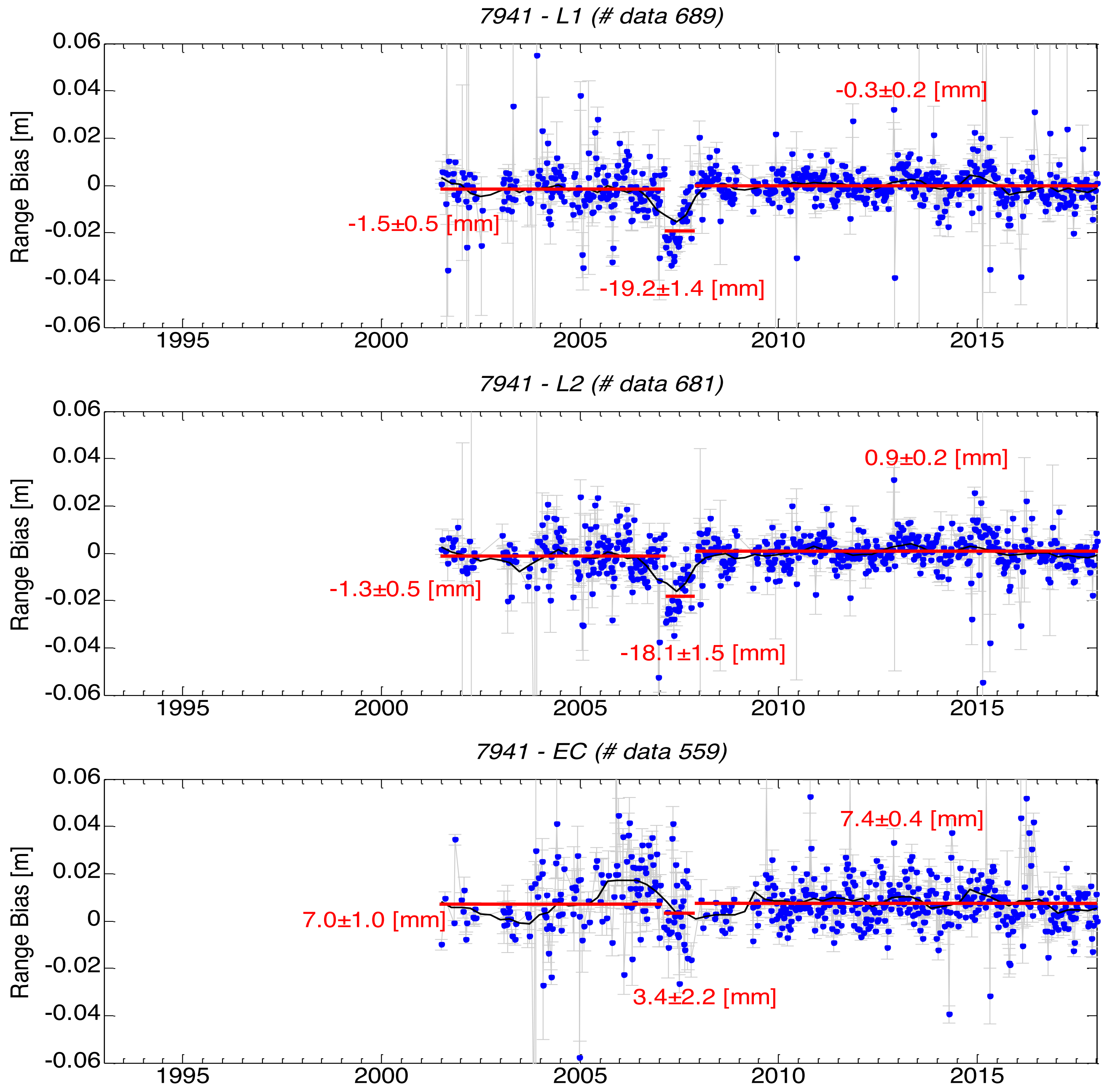
WARNING – wrong wavelength in the SINEX

> DGFI: 500 instead of 600

> GFZ: 700 instead of 600

Range Bias time series for Core Stations

7941
Matera MLRO
Italy
Operational



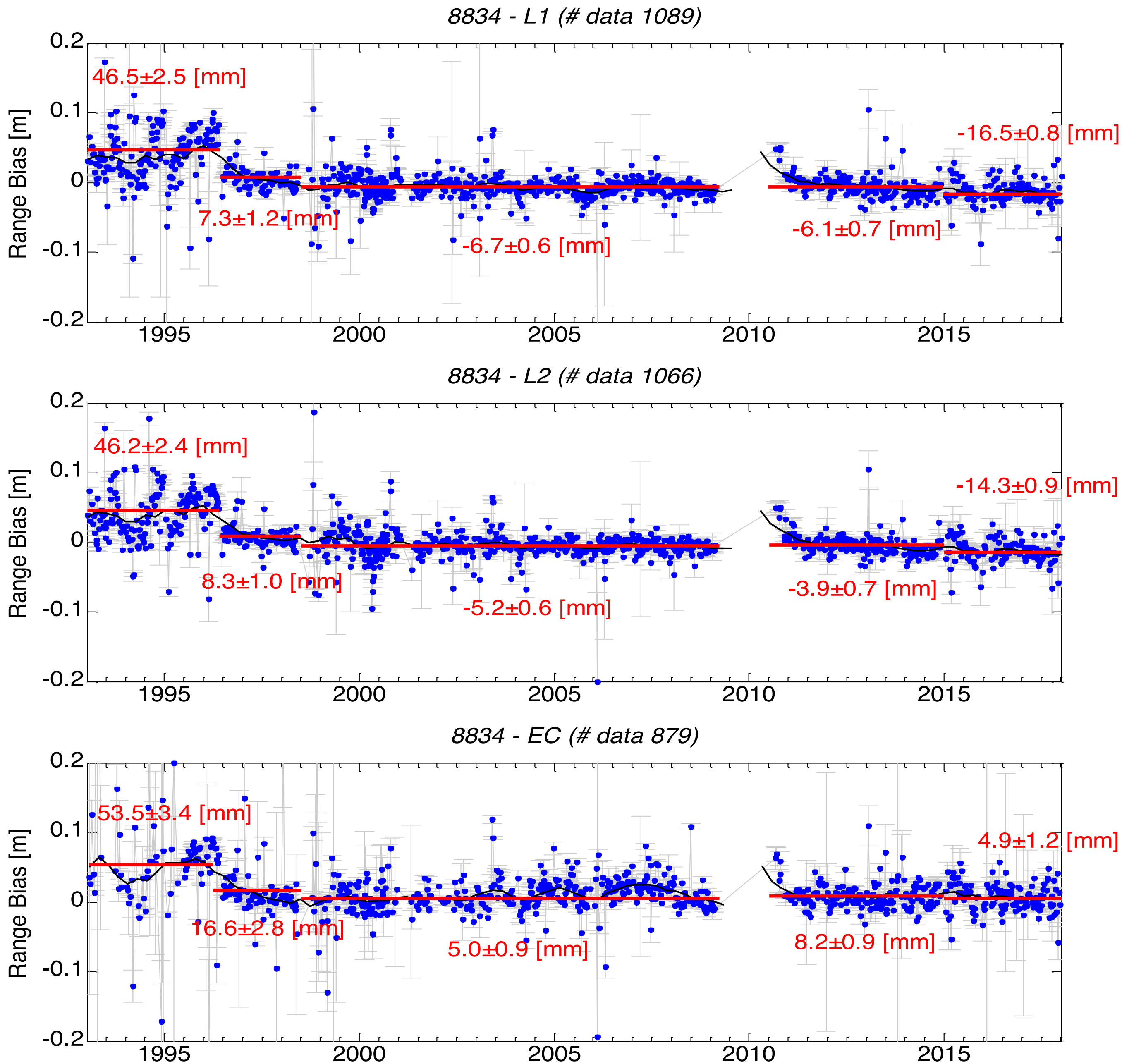
Range Bias time series for Core Stations

8834 not a core station

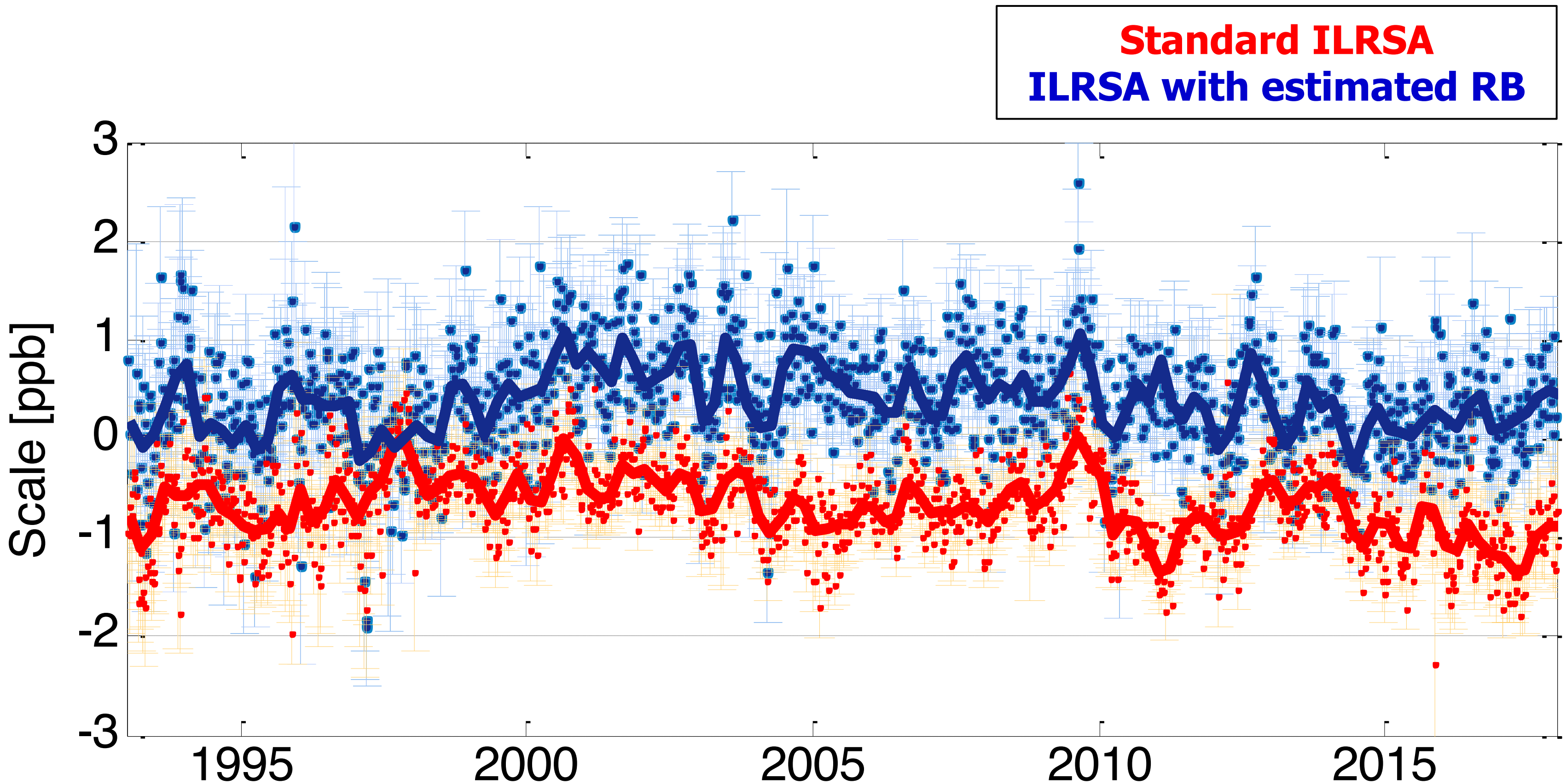
Wettzell WLRS

Germany

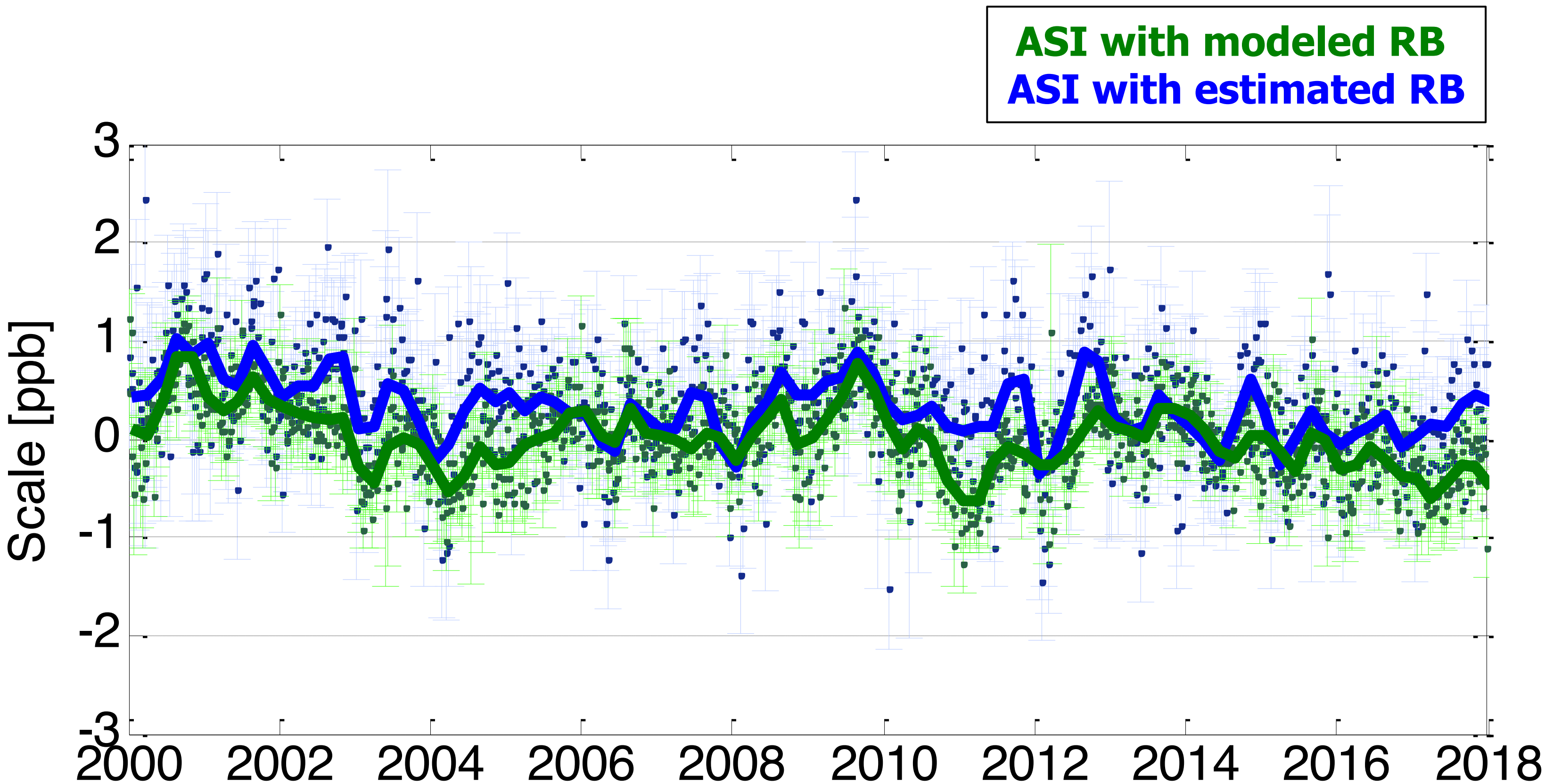
Operational



Impact on the ILRSA scale w.r.t. ITRF2014



Preliminary results with the new RB table



Remarks

- Differences in range biases from Lageos and Etalon
- Estimated bias valid when applying the actual CoM table
- What to do for stations closed before 1993 (no rbias)
  (e.g. 7834 Wettzell, 7907 Arequipa, …)
- Some sites have a few data and estimated RB are too scattered. The resulting mean RB is unreliable.
- Mean RBs have been computed regardless real events at the sites. They are preliminary and need to be validated.

Federal Agency for
Cartography and Geodesy

BKG Report

Daniel Koenig (1), Ulrich Meyer (2), Daniela Thaller (1)

(1) BKG

(2) AIUB

Activities

- Contributions to SSEM PP:
  - LAGEOS-only 1993-2017
  - LAGEOS+Etalon 2000-2017
- Problem w. weekly operational SP3 orbits:
  - **fixed!**
- Latest C04_14 EOP used:
  - smaller corrections estimated!
- Trying to derive Etalon orbits for 1993-1999
- LARES as 5th satellite:
  - development of operational procedure ongoing

Contact:

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60598 Frankfurt, Germany

Daniel Koenig
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www.bkg.bund.de

Status report of the DGFI-TUM ILRS AC

Mathis Bloßfeld, Alexander Kehm, and Sergei Rudenko

Technische Universität München
Deutsches Geodätisches Forschungsinstitut (DGFI-TUM)

21st International Workshop on Laser Ranging – ILRS Analysis Standing Committee meeting
Canberra, Australia, 2018-11-04

Content

- Current status of the ILRS AC
- Modelling high-frequency EOP variations in DOGS-OC
- Impact of T2L2 time-bias application for different satellites
- The new IERS mean pole model and its impact on SLR station coordinates
- Outlook of the ILRS AC at DGFI-TUM

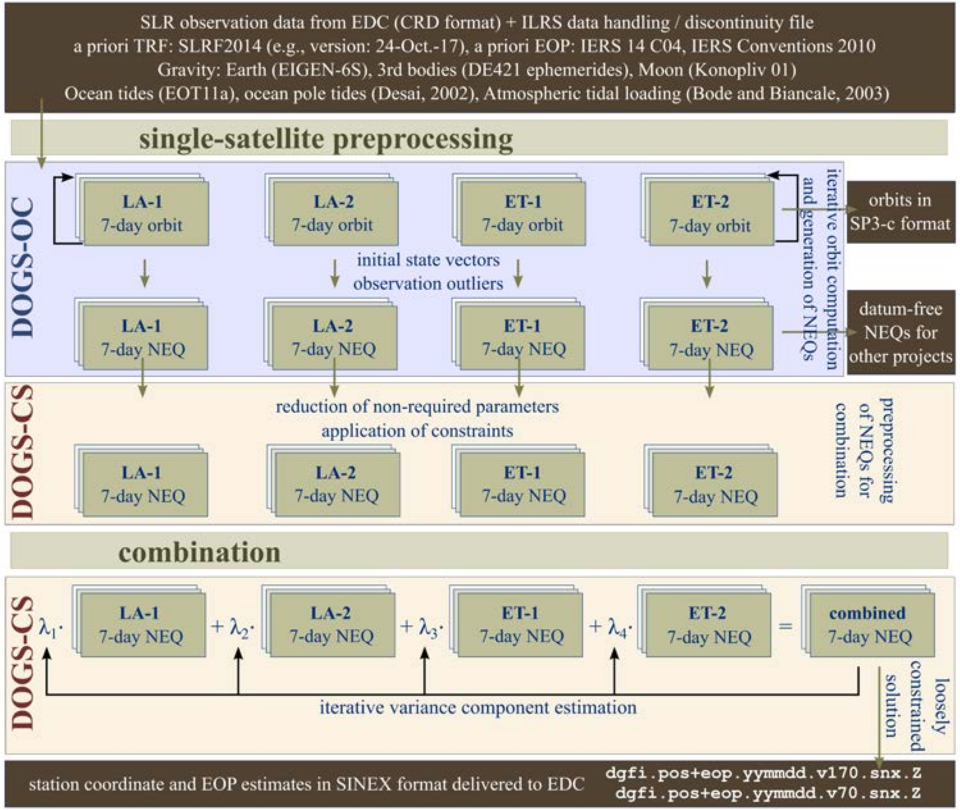
Current status of the ILRS AC

- responsibility: Mathis Bloßfeld (since April 2018), back-up: Alexander Kehm
- since September 2018, the ILRS AC is operated on a **totally new system**
  - **complete rewriting** of processing environment (pre-/post-processing tools)
  - Switch to **DOGS-OC version 5.5**

  - Switch to **DOGS-CS version 5.1**
  - After that, submission of **test files to ILRS-A/-B CC** (ASI, JCET/GSFC)
  - After validation, a **complete reprocessing** of all SLR data available will be performed

Current status of the ILRS AC

- Usage of the **DOGS libraries** in the SLR analysis
- single-satellite processing
  - iterative orbit computation
  - generation of NEQs
- inter-satellite combination
  - relative weighting (**VCE**) of individual NEQs
  - **loosely constrained solution** (1m for all station coordinates) directly written into SINEX



Current status of the ILRS AC

- **Static** and **dynamic** parameters estimable within DOGS-OC

	parameters	dynamic	static
Satellite-specific parameters	Initial state vector (Keplerian elements/Cartesian coordinates)	X	
	Center-of-Mass (CoM) corrections	X	X
	Attitude correction	X	X
Perturbing accelerations	Earth's gravity field spherical harmonics	X	
	Ocean tide spherical harmonics	X	
Scaling factors of perturbing accelerations	Solar radiation pressure	X	
	Earth's albedo	X	
	Earth's infrared radiation	X	
	Thermospheric drag	X	
	Relativistic acceleration	X	
	Empirical acceleration (cosine-/sine-term, offsets) [RTN]	X	
Earth orientation parameters	Terrestrial pole coordinates	X	X
	UT1 corrections	X	X
Station parameters	Station coordinates/velocities		X
Biases	Range/Time/Frequency (offset / drift)		X
	Tropospheric refraction		X

Modelling high-frequency EOP variations in DOGS-OC

- DGFI-TUM contributes to the **ad-hoc working group on HF-EOP** (chair: J. Gipson)
- The DOGS-OC EOP module is extended for testing different high-frequency EOP models for tidal corrections
  - Models implemented and tested in DOGS-OC: Ray, Eanes (IERS Conventions 2010)
  - Models implemented and not yet tested:
    - Gipson VLBI model
    - Gipson VLBI model with libration
    - Madzak et al.
    - Desai and Sibois
- Usage of the implemented HF-EOP models also in the **VLBI analysis** at DGFI-TUM

Time Transfer by Laser Link (T2L2)

- Time bias corrections derived from measurements to **Jason-2**
- Corrections available between **2008 and 2016**
- Corrections available in the **ILRS data handing file**
- Impact on LA-1/2, Et-1/2, LTS, and LRS is evaluated in the following (orbit fit, EOP)
  - weekly single-satellite POS+EOP solutions
  - for LEOs, not the full bias is applied until now!

```
*------------------------------------------------------------------------------
*  T2L2 Tb and Tb-dot DATA RECORDS with COMMENTED by "*" in col. #1 the cases
*  which are not significant for LAGEOS and higher orbits (range equivalent <10 mm)
*
*  IMPORTANT:   These Tb and Tb-dot values are in MICROSEC and MICROSEC/day
*
*******************************************************************************
* NOTE: Users of SLR data for other (lower) targets should evaluate by themselves
*       the significance of these Tb errors for their particular circumstances.
*******************************************************************************
*
*------------------------------------------------------------------------------
*
*CODE PT_ UNIT T _DATA_START_ __DATA_END__ M __E-VALUE___ STD_DEV _E-RATE__ _CMNTS_
*1824 --- us   A 08:183:00000 10:126:00000 T        0.000   1.000    0.0000 -------
 1824 --- us   A 10:126:00000 10:127:00000 T      -17.750   1.000    0.0000 -------
*1824 --- us   A 10:127:00000 10:132:00000 T       -0.900   1.000    0.0000 -------
 1824 --- us   A 10:132:00000 10:133:00000 T       -5.750   1.000    0.0000 -------
*1824 --- us   A 10:133:00000 12:084:68400 T       -2.000   5.000    0.0000 -------
 1824 --- us   A 12:084:68460 12:085:00000 T      -24.400   5.000    0.0000 -------
*1824 --- us   A 12:085:00000 13:001:00000 T        0.145   0.200    0.0000 -------
*1831 --- us   A 08:183:00000 10:001:00000 T        0.000   0.250    0.0000 -------
 1873 --- us   A 09:059:00000 09:110:00000 T      -21.750  50.000   -0.2600 c.drift
*1873 --- us   A 09:111:00000 09:160:00000 T       -3.300  50.000   -0.1000 c.drift
```

Time Transfer by Laser Link (T2L2) - results

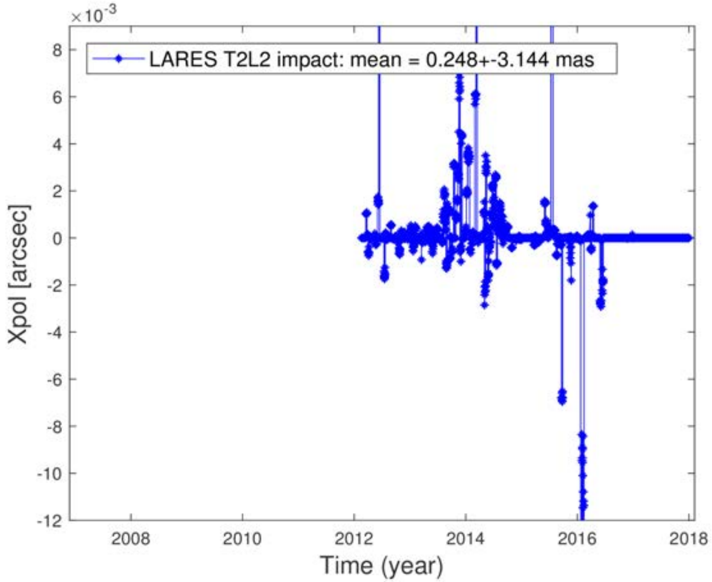
- SLR mean and RMS orbit fits are **not affected significantly** at all
- UT1-UTC/LOD are not affected
- Minor effects for pole coordinates of Etalon-1/2 and LAGEOS-1/2
- Large impact on **pole coordinate mean values of LARES and Larets**

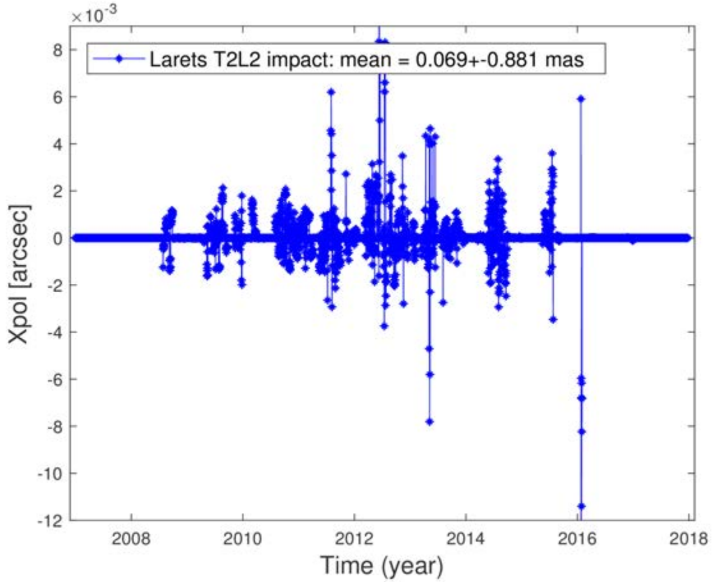
Satellite	Etalon-1	Etalon-2	LAGEOS-1	LAGEOS-2	LARES	Larets
x_p [mas]	0.001±0.040	0.002±0.057	-0.023±0.436	0.044±0.429	0.248±3.144	0.069±0.881
y_p [mas]	-0.001±0.080	-0.001±0.061	-0.207±0.632	-0.202±0.492	-1.031±2.938	-0.153±0.746

- Investigation of impact on **station coordinates** still pending

Time Transfer by Laser Link (T2L2) - results

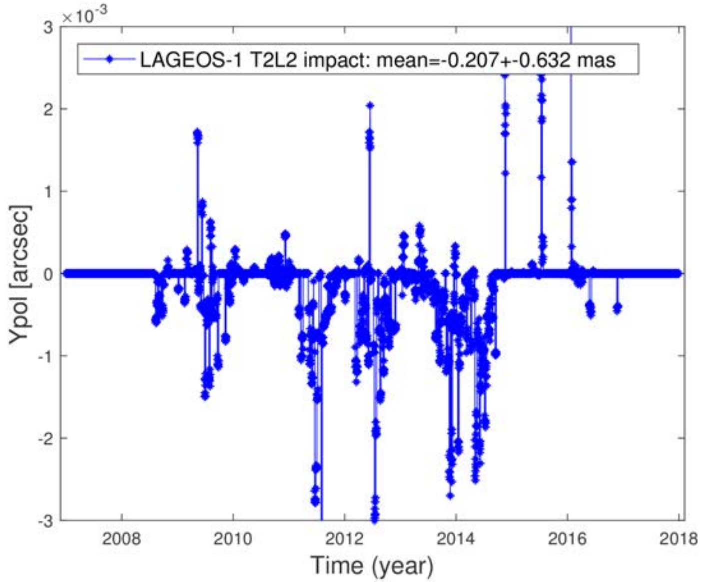
- Impact on the x_p-coordinates derived in single-satellite weekly **LARES/Larets** solutions
- The amplitude of the x_p-coordinate changes for LEOs is **about double** than for LA-1/2

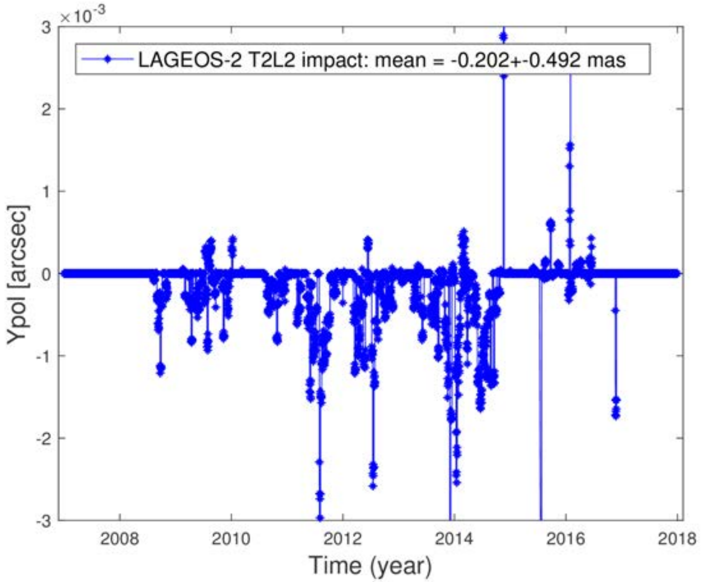




Time Transfer by Laser Link (T2L2) - results

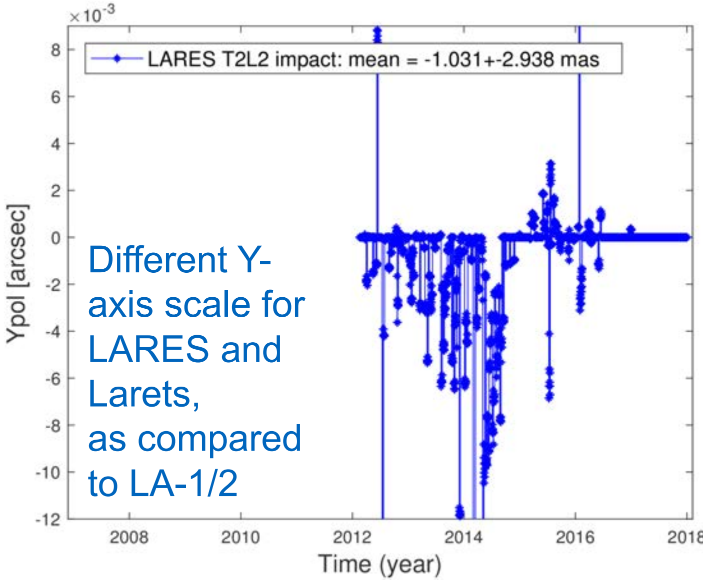
- Impact on the y_p-coordinates derived in single-satellite weekly **LA-1/2** solutions
- Rather **similar behavior** of the x_p-differences obtained for LAGEOS-1 and LAGEOS-2

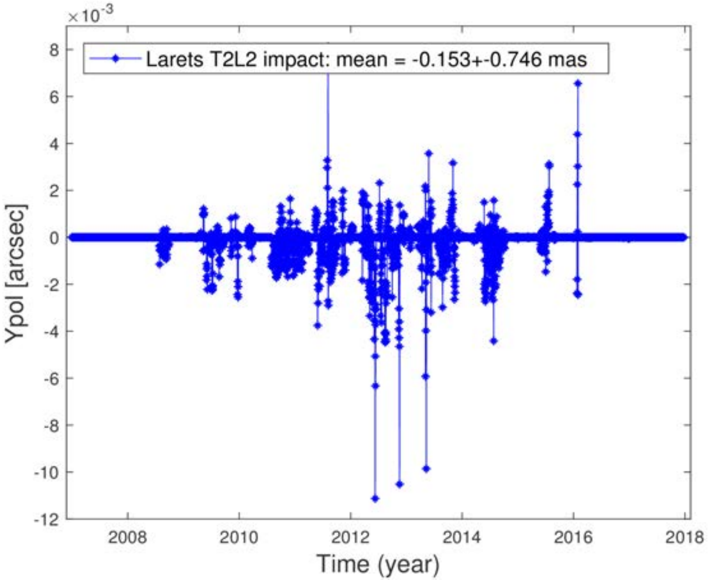




Time Transfer by Laser Link (T2L2) - results

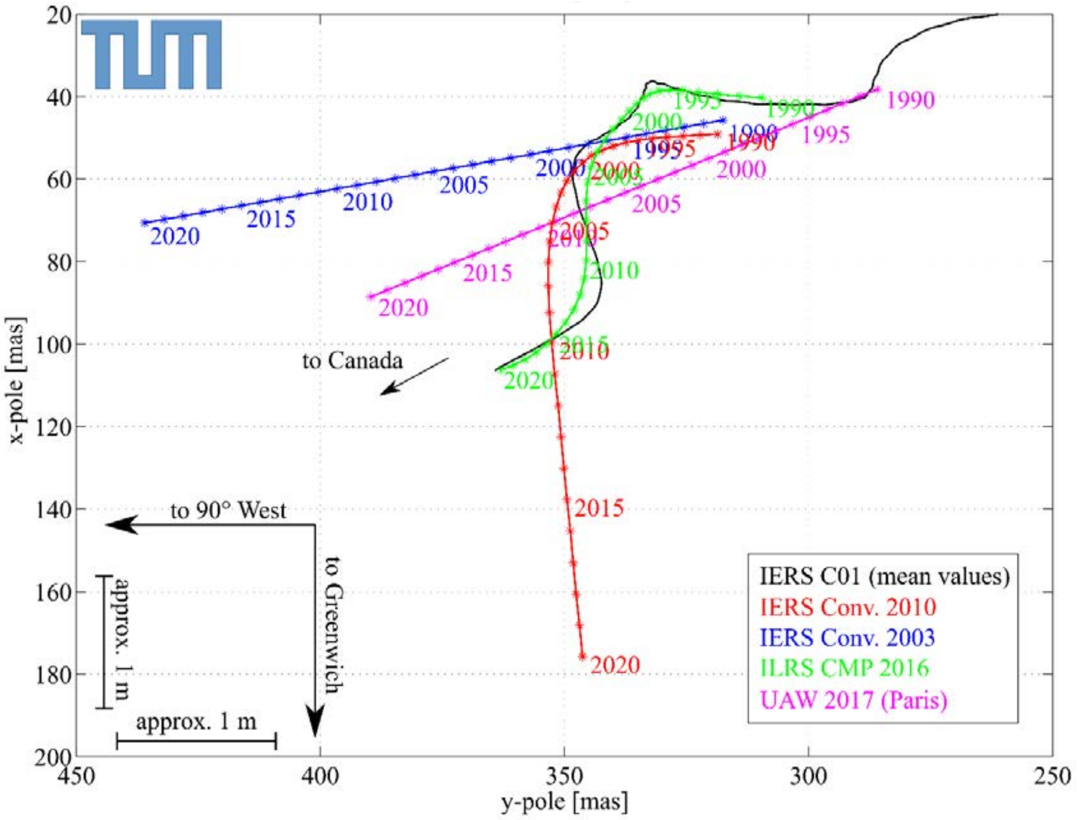
- Impact on the y_p-coordinates derived in single-satellite weekly **LARES/Larets** solutions
- The amplitude of the y_p-coordinate changes for LEOs is **about 2-4 times** than for LA-1/2





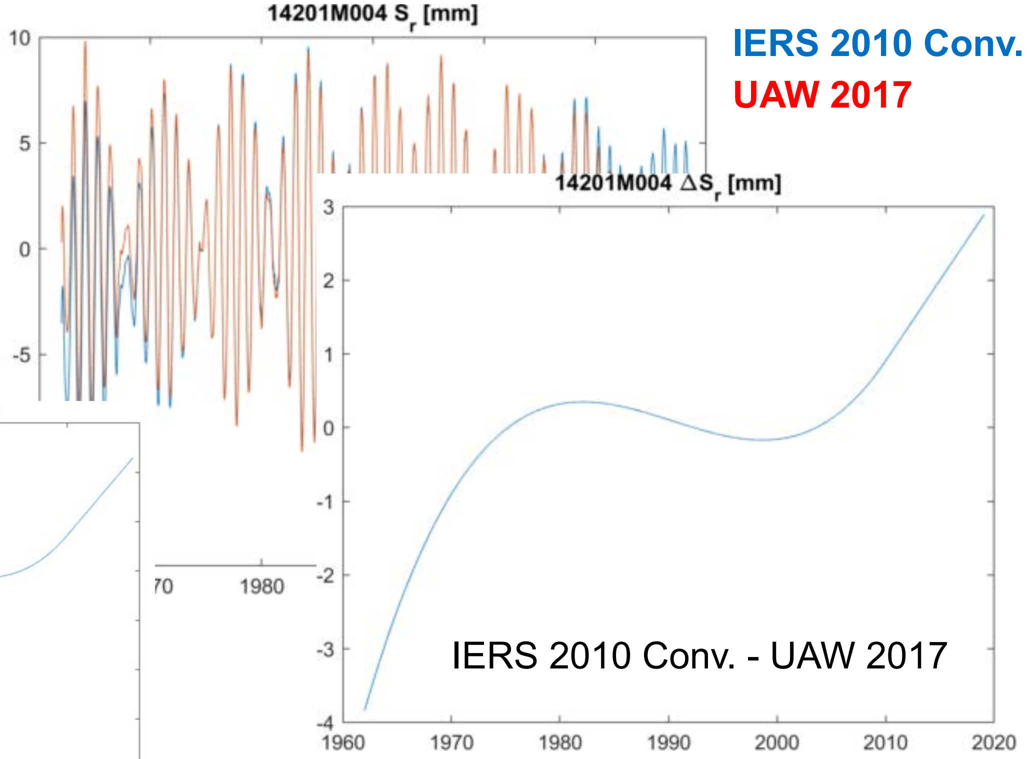
IERS mean pole models

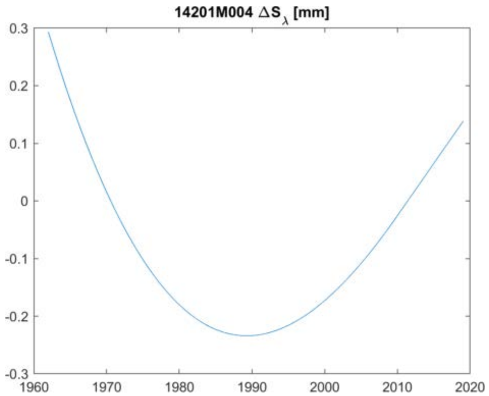
- At the Unified Analysis Workshop 2017 in Paris, a **new IERS mean pole model** was adopted
- New model is beneficial due to **unique naming**
- Mean pole is used for the computation of the **solid Earth pole tide loading** (see IERS Conventions 2010)

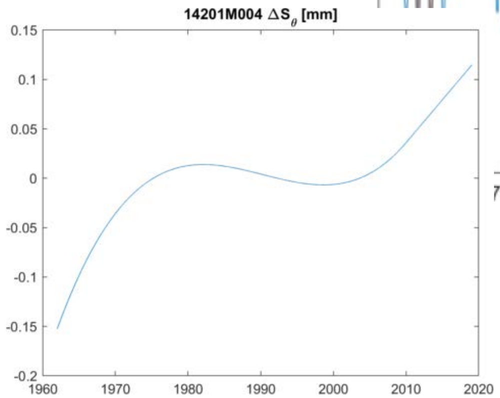


IERS mean pole models – impact on coordinates

- impact on coordinates depends on **geographical location**
- Maximum effect: up to **2 mm in 10 yr** in height (e.g. Wettzell)
- Minor effects in hz-components





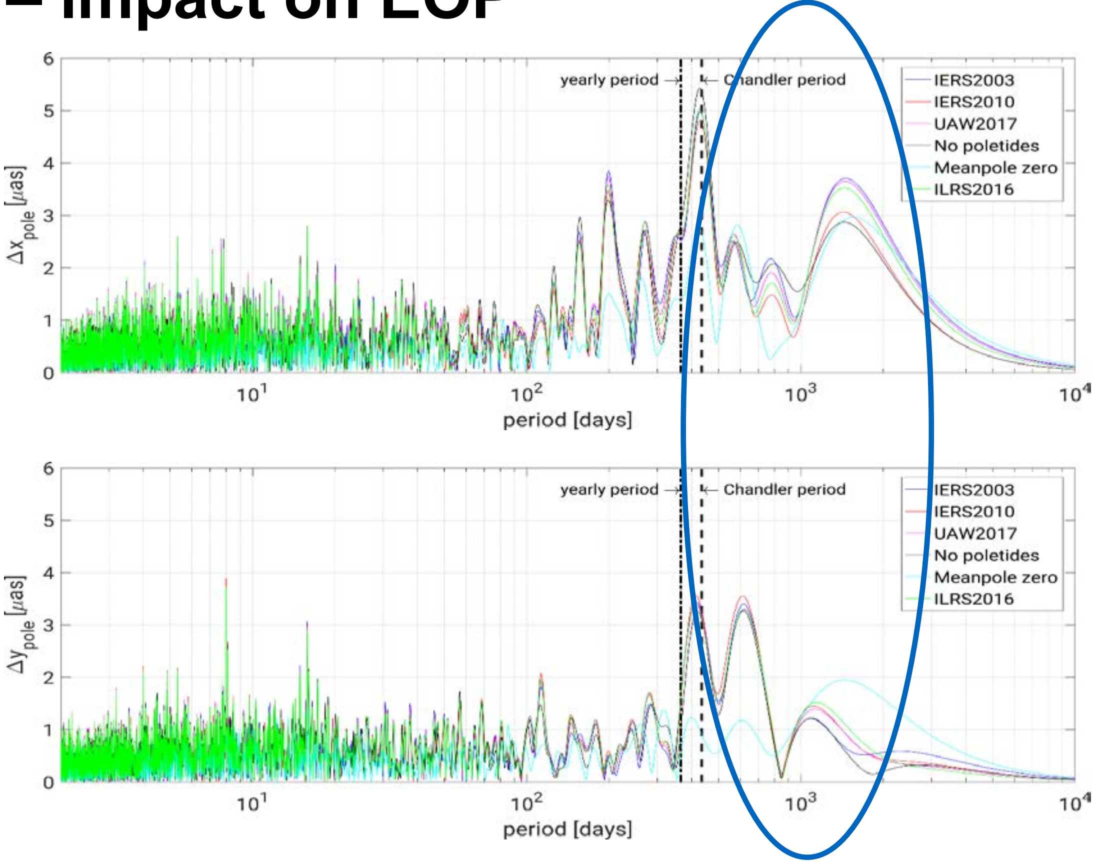


IERS mean pole models – impact on EOP

- **minor impact on LOD** at all
- **long-term signals** in pole coordinates change

BUT:

- If mean pole model is changed, **homogeneous reprocessing** gets necessary!



Conclusions and future work at DGFI-TUM

- **Various HF-EOP models** are implemented in DOGS-OC but not yet validated
- Terrestrial pole coordinates are **sensitive to the T2L2 time bias** corrections (especially the LEO satellites)
- The long-term mean impact on the pole coordinates is **up to 1 mas** (3 cm at the Earth‘s surface)
- Mean pole model affects station coordinates but not EOP
- Mean pole model also used for gravitational accelerations → consistency not ensured if **geometric** (TRF, EOP) and **dynamic** (gravity) mean poles are not identical
- ILRS AC at DGFI-TUM can contribute to all **planned ILRS pilot projects**
- Direct output of integrated orbits in **SP3c format** (omit separate post-processing program)

Status report of the DGFI-TUM ILRS AC

Mathis Bloßfeld, Alexander Kehm, and Sergei Rudenko

Technische Universität München
Deutsches Geodätisches Forschungsinstitut (DGFI-TUM)

21st International Workshop on Laser Ranging – ILRS Analysis Standing Committee meeting
Canberra, Australia, 2018-11-04

The JCET AC/CC Report to the ILRS ASC

E. C. Pavlis, M. Kuzmicz-Cieslak and K. Evans

Canberra, Australia,

November 4, 2018

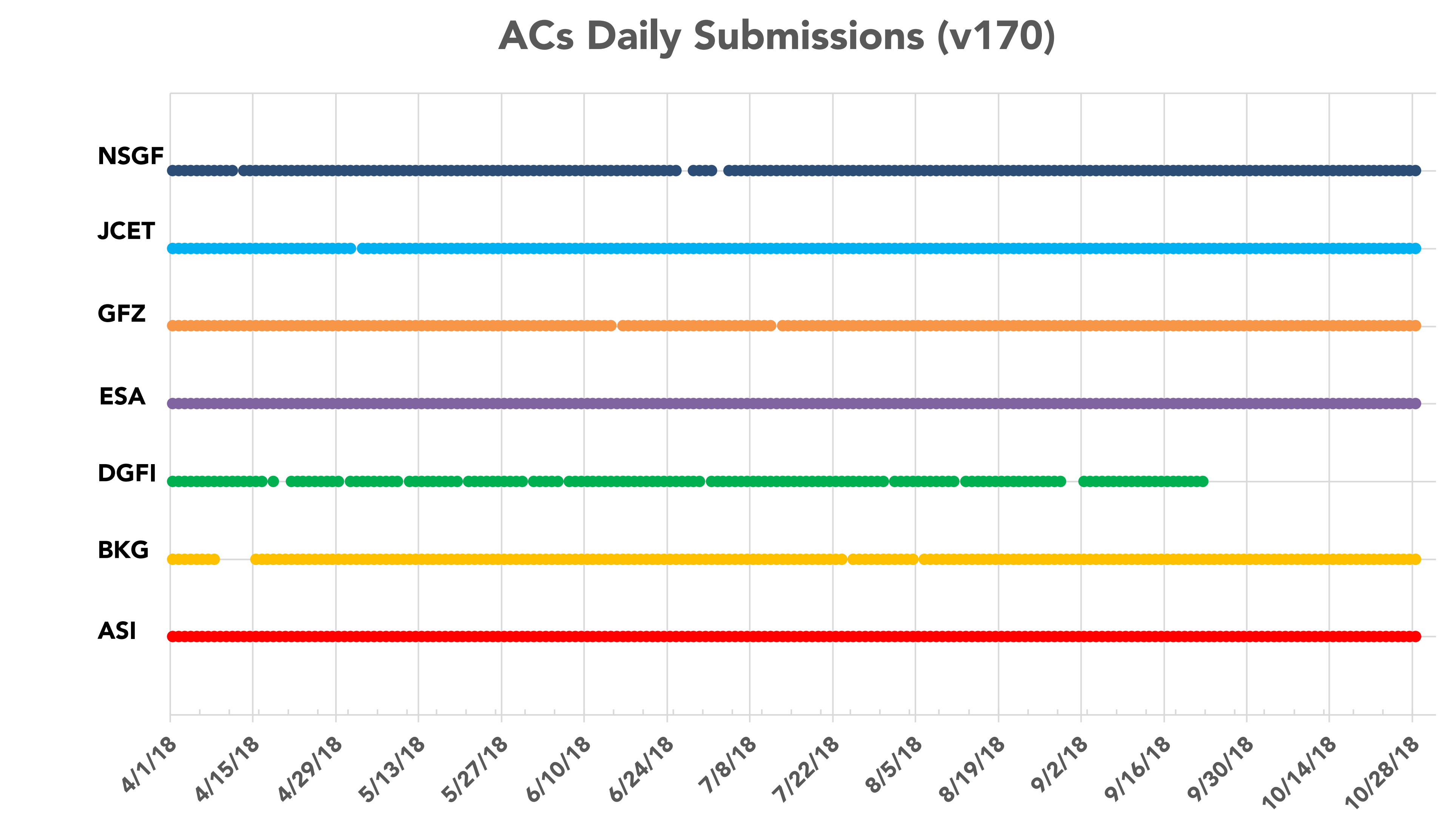
Outline

- Operational Products Status Report
- Station Systematic Error Monitoring Project
- Online Tools Updates: Weather Forecast, Data QC, Report Cards Graphics
- Wettzell (8834) Pressure Bias Error
- DGFI Test Series Examination
- Etalon 1 & 2 Tracking Campaign Plans
- Modeling Updates in view of the ITRF2020 reanalysis
- Planning for the use of SLR @ GNSS data in a future product

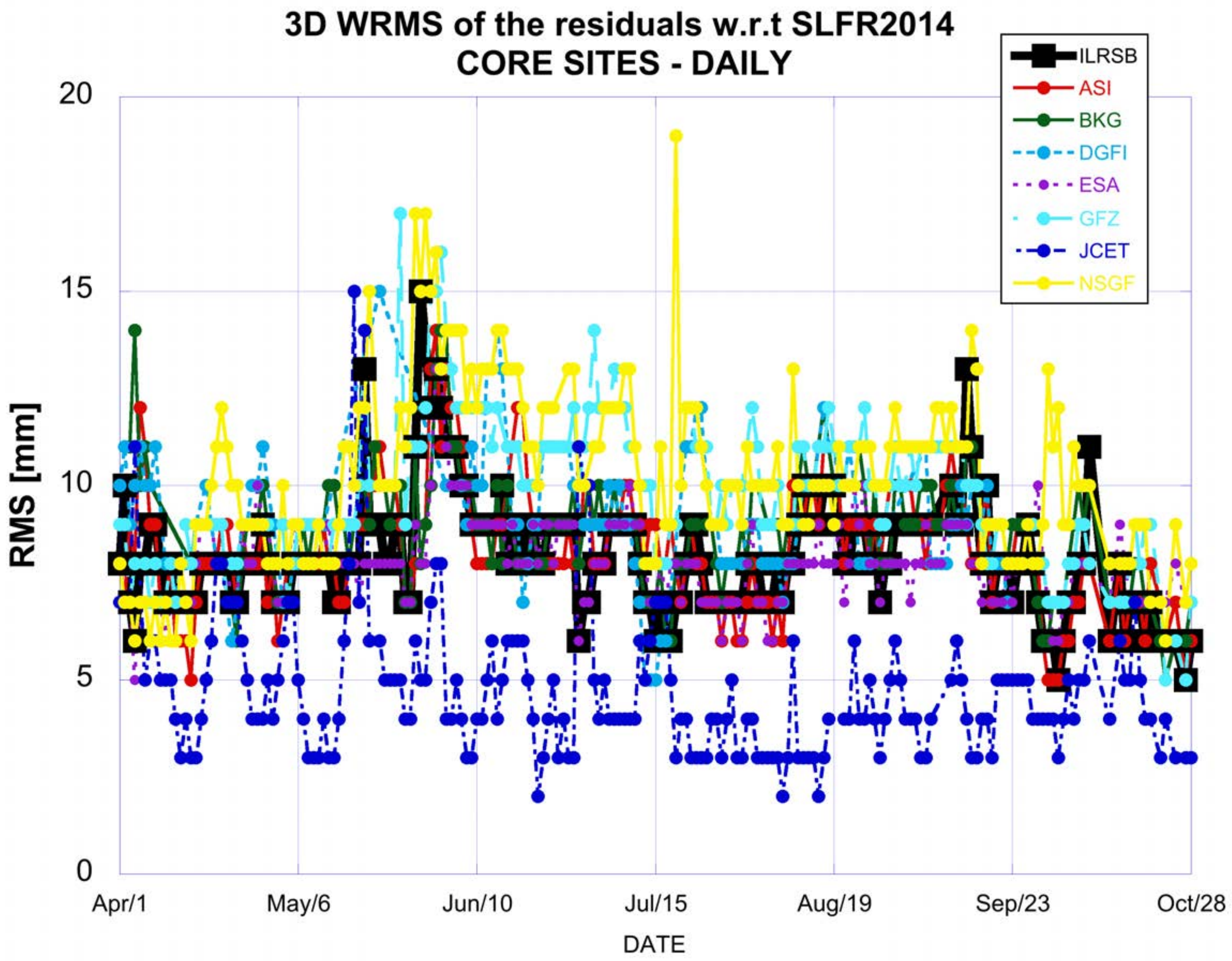
Operational Products Status

- Daily and Weekly series delivered routinely and consistently by six of the eight ACs
- We have not received contributions from GRGS for over a year
  - Latest news from Florent indicate that a restart is imminent (AGAIN)
- With the routinely contributing ACs down to six-seven, it is important that all ACs make an effort to deliver their contributions regularly, to maintain the quality of our products!
- ACs that do not participate in test PPs and demonstrate their ability to deliver quality products, delay us from wrapping up PPs and moving to the next phase or PP. We need to establish a process to move such cases to the ACC group and move on, until they can recover and come back.

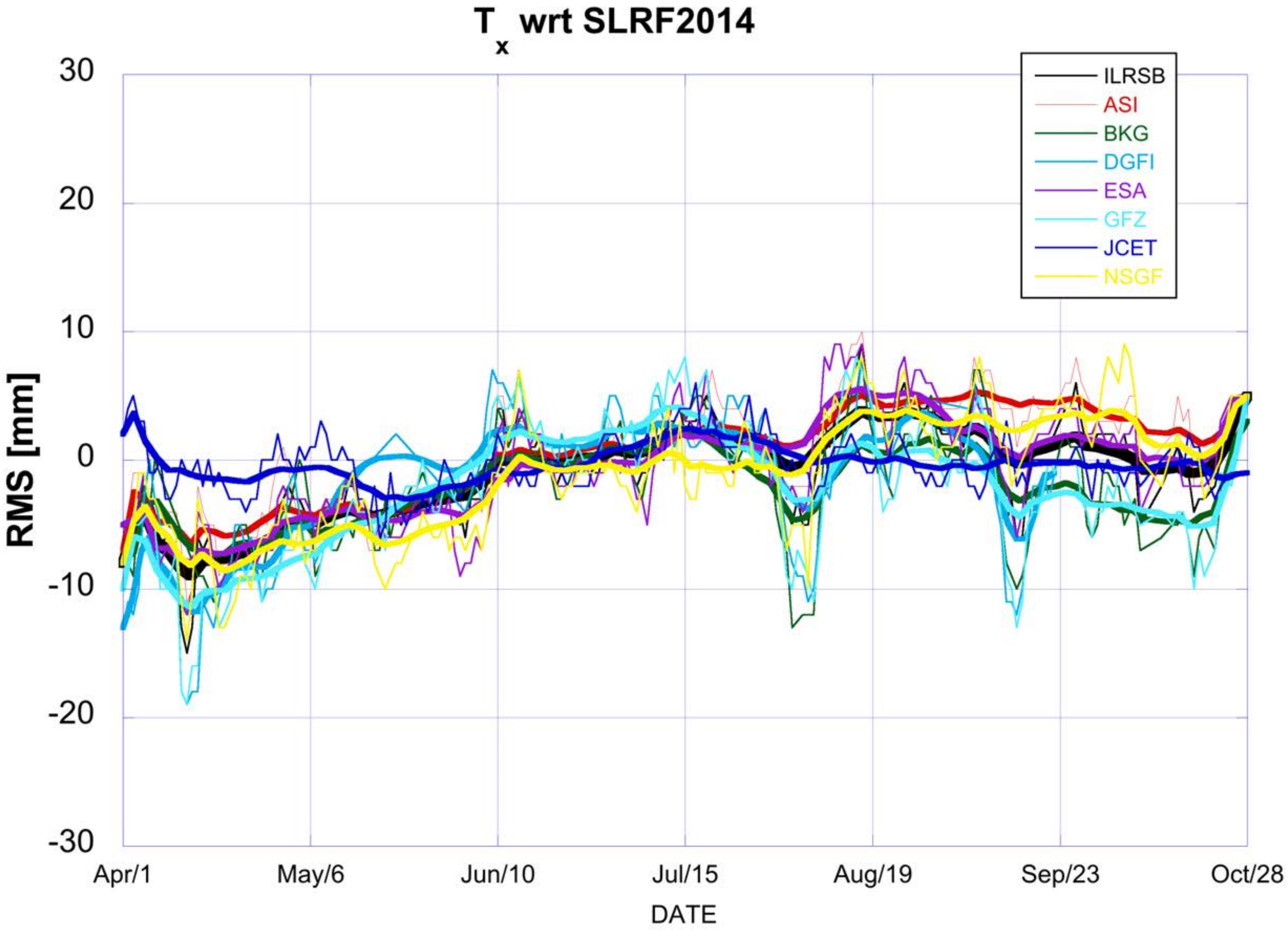
Daily Product Submissions



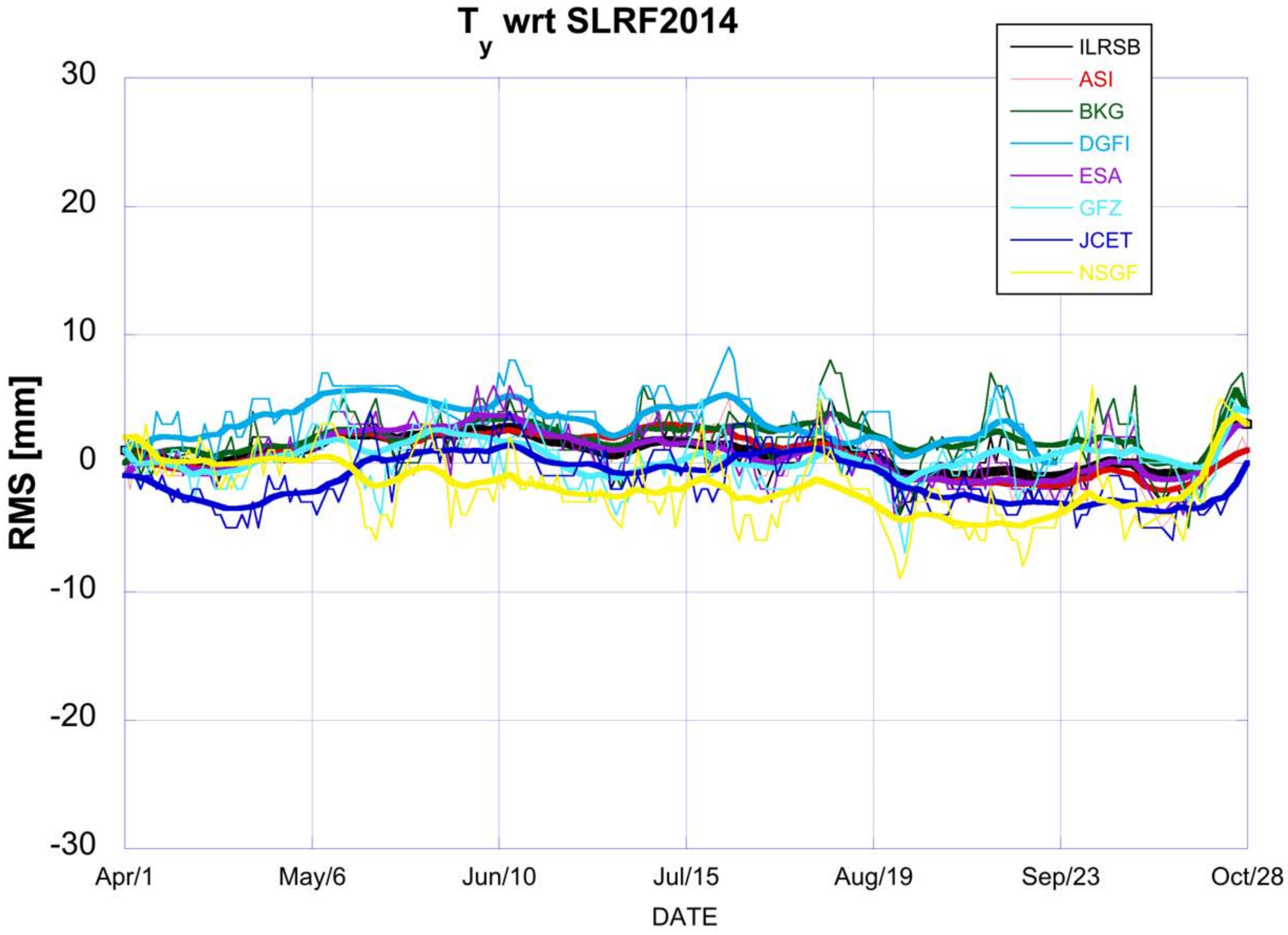
Daily Product Submissions



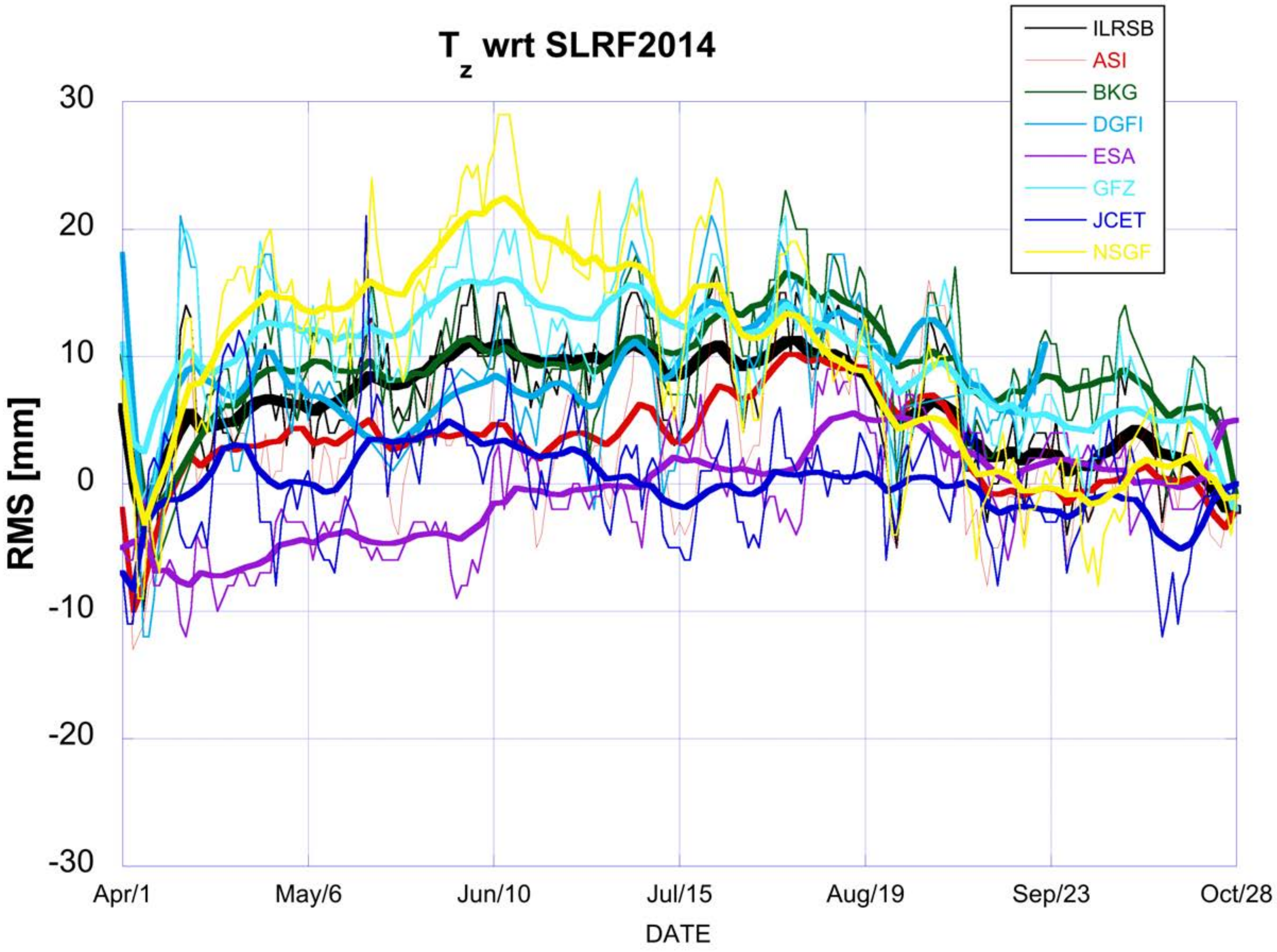
Daily Product Submissions



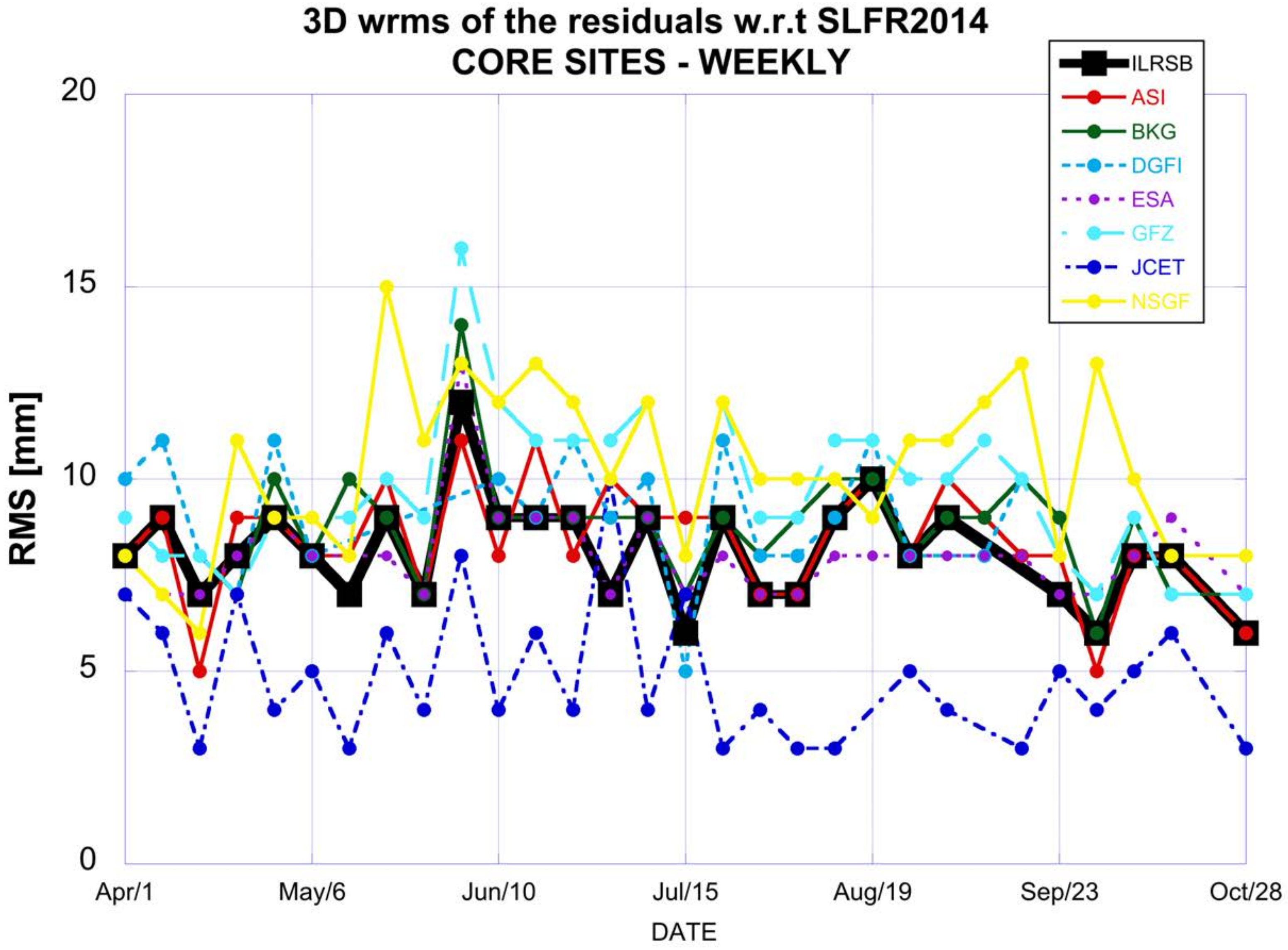
Daily Product Submissions



Daily Product Submissions



Weekly Product Submissions



Currently Quarantined Sites

Quarantine Stations

	Station	Code	Site	DC	SOD	DOMES	First Data	Last Data	
	7358	GMSL	Tanegashima, Japan	NASA	73588901	21749S001	2004-09-01	2018-10-02	31 day(s)
	7395	GEOL	Geochang, Republic of Korea	EDC	73956501	23910S001	0000-00-00	0000-00-00	None day(s)
	7816	UROL	Stuttgart, Germany	EDC	78165201	10916S001	0000-00-00	0000-00-00	None day(s)
	7824	SFEL	San Fernando, Spain	EDC	78244502	13402S007	1999-04-08	2017-07-01	489 day(s)

- ❑ One site (**in RED**) is actively undergoing validation of their data;
- ❑ Two "engineering" sites (**above in PURPLE**) that have yet to submit any data (no need for official validation, but may request it if they want to see the quality of their data assessed);
- ❑ San Fernando is reaching "end of operations" phase, so no need to proceed with validation.

Station Systematic Error Monitoring-SSEM Project

Station Systematic Error Monitoring-SSEM Project -1

- Seven ACs have contributed series following the new “labeling” of the biases according to the used wavelength for the re-analysis period 1993 to present:
  - ASI, BKG, DGFI, ESA, GFZ, JCET and NSGF
  - These results are now available online:
    - **http://geodesy.jcet.umbc.edu/ILRS_AWG_MONITORING/**
  - Preliminary ILRS-B combination results are now online too
  - GFZ has not submitted the Etalon 1+2 series yet
  - DGFI needs to update their series with cleaner version (Mathis series)
- We need to receive the final DGFI contribution before the final combination can be formed. Horst’s last submission has a lot of outliers that can be fixed with some closer look at the data;
- We need a commitment from all the ACs that they will support a weekly product, now that the PP is almost completed, so we can launch the operational phase;

ACs Supporting the SSEM Project

- AC-contributed series that we received so far:

Analysis Center	Status of Submission
ASI	Submitted
BKG	Submitted
DGFI / DGFI (Mathis version**)**	Submitted/???
ESA	Submitted
GFZ (Etalon???)	Submitted
JCET	Submitted
NSGF	Submitted

SSEM Project Revised Wavelength Table

System	CDP ID#	SOLN Flag	Wavelength
Concepcion	7405	400	423
Concepcion	7405	800	846
Zimmerwald	7810	400	423
Zimmerwald	7810	500	532
Zimmerwald	7810	800	846
SOS Wettzell	7827	400	425
SOS Wettzell	7827	800	850
Matera	7939	600	694
Matera	7941	300	355
Matera	7941	500	532

Site Selection for the SSEM Project

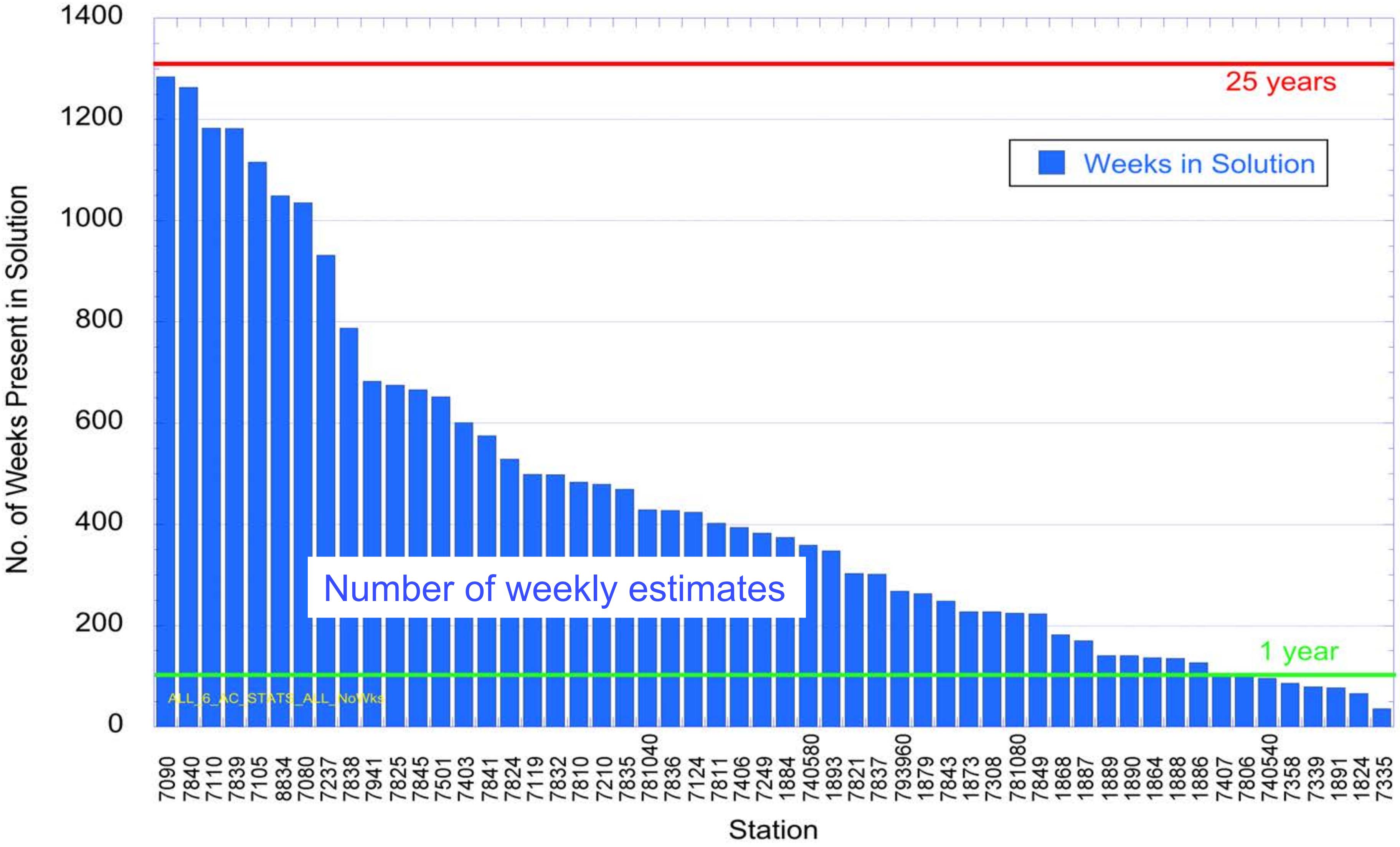
1824 Golosiiv
~~1831 Lviv~~
~~1863 Maidanak 2~~
1864 Maidanak 1 2003.0->
1868 Komsomolsk-na-Amure 2008.0 ->
1873 Simeiz 2001.0 ->
1879 Altay
1884 Riga
~~1885 Riga~~
1886 Arkhyz
1887 Baikonur
1888 Svetloe
1889 Zelenchukskya
1890 Badary
1891 Irkutsk
1893 Katzively
~~1953 Santiago~~
7080 McDonald Obs.
7090 Yarragadee
~~7097 Easter I~~
7105 Greenbelt
7110 Monument Peak
7119 Haleakala
7122 Mazatlan

7124 Easter I
7124 Tahiti
~~7125 Greenbelt~~
~~7130 Greenbelt~~
7210 Haleakala
~~7231 Wuhan~~
7236 Wuhan
7237 Changchun
7249 Beijing
~~7295 Richmond~~
7308 Koganei
~~7328 Koganei~~
7335 Kashima 99/04-00/05
~~7337 Miura~~
7339 Tateyama
~~7355 Urumqi~~
~~7356 Lhasa~~
~~7357 Beijing-A~~
7358 Tanegashima
~~7359 Daedeok~~
~~7394 Sejong~~
7403 Arequipa
~~7404 Santiago~~
7405 Conc@423
7405 Conc@847

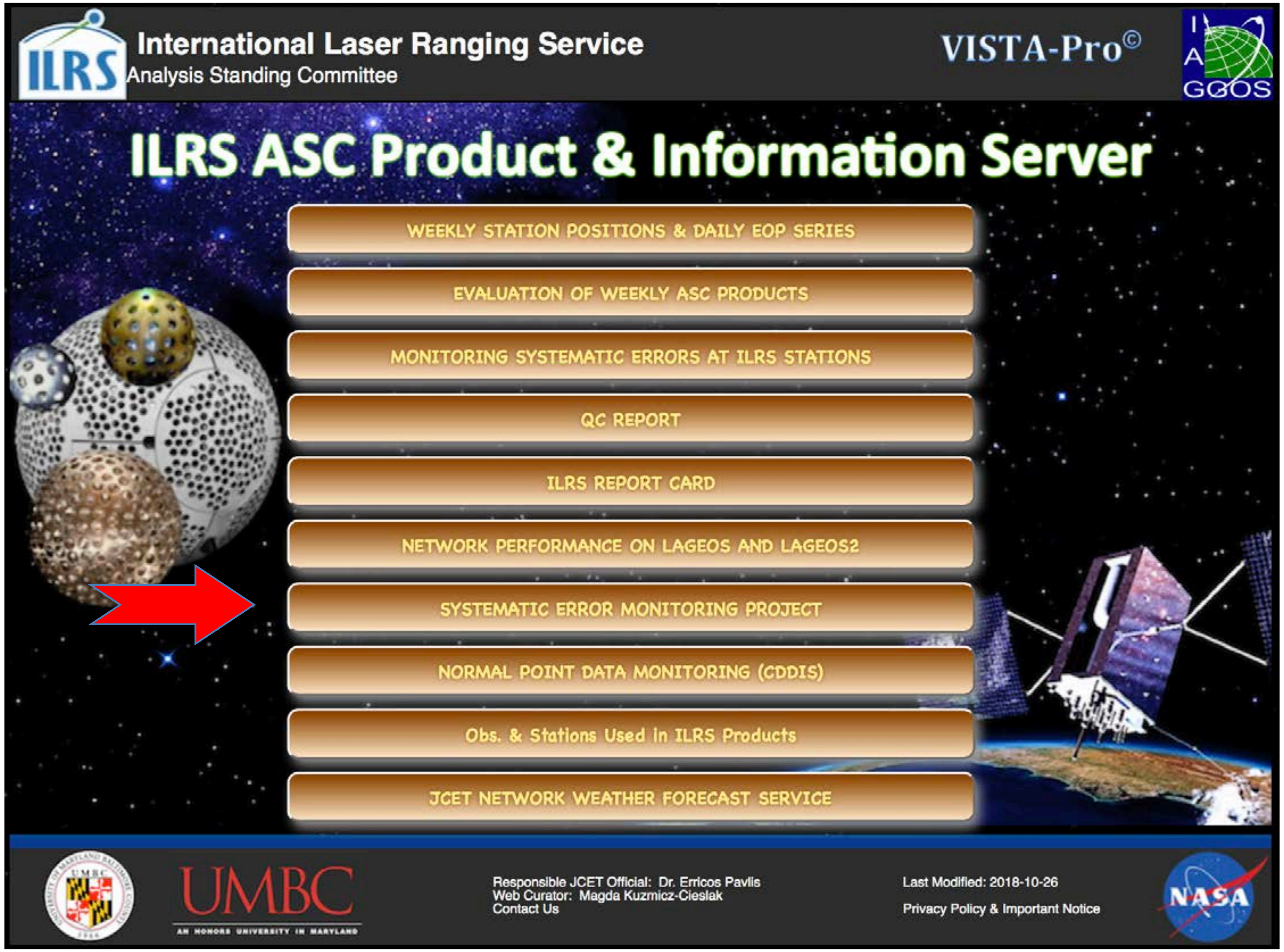
7406 San Juan → 2013.0
7407 Brasilia
~~7410 Algonqui~~
~~7411 La Grand~~
7501 Hartebeesthoek
~~7502 Sutherla~~
~~7525 Xrisokel~~
~~7530 Bar Giyy~~
~~7545 Punta Sa~~
~~7548 Cagliari~~
~~7597 Wettzell~~
7806 Metsahovi 99/09->
7810 Zimm@423
7810 Zimm@532
7810 Zimm@846
7811 Borowiec
7819 Kunming
~~7820 Kunming~~
7821 Shanghai
~~7822 Tahiti~~
~~7823 San Fernando~~
7824 San Fernando
7825 Mt Stromlo
~~7830 Chania~~
~~7831 Helwan~~

7832 Riyadh
7835 Grasse
7836 Potsdam
7837 Shanghai
7838 Simosato
7839 Graz
7840 Herstmonceux
7841 Potsdam
7843 Orroral
7845 Grasse
~~7848 Ajaccio~~
7849 Mt Stromlo
~~7850 Mcdonald~~
~~7882 Cabo San~~
~~7883 Ensenada~~
~~7884 Albuquer~~
~~7918 Greenbelt~~
7939 Matera
7941 Matera
~~8833 Kootwijk~~
8834 Wettzell

Site Participation in the SSEM Project



JCET Portal UPDATE - 1



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

Station Systematic Error Monitoring Project

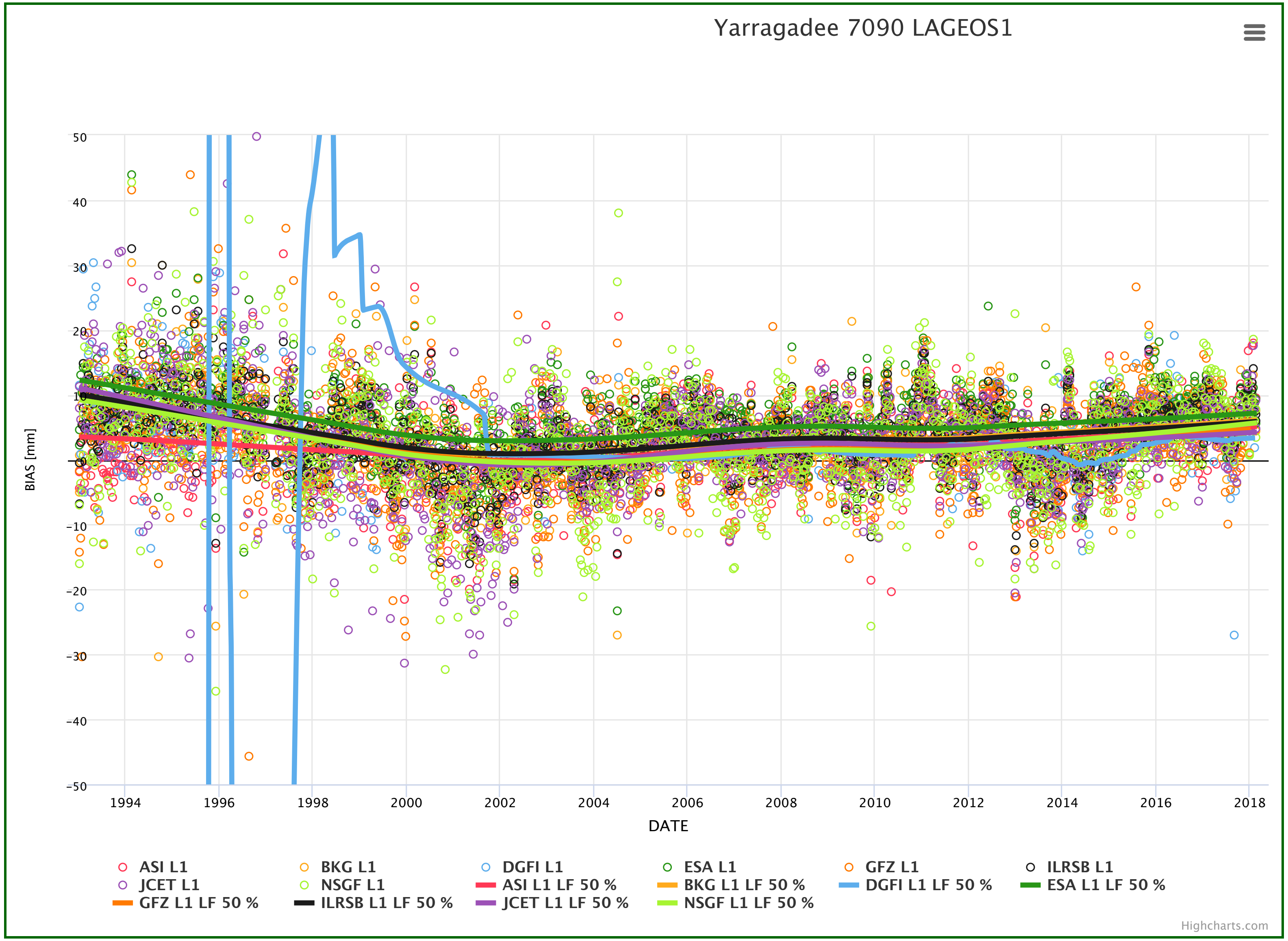
Station Systematic Errors Estimated from SLR DATA
Reanalysis Project Results since 1993

LAGEOS ESTIMATE	LAGEOS-2 ESTIMATE	COMBINED ESTIMATE ETALON1&2
☐ **ASI v220**	☐ **ASI v220**	☐ **ASI v220**
☐ **BKG v220**	☐ **BKG v220**	☐ **BKG v220**
☐ **DGFI v220**	☐ **DGFI v220**	☐ **DGFI v220**
☐ **ESA v220**	☐ **ESA v220**	☐ **ESA v220**
☐ **GFZ v220**	☐ **GFZ v220**	☐ **GFZ v220**
☐ **GFZ_L12 v220**	☐ **GFZ_L12 v220**	☐ **JCET v220**
☐ **JCET v220**	☐ **JCET v220**	☐ **NSGF v220**
☐ **NSGF v220**	☐ **NSGF v220**	☐ **ILRSA v220**
☐ **ILRSA v220**	☐ **ILRSA v220**	☐ **ILRSB v220**
☐ **ILRSB v220**	☐ **ILRSB v220**	

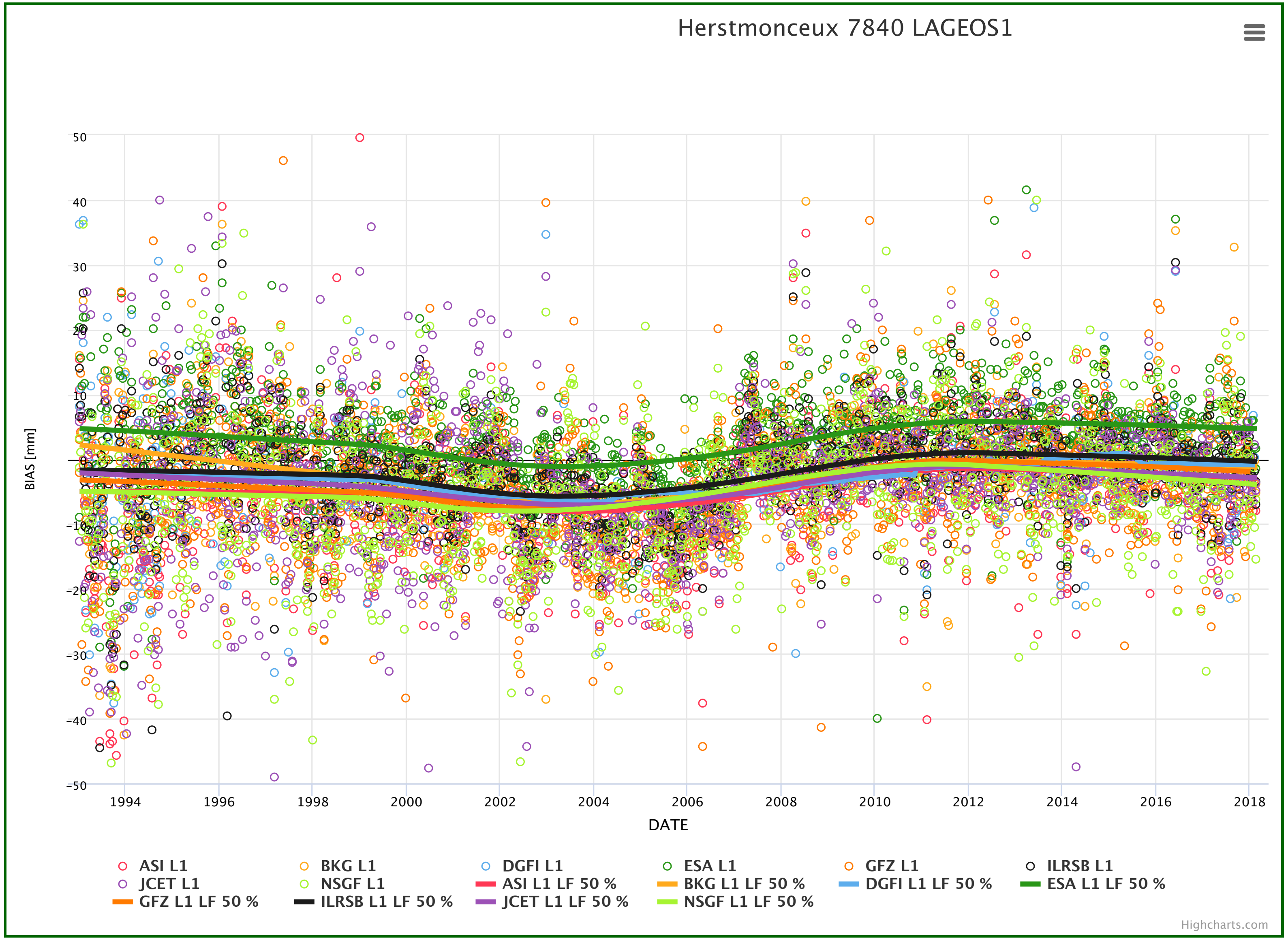
Start (MM-DD-YYYY):		
End Date (MM-DD-YYYY)		
Station	Station	
Plot Size	Minimum	Maximum
Y axis		
LOESS regression	15 %	
☐ SHOW STATION EVENTS		
LARGER THAN (SELECT BETWEEN 1-4)	0	

Submit

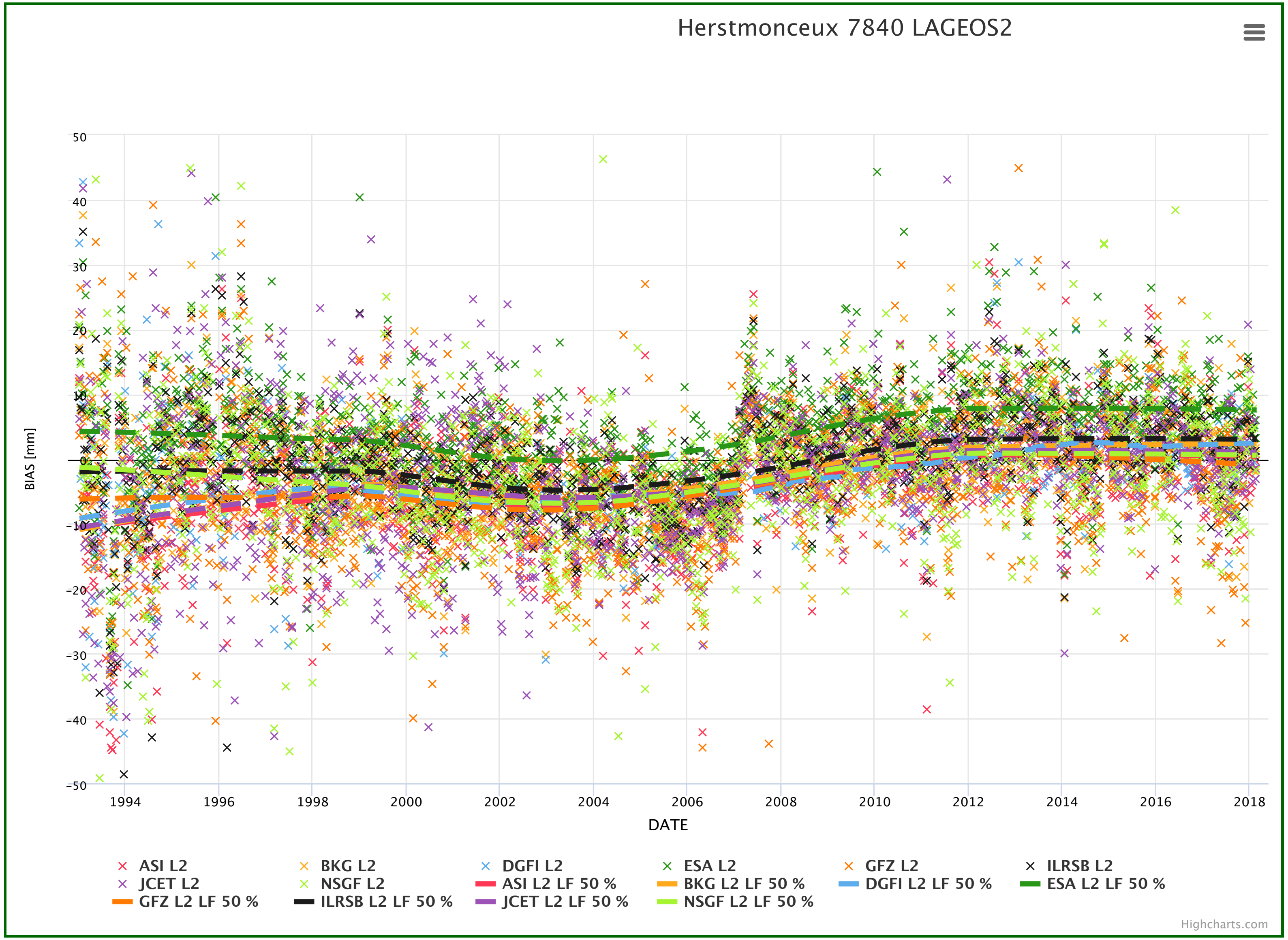
Station Systematic Error Project Results 1



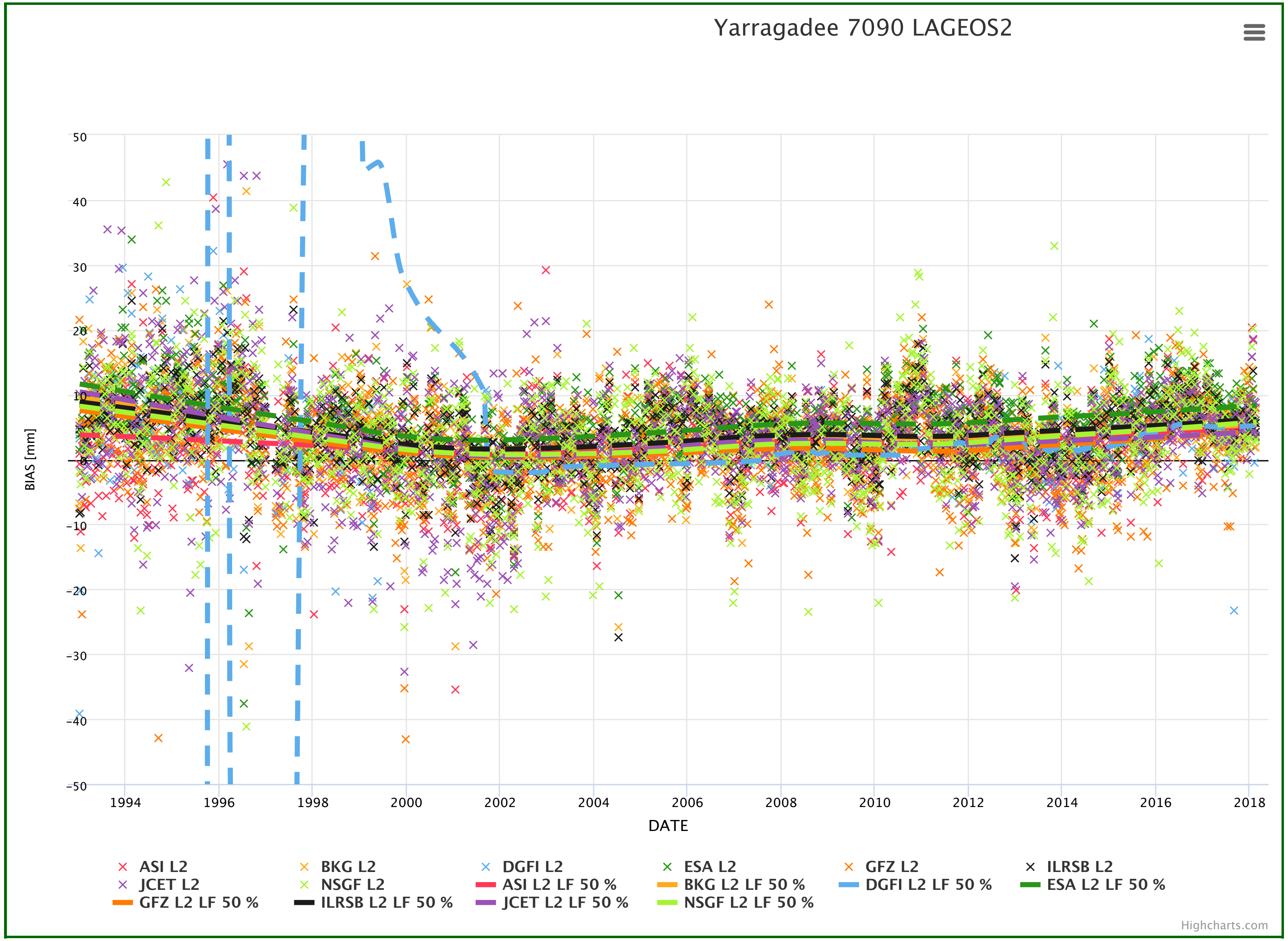
Station Systematic Error Project Results 2



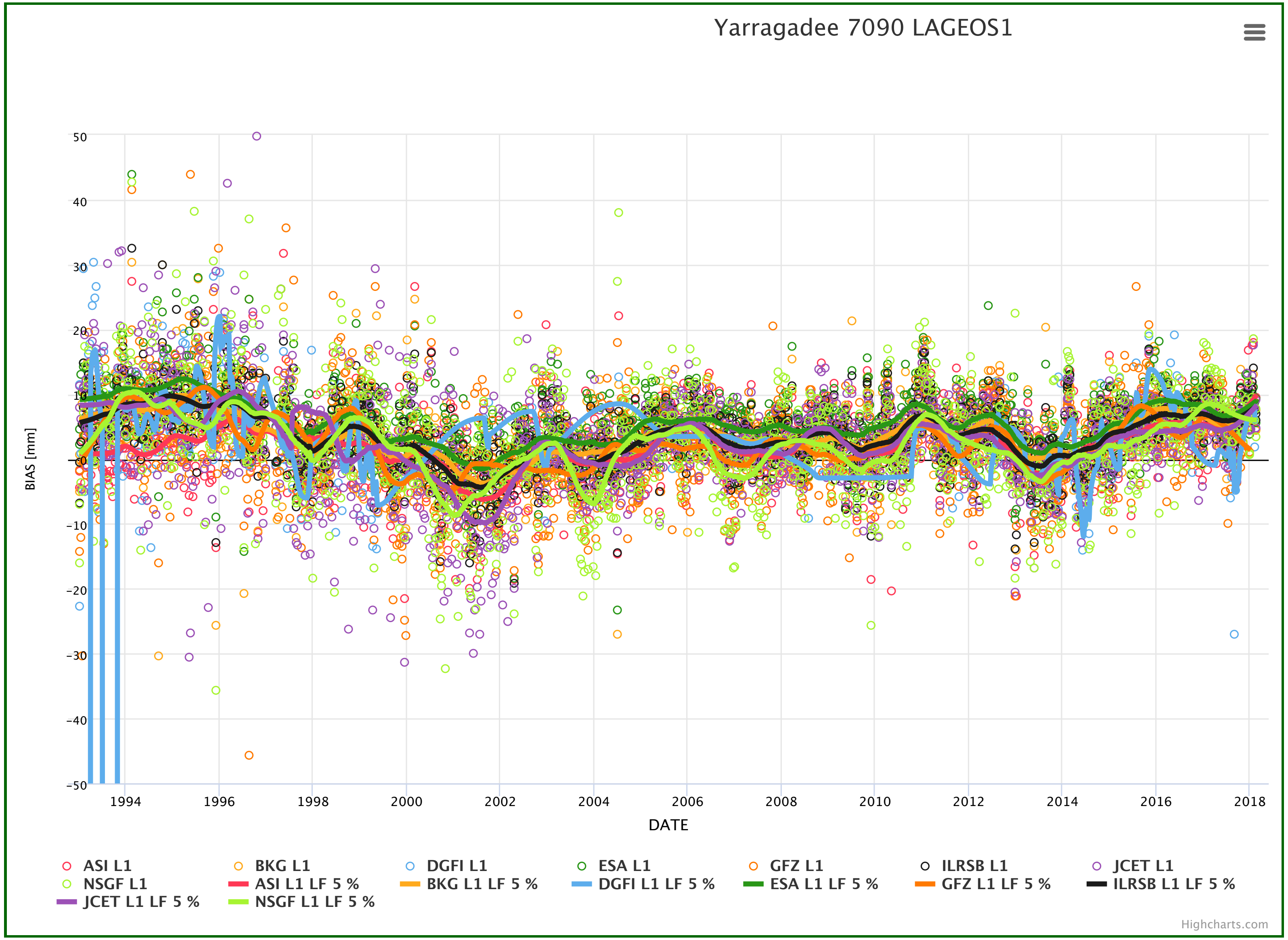
Station Systematic Error Project Results 3



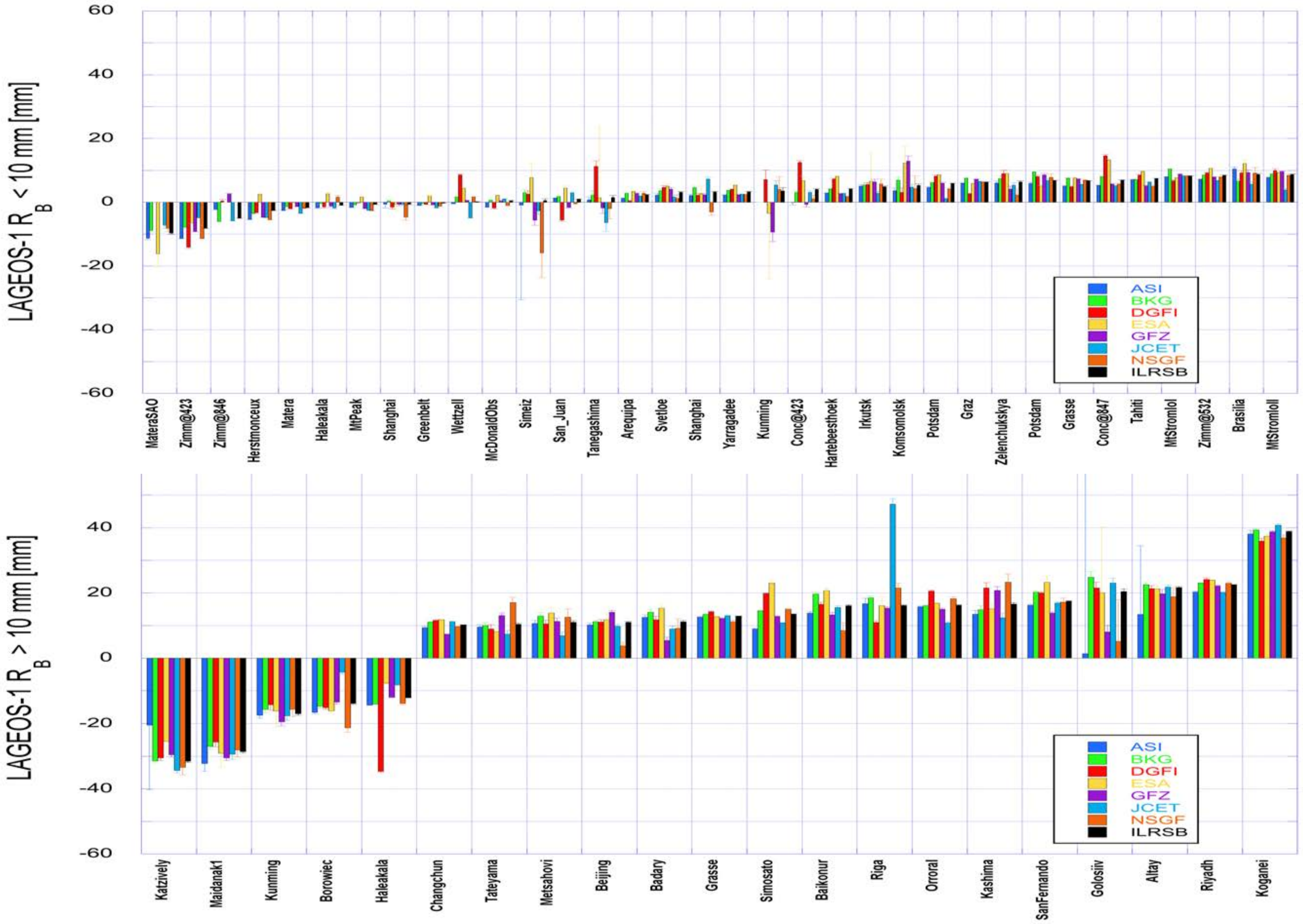
Station Systematic Error Project Results 4



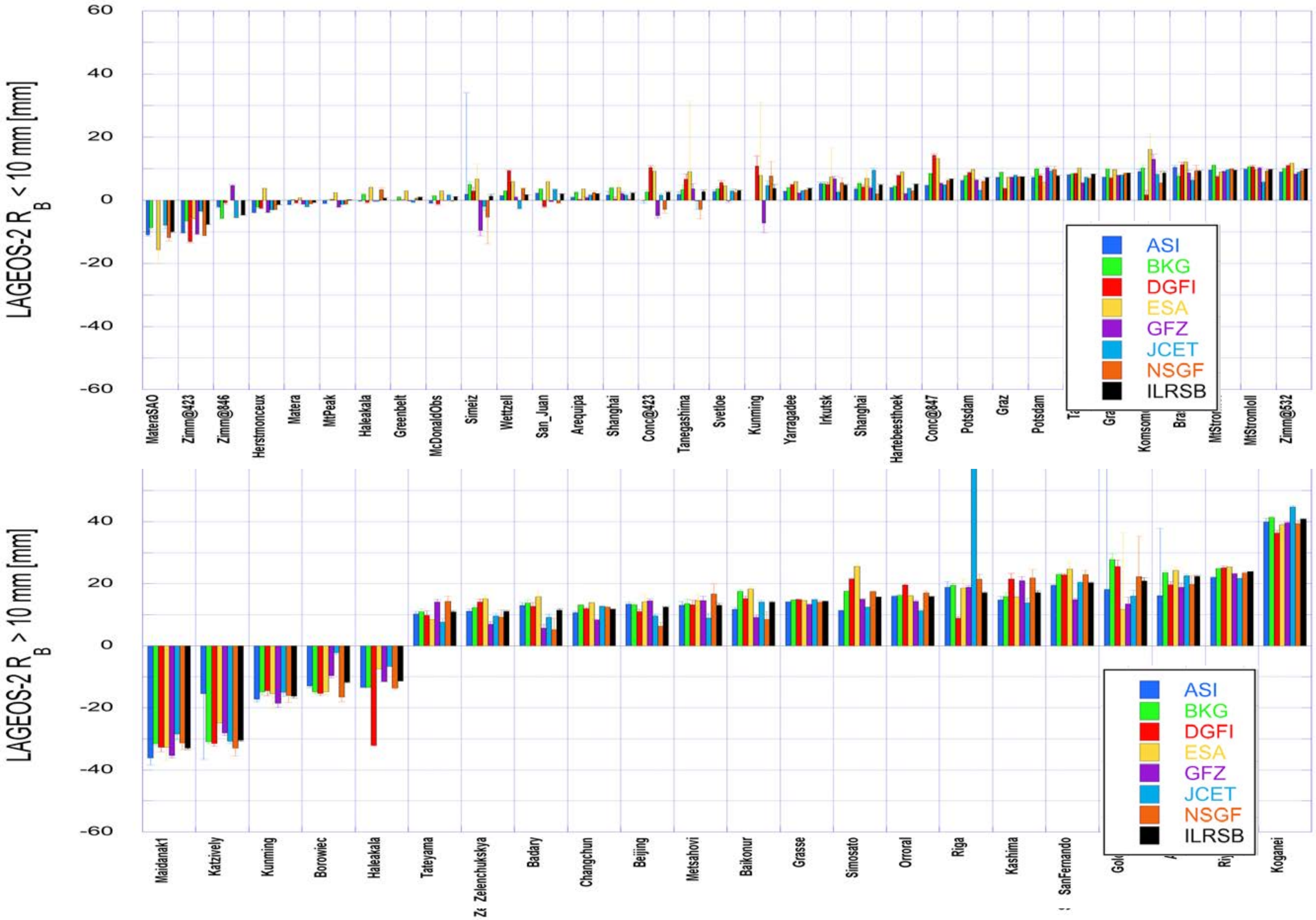
Station Systematic Error Project Results 5



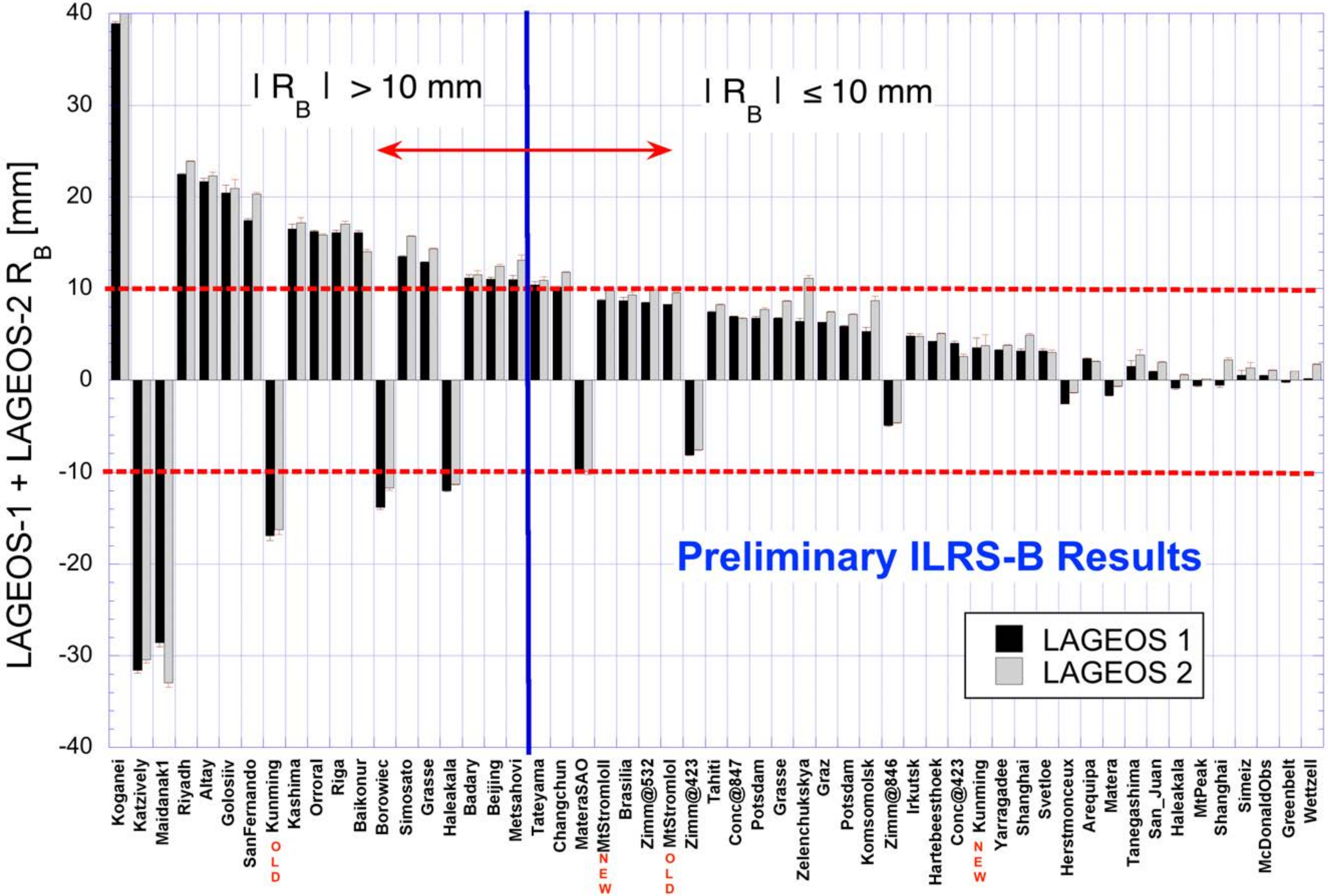
Long-term Systematic Errors LAGEOS



Long-term Systematic Errors LAGEOS-2



Long-term Systematic Errors LAGEOS1/2

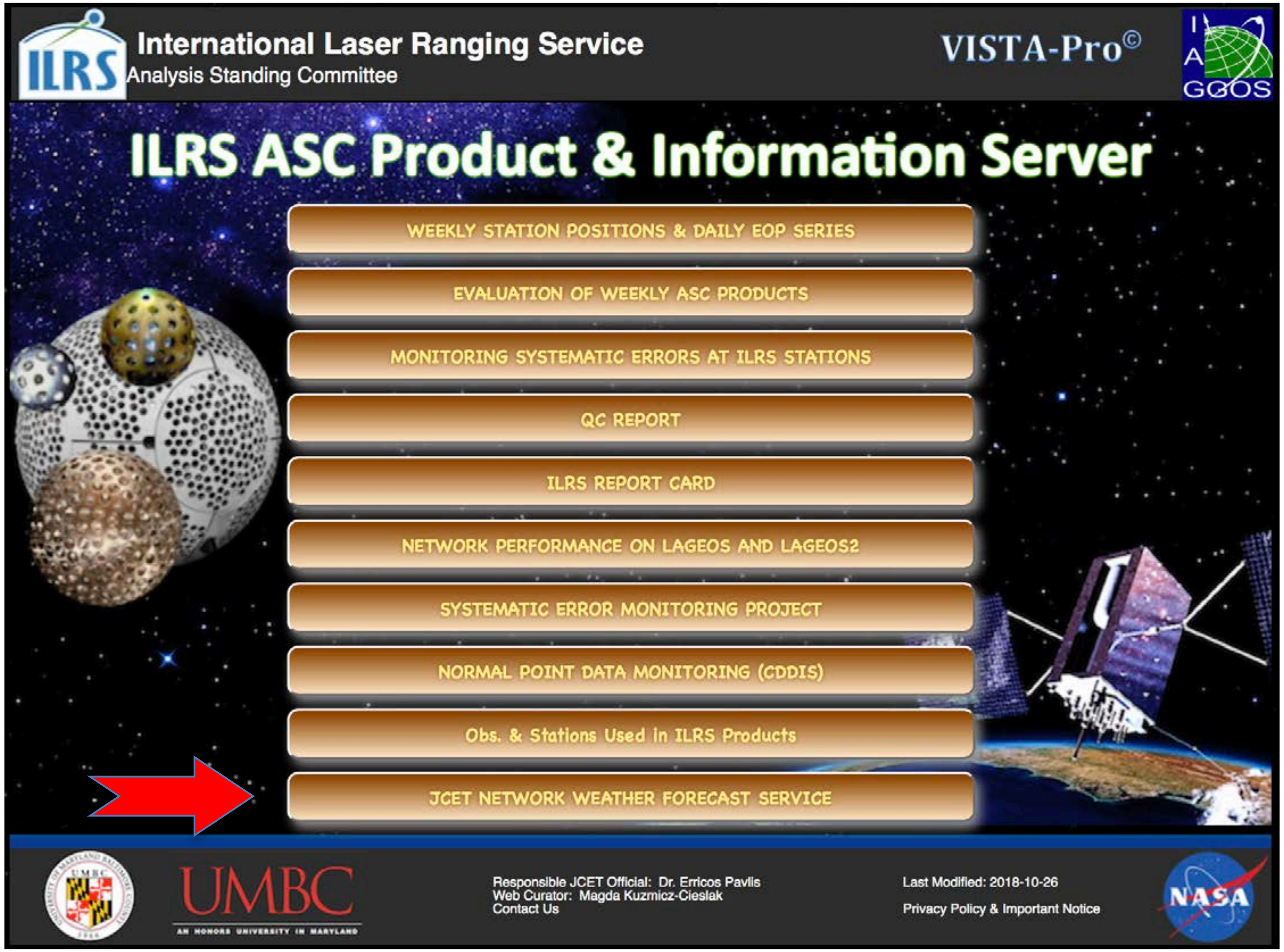


Station Systematic Error Monitoring-SSEM Project -2

- We need to evaluate the results from each AC and subsequently review the combined result for each LAGEOS;
- The combined time series will be reviewed for each system at each site and the goal here is to identify the “breaks” due to logged activities at the site (from their HST logs);
- At a next step we will need to discuss* with the stations any additional “events” identified in their time series, to rationalize the adoption of additional corrections;
- The adopted long-term mean biases will be applied a priori;
- We will need to do a “dry run” for 1-2 months, then move to an operational phase by March 1, 2019 or wait after the EGU**???**

* We already have had discussions up to ~2014, so we have most of the answers by now

JCET Portal UPDATE - 2

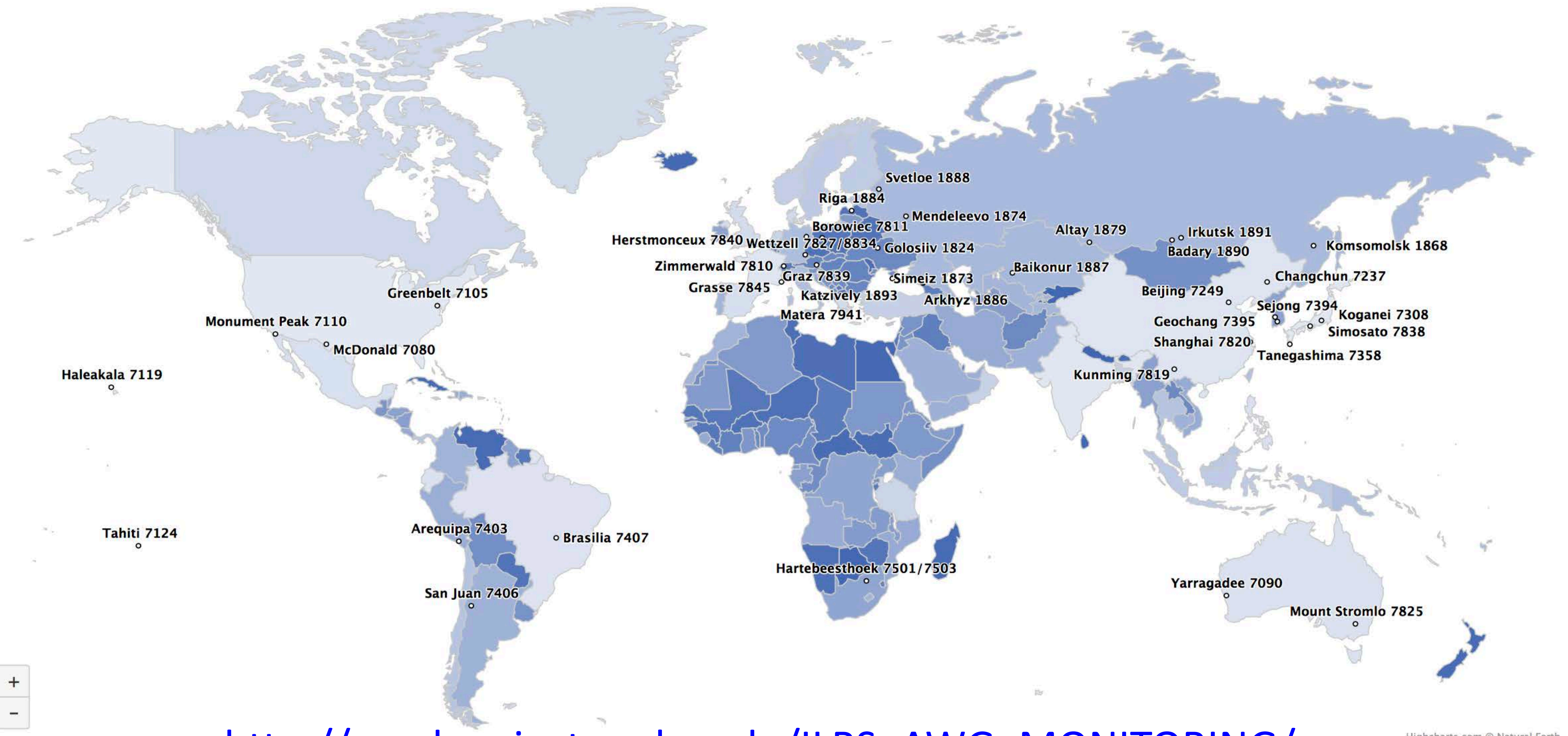


http://geodesy.jcet.umbc.edu/ILRS_AWG_MONITORING/

Network Weather Forecast - 1

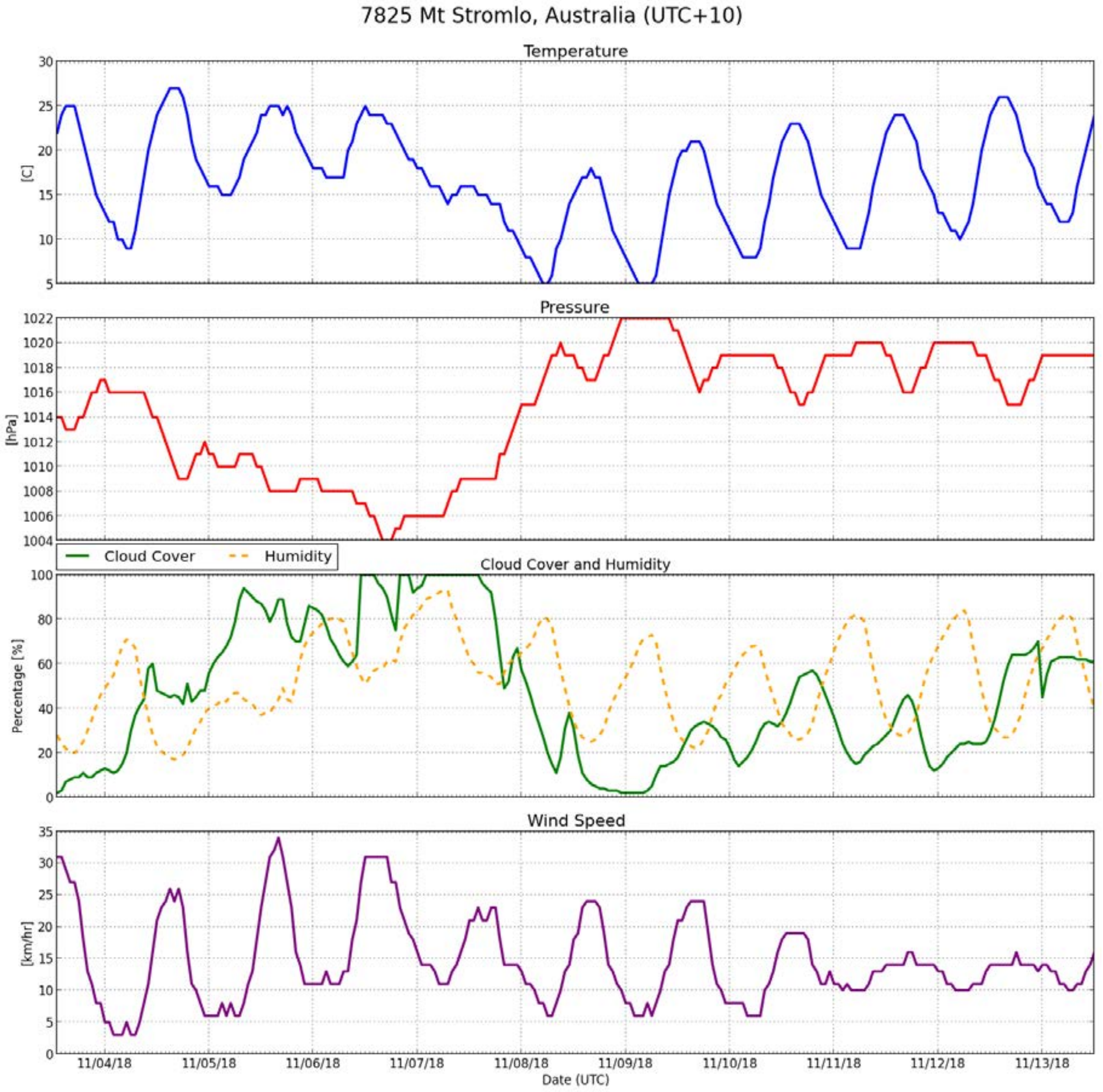
Helpful Hints and Instructions

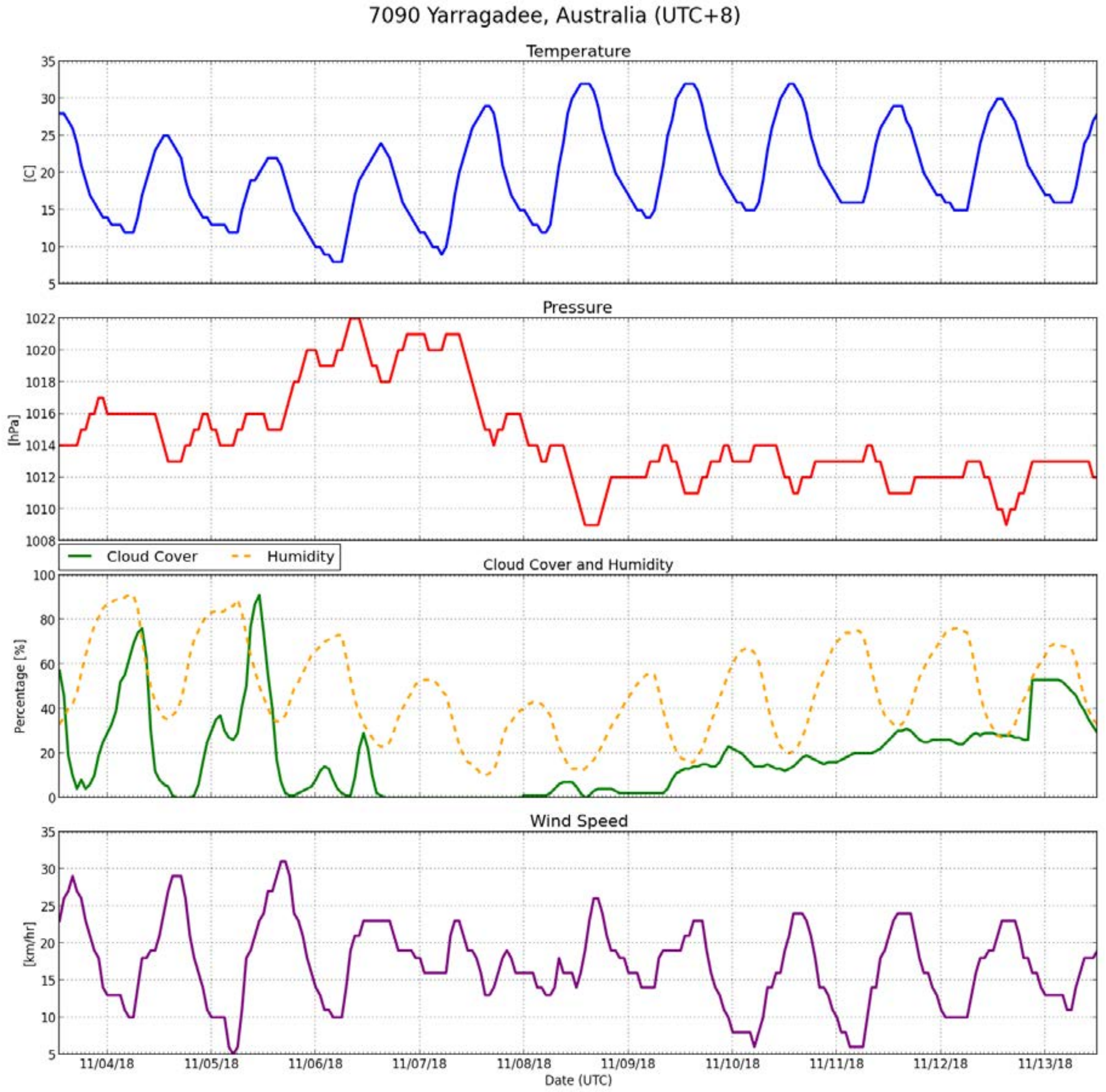
JCET Service for 10-day Weather Forecasts for the Active ILRS Sites



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

Network Weather Forecast - 2

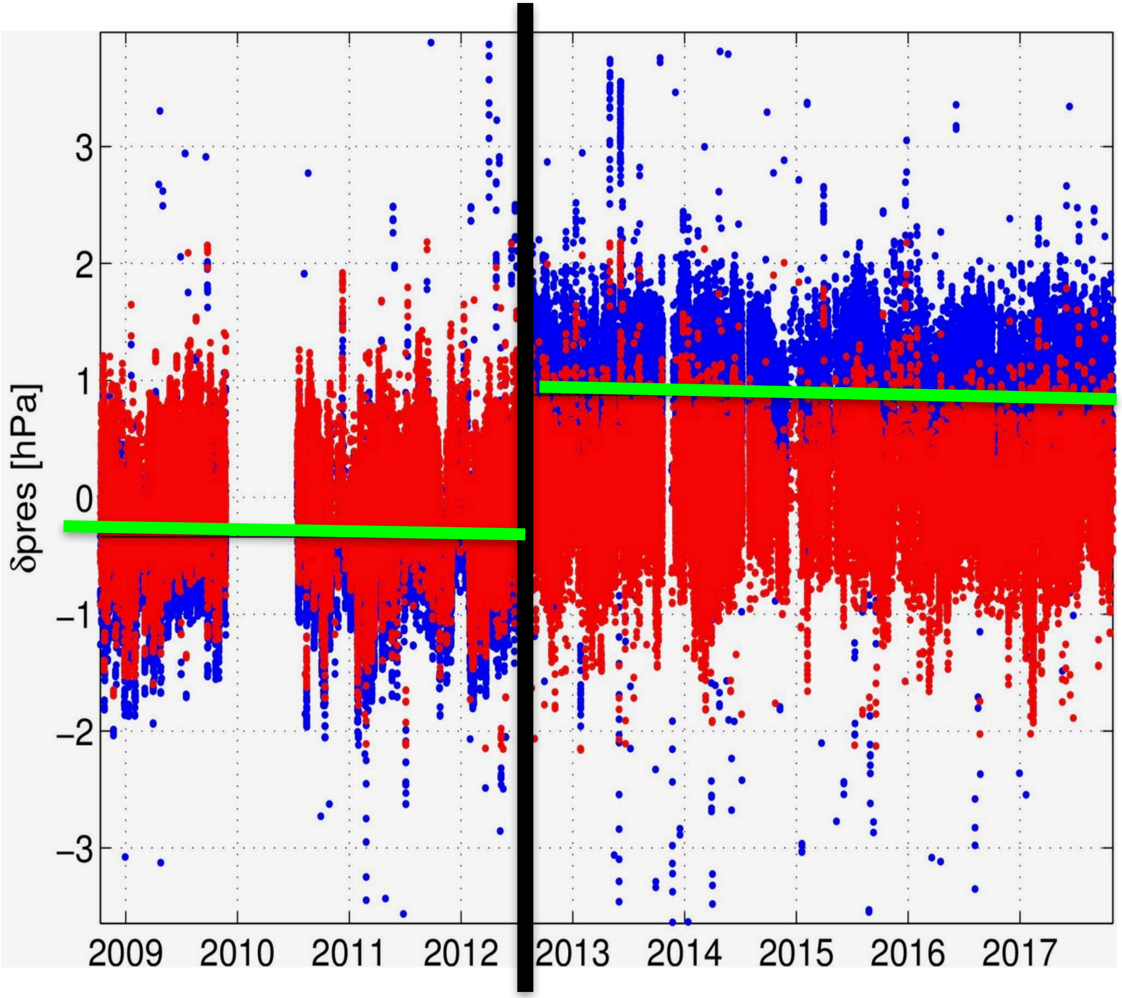


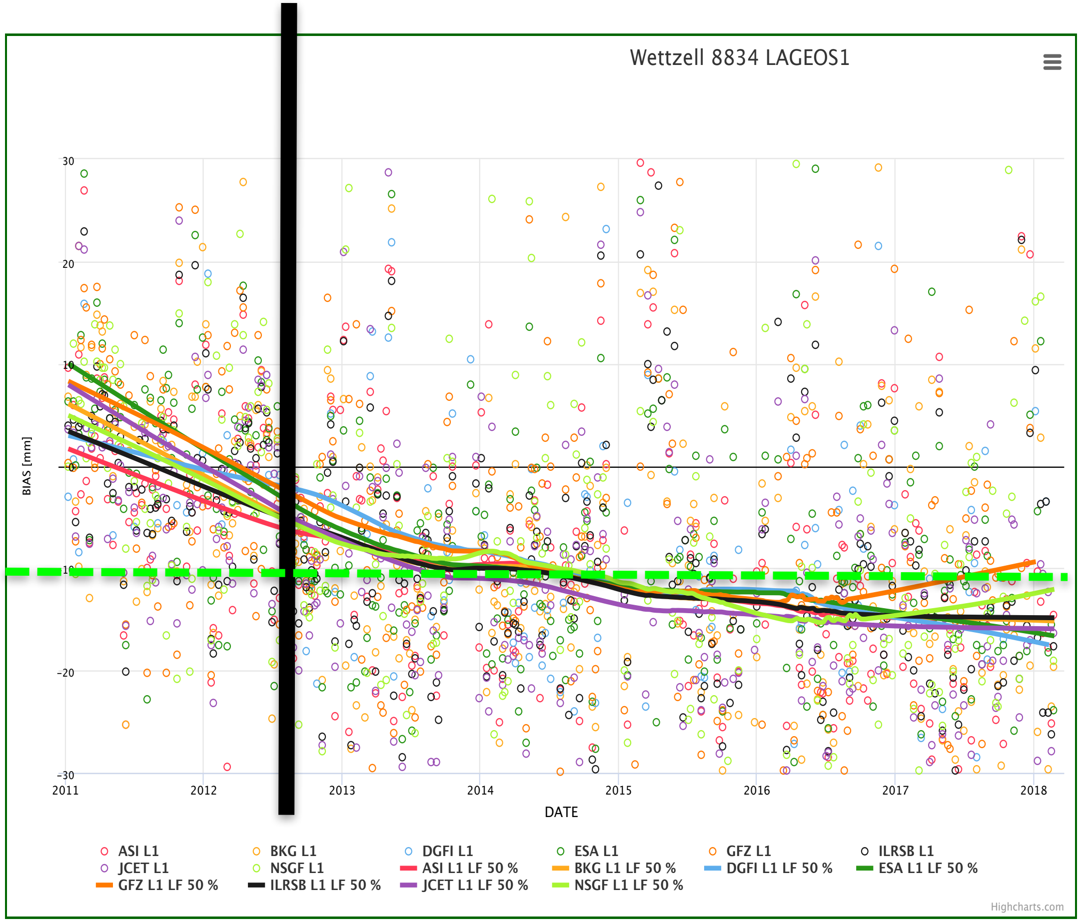


Wettzell (8834) Pressure Bias Error

Communicated by Rolf König and Ulli Schreiber

Pressure Change wrt a Standard & ASC Observed Bias





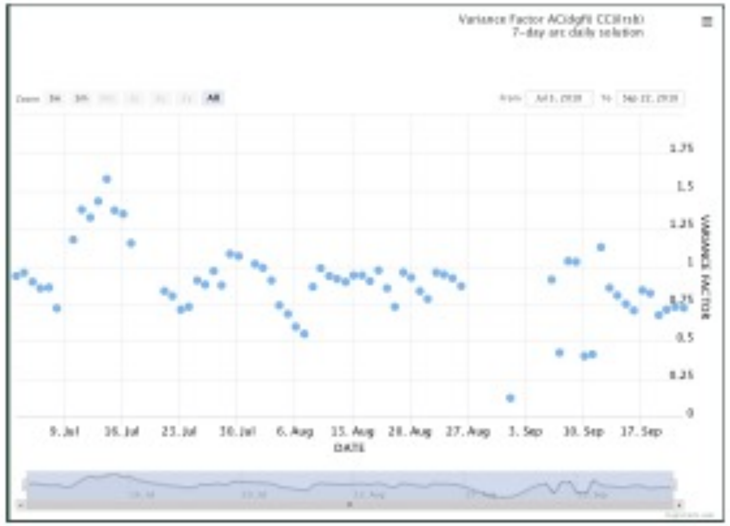
The barometer in Wettzell is located in the basement of the legacy VLBI system, where it always has been. In order to reference the SLR measurement to the invariant point of the SLR system, we applied a **1 hPa** offset correction in the ranging program in order to account for the height difference. In 2012 we progressed to a newer system. In the process this offset correction was lost!

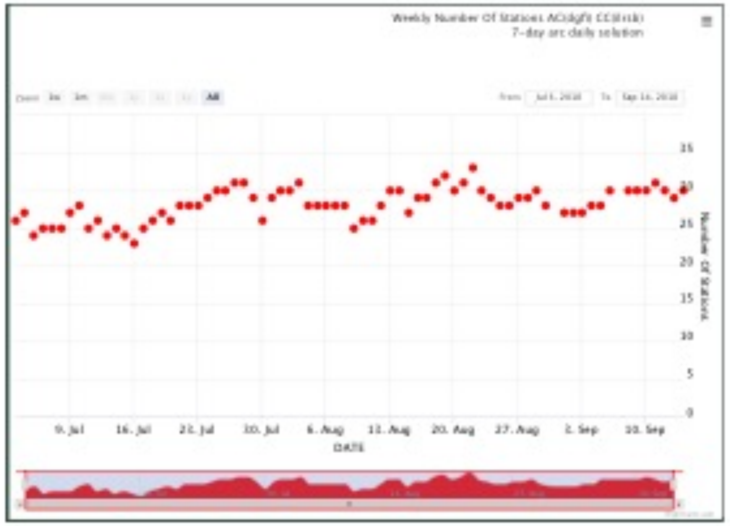
Wettzell Pressure Error Correction Process

- A plan to correct and replace the data is being developed, when the station is ready they will contact the DCs to organize the replacement and will notify the ASC and all analysts of the new release and the period covered.
- It is a complicated process due to the fact that once they apply the correction, data from before and after the correction need special attention if they happen to fall in the same arc analyzed.
- We made some proposals to the station which I assume they are considering/evaluating, with no news over the past month.

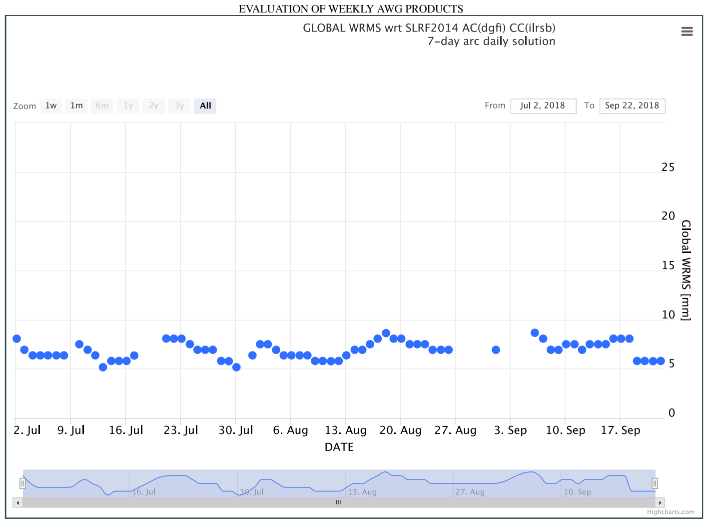
DGFI Test Series Examination

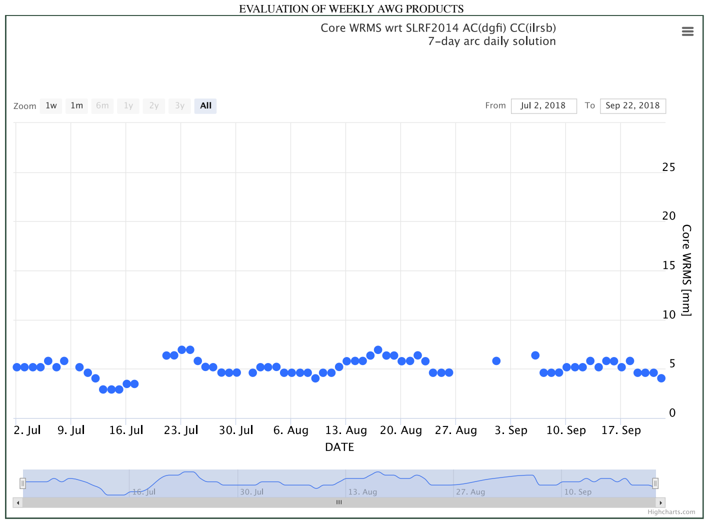
- Mathis submitted about 200 DAILY SINEXs produced with the new s/w he developed and asked us to compare their performance vs that of the standard series that is submitted from Horst's s/w production line;
- At JCET we produced the combined products series v273 (Mathis submitted three series, each one addressing problems we encountered with the prior one), where we replaced the DGFI SINEXs with the new ones;
- We noticed that not all SINEXs were successfully combined, some giving errors and others with large deviations (not a huge number though). These we need to examine more closely after the Workshop.



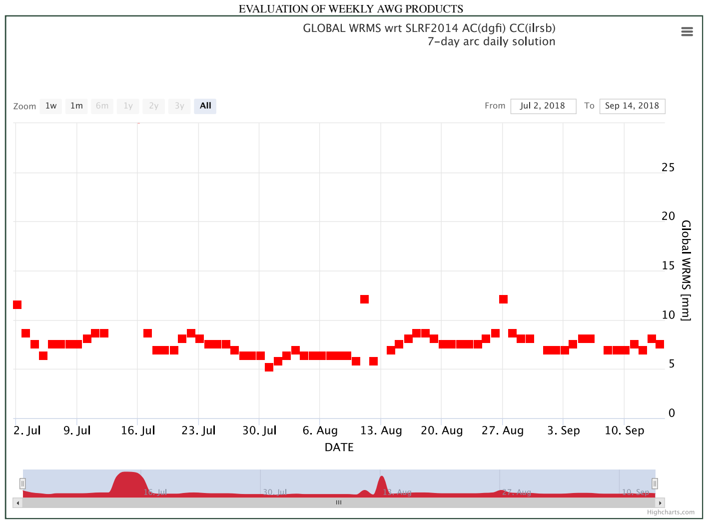


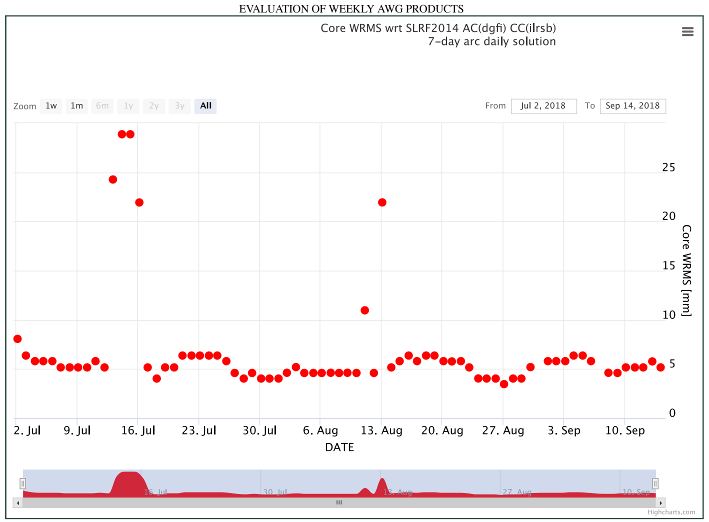
Global (left) and CORE (right) WRMS wrt SLRF2014





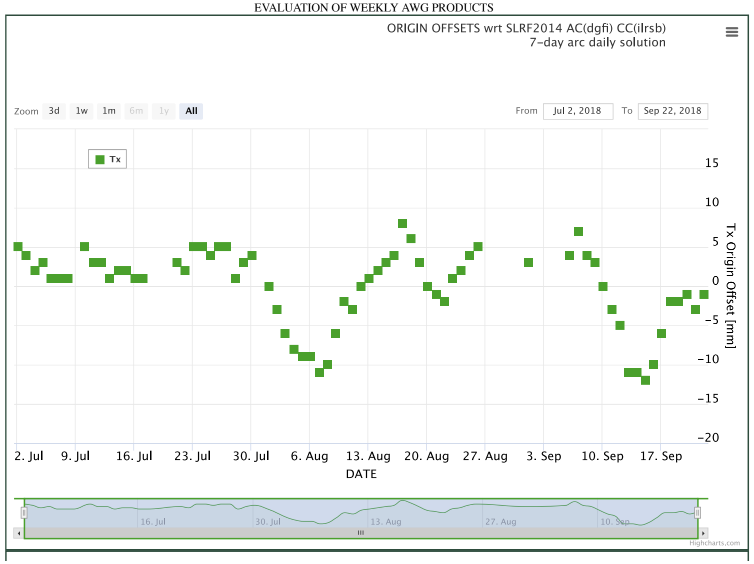
OLD

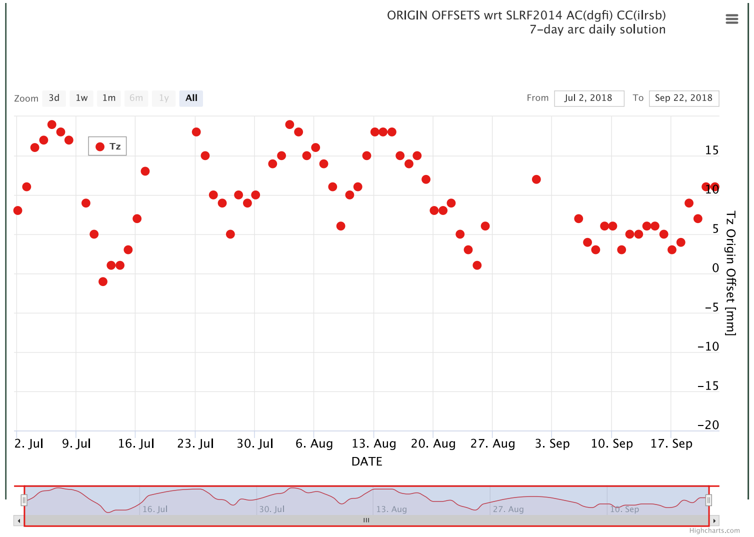




NEW

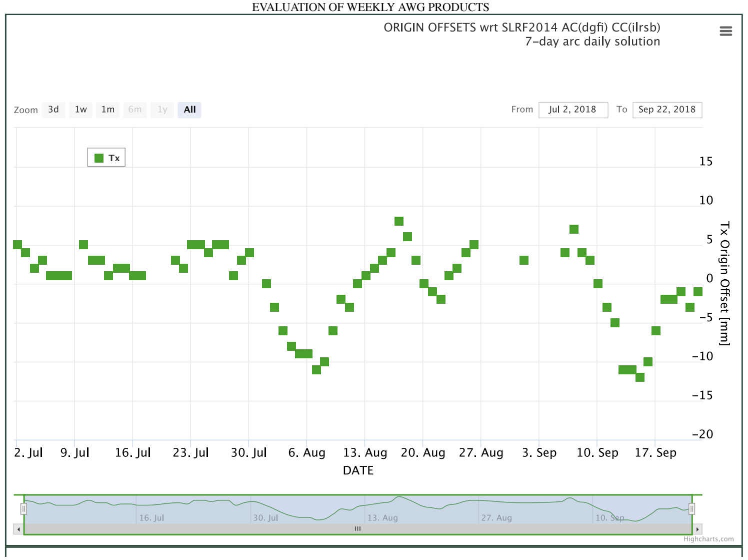
Origin Offsets wrt SLRF2014 (OLD DGFI)

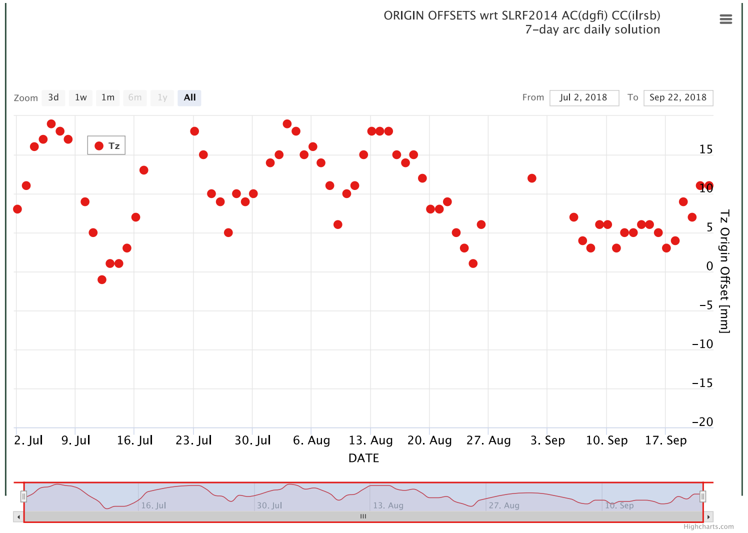




TX Origin Offset [mm] ORIGIN OFFSETS wrt SLRF2014 AC(dgfi) CC(ilrsb)	TY Origin Offset [mm] ORIGIN OFFSETS wrt SLRF2014 AC(dgfi) CC(ilrsb)	TZ Origin Offset [mm] ORIGIN OFFSETS wrt SLRF2014 AC(dgfi) CC(ilrsb)
Mean/Std. Dev.: -0.07 ± 4.96 Count: 69	Mean/Std. Dev.: 2.75 ± 2.58 Count: 69	Mean/Std. Dev.: 9.81 ± 5.37 Count: 67

Origin Offsets wrt SLRF2014 (NEW DGFI)

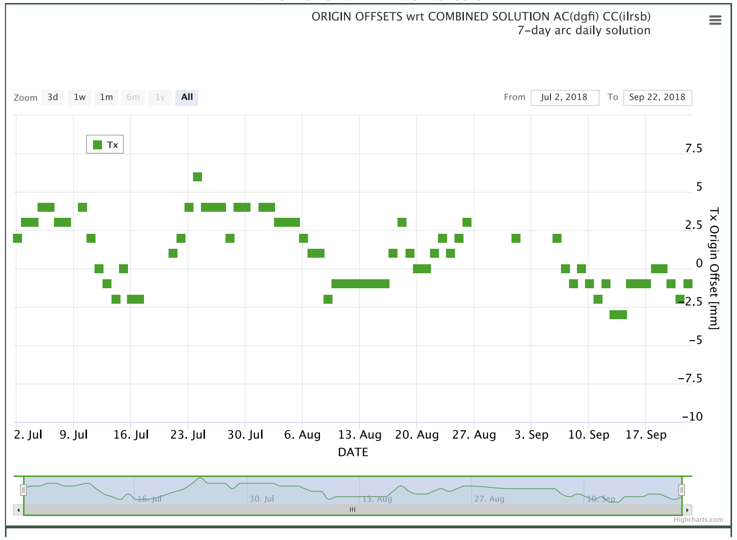


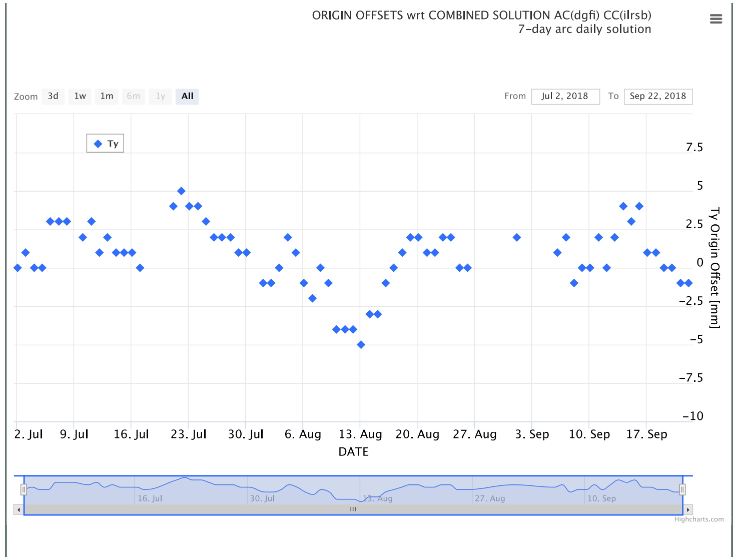


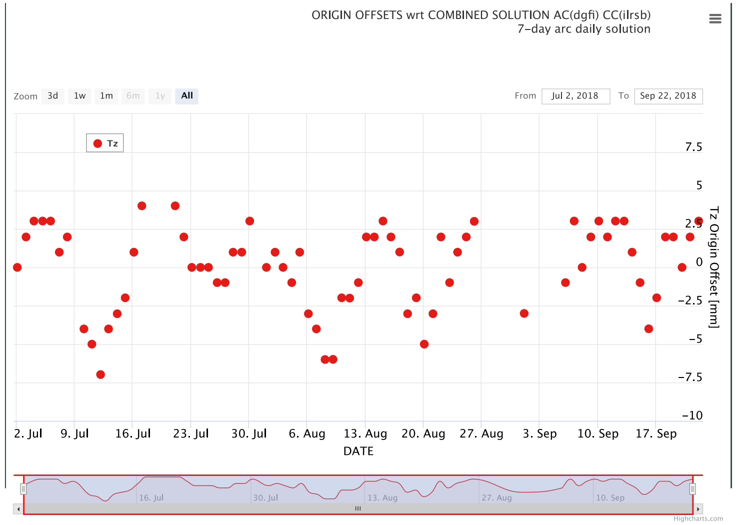
TX Origin Offset [mm] ORIGIN OFFSETS wrt SLRF2014 AC(dgfi) CC(ilrsb)	TY Origin Offset [mm] ORIGIN OFFSETS wrt SLRF2014 AC(dgfi) CC(ilrsb)	TZ Origin Offset [mm] ORIGIN OFFSETS wrt SLRF2014 AC(dgfi) CC(ilrsb)
Mean/Std. Dev.: -0.07 ± 4.96 Count: 69	Mean/Std. Dev.: 2.75 ± 2.58 Count: 69	Mean/Std. Dev.: 9.81 ± 5.37 Count: 67

Origin Offsets wrt Combined ILRS-B (OLD DGFI)

EVALUATION OF WEEKLY AWG PRODUCTS



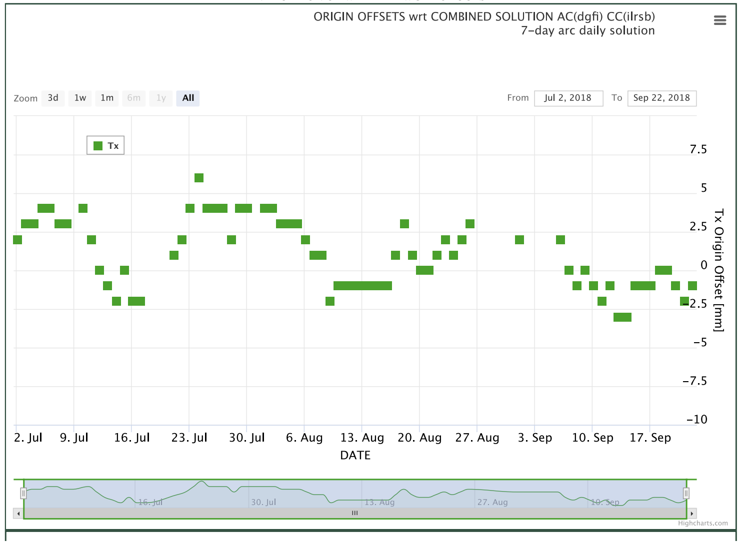


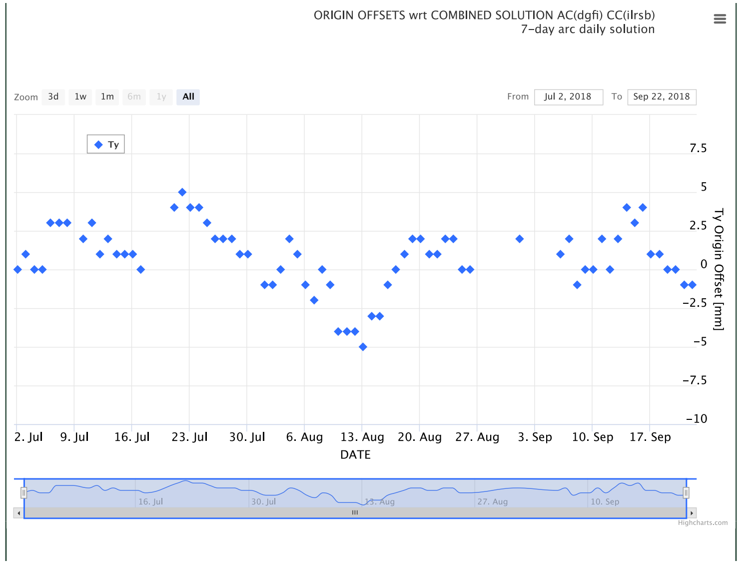


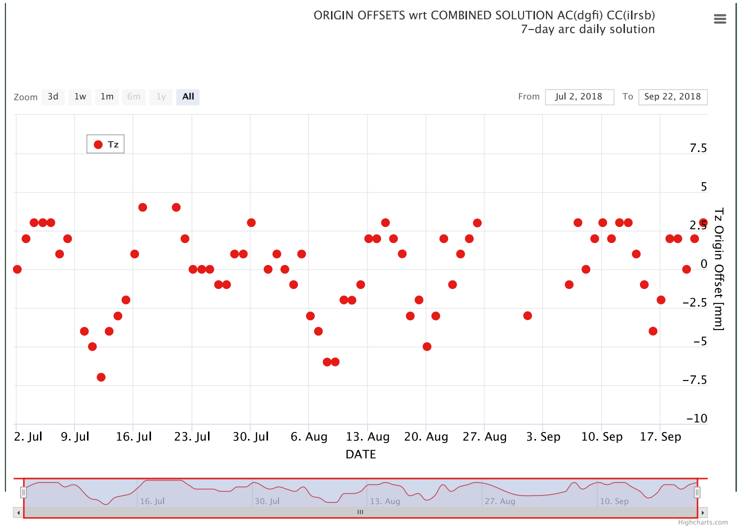
TX Origin Offset [mm] ORIGIN OFFSETS wrt COMBINED SOLUTION AC(dgfi) CC(ilrsb)	TY Origin Offset [mm] ORIGIN OFFSETS wrt COMBINED SOLUTION AC(dgfi) CC(ilrsb)	TZ Origin Offset [mm] ORIGIN OFFSETS wrt COMBINED SOLUTION AC(dgfi) CC(ilrsb)
Mean/Std. Dev.: 0.99 ± 2.19 Count: 69	Mean/Std. Dev.: 0.75 ± 2.08 Count: 69	Mean/Std. Dev.: -0.01 ± 2.71 Count: 69

Origin Offsets wrt Combined ILRS-B (NEW DGFI)

EVALUATION OF WEEKLY AWG PRODUCTS

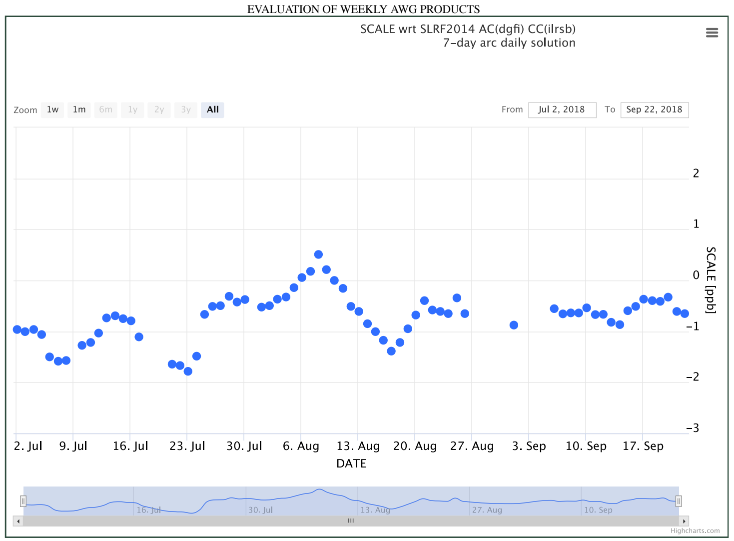


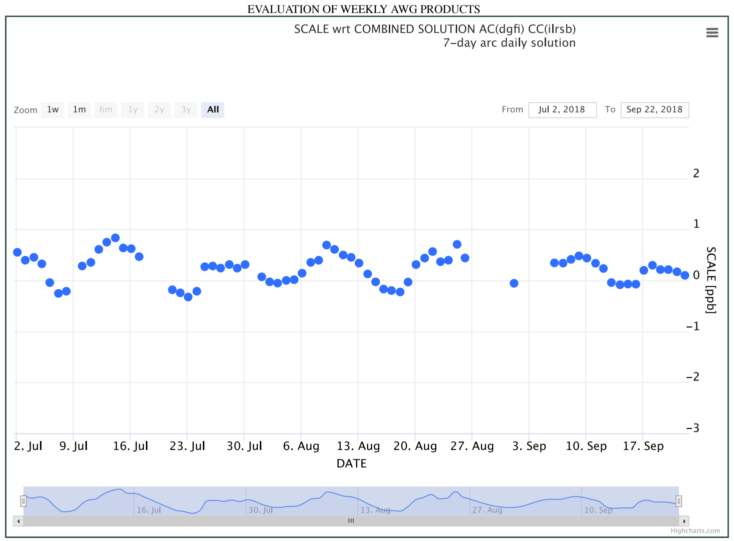




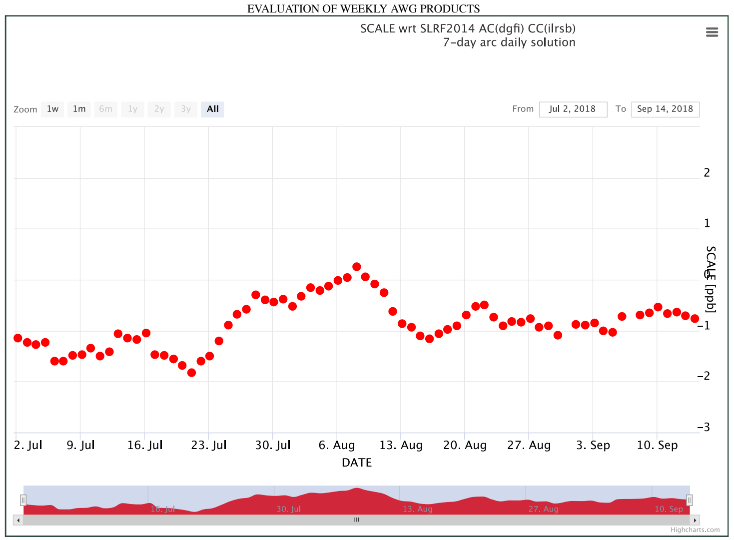
TX Origin Offset [mm] ORIGIN OFFSETS wrt COMBINED SOLUTION AC(dgfi) CC(ilrsb)	TY Origin Offset [mm] ORIGIN OFFSETS wrt COMBINED SOLUTION AC(dgfi) CC(ilrsb)	TZ Origin Offset [mm] ORIGIN OFFSETS wrt COMBINED SOLUTION AC(dgfi) CC(ilrsb)
Mean/Std. Dev.: 0.99 ± 2.19 Count: 69	Mean/Std. Dev.: 0.75 ± 2.08 Count: 69	Mean/Std. Dev.: -0.01 ± 2.71 Count: 69

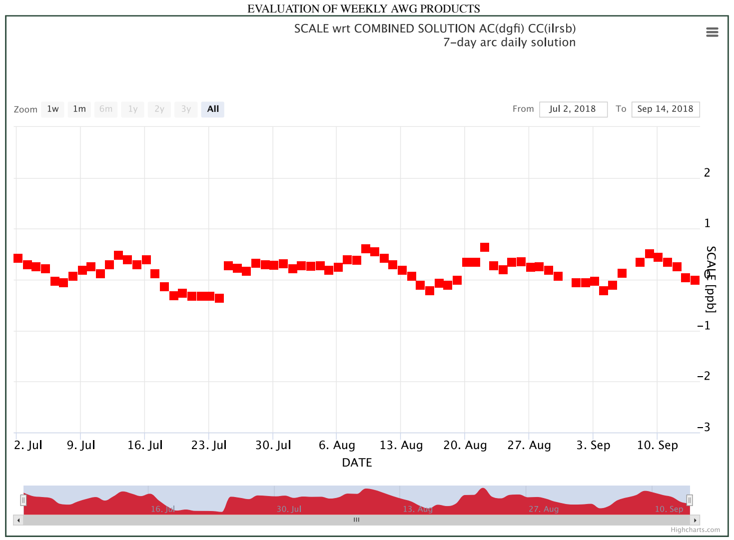
Scale wrt SLRF2014 (left) and wrt Combination ILRS-B (right)





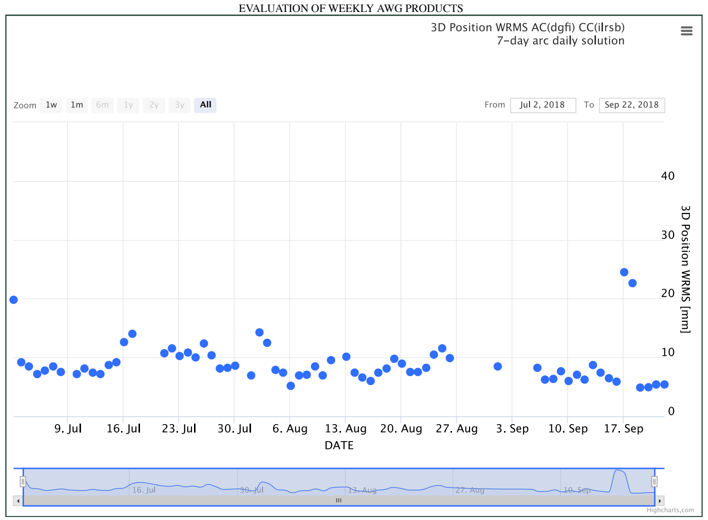
O L D

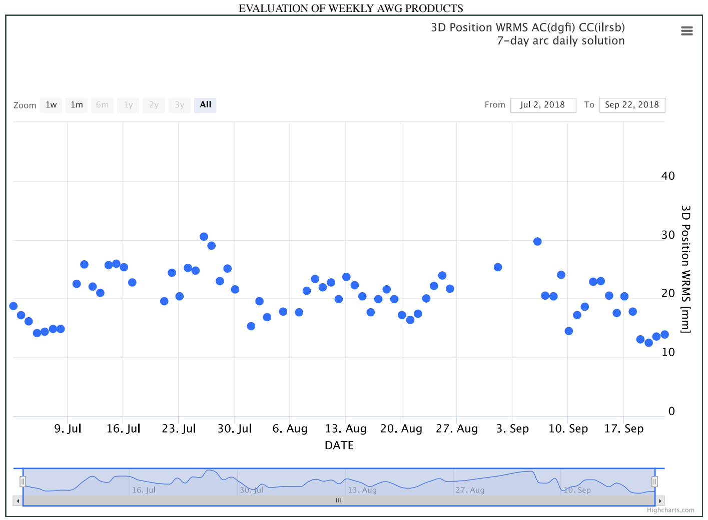




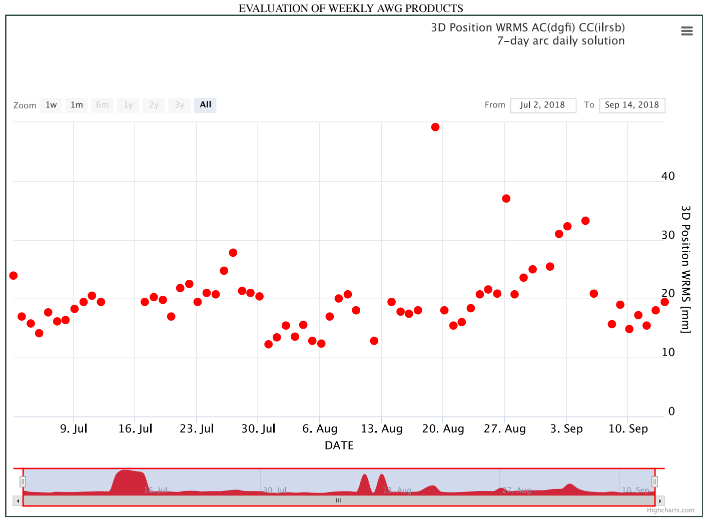
N E W

3D WRMS for Position (7090 left, 8834 right)





OLD



NEW

Preliminary Conclusions

- The new DGFI series seem cleaner, with more stations included and with better overall behavior in the comparisons to SLRF2014 as well as the combined ILRS-B product.
- We will need to check the percentage of SINEXs with issues and decide if something more needs to be tuned in procedures Mathis uses or if we can accept these series to replace Horst's products.
- It is important to see a couple of months of weekly solutions with the inclusion of bias estimation for all sites (i.e. according to the SSEM PP v220 products), so that we do not find surprises when these are submitted.

Etalon Tracking Campaign Proposal

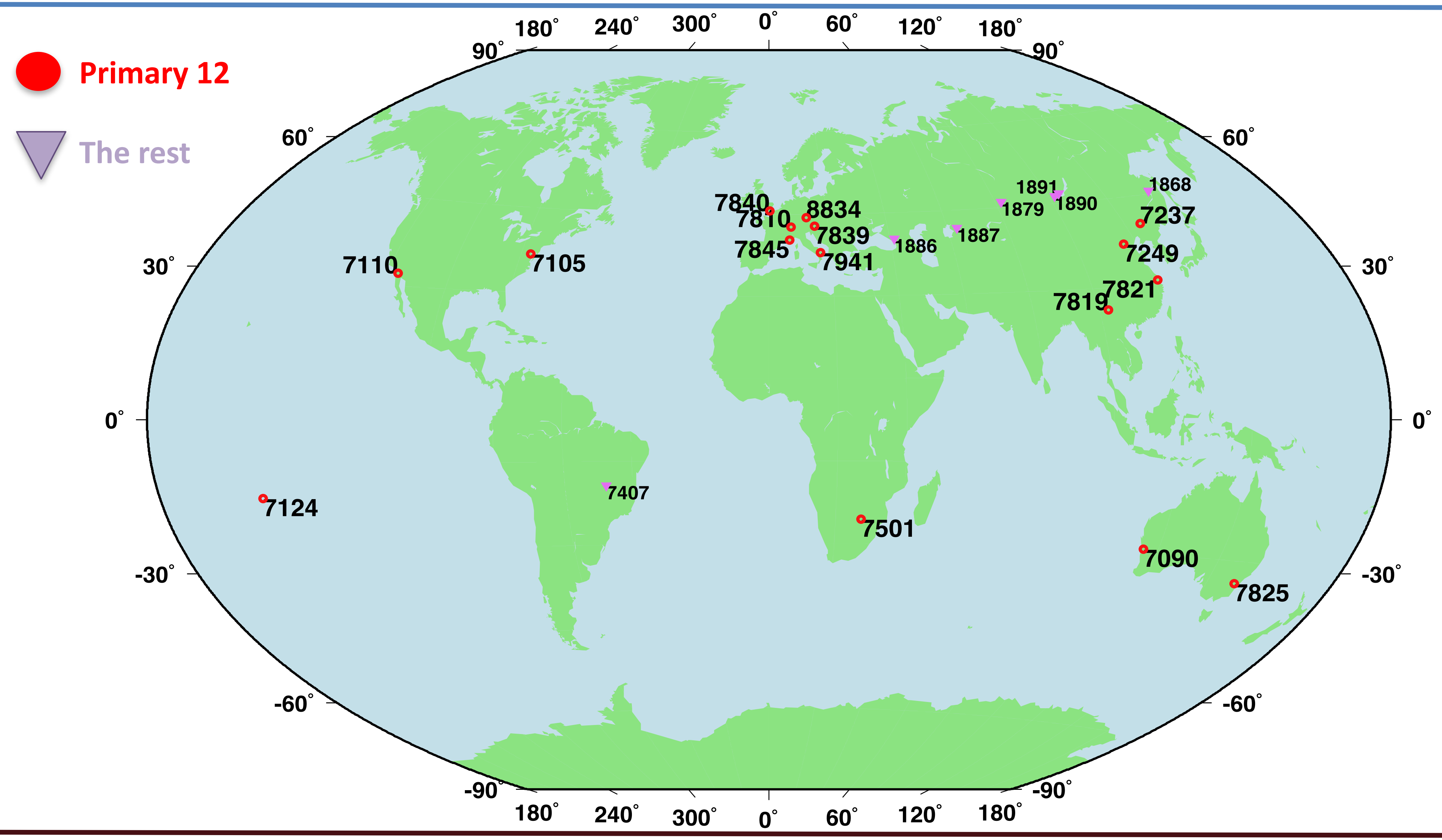
ILRS Network Sites to Support Etalon Campaign

Site Name	Sta.	GLONASS	Galileo	mpass/Bei	Total	GNSS
Zimmerwald	7810	34	232	71	337	37
Wettzell (WETL)	8834	182	227	133	542	38
Yarragadee	7090	209	203	238	650	44
Herstmonceux	7840	130	160	100	390	55
Matera	7941	141	137	101	379	24
Graz	7839	82	114	61	257	51
Mount Stromlo	7825	48	95	22	165	39
Changchun	7237	93	92	58	243	54
Shanghai	7821	69	84	64	217	48
Wettzell (SOSW)	7827	76	78	29	183	52
Beijing	7249	57	49	23	129	45
Grasse	7845	39	49	31	119	18
Potsdam	7841	40	37	5	82	43
Hartebeesthoek (HARL)	7501	35	30	5	70	19
Kunming	7819	44	27	16	87	48
Monument Peak	7110	21	23	3	47	13
Brasilia	7407	25	21	1	47	34
Irkutsk	1891	22	16	1	39	27
Tahiti	7124	27	15	10	52	19
Greenbelt	7105	50	14	3	67	15
Altay	1879	87	13	2	102	40
Komsomolsk	1868	65	11	8	84	38
Mendeleevo	1874	15	4	0	19	24
Badary	1890	20	3	0	23	10
Hartebeesthoek (HRTL)	7503	7	3	0	10	16
Svetloe	1888	11	3	0	14	13
Arkhyz	1886	36	1	0	37	20
Baikonur	1887	62	1	0	63	14
Riga	1884	0	1	0	1	1
Arequipa	7403	0	0	0	0	0
Borowiec	7811	15	0	0	15	4
Haleakala	7119	0	0	0	0	0
Katzively	1893	0	0	0	0	0
Kiev	1824	0	0	0	0	0
McDonald	7080	0	0	0	0	0
Sejong	7394	0	0	0	0	1
Simeiz	1873	13	0	1	14	19
Zelenchukskaya	1889	5	0	0	5	15
Simosato	7838	4	0	0	4	3

Site Name	Station ID#
Zimmerwald	7810
Wettzell (WETL)	8834
Yarragadee	7090
Herstmonceux	7840
Matera	7941
Graz	7839
Grasse	7845
Mount Stromlo	7825
Changchun	7237
Shanghai	7821
Beijing	7249
Hartebeesthoek (HARL)	7501
Kunming	7819
Monument Peak	7110
Tahiti	7124
Greenbelt	7105
Brasilia	7407
Irkutsk	1891
Altay	1879
Komsomolsk	1868
Badary	1890
Arkhyz	1886
Baikonur	1887

12 Primary

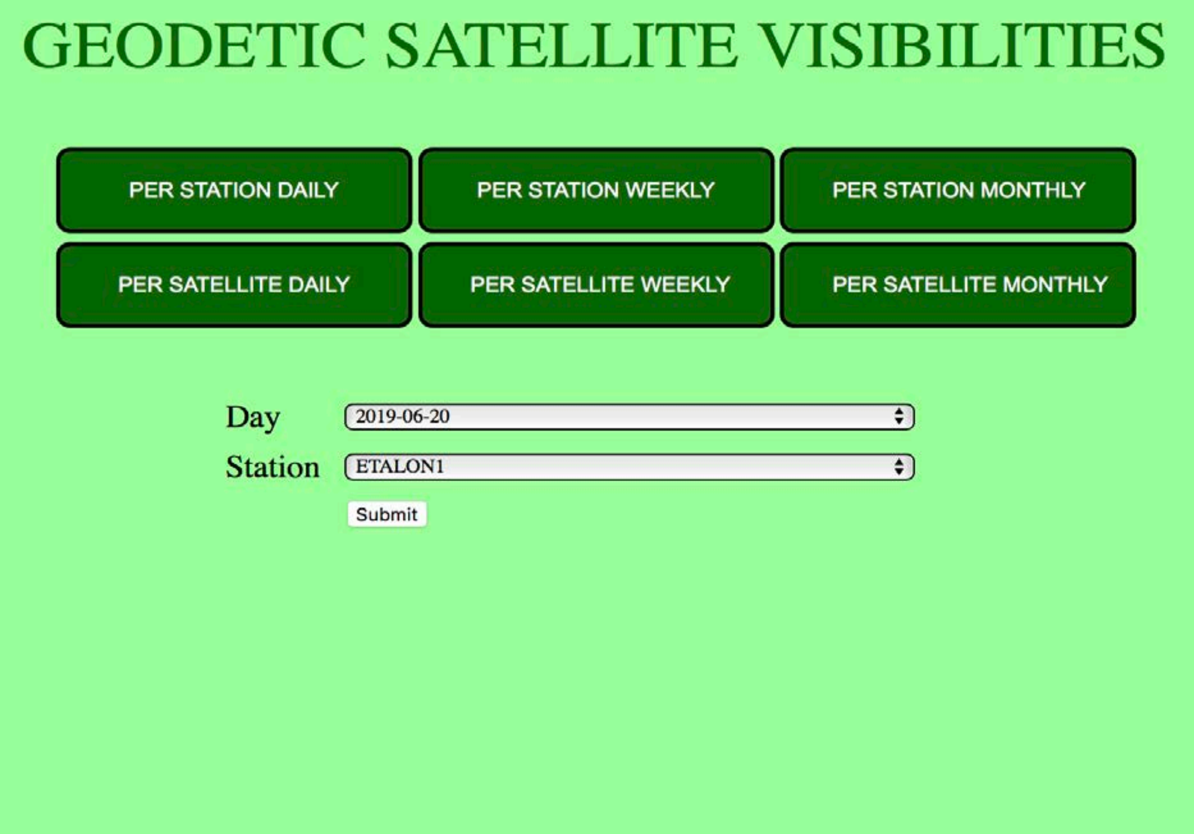
Network of Selected Stations (all)

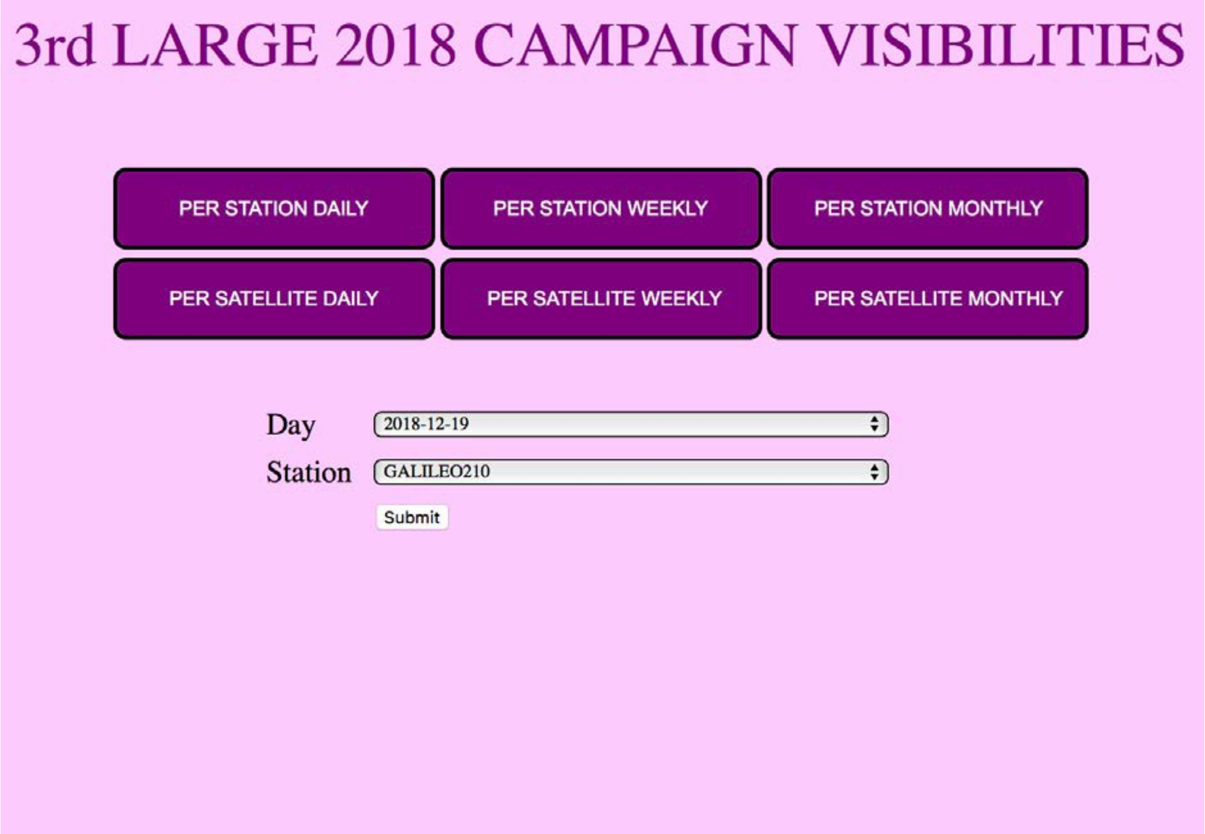


Visibility Charts Online Sites

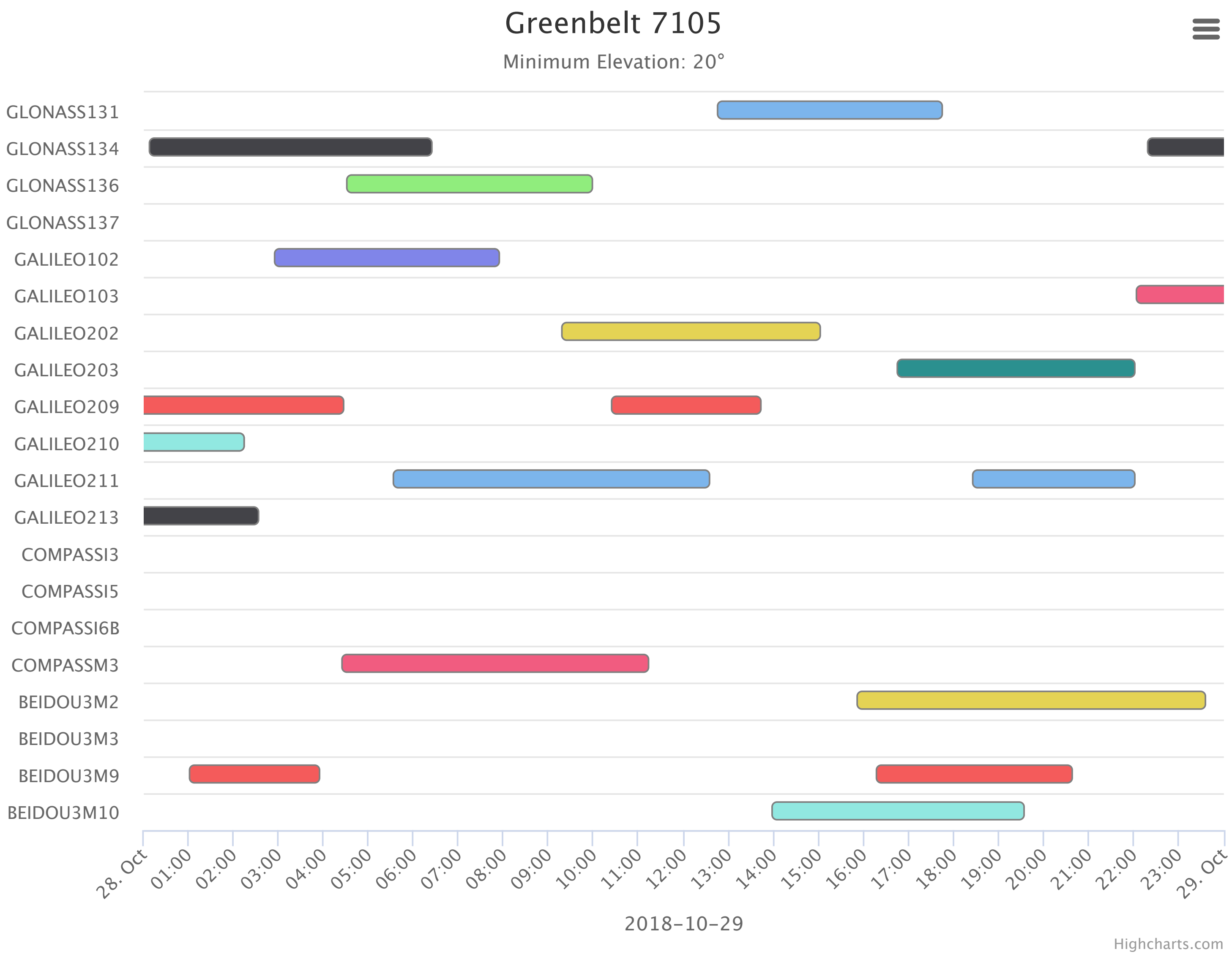
Geodetic Satellite Targets Site:
http://geodesy.jcet.umbc.edu/ALLSTAT/configuration_ALL.php

GNSS Targets Site:
http://geodesy.jcet.umbc.edu/LARGE201808_201810/configuration_ALL.php

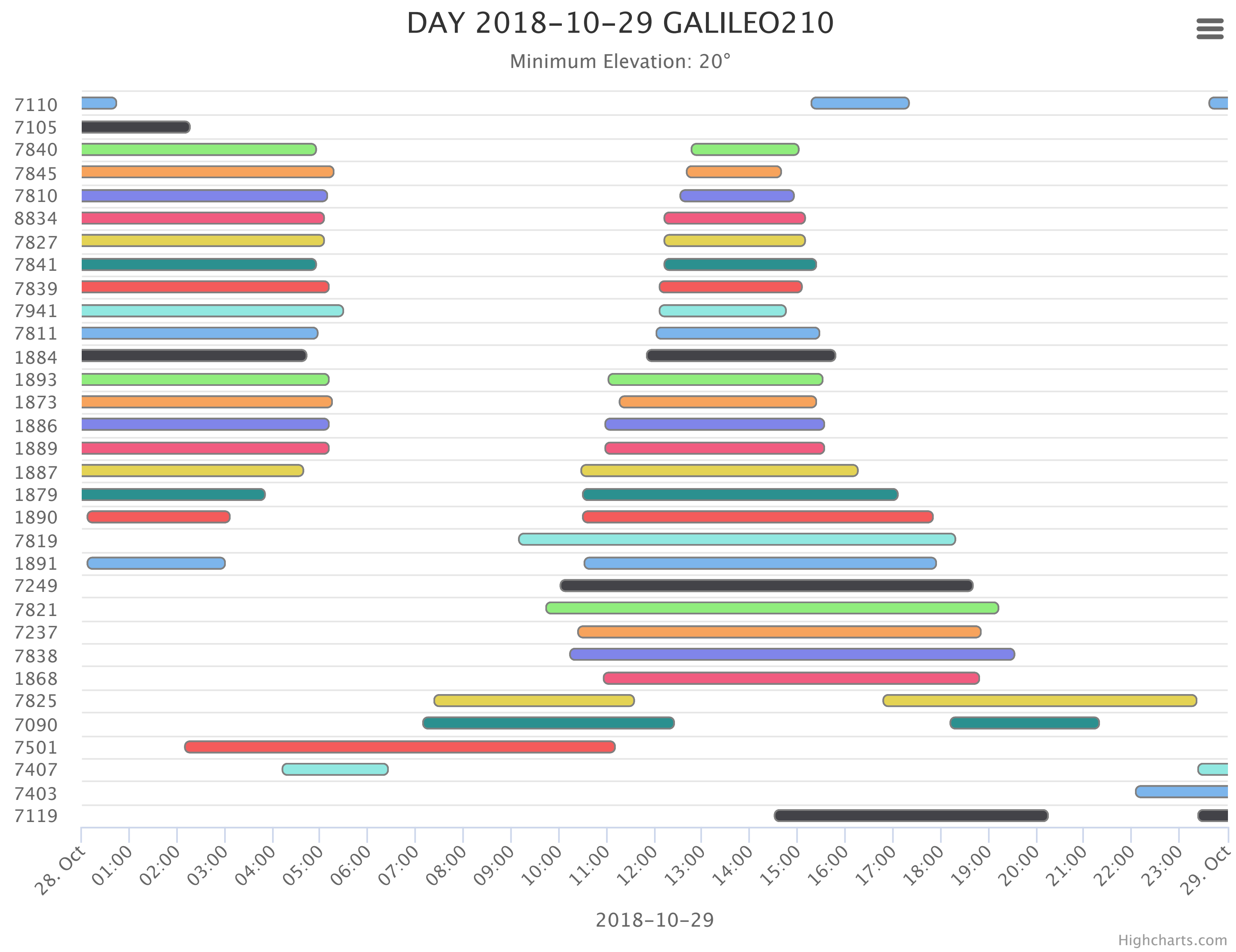




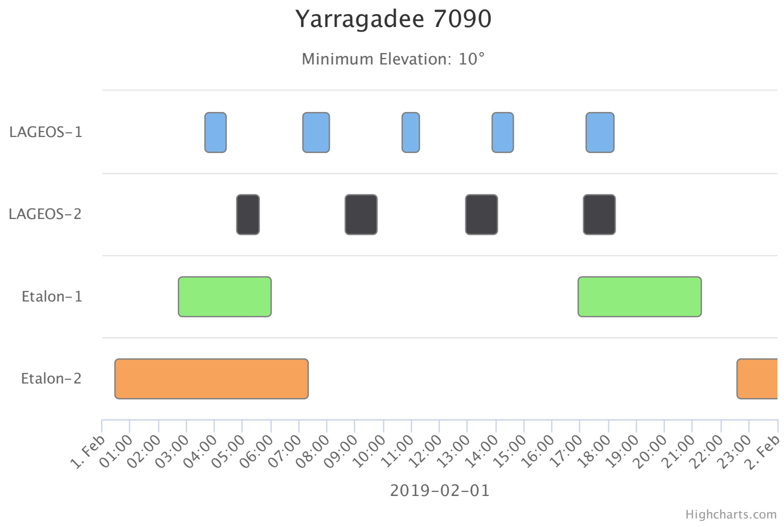
Station Visibilities for GGAO 7105: Oct. 29, 2018



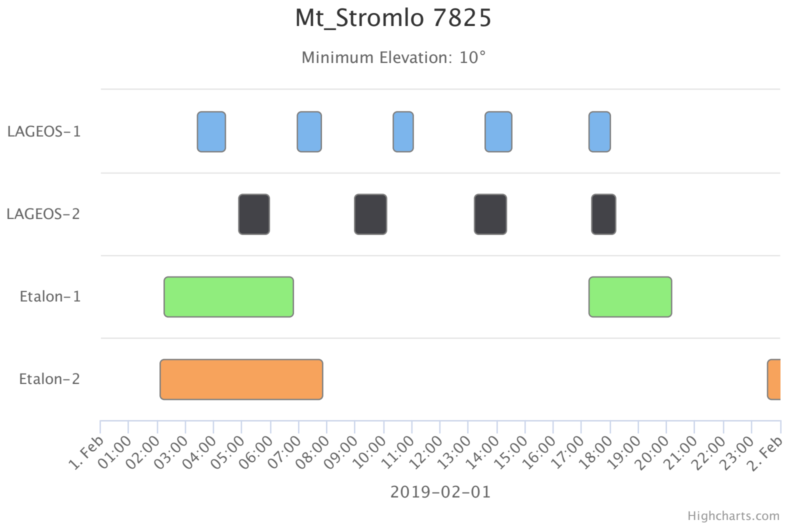
Station Visibilities for Galileo 210: Oct. 29, 2018



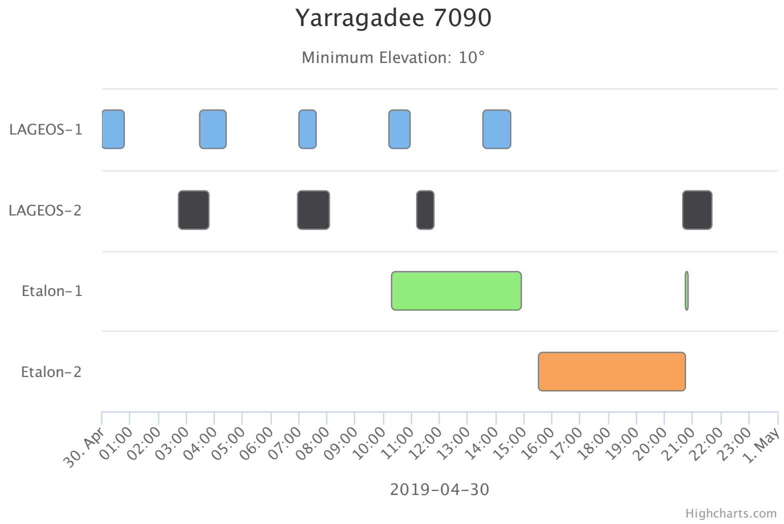
Geodetic Targets Visibilities: Feb. 1 & April 30, 2019



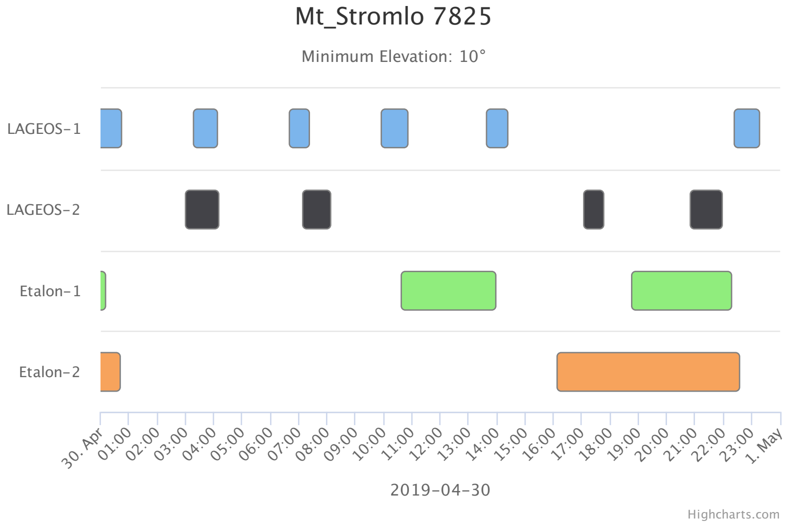
February 1



Yarragadee (7090) **Mt. Stromlo (7825)**

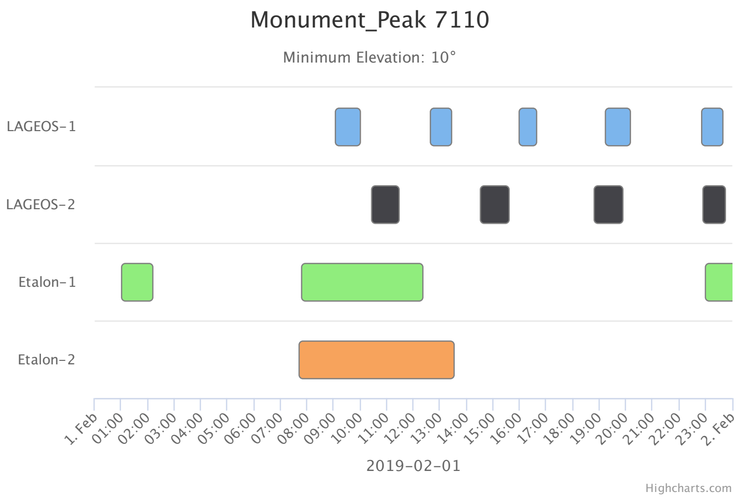


April 30



Annex

Etalon Visibility Graphs for Proposed Campaign Stations


Monument_Peak 7110
Minimum Elevation: 10°
LAGEOS-1
LAGEOS-2
Etalon-1
Etalon-2
1. Feb
01:00
02:00
03:00
04:00
05:00
06:00
07:00
08:00
09:00
10:00
11:00
12:00
13:00
14:00
15:00
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18:00
19:00
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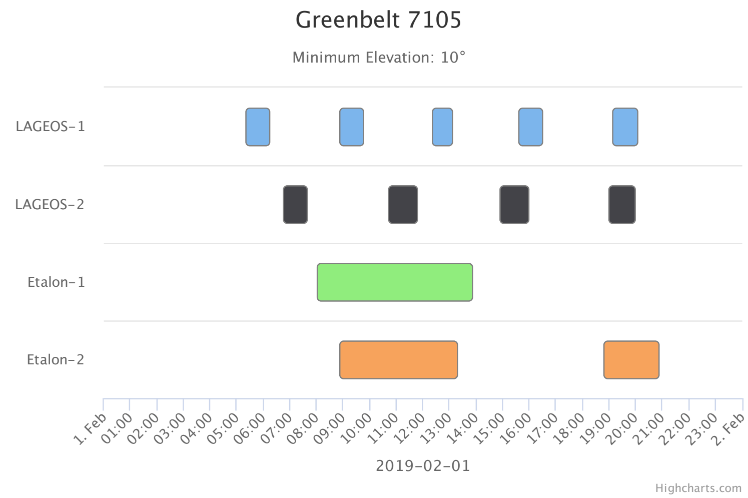
22:00
23:00
2. Feb
2019-02-01
Highcharts.com


Greenbelt 7105
Minimum Elevation: 10°
LAGEOS-1
LAGEOS-2
Etalon-1
Etalon-2
1. Feb
01:00
02:00
03:00
04:00
05:00
06:00
07:00
08:00
09:00
10:00
11:00
12:00
13:00
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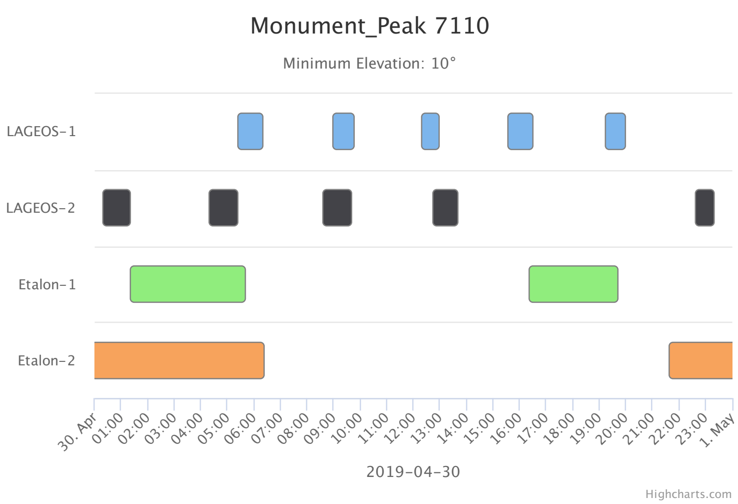
2. Feb
2019-02-01
Highcharts.com


Monument_Peak 7110
Minimum Elevation: 10°
LAGEOS-1
LAGEOS-2
Etalon-1
Etalon-2
30. Apr
01:00
02:00
03:00
04:00
05:00
06:00
07:00
08:00
09:00
10:00
11:00
12:00
13:00
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15:00
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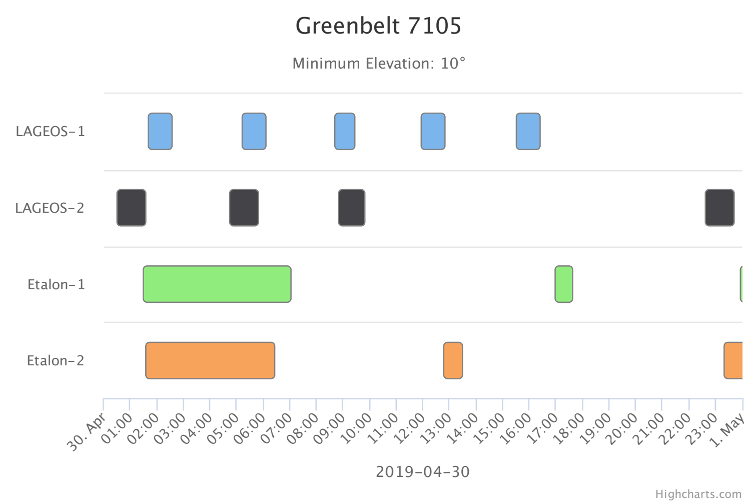
18:00
19:00
20:00
21:00
22:00
23:00
1. May
2019-04-30
Highcharts.com


Greenbelt 7105
Minimum Elevation: 10°
LAGEOS-1
LAGEOS-2
Etalon-1
Etalon-2
30. Apr
01:00
02:00
03:00
04:00
05:00
06:00
07:00
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09:00
10:00
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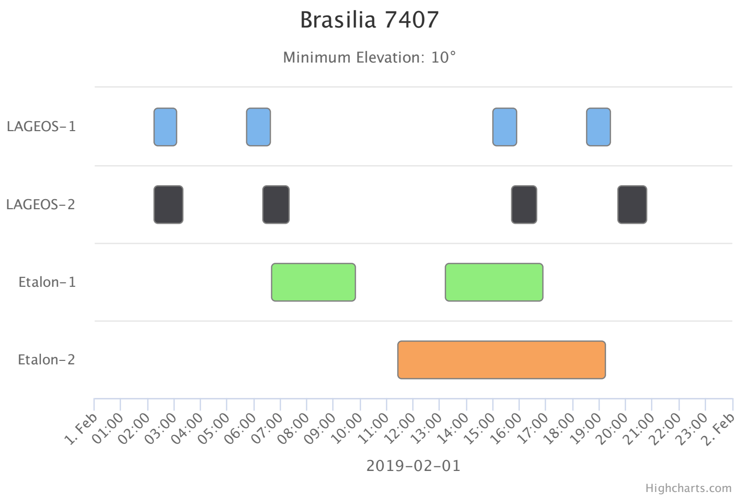
23:00
1. May
2019-04-30
Highcharts.com


Brasilia 7407
Minimum Elevation: 10°
LAGEOS-1
LAGEOS-2
Etalon-1
Etalon-2
1. Feb
01:00
02:00
03:00
04:00
05:00
06:00
07:00
08:00
09:00
10:00
11:00
12:00
13:00
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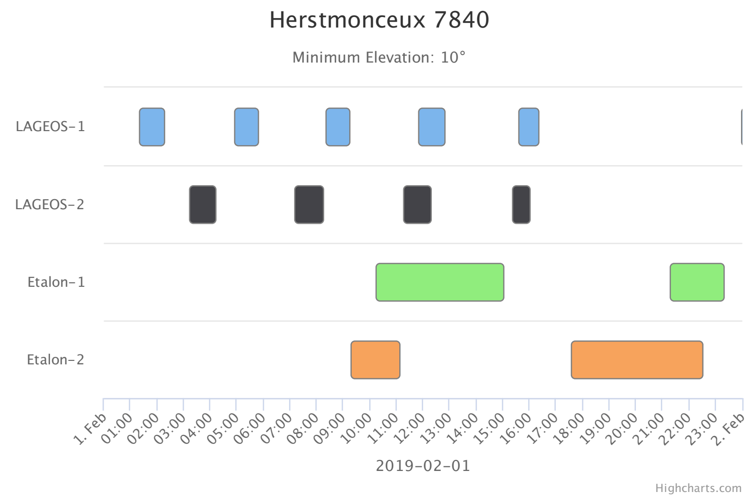
23:00
2. Feb
2019-02-01
Highcharts.com


Herstmonceux 7840
Minimum Elevation: 10°
LAGEOS-1
LAGEOS-2
Etalon-1
Etalon-2
1. Feb
01:00
02:00
03:00
04:00
05:00
06:00
07:00
08:00
09:00
10:00
11:00
12:00
13:00
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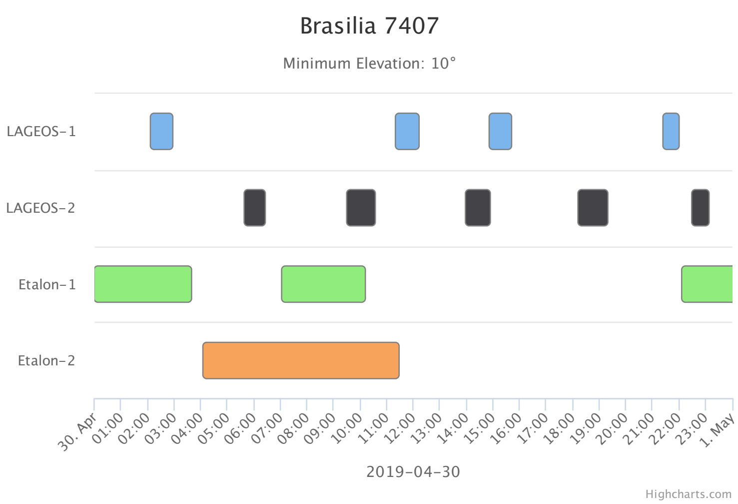
23:00
2. Feb
2019-02-01
Highcharts.com


Brasilia 7407
Minimum Elevation: 10°
LAGEOS-1
LAGEOS-2
Etalon-1
Etalon-2
30. Apr
01:00
02:00
03:00
04:00
05:00
06:00
07:00
08:00
09:00
10:00
11:00
12:00
13:00
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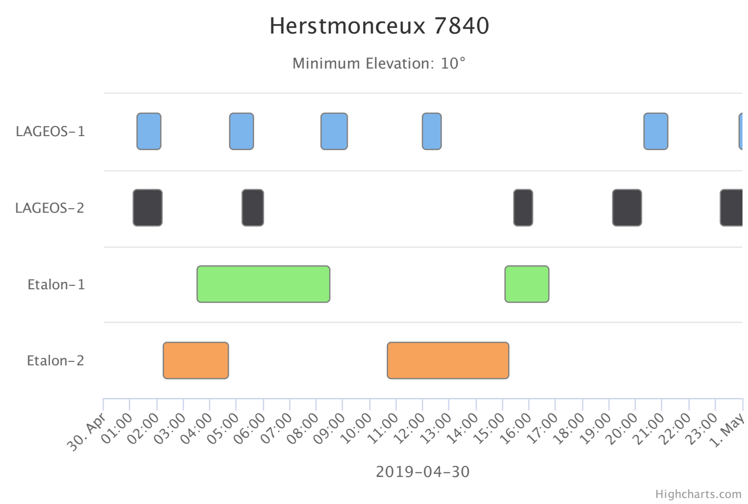
23:00
1. May
2019-04-30
Highcharts.com


Herstmonceux 7840
Minimum Elevation: 10°
LAGEOS-1
LAGEOS-2
Etalon-1
Etalon-2
30. Apr
01:00
02:00
03:00
04:00
05:00
06:00
07:00
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09:00
10:00
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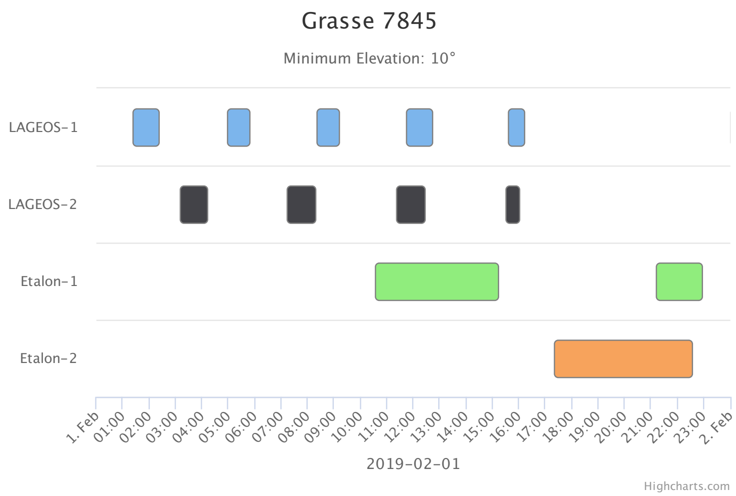
Highcharts.com


Grasse 7845
Minimum Elevation: 10°
LAGEOS-1
LAGEOS-2
Etalon-1
Etalon-2
1. Feb 01:00 02:00 03:00 04:00 05:00 06:00 07:00 08:00 09:00 10:00 11:00 12:00 13:00 14:00 15:00 16:00 17:00 18:00 19:00 20:00 21:00 22:00 23:00 2. Feb
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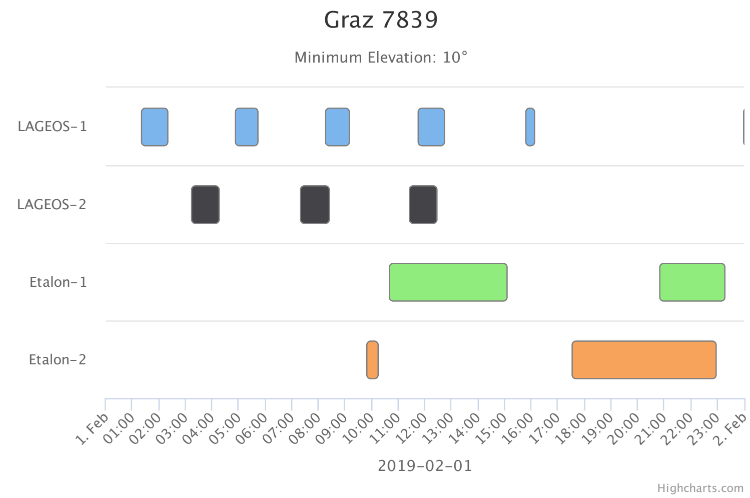
Graz 7839
Minimum Elevation: 10°
LAGEOS-1
LAGEOS-2
Etalon-1
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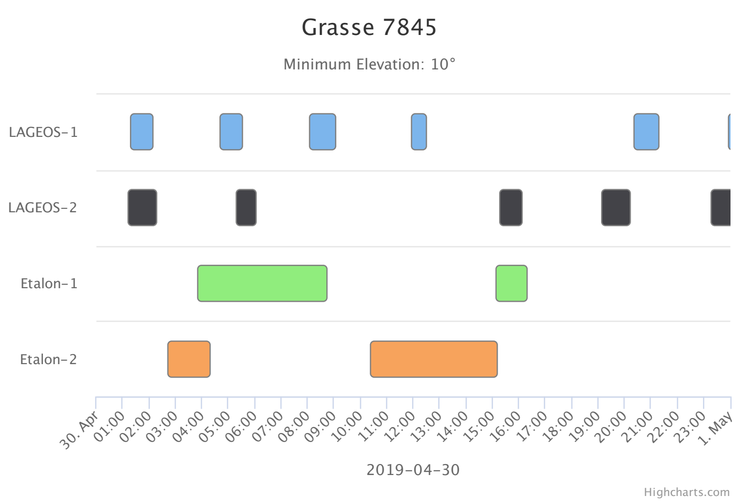
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LAGEOS-1
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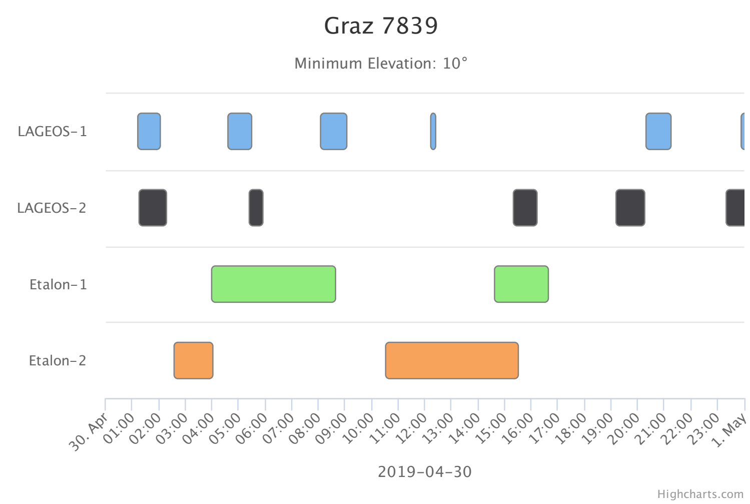
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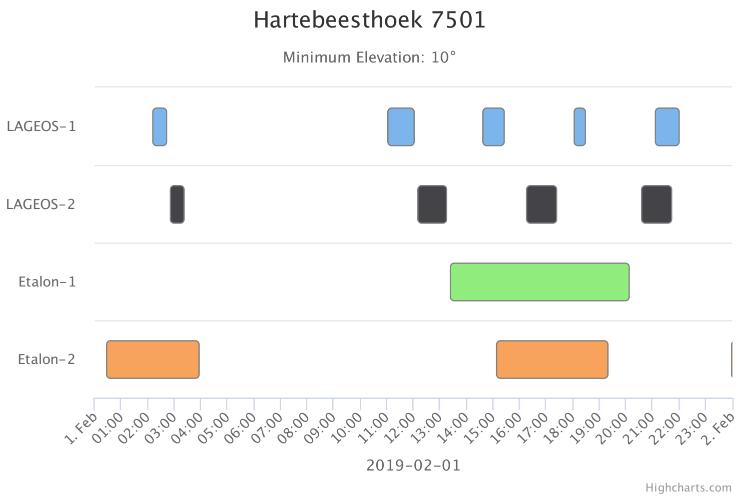
Hartebeesthoek 7501
Minimum Elevation: 10°
LAGEOS-1
LAGEOS-2
Etalon-1
Etalon-2
1. Feb
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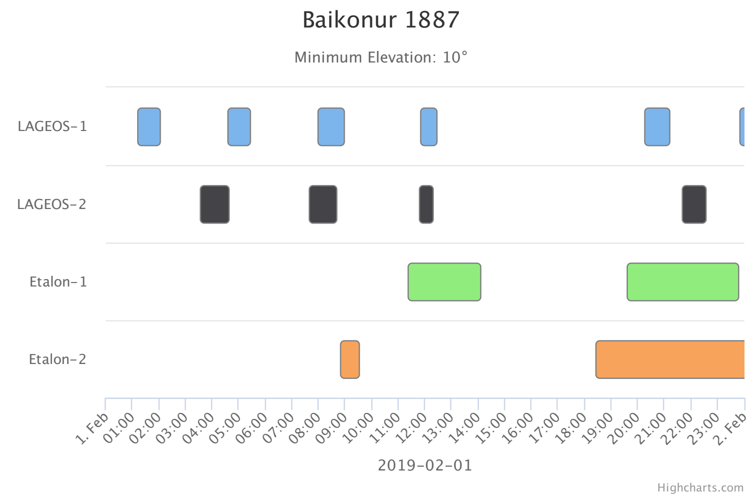
Highcharts.com


Baikonur 1887
Minimum Elevation: 10°
LAGEOS-1
LAGEOS-2
Etalon-1
Etalon-2
1. Feb
2. Feb
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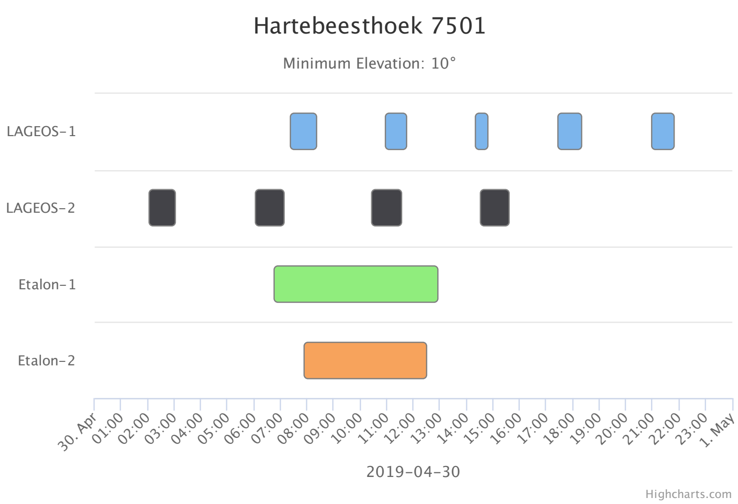
Highcharts.com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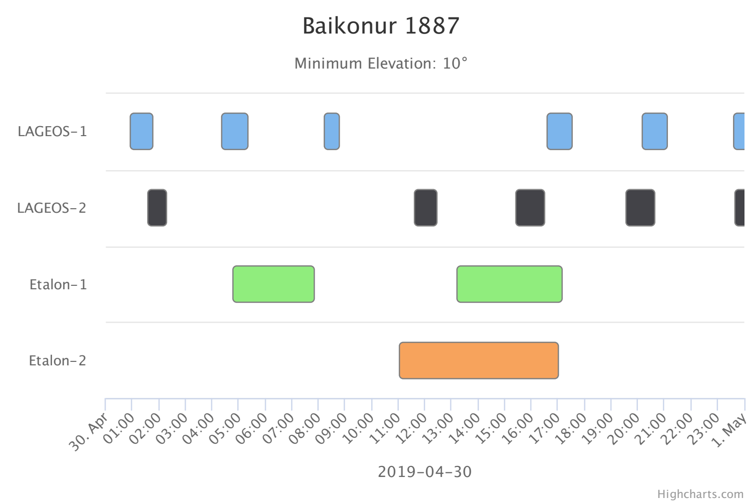
Baikonur 1887
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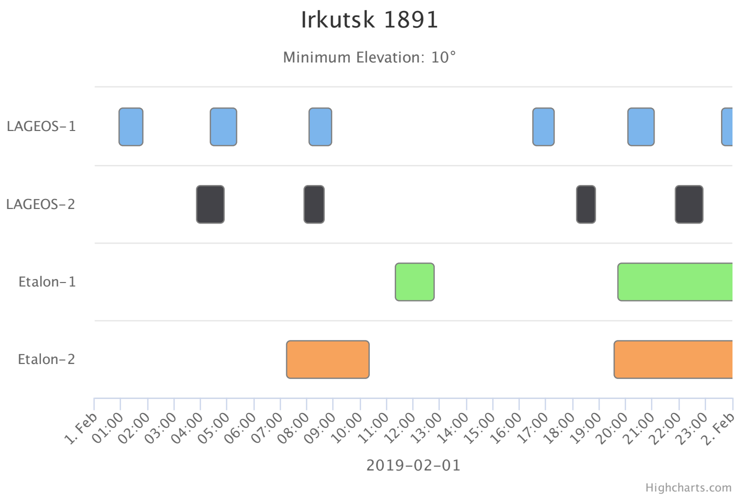
Highcharts.com



Irkutsk 1891
Minimum Elevation: 10°
LAGEOS-1
LAGEOS-2
Etalon-1
Etalon-2
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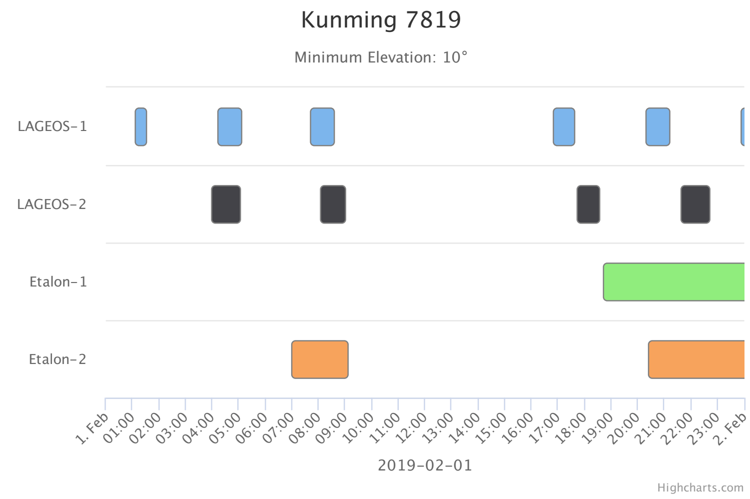

Kunming 7819
Minimum Elevation: 10°
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LAGEOS-2
Etalon-1
Etalon-2
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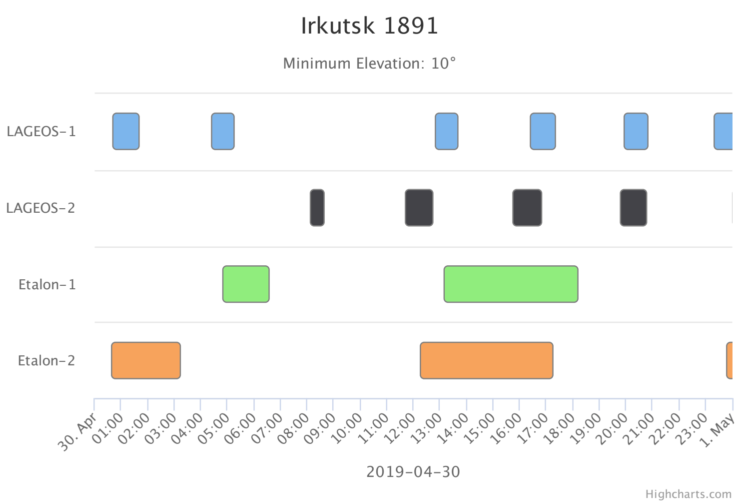

Irkutsk 1891
Minimum Elevation: 10°
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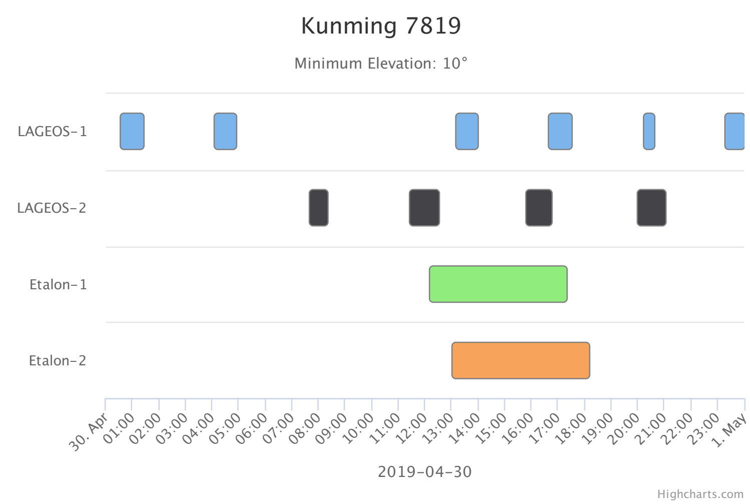

Kunming 7819
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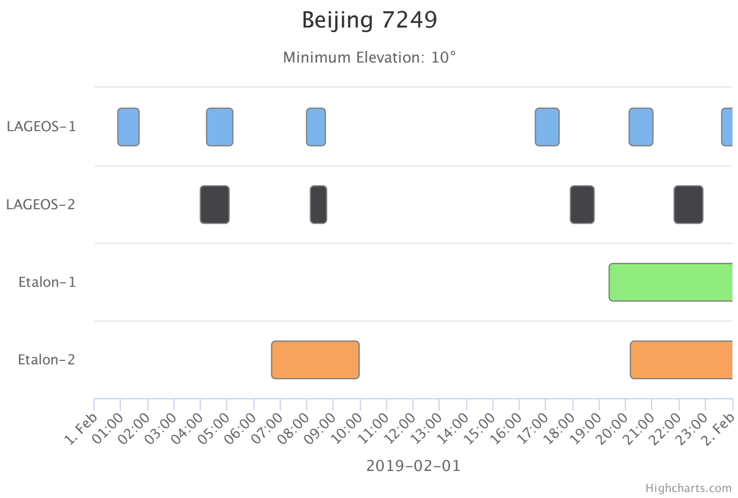
Beijing 7249
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Etalon-1
Etalon-2
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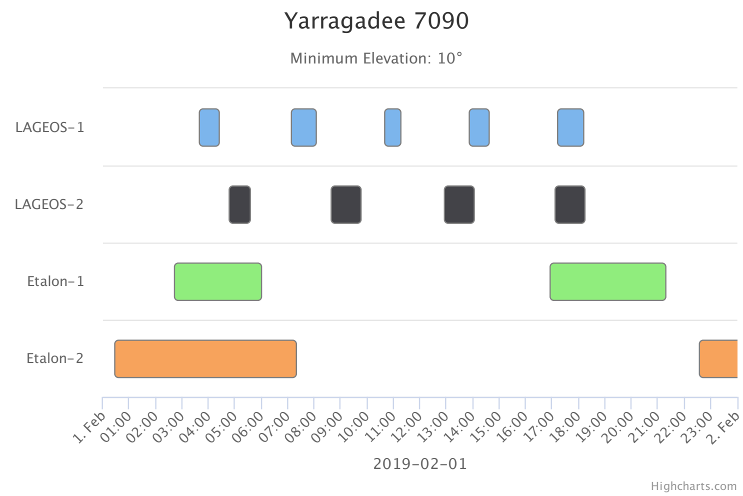
Yarragadee 7090
Minimum Elevation: 10°
LAGEOS-1
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Etalon-1
Etalon-2
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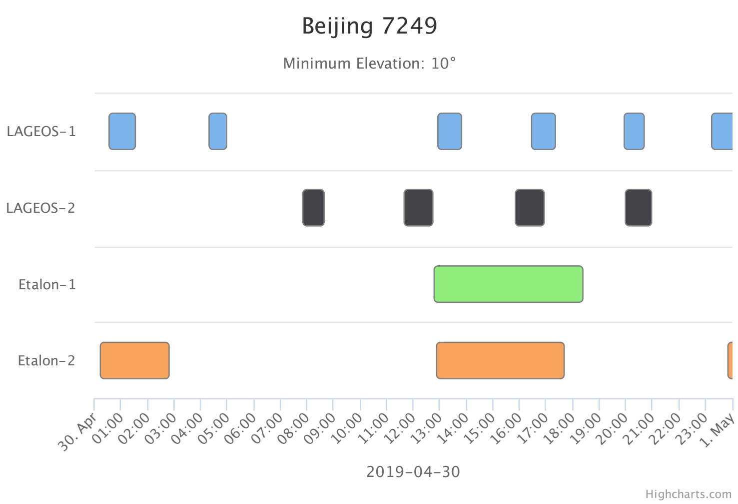
Beijing 7249
Minimum Elevation: 10°
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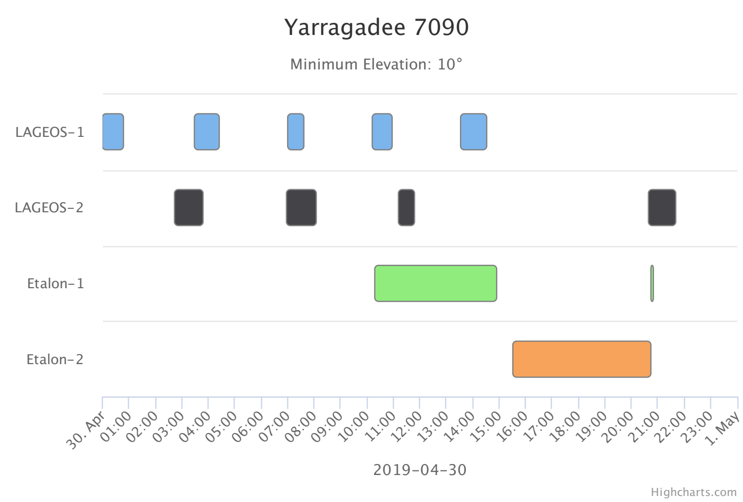
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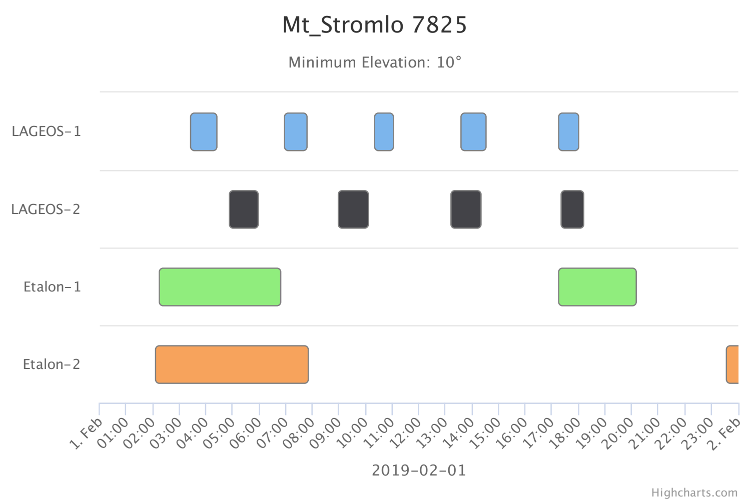
Mt_Stromlo 7825
Minimum Elevation: 10°
LAGEOS-1
LAGEOS-2
Etalon-1
Etalon-2
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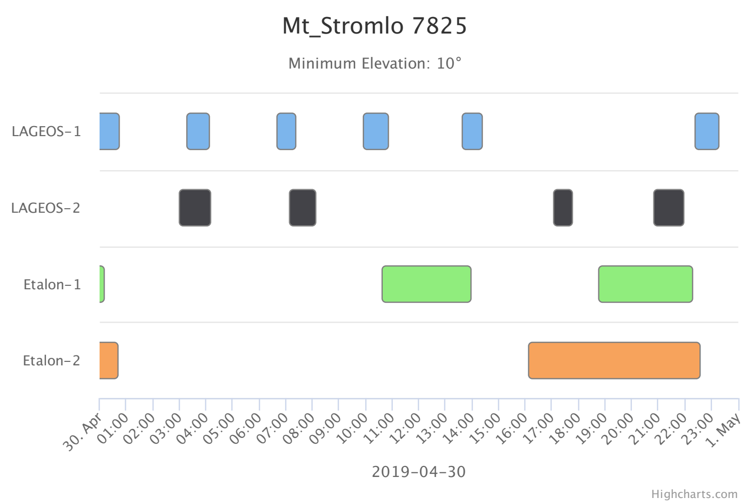
Mt_Stromlo 7825
Minimum Elevation: 10°
LAGEOS-1
LAGEOS-2
Etalon-1
Etalon-2
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1. May
2019-04-30
Highcharts.com

British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

Gateway to the Earth

NSGF Analysis Centre. Canberra 2018 update

Graham Appleby, José Rodríguez

BGS Space Geodesy Facility, UK

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Activities

Delivery of daily/weekly solutions consolidated

Gravity field estimation tests

Centre of mass corrections update completed

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Gravity field estimation

First comparisons with other solutions: DGFI (thank you, Mathis!)

Reasonable performance, but a few oddities in some parameters

Best orbit parameterisation/strategies for this solution type unclear (Which OPR terms can we estimate when/with what satellites? Weighting scheme? What to do with odd-numbered zonal harmonics? How far can we meaningfully go?)

Using in-house (made up) SINEX format at the moment, adoption of official format planned

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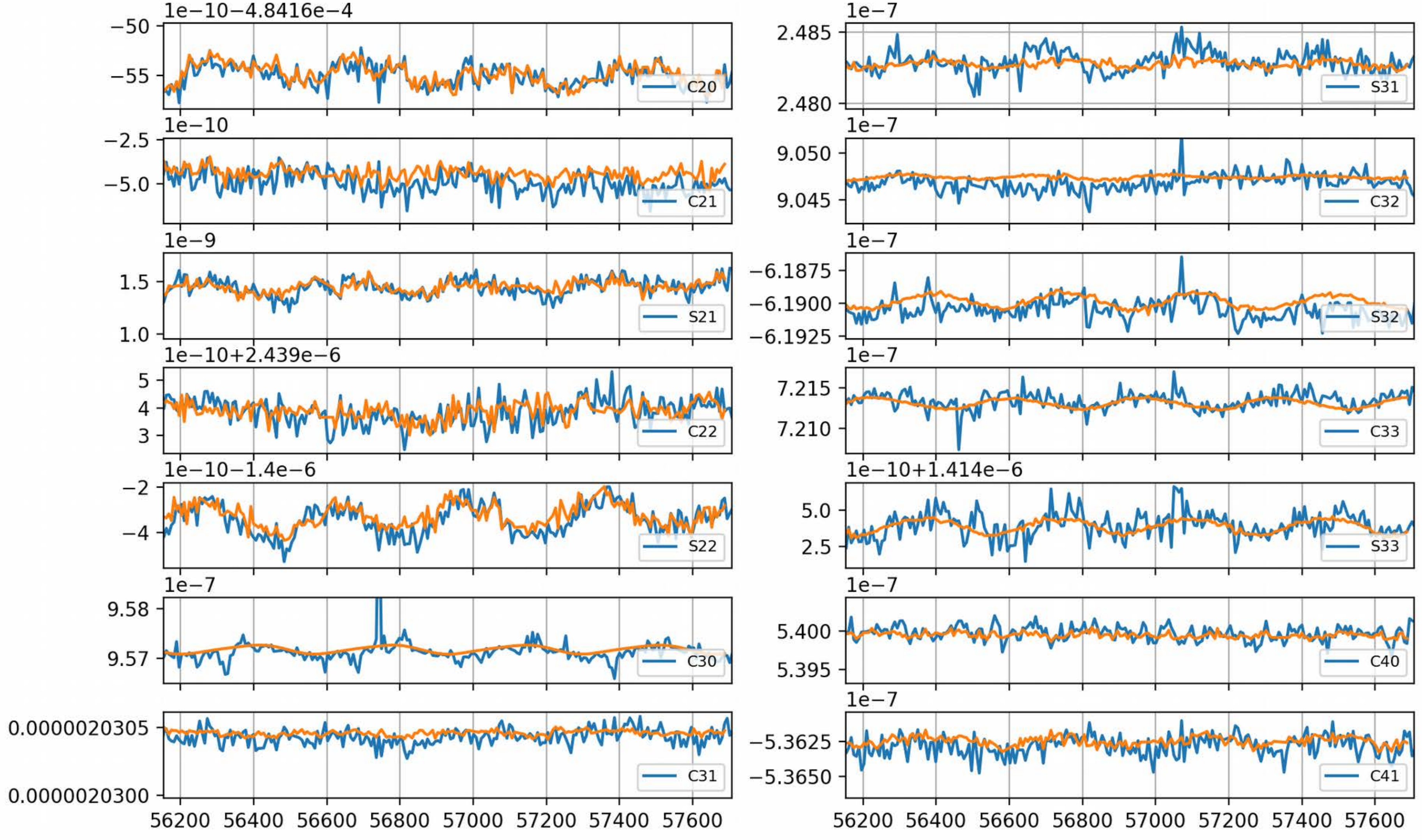
NSGF gravity estimation. Comparison with DGFI solution



CoM tables

6 satellites: LAGEOS, LAGEOS-2, LARES, Etalon, Starlette, Ajisai

Work completed (unlikely to undergo further revision except for last minute detected problems)

New stuff:

- LAGEOS/LAGEOS-2 specific CoM values (optional, recommended)
- Many more system configurations (through revision of historic system logs, direct contact with some stations, and addition of newest systems)
- Corrected errors caused by system log ambiguities and miscommunication with stations (eg 7841 and 7825)
- Brand new modelling strategy for multi-photon stations

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CoM tables

Fortran code to retrieve appropriate CoM value for station/epoch based on pre-existing code with some refactoring (f77 in principle, but some later idioms may have found their way in)

Very minor modifications required (a few array size and type changes), identical subroutine call

CoM tables generated **in the old format** for expediency and to minimise disruption

Old format is limited (it doesn't enable simple handing of multiple coexisting system configurations, absence of wavelength field)

Interim, practical solution: use the software (mine, yours, whatever) to interrogate the tables and select the **last entry** offered. This ensures the correct choice for 7941 and 7840 **most** of the time. Non-green laser entries for 7810 not handled until new format is deployed

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Summary of Results

Major changes to Etalon and Ajisai (lower values)

Substantial changes to LAGEOS satellites (1-3 mm typical)

Minor changes to LARES/Starlette

Overall tendency towards lower CoM values: increased station heights: greater frame scale

Separation of LAGEOS/LAGEOS-2 reduces the RB difference between the two objects, but doesn’t eliminate it

Range bias estimates for the whole network appear more balanced (less obvious tendency towards positive values)

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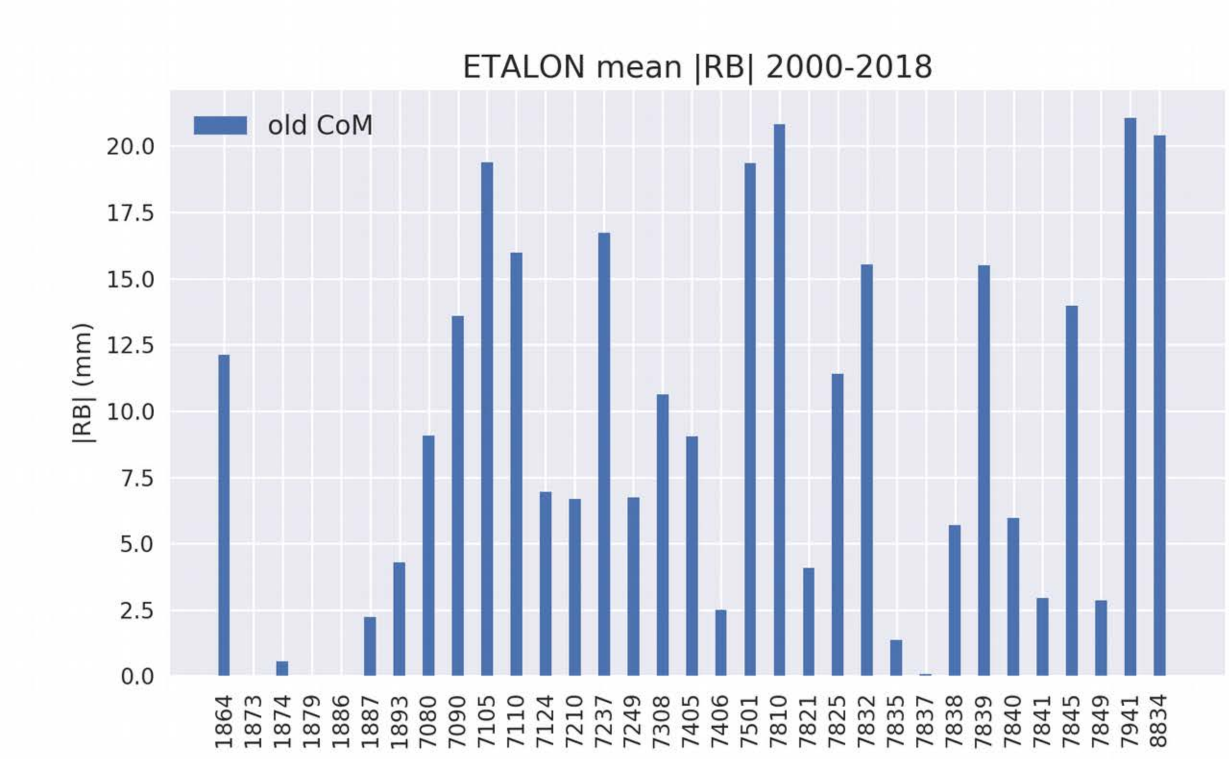

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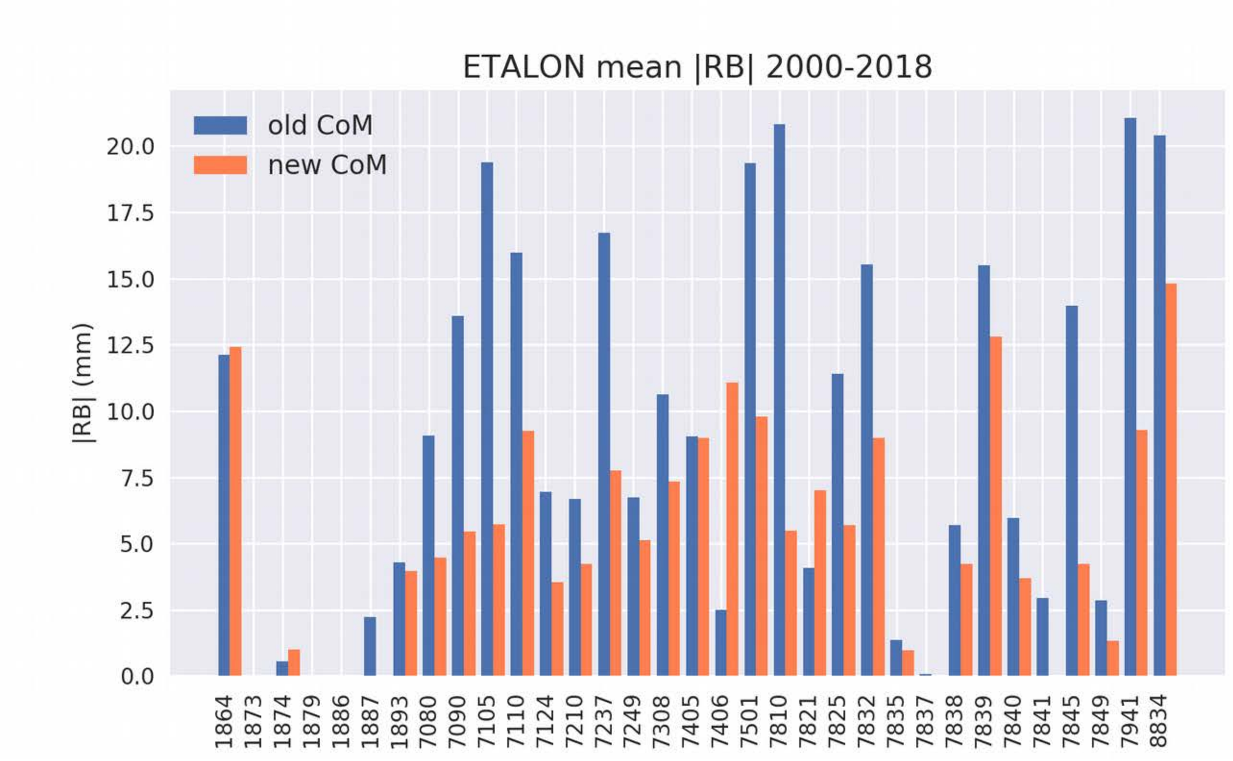

For Etalon, test CoM values remove about 1 cm biases from several stations

Very few stations see an increase in RB

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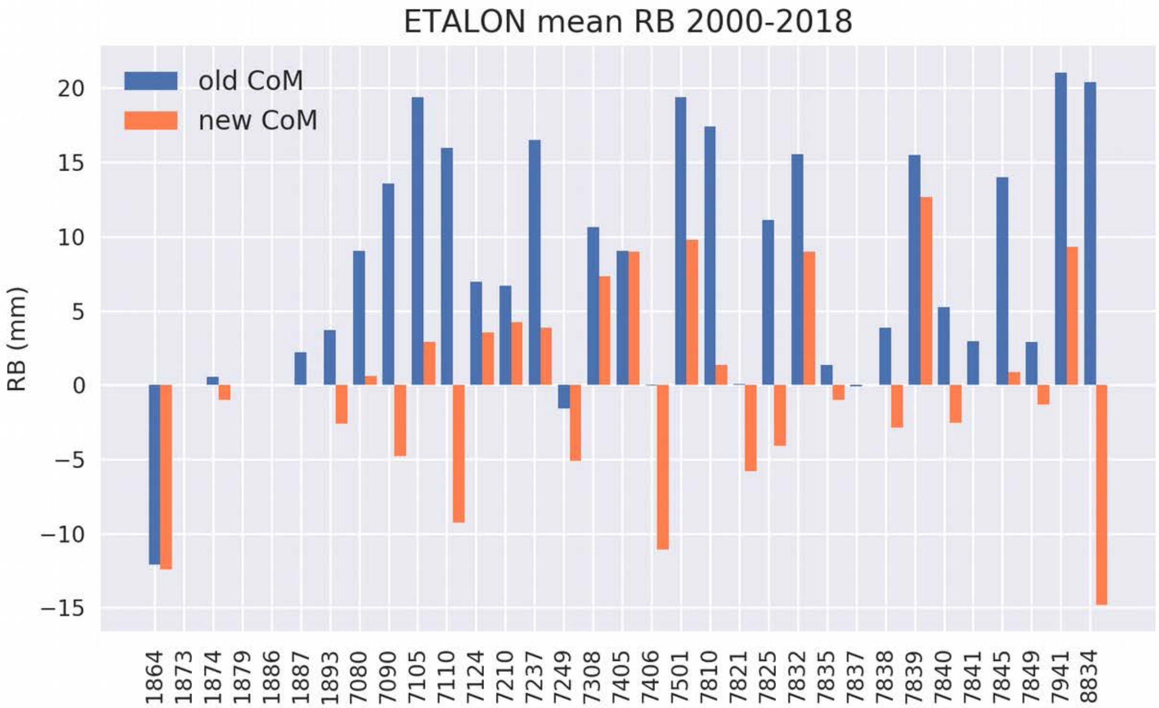

Actual differences are greater when considering the sign of the estimated biases

New CoM values remove to a large extent the predominant positive bias across the network

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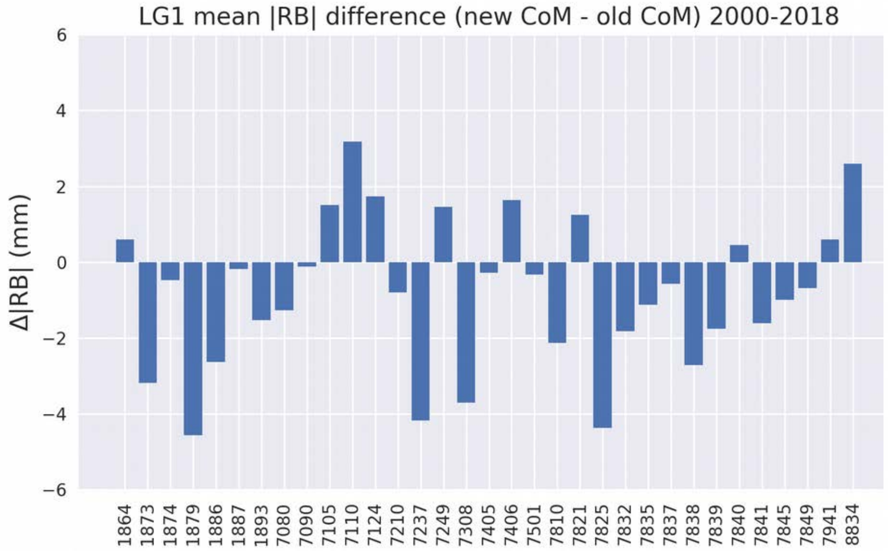
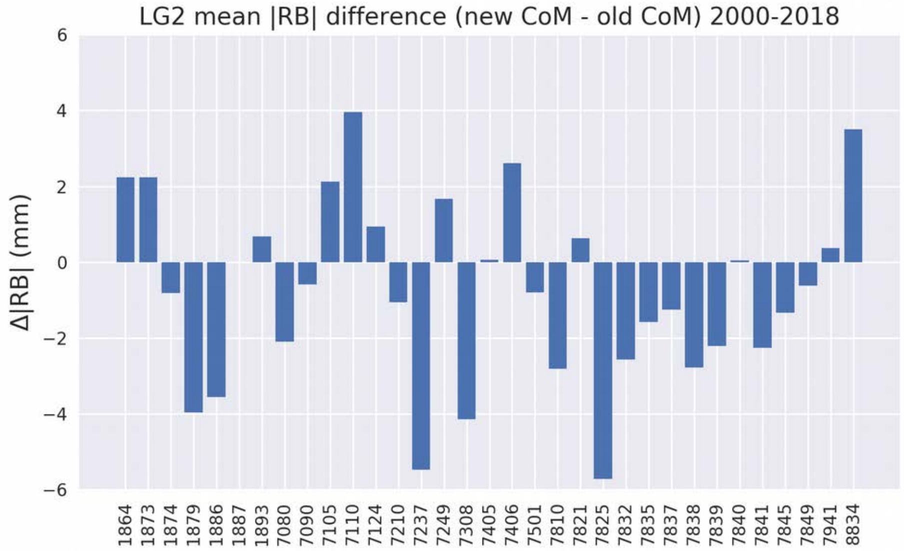
LAGEOS



LAGEOS-2



Negative is “good”: RB “removed” from stations

Positive is “bad”: RB “added” to stations

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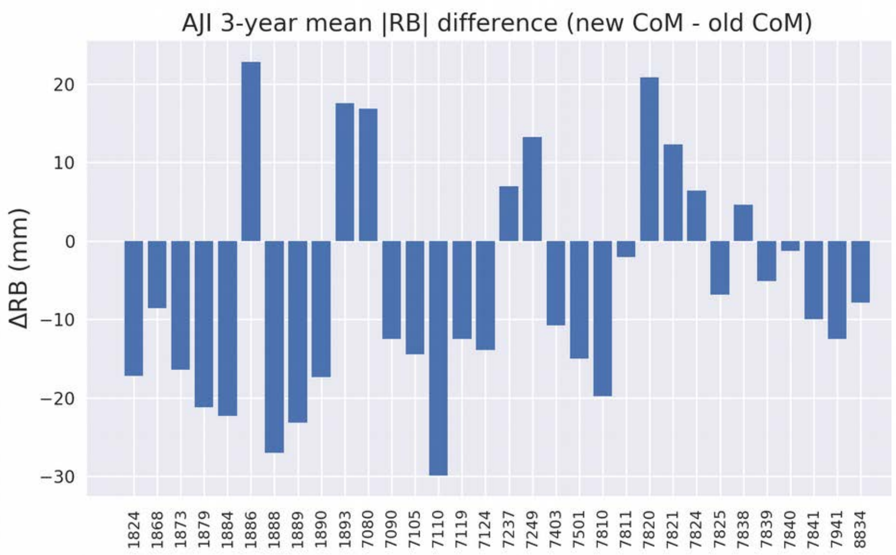
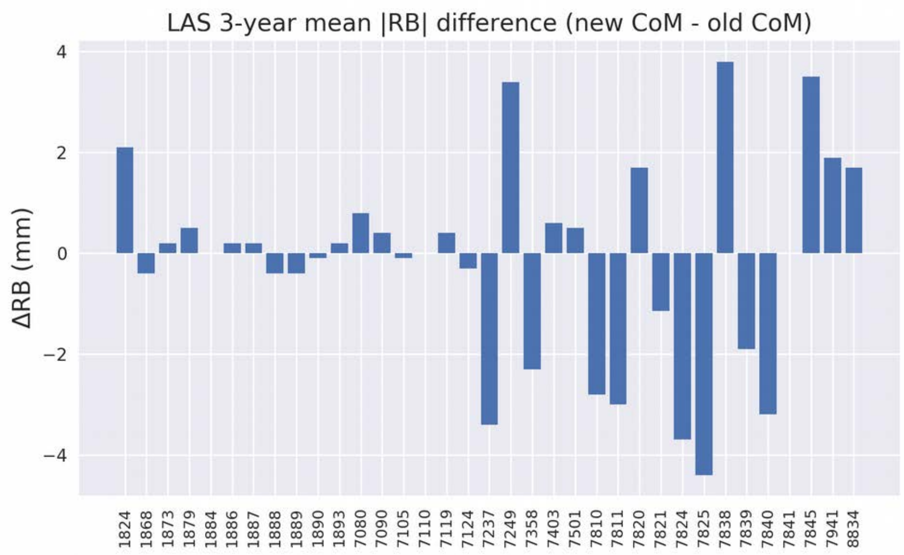
AJISAI

LARES





Negative is “good”: RB “removed” from stations

Positive is “bad”: RB “added” to stations

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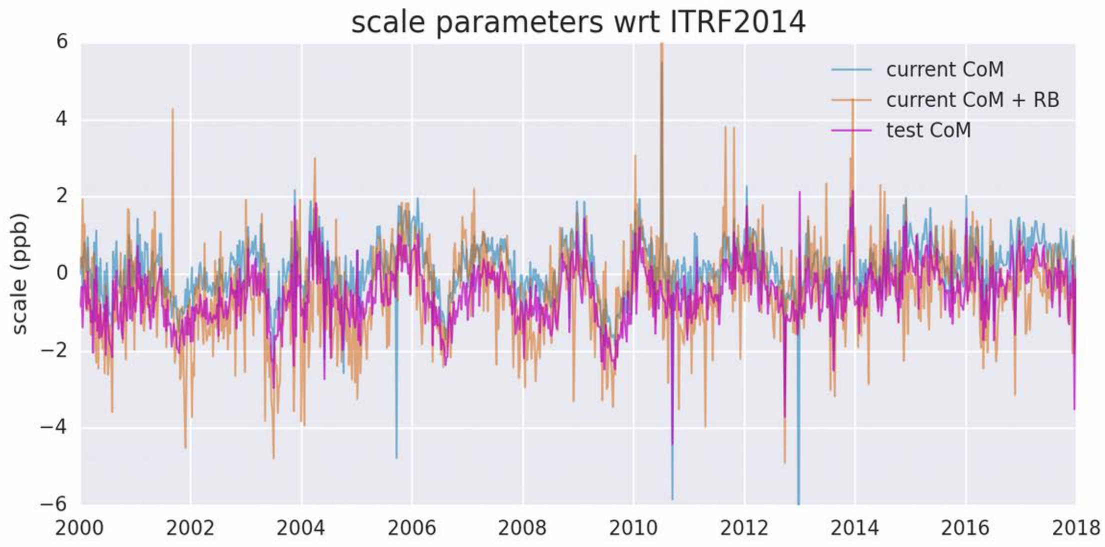

Similar average scale change when estimating RB and when using test CoM values: ~0.6 ppb

Or in other words: both solution types have **increased** station heights

Agreement between the scales realised by SLR and VLBI is improved

Have we solved the RB problems...?

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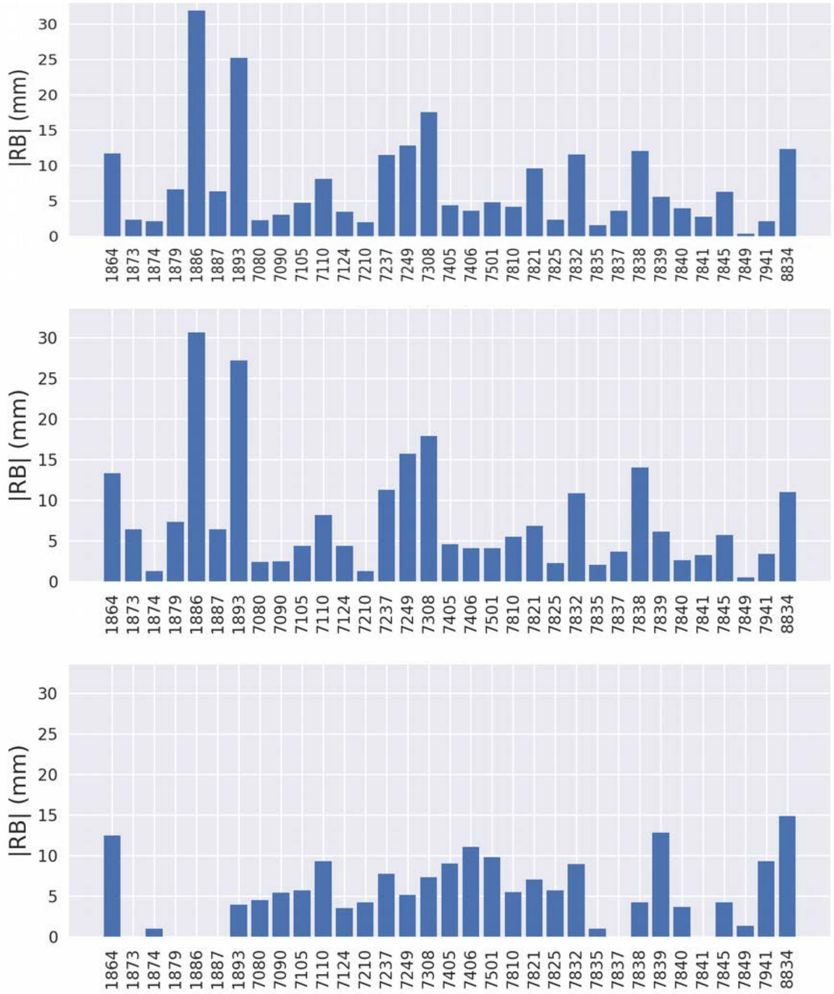
|RB| remaining using new CoM values

LAGEOS

LAGEOS-2

ETALON



Range biases do **NOT** disappear using the new CoM values

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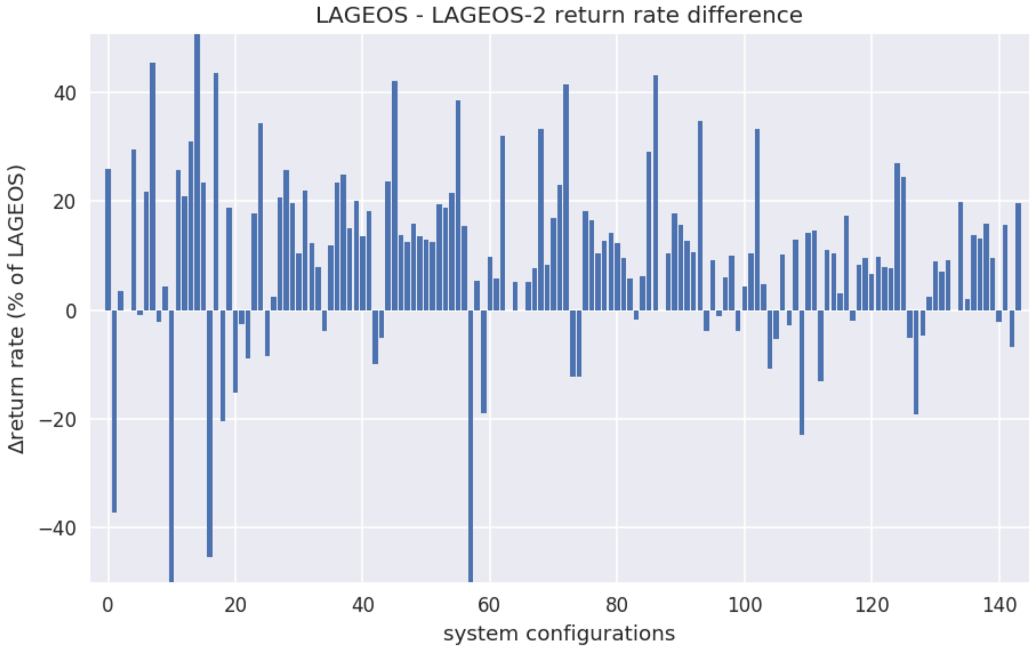

Vast majority of systems achieve significantly higher return rates to LAGEOS

These two satellites are geometrically identical, but optically different (see also different SRP coefficients; [Sosnica])

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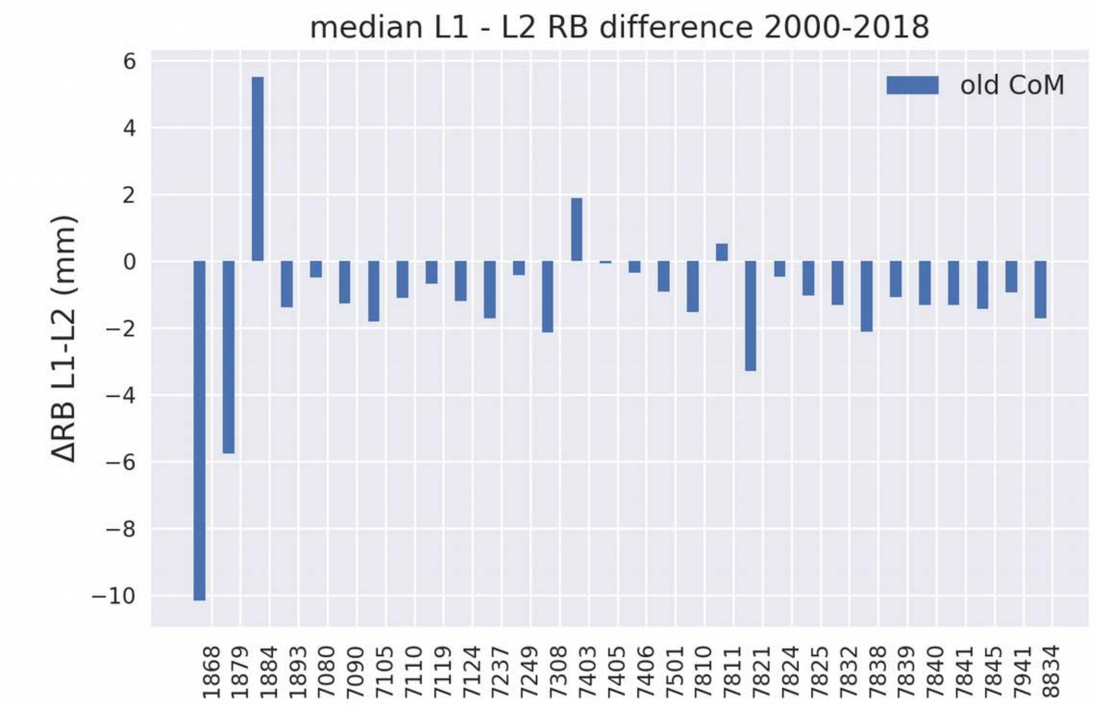

Small RB difference between satellites

Averaged over 18 years it can no longer be considered non-significant

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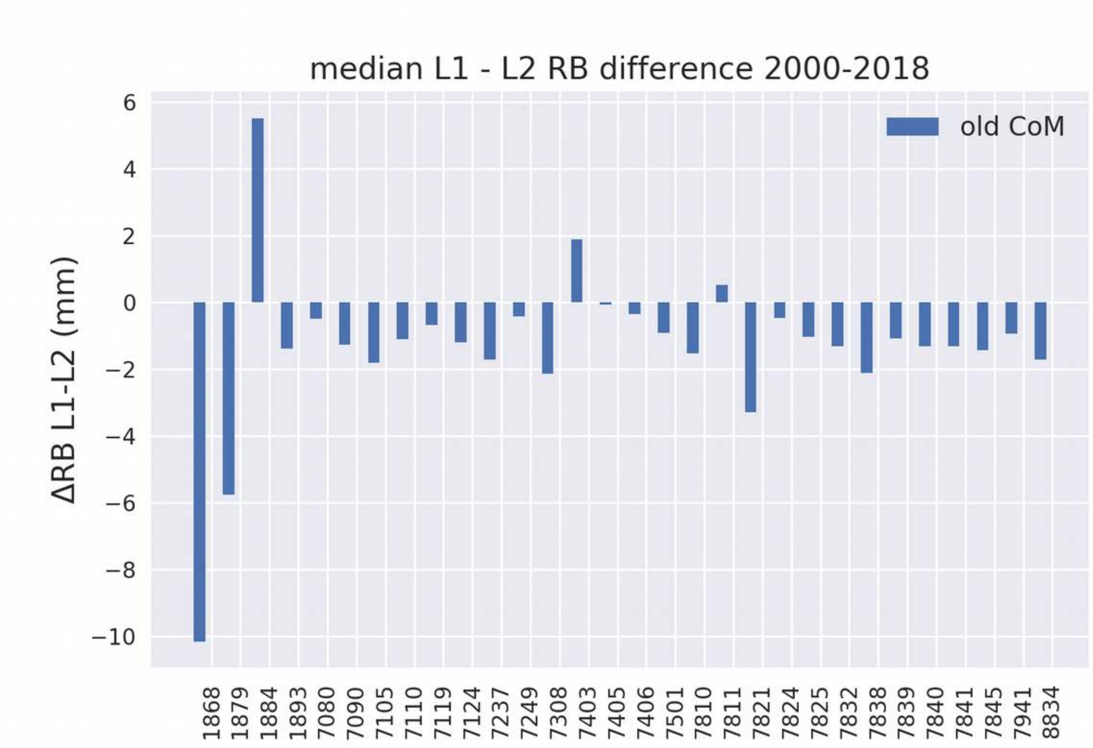

First thought: Earth radiation pressure asymmetries between LAGEOS/LAGEOS-2 caused by different orbit inclinations

But: effect is real but very small (~0.1 mm [Sosnica and own calculations])

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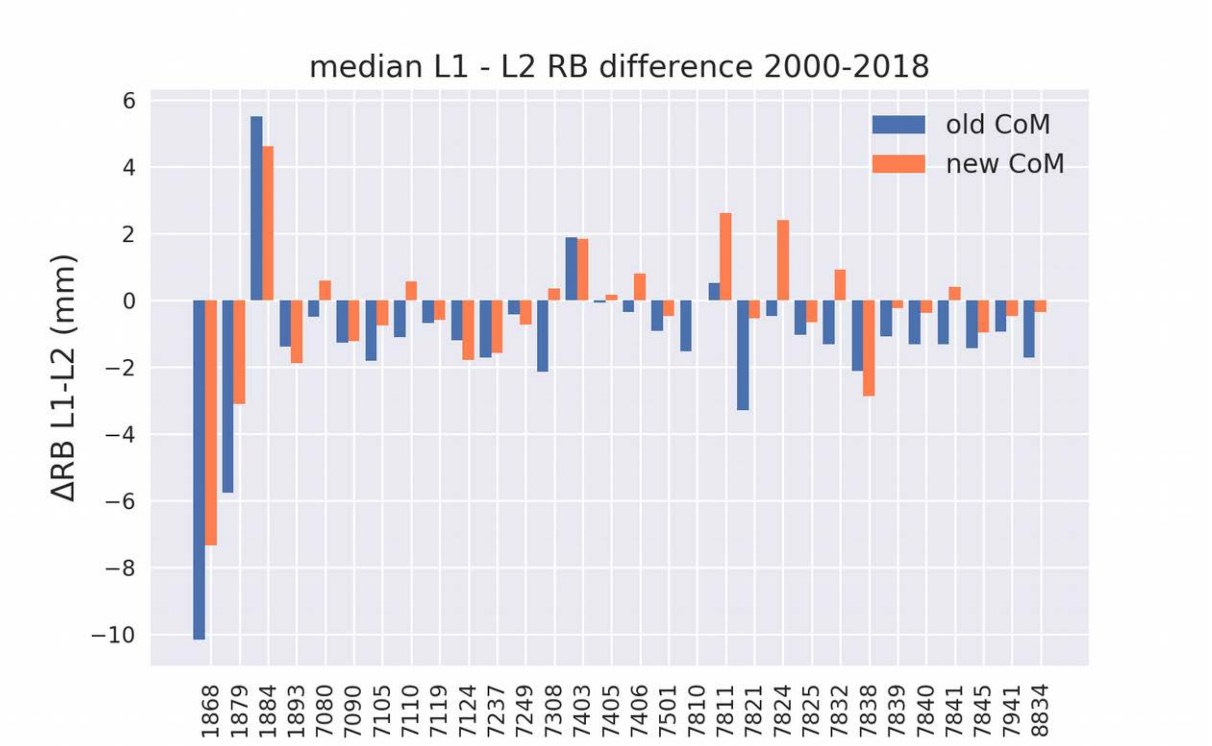

We have reasons to treat both satellites independently

Optical response computation does lead to slightly different results

CoM values slightly different (up to 0.75 mm different), decreasing the RB difference

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Thank you

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CPF and CRD v2
Status and Schedule

R. Ricklefs

UT/CSR

Current Status

- Recruited 4 - 5 stations, 1 prediction provider, and the ILRS ASC to preform pilot tests of the formats
- June 2018 – new “v2” directories set up on CDDIS and EDC
- July 2018: Released CPF v2 manual, sample code, and test data on CDDIS web site
    - Three of the pilot stations reporting saw no problems integrating and testing CPF v2
- September 2018: Released CRD v2 manual, sample code, and test data on CDDIS web site
- October 2018: MLRS analysis code incorporates CRD v2 code.

Implementation Schedule

- Dec 1, 2018: One or two stations should be able to produce v2 CRD
- Jan 1, 2019: OCs, DCs should be able to handle v2 CPFs and CRDs
- Jan 1, 2019: At least one prediction provider should be producing v2 CPFs; all should be by Jan 1, 2020
- Jan 1, 2019: Some analysts should be able to process v2 CRD files; all should be by Jan 1, 2020
- Dec 1, 2019: Almost all stations should be able to use v2 CPFs (required for those tracking ELT)
- June 1, 2020: Almost all stations should be producing v2 CRDs

21ST INTERNATIONAL WORKSHOP ON LASER RANGING

5 – 9 NOVEMBER 2018
CANBERRA, AUSTRALIA

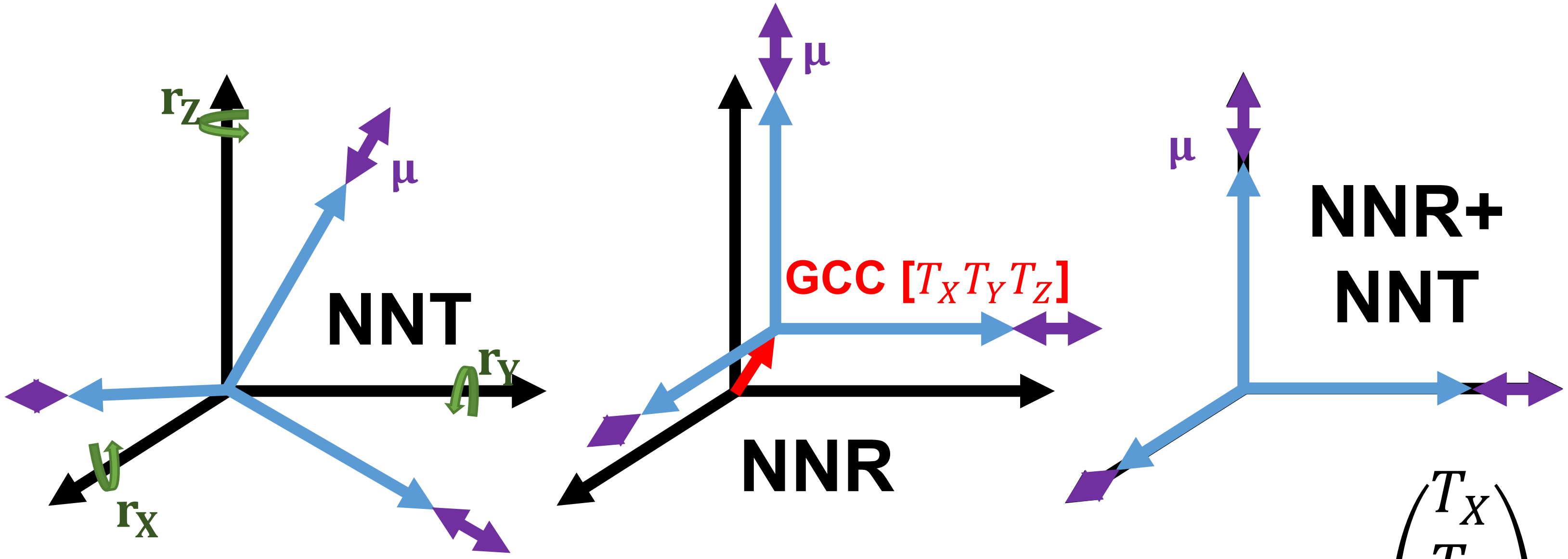
IGiG

WROCŁAW UNIVERSITY OF ENVIRONMENTAL AND LIFE SCIENCES

SLR network constraining and the selection of core stations

Radosław Zajdel, Krzysztof Sośnica, Mateusz Drożdżewski

Institute of Geodesy and Geodynamics



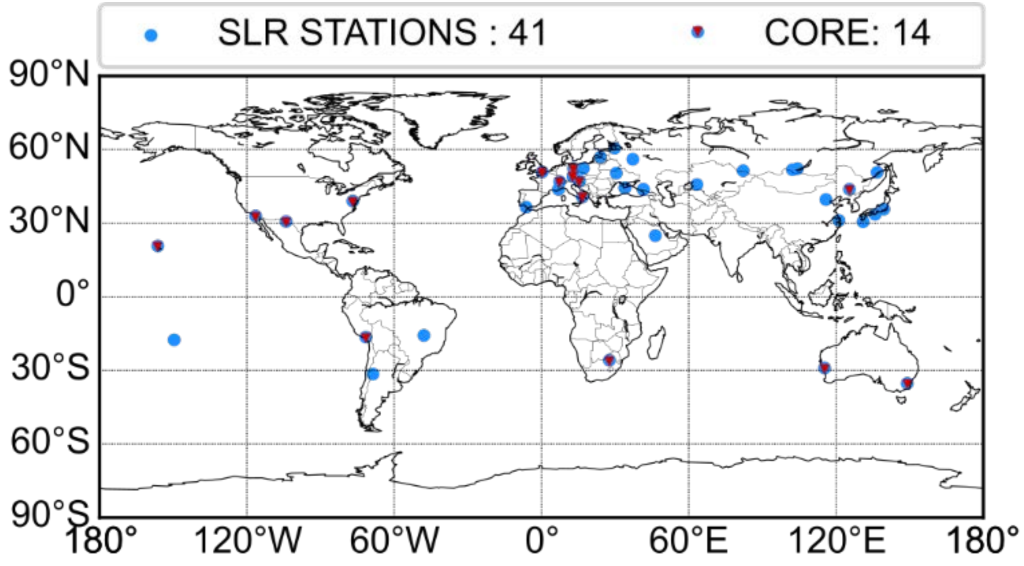
$$\begin{pmatrix}\tilde{X}_i\\ \tilde{Y}_i\\ \tilde{Z}_i\end{pmatrix} = \begin{pmatrix}X_i\\ Y_i\\ Z_i\end{pmatrix} + \begin{pmatrix}1 & 0 & 0 & 0 & -Z_i & Y_i & X_i\\ 0 & 1 & 0 & Z_i & 0 & -X_i & Y_i\\ 0 & 0 & 1 & -Y_i & X_i & 0 & Z_i\end{pmatrix}\begin{pmatrix}T_X\\ T_Y\\ T_Z\\ r_X\\ r_Y\\ r_Z\\ \mu\end{pmatrix},$$

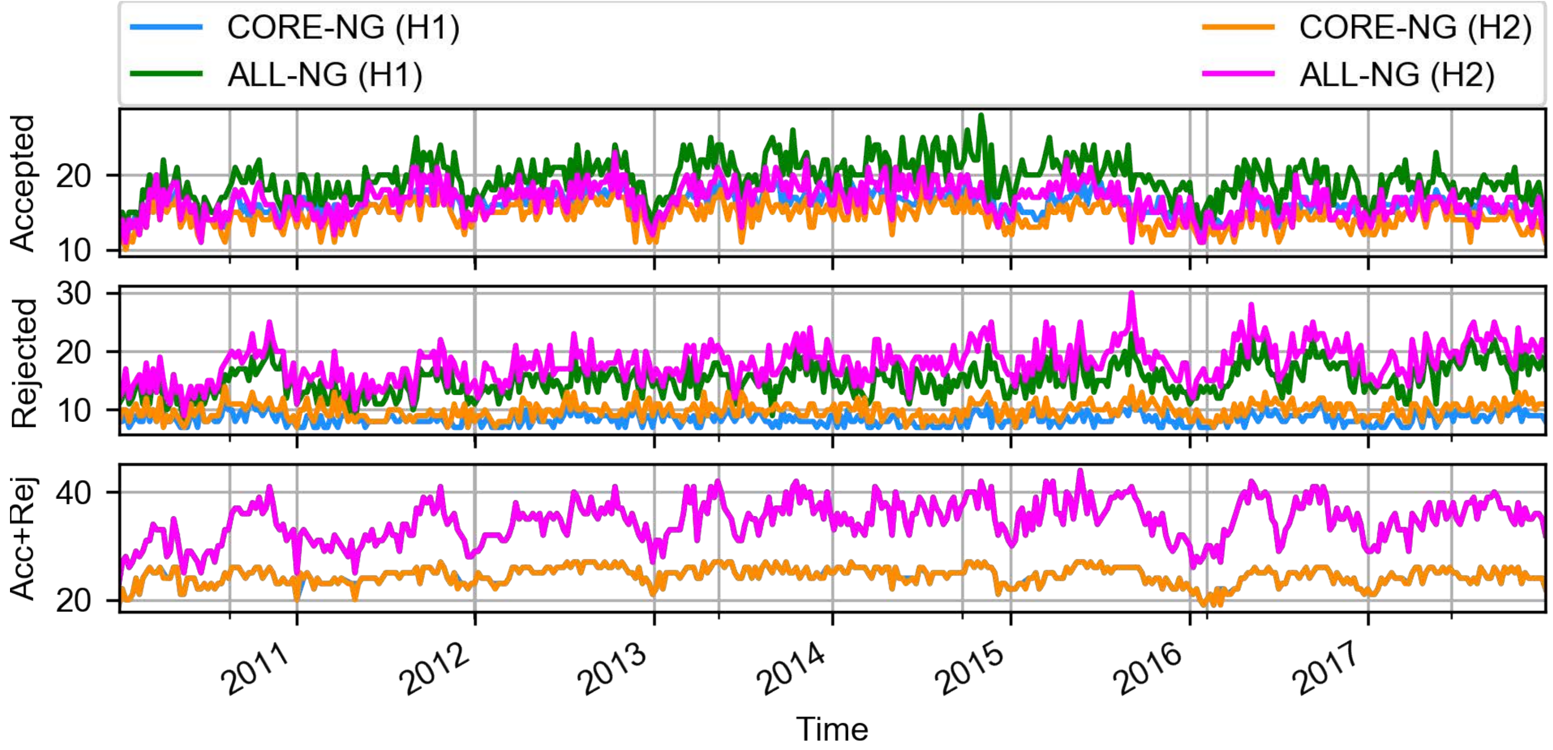
T_i – translation in i direction; r_i – rotation around i axis; μ – scale

Reference frame X_i Realized frame $\tilde{X}_i$

- group of stations considered to be used in TRF realization
  - CORE – SLRF2014
  - ALL – All possible stations

- threshold for the Helmert condition to accept the stations in the TRF realization
  - H2 – Helmert 10/10/10 mm
  - H1 – Helmert 15/15/15 mm

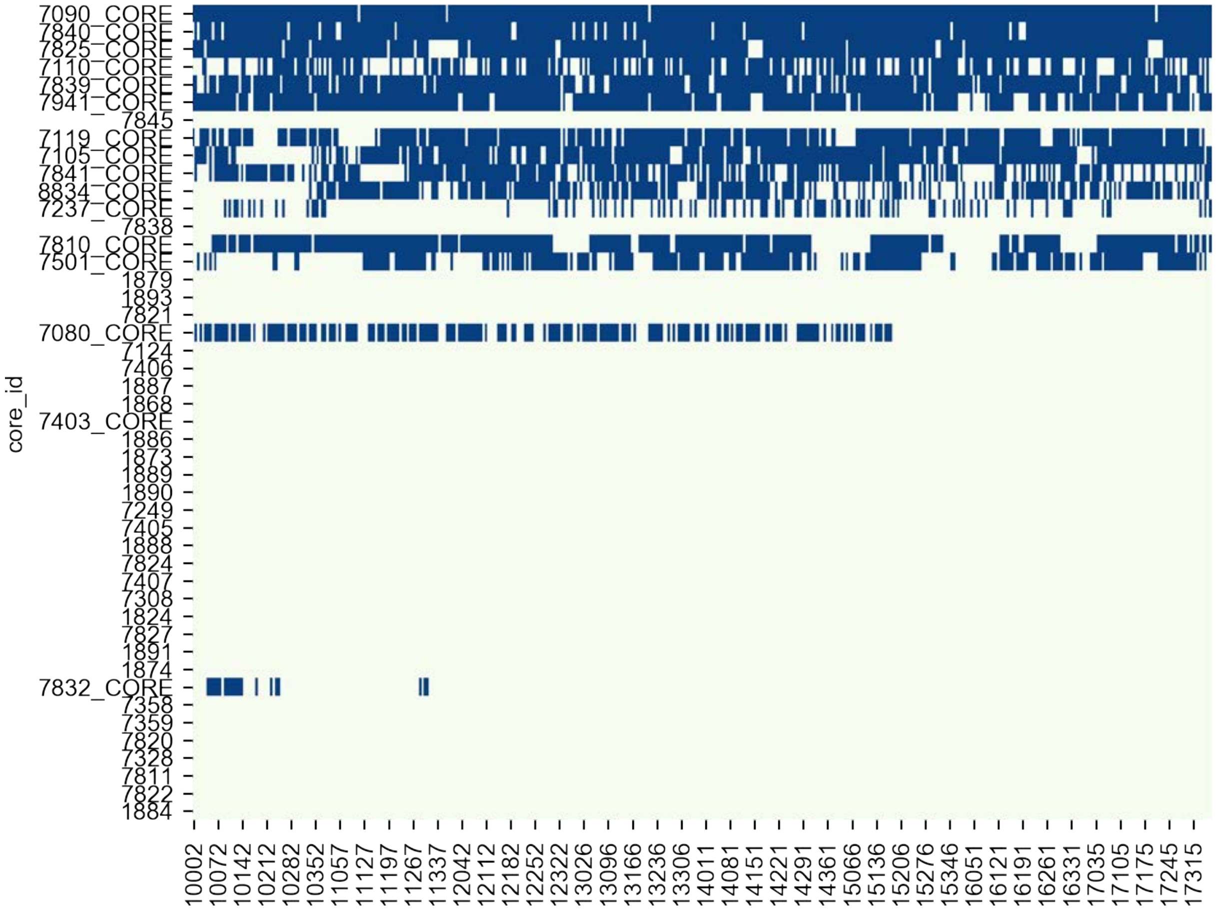




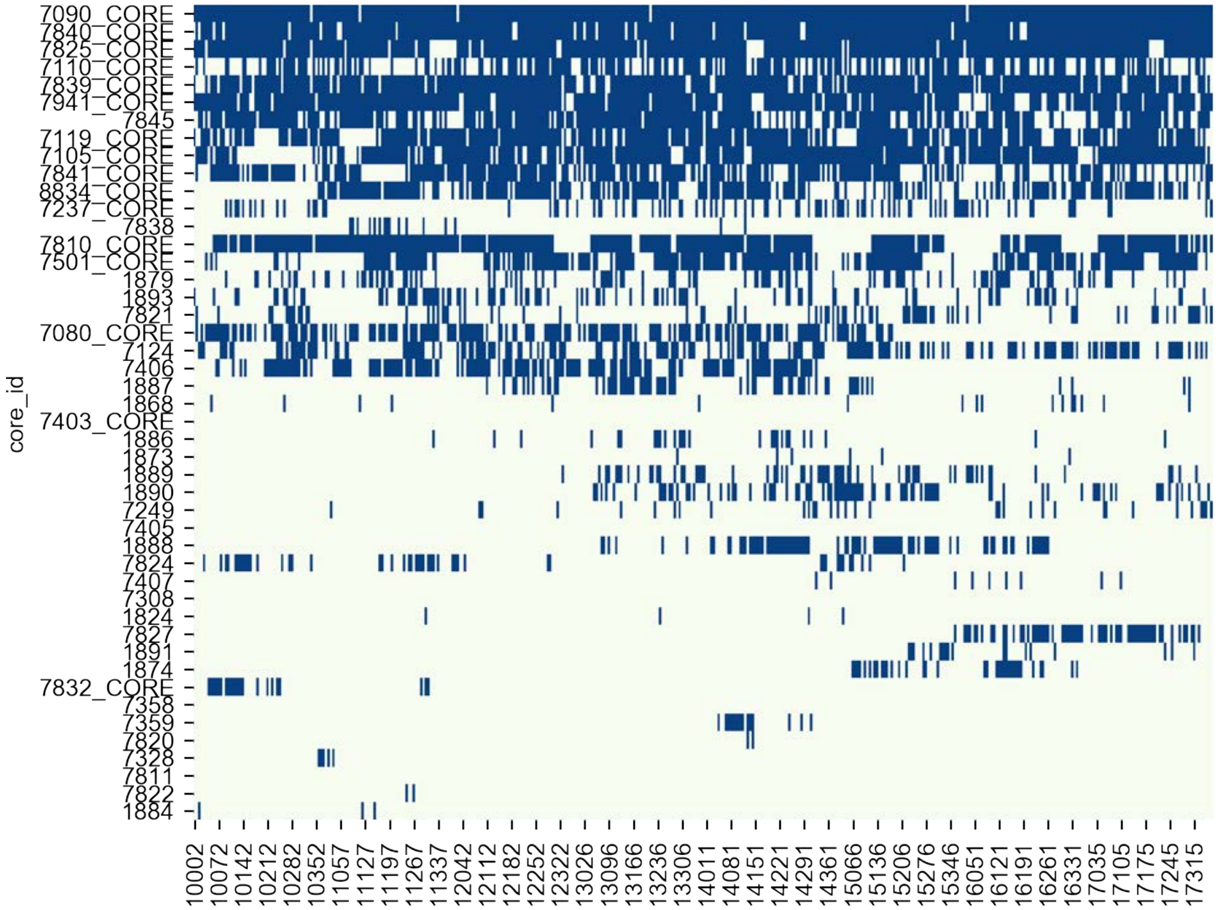
Number of accepted stations

	Median	Mean	Std
CORE (H1)	10	10	1.6
ALL (H1)	13	13	2.6
CORE (H2)	9	9	1.7
ALL (H2)	11	11	2.2

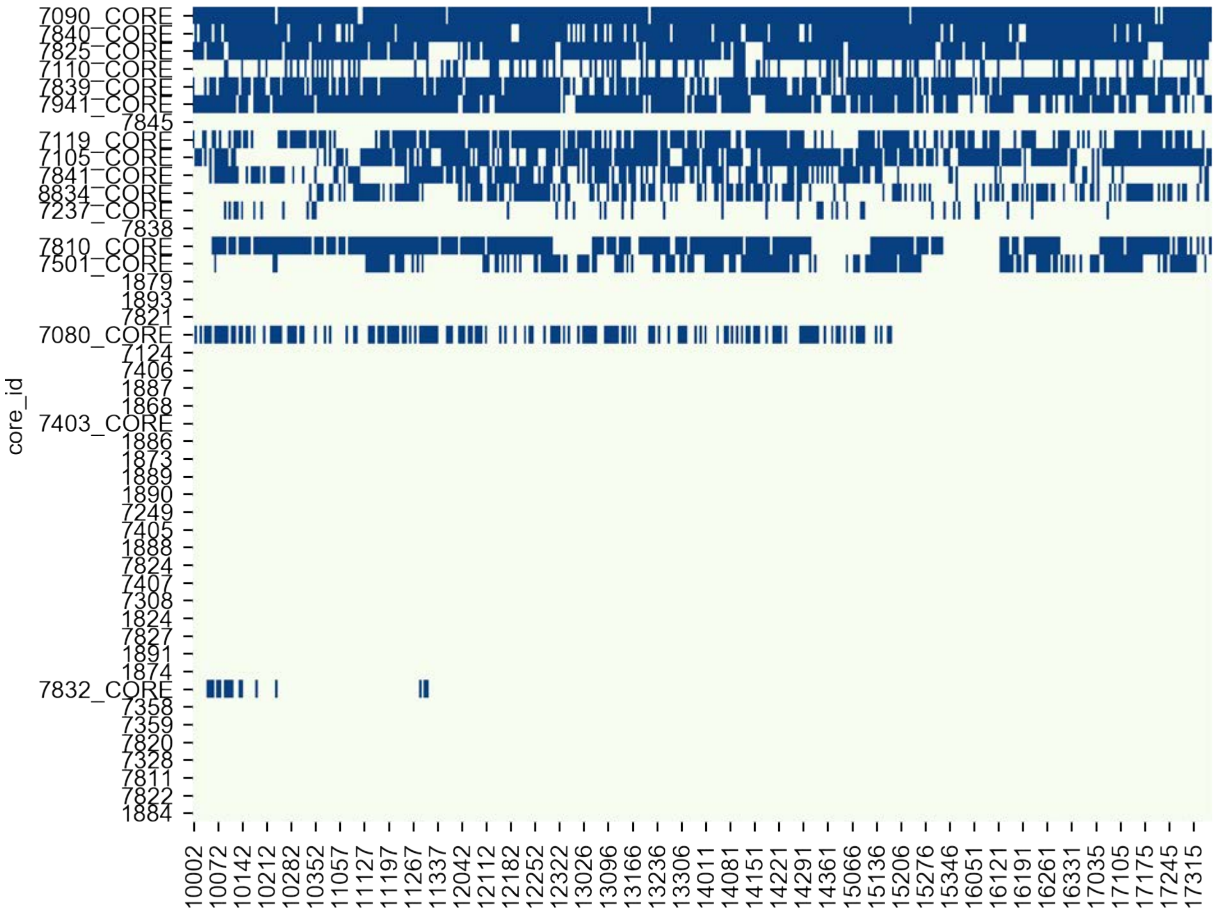
CORE H1



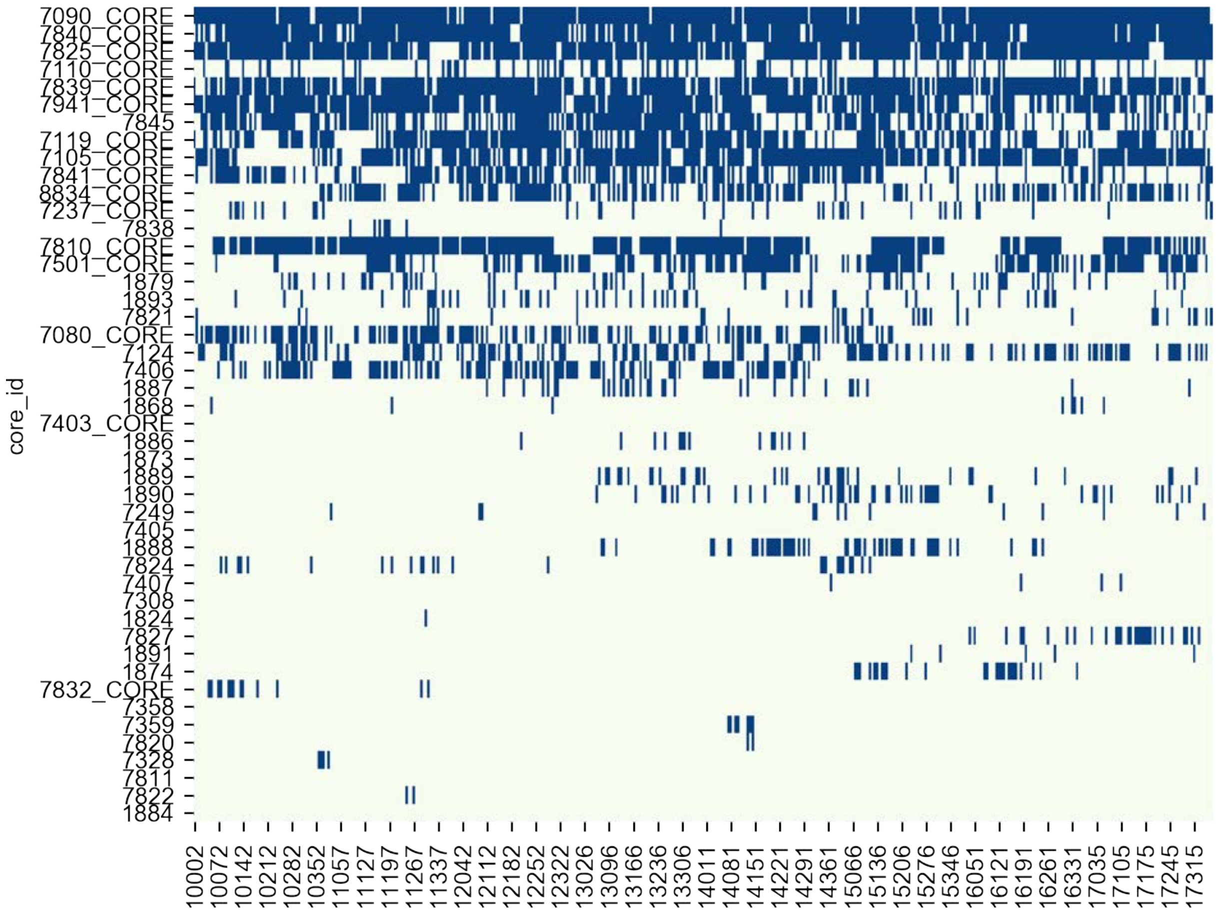
ALL H1

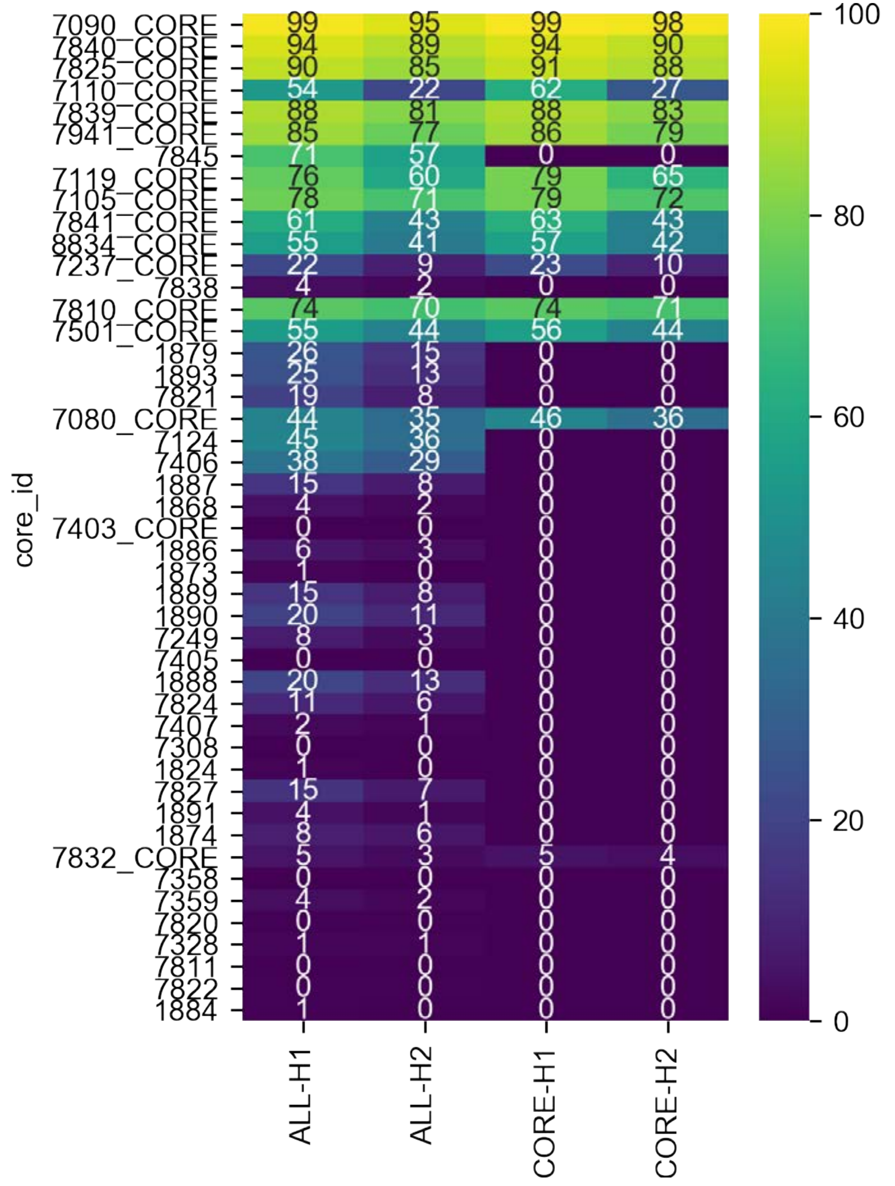


CORE H2



ALL H2





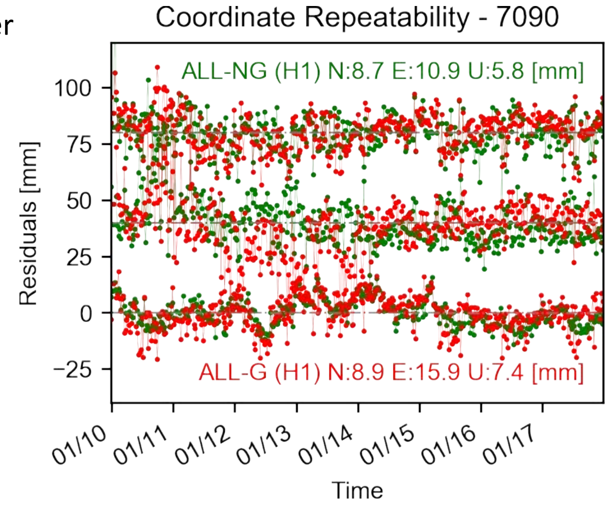
How many times the stations was included in TRF realization

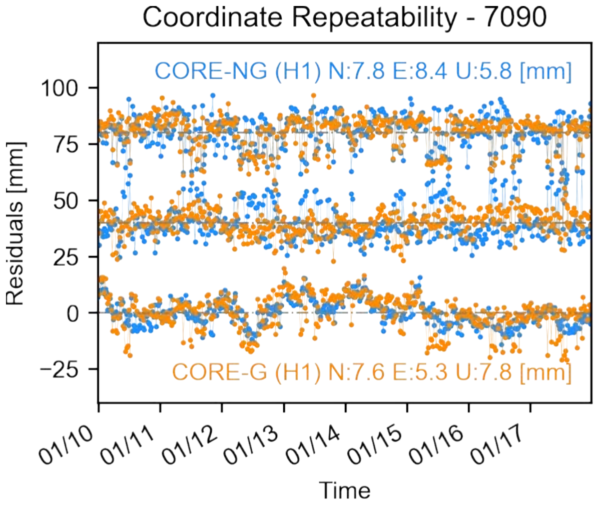
100 % - 418 solutions (2010-2018)

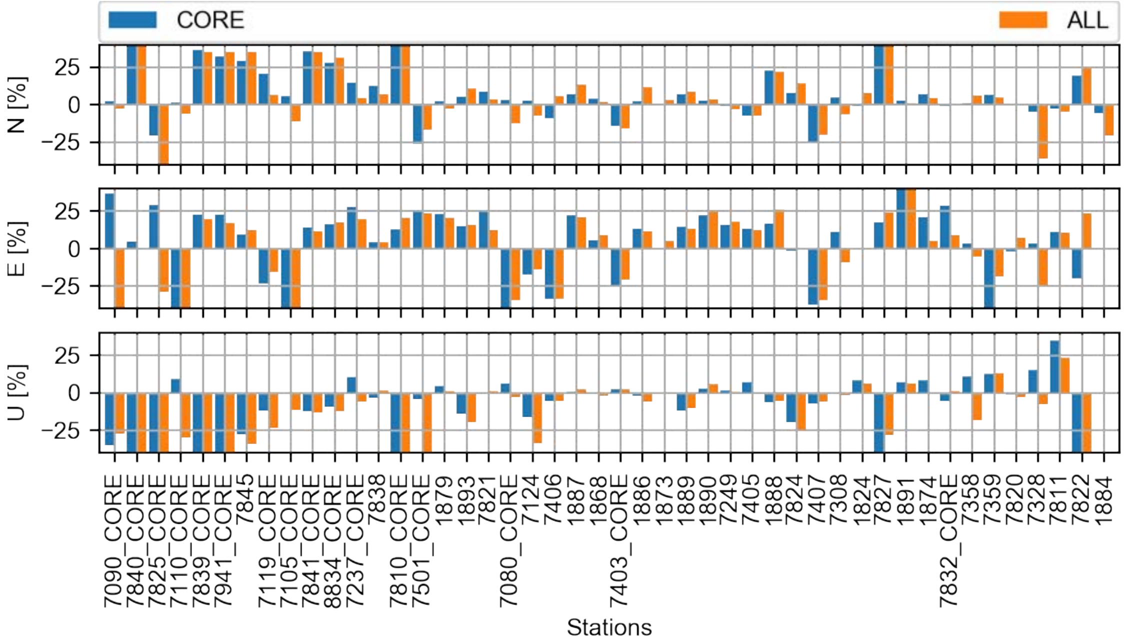
NNR vs. NNR+NNT (Helmert 15 mm)

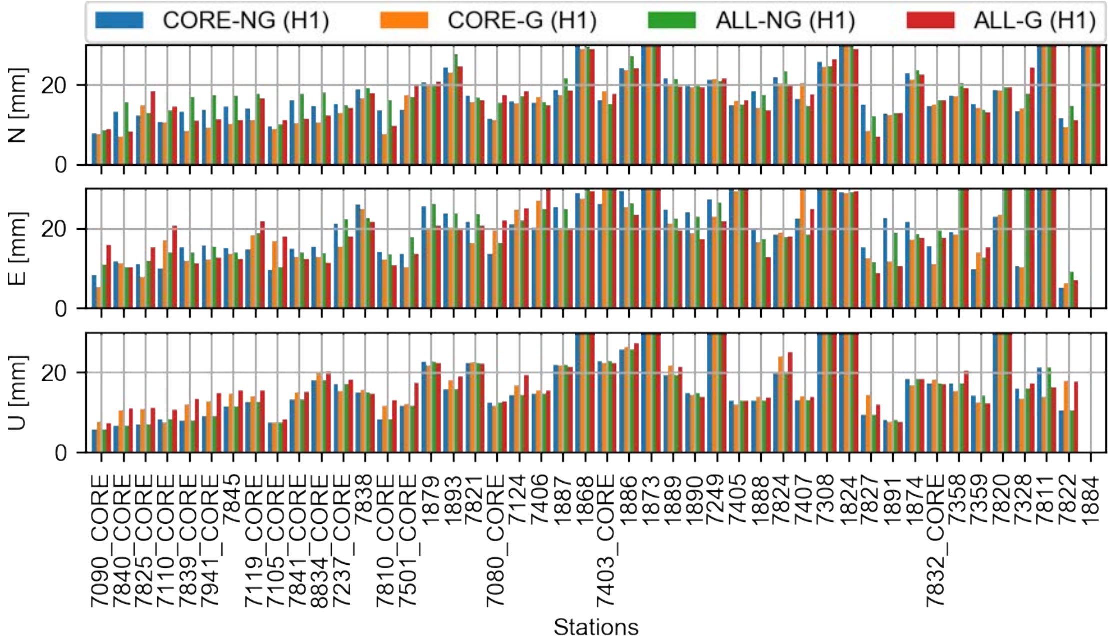
- When NNR+NNT, realized TRF is consistent with SLRF2014 by definition
- We should expect improvement in station coordinate repeatability, because no geocenter motion included in station coordinates. However, when only 15 mm threshold, deteriorate Up component

	N			E			U		
	ALL	CORE	REST	ALL	CORE	REST	ALL	CORE	REST
CORE-NG	16.0	13.6	18.8	20.2	14.5	23.0	14.9	10.5	17.3
CORE-G	15.8	10.6	19.0	18.4	12.6	20.3	15.4	12.1	16.9
Percentage	0.9	22.5	-0.9	9.1	13.1	11.9	-3.6	-16.0	2.1
ALL-NG	17.4	15.8	20.1	19.5	14.0	23.8	14.9	10.4	17.3
ALL-G	17.7	13.3	19.3	19.7	15.6	21.7	17.1	14.2	19.0
Percentage	-1.5	15.8	4.0	-0.6	-11.1	8.5	-15.2	-35.8	-10.0





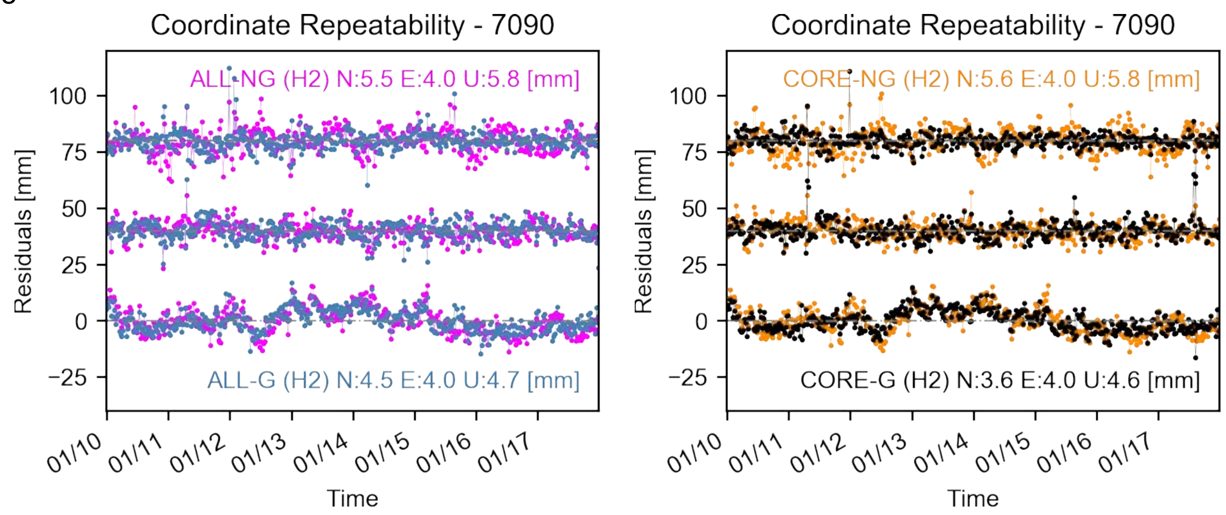


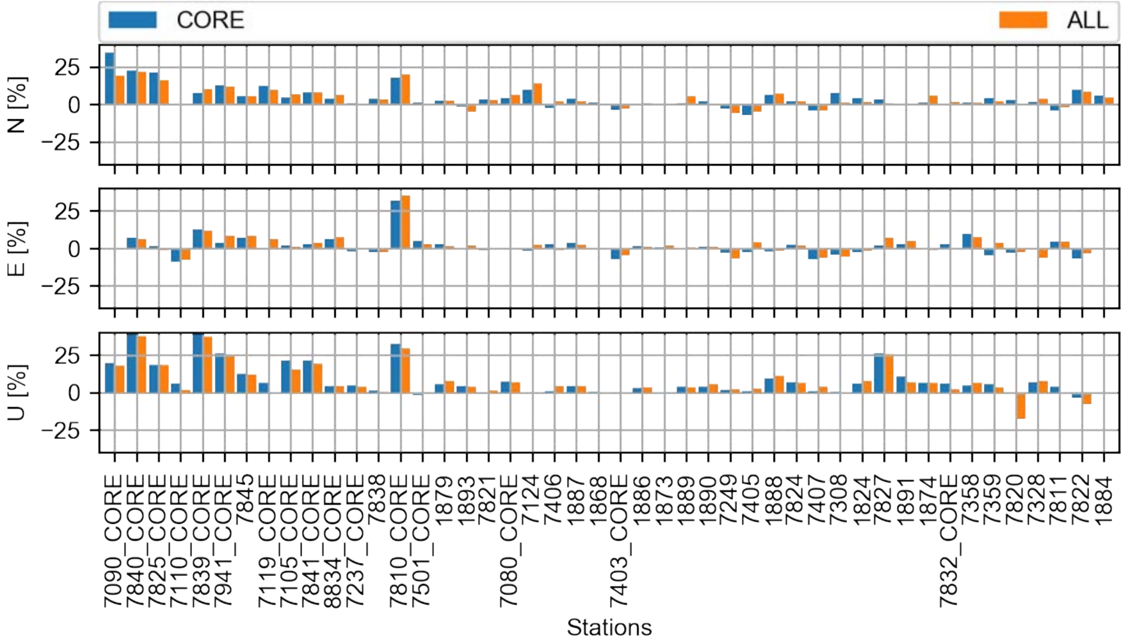


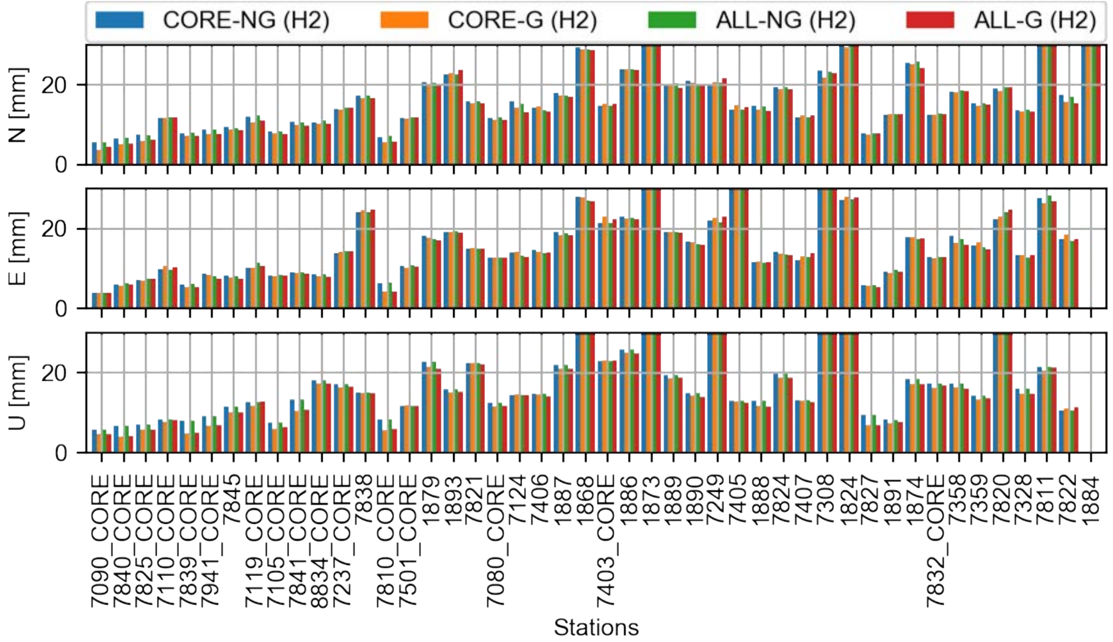
NNR vs. NNR+NNT (Helmert 10 mm)

- Improvement of station coordinate repeatability is visible for NNR+NNT when compare to NNR only for 10 mm threshold.
- We have to exclude all the low-quality stations from TRF realization, then we can see improvement when NNT+NNR is imposed

	N			E			U		
	ALL	CORE	REST	ALL	CORE	REST	ALL	CORE	REST
CORE-NG	14.6	10.7	18.6	14.2	8.9	18.2	14.9	10.4	17.3
CORE-G	14.6	10.0	18.2	14.2	8.6	17.8	14.7	9.1	16.4
Percentage	0.1	6.0	2.3	-0.3	3.4	1.9	1.4	12.7	5.0
ALL-NG	14.6	10.8	18.9	13.8	8.8	17.3	14.9	10.4	17.3
ALL-G	14.4	10.0	18.6	14.0	8.5	17.5	14.5	9.5	16.1
Percentage	1.9	7.4	1.7	-1.5	3.5	-0.7	2.5	9.3	6.7



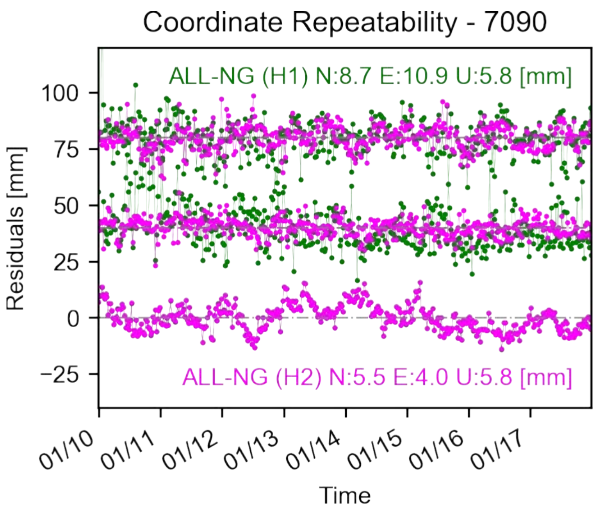


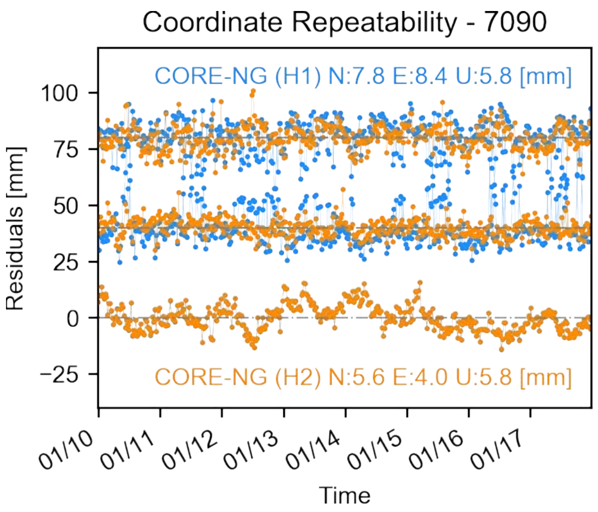


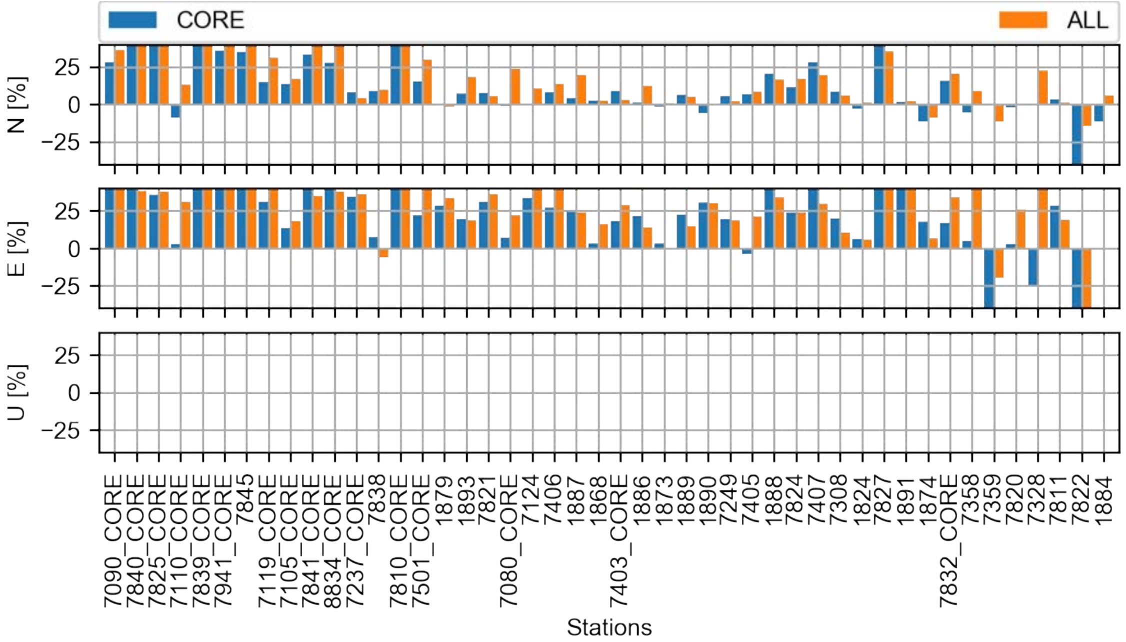
Helmert 15 mm vs Helmert 10 mm (NNR)

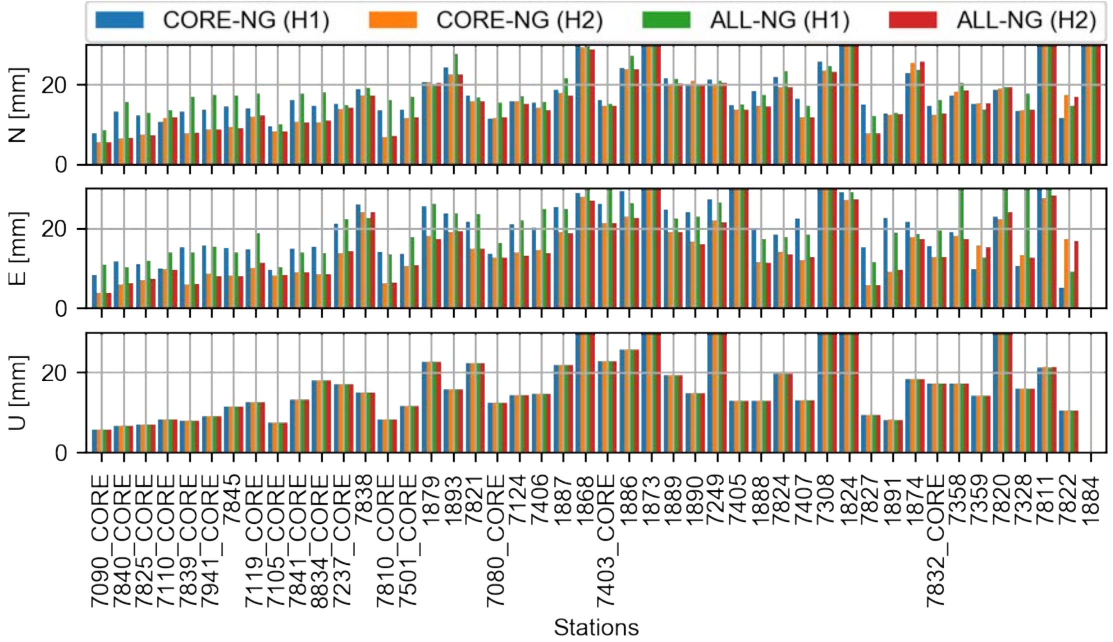
- We improve station coordinate repeatability when applying more rigid threshold
- When NNR condition is only imposed on the network Up component repetability don’t change when chaning group of datum-defining stations

	N			E			U		
	ALL	CORE	REST	ALL	CORE	REST	ALL	CORE	REST
CORE-NG (H1)	16.0	13.6	18.8	20.2	14.5	23.0	14.9	10.5	17.3
CORE-NG (H2)	14.6	10.7	18.6	14.2	8.9	18.2	14.9	10.4	17.3
Percentage	8.3	21.6	0.9	29.9	38.5	20.9	0.0	0.1	0.0
ALL-NG (H1)	17.4	15.8	20.1	19.5	14.0	23.8	14.9	10.4	17.3
ALL-NG (H2)	14.6	10.8	18.9	13.8	8.8	17.3	14.9	10.4	17.3
Percentage	16.0	31.8	5.7	29.5	37.1	27.0	0.0	0.0	0.0





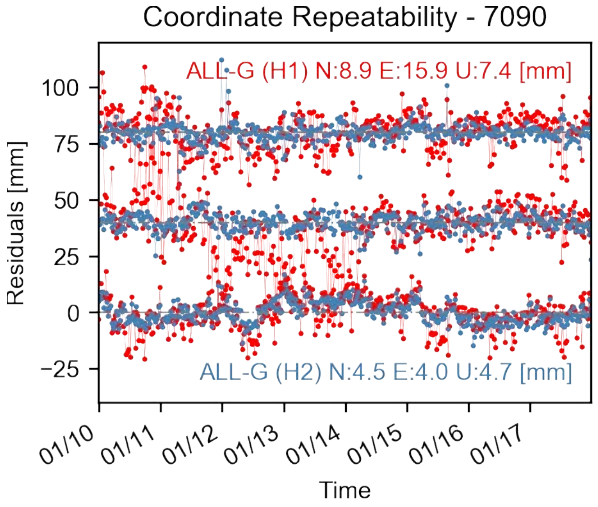


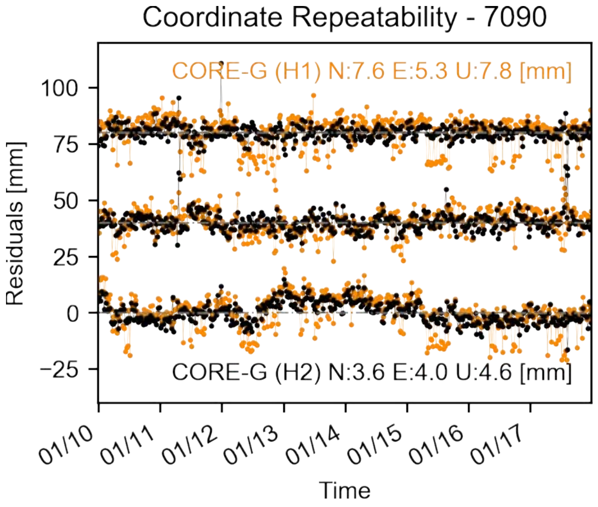


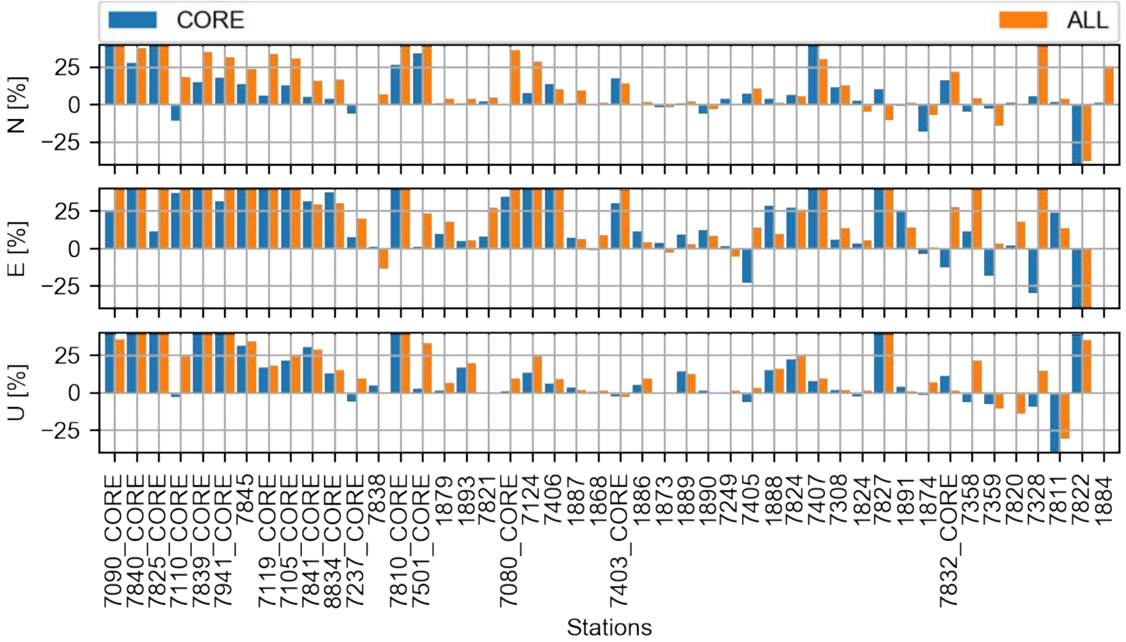
Helmert 15 mm vs Helmert 10 mm (NNR+NNT)

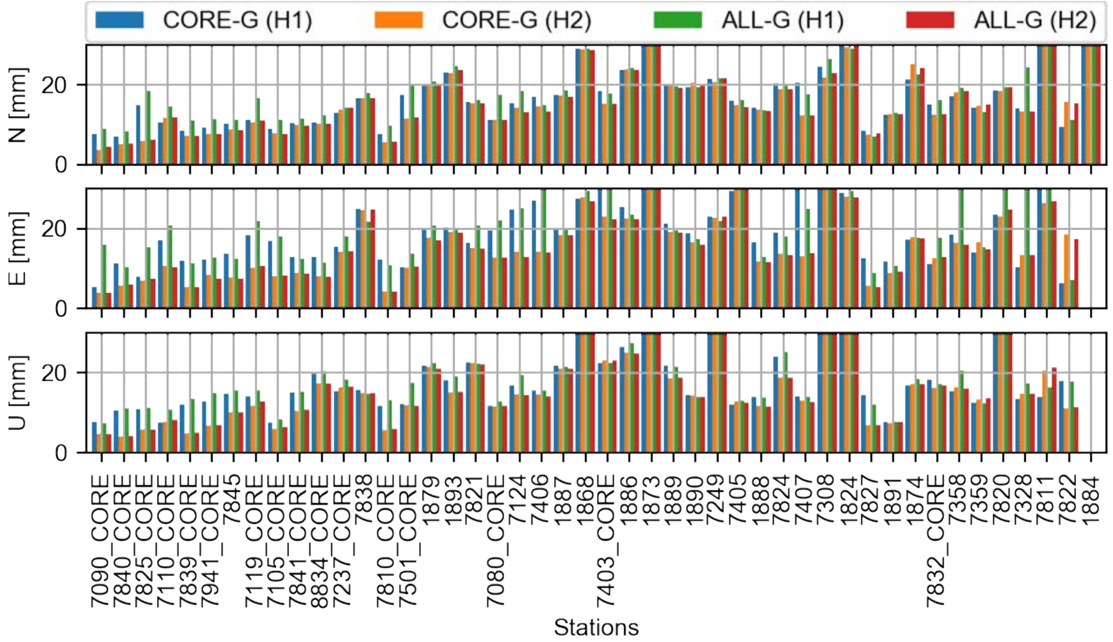
- We clearly improve station coordinate repeatability when applying more rigid threshold

	N			E			U		
	ALL	CORE	REST	ALL	CORE	REST	ALL	CORE	REST
CORE-G (H1)	15.8	10.6	19.0	18.4	12.6	20.3	15.4	12.1	16.9
CORE-G (H2)	14.6	10.0	18.2	14.2	8.6	17.8	14.7	9.1	16.4
Percentage	7.5	5.0	4.0	22.7	31.6	12.0	4.9	24.8	2.9
ALL-G (H1)	17.7	13.3	19.3	19.7	15.6	21.7	17.1	14.2	19.0
ALL-G (H2)	14.4	10.0	18.6	14.0	8.5	17.5	14.5	9.5	16.1
Percentage	18.8	25.0	3.5	28.8	45.3	19.7	15.4	33.2	15.2





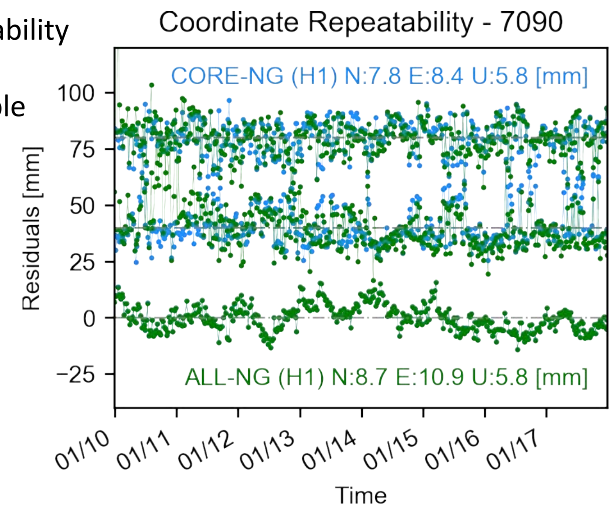


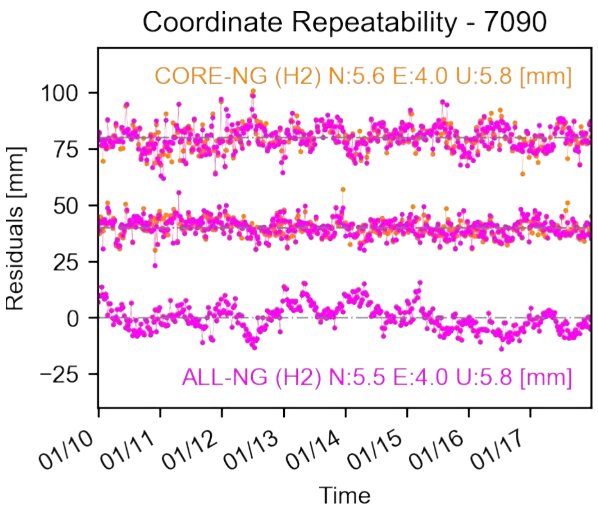


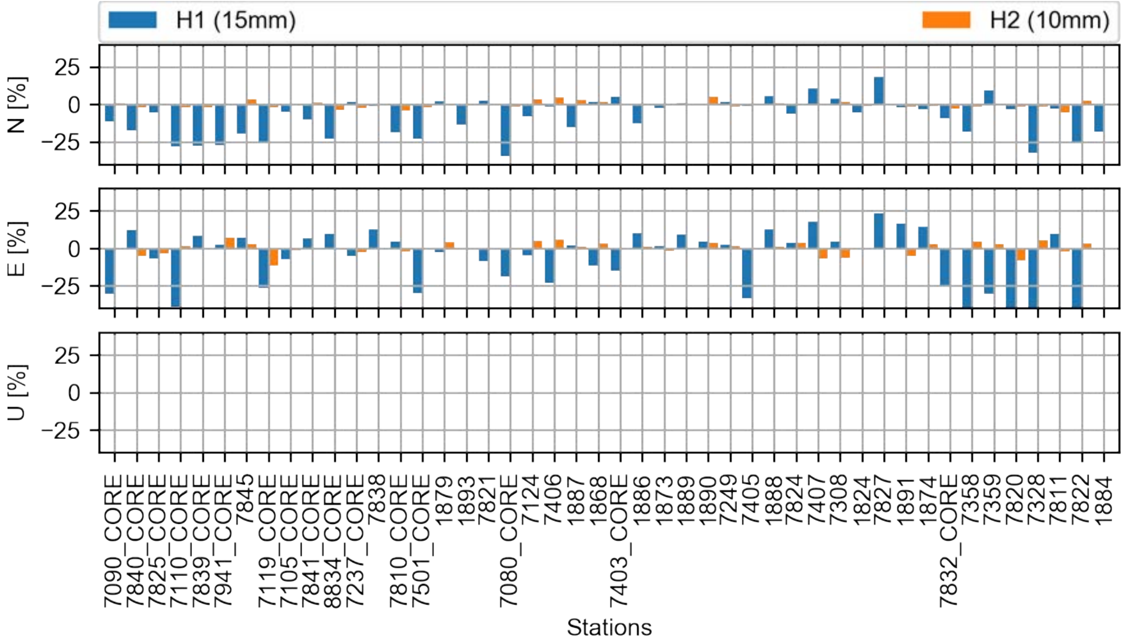
CORE vs ALL (NNR)

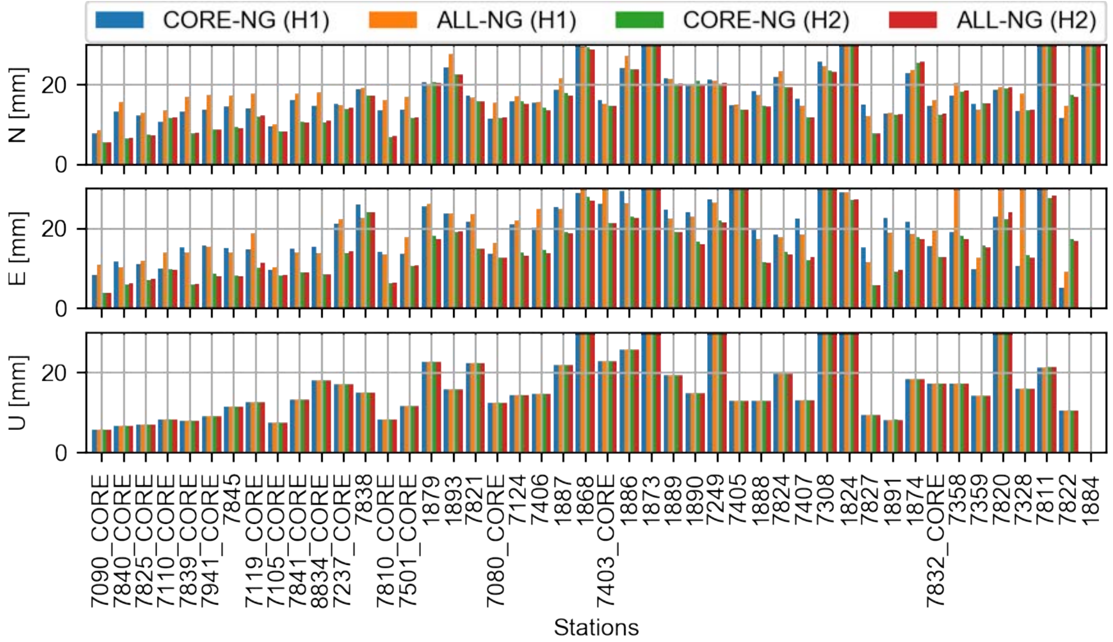
- When NNR condition is only imposed on the network Up component repetability don’t change when chaning group of datum-defining stations. The station coordinate repeatability deteriorates when using ALL stations as compared to CORE only.
- When using H2 threshold the station coordinate repeatability remains at the comparable level

	N			E			U		
	ALL	CORE	REST	ALL	CORE	REST	ALL	CORE	REST
CORE-NG (H1)	16.0	13.6	18.8	20.2	14.5	23.0	14.9	10.5	17.3
ALL-NG (H1)	17.4	15.8	20.1	19.5	14.0	23.8	14.9	10.4	17.3
Percentage	-9.1	-16.2	-6.9	3.3	3.2	-3.4	0.0	0.0	0.0
CORE-NG (H2)	14.6	10.7	18.6	14.2	8.9	18.2	14.9	10.4	17.3
ALL-NG (H2)	14.6	10.8	18.9	13.8	8.8	17.3	14.9	10.4	17.3
Percentage	0.1	-1.2	-1.6	2.6	1.0	4.6	0.0	0.0	0.0





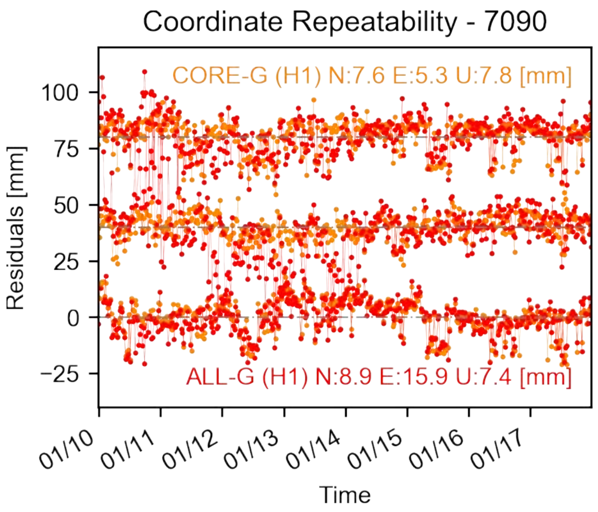


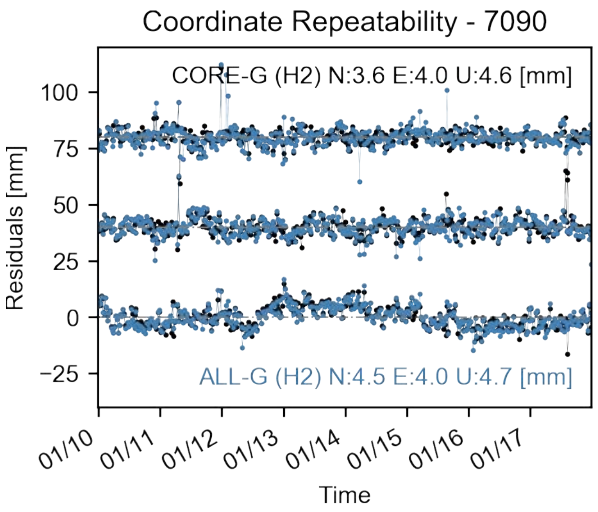


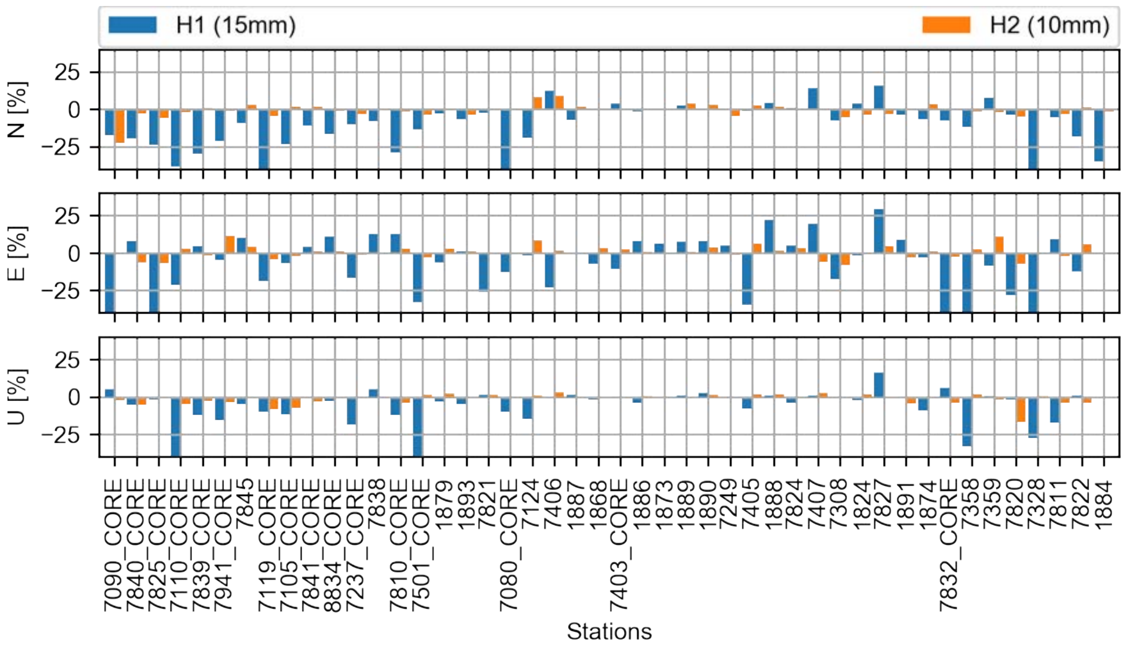
CORE vs ALL (NNR+NNT)

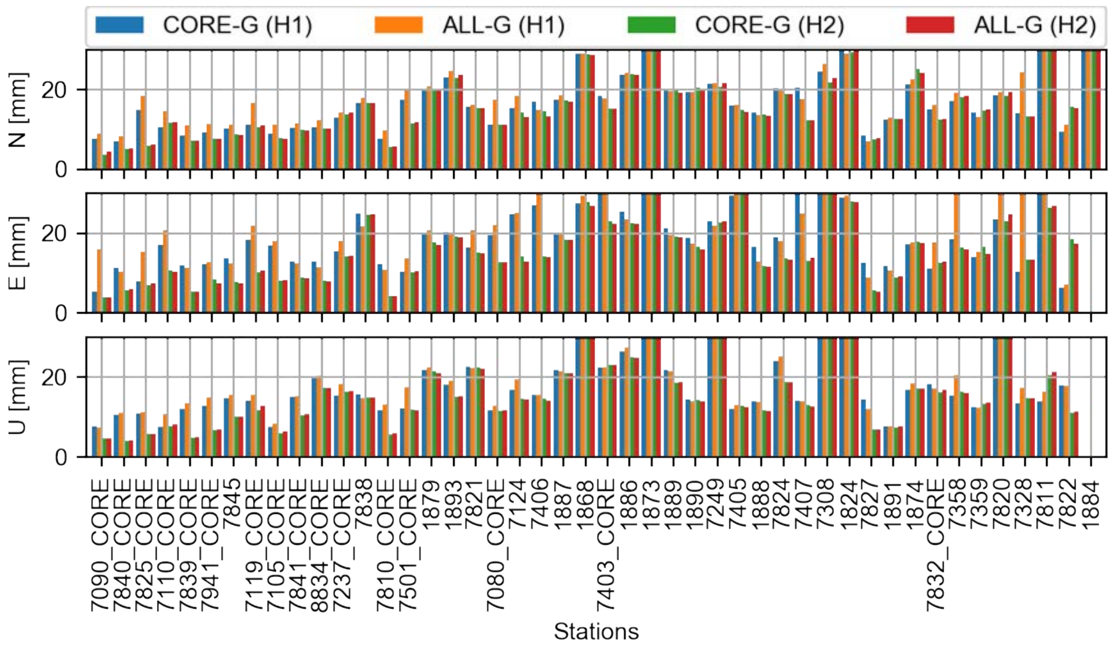
- The station coordinate repeatability deteriorates when using ALL stations as compared to CORE only. That means that the 15 mm threshold is insufficient to reduce low-quality stations in datum realization.
- When using H2 threshold the station coordinate repeatability remains at the comparable level

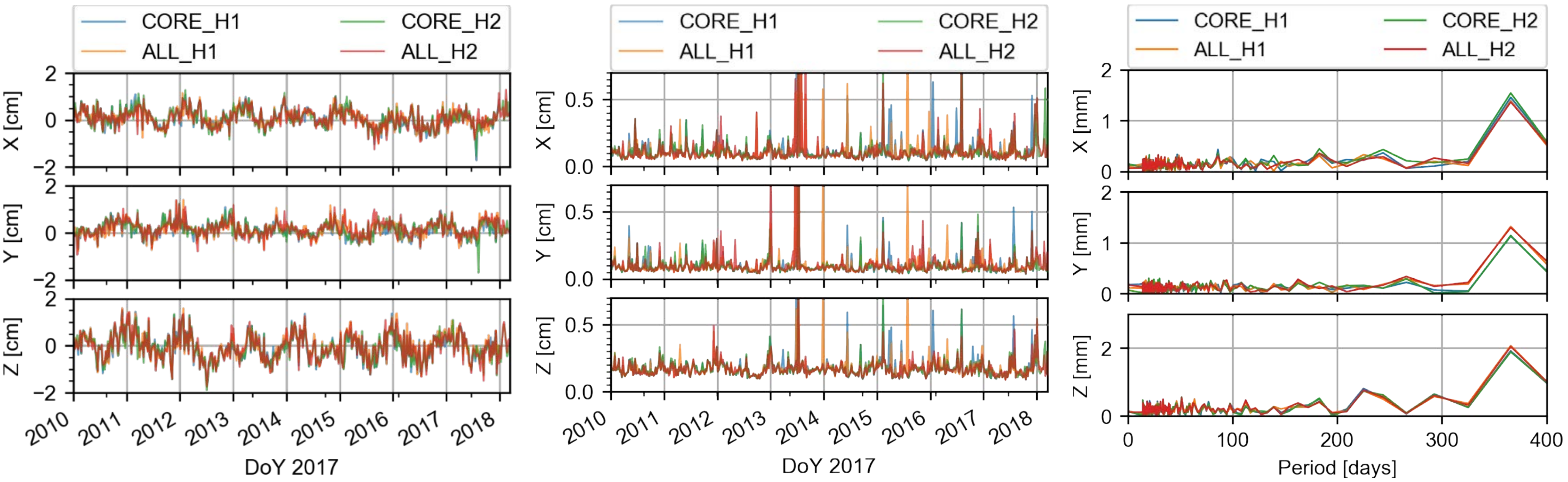
	N			E			U		
	ALL	CORE	REST	ALL	CORE	REST	ALL	CORE	REST
CORE-G (H1)	15.8	10.6	19.0	18.4	12.6	20.3	15.4	12.1	16.9
ALL-G (H1)	17.7	13.3	19.3	19.7	15.6	21.7	17.1	14.2	19.0
Percentage	-11.8	-26.4	-1.7	-7.1	-23.8	-7.3	-11.2	-17.0	-12.5
CORE-G (H2)	14.6	10.0	18.2	14.2	8.6	17.8	14.7	9.1	16.4
ALL-G (H2)	14.4	10.0	18.6	14.0	8.5	17.5	14.5	9.5	16.1
Percentage	1.9	0.3	-2.2	1.4	1.1	2.1	1.2	-3.9	1.8











- The time series of geocentre coordinates delivered in each solution correspond to each other.
- The differences are visible in the time series of formal errors. There are different epochs with increased values of formal errors of geocentre estimation. That may be caused by the inappropriate geometry of datum-defining stations.
- For solution ALL_H2 the number of epochs when formal errors drastically increase is lower than for the other solutions. In that solution, we introduced more stations to maintain a global distribution of stations as well as reduced the number of low-quality stations using more rigid threshold.