7810 ZIML Analysis

Van Husson
ILRS QCB
May-2025

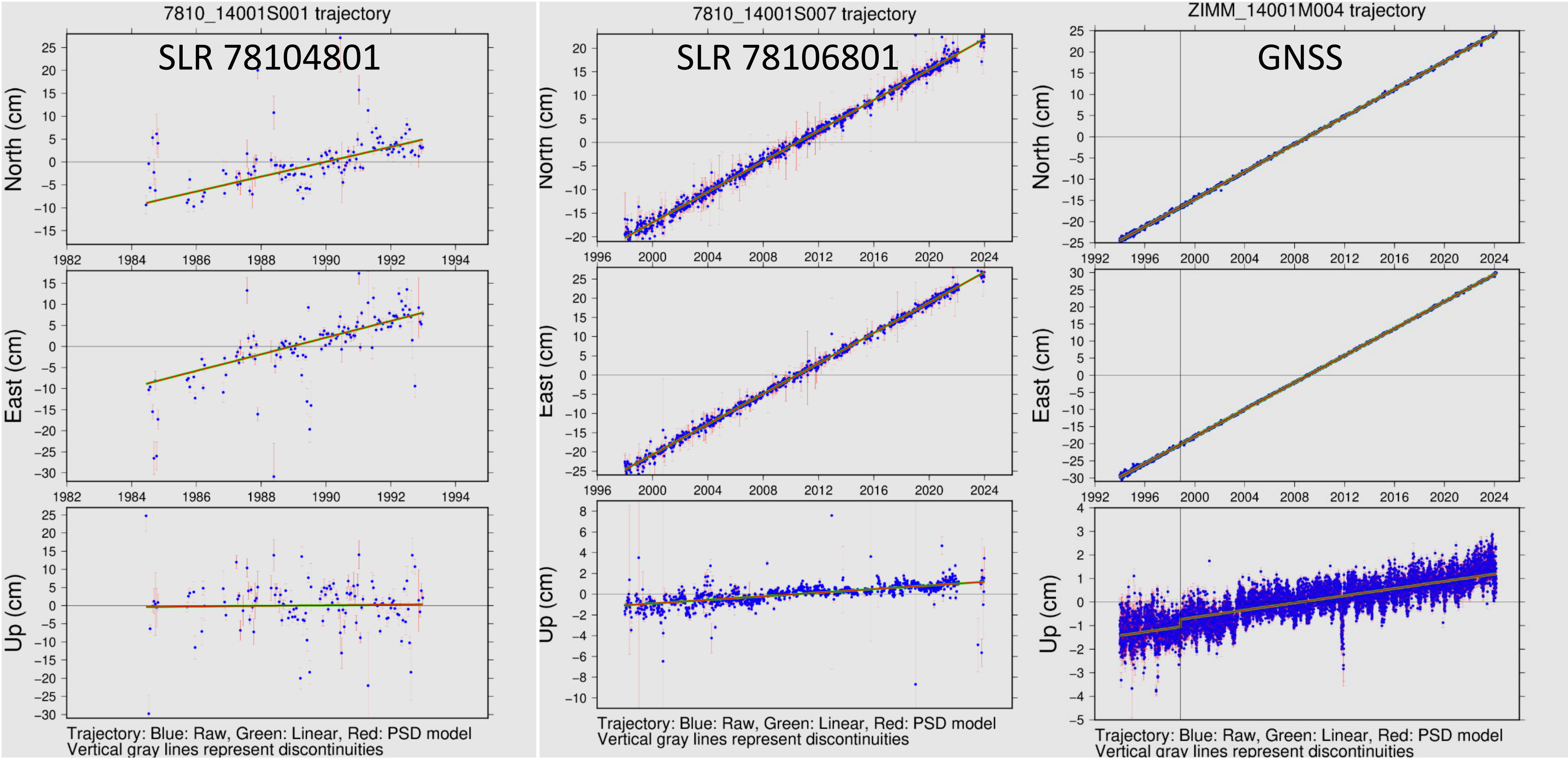
Peraton

7810 ZIML Brief History

- There were two occupations of 7810 with two different Site Occupation Designators (78104801 and 78106801) and DOMES numbers (14001S001 and 14001S007) due to a change in the telescopes. The old telescope was removed in May 1995. The new telescope is ~25 cm higher (Reference: SLRMail#0038). The date of the first pass using the new telescope was 18-Dec-1996
- The original system only operated at 532 nm while the replacement system used up to three different frequencies/receiver chains (423, 532 and 846 nm)

SOD	Wavelength	Start Date	End Date
78104801	532 nm	01-May-1984	01-May-1995
78106801	423 nm	18-Dec-1996	24-Jan-2008
78106801	846 nm	31-Jul-2002	24-Jan-2008
78106801	532 nm	10-Apr-2008	present

Zimmerwald ITRF2020_U2023 Station Residuals (SLR & GNSS)



System	ITRF2020 Solution	Xdot (m/yr)	Ydot (m/yr)	Zdot (m/yr)
7810 (old)	original	-0.01372	0.01809	0.01171
7810 (new)	original	-0.01372	0.01809	0.01171
ZIMM	original	-0.01378	0.01810	0.01164
7810 (old)	2023 Update	-0.01373	0.01810	0.01176
7810 (new)	2023 Update	-0.01373	0.01810	0.01176
ZIMM	2023 Update	-0.01377	0.01810	0.01167

- **The old Zimmerwald SLR system tracked until 1-May-1995, but based on the Data Handling File (DHF), all data after 1-Jan-1993 was to be rejected and why the station residuals stop at the end of 1992**
- **The ITRF2020_U2023 velocities for GNSS and SLR are slightly different in X and Z at 0.04 and 0.09 mm/year. The velocities for the old and new SLR system are identical**

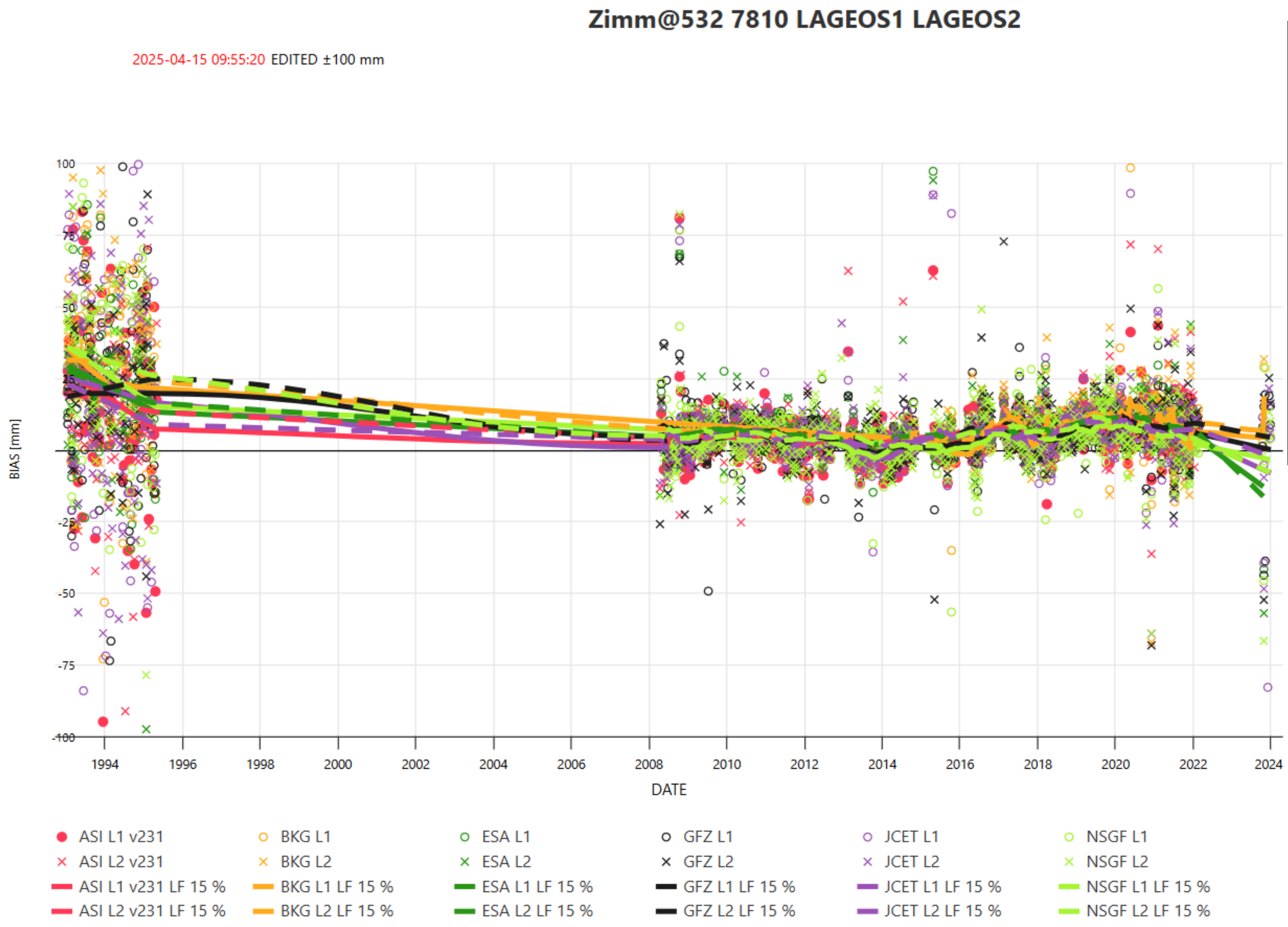
7810 ZIML Data Handling File (DHF) Range Bias (RB) Instructions

*CODE	Pad_id	Sat	T	PT	Start Date	End Date	Bias Code	Bias	STD	Rate	UNIT
	7810			A	88:145:00000	89:273:00000	R	50.0			mm
	7810		501	A	93:001:00000	96:001:00000	X				
	7810		401	B	96:353:00000	97:363:00000	X				
	7810	53	401	B	97:061:00000	06:050:00000	R	-29.8	1.1		mm
	7810	54	401	B	97:061:00000	06:050:00000	R	-29.8	1.1		mm
	7810	51	401	B	97:362:00000	02:153:00000	R	-25.1	0.6		mm
	7810	52	401	B	97:362:00000	02:153:00000	R	-25.0	0.7		mm
	7810	51	401	B	02:153:00000	05:044:00000	R	-17.2	0.6		mm
	7810	52	401	B	02:153:00000	05:044:00000	R	-17.5	0.7		mm
	7810	51	401	B	05:100:00000	06:043:00000	E				mm
	7810	52	401	B	05:100:00000	06:043:00000	E				mm
	7810		801	B	00:000:00000	07:001:00000	E				mm
	7810	53	501	B	01:091:00000	16:080:00000	R	1.3	0.4		mm
	7810	54	501	B	01:091:00000	16:080:00000	R	1.3	0.4		mm
	7810	51	501	B	08:111:00000	12:302:00000	R	4.3	0.2		mm
	7810	52	501	B	08:111:00000	12:302:00000	R	4.1	0.2		mm
	7810			B	15:184:00000	15:187:28800	X				
	7810	51	501	B	16:080:00000	00:000:00000	R	7.0	0.3		mm
	7810	52	501	B	16:080:00000	00:000:00000	R	8.2	0.3		mm
	7810	53	501	B	16:080:00000	22:051:00000	R	7.2	0.5		mm
	7810	54	501	B	16:080:00000	22:051:00000	R	7.2	0.5		mm
	7810		501	B	23:060:00000	00:000:00000	E				mm

Legend				
Satellite	T (wavelength)	PT	Bias Code	Comments
51: LAGEOS-1	401: 423 nm	A: Old System	R: Range Bias to be Applied	
52: LAGEOS-2	501: 532 nm	B: New System	E: Estimate Range Bias	
53: Etalon-1	801: 846 nm		X: Delete Data	TDP: Epoch Timing Issue
54: Etalon-2	: All			
: All				

- The DHF entries here are sorted by the Point (Point A: old System, Point B: new system) then by receiver chain/wavelength (432, 846 and 532 nm), then by time

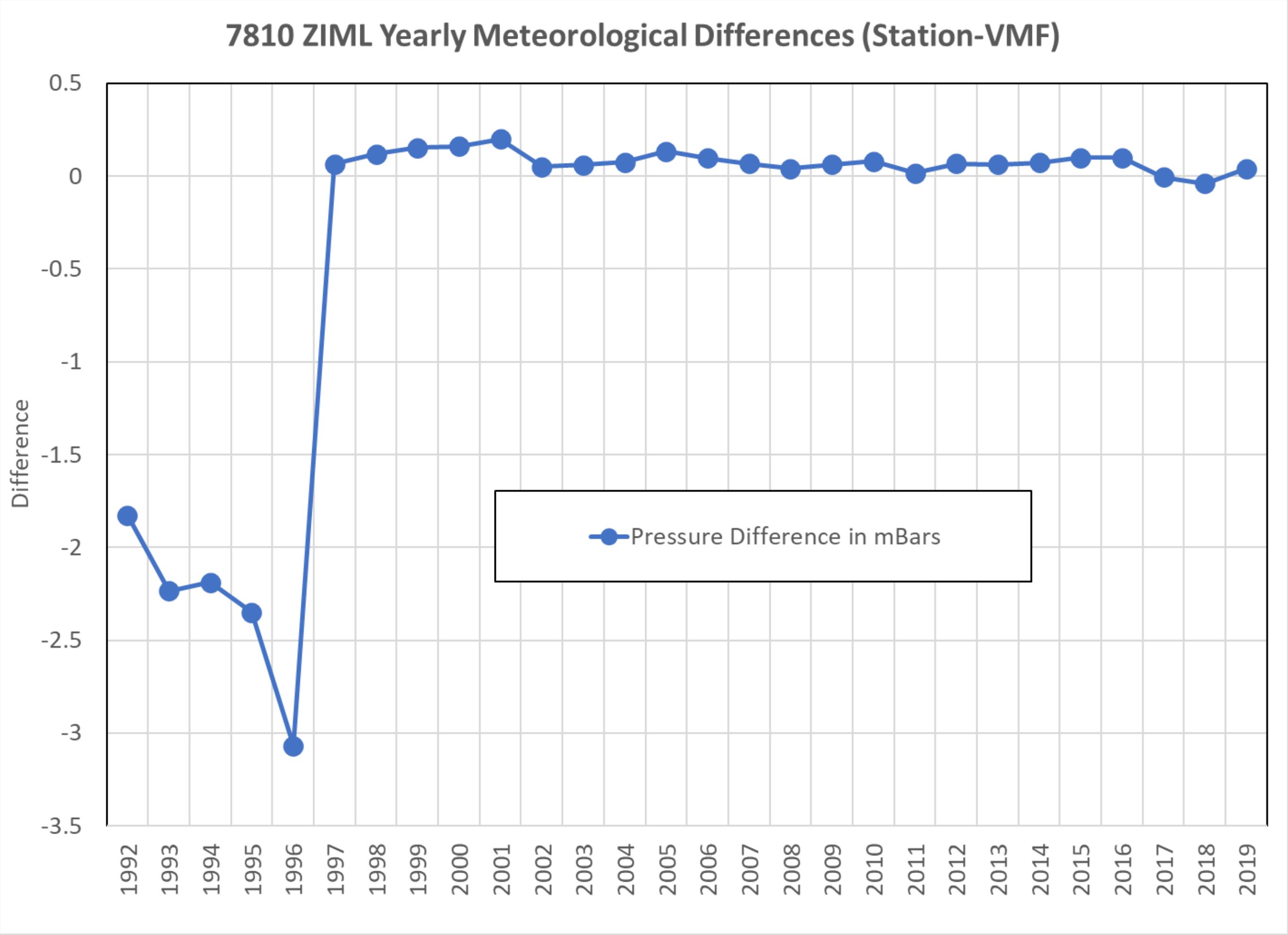
7810 ZIML SSEM Range Bias (RB) Estimates (Wavelength 532 nm)



Pad_id	Sat	T	PT	Start Date	End Date	Bias Code	Bias	STD	Rate	UNIT	Comments
7810			A	88:145:00000	89:273:00000	R	50.0			mm	
7810		501	A	93:001:00000	96:001:00000	X					
7810	53	501	B	01:091:00000	16:080:00000	R	1.3	0.4		mm	
7810	54	501	B	01:091:00000	16:080:00000	R	1.3	0.4		mm	
7810	51	501	B	08:111:00000	12:302:00000	R	4.3	0.2		mm	
7810	52	501	B	08:111:00000	12:302:00000	R	4.1	0.2		mm	
7810			B	15:184:00000	15:187:28800	X					TDP
7810	51	501	B	16:080:00000	00:000:00000	R	7.0	0.3		mm	
7810	52	501	B	16:080:00000	00:000:00000	R	8.2	0.3		mm	
7810	53	501	B	16:080:00000	22:051:00000	R	7.2	0.5		mm	
7810	54	501	B	16:080:00000	22:051:00000	R	7.2	0.5		mm	
7810		501	B	23:060:00000	00:000:00000	E				mm	

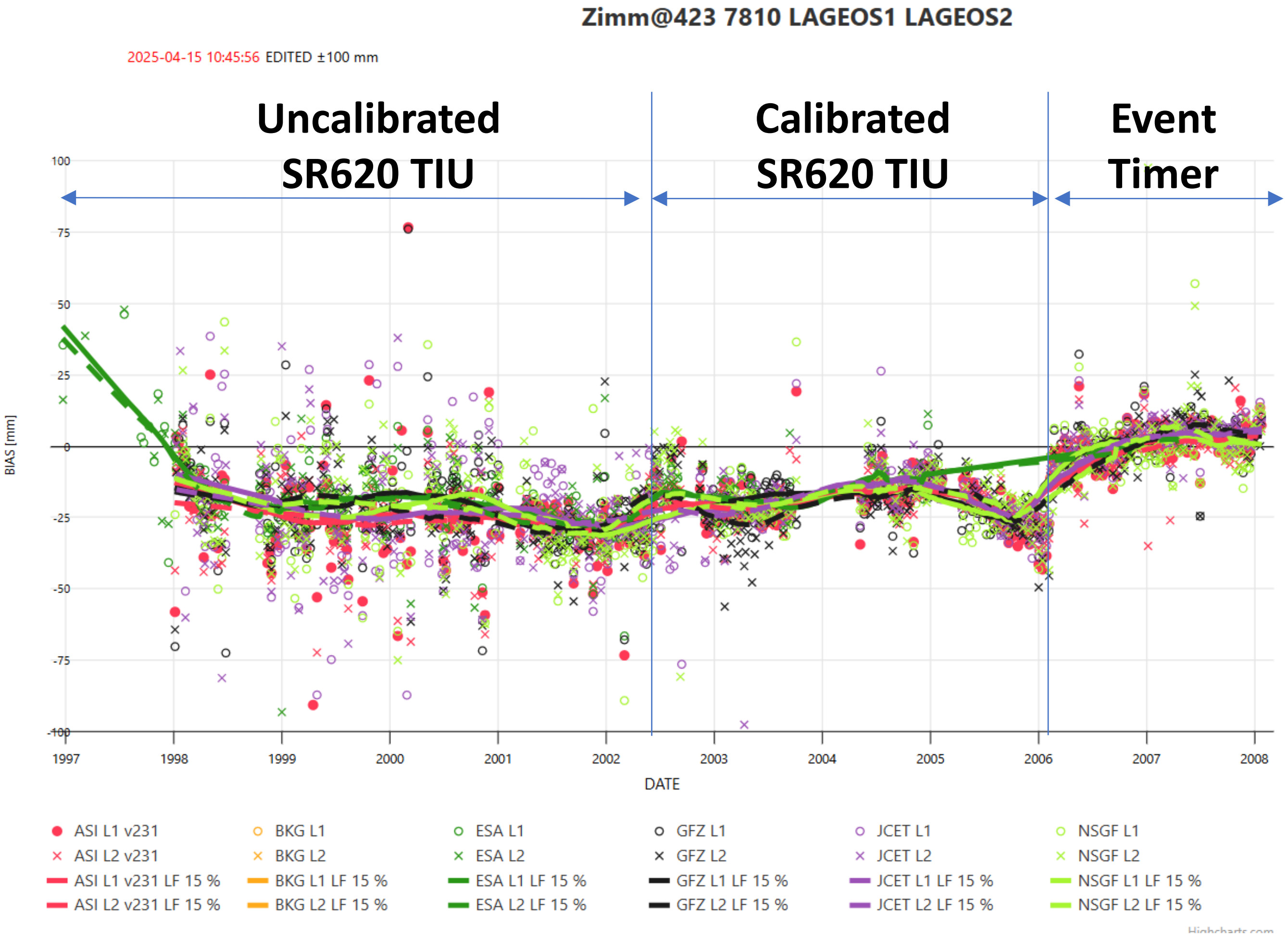
- **RBs from the old and new SLR system (532 nm)**
- **Based on the DHF, all data from the old system was deleted from 1-Jan-1993 to 1-Jan-1996, but no reason given**
- **The Stanford SR620 Time Interval Unit (TIU) was replaced by an Event Timer on 3-Feb-2006. All 532 nm data from the new system is with the event timer**
- **Part of the RB in the old system was caused by a barometer error (see next slide)**

7810 ZIML Barometric Analysis



- It appears that the old system's barometer was drifting more negative.
- A pressure error of -2 mBar will induce an apparent RB of ~+8 to +10 mm. This can partially explain some of the applied +50 mm RB
- The VMF data here is based on the climate re-analysis which ended in August 2019

7810 ZIML SSEM Range Bias (RB) Estimates (Wavelength 423 nm)



*CODE	Pad_id	Sat	T	PT	Start Date	End Date	Bias Code	Bias	STD	Rate	UNIT
	7810		401	B	96:353:00000	97:363:00000	X				
	7810	53	401	B	97:061:00000	06:050:00000	R	-29.8	1.1		mm
	7810	54	401	B	97:061:00000	06:050:00000	R	-29.8	1.1		mm
	7810	51	401	B	97:362:00000	02:153:00000	R	-25.1	0.6		mm
	7810	52	401	B	97:362:00000	02:153:00000	R	-25.0	0.7		mm
	7810	51	401	B	02:153:00000	05:044:00000	R	-17.2	0.6		mm
	7810	52	401	B	02:153:00000	05:044:00000	R	-17.5	0.7		mm
	7810	51	401	B	05:100:00000	06:043:00000	E				mm
	7810	52	401	B	05:100:00000	06:043:00000	E				mm

- **The first data taken from the new system was on 18-Dec-1996 using a 423 nm laser**
- **But based on the DHF, all data from this wavelength (423 nm) was deleted from 18-Dec-1996 to 29-Dec-1997 with no reason given. Also notice there is a conflict in the DHF for Etalon-1 and -2 data, where a fixed RB is to be applied starting on 2-Mar-1997, but based on the 1st DHF entry data in 1997 is to deleted**
- **The Event timer was installed on 3-Feb-2006 and notice the large discontinuity (~20 mm) in the RBs when this occurred.**
- **There was also a discontinuity in the RBs on 29-May-2002, when Zimmerwald adjusted their calibration distance by 18 mm and at the same time applied counter calibrations. See next slide which is SLRmail#0951. In addition, according to their Site log "since 29-May-2002 counter calibration values relative to the Herstmonceux reference are applied to the observations".**

SLRmail#0951 from Zimmerwald

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SLR Electronic Mail   Fri May 31 08:42:02 CEST 2002   Message No. 0951

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Author: Werner Gurtner
Subject: Zimmerwald Range Bias Removed

Zimmerwald Range Biases
****

Due to an error in the original reduction of the terrestrial refraction to the external ground target at a distance of approximately 600 m the computation of the internal calibration target path length was wrong by 0.12 ns = 18 mm since end of 1997, i.e., all ranges were reported 18 mm too short till now.

The weekly data analysis of UTX and others always confirmed a range bias of the order of minus 1.5 to 2 cm. However, we decided to wait with the correction of the obviously wrong calibration path length and to bundle it with other changes in the system to keep the number of changes as small as possible.

During a EUROLAS workshop at Herstmonceux in March 2002 we compared one of our spare counters with the reference counters of Herstmonceux. Recently we then compared this spare counter with our primary counter at Zimmerwald. Following the EUROLAS network decision we will start today to apply the known counter corrections to refer it to the Herstmonceux reference.

The corrections range from about +20 ps to -40 ps, depending on the size of the measured time interval. For the Lageos ranges the corrections are between -15 and -35 ps, i.e. the observed ranges are between 2 and 5 mm too long.

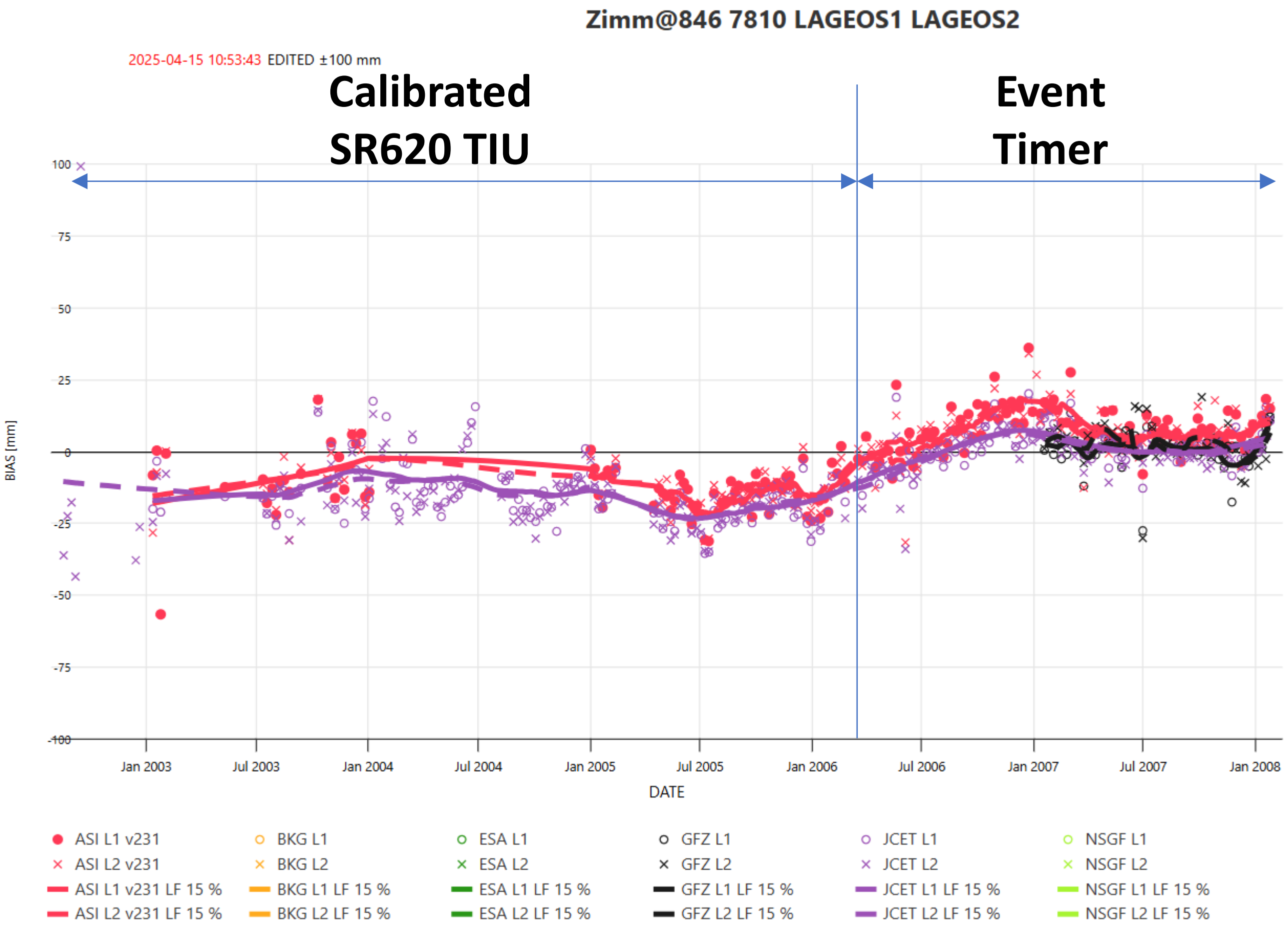
We start to use the correct calibration path length and the "Herstmonceux counter corrections" for observations performed after May 29, 2002 00:00 UT. Lageos ranges will be reported between 18-2=16 mm and 18-5=13 mm longer after this date.

More details can be found in http://aiuas3.unibe.ch/ftp/slr/zm_calibration.html.

Werner Gurtner

- **The 7810 RB did move positive after adjusting the calibration target distance by 18 mm while simultaneously applying a Stanford Research 620 (SR620) TIU correction**
- **Based on the previous slide, the SSEM RBs jumped by more than 10 mm when the Riga Event Timer was installed, indicating an issue with the previously applied SR620 TIU corrections**

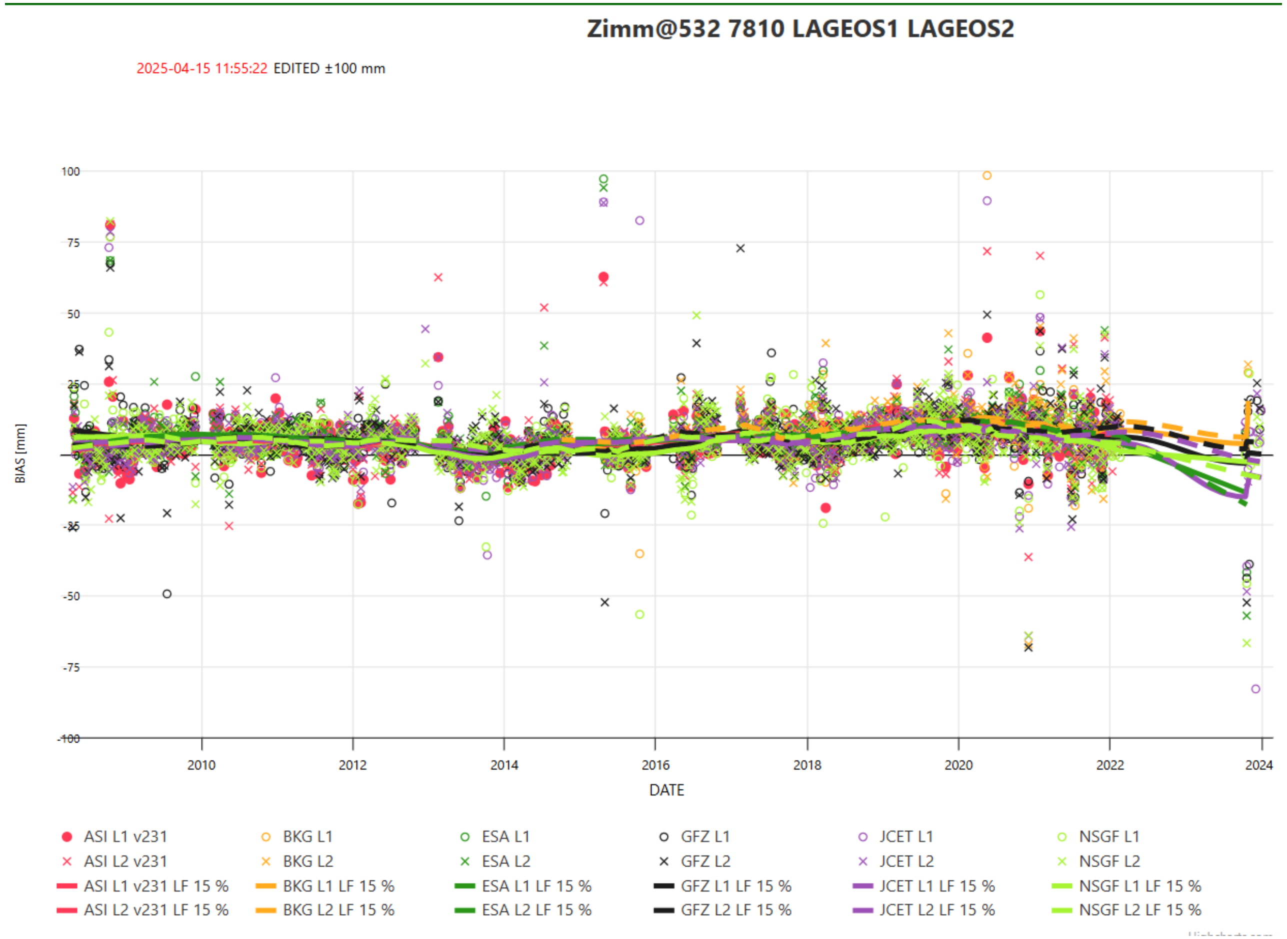
7810 ZIML SSEM Range Bias (RB) Estimates (Wavelength 846 nm)



Pad_id	Sat	T	PT	Start Date	End Date	Bias Code	Bias	STD	Rate	UNIT
7810		801	B	00:000:00000	07:001:00000	E				mm

- ❑ **Based on the DHF file entries for the 846 nm laser wavelength, the RBs are to be estimated for the entire timeframe**
- ❑ **Note that the 423 nm wavelength data (the primary receiver chain) overlaps with all the 846 nm wavelength data. Only 3 ACs computed RBs for this wavelength**
- ❑ **According to the station change history, the event timer was not installed in the 846 nm receiver chain until 23-Mar-2006, more than one month after it was installed in the 423 nm receiver chain on 3-Feb-2006. There was no discontinuity in the RB when the event timer was installed for this wavelength; but there was an obvious RB discontinuity in the 423 nm receiver chain**

7810 ZIML SSEM Range Bias (RB) Estimates (Wavelength 532 nm)



Pad_id	Sat	T	PT	Start Date	End Date	Bias Code	Bias	STD	Rate	UNIT	Comments
7810	53	501	B	01:091:00000	16:080:00000	R	1.3	0.4		mm	
7810	54	501	B	01:091:00000	16:080:00000	R	1.3	0.4		mm	
7810	51	501	B	08:111:00000	12:302:00000	R	4.3	0.2		mm	
7810	52	501	B	08:111:00000	12:302:00000	R	4.1	0.2		mm	
7810			B	15:184:00000	15:187:28800	X					TDP
7810	51	501	B	16:080:00000	00:000:00000	R	7.0	0.3		mm	
7810	52	501	B	16:080:00000	00:000:00000	R	8.2	0.3		mm	
7810	53	501	B	16:080:00000	22:051:00000	R	7.2	0.5		mm	
7810	54	501	B	16:080:00000	22:051:00000	R	7.2	0.5		mm	
7810		501	B	23:060:00000	00:000:00000	E				mm	

- **These are SSEM RBs from only the new system ranging at 532 nm and post event timer installation**
- **Based on the above DHF entries, fixed RBs are to be applied to all data prior to 1-Mar-2023 and post 1-Mar-2023, RBs are to be estimated**
- **The LAGEOS-1, -2 RBs while in quarantine in 2025 were +13.1 and +12.4 mm; respectively, which is an increase over the RBs in the current DHF**

SLRmail#1061 and 7810 LAGEOS Center of Mass Correction

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SLR Electronic Mail Tue Mar 11 18:35:17 CET 2003 Message No. 1061

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Author: Werner Gurtner
Subject: Zimmerwald: Switch to CSPAD

CSPAD as Primary Sensor
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Today we exchanged the Hamamatsu Photomultiplier of the primary receiver chain (wavelength 423 nm) with the CSPAD that was used so far for experimental purposes, only.

The first passes submitted today (starting with Lageos-1, 10:42 UT) were already observed with the SPAD. We expect to see jumps in the range bias of a very few millimeters only, if any. We continue to observe in the single to few photon regime.

The single shot rms (Lageos) should drop from about 2 cm to 1.5 cm.

A new site log has been submitted to the Central Bureau.

Werner Gurtner

	Start			End			Wave	LAG-1	LAG-2	
PAD	DD	MM	YYYY	DD	MM	YYYY	(nm)	CoM(mm)	CoM(mm)	Detector
7810	01	01	1983	01	06	1995	532	244.6	244.0	PMT
7810	01	01	1986	01	06	1995	532	244.4	243.8	PMT
7810	18	02	2008	01	01	2050	532	244.7	243.9	CSPAD
7810	01	01	1997	09	03	2001	423	242.6	241.3	PMT
7810	09	03	2001	11	03	2003	423	245.0	244.5	PMT
7810	11	03	2003	03	02	2006	423	243.4	242.6	CSPAD
7810	03	02	2006	18	02	2008	423	243.7	242.8	CSPAD
7810	01	01	2002	03	02	2006	846	246.8	246.5	PMT
7810	03	02	2006	18	02	2008	846	246.7	246.3	PMT

- **The 7810 LAGEOS CoMs for the 532 and 846 nm wavelengths vary by a few tenths of mm, but vary by a few mm for the 423 nm wavelength**
- **A new 532 nm laser (1kHz, 8 ps pulse-width) was installed on 21-Aug-2024, may require a new CoM since the old repetition rate and pulse-width were 110 Hz and 60 ps**

Conclusions

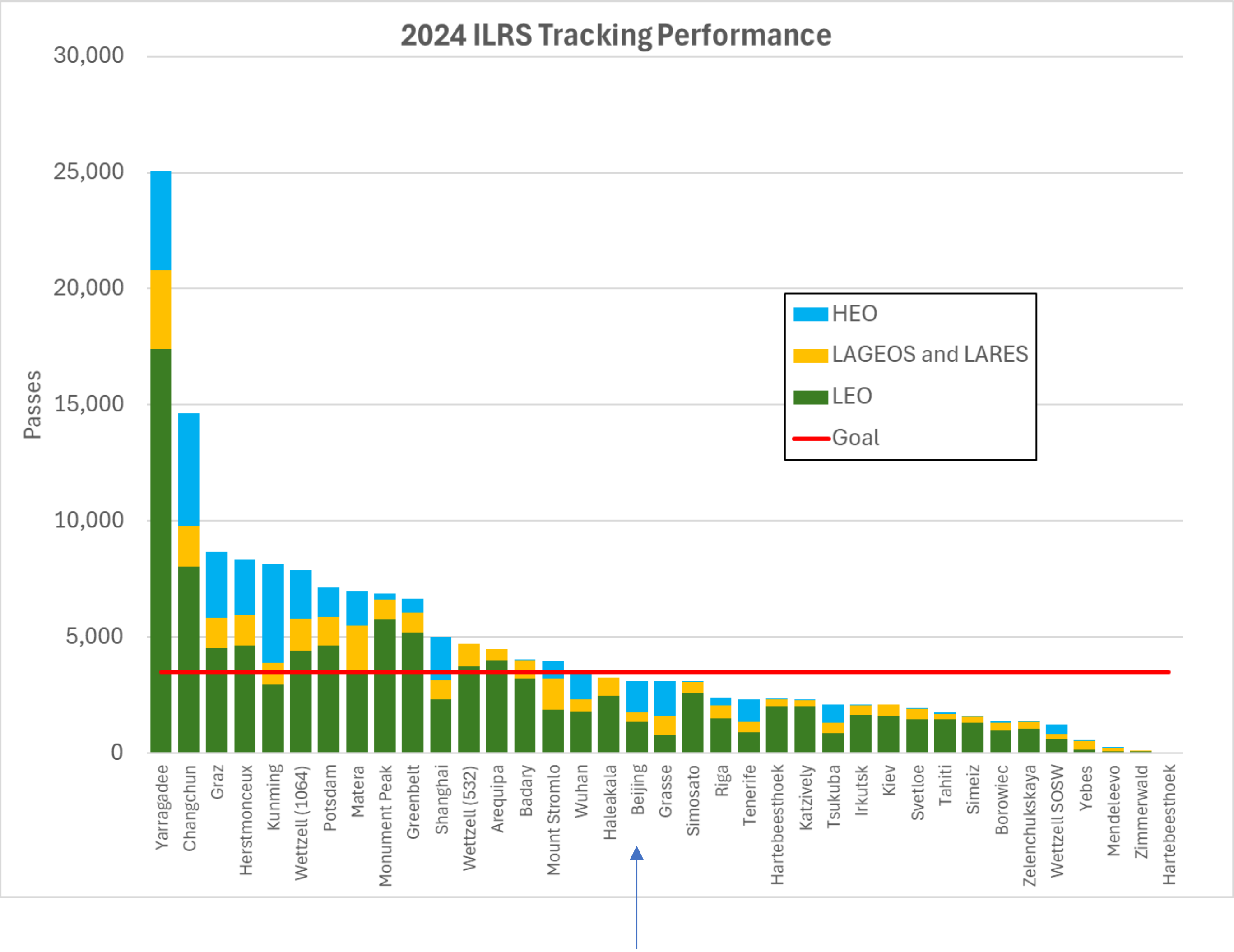
- The 7810 ZIML SLR ITRF2020 and ITRF2020_U2023 Coordinate Velocities are nearly identical with the ZIMM GNSS Coordinate Velocities, which is good and provides confidence in the SLR coordinates
- The early 423 nm data was biased short by more than 2 cm, the most recent data while in quarantine is biased positive by more than 1 cm
- The applied SR620 TIU corrections since 29-May-2002 do not appear to be correct for the 423 nm receiver chain based on the large discontinuities in the 423 nm RBs when the event timer was installed

7249 BEIL System Performance

Van Husson

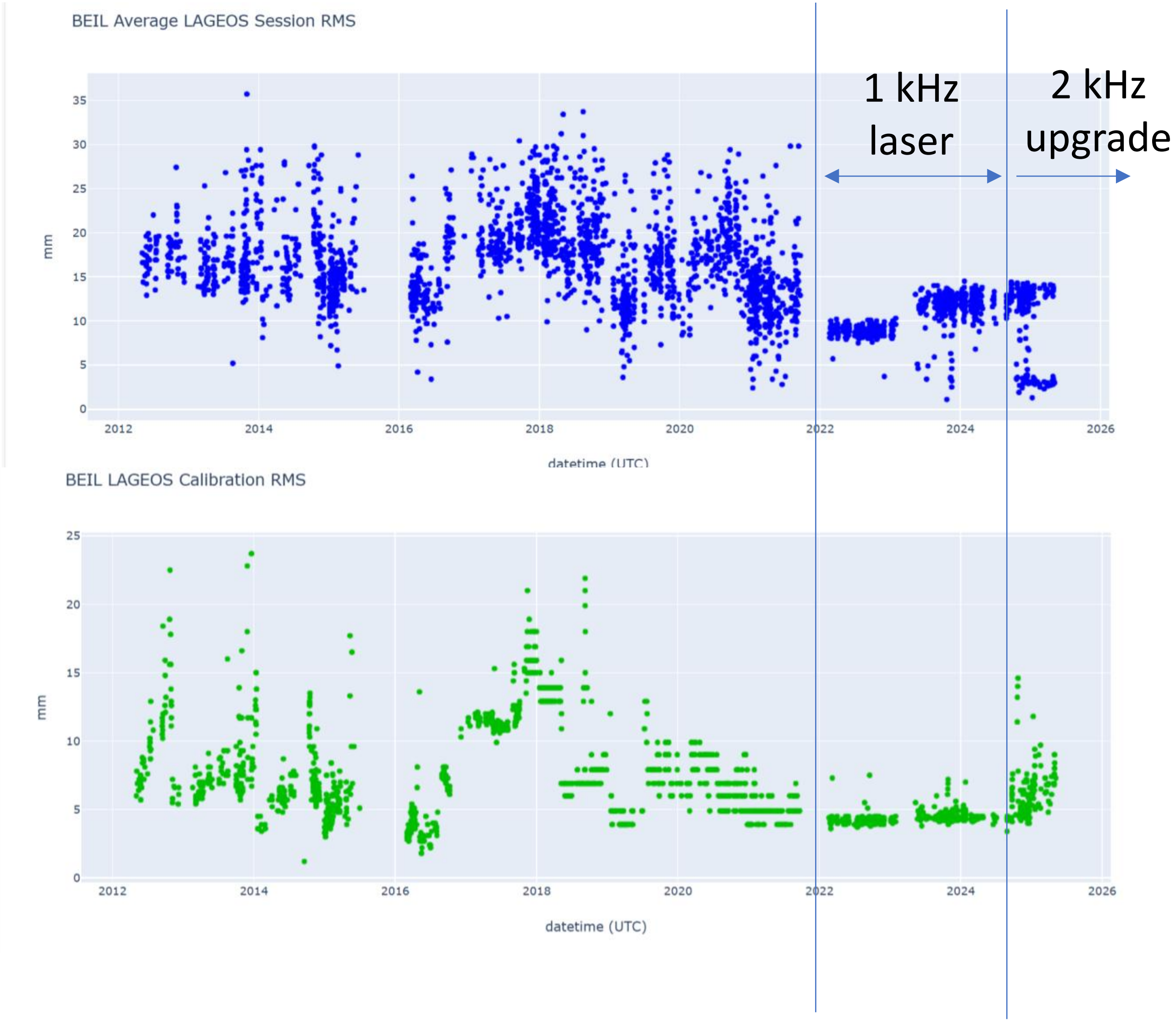
19-May-2025

Beijing (7249 BEIL) 2024 Data Quantity



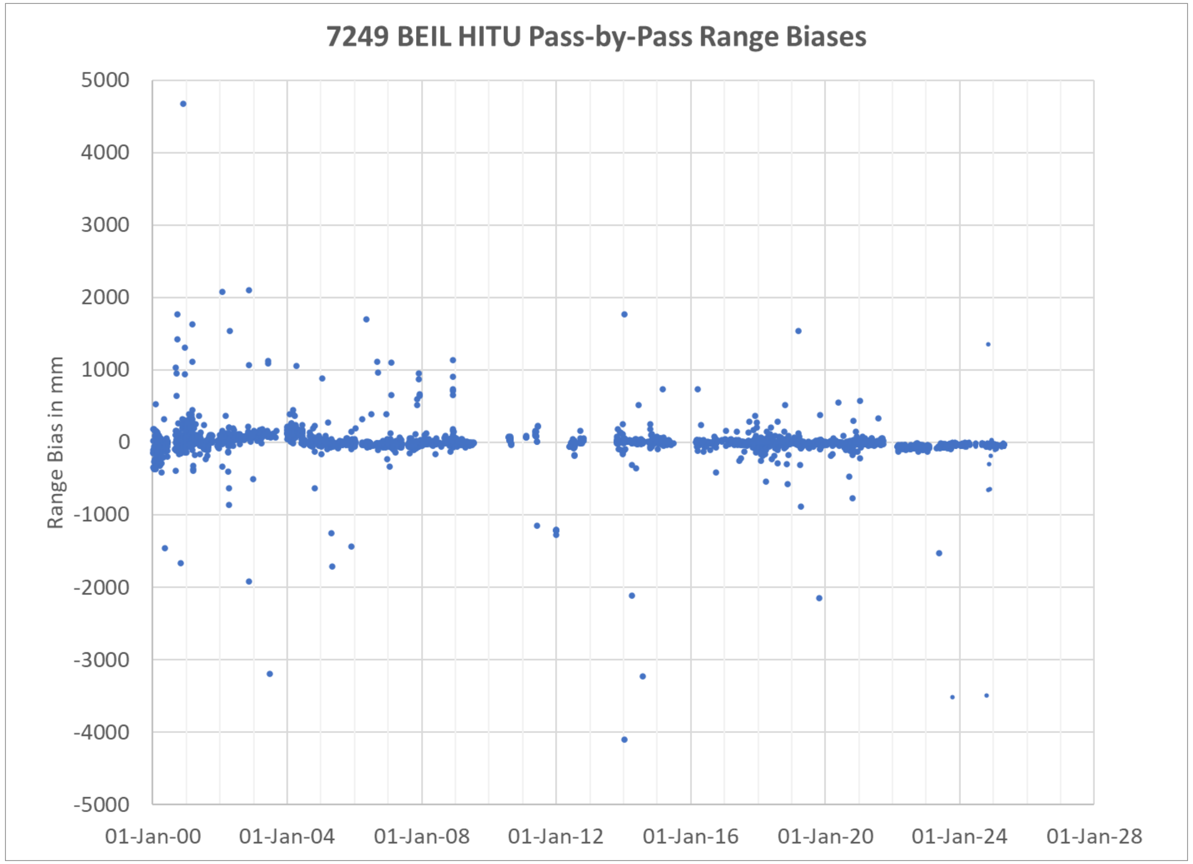
- ❑ Beijing tracked more than 3100 passes in 2024 including 397 LAGEOS class satellites

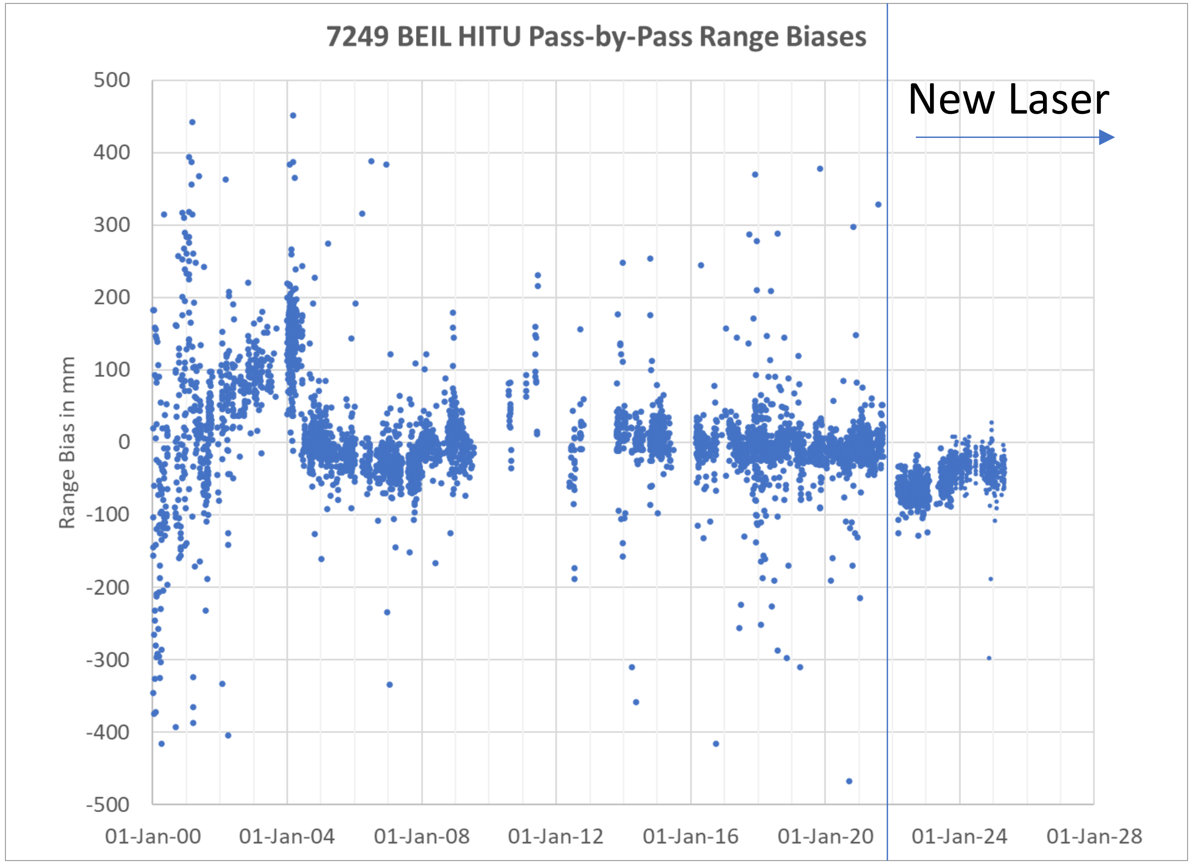
7249 BEIL LAGEOS and Calibrations Single Shot RMSs



- ❑ A new 1 kHz laser and event timer were installed on 20-Dec-2021, initially stabilizing the single shot LAGEOS and calibration RMSs. The laser was upgraded to 2 kHz on 23-Sep-2024
- ❑ Since the 2 kHz upgrade, satellite RMSs are bimodal and calibration RMSs are instable

7249 BEIL HITU
LAGEOS/LARES-2 Range Biases

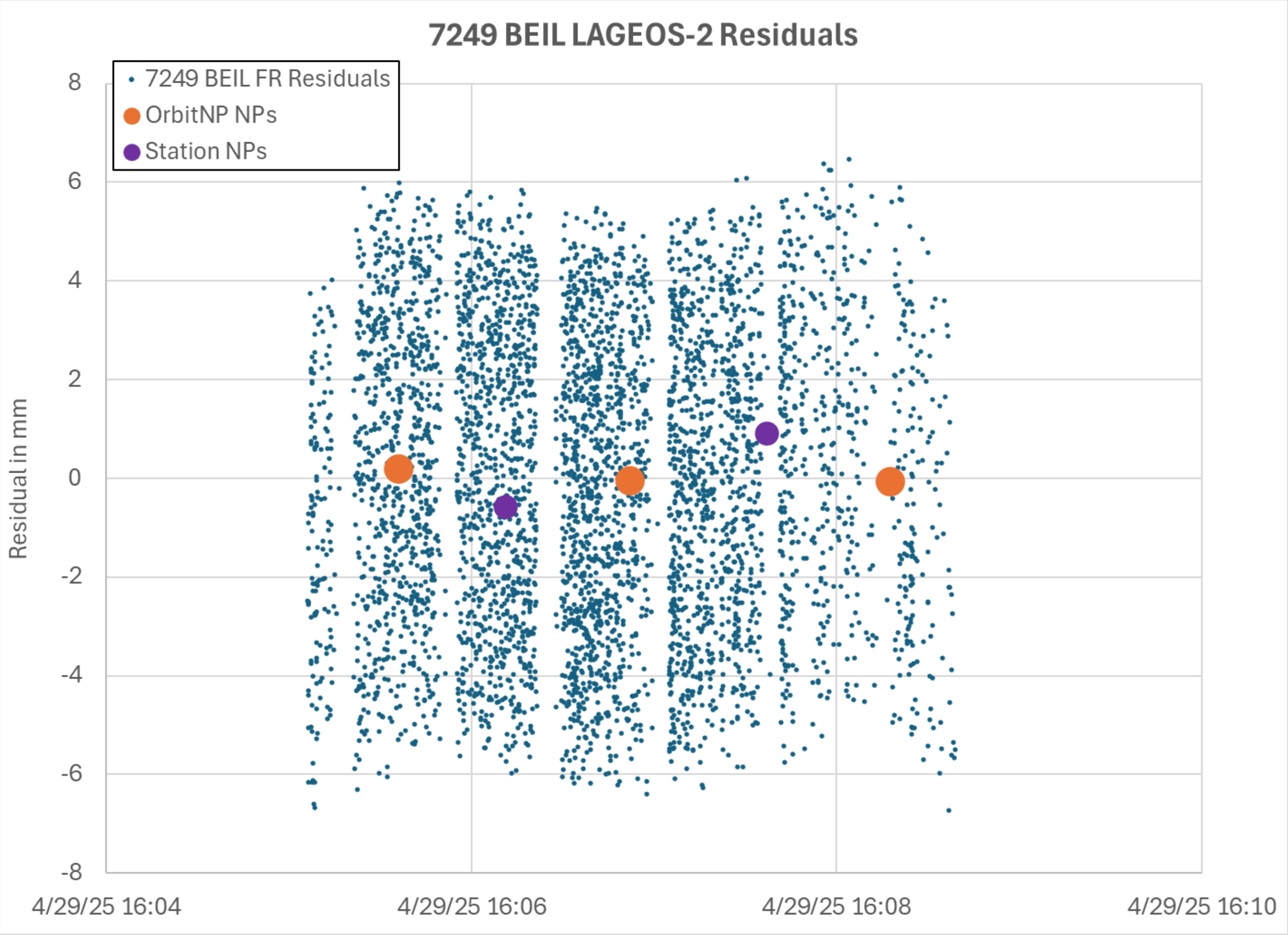




- There are less gross outliers since the new laser was installed in late 2021, but there was a definitive shift in the range bias

7249 BEIL LAGEOS NP Analysis

- ❑ NASA AutoQC has flagged a number of their CRDs (different satellites), that violate the Herstmonceux binning algorithm (i.e. NP bins are not formed based on bin intervals starting from 00:00 GMT). Bins appear to be formed based on the epoch of the first fullrate observation
- ❑ The 2 LAGEOS NPs on the right chart are from the same 2-minute Herstmonceux bin (bin 16:08:00 to 16:10:00)
- ❑ Binning changed in early November 2023



LAGEOS-1, LAGEOS-2 and LARES-2 Pass Statistics (24-Apr-2025 to 7-May-2025)

Station	Location	Average Pass Duration in minutes	Average NPs/Pass	Total Passes
8834	Wettzell	20.5	6.8	129
7090	Yarragadee	19.3	9.4	105
7827	Wettzell (SOSW)	23.9	6.0	85
7841	Potsdam	12.0	6.9	72
7825	Mt Stromlo	18.8	9.7	64
7840	Herstmonceux	29.7	12.2	54
7819	Kunming	2.9	3.2	51
7941	Matera	26.1	12.4	47
7839	Graz	19.4	5.5	34
7810	Zimmerwald	27.5	11.1	33
7845	Grasse	22.6	11.5	32
7237	Changchun	9.7	4.8	27
1884	Riga	15.5	8.1	26
7105	Greenbelt	18.7	9.3	24
7249	Beijing	3.5	3.3	20
7824	San Fernando	20.0	10.5	18
7817	Yebes	15.1	7.9	15
1824	Golosiiv	16.2	6.0	14
7701	Izana	10.7	5.9	14
7821	Shanghai	18.5	8.9	13
7119	Haleakala	27.1	12.8	12
7811	Borowiec	20.5	11.6	11
7306	Wuhan	6.7	4.9	10

- **ILRS network statistics of stations getting >=10 LAGEOS class passes in a two-week period. Stations highlighted in green averaged 4 or more LAGEOS class per week**
- **Four of the Chinese systems (Kunming, Changchun, Beijing and Wuhan) do not appear to follow LAGEOS interleaving/sampling guidance**

7249 BEIL Peak minus Mean Computations

```
NEW LASER (<3 mm RMS) LAGEOS-1 Apr 14, 2025
                EPOCH              ToF             bin    obs  RMS   skew  Kurtos   P-M   RR
11 59533.433226111898 0.053976090868 Std1 2 120.0   485 17.7  0.088 -1.165  32.0  0.2 0   1.3
11 59662.929726213653 0.051852203475 Std1 2 120.0  1086 17.9 -0.051 -1.170  32.8  0.5 0   4.0
11 59773.993726116554 0.050130580330 Std1 2 120.0  1004 18.3  0.033 -1.222  32.0  0.4 0   3.8
11 59888.183726116222 0.048474407648 Std1 2 120.0   433 18.0  0.168 -1.115  32.8  0.2 0   1.6
11 59962.790226116776 0.047463403832 Std1 2 120.0    30 13.3  0.399 -0.748  26.2  0.0 0   0.2

NEW LASER (14 mm RMS) LAGEOS-1 Apr 27, 2025
11 72242.955257112873 0.050753858689 Std1 2 120.0 40279 91.7  0.097 -0.767 196.3 16.7 0 119.7
11 72351.857257112759 0.049552062176 Std1 2 120.0 42648 91.7  0.099 -0.768 196.5 17.8 0 132.9
11 72450.140656214135 0.048613196158 Std1 2 120.0 16566 95.1  0.069 -0.831 196.2  7.0 0  64.1
```

Bin Peak minus mean values are double the bin RMSs

Notice the number of bin observation and Return Rates (RR) between the 3 and 14 mm CRDs

Summary

- Beijing does make a significant contribution in terms of data production, but could improve its spatial pass coverage of LAGEOS class satellites
- Initial data precision was stable after the installation of the new 1 kHz laser in early 2022, but there was a large change in its range bias. Despite the large change in range bias and its magnitude, it passed quarantine
- The data precision has degraded with the upgrade of the laser from 1 to 2 kHz in September 2024

Long Term Height Determination of Satellite Laser Ranging Stations

Peter Dunn and Van Husson

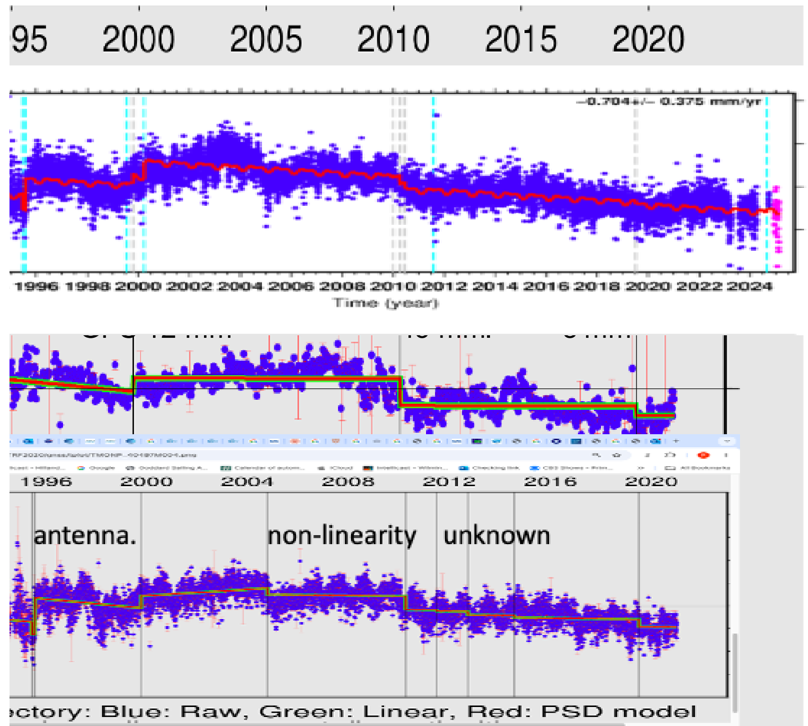
Peraton

Monument Peak shows annual and monthly height detail with SLR and GNSS heights on the same scale

NGL NGSS: no discontinuity:
shows downward displacement
In 2005

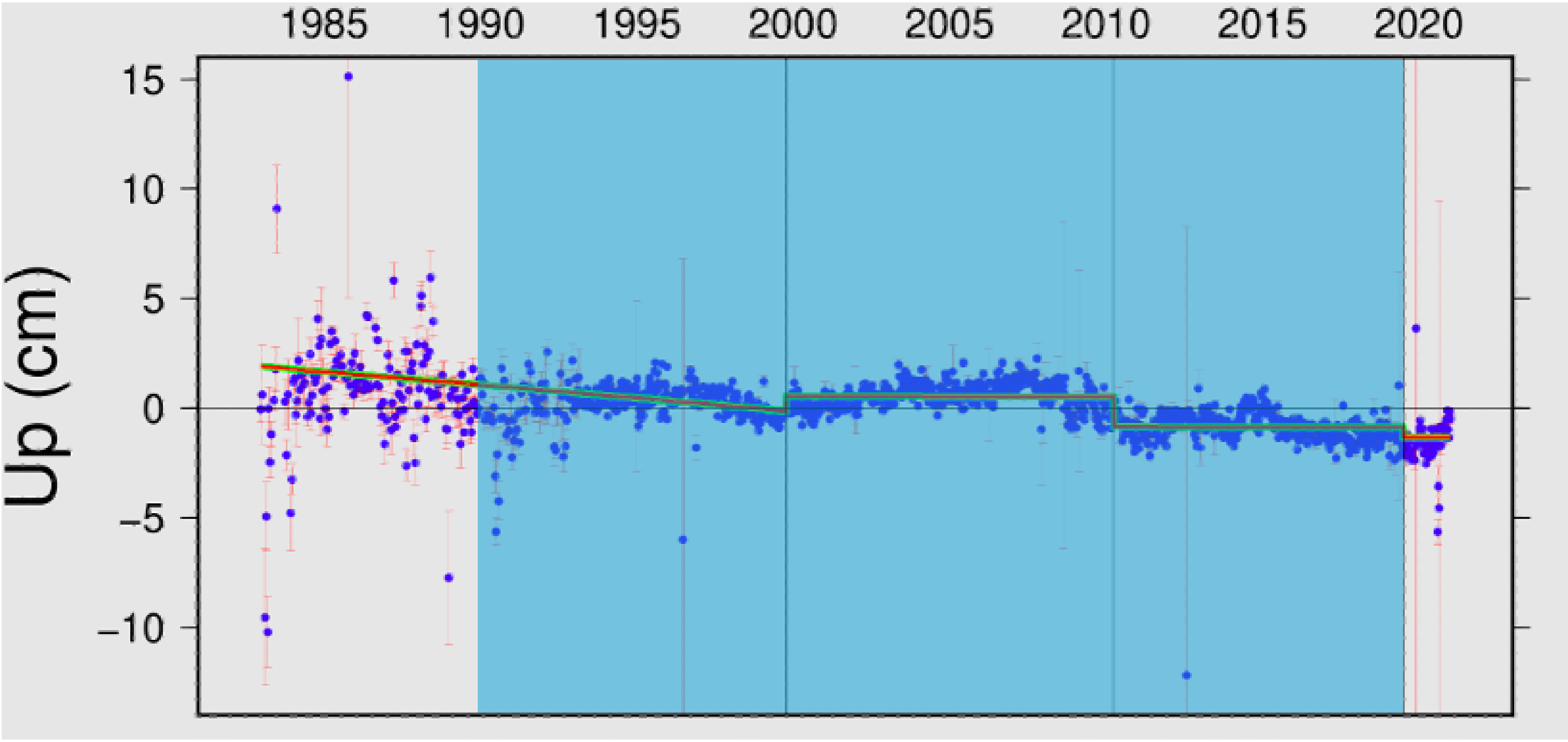
IGN SLR: no engineering
discontinuities:
shows clear non-linear motion
between 2000 and 2010

IGN NGSS: with discontinuity
for non-linearity
suggests engineering change
In 2005



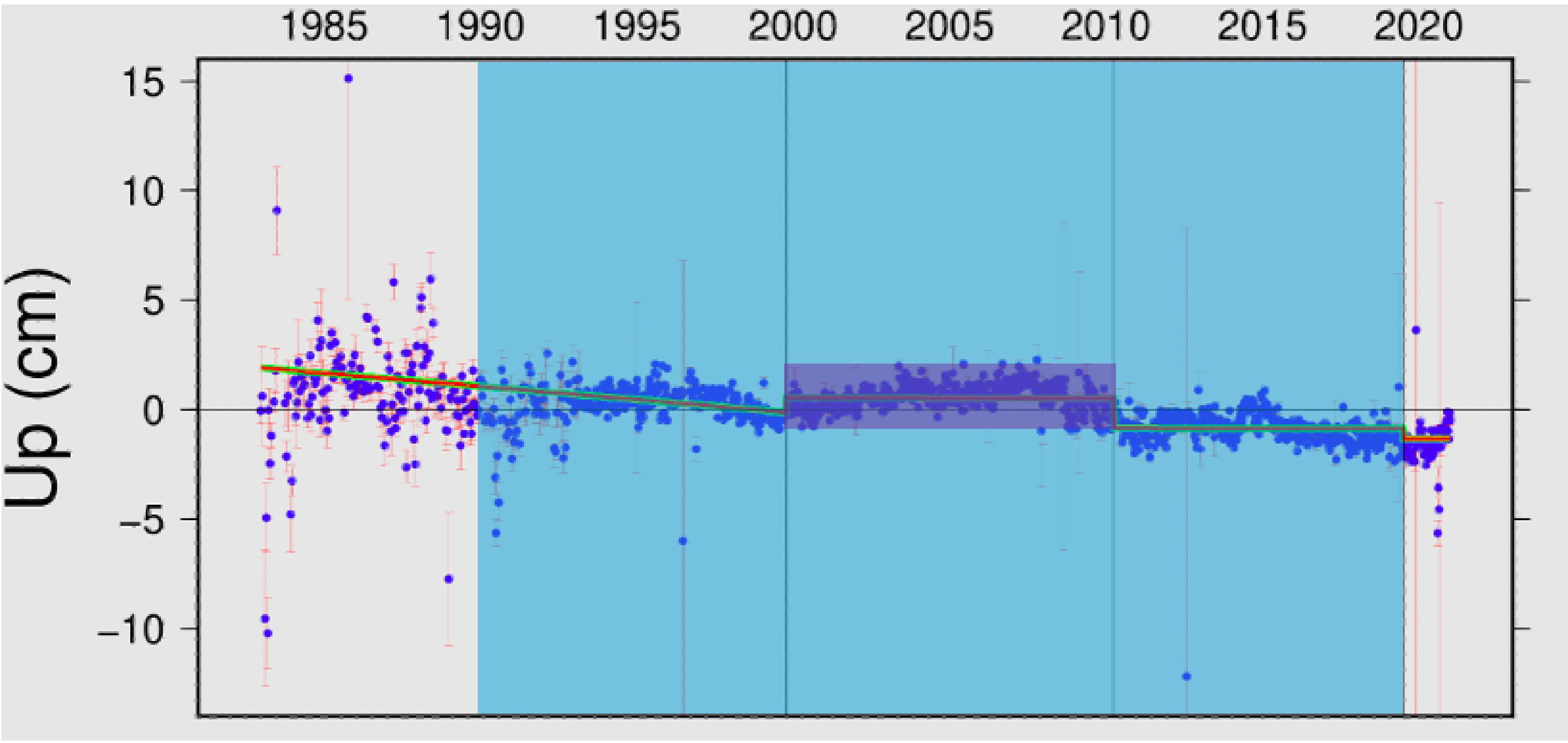
SLR and GNSS gives similar results at earthquake times
Discontinuities cloud the issue for GNSS

MONL in ITRF2020 shows clear inter-seismic trends



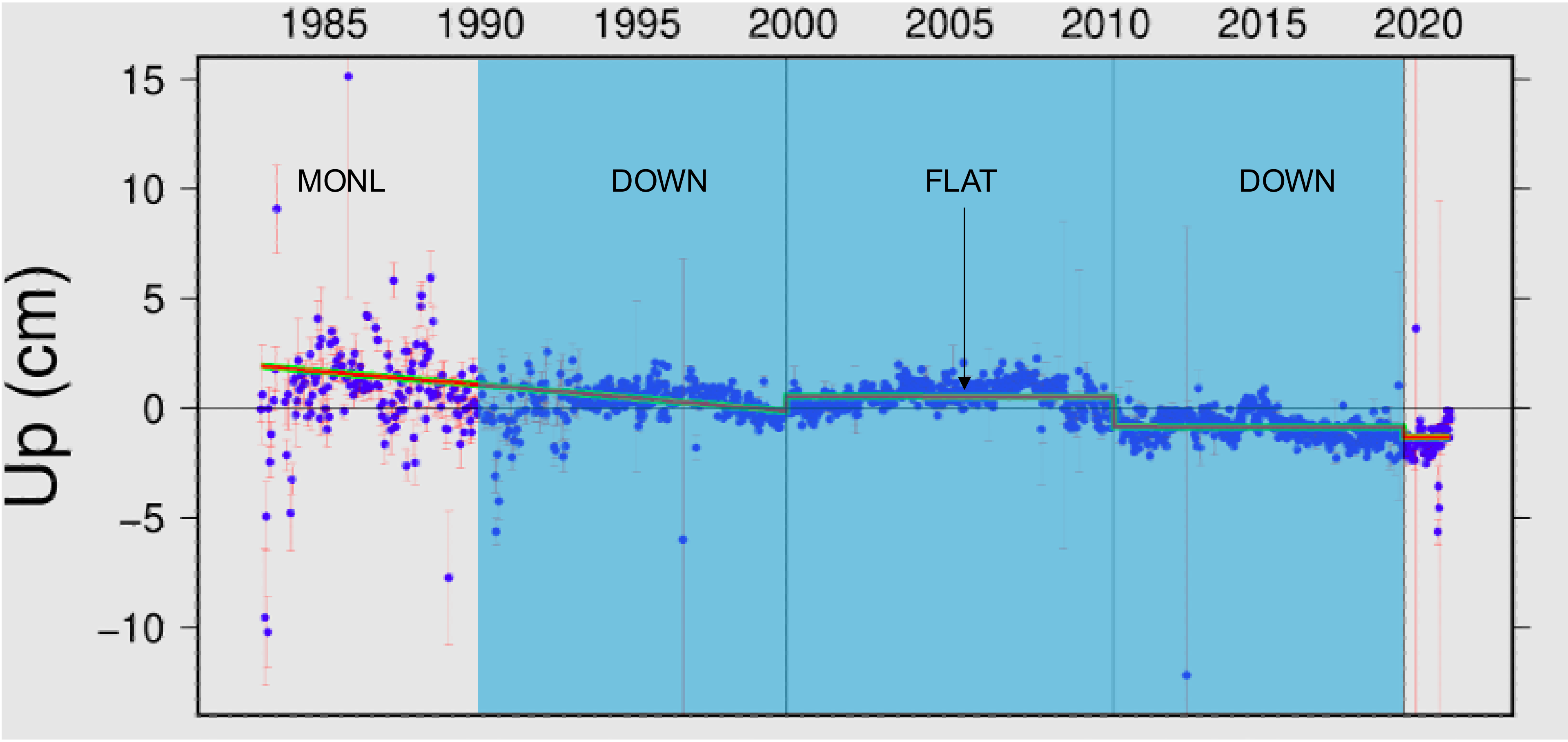
Consider three decades between 1990 and 2020

MONL in ITRF2020 shows inter-seismic deformation in more detail than the simple, linear GNSS model



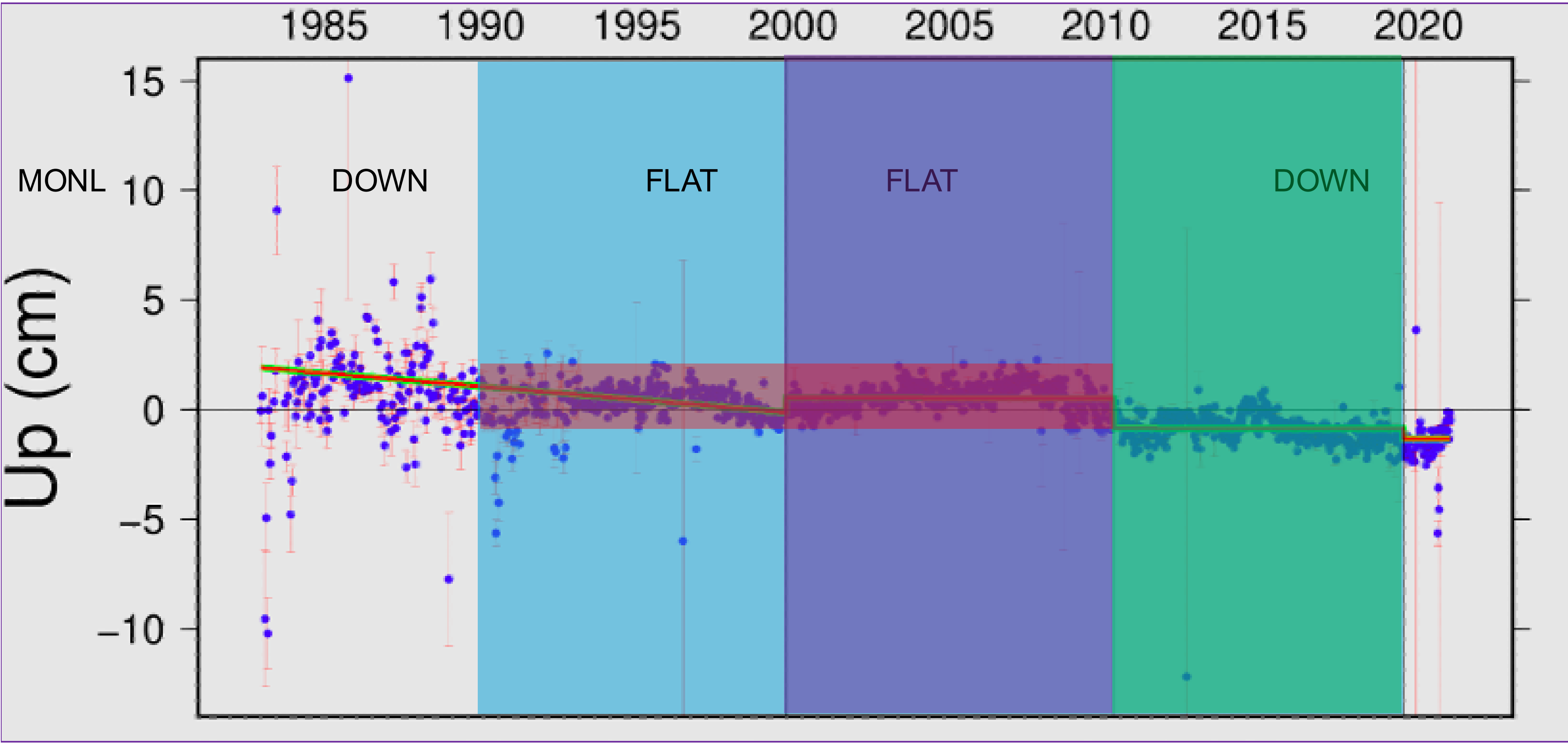
2000/2010: Uplift followed by subsidence before large M7.2 quake seen at SLR station but not GNSS

MONL in ITRF2020 shows long-term height rates (by decade)



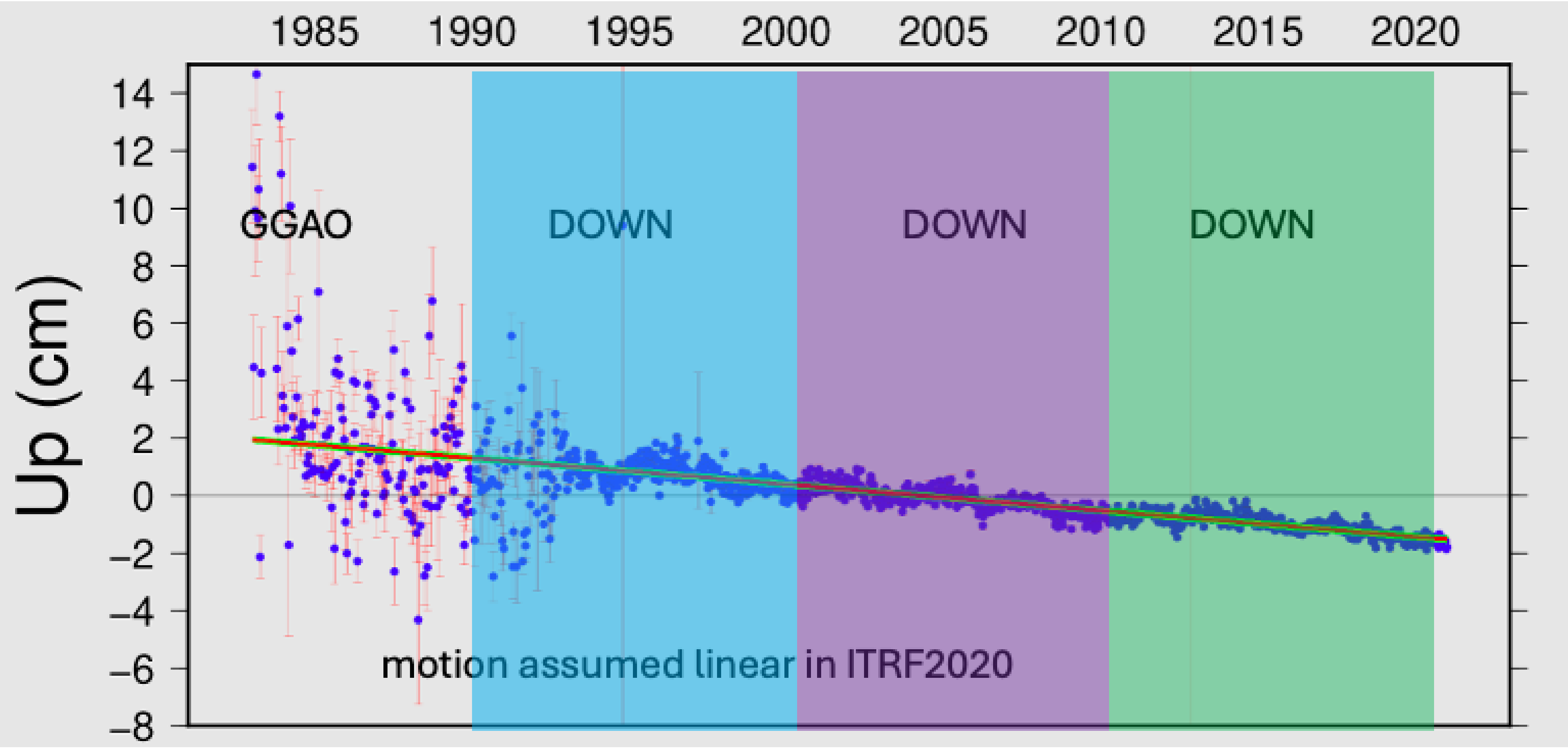
Linear assumptions between earthquake discontinuities but with different slopes in ITRF2020

MONL shows decade height rates which contradict ITRF2020



Decade by decade color scheme:
The downward linear trend in ITRF2020 was dictated by the early and late decades

GGAO in ITRF2020: decade height rates go downdowndown



GGAO shows consistent subsidence from PGR forebulge collapse

An alternative, simple, and more direct measure of long-term height deformation

The SGF Analysis (SATAN) provides a simple, rigorous measurement of long-term motion by separating RB from station position at the weekly arc level.

The systematic error mitigation technique (‘Assessment’, Appleby Rodriguez, Altamimi) has been adopted by the International Laser Ranging System’s Analysis Standing Committee to provide accuracy improvements to the stations of the SLR Network.

Station height time is computed in independent arcs of LAGEOS1 and LAGEOS2 data with simultaneously estimated range corrections; the resulting height time series is independent of any model assumptions.

It can be used to monitor height variations over decades and can establish a rigorous height rate estimate with a few years of ranges from a robust SLR station.

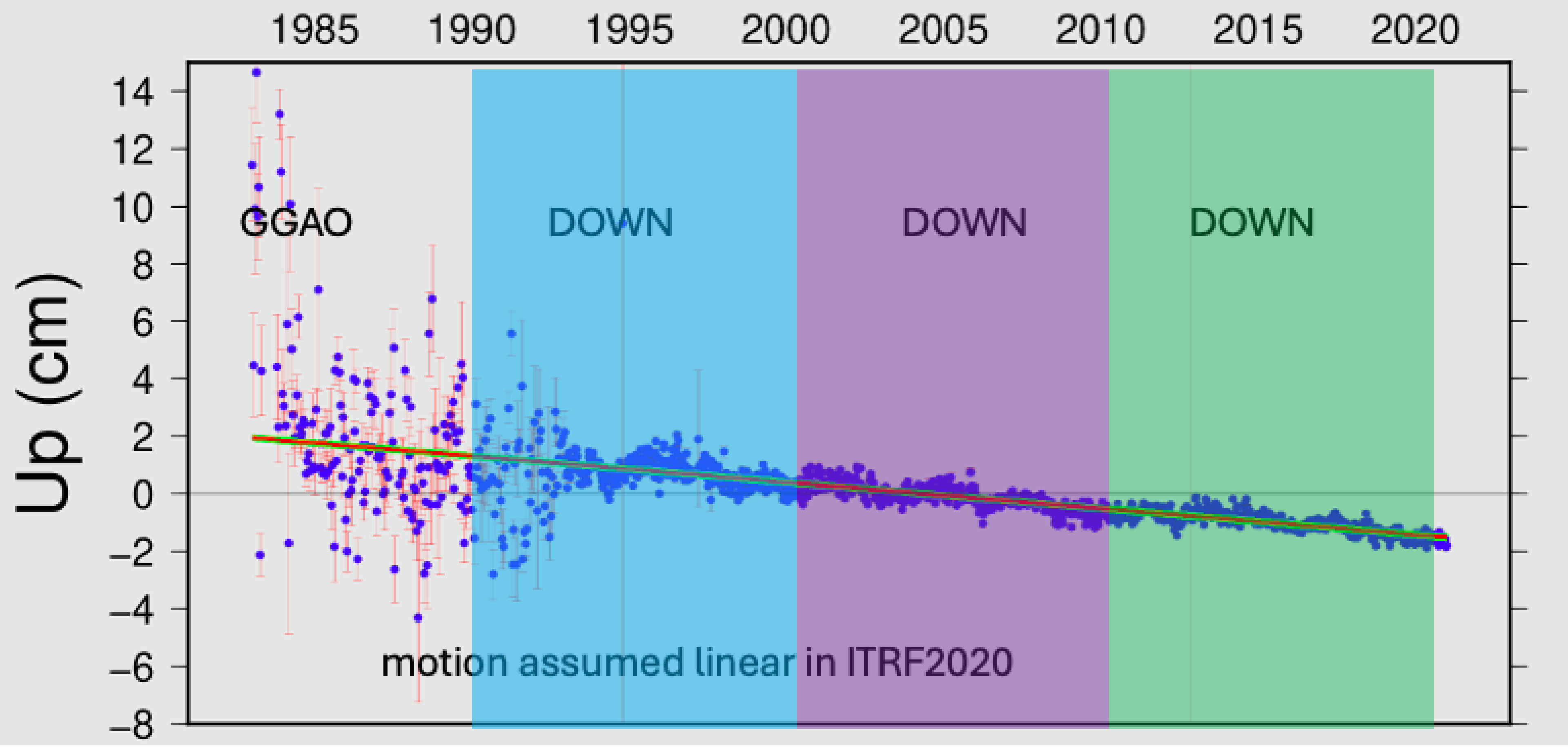
In 10 years a height rate accurate to < 1mm/year (1cm/decade) can be computed.

An alternative measure of long-term height deformation SATAN

SLRF2020/ITRF2020 includes Range Bias corrections assumed constant over time intervals of months and years.

SATAN separates RB from height week by week and gives noisier, more accurate heights.
SATAN's RBs are the source of the ITRF2020 corrections

GGAO according to SATAN



Height rates -0.8 +/- 0.5 -0.7 +/- 0.4 -.0.9 +/- 0.4 mm/year

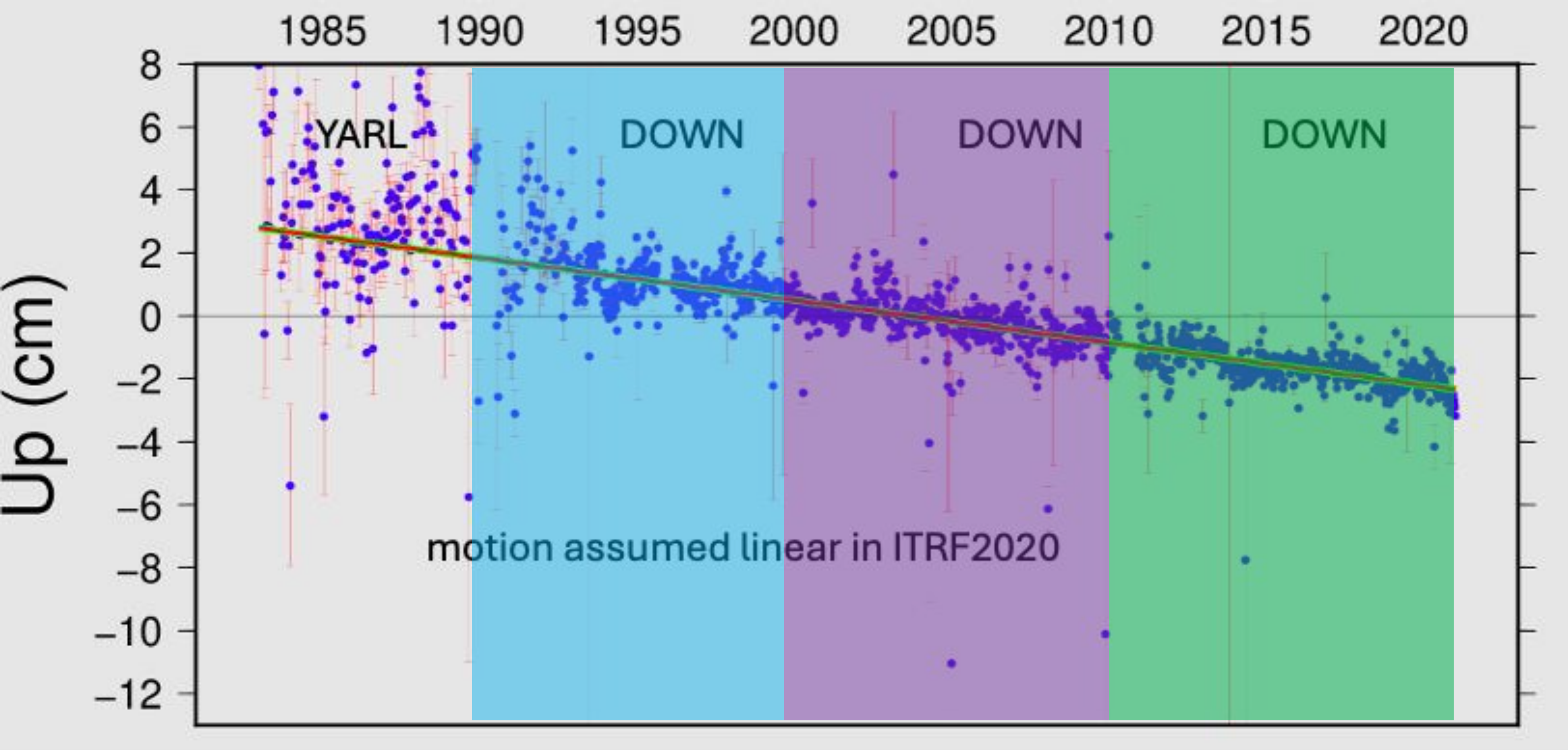
SATAN height rates over three decades

ITRF:	1994 to 2004	2004 to 2014	2014 to 2024	2004 to 2024	
7105	DOWN	DOWN	DOWN		consistent downward
7090					
SATAN:					
7105	-0.8 +/- .5	-0.7 +/- .4	-0.9 +/- .4	-0.94 +/- .19	consistent downward
7090	-1.05 +/- 0.18 DOWN	-0.9 +/-0.2 DOWN	-0.9 +/-0.2 DOWN	-0.79 +/- 0.10	

ITRF2020 and SATAN height rates match

All negative

SATAN shows continuous downward motion at Yarragadee

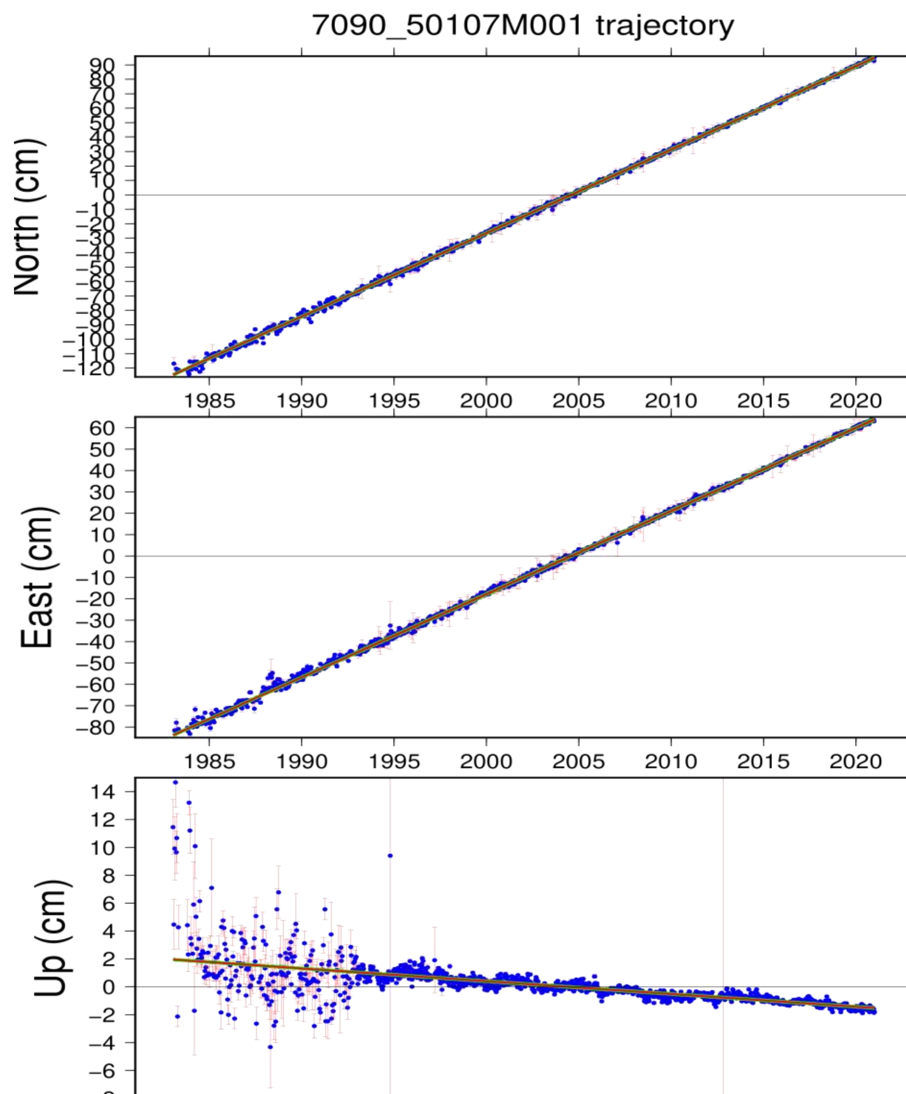


YARL also shows consistent subsidence over three decades

ITRF2020 Position Time Series: YARL

- Yarragadee shows subsidence of 4 cm over 40 years due to steady forebulge collapse

- YARL height rate is -0.8 mm/year: consistent with GNSS since 2000



Trajectory: Blue: Raw, Green: Linear, Red: PSD model
Vertical gray lines represent discontinuities

SATAN Decadal Height Rates at GGAO and Pacific SLR Stations

	1994/2004	2004/2014	2014/2024	2004/2024	
MONP 7110	0.	0	down		non-linear between earthquakes
GGAO 7105	-0.79 +/- 0.36	-0.7 +/-0.4	-0.9 +/-0.4	-0.94 +/- 0.19	consistent downward
YARL 7090	-1.05 +/- 0.18	-0.9 +/-0.2	-0.8 +/-0.2	-0.79 +/- 0.10	consistent down
TAHL 7124	+1.0 +/- 0.30	-0.6 +/-0.3	-0.5 +/-0.3	-0.36 +/- 0.17	rate change
HAWL 7210	+0.05 +/-0.31				
7119		-0.7 +/-0.2	-0.8 +/-0.2	-0.72 +/- 0.12	rate change

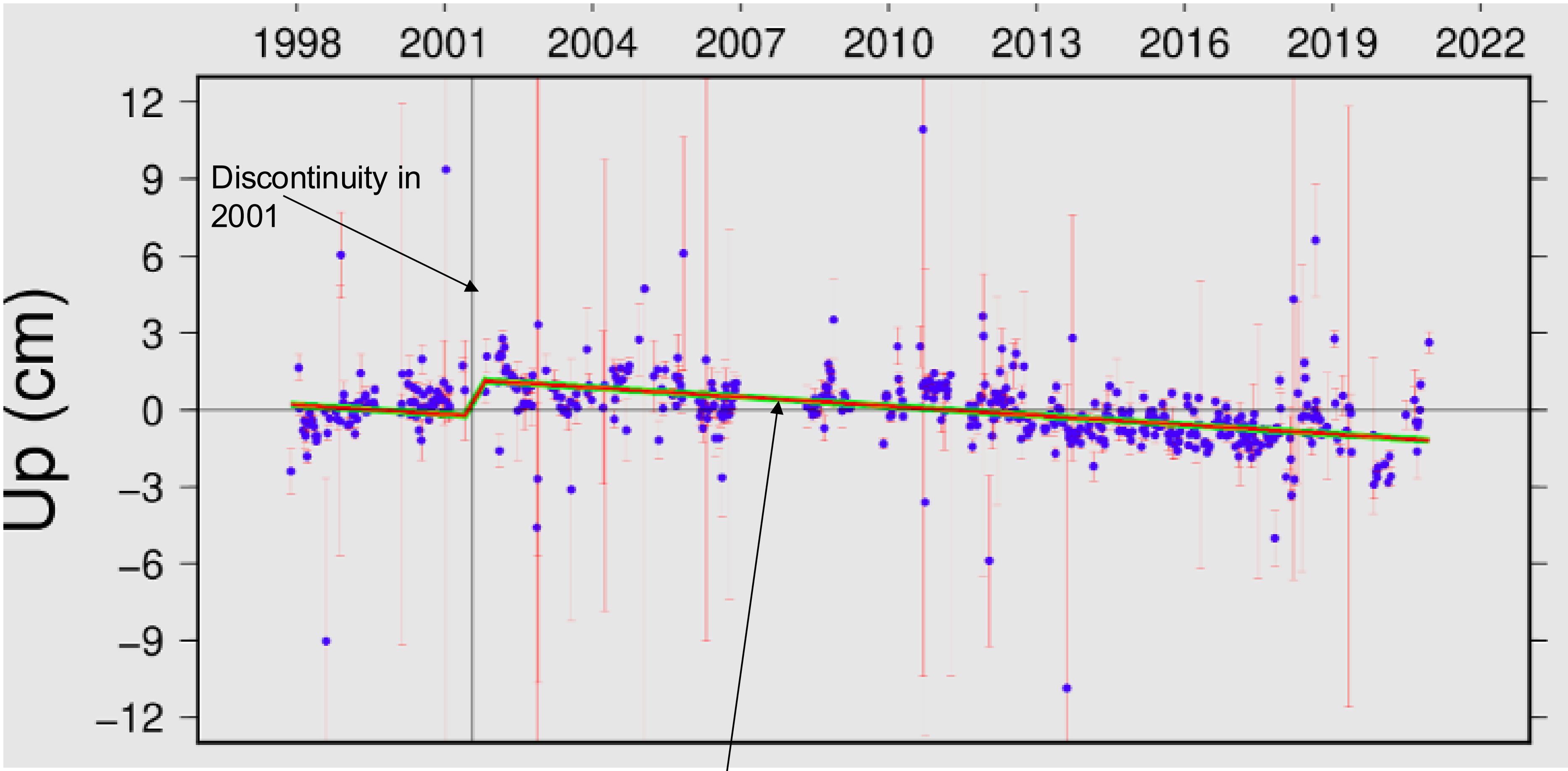
Most neg or flat after 2004
Pacific only + (before 2004)

SATAN Decadal Height Rates at GGAO and Pacific SLR Stations

	1994/2004	2004/2014	2014/2024	2004/2024	
MONP 7110	0.	0	down		non-linear between earthquakes
GGAO 7105	-0.74 +/- 0.36	-0.8 +/-0.4	-0.7 +/-0.4	-0.94 +/- 0.19	consistent downward
YARL 7090	-1.05 +/- 0.18	-0.9 +/-0.2	-0.8 +/-0.2	-0.79 +/- 0.10	consistent down
TAHL 7124	+1.0 +/- 0.30	-0.6 +/-0.3	-0.5 +/-0.3	-0.36 +/- 0.17	rate change
HAWL 7210	+0.05 +/-0.31				
7119		-0.7 +/-0.2	-0.8 +/-0.2	-0.72 +/- 0.12	rate change

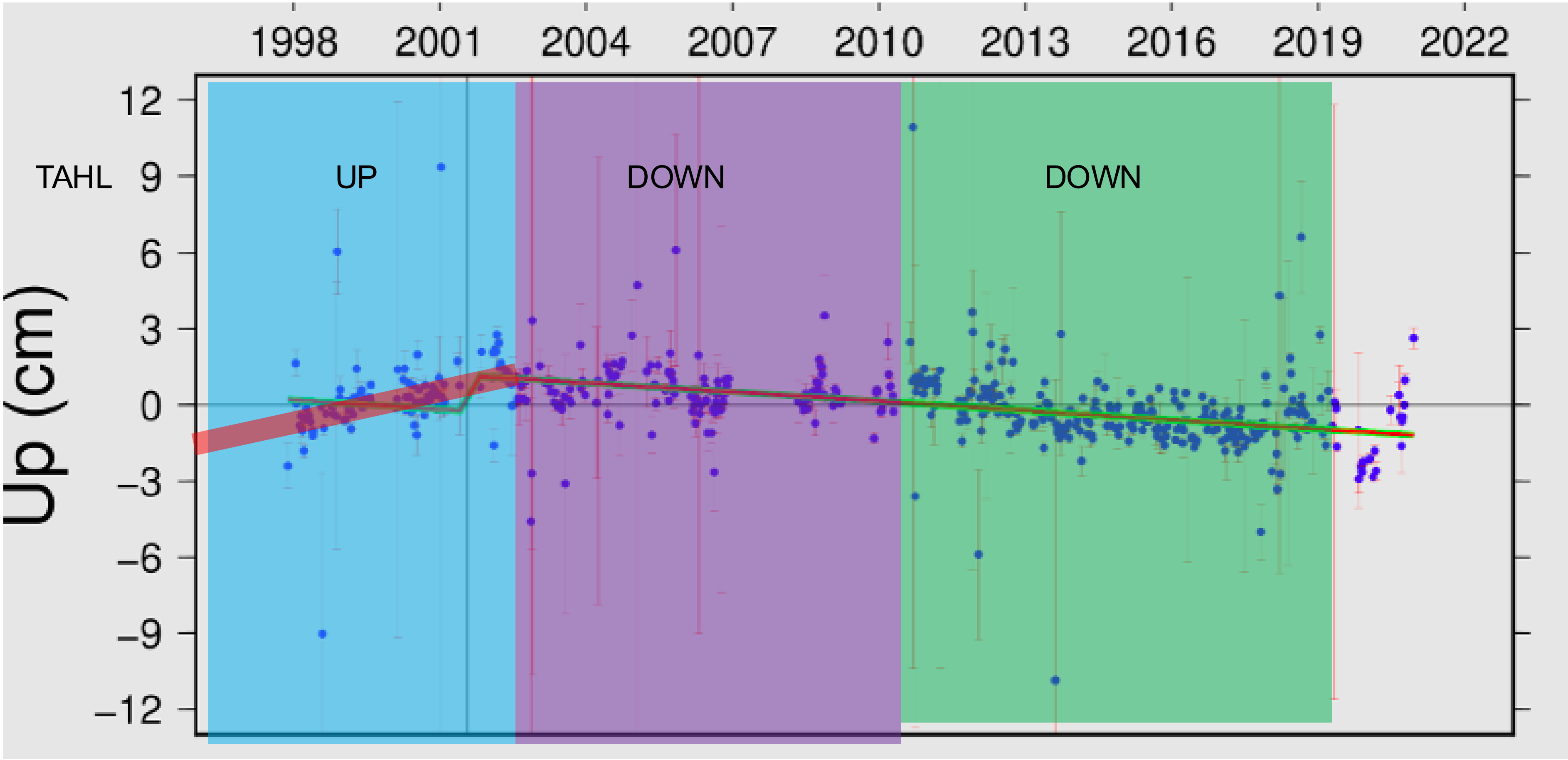
Most neg or flat after 2004
Pacific only + (before 2004)

TAHL shows consistent subsidence over three decades according to ITRF2020



Motion assumed linear in ITRF2020

SATAN sees a height rate change at TAHL



ITRF2020 linear assumption is questionable at this location
This change is also seen at HAWL (an earthquake station)

Conclusions

Subjective discontinuities in ITRF2020 distort height rate resolution

At earthquake stations when only natural discontinuities are applied inter-seismic deformation resolution is improved

At other stations, discontinuities should be applied sparingly*
if we are to accurately resolve continuous deformation trends

*never

Analysis of Data Center Holdings before 1996 including Four Different Sets of LAGEOS NPs

Van Husson

19-May-2025

Peraton

Differences in Data Center Holdings before 1996/Pre ILRS

- **History/Background:**
  - SLR Stations would transmit sampled fullrate data named “QuickLook (QL)” in the 60-byte format to the NASA Global Tracking Data System at the Goddard Space Flight Center
  - In the 1980’s, the prime data product was FullRate (FR) data in the MERIT II format. The NASA SLR Data Services Group (DSG) would merge and sort MERIT II monthly FR data from the global SLR network and provide these monthly datasets to the CDDIS on a 9-track magnetic tape
  - For a given month, there would be at least two FR data releases. The first FR data release for a month (i.e. the “A” release) would be 60 days after its end
    - There were no FR data processing standards
      - Epochs could be at the satellite or ground transmit time
      - Center of Mass (CoM) corrections were optional
      - Tropospheric corrections were optional
  - In the 1990’s, Normal Points (NPs) replaced FR as the primary SLR data product
    - NPs were to adhere to the Herstmonceux algorithm. Epochs were ground transmit time, no CoM and no tropospheric correction were to be applied

CDDIS and EDC SLR FullRate (FR) and Normal Point (NP) LAGEOS-1 Data Holdings

- **Both Data Centers have Monthly LAGEOS-1 FR data holdings since 1976. EDC also created daily LAGEOS-1 FR MERIT II files going back to 1976**
- **Since NP became the prime SLR data product, three different groups (DGFI, Delft Technical University [DUT], NASA/GSFC) went back in time and generated MERIT II NP based on the MERIT II fullrate data. Currently the EDC has no MERIT II NPs, only FR.**
- **CSTG NPs were station generated, not by an analysis center**
- **Starting with ITRF2008, there are no SLR station residuals prior to 1-Jan-1983**
- **Are there differences in the DGFI, DUT and NASA/GSFC generated NPs?**
- **Do NPs generated from FR always agree with station generated NPs?**

	CDDIS NPs					EDC NPs	
	MERIT II			CSTG	CRD	CSTG	CRD
Year(s)	DGFI	DUT	NASA/GSFC				
1983	XX Sep - Dec	XX Sep - Dec					
1984	XX	XX					
1985	XX	XX					
1986	XX	XX					
1987	XX	XX					
1988		XX	XX				
1989		XX	XX				
1990		XX	XX				
1991		XX	XX				
1992		XX	XX	XX Sep - Dec		XX Sep - Dec	
1993			XX	XX		XX	
1994			XX	XX		XX	
1995				XX		XX	
1996-2012				XX		XX	
2012 to ...					May 2012 XX		May 2012 XX

NASA/GSFC versus DUT LAGEOS-1 NP Comparison Example (7907 Arequipa (SAO) on 2-Jan-1988)

```
         1         2         3         4         5         6         7         8         9         0         1         2         3
1234567890123456789012345678901234567890123456789012345678901234567890123456789012345678901234567890123456789012345678901234567890
         DAY      FRAC                                       BINWAVE     TEMP   TROPO        REC        CAL SH CALI    PROC FL  F
COSPAR YY   SECS        SOD      AZ    EL        RANGE       RMS    PRESS    HUM        CoM      SYS DEL       RMS  OBS        C R
Actual FR Data
760390188  2110011386169790740011767838228995 55673881134    8786943 76202846 5630703  1601    0   64854       4600    1310010011A
760390188  2111113277725790740011797908261648 53985113498    8786943 76202846 5627139  1601    0   64854       4600    1310010011A
760390188  2112375268770790740011837627298747 52194124081    8786943 76202846 5624056  1601    0   64854       4600    1310010011A

NASA/GSFC NPs
760390188  2110011386169790740011767838228995 55673881134    9696943 76202846 5630703  1601    0   64854       4607   11310010011A
760390188  2111113277725790740011797908261648 53985113296    4356943 76202846 5627139  1601    0   64854       4607   61310010011A
760390188  2112375268770790740011837627298747 52194124081    9696943 76202846 5624056  1601    0   64854       4607   31310010011A
DUT NPs
760390188  211001138616879070000      0     0 55673866091    969   0 76202850 56    0 16744    0       0     0   07   117001000130
760390188  211111327772479070000      0     0 53985098206    446   0 76202850 56    0 16744    0       0     0   07   117001000130
760390188  211237526876979070000      0     0 52194108936    969   0 76202850 56    0 16744    0       0     0   07   117001000130
```

	NPs - FR Epoch (seconds)	NPs - FR Range (ps)
NASA/GSFC NPs - FR	0.0000000	0
NASA/GSFC NPs - FR	0.0000000	-2
NASA/GSFC NPs - FR	0.0000000	0
DUT NPs - FR	-0.0000001	-15043
DUT NPs - FR	-0.0000001	-15090
DUT NPs - FR	-0.0000001	-15145

- **The epochs are at satellite transmit (byte 120 is set to '1'), the FR and NASA/GSFC NPs epochs agree, but the DUT epochs are off by 100 nanoseconds (ns)**
- **Bytes 123 and 124 are the Tropospheric and Center of Mass (CoM) correction flags (0-applied, 1-not applied); respectively. The FR and NASA/GSFC NPs have the tropospheric and CoM corrections applied, while DUT NPs have the tropospheric applied but not the CoM. However; the range differences (~15 ns/2.2 meters) between NASA/GSFC and DUT NPs have no plausible explanation. A CoM of 1601 and 16744 ps are 240 and 2509 mm; respectively**
- **The DUT NPs have several data integrity issues: Site Occupation Designator; no angles; no wavelength; met data is rounded; CoM too large by factor of 10; zero tropospheric correction; no system calibration information; number of obs used to create the NP are always '1'; and the epoch time scale flag (byte 121) was changed from the FR**

NASA/GSFC and DUT LAGEOS-1 MERIT II NPs versus CSTG NPs (7090 YARL on 6-Sep-1992)

```
         1         2         3         4         5         6         7         8         9         0         1         2         3
1234567890123456789012345678901234567890123456789012345678901234567890123456789012345678901234567890123456789012345678901234567890
           DAY      FRAC                                        BINWAVE    TEMP    TROPO         REC         CAL  SH  CALI     PROC  FL   F
COSPAR  YY   SECS         SOD      AZ       EL        RANGE       RMS    PRESS     HUM         CoM       SYS  DEL        RMS   OBS          C  R
Actual FR Data
760390192250662364085329709005131447442202107 57321717003     635320 98562824 9345718   1674   706   108347    -28   450      231111 0061B
760390192250662990085333709005131473103208372 56978507143     635320 98562824 9344426   1674   125   108347    -28   450      231111 0061B
760390192250664168085323709005131522797217801 56469018723     635320 98572824 9342626   1674   262   108347    -28   450      231111 0061B
NASA/GSFC NPs
760390192250662364085329709005131447442202107 57321716958     575320 98562824 9345718   1674   706   108347    -28   457    20231111 0061A
760390192250662990085333709005131473103208372 56978507093     675320 98562824 9344426   1674   125   108347    -28   457   212231111 0061A
760390192250664168085323709005131522797217801 56469018659     655320 98572824 9342626   1674   262   108347    -28   457   123231111 0061A
DUT NPs
76039019225066236408532870900000       0      0 57321703564     56    0 98602820 93      0 16744      0          0      0    07      11701100 0130
76039019225066299008533270900000       0      0 56978493689     66    0 98602820 93      0 16744      0          0      0    07      11701100 0130
76039019225066416808532170900000       0      0 56469005240     65    0 98602820 93      0 16744      0          0      0    07      11701100 0130
CSTG NPs
760390192250              70900513                                 5320                              00108346-00028 00457     3
             662364085326                    0573217169560000057     09856282 4093                                      0020
             662990085330                    0569785070900000067     09856282 4093                                      0212
             664168085320                    0564690186610000065     09857282 4093                                      0123
```

	Epoch Difference in Seconds	Range Difference in ps
NASA/GSFC NPs -FR	0.0000000	-45
NASA/GSFC NPs -FR	0.0000000	-50
NASA/GSFC NPs -FR	0.0000000	-64
DUT NPs -FR	-0.0000001	-13439
DUT NPs -FR	-0.0000001	-13454
DUT NPs -FR	-0.0000002	-13483
CSTG NPs-FR	-0.0000003	-47
CSTG NPs-FR	-0.0000003	-53
CSTG NPs-FR	-0.0000003	-62

- **The FR epoch flag is set to ground transmit; the tropospheric and CoM correction are set to NOT applied. The DUT epoch flag is set to satellite transmit**
- **The table shows the differences in the NPs minus the corresponding FR observation**
  - The NASA/GSFC NP epochs match the FR while the ToFs are in close agreement
  - The CSTG NP epochs differ by 300 ns while the ToFs are in close agreement with the FR and excellent agreement with the NASA/GSFC NPs
  - The DUT NP epochs differ by 100 ns while the ToFs differ by a significant amount (~13ns/2.0 meters)

DGFI versus DUT LAGEOS-1 NP Comparison Example (7939 GRZL on 1-Sep-1983)

```
         1         2         3         4         5         6         7         8         9         0         1         2         3
1234567890123456789012345678901234567890123456789012345678901234567890123456789012345678901234567890123456789012345678901234567890
         DAY      FRAC                                       BINWAVE     TEMP   TROPO        REC        CAL SH CALI    PROC FL  F
COSPAR YY   SECS        SOD      AZ    EL        RANGE       RMS    PRESS    HUM        CoM      SYS DEL       RMS  OBS        C R
Actual FR data
76039018324410470018612079394101 335630219983 55657177070            96402890 9840241  1601                       0    13000   000
76039018324410512018247079394101 343580233928 54925727201            96402890 9838000  1601                       0    13000   000
76039018324410648017098079394101 371480280414 52628077239            96402890 9832162  1601                       0    13000   000
76039018324410828015679079394101 415070344938 49789721428            96402890 9826738  1601                       0    13000   000
76039018324410852035501079394101 421620353785 49431587709            96402890 9826158  1601                       0    13000   000
DGFI NPs
76039018324410470018612079394101      0     0 55657178698    807   0 96402890 98    0  1601    0       0     0   07   113000000130
76039018324410512018247079394101      0     0 54925728808   1534   0 96402890 98    0  1601    0       0     0   07   113000000130
76039018324410648017098079394101      0     0 52628078778    647   0 96402890 98    0  1601    0       0     0   07   213000000130
76039018324410828015679079394101      0     0 49789723524    240   0 96402890 98    0  1601    0       0     0   07   513000000130
DUT NPs
76039018324410470018623879390000      0     0 55657203708    567   0 96402890 98    0 16744    0       0     0   07   117011000130
76039018324410648017108879390000      0     0 52628094235    567   0 96402890 98    0 16744    0       0     0   07   117011000130
76039018324410852035511879390000      0     0 49431599074    300   0 96402890 98    0 16744    0       0     0   07   117011000130
```

	Epoch Difference in Seconds	Range Difference in ps
DGFI NPs - FR	0.0000000	1628
DGFI NPs - FR	0.0000000	1607
DGFI NPs - FR	0.0000000	1539
DGFI NPs - FR	0.0000000	2096
DUT NPs - FR	0.0000118	26638
DUT NPs - FR	0.0000108	16996
DUT NPs - FR	0.0000108	11365

- **Both DGFI and DUT have some format and data integrity issues. DGFI first two NPs are from the same 2-minute bin. The DGFI epochs at satellite transmit agree with the FR data while the DUT differ by more than 10 µseconds. The DGFI ranges differ from the FR by the CoM correction; despite the CoM correction flags being the same. The DUT ranges have no tropospheric correction, but that doesn't explain the differences with the FR**

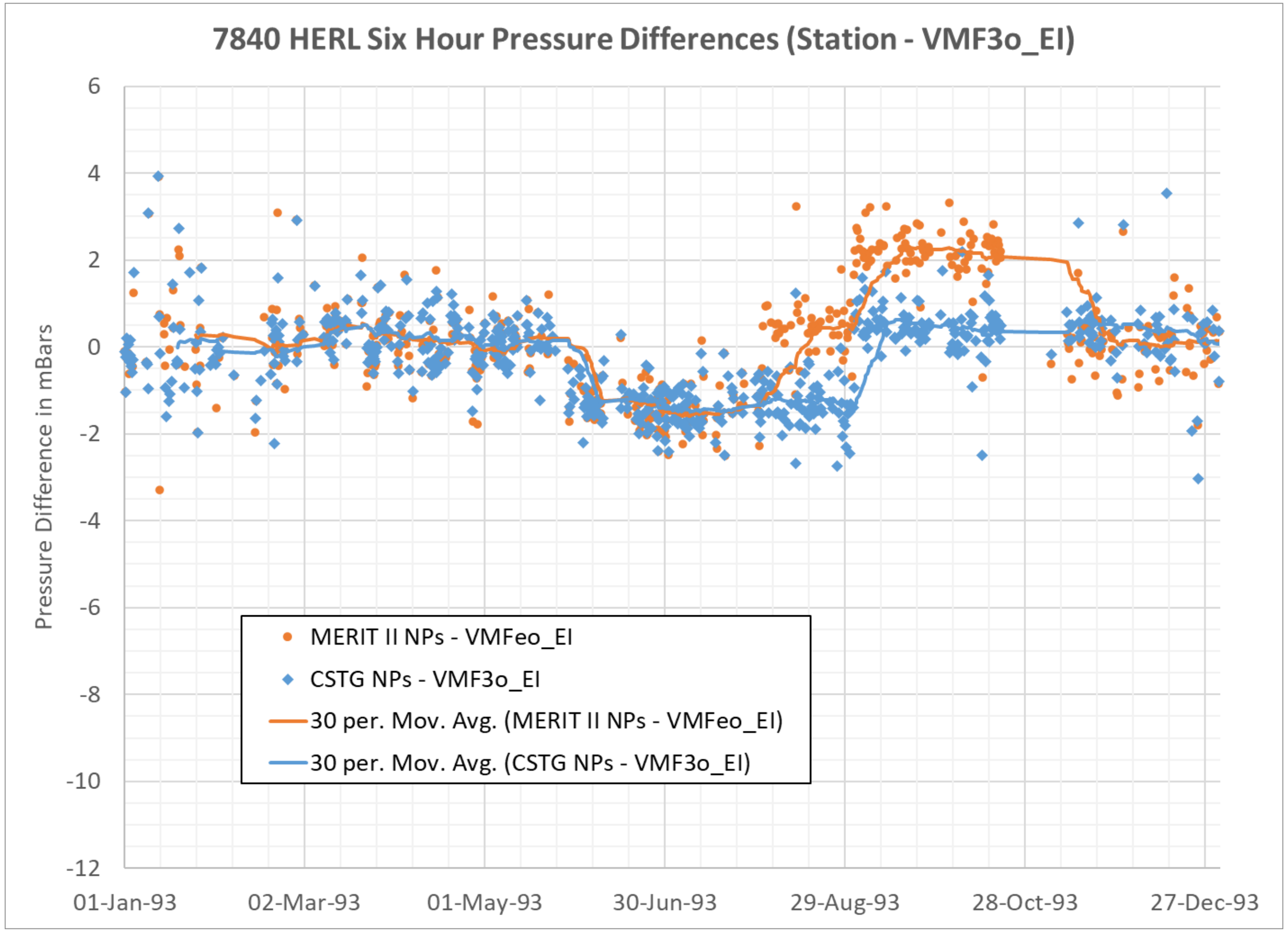
DGFI versus DUT LAGEOS-1 NP Comparison Example (7840 HERL on 1-Dec-1983)

```
         1         2         3         4         5         6         7         8         9         0         1         2         3
1234567890123456789012345678901234567890123456789012345678901234567890123456789012345678901234567890123456789012345678901234567890
         DAY      FRAC                                       BINWAVE     TEMP   TROPO        REC        CAL SH CALI    PROC FL  F
COSPAR YY   SECS        SOD      AZ    EL        RANGE       RMS    PRESS    HUM        CoM      SYS DEL       RMS  OBS        C R
Actual FR data
760390183335 8941760563078403501              40901705943           103202750 87    0  1601                            23011   000
760390183335 9024171352078403501              40350422746           103202750 87    0  1601                            23011   000
760390183335 9043345522078403501              40241307651           103202750 87    0  1601                            23011   000
760390183335 9055228998078403501              40177384176           103202750 87    0  1601                            23011   000
760390183335 9103766770078403501              39946063747           103202750 87    0  1601                            23011   000
760390183335 9106163082078403501              39935893916           103202750 87    0  1601                            23011   000
760390183335 9107760547078403501              39929179990           103202750 87    0  1601                            23011   000
760390183335 9124231027078403501              39863033115           103202750 87    0  1601                            23011   000
760390183335 9159390920078403501              39740709619           103202750 87    0  1601                            23011   000
760390183335 9179197488078403501              39683207735           103202750 87    0  1601                            23011   000
760390183335 9183699891078403501              39671289700           103202750 87    0  1601                            23011   000
DGFI NPs
760390183335 8941760563078403501      0     0 40901707139     40   0103202750 87    0  1601    0       0     0   07   1130110000130
760390183335 9043345522078403501      0     0 40241309139    260   0103202750 87    0  1601    0       0     0   07   3130110000130
760390183335 9124231027078403501      0     0 39863034089     66   0103202750 87    0  1601    0       0     0   07   7130110000130
DUT NPs
760390183335 8941780979578400000      0     0 40901692069    340   0103202750 87    0 16744    0       0     0   07   1170110000130
760390183335 9103786708578400000      0     0 39946050253    113   0103202750 87    0 16744    0       0     0   07   1170110000130
760390183335 9183719692578400000      0     0 39671275790    340   0103202750 87    0 16744    0       0     0   07   1170110000130
```

	Epoch Difference in Seconds	Range Difference in ps
DGFI NPs - FR	0.0000000	1196
DGFI NPs - FR	0.0000000	1488
DGFI NPs - FR	0.0000000	974
DUT NPs - FR	0.0204165	-13874
DUT NPs - FR	0.0199385	-13494
DUT NPs - FR	0.0198015	-13910

- **The FR data has no angles, no wavelength and no calibration information. The FR data processing flags indicate the epochs are ground transmit and the ranges are NOT corrected for the troposphere nor the CoM. The DGFI and DUT NP processing flags indicate the epochs are satellite transmit and the ranges are NOT corrected for the troposphere nor the CoM. The epoch differences (NPs – FR) indicate the DGFI and DUT epochs are ground and satellite transmit; respectively. The DGFI NPs do NOT adhere to the Herstmonceux algorithm. The DGFI range differences (NPs – FR) indicate DGFI applied a CoM correction. The DUT range differences (~-2.0 meter) are a mystery.**

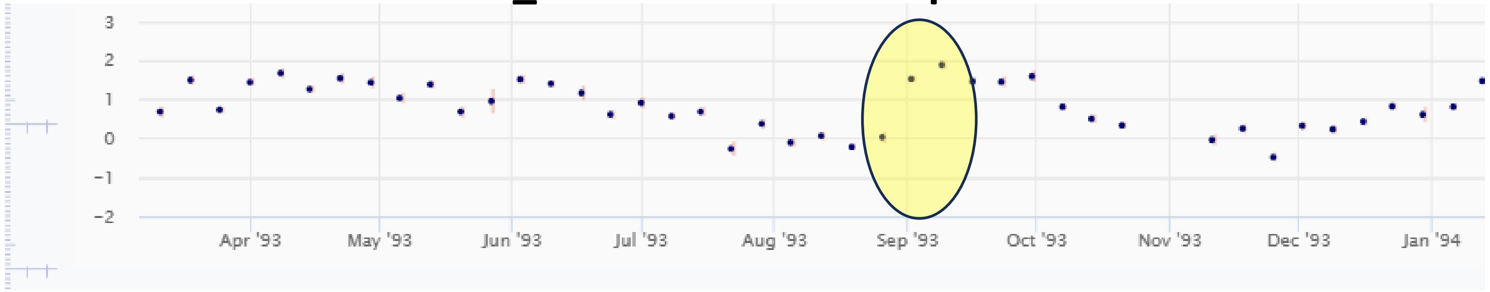
7840 HERL Pressure Differences (Station minus VMF) in 1993

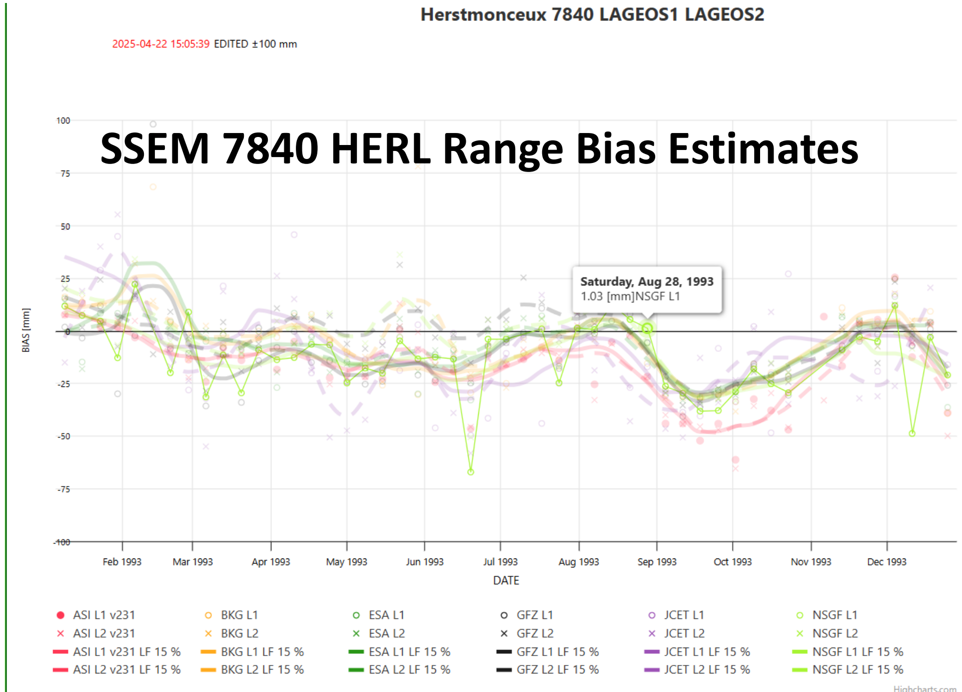


- **On the CDDIS, there are both MERIT II and CSTG NPs for 1993. On the EDC, there are only CSTG NPs, no MERIT II NPs**
- **For the months of August, September and October 1993, the 7840 MERIT II pressures were 1.8 mbars higher than their corresponding CSTG NPs. What dataset is being used by the different analysis centers? There is an obvious discontinuity in the barometric pressure on 1-Sep-1993**

7840 HERL ITRF2020 Update
2023 Up Residuals

ITRF2020_U2023 7840 HERL Up Residuals





- ❑ **Top chart, there is an ~15 mm discontinuity in the 7840 ITRF2020-U2023 station height between 26-Aug-1993 and 2-Sep-1993 that coincides with a discontinuity in barometric pressures**
- ❑ **Bottom Chart, Range Bias estimates from the Analysis CenterS, the range bias turned negative in September which coincides with the increase in barometric pressure**
- ❑ **Chain reaction: the +1.8 mbar jump in pressure, caused a drop in range bias, which caused a discontinuity in the station height**
- ❑ **We can correct this barometric error in the Data Handling File, but the correction is different depending upon which NPs are used**

Conclusions/Questions

- The NASA/GSFC NPs agree with the FR data
- The DGFI and DUT generated NPs have data integrity issues
- Do we know if any data analysts have been using the DGFI or DUT generated NPs
- Should the DGFI and DUT NPs be removed from the CDDIS?
- Station generated CSTG NPs can differ from the NPs generated from the FR data
- Which NPs (MERIT II or CSTG) are used by the different ILRS analyst centers?

Lessons Learned from a Single Ground Test

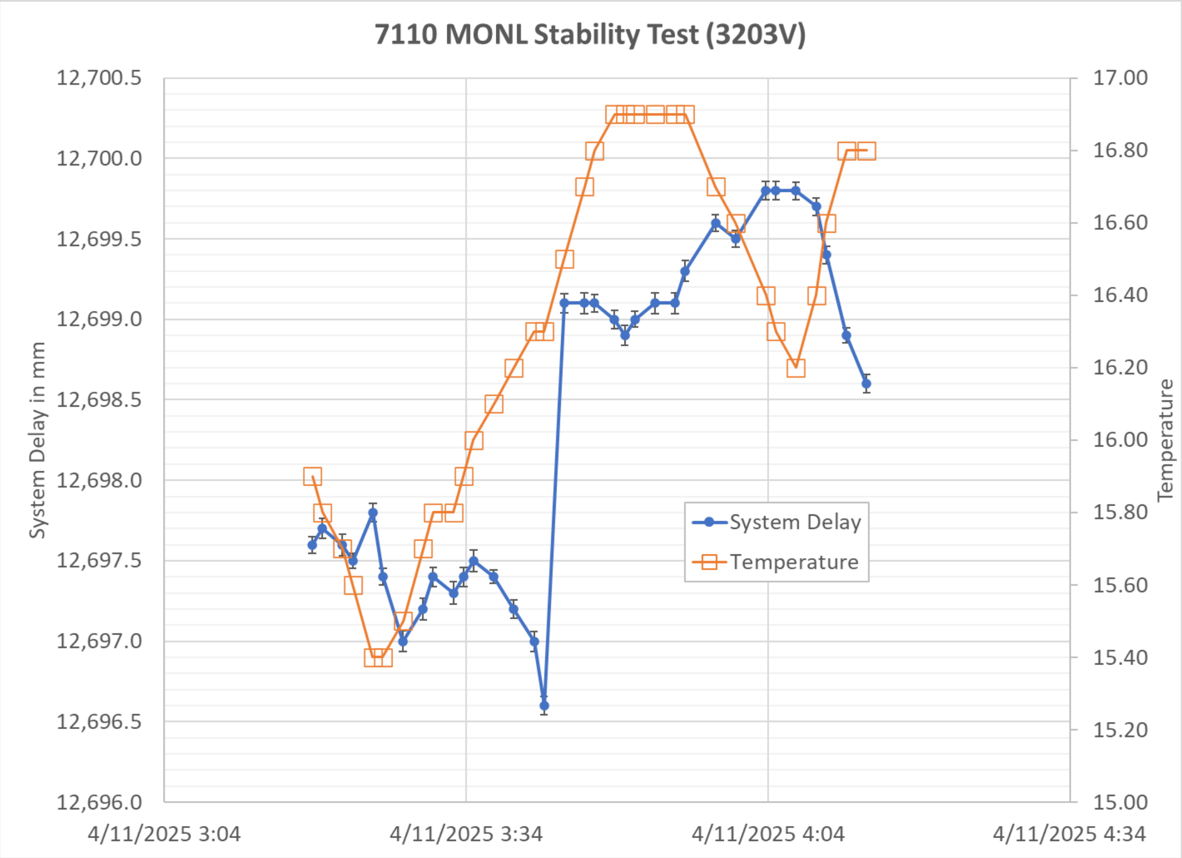
Van Husson

19-May-2025

Peraton

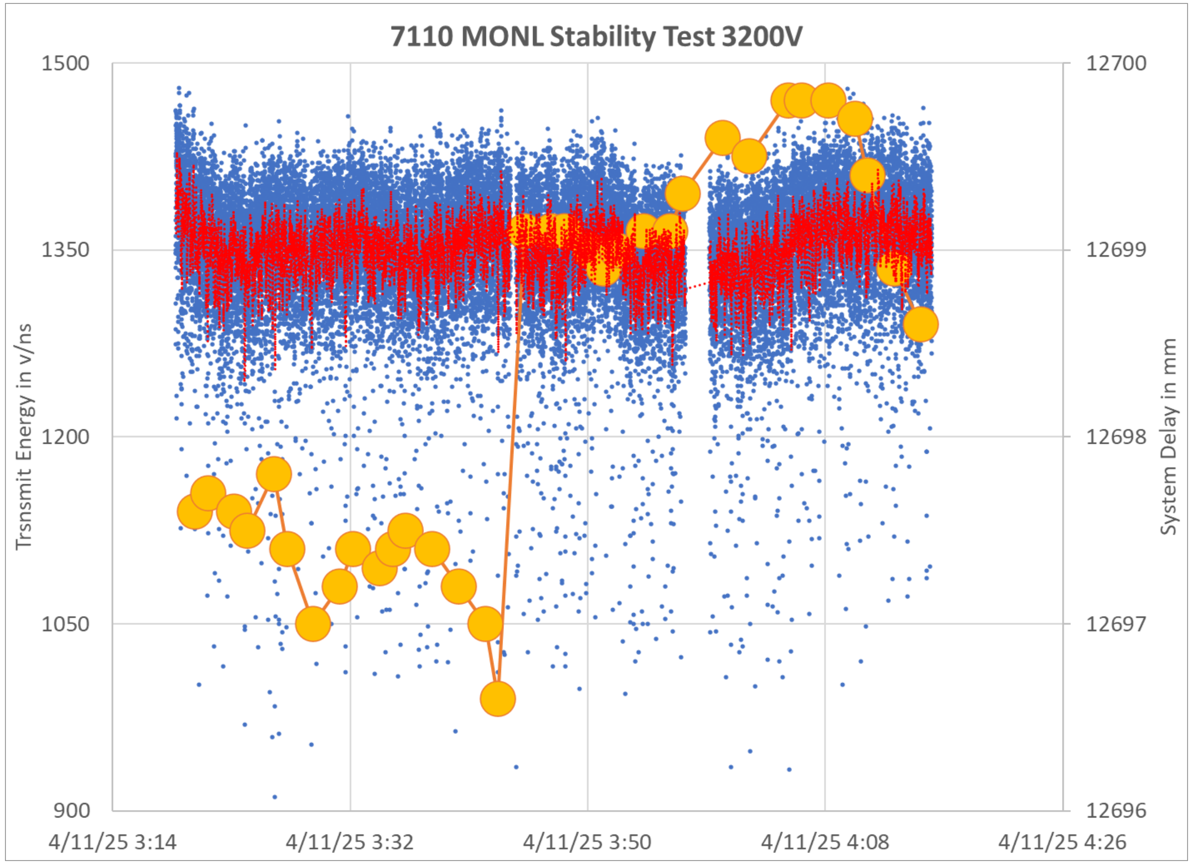
7110 MONL Monthly 1-Hour Stability Test

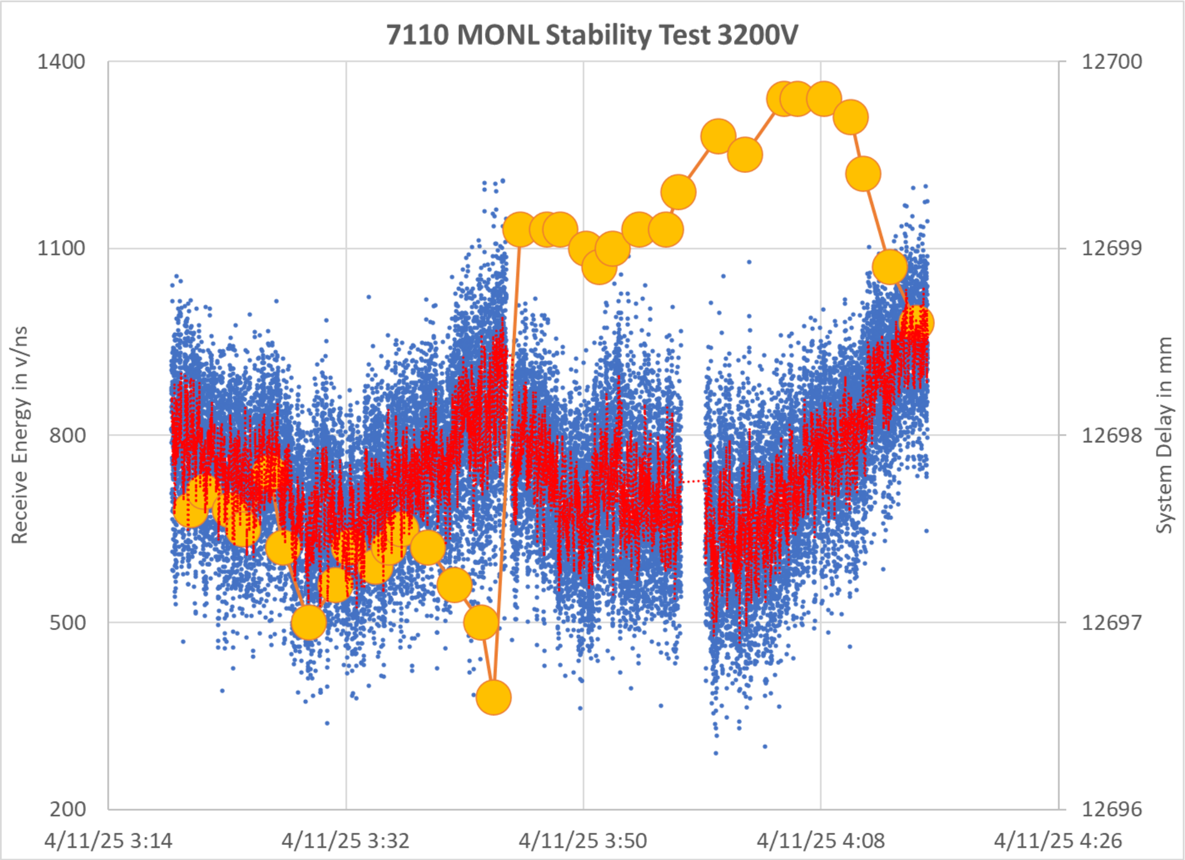
Statistic	System Delay in mm	System Delay in ns	Temperature in degrees C	RMS in mm
Average	12698.4	84.714	16.3	1.8
Peak-to-Peak	3.2	0.021	1.5	0.3



- **Each month, NASA SLR stations are to take a 1-hour stability test to determine how much the system delay could change while tracking a LAGEOS pass**
- **During a stability test, receive signal strength is to be maintained as best as possible to try and mitigate one systematic error source**
- **A change in outside temperature can cause changes in system delay because the PMT receive cable is exterior to the mount/telescope and thus is exposed to the outside environment**
  - Taking a pre and post calibration at least once every two hours mitigates the impact of temperature changes on the system delay
- **What caused the abrupt 2.5 mm change in system delay?**

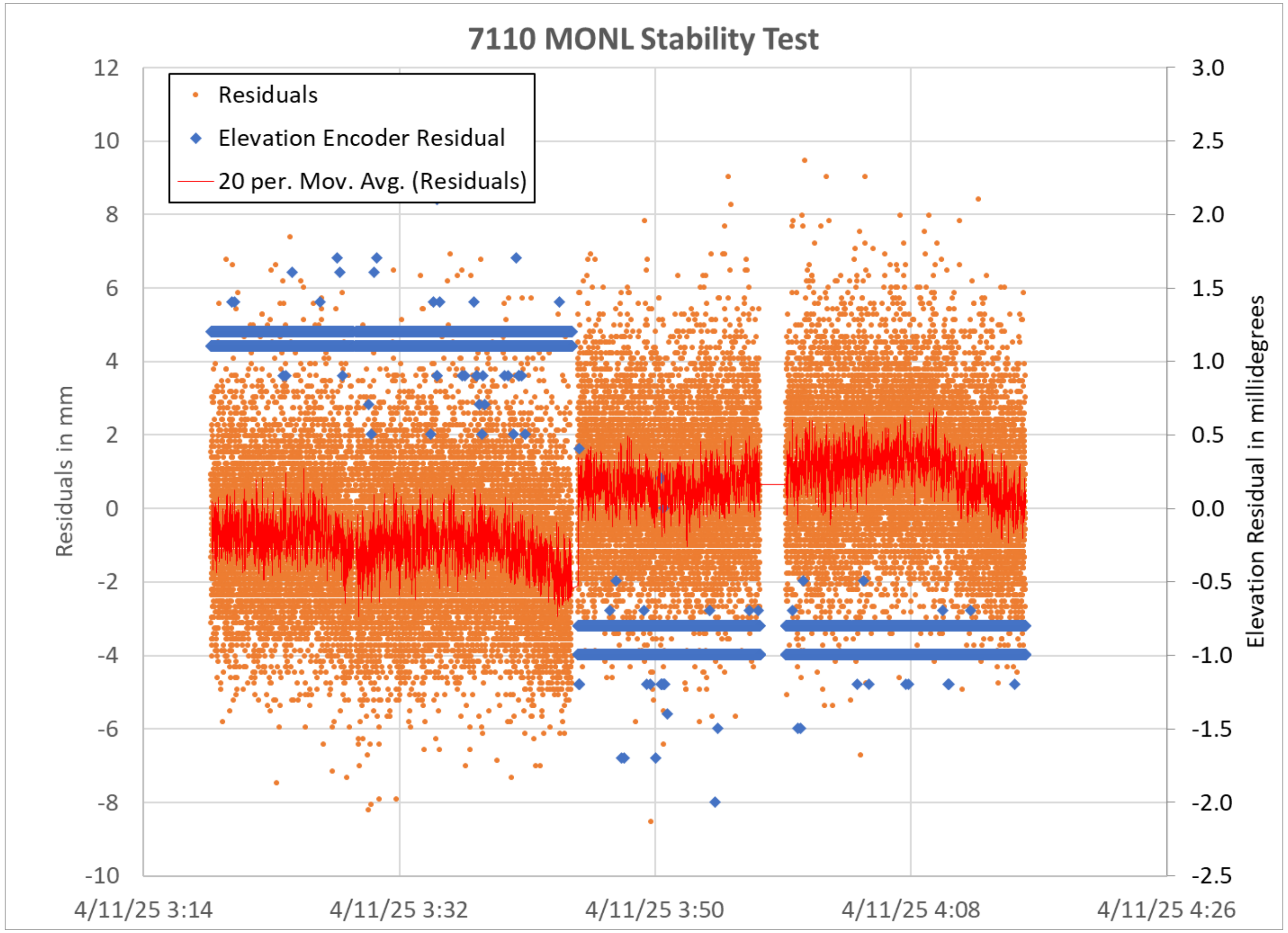
7110 MONL 1-Hour Stability Test





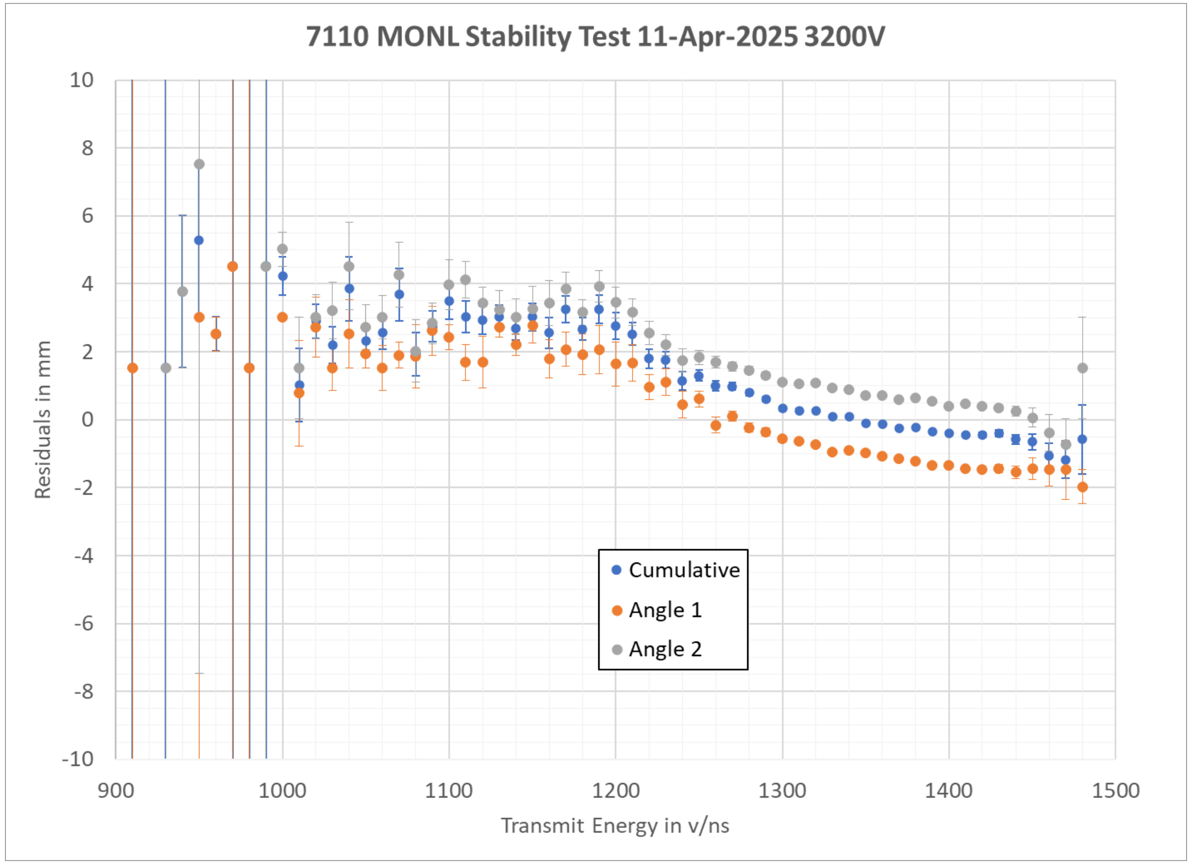
- ❑ **Left chart: time series of laser transmit energies & system delay; Right chart: time series of receive energies & system delay**
- ❑ **Transmit energies were stable, but receive energies were difficult to maintain because of issues with the optical attenuation mechanism. The sudden 2.5 mm system delay jump was not caused by changes in either transmit or receive energy**

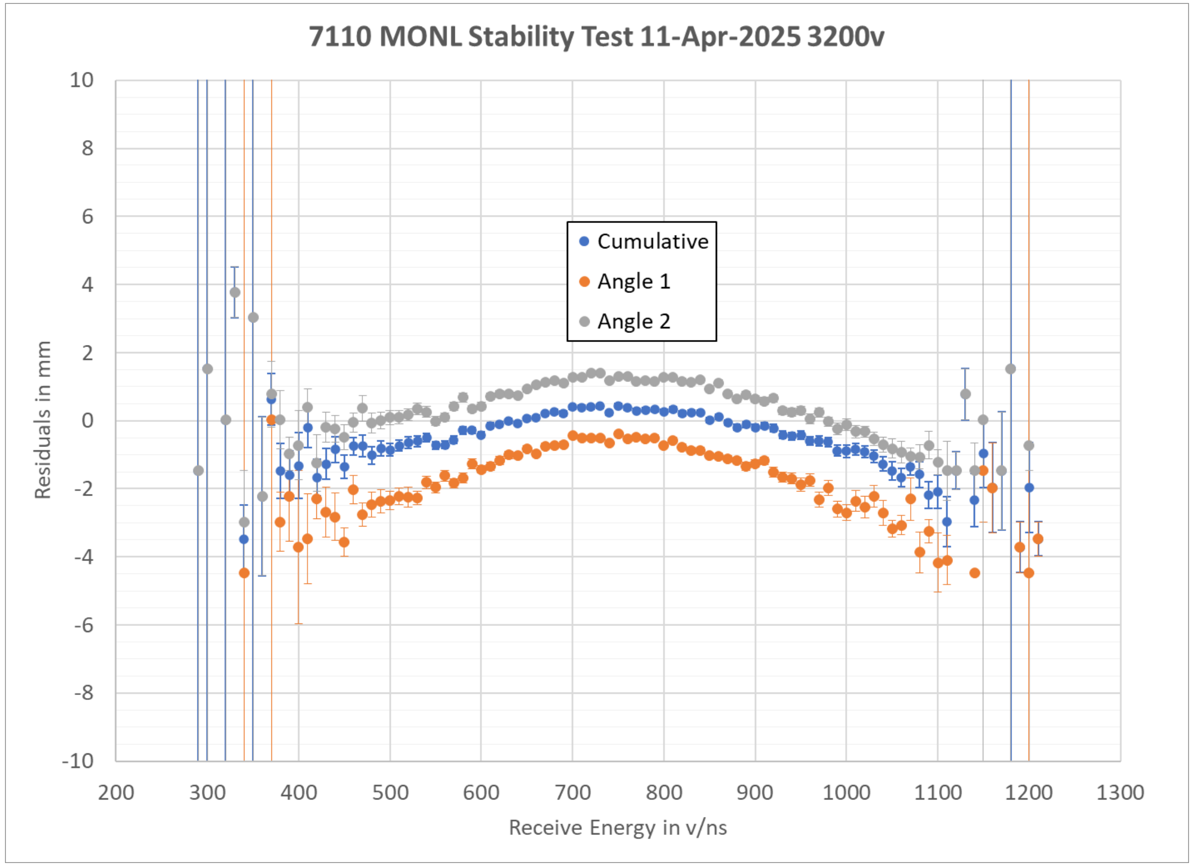
7110 MONL 1-Hour Stability Test



- Time series of system delay and elevation angle encoder residuals
- The abrupt 2.5 mm change in residuals was caused by a sudden 2 millidegree change in elevation pointing angle i.e. laser wavefront distortion

7110 MONL Transmit and Receive Discriminator Timewalk





- ❑ **There are 2 to 4 mm level systematics as a function of transmit and receive energy. The systematics were consistent based on the two different elevation pointing encoder readings**

Conclusions

- **This single stability test has characterized four potential systematic error sources**
  - Outside temperature changes
  - Laser wavefront distortion
  - Laser Transmit Discriminator Timewalk
  - Receive Discriminator Timewalk
- **Mitigation Strategies**
  - Find receive cables less susceptible to temperature changes and for each pass take a pre and post calibration to counter any temperature drifts
  - Before hitting data record during ground calibration, try and locate the center of the cube corner
  - Take calibration and satellite data at the same laser repetition rate and for each pass take a pre and post calibration to counter any drifts in laser power
  - Take calibration and satellite data at the same receive energy level

Further progress to improve the *accuracy* of satellite laser ranging data: impact on geodetic height time series of removal of range-dependent systematic errors.

Graham M Appleby[1], Andreja Susnik[2]

[1] Honorary Research Associate, SGF Herstmonceux [2]British Geological Survey, SGF Herstmonceux

Sharing is encouraged

British Geological Survey

Abstract

High precision satellite laser ranging observations to the geodetic spherical satellites are now available to the community for almost five decades, and their analyses are critical to the ongoing realisation of an accurate terrestrial reference frame.

The ground-station technologies have improved considerably over time:

- *systematic* range-measurement errors are now for the major stations at the few mm level.
- The need to improve further has prompted a review of the measurements made mostly by a number of European network stations in the early 2000s that used time-of-flight equipment known to have systematic, *range-dependent* errors of up to 10mm
- These timers (Stanford) were investigated at the UK Space Geodesy Facility, Herstmonceux in the early 2000s and the range dependencies measured against a highly accurate event timer:
- some of the implications of those results have not been utilised fully in data processing for ITRF realisations, including ITRF2020
- Here we review this work and report on our new **data analyses that include the range-dependent corrections**
- We show consequent improvements in the quality of the stations' height time series.
- We highlight our data files and simple code that can be used by analysts to implement the range- and station-dependent corrections.
- The stations characterised by our analyses are listed below, along with the dates of applicability of the range-dependent corrections

Station	Start date (MJD, civil)	End date (MJD, civil)
ZIML 7810	50449 1997 Jan 1	53769 2006 Feb 3
BORL 7811	52401 2002 May 7	62501 2029 Dec 31 (in use)
SFEL 7824	52131 2001 Aug 10	59821 2022 Aug 30
HERL 7840	49626 1994 Oct 1	52305 2002 Jan 31
POT3 7841	52110. 2001 Jul 20	55670 2011 Apr 19

Technique

The original timer characterisation work used a novel technique developed at SGF Herstmonceux (Gibbs, et al, 2006):

A highly-accurate event timer was used to define a linear timescale against which to measure departures from linearity of the Stanford counters;

The laser ranging system and its single-photon detector allowed these departures to be measured as a function of time of flight from zero to 150ms in steps of 2ms:

This timespan includes the time-distances of the geodetic satellites:

LAGEOS at about 50ms; Etalon and the GNSS satellites at about 140ms.

Those results have now been digitised to create station-specific data files for this current analysis.

Examples of the raw timer errors are shown in Figure 1 below for three stations. The timer errors (mm) are plotted against range in ms.

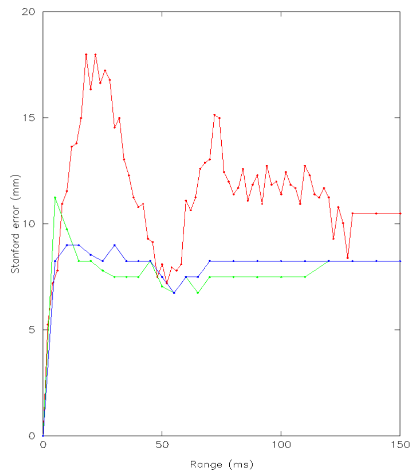


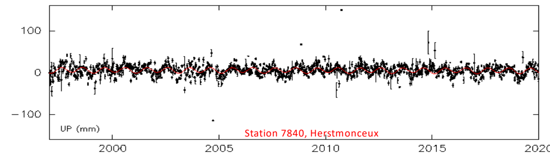
Fig 1. Stations: HERL 7840; ZIML 7810; SFEL 7824

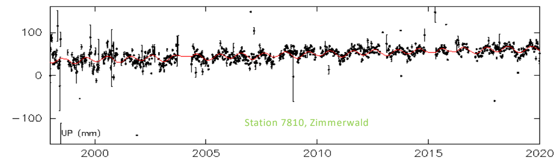
Comments.

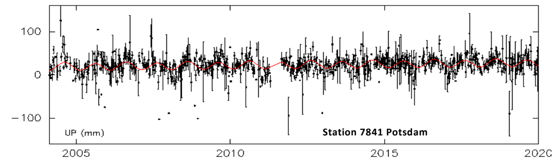
- The Stanford corrections remove only the **range-dependent** errors from tracking data; it is still necessary in most cases to solve for a fixed systematic range error as per standard ILRS practice.
- Software and data files to interpolate and smooth the error data shown in Fig 1, for all five stations reported here, **is available from the authors**.

Reference Frame Analyses

- The timer corrections for all five stations listed in the Table have been applied to the normal-point range measurements downloaded from the ILRS Data Centres at EDC and CDDIS.
- Loosely-constrained weekly reference frame solutions for the period 1997 – 2020 have been carried out using the SGF SatAn POD and analysis package;
- The resulting weekly time series of geocentric rectangular coordinates for the stations has been converted to geodetic heights, with a full error propagation using the covariance matrices.
- Some examples of the resulting time series are given below; annual, semi-annual and linear terms are fitted.
- The 'Stanford' era heights, station-dependent dates defined as in the Table, are seen to fit well with the more recent, higher-quality results
- Full and detailed results will be given in a journal paper to be written by the authors.







References

Gibbs, P. et al, 2006. A reassessment of laser ranging accuracy at SGF Herstmonceux, UK; proc. 15th Int Workshop on Laser Ranging, Canberra, Australia.

Luceri V., Pirri M., Rodríguez J., Appleby G., Pavlis E.C., Muller H. *Systematic Errors in SLR Data and their Impact on the ILRS Products*. Journal of Geodesy, 93:11, 2357–2366, 2019

SusniK, A., Appleby, G., Rodriguez, J. and P Dunn. Determination and analysis of Herstmonceux geodetic heights for the period between 1984 and 2022. Proc 22nd Int. Workshop on Laser Ranging, Yebes, Spain, 7-11 Nov. 2022.

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ILRS QCB Meeting

05/19/2024

Claudia Carabajal & Mike Pearlman

Agenda

Van:

- Data Center Holdings pre ILRS and NP Comparisons (15-20 minutes):

SLR Fullrate data was the initial primary data product replaced by Normal Points (NP). Between 1983 and 1993, three different analysis centers generated NPs based on the monthly FR datasets. All the NPs from these 3 groups similar in data quality and format integrity. In the early years of onsite NP production, do onsite generated NPs in near real time always agree with NPs generated from the fullrate dataset?

- 7810 Zimmerwald Data Analysis (15-20 minutes):

Zimmerwald had multiple receiver configuration in terms of detectors, laser wavelengths and time-of-flight measurements devices. Some of their systematic errors will be discussed along with Zimmerwald (SLR and GNSS) station velocities, Zimmerwald Data Handling File entries and SSEM range biases

- Lessons learned from a Single Ground Test (10 minutes):

A 1 hour stability test characterized four systematic error sources (temperature changes, laser wavefront distortion, transmit andreceive discriminator timewalk). What is the migration approach for each of these errors.

- Beijing System Performance (data quantity and quality, 5 to 10 minutes)

Peter Dunn and Can Husson:

- Long Term Height Determination of Satellite Laser Ranging Stations

Claudia/Mike:

- Updates from the ILRS CB

Others?

Station News

- Validation of Zimmerwald (7810) station data and release from quarantine (April 9th).
- Validation of Wettzell (7827, SOSW) station data and release from quarantine (data released April 21st, 2025).
- No news from Xian (new station).
- Need to set up meeting with Jake Griffiths this week to discuss getting permission to lase ILRS targets with a new temporary prototype station we have developed at our facility in Stafford, VA. Wants to get permission to lase ILRS targets (non restricted) from a new SLR/LLR prototype station they are developing ~150 meters from the Stafford ILRS Station in Virginia. They expect first SLR collections in May/June this year. Their laser safety coordination with US DOD Laser Clearinghouse requires a memo permitting this new system to lase ILRS targets.

Mission Updates/New Missions

- **QZS-6** (JAXA) Tracking campaign period was scheduled from April 25 to June 27, 2025.
- Message sent to stations on April 21st, 2024.
- Predictions available starting May, 2024.
- Predictions at CDDIS are here: https://cddis.nasa.gov/archive/slr/cpf_predicts_v2/current/
- Only Yarragadee and Beijing tracked the satellite according to EDC. Check with NASA SLR OC.
- Will send another message to the stations.
- At EDC:

Normal Point Data (CRDv2)

Incoming Date	Satellite	Station	Start Data Date	End Data Date	Version	Status	More
2025-05-15 19:41:00	QZS-6, 2502301	Beijing, 72496102	2025-05-15 19:28:35	2025-05-15 19:40:53	00	Valid	More
2025-05-14 23:29:49	QZS-6, 2502301	Yarragadee, 70900513	2025-05-14 20:17:41	2025-05-14 20:22:54	00	Valid	More
2025-05-05 00:29:57	QZS-6, 2502301	Yarragadee, 70900513	2025-05-04 20:56:43	2025-05-04 20:59:35	00	Valid	More

Full-Rate Data (CRDv2)

Incoming Date	Satellite	Station	Start Data Date	End Data Date	Version	Status	More
2025-05-15 19:41:02	QZS-6, 2502301	Beijing, 72496102	2025-05-15 19:28:35	2025-05-15 19:40:53	0	Valid	More
2025-05-15 16:33:10	QZS-6, 2502301	Yarragadee, 70900513	2025-05-14 20:17:41	2025-05-14 20:22:54	0	Valid	More
2025-05-05 16:33:05	QZS-6, 2502301	Yarragadee, 70900513	2025-05-04 20:56:43	2025-05-04 20:59:35	0	Valid	More

Mission Updates/New Missions

- Contacted IRNSS mission colleagues to inquire about the status of their satellites, needs for continued tracking, and status on the Priority Tracking list. No response to date.
- Agreements to track QPS-SAR received from Beijing, Shanghai, Hetsmonceux, Tsukuba. Graz pending. Sejong, Wuhan, Hartebeesthoek (HRTL), Potsdam did not confirm parameters/do not have signed agreements.
- Launch date of the Sentinel-6B/Jason-CSB will take place on 17th November 2025. All preparatory activities are on track, no delay is expected. Mission will schedule tests by beginning of July 2025. Questions for the ILRS:
  - Are the tests expected to take place three months before the launch, or is this just the time to start the coordination talks? This is important for us to plan the activity as some key people might be doing summer holidays.
  - Should I contact you, or should I use the CB email address ilrs-cb@lists.nasa.gov? [**Marc Gaset**, Copernicus Ground Segment System Engineer Satellite System Ground Segments Division]

Reports to IERS and IAG

- Need to get from Mathis Blossfeld for the version of the IERS Report submitted to IERS, which includes the Analysis/Science Section that was missing.
- Need to provide IAG Travaux 2023-2025 inputs by June 10th, 2025. Requested inputs from various ILRS members by late May to be able to meet the deadline.

IAG website changes

- Received request from the IAG to review and make changes to the ILRS material posted in the new IAG website at https://geodesy.science which will be officially launched on June 2nd, 2025, replacing both the current https://iag-aig.org and https://ggos.org. Links to their websites will also need updating on the ILRS webpage in June. In addition, the new website has dedicated sections for News, Events, and Job Announcements. Any relevant updates related to the ILRS IAG Service can be submitted directly via their submission forms (Post Your News, Post Your Event, Post Your Job). This will help increase the visibility of the ILRS Service within the IAG community and extend the range of job announcements for the ILRS Service.

GGOS C-DIS

- DF&P standing committee revived.

Meeting being set by Justine Woo in mid-June to go over the GNSS and SLR site log comparison to determine what keywords we may want to have added to GeodesyML. So far, Justine, Randy, José, Van, Kalvis, Evan, Claudia involved.

2025 Workshop Updates:

- Contacted Raul Yanyachi (UNSA/Arequipa, Peru Station Manager and 2025 ILRS Specialized Workshop Organizer) about progress on the Workshop's organization. UNSA's logistics support has proven difficult, and the workshop in Peru will be cancelled.
- Need to decide if an ILRS virtual workshop is desired. Will also be discussing with S. Merkowitz when he returns from travel.
- Need to draft communication to let the ILRS community know.

"Dear ILRS Community,

We have been alerted by the University of San Agustin that they will not be able to host the 2025 International Workshop on Laser Ranging at Arequipa this fall. They are in the process of changing university leadership and they are not in a position to access University facilities, infrastructure, and funding, nor do they have any real level of University support. This process will not be over until early 2026 and even then, it is not clear that their situation will be.

The Governing Board is considering what options are available to us at this late date. One option is to move this workshop to 2027 and seek a new location. A second option is to hold a virtual workshop later in 2025.

We are interested in your thoughts.

With best regards, the ILRS"