ILRS QCB Meeting
May 19th, 2025
9:00 – 11:00 AM EST (13:00 UTC)
Next QCB Meeting: July 14th, 2025, 09:00-11:00 AM EDT (13:00 UTC)

Participants: Linda Geisser, Van Husson, Stefan Riepl, Mike Pearlman, Randy Ricklefs, Frank Lemoine, Matthew Wilkinson, Graham Appleby, Alexandre Belli, David Sarrocco, Magdalena Kuzmicz-Cieslak, Tom Oldham, Peter Dunn, Julie E. Horvath, Mark McDaniel, Claudia Carabajal.

Agenda:

Van Husson:
- 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 Carabajal/Mike Pearlman:
- Updates from the ILRS CB.

Notes from the Meeting:

Van Husson - see presentation.

7810 Zimmerwald Data Analysis
Zimmerwald has had two occupations of 7810. The original mount/telescope subsystem was replaced, leading to a change in its Site Occupation Designator (SOD) and its associated DOMES number. The current system is approximately 25 cm higher.

The current system, which began operations in December 1996, has used multi receiver chains including three different wavelengths; different detectors and time-of-flight measurement devices; the Stanford Research Model 620 (SR220) Time Interval Unit (TIU) and the Riga event timer.

The 2023 update to the ITRF2020 coordinates (ITRF2020_U2023) indicate Zimmerwald's site velocities determined from its two space geodetic techniques, SLR and GNSS, are virtually identical.

The original SLR system only operated at 532 nm and tracked until 1-May-1995. However; based on the ILRS Data Handling File (DHF), all data after 1-Jan-1993 was to be rejected, with no reason given, and why there are no ITRF station residuals after 1992. There was a discussion about who would know why the data was marked for rejection in the DHF; especially since SSEM range biases were computed up until the system ceased operations in May 1995.

Based on comparing the station's barometric pressure to the Vienna Mapping Function for optical frequencies (VMF3o), the barometric measurements from the old system were slowly drifting negative inducing a positive range bias exceeding +1 cm. Barometric pressures from the current system are in good agreement with the VMF3o data.

The current system initially operated at a single frequency of 423 nm, but its system performance was degraded (see SLRMail#0038) and perhaps is why the DHF had its first years' worth of data marked for deletion. There were two discontinuities in the SSEM Zimmerwald 423 nm Range Biases (RBs), the first was introduced when the internal calibration distance was modified by 18 mm while simultaneously applying SR620 TIU range corrections. The second RB discontinuity occurred when the system switched from the 'calibrated' SR620 TIU to the event timer. The last pass taken at the 423 nm wavelength was 24-Apr-2008.

Graham noted during the discussion that NSGF has table/corrections and subroutines to remove the SR620 TIU satellite range dependent errors for a few of the EUROLAS systems. These subroutines are ready to be shared with the other ACs.

Note: The internal calibration path length could not be measured (ref: Section 8.01 of site log), so the 18 mm path length correction mentioned above was determined based on ground test results with an external target. Internal calibrations were eventually deemed unstable (polarization effects) and why the system switched to ranging to an external calibration target on 21-Jun-2006.

On 31-Jul-2002, the system started to range to satellite in two colors (423 nm and 846 nm). RBs were to be estimated for 7810 data taken at 846 nm, based on the DHF. Unlike the 423 nm RBs, there are no obvious discontinuities even when the event timer was installed. Note: Only three ACs estimated 846 nm RBs. The last pass taken in two colors was 24-Apr-2008.

Post 24-Apr-2008, the system was down for a few months while it was reconfigured to only range at 532 nm. The first pass taken at 532 nm was on 10-Apr-2008. Based on SLRmails#1726 the data taken between 10-Oct-2008 and before 24-Oct-2008 was biased by ~+7.5 mm. *This RB currently is not documented in the DHF.*

The station was taken off-line in February 2022 for some much-needed repairs. The station resumed operations in July 2023. Based on DHF, RBs are to be estimated for all satellite data taken after 1-Mar-2023; *however, after closing inspection of the DHF, this RB estimation contradicts two other existing DHF entries where a fixed RB for LAGEOS-1 and LAGEOS-2 of 7.0 and 8.2 mm, respectively, are to be applied to the end of time.*

Beijing System Performance (data quantity and quality)
The Beijing station tracking performance in 2024 was in the middle of the pack.

Post 20-Sep-2021, the station went offline to upgrade their laser and event timer and resumed operation in February 2022. Initially their single shot LAGEOS RMSs and calibration RMSs were very stable, while there was an approximate -7 cm change in their LAGEOS RBs and a reduction in gross RB outliers. The station went offline again in January 2023 for a few months. When the station resumed operation in May 2023, the LAGEOS and calibration RMSs had increased and weren't as consistent. Their new Daheng Optics' laser was upgraded from 1 to 2 kHz in September 2024. Since their 2 kHz upgrade, their LAGEOS RMSs were bimodal indicating an intermittent change in their data editing criteria. They started to experiment using a Leading Edge (LE) filter on select LAGEOS biases causing this bimodal distribution of LAGEOS RMSs. Post 2 kHz upgrade, there was also an increase in their calibration RMSs stability caused by excessive or unstable laser energy input to PIN detector.

NASA's AutoQC algorithm identified that their Normal Point (NP) binning algorithm, since November 2023, is NOT in adherence with NP bins being formed starting at 00:00 GMT.

The average number of NPs per a LAGEOS-1, LAGEOS-2 and LARES-2 pass is less than 5 NPs for the four Chinese systems in Beijing, Wuhan, Kunming, and Shanghai.

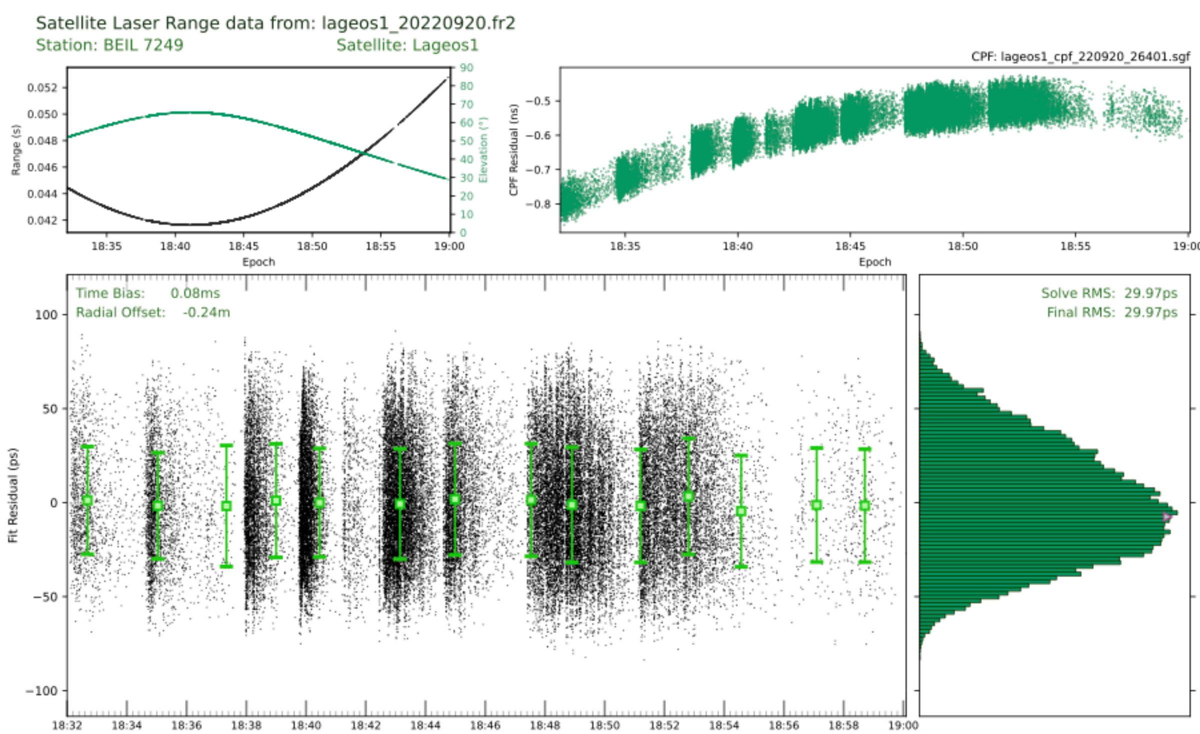
Beijing LAGEOS Residuals:

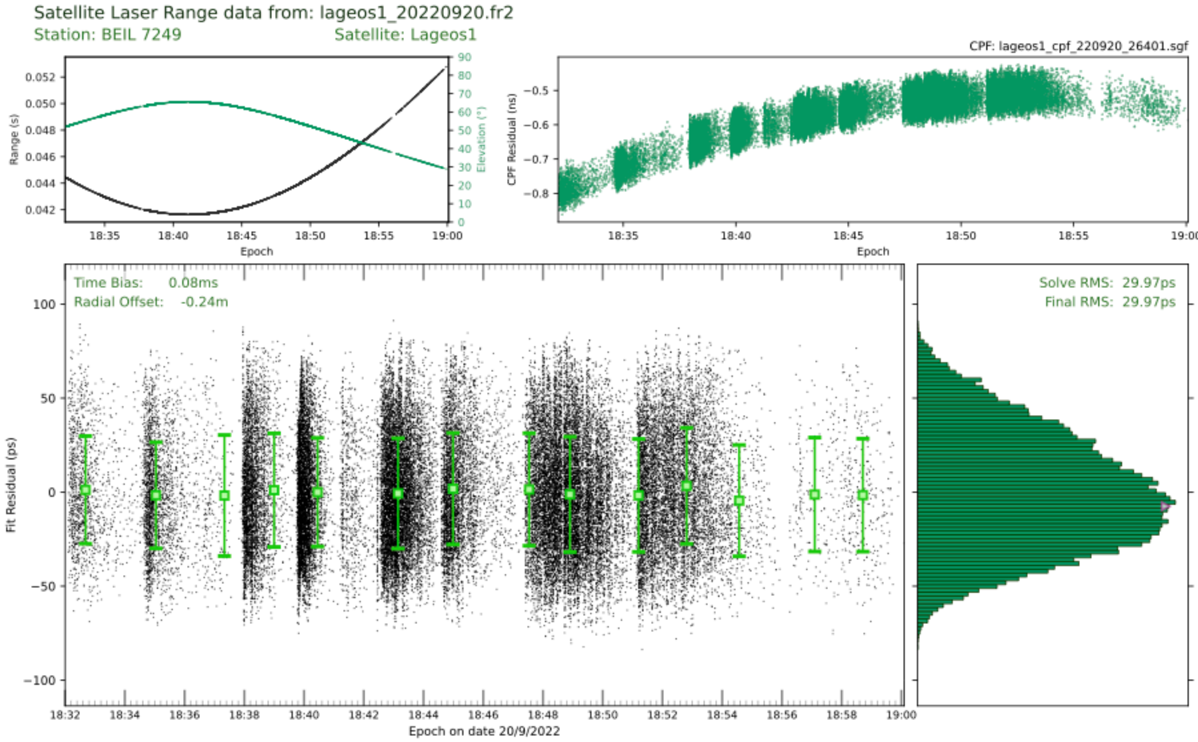
Included are three OrbitNP charts of Beijing LAGEOS residuals. The one from August 2022 is when their 1 kHz laser was working properly and their RMSs (satellite and calibration RMSs were stable). They upgraded their 1 kHz laser to 2 Khz, but their data quality has suffered since. The attached charts from April 2025 indicate that one pass has a LE filer applied and the other pass doesn't based on the single shot RMSs. The residual patterns from both these April 2025 passes looks a bit strange to me and may be the result of "excessive or unstable laser energy input to PIN detector" and not double pulsing. Not sure what they mean by "PIN" detector. According to their site log, they have a CSPAD.

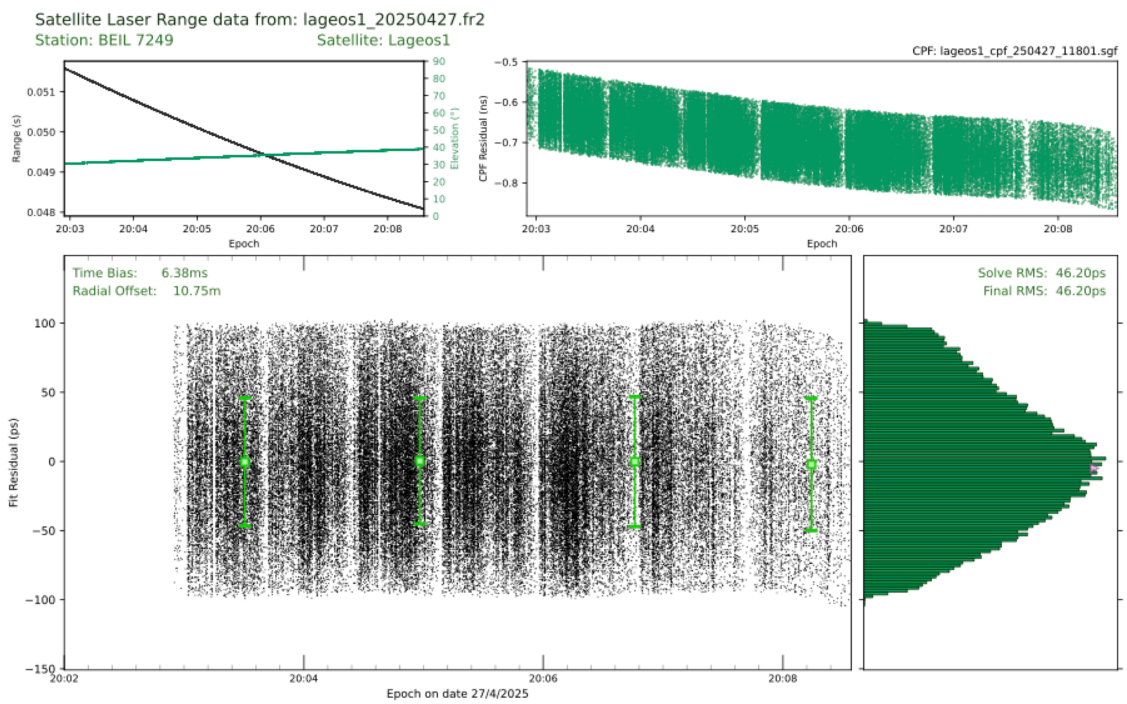
They need to take their system offline and fix their laser and then be consistent in their data editing from that point forward.

José Rodríguez commented that Van was right about the larger delay you'd expect a secondary laser pulse to have, relative to the primary one. But, under some circumstances you could also have unwanted reflections inside the optics assembly, which might reasonably (though imprecisely) be described as additional pulses (that's what they look like). These used to happen in Herstmonceux in daytime ranging, as the narrow-width filter acted as a reflective surface causing a small but obvious peak a few cm after the main one. It stayed clear of most but the widest distributions of returns, i.e. Etalon and Ajisai, although always beyond the range of the iterative rejection, so it was mainly a nuisance when working with these satellites for CoM work.

Whatever it is, using different reduction methods intermittently is just not the way to go.

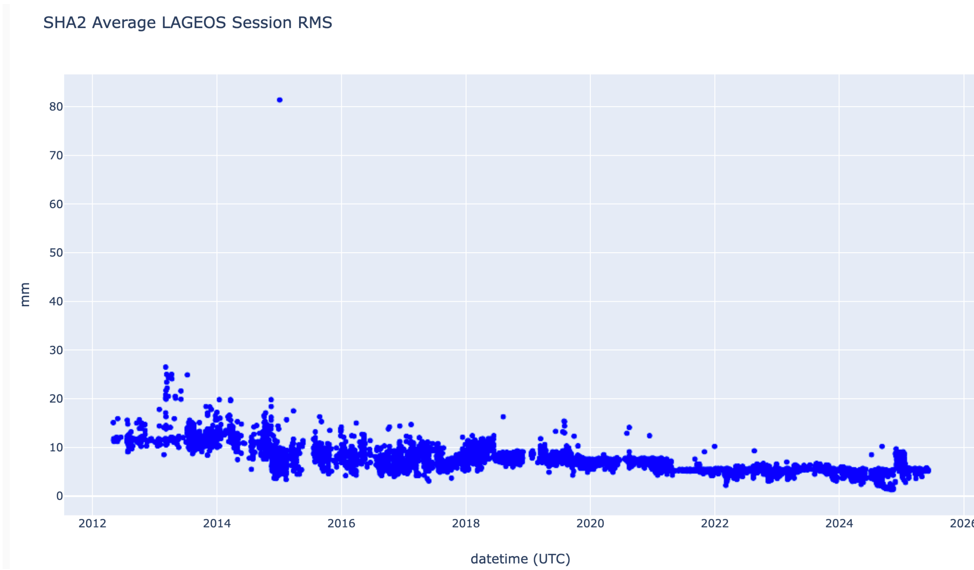






Shanghai (7821) LAGEOS single shot RMSs were pretty erratic starting last year. There were supposedly using a 20 mm Leading Edge (LE) filter. Van asked them how were they able to get less than 2 mm RMSs and why was there so much variation in their RMSs .

They responded “We use the leading-edge processing method on Lageos satellite. Due to process program misused, there are some fluctuations in RMS some months last year. We discovered this issue in January this year and promptly correct it. Since then, we have fully followed the leading-edge processing method, and the RMS has become relatively stable.”



Peter Dunn – see presentation.

Long Term Height Determination of Satellite Laser Ranging Stations
At Monument Peak, SLR and GNSS give similar results at earthquake times.
Discontinuities cloud the issue for GNSS.
Between 2000 and 2010, uplift followed by subsidence was observed before the large M7.2 quake.
This inter-seismic deformation pattern is seen at the SLR station but not GNSS.
In each of the three decades between earthquakes, linear assumptions were adopted but with different slopes in ITRF2020.
The downward linear trends at the station were dictated by the early and late decades.
GGAO, MOB7 and YARL, MOB5 show consistent subsidence from PGR fore-bulge collapse.
ITRF2020 includes Range Bias corrections assumed constant over time intervals of months and years.
The SGF-developed SATAN system separates RB from height week by week and gives accurate long-term heights.
SATAN’s RBs are the source of the ITRF2020 corrections.
In 10 years a height rate accurate to < 1mm/year (1cm/decade) can be computed with the SATAN program.
The ITRF2020 linear height rate assumption was found questionable at the Tahiti SLR Station (TAHL, MOB8).
A change in height rate around 2000 is also seen at HAWL, TLRS4.

Van Husson - see presentations.

Data Center Holdings pre ILRS and NP Comparisons
In the early 1990's as part of global data streamlining, onsite generated NPs in the CSTG format became the primary SLR dataset replacing FullRate (FR) data in the MERIT II format.

Three different analyst groups (DGFI, DUT, NASA/GSFC) took the initiative to generate MERIT II NPs from the monthly FR MERIT II datasets going back to September 1983. These MERIT II NPs only reside at the CDDIS.

By comparing the NPs epochs and Time-of-Flights (ToFs) to the corresponding FR epochs, it is possible to determine the differences in the epochs and the ToFs. Based on these NP to FR comparisons, there are some data integrity issues with the DGFI and DUT generate NPs, but not the NASA/GSFC generated NPs.

Also, it was discovered that onsite generated NPs in the CSTG format may not always agree with their MERIT II generated NPs from the FR data.

The big questions are
1. Which data analysts are using these NPs generated from these three groups and have the analysts found any issues?
2. Should any of these NPs dataset be removed from the CDDIS.

Post meeting Ron Noomen, who is retired but was the primary SLR data analyst at the Delft University of Technology (DUT), was asked who might have generated the DUT MERIT II NPs and here was his reply:

"Delft normal points? Hmm, I have to think hard. What I remember is that in the period that we had our quick-look data analysis center operating on a weekly basis, we computed normal points based on the 50 or so sampled data points that came in. This was always used for internal purposes only. Later on, this was mostly not necessary anymore because the stations computed (and submitted) their own QL NP.

As for full-rate data: we have always used the NP as they were made available by CDDIS and EDC/DGFI. We never computed anything like these ourselves, only had a critical screening and review system. The data was made available in MERIT-II, and we converted it into Geodyn Binary Format. This (after screening) might have been made available to others somewhere in the 1990s. I really do not know. The differences that you mention (2.2 m, timing, ...) might have to do with a transfer back to MERIT II? Really, I have no idea. With the data in the GBF, we ended up with residuals in the order of 1-2 cm, so it cannot have been that bad...

The only aspect where Delft might have produced NP itself, is (maybe) for data generated by any of the Dutch systems: the stationary Kootwijk station or the data generated by MTLRS-2. But that would probably have been done by the people operating these, i.e. connected to the Faculty of Geodetic Engineering, not me (I worked at Aerospace Engineering).

So I really would know what DUT NP you are refering to exactly, but feel free to not put any effort into them..... "

Lessons learned from a Single Ground Test
NASA SLR stations take regular ground tests that include stability, MINi COlocation (MINICO) and receive discriminator test to identify potential systematic errors. Analysis of a recent 1-hour stability test from Monument Peak, revealed three mm level systematic error sources (laser wavefront distortion; transmit discriminator and receive discriminator timewalk) and ways to mitigate these errors during pre and post calibrations.

Poster Presented at EGU 2025 (See Poster): Further progress to improve the accuracy of satellite laser ranging data: impact on geodetic height time series of removal of range-dependent systematic errors, by Graham M Appleby (Honorary Research Associate, SGF Herstmonceux), Andreja Susnik (British Geological Survey, SGF Herstmonceux).

Claudia Carabajal – see presentation.
Station News:

- Validation of Zimmerwald (7810) station data performed and released from quarantine (April 9th).
- Validation of Wettzell (7827, SOSW) station data performed and released from quarantine (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 SLR/LLR temporary prototype station developed at the facility in Stafford, VA, ~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.

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. Sent another message to the stations.
- 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:
- Need to verify content related to ILRS. 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 on ILRS webpage need to be updated too.

GGOS C-DIS:
- 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 update:
- 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.
- Drafted communication to make the ILRS community aware of the cancellation.

Table 1. History Log Voids by Station (2025.05.21)

Station Location	CDP #	Time Gap(s)*	Last entry
Kiev	1824	000120-080302 080402-110515	141010
Komsomolsk	1868	NO DATA	
Simeiz	1873	NO DATA	
Mendeleevo	1874	NO DATA	
Altay	1879	NO DATA	
Riga	1884		250315
Arkhyz	1886	NO DATA	
Baikonur	1887	NO DATA	
Svetloe	1888	NO DATA	
Zelenchukskaya	1889	NO DATA	
Badary	1890	NO DATA	
Irkutsk	1891	NO DATA	
Katzively	1893	NO DATA	
Yarragadee	7090		250407
Greenbelt	7105		240418
Monument_Peak	7110		250414
Haleakala	7119		250330
Tahiti	7124	020825-080414 130321-191022	230520
Changchun	7237	950101-970802 020714-051002 180410-210106	240417
Beijing	7249	881101-940301 940301-981116 981116-211013	240923
Tsukuba	7306		240919
Sejong	7394	NO DATA	
Wuhan	7396	NO DATA	
Arequipa	7403	920718-951023 951023-981130 981130-010523	200629
San Juan, Argentina	7406	NO DATA	
Brasilia	7407	NO DATA	
Hartebeesthoek_HARL	7501	020409-081105	250205
Hartebeesthoek_HRTL	7503	NO DATA	
Izana	7701		230406
Zimmerwald_532	7810	030905-060203 080715-100901	250205
Borowiec	7811	030329-071227 080205-131218	211005
Kunming	7819		241208
Shanghai_2	7821	140222-170315 170720-190811	231113
San_Fernando	7824	900703-930222 971216-010124 090302-110601 180801-210518	250122
Mount_Stromlo_2	7825		210901
Wettzell_SOSW	7827	140501-160511 160511-190528 200424-230607	250319
Simosato	7838	900701-950810 950810-991007 991019-040701 080401-181212	211209
Graz	7839	150504-190311	241009
Herstmonceux	7840		240109
Potsdam_3	7841	040906-081026 081026-110501 170303-200303	250422
Grasse_MEO	7845	010601-200818	240517
Matera_MLRO	7941	140902-171204 171206-210629	250521
Wettzell	8834	980720-001012 001012-090324 090324-131021 170407-190604	240605

* Assuming at least 2 year data gap

Status 2025.05.29

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