ILRS QCB Meeting
March 11, 2024
9:00 – 11:00 AM EST
Meeting Notes

Van Husson, Mike Pearlman, Randy Ricklefs, Andreja Susnik, Graham Appleby, Tom Oldham, José Rodriguez, Alexandre Belli, David Sarrocco, Magdalena Kuzmicz-Clesiak, Matthew Wilkinson, Justine Woo, Tom Varghese, Mathis Blossfeld, Claudia Carabajal.

Agenda

Mike/Claudia:

- Introductions of new members of the ILRS QCB and SGP
    - Dr. Alexandre Belli, SSAI @ NASA/GSFC (
      Working with Frank Lemoine, Scott Luthcke, and UMBC AC folks

Previous Presentations by Van

- 1824 GLSL Golosiiv Analysis
- ITRF2014 vs ITRF2020 Site Velocities
- 7941 MATM Analysis (Update)

Is there any need to review these again along with issues and action??

New Presentation by Van:

- The Leading Edge (LE) Filter Pros and Cons

Graham

- Verbal update on the issues with the Stanford timers

Matt/Mike:

- Station questionnaire on performance.

Justine:

- CDDIS is receiving NPT sessions where the FRD did not exist. Possible reasons:
    1. Not all stations send all their FRD data
    2. There are some passes where the FRD failed QC but not the NPT

Dr. Alexandre Belli joins SGP

Dr. Alexandre Belli (alexandre.belli @ssaihq.com) has joined the SGP team, working with Frank Lemoine, Scott Luthcke, and UMBC AC folks. He is expected to assume the role held by Erricos Pavlis.

"Dr. Alexandre Belli is currently a Lead Research Scientist at NASA GSFC/SSAI, where he works at the JCET SLR Analysis Center and Combination Center. He earned his Ph.D. in 2017, specializing in laser time transfer with the T2L2 experiment. Joining NASA GSFC thereafter, he focused on addressing issues related to DORIS satellite clock errors and time biases in laser ranging stations. He also gained valuable experience during a postdoctoral term at NOAA, working on GPS orbits. For two years, he ventured into the private sector, refining his skills in data science and machine learning."

Presentation by Van on Leading Edge Filtering and other topics:

- The Leading Edge (LE) FilterProsand Cons
- 7839 Graz System Performance Analysis
- LE System Configurations; Implementation Dates; RMS, Skew, & Kurtosis
- OrbitNP Analysis of Fullrate Data from the LE Systems
- OrbitNP Analysis of a 7701 LAGEOS-1 fullrate data using different editing techniques

Summary:

Georg Kirchner introduced the concept of the Leading Edge (LE) filter at the 16th International Workshop on Laser Ranging in 2008. During his presentation (ref: **https://ilrs.cddis.eosdis.nasa.gov/lw16/docs/presentations/rep_4_Kirchner.pdf**), he showed the process and results of applying the LE filter to Graz (7839) LAGEOS-1, LAGEOS-2 and Ajisai data. The prime advantage of applying the filter on these 3 satellites was to reduce the variation in the normal point distance to the LE of the retroreflector array to < 1 mm. Thus, in theory, the Center of Mass (CoM) correction for the LAGEOS and Ajisai normal point data collected at Graz should be very stable.

Graz (7839) implemented the LE filter in their onsite data processing on February 6, 2008. Any LAGEOS or Ajisai observations that were greater than 20 mm from the LE were rejected thus reducing the RMS of the remaining observations to 5 mm. Graz also updated their Site Section 10 (Preprocessing Information) accordingly to ensure end users are aware of this change since it impacts their station's CoM correction. A result of considering the use of the LE filter in the modelling of the CoM corrections, Graz CoM corrections for LAGEOS-1, LAGEOS-2 and Ajisai, relative to the previous values, increased by 3.1, 3.4, and 27 mm, respectively.

During the last few years, four other ILRS stations (Shanghai, Changchun, Izana and Tsukuba) have implemented a LE filter on LAGEOS (-1,-2) and other geodetic satellites. All five systems that have implemented a LE filter have slightly different system configuration in terms of the laser repetition rate, pulse-width, detector type and mode of operations (single photon, multi photon and/or combination). Of these five stations, Graz has the most consistent LAGEOS RMSs and higher moments (skew and kurtosis). The skew of the LAGEOS data after application of the filter is quite different among these five systems.

There are a few important points to consider regarding the implementation of a LE filter:

1. The LE filter depends upon how well the satellite residuals near the LE are flattened by applying a polynomial fit. If the LE residuals are not flattened, the resultant normal points could be biased (in either direction, positive or negative). Properly flattening the residuals with respect to a trend function is important in all data reduction schemes, although it might be the case that their sensitivity to inadequate residual flattening is not identical.

2. Applying the LE filter constrains the resultant satellite RMS to a very narrow range (4 to 5 mm). Therefore, the stability of the distribution of unfiltered laser returns, which could be referred to as the "inherent satellite RMS" is

important to ensure no systematic errors are introduced by the LE filter. For instance, any increases in the inherent satellite single shot RMS will bias the normal points towards more negative values when the filter is applied.

3. It must be ensured that the filter is only applied to suitable satellites, with adequate checks in the data reduction software routines and operators properly trained on this task. Failure to do so can introduce biases of centimetres, as it is the case if the LE filter is unknowingly applied to the Etalon satellites.

4. The implementation of the LE filter must be properly documented in the station's site log to avoid any errors in the station's CoM corrections. The data analysts should be given at least a few months prior notice of such a change to allow enough time for new CoM corrections to be computed.

5. The fullrate data 10 data records must be properly flagged to indicate which data was excluded by the filter. There was a discussion of what is the optimum sigma level (e.g. 2.2, 2.5, 3, 5) of the fullrate data, which is an open action item. The minimum sigma level should be at least 3, since that is the highest value currently used at stations in their data reduction.

6. Sparse data and/or time gaps in the data due to Interleaving of satellites can present challenges in identification of the LE residuals and induce random errors in the normal points.

Van presented examples of failures of the above five LE filter success factors and took the resultant action to notify Shanghai and Changchun to update their site logs ASAP.

Non-Uniform procedures in local pre-processing at the stations

We have noted for some time that different stations are using different procedures in their on-site preprocessing and data exclusion criteria. These are introducing calibration differences in the mm level. It was suggested that we could have some version of FR data sent back and generate normal points in a standard way for all stations in some kind of production process. This needs more discussion on how this process could be organized,

Stanford Counters

Graham gave an update on the Stanford Counter studies underway. Quite a few of the stations have used the Stanfords. For those that were tested at the patterns were different from system to system, so each one would have to be measured and then a correction applied. It was pointed that a correction may already have been applied to these systems during the systematics estimation process. We would need to make sure that we do not apply corrections twice. There is still the issue of how we are going to gain access to all of these systems to calibrate them against an event timer.

Station Questionnaire:

Matt has been working on a questionnaire for the field stations to try to gain a better understanding of issues and difficulties that limits their data production and quality. Early comments on the first draft suggested that it was too broad and that it might be better to have more focused questions that might then lead to a follow up iteration. A third version is attached for review.

Station Quarantine

The ILRS has a posted procedure for data passing through quarantine to become and operational station. This procedure requires 20 passes each on LAGEOS, LAGEOS 2, LARES 1 and LARES 2. Toshi suggested that this might be too high a requirement for some stations that are limited in satellite visibility or weather). A copy of the posted quarantine procedure is attached. This has stimulated discussion with a number of alternate procedures suggested. We may want to schedule a virtual meeting to help hash this out.
Discussion that followed in several emails is also included, with comments on the process by several members of the ILRS QCB.

Data issues from CDDIS

Justine brought up the following issue:

NPT session data were received without a corresponding FRD session and the problem spans from December 2018-March 2023 based on a review of LAGEOS data. From the meeting it seems like FRD data is important to keep; however, no one currently had plans to recreate all NPTs from older FRDs. If we require the missing FR data, The most we can do is ask the stations if they keep older data and to resend the missing data if possible. However, the data may not be recoverable. For the future, do we want a check to be developed so we can alert stations if NPT sessions are being sent without a corresponding CRD session? We need to decide if the full rate data is required.

Next QCB Meeting: May 13, 2014

Attachment

ILRS Survey and Station Plan (D3)

International Laser Ranging Service

ILRS stations must repeatedly observe the primary geodetic targets over many passes. Those stations in the global network that do not meet the minimum tracking requirement are not contributing significantly to the scientific output of the ILRS.

Productivity can be greatly improved with the right hardware or software developments or better funding support. Stations not meeting the minimum tracking requirement are requested to identify the main factors limiting their performance and to make a development plan to meet the required productivity level in the near future.

Please answer the following questions with as much detail as possible. Completed forms will be kept by the ILRS Central Bureau and made available within the ILRS on request.

SLR Station Contact Name

Email

Date dd/mm/yyyy

1. Is your SLR station operating at its full potential?

a) Can your station track the full ILRS target list?

b) Is your station tracking during the day and night?

c) How many days a week does your station operate?

d) Does your station have additional tracking priorities?

e) Is your station affected by thermal changes?

Please provide further information:

2. How can your station improve its SLR tracking capability?

a) Which satellite targets are difficult to acquire?

b) What percentage of LAGEOS, LARES and Etalon can you expect to track successfully?

c) Can you track the GNSS constellations at night

d) Can you track the GNSS constellations during the day?

e) Does your system interleave quickly between targets?

f) What is currently limiting the volume and quality of your data?

g) What would make a significant improvement to your station's tracking capability?

Please provide further information:

3. Is your SLR station fully supported?

a) Is your station funded to observe continuously? What times/days does your station not operate?

b) How is your station funded? How often is the work of your station reviewed?

c) How many full time and part time staff work at your station?

d) Do staff have other duties that make them unavailable to observe?

e) Is your tracking operations pattern likely to change soon?

Please provide further information:

Table 1. History Log Voids by Station (2024.03.07)

Station Location	CDP #	Time Gap(s)*				Last entry
Kiev	1824	000120-080302	080402-110515			141410
Komsomolsk	1868	NO DATA				
Simeiz	1873	NO DATA				
Mendeleevo	1874	NO DATA				
Altay	1879	NO DATA				
Riga	1884					240209
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					240212
Greenbelt	7105					240303
Monument_Peak	7110					231109
Haleakala	7119					240304
Tahiti	7124	020825-080414	130321-191022			230520
Changchun	7237	950101-970802	020714-051002	180410-210106		240128
Beijing	7249	881101-940301	940301-981116	981116-211013		230425
Tsukuba	7306					231108
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				230711
Hartebeesthoek_HRTL	7503	NO DATA				
Izana	7701					230406
Zimmerwald_532	7810	030905-060203	080715-100901			231019
Borowiec	7811	030329-071227	080205-131218			211005
Kunming	7819					240306
Shanghai_2	7821	140222-170315	170720-190811			231113
San_Fernando	7824	900703-930222	971216-010124	090302-110601	180801-210518	231121
Mount_Stromlo_2	7825					210901
Wettzell_SOSW	7827	140501-160511	160511-190528	200424-230607		240119
Simosato	7838	900701-950810	950810-991007	991019-040701	080401-181212	211209
Graz	7839	150504-190311				240117
Herstmonceux	7840					230427
Potsdam_3	7841	040906-081026	081026-110501	170303-200303		240305
Grasse_MEO	7845	010601-200818				231012
Matera_MLRO	7941	140902-171204	171206-210629			230209
Wettzell	8834	980720-001012	001012-090324	090324-131021	170407-190604	210115

* Assuming at least 2 year data gap

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