December 10, 2021

ILRS QCB Meeting
December 6, 2021
Virtual Meeting
Next Meeting February 14, 2021
9:00 am EDT (14:00 UT)

Participants

Peter Dunn, Van Husson, Mike Pearlman, Randy Ricklefs, Toshi Otsubo, Claudia Carabajal, Frank Lemoine, Tom Oldham, Erricos C. Pavlis, David Sarrocco.

The charts from the meeting are available at https://ilrs.cddis.eosdis.nasa.gov/science/qcb/qcbActivities/index.html

See the charts for more detail.

Agenda

- SSEM height difference and survey offsets between the two Hartebeesthoek systems 7501 and 7503 - Erricos
- Interpretation of ITRF 2020 SSEM Results – Peter
- GRAZ Data Analysis "The importance of Strict Adherence to the CRD Format; Is Peak – Mean (P-M) Useful?

Graz data analysis (Van)
In February 2008, Graz implemented a Leading Edge (LE) detection scheme for Ajisai and LAGEOS that accepted only returns that fell within a 20 mm window of the closest retroreflector. Returns greater than 20 mm (about 30% of the valid returns) where rejected. [Kirchner et al, 2008].

Since Graz Stella, Starlette and LARES single shot RMS values are typically sub-5 mm with peak-to-peak residuals spread of less than 20 mm, so there was no need to apply this 20 mm LE filter, and a 2.2 sigma edit is still being applied.

However, Graz Etalon single shot RMSs are typically in the 33 to 43 mm range based on a 2.2 sigma filter (i.e. have more than 20 mm peak-to-peak variation in residuals).

Graz LE editing approach give:

1. a reduction in Ajisai, LAGEOS-1, and LAGEOS-2 single shot RMS to 5.1 mm from 15.0 mm, 7.9 mm and 8.5 mm; respectively and

2. an increase in the Graz Ajisai, LAGEOS-1 and LAGEOS-2 Center of Mass (CoM) corrections of 27.0, 3.1 and 3.4 mm; respectively [Rodriguez 2019].

Questions

Should stations adhere to the Herstmonceux normal point algorithm recommendation of 3 and 2.5 sigma editing for multi-photon and single photon detection systems; respectively? Should the sigma multiplier be consistent between satellite and calibration processing?

Based on SSEM results there was a ~20 mm decrease in the Etalon range bias starting in mid-May 2017 which coincided with a significant reduction in Etalon RMSs. The change in the Etalon range bias correlated 1:1 with a change in the peak minus mean.

Using HITU Etalon pass-by-pass range bias analysis revealed the Etalon RMSs and range biases between May 2017 and April 2018, were bimodal, possibly due to different Etalon editing criteria.

Starting in October 2017, there were noticeable changes in system performance. Graz calibration, LARES, Starlette and Stella RMSs began a steady increase coupled with an acceleration in system delay drift. In mid-March 2018, the laser pulse distribution module (PDM) trigger levels were adjusted which initially returned calibration RMSs to previous nominal levels and stabilized the system delay. However, post trigger level adjustment, the Graz calibration, LARES, Starlette and Stella RMSs continued their steady increase, plus there was a less noticeable increase in LAGEOS and Ajisai RMSs. This may have been a precursor to a subsequent component failure of the laser power distribution box. One year later in March 2019, the laser pulse distribution box and power supply were repaired returning satellite RMSs to previous nominal levels.

Based on yearly aggregation of HITU pass-by-pass geodetic range biases, there appeared to be a 3 to 4 mm decrease in the LAGEOS and Ajisai range biases in 2018, which correlated with a 1:1 change in the LAGEOS peak minus mean. Results of these analyses indicate that changes in Graz peak minus mean values for Etalon and LAGEOS correlated 1:1 to respective changes in their range biases. Graz LAGEOS-1 and LAGEOS-2 peak minus mean differences might explain 50% of the observed SSEM 1.4 mm range bias difference between the two LAGEOSs. The Graz peak minus mean values can be used to model historical changes in both Etalon and LAGEOS range biases.

Currently Graz peak minus mean values only exist since 2012 when the current ILRS CRD data format was introduced. The previous CSTG normal point format did not contain any fields for peak minus mean nor skew or kurtosis. Graz is only one of a few stations that currently provide peak minus mean values in their CRDs.

We are waiting for a reply from Graz to tell us which peak minus mean algorithm they used. *Note: Andrew Sinclair's peak minus mean Fortran subroutine DISTRIB is available online at* https://ilrs.cddis.eosdis.nasa.gov/docs/DISTRIB.txt. If OrbitNP does not already contain the Graz peak minus mean algorithm, it should be incorporated.

Graz HITU time biases/along track error estimates were aggregated yearly by satellite. There is maybe some connection between the along track errors and the inclination angle of the satellite. Can the root cause of along-track errors have any impact on range bias estimation at the mm level and possibly explain part of the observed range bias differences between LAGEOS-1 and LAGEOS-2.

Comments

1. The strong correlation between changes in the Graz peak minus mean calculations and changes in Graz Etalon and LAGEOS range biases suggests that we might want to adopt the peak minus mean algorithm as an ILRS standard.
2. Monitoring of both long- and short-term trends of system performance parameters (RMSs and system delay) can be used to determine system changes.
3. HITU geodetic satellite along track errors are orbital inclination angle dependent.

Graz Etalon SSEM Data Analysis (Peter)

A 20 mm dip occurred in Etalon 1 and 2 ranges between 2017-6-24 and 2017-12-23. Since 2002, the GRAZ Etalon 1 and 2 range bias shows 15mm long +/- 1 mm (standard error). The absence of similar signals in LAGEOS data suggests that these features are unlikely to be caused by calibration errors, which would be common to all satellites. Special treatment of the Etalon data would cause the hiccup in 2017. The CoM model would be a candidate for a consistent long-term range offset.

Yarragadee LAGEOS SSEM Data Analysis (Peter)

An 8mm range bias shift in the LAGEOS data at Yarragadee between 2017 and 2021 corresponds to a 6mm Minico measurement offset. This would be explained if the prime target moved by 7mm +/- 1mm. A similar signal can be seen in Yarragadee Etalon data, reinforcing the notion that the observed SSEM range bias is calibration target distance displacement.

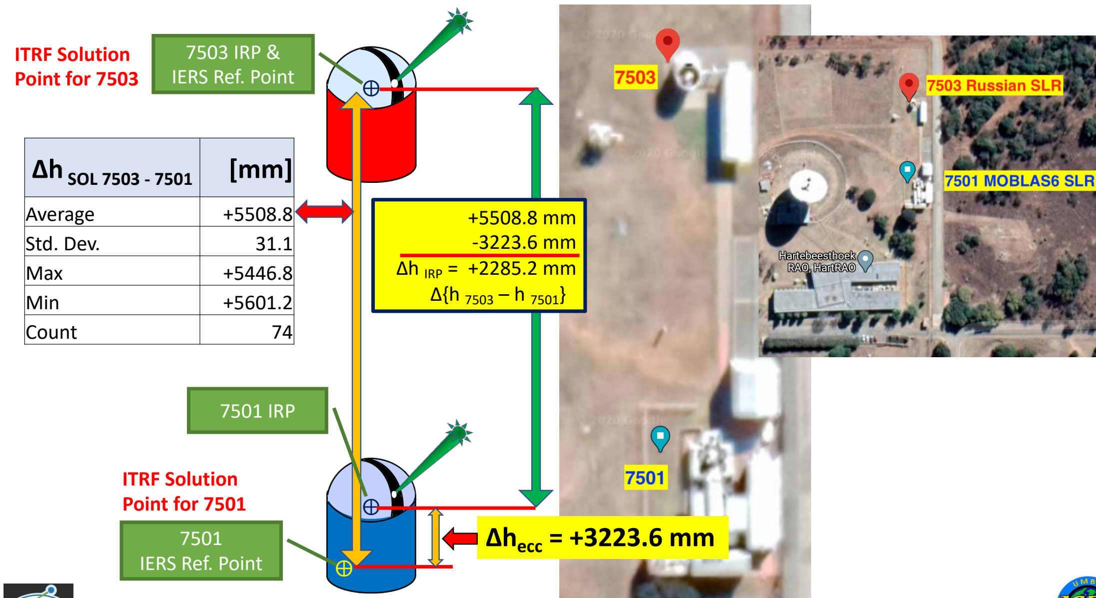
SSEM height difference and survey offsets between the two Hartebeesthoek systems 7501 and 7503 – Erricos (Erricos)

Erricos used the results from his ITRF 2020 Solution to estimate the difference in height between the NASA and Russian SLR Systems ITRF Reference Points. From 74 weekly estimates, they adopted the mean value as the height: 5508.8 ± 31.1 mm; the Min and Max are just the maximum and minimum values that appear in the 74 estimates sample. They then used the eccentricity data to extrapolate to the NASA Internal Reference point (IRP). The height difference was +2285.2 mm.

Comment from Van: Based on Erricos' height analysis, the pressure difference between the 2 stations should be 0.2 millibars (mbar), with the Russian SLR system atmospheric pressure measuring lower.

However, based on CRD pressure measurements from simultaneous passes from these 2 stations since 2018, the mean pressure different is 0.2 mbars in the opposite direction. Therefore; there appears to be a 0.4 mbar difference in the pressures between these 2 stations.

Questions: Can these two stations compare their barometric readings directly to confirm these finding? Can either or both units be calibrated versus a known standard?



$\Delta h_{SOL\ 7503-7501}$	[mm]
Average	+5508.8
Std. Dev.	31.1
Max	+5446.8
Min	+5601.2
Count	74