Multi-Satellite Daily Bias Report: How to Read and Handle it

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Abstract

A quality control system for the ILRS global network has been developed utilizing the precise orbit determination technique. Laser-range observation data for as many as 15 satellites are being processed every day within 24 to 48 hours after ranging observations, and the quality control numerical tables are available via web, ftp and email. The analysis reports, formerly provided by National Institute of Information and Communications Technology and currently by Hitotsubashi University, are widely used for detecting and alerting various kinds of problems. The anomaly information is being promptly notified to the laser stations by email.

1. Introduction

It would be ideal if satellite laser ranging data were faultlessly precise, but it is not realistic to demand the 100% of completeness. Data anomaly will occur even if every station pays careful attention to the quality of its observation data. It is, of course, important for a station to minimise the amount of anomalous data, but it is equally or possibly more important to detect and notify problems to the corresponding station managers and observers. When a laser ranging station releases its observation data, in general, it is not possible to locally assess the quality of its own observation data even at a metre or 10-metre level. Therefore quick quality checks from the analysis community have played an important role since the middle of 1990's, partly owing to the evolution of computer network. By giving a quick feedback to the corresponding station, the time span with anomalous data has been significantly shortened.

2. Ten-Year Operation at CRL/NICT/HIT-U

In 1998 we have started automated routine analysis at Communications Research Laboratory (CRL) (Otsubo and Endo, 1998). At the beginning, only three satellites, two LAGEOS satellite and AJISAI, were used for quality check. We gradually increased the number of satellite while the name of the institute being changed from CRL to National Institute of Information and Communications Technology (NICT). In 2007, as the first author moved to Hitotsubashi Univeristy (HIT-U), the routine analysis was also transferred from NICT to the university.

As of November 2008, laser-range observation data for as many as 16 satellites are being processed every day: LAGEOS-1, LAGEOS-2, ETALON-1, ETALON-2, GPS-35, GPS-36, GLONASS-99, GLONASS-102, GLONASS-109, AJISAI, STARLETTE, STELLA, ERS-2, ENVISAT, JASON-1 and JASON-2. SLR-based terrestrial reference frame SLRF2005 has been adopted for the station coordinates since December 2007.

At 21:30 UTC (=6:30 in Japanese Standard Time) every day, the automated analysis run starts and the worldwide observation data are reduced by means of orbit determination using orbit analysis software 'concerto'. This process usually ends around 0h or 1h UTC (9h to 10h in JST) which means the first analysis gets available within 24 to 48 hours after ranging observations. After checking the quantity of observations and the quality of orbit fit for each satellite, the post-fit residuals for the qualified satellites were used to generate pass-by-pass range bias and time bias. Due to this filtering procedure, some of the above 16 satellites are sometimes dropped from the final reports. The final result is assembled to one large text file, typically 300 to 400 kB, and is made available via WWW, FTP and E-Mail. The URL of this website is

http://www.science.hit-u.ac.jp/otsubo/slr/bias/

where the analysis report is updated every day around 0h or 1h UTC. In addition to the weekly

Figure 1. Routine sequence of the daily analysis at Hitotsubashi University.

report being sent to the SLReport mailing list, the email reporting service is available daily or weekly (every Wednesday) upon request.

The whole sequence of the daily procedure is summarised in Fig. 1 (Otsubo, et al., 2008).

3. Manual Check and Communication Issues

In a case of obvious anomaly, we promptly notify it directly to the station. Before sending the alert, we check:
- Is the bias large enough? Is it surely 'their' problem?
- Is the problem continuous, not a one-pass event?
- Has the problem already been solved?
- Who is a contact point of the station?

Then, we send email to the corresponding station manager, mainly based on the station specification webpage in the ILRS website. Since October 2007 when the ILRS workshop was held in Grasse, we also notify it in parallel to Task Force 1 Members. It is therefore very important to keep the ILRS web contents updated. We sometimes had problems in communicating through email when the email addresses of station managers are outdated.
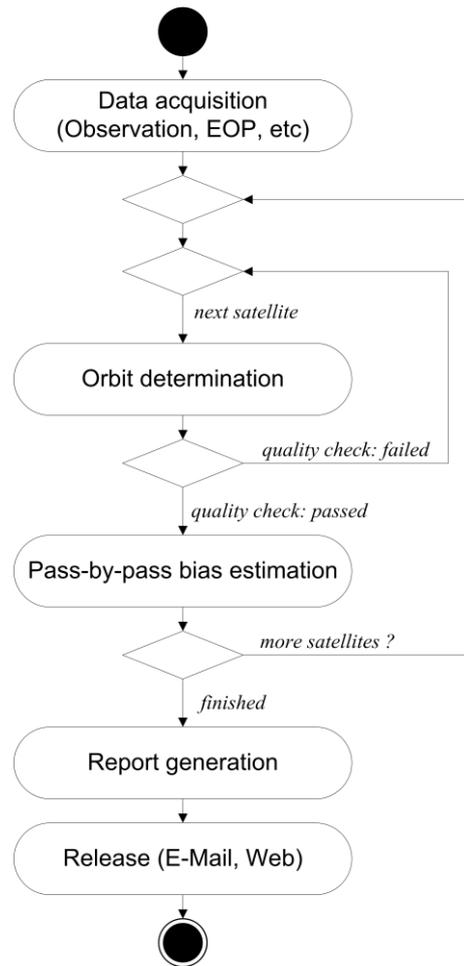
We would be grateful if the contacted station manager gives us a quick reply, just to inform us that he/she has read the notification.

The list below is the cases of actual email notification from January to September of Year 2008. RB, TB and FB mean range bias, time bias and frequency bias, repectively. For the cases in which we received a reply from a station, the cause of large bias is given in round brackets.

[Sep, 2008]	1 or 2 or 3 m RB (laser multipulse)
[Sep, 2008]	< 2 m RB (calibration (human) error)
[Jul, 2008]	1.2 km RB (calibration error. System testing.)
[Jul, 2008]	200 ms TB (?).
[Jun-Jul, 2008]	132 m RB (?).
[Jun, 2008]	-20 ms TB (hardware & software problem)
[Jun, 2008]	10 ms TB (software?)
[Apr, 2008]	Non-existing station ID (human error)
[Feb, 2008]	Atm pressure error (wire problem.)
[Feb, 2008]	0.5 to 1.7 km RB (FB?)
[Jan-Feb, 2008]	1 day TB (wrong day?)
[Jan, 2008]	3 m RB (laser multipulse)
[Jan, 2008]	18.6 ms TB (event timer)
[Jan, 2008]	< 2 m TB LEO Only (?)

4. Proposal of On-Site Use with Locally Available Information

The analysis report is not just for looking at but also for detailed investigations on various observation conditions.

One example is given in Fig. 2. Herstmoceux station, UK, is currently in the transitional phase from the 10-Hz laser ranging system to the 2-kHz laser ranging system (Gibbs, et al., 2008). According to Herstmonceux's log record, the SCI flag in the ILRS normal point header is "6" for 10 Hz and "7" for 2 kHz. Pass-by-pass range biases during June-September 2008 were plotted in this figure, for JASON-1 and 2 (left) and LAGEOS-1 and 2 (right). The
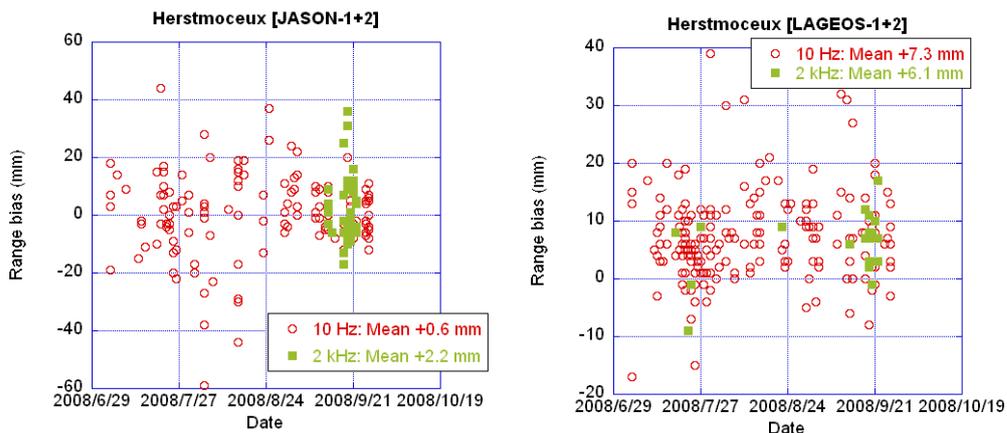

Figure 2. Range bias variation of Herstmonceux during their 10Hz – 2kHz transition.

two graphs show that the range bias has been consistent for both configurations, below 2 mm for both satellite types.

This example is generated using information available in the ILRS normal point format. However, the stations have recorded much more information than publicly available data, for instance, name of observer, time since system activation, room temperature, signal intensity, optical/electrical configuration, etc. We would like to propose the use of the reported bias values with such local information.

5. Conclusions

The daily quality check by CRL/NICT/HIT-U has been played an important role in the ILRS community for detecting unnoticed problems and shortening the period of data anomaly. The wide range of satellites from low orbits of several hundreds of km up to high orbits of GNSS altitudes are being processed and it results in easy and effective problem detection. The quick and direct notification is also a key in this activity. Various 'local' use of bias analysis reports will be possible for detailed tests of various component, and we would like to collaborate any of ILRS stations.

References

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