13-0203

Subdaily Quality Check of Laser Ranging Data at Hitotsubashi University

Toshimichi Otsubo, Mihoko Kobayashi, and Shinichirou Takakura
Hitotsubashi University, Japan.
t.otsubo@r.hit-u.ac.jp

Abstract. *Rapid quality check analysis has played an important role to improve the quality of satellite laser ranging. In August 2012, we upgraded our daily service to a 6-hourly service. It is now possible for an observer to check his/her tracking data before going home. The analysis software itself has been upgraded at the same time. The new C++ version of our geodetic analysis software 'c5++' is implemented in the automated sequence. When we detect a series of anomalous passes, we report the incident to the station and the 'rapidservicemail' mailing service operated at DGFI. Up to now, we search such incidents by human eyes, but we plan to automate the detection process in the near future.*

Introduction

Satellite Laser Ranging (SLR) has achieved very high precision of just a few millimetres. It is crucial for every station to always keep such high quality in order to contribute to long-term geodetic products. However, when a part of the system or the sequence does not work properly, the ranging data can be anomalous. It is not always possible for a station to find such problems on site, and therefore the quality-check feedback from analysts plays an important role. It is common to express the post-orbital-fit residuals by two parameters, range bias and time bias. The former represents an excessive range and the latter represents a clock error as illustrated in Fig. 1.

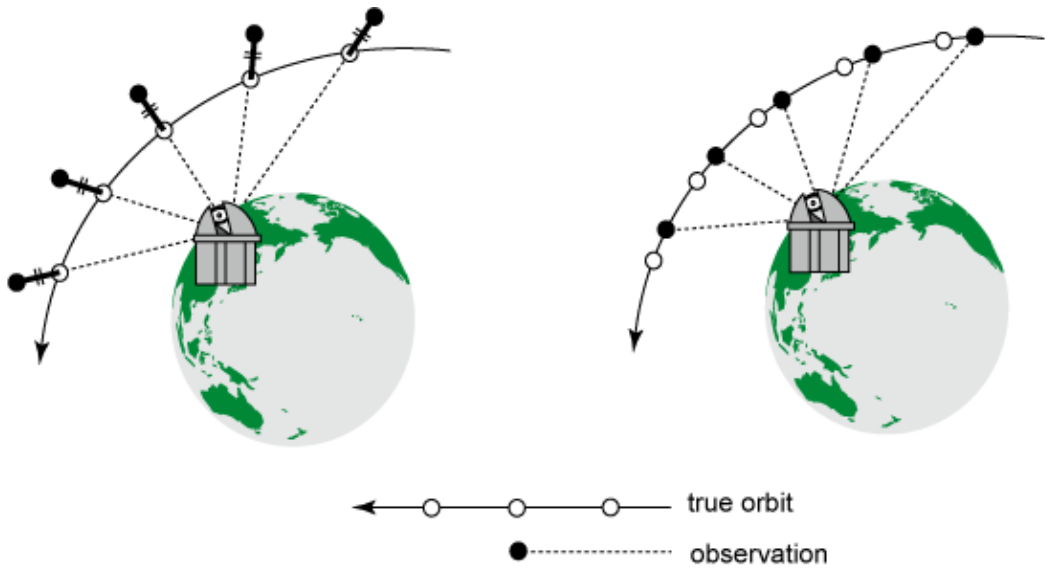

Figure 1. Range bias (left) and time bias (right).

This paper deals with the recent development on the quality check analysis at Hitotsubashi University. Having operated the quality check analysis for 14 years at NICT and later at Hitotsubashi University (Otsubo, et al, 2008), we upgraded it in August 2012 with a new software package, a new computer and a new analysis scheme.

New software: "c5++"

Through a joint project among NICT, JAXA and Hitotsubashi University, we have developed analysis software 'concerto' that has been written in Java up to the version 4. We switched the programme language to C++ and re-wrote the whole package, and the new version 5 is now called 'c5++'.

The 'c5++' software adopts a latest set of geophysical and dynamic models, mostly based upon IERS Conventions (2010) (Petit and Luzum, 2010). Orbital fit to SLR observations becomes constantly better than the previous version using IERS Conventions (2003) (McCarthy and Petit, 2003). The new version 'c5++' is designed to handle multiple types of data obtained from various space geodetic techniques although only the SLR part is used for this study.

New computer: 8-core computer and parallel processing

We have replaced the computer used for this analysis. The new one has an AMD's CPU FX-8150 that contains 8 cores. Orbital analysis of a single satellite is, in general, not well suitable for parallel processing, but we can run different satellites' analysis at the same time. A small Peal script is developed in collaboration with NICT to manage the concurrent number of single-satellite 'c5++' tasks. We set it to 7 so that one of the 8 cores is left unoccupied.

After computing pass-by-pass bias values and formatting a report as a text file, it is sent to the webserver operated at Geoscience Laboratory of Hitotsubashi University.

New scheme: 6-hourly service with additional satellites

The largest upgrade from the user's point of view is the following new analysis procedures. We had automatically run the analysis tasks every week from 1999 and every day from 2005. Now, it is being run every 6 hours so that an observer can ideally check today's results before going home. An analysis task starts at 2h, 8h, 14h and 22h UTC, and the analysis report that covers 14 days is uploaded to our website (http://geo.science.hit-u.ac.jp/slr/bias, Fig. 2) within 30 minutes. In theory an analysis report can include observed passes as fresh as 2.5 hours-old, although it is not always the case due to a delay at stations, operation centers and data centers, in transferring, reformatting and exchanging the ranging data.

Several satellites are added to the analysis. New Galileo satellites, additional GLONASS satellites, CRYOSAT-2, LARES and BLITS are newly included, although the BLITS satellite was unfortunately lost in collision in January 2013.

Notification of anomalous observations

We routinely check the quality check report by the human eye. When a series of anomalous passes are found, we dispatch an email message to the station. It is therefore critical for each station to put an active email address at the ILRS Website. We also send the message to the

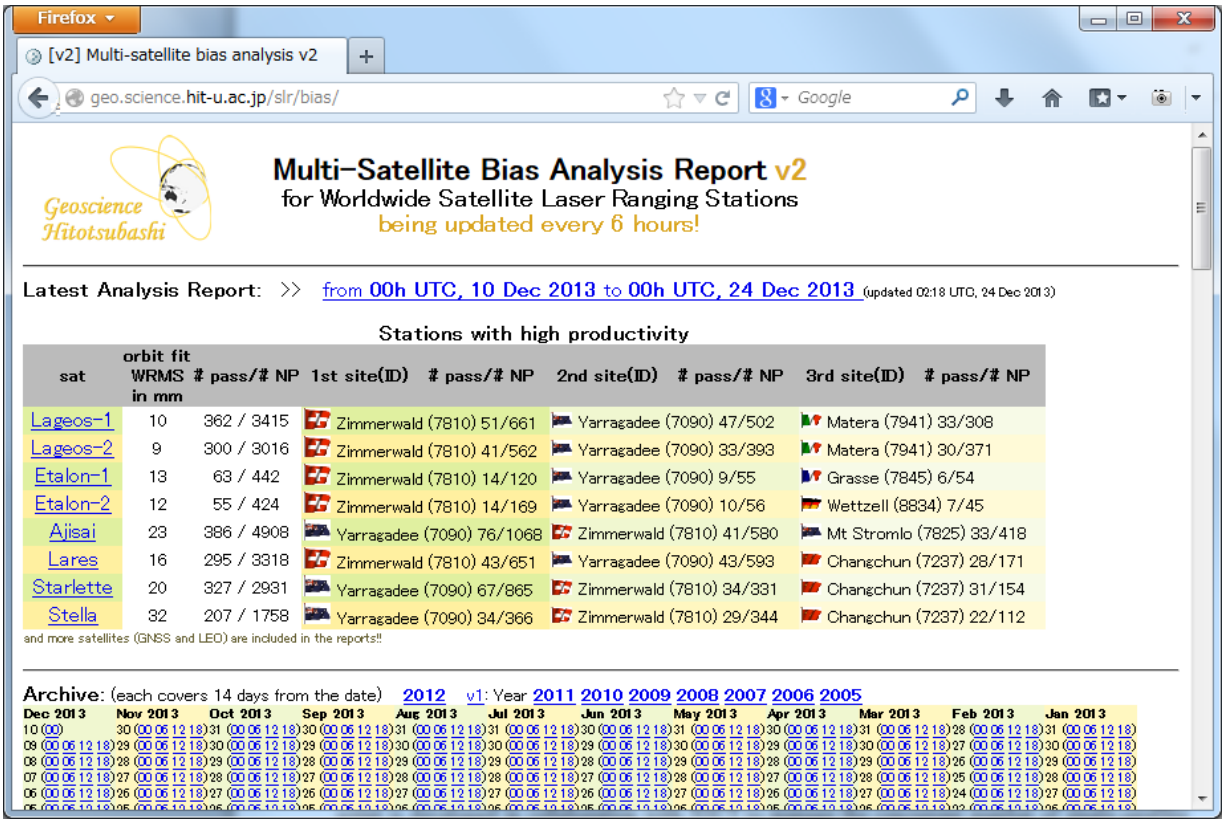

Figure 2. The webpage for the quality check analysis being updated every six hours. URL: http://geo.science.hit-u.ac.jp/slr/bias. The latest report is available by clicking 'Latest Analysis Report.'

'rapidservicemail' mailing list operated at DGFI, Germany. This is subscribed by a number of analysts involved with the quality check analysis, and the subscribers can share incidents.

Considering the fact that each report now amounts to about 3,000 lines and 400 kB, and also having upgraded the scheme to the 6-hourly reporting cycle, it is not realistic to fully rely on the human check. An ongoing project assigned for S Takakura's graduation thesis is to automate the procedure of anomalous pass detection. This in-house test has successfully extracted 80% of anomalous cases reported by the 'rapidservicemail' mailing list, and at least 3 obvious cases that have not been reported by anyone.

Summary and Future Studies

Newly equipped with the new software package 'c5++' and with the 8-core parallel computing, the quality check scheme at Hitotsubashi University is upgraded. The analysis becomes more precise and reliable, and issued more frequently, every 6 hours.

In the near future, we plan to implement the automated detection of anomalous passes so that we can send an alert message more timely and with less overlooking.

We hope this long-term effort useful in minimizing anomalous data amount and in stabilizing the high quality of the ILRS network.

Acknowledgements

The software ‘c5++’ is largely supported by NICT colleagues, Dr Thomas Hobiger, Dr Toshihiro Kubo-oka, and Dr Mamoru Sekido. The ‘rapidservicemail’ mailing list is prepared and operated by Dr Christian Schwatke and other colleagues at DGFI, Germany. The discussion among this mailing list significantly helps this study, and we thank colleagues at DGFI, GEST/UMBC, and UT/CSR.

References

McCarthy, D. D., Petit, G. (eds.), *IERS Conventions (2003)*, IERS Technical Note 32, 2003.

Otsubo, T., Kobayashi, M., Gotoh, T., Kubo-oka, T., *Daily quality control system of satellite laser ranging data for the ILRS network*, Journal of Geodetic Society of Japan, 54, 2, 69-79, 2008 (in Japanese).

Petit, G., Luzum, B. (eds.), *IERS Conventions (2010)*, IERS Technical Note 36, 2010.