2017 ILRS Technical Workshop"Improving ILRS Performance to Meet Future GGOS Requirements" on October 02 through 05, 2017 in Riga, Latvia

Model Comparisons and Optimizations of SLR Data Processing

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Abstract

SLR is one of an important space geodesy for geodetic and geophysical research as well as IERS products such as International Terrestrial Reference Frame (ITRF) and Earth Orientation Parameters (EOP). In order to obtain better and more consistent results with other space geodetic techniques SLR observation and dynamical models should be checked and better models should be applied. Therefore, we firstly checked and compared CoM correction models, Tidal models including ocean tidal models and atmosphere loading correction, atmosphere delay correction, relativistic corrections, gravity models and so on in our SLR data processing software. After comparisons we chose the better models as input and applied a fuzzy-logic method with an enhanced probability function for weighting the SLR station observations. It shows the RMS of the orbit and the individual station becomes smaller. Then we reprocessed SLR data and compared the modified tropospheric delay with other techniques. It shows there are a big difference. We added the tropospheric zenith wet delay estimation and horizontal gradient estimation in our SLR data processing. It improved the precision of the global precise orbit determination (POD) solution. Finally, by comparing our SINEX result with other ACs' solutions we checked and analyzed these models again.

1 Motivation

Different ACs often provide different solutions even using same data. Which solution is better? In order to evaluate and obtain better and more consistent results with other space geodetic techniques SLR observation and dynamical models should be checked and better models should be applied. Moreover, the POD is less accuracy for complicated SLR satellite payloads. Is it possible to improve their accuracy? This needs to check those SLR observation and dynamical models and see if there are some better models.

2 CoM and atmosphere delay models

Original CoM model: global uniform CoM correction
New CoM model: system-dependent CoM correction

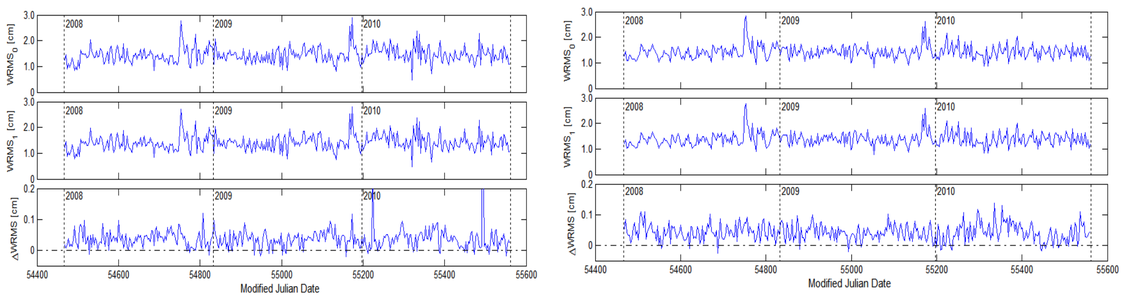

Figure 1 Precision of orbit determination for Lageos-1(left) and Lageos-2(right) by adopting global uniform CoM correction and system-dependent CoM correction, respectively. The bottom panel showed the difference between above two, i.e. the improvement of precision.

Original Atmosphere delay model: Marini
New Atmosphere delay model: Mendes-Pavilis

The original observational residuals is 0.015021m

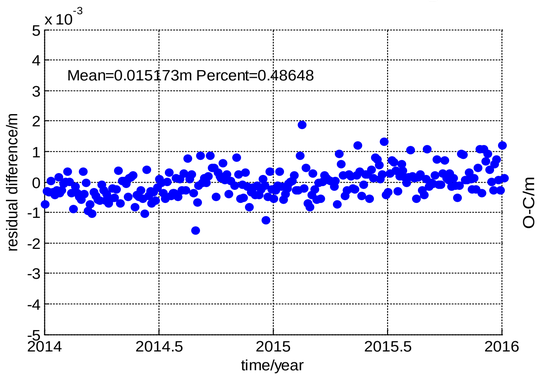

Figure 2 Observational residuals difference after applying new atmosphere delay model

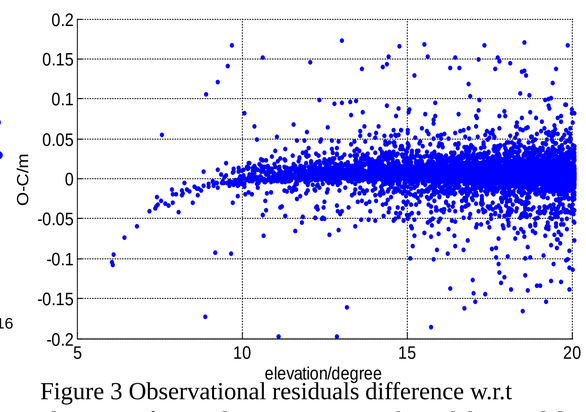

Figure 3 Observational residuals difference w.r.t elevation after applying new atmosphere delay model

3 Tidal models

Original Ocean tidal model: CSR3.0
New Ocean tidal model : FES2004

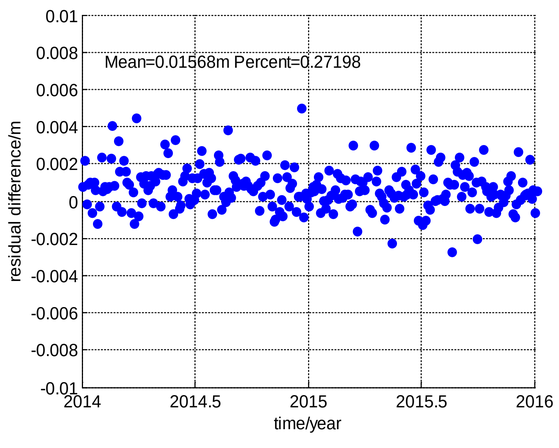

Figure 4 Observational residuals difference after applying fes2004 tidal model

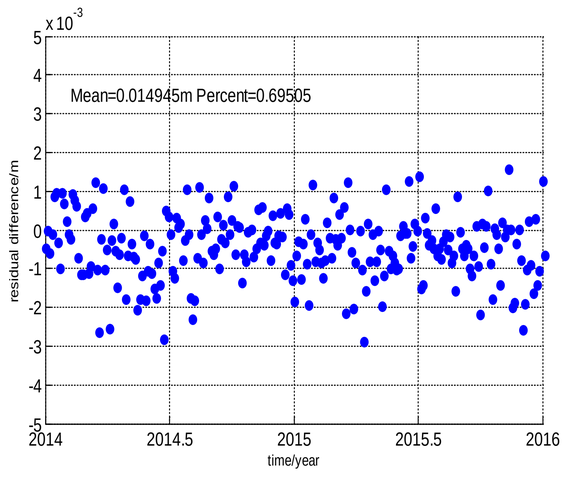

Figure 5 Observational residuals difference after applying fes2004 ocean loading model

5 Reference Frame

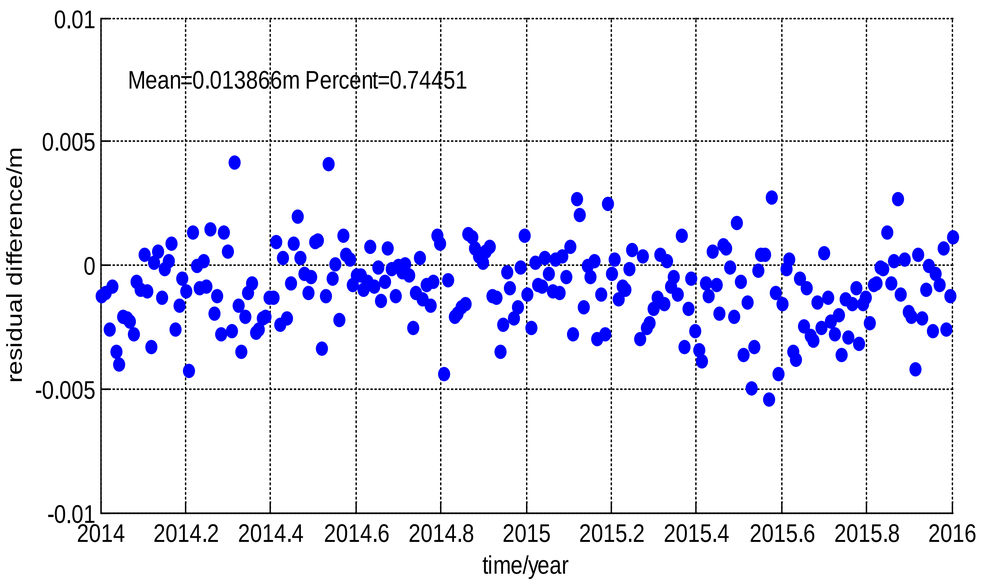

Figure 10 Observational residuals difference between SLRF2008 and SLRF2014

4 Gravity models

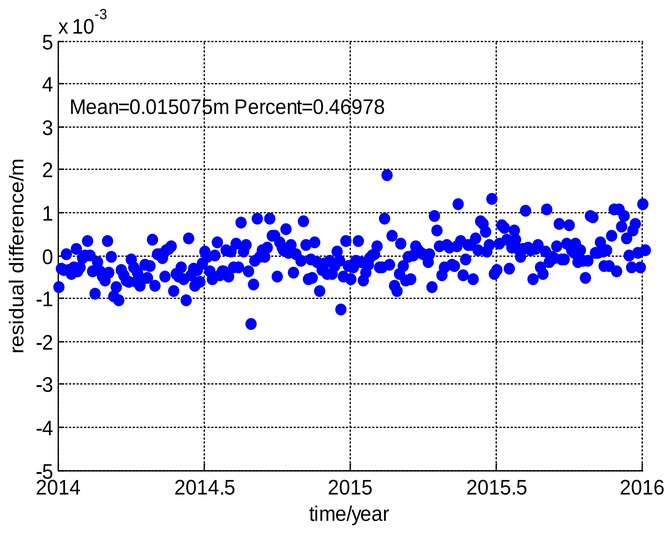

Figure 6 Observational residuals difference after using gravity model EGM2008(100 x 100)

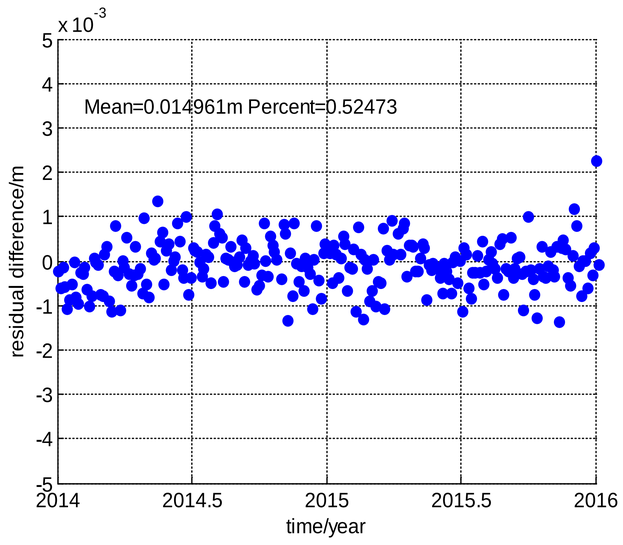

Figure 7 Observational residuals difference after using gravity model GGM05c(100 x 100)

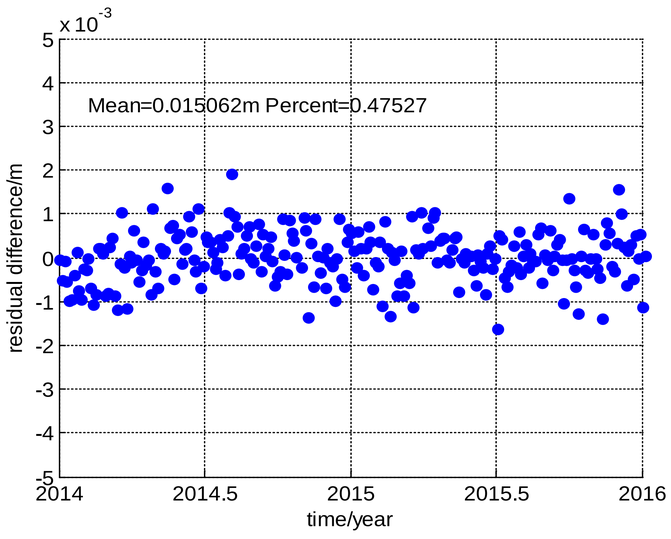

Figure 8 Observational residuals difference after using gravity model GOCO05C(100 x 100)

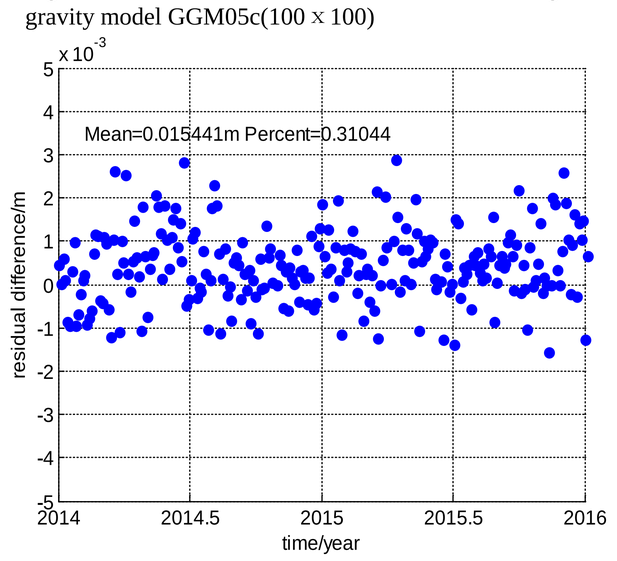

Figure 9 Observational residuals difference after using gravity model GOCO05S(100 x 100)

6 Fuzzy-logic reweighting method

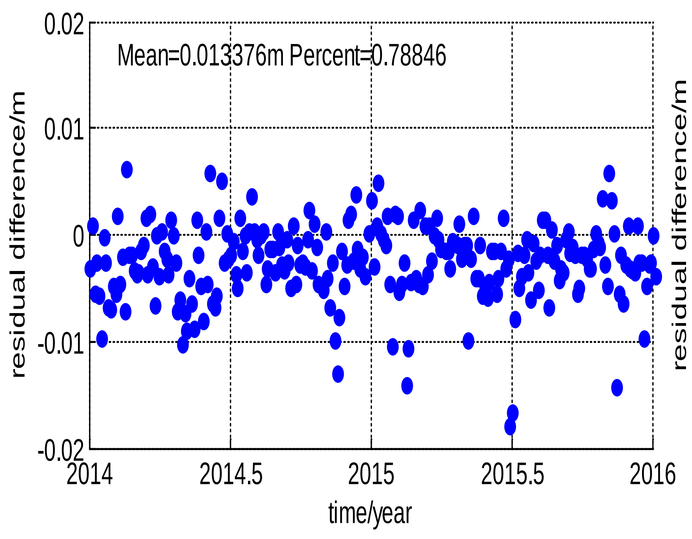

Figure 11 Observational residuals difference after applying FCM reweighting station (solution 1)

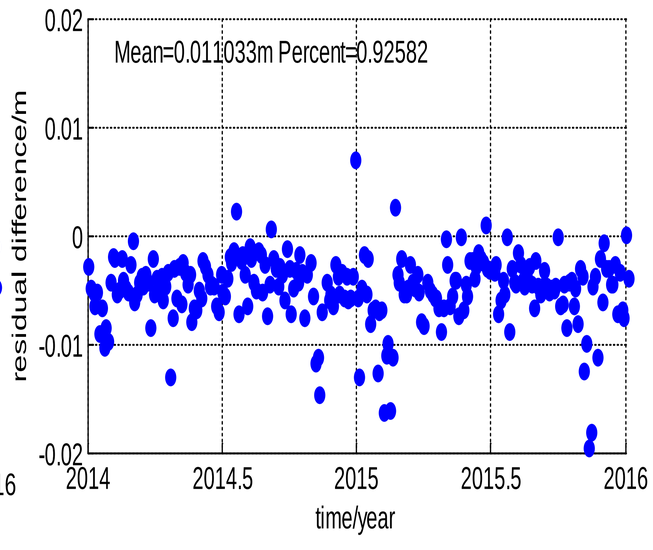

Figure 12 Observational residuals difference after applying FCM reweighting station (solution 2)

We use three variables: Lageos data volume, percentage of Lageos NP accepted, and short term bias stability for reweighting the station. The left figure using the statistical results of DEC 2016, the right figure using the statistical results once per year.

7 Conclusion and Future plan

- ◆ New tropospheric model can decrease the observational residuals at low elevation;
- ◆ New gravity model and ocean tidal model have little impact for improving the POD accuracy;
- ◆ New terrestrial reference frame and the Fuzzy-logic reweighting method can greatly improve the POD accuracy, especially using the QC file changing over time;
- ◆ SLR observation and dynamical models should be checked and evaluated.

- ➢ Provide SLR SHAO SINEX solutions and apply for ILRS AC
- ➢ Provide combined ILRS SINEX solutions for comparison and backup
- ➢ Apply the physics method of the GNSS solar radiation pressure modelling on structure complicated SLR satellites
- ➢ Continue to test the better SLR models for developing SLR data Processing standards
- ➢ Continue geodetic system error analysis and calibration

8 Acknowledgments

We thank ILRS for SLR data. This work is funded by the National Natural Science Foundation of China(NSFC, 11173048), Ministry of Science and Technology of China(2015FY310200) and the National Key Research and Development Program of China(2016YFB0501405).