Improvements in SLR Data Modelling and Reduction for POD
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Abstract
The ILRS Analysis Working Group has recently revised some of the models that are used for the reduction of SLR data for its operational products. Some of the changes are due to the implementation of the new IERS 2010 Conventions and others are coming from improved models specific to the SLR technique. The benefits for Precision Orbit Determination (POD) of SLR-based missions can be significant. The main areas of improvement since our ITRF2008 contribution are the careful evaluation and remedy of tracking station systematic errors, the improvement of the target signature models, and the evaluation and implementation of environmental models that affect the measurements and the description of the forces acting on the satellite. A new re-analysis of the contemporaneous satellite data that extends from 1993 to present will serve as a validation period for these improvements, and will eventually be contributed to the next ITRF development effort. An evaluation of the commission error from the past, present and future ITRF on the mean sea level rise indicates a very significant improvement, although we are still far from reaching the accuracy levels required by GOOS. The ILRS has implemented a number of online “live” databases to keep track of each station’s performance and a battery of systematic errors, in order to achieve the highest accuracy possible. ILRS requires that all stations track the two Lafayette satellites in order to be able to precisely calibrate them over time at the one millimeter level. The systematic errors from these observations should be applied by all users of SLR data to all tracking data from each site for the specified period, unless stated otherwise in the data base. The AVD AOs that contribute to the daily quality control (QC) of all SLR data, are now issuing standardized reports which are delivered electronically and should be consulted for very detailed characterizations of each station’s performance by the data users. We expect that the new models and the accompanying ancillary data will contribute significantly towards the improved POD for missions with very stringent accuracy requirements such as those monitoring long term sea level change.

New Modeling Standards:
- IERS Conventions 2003 (except gravity model)
- GRACE RL04-based gravity model
- Use state-of-the-art force and s/c models
- A priori Reference Frame: ITRF2008 (SLR/F2008)
- Use the latest data releases from CDDIS

Force & Measurement A Priori Models:
Gravity from GFZ and GOT4.7 ocean tides
Extended ocean tides’ model from hydrodynamics, atmospheric tides included
Secular rates for $C_{102}$, $C_{20}$, $S_{10}$, and rotational deformation
Solar Pressure and Thermal Drag with LAGEOS’ spin axes modeled by LOSSAM models
Earth Albedo (Klocke-Rubinac)
J2000 Reference frame (DE405) EOP (a priori) from IERS C04
Ocean loading from GOT4.7 tides (R. Ray/GSFC) “Geocenter” and EOP tide-induced variations (IERS–Ray model)
Improved Atmospheric Refraction zenith delay and mapping function (Mendes & Pavlis, 2004)
Adopted ILRS info on calibrated measurement biases (a priori)

Data Analysis:
- Analyze 7.5 arc in 83103 - end of 2009
- Slant-vector estimated for each arc
- Constant and 1 cpr along-track accelerations (per 3.5")
- Cross-track 1 cpr accelerations (per 3.5")
- Data biases estimated in combination (L1 & 2, ro E182)
- Polar motion, [UTC-UT1], and LOD
- estimated daily
- Site positions and velocities estimated from the entire data span

TRF Constraints applied:
Minimum Constraints:
- EOP and EOP Rates:
- Loose constraints on $X_0$, $Y_0$, and LOD (practically free)
- UT1-UTC: Estimated to avoid implicit “fixing” of the LOD to a priori

Modeling & Analysis Issues Addressed:
- Historical biases in older data and their correct handling in new analyses is ILRS’ top priority
- At present, with significant improvements since last ITRF
- Ensuring the consistent modeling across AOs at all levels and for all products
- Improve data latency from key-stations, especially those in southern hemisphere
- Use state-of-the-art force and s/c models appropriate for each tracking station
- Including temporarily varying geophysical signals (atmosphere, ocean, GIA, etc.)
- Using improved modeling to allow LEO’s to contribute to official products

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