

Validation of the French Transportable Laser Ranging Station (FTLRS) new performances with a triple collocation experiment at the Grasse observatory, France

Abstract

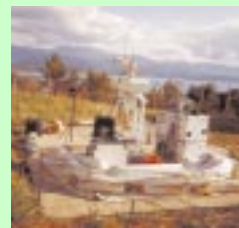
At the Grasse observatory, in the southeast of France, we have the opportunity to have 3 independent laser ranging stations very close one to each other (about 20 m). These 3 instruments are: a classical Satellite Laser Ranging (SLR) station, a Lunar Laser Ranging (LLR) station, and the French Transportable Laser Ranging Station (FTLRS). This kind of experiment was first performed to qualify the new performances of the FTLRS after a long phase of strong improvements before its departure to Corsica for the oceanographic satellite JASON-1 (2001) calibration and validation campaign during the first six-month of 2002. But furthermore, we used this unique configuration to estimate instrumental bias for each station. In this poster we will present the main results on the FTLRS, the SLR, and the LLR stations obtained with this triple laser ranging collocation experiment performed between September and December 2001.

Objectives

- Validation of the FTLRS new performances before using it for the JASON-1 CAL/VAL experiment
- Comparison of the FTLRS performances with the other laser instruments of the Grasse Observatory

The French Transportable Laser Ranging Station (FTLRS)

- Mobile satellite laser ranging station (300kg)
- Designed for altimeter calibration and orbit validation (CAL/VAL)
- Long phase of improvement (1997-2001) to reach the 1 cm accuracy level needed for JASON-1 CAL/VAL experiment



The FTLRS at Aspretto, Corsica (2002)

- New capability of tracking LAGEOS -1 and -2 satellites (6000 km high)
- Stability on ground calibration targets
- Laboratory measurements indicate an accuracy level ≤ 1 cm

The Grasse Observatory

- 3 independent laser ranging instruments
 - a classical Satellite Laser Ranging station (SLR)
 - a Lunar Laser Ranging station (LLR)
 - the FTLRS
- Triple laser collocation experiment = Unique configuration in the world

- Sept. - Dec. 2001
- Common observations on LAGEOS satellites with the 3 stations
- Common observations on TOPEX/Poseidon with the FTLRS and the SLR



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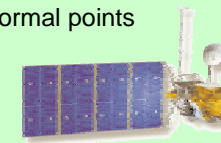
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<http://grasse.obs-azur.fr/cerga/gmc>

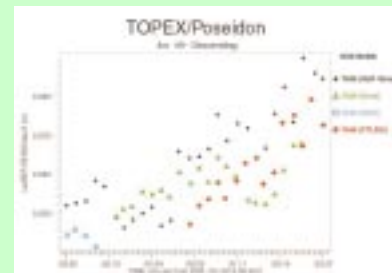
TOPEX/POSEIDON data analysis

Results

- Analysis based on the common TOPEX/POSEIDON (T/P) normal points between the FTLRS and the SLR stations over the 3 months
- Mean residual from a reference CNES orbit
 - FTLRS : 2.3 cm
 - SLR : 2.8 cm
- Good consistency between the European T/P observations



TOPEX/POSEIDON



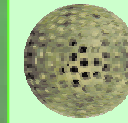
Laser residuals on a T/P pass for different European stations

Comparison with LAGEOS results

- Mean residual from LAGEOS -1 & -2 solution
 - FTLRS : 0.3 cm
 - SLR : 0.8 cm
- Systematic differences
 - of 5 mm between the FTLRS and the SLR
 - of 2 cm between T/P and LAGEOS mean residuals

LAGEOS -1 & -2 data analysis

Analysis of the common normal points of the 3 stations



LAGEOS satellite

Method

- (1) Reference orbit computation with 10 good laser stations (10-day arcs, ITRF2000, GRIM5-S1) but WITHOUT the data of the Grasse stations : $1-\sigma$ rms ~ 1.5 cm
- (2) Mean residual computation by arc, by station, and by satellite
- (3) Mean station residual over the 3 months for each station with a LAGEOS -1 & -2 combined solution

Results

- Bias differences between the Grasse laser instruments
 - SLR - FTLRS : (5 ± 1) mm
 - LLR - FTLRS : (18 ± 1) mm
 - LLR - SLR : (13 ± 1) mm

Comparison between the FTLRS and European stations

- Analysis based on all the LAGEOS passes tracked during the considered period (Sept. - Dec. 2001)
- Comparison with the 2 best European stations : Graz (Austria) and Herstmonceux (RGO, UK)

Mean bias differences

- FTLRS - Graz : (3 ± 1) mm
- FTLRS - Herstmonceux : $-(3 \pm 1)$ mm

Interpretation

It seems to exist some technical explanations for the biases between the different Grasse instruments, by order of importance :

- satellite signature depending on the detection level (single/multi photon mode)
- center edge effect of the photodiode
- calibration target distance determination
- coordinates determination

- Possible interpretation at a few mm level
- Precise computations in progress
- Validation of the FTLRS new performances at the level of 5 mm

Discussion

- Agreement between FTLRS and SLR results (systematical difference of **5 mm**)
- Systematical differences of **2 cm** between T/P and LAGEOS mean residuals

- Not due to station performance
- Not observed on JASON-1 first results
- Same difference observed for the Herstmonceux station but not for Graz
- Problem specific to T/P retroreflector array correction for some European stations



T/P retroreflector array

Conclusion and prospects

- Success of the FTLRS improvements
- Validation of the new performances of the FTLRS in its new configuration at the level of **5 mm**
- The FTLRS reaches the accuracy level of the best stations of the laser ranging network
- Systematical error of **2 cm** on T/P mean residuals for the FTLRS, the Grasse, and the Herstmonceux laser stations due to a non optimal T/P retroreflector array model
- Further investigations are in progress concerning this crucial point for the T/P CAL/VAL experiment validity
- The FTLRS is currently in Corsica for the JASON-1 CAL/VAL experiment and the first results are quite satisfactory

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