DETERMINATIONS OF THE SITE POSITION AT THE SLR TRACKING STATION (7824) AT SAN FERNANDO, SPAIN.

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Abstract

In recent years the San Fernando 7824 SLR station has been under an improvement process. This work reports on efforts that have been made in the determination of the site position. A series of solutions (UA98, UA98-UP, UA00) for the station position is obtained reducing the root-mean-square (RMS) values of the station and improving its contribution to the determination of satellite orbits, and plate motions for related geodetic studies.

The most recent solution, UA00, lowers RMSs for the station between 1.0 and 2.4 cm. for LAGEOS POD and between 2.5 and 4.9 cm. for T/P POD, reaching the standards of the best stations of the SLR network and significatively improving the ITRF00 solution for San Fernando site.

Introduction

The Royal Observatory of the Spanish Navy (ROA) at San Fernando is strategically located near the Strait of Gibraltar, by the boundary between the Eurasia and African tectonic plates. A satellite laser ranging (SLR) station, a Global Positioning System (GPS) station and a set of atomic clocks are co-located at this site. While routinely contributing to laser ranging to several satellites as well as the international time service, the San Fernando SLR station is engaged in an improvement process in hardware and software.

The ROA at San Fernando and the University of Alicante collaborate in a joint research project, which aims at improving the Spanish capabilities with regard to the tracking of geodetic satellites and the analysis of the data. Special attention has been paid to the SLR tracking station at San Fernando, after instrument upgrade to meet present precision standards, as well as the requirements for enhanced computation of crustal motions and other local and regional applications in Geodesy and Geodynamics.

Figure 1: Geographic situation of the ROA .

In the last years, a complete overhaul of 7824 SLR Station electronics and its optics have enabled routine tracking of LAGEOS at over 400 successful LAGEOS night passes per year,

while at the same time doubled the number of successful night passes for lower orbit satellites. Improved determinations of the site position have been obtained by analyzing precise laser ranging data to LAGEOS satellite, that together with LAGEOS II have been the mainstay in station positions and velocities for solutions of IERS in the past. After the upgrade process that the San Fernando SLR station has been under, past determinations of the station coordinates with respect to ITRF97 had RMSs values as large as 18 centimeters, hindering a definitive contribution to the determination of satellite orbits, and plate motions for related geodetic studies. Currently, a series of solutions has been obtained in all cases fitting 3 months data from LAGEOS I in 10-day arcs, using normal points from the global SLR tracking network. The present solution, UA00, lowers RMSs for the station between 1.0 and 2.4 cm. for LAGEOS POD and between 2.5 and 4.9 cm. for T/P POD, reaching the standards of the best stations of the SLR network.

Station Position Determination

In all cases the solutions have been obtained fitting data from LAGEOS in 10-day arcs, using normal points from the global SLR tracking network. The data have been provided by NASA´s CDDIS and processed using the NASA/GSFC software for POD and geophysical and geodynamical parameters adjustment GEODYN/SOLVE II.

The procedure followed is common to the different solutions. The 10-day arcs were combined to derive a set of station positions and station velocities, including the 7824 San Fernando station relative to certain other fiducial stations such as the 7110 Monument Peak as a reference to check the procedure evolution. Earth Orientation Parameters were estimated as independent values of time and polar motion at daily intervals. The IERS standards were followed except for the adoption of the EGM96 gravity field with expanded ocean tidal terms and a value of GM = 398600.4415 km^3/s^2.

A first solution, named UA98, was computed fitting data between March and June 1998. For this solution the CSR93 coordinates were used for San Fernando site as apriori. Once all adjustments were made combining the ten 10-day arcs, UA98 lowered RMSs below 3cm. Within the process of improving the quality of the SLR measurements, the replacement of the old dome for a new one provided a change in the SLR site position in April 1999. We applied the correction for the new position, 35 cm higher, on the former leading to UA98-UP solution.

We applied the same procedure for fitting data between September and December 1999, using as apriori value for San Fernando site the UA98-UP solution, and applying ocean loading and measurement bias adjustments -although the latter were almost negligible (in the order of a few millimeters). The resulting solution that we called UA00 is shown in Table 1 together with the corresponding solution of the ITRF 2000. In the ITRF2000 the old SLR system (until April 1999) is refereed as S004 and the SLR Fixed system, the one we include here for comparison, is refereed as S007. A comparison of the ITRF 2000 solution (for the S007 system) with the alternative solutions for SANF 7824 it is shown in Table 2. In particular we consider: the CSR93 solution, our apriori station position, the UA98 introduced above, the ITRF97 which is the first ITRF solution that includes SANF 7824 station that was computed before the new position of the laser reason why gives a large difference in the vertical, the UA98-UP corrected for new position of the laser 35 cm. higher, and the current solution UA00.

Table 1: Current solutions for San Fernando 7824 SLR station

	X /Vx	Y /Vy	Z / Vz
	(m/m s^{-1})		
UA00	5105473.9947	-555110.7739	3769892.8067
	-.237661D-09	.646437D-09	.415114D-09
ITRF00	5105473.975	-555110.726	3769892.801
	-. 294901D-09	.431253D-09	.351978D-09

Tabla 2: Comparison of solutions for SANF 7824 to the ITRF00 solution

	ΔX (m)	ΔY (m)	ΔZ (m)	ΔHeight (m)
CSR93	-0.2122	-0.0988	-0.3970	-0.4010
UA98	-0.2133	-0.0397	-0.2527	-0.3220
ITRF97	-0.2280	0.0290	-0.1880	-0.2960
UA98-UP	0.0667	-0.0660	-0.0444	0.0282
UA00	0.0197	-0.0479	0.0057	0.0233

Table 3 shows how RMSs for the station have been lowered, reaching the standards of the best stations of the SLR network. To validate the solution, and bearing in mind that our solution has been obtained fitting LAGEOS data, we have computed the TOPEX orbit provi-

Tabla 3: Comparison of solutions for SANF 7824 to the ITRF00 solution

All solutions have been obtained with SANF 7824 data withheld (downweighted)		TOPEX DATA			LAGEOS DATA		
		ARC1 991025	ARC2 991123	ARC3 991203	ARC1 991025	ARC2 991123	ARC3 991203
ITRF97	7824 STATION RMS	0.2203	0.1294	01813	0.2562	0.2062	0.2156
	POD RMS (2W RNG)	0.0601	0.0372	0.0435	0.0620	0.0415	0.0606
UA98-UP	7824 STATION RMS	0.0690	0.0490	0.0533	0.0367	0.0461	0.0340
	POD RMS (2W RNG)	0.0339	0.0318	0.0355	0.0560	0.0409	0.0508
UA00	7824 STATION RMS	0.0497	0.0253	0.0405	0.0165	0.0101	0.0246
	POD RMS (2W RNG)	0.0319	0.311	0.0351	0.0498	0.0333	0.0365
ITRF00	7824 STATION RMS				0.0542	0.0436	0.0566
	POD RMS (2W RNG)				0.0548	0.0333	0.0397

ding the position to the 7824 station of this series of solutions. For each solution we show in table 3 the POD RMS and the San Fernando 7824 station RMS. The present solution UA00, provide San Fernando station position which yields RMSs between 1 and 4 cm. for LAGEOS

POD and between 2.5 and 4.9 cm. for T/P POD. The large RMSs obtained for the 7824 station with the ITRF97 solution are not surprising bearing in mind it does not take into account the new position after the change of the dome in April 99, and the processed data is posterior. In all cases the UA00 and the ITRF00 solutions provide the lowest RMSs. UA00 reduces notably the station RMS, while for the POD lowers the RMSs with respect to the ITRF00 in the order of a few millimeters.

It is expected that further analysis of the data will yield further and better adjustments of the station position. Currently, we are in the process of analyzing additional data while combining LAGEOS I and II.

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References

Altamimi Z., P. Sillard, and C. Boucher, ITRF2000: A new release of the International Terrestrial Reference Frame for earth science applications, J. Geophys. Res., 107(B10), 2214, doi:10.1029/2001JB000561,2002.

Boucher C., Z. Altamimi, P. Sillard (eds.): Results and Analysis of the ITRF96, IERS Technical Notes No. 24.

Boucher C., Z. Altamimi, P. Sillard (eds.): The 1997 International Terrestrial Reference Frame (ITRF97) IERS Technical Notes No. 27

Boucher C., Z. Altamimi, P. Sillard, and M. Feissel-Vernier: The ITRF2000, 2004 (In print, available online http://www.iers.org/iers/publications/tn/tn31/) IERS Technical Notes No. 31

McCarthy D.D. (ed.): IERS Conventions (1996), (available online http://maia.usno.navy.mil/conventions.html) IERS Technical Notes No. 21

Lemoine, F. G., S. C. Kenyon, J. K. Factor, R.G. Trimmer, N. K. Pavlis, D. S. Chinn, C. M. Cox, S. M. Klosko, S. B. Luthcke, M. H. Torrence, Y. M. Wang, R. G. Williamson, E. C. Pavlis, R. H. Rapp and T. R. Olson. The Development of the Joint NASA GSFC and NIMA Geopotential Model EGM96, NASA Goddard Space Flight Center, Greenbelt, Maryland, 20771 USA (http://cddis.gsfc.nasa.gov/926/egm96/nasatm.html),