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Determination of UT0 from lunar laser ranging data analysis

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1. Introduction

Modern high-precision observations (VLBI, SLR, GPS and LLR) are used for determination of parameters of the Earth's rotation, corrections to stations' location and coordinates of extragalactic radio sources.

Analysis of LLR data permits to improve and to estimate a large set of seleno- and geodynamical parameters. Essentially all modern selenodynamical researches are based on LLR observations. These observations have been performed for more than 30 years. Among the results stemming from the global fitting of LLR data it should be noted the following ones: estimation of lunar dynamical flattening, improvement of the selenocentric coordinate frame, detection of free libration effect, construction of the numerical ephemerides of the Moon with high accuracy. On the other hand, LLR analysis gives the useful geodynamical information about the Earth's rotation parameters and permits to control estimations obtained from VLBI.

2. Determination of UTO – UTC and VOL

Using the modern lunar ephemerides the Moon's motion can be computed with high accuracy and over short time–intervals a lunar reflector can be regarded as a fiducial point. In this case the change in range can be assigned to the rotation of the Earth. Our method of analysis consists of two steps. First, we use numerical lunar ephemeris to estimate corrections to the set of global parameters [1].

After the global fitting of the whole set of LLR observations 1970–2000 the post-fit residuals for 1995–2000 have been analyzed to determine diurnal corrections to UT0 and the variations of latitude VOL caused by the polar motion.

The Earth orientation parameters UT1 and polar motion (x_{pol}, y_{pol}) are related with the values of UT0 and VOL obtained from the LLR analysis for a station with geocentric longitude and latitude (λ, ϕ) by the following expression:

$$UT0 - UTC = UT1 - UTC + \frac{(x_{pol} \sin\lambda + y_{pol} \cos\lambda) \tan\phi}{15}$$

$$VOL = x_{pol} \cos\lambda - y_{pol} \sin\lambda$$

At least four normal points for each station–reflector pair at one day were accepted for the diurnal UT0 estimations. Calculations were made with two lunar ephemerides EM–2 [1] and LE403 [4]. All reductions were taken into account according to the IERS Conventions 1996 [3] using the plate motion of ITRF96 [2] for corrections to the station coordinates.

We obtained in total 492 UT0–UTC values from 4860 normal points for 1995–2000, 328 from CERGA and 164 from McDonald. The estimations were derived from post–fit residuals (O–C) by two ways:

1. Calculation of (O–C) was carried out using UT1–UTC, (x_{pol}, y_{pol}) being provided by IERS EOP C04. From analysis of (O–C) we obtained corrections $\Delta(UT0 - UTC)$, ΔVOL to the corresponding IERS values.

2. Differences (UT1–UTC) were set equal to zero and not corrections but the values of (UT0–UTC) themselves and VOL were determined.

References

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