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DETERMINATION OF THE CORRECTIONS TO THE CELESTIAL POLE COORDINATES USING LLR OBSERVATIONS

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Abstract. The Lunar Laser Ranging (LLR), which is one of the most accurate astrometric technique, has many applications in various domains including astronomy, gedoynamics and gravitational physics. It consists in determining the round-trip travel times of light pulses between stations on the Earth and reflectors on the surface of the Moon.

Analysis of LLR observations allows us to determine many parameters of the Earth-Moon system, such as station coordinates on the Earth, coordinates of the retro-reflectors on the lunar surface, lunar gravity field parameters,... Here, we focus on the determination of the Earth Orientation Parameters (EOP) especially, the direction towards the Celestial Intermediate Pole (CIP) in the Geocentric Celestial Reference System.

We have first calculated the LLR residuals over a period of more than 37 years, using IAU 2000A-2006 as a model of precession nutation (i.e MHB 2000 nutation of Mathews et al. 2002 and P03 precession of Capitaine et al. 2003) and the CIO based procedure. Second, we have determined the corrections to the the IAU 2000A-2006 X and Y coordinates every 70 days. The results obtained give an interesting estimation of the celestial pole coordinates, even if the accuracy is not at the same order as from VLBI because of the insufficient density of the observations.

1 Introduction

Analysis of LLR observations allows us to determine many parameters of the Earth-Moon system, such as station coordinates on the Earth, coordinates of the retro-reflectors on the lunar surface, lunar gravity field parameters,... Here, we focus on the determination of the Earth Orientation Parameters (EOP) especially, the direction towards the Celestial Intermediate Pole (CIP) in the Geocentric Celestial Reference System.

2 Calculation and results

In a first step, we have calculated the LLR residuals using the procedure described by Chapront et al. (1999,2002) for both stations of Cerga and McDonald over the periods 1984-2005 and 1969-2006 respectively. We have used the IAU 2006-2000A model of precession nutation (MHB 2000 as a model of nutation and P03 as a model of precession) and the CIO procedure (see IERS conventions 2003 and SOFA routines).

In a second step, we have estimated the correction to the X, Y celestial pole coordinates every 70 days with respect to the IAU 2006-2000A model of precession nutation. The results are represented on Fig.1.
In order to characterize the signal, we have made a new analysis with fitting :

- First, the long-term nutation parameters (18.6, 9.3 year, a secular term, and a constant term). The results are represented on Fig.2 (left).
- Second, the annual and semi annual terms. In this case we have removed the FCN (Free Core Nutation) using a model derived from VLBI analysis. The numerical results for the amplitudes show that the error is bigger than the estimation; this is because of the imperfect distribution of the observations. The results are represented on Fig.2 (right).

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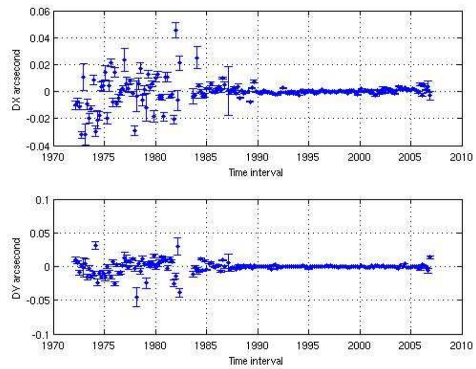

Fig. 1. DX, DY corrections to the celestial pole coordinates and their formal errors

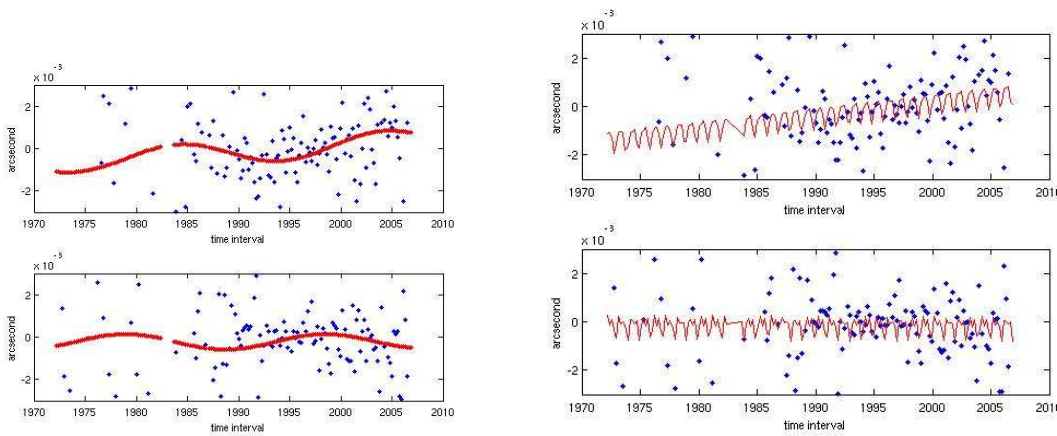

Fig. 2. Left in blue: correction DX, DY to the celestial pole coordinates - in red: the fitted terms (18.6, 9.3, secular and constant term) . **Right** in blue: correction DX, DY to the celestial pole coordinates - in red: the fitted terms (annnual, semi-annual, secular and constant term)

3 Conclusion

Fig.1 shows that from LLR observations, it is possible to have an estimation of the correction to the celestial pole coordinates (DX, DY). Due to the imperfect distribution of the observations, the accuracy is not at the same order as from VLBI.

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