WEB INTERFACE FOR LUNAR LASER RANGING OBSERVATIONS
(http://polac.obspm.fr/PaV/)

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ABSTRACT. We report the current development of a web interface for the preparation and the validation of Lunar Laser Ranging (LLR) observations. With this service which is not yet completely implemented at the time of this presentation, distant LLR observers will be able to easily run some Paris observatory tools used for the lunar motion. It will allow them to compute predictions of geocentric and topocentric coordinates of lunar targets (as retro-reflectors and craters) and predictions of round-trip times of laser-pulses between terrestrial stations and lunar retro-reflectors. It will also allow them to compare their own LLR observations with computations (lunar solutions and reduction models), in terms of rms, and with a real-time access.

1. INTRODUCTION

The address of the web site is *http://polac.obspm.fr/PaV/*. It is divided into two main web-pages : a first one for the computation of predictions of LLR observations and a second one for the validations of LLR observations. Each one of these pages is divided into two frames : the left frame is dedicated to the user requests while the right frame is used to display the results of user requests. The next two sections of this proceeding give more details about the “prediction” web-page and the “validation” web-page respectively.

2. PREDICTION OF LLR OBSERVATIONS

The user of this web interface can choose between two lunar solutions for computing predictions. Each one of these lunar solutions uses distinct lunar ephemerides and distinct reduction models.

With the first lunar solution that we named ELP96 Solution, the ephemerides are given by an improved version of the analytical solution of the Moon ELP2000-82B (Chapront-Touzé & Chapront, 1988, 1996). Initially, the lunar coordinates given by this solution are referred to the dynamical mean ecliptic. The change to the equatorial frame of the Celestial Ephemeris Pole is carried out by analytical expressions of the precession-nutation. This solution is fitted to the Lunar Laser Ranging observations made from 1972 until 2002 (Chapront & Francou, 2002).

With the second lunar solution that we named INPOP Solution, the ephemerides come from the last available version of the numerical integration INPOP (10A) which are fitted on planetary and lunar observations (Fienga et al., 2008, 2009). They are available at *http://www.imcce.fr/inpop/*. LLR observations are reduced with a model consistent with IERS Conventions 2003, including tectonic plate motion, solid tides effects, ocean and atmospheric loading, polar tide, relativistic light deviation and tropospheric time delay. This second lunar solution is not yet implemented at the time of this presentation.

With both lunar solutions, the most recent values for the “Earth Orientation Parameters” (EOP) are needed to compute accurate predictions for the preparation of future LLR observations. To do that, a daily automatic update has been implemented to download the latest EOP series and the latest EOP predictions computed by the Earth Orientation Center of IERS.

The users can also choose the following requests :
• the LLR station on Earth,
• the lunar target (retro-reflectors or craters),
• the initial date and time of the first prediction,
• the step size between two successive predictions (in second or minute),
• the number of steps,
• the weather conditions,
• the wavelenght of the laser used.

The results are displayed in the right part of the screen. By default, the display format of this prediction is a format we developed recently and named TPF (for Topocentric Prediction Format). This format gives for each instant chosen by the user and for the selected lunar target seen from the selected station the corresponding :
• apparent equatorial rectangular coordinates in meter,
• round-trip light time in second,
• right ascension and declination in degree,
• azimuth and zenith distance in degree.

The prediction can also be computed with the format CPF (acronym for Consolidated Laser Ranging Prediction Format) which has been created by the ILRS Predictions Formats Study Group for satellite laser ranging and lunar laser ranging. An explanation of this format can be found in:
http://ilrs.gsfc.nasa.gov/products formats procedures/predictions/.

3. VALIDATION OF LLR OBSERVATIONS

To validate his LLR observations, the user of this web interface can choose between one of the two lunar solutions described above.

To submit LLR observations, the user selects and copies his own LLR observations data from a file and then pastes them into the "users data capture area" in the left part of the screen. The available formats for users data submission are:
• the format MINI (explanation at: *http://www.physics.ucsd.edu/~tmurphy/apollo/norm_pts.html*),
• the format CSTG (explanation at: *http://ilrs.gsfc.nasa.gov/products_formats_procedures/*),
• the format CRD (explanation at: *http://ilrs.gsfc.nasa.gov/docs/crd_v1.01.pdf*).

The results of validation process are displayed in the right part of the screen. For each LLR observation, a line of results is given. This line contains:
• the number of processed observations,
• the station identification,
• the reflector number,
• the date and time of the observation,
• the observed round-trip light time in second,
• the difference between the observed light time and the computed light time in nanosecond and its equivalent in meter for the distance station-reflector.

These results can be downloaded as an ASCII file or as a Virtual Observatory table. The bias and the standard deviation of residuals are given for the retro-reflectors all together and for each one of them. Graphs of residuals are also available according to the stations, the reflectors, the time and residuals units.

4. REFERENCES

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