

### 3.6.2.10 Jet Propulsion Laboratory (JPL)

#### Introduction

The uncertainty in our knowledge of the Earth's changing orientation in space is a major source of error in tracking and navigating interplanetary spacecraft. Because the Earth's orientation changes rapidly and unpredictably, measurements must be acquired frequently and processed rapidly in order to meet the near-real-time Earth orientation requirements of the interplanetary spacecraft navigation teams. These requirements are currently met at JPL by using the Global Positioning System (GPS) to provide daily determinations of polar motion and length-of-day within 24 hours of acquisition. Single baseline Very Long Baseline Interferometry (VLBI) measurements are taken twice-per-month by the Time and Earth Motion Precision Observations (TEMPO) project in order to provide the benchmark Universal Time (UT) measurements between which the GPS length-of-day measurements are integrated. The Kalman Earth Orientation Filter (KEOF) is then used to combine the GPS polar motion and length-of-day measurements with the TEMPO VLBI variation-of-latitude and UT0 measurements, along with other publicly available Earth orientation measurements including proxy measurements such as atmospheric angular momentum, in order to generate and deliver the required polar motion and UT1 Earth orientation parameters to the spacecraft navigation teams.

#### Data Products

Reference series of Earth orientation parameters are generated annually at JPL. During 2002, three such reference series were generated: (1) SPACE2001, consisting of values and rates for polar motion and UT1 spanning September 28, 1976 to January 19, 2002 at daily intervals, was generated by combining Earth orientation measurements taken by the space-geodetic techniques of Lunar and Satellite Laser Ranging, VLBI, and GPS; (2) COMB2001, consisting of values and rates for polar motion and UT1 spanning January 20, 1962 to January 15, 2002 at either 1-day or 5-day intervals, was generated by additionally including the BIH optical astrometric measurements with the space-geodetic measurements used to generate SPACE2001; and (3) POLE2001, consisting of values and rates for just polar motion spanning January 20, 1900 to December 21, 2001 at monthly intervals, was generated by additionally including the ILS optical astrometric measurements with the other optical astrometric and space-geodetic measurements used to generate COMB2001. These reference series can be obtained by anonymous ftp to <ftp://euler.jpl.nasa.gov/keof/combinations/2001>. A report describing the generation of these series [Gross, 2002] is also available at this site.

The near-real-time Earth orientation requirements of the interplanetary spacecraft navigation teams are met by twice-per-week updating the annually generated reference series. The updated Earth orientation series are generated by additionally incorporating measurements that are rapidly available such as the GPS measurements from the JPL Analysis Centre of the IGS and the atmospheric angular momentum measurements from NCEP that are used as proxy length-of-day measurements. In addition, short-term predictions of the EOPs are produced in order to provide the navigation teams with an uninterrupted series of Earth orientation parameters. The updated and predicted EOP series can be obtained by anonymous ftp to

<<ftp://euler.jpl.nasa.gov/keof/predictions>>.

### Research activities

Research activities during 2002 were largely concerned with exploring methods of improving the accuracy of the combined and predicted Earth orientation parameters. The feasibility of producing daily updates was explored, Earth orientation measurements from alternate sources were evaluated including the JCET/GSFC SLR polar motion series, and methods to improve the accuracy of short-term predictions of the EOPs were investigated [Chin *et al.*, 2003].

### References

- Chin, T. M., R. S. Gross, and J. O. Dickey, Modeling and forecast of the polar motion excitation functions for short-term polar motion prediction, *J. Geodesy*, submitted, 2003.
- Gross, R. S., Combinations of Earth orientation measurements: SPACE2001, COMB2001, and POLE2001, Jet Propulsion Laboratory Publ. 02-08, 27 pp., Pasadena, Calif., 2002.

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