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JPL Planetary and Lunar Ephemerides

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JPL PLANETARY AND LUNAR EPHEMERIDES : Export Information      [30 April 2014]

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INTRODUCTION
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JPL planetary ephemerides are generally created to support spacecraft missions
to the planets. Selected ephemerides are recommended for more general use.

The latest JPL ephemeris with fully consistent treatment of planetary and
lunar laser ranging data is DE430 (Folkner et al 2014). The dynamical model
for DE430 includes a frictional damping between the fluid core and the
elastic mantle. This damping term is not suitable for extrapolation more
than several centuries into the past. In order to cover a longer time span,
the ephmeris DE431 was integrated without the lunar core/mantle damping term.
The positions of the planets for DE431 agree with the positions on DE430 to
within one meter over the time covered by DE430. For the Moon DE431 differs
from DE430 mainly in the estimated tidal damping term causing a difference
in along-track position of the Moon of 20 meters 100 years from the present
and growing quadratically for times more thna 100 years from present.

The JPL planetary ephemerides are saved as files of Chebyshev polynomials fit
to the Cartesian positions and velocities of the planets, Sun, and Moon,
typically in 32-day intervals. The positions are integrated in astronomical
units (au), but with polynomials stored in units of kilometers. The integration
time units are days of barycentric dynamical time (TDB). Prior to DE430, the
value of the astronomical unit was estimated from measurements of planetary orbits
using the Gaussian gravitational constant k. Starting with DE430, the astronomical
units has been fixed to the value 149597870.700 km as adopted by the
International Astronomical Union in 2012.

Most JPL planetary ephemeris files include Chebyshev polynomials fit to
the lunar libration angles, which are integrated along with the planetary
positions. Many ephemeris files also a fit to the 1980 IAU nutation series.
While the 1980 IAU nutation series is not current, it is maintained in the
files for backward compatibility.


ACCESSING THE JPL PLANETARY EPHEMERIDES
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For users who need positions of planets at a few specific times,
JPL's interactive website and telnet service, "Horizons", provides a wide
variety of astronomical information including planetary positions from the
planetary ephemeris DE431, at web site  http://ssd.jpl.nasa.gov/?horizons .
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For users who need the capability of looking up the positions of planets at many times or as needed for other computations, the recommended means of reading the ephemerides is through use of the SPICE software toolkit, http://naif.jpl.nasa.gov/ .
The SPICE software is supported in several languages (including C, Fortran, and Matlab) on multiple platforms and compilers. The SPICE software reads JPL planetary ephemerides in a machine-independent binary format (kernels) which are available from the SPICE web site and by anonymous ftp from ftp://ssd.jpl.nasa.gov/pub/eph/planets/bsp .

The JPL planetary ephemerides are also available in an ASCII format which are converted by the user to machine-dependent binary files for reading.
The ASCII files are created in blocks of 20 or more years. Later ephemerides tend to be stored in longer blocks. When converted into binary format, the files can be merged to span a longer time if desired.
The ASCII files are available by anonymous ftp from ftp://ssd.jpl.nasa.gov/pub/eph/planets/ascii/ .
The ascii file format is briefly described in the file ftp://ssd.jpl.nasa.gov/pub/eph/planets/ascii/ascii_format.txt .

The machine-dependent binary files differ mainly in the binary representation of numbers. The 'little-endian' representation is used by Intel x86, IA64 or Alpha based processors (and their clones). Some binary ephemeris files are available in this format from ftp://ssd.jpl.nasa.gov/pub/eph/planets/Linux .
The 'big endian' representation is used by PowerPC and SPARC processors. Some binary files in this format are available from ftp://ssd.jpl.nasa.gov/pub/eph/planets/SunOS .

Fortran programs for converting the ASCII files and for merging and reading the binary files are available by anonymous ftp from ftp://ssd.jpl.nasa.gov/pub/eph/planets/fortran .
These Fortran programs generally require some tailoring by the user.
Instructions for using these programs are available for downloading from ftp://ssd.jpl.nasa.gov/pub/eph/planets/fortran/userguide.txt .
Other programs for reading these formats have been developed independently by outside programmers, and not suported directly by JPL, are listed at ftp://ssd.jpl.nasa.gov/pub/eph/planets/other_readers.txt .

AVAILABLE EPHEMERIDES

DE102 : Created September 1981; includes nutations but not librations.
        Referred to the dynamical equator and equinox of 1950.
        Covers JED 1206160.5 (-1410 APR 16) to JED 2817872.5 (3002 DEC 22).

DE200 : Created September 1981; includes nutations but not librations.
        Referred to the dynamical equator and equinox of 2000.
        Covers JED 2305424.5 (1599 DEC 09) to JED 2513360.5 (2169 MAR 31).
        This ephemeris was used for the Astronomical Almanac from 1984 to 2003.
        (See Standish, 1982 and Standish, 1990).

DE202 : Created October 1987; includes nutations and librations.
        Referred to the dynamical equator and equinox of 2000.
        Covers JED 2414992.5 (1899 DEC 04) to JED 2469808.5 (2050 JAN 02).

DE403 : Created May 1993; includes nutations and librations.
        Referred to the International Celestial Reference Frame.
        Covers JED 2305200.5 (1599 APR 29) to JED 2524400.5 (2199 JUN 22).
        Fit to planetary and lunar laser ranging data.
        (See Folkner et al. 1994).

DE405 : Created May 1997; includes both nutations and librations.
        Referred to the International Celestial Reference Frame.
        Covers JED 2305424.50 (1599 DEC 09) to JED 2525008.50 (2201 FEB 20)

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DE406 : Created May 1997; includes neither nutations nor librations.
        Referred to the International Celestial Reference Frame.
        Spans JED 0625360.5 (-3000 FEB 23) to 2816912.50 (+3000 MAY 06)

        This is the same integration as DE405, with the accuracy of the
        interpolating polynomials has been lessened to reduce file size
        for the longer time span covered by the file.

DE410 : Created April 2003; includes nutations and librations.
        Referred to the International Celestial Reference Frame.
        Covers JED 2415056.5 (1900 FEB 06) to JED 2458832.5 (2019 DEC 15).
        Ephemeris used for Mars Exploration Rover navigation.

DE413 : Created November 2004; includes nutations and librations.
        Referred to the International Celestial Reference Frame.
        Covers JED 2414992.5, (1899 DEC 04) to JED 2469872.5 (2050 MAR 07).

        Created to update the orbit of Pluto to aid in planning
        for an occultation of a relatively bright star by Charon on 11 July 2005.

DE414 : Created May 2005; includes nutations and librations.
        Covers JED 2414992.5, (1899 DEC 04) to JED 2469872.5 (2050 MAR 07).

        Fit to ranging data from MGS and Odyssey through 2003.
        (See Konopliv et al., 2006.)

DE418 : Created August 2007; includes nutations and librations.
        Covers JED 2414864.5 (1899 JUL 29) to JED 2470192.5 (2051 JAN 21)

DE421 : Created Feb 2008; includes nutations and librations.
        Referred to the International Celestial Reference Frame.
        Covers JED 2414864.5 (1899 JUL 29) to JED 2471184.5 (2053 OCT 09)

        Fit to planetary and lunar laser ranging data.
        (See Folkner et al., 2009)

DE422 : Created September 2009; includes nutations and librations.
        Referred to the International Celestial Reference Frame.
        Covers JED 625648.5, (-3000 DEC 07) to JED 2816816.5, (3000 JAN 30).

        Intended for the MESSENGER mission to Mercury.
        Extended integration time to serve as successor to DE406.
        Fit to ranging data from MGS and Odyssey through 2003.
        (See Konopliv et al., 2010.)

DE423 : Created February 2010; includes nutations and librations.
        Referred to the International Celestial Reference Frame  version 2.0.
        Covers JED 2378480.5, (1799 DEC 16) to JED  2524624.5, (2200 FEB 02).

        Intended for the MESSENGER mission to Mercury.

DE430 : Created April 2013; includes librations and 1980 nutation.
        Referred to the International Celestial Reference Frame  version 2.0.
        Covers JED 2287184.5, (1549 DEC 21) to JED 2688976.5, (2650 JAN 25).

DE431 : Created April 2013; includes librations and 1980 nutation.
        Referred to the International Celestial Reference Frame  version 2.0.
        Covers JED -3100015.5, (-13200 AUG 15) to JED 8000016.5, (17191 MAR 15).

        DE430 and DE431 are documented in the following document:
        http://ipnpr.jpl.nasa.gov/progress_report/42-196/196C.pdf

DE432 : Created April 2014; includes librations but no nutations.
        Referred to the International Celestial Reference Frame  version 2.0.
        Covers JED 2287184.5, (1549 DEC 21) to JED 2688976.5, (2650 JAN 25).

        DE432 is a minor update to DE430, and is intended primarily to
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            aid the New Horizons project targeting of Pluto.
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ASSISTANCE

Questions may be addressed to;

William Folkner; JPL m/s 301-121; Pasadena, CA 91109
TEL: 818-354-0443   FAX: 818-393-5904
e-mail: William.Folkner@jpl.nasa.gov

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