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EXPLANATORY SUPPLEMENT
TO IERS BULLETINS A AND B

IERS Bulletins A and B provide current information on the Earth's orientation in the IERS Reference System. This includes Universal Time, coordinates of the terrestrial pole, and celestial pole offsets. Bulletin A gives an advanced solution updated weekly by e-mail subscription or daily by anonymous ftp; the standard solution is given monthly in Bulletin B. The Annual Report contains information on the data used, the models, the algorithms, and the reference frames, as well as revised solutions for the past years. All solutions are continuous within their respective uncertainties. Bulletin A is issued by the IERS Rapid Service/Prediction Centre at the U.S. Naval Observatory, Washington, DC and Bulletin B is issued by the IERS Earth Orientation Centre at the Paris Observatory.

Bulletin A is intended for users who need accurate information before the Bulletin B “finals” series is available, i.e., those who reduce data in the very recent past (require rapid service) or those who operate in real-time (require predictions). Bulletin B is intended for standard use. For scientific and long-term analyses of the Earth's orientation, users are advised to request the long-term continuous series maintained by the Earth Orientation Centre from 1846 (pole components), 1962 (UT), and 1981 (dPsi, dEpsilon) to the current date. All solutions are available electronically (see Section VIII).

Resolutions adopted at the 24th General Assembly of the International Astronomical Union (IAU) recommend the implementation of new procedures concerning the transformation between the celestial and terrestrial reference systems: adoption of a new precession/nutation model (IAU 2000), a new celestial pole (the Celestial Intermediate Pole), and a new transformation between the terrestrial and celestial systems defining UT1 as directly proportional to the Earth rotation angle. These resolutions were implemented in Bulletins A and B on January 1, 2003 and are discussed below.

I. THE IERS CONVENTIONS

The IERS uses the following conventions:

A. <u>The International Celestial and Terrestrial Reference Systems</u>

The International Celestial and Terrestrial Reference Systems (respectively ICRS, ITRS) are defined by their origins, directions of axes and, in the case of the ITRS, length unit. The ICRS is described by Arias et al. (1995). Its origin is at the barycenter of the solar system. The directions of its axes are fixed with respect to the quasars to better than +/- 20 micro-arcseconds; they are aligned with those of the FK5 within the consistency of the latter (+/- 80 milliarcseconds at epoch J1991.25 (van Leeuwen et al., 1997). The ICRS is realized by estimates of the coordinates of a set of extragalactic sources: the International Celestial Reference Frame (ICRF) (Ma and Feissel, 1997; Ma et al., 1998). According to Resolution B2 of the International Astronomical Union (IAU)

23rd General Assembly (Kyoto, 1998), after 1 January 1998 the IAU celestial reference system is the International Celestial Reference System (ICRS) as defined by the International Earth Rotation Service (IERS) and the corresponding fundamental reference frame is the ICRF constructed by the IAU Working Group on Reference Frames. The IERS was asked to monitor the maintenance of the ICRS and its ties to the reference frames at other wavelengths. In the present IERS structure, two groups share this task: the International VLBI Service for Geodesy and Astrometry (IVS) and the IERS ICRS Centre, which is jointly operated by the Paris Observatory and the U.S. Naval Observatory.

The ITRS origin is at the center of mass of the entire Earth system, including the oceans and the atmosphere. Its length unit is the meter (SI), consistent with the TCG time coordinate for a geocentric local frame. The orientation of its axes is consistent with that of the BIH System at 1984.0 within +/- 3 milli-arcseconds. The International Reference Meridian (IRM) is implicitly defined through the adoption of the set of coordinates of stations realizing the ITRF.

Its time evolution in orientation is such that it has no residual rotation relative to the Earth's crust. The ITRS is realized by estimates of the coordinates and velocities of a set of observing stations, the International Terrestrial Reference Frame (ITRF). For more details, see Boucher et al. (1996) and the IERS Conventions (2003) (McCarthy and Petit, 2004). A new ITRF realization (ITRF2000) is now available (http://lareg.ensg.ign.fr/ITRF/).

B. IERS constants and models

The IERS Conventions (2003) (McCarthy and Petit, 2004) are a set of constants and models used by the IERS Technique and Analysis Centres for Very Long Baseline Interferometry (VLBI), Global Positioning System (GPS), satellite radio positioning (DORIS), Satellite Laser Ranging (SLR), and by the IERS Product Centres in the combination of results.

The values of the constants are adopted from recent analyses. In some cases, they differ from the current IAU and International Association of Geodesy conventional ones. The models are, in general, the best estimates of the specialists in the field. Observations have shown that there are deficiencies in the IAU 1976 Theory of Precession and the IAU 1980 Theory of Nutation. As a result the IAU has adopted the IAU 2000 precession-nutation model (see IERS Conventions (2003) [McCarthy and Petit, 2004]). This model was implemented by the IERS as of 1 January 2003.

II. TIMESCALES USED IN BULLETINS A AND B

TAI is the atomic time scale calculated by the BIPM. Its unit interval is exactly one SI second at mean sea level. The origin of TAI is such that UT1-TAI was approximately 0 on 1 January 1958. The instability of TAI is about six orders of magnitude smaller than that of UT1.

UTC is defined by the International Radio Consultative Committee (CCIR) Recommendation 460-4 (CCIR, 1986). It differs from TAI by an integral number of seconds in such a way that UT1-UTC remains smaller than 0.9s in absolute value. The decision to introduce a leap second in UTC to meet this condition is the responsibility of the IERS; it is announced in Bulletin C. According to the CCIR Recommendation, first preference is given to opportunities at the end of June and December and second preference to those at the end of March and September. Since the system was introduced in 1972, only dates in June and December have been used.

A new definition of UTC is under discussion by the IAU and the International Telecommunication Union, but no action is anticipated before 2006.

III. THE EARTH ORIENTATION PARAMETERS, DEFINITION BEFORE JANUARY 1, 2003

The IERS Earth Orientation Parameters (EOP) describe the rotation of the ITRS relative to the ICRS, in conjunction with the conventional Precession-Nutation model.

A. The coordinates of the Celestial Ephemeris Pole (CEP) relative to the International Reference Pole (IRP) are defined as x and y. The CEP differs from the instantaneous rotation axis by quasi-diurnal terms with amplitudes under 0.01" (see Seidelmann, 1982). The x-axis is in the direction of the IERS Reference Meridian (IRM), the y-axis is in the direction 90 degrees West longitude.

B. UT1 is the rotation angle about the pole. It is defined by a conventional relationship between the origins of the terrestrial and celestial reference frames (Capitaine et al., 2000, Capitaine et al., 2003, McCarthy and Petit, 2004). This relationship was developed to maintain consistency with the previous defining relationship (Aoki et al., 1982). It gives access to the direction of the International Reference Meridian (IRM) in the ICRS, reckoned around the CEP axis. It is expressed as the difference UT1-TAI or UT1-UTC.

DUT1 is the difference UT1-UTC expressed with a precision of +/- 0.1s; it is broadcast with the time signals and announced in Bulletin D. The changes in DUT1 are decided by the IERS.

The difference between the astronomically determined duration of the day (D) and 86400s of TAI, is called length of day (LOD). Its relationship with the angular velocity of the Earth, Omega, is:

Omega = 72 921 151.4670698 - 0.843994809 D, where Omega is in picoradians/s and D in ms.

UT1, hence D and Omega, are subject to variations due to zonal tides. The model, which is a part of the IERS Conventions, includes 62 periodic components with periods ranging from 5.6 days to 18.6 years. UT1R, DR, and OmegaR are the values of UT1, D, and Omega corrected for the short-term part of the model by Yoder et al. (1981), i.e., the 41 components with periods under 35 days. In absolute value UT1R-UT1 is smaller than 2.5 ms, LODR-LOD is smaller than 1 ms. As recommended in IERS Gazette #13 (McCarthy and Gambis, 1997), IERS Earth orientation data are produced at daily intervals and do not include the effects of semidiurnal and diurnal variations; Ray's model has been adopted for interpolation. The corresponding numerical program is available from either Centre’s ftp site, see McCarthy and Gambis (1997) for details.

C. The IERS continues to provide the offset in longitude $\delta\Delta\psi_{1980}$ and in obliquity $\delta\Delta\varepsilon_{1980}$ with respect to the IAU 1976 Theory of Precession and the IAU 1980 Theory of Nutation. Following the implementation of the IAU 2000 precession-nutation model in 2003, however, the IERS also provides offsets with respect to this model. The offsets $\delta\Delta\psi_{1980}$ and $\delta\Delta\varepsilon_{1980}$ are labeled dpsi and deps in the released IERS EOP Bulletin A, and Bulletin B.

IV. THE EARTH ORIENTATION PARAMETERS, DEFINITION AFTER JANUARY 1, 2003

A. New parameterization of the Earth orientation

The most important changes are those introduced by IAU Resolutions B1.6 (IAU 2000 Precession-Nutation Model), B1.7 (Definition of Celestial Intermediate Pole), and B1.8 (Definition and Use of Celestial and Terrestrial Ephemeris Origins). The new precession-nutation model is accompanied by a new formulation for the transformation between the celestial (*CRS*) and terrestrial (*TRS*) reference systems in the form recommended in the IERS Conventions (2003) (McCarthy and Petit, 2004):

$$[CRS]=Q(t)\cdot R_3(-\theta)\cdot W(t)\cdot[TRS],$$

in which $Q(t)$, $R_3(-\theta)$, and $W(t)$ are time-dependent transformation matrices to account for the precession-nutation, proper rotation of the Earth about the axis corresponding to CIP, and polar motion, respectively:

$$Q(t)=\begin{pmatrix} 1-aX^2 & -aXY & X \\ -aXY & 1-aY^2 & Y \\ -X & -Y & 1-a(X^2+Y^2) \end{pmatrix}\cdot R_3(s),\quad a=\frac{1}{2}+\frac{1}{8}(X^2+Y^2)$$

, and

$$W(t)=R_3(-s')\cdot R_2(x)\cdot R_1(y).$$

The Earth rotation angle between the CEO and TEO is given as function of UT1 by a simple linear relation:

$$\theta(T_u) = 2\pi(0.779\,057\,273\,264\,0 + 1.002\,737\,811\,911\,354\,48\ T_u)$$

where $T_u = \mathrm{JD}(\mathrm{UT1}) - 2451545.0$.

Here X, Y, s and x, y, s' describe the position of the Celestial Intermediate Pole (CIP) and the Celestial/Terrestrial Ephemeris Origins (CEO, TEO) in the Geocentric Celestial Reference System (GCRS) and International Terrestrial Reference System (ITRS), respectively (see http://maia.usno.navy.mil/ch5tables.html). The developments of X, Y, and s into Poisson series, based on the IAU 2000A precession/nutation model, are published by Capitaine et al. (2003) and are available in the IERS Conventions (2003). Expressions for the classical transformation based on the new IAU 2000 model have been developed to be equivalent in the new transformation (IERS Conventions (2003)).

1) *Celestial pole offsets*

Precession-nutation is referred to the CIP that exhibits, by definition, only long-periodic motions with periods of two days and longer in space. The IERS provides the celestial pole offsets δX_{2000} and δY_{2000} referred to the new model IAU 2000 following the new formalism and the quantity s. Classical nutation angles, the celestial pole offsets in longitude and obliquity ($\delta\Delta\psi_{2000}$, $\delta\Delta\varepsilon_{2000}$), respectively, referred to the new model can be easily derived from (δX_{2000}, δY_{2000}) using equations 23 in Chapter 5 of the IERS Conventions (2003) or the relative Fortran subroutine dXdY_dpsideps included in the package, uai2000.package (see next paragraph for its availability). These values δX and δY are now smaller than 1 mas, reflecting mostly the effect of the Free Core Nutation (FCN) that is not predictable and therefore not incorporated into the new model. The position of the CEO, given by *s*, is insensitive to any small change of the precession-nutation at the level of one mas, so only its model values are to be used (http://maia.usno.navy.mil/ch5tables.html). In parallel with these values, the values of the 'classical' celestial pole offsets $\delta\Delta\psi_{1980}$ and $\delta\Delta\varepsilon_{1980}$ referred to the old IAU 1976 Precession and 1980 Nutation model are also being published in Bulletin A and Bulletin B.

2) *Polar motion*

Polar motion is not affected by adopting the IAU 2000 resolutions. Polar motion contains (relatively small) diurnal and sub-diurnal terms, due to ocean tides and high-frequency nutation terms. These are *not* part of the polar motion values published by the IERS at daily intervals; they are represented by a model (IERS Conventions (2003), Chapters 5 and 8) and should be added after interpolation. The Earth Orientation Centre makes available a Fortran subroutine for such an interpolation (ftp://hpiers.obspm.fr/eop-pc/models/interp.f). The position of the TEO, given by *s'*, depends on the actual polar motion but the value of *s'* is so small that a simple linear approximation (Lambert and Bizouard, 2002) is sufficient:

$s' = -47\ \mu as\ (t - 51544.5) / 36525$ where t is expressed in modified Julian days (MJD).

3) *Universal Time*

UT1-UTC is theoretically not affected by the resolutions. Although UT1 is now directly linked to the Earth rotation angle through the linear relation above, the positioning of CEO (represented by the quantity *s*) and IAU2000 expressions between sidereal time and universal time UT1 are such that continuity in UT1 is ensured at the epoch of change from the old system.

There are short-periodic (diurnal, semi-diurnal) variations in UT1 due to ocean tides that are treated similarly to polar motion (the IERS publishes the daily values from which these terms have been removed, and they are to be added back after the interpolation).

B. Availability of new products and models

Since January 2003, the IERS Rapid Service/Prediction Centre and IERS Earth Orientation Centre have been publishing Bulletin A and Bulletin B containing δX and δY with respect to IAU 2000A precession/nutation model in parallel to the current issue containing $(\delta\Delta\psi, \delta\Delta\varepsilon)_{1980}$.

The new Bulletin A files are available at the following ftp sites:

- anonymous ftp: maia.usno.navy.mil
  files : /ser7/finals2000A.daily
  /ser7/finals2000A.data

The new Bulletin B files are available at the following Web/ftp sites:

- Web:
  http://hpiers.obspm.fr/eoppc/bul/bulb/

- anonymous ftp: hpiers.obspm.fr
  files : / eoppc/bul/bulb/

C. Fortran subroutines

1) Transformation of $(\delta X, \delta Y)_{2000}$ to $(\delta\Delta\psi, \delta\Delta\varepsilon)_{1980}$ or $(\delta\Delta\psi, \delta\Delta\varepsilon)_{2000}$ and inversely are available in Fortran 77/90 at :

- Web page:
 http://hpiers.obspm.fr/eop-pc/models/models.html#software

Files:

- ftp://hpiers.obspm.fr/eop-pc/models/uai2000.package
- ftp://hpiers.obspm.fr/eop-pc/models/uai2000.package.readme

- anonymous ftp: hpiers.obspm.fr
  files : /eop-pc/models/uai2000.package
  /eop-pc/models/uai2000.package.readme

2) Interpolation of Polar Motion at hourly scale

- Web: http://hpiers.obspm.fr/eop-pc/models/models.html#software

Files:

- ftp://hpiers.obspm.fr/eop-pc/models/interp.f
- ftp://hpiers.obspm.fr/eop-pc/models/interp.readme

V. THE DATA ANALYSIS

The data analysis that yields the values of the EOP published in Bulletins A and B includes several steps that are summarized below.

1. The individual Technique Centres coordinated the observations made using the VLBI, SLR, GPS, and DORIS networks.

2. Analyses (operational and refined) are done by the Analysis Centres of the Technique Centres. The operational results are transmitted in parallel to the IERS Rapid Service/Prediction Centre to contribute to Bulletin A and to the IERS Earth Orientation Centre to contribute to Bulletin B. The operational results are also archived at each centre. The refined results are computed yearly.

3. The IERS Rapid Service/Prediction Centre performs additional processing of operational results. The IGS GPS satellite orbit data are used to estimate a GPS UT1-like quantity, and atmospheric angular momentum (AAM) analysis and forecast data from NOAA and the IERS Global Geophysical Fluid Center's Special Bureau of the Atmosphere are used to estimate an AAM UT1-like quantity.

4. General adjustment of ICRF, ITRF, and EOP by the IERS Product Centres are based on the refined annual results. This adjustment, described in the IERS Annual Report provides the basis for determining the systematic corrections to be added to the individual series in order to bring them into the IERS Reference System. These corrections are used in step 6. The general results are published in the IERS Annual Report and long-term monitoring results were given by Gambis (2000).

5. Determination of EOP by the IERS Rapid Service/Prediction Centre is in the form of slightly smoothed solutions at one-day intervals. This involves the application of systematic corrections and statistical weighting. The accuracy of this solution is given in Table 1. The results are published in Bulletin A with a delay of about 18-hours between the date of publication and the last available date with estimated EOP. The details of the procedure are outlined in McCarthy and Luzum (1991a).

6. Determination of EOP by the IERS Earth Orientation Centre is in the form of combined solutions derived from the individual series. Various solutions are computed: normal values at five-day intervals and slightly smoothed solutions at one-day and five-day intervals. In the procedure systematic corrections determined in step 4 and statistical weighting is applied. The accuracy of these solutions is given in Table 1. The results are published in Bulletin B with a delay of thirty days between the date of publication and the last date of the standard solution.

7. Bulletins A provides predictions of the EOP while Bulletin B gives an extrapolation of the standard solution. Details of the procedure used for Bulletin A are given in McCarthy and Luzum (1991b) . Their performances are given in Table 1.

Table 1: Precision of the current solutions. The accuracy which includes the uncertainty of the tie to the IERS System can be estimated by adding quadratically 0.0002" in terrestrial pole, 0.00003s in UT1, and 0.0002" in celestial pole.

Solutions		Terrestrial Pole 0.001"	UT1 0.0001s	Celestial Pole 0.001"
Bulletin A daily		0.1	0.2	0.3
Prediction	1d	0.6	1.1	0.3
	5d	2.6	4.2	0.3
	10d	4.8	8.8	0.3
	20d	9.0	20.3	
	40d	16.1	49.9	0.3
	90d	25.6	125.0	
Bulletin B daily		0.1	0.2	0.3

VI. CONTENTS OF BULLETINS A AND B

A. *BULLETIN A (weekly and daily)*

General information including key definitions and the most recently adopted values of DUT1 and TAI-UTC.

Quick-look daily (finals.daily) and weekly (finals.all and finals.data) estimates of the EOP are determined by combining the most recently available observed and modeled data (including VLBI 24-hour and intensive, GPS, and AAM). The combination process involves applying systematic corrections and slightly smoothing in order to remove the high frequency noise. The SLR data type is updated for the weekly estimates.

The daily solutions contain predictions of x, y, and UT1-UTC daily up to 90 days following the last day of data in Section 4, while the weekly solutions contain predictions of x, y, UT1-UTC daily up to 360 days following the last day of data and smoothed daily values of celestial pole offsets. The results are published with a delay of about 18-hours between the date of publication and the last available date with estimated EOP.

To bring the Bulletin A (weekly and daily) EOP solutions in compliance with IAU 2000 resolutions, additional files (finals2000A.daily and finals2000A.data) are available which contain δX and δY with respect to IAU 2000A precession/nutation theory.

B. *BULLETIN B (Monthly)*

Section 1: Five days sampling of section 2. Final Bulletin B values over one month and provisional extension over the next three months.

Section 2: Smoothed values of x, y, UT1-UTC, UT1-UT1R, $\delta\Delta\psi$, and $\delta\Delta\varepsilon$ at one-day intervals and provisional extension from the last Final Bulletin B value based on a combination of the series presented in section 6. What is the degree of smoothing?

Section 3: Five-day normal values of x, y, UT1-UTC, $\delta\Delta\psi$, and $\delta\Delta\varepsilon$ (EOP(IERS) C02), and their uncertainties and provisional extension from the last Final Bulletin B value based on a combination of the series of section 6. New class of robust M-Huber estimators is used in the analysis procedures (Bougeard et al., 2000).

Section 4: Smoothed values of DR and OmegaR, with the same degree of smoothing as UT1R-UTC.

Section 5: Information on the time scales and announcement of the leap seconds.

Section 6: Average precision of the individual series contributing to the combination and their agreement with the combination.

VII. INDIVIDUAL SERIES CONTRIBUTING TO IERS BULLETINS A AND B, JANUARY 2004

Table 2 gives the estimated accuracy with respect to IERS C04 of these series over 2003-2004 after removal of systematic variations, mainly a bias. The IERS C04 series is maintained by the IERS Earth Orientation Centre (see EOP Combined Series at http://hpiers.obspm.fr/eop-pc/ for details).

Table 2: Estimated accuracies of individual solutions entering the combined solutions in 2003-2004.

Individual solutions		Estimated uncertainties				
		Time	Terrestrial Pole 0.001"	UT1 (0.0001s)	LOD (0.0001s)	Celestial Pole 0.001"
VLBI - 24 h						
EOP (AUS)	01 R 01	3-4d	0.20	0.05		0.12
EOP (BKG)	03 R 04	1-4d	0.22	0.05		0.15
EOP (GSFC)	03 R 06	1-4d	0.16	0.04		0.10
EOP (IAA)	03 R 04	1-4d	0.14	0.04		0.08
EOP (MAO)	03 R 01	1-4d	0.21	0.05		0.17
EOP (SPBU)	03 R 03	3-4d	0.22	0.05		0.13
EOP (USNO)	03 R 04	1-4d	0.15	0.04		0.13
VLBI - Intensive						
EOP (BKG)	03 R 02	1-3 d		0.13		
EOP (GSFC)	03 R 05	1-3 d		0.12		
EOP (IAA)	03 R 03	1-3 d		0.13		
EOP (SPBU)	02 R 01	1-3 d		0.14		
Satellite Laser Tracking						
EOP (ASI)	03 L 02	1d	0.30		2.33	
EOP (CSR)	95 L 01	3d	0.66	1.15		
EOP (DUT)	98 L 01	3d	0.56			
EOP (IAA)	02 L 02	1d	0.27	0.27 *	0.13	
EOP (MCC)	97 L 01	1d	0.30		0.48	
GPS						
EOP (CODE)	98 P 01	1d	0.06		0.26	
EOP (EMR)	96 P 03	1d	0.10		0.31	
EOP (ESOC)	96 P 01	1d	0.13		0.25	
EOP (GFZ)	96 P 02	1d	0.09		0.29	
EOP (IAA)	01 P 01	1d	0.24		0.37	
EOP (JPL)	96 P 03	1d	0.08		0.48	
EOP (NOAA)	96 P 01	1d	0.25		0.49	
EOP (SIO)	96 P 01	1d	0.10		0.32	

** The satellite techniques provide information on the rate of change of Universal Time contaminated by effects due to unmodelled orbit node motion. VLBI-based results have been used to minimize drifts in UT estimates*

VIII. DISTRIBUTION OF THE PUBLICATIONS

A. IERS Rapid Service/Prediction Centre, at U.S. Naval Observatory:

BULLETIN A

By 0h UTC of Friday of each week via e-mail distribution:
- e-mail subscription (contact: ser7@maia.usno.navy.mil)
- World Wide Web (http://maia.usno.navy.mil/)
- Anonymous ftp (ftp://maia.usno.navy.mil/ser7)

By about 17:30h UTC daily via anonymous ftp:
- World Wide Web (http://maia.usno.navy.mil/)
- Anonymous ftp (ftp://maia.usno.navy.mil/ser7)

B. IERS Earth Orientation Centre, at Paris Observatory:

- e-mail (contact: iers@obspm.fr)
- World Wide Web (http://hpiers.obspm.fr/eop-pc/)
- Anonymous ftp (hpiers.obspm.fr or 145.238.100.28)

BULLETIN B

Updated at the beginning of each month
- World Wide Web
- Anonymous ftp (directory iers/bul/bulb)
- airmail

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GLOSSARY

BIH	Bureau International de l'Heure
BIPM	Bureau International des Poids et Mesures
BKG	Bundesamt fuer kartographie und geodaesie
CEP	Celestial Ephemeris Pole
CCIR	International Radio Consultative Committee
CIO	Conventional International Origin
CODE	Center for Orbit Determination in Europe
CGS	Space Geodesy Center, Matera
CSR	Center for Space Research, University of Texas
DORIS	Doppler Orbit determination and Radiopositioning Integrate on Satellite
DUT	Delft University of Technology
EMR	See NRCan
EOP	Earth Orientation Parameters
ESOC	European Space Operations Center
GFZ	GeoForschungsZentrum
GMST	Greenwich Mean Sidereal Time
GPS	Global Positioning System
GSFC	Goddard Space Flight Center
IAA	Institute of Applied Astronomy
IAG	International Association of Geodesy
IAU	International Astronomical Union
IERS	International Earth Rotation Service
ICRF	IERS Celestial Reference Frame
ICRS	International Celestial Reference System
IGS	International GPS Service for Geodynamics
IRP	IERS Reference Pole
IRM	IERS Reference Meridian
ITRF	IERS Terrestrial Reference Frame
ITRS	International Terrestrial Reference System
IVS	International VLBI Service
JPL	Jet Propulsion Laboratory
LLR	Lunar Laser Ranging
LOD	Length of day
LODR	Length of day corrected from zonal tides effects
MCC	Russian Mission Control Center
MJD	Modified Julian Day
NEOS	National Earth Orientation Service
NOAA	National Oceanic and Atmospheric Administration
NRCan	Natural Resources Canada, formerly EMR
OPA	Observatoire de Paris
SPBU	St Petersburg University
SLR	Satellite Laser Ranging
SI	Système International
SIO	Scripps Institution of Oceanography
TAI	Temps Atomique International
TCG	Geocentric Coordinate Time
TT	Terrestrial Time
USNO	United States Naval Observatory
UT1	Universal time
UT1R	Universal time corrected for zonal tides effects
UTC	Coordinated Universal Time
VLBI	Very Long Baseline Interferometry

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