The glossary includes some terms adopted verbatim from the IAU Division I Working Group "Nomenclature for Fundamental Astronomy (NFA)" found at http://syrte.obspm.fr/iauWGnfa/NFA_Glossary.html.[1] For a complete list of terms see the NFA website. Other terms have been adopted from http://www.iers.org[2] and http://www.ngs.noaa.gov/CORS-Proxy/Glossary/xml/NGS_Glossary.xml.[3] The definition of the term geoid was adopted from the website at http://www.ngs.noaa.gov/GEOID/geoid_def.html.[4] The definition of the term IAU was adopted from the website at http://www.iau.org.[5] The page number listed after each term indicates the first main occurence of that term.

Glossary

B

barycenter (barycentre) center of mass of the solar system. [NFA Glossary], p. 21.

Barycentric Celestial Reference System (BCRS) a system of barycentric space-time coordinates for the solar system within the framework of General Relativity with metric tensor specified by the IAU 2000 Resolution B1.3. Formally, the metric tensor of the BCRS does not fix the coordinates completely, leaving the final orientation of the spatial axes undefined. However, according to IAU 2006 Resolution B2, for all practical applications, unless otherwise stated, the BCRS is assumed to be oriented according to the ICRS axes. [NFA Glossary], p. 151.

Barycentric Coordinate Time (TCB) the coordinate time of the BCRS; it is related to Geocentric Coordinate Time (TCG) and Terrestrial Time (TT) by relativistic transformations that include secular terms. [NFA Glossary], p. 16.

Barycentric Dynamical Time (TDB) a time scale originally intended to serve as an independent time argument of barycentric ephemerides and equations of motion. In the IAU 1976 resolutions, the difference between TDB and TDT was stipulated to consist of only periodic terms, a condition that cannot be satisfied rigorously. The IAU 1991 resolutions introducing barycentric coordinate time (TCB) noted that TDB is a linear function of TCB, but without explicitly fixing the rate ratio and zero point, leading to multiple realizations of TDB. In 2006 TDB was re-defined via a linear transformation of the TCB (See IAU 2006 Resolution B3): $TDB = TCB - L_B \times (JD_{TCB} - T_0) \times 86400 + TDB_0$, where $T_0 = 2443144.5003725$, and $L_B = 1.550519768 \times 10^{-8}$ and $TDB_0 = -6.55 \times 10^{-5}$ s are defining constants. [NFA Glossary], p. 17.

C

Celestial Ephemeris Origin (CEO) the original name for the Celestial Intermediate Origin (CIO) given in the IAU 2000 resolutions. [NFA Glossary], p. 44.

Celestial Ephemeris Pole (CEP) used from 1984 to 2003 with the IAU 1980 Theory of Nutation as the reference pole for nutation and polar motion; the axis of figure for the mean surface of a model Earth in which the free motion has zero amplitude. This pole was originally defined as having no nearly-diurnal nutation with respect to a space-fixed or Earth-fixed coordinate system and being realized by the IAU 1980 nutation. It was afterwards determined by using VLBI observations of celestial pole offsets. It is now replaced by the CIP, which is defined by IAU 2000 Resolution B1.7. [NFA Glossary], p. 44.

Celestial Intermediate Origin (CIO) origin for right ascension on the intermediate equator in the Celestial Intermediate Reference System. It is the non-rotating origin in the GCRS that is recommended by the IAU 2000 Resolution B 1.8, where it was designated the Celestial Ephemeris Origin. The name Celestial Intermediate Origin was adopted by IAU 2006 Resolution B2. The CIO was originally set close to the GCRS meridian and throughout 1900-2100 stays within 0.1 arcseconds of this alignment. [NFA Glossary], p. 44.

Celestial Intermediate Pole (CIP) geocentric equatorial pole defined by IAU 2000 Resolution B1.7 as being the intermediate pole, in the transformation from the GCRS to the ITRS, separating nutation from polar motion. It replaced the CEP on 1 January 2003. Its GCRS position results from (i)

[1] This is marked in the glossary by [NFA Glossary] following the definition of each term.
[2] This is marked in the glossary by a [2] following the definition of each term.
[3] This is marked in the glossary by a [3] following the definition of each term.
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the part of precession-nutation with periods greater than 2 days, and (ii) the retrograde diurnal part of polar motion (including the free core nutation, FCN) and (iii) the frame bias. Its ITRS position results from (i) the part of polar motion which is outside the retrograde diurnal band in the ITRS and (ii) the motion in the ITRS corresponding to nutations with periods less than 2 days. The motion of the CIP is realized by the IAU precession-nutation plus time-dependent corrections provided by the IERS. [NFA Glossary], p. 25.

Celestial Intermediate Reference System (CIRS) geocentric reference system related to the GCRS by a time-dependent rotation taking into account precession-nutation. It is defined by the intermediate equator (of the CIP) and CIO on a specific date (IAU 2006 Resolution B2). It is similar to the system based on the true equator and equinox of date, but the equatorial origin is at the CIO. Since the acronym for this system is close to another acronym (namely ICRS), it is suggested that wherever possible the complete name is used. [NFA Glossary], p. 47.

celestial pole offsets time-dependent corrections to the precession-nutation model, determined by observations. The IERS provides the celestial pole offsets in the form of the differences, dX and dY, of the CIP coordinates in the GCRS with respect to the IAU 2000A precession-nutation model (*i.e.* the CIP is realized by the IAU 2000A precession-nutation plus these celestial pole offsets). In parallel the IERS also provides the offsets, $\mathrm{d}\psi$ and $\mathrm{d}\epsilon$, in longitude and obliquity with respect to the IAU 1976/1980 precession/nutation model. [NFA Glossary], p. 25.

Chandler wobble a free prograde motion of the Earth's rotational axis with respect to the Earth's crust moving with a period of approximately 435 days. [2], p. 124.

Coordinated Universal Time (UTC) a measure of time that conforms, within approximately 1 s, to the mean diurnal motion of the Sun and serves as the basis of all civil timekeeping. The term 'UT' is used to designate a member of the family of Universal Time scales (e.g. UTC, UT1). [NFA Glossary], p. 160.

D

datum (plural datums) A geodetic reference frame. In surveying and geodesy, a datum is a set of reference points on the Earth's surface, and (often) an associated model of the shape of the Earth (reference ellipsoid) used to define a geographic coordinate system. Horizontal datums are used to describe the location of a point on the Earth's surface, in latitude and longitude or other appropriate coordinates. Vertical datums are used to describe site elevations or depths. [3], p. 32.

DORIS DORIS (Doppler Orbitography and Radiopositioning Integrated by Satellite), a dual-frequency Doppler system, is used to determine geodetic positions from analyses of data transmitted from the sites of artificial satellites. Receivers are on board specialized satellites while the transmitters are on the ground. The complete set of observations is downloaded from the satellite to the ground centre for analysis. [2], p. 140.

E

Earth Rotation Angle (ERA) angle measured along the intermediate equator of the Celestial Intermediate Pole (CIP) between the Terrestrial Intermediate Origin (TIO) and the Celestial Intermediate Origin (CIO), positively in the retrograde direction. It is related to UT1 by a conventionally adopted expression in which ERA is a linear function of UT1 (see IAU 2000 Resolution B1.8). Its time derivative is the Earth's angular velocity. Previously, it has been referred to as the stellar angle. [NFA Glossary], p. 44.

ecliptic the plane perpendicular to the mean heliocentric orbital angular momentum vector of the Earth-Moon barycentre in the BCRS (IAU 2006 Resolution B1). In the past, there was no unique interpretation; an ecliptic was defined by means of the angles of the precession theory. [NFA Glossary], p. 22.

ellipsoid In geodesy, a reference ellipsoid is a mathematically-defined surface that approximates the shape of the Earth or other planetary body. [3], p. 40.

epoch a fixed date used to reckon time for expressing time varying quantities. It is often expressed in the system of Julian date, marked by the prefix J (*e.g.* J2000.0), with the Julian year of 365.25 days as unit. The term is also used to designate the date and time of an observation, *e.g.* "epoch of observation", which would be better expressed by "date of observation". [NFA Glossary], p. 22.

equation of the equinoxes (EE) the right ascension of the mean equinox referred to the true equator and equinox; alternatively the difference between apparent sidereal time and mean sidereal time (GAST−GMST). [NFA Glossary], p. 60.

equation of the origins (EO) distance between the CIO and the equinox along the intermediate equator; it is the CIO right ascension of the equinox; alternatively the difference between the Earth Rotation Angle and Greenwich apparent sidereal time (ERA−GAST). [NFA Glossary], p. 60.

equinox either of the two points at which the ecliptic intersects the celestial equator; also the time at which the Sun passes through either of these intersection points; *i.e.*, when the apparent longitude of the Sun is 0deg or 180deg. When required, the equinox can be designated by the ephemeris of the Earth from which it is obtained (*e.g.* vernal equinox of DE 405). By 2100 the equinox will have moved 1.4deg from the ICRS meridian, due to the precession of the equinoxes. [NFA Glossary], p. 22.

F

free core nutation (FCN) free mode in the motion of the Earth's rotation axis with respect to the Earth, due to non-alignment of the rotation axis of the inner core with respect to the mantle; the period is retrograde diurnal in the terrestrial frame and prograde long-period in the celestial frame. [2], p. 57.

fundamental arguments a set of mathematical expressions for angles used to describe orbital parameters of solar system objects used in precession/nutation models. [2], p. 54.

G

geocenter (geocentre) center of mass of the Earth including the atmosphere and oceans. [NFA Glossary], p. 31.

geocenter motion the motion, on the level of a few mm, of the mass center of the entire Earth system (solid Earth, ocean and atmosphere) relative to the origin of the ITRF. It is opposite in sign from the origin translation vector defined in Chapter 4. [2], p. 38.

Geocentric Celestial Reference System (GCRS) a system of geocentric space-time coordinates within the framework of General Relativity with metric tensor specified by the IAU 2000 Resolution B1.3. The GCRS is defined such that the transformation between BCRS and GCRS spatial coordinates contains no rotation component, so that GCRS is kinematically non-rotating with respect to BCRS. The equations of motion of, for example, an Earth satellite, with respect to the GCRS will contain relativistic Coriolis forces that come mainly from geodesic precession. The spatial orientation of the GCRS is derived from that of the BCRS, that is (cf. IAU 2006 Resolution B2), unless otherwise stated, by the orientation of the ICRS. [NFA Glossary], p. 151.

Geocentric Coordinate Time (TCG) coordinate time of the GCRS based on the SI second. It is related to Terrestrial Time (TT) by a conventional linear transformation provided by IAU 2000 Resolution B1.9. [NFA Glossary], p. 16.

geocentric terrestrial reference system (GTRS) a system of geocentric space-time coordinates within the framework of General Relativity, co-rotating with the Earth, and related to the GCRS by a spatial rotation which takes into account the Earth orientation parameters. It was adopted by IUGG 2007 Resolution 2. It replaces the previously defined Conventional Terrestrial Reference System. [NFA Glossary], p. 34.

geoid the equipotential surface of the Earth's gravity field which best fits, in a least squares sense, global mean sea level. [4], p. 18.

Global Positioning System (GPS) The Global Positioning System (GPS), the U.S. component of the Global Navigation Satellite System (GNSS). The GPS satellites, at an altitude of 20000 km, transmit down to the Earth carrier signals at two L-band frequencies (1.227 and 1.575 GHz) which are modulated by a pseudo-random noise code. When four satellites are in view, the user has enough information to solve for the station position and the clock offset from GPS time. [2], p. 135.

Greenwich Mean Sidereal Time (GMST) Greenwich hour angle of the mean equinox defined by a conventional relationship to Earth Rotation Angle or equivalently to UT1. [NFA Glossary], p. 61.

Greenwich Sidereal Time (GST) Greenwich apparent sidereal time (GAST), the hour angle of the true equinox from the Terrestrial Intermediate Origin (TIO) meridian (Greenwich or International meridian). [NFA Glossary], p. 47.

H

Hipparcos Acronym for High Precision Parallax Collecting Satellite, a scientific mission of the European Space Agency (ESA), launched in 1989 and operated between 1989 and 1993. It was the first space experiment devoted to astrometry, the accurate measurement of star positions, parallaxes, and proper motions. The Hipparcos Catalogue, a high-precision catalogue of more than 100,000 stars, was published in 1997 and is the primary realization of the ICRS at optical wavelengths (see IAU 2000 Resolution B1.2). [2], p. 21.

I

International Astronomical Union (IAU) Organization of professional astronomers from 90 countries to promote scientific and educational activities in astronomy. [5], p. 43.

International Atomic Time (TAI) a widely used practical realization of Terrestrial Time (TT) with a fixed shift from the latter due to historical reasons (see TT); it is a continuous time scale, now calculated at the Bureau International des Poids et Mesures (BIPM), using data from some three hundred atomic clocks in over fifty national laboratories in accordance with the definition of the SI second. [NFA Glossary], p. 151.

International Celestial Reference Frame (ICRF) a set of extragalactic objects whose adopted positions and uncertainties realize the ICRS axes and give the uncertainties of the axes. It is also the name of the radio catalog whose 212 defining sources is currently the most accurate realization of the ICRS. Note that the orientation of the ICRF catalog was carried over from earlier IERS radio catalogs and was within the errors of the standard stellar and dynamic frames at the time of adoption. Successive revisions of the ICRF are intended to minimize rotation from its original orientation. Other realizations of the ICRS have specific names (*e.g.* Hipparcos Celestial Reference Frame). [NFA Glossary], p. 22.

International Celestial Reference System (ICRS) the idealized barycentric coordinate system to which celestial positions are referred. It is kinematically non-rotating with respect to the ensemble of distant extragalactic objects. It has no intrinsic orientation but was aligned close to the mean equator and dynamical equinox of J2000.0 for continuity with previous fundamental reference systems. Its orientation is independent of epoch, ecliptic or equator and is realized by a list of adopted coordinates of extragalactic sources. [NFA Glossary], p. 21.

International Terrestrial Reference Frame (ITRF) a realization of ITRS, through the realization of its origin, orientation axes and scale, and their time evolution. [2], p. 35.

International Terrestrial Reference System (ITRS) according to IUGG 2007 Resolution 2, the ITRS is the specific GTRS for which the orientation is operationally maintained in continuity with past international agreements (BIH orientation). The co-rotation condition is defined as no residual rotation with regard to the Earth's surface, and the geocenter is understood as the center of mass of the whole Earth system, including oceans and atmosphere (IUGG 1991 Resolution 2). For continuity with previous terrestrial reference systems, the first alignment was close to the mean equator of 1900 and the Greenwich meridian. The ITRS was adopted (IUGG 2007 Resolution 2) as the preferred GTRS for scientific and technical applications and is the recommended system to express positions on the Earth. [NFA Glossary], p. 34.

J

J2000.0 defined in the framework of General Relativity by IAU 1994 Resolution C7 as being the event (epoch) at the geocenter and at the date 2000 January 1.5 TT = Julian Date 245 1545.0 TT. Note that this event has different dates in different time scales. [NFA Glossary], p. 22.

L

length of day (LOD) common term for the difference in the duration of a day as measured by UT1 and 86,400 SI seconds. In practice this quantity is determined by differencing daily values of UT1−UTC. Units are generally given as ms day^{-1} [2], p. 123.

LLR LLR (Lunar Laser Ranging) is a space geodetic technique that measures the round-trip travel times of light pulses between stations on the Earth and five retroreflectors (ca. 2010) on the surface of the Moon. [2], p. 22.

M

mean pole the position on the celestial sphere towards which the Earth's axis points at a particular epoch, with the oscillations due to precession-nutation removed. [NFA Glossary], p. 21.

modified Julian date (MJD) The Modified Julian Date or Day (MJD) is defined as $MJD = JD - 2400000.5$, where JD is the Julian Day. Start of the JD count is from 0 at 12 noon 1 January -4712 (4713 BC). [2], p. 151.

N

non-rotating origin (NRO) in the context of the GCRS or the ITRS, the point on the intermediate equator such that its instantaneous motion with respect to the system (GCRS or ITRS as appropriate) has no component along the intermediate equator (i.e. its instantaneous motion is perpendicular to the intermediate equator). It is called the CIO and TIO in the GCRS and ITRS, respectively. [NFA Glossary], p. 44.

nutation (see precession-nutation), p. 21.

P

permanent tide time-independent gravitational potential exerted on the Earth by the Sun, Moon, and planets. [3], p. 15.

polar motion the motion of the Earth's pole with respect to the ITRS. The main components are the Chandlerian free motion with a period of approximately 435 days, and an annual motion. It also includes sub-daily variations caused by ocean tides and periodic motions driven by gravitational torques with periods less than two days. Sub-daily variations are not included in the values distributed by the IERS, and are therefore to be added, after interpolation to the date of interest, using a model provided by the IERS Conventions. [NFA Glossary], p. 124.

precession-nutation the ensemble of effects of external torques on the motion in space of the rotation axis of a freely rotating body, or alternatively, the forced motion of the pole of rotation due to those external torques. In the case of the Earth, a practical definition consistent with the IAU 2000 resolutions is that precession-nutation is the motion of the CIP in the GCRS, including FCN and other corrections to the standard models: precession is the secular part of this motion plus the term of 26000-year period and nutation is that part of the CIP motion not classed as precession. [NFA Glossary], p. 44.

R

regularized UT1 (UT1R) LOD adjusted to remove the effects of zonal solid Earth tides with periods shorter than 35 days. [2], p. 123.

S

site displacements time-varying changes in the coordinates of a terrestrial site due to local deformations. [2], p. 113.

SLR SLR (Satellite Laser Ranging) measures the time intervals required for pulses emitted by a laser transmitter to travel to a satellite and return to the transmitting site. The "range", or distance between the satellite and the observing site, is approximately equal to one half of the two-way travel time multiplied by the speed of light. [2], p. 132.

T

T eph (T_{eph}) independent time argument of JPL ephemerides (Standish, A&A, **336**, 381, 1998) that is, for practical purposes, the same as Barycentric Dynamical Time (TDB). TDB is related to Barycentric Coordinate Time (TCB) by $TDB = TCB - L_B \times (JD_{TCB} - T_0) \times 86400 + TDB_0$, where $T_0 = 2443144.5003725$, and $L_B = 1.550519768 \times 10^{-8}$ and $TDB_0 = -6.55 \times 10^{-5}$ s are defining constants. [IAU 2006 Resolution B3], p. 28.

Terrestrial Dynamical Time (TDT) time scale for apparent geocentric ephemerides defined by a 1979 IAU resolution and in 1991 was replaced by Terrestrial Time (TT). [NFA Glossary], p. 151.

Terrestrial Ephemeris Origin (TEO) the original name for the Terrestrial Intermediate Origin (TIO) given in the IAU 2000 resolutions. [NFA Glossary], p. 44.

Terrestrial Intermediate Origin (TIO) origin of longitude in the Intermediate Terrestrial Reference System. It is the non-rotating origin in the ITRS that is recommended by the IAU 2000 Resolution B1.8, where it was designated Terrestrial Ephemeris Origin. The name Terrestrial Intermediate Origin was adopted by IAU 2006 Resolution B2. The TIO was originally set at the ITRF origin of longitude and throughout 1900-2100 stays within 0.1 mas of the ITRF zero meridian. [NFA Glossary], p. 44.

Terrestrial Intermediate Reference System (TIRS) a geocentric reference system defined by the intermediate equator of the CIP and the TIO (IAU 2006 Resolution B2). It is related to the ITRS by polar motion and s' (TIO locator). It is related to the Celestial Intermediate Reference System by a rotation of ERA around the CIP, which defines the common z-axis of the two systems. Since the acronym for this system is close to another acronym (namely ITRS), it is suggested that wherever possible the complete name be used. [NFA Glossary], p. 47.

terrestrial reference frame (TRF) realization of the Terrestrial Reference System (TRS), through the realization of its origin, orientation axes and scale, and their time evolution. [2], p. 32.

terrestrial reference system (TRS) a Terrestrial Reference System (TRS) is a spatial reference system corotating with the Earth in its diurnal motion in space. [2], p. 32.

Terrestrial Time (TT) a coordinate time whose mean rate is close to the mean rate of the proper time of an observer located on the rotating geoid. At 1977 January 1.0 TAI exactly, the value of TT was 1977 January 1.0003725 exactly. It is related to the Geocentric Coordinate Time (TCG) by a conventional linear transformation provided by IAU 2000 Resolution B1.9. TT may be used as the independent time argument for geocentric ephemerides. An accurate realization of TT is $TT(TAI)$ = TAI + 32.184 seconds. In the past TT was called Terrestrial Dynamical Time (TDT). [NFA Glossary], p. 151.

U

UT1 angle of the Earth's rotation about the CIP axis defined by its conventional linear relation to the Earth Rotation Angle (ERA). It is related to Greenwich apparent sidereal time through the ERA (see equation of the origins). It is determined by observations (currently from VLBI observations of the diurnal motions of distant radio sources). UT1 can be regarded as a time determined by the rotation of the Earth. It can be obtained from the uniform time scale UTC by using the quantity UT1−UTC, which is provided by the IERS. [NFA Glossary], p. 123.

UT1−UTC difference between the UT1 parameter derived from observation and the uniform time scale UTC, the latter being currently defined as: UTC = TAI + n, where n is an integer number of seconds, such that $|UT1 - UTC| < 0.9$ seconds. [NFA Glossary], p. 25.

V

VLBI VLBI (Very Long Baseline Interferometry) is a space geodetic technique that measures the time differences in the arrival of microwave signals from extragalactic radio sources received at two or more widely separated radio observatories. [2], p. 21.

Z

zonal tides tides that produce zonal (constant along a circle of latitude) deformations. [3], p. 123.