Celestial Ephemeris Origin (CEO), Terrestrial Ephemeris Origin (TEO)

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The posters recalled some basic definitions and properties.

1 Definition of CEO and TEO

The CEO is defined so that the Intermediate Celestial Reference System attached to the Celestial Intermediate Pole (CIP) and to the CEO has no component of rotation along the axis of the CIP, at any instant, in the Geocentric Celestial Reference System.

The TEO has a similar definition in the ITRS.

2 Definition and properties of the Earth Rotation Angle

The Earth Rotation Angle, θ, is defined as the hour angle of the CEO reckoned from the TEO.

By definition of the CEO and the TEO, the time derivative of θ is the component along the axis of the CIP of the Earth rotation vector (practically, the modulus of that vector).

Universal Time UT1 is defined by a linear relation with θ (definition implicitly used in the past).

3 Position of the CEO and of the TEO

The equatorial origin of the ICRF being Σ_0, the node of the equator of the CIP at t (in Terrestrial Time) being $\mathrm{N}(t)$, the CEO ($\equiv \sigma(t)$) is provided by the quantity $s(t)$ defined by

$$s(t) = \sigma(t)\mathrm{N}(t) - \Sigma_0\mathrm{N}(t). \tag{1}$$

Quantity $s(t)$ is computed by an integration along the CIP path, from J2000.0 to t. This small quantity (varying from 0 to 70 mas between 2000 and 2100) should be, in theory, derived from the observed path. However it has been shown that the values derived from the current model of precession/nutation are sufficient, at the microarcsesond level, until 2100. In other terms, the dependence of s on the observations of the CIP can be neglected when procession the observations.

The TEO is similarly provided by a quantity s'. In the long term, over several decades, s' has to be computed by numerical integration over the unpredictable motion of the CIP in the ITRF. However, it can extrapolated, at the microarcsecond level, over about a decade.

As the CEO and the TEO are obtained from an integration, their positions depend on arbitrary constants. These have been conventionally selected so that $s = 0$, $s' = 0$ at J2000.0

The positions of the CEO and the TEO are independent of the system of coordinates used in the celestial and terrestrial reference systems, after initial adjustment of the integration constants.

4 Secular motion of the CEO

The CEO (as the TEO) has a secular motion. For example, if the pole describes a closed loop between t_1 and t_2, the equators at these dates coincide, but $\sigma(t_1)$ and $\sigma(t_2)$ are different. This property is often a cause of concern. However, as shown by the posters in a simple example, this secular motion of the CEO is necessary to cancel a component of rotation induced by the motion in loop of the pole.

In the case of the precession, the compensating mean drift of the CEO is about 4.2'' per year, a large value, but it does not appear in *s* for the following reasons.

It can be demonstrated that, at any instant, the velocity of the CEO in the ICRF has the important property that it is perpendicular to the equator of the CIP. As at J2000.0 the equator of the CIP is very close to that of the ICRF, the secular terms in *s* are quite small ; then their value progressively increases.

References

Capitaine N., Guinot B., Souchay J., 1986, A non-rotating origin on the instantaneous equator : definition, properties and use, Celestial Mechanics, 39, 283-307.

Capitaine N., Guinot B., MacCarthy D.D., 2000, Definition of the Celestial Ephemeris Origin in the International Celestial Reference Frame, Astron. Astrophys., 355, 398-405.