Positioning the Terrestrial Ephemeris Origin in the ITRF

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1 Introduction

Resolution B1.8 adopted by the XXIV General Assembly of the International Astronomical Union (Manchester, August 2000) recommends the use of the Non-Rotating Origins (NRO) on the moving equator for reckoning the angle of rotation of the Earth. The NRO in the Terrestrial Reference System (TRS) is defined by the kinematical condition of non-rotation of this point around the rotation axis when the Celestial Intermediate Pole (CIP) moves on the CRS (Guinot 1979).

Astrometric and geodetic data analysis involves the computation of the transformation between the CRS and the TRS. In the framework of the IAU 2000 recommendations, they need an expression for the displacement of the Terrestrial Ephemeris Origin both for the classical transformation and for transformation based on the Non-Rotating Origin representation.

The displacement of the TEO in the ITRS, s', is related, for a date t, to the CIP coordinates u and v in the TRS by the formula (Capitaine *et al.* 2000) :

$$s' = \varpi M - \Pi_0 M = -\int_{t_0}^{t} \frac{u\dot{v} - \dot{u}v}{2} \mathrm{d}t \tag{1}$$

where u corresponds to the coordinate x_p of the CIP in the ITRS, v refers to $-y_p$, and the dot is for the time derivative (see Figure 1).

This poster presents the computation of the quantity s'. Fore more details on this study, see the paper Lambert and Bizouard 2002.

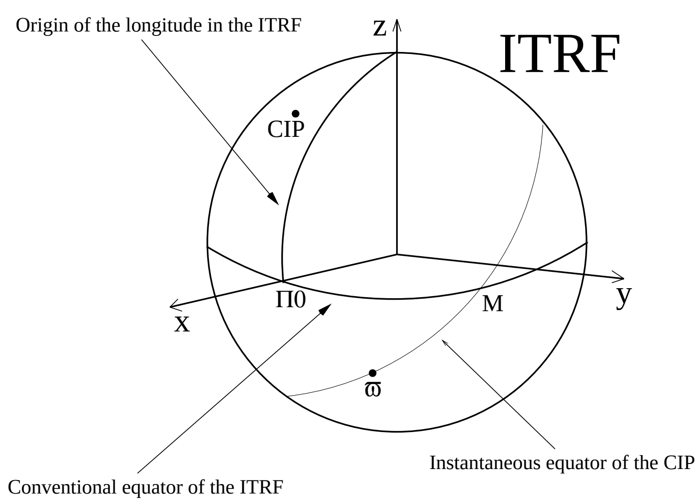

Figure 1: The Non-Rotating Origin with respect to the ITRF.

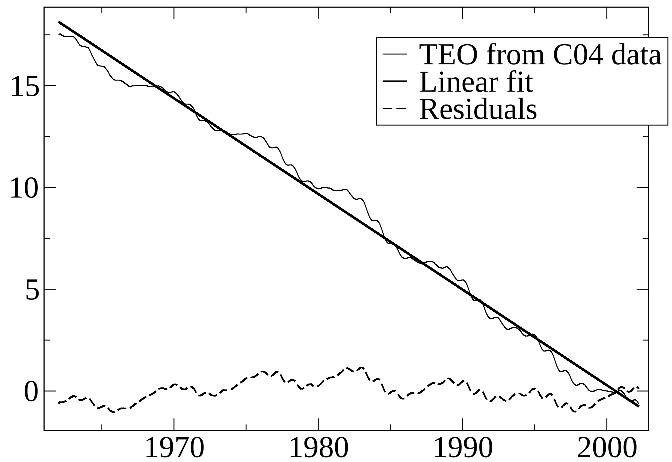

Figure 2: Displacement s' of the TEO from the IERS C04 series and model given by expression (2) (time in years, amplitudes in μas).

2 Computation of the position of the TEO from geodetic data

The computation of s' is based upon combined time series C04 for polar motion which is provided by the Earth Orientation Parameters Product Center of the International Earth Rotation Service (IERS EOP-PC) based at the Paris Observatory. Such a series is obtained by the combination of individual polar motion series from various spatial and geodetic techniques such as Very Long Baseline radio Interferometry (VLBI), Global Positioning System (GPS, GLONASS), Satellite Laser Ranging (SLR) or Lunar Laser Ranging (LLR). This series give daily averaged values for the CIP coordinates x_p, y_p. For a sampling of one day (at 0h UTC) the data covers the period from 1962 January 1st until 2002. Quantity s' given by equation (1) is obtained with a numerical derivative using three points and a time integral based on the trapeze method. The curve is plotted on Figure 2. It shows periodic variations of period 6.4 years coming from a combination of Chandler oscillation (1.2 year) and annual oscillation. Changes in amplitudes of these wobbles (Guinot 1972 and Vondrak 1985) make the trend varying along the 40 years of the computation.

GPS technique allows to estimate directly the rates $\dot{x}_p$ and $\dot{y}_p$. Differences between s' computed with the numerical derivative using C04 series and s' computed with the estimated rates using various GPS data never reach more than 0.1 μas and are not significant at the present level of EOP accuracy. This validates the two independant methods of computation.

The contribution of the tidal diurnal polar motion on s' (Ray 1994) is only about 0.06 μas per century and is therefore negligible.

3 Expression for positioning the TEO in the ITRF

As conclusion, we propose a numerical expression for the quantity s'. Although such a model is limited in time because of unprevisible changes in the wobbles amplitudes, it is possible to provide a numerical expression for s' which represents the motion of the TEO in the ITRS with an accuracy of 1 μas over the last 40 years. On this span, variations in the amplitudes of the wobbles will not produce an error larger than 1 μas. The following expression is fitted on the curve obtained from C04 data :

$$s' = -47.0 \times t \tag{2}$$

where s' is in μas. Parameter t is defined as the Terrestrial Time (TT) expressed in Julian centuries from epoch J2000.0 :

$$t = (\mathrm{TT} - 2000 \text{ January 1d 12h TT})/36525 \tag{3}$$

with TT in days.

If Chandler amplitude in the next years does not present variations larger than during the span 1962-2002, the uncertainty on the linear trend is 13 μas per Julian century. We can ensure that the 1 μas accuracy linear model can be extended on the 10 next years. Figure 2 shows the linear model of s' corresponding to expression (2) together with the numerical computation from observations. If unexpected variations in the amplitudes of the wobbles occur in the coming years, such a model will have to be updated. We propose this model be maintained by the IERS EOP-PC.

References

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