

## Exercise

### Getting to like the Earth Orientation Parameters

#### 1. Interactive Plotting:

Among the five Earth Orientation Parameters, polar motion and the excess length-of-day ( $\Delta\text{LOD}$ ) are particularly interesting because they contain geophysical signals that reflect large-scale mass motion in the Earth system. The aim of this sub-task is to use online plotting tools (<http://hpiers.obspm.fr/eop-pc/index.php> → EOP Time Series → Reference C04 Series) to visualize selected EOP time series and identify relevant geophysical effects already mentioned in the lecture:

- Plot  $\Delta\text{LOD}$  over civil date for a 20-year period (2000–2019) both with and without tidal variations. Discuss the characteristics of the tidal correction and the remaining signal content in the  $\Delta\text{LOD}$  series.
- Plot  $\text{UT1} - \text{UTC}$  over civil date for the period (2000–2019) and elaborate on the resulting curve in terms its shape and relation to  $\Delta\text{LOD}$ .
- Plot variations in the second pole coordinate  $y_p$  for a multi-decadal time span (1962–2019) and match the main signal components with known geophysical effects.

#### 2. Small Programming Task:

The time increment  $d\text{UT1} = \text{UT1} - \text{UTC}$  is an important parameter when evaluating the rotation matrix  $R = R_z(-\text{ERA})$  in the transformation of station coordinates from the ITRS to the ICRS:  $\vec{x}_{\text{ICRS}} = Q R W \vec{x}_{\text{ITRS}}$ . The argument  $\text{ERA}$  represents the Earth Rotation Angle, computed as follows:

$$\text{ERA} = 2\pi(0.7790572732640 + 1.00273781191135448 T_u)$$

$T_u = mjd_{\text{UT1}} - 51544.5 = (mjd_{\text{UTC}} + d\text{UT1}) - 51544.5$ , here  $T_u$  is the epoch of interest in mean days since J2000.0.

- Evaluate the rotation matrix  $R$  at the epoch **2 November 2017, 7:45 UTC** and write down all entries with a reasonably chosen number of digits.
- To determine the auxiliary variable  $T_u$ , both  $mjd_{\text{UTC}}$  and  $d\text{UT1}$  are needed. Extract the value of  $d\text{UT1}$  from the hpiers-website (link above) under “Interactive Search” and leave tidal variations in the quantity. The search tool also provides easy access to the modified Julian

date at 2 November 2017, 0 UTC. Add the UTC epoch of interest and the value of dUT1 in units of days to determine  $mjd_{UTC}$ .

- How would you compute the rotation matrix for the inverse transformation (i.e., ICRS to ITRS)?

Matlab (or Octave) subroutine that might be adopted from the homework assignment:

- `Rz.m`: function for the rotation matrix in the z-direction