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Abstract

1 Introduction

For many astronomical calculations, the difference between UTC and TT is negligible. The issue is that UTC is not a monotonically increasing time measure compared to TT as it is influenced by irregularities in Earth's rotation. These irregularities are difficult to impossible to predict and can only be measured. NASA publishes tables with accurate data.

To calculate moon rise and set times, it does make a difference whether we use UTC or TT. Currently, in early 2022, the difference between UTC and TT is about 68s, i.e. TT is ahead of UTC by 68s. This is more than a minute, in which the moon does move enough to make a difference in rise and set time calculations.

2 UT_1 from UTC

To calculate TT from UTC, we use

$$TT = TAI + 32.184s = UTC + leap(UTC) + 32.184s \tag{1}$$

where $leap(UTC)$ are the cumulative leap seconds up to the UTC time. Document tai-utc.dat contains leap second data for

$$TAI - UTC = leap(UTC) \tag{2}$$

from 1961 to 2017.

We also find

$$TT = UT_1 + \Delta T \tag{3}$$

where UT_1 is corrected UT. ΔT is provided by NASA for historical periods.

In order to calculate UT_1, we set equ. 1 and equ. 3 equal and find

$$UT_1 + \Delta T = UTC + leap(UTC) + 32.184s \tag{4}$$

Solving for UT_1 yields,

$$
\begin{aligned}
UT_1 &= TT - \Delta T &(5)\\
&= UTC + leap(UTC) + 32.184s - \Delta T &(6)\\
&= UTC - (\Delta T - leap(UTC) - 32.184s) &(7)
\end{aligned}
$$

3 Calculate ΔT from ΔUT

Relation

$$\Delta UT = UT_1 - UTC \tag{8}$$

corrects for variations in UTC. NASA file finals2000A.all contains ΔUT values for a large range of times and is continuously updated. We need to calculate ΔT from ΔUT to calculate TT from UTC 5. From equ. 5 and 8 we find

$$\Delta UT = -\Delta T + leap(UTC) + 32.184s \tag{9}$$

and finally

$$\Delta T = -\Delta UT + leap(UTC) + 32.184s \tag{10}$$