*URSI GASS 2023, Sapporo, Japan, 19 – 26 August 2023*

# Predicting a negative leap second

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Leap seconds are inserted so as to keep Coordinated Universal Time (UTC) within 0.9 seconds of UT1, which is the timelike quantity associated with the Earth's rotational angle. While historically only positive leap seconds have been inserted, the Earth's 50-year speedup (Figure 1) makes it possible that a negative leap second (skipped second) will be needed.

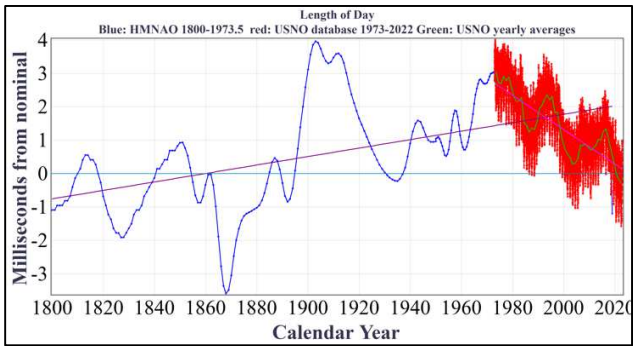


Figure 1. Length of Day since 1800. Noise is insignificant in this figure. Red points are daily averages whose scatter is dominated by the 14-day periodicity associated with lunar motion. The long-period variations are termed decadal fluctuations.

The data of figure 1 are influenced by several predictable effects. A long term slow-down, over millennia, of 1.4 ms/day/cty is by coincidence very close to the statically insignificant linear fit shown in the figure. Atmospheric angular momentum is anticorrelated with the Earth's rotation rate, and this results in a predictable yearly cycle. UT1 with the seasonal variation removed is termed UT2. Lunar motion, through tidal interactions, induces variations in the length of day (the derivative of UTC-UT1) over several periods, the largest amplitudes being predictable 14-day and 19-year cycles. UT2 with the predictable lunar effects removed is termed UT2S, and the length of day (derivative of UT2S) is termed LOD2S. The decadal variations of UT1 are ascribed to unpredictable coupling between the Earth's crust and its inner regions.

This paper uses clock statistics to infer that one appropriate model for predicting UTC-UT1 over several years involves modelling TT-UT2S as an integrated random walk (RWFM), where TT is Terrestrial Time.

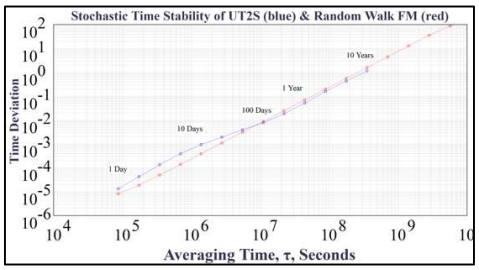


Figure 2. TDEV statistic applied to TT-UT2S over all data since 1970, along with a scaled IRW (RW FM) model. The differences between the two curves on sub-yearly scales can be ascribed to unpredictable atmospheric winds.

In this case, the derivative of UTC-UT2S, termed LOD2S is a random walk, for which the best predictor is its current value. One therefore removes the predicable terms, extrapolates the current value of LOD2S, and re-inserts the predictable variations. The limitations of this technique will also be discussed.

This technique will be used on the full set of data available two weeks before the conference in order to predict whether a negative leap second will be required in the near future.