Stochastic Prediction of UT1-UTC to support the decision towards a Continuous UTC

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The General Conference on Weights and Measures (CGPM) decided in 2022 that the maximum value for the difference (UT1-UTC) will be increased in, or before, 2035. The Consultative Committee for Time and Frequency (CCTF) is therefore working to propose a new extended maximum value as well as the implementation date. In the last years the rotational speed of the Earth has almost continuously increased and today a rotational second is almost as long as the atomic second. If this trend should continue, we will have to remove one second from UTC (negative leap second). As this case never happened before, a large concern is growing in the UTC user communities asking the CCTF to avoid the application of a negative leap second by anticipating the implementation of continuous UTC. To take a decision, it is essential to quantify the likelihood and possible timing of such an event. Earth rotation is difficult to predict: some influencing phenomena, such as atmospheric dynamics, are only partially predictable, while others, such as core–mantle interactions, are today not completely understood and not satisfactorily modelled.

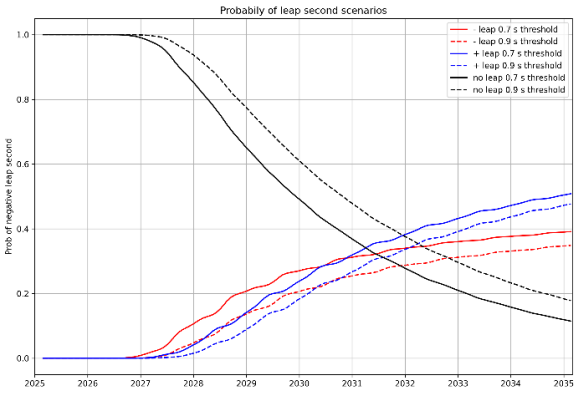


Fig. 1: Estimated probability of leap second occurrence according to the model.

For this reason, we model Earth rotation as a stochastic process. Analysis of the past two centuries of data shows that, on time scales of years to decades, UT1–TAI can be represented as an integrated random walk. By incorporating deterministic effects—tidal friction, Earth tides, and seasonal variations—we derive confidence intervals for future UT1–UTC values using stochastic differential equations. Monte Carlo simulations are then used to estimate the probability of both positive and negative leap second occurrences over the next decade. Results indicate that the probability of a negative leap second becomes non-negligible after 2027, exceeding 30% by 2035. Using data from 1830 to 2025, we validate the model by predicting past values of UT1–TAI and comparing them with historical observations. This validation is performed at 5-year intervals. The back-prediction errors consistently fall within the 3-sigma confidence interval, confirming the reliability of the computed uncertainty estimates.