

PANEL COMMUNICATION (MATHEMATICS IN SUSTAINABILITY AND
CLIMATE CHANGE)

**Space-time Bayesian modeling for the breaking of daily
maximum temperature records**

JORGE CASTILLO-MATEO^a, ALAN E. GELFAND^b, ZEUS GRACIA-TABUENCA^a, JESÚS
ASÍN^a, ANA C. CEBRIÁN^a

^a Department of Statistical Methods, University of Zaragoza
E-mail: jorgecm@unizar.es

^b Department of Statistical Science, Duke University

Abstract

Record-breaking temperature events often have serious economic and human impacts. When records are broken, media frequently question if climate change is the cause. The main question is whether and how a changing climate impacts the occurrence of records. In recent work, we proposed statistical hypothesis tests based on the breaking of records to detect a non-stationary climate. These tools are available in the R package `RecordTest` [1]. Subsequently, they were applied to a dataset consisting of over sixty years (1960–2021) of daily maximum temperatures across peninsular Spain. The results showed a significant deviation from stationarity, but not for all meteorological stations or in all periods of the year [2]. However, probabilistic approaches seem insufficient for modeling real record-breaking data. This work [3] introduces the first fully developed model to analyze the incidence of record-breaking temperatures across years for any given day within the year. The analysis requires rich modeling of the indicator events which define record-breaking sequences. Resulting from novel exploratory data analysis, hierarchical conditional models for the indicator events are proposed. Additional model-based inference tools are proposed including surfaces for the number of records, for its ratio over the expected value under stationarity, for the probability of record on a given day, and time series of the extent of record surface. The results show that the number of records has doubled in the last decade compared to what would be expected without climate change, but these deviations vary both spatially and temporally.

References

- [1] J. Castillo-Mateo, A. C. Cebrián, J. Asín: *RecordTest: An R package to analyse non-stationarity in the extremes based on record-breaking events*. Journal of Statistical Software **106** (5), 1–28 (2023). <https://doi.org/10.18637/jss.v106.i05>
- [2] J. Castillo-Mateo, A. C. Cebrián, J. Asín: *Statistical analysis of extreme and record-breaking daily maximum temperatures in peninsular Spain during 1960–2021*. Atmospheric Research **293**, 106934 (2023). <https://doi.org/10.1016/j.atmosres.2023.106934>
- [3] J. Castillo-Mateo, A. E. Gelfand, Z. Gracia-Tabuenca, J. Asín, A. C. Cebrián: *Spatio-temporal modeling for record-breaking temperature events in Spain*. Manuscript submitted for publication (2024). <https://arxiv.org/abs/2403.00080>