



Analyzing non-stationarity in record-breaking temperature events over Peninsular Spain in 1960-2021 using the R package RecordTest

Jorge Castillo-Mateo, Ana C. Cebrián, and Jesús Asín

Department of Statistical Methods, University of Zaragoza, Zaragoza, Spain (jorgecm@unizar.es)

The identification of non-stationary behavior in extremes is crucial for the analysis of climatic and environmental data. As an alternative to classical extreme value theory, the investigation of events that break new records proves particularly appealing. While the increment in averaged temperatures over recent decades is well-characterized and studied, the characterization of changes in record-breaking temperature events remains an open problem. In this work, the R package `RecordTest` (Castillo-Mateo et al. 2023a), available on CRAN (<https://CRAN.R-project.org/package=RecordTest>) and GitHub (<https://github.com/JorgeCastilloMateo/RecordTest>), is introduced. This package offers a framework for non-parametric analysis of non-stationary behavior in extremes, based on record-breaking analysis. The main idea of these inference tools is based on verifying whether the observed records in the data align with the distribution of record occurrences under stationary series of random variables. Several hypothesis tests are proposed to detect trends or change-points in record occurrences based on both upper and lower records, both in the forward and backward series. The package also implements all necessary steps in such analyses, including data preparation, record identification, exploratory tools, and supplementary graphical tools. The tools included in the package are introduced together with a careful analysis of the impact of climate change on the occurrence of calendar day records in 36 series available from the ECA&D of daily maximum temperatures in the Iberian Peninsula from 1960 to 2021 (Castillo-Mateo et al. 2023b). The objective also includes characterizing the record occurrences in different periods of the year and in different spatial regions. The effects of climate change are heterogeneous within the year, being autumn the season where the effects are weaker and summer where they are stronger. Concerning the spatial variability, the Mediterranean and the North Atlantic region are the areas where the effects are more and less clear, respectively.

References:

Castillo-Mateo, J., Cebrián, A. C., and Asín, J.: `RecordTest`: An R package to analyse non-stationarity in the extremes based on record-breaking events, *Journal of Statistical Software*, 106(5), 1-28, <https://doi.org/10.18637/jss.v106.i05>, 2023a.

Castillo-Mateo, J., Cebrián, A. C., and Asín, J.: Statistical analysis of extreme and record-breaking daily maximum temperatures in peninsular Spain during 1960-2021, *Atmospheric Research*, 293, 106934, <https://doi.org/10.1016/j.atmosres.2023.106934>, 2023b.

