Clustering of extremes is a statistical behavior often observed in geophysical processes. However, it is usually studied independently of the theoretical framework of Long-Range Dependence, or the Hurst-Kolmogorov behavior, which provides consistent theoretical and practical tools for identifying and understanding it. Hence, a dataset of daily rainfall records spanning more than 150 years is studied in order to investigate the dependence properties of extreme rainfall at the annual and seasonal timescale. The same investigation is carried out for mean rainfall at the annual scale. The research question is focused on investigating the link between the Hurst behavior in the mean rainfall, which is already acknowledged in literature, and the Hurst behavior in extreme rainfall timeseries, which is also to be tested.

1. Clustering of extremes

- Extreme behavior is often characterized by clustering.
- The clustering of extremes is a statistical behavior often observed in geophysical processes.

2. Identifying LRD in extremes

- Clustering of extremes in geophysical processes has been recursively studied.
- Here we evaluated the LRD properties of rainfall extremes derived from long rainfall records, by estimating the Hurst exponent, shown to be present in annual rainfall (e.g. Iliopoulou et al. 2016).

3. LRD in Seasonal and Annual Maxima

- Seasonal identification is achieved following Iliopoulou et al. (2016):
  - We identify the optimal temporal partition for a given number of seasons as the one that minimizes the Sum of Squared Deviations:
    \[ \sum \left( x_i - \bar{x}_k \right)^2 \]
  - And select the number of season by applying AIC to the mixture seasonal probability model.

4. Are Peaks Over Threshold Poisson-distributed?

- We select the number of events \( k \) per interval equal to the number of years in the interval, e.g. 10 for decade.
- We sample the \( i \) maximum daily rainfall values from the whole record, where \( i \) is the number of available intervals. Therefore, approximately the same POT sample is partitioned in all cases, except for cases of intervals affected from missing values and excluded.
- We generate 10000 samples of Poisson distribution with the same \( \lambda \) and equal length and estimate the sample minimum and maximum for each.
- Below, the upper 5% of the sample maxima values is plotted along with the lower 5% of the minima, and both used to form confidence regions for Poisson distribution.

5. Does LRD propagate from average behaviour to extreme behaviour?

- Links between LRD in mean precipitation and clustering of extreme rainfall
- 12 records exhibit at least one exceedance of the Poisson 5% limits during the examined period; among which, 9 show at least one exceedance of the upper limit.

Conclusions

- Weak presence of LRD in average and seasonal extremes.
- Evidence on links between LRD in mean and LRD in extreme behaviour.
- Record length is pivotal as it enables the exploration of clustering at larger scales.
- Violations of the Poisson distribution of extremes are present at these timescales; yet they do not challenge probabilistic concepts of Extreme Value Theory.
- If clustering, clustering behaviour may be exploited to condition the waiting time to the next occurrence.

References


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