Analyzing patterns of extreme heat events in Europe using extreme value theory

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Understanding the frequency and intensity of extreme heat events is crucial for policy formulation and infrastructure planning. In this study, we analyse patterns of extreme heat events of Europe, utilizing the temperatures of air at 2m above the surface (land, sea or inland waters) between 1940 and 2023 from the ERA5 dataset. A method is derived that is based on the point process approach of extreme value theory to compute the likelihoods of patterns of heat events. In contrast to existing literature, the group of heat days is evaluated instead of individual heat days. This will allow us to compute the return level of mean excesses of temperatures within a group of heat days of any length, and the return period which is the expected waiting time of next occurrence of some specific year with unusual excesses of heat days. We therefore extend the classical approach of considering return levels of one heat day only.

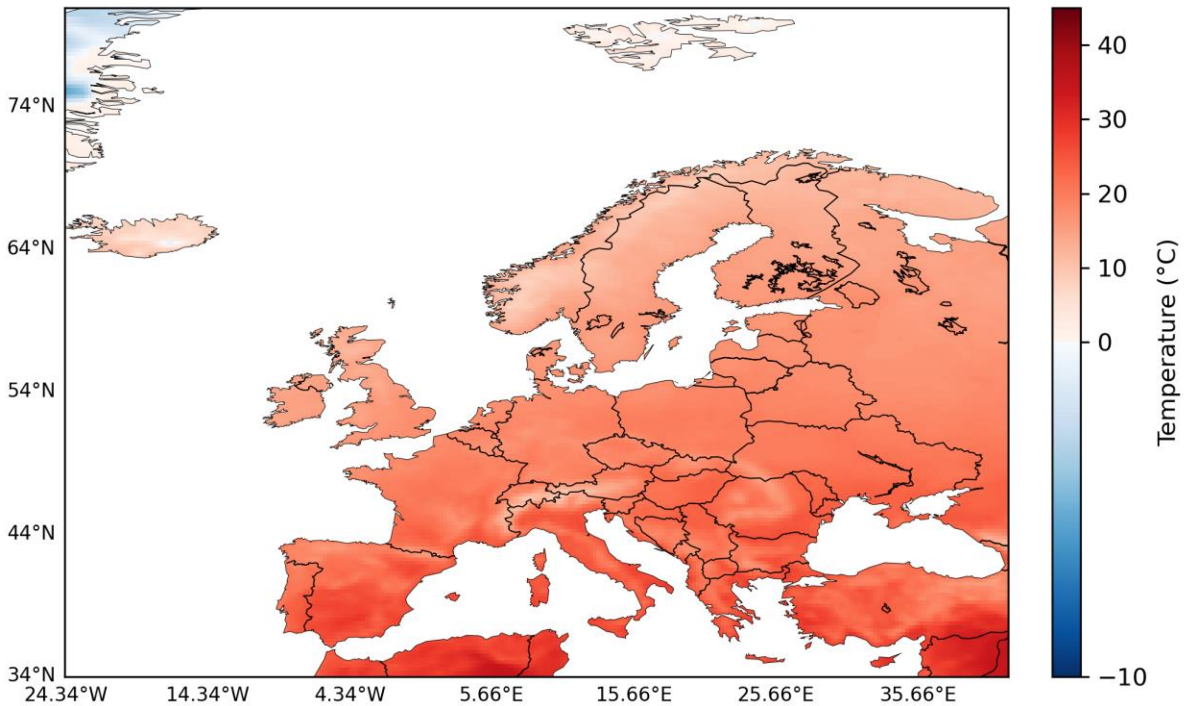

Figure 1: The temperature at 2m above the surface over Europe, August 2023.

References

Embrechts, P., Klüppelberg, C., Mikosch, T. (2013). Modelling extremal events: for insurance and finance (Vol. 33). *Springer Science & Business Media.*

Barbosa, S., Scotto, M. G. (2022). Extreme heat events in the Iberia Peninsula from extreme value mixture modeling of ERA5-Land air temperature. *Weather Clim. Extreme*, 36, pp. 1-10.

Rivoire, P., Le Gall, P., Favre, A. C., Naveau, P., Martius, O. (2022). High return level estimates of daily ERA-5 precipitation in Europe estimated using regionalized extreme value distributions. *Weather Clim. Extreme*, 38, pp. 1-13.

Clifton, D. A., Hugueny, S., Tarassenko, L. (2011). Novelty detection with multivariate extreme value statistics. *J. Signal Process Sys.*, 65, 371-389.

Clifton, D. A., Clifton, L., Hugueny, S., Wong, D., Tarassenko, L. (2012). An extreme function theory for novelty detection. *IEEE J. Sel. Top. Signal Process.*, 7, 28-37.

Poschlod, B. (2021). Using high-resolution regional climate models to estimate return levels of daily extreme precipitation over Bavaria. *Nat. Hazard Earth Sys.*, 21, 3573-3598.

Luca, S., Clifton, D. A., Vanrumste, B. (2016). One-class classification of point patterns of extremes. *J. Mach. Learn. Res.*, 17, 1-21.

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