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Sources, propagation and sinks of Europe's major heat waves; a complex network analysis of heat extremes

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In the last few decades, Europe has seen many devastating heat waves; each one producing new all-time heat records and pushing the limits of climatic extremes. The quantification of the dynamical linkage, the evolution and propagation of such heatwaves is a start to understand these processes. This network structure and propagation characteristics for European heatwaves is analyzed using a complex network approach based on E-OBS, the gridded dataset based on in situ data from the European meteorological services.

Complex networks (CN) are data-driven methods suited to model natural non-linear dynamic systems (Dijkstra et al., 2019). CN are based on graph theory; hence a network is composed by two sets (nodes and vertices) conforming a network topology that can be subsequently explored. In this work, we process European-wide daily maximum temperature gridded layers to build up a CN capable of shedding light on interesting mechanisms underlying the heatwave propagation. We identify the source and sink regions primarily responsible for heatwave propagations and the strength of association between these regions. The network coefficients are derived to evaluate the extremal dependence, evolution, and spatial propagation of specific large scale heatwave events.

Enabling the tracking of climate extremes such as heatwaves might be a relevant resource to help evaluating climate attribution methodologies and expanding them further having this visual support. In addition, having a more realistic representation of a heatwave might help reduce uncertainties, hence better guiding the decision-making process. Both types of contributions might be of service at issuing weather warnings tailored to regions, therefore improving the social preparedness and response capacity when heatwaves hit a region (e.g. excess human mortality associated with heat stress).

References

Dijkstra, H. A., Hernandez-Garcia, E., Masoller, C., & Barreiro, M. (2019). *Networks in Climate*. Cambridge: Cambridge University Press, Cambridge, UK and New York, NY, USA.