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Identifying drivers for heat waves using wavelets and machine learning approaches

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The driving mechanisms of extreme heat events are known to live on a range of spatio-temporal scales. The occurrence and severity of a heatwave can be influenced by (a) slow variations in the ocean and sub-surface, (b) planetary tele-connections, (c) variations in the jet-stream and synoptic weather systems, as well as (d) local-scale feedbacks.

While important progress has been made on each of these individual contributions, fewer studies have attempted to draw a unified picture including them all. We approach this task with tools from classic statistical modeling, as well as image processing machine learning. With the help of wavelet-transforms, predictor variables can be separated into individual scales. Together with local variables and global principal component time-series, these potential drivers are supplied to a statistical learner with the task of reconstructing the field of heatwave occurrences. Contributions from individual scales can then directly be identified, either via variable selection before or during learning, or by measures of feature importance applied to the trained models.

We demonstrate this approach for the case of summer heatwaves in the ERA5 reanalysis. If successful, our framework can also be transferred to other extreme events such as droughts, cold spells or wind storms.