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The dynamics of persistent hotspells in European summers

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Persistent summer weather can result in extreme events with enormous socio-economic impacts; recent summers in Europe have notably demonstrated this. The dynamics that cause persistent surface weather, as well as potential changes under anthropogenic climate change, are the subject of active scientific debate. Summertime atmospheric dynamics have nevertheless received less attention and we are far from obtaining a comprehensive understanding of the mechanisms involved in the formation of persistent weather conditions in summer. This study investigates the drivers responsible for making some surface extreme events more prone to being long-lasting than others.

Gaining a comprehensive understanding of such processes poses challenges due to the complex interactions of variables and fluxes operating at various timescales – from individual weather events (daily to weekly), to the general circulation of the atmosphere and its modulation by specific changes in sea surface temperature or soil moisture interactions (monthly, seasonal to interannual). Furthermore, studies are recently observing that persistent (quasi-stationary or recurrent) circulation patterns do not necessarily always translate to extreme events and persistence at the surface. This discussion extends to open questions about, such as the potential role of soil moisture preconditioning in extending the lifetime of these events.

Starting from an impact-based definition of persistent hot conditions for different European regions, we characterise their persistence by looking at the associated circulation patterns and surface conditions. Through a comparison of long-lived (persistent) and short-duration events, we discern dynamical differences and regional variations that shed light on the common ingredients and potential mechanisms influencing the persistence of extreme heat events in summer. We use the ERA5 reanalysis dataset to take advantage of its high spatiotemporal resolution and relatively long temporal coverage from the 1950s up to today.

A deeper investigation into the dynamical processes controlling persistent surface conditions over Europe in summer is essential for improved predictability at the sub-seasonal to seasonal (S2S) timescale, and it holds significant relevance for risk preparedness. Results from the study aim to

advance the discussion on summer dynamics, weather persistence and climate impacts.