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Dynamics and Thermodynamics of weather extremes: a dynamical systems approach

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A fundamental challenge in atmospheric science is decomposing the thermodynamic and dynamic drivers of hydrological and surface temperature extremes. Such a decomposition would provide insights into the drivers of individual extreme events as well as future extreme event frequencies under greenhouse forcing. In the present work, we exploit recent results from dynamical systems theory to study concurrent extremes of atmospheric variables. Specifically, we present a methodology to quantify the recurrences of bivariate fields, the repeated co-occurrences of distinct univariate fields, and the dependence between two fields. The dependence is defined by a coupling parameter, which depends on the chosen fields, season, and domain and can be understood in terms of the underlying physics of the system. For suitably chosen fields, such as near-surface temperature and sea level pressure, this approach enables decomposition of thermodynamic and dynamic drivers of climate extremes. Using the derived metrics, we identify particular weather regimes that provide information as to the subseasonal predictability of surface temperature and hydrological extreme events in the Northern Hemisphere mid-latitudes.