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Nonlinear methods for studying the temporal variability of spatial correlations between climatic time series

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In climatological studies, correlation patterns are often determined by interpolating the dynamics from a variety of spatially distributed records and applying standard methods of multivariate statistics like linear principal component analysis. However, the investigation of temporal changes of these patterns is often restricted to the consideration of typical "seasonal" patterns, which does not resolve changes on shorter as well as longer time scales.

In this contribution, we describe two alternative approaches to a temporally variable characterisation of spatial correlation patterns. In order to avoid undesired effects due to spatial interpolation, the concept of climatic correlation networks is particularly useful, which allows a quantitative characterisation of the mutual interdependences between individual records. In addition, multivariate dimension densities and related concepts are used for quantifying the complexity of mutual interdependences within a set of records by a single statistical parameter. Whereas recent studies on both approaches have mainly considered linear correlations, we present a thorough generalisation to more general statistical dependences.

As a particular application, we study daily air temperature records from a set of Japanese stations covering the last three decades. The seasonal variability of spatial correlation patterns, which is strongly affected by the action of the East Asian monsoonal circulation, is studied with a high temporal resolution. Our results are com-

pared with those obtained for a set of Central European records, which cover much longer time intervals and are thus suited to study in which way the observed long-term climate change may have influenced the spatial dynamics of short-term temperature variability. Extensions of our corresponding results to model and reanalysis data as well as long-term climatic reconstructions are outlined.