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Nonlinear Spatio-Temporal Characteristics of Regional Climate Networks: A Case Study based on Japanese Air Temperatures

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Climate variations are known to be the result of non-linear processes. In this work, we study and compare the statistical as well as dynamical properties of complex networks derived from daily air temperature time series at various Japanese stations using different threshold criteria based on linear cross-correlations as well as other types of statistical dependence, including monotonic (rank-order correlations), oscillatory (phase synchronisation), topologic (recurrence quantification analysis (RQA)) and information-theoretic (redundancies, transfer entropies) approaches.

The topological properties of the resulting regional climate networks are examined for the whole records as well as running windows in time. In order to achieve a better qualitative understanding of which types of processes may be responsible for the observed similarities and differences between the derived network structures, nonlinear dynamic characteristics (fractal dimensions, entropies, RQA measures) are estimated for the individual time series. Our results suggest systematic relationships between the spatial and temporal variations in the local complexity of atmospheric dynamics and the resulting networks.