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Spatial Correlations and Phase Coherence of Hydro-Meteorological Long-Term Observations

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Time series of hydro-meteorological observables are not only characterized by temporal, but also by certain spatial correlations. However, the strong influence of the omnipresent annual cycle may lead to artificial results of correlation analysis. Different approaches to overcome this problem are critically compared. The resulting mutual interrelationships between observations obtained at various locations are quantified by several measures (including linear cross-correlation functions and nonlinear mutual information) which allow to derive network-like structures as an approximation of the underlying continuous system. Phase coherence analysis reveals that the meaningful definition of phase variables depends crucially on the considered time scale and observable. Hence, indices from phase synchronization analysis are hardly suited to quantify mutual interdependences between hydro-meteorological records. To dynamically characterize the temporally varying amplitude of correlations between a set of records, we introduce the concept of ensemble correlations. Our corresponding approach is able to detect an increase of collective behaviour of spatially distributed records in the presence of extreme hydro-meteorological conditions.