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How complex climate networks complement eigen techniques for the statistical analysis of climatological data

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Eigen techniques such as empirical orthogonal function (EOF) or coupled pattern (CP) / maximum covariance analysis have been frequently used for detecting patterns in multivariate climatological data sets. Recently, statistical methods originating from the theory of complex networks have been employed for the very same purpose of spatio-temporal analysis. This climate network (CN) analysis is usually based on the same set of similarity matrices as is used in classical EOF or CP analysis, e.g., the correlation matrix of a single climatological field or the cross-correlation matrix between two distinct climatological fields. In this study, formal relationships as well as conceptual differences between both eigen and network approaches are derived and illustrated using global precipitation, evaporation and surface air temperature data sets. These results allow us to pinpoint that CN analysis can complement classical eigen techniques and provides additional information on the higher-order structure of statistical interrelationships in climatological data. Hence, CNs are a valuable supplement to the statistical toolbox of the climatologist, particularly for making sense out of very large data sets such as those generated by satellite observations and climate model intercomparison exercises.