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Spatiotemporal modes of climatic variability: building blocks of complex networks?

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The theory of complex networks offers a rich set of tools aimed at understanding various aspects of high-dimensional spatiotemporal systems [1]. Recently, methods based on complex network theory have been applied to quantities characterizing climatic variability (e.g. [2]) with the aim of characterizing the behavior of the atmospheric system. Typically, complex network methods are applied directly to reanalysis data [3], which are available on a high resolution planetary grid.

An important pre-requisite to the application of complex network methods is the quantification of pairwise interactions in the spatiotemporal process. When estimating such dependencies, multiple sources of bias must be taken into account, such as spatial smoothness [4] or dynamical memory variability [5]. The attenuation or mitigation of selected biases may be aided by a suitable reduced representation of the climatic spatiotemporal process.

We study decompositions based on multivariate analysis methods such as PCA, ICA or spectral clustering [6] with the purpose of providing a reduced representation of the climate system amenable to analysis using symmetric and asymmetric dependence measures. Some of the key studied questions are robustness, temporal variability and method-induced bias of the obtained spatiotemporal components. Robustness of the components is an important facet of the general validity of the decomposition and strongly affects the suitability of the resulting components as nodes in a complex network. Temporal variability will be studied especially with respect to the activity of the North Atlantic Oscillation (NAO), a major climatic mode in the Northern hemisphere.

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