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Performance Evaluation and Comparison between the Empirical Mode Decomposition, Wavelet Analysis, and Singular Spectrum Analysis Applied to the Time Series Analysis in Atmospheric Science

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Abstract : Signal decomposition approaches represent an important step in time series analysis, providing useful knowledge and insight into the data and underlying dynamics characteristics while also facilitating tasks such as noise removal and feature extraction. As most of observational time series are nonlinear and nonstationary, resulting of several physical processes interaction at different time scales, experimental time series have fluctuations at all time scales and requires the development of specific signal decomposition techniques. Most commonly used techniques are data driven, enabling to obtain well-behaved signal components without making any prior-assumptions on input data. Among the most popular time series decomposition techniques, most cited in the literature, are the empirical mode decomposition and its variants, the empirical wavelet transform and singular spectrum analysis. With increasing popularity and utility of these methods in wide ranging applications, it is imperative to gain a good understanding and insight into the operation of these algorithms. In this work, we describe all of the techniques mentioned above as well as their ability to denoise signals, to capture trends, to identify components corresponding to the physical processes involved in the evolution of the observed system and deduce the dimensionality of the underlying dynamics. Results obtained with all of these methods on experimental total ozone columns and rainfall time series will be discussed and compared

Keywords : denoising, empirical mode decomposition, singular spectrum analysis, time series, underlying dynamics, wavelet analysis
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