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Analysis of environmental time series complexity

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The analysis and modelling of time series is one of the main open topics in the field of environmental modelling. Specifically, the study of pollution time series has a crucial role in the monitoring of urban environment quality. It is widely known that the patterns of hourly pollution in urban areas are highly variable, demonstrating daily and seasonal periodicity as well as possible trends. Hence, advances in the analyses of these data are of great interest for both scientific community and decision-makers.

The present study proposes a comprehensive and consistent procedure for time series analysis by applying a variety of measures (features) to quantify the complexity of time series. In particular: covariance functions, variograms, information content, entropy, fractal/multifractal dimensions, detrended multifractal fluctuation analysis, and wavelets decomposition. These measures allow the characterization of time series from different angles by taking into account both distributional and temporal structure aspects. In this work, time series are analysed before and after performing a decomposition (by removing existing trends and seasonal components). An important task considered concerns the linearity/nonlinearity of time series using surrogate data simulations.

A real data case study deals with the detailed analysis of hourly measurements of NO_2, O_3, CO, and PM2.5 in different urban places in Switzerland provided by the Swiss National Air Pollution Monitoring Network (NABEL). Results show how the performed analyses help in better understanding of complex environmental phenomena, their predictability and in selecting of relevant forecasting models.