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A Methodology for the Parametric Reconstruction of Non-Steady and Noisy Meteorological Time Series

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Climatic and meteorological time series often show some persistence (in time) in the variability of certain features. One could regard annual, seasonal and diurnal time variability as trivial persistence in the variability of some meteorological magnitudes (as, e.g., global radiation, air temperature above surface, etc.). In these cases, the traditional Fourier transform into frequency space will show the principal harmonics as the components with the largest amplitude.

Nevertheless, meteorological measurements often show other non-steady (in time) variability. Some fluctuations in measurements (at different time scales) are driven by processes that prevail on some days (or months) of the year but disappear on others. By decomposing a time series into time–frequency space through the continuous wavelet transformation, one is able to determine both the dominant modes of variability and how those modes vary in time.

This study is based on a numerical methodology to analyse non-steady principal harmonics in noisy meteorological time series. This methodology combines both the continuous wavelet transform and the development of a parametric model that includes the time evolution of the principal and the most statistically significant harmonics of the original time series.

The parameterisation scheme proposed in this study consists of reproducing the original time series by means of a statistically significant finite sum of sinusoidal signals (waves), each defined by using the three usual parameters: amplitude, frequency and phase.

To ensure the statistical significance of the parametric reconstruction of the original signal, we propose a standard statistical t-student analysis of the confidence level of the amplitude in the parametric spectrum for the different wave components.

Once we have assured the level of significance of the different waves composing the parametric model, we can obtain the statistically significant principal harmonics (in time) of the original time series by using the Fourier transform of the modelled signal.

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