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CHAOTIC SVD METHOD FOR MINIMIZING THE EFFECT OF SEASONAL TRENDS IN DETRENDED CROSS-CORRELATION ANALYSIS

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Abstract. The detrended cross-correlation analysis (DCCA) and its generalization, multifractal detrended cross-correlation analysis (MF-DXA) have been used extensively to detect possible power-law cross-correlations between two non-stationary time series. However, recent studies have reported signals superimposed with trends, which often lead to the complexity of the signals and the susceptibility of DCCA. This paper proposes a smoothing algorithm named Chaotic Singular Value Decomposition (CSVD) based on the chaos theory and singular value decomposition to minimize the effect of seasonal trends and distortion in the log-log plots obtained by DCCA techniques. The effectiveness of the technique is demonstrated on monofractal and multifractal data corrupted with seasonal trends.

Keywords. Detrended cross-correlation analysis; Reconstruction of phase space; Singular value decomposition; Fractal; Chaos.

1 Introduction

Many physical and biological systems exhibit complex behavior characterized by cross-correlations. For quantifying the cross-correlations in time series, the random matrix approach is widely used[1, 2]. Recently, the detrended cross-correlation analysis (DCCA) and its extension, multifractal detrended cross-correlation analysis (MF-DXA) has been proposed to detect the cross-correlation behavior of the long-range power-law cross-correlated time series [3-5]. The DCCA method represents a generalization of the DFA method [6, 7] and it is designed to analyze power-law cross-correlations between two simultaneously recorded non-stationary time series. By applying the DCCA method, the cross-correlation in successive differences of air humidity and air temperature [3, 8], temporal and spatial seismic data [9], vehicles and passengers [10]were investigated.

For correctly interpreting the scaling phenomenon obtained by DCCA method, it is essential to understand the intrinsic dynamics of the real systems. In fact, for many real systems where the DCCA method was applied,