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Detrended Partial-Cross-Correlation Analysis: A New Method for Analyzing Correlations on Different Time Scales in Complex System

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A new method, detrended partial-cross-correlation analysis (DPCCA), is proposed in this work. Based on detrended cross-correlation analysis (DCCA), this method is improved by including partial-correlation technique, which can be applied to quantify the relations of two non-stationary signals (with influences of other signals removed) on different time scales. Advantages of this method are illustrated by performing two numerical tests. One shows the advantages of DPCCA in handling non-stationary signals, while the other one reveals the "intrinsic" relations between two considered time series with potential influences of other unconsidered signals removed. To further show the utility of DPCCA in natural complex systems, we provide new evidence on the winter-time Pacific Decadal Oscillation (PDO) and the winter-time Nino3 Sea Surface Temperature Anomaly (Nino3-SSTA) affecting the Summer Rainfall over the middle-lower reaches of the Yangtze River (SRYR). By applying DPCCA, better significant correlations between SRYR and Nino3-SSTA on time scales of 6-8 years are found over the period 1951-2012, while significant correlations between SRYR and PDO on time scales of 35 years arise. With these physically explainable results, we have confidence that DPCCA is an useful method in addressing complex systems.