估計線性傳遞矩陣的方法

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Abstract

In this study, we introduce two alternative methods to estimate the linear propagator and finite-time growth rates from data. The first method is generalized singular value decomposition (GSVD) and the second is singular value decomposition combined with cosine-sine decomposition (SVD-CSD). Both methods explore the common evolution structures of the predictor and predictand to make the estimations. The GSVD reveals clearly the connection between the finite-time growth rates and the singular values of the propagator. However, it can only be applied to data with more state variables than observations. The SVD-CSD is a generalization of the GSVD and has more flexibility in dealing with general data situations.

Both methods and the Yule-Walker equation were applied to the hypothetical normal mode oscillations, the Kaplan sea surface temperature anomalies (SSTA) and the NCEP/NCAR reanalysis 1000 hpa monthly mean temperature datasets to evaluate their performances. The results show that, for the same number of retained singular modes, the SVD-CSD, using the full spectrum of principal components (PCs), can effectively include information in higher empirical orthogonal functions (EOFs) to yield more correct estimations of the propagator and associate singular structures. The Yule-Walker equation, using only autocovariance and lag-covariance information of data in estimation, generally underestimates the finite-time growth rates and leads to less reliable propagator estimations. Furthermore, the observed variability is shown to be well maintained using the SVD-CSD approach.