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## A new singular spectrum analysis approach for processing incomplete time series polluted by multiplicative noise

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Since a time series is usually incomplete, the missing data are usually interpolated before employing singular spectrum analysis (SSA). We develop a new SSA for processing incomplete time series based on the property that an original time series can be reproduced from its principal components which are then estimated based on minimum norm criterion. When an incomplete time series is polluted by multiplicative noise, we first convert the multiplicative noise to additive noise by multiplying the signal estimate of the time series, then process the time series with weighted SSA, where the weight factor is determined according to the variance of additive noise, since the converted additive noise is heterogeneous. The proposed SSA approach is employed to process the real incomplete time series data of suspended-sediment concentration from San Francisco Bay compared to the traditional SSA and homomorphic log-transformation SSA approach. The first 10 principal components derived by our proposed SSA approach can capture more of the total variance and with less fitting error than traditional SSA approach and homomorphic log-transformation SSA approach. Furthermore, the results from the simulation cases conform that our proposed SSA outperform both traditional and homomorphic log-transformation SSA approaches.