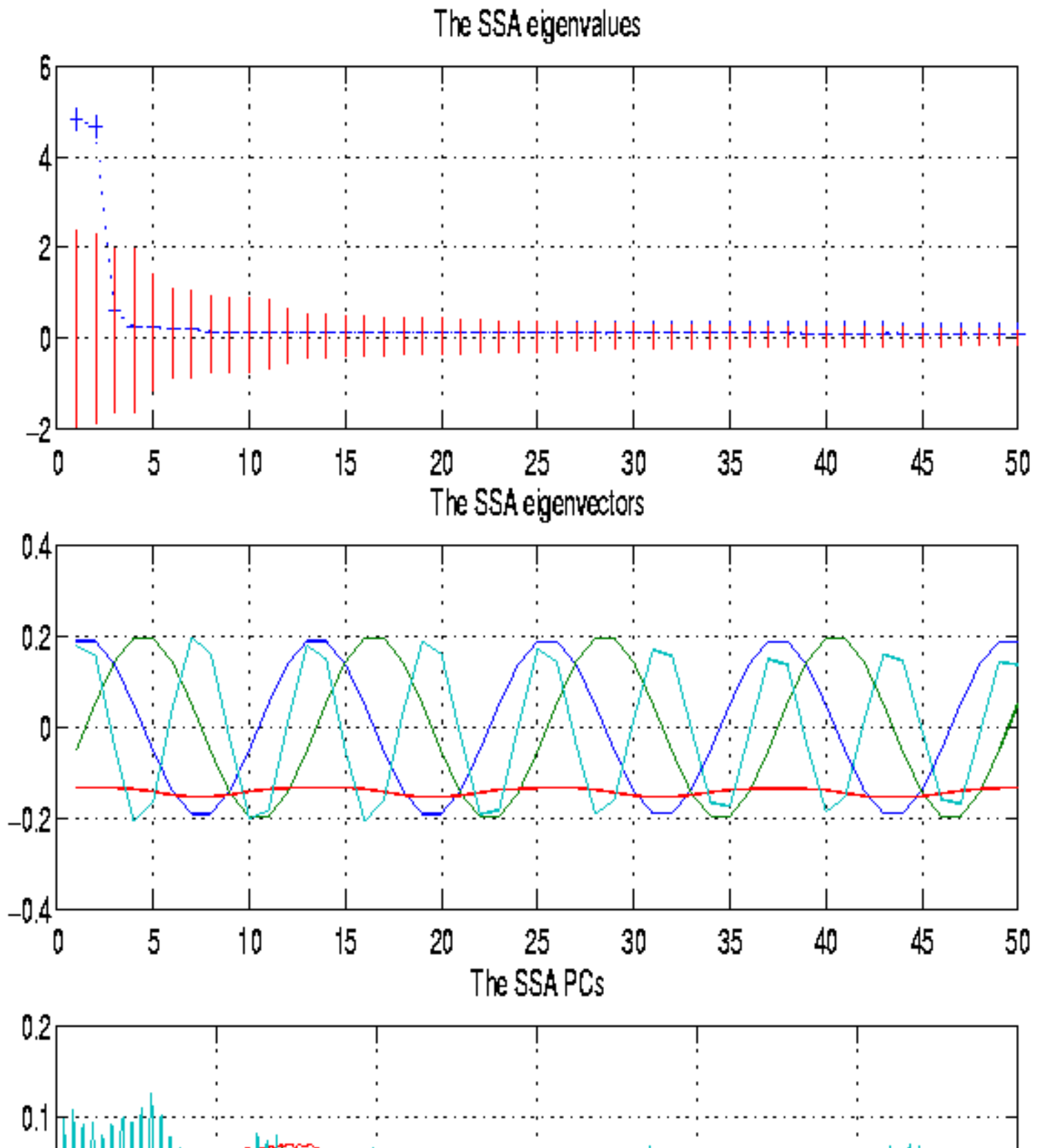
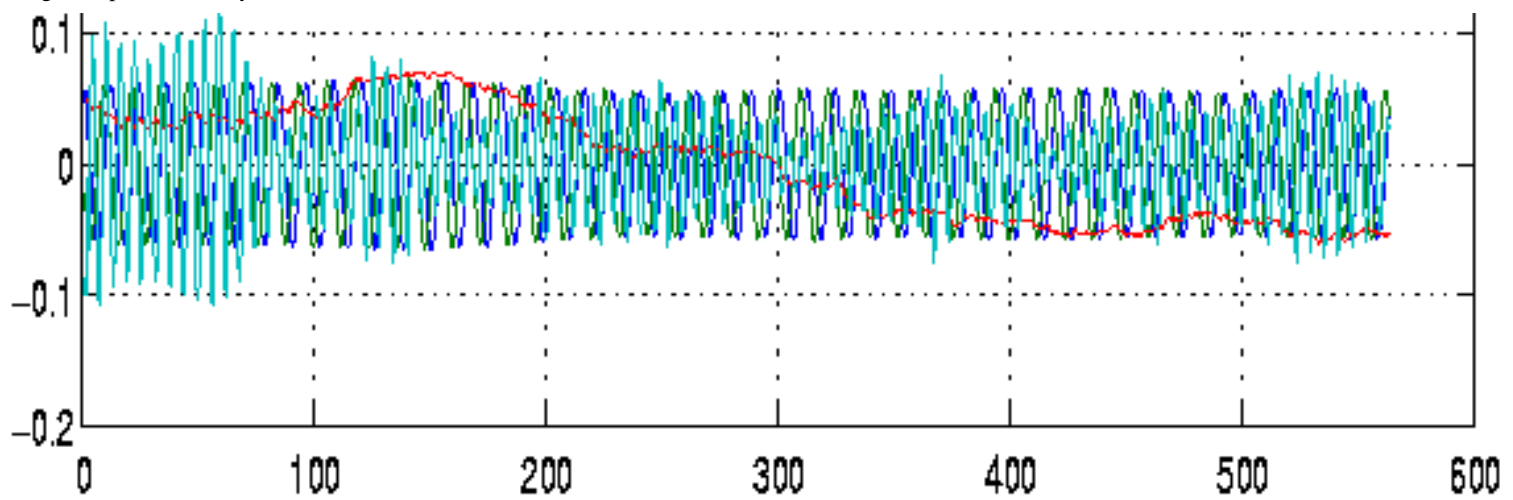


Singular Spectrum Analysis*

Figure 10.6: SSA results for the leading PC from the NCEP SLP. [stats_uib_10_1.m]





Singular spectrum analysis (SSA) [1] (p.451-459) is a method which is similar to the EOF analysis in terms of the mathematical formulation, but yields results which may be categorised under the spectral method groups. The method is suitable for extracting information from short and noisy time series. SSA unravels the information embedded in the delay-coordinate phase space by decomposing the sequence into elementary patterns of behaviour in time and spectral domains, by using "data-adaptive filters" that help separating the time series into statistically independent components, which can be classified as trends, deterministic oscillation, or noise.

First, a window size (M), which sets the maximum lag, is chosen. Then, a $M \times M$ covariance matrix \mathbf{C}_X is computed from the M sequences of the $N \times 1$ data series \mathbf{X} , each corresponding to a 1-lag shift:

$$\tilde{\mathbf{X}}_k(t) = [\mathbf{X}(t+k), \mathbf{X}(t+k+1), \dots, \mathbf{X}(N-M+k)],$$

where $k = 1, \dots, M$. The eigenvalue problem

$$\mathbf{C}_X \rho_k = \lambda_k \rho_k,$$

or

$$\mathbf{E}_X^T \mathbf{C}_X \mathbf{E}_X = \Lambda_X,$$

is solved (using SVD), giving the eigenvectors \mathbf{E}_x corresponding to the eigenvalues ρ_k (given

in decreasing order). The S/N separation is obtained by plotting the Eigenvalue spectrum.

The SSA does not yield spectral estimates directly, but may be used to reconstruct a cleaner signal that may be spectrally analysed. Multi-channel SSA (M-SSA) [] (p.469-470) performs the SSA on a vector or map of data, such as in gridded form.

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