

Statistical Significance Test of Intrinsic Mode Functions

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ABSTRACT

One of the preliminary tasks of analyzing a data set is to determine whether the data set or its components contain useful information. The task is essentially a binary hypothesis testing problem in which a null hypothesis of pure noise is often pre-proposed. To test against the null hypothesis, the characteristics of noise need to be understood first; and often, these characteristics of noise are pertained to the analysis method that is used.

In this talk, the characteristics of white noise in the Empirical Mode Decomposition method (EMD) are discussed. EMD has successfully revealed empirical facts for a long stream of data of synthetic white noise: (i) the EMD is effectively a dyadic filter, (ii) the Intrinsic Mode Function (IMF) components are all normally distributed, and (iii) the Fourier spectra of the IMF components are all identical and cover the same area on a semi-logarithm period scale. These empirical findings help infer that the product of the energy density of IMF and its corresponding averaged period is a constant and the energy density function satisfies a Chi-squared distribution. The energy density spread functions of the IMF components can then be derived based and these functions are used to design statistical testing methods against white noise for the IMFs. To demonstrate its validity and effectiveness, the EMD method is applied to some well known geophysical data sets, such as the SOI, NAO Index, and globally averaged surface temperature anomaly.