ABSTRACT

Hsu, En-Ching. Hilbert-Huang Transform Analysis of the Climatic and Hydrologic Time Series. Major Professor: Professor A. Ramachandra Rao

To accommodate the inherent non-linearity and non-stationarity of many natural time series, empirical mode decomposition (EMD) and Hilbert-Huang transform (HHT) provide an adaptive and efficient method. The HHT is based on the local characteristic time scale of the data. The HHT method provides not only a precise definition in time-frequency representation than the other conventional signal processing methods, but also more physically meaningful interpretation of the underlying dynamic processes. The EMD also works as a filter to extract the variability of signals with different scales and is applicable to non-linear and non-stationary processes. This promising algorithm has been applied in many fields since it was developed, but it has not been applied to hydrological and climatic time series. This study starts with several simulated data sets in order to investigate the capability of this method and to compare it to other conventional frequency domain analysis methods, which are based on the assumption of stationarity. Rainfall, streamflow, temperature, wind speed time series and lake temperature data are investigated in this study. The aim of the study is to investigate periodicity, long term oscillations and trends embedded in these data by using HHT. The analysis is performed in both the time and frequency domains. The results from HHT are compared to those from the multi-taper method which is based on Fourier Transform of the data. The results indicate that the HHT is clearly superior to MTM in delineating the stochastic structure of the data. Details about the data which cannot be investigated by traditional methods are clearly seen with HHT. The nonstationarities of climatic and hydrologic data are also brought out. The HHT is an excellent tool to investigate the characteristics of environmental and hydrologic time series.

Keywords: Empirical mode decomposition (EMD); Hilbert-Huang Transform (HHT); non-stationarity; non-linearity; time series