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A Method for Meteorological/Climatic Scenario Generation and Its Application for Hydrological Impacts Assessment Based on Empirical Orthogonal Function Analysis and Hilbert-Huang Transform

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The growing concern of the impacts on hydrological cycle by climate change makes it imperative to construct meteorological scenarios suitable for local/regional scale use. Recognizing the significant uncertainties in developing global climate models (GCMs) and downscaling to local/regional scale, we proposed a diagnostic approach to generating meteorological scenarios based on historical observation data. This method strategically include 3 stages, namely, data dissolving in which the observation data matrix is parsed, data analysis in which the information relevant to climate change is analyzed and simulated, and data recovering which essentially reverses the dissolving operation. Being the major stage, the data dissolving technically starts with a multivariate empirical orthogonal function analysis (EOFA), followed by a Hilbert-Huang transform (HHT) to accommodate the nonlinearity and nonstationarity in time series. In the analysis stage, the HHT-derived intrinsic mode functions (IMFs) are tested with respect to the trend in amplitude, and the statistically significant trends are then simulated to represent the climate change. The proposed method was evaluated by comparing the simulated meteorological scenarios with the observed meteorological data, over the upstream basin of Liuyang River in south central China during 2006 – 2013. The comparisons proved the skills of the method in conserving the intrinsic features while concurrently embodying the possible variability in the meteorological field. By applying the simulated meteorological scenarios to run the Soil & Water Assessment Tool (SWAT) model, the study area was found likely to experience an increasingly uneven distribution of water resources, which reflects the impact of climate change. This method has exhibited application potential as a regional/local weather generator to translate the existing subtle climate variability into hydrological variability and to study the sensitivity of hydrological system to the meteorological/climatic changes.