Undulation of the Annual Cycle in the Temperature and Rainfall Records around Taiwan

Shu-Ping Weng[1] and Wen-Hau Huang[2]
1: Department of Geography, National Taiwan Normal University
2: Research and Development Center, Central Weather Bureau

Abstract

A newly developed methodology, the cyclostationary empirical orthogonal function analysis (CSEOFA), is applied to the long-term (1911-2005) temperature and rainfall records of six stations, Taipei, Taichung, Tainan, Hengchun, Taitung, and Hualian, to study the undulation of annual cycle around Taiwan Island. Unlike the conventional analysis that the climatic annual cycle is often assumed unchanged and is removed from raw data while studying the climate variability, the CSEOFA used in this study only assumes that the annual cycle is cyclic with one-year periodicity. Decomposition of a spatiotemporally varying field in terms of CSEOFA results in two types of time dependence: structure function (i.e., loading vector representing the evolving annual cycle) and its undulation (i.e., principal component in usual term). As a result, CSEOFA enables the degree of variability of the structure function to be specifically quantified by the associated PC.

While the resulting CSEOFA of station temperatures expresses a single dominant mode: slow annual cycle, long-term rainfall activity in Taiwan has two additional fast annual cycle modes linking to the persistence of intraseasonal oscillation. After judging the fidelity of 1-yr periodicity assumption based on the complex EOF analysis, this study also examines the seasonal preference of the fluctuations in both slow and fast annual cycle modes found in the pentad-resolved temperature and rainfall records.

Along with the variability of sea surface temperature in the Indo-Pacific Oceans and mean sea level pressure at higher latitudes of East Asia, the resulting undulated PC time series of station temperature and rainfall activities are further subjected to the wavelet spectrum and squared coherency analyses to identify the dominant modes and their large-scale associations in the context of time-frequency analysis. Preliminary results such as the quadrennial tendency of rainfall activity, origin of temperature swing in 1960s, and the climate regime shift in 1980s will be reported in this study.

Key words: Annual cycle; EOF analysis; Wavelet analysis; Intraseasonal oscillation