

東亞夏季季風的年際與年代際變化： 歷史變遷與未來推估

Interannual and interdecadal changes of the East Asian summer monsoon: historical and future projection

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摘 要

東亞夏季季風(East Asian Summer Monsoon, EASM)是亞太季風的一環，伴隨季風的降水約佔一年之中的55~80%，雨量的多寡攸關東亞農業的種植與收成。過去研究顯示，EASM呈現多重時間尺度的變化，在年際變化中主要有聖嬰-南方震盪(ENSO)和印度洋偶極(IOD)的影響，年代際尺度中則以太平洋十年震盪(PDO)和大西洋年代際震盪(AMO)為主。本研究透過大氣及海洋再分析資料和耦合氣候模式對比計劃-第六期(Coupled Model Intercomparison Project 6, CMIP6)，探討EASM的歷史變遷與未來推估，研究方法主要以經驗正交函數(Empirical Orthogonal Function, EOF)、小波分析(wavelet)與回歸分析。初步結果顯示，EASM的降水與850百帕渦度在前兩個主成分(PC1, PC2)具2~5年的年際變化，以ENSO造成的海溫變異為主，週期存有變動，約1975~1985年以3~5年訊號較顯著；1986~2000年間縮短為2~3年，PC3則有PDO為主的年代際週期。目前CMIP6歷史模擬之系集平均在wavelet分析顯示具有年際與年代際震盪的週期，但訊號相較於再分析資料弱，未來將納入篩選模式的方法，再進一步探討暖化情境下的未來變遷。

關鍵字：東亞夏季季風、年際變化、年代際變化、未來推估

Abstract

East Asian summer monsoon (EASM) is one part of the Asian-Pacific Monsoon. The EASM precipitation accounts about 55~80 % in annual, and the amount of rainfall is critical to planting and harvest in East Asia. The pre studies have shown that EASM exhibits changes of multiple time scales. In the interannual variability, El Niño -Southern Oscillation (ENSO) and Indian Ocean Dipole (IOD) are major influences, the interdecadal are Pacific Decadal Oscillation (PDO) and Atlantic Multidecadal Oscillation (AMO). This study using atmospheric and oceanic reanalysis data and coupled model intercomparison project 6 (CMIP6) to investigate historical changes and future projection. The major methods are Empirical Orthogonal Function (EOF), wavelet and regression. The preliminary results show that the precipitation and 850hPa vorticity of the EASM have 2~5 years of interannual variability in two leading principle component (PC1, PC2). And the period has variability, the signal is more significant in 3~5 years during 1975 to 1985; the period was shortened to 2~3 years during 1986~2000. Moreover, PC3 has an interdecadal period dominated by PDO. Currently, ensemble of CMIP6 historical run has interannual and interdecadal period in wavelet analysis, but the signal is weaker than reanalysis data. In the future, the method of screening the models would be included, and the future projection under global warming is the next step to discuss.

Key words: East Asian summer monsoon, interannual, interdecadal, future projection