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Classification and Diagnosis of Summer Monsoon Rainfall Patterns and their Potential Predictability in Southeast China

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The East Asian Summer Monsoon (EASM) is a crucial monsoon system that profoundly influences the summer climate in Southeast China (SEC). Classification of monsoon rainfall patterns is vital to physical diagnosis, rainfall prediction and identification of sites that are prone to rainfall-triggering floods. With the great endeavors on understanding the complexity of the EASM in the past decades, the traditionally accepted rainfall patterns in SEC and the relevant analyses appear outdated or even inadequate. Having highly-improved observations at hand helps update the monsoon rainfall patterns in SEC and the potential predictability.

The present study employs a nonlinear neural network classification technique, the Self-organizing map (SOM), to identify the rainfall patterns in SEC based on gauge data. Three distinct rain belts over the Huai River basin (HRB), lower Yangtze River basin (LYRB) and South Coast region (SCR) are found. Their subseasonal variability highly agrees with the stepwise progression of the East Asian Summer Monsoon (EASM) front in space and time. Analysis reveals that precipitation in the SCR and HRB rain belts undergo a regime shift after the mid-1990s, whereas the 1990s is the most active decade for the LYRB rain belt. These systematic changes are in abreast with similar changes in EASM and other climate events documented in the literature.

Additionally, a SOM-based algorithm is developed to further divide gauge stations into three groups featuring homogeneous rain belt patterns. Promising predictability of group-averaged daily rainfall is then achieved, with about 39% to 50% of the total variance explained by circulation-informed regression models, verified by both cross-validation and blind prediction. Through further diagnosis in the useful predictors, the western North Pacific subtropical high, blocking high anomalies over northeast China and the upper-level divergence over SEC, are found to best explain the variability of the rain belts. The proposed Russia-China wave pattern (western/central Russia -> north of Tibetan Plateau -> SEC) and teleconnection between the El Niño-Southern Oscillation and the rain belts also offer additional predictability. This study aims to set an updated benchmark on the summer monsoon rainfall patterns in SEC, from which the promising daily predictability and the informative circulation patterns are obtained. Findings from this work may also advance the understanding of the EASM rain belts, and offer insights to the source of bias for numerical simulations of daily summer monsoon rainfall in the region.