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Geophysical Factor Resolving of Rainfall Mechanism for Super Typhoons by Using Multiple Spatiotemporal Components Analysis

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This study develops a novel methodology to resolve the geophysical cause of typhoon-induced rainfall considering diverse dynamic co-evolution at multiple spatiotemporal components. The multi-order hidden patterns of complex hydrological process in chaos are detected to understand the fundamental laws of rainfall mechanism. The discovered spatiotemporal features are utilized to develop a state-of-the-art descriptive statistical model for mechanism validation, modeling and further prediction during typhoons. The time series of hourly typhoon precipitation from different types of moving track, atmospheric field and landforms are respectively precede the signal analytical process to qualify each type of rainfall cause and to quantify the corresponding affected degree based on the measured geophysical atmospheric-hydrological variables. This study applies the developed methodology in Taiwan Island which is constituted by complex diverse landform formation. The identified driving-causes include: (1) cloud height to ground surface; (2) co-movement effect induced by typhoon wind field with monsoon; (3) stem capacity; (4) interaction between typhoon rain band and terrain; (5) structural intensity variance of typhoon; and (6) integrated cloudy density of rain band. Results show that: (1) for the central maximum wind speed exceeding 51 m/sec, Causes (1) and (3) are the primary ones to generate rainfall; (2) for the typhoon moving toward the direction of 155° to 175°, Cause (2) is the primary one; (3) for the direction of 90° to 155°, Cause (4) is the primary one; (4) for the typhoon passing through mountain chain which above 3500 m, Cause (5) is the primary one; and (5) for the moving speed lower than 18 km/hr, Cause (6) is the primary one. Besides, the multiple geophysical component-based precipitation modeling can achieve 81% of average accuracy and 0.732 of average correlation coefficient (CC) within average 46 hours of duration, that improve their predictability.