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Investigation of the Non-Symmetrical Dependence of Precipitation using Empirical Bivariate Copulas

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Precipitation plays important role in hydrological analysis. Some common precipitation models are developed based on the assumption of the symmetrical Gaussian dependence structure. This study tries to examine the asymmetrical spatial dependence of precipitation using empirical bivariate copulas. Empirical bivariate copulas are constructed from all possible pairwise combination of the rain gauge data at different locations located in Singapore and Germany. In addition, concept of regionalized variables in spatial random process is also applied with given separating distance. For any selected time interval, precipitation over the region of interest is assumed to be a realization of spatially stationary random process. In order to take into account temporal characteristics, precipitation with different time scales (hourly, 2-hours, 3-hours, 4-hours, 6-hours, 12-hours, daily, 5-days, 10-days, 15-days, monthly, quarterly) and different seasons are analyzed. The behavior of correlation functions are elaborated considering zero precipitation treated as censored values. Asymmetrical spatial dependence is measured by calculating integration from empirical bivariate copula density in the upper right and the lower left parts for given some thresholds, and then by their comparisons. Similarly, zero precipitation is handled as latent variables, and the thresholds are therefore taken percentiles bigger than probability of zeroes. Gaussian simulation based testing is adopted for counting its degree of uncertainty. Empirical evidences prove that precipitation correlation decrease along with the length of distance interval and increases with the length of time interval. There is an interesting systematic pattern relating to the domination of positive non-symmetrical spatial dependence in comparison to negative and symmetrical dependence in terms of distance and time interval. Number of pairs of rain gauge stations which has positive dependence is clearly seen the biggest for cases with short distances and short time scales. Number of precipitation events with positive dependence is also dominant for the events with short distances as well as short time scales.