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The impacts of precipitation amount simulation on hydrological modeling in Nordic watersheds

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Stochastic modeling of daily precipitation is very important for hydrological modeling, especially when no observed data are available. Precipitation is usually modeled by two component model: occurrence generation and amount simulation. For occurrence simulation, the most common method is the first-order two-state Markov chain due to its simplification and good performance. However, various probability distributions have been reported to simulate precipitation amount, and spatiotemporal differences exist in the applicability of different distribution models. Therefore, assessing the applicability of different distribution models is necessary in order to provide more accurate precipitation information.

Six precipitation probability distributions (exponential, Gamma, Weibull, skewed normal, mixed exponential, and hybrid exponential/Pareto distributions) are directly and indirectly evaluated on their ability to reproduce the original observed time series of precipitation amount. Data from 24 weather stations and two watersheds (Chute-du-Diable and Yamaska watersheds) in the province of Quebec (Canada) are used for this assessment. Various indices or statistics, such as the mean, variance, frequency distribution and extreme values are used to quantify the performance in simulating the precipitation and discharge. Performance in reproducing key statistics of the precipitation time series is well correlated to the number of parameters of the distribution function, and the three-parameter precipitation models outperform the other models, with the mixed exponential distribution being the best at simulating daily precipitation. The advantage of using more complex precipitation distributions is not as clear-cut when the simulated time series are used to drive a hydrological model. While the advantage of using functions with more parameters is not nearly as obvious, the mixed exponential distribution appears nonetheless as the best candidate for hydrological modeling. The implications of choosing a distribution function with respect to hydrological modeling and climate change impact studies are also discussed.