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Toward a robust method for sub-daily rainfall downscaling from daily data

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Daily-recording rainfall stations are widely spread across the world; sub-daily rainfall data, required for many hydrological applications, are much more difficult to obtain and the available records are often short. As an alternative, synthetic hourly rainfall series of any length may be simulated via rainfall generators based, e.g., on Poisson clusters models. Such models have, however, to be calibrated on selected observed rainfall statistics computed at different levels of temporal aggregation and the inclusion of the target sub-daily statistics is essential to reproduce historical sub-daily rainfall properties. If only daily records exist, the relevant sub-daily fitting statistics need to be estimated from the information available at the supra-daily time scales. This estimation is traditionally carried out by assuming a temporal scaling behavior of the rainfall statistics. However, this assumption is often questionable and, as our analyses suggest, the mathematical form of existing scaling behavior might be specific to individual gages. This work presents, therefore, a novel approach that bypasses the temporal scaling behavior assumption. The method uses multivariate adaptive regression splines (MARS); it is learning-based and seeks directly relationships between target sub-daily statistics and available predictors (including supra-daily rainfall statistics and external information such as large scale atmospheric indices. A large learning set is used to investigate these relationships, including almost 350 hourly rainfall series coming from gages spread over Switzerland, the USA and the UK. We present results demonstrating the predictive power of the new approach for several sub-daily rainfall statistics and show that it is superior to temporal scaling laws. To underline the potential of the method, we will also illustrate how such reconstructed statistics improve the accuracy of an hourly rainfall generator based on Poisson cluster models.