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Application of the State-of-Art Rainfall Disaggregation Model and Assessment of Rainfall Properties

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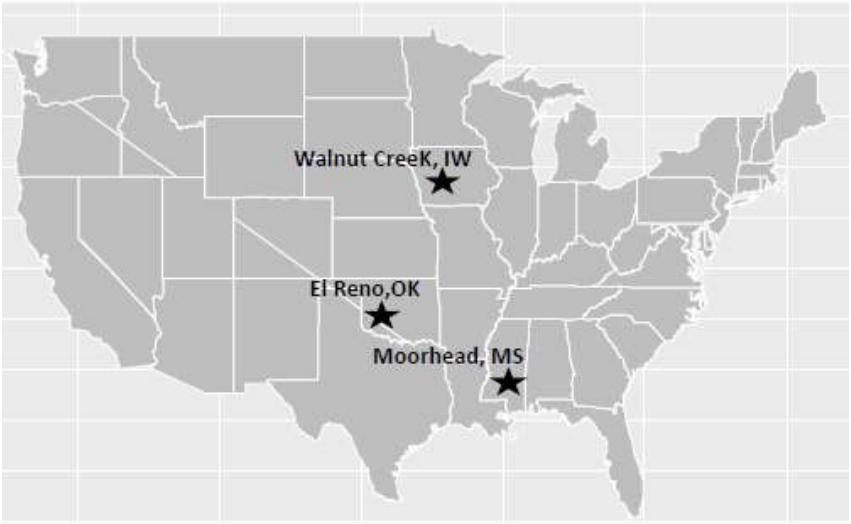
Rationale: Precipitation time-series at sub-daily time scales are important because they support detailed assessment of a wide range of applications, including studies of soil carbon storage, soil productivity, soil moisture dynamics, plant growth modeling, etc. However, sub-daily precipitation records are typically limited. Precipitation data are mostly available at daily or coarser time-steps. Of the 25,000 daily recording precipitation stations in the entire United States, only 8,000 stations record hourly data.



Furthermore, observed hourly records are available for relatively short time periods and often impaired by missing data and record keeping inconsistencies.

Rainfall disaggregation techniques address the constraint of data availability by generating finer temporal resolution rainfall time-series. Several disaggregation methods of varied complexity have been used for the enhancement of data records. However, the challenge remains to preserve the statistics of observed sub-daily series in model simulations to the extent possible.

We assessed the state-of-art rainfall disaggregation model HyetosMinute, which enables rainfall sequences to be generated at sub-daily time-scales. The model was applied in Southern plain stations of the United States at El Reno, OK, Ames, IW, and Moorhead, MS using 15 years of observed hourly and daily precipitation records from 2000-2015.

The reliability of disaggregation model, issues in temporal disaggregation, and representation of observed rainfall could be used to interpret the design storms of hydrological systems under current and future climate change conditions.

Objective: The objectives of this study were: (1) to evaluate the stability of parameters within HyetosMinute model over 5-, 10-, and 15-years at the aforementioned locations based on 15 years of continuous hourly data from 2001-2015; 2) to evaluate HyetosMinute disaggregation model ability to represent rainfall sequencing at three geographic locations, El Reno, OK; Ames, IW; Moorhead, using the properties that are included in the fitting procedure..

What we did: We used observed hourly and daily precipitation time series of a record length of 15 years (2000-2015), pertaining to El Reno, OK; Moorhead, MS; Ames, IW, to estimate parameter inputs to the disaggregation model HyetosMinute. The disaggregation scheme based on the mathematical formulation of estimated parameters was applied to daily rainfall data to obtain hourly time-series. Next, we evaluated HyetosMinute disaggregation model ability to represent rainfall sequencing at the above three geographic locations using analytical equations, cumulative distributive functions (CDFs), and cluster analysis.

Results: The comparison of the observed and model generated disaggregated data indicated the appropriateness of the model estimates at the study locations. Contrary to the general expectation that longer time series of hourly data would yield robust parameter estimates, the parameters obtained from 5-, 10- and 15- year windows of observed hourly data at El Reno, Ames and Moorhead stations were similar and within a range of 13.1%. The clustering analysis suggested that the HyetosMinute disaggregation may not reflect the sequencing characteristics of larger storm events with high precipitation intensity and duration. Thus, caution is advised when using HyetosMinute rainfall disaggregation while considering extreme events for hydrologic investigations.

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