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Hydrology and Earth System Sciences Discussions

Interactive comment on "Technical note on probabilistic assessment of one-step-ahead rainfall variation by Split Markov Process" *by* R. Maity and D. Prasad

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Reply to the Interactive comments by Anonymous Referee #1

Comments: The paper presents a markov-based daily rainfall model, with the transition probabilities from a state to a sub-state. The 9 states are defined by ranges of daily rainfall amounts and the sub-states by differences in daily rainfall amounts. However, the paper does not make any contribution to hydrologic science due to deficiencies in the modeling effort. 1) The main issue is that the sub-states are essentially the states with unnecessary increase in the number of model parameters. For example, if R=70mm in state 8 and moves to sub-state f with new R=70+20=90mm, it is the same

as moving from state 8 to state 8. 2) The paper does not show an advantage of the spilt markov model over the original markov model. The models in the references cited (eg. Stern & Coe) can produce better results. 3) You need to use all data available and not only the monsoon periods. 4) How were the states' range rainfall amounts determined? Do they reflect quantiles? 5) The paper is poorly written and ideas not clearly explained. 6) There are better tools to model uncertainty than as presented in the paper.

Responses: 1) Substates include both positive and negative changes whereas states are only nonnegative values as the states represent the values of rainfall only. Sub-states represent the changes from one state to the another state, which might be towards higher side or lower side or same state. In order to investigate the daily rainfall variation in a probabilistic way, these sub-states are necessary and introduced in addition to the existing states. However, number of parameters are not increasing – MP with 9 states will have 9x9 transition probability matrix (same as that in case of state/sub-state TPM with 9 states and 9 sub-staes). The example shown by the reviewer is one example of rainfall for two successive days being in same state. Keeping the same R (as used by the reviewer, i.e., R=70), if it a. moves to sub-state b (with r = -60) with new R=70-60=10 mm, it is moving to state 3 b. moves to sub-state g (with r = 40) with new R=70+40=110 mm, it is moving to state 9 c. (example of the reviewer) moves to sub-state f (with r = 20)with new R=70+20=90mm, it is moving to same state 8 Thus, the sub-states allow to move the system in any direction. However, the main objective of sub-states is to assess probabilistic limit of rainfall variation. These are now explained through numerical examples as well in the revised manuscript. Regarding the model parameters, by having 9 states and 9 sub-states the size of the state/sub-state TPM becomes 9x9 = 81. To determine this matrix 9760 data points were used. Thus, overparameterization is not expected to affect the estimation.

2) The concept differs from the original Markov model. In the original Markov model, only one set of states are defined. In the proposed SMP, states and as well as sub-

states are defined. Probabilistic prediction is more useful than simple point prediction. Defining another set of sub-states, classifying the changes in magnitude of daily rainfall will be helpful for such probabilistic assessment. Paper of Stern and Coe (1984) is different. They have categorized the day whether rainy or nonrainy day (binary). This is based on the Markov process. Magnitude of rainfall (if it is rainy day) is based on the Gamma distribution model. Thus, Markov Process is used only to determine whether it is a rainy or nonrainy day. 3) For rest of the year (non monsoon), rainfall magnitude is zero almost for all the days. Thus, it is not incorporated in the model. In fact, during the monsoon period itself, 40-50% data is zero rainfall (daily) as observed in all the raingauge stations considered in the analysis. 4) The states are selected in such a way that approximately 70% data falls below state 2, 80% data is below states 3, 85% data below state 4, 90% data below state 5, 95% data below state 6, 97.5% data below state 7 and 99% data below state 8. Thus, it is ensured that higher the magnitude finer the divisions. However, it is also ensured that minimum 50 data should fall in any state for all the stations.

5) Revised manuscript is thoroughly revised. New numerical examples are incorporated in the methodology section to explain the steps clearly.

6) This study does not focus to the uncertainty quantification. Rather daily rainfall variations are predicted by probabilistic limits. Probabilistic assessment of daily rainfall variation using traditional Markov Process (MP), i.e., through a single set of states, is not possible. Probabilistic prediction is more useful than simple point prediction. The manuscript investigates a possible way forward towards this. Split Markov Process (SMP) is introduced in this paper to assess the daily rainfall variation in a probabilistic way, which is not possible in MP.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 8, 189, 2011.