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Hydrology and Earth System Sciences Discussions

Interactive comment on "Temporal dynamics of hydrological threshold events" *by* G. S. McGrath et al.

Anonymous Referee #2

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General Comments

In general I think this is an interesting paper, which makes a strong and original contribution to the hydrological sciences. The primary contribution is the investigation of the statistics of the variance of the inter-event time and the variance of the flow for the saturation excess mechanism under various climatic (arid, sub-humid and humid) scenarios.

I can understand the author's motivation - to understand the drivers for the variability in the inter-event time and the flow for different climatic and flow mechanisms. The author's approach to derive analytical equations, through necessity, has some limiting

assumptions (some 3rd para in the specific comments below). Any further additions to the model to overcome these assumptions would make the derivation of analytical derivations even more challenging. Therefore, in the future, as model complexity is increased to overcome these assumptions I think a numerical simulation approach would be more suitable. I am not familiar with Struthers et al (2006) and it is no clear to me why these results cannot be achieved via numerical simulation.

Though beyond the scope of this paper, it would be of interest in the future to investigate the identifiability of these driver's of the variability using observations of physical process that can actually be measured. Questions to be investigated could include what measurements/data are required to determine the trigger for macropore /preferential flow? Such a study would improve the practical impact of this paper. An example of a recent work which looked at identifiability, albeit in a very different context, is given in Thyer et al. [2006].

Specific Comments

I agree with the other reviewer that the paper is technically very dense and at times hard to follow. I recommend that the authors revise the paper to improve its readability.

The primary technical contribution is the development of analytical expressions for the variance of the inter-event time and the variance of the flow for the saturation excess flow mechanism. As I am not a mathematician - and integration is not something I do regularly I have not checked the derivation in the appendix and supplements, as summarized in Table 2. The resulting graphs and interpretation do make intuitive sense, which raises confidence in the derived equations. Nonetheless it is recommended that the authors verify the relationships derived in Appendix A (Eq. (14) and Eq.(17) - the primary mathematical results of the paper) by the process of numerical simulation, i.e. select some typical parameter values, simulate the process and check that the simulated moments match the analytical moments.

There are some assumptions made in this paper, which are given little discussion and

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are likely to have an impact on the results. Rainfall is modelled as a series of independent and instantaneous (no duration) events which (as the authors state) is considered valid at the daily time scale. However, the physical process which cause the threshold triggers for the saturation excess mechanism (as discussed in section 1.1) such as preferential flow, macropore flow would occur at much shorter time scales, e.g. hourly (or possibly less). This incongruity may invalidate the results presented in the paper. Hence I feel it should be at least discussed in the paper, and mentioned in the conclusions with the remaining assumptions

The abstract states that this paper derives new relationships for both the infiltration excess (IE) mechanisms and saturation excess (SE) mechanism. However, in the paper it is not clear how the IE results differ from that of Rodriguez-Iturbe et al (1999). The text in section 4 or the abstract needs to be changed to better highlight what is actually new in this paper in regard to the IE mechanism

Figure 7 is difficult to interpret with both the cv and mean on the one graph - two graphs would be better.

Technical Corrections

The following are minor corrections in the paper:

Page 2862, Section 5.1, 2nd para: the units [T-1] differ in font size to the remaining text.

Page 2872, Section 6.2.1.Line 6. Change Eq (15) to Eq (16).

Page 2872, Section 6.2.1. Line 11, Insert “of” , between “irrespective” and “the nature”

Page 28743 Line 22-24. In the sentence - “This suggests adaptations to cope with temporal variability” What is adapting to the temporal variability? Please clarify.

Thyer, M., A. J. Frost, and G. Kuczera, 2006, Parameter estimation and model identification for stochastic models of annual hydrological data: Is the observed record long enough?, Journal of Hydrology, 330 (1-2),313-328.

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