

***Interactive comment on “The effect of watershed scale on HEC-HMS calibrated parameters: a case study in the Clear Creek watershed in Iowa, USA” by H. L. Zhang et al.***

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1. Comment: CCW receives an average annual precipitation of 889 mm, and the average annual runoff is  $68 \times 106 \text{ m}^3$ , here 106 should be 106?

Authors' reply: Thanks very much. We have revised this typo.

2. Comment: In an area with "an average annual precipitation of 889 mm", the use of "Hourly precipitation Stage IV products for this region" may be a key weakness of the model, because rainfall intensity for 30 min varies greatly for the same hourly intensity. Some analysis should be made concerning the climate and rainfall pattern of this area

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and its impact of the model performance when hourly precipitation data is used in the model.

Authors' reply: Thanks very much for your suggestion. We would like to briefly share the background when we chose hourly NEXRAD for this work: First of all, NEXRAD provides high-spatial resolution precipitation estimates compared with gauge station observations (3 gauges available in 15-mins intensity), and would potentially contribute to hydrological simulations; second, the National Centers for Environmental Prediction (NCEP) typically generate Stage IV NEXRAD rainfall intensity for hourly and 6-hourly records, and IIHR-Hydroscience & Engineering, University of Iowa, US, was able to process the hourly NEXRAD. Therefore, we used Hourly precipitation Stage IV products. Further, we looked into the rainfall pattern, as the reviewer suggested, based on the NEXRAD records from 2002 to 2010 as well as precipitation series in 15-mins derived from 3 tipping buckets, and we would like to explain more about the rainfall pattern in the manuscript. The total precipitation in 2008 was around 1210 mm, exceeding 36% of the annual rainfall, and Clear Creek watershed was suffering from the known 2008 extreme flood. In April, total rainfall was around 168mm, the overall time was 106 hours, and most hourly rainfall intensity was between 5-10 mm/hr. In June, comparably, the total rain amount was 226mm, total time duration was 66 hours, and most hourly rainfall intensity was above 15 mm/hr. As addressed in the manuscript: "The antecedent conditions to this period are dominated by high initial soil moisture in the basin. The period of June was characterized by short and intense precipitation events, which are usually associated with flash flooding conditions" (Page.6, Line8-10).

Concerning the impacts of rainfall pattern on hydrologic modeling, the hourly rainfall intensity may not weaken the argument about the scale effect on calibrated parameters. Generally, the performance of a rainfall-runoff model was evaluated by the agreement of simulated hydrograph to that of the observed one, and calibrated and verified primarily by adjusting the calibrated parameters. Therefore, the main objective to improve the temp-spatial resolution of the rainfall and meteorological conditions is to make the sim-

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ulated hydrograph closer to the observed one. Therefore, the 15mins intensity might produce a closer hydrograph than that of hourly data do by using another parameter set, but when comes to the scale effect, it would not matter to use 15-mins or hourly data, since all of the configurations are equally optimized by manual and automatical verification(Page.4, Line4) procedure and may reduce systematically bias.

Actually, the author discussed the impact of rainfall pattern (rainfall intensity, spatial resolution of precipitation) on hydrologic modeling in her doctoral thesis (Zhang H L. A Distributed Hydrological Model Coupled with Soil Erosion and Its Application in River Basins (in Chinese). Dissertation of PHD degree. Beijing: Tsinghua University, 2011) by using a self-developed distributed hydrologic model BPCC (Basin Pollution Calculation Center). It was stated in the thesis that after all parameters are fixed by model verification, higher rainfall intensity would produce a "thinner" hydrograph, which is characterized with higher flood peak and shorter flood time. When it comes to the HEC-HMS model, the rainfall pattern would affect the flood processes in a similar way.

Comment: Fig 5 and Fig 6 comparisons of "April flood, June flood, April flood with June parameters, and June flood with April parameters" is very interesting and more analysis should be made based on these two figures, e.g. to reveal the implication of some parameters related to pre-event conditions (why the model performance in April and June differ despite the specifically calibrated parameters?)

Authors' reply: Thanks very much for pointing out this issue. After the sentence: "The difference in parameter values in different floods indicate that hillslopes are more likely to produce surface flow instead of allowing infiltration that is later transformed into baseflow.(Page 15, Line 14-16)", we would explain more as follows: "The difference in parameter values in different floods indicate that hillslopes are more likely to produce surface flow instead of allowing infiltration that is later transformed into baseflow, demonstrating that the underestimation of June flood discharges by digesting April parameters is partially caused by the larger amount of abstraction and the inertia tendency to transform rainfall to surface flow (depicted in Fig.5 (d))."

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Comment: Fig.7 It may be difficult to compare initial abstraction in April and June without referring to the rainfall pattern, i.e., do they have the same 30 min rainfall intensity (mm per 30 min) in April and June? Is it possible that the larger abstraction in April was a result of smaller but persistent rainfall intensity (resulting in runoff after saturation) than June? And smaller abstraction in June maybe caused by larger rainfall intensity that did not last for a long time (resulting in runoff when rainfall intensity is greater than infiltration rate)? These are more related the physical process considered in the HEC-HMS model than the effect of watershed scale on HEC-HMS calibrated parameters.

Authors' reply: Thanks very much for pointing out this issue. About the relation between rainfall pattern and calibrated parameters, we agreed that rainfall pattern influences model parameters in the way you provided, that we add more words to explain this: "...transform rainfall to surface flow (depicted in Fig.5 (d)). This difference is also consist with the rainfall pattern that small but persistent rainfall in April results in larger abstraction and needs longer time for surface flow to transform into baseflow, while flash precipitation in June tends to produce more surface flow in shorter time.". However, as what we mentioned in comment 2, the difference of parameter values for two flood events does not alert the watershed scale effect(explained by 10 configurations for each flood event) which may also exist for all flood events.

Comment: About Fig.10:

1 "proportions of surface flow and initial abstraction follow a relation that decreases approximately monotonically with watershed size" - is this related to the fact that the model is constructed in such a way that the total length of channels increases with the watershed size (or the number of partitions)? So that it will take longer for the runoff to reach the outlet if the watershed is larger with more partitions, and therefore more water will be infiltrated on the way and deduced from surface flow. Please explain more.

Authors' reply: Thanks very much for your question. Actually, the sub-watershed is smaller with more partitions. In HEC-HMS, the channel loss is a function of the longest

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river length, and the lost water would not go back to the hydrologic process again. But it might be possible that more water would be lost with a larger longest river length if we have fewer partitions. Therefore, we would like to explain more as follows:" Meanwhile, ratios of baseflow ... Looking back at Figs. 7 and 9, ... values of key parameters, which further implies that, with fewer partitions, more water tends to be abstracted on hillslope and then be infiltrated into baseflow, and that more water will be lost on the way to the outlet. However, parameter sets of surface flow and baseflow yield. . .".

2 "the configuration with 1 sub-basin .... is regarded as one whole unit. ... there is no channel within the watershed, and all of the water mass has to be lost at the hillslope " - this is obviously something in the model to be improved; the original developers of such a model did not expect that users shall use a "configuration with 1 sub-basin"

Authors' reply: Thanks very much for your question. It's true that the HEC-HMS model did not expect users to use a whole basin as model input. For this work, we hold the hypothesis that configurations with 1 sub-basin and extremely large number (157 in this work) of sub-basins are two extreme cases. During model calibration, those two scenarios were found to be more time and effort-consuming. Nevertheless, they did not yield as good results as other configurations do. With those considerations and efforts, we concluded that:" we may expect a threshold level of sub-basin delineations beyond which model parameters have little possibility to enhance model performance." (Page 18, Line 19-20).

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