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Hydrology and Earth System Sciences
Discussions

Interactive comment on "Comparing the performances of WRF QPF and PERSIANN-CCS QPEs in karst flood simulations and forecasting with a new Karst-Liuxihe model" *by* Ji Li et al.

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Reply to the comments of Anonymous Referee #2-AC Anonymous Referee #2 Received and published: 24 September 2019 In this manuscript, the authors tried (1) to compare the performance of WRF QPF and PERSIANN-CCS QPEs and (2) to develop a new Karst-Liuxihe model. I agree with Reviewer 1 that it isn't convincing that the proposed new model can address the challenges of hydrological simulation in Karst areas. In addition, it isn't clear to how to add the karst mechanism into the Liuxihe model, and for example, regarding the karst water-bearing media simplification, it should be documented how to deal with this issue in the original model and how to improve it in

the new model (described as equations or parameters). Also, I agree with Reviewer 1 that this manuscript isn't concise, especially too long abstract and introduction. In this manuscript, the authors tried to interpret too many issues so that the scientific contribution isn't clear. Consequently, it seems a technique report. Therefore, I don't think that the current version is suitable to be published in this journal. Detailed comments 1. In Line 40, the authors states "to reflect the true conditions of rainfall-runoff", and what is "true conditions"? Does the original model describe not true conditions? 2. In Lines 77-78, some references for "a few studies" are required. 3. In Line 261, what's the meaning of "grid gauges"? 4. On the model simulating, it isn't clear how to obtain the information on karst fissure width and how to set the initial condition such as soil moisture. 5. In Lines 599-600, the authors introduced that total 30 floods were chose from 1982-2013 for verification, i.e. about 1 flood per year. The objective of this manuscript is flood forecasting, so it is better to choose more floods and evaluate the model according to the flood forecasting criteria. In addition, in Lines 600-60, I guess that the model used in (Li et al., 2019) isn't the new model and those results only implied the effectiveness of another model. Therefore, the sentences shouldn't be there. 6. In Figures 10-16, what is the unit of x-axis? h-1 or h? We thank the referee very much for reviewing the manuscript. The following are our point-by-point responses to the reviewer's comments. Comment: Firstly, both reviewers thought it isn't convincing that the proposed new model can address the challenges of hydrological simulation in Karst areas. Response: This issue is mainly because the authors did not provide clear descriptions of the new model, especially in introduction. The abstract and introduction were quite cumbersome and failed to explain clearly the research motivation and innovation of this study. The abstract has been simplified to focus on summarizing the research and detailing the innovation, and the introduction has been restructured in the revised version. The most important innovation of the present research lies in the improvement and perfection of the Liuxihe model structure and function. A new hydrologic model, i.e., the Karst-Liuxihe model, is proposed, which has some enhancement modules added; this Karst-Liuxihe model has never appeared in the previous literature.

The improvement of Liuxihe model is extensive and includes the division of the model into the smallest structural units, termed karst hydrology response units (KHRUs); and new algorithms of rainfall-runoff, especially for the confluence of karst groundwater. This new Karst-Liuxihe model has some advantages in hydrological simulation in karst areas. The challenges of hydrological simulations in karst areas are mainly caused by the insufficient data supply. Distributed hydrological models usually have complex structures and numerous parameters, which require a large amount of hydrogeological data to build a model. However, it is difficult to obtain such data in karst areas due to the complex terrain.

Unlike other distributed hydrological models, the application of this Karst-Liuxihe model in the karst study area has certain data advantages due to its structural characteristics. There are only 3 layers in both the vertical subsurface and horizontal directions and the model structure is explicit, which makes modelling large data volumes less complex. Therefore, it is easy to build the Karst-Liuxihe model in karst area. The advantages of our model over other distributed hydrological models in karst hydrological simulation has been added to the revised introduction, and the related literature has also been cited and listed.

When the karst sub-basins are divided, other distributed models usually divide the whole karst area into a series of karst sub-basins according to DEM data. This strategy is appropriate for small karst basins but may not be suitable for such a large study area (5.8×10ˆ4 km2). In this study, the karst sub-basins were further divided into many smallest grid units known as karst hydrology response units (KHRUs) by the Karst-Liuxihe model. These KHRUs are small enough that spatial differences in the rainfall and terrain data of the underlying surface can be ignored, thus requiring less modelling data. The other challenge of distributed hydrological models in karst areas is the problem of model calculation efficiency. This study used an improved Particle Swarm Optimization method (Chen et al., 2016) to improve the calculation efficiency; however, a parametric uncertainty analysis had not been previous performed. A contribution

of this paper is that the parametric uncertainty is evaluated and specific and detailed parametric uncertainty calculations have been added to the revised version in section 6.2.

Comment: In addition, it isn't clear to how to add the karst mechanism into the Liuxihe model, and for example, regarding the karst water-bearing media simplification, it should be documented how to deal with this issue in the original model and how to improve it in the new model (described as equations or parameters). Response: The original Liuxihe model treats the entire underground layer as a whole, and the confluence calculation of the underground river is performed using a linear reservoir method. However, the karst groundwater system is obviously nonlinear. Therefore, the original Liuxihe Model cannot be used reliably in karst areas.

The Karst-Liuxihe model proposed in this study adapts to the complex hydrogeological characteristics of karst area by adding some karst mechanisms to the original Liuxihe model. Additional explanations and descriptions (will be described as equations and parameters) about adding karst mechanisms into the model have been added to the revised paper in section 4.2. In the revised section 4.2, methods for obtaining hydrogeological data of karst water-bearing media have been added; for instance, the permeability coefficient K was calculated by an experience function. In addition, in the revised paper, the parameters of the Karst-Liuxihe model and the value range of epikarst zone parameters are listed in Table 2. To demonstrate the advantages of the improved Karst-Liuxihe model, the flood simulation effects by the original Liuxihe model and the Karst-Liuxihe model have been compared in the revised version in section 6.1. Comment: Also, I agree with Reviewer 1 that this manuscript isn't concise, especially too long abstract and introduction. In this manuscript, the authors tried to interpret too many issues so that the scientific contribution isn't clear. Consequently, it seems a technique report. Therefore, I don't think that the current version is suitable to be published in this journal. Response: The abstract and introduction are quite cumbersome; thus, the scientific contribution was not clear. In the revised version, the abstract has been simplified to focus on the contribution and the introduction has been restructured to clarify the motivation of this study and the novelty and methodology development of the model.

Detailed comments 1. In Line 40, the authors states “to reflect the true conditions of rainfall-runoff”, and what is “true conditions”? Does the original model describe not true conditions? Response:

The true conditions of rainfall-runoff here refer to the true rainfall-runoff process in karst area. Maybe it is better to write “the true rainfall-runoff process”. This sentence has been changed by “to reflect the true rainfall-runoff process”. In general, rainfall-runoff conditions are more complicated in karst areas than non-karst areas. When dealing with surface runoff confluence, both the original Liuxihe model and the Karst-Liuxihe model are applicable. However, there is only 1 underground layer in the vertical direction in the original Liuxihe model, which treats the entire underground layer as a whole. This concept is based on the traditional lumped model when dealing with groundwater confluence. The confluence calculation of the underground river is a linear reservoir method. However, the karst groundwater system is nonlinear. Thus, the original Liuxihe model cannot describe the true underground runoff process. There are 3 underground layers in vertical structure in the Karst-Liuxihe modelïijŇincluding the soil layer, the rock stratum of the epikarst zone, and the underground river. Thus, the Karst-Liuxihe model is more suitable to depict the true rainfall-runoff process in karst areas. More details on the Karst-Liuxihe model structure improvements have been added in the revised paper.

2. In Lines 77-78, some references for “a few studies” are required. Response: Some necessary related studies have been added in the revised introduction. 3. In Line 261, what’s the meaning of “grid gauges”? Response: The rainfall results calculated by these two weather models are based on the latitude and longitude of the location in the basin, and all the locations seem to form grids as shown in Figure 1a. Thus, the rainfall results are on the grids, and we called these locations grid gauges.

4. On the model simulating, it isn’t clear how to obtain the information on karst fissure width and how to set the initial condition such as soil moisture. Response: For the model simulation, some of the settings for the initial values of the model were not clear. The hydrogeological information, such as the karst fissure width, was calculated by the drill-hole pumping test, and the permeability coefficient of the rock mass and the specific yield of the karst aquifer were calculated by an experience function according to the water inrush prediction of a coal mine in the study area. Some hydrogeological information, such as the distribution of karst conduits, fissures and cracks and the direction of underground rivers, were obtained through the tracing test in this study area. An additional explanation of acquired hydrogeological information, such as the karst fissure width, has been added to the revised paper section 4.2. For the model simulation, some initial conditions were determined by multiple model tests. For instance, the initial soil moisture is set to [0%,100%], with 0 indicating extremely dry soil and 100 indicating saturated soil water content. According to the effect of the flood simulation, the appropriate initial water content of soil was determined through model multiple calculations. In fact, based on our experience with models with multiple calculations in the study area, this initial soil moisture is usually 50%-80% during floods. Additional explanations of the initial conditions, such as soil moisture in the model, have been added to the revised version in section 5.1. For the model simulation, some initial conditions of the parameter optimization by the improved PSO algorithm have been determined in the revised paper in section 5.2.

5. In Lines 599-600, the authors introduced that total 30 floods were chose from 1982-2013 for verification, i.e. about 1 flood per year. The objective of this manuscript is flood forecasting, so it is better to choose more floods and evaluate the model according to the flood forecasting criteria. In addition, in Lines 600-60, I guess that the model used in (Li et al., 2019) isn’t the new model and those results only implied the effectiveness of another model. Therefore, the sentences shouldn’t be there. Response: The reviewer is correct. The 30 floods were simulated by the original Liuxihe model in Li et al. (2019). In the revised version in section 6.1, 20 karst flood events have been added and

simulated by the Karst-Liuxihe model and the Liuxihe model to test the performance of the improvement. The results are shown in Fig. 10 and Table 3 in the revised paper.

6. In Figures 10-16, what is the unit of x-axis? h-1 or h? Response: In Figs. 10-16, the unit of the x-axis should be h, which means hours. This problem also appears in Figs. 3-7. In the revised paper, these units in Figs. 3-7 and 10-16 have been revised accordingly.

Please also note the supplement to this comment:
https://www.hydrol-earth-syst-sci-discuss.net/hess-2019-285/hess-2019-285-AC3-supplement.pdf

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