Dear Professor Romano,

We would like to thank you and two reviewers for providing useful comments and suggestions on our submission to Hydrology and Earth System Sciences. We are pleased to report that we have now completed all the required revisions and are in position of submitting a new and improved version where we took into account all the comments provided. In this revision report we will provide details on how we dealt with each of the comments and suggestions. We will be very happy to address any other issues that you may judge necessary in addition to the corrections we already completed.

We fully agree with reviewer #1 that karst system is very complex and has regional differences and as such the study area in the Chenqi catchment was selected following the criteria of being representative of the China southwest karst conditions from the topographical, geological and hydrological point of you. We are providing details to answer the specifics of the questions "what is a typical karst?" see below.

In the revised manuscript, we added following information to provide more clarifications:

1. We extended our model calibration period to Dec. 31, 2008 which includes a drought period (see Fig 9).
2. To provide additional information on the distribution of hydrological processes, we added model simulation results of spatial distribution of evapotranspiration (ET) and soil moisture content (SMC) for different vegetation covers (see pages 22 and 23, and Figs. 11~13).
3. We added geological profile in Fig 2. Limestone formations with 150-200m thickness lie above impervious marlite formation (see page 12).
4. Southwest China is located in a subtropical wet zone. Wet summer season is from May to September and a dry winter season from October to April next year (see page 12). Winter temperature is usually higher than 0, and there is seldom snow in the study area.
5. We added simulated and measured interception of rainfall by shrub in Fig 6.
6. We agree that a conceptual model can be used to simulate streamflow responses to rainfall. However, our goal for developing this sophisticated model is to simulate hydrological behaviors associated with land uses and land covers. The distributed model can give spatial distribution of soil moisture content, evapotranspiration and runoff for different land surface conditions. In the revised manuscript, we added description of simulated spatial variations of ET and SMC (see pages 22 and 23, and Figs. 11~13 in the revised manuscript).

More specifically

Reviwer #1

1. Abstract : what is a typical karst?

   Reply: From the topographical aspect: Chenqi catchment has a typical cone karst and cockpit karst geomorphology, which widely spreads in the karst region of southwest China. For example, the hilly mountainous areas with typical cone karst and cockpit karst are about 73% of the southwest karst center area of Guizhou province, China (see page 3 in the revised manuscript).

From the geological aspect: The Yunnan, Guizhou, Sichuan, Chongqing, Guangxi, Hunan and Hubei regions have a total area of 1.76 $\times 10^6$ km^2. The distribution of thick carbonate rocks in these seven regions is about 540.8$\times 10^3$ km^2, or about 30.9% of the total area. The thin carbonate rock interbeds in these regions are about 189.8 $\times 10^3 km^2$, about 10.73% of the total area. Taken together, carbonate rocks occupy 41.31% of the total area (see page 3 in the revised manuscript). The study catchment has typical geological conditions of thick and thin carbonate rocks

From the hydrological aspect: In addition soil and vegetation, topography and rock fractures control rainfall-runoff. Runoff primarily concentrates into the underground channels and flows out the basin in most of the small karst basins in the southwest China. Because of rich rock fractures and underground conduit system, streamflow hydrograph in the karst region of southwest China presents a steeper rise and decline than non-karst regions (see page 4 in the revised manuscript).

Surely, a large basin usually includes two flow systems: rivers and underground channels. The model has function to simulate river flow processes. But for this small catchment, we only simulate flow of solely existence of underground channels. We changed as “a typical small karst basin” in the abstract.

2. p 563, last paragraph "rainwater is retained near the base of the epikarst leading to the formation of an aquifer". Can you prove this in your natural example? It depends probably of the permeability distribution in the upper karstified levels.

Reply: Field investigation on a profile of DJS in Chenqi catchment demonstrates that average karst fracture porosity is 5.3%, varying from 6.9% in the upper epikarst layer (less than 2m) to 2.4% in the lower layer about 5m below ground surface (see page 14 in the revised manuscript, and Figure 1 and Table 1 below).

A larger infiltration capacity due to the larger fractures in the upper layer than in the lower layer usually results in that rainwater is retained near the base of the epikarst leading to the formation of an aquifer during heavy rainfall events.

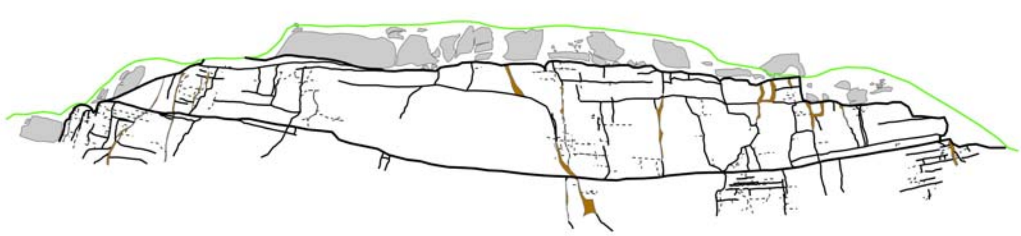

Figure 1 a profile of fracture distribution at DJS in Chenqi catchment

Table 1 statistical results of fracture porosity from field investigation

	The whole section	Upper layer	Lower layer
Fracture area (cm^2)	45507	30944.8	9746.3
Section area (cm^2)	855325.8	448913.2	406412.6
Fracture porosity	5.3%	6.9%	2.4%

3. 2.2.1 "infiltration via vertical shaft system". How is this accounted for in the model? Are there swallow holes? Where?

Reply: Shaft system is usually a hydrological connection between fractures and underground channels. Infiltrated water drainage into deep underground channels is usually through vertical shaft system in the infiltration zone (see Fig 1). For surface and subsurface flows computed by grid by grid, the model can be used to simulate flow concentration into a convex of the sink hole where surface water flows directly into underground channels through vertical shaft system. The revised DHSVM applied in other region where the shallow holes exist (Xue et al. 2009). However, in this small catchment, we did not find any shallow holes and so we did not describe this portion in the paper.

Xue Xianwu, Chen Xi, Zhang Zhicai, and Wei Linna, Effect of Karst Fracture on Saturated Subsurface Flow Confluence, Water Resources and Power, 27(6) : 20-23, 2009.

4. end of section 2.2.3. Modeling of the fracture distribution. Did you try different kind of fracture distributions? clustered (Sisavath et al., 2004), fractal (Bour et al., JGR 2002), enlarged by dissolution (Kaufman and Braun, WRR, 2000).

   Reply: Yes, other methods for statistical generation of fracture distributions are deserving of further investigation. As a key project supported by National Basic Research Program of China (973 Program) (*No. 2006CB403200*), we are now conduting research along those lines. For simplicity in this paper, its distribution is assumed as uniform.

5. end of page 571 Pen et al, 2008 is absent from the reference list. I assume that you meant Peng et al. Then as not many European researchers can read Chinese, you should summarize the results of this paper and explain how "Average thickness of the epikarst zone is estimated based on overland flow discharges".

   Reply: Yes, the correct is “Peng et al, 2008”. We corrected it in the revised manuscript and explained it in more details (see pages 13 and 14 in the revised manuscript).

6. 573 last paragraph: How do you infer that large underground channels are located in the lower areas of the basin. Can you provide some proof for that?

   Reply: Topography affects both the rock stress and the regional groundwater flow. The valley is often flooded after high precipitation events. As rainwater seeps into the ground along bedding planes or fractures in bedrock, the acidic water dissolves any limestone it touches. If the dissolution of bedrock continues, a large underground channel can form. For example, the Ajoulotte stream, underlies the valley bottom. Several springs are located along the Delle – Lebétain valley, delineating a hydrogeological boundary to the North-West of the Plateau (Kovács, A. 2003: Geometry and hydraulic parameters of karst aquifers: A hydrodynamic modeling approach: http://www.unine.ch/biblio/). Our field explorations proved that the underground channels are located in the valley areas shown in Fig 2. (see page 16 in the revised manuscript)

7. end of section 5.1. In a karstic system submitted to a winter / summer regime, the calibration should use at least one complete year. In any case a calibration during the rainy season can be used to model data outside the rainy season. This is one main flaw of the paper.

   Reply: We agree with that the calibration and validation in a longer time period give a more certainty for the simulated results. Due to observation stations in the study catchment were set on May 2007 and reliable observation data were from July. So we started our calibration from July 28, 2007. To enhance reliability of our simulation, we extended our validation period to the drought period in 2008 in the revised manuscript.

8. According to the paper, there is a threshold of 80 mm of rain for surface runoff. Could you explore this threshold with the model? Does this imply in all cases that the epikarst

   Reply: This is a very valuable suggestion. We added statistical results of our simulated surface runoff on the hillslopes of DJS, YinP, HSP and YangP (see location of surface runoff trough in Fig. 3). The statistical results demonstrate: for amount of a rainfall event is less than around 80 mm, the surface runoff is very small (less than 1mm); for the heavy rainfall event with amount of 90.2mm on 30, July, 2007, the surface runoff is 6.0mm for DJS, 3.2mm for YinP, 17.3mm for HSP and 10.8mm for YangP. The well growing forest areas of YinP and DJS have less surface runoff during a heavy rainfall due to relatively larger vegetation interceptions of rainfall. HSP in the burned shrub area produces a largest surface runoff (see below Figure). This result is consistent with statistical results from the surface runoff trough by Peng et.al (2007). We added this explanation in our revised manuscript on Pages 21 and 22.

   In the karst region of southwest China, runoff generation relies on saturation runoff generation mechanism that overflow occurs only when near surface soil and epikarst fractures are saturated. However, the critical value of rainfall for surface runoff may be different in other regions because of different soil and rock fractures. This study offers a method to describe the rainfall-runoff generation in karst regions (see revised manuscript in conclusions).

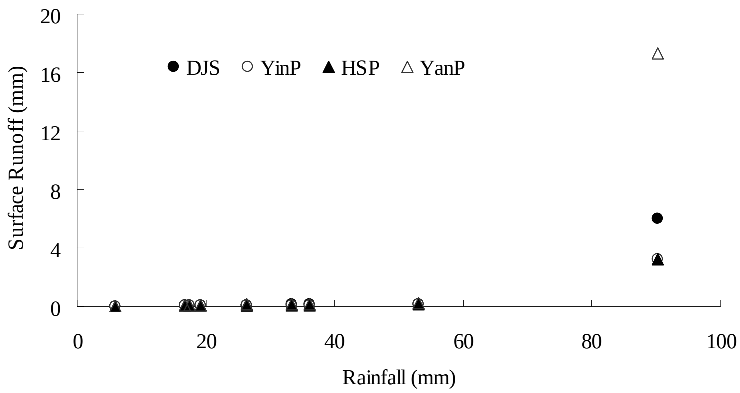

Figure 2 simulated surface runoff on DJS, YinP, HSP and YanP

9. simulation of soil moisture content. It is not clear how vegetation is coupled to groundwater. I suspect than trees are able to extract water to a several meter depth. How is this coupled to groundwater flow?
   Reply: In the karst region of southwest China, soil is usually thin with limited number of large trees. Evapotranspiration through vegetation depends on vegetation species and soil and rock fractures. Most vegetation root system concentrate in the shallow soil and the underlying rock fracture in less than 1m. Tree roots seldom extend to a several meter depth due to the hard rock in the karst region. According to investigation by Xiang et al (2004), about 70% root product is within 30cm depth of soil below the ground surface. Soil water and epikarst water were main water sources for plants in the karst forest area. The proportion of uptake of epikarst water is about 50% for the forest and about 35% for the shrub according to isotope analysis of water sources of mountain plants on south China karst plateau by Wang et al (2008). (see pages 4 and 5 in the revised manuscript)
   In our calculations soil moisture and epikarst flow dynamics of Eqs (1)~(3), vertical proportions of evapotranspiration of ET_0 are assumed as 0.5 and 0.5 for the upper and lower rooting zones for forest, 0.65 and 0.35 for the shrub, and 0.8 and 0.2 for the grass. (see page 17 in the revised manuscript)

10. section 5.3.2 It would be interesting to give some hints on the influence of the vegetation package of the model on discharge (similar comment as the previous one).
    Reply: see reply above and additional work described on Page 23.

11. section 6 : very interesting !
    Reply: Thanks!

12. your model should be compared with other models or other karst or other kind of observables (correlogram ?)
    Reply: Other models may also give reasonable results for rainfall-runoff

relationship but are not able to describe spatial distributions influenced by vegetation-soil-rock fracture-hydrology as our revised model. We added simulated surface runoff at four sites of DJS, YinP, HSP and YangP which compared with statistical results from the surface runoff trough by Peng et.al (2007).

13. Yuan, 1997; Xiao et al., 2003 are not in the reference list. Please cross check the reference list.
    Reply: We added these two references and checked all the references.

14. Fig. 2 check the label of level curves. Where is the superficial drainage network? Where are the major underground channels ? Also provide one or several cross sections
    Reply: We revised Fig 3 and merged the drainage with basin topography. We indicated orders of underground channels.

15. Fig 3 : consider merging this figure with figure 2.
    Reply: We added geological profile in Fig 2. For clearness, we left Fig 2 and added topography in Fig. 3.
16. Fig. 9 Enlargement of some rain and/or some flood event might be interesting. Also elaborate on the wrong recession curve in the validation period.
    Reply: In Fig 9, we added two enlarged flood events. The results also show that simulated results underestimate recession flow which results from the subsurface flow in Eqs. (10) and (11) exponentially decreases with the water table (Wigmosta et al, 1994). (see page 16 in the revised manuscript)

17. Fig. 10 very interesting.
    Reply: Thanks!

Reviewer #2
Minor comments

How soil moisture was measured? Is Guelph permeameter used at what depth, namely how were obtained the data for the different layers? How were determined the other soil data, like field capacity and m?
Reply: We set four groups of the soil moisture probes at the depths below the ground surface were installed at DJS, HSP, YinPu and YanP, automatically recording soil moisture content every five minutes (see page 15).
Due to thin soil in the karst region, we selected two depths of 15cm and 30 cm to measure hydraulic conductivities using Guelph permeameter. At each site, we removed upper soil above the measured depths. We took soil samples and measured other soil related parameters, like the soil porosityϕ, field capacity, and residual soil moisture content θ_r, at

laboratory (see page 13 and details refer to Chen et al, 2008). The pore size distribution index m references UNSODA (Leij et al, 1996).

Xi Chen
On behalf of all the authors.