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Interactive Comment

Interactive comment on “A modelling approach to assess the hydrological response of small Mediterranean catchments to the variability of soil characteristics in a context of extreme events” *by* C. Manus et al.

C. Manus et al.

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Important preliminaries :

This document contains two Tables and three figures that are difficult to upload properly through the HESSD website procedure. Please refer to the pdf document available at the following address : http://ltheln21.hmg.inpg.fr/PagePerso/anquetin/Access.html

General comments and answers to common questions of the reviewers

We thank the two anonymous reviewers and the editor for their comments that helped us improving the manuscript. We hope that the material added in the revised version will contribute to illustrate the performances of the model use and to clarify the objectives of the paper.

The reviewers raised the question of model validation, which is an issue, we have considered during the study concerning the particular case of flash floods. Several points can be underlined with regards to model validation:

1/ Few discharge data are available during flash-floods. On gauged watersheds, limnimeters are often damaged and out of work during such events. When they provide data, the estimation of discharge is prone to large errors because the rating curves are extrapolated far beyond the range of gauged values. For instance, for the catchment Saumane (99 km2), the maximum gauged value was 75 m3 s-1. During the post flood field investigation, the peak discharge was estimated at 770 m3 s-1 and was used to extrapolate the stage-discharge relationship. This example shows the need for post event investigation and the limits of the traditional discharge estimation.

(PLEASE REFER TO THE FIGURE available at : http://ltheln21.hmg.inpg.fr/PagePerso/anquetin/Access.html)

2/ Concerning the rainfall inputs, the availability of radar data is a requisite for a fair evaluation of models at scales that are not properly covered by raingauge data. Given the current state of radar data, it is quite difficult to have a long reliable series of radar data at a given location. This point is especially critical when we need high resolution (space and time) rain inputs for physically based hydrological models where the simulated processes have a proper dynamics lower than the hourly time step. This point is also valid for lumped models that need accurate rain inputs as well. The model proposed in our study has been evaluated on one gauged catchment (Saumane, 99 km2) and for two events (September and November 2002). In both cases, the radar rainfall estimations come from the same radar treatment than the one used in the paper and measured hydrographs are available. We have also simulated a third event (September

2000), where we have a good observed hydrograph but where the radar treatment is not exactly the same since the radar protocol changed in September 2002. The results are not presented in the revised manuscript since one manuscript is currently under review in the Geophysical Research Letter with similar simulations. Nevertheless, to clarify this point to the reviewers and the Editor, we present the results of this evaluation on this larger gauged catchment. For the 2002 events, the graphs show that the peak discharge is fairly well estimated, whereas it is largely overestimated for the 2000 event. For the latter event, a sensitivity analysis showed that drier initial conditions were not improving the peak discharge significantly with less than ś5% change. On the other hand, a simulation with a gravitational flow at the bottom of the soil columns induces a drop in the simulated discharge (about one third), which leads to an underestimation of the peak discharge. This result confirms the difficulties already raised within our observatory and confirms the open questions of the imperviousness of the bedrock (see answer to Reviewer #3) and the need to better document the soil properties and thickness. For all the events, the graphs show that the recession is occurring too quickly, but it was expected as lateral transfer is not yet included (see answer to Reviewer #3).

(PLEASE REFER TO THE FIGURE available at : http://ltheln21.hmg.inpg.fr/PagePerso/anquetin/Access.html)

3/ The use of post flood field survey provides a spatial view of the hydrological response across a large range of catchment scales (Borga et al., 2008). Of course only information on peak discharge can be retrieved (and on the timing of the event when witnesses are interviewed). Our hypothesis is that a “regional” evaluation using peak discharges is a good starting point for the evaluation of our model. In other words, we propose to use a space series validation instead of a time series one. When available, it is of course a good complement to compare the simulation within gauged catchments and one illustration is show above. The next figure presents the regional validation that is included in the revised version. Apart for catchments #7

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and #10, the relative error between the simulated and the estimated peak discharges ranges from 3% (#12) to 47% (#15). The mean error value is about 22% whereas the estimation uncertainty is about 21%. This is a fairly good result for this type of regional validation without any calibration. The simulation of the peak discharge at the outlet #6 fails. As mentioned by Bonnifait et al. , this catchment is located in a region where the rainfall gradient has been estimated to be the strongest. The rainfall input is, therefore, probably at the origin of the overestimation of the peak discharge. The underestimation of the simulated peak discharge for the catchment #10 is difficult to explain without any additional field information. Thus, this catchment will be a good candidate for a special observation device within the framework of the future HyMEx experiment in order to better document the soil characteristics. This text and this figure have been included in the paper.

(PLEASE REFER TO THE FIGURE available at : http://ltheln21.hmg.inpg.fr/PagePerso/anquetin/Access.html)

The introduction of the paper was rewritten so that the objectives of the study are stated more clearly to point out the above context. References have also been updated accordingly. In terms of validation, we underline that we focus on peak discharge at the regional scale and that we consider post flood investigation as a relevant source of data and information (see focus of the HYDRATE (Hydrometeorological data ressources and technologies for effective flash-flood forecasting) European project (http://www.hydrate.tesaf.unipd.it/).

In the revised version, a specific section is dedicated to the model validation based on 17 peak discharges estimated during the 2002 post field survey (see Gaume and Bouvier (2004) and Delrieu et al. (2005) for a description of the method).

The reviewers also underlined the impact of considering a constant flow velocity on the estimated peak discharge. We performed a sensitivity study to flow velocity by using 2, 3, and 4 m s-1 and using as well a flow routing module based on the kinematic

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wave approximation of the St-Venant equation. The latter module is now available in our model. The impact on the maximum peak discharges is shown in Table 1 below. In Table 2, we present the 17 catchments where the maximum peak of discharge was retrieved during the post flood survey. For each catchment, the most probable discharge is given as well as the range of estimated uncertainty; the impact of flow routing (Table 1) is modest in particular with regard to the range of uncertainty of the estimated discharges (Table 2). Nevertheless the chosen velocity of 1 m s-1 was certainly too low (see also answer to Reviewer 1) and a value of 3 m s-1 was probably most suitable. Since the kinematic wave approximation routine is now available, we finally chose to use it and modified the revised manuscript consequently. From the results in Table 1, we can underline the smoothing role of a flow routing module, which in general yields to maximum peak discharge values smaller than when a constant flow velocity is used.

(PLEASE REFER TO TWO TABLES available at : http://ltheln21.hmg.inpg.fr/PagePerso/anquetin/Access.html)

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