Response to Anonymous Referee #3

Anonymous Referee #3:

The manuscript "How does initial soil moisture influence the hydrological response? A case study from southern France" by Uber et al. sets out to explore the relevance of soil moisture for the generation of floods. Although the overall topic is highly appreciated, I am not sure what the novelty of this paper is, nor did the authors convince me about what they really want to do. There are several critical points I would the authors encourage to invest a bit more effort in to develop this study:

Response:

Thank you very much for the review of our paper. Your comments are highly appreciated and will help us to improve the manuscript. We regret that we could not convey the novelty of the paper sufficiently. Thank you for pointing out this important fact. In the revised version of the paper we will emphasize more clearly the novelty of the paper which lies on:

- Obtaining meaningful estimates of soil moisture at the catchment scale from a dense network of in-situ measurements that were derived from two different measurement schemes without relying on satellite data, modeled soil moisture, antecedent precipitation etc.
- Using this information to analyze the relation between initial soil moisture and the event based runoff coefficient which was equally obtained from using high resolution measurement data. Its uncertainty due to stage discharge transformation and hydrograph separation was scrutinized.

To our knowledge, no previous studies addressed this question with a similar data basis and for as many events.

(1) It is not entirely clear what the objective of this study is. Is it intended to give an overview of the spatial pattern of soil moisture and how these evolve over time? In spite of a relatively rich data set, is such an analysis really warranted by the data? In other words, are the conclusions drawn generally applicable or do they merely describe the relatively local study sites? If the latter, what can be learned from that? Or is the study rather meant to improve our understanding of soil moisture to generate flows? Then much of analysis and discussion of the spatial pattern can be condensed.

The general objective of the study is the latter: improving our understanding of the role of soil moisture in generating runoff that leads to flash floods. However, it is not easy to obtain a meaningful measure of catchment mean soil moisture due to 3-D spatial variability across scales and temporal changes within hours. To obtain this measure, we believe it is important to regard the spatial variability across scales. We agree that this analysis and the results regarding spatial patterns can be condensed. We will shorten these sections in the revised version of the manuscript and make our objectives clearer.

What I also found surprising is that in the introduction much is made of the importance of flash floods, but this is not been really picked up and discussed explicitly later with respect to the results. Why?

Thank you for pointing that out. The importance of flash floods is the motivation of our study but we do not study flash floods in this manuscript, so we will shorten that aspect in the introduction.

(2) Soil moisture and its spatio-temporal pattern have been subject to a vast body of

studies in the past. In that context, neither the introduction nor the discussion of the results here do any justice to these earlier efforts. How is this study placed in the context of this earlier work? What is different? What is novel? What is the same? Could your results and interpretation improve some of the earlier interpretations? If so, how? In which aspects are the conclusions you draw similar/not similar to other studies? Why? I would argue that there is quite a lot to discover on this topic and I would strongly encourage the authors to do so to allow the reader to better appreciate the authors' efforts. In addition to the other Reviewers' suggestions, I would also think that (at least) the following references are highly relevant and provide necessary context and should thus be considered: McMillan et al. (2014), McMillan and Srinivasan (2015), Hrachowitz et al. (2011) and Li et al. (2011)

Thank you for the additional literature recommendations which will be valuable for the revised version of the manuscript. We will re-examine the literature using these recommendations as well as the ones of the other Reviewers and better link it to our results and conclusions.

(3) More information and context is needed for the soil moisture data. It would be nice to have a more detailed map of the locations of the sensors (maybe also crosssections), to get a better idea of what is observed where.

Improvement of figure 1 was also demanded by Reviewer 2. We will provide a revised figure with a closer zoom into the area in the south of the Gazel catchment. We will provide information on the land use of the location of the measurement sites. Our experimental plan was not organized with a real upstream-downstream geometry which makes, in our opinion, cross-sections not relevant to this particular study. However, Fig. 1 caption will be modified to give precisions about the sensors depths, additionally to the main text so that the vertical profile of the measurements is better conveyed. (Just as a reminder: continuous measurements probes were installed at different depths at one location per plot, the on-alert measurements were conducted at approx. 10 randomly chosen points per field).

Related to that, much is made of the, admittedly quite extensive soil moisture data set. However, in section 4.1 no consideration is given to the limitations of what is actually measured. In a simplified way, the role of unsaturated water storage lies in the temporal storage of water between permanent wilting point and field capacity (i.e. water held against gravity). At any point in time, this storage is controlled by plant water use (transpiration) and soil evaporation, whereby plant water use extracts water more efficiently than soil evaporation. Thus, to make sure to meaningfully measure soil moisture, it therefore needs to be measured exactly where plant roots extract water from the soil. Is this the case here? it was mentioned that in the vineyards the sensors were place between the vines. Is this were the most important parts of the root system of vines is to be found? I could imagine that the measurements obtained are thus largely biased towards high soil moisture, as plant water extraction may be underrepresented in these locations. How would that change the interpretation? It would be good if the authors not only acknowledged this common problem but also discussed the limitations that come with it.

We agree that transpiration is crucial in determining initial soil moisture. The locations of the sensors in the vineyards where carefully chosen to represent a compromise between feasibility and representativeness. The root system of the vines can reach up to 4 m depth, so it was impossible to measure soil moisture throughout the root system. By installing the permanent sensors in the vine rows in a depth of up to 50 cm the sensors are as close as possible to the root system. Considering a vineyard

plot that consists of the vine rows and the (nearly) bare soil between the rows, we do not believe that we underestimate plot-scale soil moisture due to transpiration.

The manual measurements in the topsoil were conducted between the rows, because this is where surface runoff started (Visual inspection during heavy rain). We also want to stress here that measuring soil moisture in vineyards with clayey and extremely stoney soils is very challenging. To insert the 6 cm rods of the manual soil moisture probes in the stony soil without damaging the instrument, we often had to try more than 10 times before we managed to completely insert the rods.

We agree that this justification is not conveyed in the section where the measurements are described and will add an explanation for the location of the sensors and account for the problem of soil moisture heterogeneity due to transpiration in section 2.2.

(4) Throughout the manuscript, methods could be explained in a clearer and more consistent way

We regret that the methods were not explained clearly and consistently. As proposed by Reviewer 1 we will consider to use a table to explain the different variables calculated in section 2.4. We hope that will make it clearer and will allow us to shorten this section as you proposed in (1).

[…] and some of the results could be provided in a more quantitative manner. Some examples: it is stated that regression methods require the assumption of "normal distribution of dependent and independent variables". What does that mean? Why should x and y have to be normally distributed? That would only lead to clustering. Do you rather mean that the residuals need to be normally distributed? Please clarify.

Thank you for pointing that out. In order to shorten the manuscript we decided to delete the sentence you are referring to as this sentence is indeed not very clear and not necessary for the paper.

Another example section 3.1.1. What do you intend to say with this paragraph? Why is it important to have normally distributed soil moisture?

This paragraph is aimed to describe soil moisture at the plot scale, which is important for the first objective, to obtain a meaningful method for the catchment mean value. The distribution of the values helps interpreting the significance of the mean since an exhaustive sample related to all factors (land use, geology, slope, …) could not be obtained. Thus, only a statistical approach can be used to assess its uncertainty. As you proposed in your comment (1) we will shorten this section and the following.

Similarly, in section 3.1.2 it is stated that "[: : :] pdf [: : :] agree with either normal distribution or [: : :]". Please use a more formal language here and provide quantification. Do you want to say that the hypothesis that the pdf is a sample from a normal distribution cannot be rejected on a 0.0x significance level? Then please say so.

We agree to reformulate that. Thank you for pointing it out.