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Interactive comment on "Identification of soil-cooling rains in southern France from soil temperature and soil moisture observations" *by* S. Zhang et al.

S. Zhang et al.

jean-christophe.calvet@meteo.fr

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RESPONSE TO REVIEWER #3

The authors thank anonymous reviewer 3 for his/her review of the manuscript and for the fruitful comments.

3.1 [General comment: This paper presents an assessment of soil-cooling rain events in South of France and is based on observations recorded during 9 years, a long enough period to allow robust statistics. The paper is mostly a description of the dataset which is stratified in different ways. The dataset and the method are gener-

ally well described and the argument is quite relevant. The modelling aspects are less satisfactory, for instance, the comparison between ISBA and the observations is not convincing since ISBA does not represent the cooling process and the quality of the forcing is poor (duration and intensity of the rain events). On one hand the discussion of the results could have been shortened may be summarizing some of them in tables, on the other hand insights to understand when, where and why soil cooling occurs or not would have been valuable to help model development. For instance section 5.2 starts well "Does soil cooling matter" but at the end of the section it is not clear what is the added value of the paper to answer this question.]

Response 3.1:

See also Responses 2.2 and 2.5.

Now, the ISBA model has no representation of heat exchanges due to water mass movement. This process needs to be introduced in ISBA. The shown ISBA simulations represent the current state of hourly operational land surface monitoring, available over whole of metropolitan France. The message we want to convey is that the best possible operational simulations currently available are not able to represent the impact of intense precipitation on the soil temperature profile. The ISBA land surface model needs to be improved. The SAFRAN atmospheric analysis could also probably be improved by using more in situ observations together with high resolution atmospheric simulations. This is work in progress. Unfortunately, local meteorological data do not include all the atmospheric variables needed to force the ISBA land surface model. Using locally observed precipitation together with other variables from SAFRAN would not be technically correct. Therefore, properly disentangling SAFRAN and ISBA shortcomings is not possible now. We understand that this can be confusing for the readers: the ISBA simulations will be moved to the Supplement, including Figure 6. Section 5.2 shows that rain water temperature is needed for a number of applications. We think that data from a fully instrumented site including direct measurements of rain water temperature are needed to completely address this issue and to validate the upgraded model version. Such an experiment would give insights to understand when, where and why soil cooling occurs or not and would be valuable to help model development. In particular, the precipitation-induced sensible heat flux is not limited to intense precipitation and the impact of this process on the surface energy budget needs to be investigated in all conditions. We plan to perform these tasks in future works.

This discussion will be included in Section 5.2.

3.2 [Minor comments The meaning of the sentence starting line 29 in section 3.1 is not clear.]

Response 3.2:

"The missing data fraction across seasons (Table S1) is used to correct the estimation of the possible number of intense soil-cooling rainfall events, their frequency and the mean time lag between two events."

This sentence refers to Table 1. It will be rephrased and moved to Section 2, where Table 1 is presented.

3.3 [Section 3.2 l. 24 : Why the precipitation induced sensible heat flux dominates the heat exchange, is it possible to evaluate it and compare with the heat conduction?]

Response 3.3:

Since soil properties are known, the mean precipitation-induced sensible heat flux P_h can be estimated from Eq. (2) for the intense soil-cooling events used to retrieve T_rain (see Table 4). For the 10 events of Table 4 occurring at summertime, this flux ranges from 408 to 1009 W m-2, with a mean value of 648 W m-2. These P_h flux values are very high and represent large fractions of the net radiation R_net (i.e. the amount of energy available for surface heat exchanges, driven by the incoming solar radiation, that could be simulated without accounting for P_h). They are probably often much larger than R_net because the R_net energy budget component is generally small during rainfall events, in relation to the low incoming solar radiation. Moreover, 7 events out

of 10 occur at nighttime or at dusk (see Supplement), i.e. in small R_net value conditions. R_net is not measured at SMOSMANIA stations. Typical measured summertime values of the maximum daily R_net over the grassland site of Meteopole-Flux (Zhang et al. 2018) in southwestern France range from about 200 W m-2 during cloudy rainy days to about 700 W m-2 in clear sky conditions. Minimum R_net values at nighttime range from -100 to 0 W m-2.

This discussion will be included in Section 5.1.

3.4 [Section 4.1 When speaking about the minimum deltaT5cm using absolute values may render easier the reading:: even if it's correct: "larger than -0.5C" is a bit confusing.]

Response 3.4:

Yes, "are larger than -0.5 °C in 12 minutes" will be replaced by "do not depart much from 0 °C in 12 minutes".

3.5 [Panels in Figure 6 are partially commented, if they are not essential they have to be removed or put in the supplemetary materials. By the way, units are original!]

Response 3.5:

Yes, we will move Figure 6 to the supplement.

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