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Atmospheric Chemistry and Physics Discussions

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

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RESPONSE TO REVIEWER #2

The authors thank anonymous reviewer 2 for his/her review of the manuscript and for the fruitful comments.

2.1 [General comments The paper presents a study, based on in situ observations of soil temperature and soil moisture, that investigates the cooling effect of rainfall on soil water. In specific conditions, the paper also proposes a method to infer rainfall temperature from variations of soil temperature and soil moisture. The analysis relies

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on 9 years of 12-min time step data of soil temperature and soil water content (complemented by in situ climatic data from standard meteorological stations), collected in 21 stations of the southern part of France, encompassing various climatic conditions from oceanic to Mediterranean climates. The length of the time series is long enough to get sufficiently robust conclusions. As underlined by the authors themselves, data on rainfall temperature are rare – if not inexistent. The impact of potential differences between rainfall, air and soil temperature is generally not considered in atmospheric and climatic models, but it is worth trying to quantify if it is really negligible, or in which conditions it may be important to take into account this effect on the surface energy balance. Although the rainfall temperature estimation proposed in the paper is indirect and relies on hypotheses that are clearly stated by the authors, it can provide a first guess on rainfall temperature estimation to explore more in depth its impact on the surface energy balance. Besides its interest in documenting rainfall temperature, the paper also provides an interesting climatology of soil moisture and temperature changes when it rains. There is also an interesting approach for selecting and characterizing rainfall events, based on high temporal resolution data. Data presentation and analyses are clear and carefully performed, with a level of details that is suitable, although the presentation could sometimes be shortened (see details below).]

Response 2.1:

Many thanks for this positive evaluation of our work.

2.2 [General comments There is one point that is however not clear for me. The authors presents some simulations based on the ISBA land surface model, that does not include a representation of heat exchanges due to water mass movement, to show that it is not able to reproduce the observed change in soil temperature. To perform these simulations, the authors use the SAFRAN reanalysis that has a low temporal resolution for rainfall (hourly) and a spatial resolution of 8x8 km2. This resolution may not allow the forcing to capture very localized rainfall events. If in situ meteorological data are available, why didn't the authors use them? Specific comments 1/ p.4, lines 10-14; p.8

lines 10-16: why do you use SAFRAN reanalysis and not the in situ collected meteorological data? The low resolution of SAFRAN is probably not adapted to capture the high spatial and temporal variability of rainfall that is relevant if you want to relate the forcing to temperature and soil moisture local variations.]

Response 2.2:

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.

2.3 [2/ Section 3.3: the location of this section is strange. Why didn't you put it in an appendix?]

Response 2.3:

Yes. We will move Section 3.3 to an appendix.

2.4 [3/ Section 4.2: this section is very detailed. It could be shortened. Fig. 9 could also be put in the supplementary materials.]

Response 2.4:

Yes. We will shorten Section 4.2, and move Fig. 9 to the supplement. The content of

Fig. 9 can easily be summarized in a small Table.

2.5 [4/ Section 5.2. This section is somehow frustrating: the authors have gathered all the data to test the impact of cold rainfall temperature on the soil temperature and water content and the reader is expecting to see such a simulation using the ISBA model. Adding a representation of heat exchanges due to water mass movement into the model could be done in order to complement the paper. It would also give more strength to the conclusions on whether rainfall cooling matters or not.]

Response 2.5:

Section 5.2 shows that rain water temperature is needed for a number of applications. Now, the ISBA model has no representation of heat exchanges due to water mass movement. This process needs to be introduced in ISBA. 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.

See also Response 2.2. This discussion will be included in Section 5.2.

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