Hydrology and
Earth System
Sciences
Discussions

Interactive comment on "A multi-sourced assessment of the spatio-temporal dynamic of soil saturation in the MARINE flash flood model" *by* Judith Eeckman et al.

Anonymous Referee #2

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General: This study presents an assessment of two new concepts included in the MARINE flash flood model to increase the schematization of the subsurface. In situ, satellite and model soil moisture estimates are used to validate the model results for flash flood events. Both the temporal as spatial dynamics of soil moisture are studied.

The study presents interesting developments of the MARINE model. Also the comparison with both in situ and innovative satellite soil moisture data leads to interesting insights. The methodology and results are clear and generally well presented. The structure of the manuscript is good, although the conciseness of the manuscript can be improved. Furthermore, the manuscript contains many spelling errors. Based on my

comments, I suggest a major revision of the manuscript. My comments are discussed in the next sections.

Major comments: - The manuscript contains many grammar and spelling errors, which makes the manuscript rather difficult to read. The authors should correct these errors. A (rather long, but not exhaustive) list with proposed technical changes is appended at the end of the review. Also, some parts, especially in the introduction and results sections, need restructuring, as some statements are repeated quite often.

- The authors use only one in situ soil moisture station per catchment for the study. Is this sufficient? Several studies show that the use of only one point location for the validation of gridded soil moisture products introduce large uncertainties (e.g. https://doi.org/10.1016/j.rse.2020.111806, https://doi.org/10.1146/annurev.earth.30.091201.140434 or https://doi.org/10.1029/2011RG000372). Is it possible to compare the absolute values of the different soil moisture datasets while not investigating the same spatial scale? The authors should clearly state the spatial differences between the point observations, model output, and satellite estimates. Also, the authors should explain how these difference in spatial scales affect the findings of the study.

- The authors show an extensive analysis of various datasets. However, some analyses can be investigated more in-depth. As an example: P13, l308-309: "Despite being initially defined by Zoccatelli et al. (2011) to characterize rainfall fields, the delta_1 and delta_2 moments also appear to be particularly relevant when applied to soil moisture fields." –> Please explain how you calculate these moments and why they are relevant when applied to soil moisture fields. What is the consequence on the findings of the delta_1 and delta_2 moments? What do these results mean in context of the model and soil moisture products? I would like to see a discussion included in the manuscript. The same holds for the findings on the spatial variation in soil moisture.

Specific comments: -Title: either use dynamics or variability instead of dynamic -

Abstract, l17-18: "The opportunity of improving the two-layers model calibration is then discussed." Please provide a summary of the discussion instead of referring to the discussion. - Reference section: please provide doi for each reference if available. - The introduction can be improved by including a concise discussion on the relation between soil moisture content and flash floods. - Can you add a short section to the introduction on flash floods and why it is important to model them in France? - Can you be more specific about assessing the performance? What exactly do you mean with performance? Accuracy of model output? Model efficiency? - The authors often refer to "spatially extended data". Consider rephrasing this to "spatially distributed data". - The authors should be more clear on the use of the word soil moisture. An example is shown on page 11, line 275: "the MARINE soil moisture is compared to the moisture of the surface layer". Please indicate whether volumetric soil moisture content or soil saturation degree is considered. - Please move references in the middle of a sentence to the end of that sentence. As an example (P8, l 184): "LDAS-Monde (Albergel et al., 2017) assimilates satellite derived data into the ISBA land surface model." –> LDAS-Monde assimilates satellite derived data into the ISBA land surface model (Albergel et al., 2017). - P2, l25: Please define what an integrative discharge variable is. - P2, l34: "controlling coefficients". Do you refer to the parameters of the discussed representations of infiltration? - P2, l36-37: "This variety.. ..during flood events" This sentence can be removed for clarity. - P2, l42: "the lack of underground flow measurements" –> I believe you want to refer to soil moisture measurements rather than underground flow measurements. Is that correct? - P2, l44: please define event-based hydrological models. - P2, l45-47: I do not fully agree with this statement. If you simulate soil moisture using a 1D-soil column model, point measurements provide valuable information. Could you clarify this sentence? - P2, l48: "continuous models" –> what do you mean with a continuous model in this context? - P2, l50-53: please clarify why using these products lead to structural model uncertainties. - P2, l53-61. This part needs support of references (use of data-assimilation to improve RZSM representation. Examples are: https://doi.org/10.1016/j.jhydrol.2014.08.008,

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https://doi.org/10.1016/j.hydroa.2019.100040, and https://doi.org/10.1109/IGARSS.2009.5418264. - P3, l63: Isn't MARINE an abbreviation of Model of Anticipation of Runoff and INundations for Extreme events? - P3: can you include more details on the recent developments of the MARINE model in the introduction? Briefly explain how the representation of subsurface flow was improved? Also, please briefly discuss the foundings of Douinot (2016) after line 68. - P3, l76: "upper soil moisture hourly measurements" –> what's the meaning of upper in this context? - P3, l77: "kilometric resolution" this is a bit ambiguous, please use same definition of spatial resolution as used in lines 73 and 75. - The relationship between the various model components was not directly clear to me. You might consider to add a figure in section 2.1 showing the connections between the model components. - Although the structure of the manuscript is good, the authors provide a lot of information on models and datasets. The readability of the manuscript would greatly improve when a figure showing the research methodology and a table summarizing all data and models used in the study would be added. - P4, l116: What exactly are the hypotheses here? Do you mean the model developments? I would not consider that a hypothesis. - P5, l131-135: Do you have any references for these datasets? - P5, l141, p6, l153: please add reference to reference list. - P5, l143-145: How did you define these depths? Also, what exactly do you mean with a shallow depth (for Orbieu)? - P6, l152: What is the context of critized in this sentence? - P6, l158-159: Can you discuss why the response of discharge to precipitation during this flood was so fast? - It was not clear to me why you introduce the various soil moisture products in section 2.3. Please clarify at the start of this section why you need these products. - P7, l174: what is the depth of the root layer in SIM? - P8, line 184: Is LDAS-Monde a data-assimilation framework? Please make this clear. - P9, line 214: SMOS remote data –> please clarify that these data are obtained using the SMOS satellite. - Figure 2 is not clear to me. The labels are too small and not in English. Please make a clear distinction between SSM and SWI. Also, the difference between 1km and 25km resolution is not clear. In addition, the precipitation data is not visible, consider adding them in a subplot. Furthermore,

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according to the manuscript, the figure also shows the respective fraction of missing values. I do not see this in the figure. - P9, l233: How do you define the very local scale? - P11, l256: the authors state that the ADES locations are situated in the study area. However, according to figure 1, the ADES stations are situated outside the catchments. Why do you consider these stations? - P11, l257-258: What is meant with "the water table is 110 km2 large"? Is this the size of that specific aquifer? If so, what is the relation with the in situ soil moisture station? According to figure 1, the groundwater and soil moisture stations are located quite far away from each other. - P11, l265-266: Please describe the eleven soil layers of the LDAS-Monde product in the data section. - P11, l275: "is compared to the moisture of the surface layer" –> Do you mean compared to the surface layer of LDAS-Monde? - P12, l286-289: I don't understand your argumentation here. Why would you consider the drainage network in averaging of a grid/mesh? Also, do you have 16 different grids for the analysis and you choose to exclude 4 of them? Or are you referring to individual cells of the grid? Could you rephrase and clarify? - P13, l291: Add reference for NS-efficiency criterion. Also, is LNP index an abbreviation? Furthermore, please add the units of each term in equation 1. - P13, l317-318: Why do you consider two grids with different spatial resolution? Can you discuss the impact on your results? Also, why do you have a computational time step of 5 minutes while the precipitation input data has a hourly time step? Please explain. - Section 3.2.2: Shouldn't this section be part of the results section? - Table 4: maybe a figure would visualize these data better, or add the numbers in figure 5. - P15, l334-336: I don't understand the argumentation here. Is your argument here that you use the same parametrization for the BM, SSF, and SSF-DWF model variants? However, the SSF and SSF-DWF model variants contains more parameters, so how do you cope with that? - Although you state otherwise on p19, l405-407, the initialization grid shown in Figure 8 is still visible in the flood rising stages of the SSF and SSF-DWF models. Is the model able to reach an equilibrium after initialization or is the model still in a spin-up stage? Did you had a look at this? - P20, l432-433: "The computation of spatial moments for the CGLS SWI might not

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lead to robust conclusions." Ok, so what is the consequence for your message? Why even considering these data in the manuscript then? - P23, l454: "Additional research regarding the deep layer calibration should be led." Please rephrase and explain why additional research should be performed. - Figure 11: I am not convinced that you can use the piezometric observations for validation of the deep layer of the SSF-DWF model. (1) please explain why you validate soil moisture simulations with groundwater observations. Or do you investigate groundwater simulations here?(2) the groundwater observations are located outside the study area. Are they valid to use? - Conclusions: please remove references from conclusion section. - Conclusions: too much information is provided in the conclusion section. Please make the section more concise and to the point. - P27, l529: the HAND method is introduced in the conclusions, but not discussed in the rest of the manuscript. Either discuss the HAND method in the discussion or remove this line from the conclusions. - P27, l531-534: "In conclusion, this work exposes that enhancing the degree of refinement of the soil physics for the representation of subsurface flow in the MARINE model appears to enhance the upper soil moisture simulation during flash floods, with respect to both spatialized model outputs and satellite-based data, as well as with respect to local soil moisture measurements." –> This final statement is difficult to read and follow, although I believe this sentence is strong in summarizing the entire manuscript. The authors should clearly rephrase this sentence. - The authors refer to several articles written in French, such as PhD theses. Is the work of these theses not published in English journal articles or other works written in English?

Technical comments: - Abstract, l5: performances –> performance - Abstract: Do you provide the same conclusion twice in l13-19? Please clarify. - P1, l22-24: In my opinion, these sentences can be split for clarity: Extreme precipitation events are expected to increase both in frequency and amplitude in the context of a changing climate (IPCC, 2014). The performances of modelling tools available for operational purposes are of increasing stake. - P2, l25: remove the word "itself". - P2, l27: "models" change to "hydrological models" - P2, l29: "a large panel of formalism" –> please

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rephrase. - P2, l34: replace ""whether" by "either" - P2, l48: "consists in" –> "consists of" - P2, l40-41: please rephrase into something like: "They show that uncertainties in the representation of infiltration processes strongly impact both discharge and surface runoff simulations during flood events." - P2, l41-42: please rephrase. - P2, l49: "necessarily biased" –> "inherently biased" - P2, l50: change "by structural uncertainties of the model and uncertainties on model input" to "due to structural uncertainties of the model schematization and model input" - P2, l52: "plateform" –> "platform" - P3, l69: "dynamic" –> either "dynamics" or variability"" - P3, l81-86: please have a look at the use of language in this section and rephrase. - Several occurrences: "physically based" –> "physically-based" - P4, l92: either Darcy's law or the Darcy law. - P4, l95: "saturation hydraulic conductivity" –> "saturated hydraulic conductivity" - P4, l113, p5, l134, p13, l314 and l316, p17, l359: "data base" –> "database" - P5, l121: "model's" –> "model" - P5, l129-130: Awkward English, please rephrase. - P5, l139-140: "in particular with" –> "for example" - P5, l142: "consists in" –> "is situated in" - P5, l147: "found is" –> "found in" - P6, l149: "quantitatives" –> "quantitative" - P6, l154: "event" –> "events" - P6, l161: "Mars" –> "March" - P6, l162: "serie" –> "series" - P6, l162: "have mainly been" –> "mainly have been" - P7, l164-165: please rephrase. - P9, l208: "neural networks" –> "neural network" - P9, l209: "globally covered" –> do you mean approximately? - P9, l209-210: please rephrase. - P9, l228: "this products intercomparison" –> "comparison" - P9, l228: "the products temporal dynamics" –> "the temporal dynamics of the products" - P9, l231: "product" –> "products" - P9, l235: Please rephrase: "the product that offered the most important data availability". - P9, l237: I do not understand the use of the word important in this sentence. Please rephrase. - P10, l 243: "scale" –> "scales" - P11, l256: "One point of measurement" –> "One measurement location" - P11, l259: "water level" –> "groundwater level" - P11, l266-269: "Two behaviors can be distinguished for the different layers: for the five superficial layers, a fast-responding soil moisture and a more stable soil moisture, with a slower response to precipitation and narrower amplitude range for the deeper layers." –> Awkward English, please rephrase. - P12, l280-281: "However, it raises the issue

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to compare point measurements to the gridded simulated soil moisture" –> "However, scale differences exist between the point measurements and the gridded simulated soil moisture content/percentage." - P13, l291: "are estimated" –> "is estimated" - P13, l304-308: "The closer of 1 are the delta_1 values, the more centred around the centroid of the catchment is the field. Values of 1 lower that 1 mean that the field get closer from the outlet, whereas values higher that 1 characterize a field overally located on the highest areas of the catchment. The closer of 1 are the 2 values, the more uniform is the distribution of the field. Values of 2 lower that 1 represent an unimodal distribution and values of 2 higher that 1 mode likely represent a multimodal distribution." –> Awkward English, please rephrase. - P15, l332: "However, in the SSF-DWF model, this dynamics is influenced by the contribution of the deep layer, itself mainly controlled by the parametrization of the thickness of this deep layer." Please rephrase. - P16, l346: "on figure 6" –> "in figure 6". - P16, l351-352: "leading to a simulated soil moisture significantly lower with the base model than with the two other models." –> "leading to a simulated soil moisture significantly lower than the SSF and SSF-DWF models." - P17, l358-359: "In addition, the soil moisture simulated for the surface layer with the SSF-DWF is globally higher than for the two other models." –> "In addition, the soil moisture output of the SSF-DWF model are generally larger than the output of the base and SSF models." - P17, l360: What is the context of superior here? - P17, l366: "This shows that the dynamic of the LDAS-Monde HUsurf variable is locally significant with in-situ surface soil moisture measurement. The reliability of the LDAS-Monde HUsurf dynamic for surface soil moisture description can thus be considered as satisfying." –> Please rephrase and revise the word dynamic in the entire manuscript. - P17, l382: "appear" –> "appears" - P17, l383: "both a point" –> "both at the point" - P18, l390: "On overall" –> "Overall - P18, l394: "is very consistent" –> "is consistent" - P18, l392: "sharp decreases" –> "sharp decrease" - P18, l393-394: "the dynamic of the CGLS SWI is very consistent" –> "the dynamics of the CGLS SWI are very consistent" This error occurs often in the manuscript. Please revise. - P20, l414: "Indeed, precipitation that waters the catchment are doomed to flow toward the outlet." –> Please rephrase.

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- P20, l428: "spatial resolution is the LDAS-Monde HUsurf" –> "spatial resolution of the LDAS-Monde HUsurf product" - P20, l430-432: "This can be explained not only by the spatial resolution coarser than for the MARINE outputs but also by the important amount of missing pixel in this data source, in particular for the Ardeche catchment." –> please rephrase. - Please revise the vertical axis label of figure 9. - P22, l450: "emptying of deep soil faster" –> "emptying of deep soil moisture faster" - P26, l518 "is of satisfying accuracy" –> "are of satisfying accuracy"

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