

***Interactive comment on* “Flash drought onset over the Contiguous United States: Sensitivity of inventories and trends to quantitative definitions” by Mahmoud Osman et al.**

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Anonymous Referee #1

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Osman et al. provide an overview of definitions that have been developed to identify and quantify flash droughts (including a new definition developed by the authors here) and examine the robustness of these definitions with regard to characterizing flash droughts over the United States. They find that different definitions often lead to different conclusions with regard to flash drought frequency and trends, as well as the

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characterization of well-known past events. The results stress the importance of careful consideration of physical drivers when selecting a flash drought definition and the need to exercise caution when interpreting the results derived from a given definition. The paper is both informative and comprehensive and the topic is highly relevant to the broader scientific community, which is becoming more and more interested in the topic of flash drought. I have only minor comments related to clarity and presentation, described below.

»Reply: We would like to thank the reviewer for the supportive and constructive comments. The original comments and our responses are noted after each comment.

Comments:

Figure 1: While this figure is generally informative and understandable, some aspects of it are a bit confusing and can use further explanation/clarification. First, I suggest expanding the acronyms SM, PET, and AET on the figure. The general reader may not immediately know what these acronyms represent, especially since they do not appear to be defined prior to Fig. 1 in the text. Second, some aspects of the diagram itself are unclear. For example, it's unclear exactly what the box "pre-drought conditions" fundamentally represents and why there is an arrow drawn to it from "agriculture and ecological impacts" and another arrow drawn from this box toward "PET". Also, it seems some information may be omitted from some boxes, which may raise questions – e.g., could PET itself also be a function of crop type and density, and isn't air temperature also a function of surface heat fluxes? Overall, I think it would be helpful to provide a brief explanation of this figure (either in the main text or as part of the caption), to clarify some of the issues raised above.

»Reply: Thank you for these suggestions. Regarding presentation of the figure, we have expanded all acronyms as the reviewer suggests. Regarding substance, we have attempted to clarify what is meant by "pre-drought conditions" in the text (revised manuscript lines 34-37 and line 49, with reference to Wolf et al., 2016). The reviewer's

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points about missing elements and simplifications in other components of the diagram are also appreciated. We recognize that there are many ways to think about different processes feedbacks and interactions with environment, and that our schematic does not capture all possible links and feedbacks. We now emphasize in the text (line 34) that the diagram is a simplification that shows “key” processes identified in previous literature. We do this to provide insight and a general framework for some interactions between environmental processes that could help in identifying pathways for the onset of a flash drought event.

L98 and in the Fig. 2 caption: Please define NDVI and briefly explain what this quantity represents. Including a reference that provides more information would also be helpful.

»Reply: Revised manuscript is updated with the clarification.

L122-126: The procedure to compute SESR could use more clarification. As currently written, the method is difficult to understand, particularly with regard to changes in SESR and how they relate to the given percentiles (40th, 25th). A suggestion is to emphasize that the change in SESR must be less than the Nth percentile of SESR changes (determined from a distribution of SESR changes, with lower percentiles representing more negative changes or larger decreases).

»Reply: We appreciate that the SESR method may appear confusing due to the multiple criteria and thresholds that can be difficult to follow. To address the reviewer’s specific point, the percentiles defined in the SESR method are based on the climatology of SESR at every grid point as defined by Christian et al. (2019a). In an effort to provide as much detail as possible within the constraints of the current manuscript, we have simplified the SESR description in section 2.1 in the revised manuscript to remove the confusion with percentiles used. For further details we refer the reader to Christian et al. (2019a), as it would take quite a significant amount of space to offer a full explanation and rationale for SESR methods.

L283: “SESR stands out as having no positive correlation with any other definition”

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There is indeed one positive correlation. I suggest adding the phrase “(except with QD1.0, which is small)” to the end of this sentence.

»Reply: Agreed. Revised manuscript is updated with the suggestion.

Fig. 5 and especially Fig. S1: It would help to display the region name above each panel.

»Reply: Labels added to Fig. 5 and Fig. S1.

L339-340: Could you say a bit more about the scientific consensus on when the 2017 flash drought actually occurred, as done for the other 3 events? Is it believed to have started in the summer?

»Reply: The 2017 Flash drought had started with as small footprint in April and May and the onset then spread widely over the three impacted states. Text is updated with these information and references added (Line 371)

Fig. 9: Is this for CONUS? Please clarify in the figure caption.

»Reply: Yes. Revised manuscript is updated with the clarification.

Typos/writing:

Abstract, L17: “several types of event” -> “several types of events”

»Reply: Revised manuscript is updated with the correction.

L62: “is the concept of flash drought robust to different definitions” should end with a question mark.

»Reply: Revised manuscript is updated with the correction.

L289: I suggest changing “less flash droughts frequency” to “lower flash drought frequency”

»Reply: Revised manuscript is updated with the suggestion.

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Fig. 7: For temperature, the legend shows a square but on the plot it is an “x”. Please correct.

»Reply: Revised manuscript is updated with the correction.

» References:

Christian, J. I., Basara, J. B., Otkin, J. A., Hunt, E. D., Wakefield, R. A., Flanagan, P. X. and Xiao, X.: A Methodology for Flash Drought Identification: Application of Flash Drought Frequency Across the United States, *J. Hydrometeorol.*, JHM-D-18-0198.1, doi:10.1175/JHM-D-18-0198.1, 2019a.

Wolf, S., Keenan, T. F., Fisher, J. B., Baldocchi, D. D., Desai, A. R., Richardson, A. D., Scott, R. L., Law, B. E., Litvak, M. E., Brunzell, N. A., Peters, W. and Van Der Laan-Luijkx, I. T.: Warm spring reduced carbon cycle impact of the 2012 US summer drought, *Proc. Natl. Acad. Sci. U. S. A.*, 113(21), 5880–5885, doi:10.1073/pnas.1519620113, 2016.

Interactive comment on *Hydrol. Earth Syst. Sci. Discuss.*, <https://doi.org/10.5194/hess-2020-385>, 2020.

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