

***Interactive comment on* “Quantifying the Impacts of Compound Extremes on Agriculture and Irrigation Water Demand” by Iman Haqiqi et al.**

Anonymous Referee #1

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The paper provides a novel approach to quantify the compounding effects of soil moisture and heat stressors on crop yield in the US over a historical time period. The study investigates multiple statistical representations to try to tease out the importance of the interactions between heat stress and soil moisture conditions on crop yield, and takes advantage of a large scale hydrologic model to extract the necessary soil moisture data to build the various models. The paper looks technically sound, and the paper is a great contribution to the literature. However, the paper could almost be cut in half to get the key messages of the paper, and much of the text can be either moved to supplementary materials or completely omitted. For example, I would suggest moving the first 5 figures to supplementary materials. I struggled with the flow of the ideas and text, and there is quite a bit of redundancy, and unnecessarily verbose. I would

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recommend major revisions, with most of the efforts on rearranging and streamlining the flow of the paper.

Specific comments:

Lines 1-2: I would suggest changing the title to something like “Quantifying the compounding effects of soil moisture and heat on crop yield” The paper does not talk about the impacts on irrigation water demand, and none of the figures show results looking at water demands.

Line 12: Are high-resolution and fine-scale intended to mean different things?

Introduction: The introduction section needs better arrangement for better flow of the ideas. I would recommend focusing on the importance of this work, what is the current state of the knowledge in this space, how this differs or builds on previous efforts, the key novelties it adds to the field, and the specific science/research questions it is trying to tackle. All of this is pretty much there, but it needs to flow better, and certainly results should be omitted from the introduction section to avoid redundancies.

Lines 22-32: this section is redundant with some of the content of the abstract and talks about the approach and key messages before even articulating the importance of the work. I would recommend omitting.

Lines 57-62: “We show that the coefficient . . .” Avoid throwing results in the middle of the introduction section to avoid redundancy. I would suggest omitting.

Line 79: it is a bit weird to talk about concerns before even talking about the approach.

Line 82: spell out Sec for consistency sake.

Line 83: Do you mean “background: Key factors impacting yield” or something along that line?

Line 85: “before starting our discussion” please rephrase.

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Line 94: “we will briefly talk about” please rephrase

Lines 97-101: I would suggest omitting this paragraph. Water is discussed in section 2.3, and here the focus is on spatial aggregation.

Line 100: a sample of what? The sentence is somewhat vague.

Lines 105-110: “we construct our. . .” this reads like a methodology section and should be part of section 3.

Line 111: “another empirical challenge” This reads like you are talking about a different challenge than what was discussed in the above two paragraphs under 2.1. I would suggest separating this section as ‘2.2 Degree of temporal aggregation’ and keeping the previous sub-section on the spatial aspect only.

Line 130: if you are going to end of each challenge with how this study tackles this challenge or differs from previous efforts, then I would suggest that this is done here as well, and at the end of each of the other challenges discussed in section 2.

Line 144: “To undertake. . .” please omit sentence. It does not add much.

Lines 145-147: Omit. I would suggest not throwing results at this stage. Plus, the reader does not know anything about WBM yet.

Line 166: “a fixed effect panel regression” I am not sure what that means. Please explain. Also, in the following sentence, what coefficients are you referring to? Please be specific.

Line 182: rephrase “as we prefer to take care of. . .”

Line 189: this section needs a concluding sentence to connect the dots.

Line 217: having read through section 2, it leaves the reader wondering what all of this has to do with compounding extremes. I wonder if section 2 can be shrunk or moved to a later section after describing the method section of the paper to improve the flow

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of the paper.

Line 219: “we introduce two models.” What kind of models? Please specify.

Lines 219-221: why design the two models in this manner? Explain the logic.

Line 226-227: “in summary,” omit. You just started talking about the model here.

Line 229: “as reported by WBM” omit since the reader has not read about WBM yet unless you go with my recommendation to have section 3.3 moved to 3.1 as explained later.

Lines 227-233: these equations (1a-d) need to be shown here. They are core to the whole paper and deserve more attention in the paper.

Lines 225-234: are metrics, indicators, and water variables the name thing here?

Line 243: I would suggest making this sub-section (3.3 Data) as the first sub-section in the methods section for better flow. Sub-section 3.4 builds nicely on what’s covered under the first two subsections, and the data comes in the middle and breaks the flow.

Line 250: “Daily interaction” how is this defined or calculated? Is this a term in equation 2? If so, then please state so.

Lines 261-265: omit this paragraph. It is identical to lines 249-255.

Line 231: Was there any validation work done on the soil moisture data? I am not necessarily asking for that to be shown here, and rather some citations of the previous validation work using WBM should suffice.

Line 304: are you using a single scan, or are you capturing the evolution of the cropland over the historical time period?

Line 319: I would suggest moving the materials here to be merged with subsections 3.1 and 3.2. For example, I would suggest moving lines 320 to 331 to appear in line 234. This would mean deleting the sentence “the estimation strategy is described in

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section 3.4.” Similarly, I would move lines 232 through 361 to line 242.

Line 363: “This section provides estimation results for different representations of Model (1)” well the authors discuss results from Model (2) as well (starting around line 389).

Line 384: so what does all of this mean? Which is the ‘best’ model formulation, on what basis, and how does this compare with previous findings?

Line 387: “the deficit and by 2300” – delete ‘and’

Line 397: “The figure shows that Model (1) would. . .” It was not clear that the intent was to compare the two models (1 and 2) to get at the compounding aspect. Some articulation of that upfront would help the reader follow through.

Line 44: “from previous models” which models are you referring to? 1a,b,c,d, 2a?

Lines 409-422: I would suggest moving this to be part of the results section. And to change the title for section 5 to be simply “Discussion” and then to jump to 5.1 directly.

Lines 416-420: please expand on this section to explain what you found out from these additional analyses that are in the appendix. Currently, they come across as throw away sentences.

Lines 420-422: “Finally, we have provided . . .” I would omit these two sentences.

Line 432: “we recommend the use of soil . . .” I can’t tell if this recommendation is based on the findings in this study, or simply an opinion based on past efforts/studies. Please clarify.

Line 454: “Model (2)” 2a or 2b?

Line 454: “while Model (3) predicts ...” do you mean model 1 here?

Lines 484-499: Subsection 5.4 comes as a surprise to the reader. It also reads more like a methods section. I would suggest dropping this subsection.

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Lines 500-509: The first sentence is redundant. The subsection is relatively shallow as compared to previous subsections. Also, it is not clear if there is any conclusion that can be drawn from Figure 10. I wonder if this would fit better if moved to the results section instead of being a discussion subsection.

Lines 510-536: Subsection 5.6 is another big surprise to the reader. I was not expecting this as this was never baked in the framing of the paper in the initial sections. All the previous sections including the data subsection focused on the US. Though this extends the work globally, which begs the question of how the extrapolation was done. I would suggest omitting this from this paper and keeping it for a follow-on paper.

Figure 6: what are the units for the y-axis and for the color bar on the far right?

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