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Hydrology and Earth System Sciences
Discussions

Interactive comment on "A Universal Multifractal Approach to Assessment of Spatiotemporal Extreme Precipitation over the Loess Plateau of China" *by* Jianjun Zhang et al.

Anonymous Referee #2

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In this paper, the authors study observed extreme precipitation in the Loess Plateau in China, derived from 87 meteorological stations in the period 1961 to 2015. They find that while there was a decreasing trend in mean precipitation in general, the trend in extreme precipitation frequency, intensity, and severity was increasing in parts of the study area. They further find a correlation of extreme precipitation thresholds with soil erosion hazards that regularly happen in this area. They apply multifractal theory and a segmentation algorithm to derive thresholds of extreme precipitation, and state that this method is superior to non-parametric methods that use fixed absolute values or percentiles to define the extreme precipitation threshold. The structure of the paper and the language is clear.

This analysis in an area that is exposed to hazards related to extreme precipitation is certainly valuable. It further promotes an advanced statistical analysis method based on multifractal theory, that many potential readers are probably not familiar with, including myself. The presentation of the method is at some points confusing, and it has not become entirely clear to me what makes the multifractal method superior to the more common methods from reading the manuscript. I recommend that the authors could improve the manuscript in a major revision, by a better motivation and explanation of the analysis method, and by some additional analysis. In the following, I separate my comments into major and minor points.

Major points:

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1. Many readers may be unfamiliar with the theory of multifractals, therefore I recommend to make the explanation in the Methods section somewhat more "didactial". I understand that it is only possible to provide a very brief outline of the theory in the paper, but I think it might be possible to present the method in a way that allows readers to grasp the general idea, and make them aware of this new method. The more interested reader can then be drawn to book by Lovejoy and Schertzer. Here are some specific issues:

1a) Eq. (1): What would be L and l in this specific case of station measurements? Why is lambda the density of stations? I thought you apply the method to each station individually, so I would rather expect it is something like the measurement interval?

1b) I don't really understand what "singularity" means in this context. Could you give a simple explanation in your own words, if this is possible in a few sentences? Which values can gamma take?

1c) Eq. (3): Is q an integer defining the order of the moment?

1d) Similar to 1b: Can you give some more explanation what the mulitfractal index

alpha means? For example, what does it mean if alpha<1 versus alpha>1? In Eq. (4) and Eq. (6) it looks like that alpha is written with a "'" ("prime"). Is this a typo?

1e) l. 135: Is the interval space d a parameter? How is it selected?

1f) Eq. (7): Define and explain mu_L, mu_R, s_D.

1g) Eq. (8): Should it be P(tau) instead of P(t) here? Otherwise I don't understand the meaning of this equation.

2. The trend calculation in section 4.3 is certainly an important result of your paper. Therefore, I strongly recommend to perform significant tests for ALL indices shown in Fig. 4, including the mean precipitation. Why did you use significance level p<0.1 for EPI, and p<0.05 for EPS? It would be better to use the same significance level for all indices. It would also be good to mark regions with significant trends in all panels. One possibility would be to mark all stations with positive significant trends with blue dots, all stations with negative significant trends with red dots, and all stations with insignificant trends with black dots.

3. I think the claim that the mutifractional method is superior to the more common analysis methods it is not yet clearly justified. There should be a direct comparison of the non-parametric methods with the multifractal method, especially for the results shown in section 5.2. In Fig. 8, can you add a panel with the EPTs calculated from the multifractal method, and explain the differences to the others? The "standard deviation method" shown in panel 8f comes out of nowhere, please define it. It is not explained anywhere yet. Could you also show the goodness-of-fit numbers for the EP distributions from the multifractal results, and compare them to the non-parametric methods shown in Fig. 9? You could mark them in the panels in Fig. 9, or list them in a table.

Minor points:

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4. Definition of the EP indices (Section 2.3): The abundance of symbols is confusing

here. The EP severity EPS is called EPSI in Table 1, Fig. 3f, and probably other places. Plase use the same acronyms everywhere. It is also confusing that EPI and EPT are called P_I and P_T, respectively, in Eq. (9). Better use EPI and EPT in Eq. (9). In Eq. (11), P_F is not defined. It is the same as EPF, I assume, so you can also better use EPF here.

5. Eq (11): How sensitive are the results for EPS to the choice of k1 and k2? (See Fig. 3f, Fig. 4e)

6. l. 84/85: "For precipitation, a scaling break ... roughly two weeks." What does this sentence mean? Could you be more precise?

7. The index EP as shown in Fig. 4b is not given in Table 1. Or do you mean MEP here?

8. l. 236: "... the annual EPF changed by -0.6 to +0.5 days,..." Where are these numbers from? They are not given in the figure. Is this the totlt trend for the whole time series?

9. l. 273: "According to the average sea level pressure and winds at the 1000 hpa level..." This does not seem to make sense. Either you can give the air pressure at a given height level, or the geopotential height at a given pressure level.

10. l. 334/335: "It can be seen... lower percentiles". This seems trivial. Either remove this sentence, or write something like: "Trivially, thresholds are smaller...."

11. Figs. 3 and 4: Why are there different station names shown in different panels? For example, the Xiji station is mentioned in connection with panel 4e, but it is not shown in this panel. So one has to find it in one of the other panels.

12. The tropical cyclone situation shown in Fig. 6c and 6d: Do these maps show mean fields for the whole day, or an instantaneous situation?

Small corrections:

l. 19: "scarce" (instead of "scare")

l. 167: "1" should be subscript in "k1".

l. 193: There is no Fig. 2b

l. 194: Link is not accessible to me.

l. 255: "... and EPS had a negative *trend in* annual..." and in the following line "... LP area with negative *trend in* annual..."

l. 332: "...parametric and non-parametric..."

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