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Hydrology and Earth System Sciences
Discussions

Interactive comment on "Convective suppression before and during the United States Northern Great Plains Flash Drought of 2017" *by* Tobias Gerken et al.

Tobias Gerken et al.

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1 Response to reviewer 2

1.1 General Comments:

This work demonstrates the relevance of convective inhibition and convection suppression for rapid drought intensification in the NGP region. This work is particularly relevant given the heightened awareness of flash drought and the knowledge gap in our understanding of its drivers. Overall the analysis, writing, and presentation are of

high quality. Therefore I recommend acceptance of this manuscript for publication after consideration of the following (minor) suggestions.

We thank the reviewer for their work and the supportive comments. Please find below answers and changes to the text made in response to their thoughtful suggestions.

1.2 Specific Comments:

1) Because of the importance of high quality ETp estimates to the manuscript results, it would be nice to get an understanding of any error or bias in the Rn estimates (based on daily temperature range). The Bismarck airport ASOS station does have solar radiation observations - as part of the National Solar Radiation Database (http://rredc.nrel.gov/solar/old_data/nsrdb/) - spanning 1961 to 2010. These direct observations can be used to get an idea for error or bias in your Rn estimates, and perhaps even some analysis of how these errors propagate when computing ETp.

Thank you for pointing out this interesting dataset. Because our research in flash droughts and the NGP drought is ongoing, we are thankful for any additional data sources. The analysis demonstrated that ET_p from the well-established FAO framework was not anomalously high or low before the NGP flash drought and would not have provided skill in forecasting the drought. This does not mean that it may not provide inference for future flash droughts, and we will consider this database for future studies.

2) Figure 5: I like the comparison of 2017 ETp to the climatology at each station; however, the daily ETp line is quite noisy, and it makes it difficult to see the 2017 absolute deviation from "normal". Could you perhaps show cumulative ETp over the course of the year instead? I think this would provide more insight as to how much larger evaporative demand was in 2017.

During preparation of the manuscript we discussed whether to include ET_p sums or daily values and decided on the former, since daily ET_p is small compared to the total

annual sum. Consequently, changes on monthly scales are not readily seen. We have already included the annual sum figure in the supplement to this manuscript (Fig. S4). We have now made the reference to the supplement more explicit in the text.

3) It is mentioned in multiple places throughout the manuscript that convective inhibition or convection suppression is important for flash drought monitoring or can be useful for drought early warning. This is supported by the results of this manuscript;however, these statements come with the significant caveat of a sample size of 1 (2 if you count the related Myoung and N-G studies). Any broader conclusions regarding the importance of convection suppression for rapidly intensifying drought cannot be made without more analysis of historical drought events. I don't think that this analysis is necessary for this manuscript, but any inference of the ability of convective inhibition (or HIlow) to improve flash drought forecasts based on this work should be made with this caveat in mind. I would like to see this limitation mentioned explicitly in either the discussion or conclusions section (preferably both).

Thank you for noting this, we were careful to avoid general statements regarding all droughts in the text. In response to this comment, we added to the discussion: "However, our findings are derived from a single flash drought event. To generalize our findings and to potentially establish effective metrics to estimate flash drought onset, the historic record of flash droughts should be investigated to detect similar clues."
For the conclusion we modified the sentence in question to: "Integrating information about convective inhibition into drought monitoring and drought early warning systems might be advisable based on this study. A critical course of future research and to generalize our findings beyond a single case is to compare the conditions that precede flash droughts using multiple metrics in order to provide the best possible inference for drought forecasts in the U.S. and across the globe.

1.3 Technical Comments:

1) Page 2, line 3: I think you should replace "consequences" here with "impacts"

Thank you for pointing this out, we took the recommendation.

2) Page 3, line 4: add "land-atmosphere" in front of coupling

Added, thank you.

3) Page 3, equation 1: although not as important here as HIlow, it would be nice to include the CTP equation as well.

Thank you for the comment. Interestingly, we are not aware of a paper that has included the equation for CTP. The equation and explanation were added: '

$$\mathrm{CTP} = \int_{100\,\mathrm{hPa}}^{300\mathrm{hPa}} R_d\ (T_{v,sp} - T_{v,e})\ \mathrm{d}\ln p \tag{1}$$

with $T_{v,sp}$ and $T_{v,e}$ as virtual temperatures of a saturated air parcel and the environment, the specific gas constant for dry air (R_d, and pressure (p).'

4) Page 4, line 8: do you mean "Table 1" instead of "Tab 1"?

Thank you. To avoid confusion, we now use "Fig." and "Tab." as abbreviations throughout the text.

5) Page 4, line 10: I think you can delete "for data" here

Deleted, thank you for the suggestion.

6) Page 5, line 7: perhaps "boundary layer perspective" would be more precise than "atmospheric perspective"?

We added 'boundary-layer' to the text, leaving 'atmospheric' in as well since strictly speaking convection goes beyond the ABL.

7) Page 8, line 1: replace "tall" with "deep"

We changed the text, thank you for the suggestion.

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