

## ***Interactive comment on “Adverse Effects of Increasing Drought on Air Quality via Natural Processes” by Yuxuan Wang et al.***

### **Anonymous Referee #1**

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This study addresses the effects of drought on air quality in the United States through statistical analysis of historical observations at surface monitoring sites and two drought indices, the Standardized Precipitation Evaporation Index (SPEI) and the Palmer Drought Severity Index (PDSI). It also examines the ability of several current climate-chemistry models to simulate observed responses of ozone and fine particulate matter under drought conditions as identified by model-derived SPEIs. Future model projections of SPEI and air quality are examined as well. The relationship of drought and air quality is a timely, highly relevant topic, appropriate for the readership of Atmospheric Chemistry and Physics.

Overall, the manuscript is generally well-written with only a few minor typographical or grammatical areas. There are several technical questions/comments that should be addressed prior to reconsideration for publication:

(1) Have many previous studies examined relationships between drought indices and observed air quality? Previous studies should be identified and to the extent possible discussed in the context of this work. See for example, Tian et al. doi: 10.1002/ehs2.1203.

(2) Many drought indices exist now and the number will likely further evolve in the future. Are there indices that are particularly relevant for examining the relationship between drought and air quality, and if so why?

(3) Is there evidence in the historical data that the timing of the onset of drought influences air quality (e.g., late spring vs. early summer vs. late summer)? Is there evidence that prolonged drought more strongly influences air quality over time?

(4) More explanation as to how model-derived SPEIs were calculated (e.g. what method in the R package was used to determine PET?) and their performance relative to the global SPEI dataset and to each other would be beneficial. Model-derived SPEIs are important to establishing predicted air quality during drought versus non-drought conditions and evaluating model deficiencies relative to observed responses in this work.

(5) It is acknowledged in the manuscript that the ACCMIP models vary widely in their predicted responses of air quality to drought. More explanation is needed regarding differences in the configuration and input data resources that could contribute to differences in their performance. A key outcome of this study should be to recommend specific paths forward for research that could lead to improvements in chemistry-climate model performance.

(6) Table 1, Fig. 2, Table S2 etc suggest that there are regional differences in contributions to drought effects to air quality, but the discussion is too limited in this regard. Are there opportunities to better understand model performance via examining regional responses?

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Minor corrections: First paragraph, introduction: Line 2: "matters" should be matter; Line 4: missing "the" at the of the line; Line 10: missing noun after "recurring", Line 11: missing "the" before "atmosphere". Page 6, Line 2: "primarily resulted from" should be "primarily result from"

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