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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Spatial features of rain frequency change induced by pollution and associated aerosols" *by* Yanfen Lin et al.

Anonymous Referee #1

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Review of 'Spatial features of rain frequency change induced by pollution and associated aerosols' by Lin et al.

Suggestion: Major revisions

Summary:

This paper examines the spatial distribution of trends in NO2, aerosol, and precipitation from satellite data over China and nearby areas. This is an important region within which to examine relationships between pollution and precipitation due to the rapid industrialization of the region causing noticeable changes in the aerosol burden and the large human population, which could be affected by changing precipitation patterns. The authors conclude that pollution aerosol has an inverse relationship with the

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precipitation occurrence.

My primary concern with the manuscript is that the conclusions reached by the authors, while plausible, are not supported quantitatively by the data. The analysis method employed by the authors is cursory and a more appropriate analysis is offered in the specific comments provided below. A secondary major concern is that the abstract implies causal relationships that are unsupported by the data. A final major concern is that some of the data are not properly referenced and described.

Major Comments:

1. Page 14499, Lines 22-26: What is the correlation? Is it statistically significant? Can you quantify the spatio-temporal discontinuity? Where is the rain gauge data coming from? All we know is that it is near Shanghai. This is not a reproducible or transparent result. Finally, A table of where the other sites are located and associated correlations and significance tests should be provided for the other sites from which similar conclusions can be drawn. At the very least some references and summary statistics need to be provided (i.e. how many sites were used and what percentage show significant trends that agree with the PR).

2. Page 14501, Line 23: 'In general, the significant decrease trends in precipitation frequency were detected at the industrial areas with rapid economic growth'. This statement is inconsistent with the large area in box #3 (India-Myanmar) highlighted in Figure 2 where there seems to be no change in pollution but a significant reduction in rainfall.

3. Page 14502, Line 5: What is the spatial correlation? This is a major conclusion of the paper. Therefore, quantification of the results supporting the conclusion needs to be given.

4. Page 14502, Line 5: Following from the previous comment, a more appropriate analysis would correlate the time series of NO2 and aerosol with the time series of pre-

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cipitation occurrence within each grid box. This analysis would make a much stronger case that the trends in aerosol and precipitation are related to each other.

5. The data and analysis method used are insufficient to reach a conclusion of causality. The authors need to be particularly mindful of this in the abstract (here causality is implied) and in the conclusions. Two specific concerns that need to be mentioned in the conclusions are given here. First, the seasonal mean data can be used to support the case for aerosol effects on cloud and precipitation. However, the processes in question occur on time scales of minutes and cannot be causally related through seasonal mean data. Do the relationships purported to be shown here by the authors exist on shorter time scales? Second, Aerosol indirect effects on precipitation follow a chain of events. An assertion of causality must address each of these events. It is insufficient to jump directly from aerosol to precipitation and assert causality. Take for example the 'second indirect effect' through which aerosol modify cloud microphysics which then affects coalescence processes which then effects the occurrence of precipitation. There is a potentially observable hypothesized effect on clouds that is unexamined by the authors. The 'semi-direct effect' hypothesizes cloud effects as well. In an area as contentious as aerosol-precipitation interactions it is best to exercise caution in asserting causality.

Minor Comments:

1. Throughout the manuscript the words increase and decrease are used incorrectly. In many but not all places they should be changed to increasing and decreasing.

6. Page 14496, Line 12: 'Besides the greenhouse gases-induced global warming, anthropogenic aerosols increase concentrations of cloud condensation nuclei (CCN) and ice-forming 15 nuclei (IN), which alter the main path of precipitation-forming microphysical processes and the precipitation amount (e.g., Cotton and Pielke, 1995; Lohmann et al., 2005; Rosenfeld et al., 2008).' This sentence is grammatically incorrect. Furthermore, it contains two unrelated thoughts.

7. Page 14496, Lines 15-20: I am troubled by the sentence 'The response of the

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hydrological cycle to the aerosol indirect effect is different to the greenhouse effect, and the hydrological cycle is expected to be weakened due to aerosol effects (Ramanathan et al., 2001; IPCC, 2007)'.

The authors might want to mention that the hydrologic cycle (global mean rain rate) is expected to increase due to greenhouse warming by 2-3%/K (Held and Soden: 2006, Stephens and Ellis, 2008)

They mention the 'aerosol indirect effect', which I presume to mean a change in cloud albedo with variation in CCN concentration for a fixed liquid water path. They then proceed to mention aerosol effects on the hydrologic cycle in the same sentence and reference a paper (Ramanathan et al. 2001) that primarily addresses aborbing aerosols and regional precipitation changes. The authors need to be specific in what they are referring to (i.e. global or regional changes to precipitation and through which mechanisms)

8. Page 14496, Lines 19: I believe that location should be changed to source.

Interactive comment on Atmos. Chem. Phys. Discuss., 10, 14495, 2010.