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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Synoptic meteorological modes of variability for fine particulate matter ($PM_{2.5}$) air quality in major metropolitan regions of China" *by* Danny M. Leung et al.

Anonymous Referee #1

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Leung et al. present a detailed study of meteorological drivers of present day PM2.5 seasonal and inter-annual variability in China. The authors leverage multiple data sets and sources including: meteorological reanalysis, observed PM2.5, satellite-derived PM2.5, and the CMIP5 ensemble of models. Their analysis examines the relationship between PM2.5 and meteorology in several regions of China. PM2.5-meteorology relationships derived from present day conditions are used to project how future climate may affect PM2.5.

Major comments:

1. The need for different data sets is explained (surface observed PM2.5 is limited in

terms of how long it has been collected, satellite PM2.5 is available for a longer time period, but only on an annual average basis, etc), but it's not clear to what degree using the different data sets leads to the same or differing conclusions. For example, how well do the meteorological principle components explain surface PM2.5 (if annually aggregated) vs satellite PM2.5?

2. Can the ability to project the effects of future conditions be strengthened? The r-squared of the PM2.5-meteorological model is 0.31 indicating it explains 31% of the interannual variability in PM2.5. The factor explaining the most variability is the Siberian High followed by RH. Could the r-squared be meaningfully increased by using all available meteorological variables? While the authors point out that meteorological variables co-vary, does that matter when trying to determine changes over a period of decades?

General comments:

1. Page 4, line 21: How were the relevant meteorological variables determined? Was there data on other variables that was not used or was this all that was available?

2. Can you clarify the relationship between the meteorological drivers and PM2.5 and whether information about one influences the determination of the other. Specifically:

2a. Near page 8: Meteorological principle components are determined without information on PM2.5 and then a regression is performed to determine how the meteorological PCs are related to PM2.5. Did the authors consider performing the principle component analysis with PM2.5 information (such as using PM2.5 as a variable in the PCA)?

2b. Near page 10: Can you comment on whether the synoptic modes represent purely meteorological features vs. any emission driven influences? For example, is there a mode that might cause increased emissions due to cold temperatures and increased home heating requirements thus increasing PM2.5 for reasons not driven by meteorol-

ogy?

3. Page 13, line 10: Returning to your earlier objective regarding separating synoptic features vs individual meteorological drivers, what remaining variability can be explained by meteorological variables that are not related to synoptic patterns?

4. Figure 2: Explain more how correlation with wind direction was determined. There were separate indicators for east/west and north/south (X7, X8) but panel (g) indicates one metric for direction.

Technical corrections:

1. Page 4, line 27: Add equation for deseasonalization and normalization.

2. Page 6, line 1, is subscript "k" needed on x bar?

3. Page 12, line 6: Figure 8a seems to have more than 3 models with negative changes in frequency in contrast to the text.

4. Page 12, line 19: What baseline PM2.5 values are the changes referenced to?

5. Figure 4: color bar indicates mm/day, not temperature.

6. Table 2: indicate observed PM2.5 or satellite-derived PM2.5.

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