

## ***Interactive comment on “Meteorological modes of variability for fine particulate matter (PM<sub>2.5</sub>) air quality in the United States: implications for PM<sub>2.5</sub> sensitivity to climate change” by A. P. K. Tai et al.***

### **Anonymous Referee #2**

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This manuscript applied a multiple linear regression model and PCA analysis to understand the relationship of PM<sub>2.5</sub> with various meteorological fields in the United States and further used these relationships to infer the sensitivity of PM<sub>2.5</sub> to climate change. The analytic methods utilized by the authors are relatively new in the field of atmospheric chemistry, and hence provided a lot of quantitative and new results. This paper is well written. It would be of interests to the readers of ACP and contributes to the literature in atmospheric chemistry study. I think it should be suitable to be published on ACP.

However, there are a few things I would like to see more detailed discussion in the

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paper.

The authors attempted to establish connections between meteorological modes and PM<sub>2.5</sub> air quality. To do that, they first identified the modes for various regions in the US. I would like to know, for example, how much each of the identified modes explains the total variability in meteorology over that region. The authors showed in Section 4.1 “The PCs are ranked by their variance, usually with the leading two or three PCs capturing most of the meteorological variability”. Can the authors show how much their “mode of cold front” explains the meteorological variability in their NE, MW and SE US regions? As the model is driven by reanalysis or GCM, it should show the same modes with similar meteorological variability explained, is that right?

Then, the authors showed dominant meteorological modes of PM<sub>2.5</sub> variability. Over MW US, they identified the mode as “eastward propagating mid-latitude cyclone with precipitating cold front at the southwest tail end”. It is not very clear to me how they can determine this mode. They showed in Figure 6 that the mode occurs with “low temperature, high precipitation, low and rising pressure, and strong northwesterly winds”. Are these criteria enough to define “eastward propagating mid-latitude cyclone with precipitating cold front at the southwest tail end”? They also showed two weather maps as examples of “stagnation” and “frontal passage”. Are these also used as a way to define this mode as “eastward propagating mid-latitude cyclone with precipitating cold front at the southwest tail end”? Did the authors also check the weather maps on many other days?

The authors show the case on Jan 28 and Jan 30, both are nice examples. I am also curious about some disagreements from the top of Figure 6, i.e. Jan 13, Jan 15? What happened on those days?

In addition, I wonder if the authors have done this analysis: let’s focus on the mid-west US, the author already have a time series of daily PM<sub>2.5</sub> (detrend and deseasonalized). If they do a correlation/regression study of this MW PM<sub>2.5</sub> time series ( $Y_t$ ,  $t$  represent

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each date) with their meteorological field (i.e.,  $SLPi_{i,j,t}$  or  $HGHTi_{i,j,t}$ ) on each U.S. model grid ( $i,j$ ), and map the correlation coefficient ( $Ri_{i,j}$ ) over each grid. If PM<sub>2.5</sub> is strongly associated with low pressure system and cyclone passages, would we see a center of strong correlation somewhere on the map of  $Ri_{i,j}$ ?

Specific comments: Pg 31044, line 5-9: I agree with Anonymous referee #1, more figures and detailed explanations are needed here. Can the authors explain how they define high  $|\alpha_{kj}|$  values? And how they obtain 70% of the observed PM<sub>2.5</sub> components with temperature? Also, Line 9-11, how do they obtain 60% for the SE US?

Pg 31043, line 12-14, “From synoptic weather maps, we can verify that high positive values of this PC represent the center of an eastward propagating mid-latitude cyclone with a precipitating cold front at the southwest tail end. “. I would like to see more explanation here. How many weather maps are examined? How exactly do the authors verify this mode? By any quantitative methods or just visually chosen?

Pg 31044, Pg 31045: so far, section 5 focuses solely on the cyclone frequency change under climate change. However, climate change may have effects on weather at different temporal scales: climate shifts (a general increase in humidity and temperature), interannual scales (NAO, ENSO), seasonal scales and so on. Discussion on climate change effect on PM<sub>2.5</sub> should be much complicated than just considering cyclone frequency.

Minor comments: Pg 31033, line 6-8: a potential reference to cite here: Rasmussen, D J., Arlene M Fiore, V Naik, Larry W Horowitz, S J McGinnis, and M G Schultz, February 2012: Surface ozone-temperature relationships in the eastern US: A monthly climatology for evaluating chemistry-climate models. Atmospheric Environment, 47, doi:10.1016/j.atmosenv.2011.11.021

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