

## ***Interactive comment on “Spatiotemporal variability of NO<sub>2</sub> and PM<sub>2.5</sub> over Eastern China: observational and model analyses with a novel statistical method” by Mengyao Liu et al.***

### **Anonymous Referee #1**

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This paper analyzes spatial and temporal variability in Fall-Winter 2013 of PM<sub>2.5</sub> and NO<sub>2</sub> in Eastern China in observations, GEOS-Chem, and CMAQ. The authors have done a good job of distilling a lot of complex information in a clear format. The EOF-EEMD method seems novel and is interesting. I recommend acceptance after the following issues are addressed.

The most substantial issue is the choice to exclude SOA from the GEOS-Chem model simulations. This is a huge caveat that strongly impacts the interpretation of any of the GEOS-Chem results and conclusions. The authors correctly point out that more than 20% of the PM<sub>2.5</sub> in Eastern China could be from SOA. The reason given for not

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including SOA is that the mechanism underestimates aerosol formation, but then the main conclusion about GEOS-Chem is that it severely underpredicts PM<sub>2.5</sub> in Eastern China anyway, so this is circular reasoning. Even a simple SOA scheme would be better than nothing. I recommend that the authors add some discussion about how the lack of SOA may impact their evaluation of GEOS-Chem, beyond just the bias in the seasonal mean. How does the lack of SOA impact the day-to-day and diurnal model-observation comparison? Since it is stated that CMAQ includes SOA, perhaps you can draw conclusions about the impact of SOA from CMAQ.

(By the way, it is stated in the manuscript that GEOS-Chem "does not include" SOA, but the more accurate statement would be something like "these simulations of GEOS-Chem do not include SOA", since the capability is there in the model in general.)

Minor comments: Line 33-34. Mention what time averaging frame these biases refer to (I assume Fall-Winter seasonal average)

Line 39 and several other places in the manuscript: change "anthropogenic dusts" to "anthropogenic dust". Also there was a mention of "sea salts" which should be changed to "sea salt". These are typically already plural without the added "s".

Line 50. "Downwind" is probably more appropriate than "downstream" since we're talking about air pollution here.

Line 81. PM<sub>2.5</sub> is called "the dominant pollutant". In terms of what? Emissions, mass, human health burden? Specify and cite.

Line 86. Reference Wu et al. is written in all capital letters. Same in the reference list. Please fix.

Line 93. I don't know what the "M" in "MEEMD" is. Thus far, I think you've only defined the acronym "EEMD"

Line 277. "while noise" should be "white noise"

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Section 3.1 and Figure 5. There is a units issue here. The text says microgram per cubic meter, but Figure 6 is labeled as microgram per cubic centimeter. Surely that must be an error. Please check all units.

Section 3.2. Why are only RH, wind, and temperature chosen for meteorological parameters? Was this the only data available. Justify the choice.

Line 545: "...both models simulate the observed EOF1 and EOF2 patterns fairly well". This is vague. "Fairly well" is a value judgement; please quantify.

Figure 9 and throughout: Label your plot axes.

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