

# ***Interactive comment on “Exploring the relationship between surface PM<sub>2.5</sub> and meteorology in Northern India” by Jordan L. Schnell et al.***

## **Anonymous Referee #1**

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### General comments

The authors applied the NOAA GFDL-AM4 model to simulate air quality over India for 20 years. They used a coarse horizontal resolution and two different emissions estimates (CMIP5 and CMIP6) in the model. They compared model predictions with observed PM<sub>25</sub> in India for six winter months and performed detailed analysis. Model with CMIP5 substantially underestimated PM<sub>25</sub> compared to observed data in Northern India. While the model with CMIP6 improved the predictions, it still underestimated PM<sub>25</sub>. Most monitoring stations in India are located in urban areas. The model with a coarse horizontal resolution is not suitable for examining PM<sub>25</sub> in urban areas in India.

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Discussion paper



As such model under-prediction is expected. Finer scale resolution is needed. Several other issues need to be addressed.

### Specific comments

Line 199-200 Reference is needed for the heterogeneous uptake coefficients used in the model.

Line 204-206 Several acronyms have already been defined before and are defined here and later. No need to define the acronyms multiple times.

Line 215-216 Dust1, dust2, ssalt1, ssalt2, ssalt3 are not defined in the article?

Line 261-266 and Figure 1 It is not clear if NO or NO<sub>2</sub> emissions are shown in Figure 1. “NO” is used in one sentence but “NO<sub>2</sub>” is used in the other sentence. Need clarification. How NO<sub>x</sub> emissions are being speciated into NO and NO<sub>2</sub> emissions?

Figure 2 Title of Figure 2 indicates “CMIP5-dry”. However, legend shows “AM4-CMIP5 (wet)”. Need clarification.

Figure 3 Observed data are taken from Kanpur site which is not clearly indicated in the Figure title.

Line 325-340 The model over-predicts aerosol nitrate substantially which may result from many factors including the use of high heterogeneous uptake coefficient for N<sub>2</sub>O<sub>5</sub> (Table S1). Recent studies (Davis et al., 2008; Reimer et al., 2009; Brown et al., 2009; Phillips et al., 2016; Chang et al., 2016) suggest a much lower value for the heterogeneous uptake coefficient. A discussion of the impact of high heterogeneous uptake coefficient for N<sub>2</sub>O<sub>5</sub> on model results is relevant.

Davis et al., 2008: Parameterization of N<sub>2</sub>O<sub>5</sub> reaction probabilities on the surface of particles containing ammonium, sulfate, and nitrate, Atmos. Chem. Phys., 8, 5295–5311.

Rierner et al., 2009: The relative importance of organic coatings for the heterogeneous

hydrolysis of N<sub>2</sub>O<sub>5</sub>, JGR, 114.

Brown et al., 2009: Reactive uptake coefficients for N<sub>2</sub>O<sub>5</sub> determined from aircraft measurements during the Second Texas Air Quality Study: Comparison to current model parameterizations, JGR, 114.

Phillips et al., 2016: Estimating N<sub>2</sub>O<sub>5</sub> uptake coefficients using ambient measurements of NO<sub>3</sub>, N<sub>2</sub>O<sub>5</sub>, ClNO<sub>2</sub> and particle-phase nitrate, ACP, 16, 13231–13249.

Chang et al., 2016: Evaluating N<sub>2</sub>O<sub>5</sub> heterogeneous hydrolysis parameterizations for CalNex 2010, JGR: Atmosphere, 121, 5051–5070.

Line 443-444 The sentence suggests that annual cycle is shown in the Figure. However, it shows data for 6 months, not for the year.

Line 449-450 The sentence suggests model is biased high in RH. However, Figure 6b shows under-prediction of RH compared to observed data. Need clarification.

Line 492-497 Ram and Sarin (2011) analyzed measurement data and reported that nighttime aerosol nitrate level is five times greater than the day-time nitrate level. In contrast, this modeling study finds that aerosol nitrate peaks during mid-day. Despite the use of high uptake coefficient for N<sub>2</sub>O<sub>5</sub>, it finds that aerosol nitrate peaks during the day which reveals that HNO<sub>3</sub> produced from the reaction of NO<sub>2</sub> + OH likely dominates the production of aerosol nitrate. What caused the results to be completely opposite to that of Ram and Sarin (2011)?

Figure S7 Title is not clear. Figure d-f are missing.

Figure S8 Title refers to Figure 4 which should probably be Figure 5.

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