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Supplement of

Radiative and thermodynamic responses to aerosol extinction profiles during the pre-monsoon month over South Asia

Y. Feng et al.

Correspondence to: Y. Feng (yfeng@anl.gov)

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Supplement

1. Contributions by individual aerosol species to aerosol optical depth (AOD) and burdens

In the WRF-Chem model used in the study, AOD is calculated with internal mixing assumption. In order to attribute the AOD underestimation to major aerosol types, the species-specific aerosol burdens are plotted as a proxy for understanding the contribution to the AOD by individual aerosol species. Fig. S1 shows the aerosol burdens calculated for March 2012. Dust is the dominating species over northwestern India semi-arid regions and the adjacent Arabian Sea, and the main contributor to the underestimation of AOD over these regions. In contrast, anthropogenic sulfate, OC, and BC contribute to the main composition of aerosols (thus AOD) in northern and northeastern India, as well as in the long-distance transported aerosols over the downwind of southwestern Indian sub-continent.

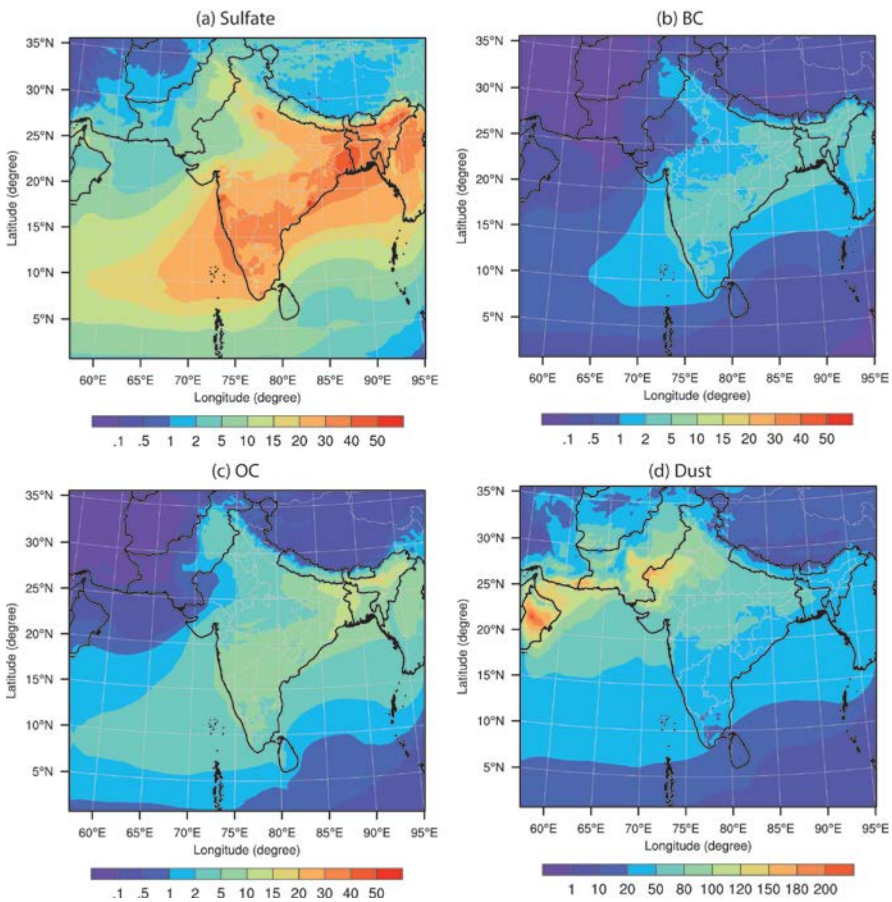

Figure S1. Calculated aerosol burdens (mg/m^2) of (a) Sulfate, (b) BC, (c) OC, and (d) Dust for March 2012

2. Time-averaged AOD comparison with the MODIS observations for the time period of August 2011 to March 2012

The AOD comparison between August 2011 and March 2012 is shown below in Fig. S2. It shows underestimation in the model-calculated AOD similar to that for March 2012. Resolving these mismatches between simulated and observed AOD requires development of a verification database extending from field campaigns, ground-based and aircraft measurements for evaluation of model simulated boundary layer dynamics and aerosol concentrations and chemical composition. It then can lead to possible upgrades of model physics schemes and quantification of key parameters. This is considered beyond the scope of this paper and certainly deserves further investigation.

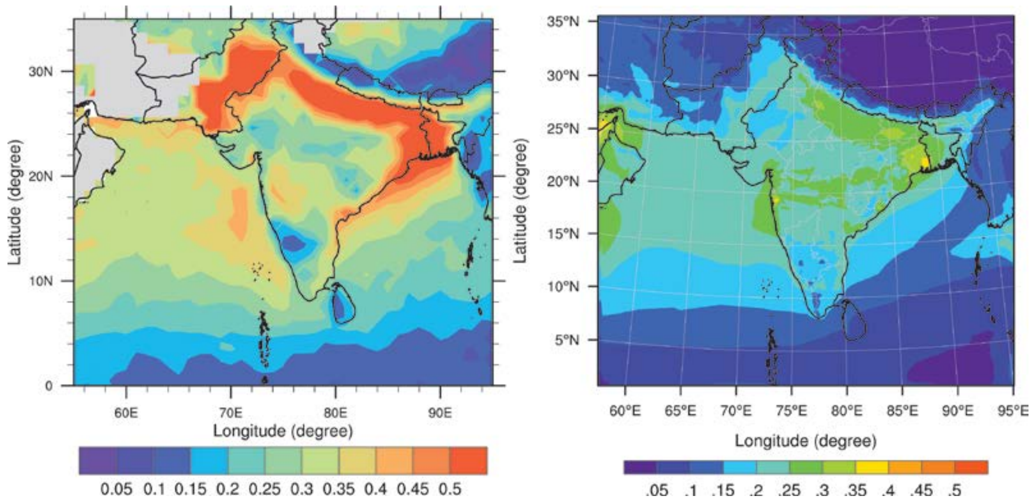

Figure S2. Time averaged AOD between Aug 2011 and March 2012 from (left) MODIS/Terra, and (right) WRF-Chem simulations

3. Significance of differences in the aerosol extinction profiles between model and observations

Figure S3 below shows the calculated monthly mean and standard deviation of modeled and observed daily aerosol extinction profiles for Nainital, Kanpur, and South Asia, respectively. Since there are only 3 and 4 CALIPSO tracks with valid retrievals over Nainital and Kanpur in March 2012 (as given in Table 2; numbers in parentheses), the ground-based MPL profiles are shown for those two ground sites instead of CALIPSO retrievals and used in the two sample t-test discussed below. This figure shows that the model means ± standard deviations are less than the observed means below 2.5km for all three locations.

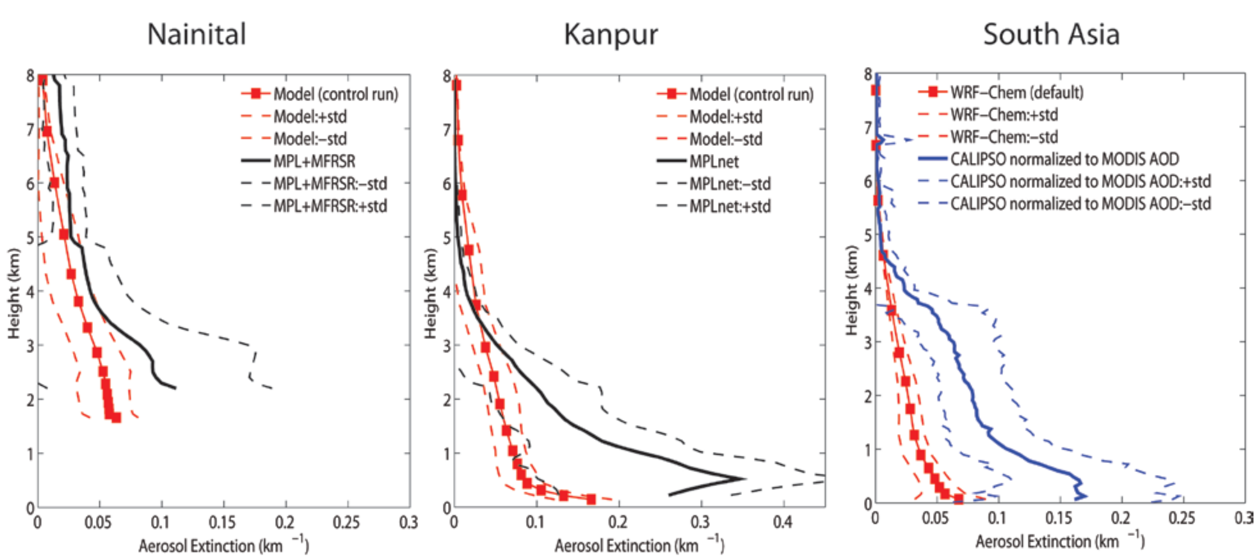

Figure S3. Monthly mean and mean ±standard deviation of modeled and observed daily aerosol extinction profiles for Nainital, Kanpur, and South Asia, respectively

Moreover, the p-values are calculated in the two-sample t-test of daily time series of aerosol extinction for a selection of altitudes and listed in the table below for each of the three locations. Below 2.5km, the model and observed extinctions are statistically different with p-values less than 0.05.

Nainital Z(km)	2.3	2.5	2.9	3.3	3.8	4.3	5
P value	0.009	0.0489	0.112	0.128	0.188	0.115	0.207

Kanpur Z(km)	0.2	0.6	1.4	2.4	3.	3.7	4.8
P value	8e-8	1e09	1.9e-7	0.004	0.10	0.31	0.005

South Asia Z(km)	0.2	0.7	1.3	2.3	2.8	3.6	4.6
P value	0.	0.	0.	0.	0.	0.	0.06