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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Improving regional air quality predictions in the Indo-Gangetic Plain-Case study of an intensive pollution episode in November 2017" *by* Behrooz Roozitalab et al.

Anonymous Referee #2

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General summary

This study investigates the processes causing severe air pollution episodes in New Delhi, India by focusing on one such event observed during November 2017. Specifically, the authors evaluate the impact of biomass burning emissions, long-range transport of dust, and dust emissions on WRF-Chem simulated PM2.5. The model captured the day to day variability but missed the peak pollution peak during 7-10 Nov. Secondary Inorganic Aerosols and Secondary Organic Aerosols are estimated to contribute 30% and 27% of total PM2.5 concentrations in Delhi. Back trajectories showed influence of agricultural fires in Punjab on PM2.5 in Delhi. Long-range transport of dust

is not found to affect air quality in Delhi during this time. High biases in model AOD were observed over central India and low biases over the eastern IGP.

While such studies are very important as they provide important information about the sources leading to dangerous air pollution episodes and inform the mitigation strategies, unfortunately this study does not consider all the key sources of uncertainties in the model simulations and may misinform the mitigation strategies. I am particularly concerned about the ignorance of anthropogenic emission uncertainties that were left out irrespective of several evidences pointing to their key role in the analysis presented in the paper itself. The authors should also provide a clear description of the rationale behind selecting biomass burning and dust aerosols as the most important sources of uncertainties in the model simulations. Below I provide my major and minor comments.

Major comments:

Figure 3 shows that increasing the fire emissions by a factor of 7 is too high and leads to large overestimation of AOD especially in the western part of the domain. Large underestimation in the IGP is reflecting the underestimation of anthropogenic emissions but no sensitivity experiment was designed to look into that. So, the "base" configuration might be showing good performance in Delhi for wrong reasons. Fig. 4a shows an AOD of 4 which is unrealistic for Jaipur. It looks like the authors paid all the attention to getting PM2.5 in Delhi correct simply by upscaling the emissions in the upwind regions but no care was taken to maintain the model performance in the upwind regions. Consequently, the model shows a positive bias in PM2.5 in Punjab with a spatial variability (reflected by standard deviation in Table 3) that is nearly 3.5 times higher than the observed variability in Punjab. Nov. 24 case (no fire day) also supports the idea that the anthropogenic emissions are substantially underestimated. Figure S3 shows that PM2.5 concentrations in Punjab were lower than those in Haryana and increasing the fire emissions by a factor of 7 introduced large uncertainties in model simulations as the model PM2.5 in Punjab became nearly a factor of 4 higher than the observations. If crop residue burning was the major source of this air pollution episode, one must see the highest observed concentrations in Punjab followed by Haryana and Delhi. Such a pattern exists in the model but not in the observations reflecting that the increasing fire emissions by a factor of 7 is not a reasonable choice. The authors have used back air trajectory to corroborate their assumption that crop residue burning is the major source but backward trajectories only show that the air masses passed over the fire region before arriving at Delhi and are possibly influenced by the fire emissions but they do not tell that agricultural fires are the main source of PM2.5 during this episode. Backward trajectory analysis in Figure 7 also shows that PM2.5 during the pollution episode was driven by a combination of both the anthropogenic and fire emissions. Thus, this approach presents the danger of attributing missing anthropogenic sources to fire sources and may misinform the mitigation strategies if used for that purpose. Therefore, I recommend the authors to include additional sensitivity simulations exploring the role of anthropogenic emission uncertainties.

Fig 4 and related discussion: In addition to the AOD, could you please evaluate the Angstrom exponent to examine if there any differences in the abundance of fine and coarse mode particles and if the model was able to capture those variations. Can you also plot VIIRS AOD in Figure 4 to see if the satellite observed an AOD of 4 in Jaipur?

Fig 5/Table 3: Could you please add a few panels in Figure 5 showing the evaluation against the CPCB data?

Line 301: I think the model observation comparison for the non-episode periods looks good because of the scale of Figure 5a. A zoom into the figure 5a shows that on several occasions, the model showed a bias of up to 100 ug/m3 even in the non-episode period.

Line 308: Are you referring to the model biases relative to MERRA-2 here? If yes, is it reasonable to do so given large biases in MERRA-2 simulated PM2.5 itself as shown in Figure 5a?

Line 368-369: Why do you attribute this error only to transport and not to uncertainties in anthropogenic emissions or other physical processes in the model.

Figure 8: Could you please add PBL height to these panels to help understand whether the smoke was injected in the free troposphere.

Minor comments:

Line 100: Replace ‘*’ with the ‘x’ and also elsewhere in the paper where you describe the resolution.

Line 194-195: Have you applied any filtering criteria to the CPCB data?

Equation (1): I assume this equation is used to calculate MERRA-2 PM2.5 and not WRF-Chem.

Line 288-289: But the underestimation could also be because of the underestimation of emissions from Delhi.

Line 322-333: This is not true as EDGAR-HTAP provides monthly varying emissions with higher emissions in winter.

Figure 6: It would be useful to mark period 1 and period 2 in the figure.

Line 365: Change “lower” to “smaller”.

Line 567: change “intensify” to “accuracy”.

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