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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Amplification of South Asian haze by water vapour-aerosol interactions" *by* Vijayakumar Sivadasan Nair et al.

Anonymous Referee #1

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This paper assesses the contribution of the hygroscopic growth of aerosols to the total AOD and demonstrate that the increased surface cooling due to the hygroscopic effects of aerosols further increases the humidity in the boundary layer and thus enhances the confinement of pollutants through aerosol-boundary layer interactions. This study is a timely contribution to our growing understanding of the chemistry-weather interactions. The paper is well written and easy to follow. However, the paper lacks a comprehensive evaluation exercise necessary to allow the readers lend confidence in the scientific findings presented here. My major and minor concerns are listed below.

Major comment: Specifically, a qualitative model evaluation is not enough considering the importance of this topic. While I understand that chemical composition measurements are limited over India but the lead author is a part of the Aerosol Radiative

Forcing over India (ARFI) project which has done an excellent job in collecting hourly AOD and black carbon at more than 30 sites in India since early 2000s. I will suggest comparing model AOD and BC from the "Dry" and "Ambient" experiments with daily (hourly if possible) measurements of AOD and BC performed at the ARFI sites (similar to Fig. 3 for the AERONET sites). This evaluation will highlight where and when the hygroscopic properties play the most important role in the Indian context. In addition, the authors should also evaluate the model performance against available CPCB PM2.5 measurements because understanding the processes leading to poor air quality episodes is of utmost importance in this part of the world as also stated in the Introduction of this paper. I think a detailed PM2.5 evaluation during three seasons would provide a robust insight into the implications of aerosol hygroscopicity for air quality. Furthermore, diurnal profiles of surface RH and temperature should also be evaluated. It is particularly important to understand if the model is able to capture nighttime increase in RH which is one of the key factors in haze and fog formation. Therefore, I recommend a major revision before the paper can be accepted for publication in ACP.

Minor comments:

Line 11: Change low to poor.

Line 35: Change boundary layers to boundary layer.

Line 66: Does all aerosol optical properties (AOD, SSA, and asymmetry parameter) increase by a factor of 2 at RH > 80%?

Line 84: How many levels do you have in the boundary layer and are these sufficient to resolve the PBL processes?

Line 100-104: Does the model also include secondary organic aerosols?

Line 190: Are not organic carbon aerosol also emitted as hydrophobic?

Line 194-195: If aerosol hygroscopic growth is not a major factor at Jaipur, what is the reason behind large differences between Ambient and Dry AOD at Jaipur in Figure

3a.?

Line 209: I am not convinced that most of the AOD variability can be simply attributed to variability in RH. Since Ambient AOD is higher, surface temperature will be lower in Ambient experiment compared to the Dry. Consequently, PBL will be lower and lead to accumulation of aerosols in the PBL. The winds may also respond to aerosol induced thermodynamic changes and lead to different emissions of dust aerosols. All these aspects should be discussed.

Lines 249-255: It is really interesting to note that changes in temperature and RH are not located in the same place as the changes in AOD. Could you show the distribution of solar radiation reaching at the surface as well to corroborate your explanation because the largest changes in solar radiation reaching at the surface should coincide with the largest changes in AOD.

Line 314: What is the difference between radiative and climatic feedback?

Fig 8b: I think it is delta AOD-RH relationship. Please add delta symbol to the figure title. Why is deltaAOD-RH correlation highest over the Thar Desert?

Line 338-339: I think PM2.5 response will depend largely on how the PBL height changes and how aqueous-phase production of SO4 will change. Can you add some discussion on these points?

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