This study uses the Weather Research and Forecasting model coupled with chemistry (WRF-Chem) to understand how (a) spatial distribution, mass, and composition of aerosols and (b) formation, duration and dissipation of fog is affected by aerosol-radiation feedback and aqueous-phase chemistry during a winter fog event over the highly polluted Indo-Gangetic Plain (IGP).

The paper is well written and well structured. The study is important and within the scope of the journal, but following major and minor comments need to be addressed before I can recommend the paper for publication.

Major Comments

1. The motivation to design EXP1, EXP2 and EXP3 is not very clear. Previous studies (for e.g., Mohan and Gupta, 2018) have already confirmed that ACM2 scheme performs better than other parameterizations. Does using a new PBL scheme improves the model performance or nudging the soil moisture improves the model performance?
2. L225: "Aerosol cloud interactions are not possible"- does that mean fog droplets do not activate? Explain. How realistic is fog lifecycle in EXP3 without 'Aerosol Cloud Interactions'?
3. Why Figure S1 only shows 6 stations? On that note, the authors need to explain how the gridded model results are compared to point observations? The wind speed observations are present only in 4 stations. Among that at Amritsar and at Delhi-RKP, wind speeds have large biases. The hypothesis of 'low measurement height and obstructions' needs some evidence. The authors should read previous literature and figure out how WRF-Chem performs in those regions? Are there any systematic biases?
4. The model performance in predicting mass and composition of PM2.5 is poor. The authors should add a table showing the correlation and error between observations and simulation and compare that with existing literature. Is it possible to design a sensitivity experiment by scaling up the rate of emissions (including the HCl emissions) in the EDGAR-HTAP inventory. Why inorganic ions (other than chloride) are also heavily underestimated and fails to predict the diurnal variations (sulfate for example)?
5. Both CIGP and EIGP regions are foggy. However, for the wFB simulation, in figure S5, the Single Scattering Albedo increases at EIGP but decreases at CIGP near the surface. Why?
6. When composition of different inorganic ions is discussed, is it an average over the entire sub-region? In that case a standard deviation value should also be reported. Are there previous similar studies from where the authors can

compare their results? Inside CIGP and EIGP, are there any differences in composition between the foggy and non-foggy grid boxes?

7. Why fog deposition is extremely important in the area marked by the box n Fig. 12a? and less important in other areas? Are the meteorological conditions different?

8. Why is the fog water content higher when aqueous chemistry is included?

9. Figure 15 needs to be modified and variations at three separate IGP regions need to be shown with a median and interquartile range, taking foggy grid boxes. Observations from the WiFex Campaign should also be added.

10. L559 mentions that Aerosol-Radiation feedback affects the timing of the fog. However, L584 mentions that aqueous phase chemistry together with radiation feedback promotes early fog formation. This is confusing. How does aqueous chemistry affect fog formation? Explain.

Minor Comments

1. The abstract needs to be shortened. The goal of the paper on L14 needs to be more specific. 'Aerosol-Radiation Interactions' and 'Aqueous Chemistry' should be mentioned in the beginning of the abstract.

2. L116: 'it is divided into three areas…'- Describe the areas. What are the spatial extends (latitude, longitude)? Which states/major cities included in each of the three areas?

3. L128: 'the WRF-Chem model version 4.0.3 has been used for this study'-cite a few studies who have used WRF-Chem or similar models to study aerosol-radiation feedback in fog.

4. L170: Avoid Italics. 'wFB-nFB' needs a bit more explaining. Write the expression in a way to make it more understandable to a general audience: for example: (Properties/ Parameters in wFB - Properties/ Parameters in nFB)

5. Figure1: True color MODIS reflectance map doesn't confirm presence of fog. Could they be low level clouds? Also, a different color (other than black) should be used to mark the stations.

6. The Taylor's diagram needs to be explained more carefully. How are the standardized normalized deviations calculated (include an equation)?

7. Add a table showing timings of the fog and liquid water content for all the sensitivity studies, for three different regions (with a mean and standard deviation). Also add mean and standard deviations of observations from all stations (for each area).

8. Figure 2: x and y-axis need proper labels. Also, can the authors use a color other than blue for EXP2?

9. What is 'ddmass'. Write clearly in figure captions.

10. 'ug/m3' should be changed to '$\mu g/m^3$'.

11. L522: Need citations for $PM_{2.5}$ compositions.
12. L567: change '01 UTC' to '01:00 UTC' and L 568: change '10 UTC' to '10:00 UTC'.

<u>References</u>
- Mohan, Manju & Gupta, Medhavi. (2018). Sensitivity of PBL parameterizations on PM 10 and ozone simulation using chemical transport model WRF-Chem over a sub-tropical urban airshed in India. Atmospheric Environment. 185. 10.1016/j.atmosenv.2018.04.054.