

**Reviewer 2** (Reviewer's comments in black and our responses in red)

This study investigated the severe regional haze episodes in 2013 over the Northern China Plain through both measurements and simulations. The authors showed strongly correlated OOA and Ox concentrations during transition periods and positive feedback to haze formation by aerosol-PBL interactions during polluted periods. In general, this paper is well written and suitable for publication after the minor comments below are addressed.

We are grateful to the positive comments to our manuscript by this reviewer and have fully addressed the issues raised by this reviewer below.

1. I couldn't find any tables in the main text.

The missing tables have been included.

2. I couldn't find in the paper how the OOA concentrations were measured or determined. Can the authors add more details of how the OOA data were obtained? Also, can the authors add OOA time series to Figure 1, on top of PM<sub>2.5</sub> concentrations?

Measurements of aerosol chemical compositions were only available in Beijing, which have been previously reported by Guo et al. (2014). We have now stated that "For example, the mass concentrations of various inorganic and organic aerosol species, including oxygenated organic aerosol (OOA), were measured using an aerosol mass spectrometer (AMS) in Beijing (Aiken et al., 2009; Guo et al., 2014)" (Lines 185-188).

3. Line 246: The authors retrieved PBLH from MERRA2, but PBLH can also be estimated by the Nozaki's equation provided here. I wonder if the PBL estimations from the two methods were consistent.

Recently we obtained a new dataset of ceilometer measurements on PBL heights at Beijing and used these data to replace the MERRA2 to recalculate RH for the two clean days (the PBL height values on hazy days are comparable between the new dataset and the one used in the original manuscript). The PBL height data is presented in Table 3. Using the observed RH as inputs for Nozaki's equation, we can derive the PBL heights as 1289/456 m and 1411/442 m on clean/hazy days for EP1 and EP2, respectively, which are comparable to the observations, i.e., 1180/395 m and 1313/370 m (also see Table 3). Accordingly, we modified Lines 412-415 to "The calculated RH increases from 29% to 68% for EP1 and from 28% to 73% for EP2, when the PBL height decreases from 1180 to 395 m and 1313 to 370 m from clean days to the polluted days for EP1 and EP2, respectively, indicating that the humidity is highly sensitive to the PBL height".

4. Figure 3: Can the authors add R<sup>2</sup> between OOA and total PM<sub>2.5</sub>? It seems that even OOA only accounted for less than 1/3 of PM<sub>2.5</sub> mass, their concentrations were highly correlated. In this way, would PM<sub>2.5</sub> also show a good correlation with Ox? In addition, it would be helpful to add the same set of graphs for clean days.

The PM<sub>2.5</sub> mass consists of both primary and secondary components, while the OOA corresponds to only the secondary component. Since O<sub>x</sub> represents the level of oxidants relevant only to secondary aerosol, a simple correlation between PM<sub>2.5</sub> and O<sub>x</sub> would be less meaningful.

The shaded area for the correlation in Fig. 3 was selected to represent the largest variation in  $O_x$ , which covered both clean and transition periods. This point has been clarified in the caption.

5. Figure 4: Can the authors add the PBLH profile for transition days?

We added the diurnal cycle of PBL height of transition days ( $30 \mu\text{g m}^{-3} < \text{daily mean PM}_{2.5} < 200 \mu\text{g m}^{-3}$ ) to Fig. 4b.

6. Line 405: How did these calculated RH compare to the measured RH in Figure 1?

We have described the measured RH changes in the original manuscript, and quoted here for reference: “the measured RH increases greatly during the two episodes (Fig. 1d), i.e., from about 18%-19% on the clean days (25 September and 2 October) to 53%-55% on the polluted days (28 September and 5 October)” (Lines 412-415). The calculated RH was reported in Table 3, showing that RH is slightly overestimated in all the four days relative to observations.

7. Line 406: where did the 1000 m decrease come from? I only find in Line 371 “the simulated maximal height of PBL under the polluted condition is reduced by more than 300 m relative to the clean condition”.

In the previous manuscript we extracted the PBL height from MERRA2 because we didn't get the available observations on the two clean days, and the difference between the clean and hazy days are about 1000 m. Recently we obtained a new dataset of PBL height based on ceilometer measurements (see Table 3) for the two clean days and we used it to replace MERRA2 data.

The statement “the simulated maximal height of PBL under the polluted condition is reduced by more than 300 m relative to the clean condition” is based on simulation results.

8. Figure 4&5: Both figures show PBLH diurnal profiles, but with very different magnitude.

Only looking at clean days, Figure 5 PBLH is only half of that in Figure 4. Why are the simulated results so different from the MERRA2 reanalysis?

There are several possible factors which may contribute the relatively large discrepancy in PBL heights between Fig. 4 and 5: 1) Fig. 4 shows the statistics of PBL heights under all the clean and hazy days in 2013 based on MERRA2 data, with error bars denoting uncertainties. As such, the PBL height values shown here include both warm and cold seasons. As we know, the PBL during warm season (e.g., summer) is much higher than that during cold season because of the much higher temperature during warm season than cold season. Fig. 5 shows the PBL heights in late fall when the temperatures were already low, so the lower PBL heights during these simulation days are expected; 2) MERRA2 has much coarser spatial resolution (i.e.,  $0.5^\circ$  by  $0.625^\circ$ ) than the simulations in this study (i.e., 2 km by 2 km), which might cause the discrepancy between the two.

9. Figure 5: Can the authors either add legend or rewrite the caption? It should be clearly stated that the top 6 figures and bottom 6 figures are for two episodes.

In the caption (line 894), we have indicated that “(a-f) are for EP1 and (g-n) are for EP2”.