Anonymous Referee #2

Comments on manuscript entitled “Enhancement of secondary aerosol formation by reduced anthropogenic emissions during Spring Festival 2019 and enlightenment for regional PM2.5 control in Beijing"
General comments: This manuscript reported primary pollutant reduction but enhanced SIA formation in an emission reduction period during the 2019 Spring Festival in Beijing. The opposite trend of atmospheric oxidative capacity responding emission reduction was proposed the cause for enhanced SIA formation. Though the supporting discussion still appeared to be weak. Nevertheless, this study should call for the attention on SIA pollution control policy mitigation. I thus recommend publication of this manuscript on ACP with minor revision.

Specific comments:
Lines 21-22: O3 control regime on a regional scale is still a controversial topic. This manuscript did not intend to discuss on such topic given no VOCs measurements were present. Therefore, it is a bit risky to go such far with current data available. I suggest to delete the statement on NOx and VOCs control strategy if no more discussion shall add.
Response: Agreed. The sentence “The emission control of volatile organic compounds (VOCs) may be more suitable than the emission control of NO_x to reduce O_3 because VOCs under current emission conditions likely control the formation of O_3 in winter in the BTH region” has been deleted.

Line 56: be specific! Change to “secondary inorganic aerosol formation”
Response: Revised.

Line 92: consider to revise this sentence
Response: This sentence has been revised as: “Our measurements around this period of the field campaign are thus ideal for investigating the impact of reduced anthropogenic emissions on surface O_3 and aerosol formation.”.

Line 160: as shown in Fig.2, O3 titration appeared to occur in both POL and BG period. Ox=O3+NO2 is thus suggested to add in Fig.2.
Response: The time series of O_x (O_3+NO_2) has been added to Fig. 2 in the manuscript (shown below as Fig. R1). It shows a weak variation of O_x from the POL period to the BG period, indicating that the presence of strong O_3-titration during Spring Festival 2019. The corresponding discussion about O_x and O_3 titration has been added to section 3.1 of the revised manuscript.

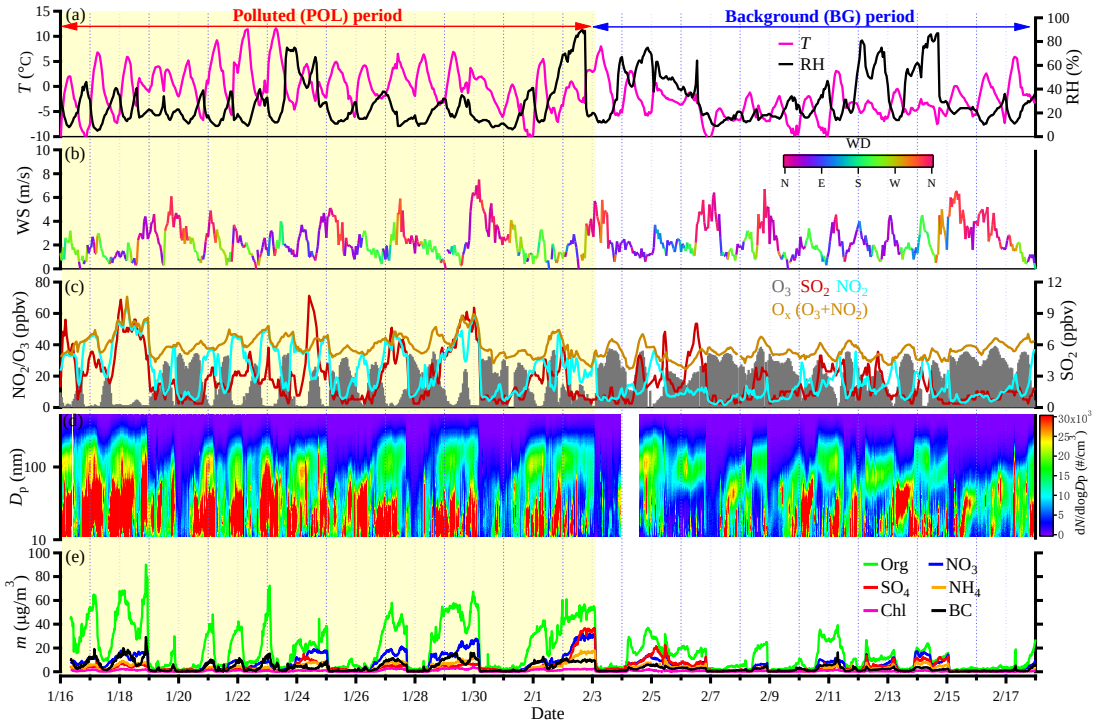

Figure R1. Time series of (a) ambient temperature (T) and relative humidity (RH), (b) wind direction (WD) and speed (WS), (c) volume mixing ratios of trace gases [O_3, SO_2, NO_2 and O_x (O_3+NO_2)], (d) the aerosol particle number size distribution measured by the SMPS, and (e) mass concentrations of aerosol chemical species in $PM_{2.5}$ measured by the ACSM and the AE-33. The trace gas information was from the Yizhuang station, and the others were observed at the experiment site in Beijing (16 January to 17 February 2019).

Lines 202-203: cannot read from Figure 2 that morg and mBC increase by % at night from daytime is less in BG relative to POL Lines

Response: We're sorry that this sentence has confused the reviewer. Figure 2e depicts that the peaks of m_{org} and m_{BC} at night during the BG period were much lower than those during the POL period, caused by emission reductions during the BG period. Therefore, here we want to express that the enhancement of m_{org} and m_{BC} at night during the BG period was not as strong as that during the POL period.

This sentence has been revised as: "However, the increases in m_{org} and m_{BC} at night during the BG period were not as strong as those during the POL period.".

203-204: both mnitrate and msulfate varied!

Response: Figure 2e depicts that both m_{NO3} and m_{SO4} decreased from the POL period to the POL period. However, their reduction magnitudes differed considerably.

Lines 246-24: decreased from what?

Response: This sentence has been revised as:" Table 2 also indicates that the mass concentrations (m) of aerosol chemical species in $PM_{2.5}$ were much less during the BG period than during the POL period".

Lines 255-257: From the context, I can only get that Org and BC reduction was sharper than sulfate and nitrate. If I can accept that "secondary (inorganic) aerosol" could replace "sulfate and nitrate", I am still reluctant to accept that Org and BC are all primary aerosol.

Response: The reviewer asks a good question. BC is mainly from primary emissions, but organics were not. Part of the organics is from primary emissions (i.e., primary organic aerosols, or POA), but another part is from gas-to-particle transformations (i.e., secondary organic aerosols, or SOA). Unfortunately, we are not able to separate POA and SOA in organics using our measurement data from the campaign. In this paper, we were not trying to define BC and organics as the primary matter. They were simply regarded as representing primary matter because many of them were from primary emissions. To a certain extent, the mass variations of BC and organics can represent the mass variations of primary aerosols. Similarly, SIA matter (mainly sulfate, nitrate and ammonium) are important chemical components of secondary aerosols, so their mass variations can represent the mass variations of secondary aerosols.

Figure 5: The high SIA and large PM2.5 number in POL were mostly seen at low RH, which is against the impression that heavy PM2.5 pollution was usually accompanied by high RH condition in literature. The author should at least address such unusual data.

Response: Some studies have found that heavy haze events are generally associated with high RH conditions and southerly winds. This is because the southerly winds are not only beneficial to the transport of pollutants from southern highly industrialized areas, but also to the transport of water vapor. In our study, the prevailing winds during both the POL and BG periods were northerly, which were beneficial to dispersing pollutants in Beijing, so no heavy haze episodes occurred during the two periods. However, the $PM_{2.5}$ during the POL period with ordinary emission conditions could reach moderate pollution level (over 100 $\mu g/m^3$) although the ambient RH was low.

The basic meteorological and environmental characteristics have been described in section 3.1.

Figure 6: Given the discussion on RH or ALWC in the context, I would suggest to add one of the two parameters in one column.

Response: That is a good suggestion. A figure showing the diurnal variation in ambient relative humidity (RH) (Fig. R2 below) was added to the supplement (Fig. S4). It shows that the ambient RH levels at night are elevated during both the POL and BG periods, favorable for aqueous chemical reactions.

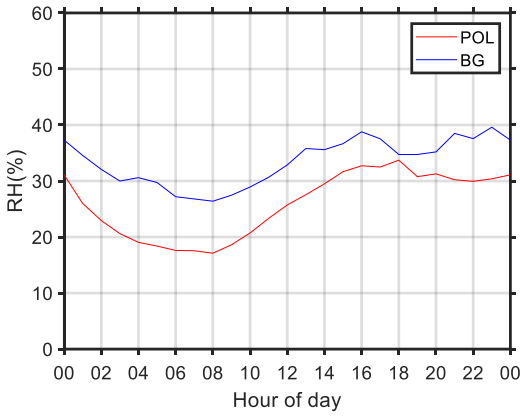

Figure R2. Diurnal variation of ambient relative humidity (RH) during the POL and BG periods.

Line 403: High O3 concentration itself will not surely lead to strong atmospheric oxidative capacity or even O3 production. The first reason is that O3 was titrated in Figure 2. The secondary reason is that O3 can be regionally transported as a relatively long-lived species. And the third, OH instead of O3 is the major oxidant in the atmosphere, which better represents the atmospheric oxidative capacity and does not differ significantly from pollution days to clean days in winter Beijing (see Eloise et al., Elevated levels of OH observed in haze events during wintertime in central Beijign). More data or discussion are needed here.

Response: Agreed. The analysis of O_x above shows that O_3-titration appeared during the special period studied. In this campaign, OH was not measured, so the atmospheric oxidation capacity wasn't analyzed accurately. For this reason, the discussion about atmospheric oxidation capacity in the manuscript has been deleted.