Comment on acp-2022-557
Anonymous Referee #1

Referee comment on "Composited analyses of the chemical and physical characteristics of co-polluted days by ozone and PM$_{2.5}$ over 2013–2020 in the Beijing–Tianjin–Hebei region" by Huibin Dai et al., Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2022-557-RC1, 2022

In this manuscript the chemical and physical characteristics of O3 (O3SPD), PM2.5 (PM2.5SPD) polluted days and O3 and PM2.5 (O3&PM2.5PD) co-polluted days over BTH are investigated by using the 3-D global chemical transport model (GEOS-Chem). This manuscript is clearly written and well organized, and its conclusions are interesting.

- The simulated PM2.5 components including NO$_3^-$, NH$_4^+$, SO$_4^{2-}$, BC, and OC are compared against observed PM2.5 concentrations, and the comparison shows that the simulated PM2.5 had a NMB of -26.9%. Even with the adjusted thresholds, percentages of observed polluted days for PM2.5SPD shown in Figure c are lower than for O3SPD and O3&PM2.5PD. Is the underestimation attributable to some missing primary aerosols?
- In the analysis two oxidation indicators (sulfur oxidation ratio and nitrogen oxidation ratio) are used, but not assessed. As observed SO$_2$ and NO$_2$ concentrations are available at CNEMC, model performance for SO$_2$ and NO$_2$ is suggested to be evaluated.
- Figure S5a shows the hourly variations of PBLH (m) averaged in all model-captured O3SPD (blue), PM2.5SPD (yellow), and O3&PM2.5PD (purple). Average PBLH at noon time for O3SPD and O3&PM2.5PD is over 2000m, why are they so high? Figure S5b shows the daily anomaly of PBLH for O3SPD and O3&PM2.5PD at night time exceeds -500m, while at noon time over 1000m. How does PBLH usually change over BTH?
- Figure S6 shows the vertical profile of SO$_4^{2-}$ chemical production. Why is SO$_4^{2-}$ chemical production larger at high levels than at low levels? Is it associated with cloud or high relative humidity? How is SO$_2$ concentration distributed vertically? How to understand the difference between O3SPD and PM2.5SPD?
- It is interesting to see Figure 8a that O3 levels for O3SPD are lower than for O3&PM2.5PD. Does it mean high PM2.5 leads to increase in O3? Figure 8b also shows BC is well mixed vertically up to ~819h Pa. Is it an average for all selected days?