Replies to Referee #2's comments

We thank for your thoughtful, valuable and detailed comments and suggestions that have helped us improve the paper. Our detailed responses (Blue) to the reviewer's questions and comments (Italic) are listed below.

This manuscript reports on the distinct impacts on precipitation start/peak time by aerosol radiative effect over three different megacity regions of eastern China, which is found mainly caused by the different aerosol concentration and types over the three regions. The manuscript argues that the precipitation start time is 3 hours advanced in North China Plain due to high proportion of absorbing aerosol, 2 hours delayed in Pearl River Delta due to high proportion of scattering aerosol and negligible changed in Yangtze River Delta. The authors found that the period with the most occurrence frequency of precipitation start time is delayed and prolonged by aerosols over North China Plain, and discussed the response to precipitation to aerosol under different meteorological conditions. With the very interesting and valuable findings that include but are not limited to the parts I mention here, I believe this study is very important contribution to the science community regarding the aerosol-precipitation interaction.

We highly appreciate the reviewer's positive evaluation about our study and have made corresponding changes based on the valuable comments from the reviewer.

Some minor comments

Line 60: "with the increase of the aerosol" should be "with the increase of aerosol".

Thank you. We have corrected it.

Line 86-87: "in the initial stage" should be "at the initial stage", "in the development stage" should be "at the development stage".

Thank you. We have corrected them.

Line 114-115: I would suggest adding a reference for topographic rain effect.

We have added a reference at Lines 118-119: "Due to the topographic rain effect **(Jiao and Bi, 2005)**, this study only selects the area with DEM less than 100 meters as the study region.".

Jiao, M. Y. and Bi, B. G.: Mesoscale structure analysis of topography-induced heavy rainfall in Beijing in summer, Meteorology, 31(6), 9-14, http://dio.org.10.3969/j.issn.1000-0526.2005.06.002, 2005, (in Chinese).

Line 134-135: I would suggest changing the description to "at a vertical interval of 125 meters".

We have changed it as suggested.

Lines 140-141: Please provide a brief description about the method to classify the convective, stratiform, and other precipitation types.

Following this valuable suggestion, we have provided a brief description about the method to classify precipitation types at Lines 144-166: "**The method of precipitation type classification for DPR is based on different vertical motion distributions and microphysical mechanism of different precipitation types. The difference between two frequency (Ku and Ka band) observations or so-called measured dual-frequency ratio (DFRm) provides rich information to investigate the microphysical properties of precipitation. The DFRm vertical profile is controlled by the non-Rayleigh scattering effect and the path integrated attenuation difference (δPIA) between two frequency channels (Le et al., 2010). The DFRm is mainly controlled by non-Rayleigh scattering effect in the ice region. Both non-Rayleigh scattering effects and δPIA play a role in the melting region. The DFRm is dominated by δPIA in the liquid precipitation region. Different precipitation types have different characteristics. As the case for convective precipitation, mixing of hydrometeors can be present in the melting layer, and in general, density of the mixture is higher than the case of stratiform precipitation (Le and Chandrasekar, 2013). Therefore, the vertical profile of DFRm has different characteristics for stratiform and convective rain according to significant on-Rayleigh scattering part and δPIA part. More details about the precipitation type classification method for DPR can be found in Le et al. (2010) and Le and Chandrasekar (2013).**".

Le, M., Chandrasekar, V. and Lim, S.: Microphysical retrieval from dual frequency precipitation radar board GPM, Proc. IEEE IGARSS, 3482-3485, http://dio.org.10.1109/IGARSS.2010.5652487, 2010.

Le, M. and Chandrasekar, V.: Precipitation Type Classification Method for Dual-Frequency Precipitation Radar (DPR) Onboard the GPM, IEEE Trans. Geosci. Remote Sens., 51(3):1784-1790, http://dio.org.10.1109/TGRS.2012.2205698, 2013.

Line 174-181: The authors attempt to find suitable indicator as a proxy for CCN and they select 4-hours mean $PM_{2.5}$ mass concentration before precipitation to investigate the impact of aerosols on precipitation. Why do not the authors choose 5-hours mean $PM_{2.5}$ mass concentration before precipitation or the $PM_{2.5}$ mass concentration during the precipitation to represent the CCN?

Thank you for the question. As shown in Figure R1, the correlation coefficients between the $PM_{2.5}$ mass concentration averaged in 4 hours before precipitation and $PM_{2.5}$ mass concentration averaged in 5 hours before precipitation are good over three study regions. However, taking diurnal variations of $PM_{2.5}$ and aerosol accumulation effect into account, this study selects the 4-hours mean $PM_{2.5}$ mass concentration before precipitation to investigate the impact of aerosols on precipitation.

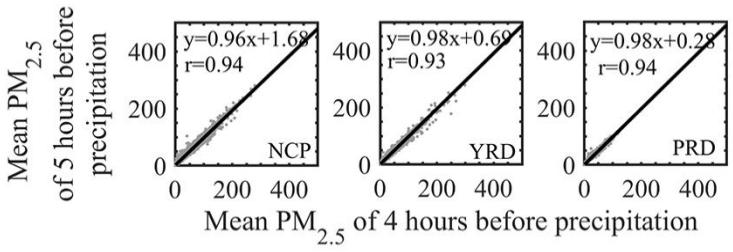

Figure R1: The relationships between the mean $PM_{2.5}$ mass concentration of 4 hours before precipitation (μg/m^3) and the mean PM2.5 mass concentration of 5 hours before precipitation in June-August from 2015 to 2020 over North China Plain (NCP), Yangtze River Delta (YRD), and Pearl River Delta (PRD), respectively.

Line 187: I would suggest changing the description to "The low troposphere stability (LTS) can ..." to define LTS.

We have changed the description as suggested: We provide the full name and abbreviation of LTS when we first refer at lines 100-103: "Moreover, the changes of aerosol impacts on precipitation time with meteorological conditions that can affect precipitation have also been investigated, including the relative humidity, low troposphere stability **(LTS)**, and vertical wind shear **(WS)**, which are essential to aerosol-cloud-precipitation interactions (Boucher and Quaas, 2012; Fan et al., 2009; Klein, 1997; Slingo, 1987; Zhou et al., 2020).".

Line 199-200: I would suggest changing "have contributed to" to "have been used by".

We have changed it as suggested.

Line 203: I would suggest changing "on different pressure levels" to "at different pressure levels".

We have changed it as suggested.

Line 220-222: It seems the description here is wrong. I believe the correct description should be "Second, we rank the $PM_{2.5}$ mass concentration observations from high to low, and define the top 1/3 of group C as polluted condition and the bottom 1/3 group C as clean condition."

We appreciate the reviewer's help figuring this out and have corrected it.

Line 240: "The diurnal variations" should be "The diurnal variation".

Corrected as suggested.

Line 250: I would suggest changing "make" to "making".

We have changed it as suggested.

Line 288: I would suggest changing the description here from "the PDFs of the precipitation duration time and when the peak time occurs after start time" to "the PDFs of the precipitation duration time and the time difference between precipitation peak and start time".

We have changed it as suggested.

Line 416: I would suggest adding "that" after "show" here.

We have changed it as suggested.

Line 531: "are" should be "is", corresponding to "response".

We appreciate the comment and have changed "response" to "responses".

Line 590: "which are essential for improve our understanding" should be "which are essential to improve our understanding.

We have changed it as suggested.