Response to Reviewers #1' Comments

Reviewer: Y. Lin

General comments:

The study utilized the TRMM radar reflectivity and PM10 data over the PRD region to investigate the potential impacts of aerosol on precipitation. How to quantify aerosol impacts on precipitation based solely on observations is a tough task since meteorological factors need to be isolated effectively. The study is unique in that it separated precipitation associated with synoptic or mesoscale forcing from those localized precipitation events. Furthermore, other meteorological factors, including vertical wind shear, which is important for convective system development, are also analyzed and described. The finding that aerosol is able to invigorate deep convections is generally consistent with previous modeling studies. The study is thus a good contribution to this community. Nevertheless, I have some suggestions for the authors to consider.

Response: We thank the reviewer for his thoughtful and thorough comments and suggestions. We have tried as much as possible to address all concerns and have revised the manuscript accordingly. The comments are written in normal font, and our point-to-point responses to the comments are in bold italics.

Specific comments:

1. Although manual identification of synoptic or localized precipitation event is described on 26-28 p11, a few more description might help since it is very subjective. I am also wondering whether localized precipitation is more appropriate than local-scale precipitation.

Response: Thanks for pointing this out. More descriptions regarding how to identify a synoptic or localized precipitation event are added in Section 3.1 of our revised manuscript, which are described as follows:

"…The discrimination between localized and synoptic-scale precipitation events for a given day largely relies on the weather composite charts, where daily averaged wind field at 850 hPa was overlaid with the geopotential height at 500hPa. Particularly, the localized precipitation event for a given day was subjectively determined as follows: (1) There exists favorable atmospheric conditions for the initiation and development of localized precipitation events through visual interpretation of the weather composite plot for the day analyzed; (2) The minimum rainfall greater than 0.1 mm/d was recorded at any gauges in the study area (red box in Figure 1); (3) there are ground-based PM_{10} measurements collocated with precipitation measurements from TRMM to obtain a pair of valid aerosol-precipitation data. As such, the total number of collocated samples reached up to 253 for localized precipitation events, whereas 194 for synoptic scale

precipitation events…".

In addition, "local-scale precipitation" has been revised to "localized precipitation", per your suggestion.

2. Smaller reflectivity below the freezing level for polluted cases than clean cases (Fig. 5c, P14 Line 10) might be due to the large numbers, but smaller sizes of rain drops within polluted environment.

Response: Agreed, and we add the following discussion to better elucidate the possible causes for the smaller reflectivity observed below the freezing level under polluted conditions:

"Below the freezing level where the reflectivity is less than 40 dBZ, the color is virtually all blue, meaning that precipitation is weaker under polluted conditions than clean ones. This could also be due to a large number of smaller rain drops within polluted environment."

3. Looks like PM_{10} (P8, Line 5) is much higher during the periods with occurrence of shallow convection than other two types of precipitation. Any reasons for this? Does this imply heavy pollution tends to inhibit deep convection development sometimes, although it will invigorate deep convection once the negative impacts of aerosols are overcome?

Response: Agreed. The phenomenon you noticed likely imply heavy pollution tends to inhibit deep convection development sometimes. After double checking the original dataset, one cause for such a higher average PM10 for shallow precipitation regime is due to two days with abnormal high PM_{10} concentration, corresponding to 255.33 and 260μg/m^3, respectively. In contrast, for other two precipitation regimes (i.e., Stratiform and convective), the maximal PM_{10} concentration is just 193μg/m^3. As you suggested, this implies heavy pollution tends to inhibit deep convection development sometimes, although it will invigorate deep convection once the negative impacts of aerosols are overcome. Related discussion has been added to our revised manuscript.

4. Regarding that deep convections sometimes developed from shallow convections, is it possible that the composite will divide one precipitation event into different types. This need to be mentioned somehow.

Response: Per your suggestions, we added the following discussion in section 3.1:

"Given the fact that deep convections sometimes develop from shallow convections (Houze 1993; Li and Schumacher, 2011; Yang et al., 2015), it is possible that the subjective composite method will divide one precipitation event into different types, which will lead to large uncertainties in determining precipitation regimes from TRMM data alone. This deserves more explicit analyses aided by geostationary satellite data in the future, which is out of the scope of this study."

Minor comments:

1. Why use the vertical wind shear between 1000 and 700 hPa instead over a higher level?

Response: This is a typo, since we confused the two pressure levels used to define the wind shear with those for the calculation of LTS (lower troposphere stability). LTS is defined as potential temperature difference between 1000hPa and 700hPa. Actually, the vertical wind shear used in the main text is calculated from the winds between 850hPa (~1.5km) and 500hPa (~5.5 km), rather than between 1000hPa and 700hPa, which has been corrected in this revised manuscript.

2. P6, L20, delete "use to"

Response: Deleted as suggested.

3. There are some other typos. Please double check.

Response: We corrected other typos in our revised manuscript.