Review Comments for ACP

The complex interaction between dust aerosols and precipitation remains challenging. This study investigates the interaction between dust aerosols and precipitation along the Eastern coast of the Red Sea and the underlying mechanism by the use of WRF-Chem with an advanced double-moment cloud microphysics scheme coupled with a sectional 8-bin aerosol scheme. The simulation results show that dust aerosols increase the rainfall amount of **extreme rainfall events** but decrease the rainfall amount of normal rainfall events. This result theory further supports the conclusion that "dust aerosols enhance heavy rainfall events and suppress light rainfall events". The paper suggests that the direct effect of dust aerosols influences the precipitation magnitude by the sea breeze circulation, which is intriguing. It is well known that the effect of dust aerosols is normally estimated by “radiative forcing”, and this study further innovatively illustrate the transform from these effects to rainfall, however, the detailed calculation methodology needs to be presented.

Acceptation is recommended after revision.

Major comments:

Comment1:

extreme rainfall events： indirect (4.54%), direct (1.51%) and indirect effects were statistically significant whereas the direct effect was not.

normal rainfall events:indirect (4.76%),direct(-5.78%), all of which were statistically significant.

Here is a question, which is the constant value of water vapor or dust concentration in the premise of this conclusion? I think this is a very important question.

If the dust concentration is constant value, the dust aerosols as CCN make raindrops grow enhancing the precipitation given abundant water vapor, thus, the indirect impact (4.54%) dominates the extreme rainfall events. On the contrary, the rainfall will decrease due to the competition of the raindrops for vapor, in other words, the indirect impact suppress normal rainfall events. Therefore, the reason for the indirect （+4.76%） needs to be clarified.

If water vapor is constant value, the increasing dust aerosols will enhance extreme rainfall events given high vapor with the positive indirect impact. If the constant value of water vapor is very low, indirect is negative and inhibits precipitation, it still does not explain the fact that indirect effect is positive in normal rainfall events.

An experiment of the ratio of dust aerosol concentration vs vapor is highly recommended to determine a threshold for the clear explanation of the indirect impact to avoid confusion as stated above.

Comment2:

In the conceptual model (fig.15), the direct effect of the dust aerosols plays a dominating role. when the dust concentration increases, the surface cooling induced by scattering weakens the sea breeze circulation, which decreases the associated landward moisture transport, ultimately suppressing rainfall. Is that mean that the indirect effect is

less important? If so, the conclusion is consistent with Koren et al.(2014) in line 530-532.

Because dust aerosol concentration is closely related to CCN, it implies that the indirect effect of precipitation is not well related to dust concentration. If so, according to the newly developed conceptual model of the paper, it cannot explain the conclusion of increased rainfall in extreme rainfall events, because as the dust concentration increases, surface cooling induced by scattering weakens the sea breeze circulation, thus reducing land moisture transport and ultimately suppressing rainfall. These contradictions in logic need to be explained.

Comment3:

Whether the relationship between dust aerosols and precipitation as shown in fig.1 and fig.2 can be explained by the conclusion derived from the conceptual model?

Comment4:

line 649-650 “Although the domain-average rainfall change caused by dust averaged over multiple years (2006–2015) appeared small, the effect can be large at different grid points and times. This is a very interesting fact, which implies that the large circulation (mainly direct effect effects) has very little variation on the domain average rainfall, i.e. the conceptual model of dust and precipitation (fig.15) has very little effect on precipitation?

Comment5:

It is an very interestingly conclusion in Lines 766-768， “However, our results suggest that cloud seeding efficiency may be affected by the presence of background dust aerosols, and that it may not be as effective in dusty regions as in clean environments.”. If AgI is used for cloud seeding experiments, high background dust aerosols in desert areas must be considered because both Agl and dust aerosols increase CCN, making it difficult for droplets to grow and thus inhibiting precipitation. Therefore, using Agl for cloud seeding in these areas may be a futile attempt to increase precipitation.