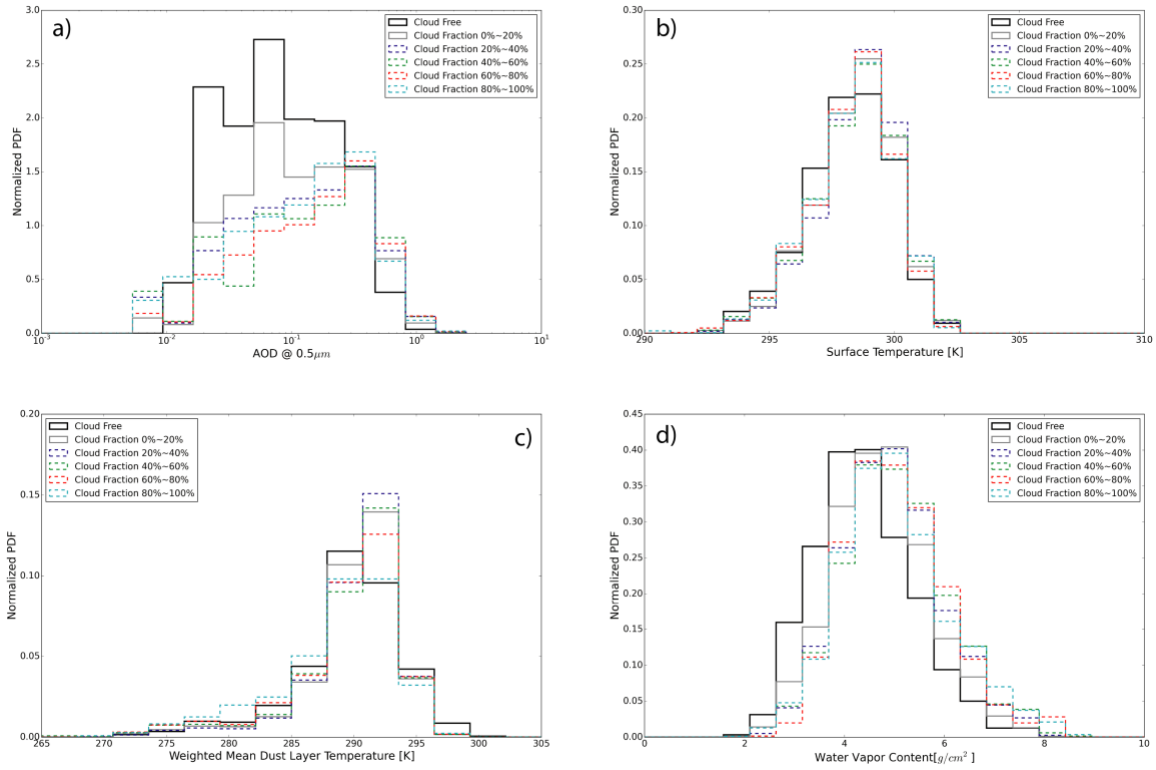
Review 3

1. Only 5% pixels are cloud free in the analysis region and season. Such a small occurrence would make readers wonder to what extent the dust DRE calculated in this study contribute to the dust all-sky radiative forcing in this region. I can see that dust radiative forcing in cloudy sky is complicated and beyond the scope of this study, but it is still helpful to discuss the possible influence of different types of clouds at different levels on the dust radiative forcing at both TOA and surface.

Reply We appreciate your concern and question regarding the representativeness of our results. We think a key question is *whether the results derived from our cloud-free cases can be applied to the clear-sky part of those cloudy CERES pixels.* To address this question, we investigated if the dust properties (e.g., AOD) and meteorological conditions (e.g., surface temperature and precipitable water) have any correlation with the cloud fraction. If it turned out that the statistics of the dust properties and meteorological conditions from the clear-sky cases are similar to those from the cloudy cases, then we can argue that our results are representative of not only the clear-sky dust dominant CERES pixels, but also the clear-sky part of cloudy and dust dominant CERES pixels.

We first checked the AOD. This time we identify the dust-dominant cases based on CALIPSO observations regardless of the cloud fraction. Then, we divide the selected cases into 5 groups according to the cloud fraction within the CERES pixel, i.e., 0~20%; 20~40% 40~60% 60~80% and >80%. The figure a) below shows the dust AOD histogram of each group. Apparently, the AOD from our cloud-free cases tend to be smaller than those from the cloudy group. If the DRE efficiency remains the same, then the DRE of our cloud-free cases would be smaller than those of the cloudy group.

We don't know whether and to what extent other dust properties, such as size, shape and refractive index, co-vary with the cloud cover. Investigating this is extremely challenging, if not impossible, using satellite observations. We have to leave this for future studies using other types of measurements (e.g., in situ).



After AOD, we also checked the surface temperature, the dust layer temperature (weighted by the dust extinction coefficient from CALIPSO) and the total amount of water vapor in the column. These quantities are potentially important for the DRE_{LW}. As shown in the figure above, in terms of the surface temperature (figure b)) and dust layer temperature (figure c)), the cloud-free cases are very similar to those cloudy-cases.

However, not surprisingly, we found that the cloud-free cases are drier than the cloudy cases (figure d). Note that, given the same dust properties, an increasing of water vapor increases the atmospheric opacity in the LW, which tends to reduce the dust DRE_{LW}.

In summary, if the dust particles properties (i.e., dust size, shape and refractive index) remain the same, then the DRE_{SW} of dust in the clear-sky part of cloudy CERES pixels would be slightly larger than that based on our results because of the larger AOD. In the LW, the larger AOD of the clear-sky part of cloudy CERES pixels would lead to a larger DRE_{LW}, but on the other hand, they are also more humid which would counteract the effect of larger AOD. The net result is dependent on the relative importance of these two competing factors.

We hope these analyzes address your questions. We have added the figure above to the revised manuscript as the new Figure 11 and also discussed the representativeness of our results.

2. How is the dust DRE sensitive to the altitude of dust layer? It is a non-trivial question for the longwave radiation. Also, the analysis region is away from the source region, so there should be some variability of the dust layer height.

Reply: Generally, under clear sky conditions, as dust layer altitude increasing, LW dust DRE at TOA increases but surface LW dust DRE decreases. (Under clear sky conditions, SW dust DRE is not sensitive to altitude of dust layer). In our study, we take into account the dust layer height variability by specifying dust aerosol extinction coefficient profile for each case based on CALIPSO retrieval. In future study, we will analyze how the dust layer height influence the DRE_{LW}.

3. Would dust outflows over the North Pacific exhibit similar DRE as the values reported in this study?

Reply: Dust DRE depends on dust aerosol optical depth and dust physical properties such as dust size distribution, refractive index and particle shape. Those physical properties are highly dependent on dust source region and dust aerosol transport processes. Considering the difference in dust AOD and dust source region between dust aerosol over North Pacific and North Atlantic, we would not say they have the similar or different DRE values. We plan to investigate this in future studies.

4) Fig. 7 and 9. Hard to distinguish lines in those figures. Please consider using color plots.

Reply: We changed them to color plots.

5) L84, is it supposed to be [Zhang et al., 2016]? Also Xu et al. [2017, AE] is relevant here and should be cited as well.

Reply: Thanks for suggestion, we fixed our citation and cited the paper Xu et al., 2017.

6) The title is a little bit wordy. Suggest to remove "Through Integrating Satellite Observations and In Situ Measurements of Dust Properties"

Reply: We changed the title to "Radiative effects of dust in tropical north Atlantic based on integrated satellite observations and in situ measurements"