Response to Reviewer #1's Comments:

Bida Jian et al. (Author)

We are very grateful for the Reviewer #1' detailed comments and suggestions, which help us improve this paper significantly. Based on the comments and suggestions from the editor and two Reviewers, we add some interpretations and discussions in each section in order to make the manuscript clearer. In particular, some superfluous information in each section is deleted.

Please see our point-by-point reply to comments. In addition, all revisions were highlighted in revised manuscript by using track changes.

General responses:

1. Line 11, please change "the subtropical marine subtropical stratocumulus" to "the subtropical marine stratocumulus"

   Response: We are sorry to make this mistake. It is corrected in the revised manuscript. Please see the Line:11.

2. Line 12-13, please change "the long-term, monthly and seasonal cycle averaged cloud albedo at five stratocumulus regions were investigated" to "the long-term, monthly and seasonal cycles of averaged cloud albedo at five stratocumulus regions were investigated"

   Response: Thanks for your comments. It is corrected in the revised manuscript. Please see the Line: 12-13.

3. Line 16-18, past tense and present tense cannot be used together in a sentence.

   Response: It is corrected in the revised manuscript. Please see the Line: 16-18.

4. Line 38, "those of" -> "those over"

   Response: It is corrected in the revised manuscript. Please see the Line: 38.

5. Line 50-53, it is only true when considering the cloud albedo for particular clouds that the cloud albedo is determined by COT and solar zenith angle. From a statistical view, it is also strongly

dependent on cloud fraction. In addition, regarding the change of COT with cloud droplet number, size, and liquid water path, a couple references could be mentioned, Zhao et al. (2012, doi:10.1029/2012GL051213) and Xie et al. (2013, doi:10.1175/JCLI-D-12-00517.1). Also, changing "cloud droplets number and sizes" to "cloud droplet number and sizes".

Response: We agreed with reviewer. It is corrected and the relevant references are added in the revised manuscript. Please see the line: 53-54.

6. Line 57-59, are you sure these three referred studies are for aerosol-cloud-radiation interaction over subtropical marine stratocumulus regions? In my memory, Twomey (1977) studied the clouds over continent and over the tropical ocean. Anyway, how did you define your study regions here?

Response: We are sorry to make this mistake. It is corrected in the revised manuscript. Please see the Line: 57-59. Our study regions are focused on several typical subtropical marine stratocumulus regions (latitude is greater than 10°). Details about the study regions can be found in Section2.

7. Line 67-69, not only the cloud supersaturation, but also other properties (such as aerosol amount, entrainment, detrainment, and so on) would be changed by the dynamical processes. You may read and cite some recent studies to emphasize this point, such as the effect from aerosols and vertical velocity.

Response: Thanks for your comments. The sentence is reorganized and relevant references are added in the revised manuscript. Please see the Line: 57-70.

8. Line 90, you may change "addresses" to "provides", "showes" or "gives".

Response: It is corrected in the revised manuscript. Please see the Line: 99.

9. Line 94-96, how would you expect the extra errors caused by this kind of interpolation?

Response: Thanks for your comments. Indeed, data interpolation will cause extra errors. We calculated the relative bias of monthly cloud albedo between original and interpolation data, the extra errors are about 1% for a single model (see Fig. R1). This indicates that the interpolated data
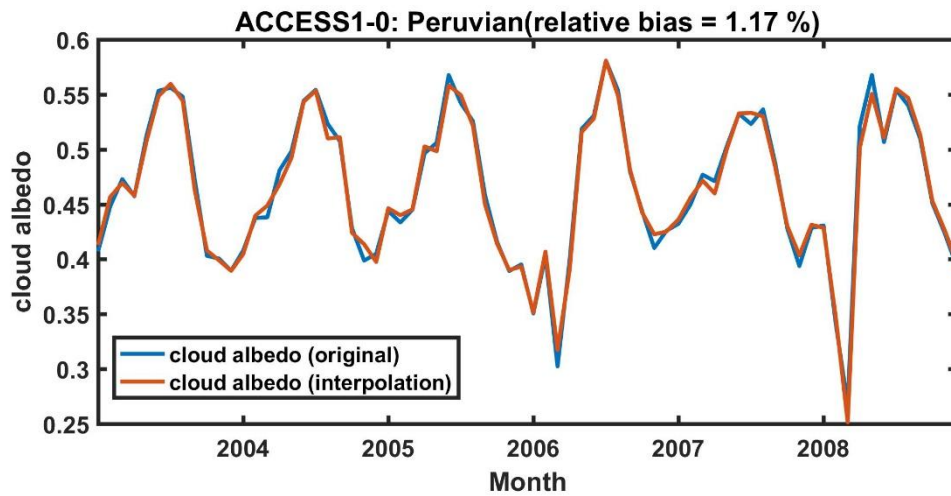
is valid for this study.

Figure R1: Monthly mean time series of estimated cloud albedo from ACCESS1-0 original (blue line) and interpolation (red line) data during 2003-2008 over Peruvian. The relative bias of monthly cloud albedo between original and interpolation data is given in the title.

10. Line 98, "is required" -> "requires"

    Response: It is corrected in the revised manuscript. Please see the Line: 101.

11. Line 101, delete "also" since they are from different product.

    Response: Thanks for your comments. It is deleted in the revised manuscript.

12. Line 104-107, a little information about the potential uncertainties from these data process could be helpful.

    Response: Thanks for your comments. It is added in the revised manuscript. Please see the Line: 110-113.

13. Line 109-112, two comments I would like to give here. First, you should indicate whether the time is local time or UTC time. Second, regarding the use of the average of two time point cloud observations to represent daily average, it would introduce the time representation error as indicated by Wang and Zhao (2017, doi:10.1002/2016JD025954). This representation error is significant when considering short-term studies (up to 14%), but is neglible when considering long-term statistical analysis. This representation error which is negligible in this study should be

acknowledged.

Response: We very thank reviewer for providing detailed comments and suggestions. It is corrected and the relevant references are added in the revised manuscript. Please see the line: 117-120.

14. Line 121-123, As mentioned above, this time representation error could be large for short term, but becomes negligible when considering long-term period.

    Response: Thanks for your comments. The comment is added in the revised manuscript. Please see the Line: 132-133.

15. Line 147, delete "for"

    Response: It is deleted in the revised manuscript.

16. Line 153-154, why do the authors put this single sentence as a paragraph? Also, I am a little confused about the method described with this sentence, may you please explain a little more?

    Response: This sentence is rephrased in the revised manuscript and some extra interpretations are added. Please see below (Line: 175-178):

    "In the study, to avoid influence from seasonal cycle, the long-term mean analyses are implemented with deseasonalized monthly mean data processed by removing a mean seasonal cycle, and then adding the monthly mean value to the interannual anomalies data."

17. Line 158, why 90% instead of 95% confidence level is selected here?

    Response: Thanks for your comments. The factors we have selected for this study are supported by physical mechanisms, therefore we consider a confidence level of 90 % is sufficient. In fact, we find that the predictor factor we used here are also significant at a 95% confidence level.

18. Line 160, this is not a complete sentence, you might use "The regression model of cloud albedo α_{cloud} is as follows"

    Response: It is corrected in the revised manuscript.

19. Line 198-200, it is still not clear to me how the model NorESM2-LM improve the stratiform cloud parameterization?

    Response: Thanks for your comments. Based on the suggestions from Reviewer #2, we delete the superfluous discussions about the individual models in the result section in order to make the results clearer. Thus, the Result (Section 3) are reorganized in the revised manuscript.

20. Line 205, "shows" -> "show"

    Response: It is corrected in the revised manuscript.

21. Line 226-230, what do these positive and negative correlations indicate?

    Response: In the paper, the positive (negative) correlations indicate that model with a higher mean cloud fraction tend to display a higher (lower) cloud albedo.

22. Line 246-247, please rephrase this sentence.

    Response: In the revised manuscript, we reorganize the Result section (Section 3) and the sentence is deleted.

23. Line 260-261, please rephrase the sentence.

    Response: In the revised manuscript, we reorganize the Result section (Section 3) and the sentence is deleted.

24. Line 266-267, sorry that I do not understand this sentence, please rephrase it or explain.

    Response: It is rephrased in the revised manuscript. Please see the Line: 275-278.

25. Line 272, "the smallest"

    Response: It is corrected in the revised manuscript.

26. Line 278-280, how could you explain the large cloud albedos in winter? The following sentences in Line 280-292 did not explain this except they show some influential factors to marine cloud properties.

Response: Thank you for your comments. The statistical results show that the cloud albedo is large in winter. We also find that the LWP is generally higher in winters (See Fig. R2). The cloud optical thickness usually increases with an increase in cloud LWP, resulting in an increase in the cloud albedo. However, the underlying physical mechanisms of LWP and cloud optical thickness increase are complex and require more detailed meteorological conditions analysis (e.g., transport of water vapor, relative humidity, high/low pressure system) to explain the result in these regions. Dong et al., (2014) found that at the Azores site (39.098N, 28.038W), the seasonal changes of cloud thickness are link to the seasonal synoptic patterns. They found that the persistent high pressure and dry conditions produce more single-layered clouds during summer, whereas the low pressure and moist air masses during winter generate more total and multilayered clouds, and deep frontal clouds associated with mid-latitude cyclones. During winter the clouds are higher, colder, and thicker with reduced LWP. In order to understand the seasonal variation mechanism over these subtropical marine stratocumulus regions, the analysis of seasonal synoptic patterns is necessary. However, this discussion is beyond the scope of this paper, so we just give the possible influencing factors. We also did some correlation analysis of meteorological factors (e.g., relative humidity at 700hPa, estimated inversion strength and horizontal temperature advection at the surface) and cloud albedo. However, we found that the seasonal change of meteorological factors can't adequately explain the seasonal change of cloud albedo. Thus, we do not consider the results as the content of the manuscript. Please see Figs. R2-R5.

Dong, X., Xi, B., Kennedy, A., Minnis, P., and Wood, R.: A 19-Month Record of Marine Aerosol- Cloud-Radiation Properties Derived from DOE ARM Mobile Facility Deployment at the Azores. Part I: Cloud Fraction and Single-Layered MBL Cloud Properties, J. Clim., 27, 3665-3682, https://doi.org/10.1175/jcli-d-13-00553.1, 2014.
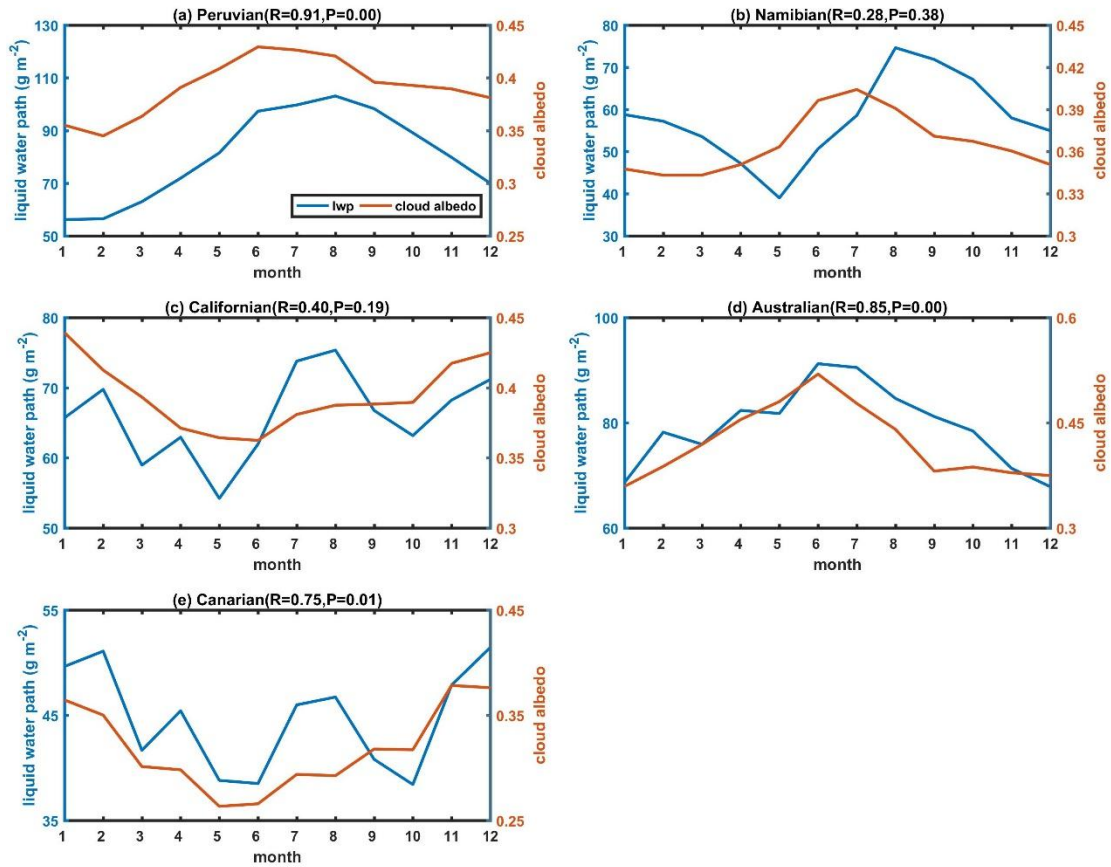
Figure R2: Annual cycles of the estimated cloud albedo and LWP from satellite observations during 2003-2014 over the (a) Peruvian, (b) Namibian, (c) Californian, (d) Australian, (e) Canarian regions. The temporal correlations (R value) and P value (if P<0.10, indicating the correlation R is significant) between cloud albedo and LWP are given in parentheses.
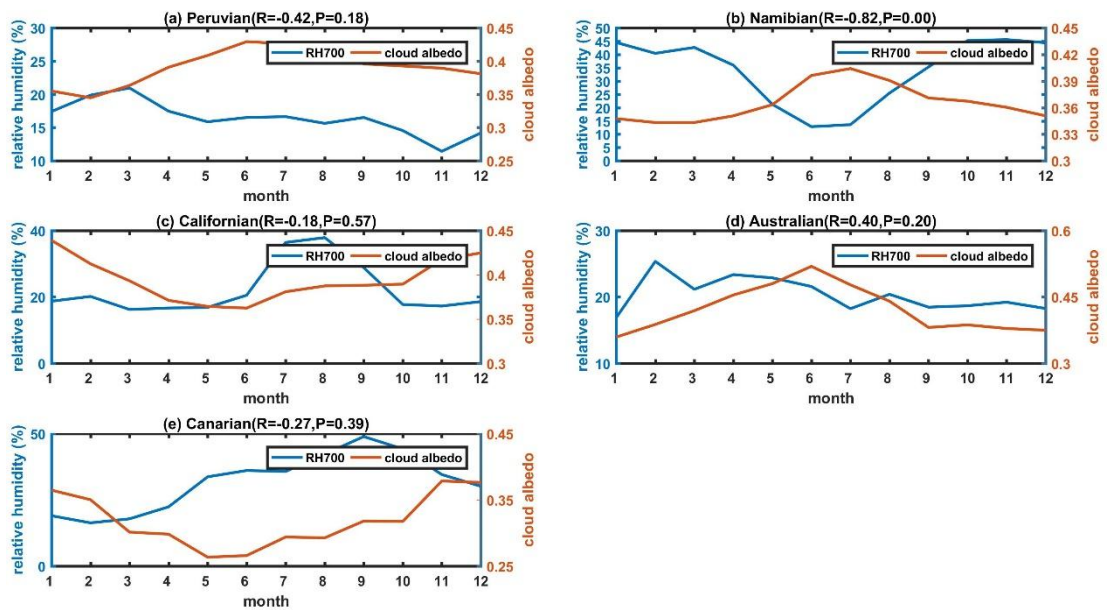
Figure R3: Similar to Fig. R2, but for relative humidity at 700hPa (RH700).
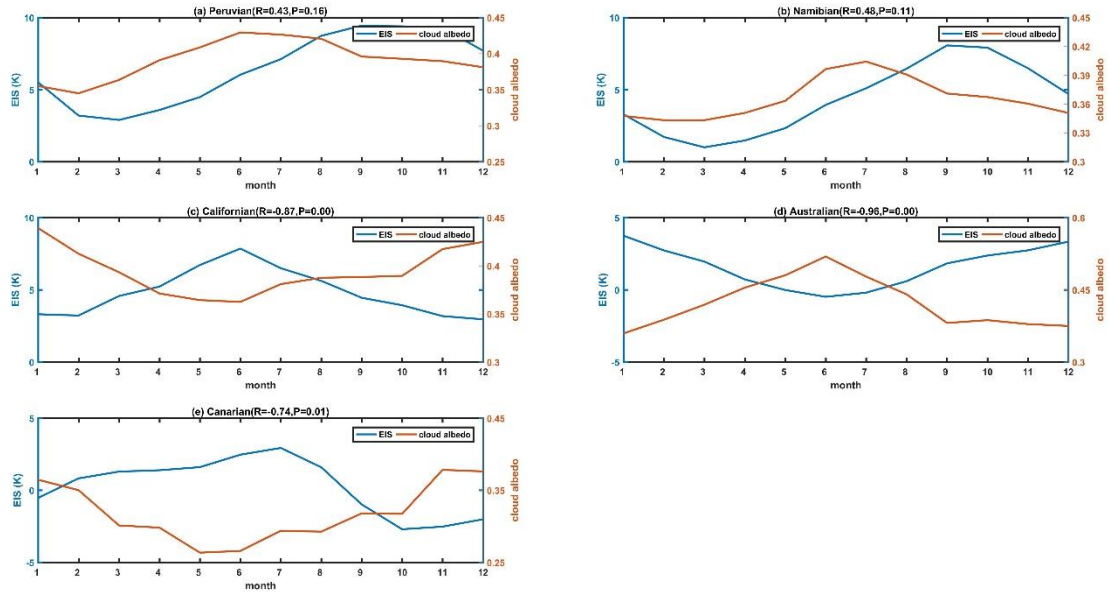

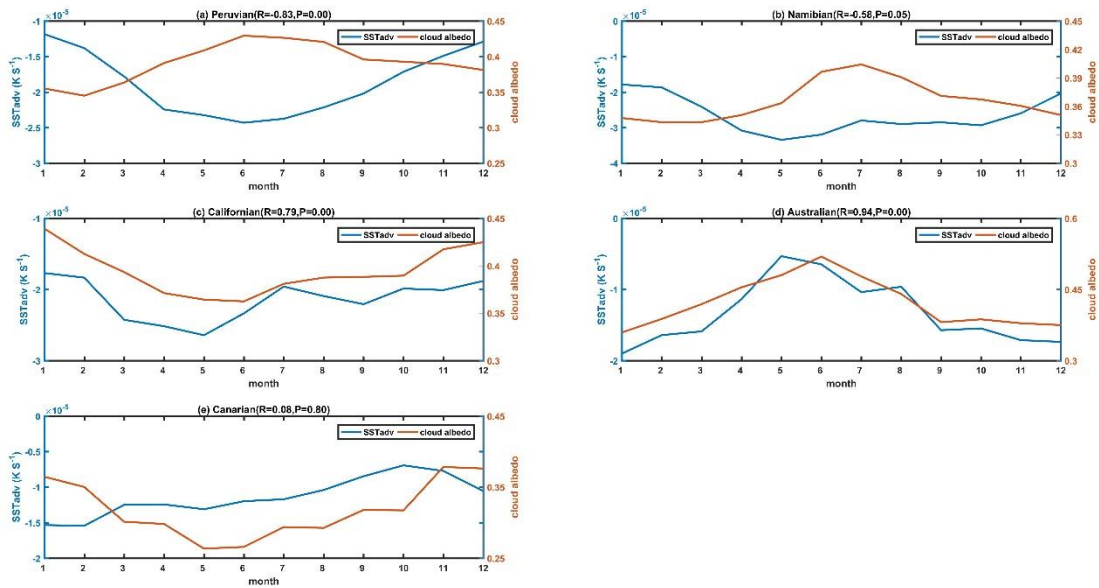Figure R4: Similar to Fig. R2, but for estimated inversion strength (EIS).

Fig. R5: Similar to Fig. R2, but for horizontal temperature advection at the surface (SSTadv).

27. Line 323-324, what are the potential reasons for the superior performance of AMIP6 at the Australian region?

    Response: Thanks for your comments. In the revised manuscript, we reorganize the Result sections (Section 3) and the discussion is deleted. The potential reasons for the superior performance of AMIP6 at the Australian region may be due to its better simulation of cloud fraction and planetary albedo. Please see Figs. R6-7. We can see that the AMIP6 performance is

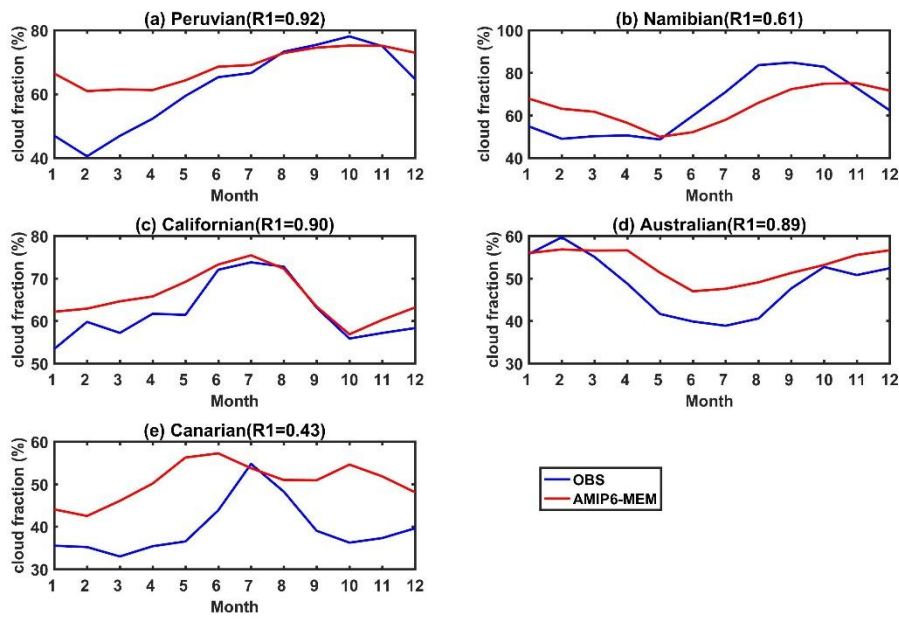better at the Australian region than other regions, except that Peruvian region.

Figure R6: Seasonal cycles of cloud fraction from AMIP6 MEM outputs (red line) and during 2003-2014 compared with satellite observations (blue line), over the (a) Peruvian, (b) Namibian (c) Californian, (d) Australian and (e) Canarian regions. The R1 indicate the temporal correlations between satellite observations and AMIP6-MEM.
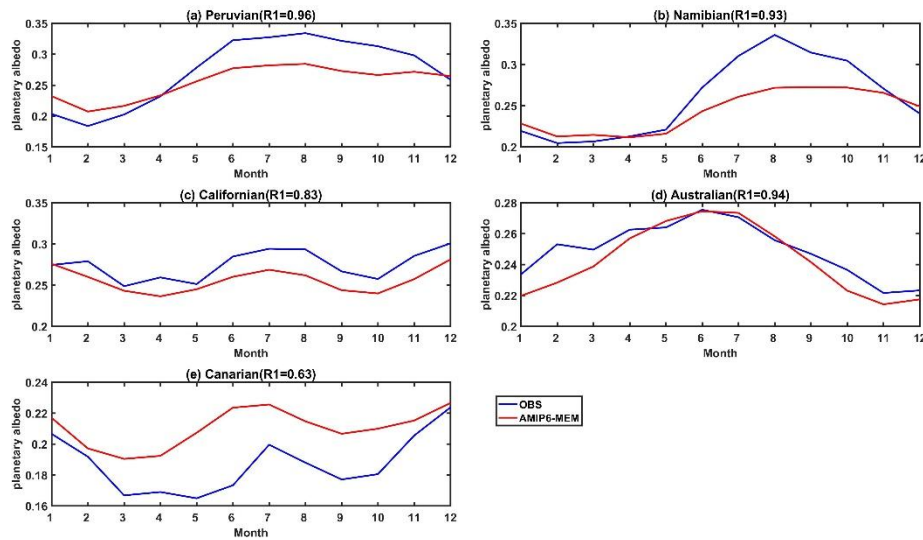

Figure R7: Similar to Figure R5, but for planetary albedo.

28. Line 328-329, these two sentence show almost the same meanings and have been described ealier. You may delete them or one of them to avoid redundant descriptions.

Response: It is deleted in the revised manuscript.

29. Line 329-331, regarding the significant role of LWP on the relationship between aerosol and clouds, some recent studies are worthy to read and mention here, Qiu et al. (2017, doi:10.1016/j.atmosenv.2017.06.002) and Zhao et al. (2019, doi:10.3390/atmos10010019).

Response: Thanks for your comments. Related information and reference is already added in the revised manuscript. Please see the Line: 330-333.

30. Line 332-333, you may rephrase this sentence to make it more clear.

Response: It is rephrased in the revised manuscript. Please see the Line: 333-334.

31. Line 341-342, "that the cloud albedo increase with increasing BC and decrease with increasing" -> "that the cloud albedo increases with increasing BC and decreases with increasing"

Response: It is corrected in the revised manuscript. Please see the Line: Line 342-343.

32. Line 355-365, in addition direct effect of dust on cloud properties, the dust aerosol can even further influence the meteorological environment that the clouds form as indicated by Sun et al. (2020, doi:10.1029/2020JD033454)

Response: Related information and reference is already added in the revised manuscript. Please see the Line: 361-364.

33. Line 374-376, do you mean "SO42-"?

Response: It means the "SO4", i.e., the sulfate aerosols.

34. Line 383-384, you cannot compare time scale with region scale. I think what you would like to deliver is the time scale difference between "monthly average" and "instaneous"?

Response: Thanks for your comments. It is corrected in the revised manuscript. Please see the Line: 387.

35. Line 407-408, while this result could be right, personally, I think theoretically the meteorological

factors should have important influence on the interactions between aerosols and cloud albedo for low LWP conditions.

Response: We very thank reviewer for providing detailed comments and suggestions. Based on the suggestions from Reviewer #2, we reorganize the Result section (Section 3) and new meteorological factors are considered in the partial correlations analysis in the revised manuscript. We find that the correlations of all aerosol types vary significantly by eliminating the influence of all meteorological parameters in the revised manuscript. The meteorological factors indeed have important influence on the interactions between aerosols and cloud albedo for both low and high LWP conditions.

36. Line 410-414, have you used the data of "SO2"?

    Response: The data of "SO2" is used in the study.