Response to Reviewer #1's Comments:

Jiming Li et al. (Author)

We are very grateful for the Review #1's detailed comments, which helped us improve this paper significantly. Some grammatical errors already were corrected in the revision and the paper also be edited by a native English speaker to make it more readable. In addition to our point-by-point responses to the reviewer's comments provided below, we also added some scientific discussions in section 4 of the revised paper.

Specific Comments

(1) The authors mentioned that the CloudSat and CALIPSO satellites provide 3-D structures of clouds on a global scale with high vertical resolution, but the analyses of geographical distributions were performed on 2-D maps, thus the useful vertical information is actually lost. It may be more interesting and useful to include the vertical distributions, which are the most significant advantages of these satellites compared to previous observations and studies. The authors did not explicitly explain how they calculated the global distribution maps, is it just for one layer or column integrated?

Response: We appreciate the insightful suggestion made by reviewer. In this manuscript, we didn't include the cloud vertical distribution and the vertical separation of two cloud types. Detailed analysis mainly focuses on the cloud-type overlap, and the calculation of overlap parameter "*a*". In the following work, we will pay more attention to establish the statistical connection between multilayered cloud types and the environmental conditions by considering the vertical distribution of cloud types and their separation distance. In revised paper, we also further added some explanation in section 2 about global distribution of multilayered cloud fraction (see paper 8, Line 204-214). That is, "we consider one data profile as a multilayered (or single-layered) cloud profile when two or more cloud layers (or only one layer) are present within the vertical profile based on the parameter "cloud layer". To map the regional variability in the studied variable, we group the global area into 2°×2°

grid boxes to collect a sufficient number of samples in each grid box. Following the definitions of cloud fraction and cloud amount proposed by Hagihara et al. (2010), the cloud-type fractions and amounts in a given grid box are defined as the number of particular cloud-type profiles divided by the number of total sample profiles and the total cloud profiles within this box, respectively. For example, the cloud fraction for multilayered clouds is the ratio of the number of multilayered cloud profiles to the number of total sample profiles in a given grid box".

(2) Although the authors mentioned that the diurnal variations of cloud properties are referred as the differences between the two overpass times of CloudSat/CALIPSO, it is still not appropriate to use these data for the diurnal study due to the narrow swath and low signal-to-noise ratio during daytime. Moreover, deep convection and precipitation events occur most frequently in the late afternoon or early evening over land and could not be detected by CloudSat, which may introduce bias to the statistics of some cloud types (e.g., deep convective cloud).

Response: We agree with reviewer. The full diurnal cycle cannot be captured by CALIPSO and CloudSat. Thus, the day-night comparisons of cloud fractions are only represented by the two overpass times of the satellites. We also didn't plan to further study the diurnal variations of cloud properties using CALIPSO and CloudSat.

(3) In Table 5, the authors compared their results with previous results from other 3 datasets and claimed "reasonable agreement with at least one of the other datasets". However, the authors did not provide any quantitative comparison (e.g., percentage difference) or any statistical test, thus it is not quite convincing to the readers. I suggest remove this table and corresponding discussions.

Response: Following the suggestion of reviewer, we already removed table 5 and corresponding discussions in the revise paper.

(4) When considering cloud-overlap, the authors only discussed the overlap of 2 cloud types, what about 3 or more types overlap? In Fig.2, the authors divide the overlap into two groups, is there any reason for this?

Response: In revised paper, we added some explanation in section 3.1. For the occurrence frequencies of specific two cloud types (e.g., Fig. 2 and 3), their overlap in any three or more layer cloud systems (Such as, High+As+Cu) is also included in statistical results. But, only two layer cloud systems is used when we calculate the weighted cloud radiative effect of specific two cloud types-overlap in section 3.3 (page 9, 251-254). In Fig. 2, we divided the overlap into two groups based on their frequencies. There is no any other reason.

(5) Section 4 is the most interesting and useful part of this study, but there are too many tedious statements and descriptions which blur the most important points. I suggest the authors add more discussion on how the evaluation of overlap assumptions could help improve future cloud parameterizations in GCMs and reduce the model uncertainties. One question is that GCMs do not provide so many different cloud types as ISCCP/CloudSat does, they generally divide clouds into stratiform and convective types, so how will your cloud overlap study benefit the cloud modeling community?

Response: We appreciate the insightful suggestion made by reviewer. In revised paper, we added more discussion about cloud overlap assumption in section 4. At present, it is difficult to parameterize the cloud overlap characteristics in numerical models by using cloud type information, because only three cloud types (e.g., low-level marine stratus, convective cloud and layered cloud) are diagnosed by the cloud scheme in current GCMs. But, this study support the findings of Naud et al. (2008) that factors such as dynamics could be connected to the way cloudy layers overlap, because cloud types are governed by different types of atmospheric motion and state. Thus, we consider environmental conditions related to cloud formation as a means to parameterize the overlap characteristics in numerical models. However, before that, statistical connection between multilayered cloud types and the environmental conditions should be established in the future studies by using global cloud-overlap and meteorological reanalysis datasets.

Technical corrections:

We already revised some grammatical errors and made editorial changes in the revision to make it more readable.

(17) L208: when you calculate cloud fraction average, did you include clear-sky? It should be the total sample profiles.

Response: Following the definitions of cloud fraction and cloud amount proposed by Hagihara et al. (2010), the cloud-type fractions and amounts in a given grid box are defined as the number of particular cloud-type profiles divided by the number of total sample profiles and the total cloud profiles within this box, respectively. For example, the cloud fraction for multilayered clouds is the ratio of the number of multilayered cloud profiles to the number of total sample profiles in a given grid box.

(18) L225: how did you calculate cloud fraction for multilayered clouds?

Response: We consider one data profile as a multilayered (or single-layered) cloud profile when two or more cloud layers (or only one layer) are present within the vertical profile based on the parameter "cloud layer". The cloud fraction for multilayered clouds is the ratio of the number of multilayered cloud profiles to the number of total sample profiles in a given grid box.

(19) L357: I did not see STD in Fig. 4c-4d.

Response: We only provide the global average along-track horizontal scales and standard deviation (STD) of cloud systems in Fig. 4c-4d for the clarity of the Figure.

(20) L370–372: "Although….However…", need to rewrite this sentence.

Response: we already revised it.

(25) L506–511: this sentence is too long, need to reconstruct.

Response: we already revised it.

Response to Reviewer #2's Comments:

Jiming Li et al. (Author)

We are very grateful for the Review #2' important suggestions, which helped us improve this paper significantly. Some grammatical errors already were corrected in the revision and the paper also be edited by a native English speaker to make it more readable. In addition to our point-by-point responses to the reviewer's comments provided below, we also added some scientific discussions in section 4 of the revised paper.

Comments:

In their revised submission, the authors have removed some of the more trivial and uncertain results included in their original version, put more emphasis on deriving overlap statistics, and added an analysis of the radiative fluxes for the different cloud types. This along with the useful section on the evaluation of model overlap assumptions makes the paper worth of publication in a scientific journal. However, the authors should work to provide more comprehensive and detailed suggestions for overlap assumption improvements based on their analysis, rather than vaguely suggest the incorporation of the Radar-LIDAR results in the overlap schemes through a linear combination of minimum and random overlap assumptions.

Response: We appreciate the insightful suggestion made by reviewer. In revised paper, we added more discussion about cloud overlap assumption in section 4. At present, it is difficult to parameterize the cloud overlap characteristics in numerical models by using cloud type information, because only three cloud types (e.g., low-level marine stratus, convective cloud and layered cloud) are diagnosed by the cloud scheme in current GCMs. But, this study support the findings of Naud et al. (2008) that factors such as dynamics could be connected to the way cloudy layers overlap, because cloud types are governed by different types of atmospheric motion and state. Thus, we consider environmental conditions related to cloud formation as a means to parameterize the overlap characteristics in numerical models. However, before that, statistical connection between multilayered cloud types and the environmental conditions should be established in the future studies by using global cloud-overlap and meteorological reanalysis datasets (see section 4).