Response to Referees' Comments

This paper used RS and lidar measurements to develop a robust remote sensing method to distinguish coupled and decoupled clouds over land because the traditional method(s) used over Ocean cannot be used over land due to the relatively complex thermodynamics over land. This study provides the first lidar-based method to automatically determine the coupling and decoupling of low clouds over land, which will provide an advanced tool to investigate low clouds in climate systems.
However, some descriptions in the abstract and text are not clear for this reviewer. For example, in the abstract, they did not clearly describe what are their new methods (both RS and lidar, see may detailed comments in abstract) and some sentences are confusing. Also they should also discuss what are advantages in the new methods compared to those in MBL clouds (Dong et al. 2015 and Jones et al. 2011). In your Figures and discussions, you may add one plot or some sentences to discuss what are similarities and differences using new method and over Ocean (Dong et al., Jones) in which you can demonstrate how robust of new method applied over land, while previous method(s) have a relative large difference to false alarm etc……
In my point of view, a number of details need to be cared in the revision. Therefore, I suggest a minor or major revision for ACP editor.

Response: We appreciate the reviewer's constructive comments on our work.

To address the concerns from the reviewers, we made corresponding revisions, which are outlined as follows.
1) We described the basic principle of our method in the revised abstract.

2) Compared to the traditional method using lifted condense levels, we discussed the merits and advantages of our method in the revised introduction.

3) In the revised Section 3.1, we added substantial discussions for the similarities and differences between our method and the methods for MBL clouds (Dong et al. 2015 and Jones et al. 2011).

Our detailed responses to the reviewer's specific comments are listed below. For clarity, we have listed the reviewers' comments in italics, followed by our responses in bold plain font.

Specific comments:

1. Page 2, line 25: Should use one sentence to mention what similarities and differences comapred to the method over Ocean, such as Jones et al. 2011 and Dong et al. 2015, because they also used Potential temp profiles. A threshold $\Delta\theta L<0.5$ K was suggested by Jones et al. [2011] to differentiate coupled and decoupled boundary layers. In the study of Dong et al. 2015, an additional criterion $\Delta qt<0.5$ g/kg was added for selecting the coupled cases. So what is your new method?

Response: The radiosonde-based method is largely adopted from the previous study (Jones et al., 2011; Dong et al., 2015). For radiosonde, we also use a threshold

Δθ. Instead of using the potential temperature differences between cloud-base and surface as adopted in the two previous studies, we use the potential temperature differences between cloud-base and PBL top. The change is necessary due to the complex thermodynamic structure over the land. The large variability of θ near the surface layer would notably affect the result. Hence, we use the potential temperature at the PBL top rather than those values near the surface.

In general, the idea for the radiosonde-based method is the same as previous studies. During the daytime, the potential temperature at the PBL top is close to the potential temperature at the top of the surface layer for most cases.

This study aims to develop the lidar-based method to diagnose cloud coupling. The radiosonde-based method is used to compare and validate the lidar-based retrievals.

A detailed discussion has been incorporated into the revised introduction and Section 3.1.

2. Page 2, line 30-31: Above you mention to derive coupling using potential temp profile (from sounding or merged sounding?), Now you said the coupled states derived from lidar and consist with sounding. Confusing.

Response: Our study aims to use lidar backscatter signals to diagnose cloud coupling. Meanwhile, the radiosonde method is used for evaluation. We clarify this point in the revised abstract.

3. Page 2, line 35, See my last comment, what is new method? Should briefly mention it.

Response: We added a brief description to the new method as follows:
"The new lidar-based method jointly uses the differences between the PBLH, the lifted condensation level, and the cloud position to diagnose the cloud coupling. As a result, the coupled states derived from this lidar-based method are rather consistent with those derived from radiosondes. "

4. In Figure 3, you said only use Ds=1 km, not relate to delta

Response: We do use delta in the threshold. The caption for Figure 3 is revised to make it clear.

5. Table 1: You can move "These parameter....., respectively" below the Table to keep Table title as short as possible

Response: We revised it as suggest.

6. For coupled cloud, it is different to Figure 1 of Dong et al. 2015, as well as in Jones et al. 2011, where ΔθL and ΔqL are nearly constant below and within cloud layer. For decoupled cloud, they are constant to each other.

Response: Here, we use the virtual potential temperature instead of the liquid potential temperature as in the previous two studies. Without the information of

liquid water mixing ratio within clouds, the virtual potential temperature is more convenient to calculate from radiosonde data.

For the liquid potential temperature, it should be a near-constant within the stratocumulus. For the virtual potential temperature, it would decrease following the moist adiabatic process.

Since we use the potential temperature profiles in the sub-cloud layer to diagnose the cloud coupling, there should be no difference in the identification results by using virtual potential temperature.

These discussions have been incorporated into the revised Section 3.1.

7. Figure 2: totally differ to your Figure caption. Blue line should be potential temp, and red line is WVMR. ΔθL should use blue color. I have no clue how did you plot X-axis with uneven space? from current plot, I can not get Δθ=5.0.

Response: The mistake is corrected in the figure caption. We do use an even space for X-axis in all sub-figure. We revised the minor tick in figure 2d to make it clear. In Figure 2d, θ_v at cloud base and PBL top are 284.8 and 279.8, respectively.

8. In Dong et al and Jones et al., they calculate Δθ between CBH and surface to define coupled or decoupled. here you use different definition, what is benefit or advantage compared to those two studies?

Response: Compared to the previous studies for marine clouds, we use θ at the PBL top instead of θ near the surface. This change is due to the large variation in θ near the land surface. Meanwhile, the difference between cloud base and PBL top also can represent the turbulent coupling between cloud and PBL.

On the other hand, the potential temperature at the PBL top is close to the potential temperature at the top of the surface layer. Hence, the principle is the same as the previous methods, but the treatments are different in light of the differences between marine and continental boundaries. The retrievals from the radiosonde method are not the central point in our study but are used for comparison.

We incorporated these discussions into the revised Section 3.1.

9. only Ds=1K, not relate to ΔθL?

Response: We revised this statement as:

"By using a threshold of $\Delta\theta_v < \delta_s$ (1 K), we can identify the coupled cloud regime".

10. How did you get these five values? Based on statistical results?

Response: Indeed, the selections of these parameters are related to the statistical relationships between PBL and cloud position for coupled and decoupled conditions. For example, A_1 represents the maximum differences between the cloud base, LCL, and PBL top for coupled conditions. We found the differences

between these parameters are less than 0.7km for more than 95% of cases. Hence, A_1 is set as 0.7km. Moreover, A_5 represents the averaged ratio between CBH and PBLH. If A_5 is above 1.1, PBLH retrievals under cloudy conditions are overestimated. We set A_5 as 1.1 to achieve a relatively low bias and a relatively high correlation coefficient at the same time.

The detailed discussions for selecting these five values can be found in Section 3.2.2.