Atmos. Chem. Phys. Discuss., 11, C4493–C4496, 2011
www.atmos-chem-phys-discuss.net/11/C4493/2011/

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Relationship between cloud radiative forcing, cloud fraction and cloud albedo, and new surface-based approach for determining cloud albedo" *by* Y. Liu et al.

Y. Liu et al.

lyg@bnl.gov

Received and published: 7 June 2011

Dear Editor,

Please find the revised manuscript entitled "Relationship between cloud radiative forcing, cloud fraction and cloud albedo, and new surface-based approach for determining cloud albedo" electronically submitted to Atmospheric Chemistry and Physics for publication according to the reviewers' comments.

We highly appreciate the constructive comments from both reviewers, and have taken virtually all of them in the revision. Briefly, Section 3.3 is added to examine the assumptions underlying the formulation as possible reasons for the discrepancy presented in

Fig.1, along with new Figures 2-9, Appendix A, and some new equations and references. Three paragraphs are also added at the end of Section 3.2 to discuss cloud fraction measurements and compare the estimates derived from surface and satellite measurements in context of cloud albedo estimates presented in Fig 1. Our detailed responses are given below. For your and reviewers' convenience, the responses are organized into two parts: the first part addresses the comments shared by both reviewers, and the second part is reviewer-specific.

Sincerely

Yangang Liu

****

Responses to Both Reviewers

General response: We thank both reviewers for their insightful comments and suggestions. We have taken virtually all the comments/suggestions in the revision by adding Section 3.3 with four subsections, along with an Appendix, new Figures 2-9, and some new equations and references. The following are our responses to the common concerns shared by both reviewers.

1. Not enough information on surface-based measurements and error discussion: Taken. Three paragraphs are added in Section 3.2 to address these concerns, along with new Figures 2-3 and some new references.

2. Effect of multilayer clouds: Taken. A new Subsection 3.3.1. is devoted to this concern, along with new Figures 4-6, and some new equations and references. Briefly, we use the concurrent ARM ARSCL cloud fraction products derived from surface-based remote sensors such as radar and lidar to partition clouds into single layer and multilayer clouds, and then perform analysis for samples with different percentages of single-layer clouds.

3. Not enough discussion on the results and assumptions underlying the theoretical

ACPD

11, C4493–C4496, 2011

formulation: Four subsections are added under a new Section 3.3 to discern and discuss potential causes for the discrepancy between the surface-based cloud albedo and satellite-based cloud albedo shown in Fig. 1, including the major assumptions underlying the theoretical formulation: single-layer cloud (Section 3.3.1), neglect of surface albedo and multiple reflections between surface and clouds (Section 3.3.2), and absorption associated with clouds (Section 3.3.3). New figures 4-9, equations, and references are added as a result.

4. Unsatisfactory discussion on results of multiscale variation: This section is modified to accommodate the questions and suggested changes.

****

Some specific responses to Reviewer 1:

1. Concern over circular argument: The surface-radiation measurements include downwelling total and diffuse irradiance, and upwelling irradiance. Cloud fraction is primarily based on diffuse radiation, and has been validated against whole-sky imager measurements. Surface albedo is calculated from upwelling and downwelling measurements. We believe there is enough information in these measurements to infer both cloud fraction and cloud albedo, no circular argument involved. Also, we purposely try to demonstrate a method that is solely based on surface radiation measurements, and use data as such. Nevertheless, to make it clearer and eliminate possible misunderstanding, we add three paragraphs at the end of Section 3.2 to discuss cloud fraction measurements and compare the surface-based and satellite measured cloud fractions. New references (Long et al. 2006 and Hogan et al. 2001) are added.

2. Need for surface-based method: As discussed in the beginning of Section 2, measurements of cloud albedo are underdeveloped, and any additional methods would be a plus to the community. A surface-based method like the one presented here is particularly needed, because it provides another set of measurements with much higher temporal resolution than satellites. The number of surface-based measurements is

ACPD
11, C4493–C4496, 2011

growing and their applications warrant investigation like this paper.

Interactive comment on Atmos. Chem. Phys. Discuss., 11, 5681, 2011.