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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.

Anonymous Referee #1

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The paper first derives an analytical expression between a relative cloud radiative forcing parameter and cloud fraction and cloud albedo. Then, using surface flux measurements from the ARM facility they derive the cloud radiative forcing and cloud fraction and use these derived properties to calculate the cloud albedo. Comparisons are made to satellite albedo and diurnal and seasonal cycles of the various parameters are presented.

Although the relative cloud radiative forcing parameter and derivation of cloud albedo from surface measurements is an interesting idea, this paper needs major revisions before it is suitable for publication.

The primary weakness of the paper is that not enough information is given about the surface flux measurements from which all the results in the paper are derived. Basically all the information about these measurements is in one sentence. The Long and Ackerman 2000 reference cited gives information about how the clear sky fluxes are estimated, but no information about how cloud fraction is derived. Without more detail about how the cloud fraction is estimated from the surface flux measurements, it is hard to know whether there is any circularity in the approach. For instance, the cloud fraction must be estimated in some way from the measured fluxes, as is the clear sky flux. Given that all parameters are estimated from a single set of measurements, it is not surprising that they show strong correlation (Fig 3). A more satisfying methodology would be to use completely separate measurements of cloud fraction (perhaps from the total sky imager at the site) along with the clear sky flux estimates from the broadband radiometers to derive the cloud albedo. Additionally, some discussion of uncertainty in the measured and derived parameters would be useful for interpreting the results.

A further weakness of the paper is the minimal discussion of the figures. Figure 1 compares the cloud albedo derived from the satellite and the ground-based approach. There are two sentences of total discussion about this figure. Neither sentence mentions nor explains the clear difference in slope between the two measurements for cloud albedo greater than or less than 0.3. Nor is there any discussion of how cloud fraction may play an important role in the satellite estimates. It would be useful to separate the comparison into points with low and high cloud fractions to see how the comparisons vary. Finally, if the satellite cloud albedo measurements (which are clearly more direct measurements than the ground-based ones) are trustworthy, why do we even need a ground-based method that will clearly be more limited in spatial extent? If the satellite cloud albedo measurements are only useful for certain conditions (i.e. for overcast clouds that completely fill the pixel) this needs to be clarified and the comparison only done for those conditions.

The discussion of Figure 2 is also unsatisfying. The authors claim that the basic char-

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acteristics of the diurnal and annual variations in cloud fraction are consistent with other cited studies. Although I did not look at the other papers, examination of the diurnal cycle of total cloud fraction shown in the Dong et al. 2006 reference cited (their Figure 4) shows no evidence of a strong minimum near local noon. In fact the fraction of low clouds shows a maximum near local noon. Given this discrepancy, further analysis of the diurnal cycle of the results in this paper is warranted.

Finally, the derivation of the equations for their relative cloud forcing rely on the assumption of a single layer cloud (p. 5686, first line). Nowhere in the paper do the authors discuss the effect of that assumption on their results or attempt to limit their analysis to only single layer clouds. Given the vast information about cloud vertical structure available at the ARM site, screening for single-layer clouds should be relatively easy.

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