

## General comments

This paper presents useful insights into the quality of the two most commonly used global cloud climatologies, from MODIS and ISCCP. The results reported here should be of great interest to those using MODIS and ISCCP cloud products. The paper is generally well written, though a number of improvements are needed:

The introduction should be improved. It does a good job of citing the literature but lacks a clear organization and contains information which is not relevant to the manuscript, especially in the first two paragraphs. For example, it mentions contrails twice but the manuscript does not report results for contrails. It discusses cloud trends, but can a study looking at a single year tell us anything about trends? Many studies of global cloud cover have been performed over the years. The inclusion of so many different results makes it difficult to follow. The introduction should tell us what motivated this study and in what way the results reported here will improve our knowledge of global cirrus. Lines 51 – 78 exhibit better organization, describing the evolution of techniques to observe clouds and some of the difficulties in characterizing them.

A major reason for the discrepancy of high cloud cover between CALIOP and MODIS is the greater detection sensitivity of CALIOP to optically thin cirrus. This can be seen in the large discrepancy in cloud cover in the upper tropical troposphere, which is dominated by optically thin cirrus. It would be very useful to the community to examine the extent to which the superior detection sensitivity of CALIOP can explain the differences with MODIS. Repeating these comparisons after CALIOP cirrus is filtered by removing optically thin cirrus layers (optical depths less than 0.1, for example) could provide important insights.

## Specific comments

The abstract should be a little more clear on the motivation for this research. It says the usefulness of active sensor data in climatological studies is limited. Limited in what way and in what way are active sensor data useful for this study?

Line 18: It is useful to point out that it has been known for decades that clouds are radiatively significant, but global net cloud forcing is now estimated to be closer to  $-20 \text{ W/m}^2$ . It would be good to add a more recent estimate.

Lines 35-36 state that cirrus occurrence is between 28% and 42%. A citation should be given for these estimates. A few lines later, cirrus cover is given as 17%, from Sassen (2009), based on CALIOP observations. Why the discrepancy? Sassen is using the WMO definition of cirrus (optical depth less than 3.6 and above 440 hPa, as in Figure 1). Are other studies using a different definition, or have difficulty in determining cloud altitude?

Line 80: The Introduction discusses “high level clouds” as composed of Cirrus, Cirrocumulus, and Cirrostratus. It should be made clear at this point what is meant when the text says “cirrus”.

Line 82: MODIS is more properly referred to as a multi-band radiometer than a spectroradiometer

Line 83: Was there a reason that 2015 was picked as the year of study? It should be pointed out somewhere in the paper, perhaps in the discussion in Section 5, that the ISCCP statistics presented in the paper are not representative of the early years of the ISCCP climatology, which relied on polar orbiting data from AVHRR rather than MODIS.

The symbols used in the math expressions in lines 127 and 131 should be explained. I am not familiar with these.

Line 143-145: This description of ISCCP should be moved to the Introduction. The Introduction should also discuss the significance of the ISCCP project and the resulting climatology, as the manuscript reports many results for ISCCP.

Line 152-157 present two different definitions of 'cirrus'. When cirrus statistics are presented later, it should be made clear which of these definitions is being used. Further, regarding Figure 1: The current version (Version 4) of the CALIOP retrieval algorithm does not report optical depths larger than about 10 (see the right panel of Figure 3). Thus the optical depth reported by CALIOP will be less than 23 whether the actual cloud is Cirro-stratus or Deep Convection, as defined in Figure 1. The manuscript needs to be more clear on what classes of high cloud are included in the various occurrence statistics which are reported.

Line 166 mentions the CALIOP cloud subtype flag. In computing statistics in this manuscript, is this flag being used to define "cirrus" (category 6) as observed by CALIOP? It is not clear how the CALIPSO-based cloud mask is constructed.

Lines 185-190: More details on spatial matching of CALIPSO and MODIS observations should be given. There are between one and three CALIOP lidar shots within each 1-km MODIS pixel, depending on the exact alignment of the two satellites. What criteria was used to define a 'match'? Also, the CALIPSO orbit was offset from the orbit of Aqua. At the equator, the view angle of MODIS to the CALIOP footprint at the Earth surface was about 17 degrees, which introduces parallax. Was this considered in the spatial matching? If so, how?

Lines 205-230: I had a hard time remembering what all the 2- and 3-letter abbreviations for the statistical parameters mean (ROP, POD, OA, etc). Listing these in a table would be helpful.

Lines 237-248: If bootstrapping is really necessary to avoid biased results, more detail is needed here as I'm not aware that bootstrapping has ever been used in previous studies of global cloud cover. Bootstrapping is often applied in situations where the number of samples is small but in this case the number of samples seems large enough that bootstrapping is not necessary. Is the bootstrapping needed for estimating cloud cover, or only for the performance statistics (POD, FAR, etc). Please consider providing a simple example to illustrate the bias that bootstrapping avoids.

Lines 258-259: These numbers for cirrus coverage are lower than I would expect from CALIOP observations and the difference between day and night is larger than I would expect. How is "cirrus cloud" being defined here? Is additional filtering being done besides CAD score greater than 80? Is bootstrapping being used to compute cloud cover here?

Line 265: Regarding figure 3, I find cumulative distributions useful but difficult to interpret without also showing the frequency of occurrence, which in this case would show the difference in the day and night

cumulative distributions to be due to the detection of many more low optical depth clouds at night. I suggest adding a figure showing the two frequency-of-occurrence distributions. By the way, the paper should point out that the major reason for the CALIOP day-night difference in cirrus occurrence is better detection sensitivity at night.

Caption of Table 2: what does “precluded the use of the test” mean? Which test?

Line 290: what does “physical properties of the respective radiation range” mean? Please reword or explain.

Figure 4: I can’t tell the difference between the curves for ATC and ISCCP3.6 here, or between BT6.7 and BT1.38. Switching to colored lines would make this more legible. I have similar difficulties with Figure 5.

Summary: Due to the importance of the ISCCP cloud climatology, results related to the ISCCP evaluation should be summarized in Section 5.

Figure 6: It seems the choice of color bar could be improved for 6i and 6j.

Line 374: The “CALIOP data cirrus mask” isn’t really described in Section 3. Some description is necessary (in Section 3) as there are many ways the data might be used to create a mask.

### **Technical corrections**

Line 158: “for example CALIOP” rather than “in example CALIOP”

Line 226: I don’t think PE is ever defined

Line 269: I think maybe “4.20 at night” is a typo and should be “0.42 at night”?

Figures 2 and 3: the captions should state that these statistics are based on CALIOP data.

Line 273: “table” should be spelled out (not tab.2), here and elsewhere

Line 297: Should be “A similar pattern ...”

Line 302: I think “Figure 5” here should be Figure 4

Line 326: “notably the ATC test”

Line 329: Should be “An increasing number of ...”

Line 334: “IGBP groups were aggregated ...”

Line 374: “The CALIOP data mask ...” would be better