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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Resolving ice cloud optical thickness biases between CALIOP and MODIS using infrared retrievals" *by* R. E. Holz et al.

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I would like to thank both reviewers for taking the time to carefully read our manuscript and provide a very thoughtful and constructive reviews. Based on the reviews the manuscript has been modified and greatly improved. We now provide a detailed response to the reviewer comments and suggestions.

Reviewer 1: To address your feedback we have made modifications to the manuscript which include: 1. Modified the introduction to provide a "story line" beginning in the second paragraph of the introduction. We hope that his helps the reader better understand the motivation focus of the manuscript. 2. Your question about the relationship to

cloud boundaries measured by CALIOP and used in the IR simulations and retrievals is a good one. The LBLDIS radiative transfer software was selected to address this exact issue. The radiative calculation distributes the cloud ice water path through the cloud boundaries defined by CALIOP. The atmospheric temperature is interpolated by LBLDIS so that the calculations account for the changes in the emission through the vertical profile of the cloud. For cirrus with equally distributed IWP in the vertical this methodology will accurately simulate the TOA radiance. There will be some uncertainty introduced for clouds where the extinction (IWP) varies considerably in the vertical. To limit this uncertainty only cloud with vertical depths less 4 km. 3. We only use FOV where CALIOP is not attenuated (all the way to the surface). Using this constraint eliminates the cloud base underestimation concern. I added this clarification to section 2.1. 4. With regards to your concern about the CALIOP unconstrained retrievals in the paper and the change of the assumed lidar ratio to 32. I talked with Mark Vaughan (Co author) and he feels this result is a very important to present as it provides the motivation for there the CALIOP teams current efforts to better define the lidar ratio (ie Garnier 2015). I did add some text clarifying the goals of this initial study presented in the manuscript in section 5.3.

Reviewer 2: We present our response to your review and questions listed by page number. Page 58: Added reference to the section describing the results of Figure 1. Page 60: The sections where re-organized (section 3 and 4 have been combined) and added an overview paragraph to the intro providing an outline. Page 61:line 9: The IR cirrus optical thickness has very little sensitivity to effective radius at 11 um (the channel used to retrieve the OT). I added a sensitivity discussion to the paragraph. Page 63: The Beta retrieval used are 11-12 um and 8.5-11um pairs. I have added this to the discussion on page 63. Page 65. Decided to remove the +- 10 as it is not very accurate. Instead added text to explain the expected variability. Page 68: Added a more detailed explanation of the MODIS C5 filtering Page 71: The scattering angles range from 175 (left middle) – 100 (right side of image) Page 71: line 12 Added a discussion about the dependence on scattering angle. Page 72 line 1: added Ping

Yang reference Page 72 Page 72 line 13: Added suggested references. Page 73: line 26 added 2 references to support the smaller asymmetry parameter. Page 74: line 14 fixed .. Page 76:line 8 Made the suggested change in wording Page 76: line 7: It is not consistent with the Ping Yang's database for severely roughened aggregated columns. There is considerable uncertainty in Ping's simulations at the 180-degree backscatter. He is currently working on improving the calculations for the 180 peak. Given the current work I would rather leave it out of the paper. Page 77 line 12: Very good point. I have added this to the conclusions. Page 77 line 14: Added the sentence and references Page 77 line 26: made the correction.

Interactive comment on Atmos. Chem. Phys. Discuss., 15, 29455, 2015.