

Interactive comment on “Changes in the shape of cloud ice water content vertical structure due to aerosol variations” by Steven T. Massie et al.

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Received and published: 21 April 2016

Changes in the shape of cloud ice water content vertical structure due to aerosol variations, by Steven T. Massie, Julien Delanoë, Charles G. Bardeen, Jonathan Jiang and Lei Huang Anonymous Referee #2 Received and published: 16 February 2016

This paper is generally well written. After addressing my major concern below, the results of this paper would undoubtedly motivate worthwhile future research efforts in this field.

My major concern is that this study uses only MODIS AOT to analyze vertical structure changes of ice clouds under various AOT amounts. It is noted that MODIS can not distinguish aerosol types. While aerosols could perturb the vertical profiles of clouds via cloud particle size change and latent heat release, and thus invigorate convection

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(Rosenfeld, 2008), absorptive aerosols could result in less solar radiation at the surface and more stable vertical temperature profile and thus inhibit cloud development (see work by Ramanathan 2005, 2007). I noted in most cases different aerosol types are mixed, which may explain why only very small changes of cloud vertical structure were found by this study. My suggestions is to expand the database to include OMI absorptive aerosols, or perhaps Aura MLS CO (the newest version 4) and thus the cases for absorbing aerosols can be identified and distinguished.

We agree that analysis that compares the effects of both absorptive aerosol (OMI AAOD and 215 hPa MLS CO, an absorptive aerosol proxy) and MODIS AODs (which include both scattering and absorptive aerosol) is an important task. In the revised paper additional text and figures have been added to include calculations in which absorptive aerosol (OMI AAOD and MLS V4 CO at 215 hPa) data is used in the same manner as the MOIS AODs. As discussed in the revised paper, the calculations (see Figure 15 and Figure 13) are supportive of the assertion that absorptive aerosol tends to inhibit cloud development. Figures 15 and 13 graphically illustrate differences between the effects of absorbing aerosols (from OMI and MLS) and all aerosols (from MODIS). This is especially apparent in comparing the positive MODIS AOD means and negative MLS CO means.

Minor comments:

(1) Figure 1. The reason for conducting the study in 12 different regions should be explained more clearly. For example, the regions can be defined by cloud dynamics, which varies from region to region.

Text on page 109 has been revised to indicate that topographical and surface heating characteristics vary from region to region. The 12 regions were selected to cover the tropics, selected to separate ocean from land, and selected to include as many IWC profiles as possible in order to reinforce the statistics.

(2) Figure 5, and also page 12 Line 7. You mentioned the largest derivatives are over

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India, why?

As stated in the text, the variance in the derivatives (new Figure 7) increases as the number of profiles decreases. India has the smallest area of the 12 regions. We believe that this is why India primarily has the largest spread in the derivatives. Text has been added (page 15 of revised paper) to also mention the fact that India is subject to complicated monsoon dynamics, and the “elevated heat pump” physics of William Lau likely also is of importance. Absorptive aerosol above the Tibetan plateau is attributed to provide an elevated heating source which leads to enhanced circulation that will draw air from the surface upwards along the southern flank of the Himalayas. India likely is subject to some of the most complicated aerosol-cloud interactions as anywhere in the world.

Also, how derivatives in the 12 regions differ?

Text on page 17 (revised paper) discusses the spatial variations (revised paper lines 5-8, page 17) and seasonal variations (revised paper lines 24-29, page 17) of the derivatives.

(3) I also suggest the authors to analyze the vertical velocity field in each of the 12 regions using MERRA data, which could provide additional information.

We agree that additional calculations in regard to the cloud dynamic variables is an important task. For completeness, such a study should examine several dynamic variables: the vertical velocity field, wind shear, relative humidity, and CAPE, on a region by region basis. A concern we do have in such a study is that models and observations need not necessarily agree in spatial and temporal agreement in regard to the location and timing of cloud development. This task is deserving of careful analysis but we feel it is substantially outside the scope of the present study which in its revised form is already long in length.

Interactive comment on Atmos. Chem. Phys. Discuss., doi:10.5194/acp-2015-732,

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2016.

Please also note the supplement to this comment:

<http://www.atmos-chem-phys-discuss.net/acp-2015-732/acp-2015-732-AC2-supplement.pdf>

Interactive comment on Atmos. Chem. Phys. Discuss., doi:10.5194/acp-2015-732, 2016.

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