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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Aerosol-induced changes of convective cloud anvils produce strong climate warming" *by* I. Koren et al.

Anonymous Referee #3

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This manuscript explores the link between aerosol loading and the properties of deep convective anvils. By analyzing the MODIS cloud and aerosol data and the wind profiles from radiosonde measurements, the authors identified that the invigoration of deep convection by increased aerosol concentrations leads to higher anvil heights. The anvils are therefore expanded and diluted by the stronger winds in higher altitude. The authors then examined the sensitivity of cloud radiative forcing to cloud top height and optical depth, and qualitatively concluded that the aerosol indirect effects on anvil clouds can potentially produce an overall positive radiative forcing.

Major Comments

1) The study emphasizes on the dynamic and thermodynamic feedbacks of the aerosols to anvil height and morphology. A region of the tropical Atlantic is chosen for

the analysis of AOD-anvil relationship, and the clouds are simply sorted by AOD levels. As there are many crucial ambient controls on deep convection besides aerosol, the sensitivity of anvil height and optical thickness to aerosol loading identified here may not be relevant to the other regions. The thermodynamic environmental conditions (e.g., boundary layer moisture, SST, stability, etc) should be included when classifying the clouds. A discussion on how the current results may hold or change with different convection regimes would also be valuable.

2) Better descriptions on data processing and methodology are needed. For example, where are the radiosonde stations (mentioned in the caption in fig .1 but not in the text), and how frequent are the measurements? Which versions of MODIS aerosol and cloud products are used? How the deep convection clouds are identified? Is it by setting criteria on MODIS cloud top pressure? Why use tau=10 to separate convective tower and anvil, and how the results may differ if a different cut-off value is chosen? The basic information and sensitivity tests on the methodology should be addressed.

3) The uncertainties and biases mentioned in Appendix B is crucial, and should be moved to the main text. As the histogram indicates there are many cases with complete anvils coverage (and therefore no AOD retrieval), a sensitivity test of gridding the data to a coarser resolution might provide some additional insights.

4) Although the current results indicate that aerosols lead to expanded area and thinner optical depth of the anvils, the lifetime of the diluted anvils can also change, and this effect may have stronger impacts on the radiative forcing than the changes in cloud height and optical depth. Although the tau-Z plots provide important information to the scientific question, they cannot address the effects of anvil coverage expansion and lifetime on the forcing, and therefore may not tell us the full story.

Minor Comments:

1) In Section 2, the tower to anvil ratio (TAR) is mentioned and analyzed in the 1st paragraph and Fig 1, but the explanation on how TAR is derived from MODIS data is

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provided in the 3rd paragraph. Please consider re-organizing the flow by moving the 3rd paragraph to the beginning of the section.

2) Please use a larger font size for all figures, especially the axes.

3) A legend/explanation for the line color is missing in Fig. 1b.

4) Fig. A1 and A2 can be merged, since one of the panels is identical.

5) Units on the color bar of Fig. B1 and B2 are missing.

Interactive comment on Atmos. Chem. Phys. Discuss., 10, 1939, 2010.