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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Comparison of a global-climate model to a cloud-system resolving model for the long-term response of thin stratocumulus clouds to preindustrial and present-day aerosol conditions" *by* S. S. Lee and J. E. Penner

Anonymous Referee #1

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General comments

This paper performed the numerical simulations with a GCM and a cloud-system resolving model (CSRM) for aerosol and environmental (meteorological) effects on cloud fields, and compared the results of these two kinds of models. Although the approach of comparing the GCM with CSRM described here may be helpful for identifying what aspect of aerosol-cloud interactions lacks to be represented in GCMs, there are several

concerns with fundamental mechanisms responsible for the cloud behavior in CSRM that are not well explained in current manuscript. Another difficulty in this manuscript is quite redundant presentations especially when the authors explain the results in figures, and I couldn't catch the main points until I reached the last section (summary section). The authors should make the presentations much more compact to make it easier for readers to understand what the authors intend to emphasize. I would like to recommend eventual publication of this paper after the authors appropriately addressed my concerns listed below and improved their presentations.

Specific comments

Page 21326, line 22-24: "LWP in the GCM-PD run generally shows much larger temporal fluctuations than the MODIS-observed LWP and the CSRM-PD-run LWP." What is the main reason for the larger fluctuations in GCM run?

Page 21332, line 20-22 and Page 21333: The authors try to explain the reason why "condensation and evaporation are one to three orders of magnitude larger than autoconversion and accretion" in CSRM runs. Although a theoretical explanation according to cloud physics textbook is provided in page 21333, I'm not sure how these theoretical mechanisms take place in terms of CSRM parameterizations. Can you explain how the model parameterizations represent these mechanisms described in page 21333?

Page 21335, line 10-12: "The effects of the increased surface area for condensation outweigh the effects of decreased supersaturation" Why is the effect of increase in surface area is larger than that of decrease in supersaturation in CSRM? Is this a direct result of the parameterization formulation?

Page 21335, line 2-14: Same mechanisms should operate for evaporation process except for an opposite sign. To my understanding, what determines the cloud water budget is a net effect determined by difference between condensation and evaporation, rather than only condensation. Can you discuss a mechanisms for the overall effect of condensation and evaporation?

Page 21335, line 23-24: “The effects of condensation on LWC outweigh those of evaporation and entrainment, leading to the increased LWP in the PD run.” What is the reason for this excess of condensation effect over evaporation effect?

Page 21336, line 26-29: “the larger cloud-base instability is outweighted by the weaker interactions among CDNC, supersaturation, and condensation in the CSRM-PI run compared to those in the CSRM-PD run.” I didn’t understand what this part means. Can the author explain in more comprehensive way what they mean by this part?

Page 21337, last line: “the effects of the increased aerosols on CDNC and thus condensation outweigh the effects of the increased cloud-base instability”. Can you also explain the reason why the aerosol effects are larger than instability effects in the CSRM?

Page 21341, line 2-4: “This leads to increased condensation in the GCM-PD (-PI) run as compared to that in the CSRM-PD (-PI) run. This increased condensation is large enough to result in a larger LWP despite the higher conversion efficiency.” It may be interesting to show water budget analysis for GCM as well as CSRM and to compare the numbers of them.

Page 21345, line 16-22: This is an interesting diagnosis of the CSRM and GCM results, and, I believe, is a main finding of this study which should be shown in more pronounced way throughout the paper. I didn’t catch this message until reaching here. Can authors make a significant change in presentation style for emphasizing this finding?

Technical corrections

Page 21328, line 1: clouds fractions -> cloud fractions

Page 21333, line 15: Figure 9a and b shows -> Figures 9a and b show (Similar errors are found throughout the manuscript. Please check.)

Interactive comment on Atmos. Chem. Phys. Discuss., 9, 21317, 2009.