

Interactive comment on “Constraints on first aerosol indirect effect from a combination of MODIS-CERES satellite data and global climate simulations” by X. Ma et al.

Anonymous Referee #1

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This study shows that a particular GCM, the CCCma CanAM4 reproduces aerosol indirect effects more faithfully by using a more sophisticated parameterization relating aerosol concentrations to cloud droplet number concentration. The experimental structure is simple, clear and convincing.

There are some improvements that could be made to improve the manuscript. These are outlined below.

1. The paragraph describing constraints on model analysis on p. 13947 is much too brief to be convincing and really deserves to be discussed in a separate methods section. First, mixed-phased clouds are ubiquitous below 700 hPa, even outside polar

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regions. I agree that constraining to liquid clouds is important, but why not do this using the operational MODIS cloud phase product or the MODIS/POLDER product by Riedi et al., 2007? (Incidentally on p. 13946 the satellite is PARASOL: POLDER is the instrument). With regards to co-locating aerosol and cloud fields, this is an important point, and has been highlighted in articles by Avey et al. (2007, JGR) and Brioude et al. (2009, ACP).

2. There is no discussion in the article about how the GCM parameterizes the removal of aerosol by clouds. Perhaps the GCM is underestimating the indirect effect, not because it is insensitive to the effects of aerosols on clouds, but rather that it is overly efficient at removing aerosols from the cloudy column through wet scavenging. Aerosols have sources and sinks, and both of these points can influence aerosol-cloud interactions. Currently the manuscript presents a very one-sided picture on this point.

3. At the top of p. 13950, it is unclear what exactly is being said, however, it seems to state that it is reasonable to compare climatological averages of aerosol and cloud properties over a large region. This is not necessarily so. Imagine as an extreme hypothetical case a partly cloudy region where aerosol concentrations are only high where there is no cloud. These partly cloudy regions move around (say with frontal passages) such that averaged over time and space, the cloudy regions look polluted. In reality, though, the opposite is true: it is only ever polluted where the sky is clear. The impression would be a very weak effect of aerosols on clouds, just as is simulated in the GCM.

4. Top of 13951: This figure doesn't look at all similar to the observations, as stated in the text.

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