First of all, we would like appreciate Dr. David Mitchell's comments and suggestions. In response to the reviewer comments, we have made relevant revisions in the manuscript. Listed below are our answers and the changes made to the manuscript according to the questions and suggestions given by Dr. David Mitchell. Each comment of Dr. David Mitchell is listed (black) and followed by our responses (blue).

Interactive comment on "Aerosol effects on ice clouds: can the traditional concept of aerosol indirect effects be applied to aerosol-cloud interactions in cirrus clouds?" by S. S. Lee and J. E. Penner

D. Mitchell (Referee)
david.mitchell@dri.edu

Received and published: 27 May 2010

This modeling study describes processes by which changes in aerosol concentrations may affect cirrus clouds, especially the ice water path (IWP) and hence radiative properties of cirrus. The increased IWP is due to the aerosol increasing the cloud ice number concentration (CINC), which increases the ice surface area and vapor deposition rates. The resulting latent heat increases updraft speeds which further add to the ice water content and IWP. While these results appear novel and interesting, some questions could be clarified:

1) It is commendable that ice crystal shape (the capacitance and mass-dimension expressions) is diagnosed as a function of temperature and ice supersaturation. This study uses Table 1 in Myers et al. (1997) for the habit diagnoses, but more recent work more relevant to cirrus clouds is found in Bailey and Hallett (2004, JAS, Vol. 61,514-544). What differences in habit diagnoses are found between these two studies, and how would these differences affect deposition rates/IWP?

We repeated simulations with no consideration of ice crystal habit as a function of temperature and ice supersaturation; ice crystals are just assumed to be spherical. From a comparison between these repeated simulations with the standard simulations (shown in paper), we found that results here are robust to whether ice crystal habit as a function of temperature and ice supersaturation is considered or ice crystals are just assumed to be spherical. We believe that variations of crystal habit between Table 1 in Meyers et al. (1997) and Bailey and Hallett (2004) is much smaller than that between Table 1 and the assumption of spherical ice crystals. Hence, we think the robustness of results here to crystal shape identified by these repeated simulations can be applicable to the variation of crystal habit between Table 1 and Bailey and Hallett (2004).

2) Section 4.4, 1st paragraph: The high- and low-aerosol runs are repeated holding CINC constant for the purpose of calculating vapor deposition rates, which is said to make the ice surface area constant. But ice surface area also depends on the ice particle size distribution slope. Was the PSD slope held constant too?

The gamma distribution shape parameter and the characteristic diameter of the distribution are held constant. Hence, the PSD slope was held constant as well.

3) Section 4.6: Since cirrus clouds tend to be grey bodies (i.e. not black), microphysical changes often affect both LW and SW cloud forcing in comparable ways, with LWCF canceling SWCF more than reported here (only 35%). Hence the net SW cooling effect appears to be climatologically significant if many other case studies yielded similar results. This point could be addressed more to encourage research in this area.

The following is added:

(LL617-623 in p21-22)

Also, we want to point out that cirrus clouds tend to be grey bodies (i.e. not black). Thus, microphysical changes can affect both longwave-radiation and shortwave-radiation cloud forcings in comparable ways, with aerosol-induced LW changes canceling those in SW more than reported here (only 35%). This indicates that the compensation of aerosol-induced SW changes by those in LW can vary among cirrus clouds. The impact of this variation on global radiation budget and climate merits future study.

Technical points:
1) Walko et al. is referenced for 1997 in text and 1995 under references.

Walko et al. (1997) is a typo. It is Walko et al. (1995) and Walko et al. (1997) is replaced with Walko et al. (1995) in text.

2) Section 4.3, Eqns. 8 & 9: S is defined as both supersaturation and crystal shape factor. S should be uniquely defined.

Following a comment of one of the other reviewers, "S_h D" in Eq. (9) becomes "C" in the new manuscript for the simplicity of the equation. Hence, we don't need to define S_h any more.

3) Section 4.6: Consider changing "Those changes in LW offset changes in SW" to "Those changes in LW partially offset changes in SW". Also, is it correct to begin a sentence with "35%"?

"partially" is added in the sentence pointed out here. 35% is moved to the end of the sentence.