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Interactive comment on “Longwave indirect effect of mineral dusts on ice clouds” by Q. Min and R. Li

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We appreciate the reviewer’s constructive suggestions on our paper of “Longwave indirect effect of mineral dust on ice clouds”. Here is the point-by-point response to the questions:

“How reliable is the results that the ice particles in the cloud are larger by night than by day ? I realise this observation is not unique but it would be useful to know more about whether this could be an artefact of the retrieval.”

Answer: 1) Unfortunately, the validation of nighttime satellite retrievals is limited. However, our result is consistent with some of other’s studies (i.e. Lohmann et al 2004; Chylek et al. 2006). As mentioned in CERES data quality summary (page 766, lines 6-7; page 770, lines 22-26), the nighttime retrievals are based on all infrared channels, which may have large uncertainties. The reason for the larger effective size during the

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dust period in the nighttime warrants further investigation, both in satellite retrievals and in physical mechanism. Furthermore, as shown in sensitivity study, induced changes of ice particle size by mineral dusts influence cloud emissivity and play a minor role in modulating the outgoing longwave radiation for optically thin ice clouds.

“Forming ice at warmer temperatures would generally result in the release of latent heat of fusion, this might be expected in some circumstances to cause the cloud to grow higher and so have a cooler cloud top temperature. The consequence of this is that had the clouds remained liquid then the tops would have been warmer and the outgoing thermal IR would be enhanced. This point needs clarification within the paper which seems to focus only on ice clouds.”

Answer: Yes, you are right. In our recent cloud resolving model study (Gong et al, 2010), the enhanced heterogeneous nucleation results in increasing latent heat and consequently stronger updraft velocity. As stated in the paper, we did observe thick ice clouds with WP >300 g/m² in the DS period tend to have colder CET than their DF counterparts. Those thick ice clouds, a few in number (~15% of total cloud samples), may be associated directly with deep convective cells. Assuming background dynamic conditions were comparable in both periods, the observed difference of CET of thick ice clouds may suggest that dust invigorate the convection, resulting in higher cloud tops. On the other hand, more IN introduced by large concentrations of mineral dusts may produce more ice particles at warmer temperatures. Additionally, water vapor depletion as a consequence of mineral dust heterogeneous nucleation and freezing may reduce the peak supersaturation at higher altitudes, which limits the onset of the homogeneous nucleation process. As a result, dust suppresses the homogeneous droplet freezing and nucleation and weakens the transport of water vapor to the lower stratosphere. These effects lead to lower the cloud top height.

The contrast in cloud top temperature between super-cooled water clouds vs. heterogeneous nucleated and frozen ice clouds, as elaborated by the reviewer, is possible. However, the super-cooled water clouds formed between -20 and -40 °C are relatively

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fewer than low-level water clouds or high-level ice clouds. Also we excluded all possible water clouds in our study. Of course, such hypothesis deserves a further study

Gong, W., Min, Q., Li, R., Teller, A., Joseph, E., and Morris, V.: Detailed cloud resolving model simulations of the impacts of Saharan air layer dust on tropical deep convection – Part 1: Dust acts as ice nuclei, *Atmos. Chem. Phys. Discuss.*, 10, 12907-12952, doi:10.5194/acpd-10-12907-2010, 2010.

“The use of a large number of acronyms in the paper which are sometimes not defined when first encountered is confusing. I suggest using the full name rather more extensively.” Answer: Yes, we reduced the using of acronyms in the revision as possible as we can.

Interactive comment on *Atmos. Chem. Phys. Discuss.*, 10, 763, 2010.

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