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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Characteristics, impacts and direct radiative forcing of aerosols at the ARM Southern Great Plains Central Facility" *by* M. G. Iziomon and U. Lohmann

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We thank the reviewer for their helpful comments. We have now revised the manuscript. We address the issues raised by the reviewers as follows:

(1) We now include nitrate and ammonium in the introduction. We also mentioned Iziomon and Lohmann (2003) in this section and made the objectives of the present study clearer.

(2) We added the air masses reaching the SGP in section 3.

(3) We included a discussion about aerosol measurement uncertainties and clarify the significance of the plus/minus sign where previously missing in the text.

(4) We streamlined our discussion on aerosol variation and now restrict our aerosol

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measurement comparison to only continental sites. In order to improve the readability of the paper, we added more subtitles. In line with the recommendation of the reviewers, we exclude (in the revised manuscript) the trend analysis as well as Figs. 6 to 9 and Tables 1 and 4 of the ACPD manuscript, since they do not add significantly to the subject discussed here. In effect, we also dropped the IPCC statement that biomass burning and fossil fuels are linked to the degradation of air quality and acid deposition.

(5) We now incorporate the aerosol chemical composition at the SGP as well as optical depth measurements to complement the seasonal and annual variation of aerosol properties. We also present aircraft measurements of aerosol vertical distribution at the site.

(6) Rather than presenting the diurnal cycle of all aerosol properties at the ARM site, we now focus on the aerosol number concentration, which is of most interest. We extended our analysis and examine, among others, the diurnal cycle in aerosol concentrations on rainy and non-rainy days as suggested. Due to the weak diurnal cycle of aerosol concentration on rainy days, we state categorically (in section 4.1 as well as in the abstract and conclusion) that precipitation occurence does not seem to play a role in the observed afternoon peak of aerosol concentration at the ARM site. We attribute the afternoon peak in aerosol concentration mainly to photochemistry.

(7) We provided more information on the estimation of the average upscatter fraction at the site. We agree with the reviewer on the definition and significance of the upscatter fraction in determining the sign of the aerosol direct effect. We stated in section 4.7 of the revised manuscript that the upscatter fraction (beta) is dependent on solar zenith angle. The measured hemispheric backscatter fraction b (which is a fraction of the scattered intensity that is redirected into the backward hemisphere of the scattered particle measurements) is also dependent on the phase function. When the solar zenith angle is directly overhead, the upscatter fraction coincides with b (Boucher 1998). In estimating the sign of the direct radiative forcing of aerosols sampled during the LBA-EUSTACH campaign, Guyon et al. (2003) utilized the upscatter fraction for so-

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lar zenith angle = 0 (i.e. b). In our study however, we chose to use the parameterization of Anderson et al. (1999) for the aerosol upscatter fraction (expressed in terms of b). Although other methods of estimating b abound, our use of Anderson et al. (1999) parameterization is consistent with our approach to directly utilize local measurements as much as possible. The equation used in estimating the critical single scattering albedo here was taken from Eq. 2 of Hegg et al. (1996), which encompasses beta_bar. In contrast to the cooling observed here, Ackerman et al. (1986) report that Arctic haze produces a net warming in winter. We also estimate the effect for solar zenith angle = 0. As recommended by the reviewer, we have modified our use of the term - net diabatic impact. This change is also reflected in the modified title of the study.

(8) In an effort to keep the manuscript as concise as possible, we exclude section 4.4 of our ACPD manuscript. However, we determine the sign of the radiative forcing at the site. As indicated in our conluding remarks, future studies should be aimed at estimating both the direct and indirect aerosol forcing at the site by using detailed numerical models in conjunction with ARM in-situ measurements.

(9) We state the wavelengths at which aerosol optical properties are measured where missing in the ACPD paper.

(10) As suggested we now compare the optical properties of dust and smoke haze for fine and coarse aerosols.

(11) We addressed all the minor comments adduced by the reviewers regarding Figures, Tables and references.

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