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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

Anonymous Referee #2

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General:

The paper describes aerosol optical properties and meteorological parameters for 5 years of measurements at the Southern Great Plains Central Facility. The dataset is in principle of interest because of the long-term comprehensive physical and optical characterization. However, the authors have not succeeded in presenting a coherent and convincing story. The results and discussion section is long and not structured, with descriptions of trends and averages without making a clear point. Dividing this section with sub-titles indicating the purpose of the following text would already increase the readability. Further, to my opinion a better job could have been done in analyzing the aerosol optical properties, more in particular on the calculation of forcing, by mak-

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ing use of vertical profiles from LIDAR and aircraft. In fact, the case study on page 2367 seems completely out of the context of the paper as the observations are just mentioned and not further used.

A number of analyses of radiative properties are flawed, and the trend analysis is doubtful (see comments below). The paper is full of speculations of what could be the reason (aerosol sources) of the observed properties, and although such an analysis is difficult without chemical characterization I feel the authors have not made fully use of the information in the datasets.

The paper at present does not meet the standard of ACP and needs major revisions before it can be accepted for publication.

Specific comments:

page 2354:

line 23: in general also nitrate and ammonium are important components in atmospheric aerosol

page 2356:

In the description of the site it may be useful to mention what kind of air masses it is exposed to.

page 2357: Please specify the instruments used for measuring Na and Np. What is the lower diameter for Na? Does the OPC also measure the size distribution in the 0.1 - 10μm size range? If so, why not use that information when discussing particle size later on (now based on å)?

How is the conditionning to 40%RH done? Does this have implications for possible sampling artefacts?

An important problem with the further data discussion, in particular regarding the dust and smoke optical properties, is that the properties are limited to D < 1μm. In partic-

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ular for dust, this does not represent the full atmospheric size distribution, hence the results will be biased, and the impact and forcing calcucations are basically meaningless. Why not consider the full size range (with properties of coarse and fine aerosol discussed separately)? If the reason is that this discussion has been made by Sheridan et al., 2001, JGR (as the authors mention, they discussed the < 10μm size range), the present paper is not adding substantially new material and should be rejected.

Page 2358:

Over which time period has the "statistically significant data set of vertical distributions" been obtained? Why is this mentioned if it is not used in this study (apart from a 3 day case study which is not statistically significant)?

Page 2359:

Same remark for the LIDAR: why not make fully use of the vertically resolved aerosol properties?

page 2360:

line 3: Convective transport is probably not an issue at the SGP CF; the study of Weingartner was in the free troposphere where he used optical properties to document upslope transport from the boundary layer.

line 5: number concentrations in Fig. 3 are not really optical properties.

Line 13: "Thermally" driven should rather be "photochemically driven"; it is the photochemical production of low vapour pressure products that initiates the nucleation and growth of aerosol particles.

Line 18: If precipitation is the cause of the trend in Na, one would expect to find the same influence on Np, which is not the case. It is more likely that coagulation reduces the number of small particles during the night and early morning. Can the trend in Np be explained by the evolution in the boundary layer height? Usually during the night,

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the mixing height gets lower, leading to an increase in Np; the corresponding increase in Na is masked by it's decrease by coagulation (also enhanced by the compressed boundary layer).

Line 22: the discussion of the role of RH on σ_a, σ_s and N_p is flawed: first of all RH would not affect Np, and second, RH in the sampling line is controlled, hence ambient RH should not affect measured scattering coefficients.

Page 2362:

line 1: what type of absorbing aerosol is meant here? Biomass burning? But on the next page it is stated that biomass burning activities are more pronounced during summer. According to figure 3, the low single scattering coefficient in autumn is a combination of relatively high absorption and relatively low scattering compared to the other seasons. Can the authors be more specific on the cause of this? Stating that it could be related to agricultural activities is not sufficient. It also appears that ω_0 is lower during the night and morning; is this consistent with agricultural practices and transport times to the site? Further, the values in table 1 for single scattering coefficient do not seem to match the ones in Fig. 3 where a clear difference is seen between summer and autumn.

line 12: stating that it is noteworthy that σ_s, σ_a and N_p are high when aerosol levels are high is a tautology. Looking at figure 5 I would not say July and August jump out for scattering and absorption.

I don't see why it is so remarkable that monthly means of a and b reach a maximum in spring and autumn.

I think figure 5 can be explained better in terms of sources and processes; eg it is now more clear where the low single scattering coefficient in autumn comes from: in autumn there is a clear increase in small, absorbing particles which are not contributing to scattering, whereas during summer, dust contributes more than in autumn to

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scattering.

Line 20: It would be of interest to see if there is a trend in visibility over the years of the study.

Page 2362:

line 17 - 20: what is the relevance of this finding?

Page 2364:

line 7: "..which implies that marine aerosols are more hygroscopic..." this is not really a new finding resulting from this study; the hygroscopicity of marine and continental aerosols has been studied in numerous field campaigns. Use rather "this is in agreement with previous observations . . . "

line 16 -29: It's not clear what the purpose is of this paragraph, and what information it adds compared to previous diurnal, monthly and seasonal averages.

Page 2365:

line 12 - 17: There is little coherence in these phrases. What is the point you want to make?

line 19 - 29: how significant are these trends in Fig. 7? Especially Ozone does not seem to show a particular trend, with the higher values in 97 and 2001 and constant in between.

I wonder how meaningful it is to talk about trends in a 5 year period which are dominated by subsequent el niño and la niña events. The authors speculate on the fact that the el nina drought is reinforced by enhanced black carbon, but there is no real evidence for this.

Page 2367:

I don't see what this case study of 9 -11 May is doing here.

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page 2368:

line 4: here it is said that dust is mainly due to agriculture whereas earlier long-range transported dust (Prospero) was mentioned as contributor. How do the measured "foggy" optical parameters (at 40% RH) relate to the ambient parameters, at high humidity? It is not clear if the statements are made for ambient conditions.

Here the diameter cut for dust and fog is 10 μm, whereas for smoke 1 μm is taken. Why not use 10 μm for all cases?

Line 10: the authors make often improper use of the word "implication" and "imply": the scattering and absorption properties are not an implication of the value of the single scattering coefficient, they are equivalent, i.e. saying the same thing in other words.

Line 15: As D < 1 μm has been taken for smoke, and 10 μm for dust, it is not surprising that smoke particles result to be smaller.

Page 2369:

Not being a specialist myself in radiative transfer calculations, I believe however that a better job can be done than using the box-model of Charlson, in particular because vertical profiles of aerosols and water vapor are available at the site.

Page 2370:

line 1: How does "aerosol aging" contribute to the high negative forcing in spring?

How much of the "all aerosols" consists of natural and anthropogenic aerosol? Forcing applies only to anthropogenic aerosols!

page 2371:

line 7 - 8: It is probably more correct (although equivalent) to say that smoke aerosol absorb more radiation than do dust aerosols.

The finding that the Angstrom exponent is higher than in marine sites is not a major

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result, also because the particles size range has been limited to D < 1μm. I don't see why the properties of the ARM site, which is a very continental location, should be confronted in particular with marine aerosols.

Typo's:

page 2360 line 29: " . . . are probably"

page 2361 line 6: submicron

page 2371 line 8 " . . . than do smoke aerosols"

Tables:

Table 1, 2 and 4 are confusing because of the alignment with the parameters in the first column. Suggest to leave some space between the groups.

Figures:

Figures 2,3 and 5 are much too small.

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