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Interactive comment on “Empirical predictions of CCN from aerosol optical properties at four remote sites” by A. Jefferson

A. Jefferson

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Thanks to Dave Delene for his helpful comments.

“I feel it is important to look at how well the measured C and k parameters compare to estimated C and k parameters.”

I’m apprehensive about showing such a comparison in this paper because I use the C and k parameters from a power law fit of the CCN data to derive the estimated C and k parameters. A comparison of the estimated parameters back to the power law fit parameters may present a circular reference.

The difficulty with this analysis is that the aerosol single scatter albedo, backscatter fraction and scattering coefficient are coupled or covary. As aerosol scattering in-

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creases the albedo increases and the backscatter fraction decreases. Trying to define parameters like C and k that uniquely define either the backscatter fraction or albedo is difficult because the two parameters are coupled. What occurs is that the estimated C and k from the optical properties “compensate” to fit the data. If k is too high then the C value will adjust higher to make the calculated CCN fit the data. I added a plot to show the correlation between $(k - k_{\text{est}})/k$ and $(C - C_{\text{est}})/C$. As the estimated k declines relative to the power law fit k the estimated C relative to the power law fit C is also lower. The trick here is to decouple the single scatter albedo and backscatter fraction as much as possible. These parameters can be refined or decoupled with a more detailed analysis that separates the aerosol by type, air mass, season, organic mass fraction or size. You can see that the difference between the power law and estimated parameters varies quite a bit. This paper is first cut at correlating the CCN to the optical properties. I hope to continue the work and bring in aerosol size and composition and maybe do some detailed laboratory work with a known aerosol type.

“Could a reference or additional information be added to the paper to make it explicit how much better the presented method is than only using scattering or extinction. I feel that this would be an important conclusion of the paper.”

I started this analysis looking at correlations between CCN and extinction, as I wanted to compare my data to that in the Andreae 2009 paper. His paper looks at AOD or column integrated extinction with in-situ CCN. I included plots in this response of the extinction at 450 nm vs measured CCN at 0.4% SS. I made plots like this for 3 to 4 different %SS values. I couldn’t find an obvious correlation between the different %SS values or reason for the varying slopes between the sites. The extinction vs CCN is valuable information. I added a short paragraph below that I placed in the Discussion section before the presentation of the BSF and SSA correlations to CCN.

“Initial analysis involved simple correlations of the aerosol extinction to the measured CCN. Figure 2 shows these correlations for submicron aerosol extinction at 450 nm. While a linear fit seems to characterize the Oklahoma data fairly well, the other three

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sites exhibit nonlinear behavior or multiple modes to the correlation that point to a more complex behavior. No strong trend in the slopes with aerosol type is evident.”

“Pg 8997 Line 5: The Andreae 2009 paper is about optical thickness and not directly aerosol extinction.”

AOD was added to the sentence to reflect the Andreae paper.

“Pg 8999 Eq 2 & 3: Use subscripts or different symbols for the m and b parameter in these equations since they are different fit parameters. Pg 9000 Line 7: “... are essentially a non-activating’ should be “ are essentially nonactivating”.

Both done.

“Table 1 caption: It would be helpful to give the full name of each site in all table and figure captions.”

Done.

“Figure 1: “The dashed lines show the range of backscatter values used in this study” can be written clearer. Something like, “The horizontal gray solid lines denote the 0.08 and 0.18 values of backscatter fraction used in this study, with the dashed vertical lines showing the corresponding range of median radius values”.

Recommended wording for Figure 1 caption used. Thanks for the clarification.

“Figure 3: Please use the same x and y axis ranges for all plots”

Done.

“Figure 4: Please use the same number (3) of digits on all x-axis tick labels.”

Done.

I’m sorry that the figures are so small. The submission options made them either oversized or very small.

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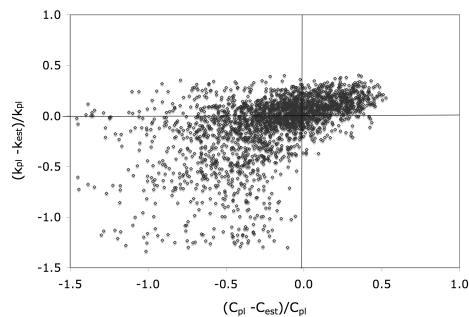
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Figure 1. Deviation of estimated (est) C and k parameters from power law fit (pl) parameters using data from the Oklahoma (SGP) site.

Fig. 1.

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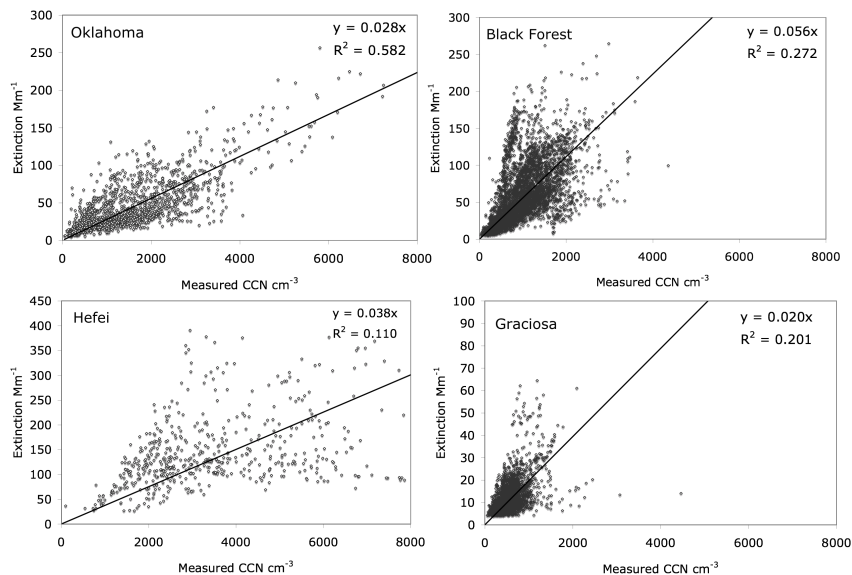
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Figure 2.0 Plots of aerosol extinction at 450 nm versus the measured CCN concentration at 0.4% supersaturation at four locations.

Fig. 2.

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