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Atmospheric Chemistry and Physics Discussions

# *Interactive comment on* "Measurement-based climatology of aerosol direct radiative effect, its sensitivities, and uncertainties from a background southeast U.S. site" *by* James P. Sherman and Allison McComiskey

**Anonymous Referee #1**

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## 1 General Comments:

Authors have analysed about four years of ground-based measurements of aerosol optical depth (AOD), scattering coefficient and absorption coefficient data at a remote site in south-east U.S. Measured daily mean values are used in radiative transfer code to estimate aerosol direct radiative effect (DRE) and radiative efficiency (RE; DRE per unit AOD at 550 nm). They also present analysis of uncertainties in the estimated DRE and RE values. In spite of lot of progress, aerosol radiative effects remains a big



source of uncertainty in projecting future climate change. The RE numbers are often used directly in models to simulate effect of aerosol on atmospheric dynamics as well as indirectly to validate model for their ability to simulate aerosol concentrations and their effects on climate. In this context, authors' contribution is important.

Overall manuscript is well written. Introduction provides concisely and clearly the importance of DRE and objectives of the manuscript. Methodology is described with sufficiently detail to allow others to reproduce their results and the results are provided with good clarity describing how their finding improve upon previous study.

As a suggestion for improvement. The manuscript focuses a great deal on sensitivities to AOD, single scattering albedo (SSA), asymmetry parameter (g) and surface reflectance (R). I believe sensitivities are intrinsic property of radiative transfer model and their emphasis would have made more sense if the results were about comparison of different radiative transfer models. In the present case, their findings on sensitivities will differ from others (previous studies) only to extent differences in base cases and impact of non-linearity over the range of difference. I believe emphasis should have been more on seasonal variations in aerosol properties and how they differ from generic aerosol models used in various models and satellite retrieval algorithms, and ultimately what would be the penalty in terms of error in DRE if the generic models are used instead of measurements.

## 2 Technical comment:

1. Authors discuss effect of measurement uncertainties on uncertainties in DRE. However, it is rare that DRE is estimated for instantaneous values measured by various instruments. Generally, required parameters are averaged over certain time-period (typically one day) and will have associated variabilities, quite often larger than instrumental error leading to further uncertainty in DRE estimation. I

am not clear about whether authors mention uncertainty in DRE including variability of input parameters or only of measurement error. Authors may consider including discussion on uncertainty that arises from variability of the input parameters in addition to the measurement error.

2. Authors have used power law equation to extrapolate AOD and SSA beyond visible wavelength. Originally, the power law was derived for visible wavelength range and there aren't many evidences to suggest applicability of the law in infra-red. At the same time, I believe authors may not have made big error in DRE numbers in doing so as the solar energy in that part of spectrum is very little compared to visible range. However, I feel a caveat in the manuscript is necessary to reflect that power law assumption may or may not be valid in infra-red region of the spectrum.

3. Authors imply on page 10(line 2 to 4) that uncertainty in SSA at higher RH is not known. However in the section 3, authors have mentioned that the site is equipped with scanning humidograph to study effect of RH on scattering and absorption coefficient. Authors may explain why can't this data be used to find uncertainty in SSA at high RH?

4. Authors present sensitivity of DRE to surface reflectance ($S_R$) at TOA and surface as $3.3Wm^{-2}$ and $2.7Wm^{-2}$ during June and $0.22Wm^{-2}$ and $0.20Wm^{-2}$ during December. What surprises me is the very small difference in $S_R$ values at TOA and at surface. It is common knowledge that surface reflectivity will have very little effect on DRE at surface but can have significant effect at TOA. One can read reason for it in Chung (2012). In other words, a significant difference is expected between TOA and surface $S_R$ values. See for example Figure 10 of Gadhavi and Jayaraman (2004) who have used similar approach and the same radiative transfer code (SBDART) to calculate DRE (they called it radiative forcing) as a function of AOD and surface reflectance. They have reported that when surface



type changes from sea to sand (which is large change in surface reflectance) it causes a little change in DRE at surface but a large change in DRE at TOA for a fixed AOD. The values reported in the current manuscript may not be wrong but a thorough discussion needs to be included why their finding is at variance with others or the common knowledge. I believe such a discussion will add value to their manuscript as it will lead to better understanding of how non-aerosol parameter affects aerosol radiative forcing.

## 3 Typing Errors:

Page 35 caption of Fig. 1: Longitude number of the site should have suffix "W".

## 4 References:

1. Chul Eddy Chung (2012). Aerosol Direct Radiative Forcing: A Review, Atmospheric Aerosols - Regional Characteristics - Chemistry and Physics, Hayder Abdul-Razzak (Ed.), InTech, DOI: 10.5772/50248. Available from: https://www.intechopen.com/books/atmospheric-aerosols-regional-characteristics-chemistry-and-physics/aerosol-direct-radiative-forcing-a-review

2. Gadhavi, H. and Jayaraman (2004), A. Aerosol characteristics and aerosol radiative forcing over Maitri, Antarctica, Current Science, 86, 296-304.

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