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Atmospheric Measurement Techniques
Discussions

Interactive comment on "New In Situ Aerosol Hyperspectral Optical Measurements over 300–700 nm, Part 1: Spectral Aerosol Extinction (SpEx) Instrument Field Validation during the KORUS-OC cruise" *by* Carolyn E. Jordan et al.

Anonymous Referee #2

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Title: New In Situ Aerosol Hyperspectral Optical Measurements over 300-700 nm, Part 1: Spectral Aerosol Extinction (SpEx) Instrument Field Validation during the KORUS-OC cruise

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General Comments: This is a well written paper about an important topic: the wavelength variation of aerosol extinction. The in situ aerosol extinction data as measured by SpEx presented in this paper are convincing and an important contribution to the literature as most if not all spectral extinction data published to date are column integrated from remote sensing measurements of the total atmospheric column (AOD). However there are a few issues in the manuscript that I think should to be expanded upon or require some clarification. I think the authors should discuss in greater detail (in the text) the departure of the sampling RH from ambient by $\sim$25% to $\sim$30% (SpEx sampled particles are drier). This is significant since particle scattering due to particle growth increases exponentially as RH increases. See Kotchenruther et al. (1999; JGR), figure 5 of that paper. Therefore, light scattering at ambient RH under high humidity conditions would sometimes be significantly greater than that measured by SpEx. This also has potential implications for the measurement or computation of ambient single scattering albedo. Additionally, please provide some discussion on why plotting the data in spectral fit coefficient space (a1, a2; Figs 9 & 10) is better or more informative than utilizing the two spectral parameters of Angstrom Exponent (AE; for say 370-700 nm) and its Curvature (AE') as defined by a 2nd order fit of extinction versus wavelength (logarithmic), again over the entire measured WL range. It would seem to be more physically intuitive to most readers to analyze the data in this manner than to analyze and plot the fit coefficients. I suggest acceptance by the journal after the above and following comments/suggestions have been considered, and the manuscript revised in response.

Specific Comments:

Page 2, Lines 35-36: Perhaps this sentence should be re-written to suggest that the combination of both Angstrom Exponent and spectral curvature information provides the most information related to particle size distribution.

Page 3, Lines 65-66: I think this statement is too strong. Hyperspectral data are not really required since the wavelength dependence of extinction varies smoothly with wavelength. Therefore sufficient wavelength sampling does not need to be hyperspectral, but does require several narrowband spectral measurements spanning the UV, visible and NIR wavelengths.

Page 3, Lines 67-74: It would be appropriate in this section to also discuss the work of O'Neill et al. (2001, 2003) that utilized the 2nd order fit to AOD spectra (parameter AE') and AE to separate fine mode versus coarse mode AOD components. This algorithm was also successfully applied by Kaku et al. (2014; AMT) to in situ air sampling instrumentation on ship to determine fine and coarse mode extinction components.

Page 4, Lines 94: FOV is typically used to define pixel size, so perhaps viewing region or something like that is more accurate in the context of this sentence.

Page 4 Line 123-124: It would be very useful to be clearer here. Did you make adjustments to bring the SpEx data close to ambient conditions or leave them as extinction spectra of partially dried aerosol?

Page 8 Line 271-272: The slope of near unity occurs in Figure 3 since it seems that both instruments have partially dried aerosol with RH lower than ambient by $\sim$25% to $\sim$30%. Perhaps this should be mentioned in the text when discussing this Figure.

Page 9 line 305: Please discuss why the data are noisier in Fig 7 at the longest wavelength end of the SpEx measured extinction coefficients. Is this consistent for all measured spectra from SpEx? Is this random variation or does it depend on temperature or some other variable?

Page 11 line 353, equation 5: It would be useful to state that -2a2 is equal to the parameter AE' which defines the curvature of extinction spectra, AE'=-dAE/d lnWL .

Page 11 line 366-367: Note that another significant difference between the SpEx extinction coefficient data and AERONET AOD data is that in the total atmospheric column measured by AERONET there is always some variable amount of coarse mode particles present, while the SpEx sampling excludes all coarse mode particles and

even the shoulder of some very large fine mode particles (see Dall'Osto et al., 2009 and Eck et al. 2018). Coarse mode (super-micron sized radius) particles have Angstrom Exponent close to zero (actually slightly negative) and also curvature near to zero. I suspect that this difference in particle size sampling is of greater importance than the spectral range since the 2nd order fit is excellent with AERONET data (within measurement uncertainty) throughout the 380 to 870 nm wavelength range. Note that the 1020 nm AOD data in the AERONET database in 2006 had greater uncertainty due to water vapor absorption in the Schuster et al. 2006 paper than current V3 data and also that the 340 nm channel has significantly larger uncertainty than the other measured wavelengths due to interference filter issues (out-of-band blocking & higher transmission degradation rate at this wavelength). For these reasons both the computation of AE' (Eck et al., 1999, 2001 etc) and SDA retrievals (O'Neill et al. 2001, 2003 etc) of fine and coarse AOD only utilize the 380, 440, 500, 675 and 870 nm wavelengths from the AERONET database. Also the 340 nm and 1020 nm are excluded from the AOD input to the SDA algorithm in the AERONET database due to significantly larger uncertainties and potential biases at those wavelengths.

Page 12 line 419-421: It seems that only full spectra (or at least encompassing the wavelength extremes and mid-point) should be analyzed. This is the strategy with making SDA retrievals from AERONET data at Level 2 (publication quality). For AERONET the 380, 500 and 870 nm wavelengths at a minimum must be available thus encompassing the minimum, maximum and middle wavelengths over the wavelength range considered. This ensures an accurate characterization of the non-linearity of the AOD spectra. The other possible wavelengths are 440 and 675 nm and are utilized in addition to the minimum three, if available.

Figure 7, x-axis labeling and caption: It would be much more useful for most readers if you label the x-axis in wavelength (with logarithmic scale) either in nm or microns not as logarithm of wavelength.

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