Atmos. Chem. Phys. Discuss.,
https://doi.org/10.5194/acp-2019-277-RC1, 2019

Atmospheric Chemistry and Physics Discussions

Interactive comment on "One year of aerosol refractive index measurement from a coastal Antarctic site" *by* Z. Jurányi and R. Weller

Anonymous Referee #1

Received and published: 21 June 2019

Aerosol refractive indices determined from two different size distributions measured at a coastal Antarctic site are described in this manuscript. The authors have done a commendable job of deriving these values under difficult measurement conditions and have attempted to account for calibrations and measurement losses with minimal supplies and creative means. Their results suggest that the refractive index was very stable over the period of the study, reflecting the low relative variability of aerosol composition at the site. The results are useful for understanding aerosol optical properties in extremely remote and clean regions, as well as method dependent variability in terms of sampling duration and sampling losses. The authors do not discuss size distribution information in this paper (perhaps this is the topic of a later analysis) but it would be interesting to understand size distribution variability, especially considering the scatter-

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ing distribution results. Methods that determine refractive index from size distributions measurements are important because they provide estimates of refractive indices from which scattering coefficients can be determined, without the additional effort and cost of composition measurements needed to calculate refractive index. These methods also provide higher time resolution refractive indices than composition measurements typically can.

The paper could be strengthened by including some discussion of the implications of this work towards climate change estimates, which is one of their stated motivations for the study. There were several typographical errors in the text that I did not attempt to correct; I suggest another careful editing of the manuscript. I recommend publication after addressing comments listed below.

Specific comments

Page 1, Line 1-3: This sentence is a bit unclear. I think the authors are trying to state that reducing uncertainties in modeling evaluations of climate change require more accurate aerosol optical properties. It might also help to point out why it is important to have measurements of refractive index at the poles- is this because climate change is enhanced there relative to other locations? It would also help to state when these measurements were made earlier in the abstract.

Page 1, line 7: Do the authors refer to 2439 individual size distributions when they refer to measurement points?

Page 1, line 7: It is always helpful to also include wavelength and relative humidity conditions associated with optical property measurements. Sometimes people only read abstracts and figures.

Page 1, line 8: It would also help to include some uncertainty estimates or an estimate of standard deviation with the reported average RIeff.

Page 1, line 13-19: This paragraph is a bit unclear. I understood it better after I had

read the paper, but as part of the abstract it could benefit from clarification. Part of the issue is that the location of the site has not been described yet, so understanding the wind direction in respect to the site location and the Neumayer station is a bit confusing. It might be helpful to state the wind direction impact in a more generalized way, or provide more description of the site location first.

Page 1, line 20: Referring to the time-averaging here is also confusing without having read the paper first. It may not be necessary to include in the abstract. Are these differences larger than the uncertainties of the measurements?

Page 1, line 20: It would also help here to state something about the larger implications of this work, tying back to the point of the study so that the reader grasps the larger importance of the work.

Page 2, line 14: Probably the most common method would be from volume-weighted calculations of composition data because these are generally more available than detailed size distribution and scattering measurements.

Page 2, line 24: It is important to point out that these methods do not directly measure refractive index- they use closure studies between a variety of measurements to determine the refractive index that provides agreement.

Page 2, line 25: Remove “parallel their” for clarity.

Page 2, line 34: What does it mean, “Until the particles disappeared”?

Page 3, line 5: To what RH do these values correspond?

Page 3, line 5: It would also be helpful here to point out the importance of this work- why is it important to have yearlong estimates of RI from the Antarctic? What are the larger implications?

Page 3, line 10: Include the study time period earlier, it will help when considering the information provided in the next paragraph.

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Page 3, line 31: Is RH and temperature measured? Define RH if it has not already been done.

Page 5, line 8: How was 'penetration efficiency' determined?

Page 6: Was there a quantitative measure by which "too noisy" was defined?

Page 6, line 7-8: This sentence is confusing, I suggest rewording.

Page 6, line 10: How was "good enough signal to noise ratio" defined?

Page 11, line 10: How long was the averaging time? I am not sure why rapidly changing aerosol should results in poor fit if both instruments are sampling the same aerosol at the same time? Was the aerosol changing faster than the SMPS could sample it? Did CPC data indicate this?

Page 11, line 20: Based on the stated estimated uncertainty ($\sim$3%), reporting this many significant digits seems unnecessary. This comment also holds for Table 1 and reporting of values throughout the paper. It would also help to report standard deviation for each month in Table 1.

Page 12, line 11: How was "significantly different from the yearly mean" determined?

Page 11, line 15: Providing standard deviations would help in discussing the lack of scatter in the data.

Page 13, line 4-5: Organic carbon was not measured, can the authors comment on the possible contribution to mass at the site? Has it been measured during previous studies?

Page 13: line 14: Typically, thermodynamics favor the formation of ammonium sulfate before ammonium nitrate, such that if there is enough ammonium available, it will neutralize sulfate before nitrate. What is the molar ratio of NH4/SO4 during the study? Were the aerosol acidic? (Seinfeld and Pandis, 1998)

Page 14, line 15: The RIeff values look somewhat lower with East winds. It would help to expand the scale in Figure 6 to values ranging from 1.35-1.55 to sees these differences more clearly. Are these differences greater than uncertainty in the values themselves?

Page 15. Line 3: The values in Figure 6 refer to an average value of all RIeff from the North. Did any individual distributions suggest contamination?

Page 16, line 12: Please provide units for scattering coefficient and a more detailed description of Cs. It must include a diameter-squared parameter.

Page 16, line 14. Is the scattering distribution in Figure 9 an average? Is the bimodal distribution is a function of the averaging of several different monomodal distributions at different times (suggesting interesting changes in the aerosol size distribution or refractive index).

Page 17: Figure 9 caption: What time period do these data correspond to? Is this an average of several distributions?

Page 17, line 9: This sentence is unclear.

Page 17, line 15-18: As Figure 2 shows, the instrument response at higher sizes shows a cross over region such that the instrument is unable to distinguish between refractive indices. Others have also shown this behavior at larger sizes (Garvey and Pinnick, 1983; Hand et al., 2000). Reporting refractive indices in these larger size ranges is probably not meaningful.

Page 18, line 15: I am not sure what the authors mean by "geographic borders of this value's validity"?

Page 19, line 14. Including experimental uncertainties here would help, as would re-stating the RI derived from composition data. Deriving Reff and the ability to calculate scattering coefficients using it and the measured size distributions, without the additional effort and cost of composition measurements, is an important benefit to this

analysis. Comparing the RI derived from composition in the context of experimental uncertainty can strengthen the arguments for the importance of this type of analysis. In addition, composition measurements are usually unavailable with the time resolution of size distribution measurements.

Page 19: Line 1: It would help to state the seasonal variability more strongly if the readers could comment whether the seasonal values or wind direction values were greater than the experimental uncertainty. As it stands, it appears somewhat subjective.

General comment: Please provide wavelength and RH on each of the figure and table captions- it can help the reader quickly orient themselves without having to scroll back through the text.

References:

Seinfeld and Pandis, Atmospheric Chemistry and Physics, 1998, John Wiley and Sonas, page 538.

D.M. Garvey and R.G. Pinnick (1983) Response characteristics of the Particle Measuring Systems Active Scattering Aerosol Spectrometer Probe (ASASP-X), Aerosol Science and Technology, 2:4, 477-488.

J.L. Hand, R. B. Ames, S. M. Kreidenweis, D. E. Day, and W. C. Malm (2000) Estimates of particle hygroscopicity during the Southeastern Aerosol and Visibility Study, Journal of the Air & Waste Management Association, 50, 677-685.

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