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Interactive Comment

Interactive comment on "Optical properties of Saharan dust aerosol and contribution from the coarse mode as measured during the Fennec 2011 aircraft campaign" *by* C. L. Ryder et al.

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The authors would like to thank Dr. Gao Chen for his insightful comments on the article, and we are pleased that he considers this work to represent significant advances regarding airborne dust measurements. We respond to specific comments below.

Specific Comments:

1) Both PCASP measurement and the SSA assessment associated with the coarse particles are based on an implicit assumption that the dust particle refractive index does not have a significant dependence on particle size. This assumption should be explicitly stated in the manuscript.

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This is now explicitly stated in Section 2.3, already stated in Section 2.6 and 4.1. A sentence in Section 4.1 reading, “The assumptions of spherical particles and a constant refractive index with particle size both introduce uncertainties which are not explored further here,” has been added.

2) It is unclear whether or not the number of the bins and the size of bins of PCASP were changed after the refractive index correction.

The number of bins in the PCASP data were changed (merging of bins 5 and 6, 15 and 16, and removal of bin 30) before refractive index correction. Thus the size of bins 5/6 and 15/16 also changed before the refractive index correction. Additionally, the size of the merged bins (as well as all other bins) also changed as a result of the refractive index correction. A sentence to this effect has been added to section 2.2.1.

As the number concentration tends to be rather low for coarse particles, it would be important to provide some information on the number of counts for the larger size bins over the integration time.

We have added some typical mean particle counts for one example horizontal leg into section 2.4. During one horizontal flight leg in flight b612, when dust loadings were among the lighter observed during Fennec, the CDP measured zero particles in its largest size bin, while the CIP measured a mean of 2×10-6 particles at the same size.

3) The PSAP is a centrally important instrument in this study. The cited data processing document by Turnbull is a FAAM document. Fortunately, it can be found through Google. It would be ideal if a URL can be provided.

The URLs have been added – please see response to reviewer 1.

In addition, the authors should point out the difference between the Turnbull approach and the original Bond et al. (1999) as well as more recent work by Lack et al. (2008) and Virkkula et al. (2010). These differences may directly affect the uncertainty in the refractive index estimate and may contribute to the overall uncertainty of the SSA assessment from this work.

Turnbull (2010) reports on corrections necessary to the FAAM PSAP measurements based on the original work by Bond et al., (1999), and clarifications to this publication described in Ogren (2010), and clarifies any errors in calculations performed by Haywood and Osborne (2000).

Virkkula et al (2010) report corrections to the Virkkula et al (2005) publication, dealing with inconsistencies between a one and three-wavelength PSAP. The latter publication resolves the discrepancies. Since we employ a one-wavelength PSAP, not a three-wavelength PSAP, we do not consider these publications in our corrections. Lack et al. (2008) report on the accuracy of PSAP measurements related to the ratio of organic aerosol to light absorbing carbon present in the aerosol, due to 1) "redistribution of liquid-like organic particulate matter around the filter surface," and 2) "possible coating and absorption enhancement of pre-existing absorbing particulate matter as organic aerosol deposition and redistribution occurs." During Fennec, dust was the dominant aerosol type, and contributions from these types of aerosol are considered unlikely, although this was not measured. Therefore we do not perform any corrections based on Lack et al. (2008), since they recommend, "Any use of this data for a correction must consider the uncertainties in the PSAP correction applied, measurement of OA (Organic Aerosol) and LAC (Light Absorbing Carbon) mass concentrations and type of OA present." We mention this briefly in the manuscript. We consider further the uncertainty in the PSAP due to the corrections, expected to be 20 to 30% (Johnson and Osborne, 2011; Lack et al., 2008). Using the upper value of 30% error we calculate resulting errors in extinction and SSA (see point below).

4) Several works have suggested potential problems (i.e., truncation correction) in coarse particle scattering measurement using nephelometer, e.g., Heintzenberg et al. (2006) and Quirantes et al., (2008). This issue should be briefly discussed and may be considered as part of the uncertainty for both refractive index and SSA estimate.

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We thank the reviewer for pointing out these useful references. Section 2.2.2 now includes acknowledgement of these publications and a more thorough inclusion of nephelometer uncertainties due to truncation errors. Angstrom exponents were indeed low during Fennec, typically at -0.4 to -0.3 between 450 and 700 nm, rendering the limitations of the Anderson & Ogren (1998) corrections appropriate, as shown by Quirantes et al., (2008). Based on Heintzenberg et al., (2006) we estimate that up to 35% of the scattering coefficient is not measured by the nephelometer during Fennec. This results in upper error bounds on measured scattering, since the truncation errors result in the instrument measuring lower values of scattering coefficient. Upper errors on extinction coefficient and SSA can be calculated using this value, and an error of 30% for the PSAP. Lower error bounds are now also calculated which only include PSAP uncertainties. This results in lower and upper bounds of 1% and 11% on extinction coefficient, and 3% and 15% on SSA, respectively. This is explained in Section 2.2.2, and also mentioned again in Section 4 during the SSA data analysis. The uncertainties in SSA at the lower end are not large enough to reconcile the differences between Figure 7a and 7b, and at the upper end shift the SSAs more towards values of 1, amplifying the differences between the measured and calculated values. This SSA uncertainty results in an uncertainty in the derived imaginary part of the refractive index of 0.002, which is now stated in Section 4.2.

5) The authors have stated that the dust particle size distribution remained relatively constant during long range transport. One additional reference, i.e., Liu et al. (2006), should be cited to support this hypothesis. At the same time, it should be mentioned that this observation is not consistent with the current particle sedimentation theory.

This has been added as suggested.

6) Based on the author's definition, the imaginary part of the refractive index should be referred as k not ki, or #.### not #.###i.

This has been changed. Please see response to reviewer no. 1.

7) It would be much easier to read the figures if the authors can use larger font sizes for tick labels and axis labels.

Figures 7, 10 and 11 have been changed (larger font sizes and tick marks).

8) “colour” and “color” should be consistently spelled as “color” which is more internationally acceptable.

This has been changed. Please see response to reviewer no. 1.

Additional References:

Bond, T. C., Anderson, T. L., and Campbell, D.: Calibration and intercomparison of filter-based measurements of visible light absorption by aerosols, Aerosol Sci Tech, 30, 582-600, Doi 10.1080/027868299304435, 1999.

Haywood, J. and Osborne, S., Corrections to be applied to the PSAP and nephelometer for accurate determination of the absorption coefficient, scattering coefficient and single scattering albedo, Met Office Technical note, no. 31, Met Office, Exeter, UK, 2000.

Ogren, J. A.: Comment on oCalibration and Intercomparison of Filter-Based Measurements of Visible Light Absorption by Aerosolso, Aerosol Sci Tech, 44, 589-591, Pii 924399079, Doi 10.1080/02786826.2010.482111, 2010.

Virkkula, A., Ahlquist, N. C., Covert, D. S., Arnott,W. P., Sheridan, P. J., Quinn, P. K., and Coffman, D. J. (2005) Modification, Calibration and a Field Test of an Instrument for Measuring Light Absorption by Particles. Aerosol Sci. Technol. 39:68–83

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