

Interactive comment on “Synchronous starphotometry and lidar measurements at Eureka in High Canadian Arctic” by K. Baibakov et al.

Anonymous Referee #2

Received and published: 24 March 2015

Summary:

This paper presents aerosol optical depth measurements taken in a remote location in the Canadian Arctic for multiple case studies. These measurements include methods from lidar and starphotometry in a novel combination useful for retrieving fine mode aerosol optical depth in the Arctic night. In this difficult environment for measurements, this paper presents and tests methods for screening clouds in aerosol optical depth time series and therefore presents a more robust view of slight nocturnal variations in polar aerosol optical depth. This method and presented data will be a good foundation for further climatic studies of high Arctic aerosol optical depth.

Paper is within the scope of Atmospheric Measurement Techniques and is recom-

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mended for publication with revisions. Please find comments for consideration below.

General Comments:

1. The paper is well written and well structured, with few problems. Some work on figures should be made for increased clarity (see below for specifics).
2. Abstract lacks specificity, especially with the use of vague words such as "good agreement" and "moderately well". Agreement should be quantified and reported.
3. The CRL lidar measures polarization, yet it is not used for cloud screening, especially for ice crystals. Although a note on page 2040 indicates that data for 2011 was not available, there is also data from 2012 presented that could benefit from cloud screening using depolarization ratios. Please bring the comment on the availability of the data earlier in the manuscript and comment on its use for data measured in 2012.
4. There is no reference to what stars were used or at what range of airmasses that were sampled.
5. In uncertainty calculations (Sect. 4.3.2. and Appendix A), there is no mention of uncertainty in airmass calculations for the different atmospheric species. Although at low airmass, such considerations is much less significant than other sources of errors, there is no such indication in the manuscript. (This point is linked with the previous point). An example comparison of two airmass calculations, at high airmass, was described by Russell et al. (2005)
6. There are many references to unpublished data, is there any other source possible which has been published?
7. The Angstrom exponent, which has been used in the past for cloud screening (e.g., Shinozuka et al., 2011), is not discussed and may prove a valuable comparison to other cloud screening tools presented in this manuscript.

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8. In Sect. 4.4, the CRL is described to measure down to 200 m, but all figures show measurements down to 0 m. In addition, there is no discussion about the effect of not measuring the lowest aerosols. This may be an effect plaguing all data comparison.
9. The structure of Sect. 4.5.2 could be improved to facilitate the reader's comprehension. This could be achieved by splitting Fig. 2 into two separate figures, and discussing Fig. 2a first, then the sensitivity study of Fig. 2b.
10. In discussions, there are many references to the shape of R_x^2 vs. β_{trh} , but the reference Fig. 3b is lacking in those details. In addition, Fig. 3a does not seem necessary and may hinder comprehension. Figure 3 should be revised accordingly.
11. Term optically active is not defined. Please define.
12. Please indicate clearly at what wavelengths the different optical thicknesses are reported from CRL and SPSTAR.
13. Please elaborate on the systematic difference between τ_f and τ'_f on 9-10 March 2011.
14. Please increase the font size on nearly all figures
15. When showing optical depth, please indicate where there is missing data, and not just link data from two nights together.

Specific Comments:

16. Acronym SPSTAR not defined: p. 2014, line 5
17. Typo: course -> coarse: p. 2014, line 20
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18. Acronym CALIOP not defined: p.2018, line 15
19. Typo: course -> coarse p. 2025, line 25 (foot note)
20. Sentence concerning a summary of transfer calibration is slightly confusing: p. 2026, lines 25-30
21. Uncertain meaning of "~", please be more specific: p. 2028, line 27
22. Verb tense should be reviewed "as discussed in Sect 5.1": p. 2033, line 9
23. Acronym PSC not defined: p. 2036, line 2036
24. Typo: "inasmuch" p. 2037, line 6
25. Units or measurements not indicated "<~0.01": p. 2038, line 10
26. Please be more specific "total integrated value": p. 2039, line 23
27. All 3 pane figures, right corner numbers can be confounded with right axis, please move
28. Fig 2b, middle pane, y-axis is not correct
29. Fig 2a, pane 3, please add legend for orange and blue – it is not defined anywhere
30. Fig 2b, x-axis units unclear
31. Fig 2b, middle pane, there is 2 dashed black in the legend and figure, they are indistinguishable.
32. Fig 3b, please add legend for symbols related to specific dates.
33. All 3 pane figures, pane 3 y-axis label should have a space between "Height" and "(km)"

34. Fig 6, y-axis, please label the change in day

Bibliography:

Russell, P., Livingston, J., Schmid, B., Eilers, J., Kolyer, R., Redemann, J., Ramirez, S., Yee, J.-H., Swartz, W., Shetter, R., Trepte, C., Risle, a., Wenny, B., Zawodny, J., Chu, W., Pitts, M., Lumpe, J., Fromm, M., Randall, C., Hoppel, K. and Bevilacqua, R.: Aerosol optical depth measurements by airborne sun photometer in SOLVE II: Comparisons to SAGE III, POAM III and airborne spectrometer measurements, *Atmos. Chem. Phys.*, 5(5), 1311–1339, doi:10.5194/acp-5-1311-2005, 2005.

Shinozuka, Y., Redemann, J., Livingston, J. M., Russell, P. B., Clarke, a. D., Howell, S. G., Freitag, S., O'Neill, N. T., Reid, E. a., Johnson, R., Ramachandran, S., McNaughton, C. S., Kapustin, V. N., Brekhovskikh, V., Holben, B. N. and McArthur, L. J. B.: Airborne observation of aerosol optical depth during ARCTAS: vertical profiles, inter-comparison and fine-mode fraction, *Atmos. Chem. Phys.*, 11(8), 3673–3688, doi:10.5194/acp-11-3673-2011, 2011.

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