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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Combining airborne in situ and ground-based lidar measurements for attribution of aerosol layers" *by* Anna Nikandrova et al.

Anonymous Referee #1

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This is a nice workup of case studies using multiple sources of data (lidar profile measurements, relative humidity from radiosondes, in situ size distributions, and back-trajectory analysis). Although it is somewhat limited in scope, I think the analysis successfully uses these multiple disparate data sources to gain a deeper understanding of the atmospheric layers in the case studies. The figures are informative and well constructed for showing correspondence between different measurement types and for illustrating interesting aspects of the case studies. I recommend publication after addressing a few points.

Specific comments:

Page 2, line 30. Delete "at higher latitudes". Smoke aerosol is not limited to high latitudes.

Page 4, line 13. "the cross-polarization channel measures the degree of circular polarization". I think this should probably be reworded. I don't think just one channel by itself can measure the degree of polarization; it must be compared to another channel. A related question: what is the polarization state of the combined channel? That is, does the polarization split occur before or after the Rayleigh-Mie split?

Page 4, line 14. I would have liked to look up the answer to my previous question in the quoted reference (Goldsmith 2016) but it isn't in the bibliography.

Page 4, line 24. What is the particle size cutoff of the inlet?

Page 5, line 29-31. Are these quoted sizes radius or diameter?

Page 10, line 11. "aged dust, especially since the low HSRL circular depolarization values suggest more spherical particles". I am confused by this sentence. Dust, even aged dust, would be expected to be dominated by non-spherical particles. Either I'm misunderstanding the intent of the sentence (in which case, please reword) or else you are suggesting that aged dust would be expected to have spherical depolarization values similar to what's observed. If that's the intent, please include more discussion and references to support this idea.

Figures 1 seems to show enhanced depolarization during the time period selected for the case study (8 April). Any comment about what this might indicate?

Lidar ratio can give important insight into aerosol type and therefore would potentially provide another useful clue for analyzing the case studies. Also, there is significant interest in the aerosol lidar community in cataloging lidar ratio for different aerosol scenarios. HSRL measures backscatter and extinction separately and therefore includes lidar ratio. Why not include lidar ratio in Figures 1 and 6 and in the analysis?

Page 10, line 23 discusses the depth of cumulus clouds. Since these block the laser

light, it's not clear how you estimate the top-heights of these clouds. Please explain.

In the discussion section, please include more discussion of the proposed mechanisms for new particle formation in the particular cases discussed. I realize there are no measurements available to explain this definitively, but I think some more specific discussion of possibilities supported by literature references would be helpful. Specifically, you discuss new particle formation in the boundary layer for case 1 and then use back-trajectory analysis to infer that the airmass originated over the Arctic Ocean. Does this mean that the new particle formation occurred over the Arctic Ocean? Was this area covered by sea ice? You also suggest that new particle formation occurred in the elevated layer at the same time. What are published mechanisms for new particle production over sea ice and in elevated layers that would be consistent with these observations?

Typos, etc.

Page 4, line 14. "Goldsmith" misspelled

Page 4, line 24. Is this liters per minute? Can the "L" be capitalized? It looks like a "one".

Page 5, line 14. "for the algorithm" is not clear. Do you mean for the layer-detection algorithm?

Page 5, line 18. "most often indicate edges of layers". Fragmented sentence.

Page 7, line 1. "this layer" is not clear, since you mention four layers. Which layer?

Table 1. Please explain acronyms in the table caption (particularly "NPF"). Also, the formatting of the "MidLII" column is strange in that it is unlike any other column in having both the height and depth. I realize this is to save space since there is only one layer. Another possibility that might be clearer is removing the "MidLII" column and putting two sets of measurements (separated by a comma) in that row of the "MidL height" and "MidL depth" columns.

Figures 2 and 7, the annotations are hard to read. Repeating the information from the color legend in the caption would help. It would also be useful to indicate the layer boundaries as lines or markers on the humidity profile or lidar curtain so that it would be more immediately obvious where the in situ size distributions are applicable.

Also, it would be useful to make the axis labels bigger in Figures 2, 3, 7, 8 and 9.

There seems to be a rendering or smoothing artifact in the lidar curtain in Figure 2e that shows as a series of horizontal lines where the lidar backscatter profile does not change for 15 or 20 minutes between 11:50 and 12:10.

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