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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Reconciling aerosol light extinction measurements from spaceborne lidar observations and in-situ measurements in the Arctic" *by* M. Tesche et al.

Anonymous Referee #1

Received and published: 3 April 2014

Overview:

The study provides a comparison of ground-based in-situ measurements (Zeppelin Station) of aerosol light extinction to observations from the satellite CALIOP sensor. The manuscript details the difficulties in quantitatively comparing satellite and in-situ measurements, including discrepancies in space and time, uncertainty associated with aerosol humidification, and differences in actual measurement techniques. The authors use a complex approach in order to match appropriate CALIOP overpasses with in-situ data involving back trajectory analysis, CALIOP cloud-screening, and use a combination of humidified size distribution and chemical composition measurements

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Interactive Discussion
Discussion Paper

to correct in-situ data to ambient humidity. The number of matching cases is extremely low (57 of a total of 2018 CALIOP overpasses), and a comparison of extinction coefficients yields agreement only within a factor of 10 (plus/minus a factor of 5). Additionally, the overpasses closest to the ground-site showed the worst correlation. Since the focus of the manuscript seems to be more about the process of linking the two measurements, rather than on the fairly uncertain results, it is suggested that more work is required to explore which steps are most important and if simplified methods could produce similar results.

Major comments:

I fully appreciate the amount of work that went into this study and the detailed approach was thorough and well-presented, involving humidity correction, spatial scale matching with back-trajectories, and careful cloud-screening. The uncertainties of this process, coupled with the uncertainties associated with CALIOP measurements in the clean Arctic somewhat expectedly lead to non-ideal comparisons between the two measurements. Still, it is unclear how this study does anything more than point out these uncertainties in the form of Figure 4, including what visually looks like a lack of correlation at all. Results indicating that increased overpass proximity-to-the-groundsite leads to decreased accuracy only suggest that the method was fundamentally unnecessary. If accuracy to a factor of 10 is the best possible result, and if presenting this approach is the real result of the manuscript, then I believe a sensitivity study is necessary to assess each step in the process. For example, what does the comparison look like prior to each step in the analysis process? Examples of steps that could be simplified and evaluated for the effect on accuracy and uncertainty of the final in-situ/CALIOP comparison are (but shouldn't be limited to):

1.) Can a constant humidification factor be used instead of necessitating continuous size distributions and chemical composition data?

2.) Can back trajectories be avoided by using the overpass point closest to the ground

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site?

3.) What are the results if a less rigorous could-screening process is applied?

The beneficial result of a less-rigorous point-matching process is more comparison points and better statistics. The step-by-step evaluation will also be useful for readers without such comprehensive in-situ measurements, and help to justify the benefits of the process. Additionally, I would suggest presenting a few case studies that highlight good/bad correlations that may shed light on the underlying issues with the method.

Minor comments

Page-line

5689-13. remove “among either”

5695-4. Observations from the summer were not used for comparison because of difficulties by CALIOP. If scattering enhancement factors were only derived from July-October, were they used at all in the analysis? If not, it may make sense to remove them.

5689-15. The four ‘issues’ you present are certainly pertinent to the study and provide a good review of the difficulties associated with remote/in-situ comparisons. I would suggest providing examples for each, e.g., specifically reference lidar and radiometer techniques under 2.

5695-9. What variability in the enhancement factor was observed? A factor 3 is very large compared to mid-latitude, continental sampling. Was the humidified nephelometer system verified with known substances like ammonium sulfate and nitrate? Was there any evidence of biomass burning aerosols being transported to the site, which would likely reduce the enhancement factor significantly?

5695-20. How is bimodal (externally mixed) aerosol treated in this scheme? How often were distributions simple and mono-modal? Where changes in the chemical

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composition consistent with variability in the scattering enhancement factor?

5696-1. The average contribution is minor, but were any biomass burning episodes observed which would result in anomalous comparison datapoints?

5697-3. The effective radius calculation seems superfluous and seemingly was not used in the analysis. I would suggest removal.

5701-1. It is hard to believe that distances this large are applicable in most environments. Can you comment on this result, based on your work?

5705-13. The dependence on wind direction is weak and only really depends on a few datapoints at high extinction. I would suggest an analysis more quantitative than point-coloring for this figure. Wind-rose plot?

Figure 2. panel a, the colors for the labels ('no features' etc.) are difficult to distinguish.

Figure 2. panel b, is 'cloudfree' and 'aerosol only' the same data? If so, please use consistent labels. Likewise for 'cloudy' and 'clouds and aerosols'.

Figure 3. The triangles at the top are difficult to discern, please increase size. Since the colors are the same as other symbols in the figure, it is confusing to interpret. Consider using different shapes?

Figure 4. Is there any linear correlation between variables? Can a regression line w/confidence limits be added to provide some statistical basis of the correlation? An average CALIOP/in-situ factor of 1.85 and is noted in the text, can these be shown in

Figure 4? Are geometric means more appropriate for log/log plotting like this?

Interactive comment on Atmos. Chem. Phys. Discuss., 14, 5687, 2014.

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