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Atmospheric Chemistry and Physics Discussions

Interactive comment on "A study on aerosol extinction-to-backscatter ratio with combination of micro-pulse lidar and MODIS over Hong Kong" *by* Q. S. He et al.

Q. S. He et al.

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General Comments: Comments (C): The authors present extended measurements of the lidar ratio (LR) retrieved using MODIS optical depth measurements in Hong Kong, and analyze this parameter with respect to a ground based measurement. Seasonal variations in LR are explained using knowledge of local meteorology. The paper presents information that is valuable to the scientific community, and therefore should be published with some corrections/improvements. Some significant deficiencies of this paper are found in the analysis of the visibility sensor data. Here the authors should consider in more detail, why the scattering coefficient differs from the extinction coefficient. The paper also lacks references to published measurements of aerosol size distribution and chemical composition. Grammar corrections are also needed.

Reviewer #2's comments are quite valid and a detailed discussion of the overlap effect should be included before publication. Reply (R): With respect to the significant deficiencies in this paper for the analysis of the visibility sensor data, we have checked it for many times and insisted on our opnion about the reasons inducing the deficiencies between the both instruments finally. But the comparison is further discussed to convert the scattering coefficients from visibility sensor into extinction coefficients at the same wavelength as that of lidar according to single scattering albedo of 0.9 and aerosol Ångström exponent of 1.0. The result shows good agreement with correlation coefficient of 0.91 and RMS of 0.07 km-1. The information about particle size obtained from retrieval should be referred to the direct measurement, but as we known, the direct measurement is difficult to collect for this comparison. Therefore, much more literatures about this subject are added in the context to offset the lack of references. The spelling has been checked throughout the manuscript and been corrected according to the reviewer. Also, the detailed discussion of the overlap effect has been included in the revised manuscript.

Specific comments

C: If the authors use a visibility sensor, the experimental details of this instrument should be included in the measurements section. Some details to include would be spectral range and angular range, in addition to the normal inclusions that belong in this part of the paper. R: The details of the visibility sensor are added in the "measurements" Section as a paragraph.

C:Line 18, p3013: this reviewer does not understand the convention deltaAOD=+/-0.05+/-0.2AOD. please clarify. R: We give a further explanation in a sentence about the accuracy of MODIS AOD product in the corresponding paragraph.

C: P. 3105:The authors use the NASA standard atmosphere. The authors should comment on the magnitude and sources of error by assuming the standard atmosphere. For example, if the vertical profile of relative humidity is significantly different than the

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standard atmosphere, how does this affect the results? What sorts of deviations from the standard atmosphere are expected from Hong Kong. R: Pag. 3105: The molecular contributions to the backscattering and the extinction are calculated by using of Standard Atmosphere. This algorithm is rather sophisticated one for molecule optical calculation and is employed in many literatures. The error of molecular extinction induced by variable atmospheric condition is negligible ($<$1%) even under the situation of extremity. Especially, it could take no account of the molecular contributions to the total atmospheric extinction for the heavy haze event (Klett, 1985, Appl. Optics) that occurs frequently in South China. Therefore, Employing NASA Standard Atmosphere in this study is feasible and exact.

C: Section 4.1, first paragraph: The details of the visibility sensor should be moved to the "measurements" section. More detail can be included regarding the spectral response and angular range. R: Pag. 3104: The details of the visibility sensor are added in the "measurements" Section as a paragraph.

C: Lines 11-12, p3108: are sulfate particles implied to be large in this sentence? Most commonly, sulfate mainly occurs from 10nm to 1000nm. Are the sulfate aerosols in Hong Kong expected to be different? Why? R: Pag. 3108: Thanks. The statement about sulfate particles in the context is irrelevant and it should be dust particles.

C: Please comment Lines 1-5, p3109: When discussing particle size the authors should reference direct measurements rather than those obtained via retrieval. R: Pag. 3109: The comment of referee is reasonable and constructive. The information about particle size obtained from retrieval should be referred to the direct measurement, but the direct measurement is difficult to collect for this comparison. Also, the particle size information derived from MODIS represents the aerosol column-average property, which might be complex for comparing with in situ measurement on the ground.

C: Lines 13-30, p3109: A comment on the reason why the scattering coefficient measured with the visibility sensor is different from the extinction coefficient measured with

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MPL: Firstly, there are no nephelometers or visibility sensors that measure the scattering coefficient exactly. This is because these integrating measurements do not cover the entire phase function - there will be some scattered light that is not collected. Obviously this changes with particle size. Typically if particle size is larger the measured scattering coefficient will be lower. Secondly, the authors are correct in reason 3 that the visibility sensor does not measure absorption. The authors are comparing an EXTINCTION coefficient with a convoluted SCATTERING coefficient. The authors have stated repeatedly that the visibility sensor is measuring extinction, which is incorrect. It is the reviewer's belief that these two reasons are the most probable explanations for the difference between extinction and scattering coefficients. It might be interesting to take the difference between extinction and scattering coefficients to derive absorption. Maybe this will correlate well with the urban air masses? If the authors wish for the readers to think quantitatively about the scattering coefficient and how it differs from the extinction coefficient, it would be useful to list the angular range of the instrument in the "measurements" section. R: Pag. 3109: Some new results are complemented in the comparison between lidar extinction values with the visibility values according to the both referee.

C: Line 7, p3111: are the trends really considered to be significant if the error bars overlap? Looking at the number of observations for some of the months, one can see why some of the errors are so large. The error bars for Jun should be 100%. How was the error calculated here? It should also include an analysis any systematic errors. R: Pag. 3111: We remove the paragraph about monthly mean LR variation and the corresponding figure for too small samples.

C: Line 1, p3112: the authors should be careful when stating that soot is the major pollutant in Asia. I'm sure a significant amount of organic carbon, dust and others contribute to the Asian pollution. If the authors state that soot is the major component, they should find a reference from the area that quotes soot number or mass concentrations. R: Pag. 3112: The comment of referee is valuable. We remove the dixit about the soot

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proportion in Asian pollutants.

C: Line 20, p3114: sentence should read: “(b) large particles contribute more to the extinction coefficient”. A comment on this statement: Sure, larger particles extinguish more light, but it also depends on concentration. Typically the mode in the surface area distribution is larger than that in the coarse mode. The extinction efficiencies may be similar; therefore the fine mode would contribute more to scattering. Before making these statements, it would be nice to compare to direct ambient size distribution measurements (previously published) and microphysical properties. If chemical information is available this would be an even more robust argument. R: Pag. 3114: The sentence “ large particles contribute more for the extinction coefficient” has been altered to “large particles contribute more under the situation of heavy haze event”.

C: Technical Corrections Line 4, p 3105: There should be a period in place of the comma after “C”. Line 6, p3103: “Detail” should be changed to “detailed” Line 9, p3103: “describes” should be changed to “describe” Lines 15-16, p3103: “continuously” should be changed to “continuous”, and “products” should be “product”. Line 2, p3106: “separated” should be “separate”. Line 25, p3106: “monotonously” should be “monotonically”. Line 3, p3107: "separated" should be "separate" Line 5-6, p3108: “extinction” should be changed to “scattering” Line 26, p3108: “extinction” should be changed to “scattering”. Line 6, p3109: “extinction” should be changed to “scattering” in the case of the visibility sensor. Line 13, p3109: “related” should be changed to “due to” Line 8, p3110: should read “absorption contributes more to ąę E” Line 9, p3110: “companied” should read “accompanied” Line 16, p3111: “precipitations” should read “precipitation” and “rich oceanic aerosol ”should read “air masses rich in oceanic aerosol”. Line 27, p3111: “find” should read “found” Line 28, p3111: “is” should read “are” Lines 18-19, p3112: should read “easterly and southerly flows ąę E” Line 10, p3113: “constitute” should read “composed of ąę E” Line 18, p3113: “dense-populated” should read “densely-populated”. Line 27, p3115: “aerosols” should read “aerosol”. R: Many thanks to the reviewer. The corrections have been incorporated into our paper.

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