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Interactive Comment

Interactive comment on "Validation of aerosol and cloud layer structures from the space-borne lidar CALIOP using Seoul National University ground-based lidar" *by* S.-W. Kim et al.

S.-W. Kim et al.

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We greatly appreciate for your detailed and helpful comments. We are fully aware that taking time to provide in-depth reviews is a sacrifice. Below we have reply to the comments of the reviewer and revised text and figures have been provided. We have made additional significant changes by including corrections for molecular attenuation as well as calculations of aerosol extinction profiles from CALIOP and ground-based SNU lidar data. We have updated the figures and text to reflect these changes. We apologize to the reviewer that such significant changes were made. Again, we really appreciate your valuable comments and suggestions given by the reviewer and thank him/her for his/her interest in our paper. Responses to the comments of the referee are embedded below.

This is a useful paper, but not an impressive one. It compares CALIOP lidar profiles and designation of cloud and aerosol layers there from with similar profiles obtained from a ground-based lidar. The paper contains no surprises 8211; it basically says that CALIOP seems to be doing a good job. However, the paper doesn8217;t discuss or indicate how accurate or good the CALIOP results are. The comparison is at a rather elementary level.

We had discussed aerosol and cloud layer structures from total attenuated backscatter (beta) in previous our manuscript published in ACPD. In a revised manuscript, however, we have calculated apparent scattering ratio to eliminate the effects of air molecules, and then have compared aerosol and cloud layer structures between CALIOP and ground-based lidar measurements. Apparent scattering ratio represent that the lidar return signal is only attenuated by atmospheric aerosol and cloud. Also, in a revised manuscript, we have provided aerosol extinction profiles both under cloud-free conditions and in cases of multiple aerosol layers underlying semi-transparent cirrus clouds. We have added some discussion on CALIOP comparisons and have also rewritten most parts of the paper regarding these changes.

The authors should give attention to the following before publication:

1. Shorten the title. Perhaps 8220;Validation of aerosol and cloud layer structures from using a ground-based lidar in Seoul8221;

This paper covers initial validations of aerosol and cloud layer structures from space-borne lidar CALIOP and ground-based SNU lidar. The title 8220;Validation of aerosol and cloud layer structures from using a ground-based lidar in Seoul8221;

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suggested by the reviewer is somewhat unclear to represent our intention. We have changed the title of the paper**Validation of Aerosol and Cloud Layer Structures from the Space-borne Lidar CALIOP Using a Ground-based Lidar in Seoul, Korea**

2. Calibration of the SNU lidar was not described. The reader cannot understand the differences in the two lidar8217;s profiles or the discussion in the paper without knowing the method and accuracy of the calibration of the ground-based lidar.

It is good comment. We have added several paragraphs and articles on an entire history of the SNU lidar, including calibration method and associated uncertainty.

3. Remove the claim of 8220;first observationally based validation.8221; How do the authors know theirs is the first? Even if it is, being first is not important for the purpose of this paper. They are substantiating only the expected, not discovering any previously undetected problem. There is no new theory or understanding, where 8220;first8221; might matter

As reviewer said, the wording **first** may be prolific of misunderstanding and is not important for the purpose of this paper. We accept your argument and have eliminated the wording **first** in the revised manuscript. We have written that we present initial validation results of space-borne lidar CALIOP profiles-
Please see the reply to the anonymous referee 1 and Dr. Hoff.

. **4. Fig. 2 caption. State range gate resolution for SNU lidar as well.**

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We have added it.

5. The reader needs to know the answers to these questions. Is the SNU analysis method equivalent to that for CALIOP? Is the comparison for measurement quality, processing algorithm, or both?

We have applied an identical analysis method for both lidar systems in revised manuscript. Apparent scattering ratio have calculated both in CALIOP and ground-based lidars by using the total attenuated backscatters (beta), which are derived from the range-corrected and background noise subtracted from lidar return signal. Similarly, aerosol extinction profiles have calculated by using the aerosol optical depth (AOD) data derived from co-located sunphotometer. Sunphotometer AOD data at SNU lidar site have used for lidar inversion in order to retrieve lidar ratio (extinction-to-backscattering ratio). The results have implemented in a revised manuscript.

6. The time series in both the CALIOP and SNU data streams give information about the spatial variability. This should be examined and discussed to establish the degree of this variability and how it influences that comparison.

We have added color coded time-height images of the data at 532 nm acquired by space-based CALIOP and ground-based SNU lidars in a revised manuscript. The points of nearest spatial/temporal coincidence of the SNU lidar site and CALIPSO flight have also superimposed to examine and discuss on the degree of spatial variability. Detailed results and discussions for each case have been implemented.

7. 11213 line 12: What does 8220;excellent8221; mean? 11215 line 2: What does 8220;sound8221; mean? The authors need to describe the kinds of errors

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and their magnitude that might occur from either the measurements or analysis methods, and state whether the comparisons reveal anything about those potential errors. The conclusion may well be that the results for layers are identical within the uncertainties from spatial/temporal changes. A validation exercise that compares only a few cases that appear relatively simple is not enough to say the CALIOP method is 8220;excellent8221; or 8220;sound.8221; The comparison must look at difficult cases, even those where the algorithm is expected to have problems, before one can make such strong statements.

It is good comments. **Excellent**, **Sound**. Such strong statements or wordings may be prolific of misunderstanding. We have removed these words and have rewritten to read that the results for layer structures between two lidars are identical within the accuracy/uncertainty.

8. 11209 line 24: Unclear whether the CALIOP switches polarization in the transmitter, or whether discrimination is in the receiver (simultaneous or switching?) Most likely it is in the receiver with simultaneous measurement of both polarizations.

The CALIOP transmitter emits polarized light at both 1064 and 532 nm (pulse energy - 110 mJ) with a pulse repetition rate of 20.25 Hz, but polarization discrimination in the receiver is only done for the 532 nm channel. We have added this information in Section 2.

9. 11215 line 1: . . . 8221;study, we validated in an approximate manner the space-. . . .8221; would be better. The comparisons weren8217;t quantitative or comprehensive enough to say that the CALIOP profiles and layer products were

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validated.

The manuscript published in ACPD was not enough to conclude that the CALIOP profiles and layer products were validated, because we only compared total attenuated backscatter. However, as we mentioned above, we have added the comparison results of apparent scattering ratio as well as aerosol extinction profile. As reviewer suggested, we have changed the sentence as 8220;In this study, we validated in an approximate manner the space-borne 8230;8230;8230;8230;8221;.

Additional considerations I urge the authors also to address, resources permitting, before publication. The editor might decide whether to make any of these a requirement.

1. English usage has quite a few problems. However, the paper is adequately readable. I encourage the authors to have it edited for English usage and style.

The English grammar and expressions in the revised manuscript have carefully examined by the English native speaker.

2. Averaging the SNU lidar at higher altitudes, up to the 600 m average used by CALIOP, would permit useful comparison for heights > 10 km.

Because 600 meters of smoothing for heights > 10 km can introduce distortions in apparent base and top heights of cirrus clouds, as commented by the referee 1, we have not averaged CALIOP data with altitude and used its original vertical resolution data in a revised manuscript. The CALIOP data has 30 and 60 m vertical resolutions below and above 8.2 km, respectively. Also, the SNU data with 6 m vertical resolution data have used.

3. A suggestion for all comparisons of this kind (zenith and nadir lidars): Correct for the molecular attenuation, which can be easily calculated from a meteorological sounding or weather model output. If those are not easily available, a standard atmosphere air density profile will suffice very nicely. This will reduce the opposite trends in lidar data slope, and make clearer the differences due to backscatter and extinction from aerosol particles and clouds.

We have calculated the profiles of apparent scattering ratio to eliminate the effect of air molecular attenuation in revised manuscript. We have added detailed theoretical background and calculation procedure of apparent scattering ratio in revised manuscript. Also, please see the reply for the anonymous referee 1.

4. The authors qualitatively discuss differences due to extinction for zenith and nadir views. They could go one step farther and quantitatively test this difference to see if the results are reasonable (and thus more deeply evaluate the performance of CALIOP). This would be important if users desire to infer aerosol backscatter or extinction profiles from CALIOP, or optical depths of layers.

We have added the comparisons of aerosol extinction profile both under cloud-free conditions and in cases of multiple aerosol layers underlying semi-transparent cirrus clouds, and the results have provided in revised manuscript. Sunphotometer aerosol optical depth (AOD) data at SNU lidar site was used for lidar inversion in order to retrieve lidar ratio (extinction-to-backscattering ratio). We have reworded several parts of the paper regarding these changes.

5. It would also be good to consider advection of the air where CALIOP observed and match that as closely to the SNU data as possible. This might mean choosing SNU profiles staggered a little in time, but observing closer to the same air mass. This might be done after seeing where the layers are 8211; the advection of the cloud layer may be very different than advection of the boundary-layer aerosol layer. This could be done in combination with 6 above.

Based on the lidar measurements of aerosol and cloud layer heights, we have closely investigated the advection of air mass and its effects on the discrepancy between two lidars by using NOAA HYSPLIT backward trajectory model, NCEP/NCAR reanalysis data, and weather maps and so on. As we mentioned in the paper, however, it is hard to distinguish the effects of advection of the air mass on each lidar profile, because all selected CALIOP profiles are located within 10 km horizontal from the SNU site and current meteorological data set does not provide enough spatial resolution. Backward trajectories starting at SNU site and CALIOP tracks showed that there was no difference in the advection of air mass between two lidar measurements in all cases of this study.

We really appreciate his/her valuable comments and suggestions, and close investigations of English grammar. Thank you so much again. -Authors-

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Interactive comment on Atmos. Chem. Phys. Discuss., 7, 11207, 2007.