Atmos. Meas. Tech. Discuss., 2, C101–C104, 2009
www.atmos-meas-tech-discuss.net/2/C101/2009/


Atmospheric Measurement Techniques Discussions



# *Interactive comment on* "Validation of CALIPSO space-borne-derived aerosol vertical structures using a ground-based lidar in Athens, Greece" *by* R. E. Mamouri et al.

**Anonymous Referee #3**

Received and published: 11 May 2009

The authors state they are validating CALIOP aerosol retrievals, even though they are comparing with Level 1 profiles, which are calibrated, range-corrected signals. The authors use the term "aerosol attenuated backscatter coefficient" in at least one place. There is no such thing. The "attenuated backscatter coefficient" is the calibrated, range-corrected backscatter signal and there is no separation of contributions from aerosol or other scatterers. The authors need to clarify what they are validating. The objectives are not stated very clearly.

Page 562, line 24 - should be NASA/CNES, not NASA/CNRS

Discussion of IIR, WFC, and CALIOP Level 2 data products in Section 2.2 seems to be unnecessary detail and should be removed as they are not relevant to the comparisons being presented here.

One of the references in Section 2.2 (Hostetler et al., 2006) is project document which is only available on-line. A better reference on the A-train would be Stephens et al. (2003) and a better reference on the CALIOP instrument would be Winker et al. (2007) or Hunt et al. (2009).

Section 2.3 should provide a clearer description of what is actually being validated. The approach adopted is to convert an upward-looking lidar backscatter profile to an effective downward-looking backscatter profile by correcting for the attenuation profile. The authors are essentially validating the calibration and linearity of CALIOP, though this is not clearly stated anywhere. Because of spatial separation of the day and night orbit tracks from the ground-based system (80 km and 16 km, respectively), errors due to spatial mismatch of the measurements will be much larger within the mixed layer than in the free troposphere. This is evident in Figure 4. Results should be presented separately for comparisons of signals in the free troposphere and within the mixed layer.

In any validation comparison, uncertainties in the reference measurements should be discussed quantitatively. In this case, the authors mention uncertainties in the ground-based lidar profiles being compared with CALIOP due to incomplete near-range overlap, due to applying lidar ratios measured at night to daytime observations, and to spatial matching errors, and errors in calibration of the ground-based system itself. None of these errors are quantified. The authors mention that ground-based profiles below 1-1.5 km are affected by incomplete lidar overlap. If this is a concern, comparisons should be performed only above this altitude to avoid potential biases in the ground-based profiles. The ground-based lidar is calibrated using returns from the 7-9 km altitude region, which is quite low. The calibration procedure used, assumptions, and uncertainties of the procedure should be described. Given the uncertainties involved, the authors should add a short statement to the effect that nighttime comparisons above the boundary are most reliable, that comparisons within the boundary layer are more uncertain than comparisons above the boundary layer, and that daytime comparisons are less reliable than nighttime.

The primary results are presented in terms of mean bias, though this quantity is never defined precisely. To avoid ambiguity, the equation used to compute mean bias should be given.

CALIOP experiences significant multiple scattering effects in cirrus which result in an attenuation which is much less than that measured by a ground-based lidar. I suspect the large biases in comparisons of aerosol signals underneath cirrus noted by the authors in Section 3 are due to difficulties in their method of properly accounting for the cirrus attenuation experienced by CALIOP. There is no reason that CALIOP calibration would be worse when cirrus is in the column than in clear sky. It seems it would be more appropriate to be comparing retrieved aerosol backscatter and extinction under cirrus, than raw signals.

There is an incorrect statement on page 572, line 25. Both daytime and nighttime profiles are calibrated but cirrus backscatter is not used for calibration of 532 nm signals, only for 1064 nm data.

The conclusion that "CALIPSO profiles are possibly unreliable for the representation of boundary layer vertical aerosol structures" seems like an unwarranted, overly general statement given the lack of analysis of errors in the comparison procedure used here. Meaningful comparisons of "vertical aerosol structures" are dependent on good spatial matching of the two datasets, which is a major weakness of the study presented here.

The final paragraph of Section 3 states that the mean biases do not seem to depend on the horizontal difference between the two instruments. Visually subtracting a few outliers in Figure 8, it appears to me there biases do increase with horizontal separation. A quantitative statistical analysis of the dependence would be preferable to a qualitative statement.

In Section 4, the authors state that discrepancies in the boundary are due in part to "decrease of the CALIOP signal-to-noise ratio in the boundary layer." This statement is never explained and seems counter-intuitive. Signal variability is driven by signal noise and also by atmospheric variability. An increase in variability of the profile in the boundary layer is likely due to an increase in aerosol inhomogeneity, while the SNR is probably improved in the boundary layer.

A very large effort has been made by the European lidar community to acquire data for comparisons with CALIOP. To make best use of this dataset, refinements in the comparison technique are necessary and uncertainties in the conversion of groundbased up-looking profiles to equivalent down-looking profiles must be better understood and quantified.

References:

Hunt, W. H., D. M. Winker, M. A. Vaughan, K. A. Powell, P. L. Lucker, and C. Weimer, 2009: CALIPSO Lidar Description and Performance Assessment. J. Atmos. Oceanic Technol. (in press)

Stephens, G. L., and Coauthors, 2002: The CloudSat mission and the A-Train: A new dimension of space-based observations of clouds and precipitation, Bull. Am. Meteorol. Soc., 83, 1771– 1790.

Winker, D. M., B. H. Hunt, and M. J. McGill, 2007: Initial performance assessment of CALIOP, Geophys. Res. Lett., 34, L19803, doi:10.1029/2007GL030135.

Interactive comment on Atmos. Meas. Tech. Discuss., 2, 561, 2009.