Atmos. Meas. Tech. Discuss.,
doi:10.5194/amt-2018-79-RC1, 2018

Atmospheric Measurement Techniques Discussions

Interactive comment on "A multi-wavelength numerical model in support to quantitative retrievals of aerosol properties from automated-lidar-ceilometers and test applications for AOT and PM10 estimation" *by* Davide Dionisi et al.

Anonymous Referee #3

Received and published: 7 May 2018

General comments: The authors present an interesting study about retrieving aerosol properties (extinction coefficient (E), surface area (S) and volume (V)) from lidar and/or automated lidar-ceilometer (ALC) backscatter measurements. The key of the method is using a "Monte-Carlo" model to simulate the relationship between E, S, V and backscatter for different continental aerosol microphysical properties which could occur in real life and then implementing the relationships in the retrievals. Based on the 20000 model simulations, the relationship between lidar backscatter and aerosol E, S, V were

investigated and dependence of lidar ratio (LR) to the backscatter at three lidar wavelengths (355 nm, 532 nm, 1064 nm) were fitted. The model-based LR were tested by comparing model simulations with raman lidar observations at 355 nm and found agree well with observations. Then the method was implemented to retrieve AOT and aerosol volume, PM10 and the results were compared with in-situ measurements. Although this method has some limitations in retrieving aerosol volume, mass, it shows the potential of using ALC for aerosol properties retrieval. The paper is well written and structured. The method was explained clearly, and main assumptions and limitations of the method were discussed. The topic is well suited for the AMT. I have a few comments and recommendations before the paper can be published.

Line 128: Both the step 1 and step 2 are about the aerosol model, why didn't authors put them both in the same section (section 2)?

Line 140: Is the r_mi at here same as the r_i in the equation 1 or it is another parameter? What are the m_(r i) and m_(im i)?

Line 143: what are the specific rules?

Line 147: The description of m_(r i) and m_(im i) should be given at the first time when they appeared in the paper, see the related comment above. Secondly, more explanations about the real and imaginary refractive indices and how they are used in the aerosol optical properties calculation should be provided.

Line 151: What is the exact size range? The authors should indicate the range or refer the tables which shows the range of the parameters at here. Same as the mode 1, 2 and 3.

Line 154: Why did the authors only use those values at 355 nm?

Line 175-182: How did the authors decide to use those equations to stand the altitude-dependence? Some references should be added here. What is the BG1? Is it the BG01 mentioned before?

Line 197: The reference of the Mie theory or code should be added here.

Line 203: For mode 1 and mode 2, only the values of m_(r i) and m_(im i) at wavelength at 355 nm were introduced. How did the authors get the value at 1064 nm?

Line 215: The "(A)" should be after the "average".

Line 242: The maxima is the maxima of the fitting curve but not the maxima of the all samples. Right?

Line 245: For the wavelength 1064 nm, there are some samples with LR larger than 80 based on the figure 3c.

Line 292: Are the relative errors the errors of lidar measurements? What are the standard measurements (truth)?

Line 298: 5 sites were chosen, but why there are only 4 sites depicted in the figure 4.

Line 313: ãĂŰLRãĂů_mod,ãĂŰLRãĂů_meas should be explained at here.

Line 329: The table 6 should be referred at here.

Line 366-371: Although the retrieval method was introduced by other scientists before, it is better to discuss more about how to derive aerosol extinction from the ALC e.g. show the key equations. Audiences may have questions like what are the raw data of the ALC? Are the raw data the range corrected backscatter? Does the raw data already consider the attenuation of signal from height z to surface due to aerosol and molecular extinction?

Line 389: What made the authors to choose this threshold of AOT for cases screen?

Line 408-421: It is suggested to give a AOT VS AOT scatter plot at here. Then it will help the audiences to have sense of both absolute and relative errors of AOT.

Line 431: With the fixed LR=52, the bias (<|dAOT|>=0.021 and 0.006) are smaller than the model-based bias (<|dAOT|> =0.11, 0.13) shown in line 428, right? Why the

authors said it is larger?

Line 440-444: How did the authors calculate the aerosol volume? Was the retrieval based on equation 7 and 10? Authors should explain more about the retrieval at here.

Line 460-470: The hygroscopic growth could induce large differences between the in-situ measured and the ALC retrieved aerosol volume. In the work of Siwei Li et al. (2016, 2017), they discussed the impacts of aerosol size distribution in the retrieval of PM2.5 using ceilometers (Li et al., 2016) and relationship between relative humidity and PM2.5/ceilometer-backscatter ratio (Li et al., 2017). More discussion about volume, PM retrieval and comparisons of model-based retrieval with in-situ measurements e.g. model vs in-situ scatter plot should be added here. Adding aerosol size (can compare the in-situ measurements and angstrom exponent) and relative humidity information and analysis at here may help the authors to support their conclusion.

Line 477: What specific aerosol densities did the authors use in the retrieval and why?

Line 485: Why did the authors use different heights in estimation of surface aerosol volume (0-75 m) and mass (at 225 m)?

Line 488-490: Were the mean and relative difference between the two-series based on hourly average PM10 or daily average PM10? What is the absolute difference? What is the R between them?

Line 496: Where is the close bracket?

Line 549: Surface area and volume are not the optical properties. The results from this work showed that ancillary data information are needed to get accurate aerosol properties e.g. volume, mass. . ..

Line 551: What kind of meteorological monitoring can be provided by the method?

Interactive comment on Atmos. Meas. Tech. Discuss., doi:10.5194/amt-2018-79, 2018.