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Atmospheric Measurement Techniques Discussions

# *Interactive comment on* "Remote sensing of $PM_{2.5}$ during cloudy and nighttime periods using ceilometer backscatter" *by* Siwei Li et al.

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General comments: The authors present an interesting study about the application of ceilometer backscatter data for getting information about the air quality at the surface layer which is expressed as the PM2.5 aerosol mass concentration. This is done by means of a regression model which is able to taking into account relevant meteorological parameters. In my opinion the topic of this study is of larger relevance. It shows a way getting almost continuously air quality information at the surface, or more precisely information about the PM2.5 aerosol mass concentration, by using standard measurement devices which are installed world-wide. Although this may not be enough getting information about the air quality in a manner that will stand up in court, which is an important constraint for governmental organisations, it is an applicable and promising method.



The paper is well written and it clearly shows the way the authors followed to get their results. Main assumptions and limitations of the applied method are discussed and results are presented in an appropriate way. The list of references is fairly complete. The topic is well suited for AMT. I therefore have only a few comments and recommendations before the paper can be published.

Specific comments: The authors used the somewhat outdated and no longer officially supported CT25K Vaisala instrument for their study. Although this instrument is still in use at many places it would be helpful for the community knowing about the impact of the instrumental design and the performance of the CT25K w.r.t. the results. Would it e.g. simply be possible to replace the CT25K by e.g. the CL31, the CL51 from Vaisala or by one of the newer Lufft instruments (the CHM15K) ?

The overlap of the CT25k can't be zero since the mirror is in the optical path of the laser beam. The overlap range is about $\sim$30 m for the CL31 and since the CT25K is kind of a predecessor instrument with similar optical design, it is likely the same for the CT25K. I guess the authors actually wanted to say that they are able to retrieve (probably) useful information down to the height of the ceilometer, or in other words, that the built-in overlap correction works down to the surface level. Could be clarified in the text.

The CT25K, as well as other ceilometers, is an uncalibrated instrument. Therefore, the backscattered radiation is variable from instrument to instrument, depending on the laser power, the age of the laser, possible optical distortions, and production tolerance a.s.o. The necessity of calibrating the ceilometer for this application should be discussed. An explaining paragraph should be added since this is a major drawback for the application to other places and other instruments, even of the same instrument model.

During a recent ceilometer intercomparison campaign (see http://ceilinex2015.de, paper by S. Kotthaus et al., Atmos. Meas. Tech., 9, 3769–3791, 2016) it became clear

that firmware issues can have a large impact on aerosol retrieval results. Did the authors check the firmware versions of the two instruments used in this study ? If the authors found a difference there I recommend adding a discussing paragraph.

The applicability of the regression model to “any” aerosol composition thus “any” geographic area is limited. The authors analysed situations with predominantly sulphate components. If however larger aerosol particles, e.g. mineral dust advected from the American and Mexican deserts become part of the game the ceilometer backscatter will largely change. Same for coastal zones with dust and sea salt in the atmosphere. It would be helpful if the authors discuss the impact of different aerosol types in a corresponding paragraph.

Section 3.1: It is somewhat surprising that different fits/models are required for daytime cloudy and daytime clears-sky scenes. The reason for this should be explained in a paragraph. The approach would be better applicable if just two fit data sets are required, a daytime and a night-time data set. What makes the cloudy scene so different from the clear-sky scene ?

Technical corrections: P 5, Eqs. (9) and (10): It might be better renaming the fit coefficients a0,. . .,a4 and b1, b2 in Eq. 10 to c0,. . .,c4, d1, d2. The reader might assume that these coefficients a,b are the same as above, which is according to Tabs. 1,2 not the case.

P6., line 7: explain COD

P11, p12, Figs. 9, 10: The y-axis up to 80 microgram/m**3 makes actually no sense since values higher than 60 do not exist. Maybe the plots are also more conclusive if the x-axis has a similar scale from 0 to 60 in steps of 10 micrograms/m**3.

P 20, table captions, Eqs. (11) and (12) do not exist, should be 9 and 10 instead, as far as I understood it.

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