

## ***Interactive comment on “Profiling the PM<sub>2.5</sub> mass concentration vertical distribution in the boundary layer” by Z. Tao et al.***

**Anonymous Referee #2**

Received and published: 31 December 2015

General comments:

The manuscript presents a methodology and case study for profiling PM<sub>2.5</sub> mass vertical distribution in the planetary boundary layer (PBL) using a CCD lidar and PM<sub>2.5</sub> sampler. This subject is quite interesting to the air quality modeling and lidar remote sensing communities because there is lack of direct measurement of PM<sub>2.5</sub> vertical profile by EPA and other agencies. The ratio of aerosol extinction to PM<sub>2.5</sub> mass (or K) and its height dependence are critical in this study. Authors estimate the ratio K at the ground level with the RH<70% and then convert the aerosol extinction profile to PM<sub>2.5</sub> mass profile in the PBL with an assumption of constant K. Three cases show a stable value of the ratio K over the nights, however the potential uncertainty or variation of the ratio K with altitude is not discussed except the RH effect. In addition, the validation

C4563

on the CCD-lidar retrieved extinction or PM<sub>2.5</sub> profile is not discussed or shown. The method might work in the well-mixed PBL where the aerosols are relatively homogenous. Overall, this manuscript is within the scope of Atmos. Meas. Tech. and can be accepted for publication once the following specific comments are taken into account.

Specific comments:

1. The potential uncertainty or bias of the CCD-lidar retrieved aerosol extinction is not discussed or presented. The validation of the CCD lidar retrievals with a Raman lidar or other ground in-situ measurement might be useful to evaluate the errors or bias of the CCD-lidar retrievals.
2. The height dependence or variation of the ratio of aerosol extinction-to-PM<sub>2.5</sub> mass (or K) is critical to the accuracy of PM<sub>2.5</sub> mass concentration profile. An assumption of homogenous microphysics (size distribution) and chemical compound (refractive index) of aerosols in this study is quite arbitrary for the night-time PBL due to the weak turbulence mixing or even in the day-time (see the varied aerosol sizes from the aircraft measurement by Li, et al., 2015). Thus, authors need to point out this limitation or/and show further discussions or evidences for this assumption.
3. There are a few measurements of aerosol hygroscopic factor  $f(\text{RH})$  of scattering coefficients in China (see the reference by Chen, et al., 2014; Zhang, et al., 2015). It seems that the  $f(\text{RH})$  is in the range of 1.2-1.4 at RH=70% which is still big.
4. For the case results in this study, if possible, the relative humidity (RH) profile needs to be shown from the measurements from either radiosonde, Raman lidar or microwave radiometer.

Some minors:

1. Line-49, please add “in diameter” in the definition of the PM<sub>2.5</sub>.
2. Line-59, “were” should be “was”.

C4564

3. Line-117, what is the parameter “D”?
4. Lines 180-183, please add the reference for this point.
5. For the three cases, why is the distance D between the laser beam and CCD camera set to be different?
6. Line 171, Eq.(7) is an approximate formula in which  $Q_{ext}$  is assumed to be a constant. This is fine for a single particle, but for all different sizes of aerosols in the atmosphere  $Q_{ext}$  is a function of aerosol radius and refractive index.

References:

Junxia Li, Yan Yin, Peiren Li, Zhanqing Li, Runjun Li, Maureen Cribb, Zipeng Dong, Fang Zhang, Jin Li, Gang Ren, Lijun Jin, Yiyu Li, Aircraft measurements of the vertical distribution and activation property of aerosol particles over the Loess Plateau in China, *Atmospheric Research*, Volume 155, 15 March 2015, Pages 73-86, ISSN 0169-8095, <http://dx.doi.org/10.1016/j.atmosres.2014.12.004>.

Chen, J., Zhao, C. S., Ma, N., and Yan, P.: Aerosol hygroscopicity parameter derived from the light scattering enhancement factor measurements in the North China Plain, *Atmos. Chem. Phys.*, 14, 8105-8118, doi:10.5194/acp-14-8105-2014, 2014.

Zhang, L., Sun, J. Y., Shen, X. J., Zhang, Y. M., Che, H., Ma, Q. L., Zhang, Y. W., Zhang, X. Y., and Ogren, J. A.: Observations of relative humidity effects on aerosol light scattering in the Yangtze River Delta of China, *Atmos. Chem. Phys.*, 15, 8439-8454, doi:10.5194/acp-15-8439-2015, 2015.

---

Interactive comment on *Atmos. Meas. Tech. Discuss.*, 8, 12933, 2015.