Dear Reviewers,

Thank you very much for your valuable comments on our paper amt-2012-97 "A new method for estimating aerosol mass flux in the urban surface layer by LAS". Below we present the detailed replies to your comments.

Please find also the revised manuscript with all changes marked.

Yours sincerely

On behalf of all co-authors,

Renmin Yuan

Interactive comment on "A new method for estimating aerosol mass flux in the urban surface layer by LAS" by R. M. Yuan et al.

Anonymous Referee #1

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Comments:

The manuscript presents a novel method for estimating aerosol vertical transport flux in the urban surface layer by LAS. This subject is interesting to the air quality modeling and light propagation communities. The theoretical analysis and experimental observation demonstrate the rationale of this new method. However, some technical details are confused.

Technical issues:

1. About the Eq.(8) for the relationship of aerosol absorption and the imaginary part n(Im). The application of this formula in this study is confused because the visibility-derived aerosol extinction can not be related to the aerosol imaginary part n(Im) in this way. In other words, the visibility-derived aerosol extinction is much different from the aerosol absorption due to the aerosol scattering contribution. In this study, for the visibility-derived aerosol extinction in the open atmosphere, the aerosol scattering coefficient is often dominated in comparison to the aerosol absorption. On the other hand, for the filter-based techniques or integrated plate measured aerosol absorption (Moos-müller, et al., 2009), it can be referred to or equal to the aerosol extinction because the aerosol scattering might be small enough to be ignored.

In addition, the citations or the reference for this formula should be given with the page number.

Answer: According to the theory of small particle scattering (Liou, 2002), the extinction cross section of one particle is given by (Eq. (5.2.92) in Page 189 in Liou's book),

$$\sigma_e = \frac{4\pi}{k^2} \mathrm{Re}[S(0)]$$ (1)

So, for aerosols with a size distribution of dN/dD, the total extinction coefficient can be calculated as,

$$\beta_e = \frac{4\pi}{k^2} \int_0^\infty \mathrm{Re}[S(0)] \frac{dN}{dD} \, dD$$ (2)

Comparison to Eq. (A3) gives Eq. (8), namely,

$$n_{\mathrm{Im}} = \frac{\lambda \beta_e}{4\pi}$$ (3)

It is noted that the variable n_{im} in Eq. (8) links with the extinction, which is the sum of scattering

and absorbing.

Equations (1) and (2) given here have been added in the Appendix as equations (A4) and (A5), and relative statements were added in the text too. Please see Page 17 Line 3-7.

2. Page 10, Line 10. What is the means of parameter "z/L"? Why it represents the atmospheric stability? How to get it?

Answer:

The definition of non-dimensional parameter 'z/L' (here, z is the effective height above the reference plane (=18m in this study); L is the Monin-Obukhov (M-O) scale and defined as

$$L = \frac{\bar{T}u_*^2}{\kappa g T_*} = -\frac{\bar{T}u_*^3}{\kappa g \overline{\theta'w'}})$$ characterizes the turbulence processes in the surface layer (Stull, 1988). The

definition was provided in Section 2.

Please see Page 4 Lines 25-26.

According to Stull (1988), the dimensionless parameter z/L measures the relative contributions from convection ($\overline{w'\theta'}$) and shear movement (u_*) to the turbulence. When z/L <0, it is unstable stratification ($\overline{w'\theta'}$ >0). When z/L >0, it is stable stratification ($\overline{w'\theta'}$ <0). And when z/L close to 0, it is neutral stratification ($\overline{w'\theta'} \to 0$).

In this study, Campbell CSAT3 3-D anemometer can provide fluctuation data (u', v', w' and T'). Then cross-correlations between velocity components ($\overline{u'w'}$, $\overline{v'w'}$ and $\overline{u'v'}$) or between velocity components and temperature fluctuation ($\overline{u'T'}$, $\overline{v'T'}$ and $\overline{w'T'}$) can be calculated. And then the friction velocity u_* can be calculated based on the expression $u_*^2 = \sqrt{(\overline{u'w'})^2 + (\overline{v'w'})^2}$. So dimensionless parameter z/L can be obtained based on M-O length definition(Stull, 1988; Wyngaard, 2010).

Related statements are added from Page 8 Line 20 to Page 9 Lines 3-9.

Stull, R. B.: An Introduction to Boundary Layer Meteorology, Reidel Publishing Co., Dordrecht, 666 pp., 1988.

Wyngaard, J. C.: Turbulence in the Atmosphere, Cambridge University Press, New York, 393 pp., 2010.

3. Is it possible to make the vertical wind velocity measurement in the meteorological tower? It may help explain the vertical transport of aerosol mass.

Answer: Vertical wind speed measurements were available from a CAST3 sonic anemometer. The following figure shows the variations of vertical wind speed during Dec. 26, 2014, 11:00-12:00. The vertical wind speeds always fluctuate and the mean value of vertical wind is close to 0 with a 30-min or 1-hour averaging.
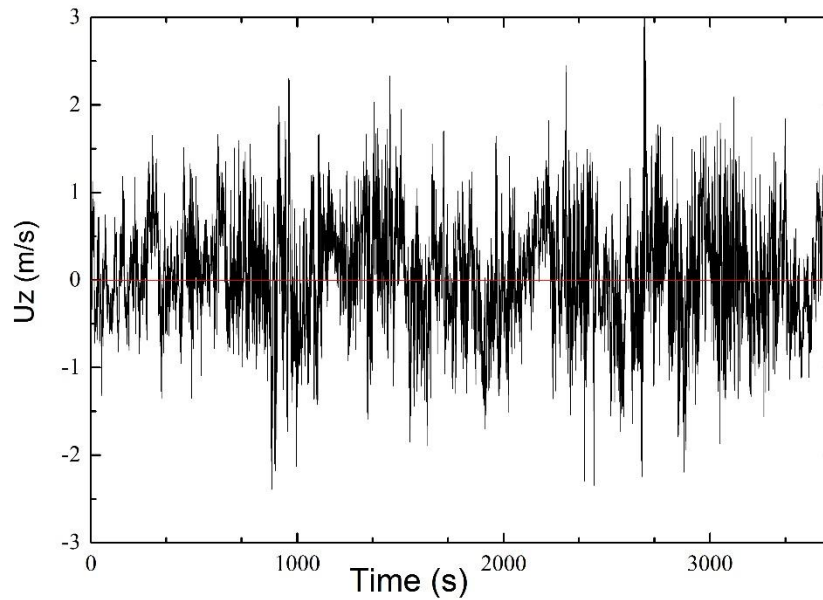
Figure 1 The temporal evolution of vertical wind speed during Dec. 26, 2014, 11:00-12:00.
Sample frequency is 10Hz. The red line in the figure indicates zero.

The vertical transport flux can be expressed as $\overline{wa}$, where w is the vertical velocity, a is the aerosol mass. By using the Reynolds decomposition ($w = \overline{w} + w', a = \overline{a} + a'$, where the overbar denotes the mean field of the variable, and the prime denotes fluctuating part of the variable), $\overline{wa} = \overline{w} \cdot \overline{a} + \overline{w'a'} \approx \overline{w'a'}$, because $\overline{w}$ is close to 0 m/s. Therefore, the vertical velocity only cannot explain the vertical transport of aerosol mass.

Minors:

1. Page-12, Line 2-3 "which is similar to the main aerosol source in Hefei City". Please delete it. The air pollution mechanism and process in Hefei might be more complex and much heavier.
Answer: We deleted "which is similar to the main aerosol source in Hefei City".

2. Some citations or the references from the books should be given with the page number.
Answer: We added the page number
References: H. Moosmüller, R.K. Chakrabarty, W.P. Arnott, Aerosol light absorption and its measurement: A review, Journal of Quantitative Spec-troscopy and Radiative Transfer, Volume 110, Issue 11, July 2009, Pages 844-878, ISSN 0022-4073, http://dx.doi.org/10.1016/j.jqsrt.2009.02.035. (http://www.sciencedirect.com/science/article/pii/S0022407309000879
Answer: We added the reference.