

***Interactive comment on* “Direct determination of highly size-resolved turbulent particle fluxes with the disjunct eddy covariance method and a 12 – stage electrical low pressure impactor” by A. Schmidt and O. Klemm**

**A. Schmidt and O. Klemm**

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Response to the comments of Referee #2

General comments "In the manuscript, the size-resolved aerosol particle fluxes measured with disjunct eddy covariance method in urban area are analyzed. Direct aerosol particle flux measurements are very rare in urban environments and thus the paper gives important contribution on the subject. Especially, new information is given by the different sized of particle fluxes. The manuscript is well laid out and reasonably well written. However, in order of publishing it in ACP some minor corrections should be applied on the manuscript."

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Thanks for the positive statement. We also think that especially the size-resolved analysis gives some new insight to turbulent particle exchange processes.

"The text in the introduction should be improved. In the beginning of introduction a sentence "...atmospheric processes by influencing and driving reams of chemical activity..." is not well written. Also the second paragraph in the introduction should be improved. For example, it is not clear from where to where the focus of the atmospheric research has moved, and are the writers saying that EC technique is based on the vertical concentration gradients."

Of course the eddy covariance method is not based on the vertical concentration gradients. The respective sentence (page 8999, lines 12-17 in the discussion paper) seemed to be misleading and has been changed to make it more clearly. Concerning the comment on the second paragraph of the introduction: The introduction is supposed to give a very short overview with strict connection to the current study. We think, to give an introduction of "from where to where" the focus of the atmospheric research has moved in the last years is out of scope of our introduction. Especially, due to the extremely wide field of atmospheric research it seems not reasonable to give an appropriate overview within this manuscript. This also applies to the more specific research field of turbulent exchange. We think that such discussions would be better placed in a textbook or a review article. Nevertheless, the text in the introduction was rearranged and the wording referee #2 mentioned has been improved and some important studies were added (i.e. we referred to in the text).

"There is rather weak comparison between the aerosol particle fluxes reported here and in other particle flux studies. Are the total fluxes reported similar to those reported in other urban studies, and what about the differences of size-resolved particle fluxes in different surroundings (like forests)?"

We already referred to some related studies in our manuscript in the only reasonable general way. See for instance on page 3, lines 14-17, page 9005 line 9 – page 9006 line

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1, or page 9006 line 24 - page 9007 line 1, page 9015 lines 20 – 23. Additionally, some further references to related studies were added according to the hints of referee #1. The most limiting circumstance, which makes it impossible to follow the recommendation of referee #2, is the sheer fact that the size-resolution of the type presented here, is not available in former studies about particle fluxes. Hopefully, we can help to improve this current situation of micrometeorology and aerosol research with our present study. Even existing and published total number (or mass) fluxes are very different in nature, when different size ranges form the basis of the observations. A comparison is only possible, if the same or at least similar equipment (particle measurement devices) would have been used. In principle, it would be possible to give the results of other studies (conducted under completely different environmental circumstances showing other particle size distributions, e.g. forests) but, due to the reasons mentioned above, this does not allow a meaningful direct comparison. We prefer to keep the references in the text without trying a direct comparison of the different results in our manuscript. An extensive and very new comparison of turbulent particle atmosphere-surface exchange studies over vegetated areas during the last decades is given in the review paper by Pryor et al. (2008). We added the useful hint to this review paper in the introduction.

S. C. Pryor, M. Gallagher, H. Sievering, S. E. Larsen, R. J. Barthelmie, F. Birsan, E. Nemitz, J. Rinne, M. Kulmala, T. Grönholm, R. Taipale and T. Vesala: A review of measurement and modelling results of particle atmosphere-surface exchange, *Tellus B*, 60, 42-75, 2008.

"At the beginning of abstract, it should be stressed that both aerosol number and mass fluxes are considered."

This was corrected the beginning of the abstract was changed to: "During summer 2007, turbulent vertical particle mass and number fluxes were measured"

"Page 9004, line 9: Sentence "measured interval of 5 s is combined with a sampling duration of 0.4 s" could be removed since in next sentence it is repeated."

This was corrected.

"Page 9008, line 12: Sect. 3.2 should be Sect. 2.4."

This was corrected. Thanks for the hint.

"Page 9010, first paragraph: Text is not referring to any figure of table, so for clarification a text "(Not shown)" should be added."

We added the text (not shown) to the respective text passage to clarify the circumstances.

"Page 9012, lines 11-14: The diurnal cycle (with daily main peak) of particle number fluxes is related to both turbulence development and anthropogenic emissions. Now it is said to be related only to the turbulence."

On page 9012 (lines 11-14) we do not state that the particle number fluxes are only related to the turbulence. Actually we wrote: " The total particle number flux exhibits a pattern with 3 peaks (about 7:30, 13:00, and 16:00 local time) that are embedded in the daily main peak that is obviously related to the known diurnal cycle of atmospheric turbulence development" Hence, of course the daily run of the fluxes is always a consequence of both influences – (traffic) emissions and development of the boundary layer (i.e. turbulence regime). The threshold value of the friction velocity was obtained to be 0.15 m/s and was used for filtering the data with respect to the strength of turbulence (p 9005, lines 6-8). But the flux is not independent the strength of turbulence. Of course, the stability conditions and therefore the development of turbulence exhibit a diurnal pattern and have an important effect on the fluxes. This superposition of meteorological and anthropogenic causes which affect the particle flux values has also been observed and stated in other studies about particle fluxes above urban areas e.g.:

Mårtensson, E. M., Nilsson, E. D., Buzorius, G., and Johansson C.: Eddy covariance measurements and parameterisation of traffic related particle emissions in an urban environment, Atmos. Chem. Phys., 6, 769–785, 2006.

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Dorsey, J. R., Nemitz, E., Gallagher, M. W., Fowler, D., Williams, P. I., Bower, K. N., and Beswick, K. M.: Direct measurements and parameterisation of aerosol flux, concentration and emission velocity above a city, *Atmos. Environ.*, 36, 791–800, 2002.

We enhanced the text by the explanation of this superposition.

"Page 9014, lines 25: The measured fluxes represent the net effect of vegetation uptake and anthropogenic emissions. Thus, a sentence "...show the biological net uptake by the vegetation within the city area" is somewhat misleading."

Yes, the wording can be misleading, since the effect of the biological net uptake is only included in the total CO<sub>2</sub> flux. The wording was changed to: "By contrast, the mean flux values on Sundays indicate the effect of the biological net uptake"

"Page 9014, last line: The measured fluxes represent exchange from a certain source area and by assumption are not affected by the long-range transport"

The footprint area is not a sharp, strict defined isolating border. As a straight consequence, this would otherwise mean that the source area is isolated from the rest of the atmosphere. We are aware of the fact that there is a (probably small) contribution of long-rang transport to the measured fluxes. However, mentioning this contribution apparently lead to misunderstandings. We therefore decided to keep out the respective wording.

"Table 3: It would be nice to have also the daily averages of total aerosol particle fluxes."

This was improved. The values were summarised in Table 3 to get the daily averages of total number fluxes and mass fluxes, respectively.

"Figure 2: In the legend, it should be more carefully stated what the different variables, lines and equations represent in the figure."

In order to avoid an overload of the Figure 2, we decided to respect the useful hint of

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referee #2 by enhancing the figure caption. Now, the meanings of the different variables and lines are described unambiguously.

The authors would like to thank referee #2 for his time and the comments and hints provided, which helped to improve the manuscript.

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Interactive comment on Atmos. Chem. Phys. Discuss., 8, 8997, 2008.

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