Atmos. Chem. Phys. Discuss.,
doi:10.5194/acp-2015-1047-AC2, 2016

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Anthropogenic and biogenic influence on VOC fluxes at an urban background site in Helsinki, Finland" *by* P. Rantala et al.

P. Rantala et al.

pekka.a.rantala@helsinki.fi

Received and published: 31 May 2016

We thank the editor for the helpful comments and suggestions. Editor comments are bolded whereas author responses are written in a normal text.

Looking at the map provided in the figure 2, the site seems to be particularly influenced by green vegetation. Even the sector identified as buildings is comprised of a fairly large fraction of vegetation, rather unique compared to the urban UK sites the authors compare their measurements with. Consistently this sector does not show a significantly different pattern of m/z 69 emissions. Perhaps a better description of this sector would be to call it 'urban residential sector with vegetation'.

This is true, the sectors have only small differences in vegetation coverage (Table 1). Therefore, the names of the sectors are somewhat vague but have been widely used in previous publications concerning the same site (Vesala et al., 2008; Järvi et al., 2012, 2014). In that sense, we would still like to use the original names. However, we expanded the discussion about the land use (section 2.1).

Temperature and PPFD normalized isoprene emissions were around the same from all wind directions. However, absolute values differ because the ambient temperature was typically the lowest when the wind blew from the built sector.

BTEX emissions: The sector identified as road boarders to what it seems like an industrial complex (for example: at a distance of about 300-400 m a smoke stack is evident on google earth). It is argued that this sector is primarily influenced by road traffic. The influence of additional BTEX sources in this sector (other than traffic) could perhaps be obtained by explicitly comparing toluene to benzene fluxes during rush hour peaks with other periods. The upper limit of traffic related emission ratios should be close to 2 (1.9) based on the emission factor database for the average European fleet. The authors compare their measurements to other cities. In this context it is noted that Mexico City seems to be a special place with respect to many of the measured VOC fluxes. For example toluene measurements by Velasco et al., 2009, were thought to be influenced by local application of resin surrounding the flux tower resulting in toluene / benzene flux ratios of about 8-10. Measurements by Karl et al., 2009, reported a city wide average ratio of about 3.2 for Mexico City and concluded that about 60-70% of toluene could be due to evaporative emissions. Figure 11: It is noted that a correlation of fluxes between some compounds (such as toluene) and CO2 needs to be discussed with caution. For example most of traffic related toluene emissions are evaporative and not produced by the ICE - thus not intrinsically linked to CO2 tailpipe emissions. This is fundamentally different for benzene emissions for example, which are much more closely related to tail-pipe emis-

sions.

We thank for the good suggestion. We calculated the ratio between the average toluene flux and the average benzene flux for two cases: all the data and periods when the traffic rate was over 2000 vehicles per hour. The ratios were 2.9 ± 0.7 and 3.1 ± 1.0, respectively, indicating non-traffic related toluene sources. Interestingly, the ratio was higher for the high traffic period but the difference was statistically insignificant. On the other hand, the toluene fluxes alone followed also well the traffic counts with an intercept of 4 ± 5 ng $m^{-2}s^{-1}$. Of course, toluene might still have evaporative emissions, but the traffic related emissions seemed to be still more important source if the offset is assumed to describe the non-traffic related emissions. We expanded the discussion related to non-traffic related sources of toluene and C_2-benzenes (sections 3.2.1 and 3.3). We also added Table A2 to the manuscript which contains the VOC to benzene flux ratios for each season.

We agree that the terrain in quite heterogeneous consisting of different land covers, but the old ceramic factory to which the editor likely refers to is not active anymore. The nearest industrial and workshop activities are over 800 -1000 m to the east south but these start to be already outside the flux footprint which typically expands less than that (e.g. Ripamonti et al. 2013, Figure 2). Also these emissions sources did not show up the in the Fig. S2 where the average VOC fluxes are plotted as a function of wind direction.

We also agree that the VOC fluxes are not totally comparable with the CO_2 fluxes as many VOCs have also other anthropogenic sources than CO_2 does. We pointed this out more carefully in the revised manuscript (section 3.3). The message of the comparison was to show that the low VOC fluxes measured in Helsinki are rather sensible when taking to account also low CO_2 fluxes, indicating less intense anthropogenic activities, such as traffic related emissions. However, we did not want to argue that those two emissions should have necessarily a linear dependency.

We included also Karl et al. (2009) to the discussion. We admit that the study by Velasco et al. (2009) was done at a unique location, but that was one of the rare studies which provided both the CO_2 and VOC fluxes from the same urban location.

References

Järvi, L., Nordbo, A., Junninen, H., Riikonen, A., Moilanen, J., Nikinmaa, E., and Vesala, T.: Seasonal and annual variation of carbon dioxide surface fluxes in Helsinki, Finland, in 2006–2010, Atmospheric Chemistry and Physics, 12, 8475–8489, 2012.

Järvi, L., Nordbo, A., Rannik, Ü., Haapanala, S., Riikonen, A., Mammarella, I., Pihlatie, M., and Vesala, T.: Urban nitrous-oxide fluxes measured using the eddy-covariance technique in Helsinki, Finland, Boreal Environment Research, 19B, 108–121, 2014.

Karl, T., Apel, E., Hodzic, A., Riemer, D. D., Blake, D. R., and Wiedinmyer, C.: Emissions of volatile organic compounds inferred from airborne flux measurements over a megacity, Atmospheric Chemistry and Physics, 9, 271–285, 2009.

Ripamonti G., Järvi L., Molgaard, M., Hussein T., Nordbo A. and Hämeri K. (2013). The effect of local sources on aerosol particle number size distribution, concentrations and fluxes in Helsinki, Finland. Tellus B 65.

Vesala, T., Järvi, L., Launiainen, S., Sogachev, A., Rannik, Ü., Mammarella, I., Siivola, E., Keronen, P., Rinne, J., Riikonen, A., and Nikinmaa, E.: Surface-atmosphere interactions over complex urban terrain in Helsinki, Finland, Tellus B, 60, 188–199, 2008.

Interactive comment on Atmos. Chem. Phys. Discuss., doi:10.5194/acp-2015-1047, 2016.