Understanding ultrafine particle dynamics within a one km urban grid

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Introduction

Due to ever increasing awareness about the health relevance of Ultrafine particles (UFP) several studies have examined particle number concentrations (Rank et al., 2001; Gulliver and Briggs, 2007; Briggs et al., 2008), using a variety of different measurement methods. Exposures to UFP in traffic are generally higher than and poorly correlated with concentrations measured simultaneously at fixed monitoring locations, even if these are located in major streets (Kaur et al., 2007). Hence characterization of UFP cannot rely only on fixed site monitoring. A combined mobile and fixed monitoring have been performed to understand fine scale dynamics of UFP within a grid of 1 Km at Borgerhout, Antwerp, Belgium.

Material and methods

A combination of mobile (bicycle equipped with P-Trak, Dust Track, GPS, and video camera) and stationary measurements (Condensation Particle Counter (CPC), UFP monitor, and P-Trak) were performed during summer of 2009 (March-August) within a radius of about 1 km around an air quality monitoring station of the Flemish Environmental Agency (VMM), at Borgerhout, Belgium.

Results and discussion

It was found that although the sites follow similar diurnal patterns of UFP variation, individual variation at the sites were also substantial. The UFP levels at the three stationary measurement sites show good correlation with each other and also with NO and O_3 concentration levels. Detailed statistical analysis of the data showed inherent differences in the diurnal variation between the three sites.

The mobile measurements inside the grid showed more local variation which can lead to false conclusions on very high within street UFP levels. Mobile measurement performed on different times and different days of the week concluded that while determining within street exposure levels, it is advisable to take into account the baseline values attained in each of the streets, rather than individual peaks which can be attained while crossing any active vehicle or any other emission source. In other words, it is more important to understand how the UFP are handled by the ambient air after its emission from various sources rather than just measuring the numbers and reporting it as high and low which can be misleading due to its very local and transient nature.

Using different statistical techniques, and also by using different averaging times, it was attempted to show that averaging can affect the amount of correlation between UFP and other gaseous species. Also, differences in averaging times can lead to slightly different diurnal trends of UFP concentration at individual sites.

Conclusion

It was found that although the sites follow similar diurnal patterns of UFP variation, individual variation at the sites were also substantial. The short term peaks achieved during high traffic conditions substantially increase the mean number concentration at the site, thus reducing the level of correlation among different sites. The comparison of the results of UFP monitor with condensation particle counters (CPC) showed that a lot of smaller particles (<25nm) are freshly emitted from vehicular exhaust and do not have a long half life. The strong correlation observed between NO_2 and UFP levels at the two sites further confirm strong influence of traffic emissions on UFP. The third site showed strong correlation between UFP and O_3 showing more importance of photochemical processes in UFP dynamics at this site.

References

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