The origin of particles at Vavihill

A. Kristensson[1], S. Fransén[1], A. Massling[2], J. Samuelsson[1], M. Ketzel[2], F. Wang[3], E. Hermansson[1], and G. Frank[1]

[1]Department of Physics, Lund University, P. O. Box 118, SE-221 00, Lund, Sweden
[2]Department of Environmental Science, Aarhus University, Frederiksborgvej 399, DK-4000, Roskilde, Denmark
[3]The Department of Civil and Environmental Engineering, Politecnico di Milano, Piazza Leonardo da Vinci, 32, IT-20133, Milano, Italy

Keywords: particle number size distribution, DMPS, new particle formation, combustion

Due to aerosol processes in the atmosphere, aerosol particle properties change markedly during long-range transport. Hence, it is a difficult task to pin-point the sources of the particle number measured at a background field site. A combination of different analytical methods and measurement techniques is required to determine the source apportionment for any field station.

One of the European long-term monitoring field sites, where the source apportionment of the particle number size distribution is tried, is the rural background site Vavihill in southern Sweden.

Several years of submicrometer particle number size distribution data is analysed for new particle formation, which is one important source of particles in Vavihill (Kristensson et al., 2008). Previously undefined formation event days are upgraded to event days with the Buenrostro Mazon (2009) method. An analysis of events observed at Lille Valby in Denmark (Wang et a., 2013) gives an answer if these particles have further been transported to Vavihill and then have been observed there as slightly larger particles due to condensational growth. Hence, we have situations where particles at Vavihill have their origin from new particle formation although new particle formation is not taking place at Vavihill.

During occasions with winds from Copenhagen it is also possible to estimate the contribution from combustion generated particles. This is complemented with hygroscopic growth data at 90 % relative humidity as function of particle diameter. Water uptake could be different for new particle formation and combustion generated particles. In other words, it can also potentially be used for source apportionment of particles at Vavihill.

In a winter case-study with air transported from Copenhagen to Vavihill in three hours, Copenhagen emissions were able to increase the number concentration two-fold in Vavihill compared to the air masses which just missed Copenhagen on this day (Figure 1). Hygroscopic data from another winter occasion showed that 35 nm diameter particles had tri-modal growth factors at 90 % RH. About 30 % of the particles had a mean growth factor of 1.0, and 45 % and 25 % of the particles had a growth factor of 1.3 and 1.5 respectively. This shows that the plausible soot particles having a growth factor of 1.0, can be used for source apportionment of combustion generated particles, since no other near-regional source could produce particles with this low growth factor. Since we have subtracted the background particles from the Copenhagen contribution, also the particles with growth factors of 1.3 and 1.5 should have been emitted in Copenhagen. However, these factors are unexpectedly high, and we have to analyse the data further to investigate whether we have some contamination from background particles after all.

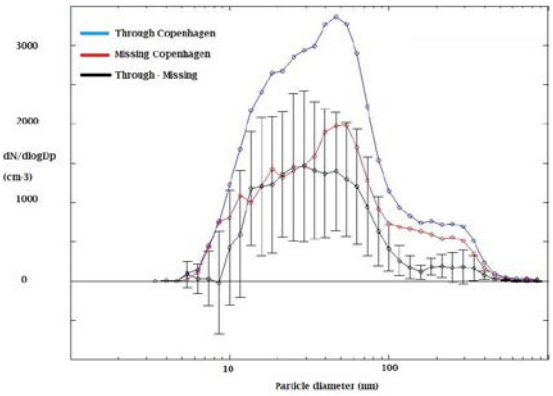

Figure 1. The particle number size distribution observed at Vavihill during 4 hours on February 6, 2012 for air passing Copenhagen (blue), air just missing Copenhagen (red), and the Copenhagen contribution (passing Copenhagen - missing).

The new particle formation analysis showed that there are indeed a few cases when the particles observed at Vavihill are likely from formation at Lille Valby, but not from formation at Vavihill.

We acknowledge the Swedish research council FORMAS, Stina Werner's foundation, and the study is a contribution to Lund University Strategic Research Areas: Modeling the Regional and Global Earth System (MERGE).

Buenrostro Mazon, S., et al. (2009). *Atmos. Chem. Phys.*, 9, 667-676.
Kristensson, A., et al. (2008). *Tellus*, 60B, 330-344.
Wang, F., et al. (2013). *Environ Sci Pollut Res*, 20, 3050-3059.