Aerosol number concentration measurements in five European cities during HEAPSS

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Network for Environmental Risk Assessment and Management

Objectives

Epidemiological research during the last decade has indicated that exposure to air pollution at the levels presently measured in European urban environments is associated with an increase in mortality and with a variety of health conditions, including emergency room visits and hospital admissions for respiratory and cardiovascular diseases. Particulate matter (PM) appears to be the air pollutant most consistently associated with adverse health outcomes. Although the toxicological mechanism has not been established, the small size fraction of ambient aerosols, measured as PM10 (particles with aerodynamic diameter less than 10 μm) or PM2.5 (less than 2.5 μm), rather than the larger particles, is considered to be responsible for most of the health effects. The number of concentrations of ultrafine particles (0.01 to 0.1 μm) are hypothesized to be of particular concern (1) .

The main objective of the HEAPSS-project (Health Effects of Air Pollution on Susceptible Subpopulations) is to quantify the risk of hospitalisation and of death due to air pollution, in particular airborne ultrafine particles, in individuals with coronary heart disease. This comprises the collection of a database of cross-European data on ultrafine particles.

Methods

The study is performed in five European cities - Augsburg (Germany; 0.45 million inhabitants), Barcelona (Spain; 1.5 million inhabitants), Helsinki (Finland; 0.5 million inhabitants), Rome (Italy; 2.7 million inhabitants), Stockholm (Sweden; 1 million inhabitants) - chosen so as to include a variety of geographical conditions and air pollution characteristics.

The measurement sites inside the cities are selected so that the concentrations measured represent an city-wide background concentrations (urban background). Three of the sites, Barcelona, Stockholm and Helsinki are elevated sites, Augsburg site is located inside a park. The site in Rome is located by a fairly busy road and could be classified as a kerbside site. Stockholm and Rome have also secondary sites. In Stockholm the secondary site is located inside a street canyon and in Rome inside a park (urban background).

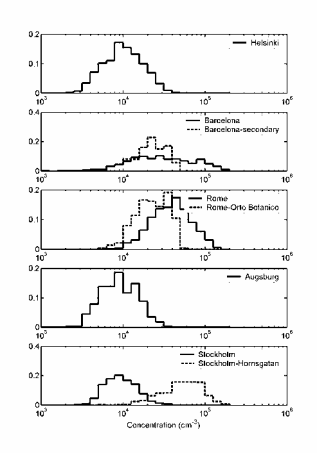
Ultrafine particle number concentrations are measured with a condensation particle counter TSI-3022 (TSI-Incorporated) (2). The sample is drawn to the instrument with a flow rate around 1.5 LPM through a Stainless Steel tube with an inner diameter of four millimeters. The tube length was tried to be kept as short as possible, less than four meters. Later on at some sites sample flow drier was added to the sample line to prevent water accumulation inside the instrument.

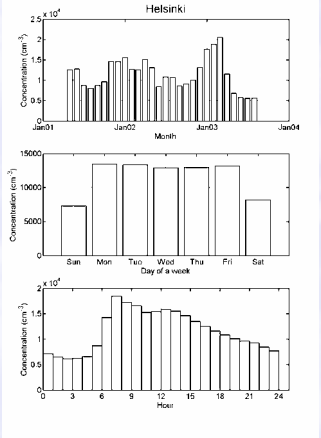
Results

Measurements at all five sites started during May 2001 and have continued since then.

The top table on the right column present the yearly averages of the particle number concentration in 1/cm^3 from all the five sites. Data is not yet fully analyzed and some poor quality data might appear. Average concentrations are highest in the southern cities especially during the winter. The three northest cities have equally low concentration. Fairly strong annual variation in the concentration is evident especially in Rome and Barcelona. Daily variation is strongest in Barcelona and Helsinki which both are influenced by the sea with cleaner marine air.

Year	Helsinki	Stockholm	Augsburg	Barcelona	Rome
2001	11530± 8921	10194± 6008	11535± 6694	65674± 62511	41682± 32765
2002	11680± 8921	10164± 6406	9402± 7439	46431± 51159	49994± 39297
2003	11530± 11780	10614± 7983		22091± 24731	39389± 30377





The northern cities, Stockholm and Helsinki are also effected by the strong meteorological inversions especially during the spring, which prevent the particles produced inside the city to be mixed to cleaner free tropospheric air.

The secondary urban background site of Rome is cleaner than the kerbside site. The Stockholm street canyon site has almost ten times higher daily mean concentration than the urban background site. Secondary site of lower concentrations was in operation also in Barcelona.

The lower left graph presents the histograms of particle concentrations. Barcelona has the highest variation in concentration.

The lower right graph shows as an example variation of monthly mean, weekday dependency and hourly dependency of particle concentration in Helsinki. Highest concentrations are observed during the winter months. All the working days have almost the same average concentration. Lowest concentrations are observed on Sundays. During one day highest concentrations are observed during the morning rush hours before the break-up of nocturnal boundary layer.

References

1. Seaton A, MacNee W, Donaldson K, et al. Particulate air pollution and acute health effects. Lancet 1995; 345:176-8.

2. G. J. Sem, Design and performance characteristics of three continuous-flow condensation particle counters: a summary. Atmospheric Research 2002; 62:267-294.