Comparison between PM1 and Visibility Measurements in an Urban Area – Looking for Innovative Air Quality Indicators

Nayla Sabbagh-Kupelwieser
Wladyslaw W. Szymanski
Xi’an, 11 May 2010
Motivation

- PM2.5 and PM10 are routinely measured in urban atmosphere
- Satisfactory for the first step
- PM1 seems to contain more information
- Mass concentration alone not significant
- Number concentration, surface concentration more health related effects

We search for other description methods or easier approaches
Size distribution of the urban aerosol from J. Seinfeld, HKUST Lecture, 1995.
Experimental Methods

- Mass measurements (Impactor)
- Number size distribution (SDMA)
- Surface area concentration (NSAM)
- Extinction coefficient measurements and thus visibility (TPM)
- RH and temperature measurements
- Wind data (Austrian meteorological institute)
- Sky observation (webcam)
Setup

Spectrometer

Object

Observed Aerosol

Reference Object

TPM

AE in

AE in

PC

Commercial Impactor

> 10
> 2.5
> 1.0
PM1.0

Pump out

> 10
> 2.5
> 1.0
PM1.0

CAVI

Minorflow out

Filter

5 lpm

NSAM

2.5 lpm

DMA

1.5 lpm
Results

Typical PM mass measurements in Vienna

![Graph showing PM mass measurements for Sep, Oct, and Nov](image)
Measured deposited surface area in the tracheobronchial region on a workday in November 2008 (NSAM)

Relative humidity for the same time
Increasing of wind speed by a factor of four

Time resolved number concentration on a workday in November

Beginning of the morning traffic
Wavelength dependent extinction coefficient on two different days (TPM)

Number size distribution on the same days (SDMA)
Wavelength dependent extinction coefficient on two different days (TPM)

Deposited surface area in the alveolar region on the same days (NSAM)
Correlation between the measured extinction coefficient (550nm) and PM-ratios in Vienna
Conclusion

- More than half of measured mass in PM10 belongs to PM1 fraction
- SDMA and NSAM data correlates well with RH, wind speed and traffic
  - Dynamics of particle change can be observed but not in mass measurements (integrating method)
- Comparison TPM – SDMA and NSAM =>
  - Higher extinction coefficient correlates well with higher PM1 burden (number and surface concentration)
- Extinction coefficient correlates well with ratio PM10/PM1 or PM2.5/PM1
The leapfrogging suggestion

\[ V = \frac{3.9}{\sigma_{\text{ext}}} \]

- Determination of visibility rather simple
- Knowing visibility and PM10 or PM2.5 => estimation of PM1 fraction
Thank you for your attention
Wind speed and wind direction on a workday in November to correlate with the measured particle number and surface distribution.
Respiratory system
„A second point is that the retention in the alveolar space—more precisely the dose retained in AM expressed as particle surface area—rather than the overall pulmonary retention of the TiO2 particles, is important for the effect on AM clearance function. Third, the **volumetric load of the AM is not a good predictor** for the delayed clearance effect when ultrafine particles are involved. **The surface area of the retained particles appears to be a better dose determinant.**“

*Correlation between Particle Size, In Vivo Particle Persistence, and Lung Injury*  
Günter Oberdörster, Juraj Ferin, and Bruce E. Lehnert
Wilson et al. 2004 data

Surface area deposited in the regions of the lung per cm³ of air inhaled versus EAD (resting and nose breathing)

Surface area deposited in the regions of the lung per cm³ of air inhaled versus EAD (jogging and mouth breathing)

RSC Meeting on Environmental Nano
Particles 8th June 2005