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Continuous air pollution and surface-atmosphere interaction measurements at the SMEAR III station in Helsinki

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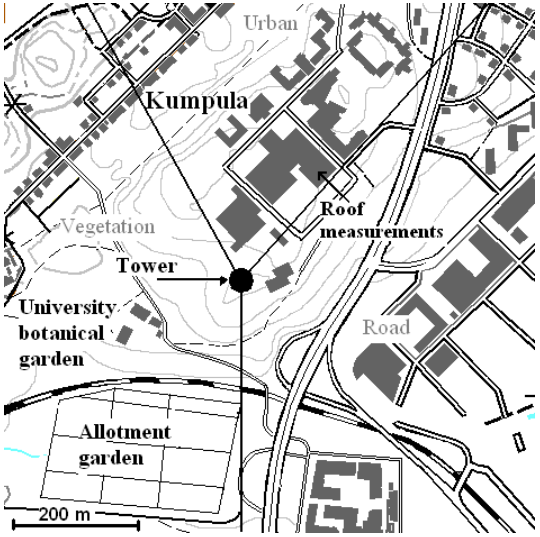
Motivation

- Urban areas create very different circumstances for the lower level of the atmosphere
  - Many of the pollution sources and majority of people are located in cities
  - Urban areas are characterized by high surface roughness and different thermal conditions which affect turbulent mixing and further pollutant dispersion
- Still lot of information missing about the sources, sinks and mixing of air pollutants
- Measurements at the SMEAR III station try to give answers also these questions

Measurements used in this study

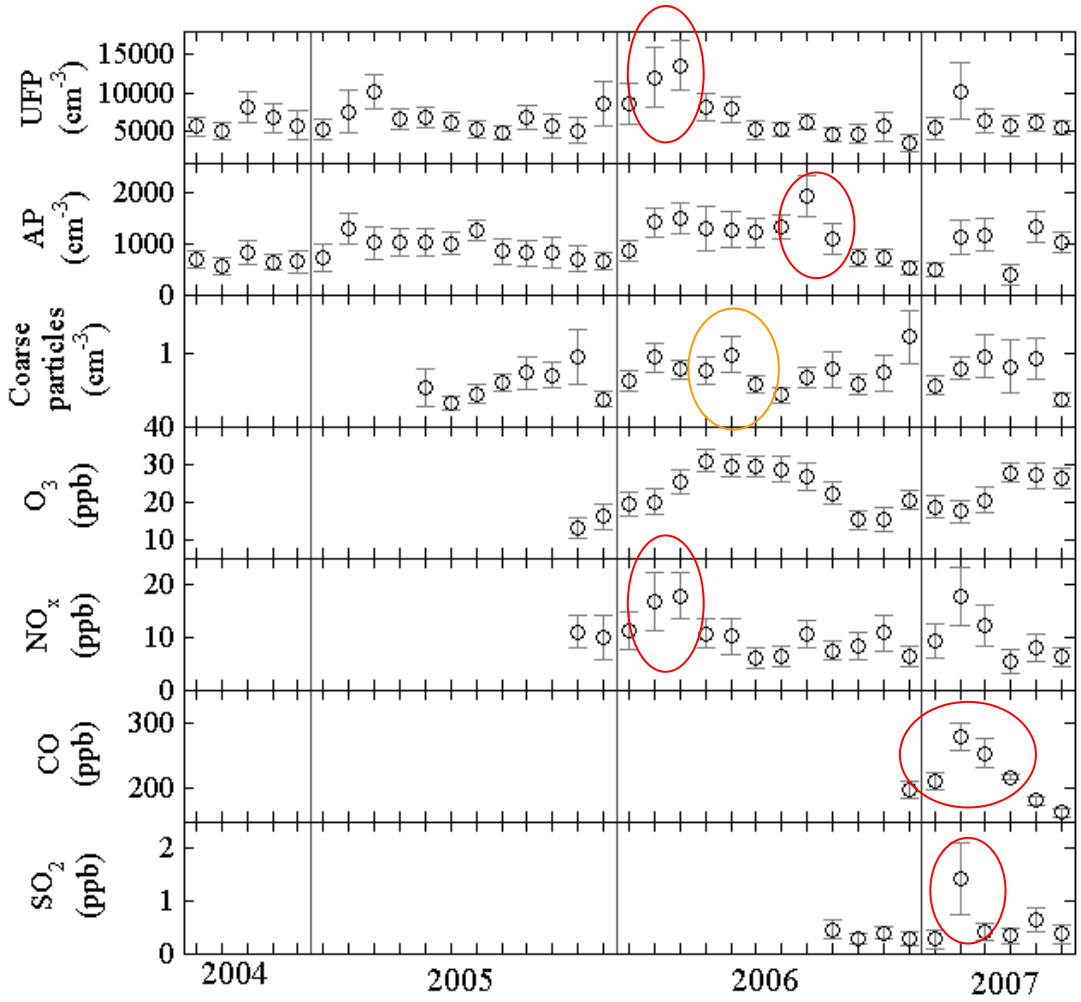
- The aerosol particle number concentration with size range 3 nm-20 μm are measured with twin DMPS and APS

- Particles are divided in three classes due to their different dynamics and sources
  - Ultrafine particles (UFP, d<100 nm), accumulation mode particles (100nm<d<1 μm) and coarse particles (d>1 μm)

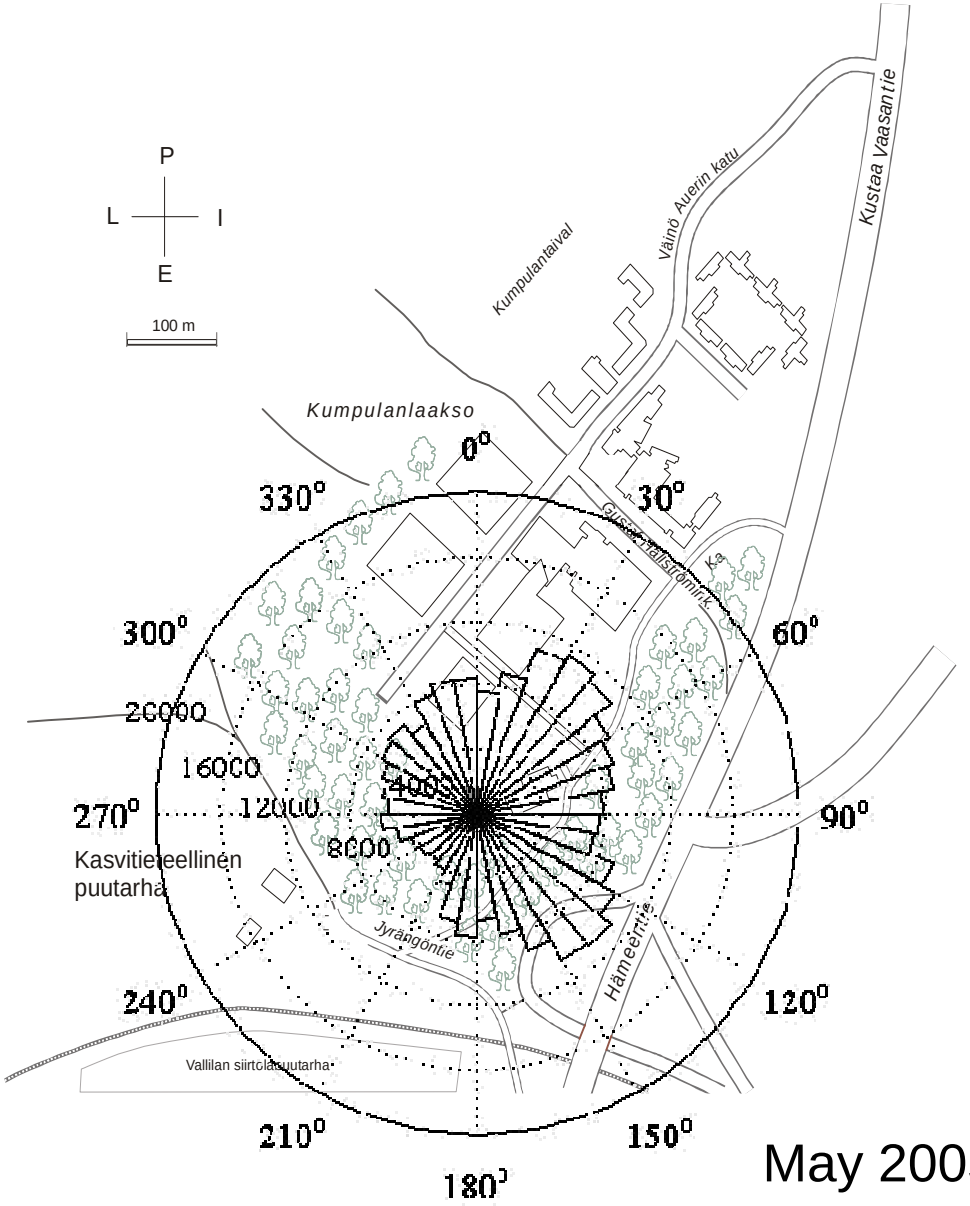


- Pollutant gases: Ozone (O_3), nitrogen oxides (NO_x), carbon monoxide (CO) and sulphur dioxide (SO_2)
- Meteorological variables: Pressure, solar radiation, wind speed and direction, RH and turbulent exchange
- Data between Aug 2004 and Jun 2007 is shown
  - Not all variables available the whole time
- Data was divided into four seasons: winter, spring, summer and fall

Time series of pollutant concentrations

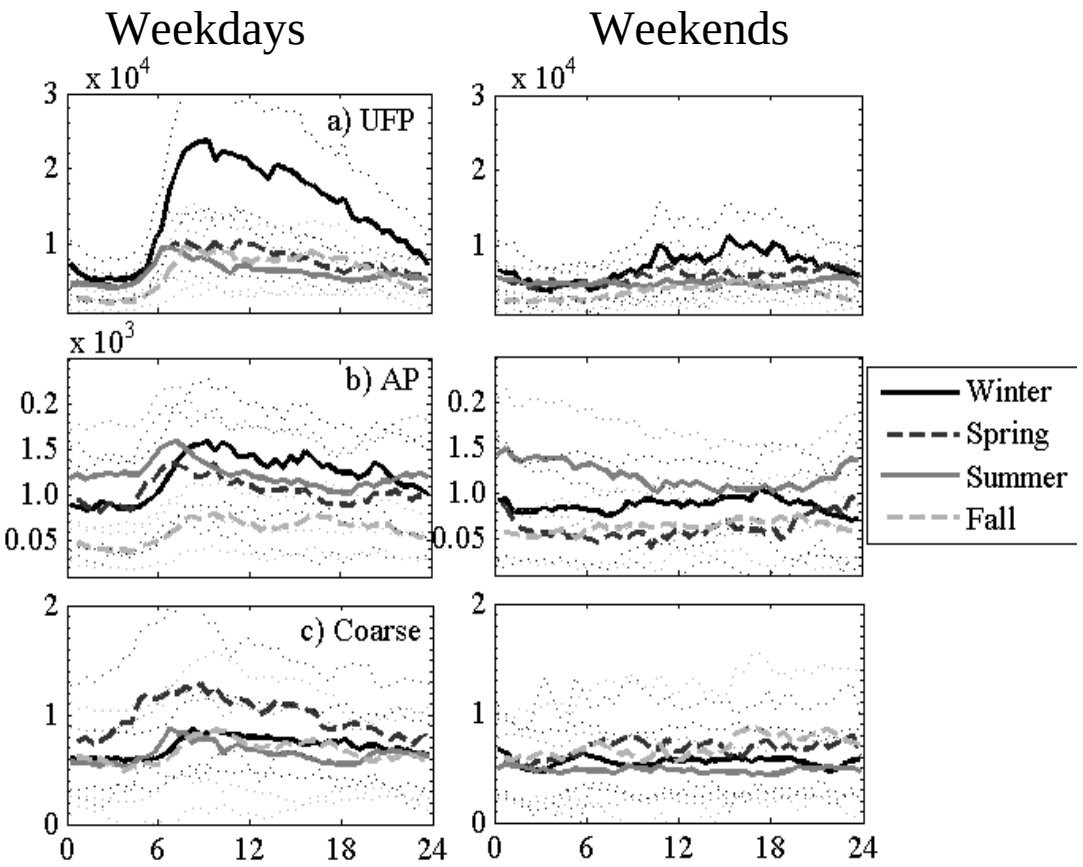


Wind direction dependence of ultrafine particles



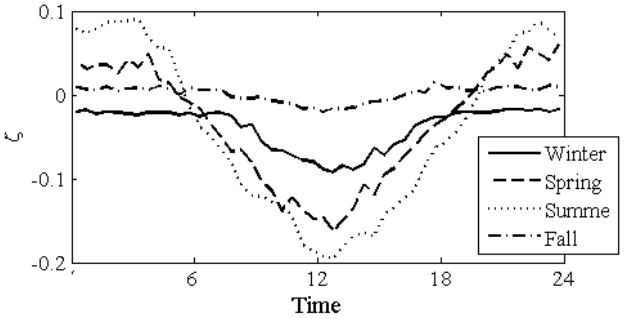
May 2005-Jun 2007

Diurnal behavior of aerosol particle concentrations for different seasons and separately for weekdays and weekends

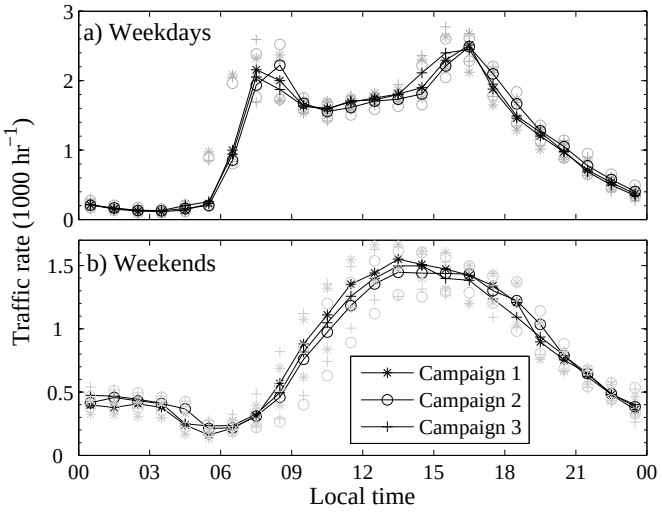


May 2005-Jun 2007

Järvi et al. (2007)



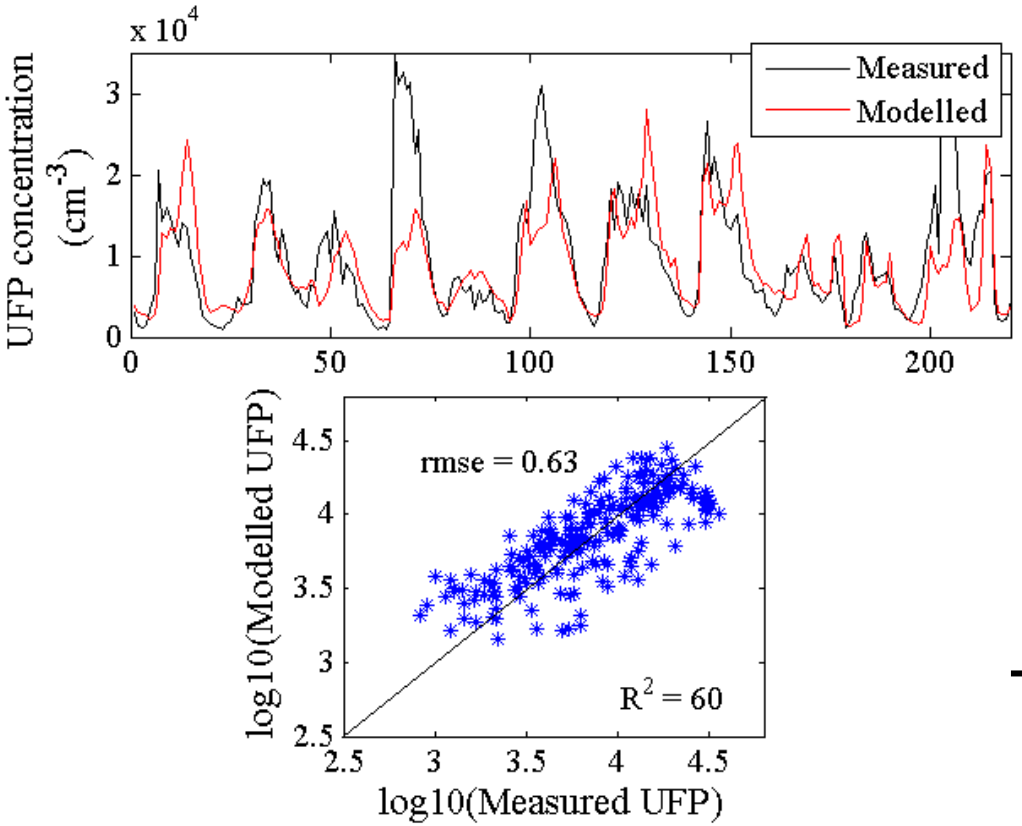
Järvi et al. (2008)



Dependency of particle concentrations on traffic rate and meteorological variables

- A multiple linear regression (MLR) models ($Y = b_0 + b_1X_1+\ldots+b_nX_n$) were made for UFP, accumulation mode particle and coarse particle concentrations
- We wanted to find those independent variables which minimize the difference between the measured and modeled concentrations
- We also get the relative importance of each independent variable compared to the other variables in the model
- MLR was made for Dec 2005-Aug 2006.

Example from MLR analysis: Ultrafine particle concentrations in Dec 2005

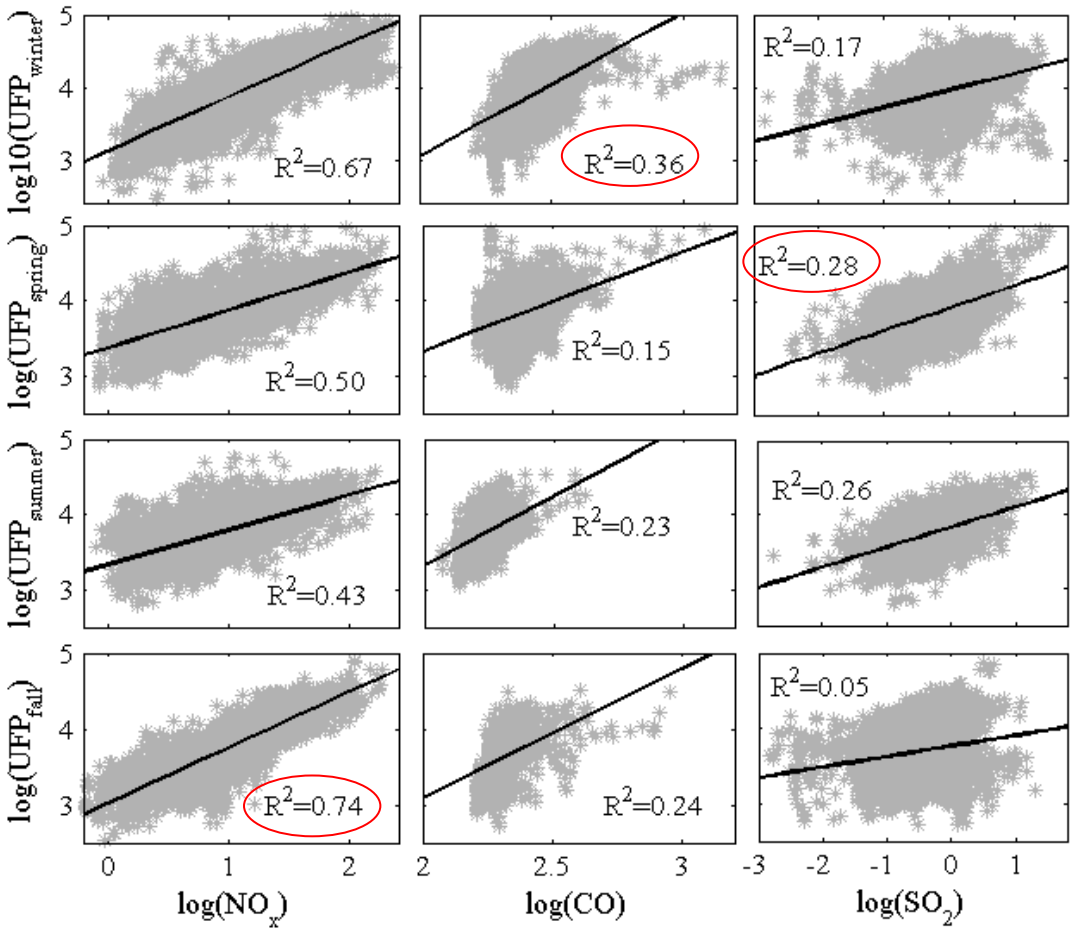


Variable	β-constant
H_2O	-0.15
WD_1	0.04
σ_w	-0.21
Traffic	0.70

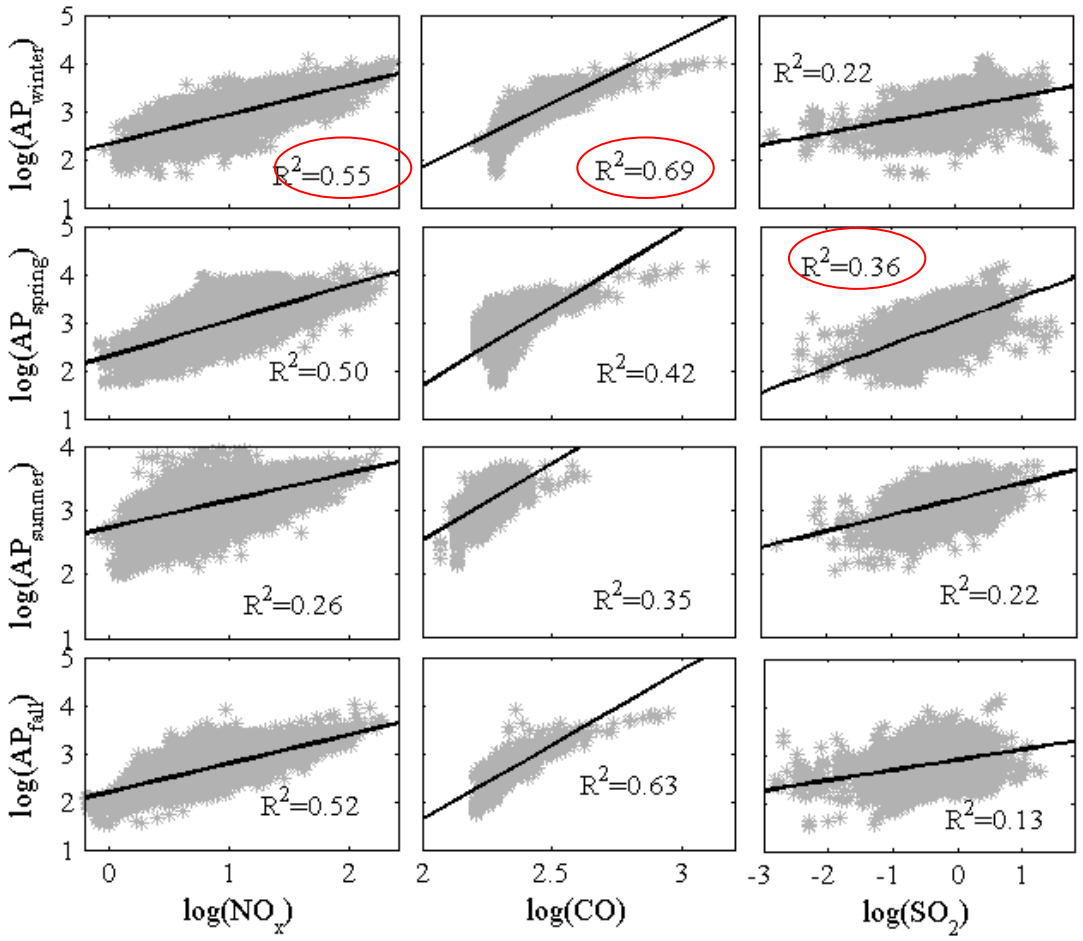
Main findings from the MLR analysis

- UFP concentrations could be explained best with the available variables
  - Most affected by traffic, turbulent mixing and H2O
- In the case of accumulation mode particles, traffic was equally or less important than meteorological variables
- Coarse particle concentrations could not be explained as well as fine particle concentrations
  - Humidity had an great impact especially in spring
- Turbulent mixing had an inverse effect on different sized of particles
  - Increases the mixing volume and concentrations decrease
  - On the other hand, larger particles are re-suspended more efficiently

Correlations between ultrafine particles and concentrations of NO_x, CO and SO_2



Correlations between accumulation mode particles and concentrations of NO_x, CO and SO_2



Conclusions

- Most the pollutants showed dependence on traffic
  - For particles, the importance decreased with increasing particle size
- Fine particles, NO_x, CO and SO_2 experienced their maxima in winter due to the lowered mixing and enhanced emissions
- The effect of re-suspension could be seen in coarse particle concentrations especially in spring

- Long-range transport had an effect on accumulation mode particles (Aug 2006!)

- Correlation between UFP and SO_2 increased in spring and summer → New particle formation?