Multi-channel statistical analysis of background fine particle aerosols

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In this paper, the new statistical method for the determination and investigation of particle modes in nanoparticle aerosols in the presence of strong turbulent mixing (Gramotnev & Gramotnev, 2005) is applied for investigation of background aerosols in Brisbane, Australia. The meteorological parameters during the measurements are presented in the Table:

Meteorological Parameters	
Temperature, [°]	20.5 ±0.9
Humidity, [%]	39±4
Solar radiation, [W·m^{-2}]	200±100
Wind speed, [m·s^{-1}]	1.7±0.8
Wind direction to the road, [°]	46 ±50

Concentrations of fine particles in the aerosol were measured within the range from 13 nm to 763 nm. 38 scans with 113 equal intervals of Δlog(Dp), where Dp is particle diameter in nanometers, where taken by means of a differential particle sizer.

The resultant average particle size distribution is presented in Fig. 1. It can be seen that only two maximums can be seen on this size distribution - at ~20 nm and ~100 nm. Otherwise, the size distribution does not display any peculiar features and/or distinct particle modes. Nothing can be said about possible sources and/or relationships between particles in the obtained size distribution.

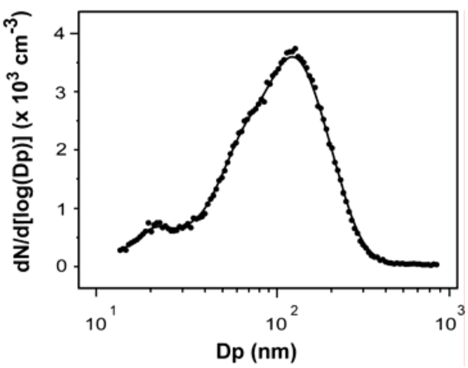

Figure 1. Typical size distribution in the urban background aerosol in the Brisbane area, Australia.

However, application of the new statistical method of analysis based on the determination of the moving average correlation coefficient for particle concentrations in neighbouring channels (Gramotnev & Gramotnev, 2005) displays strong relationships between the particles (Fig. 2). At least five distinct modes (corresponding to particle diameters ~ 21 nm, 35 nm, 57 nm, 105 nm, and 168 nm) can be seen in this figure. The presented error curves demonstrate that these modes are statistically significant.

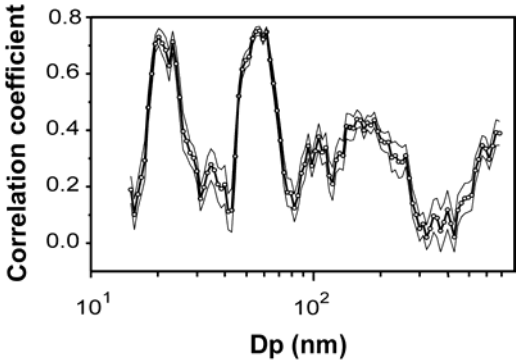

Figure 2. The dependence of the moving average correlation coefficient for particle concentrations in neighbouring channels, and the error curves.

Therefore particles in each of these modes should come from the same source (generated by the same process) and/or have the same physical nature.

Multi-channel canonical correlation analysis has been used for the determination of the effect of solar radiation, temperature, and humidity on the aerosol particles. It has been shown that humidity has negligible effect *on* background particle modes. This suggests that, at least at the considered low levels of humidity, mechanisms of formation of background particle modes are not related to humidity. On the contrary, decreasing temperature results in a strong increase of the 170 nm mode in Fig. *1*. This might be because these particles experience thermal fragmentation (Gramotnev & Gramotnev, 2005), which becomes inefficient at lower temperatures, leaving more particles of the same type in this mode. Statistical weights and loadings for particles between ~20 nm and ~35 nm are both negative for solar radiation, which suggests that concentration of these particles significantly increase with decreasing solar radiation. Explanation of this effect can again come from the fragmentation theory. Indeed, fragmentation of these modes into smaller particles is expected to become weaker with decreasing solar radiation, leaving more particles in the considered modes.

Gramotnev, D. K. & Gramotnev, G. (2005). *J. Aerosol Science, 36, 323-340,*