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Original article

Modalities of PM_{10} and $PM_{2.5}$ Quantification in Environmental Air Using the Standardized Method

OROIAN I.*, Laura PAULETTE, C. IEDERAN, I. BRAŞOVEAN, P. BURDUHOS, Claudia BALINT

University of Agricultural Sciences and Veterinary Medicine Cluj – Napoca, Faculty of Agriculture, Mănăştur 3 – 5, 400372 Cluj – Napoca, Romania

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Abstract

The distribution of PM_{10} and $PM_{2.5}$ particles with respect to size is an important physical parameter affecting public health. During January – February 2009, a trial was developed. It aimed the quantification of the PM_{10} and $PM_{2.5}$ particles from the air in the University of Agricultural Sciences and Veterinary Medicine Cluj – Napoca, using the facilities of the mobile Laboratory of Air Quality Control. The particulate matter was gravimetrically quantified according to the stipulations of the SR EN 12341: 2002, and the air sample is directly aspired with a Sven – Lackel system. The PM_{10} and $PM_{2.5}$ indices had values within admitted limit (50 $\mu g/m^3$), but with large variability 63.33% for PM_{10} and 77.71% for $PM_{2.5}$. Moderate correlation was established between PM_{10} and $PM_{2.5}$ values during experimental interval (r = 0.55960).

Keywords: air quality, PM_{10} and $PM_{2.5,}$ quantification, standards, correlation

1. Introduction

The particulate matters are one of the air pollutants of most concern for public health. They include as main components nitrate, sulfate, organic carbon, elemental carbon, soil dust and salt. They originate from a variety of sources and possess a range of morphological, chemical, physical, and thermodynamic properties. The distribution of particles with respect to size is an important physical parameter governing particle behavior. PM_{10}, as defined by EPA, refers to particles collected by a sampler with an upper 50% cut point of 10 µm Da and a specific, fairly sharp, penetration curve [1].

$PM_{2.5}$ is analogously defined, as to particles collected by a sampler with an upper 50% cut point of 2.5 µm Da and a specific, fairly sharp, penetration curve [3].

The $PM_{2.5}$ should be considered an indicator of fine particles (because it contains some coarse particles). It would also be appropriate to call PM_{10} an indicator of thoracic particles. The ultrafine particles are the result of nucleation of gas phase species to form condensed phase species with a very low equilibrium vapor pressure. The variability of PM concentrations on time scales shorter than a day can, in principle, be characterized by measurements made by continuous samplers [2].

* Corresponding author.
Tel.: 0040 264 596384/371; Fax: 0040 264 593792
e-mail: neluoroian@gmail.com; neluoroian@yahoo.fr

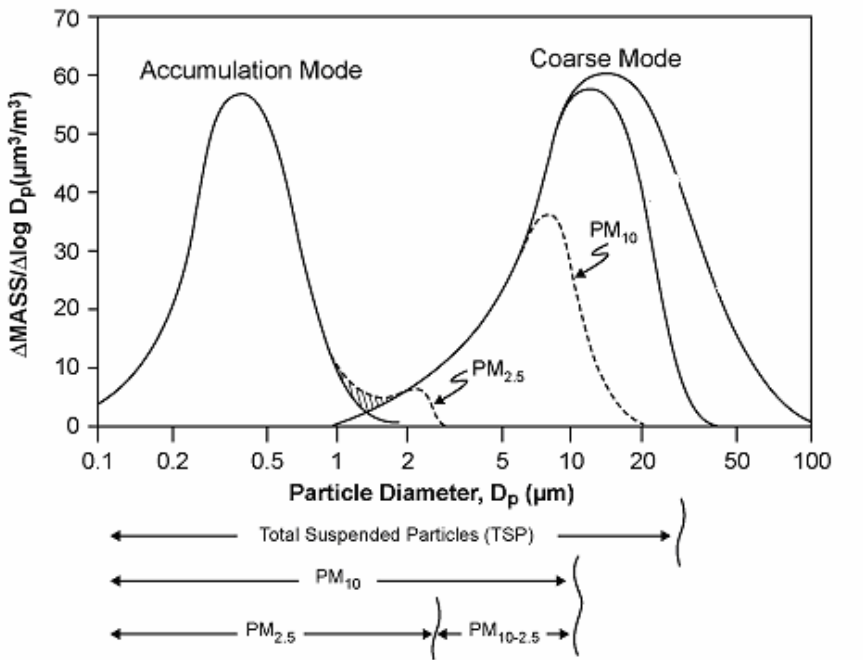

Figure 1. An idealized distribution of ambient particulate matter showing fine-mode particles and coarse-mode particles and the fractions collected by size-selective samplers (Lundgren and Burton, 1995, cited by National Center for Environmental Assessment-RTP Office, 2004)

2. Material and method

The trial was developed during January – February 2009, within the mobile Laboratory of Air Quality Control (LACA) of the University of Agricultural Sciences and Veterinary Medicine Cluj – Napoca. The air samples were prelevated from the university territory.

The particulate matter was quantified according to the stipulations of the SR EN 12341: 2002 [4]. The air sample is directly aspired with a Sven – Leckel system, vacuum pump of de 2.3 m^3/h debits, respectively. The air debit is measured with a device which contains a plaque with gaps installed between filter and vacuum pump. The prelevation time is of 24 hours.

The instruments are destined for outside use and can be handled without protection devices against rain or other similar. Even the outdoor temperature decreases under 5^0C, the automatically system for the equipment will be in function. When temperature increases over 30 ^{0}C, a ventilator is functioning.

The controller deviation is < 1% from established value within outside condition. The prelevation time is monitored by a microcontroller and saved in system memory. The information stored in memory may be visualized on the device screen. If the electric energy is accidentally disconnected, all data stored in microcontroller and system memory will be saved for several years, by a high capacity battery.

The previously weighted filter must be installed and aspiration pump will be started. After time interval needed for prelevation, the pump must be stopped, the filter with the particulate matter must be taken out and carefully introduced in transport support, avoiding any loose. The filter must be conditioned in the same manner as previously and will be weighted.

Filter with a separation efficiency of > 99.5%. In order to minimalize the filter artifacts, filters with quartz fibers must be used. The unused filters must be exposed in open environment, for 48 hours in a room with conditioned air at 20 (± 1%) ^{0}C and relative humidity of 50 (± 1% - 5%) before measurements. The filters charged with dust must be balanced in the same conditions before weighing.

The $PM_{10(2.5)}$ concentration is calculated acording to the following formula:

$$C_{PM_{10(2.5)}} = \frac{M}{V}\left(\mu g / m^3\right)$$

where:

$C_{PM10(2.5)}$ = concentration of the $PM_{10(2.5)}$ dust (µg/m^3)

M = weight of the dust on the exposied filters (µg)
V = the volume of the aspired sample (m^3)

The weight of the harvested dust is calculated as difference between the filter weight before and after sample harvesting:

$$M = m_2 - m_1$$

where:
m_1 = weight of the clean filter (µg)
m_2 = weight exposed filter (µg)

The sample volume is calculated as environmental debit (measured in the beginning and ending of prelevation) multiplied with time interval while the prelevation was performed:

$$V = [(F_1 + F_2)/2] \times T /1000$$

where:
F_1 = initial debit, before prelevation (l/min)
F_2 = debit in the end of prelevation (l/min)
T = prelevation interval(minute)
1000 = conversion liter to m^3

The Order of the Environment Ministry no. 592/2002 stipulates the limit values for the human health protection function of the sample prelevation time, as follows:

- daily limit value – 50 µg/m^3 without being exceeded more than 35 times within a calendar year;
- annual limit value - 40 µg/m^3.

3.Results and discussions

The values obtained for PM_{10} and $PM_{2.5}$ indices from the air during experimental interval recorded low values, much under admitted limit (table 1), 50 µg/m^3, according to HG 592/2002 [5]. Although the averages are low, the coefficient of variability is very big 63.33% for PM_{10} and 771.71% for $PM_{2.5}$, meaning large variation during experimental interval (fig. 2).

Table 1. The average and dispersion parameters for PM_{10} and $PM_{2.5}$ indices determined during experimental interval

Parameter	n	X	±	s_X	Minimum	Maximum	V%
PM_{10}	60	0.11	±	0.02	0.01	0.24	63.33
$PM_{2.5}$	60	0.05	±	0.01	0.01	0.13	77.71

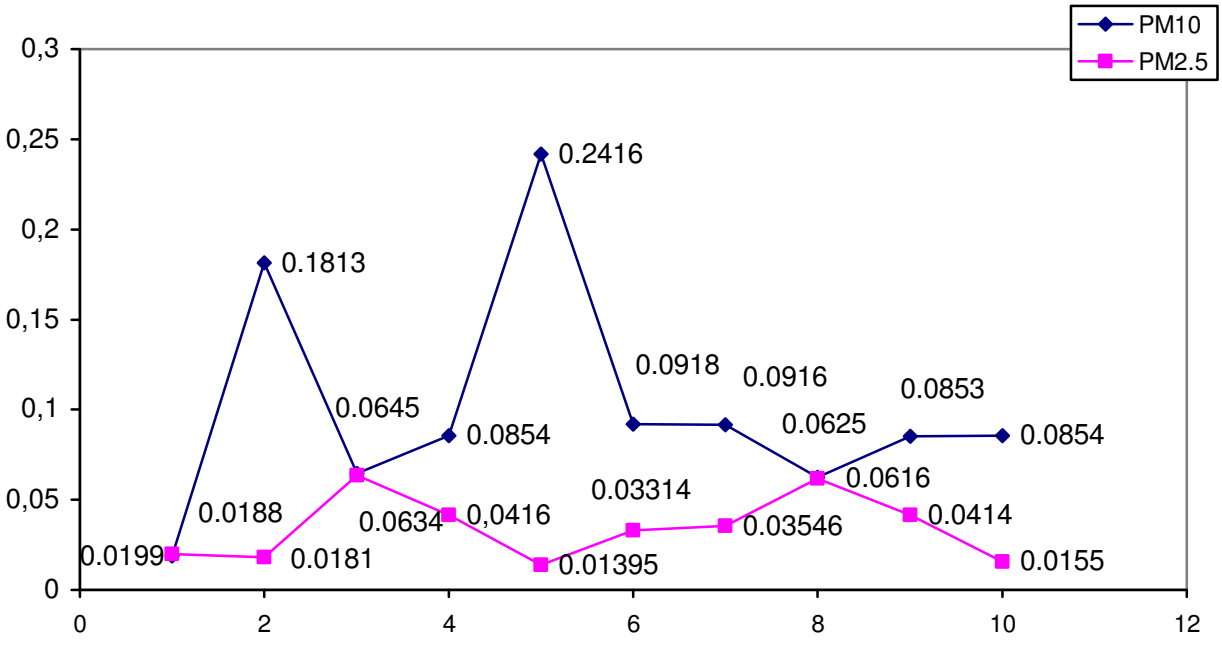

Figure 2. The variation of PM_{10} and $PM_{2.5}$ values recorded during experimental interval

Statistically negative but not significant differences were obtained between both experimental months between the values recorded for PM_{10} and $PM_{2.5}$ indices (table 2, fig. 3, 4).

Table 2. The significance of the differences in PM_{10} and $PM_{2.5}$ indices from environmental air determined during experimental interval, by months

Differences		DF	t	p
PM_{10} $X_{January} - X_{February}$	-0.002	58	- 0.702 ^{ns}	0,96019
$PM_{2.5}$ $X_{January} - X_{February}$	-0.004	58	- 0.833 ^{ns}	0,47451

ns – $p > 0.05$

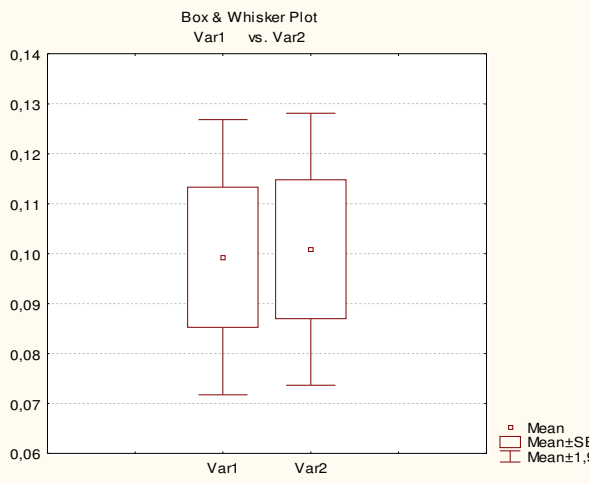

Figure 3. The diferences statistically not significand between the PM_{10} values recorded within experimental interval, January - February 2009

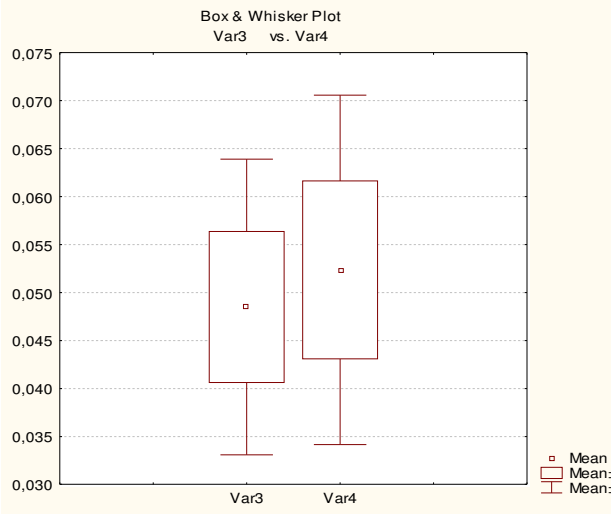

Figure 4. The diferences statistically not significand between the $PM_{2.5}$ values recorded within experimental interval, January - February 2009

Moderate correlation (r = 0.55960), but statistically very significant ($e^{0.000174}$) was recorded between PM_{10} and $PM_{2.5}$ values during experimental interval (fig. 4).

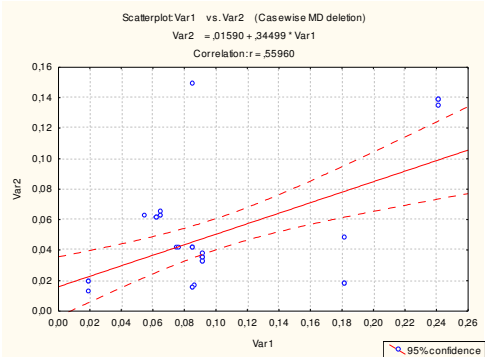

Figure 4. The correlation between PM_{10} and $PM_{2.5}$ values recorded within experimental interval, January - February 2009

4.Conclusions

- The PM_{10} and $PM_{2.5}$ indices quantified from air within University of Agricultural Sciences and Veterinary Medicine Cluj – Napoca during experimental interval January – February 2009 recorded values within admitted limit, but with large variability 63.33% for PM_{10} and 771.71% for $PM_{2.5}$.
- The coefficient of correlation between PM_{10} and $PM_{2.5}$ values during experimental interval was moderate (r = 0.55960), and statistically very significant ($e^{0.000174}$).
- The standardized method for gravimetric quantification of PM_{10} and $PM_{2.5}$ indices according to SR EN 12341: 2002 is suitable for air pollution estimations in urban areas.

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