INVESTIGATION OF AEROSOL NUMBER CONCENTRATION IN JONAVA TOWN

Raminta Vyzienė[1], **Aloyzas Girgždys**[2]

[1]*Lithuanian Environmental Investment Fund, Laisvės al. 3, LT-04215 Vilnius, Lithuania*
[2]*Laboratory of Nuclear Hydro-physics, Vilnius Gediminas Technical University,*
Saulėtekio al. 11, LT-10233 Vilnius, Lithuania
E-mail: [1]*raminta@baaif.lt;* [2]*aloyzas.girgzdys@fm.vgtu.lt*

Abstract. Though some authors declare that aerosol number concentration might be a better indicator of health effects of the particulates than the mass method, there is lack of aerosol number investigation studies. Most of air quality studies so far have been based on aerosol mass concentration measurements. Lithuanian National Air Quality Monitoring Network does not carry out aerosol number concentration measurements. Nonetheless, detailed particulate matter mass concentration investigation studies are made periodically in the biggest Lithuanian cities by various scientific organizations. Jonava seems to be overpassed even there. This is the reason for choosing the investigation object. In Jonava town persistent measurements of aerosol number concentration were performed since 21 till 29 of November in the year 2006. The pollutants were measured with an optical particle counter AZ-5. The fluctuations of 24 hours, diurnal aerosol number concentration were analysed. The weather was favorable for pollutant accumulation and stood quite stable during the experimental period. The variation of aerosol number concentration was compared with other pollutants and wind speed changes. The increase of aerosol number concentration was detected with the decrease of wind speed and vice versa. The biggest concentration was detected when the wind blew from the South, there green territories are located. The increase of particulate concentration was not observed with the South-eastern wind directions coming from a fertilizer plant. The correlation between aerosol number concentration and nitrogen compounds was found. The tendency for high aerosol number concentrations was not observed during the rush hours as well as weekend effect could not be detected, indicating about low impact of local transportation. Comparison between particulate matter (PM_{10}) mass and aerosol number concentrations was performed. The linear tendency between aerosol number and mass concentration was found. The increase of PM_{10} mass concentration was found to be 1,6 μg/m^3 for each additional 1000 aerosol particle cm^{-3}. While comparing aerosol number concentration fluctuations in Jonava and Preila locations, the results exhibited great variability on both monitoring sites. Aerosol number concentration was higher in Preila in February, March and April. Meanwhile, in summer months the aerosol number concentration increased on the urban site. These urban and rural differences were influenced by geographical and meteorological site peculiarities and air mass transport.

Keywords: aerosol number concentration, particulate matter (PM_{10}) mass concentration, linear relation, average 24-hour variation, diurnal variation, urban pollution, background pollution.

1. Introduction

Particulates are very complex pollutants, having various sizes, shapes and made up of hundreds of different chemicals (US EPA 2005; Lazaridis *et al.* 1999). The term "particulate matter" (PM) is often used interchangeably with "aerosols" in scientific literature. In this paper both definitions are used equally.

There is growing concern related to the health effects of particles, because results of experiments support hypothesis that physical and chemical properties of particles are involved in toxic and carcinogenic health effects (Spurny 2000; Baltrėnas *et al.* 2008). Particulate matter content is emitted from a large variety of sources with significant technical and economic differences that are strongly influenced by specific conditions of various countries (Lazaridis *et al.* 1999; Zbigniew *et al.* 2002). These country-specific factors are time of year, location and several aspects of weather, such as temperature, humidity, and wind (US EPA 2005). Lithuania needs to comply with Air Quality Directives as it has become a European Union Member State. Since the current European policy addresses PM_{10} concentrations, it is important to better understand sources and ways of controlling the particulate matter (Zbigniew *et al.* 2002). It is hard to measure the concentration of PM_{10} because of their small size (Baltrėnas *et al.* 1999; Baltrėnas and Kvasauskas 2005). Various devices are used to determine particulate matter concentrations. These devices differ in their physical and chemical features and measuring precision (Baltrėnas and Kvasauskas 2005). It is emphasized in Cooperative Program for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe (EMEP) that every local measurement is on the base importance as the existing regional network is not capable to provide all-around information regarding particular matter (Lazaridis *et al.* 2000; Ketzel *et al.* 2004).

Air Quality Monitoring Network exists in Lithuania, giving information about the main pollutants (Baltrėnas *et al.* 1999; Hoekstra *et al.* 2004), but it does not carry out aerosol number concentration measurements. Most of the air quality studies so far have been based on particulate mass concentration measurements, ignoring the fact that the number concentration might be a better indicator of the health effects of the particulates than the mass method (Peters *et al.* 1999). In the biggest Lithuanian cities particulate matter mass concentration investigation studies are made periodically. Jonava seems to be overpassed even from this point of view. Lack of particulate matter studies in Jonava became the reason for choosing the investigation object.

The aim of this work was to measure aerosol number concentration in Jonava, to see the tendencies of concentration fluctuations (24-hour, diurnal variations) and to identify the sources of particulate matter pollution in Jonava. Also, the target was to indicate if correlation between PM_{10} mass and aerosol number concentrations exits, giving the opportunity converting one to another in the case of urgency when substantial measurements are impossible.

The aerosol number concentration changes in Jonava were compared with those on a rural site (Preila) which is an international longevous monitoring post. Measurements in Preila are held continually, and plenty of measurement results are cumulated there. As the experiment in Jonava was carried out for quite a short period of time, it was purposive to compare the results with those in Preila benefiting in assessing the nature (regional, local or city background) of particulate matter pollution in Jonava.

2. Investigation object and experimental details

In spite of substantial cut in particulate emissions in recent years, air quality problems are still acute in the biggest cities of Lithuania and on certain sites of specialized industrial and energy facilities like Jonava (a fertilizer plant locates there).

Jonava is the 9th largest city in Lithuania with the population a bit less than 35 000. Jonava district covers a territory of 944 square kilometers. It is located in the center of Lithuania, 30km northeast from Kaunas, the second largest city in Lithuania. The main sources of pollution emissions in Jonava are road transport and various processes of production (furniture, textile manufacture, bake house, agribusiness, etc.). The main industrial polluter is the Achema plant, which is the biggest nitrogen fertilizer producer in the Baltic States, with 2400 employees. The most important production lines and their respective output rates in tones per year are: ammonia (450 000), ammonium nitrate (450 000), urea (270 000), urea ammonium nitrate solution (400 000), methanol, formalin and others.

The aerosol number and mass concentrations were measured in different places. Still both locations were comparable as they had similar characteristics. The distance between Paneriai 17 (aerosol mass concentration measurement post) and Parkas 5 (aerosol number concentration measurement post) is 120 meters. Both places locate at the edge of the city, in an industrial, residential districts, near a river, 72 meters over the sea level,

2–3 km to the west from the fertilizer factory. Traffic intensity is comparable in both locations and reaches approximately 2 000–10 000 cars per day. The transportation is more intense in daytime, in workdays, during rush hours (at 7–10 a.m. and 4–7 p.m.). Vehicle flows are typically lower in winter due to worse weather conditions and in summer due to vacation season when a part of the citizens leaves the town.

The aerosol number concentration was measured in Jonava town, in Parkas 5 Street, from 21 till 29 of November, in the year 2006 with an optical aerosol particle counter AZ-5. The equipment AZ-5 uses optical (light spread) method for pollutant detection and is able to rate a dispersive constant from 0.4 to 10 μm of aerosol size. An electrical part, optical sensor and pneumatic unit comprise the device. The optical sensor AZ-5 creates an electric impulse for each particle. The amplitude depends on the particle size. These impulses increase and totalize by a separate amplitude size in the electrical part. The pneumatic device is aimed and designed to pump the air through the measuring zone of the optical sensor (proper capacity is 1.2 l/min). AZ-5 measures particle number concentration from 0 to 300 000 particles in liter. Due to instruction, the possible systematic error is from ±20% (Photoelectric … 1981). The measurement data were transferred to an electronic format (personal computer) with the help of ADC-16 data logger, which offers high resolution (16 bits + sign) and is capable of detecting signal changes as small as 40 μV.

The PM_{10} mass concentration in Jonava was analysed according to the data of National Air Quality Monitoring Network. In Jonava town the monitoring post locates in Paneriai 17 Street. In the monitoring post these pollutants are measured: SO_2, NO_2, NO, CO, NH_3, PM_{10}, ozone, benzyls, and toluene and meteorological parameters. Similarly to other European countries β-ray absorption method is practiced for PM_{10} mass measurements in Lithuania. Using this method the correction coefficient has a value of 1.3 (Environmental … 2006).

In this work PM_{10} mass concentration measurement results were used for identifying the relationship between aerosol number and mass concentrations. Lately, when the linear relationship between aerosol number and PM_{10} mass concentrations was found, a formula was used for converting PM_{10} mass concentration to aerosol number concentration. After this conversion was made, the aerosol number concentration variations comparison on Preila and Jonava sites became available.

The Environmental Pollution Station in Preila is located in western Lithuania on the coast of the Baltic Sea, 5 m above the sea level. This monitoring site was selected according to strict siting criteria designed to avoid undue influence from point sources, area sources and local activities. There are no great sources of anthropogenic pollution of the atmosphere close to the monitoring site. One of the nearest industrial cities, Klaipėda, is at a distance of about 40 km to the north and the other, Kaliningrad (Russia), is 90 km to the south from the site. The dunes up to 50 m in height as well as natural forests in low-lying lands predominate in the region (Institute … 2002).

AZ-5 equipment was used for aerosol number concentration measurements in Preila.

3. Investigation results

Aerosol mass and number concentration variations are usually influenced by three sources: regional, city background and local. Analyzing the data of measurements, it is possible to predict which of these sources were dominant in the period of time.

Interesting variations of aerosol number concentration were found in Jonava during the period of experiment.

Fluctuations of aerosol number concentration could be seen in the graph below (Fig. 1). The pattern represented two clear aerosol number decreases on 23 and 29 November.
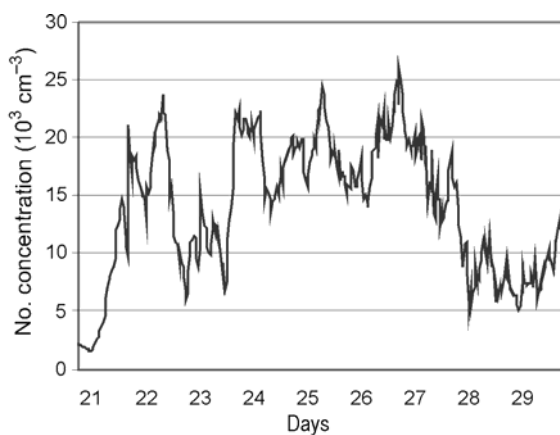
Fig. 1. Variations of aerosol number concentration in Jonava during the experimental period in November of 2006 (21st is Wednesday)

Strong fluctuations of the aerosol number concentration and high amplitudes usually indicate changes in weather conditions. If weather situations stood stable for some time, the concentration levels could rise due to accumulation of pollutants in the mixing layer (Gomiscek *et al.* 2004). This tendency explained aerosol number fluctuations in Fig. 1. Since weather conditions could vary dramatically while different days, intensive weather changes in one day period were not common. Possibly, this is the reason, why strong amplitudes could be seen while different days, but diurnal amplitudes were not so clearly expressed.

Pollution level is closely tied to favorable weather conditions, namely, high temperatures, low winds, intense radiation and low precipitation.

During the experimental period the weather conditions could be characterized by a high-pressure zone, 8–11 °C average 24-hour temperature, moderate wind speeds (0,5–1,3 m/s), 92–100% average 24-hour humidity. The prevailing wind direction in the measurement post was from the South and Southeast. Low wind speeds, high humidity (causes of upstart of condensation products), relatively low temperatures (background for more intensive heating) were favorable conditions for pollutant accumulation.

Evaluating average aerosol number concentration changes, we could see that a low average particle number concentration of about 7000 particles cm^{-3} was traced at the beginning of investigation (Fig. 2). Lately an average number concentration increase was observed on 22nd and then a decrease was found on 23rd of November (12 000 particles cm^{-3}). Maximum average aerosol number concentration, more than 18 000 cm^{-3}, was observed on 25th, 26th, 27th of November. On 28 November the decrease started again reaching 8 000 particles cm^{-3}.

Looking at Fig. 2 and assuming that the reason for aerosol number concentration fluctuations was weather changes, we could draw a hypothesis that weather conditions could stay stable on 24–27 November, causing accumulation of aerosols and increase in number concentration. Days 25 and 26 could be characterized by very similar conditions because the aerosol number concentration stood quite equal in these days, and days 22, 23 and 27 (when aerosol number decrease started) could be characterized with drastic weather changes. The truth was that no drastic weather changes were registered in reality, so probably the reason for aerosol number concentration decrease was not associated with meteorology.
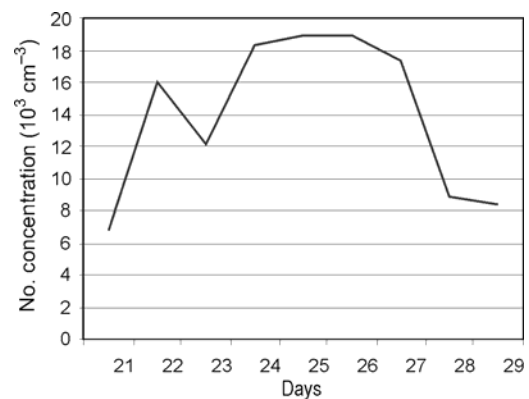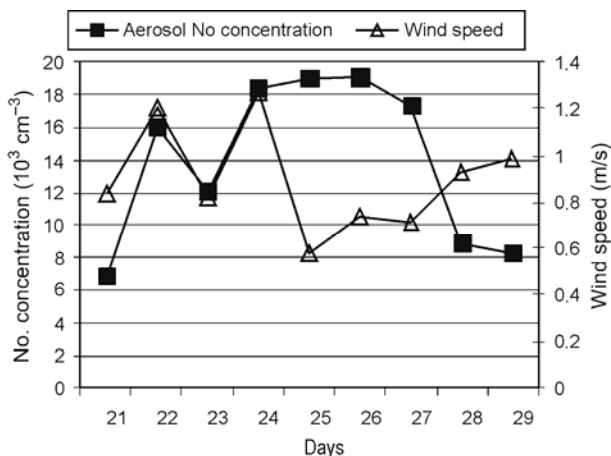

Fig. 2. Variations of average 24-hour aerosol number concentration in Jonava during the experimental period in November of 2006 (21st is Wednesday)

Interesting correlations were found between aerosol number concentration and wind speed. As wind speed was relatively low (maximum 1.3 m/s) during the analysed period, its influence on aerosol number concentration changes could be relatively low. Still some tendencies between aerosol number concentration and wind speed were reflected in the graph below (Fig. 3).

In the first part of the experiment common relation between the wind speed and aerosol number concentration could not be detected. The decrease of aerosol number concentration on 23 November could not be associated with the wind speed. But the second part of experimental data indicated increase of particulates when the wind speed decreased and vise versa.

The prevailing wind direction during the experiment was from the Southeast and the South. The fertilizer plant was located to the East of the measurement post. An interesting detail was that the biggest concentrations were registered when the wind direction was from the South, where parks and green territories are mainly located. A

Fig. 3. Comparison between aerosol number concentration fluctuations and wind speed changes in Jonava during the experimental period in November of 2006 (21st is Wednesday)

direct wind from the fertilizer factory on 22 November was associated with concentration decrease.

It seemed that Achema was not the main reason for experimental result changes. The influence of transportation should be examined. In the biggest cities of Lithuania 75% of pollutants are emitted into the air from road transport (Lazaridis *et al.* 1999). Jonava town is not an exception in this case.

The diurnal concentration pattern is driven by emission characteristics of dominant sources and meteorological conditions (Gomiscek *et al.* 2004; Gonzalez 2002). Diurnal changes are helpful for identifying the influence of local vehicles.

Strong amplitudes of diurnal variations of aerosol number concentration were not observed in Jonava during the experimental period as the figures below indicate (Figs. 4 and 5).

Monitoring networks with stationary equipment report prevailing average concentrations near a measurement site but cannot usually detect "hot spots" (Diapouli
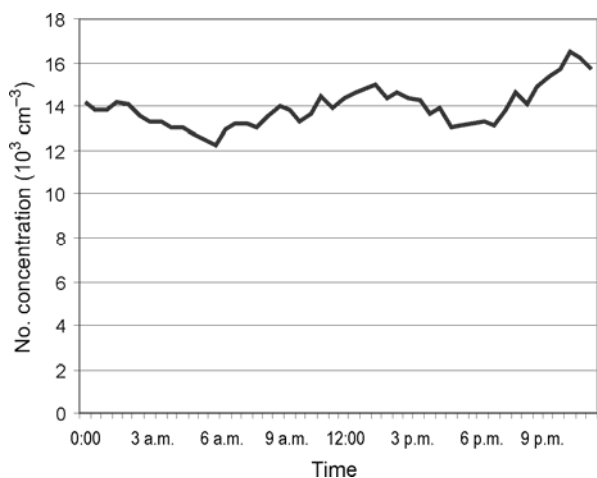
Fig. 4. Variations of average diurnal aerosol number concentration in Jonava during the experimental period in 2006
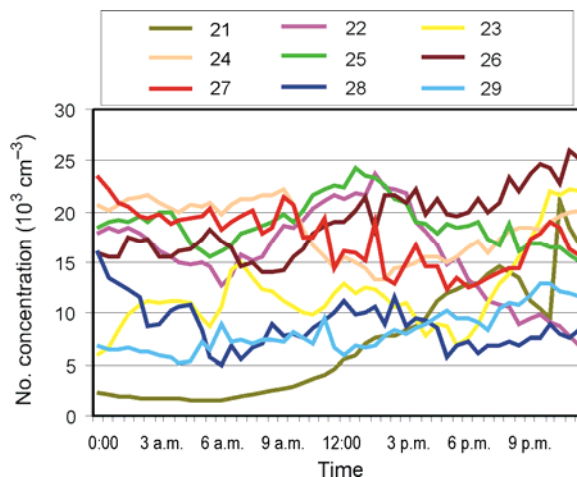
Fig. 5. Variations of diurnal aerosol number concentration in Jonava for different days during the experimental period in November of 2006

et al. 2006). The term "hot spot" refers to an area that has more contamination than the surrounding area and may expose individuals and population groups to elevated risks of adverse health effects (Zee *et al.* 1998; Green facts … 2007).

The local transportation could not be considered to be the major pollution source in Jonava town regarding the results of experiment. The average diurnal aerosol number concentration curve showed concentration increase during the day time starting from 6 a.m. The pick was reached at 10.30 p.m. when transportation flows were quite low. No strong amplitudes were seen in the figure, which could be related with car accident, traffic jam or other unexpected situation.
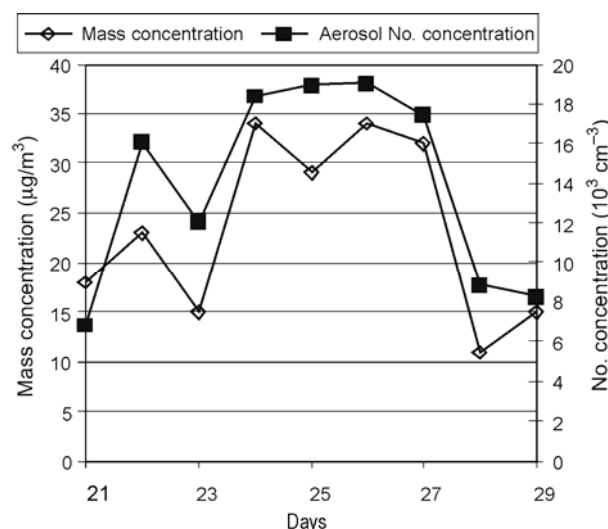
A tendency for high number concentrations of aerosols in the morning (6–8 a. m.) and in the evening (5–9 p.m.) was not observed. This absence of tendency allows to draw a conclusion that the local transportation impact on aerosol number concentration results was not significant. Parkas and other streets which are situated near the place, where measurements were taken, seemed to be inconsiderable for influencing increase of aerosol number concentration. The highest aerosol number concentration observed during the measurement period was fixed on 26 November at 10 p.m. and reached 26 000 particles cm^{-3}. The other relatively high number concentrations were observed on 26 November at 9.30 p.m., on 22 November at 1.30 p.m., on 25 November at 1 p.m. (respectfully 24.78, 23.73, 23.66 10^3cm^{-3}) particles. The lowest aerosol number concentration was observed at the beginning of measurements on 21 November and reached 1490 particles cm^{-3}.

The aerosol number concentration was higher during weekends (Fig. 6) comparing with workdays, blinking the fact, that traffic intensity was higher during workdays. This also proved the fact that aerosol number concentration fluctuations during experimental period could hardly be associated with local vehicle emissions.
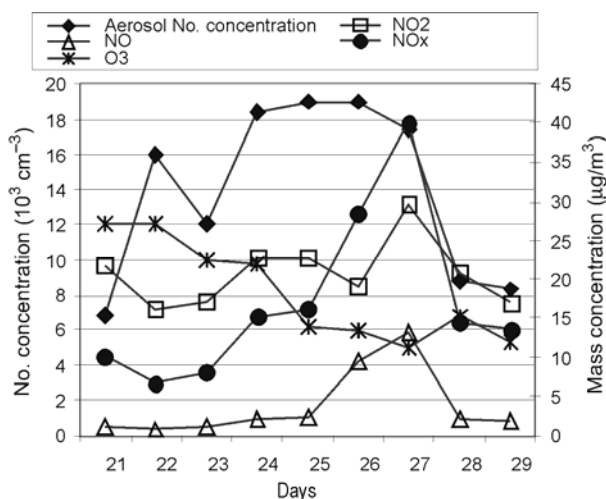
Still the aerosol number concentration correlated with N compound concentrations (Fig. 7).
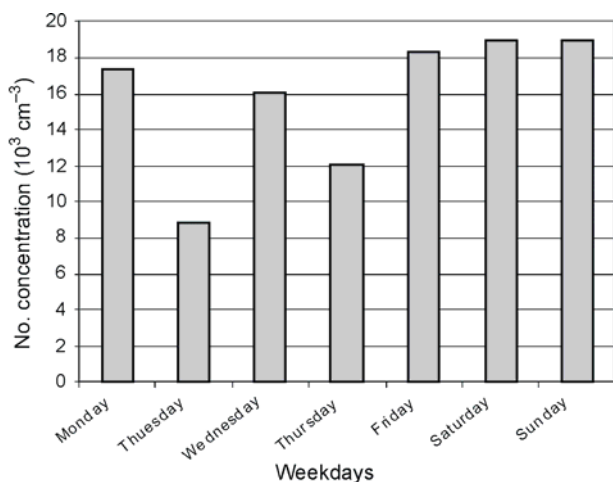
Fig. 6. Variations of average 24-hour aerosol number concentration in Jonava for weekdays during the experimental period in 2006

Fig. 7. Variations of aerosol number concentration in Jonava in comparison with other pollutant concentration changes during the experimental period in November of 2006 (21st is Wednesday)

This fact indicated that one major source of aerosol particles for the monitored site might be vehicular emission. In this case aerosol pollution associated with transportation could be rather of city background and regional nature than local due to the conclusions drawn before. Also, domestic use of fossil fuels and bio-fuels could not be neglected.

While comparing the experimental aerosol number concentration results with PM_{10} mass concentration data obtained from the national Monitoring Network, an interesting relationship was observed (Fig. 8).

The charts reiterated each other. The discrepancy was observed twice: at the beginning of the investigation when PM_{10} mass concentration values were higher comparing with aerosol number concentration values. The other point of interest was the results of measurement on 25 November. As aerosol number concentration reached the maximum values of 19 000 particles cm^{-3}, PM_{10} concentration dropped comparing with relative values. Still the relations between graphs were obvious.

Fig. 8. Comparison of average 24-hour aerosol number concentration and PM_{10} mass concentration changes during the experimental period in November of 2006 (21st is Wednesday)

P. Monkkonen and other scientists (2004) propose a theory that the number concentration increases with the mass concentration up to 300 µg/m³. However, after this point, the number concentration decreases even if the mass concentration increases. The linear relationship between the mass and number concentration in the ambient air is valid if the mass concentration is relatively low. A high sink, however, means that the number concentration cannot be high, resulting in a decline in the number vs. mass plot (Monkkonen *et al.* 2004).

On the basis of P. Monkkonen *et al.* (2004) theory, possible linear relations between PM_{10} mass and number concentration were examined, as PM_{10} mass concentration didn't exceed the mentioned 300 µg/m³ line (Fig. 9).
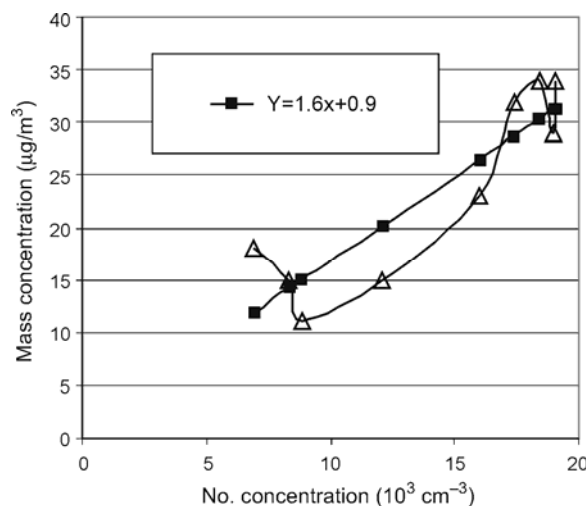
Fig. 9. Functional expression of relationship between PM_{10} mass concentration and aerosol number concentration

The linear tendency between aerosol number and PM_{10} mass concentration was found. The formula defining the relationship between these variables was:

$$m = 1,6n + 0,9, \qquad (1)$$

where m – PM$_{10}$ mass concentration ($\mu g/m^3$); n – aerosol number concentration ($10^3 cm^{-3}$).

It means that the increase of PM$_{10}$ mass concentration was 1.6 $\mu g/m^3$ for each additional 1000 aerosol particles cm^{-3}.

The strength of the linear association between two variables is quantified by the correlation coefficient. The correlation coefficient between aerosol mass and number concentration was found to be 0.89.

Particulate matter measurements in an urban and rural environments help to indicate which of the particulate matter sources regional or local are dominant in a certain place. The comparison between aerosol number concentration fluctuations in Preila and in Jonava was performed during winter-summer period.

Aerosol number concentration exhibited great variability during the measurement period on both monitoring sites, in urban and rural background as well (Fig. 10).

The maximum average monthly aerosol number concentration during the analysed period was registered in a winter month in Preila and reached 43 000 particles cm^{-3}. The lowest concentration was also noticed in Preila station in June (7000 cm^{-3}).
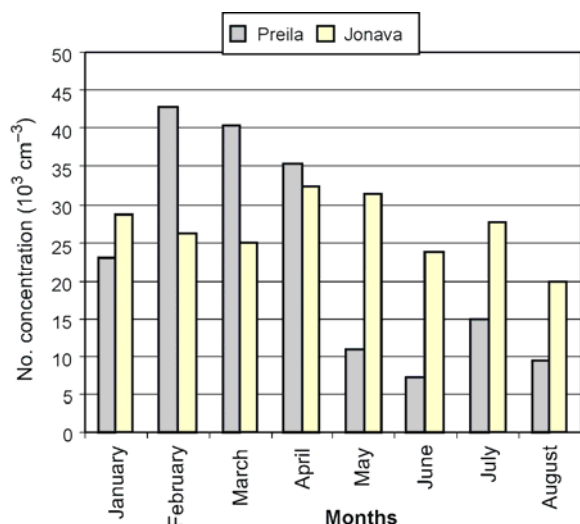
Fig. 10. Comparison of average monthly aerosol number concentration variations on urban (Jonava) and rural (Preila) sites

The aerosol number concentration distinctions might be related with local meteorological differences because particulate matter concentration variations in an urban and non-urban environment depend strongly on meteorology (Gomiscek *et al.* 2004), in particular on wind direction (Zee *et al.* 1998). Wind regime depends on pressure gradients in active sections (Task … 2000). Average annual wind speed at the Baltic coast is equal to 5,5–6,0 m/s, further from the sea, the speed decreases to 3,0–3,5 m/s. In summer, average wind speed is lower by 1–2 m/s than in winter. The prevailing wind direction depends on the season. The frequency of prevailing winds blowing from the Southwest and the South amounts to 25–30% in autumn and winter. In spring, the South wind

is less frequent and the Northwest wind prevails. Western winds are the main global factor causing particulate matter dispersion in Lithuania prevailing in the mid-latitude sand encompassing the whole troposphere and a part of the stratosphere. Westerly winds are dominant in Lithuania in summer time (Atlas … 1981).

As Fig. 10 represents, aerosol number concentration dropped significantly in May and summer months in Preila, reaching the minimum observed average monthly concentration of 7000 particles cm^{-3} and the maximum of 14 000 particles cm^{-3} in July. Westerly winds were associated with easterly moving depressions, cold front and rain. These factors caused mass renovation and dilution of pollutants (Gonzalez 2002), not allowing the concentrations to reach excessive levels. The other factor causing a low pollution level in Preila in summer were dominant winds from the sea, which resulted in low concentrations but larger relative differences between urban and non-urban areas (Gonzalez 2002). Meanwhile, the increase of particulate matter concentration in an urban environment was observed during summer with the maximum and minimum concentration of 26 000 particles cm^{-3} and 24 particles cm^{-3}, respectfully. This could be explained by meteorology. High weather temperatures, a small amount of precipitation, lower wind speeds and local transportation contribution were favorable conditions for particulate accumulation in urban areas, including Jonava.

Van der Zee *et al.* (1998) declared that a small contrast in particle concentrations between urban and non-urban areas may be a result of the small size of the country, lack of small-scale geographical and meteorological differences, and the importance of long-range transport of air pollutants.

Though Lithuania is a small country, the differences between urban and background particulate pollution were clearly expressed as the analyses showed.

The difference between rural and urban sites was more temperate climate in winter and the first spring months because of southwest, south winds characteristic of that season in Lithuania. These winds resulted in an influx of air masses from Central and Western Europe, which were usually associated with high concentrations and minimal urban-non-urban differences. The Western-Central parts of Europe are surrounded by high coastal ranges and are subject to weak gradient baric conditions (Gonzalez 2002).

Aerosol number concentration was higher in Preila during February-April months. In February and March the maximum difference between urban and background pollution was significant enough reaching 19 000 particles cm^{-3}. In April the difference between locations decreased with the tendency of particulate matter number concentration increase an urban environment. The biggest difference between rural and urban locations reached 20 000 particles cm^{-3} in June as Fig. 11 below represents.

Annual amounts of the continental and marine air masses coming to Lithuania are almost equal, despite the country being a seaside state (Task … 2000). The meteorological condition differences in the western part, where Preila station locates, and in the middle part of Lithuania, in Jonava, are significant all year round (Bukantis 2001).
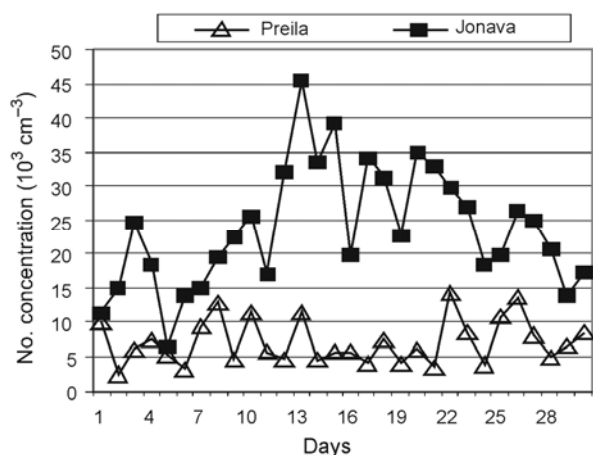
Fig. 11. Comparison of average 24-hour aerosol number concentration variations in Preila and Jonava in June

The fluctuations of aerosol number concentration were more drastic in Preila during the analysed period because of the nfluence of more unstable weather conditions and the seaside breezes that might change the direction of air masses and pollution levels as well. PM_{10} concentration variations in Jonava were more temperate. This tendency is nicely reflected in Fig. 12 below.
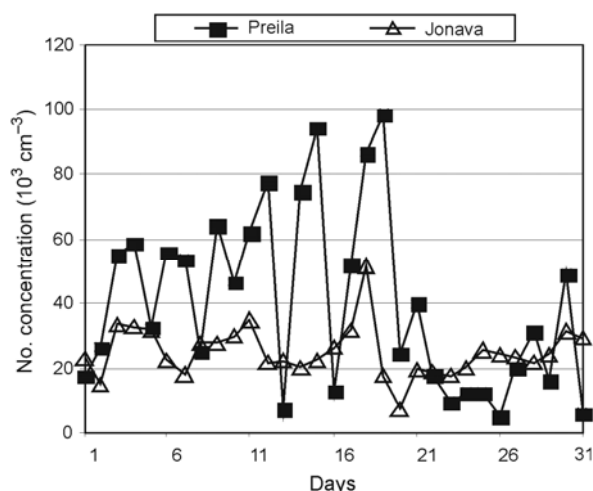

Fig. 12. Comparison of average 24-hour aerosol number concentration variations in Preila and Jonava in March

Absence of a tendency of persistent higher particulate matter concentrations in an urban environment allowed to think that the fluctuations of particulates were more of a regional nature than due to local anthropogenic sources.

4. Conclusions

1. During the experimental measurements in Jonava town, the minimum and maximum aerosol number concentration was traced to be of 1490 particles cm^{-3} and 26 000 cm^{-3}, respectfully.

2. The weather conditions were favorable for pollutant accumulation and stood quite stable during the experimental period. Sudden aerosol number concentration increase and decrease could hardly be associated with drastic weather changes because of their absence at that time. Still the increase of aerosol number concentration was detected with the decrease of wind speed and vice versa. The highest concentrations were registered with South winds blowing from the periphery. The Southeastern winds from the fertilizer factory were associated with an even concentration decrease. It means that the impact of Achema was not significant for the experimental results.

3. Aerosol number concentration fluctuations during the experimental period could hardly be associated with local vehicle emissions, as a tendency to a high aerosol number concentration was not observed during rush hours as well as weekend effect could not be detected.

4. Great variability of aerosol number concentration measurement results in an urban and non-urban environment was recorded, influenced mainly by geographical and meteorological site peculiarities and weather conditions.

5. All the conclusions drawn before allowed to think that aerosol pollution in Jonava seemed to be more of a regional nature and influenced mainly by air mass transport.

6. The linear relationship between aerosol number and PM_{10} mass concentration was found. Increase of PM_{10} mass concentration was 1.6 $\mu m/m^3$ for each additional 1000 of aerosol particles cm^{-3}.

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AEROZOLIŲ SKAITINĖS KONCENTRACIJOS TYRIMAI JONAVOJE

R. Vyzienė, A. Girgždys

S a n t r a u k a

Nors kai kurie autoriai teigia, kad aerozolių skaitinė koncentracija gali būti geresnis indikatorius, vertinant kietųjų dalelių įtaką sveikatai nei masinė koncentracija, aerozolio skaitinės koncentracijos tyrimų trūksta. Daugelis oro kokybės tyrimų remiasi kietųjų dalelių masinės koncentracijos matavimais. Didžiuosiuose Lietuvos miestuose masinės kietųjų dalelių koncentracijos tyrimai atliekami periodiškai įvairių mokslinių organizacijų. Kietųjų dalelių tyrimų Jonavoje trūkumas lėmė tyrimo objekto pasirinkimą. Aerozolių skaitinė koncentracija nenutrūkstamai buvo matuojama Jonavoje lapkričio 21–29 dienomis optiniu dalelių skaičiuotuvu *AZ*-5. Vėliau gauti duomenys buvo analizuojami, stebimi valandiniai ir paros skaitinės koncentracijos kitimai per visą matavimo laikotarpį. Buvo tiriama sąsaja tarp skaitinės aerozolių koncentracijos ir kitų teršalų bei vėjo greičio. Nustatyta priklausomybė tarp aerozolių skaitinės koncentracijos ir azoto junginių, taip pat vėjo greičio. Oro sąlygos teršalų kaupimuisi matavimo laikotarpiu buvo palankios, viso eksperimento metu gana pastovios, todėl staigūs aerozolių koncentracijos pokyčiai negali būti siejami su netikėtais oro sąlygų pokyčiais. Vis tik aerozolių skaitinės koncentracijos padidėjimas nustatytas mažėjant vėjo greičiui, ir atvirkščiai. Didžiausios koncentracijos užfiksuotos pučiant pietų vėjui iš periferijos. Gi pučiant rytų vėjui, nešančiam oro mases nuo trąšų fabriko, koncentracijos netgi sumažėjo. Aerozolių skaitinės koncentracijos padidėjimo neužfiksuota rytinių ir vakarinių transporto pikų metu. Nebuvo nustatytas ir „savaitgalio efektas". Tai byloja apie nežymią vietos transporto įtaką matavimo rezultatams. Tarp aerozolių masinės ir skaitinės koncentracijų rasta tiesinė priklausomybė. Nustatyta, kad aerozolių skaitinei koncentracijai padidėjus 1000 dalelių/cm^3, aerozolių masinė koncentracija padidėja 1,6 μm/m^3 Lyginant kietųjų dalelių (PM$_{10}$) masinės koncentracijos kitimą miesto ir kaimo vietovėse, pastebėta didelis rezultatų skirtumas. Aerozolių skaitinė koncentracija buvo žymiai didesnė Preiloje vasario – balandžio mėnesiais, palyginti nei Jonavoje. Vasarą kietųjų dalelių masinė koncentracija buvo didesnė miesto aplinkoje. Šiuos kietųjų dalelių koncentracijų skirtumus kaimo ir miesto aplinkoje lemia geografiniai bei meteorologiniai vietovių skirtumai. Įvertinus tyrimo duomenis paaiškėjo, kad kietųjų dalelių koncentracijų kaitą eksperimento metu Jonavoje labiausiai lėmė tolimieji oro teršalai. Vietinių taršos šaltinių įtaka kietųjų dalelių koncentracijų pasiskirstymui eksperimento metu nebuvo esminė.

Reikšminiai žodžiai: kietųjų dalelių masinė koncentracija, aerozolių skaitinė koncentracija, tiesinė priklausomybė, paros koncentracijų svyravimai, valandos koncentracijų svyravimai, miesto užterštumas, foninis užterštumas.

ИССЛЕДОВАНИЕ ЧИСЛОВОЙ КОНЦЕНТРАЦИИ АЭРОЗОЛЯ В ГОРОДЕ ЙОНАВЕ

Р. Визене, А. Гиргждис

Р е з ю м е

По мнению некоторых авторов, числовая концентрация аэрозоля может быть лучшим индикатором воздействия твердых частиц на здоровье людей, чем массовый метод, однако она недостаточно исследована. Большинство исследований качества воздуха пока основано на измерении массовой концентрации макрочастиц. В больших городах Литвы исследования массовой концентрации твердых частиц осуществляются различными научными организациями периодически. В Йонаве таких исследований было недостаточно. Постоянные измерения концентрации числа аэрозоля в городе были выполнены с 21 по 29 октября 2006 г. Загрязнители были измерены фотоэлектрическим счетчиком аэрозольных частиц АЗ-5. Суточные и часовые колебания числовой концентрации аэрозоля были проанализированы. Исследовалась связь между числовой концентрацией аэрозолей и других загрязнителей и скоростью ветра. Была найдена корреляция между числовой концентрацией аэрозоля, соединениями азота и скоростью ветра. Увеличение числовой концентрации аэрозоля было установлено с уменьшением скорости ветра и наоборот. Высокая числовая концентрация аэрозолей не наблюдалась в часы «пик» утром и вечером. В этом же отношении не был установлен эффект конца недели из-за небольшого воздействия местного транспорта на результаты измерений. Была установлена линейная зависимость между числовой и массовой концентрацией аэрозоля. С увеличением числовой концентрации на 1000 частиц аэрозоля на 1 см^3 массовая концентрация PM_{10} увеличивается на 1,6 μм/м^3. Сравнение колебаний числовой концентрации аэрозоля в Йонаве и Прейле выявило большую изменчивость результатов. Числовая концентрация аэрозоля в Прейле была выше в феврале, марте и апреле, а в летние месяцы она увеличивалась на городском участке. Эти городские и сельские различия объясняются особенностями географических и метеорологических участков и движением транспорта.

Ключевые слова: массовая концентрация PM_{10}, числовая концентрация аэрозоля, линейное соотношение, суточное изменение, часовое изменение, городское загрязнение, фон загрязнения.

Raminta VYZIENĖ. Master student, Dept of Environmental Protection, Vilnius Gediminas Technical University (VGTU).

Aloyzas GIRGŽDYS. Dr Habil, Prof and head of Laboratory of Nuclear Physics, Vilnius Gediminas Technical University (VGTU).
Doctor of Science(environmental physics), Moscow Institute of Atmospheric Physics, 1985. First degree in Physics, Vilnius University (VU), 1970. Publications: author of 1 monograph, over 120 research papers. Research interests: environmental physics, aerosol physics.