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Study of Batumi Atmosphere Pollution with Microparticles According to 2025 Operating Observation

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Abstract.

Time behavior of atmospheric concentration of PM2.5 and PM10 microscopic particles hazardous for health has been assessed by means of operating supervision data obtained from Batumi air quality monitoring stations. 2025 data obtained from two observation points of the city have been used for analysis. Variation range, range of maximum, minimum and average values of PM2.5 and PM10 concentrations have been determined. Linear correlation coefficients between PM2.5 and PM10 concentrations have been calculated. It has been accepted that there is a large correlation relationship between them. Values of linear correlation coefficients between data taken from the same observation point and different observation points mainly exceed 0.9. It has been also accepted that concentrations are mainly within the permissible levels. Concentration surpassing over the maximum permissible values takes place in separate days only.

Key words: Air pollution, daily concentration, Particulate Matter.

Introduction.

Microparticles present in the atmosphere of urban territories, which sizes don't exceed 2.5 μm and 10 μm – PM 2.5 and PM10, are extremely hazardous for human and animal health. Due to small sizes, they easily penetrate human body, cause many types of diseases and even result in death [1-10]. That is why, protection of urban areas from microaerosol pollution is a critically important environmental problem.

This problem is especially noteworthy for large cities – administrative and industrial centers [11-14], as well as for small towns [15-17] – touristic and medical and health-promoting resorts, with gathering of large crowds for recreation and health-improving and curative measures takes place.

Over the last 5-8 years, important practical air-protecting measures have been carried out in the cities of Georgia, aimed to monitoring of PM2.5 and PM10 pollution of atmospheric air of Georgian cities both through field observation and mathematical modeling [17-21].

Batumi, the second largest administrative and transport city of Georgia is a hub center connecting east and west, north and south. It links the Eastern Europe and Russia with countries of the lesser Asia. At the same time, it is a very important cultural and resort city, with millions of humans, coming here every year from different regions of the world and taking a rest here. That is why, preservation of clean air and ecologically safe environment of Batumi is an urgent problem.

An observation of air pollution with PM2.5 and PM10 in the city of Batumi has been carried out since 2018. Now an observation is carried out at two automated monitoring stations located approximately 880 m apart, 600m from the sea is Central Park, 800m from the sea is T.Abuseridze.

Both stations are located in highly urbanized areas of the city. The station on T. Abuseridze Street is located in close proximity to one of the city's main central streets, while the second station is located in a green zone of the city, 100–150 meters away from central roads. Monitoring has been conducted by the Batumi branch of the National Environmental Agency of Georgia according to internationally recognized standard program [22]. The
measures' are made by Physical and chemical methods of analysis (APDA-372 PM10&PM2.5HORIBA and statistical data processing methods (StatSoft STATISTIKA 10.0 portable, Microsoft ®Exel219).

Observation data and research results.

The pattern of Batumi atmospheric air pollution with PM2.5 and PM10 particles has been analyzed in the presented article based on 2025 operating observation data [22]. Fig. 1-12 show a monthly variations of the average daily concentration (ADC) of PM2.5 and PM10 during 12 months of 2025, at operating observation points located on T. Abuseridze Street and in the Central Park of city. Maximum permissible ADC of PM2.5 and PM10 are equal to 25 μg/m^3 and 50 μg/m^3, respectively [22, 23].

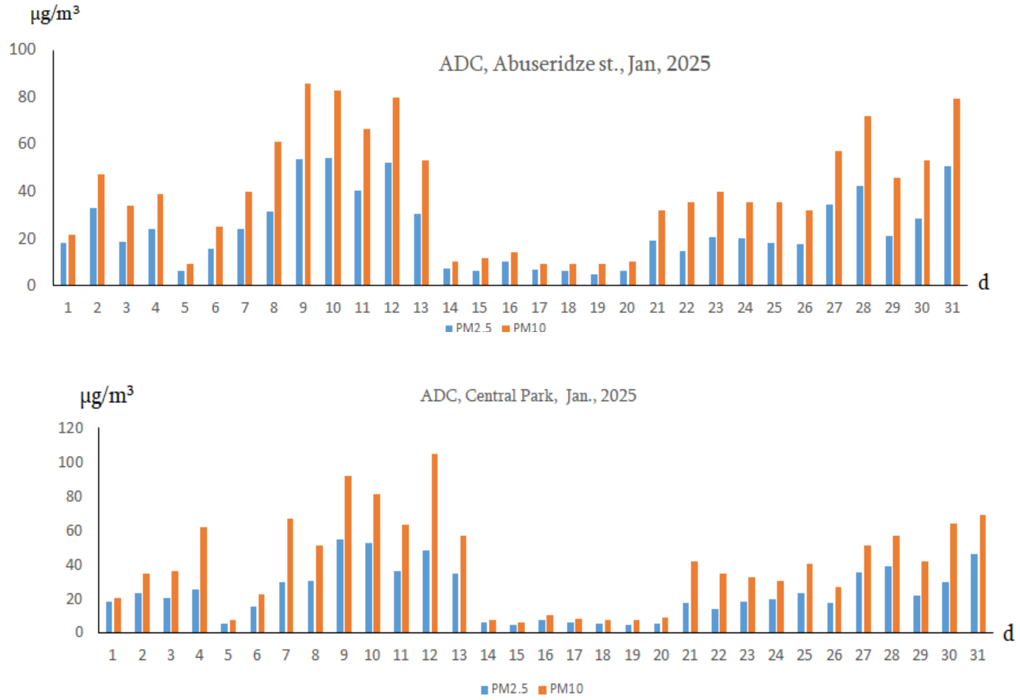

Fig. 1. ADC of PM2.5 and PM10 in January at the observation points T. Abuseridze and Central Park.

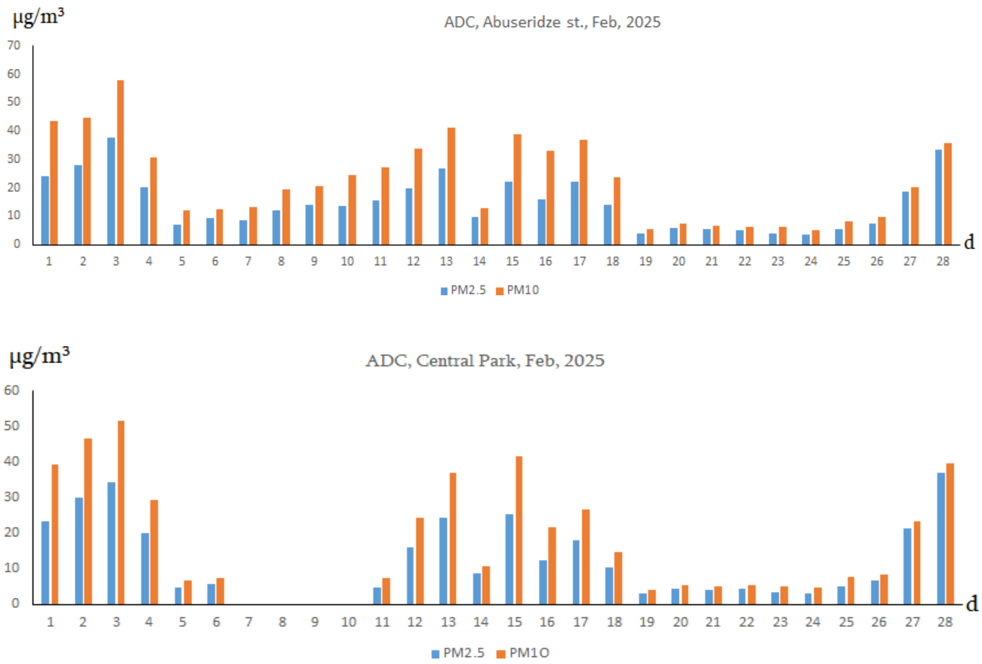

Fig. 2. ADC of PM2.5 and PM10 in February at the observation points T. Abuseridze and Central Park.

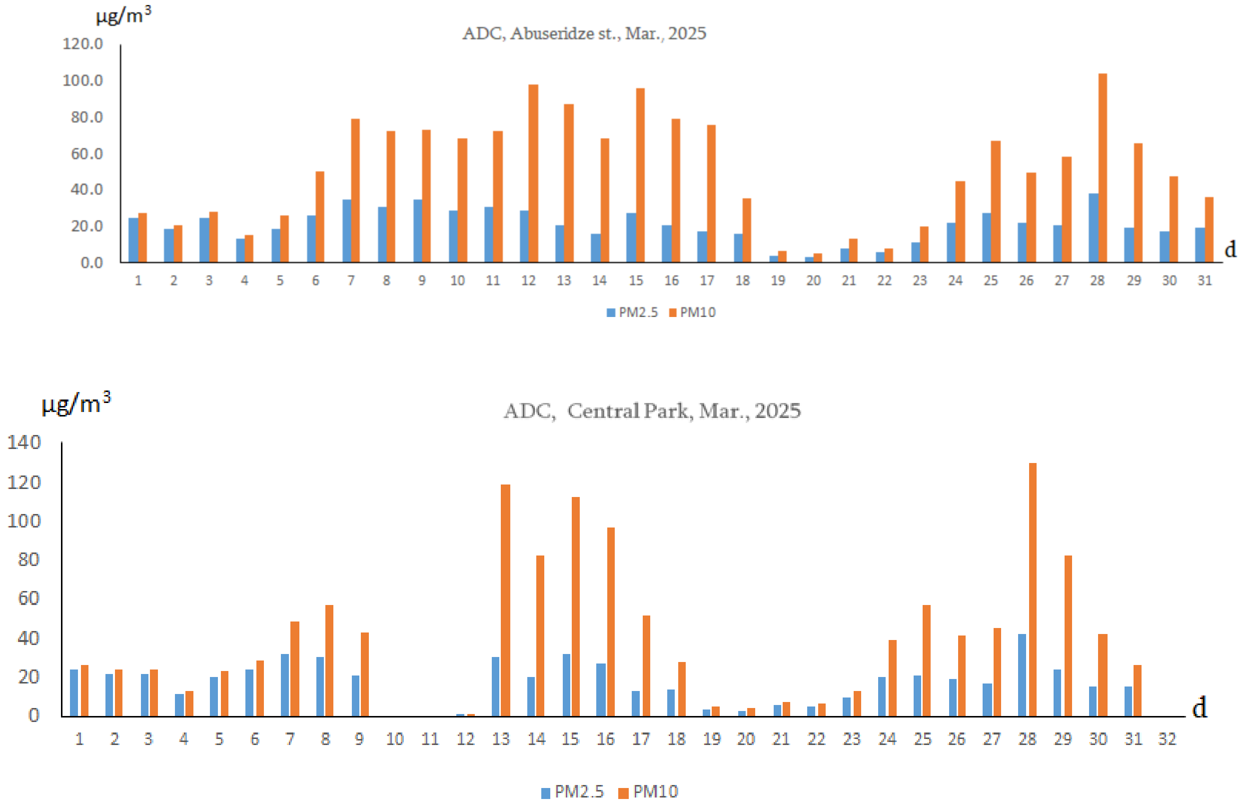

Fig. 3. ADC of PM2.5 and PM10 in March at the observation points T. Abuseridze and Central Park.

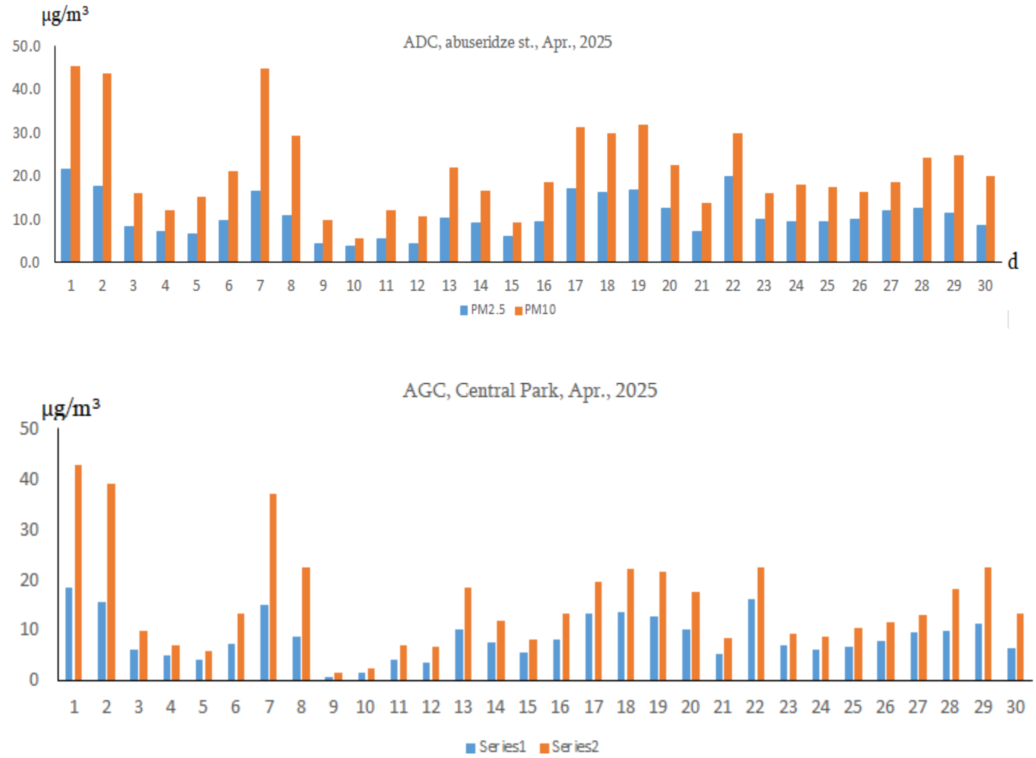

Fig. 4. ADC of PM2.5 and PM10 in April at the observation points T. Abuseridze and Central Park.

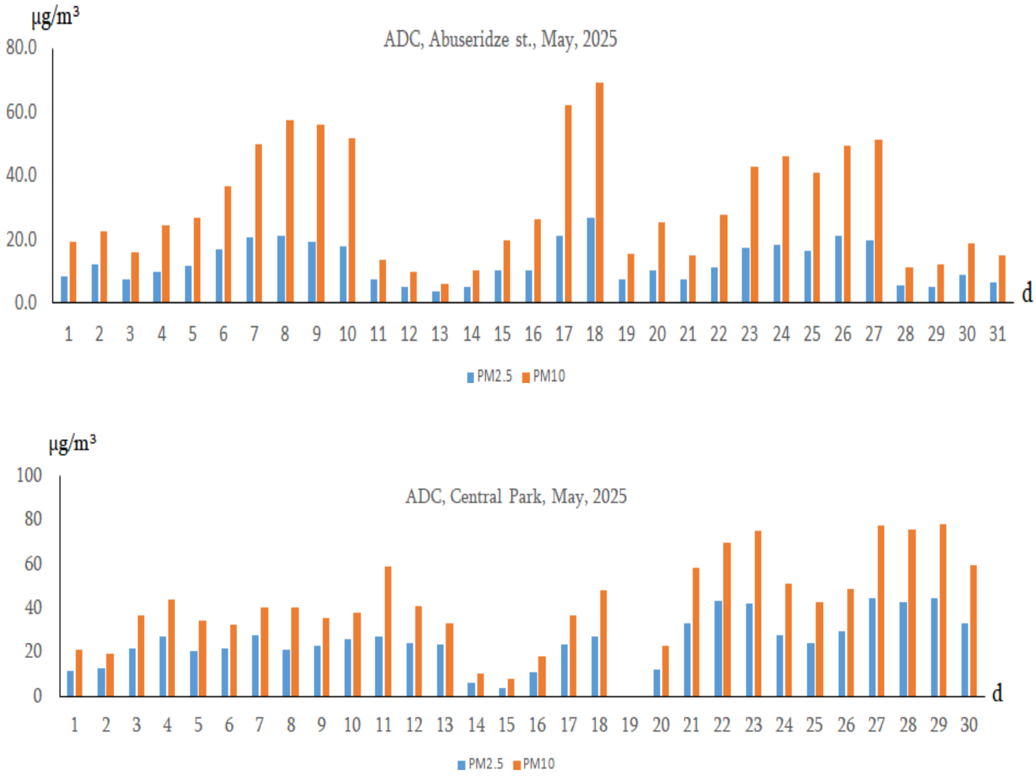

Fig. 5. ADC of PM2.5 and PM10 in May at the observation points T. Abuseridze and Central Park.

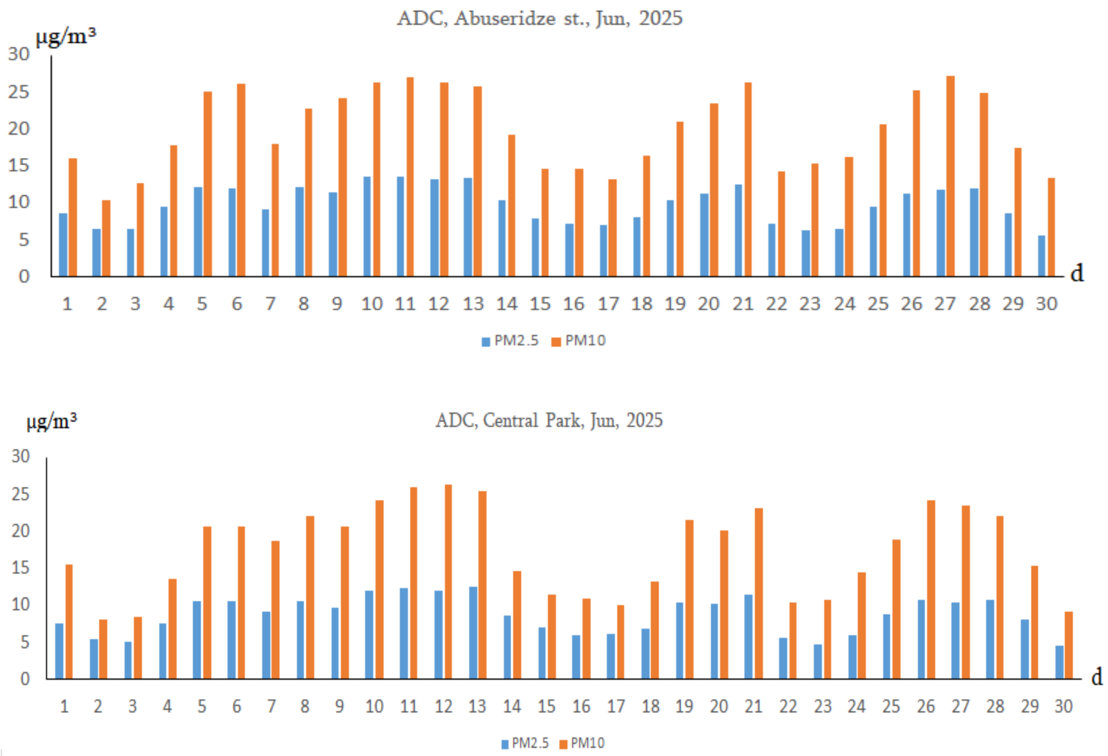

Fig. 6. ADC of PM2.5 and PM10 in June the observation points T. Abuseridze and Central Park.

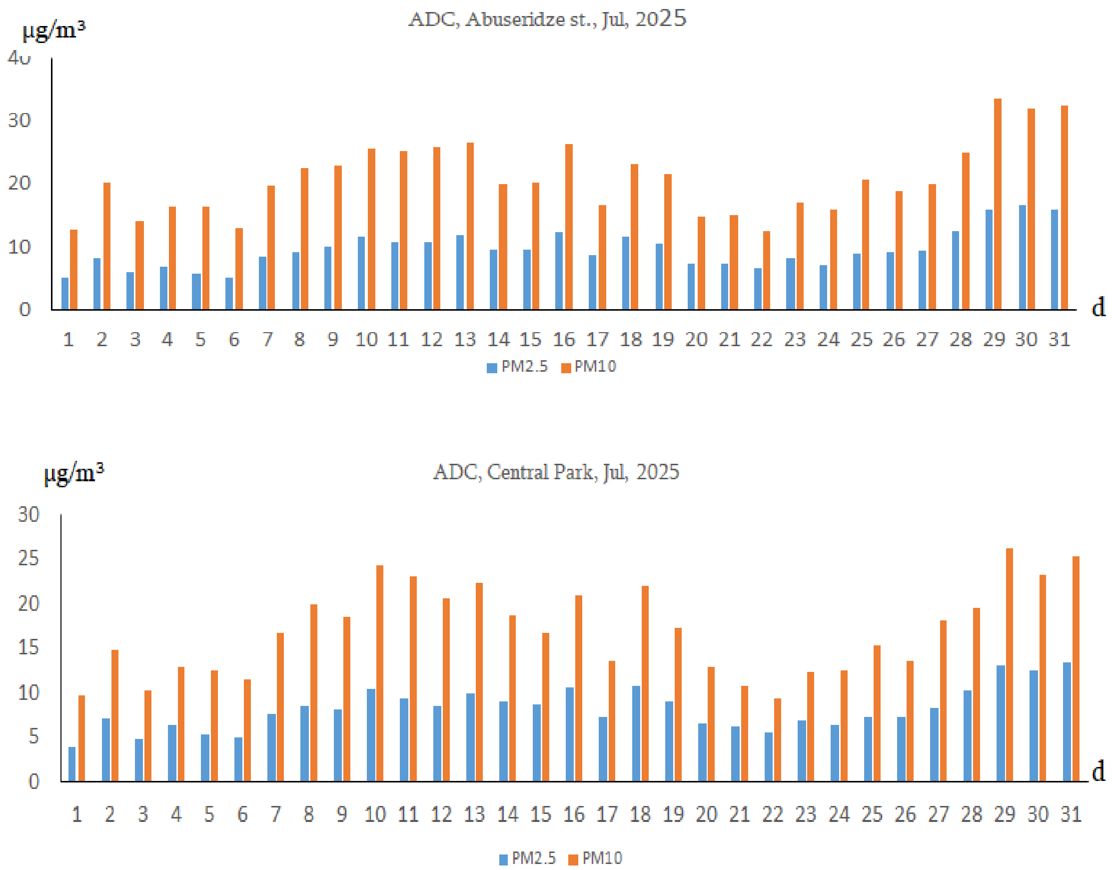

Fig. 7. ADC of PM2.5 and PM10 in July at the observation points T. Abuseridze and Central Park.

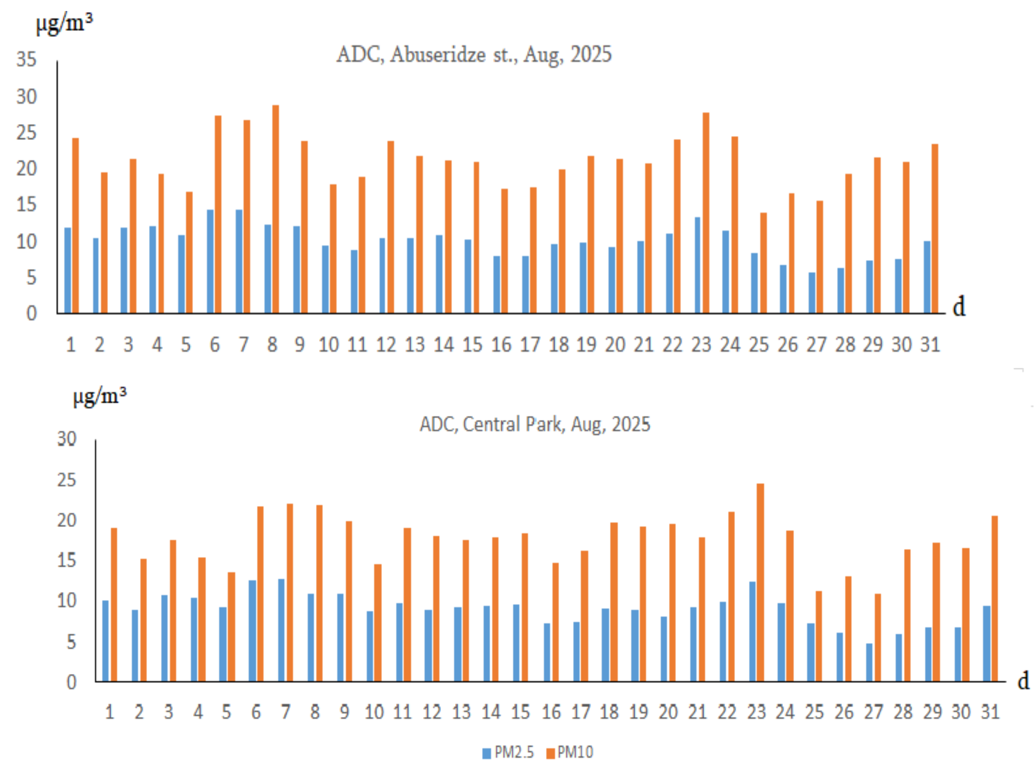

Fig. 8. ADC of PM2.5 and PM10 in August at the observation points T. Abuseridze and Central Park.

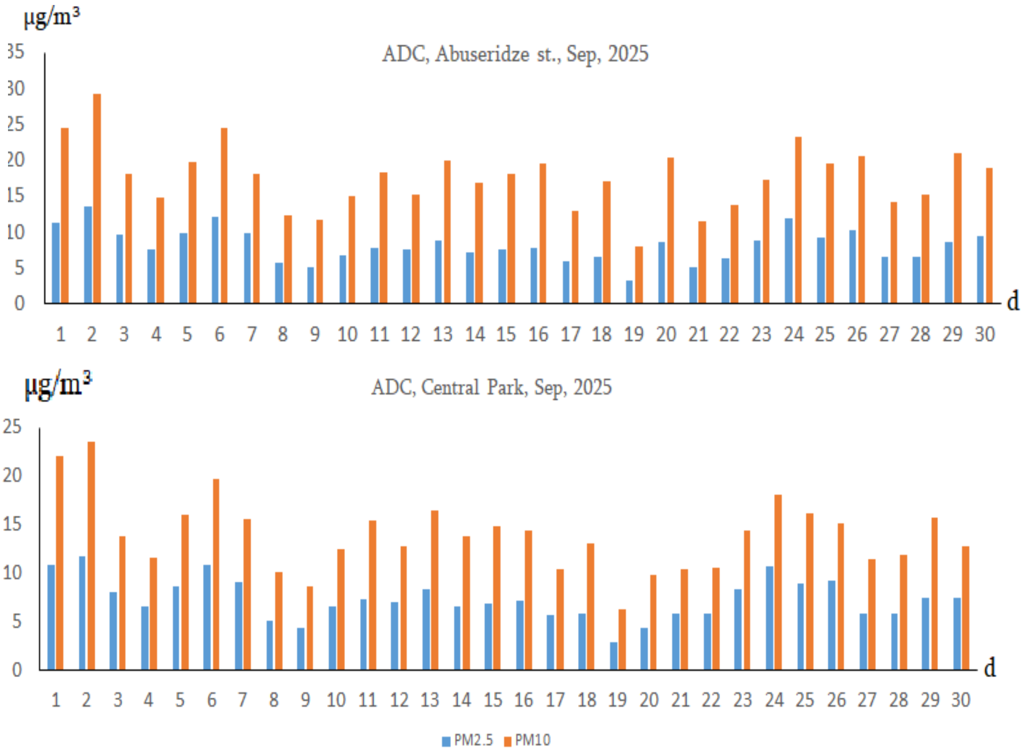

Fig. 9. ADC of PM2.5 and PM10 in September at the observation points T. Abuseridze and Central Park.

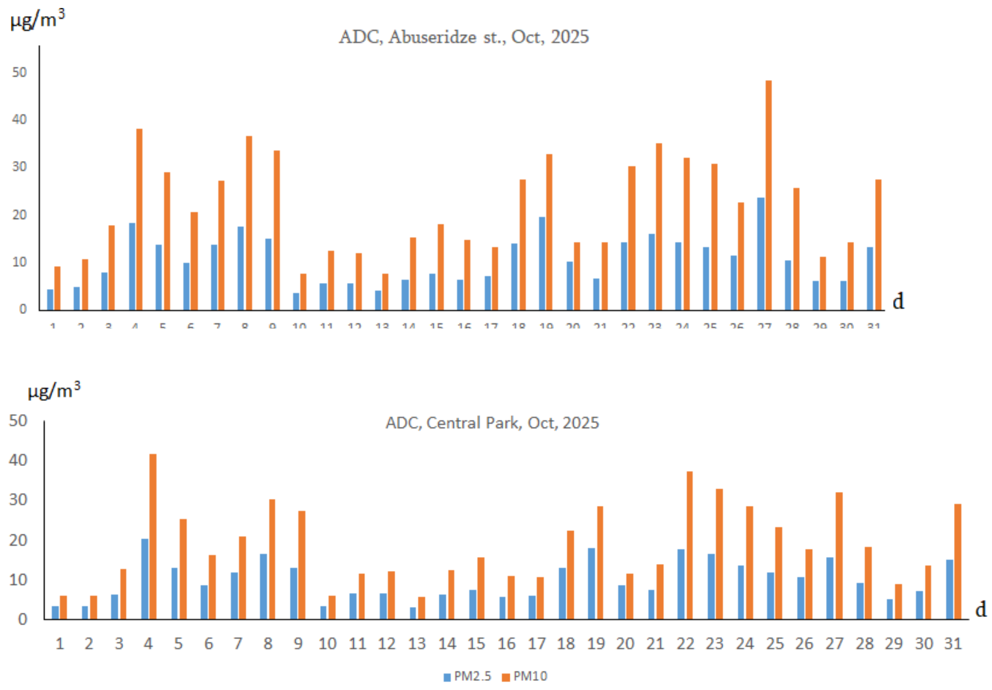

Fig. 10. ADC of PM2.5 and PM10 in October at the observation points T. Abuseridze and Central Park.

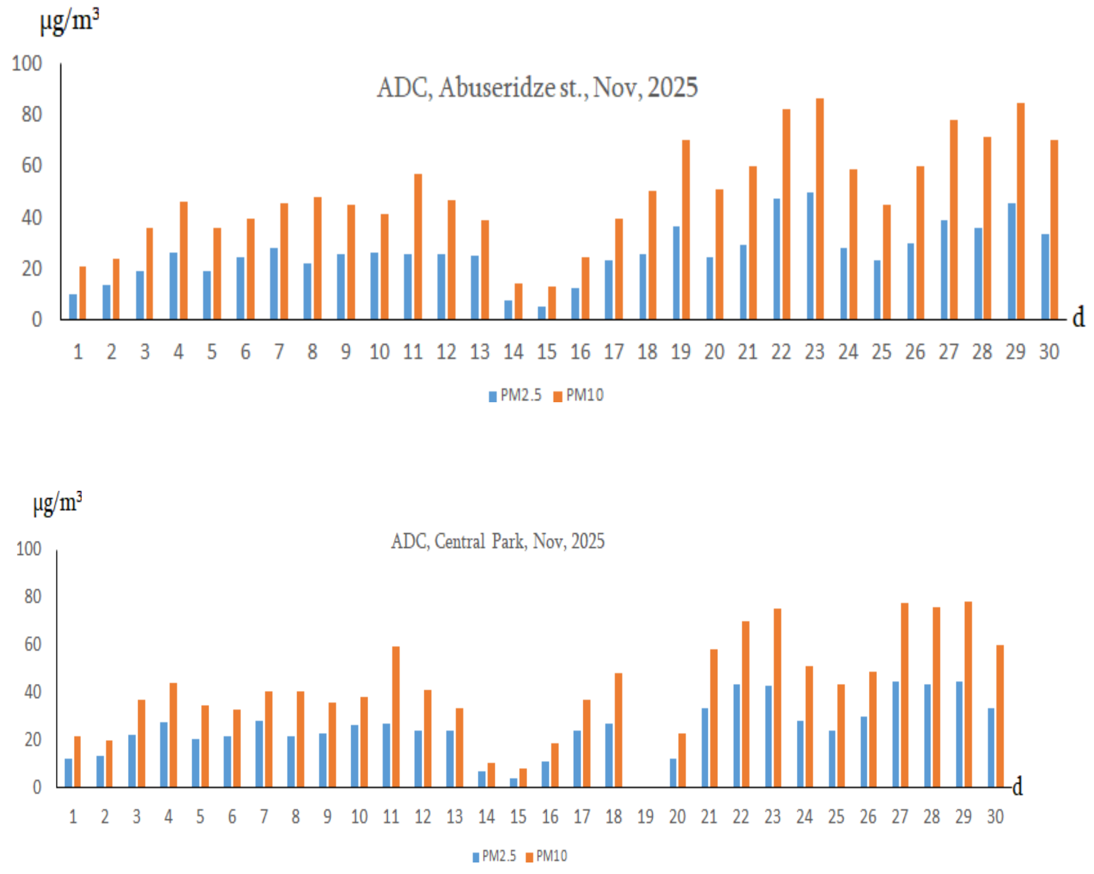

Fig. 11. ADC of PM2.5 and PM10 in November at the observation points T. Abuseridze and Central Park.

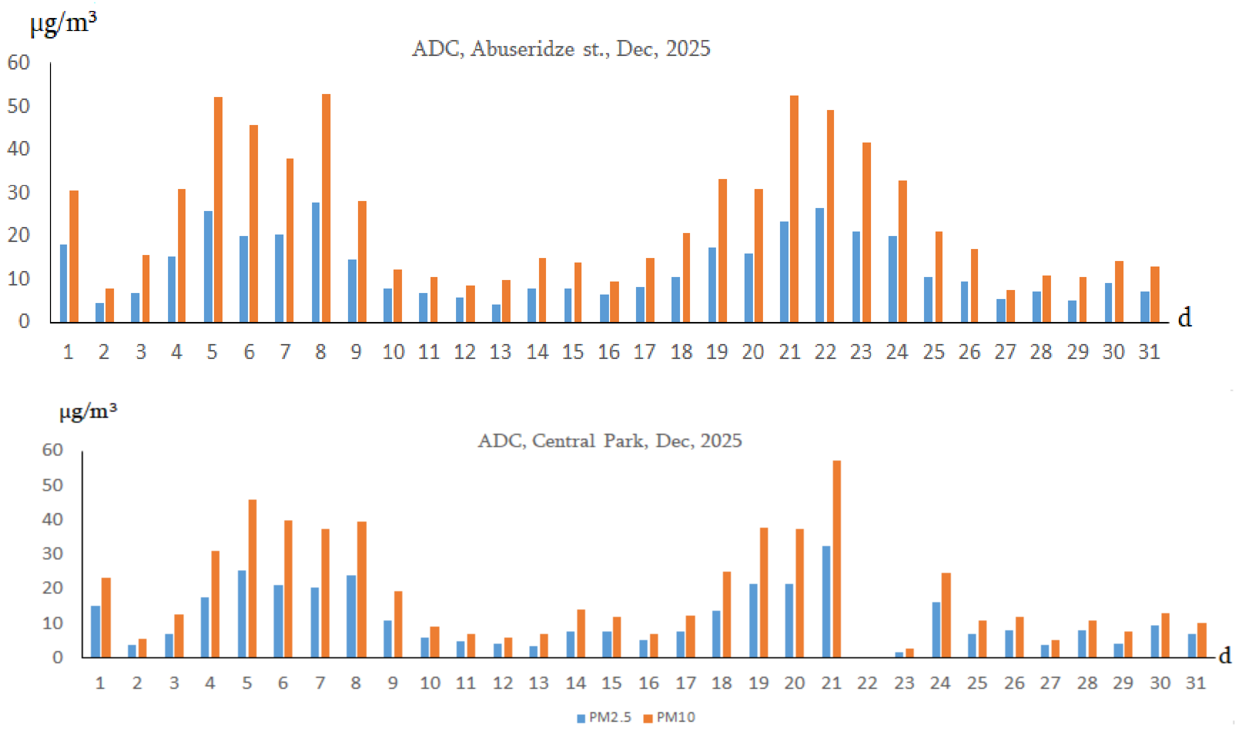

Fig. 12. ADC of PM2.5 and PM10 in December at the observation points T. Abuseridze and Central Park.

It is seen from the Figures that microaerosol concentrations are mainly varied in synchronism: concentration of PM2.5 is always less than PM10 concentration; the range of its increase/decrease coincide in time with those of PM10. Monthly numbers of increase/decrease ranges are within 2-4, while duration of every single time interval varies from 3 to 8. The mentioned effect is presumably associated with change of local meteorological conditions. At the same time, some deviations from common pattern – short-term (one-day) drastic changes of concentration – take place. For instance, one-day sharp increase of concentration are observed on 12th, 31st of January14th of February etc.

Concentration change statistics can been characterized by means of data presented in Table 1 and Table 2, where numerical values of statistical characteristics of PM2.5 and PM10 concentrations calculated by Exel are given. It is seen from Table 1 that a minimal value of ADC of PM2.5 concentration on T. Abuseridze Street varies within a range of 1.9-5.7 μg/m^3, while an average value – 10.1 – 26.2 μg/m^3, and maximal – 13.5 – 58.0 μg/m^3. For PM10, these data are as follows: 5.0-13.9 μg/m^3, 17.6 -51.4 μg/m^3, 27.5 – 104.0 μg/m^3. As for the PM10/PM2.5 ratio, its values vary within following ranges: minimal – 1.1-1.9, average – 1.7-2.4, and maximal – 2.1-4.5. In some days, the exceedance of average daily concentrations over maximum permissible average hourly concentrations is obtained. In case of PM2.5 particles, the mentioned exceedance took place during 44 days throughout 2025, while for PM10 – during 46 days. Correlation between PM2.5 and PM10 concentrations is quite high. Linear correlation values mainly exceed 0.90. Only in two months, in March and August, linear correlation coefficients are less than 0.9 and equal to 0.80 and 0.76 in observation points located on T. Abuseridze Street and in the Central park.

Table 1. Statistical characteristics of PM2.5 and PM10 concentrations. Batumi, 2025, T. Abuseridze Street.

Month	PM2.5 (μg/m^3)				PM10 (μg/m^3)				PM10/PM2.5			PM10, M2.5 Correl. Koeff
	Min	Aver	Max	>MPC	Min	Aver	Max	>MPC	Min	Aver	Max	
Jan	5.0	23.7	53.9	11	9.0	39.3	85.9	10	1.2	1.7	2.4	0.98
Febr	3.4	14.8	58.0	4	5.0	22.8	58.0	1	1.1	1.5	2.1	0.96
March	3.2.	11.1	38	10	5.1	51.4	104.0	15	1.1	2.4	4.5	0.80
April	3.8	10.7	21.8	0	5.5	21.5	45.4	0	1.5	2.0	2.8	0.92
May	3.6	12.6	26.7	1	5.8	30.6	69.4	5	1.6	2.3	2.9	0.99
June	5.5	9.8	13.6	0	10.3	19.4	27.5	0	1.6	2.0	2.5	0.96
July	5.0	9.6	16.6	0	12.4	20.8	33.4	0	1.9	2.2	2.8	0.96
Aug	5.7	10.1	14.7	0	13.9	21.2	28.8	0	1.5	2.1	3	0.76
Sept	1.9	8.2	13.5	0	8.1	17.6	29.2	0	1.8	2.2	2.7	0.95
Oct	3.5	10.7	23.6	0	7.7	22.3	48.3	0	1.4	2.1	2.7	0.97
Nov	5.1	26.2	49.8	16	12.9	49.4	86.3	13	1.6	1.9	2.5	0.99
Dec	4.1	12.8	27.7	2	7.4	24.2	53.0	2	1.4	1.9	2.4	0.98

In terms of quantity, the data observed in the air Central Park quality are similar to concentrations values obtained on T. Abuseridze Street. In particular, minimal value of PM2.5 average daily concentration varies within a range of 0.13-6.9 μg/m3, average one – 7.3-25.6 μg/m3, and maximal – 11.8 – 54.6 μg/m3. For PM10 particles, these data are as follows: 0.5-10.9 μg/m3, 13.9-43.9 μg/m3, 20.4-129.8 μg/m3, respectively. As for the PM10/PM2.5 ratio, its values vary within following ranges: minimal – 1.1-1.7, average – 1.7-2.4, and maximal – 2.1-4.5.

Table 2. Statistical characteristics of PM2.5 and PM10 concentrations. Batumi, 2025, the Central Park.

Month	PM2.5 (μg/m^3)				PM10 (μg/m^3)				PM10/PM2.5			PM10, M2.5 Correl Coeff
	Min	Aver	Max	>PMC	Min	Aver	Max	>PMC	Min	Aver	Max	
Jan	4.2	22.9	54.6	13	6.2	40.9	104.5	12	1.1	1.7	2.5	0.95
Febr	2.2	12.7	36.8	4	4.0	18.8	51.5	1	1.1	1.4	1.8	0.99
Mar	0.13	18.4	47.9	5	0.5	43.9	129.8	9	1.1	2.3	4.2	0.80
Apr	6.9	8.5	18.3	0	1.5	15.4	43.6	0	1.1	1.8	2.6	0.92
May	2.5	11.1	25.1	1	3.9	27.0	73.0	4	1.6	2.2	3.4	0.98
June	4.6	8.7	12.4	0	8.1	17.5	26.2	0	1.5	2.0	2.4	0.97
July	4.1	8.2	13.3	0	9.46	16.9	20.4	0	1.7	2.1	2.5	0.94
Aug	4.9	9.15	12.9	0	10.9	17.2	24.5	0	1.4	2.1	2.7	0.74
Sept	6.2	7.3	11.8	0	2.9	13.9	23.5	0	1.6	1.9	2.2	0.95
Oct	3.2	10.1	20.3	0	5.6	19.0	41.6	0	1.4	1.9	2.1	0.95
Nov	4.15	25.6	44.7	14	8.1	43.1	78.4	9	1.4	1.7	2.2	0.98
Dec	1.7	11.5	18.9	2	2.6	18.9	57.1	1	1.3	1.6	2.1	0.99

As for exceedance of ADC concentrations over maximum permissible ADC, it took place during 39 days in case of PM2.5 and 36 days – for PM10. Correlation between PM2.5 and PM10 concentration is very high. The value of linear correlation coefficient between them mainly exceeds 0.90. Only in two months, in March and August, linear correlation coefficients are less than 0.9 and equal to 0.80 and 0.74.

Table 3. Values of linear correlation coefficient between PM2.5 and PM10 concentration in the observation points T. Abuseridze and the Central Park and number of cases with concentration exceedance PM2.5 C.P. > PM2.5 Abus. და PM10 C. P> PM10 Abus.

Month	Jen	Febr	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
PM2.5	0.98	0.96	0.75	0.98	0.98	0.98	0.98	0.97	0.93	0.93	0.95	0.83
PM10	0.93	0.94	0.77	0.97	0.97	0.96	0.95	0.90	0.92	0.93	0.96	0.82
PM2.5 C.P. >PM2.5Abu.	10	4	8	0	2	1	1	1	1	8	12	10
PM10 C.P. >PM10Abu.	10	4	7	0	3	2	0	1	0	4	4	5

It is seen from Fig. 3, that there is a very high correlation between concentrations observed on T. Abuseridze Street and at the Central Park territory. At the same time, pollution level at the Central Park territory is mainly less than that registered on T. Abuseridze Street. Only during 4-12 days of January-March and October-December, average daily concentrations are higher than values observed on T. Abuseridze Street.

Conclusion. Availability of high linear correlation relationship between concentrations of PM2.5 and PM10 particles both between data of the same observation point and different observation points, as well as similarity between a range of high, average and low values points at the fact that air pollution with PM particles in the vicinity of two observation points is formed by one and the same pollution source. (avtotransporti amoviRe)

Analysis of variation range of PM2.5 and PM10 concentrations, and the small number of those days, when an average daily concentration exceeds maximum permissible concentration, enable us to make conclusion that city of Batumi, according to its atmospheric air purity, may be placed into a category of slightly polluted cities. At the same time, proceeding from complex terrain of the city and adjacent territories and city urbanization nature, for improve air quality assessmentნ is deemed reasonable to increase a number of observation points situated in the city. For this purpose, the frequent observation low-cost sensor networks introduced in Europe can be used [24-27].

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ქ. ბათუმის ატმოსფეროს მიკრო ნაწილაკებით დაბინძურების კვლევა 2025 წლის ოპერატიული დაკვირვების მიხედვით /ა. სურმავა, ფ. სბრანა, ვ. კუხალაშვილი, ლ. ინწკირველი, ნ. გიგაური/სტუ ჰმი-ის შრომათა კრებული-2026. ტ.139. გვ.125-136, ინგ., რეზ.: ქართ., ინგ., რუს.

ქ. ბათუმის ჰაერის ხარისხის მონიტორინგის სადგურების ოპერატიული დაკვირვების მონაცემების ანალიზის საშუალებით შეფასებულია ატმოსფერულ ჰაერში ჯანმრთელობისათვის საშიში მიკროსკოპული ნაწილაკების PM2.5 და PM10-ის კონცენტრაციების დროში ცვლილების ხასიათი. ანალიზისათვის გამოყენებული ქალაქის ორ სადამკვირვებლო პუნქტის 2025 წლის მონაცემები. განსაზღვრულია PM2.5 და PM10-ის კონცენტრაციათა ცვლილების დიაპაზონი, მაქსიმალური, მინიმალური და საშუალო მნიშვნელობათა ინტერვალები. გამოთვლილია PM2.5 და PM10-ის კონცენტრაციებს შორის წრფივი კორელაციის კოეფიციენტები. მიღებულია, რომ მათ შორის არსებობს დიდი კორელაციური კავშირი. წრფივი კორელეციის კოეფიციენტების სიდიდეები ერთი და იგივე დაკვირვების პუნქტისა და სხვადასხვა დაკვირვების პუნქტების მონაცემებს შორის ძირითადად აღემატება 0.9. ასევე, მიღებულია, რომ კონცენტრაციები ძირითადად დასაშვები ნორმის ფარგლებშია. კონცენტრაციის ზღვრულად დასაშვებ მნიშვნელობაზე გადაჭარბებას ადგილი აქვს მხოლოდ ცალკეულ დღეებში.

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Study of c. Batumi Atmosphere Pollution with Microparticles According to 2025 Operating Observation/Aleksandre A. Surmava, Francesco Sbrana, Vepkhia G. Kukhalashvili, Natia G.Gigauri, Liana N. Intskirveli/ Transactions IHM,GTU. -2026. -vol.139. -pp. 125-136 . Eng., Summ.: Georg., Eng. Rus.

Time behavior of atmospheric concentration of PM2.5 and PM10 microscopic particles hazardous for health has been assessed by means of operating supervision data obtained from Batumi air quality monitoring stations. 2025 data obtained from two observation points of the city have been used for analysis. Variation range, range of maximum, minimum and average values of PM2.5 and PM10 concentrations have been determined. Linear correlation coefficients between PM2.5 and PM10 concentrations have been calculated. It has been accepted that there is a large correlation relationship between them. Values of linear correlation coefficients between data taken from the same observation point and different observation points mainly exceed 0.9. It has been also accepted that concentrations are mainly within the permissible levels. Concentration surpassing over the maximum permissible values takes place in separate days only.

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Исследование загрязнения атмосферы г. Батуми микрочастицами на основе данных оперативного наблюдения 2025 года /Сурмава А.А., Франческо Сбрана, Кухалашвили В.Г.,Гигаури Н.Г., .Инцкирвели Л.Н. / Сб. Трудов ИГМ ГТУ. - 2026. – том 139. – ст. 125-136. Груз.; Рез: Груз., Англ., Рус.

Динамика изменения концентрации в атмосфере г. Батуми опасных для здоровья микроскопических частиц PM2.5 и PM10 оценивалась на основе данных оперативного мониторинга, полученных со станций контроля качества воздуха в г. Батуми. Для анализа использованы данные за 2025 год, полученные с двух точек наблюдения в городе. Определены диапазон колебаний, диапазон максимальных, минимальных и средних значений концентраций PM2.5 и PM10. Рассчитаны линейные коэффициенты корреляции между концентрациями PM2.5 и PM10. Получено, что между ними существует сильная корреляция. Значения коэффициентов линейной корреляции между данными, полученными из одной и той же точки наблюдения и из разных точек наблюдения, в основном превышают 0,9. Также получено, что концентрации микрочастиц в основном находятся в пределах допустимых уровней. Превышение концентрации над максимально допустимыми значениями наблюдается только в отдельные дни.