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Comparative Characteristics of the Changeability of Atmospheric Pressure in the Meteorological Stations in the Tbilisi Airport, Tortoise Lake and in Cosmic Rays Observatory of M. Nodia Institute of Geophysics

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ABSTRACT

The paper considers the comparative analysis of the changeability of atmospheric pressure in the meteorological stations in the Tbilisi airport, the Tortoise Lake and in the Cosmic Rays Observatory of M. Nodia Institute of Geophysics during June 2015. The measurements of pressure at the meteorological stations are conducted once in every three hours, and in the observatory of cosmic rays - hourly. In particular, based on the example of the intensive local convective process of June 13-14, 2015 it becomes obvious that the hourly measurements of atmospheric pressure are more sensitive to their variations than three-hour measurements. It is proposed to use data of observatory about the atmospheric pressure for studying different processes in the environment.

Key words: atmospheric pressure variation.

Introduction

Variations in the atmospheric pressure are connected both with the global (cyclones, anticyclones, atmospheric fronts, etc.) and the local (air-mass clouds, etc.) atmospheric processes. On the territory of Caucasus the weather conditions (as well as atmospheric pressure variation) are formed a result of intensive impact of those large-scale circulation processes, which start on the Eurasian continent, in the North Atlantic and its neighbouring arctic basin [1]. Examples of the local variations of the atmospheric pressure connected with the influence of convective cloudiness are given in [2].

Many processes, which take place in the environment, are connected with the changeability of atmospheric pressure (the level of underwater water [3], flux of radon from the soil [4], etc.). Variations in the atmospheric pressure substantially influence on the health of people [5,6].

During several decades the hourly measurements of variations in the atmospheric pressure have been conducted in the Cosmic Rays Observatory of M. Nodia Institute of Geophysics. The data are used for the correction of the results of monitoring the intensity of neutron component of galactic cosmic rays.

For studying different processes, which take place in the atmosphere, these data have not had any wide application so far except the preliminary studies of the influence of variations of atmospheric pressure on the health of the population of Tbilisi city [6].

The purpose of this work is the development of the advantage of the hourly measurements of variations in the atmosphere in comparison with the three-hour measurement during the study of local atmospheric processes, which are conducted at standard meteorological stations.

Material and methods

In the work, besides the data of the Cosmic Rays Observatory, the data of the meteorological stations, located in the Tortoise Lake and in Tbilisi Airport are used (https://rp5.ru/Weather_in_Georgia). The coordinates of the points of measurement and distance between them are given in Table 1.

Table 1

Coordinates of the points of the measurement of atmospheric pressure in Tbilisi.

No St.	Points of the measurement (Stations)	LAT, N	LON, E	Height a.s.l., m	Distance from stations, km		
					1	2	3
1	Turtle Lake	41.70°	44.75°	425	0	16.9	3.3
2	Airport	41.67°	44.95°	472	16.9	0	18.5
3	Cosmic Rays Observatory	41.73°	44.74°	510	3.3	18.5	0

The comparison of variations in the atmospheric pressure in three indicated points of measurement is carried out for June, 2015. In the first half of the month unstable rainy weather was observed in Tbilisi. On June 13-14 in Tbilisi recorded the well known catastrophic flood, provoked by intensive rain with the subsequent landslide in the environments of Akhaldaba [7,8].

A relative variation of the atmospheric pressure ΔP with respect to its mean monthly value P_{mean} was studied:

$$\Delta P = 100 \cdot (1 - P/P_{mean}), \%$$

where P is atmospheric pressure.

In the proposed work the analysis of data is carried out with the use of the standard statistical analysis methods and methods of mathematical statistics for the time-series of observations [9,10].

The following designations will be used below: Min – minimal values, Max - maximal values, Range - variational scope, σ - standard deviation, σ_m - standard error (68% - confidence interval of mean values), 95%(+/-) - 95% - confidence interval of mean values, R - coefficient of linear correlation, R^2 – coefficient of determination, R_a - autocorrelation coefficient.

Results and discussion

The results are given in Tables 2, 3 and Fig. 1-5.

Table 2

The statistical characteristics of relative values of atmospheric pressure in 3 measurement points in June, 2015 in Tbilisi

Parameter	Tortoise Lake	Airport	Cosmic Rays Observatory
Min	-1.39	-1.34	-1.35
Max	0.95	0.76	0.85
Range	2.34	2.10	2.20
St Dev	0.48	0.45	0.47
σ_m	0.03	0.03	0.02
95%(+/-)	0.06	0.06	0.03
Correlation Matrix, (R)			
Tortoise Lake	1	0.97	0.98
Airport	0.97	1	0.97
Cosmic Rays Observatory	0.98	0.97	1

According to Table 2 and Fig. 1 high correlation is observed between the values ΔP in all points of measurements. The statistical parameters weakly differ from each other, except the standard error. The sensitivity of measurements ΔP in the Cosmic Rays Observatory is higher than at two remaining stations.

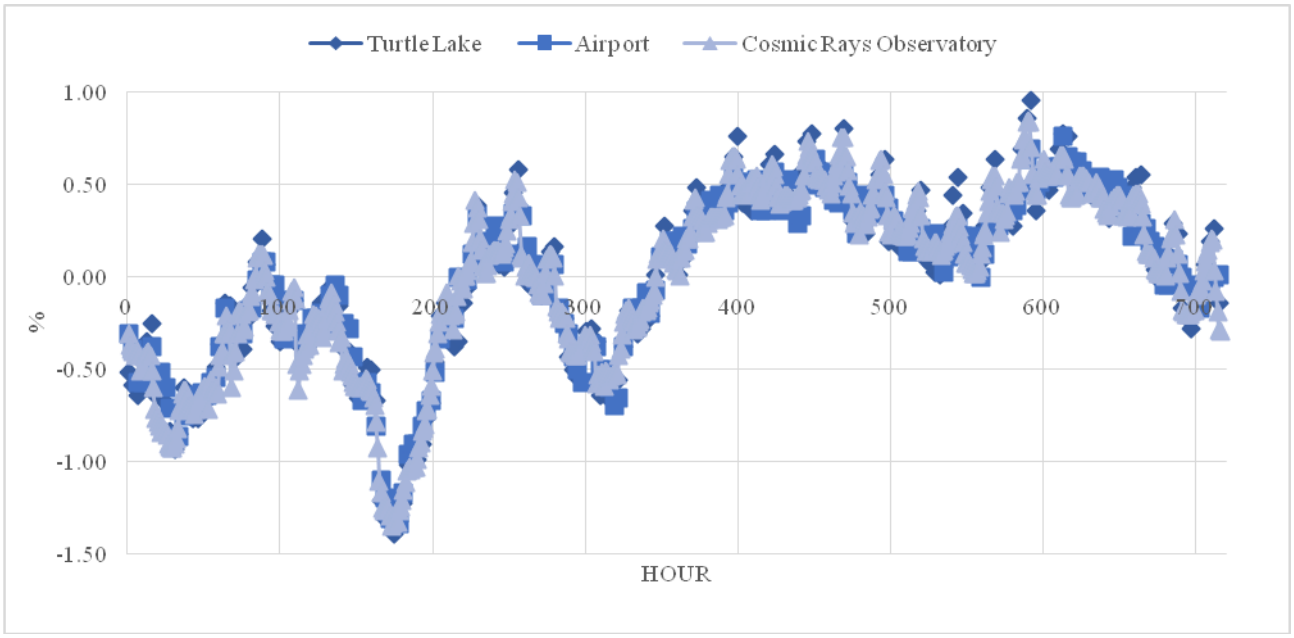

Fig. 1. Changeability of relative values of atmospheric pressure in 3 measurement points in June 2015 in Tbilisi.

As it was noted above, in the first half of June unstable rainy weather was observed in Tbilisi. This is well illustrated by means of the time variations of the values ΔP. They, in essence, have negative values in the first half of the month.

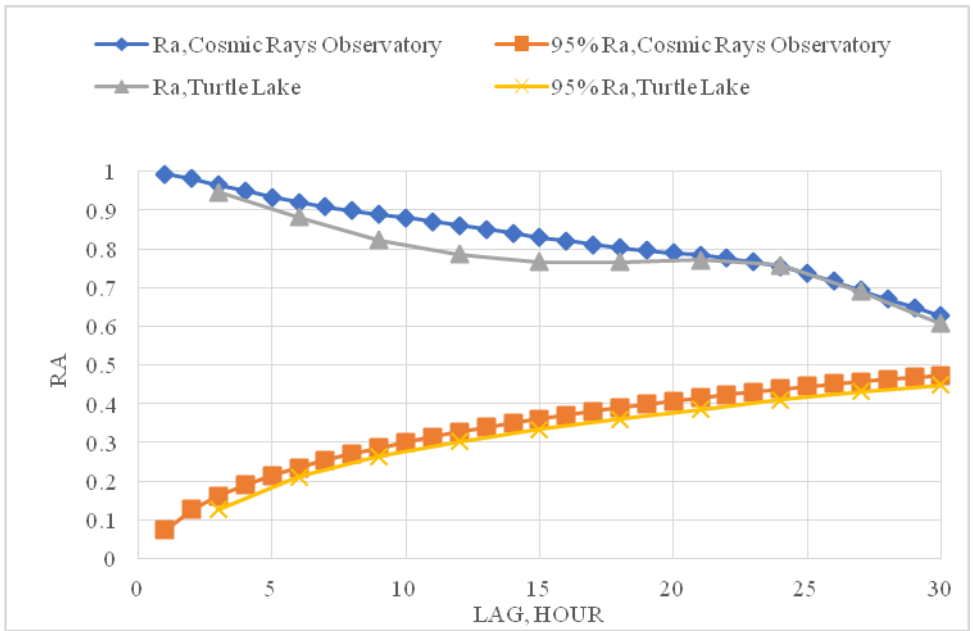

Fig. 2. Autocorrelation function of atmospheric pressure in 2 measurement points in June 2015 in Tbilisi.

Time series of ΔP are strongly auto-correlative (Fig. 2). Autocorrelation of time series of ΔP obtained at the Cosmic Rays Observatory is somewhat higher than that obtained at the station at the Tortoise Lake. In both cases the autocorrelation is meant at least to the Lag of 30 hours.

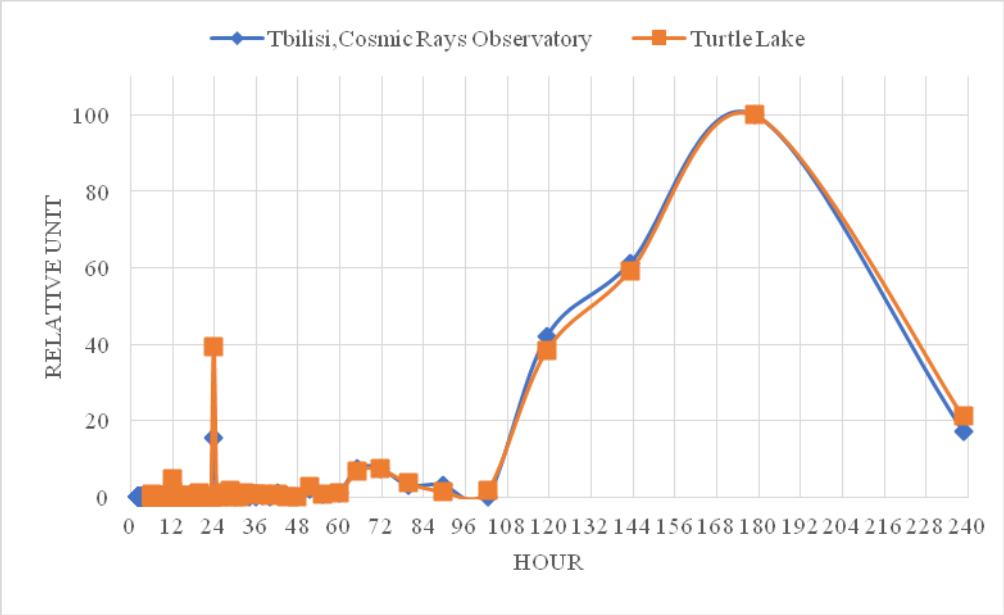

Fig. 3. Periodicity of atmospheric pressure in 2 measurement points
in June 2015 in Tbilisi.

The periodicity of values ΔP has the basic peak, which fit approximately to 180 hours (7.5 days) and two auxiliary - about 72 hours (3 days) and 24 hours (Fig. 3).

Let us examine the special features of changeability ΔP at all stations during catastrophic flood on June 13-14, 2015 in Tbilisi (Table 3, Fig. 4,5).

In the indicated interval of time the rain cloud was located in one and the same place for almost five hours. Process was air-mass. Precipitation intensity at the separate moments of time was found in the range 100-200 mm/h. Distance from the center of cloud to the points of measurement comprised: Tortoise Lake - 6 km, Cosmic Rays Observatory - 8.5 km, Tbilisi Airport - 20 km [7,8].

Table 3

The statistical characteristics of relative values of atmospheric pressure in 3 measurement points
from June 13, 19:00 to June 14, 04:00 in Tbilisi.

Parameter	Tortoise Lake	Airport	Cosmic Rays Observatory
Mean	-0.48	-0.44	-0.50
Min	-0.64	-0.50	-0.59
Max	-0.28	-0.36	-0.36
Range	0.36	0.14	0.23
St Dev	0.19	0.08	0.09
σ_m	0.11	0.04	0.03
95%(+/-)	0.22	0.09	0.06

Table 3 clearly demonstrates the influence of local cloud processes on the variation of the atmospheric pressure depending on distance during this process. The greatest variations in the values ΔP were observed at station Tortoise Lake, which was the closest from the cloud (Range = 0.36%), the smallest - in the Airport (Range = 0.14%).

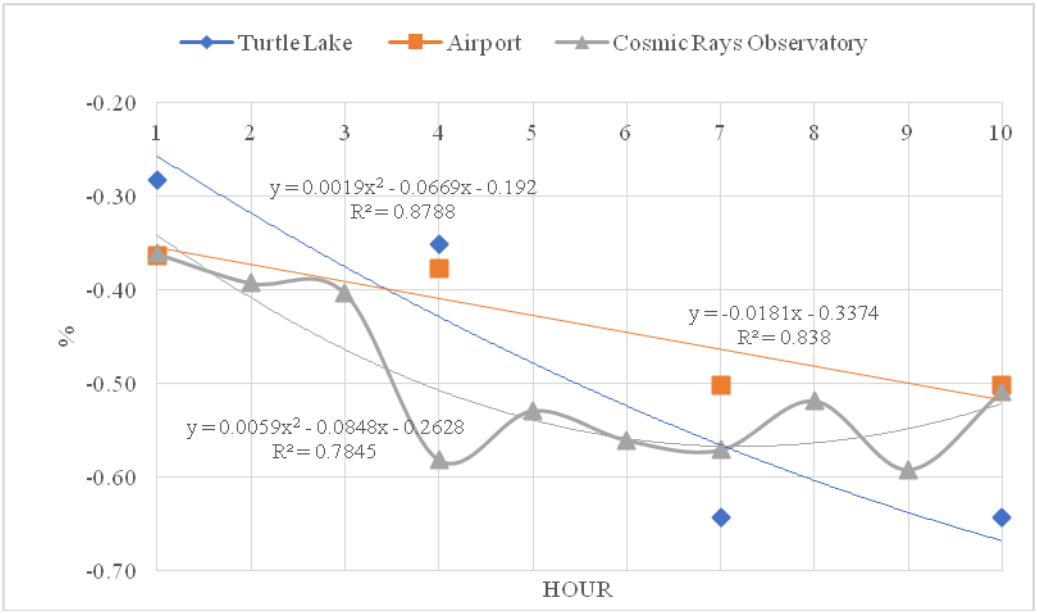

Fig. 4. Changeability of relative values of atmospheric pressure in 3 measurement points from June 13, 19:00 to June 14, 04:00 in Tbilisi.

Changeability in the time of values ΔP at station Tortoise Lake and Cosmic Rays Observatory satisfactorily described by second power polynomial, and in airport - linear (Fig. 4).

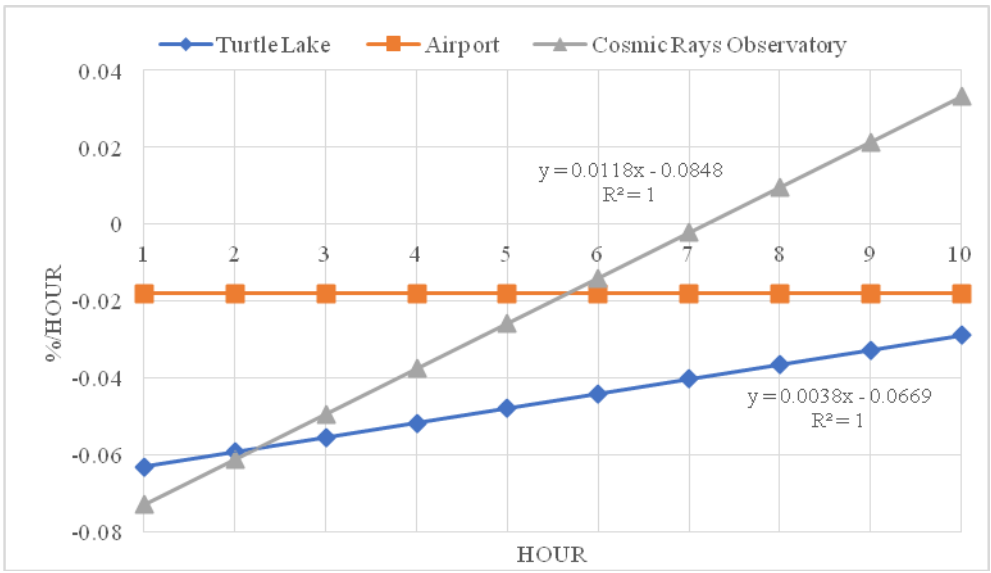

Fig.5. Changeability of speed of change of relative values of atmospheric pressure in 3 measurement points from June 13, 19:00 to June 14, 04:00 in Tbilisi.

Finally, Fig. 5 clearly demonstrates the higher sensitivity of hourly measurements in comparison with the three-hour measurement. Rate of change in the time of values ΔP in Cosmic Rays Observatory (0.0118 %/hour) is three times higher than at the station Tortoise Lake (0.0038 %/hour). In Tbilisi Airport this speed is constant (practically, the station did not react to the process).

In the future, by analogy with [2], it is possible to investigate the variability of atmospheric pressure under the passing clouds recorded by the radar used in the anti-hail service [7,11,12]

Conclusions

During the local atmospheric processes the hourly measurements of the atmospheric pressure, which are conducted in Cosmic Rays Observatory of M. Nodia Institute of Geophysics, are more sensitive to their variations than three-hour measurements, which are conducted at usual meteorological stations. Atmospheric pressure is an exogenous factor, which is infused on the Earth and water level in boreholes. It causes water level variation in boreholes together with tidal factors. Amplitude of their variation was changing depending tensor- sensitivity of boreholes and aquifer area totally. At the same time, it is one of the important factors for assessment of geodynamic processes. Using and developing this kind of observations and organization real-time monitoring of atmospheric pressure will be a support for forecasting geodynamic events. It is also possible to investigate the variability of atmospheric pressure under the passing clouds recorded by the radar used in the anti-hail service.

References

[1] Budagashvili T., Karchava J., Gunia G., Intskirveli L., Kuchava T., Gurgenidze M., Amiranashvili A., Chikhladze T. Inventory of Greenhouse Gas Emissions and Sinks. Georgia's Initial National Communication on Under the United Nations FrameworkConvection on Climate Change, Project GEO/96/G31, Tb., 1999, 137 p.

[2] BibilashviliN.Sh., Ivanov G.I., Kovalchuk A.N. Raspredelenie meteoelementov pod kuchevo-dozhdevimi oblakami po dannim nazemnoi meteoseti. Tr. Visokogornogo Geofizicheskogo Instituta, vip. 44, M., Gidrometeoizdat, 1979, s. 23-27.

[3] Melikadze G., Jimsheladze T., Kobzev G., Tchankvetadze A., Devidze M. Hydrodynamic and geomagnetic anomalies related with preparation of earthquakes in Caucasus. Journ.of Georgian Geophysical Soc., Iss.(A), Physics of Solid Earth, v. 19A, Tb., 2016, pp. 84-103.

[4] Schery S. D.,Gaeddert D. H. Measurements of the effect of cyclic atmospheric pressure variation on the flux of ^{222}Rn from the soil. Geophysical Research Letter, v. 9, iss. 8, August 1982, pp. 835–838.

[5] Sharafi R., Bogdanov V.B., Gorlov D.S., Gorgo Y.P. The influences of meteorological factors on the health and functional state of human. Health, v.5, No.12, 2013, pp. 2068-2076, http://dx.doi.org/10.4236/health.2013.512281

[6] Amiranashvili A., Bliadze T., Chikhladze V. Photochemical smog in Tbilisi. Monograph, Trans. of Mikheil Nodia institute of Geophysics, ISSN 1512-1135, v. 63, Tb., 2012,160 p., (in Georgian).

[7] Amiranashvili A.G., Chikhladze V.A., Dzodzuashvili U.V., Ghlonti N.Ya., Sauri I.P. Reconstruction of Anti-Hail System in Kakheti (Georgia). Journ. of the Georgian Geophysical Society, Iss. B. Physics of Atmosphere, Ocean and Space Plasma, v. 18B, Tb., 2015, pp. 92-106.

[8] Banetashvili V., Gelovani G., Grebentsova A., Javakhishvili N., Iobadze K., Mitin M., Saginashvili N., Samkharadze I., Khurtsidze G., Tsereteli A., Tskhvediashvili G., Chkhaidze B. Some examples of strong precipitation in eastern Georgia according to the data of radar surveillance of 2015. Trans. of Mikheil Nodia institute of Geophysics, ISSN 1512-1135, v. 66, Tb., 2016, pp. 75-83, (in Russian).

[9] Kobisheva N., Narovlianski G. Climatological processing of the meteorological information, Leningrad, Gidrometeoizdat, 1978, 294, (in Russian).

[10] Kendall M.G. Time-series, Moscow, 1981, 200 p., (in Russian).

[11] Amiranashvili A., Burnadze A., Dvalishvili K., Gelovani G., Ghlonti N., Dzodzuashvili U., Kaishauri M., Kveselava N., Lomtadze J., Osepashvili A., Sauri I., Telia Sh., ChargaziaKh., Chikhladze V. Renewal works of anti-hail service in Kakheti. Transactions of Mikheil Nodia Institute of Geophysics, v. 66, ISSN 1512-1135, Tb., 2016, pp. 14-27, (in Russian).

[12] Abaiadze O., Avlokhashvili Kh., Amiranashvili A., Dzodzuashvili U., Kiria J., Lomtadze J., Osepashvili A., Sauri I., Telia Sh., Khetashvili A., Tskhvediashvili G., Chikhladze V. Radar providing of anti-hail service in Kakheti. Transactions of Mikheil Nodia Institute of Geophysics, v. 66, ISSN 1512-1135, Tb., 2016, pp. 28-38, (in Russian).

ატმოსფერული წნევის ცვალებადობის ფარდობითი მახასიათებლები მეტეოროლოგიურ სადგურებზე თბილისის აეროპორტში, კუს ტბაზე და მ. ნოდიას სახ. გეოფიზიკის ინსტიტუტის კოსმოსური სხივების ობსერვატორიაში

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რეზიუმე

თბილისის აეროპორტში და კუს ტბაზე განლაგებულ მეტეოროლოგიურ სადგურებზე და მ.ნოდიას სახ. გეოფიზიკის ინსტიტუტის კოსმოსური სხივების ობსერვატორიაში 2015 წლის ივნისში დაკვირვებული ატმოსფერული წნევის ცვალებადობის შედარებითი ანალიზია მოყვანილი. წნევის გაზომვა მეტეოროლოგიურ სადგურებზე წარმოებდა ყოველ სამ საათში ერთხელ, ხოლო კოსმოსური სხივების ობსერვატორიაში-ყოველ საათს. კერძოდ, 2015 წლის 13-14 ივნისის ინტენსიური ლოკალური პროცესის მაგალითზე მიღებულია, რომ ატმოსფერული წნევის ყოველსაათიანი გაზომვები უფრო მგრძნობიარეა მათ ვარიაციებზე, ვიდრე სამსაათიანები. შემოთავაზებულია გამოყენებული იქნას ობსერვატორიის მონაცემები ატმოსფერულ წნევაზე გარემოში მიმდინარე სხვადასხვა პროცესების შესწავლისათვის.

Сравнительные характеристики изменчивости атмосферного давления на метеорологических станциях в Тбилисском аэропорту, Черепашьем озере и в обсерватории космических лучей Института геофизики им. М. Нодиа

Т.С. Бакрадзе, П.А. Барбакадзе, Н.Я. Глонти, И.И. Туския

Резюме

Приводится сравнительный анализ изменчивости атмосферного давления на метеорологических станциях в Тбилисском аэропорту, Черепашьем озере и в обсерватории космических лучей Института геофизики им. М. Нодиа в июне 2015 г. Измерения давления на метеорологических станциях проводится каждые три часа, а в обсерватории космических лучей – ежечасно. В частности, на примере интенсивного локального конвективного процесса 13-14 июня 2015 г. получено, что ежечасные измерения атмосферного давления более чувствительны к их вариациям, чем трехчасовые. Предлагается использовать данные обсерватории об атмосферном давлении для изучения различных процессов в окружающей среде.