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Preliminary Results of the Analysis of Radar and Ground-Based Monitoring of Dust Formation in Atmosphere Above the Territory of Eastern Georgia on 27 July 2018

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ABSTRACT

There are represented the preliminary results of the radar analysis and ground-based monitoring of dust formation in the atmosphere above the territory of eastern Georgia on the 27th of July, 2018. Distance monitoring was accomplished with the aid of the meteorological radar «METEOR 735CDP10». The dust concentration was hourly measured (PM10 and PM2.5) in surface boundary layer in three points of Tbilisi city. There are given Radar data about the movement of dust formation in the atmosphere above that investigated territories. It is shown that in second half of day there was noted the strong growth of PM10 and PM2 on the earth's surface 5.

Key Words: Radar monitoring, dust, PM10, PM2.5

Introduction

M. Nodia Institute of Geophysics conducts experimental laboratory, theoretical studies of atmospheric aerosols during many decades fields (stationary and mobile monitoring)[1-4]. In particular, we studied different physical characteristics of mineral and secondary aerosols, and also their changeability in the time and connection with some atmospheric processes (distribution according to the sizes [1,3], weight and numerical concentrations [2-7], coagulation, washing, ice-forming properties [1], vertical distribution of aerosols in the lower troposphere [8-10], processes of the photochemical smog formation [2], influence of the ionizing radiation on the secondary aerosols formation [2,11], aerosols optical properties [12-14,18], long-term changeability of the aerosol optical depth of the atmosphere (AOD) [15-18], connection of AOD with the content of surface aerosols [19], connection of aerosols with atmospheric ozone content [1,2,6,20], ecological aspects of atmospheric aerosols [2-7,18,2], influence of aerosols on the changeability of climate,

including of thunderstorm and hail processes [18,22,23], numerical simulation of the aerosols distribution from different sources [1,24], simulation of the aerosol optical depth distribution above territory of Georgia in the correspondence with the methodology of the combined analysis of satellite and ground-based measurements of AOD in Tbilisi [25-27], etc.).

In recent years in connection with the renewal of anti-hail works in Kakheti [28-31], it's appeared the possibility of the radar monitoring of the atmosphere above the eastern Georgia and adjacent countries (Armenia, Azerbaijan, Russia, Turkey) [28,30,32]. Anti-hail service is equipped with contemporary meteorological radar "METEOR 735CDP10", capable of recording the significant number of atmospheric formations [33,34].

The radar is usually used for monitoring of the hail processes [35-37] and strong showers [38]. Together with this aid of the radar there is a possibility for monitoring of movement in the space above the large territories of powerful dust formations (the dust storms, volcanic ejections, etc.) [33]. This makes it possible to enlarge the represented above [1-27] area of studying atmospheric aerosols.

This paper depicts the radar monitoring example of the dust formation movement in the atmosphere above the territory of eastern Georgia on the 27th of July, 2018.

A dust cloud covered Baku on the 26th of July (Fig. 1a, [Photo *Vesti.az,* https://jam-news.net/тбилиси-накрыло-пылью-специалисты-го/?lang=ru]). The Ministry of Ecology of Azerbaijan said that the cloud had come to Azerbaijan from Turkmenistan (https://jam-news.net/tbilisi-covered-in-dust-cloud-experts-say-there-is-no-danger/). Residents of Tbilisi were exhibiting this cloud on the 27th of July (Fig. 1b, [Photo Irakli Oragvelidze, http://agenda.ge/en/news/2018/1594]).

Fig.1a. Baku, 26.07.2018 Fig.1b. Tbilisi, 27.07.2018 – 15:33 hour

On the presence of powerful dust formation in the atmosphere on the south Black Sea-Caspian region from the 20th of July through the 4th of August, 2018 testify the data of the satellite monitoring of the aerosol optical depth in atmosphere.

(Fig. 2a, 2b, [https://neo.sci.gsfc.nasa.gov/servlet/RenderData?si=1749095&cs=rgb&format=JPEG&width=3600&height=1800]).

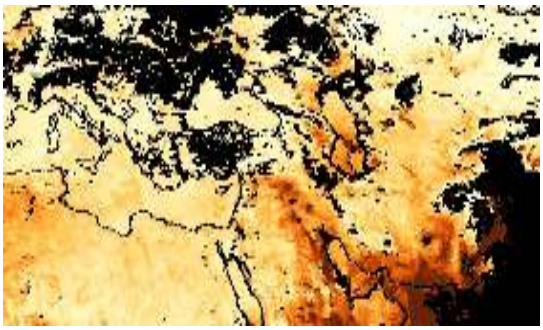


Fig.2a. AOD, July 20 - 27, 2018

Fig.2b. AOD, July 28 - August 4, 2018

In the maps (Fig. 2a, 2b) dark brown pixels show high aerosol concentrations, while tan pixels show lower concentrations, and light yellows areas show little or no aerosols. Black ones show where the sensor could not make its measurement.

In particular, as it follows from Fig. 2a, between the 20th and 27th of July, 2018, dusty cloud covers of the territories of Turkmenistan, Azerbaijan and eastern Georgia. During the following week (Fig. 2b) this cloud is noticeable.

Below the figures there is represented the preliminary results of radar analysis and ground-based monitoring of dust formation in the atmosphere above the territory of eastern Georgia on the 27th of July, 2018.

Material and methods

In the work there are used the data of radar "METEOR 735CDP10" about the dust objects in the atmosphere (product MPPI(ET) [33]). In addition, we used the data of Georgian National Environmental Agency about the dust concentration (atmospheric particulate matter - PM2.5 and PM10) in three points of Tbilisi city (http://nea.gov.ge/ge/service/haeris-monitoringi/14/haeris-dabindzurebis-yoveldgiuri-biuletini/).

In Table. 1 and Fig. 1 Are presented Coordinates and locations of air pollution measurements points in Tbilisi.

Table 1

Coordinates of air pollution measurements points in Tbilisi

Location	Latitude, N°	Longitude, E°	H, m
1. Tsereteli str.	41.742539	44.779069	423
2. Kazbegi str.	41.724767	44.752956	467
3. Varketili	41.699947	44.871611	518

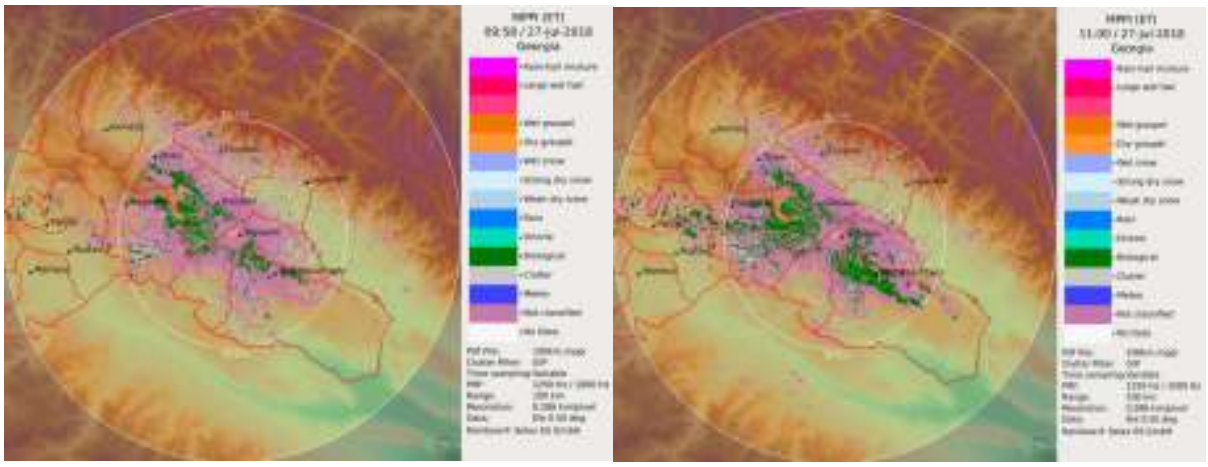
Fig.3. Locations of air pollution measurements points in Tbilisi.

In the correspondence with the standards of the World Health Organization maximum permissible concentration (MPC) composes for PM2.5: annual mean - 0.01 mg/m³, 24-hour mean - 0.025 mg/m³ and for PM10: annual mean - 0.02 mg/m³, 24-hour mean - 0.05 mg/m³ [39].

Results and discussion

Results are presented in the Fig. 4-5 and Table 2.

In the Fig. 4 radar data shows about migration of dust formation in the atmosphere above the territory of eastern Georgia on the 27th of July, 2018 from 09:58 to 17:00 hour (8 moments of time, green color). As follows from this figure dust cloud into the indicated time interval is located above the significant part of Kakheti and it is revealed also above Tbilisi in the second half of day.



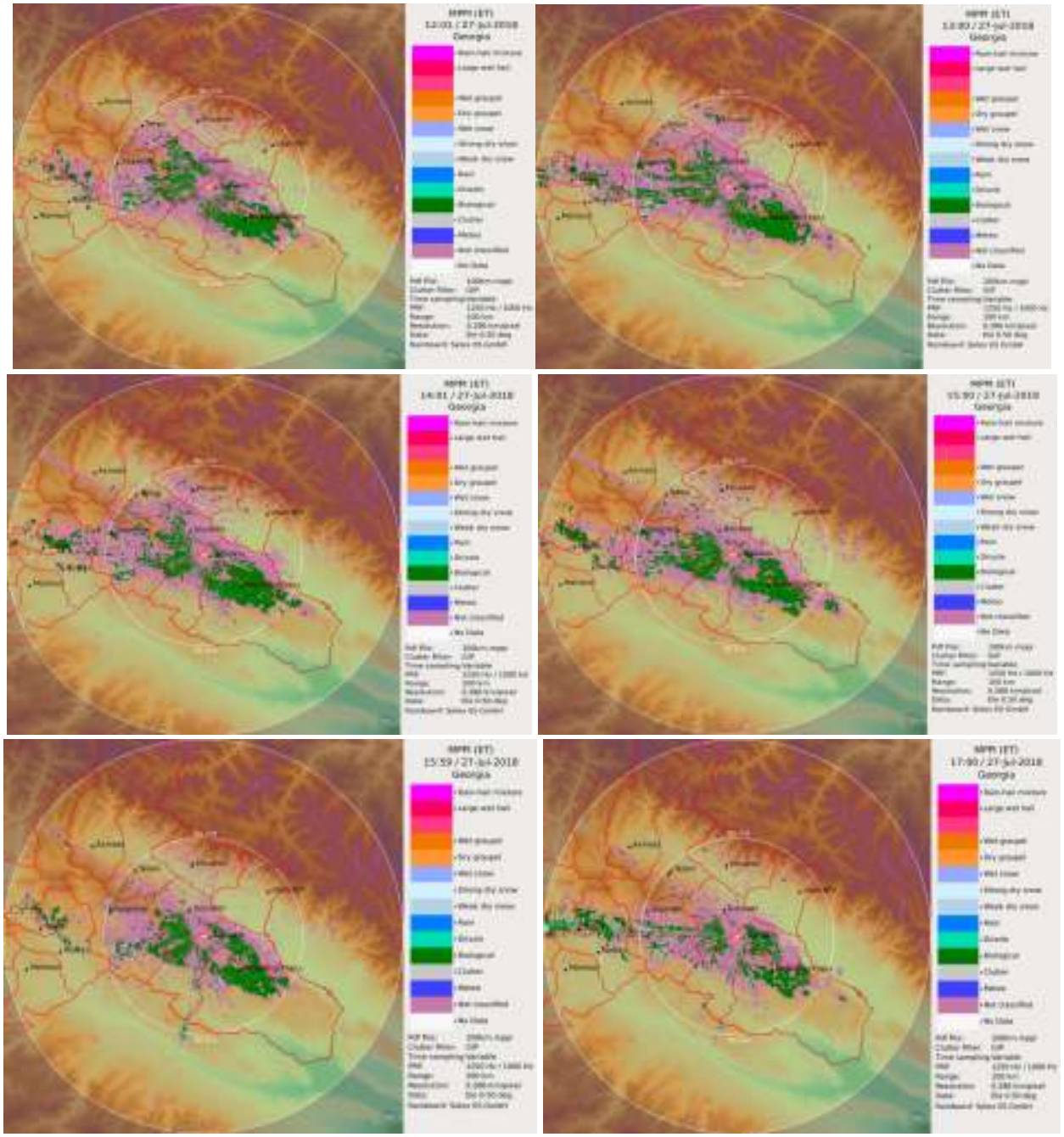


Fig.4. Migration of dust formation in the atmosphere above the territory of eastern Georgia on the 27th of July, 2018 from 09:58 to 17:00 hour.

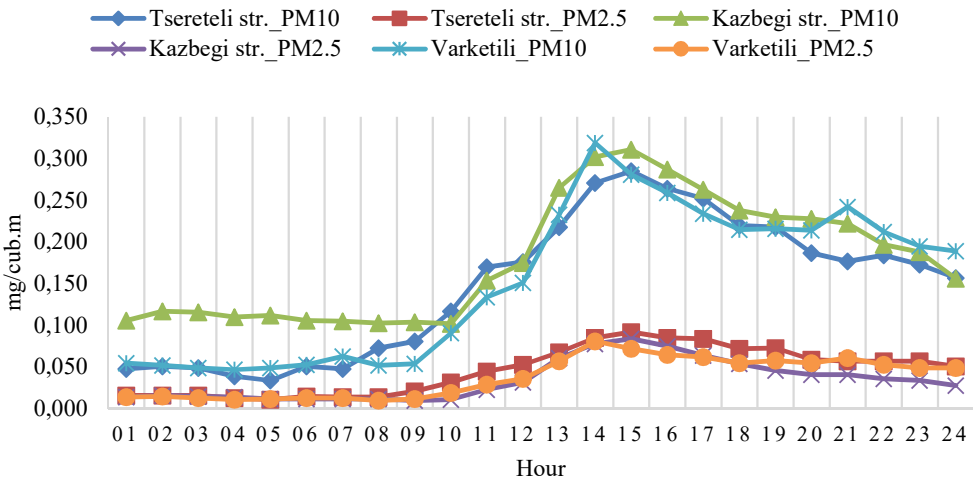


Fig.5. Dust Concentration in Three Locations of Tbilisi 27.07.2018

The propagation of dust formation above Tbilisi led to a strong increase in the concentration of solid particles in surface boundary layer (Fig. 5). As follows of this figure we noted all three points of measurement of increasing the dust particles concentration by diameter less than 2.5 and 10 μm (respectively - PM2.5 and PM10).

Table 2

Statistical characteristics of dust concentration in three locations of Tbilisi 27.07.2018 (mg/m³)

Location	1.Tsereteli str.		2.Kazbegi str.		3.Varketili	
Parameter	PM10	PM2.5	PM10	PM2.5	PM10	PM2.5
Min	0.034	0.011	0.102	0.010	0.047	0.010
Max	0.285	0.092	0.311	0.084	0.319	0.081
Mean	0.148	0.046	0.179	0.034	0.152	0.038
Range	0.251	0.081	0.209	0.074	0.272	0.071
St Dev	84.3	27.9	72.6	23.8	90.7	23.7
Cv, %	57.1	60.6	40.5	69.4	59.5	62.3
Mean/24-hour mean MPC	2.96	1.84	3.58	1.36	3.04	1.52

There is presented [In Table 2] statistical characteristics of dust concentration in three locations of Tbilisi. In particular, as it follows from this Table, on the different points of measurement on the 27th of July, 2018 the 24-hour mean values of PM10 and PM2.5 exceeded their maximum permissible concentrations into 2.96-3.58 and 1.36-1.84 times respectively.

Conclusion

In the prospect besides the radar "METEOR 735CDP10" what we use in the work of anti-hail service, also can be used for early warning of population about the danger of aerosol air pollution during the action of the large sources of dust.

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აღმოსავლეთ საქართველოს ტერიტორიაზე ატმოსფეროში 2018 წლის 27 ივლისს მტვრის წარმონაქმნის რადიოლოკაციური და მიწისპირა მონიტორინგის ანალიზის წინასწარი შედეგები

ა.ამირანაშვილი, ნ. ბერიანიძე, ვ. ჩიხლაძე,
მ.მიტინი, ა. მჭედლიშვილი

რეზიუმე

წარმოდგენილია აღმოსავლეთ საქართველოს ტერიტორიაზე ატმოსფეროში 2018 წლის 27 ივლისს მტვრის წარმონაქმნის რადიოლოკაციური და მიწისპირა მონიტორინგის ანალიზის წინასწარი შედეგები. დისტანციური მონიტორინგი «METEOR 735CDP10» ტიპის მეტეოროლოგიური რადიოლოკატორის მეშვეობით ხდებოდა. მტვრის კონცენტრაცია (PM10 და PM2.5) ჰაერის მიწისპირა ფენაში ქალაქ თბილისის სამ პუნქტში ყოველ საათს იზომებოდა. მოყვანილია ატმოსფეროში საკვლევი ტერიტორიის თავზე მტვრის წარმონაქმნის გადაადგილების რადიოლოკაციური მონაცემები. ნაჩვენებია, რომ დღის მეორე ნახევარში დედამიწის ზედაპირთან PM10 და PM2.5-ის ძლიერი ზრდა აღინიშნებოდა.

Предварительные результаты анализа радиолокационного и наземного мониторинга пылевого образования в атмосфере над территорией Восточной Грузии 27 июля 2018 года

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Резюме

Представлены предварительные результаты анализа радиолокационного и наземного мониторинга пылевого образования в атмосфере над территорией Восточной Грузии 27 июля 2018 года. Дистанционный мониторинг осуществлялся с помощью метеорологического радиолокатора «METEOR 735CDP10». Концентрация пыли (PM10 и PM2.5) в приземном слое воздуха ежечасно измерялась в трех пунктах города Тбилиси. Приведены радиолокационные данные о перемещении пылевого образования в атмосфере над исследуемой территорий. Показано, что во второй половине дня у земной поверхности отмечался сильный рост PM10 и PM2.5.