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ABOUT THE POSSIBILITY OF USING THE "METEOR 735CDP10" RADAR FOR MONITORING VOLCANIC FORMATIONS, DUST STORMS AND SMOKE FROM LARGE FIRES IN ATMOSPHERE IN SOUTH CAUCASUS

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Summary: *There are presented some results of the analysis of radar and ground monitoring of dust storms and smoke from large fires in the atmosphere over the territory of Eastern Georgia. Remote monitoring was carried out using the "METEOR 735CDP10" weather radar. The dust concentration (PM10 and PM2.5) in the surface air was measured hourly at four locations in Tbilisi. Also here are presented radar data on the movement of dust formation in the atomsphere above the study area. It was shown that, following the appearance of dust formations in the atmosphere above the studied points, a strong growth of PM10 and PM2.5, as well as a decrease of the visibility, were noted at the Earth's surface.*

If necessary, it is possible to monitor volcanic formations, dust storms and smoke from large fires in the atmosphere and in the South Caucasus.

Key Words: *Radar monitoring, volcanic formations, dust storms, smoke.*

Introduction. M. Nodia Institute of Geophysics conducts experimental laboratory, field and theoretical studies of atmospheric aerosols during many decades (stationary and mobile monitoring) [1-7]. In recent years in connection with the renewal of anti-hail works in Kakheti, it's appeared there is a possibility of the radar monitoring of the atmosphere above the eastern Georgia and adjacent countries (Armenia, Azerbaijan, Russia, Turkey) [8-10]. Anti-hail service is equipped with contemporary meteorological radar "METEOR 735CDP10", capable of recording the significant number of atmospheric formations [10]. The radar is usually used for monitoring of the hail processes and strong rains. Together with this aid of the radar there is a possibility for monitoring movement of powerful dust formations in the space above the large territories (the dust storms, large fires, volcanic ejections, etc.). This makes it possible to enlarge the represented above area of studying atmospheric aerosols [10]. Thus, in work [11] 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 was presented. This paper depicts more detailed data on the radar characteristics of this process and present data about the dust formation above the territory of Kakheti caused forest fire in the environments of Lagodekhi and Dedoplistskaro on 23 August, 2017.

Material and methods. In this work we used the data of radar "METEOR 735CDP10" about the dust objects in the atmosphere (product MPPI (ET) [10]). In addition, we used the data of Georgian National Environmental Agency about the dust concentration (atmospheric particulate matter – PM2.5 and PM10) in four points of Tbilisi city (http://nea.gov.ge/ge/service/haeris-monitoringi/14/haeris-dabindzurebis-yoveldgiuri-biuletini/) and the data of the satellite monitoring of the aerosol optical depth (AOD) in atmosphere (https://neo.sci.gsfc.nasa.gov/servlet/RenderData?si=1749095&cs=rgb&format=JPEG&width=3600 &height=1800.). The mass media information was used also.

Results and discussion. Results are presented in the Fig. 1-9 and Table. As follows from Fig. 1 above the study region the cloud formations practically was not observed. Wind direction – to the northeast (Fig. 2).

In Fig. 3 radar data shows about migration of dust formation in the atmosphere above the territory of eastern Georgia on the 27th July, 2018 from 11:00 to 17:00 hour (2 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.

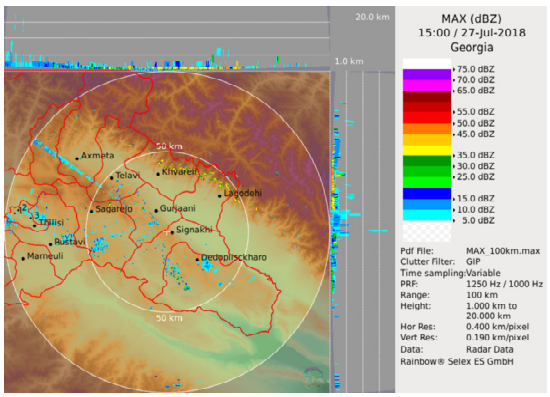

Fig. 1. Data of Radar Product MAX(dBZ) on 27.07.2018, 15:00 h.

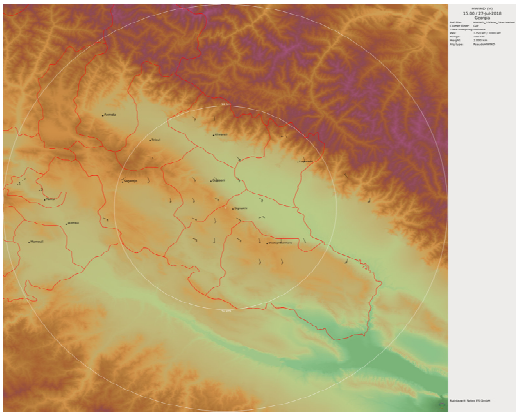

Fig. 2. Wind Field at 2 km above Sea Level on 27.07.2018, 14:15 h. Radar Product HWIND (V).

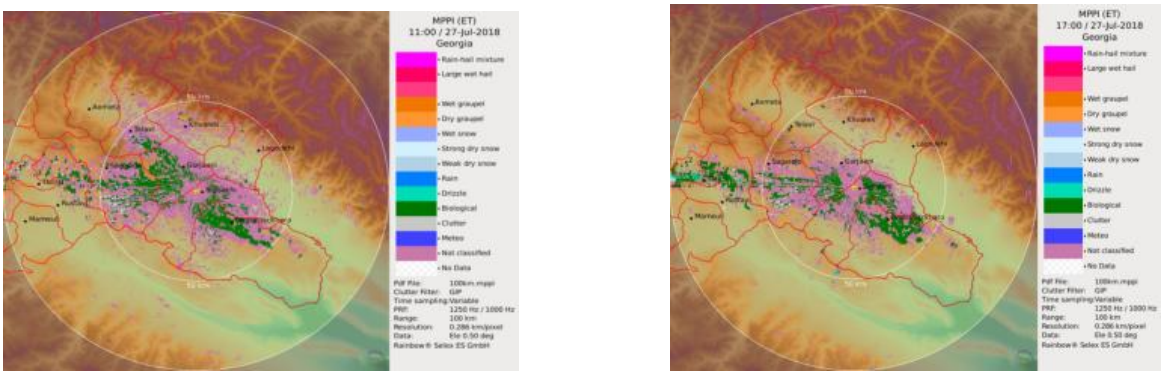

Fig. 3. Migration of Dust Formation in the Atmosphere above the Territory of Eastern Georgia on 27.07. 2018 in 11:00 and 17:00 h.

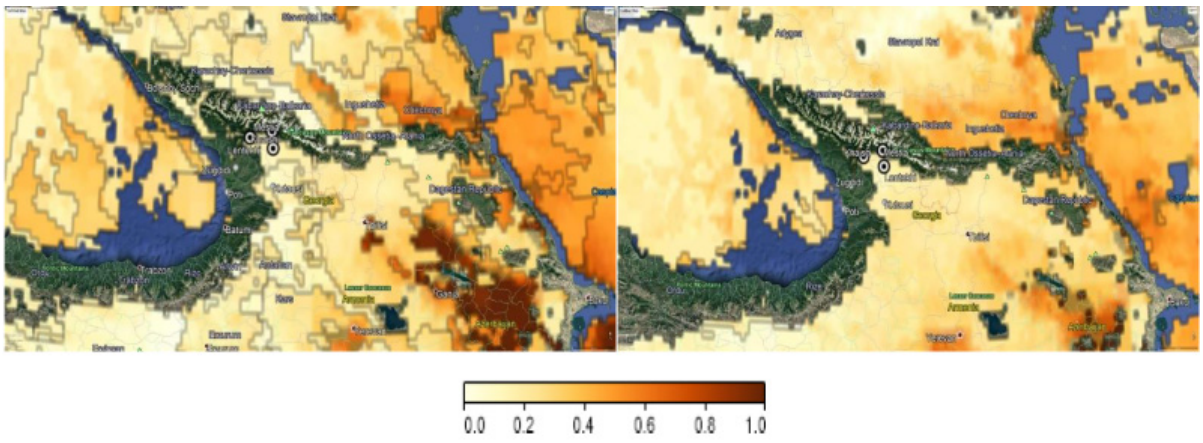

Fig. 4. AOD above the Caucasus Region 27.07.2018 (to the Left) and 28.07.2018 (to the Right).

It follows from Fig. 4 and there were observed 27.07.2018 above the territories of eastern Georgia (Tbilisi, Kakheti) and Azerbaijan the high values of AOD. Next day occurred the considerable decrease of values AOD. In Baku the poor visibility was 26.07.2018, while in Tbilisi – in the daytime 27.07.2018. [https://jam-news.net/tbilisi-covered-in-dust-cloud-experts-say-there-is-no-danger/; http://agenda.ge/en/news/2018/1594]

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 four points of measurement of increasing the dust particles concentration by diameter less than 2.5 and 10 μm (respectively – PM2.5 and PM10).

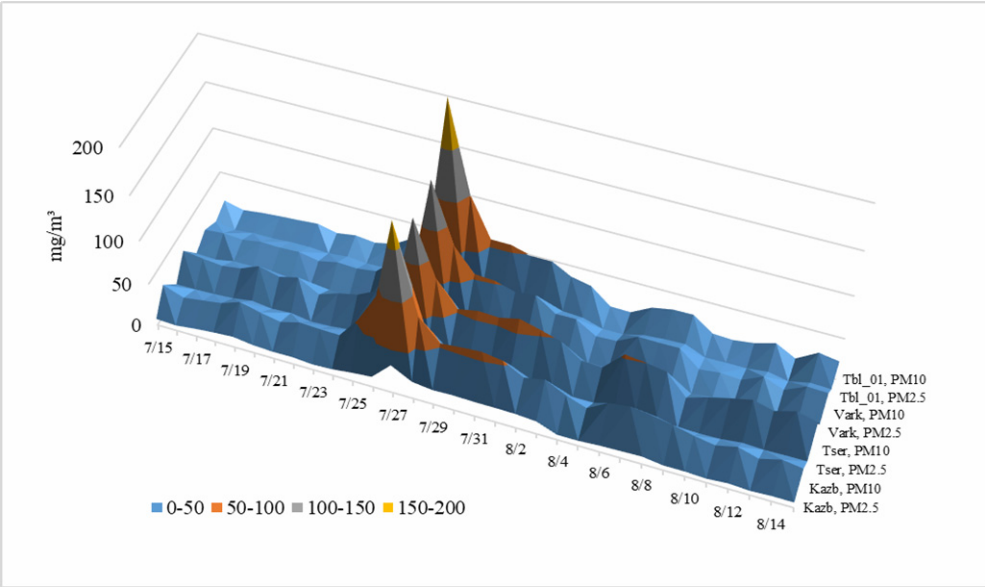

Fig.5. Twenty-Four Hours Average of Dust Concentration PM2.5 and PM10 in Four Points of Tbilisi from July 15 to August 15, 2018.

Table

Statistical Characteristics of Twenty-Four Hours Average of Dust Concentration PM2.5 and PM10 in Four Points of Tbilisi from July 15th to August 15th, 2018 (mcg/m^3)

Location	Kazbegi str.		Tsereteli str.		Varketili		Marshal Gelovani av. (Tbl_01)	
Parameter	PM2.5	PM10	PM2.5	PM10	PM2.5	PM10	PM2.5	PM10
Mean	11.0	41.9	14.9	44.5	12.3	33.6	13.3	33.1
Min	4.9	20.0	4.9	22.0	4.4	13.3	5.0	10.8
Max	33.9	177.9	44.8	143.5	36.8	147.8	50.9	199.1
Range	29.0	157.9	39.9	121.5	32.3	134.5	45.9	188.3
St Dev	6.2	29.5	8.1	22.4	6.6	25.6	9.0	35.7
Cv (%)	56.8	70.5	54.0	50.3	53.7	76.2	67.9	107.8

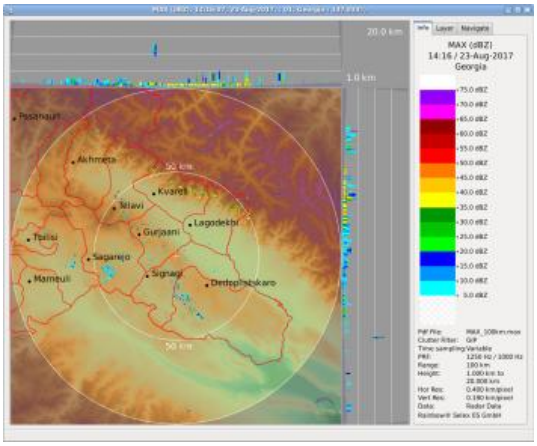

Fig.6. Data of Radar Product MAX(dBZ) on 23.08.2017, 14:16 h.

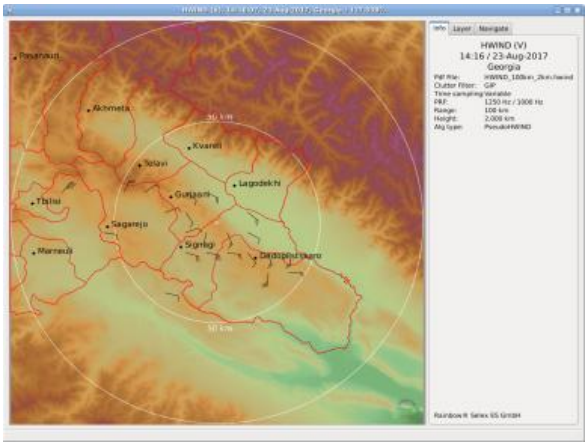

Fig.7. Wind Field at 2 km above Sea Level on 23.08.2017, 14:16 hour. Radar Product HWIND (V).

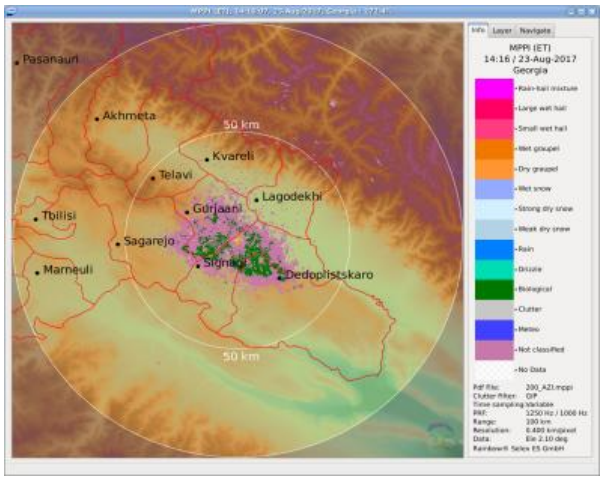

Fig.8. Dust Formation in the Atmosphere above Territory of Kakheti on 23.08.2017,14:16 h.

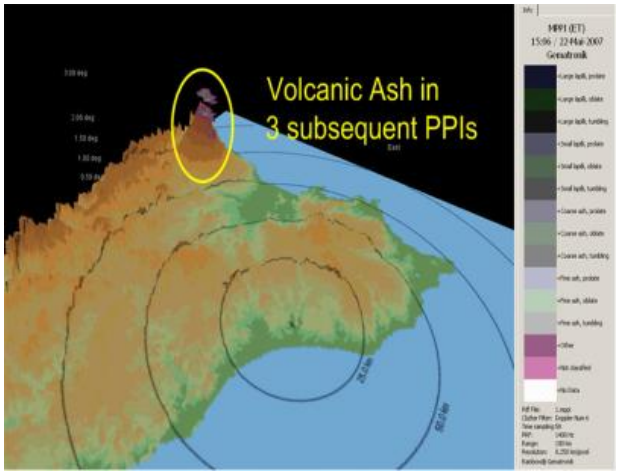

Fig.9. VAD3D – VOLCANIC ASH DETECTION 3D, Simulated Data for Mt. Etna, Italy.

Table presented statistical characteristics of dust concentration in four 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 [6, 12] into 2.87-3.98 and 1.36-2.04 times respectively.

Fig. 8 gives an example of dust formations detectable by the radar in the atmosphere above the territory of Kakheti (23.08.2017, 14:16 h.), which were being formed as a result of forest fires in the environments of Lagodekhi (5 hectares) and Dedoplistskaro (20 hectares). In this day above Kakheti the cloud formations was not observed (Fig. 6), wind direction – to the northeast (Fig. 7).

Fig. 9 gives an example of simulated dust formation detected by the radar in the atmosphere above the volcano Etna, Italy, with the use of a radar product VAD3D – VOLCANIC ASH DETECTION 3D [RAINBOW® 5PRODUCTS & ALGORITHMS, © Selex ES GmbH, 2017].

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

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References

1. Amiranashvili A.G., Gzirishvili T.G. Aerosols and Ice Crystals in the Atmosphere. // Tbilisi, Metsniereba, 1991, 113 p. (in Russian).
2. Kirkitadze D., Nikiforov G., Chankvetadze A., Chkhaidze G. Some Results of Studies of Atmospheric Aerosols in M. Nodia Institute of Geophysics in the Recent Three Decades. // Trans. of Mikheil Nodia Institute of Geophysics, ISSN 1512-1135, vol. 66, Tbilisi, 2016, pp. 178-185, (in Russian).
3. Styra B., Amiranashvili A. Aerosol Distribution above Georgia Investigations. // Institute of Physics of the Academy of Sciences of the Lithunian SSR, Atmospheric Physics, ISSN 0135-1419, vol. 8, Vilnius, Mokslas, 1983, pp. 18-24, (in Russian).
4. Amiranashvili A.G., Gzirishvili T.G., Kartsivadze A.I., Nodia A.G. Aircraft Investigations of the Distribution of Aerosols in the Lower Troposphere. // Proc. 9th Int. Conf. on Atmospheric Aerosols, Condensation and Ice Nuclei, Budapest, Hungary, 3-8 September, vol.1, 1984, p. 148-153.
5. Amiranashvili A., Amiranashvili V., Chochishvili K., Kirkitadze D. The Distribution of Aerosols over the Georgian Territory in the Lower Troposphere. // Journal of Georgian Geophysical Society, ISSN 1512-1127, Jssue B. Physics of Atmosphere, Ocean and Space Plasma, Vol. 8 B, 2003, Tbilisi, 2004, pp. 70-76.
6. Amiranashvili A., Bliadze T., Chikhladze V. Photochemical smog in Tbilisi. Monograph. // Trans. of M. Nodia Institute of Geophysics, ISSN 1512-1135, vol. LXIII, 2012, 160 p., (in Georgian).

7. Stankevich S., Titarenko O., Amiranashvili A., Chargazia Kh. Determination of Atmospheric Aerosol Optical Depth over Territory of Georgia during Different Regimes of Cloudiness Using the Satellite and Ground-Based Measurements Data. // Bulletin of the Georgian National Academy of sciences, v. 9, No. 3, 2015, pp. 91-95.
8. Amiranashvili A.G., Chikhladze V.A., Dzodzuashvili U.V., Ghlonti N.Ya., Sauri I.P. Reconstruction of Anti-Hail System in Kakheti (Georgia). // Journal of the Georgian Geophysical Society, Issue B. Physics of Atmosphere, Ocean and Space Plasma, Tbilisi, vol.18B, 2015, pp. 92-106.
9. 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. Trans. of Mikheil Nodia Institute of Geophysics, ISSN 1512-1135, Tbilisi, vol. 66, 2016, pp. 28-38, (in Russian).
10. Selex ES GmbH · Gematronik Weather Radar Systems. // Rainbow®5 User Guide, 2015, 464 p., www. gematronik.com.
11. Amiranashvili A.G., Berianidze N.T., Chikhladze V.A., Mitin M.N., Mtchedlishvili A.A. 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. // Journal of the Georgian Geophysical Society, ISSN: 1512-1127, Physics of Solid Earth, Atmosphere, Ocean and Space Plasma, v. 21(2), 2018, pp. 61 – 69.
12. WHO Air Quality Guidelines for Particulate Matter, Ozone, Nitrogen Dioxide and Sulfur Dioxide. Global Update 2005 Summary of Risk Assessment. //World Health Organization, 2006, 22 p., http://apps.who.int/iris/bitstream/handle/10665/69477/WHO_SDE_PHE_OEH06.02_ eng.pdf;jsessionid=48F380E7090ADBB4A166AC7A8610624A?sequence=1