

PRELIMINARY ANALYSIS OF THE HAIL PROCESS ABOVE THE TERRITORY OF GEORGIA, ARMENIA AND AZERBAIJAN ON JULY 13, 2019

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Summary: Results of the preliminary analysis of the hail process on July 13, 2019, which was observed above the territory of Georgia, Armenia and Azerbaijan with 17 hour of 30 min to 21 hours of 31 min (in all - 11 hail clouds) are represented. This hail process was moved approximately in the direction of the main flow and was stretched almost on 250 km. In particular it is obtained that in the separate clouds the max diameter of hailstones varied from 3.2 to 38.1 mm, and on the average - from 10.5 to 24.1 mm.

Key words: Radar monitoring, dangerous meteorological processes, hail.

Introduction

In recent years in a number of works were represented the preliminary results of radar studies of rainfall [1-4], dust formation migration [5, 6] and hail processes [7-11] in Eastern Georgia and its neighboring countries (Azerbaijan, Armenia). In particular, in the works [10, 11] data about the hail process in Tbilisi, Kakheti and the territory of Azerbaijan on May 28, 2019 were presented. This work is the continuation of the indicated series of the experiments. Some data about the hail process, which occurred in Georgia, Armenia and Azerbaijan on July 13, 2019, are represented below.

Material and methods

The Anti-hail service is equipped with contemporary C-band, dual polarized Doppler meteorological radar “METEOR 735 CDP 10 - Doppler Weather Radar”, which is installed in the village Chotori (1090 m height from sea level) of the Signagi municipality of the Kakheti region of Georgia [12]. In this work two radar products are presented, MAX (dBZ) and HAILSZ (Size) [13, 14].

Study regions: Georgia – Kakheti; Armenia – areas of Stepanavan and Noyemberyan; Azerbaijan – areas to the north and the west from the boundary with Georgia. Date and time of the study: July 13, 2019 from 17 hour 30 min to 21 hour 31 min (below - 17:30 [hour: min], etc., or 17.50 [hour. portion of the hour], etc.). Discreteness of radar measurements - every three minutes.

Accordingly, every three minutes the maximum hailstones diameter D_0 (mm) in clouds and coordinates of the convective cells with the maximum size of hailstones were determined.

The following designations of statistical information are used below:

Min – minimal values; Max - maximal values; St Dev - standard deviation; $Cv = 100 \cdot St Dev / Mean$ – coefficient of variation, %; σ_m – standard error; 99%(+/-) - 99% upper and lower levels of the confidence interval of average; Count - the number of measurements.

Results and discussion

Results in the fig. 1-7 and table 1 clearly are presented.

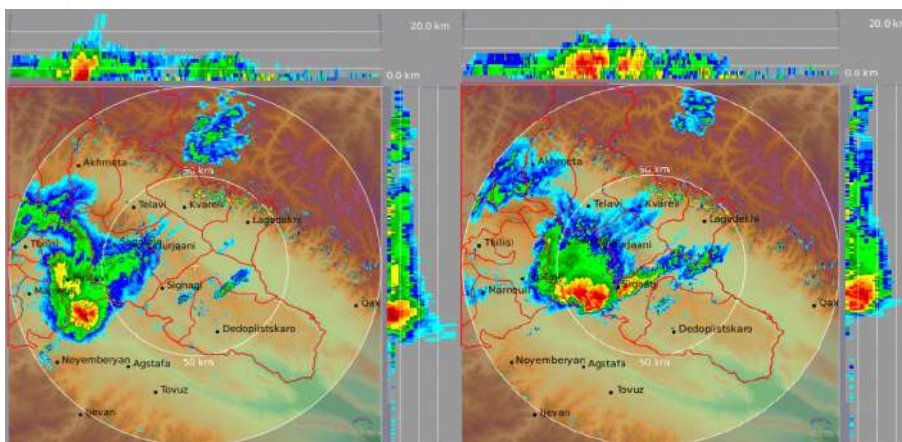


Fig. 1(a)

Fig. 1(b)

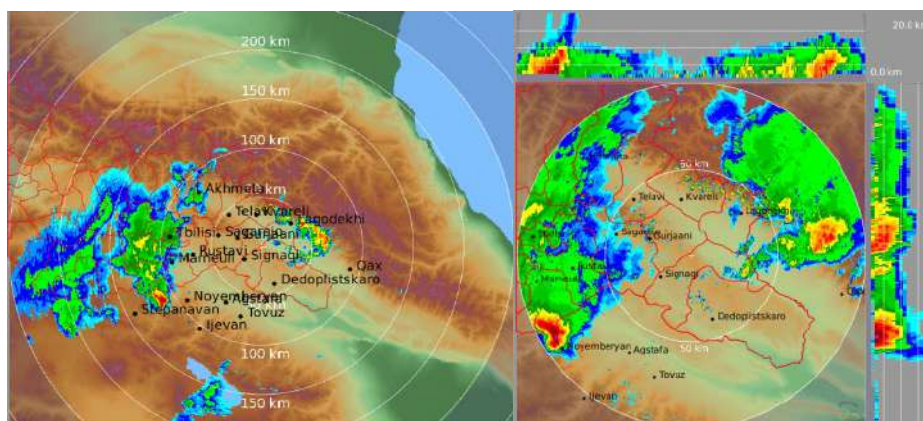


Fig. 1(c)

Fig. 1(d)

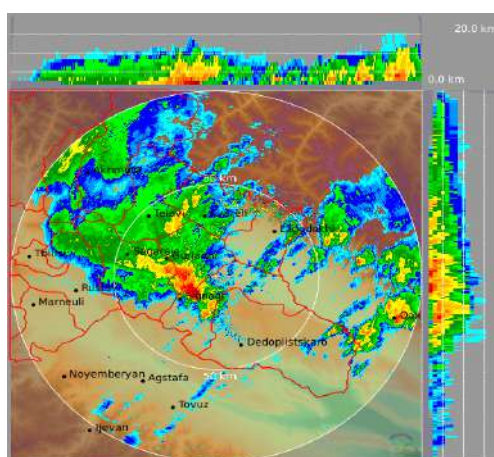


Fig. 1(e)

Fig.1(a-e). Radar picture of the movement of hail process above the investigated territory on 18:07 (a), 18:35 (b), 20:10 (c), 20:32 (d) and 21:31(e).

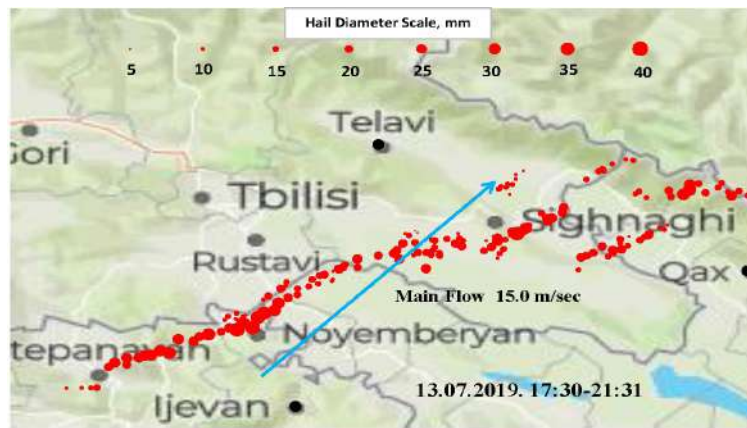


Fig.2. Convective cells with the maximum diameter of hailstones trajectory about the investigated territory from 17:30 to 21:31

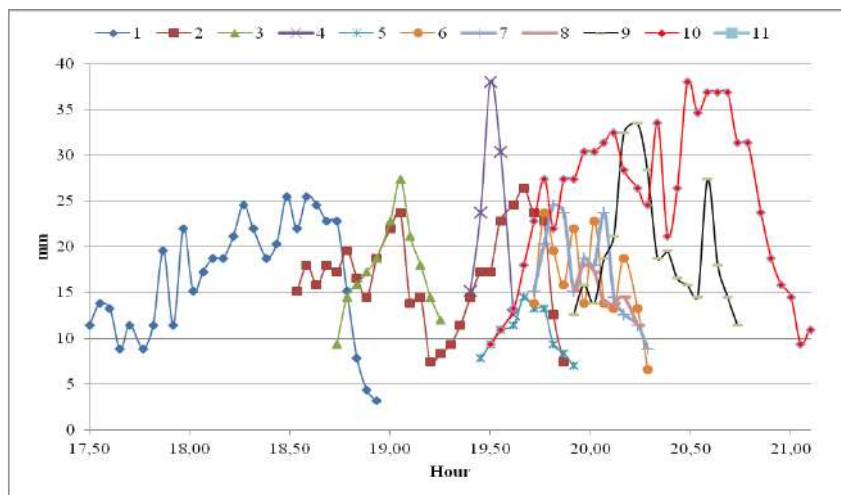


Fig.3. Changeability in the time of Do in the clouds from 17.50 to 21.52 hour (in the upper part of the figure - number of convective cells).

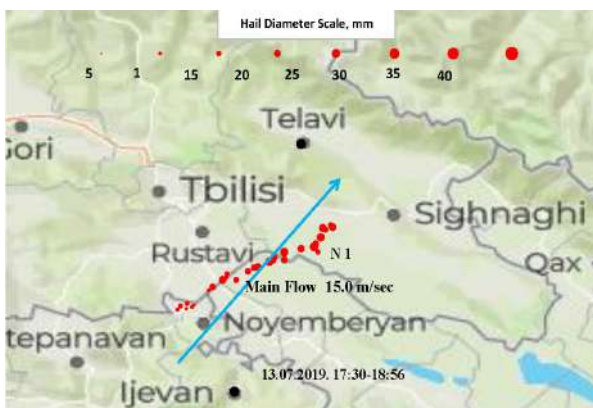


Fig.4. Convective cell N 1 with the Do (17:30-18:56)

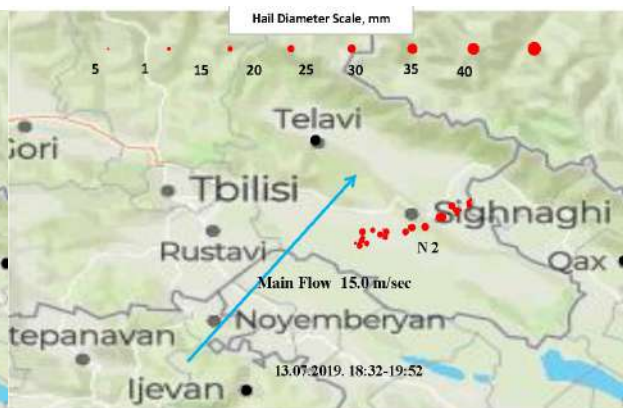


Fig.5. Convective cell N 2 with the Do (18:32-19:52)

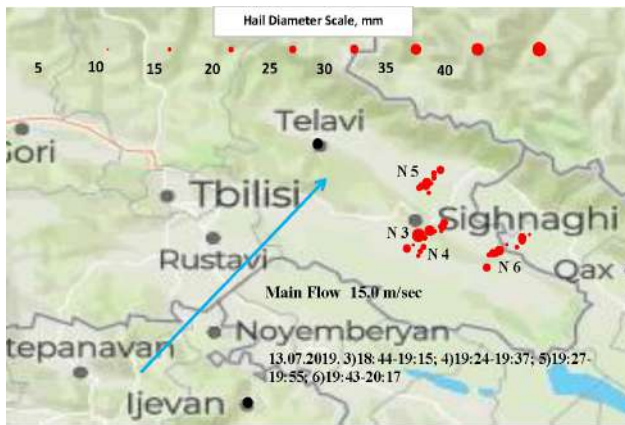


Fig.6. Convective cells N 3-6 with the Do.
3)18:44-19:15; 4)19:24-19:37; 5) 19:27-19:55;
6) 19:43-20:17

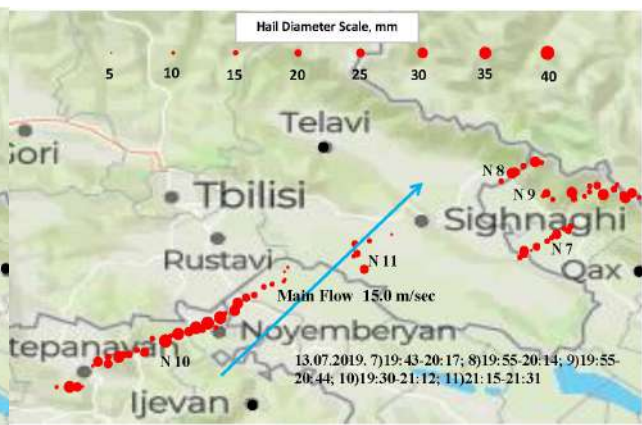


Fig.7. Convective cells N 7-11 with the Do.
7)19:43-20:17; 8)19:55-20:14; 9) 19:55-20:44;
10) 19:30-21:12; 11) 21:15-21:31

On July 13, 2019 from 17:30 through 21:31 hail clouds were observed above the territory of Georgia (Kakheti) and the near-boundary to it territories of Armenia and Azerbaijan (fig. 1,2). In all in this time were fixed 11 hail clouds (convective cells). In fig. 1(a-e) for the illustration the radar pictures of the hail processes above the investigated territory at the separate moments of time are represented. Fig. 2 depicts the generalized picture of the distribution of convective cells with the maximum size of the hailstones above the investigated territory. In particular, as it follows from fig. 2, the hail process on July 13, 2019 was moved approximately in the direction of the main flow and was stretched almost on 250 km.

Table 1. Statistical characteristics of Do in clouds in Georgia, Armenia and Azerbaijan on July 13, 2019.

Cloud	Hour	Min	Max	Mean	StDev	$C_v, \%$	σ_m	99%(+/-)	Count
1	17:30-18:56	3.2	25.5	16.6	6.5	38.8	1.2	3.1	29
2	18:32-19:52	7.4	26.4	16.8	5.3	31.8	1.0	2.6	27
3	18:44-19:15	9.3	27.4	17.4	5.1	29.2	1.5	4.0	11
4	19:24-19:37	12.6	38.1	24.0	10.6	44.0	5.3	13.6	5
5	19:27-19:55	7.0	14.5	10.5	2.6	24.4	0.8	2.1	10
6	19:43-20:17	6.6	23.7	16.4	5.0	30.6	1.5	3.7	12
7	19:43-20:17	8.8	24.6	17.2	5.2	29.9	1.5	3.8	12
8	19:55-20:14	11.5	18.0	14.9	2.2	14.9	0.9	2.3	7
9	19:55-20:44	11.5	33.6	19.6	6.8	34.7	1.7	4.3	17
10	19:30-21:12	7.0	38.1	24.1	9.5	39.4	1.6	4.2	34
11	21:15-21:31	7.4	25.5	16.4	6.4	39.1	2.9	7.4	6
1-11	17:30-21:31	3.2	38.1	18.3	7.5	40.8	0.6	1.5	170

Fig. 3 and table 1 present the data about the maximum sizes of hailstones into all 11 convective cells. Fig. 4-6 depicts the pictures of the location of each convective cell during its existence. As it follows from fig. 3 and table 1 value of Do varied from 3.2 mm (cloud N 1) to 38.1 mm (cloud N 4 and 10). Mean values of Do varied from 10.5 mm (cloud N 5) to 24.1 mm (cloud N 10).

Cloud N 1 was moved near the border of the Georgia with Armenia and Azerbaijan, and more lately it passed to the territory of Kakheti (Georgia). Range of Do: 3.2-25.5 mm, on the average - 16.6 mm (fig. 3,4; table 1). Cloud N 2 was moved only above the territory of Kakheti. Range of Do: 7.4-26.4 mm, on the average - 16.8 mm (fig. 3,5; table 1). Clouds N 3-5 were moved above the territory of Kakheti. Range of Do: 7.0 - 38.1 mm, on the average - 10.5-24.0 mm; cloud N 6 from the territory of Kakheti moved for the territory of Azerbaijan. Range of Do: 6.6-23.7 mm, on the average - 16.4 mm (Fig. 3,6; table 1).

Clouds N 7 and 8 were moved from the territory of Kakheti to the territory of Azerbaijan. Cloud N 9 was moved above the territory of Azerbaijan. Range of Do: 8.8 - 33.6 mm, on the average - 14.9-19.6 mm. cloud N 10 from the territory of Armenia moved for the territory of Azerbaijan. Range of Do: 7.0-38.1 mm, on the average - 24.1 mm. cloud N 11 was moved above the territory of Kakheti. Range of Do: 7.4-25.5 mm, on the average - 16.4 mm (fig. 3,7; table 1).