

Statistical Characteristics of the Monthly Average Values of the Air Temperature in the Layer of Atmosphere 0.54-27 km above the Kakheti Territory (Georgia) in 2012-2016

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ABSTRACT

Here is presented the data of statistical analysis of the monthly average values of the air temperature in the atmosphere above the territory of Kakheti at 19 levels in the range of heights from 0.54 to 27 km for the period from 2012 through 2016.

Key words: aerological sounding of atmosphere, air temperature vertical distribution.

Introduction

Information about the vertical distribution of the air temperature in atmosphere has great value for the solution of different problems of meteorology and climatology. In particular - forecast of the dangerous meteorological phenomena (thunderstorm, hail, snow-storm, etc.) [1,2], determination of different microphysical characteristics of clouds according to the data of radar measurements [2-6], weather modification of [2, 7-11], estimation of climate change [12-14], etc.

In the past century in Soviet Georgia the regular aerological sounding of the atmosphere in Tbilisi, Sukhumi and Batumi were carried out [15-17]. In the years with the work of anti-hail service in Kakheti the aerological sounding of the atmosphere in the village of Ruispiri in the Telavi municipality was carried out also [3,7,18]. The aerological sounding of atmosphere is not conducted since 1991 in Georgia.

The necessity of regular obtaining of information about the vertical distribution of meteorological elements in the atmosphere arose after the restoration of anti-hail works in Georgia [19-22]. These works were begun in 2015 [23] with use data of <https://www.ready.noaa.gov/READYcmet.php>. Subsequently it was studied above Kakheti Territory (Georgia) the vertical distribution of the average monthly values of air temperature in 2012-2016 during January, April, July and October in the range of heights from 0.543 to 27 km above sea level [24], they were studied the statistical characteristics of monthly and ten-days average values of freezing level in the atmosphere and hourly values of the height of isotherm -6°C in the atmosphere from April to October [25,26].

Material and methods

For investigating the thermal regime in the free atmosphere above the territory of Kakheti the resources of <http://ready.arl.noaa.gov/READYcmet.php> and https://rp5.ru/Weather_in_Georgia were used.

Here is carried out the statistical analysis of hourly (04, 10, 16 and 22 hours on the Tbilisi time) air temperature at the 19 heights about Kakheti territory from January through December 2012-2016. The total quantity of data composes is 138852. As the informational unit the values of average air temperature in the twenty-four hours are used, averaged in five years.

The analysis of data with the use of the standard statistical analysis methods is carried out [27]. The following designations will be used below: Min – minimal values, Max - maximal values, Range - variational scope, St Dev - standard deviation, σ_m – standard error, 95%(+/-) - 95% of confidence interval, mb –millibars, diurnal value – average value for 4, 10, 16 and 22 hours.

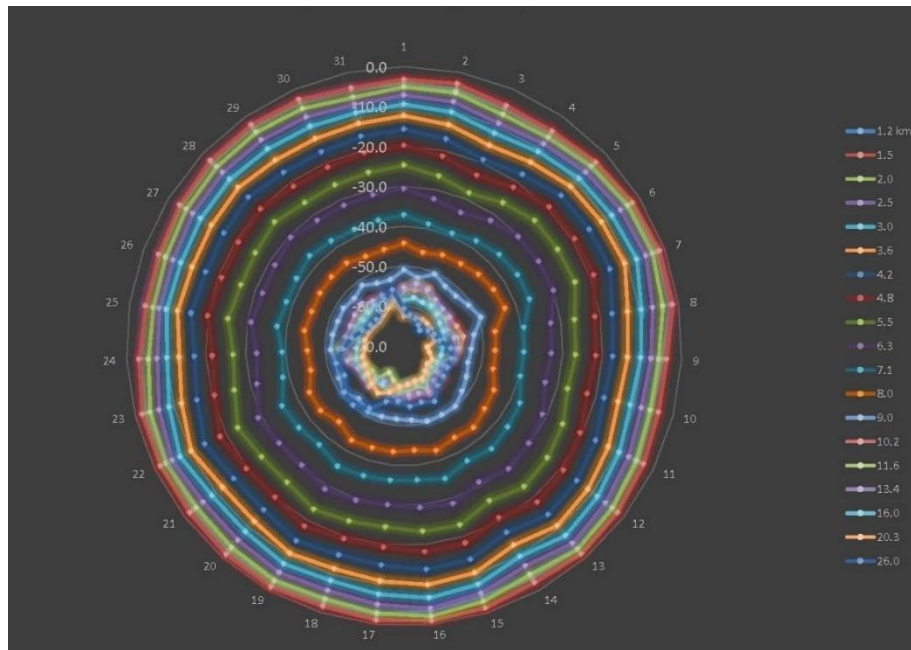


Fig. 1. Example of the vertical distribution of diurnal average values of air temperature above Kakheti territory in January 2012-2016

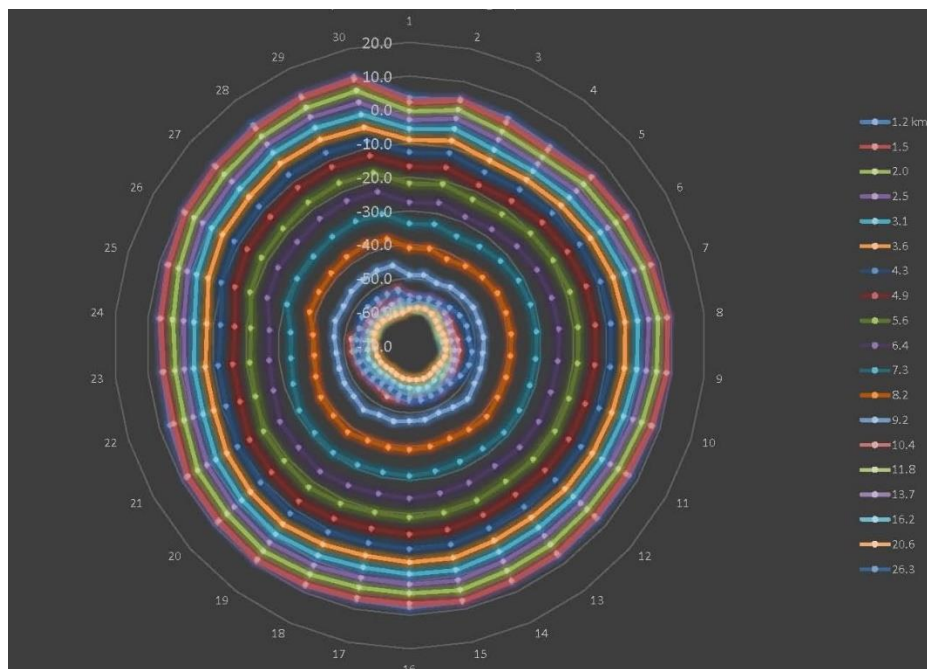


Fig.2. Example of the vertical distribution of diurnal average values of air temperature above Kakheti territory in April 2012-2016

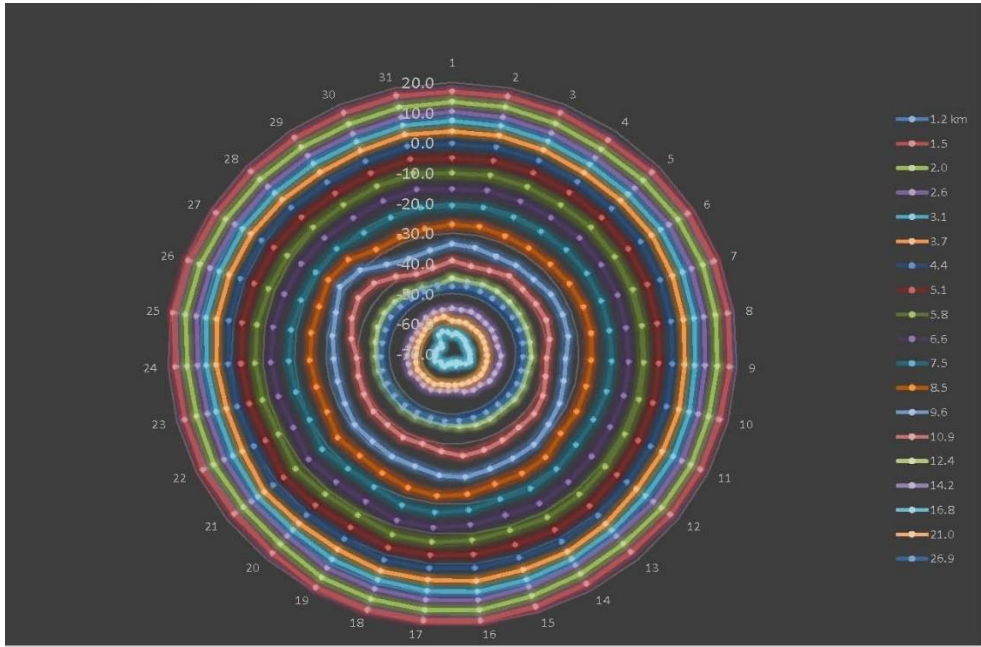


Fig.3. Example of the vertical distribution of diurnal average values of air temperature above Kakheti territory in July 2012-2016

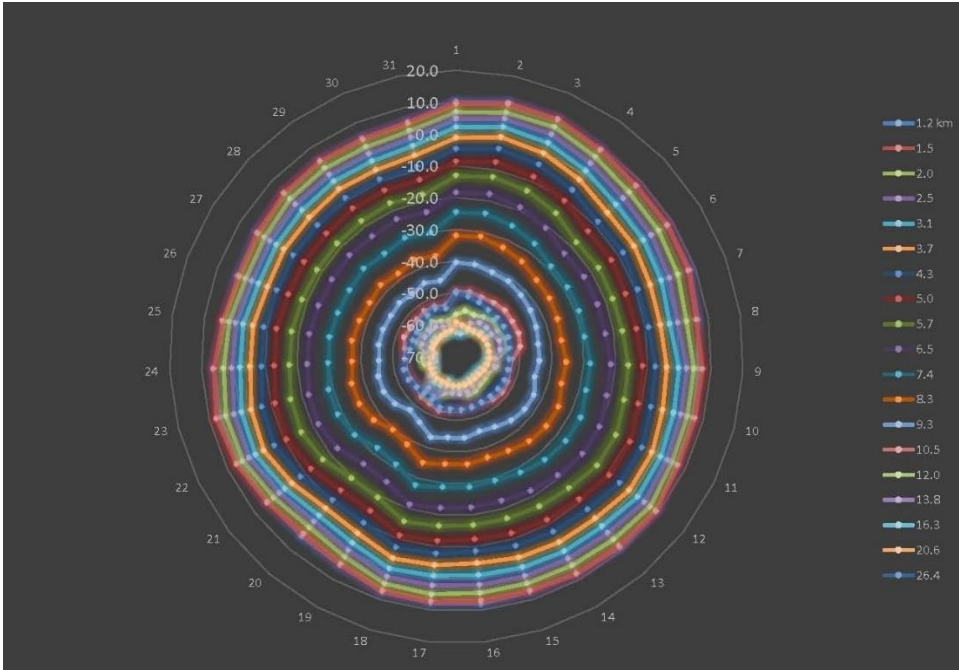


Fig.4. Example of the vertical distribution of diurnal average values of air temperature above Kakheti territory in October 2012-2016

Fig. 1 - 4, as an example, 2D pictures of the vertical diurnal average distribution values of air temperature above Kakheti territory in January, April, July and October 2012-2016 are demonstrated.

The statistical data about the monthly average values of the air temperature are represented below above the investigated region.

Results and discussion

The results of studies are presented in tables 1-12 and figures 5-19.

There is represented the statistical structure the monthly average values of the air temperature of the vertical distribution above the territory of Kakheti from January through December 2012-2016 in tables 1-12 and in Fig. 5-16.

Table 1

Statistical characteristics of the five years mean of diurnal air temperature values on the different heights above Kakheti during January

Km	Mean	Min	Max	Range	St Dev	σ_m	95% (+/-)
0.543	2.5	-14.5	15.7	30.2	4.30	0.17	0.34
1.478	-2.5	-13.4	6.9	20.3	3.36	0.13	0.26
1.957	-4.5	-16.4	3.9	20.3	3.47	0.14	0.27
2.463	-6.6	-18.9	0.8	19.7	3.55	0.14	0.28
3.000	-9.1	-21.8	-2.3	19.5	3.63	0.15	0.29
3.570	-12.3	-25.7	-5.5	20.2	3.73	0.15	0.29
4.177	-16.0	-30.4	-9.0	21.4	3.83	0.15	0.30
4.827	-20.2	-35.5	-12.7	22.8	3.89	0.16	0.31
5.526	-25.2	-40.8	-17.4	23.4	3.90	0.16	0.31
6.282	-31.0	-45.0	-23.0	22.0	3.87	0.16	0.30
7.106	-37.4	-47.7	-27.5	20.2	3.74	0.15	0.29
8.013	-44.6	-54.8	-33.5	21.3	3.40	0.14	0.27
9.028	-51.7	-58.9	-41.8	17.1	2.74	0.11	0.22
10.194	-57.1	-64.6	-47.0	17.6	3.21	0.13	0.25
11.600	-57.9	-69.7	-44.5	25.2	4.85	0.19	0.38
13.421	-56.7	-68.3	-45.5	22.8	3.53	0.14	0.28
15.981	-58.9	-66.4	-49.8	16.6	2.77	0.11	0.22
20.298	-60.8	-70.6	-46.4	24.2	4.14	0.17	0.33
26.003	-57.5	-75.9	-38.5	37.4	7.14	0.29	0.57

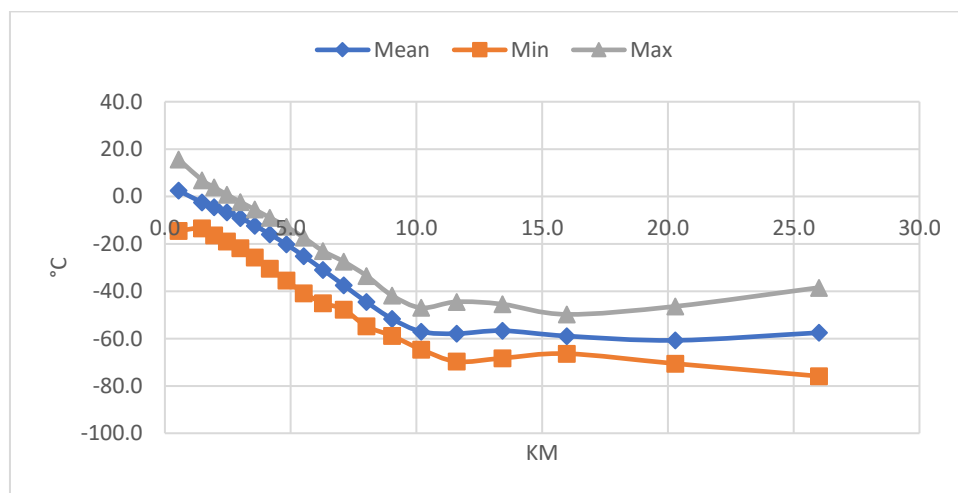


Fig.5. Vertical distribution of mean monthly, maximum and minimum air temperature over territory of Kakheti in January

As it follows from Table 1 and Fig.5, during January the average monthly air temperature (T) approximately linearly decreases with 2.5 °C (amplitude of hours values from -14.5 °C to 15.7 °C) on the earth's surface to -57.1 °C (Range: -64.6÷-47.0 °C) at the height of 10.2 km (lower boundary of tropopause), then little change to the height of 26 km (T = -57.5 °C, the range: -75.9÷ 38.5 °C). Limits of a change of the values T in the layer 11.6 - 26.0 km: from -60.8 °C (height of 20.3 km) to -56.7 °C (height of 13.4 km). The greatest variations are observed in the air temperature on the earth's surface, and also at heights 11.6 and 26.0 km (Range > 25.0 °C).

Table 2

Statistical characteristics of the five years mean of diurnal air temperature values on the different heights above Kakheti during February

Km	Mean	Min	Max	Range	St Dev	σ_m	95%(+/-)
0.543	3.5	-13.5	18.5	32.0	5.06	0.21	0.42
1.488	-1.4	-16.5	8.3	24.8	4.64	0.20	0.38
1.969	-3.6	-17.5	6.0	23.5	4.44	0.19	0.37
2.477	-5.7	-19.0	3.9	22.9	4.33	0.18	0.36
3.015	-8.1	-19.4	1.6	21.0	4.25	0.18	0.35
3.589	-11.2	-22.0	-1.6	20.4	4.16	0.18	0.34
4.200	-14.8	-24.7	-5.2	19.5	4.10	0.17	0.34
4.852	-19.2	-29.0	-9.9	19.1	4.04	0.17	0.33
5.554	-24.2	-34.2	-15.5	18.7	3.98	0.17	0.33
6.313	-30.0	-40.1	-21.5	18.6	3.97	0.17	0.33
7.140	-36.6	-45.7	-27.5	18.2	4.00	0.17	0.33
8.050	-43.9	-53.3	-35.4	17.9	3.96	0.17	0.33
9.067	-51.3	-58.9	-43.3	15.6	3.43	0.14	0.28
10.235	-56.6	-65.6	-49.1	16.5	2.62	0.11	0.22
11.644	-57.2	-67.2	-48.6	18.6	4.10	0.17	0.34
13.468	-56.4	-69.9	-49.3	20.6	3.66	0.15	0.30
16.024	-59.4	-67.5	-53.8	13.7	2.76	0.12	0.23
20.332	-61.1	-69.5	-53.3	16.2	2.77	0.12	0.23
26.064	-56.4	-69.5	-44.7	24.8	4.24	0.18	0.35

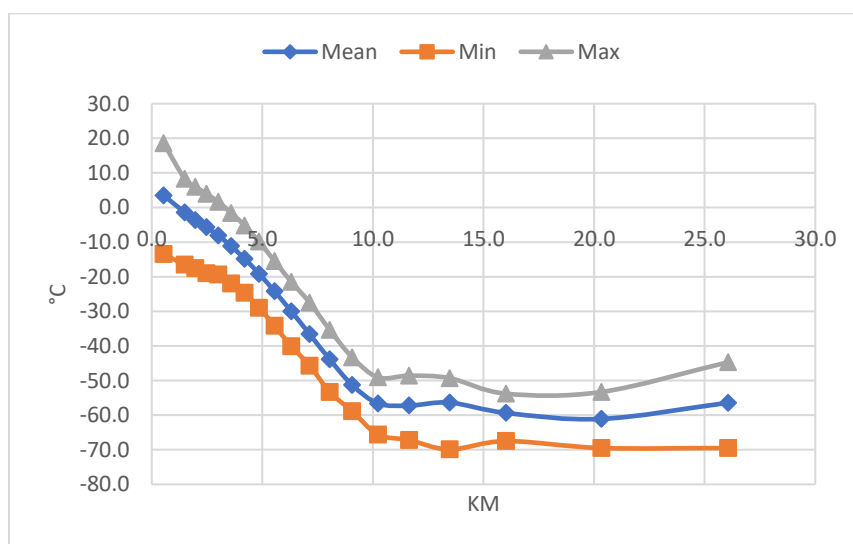


Fig.6. Monthly vertical distribution, maximum and minimum air temperature over territory of Kakheti in February.

During February (Table 2 and Fig. 6) the average monthly air temperature approximately linearly diminishes with 3.5 °C (maximum range of hours values from -13.5 °C to 18.5 °C) on the earth's surface to -56.6 °C (Range: -65.6— -49.1 °C) at the height of 10.2 km (lower boundary of tropopause), then insignificantly change to an altitude 26 km (T = -56.4 °C, Range: -69.5 — -44.7 °C). Limits of a change of the values T in the layer 11.6 - 26.0 km: from -61.1 °C (height of 20.3 km) to -56.4 °C (height 13.5 and 26.6 km). The greatest variations are observed in the air temperature on the earth's surface, and also at heights 1.5 and 26.0 km (Range >24.0 °C).

Table 3

Statistical characteristics of the five years mean of diurnal air temperature values on the different heights above Kakheti during March

Km	Mean	Min	Max	Range	St Dev	σ_m	95%(+/-)
0.543	7.3	-3.4	22.6	26.0	4.55	0.18	0.36
1.474	0.7	-11.0	12.7	23.7	4.27	0.17	0.34
1.958	-2.1	-14.4	8.5	22.9	4.27	0.17	0.34
2.469	-4.6	-17.9	6.0	23.9	4.40	0.18	0.35
3.009	-7.4	-21.3	3.8	25.1	4.53	0.18	0.36
3.583	-10.7	-24.4	0.8	25.2	4.57	0.18	0.36
4.195	-14.4	-28.8	-3.3	25.5	4.50	0.18	0.35
4.849	-18.6	-33.7	-8.3	25.4	4.36	0.18	0.34
5.553	-23.5	-37.1	-13.0	24.1	4.22	0.17	0.33
6.315	-29.1	-41.1	-18.1	23.0	4.10	0.16	0.32
7.146	-35.7	-46.6	-24.2	22.4	3.98	0.16	0.31
8.060	-42.9	-52.4	-31.7	20.7	3.72	0.15	0.29
9.082	-50.2	-58.0	-41.1	16.9	2.91	0.12	0.23
10.257	-55.6	-61.5	-45.6	15.9	3.05	0.12	0.24
11.672	-56.6	-69.1	-44.7	24.4	5.12	0.21	0.40
13.504	-55.7	-71.4	-47.6	23.8	3.83	0.15	0.30
16.075	-58.4	-67.4	-48.9	18.5	2.56	0.10	0.20
20.411	-60.1	-67.7	-51.7	16.0	2.88	0.12	0.23
26.147	-55.8	-70.4	-39.7	30.7	4.93	0.20	0.39

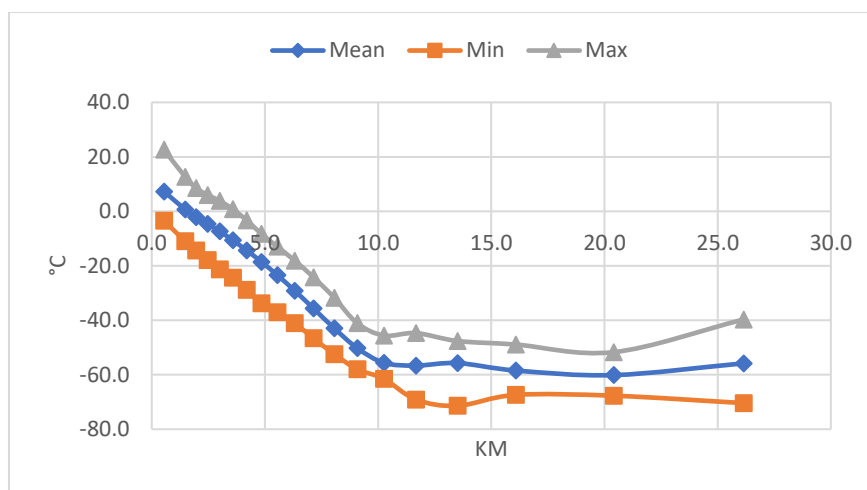


Fig.7. Monthly vertical distribution, maximum and minimum air temperature over territory of Kakheti in March

During March (Table 3 and Fig. 7) the value T linearly diminishes with 7.3 °C (maximum range of hours values from -3.4 °C to 22.6 °C) at the level of meteorological station to -55.6 °C (range: -61.5– -45.6 °C) at the height of 10.3 km (lower boundary of tropopause), then as during January and February, little change to the height of 26 km (T = -55.8 °C, the range: -70.4– -39.7 °C). Limits of a change of the values T in the layer 11.7 - 26.0 km: from -60.1 °C (height of 20.4 km) to -55.7 °C (height of 13.5 km). The greatest variations are observed in the temperature of air on the earth's surface, in the layer of heights from 3.0 to 4.85 km, and also at the height of 26.0 km (Range > 25.0 °C).

Table 4

Statistical characteristics of the five years mean of diurnal values of the air temperature on the different heights above Kakheti during April

Km	Mean	Min	Max	Range	St Dev	σ_m	95%(+/-)
0.543	12.9	-0.9	27.6	28.5	5.15	0.21	0.41
1.486	6.7	-5.3	17.5	22.8	4.25	0.17	0.34
1.981	3.6	-7.9	12.7	20.6	4.02	0.16	0.32
2.502	0.7	-10.6	9.3	19.9	3.79	0.15	0.30
3.054	-2.4	-14.1	5.7	19.8	3.59	0.15	0.29
3.638	-6.0	-17.8	1.9	19.7	3.39	0.14	0.27
4.260	-10.0	-22.0	-3.0	19.0	3.19	0.13	0.26
4.925	-14.4	-26.1	-7.6	18.5	3.06	0.12	0.24
5.641	-19.4	-30.9	-12.2	18.7	2.98	0.12	0.24
6.415	-25.2	-35.9	-17.6	18.3	2.94	0.12	0.24
7.258	-31.8	-41.8	-24.4	17.4	2.89	0.12	0.23
8.187	-39.2	-46.7	-32.3	14.4	2.77	0.11	0.22
9.224	-47.3	-53.8	-41.0	12.8	2.43	0.10	0.19
10.408	-54.6	-59.8	-44.6	15.2	2.42	0.10	0.19
11.823	-56.9	-65.3	-45.1	20.2	4.06	0.17	0.33
13.652	-55.5	-64.1	-47.8	16.3	2.65	0.11	0.21
16.219	-58.3	-65.0	-52.0	13.0	2.25	0.09	0.18
20.553	-59.4	-64.1	-51.2	12.9	2.14	0.09	0.17
26.347	-53.8	-62.9	-43.9	19.0	2.85	0.12	0.23

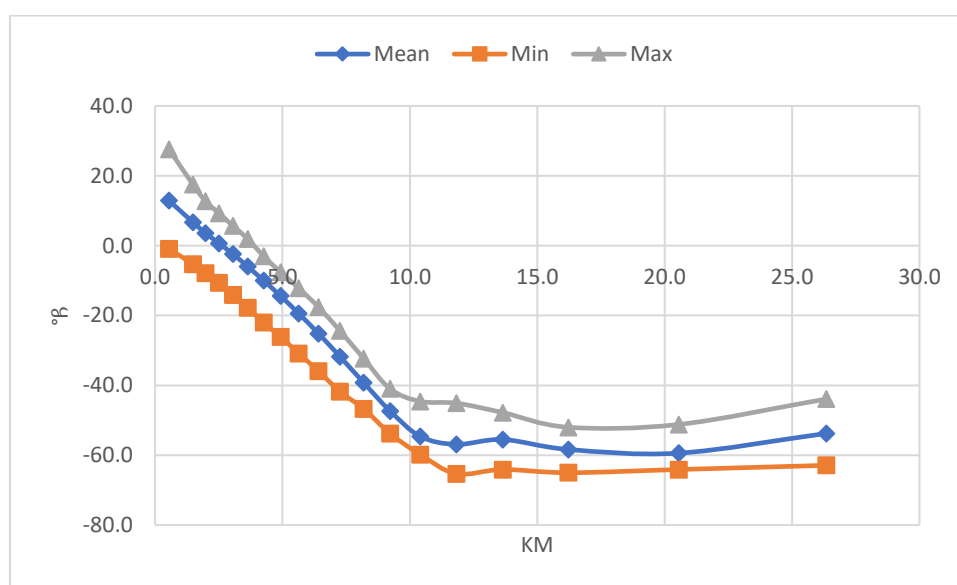


Fig.8. Vertical distribution of mean monthly, maximum and minimum air temperature over territory of Kakheti in April

During April (Table 4 and Fig. 8) the average monthly temperature of air linearly diminishes with 12.9 °C (maximum amplitude of hours values from -0.9 °C to 27.6 °C) at the level of meteorological station to -54.6 °C (range: -59.8 – -44.6 °C) at the height of 10.4 km (lower boundary of tropopause), then as in the foregoing months, insignificantly change to an altitude 26.3 km (T = -53.8 °C, the range: -62.9 – -43.9 °C). Limits of a change of the values T in the layer 11.8 - 26.3 km: from -59.4 °C (height of 20.6 km) to -53.8 °C (height of 26.3 km). The greatest variations are observed in the temperature of air on the earth's surface and at heights 1.5 and 2.0 km (Range > 20.0 °C). It should be noted that in comparison with the foregoing months, during April is somewhat more greatly expressed the tendency of an increase in the temperature at the height of approximately 26.0 km.

Table 5

Statistical characteristics of the five years mean of diurnal values of the air temperature on the different heights above Kakheti during May

Km	Mean	Min	Max	Range	St Dev	σ_m	95%(+/-)
0.543	17.7	4.8	30.4	25.6	4.15	0.17	0.33
1.494	11.4	-8.7	27.0	35.7	4.55	0.18	0.36
1.998	7.9	-11.9	21.9	33.8	4.25	0.17	0.33
2.527	4.7	-15.9	17.1	33.0	4.02	0.16	0.32
3.087	1.4	-20.0	13.7	33.7	3.93	0.16	0.31
3.680	-2.3	-24.2	9.6	33.8	3.81	0.15	0.30
4.311	-6.4	-28.8	4.1	32.9	3.64	0.15	0.29
4.986	-10.8	-32.2	-1.8	30.4	3.48	0.14	0.27
5.711	-15.7	-35.8	-7.4	28.4	3.39	0.14	0.27
6.497	-21.4	-41.1	-13.2	27.9	3.39	0.14	0.27
7.354	-27.9	-46.6	-19.2	27.4	3.44	0.14	0.27
8.298	-35.4	-51.7	-25.0	26.7	3.37	0.14	0.27
9.352	-43.9	-54.2	-31.3	22.9	3.01	0.12	0.24
10.552	-52.0	-59.3	-36.9	22.4	2.82	0.11	0.22
11.981	-55.2	-63.3	-44.6	18.7	4.13	0.17	0.33
13.822	-54.3	-63.5	-47.3	16.2	2.88	0.12	0.23
16.396	-58.5	-66.6	-53.6	13.0	2.09	0.08	0.16
20.721	-59.5	-63.6	-56.4	7.2	1.31	0.05	0.10
26.549	-51.0	-56.7	-45.4	11.3	2.02	0.08	0.16

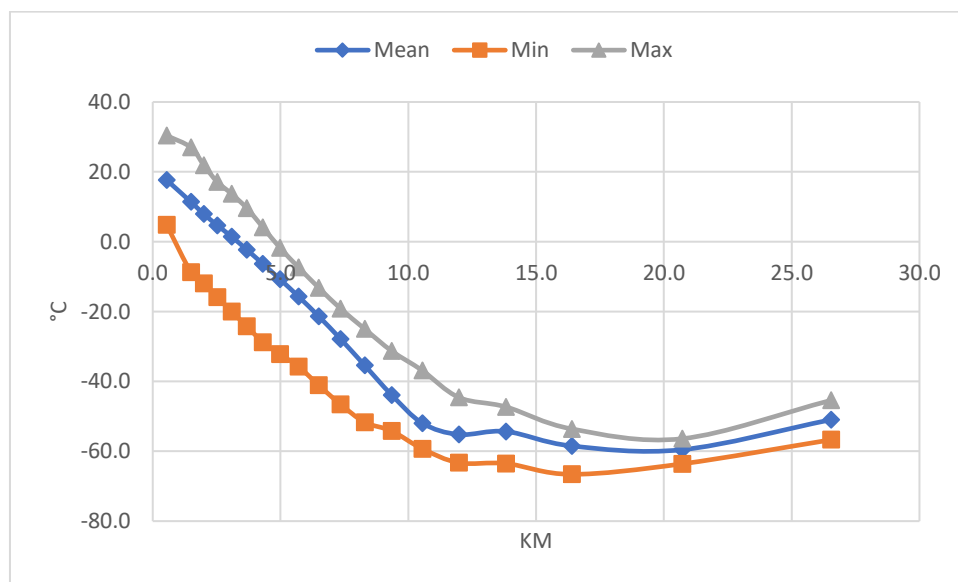


Fig.9. Vertical distribution of mean monthly, maximum and minimum air temperature over territory of Kakheti in May

During May (Table 5 and Fig. 9) the value T linearly diminishes with 17.7 °C (maximum amplitude of hours values from 4.8 °C to 30.4 °C) at the level of meteorological station to -52.0 °C (range: -59.3– -36.9 °C) at the height of 10.6 km, then very considerably it does not change to the height of 26.6 km ($T = -51.0$ °C, the range: -56.7– -45.4 °C). Limits of a change of the values T in the layer 12.0 - 26.5 km: from -59.5 °C (height of 20.7 km) to -51.0 °C (height of 26.5 km). The greatest variations are observed in the temperature of air in the layer of heights from 1.5 to 4.3 km (Range >30.0 °C). Lower boundary of tropopause - 12.0 km. During May the tendency of an increase in the air temperature at the height of more than 26.0 km is more expressed than during April.

Table 6

Statistical characteristics of the five years mean of diurnal values of the air temperature on the different heights above Kakheti during June

Km	Mean	Min	Max	Range	St Dev	σ_m	95%(+/-)
0.543	21.7	11.3	33.6	22.3	4.56	0.19	0.37
1.498	16.0	6.8	23.9	17.1	3.28	0.13	0.26
2.009	12.3	4.6	19.2	14.6	2.94	0.12	0.24
2.547	8.8	1.3	15.4	14.1	2.67	0.11	0.21
3.115	5.5	-2.0	11.7	13.7	2.52	0.10	0.20
3.717	1.7	-5.3	7.3	12.6	2.43	0.10	0.19
4.358	-2.4	-9.3	3.1	12.4	2.32	0.09	0.19
5.042	-6.9	-13.2	-1.5	11.7	2.22	0.09	0.18
5.779	-11.9	-18.2	-6.2	12.0	2.22	0.09	0.18
6.577	-17.4	-23.1	-10.4	12.7	2.29	0.09	0.18
7.448	-23.7	-29.4	-13.8	15.6	2.56	0.10	0.20
8.409	-30.8	-37.5	-18.2	19.3	3.04	0.12	0.24
9.485	-38.4	-45.5	-25.2	20.3	4.08	0.17	0.33
10.719	-44.9	-53.8	-32.5	21.3	5.33	0.22	0.43
12.197	-48.5	-61.0	-39.8	21.2	4.52	0.18	0.36
14.069	-53.6	-59.9	-48.3	11.6	2.48	0.10	0.20
16.622	-61.7	-70.6	-55.3	15.3	3.35	0.14	0.27
20.908	-59.0	-62.9	-54.2	8.7	1.55	0.06	0.12
26.790	-48.3	-50.8	-45.3	5.5	1.07	0.04	0.09

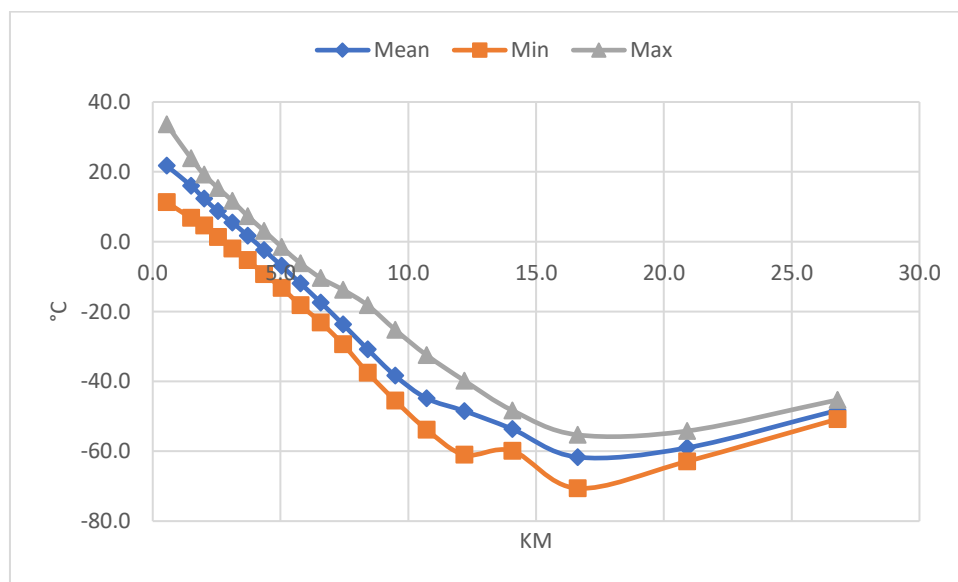


Fig.10. Vertical distribution of mean monthly, maximum and minimum air temperature over territory of Kakheti in June

During June (Table 6 and Fig. 10) the average monthly temperature of air linearly diminishes with 21.7 °C (maximum amplitude of hours values from 11.3 °C to 33.6 °C) on the earth's surface to -44.9 °C (range: -53.8 – -32.5 °C) at the height of 10.7 km then, with the smaller gradient, the linear decrease of the temperature of air continues in the layer from 12.2 km (T = -48 °C, the range: -61.0 – -39.8 °C) to 16.6 km (lower boundary of tropopause, T=-61.7 °C, the range: -70.6 – -55.3 °C). After this, the temperature of air grows to -48.3 °C (range: -50.8 – -45.3 °C) at the height of 26.7 km. The greatest variations are observed in the air temperature on the earth's surface in the layer of heights from 9.5 to 12.2 km (Range > 20.0 °C). During June the tendency of an increase in the temperature at the height of more than 26.0 km is more expressed than during April and May.

Table 7

Statistical characteristics of the five years mean of diurnal values of the air temperature on the different heights above Kakheti during July

Km	Mean	Min	Max	Range	St Dev	σ_m	95%(+/-)
0.543	23.5	13.0	35.8	22.8	4.20	0.17	0.33
1.497	17.7	9.2	26.9	17.7	3.00	0.12	0.24
2.012	13.9	5.9	21.9	16.0	2.63	0.11	0.21
2.553	10.5	3.3	17.0	13.7	2.39	0.10	0.19
3.125	7.6	0.9	13.3	12.4	2.38	0.10	0.19
3.733	4.3	-3.3	9.6	12.9	2.34	0.09	0.18
4.380	0.4	-7.2	5.7	12.9	2.20	0.09	0.17
5.073	-4.0	-11.7	0.9	12.6	2.08	0.08	0.16
5.818	-8.7	-16.7	-4.0	12.7	2.09	0.08	0.16
6.626	-13.9	-22.3	-7.4	14.9	2.30	0.09	0.18
7.510	-19.5	-29.1	-11.7	17.4	2.84	0.11	0.22
8.490	-25.6	-36.6	-17.3	19.3	3.63	0.15	0.29
9.591	-32.2	-44.1	-23.2	20.9	4.20	0.17	0.33
10.860	-38.4	-47.8	-31.4	16.4	3.45	0.14	0.27
12.370	-45.7	-53.5	-41.5	12.0	1.82	0.07	0.14
14.242	-55.8	-60.7	-48.7	12.0	2.33	0.09	0.18
16.760	-64.7	-70.2	-54.1	16.1	3.10	0.12	0.24
21.020	-58.7	-63.9	-54.9	9.0	1.56	0.06	0.12
26.919	-47.5	-49.8	-44.9	4.9	0.79	0.03	0.06

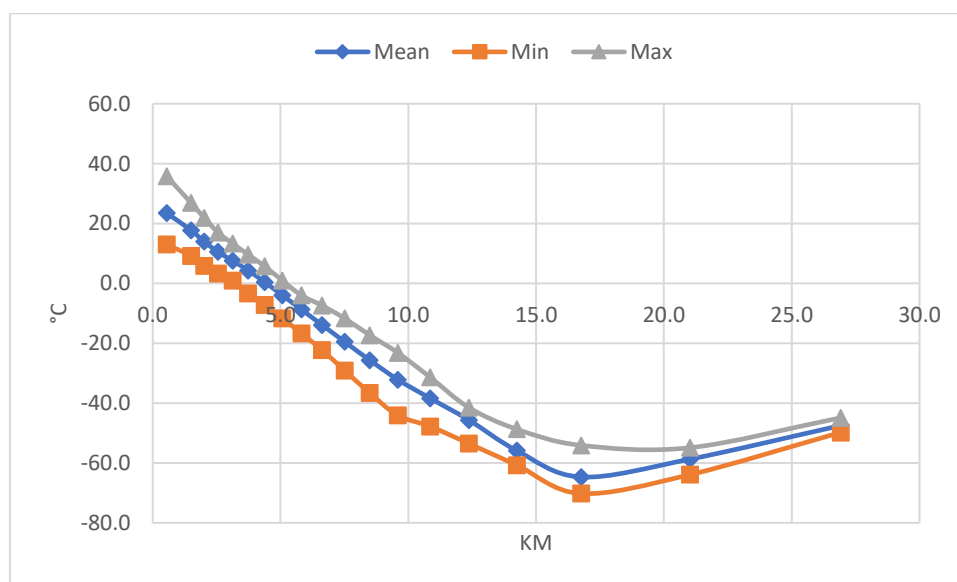


Fig.11. Vertical distribution of mean monthly, maximum and minimum air temperature over territory of Kakheti in July

During July (Table 7 and Fig. 11) the value T approximately linearly diminishes with 23.5 °C (maximum amplitude of hours values from 13.0 °C to 35.8 °C) on the earth's surface to -64.7 °C (range: -70.2— -54.1 °C) at the height of 16.8 km (lower boundary of tropopause), then grow to -47.5 °C (range: -49.8— -44.9 °C) at the height of 26.9 km. The greatest variations are observed in the temperature of air on the earth's surface and at an altitude 9.6 km (Range >20.0 °C).

Table 8

Statistical characteristics of the five years mean of diurnal values of the air temperature on the different heights above Kakheti during August

Km	Mean	Min	Max	Range	St Dev	σ_m	95%(+/-)
0.543	25.0	13.5	41.0	27.5	5.00	0.20	0.39
1.512	18.1	3.7	28.0	24.3	4.03	0.16	0.32
2.027	14.4	1.4	22.8	21.4	3.66	0.15	0.29
2.570	11.0	-0.5	17.7	18.2	3.36	0.14	0.26
3.143	8.0	-4.0	14.4	18.4	3.22	0.13	0.25
3.751	4.6	-7.8	10.3	18.1	3.07	0.12	0.24
4.399	0.5	-11.2	5.6	16.8	2.79	0.11	0.22
5.091	-4.2	-15.5	1.2	16.7	2.51	0.10	0.20
5.835	-9.2	-20.3	-4.3	16.0	2.38	0.10	0.19
6.642	-14.5	-26.6	-9.4	17.2	2.42	0.10	0.19
7.524	-20.4	-33.4	-14.5	18.9	2.63	0.11	0.21
8.499	-27.2	-41.2	-20.1	21.1	2.97	0.12	0.23
9.592	-34.1	-47.0	-26.0	21.0	3.45	0.14	0.27
10.851	-40.3	-51.0	-31.6	19.4	3.69	0.15	0.29
12.349	-47.5	-57.2	-42.7	14.5	2.22	0.09	0.18
14.207	-57.3	-60.8	-51.7	9.1	1.70	0.07	0.13
16.715	-64.5	-70.2	-56.0	14.2	2.65	0.11	0.21
20.986	-58.7	-62.5	-52.5	10.0	1.35	0.05	0.11
26.876	-48.3	-54.8	-45.2	9.6	1.51	0.06	0.12

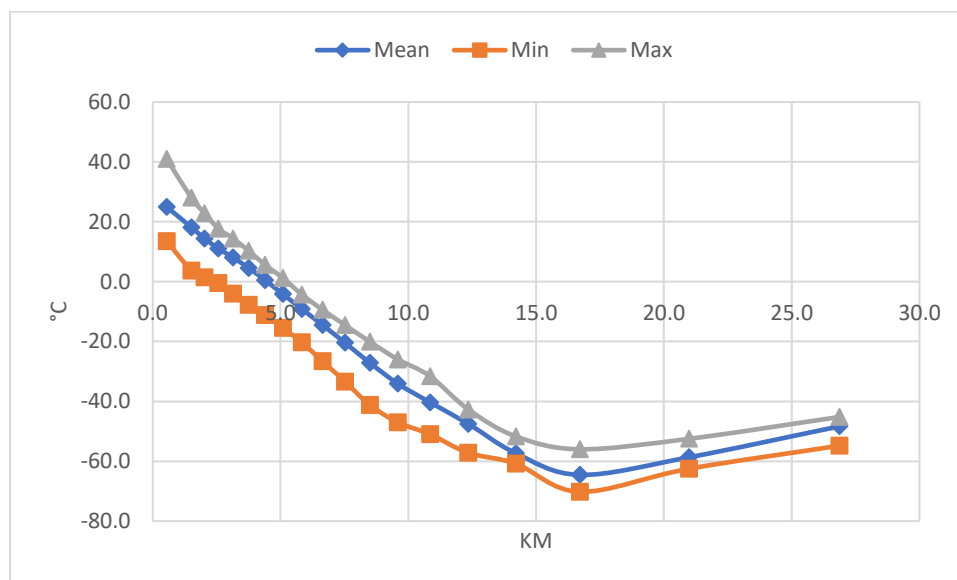


Fig.12. Vertical distribution of mean monthly, maximum and minimum air temperature over territory of Kakheti in August

During August (Table 8 and Fig. 12) the average monthly temperature of air linearly decreases with 25.0 °C (maximum amplitude of hours values from 13.5 °C to 41.0 °C) at the level of meteorological station to -64.5 °C (range: -70.2— -56.0 °C) at the height of 16.7 km (lower boundary of tropopause), then grow to -48.3 °C (range: -54.8— -54.8 °C) at the height of 26.9 km. The greatest variations are observed in the temperature of air on the earth's surface and at heights 1.5, 2.0, 7.5 and 9.5 km (Range >20.0 °C).

Table 9

Statistical characteristics of the five years mean of diurnal values of the air temperature on the different heights above Kakheti during September

Km	Mean	Min	Max	Range	St Dev	σ_m	95%(+/-)
0.543	19.8	8.4	32.0	23.6	4.59	0.19	0.37
1.515	12.7	-5.3	22.3	27.6	4.40	0.18	0.35
2.021	9.4	-8.8	17.7	26.5	4.05	0.17	0.32
2.554	6.6	-11.8	13.6	25.4	3.94	0.16	0.32
3.117	3.6	-14.6	10.7	25.3	3.99	0.16	0.32
3.715	0.1	-18.5	6.3	24.8	3.95	0.16	0.32
4.352	-3.8	-22.6	2.5	25.1	3.82	0.16	0.31
5.033	-8.1	-26.8	-1.2	25.6	3.68	0.15	0.29
5.767	-12.9	-31.5	-6.3	25.2	3.59	0.15	0.29
6.561	-18.4	-37.1	-12.5	24.6	3.55	0.15	0.28
7.429	-24.7	-42.1	-19.3	22.8	3.50	0.14	0.28
8.386	-32.0	-47.8	-26.2	21.6	3.33	0.14	0.27
9.456	-40.0	-53.4	-31.6	21.8	3.30	0.13	0.26
10.679	-47.5	-60.4	-37.4	23.0	3.80	0.16	0.30
12.133	-52.8	-61.5	-45.0	16.5	3.73	0.15	0.30
13.969	-57.5	-66.4	-51.4	15.0	2.45	0.10	0.20
16.498	-61.7	-67.4	-53.8	13.6	2.65	0.11	0.21
20.803	-59.0	-66.3	-53.1	13.2	1.92	0.08	0.15
26.653	-50.7	-60.8	-46.4	14.4	2.26	0.09	0.18

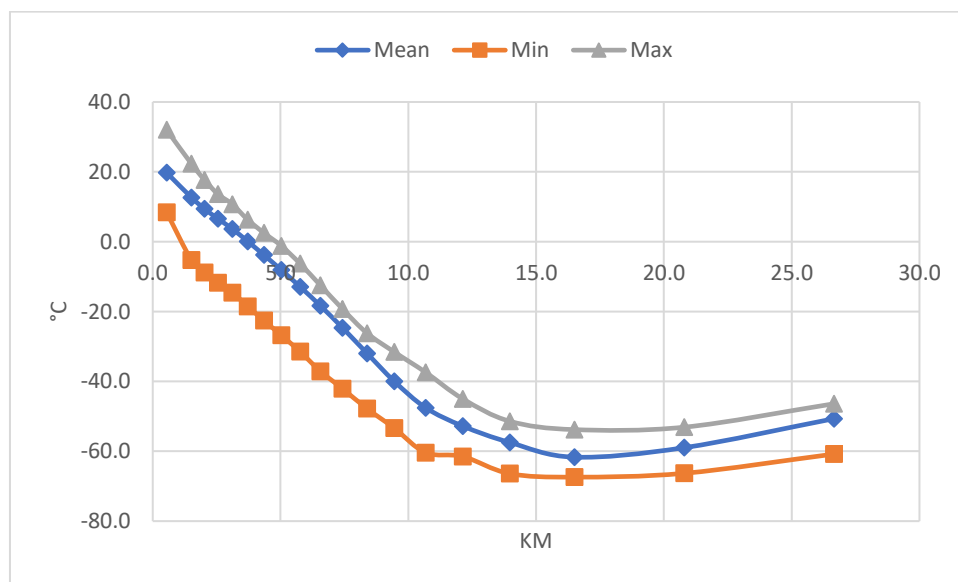


Fig.13. Vertical distribution of mean monthly, maximum and minimum air temperature over territory of Kakheti in September

During September (Table 9 and Fig. 13) the value T approximately linearly decreases with $19.8\text{ }^{\circ}\text{C}$ (maximum amplitude of hours values from $8.4\text{ }^{\circ}\text{C}$ to $32.0\text{ }^{\circ}\text{C}$) on the earth's surface to $-57.5\text{ }^{\circ}\text{C}$ (Range: $-66.4\text{ }^{\circ}\text{C}$ – $-51.4\text{ }^{\circ}\text{C}$) at the height of 14.0 km (lower boundary of tropopause), then proceeds an increase in the temperature in the range of heights from 16.5 km ($T = -61.7\text{ }^{\circ}\text{C}$, range: $-67.4\text{ }^{\circ}\text{C}$ – $-53.8\text{ }^{\circ}\text{C}$) to 26.7 km ($T = -50.7\text{ }^{\circ}\text{C}$, range: $-60.8\text{ }^{\circ}\text{C}$ – $-46.4\text{ }^{\circ}\text{C}$). The greatest variations are observed in the temperature of air in the layer from 1.5 to 3.1 km , 4.4 and 5.8 km (Range $> 25.0\text{ }^{\circ}\text{C}$).

Table 10

Statistical characteristics of the five years mean of diurnal values of the air temperature on the different heights above Kakheti during October

Km	Mean	Min	Max	Range	St Dev	σ_m	95%(+/-)
0.543	13.1	0.2	28.1	27.9	4.88	0.20	0.38
1.521	6.7	-5.5	17.8	23.3	4.08	0.16	0.32
2.015	4.0	-7.9	13.1	21.0	3.96	0.16	0.31
2.537	1.7	-9.6	10.2	19.8	3.90	0.16	0.31
3.090	-0.9	-11.6	6.8	18.4	3.69	0.15	0.29
3.692	-4.1	-14.4	3.0	17.4	3.45	0.14	0.27
4.318	-7.8	-16.7	-0.6	16.1	3.24	0.13	0.26
4.990	-11.8	-19.3	-5.0	14.3	3.08	0.12	0.24
5.713	-16.6	-24.2	-10.0	14.2	3.01	0.12	0.24
6.496	-22.2	-30.5	-15.5	15.0	2.98	0.12	0.23
7.350	-28.6	-37.1	-22.1	15.0	2.92	0.12	0.23
8.292	-36.0	-44.4	-29.0	15.4	2.81	0.11	0.22
9.343	-44.2	-52.3	-36.4	15.9	2.57	0.10	0.20
10.543	-52.1	-60.7	-43.7	17.0	2.59	0.10	0.20
11.966	-57.4	-67.8	-45.3	22.5	3.91	0.16	0.31
13.776	-59.0	-72.9	-51.8	21.1	3.27	0.13	0.26
16.301	-61.2	-68.4	-54.7	13.7	2.20	0.09	0.17
20.598	-60.8	-66.8	-54.9	11.9	1.96	0.08	0.15
26.378	-53.4	-60.7	-47.7	13.0	2.14	0.09	0.17

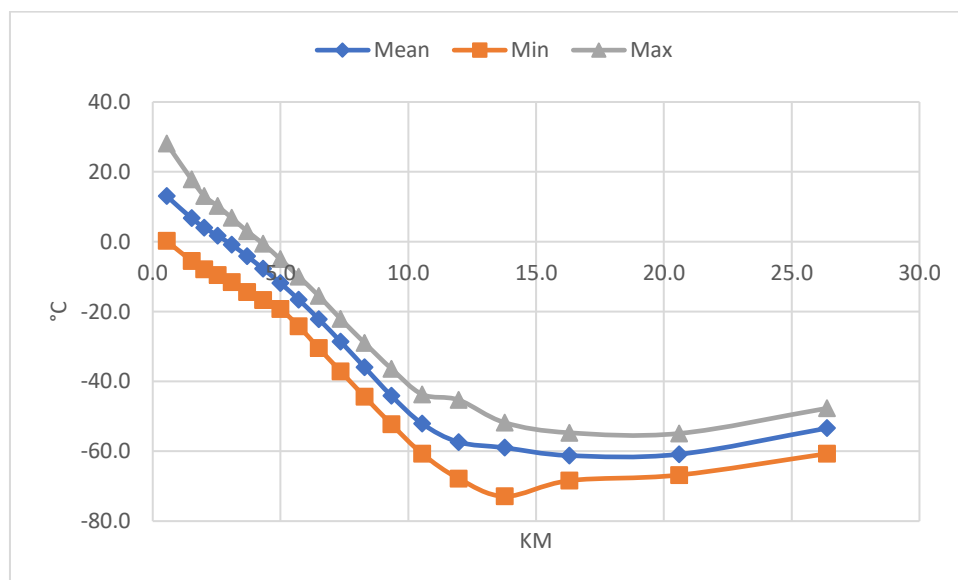


Fig.14. Vertical distribution of mean monthly, maximum and minimum air temperature over territory of Kakheti in October

During October (Table 10 and Fig. 14) the average monthly temperature of air linearly decreases with 13.1 °C (maximum amplitude of hours values from 0.2 °C to 28.1 °C) at the level of meteorological station to -57.4 °C (Range: -67.8 – -45.3 °C) at the height of 12.0 km (lower boundary of tropopause), then after insignificant decrease smoothly it grows to -53.4 °C (Range: -60.7 – -47.7 °C) at the height of 26.4 km. The greatest variations are observed in the temperature of air on the earth's surface and at heights 1.5, 2.0, 12.0 and 13.8 km (Range > 20.0 °C).

Table 11

Statistical characteristics of the five years mean of diurnal values of the air temperature on the different heights above Kakheti during November

Km	Mean	Min	Max	Range	St Dev	σ_m	95%(+/-)
0.543	7.8	-4.3	22.3	26.6	4.43	0.18	0.35
1.525	3.1	-8.1	12.4	20.5	3.97	0.16	0.32
2.014	0.8	-10.6	9.6	20.2	3.86	0.16	0.31
2.530	-1.4	-11.8	6.7	18.5	3.75	0.15	0.30
3.078	-3.9	-14.6	4.1	18.7	3.59	0.15	0.29
3.659	-7.0	-18.5	1.7	20.2	3.55	0.15	0.28
4.279	-10.7	-22.6	-2.5	20.1	3.48	0.14	0.28
4.943	-14.9	-26.8	-7.3	19.5	3.42	0.14	0.27
5.657	-19.8	-31.5	-12.3	19.2	3.38	0.14	0.27
6.430	-25.5	-37.1	-17.9	19.2	3.36	0.14	0.27
7.273	-32.0	-42.1	-24.6	17.5	3.29	0.13	0.26
8.202	-39.3	-47.8	-32.3	15.5	3.12	0.13	0.25
9.238	-47.5	-55.6	-41.4	14.2	2.82	0.12	0.23
10.422	-55.0	-61.7	-45.4	16.3	2.60	0.11	0.21
11.831	-58.9	-67.8	-47.7	20.1	3.70	0.15	0.30
13.633	-59.7	-72.9	-50.8	22.1	3.52	0.14	0.28
16.153	-62.2	-68.8	-55.9	12.9	2.40	0.10	0.19
20.424	-62.7	-68.3	-52.8	15.5	2.05	0.08	0.16
26.124	-56.9	-65.5	-46.1	19.4	3.41	0.14	0.27

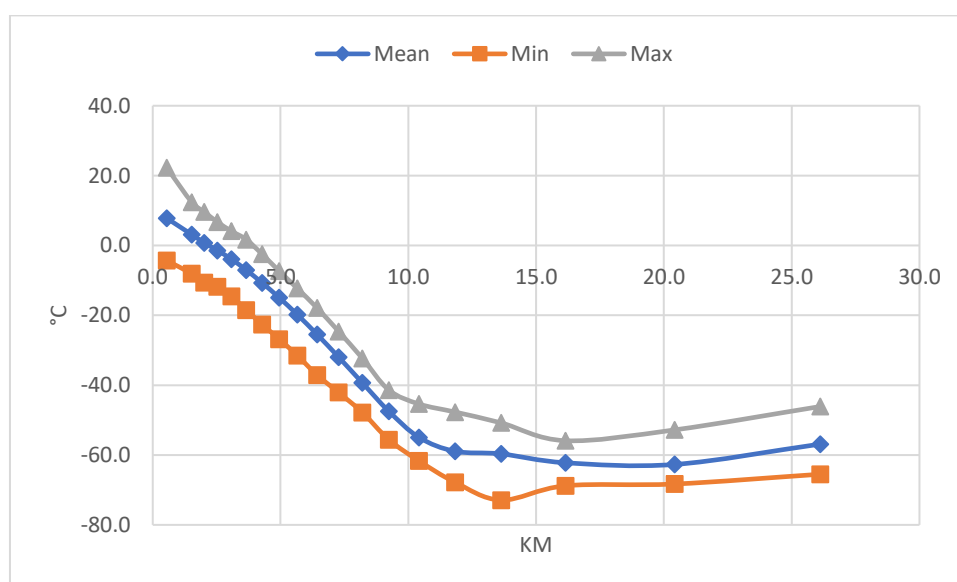


Fig.15. Vertical distribution of mean monthly, maximum and minimum air temperature over territory of Kakheti in November

During November (Table 11 and Fig. 15) the value T approximately linearly decreases with $7.8\text{ }^{\circ}\text{C}$ (maximum amplitude of hours values from $-4.3\text{ }^{\circ}\text{C}$ to $22.3\text{ }^{\circ}\text{C}$) on the earth's surface to $-58.9\text{ }^{\circ}\text{C}$ (range: $-67.8\text{ }^{\circ}\text{C}$ — $-47.7\text{ }^{\circ}\text{C}$) at the height of 11.8 km (lower boundary of tropopause), then after certain further decrease occurs an increase in the temperature to $-56.9\text{ }^{\circ}\text{C}$ (range: $-65.5\text{ }^{\circ}\text{C}$ — $-46.1\text{ }^{\circ}\text{C}$) at the height of 26.1 km. The greatest variations are observed in the temperature of air in the layer from 0.543 to 2.0 km, at the heights 3.7, 4.3, 11.8 and 13.6 km (Range $> 20.0\text{ }^{\circ}\text{C}$).

Table 12

Statistical characteristics of the five years mean of diurnal values of the air temperature on the different heights above Kakheti during December

Km	Mean	Min	Max	Range	St Dev	σ_m	95%(+/-)
0.543	2.6	-7.2	17.8	25.0	4.34	0.17	0.34
1.507	-1.8	-12.1	10.0	22.1	3.99	0.16	0.31
1.988	-3.8	-14.7	7.3	22.0	4.19	0.17	0.33
2.495	-5.8	-16.7	4.3	21.0	4.30	0.17	0.34
3.033	-8.2	-19.5	0.9	20.4	4.39	0.18	0.35
3.605	-11.2	-23.5	-2.4	21.1	4.43	0.18	0.35
4.215	-14.7	-27.7	-5.7	22	-14.1	0.18	0.35
4.869	-18.8	-31.5	-9.3	22.2	4.35	0.17	0.34
5.572	-23.6	-36.5	-13.7	22.8	4.25	0.17	0.33
6.333	-29.2	-41.2	-18.9	22.3	4.05	0.16	0.32
7.164	-35.5	-46.5	-25.3	21.2	3.76	0.15	0.30
8.079	-42.6	-53.7	-33.0	20.7	3.40	0.14	0.27
9.102	-50.1	-56.9	-41.5	15.4	2.78	0.11	0.22
10.274	-56.4	-62.6	-45.8	16.8	2.83	0.11	0.22
11.678	-58.8	-68.0	-45.3	22.7	4.44	0.18	0.35
13.487	-58.0	-71.3	-47.5	23.8	3.39	0.14	0.27
16.029	-60.2	-69.7	-50.4	19.3	2.89	0.12	0.23
20.333	-61.3	-72.9	-50.3	22.6	3.46	0.14	0.27
26.058	-56.8	-68.6	-40.1	28.5	5.07	0.20	0.40

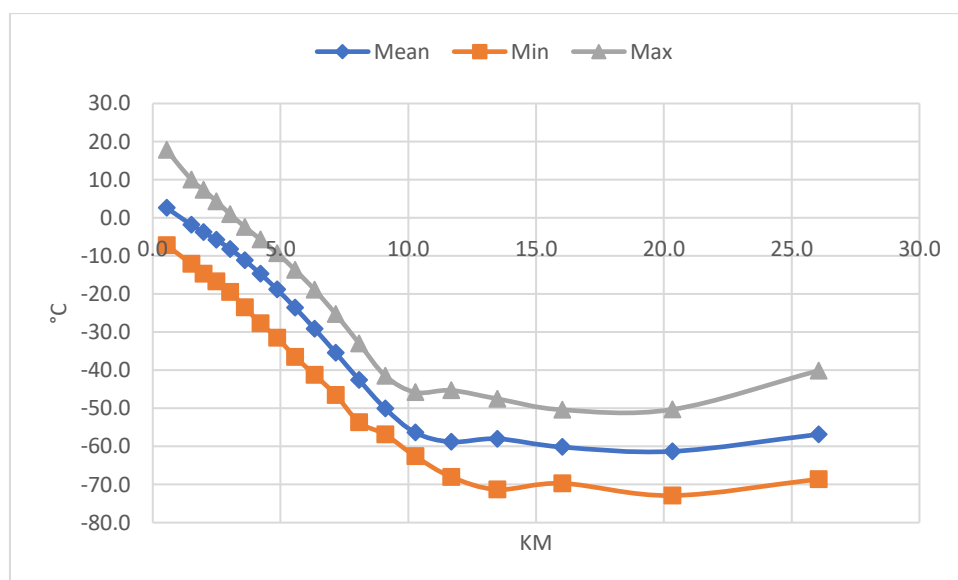


Fig.16. Vertical distribution of mean monthly, maximum and minimum air temperature over territory of Kakheti in December

During December (Table 12 and Fig. 16) the average monthly temperature of air approximately linearly decreases with 2.6 °C (amplitude of hours values from -7.2 °C to 17.8 °C) on the earth's surface to -56.4 °C (range: -62.6 – -45.8 °C) at the height of 10.3 km (lower boundary of tropopause), then little change to an altitude 26 km (T = -56.8 °C, range: -68.6 – -40.1 °C). Limits of a change of the values T in the layer 11.7 - 26.0 km: from -61.3 °C (height of 20.3 km) to -56.8 °C (height of 26.0 km). The greatest variations are observed in the temperature of air on the earth's surface and at the height of 26.0 km (Range > 25.0 °C).

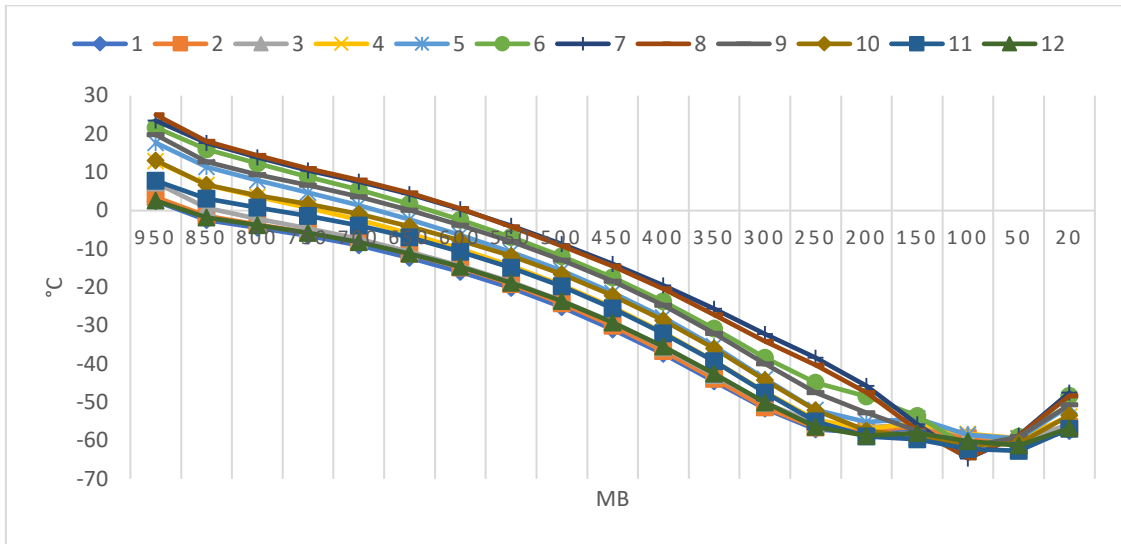


Fig. 17. Vertical distribution of mean monthly air temperature over territory of Kakheti in January – December 2012-2016

Fig. 17 for the clarity depicts the vertical distribution of the average monthly values of the temperature of air above the Kakheti for the separate months of year. Fig. 18 depicts the vertical distribution of the annual amplitude of the average monthly values of the temperature of air above the Kakheti (difference between average monthly maximum and minimum temperature).

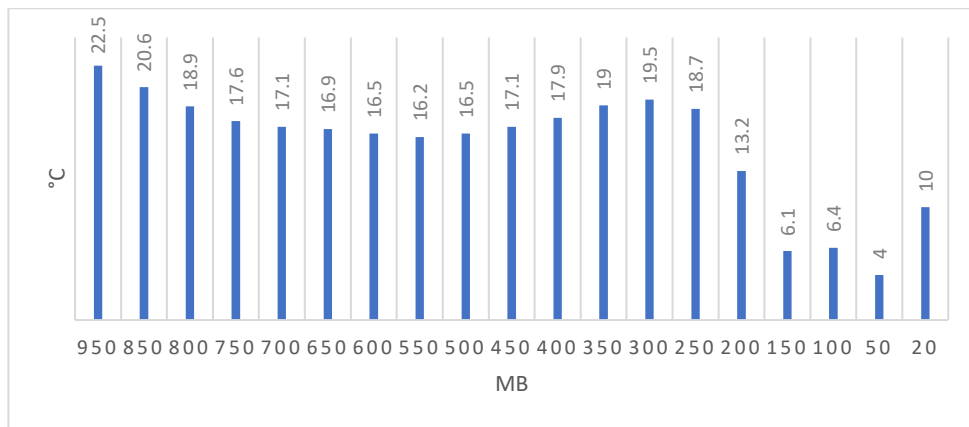


Fig. 18. Vertical distribution of the annual amplitude of mean monthly air temperature values over territory of Kakheti in January-December 2012-2016

As follows from these figures the annual amplitude of average monthly temperature it decreases with the height from the earth's surface (22.5 °C) to the level 550 mb (16.2 °C, height of approximately 5.0 km). Then occurs an increase in this amplitude to the level 300 mb (19.5 °C, height of approximately 9.0 km). In the layer 250-50 mb (approximately 10-20 km) occurs a sharp drop in the annual amplitude of the average monthly temperature of air (18.7 °C at the level 250 mb and 4.0 °C at the level 50 mb). At the level 20 mb (about 26 km) occurs a certain increase in this amplitude (10.0 °C).

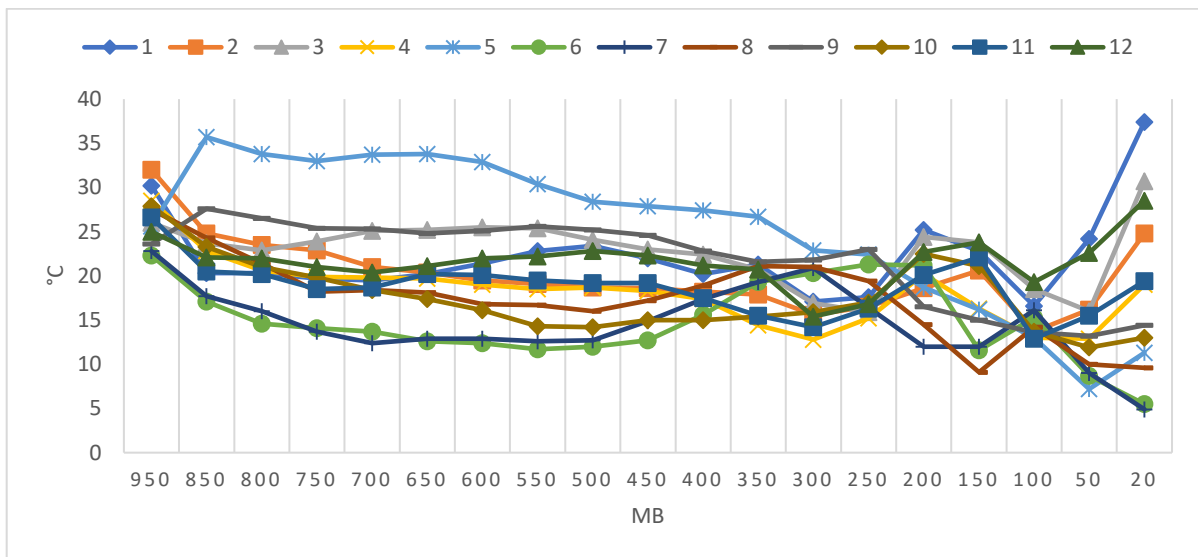


Fig.19. Vertical distribution of monthly values of the range of air temperature over territory of Kakheti in January-December 2012-2016

Finally, Fig. 19 depicts the vertical distribution of the monthly values of the variation scope of the temperature of air above the Kakheti territory for the separate months. As it follows from this figure, the greatest variations in the hourly values of the temperature of air in the layer of the atmosphere from 850 to 450 mb (approximately in the layer 1.5 - 6.0 km) during May and smallest - during June and July are observed. At the level 20 mb (approximately 26 km) the greatest variations are observed in the hourly values of temperature during January and smallest - during June and July.

Conclusion

It is planned in the near future conducting more detailed studies changeability of the vertical distribution of air temperature above Kakheti in the days with the convective processes in atmosphere. This information, in particular, will be useful for the construction of the more detailed maps (than in [28]) of the distribution of potential damage from the hail of agricultural crops, etc. taking into account the dimensions of hailstones in the clouds according to the data of radar measurements, heights of freezing level and locality [1, 29-34].

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კახეთის ტერიტორიაზე (საქართველო) 2012-2016 წწ. ატმოსფეროს 0.54-27 კმ ფენაში ჰაერის ტემპერატურის საშუალოთვიური მნიშვნელობების სტატისტიკური მახასიათებლები

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რეზიუმე

წარმოდგენილია სტატისტიკური ანალიზის მონაცემები 2012 - 2016 წწ. კახეთის ტერიტორიაზე ატმოსფეროში 19 დონეზე 0.54-დან 27 კმ-მდე სიმაღლეების დიაპაზონში ჰაერის ტემპერატურის საშუალოთვიური მნიშვნელობების შესახებ .

Статистические характеристики среднемесячных значений температуры воздуха в слое атмосферы 0.54-27 км над территорией Кахетии(Грузия) в 2012-2016 гг.

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Резюме

Представлены данные статистического анализа среднемесячных значений температуры воздуха в атмосфере над территорией Кахетии на 19 уровнях в диапазоне высот от 0.54 до 27 км для периода с 2012 по 2016.