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EFFECT OF CLIMATE CHANGE ON THE FREEZING LEVEL IN KAKHETI

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Summary: *Results of a study of the impact of climate change on the level of zero isotherm in Kakheti are presented. To do this, a statistical analysis of data on monthly average maximum air temperatures was carried out for six points of Kakheti (Telavi, Sagarejo, Kvareli, Gurjaani, Dedoplistskaro and Lagodekhi) from 1956 to 2015, as well as data on the height of the zero isotherm over the studied region from 1958 to 1961 and from 2012 to 2016. In particular, it was obtained that from 1956 to 2015 in Kakheti, at almost all six points in June and August, climate warming took place. In July, September and October an increase in the maximum air temperature is noted in the majority points. Accordingly, from June to October over the study area in 2012-2016, compared with 1958-1961, there was an increase in the height of the zero isotherm within 71-442 m. During May changes in the values of maximum air temperature in 1958-2015 is not observed, the height of the zero isotherm in this month in the second period decreased by 260 m. In all months, except June, into 2012-2016 in comparison with 1958-1961 an increase in the values of vertical gradient of air temperature is noted.*

Key Words: *Climate change, air temperature, zero izotherm.*

Introduction

The thickness of the supercooled part of the convective clouds is one of the most important conditions for formation and development of hail processes in them. Besides this, the data about the levels of negative temperatures in the clouds are necessary for the meteorological forecast of showers, thunderstorms and hail, determination of different characteristics of convective clouds from the data of radar measurements, optimum zones of sowing in them by the ice-forming reagent with the operations on the active actions for the purpose of the interruption of hail, the regulation of precipitations, etc. [1].

In the past century in the Soviet period of time the aerological sounding of the atmosphere in Tbilisi, Sukhumi, Batumi [2], and in the years of the work of anti-hail service in Kakheti in the village of Ruispiri of the Telavi municipality was carried out [3,4]. The aerological sounding of the atmosphere is not conducted after 1991 in Georgia.

At present, in connection with the restoration of anti-hail works in Kakheti [5,6], arose the need of obtaining the operational information about the vertical distribution of the meteorological parameters in this region of the Georgia, which was necessary both for conducting active actions to the hail-dangerous and hail clouds and for operational provisions of contemporary radar on recording of the parameters of hail clouds (probability of hailstorm, the size of hail, etc.) [1, 7]. For obtaining this information the resources of service of the worldwide network of the aerological observations of http://ready.arl.noaa.gov/READYcmet.php are used, according to data of which is possible the extrapolation of the vertical distribution of meteorological elements for by any point of world.

In connection with the climate warming [8-10] it is important to estimate the influence of this warming on the height of zero isotherm. This question, besides the scientific interest, has at least great practical value for developing the optimum means of active action on the hail clouds.

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 were used. For investigating the thermal regime change on the ground level in Kakheti data of the Hydrometeorological department of Georgia about monthly mean max air temperature in five locations of this region (Telavi, Sagarejo, Kvareli, Gurjaani, Dedoplistskaro and Lagodekhi) in 1956-2015 are used. Data about height of zero isotherm over Kakheti in 2012-2016 and 1958-1961 in respectively [2] and [3] are presented. Comparison of mean values of mean max air temperature in two periods of time was produced with the use of Student's criterion with the level of significance α not worse than 0.15.

Results and discussion

Results in Table1,2 and Fig. 1-4 are presented.

Table 1

Monthly Mean Values (1956-2015) and Difference Between Monthly Mean Max Air Temperature in Kakheti in 1986-2015 (II) and 1956-1985 (I) from May to October

Month	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**
Location	Telavi					
Mean	22.3	26.4	29.4	29.2	24.6	18.2
II-I	-0.1	1.3	1.1	1.7	1.3	1.1
α	No	0.001	0.01	0.001	0.001	0.05
Location	Sagarejo					
Mean	21.6	25.6	28.4	28.2	23.8	17.7
II-I	-0.5	0.7	0.4	0.9	0.5	0.1
α	No	0.1	No	0.1	No	No
Location	Kvareli					
Mean	23.4	27.6	30.6	30.3	25.7	19.3
II-I	0.1	1.4	1.0	1.6	1.1	1.0
α	No	0.001	0.05	0.001	0.01	0.05
Location	Gurjaani					
Mean	23.4	27.5	30.3	30.0	25.4	18.9
II-I	-0.1	1.1	0.9	1.4	0.9	0.7
α	No	0.001	0.05	0.001	0.05	0.15
Location	Dedoplistskaro					
Mean	20.8	25.5	28.5	28.3	23.5	17.0
II-I	0.0	2.1	1.8	2.4	1.8	1.2
α	No	0.001	0.001	0.001	0.001	0.01
Location	Lagodekhi					
Mean	23.6	28.0	30.8	30.4	25.9	19.5
II-I	-0.4	1.1	0.7	1.3	0.8	1.0
α	No	0.05	No	0.05	0.15	No

As follows from Table 1 and Fig. 1 in 1956 – 2015 in Kakheti, at almost all six points in June and August, climate warming took place. In July, September and October an increase in the maximum air temperature is noted in the majority points. During May changes in the values of maximum air temperature in 1956-2015 is not observed.

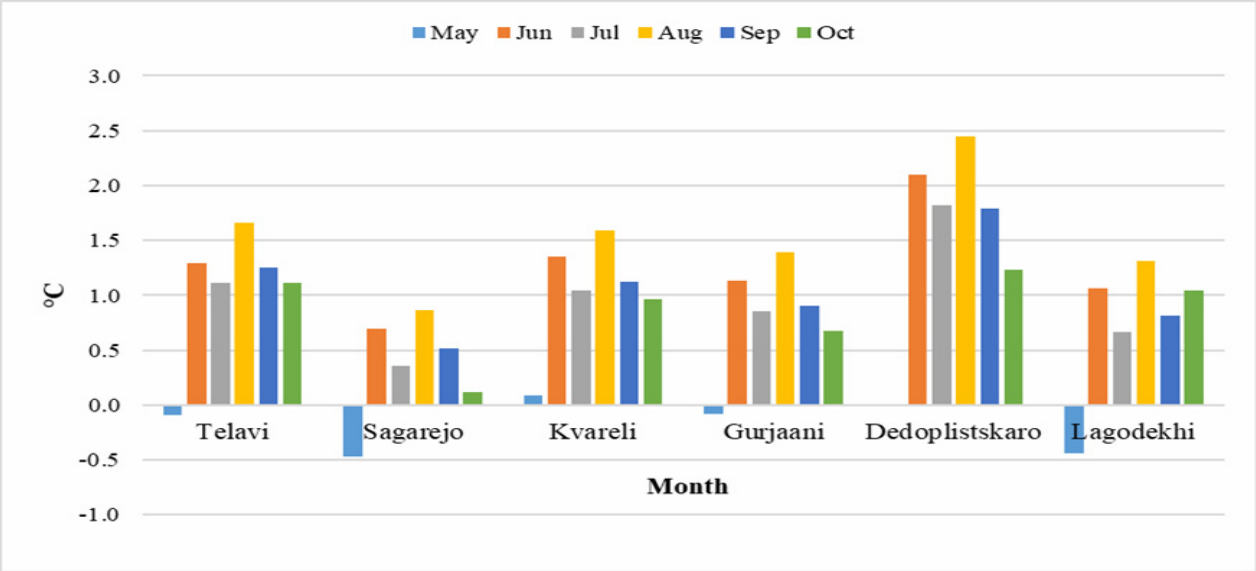

Fig. 1. Difference Between Monthly Mean Max Air Temperature in Kakheti in 1986-2015 and 1956-1985 from May to October

Accordingly, from June to October over the study area in 2012-2016, compared with 1958-1961, there was an increase in the height of the zero isotherm within 71-442 m (Table 2). During May the height of zero isotherm the second period decreased by 260 m.

Table 2

Difference Between Freezing Level Height over Kakheti in 2012-2016 and 1958-1961 from May to October (meter)

Month	I. 1958-1961	II. 2012-2016	II – I
May	3600	3340	-260
Jun	3800	3978	178
Jul	4250	4432	182
Aug	4200	4439	239
Sep	3650	3721	71
Oct	2400	2842	442

In Fig. 2-4 data about vertical distribution of air temperature over Kakheti in from May to October in 1958-1961 and 2012-2016 are presented.

As it follows from these Figures, the vertical gradient of air temperature in the first and second periods of time respectively constituted – May: -6.52 and -6.73 ˚C/km; June: -6.73 and -6.32 ˚C/km; July: -6.0 and -6.29 ˚C/km; August: -6.1 and -6.61 ˚C/km; September: -5.82 and -6.48 ˚C/km; October: -5.74 and -6.14 ˚C/km. It should be noted that in all months, except June, into 2012-2016 in comparison with 1958-1961 an increase in the values of vertical gradient of air temperature is noted. In this case a maximum increase in the vertical gradient of air temperature in the second period of time in comparison with the first is observed in September (0.66 ˚C/km).

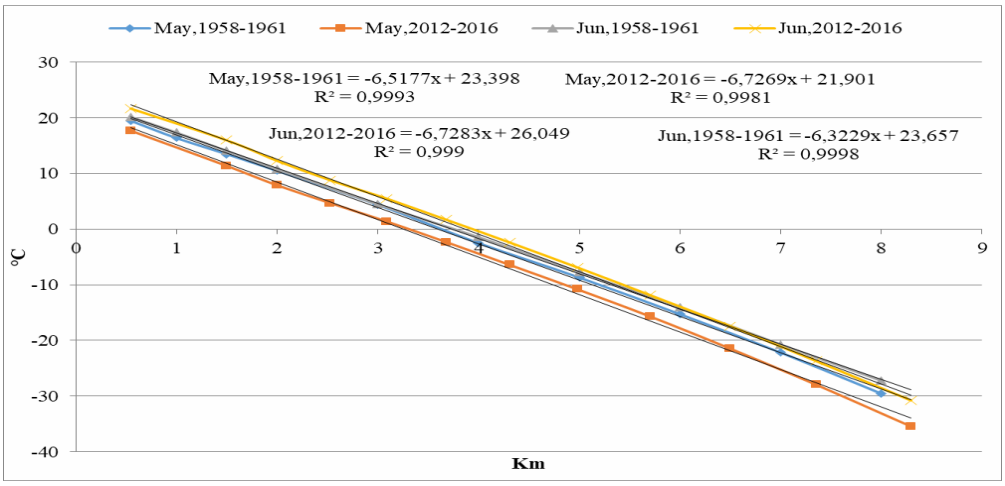

Fig. 2. Vertical Distribution of Air Temperature over Kakheti in May and June in Two Period of Time

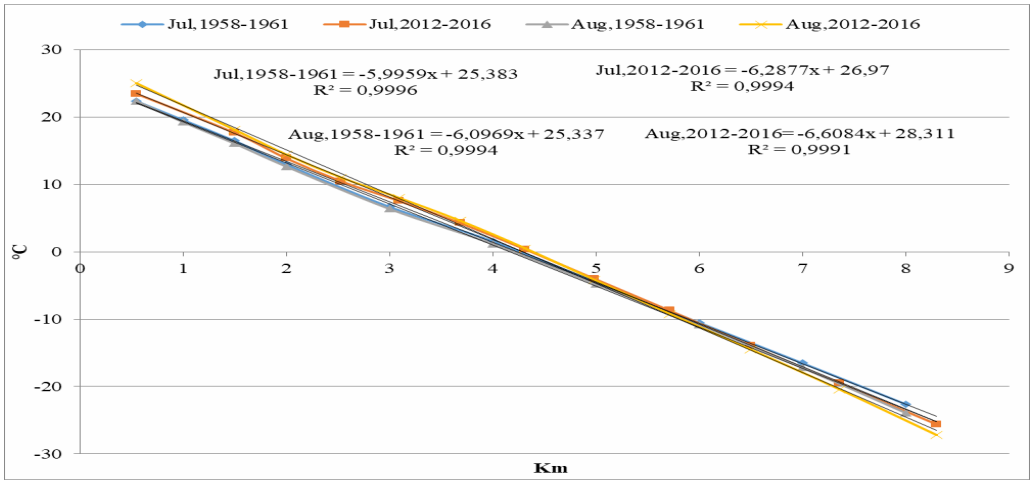

Fig. 3. Vertical Distribution of Air Temperature over Kakheti in July and August in Two Period of Time

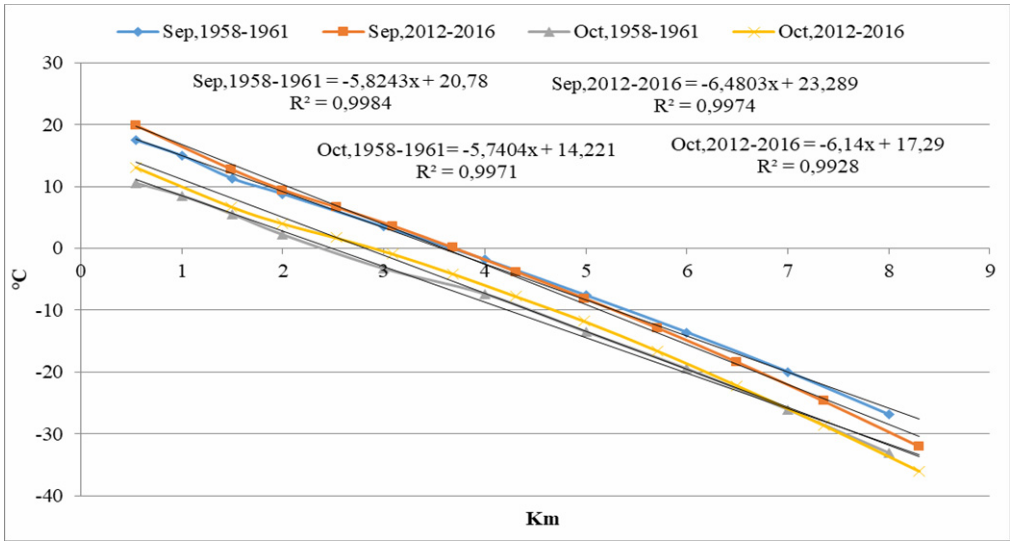

Fig. 4. Vertical Distribution of Air Temperature over Kakheti in September and October in Two Period of Time

Conclusion

Over the long term, in proportion to the accumulation of data, we plan performing analogous work for the days with the hail processes.

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