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Geophysics

The Propagation of the Horizontal Homogeneity of Surface Air Temperature Field in Mountainous Conditions (the Case of Georgia)

Kukuri Tavartkiladze, Dali Mumladze

Vakhushti Bagrationi Institute of Geography, Tbilisi

(Presented by Academy Member T. Chelidze)

ABSTRACT. The relation of surface air temperature field's variations to the distance between observation posts has been studied by the data of 89 meteorological stations of Georgia for a 90-year period, allowing to determine the propagation of horizontal homogeneity in mountainous conditions. An analytical expression, which determines the change of surface air temperature field's horizontal homogeneity with distance is given for a mountainous relief.

Key words: *temperature field, meteorological station, mountainous conditions.*

The location of weather stations in any region is very important for studying this region's climatic peculiarities. The proximity of observation posts depends on relief conditions. The horizontal homogeneity of the main climatic parameters covers much more area in valleys and lowlands than in mountains. Therefore the network of meteorological stations should be more compact in mountains than in valleys. Such stations are few and tend to be located at conveniently accessible sites, that is oftener in valleys and lowlands than in mountains (especially at high altitudes). The optimum configuration of the observation network is very important for constructing a detailed temperature field, especially when the observations are carried out at discrete points and the disposition of these points is sparse.

The aim of this paper is to study and determine the connection between the variations of surface air temperatures for two observation points situated at any distance in mountainous conditions, that is to study the size of the area of regularity of temperature field's (horizontal homogeneity) and develop its mathematical model. To solve this problem the observation data (on surface air temperature in 1906-1995) of 89 meteorological stations in Georgia were used.

It must be noted that the relief complications are rather well defined by location of used observation posts on Georgia's territory. For example: there are 18 meteorological stations located between 0-200 meters; as many at 200-500 m; 27 between 500-1000 m; 20 stations at 1000-2000 m; 6 are located above 2000 m; the highest station has the altitude of 3653 m above sea level.

In solving this problem, the homogeneity of the data base must be strictly observed as when studying any long term process in the environment, calling for this use of the empirical data base. Constancy of the observation method, equipment and location of stations determined the homogeneity for the given period. The methodology for restoring homogeneity was being worked out for many years, as there was no possibility of observing the above conditions in the hydrometeorological network. This problem has been studied and reported in [1] and now it is used in the present paper.

Thus the used basic data base was formed of two parameters: the average monthly temperature (T) of sur-

Table

Change of correlation coefficients between temperature variations according to the distance of two observation posts on Georgian territory

Range of distance between posts, km	Mean distance, km		Average coefficient of range correlations		Number of cases
	s	σ_s	r	σ_r	
0 – 30	22	6.0	0.880	0.081	118
31 – 60	47	8.3	0.849	0.087	371
61 – 90	76	8.5	0.823	0.093	451
91 – 120	105	8.7	0.798	0.092	512
121 – 150	136	8.7	0.778	0.097	453
151 – 180	165	8.8	0.768	0.096	402
181 – 210	196	8.6	0.751	0.101	377
211 – 240	226	8.7	0.743	0.095	292
241 – 270	254	8.5	0.731	0.081	267
271 – 300	285	8.8	0.713	0.076	203
301 – 330	315	8.6	0.728	0.062	138
331 – 360	344	8.7	0.726	0.059	109
361 – 390	375	9.2	0.718	0.054	87
391 -420	404	8.7	0.716	0.054	52
421 – 450	432	8.5	0.701	0.048	37
451 – 480	463	7.4	0.699	0.037	21
481 – 510	492	8.3	0.702	0.030	13
511 – 540	522	7.1	0.713	0.028	7
541 – 570	555	11.9	0.681	0.034	6

face air at 89 weather stations for 90 years (96120 cases) and direct distances (s) between any two observation posts determined by the geographical coordinates and altitudes (3916 cases) above the sea level.

Correlation coefficients $r(T_i,T_j)$ were calculated between mean monthly temperature variations for any two posts, and they were arranged according to the increase of distance between two posts. For every 30 km range the mean distance (s) was determined between the observation posts as well as their mean quadratic deviations (σ_s). Accordingly the coefficients of correlation (r) between two posts temperature variations were calculated as well as their mean quadratic deviations (σ_r). The results are given in the Table.

The correlation between s and r is shown in the Figure. As one can see, according to the variations of mean monthly temperatures, the correlation between any two meteorological stations gradually decreases with the increase of distance. The decrease is non-linear but follows a clear regularity.

In spite of mountainous relief the correlation coefficients between observation posts are high. For example, the lowest coefficient for the remote two observation posts is around 0.65, when the distance between them is 560 km.

We tried to represent the change of temperature field variations with distance or propagation of temperature field horizontal homogeneity by an exponential expression. Empirical coefficients were determined by the least squares method and the expression has the following form:

$$r(T_i,T_j) = \exp(-0.1s^{0.2}).$$

The curve (Fig.) built by the above formula, represents sufficiently well the actual change of correlation coefficients with distance and we believe that it can be used successfully in estimating the extent of temperature field horizontal homogeneity in any mountainous conditions.

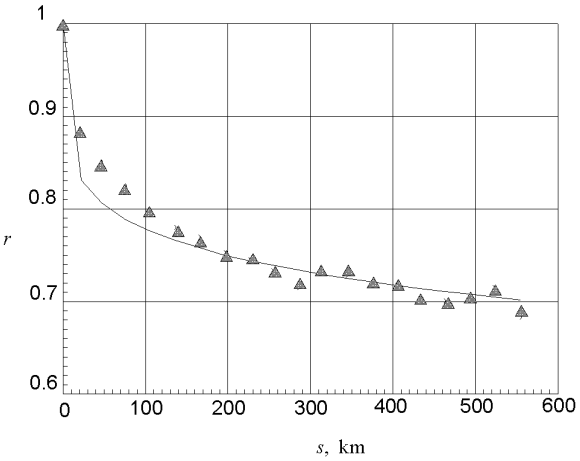

Fig. Connection of correlation coefficients (r) with distance (s)

გეოფიზიკა

ჰაერის მიწისპირა ტემპერატურული ველის ჰორიზონტული ერთგვაროვნების გავრცობადობა მთაგორიანი რელიეფის პირობებში (საქართველოს მაგალითზე)

კ. თავართქილაძე, დ. მუმლაძე

ვახუშტი ბაგრატიონის გეოგრაფიის ინსტიტუტი, თბილისი

(წარმოდგენილია აკადემიის წევრის თ. ჭელიძის მიერ)

ნაშრომში საქართველოს 89 დაკვირვების პუნქტის 90-წლიანი პერიოდის მონაცემებით შესწავლილია ჰაერის მიწისპირა ტემპერატურული ველის ვარიაციათა კავშირი დაკვირვების პუნქტებს შორის მანძილთან, ანუ ტემპერატურული ველის ჰორიზონტული ერთგვაროვნების გავრცობადობა მთაგორიანი რელიეფის პირობებში. მიღებულია ანალიზური გამოსახულება, რომელიც განსაზღვრავს მიწისპირა ტემპერატურული ველის ჰორიზონტული ერთგვაროვნების ცვლილებას მანძილის მიხედვით მთაგორიანი რელიეფისთვის.

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