T.Davitashvili [1], Z.Khvedelidze.[1], A.Khantadze [2], KTavartkiladze [3], I.Samkharadze [1]

[1]*Georgian Hydro-meteorological Institute,Tbilisi, Georgia.*
[2] *Tbilisi State University, Faculty of Exact and Natural Sciences, Tbilisi, Georgia.*
[3]*Georgian Geographic Institute, Tbilisi, Georgia*

INVESTIGATION OF SOME CLIMATE SINGULARITIES ON THE TERRITORY OF GEORGIA BY MATHEMATICAL MODELING

Introduction

Against the background of global climate change, climate change of Georgia is characterized with strongly expressed regional peculiarities. There are observed as warming as well cooling processes on the territory of Georgia. Namely statistical treatment of data of average climate temperature of 1905-1995 years has shown simultaneously sharp process of warming in the Eastern Georgia and climate cooling in the Western Georgia. There are also exposed the micro regions, where the average climate temperature does not change according to time. The mentioned changeability of the climate on the whole territory of Georgia corresponds to the picture of climate change on the territory of Georgia obtained by the observations conducted according to the program of the global climate investigation and model calculations of global climate [8].

1. Some Peculiarities of Climate Change on the Territory of Georgia

Since on the whole territory of the Western Georgia takes place the climate cooling process, it is necessary to find such constantly acting thermal and advective-dynamic sources, which will be periodic according to time, its periodically will have the order of the year and the characteristic horizontal L and vertical H scales will be equal accordingly to 200-300 km and 3-4 km. Among many atmospheric circular processes, which take place in the Western Georgia, only the circulation of the monsoon type is characterized by spatial and time parameters[12], that is caused by the irregular warming of the territory of Black Sea and Kolchi lowland during the year. This circulation (which can not exist in the Eastern Georgia), must be caused by the action of constantly acting two heating mechanisms, in which the Kolchi lowland plays the role of heating and the Black Sea - the role of refrigerator during the summer, but in winter – conversely: Kolchi lowland is a refrigerator and the Black Sea – heating. It is natural, that this alternation of the sources gives rise to the changes of temperature by the annual period. According to[8], the variety of general circulation of the Earth atmosphere and the failure in zonal regularity is caused by the thermal and cool sources (ocean - land), which are known as thermal machines of “second order” in atmosphere thermodynamic.

To the existence of the monsoon circulations in Georgia point the investigations [8], but there is mentioned, that the horizontal component U of the monsoon velocity, the magnitude of which does not exceed 1-3 m/c, is insignificant in comparison with the dominating winds (5-10 m/c) and its exposition needs the statistical treatment of climate parameters during long time. Unfortunately, Georgian meteorologist–experimentalists have not carried out large-scale investigations in this direction.

Since the reality of the existence of sources generating the monsoon circulation in the Western Georgia has no alternative and analogously are daily and nightly sources of breeze and valleys and mountains circulation, we assume as a priori the compulsory existence of the circulation of such type in the Western Georgia, the real exposition and detailed description of which must be the actual subject of the future research. The monsoon circulation, which is the most large-scaled among the daily and nightly breeze and valley and mountains’ circulations existing in the Western Georgia, easily can comprise all the territory of the Western Georgia till Surami Range. This circulation, which in winter generates the monsoon circulation rotating clockwise and the up flow stream in the Black Sea sufficiently far from the shore , is characterized by the down flow streams at Surami Range [8]. In summer, the circulation has the opposite direction of rotating and at Surami Range the up flow streams change by down flow ones in the Black Sea. The distance of up flow and down flow streams from the shore and the spatial scales of generated circulations depend on the contrast (intensity) of summer and winter seasons during a year [5].

2.Investigation of some singularities of atmospheric flows blowing from the Black Sea to the Kolchi lowland

Investigation of changeability of atmospheric currents transferred from the Earth one region to another with different physical properties is very actual problem of science. This problem especially is important for the territory of west Georgia, as there is observed cooling process on the background of global warming process. Usually such kind general problem is solved by numerical methods [7] but on purpose to obtain elementary features of this process we’ll simplify physical aspects of the problem. Namely at first we’ll study transformation of temperature and humidity fields (transformation of dynamic processes will be study separately) of atmospheric currents dislocated from the Black Sea to the Colchi lowland which has different physical parameters. We’ll investigate changeability of temperature and humidity fields structure in the lower layer of atmosphere(about 1000m). If we assume that in this layer intensities of the friction forces are constant and in the period of our observation the process is kvazi stationary i.e. the process is limited to stationary state and also if we neglect ray-radiation and phase currents of heat and presume that convection currents are minor in comparison to turbulence and advection movements, then system of hydro-thermodynamics equations describing above mentioned general process is coming to the following system of equations[7]:

$$u\frac{\partial\theta}{\partial x}=\frac{\partial}{\partial z}(k\frac{\partial\theta}{\partial z}),\ u\frac{\partial q}{\partial x}=\frac{\partial}{\partial z}(k\frac{\partial q}{\partial z}), \qquad (2.1)$$

with the following boundary conditions:

$S(x,z)\big|_{X=0} = S_1(x)$, $S(x,z)\Big|_{\substack{Z\to\infty \\ X \phi 0}} = S_1(\infty)$, $S(x,z)\Big|_{\substack{Z=0 \\ X\phi 0}} = S_0(x)$,(2.2) where S=(θ , q); θ is potential temperature; u is component of wind velocity along coordinates X; q is specific humidity; k -is coefficient of turbulence.

Let us assume that: wind velocity $\bar{u}$ is directed along the axis ox and does not depend on x and z . Also if we take into consideration that :

$$\frac{\partial\theta}{\partial z} = \gamma + \frac{\partial T}{\partial z} \text{ and } \frac{\partial\theta}{\partial x} = \frac{\partial T}{\partial x}, \qquad (2.3)$$

where T is temperature and γ is gradient of temperature.

For those idealist conditions we will have:

$$\bar{u}\frac{\partial T}{\partial x} = k\frac{\partial^2 T}{\partial z^2}, \qquad (2.4)$$

Solution of equation (2.4) we are searching by the following function:

$$T = T_0 - \gamma \cdot z + \Delta T(x,z), \qquad (2.5)$$

with the following boundary conditions:

when $x = 0$, $\Delta T = 0$ and when $z = 0$ and $x \phi 0$, $\Delta T = T_1 - T_0$,

where T_1 is temperature of Sea (we assume that it is constant), T_0 is temperature of land. Substituting (2.5) in (2.4) and with account of boundary conditions (2.2) we will have the following solution [7]:

$$\Delta T = (T_1 - T_0)[1 - \Phi(z\sqrt{\frac{\bar{u}}{4kx}})], \qquad (2.6)$$

where $\Phi(\xi)$ is integral of probability. By examining (2.6) it is follows that for the same values of ΔT are corresponding equal values of argument of function $\Phi(\xi)$. Let us denote:

$$z\sqrt{\frac{\bar{u}}{4kx}} = C \text{, or: } z^2 = \frac{4ck}{\pi}x \qquad (2.7)$$

It is obvious that C determinant value of $\frac{\Delta T}{T_1 - T_0}$ - which shows air masses transformation. If we change this value from 0.1 to 1.0 with the step 0.1 and find $\Phi(\xi)$ from the special table [7], then we get figure 2.1

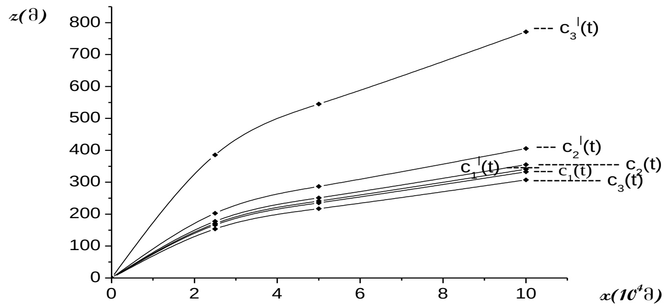

Fig.2.1

On the Fig.2.1 are represented dependence of Z from X, for the deferent values of C. Fig.2.1 shows that, process of transformation is limited to stable state with extending distance from the Sea shore and this process is going as fast as low the area of currents vertical spreading and bigger value of C.

If we take into account an orography of investigated region, namely go to the new Z coordinate $z_1 = \frac{z - \zeta(x,y)}{H - \zeta(x,y)} \cdot H$,

where $\zeta(x,y)$ - is describes non-homogeneity of relief; H -is top height, then (2.7) will get the form:

$$z_d^{\ 2} = \frac{4d^2Ck}{\bar{u}} \cdot x, \qquad (2.8)$$

where $d = \frac{H}{H - \zeta(x,y)}$ describes influence of orography.

Now let us consider this theory for real conditions, namely for the territory of western Georgia. We have chosen three zones with radius 25, 50 and 100 km from the Black Sea shore. On the bases of the data represented in the table 2 we have calculated the values of transformations parameters $C(t)$ and $C(q)$ also values of z and z_d - on the bases of formulas (2.8) Results of calculations are presented on the figure2.2.

On the figure2.2 are presented curves illustrated dependence of z and z_d on the x for deferent values of $C(q)$. Analysis of behavior the curves on the figure 2.2 shows that with the increasing distance from the Black Sea shore the process of air masses transformation limits to stability not only for the bigger value of C (as it is in the theoretical part) but also by influence of relief. Also taking into account orography increased height of transformation area. That is important result as this fact was known in synoptic practice. Namely synoptic observations have shown that influence of relief on transformation of meteorological fields is distinctly observed not only on the 850mb, but also on the 700mb surface

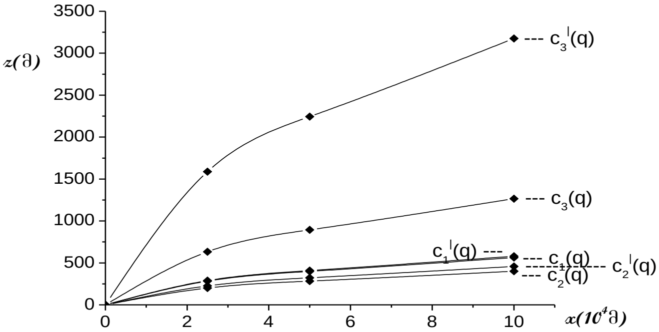

Fig. 2.2

Also results of calculations have shown that inside of zone with radius 25km. atmospheric masses have preserved the Black Sea's parameters. The main changeability of atmospheric currents parameters were observed inside of zone 25-50km. Inside of zone 50-100km. atmospheric flows have gotten the land's parameters. These results were obtained at first time by theoretical methods and they are in a good accordance with the data available in operational practice.

3. Some peculiarities of droughts on the territory of Georgia

Droughts in Georgia is characterized by special extra conditions of the weather, with high temperature, low humidity and absence of atmospheric precipitations for a long period of time, i. e. when a daily norm of atmospheric precipitations are less than 1mm. Genesis of droughts is determined by numerous natural phenomenon, but on the territory of Georgia atmosphere currents play an great importance. Namely when air currents are invading from the east, or south-east regions, they bring dry air masses on the territory of Georgia. Namely during the influence of the Asia Depression, the currents of summer thermal cyclone are extending from the south-east and as a result dry and hot air masses are formed over the territory of Georgia. Minimum temperature of the lowland dos not fall below +20° C , and a daily maximum exceeds +38° C. Recurrence of the influence is the highs in July (25,1%).

. In the dry regions of eastern Georgia 15-20 days with dry weather is observed 5-6 times in year and some times dry weather period exceed 80-90 days. Reiteration of the eases the amount of atmospheric precipitations is less then 150 mm. For example in Shiraci it is equal19% and in Gardabani area 44%. That is way there is observed desertification processes in Gardabani and Shiraci regions[11]. It is known that in Georgia the most drought regions are lower Kartli and lowland of Eldary, where possibility of the severe drought is about 40%, in Shiraki Valley- 20-40% and in the vest regions of arid East Georgia probability of the severe droughts is 10-20%. Also investigations have shown that during XX century in every ten years annual average temperature has increased in average about 0.02-0.07^0 C, which is closed to the velocity of global average annual temperature rise[4].

4. On The Thermodynamic Model of Desertification Process

Conditions, which stipulate the surface layer desertification are so versatile that their simultaneous consideration in a general desertification problem meets unsolvable mathematical difficulty . So, while discussing indicated problem by mathematical modelling it is necessary to separate out these main factors , which essentially condition surface layer desertification process. As well as in other physical problems desertification problem should be brought down to the creation of a certain desertification theoretical model , in which main physical mechanism causing desertification will be preserved. So that to find out whether what kind of physical process is going on during the baring of soil surface , it is necessary to proceed from soil , as a physical environment, conception. Following to [9] if we generally mark the heat flow and loss functions by $Q(t)$ and $R(t)$ functions, the equation of soil heat conductivity formula will look as[2.6]:

$$pc = \frac{\partial T}{\partial t} = \frac{\partial}{\partial z}\lambda\frac{\partial T}{\partial z} + Q(T) - R(T). \qquad (4.1)$$

where p, c, λ parameters represent the power functions of temperature T . Generally the equation (4.1) is solving with the initial and the boundary conditions:

$$T(0,t) = \varphi(t) * T(z,0) = f(z), \qquad (4.2)$$

where the quantities $\varphi(t)$ and $f=(z)$ represent the functions depended on the solar radiation and the intensity of Earth radiation. Certainly, the temperature change caused by the solar radiation at the considerable depths of the soil $(z\to\infty)$ should tend to zero. Let us consider a thermal function of volume and the heat conductivity coefficient[10]:

$$du = pcdT; \qquad f=\frac{\lambda}{pc}=au^{n}, \qquad (4.3)$$

The result of equation (4.1) and the relation (4.2) gets the following form:

$$\frac{\partial u}{\partial t}=\frac{a}{n+1}\frac{\partial^2 u^{n+1}}{\partial z^2}+Q(u)-R(u)\cdot \qquad (4.4)$$

$$U(0,t)=\Phi(t): \quad U(z,0)=F(z), \qquad (4.5)$$

where $a=f_0u_0^{-n}$; $f_0=\dfrac{\lambda_0}{p_0c_0}$; the coefficient n shows the nonlinear character of desertification process; ρ_o, C_{po} and λ_o are values of density and heat transfer coefficients , respectively, when $T=T_0$.

5. **Analytical Consideration**

In order to solve the task, the thermal sources should be identified. Let us consider the case when the difference between heat flow and loss functions represents the power function of the u function

$$Q(u)-R(u)=\alpha u^{\sigma}, \qquad (5.1)$$

where α and u^{σ} are the parameters of the thermal function.

The representation of thermal functions $Q(u)$ and $R(u)$ by means of power formula of u function is justified by the fact that they represent the complex temperature function in the thermodynamic tasks of the soil. The aforementioned appropriateness changes from the appropriateness of Newtonian thermal function ($\sigma=1$) to the appropriateness of the Boltsman thermal function ($\sigma=4$) according to the value $\Delta T=T-T_e$, where T_e is the temperature of environment. According to the relation (5.1), the equation (4.4) get the following form [2,3,6]:

$$\frac{\partial u}{\partial t}=\frac{a}{n+1}\frac{\partial^2}{\partial z^2}u^{n+1}+\alpha u^{\sigma}. \qquad (5.2)$$

The first term in the right part of the equation (5.2) expresses the nonlinear heat transfer process, and the second member marks the action of the nonlinear thermal sources in the soil.

An exact solution of equation (5.2) was obtained by us in case when $\alpha=0$ [2]. It is easy to demonstrate that considering the thermal source the equation (5.2) preserves the mechanism of "greenhouse effect" in case when we assume that $\sigma=n+1$. Consider also that the α parameter must include the effect of the thermal activity resulted by the change of internal soil parameters (p,c,λ). The intensification of this thermal activity effect promotes the sharpening of "greenhouse effect", and the growth of q parameter, which prevents the development of "greenhouse effect" in the soil. Out of the aforementioned let us introduce α parameter as a two members difference

$$\alpha=\alpha_1(p,c,\lambda)-\alpha_2(q) \qquad (5.3)$$

and rewrite the equation (5.2) in the following way:

$$\frac{\partial u}{\partial t}=\frac{a}{n+1}\frac{\partial^2 u^{n+1}}{\partial z^2}+(\alpha_1-\alpha_2)u^{n+1}. \qquad (5.4)$$

By direct insertion it is possible to show that the nonlinear solution of the equation (5.4), which includes the "greenhouse effect" will be [3,6]:

$$u(z,t)=u(0,0)\cos^{\frac{2}{n}}\left(\frac{\pi}{2}\frac{x}{|\Delta|}\right)\cdot\left(1-n\frac{t}{|t_f|}\right)^{-\frac{1}{n}}, \qquad (5.5)$$

where $|\Delta|$ and t_f are defined by the formulas:

$$|\Delta|=\frac{\pi}{n}\sqrt{n+1}\sqrt{\frac{f_0}{|\alpha_1-\alpha_2|}}; \quad |t_f|=\frac{2(n+1)}{(n+2)}\frac{u_0^n}{u^n(0,0)|\alpha_1-\alpha_2|}. \qquad (5.6)$$

The formula (5.5) shows that desertification process develops in time in three stages:

1.If the water content q is sufficient to satisfy the condition $\alpha_1(p_1,c_1,\lambda_1)=\alpha_2(q_1)$ then $|\Delta|\to\infty$, $|t_f|\to\infty$ is obtained from (5.6) formulation, and the stationary temperature distribution can be obtained from the formula (5.5):

$$u=u(0,0), \quad that\ \ is \quad T=T_{st}^{(1)}. \qquad (5.7)$$

This kind of thermal condition of the soil takes place before the desertification process begins, when the vegetation coverage and the precipitation amount is sufficient for normal functioning of the thermally active soil layer;

2.If the thermal activity coefficient is higher than the heat loss coefficient, which represents the q water content function, than the following equation will be obtained from $|\Delta| = \Delta > 0$, $|t_f| = t_f > 0$ and formula (5.5):

$$u(z,t) = u(0,0)\frac{\cos^{\frac{2}{n}}\left(\frac{\pi}{2}\frac{z}{\Delta}\right)}{\left(1 - n\frac{t}{t_f}\right)^{1/n}}, \quad (5.8)$$

which includes the "greenhouse effect" - thermal process that is space limited ($z < \Delta$) and grows by time for the $t < \frac{t_f}{n}$ interval. This type of appropriateness of soil temperature field should take place in desertification process.

3.If by human active interference in the desertification process the water content q grows up so as to satisfy the condition $\alpha_1 < \alpha_2$ then, $|t_f|_f$ in the (11) formulation will be negative and equal to and imaginary $|\Delta|$ to $|\Delta| = i\Delta$. Therefore (5.5) solution will have the following form:

$$u(z,t) = u(0,0)\frac{\cos^{\frac{2}{n}}\left(\frac{\pi}{2}\frac{z}{\Delta}\right)}{\left(1 + n\frac{t}{t_f}\right)^{1/n}}, \quad (5.9)$$

The (5.9) formula demonstrates that the thermal function of soil will be space limited in this case as well ($|z| \le \Delta$), and will have the form of time reducing function. This kind of thermal process will develop in the soil under the soil-conservation methods accomplished by a man. At this time the $u(u^t)$ function achieves zero for a long-term interval and the "greenhouse effect" exists. Out of the above mentioned it may be concluded, that analytical formula (5.5) quantitatively well describes the three stages of desertification process and includes the basic physical mechanism which is the basic reason of desertification. This physical mechanism proceeds in cooperation of two opposite process (sharpening of the "greenhouse effect" because of the structural change of the soil and thermal activity on the one hand and the weakening of the process resulted by man's active interference).

6. Estimation Method of Desertification Process

There was elected such long-term climatic observation station in the region of expected desertification, which has been characterized by the increased drought frequency in recent years. We have studied the temperature of soil surface in the selected station and variations of precipitation and established the climatic parameters, which can be regarded as the beginning of desertification. In the region of climatic warming we have examined the anomaly variation of soil surface average monthly temperature from January 1936 to December 1990 in order to reveal the most clearly expressed increasing of the surface temperature. Such observation station was selected in Shiraki. Variation of temperature by seasons as it known[13], happens in different ways. For instance, according to years the warming process is conditioned by an increase of temperature in cold period of the year.

Only the temperature variation of the warm period might have a main effect on the desertification process. Therefore, it is necessary to examine the action of cold and warm season variations on the average annual variation of anomalies according to the soil surface temperature as well as precipitation anomalies. For this purpose, normalized autocorrelation matrix was determined for Shiraki according to the soil surface temperature and average annual and seasonal precipitation anomalies [13]. Calculations have shown that the anomalies of the soil surface average annual temperature are mainly determined by cold season (correlation coefficient-0.83), but warm season also has rather great share (correlation coefficient-0.67) in temperature increase according to the years. As to the precipitations variation it occurs almost completely on the expense of warm season (correlation coefficient-0.89).Comparatively high correlation link between temperature and precipitation anomalies is revealed in conditions of warm season (correlation coefficient-0.6), which is one more index of desertification process development. This dependence is well expressed by the curve constructed with the method of least squares which analytical form is:

$$\Delta N = -21.9 - 108.2\Delta T + 32.6(\Delta T)^2$$

Where ΔT and ΔN are the anomalies of temperatures and precipitations of correspondingly.

Thus, as criteria of quantitative estimation of desertification process the anomalies of soil surface temperature and the amount of precipitation were selected. For determination of the criterion the following procedure seems to be reasonable: temperature anomalies are determined by 40-50 year, monthly complete data of soil surface temperature of observation station.

Those years are selected in warm period of which three or more months anomalies (one by one) are positive and each one is not less than 0.5 °C. According to corresponding periods precipitation anomalies are determined and according to temperature from selected years those will be left when positive anomalies of temperature will be followed synchronically only by negative anomalies of precipitations. The anomaly of month average temperature and precipitations of drought period is determined. Their product on the amount of the given months period determines the values of temperature excess stimulating desert and lack of precipitations. Let's take practical example according to the data from Shiraki. In the 1936-1990, in Shiraki 13 years appeared too droughty by anomalies of soil surface temperature and precipitations. Calculations for these years have shown the greatest excess of soil surface temperature was recorded in June-December , 1966 and made 17.8 °C. The lack of precipitations in the mentioned period was 21 mm. If the average annual value 2.3 °C /year of temperature excess stimulating desertification. Correspondingly, the value of precipitations lack will be 19 mm.The same approach can be applied to determine the values of the mentioned parameters for other stations, which help to determine numeric values of the parameters characteristic for the beginning of desertification[13]..

8. Conclusions

As our conception about climate cooling has the general form, climate cooling must take place in other regions of the Earth; particularly, where the monsoon flow and the advective – orographic factors are sharply expressed. For verification of this conception we can take the picture of global climate warming, which has a mosaic structure. There are given cooling and warming regions of the Earth caused by big variety of the regional factors. The fact of climate cooling in the Western Georgia can become the important conception of Georgian governmental policy. It will be reasonable strategically if the development of industry in the future connected with green house gases takes place in the Western Georgia.

Out of above considered theoretical model of desertification it proceeds that to halt the desertification process, first of all it is essential to stop non-linear thermal process occurring in the soil, causing its structural change due to the "greenhouse effect". In order to achieve this aim, the measures, that will decrease solar radiation load upon the soil and will cause naturally the "greenhouse effect" extinction in its active layer, should be conducted. This needs to use a system of drip irrigation and well-known methods of hydroponics basing upon a many-year experience of the scientists from Israel. This time it is necessary to sow such heat-resistant wild plants, which in several months form the vegetation cover of the soil are characterized with deep and branchy roots and even in case of their upper part burning, they should preserve vitality and biological activity. As a result of conducting multiple indicated measured the intensity of radiation load upon the soil surface will decrease and the introduction of salts, necessary for soil by a method of hydroponics and the soil biological enrichment (as a result of wild decay) with the mass, accumulated at the expense of wild plants, will result, in our opinion, suspension of desertification process and extinction of the "greenhouse effect" in the soil active layer.

ლიტერატურა - REFERENCES – ЛИТЕРАТУРА

1. T.Davitashvili and A.Kantadze 2004, Research of Conditions of the climate Change in Georgia in view of Regional Antropogenie Factors., Journal Geography and Natural Resorses, Novosibirck, Russian Academic Publishers, p.p302-308.
2. T.Davitashvili, A.Khantadze, Kh.Sharikadze 2002, Influence of Non-linear Heat sources on Climate Change. Reforts of VIAM Vol.17, No3, p.21-29.
3. T.Davitashvili 2006,Oil Filtration in Soil: Problems of the Georgian Section of TRACECA and Their Numerical Treatment. ARW/NATO, Amsterdam, Springer, Netherland Press, p.p56-69.
4. M,Elizbarashvili, T.Aladashvili, N.Sulxanishvili 2002, Climate Current Variation and Expected Climate Seevarios for Arid Regions in Georgia, Transactions of the Institute of hydrometeorologe v. 107 p. 175-178., (Georgian).
5. Sh.Javakhishvili 1988, Description of Georgian Climate by the Months: Publishing House “Ganatleba”. Tbilisi, , pp.153. (Georgian).
6. A.Khantadze, T.Gzirishvili, G.Lazriev 1997, On the Non-linear Theory of Climatic Global Warmining,. Bulletin of CRNC. No 6, p.3-33.
7. Z.Khvedelidze,T.Davitashvili, N.Ramishvili 2008, Investigation of changing of temperature and humidity fields during transformation of air currents blowing from the Black Sea, Transactions of the Institute of hydrometeorologe(in press).
8. M.Kordzakhia 1981, Climate of Georgia,198, Ganatleba, Press.
9. V.Krapivin, K.Kondratyev,2002,Environmental Global Change: Ecoinformatics, 476, Gidrometeoizdat Press.
10. L.Landau, E.Lifshits. 1988, Hydrodynamics,Nauka.Press p. 347.
11. L.Papinashvili 2002: Drought in Georgia: Transactions of the Institute of Hydrometeorology: 107: p.p 28-33(Georgian).
12. V.Shuleikin, 1968, Physics of Sea, Nauka Press, p.p 367
13. K.Tavartkiladze, G.Mestiashvili, E.Sajaia, L.Beroshvili 1998, On Estimation Method of Desertification Process, Bulletin of the Georgian Academy of Sciences, 165, No..2, p.p 289-293.

უაკ 551.58

საქართველოს ტერიტორიაზე კლიმატის ცვლილების ზოგიერთ თავისებურებათა გამოკვლევა მათემატიკური მოდელირებით. /დავითაშვილი თ., ხვედელიძე ზ,. ხანთაძე ა., თავართქილაძე კ., სამხარაძე ი./ ჰმი-ს შრომათა კრებული -2008.-ტ.115.-გვ. 7-18.- ინგლ.; რეზ. ქართ., ინგლ., რუს.

ამ ნაშრომში შეისწავლება რეგიონალური კლიმატის ცვლილების ზოგიერთი თავისებურებები მათემატიკური მოდელირებით. კერძოთ მათემატიკური მოდელირებით შეისწავლება კლიმატის აცივების ეფექტი დასავლეთ საქართველოში და კლიმატის დათბობა აღმოსავლეთ საქართველოში.

მოცემულია გაუდაბნოების თერმოდინამიკური მათემატიკური მოდელი გაუდაოზბნების პროცების ხელშემწყობი პროცესების შეფასების მიზნით შესწავლილია მიწის ზედაპირის ტემპერატურისა და ნალექების ურთიერთ კავშირი.

UDC 551.58

INVESTIGATION OF SOME CLIMATE SINGULARITIES ON THE TERRITORY OF GEORGIA BY MATHEMATICAL MODELING./Davitashvili T., Khvedelidze Z., Khantadze A., TavartkiladzeK., Samkharadze I./ Transactions of the Georgian Institute of Hydrometeorology. -2008. - т.115. – p. 7-18, - Eng.; Summ. Georg.; Eng.; Russ.

In the present work the specific properties of regional climate change on the territory of Georgia is studied by mathematical modeling. Namely the processes of climate cooling in the western Georgia and climate warming in the Eastern Georgia (for assessment of risk of desertification process development) are studied. The specific peculiarities of the thermodynamic model describing desertification process is discussed. For description of desertification favoring processes, behavior of the earth surface temperature and precipitations are studied.

УДК 551.58

ИССЛЕДОВАНИЕ НЕКОТОРЫХ ОСОБЕННОСТЕЙ КЛИМАТА НАД ТЕРРИТОРИЙ ГРУЗИЙ С ПОМОЩЬЮ МАТЕМАТИЧЕСКОГО МОДЕЛИРОВАНИЯ./ Давиташвили Т., Хведелидзе З., Хантадзе А., Таварткиладзе К., Самхарадзе И**./** Сб.Трудов Института Гидрометеорологии Грузии. –2008. – т.115. – с. 7 -18 . – Анг.; Рез. Груз., Анг.,Рус**.**

В данной работе изучается некоторые особенности изменения регионального климата с помощью математического моделирования. Именно изучается процесс похолодание климата в Западной Грузии и потепление в Восточной Грузии. Предлогается термодинамическая модель опустошения. С целью исследования процесса опустошения изучается взаимосвязь между атмосферной температуры и полей влажности.