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Roman Corobov, Alla Nicolenco

SPATIAL PRESENTATION OF REGIONAL CLIMATE CHANGE INFORMATION

Abstract: The method to calculate the climate change projections in any point of territory is proposed. The procedure is based on statistically significant dependence of the climatic variable changes on geographical latitude and enables to automate their digital mapping. Two possible applications of the method are demonstrated: (1) digital mapping of spatial distribution of the likely future values of key climatic variables; (2) mapping of the projected parameters of applied climatology.

Key words: aridity, climate change, climatic mapping, general circulation models.

1. Introduction

As is well known, the climate change scenarios, based on the General Circulation Models (GCM), use the simulated values attributed to a model's regular geographical grid nodes (Viner, Hulme 1997). However, for the small countries, such as the Republic of Moldova, direct use of this gridded data is extremely hampered because of relatively low original spatial (latitude/longitude) resolution of the GCMs: their geographical grid boxes vary from $2.8^{o}x2.8^{o}$ to $7.5^{o}x4.5^{o}$ (IPCC-TGCIA 1999). As a result, an obligatory element of any regional climate change research is downscaling of the modeled projections to the dimensions providing for necessary spatial details.

The climate change modeling outputs, attributed to a grid node, result from spatial averaging over a grid box and assume uniform distribution of the variables within this box that is not so in reality. In this connection the different methods are proposed for transition from such averages to values in any point of territory. For example, it may be named the statistical approach as well as the formal linear interpolation by the nearby grid box values. However, both these methods do not solve completely the task of transition to local information. In the first case (Harrison et al. 1995) there are needed the dense time-depended network of observation stations and labor-consuming calculations to establish statistical relationships for the present-day climate. In the second case any linear interpolation is a formal procedure even if to take into account the distances between an estimated point and the nodes (Feenstra et al. 1998). Therefore, in our work an attempt was maid to use for this goal *the real regularities* in spatial variability of the meteorological characteristics' modeled change.

2. Methods

To identify the regularities in spatial variability of climate change, its dependence on geographical latitude and longitude was studied. As a rule, there is a high level, statistical significant correlation between projected change of at-site surface air temperature and precipitation, and latitude. These relationships are very well described by the second order polynomial, herewith the form and parameters of polynomial depend on studied climatic characteristic and month. However, it was not found the analogous, mathematically formalized dependence in a latitudinal course of the changes and algorithm, developed for description of spatial variability in the climate projections, used a mixed approach.

As an example, the procedure for transition from the air temperature change's value (δT) for Moldova on the whole to a local (in a point) value included next steps (Fig. 1):

1. Estimation of δT in each grid node along the meridians crossing the Moldova's territory for the optimal latitudinal diapason from 30° to 60°N (Tab. 1).

2. Construction of the graphs for dependence of δT on latitude and their approximation by polynomial functions (Fig. 2).

3. Based on the corresponding regression equation the calculation of δT values for latitude of the point (ϕ) at two adjacent meridians (λ_1, λ_2).

4. By means of linear interpolation between the values received at step 3 the calculation of final δT value as function of the point's longitude.

To automate this algorithm a special computer program was developed. The program allows the calculation of a climate change value both in any point of territory and in the nodes of arbitrarily selected regular grid, that is allows to transit to *cartographic representation of climate change simulations in a digital form*, or to produce so-called "*changefields*" (Carte, Hulme 1999).

Tab. 1. Fragment of the mean monthly air temperature changes for the different nodes of CSIRO regular grid (April, 2040-2069 projections).

Longitude, degrees EL	Latitude, degrees NL							
	36.635	*39.821*	*43.007*	*46.192*	*49.378*	*52.563*	*55.749*	*58.934*
22.500	1.87	2.16	2.36	2.40	2.41	2.53	3.39	4.58
28.125	2.01	2.26	2.44	2.55	2.56	2.90	4.26	6.05
33.750	2.39	2.29	2.39	2.65	2.78	3.35	5.05	5.97

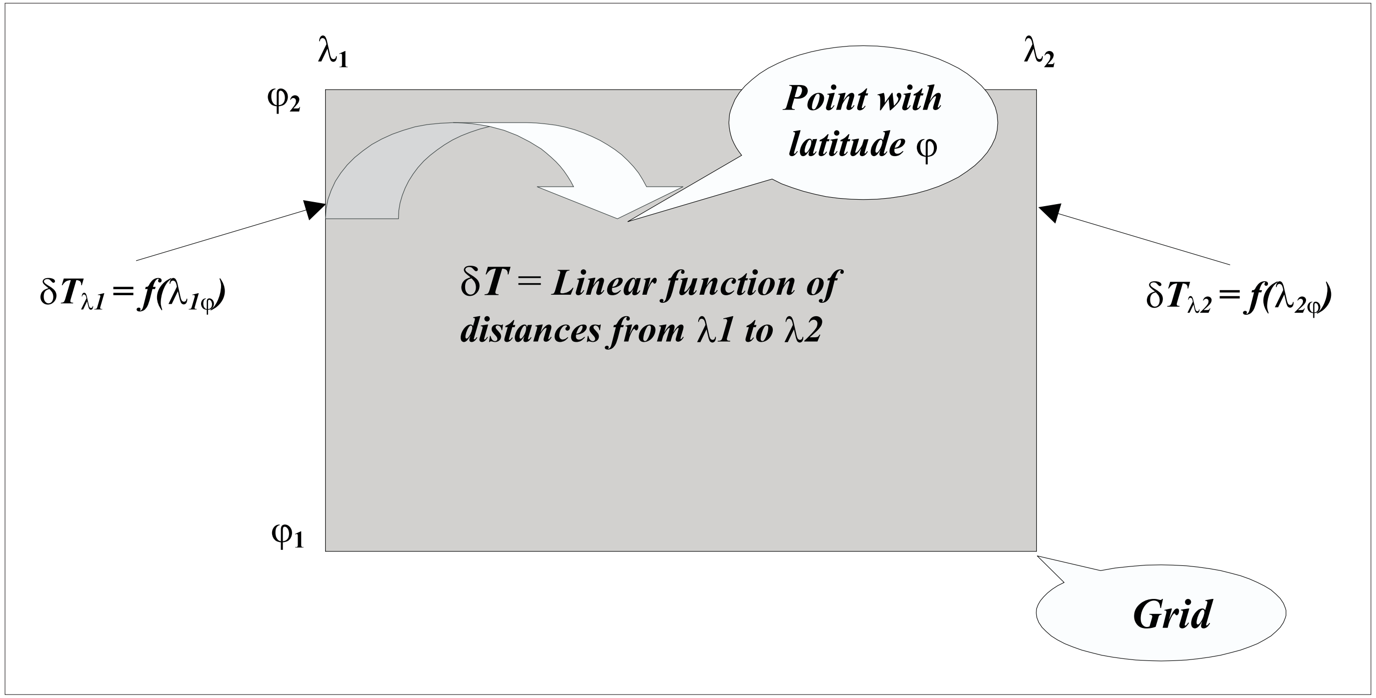
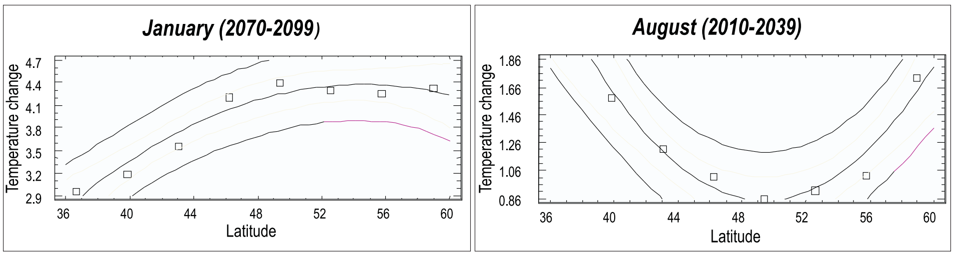


Fig.1. Scheme of the air temperature change *(dŇ)* estimation in a point.



Month	Timeslice	Coefficients of polynomial regression			r	p
		Intercept	For φ	For φ^2		
January	2070-2099	-9.925	0.524	-0.005	0.973	0.001
August	2010-2039	21.874	-0.851	0.009	0.965	0.005

Fig.2. An example of monthly mean temperature dependence on latitude and its approximation by the second order polynomial regression.

3. Results and Discussion

Although the proposed method takes into account mainly the zonal factors of climate variability (without influence of orography), it none the less allows working out in more spatial details the climate change simulations. In particular, climatic digital cartography gives opportunity to solve several tasks, which are possible only due this procedure. Among them one may pick out two the most important:

1. *Mapping of the likely future climate* by compiling of the «changefield» maps with the baseline climate ones. The letters, being developed as digital in General Information System (GIS)-environment, take into account the relief practically completely (Corobov et al, 1995). Overlapping of two information coverages gives directly the maps of expected climate (Fig.3).

2. *Mapping of the different parameters of applied climatology*. To solve the task the temperature and precipitation change projections have been transformed in some complex indexes. As an example in Figure 4 there are shown the aridity maps of Moldova territory for the present-day climate as well as for a likely climate change for two alternative scenarios *(CSIROMk2* and *ECHAM4)*. Aridity index is usually calculated as a precipitation to potential evaporation ratio (Milich 1997). Possible change of potential evaporation was estimated as regression function of its present response to the key variables' (air temperature and precipitation) change.

The main distinction of this method from the first is that all variables have been calculated for the observation stations only and then the aridity maps were constructed, using a standard software, in particular *Surfer*. Therefore, in this case the outputs are