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REGIONAL CLIMATE MODEL SIMULATION OF GEORGIA PRECIPITATION AND SURFACE AIR TEMPERATURE DURING 2009–2014

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Abstract. *This study uses the latest version – v4.7.1 of the Regional Climate Model (RegCM) of Abdus Salam International Center for Theoretical Physics (ICTP). The complex orography of the Caucasus and the proximity of the Black and Caspian Seas make it necessary to use high-resolution models. The spatial resolution of the model is 12 km. Model predictions are compared with observational data, and some estimations are made. We use ERA5 high-resolution climate data (ECMWF) for RegCM in the years 2009-1014.*

Key words: *climate change, Monthly mean air temperature, Monthly mean precipitation.*

Introduction

Atmosphere-ocean global climate models (AOGCMs) are the most modern tools for making climate change projections. However, their low resolution does not adequately resolve the issue of small-scale topography and weather systems, which are necessary to assess impacts at local and regional scales. Regional climate modeling is a widely accepted tool that can be used to expand AOGCM information to a resolution sufficient for impact studies and, therefore, for local policy makers. Before the projection of climate change using the regional climate model, it is necessary to study the issue of reproducing historical data by the regional climate model, which means comparing the model and observational data. From this point of view, several experiments were conducted for Georgia using the regional climate model [1,2]; the article presents one more experiment and assessments.

Materials and Methods

In this study, a Regional Climate Model (RegCM4.7.1) with CLM 4.5 option was compiled [3]. The model was run with Emanuel Cumulus convection scheme and Explicit Nogherotto-Tompkins moisture scheme [4, 5]. The simulation for the period of 2009-2014 years is performed at a 12 km horizontal grid spacing using ERA5 high-resolution climate data (ECMWF) as boundary conditions. The domain with 252 points in the E/W direction, 172 points in the N/S direction and 41 vertical levels, with the center in clat = 41., clon = 43 was used. This domain completely covers Georgia's territory, the Caucasus mountains, the full Black and Caspian Seas and surrounding areas. The output from high-resolution simulation of monthly mean precipitation and air temperature were compared with observed station data for Georgia for 2010-2014 years as 2009 year was a spin up year. 7 weather stations data, which are located in different physical-geographical regions and characterize the climatic conditions of this area, were used in this study [6]. Dedoplistskaro, Sagarejo, Telavi and Pasanauri stations are located in the eastern part of Georgia and Ambrolauri, Kutaisi and Kobuleti – in the western part of Georgia (Table 1).

Table 1. Location of weather stations

Weather Station	LAT	LONG	Elevation, m a.s.l.
Dedoplistkaro	41.46	46.11	800
Sagarejo	41.74	45.33	770
Telavi	41.92	45.48	800
Pasanauri	42.35	44.69	1050
Ambrolauri	42.52	43.15	559
Kutaisi	42.27	42.7	120
Kobuleti	41.82	41.78	10

Results and Discussion

Annual air temperature

Comparing the annual air temperature variation according to the model and observational data for Dedoplistkaro, Sagarejo, Telavi, Pasanauri, Ambrolauri, Kutaisi and Kobuleti weather stations showed that model well describes the annual air temperature variation. In most stations, the model data exceeds the observational data. The biggest difference between the model and observational data for these stations of average annual air temperature is observed in eastern Georgia in Pasanauri in 2011 and the difference is -2.76 ^{o}C.

Monthly Mean Air Temperatures

The intra-annual trend of monthly mean air temperature is in a good agreement with each other according to observational data and model data for all considered weather stations.

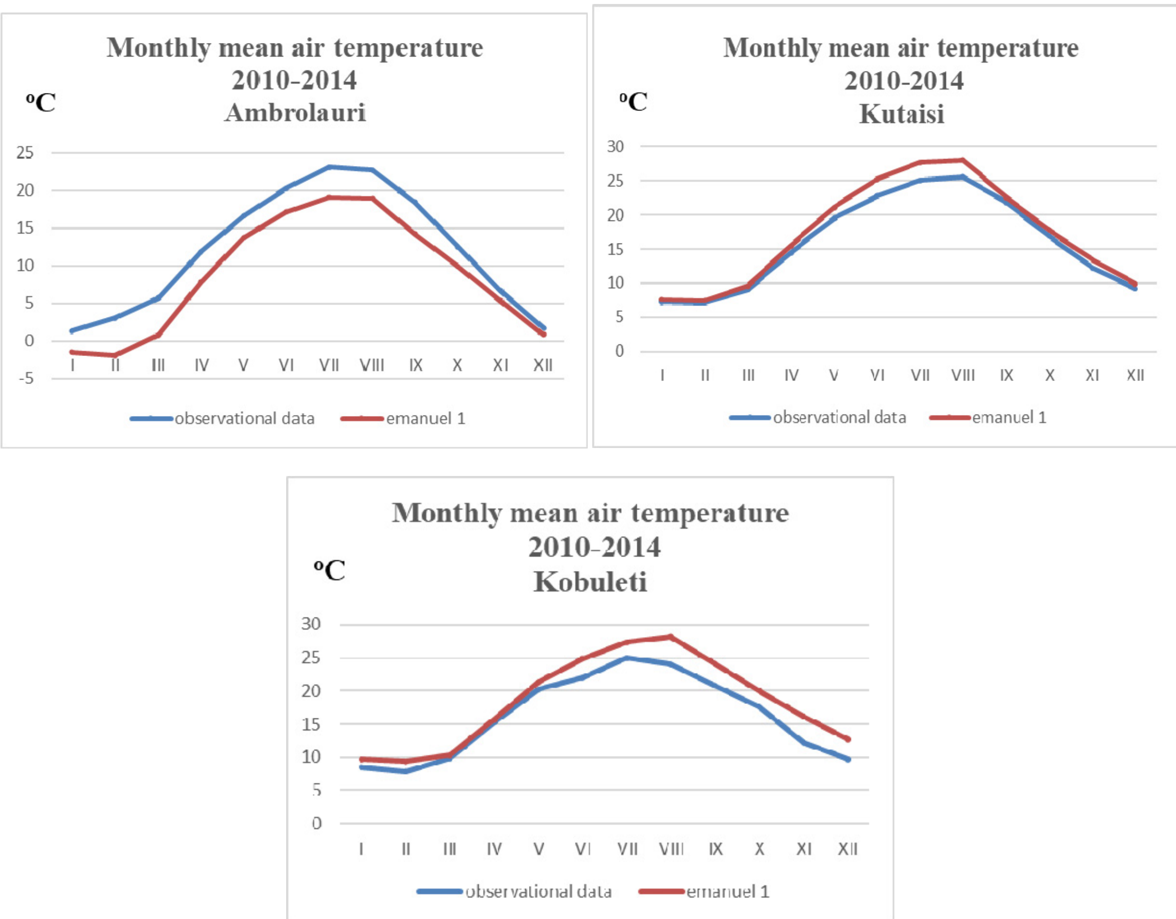

Fig. 1. Monthly mean air temperature for Western Georgia's stations according to model and observational data.

The difference between the intra-annual course of average monthly air temperature according to observational data and model is greater for the weather stations in eastern Georgia than in western Georgia (Fig. 1 and 2). In western Georgia, for Ambrolauri, the model data is less than the observation data throughout the year, in Kutaisi and Kobuleti the model data exceeds the observation data.

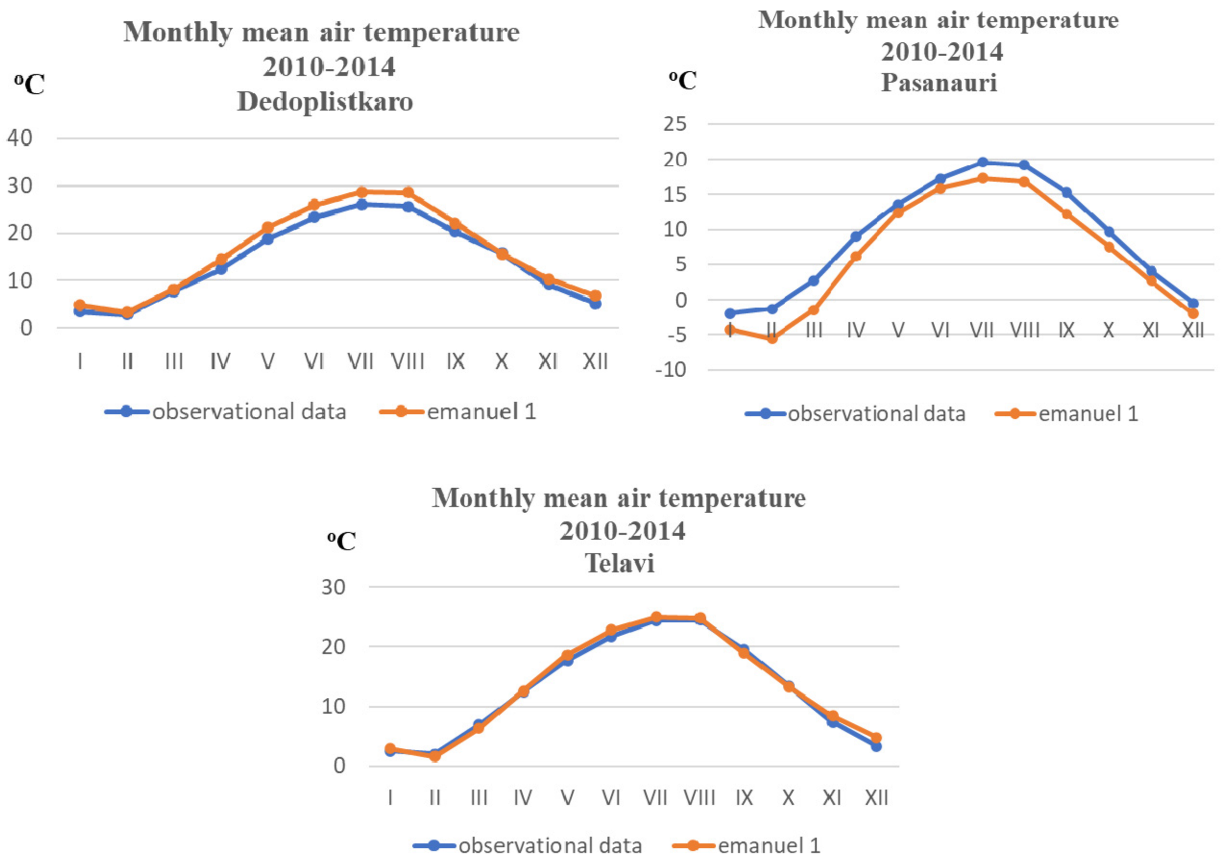

Fig. 2. Monthly mean air temperature for the weather stations of eastern Georgia according to the model and observational data.

The biggest difference between model and observational monthly mean air temperature is observed for Dedoplistskaro and Pasanauri weather stations. In Pasanauri, the model data is less than the observational data all months, and the biggest difference is observed in February - 4.26 ^{O}C. And for the case of Dedoplistskaro, the model data exceeds the observational data and the biggest difference is observed in August - -2.87 ^{O}C. Model data well describes the intra-annual trend of monthly mean air temperature for Telavi (Fig. 2).

Annual precipitation

Comparing the variation of annual precipitation according to model and observational data for the weather stations selected by us located in the eastern and western parts of Georgia showed that in most cases of these stations, the model data differs significantly from the observational data.

Monthly mean precipitation

The intra-annual movement of average monthly precipitation differs from each other according to observational data and model data. For the weather stations of eastern Georgia: in Dedoplistskaro, Sagarejo, and Telavi, the model and observational data of some months coincide with each other. In the Fig. 3 the monthly mean precipitation according to model and observational data for Telavi and Pasanauri during 2010-2014 are presented.

There is a significant difference in Pasanauri weather station (1050 m) located in the high mountainous areas of eastern Georgia, where the model data significantly exceeds the observational data in all months.

There is also a significant difference for the weather station in western Georgia, located directly on the Black Sea coast: the model data in Kobuleti is less than the observational data in all months. And in Ambrolauri, the model data exceeds the observational data in all months.

Fig. 3. Monthly mean precipitation according to the model and observational data for Telavi and Pasanauri weather stations, 2010-2014.

Conclusions

• Comparison model simulation with observed weather station data shows that the model performs better in simulating the monthly mean temperature than precipitation in all selected weather stations of Georgia.

• The simulation captured the variation of the annual and monthly mean values of air temperature better in the weather stations located in eastern Georgia than in western Georgia.

• There are a lot of uncertainties of the yearly and monthly precipitation for all selected weather stations of Georgia. The biases between observation and simulated precipitation are high.

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