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Precipitation and temperature changes in Zayandehroud basin by the use of GCM models

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Abstract
Surveys show that rate of emission greenhouse gases has increased considerably in recent decades. Increasing these gases in earth's atmosphere leads to changes in climatic parameters of earth. By using variety of simulated models of meteorological variants in general frame of weather generators during recent decades, it is necessary to apply these changes in simulated series. In this study, using statistical down –scale for periods of 2011-2039 by using statistical model of LARSE-WG daily data of temperature rain and radiation and its results were considered on synoptic station of zayanderoud basin. Results show that changes in climatic parameters will be existed during survey period in the way that temperature mean among studied stations will increase between 1/7 centigrade and 2/9 centigrade and raining rate will be decreased.

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Introduction

Climate is a complex system which is changing mainly because of increasing greenhouse gases. Climatic change is gradually spreading all over the earth and its impact on water resources, agriculture and climatic parameters are in region-scale. Different factors lead to disturb the static of temporal series of climatic variants of one region that finding these factors can help climatic survey of region in future periods. Parts of these factors related to interaction between system components of earth climate such as AMO, PDO and ENSO that leads to interior oscillations in temporal series of climatic region variants (Hegerl *et al*, 2007) .Zayanderoud River is one of the greatest Iran Rivers which provide main water in center of Iran. Every change in climate effect on hydrology elements. Runoff and giving water to rivers, subterranean water, intensity of torrent and dryness are effective on rainfall and temperature that are the most important climatic element. These changes could have important agriculture, economic, social and political effects. We can minimize its miss-effects with informing events of these changes especially in future decades and suitable planning. Various researches have done especially temperature and rainfall changes in different regions of Iran and the world including: (Wibly *et al* 2001), SDSM was invented for micro-scale of rainfall and temperature by using statistical methods. (harmel *et al* 2002) model minimum and maximum temperature of African meteorological stations in research institute of American agriculture by using statistical methods.MC (Kague, 2003) studies ability of CLIMGEN model for simulating meteorological parameters.

(Semenov and Barrow 2002) studied data simulation by using LARSE-WG model in England. (Babaeian and Kwon 2004) evaluate climatic changes of south-Korea by using LARSE-WG model from 2010 to 2039.This study was done over climatic parameters of rainfall, radiation, min and max temperature, and period of dry and wet days, hot and glacial period and changes' process of rainfall in synoptic station of South Korea. Model results show that very good ability of LARSE-WG model for min and max temperature model and their standard deviation in statistical period and using for climatic change in future decades. (Alshamy *et al* 2005) studied hydrology effects of climate change by atmosphere GCM models and small model of analogue scale in south of England. This research aims at clarifying process of climatic parameters during future decades in Zayanderoud basin by noticing at changing greenhouse gases by using this model. It is tried to survey many models of climate change with different emission scenarios. We could find the most appropriate model and scenario for predicting future climate. Introducing studied region and data Present study is about synoptic stations located at Zayanderoud branches in Chaharmahal and Bakhtiari and Isfahan province because it is necessary for doing this research of long-term statistics of temperature, rainfall and radiation, among region stations of two Koohrang and Daran stations, they have acceptable statistic (20 years) and includes all necessary parameters and they are chosen and its data were received from meteorology organization. Existence of various and high mountains leads to considerable rainfall for snow and rain, low temperature and evaporation and it makes this region one of the most important regions of country due to water resources.

Method of working

Model introduction

General circulation models can provide the best information with atmosphere response to focus on increasing greenhouse gases (Darcup, 2005).Now, the most valid tool is atmosphere-ocean general circulation model(AOGM) for producing climatic scenarios (Wibly and Harris,2006).These models depend on basis of physical values which are presented by mathematic relations. In order to simulate earth climate, main climatic processes (atmosphere, ocean, earth surface, crust of ice and biosphere) in separated secondary models are coupled and they form models of AOGCM. These models are performed in different centers which some

of them include: CSIRO-MK2 model in CSIRO research center of Australia, HADCM3 and HADCM2 models in HCCPR research center in England, CGCM1 and CGCM2 models in CCMA center in Canada, GFDL-R15 model in GFDL center in America, IPCM4 in France, INCM3 in Russia and CCSR and NIES models in Japan are done in center with the same name (IPCC, 1996).

Important inputs of AOGCM models are amount of emission greenhouse gases in future periods. IPCC already presented different scenarios that SRES is the newest one. Each one of sub-SRES scenarios are related to one of B_2, B_1, A_2, and A1 groups.

In A_1 family, emphasis is on rapid economic growth and population growth to middle of century and then it's reducing and introducing new and efficient technologies. Family of A_1scenario divides development into 3 groups for changing technology in energy system which includes fossil energy (A_1F_1),non-fossil energy resources (A_1T) and balance in all resources(A_1B).Generally, It can be said that scenarios of A family have pessimistic scenarios and scenarios of B family have optimistic scenarios and AB scenarios have middle station. In this research, we compare 3 atmosphere general circulation models (INCM3, IPCM 4 and HADCM3).

By using B1, A2 and A_1B emission scenarios are considered future climate of region to determine the best atmosphere-general circulation model and emission scenario for region.

Data of this research include daily data of min temperature, max temperature, rainfall and radiation of studied station from establishing time to 2010.

Downscaling

For using data of atmosphere general circulation patterns over these patterns, making time and place be downscaling, should be applied to change data from all sphere scale to studied location scale and in time scale of monthly, daily and less than day.

Despite of considerable increasing of accuracy of atmosphere GCM, none of these models are able to predict in micro-scale and meteorologic stations. For this reason, different dynamic and statistical models are invented for simulating and changing micro-scale of GCM models that are able to model output of numerical models to the extent of station. Scale LARSE-WG model is one of the most famous generator model of stochastic weather data that is used for producing daily data of rainfall, radiation, min and max temperature of one station are applied under present and future climate conditions (Semnov and Barrow,2002).

LARSE-WG model is a statistical model that doesn't have the identity of predictable models but is able to produce a series of meteorological data with statistical features similar to climatic period (Rasco *et al*, 1991). These models consist of 3 main parts including calibration, assessment and making meteorological data.

Accuracy of measuring model

Accurate calibration and accuracy of measuring model is of high importance in every model. Calibration of LARSE-WG model is applied by using long-term statistics of studied region stations and its comparison with produced data of model in this period.

It needs at least 15 years of observation data of that station for estimating process of climate change of one station by LARSE-WG model. So data of Daran and Koohrang stations are chosen from establishing time to now and are evaluated over 4 parameters, min and max of daily temperature, rainfall and radiation, accurate measuring of model, in order to calibrate and accurate measuring of model, at first a scenario of basis station is compiled for statistical period of 1989-2010.

Model is performed for this period. Then, model output includes min and max temperature, rainfall, radiation and standard deviation are compared with

data of statistical period, produced data by model by using statistical exams and comparison diagrams and analyzing obtained results from exit T statistical exams. There aren't significance exams between model amounts and real amounts with 05/0 crisis error. Pearson correlation amount is also acceptable between modeling data and real data in 01/0 significant level. For comparison, results of scouting and model in synoptic stations are surveyed and diagrams were designed for different parameters, ability of LARSE-WG model is acceptable in modeling min and max temperature, radiation of Koohrang and Daran stations and has complete concordance with real data. Deficiencies are seen in model ability in modeling rainfall of Koohrang station in November, January and February that its most amounts is related to February in which are scouted less than amount in November. February and December and January have amount of scouted amounts.

In rest of months, there are approximately acceptable coincidences.

Rainfall of Daran station has deficiency in November, December, January, February and March and has acceptable coincidence in rest of months.

Discussion and results

GTM model can provide the best information with atmosphere response to increasing greenhouse gases' focus (Dracup, 2005).

In this research, by using exit of GCM models under emission.

Scenario of B1, A2 and A1B of province climate evaluated. As seen in shapes 1 to 6, rainfall and observed temperature of stations are compared with rainfall and produced temperature by LARSE-WG under GCM models (3 models of HADCM3, INCM3, and IPCM4) and different scenarios of emission.

For better conclusion, weight of each model is determined and finally mean of all models are determined with each weight.

Table 1. Weight of different models for producing future rainfall.

	HAD-A1B	HAD-A2	AD-B1	INCM3-A1B	INCM3-A2	INCM3-B1	IPCM4-A1B	IPCM4-A2	IPCM4-B1
Weight of Koohrang station	0/128	0/125	0/131	0/104	0/104	104/0	0/1	0/1	0/1
Weight of Daran station	0/165	0/575	0/1	0/029	0/03	0/03	0/023	0/023	0/024

Table 2. Weight of different models for producing future temperature.

	HAD-A1B	HAD-A2	HAD-B1	INCM3-A1B	INCM3-A2	INCM3-B1	IPCM4-A1B	IPCM4-A2	IPCM4-B1
Weight of Koohrang station	0/082	0/081	0/079	0/193	0/182	0/192	0/062	0/063	0/062
Weight of Daran station	0/067	0/065	0/066	0/225	0/203	0/223	0/049	0/049	0/048

Interference (Ensemble)

Noticing at standard deviation of produced data was less than standard deviation of observed data, standard deviation of produced data are rebuilt (Inflait). Most studies in this field in Iran and especially Zayanderoud basin are studies that one climatic model is surveyed. This could be one of the weakness points of these studies in the way that Azranfar and colleagues consider only Hadcm3 model with two emission scenarios in evaluating climatic change on rainfall and temperature in Zayanderoud basin by using exit of GCM and results suggest 2 to 5 centigrade in future decades that seems exaggerated. In present research, mean of all models is used by noticing at their weight for producing climatic elements by surveying different climatic models and different scenarios and determining weight of each model that results of temperature increasing are obtained 1/7 centigrade for Daran station and 2/9 centigrade for Koohrang station.

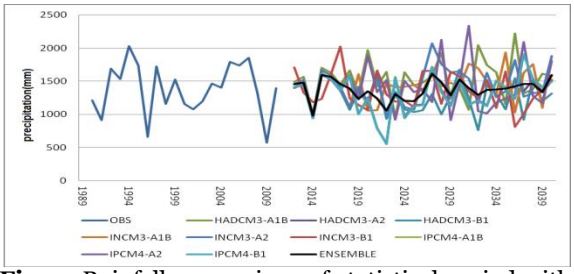


Fig. 1. Rainfall comparison of statistical period with rainfall of GCM models and emission scenarios in Koohrang station.

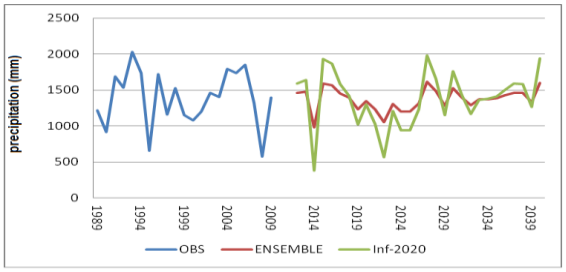


Fig. 2. Rainfall comparison of statistical period with future period in Koohrang station.

Rainfall

Rate of daily rainfall of surveyed stations is computed in period of 2011-2039 by using LARSE-WG model and GCM models. It has more weight among different models and scenarios of HADZM3 model with B1 emission scenario in Koohrang station and HADCM3 with A2 scenario in Daran station (table3).So it is more suitable for producing future rainfall. As seen in shape 1, this model has better coincidence for models' mean. Results of these models show respectively that in Koohrang station, annual rainfall rate in 2011-2039 periods in comparison with statistical period (1988-2010) that has decreased to 9/22 and 3/9 centigrade Daran station.

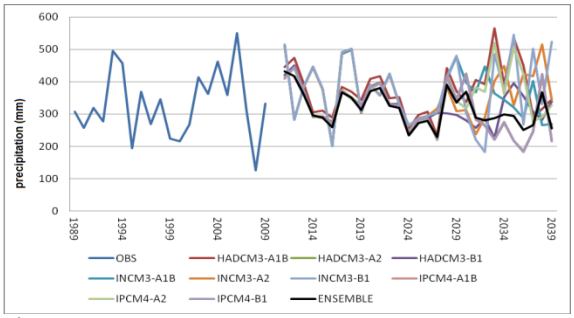


Fig. 3. Rainfall comparison of statistical period with rainfall of GCM model of B and emission scenarios in Daran station.

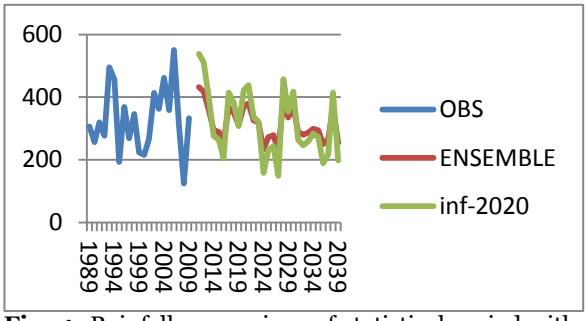
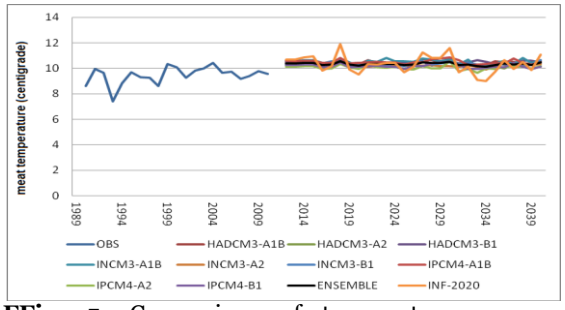


Fig. 4. Rainfall comparison of statistical period with future period in Daran station.

Temperature

Survey of different models show that INCM3 model with A1B emission scenario has more weight for producing data of region temperature mean and it is more suitable for producing data(Table 2).Model results show that annual mean of temperature will increase 2/9 centigrade 2/9 centigrade in Koohrang.



FFig. 5. Comparison of temperature mean of statistical period with temperature of models and different scenarios and future period of Koohrang station.

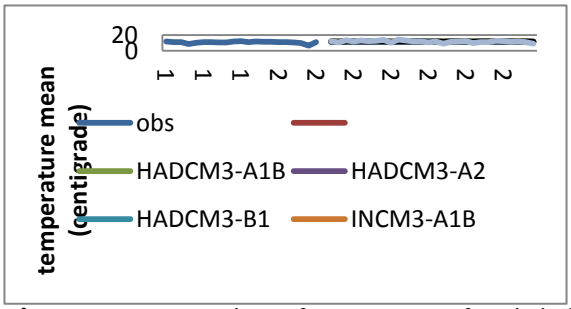


Fig. 6. Mean comparison of temperature of statistical period with temperature of models and different scenarios and future period of Daran station.

Conclusion

Results show that ability of LARSE-WG is much

suitable climatic parameters of studied region. This model exit shows that changes will occur at climatic parameters in Zayanderoud basin during 2011-2039 period in the way that annual temperature mean will increase at synoptic stations in 2011-2039 period in comparison with statistical period. This increase will be 2/9 centigrade in Koohrang station and 1/7 centigrade in Daran station and rainfall rate of Koohrang station will decrease 9/22 centigrade in comparison with statistical period during 2011-2039 years. Rainfall reduction will be 3/9 centigrade in Daran stations. Oscillations are observed in rate of rainfall and temperature among monthly means. Noticing at temperature increase of studied stations, it is expected that rate of snow saving, changing torrent regime and runoff and giving water to rivers and subterranean water are changed. So clear-sighted and planners could design comprehensive plans in different parts such as hydrology, agriculture, economics and politics with regarding these climatic conditions for next years.

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