

## Climate Change Projection over Iran using the PRECIS Regional Modeling System

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### Abstract

Monthly precipitation of Iran has been modeled using PRECIS model driven by HadAM3P boundary conditions data with A2 and B2. Model run in  $0.44 \times 0.44$  degree in latitude and longitude (approximately  $50 \text{ km} \times 50 \text{ km}$ ) horizontal resolutions. We found that overall precipitation error of modeling is 5.3%. Monthly maximum precipitation errors occurred in September as the transition month from summer to autumn. Minimum monthly precipitation has happened in May. As a main result, PRECIS can model well the total precipitation of Iran, but its skill in modeling regional precipitation, especially over the regions with high amount of convective and local precipitation, is relatively low. Mean annual precipitation over Southeast of Caspian Sea, South Zagros mountain chain, Northwest and Southeast provinces will be decreased by 0.1-0.2mm/day both in A2 and B2 scenarios during 2071-2100. Average temperature of Iran will increase by 5-6 oC relative to the base period of 1961-1990 in A2 scenario. Mean future temperature of Iran in B2 scenario is 1.5-2oC less than A2 scenario. Results from A2 and B2 scenarios indicate an 85% increase in annual runoff by the end of 21st century in central and western part of Caspian Sea and south Zagross mountain chains, but in the other regions of the countries the runoff rate change is negligible.

### Introduction

The climate of Iran has experienced a gradual warming of approximately 0.5oC from 1961 (Rahimzadeh and Asgari, 2004). Frequency of extreme precipitation events also is investigated to increase over majority of Iran due to greenhouse gases (Asgari et al, 2007). In the recent years, Iran has experienced many extreme weather and climatic events such as heavy flooded weather systems and tropical cyclones. Southeastern and Southern coasts of Iran have experienced two unusual and major tropical cyclones of Gonu and Phet in June 2007 and 2010.

The Intergovernmental Panel on Climate Change (IPCC) confirmed that there are strong evidences that most of warming observed over last 50 years is attributed to human activities (IPCC, 2007). Many studies have confirmed that global mean temperature is projected to increase by 1.4 to 5.8oC during 21st century (Kwon et al. 2005). PRECIS (Providing REgional Climate for Impact Studies) model was used to obtain fine resolution climate change responses for the South Asia region in 2080s under A2 scenario. The simulated spatial patterns show an increase of precipitation over the monsoon belt and over some central parts of India. The rise of temperature in Pakistan varies from 6°C in summer and 4 to 5°C in winter (Khan and Chaudhry, 2007). A regional climate model can be used to resolve detailed climatic and geographical characteristics of the surface (Babaeian et al, 2009). In this regard, PRECIS regional climate modeling system is issued to simulate detailed climate change projection over Iran. In this paper, skill of PRECIS model in simulation of precipitation and temperature of Iran as well as future climate of Iran during 2071-2100 under SRES A2 and B2 scenarios has been studied. The findings of this research can be used for long term planning climate change mitigation and adaptation in the field of agriculture and water resource management which is in line with GFCS goals.

### Data and Methodology

Area of study is Iran, which consist from two mountain chain of Alborz in the North, Zagros in the West, Caspian Sea in the North, Persian Gulf and Oman Sea in the South and two great deserts of Lut and Kevir in the Central-east. Simulations has been done for two period of 1961-1990 and 2071-2100. Two kinds of data are used in this research: 1-observed precipitation of 12 precipitation regimes of Iran (Fig.1) and 2-HadAM3p boundary condition data to feed the PRECIS model.

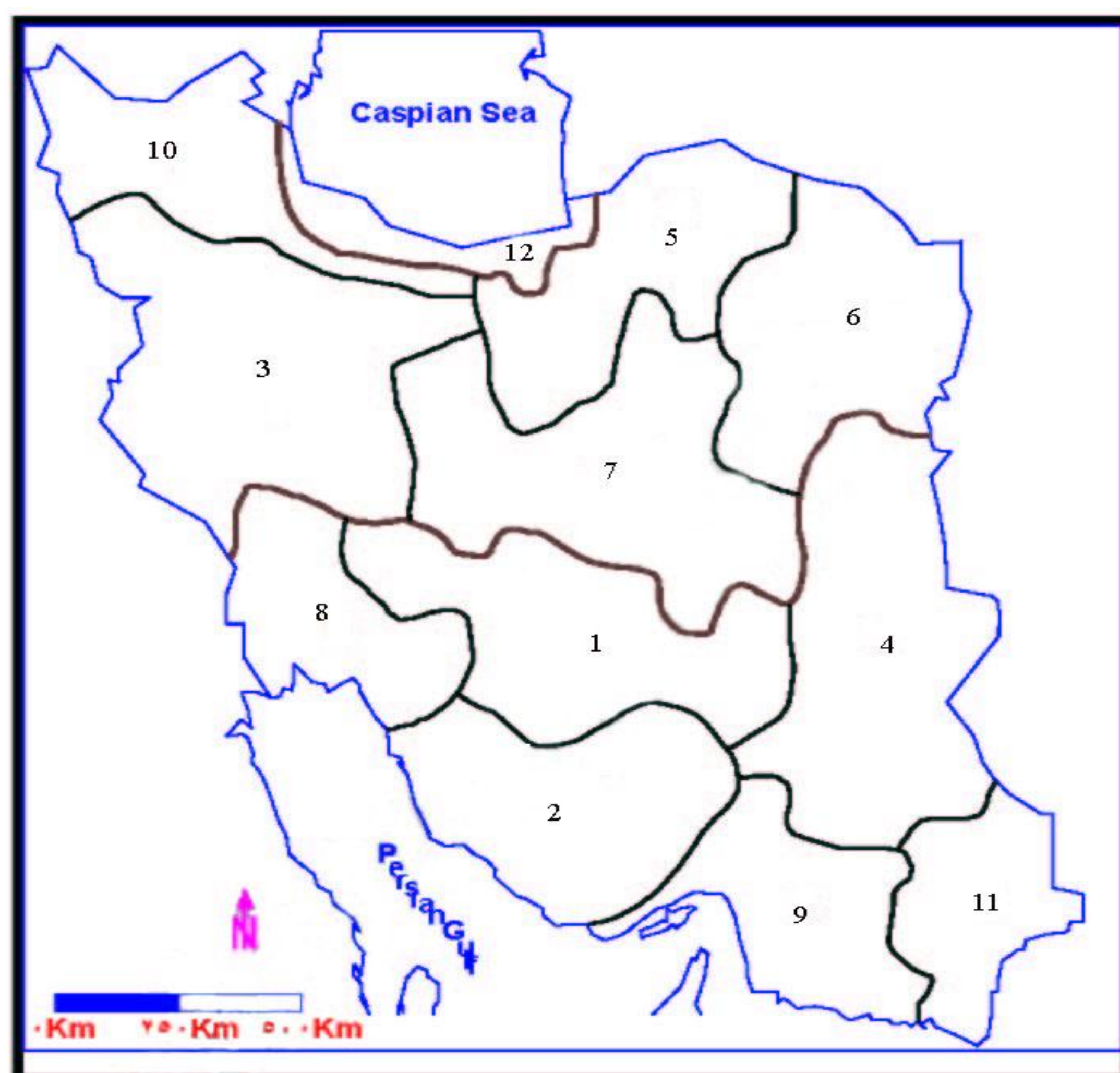


Figure 1. Precipitation regime of Iran. 1: Central South, 2: Farsi, 3: Kordi, 4: Sistani, 5: West Khorasan, 6: East Khorasan, 7: Central North, 8: Khuzi, 9: Hormozi, 10: Azari, 11: Baluchi and 12: Khazari (Masoudian, 2008).

The formula use for computing percentage error of the modeled precipitation is as bellow:

$$RE(\%) = \left( \frac{P_{mod}}{P_{obs}} - 1 \right) \times 100$$

Where RE(%) is relative percentage error of modeling, Pmod is amount of modeled precipitation and Pobs is observed precipitation (Wang, et. al; 2010).

Modeling bias of meteorological variables is computed using bellow formula.

$$Bias = \sum_{i=1}^n \frac{P_{mod} - P_{obs}}{n}$$

### Results

Results showed that, Minimum errors are occurred during rainy season starting from October to May while maximum errors are seen in summer when there are convective and local rainfalls because of surface instability due to high temperature gradient in the surface and near surface layers. Two important regions of convective and local rainfalls are in the northern (Caspian Sea or Khazari region) and southeastern region (Baluchi and Hormozi region) of Iran (Fig. 2).

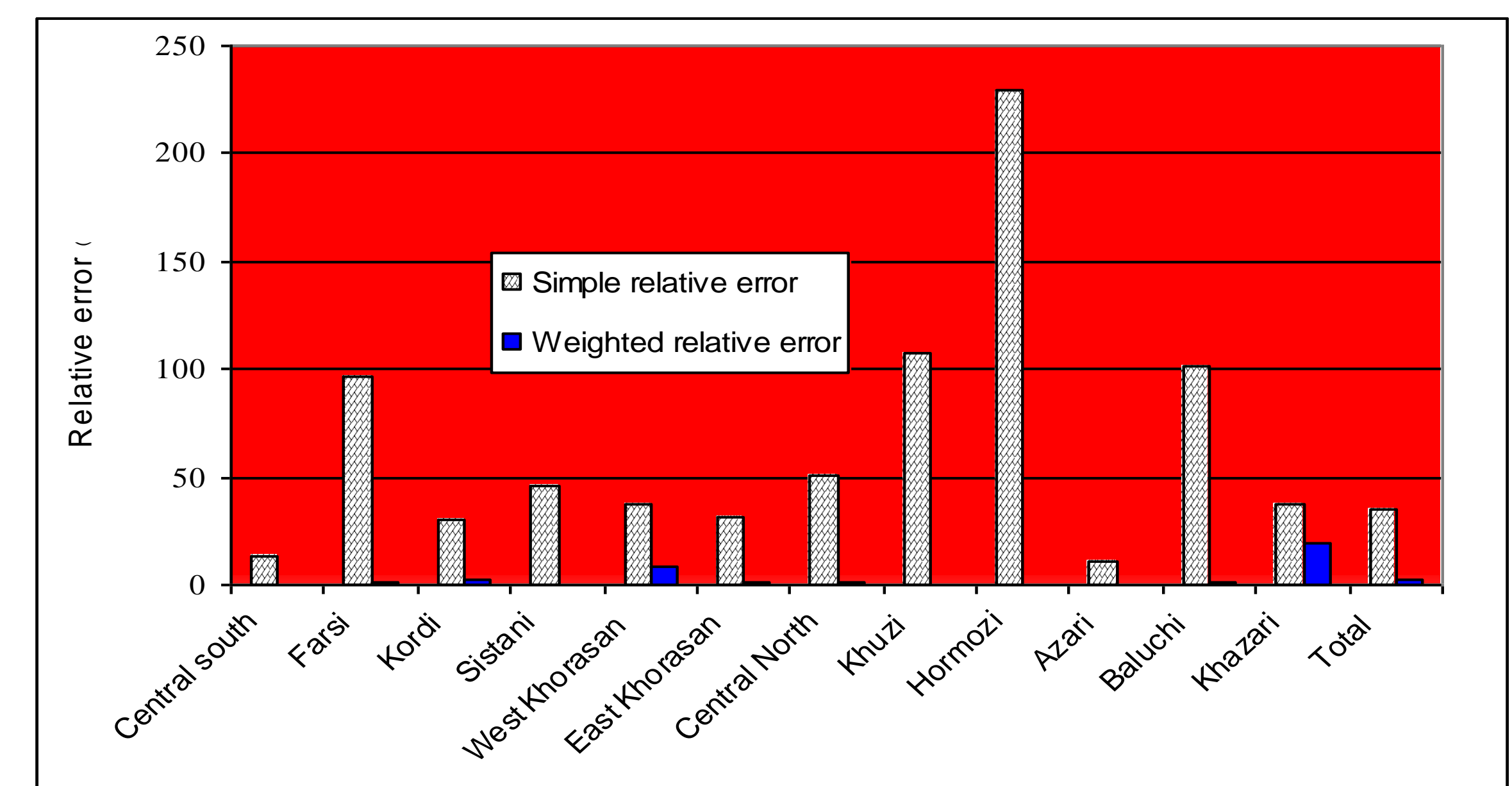


Figure 2. Simple and weighted regional errors in different precipitation regimes of Iran in the base period of 1961-1990.

In 2071-2100 the maximum increasing in annual precipitation will be occurred in South-central and maximum decreasing will be occurred in Caspian Sea (Khazari) region (Fig.1). In A2 scenario, maximum annual temperature increase has been occurred in East and central part of Iran by more than 7oC. South of Eastern Alborz Mountain, Southwest and Southeast of Iran will experience the minimum annual rising temperature less than 5oC. Annual pattern of temperature change in B2 run is almost same to A2 scenarios. maximum runoff change has been occurred in mountainous area of Alborz in the north and Zagross in the west. Also in the Hezar-Masjed Mountain in the northeastern part of Iran, the runoff is increased as well. On the other remaining parts of Iran there is no significant change in runoff comparing to the base period of 1961-1990. A2 scenario shows greater amount of runoff relative to B2.

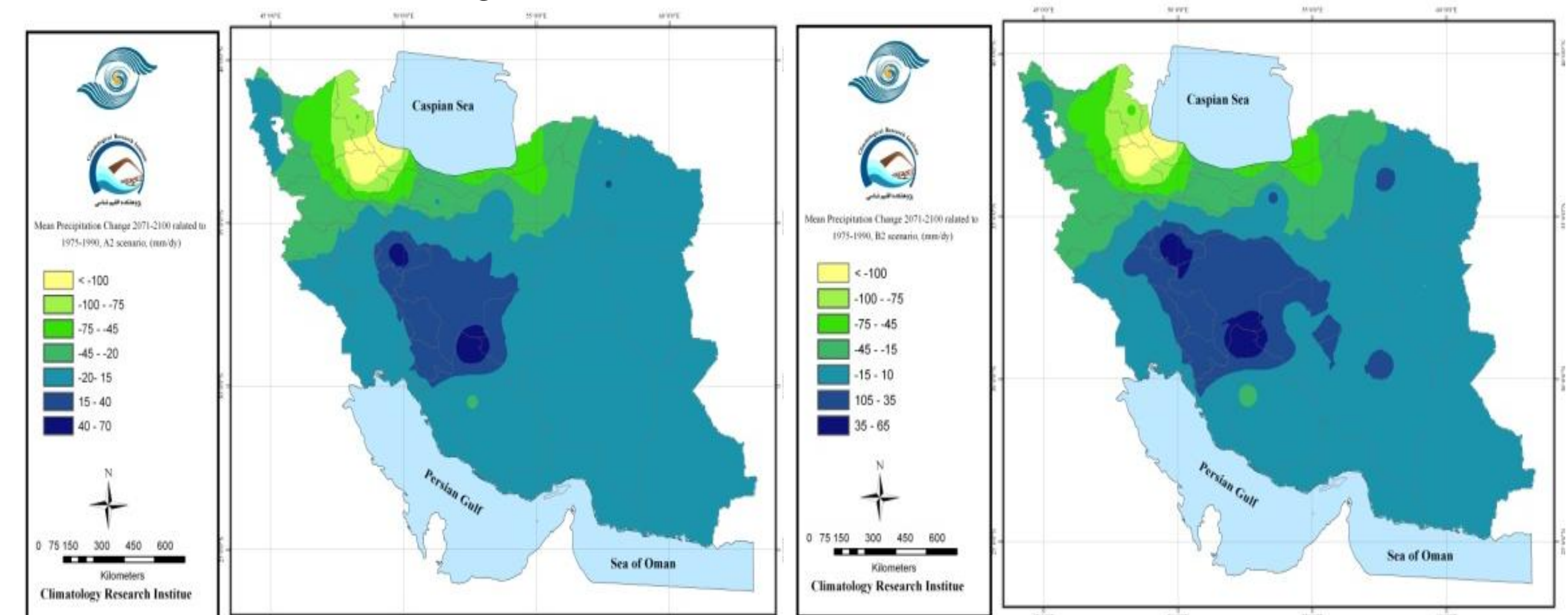


Figure 3. Annual amount of precipitation change in 2071-2100 comparing to the base period of 1961-1990 in A2 scenario (left) and B2 scenario (right).

### Summary

Results show that PRECIS capability in modeling regional precipitation is relatively low, especially over convective precipitation regions which are located in south and southwest of Iran, but its overall capability is highly accepted, with percentage error of 5.3%. Maximum annual temperature increase in A2 scenario has mainly occurred in east and central part of Iran. Southwest, Persian Gulf, Oman sea beaches and north central part of Iran will experience the minimum annual rising temperature of 0.5-3oC. Mean temperature increase in B2 scenario is 1.5-2oC less than A2 scenario. Because of rising in mean temperature of Iran, amount of runoff will be increased considerably during 2071-2100. Maximum runoff increase of 15.8mm and 14.3mm is modeled over mountainous area of Alborz in the north using A2 and B2 scenarios, alternatively.

### Acknowledgement

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### References

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