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Investigation and Synoptic Analysis of Heat Waves using some GCM Models in the Ardabil Plain

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Abstract

Background and Objective: Heat waves are among the most important climatic disasters that bring devastating environmental consequences every year. Heat waves are a very important climatic event that is likely to occur with greater frequency and intensity in the future. Therefore, in order to manage and reduce the effects of heat waves on a regional scale, it is necessary to analyze and predict changes related to heat waves. The aim of this paper is to identify, classify, and synoptically analyze heat waves and its long-term forecast in the Ardabil Plain.

Methodology: First, the 20-year long-term statistics of heat waves from 1995 to 2014 at the Ardabil synoptic station were prepared, and heat wave synoptic maps were extracted and analyzed using the Grads software. Using the LARS-WG model, possible heat waves were predicted in the next 38 years (2015-2050).The studies identified 25 heat waves during the 20-year period. To evaluate the model performance, observational and simulated data were compared in the base period (1995-2014).

Results and Findings: The results also showed that the usual time for the onset of heat waves is in early August. The results showed that the dominant patterns during the occurrence of heat waves include a zonal high pressure accompanied by a westerly wind wave ridge and a low pressure prevailing over the sea surface and the Pakistan and Saudi low pressure over the study area. The results also showed that the average annual maximum temperature of Ardabil during the statistical period from 2015 to 2050 will be about 13.68 degrees Celsius. According to the HadCM3 model, under the A1B scenario, the temperature is about 16.46, according to the IPCM4 model, under the B1 scenario, the temperature is about 16.54, and according to HADGEM, under the A2 scenario, the temperature is 16.55 degrees Celsius, with a difference of 0.01.The output of the aforementioned models showed that the temperature of the Ardabil plain will increase by an average of about 3 degrees Celsius by 2050.

Keywords GCMs, LARS-WG Model, Maximum Temperatures, Synoptic Analysis, Ardabil Plain.

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EXTENDED ABSTRACT

Introduction:
Heat waves are a very important climatic event that is likely to occur with greater frequency and intensity in the future. Therefore, in order to manage and reduce the effects of heat waves on a regional scale, it is essential to analyze and predict changes related to heat waves. The aim of this paper is to identify, classify and synoptically analyze heat waves and its long-term forecast in the Ardabil plain. Based on the report of the Intergovernmental Panel on Climate Change (IPCC), the global mean surface temperature increased by approximately 1.1°C between 1985 and 2021. This warming trend has accelerated since the 1970s. It is also projected that this global warming trend will continue throughout the 21st century. Among climate-related hazards, heatwaves are considered one of the most dangerous threats associated with global warming, affecting various aspects of human life, including architecture, thermal comfort, transportation, agriculture, and industry

Methodology:
First, the 20-year long-term statistics of heat waves from 1995 to 2014 at the Ardabil synoptic station were prepared, and heat wave synoptic maps were extracted and analyzed using the Grads software. Using the LARS-WG model, possible heat waves were predicted in the next 38 years (2015-2050).The studies identified 25 heat waves during the 20-year period. To evaluate the model performance, observational and simulated data were compared in the base period (1995-2014).

Results and Discussion:
Results and findings: The studies identified 25 heat waves during the 20-year period. The results also showed that the usual time of onset of heat waves is in early August. The results proved that the dominant patterns during the occurrence of heat waves include a zonal high pressure accompanied by a westerly wind wave ridge and a low pressure prevailing over the land surface and the Pakistan and Saudi low pressure tongues over the study area. The results also showed that the average annual maximum temperature of Ardabil during the statistical period from 2015 to 2050 will be about 13.68 degrees Celsius. Based on the HadCM3 model under the A1B scenario, the temperature is about 16.46, based on the IPCM4 model under the B1 scenario, the temperature is about 16.54, and based on HADGEM under the A2 scenario, it also shows 16.55 degrees Celsius with a difference of 0.01. The output of the aforementioned models showed that the temperature of the Ardabil Plain will increase by an average of about 3 degrees Celsius by 2050.

Conclusion:
The results of the analysis of synoptic maps showed that on representative days, the analysis of the land surface maps shows that in every 10 days, the study area is in low pressure or its edge. The HadCM3 model under the A1B scenario shows 16.46 for the average maximum temperature during 2012 to 2050 for the Ardabil station. The results of the data forecast based on the IPCM4 model under the B1 scenario are about 16.54 degrees Celsius. Also, the results of the data forecast based on the HADGEM model under the A2 scenario also show a difference of 0.01 degrees Celsius and 16.55. Based on the review of the aforementioned models, the temperature of Ardabil will increase by about 3 degrees Celsius on average by 2050; Therefore, it can be stated that the occurrence of heat waves for several days in winter

or early spring, when trees and plants are in hibernation or are flowering, makes this economic sector vulnerable. In the hot season of the year, heat waves and sudden increases in temperature will cause heatstroke, the need to use cooling devices, and increased use of water and electricity.

Declarations
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•**Conflict of Interest:** The authors declare no conflict of interest.

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