

Statistical Analysis of Frost Characteristics in Saghez Weather Station

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Received: Jun., 2014 Accepted: Aug., 2014

Expanded Abstract

Introduction

Frost is one of the most hazardous natural phenomena, accompanied, at times, by abundant damages in the life and properties. Freezing and frost are very important for agricultural products in different stages of the growth. This is because, in case of happening, it results in the reduction of the products. Frost is one stage of water freezing. In such condition, when the air temperature decreases to dew point, ice cover is formed over the surface. Mojarrad Gharehbagh, in addition to presenting a new definition of frost, analyzed and extracted the frost characteristics based on 16 indices systematically. Mirmousavi and Hosseinbabaei studied the temporal-spatial distributions of the frost occurrence probability in Zanjan province. They found that, on average, the first frost events of the region are occurred in autumn season from September 19 to November 15, and generally the frosts events are ended from April 9th to May 20.

Montazeri attempted to study the agricultural frosts in Najaf Abad City. The results of their study showed that the general frequency of frost days were not decreased, meanwhile the occurrence of the severe frosts have been decreased as well as the frequency of the occurrence of zero-temperature frosts have also been highly increased. Jahanbakhsh et al. attempted to analyze the springtime frosts of Tabriz by synoptic approach. Their results indicated that the longest and the most severe frosts occurred between 27 March – 1 April 2003 and 5 April 2004, which this is due to the formation of low pressure centers and deepening of the related troughs over the north of Caspian Sea. Masoudian and Darand investigated the widespread frosts of Iran and found that 5 patterns of sea level pressures (SLPs) result in severe and widespread frosts in Iran. They also concluded that the severity of the frost events in different regions of Iran is in good agreement with those in the path of the anticyclonic systems. Thom and Show proved that the dates of frost occurrences are random and mainly based on a normal distribution. For this reason, using mean and standard deviation are considered as valid indices to study the frost events. Tavakoli and Hosseini analyzed the frost indices and its autumn-time occurrence in Ekbatan-Hamedan station and presented a model to predict the autumn-time frosts. Zolfaghari et al. predicted the last date of spring-time frosts in west and northwest of Iran. Their results showed that it was possible to predict the last dates of the spring-time frosts among the stations in the study area using error post-distribution network. The computed error was low in all the stations. The highest error was measured in Arak station with 1.1142%, while the lowest one was computed in Mahabad station with 0.254%. Easterling attempted to investigate the recent changes in days with frost and no frost in the USA. He found that during the period 1948-1999 the frequency of frost days declined, but the length of the days without frost increased.

Home studied the temporal distribution of seasonal-annual frosts in relation to their trends in the past years. Karl investigated the precipitation and also minimum and maximum temperatures, and found that these parameters can be statistically predicted. Bootsma analyzed the minimum temperature and possible occurrence of frost in mountainous regions of Canada. In a research, Behyar studied the cold event of 27 April, 2003 in Charmahale-e-Bakhtiari province using different meteorological variables to identify the dynamical-synoptic factors responsible for this cold event in the region. Rabani and Karami attempted to study the frequency trend of frost days in Northern Khorasan province. Their results showed that the number of frost days during the examined period indicated a descending trend in such a way that it is in good agreement with the increasing trend of annual temperature in the study area.

Soltani et al. studied the meteorological aspects of an abnormal cooling event over Iran in April 2009. Their results showed that a polar vortex was responsible for the freezing event over the country extending southward extraordinarily in such a way that its ridge influenced most parts of Iran. This was recognized as an abnormal extension of a polar vortex in the recent years. The sea-level pressure fields indicated that a ridge of large-scale anticyclone centered over Black Sea extended southward and prevailed over most parts of Iran. This resulted in the formation of a severe cold air advection from high latitudes (Polar region) over Iran.

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Materials and Methods

In order to investigate the frost characteristics in synoptic station of Saghez, the frequency of frost days is extracted for the period 1976-2007 and then the minimum temperature data are analyzed. The geographic position of the study station is shown in Fig. 1. The homogeneity of the data series verified using Runs Test. After that, the days with a temperature less than 0°C are extracted as a frost day, and the frosts are classified into three categories: weak (ranging from 0°C to -1.1°C); moderate (ranging from -1.1°C to -3.3°C), and severe (less than -3.3°C). Table 1 shows the frequency of occurrence and the beginning/ending date of the frosts with different thresholds during the examined period in Saghez station. In addition, to determine the trend of frost days in Saghez station, a correlation equation was applied between the number of the frost days and length of records (in years), which the linear equation is as follows:

$$y = 0.7953x - 1456.6$$

$$R = 0.435$$

where, x is the length of records; y is the total frost days. It is worthwhile to mention that the above equation is significant at 5%.

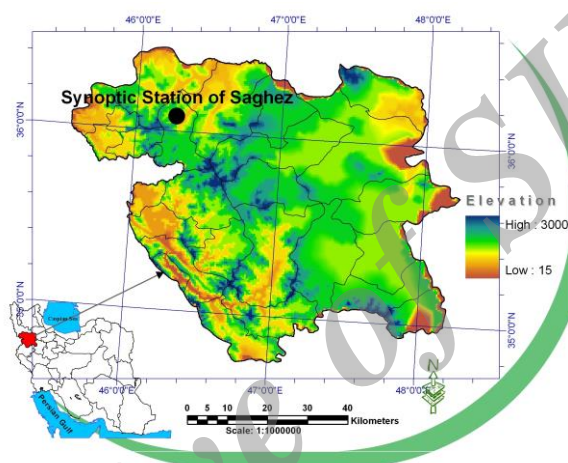


Fig. 1. The geographic position of the study station

Results and Discussions

The knowledge and experience of scientists have presented some solutions over the course of the time, which have been useful in reducing the damages from climatic disasters like frost. The maps of frost occurrence probability and the first data of autumn-time frosts as well as the last date of spring-time frosts are a simple example, but it is significant in studying the frosts for agricultural purposes. By studying the temperature data and frosts days in Saghez station during a 32-year period, we found that the minimum temperature over the past two decades had an increasing (positive) trend in such a way that this trend was most severe in the past five years. This indicates the effect of global warming as a result of a natural process or human activities in the globe. The findings indicate that the severe frosts in Saghez station are mostly occurred in January, February and December months, and the moderate frosts happen in January, February, November, December and March months, and finally the weak frosts usually take place in the months of March, October and April. The trend of frosts days and the minimum temperature in Saghez station indicates a negative correlation as well as an increasing trend in frost days and decreasing trend in the minimum temperature. This unusual trend is due to the decrease of temperature from 1986 to 1989, which is clear for the number of frost days, as well.

Conclusion

The important point in studying the frosts in Saghez station is that according to the obtained equation, there is a significant correlation between the beginning dates of autumn frosts and ending dates of springtime frosts as well as the minimum temperatures of September and April of the same year. The sooner the springtime frosts are ended accompanied by a high minimum temperature of September and April, the later the autumn frosts are started and vice versa. Furthermore, it was determined that the soonest autumn frost occurred on the 2nd day of 2002, and the latest springtime frost took place on the 247th day of this year. Therefore, it can generally be said that through studying and predicting the frost events on time, we will be able to protect the agricultural products against frosts using different methods of using heating systems like stove/heater, wind generator machines or helicopters, producing artificial fog, and etc.

Keywords: frost, linear regression model, occurrence probabilities, Saghez site.