

Mahabad Spring Freezing Forecasting, Using Synoptic Study

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Abstract

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The quality of pressure distribution over the atmosphere of the sea level and geopotential altitude at different atmosphere layers affect on many climate and meteorology phenomena of the earth surface. One of the important meteorology phenomenon is the occurrence of frost phenomenon especially late spring frost. In this survey, occurring late spring frost days and minimum temperature during these days were determined using the minimum temperature statistic during the solar years 1364-1384 at Mahabad meteorology station. Moreover, the patterns of daily mean pressure distribution over the sea level atmosphere and atmosphere patterns at the layers 850, 700 and 500 HP in Asia Europe and the north of Africa have been mapped and identified and the relationship between frost phenomenon occurrence in Mahabad studied by atmosphere patterns at different atmosphere layers. The studies showed that there is a relationship among the incidence of spring frost phenomenon in Mahabad and pressure distribution over the earth surface and atmosphere patterns at layers 850, 700 and 500 of HP in order that when forming and expanding the high-pressure center in east Europe, the weather temperature decreases in Mahabad and sometimes it goes down below water freezing-point. [A. Gandomkar. Mahabad Spring Freezing Forecasting, Using Synoptic Study. International Journal of Agricultural Science, Research and Technology, 2011; 1(2):89-93].

Key Words: Spring freezing, Geopotential Height, Synoptic Analysis, High-pressure.

1. Introduction

From the standpoint of meteorology, frost occurs when the minimum temperature is less than 0° Celsius and the weather temperature above it has reached dew point technically called "frost". In agriculture science, frost is a temperature event causes damages to the plant tissues. This critical temperature may not be concord with 0° Celsius and occur at above or below 0° Celsius but there is more emphasis on 0° Celsius (Kaviani, 2001).

Frost is an important damaging phenomenon influences on many of the human activities especially agricultural activity. The most damages of the frost doesn't happen in winter but early fall frosts as well as late spring frosts may cause more intensive damages to the plants in Najafabad, Isfahan. The most early or late frosts occur when a polar cold and dry air mass penetrates from the Northwest to the north east in the area. Cold weather especially in spring drops down from a cyclone occupied by a cyclone. As the pressure increases, the sky gets clear

and effective relaxation increases that cause a nightly cold air layer. This kind of frosts resulted from a radiation cold and occurs when the sky is clear with no clouds and calm or a mild wind is called radiation frost (Gandomkar, 2008). Talebi et al (2005) in a research titled effective Synoptic patterns on early fall cold and late spring cold in Yazd province showed the local array of isobar or produces special patterns like low-pressure, cyclone, anti-cyclone and fronts on the high-level maps. Cyclonic or frontal frostbite is a mode of frostbite incidence evolved as the result of passing a cold polar flow from the evolved area and causes an intensive decrease of temperature and thermometer drop to some degrees below zero.

Fatahi et al (2005) in a research titled "the analysis of Iran's winter frosts Synoptic patterns" showed that the patterns of atmospheric circulation play the essential role in occurring the frost, the intensity of frost and frost spatial distribution especially on the temperate zones and the incidence of environmental events like frost and frostbite are

related to the repetition of Synoptic systems and weather types. The aim of this survey is to study the frequency, intensity and duration of spring frost incidence and to identify the Synoptic patterns caused this phenomenon in order to forecast the spring frost incidence. This study will try to synoptic analysis using surface to atmospheric circulation method, phenomenon of frost in the ground to be identified and then synoptic patterns in the atmosphere to be found.

2. Material and Methods

To determine the late spring frosts incidence in Mahabad (Western Azarbaijan province, Iran), minimum temperature statistic at Mahabad station from the first day of January, 1985 to the end of December 2005 has been analyzed. To study Mahabad's late spring frosts Synoptic, sea level pressure data and geo potential altitude data of different atmospheric level were applied. Sea level pressure and geo potential altitude data of layers 250,300,500,700 and 850 HP have been studied.

The size of these data has been 2.5 to 2.5 degree as daily from the first of January 1985 A.D to the end of December 2005 at the latitude domain of northern 0° to 90° and longitude domain of eastern 0° to 150° . Hence, daily maps of each layer have been drawn during mentioned period. These data have been extracted from the U.S Atmosphere and Oceanography Department.

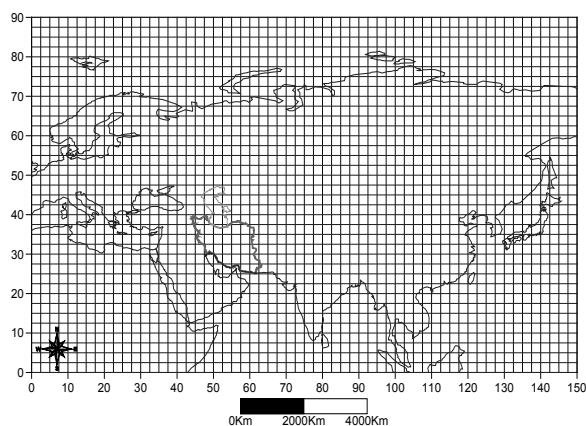


Figure 1. Range of sea level pressure and geopotential height data

3. Results and discussion

Late spring frosts in Mahabad for each year from 1985 to 2005 (the datas of past years is not published by Iranian Meteorological Organisation) have been given in the following table.

Table 1. Spring late freezing in Mahabad from 1985 to 2005

| N | Year | Month | Day | Minimum Temperature |
|---|------|-------|-----|---------------------|
| 1 | 1987 | April | 7 | -2.4 |
| 2 | 1988 | April | 2 | -1.6 |
| 3 | 1990 | April | 5 | -1 |
| 4 | 1992 | April | 3 | -0.4 |
| 5 | 1995 | April | 7 | -0.4 |
| 6 | 1997 | April | 12 | -3.2 |
| 7 | 2003 | April | 2 | -0.8 |
| 8 | 2004 | April | 6 | -4.6 |
| 9 | 2005 | April | 7 | -1.4 |

Also, in this table, the minimum temperature occurred at the time of frost in each day has been given. During this 20-year-period the lowest temperature was related to April 6th, 2004 with -4.6°C . Dropping the temperature down to -4.6°C at this time is a rare event and the incidence of such this frost may cause lots of damages to agriculture products. The other important frost was related to April 12th, 1997 at which the minimum temperature dropped to -3.2°C and this temperature at this time could cause lots of damages to agriculture products especially garden products.

For instance, the spring frost in April 1997 is studied. In this year, the minimum temperature reached -3.2°C at the day of 12th.

Studying the maps of the sea level (Fig.2) shoes that at the days before the frost incidence, a low-pressure center has been located over the Caspian Sea and at the same time a high-pressure center has been forming over Southeastern Europe and Turkey. During the next days, this low-pressure center has become weaker and moved toward the east and the high-pressure center also become stronger and moved toward the east and gradually located over Northwest areas of Iran. At the previous day and when occurring the frost, the central core of this high-pressure center having 1030 HP was located on the Northwest of Iran and caused the frost phenomenon. By a gradual movement of the high-pressure system toward the east and going out from the Northwest areas of Iran, the temperature increase at the Zone and replacing a Mediterranean low-pressure center at the Zone, the frost phenomenon also ends.

Expanding a high-pressure center on Iran results in dominating a clear and mild atmosphere and this condition provides a suitable ground for a radiation frost due to the radiation earth radiations so that this phenomenon could damage the agricultural products.

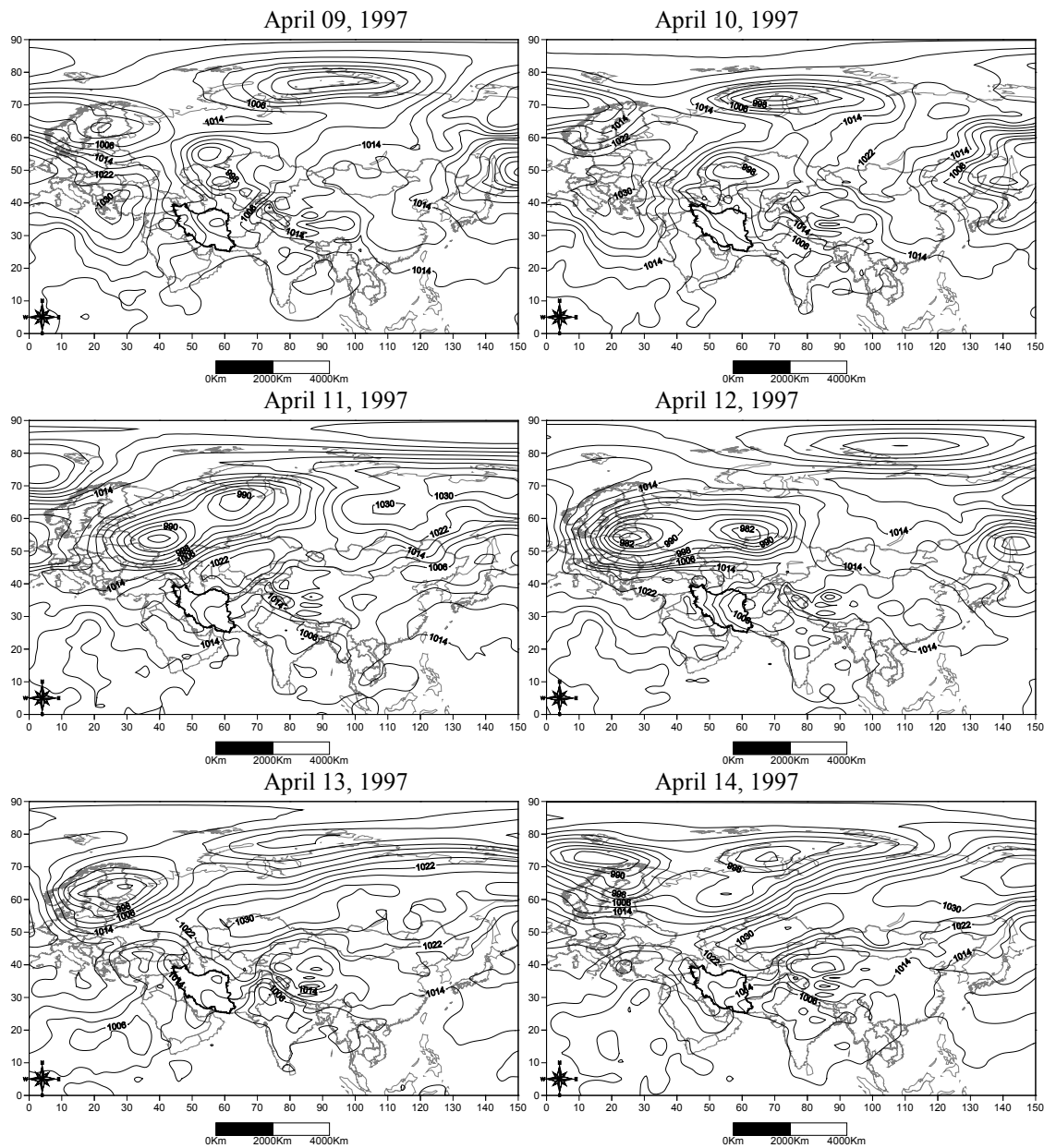


Figure 2. Sea level pressure maps from April 09, 1997 until April 14, 1997

At this time at the level 850 HP both forming and expanding a high-height center are observed (Fig.3). At the days before the frost incidence, the height of this layer over the northwest areas of Iran was about 1520 m while it starts to increase during the next days and from the day April 12th on words it increases to about 1560 m and more. The center of this high-height system locates on the east Mediterranean and gradually by reinforcing at

the lower atmospheric layers, it moves toward the east and it's flaps affect on the northwest areas of Iran. Locating this high-height center at this atmospheric layer accompanying with locating a surface high-pressure center on the earth surface cause that the temperature decreases and reaches to the below freezing point of the water.

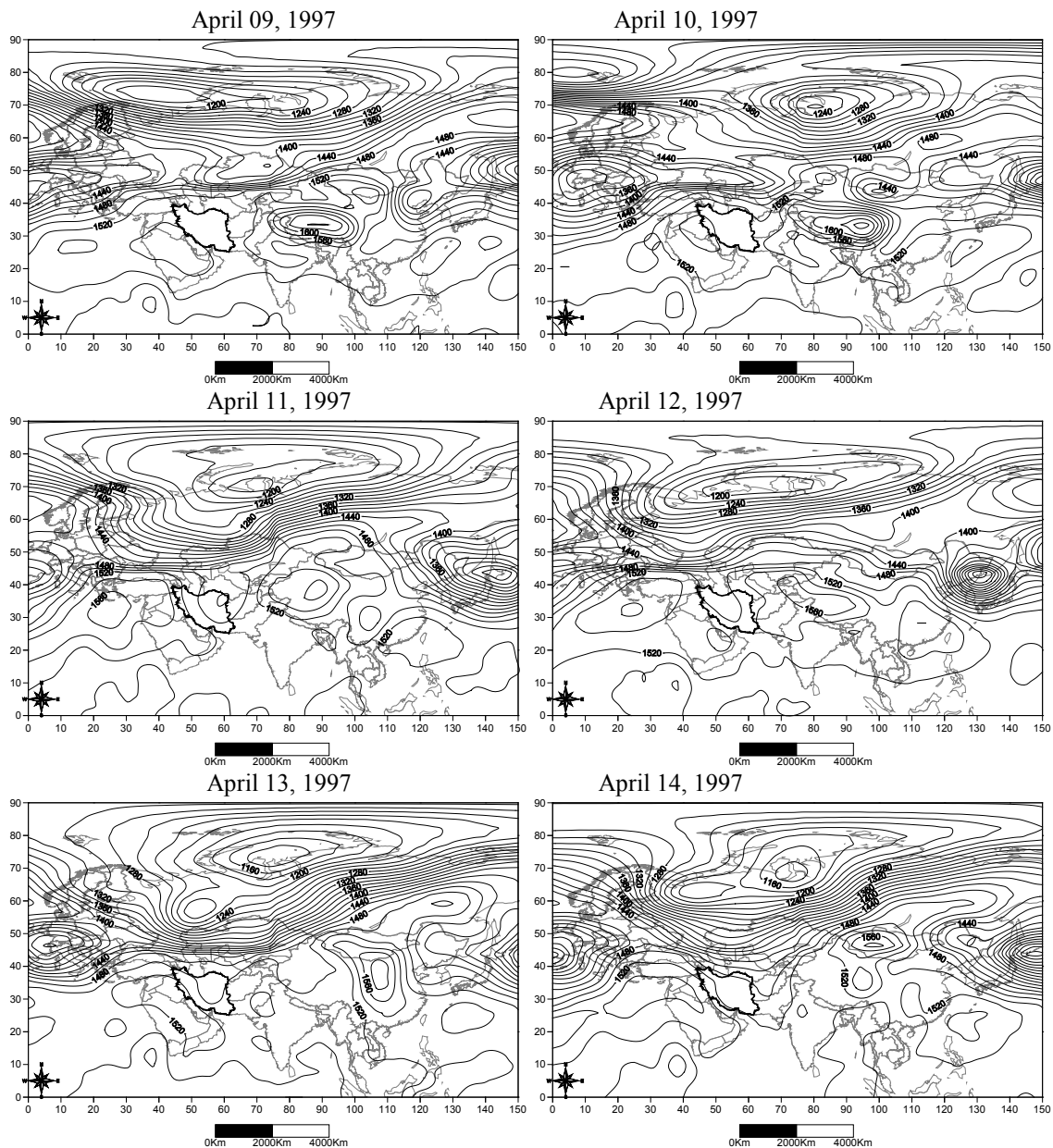


Figure 3. 850 geopotential height maps from April 09, 1997 until April 14, 1997

At this time, at layers 700 and 500 HP which is the representatives of the atmospheric middle layers, locating a low-height center is observed. In fact, the high-pressure and high-height center of southeast Europe is a high-pressure center with large horizontal and small vertical expansions. For this reason, the effects of being this center on the patterns of the sea level pressure and the atmospheric layers near the earth surface are observed but at the middle and up layers no effect of this center be observed and at these atmospheric layers at this time, western wind

wares and falling and rising of these wares are observable.

The most dangerous late spring frost occurred during the last 20 years in Mahabad was related to April 1997 and 2004 and after a hot weather period, a severe frost happened suddenly and the minimum temperature reached about -4°C .

Synoptic studying of Mahabad's spring frosts shows the incidence of this phenomenon follows a special atmospheric pattern. Concerning that a high-pressure center forms at the sea level over southeast Europe and its flaps are drawn toward

Iran. This high-pressure center is formed due to the air location over the Eastern Europe cold areas after several days it starts to expand and move specially toward the east and arrives in Iran from the direction of the northwest and affects on all the northwest areas of Iran. Forming and moving this system occurs more in the winter but in some years early in the spring this system is also reinforced and influences on Iran.

At this time a high-height center is also located at the level 850 HP down to the atmospheric layers near the earth surface. At this time, this high-pressure center has no much vertical expansion and is limited to the earth surface. For this reason, a location of low-height system is usually observed at the upper atmospheric layers at this time.

4. Recommendation:

Considering, Mahabad spring freezin is predictable; recommended to find ways to deal with spring freezing in this area, and before the freezing occurrence, anti-frost begins and prevent damage to agriculture in this area.

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