

## Synoptic analysis of extensive and persistent frosts in Iran

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### Extended Abstract

#### 1- Introduction

In the point of meteorological view, frost occurs when minimum temperature is below 0° centigrade degree. In total, frosts classified in two groups: a) Radiative Frosts and b) Advective frosts. Radiative frost is the most common form of the phenomenon. Nocturnal long wave (heat) radiation loss from the surface leads to the progressive reduction of surface temperature (and that of the adjacent air) between sunset and sunrise (Oke, 1987; Linacre and Geerts, 1997). Advective frost occurs under meteorological conditions that typically include the passage across a region of a large mass of very cold, dry air followed by a well-mixed, windy atmosphere and a temperature that is often subzero, even during the daytime (Scholefield, 1994; Davidson, 1997). The combination of factors such as those related to atmospheric

circulation, radiative balance, soil humidity, topographic features (Muller et al., 2005) and local factors (for example, latitude and close to the big water resources) are an example of the multiple processes taking part to produce a marked drop in temperature. The frosts have obvious effects on the energy, transportation and agriculture that among the three above-mentioned issues, frost temperature have the most effect on agriculture (Vega et al., 1994). The aim of this study is the synoptic analysis of the extensive and persistent frosts in Iran.

#### 2-Data and Method

In this study the interpolated minimum daily temperature data from Asfazari data base during 11/3/1962 to the 31/12/2004 has been used. The data base by using recorded minimum temperature in 663 synoptic and climatology stations and Kriging geo-statistic method has been interpolated for 15\*15 kilometer pixels over Iran. The matrix with 15706\*7187 dimension created that days located on the rows and pixels were on the columns. This matrix was the base of calculation frost days in this study.

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For recognition of extensive and persistent frosts, two criteria have been considered. The first one was that frost observed over 50 percent area of Iran. And the other one frost persistence over 3 days. These two criteria discriminate the Advective frost in contrast to Radiative frost type.

### 3- Discussion

The results of cluster analysis on the sea level pressure data in the extensive and persistent frost days showed that 5 different synoptic atmospheric circulation patterns result in extensive and persistent frosts in Iran. The extensive and persistent frosts observed during cold seasons so that starts in November and ending in March. The highest frequency occurrence observed in January.

Pattern 1: In this pattern two strong anticyclones observed over Siberia and Europe. The low pressure of sub-polar is very extensive and strong. The displacement of sub-polar low pressure to the southern and eastern part of study region result in displacement of two high pressures of Europe and Siberia to the south and drive to the Iran and occurrence of extensive frost.

Pattern 2: In this pattern the high pressure with the two strong cores between Mongolia and Kazakhstan country. The sub-polar low pressure has been weak rather than pattern 1. Although the Siberian high is very strong in this pattern but the temperature decrease in Iran is weak. The reason is weakness and location sub-polar low pressure in west part.

Pattern 3: In this pattern the geographic location of circulation atmospheric patterns is same as the pattern 1 but the sub polar low pressure is weak. The temperature decrease is accompanied to the occurrence and invasion of the cold air result in two

high pressures over Europe and Siberia.

Pattern 4: The geographic distribution of circulation atmospheric patterns in this pattern is same as the pattern 2 but the sub-polar low pressure is located in western statue. At the point of time view, the highest occurrence of this pattern is in February.

Pattern 5: In this pattern the geographic distribution of atmospheric systems is very different to the other ones. The two high pressures over the Siberia and eastern part of Europe are observed. On the northern part of Russia, a weak low pressure is formed that control the behaviour of high pressures over the Siberia and Eastern Europe.

### 4-Conclusion

The results of analyzing sea level pressure during the occurrence of extensive and persistent extreme frost over the Iran showed that five atmospheric circulation patterns with different geographic distribution observed. In total in the some patterns the Siberia high presence alone. In the other ones the Siberia and Europe high observed together. If the sub polar low pressure has been strong and displacement to the south, result in displacement of two high pressure of Siberia and Europe to the south and negative temperature anomaly in Iran. Therefore, the sub polar low pressure role is indirect on the occurrence of extensive and persistent extreme frost over the Iran. The extreme extensive frost observed when the Siberia and Europe are presence together. The highest negative temperature decrease is observed over the Zagros, Alborz and north-eastern range mountains. The southern part of Iran and the south

of Caspian Sea didn't experience any frost in the study period.

**Keywords:** Frost, Synoptic analysis, Extensive, Persistent, Iran

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