Synoptic Analysis of Cold Waves in the Northeast of Iran

Soleyman Sadeghi [1] Hosseinzadeh. SR [2] Doostan. R [3*] Ahangarzadeh. Z [4]

[1] Department of Geography, Ferdowsi University of Mashhad, Mashhad, IRAN
[2] Department of Geography, Ferdowsi University of Mashhad, Mashhad, IRAN
[3] Department of Geography, Ferdowsi University of Mashhad, Mashhad, IRAN
[4] M.S Student of Geography, Ferdowsi University of Mashhad, Mashhad, IRAN

Received 4 December 2012
Accepted 11 January 2013

Introduction

Climate change is an important environmental hazard that has been discussed in recent years. Increasing the number or frequency of extreme climatic events such as severe droughts, floods, storms, heat and cold waves and heavy rains are the evidences of climate change. Any of these events, due to the severity and persistence and their spread are a natural hazard that adverse effects on living life to enter. Among the environmental hazards, the occurrence of severe colds cause adverse effects on various aspects of development planning and regional economic recession and social crisis each year in different parts of Iran. As part of the interaction between temperature and atmospheric circulation characteristics of the local space is uneven and the altitude (Masoudian, 2012), explaining the relationship between climate change and the patterns of abnormality surface can reduce the effects of climate planners and Forecasting atmospheric climatic disasters and help. Preliminary studies showed that all of the spring frosts is the type of transmission (synoptic) and in nearly all cases the displacement of the trough at 500 hPa and surface migratory high movement in the West Mediterranean, towards Iran, and integration with Siberian High pressure is going on spring frost leads (Barati 1986).

Lashkari (2008) found that the synoptic causes of widespread cold wave in the country in December 2003 cause consistent systems in lower and middle levels of the atmosphere. The main factor in decreasing temperature is the influence of the Siberian High at ground level, which is formed around Lake Baikal. Alijani and hoshyar (2008) demonstrated the synoptic patterns leading to severe cold in the North West of Iran and concluded that in 70% of cases of severe colds in the North West of Iran, cold ground radiation is the main cause of severe cold by deep trough region in northern Iran and putting it in the rear there is also a high pressure on land and other items. Fattahi and pak Salehi (2010) have examined the patterns of synoptic winter frost. And concluded the type of high-pressure air from Northern Europe, Siberia and Eastern high pressure, the greatest impact of the pervasive had caused severe frost. So, this type of weather, cold polar air from high latitudes to the low latitudes moves and Followed by severe and pervasive frosts occur in Iran. In this study, analysis of the synoptic patterns in the occurrence of cold waves in the North East of Iran.

Study Area

The study area is located in the North Eastern part of Iran. Which is consists Khorasan Shomali and Khorasan Razavi provinces. This area is affected by cold Northern waves during the winters. The study of synoptic causes of the cold waves is necessary for local planning.

[*] Email: doostan@um.ac.ir Corresponding Author 00989128070367

Material and Methods

The objective of the synoptic studies is to explain the interaction between the atmosphere and surface environment (Yarnal, 1993: 7). Two types of data were used: surface and the upper atmospheric data. Daily minimum temperature data from 13 synoptic stations for September to March in North East of Iran (Khorasan) during the period 89-1368 were the surface data. this data were collected from the Meteorological Organization of Iran. High atmospheric variables that were used in this study, The 500 hPa height and sea level pressure data were for used very cold days. These variables were extracted of the National Center for Environmental Prediction data digitally and carefully place in 2.5 degree resolution. The frame coordinate for this study is 10 to 60 degrees of north latitudes and 10 to 80 degrees of east longitudes. Two main approaches are considered in Synoptic Studies: environment to circulation and circulation to environment approach (Yarnal, 1993: 10). The methodology used in this research is an approach to the environment to circulation. In the first step, time series of daily minimum temperatures during the months of September to March 1979-2010 of was converted to standard scores. Then a very cold days, with the introduction of threshold (score less than -1.2) were selected. During the study day was chosen as a day of intense would score less than -1.2 (Alijani, 2008: 4). thus, 203 days were extracted through 3900 days. Thus, for selected days, using digital data of 500 hPa geo potential height in the frames of 10 to 60 degrees were obtained the matrix size 203 × 609.in the Present paper, principal component analysis was used with varimax rotation and s state of principle component. Using principal component analysis approach, the matrix size reduction was related to the merger. Finally, maps of mean sea level pressure and the 500 HP geo potential height data were prepared for each group.

Results and Discussion

The most of the days are very cold (57%) occurred in the month of January with 115 days, 33% of the days for February (68 days), 5% December and 5% for the remaining months. During the study, with 43 days in 2007, the largest share of the 203 days that have been selected. In 2007, 45 days has been a critical minimum temperature across the region (Figure 3). According to Table 3, the new record exists are registered in most of the cooling stations. The Cluster analysis on the level of 500 hPa geo potential height of the 203 days was extracted 6 patterns by cold wave in the North East.

- Pressure patterns

Pattern No 1: This pattern includes 22 days of selected days with minimum temperature and Includes 21% of the variance. Of the month, January is the most common occurrence of this pattern (Table 4).the Maps of mean sea level pressure (Fig. 4), the expansion of the Khorasan show Siberian high pressure. Central pressure is equal to 1035 hPa in the North East of Lake Baikal. Despite the high pressure and its extension to the north-east - south-west flow the motion of the anticyclone and cold dry air in the region. 500 hPa level maps (Figure 5), there is a trough in the north of the Black Sea and the Mediterranean and a strong ridge along its axis north - south are drawn from the North Sea of Caspian to northern Europe and adjacent Arctic latitudes. Also located in the East of the trough axis is drawn with the direction north south and South East of the East Aral lack.

Pattern No 2: 37 days from the days of is the second pattern and contains 19% of the variance. The most common occurrence of this pattern is related to the month of January (Table 5). Maps of mean sea level pressure (Figure 6) shows spread of Siberian high pressure to central pressure 1038 hp of Lake Baikal south, covers the Wide part of Iran. The Siberian high expands of the North East - South West. So the pressure is 1029 hPa in this study area. Map of 500 hPa (Figure 7) consists of a strong ridge to north - south axis in the East Mediterranean Sea that the ridge polar axis this will continue to Eastern Europe.

Pattern No 3: The third pattern is identified, including 39 days that 9.3% of the variance is explained. In the months, the February is the most frequent (Table 6). The average surface map (Figure 8), the central high pressure to 1038 hPa show in the East Siberia to the Aral. Siberian High in its expansion in the east has been developed to the west of Black Sea, and on the heights of the North West of Iran and Mountains Ararat heights because of high altitude and extreme cooling surface area were formed as a local pressure. This local high pressure merged to the Siberian high pressure to Made a large regional high pressure. To extend this high is the North East - South west and with their development, spread to a wide expanse of the North-East region of Iran? So the isobaric to 1029 hp pass from the study area. 500 hPa level maps (Figure 9), there is a ridge in northern Siberia, which is the axis of the ridge north of Aral Lake And is the axis of the northeast – southwest.

Pattern No 4: This pattern is most frequent among the identified patterns. So, 45 days from the study day may follow of this pattern. In the months, most common pattern are the month of January and November (Table 7), this pattern is explained 8.8% of the variance. in the Mean sea level pressure map (Figure 8), is seen a belt of high pressure cells at 35 to 45 degrees north latitudes. Thus, the Siberia high with central pressure of 1035 hPa is seen at the East of Aral Lake. This high spread in the northeast - southwest axis, And parts of the North East and East of Iran is taken. At the level of 500 hPa (Figure 9), ridge of the East Europe to axis of the north – south spread of the Mediterranean west to polar latitude. So, its eastern side, with enhanced meridional component of the trough is extending to lower latitudes. So, that a trough to axis of the north - south-east is seen on the border of the Afghanistan and Pakistan.

Pattern No 5: 40 days of very cold days is impacted by the fifth pattern and 7.6% of the variance is explained. This pattern can be identified coldest pattern in the six pattern introduced. Another feature of this model is its continuity and consistency in the event of a cold. The highest frequency of occurrence of this pattern is related to December (Table 8). The map of the Mean sea level pressure (Figure 10) with a central Siberian High 1040 hPa, north of Lake Baikal, have Extended orientation towards the West and have extended meridional towards the South.in the 500 hp level of fifth pattern(figure 11), Long ridge to axis of the Northeast - Southwest is observed on the East of the Ural Mountains. There is a North strong flow in the eastern part of the ridge.

Pattern No 6: This pattern is the least of days. So, 20 day from study days may follow of this pattern. Among the months of study, the highest frequency of occurrence of this pattern is due in January. The Maps of sea level pressure pattern 6 (Fig. 12) shows the meridional extending of the Siberia high to southern latitudes. As 1025 hPa isobar of this high passed from the study area. At the level of 500 hPa (Figure 13), a shallow trough to axis of the north - south there is in East Afghanistan and Pakistan.

Conclusion

Influx and invasion of the cold wave to khorasan is due to the atmospheric patterns in the 500 hPa level including deep trough in short-wave, cut off of the west winds at high level and the Siberian high on the surface of earth. From above pattern, nearly 90 percent of the cold wave were because enter of the patterns including deep trough in short-wave, cut off of the west winds. 10% of cold wave is because the Siberian high to khorasan from northeast. When the blocking is formed in north of the Caspian Sea and Baikal lack, duration and severity of cold is most.

Key Word: Synoptic Analysis, Cold air waves, Khorasan provience.