DESERT

DESERT
Online at http://jdesert.ut.ac.ir

DESERT 13 (2008) 89-103

A synoptic study on seasonal patterns of wet and dry spells in midwest of Iran

F. Khoshakhlagh[a*], R. Ouji[b], M. Jafarbeglou[c]

[a] *Assistant professor, Faculty of Geography, University of Tehran, Tehran, Iran*
[b] *MSc. Graduate in Physical Geography, Climatology*
[c] *Scientific staff, Faculty of Geography, University of Tehran, Tehran, Iran*

Received 2 January 2006; Received in revised form 22 June 2007; Accepted 3 September 2008

Abstract

The effective patterns and mechanisms of synoptic systems during the wet and dry spells in Midwest of Iran (MWI) analyzed and discussed on seasonal scales from 1974 to 2003. Synoptic Analysis is based on synoptic charts on Sea Level Pressure (SLP), 850 and 500 Hpa levels. The results of synoptic analysis show that dry spells in MWI are mostly corresponded to Azores High (AZH) intensifying and its central movement to east and northeast of normal position. Furthermore the Siberian High (SH) ridge is extended from northeast to Iran. The linkage between SH and AZH ridges through Iran, Mesopotamia (Iraq) and Arabic Peninsula lead to drought occurrence in the Middle East especially Iran. The Sudan Low (SL) and Mediterranean Trough (MT) have a limited extend during drought periods (dry spells). The most important occurrence index of droughts in upper charts is reinforcing and extending northward of Arabia South High (ASH) to Iran and Mesopotamia. This event is marked by a strong ridge in 500 Hpa charts over study area. The Circumpolar Vortex (CPV) is contracted to polar area during dry spells and expanded equatorward in wet spells. In Summarized SH extends during wet spells but dose not reach to Iran. In addition Mediterranean East Trough (MET) reinforced and extended from 25°E to 40°E and its meridional expands reaches to the Red Sea (RS) and Sudan Low. The other result is that during wet and dry spells, the orientation of Blocking Highs ridges in the north of Caspian Sea and over Ural Mountain (UM) causes different climatic conditions in Iran.

Keywords: Synoptic climatology, Wet spell, Dry spells, Atmospheric action centers, Midwest of Iran

1. Introduction

Atmospheric circulation is an important factor for climatic and ecological conditions. General atmospheric circulation having some patterns that create abnormalities and follow it precipitation, temperature and pressure regimes changes in some parts of the globe from spatial and temporal viewpoint. One of the severe changes is the decreasing in rainfall (drought occurrence) and other is precipitation abnormal increasing (humid period). The aim of this paper is finding of reasons for the mentioned circumstances. The best method for studying the especial weather types is Synoptic Climatology. The synoptic maps (charts) are important tools for considering in this field. *Jacobs* (1946) has presented an integrated and synchronized view (synoptic) in climatology for the first time. *Barry* (1973) introduced two stages for synoptic studies in his books titled: *"Synoptic Climatology"*, determining the especial and distinctive weather circulations patterns، pressure distribution, and then; general assessments another climatic elements such as temperature and precipitation related to those especial patterns. *Kutiel et al*. (1998) have studied different probability levels associated with seasonal strong correlation in every season by concerning to weather pressure patterns in Mediterranean east and their relation to change of wet and dry spells in the globe. *Sergey et al*.

* Corresponding author. Tel.: +98 21 61113528; fax: +98 21 66401894.
E-mail address: khf1345@yahoo.com

(2002) have surveyed the climatic conditions and interanual variations north Atlantic area in synoptic scale by analyzing of synoptic patterns using six hours charts in NCEP-NCAR website. *Lana* et al. (2007) have presented mechanisms of atmospheric patterns of heavy rainfall by concerning to synoptic charts of 1000, 850 and 500 Hpa related to January until May in a 9 years period in Balearic Isles.

The synoptic studies in Iran are frequent and valuable especially on rainfall patterns in west, northwest and southwest parts of country. For example *Alijani* (1987) in studying on cyclonic tracks in the Middle East found three certain tracks enters to Iran from west. *Sabziparvar* (1991) has mentioned about Sudan Low (SL) effects on origin of flood-maker synoptic systems in southwest of Iran. *Lashkari* (1996) emphasized on Sudan-Mediterranean Low effects in studying on synoptic patterns of severe rainfalls in south and southwest of Iran. *Khoshakhlagh* (1998) has also mentioned the role of Sudan-Mediterranean Low and their common trough in droughts or humid periods occurrence on monthly, seasonal and annual scales. *Zolfaghari* (2000) in a study has identified the spatial and temporal patterns of daily rainfall in west of Iran by using cluster analysis and synoptic methods. *Moradi* (2001) concluded that Polar Vortex (PV) effects on rainfall and temperature in north and south parts of Iran are very different by using synoptic considerations on Polar Vortex and its effects on Iran climate based on its central cell geographical positions. *Ouji* (2006) by using synoptic analysis on cyclone tracks coming to Iran has identified three tracks that are influenced by Sudan low trough and blocking highs formed from Europe to north of Caspian Sea and Siberia.

The normal and critical atmospheric conditions were investigated by quantitative considerations and synoptic analysis through inductive approach in this research. Finally appropriate synoptic patterns were schematically illustrated for wet (humid) and dry (drought) spells within humid season of Midwest of Iran by simplified charts.

2. Materials and methods

Midwest of Iran (MWI) is a zone that marked by seven synoptic stations; *Arak*, *Hamedan*, *Kermanshah*, *Khoramabad*, *Ilam*, *Zanjan* and *Sanandaj* [Fig 1]. Then a 30 years period was selected and the monthly period of study was selected from October until May because of time continuity and the interrelationship of weather systems as a unique rainfall season. At first months and years were studied by standard score (Z) method and then for every months five case of wettest (Z >= 1) and driest (Z<= -1) cases were selected. Then related weather charts have been extracted in three atmospheric levels namely SLP, 850 Hpa and 500 Hpa with long term mean charts from NOAA website (NCEP-NCAR).

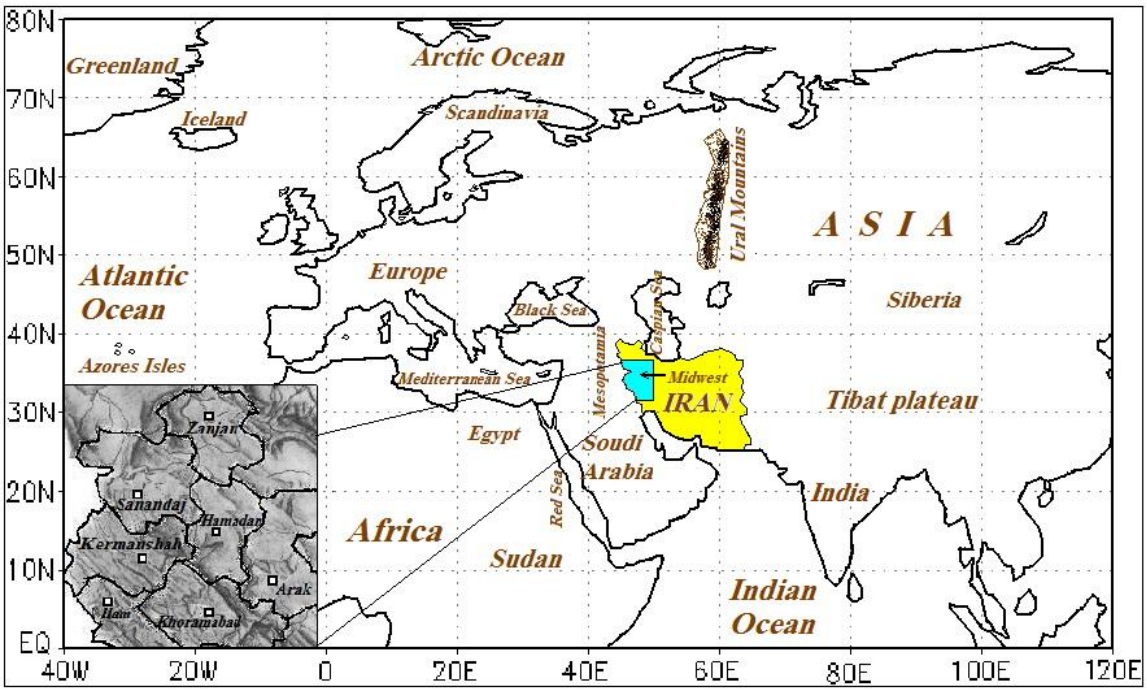

Fig. 1. The whole synoptic base map and location of Midwest of Iran

Natural season selection was performed by the best fitness of rainfall, temperature and pressure in similar months. With this circumstances October to November period was taken account as *autumn*, December to March take account as *winter* and March to May as *spring*.

It was made monthly charts analysis based on standard score (Z) and ratio of rainfall intensity-area and also temperature and pressure for all stations. Finally it provided schematic and simplified appropriate patterns of atmospheric action centers and their relations in three synoptic levels prepared by using GIS softwares (Ilwis and ArcGIS).

3. Results and discussion

3.1. Synoptic patterns of wetter rainy season

a) Autumn (October and November):

Regarding to SLP charts in autumn and comparing them with long term charts, it can be seen that Azores High (AZH) relatively reinforced and its northeast-southwest ridge caused the intensifying and also movement of Iceland Low (IL) trough eastward and southeastward. Intensifying this low caused to extend its trough into Europe and Mediterranean Sea and reinforcing the Mediterranean trough. Siberian High (SH) almost was powered and its ridge axis extend as zonal toward north of the Caspian Sea to Europe. Intensifying of these highs and developing of their ridge toward each other caused to Blocking High (BH) formation in north of Black Sea and Caspian Sea and over the Ural Mountains (UM) that resulted to appropriate conditions for entrance Mediterranean and Black sea cyclones into Iran in most cases. Sudan Low has become stronger and its trough penetrates to north of Red Sea, eastern Mediterranean, and Mesopotamia and west of Iran [Fig 2(a)].

Tibetan High (TH) was reinforced in 850 Hpa level and its ridge often extends toward northwest. The Azores, North Africa and Arabia South highs were powered but the west of Iran is free of their ridges and because of meridional development of Iceland Low trough or existence of blocking highs created favorable conditions for instability occurrence in study region [Fig 2(b)]. The Azores High retreated and by Arabia south high weakening and sometimes splitting the westerlies in two branches, it has appeared strong trough in east Mediterranean to Red sea in 500 Hpa level by sliding of Polar Vortex (PV) to south [Fig 2(c)].

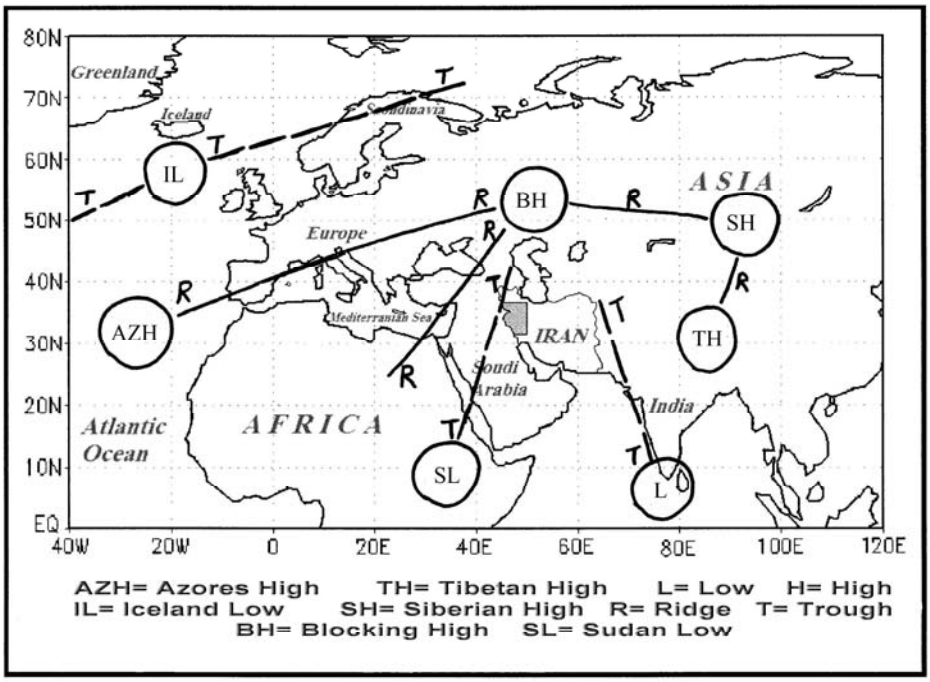

Fig. 2(a). The simplified SLP chart of frequent synoptic action centers patterns in autumn wet spells

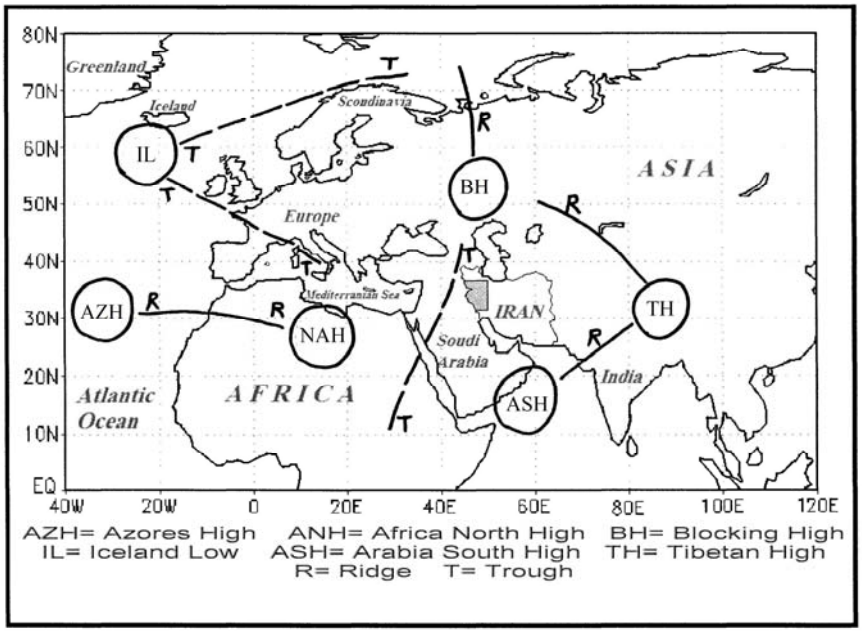

Fig. 2(b). The simplified 850 Hpa chart of frequent synoptic action centers patterns in autumn wet spells

By establishing of these situations from surface to upper levels, favorable conditions are formed for intense instability and heavy rainfall. Finally Circumpolar Vortex (CPV) has developed and advanced southward to study area and caused heavy rainfalls.

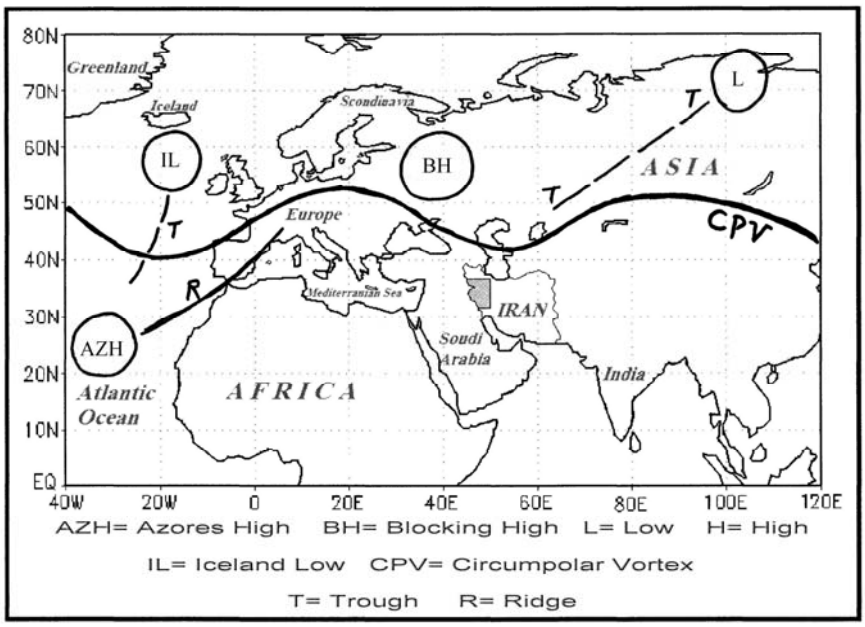

Fig. 2(c). The simplified 500 Hpa chart of frequent synoptic action centers and CPV patterns in autumn wet spells

b) Winter (December to March):

With concerning to SLP chart comparing the long term charts with study period charts shows that the Siberian High developing ridge often occurs in zonal direction and reaches to north of Caspian Sea and Europe but does not enter to Iran. Azores High also relatively powered and its ridge often extends to northeast and east of Atlantic. This extension caused the movement of Iceland Low trough to east and southeast and finally leads to intensifying the Mediterranean trough. Sudan Low has been relatively stronger than normal and its trough extends to Mediterranean Sea east and southwest to west of Iran [Fig 3(a)].

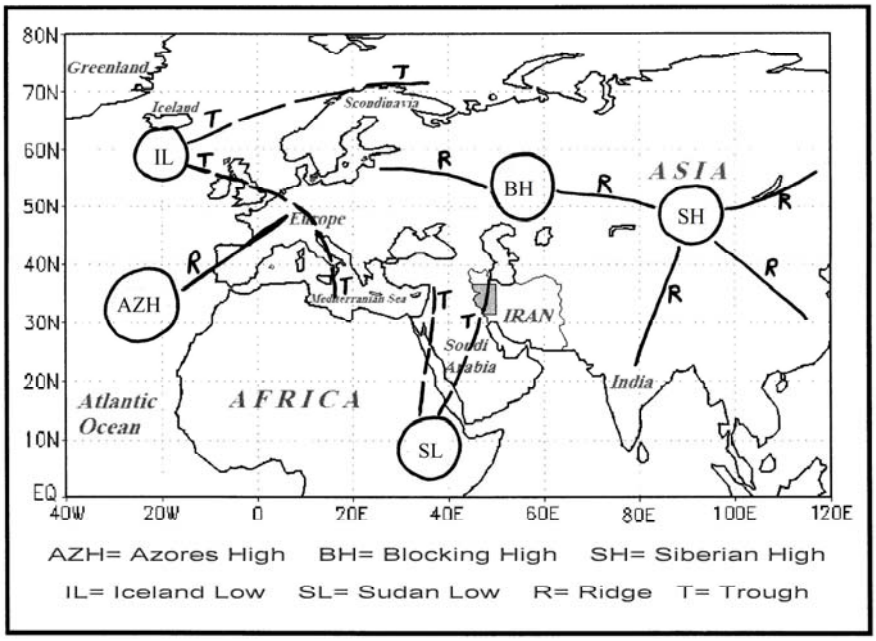

Fig. 3(a). The simplified SLP chart of frequent synoptic action centers patterns in winter wet spells

Sometimes existence of blocking high in north of the Caspian Sea led to Mediterranean low intensifying by concerning to 850 Hpa level. In these circumstances the Azores, North Africa and Arabia south highs move to southern latitudes than normal and therefore the ridges of these highs exit from Iran. The Iceland Low Intensifying and extending southeastward of its trough to Mediterranean Sea east has an effective role in Mediterranean east lows [Fig 3(b)]. The splitting the westerlies flows in two branches has led to formation a powerful trough over Mediterranean east and Red Sea and formation of two ridges in trough sides that effect on instable conditions in 500 Hpa level. Circumpolar vortex countor penetrates over Caspian Sea in 40°E and the ridge in west side of it in 10°E to 35°E becomes deeper in wet spells [Fig 3(c)].

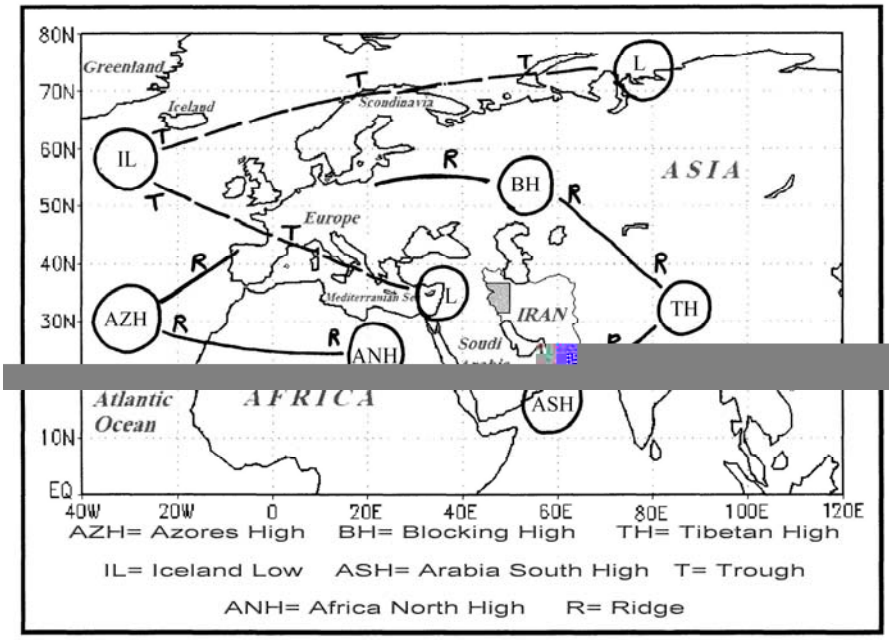

Fig. 3(b). The simplified 850 Hpa chart of frequent synoptic action centers patterns in winter wet spells

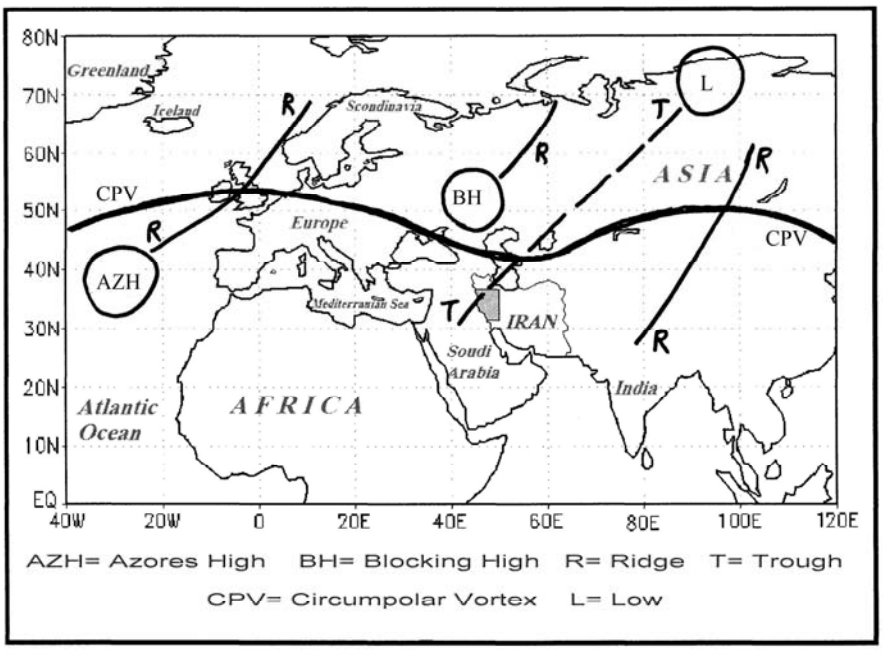

Fig. 3(c). The simplified 500 Hpa chart of frequent synoptic action centers and CPV patterns in winter wet spells

c) Spring (March to May):

The central pressure of Siberian high in compare with long term averages shows slightly decreasing and also east to west extension with considering to SLP chart. Azores high has not distinct changes and its ridge with southwest-northeast orientation in combination with ridge of Siberian high have formed a blocking high in north of Caspian Sea that develops a ridge from northwest of Caspian sea to southeast of Iran. This ridge has caused with west ridge of Mediterranean sea reinforcing the trough of Mediterranean Sea east. Sudan low is reinforced in compare to long term state and its trough has extended to Mesopotamia plain until to Black Sea, southwest of Iran and also through the Red Sea over the east of Mediterranean Sea [Fig 4(a)].

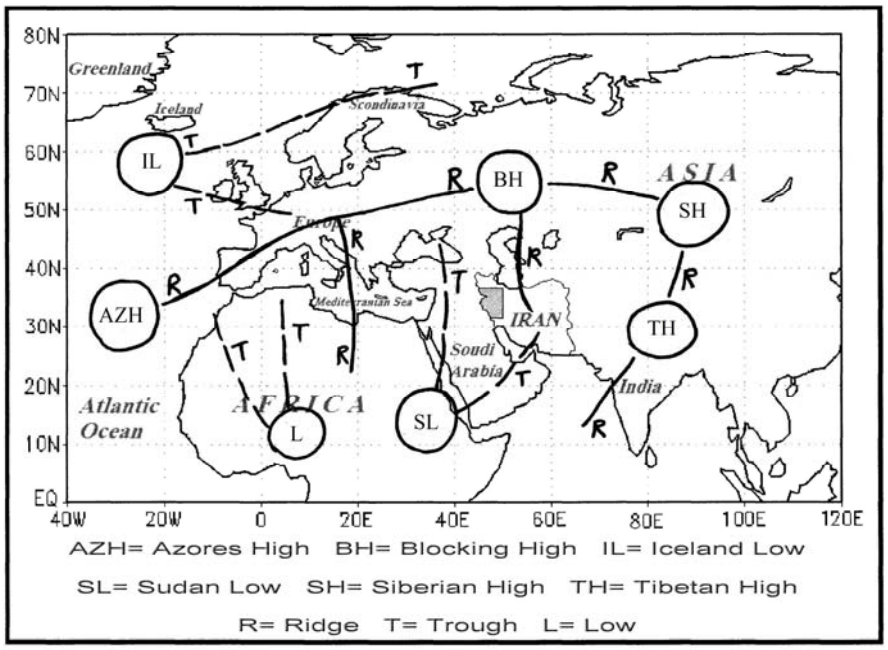

Fig. 4(a). The simplified SLP chart of frequent synoptic action centers patterns in spring wet spells

Tibetan high has not any change except its ridge extend in two axes either northeast or northwest in 850 Hpa level. Azores high has slightly reinforced and extended from southwest to northeast. Blocking high in north of Iran and North Africa and Arabia south highs are affected in reinforcing eastern Mediterranean trough and southwestern flows over the study area [Fig 4(b)].

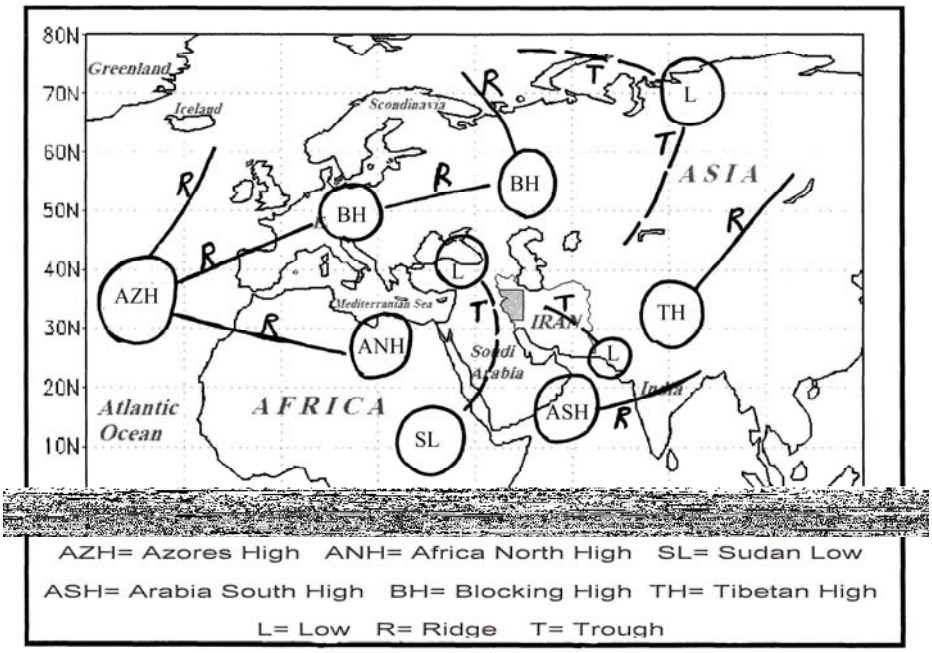

Fig. 4(b). The simplified 850 Hpa chart of frequent synoptic action centers patterns in spring wet spells.

The 500 Hpa level patterns such as interactions of deep ridges resulted by North Africa high pressure and ridge of Arabia south and also ridge of blocking high in north of the Caspian Sea over Iran caused to more strengthening eastern Mediterranean trough from Scandinavia to Red Sea. In addition circumpolar vortex contour shows less regularity than the winter in spring of humid season [Fig 4(c)].

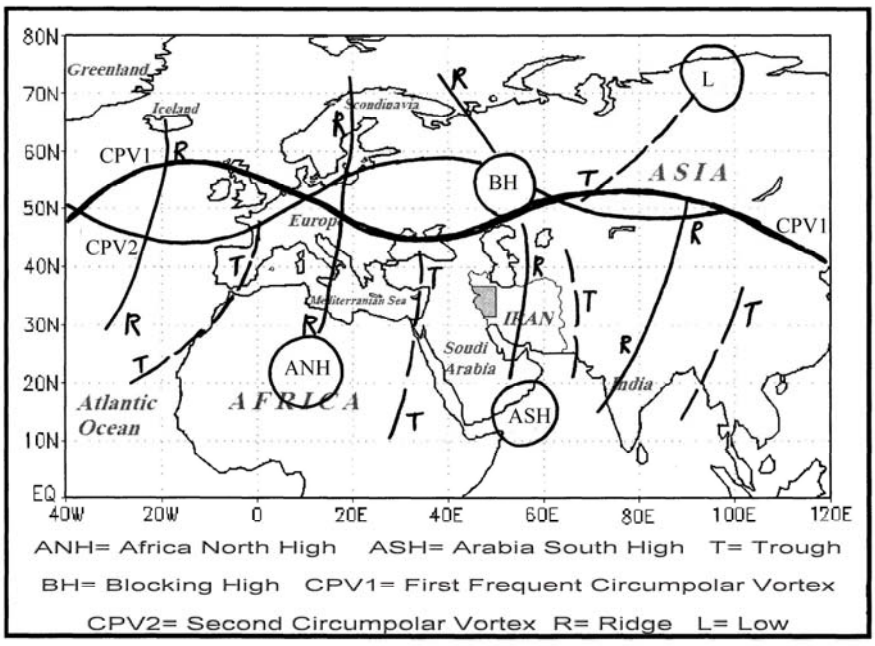

Fig. 4(c). The simplified 500 Hpa chart of frequent synoptic action centers and CPV patterns in spring wet spells

3.2. Synoptic patterns of drier rainy season

a) Autumn (October to November):

Azores high reinforced and its ridge extends to East into Mediterranean Sea and southern Europe. Siberian high ridge with northeast-southwest orientation have occupied whole of Iran and even east of Mediterranean and Black sea and as a blocking high is connected to Azores high. Mediterranean lows have become weak or can not enter to Iran since Siberian high ridge blocks the cyclonic tracks. Sudan low has not change but its trough over Red Sea is limited. Iceland low often reinforced because of northward extension of Azores ridge and its trough extending into zonal direction, and due to its retreat in Atlantic its second center in Scandinavia east moved to southern latitudes and cause to establishing the Azores-Siberian high belt over the whole of Iran [Fig 5(a)]. Tibetan high reinforced and caused to create some ridges in 850 Hpa level. One of the ridges connects to Arabia south high from west southern part.

Then Arabia south high reinforced and move to some distances to north and its extended ridge occupies most part of Iran in south of the Caspian Sea, Caucasus node and northeast of country in this conditions. These events caused the weakening the Mediterranean east low pressure and blocks the entrance of cyclonic tracks to Iran [Fig 5(b)].

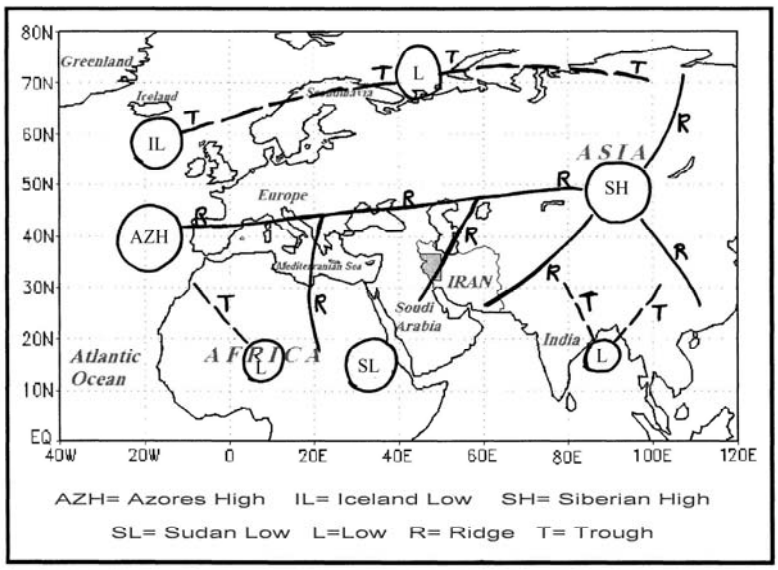

Fig. 5(a). The simplified SLP chart of frequent synoptic action centers patterns in autumn dry spells

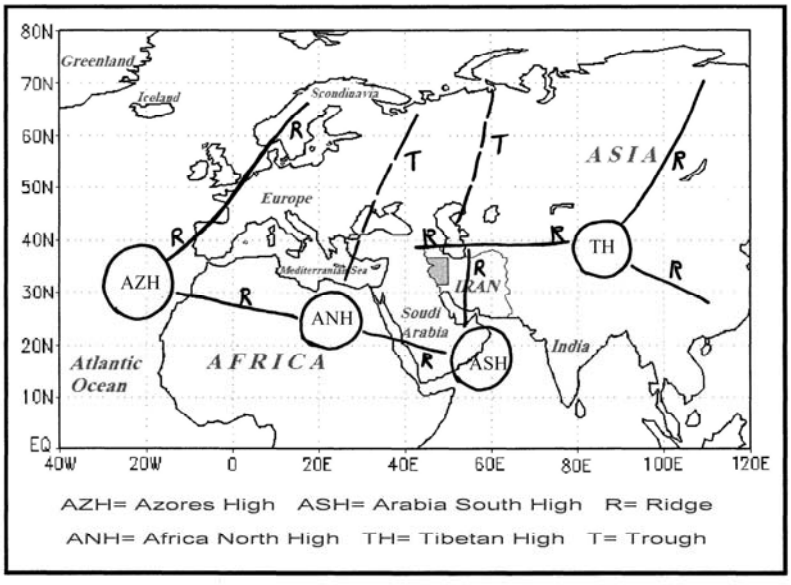

Fig. 5(b). The simplified 850 Hpa chart of frequent synoptic action centers patterns in autumn dry spells

The 500 Hpa charts shows the governing a powerful ridge that originated from south Arabia south high to north of Europe over Iran especially over study area. The circumpolar vortex contour had been zonal form and showed a ridge from 30°E to 80°E in most times [Fig 5(c)].

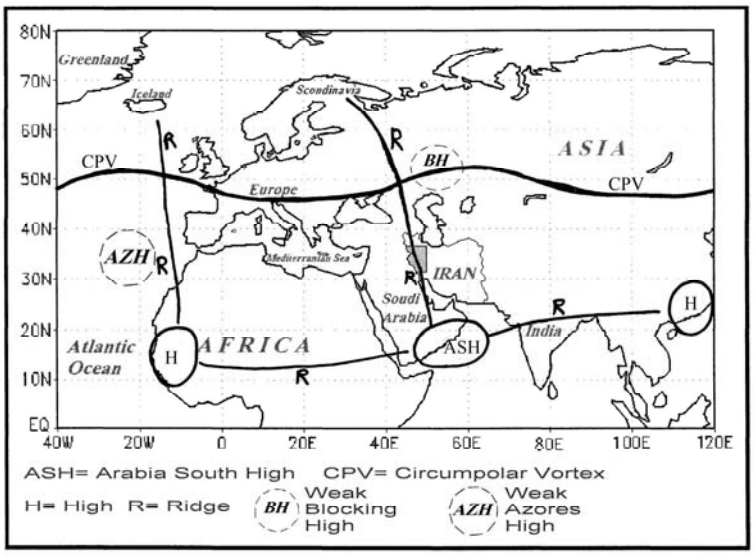

Fig. 5(c). The simplified 500 Hpa chart of frequent synoptic action centers and CPV patterns in autumn dry spells

b) Winter (December to March):

The Azores high reinforced and its ridge northeastward extends to west of Europe and also southeastward to north of Africa as has been observed in SLP chart. It has not changed central pressure of Siberian high but its extended ridge in east-west direction extends to Mediterranean north through Black sea. This wide ridge covers the whole of Iran and connects to Arabia south high southward. The Siberian high ridge is connected to Azores high in north of Caspian Sea in the extending times. The blocking high ridge extends to Arabia south high pressure through west and south of Iran. The Sudan low has no changed but its trough is limited over Red Sea because of the extension of Azores-Siberia highs belt. Iceland low extends zonal direction and reinforced when it closes to axis of Azores high and with movement and deepening its center in east of Scandinavia caused to southward movement of Azores-Siberian high pressure belt especially over Iran [Fig 6(a)].

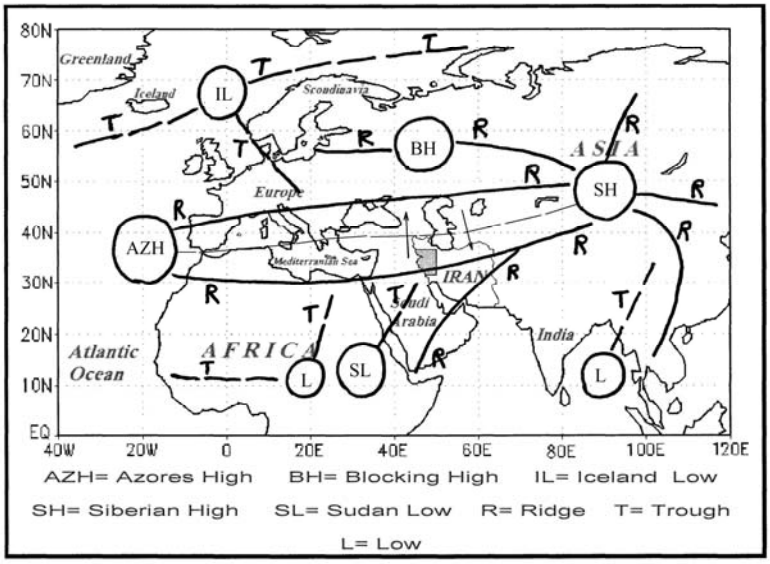

Fig 6(a): The simplified SLP chart of frequent synoptic action centers patterns in winter dry spells.

It originated the extension of Azores ridge in a band with southwest-northeast direction to northwest Europe coasts reinforcing a high that has limited Iceland low activities to further north and west of normal position in 850 Hpa charts. The Arabia south high has been strengthened and created a powerful and deep ridge in west of Iran. Mediterranean trough has weakened and there is a trough in east of Iran that speed up the above mentioned position [Fig 6(b)].

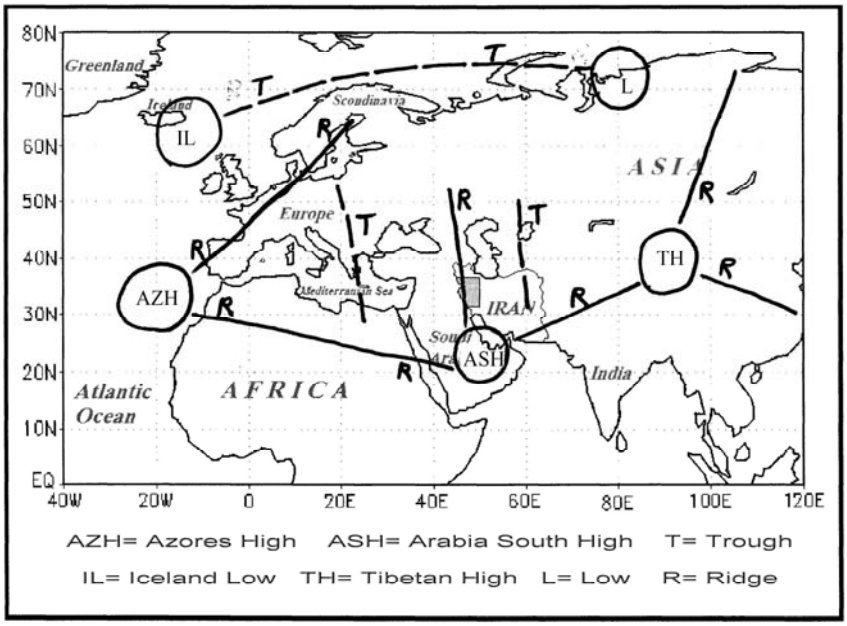

Fig. 6(b). The simplified 850 Hpa chart of frequent synoptic action centers patterns in winter dry spells

It shows strengthening Arabia south ridge and governing a powerful ridge over the study area in 500 Hpa level. This ridge reinforced and extend in relation with Mediterranean east trough and Iran east trough from Arabia south to northeast of Europe. The circumpolar vortex shows a ridge-like pattern from 25°E to 65°E, but in east and west the conditions for streamlines are normal and zonal [Fig 6(c)].

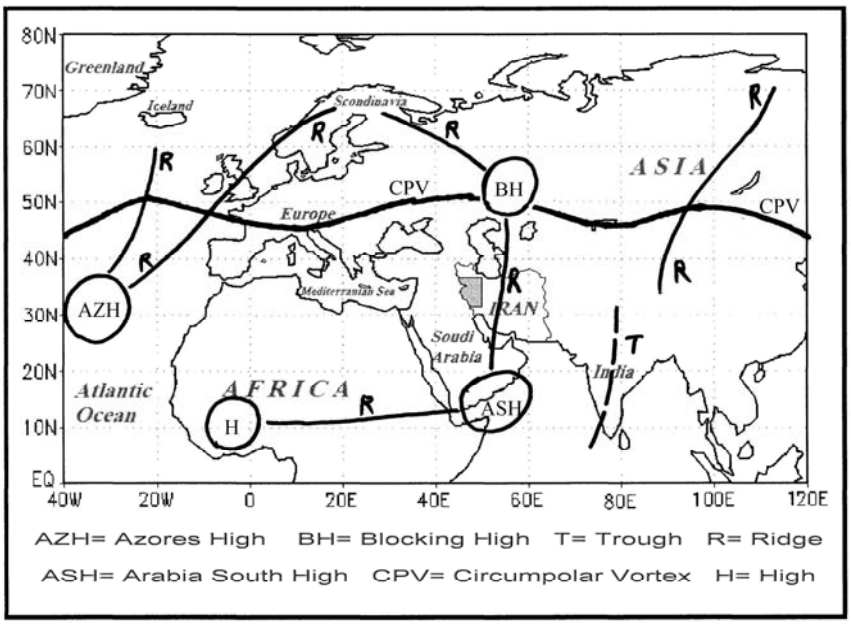

Fig. 6(c). The simplified 500 Hpa chart of frequent synoptic action centers and CPV patterns in winter dry spells

c) Spring (March to May):

Azores high has not changed and its extension is southwest-northeast with concerning to SLP chart. Siberian high has same condition but its center has become weak and its axis extends to north of Caspian Sea. Sudan low has no trough to Mediterranean Sea east. Because of the high center dominant in northwest of Iran and because of its ridge over study area the Sudan low and Mediterranean east cyclones can not enter to Iran. Iceland low center moves to northeast and has no remarkable effects on the Europe and Mediterranean area [Fig 7(a)].

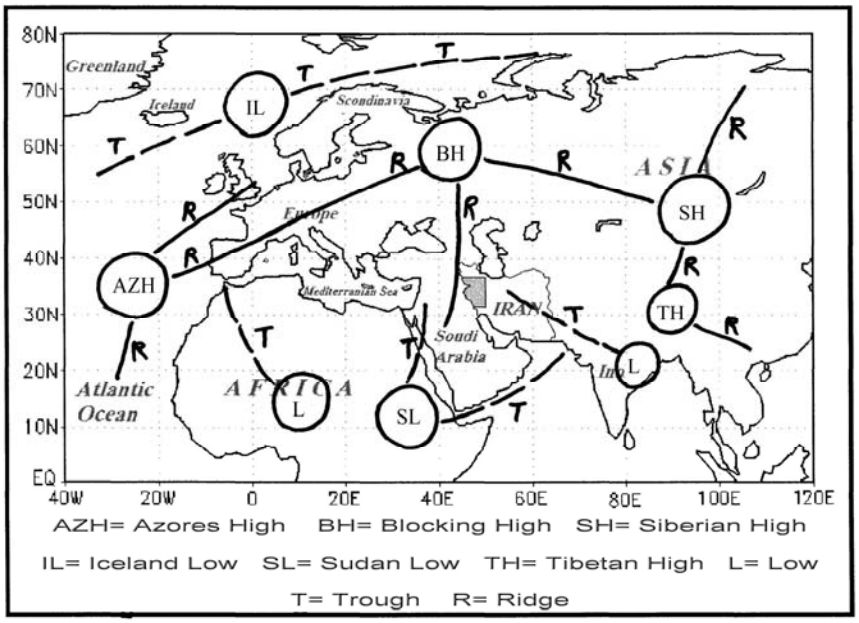

Fig. 7(a). The simplified SLP chart of frequent synoptic action centers patterns in spring dry spells

Azores high center is evident with north-south axis on ocean In 850 Hpa chart. South Arabia high reinforced and by creating a ridge in west of Iran blocks the entrance of low systems to reach Iran [Fig 7(b)].

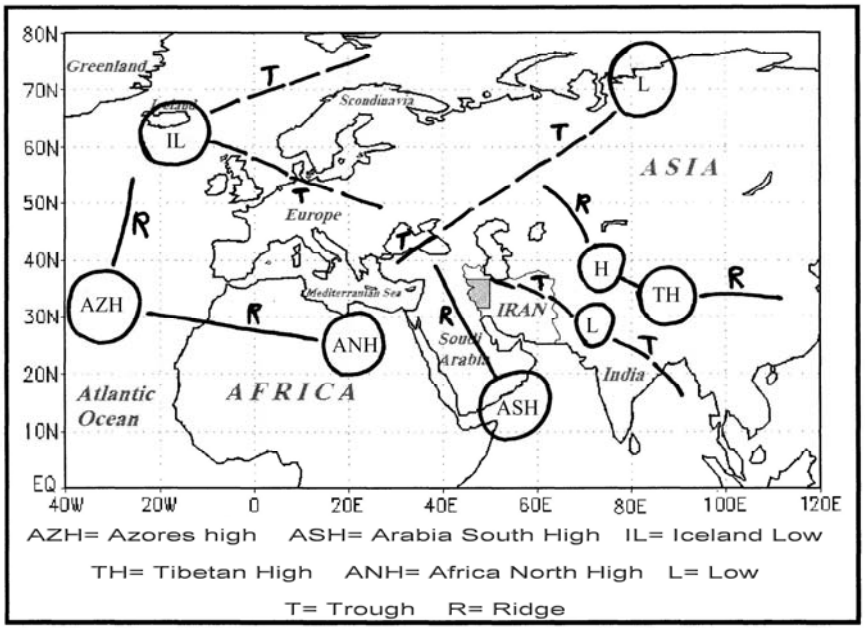

Fig. 7(b). The simplified 850 Hpa chart of frequent synoptic action centers patterns in spring dry spells

The 500 Hpa chart illustrates the movement of Subtropical High Pressure (STHP) centers to higher latitudes and establishing a ridge over the Iran, that blocks the tracks of low systems toward study area [Fig 7(c)].

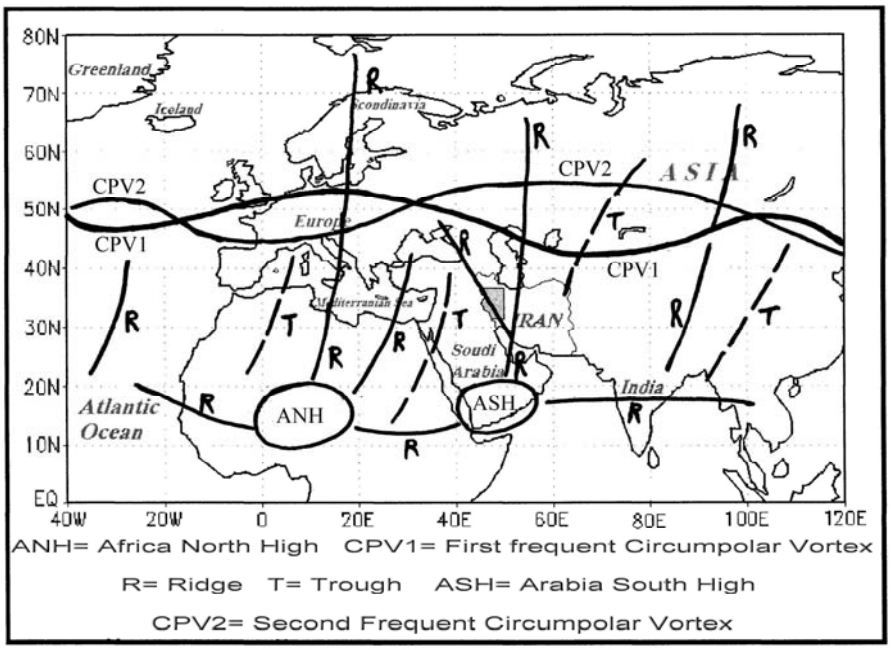

Fig. 7(c). The simplified 500 Hpa chart of frequent synoptic action centers and CPV patterns in spring dry spells

As it was previously determined the spring season in Iran is very short and appears suddenly summer because of poleward fast advancing of STHP (opposite equatorward and slow retreat of it). The circumpolar vortex having an irregular shape in spring than the autumn and winter. The reason may be a trough-like pattern on circumpolar vortex that deepen in 60°E and or that the widely ridge of subtropical high moves to higher latitudes from 10°E to east of Middle East [Fig 7(c)].

4. Conclusions

4.1. The synoptic model of atmospheric levels in wetter rainy season.

a) The SLP patterns:

The Azores high reinforced so its central pressure increases 2 Hpa in average, and its central cell moves to Atlantic center. The Azores ridge extends to northeast toward western coasts of Europe and finally to Eastern Europe to Ural mountains. Following it and its connection with Siberian ridge is caused to blocking high formation and therefore reinforcing the Iceland low. But Azores high can reinforce Sudan low in east and southeast extensions (with developing Egyptian local high pressure). The developing axis of Siberian high becomes more zonal and through north of Caspian Sea reaches to the central Europe in most times. Another branch of Siberian high ridge spreads in relation to Tibetan high pressure with southwest direction over India. The thermal Sudan low relatively reinforced and its trough extends northeastern to southwest area of Iran and northern to north of the Red Sea and even eastern part of Mediterranean Sea. Sudan low plays a significant role by combination its trough with Mediterranean east low, in precipitation formation in Midwest of Iran. The central cell of Iceland low somewhat reinforced and sometimes through western and central Europe caused to entrance the Atlantic cyclones to Mediterranean sea and toward Middle East and occurrence of humid period (wet spells) for the study area. It seems that blocking highs creates direct or couple omega systems that mostly are in relation with Azores or Siberian high ridges and mostly form in eastern Europe and Ural mountains and sometimes in western Europe strengthens the independed ridges, simultaneously reinforce the meridional flows and eventually play an important role in precipitation occurrence in Midwest of Iran [Figs; 2(a)، 3(a) and 4(a)].

b) The patterns of 850 Hpa level:

Azores and North Africa highs are very clear in this level. Reinforcing of North Africa high and its central cell movement to north of Mediterranean Sea is caused to intensifying the lows in east and west parts of Mediterranean Sea in this situation. Arabia south high retreat to southeast without decreasing in central pressure. The ridge in west of Iran disappears and provides conditions for entering the lows to study area in pervious mentioned conditions. With Tibetan ridge continuing toward southwest and its connection to Arabia high in autumn, the conditions for extending of Iceland trough toward southeastern in autumn and winter and also further reinforce of eastern Mediterranean trough in every three seasons caused to entrance instable flows to the study area. It is necessity to consider the blocking systems in the Caspian Sea north and over Ural mountains due to reinforcing the ridges of Iran east and west of Mediterranean Sea in favorable meridional flows play an important role in Midwest of Iran precipitation regime [Figs; 2(b)، 3(b) and 4(b)].

c) The patterns of 500 Hpa level:

Atmospheric systems arrangements especially meridional flows in 500 Hpa level support the conditions of SLP and 850 Hpa levels. In addition circumpolar vortex shows a trough-like feature during the wet spells in 20°E to 40°E that southward penetrates to 34°N and in other hand with further deepening of trough in pointed longitudes were intensified during humid periods or wet spells [Figs; 2(c)، 3(c) and 4(c)].

4.2. The synoptic model of atmospheric levels in drier rainy season

a) The SLP patterns:

The Azores high reinforced so that its central pressure increases 4 Hpa in average, and its central cell moves to east and northeast of normal position. Siberian high and its ridge establishes the belt of Siberian-Azores without any increasing in central pressure extended to west and southwest and by integrating to Azores high ridge in central Europe and Mediterranean area. This belt puts over Iran caused to stable weather conditions and no precipitation in dry spells. The eastern Mediterranean Sea trough often weakened and no cyclogenesis and because of or cyclones existence due to extending of Siberian high over Iran the Mediterranean cyclones could not enter to the study area. Iceland low reinforced with pressure decreasing about 2 or 3 Hpa and its central cell with movement to east of Iceland due to elongating a branch toward low latitudes helps to putting the Siberian-Azores highs belt over Iran. Sudan low is also limited without certain changes in its central pressure [Figs; 5(a)، 6(a) and 7(a)].

b) The patterns of 850 Hpa level:

Azores high has reinforced and interim extending to east related to ridge of Tibetan high that is much intensified in dry spells of Iran and finally Azores-Siberian belt forms in this level. By a ridge extending from Tibetan high over Iran leads to stable conditions and blocking the cyclonic tracks to Iran. The Africa north high also shows different behaviors because of strengthening and movement of its central cell. In this condition cyclogenesis is ceased by extending high pressure cell over central Mediterranean Sea, and or in extending toward southwest or southeast leads to reinforcing mentioned high pressure belt. Arabia south high plays an important role in restraint of cyclones to enter the study area through central cell movement to higher latitudes and make a ridge in west of Iran and finally dry spells occurrence in Midwest of Iran [Figs; 5(b)، 6(b) and 7(b)].

c) The patterns of 500 Hpa level:

The 500 Hpa charts show that the eastern Mediterranean trough is weakened in dry spells. A trough often establishes in central Mediterranean area to north of Africa and resulted ridge from south Arabia high to west of Iran may be reinforced due to factors such as; eastern Mediterranean trough and or resultant ridge from high pressure in north of the Caspian sea, continues dry spell conditions in Midwest of Iran. It is necessary to concern that formation the blocking highs are limited in dry spells and shows a lower frequency rather than wet spells. The circumpolar vortex contour shows a zonal feature or a ridge-like pattern in 20°E to 40°E in dry spells [Figs; 5(c)، 6(c) and 7(c)].

4.3. General results comparison for wet and dry spells

a) Siberian high may be strong or weak in humid periods (wet spells) of Iran Midwest. When this high pressure is strong, with extending a ridge toward north of Caspian Sea until central Europe and occurrence of cold advection toward east of Mediterranean Sea leads to severe cyclogenesis in eastern

Mediterranean. Another branch (ridge) of Siberian high extends southward to Tibet. When it is weak, the extension of its ridges is very limited and the study area in Iran is free from Siberian high ridge. The depth of precipitation will be increased with decreasing the velocity of cyclones entered to Iran in these conditions. The ridge of Siberian high often occupies Iran with northeast to southwest orientation in drought years (high frequent dry spells).

b) The Azores high central cell reinforced and its ridge with northeast direction extends to northeast of Atlantic or even in central Europe and resulted to Mediterranean Sea becomes free of high pressures in more humid period of Iran. This high pressure system also extends and intensifies a ridge to near the Sudan low. Azores high is more reinforced in droughts rather than wet years but its ridge forms a high pressure belt with Siberian high in drought years with zonal extension over Mediterranean Sea and prevents the air ascending and precipitation in the study area.

c) The blocking high systems in direct Omega (Ω) or coupled forms that have formed in east Europe, Ural mountains and sometimes in central or west Europe by creating and reinforce the ridges and troughs have a key role in occurrence of rainfall in Iran Midwest through intensifying the meridional flows in different levels of atmosphere.

d) The Sudan low is active in humid periods and its troughs with northeast direction extends to southwest of Iran and Mesopotamia plain and with northern extension, spread on north Africa, central and Mediterranean east. This low pressure system in sole or together with Mediterranean cyclones creates thunderstorms with severe rainfall in study area because of its thermal nature.

e) The north Africa subtropical high reinforced and with movement toward high latitudes with a northern-southern axis stays on southern edge of central Mediterranean area in humid periods, that by creation a powerful ridge onto northern Europe and sometimes onto subpolar area caused to cold advection and reinforce the eastern Mediterranean trough.

f) The Arabia south subtropical high has a key role in occurrence wet and dry spells in study area, so that whenever this high pressure reinforced and moved to northwest, the most severe drought events occur because of creation a ridge with northern or northwestern orientation in west of study area. But when this pressure system moved to southern or eastern than normal position leads to reinforcing the eastern Mediterranean trough and increasing precipitation in west of Iran because of establishing a ridge in central to eastern longitudes of Iran.

g) The trough of eastern Mediterranean reinforced and often shows parallel orientation with axis troughs of mid or higher latitudes with a northeastern to southeastern, northern to southern and partly northwestern to southeastern directions pushed to lower latitudes, by reinforcing the diffluent southwestern flows toward study area with due attention to cases (e) and (f), and leads to wet spells occurrence in Iran Midwest. It is considerable the statistical correlation between precipitation index (Intensity×Area) and orientation of Mediterranean trough axis is R=-0.245 that is significant in %99 level. In other words relation between Iran Midwest precipitations with northwestern-southeastern orientation of trough is negative and with northeastern-southwestern orientation of that trough is positive. It means that if trough axis becomes southwestern, the rainfall will be increased. The trough of northeastern-southwestern direction has more frequent in humid periods of Iran Midwest.

Acknowledgment

The autors are grateful and acknowledge the assistance and facilities provided by Dr. Hossien Mohammadi and Dr. Sead Kazem Alavipanah for helpful commands on draft of this paper

References

Alijani, B., 1987. Relationship between spatial distribution of cyclonic tracks of Middle East with upper atmospheric weather systems (to Persian), Geographical Research Quarterly, 4: 125-143.

Barry, R. G and A. H. Perry, 1973. Synoptic Climatology; Methods and Applications. Methuen and CO Ltd, U.S.A, 555 pp.

Jacobs, W. J., 1946. Synoptic Climatology. Bult. Amer. Met. Soc., 27: 306-311.

Khoshakhlagh, F., H. Ghaemi and M. Zahedi, 1997. Consideration on monthly patterns of droughts and humid periods in Iran (to Persian). Geographical Research Quarterly, 45: 136-154.

Kutiel, H., P. Maheras and S. Guika, 1998. Singularity of atmospheric pressure and wet spells. Int. J. Climatol, 18: 317-327.

Lana, A., J. Campins., A. Geno'es and Jans'a, 2007. Advances in geosciences atmospheric patterns for heavy rain events in the Balearic Islands. Cntre

Meteorologic de les Illes Balears, Instituto nacional de meteorolog' y'a. Spain, www.adv-geosci.net.

Lashkari, H., 1996. The synoptic Pattern of severe rainfall in south and southwest of Iran (to Persian), Ph.D. Dissertation. Tarbiyat Modaress University. Tehran.

Moradi, H., 2001. Synoptic analysis on polar vortex and its effects on Iran climate (to Persian). Ph.D. Dissertation. Tarbiyat Modaress University. Tehran.

Ouji, R., 2006. A synoptic study on atmospheric patterns, frequency and cyclone tracks of humid periods in Midwest of Iran (to Persian). M.S. thesis on climatology, University of Tehran. Tehran.

Sabziparvar, A., 1991. Synoptic consideration on flood-maker systems in southwest of Iran (to Persian). M.S. thesis on meteorology. Geophysic Institute of University of Tehran.

Sergey, K. G., T. Jung and E. Ruprecht, 2002. Climatology and interannual variability in the intensity of synoptic scale processes in the north atlantic from NCEP-NCAR reanalysis data. Journal of Climate, 15: 809-828.

Zolfaghari, H., 1998. An analysis on spring precipitation of west of Iran (to Persian). Nivar Quarterly. IRIMO publishing, 40: 7-22.