

Synoptic Analysis of Total Rainfall Patterns at Azerbaijan District

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Abstract: This research analyzes the synoptic patterns of general raining of Azerbaijan district that includes west Azerbaijan, east Azerbaijan and Ardebil provinces. General raining means the amount of raining which is recorded simultaneously in all of the stations of the studied districts during one or more than one days. Daily statistics of raining is one or more than one mm. During seven years of statistic period (2000-2006) about 23 synoptic stations have been used. After studying and analyzing the related statistics of the stations during above –said statistic period 14 days of general raining were determined. By analyzing the earth maps and the surface of 500 hectopascals general raining days, general raining patterns of district and the frequency of happening of each case across the studying district were recognized which includes: 1-Cyclone patterns: After formation on the surface of Mediterranean Sea, it is transferred toward Iran by a high descend and causes raining at the district. 2-Immigrant anti- cyclone pattern: It is formed at the Siberia zone and by developing its troughs at the south and east-south directions and also absorbing of Caspian Sea humidity it causes raining at the zone. 3-Cyclone and anti-cyclone pattern: Because of the wideness of the studying district in some cases it is affected by both of the Siberia anti-cyclone from the east- north and immigrant cyclone from the west of the studying zone.

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1. Introduction

Studying and recognizing the phenomenon's distribution on a region is done in order to specify a suitable place for human living and activity. Determining of this place and space is just complete when the phenomenon is recognized and their relations have been analyzed and specified. There are two types of phenomenon or place characteristics: The first one includes stable characteristics such as height, slope, soil and covering which have not changed for a long period. The second one includes unstable characteristics of the environment like as raining rate, rivers discharge. A perfect recognition of the place can't be obtained just by one observation of this phenomenon. Synoptic climatology has done the general observation and recognition of the geography science and that is why it is the closest branch of the climatology to the geography. Synoptic climatology provides all of the information generally or simultaneously about the regions and final results of the synoptic operations and analyses are the expression of the atmosphere behavior within the local average scales. Synoptic data have no meaning or value without relying on one district. Studying of pressure distribution, systems movement, relation of different weather types and environment condition within a district limitation is practical. Therefore synoptic climatology is three dimensional like geography and continues to a height of atmosphere

which affects the human life. The size (wideness) of the studying district is different on the basis of geographical phenomenon. Unit of studying or climatology district in synoptic climatology is equal to normal amount of the synoptic system which is about 1000 kilometer. In fact synoptic climatology is the main branch of the geography between all of the climatology branches because it divides the earth surface into studying units such as synoptic units. In each unit a district has been recognized regarding the environment elements and their relations. This recognition emphasizes long term dominant condition and it recognizes and evaluates the relation between the local phenomenon and its direct factors such as pressure patterns. Because of the Iran location that is situated on dry and semi-dry belt of the world and also being neighbor with the subtropical high pressure center and weather condition resulted from this system It has the little amount of raining. This is because of the hard and long lasting governing of this system at the dry region. On the condition that the rate of precipitation of Iran is less than the one third of the world's precipitation. This less rate of precipitation doesn't have stable distribution in terms of place and time. In terms of place an extend part of the country receives less raining and the other part which has noticeable rate of raining in terms of time It is arid most time of the year or it has less raining. So all of the studies that deals with the analyses and

recognition of the climate parameters behavior specially rainfall in the country in different ways and due to principal planning in this issue has special significance. This article deals with the determining and recognizing of the stable rainfall patterns and causing factors of rainfall at Azerbaijan district. Synoptic climatology in Iran is rarely young. This science in Iran has been started along with the scientific academic activity of Dr. Alijani (1985-2002) and publication of his articles at the local and external valid sources. Dr. Alijani determined the cyclone routes of Iran manually and also recognized the effective climate systems on rainfall by association of Harman. According to the cyclone changes he also recognized the effective climate types on Tehran rainfall for the first time. This subject has been flourished along with publication of "Climatology Basics" book and by translation of "The Earth Globe Climate" book and It has found large extension by spread of "Synoptic Climatology" book in 2002 as a first Persian book. Other researchers have investigated the synoptic factors of Iran rainfall, for example "Synoptic Systems the Reason for Habaleh River Floods" by Hosseini (1994), "Monsoon Precipitations" by Najjar Saligeh (1998) and "The Synoptic Reason of Summer Cloud-Burst" By Arabi (2000). In an article by Alijani and Zahedi (2002) with the title of "Statistic and Synoptic Analyses of Rainfall in Azerbaijan" in order to study Azerbaijan rainfall they have provided daily statistics of rainfall of Tabriz station which represents Azerbaijan district during 1995-1961, for the same statistic period the pressure at 12 according to Greenwich time for the domain of 20-50 of north degree and 35- 67.5 east degree at the junction with the distance of 2.5 degree for earth surface and surface of 500 hectopascals which has been provided from the reformed data of NCEP climatology research center of east Engelia University of Norwich City of England. The statistic research of the rainfall days have been represented in this data which two days successions have the most abundance and the daily rainfall intensity of the most rainfalls on October is mostly from 1-5 mm. also in this research it has been cleared that most of the daily rainfall happens during the warm period of the year but abundance year of long lasting rainfall is in winter. After analyzing the synoptic charts of the studied days and classifying them by using the correlation method at least eleven types of the effective weather on Tabriz rainfall were recognized which three of these eleven types have the high pressure quality. The circular type has more abundance than the west-north high pressure type. Along this period of studying meaningful variations have not been observed in the abundance of the weather types.

Bigdeli (2006) in her PHD thesis with the title of "Synoptic Analyses of Rainfall at the Southern Seashore of Caspian Sea" has gathered data for daily rainfall of ten synoptic and climatology meteorology stations which includes seven synoptic and three climatology stations. She received these information in an engineering year (1986-2003) statistic period. She also provided the pressure charts of the earth level and the surface of 500 hectopascals for the boundary of 25-50 northern degree and 35-70 eastern degree. The obtained analyses of her article shows that rainfall with the succession of 2-6 days at the studying boundary as southern seashore of Caspian Sea follows the high pressure pattern. Also these researches indicate that high pressure systems are immigrant and they enter to this region from the west north and west of Caspian Sea. According to the selected successions of two days or more 92 percent of the rainfall creating systems are the dynamic high pressures.

2. Data and Method

In this research the first step is to recognize the days of global rainfall at the boundary of Azerbaijan during the statistic period of seven years (2000-2006) and also providing the synoptic charts of the earth surface and surface of 500 hectopascals and studying and analyzing the prevailing patterns of these rainfalls at the studied boundary.

2.1 Data

Daily rainfall data of 23 synoptic meteorology stations of the region for a common statistic period of seven years (2000-2006) has been received from the Iran meteorology organization. The statistic period has been selected in a way that there is no statistic fault or error in any of the data of studying stations and there will be no need to make statistics or statistical reform. The data of the studying stations locations have been shown in Table 1. Pressure charts of the earth surface and the level of 500 hectopascal for the boundary of 20-60 northern degree and 10 western degree to 70 eastern degree have been provided from the site of NCEP.

2.2 Analysis Method

Daily rainfall pattern analyses is basically a synoptic analyses. In synoptic researches the weather condition of the region by using the statistical methods and the studying region according to one or more parameters has been divided into some parts. Then the effective patterns have been recognized and analyzed by using the synoptic charts. The main method in this research is synoptic method which includes the following processes: 1-The map of the studying boundary by using the clear political and topographical maps and Arc Gis software (Figure 1). 2-Daily rainfall data of the 23 synoptic stations for

the statistical period have been entered into Excel software.

Table 1. Characteristics of studying stations in daily analysis

Station	Latitude	Longitude	Height (m)	Station	Latitude	Longitude	Height (m)
Tabriz	38.05	46.17	1361	Maragheh	37.42	46.16	1477.7
Urmia	37.4	45.03	1328	Marand	38.28	45.46	1550
Parsabad	39.39	47.55	31.9	Meshkin-Shahr	38.23	47.4	1568.5
Jolfa	38.45	45.4	736.2	Miandoab	36.58	46.03	1300
Ardabil	38.15	48.17	1332	Mianeh	37.27	47.42	1110
Bonab	37.2	46.4	1290	Piranshahr	36.4	45.08	1455
Salmas	38.13	44.51	1337	Naghadeh	36.57	45.25	1338
Kalybar	38.52	47.01	1180	Sahand	37.56	46.07	1641
Khalkhal	37.38	48.31	1796	Sarab	37.56	47.32	1682
Khoy	38.33	44.58	1103	Sardasht	36.09	45.3	1670
Mahabad	36.49	45.43	1385	Takab	36.23	47.07	1765
Maku	39.2	44.26	1411.2				

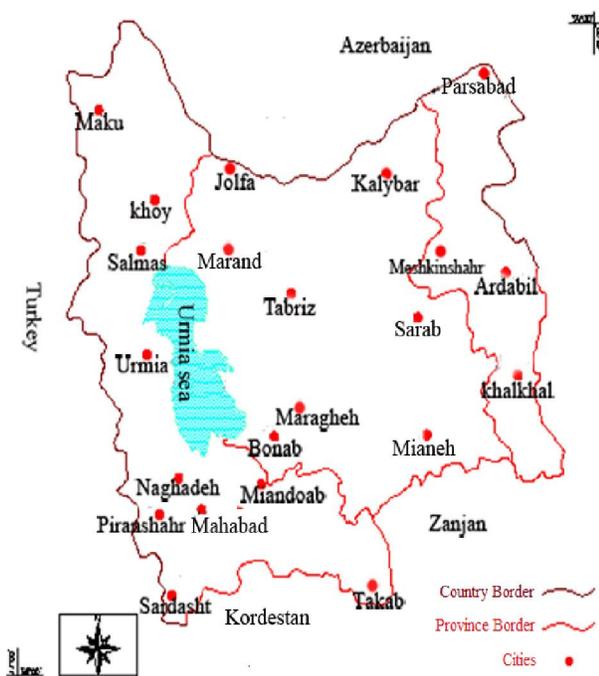


Figure 1. Skeleton of studying border

The data has been screened and global rainfall days were cleared. In this screening our scale is daily rainfall of 1 mm or more because the aim of this research is to recognize the synoptic systems and the rainfalls of less than 1mm may be happen by the local factors which can't be recognized at the scale of synoptic charts. 3-Earth surface maps and the surface of 500 hectopascals relating to any of the global rainfall along with a previous day and coming day

have been provided for each boundary. After analyzing the synoptic maps of the boundary global rainfall, the effective patterns, synoptic condition location and arrangement of the effective systems on rainfall, movement direction, system duration and their rainfall rate have been clarified.

3. Global Rainfall Pattern in Azerbaijan District

3.1 Cyclone Pattern

Cyclones are the major and most important factor of the western winds turbulence. Effective cyclones on Iran's Weather are some part of the middle east cyclones which after forming on the Mediterranean sea transferred toward Iran by a high subsidence. These cyclones which are formed on Mediterranean Sea are called frontal cyclones. Most of the middle east cyclones that are formed at the Mediterranean sea or Atlas ocean have been boosted at the Cyprus island so some researchers called them Cyprus depression. Global rainfall pattern on these dates have been cyclone patterns: 25 March 2001, 3 May 2001, 7 April 2002, 21 December 2002, 26 March 2003, 23 November 2004, 3 May 2005, 8 January 2006, 25 April 2006. A sample of earth surface maps (Figure 2) and surface of 500 hectopascals (Figure 3) relating to 21 December 2002 is presented. As indicated in figure-2 there is a cyclone with the central pressure of 1005 hectopascals at the studying boundary which its ridges expanded toward the east and passed by the north-eastern borders of Iran. The region is affected by the rainfall of cold front of this system. And figure-3 is the map of 500 hectopascals surface on December 21, 2002. There is a deep trough in the west of Iran above Iraq. The front part of this trough is located on Iran. Existence of this part of southern wind trough at the middle level of the atmosphere and induction of the recent low-pressure causes weather instability at the earth surface and rainfall happens if the condition will exist. Azerbaijan region is located in a part of trough which is confronted with weather raising and instability.

3.2 Anti- Cyclone Pattern

Anti- cyclone pattern at the studying boundary is divided into two categories: immigrant anti-cyclone and Siberia anti- cyclone.

3.2.1 Immigrant Anti-Cyclone

These anti-cyclones are formed on Mediterranean Sea and after locating in the direction of the western winds enter into the country from the west and north-west which mainly receive their humidity from the Mediterranean and Black sea. There will be rainfall in the case of existing suitable condition for raining. For instance the rainfalls of March 9, 2001 and May 9, 2002 have had the immigrant anti-cyclone pattern. Figure-4 represent the earth surface chart on May 9, 2002.

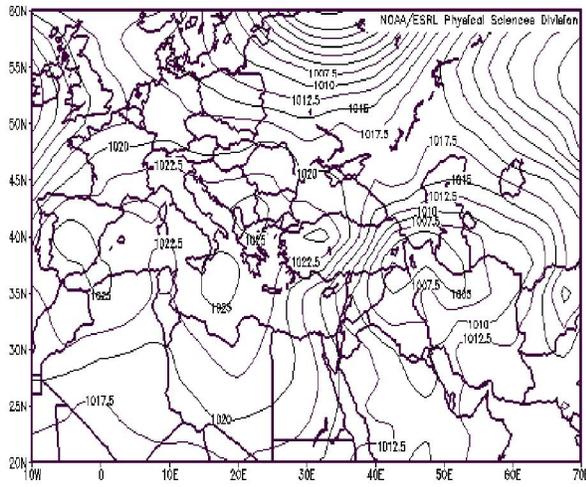


Figure 2. Isobar arrangement pattern at ground surface (Dec. 21, 2002)

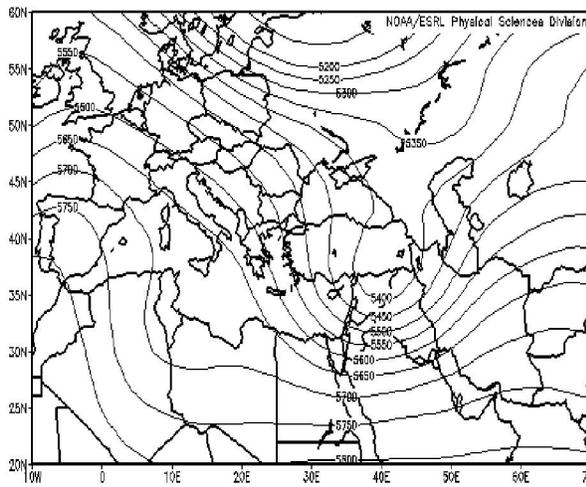


Figure 3. Contour arrangement pattern at 500 hectopascals level (Dec. 21, 2002)

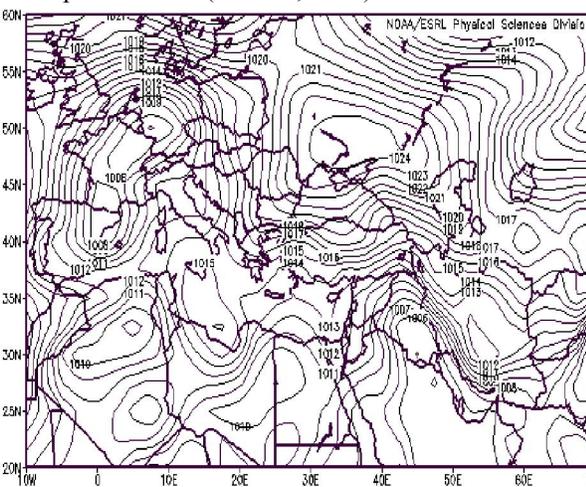


Figure 4. Isobar arrangement pattern at ground surface (May 09, 2002)

As indicated in the map there is an anti-cyclone with the central pressure of 1024 hectopascals at the north of Black sea which its ridges expanded in the direction of south- east and affect the northern part of Iran and studying area and Caspian Sea. Also there is a cyclone with the central pressure of 1111 hectopascals in the central areas of Iran. Figure-5 represent the 500 hectopascals surface map on May 9, 2002. As indicated in map there is a trough with a close curve in the east of Black sea. Southern half of the Caspian Sea and northern half of Iran are affected by the front part of this trough. The lines arrangement at Azerbaijan boundary and the area near these lines represent the air raising and instability at the earth surface along with intensive wind.

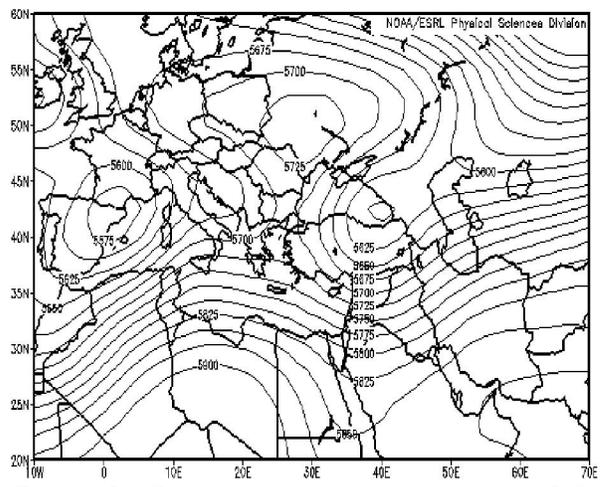


Figure 5. Contour arrangement pattern at 500 hectopascals level (May 09, 2002)

3.2.2 Siberia Anti-Cyclone

Anti-cyclones which are formed in the Siberia areas and their ridges expand toward the south and after passing the Caspian Sea and absorbing humidity for raining they produce noticeable raining in different areas on the condition suitable for raising at the surface of 500 hectopascals. During 14 days of global rainfall in Azerbaijan boundary the most rate of rainfall is 22.6 mm in April 16, 2003 which produced by Siberian anti-cyclone pattern. Figure-6 represent the earth surface map on April 16, 2003. Siberia high pressure ridges with the central pressure of 1045 hectopascals lengthen toward the down geography latitude and causes the cold weather in these areas. Because the cold weather pass by Caspian Sea, Black Sea and north- east of Europe so the necessary humidity for raining at the studying region regarding the middle level chart of atmosphere are provided. Figure-7 shows the map of 500 hectopascals on April 16, 2003. As indicated in the chart there is a relatively deep trough with south-

west and north-east level axis and close curve in the south-east of turkey. The front part of this trough is on Iran. Azerbaijan boundary and western seashores of Caspian Sea are located in some part of trough which air raising and highest instability are recognized in these regions.

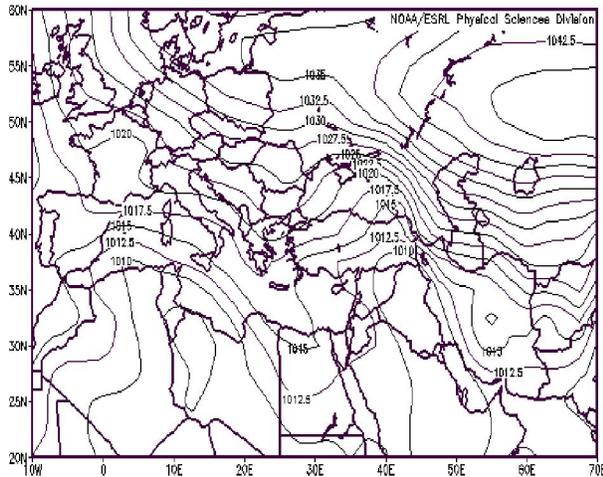


Figure 6. Isobar arrangement pattern at ground surface (April 16, 2003)

map a cyclone with the central pressure of 1006 hectopascals enters the country from the north-west which affects the Azerbaijan boundary. There is another anti-cyclone with the central pressure of 1020 hectopascals in the north of Caspian Sea and affects the north-east of Azerbaijan. Figure-9 is the map of 500 hectopascals surface on April 18, 2006.

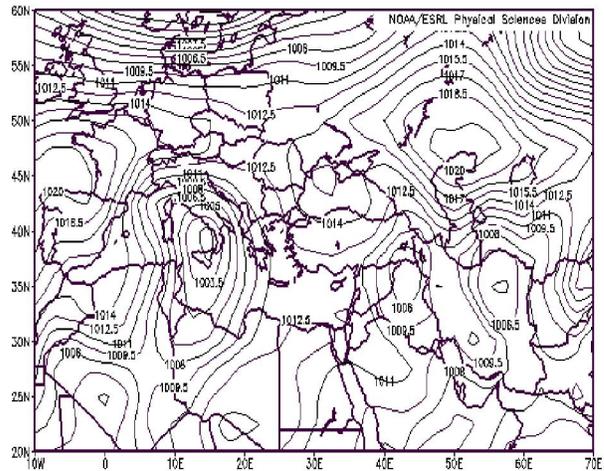


Figure 8. Isobar arrangement pattern at ground surface (April 18, 2006)

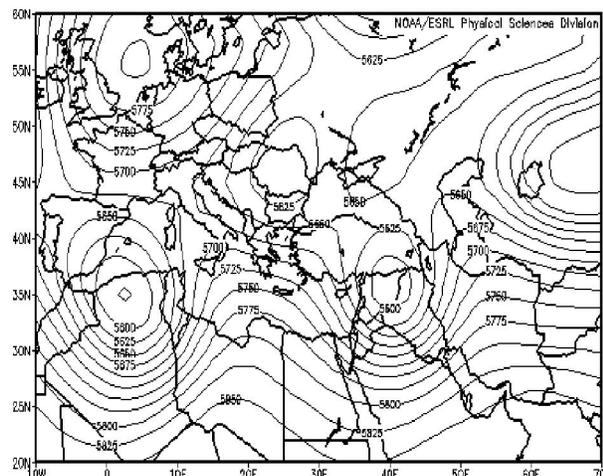


Figure 7. Contour arrangement pattern at 500 hectopascals level (April 16, 2003)

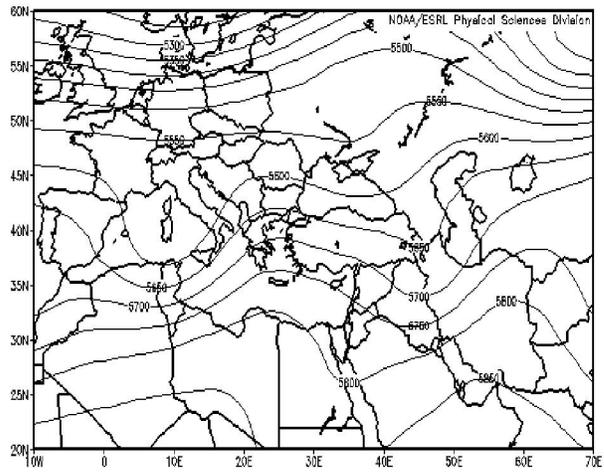


Figure 9. Contour arrangement pattern at 500 hectopascals level (April 18, 2006)

3.2.3 Cyclone and Anti-cyclone Patterns

Sometimes because of the extent of the studying region it is affected by both of the Siberia anti-cyclone from the north-east of the region and immigrant cyclones from the west of the studying region. Their patterns are shown in the global rainfall on April 9, 2001 and April 18, 2006. Therefore regarding the arrangement of the atmosphere middle pattern there will be rainfall in the region by two different systems. Figure-8 represents the earth surface map on April 18, 2006. As indicated in the

The studying boundary is affected by a weak wave with the north- east axis. In spite of the weak wave whereas the trough axis is on the studying region, there is most instability in this arrangement. These arrangements of western wind in the middle level of atmosphere represent the weather raising and instability and rainfall at the studying boundary.

4. Conclusion

Number and percentage of the global rainfall production in Azerbaijan boundary by any of the

patterns were given in Table-2. As indicated 64.28 percent of studying boundary global rainfall is produced by cyclone patterns. Number and percentage of humidity source of the Azerbaijan boundary global rainfall is represented in Table-3. About 64.28 percent of global raining source of the boundary is provided by the Mediterranean Sea.

Table 2. Number and percentage of rainfall of each pattern at Azerbaijan

Pattern	No.	Percentage
Cyclone	9	64.28
Immigrant Anti-Cyclone	2	14.28
Siberia Anti-Cyclone	1	7.14
Cyclone, Anti-Cyclone	2	14.28

Table 3. Number and frequency percentage of different humidity sources effects at borders rainfall

Rainfall Humidity Source	No.	Percentage
Mediterranean Sea	9	64.28
Black Sea	2	14.28
Caspian Sea	1	7.14
Mediterranean Sea, Caspian Sea	2	14.28

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