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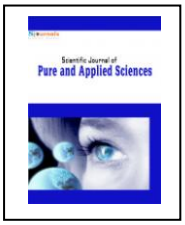

Original article

The study of atmospheric movement patterns and its effect on heavy rainfalls in Iran: case study (January 6th of 1998)

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ABSTRACT

Iranian Plateau due to its specific location is at the transition point than large-scale general circulation models of the troposphere and is seating location of the extra tropical, subtropical and tropical systems. The aim of this study is the synoptic analysis of the atmospheric conditions concurrent with the heavy precipitations of Lorestan, Fars and Hormozgan provinces and determination of the temporal and spatial distribution of them. the objective of this scheme is that heavy rainfall on soil and water resources is a bad influence and the study area is located in an arid region, the floods impact on the region is enormous.heavy precipitation in January 1998 to 2014 were selected. In January 1998, a special precipitation was heavy rainfall That happened in many provinces. And the reason for this day to study.the Studied regionswere provinces: Charmahal, Bushehr, Fars, Hormozgan, Khoozestan, Kohkilooye, Lorestan and Ilam In this study rainfall with greater than 30 mm considered as the criterion of days with heavy rainfall that their information was collected of synoptic and climatology stations of studied provinces.Requested atmospheric data for this research was taken from databases related to the National Organization of Atmosphere and Oceanology of United States. More maps of the site were taken. Then the Earth's surface, 500,700 and 850 Hecto Pascal maps, orbital

and meridional winds, earth temperature of earth surface and top of the atmosphere were prepared in Grads software and some of maps were drawn in GIS software.The following results were obtained: On the earth surface map, the main and controller role is with the Siberian high pressure, the Azores's dynamic high pressure and integrated mode of the Sudan and the Mediterranean low pressure systems. The main controller role in high levels is with the high altitude center of Azores in the back of the system, the high altitude center of Arabia in the front of the system and deep traffic of North Africa. Another important factor is the moisture mixture of Mediterranean Sea, Red Sea, Persian Gulf, Oman Sea and Indian Ocean. Air rise factor with enhancing meridional winds that causes to subsidence of cold air, rising warm air and strengthening the polar front is one of the heavy rainfall conditions too. Eastern winds cause to entering of moisture from the Indian Ocean and western winds cause to strengthen of cyclones and heavy rainfall in the region.

1. Introduction

The aim of synoptic studies is the determination of interactions between atmosphere and environment (sadeghi, 1391). Precipitation systems have a main role in providing of water resources; hence the recognition of their properties such as formation, humidity resources and activity location of them is of utmost importance (ghaffarian, 1389). Heavy rainfalls in anomalistic times are one of important causes of great damages at different geographical locations (musavi bayegi, 1389). Tropical cyclones have a direct relation with the tropical circulation (lashkari, 1389). The main cause of flood is heavy rainfalls. Nowadays one of the proposed tools and techniques in conjunction with heavy rainfall phenomena is the synoptic analysis of these rainfalls because the precise recognition of mechanism and action of atmospheric circulation model and effective parameters on heavy rainfalls is of utmost important (paranadeh khozani, 1390). Humidity and rise factor existence is necessary for clouds and rainfall formation at every location (nouri, 1391). In viewpoint of temporal distribution, Bandali patterns form concurrently with the high intensities mainly at recent of winter season and first of spring season. However, the Bandali patterns with mediocre intensity mainly form at winter season (azizi, 1391). Fluctuation of precipitation regime in Iran and climate conditions such as short and stormy rainfalls have left devastating floods every year (lashkari, 1386). Humidity factor is more important than rise factor in formation of heavy rainfalls (alijani, 1389). In case of synoptic evaluation of rainfall, much research has been done in the country and abroad that a number of them are considered. (Hidman, 1988) shows that the main cause of summer heavy rainfall in America is meso-scale factors. He cites the researches of this context: (Oscars, 1981) has investigated the heavy rainfalls of Ohio, (randerson, 1976) has examined the heavy rainfalls of Nevada, (cangiser, 1972) has evaluated the heavy rainfalls of Arizona and (rogash, 1988) has studied the heavy rainfalls of Wyoming. Then he says that predicting of heavy rainfall with factors affecting that are known as meso-scale is difficult. Roberto (1997) has researched the summer heavy rainfalls of Utah. He considered the heavy rainfall equal or over than 50 mm along the 36 or 24 hours. He recognized that the cooling and stabilization of humidity in lower levels of atmosphere is the cause of the summer heavy rainfall of Utah State. Gandomkar (1386) has checked the flooding rainfalls of Zayandehrood River and has concluded that crossing of Mediterranean cyclones and western wind waves are the most important effective factors on these rainfalls. Alijani (1372) has studied the synoptic effective factors on formation of Iran rainfalls based on synoptic maps of earth surface and top levels of atmosphere and has proposed the western turbulence factor as the main cause of rainfalls excepting summer reason. He also in other research has evaluated the mechanisms of air rising leads to Iran summer rainfalls and has proposed the earth's warming as the most effective factor of these rainfalls especially in the southeastern region. Taghizadeh (1366) has investigated the flooding rainfall of August, 1366 and has introduced the monsoon phenomenon as the dominant factor of this rainfall.

Moradi, 1381 studied the rainfalls of north coast of Iran based on monthly maps of earth surface and 500 Hecto Pascal in six months in the cold season of year during the period 1971-1989. He concluded that the occurrence of heavy rainfalls in the north of country at the 500 Hecto Pascal level is associated with dominating of stack on the Black Sea, east to center of Europe, east of Mediterranean Sea and existing of deep trough in east of Black Sea. Rezakuva et al. (2005) studied the Sylza rainfalls at August 2012 as the most severe rainfall in Czech. Earth surface maps were used to study of the synoptically conditions of heavy rainfalls formation. Heavy rainfall in the region forms with the notable horizontal gradient in the back part of the cyclone that very slowly advances toward northeast of central Europe and conditions are provided for transitions of air humidity and rise as orography in the region. Wilhend (2003) in his research with title of "Historical study of most flooding rainfalls in twentieth century" studied the 50 rainfalls lead to flood during 1900-1991 in the England. Chingsen et al. (2002) investigated the rainfalls with over than 100 mm depth in 1993 to 1997 during spring season in the Taiwan. They concluded that two groups of systems cause precipitation. First are those that have south direction and their altitude is above the east of the country. Second are those that have southwest direction and their altitude axis is above the south of Taiwan. Jensa et al. (2001) studied the role of west Mediterranean cyclones on the heavy rainfalls with over than 60 mm depth and super heavy rainfalls with over than 100 mm depth in 1992 to 1996. They concluded that 90 percent of rainfalls have occurred than cyclone centers vicinal of event location of heavy rainfalls of west Mediterranean. Also some of these events have convection origin.

2. Materials and methods

The information of most daily rainfall of synoptic stations of Fars, Lorestan, Bushehr and Hormozgan provinces were checked and rainfalls with over than 30 mm depth considered as the heavy rainfall. Figure 1 shows the location of stations and their rainfall amounts.

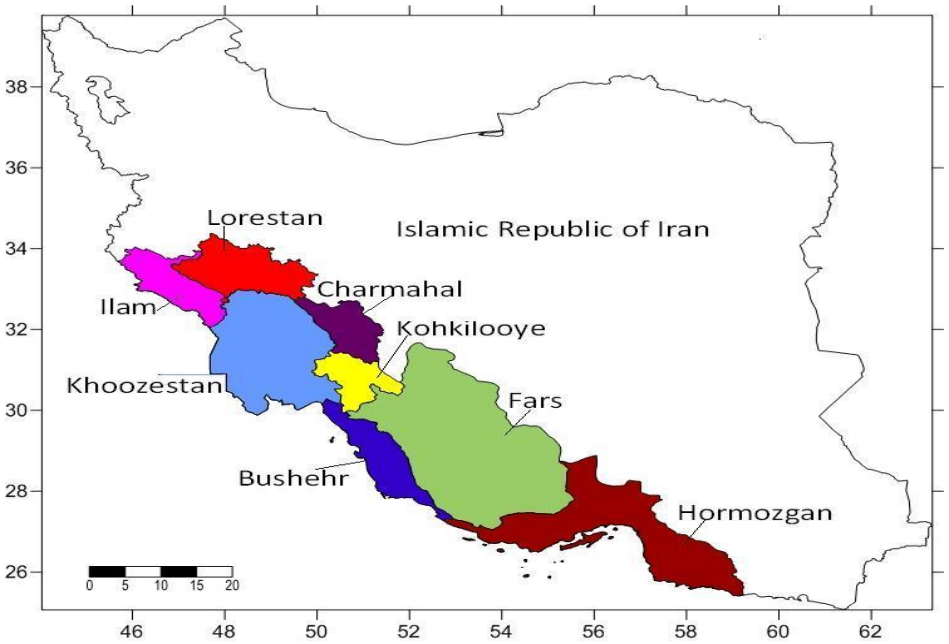

Fig. 1. The study area, source authors.

The information of most daily rainfall of synoptic stations of Fars, Lorestan, Bushehr and Hormozgan provinces were checked and rainfalls with over than 30 mm depth considered as the heavy rainfall. Figure 1 shows the location of stations.

In this study rainfall with depths greater than 30 mm considered as the criterion of days with heavy rainfall that their information was collected of synoptic and climatology stations of studied provinces. Initially databases of surface environment were provided that includes information of daily rainfall of south and southwest of Iran. Another database was provided for the atmospheric data that determines the atmospheric flows and includes

pressure levels and earth surface data. Requested atmospheric data for this research was taken from databases related to the National Organization of Atmosphere and Oceanology of United States.*www.esrl.noaa.gov/psd/data/gridded/data.ncep.reanalysis.pressure.html*. More maps of the site were taken. These databases encompass the period from 1948 to now and cover four observations at synoptic hours (zero, six, twelve and eighteen) for every day. Moreover daily and monthly mean of atmospheric data was provided in this database. The greatest daily precipitation was used in this study. Research method in this study is circulating environmental approach. Main reason of choosing this approach as a systematic method to study is that the spatial and temporal variation of rainfall is more intense than in other climatic variables. Then the Earth's surface, 500,700 and 850 Hecto Pascal maps, orbital and meridional winds, earth temperature of earth surface and top of the atmosphere were prepared in Grads software and some of maps were drawn in GIS software.

3. Results of research

1. **Slp 4 January1998 A:** polar high-pressure with central core was seen in north of the map. And in its below island's low-pressures have formed tri-cores, one on the Russia, others on Scandinavian and Europe north. Siberia's high pressure was placed below these low-pressures with multiple cores. Sudanese low-pressure has placed below the Siberia's high-pressure forming two cores of pressure. One high-pressure also is forming in north of Africa.
2. **Hgt 4 January1998 A1:** it has formed in the top low height atmosphere because of air rise from low-pressures. But near the pole two high height cores were formed because of air descend on polar high-pressure. A ridge has formed on the Siberia which lead to air descend and region coldness because this cold weather direct to the surrounding by high-pressure. In the conjunction of two mentioned high-pressures in the north of Caspian, Mediterranean, and Black seas a Traff has been formed. Half of a ridge which has seen in the west of map is on the tropical side high-pressure and it causes air descends towards Mediterranean and Egypt. The Traff formed in the north of Africa and Arabia could be an introduction of a heavy rain fall in the west of Iran because it carries high moisture. Iran country is located under descend of cold weather of Siberia.
3. **Slp 5 January1998 B:** Siberia high pressure has moved to east. Its tabs became weaker than the previous day, and the width of high-pressure has declined. Par line of 1020 which interconnected two high-pressures of polar and Siberia in the previous day, today surround two low-pressures of island and south polar. The low-pressure core on the Russia has formed two cores. Par line of 1020 where located below the Persian Gulf today has moved upward the Iran. Tropical side high-pressure come forward and combined with Siberia's high-pressure. Sudanese low-pressure has formed two cores and moved upwards relative to its past location.
4. **hgt 5 January1998 B1:** A Traff has formed in 500 levels on the Sudanese low-pressure. The air on the tropical side high-pressure catches the Mediterranean moist and Europe coldness and has downward movement to Red Sea. Arabia peninsula is in front of Traff air rise and if possible it could rain. South of Iran has also heavy rainfall.
5. **Slp 6 January1998 B1 C:** polar high-pressure also changed its location and moved towards the east and 1040 curve became smaller than yesterday. Convergence of Sudanese low-pressure in the south and divergence of two high-pressures in both sides caused the formation of a low-pressure on the Iran. This low-pressure is migrant Silicon that if it has been located on a region it acts as an aerologic bomb and has heavy rainfalls.
6. **C1:** previous day Traff has moved closer. On top of the silicon there is air rise and because this silicon has caught the moist from surrounded seas it caused many rains especially in south of Iran.

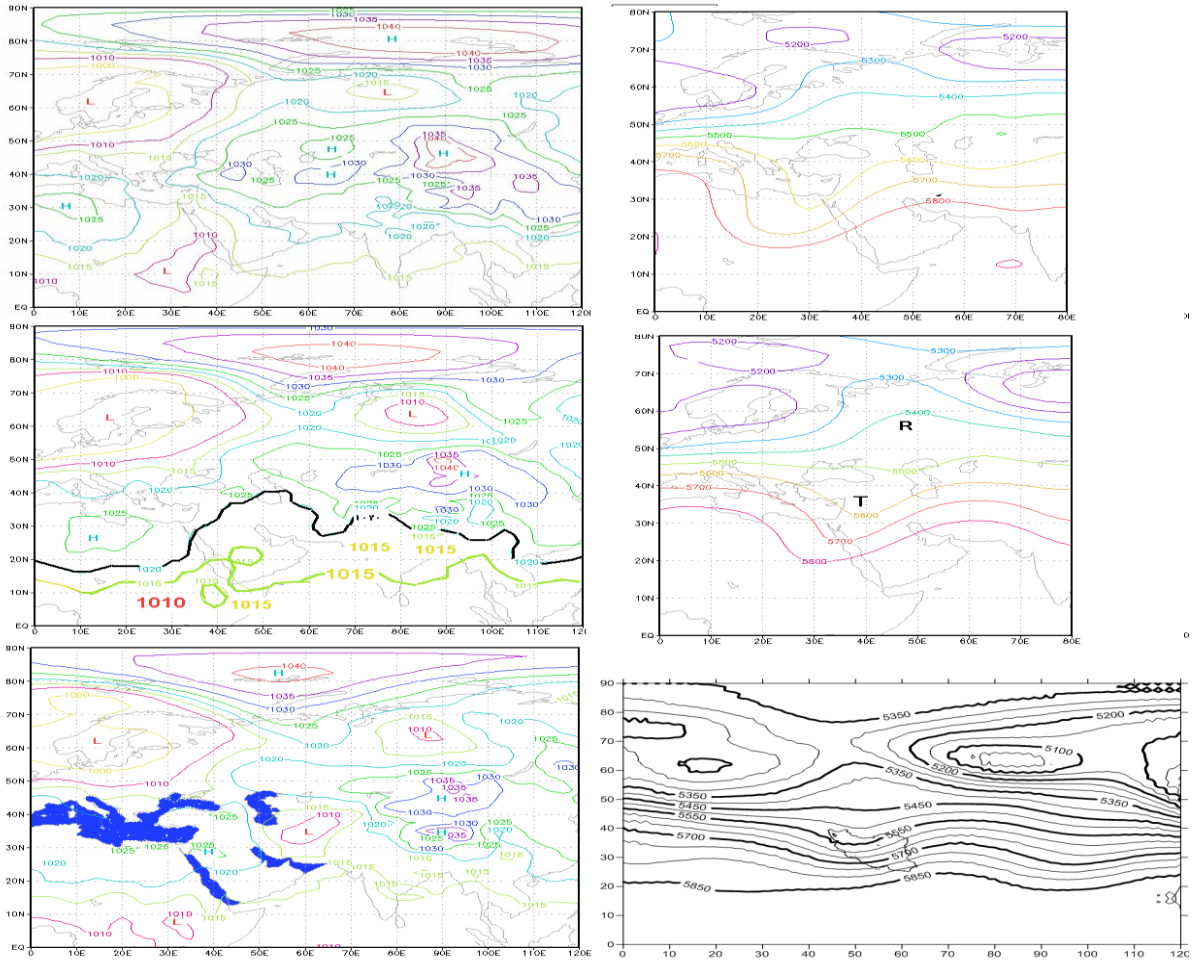

Fig. 2. surface pressure &hgt map on 4,5,6. January1998.

3.1. Synoptic analysis of precipitation 1998

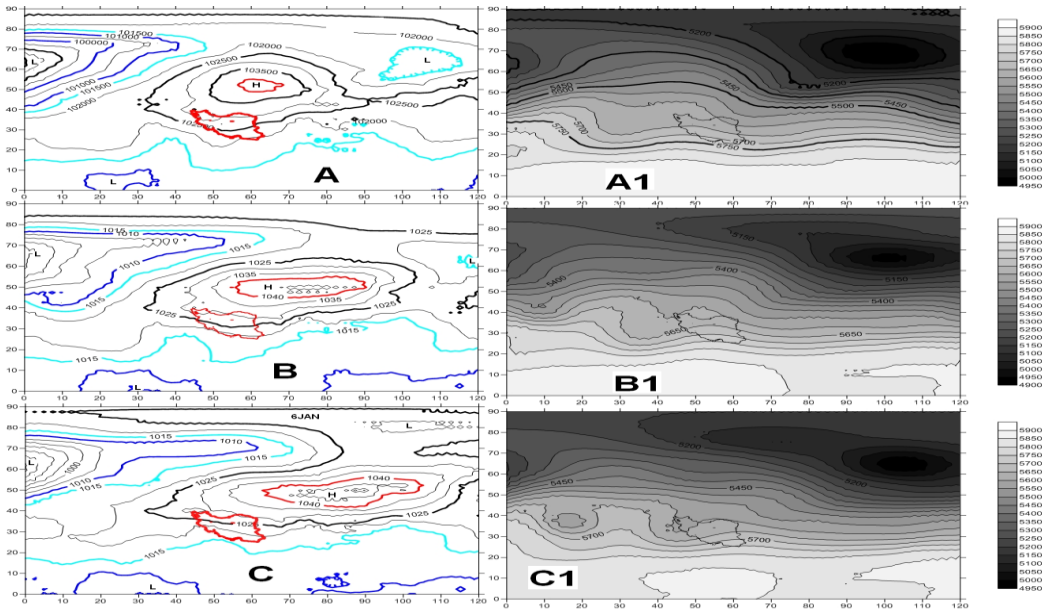

Fig. 3. surface pressure &hgt map on 4,5,6. January1998.

3.1. Synoptic analysis of precipitation 2014

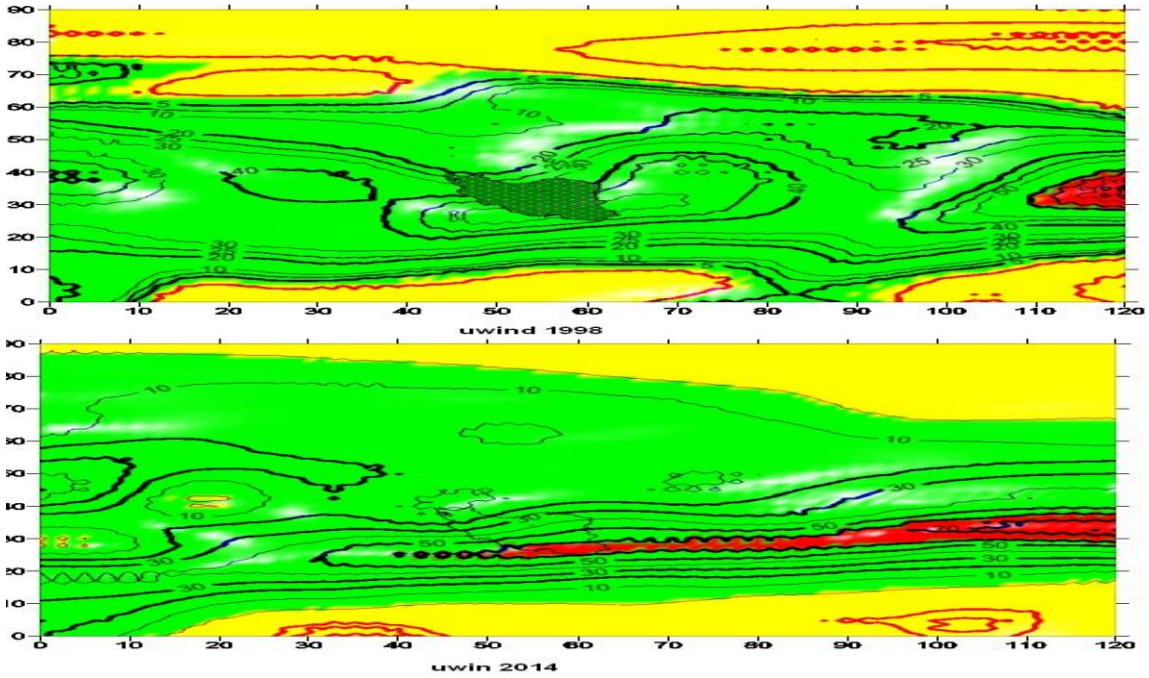

Fig. 4. mean uwind map on 6 January.

UWIND: in the above maps yellow color is indicative of east winds and green and red show west winds. In both days prevailing wind is west wing but difference of these days is in the blow speed that bi-speed lines of 40km/s were passed the region and in 2014 bi-speed lines of 50km/s were passed the region. Another difference is that speed and the route wind passed are many higher in 2014 than 1998.

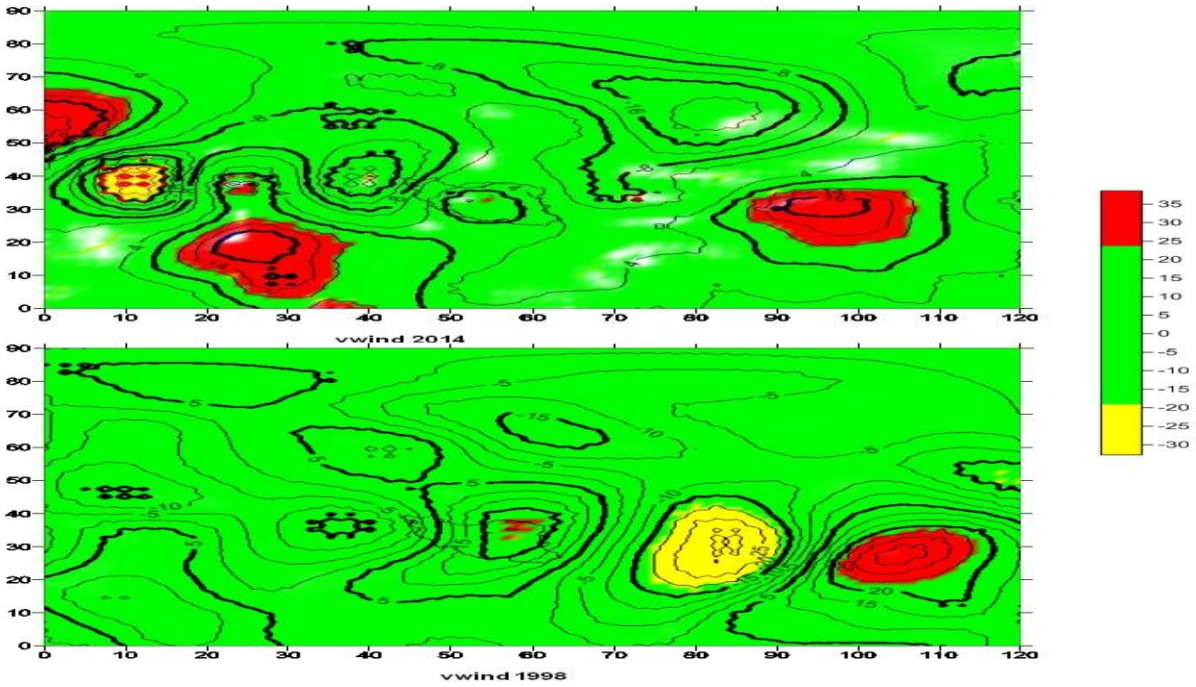

Fig. 5. mean vwind map on 6 January.

VWIND: difference of 1998 wind with 2014 is that this wind has meridian status and in northeast of Iran it has high speed. Thickness and earth map of 1998. Wave pattern: wave of western winds is the main reason of this rainfall. Type of rainfall is silicon which two high-pressures were located in both sides of the region and a front between them. Falling cold air and formation of anti-silicon in the west of region, silicon formation and air ascending have caused heavy rainfall 2014 January a thermal bi-arrived fall, divergence and air descend in the east of map, convergence and air rise in the west of map are some properties of this type of rainfall. A long high-pressure has located on the region which shows that an anti-silicon has lied on the region in orbital direction.

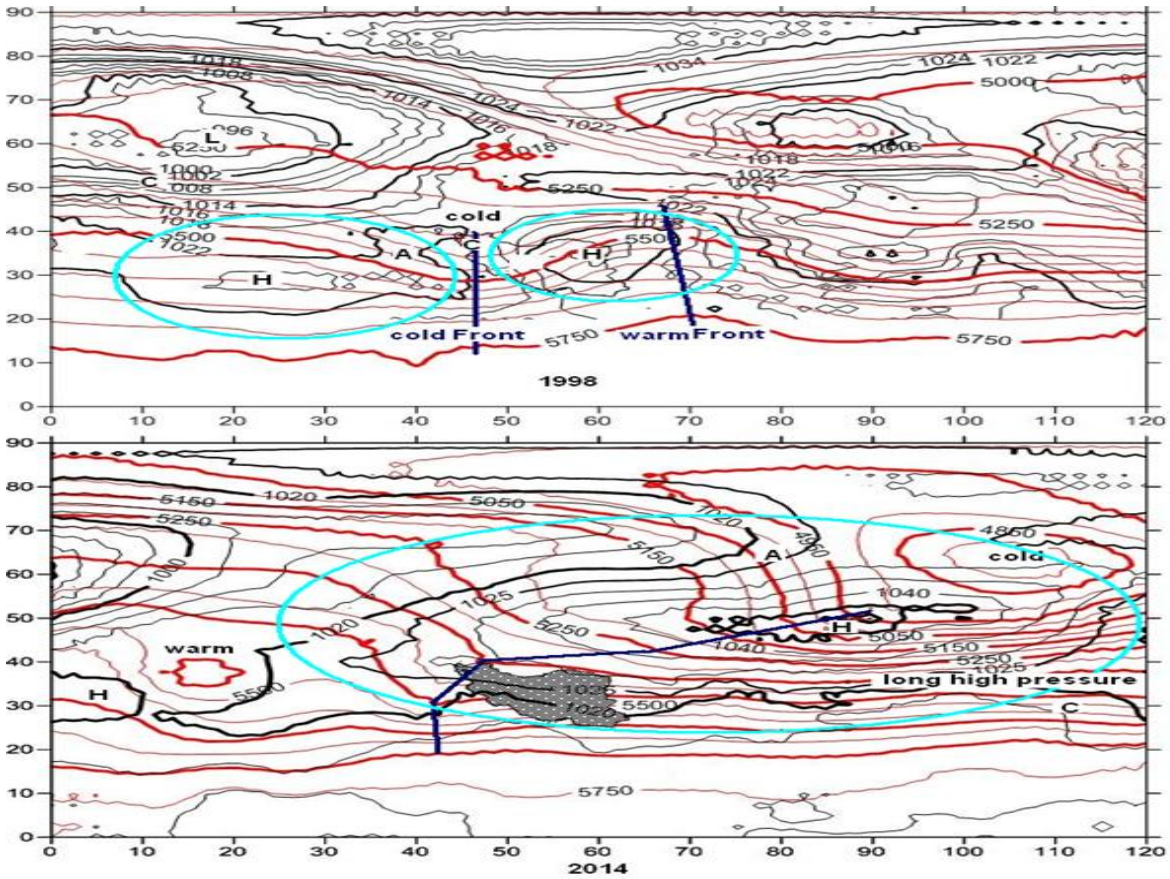

Fig. 6. mean slp 500-1000hp map on 6 January.

4. Discussion and conclusion

In these two days there are differences from reasons of rainfall view. In 1998 from north to south the following cores are seen in the maps of two past days: polar high-pressure in the pole region, three cores of polar side low-pressure (island low-pressure), three cores of high-pressure (Siberia and Bermuda), and two cores of low-pressure (tropical convergence). While two days before heavy fall of 2014 the only high-pressure in the region was Siberia and in its north and south there located two low-pressure cores. Heavy rainfall in 1998 was rain and in 2014 it appeared as heavy snowfall on the heights. In 1998 low-pressure or migrant silicon was the reason of heavy fall but in 2014 cold hole in Mediterranean has caused heavy fall.

In 1998 wave pattern has caused the heavy fall and in 2014 a bi-arrived thermal descent caused heavy fall in the region.

Iranian Plateau due to its specific location is at the transition point than large-scale general circulation models of the troposphere and is seating location of the extra tropical, subtropical and tropical systems (Azizi, 1385). Rain is a climatic variable that has high temporal and spatial variety. Its spatial distribution is affected by earth altitude, slope and etc. (joule, 2003). Thus Iran rainfalls arise from different systems. Rain is the most important

environmental phenomenon that is done with the special circumstances such as air rise, moisture content and Wind River formation. Special conditions need to heavy rainfall too. In this study, creating blocking conditions in the north of the country is one the important factors of heavy rainfall in the south. Another important factor is the moisture mixture of Mediterranean Sea, Red Sea, Persian Gulf, Oman Sea and Indian Ocean. Air rise factor with enhancing meridional winds that causes to subsidence of cold air, rising warm air and strengthening the polar front is one of the heavy rainfall conditions too. Eastern winds cause to entering of moisture from the Indian Ocean and western winds cause to strengthen of cyclones and heavy rainfall in the region.

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