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Synoptic Analysis of Dust Systems in Yazd Province

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Abstract

Dust is a common atmospheric phenomenon in Iran especially in central arid regions. This severely affects environment as well as resident's health. Among the results of this phenomenon are Respiratory diseases, bash radiation, accelerated soil erosion, Desertification and degradation of ecosystems. Some dusts are originated from local desert conditions but adjacency to neighboring countries deserts as Saudi Arabia has intensified this. Yazd province due to its climate and geographical condition is always faced with dust in spring and summer times which leaves hazardous damages to the area. So, to understand the formation and origin of dust would help in reducing the damages. In this paper metrological station data was used. Days coded 07 were extracted and eventually day 3 was used as a sample, Synoptic maps of SLP, 850 hPa, soil moisture and temperature maps, humidity, and wind direction and speed at different levels of the atmosphere, temperature and dust vorticity for the day before and the day after it was drawn. Results have shown that due to the expansion of low pressure heated air tongue of lower latitudes, entered the Iran from east and caused increased temperature. Due to the low pressure gradient on the region in three days, the wind speed at ground level is very low. However, align the tongues on the 850 hPa due to the expansion of low-lying northern Europe centers on the area; the speed amount of vertical motion and horizontal motions in the level is remarkable . Atmospheric moisture maps indicate the general trend of decreasing moisture in the atmosphere in the three days. of soil moisture and temperature maps Survey at 10 cm showed that the temperature in the first three days have risen sharply and soil moisture has started to decline in relation to it.

Key words: Synoptic, Dust, Vorticity, Gang low, Yazd

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Introduction

One of natural disasters every year, causing losses in the dry desert areas of the world and Iran is the dust and sand storms and high winds (Omidvar, 2005). Dust containing fine particles of dust storms in certain cases is possibly traveled to a height of several kilometers above the earth's surface (Lashkari, 2006). There are typically four kinds of storms including severe dust storms, dust storms, blowing dust, dust floating in the air (Wang et al., 2005).Big storms are caused when the long-term drought occurred and the soil is quite dry and the wind blows at a substantial speed (Azimzade et al., 2001, 140). Of the most dust formation conditions along with the unstable weather conditions is presence or absence of moisture, so that if unstable air has enough moisture, precipitation and thunderstorm will be formed, otherwise it will create dust storms (Alijani, 1999, 195). Kaviani, 2000, 137 thinks that dust formed in the desert is due to air instability, and believes that the atmosphere above the surface of the wilderness is very unstable in convective terms and has the conditions of formation of transient phenomena like dust, or small tornados.Abundance of dust particles in the atmosphere, in addition to the intensity and wind speed also depends on the size and diameter of the soil particles.Vegetation type may play a role in the incidence of dust (Zolfaghari and Abedzade, 2004). However, Human activities role along with natural geographical environment in terms of management of mitigating the effects of phenomena should also be considered.

Asian Dust Storms (ADS) are known as one of the most important air pollutants (Peijian, 2008). The storms impact on human life and environment from several aspects as disrupting the beam balance, accelerating ecosystem degradation and desertification in arid regions of Asia, which is usually known to be the origin of storms (Jigjidsuren, 1998), (Sokolik, 1996).The floating particles in the air scatter or absorb sunlight and as a result affect regional balance and atmosphere vertical movement and in a large-scale climate and hydrological cycle of the atmosphere (Menon et al., 2002). Although the dust storms cause soil erosion, on the other hand in some areas this particulate matter deposited lead to soil formation. The particles originated from the desert areas are salted and salty soil are also being triggered (Kai et al. 1969). Reduced visual acuity is one of the main features of the dusty systems, which in addition to the unpleasant effects of respiratory and lung problems can infect the human living environment, as well as disruptions in ground and air transportation (Sun et al., 2006), (Zhuang et al., 1992).

Literature Review

There have been lots of studies in Iran and worldwide regarding the dust issues. Alpert et al.1989 studied Mediterranean dust storms and concluded that spring and summer the best timed for the formation and expansion of low pressure centers on north Africa which after travelling on Egypt and Israel enter and affect Mediterranean area. Wang (2005) has studied the relations between the formation and evolution of dust storms and their synoptic changes in North East Asia. He concluded that in cold religions, cyclonic dust levels are less than that of warm ones due to height of dusty air. Alijani, (1999, 96) analyzed the causes of Iran dusts and provided temporal and spatial maps of dust incidence. Fayaz (2004) using remote sensing data and based on differences in spectral reflectance caused by terrestrial phenomena on satellite imagery and ground control studied wind slope erosion range, and atmospheric currents affecting. He highlighted dust storms occurrence range and scope of regional and trans-regional influence of it. Omidvar (2005) studied Yazd- Ardakan plain sand storms synoptic and showed that dynamical in the low pressure cold front are associated that vertical air flows cause severe instabilities in atmosphere and creating severe storms, sand becom Also nearing a trough placed and in the region west along with intense the advection cold air and the the ground surface pressure gradient is another operating for this

storm. Marjani, 1992 using synoptic maps studied severe winds more than 15 m/s in Khorasan and that presence of low pressure thermals in center and south Iran and high pressure thermal from central and south Siberia are causes of sand storm in north Khorasan in winter.

Methods and Material

To study dusty days, Yazd metrological station data was used. 20 Days coded 07 were extracted and eventually day 3 was used as a sample synoptic conditions days the dust before until days then necessary weather data from the NCEP/NCAR website. Then SLP maps and 850 hPa as well as soil temperature and moisture maps, atmosphere temperature and moisture, and speed and rate of vorticity were drawn using GrADS software.

Discussion

figures 1 to 3 show the sea level pressure in 12 GMT in 21 to 23 April. According to first figure, in the day before dust onset, a low pressure center with 1002 hPa isobar has been formed in northwest to southeast Iraq and from north is hindered by a low pressure center with central curve of 1002 hPa on Ukraine, being mingled with Gang and Sudan low pressure centers in south. In the same day, a high pressure center with central pressure of 1018 hPa has been formed on Mediterranean Sea consisting of some parts of North Africa. Low pressure Gang center also expands during this day so that 1008 hPa isobar of this tongue is on the station. This center causes increased temperature in country due to warmer climates of lower latitudes. There is also a secondary low pressure center in the South Aral Sea which mingled with Gang low pressure tongue on Iran from its southwest, the country is under the influence of low pressure centers all day long.There is also a high pressure center on Kazakhstan with 1020 hPa central isobar. tongues from this center are alienated from north to south up to Caspian Sea causing cold air to enter half northern parts of Iran in higher latitudes. In this day pressure gradient of study region is higher compared to other Iran regions, but it value is very low, so there is a wind current from Caspian Sea high pressure tongue toward Yazd station.

On the second day of low pressure center to the southeast is a slight displacement of in Iraq, but it has not changed and also severity push 1002 hPa to reaches. This center is completely mingled with Sudan low pressure center today which engulfed all Saudi Arabia peninsulas. There have been subtle movements in North Africa high pressure center toward east with constant pressure. But, there is a tongue from this center elongated from southwest to northeast up to 45° north latitude. High pressure center on Kazakhstan in the other day is significantly strengthened and moved towards the east to locate at south Russia. In the same day, center tongues are moved away from Iran borders with the minimum effects on country. In the this day of days has not changed and continues to push towards the station is 1008 hPa.

As figure 3 indicates, a low pressure center with a pressure less than 1002 hPa has been formed on south Oman, with tongues expanded toward northwest. It is replaced by a low pressure center on Iraq. Gang low pressure center is weaker than the day before with 1009 hPa pressure. Compared to yesterday, North Africa high-pressure center has moved toward Mediterranean Sea and mingled with the high-pressure center located on the Black Sea. The center tongues has elongated to the Northwest and affected the area, so that 1014 hPa isobar of the center is on East Azerbaijan Province. this center Russia from side Eastalso cold air his caused low of temperature in the northern Areas and northwestern

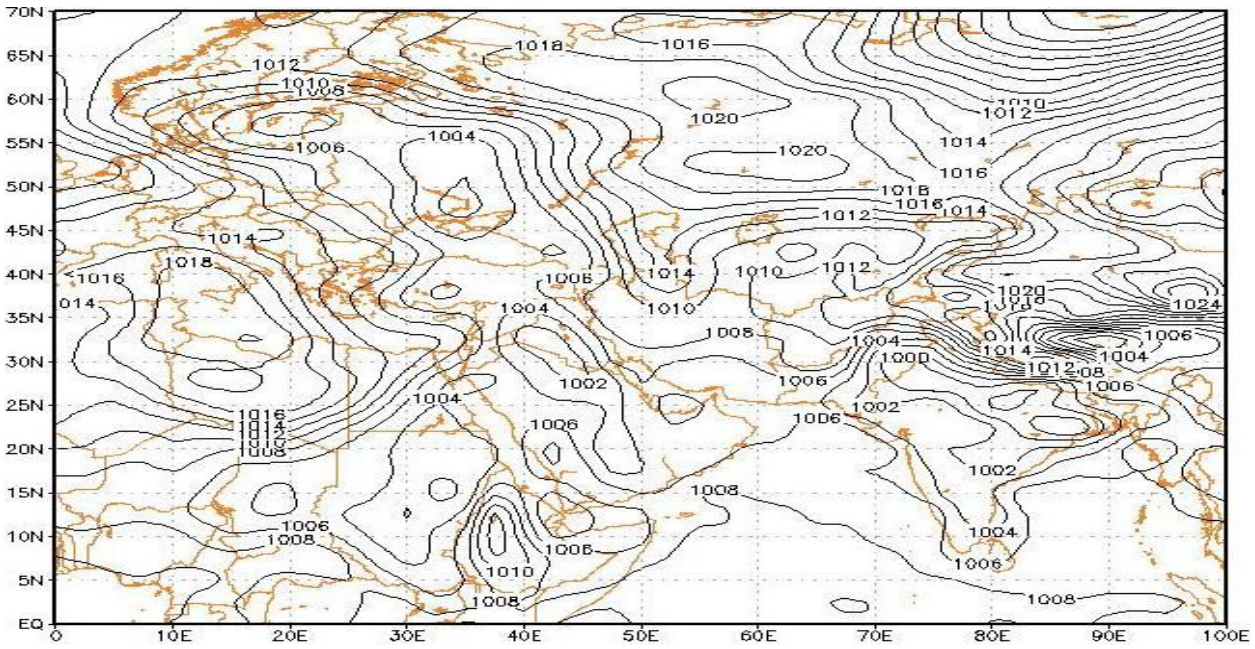

Figure 1 Sea level pressure (SLP) patterns, 24 hours before dust

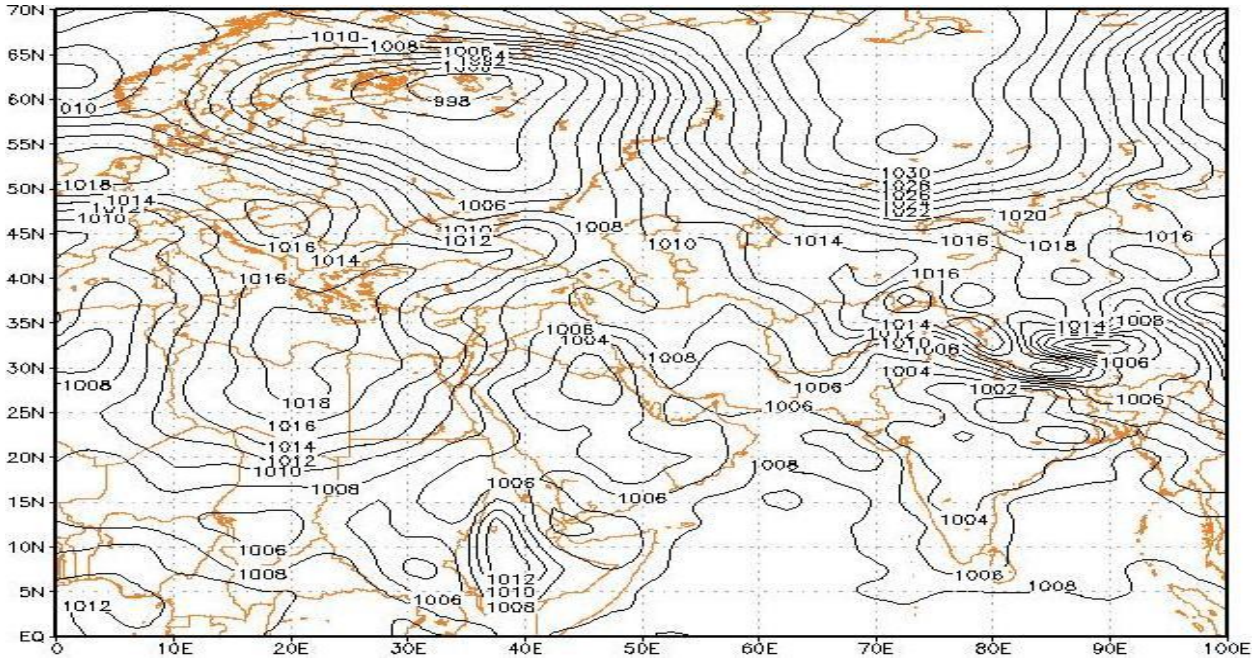

Figure 2 Sea level pressure(SLP) patterns, on the day of dust

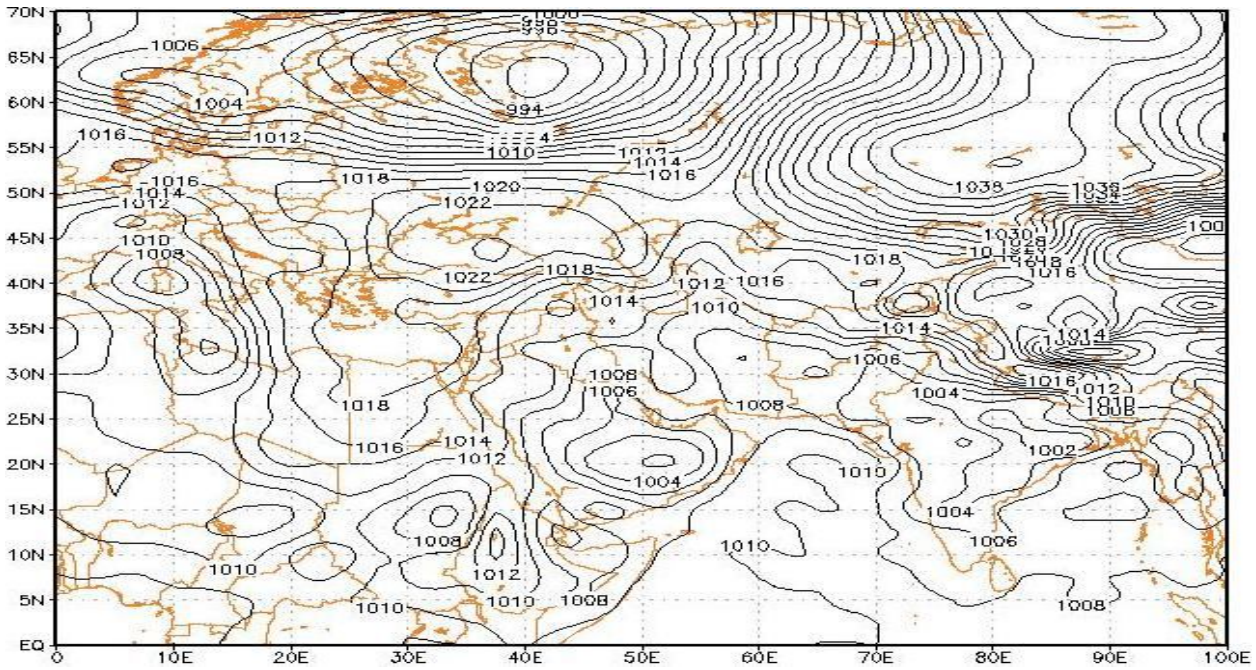

Figure 3 Sea level pressure(SLP) patterns,24 hours after dust

Below figures show position system elevation for 850 hPa at 12 GMT. According to the first figure, in the day before dust there is a secondary low pressure center with 1470 m contour line on the eastern half of country covering the study area as well. From southeast, Pakistan low pressure center with Contour line less than 1450 m has been formed which is mingled with central Iran low pressure center toward east. In the same day, there is a low pressure center with 1330 m contour line has been formed in north Europe, with their tongues are elongated from north west to southeast to Saudi Arabia so that eastern parts of this wave are located on west Iran causing arid and hot air from Saudi Arabia and Africa deserts moved into Iran. There is a high pressure center with more than 1579 m formed in North Africa. On this day in 1470 m contour line passes through the station and pressure gradient on the study area is very low at this level.

figure 5 is about dusty day. In this day, North Africa high pressure center is displaced from Algeria to Libya. As a result of this displacement, north Europe low pressure tongue is drawn into Iran replace by Iran low pressure. But contour line were not changed and continues on station 1470 m. From this center, like the day before, another tongue is deeply located into internal deserts of Saudi Arabia and wave axis along north-south has reduced to 20° north. Pakistan's low pressure center exist in that same day and replaced with Gang low pressure tongue. This tongue has been mingled with low pressure tongue from North Europe. It is evident that, there is a weak high pressure secondary center on Oman And due to its clockwise motion in the same direction with Europe low pressure has moved dry and warm air to these areas of Iran.

In the third day, High height of the center of north Africa along the south west - north east facing the has led to a disconnect tongues The center is the center low height North Europe As a result, in the same day there is a low pressure center with1490 m contour line from Pakistan to Iraq. There is another low pressure center on Saudi Arabia peninsula and its tongues elongated from

northwest towards the low pressure center on Iraq and merged with it. In the same day, a high pressure tongue enters Iran from southeast coast of country, so that 1520 m central contour line of the tongue is located on southern coast of Iran. There is another high pressure center on Syria with 1650 m contour line, with 40 m stronger that the before day. This center tongues has entered Iran from Khorasan province along northeast to southwest and has caused increased pressure gradient in this part of country. In the this day 1490 m contour line stations covers studies which compared to previous days has increased to 20 m..

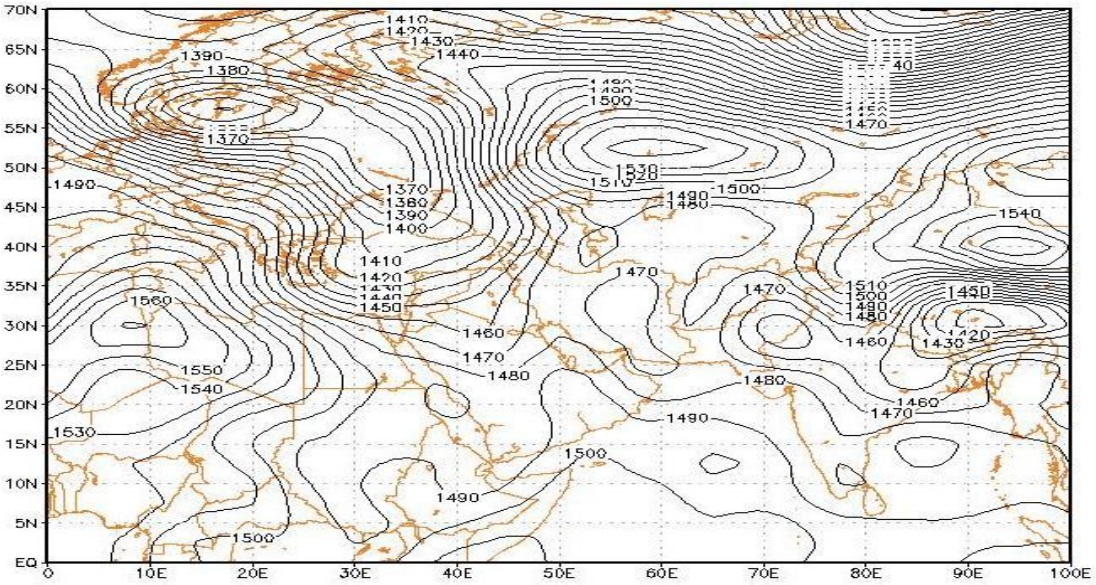

Figure 4: Circulation patterns at 850 hPa for the day before onset of dust

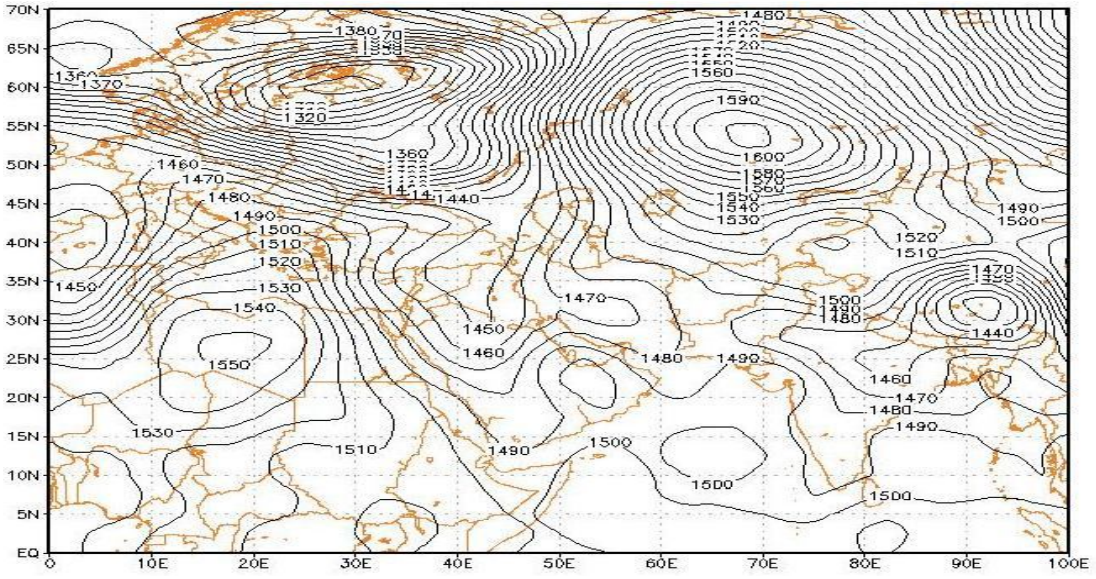

Figure 5: Circulation patterns at 850 hPa for dusty day

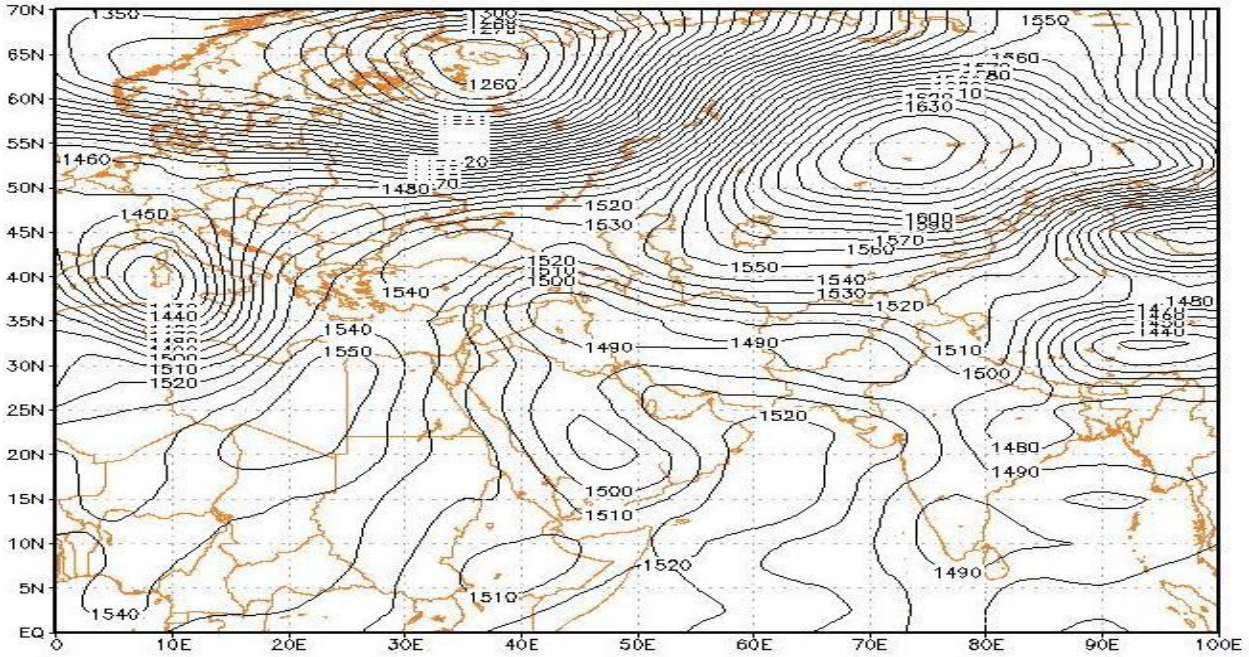

Figure 6: Circulation patterns at 850 hPa for 24 hours after the onset of dust

The following Hovmoller diagram shows moisture and wind speed changes for different levels of the atmosphere at 12 GMT. According to this diagram, the atmospheric moisture from the day before dust to the next day had a descending trend, so that reaches to its minimum the day after dust onset. But, there are low changes under the influences of atmospheric temperature. As velocity contours show wind speed suddenly increases the day before dust onset at 12 GMT and reaches to its primary speed at 18 GMT. But, the wind speed suddenly reduces at 06 GMT in the dusty day, this trend continues to the next day; so that it reaches to its minimum level at 00 GMT in the day after dust onset. At 06 GMT, the third day, wind speed increases for some hours but at 12 GMT again starts reducing. The other point by this diagram is that only in the day before dust onset there is a jet stream core on the region which has come down to 400 hPa.

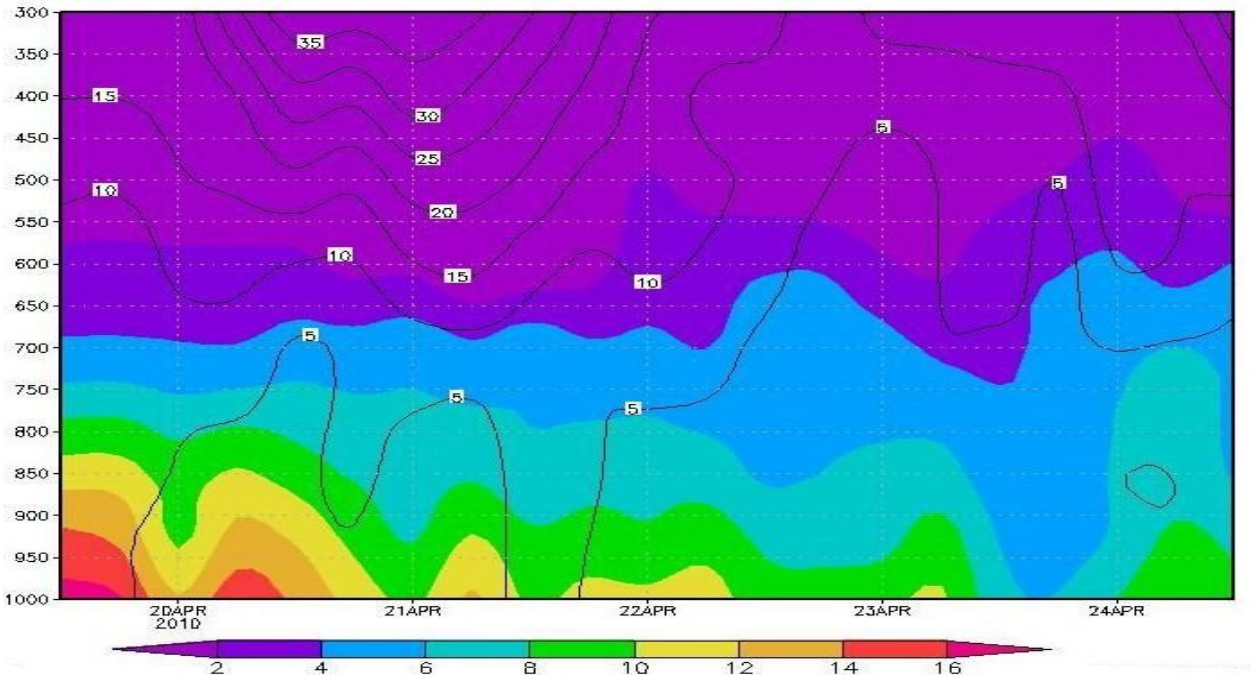

Figure 7 Humidity and wind speed changes at different atmospheric levels of Yazd station

The following figures show vorticity, temperature, wind speed and direction on 850 hPa at 12 GMT. figure 8 indicates a zero amount of vorticity in the day before dust due to the fact that station is located between several centers with various pressures. Wind blows with speed of 5 m/s from northwest from a high pressure center located in the north west towards the station. Regarding isothermal lines in the same day and this level, station temperature reaches to 24°C.

Next day, although there is a tangible change in pressure centers, vorticity has not changed on the station and still north high pressure tongue indicates wind direction and speed. In this day, wind speed has reduced and reached to less than 2.5 m/s, but there is a low change in direction. Regarding isothermal lines, station temperature has Increase compared to the before day from 24° to 27 °C.

According to figure 10, there is a more positive vorticity on the study area at the same time with low pressure center tongue enters Iran from northwest. Due to dominance of a high pressure tongue in south station with a negative vorticity the air flow direction from high pressure center, and wind blows from southwest to northeast with 2.5 m/s toward station.

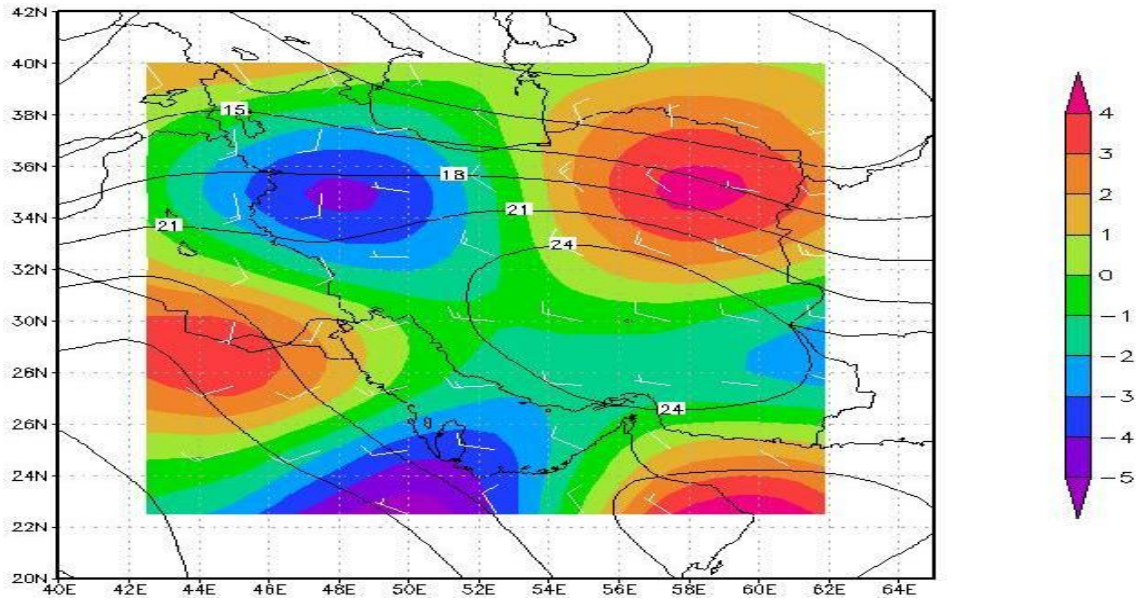

Figure 8 vorticity rate, temperature and wind speed and direction at 850 hPa level, the day before the dust

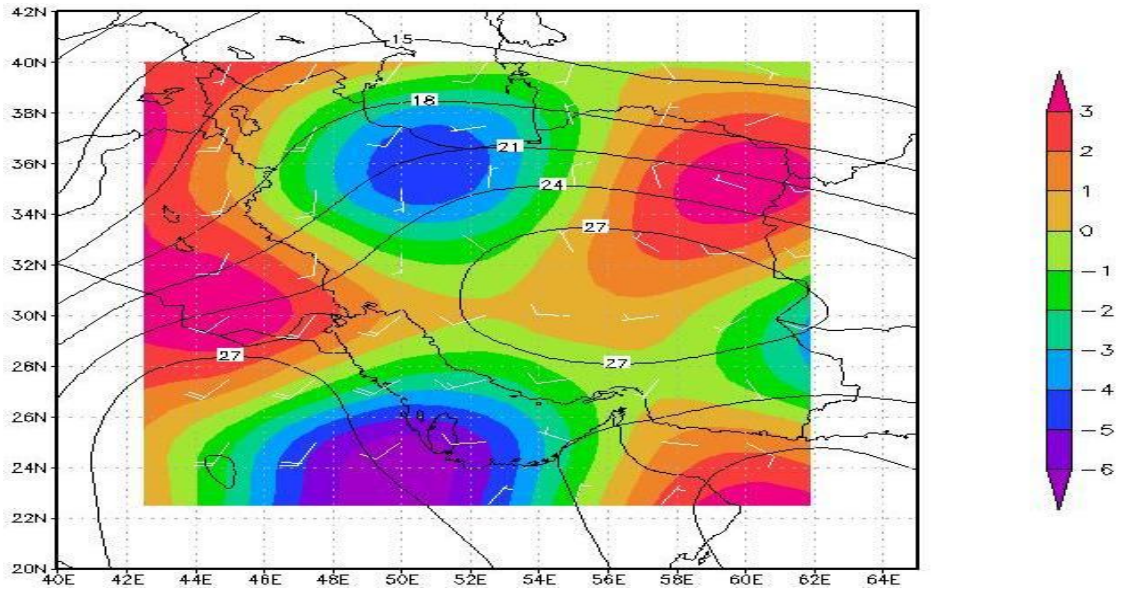

Figure 9 vorticity rate, temperature and wind speed and direction at 850 hPa level, the dusty day

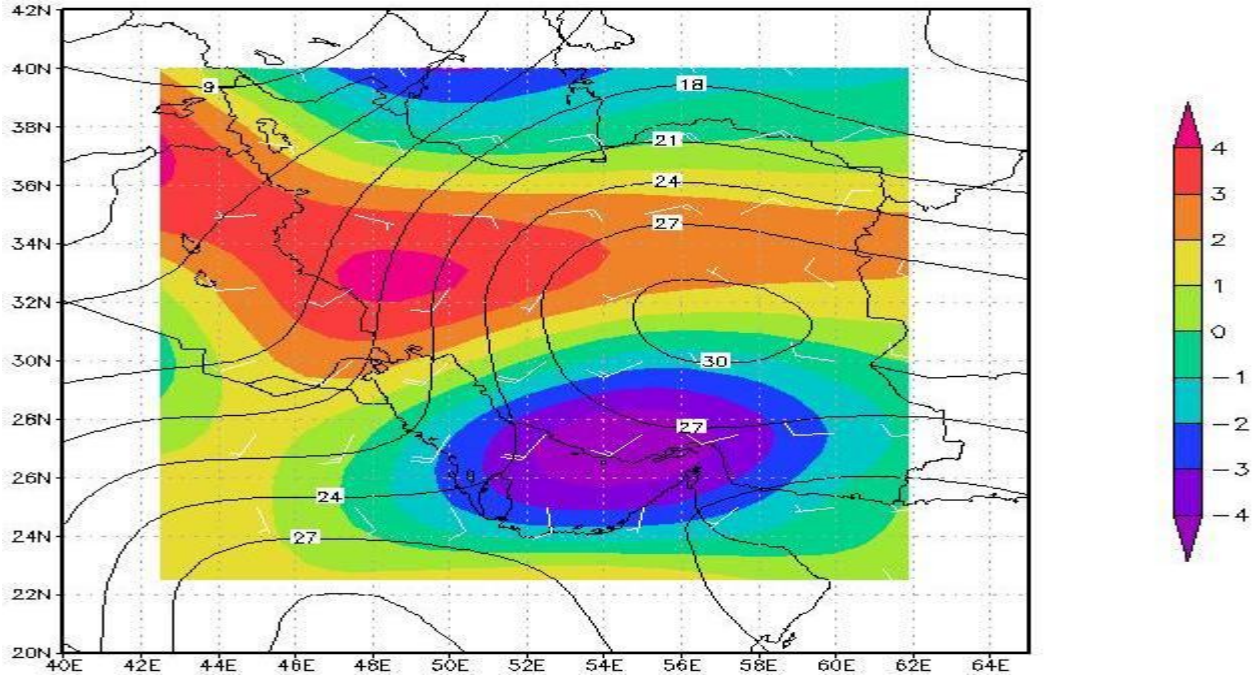

Figure 10 vorticity rate, temperature and wind speed and direction at 850 hpa level, the day after the dust

The following Hovmoller diagram shows moisture and temperature changes on the first 10 centimeter soil in the study area. According to this diagram, in the day before dust at 06 GMT soil temperature Because of the increased radiation angle and then stats to reduce. The maximum temperature at the same day is 27°C. But in the second day the intensity of these changes increases and soil temperature at 06 GMT reaches to 30° C, then stats to reduce. The day after dust the temperature increases and reaches to 33° C. The minimum temperatures are related to the last hours of the day which gradually increase, in the first day it is 15° C, in the second and third days become 21 and 24° C, respectively.

According to curves of moisture, moisture content shows a descending trend related to temperature changes so that in first hours of day before dust reaches to 0.221, while at the end of the day after dust it is less than 0.215.

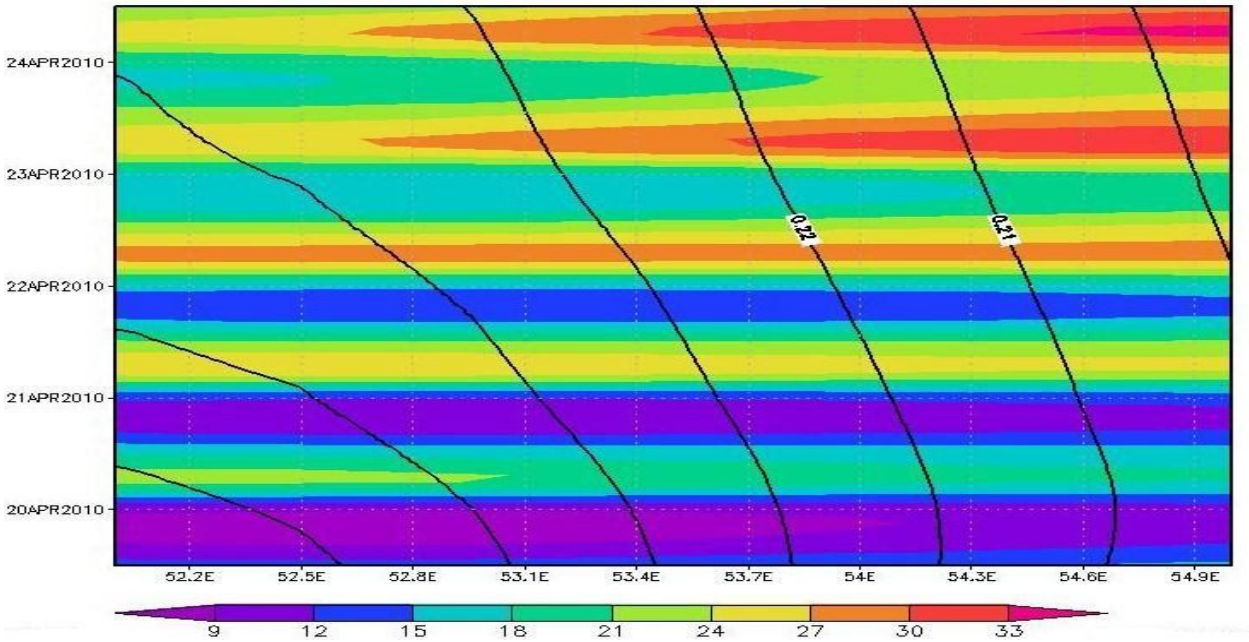

Figure 11 The first 10 cm of soil temperature and moisture changes for 32 ° N

Conclusion

According to figures of SLP, the expansion of Gang low pressure tongue in this season causes warm air in lower latitudes which almost affects all parts of Iran, so that pressure gradient in all parts of country except for north half influenced by high pressure center from Black Sea is very low. Also low pressure center tongue has formed in 850 hPa on north Europe from along the northwest - southeast of Saudi Arabia has occurred day occurrence in the dust on the study area is located but the day after advancement of high pressure tongues located on Libya lead to retreating of low pressure tongues on Europe and thus a cut down on the vertical motion of air. Atmospheric moisture figures also indicate a decrease in atmosphere moisture content in three days, so that in the end of the day after dusty day reaches to its lowest level. Soil moisture also reduced during these three days reaching to its lowest level in the third day. This is due to soil temperature increase, from 27° to 33° C in the third day. According to above results and regarding wind speed and direction in SLP and 850 hPa as well, dust in these days is of a local origin from arid areas surrounding the province.

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