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Analysis of the dust event in the recent decade (2002- 2012): Mashhad case study

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ABSTRACT

Dust is one of the atmospheric phenomena with undesired bio-environmental outcomes. Due to Iran's geographical situation in arid and semi-arid parts of the world, this country is repeatedly exposed to synoptic and local dust systems. This study investigates the initiation conditions and the origin of dust systems of Mashhad during a statistical decade (2002- 2012). The results of statistical analysis show that summer, especially June with 29 days has the highest abundance of the dust event phenomenon in Mashhad. Statistics has shown a decreasing trend of this phenomenon in recent years. Of course it is important to mention that this event has increased from 2012 to the previous year, i.e. 2011. In addition, the abundance of the days of the dust event phenomenon with intra-regional and local origin is higher than its occurrence with extra-regional one. Finally in order to synoptically analyze this phenomenon, the effective factors on this atmospheric phenomenon were investigated typically with the help of the maps received from the weather forecast site. For the analysis, two waves were selected due to the dispersion of the area and its deployment in the region. The dates of the phenomenon were selected as July 9th 2009 as the extra-regional factor and March 15th 2008 as the intra-regional one. Results show that in July 9th for the extra-regional factor, there

was a fairly moderate atmosphere on the region, while on the surrounding regions, the placement of a low-pressure atmosphere, reinforcement of the instability conditions and cutting the upper-layer winds has led to the weather calmness and therefore the occurrence of the dust phenomenon and its placement on the region. By investigating the maps of the atmosphere's various surfaces on March 15th with the intra-regional factor, there were different conditions in comparison with the July 9th. At the time of the occurrence of the phenomenon on March 15th, the conditions were instable on various surfaces from the Earth to the over-atmosphere surfaces, while there was a fairly moderate atmosphere around the regions. This instability on the regions leads to the air movement and the region's aridness makes local dust.

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1. Introduction

Dust phenomenon is one of the most important forms of pollution. When solid particles suspend in the atmosphere, they tarnish the air and reduce the horizontal visibility. This is known as the dust phenomenon. Countries located in the arid and semi-arid belt of the world, including Iran, have always been stuck with dust phenomenon. More than two third of the Iranian area is located in the arid and semi-arid climate. On the other hand, the average annual rain of the country is half the average annual rate of the world. Iran is exposed to the dust phenomenon on local, regional and global levels. In addition, repeated droughts in recent years and the potential consequences of climate change on today's desertification, had made dust storms under the attention focus of many scholars (Zolfaghari 18:2011 et al.). The dust phenomenon is a natural event that occurs widely in arid and semiarid regions of the world. The common feature of these regions is low rainfall, high evaporation, high heat, and the temperature difference between night and day (Alijani 95:1997). The dust event is not only the result of severe winds, but the instable conditions of the atmosphere. The most important condition of dust formation is the lack of sufficient moisture in the region, since air ascendance and instability leads to rainfall in the case of the existence of moisture. The extent of dust phenomenon in a region depends on the wind speed, dry air as well as soil particle size and particle diameter. Vegetation and its type also play an important role in the incidence of dust (Engelstadler: 2001:2).

The most important dust focuses in the world are the African deserts, Saudi Arabia, Iraq and Syria. Unfortunately the proximity of Iran to these locations has made our country exposed to this phenomenon. This phenomenon is especially important in the Western Iran due to its proximity to these focuses which has annually led to damages to this region. The decreased atmospheric falls, increased temperature and extension of the deserts are the causes of dust. Iran with such conditions is not an exception. Every day it sees the increased occurrence of these vents.

The purpose of this study is to investigate the situation of dust phenomenon in Mashhad in the recent decade. Since Mashhad is farther to the West and therefore the dust focuses and it is considered as one of the most important cities of the Eastern part of the country, it is important to investigate the causes and origin of this phenomenon. Therefore based on the existing statistics and information, the phenomenon may be analyzed in terms of the changes in Mashhad as well as the intra and extra-regional causes and factors. Therefore according to the fact that this phenomenon has irreparable outcomes/damages for the bio-environment, especially the humans' health and hygiene, it is necessary to perform more serious and integrated researches on the origin of this phenomenon so that it would be better controlled and decrease its damages.

According to the dust weather reports, the dust phenomenon in the world, especially in countries with arid and semiarid climates, shows an increasing trend. This phenomenon has outcomes such as respiratory, cardio-vascular diseases, lung inflammation, eye/skin allergies, etc. for the humans' health and their daily activities. Its damages on the buildings' view and beauty lead to decreased vision as well as bio-environmental and transportation impacts (Nouhi: 1373, 145).

Big industrial cities are faced with the problem of the pollutants of factories' fossil fuels and automobiles' fumes. The dust phenomenon complicates the bio-environmental difficulties for them. Mashhad is located between the 36 ° 20 , 36 ° 10 North latitude, and 59 ° 28 to 59 °43 East longitude. The city is located in the central part of the northeastern city of Mashhad, Khorasan Razavi Province.

The average height of about 1050 meters above sea level (Fixed; 2012)., This city as one of the major cities of the country in the East River. Therefore, studies in this regard can increase and decrease the contrast of the consequences.

2. Materials and methods

In this study, a statistical period covers the years 2002 to 2012 AD. So the data required for these study phenomena such as the number of days of dust, horizontal visibility, relative humidity, precipitation and synoptic stations of Mashhad have been obtained.

According to the weather forecast department guidelines and dust codes, the causes of this phenomenon in the region including the intra and extra-regional factors are investigated (table 1).

Table 1
dust codes and their definitions.

Codes definitions	Code No.
Airborne dust in the wind, sand and dirt out of the station.	6
Dust or sand or near the time by Baddr monitoring station reported.	7

3. Statistical analysis

For a more thorough review and comparison charts below, according to the above table data is plotted. As shown in Figure (1) is evident in the frequency of occurrence of this phenomenon in the city of Mashhad in 2008 had the highest frequency.

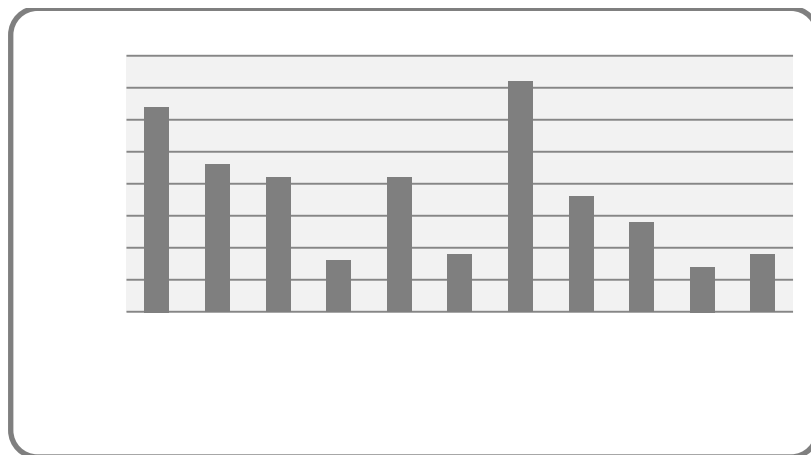


Fig. 1. the annual comparison of the days with dust in Mashhad (During the statistical period of 2002-2012.

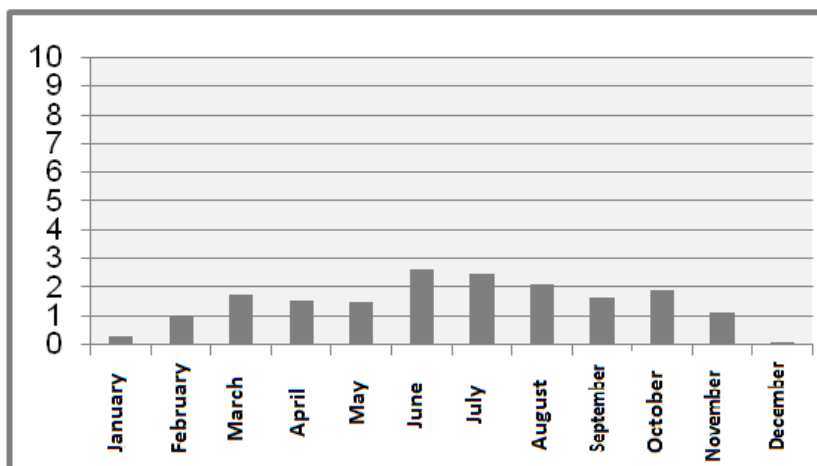


Fig. 2. Comparison of monthly frequency of occurrence of dust occurrence of Mashhad.

(The period from 2012 to 2002 AD)

Table 2

Statistics of days with dust Mashhad in the period 2002 to 2012 AD.

Ann ual	Decem ber	Novem ber	Octo ber	Septem ber	Aug ust	Jul y	Ju ne	M ay	Ap ril	Mar ch	Febru ary	Janu ary	year
32	0	2	2	3	4	2	11	4	2	1	3	0	2002
23	0	2	3	2	0	4	5	2	0	4	1	0	2003
21	0	0	2	1	0	6	1	0	3	4	4	0	2004
8	0	0	1	1	4	1	1	0	0	0	0	0	2005
20	0	2	1	3	2	3	2	2	5	0	0	1	2006
9	0	3	1	1	1	1	1	0	0	0	0	1	2007
36	0	0	4	5	7	2	4	7	3	3	1	0	2008
18	0	2	1	0	1	7	3	1	0	2	1	0	2009
14	2	0	2	2	2	2	0	1	3	0	0	0	2010
7	0	0	3	0	1	0	1	0	2	0	0	0	2011
11	0	0	0	0	0	0	2	0	0	5	1	1	2012
199	2	11	20	18	22	28	29	17	18	19	11	3	Total

Well the origin of this phenomenon in the years 2011 and 2012 were almost identical. Applying noted that this phenomenon is occurring in December only local sources reported. (Figs. 3 and 4)

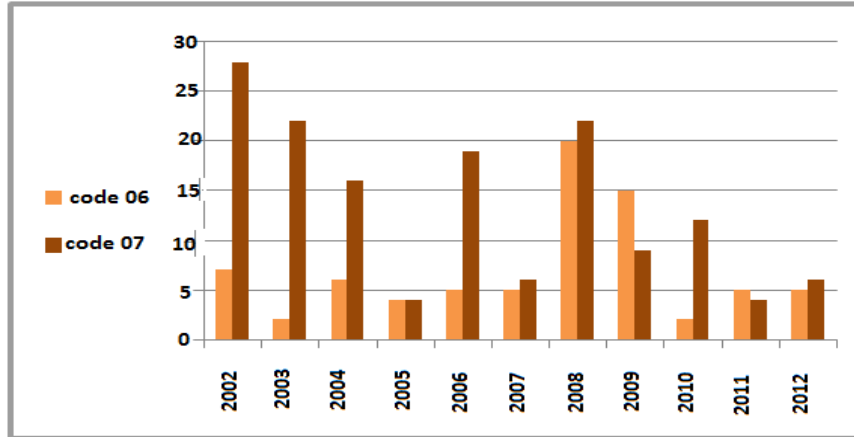


Fig. 3. Comparison of annual occurrence frequency of dust events Mashhad city code 06 and 07.

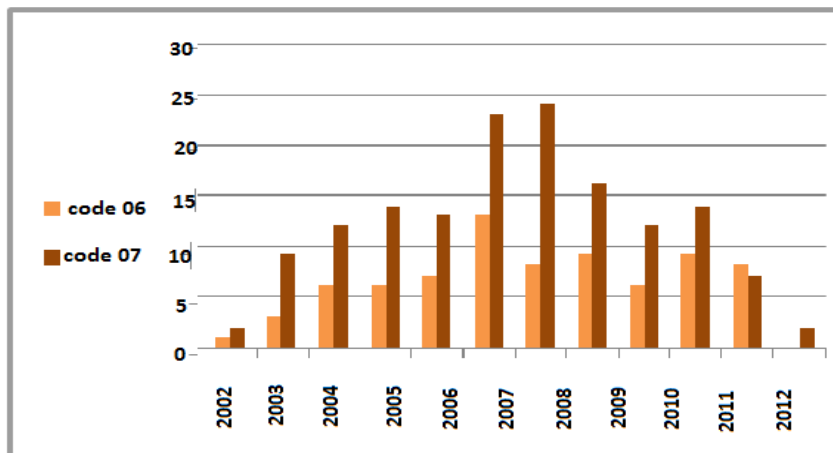


Fig. 4. Comparison of monthly occurrence frequency of dust events Mashhad city codes 06 and 07 in the period of 2012 to 2002 AD.

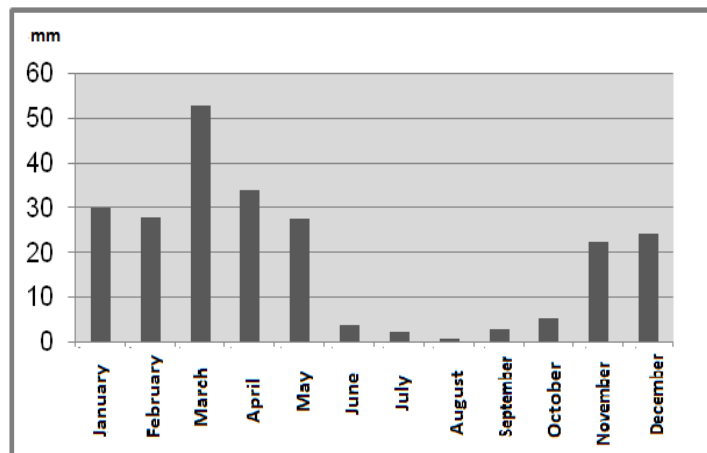


Fig. 5. Average monthly rainfall in Mashhad during the statistical period 2012 to 2002 AD.

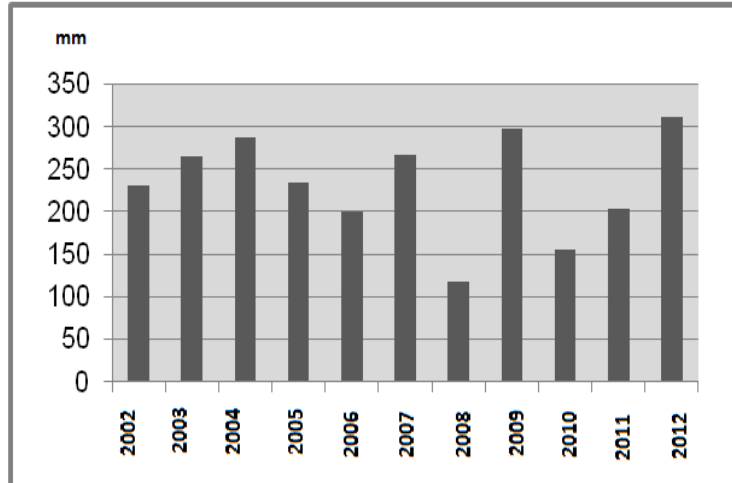


Fig. 6. The amount of annual rain in Mashhad during the period of 2012 to 2002 AD.

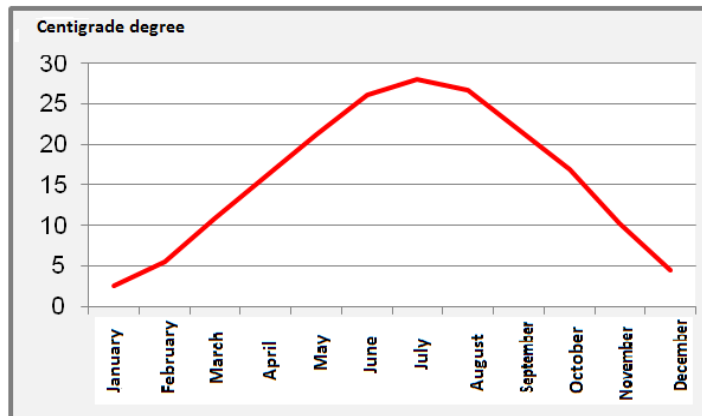


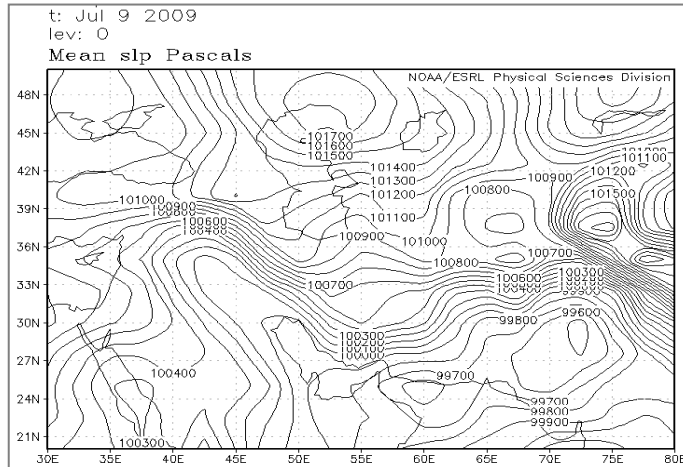
Fig. 7. Average monthly temperatures during the Mashhad by 2012 -2002.

As mentioned in the specification table on phenomena occurring in both history, very low humidity and precipitation is zero. Therefore, the inverse relationship between the occurrence of dust precipitation and humidity there.

3.1. To sea level pressure pattern on 9 July 2009

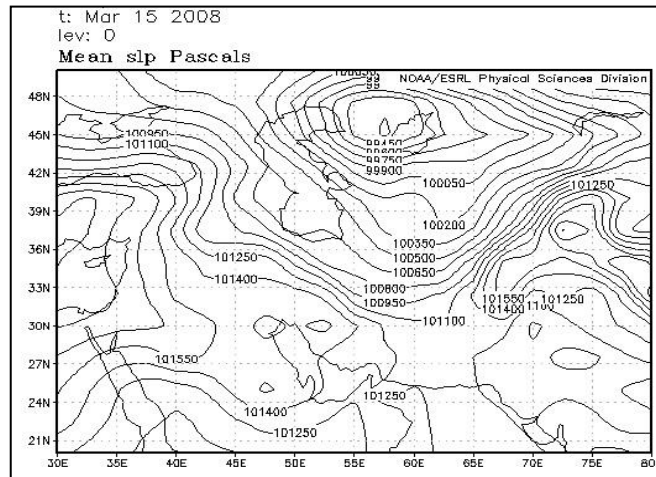
A map of a certain length and width of the surface pressure at sea level on 9 July 2009 with (code 06) is depicted. This map is a compact curves in the West, South and South-West and in the East region is observed, which is indicative of an instability in the region. But in the study area is air-stable form partly because of the pressure gradient is less steep than the surrounding areas. (Map No. 1)

Map No. 1. The 500 sea surface map for July 9th 2009 (code No. 6).



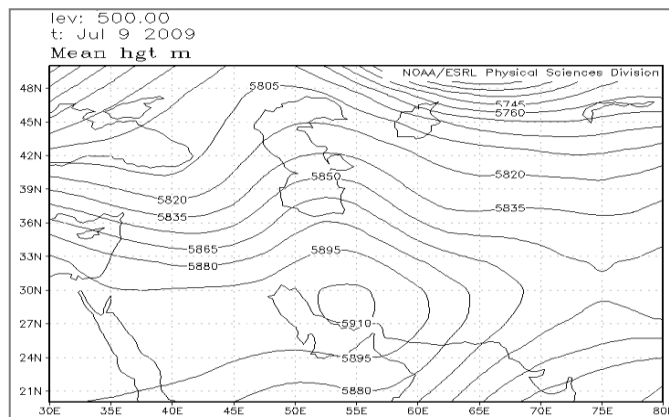
3.2. The pattern of sea level pressure at the date of March 15, 2008 AD The area studied is unstable., and the surrounding area curves indicate stable air pressure. (Map No. 2).

Map No. 2. The sea surface map for March 15th 2008 (code No. 7).

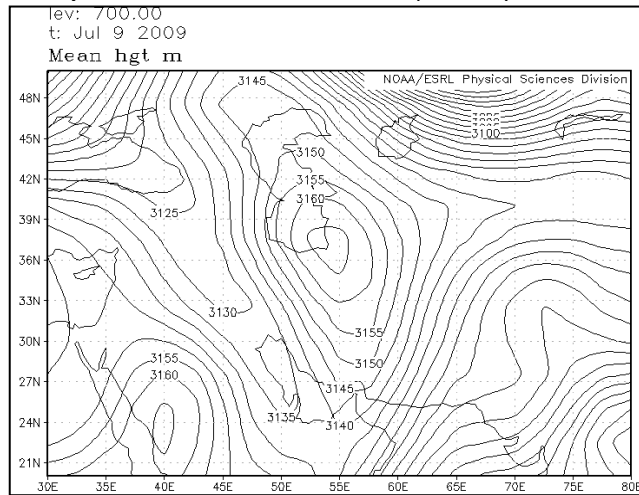


3.3. Models 500 and 700 and 850 hpa pressure levels on occurrence

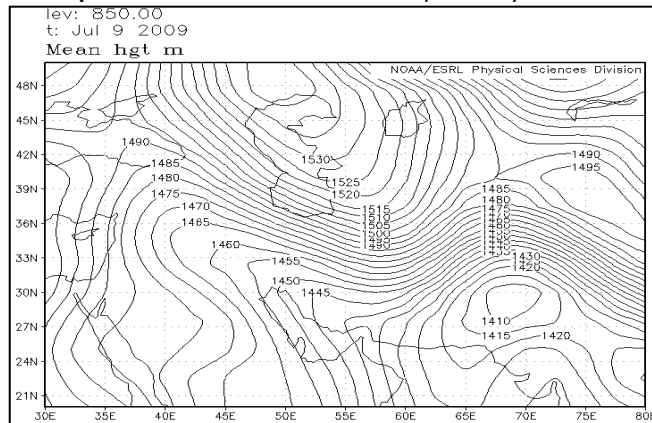
Map No. 3. The 500 HP balance map for July 9th 2009.



Map No. 4. The 700 HP balance map for July 9th 2009.



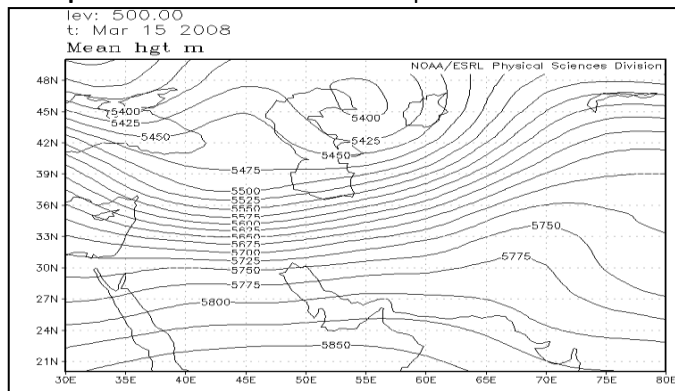
Map No. 5. The 850 HP balance map for July 9th 2009.



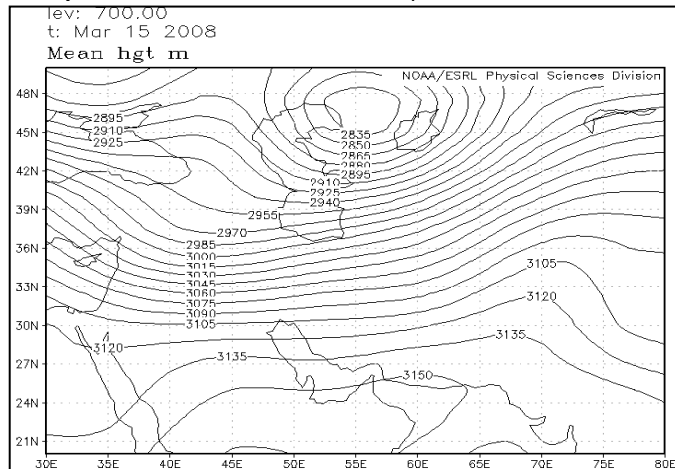
More maps on March 15, 2008 The occurrence of high levels of atmospheric dust with the code 07 is reported, are discussed.

On the map above the level of 500, 700 hp, which are almost identical conditions and with the same level maps on 9 July are very different. March 15 in the drawings can be seen in the upper levels of the atmosphere, made up of traffic caused instability in the West the area is in the East. That is unstable modes in this region than its western areas. (Maps 6 and 7)

Map No. 6. The 500 HP balance map for March 15th 2008.

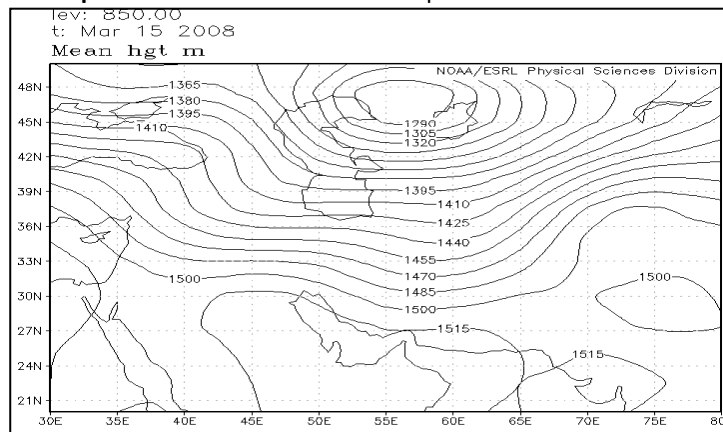


Map No. 7. The 700 HP balance map for March 15th 2008.



Maps of 850 hPa level on March 15 conditions, including levels of 500 and 700, so almost all the atmosphere of instability in the region and that the conditions for surface flow and interact with local dust buildup.

Map No. 8. The 850 HP balance map for March 15th 2008.



4. Conclusions

It may be concluded by investigating the integrated maps on the occurrence dates of the dust phenomenon in the region that when the dust phenomenon is of the intra-regional type, the region's conditions are less stable than the surrounding regions. Also the instability conditions in the upper atmospheric layers impact this and all of these factors as well as the dry air lead to the occurrence of surface flows so that local dust is produced. However when the region has a stable air region and the surrounding regions and even the middle levels such as levels 700 and 850 hPa have unstable atmospheres, dust is the extra-regional factor. Of course it is important to mention that there is a stable atmosphere on the upper atmosphere, i.e. the 500 hPa level that causes the localization of dust in the region.

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