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ASSESSMENT FOR SYNOPTIC OF SEVERE DUST STORMS OVER IRAQ USING REMOTE SENSING

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Abstract
Dust storm is relate with climate change specially with semi-arid region, this research is concerned with studying the synoptic pattern and anaerobic variables and their relationship with dust storms and identifying the main types of patterns synchronized with dust storms. The research relied on the Atmospheric dynamic and synoptic analysis of weather maps related to dust storms over Iraq. The study focused on the dust storms factors affecting them (air temperature, wind speed) .The analysis of weather maps of the surface (MSL) explained the presence of pressure low and high pressure and their impact on Iraq, the Gulf states and Saudi Arabia. The results of the contour lines geopotentail high at the pressure level 500 (hPa) and growth the trough and ridge. In addition to the dynamic analysis of weather maps at the pressure level 850 (hPa) and the interpretation of wind movement, speed and change of direction within this level.The significant results showed that dust storms occur during the summer and spring months, the winds were northwesterly heading south or east, these winds were very fast winds that pass over Iraq from the Iraqi-Syrian border, causing the lifting of dust particles from arid or/and semi-arid areas, which are sources of dust.
Keywords: Dust storm, Remote Sensing, Atmospheric Dynamic, Iraq.

Introduction
The phenomenon of dust storms occurs in areas characterized by drought and lack of rain, large areas of the world include dry, arid and semi-arid areas such as the Middle East in general and Iraq in particular, solid suspended particles in the atmosphere are dust or sand that rise from the bottom (surface) by wind, where the wind lifts them from dry areas and transports them from one area to another and rises to hundreds or thousands of kilometers (Majeed et al. 2003), Dust storms reduce the efficiency of solar-powered devices, reduce soil fertility and destroy agricultural crops (Sissakian et al. 2013). Dust storms occur in the spring and summer months and occur on a monthly and annual basis, which led to the work and study of many researches on various topics to study dust storms, especially the field of dynamic movement and synoptic analysis (Goudie et al. 2002). The seasonal thermal depression at the level pressure (MSL) hPa coming from the Indian Ocean towards the Arabian Peninsula and Iraq affects the region, especially Iraq, where dust storms intensify due to this depression. (Najafi et al, 2017) identified the atmospheric circulation patterns of Arabian dust in western Iran using NCEP/NCAR reanalysis data. They found that the

atmospheric circulation patterns which lead to dust events in the Arabian region and western Iran can be classified into two main categories: The Shamal dust events that occurs in warm period of year and the frontal dust events as cold period pattern. (Jasim 2018) He studied the dust storms that occur constantly over the Middle East and their occurrence is concentrated over Iraq and the Arabian Gulf region. Dust masses rush from arid and dry areas and study the equatorial conditions that cause dust storms and their spread and analyze the surface maps of the weather and the maps of the upper layers of the atmosphere, and clarify the effect of the depression system and the surface wind patterns at the pressure level 850 (hPa) on raising dust particles from the surface to the top. In addition, the negative vertical velocity (rising air) over the storm source region and the positive vertical velocity over the eastern Mediterranean region (downward air) leads to dust moving near the surface of the earth. (Mohammed 2010) Studies have shown that research has indicated that low rates and a significant decrease in rainfall enhance the decrease in soil moisture and vegetation cover, which leads to the ease of dust emission from the soil surface. In addition to the temperature change that affects the formation of dust storms in hot periods, and the effect of synoptic systems on the emission of dust. (Mashat et al, 2020) Synoptic and dynamic characteristics of dust storms studied during the spring season by means of surface observations of dust storms ,the study shows that the frontal and northern systems are accompanied by high pressure and temperature changes ,The study proved that the kinetic energy (KE) shifted east and the available potential energy (APE) shifted north. (Al-khalidi et al, 2021) this study showed that dust storms occur in spring and summer times. The surface monitoring maps, geopotintail high at the level pressure 850 (hPa), wind direction and speed confirmed the occurrence of dust storms. Was explained that the air masses have the main and direct role in the emergence of the storm, which carries with it the dust particles, when cold air rushes towards warm air, it raises it up, so dust particles rise with warm air and move with horizontal winds, high speed of northwest winds help spread dust and carry it to great distances. The presence of the eastern desert in Syria, the Rub Alkhali in Saudi Arabia, the western region of Iran and the area between the Tigris and Euphrates, they are major areas of dust, which enhance the dust storm. (Majeed et al. 2021) Explain that the synoptic study of the severe dust storm using remote sensing data includes daily images, aerosol index (AI), surface weather maps and 850 (hPa) weather maps. The study showed that the storm that blew over the northwest of Iraq, and the transmission of the storm was due to an low pressure over one of the sources of dust, In addition to the presence of two ridges and with a pattern of the trough, this led to the spread of the dust storm over the central and southwestern regions of Iraq and the northern borders of the Kingdom of Saudi Arabia with Iraq.The study shows the dynamic and synoptic analysis of continuous severe dust storms over Iraq in the summer of the surface maps and the pressure level 500 (hPa), which are affected by the extensions of the seasonal thermal low over Iraq, the Arabian Gulf and Saudi Arabia with the progression of high pressure towards Iraq, Turkey and Syria, with the possibility of analyzing and studying the movement , wind speed and its direction at the pressure level 850 (hPa) . Winds are affected by high temperatures due to the presence of the thermal low, which increases the horizontal wind speed, that's carries with it dust particles.

Material and Method

This research shows the locations of the emergence of the continuous dust storm, its path and its change of direction towards Iraq by The United States National Centers for Environmental Prediction (NCEP) ,NCEP it is a method of determining meteorological standards for each of the surface, water, pressure, climate and weather to serve the community, the environment and the economy and to enhance the need for environmental information which is an important part for determining the sources of dust storms in general and continuing in particular over Iraq.The vertical wind maps were taken from it (Abd AlKareem 2015). Meteorological data were plotted for the same areas as the dust storm in order to identify the associated synoptic patterns over the two or three-day period. The synoptic system maps of lows pressure, the high pressure and the dynamical system of the winds were drawn using the Grid of Analysis Display System program (GRADS).

Results and Discussions

The case of dust storm in 7, 8 and 9 August 2005

To analyze the dusty situation for the year 2005 and according to the Figure (1) of three days 7,8 and 9 August 2005 represents a comparison of the pressure at the surface with the pressure level in the upper atmosphere 500(hPa) because thinks that the relation between the (MSL)hPa and (500) hPa is the reason for the occurrence of dust storms , so the air rises from the bottom to the top it means that the amount of dust pulls in with it, and this leads to growth of dust storms, to prove these that must compare the systems of pressure with geopotentail high at the level pressure 500 (hPa), and linked the effect of high temperatures on wind speed on the same day at level pressure 850 (hPa) . When comparing the pressure systems from the Figure (1.a) on 7 August at the surface notice there is an area of thermal seasonal low concentration on east of Arabian Peninsula indicated in red color its value is 994 (hPa), while the northern region, especially the northern Red Sea and Turkey there is extensions of high pressure system area shaded in blue which value 1006-1014 (hPa). It's known that winds move from areas of high pressure system towards areas of low pressure system so this characterized by a bad atmosphere, that's good indicator to occurrence dust storm and through the concentration of thermal seasonal low, which confirms that the process of suctioning air from the surface of the earth to the top and kinetic force that helps to raise dust. Thermal low in southern Iraq that progresses and expands, as notice since 7August 2005 this continues to expand until 9 August, due to the formation of two seasonal thermal lows in the same area and thus it became clear that it was a case of a continuous dust storm for 3 days. In Figure (1.b) from the synoptic map of 850 (hPa) it was found that strong winds that crossed over Iraq are northwesterly winds heading towards southern Iraq and the Arabian Peninsula extending towards the Indian Ocean. It has been observed that the temperature rises over Iraq, Iran and the Arabian Peninsula, as the rise in temperatures leads to raising the air to the upper atmospheric because it becomes less dense , strong winds rising upwards take dust particles from desert and arid areas that pass over them as they move from one area to another. From the Figure (1.c) the synoptic map of 8 August 2005 at the level pressure 500(hPa) on the surface, thermal

low it's still continuing progress over Iraq, shaded in red and its extensions were concentrated in central and southern Iraq and the southeastern side of the Arabian Peninsula, its value is 1000-996(hPa). High pressure system moved and its extensions centered over northern Iraq and Turkey, shaded in blue its value is1010-1014 (hPa). In the upper notice geopotentail high lines expanding and gradually increasing in value over Iraq. From the Figure (1.d) of the level pressure 850 (hPa) it was notice that the wind movement and its speed increased as it concentrated over Iraq, heading from the northwest to the southeast, very strong winds. Notice a wind speed of (10) m/s, strong winds proves the existence of an atmospheric conditions, fast winds move dust particles and rise to the top due to the kinetic force of the wind. From synoptic maps of 9 August at the figure (1.e), it was found that thermal low moved in central Iraq, and its extensions were centered in northern Iraq and Turkey, shaded in red, with value of 998 (hPa) .High pressure system shaded in blue moved and dominated from both sides. It was noted from the figure that its value is 1012-1016 (hPa) at the surface. The geopotential high expanded in the east and west of Iraq, its value was 590 (hPa) at the pressure level of 500 (hPa). The movement of high pressure towards thermal low causes strong winds due to the pressure difference between the two regions, where winds move from areas of high pressure system towards areas of low pressure system at the surface. From synoptic map at the Figure (1.f) in the 9 August 2005 at the level pressure 850 (hPa), It was found that the winds gradually decrease in intensity with decrease in the temperatures affecting Iraq. The strong winds affect the west and south of Iraq, moving away from the center, as happened in the previous two days, which explains possibility that the wind's influence will gradually recede, and the dust storm will begin to fade and continue to affect the desert-style region of the Arabian Peninsula.

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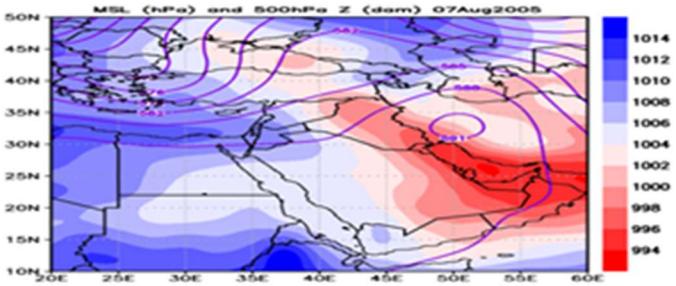

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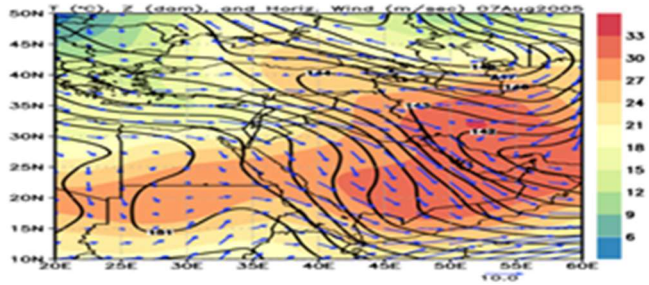

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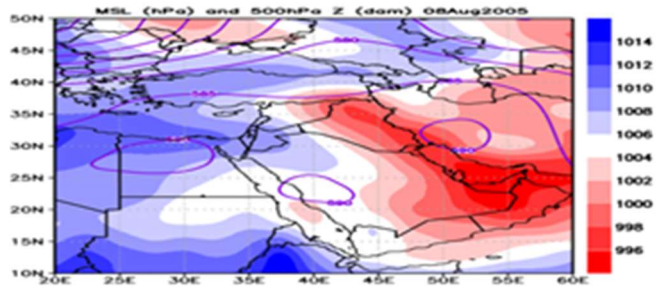

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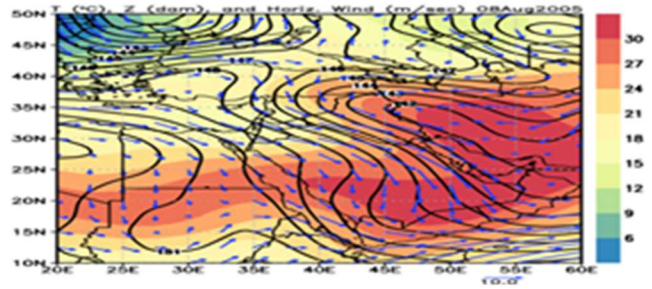

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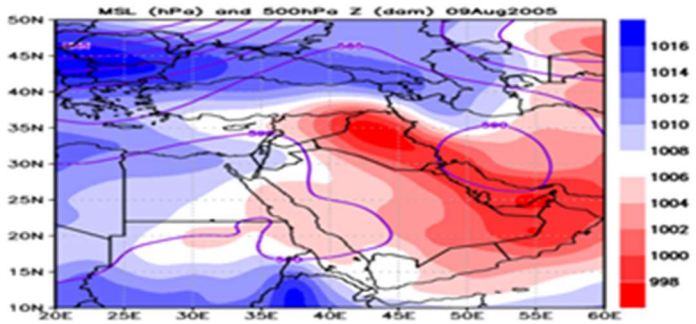

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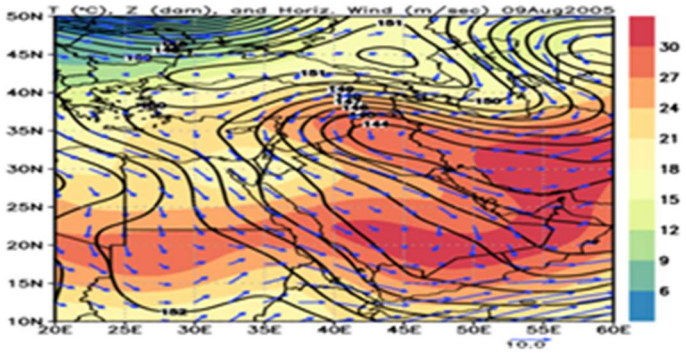
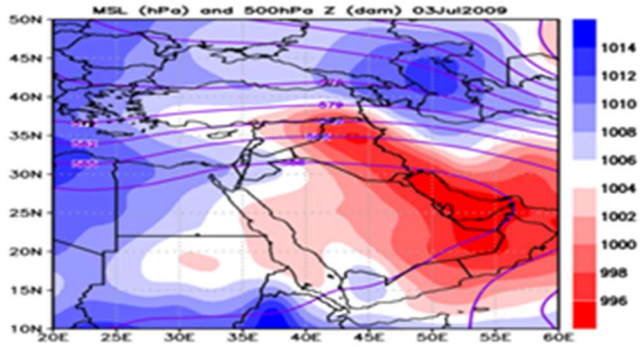


Figure 1 Synoptic dust storm in 7, 8 and 9 August 2005. (a) MSL (hPa) as shadow, 500 (hPa) geopotential high, (b)/Temp.as shadow, 850 (hPa) arrow winds, (c) MSL (hPa) as shadow, 500 (hPa) geopotentail high, (d) Temp.as shadow, 850 (hPa) winds arrow, (e) MSL (hPa)as shadow, 500 (hPa) geopotential high, (f) Temp.as shadow, 850 (hPa) winds arrow.

The case of dust storm in 3,4and 5 July 2009

Synoptic analysis of map for 3 July 2009 observed from Figure (2.a) the extensions of thermal seasonal low over Iraq, shaded in red and its value is 1002-998 (hPa). The geopotentail high contour lines converge in western Iraq and represent a trough at a pressure level of 500 (hPa). High pressure system, shaded in blue, dominates northern Iran and Turkey and is centered over the Mediterranean region in the west. Extensions of high pressure system dominate from both sides of Iraq, with a value of 1006-1014 (hPa). The contour lines converge at the pressure level 500 (hPa) above the high pressure system area west of the low pressure system area. From Figure (2.b) that's observed at the level pressure 850(hPa) wind moves from the high pressure system area towards the low pressure system area in southern Iraq, with a speed of (10)m/s. The contour lines converge and increase in value. The figure shows the presence of two pressure lows systems in northern Iraq and southern Iran, which explains the possibility of a dust storm and it is inevitable that it will continue for several days. From Figure (2.c), it was observed that the extensions of the thermal seasonal low progressed towards Iraq and southern Turkey on the next day, the convergence of the geopotentail contour lines in western Iraq at the pressure level 500 (hPa) increases due to the high presence of the seasonal thermal low over Iraq, the rise in temperatures raises the air from bottom to top .Synoptic analysis of the map (2.d) at the pressure level of (850) hPa. It was noted that the wind continues for the next day with a strong fast movement of (10) m/s. They are northwesterly winds coming from the high pressure in the west towards the seasonal thermal low centered over Iraq. The continued growth of secondary lows in northern Iraq and central Iran confirms the possibility of winds continuing at their high speeds that lead to lifting dust particles and transfer with the winds from the surface towards the upper atmosphere. Winds cross the arid regions and the western plateau in Iraq, which are sources of dust. Winds move from high pressure system areas to low pressure system areas due to the pressure difference between the two regions, which leads to strong winds that raise dust particles with them. Dust particles rise due to the kinetic force of the winds that rise from the surface towards upper atmosphere. Synoptic analysis of map for 5 July, from Figure (2.e) it was noted that the extensions of low pressure (thermal seasonal) shaded in red and its value 1000-998 (hPa), move away and reduce its impact over Iraq at the surface and the Arabian Peninsula because of the progression of high pressure system, which is shaded in blue, it has a value of (1006-1008) hPa at the surface. The geopotentail high contour lines approach Iraq in the west, they get closer to each other and diverge between them in eastern Iraq, so Iraq is confined between the two regions of the trough west and the ridge in the east, This case is explain the possibility that Iraq will continue affected by the seasonal thermal low and progression of high pressure system for three consecutive days and the resulting climatic effects. From Figure (2.f) it was found that the extensions of high pressure system approached at the pressure level of 850 (hPa), the wind continues with its fast movement of (10) m/s, which is northwesterly winds that pass through Iraq towards the east of Iran. The values of the contour lines are increasing and getting closer to each other because of the thermal seasonal low that affects Iraq in summer, the air rises to the top due to the high air temperatures, the two pressure lows have not disappeared, which may be explained by the possibility of a continuous dust storm across Iraq for three days or more.

a)



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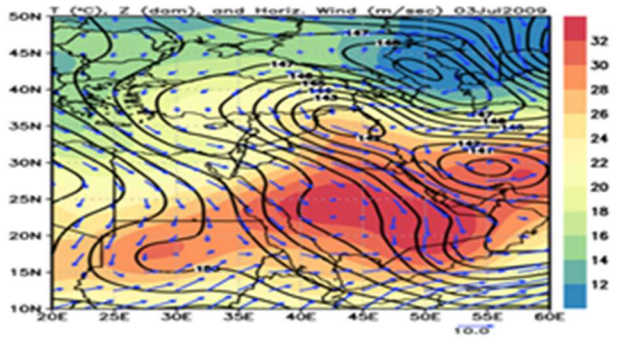

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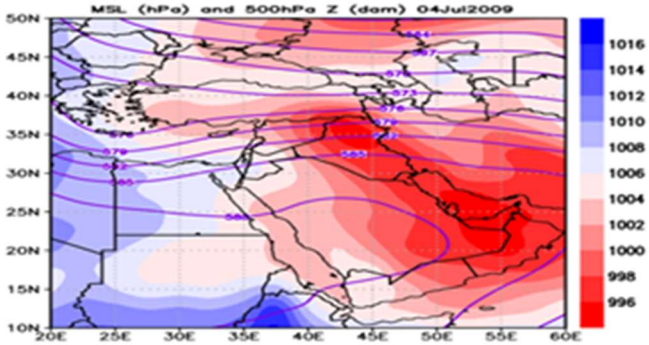

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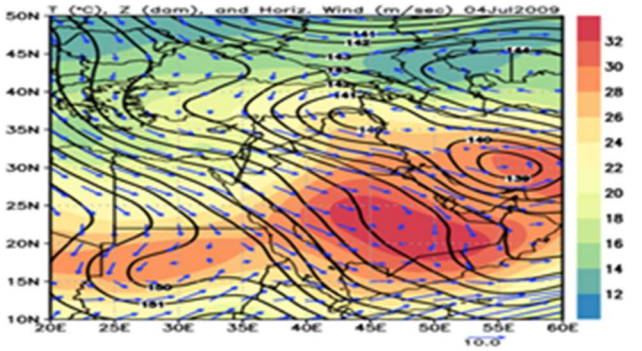

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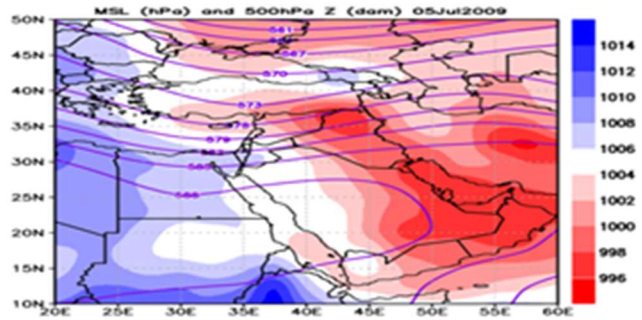

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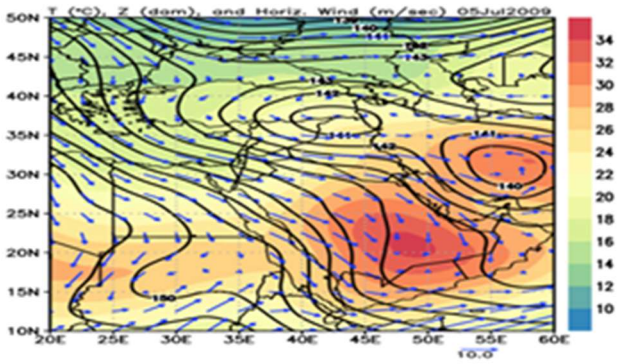
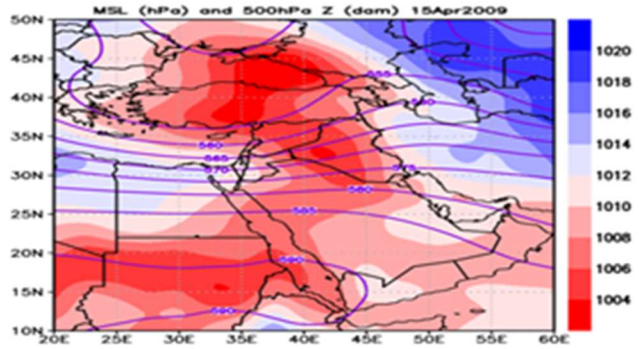


Figure 2 Synoptic maps of dust storm in 3,4and 5 July 2009. (a) MSL (hPa) as shadow, 500 (hPa) geopotential high, (b) Temp.as shadow, 850 (hPa) arrow winds, (c) MSL (hPa) as shadow, 500 (hPa) geopotentail high, (d) Temp.as shadow, 850(hPa) winds arrow,(e) MSL(hPa)as shadow, 500 (hPa) geopotential high, (f) Temp.as shadow, 850 (hPa) winds arrow.

The case of dust storm in 15, 16 April 2009

Synoptic analysis of the 15,16 April 2009 map is illustrated by the figures other dusty case of 2009, which discuss in the following form the pressure level at the surface is compared with the pressure level 500(hPa). Notice from Figure (3.a) that high pressure system whose value is 1020 (hPa) located at north of Iran that shaded in blue at the surface, low pressure system of 1004(hPa) centered in west of Turkey on 15 April 2009, at the upper atmosphere was observed that the contour lines converged in western Iraq and diverge between them over the high pressure system area in northeastern Iraq at the level pressure 500 (hPa). From Figure (3.b) at the pressure level 850 (hPa) noted strong winds, the wind moves from high pressure system area towards the low pressure system area and these winds pass through Iraq. At the Figure (3.c) on the next day 16 April, where high pressure system shaded in blue moved and surrounded low pressure system shaded in red at the surface of the earth, which causes strong winds of (10) m/s at the pressure level of 850 (hPa) as figure (3.d) it can be seen that the effect of high pressure system is very clear, where the wind movement expands greatly, including Iraq and the Arabian Peninsula. This explains the continuity of the winds for two consecutive days, a storm raises dust particles, through the control of high pressure on both sides of low pressure system, dust storms are formed, which causes dust to rush to the top.

a)



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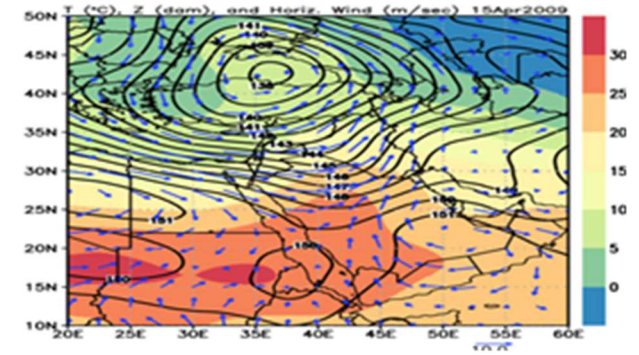

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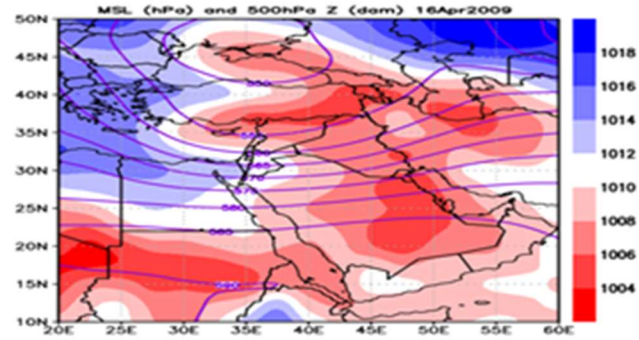

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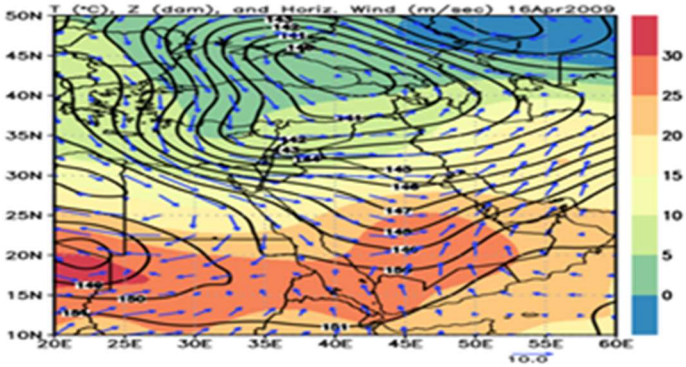
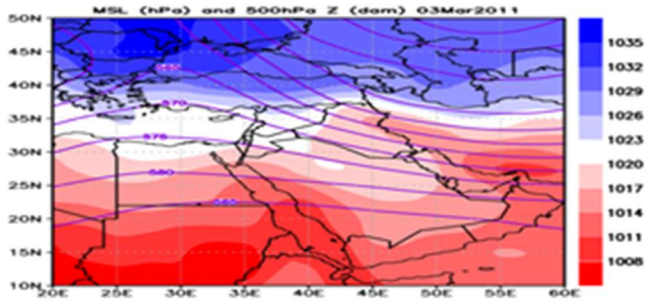


Figure 3 Synoptic analysis maps in 15, 16 April 2009. (a) MSL (hPa) as shadow, 500 (hPa) geopotential high, (b) Temp. as shadow, 850 (hPa) as winds arrows, (c) MSL (hPa) as shadow, 500(hPa) geopotentail high, (d) Temp.as shadow , 850 (hPa) as winds arrows.

The case of dust storm in 3, 4 March 2011

To analyze a map on 3, 4 March 2011, this is considered a spring month, during which temperatures vary, wind speed and weather vary. From Figure (4.a) the extension of thermal seasonal low shaded in red at the surface was observed in southern Iran to the western Red Sea, Egypt and Sudan, its value 1020-1008 (hPa). High pressure system and its extensions shaded in blue dominate the northern side, with a value of 1023-1035 (hPa) at the surface. At the pressure level 500(hPa), it was observed that the high geopotentail lines converged over Iraq and diverge from western Iraq, central Syria and Jordan. The lowest value of the contour lines represents a low pressure area in northern Syria, and the highest value is west of the Red Sea and represents a high pressure area. The region in western Iraq is characterized by a calm atmosphere. The low pressure area is considered the area of bad weather that promotes winds and moves at a high speed of (10) m/s. Through Figure (3.b) the winds coming from northern Syria move towards the borders of Iraq and move towards the south towards the Arabian Gulf and the Arabian Peninsula because of the kinetic force and the strength of its speed, it takes dust particles with it and transports it from its sources. The Iraqi-Syrian borders and the western region of Iraq are characterized by desert areas that enhance the wind with dust. Dust rises and moves with the wind from one area to another.On the next day, 4 March from Figures (3.c), (3.d) was notice that the wind speed and intensity gradually decrease as the contour lines diverge over Iraq, which is characterized by a calm atmosphere.

a)



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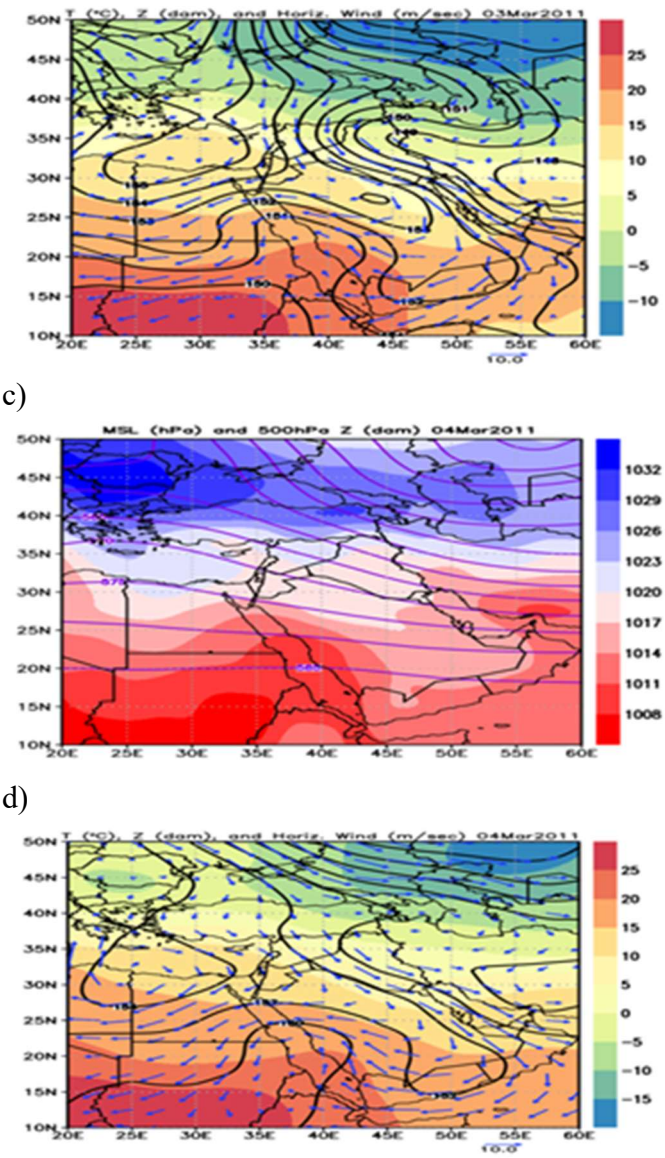

c)

d)

Figure 4 Synoptic analysis maps of 3, 4 March 2011. (a) MSL (hPa) as shadow, 500 (hPa) geopotential high, (b) Temp. as shadow, 850 (hPa) as winds arrows, (c) MSL (hPa) as shadow, 500 (hPa) geopotential high, (d) Temp.as shadow, 850 (hPa) as winds arrow.

Conclusions

The emission of dust particles in Iraq occurs throughout the year and increases in spring and summer and decreases in autumn and winter. Dust emitted from arid areas with little vegetation cover especially in Iraq, which supports strong winds and the phenomenon of dust storms occurs, The process of dust emission occurs in months and years that are characterized by high rates of wind speed and temperatures with the growth of low pressure system and high pressure system and their rush towards Iraq and Saudi Arabia, the effect of emergence of ridge and trough which feed low pressure and high pressure, thus create very strong northwesterly winds that pass over

Iraq heading from west to east, carrying with them particles of dust suspended in the atmosphere that cause damage to social life and the extent of vision, winds move from areas of high pressure towards areas of low pressure due to the pressure difference between the two areas.

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