IOSR Journal of Applied Physics (IOSR-JAP)
e-ISSN: 2278-4861.Volume 7, Issue 2 Ver. II (Mar. - Apr. 2015), PP 01-07
www.iosrjournals.org

The effect of dust storms on some meteorological elements over Baghdad , Iraq: Study Cases

Ali M. AL-Salihi[1], Thaer H. Mohammed[2]
[1]*Department of Atmospheric Sciences, College of Science, Al-Mustansiriyah University. Baghdad, Iraq.*
[2] *Iraqi Meteorological Organization and Seismology, Ministry of Transport, Baghdad, Iraq*.

Abstract: *Dust Storms play a key role in environmental pollution. They have a significant impact on climate-forcing factor by solar and terrestrial radiation by scattering and absorption. The dust storms represent a familiar phenomenon of frequent occurrence over Iraq atmosphere, especially during the period (April-September) of each year. In present study, the effect of 20 dust storms struck Baghdad city during the period (2008-2012) on meteorological parameters was investigated. These parameters include visibility, solar radiation, atmospheric pressure, air temperature and relative humidity. Through the comparison among the impact of the selected dust storms, it was found that the dust storm which struck Baghdad city 16th May 2008 had a more severe Impact on the meteorological variables than the other dust storms. the difference in the radiation to the (5229) W\m^2 from the day before the storm and the temperature dropped by 2.5 ^{o}C and visibility deteriorated greatly to be the difference from the day before the storm of dust in limits 6467 m. It has been found that this storm has had a greater impact on the meteorological variables from other storms.*

I. Introduction

Dust storms are among the most severe environmental problems in certain regions of the World. Where they occur most of the dust in the atmosphere is from Aeolian origin. Estimates of the total Aeolian dust from deserts in the atmosphere are about 5×10^8 tons yr^{-1} [1]. Several authors [2–4] have estimated that the Sahara desert alone contributes 2×10^8 - 3.3×10^8 tons year $^{-1}$ or between 40–66 % of the total dust. Dust storms may be traced as far as 4000 km from their origin. Environmental impacts of dust storms, reported in the literature include reduced soil fertility and damage to crops, a reduction of solar radiation and in consequence the efficiency of solar devices, damage to telecommunications and mechanical systems, dirt, air pollution, increase of respiratory diseases and so on [5]. Aerosols are to cool the planet by reflecting incoming solar radiation, [6]. The frequency of dust-storm occurrence in Iraq at a maximum during the (March–May), when dust aerosols are transported by south-westerly winds from the arid and semi-arid regions around the Iraq. Several investigators have studied desert dust in Arabian regions [7]. Most of the previous studies have used either surface or satellite observations to characterize the large-scale dust In Saudi Arabia, dust storms are considered among the most severe environmental problems. Khalid [8] used TOMS Aerosols Index (AI) data to determine the origin of dust storm sources in Iraq. Desouza et al., [9] studied the evolutionary characteristics of a dust storm over Oman on 2 February 2008 by analyzing the weather associated with it. They concluded that the weakening of the inversion in the lower troposphere and the formation of a mixed layer due to transfer of horizontal momentum from upper air towards the surface led to strong surface winds and these strong winds lifted a large amount of dust particles off the ground, resulting in the dust event under study. Maghrabi [10] investigated the impact of dust storm on meteorological parameters in central Saudi Arabia. Khoshhal et al., [11] explored the recognition and assessment of atmospheric circulation patterns transferring dust storms. They suggested that the temporal and spatial investigation of dust storms shows the interference of various factors in their occurrence and expansion. Al-Dabbas et al., [12] studied eight dust storms that occurred between December 2008 and March 2009 to determine the dust load of these storms.

On the 16th of May 2008, a dramatic dust storm moved over Baghdad that was accompanied by a strong dust storm which caused a heavy dust load, greatly affected visibility and air quality, and caused a total airport shutdown as well as damage to buildings, vehicles, power poles and trees throughout the city of Baghdad. This storm was massive enough to be seen clearly from outer space and is considered to be one of the heaviest recorded dust storms in the last decade.

II. Experimental Site and data

The source of data used in present paper includes the following: Hourly data of principle meteorological elements for surface levels concluded [visibility (m) air temperature (^{o}C) relative humidity (%)] provided by Iraqi meteorological organization and seismology (Baghdad Station) [13] and solar radiation data (W/m^2) provided by the Automatic weather station installed on the roof of the department of atmospheric Sciences, Al-Mustansiriyah university as shown in figure (1) [14].

Fig (1): Automatic weather on Department of atmospheric Sciences, Al-Mustansiriyah University.

Color satellite maps of aerosols optical depth at wavelength 550 mn measured by the Moderate Resolution Imaging Spector-radiometer (MODIS) on board Aqua and Terra satellites which are operated by the National Aeronautics and Space Administration (NASA) [15]. The Total Ozone Mapping Spectrophotometer (TOMS) aerosol data, The Aerosol Index (AI) is defined as the difference between the observations and model calculations from a pure molecular atmosphere with the same surface reflectivity and measurement conditions. The Index can be interpreted in terms of optical depth if the index of refraction, particle size distribution, and the height of the aerosol layer are known from other measurements [16].

III. Results and Discussion

Dusty Events Description

In order to clarify and discussion the results which include the behavior of the considered variables during day before and day after the storm along with the event day. These will be referred as pre-event, post-event and the event day respectively.

The hourly values of four meteorological variables; visibility (Vis), solar radiation (SR), atmospheric pressure (P), air temperature (T) and relative humidity (RH) for the period 15-17 May 2008, are plotted in Figures (2 – 6). As shown in Figure 2 , The visibility at nine in the morning has fallen very sharply, reaching 200 meters after it was 8,000 meters three hours before any at six o'clock in the morning and continued visibility low values throughout the day the storm is, until the evening, and at twelve o'clock noon of the day that followed the storm increased gradually, reaching 1,000 meters then started to improve gradually to be arrived at any normal values at 10 km and then came back to the decline of up to 5,000 meters after 6 hours at two o'clock at night, As for the total solar radiation values of the dust storm left a clear impact on the total solar radiation values as shown in Figure (3), where the difference between the total solar radiation values for pre-event day and event day was (5229) W/m^2. As for the air pressure was represented in Figure (4) with the arrival of the storm began to atmospheric pressure to drop as it recorded its lowest value at three o'clock in the morning of the day the storm where it was (1006.9) hPa after it was (1011.5) hPa at the same time of day that preceded the storm then rebounded on the day of the storm that reached its highest value during the day, a storm (1012.3) hPa at nine o'clock in the morning and continued to fluctuate until the ninth hour of the morning, which was followed after the storm dropped up to (1006.8) hPa, Figure (5) shows the daily behavior of the temperature for the period from 15 May to 17 May 2008 from the figure shows that the maximum temperature for the day the storm decreased from (36.2) °C the day before the storm to (29.2) °C and then returned to natural values after the storm to reach (36.0) °C, where the difference between the day the storm and the day before (7.0) °C which is due to the amount of radiation a short wave reaching earth surface through on the storm, which reached (5229) W/m^2, For values of relative humidity affected significantly during this storm as in Figure (6) where it became 30% in the sixth hour of the day the storm morning after it was 55% at the same time the day before the storm and then returned to rise a day after the storm to reach 46% at six o'clock, the corresponding values of the aerosols optical depth at the wavelength of 550 nm and aerosol index for dust storm day on 16 May were respectively 0.9 and 12 as shown in figures 7 a and 7 b.

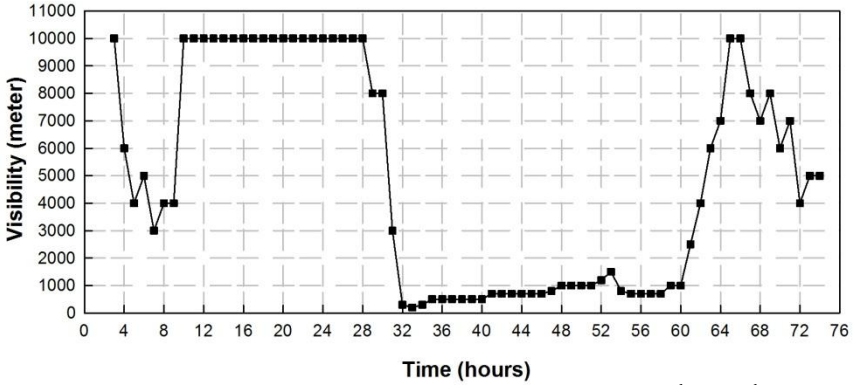

Fig 2. Day-to-day variations of visibility for the period from 15th to 17th May 2008.

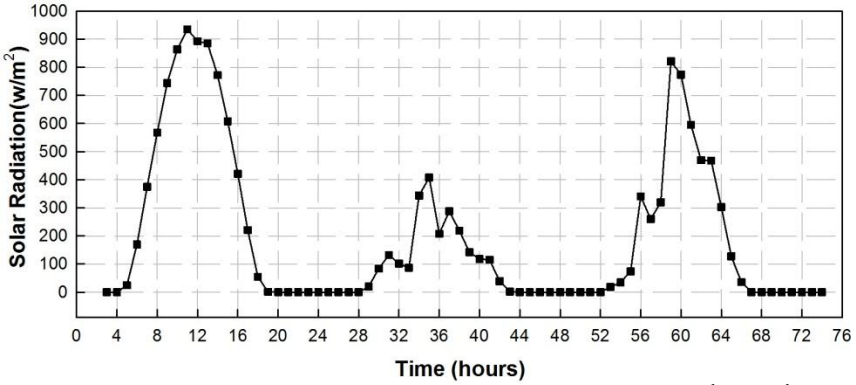

Fig 3. Day-to-day variations of solar radiation for the period from 15th to 17th May 2008.

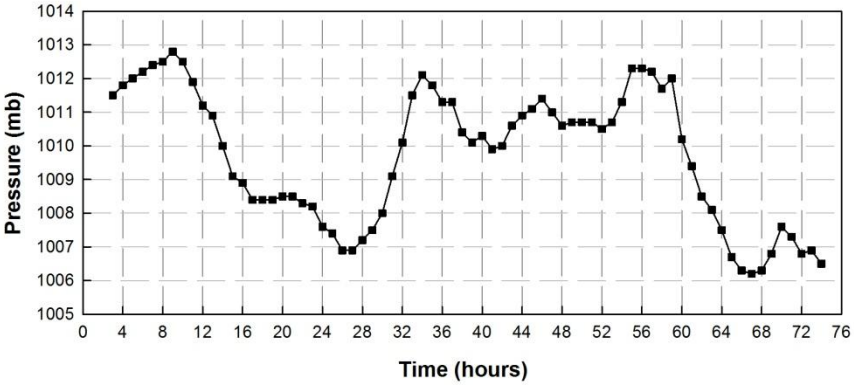

Fig 4. Day-to-day variations of atmospheric pressure for the period from 15th to 17th May 2008.

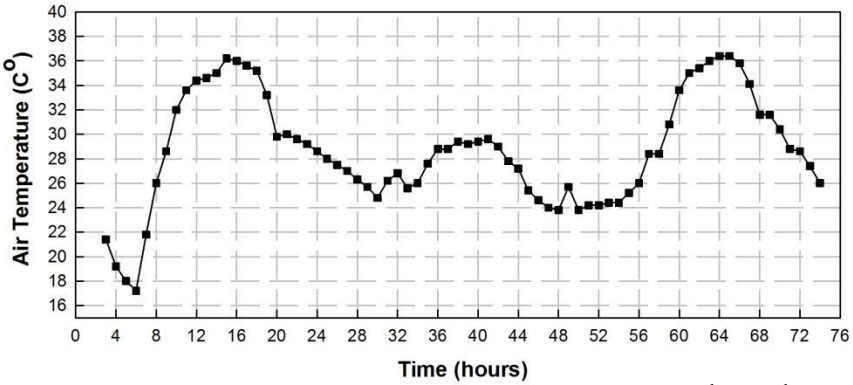

Fig 5. Day-to-day variations of air temperature for the period from 15th to 17th May 2008.

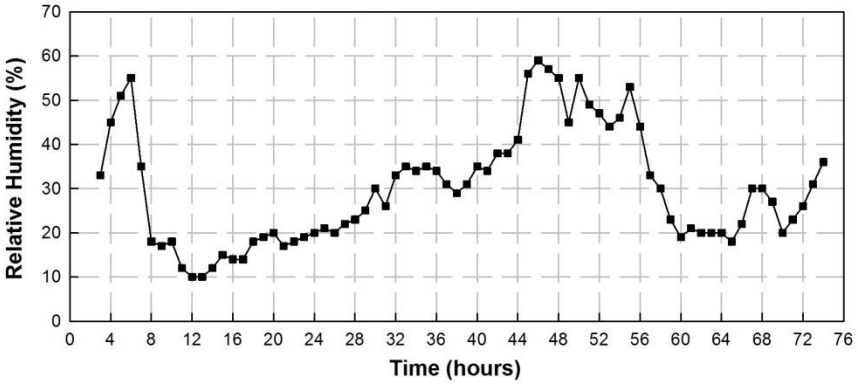

Fig 6. Day-to-day variations of relative humidity for the period from 15th to 17th May 2008.

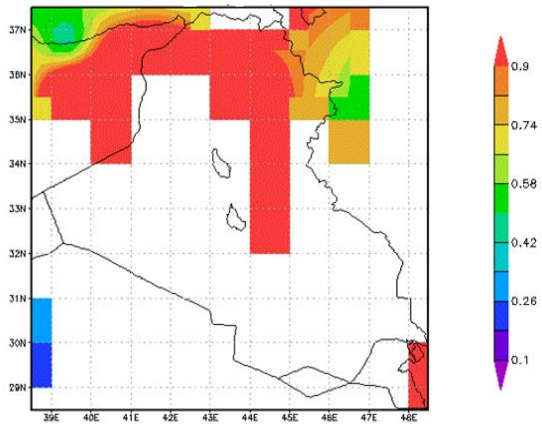

Fig7a. The value of Aerosols Optical Depth at 550 nm for the day 16th May 2008.

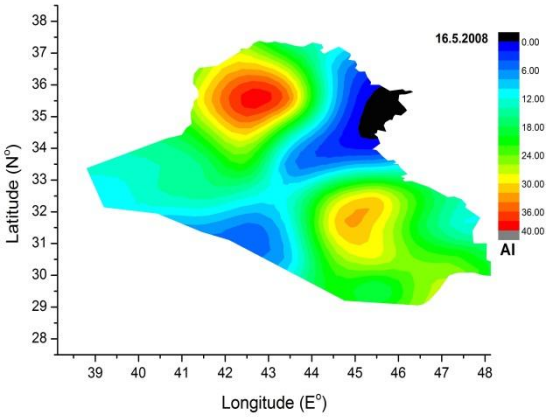

Fig7b. The value of Aerosols Index for the day 16th May 2008.

Comparisons with other considered dust storms events

Table (1) shows Twenty dust storm observed in this study and changes in the values of (visibility and temperature of the solar radiation and the aerosols optical depth(AOD) as these variables represent the difference between the measured values by storm Day and values during the storm occurrence , these changes can be summarized in visibility (267- 8447) meters, temperatures (0.1 to 4) °C and solar radiation reaching to earth surface from (349-2522) W/m^2 and the aerosols optical depth (0 - 0.4).

Table 1: the difference between the meteorological variables (visibility, temperature, solar radiation and Aerosols optical depth) before and the dust storm event for the storm event during the period (2008 – 2012).

	Date of storms	Visibility change (m)	Temperature change (^oC)	Solar radiation change (W/m^2)	Aerosol Optical Depth change
1	1.10.2008	6117	3	1620	0.2
2	15.3.2008	7291	0.4	1916	0
3	16.5.2008	6467	2.5	5229	0.2
4	17.4.2008	8447	4.9	3122	0.12
5	24.9.2008	5175	2	2012	0.6
6	30-6-1-7.2008	4129	2.4	2131	0.3
7	5-6.5.2009	4929	0.1	343	0
8	15-16.3.2009	267	2.4	1519	0.2
9	17.9.2009	2400	0	1032	0.32
10	24.3.2009	4913	0.6	2319	0.32
11	7-8.6.2010	1917	3.4	3062	0.1
12	16.3.2010	5209	4	1155	0.32
13	19.9.2010	4600	2.2	788	0.4
14	20-21.7.2010	3455	0.2	2056	0.32
15	23-24.6.2010	5292	1.7	3114	0.32
16	13.5.2011	3388	2.8	2282	0.04
17	13.10.2011	4255	2.6	1618	0.32
18	27.7.2011	3568	0.2	1710	0.32
19	12.6.2012	3121	0	407	0.16
20	19.4.2012	634	0.9	1030	0

Figure (8), (9) and (10) shows the relationship between the change in aerosols optical depth (AOD) and visibility, temperature and solar radiation and Table (1) shows that the optical path depth directly affects the solar radiation striking clearly changed and the effect of the depth of the optical path on the temperature too obvious but its effect is not noticeable and almost influence non-existent on the values of the change in the visibility and the cause of the effect of the change in the track depth visual on the change in solar radiation values of connecting to the earth's surface because it is when you increase the values of the depth of the optical path, the processes of absorption and dispersion and reflection of solar rays increasingly visible and thus less solar radiation connecting to the earth's surface values due to increased values of aerosols optical depth.

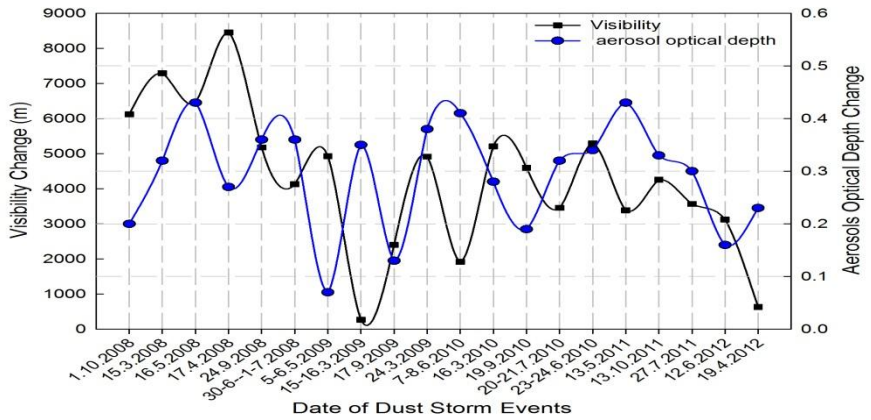

Fig 8. The relationship between the change in aerosols optical depth (AOD) and visibility change for the considered dust storms during the period (2008-2012).

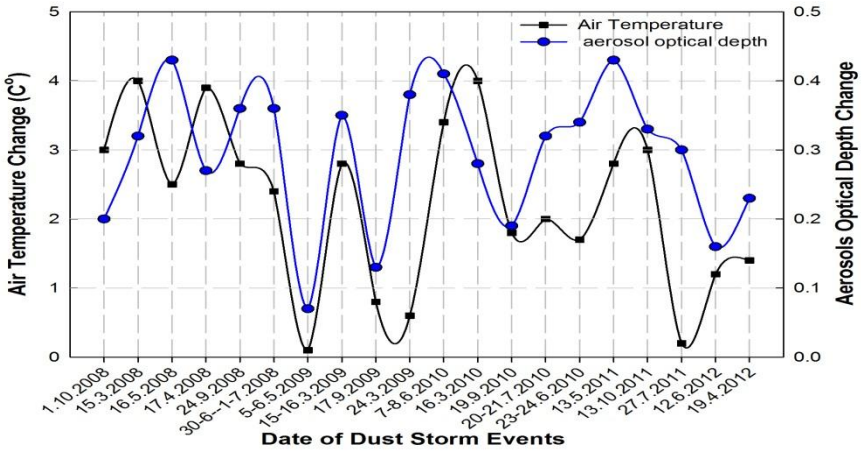

Fig 9. The relationship between the change in aerosols optical depth (AOD) and air temperature change for the considered dust storms during the period (2008-2012).

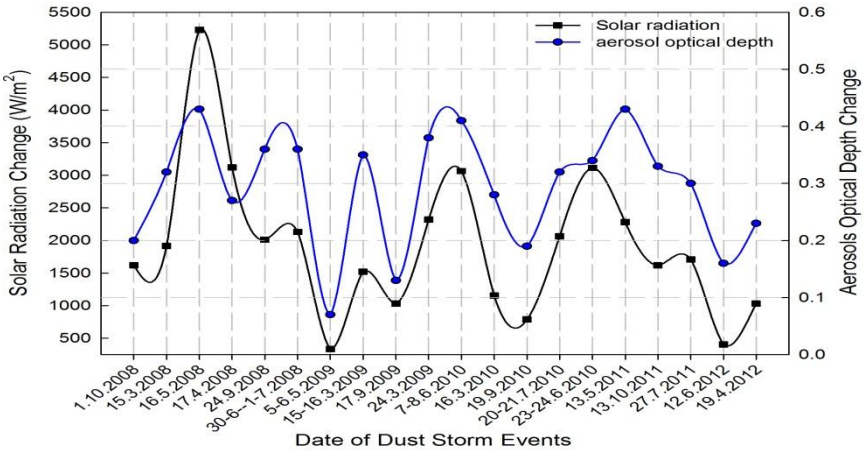

Fig 10. The relationship between the change in aerosols optical depth (AOD) and solar radiation change for the considered dust storms during the period (2008-2012).

IV. Conclusion

On 16th may 2008, a strong dust storm event struck Baghdad city. The impact of this dust storm and other dust storms during the period (2008-2012) on ground–based measurements of meteorological parameters and satellite observations were investigated. These parameters are visibility, solar radiation, atmospheric pressure, air temperature, relative humidity, aerosols optical depth at 550 nm and aerosols index. The analysis for the behavior of the considered variables included one days before and one day after the storm along with the event day were conducted and presented and these investigations show significant changes in all of the measured parameters as a result of this event. Around noon local time on the event day, with the arrival of the dust storm, there were dramatic changes in weather conditions. Air temperature dropped by about 2.4 °C, relative humidity increased dramatically reaching a value of 35 %. The visibility deteriorated dramatically to a value less than 300 m. These results also, show that the effect of this storm was associated with an increase in both atmospheric pressure and relative humidity as well as a reduction in temperature and visibility for the following day.

References

[1]. Middleton NJ: Dust storms in the Middle East. J Arid Environ 1986;10:83–96.
[2]. Morales C: Saharan Dust. Scope 14, New York, John Wiley & Sons, 1979, 297 pp.
[3]. Ganor E, Mamane Y: Transport of Saharan dust across the eastern Mediterranean. Atmos Environ 1982;16:581–587.
[4]. Hagen LJ, Woodruff NP: Air pollution from dust storms in the Great Plains. Atmos Environ 1973;7:323–332.
[5]. Warner, T.T. Desert Meteorology. Cambridge University Press, 2004.
[6]. H. Kutiel, and Furman, H.,. Dust storms in the Middle East: Sources of origin and their temporal characteristics. Indoor and Built Environment, 2003, 12(6),419-426.
[7]. El-Askary, H., Sarkar, S., Kafatos, M., and El-Gazawi, T., "A Multi-Sensor Approach to Dust Storm Monitoring over the Nile Delta," IEEE Trans. Geosc. Remote Sensing, 41(10): 2386-2391, 2003a.

[8]. Khalid ,O.L.Determination of dust storms source regions using TOMS and meteorological data. M.Sc. Thesis, Dept. of Atmospheric Sciences, Al-Mustansiriyah University (in Arabic), 2009.
[9]. Desouza, N.D., Simon, B., Qureshi, M.S. Evolutionary characteristics of a dust storm over Oman on 2 February 2008. Meteorol Atmos Phys 114,107-121, 2011.
[10]. Maghrabi, A.H.The impact of the March 10, 2009 dust storm on meteorological parameters in central Saudi Arabia. World Renewable Energy Congress 2011. 8-13 May 2011, Linkoping, Sweden, 719-723, 2011.
[11]. Khoshhal, J., Mousavi, S.H., Kashki, A. Synoptic analysis of Ilam dust storms (1987-2005) Geography and Environmental Planning Journal 23rd Year, 46 (2), 5-10, 2012.
[12]. Al-Dabbas, M.A., Abbas, M.A., Al-Khafaji, R,M. Dust storms loads analyses in Iraq. Arabian J. of Geosciences, 5 (1), 121-131, 2012.
[13]. Iraqi Meteorological Organization and seismology (IMOS) unpublished data.
[14]. Automatic Weather Station ,Department of Atmospheric Science , College of Science, Al-Mustansiriyah University. unpublished data.
[15]. http://modis.gsfc.nasa.gov/
[16]. http://ozoneaq.gsfc.nasa.gov/