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Research Article – Atmospheric Sciences

Impact of aerosol on air temperature in Baghdad

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Abstract

Aerosol Optical Depth (AOD) is the measure of aerosol distributed with a Column of air from earth's surface to the top of atmosphere, in this study, temperature variation of aerosol optical depth (AOD) in Baghdad was analyzed Moderate Resolution Imaging Spectrometer (MODIS) from Aqua and its relationship with temperature for the period 2003 – 2015 were examined. The highest values for mean seasonal AOD were observed in spring and summer and the maximum AOD values ranged from 0.50 to 0.58 by contrast minimum AOD values ranging from 0.30 to 0.41 were found in winter and autumn. Results of study also showed that the temperature (max., min., mean air temperature and DTR) have a strong correlation with AOD (0.82, 0.83, 0.82 and 0.65) respectively.

Key words: Aerosols, Aerosol optical depth, Air temperature, Dust, MODIS.

Introduction

Atmospheric aerosols, defined as solid or liquid particles suspended in a gas, can have a large impact on the climate, chemical, biogeochemical cycles and human health [1]. Atmospheric aerosols can originate from both natural and anthropogenic sources, or be formed by chemical processes in the atmosphere. Aerosol particles that are directly injected into the atmosphere are called primary aerosols. Natural primary aerosols such as wind blown dust, sea spray, mineral dust, volcanic ash, plant and animal debris, are produced by mechanical means [2]. Aerosol particles are typically in the range from nanometers to 10's of μm and can stay suspended in the troposphere for a few minutes to a couple of weeks Throughout this time, the particles can be transported long distances and undergo complex chemical and physical aging processes These atmospheric aerosols also have a large effect on the earth's radiation balance [3]. Since the past two decades, there has been increased interest in aerosols because they have significant environmental and health impacts. Extreme weather events have yet demonstrated the devastating consequences Earth's warming [4]. Like green-house gases, atmospheric aerosols affect the Earth's radiation balance. They have the potential to influence climate directly by affecting the amount of radiation reaching the Earth surface due to scattering and absorption, and indirectly by playing a key role in the formation and behavior of clouds in the climate system. At the global scale, aerosols tend to counteract the effect of greenhouse gases, by contributing to global cooling. However, anthropogenic aerosols alter air quality, and increased levels of small particles can be responsible for serious health hazards. Therefore, the relative impact of natural aerosols and those of human origin has to be accurately quantified. The variability in particle chemical composition, physical and optical properties renders it difficult to assess both their effect on human health, and their influence on long term global climate change [5]. Several studies have impact of aerosol on climate, because such modification may lead to important changes in earth's climate. The meteorology-chemistry model was employed to simulate the impacts of aerosol–meteorology interactions on fine particles pollution during this haze episode [6], Spatio-temporal analysis of

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aerosol concentration over Saudi Arabia using satellite remote sensing techniques examined Moderate Resolution Imaging Spectroradiometer (MODIS) Deep Blue (DB) Aerosol Optical Depth (AOD) variability both from Terra and Aqua satellites and its relationship with temperature for the period 2002-2007 [7], the impacts of anthropogenic aerosols on some relevant atmospheric parameters such as temperature, precipitation, the wind, and shortwave radiation, from 2001 to 2006 [8], impacts of anthropogenic aerosols on surface temperature and precipitation over East Asia. Besides their direct and indirect reduction of short-wave solar radiation [9]. The aim of study the effect of Atmospheric aerosols on air temperature of Baghdad using MODIS aerosol optical depth (AOD) data observed over Baghdad during the 12 year interval 2003–2015. The study area is represented by Baghdad capital of Iraq, where it between longitude 44.23° and latitude 33.23° as shown in Figure 1.

Fig. 1. Baghdad map capital of Iraq and surrounding countries

Meteorological Data

In this study a historical records of daily AOD data from MODIS Satellite, daily maximum temperature and daily minimum temperature were acquired from the Iraqi Meteorological Organization and Seismology (IMOS) for the period 2003-2015. The long term data were collected from Baghdad weather station, he period of record of these station varies and some have missing data. Thus the period of the study has been chosen as long as possible depending on the availability of record data, and it has been dealing with the period of the study as a hydrological period.

Results and Discussion

In this study, MODIS Aqua AOD data were acquired to investigate the aerosols characteristics over Baghdad. The temporal variations of monthly, seasonal and annual for AOD and temperature (max., min. and mean air temperature) were analyzed. Finally AOD relationship with temperature has been studded over Baghdad city. Figure 2 shows the time series of daily mean of AOD data. These data cover 12 years period from 2003 to 2015.

A total of 3580 days with AOD data were used in analysis. Black horizontal line in figure 2 represents the mean value of AOD plus its associated standard deviation $(\overline{AOD} + \sigma)$ (0.52 + 0.13 =0.65) over the whole period. A total of 613 days with AOD ≥ 0.65 (above the horizontal line) while 2967 days less than 0.65 (below the horizontal line).

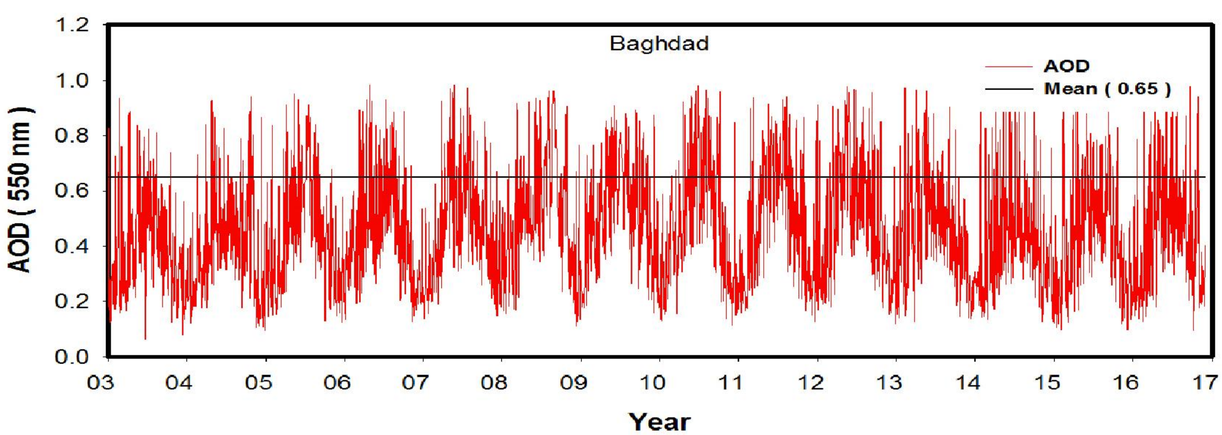

Fig. 2. Daily average of AOD (550 nm) at Baghdad city during the period 2003–2015

Monthly analysis and annual of AOD & Temperature

From figure 3, it can be noted that there were a significant correlation in behavior between curved AOD and max. temperature, min. temperature, mean air temperature and DTR temperature.

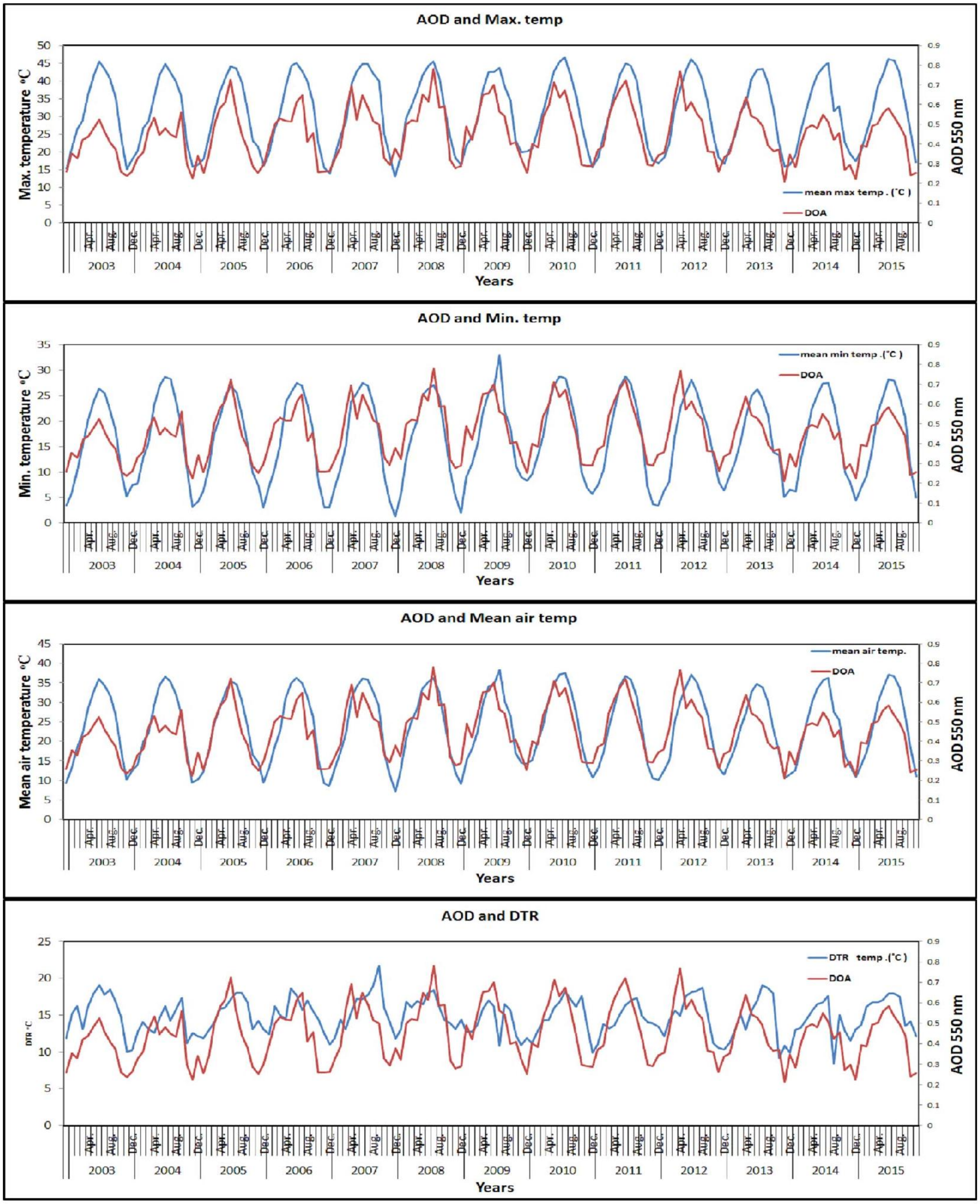

Fig. 3. Monthly averaged values variations of AOD and temperature during 2003 – 2015

Figure 4 shows monthly means variation of AOD which has been calculation over Baghdad for the period 2003-2015 from Aqua satellite. It is clear There are two distinct peaks in June 0.57 and the second in July 0.60.Therefore, we see from the graph of the monthly averages for the period 2003 – 2015 that the highest value in July 0.60. It can be seen that AOD distributions is found to be in the range from 0.3 to 0.6, accounting for 84% and the AOD value above 0.6 is 11%, monthly mean of AOD.

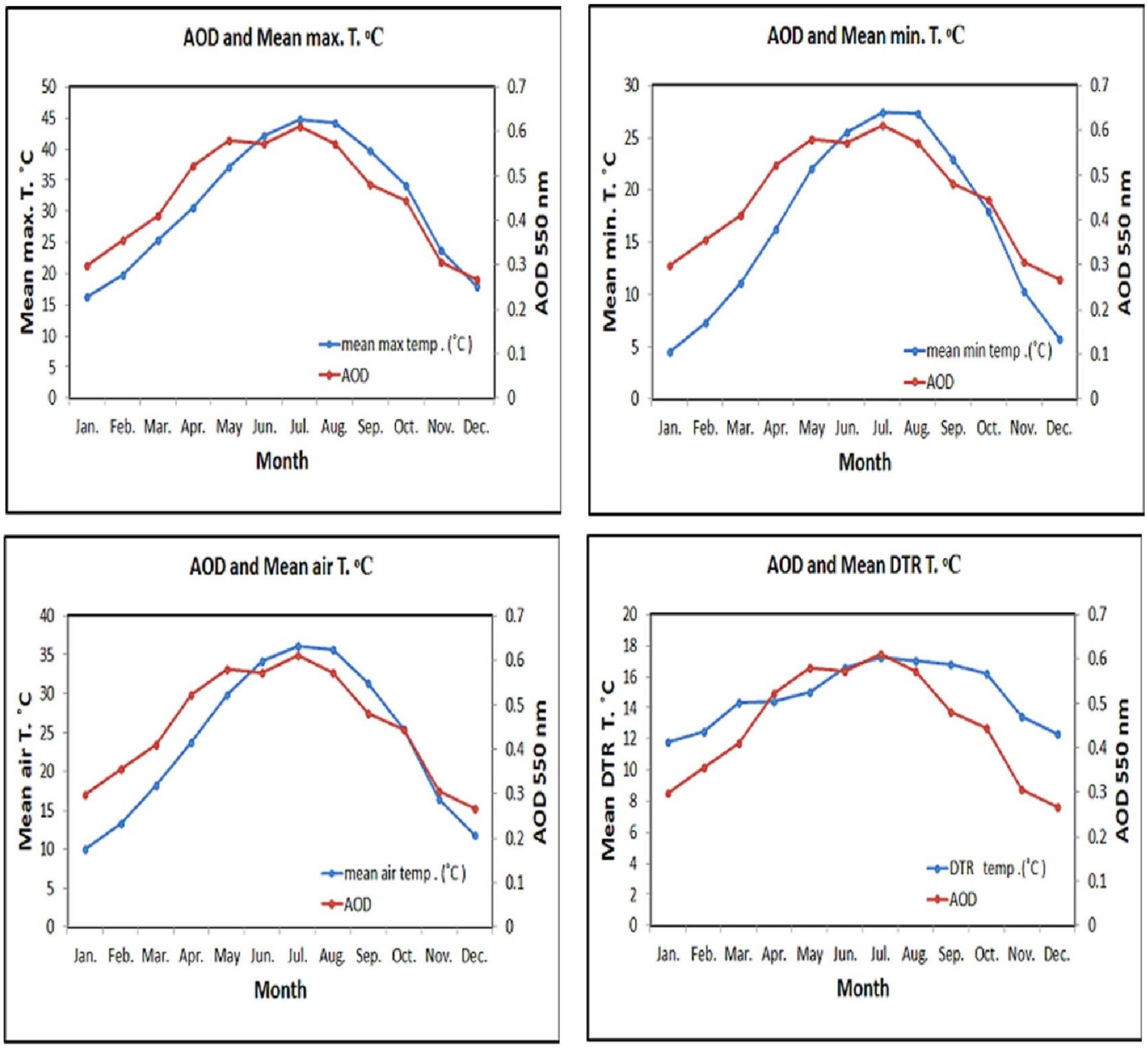

Fig. 4. Monthly means of AOD and temperature for the period 2003- 2015 at Baghdad city

From figure 5, it can be see that there is a significant correlation in behavior between curved AOD and temperature (max., min., DTR and mean air). The peak AOD value and max., min., DTR and mean air temperature are observer in July (0.58, 44.7°C, 27.4°C, 17.3°C and 36.1°C) respectively.

Similarly, the minimum AOD value is observed in December 0.25, while the minimum value of max., min., DTR and mean air temperature are (16.3, 4.5, 11.8 and 10°C) respectively.

The AOD variation and the values of temperature increasing trend from the January to July and decreasing trend from the August to December.

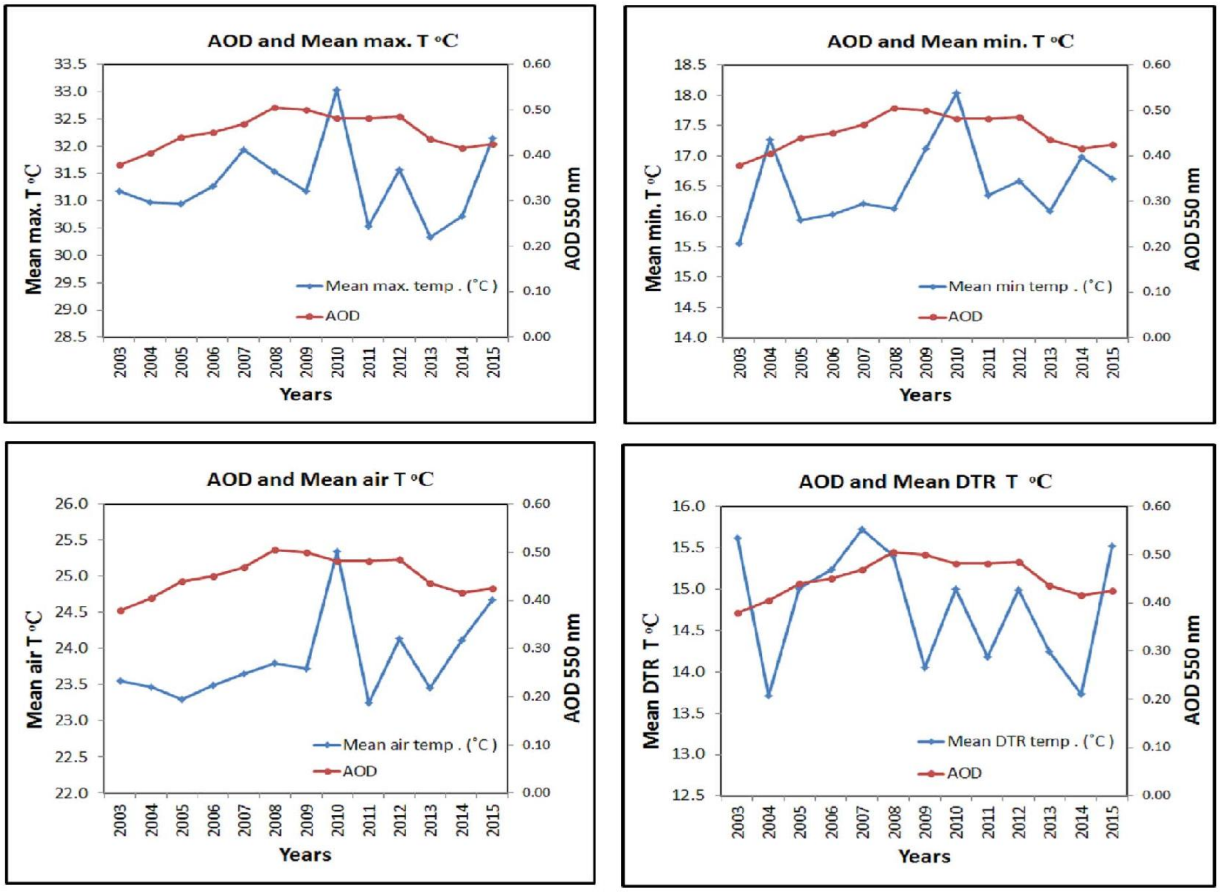

Fig. 5. Mean annual variations temperature and AOD during 2003 – 2015

Seasonal analysis of AOD and temperature

Figure 6 shows the seasonal mean values of AOD, max., min. and DTR are plotted in figure 6 the lowest seasonal mean AOD value (0.27–0.37) were observed in Winter. By contrast, maximum AOD values were observed during the Summer and Spring with seasonal mean of (0.46 – 0.68) and (0.4 – 0.6) respectively. This result is due to the increase in wind speed and Boundary layer height. The speed of wind initiated the movement of copious amounts of soil dust aerosols into the atmosphere from the surface of dry ground of arid and semiarid regions.

The erodent reduction in AOD values during rainy season was caused by fine mode particles, which are non-hygroscopic in nature. Furthermore, the height of boundary layer decreased during Winter, resulting in small volume of pollutant compared with that during summer.

From figure 6. It can been seen that the highest value of max., min., mean air and DTR temperature was (43.69 °C, 26.75 °C, 35.31 °C and 14.49 °C) during summer.

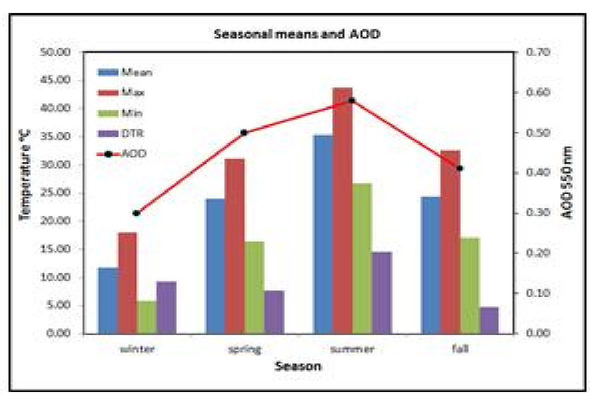

Fig. 6. Frequency distributions and seasonal means of AOD and temperature the period 2003–2015 at Baghdad city

Correlation between AOD and Temperature (°C)

The correlation of AOD for Baghdad with DTR, maximum temperature, minimum temperature and mean air temperature was also analyzed by scatter plot and is shown in Figure 7. The correlation between AOD and DTR is r = 0.65 while between AOD and maximum temperature is r = 0.82 while between AOD and minimum temperature r= 0.83, mean air temperature r= 0.82.

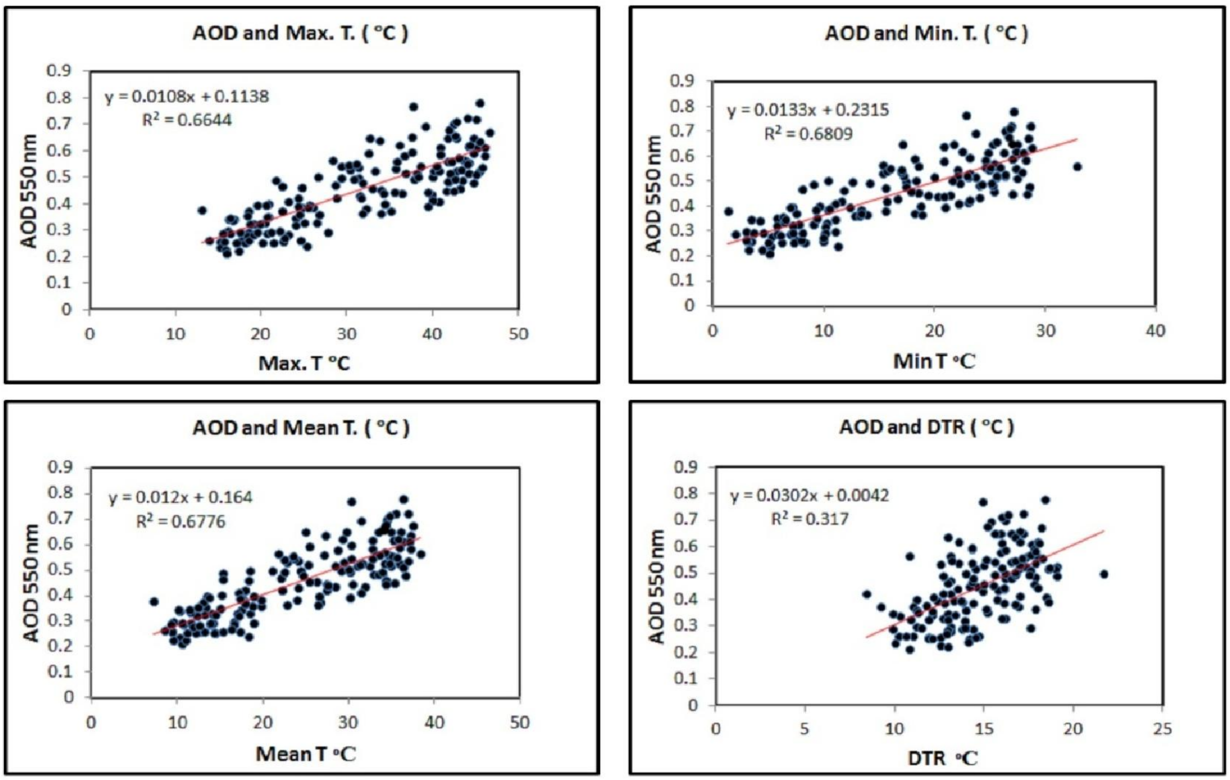

Fig. 7. Linear correlation Monthly to AOD, DTR, Maximum temperature, Minimum temperature for Baghdad

Conclusion

Aerosols optical depth (AOD) seasonal and annual variability and its relationship with temperature (max., min., mean air and DTR) over Baghdad city for the period 2003 – 2015 are presented in this paper. The height value of mean season AOD were found during seasonal Spring and Summer, while the lowest value of AOD were found during Winter and Autumn. Strong correlation is found between aerosol and temperature which shows that the aerosols can have potential impact on the climate of Baghdad city.

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