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# Variability of Solar UV Radiation and Its Relationship to Pollutants in Baghdad City

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## ABSTRACT

The atmospheric constituents generated by the activities of an urban area may affect UV radiation reaching the ground. In this study, two areas were chosen in Baghdad city (Zafaraniyah and Abu Ghraib). Parameters of the pollutants data (Total column NO2 and Total column CO) and UV radiation for specific bands were collected and analyzed for the period of three years (2017-2019) were taken hourly from the European Center for Medium-Range Weather Forecasts (ECMWF) for each parameter through the years. The results show that the concentrations of pollutants in Zafaraniyah higher than Abu Ghraib throughout the year, Where total column NO2 reaching to about 9.6 * 10-5 kg m-2 in 2019 for Zafaraniyah and 8.48 * 10-5 kg m-2 for Abu Ghraib. While total column CO reaching to about 45 * 10-4 kg m-2 in 2019 for Zafaraniyah and 43 * 10-4 kg m-2 for Abu Ghraib in the same year. While the values of UV radiation in Abu Ghraib higher value 487.3W/m2 than 443.7 W/m2 Zafaraniyah throughout the year.

**KEYWORDS**: Carbon monoxide, Nitrogen dioxide, Polluted, Ultraviolet radiation.

**الخلاصة**

المكونات الجوية الناتجة عن أنشطة منطقة حضرية لها تأثير كبير على مستويات الأشعة فوق البنفسجية التي تصل إلى الأرض. في هذه الدراسة تم اختيار منطقتين في مدينة بغداد (الزعفرانية وأبو غريب). تم جمع معلمات بيانات الملوثات (العمود الإجمالي NO2 والعمود الإجمالي CO) والأشعة فوق البنفسجية لنطاقات معينة وتحليلها لمدة ثلاث سنوات (٢٠١٧-٢٠١٩) كل ساعة من المركز الأوروبي للتنبؤات الجوية متوسطة المدى (ECMWF) لكل معلمات عبر السنين. أظهرت النتائج أن تراكيز الملوثات في الزعفرانية أعلى من أبوغريب على مدار العام ، حيث بلغ إجمالي عمود NO2 حوالي ٩,٦ * ١٠-٥ كجم م ٢ في عام ٢٠١٩ للزعفرانية و ٨,٤٨ * ١٠-٥ كجم م ٢ لأبو. غريب. بينما بلغ إجمالي عمود ثاني أكسيد الكربون حوالي ٤٥ * ١٠-٤ كغم م ٢ عام ٢٠١٩ للزعفرانية و ٤٣ * ١٠-٤ كغم م ٢ لأبو غريب في نفس العام. بينما قيم الأشعة فوق البنفسجية في أبو غريب أعلى قيمة ٤٨٧,٣ واط / م ٢ من ٤٤٣,٧ واط / م ٢ الزعفرانية على مدار العام.

## INTRODUCTION

Air pollution is a major problem of the recent era [1], which exercises negative effects on respiratory and cardiovascular system and human skin [2] [3] [4].

Intercity automobile use and growing urbanization, industrial activity, near towns, heating increase pollutants in air [5]. Ultraviolet C rays are completely absorbed by stratospheric ozone. Solar, ultraviolet rays that have a great impact on human life, plants and animals, and thus exposure to ultraviolet rays can generate important vitamin D in the skin, while it can also be a cause of skin cancer or eye diseases, depending on the absorption of excessive doses of ultraviolet rays [6].

In recent years, many cities in the world have suffered from many severe problems in quality of the air, and this is mainly due to home heating and emissions from cars, where the emission of large types of pollutants into the Earth's atmosphere every year is almost a ton. Pollutants are classified by the Environmental Protection Agency (EPA) into two main categories [7] [8] which are:

The main pollutants are those that are seen to be emitted directly from the sources and without any chemical or physical transformation. Like carbon monoxide emitted from car exhaust. Where these emitted gases are called non-reactive or unproductive because these gases not generally interact with other gases and not affected by solar radiation.

Secondary pollutants are those that are created in the Earth's atmosphere, which are the result of chemical reactions between simple pollutants and other types, and most important of these chemical reactions is that which leads to the formation of ozone in the troposphere, and that reactions can lead to the formation of particle [9].

The chemical reactions involved in the formation of ozone occur, which in turn can reduce approximately ~ 20% of the UV rays reaching the surface [10]. Where the occurrence of absorption of gases from the troposphere, such as sulfur dioxide, nitrogen dioxide and many types and organic gases that reduce surface ultraviolet rays in areas where there is pollution [11].

The aim of this work is to determine a changes in UV radiation and the changes in pollutant concentrations for Al-Zafaraniya and Abu Ghraib.

## Air pollution and UV irradiation

Ozone ($O_3$), particulate matter (PM), Carbon monoxide (CO), Sulphur dioxide ($SO_2$) and nitrogen dioxide ($NO_2$) are the five most common air pollutants [12]. In polluted areas interesting feedback exists by which photochemical smog production depends on the ultraviolet radiation. Whether the net effect is an increase or decrease in photochemistry depends on the relative importance of scattering and absorption by these pollutants. Solar photons initiate and sustain smog photochemistry by breaking relatively stable molecules into much more reactive fragments, i.e. the photolysis of nitrogen dioxide ($NO_2$) pollutants, such as $NO_2$, may also reduce the actinic flux through direct absorption. However, aerosols in the planetary boundary layer (PBL) also scatter incident solar radiation and effectively increase photolysis frequencies above the PBL [13].

The thickness of the planetary boundary layer is approximately one kilometer, which extends from the surface to this high altitude, as in the early morning hours it is as small as (400 – 800) m which can rise to approximately 1500 - 2000 m during the afternoon with heat Aliyah. In this area there are the most important concentrations of air pollutants, especially aerosols, which can cause location differences in the PBL in the shape and structure of the layer. Therefore, spatial changes occur due to the occurrence of meteorological variables that are wide Range, which could compress these thermal reflections on the PBL and thus increase the thickness of the low pressure systems [14].

## Interactions of pollutants with Ultraviolet radiation

The medical and biochemical effects of pollutants and possible interactions with UV radiation - is clear from Figure 1.

The direct absorption through the skin occurs with the accumulation of airborne pollutants affecting the stratum corneum and subsequent penetration.

Indirect cutaneous absorption occurs in the dermis and basal epidermis layer, which is responsible for the systemic distribution of blood for inhaled pollutants that may have been metabolized (the obvious black points).

Left panel: The pollutants (clear black dots) that directly or indirectly penetrate the skin (clear black arrows) that cause biochemical effects such as increased production of ROS via hydrocarbon aryl receptors, an increase in lipid peroxidation, protein oxidation and thus cell death (Normal cell death), or a decrease in cell proliferation, antioxidants, and ATP levels [15].

From a medical point of view, as the effects of pollutants correspond to an exacerbation and increase in the aging processes of the skin in terms of symptoms of inflammatory diseases (such as atopic dermatitis) and the emission of skin moisture. Right panel: shows skin-penetrating UV rays that stimulate ROS production. Moreover, some contaminants present on the outer surface or inside the skin may produce ROS (filled circles shown and visible in red and black). Therefore, the combination of ultraviolet rays and pollutants leads to an exacerbation and increases in the biochemical and clinical effects of pollutants in the atmosphere [16].

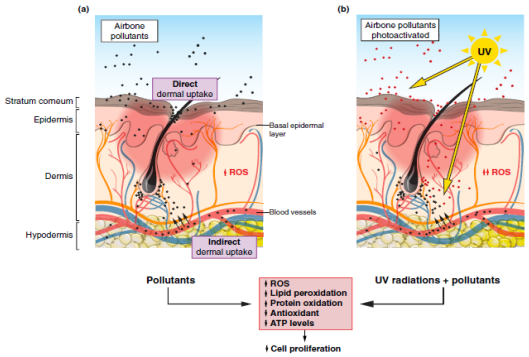


**Figure 1.** The Figure shows the effect of ultraviolet radiation and pollutants on the skin [6].

## DATA AND METHODOLOGY

In this study, two areas were chosen for Baghdad city, the first in the southeast of Baghdad (AL-Zafaraniya) (Lat. 33.25, Long. 44.52), which considered as a crowded and polluted city, where human activities appear more clearly in urban cities especially in the atmospheric layer near the earth's surface. The second region, in the west of Baghdad (Abu Ghraib) (Lat. 33.25, Long. 44.125), which represent a pollution-free atmosphere.

Data were taken hourly measurements from the European Center for Medium Range Weather Forecasts (ECMWF) for each parameter through the years. Collected data have been analyzed and figured in this research to illustrate the behavior of these parameters for both regions.

The reason for choosing these pollutants (NO2 and CO) because it is more widespread and provides data for these locations used UV radiation and pollutant values for both regions in the period 2017-2019.

for the days used in this work for UV radiation values in Figure 1 We chose the second day in January to represent the winter season, the second day of April represents the spring season and second day of the month, July, represents the summer season and the second day of the month, October, is the autumn season.

## RESULTS AND DISCUSSION

### 1- Ultraviolet radiation changes in the city of Baghdad (comparison between Al-Zafaraniya and Abu Ghraib):

In Figures 2, 3 and Table 1 shows the values of (UV radiation values) in the city of Baghdad as having a high value in the summer and the lowest values in the winter season for both Zafaraniya and Abu Ghraib regions, where the highest value for Abu Ghraib was (447.7w/m2), and for the Zafaraniyah region (431 w /m2), which is normal due to the presence of pollutants in the Zafaraniyah area, and agrees with Jasim M. *et. al* [17].

### 2- The Variations of Total Column Nitrogen dioxide

Through Figures 4, 5, 6 showed that the monthly variations in the values of nitrogen dioxide for a period of three years were obviously reduced during the summer months while the rise was in the winter months this is in agreement with the study make over china in 2017 [18], and this is due to the fact that in the months of high temperature, the temperature works to prevent the concentration of pollutants near the surface of the earth, which leads to clear decrease in pollutant concentrations compared to the winter season.

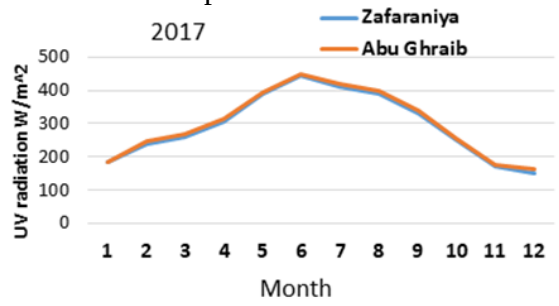


**Figure 2.** The Monthly values of total UV for AL-Zafaraniya and Abu Ghraib during 2017.

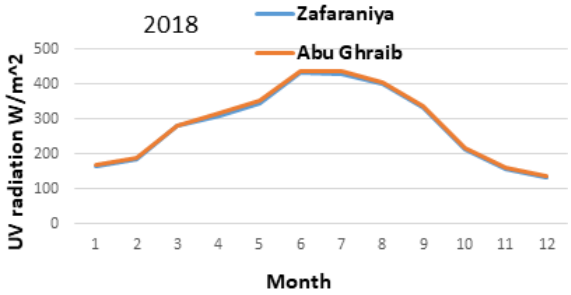


**Figure 3.** The monthly values of total UV for AL-Zafaraniya and Abu Ghraib during 2018.

**Table 1.** Highest UV radiation values for the period (2017-2019)

| year | UV radiation ($W/m^2$) for Abu Ghraib | UV radiation ($W/m^2$) for AL-Zafaraniya |
|---|---|---|
| **2017** | 487.3 | 443.7 |
| **2018** | 438.3 | 432.7 |
| **2019** | 432.4 | 420.5 |

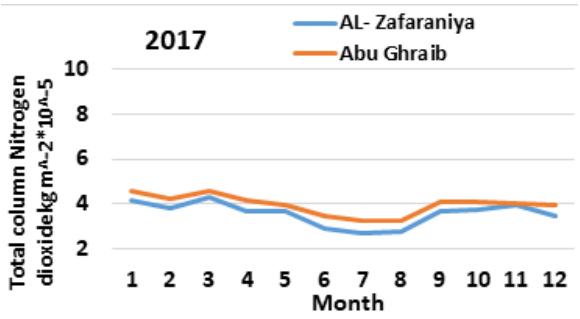


**Figure 4.** The monthly values of the total column Nitrogen dioxide during (2017).

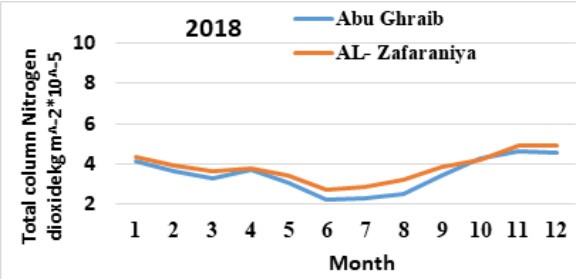


**Figure 5.** The monthly values of the total column Nitrogen dioxide during (2018).

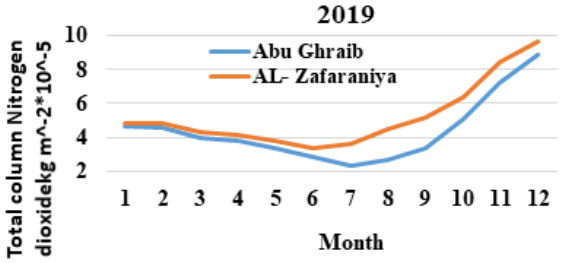


**Figure 6.** Total column Nitrogen dioxide during (2019).

## 3- Hourly Variations of the total column of nitrogen dioxide (2017)

In Figures 7, 8 shows that the total Nitrogen dioxide. The hourly Variations in concentrations were clear, as the highest concentrations appeared during the night hours and the lowest concentrations of the pollutant were during the daylight hours and throughout the months of the year for each of the two regions Al-Zafaraniya and Abu Gharib. In addition, the lowest concentrations of the pollutant were during 12 middays, and the highest concentrations were during the night hours for both regions.

## 4- The Variations of Total Column Carbon monoxide

The monthly changes of the carbon monoxide concentrations were evident during the Figures 9, 10, 11. The highest concentrations were in the cold months and the lowest concentrations in the hot months this is in agreement with reference [19], and this behavior was clear and correlated for both areas in Abu Ghraib and Al Zafaraniyah region. These Figures also clarified that the concentrations in the Zafaraniya area were higher than the concentrations in Abu Ghraib area throughout the study period.

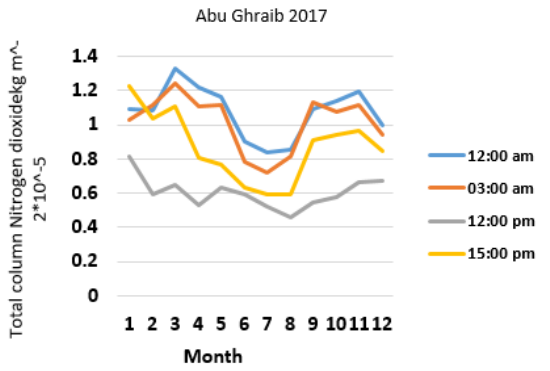


**Figure 7.** Variations of the total column of nitrogen dioxide in Abu Ghraib (2017).

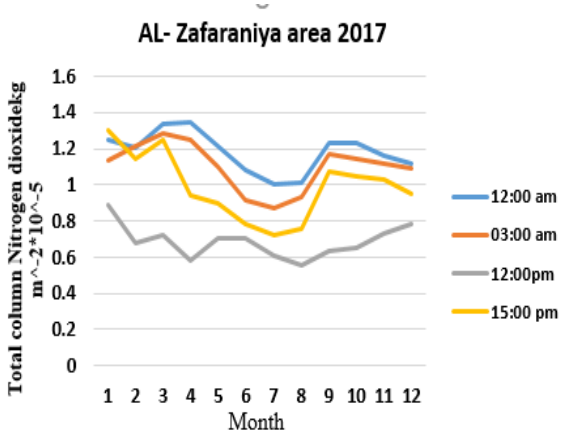


**Figure 8.** Variations of the total column of nitrogen dioxide in AL- Zafaraniya area 2017.

**Table 2.** The highest concentrations of pollutants ($NO_2$ and CO) for the period 2017 – 2019

| The location | Total column $*10^{-4}$ CO kg $m^{-2}$ | Total column $*10^{-5}$ $NO_2$ kg $m^{-2}$ | Year |
|---|---|---|---|
| AL- Zafaraniya | 44.82 | 4.52 | 2017 |
| Abu Ghraib | 41.02 | 4.30 | 2017 |
| AL- Zafaraniya | 44.53 | 5.03 | 2018 |
| Abu Ghraib | 43.42 | 4.18 | 2018 |
| AL- Zafaraniya | 45.29 | 9.61 | 2019 |
| Abu Ghraib | 42.71 | 8.29 | 2019 |

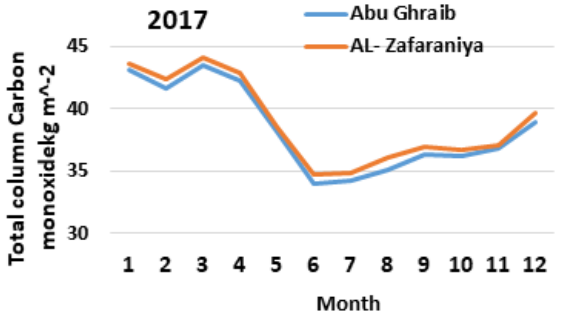


**Figure 9.** Total column Carbon monoxide during (2017).

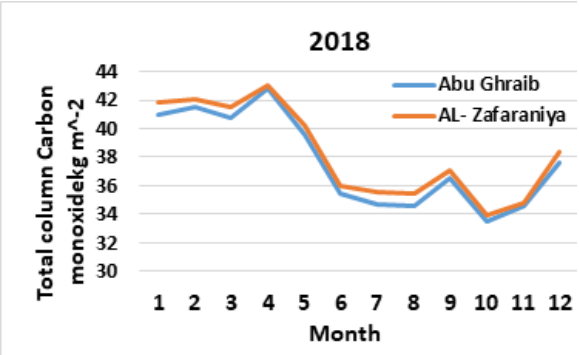


**Figure 10.** Total column Carbon monoxide during (2018).

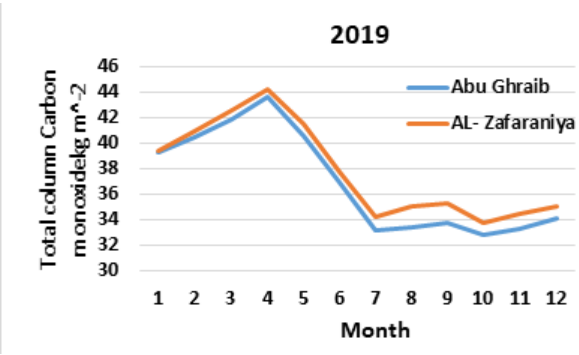


**Figure 11.** Total column Carbon monoxide during (2019).

## 5- Hourly Variations of the Total Column Carbon monoxide during (2017)

As for the hourly Variations of the shapes 12,13 column Carbon monoxide in the Abu Ghraib area, which is considered a less polluted area than the Zaafaraniya region, the pollutant concentrations were close at all hours, while in the Zaafaraniya area, which is considered the most polluted, it is characterized by high concentrations of pollutants during the midday hours.

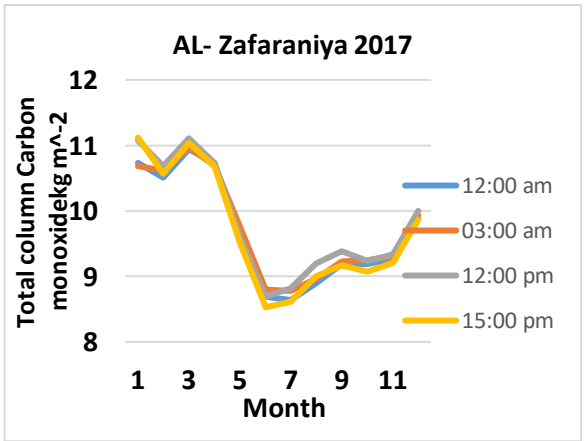


**Figure 12.** Total column Carbon monoxide in AL-Zafaraniya area (2017).

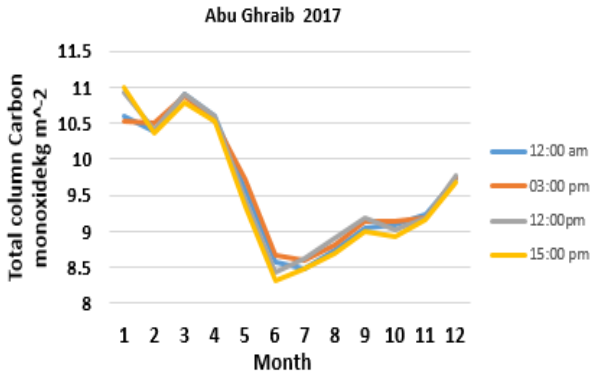


**Figure 13.** Total column of nitrogen dioxide in Abu Ghraib area (2017).

## CONCLUSION

The main findings of the research can be summarized as follows:

The highest values of ultraviolet radiation were during the summer months (June, July and August), and the lowest values were in the winter months (December, January and February) for both locations. While the highest values for UV radiation in Abu Ghraib is 487.3 W/m$^2$ and 443.7 W/m$^2$ for AL- Zafaraniya. The highest concentrations of the pollutant nitrogen dioxide appeared in the midnight hours and the least during the midday hours for both regions and in all months of the year, where the total column $NO_2$ reaching to about 9.6 * 10-5 kg m$^{-2}$ for Zafaraniyah and 8.48 * $10^{-5}$ kg m$^{-2}$ for Abu Ghraib. and hourly changes for CO in both locations were very close. where the total column CO reaching to about 45 * $10^{-4}$ kg m$^{-2}$ for Zafaraniyah and 43 * $10^{-4}$ kg m$^{-2}$ Abu Ghraib for the same year. While the values of UV radiation in Abu Ghraib higher than Zafaraniyah throughout the year.

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