
Simulation to Determine Pollution Gases of the atmosphere by Real Time Method

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Abstract

Air pollution refers to the release of various gases, solid particles, and dispersed liquids into the atmosphere at rates that exceed the environment's ability to disperse, absorb, or neutralize them. In this study, a simulation program was developed using MATLAB to calculate the real-time concentrations of pollutants in Baghdad city, including PM_{2.5}, CO, SO₂, NO₂, and O₃. Air pollution levels were monitored based on real-time air quality indicators. The results showed that the air quality in Baghdad is classified as very unhealthy for most months of the year, and "unhealthy" for sensitive groups due to exposure to fine particles and dust. A key feature of this work is the ability to generate simulation data that closely matches actual data obtained from the Air Quality Map, relying on radar monitoring above the U.S. Embassy in Baghdad. The results highlight the urgent need for effective measures to reduce pollution levels and improve air quality in the city.

Keywords: environmental air pollution, air pollution, microscopic particles, Geographic Information Systems.

1. Introduction

The air components in the natural atmosphere are nitrogen, oxygen, argon in addition to carbon dioxide, neon, helium, hydrogen, and water vapor with known concentrations. Any increase or change in the concentrations of these components, or the presence of toxic gases in the atmosphere such as sulfur dioxide, carbon monoxide (CO) and nitrogen oxides (NO), is considered pollution [1].

The research presents the concept of pollution and its degrees represented by reasonable, dangerous and deadly pollution in addition to the forms of air pollution. It also addressed the most important types of pollutants in the city of Baghdad, including hydrocarbons, carbon monoxide (CO) and nitrogen oxides (NO) and sulfur dioxide (SO₂), while the most important sources of pollution were air with gases is the means of transportation and industry, as well as pollutants from household uses and pollutants from solid waste. Pollution: Real-time Air Quality Index (AQI) where the highest percentage of sulfur dioxide (SO₂) was registered at the air pollution in world: real-time Air Quality Index Visual Map depends on the Baghdad US Embassy Air [2]. The change to our atmosphere associated with reactive gases like the ozone and the ozone-forming chemicals like the relatively short-lived nitrous oxides. addition the Carbon dioxide to the atmosphere, it hangs around, for a long time approximately: between 300 to 1,000 years. Thus, as the humans changing the atmosphere by emitting carbon dioxide, those changes will endure on the timescale of many human lives [3].

1.1 Air Quality Index (AQI):

The AQI is a composite measure reflecting levels of various pollutants, including particulate matter (PM_{2.5}, PM₁₀), ground-level ozone, carbon monoxide, sulfur dioxide, and nitrogen dioxide.

1.2 PM_{2.5} (Particulate Matter 2.5):

Sources include vehicle exhaust, industrial emissions, wildfires, and indoor activities like cooking or smoking. PM_{2.5} particles are small enough to enter the lungs and bloodstream, leading to respiratory issues, cardiovascular problems, and long-term diseases like cancer.

1.3 PM₁₀ (Particulate Matter 10):

Sources include road dust, construction activities, agricultural dust, and natural phenomena like dust storms. These larger particles primarily affect the upper respiratory tract, causing irritation, coughing, and exacerbating conditions like asthma [4].

2. Mythology

2.1 Types of air pollution:

1. Hydrocarbons: These are organic of carbon and oxygen compounds consisting, such as propane. (Propane), methane, benzene (benzene) and other substances in the oil, so these are the most important sources pollutants are filters and incinerators of waste and vehicles, and these components work to form smog, smoke.
2. Carbon monoxide (Co) carbon monoxide is characterized by being toxic, colorless, tasteless and odorless. It is one of the most dangerous gases to human health and results from the incomplete combustion of organic matter. The sources of this gas are cars, heating and various industries.
3. Nitrogen oxides (No) mean the oxides of gaseous nitrogen, which are formed when nitrogen is combined. And oxygen is under high temperatures, as is the case when gasoline and liquids are burned in vehicles such as cars and others, the most important of which are nitrogen (No) and nitrogen dioxide (No₂) [4].

4. Sulfur Dioxide (SO₂) Sulfur dioxide gas is colorless and has a sharp odor that leads to coughing. Most of it is produced due to the combustion of fossil fuels, and sulfur dioxide gas causes severe damage. In health, it causes chronic organic infections [4, 5].
5. PM_{2.5}, PM₁₀: Polluted fine particles, which are particles that remain suspended in the air such as PM_{2.5}, PM₁₀ [3, 4]. (PM_{2.5}) is a microscopic particulate matter often responsible for health problems caused by air pollution. Measuring its concentration and understanding its sources is key to formulating policies to control its presence in the air that humans breathe [5]. Global satellite data reflect progress in how to measure the level of fine particulate air pollution, but this approach has its limitations and needs more research and data [6]. They are microscopic particles up to 2.5 microns across and 30 times less than the diameter of a human hair [7]. When levels rise, these particles form a mist in the atmosphere, enter the human respiratory system and enter the lungs. It is only within the past decade that we have come to better understand these particles, called the silent killers - as we have come to know their sources and their long-term impact on lung and heart disease [7, 8]. Fine particles consist of sulfates, nitrates, ammonia, sodium chloride, carbon, mineral dust, and water. It consists of a complex mixture of organic matter suspended in the air in solid and liquid form [6]. These particles are classified into two types according to their diameter, PM₁₀ (particles with a diameter of less than 10 micrograms) or PM_{2.5} (particles with a diameter of less than 2.5 micrograms) [9]. The second type is more dangerous than the first, as its particles, if inhaled, can penetrate the respiratory mucosa and reach the inside of the body. Chronic exposure to particulate matter contributes to an increased risk of lung cancer, cardiovascular and respiratory diseases. The PM_{2.5} concentration the Particulate Matter less than 2.5 μm in air is typically measured in ($\mu\text{g}/\text{m}^3$)

micrograms per cubic meter. The calculation depends on the measurement method used.

2.2. Gravimetric Method (Filter-Based):

This method collects particulate matter on a filter and determines concentration based on mass and volume [10]:

$$PM_{2.5} = \frac{M_f - M_i}{V} \dots \dots \dots (1)$$

Where

M_f: Final Mass for the sample after filtering.

M_i: Initial Mass for the sample before filtering.

2.3. BAM (Beta Attenuation Monitor) Method

BAM measures PM_{2.5} based on the attenuation of beta radiation by particles on a filter tape:

$$PM_{2.5} = \frac{I_0 - I}{K \times V} \dots \dots \dots (2)$$

Where

I₀ = Initial of Intensity Beta Radiation

I = Intensity of Beta Radiation after Attenuation

K = Factor of Calibration

V = Volume of Air Sample (m³). [11,12]

3. Data and Working Methods

Spatial analysis of air pollutants in the city of Baghdad:

The spatial analysis of air pollutants in the city of Baghdad was based on the station of the US Embassy; to measure the percentage of pollutants, the annual average of those polluted gases was extracted the percentage of sulfur dioxide gas constitutes the highest percentage of gases in the station when the lowest percentage of polluting gases was recorded. As for carbon monoxide gas, the station was registered where reached (0.7) ppm. Also, we have got data of PM10, PM2.5, SO₂, NO₂, CO, O₃ from the site of the (AccuWeather) for Baghdad Air quality radar maps.

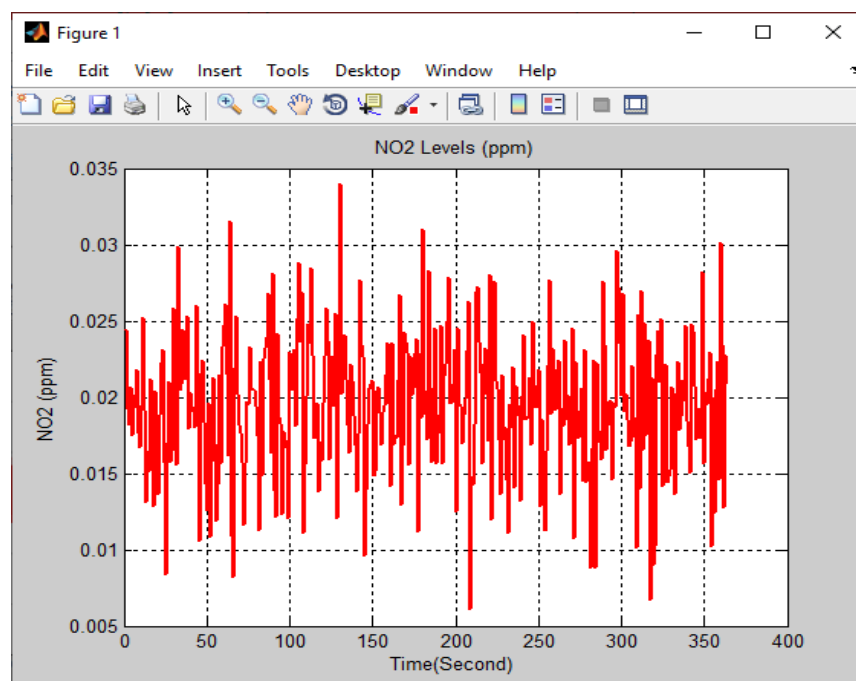


Figure (1): showing consistently high pollutant concentrations NO₂ (ppm) measured in parts per million (ppm).

3.1 The Work Stapes:

1. The MATLAB-based simulation program effectively provided real-time pollutant concentration values (in ppm) that closely matched actual field data obtained from radar monitoring above the U.S. Embassy in Baghdad.
2. The data revealed that Baghdad's air quality is classified as very unhealthy for the majority of the year, with daily pollutant levels exceeding safe thresholds.
3. Sensitive groups (such as children, the elderly, and individuals with respiratory diseases) were especially at risk, as fine particulate matter (PM_{2.5}) and gas pollutants like CO, SO₂, NO₂, and O₃ frequently exceeded recommended safe concentrations.
4. The study highlights the urgent need for effective pollution control strategies to reduce daily exposure to harmful air pollutants and improve overall air quality.
5. The simulation results covered all 365 days of the year, ensuring a comprehensive assessment of Baghdad's air pollution trends in ppm.

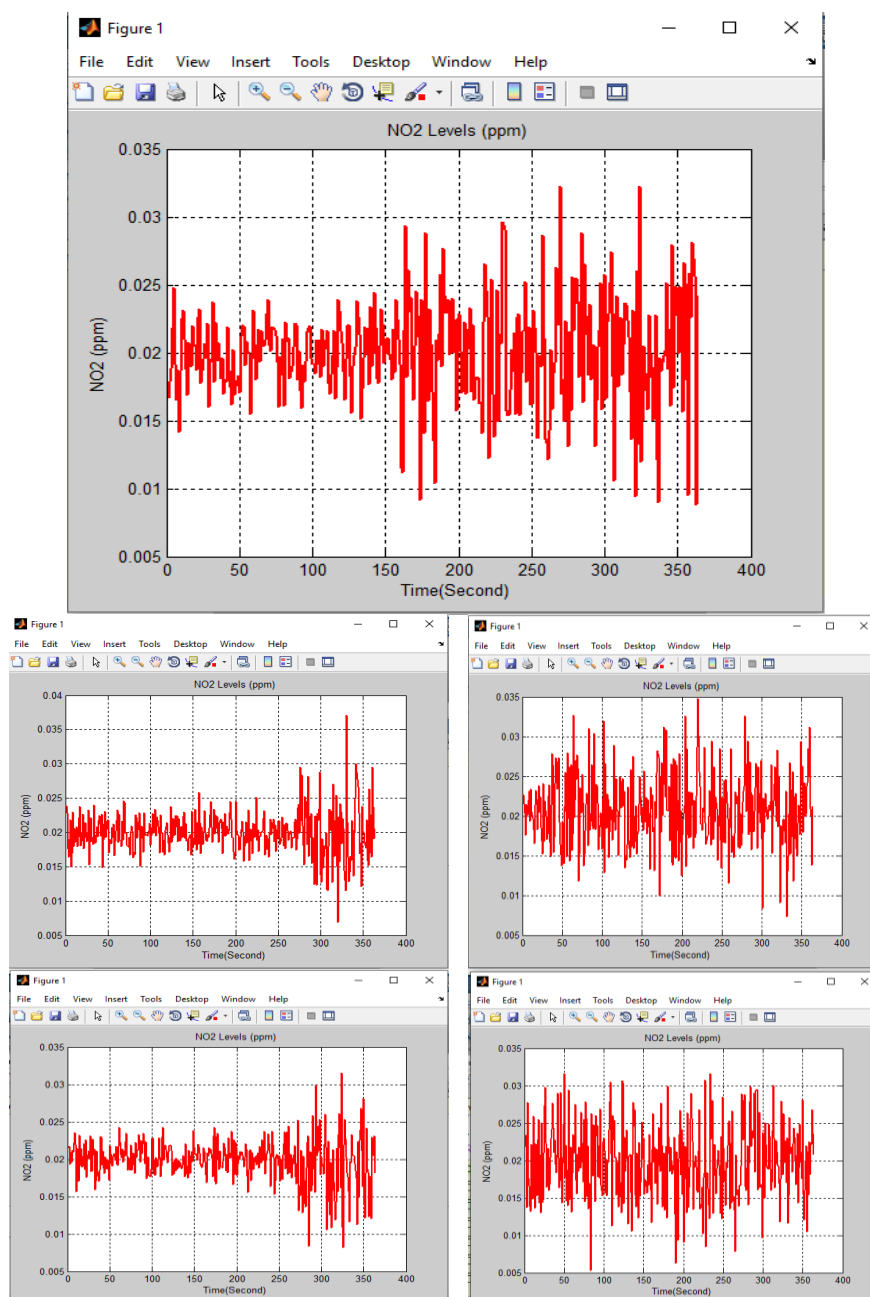


Figure (2) : represents different NO₂ (ppm) concentrations at different instantaneous times (the NO₂ concentration in real time has a very fast movement). We were taken some of the shots from this focus were taken as samples. This is some samples of real times

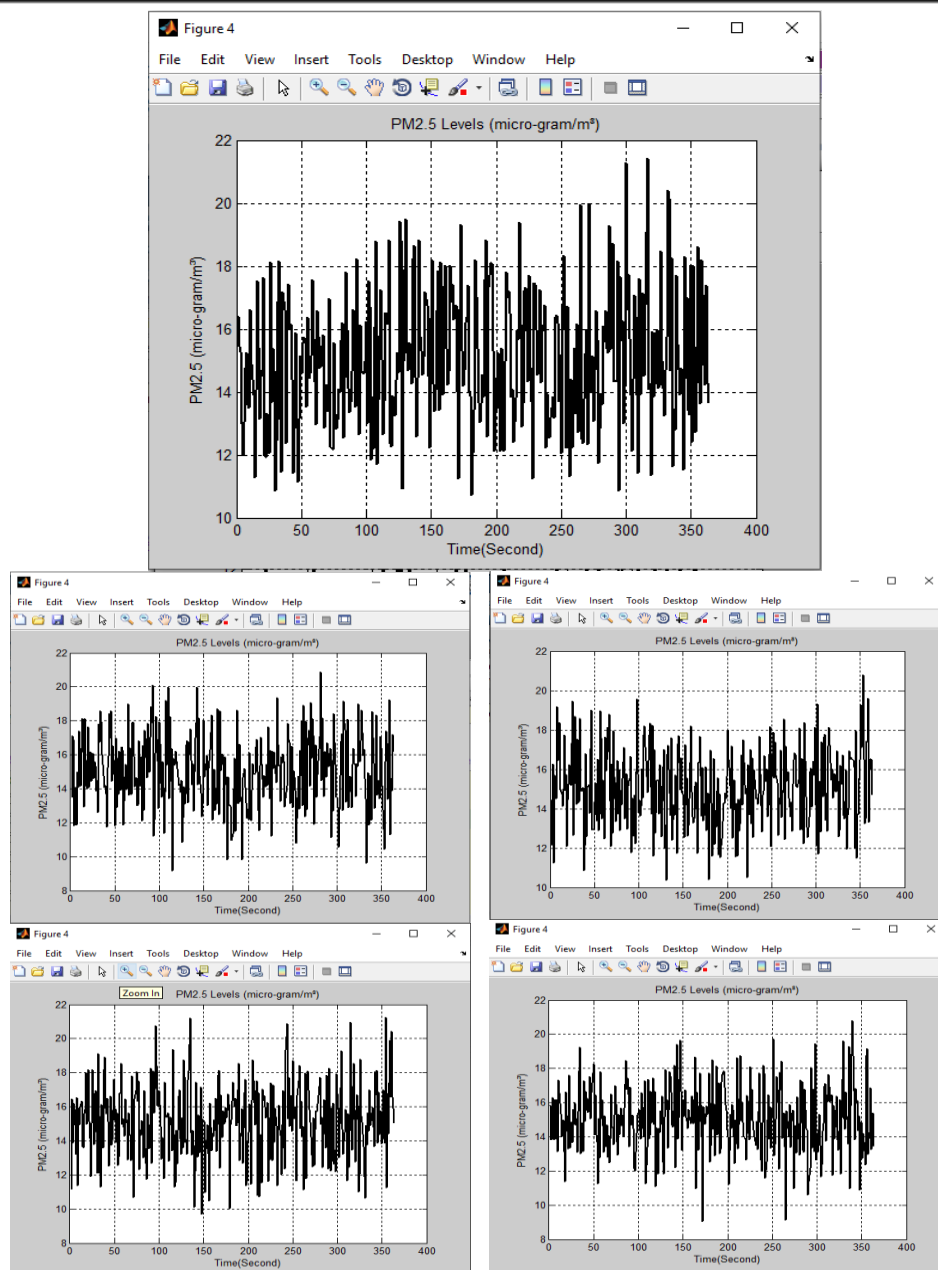


Figure (3) : represents different PM_{2.5} ($\mu\text{g}/\text{m}^2$) concentrations at different instantaneous times (the PM_{2.5} ($\mu\text{g}/\text{m}^2$) concentration in real time has a very fast movement). We were taken some of the shots from this focus were taken as samples. This is some samples of real times

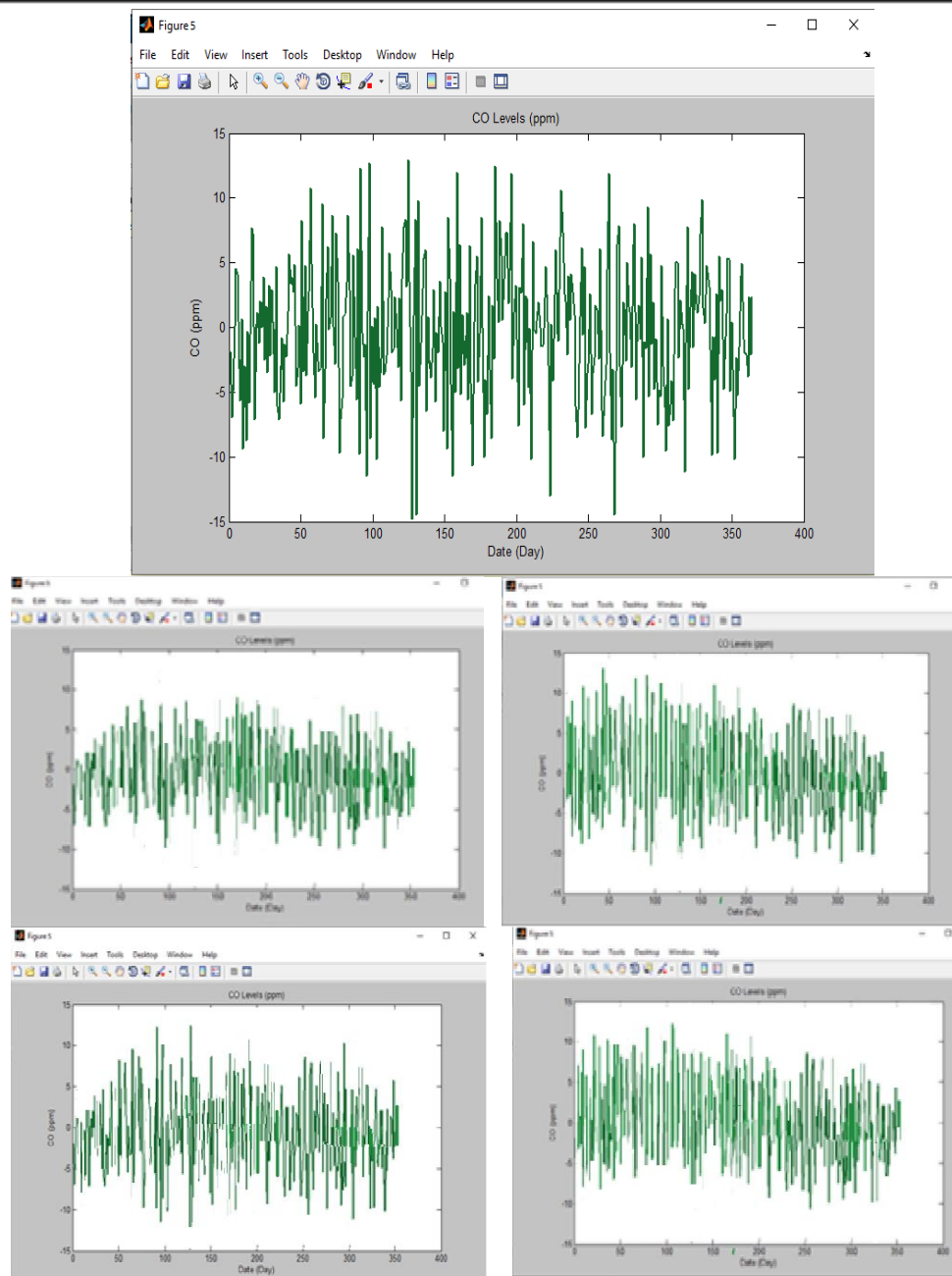


Figure (4) : represents different CO (ppm) concentrations at different instantaneous times (the CO concentration in real time has a very fast movement). We were taken some of the shots from this focus were taken as samples. This is some samples of real times

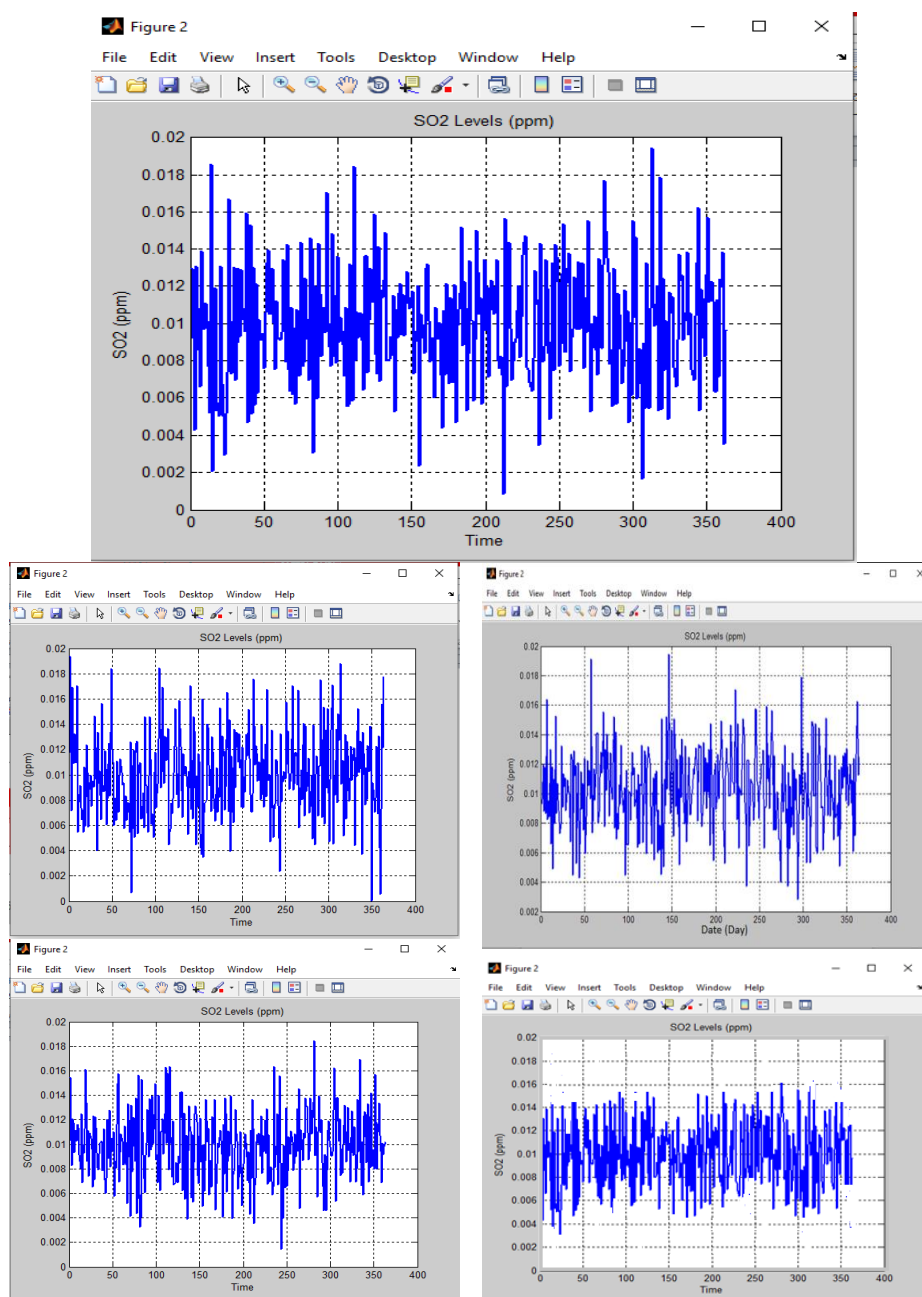


Figure (5) : represents different SO₂ (ppm) concentrations at different instantaneous times (the SO₂ concentration in real time has a very fast movement). We were taken some of the shots from this focus were taken as samples. This is some samples of real times

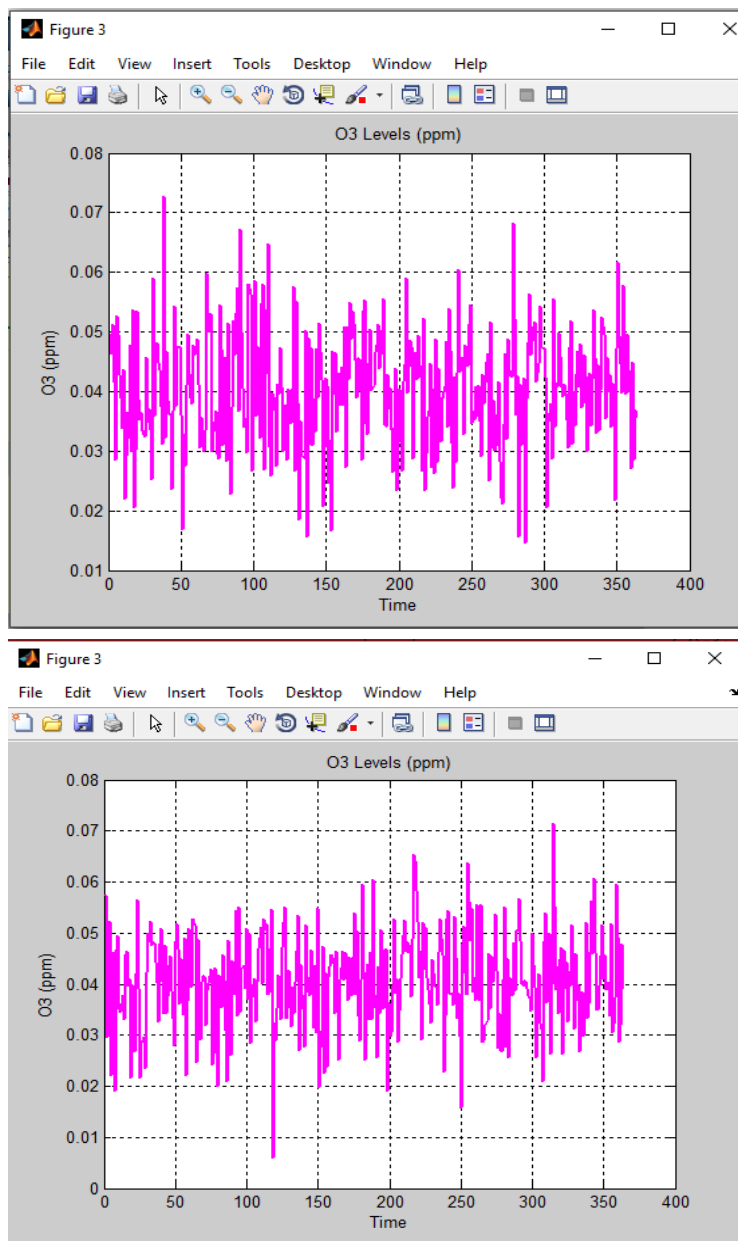


Figure (6) : represents different (Ozone_ O3 (ppm) concentrations at different instantaneous times (the Ozone (O3) concentration in real time has a very fast movement). We were taken some of the shots from this focus were taken as samples. This is some samples of real times

Conclusion

In this research was applied the simulation program using MATLAB to produced data of air gases like (Co , No₂ , So₂ and O₃ and MP_{2.5}) at real-time that closely aligns with actual measurements of MP_{2.5} , by using the equations 1 and 2 to determine the values which can also obtained from the Air Quality Map, particularly from radar monitoring above the U.S. Embassy in Baghdad. The air quality in Baghdad is classified as very unhealthy for the majority of the most days of the year, posing significant health risks to the general population. For sensitive groups, such as individuals with respiratory or the heart conditions, the air quality remains unhealthy due to high levels of fine particulate matter (PM_{2.5}) and dust. the study successfully demonstrates the potentially of real-time simulation tools in supporting environmental monitoring and public health decision-making. So, immediately we must take effective actions to reduce pollution sources and enhance air quality management in Baghdad. we can use this data for the GIS future study,

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