

Relationship Between Greenhouse Gases Emissions with Some Meteorological Variables Over Baghdad City

Jamal S. Abd Al Rukabie, Zainab M. Abbood¹, Dalia A. Mahmood¹
and Osama T. Al-Taai^{1*}

Department of Science, College of Basic Education, University of Sumer, Thi-Qar, Iraq

¹Department of Atmospheric Sciences, College of Science, Mustansiriyah University, Baghdad, Iraq

✉ osamaaltaai77@uomustansiriyah.edu.iq

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Abstract: When infrared radiation from the earth is emitted and back to it, the gases known as greenhouse gases can absorb this entire thermal energy, which is what causes global warming. In addition to other gases including those present on the surface of the ozone layer, nitrous oxides, and fluorinated gases, water vapour is one of the most significant greenhouse gases, albeit its impact is less. Although it is a straightforward type of atmospheric gas, greenhouse gases have a huge impact on the planet's energy system and have been implicated in significant global climate change. The methods used in the study depend on the daily and monthly average CH₄, H₂O, N₂O, CO₂ and temperature (T) and Dewpoint temperature (Td) and relative humidity (RH) taken from the European Mediterranean Weather Forecast (ECMWF) during the year (2021) for the Baghdad region. As a result, in the Statistical analysis of air pollutants, carbon dioxide gas represents the highest correlation with heat, and this leads to high global warming, followed by ozone, methane, and water vapour.

Key words: Temperature, relative humidity, greenhouse gases, atmospheric pollutants, Baghdad city.

Introduction

Greenhouse gases (GHG) are gases that are present in the Earth's atmosphere and are distinguished by their capacity to absorb and re-emit (IR) emitted by the Earth, which raises air temperatures and reduces heat loss to space. As a result, greenhouse gases help to warm the Earth's atmosphere, which in turn helps to cause global warming (Jeffry, 2021). Without GHG, the Earth's would generally be about -18 °C, as opposed to the average temperature of 15 °C that it is presently. Hazardous GHG emissions, which are mainly produced by cars and oil- or coal-fired power plants, are currently highest in China (Tuckett, 2019; Smith et al., 2008). The accumulation of GHG like carbon dioxide (CO₂) and

nitrite oxides (NO_x) in the "stratosphere" layer, which absorbs long-wave thermal solar radiation (infrared radiation), has been proven by science to prevent solar radiation reflected from the Earth's surface from penetrating space (Herzog, 2009). It keeps it trapped in the atmosphere, increasing Earth's temperature and endangering the planet's ecosystem, climate, and human health. "Global warming" is the name given to this phenomenon (Ritchie et al., 2020). The main problem is the increase in GHG, with carbon dioxide gas being the major one. This gas is produced when fossil fuels are used, whether in manufacturing facilities, power plants, or transportation systems. More than 20 billion tonnes of this gas are released into the atmosphere each year, or 0.7% of the gas that is naturally present

*Corresponding Author

in the atmosphere (Casper, 2010). The proportions of GHG in the atmosphere were nearly constant before the Industrial Revolution, but since the beginning of the Industrial Revolution (around the year 1750), human activity has caused a forty-five percent (45%) increase in the concentration of CO_2 in the atmosphere, going from 280 part per million in 1750 to 415 parts per million in 2019 (Gillingham & Stock, 2018). More than three million years ago, the atmosphere's CO_2 content was last at this high level. This increase took place even though the various natural “sinks” involved in the carbon cycle absorbed more than half of the emissions, for instance, plant photosynthesis (Abbood & Al-Taai, 2018). The Intergovernmental Panel on Climate Change (IPCC) has established a maximum temperature increase of 2°C with current GHG emissions. By 2036, the United Nations must prevent “dangerous” levels. With additional contributions from deforestation, vegetation, and other land-use changes (such as desertification, for example Abbood & Al-Taai, 2020; Nassif et al., 2020), the combustion of fossil fuels particularly coal, oil, and natural gas is responsible for the vast bulk of anthropogenic CO_2 emissions, The main goal of this work is to find the relationship between greenhouse gas emissions and some weather factors, see Figure 1.

Greenhouse Gases

Figure 2 shows below the absorption and dispersion of various electromagnetic waves in the atmosphere depending on their wavelength. The fundamental effect of the biggest band of CO_2 absorption is that it partially limits the window of water transparency, which is not far from the maximum heat output from Earth (Abbood & Al-Taai, 2018). The gases that absorb and emit infrared light in the spectrum that the Earth

emits are referred to as greenhouse gases. Rare gases like CO_2 (0.04%), nitrous oxide (0.01%), CH_4 , and O_3 which make up almost one in a thousand of the Earth's atmosphere, have a significant impact on global warming. In descending order, the most prevalent greenhouse gases in the Earth's atmosphere are Al-Taai et al., 2021; Hashim et al., 2022):

1. Water vapour gas: Its chemical symbol is (H_2O). It is produced from evaporation processes in natural water and ice bodies such as oceans, seas, lakes, rivers, glaciers, and the poles, and industrial bodies such as dam, lakes and open irrigation canals, etc.
2. Carbon Dioxide Gas: Its chemical symbol is (CO_2), and it results from the combustion of fossil fuels, and any source of smoke such as car exhaust.
3. Nitrous oxide gas and its chemical symbol (N_2O).
4. Methane gas, and its chemical symbol (CH_4), are produced from livestock waste.
5. Ozone gas (in English: Ozone), and its chemical symbol (O_3).

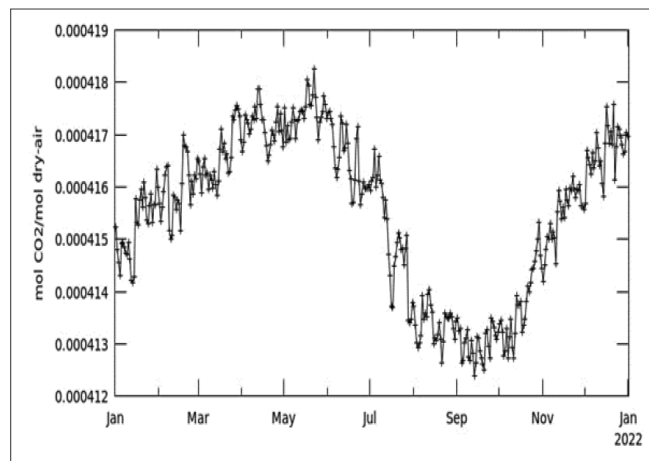


Figure 1: Carbon dioxide behaviour for the year 2022.

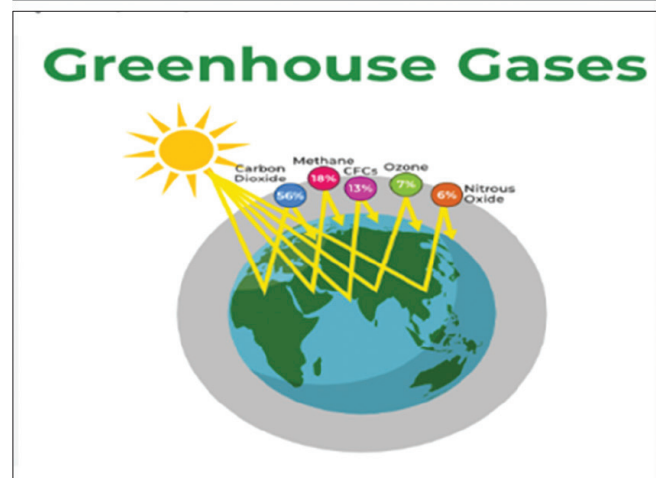
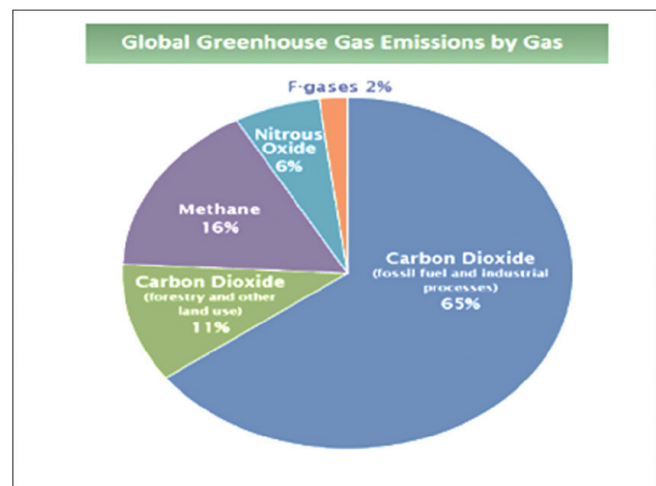


Figure 2: Green Houses Gases (Jeffrey, 2021).

6. Chlorofluorocarbon gas and its chemical symbol (CFCs), and this type of gas was until recently used in the refrigeration process in refrigerators.
7. Hydrofluorocarbons (including hydrochlorofluorocarbons (HCFCs) and hydrofluorocarbons (HFCs) (Hashim et al., 2023; Nassif et al., 2023).

It was established that the use of chlorofluorocarbon gases in refrigerators interacts with the ozone layer in the upper layers of the atmosphere, causing it to break down more quickly and accelerate ozone depletion, leading to the “ozone hole” and its widening, which is scientifically known to be, The ozone layer, which is present in the top levels of the atmosphere, shields the planet from the severely destructive effects of UV radiation by absorbing a significant amount of it and preventing it from reaching the earth’s surface. To keep Earth’s living things safe, the ozone layer is essential (Al-Awadi et al., 2023). The balance between sources and sinks (removing gas from the atmosphere by changing it into a new chemical compound or absorbing it through bodies of water) affects the concentrations of gases in the atmosphere (Redah et al., 2023). The yearly airborne fraction is the ratio of the growth in emissions still present in the atmosphere in a particular year to the total emissions of that year. The “airborne fraction” (denoted by AF) is the portion of emissions still present in the atmosphere after a specific amount of time. The yearly airborne portion increased at a rate of (0.25 0.21%) per year between 1959 and 2006, reaching a value of roughly 0.45 as of 2006 (Abbood et al., 2023).

Materials and Methods

Data Source and Study Station

Data (CH_4 , H_2O , N_2O , CO_2 , T, Td, and RH) from the ECMWF data center were used for this investigation (Al-Taai et al, 2021). To illustrate seasonal influences, this data was transformed into monthly rates. SigmaPlot was used to draw the data after MATLAB had analysed it. The Baghdad station is located at longitude 44.45°E and latitude 33.24°N on the Iraqi map (Rosa & Dietz, 2012).

Statistical Functions

The statistical functions that were used in this research are: The COUNT function helps count the number of cells that contain a number, as well as the number of arguments that contain numbers. It will also count numbers in any given array. And use this function.

MAX: This function determines the cell’s maximum value from the argument. MIN: The lowest value of a cell that is a part of the argument is specified by this function. The arithmetic mean, often known as the average, is determined by adding a set of integers, and then dividing the result by the total number of those numbers (Al-Behadili et al., 2023). The median of a group of numbers is the number that falls in the middle, with half of the numbers having values above the median and the other half below. The mode of a set of numbers is the one that occurs the most frequently. A measurement of the deviation of the values from the mean. The difference between the true score and the obtained score is represented as a set of differences, each with a standard deviation equal to the standard measurement error. The correlation coefficient, which can take any value between (−1) and (1), where its calculated value shows the strength of the association between the two parameters, is a quantitative measure of the magnitude and directions of the relationship between two parameters (Redah et al., 2023).

Results and Discussion

Analysis of the Behaviour of the Greenhouse Gases at Baghdad Station

Figure 3 shows the hourly mean CO_2 . Beginning of winter and spring it starts to increase and starts to decrease during the summer. Also CH_4 and H_2O , and O_3 during the spring rise conspicuously and decrease during the summer due to natural sources including wetlands, termites, hydrates, geological, fires, wild animals and ocean, the anthropogenic sources are rice agriculture, landfills and waste, biomass burning and fossil fuel and geological sources such as the natural gas seepage, geothermal and volcanic CH_4 as well as weather factors such as temperature, humidity, wind, solar radiation, rain, and others, geological location, seasons, and the time of the day. The burning of fuels from fossil sources, such as oil, coal and natural gas in industry, power plants and transportation, causes a lot of carbon dioxide emissions. Farm animals emit large amounts of methane. Processes such as agricultural fertilisation release nitrogen dioxide into the atmosphere. Refrigeration systems use freons. These gases absorb solar and thermal radiation, which in turn heats the atmosphere through the emission of infrared rays, thus increasing global warming.

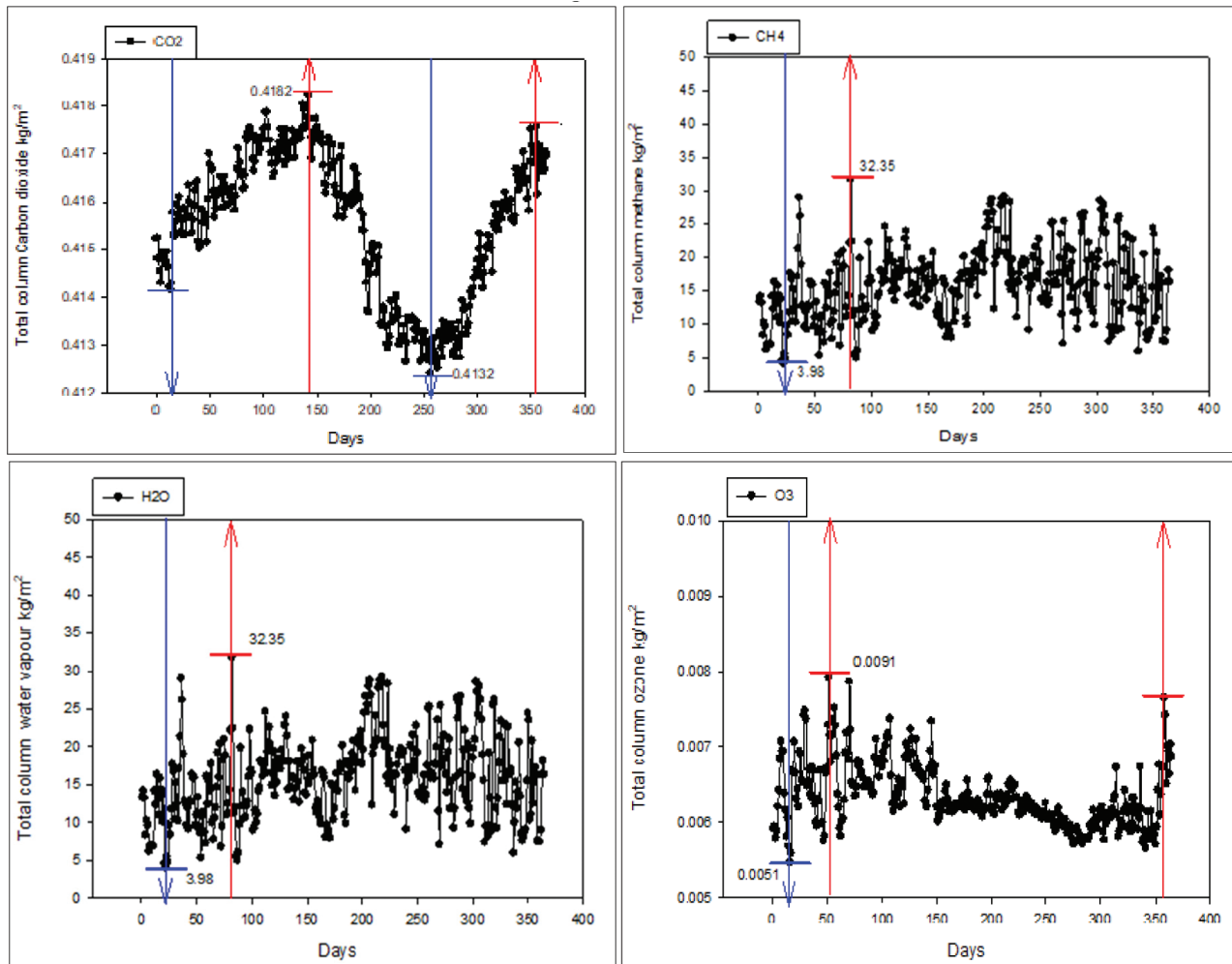


Figure 3: Explain the behaviour of the greenhouse gases for the Baghdad station period 2021.

The Monthly and Seasonal Average of Greenhouse Gases for Baghdad Station

Figures 4 and 5 show the monthly and seasonal average of CH_4 , H_2O , CO_2 , and O_3 for Baghdad station where observed CH_4 was high during Aug (summer) and low during Feb (winter) while CO_2 was high during May (Spring) and low during Oct (Autumn). Also, H_2O was high during Aug (summer) and low during Feb (winter) while O_3 was high during Jun (Spring) and low during Nov (Autumn). This was due to weather factors, pressure systems and surface nature, and Human and natural activities. Statistical analysis of air pollutants, that carbon dioxide gas represents the highest

Correlation with heat and this leads to high global warming, followed by ozone, methane, and water vapour as shown in Table 1. CO_2 absorbs and emits infrared radiations at wavelengths ranging from 4.26 μm to 14.99 μm , so it is a GHG that has an important effect on the surface temperature of the Earth caused

by global warming. Rising temperatures are causing ice sheets to melt, sea levels to rise and storms to become more intense, as well as exacerbating dry seasons around the world. In addition, rising levels of carbon dioxide in the atmosphere threaten to raise the acidity of ocean waters, which may lead to the death of some marine organisms.

Table 1: Statistical analysis of air pollutants

Statistical	O_3	CO_2	CH_4	H_2O
Mean	6.34e-3	0.4155	15.8105	15.8105
Medium	6.24e-3	0.4159	15.9270	15.9270
Std. Dev	4.18e-4	1.5e-3	5.4428	5.4428
Std. Err	2.18e-5	7.9e-5	0.2849	0.2849
Min	5.47e-3	0.4124	3.9871	3.9871
Max	7.92e-3	0.4182	31.7736	31.7736
R^2	0.385	0.758	0.216	0.216

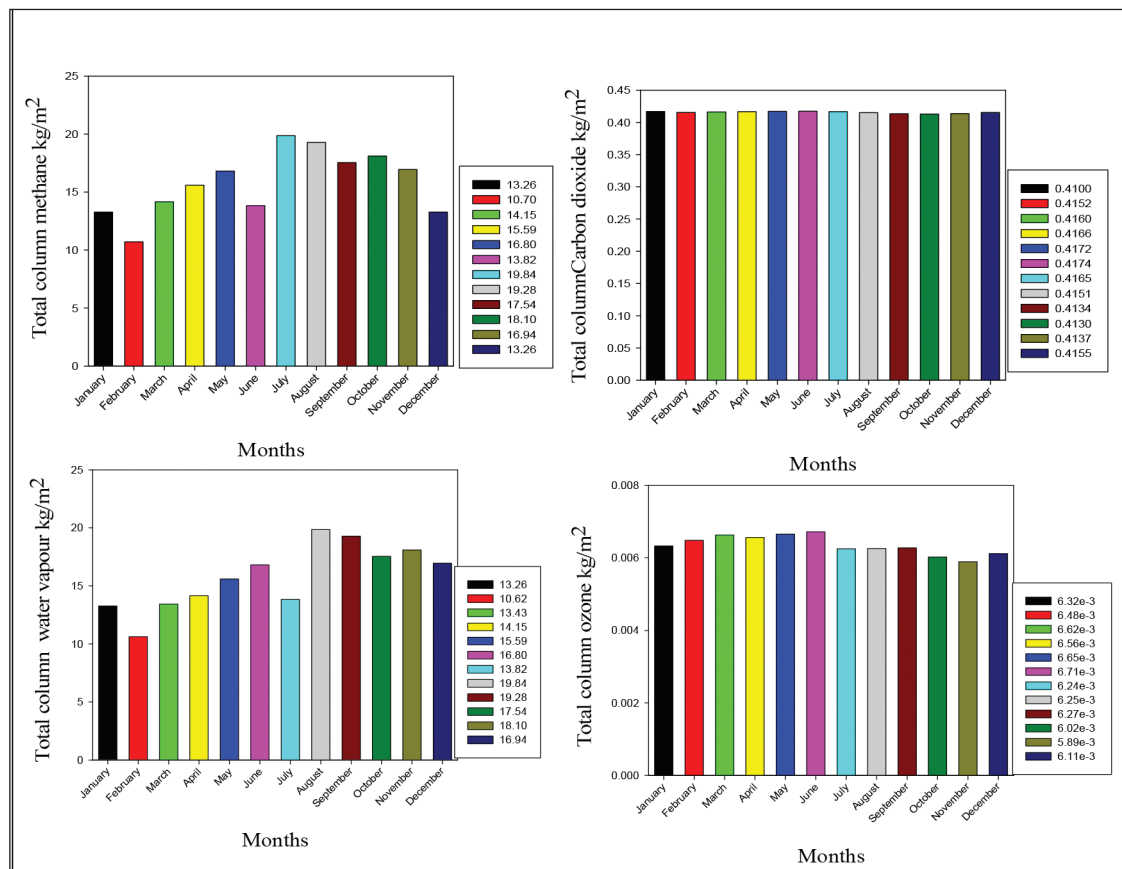


Figure 4: Explain the monthly average analysis over the Baghdad Station period 2021.

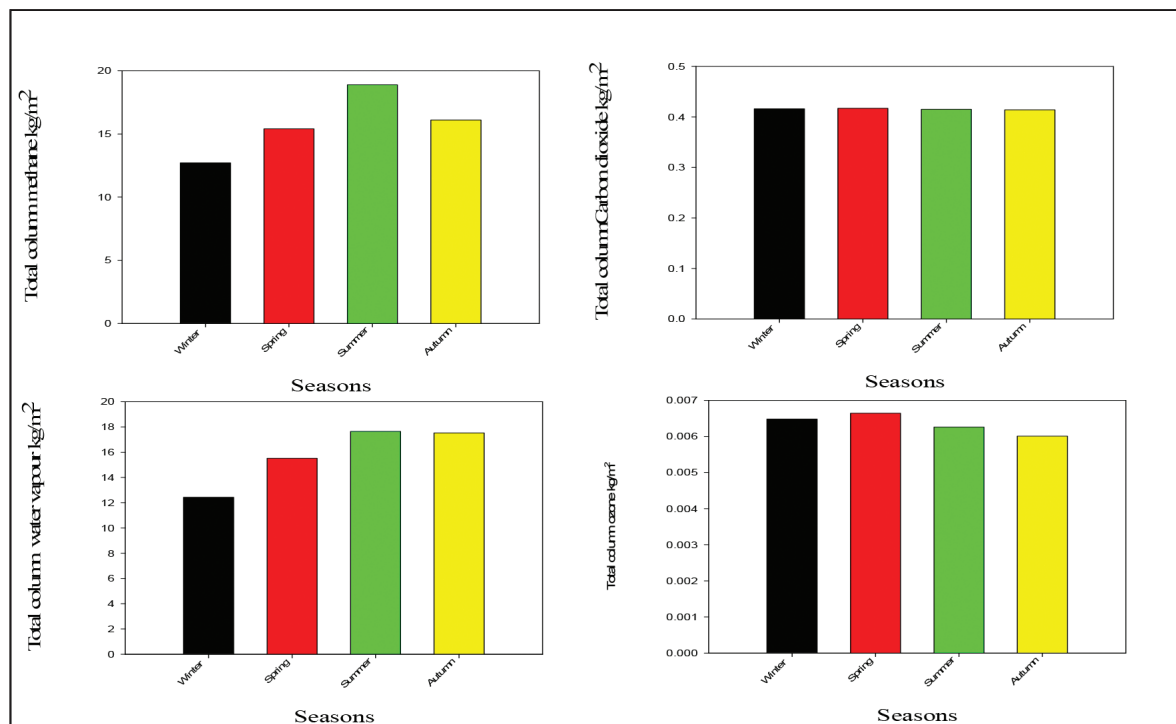


Figure 5: Explain the seasonally average analysis over the Baghdad Station period 2021.

Determine the Behaviour of the Temperature Curve, Dew Temperature and Relative Humidity

The heights of the convergences and divergences point between temperatures and the dews temperature vertical change curve, which represents the cloud base and top cloud, were calculated during the study period and classified according to height and thickness in Figure 6.

Between the hours of 00 and 12, low, medium, and high clouds of varied heights were visible. Geographical location, seasons, temperature, humidity, and height all affect how these clouds look and behave. The increase in cloud cover is caused by either surface cooling from the albedo effect or surface heating from the greenhouse effect. Whenever the temperature is low and the humidity is high, this helps to form clouds during the winter and spring, as the temperature curve approaches the humidity curve, where the point of convergence represents the base of the cloud and the points of divergence represent the base of the cloud.

The temperature curve is far from the dew point curve during summer and autumn, and the humidity is low. For this reason, we notice high clouds in the summer and fall, which are characterised by clear air.

Conclusions

CH₄ was high during Aug (summer) and low during Feb (winter) while CO₂ was high during May (Spring) and low during Oct (Autumn). Also, H₂O was high during Aug (summer) and low during Feb (winter) while O₃ was high during Jun (Spring) and low during Nov (Autumn). This was due to weather factors, pressure systems and surface nature, and Human and natural activities. The statistical analysis of air pollutants, shows that carbon dioxide gas represents the highest correlation with heat, and leads to high global warming, followed by ozone, methane, and water vapor. Whenever the temperature is low and the humidity is high, this helps to form clouds

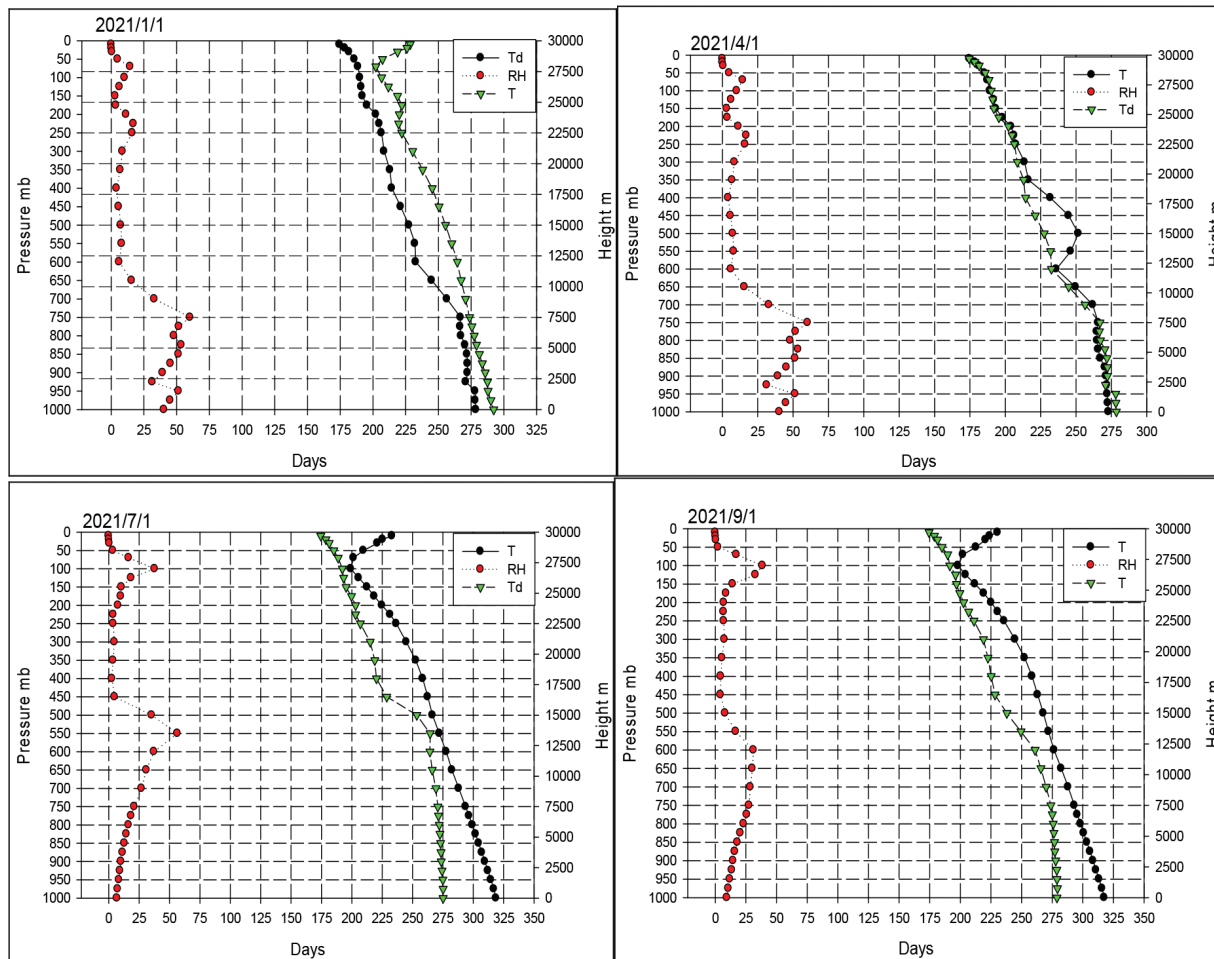


Figure 6: Curved vertical temperature change, dew temperature, and zones of convergence and divergence over the Baghdad station for the study days of the winter months in 2021.

during the winter and spring, as the temperature curve approaches the humidity curve, where the point of convergence represents the base of the cloud and the points of divergence represent the base of the cloud. The temperature curve is far from the dew point curve during summer and autumn, and the humidity is low.

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