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Impact Of Atmospheric And Solar Radiation Parameters In Portharcourt, Nigeria Before, During And After Covid-19 Lockdown

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Abstract
This research investigated the variations in atmospheric and solar radiation parameters in Portharcourt, Nigeria, focusing on the periods before, during, and after the COVID-19 lockdown exploring how changes in human activities and reduced anthropogenic emissions during the lockdown may have influenced the atmospheric conditions and solar radiation reaching the Earth's surface. The study compared the variation of solar radiation and atmospheric parameters in Portharcourt, Rivers State, Nigeria before, during, and after the COVID-19 (2019, 2020, and 2021) lockdown. Data was obtained from the Nigeria Meteorological Center (NIMET) in Abuja and MINITAB's time series method and procedures were used to analyze the data. Results showed that Portharcourt witnessed an increased amount of solar radiation during COVID-19 (2020) when compared with the values of solar radiation distribution observed before and after COVID-19 (2019 and 2021). Atmospheric ozone increased slightly in Portharcourt during the period of COVID-19 when compared with the periods before and after COVID-19 in the same area. Relative humidity variations were observed to be lower before and during COVID-19 when compared with the values after COVID-19, whereas temperature and pressure variation distributions were maintained approximately within the same range in the years of study (2019, 2020, and 2021). These findings provide an insight into the effects of the COVID-19 lockdown on solar radiation and atmospheric parameters in Portharcourt, Nigeria.

Key words: *Solar radiation, atmospheric parameters, COVID – 19, lockdown and Portharcourt.*

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I. Introduction

The air around us is really important for life on Earth. It does a lot of things, especially when it comes to sunlight. Sunlight, or solar radiation, is like the sun's energy that comes to us. This sunlight is crucial for many things, including a type of energy we can use. Solar radiation has two main types: direct and diffuse. Direct is like the strong sunlight you feel on a sunny day. Diffuse is more scattered sunlight that happens when the sun's rays bounce around in the air. The amount of sunlight that actually reaches the ground depends on things in the air, like tiny particles, gases, and water [1]. These things can affect how much sunlight gets through. This is important for using solar power, which is a kind of energy from the sun.So, when we talk about solar radiation and how it reaches us, we need to understand how the air and its components play a big role. This is not just interesting for science but also for using solar energy in a useful way.

Solar radiation is essential for life, transferring energy to plants and forming the basis of food webs. Organisms have evolved thermoregulatory behaviors and responses to concentrated periods of solar radiation as well as to changes in ambient temperature, which is also affected by solar intensity. Behavioral responses to solar radiation and other environmental variables can be paired with changes in skin surface blood circulation [2]. Atmospheric parameters play an important role in the radiative balance of the atmosphere. Atmospheric aerosols, for instance, serve a prime role in the Earth's radiative budget [3].

Aerosols, comprising suspended solid or liquid particles like smoke, dust, and pollen, play a role in cloud formation and can influence atmospheric processes. It act as condensation nuclei for cloud droplets and enhance cloud formation. Aerosol particles can modify ozone removal in the upper atmosphere and can weaken

the turbulent properties of the atmosphere, which hampers major planetary boundary layer processes and the atmospheric pollutant dispersion ability [4]. The availability of high quality in situ solar radiation data is critical for the development of solar generation in the country. As solar radiation and the presence of atmospheric aerosols have a strong relationship, this study attempts to analyze these features during the time of lockdown in Nigeria and the overall change in radiation characteristics in the vicinity of lockdown [5].

The global spread of the COVID-19 pandemic wreaked havoc in affected countries, prompting the World Health Organization (WHO) to declare it a pandemic in 2020. In response to curb the disease's transmission, numerous countries, Nigeria included implemented preventive measures such as lockdowns. These lockdowns resulted in the cessation of non-essential industrial activities, changes in travel patterns, and a notable reduction in greenhouse gas emissions and air pollution worldwide. While the lockdowns had adverse effects on human lifestyles, they inadvertently created a low-carbon environment [6]. Therefore, this work is aimed at exploring the interactions between atmospheric parameters and solar radiation, comparing the variation of solar radiation and atmospheric parameters in Portharcourt, Rivers State, Nigeria before, during, and after the COVID-19 period (2019, 2020, and 2021).

II. Theory

Solar Radiation

Solar radiation refers to the energy emitted by the sun in the form of electromagnetic waves. It is essential for sustaining life on Earth, drives weather patterns, and serves as a renewable energy source (solar power). It is divided into direct (focused sunlight) and diffuse (scattered sunlight) radiation.

Atmospheric Parameters

Atmospheric parameters are factors describing the state of Earth's atmosphere. They include airborne particulate matter, gaseous pollutants, water vapor, ozone, humidity, temperature, and pressure. It`s significance is that it influences climate, weather patterns, and the quality of air we breathe.

COVID-19

COVID-19 is a respiratory illness caused by the SARS-CoV-2 virus. The Pandemic Impact is that it led to widespread health concerns, global disruptions, and changes in human behavior, including reduced mobility and economic activities all over the world especially in highly populated cities like Portharcout.

Lockdown

Lockdown are restriction measures imposed by authorities to limit movement and social interactions, often used during emergencies like the COVID-19 pandemic. In Nigeria and the world at large, it was introduced to control the spread of the COVID-19 virus by reducing person-to-person contact. It altered daily routines, economic activities, and environmental impacts due to reduced human activities.

Study area

This study was conducted in Portharcourt, Nigeria. Portharcourt is a port city in southern Nigeria and one of the most rapidly developing cities on the African continent. Port Harcourt is a large city and the capital of Rivers State Nigeria. The city is situated in the southernmost part of the country, in the Delta of the Nigeria River. Port Harcourt is at latitude of 4.8 degree North and Longitude 6.9 degree east [9].

III. Experimental Detail

Data acquisition

Data from the Nigeria Meteorological (NIMET) Center in Abuja was used for this work, covering a period of three years from 2019 to 2021.

Data Computation and Analysis

The datasets comprising atmospheric parameters and solar radiations obtained from NIMET was processed and studied using software like MINITAB and Excel. In MINITAB, we used time series methods to handle the data collected over time. This type of data analysis looks at how things change in a linear way over the years of the study. It examines the linear trend of the data changes over the period of study. Trend analysis uses the linear trend model by default, which is represented as:

$$y_1 = \beta_0 + \beta_1 t + et \qquad 1$$

Where, β_1 shows the average change from one time period to the next. This formula helped us understand how the data is changing over time during the study years. It's a way to see if there's a consistent trend in the information we collected.

IV. Results and Discussion

The daily variation of temperature, relative humidity, tropospheric ozone, pressure, and solar radiation before, during, and after the COVID-19 lockdown in Portharcourt City, Rivers State, Nigeria is displayed in Figures 1-8.

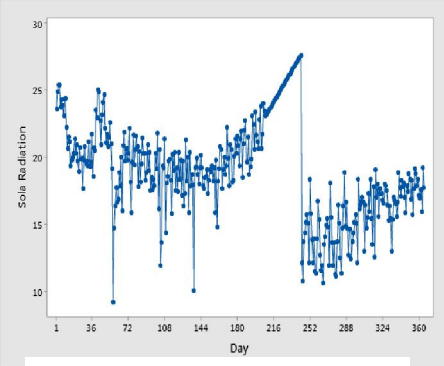

Fig.1 Variation of solar radiation before COVID-19 in Portharcourt 2019

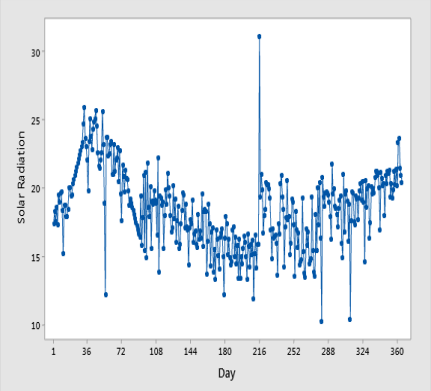

Fig.2 Variation of solar radiation during COVID-19 in Portharcourt 2020

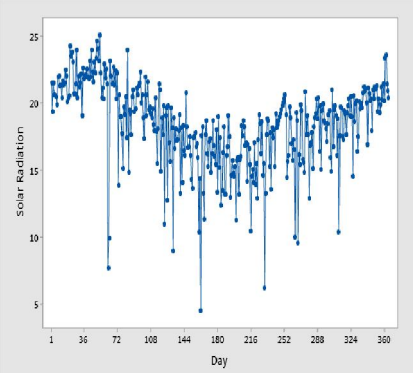

Fig.3: Variation of solar radiation after COVID-19 in Portharcourt 2021

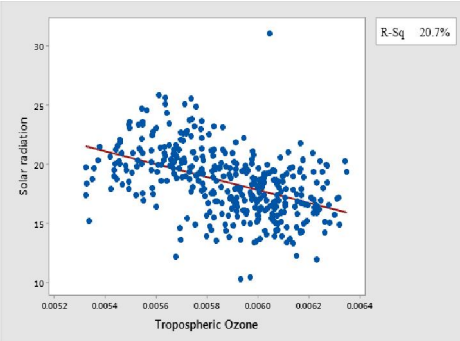

Fig.4: Solar Radiation against Tropospheric Ozone in Portharcourt 2019

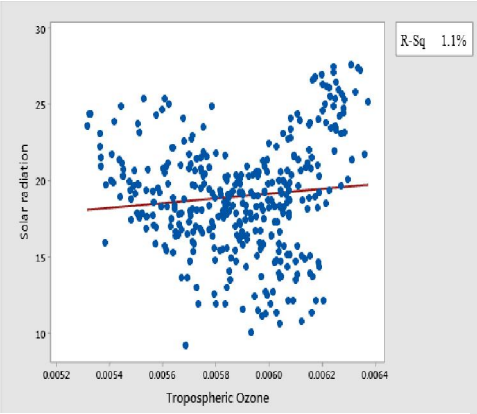

Fig.5: Solar Radiation against Tropospheric Ozone in Portharcourt 2020

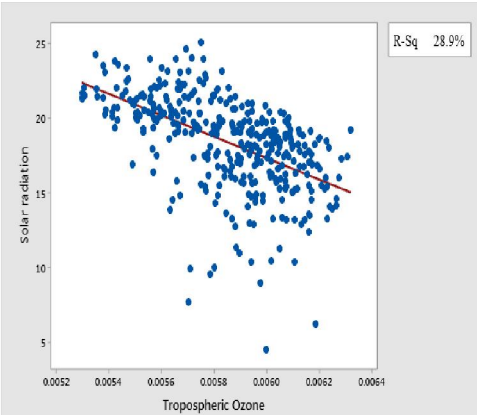

Fig.6: Solar Radiation against Tropospheric Ozone in Portharcourt 2021

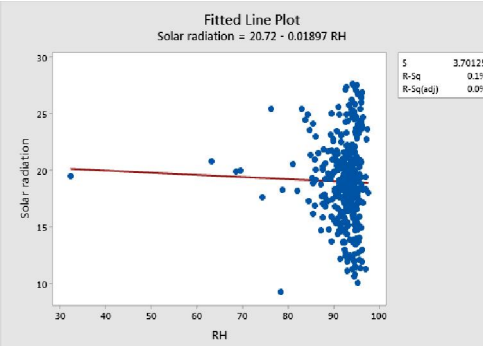

Fig.7: Solar Radiation against Relative Humidity in Portharcourt 2019

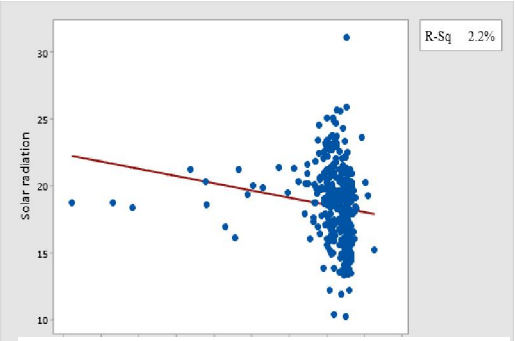

Fig. 8: Solar Radiation against Relative Humidity in

Notably, during the pandemic, there was a rapid increase in solar radiation, attributed to reduced human activities and decreased air pollution, allowing more sunlight to reach the Earth's surface. They were changes in tropospheric ozone levels during the same periods. While there was a slight increase in tropospheric ozone during the pandemic, the region's susceptibility to higher solar radiation levels and increased temperatures was evident. This elevation in ozone levels could have negative implications for agriculture and commercial forests, impacting yields and tree growth. Figures 4, 5, and 6 also revealed lower tropospheric ozone values during the dry season (early and later parts of the year) compared to the rainy season. This seasonal pattern persisted before, during, and after the COVID-19 pandemic, potentially influenced by emissions from various sources interacting with the ozone layer. Figures 7, 8, and 9 demonstrate less variation in relative humidity values before and during the COVID-19 pandemic in Portharcourt, with more noticeable fluctuations in the post-pandemic period.

V. Conclusions

In summary, the study underscores the influence of various environmental factors on the observed patterns in Portharcourt, Nigeria. These factors include human activities, air pollution, geographical location, and seasonal variations, shaping trends in solar radiation, tropospheric ozone levels, relative humidity, temperature, and atmospheric pressure. The fluctuations in solar radiation, with notable increases during the COVID-19 period, suggest a connection to reduced human activities and less air pollution. Tropospheric ozone levels, influenced by the region's geographical location, exhibited slight increases during the pandemic but decreased in other periods, showing a correlation with seasonal variations. Relative humidity displayed less variation before and during COVID-19, with pronounced fluctuations afterward, influenced by water bodies and a consistently wet atmosphere. Temperature remained consistent but showcased higher levels during the COVID-19 lockdown and mid-year, reflecting contributions from moisture and solar radiation. The slight increase in atmospheric pressure in 2021, coupled with fluctuations, indicates a dynamic relationship with changes in water vapor content. Overall, these findings provide valuable insights into the complex interplay of atmospheric elements, geography, and human-related factors in Portharcourt.

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