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Investigating Relationship between Particulate Matter (PM2.5µg/M³) and Some Lower Atmospheric Parameters in North-Western Nigeria, During the High Solar Activity

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ABSTRACT

The seasonal variation of PM2.5 µg/m³ and some lower atmospheric parameters (temperature, pressure, rainfall, and wind speed) were determined using correlation analysis technique using Microsoft excel. The strength and direction of correlation for each parameters with PM2.5 µg/m³ were analyzed using the correlation matrix table using hourly data that was converted to daily averaged. The result of the analysis showed that, during the year of 2014 in Sokoto PM2.5 µg/m³ shows higher correlation with wind speed in winter 0.4619 and followed by temperature 0.4069 in summer but with least magnitude with temperature -0.1263 during winter and pressure -0.4165 during summer season, as express by 46.2.%, 40.7% 41.7%, 12.6% respectively. While in spring and autumn pressure and temperature indicate similar magnitude of 0.2397 and 0.1066 respectively. Furthermore moderate magnitude was observed with wind speed in both spring and autumn, with 0.3684, 0.2925 respectively. The distribution of spatial and temporal variation were 22.2%, 13.3% with pressure, and rainfall respectively. Generally Sokoto (Bodinga) has much PM2.5 µg/m³ during winter (0.4619) with wind speed this coincide with harmattan season were the north easterly trend wind transport particulate matter from the Sahara region. The result of this study would provide a vital information to the government authorities on when and why the PM2.5 µg/m³ concentration level increases and varies with season. This would predictive analysis would provide a useful information for public to minimize negative impacts of air pollutant on public health.

Key words: Sokoto, Air temperature (˚C), Rainfall (mm), Pressure (hpa), wind speed (m/s) PM2.5 µg/m³.

I. INTRODUCTION

Particulate Matter (PM2.5 µg/m³) is defined as particles with diameters equal to or less than 2.5 µg/m³, aerosol, on the other hand, encompasses all particles that are suspended in the air, refers to particles suspended in the atmosphere, either in liquid or solid form, which exhibit significant heterogeneity in both temporal and spatial dimensions and are frequently observable as dust, smoke, and haze a approximately 10% of aerosols are generated or influenced by human activities such as vehicular emissions, combustion of fossil fuels, and construction side, while the remaining 90% originates from natural sources like volcanic eruptions, sea spray, and dust, the scattering and absorption of light by the aerosol particles lead to a deterioration in visibility, satellite-based aerosol remote sensing provides data on Aerosol Optical Thickness (AOT), which serves as a quantitative measure of PM2.5 µg/m³ loadings in the atmospheric column, to a certain extent, the

AOT can be regarded as a crucial indicator of air pollution and is the most easily recognizable manifestation of the presence of particulate air pollution, airborne particulates can be inhaled into the human respiratory system, where they are absorbed into the bloodstream and subsequently give rise to detrimental health effects.

The significance of the adverse effects on human health is contingent upon the size and composition of the particulates, for example, particles smaller than 2.5 µg/m³ can penetrate deeper into the alveoli of the lungs, thus posing the greatest risk to human health, environmental epidemiological investigations have identified that particulate matters impair pulmonary function and can thereby induce respiratory diseases and have adverse effects on public health, and in extreme cases, even premature death (Shi et al., 2012). But a comprehensive comprehension of the long-distance dispersion of aerosol is of paramount importance in ascertaining the ultimate destiny of atmospheric discharges and enhancing the accuracy of atmospheric aerosol models, the transportation of nutrients, bacteria, and pollutants across vast distances worldwide can be achieved through the medium of the atmosphere, Atmospheric aerosol has the capacity to undergo transformative alterations (Braun et al., 2020). Meanwhile according to (Daly et al., 2007) Particles with a diameter smaller than PM2.5µg/m³, known as PM2.5µg/m³, can be found in both solid and liquid states, encompassing substances such as smoke, dust, aerosols, metallic oxides, and pollen. PM2.5µg/m³ originates from various activities including combustion, industrial processes, construction, demolition, farming practices, vehicular emissions, and wood combustion. Prolonged exposure to sufficient levels of PM2.5µg/m³ can elevate the susceptibility to developing chronic respiratory ailments. it is possible to quantify the impact of aerosols on climate and air quality. Ground-based remote sensing is a commonly employed techniqueworldwide for accurately estimating AOD. The aerosol Robotic Network (AERONET) is a valuable resource that offers high-quality sun photometer measurements of AOD at various wavelengths, to enhance the accuracy of these measurements, computerized procedures are employed for cloud-screening and pre- and post-field calibration generalization. However, it is important to note that these measurements suffer from limited coverage over the earth and lack long-term observations at many of the ground-based sites (Aldabash & Balcik, 2020).

According to (McNeill, 2017), Atmospheric aerosol particles have a significant impact on Earth's radiation balance, these particles modify Earth's albedo through the scattering and absorption of solar radiation, as well as through their influence on cloud formation and properties. The effects of aerosols result in a net negative forcing, which can be comparable in magnitude to the positive forcing caused by the greenhouse gas carbon-dioxide (CO_2). Nevertheless, due to substantial gaps in our scientific comprehension of aerosol-related climate forcing, there exist considerable uncertainties in estimating their magnitudes.

The Saharan desert dust was examined using scanning electron microscopy to inspect its mineralogical phase composition through transmission electron microscopy and to analyze aerosol size distribution using an optical particle spectrometer, the results were subsequently compared and it was revealed that the average composition (by volume) of the aerosol was predominated by mineral dust, which consisted of 64% silicates, 6% quartz, 5% calcium-rich particles, 14% sulfates, 1% hematite, 1% soot, and 9% other carbonaceous materials, particularly for particles larger than 1.0 µm and less than 2.5 µm (Zaheer et al., 2018).

However anthropogenic aerosols have a direct influence on the Earth's radiation budget and climate, they achieve this by scattering solar light in the cloud-free atmosphere, Additionally, they exert an indirect influence by altering the properties of clouds, overall, anthropogenic aerosols contribute to cooling the climate, however, it is important to note that black carbon and mineral dust have the capacity to absorb solar radiation, monitoring the parameters of air quality, such as aerosols, is of utmost importance.

This monitoring serves the purpose of identifying their sources and providing timely alerts to the public, the study and monitoring of anthropogenic aerosols heavily rely on this widely used parameter, by analyzing long-term variations and trends in Aerosol Optical Depth (AOD), it is possible to quantify the impact of aerosols on climate and air quality, ground-based remote sensing is a commonly employed technique worldwide for accurately estimating AOD, the aerosol Robotic Network (AERONET) is a valuable resource that offers high-quality sun photometer measurements of AOD at various wavelengths, to enhance the accuracy of these measurements, computerized procedures are employed for cloud-screening and pre- and post-

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field calibration generalization, however, it is important to note that these measurements suffer from limited coverage over the earth and a lack of long-term observations at many of the ground-based sites (Aldabash & Balcik, 2020). Meanwhile approximately one-third of the land surface of the Earth was encompassed by arid and semiarid regions, which serve as a significant source of Aeolian dust, the suspension of crustal particles into the atmosphere occurred throughout the year, contingent upon meteorological conditions, the chemical composition of particulate matter (PM2.5 μg/m^3) varies depending on location, the average global chemical composition of PM2.5 μg/m^3 was reported to consist of sulfate (20%), crustal material (13.4%), equivalent black carbon (11.9%), ammonium nitrate (4.7%), sea salt (2.3%), trace metal oxides (1.0%), water (7.2%) at a relative humidity of 35%, and residual matter (40%) in a study conducted in 2005.

The Saharan desert dust was examined using scanning electron microscopy to inspect its mineralogical phase composition through transmission electron microscopy and to analyze aerosol size distribution using an optical particle spectrometer, the results were subsequently compared and it was revealed that the average composition (by volume) of the aerosol was predominated by mineral dust, which consisted of 64% silicates, 6% quartz, 5% calcium-rich particles, 14% sulfates, 1% hematite, 1% soot, and 9% other carbonaceous materials, particularly for particles larger than 1.0 μg/m^3 and less than 2.5 μg/m^3(Zaheer et al., 2018). According to (McNeill, 2017), Atmospheric aerosol particles have a significant impact on Earth's radiation balance, these particles modify Earth's albedo through the scattering and absorption of solar radiation, as well as through their influence on cloud formation and properties.

The effects of aerosols result in a net negative radiative forcing, which can be comparable in magnitude to the positive forcing caused by the greenhouse gas nevertheless, due to substantial gaps in our scientific comprehension of aerosol-related climate forcing, there exist considerable uncertainties in estimating their magnitudes, climate forcing is defined as the disparity between forcing elements in the climate system, and the primary source of uncertainty in determining aerosol climate forcing lies in the lack of information regarding aerosol loadings during preindustrial times, unlike numerous greenhouse gases, aerosols possess a short lifetime and, consequently, are not well-mixed and uniformly distributed throughout the atmosphere, therefore, it is crucial to investigate the sources and characteristics of aerosols in pristine regions, as they may exhibit similarities to preindustrial aerosols, in preindustrial times, sources of aerosols included marine aerosols, mineral dust, biomass burning, volcanic emissions, and the formation of new particles from biogenic activities, when condensational sinks are not dominant, new particles can emerge through the condensation of gas-phase precursors, many aerosols are discharged directly into the atmosphere (referred to as primary emissions) through human activities or natural processes.

Nevertheless, the majority of aerosol particles with a diameter smaller than 2.5 μg/m^3 in size (also referred to as PM2.5 μg/m^3) are produced through chemical and physical transformation of gas-phase precursors in the atmosphere (known as secondary particles), but regarding the atmospheric parameters temperature is a fundamental aspect of the thermodynamic state of a physical entity, it characterizes the average random motion of molecules within said entity, In the case of air temperature, it serves as an indicator of the heat content in the atmosphere, resulting from the cumulative effects of solar radiation absorption by the surface, air convection through turbulent heat fluxes in the vertical direction and the horizontal transport of warm and cold air masses, when air temperature rises, it leads to an escalation in the rate of heat transfer at the surface, subsequently resulting in increased evaporation rates In conditions of abundant sunlight, the highest air temperature is typically observed during daytime, while the lowest air temperature is attained during the nighttime, surface temperature on the other hand, pertains to the skin temperature of the Earth's surface, it encompasses various processes, such as the rate and timing of plant growth, the exchange of energy and water between the Earth's surface and the atmosphere, surface temperature is also susceptible to changes in soil moisture and vegetation, thus making it a valuable tool for the identification of alterations in land use and land cover.

Additionally, surface temperature can be utilized in the determination of radiation budgets and as a regulatory element within climate models, temperature can be measured at different levels, including, the vicinity of the Earth's surface, the upper atmosphere, the ground surface, surface levels of seas and lakes, and various depths within the soil, different instruments are employed for

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temperature measurement, such as, liquid-in-glass thermometers, and sonic sensors.

But solar radiation refers to the direct radiation that is received at the surface of the Earth, it plays a crucial role in determining the amount of energy available for various physical and photochemical processes, net radiation, on the other hand, is the sum of incoming, outgoing solar and terrestrial radiation, taking into account the algebraic sign, the measurement of radiation, including solar and net radiation, is influenced by several factors such as the season, surface temperature, geographical location, time of the day, cloudiness, as well as the type and condition of the surface, which can be determined by factors like albedo and emissivity, the observation of radiation is highly relevant in the study of land-surface processes, to quantify solar radiation, a pyranometer can be utilized, while a net radiometer can be employed to measure net radiation, however wind is the movement of air in motion known is a direct result of the uneven distribution of solar radiation on the Earth's surface.

it is important to note that wind speed is characterized by small-scale, random variations in air movement across both space and time, the measurement of wind is crucial for various purposes such as assessing wind energy potential, estimating the impact of wind on structures, determining surface heat fluxes, as well as monitoring and predicting weather conditions (PM2.5 µg/m^3, In order to quantify wind speed, one can employ either a wind gauge or anemometer, however, satellite data can potentially supplement the scarcity of these measurements, it is unable to offer the same level of precision in terms of spatial and temporal resolution as in-situ sensors, particularly for activities that are weather-dependent and localized in nature (Obisesan, 2022). Precipitation refers to any result of the condensation of atmospheric water vapor, which descends from clouds due to the force of gravity, the principal forms of precipitation include drizzle, rain, sleet, snow, ice pellets, and hail, precipitationoccurs when a portion of the atmosphere becomes saturated with water vapor, reaching a relative humidity of 100%, causing the water to condense and fall, therefore, fog and mist are not considered precipitation but rather colloids, as the water vapor does not condense enough to precipitate, there are two processes, which can potentially occur together, that can lead to the air becoming saturated, cooling the air or adding water vapor to it, precipitation takes shape as smaller droplets come together through collision with other raindrops or ice crystals within a cloud, moisture that is lifted or forced to rise over a layer of sub-freezing air at the surface may condense into clouds and rain, as long as the atmospheric moisture content is sufficient, the moisture within the rising air will condense into clouds, namely nimbostratus and cumulonimbus if significant precipitation is involved, eventually, the cloud droplets will grow large enough to form raindrops and descend towards the Earth, thunder snow is also possible within a cyclone's comma head and within lake-effect precipitation bands, In mountainous regions, heavy precipitation can occur when upslope flow is maximized on the windward sides of the terrain at higher elevations, on the leeward side of mountains, desert climates can exist due to the dry air caused by compressional heating, the majority of precipitation occurs within the tropics and is caused by convection, the movement of the monsoon trough, or inter tropical convergence zone, brings rainy seasons to savannah regions.

However surface pressure is often observed during calm and cloudless weather conditions, when the mixing of air masses is sluggish, conversely, low pressure is typically present during convective and stormy conditions, characterized by strong winds, these particular weather conditions may facilitate the rapid dispersion of airborne particles, such as infectious agents, additionally, they may also coincide with rainfall events, which effectively remove airborne particles from the atmosphere (Ghazvinian et al., 2020).

II. MATERIALS AND METHOD

The study was carry out at sokoto(boding) located at extreme of north western Nigeria with geographical coordinate of 12˚ 54'' 58N' and 05˚ 12'' 25'E at an altitude of about 307m with mean sea level. This region were classified under sahel savannah were it exhibit high temperature due to high proximity with equator. Due to the topography of this region it experience horizontal transport of particulate matter. An hp system (materials)Microsoft Excel version starter, v. 2010.lnk were used. Format and calculate data with formulas using a spreadsheet system, a Microsoft excel is software that was used to carry out the correlation analysis in Microsoft excel. Workbooks are just like huge electronic books withsheets that have been ruled into columns and rows.A four spreadsheet where used and plotted a one figures of seasonal graph of PM2.5 µg/m³ and temperature, wind speed, rainfall, and pressure and four seasonal tables of correlation matrix where constructed and

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the variation of PM2.5 µg/m³ and lower space atmospheric parameters during the year of 2014 (high) ofsolar activity where determined.Which was downloaded from www.giovanniearthdatascience.com. However regarding the methodology, Correlation analysis is a statistical measure that describes the strength and direction of a relationship between two variables, it is commonly used in statistical analysis, the method used to study how closely the variables are related is called correlation analysis, an essential thing to understand about correlation is that, it only shows how closely related two variables are Correlated.Normalization procedure were also carryout in the data in order to remove irregularities within the data points using min-max scalers formula as showed in equation 1 below were each data point were subtracted from maximum value and divided by the difference between the maximum and minimum values. The data point were drawn to a common scales between 0 an1 the data were converted to daily average from hourly average. The data used include temperature, atmospheric pressure, rainfall, wind speed and particulate matter (PM2.5 µg/m³) from sokoto and kebbi of 2014 were used while equation two were the correlation technique equation that was used and determined the correlation coefficients which was automatically generated from the excel sheet.

$$X_{normlized} = \frac{X - X_{min}}{X_{max\,.} - X_{min}} \qquad 1$$

$$p = 1 - \frac{6\sum d_i^2}{\eta(\eta^2 - 1)} \qquad 2$$

CORRELATION COEFFICIENT IN EXCEL

Interpretation of correlation; The numerical measure of the degree of association between two continuous variables is called the correlation coefficient (r), the coefficient value is always between -1 and 1 and it measures both the strength and direction of the linear relationship between the variables. Strength the larger the absolute value of the coefficient, the stronger the relationship, the extreme values of -1 and 1 indicate a perfect linear relationship when all the data points fall on a line. In practice, a perfect correlation, either positive or negative, is rarely observed.

A coefficient of 0 indicates no linear relationship between the variables. That is what is likely to get with two sets of random numbers. Values between 0 and +1/-1 represent a scale of weak, moderate and strong relationships. As r gets closer to either -1 or 1, the strength of the relationship increases. While the Direction the coefficient sign (plus or minus) indicates the direction of the relationship Positive coefficients represent direct correlation and produce an upward slope on a graph - as one variable increases so does the other, and vice versa. Negative coefficients represent inverse correlation and produce a downward slope on a graph - as one variable increases, the other variable tends to decrease.

PEARSON CORRELATION

In statistics, they measure several types of correlation depending on type of the data you are working with. In this aspect, we will focus on the most common one. Pearson Correlation, the full name is the Pearson Product Moment Correlation (PPMC), is used to evaluate linear relationships between data when a change in one variable is associated with a proportional change in the other variable. In simple terms, the Pearson Correlation answers the question. Can the data be represented on a line? In statistics, it is the most popular correlation type, and if you are dealing with a "correlation coefficient" without further qualification, it's most likely to be the Pearson.

CORRELATION MATRIX IN EXCEL WITH DATA ANALYSIS

When you need to test interrelations between more than two variables, it makes sense to construct a correlation matrix, which is sometimes called multiple correlation coefficients. The correlation matrix is a table that shows the correlation coefficients between the variables at the intersection of the corresponding rows and columns.

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III. RESULTS AND DISCUSSION

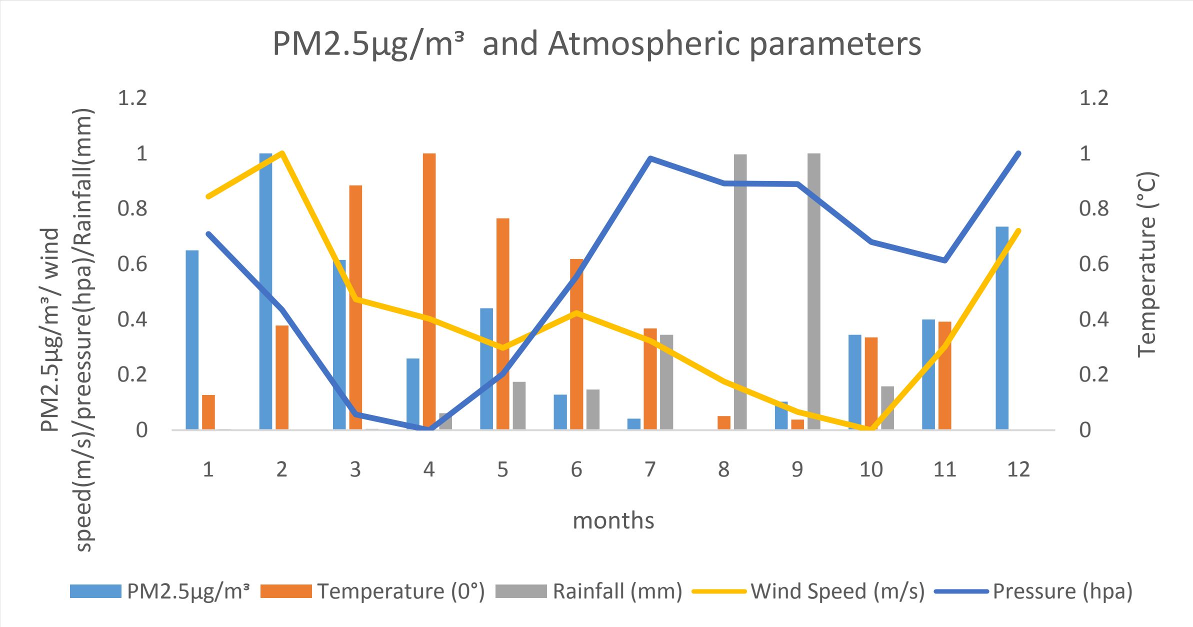

FIGURE 1.2 SHOWS A SEASONAL VARIATION OF PM 2.5µg/m³ AND SOME LOWER ATMOSPHRIC PARAMETERS DURING THE YEAROF 2014 AT BODINGA.

TABLE 1.1 SHOWS CORRELATION COEFFICIENTS OF WINTER SEASON BETWEEN ATMOSPHERIC PARAMETERS WITH PM2.5 µg/m³ OF 2014 AT SOKOTO STATE

Coefficients	PM2.5µg/m³	Rainfall(mm)	Pressure (hpa)	Temperature (0°)	Wind speed (m/s)
PM2.5	1				
Rainfall	-0.09059	1			
Pressure	0.210219	-0.14819	1		
Temperature	-0.12627	0.130098	-0.69162	1	
Wind speed	0.461929	0.140804	0.352775	-0.23682	1

TABLE 1.2 SHOWS CORRELATION COEFFICIENTS BETWEEN PM2.5 µg/m³ AND ATMOSPHERIC PARAMETERS IN SOKOTO REGION DURING SUMMER IN 2014

coefficients	PM2.5µg/m³	Rainfall(mm)	Pressure (hpa)	Temperature (˚C)	Wind speed (m/s)
PM2.5	1				
Rainfall	-0.13017	1			
Pressure	-0.41647	0.088364	1		
Temperature	0.406912	-0.12582	-0.62259	1	
Wind speed	0.154988	-0.00211	-0.32932	0.431765	1

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TABLE 1.3, SHOWS AUTUMN SEASONAL CORRELATION COEFFICIENTS BETWEEN PM2.5 µg/m³ AND SOME LOWER ATMOSPHERIC PARAMETERS AT SOKOTO REGION DURING THE YEAR OF 2014

coefficients	PM2.5µg/m³	Rainfall(mm)	Pressure (hpa)	Temperature (˚C)	Wind speed (m/s)
PM2.5	1				
Rainfall	-0.1452	1			
Pressure	-0.07677	0.11887	1		
Temperature	0.106627	-0.18005	-0.3543	1	
Wind speed	-0.29246	0.092172	0.190529	-0.18731	1

TABLE 1.4 SHOWS A SEASONAL CORRELATION COEFFICIENTS BETWEEN PM.5 µg/m³ AND SOME LOWER ATMOSPHERIC PARAMETERS IN SOKOTO 2014 DURING SPRING SEASON.

coefficients	PM2.5µg/m³	Rainfall(mm)	Pressure (hpa)	Temperature (˚C)	Wind speed (m/s)
PM2.5	1				
Rainfall	-0.01215	1			
Pressure	0.239736	-0.14043	1		
Temperature	-0.15724	0.09291	-0.58817	1	
Wind speed	-0.36837	0.194292	-0.28442	0.327507	1

From able 1.1 shows a winter seasonal correlation in Sokoto 2014.

All the data were normalized and the values were between 0-1 without unit. The seasonal variation were classified in to four season, winter (January, February, November and December), summer solstice (May, June, July, august), autumn (September, October) and spring equinox (march April). From table 1.1 The seasonal correlation between PM2.5 µg/m³ and rainfall indicate an indirect low coefficient (-0.0906) during the winter season due to scavenging process indicating that if rainfall increases PM2.5 µg/m³ decrease or vice –versa. While the correlation coefficient of PM2.5 µg/m³ with temperature indicate low magnitude value. Due to increase in temperature, the planetary boundary layer expand which give more area for accumulation of PM2.5 µg/m³due to higher inversion layer. Furthermore the coefficient of correlation between PM2.5 µg/m³ and atmospheric pressure indicate a positive magnitude (0.2102) due to higher surface pressure and low surrounding pressure during this period, which lead to sinking of PM2.5 µg/m³ . But wind speed has positive magnitude with PM2.5 µg/m³ (0.4619) because lower wind speed lead to deposition, accumulation of PM2.5 µg/m³ during this period. Therefore in winter season PM2.5 µg/m³ has strong correlation with wind speed (0.4619) and lowest with temperature (-0.1263) while the correlation between PM2.5 µg/m³ and pressure, rainfall, were intermediate as depicted in figure 1.2. and this study agreed with (Muhammadet al., 2020)in Irag Baghdad were he found out that wind speed has (-0.487), temperature (-0.789), temperature (-0.457) and temperature (0.745) for summer, autumn, winter and spring respectively but is contrary during spring.

However, from table 1.2 above during summer solstice when the sub-polar point is directly facing the equatorial region. The coefficient of correlation PM2.5 µg/m³ between and rainfall shows an indirect magnitude (-0.1302) due to presence of hygroscopic substance in the

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atmosphere that lead to absorption of PM2.5 µg/m³.furtherore the PM2.5 µg/m³ exhibit low negative magnitude (-0.4165 due to lower surface pressure and higher surrounding pressure which lead to vertical (diffusion) of PM2.5 µg/m³ during this period. Furthermore the correlation between PM2.5 µg/m³ and temperature indicated a positive magnitude (0.4069) this is due to higher inversion during the summer solstice. While between PM2.5 µg/m³ and wind speed also show a weak positive magnitude (0.1549) due to lower horizontal wind speed across the region as depicted in figure 1. Generally in summer solstice the correlation is lowest between PM2.5 µg/m³ and pressure as compare to other atmospheric parameters. This result disagreed with the result of (Tran et al., 2020) In Isfahan japan found out that, the correlation coefficient between wind speed and PM2.5 µg/m³ was 0.0363) in winter and (-0.268) in summer while temperature has (-0.4474) in spring the controversy is due to the pressure belt at the equatorial region and also (Munir et al., 2017) found out that temperature has moderate relationship (0.27), while wind speed has (0.12) magnitude this is due to difference in the geographical location.

From table 1.3 showing correlation statistics in autumn season during 2014 in sokoto
During the autumn season which is a transition period between the extinction and reduction of aerosols. The variability exist between PM2.5 µg/m³ and rainfall, pressure, temperature and wind speed. The correlation coefficients indicate an indirect magnitude (-0.1452) with rainfall due to presence of condensation nuclei particles during the period which lead to in decrease in PM2.5 µg/m³concntration level due to increase in the intensity of rainfall during the autumn. Furthermore the correlation of PM2.5 µg/m³ and atmospheric pressure indicate weak magnitude and indirect magnitude (-0.0768) due to weightless of air column in this region which is affected by rainfall, temperature, and wind speed but mostly due to high enhancement of temperature as depicted in figure 1. Meanwhile PM2.5 µg/m³ and temperatures has positive magnitude (0.1066) due to lower temperature and inversion layer profile within 2-3kms in the troposphere and mostly affected by enhanced wind speed as indicated in figure 1. Generally in autumn season the correlation is higher with temperature (0.1066) and lowest with wind speed (-0.2925) as compare with other parameters and this study agree with the study conducted by (Kermani et al., 2020) in Isfahan in iran with wind speed (-0.412), rainfall (-0.27) but is contrary to temperature (0.37) and pressure(0.219).

From table 1.4 indicating correlation coefficients during spring in sokoto2014, due to province location of this region (equatorial region) were high intensity of solar radiation deteriorate many atmospheric parameters in the troposphere like temperature, pressure, rainfall, and wind speed. During the spring equinox which is period where earth surface experiences equal day and night. The correlation between PM2.5 µg/m³ and rainfall exhibit low and indirect magnitude (-0.01220) which disagree with the study conducted by (Ayanlade et al., 2019) who found positive correlation while PM2.5 µg/m³ with wind speed as also contrary to this study and this is due to presence of condensation nuclei particles that absorbed the aerosols. Furthermore PM2.5 µg/m³ and atmospheric pressure exhibit higher positive magnitude among others parameters due to higher surface pressure value during this season which could be influenced by low enhancement of wind speed (-0.3684) in addition to this, the correlation coefficient between PM2.5 µg/m³ and temperature indicate a weak and indirect magnitude (-0.1572) due to dispersion and scattering by temperature within the troposphere. Furthermore lower wind speed increases the mass concentration and accumulation of PM2.5 µg/m³ hence which lead to negative magnitude between PM2.5 µg/m³ and wind speed (-0.3684) during the spring equinox and is mostly affected by higher atmospheric pressure (0.2397). In conclusion PM2.5 µg/m³ has higher coefficient of correlation with pressure (0.2397) and lowest with wind speed (-0.3684). The result of correlation between temperature and PM2.5 µg/m³ at different season agreed with (Li et al., 2017) conducted in Hong Kong China that showed that, temperature has coefficient of (-0.524) for winter, (0.022) for summer and pressure is (0.023) for winter, spring (0.164) and the correlations is different with pressure in summer (0.0220, autumn (0.042), wind speed (-0.2840) and pressure (0.507). this is due to the geographical location because equatorial region exhibit high temperature and low pressure belt.

IV. SUMMARY

The seasonal variation of PM2.5 µg/m³ and some lower atmospheric parameters (temperature, pressure, rainfall, and wind speed) were determined using correlation analysis technique. The strength and direction of correlation for each parameters with PM2.5 µg/m³ were analyzed using the correlation matrix table. The result of the analysis showed that , during the year of 2014 in sokoto PM2.5 µg/m³ shows higher correlation with (0.4619) and with least magnitude (-0.1263) during winter with temperature, as express in the percentage 48.2%, 12.6%, 21.0% and 9.0% of wind speed, temperature, pressure and rainfall respectively. While during the summer season in 2014 (Sokoto) PM2.5 µg/m³ has higher coefficient with temperature (0.4069) but indicating least magnitude with pressure (-0.4165) during summer, the result indicate consecutive increase relationship with percentage as 15.5, 40.7%, 41.7%, and 13.0% with wind speed, temperature, pressure and rainfall respectively. Furthermore during the spring season PM2.5 µg/m³ has higher coefficient with pressure (0.2397) and less with wind speed (-0.3684) as compare with temperature (-0.1572) and rainfall (-0.0122). the percentage distribution indicate a variation of PM2.5 µg/m³ with wind speed, temperature pressure, rainfall with 36.8%, 15.7%, 24.0%, 1.2% respectively. Furthermore during the autumn season in 2014, temperature indicate much impact on PM2.5 µg/m³ temporal variation (0.1066) while wind speed indicted lowest coefficient (-0.2925) as compare with atmospheric pressure (-0.0768) and rainfall (-0.1452) as indicated with by the percentage distribution of wind speed, temperature, pressure, and rainfall with 29.3%, 10.7%, 7.7%, and 14.5% respectively.

V. CONCLUSION

The special and temporal variation of PM2.5 µg/m³ mass concentration level were analyzed at different season to see its variability. The research was concluded base on the following findings;

After conducting the correlation analysis the special and temporal variation between PM2.5 µg/m³ and some lower atmospheric parameters were achieved. Like PM2.5 µg/m³ has correlation coefficient with pressure of (0.2102), rainfall (-0.0906) during winter season. While during summer PM2.5 µg/m³ has coefficient of (0.1549) with wind speed and (-0.4165) with pressure while in spring PM2.5 µg/m³ has (-0.1572) with temperature and rainfall has (-0.0122). But in autumn rainfall has coefficient of (-0.1452) during the year of 2014 in sokoto.The correlation coefficients across all season indicated that sokoto region has much impact of particulate matter during the winter season with wind speed (0.4619) and (0.2102) with pressure while in summer is (0.4069) for temperature and (0.1549) with wind speed.

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CONFLICT OF INTEREST

Author have no conflicts of interest exist.

REFERRENCE

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