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BULLETIN

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4th Quarter 2022

Air Quality Bulletin

October - December 2022

A publication of Nigerian Meteorological Agency

Our Mandate

To provide for the regulation of meteorology and for related matters

Our Vision

To be a World Class provider of Weather and Climate services for safety and sustainable national socio-economic development.

Our Mission

To observe Nigerian Weather and Climate and provide Meteorological, Hydrological, and Oceanographic Services in support of National needs and International Obligations

Who We Serve

Aviation, Agriculture, Building and Construction, Commerce, Health, Hydrology, Marine, Oil and Gas, Sports, Social Events, Power and Energy, Telecommunication and more...

EDITORIAL

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Preface

The NiMet Air Quality Quarterly Bulletin serves as a comprehensive analysis of air pollution levels and trends throughout Nigeria. This bulletin is specifically designed to inform and raise public awareness about the state of air quality while emphasizing the crucial need for coordinated efforts to minimize pollution and mitigate its detrimental effects on the society.

In this edition, the first three chapters provide detailed insights into the three key pollutants that significantly impacted air quality across Nigeria: PM2.5, NO2, and CO from October to December 2022. The spatial distribution and the diurnal variations of the concentrations of these three pollutants are presented in Chapters One to Three. Furthermore, these chapters elucidate the intricate relationship between weather conditions and air quality levels in the atmosphere. The influences of crucial atmospheric features, such as the Inter-Tropical Discontinuity (ITD), wind speed and direction, and mean sea level pressure, notably the Azores and St. Helena high-pressure systems over the North and South Atlantic Ocean, respectively. These weather features play a pivotal role in determining the rainfall patterns within the country, which consequently impact the concentration of pollutants in the atmosphere. Chapter Four provides an in-depth analysis of the quarterly changes in air quality trends and mean values of pollutants concentration (PM2.5, NO2, and CO) during the months of October, November and December 2022.

The analyses presented in this bulletin rely on data sourced from the Copernicus Atmospheric Monitoring System (CAMS), with satellite data cross-referenced against available surface observations. NiMet is unwavering in its commitment to the continuous monitoring and analysis of spatial and temporal air pollution conditions within the country, recognizing their significant impacts on the environment. This document has been crafted for broad dissemination and is designed to be a valuable tool for various stakeholders, including the general public, health practitioners, research communities, environmentalists, and regulatory agencies, among others. The comprehensive information contained within the bulletin aims to be a cornerstone in shaping policies geared towards improving air quality and mitigating the impact of climate change in Nigeria. Through transparent and data-driven insights, NiMet seeks to contribute to informed decision-making and collaborative efforts to create a sustainable and healthier environment for all.

Professor Charles Anosike
Director General/CEO NiMet & Permanent Representative of Nigeria with WMO

Introduction

The NiMet Air Quality Quarterly Bulletin is a valuable resource, offering insights into the pollution levels across the country and comparing the pollution level with the Air Quality Standards recommended by the World Health Organization (WHO). The WHO standards serve as the reference for regulatory purpose and the benchmark for setting air pollution reduction targets and, ultimately, achieving cleaner air. The bulletin provides the public and relevant stakeholders with essential information on air quality in Nigeria. By aligning with global standards, NiMet uses this bulletin to contribute to the broader goal of fostering a healthier environment and promoting measures that safeguard the well-being of the populace.

Addressing air pollution necessitates the implementation of both regional and national strategies, underscored by effective government coordination. The complexity arises from the fact that pollution sources frequently extend beyond local boundaries, traversing both regional and national political borders, and even spanning oceans[1]. Consequently, a crucial emphasis should be placed on establishing air monitoring stations across all urban centers within the country. This proactive measure is imperative for furnishing precise and ongoing data on air quality, serving as a foundation for informed decision-making in combatting the adverse impacts of air pollution.

The efficacy of addressing air pollution challenges depends on the accessibility and quality of information available to the general population. This bulletin serves as an educational resource for raising public awareness about the effects of air pollution on the environment and human health.

[1] Abaje et al 2020 DOI: https://dx.doi.org/10.4314/jasem.v24i2.25

CHAPTER ONE

October 2022 Review

1.1 Position of the Inter-Tropical Discontinuity (ITD) in October 2022 and the Effect on Rainfall

The region where the moisture laden south-westerlies from the Atlantic Ocean meet the dry dusty north-easterlies from the Sahara Desert is known as the Intertropical Discontinuity (ITD). The ITD is a region of low pressure and it is an important factor for Nigeria weather and climate. It oscillated between latitudes 8 to 25°N on the West and 5 to 17°N on the Eastern part of the country in October (Figure 1.1).

The ITD was observed to progressively retreat southwards from a position of 16.4 °N in the 1st dekad to 12.6°N in the 2nd dekad and reached 8.6°N in the 3rd dekad of the month. The mean position of the ITD was approximately 12.5°N (black dash line in Figure 1.1) and appeared to be more southerly than the climatological mean position (red bold line in Figure 1.1) of 14.3°N.

The observed mean position, even though lower than climatological mean, was favorable for rainfall in most parts of the country. The Southern region experienced the most substantial rainfall during the period, with Asaba recording the highest amount at 525mm. This precipitation played a pivotal role in mitigating the occurrences of PM2.5 air pollution, thereby sustaining favorable horizontal visibility across most parts of the country. Consequently, the overall air quality during the month was observed to be moderate throughout the month.

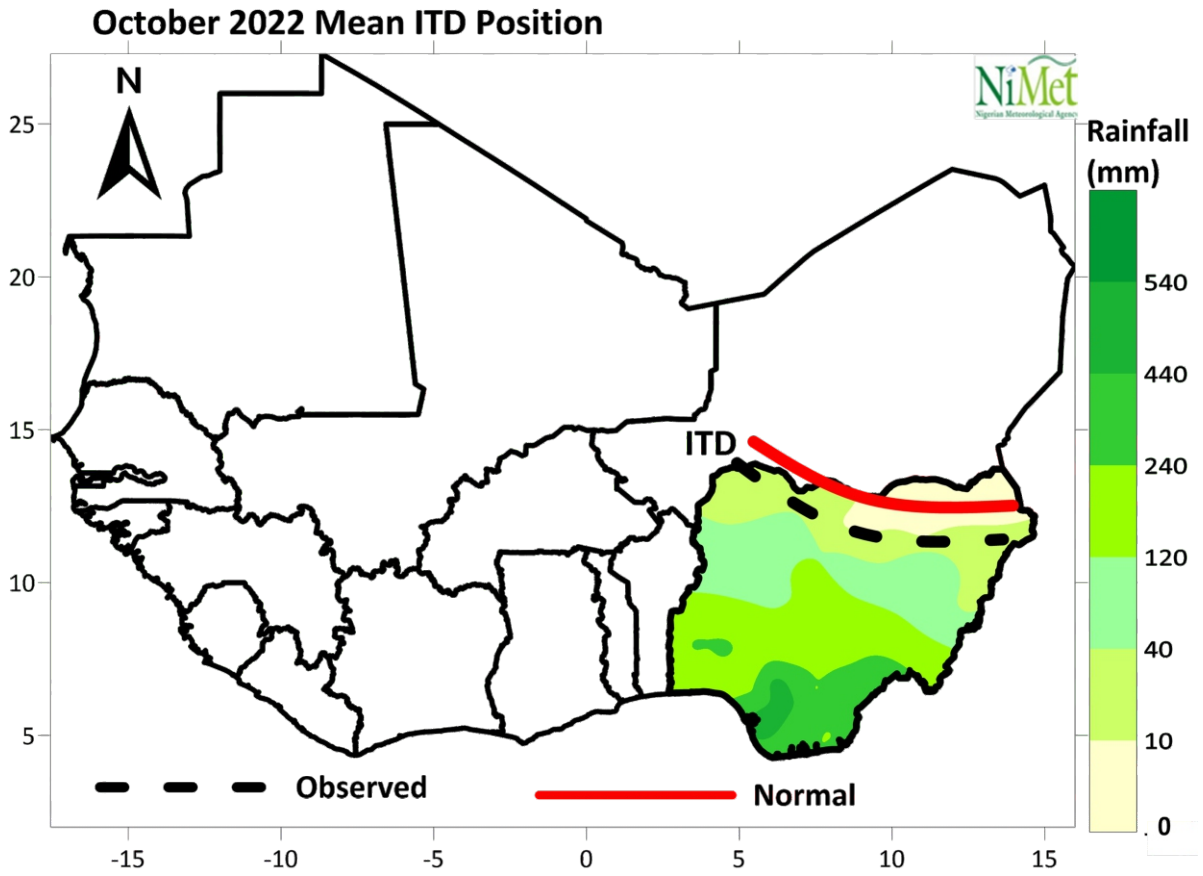

Figure 1.1: ITD Position and Rainfall in October 2022

1.2 Mean Sea Level Pressure (Azores and St. Helena Highs)

The two high-pressure areas which modulate weather over Africa are the Azores and St. Helena high pressure systems located around 30°N and 30°S, respectively. The daily central values of mean sea level pressure in the Azores exhibited a range from 1015 to 1029 hPa, with an observed mean value of 1020 hPa. In contrast, over the St. Helena high-pressure system, the pressure values fluctuated between 1021 and 1034 hPa, with a central mean value of 1022 hPa (Figure 1.2). The elevated pressure over St. Helena during the month facilitated an increased moisture flow into the country. The average position of the 1015hPa isobar (blue line in Figure 1.2) oscillated between Latitudes 0 to 12°S and a monthly mean position of about 10°S. Lower pressure values below 1012hPa which are favorable for rainfall prevailed over the country and eventually led to moderate air quality that was observed over most places in the month.

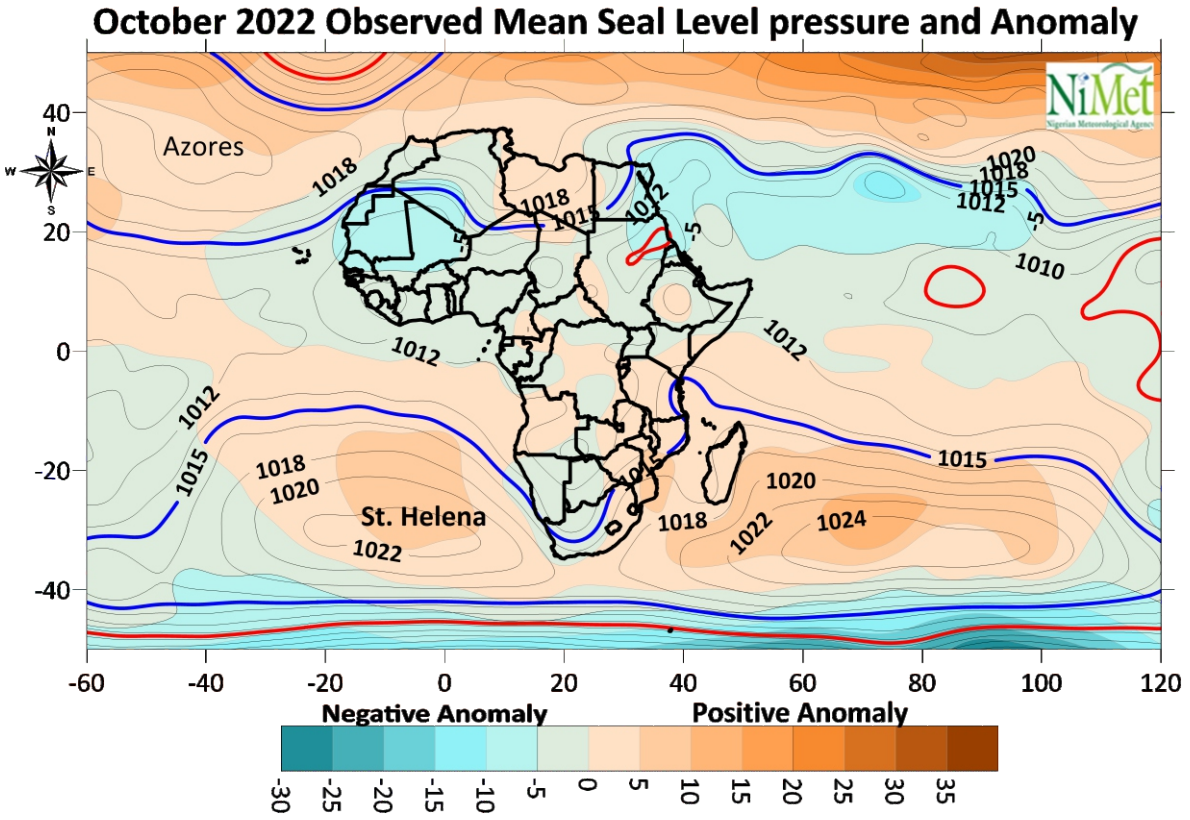

Figure 1.2 Mean Sea Level Pressure in October 2022

1.3 Winds

1.31 Wind at 925 hPa Level (900m above the ground level)

During the first ten days (1st dekad) of the month, moist south westerly winds from the Atlantic Ocean was predominant across the country with wind speeds of about 5-20kts (2.5 -10 m/s). However, during the 2nd and 3rd dekads (last 20 days) of the month, dry northeasterly winds from the Sahara Desert prevailed over the North with daily speeds varying from 5 to 35Kts while moist south-westerlies were predominant in the South with daily wind speeds of 5 to 15Kts. The winds were still favorable for significant precipitation over the South while the northeast trade winds from the desert transported some dust into the northern parts of the country in the later part of the month. This affected air quality for few days of the month over Kano and Katsina states where horizontal visibility reduced to about 1000-2000m and the air quality was unhealthy over the region but overall, the horizontal visibility across the remaining parts of country was generally above 10km with moderate air quality.

1.32 Winds at 850 hPa Level (about 1500 m above the ground)

Winds at this level were generally dry and flowed northeasterly direction with daily mean speeds of 5 to 30Kts across the country. While southerly to southwesterly winds with speeds ranging from 5 to 15 knots and the presence of vortices were noted during the initial five days of the month over the South, these atmospheric conditions proved to be non-sustainable throughout the first dekad of the month.

Table 1: World Health Organization Air Quality Guidelines (Source: World Health Organization. Air Quality Guidelines - Update 2021)

Pollutant	Averaging Time	2005 AQGs	2021 AQGs
$PM_{2.5}$, $\mu g/m^3$	Annual	10	5
	24-hour[a]	25	15
PM_{10}, $\mu g/m^3$	Annual	20	15
	24-hour[a]	50	45
O_3, $\mu g/m^3$	Peak season[b]	-	60
	8-hour[a]	100	100
NO_2, $\mu g/m^3$	Annual	40	10
	24-hour[a]	-	25
SO_2, $\mu g/m^3$	24-hour[a]	20	40
CO, mg/m^3	24-hour[a]	-	4

1.4 Air Quality Index (AQI)

The Air Quality Index (AQI) is a scale used to determine the quality of air based on the level of pollutant concentrations in the air and its associated health risks. The AQI has values which range from 0 to 500 but categorized into six classes with different colour codes based on concentration of pollutants in the air and health risks associated with each category of the scale. The lowest category of the index (1-50) suggests clean air without threat to health while the highest category (251-500) suggests a hazardous air quality with very high health risks (Table 2). This unique color-coded system enhances the ease of understanding and interpretation for the general public[2]. Generally, a moderate air quality with index of 51-100 was observed in October

Table 2: Air Quality Index Chart (Nigerian Meteorological Agency)

Air Quality Index	Class	Advisory
1-50	Good	The quality of the air is good, presents no threat to anyone' health.
51-100	Moderate	The air quality is acceptable, exce for unusually sensitive individuals.
101-150	Unhealthy fo Sensitive group	Outdoor activity should minimized for sensitive group su as the elderly, children, and individuals with heart and lu diseases.
151-200	Unhealthy	Everyone should avoid prolong exposure to prevent breathi difficulties which may be mo severe in sensitive populations.
201-250	Very Unhealthy	Minimize time spenbutdoors. The entire populace is likely to affected.
251-500	Hazardous	Hazardous for everyone and m prompt emergency condition alert

[2] Air Quality Index (AQI) Basics https://www.airnow.gov/aqi/aqi-basics/

1.5 Particulate Matter (PM)

1.51 Particulate Matter (PM 2.5) Concentration in October

Figure 1.3 illustrates that the monthly mean concentration of PM2.5 ranged generally from 19.45 to 46.22 µg/m3 across the country. The lowest concentrations, falling within the range of 17.0 to 22.0 µg/m3, were observed over the southeast coast, particularly spanning parts of Bayelsa, Delta, Rivers, Akwa Ibom, and Cross River. In contrast, the highest concentration of 44.0 µg/m3 and above was noted over parts of Kano, Katsina, and the eastern segment of Zamfara States. Most regions of the country recorded PM2.5 concentrations ranging from 28.0 to 36.0 µg/m3, with areas including Sokoto, Zamfara, southern Kano, Jigawa, Kaduna, eastern Bauchi, Federal Capital Territory, Nasarawa, Ekiti, Osun, Oyo, Benue, Enugu, and Ebonyi states recording concentrations between 36.0 and 44.0 µg/m3. Conversely, parts of Ogun, Lagos, Edo, northern Delta, northern Port Harcourt, northern Cross River, and northern Akwa Ibom observed mean PM2.5 concentrations ranging from 22 to 28 µg/m3.

The highest observed mean concentration of PM2.5 within a 24-hour period occurred in Katsina, reaching 46.22 µg/m3, which is far above the recommended World Health Organization air quality guidelines.

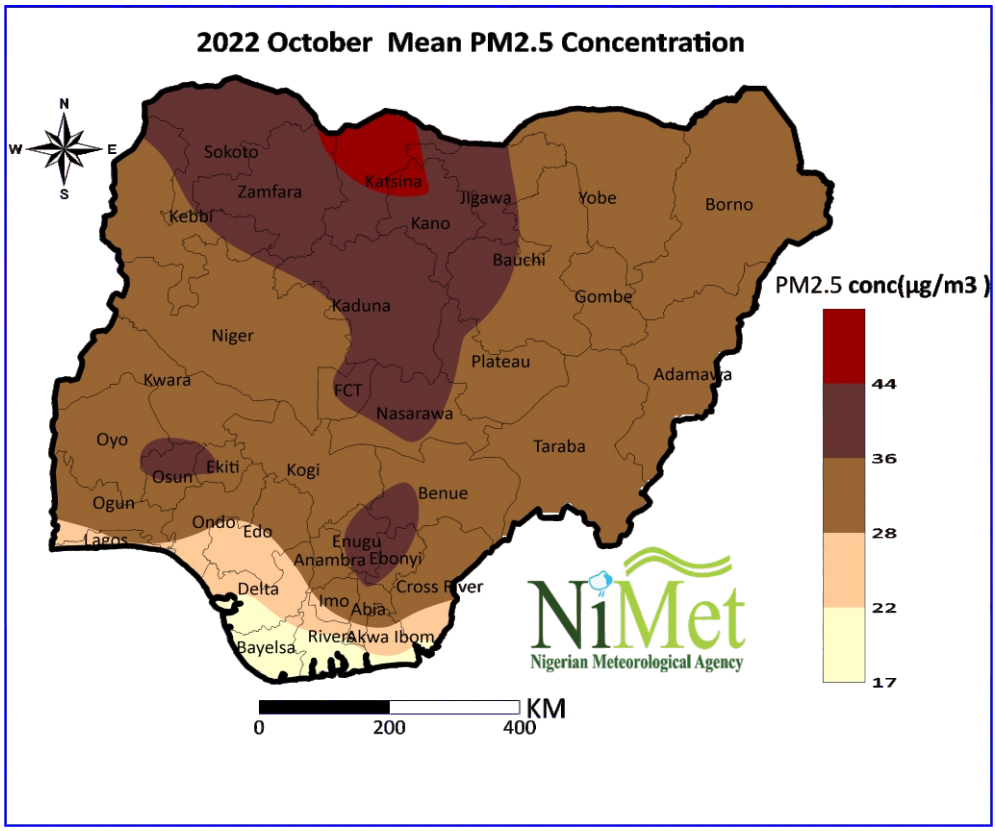

Figure 1.3: Mean concentration of Particulate Matter PM 2.5 for October 2022 across Nigeria

1.6 Horizontal Visibility in October 2022

Horizontal visibility is the maximum distance at which an observer can see an object situated in essentially the same horizon plane. Visibility is a practical index of air quality, as most people directly judge air pollution according to visibility. However, visibility is influenced by many factors, such as meteorological conditions, concentrations of gas pollutants and airborne particles. At a high relative humidity, the aerosol absorbs moisture, thus causing the aerosol to grow rapidly in size. Particulate matter (PM) pollution impacts on visibility (haze). These particles vary greatly in shape, size and chemical composition, and come from a variety of natural and manmade sources. Some haze-causing particles are directly emitted to the air such as windblown dust and soot. Fine particles, generally characterized as PM PM2.5, are believed to be primarily responsible for the scattering of visible light and a cause of the degradation of visibility (Sloane et al..,1991).

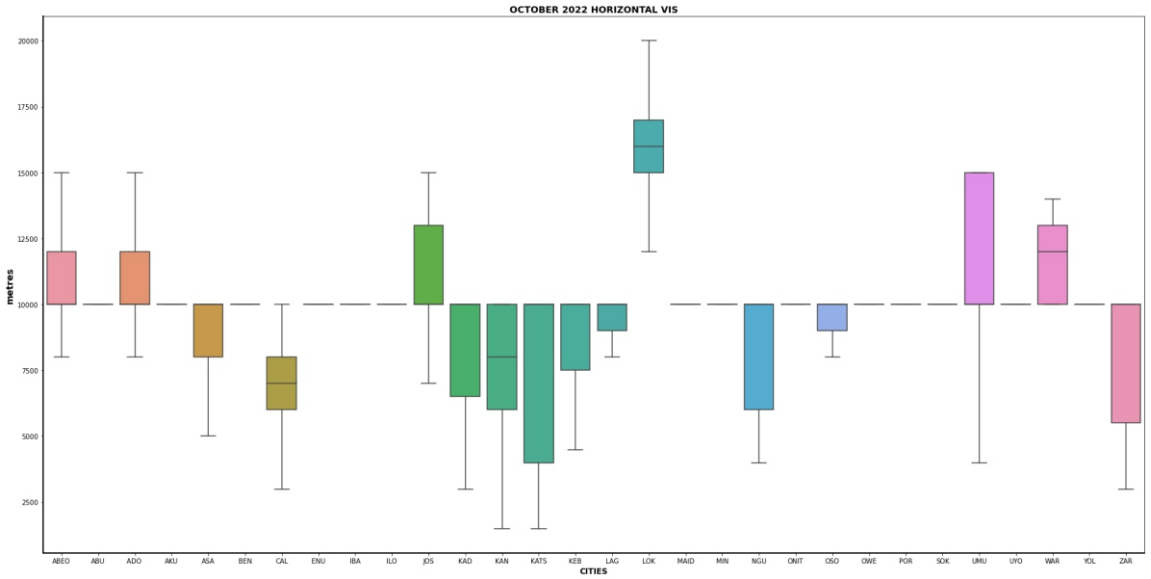

Figure 1.4: Daily Horizontal Visibility for October 2022

Figure 1.4 shows that the daily horizontal visibility value ranged from 1000m to 22000m across the country in the month of October. The lowest horizontal visibility of 1000m was observed over parts of Kaduna and Kebbi states. Most of the states reported horizontal visibility values of 5000m and above, while few states like Kaduna, Kano, Katsina, Kebbi, and Rivers recorded visibility between 1000m to 2000m as shown in Table 3. The reduction in horizontal visibility over the northern

states was as a result of incursion of dust particles into the region from the Sahara Desert. However, the reduction in horizontal visibility over part of Rivers was as a result of rain that occurred during the morning hours of 7th October which reduced the visibility to 2000m

Table 3: Stations with Horizontal Visibility between 1000 and 2000m in October 2022

VISIBILITY (m)	LOCATIONS	DATE	TOTAL NUMBER OF DAYS
1000-2000m	Kano, Katsina, Port-Harcourt.	7^{th},12^{th},15^{th},16^{th},18^{th}, 25^{th}, 27^{th}	7

As shown in Table 3, horizontal visibility was good across the country in October 2022, except for parts of Kano, Katsina and Rivers states which observed visibility between 1000m to 2000m in a total number of seven (7) days in the month.

1.7 Mean Concentration of Nitrogen Dioxide (NO2) in October 2022

As shown in Figure 1.5, the monthly mean concentration of NO2 across Nigeria in October 2022 ranged from 1.0 to 13.1 µg/m3 across the country. The Eastern States, with partial coverage over areas in Niger, Enugu, Kogi, Ekiti, Ondo, Taraba, Gombe, Bauchi, Yobe, Plateau, Nasarawa, Bayelsa, Ebonyi, Cross River, Zamfara, and Adamawa States, recorded the lowest concentrations, falling within the range of 1.0 to 4.0 µg/m3. Conversely, the Central states, including FCT, Kaduna, Kwara, Imo, Rivers, Katsina, Kano, Jigawa, Abia, Oyo, Osun, and some parts of Ondo, Edo, Delta, Bayelsa, Anambra, Sokoto, and Zamfara, observed NO2 concentrations between 4.0 and 8.0 µg/m3. Higher concentrations ranging from 8.0 to 13.1 µg/m3 were noted in parts of Ogun and Lagos, with vehicular emissions and industrial activities likely contributing to these elevated levels. It is essential to note that prolonged exposure to NO2 can have adverse health effects, including damage to the respiratory tract, increased vulnerability to respiratory infections, asthma, and chronic lung diseases. Additionally, it may impact the senses by diminishing the ability to smell or detect odors. However, it is noteworthy that the highest monthly mean NO2 concentration observed remained below the WHO's 2021 recommended standard of 25 µg/m3 in 24 hours.

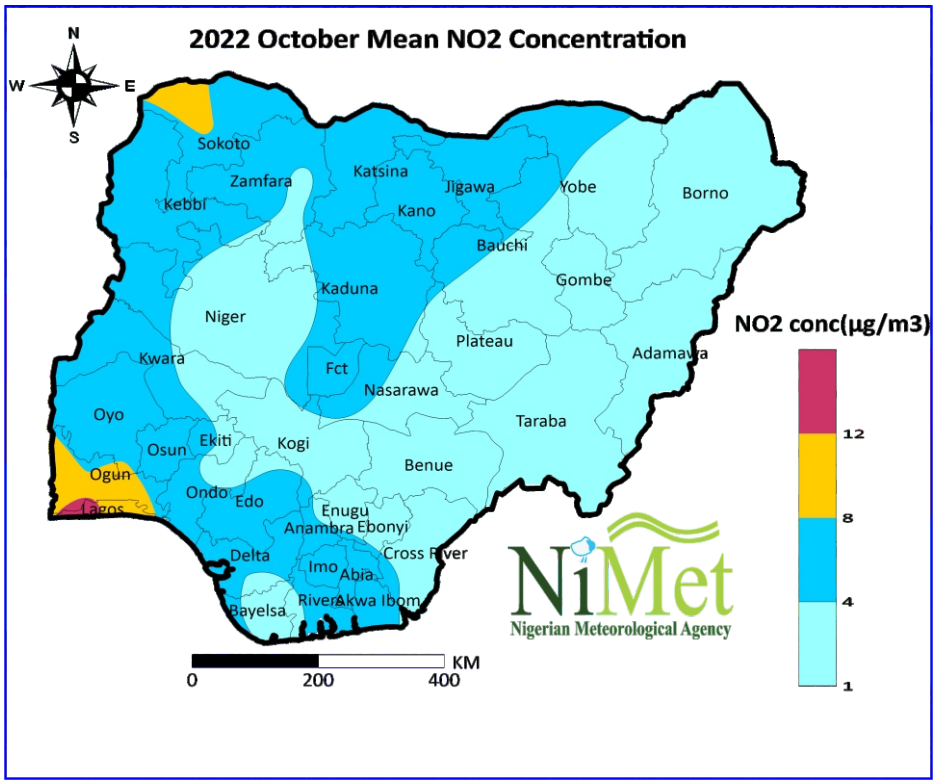

Figure 1.5: Mean Monthly Nitrogen Dioxide (NO2) Concentration across Nigeria in October 2022

1.8 Concentration of Carbon Dioxide in October 2022

As shown in Figure 1.6, the monthly mean concentration of CO in October 2022 ranged from 100 to 350 parts per billion by volume (ppbv), equivalent to 0.115 to 0.4025 milligrams per cubic meter (mg/m3) across the country. The lowest concentrations, falling within the range of 100 to 200 ppbv (0.115 to 0.23 mg/m3), were observed in northeastern cities such as Nguru and Dutse, as well as Yenegoa in the South-South region. Conversely, the highest concentrations of 350 ppbv and above were noted over parts of Kwara, Osun, and Oyo States. Most states recorded CO concentrations ranging from 200 to 250 ppbv (0.23 to 0.29 mg/m3), while Kebbi, Zamfara, Kaduna, FCT, and parts of Nasarawa, Edo, Kogi, Enugu, Anambra, Ogun, Kano, Niger, Ekiti, and Ondo States registered concentrations between 250 and 300 ppbv (0.2875 and 0.345 mg/m3). Niger, Ekiti, and parts of Osun States recorded CO concentrations ranging from 300 to 350 ppbv (0.345 to 0.4025 mg/m3). It is noteworthy that the observed range of CO values (100 to 350 ppbv or 0.115-0.4025 mg/m3) across the country, when compared to the World Health Organization

(WHO) air quality guidelines of 4 mg/m3 for a 24-hour period, indicates that CO levels in October remained generally below the recommended guidelines.

Carbon monoxide (CO) is an odorless, colorless gas, its silent nature poses a significant threat, capable of causing rapid harm before detection. It that can be lethal at high concentrations. When inhaled, CO binds to hemoglobin in the blood, reducing the amount of oxygen that can be transported to vital organs. At moderate levels, CO exposure leads to symptoms like dizziness, confusion, and fatigue. But at very high concentrations, such as those possible in enclosed spaces with poor ventilation, CO poisoning can cause unconsciousness and death within minutes. The health risks of CO are greater indoors, where dangerous accumulation of the gas is more likely. But outdoor air quality can also be impacted by high CO levels near emission sources like vehicles, generators, and industrial operations. Limiting exposure and using CO detectors can provide protection from this toxic gas.

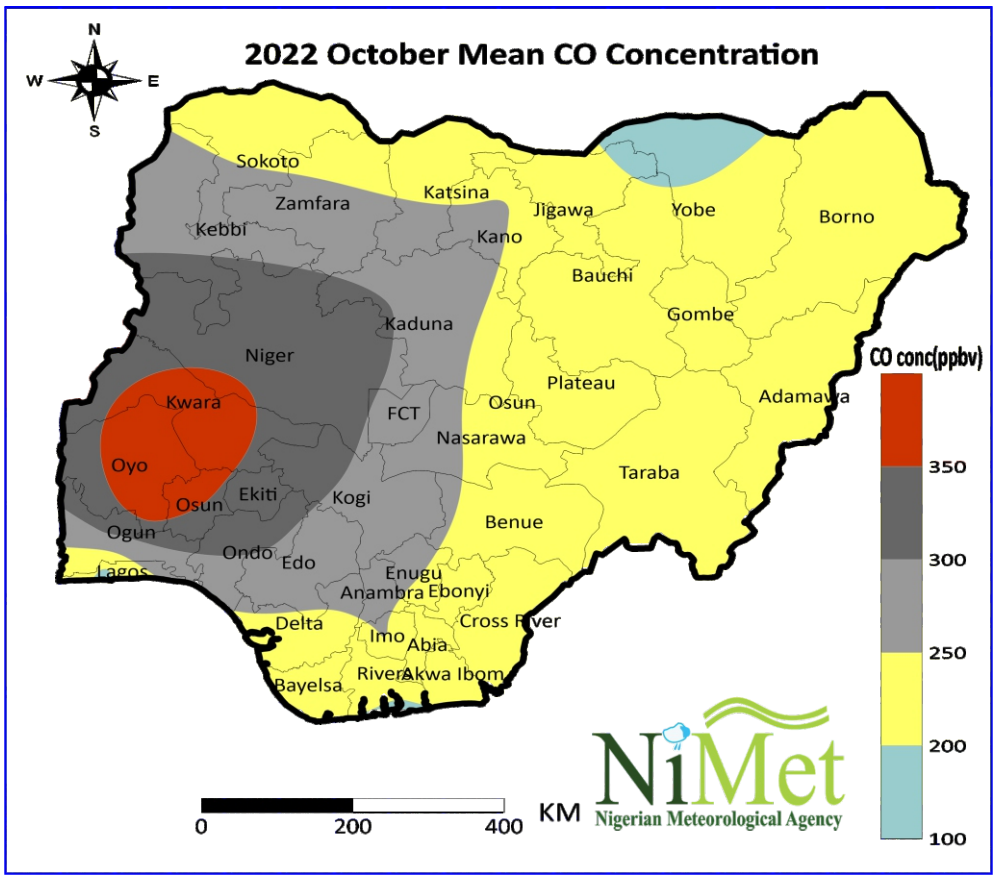

Figure 1.6: Mean Carbon Monoxide Concentration Over Nigerian Cities in OCT 2022

CHAPTER TWO
2.0 November 2022 Review

2.1 Position of the Inter-Tropical Discontinuity (ITD) in November 2022 and the Effect on Rainfall

In November, the Inter-Tropical Discontinuity (ITD) shifted between Latitude 7°N and 12°N in the west and from 5°N and 9°N in the east of the country within the month. Figure 2.1 illustrates the mean monthly position of the ITD, which subtly inclined downward from the left (west) to the right (east). The average position was noted to be at latitude 8.1°N during the month, presenting a southward shift from the previous month's mean position of 12.5°N. This observed position was also lower than the long-term normal mean position (indicated by the red line) of 11.5°N for the month. This lower-than-average position favoured rainfall in the southern parts of the country. In contrast, northern and central states experienced a cessation of rainfall, resulting in dry and dusty atmospheric conditions. The observed lower position of the ITD contributed to a drier and dustier atmosphere in the North and central regions, highlighting the distinct climatic conditions experienced across the country during this period.

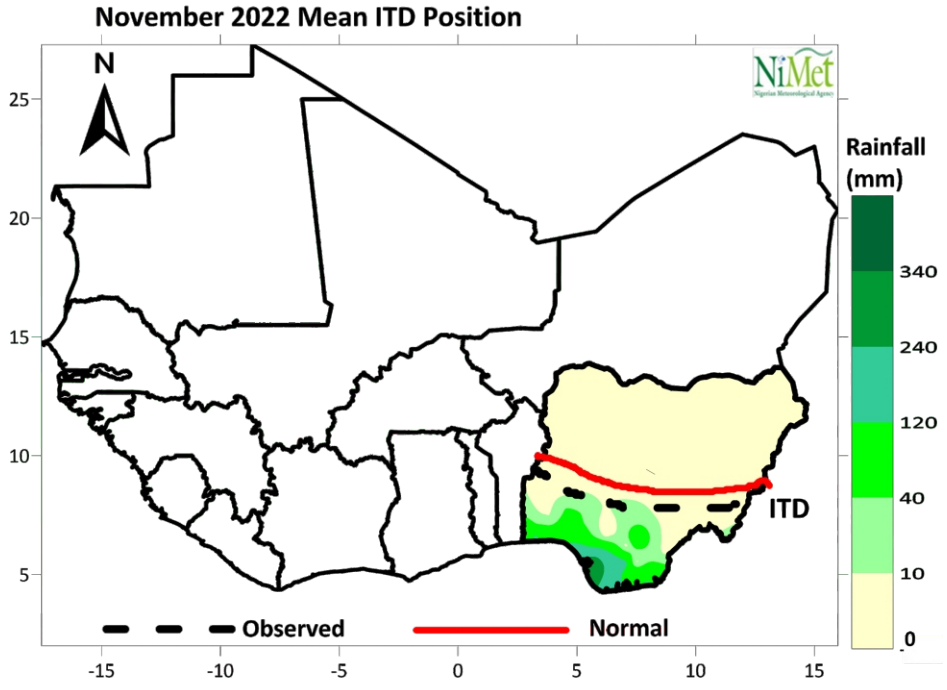

Figure 2.1: ITD position and rainfall in November 2022

2.2 Mean Sea Level Pressure (Azores and St. Helena Highs)

Daily mean values of the Azores mean sea level pressure system varied from 1015 to 1034 hPa with a monthly mean center value of 1022 hPa. The St. Helena high pressure system also maintained a monthly mean center value of 1022hPa with daily variations between 1021 and 1035 (Figure 2.2).

The extent of the 1015 hPa isoline also fluctuated between 0ON and 10 oN with a monthly mean position around Latitude 9 oN. Lower Pressure values within the country especially over the South were favorable for the rains observed in the southern part of the country during the month.

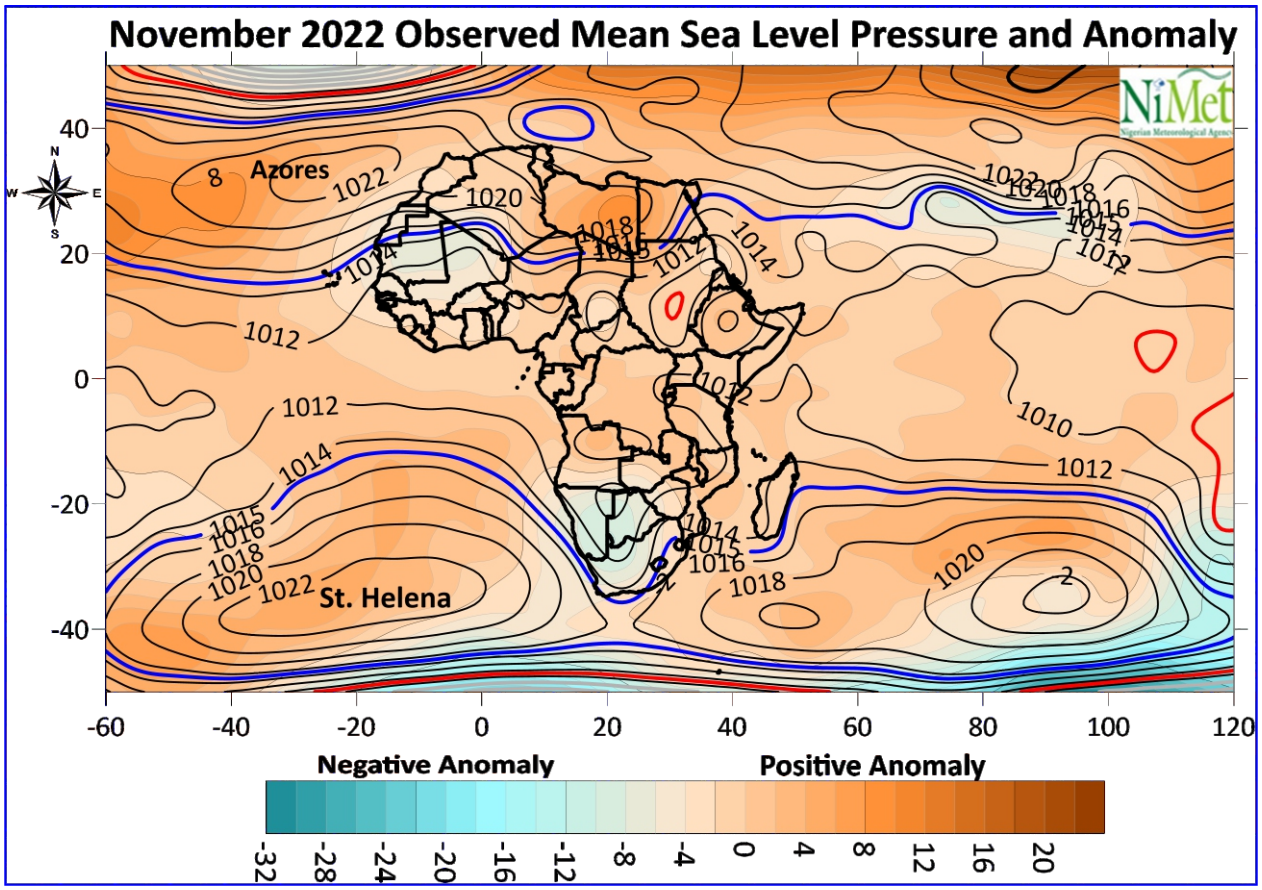

Figure 2.2 Mean Sea Level Pressure in November 2022

2.3 Winds

2.3.1 Wind at 925 hPa Level (900m above the ground level)

In November 2022, northeasterly winds dominated over the North and Central States with daily wind speeds of 5 to 30 Kts while the southwesterly flow dominated over the South with speeds of 5 to 15Kts. Only few days of the month recorded dominance of northeasterly wind direction across the entire country. The observed dry northeast trade winds transported particulate matter (PM2.5) mainly from dust into the northern parts of the country and reduced horizontal visibility to values as low as 600 to 1000m over Kano, Zaria and Nguru, and values of 1000 – 2000m over Borno, Katsina, Kebbi, and Kaduna states on some days of the month.

2.32 Winds at 850 hPa Level (about 1500 m above the ground)

Winds of northeasterly direction prevailed across the country with mean speeds of 5 to 20 kts daily and occasionally 5 to 30 Kts over the North. The dominance of northeasterly winds at this level was favourable for the observed widespread higher concentration of particulate matter in the month compared to the previous month.

2.4 Concentration of Particulate Matter (PM 2.5) in November 2022

As shown in Figure 2.3, the monthly mean concentration value recorded across the country was above 15.0 µg/m3 which is higher than the WHO 2021 recommended guidelines of 15 µg/m3 in 24 hours. Most states in the country recorded PM2.5 concentrations between 28.0 to 36.0 µg/m3, while Sokoto, Zamfara, southern Katsina, Kaduna, southern Kwara, Oyo, Osun, Ekiti and Enugu states recorded mean PM2.5 concentrations of 36.0 to 40.0 µg/m3. The highest mean PM2.5 concentration of above 40 µg/m3 was observed over parts of Osun state. Parts of Borno, Yobe, Abeokuta, Lagos, Delta, Rivers, Cross River and Akwa Ibom states experienced mean PM2.5 concentration of 22 to 28 µg/m3, while few places like the Federal Capital Territory, Bayelsa and southern Rivers state recorded mean PM2.5 concentrations of 17 to 22 µg/m3.

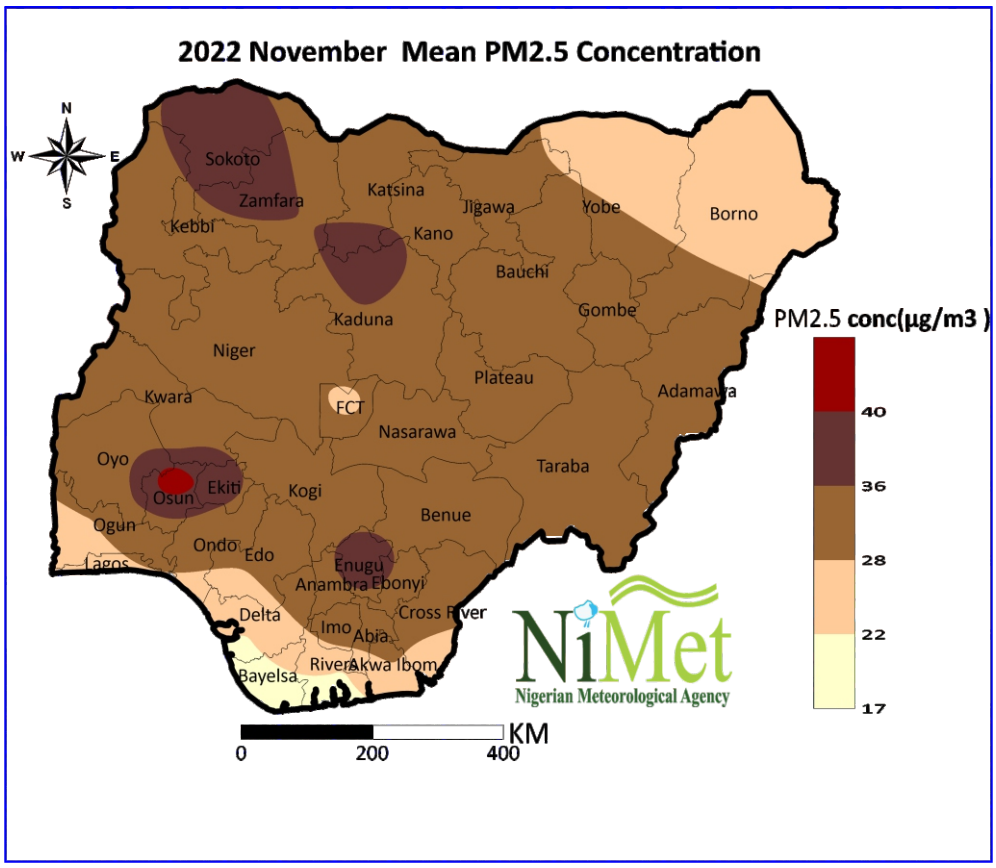

Figure 2.3: Mean concentration of Particulate Matter (PM2.5) for November, 2022.

When compared to October, the PM2.5 concentration was generally within the same range. This could be attributed to the persistent absence of precipitation during the period. The observed mean concentration of above 15 µg/m3 across the country compared to the WHO 2021 guidelines of 15 µg/m3 in 24 hours suggests that although horizontal visibility was good in most places in the country, the level of PM2.5 concentration in the atmosphere was high, hence, the quality of air in the month under review was not healthy.

2.5 Horizontal Visibility in November 2022

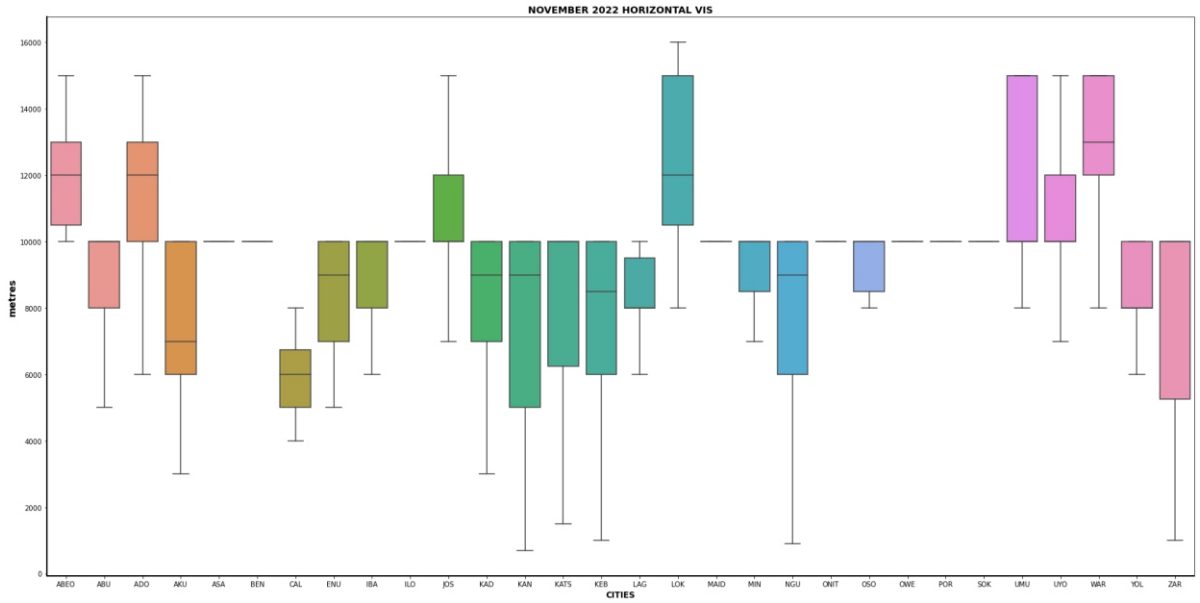

Figure 2.4: Daily Horizontal Visibility for November 2022.

As shown in Figure 2.4, the daily horizontal visibility for November 2022 was between 700m and 16000m across the country. The lowest value of 700m was observed over parts of Kano, while the highest visibility of 16000m was observed over part of Kogi. Most of the states recorded visibility of 10 km and above. However, parts of Kano and Yobe states recorded visibility of 700m and 900m respectively, while parts of Kaduna, Kano, Katsina, Kebbi, Borno, and Yobe, recorded visibility between 1000m and 2000m. This was as a result of dust particles in the atmosphere that were raised and advected from the source region into the country. The low visibility values were mostly observed over parts of the northern states of the country.

Table 3: Stations with Horizontal Visibility between 1000 and 2000m in October 2022

VISIBILITY (m)	LOCATIONS	DATE	TOTAL NUMBER OF DAYS
100-200	-	-	-
201-400	-	-	-
401-600	-	-	-
601-1000	Kano, Nguru, Zaria.	2nd,3rd	2
1000-2000	Kaduna, Kano, Katsina, Kebbi, Lagos, Maiduguri, Nguru, Port-Harcourt.	1st,2nd,3rd,4th,22nd,26th, 27th,29th,30th	9

2.5 Horizontal Visibility in November 2022

November recorded slightly lower NO2 concentrations between 1.0 to 8.0 µg/m3 across the country compared to October as shown Figure 2.5. However, the month also recorded a spatial increase of NO2 across the country. The lowest concentration of 1.0 to 2.0 µg/m3 was observed in some parts of Adamawa, Taraba, Plateau, Nasarawa, Benue and Bayelsa while majority of the states across the country observed NO2 concentration ranging from 2.0 to 4.0 µg/m3. Observed NO2 concentration from 4.0 to 8.0 µg/m3 was observed over parts of Kogi, Edo, Anambra, Imo, Rivers, Akwa Ibom, Abia Kano, Jigawa, and parts of Katsina, Kano, Sokoto, Kebbi, Kwara, Jigawa states and the FCT as shown in Figure 2.5. Parts of Lagos, Oyo, Ogun, and Osun states observed highest monthly mean concentrations that were above 8.0 µg/m3 but less than the WHO 2021 recommended standard of 25 µg/m3 in 24 hours. High levels of NO2 concentration in the environment are harmful to vegetation, damaging foliage, decreasing growth and reducing crop yields. It can also fade and discolor furnishings objects, fabrics and reduce horizontal visibility.

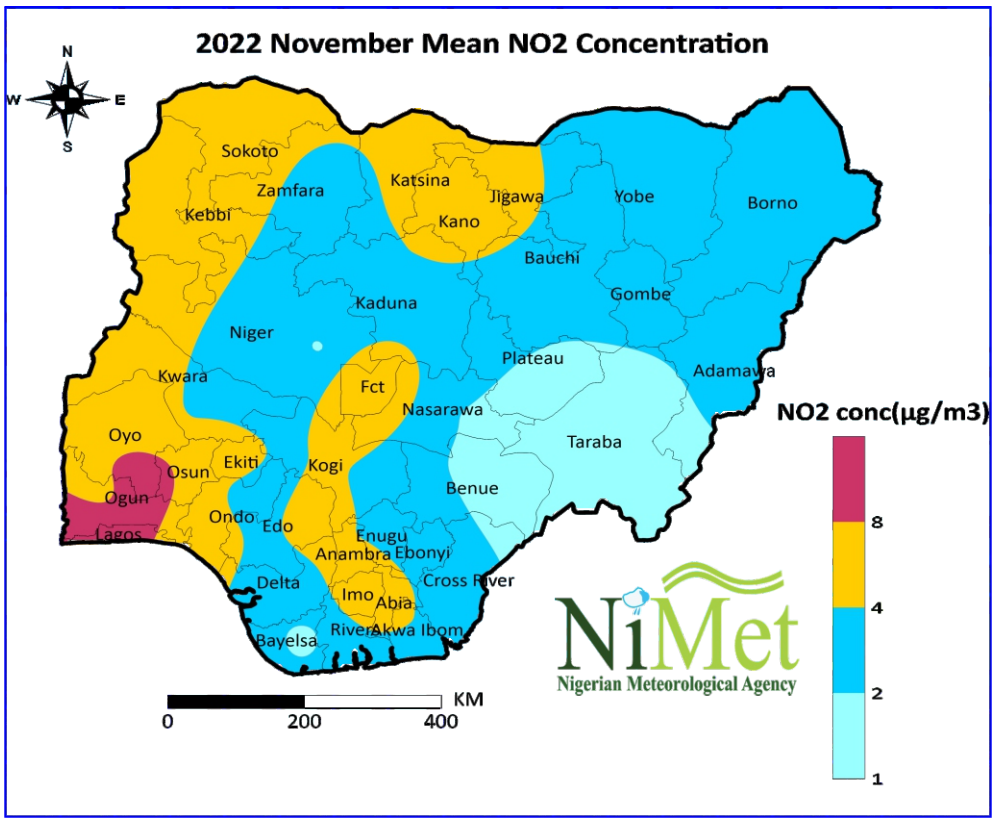

Figure 2.5: Mean Concentration of Nitrogen Dioxide (NO2) Over Nigerian Cities in November 2022

2.7 Carbon Monoxide (CO) Concentration in November 2022

Figure 2.6 shows the observed monthly mean concentration of CO across Nigeria in November 2022. Generally, the concentrations ranged from 100 to 450 ppbv (0.115 to 0.5175 mg/m3) in most part the country. The lowest concentrations of 100 to 200 ppbv (0.115 to 0.23 mg/m3) were observed in Yobe, Jigawa, some parts of Sokoto, Gusau, Katsina, Dutse, Bauchi, Nguru and Borno States, while the highest range 450ppbv and above (0.5175 mg/m3) was over parts of Oyo and Osun states. CO concentrations of 200 to 250 ppbv were recorded over Gombe, River, Akwa Ibom, Bayelsa, Plateau, and Zamfara and part of Kano, Kaduna, Kebbi and Lagos states. CO concentrations between 250 and 300 ppbv (0.2875 and 0.345 mg/m3) were recorded over Kaduna, Nasarawa, Adamawa, Taraba, Benue, Ebonyi, Imo, Abia, Delta, Cross River and parts of Kebbi States. CO concentrations of 300 to 450ppb (0.2875 and 0.5175 mg/m3) were recorded over Niger, Kwara, Kogi, Enugu, Anambra, Edo, Ekiti, Ondo, Osun, Ogun and Oyo states. The observed monthly mean CO concentration across Nigeria was lower than the WHO 2021 recommended standard of 4 mg/m3 in 24 hours.

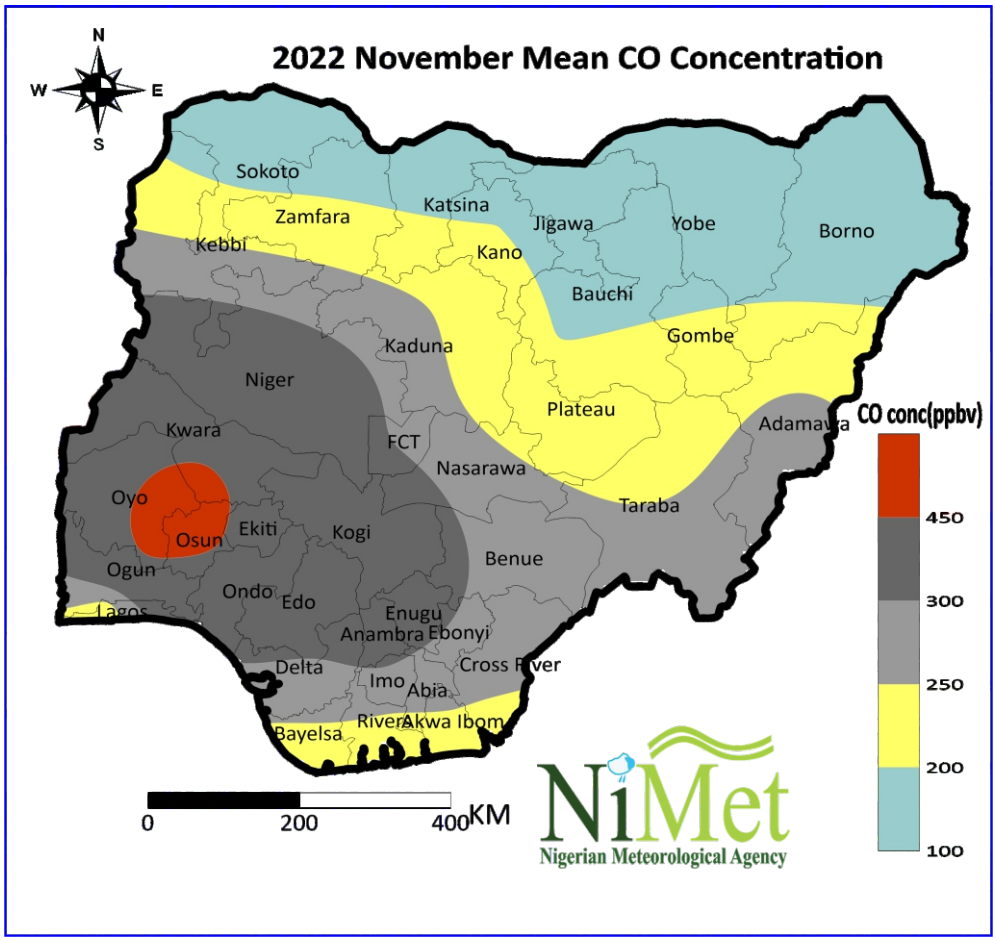

Figure 2.6: Mean Carbon Monoxide Concentration Over Nigerian Cities in November 2022

CHAPTER THREE
3.0 December 2022 Review

3.1 Position of the Inter-Discontinuity (ITD) and Rainfall in December 2022

The position of the Inter-Tropical Discontinuity (ITD), the convergence zone where arid winds from the desert meet moist winds from the Atlantic Ocean, exhibited variability across Latitude 6 to 11°N in the west and 4 to 9°N in the east of the country throughout the month. The mean monthly position of the ITD was observed at 7.3°N (See to Figure 3.1). It underwent a gradual retreat, starting at Latitude 8.3°N in the 1st dekad, progressing to latitudes 7.6°N and 6.0°N in the 2nd and 3rd dekads of December, respectively. The average position for the month was below the long-term normal and also lower than the previous month's mean of 8.1°N. Despite this, the position remained conducive to rainfall over the coastal region, while other parts of the country experienced dry conditions due to the dominance of dry northeasterly trade winds.

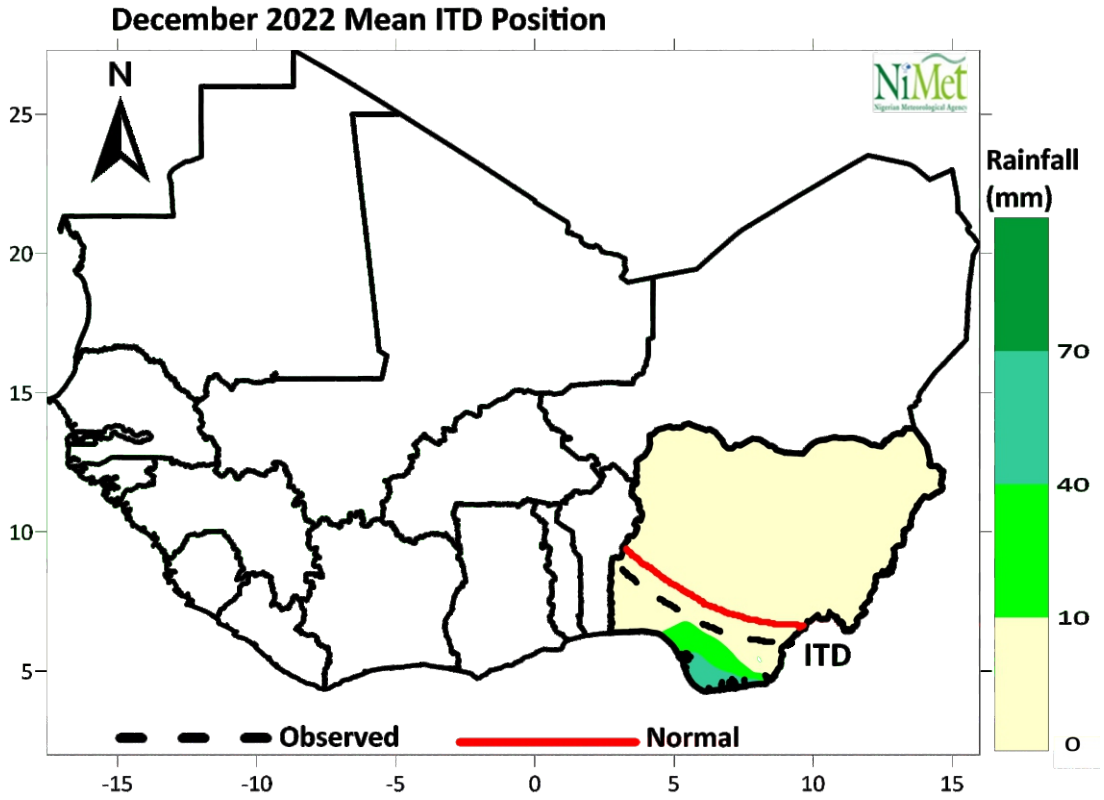

Figure 3.1: ITD position and rainfall in December 2022

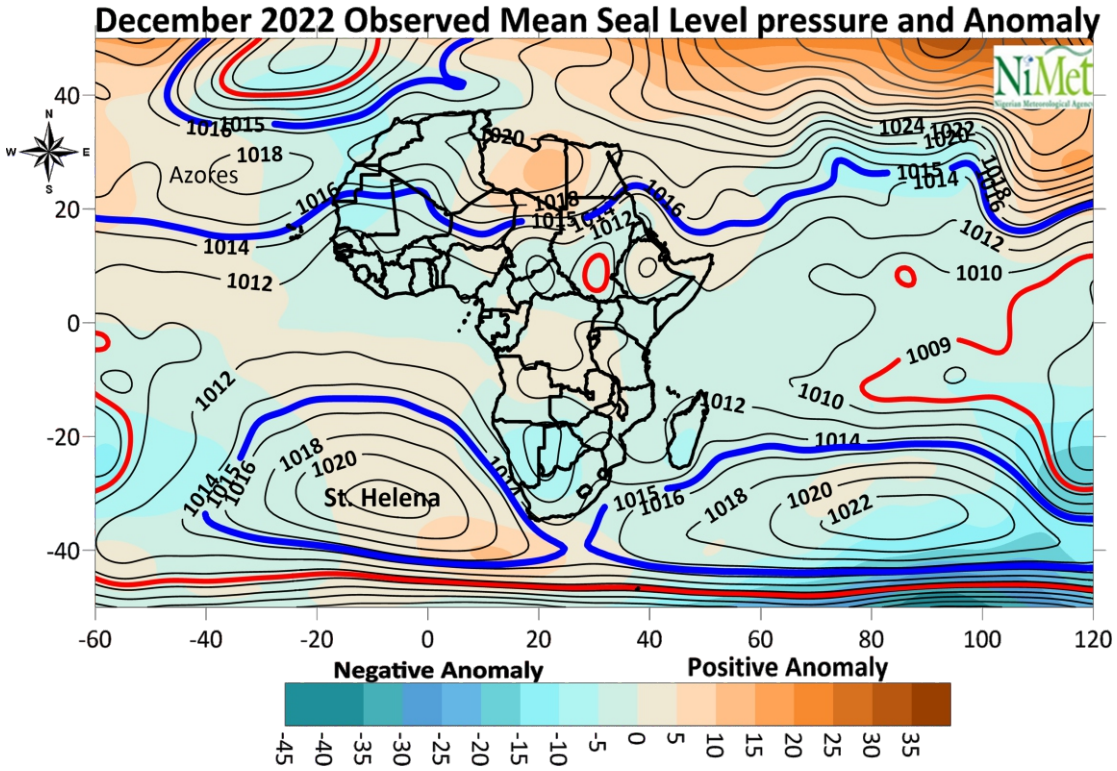

Figure 3.2 Mean Sea Level Pressure in November 2022

3.3 Winds

3.31 Wind at 925 hPa Level (900m above the ground level)

In the first 20 days of the month, dry northeast trade winds at 950 hPa, ranging in speed from 5 to 35 knots, prevailed over the North, Central, and inland areas of the South. Simultaneously, moist winds in a southwesterly direction, with speeds of 5 to 25 knots, influenced the coastal regions, occasionally extending inland. However, a significant shift occurred in the last 10 days (3rd dekad) of the month, marked by the prevalence of northeasterly winds throughout the entire country. These northeasterly winds, accompanied by associated dust particles, contributed to an elevated concentration of PM 2.5 in the air. This increase in particulate matter led to a decline in horizontal visibility to below 1000 meters in the North, Central, and certain southwestern states during the month. Consequently, air quality deteriorated, particularly in the northern parts of the country, due to these atmospheric conditions.

3.32 Winds at 850 hPa Level (about 1500 m above the ground)

At this level, the entire country was overlain with dry winds in northeasterly direction with speeds which varied daily between 5 and 25 Kts during most of the days in the month. The last dekad however witnessed stronger winds with speeds up to 30 Kts. These winds were not favorable for rainfall but enhanced dust transportation to higher levels of the atmosphere.

3.4 Particulate Matter (PM2.5) Concentration in December

Figure 3.3 presents the spatial distribution of PM2.5 concentration across Nigeria for December. There is a significant shift in the highest concentration towards the southern region of the country compared to both October and November. The analysis indicates a mean concentration ranging from 27.87 to 52.64 µg/m3.

In the North and North Central regions, most places experienced a mean PM2.5 concentration ranging from 30.0 to 36.0 µg/m3. Conversely, the southern region, encompassing areas such as well parts of as Kogi, Kwara, Benue, southern Kano, southern Katsina, southern Zamfara, Kaduna, and Kebbi states, recorded a higher mean PM2.5 concentration, ranging from 36.0 to 42 µg/m3. Notably, the lowest mean value of approximately 27.87 µg/m3 was recorded over Abuja, parts of Borno, and Yobe states, while the highest mean value of 52.64 µg/m3 was observed over Onitsha, followed by Enugu (51.84 µg/m3) and Osogbo (46.92 µg/m3).

Areas such as Oyo, Osun, Ekiti, Ondo, southern Kogi, Edo, Delta, Imo, Ebonyi, and southern Benue states reported mean PM2.5 concentrations ranging from 42.0 to 48.0 µg/m3. Interestingly, Borno state, despite its proximity to the source region, reported the least amount of PM 2.5. This could be attributed to the strong local winds observed over the area, facilitating the dispersion of dust particles.

The highest mean concentration of PM2.5 of 48 µg/m3 was observed over parts of Edo, Enugu, Anambra and northern Delta states. This greatly impacted the air quality of the area, especially over Edo, Enugu and Eboyin states. The observed mean concentration of PM2.5 were above WHO threshold of 15 µg/m3 within 24 hours in all parts of the country as the minimum mean concentration of PM2.5 over the country is 27. 87 µg/m3.

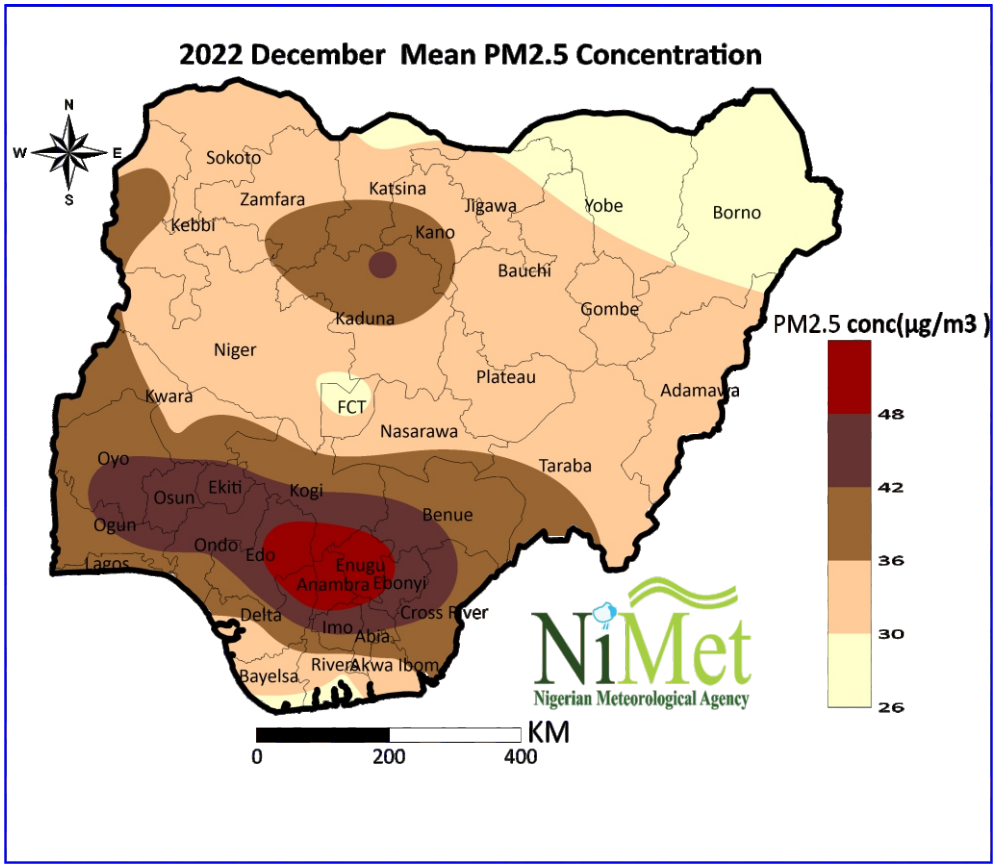

Figure 3.3: Mean concentration of Particulate Matter (PM2.5) over Nigeria in December, 2022

3.5 Daily Horizontal Visibility in December 2022

The daily horizontal visibility across Nigeria throughout December 2022 varied between 400m and 20,000m (20km). (See Figure 3.4). Notably, the frequency of days with observed visibility between 400m to 2000m was higher during the month compared to October and November. The increased occurrence of reduced visibility is attributed to the intrusion of dust particles from the Sahara Desert, amplified by the dry atmospheric conditions and the substantial volume of dust particles present impacting the air quality during the period. The air quality was mostly unhealthy during the month.

Specifically, the northern states of Kaduna, Kano, Katsina, Kebbi, Borno, Yobe, and parts of Abuja, Kwara, Kogi, as well as Edo, and Ado-Ekiti experienced visibility between 400m to 1000m on certain days, indicative of thick dust haze conditions The dates and total number of days for stations that observed horizontal visibility within the range of 400m to 1000m throughout the month are shown in Table 5. The days with poor visibility also correspond with very poor air quality.

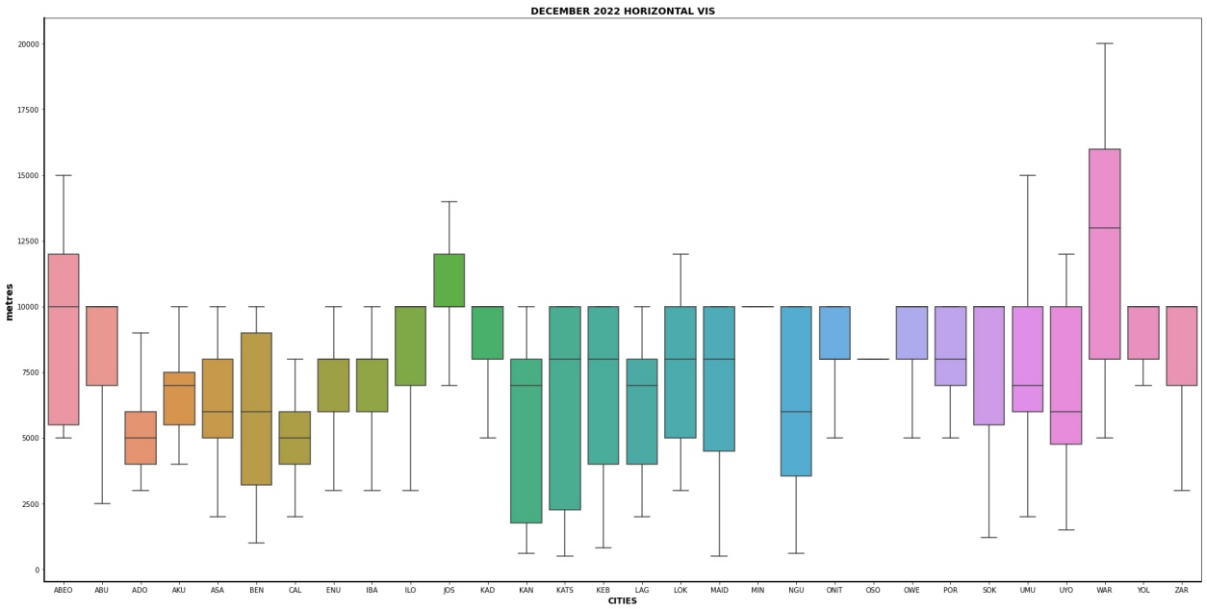

Figure 3.4: Daily Horizontal Visibility for Some Nigerian Cities in December 2022

Table 3: Stations with Horizontal Visibility between 1000 and 2000m in October 2022

VISIBILITY(m)	LOCATIONS	DATE	RANGE OF AQI	TOTAL NUMBER OF DAYS
400-600	Ado-Ekiti, Kano, Katsina, Maiduguri, Nguru.	6th,7th,8th,10th		4
601-1000	Abuja, Benin, Ilorin, Kaduna, Kano, Katsina, Kebbi, Lokoja, Maiduguri, Nguru, Zaria.	6th,7th,9th,12th,21st,26th, 28th,29th,30th,31st,		10
1000-2000	Asaba, Benin, Jos, Kaduna, Kano, Katsina, Kebbi, Lagos, Maiduguri, Nguru, Minna, Sokoto, Uyo, Umuahia.	6th,7th,8th,10th,17th, 22nd,24th,25th,27th,28th, 29th,30th,31st		13

3.6 Nitrogen dioxide Mean concentration in December 2022

Figure 3.5 depicts the spatial distribution of NO2 concentration across the country for December 2022. Despite an expanded spatial distribution, the overall concentration levels of NO2 remained consistent, ranging between 1.0 to 8.0 µg/m3 for the entire month. Most regions parts of the country exhibited concentrations between 2.0 to 4.0 µg/m3, with exceptions of Adamawa, Taraba, Benue, Niger, Nasarawa, and Plateau states, where the lowest concentrations of 1.0 to 2.0 µg/m3 were observed.

Katsina, Jigawa, and Kano, Edo, Anambra, Enugu, Imo, Rivers, Abia, Akwa Ibom, and substantial parts of the Southwest (Kwara, Oyo, Osun, Ondo, Ekiti, and Ogun states) recorded NO2 concentrations within the range of 4.0 to 8.0 µg/m3. Remarkably, Lagos consistently reported NO2 concentrations of 8.0 µg/m3 and above. It is noteworthy that, although these concentrations were generally lower than the WHO 2021 recommended standard of 25 µg/m3 in a 24-hour period, Lagos exhibited concentrations. This is due could be attributed emissions from motor vehicles and and other industrial activities over Lagos.

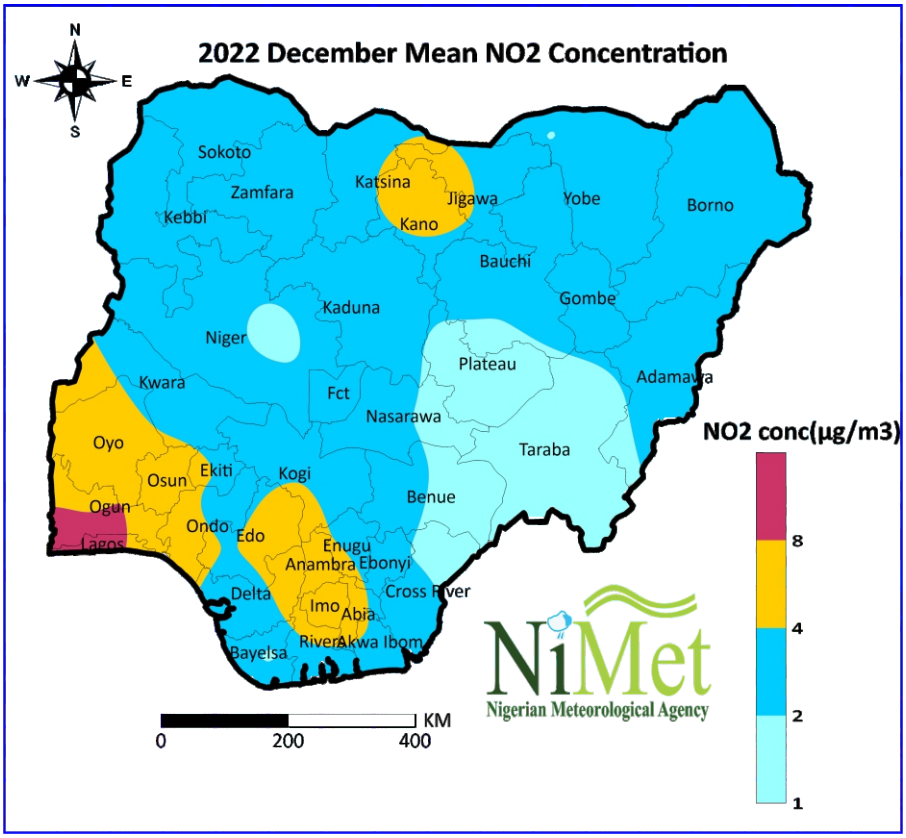

Figure 3.5: Mean NO2 Concentration Over Nigerian Cities in December 2022

3.7 Mean Carbon Monoxide (CO) Concentration over Nigeria in December, 2022

Figure 3.6 illustrates the observed monthly mean concentration of CO, indicating a general range from 100 to above 450 ppbv across the country. The lowest concentrations, ranging from 100 to 200 ppbv, were noted in specific areas of Sokoto, Katsina, Kano, Nguru, Jigawa, Bauchi, Yobe, Borno, and parts of Zamfara and Gombe States. In contrast, the highest concentration range of 450 ppbv and above was observed over Ekiti, Osun, Oyo, Ondo, Ogun, and parts of Edo and Lagos States.

The majority of states recorded CO concentrations within the range of 200 to 300 ppbv. Concentrations between 300 and 400 ppb were observed in Niger, Enugu, Ebonyi, Cross River, Imo, Abia, Delta, Bayelsa, Rivers, Akwa Ibom, and parts of Anambra and Kogi states. Notably, Kwara and parts of Kogi, Edo, and Lagos States, recorded concentrations between 400 and 450 ppbv. It is important to highlight that the observed monthly mean concentration, exceeding 1.0 µg/m3, was generally lower than the WHO 2021 recommended standard of 4.0 µg/m3 for a 24-hour period across most states.

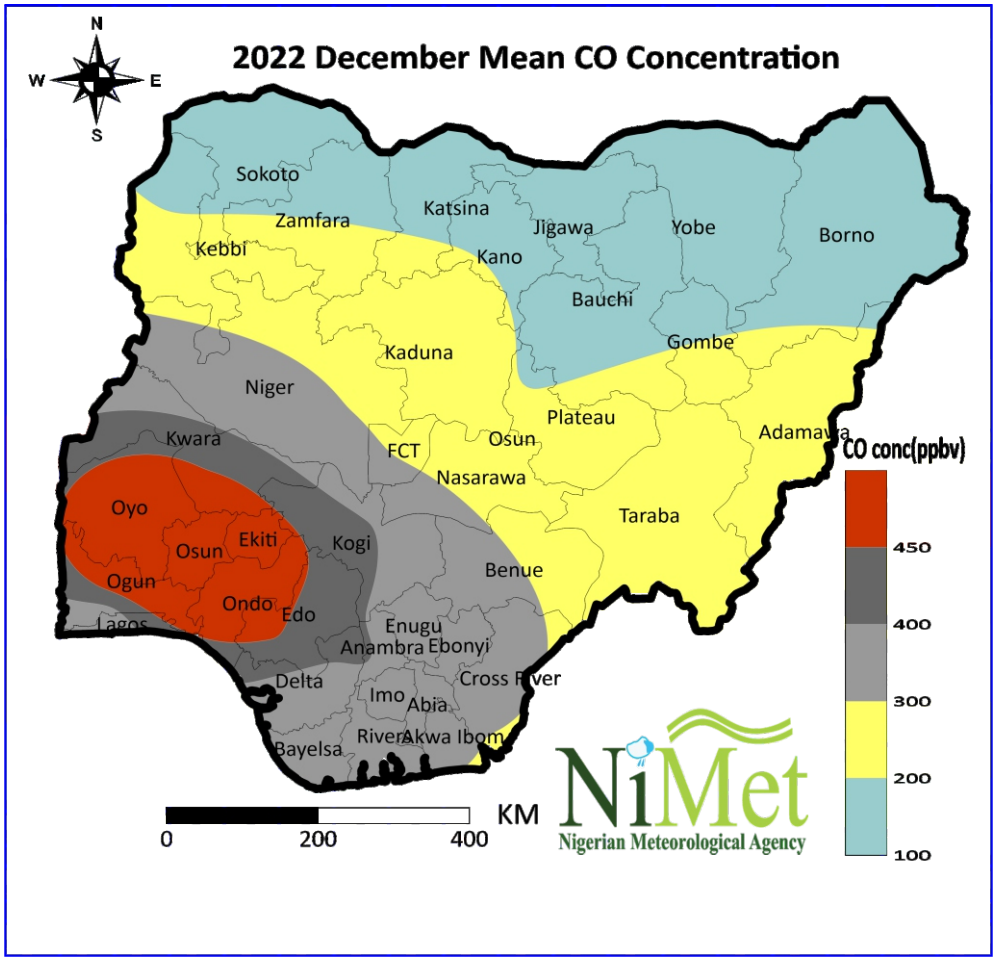

Figure 3.6: Mean Carbon Monoxide Concentration Over Nigerian Cities in December 2022

CHAPTER FOUR

4.0 Quarterly Changes: October-November-December

4.1 Observed ITD Positions in October - December 2022

During the fourth quarter of the year (October, November, December), the ITD fluctuated between latitudes 16.4ON and 36.0ON. It progressively retreated southwards during the period from a mean position of 12.5 ON in October to 8.1 ON in November and 7.3 ON in December (Figure 4.1). The ITD attained its northernmost position in October while its southernmost position within the quarter was recorded in December with the prevalence of dust over places north of the ITD and this consequently impacted the air quality during the month. The observed monthly mean position was south of the climatological average position during the period.

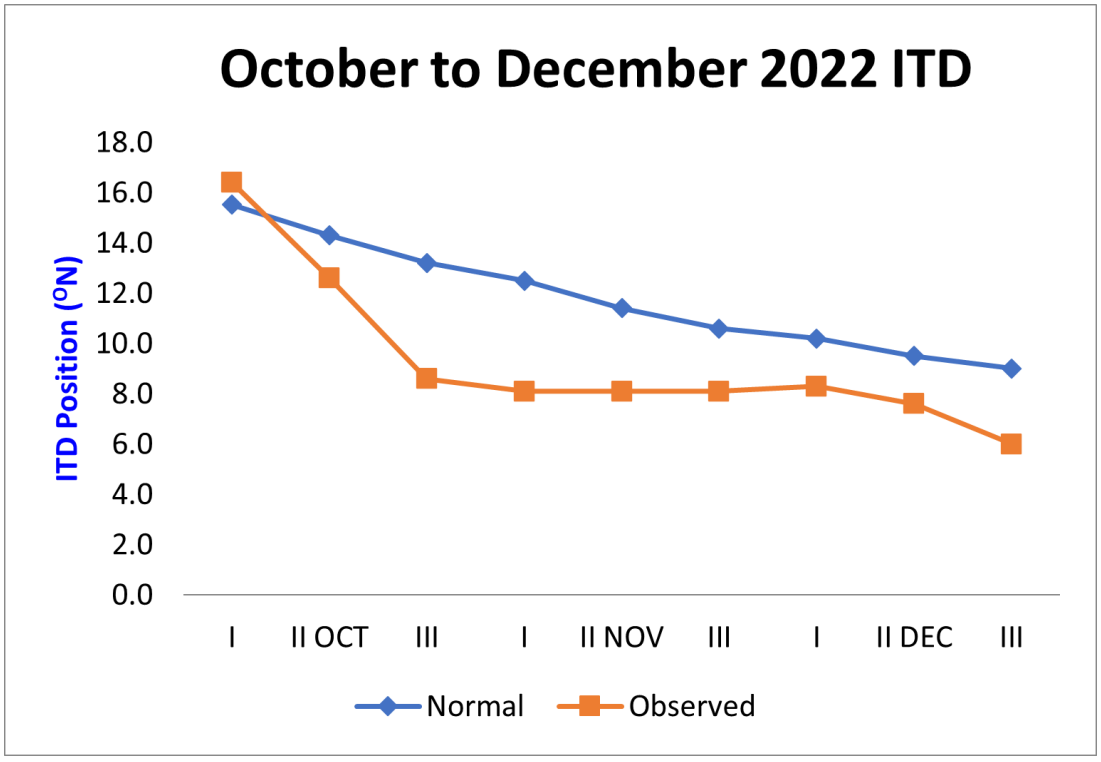

Figure 4.1: ITD position during the 4th Quarter of 2022

4.2 Observed Quarterly changes in Mean Sea Level Pressure and Winds (October - December 2022)

The Mean Sea Level Pressure of Azores High Pressure System intensified from 1020 hPa in October, to 1022 hPa in November and then weakened to 1018 hPa in December while values over St. Helena High Pressure System maintained a mean center value of 1022 hPa during the 4th quarter of the year. The extent of the 1015 hPa isobar maintained a mean position of 10oS during the period. Winds at 925 hPa were dominantly northeasterly over the North and Central States of Nigeria, but southwesterly over the South with mean daily wind speeds of 5 to 35 Kts. At 850 hPa levels winds were generally northeasterly across the country with mean daily speeds of 5 to 30 Kts. These conditions were favorable for dust transportation from the desert into the country. This led to the poor horizontal visibility recorded during the 4th quarter, especially over the northern States in November and December. The southwesterly winds observed over the south were however favorable for rainfall over the region during the period.

4.3 Mean Particulate Matter PM2.5 Concentration from October to December 2022

Figure 4.2 provides a spatial analysis of the mean concentration of particulate matter PM2.5 from October to December 2022. The analysis identifies hotspots with the high concentrations of PM2.5 in the North-Western region, inland cities of the South-East, and the South-West. Specifically, parts of the North-West, including areas in Katsina, Kano and Kaduna states. Oyo, southern Kwara, Ekiti, Osun, southern Kogi, Edo, Anambra, Ebonyi, Imo, and Abia states reported mean PM2.5 concentrations of 35 to 40 µg/m3. The highest value above 40 µg/m3 were reported in parts of Osun, Ekiti and Kaduna states. The rest of the country reported mean PM2.5 concentrations ranging from 25 to 30 µg/m3, particularly over the Federal Capital Territory, Borno, Yobe, Niger, southern Delta, northern Rivers, Cross River, Akwa Ibom, and southern Taraba states. The lowest concentrations of PM2.5, ranging from 22 µg/m3 to 25 µg/m3, were reported over Bayelsa and Port Harcourt. It is noteworthy that, overall, PM2.5 concentrations across the country during this period exceeded the WHO air quality guidelines of 15 µg/m3 in 24hours. PM2.5 particles are small enough to be inhaled deep into the lungs, causing respiratory problems, aggravating

conditions like asthma, and increasing the risk of cardiovascular diseases. Long-term exposure to high PM2.5 levels has been linked to increased mortality rates, lung cancer, and other chronic diseases. Therefore emissions control measures for industrial and transportation sources, promotion of clean energy sources, urban planning to reduce pollution hotspots, and public awareness campaigns is necessary to mitigate the impact of high level of PM 2.5 across Nigeria.

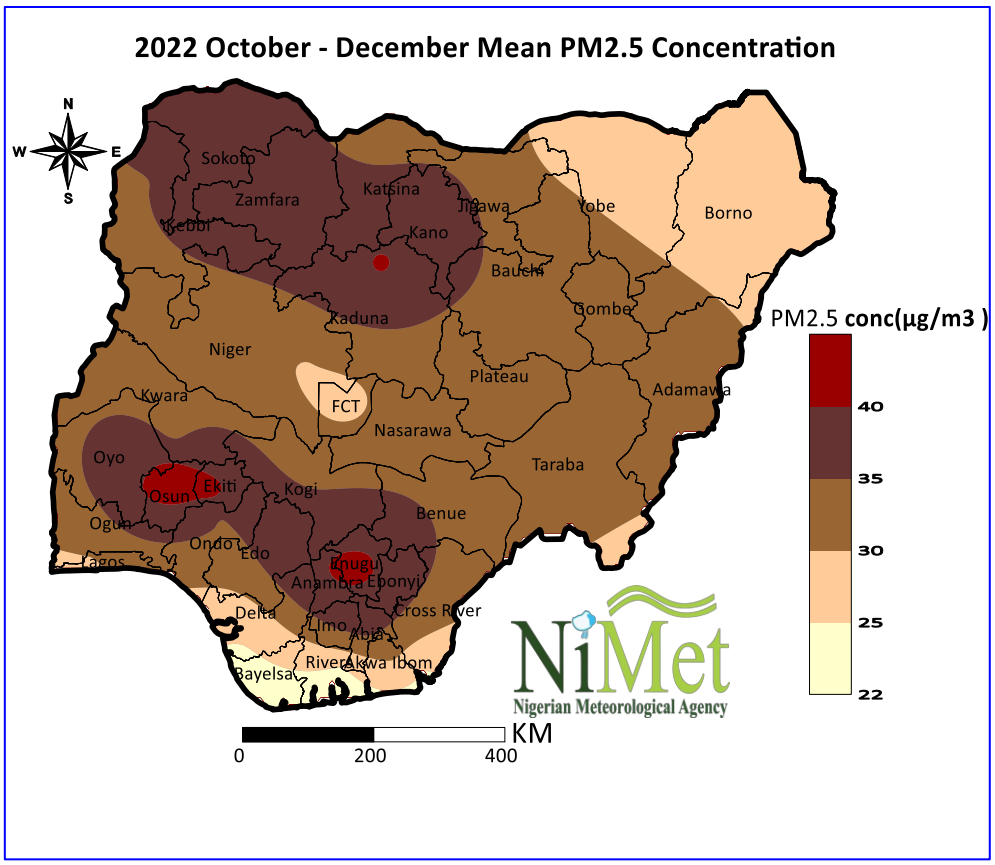

Figure 4.2 Mean Particulate Matter PM2.5 Concentration from October to December 2022

4.4. Daily Concentration of Particulate matter (PM2.5) over cities in Southern Nigeria from October to December 2022

As shown in Figure 4.3, majority of urban areas in the southern states of the country observed PM2.5 concentrations ranging between 15 µg/m³ and 78.75 µg/m³ during the assessed months fourth quarter of 2022. Port Harcourt recorded the lowest PM2.5 concentration at 11.75 µg/m³ on October 5, 2022, while Enugu registered the highest concentration at 98.75 µg/m³ on December 21, 2022. The Southern region

experienced its peak PM2.5 concentrations in December, primarily due to the influence of the harmattan season characterized by dust-laden northeasterly trade winds. A noteworthy factor in this scenario was the relatively weaker winds prevalent in the southern part of the region compared to the northern areas. This disparity in wind strength allowed the dust to accumulate and persist in the atmosphere for an extended duration, exacerbating the health risks of the overall PM2.5 concentrations. In contrast, November and October experienced comparatively lower PM2.5 levels. Moreover, the festive season in December intensified anthropogenic activities, further exacerbating the concentration of PM2.5 pollutants in the air. Throughout the Southern cities, daily PM2.5 values consistently exceeded 15 µg/m³ over a 24-hour period. Considering the World Health Organization's threshold of 15 µg/m³, individuals in the Southern region faced significant health risks due to PM2.5 exposure.

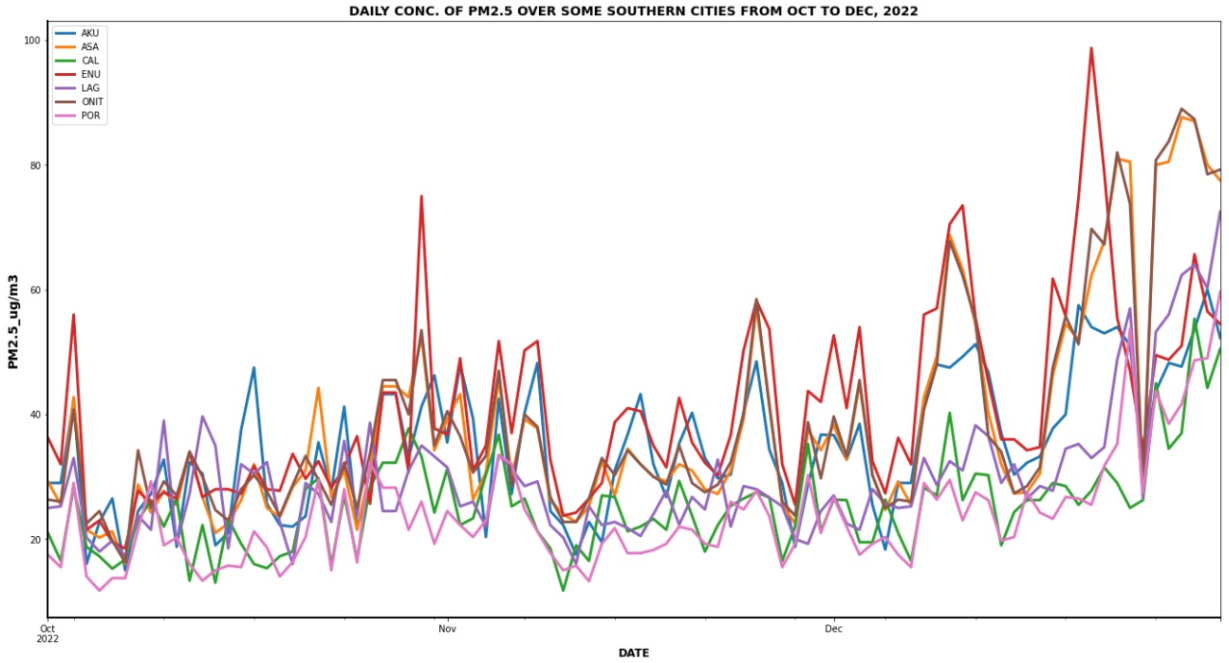

Figure 4.3: Daily concentration of particulate matter (PM2.5) over cities in Southern Nigeria from October to December, 2022

4.5 Daily concentration of Particulate matter (PM2.5) Over cities in the Northern Nigeria from October to December 2022

The northern region recorded a range of PM2.5 concentrations from 16 µg/m³ to 53 µg/m³ as shown in Figure 4.4. The highest PM2.5 concentration occurred in October, attributed to turbulent weather conditions marked by strong winds. This atmospheric turbulence led to the significant lifting of dust, resulting in heightened PM2.5 levels across most northern cities. In contrast, November and December witnessed a progressive decline in PM2.5 concentrations in these cities.

During December, the presence of strong north-easterly trade winds in the region, facilitated the rapid transport of dust from the north to the south. Abuja recorded the lowest PM2.5 concentration of 13.5 µg/m³ on October 4, 2022, while Kano experienced the highest concentration at 57.75 µg/m³ on October 10, 2022. Despite the fluctuations, daily PM2.5 values consistently surpassed the World Health Organization's threshold of 15 µg/m³ over a 24-hour period in most northern cities. This elevated exposure to PM2.5 in the region also increased the health risks for residents during the observed period.

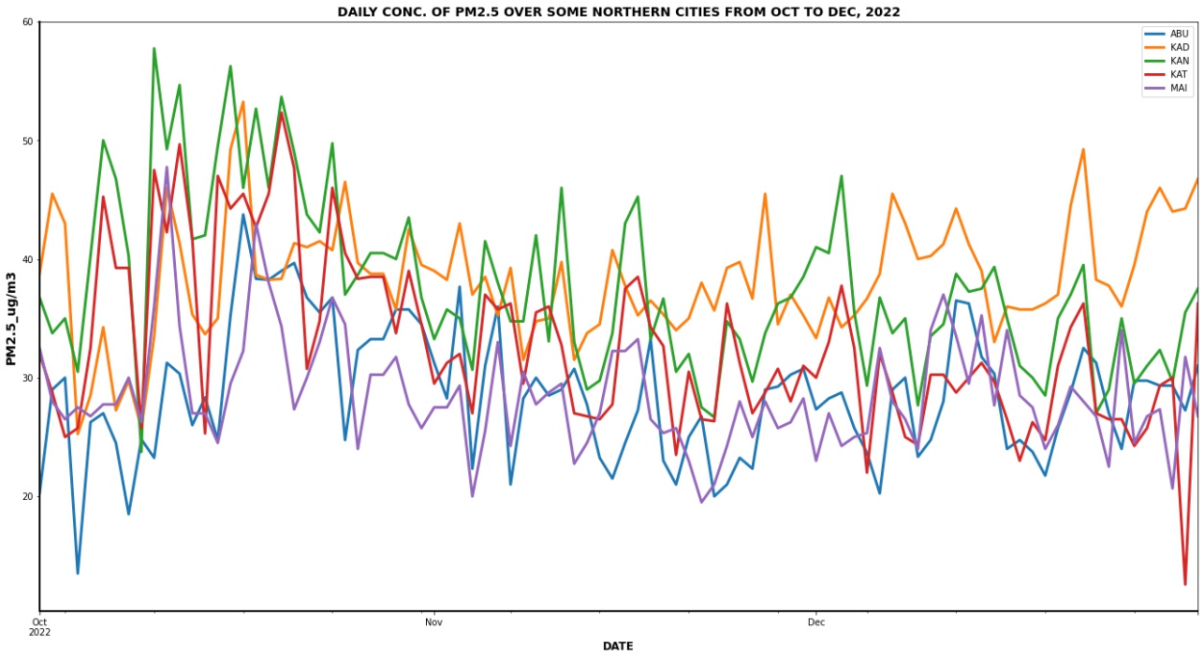

Figure 4.4: Daily concentration of particulate matter ($PM_{2.5}$) over cities in Northern Nigeria from October to December, 2022

4.6 PM2.5 concentration over some cities in Nigeria from October to December 2022

Figure 4.5 compares the average PM2.5 concentration of cities from October to December. The analysis shows that average PM2.5 concentration was highest in December over most cities of the country especially in southern cities such as; Asaba, Enugu, Ibadan, Osogbo, and Onitsha. Onitsha, Enugu and Asaba recorded the highest values above 50µg/m3 followed by Ibadan (47.0µg/m3) and Osogbo (42.2 µg/m3). In the North, Katsina recorded the highest average concentration values of 46.22 µg/m3 in October followed by Kano. The lowest average concentrations of 19.45 µg/m3 and 21.23 µg/m3were however recorded over Port Harcourt and Warri respectively in October. The observed average daily values were above WHO threshold of 15 µg/m3 in 24 hours over most cities which suggest that people in these areas were exposed to high health risks of PM2.5 concentration.

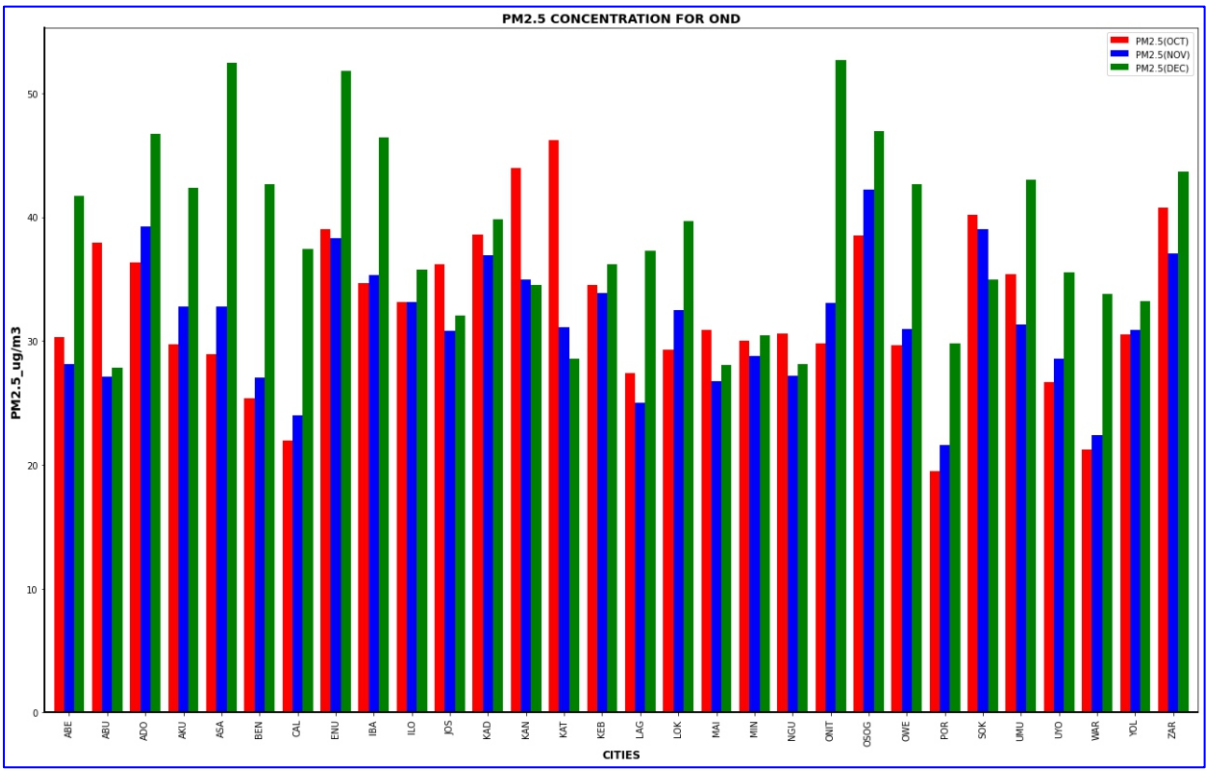

Figure 4.5: PM2.5 concentration over cities in Nigeria from October to December 2022

4.7 Mean Concentration of Nitrogen Dioxide (NO2) for October to December 2022

As shown in Figure 4.6, Lagos and parts of Ogun and Oyo states recorded highest concentration of NO2 during the last quarter of 2022 from October to December with values ranging from 8.0 to 11.0 µg/m3. Part of Kebbi, Zamfara, Jigawa, Ekiti, Rivers, Ogun, Cross River, Ondo, Kwara, Kano, Delta, Kogi, Oyo, Edo, Imo, Abia, Osun states, and the FCT reported concentration values ranging from 4.0 to 8.0 µg/m3, while parts of Borno, Yobe, Gombe, Bauchi, and Adamawa extending to most part of Kaduna, Zamfara, Plateau, Niger, Kogi, Nasarawa, Enugu, Ebonyi, Cross River, Bayelsa, Delta, and Kwara states observed NO2 concentrations between 2.0 to 4.0 µg/m3. The remaining parts of the country reported lower NO2 concentrations between 1.0 to 2.0 µg/m3. Overall, the observed October to December mean NO2 concentrations were below the WHO recommended standard which posed no serious health risks to persons.

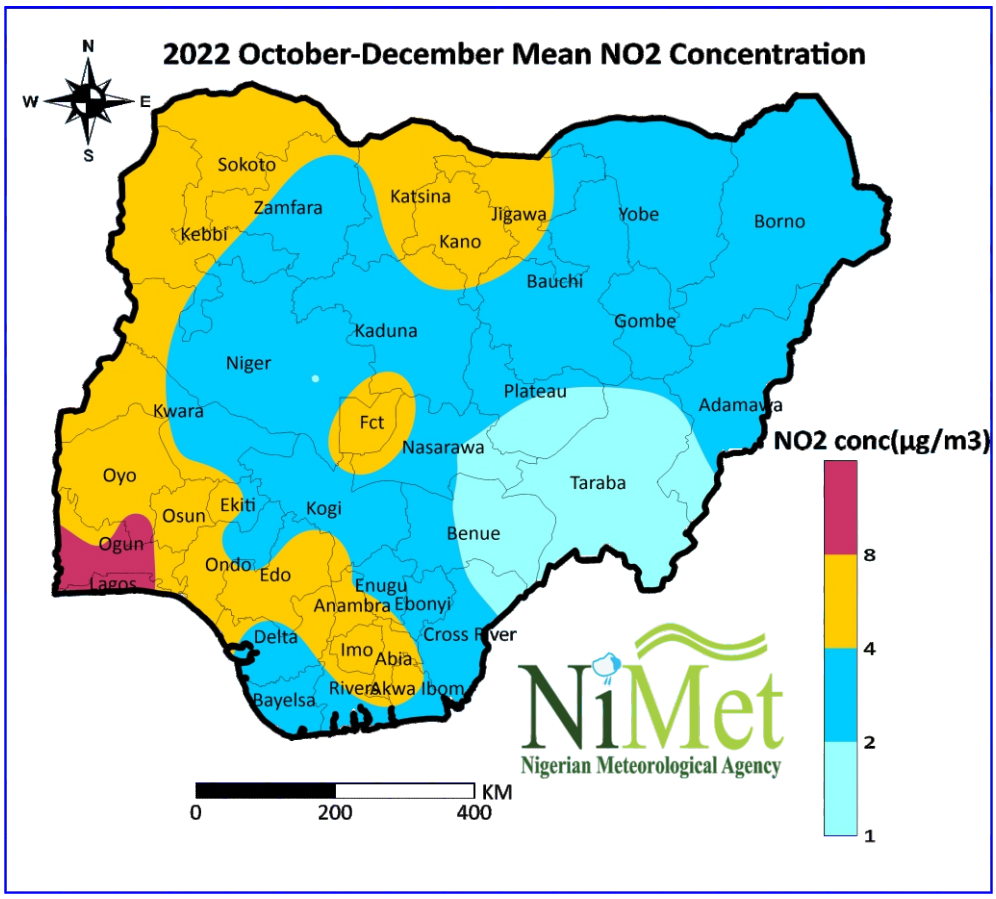

Figure 4.6: Mean concentration of Nitrogen Dioxide (NO2) for October to December 2022

4.8 Daily Mean NO2 concentration from October to December 2022 over Northern Nigeria

During the period under review, selected cities in the northern states recorded average daily NO2 concentrations between 2 and 10 µg/m3. Abuja however observed the highest daily value of 51.72 µg/m3 during the last quarter of the year in October 2022 while Nguru recorded the lowest concentration between 0.93 to 7.44µg/m3 during the period. Generally, the observed average daily NO2 concentration during the period over the northern cities was lower than the WHO recommended threshold of 25 µg/m3 in 24hours. However, two cities (Sokoto and Abuja) recorded concentrations above 40 µg/m3 in October within 24 hours. Since this concentration is higher than WHO recommended threshold of 25 µg/m3 in 24 hours and therefore considered a significant threat to health of the people living in Sokoto and Abuja on those two days. This spike of NO2 could be attributed to certain industrial processes, such as power generation from fossil fuel-fired power plants, vehicular emissions and chemical manufacturing which can release significant amounts of NO2 into the atmosphere. However, most of the days from October to December observed concentrations below WHO recommended threshold of 25 µg/m3 in 24hours and therefore the people were not exposed to Nitrogen Dioxide – related health risks during the period.

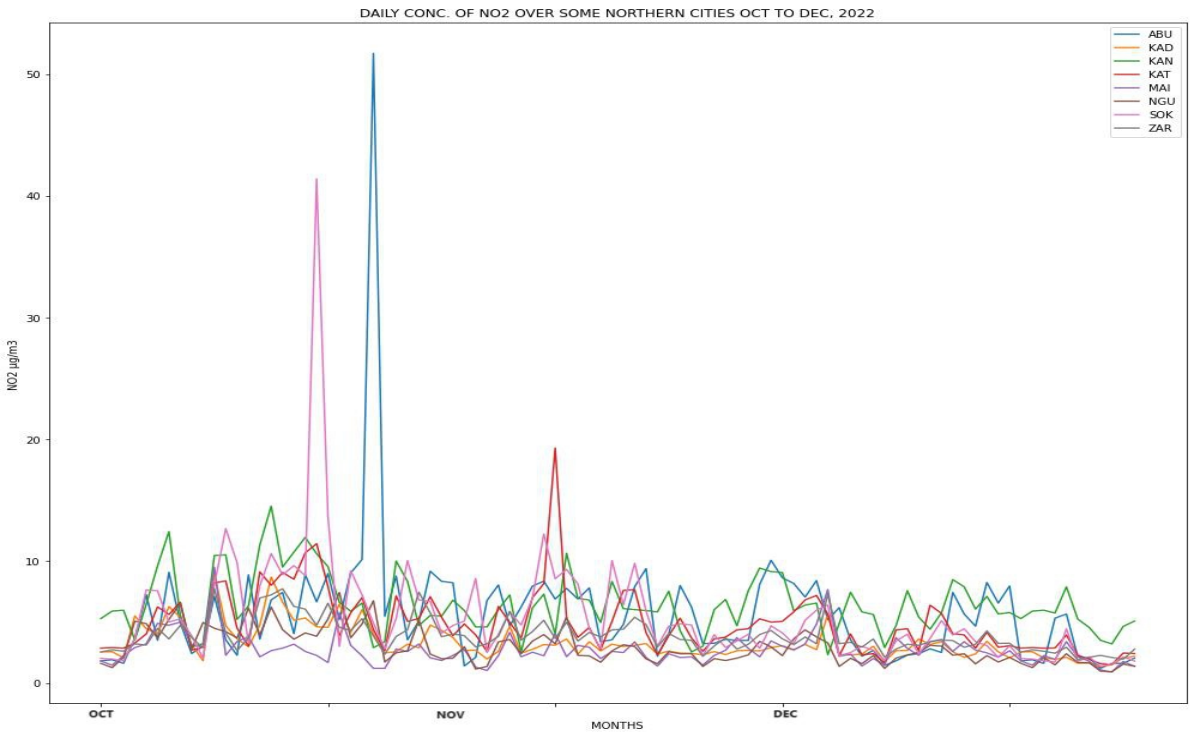

Figure 4.7: Observed concentration of Nitrogen Dioxide over Cities in Northern Nigeria from October to December 2022

4.9 Observed Concentration of NO2 over southern Cities from October to December 2022

Figure 4.8 shows that over the southern cities, Lagos had the highest concentration of NO2 concentration during the period October to December 2022, with the peak value of 28.3 µg/m3 experienced on the 24th of October while Akure experienced the lowest concentration below 0.79 µg/m3. The analysis also shows that there is a large difference in observed concentration of NO2 in Lagos compared to other southern cities during the period. There was also an observed spike in December on a particular day over Owerri where the NO2 concentration was as high as 66.40µg/m3. This could be as a result of high quantity of vehicular emissions, industrial activities and biomass burning. Most of the cities recorded NO2 concentrations that ranged between 1.0µg/m3 and 7.57µg/m3. The observed concentrations during the period were also below WHO threshold of 25 µg/m3.

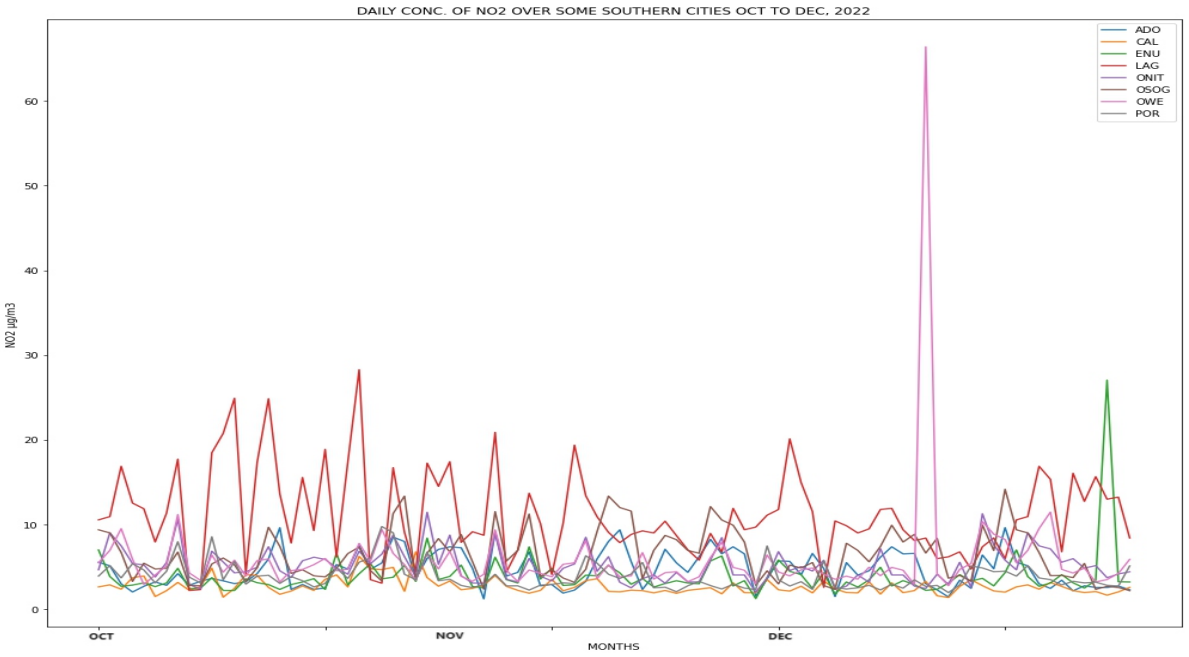

Figure 4.8: Observed Concentration of NO2 over southern Cities from October to December 2022

4.10 Carbon Monoxide (CO) Concentration from October to December 2022

Figure 4.9 shows a comparative assessment of mean CO concentration from October to December 2022. The observed monthly mean concentration of CO generally ranged from 150 to 400 ppbv (0.15 to 0.46 mg/m3) across the country. The lowest range of concentration 150 to 200 ppbv (0.115 to 0.23 mg/m3) was observed in some parts of the extreme northwestern states and Jigawa, Bauchi, Yobe, Borno States, while the highest range of 400ppbv and above (0.5175 mg/m3) was over parts of Oyo, Ekiti, Kwara and Osun states. CO concentration of 200 to 250 ppbv was recorded over Sokoto, Katsina, Kano, Gombe, Plateau, Taraba, Adamawa, Zamfara, part of Yenegoa and Akwa Ibom state. CO concentrations between 250 and 300 ppbv (0.2875 and 0.345mg/m3) were recorded over Kaduna, Kebbi, Nasarawa, Benue, FCT, Ebonyi, Cross River, Abia, Rivers, Bayelsa and parts of Akwa Ibom States. CO concentrations from 300 to 400ppb (0.345 and 0.5175 mg/m3) were recorded over Niger, Kogi, Edo, and parts of Enugu, Anambra, Imo, Delta, Ondo, Ogun, Kwara and Lagos states. The observed three months mean CO concentration across Nigeria was lower than the WHO 2021 recommended standard of 4 mg/m3 in 24 hours.

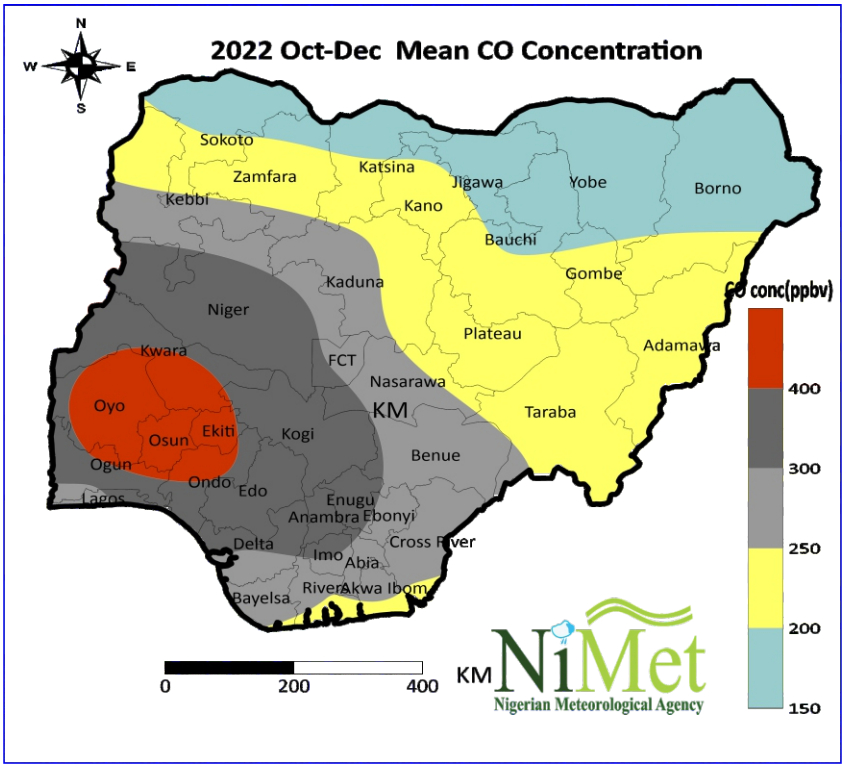

Figure 4.9: Mean Carbon Monoxide Concentration Over Nigerian Cities in OCTOBER-DECEMBER 2022

4.11 Daily Concentration of Carbon Monoxide (CO) over Cities in Southern Nigeria from October to December 2022

The analysis shows that there was an increasing trend of CO concentration from October to December in all the cities (Figure 4.10) over the Southern states. Ikeja in Lagos state, experienced the lowest CO concentration (260pppv = 0.30 mg/m3) during the period, while the highest concentration (398pppv = 0.459 mg/m3) of CO was experienced over Akure. Generally, the concentration of CO ranged from 120 to 650 ppbv (0.138 to 0.750mg/m3). The observed values in the months under review were below the WHO threshold of 4 mg/m3 in 24 hours which implies that there was no health risk posed by the ambient air quality due to carbon monoxide.

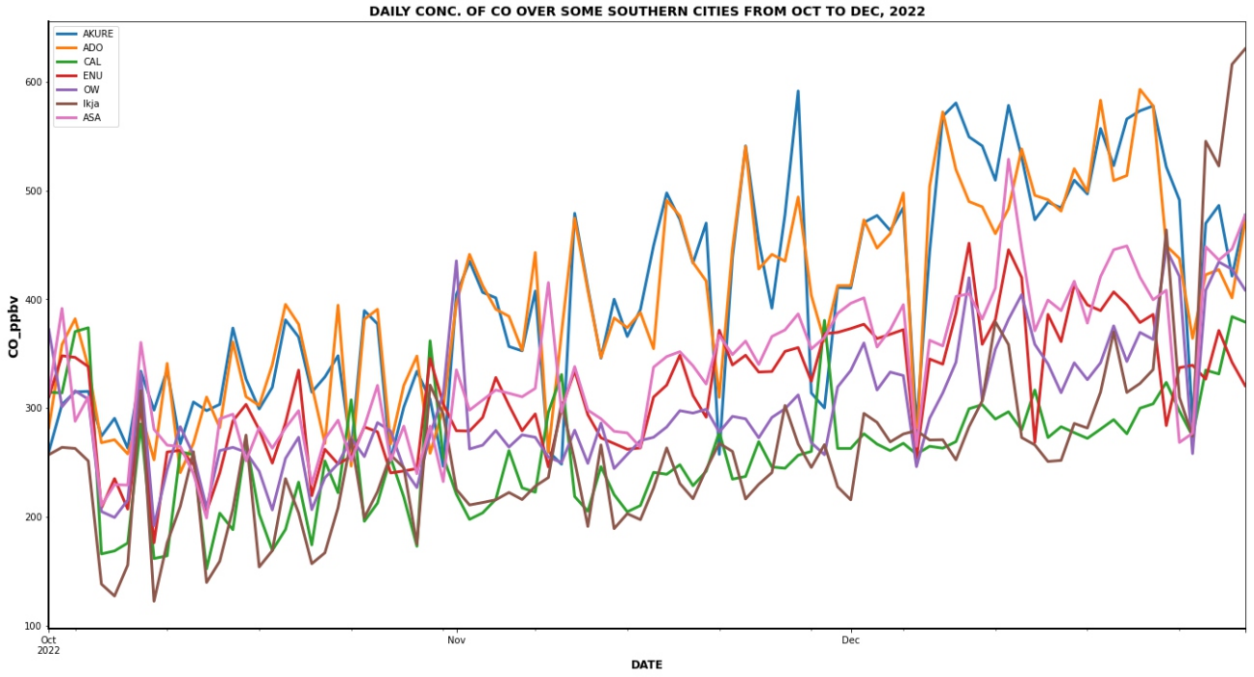

Figure 4.10: Daily concentration of carbon monoxide (CO) over cities in Southern Nigeria from October to December 2022

4.12 Regional Carbon Monoxide (CO) Concentration in October to December 2022

Figure 4.11 shows that Maiduguri experienced the highest CO concentration in the region compared to other Northern cities during the period from October to December 2022. The highest concentration of 395ppbv (0.456 mg/m3) was observed on the 25th of November over Maiduguri while Katsina experienced the lowest level of CO concentration with value of 90 ppbv on the 21st of December.

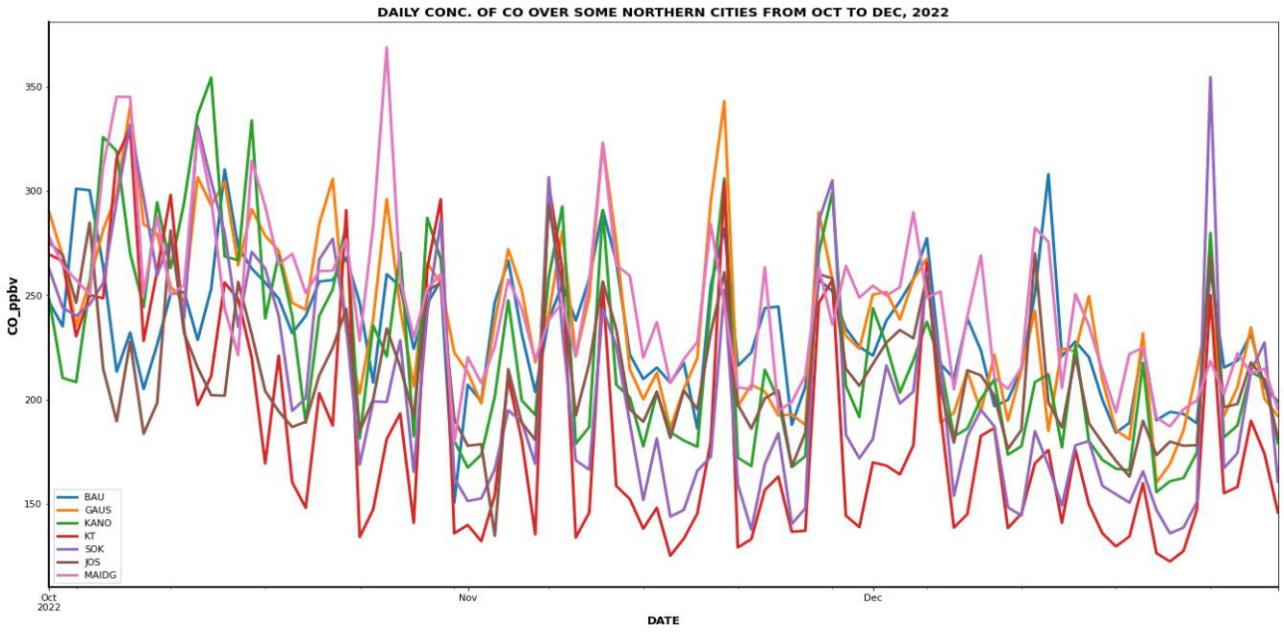

Figure 4.11: Daily Concentration of Carbon Monoxide (CO) over Some Cities in Northern Nigeria from October to December

4.2 SUMMARY

In the final quarter of 2022, the nation witnessed a significant decline in precipitation levels, marking a geographical shift from the northern to the southern region. This transition was attributed to the gradual southward retreat of the Inter-tropical Discontinuity (ITD), moving from its average latitude position of 12.5ON in October to 7.3ON in December. This shift set the stage for a reversal in wind patterns, transitioning from the prevailing moist southwesterly winds to the dry northeasterly trade winds, ushering in the onset of the harmattan season, particularly in the northern regions.

During this period, the prevailing winds at both 925 and 850 hPa levels were predominantly dry northeasterly, facilitating the transportation of dust particles from the source region over the Sahara desert into the country. This phenomenon contributed to a decline in horizontal visibility in some cities, with the most significant impact observed in North during the month of October when horizontal visibility deteriorated to 1000m caused by the presence of particulate matters in the atmosphere. Subsequently, the situation worsened, with the poorest horizontal visibilities, measuring between 400 and 600m in some cities such as Ado-Ekiti, Kano, Katsina, Maiduguri, Nguru in December. This resulted into poor air quality across the region.

The Azores mean sea level pressure system recorded mean monthly center values which varied from 1018 to 1022hPa while the St. Helena pressure system maintained a mean monthly center value of 1022 during the period.

The mean monthly observed levels of PM2.5 concentrations consistently exceeded the WHO standard threshold of 15 µg/m3 in a 24-hour period across several Nigerian cities, particularly in Lagos, Osun, Ekiti, Anambra, Abia, Enugu, Kano, Zaria, Kebbi, Kaduna, and Nguru. In December the nation experienced the highest recorded PM2.5 values, attributed to the onset of the harmattan season. Enugu reported the highest PM2.5 value of 98 µg/m3, during the last quarter of 2022. Exposure to fine particles posed significant health risks, potentially impairing heart and lung function and exacerbating conditions such as heart disease and asthma. Scientific research has established a correlation between exposure to elevated daily PM2.5 levels and an increase in cardiovascular and respiratory cases in hospital admissions.

In recent times, cardiovascular diseases (CVDs) have emerged as a leading cause of both mortality and disability on a global scale. Long-term exposure to fine particulate matter is associated with an increased risk of

heart disease mortality, chronic bronchitis, impaired lung function, and lung cancer. Vulnerable populations, including individuals with pre-existing heart and respiratory conditions, children, and the elderly, may be more susceptible to the adverse effects of PM2.5. Therefore, understanding and reducing exposure to such air pollutants are crucial for public health and the well-being of communities.

The observed CO concentration during this period, varying from 260 to 398 ppbv (0.299 to 0.46 mg/m3) across the country was consistently below the WHO threshold of 4 mg/m3 within a 24-hour timeframe. Likewise, the concentration of NO2 observed across the country from October to December remained below the WHO stipulated threshold of 25 µg/m3. This indicates that the potential health risks associated with CO and NO2 exposure during this period were minimal in Nigeria during the period when compared to PM2.5 exposure.

Acronyms

AQGs	**Air Quality Guidelines**
CAMS	**Copernicus Atmospheric Monitoring System**
CO	**Carbon monoxide**
CVDs	**Cardiovascular Diseases**
FCT	**Federal Capital Territory**
hPa	**Hectopascal**
ITD	**Inter-Tropical Discontinuity**
Kt	**Knot**
MSLP	**Mean Sea Level Pressure**
mg/m3	**Milligram per cubic meter**
NO2	**Nitrogen dioxide**
O3	**Ozone**
PM	**Particulate Matter**
ppbv	**Part per billion by volume**
PPM	**Part per million**
SO2	**Sulphur dioxide**
WHO	**World Health Organization**
µg/m3	**Microgram per cubic meter**
m	**Micrometer**

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