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Assessment of the Nigerian Television Authority (NTA), Abuja, Signal Strength with Atmospheric Components

Abdullahi Ayegba[1], Desmond Wysenyuy[2], Engr Martins Iyeh Unekwu[3], Ndahi Aisha[4], Iruemi Olohimai Juliet[5]

[1,5]Engineering and Space Systems Department, National Space Research and Development Agency, Abuja, Nigeria
[2]Management and Research Analysis, School of Space and Earth Observation, Arizona State University, USA
[3]Lighting Maintenance Coordination, Dover Engineering Nigeria LTD,
Nigeria LNG Plant, Bonny Island, Rivers State, Nigeria
[4]Interplanetary Initiative, Arizona State University, USA

ABSTRACT

This research investigates the Nigerian Television Authority (NTA), Abuja, signal strength in relation to the variability of atmospheric temperature and atmospheric pressure during March, June, August, December 2023. The study aims to analyze the impact of atmospheric conditions on TV signal propagation, focusing on how changes in temperature and pressure affect signal strength. Data was processed using computational models and simulations based on atmospheric parameters obtained from meteorological records. The work involved the analysis of signal attenuation due to varying temperature and pressure conditions typical of the specified months. Results indicate significant fluctuations in signal strength across different atmospheric conditions, highlighting the importance of weather variability in broadcasting reliability. It was also observed that the NTA signal strength is indirectly proportional with the atmospheric temperature and atmospheric pressure as indicated in the correction coefficient of -0.12, -0.24, -0.63 and -0.04 in March, April, August and December for temperature and, -0.03, -0.07, -0.12 and -0.51 respectively for atmospheric pressure in March, April, August and December. Findings from this study contribute to improving the understanding of environmental influences on TV signal transmission, aiding in the optimization of broadcasting technologies for enhanced reliability and quality in varying weather conditions. Future research may explore additional factors such as humidity and wind speed to further refine predictive models and optimize broadcasting infrastructure.

KEYWORDS: *Attenuation, Pressure, signal loss, temperature, weather*

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1. INTRODUCTION

All weather conditions such as temperature difference, density, cloud formation and air pressure take place in the lower troposphere (Ayegba, *et al.,* 2021). Wireless communication technology, be it radio and television broadcast, radar communication, global positioning system (GPS), satellite communication, cellular communication, wireless fidelity (Wi-Fi), radio frequency identification, and Bluetooth, employs the atmosphere in its communication (Amajama *et al., 2023*), and so, the signal experiences attenuation due to the atmospheric components. Attenuation is defined as the reduction in power density of electromagnetic waves as it propagates through space. This term is commonly used in wireless communication and signal propagation. Attenuations may be due to many effects such as free space loss, refraction, diffraction, reflection, aperture-medium, coupling loss and absorption (Oyeleke *et al., 2018*). It has been discovered that signal strength generated by radio is affected by temperature and relative humidity. Signal strength decreases as the temperature rises and increases with increasing relative humidity, and that most wireless systems operating outdoors are unprotected to varying weather conditions, which may result in intense deterioration in network performance (Prince *et al,* 2018). Atmosphere is a layer or set of layers of gases surrounding a planet or other material body that is held in place by the gravity of that body. The earth's atmosphere is rich in Nitrogen, oxygen and argon. These layers are the troposphere, stratosphere, mesosphere, thermosphere and Exosphere. As radio frequency signals propagate through the atmosphere, the signals degrade because of the absorption and scattering by the atmospheric particles. This degradation reduces the quality of the signal received (Jimoh et al., 2019). Humidity can also impact the propagation of electromagnetic waves, as water vapor in the air can absorb and scatter the waves. This can cause attenuation or weakening of the signal, particularly at higher frequencies. Pressure can affect the density of the atmosphere, which in turn can impact the speed of electromagnetic waves (Chibuzo, 2023). This work became necessary as it would provide n updated result on the effect of atmospheric components on television signal strength in FCT, Abuja through the use of the data of atmospheric pressure and temperature, and the NTA signal of 2023 for March, June, August and December.

2. Materials and method

2.1. Materials

The materials used for the research work are the frequency of operation of the Nigerian Television Authority (NTA), Abuja, which is 567.25 MHz, measurement equipment which are: i. Digital television signal meter, ii. Weather station, iii. MATLAB and excel software. It also made use of some library and online materials for review.

2.2. Methodology

The measurement of the television signal strength was done with the CATV signal meter. The signal from the NTA station was received with the aid of the Yagi antenna. A Yagi-Uda antenna was mounted on a vertical pole was fixed in the ground, and the antenna made to face the direction towards the maximum television signal level. The direction of the antenna remained fixed in this direction throughout the study period; March, 2023; June, 2023; August, 2023; and December, 2023. The location or equipment site is Mathson Space International School, Karshi. It is located on latitude 8.83^o North and 7.57^o East. The measurement of the NTA, Abuja and the atmospheric temperature and pressure was carried out at the same time beginning from 6.00 am to 6.00 pm every day at an interval of one hour. The data was measured in March, June, August and December of 2023. The average of all the measurements taken on each day was done in order to have an average daily value. The computation and analysis of the data were done in excel and MATLAB software.

3. Results and Discussion

3.1. March result and analysis

Figures 3.1 (i - iii) show the graphical representations of average daily NTA signal strength and atmospheric temperature in the month of March, Average daily NTA signal strength and atmospheric pressure in the month of March and Average daily NTA signal strength, atmospheric temperature and atmospheric pressure in the month of March. From the graphs, it can be seen that the two quantities, the average NTA signal level and the atmospheric temperature both varied as the days pass by. It can be observed from the graph (3.1 (i)) that the average NTA signal was low on the first two days in March, but increases on the third and the fourth day before falling to low value again. The NTA signal then from the low level on the fifth day rose slowly but near steadily until on the thirteenth day when it started falling or reducing. But from around on the nineteenth towards the end of March, the level of NTA signal received daily appeared to be in semblance of zigzag nature. But assessing the entire trend of the NTA signal, it can be found out that the signal strength of the NTA signal received or measured was lower in the beginning of March compared to the level recorded at the end of the month of March.

In the same way, the atmospheric temperature recorded in Abuja in the month of March is a bit stable, though changes occur, but the magnitude of the changes recorded on these days are not much, hence not well pronounced or displayed in the trend of the temperature graph. It was lower in the first five days of the month of March, then increased slightly and began to fall again, and remain almost steady from around on the ninth March to on the twentieth when it fell to the lowest level in the month. In the same way, there was a change in the atmospheric pressure and the NTA signal strength. Although there was almost a daily change in the atmospheric pressure, the variation is not noticed in the graph except around on the fifteenth due to the amount of change compared to its original or main values. In figure 3.1 (iii), there was a change in each of the quantities but the larger values of the atmospheric pressure compared to the atmospheric temperature and the signal strength makes the changes less noticeable.

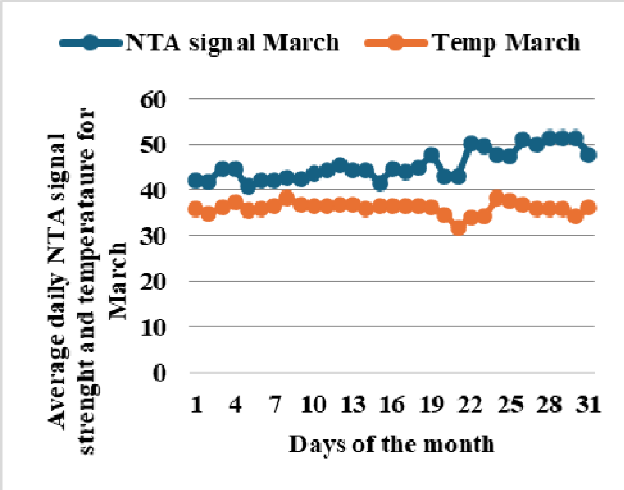

Figure 3.1 (i): Graph of Average daily NTA signal strength and atmospheric temperature in the month of March.

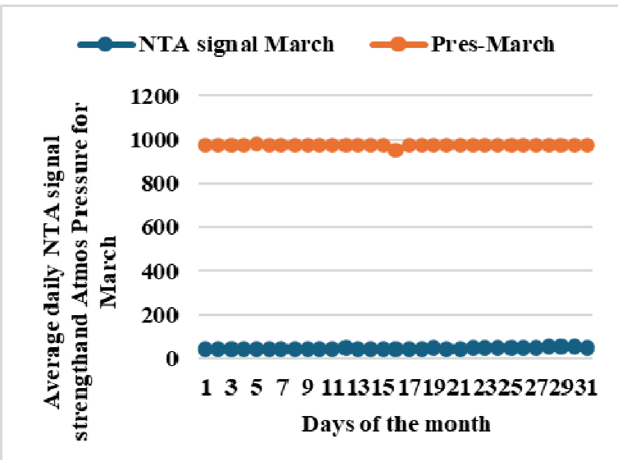

Figure 3.1 (ii): Graph of Average daily NTA signal strength and atmospheric pressure in the month of March.

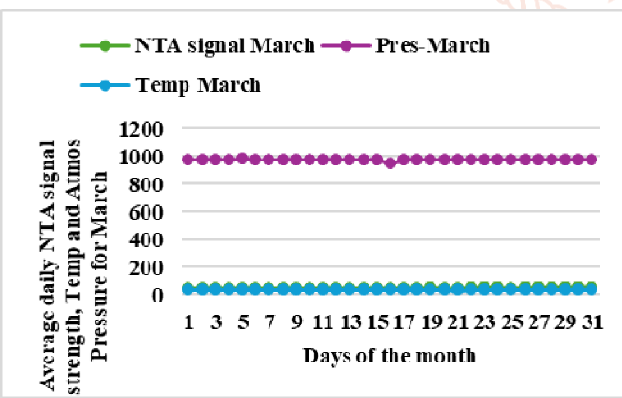

Figure 3.1 (iii): Graph of Average daily NTA signal strength, atmospheric temperature and atmospheric pressure in the month of March

3.2. June result and analysis

Figure 3.2 (i - iii) show the graphical representations of average daily NTA signal strength and atmospheric temperature in the month of June, Average daily NTA signal strength and atmospheric pressure in the month of June and Average daily NTA signal strength, atmospheric temperature and atmospheric pressure in the month of June. From the graphs, it can be observed that the two quantities, the average NTA signal level and the atmospheric temperature exhibited a change on daily basis. It can be seen from the graph (3.2 (i)) that the average NTA signal was low on the first day in June, but increases on the second day, and then decreased slowly but steadily to on the fifth of June when it started increasing again, and continued to rise until on the tenth day when started falling after reaching that higher point. The change in the signal strength was a continuous one, though not regular in terms of the rise and fall of the values on each day.

Similarly, the atmospheric temperature recorded in Abuja in the month of June was lower on the first two days, and then increased on the third day and remaining almost at the same level on the next three days of the month, then falling or decreasing from the on the seventh to around ninth and then increased to a higher point in the month on the tenth, before decreasing to the lower level on the eleventh day, and the temperature remains almost around this level throughout the remaining period of the month, though the there was a daily change but with little differences.

In figure 3.2 (iii), there was a change each of the quantities but like in 3.1 (iii), the larger values of the atmospheric pressure compared to the atmospheric temperature and the signal strength makes the changes less noticeable which is the same scenario in the March.

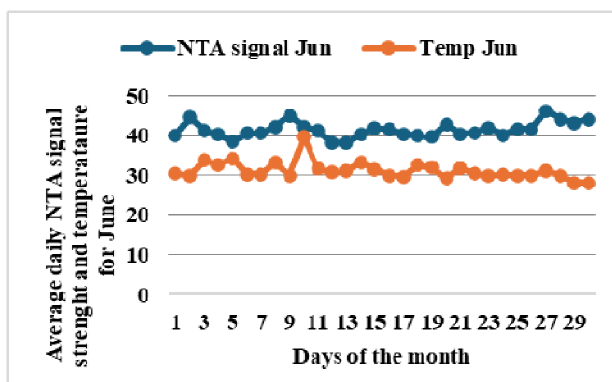

Figure 3.2 (i): Graph of Average daily NTA signal strength and atmospheric temperature in the month of June.

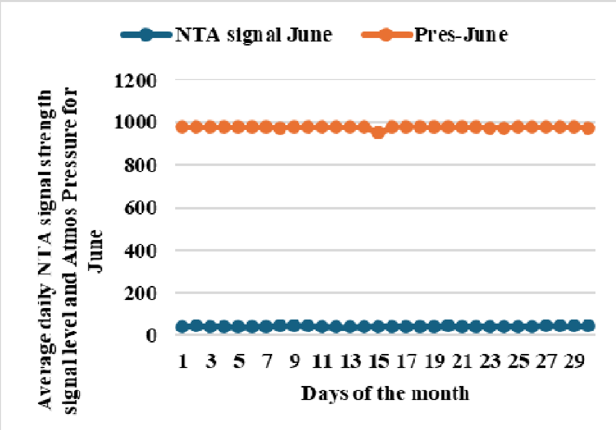

Figure 3.2 (ii): Graph of Average daily NTA signal strength and atmospheric pressure in the month of June.

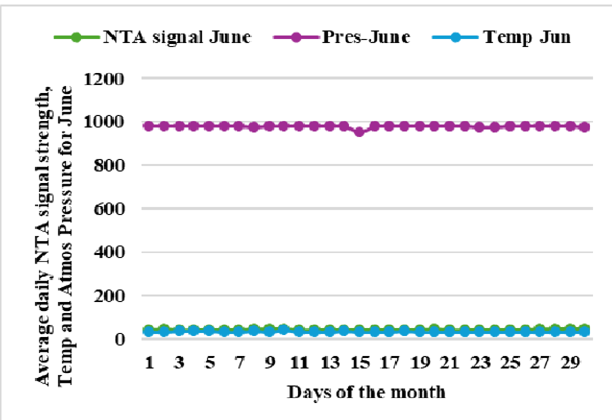

Figure 3.2 (iii): Graph of Average daily NTA signal strength, atmospheric temperature and atmospheric pressure in the month of June

3.3. August result and analysis

Figures 3.3 (i - iii) show the graphical representation of the average daily NTA signal strength and atmospheric temperature in the month of August, Average daily NTA signal strength and atmospheric pressure in the month of August and Average daily NTA signal strength, atmospheric temperature and atmospheric pressure in the month of August. From the graphs, it can be observed that average NTA signal level and the atmospheric temperature both exhibited a change on daily basis. It can be seen from the graph (3.3 (i)) that the average NTA signal was high on the first day in August, but decreased on the second day, and remained at that level with little noticeable change from around on the fifth to on the thirteenth when the signal strength decreased a little more until it started rising slowly around on the twenty first, then fell on the next day with no much change in the trend until on the twenty fifth when the signal strength rose slightly and fell on the next day, then, increased steadily till the last day of the month.

From the temperature, the variation is also almost on daily basis, and it is more noticeable compared to that of the signal strength. The average daily temperature received in Abuja in August was in a form of "rise and fall and rise and fall" even though it is not regular. In other words, there was no much noticeable level or point where the atmospheric temperature in August were the same on some consecutive days.

Atmospheric pressure on its own also varied daily in August as observed in other parameters. The change is atmospheric pressure is not much with significant value compared to its own daily value thereby making the change less noticeable. However, the change in the atmospheric pressure in August could be noticed around on the ninth and on the twenty fifth of August.

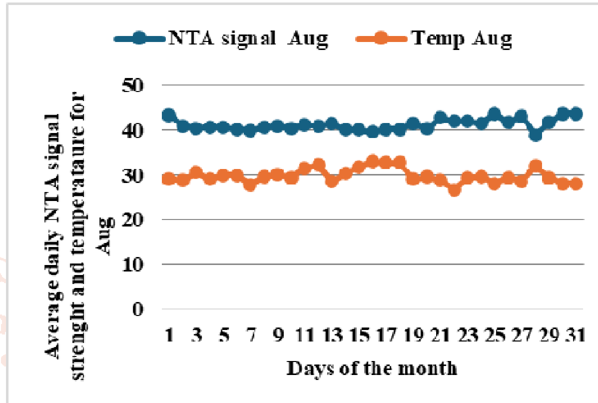

Figure 3.3 (i): Graph of Average daily NTA signal strength and atmospheric temperature in the month of August.

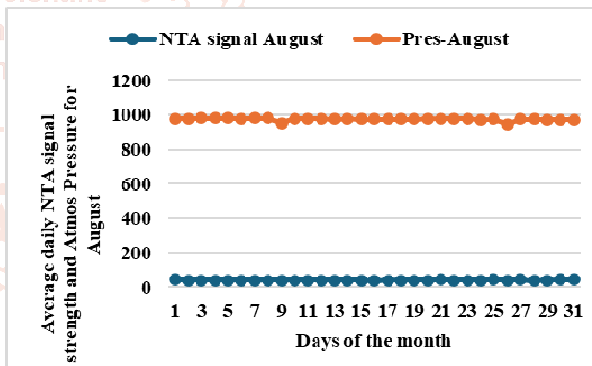

Figure 3.3 (ii): Graph of Average daily NTA signal strength and atmospheric pressure in the month of August.

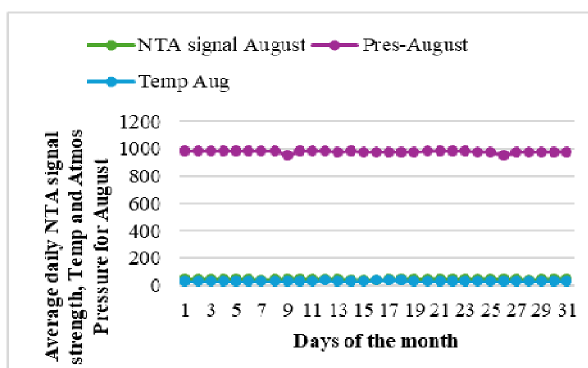

Figure 3.3 (iii): Graph of Average daily NTA signal strength, atmospheric temperature and atmospheric pressure in the month of August

3.4. December result and analysis

Figures 3.4 (i - iii) shows the graphical presentation of average daily NTA signal strength and atmospheric temperature in the month of December, Average daily NTA signal strength and atmospheric pressure in the month of December and Average daily NTA signal strength, atmospheric temperature and atmospheric pressure in the month of December. It can be observed from the figures that the two quantities, the average NTA signal level and the atmospheric temperature experienced a daily variation. From the graph (3.3 (i)), it can be observed that the average NTA signal was low on the first day in December, but increased on the second day, and started coming down slowly to the lower level on fourth and then increased slowly from the fourth day to on the ninth. The signal then showed a little change until around on the seventeenth when the signal felled to the lowest value in December, and then increasing on the next day. The trend continued in almost the same manner until on the last day when higher signal strength was recorded. In December, the temperature variation was not much. This was probably because of the December being the month of Harmattan, and the temperature is almost stable or steady due to cold weather. However, it can be observed from the figure that the atmospheric temperature was higher at the beginning of the month compared to the temperature from around the middle towards the end. The atmospheric pressure in December showed little or no observable change in the trend. It is because of the insignificant values of the change or increase and decrease.

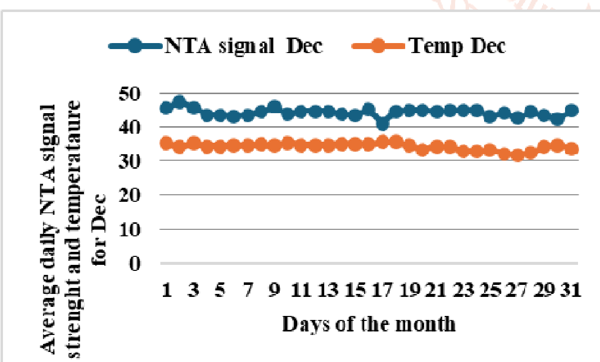

Figure 3.4 (i): Graph of Average daily NTA signal strength and atmospheric temperature in the month of December.

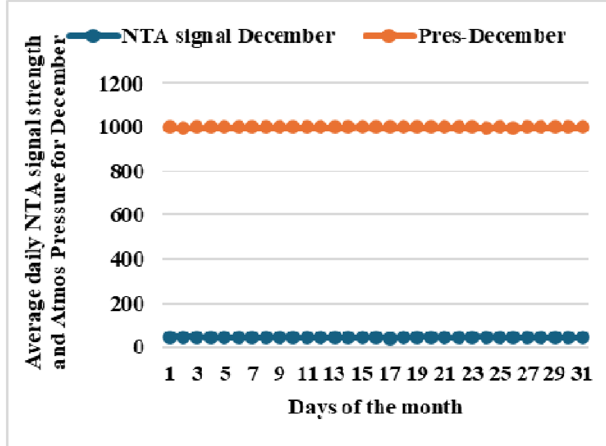

Figure 3.4 (ii): Graph of Average daily NTA signal strength and atmospheric pressure in the month of December.

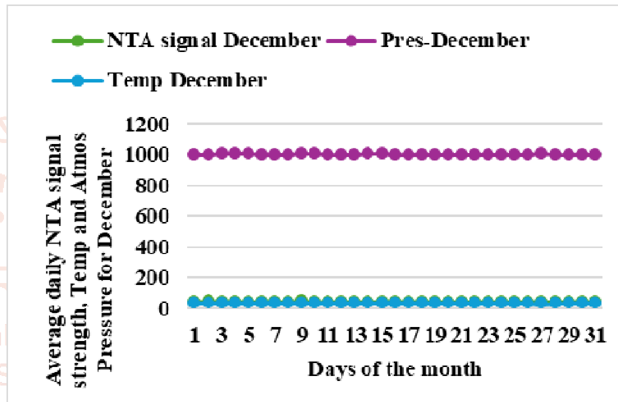

Figure 3.4 (iii): Graph of Average daily NTA signal strength, atmospheric temperature and atmospheric pressure in the month of December

Table 3.1 shows the correlation analysis results between the NTA and the atmospheric components; atmospheric temperature and pressure in the four months. From the table, it can be observed that the correlation coefficients between the NTA and atmospheric temperature in March, April, August and December are -0.12, -0.24, -0.63 and -0.04 respectively, while the correlation coefficients between the NTA and atmospheric pressure in March, April, August and December are -0.03, -0.07, -0.12 and -0.51 respectively. This implies that the both atmospheric temperature and atmospheric pressure are inversely proportional with the NTA signal strength. In other words, an increase in atmospheric pressure or temperature or both will lead to the decrease in the NTA signal strength received in the area.

Table 3.1: Correlation analysis results

Month and	March	June	August	December
Variables	NTA	NTA	NTA	NTA
Temperature	-0.12	-0.24	-0.63	-0.04
Pressure	-0.03	-0.07	-0.12	-0.51

4. Conclusion

The research work was carried out to study the effects of atmospheric temperature and atmospheric pressure on the NTA, Abuja signal strength. This research was carried out using the data of NTA, atmospheric pressure and atmospheric temperature measured in the months of March, June, August and December of 2023 at an observatory at Mathson Space School, Karshi, Abuja. From the results, it can be concluded that there was a daily variation in the signal strength, atmospheric temperature and pressure in the four months studied in this work. It can also be concluded from the result that the signal strength was higher in the dry season months and lower in the rainy season months. Also, from the correlation analysis, it can be concluded that the NTA signal strength is indirectly proportional with the atmospheric temperature and atmospheric pressure. This is indicated in the correction coefficient of -0.12, -0.24, -0.63 and -0.04 in March, April, August and December for temperature and, -0.03, -0.07, -0.12 and -0.51 respectively for atmospheric pressure in March, April, August and December.

5. Recommendation

The signal strength observed in the four months has shown that the signal was higher in dry season and lower in rainy season even as temperature is always higher in dry season, which should have made the signal strength lower in dry season. It is recommended that the effect of rainfall on this television signal strength be studied in future work too.

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