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Influence of Atmospheric Parameters on Terrestrial Television Signals in South-Eastern Nigeria

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Abstract This study investigates the effect of some atmospheric parameters on the received signal strength level (RSSL) of the Nigeria Television Authority (NTA) in South-Eastern Nigeria at a distance of 5 km along selected routes around each of the NTA stations using a digital cable television (CATV) signal level meter. The signal strength of each of the NTA stations investigated was measured for different atmospheric pressure, temperature, and humidity obtained from the Meteo-trend compact weather station between October 2020 and April 2021. The average values of NTA signal strength and atmospheric parameters investigated were obtained, and the results were analyzed using Mat Lab software to determine the influences of some atmospheric parameters on NTA signal strength in South-Eastern Nigeria. The results show that NTA signal strength drops slightly as atmospheric temperature, pressure, and relative humidity rise, with average correlation values of -0.9935, -0.9964, and -0.9853, respectively. The results further show that NTA Enugu, NTA Umuahia, NTA Aba, NTA Owerri, NTA Awka, and NTA Abakaliki all perform poorly over distances of 20 km, 22 km, 18 km, 24 km, and 12 km, respectively. It is posited that the findings of this study be considered by NTA management for purposes of network enhancement and planning.

Keywords Television signals, Troposphere, Nigeria Television Authority, Atmospheric parameters, Signal strength, Communication

Introduction

The quality of the television broadcast signal received by viewers is critical to broadcast stakeholders, but it is influenced by a variety of factors, particularly environmental factors such as meteorological variables. One of the factors influencing signal reception quality is noise, such as thermal noise, galactic noise, atmospheric noise, and so on [1]. Many Nigerian television network planners rely on the troposphere muggy of south-eastern Nigeria for the transmission of television signals, which is dominated by variable air temperatures, relative humidity, and humidity, without first assessing the losses and attenuations of the television signal path in the region and identifying the impact of the parameter changes, which is one of the reasons for poor signal quality [2].

Transmitting and receiving arrays and sensors are essential parts of communication systems, and the channels they link up are pivotal in influencing received signal strength. A variety of factors influence these communication channels. Signal attenuation is influenced by a lot of impediments that lead to a loss of signal strength in the channel. The signal traverses the tropospheric layer of the Earth's atmosphere via this channel [3]. The troposphere is one of the tiers that make up our atmosphere. It is the layer that stretches from the earth's surface to 16 km and from the earth's poles to 8 km. This tier is in charge of the air's refractive power, which is pertinent for signal propagation [4]. Although many other factors influence wave transmission, changing atmospheric factors in the transmission channel play a significant role. These factors are directly related to the tropospheric layer of the atmosphere, either explicitly or implicitly. Atmospheric pressure, temperature, wind speed, humidity, and other factors affect the refractive power and refractive index of air in the troposphere [5].

The refractive phenomenon of the atmosphere and landscapes in the immediate area of the transmitter and receiver is taken into account when predicting signal strengths in the very high frequency (VHF) and ultra-high frequency (UHF) bands. It also considers geographic volatility when estimating area coverage, as well as regional information overload around the receiver [6]. Furthermore, changes in atmospheric conditions can cause daily and seasonal differences in signal strength between expected and actual results. Such variations can cause a major increment (or decline) in signal strength that lasts for several hours. More irreversible changes can happen when the diagonal stripe of radio refraction in the atmosphere diverges substantially from the standard values referenced by the transmission contour. Radiofrequency energy transmission requirements at the Earth's surface commonly vary considerably monthly, and this monthly fluctuation can change significantly from season to season [7]. These signal fluctuation metrics are necessary for predicting broadcasting system performance and planning frequency bands. As a result, it is essential to consider, for example, the signal strength that has been surpassed for lengthy periods of space and time. Intrusion from trans-horizontal co-channel signals caused by television channels can impede some radio frequencies, particularly television on VHF. As a result, having a precise method of estimating the signal strength received is critical [8].

Temperature, atmospheric pressure, and relative humidity have all been shown to have a significant impact on wireless signal strength. According to studies, the signal strength of wireless communication decreases as temperature, atmospheric pressure, and the humidity rise. Most outdoor wireless systems, such as televisions, are vulnerable to changing weather conditions, which can result in significant network performance drops [1, 6]. As a result, it is critical to investigate the impact of these atmospheric parameters on wireless network performance to mitigate their impact and adapt to changing weather conditions. Typically, this variability in atmospheric parameters is monitored using simple measurement gauges or by observing the resulting variations in parameters that depend on the measured weather factors. Highlighting the communication system characteristics is the best way to do this. In an optimal situation, radio signals are influenced by the earth's shape, atmospheric parameters such as temperature, wind, humidity, and pressure as well as interactions with objects on the ground such as mountains, hills, bodies of water, trees, valleys, and so on, as well as buildings [9].

The television transmitter network is extremely well-engineered, so weather-related disruptions are very rare. However, there will be times when the signals carrying television services can travel further than usual due to weather conditions. This can result in issues such as pixilation [10]. When these conditions occur, the only option is to wait for the weather system to pass. Only residences with antennas in direct line of sight of the transmitter can normally receive the signals from each transmitter. The right to access multiple signals at the same time on the same frequency can lead to issues such as distortions. This is known as co-channel interference, and it can be caused by the meteorological phenomenon known as tropospheric channeling or ducting [11]. Tropospheric ducting or channeling occurs primarily during spring tides and decreases as a result of temperature transposition, which occurs when the temperature of the atmosphere increases with altitude [1, 12]. During the summer, tropospheric ducting of television signals is relatively common, especially in the evenings when the weather is stable and perfectly normal. It may, however, occur at any time of year. It usually occurs when the weather is hot during the day and then quickly cools down at night [12, 13]. That's why it's so common along the coast. Temperature inversion occasionally allows out-of-band UHF and VHF transmitting stations to block endemic stations on the same frequency. The blocking station is usually powerful enough to dominate endemic stations such as the Nigeria Television Authority (NTA). This is most common in the early morning hours, and the effects are completely gone by the afternoon [14].

The inordinate abnormal propagation of television signals through the troposphere is difficult to control because television operators cannot easily influence the weather. As a result, it is only possible to design a television network where interference occurs less than 1% of the time to mitigate the effects of bad weather on television signals [15]. To improve television signal strength, broadcasters would also need to significantly increase the power and number of transmitters, as well as build a much more sophisticated communications system [16]. This is almost unattainable and hideously expensive. Unfortunately, tropospheric anomalies and interference do not occur evenly throughout the year. This usually happens in the evenings when television (TV) is at its best and special frequency-modulated (FM) programs are on the air. It frequently occurs on consecutive days simultaneously and then vanishes for months. Some years are worse than others, depending on meteorological conditions [12, 17]. When this type of interference is analyzed over a given period, most TV viewers and FM listeners should be 90 % immune to the poor signal as long as they are within their broadcaster's network coverage and use a good directional antenna. Weather-related issues are most common during the spring season, when high atmospheric pressure can cause tropospheric ducting and pixilation [17, 18]. Due to the dynamic weather conditions in Nigeria, it is pertinent to study the effects of some atmospheric parameters such as temperature, relative humidity and atmospheric pressure on wireless networks. Thus, this research aims at investigating the effect of some atmospheric pressure on signals generated by Nigeria Television Authority in South-Eastern region of Nigeria.

Study Location

The eastern region of Nigeria, formerly known as Eastern Nigeria, is one of Nigeria's six geopolitical zones, comprising the states of Abia, Anambra, Ebonyi, Enugu, and Imo. The Kwa-speaking people are from Nigeria's southeastern region, where Igbo is the dominant language.

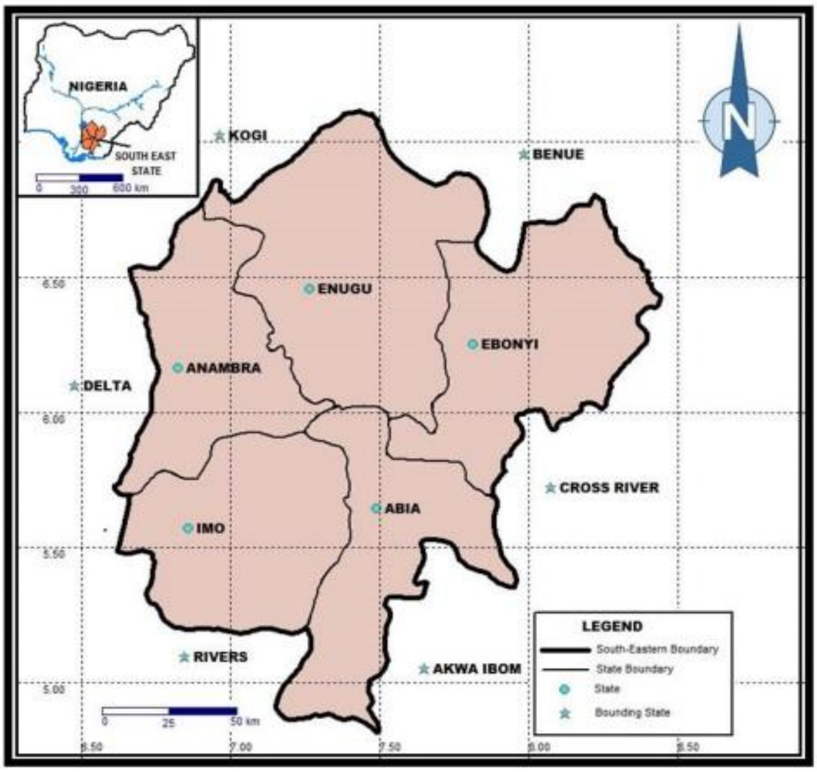

Figure 1: Map of South-Eastern Nigeria [22]

The Eastern Region of Nigeria is geographically located in southeastern Nigeria. It shares a cultural and administrative boundary to the north with Nigeria's Northern Region, as well as a western boundary with the Niger River [19, 20]. The South-Eastern region of Nigeria is located between the Nigeria-Cameroon border in the east and the Atlantic Ocean and the Gulf of Guinea along the southern coast. The region covers an area of approximately 76,000 square kilometers. It had a population of approximately twelve (12) million people in 1965 and was located at latitude 5° 45' 00.0 "N and longitude 8° 30' 00.0 "E. It is one of West Africa's most densely populated regions [21].

The southeastern region of Nigeria has three types of vegetation: coastal areas with tidal waterways and mangrove swamps in the south; tropical forest in the north with many green trees that have been cleared for palm plantations for some time; and Guinea savannah in the far north [22]. The major rivers in Nigeria's eastern region are the Cross River, the Qua Iboe River, the Imo River, and the Orashi River. Some of the region's high plateaux in the northeast include the Obudu Plateau, Oban, and the Ikom Hills along the eastern border with Cameroon. Figure 1 shows the map of South-Eastern Nigeria.

Methodology

An electronic cable television (CATV) signal level meter, a global positioning receiver (GPR) system, a receiving antenna, travel - distance software, Meteo-trend weather station technology, and other materials were used to conduct this research. A CATV signal level meter with design model S110/S110D was used to measure signal strengths generated by the Nigeria Television Authority (NTA) along five (5) different motorable and accessible routes in each of Nigeria's South Eastern region's five (5) states at a distance of 5 Km from each of the NTA base stations investigated. Imo, Enugu, Ebonyi, Anambra, and Abia are the states involved. Six (6) NTA base stations were monitored for this study. NTA channel 6 Aba, NTA channel Umuahia, NTA channel 5 Awka, NTA channel 43 Abakaliki, NTA channel 8 Enugu, and NTA channel 12 Owerri were the NTA base stations investigated. Table 1 shows the different paths taken to measure signal intensity.

At the study sites, the receiving antenna was pointed in different directions to see if the strongest signal came from somewhere other than the transmitter's direction. The receiving antenna was raised to a height of 5 meters during signal level measurement to intercept the horizontally polarized signal under investigation. During field strength measurements, an agreement was reached with the management of each NTA station under investigation to ensure that the transmitting parameters remained constant. Meteo-trend weather software was used to obtain the temperature, pressure, and humidity values for each measurement location. The signal strength measurements were taken from October 2020 to April 2021. In general, signal strength measurements were taken in different months, at different times of day, and varying temperatures, pressures, and humidity levels. For the study period, average signal strength results, as well as atmospheric parameter measurements, were obtained, and the data was analyzed using Mat Lab software to determine the performance of the NTA signal strength in different atmospheric parameters.

Table 1: Routes description

Base Station	**Routes Description**				
	Route A	**Route B**	**Route C**	**Route D**	**Route E**
NTA Abakaliki	Abakaliki-Ikom	Abakaliki-Afikpo	Abakaliki-Enugu	Abakaliki-Otukpo	Abakaliki-Utonkon
NTA Akwa	Awka-Aguata	Awka-Nnewi	Awka-Onitsha	Awka-Enugu	Akwa-Adani
NTA Aba	Aba-Ikot Ekpene	Aba-Utu-Etim Ekpo	Aba-Portharcourt	Aba-Umuahia	Aba-Owerri
NTA Enugu	Enugu-Abakaliki	Enugu-Okposi	Enugu-Umuahia	Enugu-Awka	**Enugu-Agenebode**
NTA Owerri	Owerri-Onitsha	Owerri-Aba	Owerri-Umuahia	Owerri-Orlu	Owerri-Okigwe
NTA Umuahia	Umuahia-Ikot Ekpene	Umuahia Aba	Umuahia-Owerri	Umuahia-Enugu	Umuahia-Abakiliki

Results and Discussion

This session includes an analysis and discussion of the study's findings based on the methods adopted in this research. The received signal levels were measured at a radius of 5 kilometers around each of the NTA stations investigated. The average received signal at each measuring point was used to average out inconsistencies. The performance of the NTA stations is presented graphically for varying temperatures, pressures, and humidity levels. The average value of the signal strength measured over the investigation period was obtained and tabulated, as shown in the appendices (Appendix 3–5).

This study looked at the impact of atmospheric parameters (temperature, relative humidity, and atmospheric pressure) on the signal strength generated by NTA transmitters in South-Eastern Nigeria at a distance of 5 km from the respective NTA stations. The average value of these atmospheric parameters investigated along with their corresponding average signal strength level (SSL) for six (7) months (October 2020 to April 2021) was computed and plotted. Figures 2-4 show how temperature, relative humidity, and atmospheric pressure affect the signal strength generated by NTA televisions in Nigeria's south-eastern region.

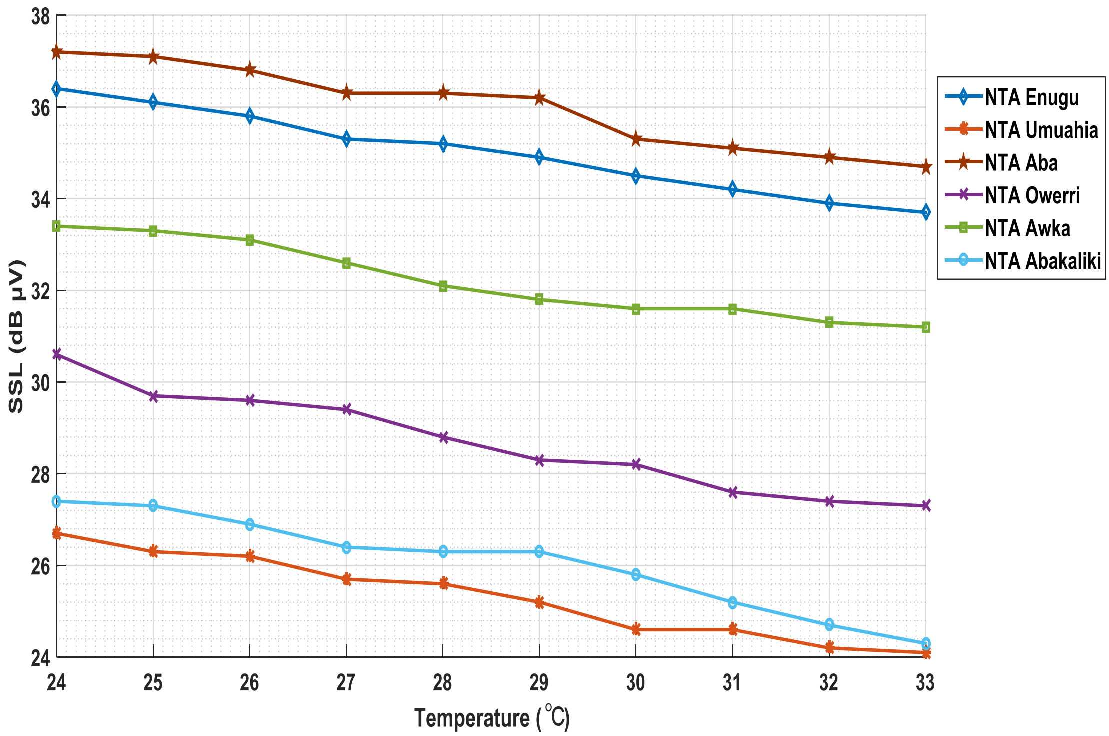

Figure 2: Variation of signal strength generated by NTA stations in South-Eastern Nigeria with temperature at a distance of 5 km from the respective NTA base stations

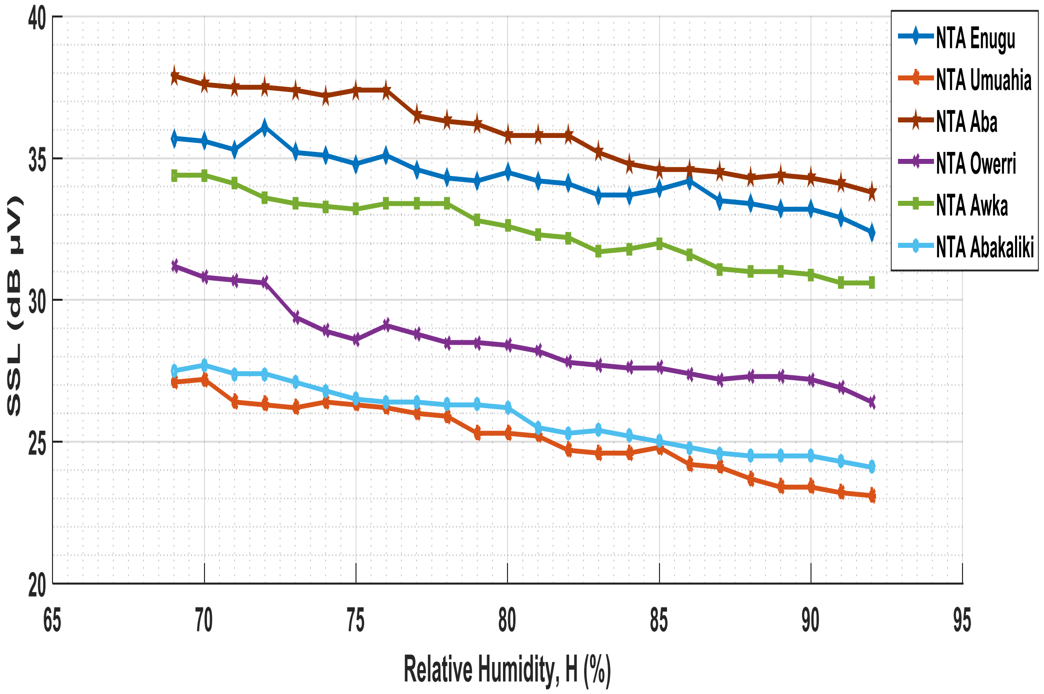

Figure 3: Variation of signal strength generated by NTA television's stations in South-Eastern Nigeria with relative humidity at a distance of 5 km from the respective NTA base stations.

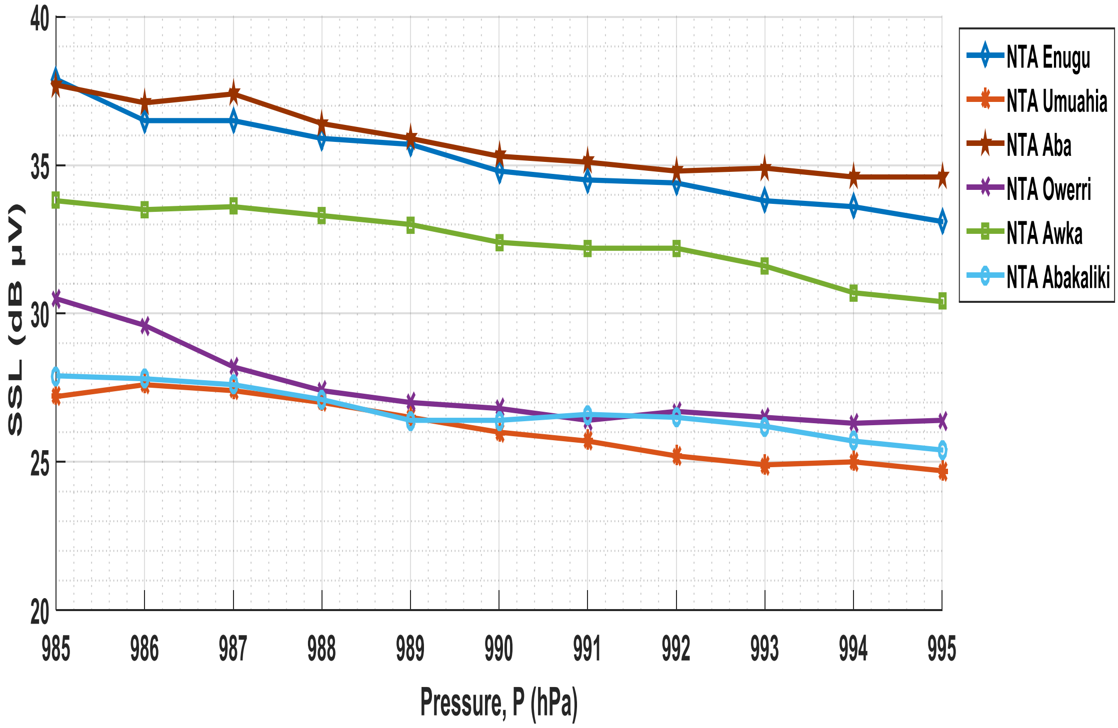

Figure 4: Variation of signal strength generated by NTA television's stations in South-Eastern Nigeria with atmospheric pressure at a distance of 5 km from the respective NTA base stations

From the figures, although temperature, humidity, and pressure affect the strength of signals generated by the various NTA stations studied, their effects on signal strength are minor. The signal strength generated by the NTA stations investigated decreases slightly as temperature and the other atmospheric parameters studied increase, as shown in the figures. For example, in figure 2, the average signal strength generated by NTA Enugu at a distance of 5 km was 36.4 dBV when the temperature in Enugu was 24 ^{o}C, and 36.1 dBV when the temperature increased to 25 ^{o}C. At the same distance of 5 km from the base station, the average signal strength generated by NTA Enugu decreased slightly to 35.8 dBV and 35.3 dBV, indicating a slight decrease as the atmospheric temperature rises. The signal strength generated by NTA Umuahia, NTA Aba, NTA Owerri, NTA Awka, and NTA Abakaliki followed a similar pattern. NTA Enugu, NTA Umuahia, NTA Aba, NTA Owerri, NTA Awka, and NTA Abakaliki have correlation coefficients of -0.9972, -0.9908, -0.9814, -0.9858, 0.9766, and -0.9806 for SSL and temperature, respectively. As a result, the signal strength (SS) generated by the NTA stations investigated was found to be inversely proportional to temperature. This is in line with findings made by Ukhurebor, 2018.

That is, $SSL\ \alpha\ \frac{1}{T}$ (1)

This may be rewritten as $SSL = \frac{K}{T}$

Where SSL is the signal strength level in dBμV, T is the atmospheric temperature in degree Celsius (^{o}C) and k is the constant of proportionality.

Figure 3 depicts the relationship between signal strength levels (SSL) at a given distance and relative humidity for each of the NTA stations studied. The signal strength generated by the NTA stations investigated within the study environment is also affected by relative humidity. As the relative humidity rises, the SSL decreases slightly on average. For example, in Enugu, the SSL was 35.7 dBV when the relative humidity was 69 %, and 35.6 dBV when the relative humidity was 70 %. Also, when the relative humidity was 72 dBV and 73 dBV, the SSL was 36.1 dBV and 35.2 dBV, respectively. Although, there are a few instances where the outcome differs such as the NTA Enugu SSL when the humidity is 71% and 72% in Enugu, the average SSL decreases with humidity. The coefficient of correlation obtained for the SSL and relative humidity variations for NTA Enugu, NTA Umuahia, NTA, Aba, Nta Owerri, NTA Awka and NTA Abakaliki are -0.9611, -0.9852, -0.9822, -0.9508, -0.9837 and -0.9894 respectively. It can therefore be postulated from the data analysis that the SSL generated by NTA stations in the South Eastern Part of Nigeria varies inversely to the relative humidity of the environment. That is,

$$SSL \ \alpha \ \frac{1}{H} \qquad (2)$$

Thus, $SSL = \frac{K}{H}$

Where SSL is the signal strength level in dB, H is the atmospheric relative humidity in degree percentage (%) and k is the constant of proportionality.

The variation of atmospheric pressure with signal strength level is shown in figure 4. From the figure, it is observed that the signal strength generated by the NTA television studied decreases as the atmospheric pressure of the given environment increases. The variation of the signal strength with pressure is very mild and irregular as the signal seems to increase on a few occasions even when the pressure is relatively high. For example, the average signal strength of NTA Enugu at an atmospheric pressure of 985 hPa is 37.9 dBμV and 36.5 dBμV when the atmospheric pressure was 986 hPa for a constant distance of 5 km showing a slight decrease in the level of the signal strength generated. At atmospheric pressure of 987 hPa, the average signal strength of NTA Enugu remained 36.5 dBμV despite an increase in the average atmospheric pressure in the given environment. The average signal strength generated by NTA Aba at an atmospheric pressure of 992 hPa is 34.8 dBμV and 34.9 dBμV for atmospheric pressure of 993 hPa showing a decrease in the level of signal strength generated. These irregularities may be due to other factors that affect signal strength interference, scattering, etc. but at an average, the signal strength generated by the different NTA stations investigated decreases as the atmospheric pressure increases. The coefficient of correlation obtained for the SSL and atmospheric pressure variations for NTA Enugu, NTA Umuahia, NTA, Aba, Nta Owerri, NTA Awka and NTA Abakaliki is -0.9825, -0.9697, 0.9545, -0.8676, -0.9696 and -0.9551 respectively indicating a very strong correlation.

This can be written mathematically as

$$SSL \ \alpha \ \frac{1}{P} \text{ or } SSL = \frac{K}{P} \qquad (3)$$

Where SSL is the signal strength level in dBμV, P is the atmospheric pressure in degree percentage (%) and k is the constant of proportionality.

General performance of NTA Signals

In addition, the efficiency of the NTA Signals studied was investigated in this study. The goal is to figure out how effective NTA signals are at a given distance and a given temperature, atmospheric pressure, and relative humidity. Equation 4 gives the expression for calculating the efficiency of the various NTA signals studied at a given distance [23].

$$P\ (\%) = \frac{TSR\ (dB)}{TST\ (dB)} \text{ x } 100\% \qquad (4)$$

Where TSR = total signal received and TST = total signal transmitted

If the efficiency of the television signals received is between 71 – 100%, the signals perform excellently and are very good when the efficiency is between 51 – 70%. When the efficiency of the received signals is between 41-50%, the performance of the signals is considered good and fair if it is within 31– 40%. The efficiency between 0–30% for television signals is very poor and thus very uncomfortable for the receiving audience [23]. The results obtained for the performance analysis of the different NTA signals studied at a given distance are presented in table 21. The results reveal that NTA Enugu, NTA Umuahia, NTA Aba, NTA Owerri, NTA Awka, and NTA Abakaliki perform poorly at a distance of 20 Km, 22 Km, 18 Km, 24 Km, and 12 Km respectively.

Table 2: Performance analysis of the different NTA signals

Distance (km)	Signal strength (dBμV)					
	NTA Enugu	NTA Umuahia	NTA Aba	NTA Owerri	NTA Awka	NTA Abakaliki
2	53.2	49.4	60.1	59.0	65.1	50.9
4	44.9	43.6	55.2	53.9	52.6	42.5
6	40.1	37.1	46.9	45.0	48.5	37.4
8	37.8	31.6	43.6	42.4	46.6	34.9
10	36.9	29.6	39.6	39.9	44.2	31.7
12	33.5	27.5	38.5	38.0	42.7	28.8
14	33.1	26.6	36.7	33.6	39.6	25.4
16	32.0	25.3	34.6	30.5	37.3	22.6
18	30.5	22.1	31.9	28.9	35.5	20.3
20	29.5	20.3	30.7	23.6	33.3	16.9
22	27.8	18.3	29.8	22.6	30.3	15.2
24	25.5	14.8	27.4	19.3	27.9	11.4

Conclusion

An experimental investigation of the effects of atmospheric parameters on signal strength measured in the 46 and 760 MHz frequency bands was conducted using the results of received signal strength measurements from NTA stations in Nigeria's South Eastern region. The investigation took place in the five states that make up Nigeria's Southeastern region from October 2020 to April 2021. Furthermore, the efficiency of each of the analyzed NTA signals was investigated.

The primary findings are as follows:

1. NTA Enugu, NTA Umuahia, NTA Aba, NTA Owerri, NTA Awka, and NTA Abakaliki all perform poorly over distances of 20 km, 22 km, 18 km, 24 km, and 12 km, respectively.
2. Television signal strengths in the investigated environments suffer significant distortion between 0.3 km and 2 km from the base station.
3. NTA signal strength drops slightly as atmospheric temperature, pressure, and relative humidity rise, with average correlation values of -0.9935, -0.9964, and -0.9853 respectively.

Recommendations

From the findings of this study, it is recommended that more repeater stations be sited at a distance of 20 km from each of the NTA base stations investigated to the transmitter to ensure that the broadcast signals are received beyond this distance. A similar study should also be conducted in other parts of the country and for other TV stations to determine their performance in various weather conditions. Furthermore, a propagation model should be developed that can accurately estimate the values of NTA signal strength in southern Nigeria under different atmospheric conditions.

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Conflict of interest statement

The authors want to make it clear that they have no financial or personal interests or beliefs that might influence their objectivity or cause a conflict of interest. There are no financial interests to report, and all co-authors have seen and agreed with the contents of the manuscript. We certify that the work submitted is original.

References

[1]. Iwuji, P. C. & Bassey, D. E. (2018). Investigation of the Effect of Atmospheric Temperature on Signal Strength Generated by FM Transmitter in Imo State, Nigeria. International Journal of Science and Research, 7(6): 82 - 85

[2]. Segun, A. A., Olusope, A. M. & Kofoworola, A. H. (2015). Influence of Air Temperature, Relative Humidity and Atmospheric Moisture on UHF Radio Propagation in South Western Nigeria. International Journal of Science and Research, 4(8): 588 – 592

[3]. Ofure, E. J., David, O. O., Oludare, A. M., Musa, A. A. (2017). Artificial Neural Network model for the determination of GSM Rxlevel from atmospheric parameters. Engineering Science and Technology, an International Journal, 20(2): 795-804.

[4]. Hanchinal, C. S., Muralidhara, K.N. (2016). A Survey on the Atmospheric Effects on Radio Path Loss in Cellular Mobile Communication System. International Journal of Computer Science and Technology, 7(1): 120-124.

[5]. Choudhary, S., Sharma, A., Gupta, S., Purohit, H., Sachan, S (2020). Use of RSM Technology for the Optimization of Received Signal Strength for LTE Signals Under the Influence of Varying Atmospheric Conditions. EVERGREEN Joint Journal of Novel Carbon Resource Sciences & Green Asia Strategy, 7(4): 500-509.

[6]. Chima, A.I., Onyia, A.I., and Udegbe,S.U. (2018). The Effects of Atmospheric Temperature and Wind Speed on Uhf Radio Signal; a Case Study of ESUT Community and Its Environs in Enugu State. IOSR Journal of Applied Physics, 10(2): 83-9.

[7]. Zafar, S. N. A. S., Sabri, N. H., Umar, R & Ibrahim, Z. A. (2019). Radio Frequency Interference on Nearby Radio Astronomical Lines: Relationship between Wind Speed and Radio Signal Strength Measured at East Coast of Peninsular Malaysia. Sains Malaysiana, 48(1): 183–189.

[8]. Fang, S. and Yang, Y. S. (2016). The Impact of Weather Condition on Radio-Based Distance Estimation: A Case Study in GSM Networks with Mobile Measurements. IEEE Transactions on Vehicular Technology, 65(8): 6444 – 6453.

[9]. Ade F., Agboola A. O., Halidu D.I., Abdullahi A., Jegede J.O., Wysenyuy D.F. & Ademu V. (2017). Investigation of the Influence of Atmospheric Temperature and Relative Humidity on Fm Radio Signal Strength: A Case Study of WeFm Abuja. International Journal for Scientific Research & Technology research, 2(11), 70-74.

[10]. Nweke F. U. and Ukwu C. N. (2015). Weather Variation and its Effect on Transmission of Communication Signal. International Journal of Scientific & Engineering Research. 6(6), 643-645

[11]. Akinsanmi, A., Ajewole, M. O., Adediji, A. T. & Ojo, J. S. (2017). The Influences of Meteorological Parameters on Digital Terrestrial Television (DTT) Signal in the Tropics, International Journal of Digital Information and Wireless Communications, 7(3); 161-172.

[12]. Emeruwa, C. (2015). Comparative Analysis of Signal Strengths of some Networks in Umuahia Eastern Nigeria. Journal of Electronics and Communication Engineering Research, 2(10): 01 - 05

[13]. Wuyep, S. Z. & Daloeng, H. M. (2020). Climate Change, Rainfall Trends and Variability in Jos, Plateau. Journal of Applied Science, 20(2), 76 – 82.

[14]. Mat, R., Shafie, M. M., Ahmad, S., Umar, R., Seok, Y. B. & Sabri, N. H. (2016). Temperature Effect on The Tropospheric Radio Signal Strength for UHF Band at Terengganu, Malaysia, International Journal on Advanced science, Engineering and information technology, 16(5); 770 – 774

[15]. Ukhurebor, K. E. & Umukoro, O. J. (2018). Influence of Meteorological Variables on UHF Radio Signal: Recent Findings for EBS, Benin City, South-South, Nigeria. *IOP Conference Series: Earth and Environmental Science 173(01), 1-8.*

[16]. Chima, A. I., Onyia A. I. & Chikeleze, P. C. (2020). Investigating the impact of weather parameters on signal strength of satellite Dish in Enugu metropolis. International Journal of Astrophysics and Space Science, 8(2); 11 – 15.

[17]. Iwuji, P. C. & Emeruwa, C. (2018). Investigation of Signal Strength-Level Generated by Orient 94.4 FM Transmitter in Imo State, Nigeria. International Journal of Science and Research, 7(5): 1089 – 1094.

[18]. Amajama, J. (2016). Atmospheric Pressure Bearing on (UHF). Radio Signal. Department of Physics, University of Calabar, International Journal of Scientific Engineering and Technology, 5(3), 131- 133.

[19]. Anejionu, O. C. D., Nwilo, P. C. & Ebinne, E. S. (2013). Long Term Assessment and Mapping of Erosion Hotspots in South East Nigeria. FIG Working Week 2013 Environment for Sustainability Conference, Abuja, Nigeria. Retrieved from file:///C:/Users/PRINCE/Downloads/AnejionuFIG_ErosionHotspots.pdf

[20]. Emeruwa, C. & Diieokuma, T. (2021). Electric Field Strength Distribution of UHF Television Signal: A Case Study of Niger Delta Television Yenegoa, Bayelsa State Nigeria. IOSR Journal of Electronics and Communication Engineering, 16(3): 52 – 59

[21]. Okali, D., Okpara, E., & Olawoye, J. (2001). The case of Aba and its region, southeastern Nigeria. International Institute for Environment and Development. Retrieved May 4, 2021, from http://www.jstor.org/stable/resrep01762.5

[22]. Obidiegwu, J. E. & Akpabio, E. M. (2017). The geography of yam cultivation in southern Nigeria: Exploring its social meanings and cultural functions. Journal of Ethnic Foods. 4 (2017). 28-35.

[23]. Onoja, U. S., Nweze, I. E., Agbo, M. O., Nnamani, P. O., Eke, F. N., Ivoke N., Eyo, J. E., Attama, C. I. and Ejere, V. C. (2015). Evaluation of bacteriological quality and essential elements in commercially bottled/packaged water produced and marketed in Southeastern Nigeria. African Journal of Microbiology Research, 9(15); 138-149

Appendices

Appendix 1: Variation of signal strength with temperature for the different NTA stations investigated

Temperature (^oC)	Signal strength (dBμV)					
	NTA Enugu	**NTA Umuahia**	**NTA Aba**	**NTA Owerri**	**NTA Awka**	**NTA Abakaliki**
24	36.4	26.7	37.2	30.6	33.4	27.4
25	36.1	26.3	37.1	29.7	33.3	27.3
26	35.8	26.2	36.8	29.6	33.1	26.9
27	35.3	25.7	36.3	29.4	32.6	26.4
28	35.2	25.6	36.3	28.8	32.1	26.3
29	34.9	25.2	36.2	28.3	31.8	26.3
30	34.5	24.6	35.3	28.2	31.6	25.8
31	34.2	24.6	35.1	27.6	31.6	25.2
32	33.9	24.2	34.9	27.4	31.3	24.7
33	33.7	24.1	34.7	27.3	31.2	24.3

Appendix 2: Variation of signal strength with pressure for the different NTA stations investigated

Pressure (hPa)	Signal strength (dBμV)					
	NTA Enugu	**NTA Umuahia**	**NTA Aba**	**NTA Owerri**	**NTA Awka**	**NTA Abakaliki**
985	37.9	27.2	37.7	30.5	33.8	27.9
986	36.5	27.6	37.1	29.6	33.5	27.8
987	36.5	27.4	37.4	27.5	33.6	27.6
988	35.9	27.0	36.4	27.4	33.3	27.1
989	35.7	26.5	35.9	27.0	33.0	26.4
990	34.8	26.0	35.3	26.8	32.4	26.4
991	34.5	25.7	35.1	26.4	32.2	26.6
992	34.4	25.2	34.8	26.7	32.2	26.5
993	33.8	24.9	34.9	26.5	31.6	26.2
994	33.6	25.0	34.6	26.3	30.7	25.7
995	33.1	24.7	34.6	26.4	30.4	25.4

Appendix 3: Variation of signal strength with humidity for the different NTA stations investigated

Humidity (%)	**NTA Enugu**	**NTA Umuahia**	**NTA Aba**	**NTA Owerri**	**NTA Awka**	**NTA Abakaliki**
69	35.7	27.1	37.9	31.2	34.4	27.5
70	35.6	27.2	37.6	30.8	34.4	27.7
71	35.3	26.4	37.5	30.7	34.1	27.4
72	36.1	26.3	37.5	30.6	33.6	27.4
73	35.2	26.2	37.4	29.4	33.4	27.1
74	35.1	26.4	37.2	28.9	33.3	26.8
75	34.8	26.3	37.4	28.6	33.2	26.5
76	35.1	26.2	37.4	29.1	33.4	26.4
77	34.6	26.0	36.5	28.8	33.4	26.4
78	34.3	25.9	36.3	28.5	33.4	26.3
79	34.2	25.3	36.2	28.5	32.8	26.3
80	34.5	25.3	35.8	28.4	32.6	26.2
81	34.2	25.2	35.8	28.2	32.3	25.5
82	34.1	24.7	35.8	27.8	32.2	25.3
83	33.7	24.6	35.2	27.7	31.7	25.4
84	33.7	24.6	34.8	27.6	31.8	25.2
85	33.9	24.8	34.6	27.6	32.0	25.0
86	34.2	24.2	34.6	27.4	31.6	24.8
87	33.5	24.1	34.5	27.2	31.1	24.6
88	33.4	23.7	34.3	27.3	31.0	24.5
89	33.2	23.4	34.4	27.3	31.0	24.5
90	33.2	23.4	34.3	27.2	30.9	24.5
91	32.9	23.2	34.1	26.9	30.6	24.3
92	32.4	23.1	33.8	26.4	30.6	24.1