The Effect of Solar Radiation on the Signal Strength of Some Radio Stations in Nigeria.

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ABSTRACT

The alternating voltages of some frequency modulation (FM) stations in Nigeria were obtained at Ilorin in the southern guinea savannah (Latitude 08.29^{o}N and Longitude 04. 32^{o}E; elevation 31m) during the period of three months as follows 12-31 October, 5-30 November and 1-31 December 2002. The data were taken from 7.00am when the stations start transmission to 11.00pm when the stations stop transmission within the interval of thirty minutes. The stations that transmit throughout the day were also considered. The results showed that some stations have all day signal strength, while some show variability in signal strength. This observation may be attributed to the solar activity in the atmosphere.

(Keywords: signal strength, voltage, solar activity, frequency modulation stations, FM)

INTRODUCTION

Radio waves are electromagnetic waves used for radio communications with the frequency range from 3 to 3000GHZ. The ways by which they travel from the transmitting station to a receiving antenna are ground, space, and tropospheric waves. Radio waves, the ultimate waves for communication, suffer a lot of disturbances as a result of irregular behavior of the ionosphere attributed to erratic solar radiation from the sun (Ezekoye and Obodo, 2007).

Radio waves are also affected by the phenomena of reflection, refraction, diffraction, absorption, polarization and scattering (Demetrius and Kenneth, 1969). Solar insolation on the other hand is the sum total of the amount of sun radiant energy arriving at a unit area during one hour at the Earth's surface.

The use of radio waves for long distance communication depends on the reflecting regions of the ionosphere which returns the signals that would be lost to the earth. As radio signals pass through any medium, they experience some delay as a result the signals received by an antenna located on the surface of the earth experience a decrease in speed of propagation and as a result they deviate from a straight line (Adegoke and Onasanya, 2008).

The atmosphere contains, at variable quantities, clouds, water vapor, air molecules and solid particles at different period of the year. Bean and Dutton (1966) stated that water vapor molecules have electric dipole moments which contribute significantly to the dielectric nature and hence the radio refractive index of the atmosphere. These molecules absorb radio waves and successively lead to attenuation of radio signals. However, Chiemeka (2007) reported that aerosols are characterized by low relative humidity and degradation of visibility, attenuation of radio signal and reduction of solar radiation.

The variation of the electron density in the atmosphere has an important role to play in understanding of the atmosphere. One of such roles is the effect of phase and amplitude scintillation caused by irregularities in electron density distribution. (Ezekoye and Obodo, 2007) observed that there is a general trend of maximum electron density appearing around noon and minimum at night. These variations of electron density are attributed to various reactions taking place in the atmosphere (Okeke et al., 2009). The present study therefore investigated the effect of solar radiation of the ionosphere on radio signals with the view to ascertain the quality of reception of radio signals and how they affect radio communication in Ilorin, Nigeria.

MATERIALS AND MEASUREMENT PROCEDURE

A receiver with trademark model number UX-C7 serial number 149P3095 VICTOR was used to measure the alternating voltages of some frequency modulation stations in Nigeria in the southern guinea savannah (Latitude 08.29^{o}N and Longitude 04. 32^{o}E; elevation 31m). It is a digitalized receiver designed to give excellent signals. An external antenna was connected to it to serve as a booster since receptions of frequency modulation (FM) signals are poor.

The multi-meter used is a digitalized one of 9V with trademark number AVD830B. It was used to measure the alternating current voltage from the receiver. The data were taken from 7.00am when the stations start transmission to 11.00pm when the stations stop transmission within the interval of thirty minutes. The stations that transmit throughout the day were also considered. The seven stations selected were EKO FM (89.75MHZ), OGBC FM (90.45MHZ), MINNA FM (91.20MHZ), Rhythm FM (93.70MHZ), Ibadan FM (98.50MHZ), Raypower FM (100.50MHZ) and Star FM (101.50MHZ).

The volume of the receiver was taken to maximum with the loudspeaker detached from the receiver to avoid disturbance. The multi-meter was used at the speaker point of the receiver to measure the alternating voltage at thirty minutes interval. The voltages were recorded with respect to time for the seven frequency modulation stations chosen for a period of three months, starting from 12 October 31 December 2002.

RESULTS AND DISCUSSION

The values of the daily average voltages (signal strength) for three months (October- December 2002) recorded at Ilorin for the seven stations are as shown in Figures 1 to 3. Consistent trend of signal strengths were observed in the three months. High signal strength was noted from 7.30hours to 10.00hours for the seven respective stations, and a decrease in signal strength from 11.00hours to 16.30hours.

A flunctuative increase in signal strengths is noticed from 17.00hours to the rest of the day's transmission (23.00hours) for most of the stations under study. However, high signal strength at the early hours of transmission may be attributed to low solar activities in the atmosphere as a result of low solar radiation. From 11.00hours to 16.30hours within these months, high solar radiation is usually experienced in most part of the country thereby increases solar activities in the atmosphere. This effect invariably causes fading and attenuation to the radio signals. This corroborates with Adimula and Willoughby (2008) who noted that there is a general rise in temperature resulting from high solar radiation between October and March.

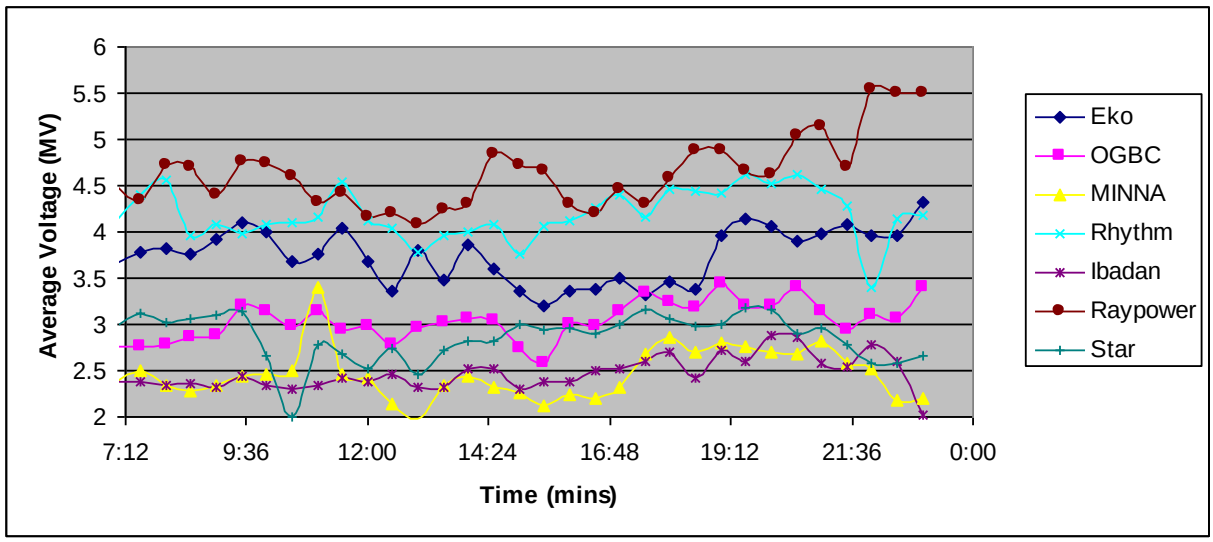

Figure 1: Signal Strength of Stations from 12-31 October, 2002.

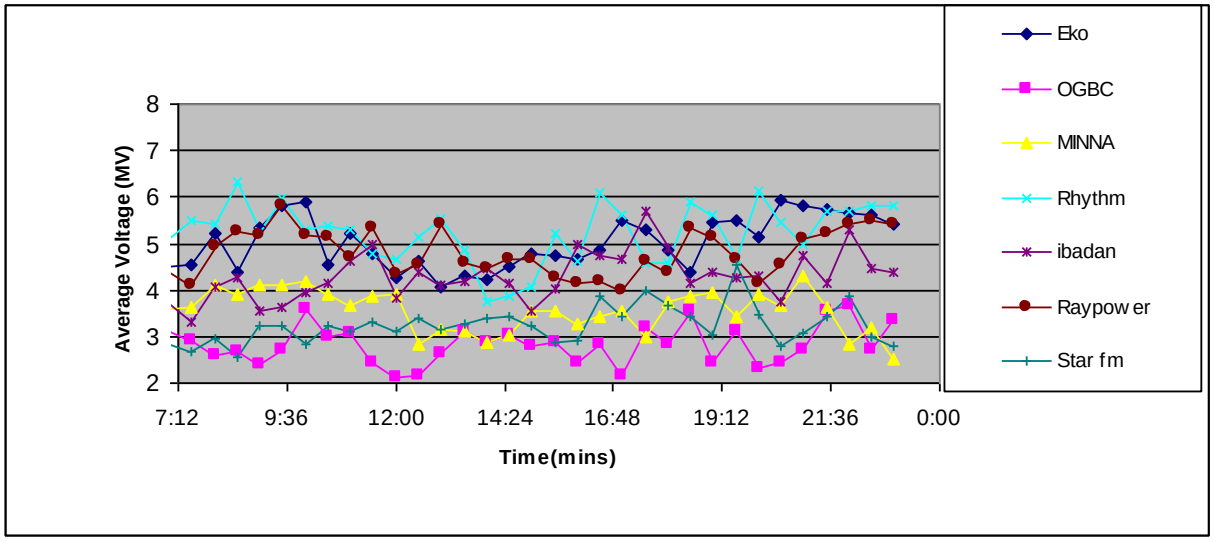

Figure 2: Signal Strength of Stations from 5-30 November, 2002.

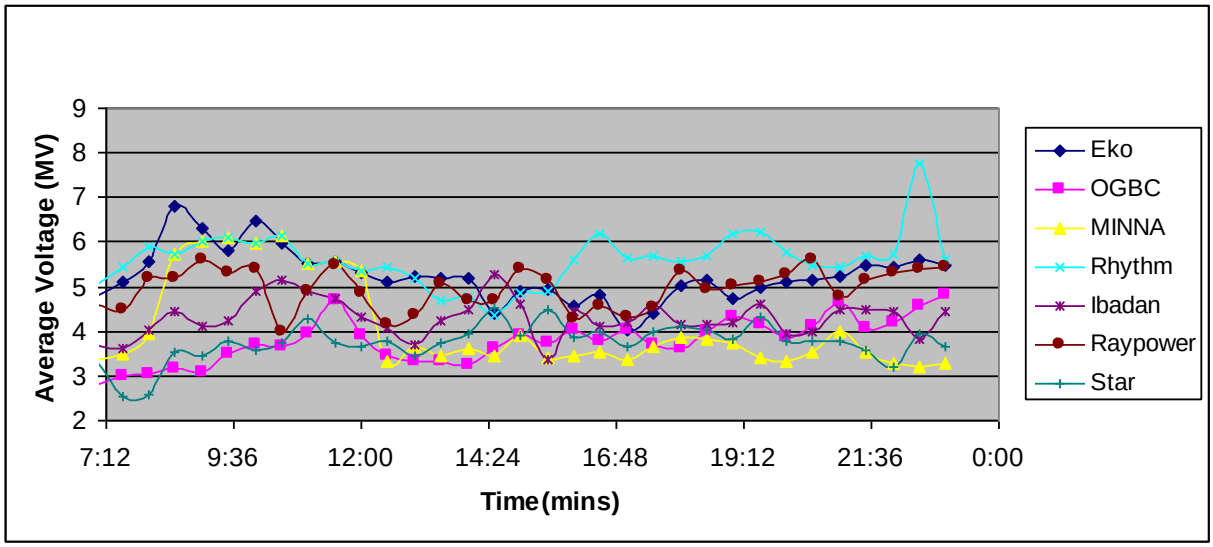

Figure 3: Signal Strength of Stations from 1-31 December, 2002.

From the evening (17.00hours) transmission into the night (23.00hours) a better signal strength was experience due to absent of the sun's ionizing radiations. Ezekoye and Obodo (2007) noted that there is a sharp increase in electron density from 5.00hours to a maximum at 12.00hours and a gradual decrease to zero at 18.00hour this is also in accordance with the study made by Tereshchenko et al. (2002) and Adeniyi et al. (2001). This variation is also a function of atmospheric radiation.

However, Eko FM (89.75MHZ), Raypower (100.50MHZ) and Rhythm (93.70MHZ) stations located in Lagos State maintained high signal strength as compared to the rest stations under observation. This can be attributed to the proximity of Lagos State to the Ocean, where continual onshore advection of cool air keeps average temperatures low and uniform, even in the dry season.

Table 1: Standard Deviation Intervals, Percentage Observations and Voltage of Some Stations in Nigeria.

Standard deviation intervals	Eko FM		OGBC FM		MINNA FM		Rhythm FM		Ibadan FM		Raypower FM		Star FM	
	(%)	voltage	(%)	voltage	(%)	voltage	(%)	voltage	(%)	voltage	(%)	voltage	(%)	voltage
0.10-0.29	3	4.7	-	-	9.1	3.5	15.2	5	3	4.8	-	-	6.1	3.2
0.30-0.49	7.6	5.2	18.2	3.9	18.2	3.1	10.6	5.3	8.1	3.9	9.1	4.9	13.6	3.7
0.50-0.69	18.2	4.8	9.1	3.1	29.3	3.1	12.5	4.9	26.3	3.6	9.1	4.8	24.2	3.5
0.70-0.89	29.3	4.7	26.2	3.1	24.3	3.3	25.2	5	30.3	3.7	21.2	4.5	30.3	3.3
0.90-1.09	22.2	4.6	29.3	3.1	12.1	3.5	30.3	4.3	12.1	4	18.2	5	16.7	3.4
1.10-1.29	15.3	4.7	16.2	3.3	5.1	3.7	8.1	4.1	14.1	3.6	23.3	4.7	9.1	3.5
1.30-1.49	21.1	5.3	10.6	3.6	6.1	3.1	10.6	4.2	12.1	4.2	11.1	5.1	4.6	3.5
1.50-1.69	6.1	5.1	6.1	3.8	-	-	3	3.9	3	3.3	8.1	4.9	-	-
1.70-1.89	6.1	5.1	-	-	3	4	-	-	3	3.6	6.1	5	-	-
1.90-2.09	-	-	3	3.5	-	-	-	-	3	3.5	-	-	-	-
Mean		4.91		3.42		3.41		4.59		3.82		4.86		3.44

This could reduce solar radiation by the atmosphere due to absorption, reflection, scattering by water vapor, clouds and particulates, which in turns reduce attenuation of radio signals. Standard deviation intervals, percentage observations and signal strength of some stations in Nigeria are presented in Table 1.

Rhythm, Ibadan, and Star FM stations have the same highest percentage of observation of 30.3% with variable signal strength of 4.3 MV, 3.7MV and 3.3MV, while similar percentage of observation of 29.3% were recorded for Eko FM, OGBC and MINNA with signal strength of 4.7MV, 3.1MV and 3.1MV respectively. Raypower had the least percentage of observation of 23.2% with signal strength of 4.7MV.

From this result, all stations showed percentage of observation of a range of 29-30% at low standard deviation interval with signal strength between 3.3MV and 4.7MV. Since percentage of observation and signal strength of these stations are relatively close, the stations may be using almost the same strength of equipment for their transmission. The mean signal strength from table 1 reveals that Eko and Raypower featured prominently as the best reception stations among the stations under observation.

These are stations sited in Lagos State, where the weather is relatively better for radio propagation due to low solar radiation as a result of the proximity of Lagos State to the Ocean, where continual onshore advection of cool air keeps average temperatures low and uniform, even in the dry season. The station with the least signal strength (Minna) a station located in the northern part of the country. This may be attributed to high solar radiation in this area. The rest of the stations observed show average signal strength.

CONCLUSIONS

The results showed that the stations in the coastal area south of the country have a better reception than the station in the northern part of the country which is however due to solar radiation effect. So the ability to carefully observe the conditions of the sun and its radiation will go a long way to broaden the range of radio propagation in any part of the world.

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