ASSESSMENT OF THE EFFECT OF ATMOSPHERIC PRESSURE ON THE SIGNAL STRENGTH OF FREQUENCY MODULATION RADIO STATION- WE FM ABUJA, NIGERIA

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Abstract

The radio signal strength of an FM radio station, WE FM, 106.3 MHz Abuja was simultaneously measured along with the atmospheric pressure of the study area.

The measured atmospheric pressure using digital barometer and the radio frequency signal strength of the radio station using digital CATV signal meter from 5.00 am to 8.00 pm and at one hour interval on 10th and 11th of January, 2018 were used to investigate the effect of atmospheric pressure on signal strength of the FM radio station (WE FM) in Abuja, Nigeria.

It was observed from the result that atmospheric pressure has effect on the signal strength of the radio station. The coefficient of correlation, r, between the two quantities- signal strength and atmospheric pressure is 0.701 (70.1%).

The result also showed that the measured atmospheric pressure and signal strength of the radio station are directly proportional, hence concluded that increase in atmospheric pressure leads to increase in signal strength.

Keywords: Atmospheric pressure, Barometer, Frequency, Harmattan, Signal strength.

1.0 Introduction

Pressure can be defined as a continuous force which is exerted against or on a body by another body in contact with it. It is the force exerted per unit area perpendicular to the surface of an area over which the force is spread or distributed. The units of pressure are Newton per meter squared (N/M^2), millibar (mb), hectopascal (hpa), etc. Atmospheric pressure is the pressure within the earth's atmosphere. Thus, it the force exerted per unit area on some bodies or objects in the earth's atmosphere.

There are various particles in the earth's atmosphere especially the troposphere whose components always influence radio frequency signal transmission. Previous studies on effects of temperature and/or relative humidity on radio frequency signal strength have shown how signal strength was influenced by these quantities such as pressure, temperature and relative humidity though the focus of this study is on atmospheric pressure.

According to Joseph and Oku (), the atmosphere is a communication channel which opposes or reduces signals. The magnitude of the signal reduction depends upon its condition at a particular time and it is characteristic of a particular weather and climate.

According to Amajama (2015), the atmosphere condition has serious effect on signal and can result to loss signal. He observed that the major atmospheric elements that the components of the weather are the atmospheric temperature, pressure, humidity and wind speed and direction, and thus, finding how each or some of these components influence the radio signal strength is very paramount.

According to Michael (2013), some the factors affecting radio wave propagation are as rain, wind, temperature, and water content of the atmosphere and that they can combine in different ways to affect radio wave propagation to a point that some combination may cause radio signals to be heard far away beyond its ordinary range or resulting in attenuation that can make the signal not to be heard even over a normally satisfactory path.

Ale et al. (2017), stated that the results of their work on WE FM (106.3MHz) Abuja, Nigeria show that signal strength reduces as the atmospheric temperature increases, but increases with the increase in relative humidity.

Since we have not been able to access a significant number of previous works on how atmospheric pressure affect radio frequency signal strength knowing well that it might have an effect since it is a component of radio refractivity prediction, we find this work very necessary.

2.0 Materials and method

2.1 Materials

The materials are CATV signal meter, Digital barometer/altimeter, and Microsoft excel software package. The CATV signal level meter is S110 model and operates on a 9v DC inbuilt battery. The Digital barometer/altimeter operates on two medium size 1.5v dry cells. It reads the atmospheric pressure as well as altitude of the experiment. The frequency of the radio station, WE FM, Abuja, Nigeria, 106.30MHz, obtained from their website is also required.

Plate 1: Digital CATV signal strength meter

2.2 Methods

The experimental setup was done at Mathson Space International School, Karshi, Abuja.

A yagi uda antenna was mounted on a vertical pole of about 14m tall to allow clear line of sight due to hilly nature of Karshi, the location of the experimental setup. One of the ends of coaxial cable was connected to the antenna connector and the other end of the cable was attached to a connector which was then connected to the CATV meter through its connector. The device was then put on by pressing the on/off button. The frequency (106.30MHz) was inputted into the device, and when “OK” was pressed, it would display the signal strength of the radio station at that moment, in which a stable value will be read and recorded. The digital barometer puts itself on automatically as soon as the batteries were inserted in the battery position.

The direction of the antenna in the direction of higher signal as displayed on the meter screen, and it was left at the fixed position and direction throughout the study period to avoid receiving varying signal strength from various directions as well as loosing the line of sight of the transmitter.

The readings were taken beginning from 5.00 am to 8.00 pm and at one hour interval on 10th and 11th of January, 2018. At each point of the readings, the highest and stable value of the signal strength was taken on the CATV signal meter and the atmospheric pressure was also read from the barometer simultaneously with the signal strength.

The graphical comparisons of the measured quantity or data as well as regression and correlation analyses were used to assess the relationship between the signal strength and atmospheric pressure at the study location for the period of studies.

3.0 Results and Discussions

The Measured signal strength and atmospheric pressure in table 1.0. The experiment was conducted on the 10th and 11th of January, 2018 when there was intense effect of Harmattan, and the average of the two days reading was taken to have a single column value for each of the quantities as represented in table 1.0.

The result shows the rise in atmospheric pressure though very minimal from 5am to 10am when it started decreasing, and which continues till 5pm when it started rising again until 8pm. Although, the pressure decreased from after 10am until 5pm, there an irregular change that occurred at 4pm as the pressure slightly increased and then decreased in the next hour.

Table 1.0: The Measured signal strength and atmospheric pressure

S/N	Time	signal strength (dBuV)	P(hpa)
1	5.00am	45.20	970.0
2	6.00am	46.30	970.3
3	7.00am	48.00	970.6
4	8.00am	44.90	971.1
5	9.00am	44.90	971.9
6	10.00am	44.60	971.9
7	11.00am	44.70	971.5
8	12.00pm	43.44	970.5
9	1.00pm	40.00	969.1
10	2.00pm	42.30	968.1
11	3.00pm	39.40	967.4
12	4.00pm	40.20	967.5
13	5.00pm	41.50	967.3
14	6.00pm	43.00	967.5
15	7.00pm	43.10	968.0
16	8.00pm	44.20	968.7

The maximum atmospheric pressure of the study area was 971hpa and it occurred at 9.00 am and 10.00 am, while the minimum atmospheric pressure, 967.3hpa occurred at 5.00 pm.

From the results, it can also be seen that the measured signal strength of the radio station received in the area did not have a particular regular trend of variation except from 3.00 pm to 8.00 pm. There was little increase in the value of the signal strength from 3.00 pm to 8.00 pm with the values measured as 39.4, 40.2, 41.5, 43.0, 43.1 and 44.2 dBuV respectively (Table 1.0).

Furthermore, there was an increment in the signal strength from 5.00 am to 7.00 am, and it decreased from 8.00 am to 9.00 am, then remained constant till 9.00am and started decreasing and increasing irregularly.

Also from 5.00pm – 8.00pm, the increase in the signal corresponds with increases in the atmosphere pressure i.e. we have positive correlation. But from 9.00am – 3.00pm, the variation of the signal is irregular. The signal experienced rising and falling like a crest and trough in the wave oscillations, from 9.00am-12.00pm and then from 1.00pm – 3.00pm while the atmospheric pressure from 9.00am – 3.00pm indicates normal trend of decrease.

The irregularities in the signal from 9.00am – 300pm that does not corresponds with the variation in the atmospheric pressure might be due to others atmospheric parameters that were not considered in the course of the experiment. The other atmospheric parameters seem to have more effects on the signal strength than the atmospheric pressure which we can consider to have negligible effect from 9.00am – 3.00pm.

The alternate heating and cooling of the air above the experimental location that can produce rhythmic expansion and contraction of the atmosphere might have produced the same positive and negative pressure gradient that cancelled out in the process thereby produces little or no effects of atmospheric pressure on the signal. Definitely, the alternate heating and cooling of the atmospheric air occurring at the point considered will cause irregular temperature gradient variation from 9.00am – 3.00pm which also causes signal irregularities at these times. Other parameters such as humidity gradient variations and variations in the air density gradient over the location of the experiment or variations in the environmental air density between the antenna height and the signal receiver can cause a lot of variations especially during thunderstorms and when air descended down during harmattan. Even at a very high temperature the molecules of the atmospheric gas are far apart, so that the potential energy due to inter-molecular force will be no significant compared with the kinetic energy of atmospheric air particles, so the pressure present will not bring the molecules together, and can result in irregularities in the signal received.

However, the trend of variations in the two quantities is mostly the same in some areas as in figure 3.0.

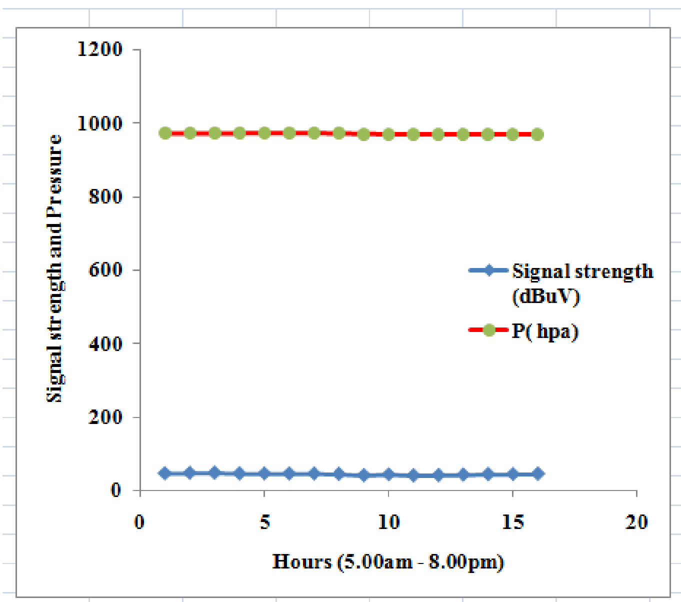

Figure 3.0: Graphical representation of signal strength and atmospheric pressure

From the figure, it can be observed that at some points, the lines of best fit of the signal strength and atmospheric pressure change in the same way.

This was clearly shown in the regression analysis of the two quantities shown graphically in figure 4.0. The regression coefficient, r^2, between the signal strength and atmospheric pressure is 0.492. Thus, the coefficient of correlation, r, between the two is 0.701. That is; the relationship between atmospheric pressure and the radio station signal strength is 70.1%.

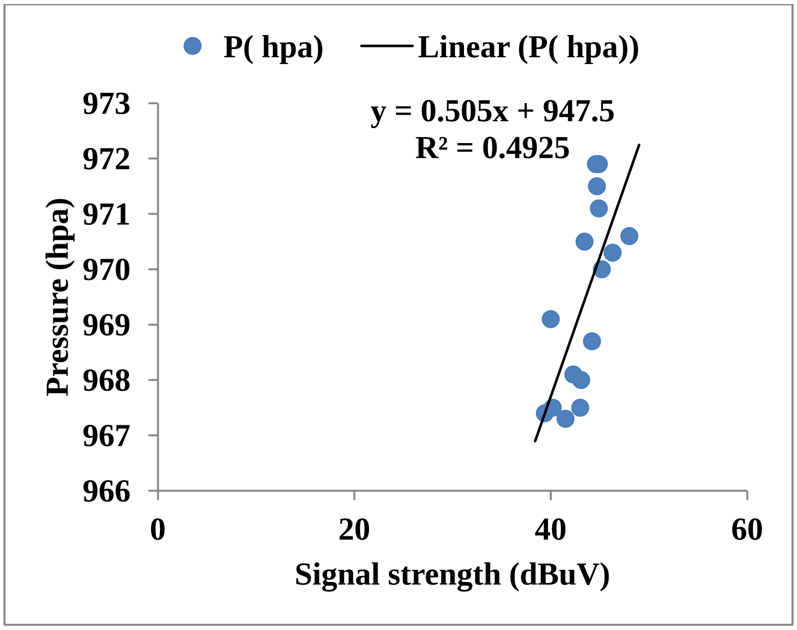

Fig. 4.0: Regression analysis of signal strength and atmospheric pressure

Figure 4.0 shows that the graph of pressure and signal strength slopes upward from left to right. This shows that both quantities increase or decrease at the same time. In other words, the signal strength increases with increase in atmospheric pressure and vice versa. Therefore, it can be said that the radio station (WE FM) signal strength is directly proportional to the atmospheric pressure. Thus, atmospheric pressure has effect (and high effect in this case considering the correlation coefficient of 0.701) on the frequency modulation (WE FM Abuja) signal strength. This result is however in contradiction with the result from the work by Amajam, (2016) on Cross- River State Broadcasting Corporation, 519.25 MHz (UHF), Calabar, in which he stated that the correlation coefficient between the signal strength and atmospheric pressure was -0.99 provided that temperature, relative humidity, wind speed and direction remain constant. This contradiction might be as a result of these conditions which he observed in his work but are not observed in this work, or as a result of his work which focused on Ultra High Frequency (UHF) (300MHz – 3000MHz) while this work was done for Very High Frequency (VHF) (30MHz – 300MHz) though subject to further research investigation.

4.0 Conclusion

The measured atmospheric pressure using digital barometer and the radio frequency signal strength of WE FM (106.3 MHz) radio station Abuja, Nigeria using digital CATV signal meter have been used to study the effect of atmospheric pressure on signal strength of an FM radio station.

It was observed from the result that atmospheric pressure has effect on the signal strength of the radio station. The coefficient of correlation, r, between the two quantities- signal strength and atmospheric pressure is 0.701 (70.1%).

The result showed that the measured atmospheric pressure and signal strength of the radio station are directly proportional, which means increase in atmospheric pressure in the study area will result in increase in signal strength. Designers of communication link and network personnel will find this result valuable in any work in this study area.

5.0 Recommendation

As stated above, this experiment was carried out in January in which there was intense harmattan, therefore, the effect of harmattan cannot be ruled out completely. Carrying out of similar work outside harmattan period in the study area is still necessary in future work. Also, with respect to the disagreement between the result of Amajama and ours, further work is recommended on UHF to see if the result will be in conformity with that of Amajama or will still contradict it.

6.0 References

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