International Journal of Scientific Engineering and Technology ISSN:2277-1581
Volume No.5 Issue No.3, pp: 131-133 01 March.2016

Atmospheric Pressure Bearing on (UHF) Radio Signal

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Abstract: ***Signal strength from Cross River State Broadcasting Co-operation ($4^0$57'54.7''N, $8^0$19'43.7''E) was measured in a residence along Etta-abgor, Calabar ($4^0$57'31.7''N, $8^0$20'49.7''E) simultaneously with the meteorological components. Results indicated that signal strength is inversely proportional to atmospheric pressure; provided that, other measured metrological components were observed constant, including the wind speed and direction.***
Keywords— Metrological components, Atmospheric pressure, Signal strength, Radio signal, Ultra High Frequency (UHF).

I. Introduction

Air pressure is a measure of the force exerted on the surface by the overlying air adjusted to sea level elevation [xi]. In short, it is the pressure exerted by the atmosphere [ii]. Atmospheric pressure is expressed in several systems of units: pounds per square inch (psi), millimetres (or inches) of mercury, dynes per square centimetre, standard atmospheres, millibars (mb), or kilopascals [i]. Atmospheric pressure typically ranges from 950 mBar to 1050 mBar (approximately 1000 mBar, amounts to standard atmospheric pressure) [xi]. Variations about these range of values are quite minute; for example, the lowest sea-level and highest pressures ever registered are 877.07 mBar (in the middle of Siberia) and 1083.98 mBar (in a typhoon in the Southern Pacific) [i]. The little pressure variations that do exist, determine the wind and storm patterns of the Earth to a large extent [i]. Lower pressure indicates stormy weather and higher pressure normally spell fair weather [xi]. More so, atmospheric pressure can be expressed as force per unit area exerted by an atmospheric column (that is, the entire body of air above the specified area) [i]. Atmospheric pressure also named barometric pressure can be measured with a mercury barometer (hence the commonly used synonym *barometric pressure*), which indicates the height of a column of mercury that exactly balances the weight of the column of atmosphere over the barometer [i]. Atmospheric pressure is also measured using an aneroid barometer, in which the sensing element is one or more hollow, partially evacuated, corrugated metal disks supported against collapse by an inside or outside spring; the change in the shape of the disk with changing pressure can be recorded using a pen arm and a clock-driven revolving drum [i]. Researchers have shown that there is a decrease in pressure with height. Near Earth's surface, the pressure decreases with height at a rate of about 3.5 millibars for every 30 metres (100 feet). However, over cold air the decrease in pressure can be much steeper because its density is greater than warmer air [i].

The atmosphere causes signal path loss as a radio wave propagates through it [iv]. The meteorological state or condition of the atmosphere determines the extent of this loss [v] [ix] [x]. The pressure of the atmosphere is one of the four major elements of the atmosphere (aside temperature, humidity and wind) that comprise the weather of a place. And science literatures have shown that weather has a significant effect on radio communications [vi] [vii], hence pressure.

The atmospheric pressure also affects the radio refractivity [iii] [vii] [xii]. It determines the refraction and attenuation of radio signals as they propagate through the troposphere of the atmosphere.

This research work zero in on the bearing of the weather parameter: atmospheric pressure from a residence at Etta-agbor in the Calabar metropolis on signal of about 519.25 MHz and 35 mdB, from the Cross River Broadcasting Corporation Television (CRBC-TV), Calabar, Cross River State, Nigeria.

II. Material and Methodology

The examination was carried out in a residential area (Etta-abgor) within the Calabar metropolis in Cross River State, Nigeria. The main object of the experiments was to obtain statistical data of signal strengths and weather parameters in the aforementioned residential area to investigate the impact of the atmospheric pressure on radio signal. Signal strengths were obtained every 30 mins at the residential area for over 24 hrs and simultaneously, the weather parameters: atmospheric temperature and pressure and relative humidity and wind direction and speed were recorded to probe the bearing of the atmospheric pressure on the radio signal. The measurement of the signal strength was made using the Digital community – Access (Cable) Television (CATV) analyzer with 24 channels, spectrum 46 – 870 MHz, connected to a domestic receiver antenna of height 4.23 m.

To be able to draw a justifiable conclusion on the bearing of the atmospheric pressure on the radio signal, the dependence of the signal strength on relevant parameters was analyzed. These relevant parameters were the: atmospheric temperature and pressure, relative humidity and the wind speed and direction. The received signal strengths were measured only on the downlink and the receiver antenna was adjusted until the best obtainable result of signal strength via the generated images on the screen was captured on the cable analyzer before recording.

The site ($4^0$57'31.7"N, $8^0$20'49.7"E) where the weather was under study to ascertain the bearing of the atmospheric pressure on the radio signal was a residential area with scanty trees and predominantly low height buildings of about 2 m to 3 m.

To determine the bearing of the atmospheric pressure on radio wave, the CATV analyzer was stationed in an apartment and the 4.23 m high antenna was connected to it and mounted outside. The atmospheric temperature and pressure, relative humidity and the wind speed and direction and corresponding signal strength were taken every 30 mins for over 24 hrs.

 ISSN:2277-1581
01 March.2016

Measurements with the digital CATV analyzer being time dependent were made approximately within every sixty seconds (60 s). The average signal strength value (mean of minimum and maximum reading) was recorded when the images were sharpest.

III. **Results and Tables**

The result of the experiments is analyzed below. To determine the bearing of the atmospheric pressure on radio signals, some data or measurements was extracted from the whole and analyzed. The bearing of the weather parameter: atmospheric pressure on the signal strength was drawn, through the curves that were produced from the data or measurements excerpted.

Analysis of the bearing of the weather parameter: atmospheric pressure on radio signal.

The four weather parameters that govern our weather are the atmospheric temperature, pressure, humidity and wind speed and direction.

Fig. 1 below shows the graphical relationship between radio signal strength and atmospheric pressure.

TABLE 1

Measurement of signal strength (mdB) and atmospheric pressure (inHg) at uniform temperature of 77 ^{0}F, uniform relative humidity of 94 % and wind speed and direction of 0 mph NA

Atm. Press. (inHg)	Signal strength (mdB)	Atm. Temp. (^{0}F)	Relative humidity (%)	Wind (mph) N	Time (hour)
29.91	9.4	77	29.91	0 NA	22:30
29.94	9.3	77	29.91	0 NA	12:30
29.88	9.7	77	29.91	0 NA	24:00
29.85	9.8	77	29.91	0 NA	6:00
29.81	10.0	77	29.91	0 NA	21:00

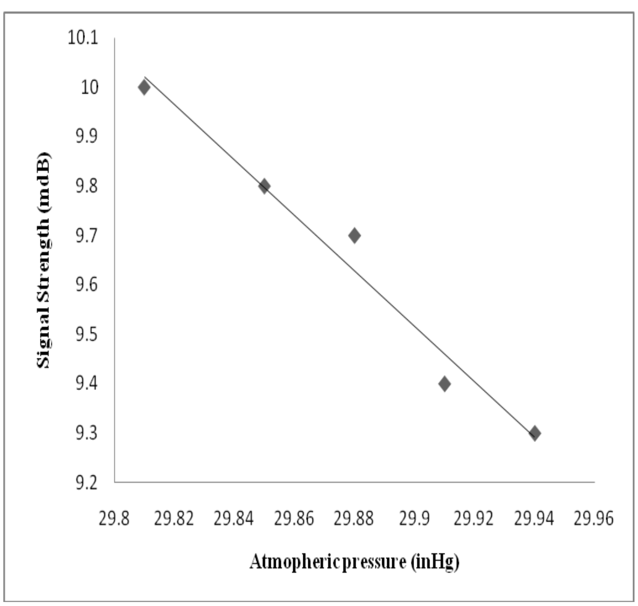

Fig.11. Relationship between signal strength (mdB) and atmospheric pressure (inHg), at uniform atmospheric temperature of 77 ^{o}F, relative humidity of 94 % and uniform wind speed and direction of 0 mph NA

Fig. 1 shows the relationship between signal strength and atmospheric pressure, at uniform atmospheric temperature and relative humidity of 77 ^{o}F and 94 % respectively and wind speed and direction of 0 mph NA. The signal strength decreased with increase in atmospheric pressure. The numerical value of the correlation between the above-mentioned parameters is -0.99. Hence, the higher the atmospheric or air pressure: the lower the signal strength. Paraphrasing, the signal strength has a mathematical inverse relationship with pressure, assuming other weather or metrological parameters: atmospheric temperature, relative humidity and wind speed and direction are observed constant.

If S and P symbolize signal strength and atmospheric pressure respectively, it can be postulated that $S \propto \frac{1}{P}$ or SP = K at the same atmospheric temperature, relative humidity wind direction and speed, where K is a constant.

In summary, experiments have been carried out to characterize the propagation of radio signals through the atmosphere to determine the bearing of the weather parameters: atmospheric pressure on propagating radio signal. Results from the weather parameters at the residence in Etta-agbor: atmospheric temperature and pressure, relative humidity, wind speed and direction and signal strength revealed that; the atmospheric pressure negatively bear on radio signal provided that other weather parameters: atmospheric temperature and humidity and wind speed and direction are observed constant. The correlation between atmospheric pressure and radio signal strength is r = -0.99. The above-mentioned phenomenon is observed similar to when a particle is impeded by the pressure from a force field acting oppositely against it [viii] [xiii].

IV. **Conclusion**

In conclusion, it was observed from the residential area in Etta-agbor, Calabar-Nigeria, that the atmospheric pressure is inversely proportional to the radio signal strength, provided that the weather parameter: atmospheric temperature and humidity and wind speed and direction is observed constant. Hence SP = K (that is $S_1P_1 = S_2P_2 = K$ where S P and S P are initial and final state conditions respectively). S = Signal strength, T = Atmospheric temperature, P = Atmospheric pressure, H = Relative humidity and K = Constant.

Acknowledgement

From the well of joy in the heart, a huge volume of gratitude is poured on the Cross River Broadcasting Cooperation (CRBC) for granting a ready access to their Community Access Television (CATV) Analyzer throughout the course of this research.

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