International Journal of Engineering Research and General Science Volume 4, Issue 3, May-June, 2016
ISSN 2091-2730

Impact of Weather Components on (UHF) Radio Signal

Joseph Amajama

Electronics and Computer Technology Unit – Physics Department – University of Calabar – Nigeria, joeamajama2014@yahoo.com, +2347036357493

Abstract— This work probes the impact of major weather components on UHF radio signal. Measurements of the radio signal strength from Cross River State Broadcasting Co-operation (CRBC), ($4^0$57'54.7"N, $8^0$19'43.7"E) transmitted at 35mdB and 519.25 MHz (UHF) were done in a residence along Etta-abgor, Calabar ($4^0$57'31.7"N, $8^0$20'49.7"E) to ascertain the impact of the weather components: atmospheric temperature, pressure, humidity and wind on radio signals. The components: atmospheric temperature, pressure, humidity and wind speed and direction with signal strength were measured half hourly from the residence in Etta-agbor to draw a justifiable inference on the impact of the aforementioned quartet on UHF radio signal. Results indicated that radio signal strength is inversely proportional to atmospheric temperature, pressure and humidity; provided that for any of the giving components, others were observed constant, including the wind speed and direction, since it has been erected that wind has a marked effect on radio signal. The correlation of the signal strength and atmospheric temperature, pressure and humidity were respectively r = -0.94, -0.99 and -0.93 and the equation $S = \frac{K}{TPH}$ at constant wind speed and direction was postulated, where S, T, P, H and K are Signal strength, Atmospheric temperature, Atmospheric pressure, Relative humidity and Constant respectively.

Keywords— Weather components, Radio signal, Signal strength, Ultra High Frequency (UHF), Atmospheric temperature, Atmospheric pressure, Relative humidity (Atmospheric humidity) and Wind.

INTRODUCTION

Basically, weather is the state or condition of the atmosphere [1]. In meteorology, the atmosphere is studied within the compass of the troposphere which is the sphere that governs our weather. In other words, the troposphere is of utmost concern to the weather scientist or meteorologist [5].

The way that radio signals propagate from the radio transmitter to the radio receiver is of great importance when planning a radio communications network or system. This is controlled to a great degree by the regions of the atmosphere through which they pass. Without the action of the atmosphere, it would not be possible for radio communications signals to propagate around the globe on the short wave bands or propagate greater than only the line of sight distance at high frequencies [5].

The atmosphere is one of the factors responsible for signal path loss depending upon its condition or the weather [4] [10]. The conditions produced by different weather components have an impact on the quality of radio signal in our environment. Radio signal paths are affected by the condition of the atmosphere [13]. The atmosphere may refract and return the signals to the earth in consequence of its varying refractivity index owing to its temperature, pressure, humidity and wind which are components of weather or meteorology [2] [3] [6] [8] [9] [14]. The coverage of broadcast can stretch to the neighborhood of beyond three times the horizon for UHF (Ultra high frequency) [9].

There is a marked improvement in propagation signal strength corresponding to clear sky condition. The dependence of refractivity on the physical structure of the atmosphere implies that changing metrological or weather conditions can lead to changes in radio wave propagation [14].

Wind, air temperature, and water content of the atmosphere can combine in many ways. Certain combinations can cause radio signals to be heard hundreds of miles beyond the ordinary range of radio communications. Conversely, a different combination of factors can cause such attenuation of the signal that it may not be heard even over a normally satisfactory path. Unfortunately, there are no hard and fast rules on the effects of weather on radio transmissions since the weather is extremely complex and subject to frequent change [13].

Weather is a factor that affects the propagation of radio waves [7] [13]. Wind and rain can impose an additional attenuation on the propagation of signal within a forest environment. The additional attenuation increases as the strength of the wind and rain increases [7].

A research shows that the strength of radio signals on the ground is a reliable indicator of temperature change above. The research team used a simple radio antennae on the ground to measure radio waves broadcast by navigational transmitters around the globe, and then compared information on the strength of these radio signals with data on temperature fluctuations in the upper atmosphere. They discovered that climate change in the upper atmosphere -- caused by an abundance of greenhouse gases -- may lead to a greater absorption of radio waves. Weaker signals could therefore be indicative of greater climate change [1].

Many wireless sensor networks operating outdoors are exposed to changing weather conditions, which may cause severe degradation in system performance. Therefore, it is essential to explore the factors affecting radio link quality in order to mitigate their impact and to adapt to varying conditions. Experimental measurements were performed using Atmel ZigBit 2.4GHz wireless modules, both in summer and wintertime and employing all the radio channels specified by IEEE 802.15.4 for 2.4GHz ISM frequency band with two transmit power levels. Results show that changes in weather conditions affect received signal strength. Of the studied weather variables: temperature and humidity; variation in signal strength can be best explained by the variation in temperature [6].

Wind, air temperature, and water content of the atmosphere can combine in many ways. Radio signals can be heard hundreds of miles beyond the ordinary range of radio communications at certain atmospherical combinations as earlier sated [5] [9] [13]. Conversely, a different combination of factors can cause such attenuation of the signal that it may not be heard even over a normally satisfactory path. Unfortunately, since the weather is extremely complex and subject to frequent change there are no hard and fast rules on the effects of weather on radio transmissions [13]. Therefore our discussion shall be limited to the effects of weather on radio waves to general terms.

Weather is made up of multiple parameters, including the temperature, pressure, humidity of the atmosphere, solar radiation and wind [12]. This research work condenses attention on the impact of the weather components: atmospheric temperature, pressure and humidity and wind from a residence at Etta-agbor in the Calabar metropolis on radio signal of about 519.25 MHz (UHF), which is the frequency of transmission for the Cross River Broadcasting Corporation Television (CRBC-TV), Calabar, Cross River State, Nigeria. In this work, study was made of how and to what extent the various weather phenomena affect wave propagation.

To strike the object of this work, signal strength evaluations in the Etta-agbor residence were made simultaneously with the weather components (atmospheric or tropospheric temperature and pressure, relative humidity and wind speed and direction) to investigate the atmospheric temperature, pressure and humidity and wind bearing on radio waves or signal.

MATERIALS AND METHOD

The campaign was carried out in a residential area (Etta-abgor) within the Calabar metropolis in Cross River State, Nigeria. The object of the experiments was to obtain statistical data of signal strengths and weather components in the aforementioned residential area. Signal strengths measurements were obtained half hourly at the residential area for over 24 hrs and simultaneously, the weather components: atmospheric temperature and pressure and relative humidity and wind direction and speed were recorded to probe the impact of the weather components on 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.

Majorly, four meteorological components define our weather, that is: atmospheric temperature, atmospheric pressure, relative humidity (atmospheric humidity) and wind. To ascertain the actual impact of the individual meteorological component: each of the other parameters that will have an effect on the inference on the result of that individual component was observed constant. Hence only some of the data were utilized. Find in appendix, the detail results of measurement

RESULTS AND ANALYSIS

If acknowledgement is there wishing thanks to the people who helped in work than it must come before the conclusion and must be same as other section like introduction and other sub section.

The results of each of the experiments are analyzed separately. To determine the impact of the atmospheric temperature, pressure and humidity and wind on radio signal. Some data or measurements extracted from the whole were used to determine the impact of each weather parameter mentioned above on the signal strength, through the curves that were produced from the data or measurements excerpted. In the Appendix is the detail of the results obtained that was used to ascertain the impact of the weather components on radio signals.

a. Analysis of effects of meteorological components (or weather parameters) (atmospheric temperature and pressure, relative humidity and wind) on radio waves or signal strength.

The four meteorological components (or weather components) that govern our weather are the atmospheric temperature, pressure, humidity and wind speed and direction.

Figures 1, 2 and 3 below show the graphical relationships between signal strength and atmospheric temperature and pressure and relative humidity respectively. Before each figure or graph is its table. Also, figure 4 shows the direction of the residence where the receiver (CATV Analyzer) was stationed away from the CRBC-TV transmitter and figures 5, 6, 7 and 8 show the graphical relationships of the signal strength and wind at different constant atmospheric components. Just before the figures 5, 6, 7 and 8 are their tables.

TABLE 1

Measurement of Signal strength (mdB) at different atmospheric temperature, at uniform relative humidity of 94 %, near uniform atmospheric pressure of 29.93 ($\pm$ 0.02) inHg and uniform wind speed and direction of 0 mph NA

Atmospheric temperature (^{0}F)	Signal strength (mdB)	Relative humidity (%)	Atmospheric pressure (inHg)	Wind (mph) N	Time (hour)
77.0	9.4	94	29.91	0 NA	22:30
78.5	9.0	94	29.94	0 NA	8:00
78.0	9.3	94	29.94	0 NA	8:30
79.5	7.8	94	29.94	0 NA	11:30
79.0	8.0	94	29.94	0 NA	12:00

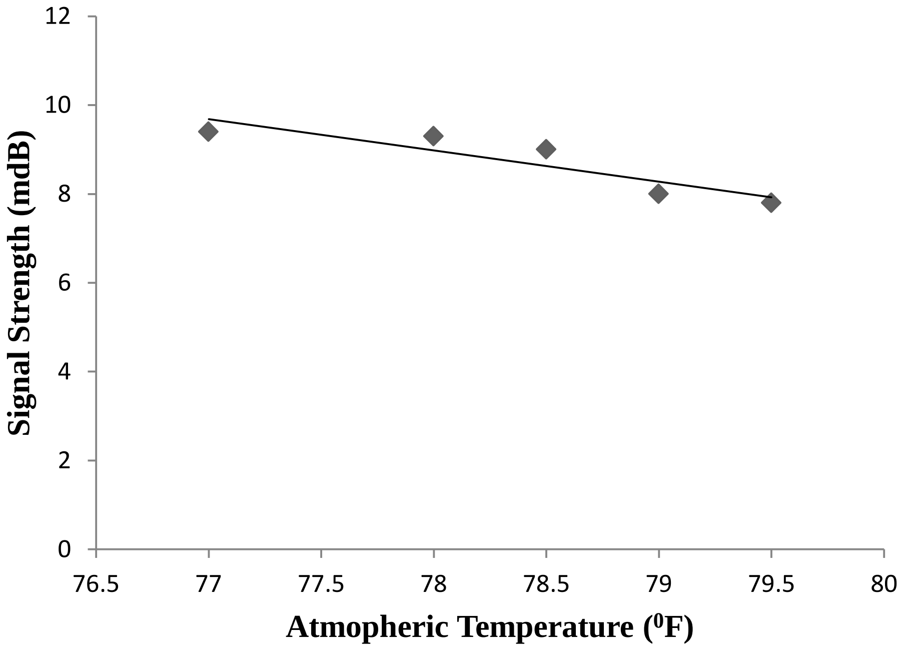


Figure 1: Relationship between signal strength (mdB) and atmospheric temperature (^{0}F), at uniform atmospheric pressure of 29.93 ($\pm$ 0.02) inHg, uniform relative humidity of 94 % and uniform wind speed and direction of 0 mph NA

TABLE 2
Measurement of signal strength (mdB) at different relative humidity (%), uniform atmospheric temperature of 77 ^{0}F and pressure of 29.91 inHg and uniform wind speed and direction of 0 mph NA

Relative humidity (%)	Signal strength (mdB)	Atmospheric temperature (^{0}F)	Atmospheric pressure (inHg)	Wind (mph) N	Time (hour)
94	9.5	77	29.91	0 NA	5:30

ISSN 2091-2730

100	8.5	77	29.91	0 NA	13:30
89	9.7	77	29.91	0 NA	7:30
90	9.6	77	29.91	0 NA	0:30
82	10.0	77	29.91	0 NA	24:00

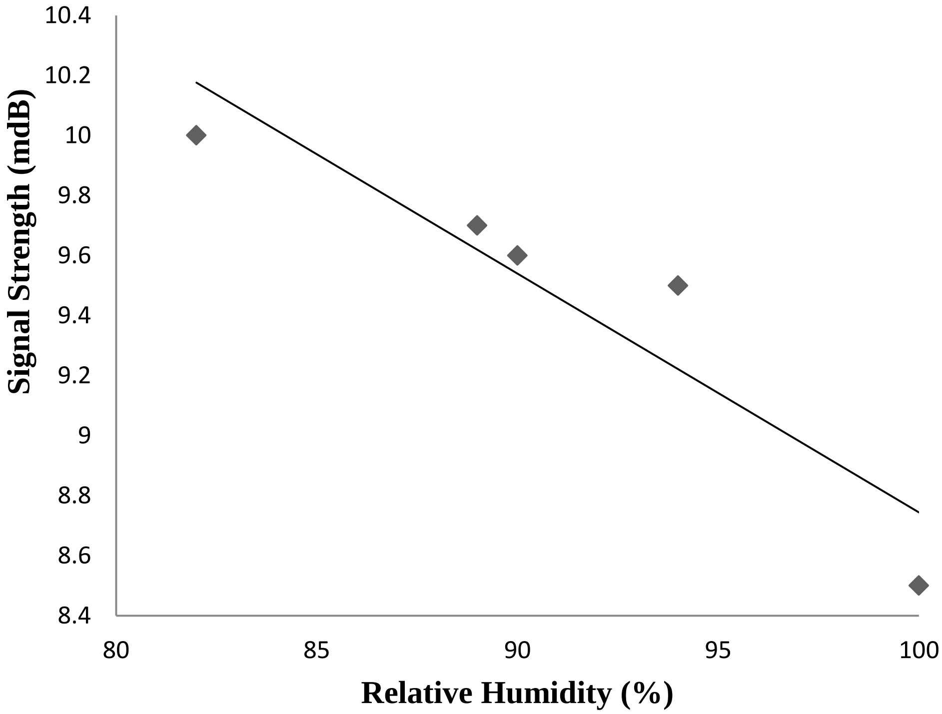


Figure 2: Relationship between signal strength (mdB) and relative humidity (%), at uniform atmospheric temperature of 77 ^{0}F and pressure of 29.91 inHg and uniform wind speed and direction of 0 mph NA

TABLE 3

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

Atmospheric pressure (inHg)	**Signal strength (mdB)**	**Atmospheric temperature (^{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

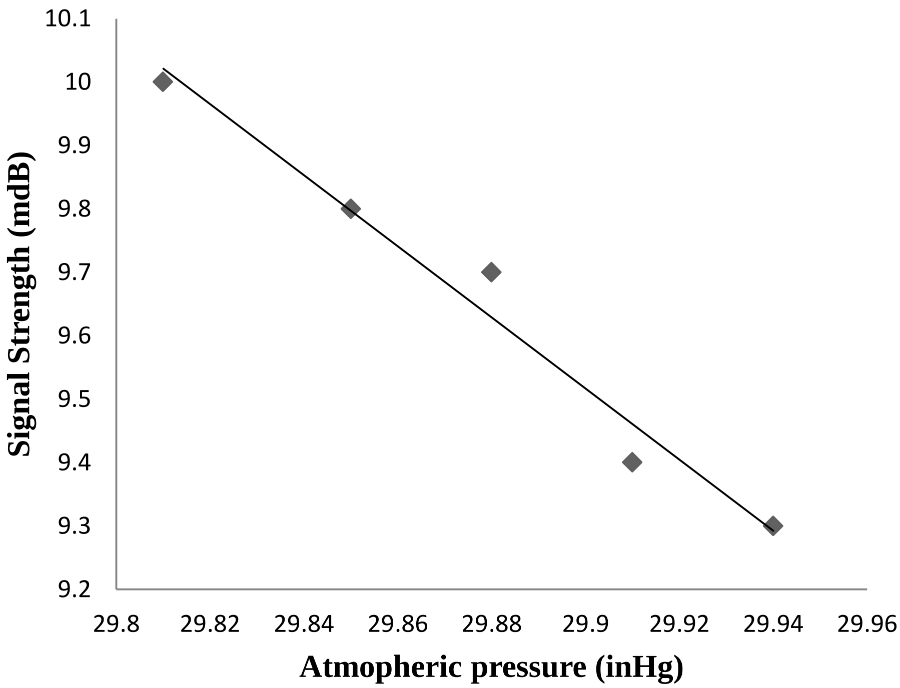


Figure 3: Relationship between signal strength (mdB) and atmospheric pressure (inHg), at uniform atmospheric temperature of 77 ^{0}F, relative humidity of 94 % and uniform wind speed and direction of 0 mph N.

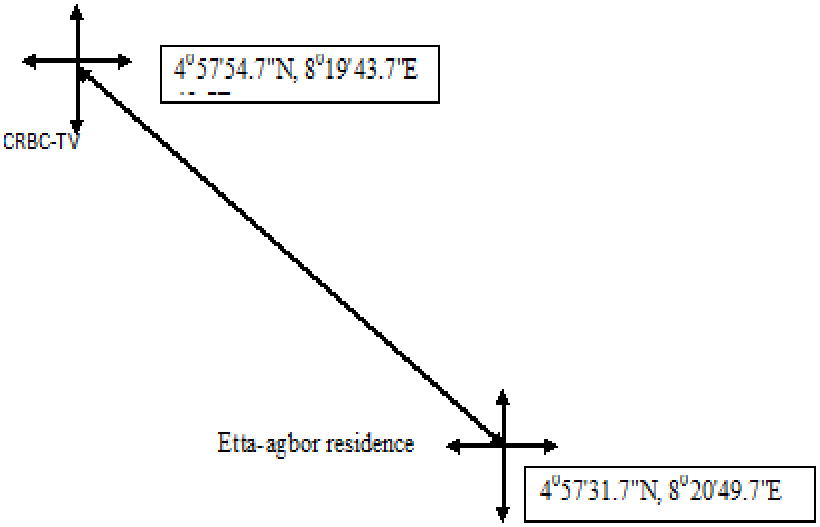


Figure 4: Diagram showing the direction of CRBC-TV away from the Etta-abgor residence.

TABLE 4

Signal strength and wind speed and direction measurements at uniform temperature of 77 ^{0}F, uniform pressure of 29.88 (± 0.03) inHg and uniform humidity of 94 %

Signal strength (mdB)	Wind speed and direction (mph) N	Atmospheric temperature (^{0}F)	Atmospheric pressure (inHg)	Relative humidity (%)
9.5	0 NA	77	29.91	94
8.5	7 WSW	77	29.91	94
8.5	7 WSW	77	29.91	94
8.6	5 WSW	77	29.91	94
8.7	5 WSW	77	29.91	94
9.3	0 NA	77	29.91	94
9.1	3 S	77	29.85	94
9.2	3 S	77	29.85	94
9.5	0 NA	77	29.91	94
9.4	0 NA	77	29.91	94
9.4	0 NA	77	29.91	94
9.4	0 NA	77	29.91	94
9.7	0 NA	77	29.88	94
9.8	0 NA	77	29.85	94
9.8	0 NA	77	29.85	94

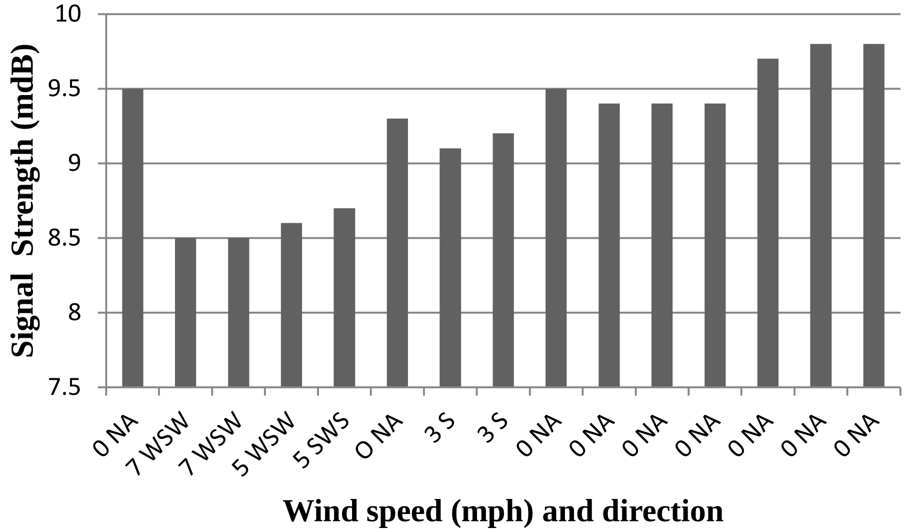


Figure 5: Signal strength versus wind speed and direction at uniform temperature of 77 ^{0}F, uniform pressure of 29.88 ($\pm$ 0.03) inHg and uniform humidity of 94%.

TABLE 5
Signal strength and wind speed measurement and direction at uniform temperature of 79 ^{0}F uniform pressure of 29.68 ($\pm$ 0.24) inHg and uniform humidity of 94 %

Signal strength (mdB)	**Wind speed and direction (mph) N**	**Atmospheric temperature (^{0}F)**	**Atmospheric pressure (inHg)**	**Relative humidity (%)**
8.8	9 W	79	29.88	94
8.8	9 W	79	29.88	94
8.9	5 WSW	79	29.91	94
8.9	5 WSW	79	29.91	94
9.0	2 E	79	29.44	94
9.0	2 E	79	29.44	94

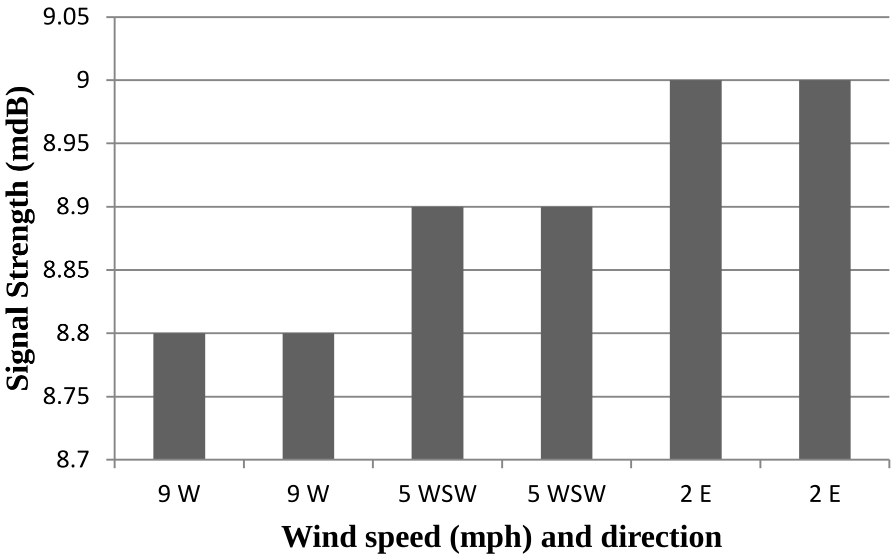


Figure 6: Signal strength versus wind speed and direction at uniform temperature of 79 ^{0}F, uniform pressure of 29.68 (± 0.24) inHg and uniform humidity of 94 %

TABLE 6
Signal strength versus wind speed and direction at uniform temperature of 80 (± 1.0) ^{0}F, uniform pressure of 29.85 inHg and uniform humidity of 89 %

Signal strength (mdB)	**Wind speed and direction (mph) N**	**Atmospheric temperature (^{0}F)**	**Atmospheric pressure (inHg)**	**Relative humidity (%)**
9.1	3 SW	79.5	29.85	89
8.7	3 SW	79.0	29.85	89
8.6	2 NA	79.5	29.85	89
8.6	2 NA	79.0	29.85	89
8.8	9 SSW	81.0	29.85	89
8.8	9 SSW	81.0	29.85	89
8.8	7 SW	79.0	29.85	89
8.8	7 SW	79.0	29.85	89

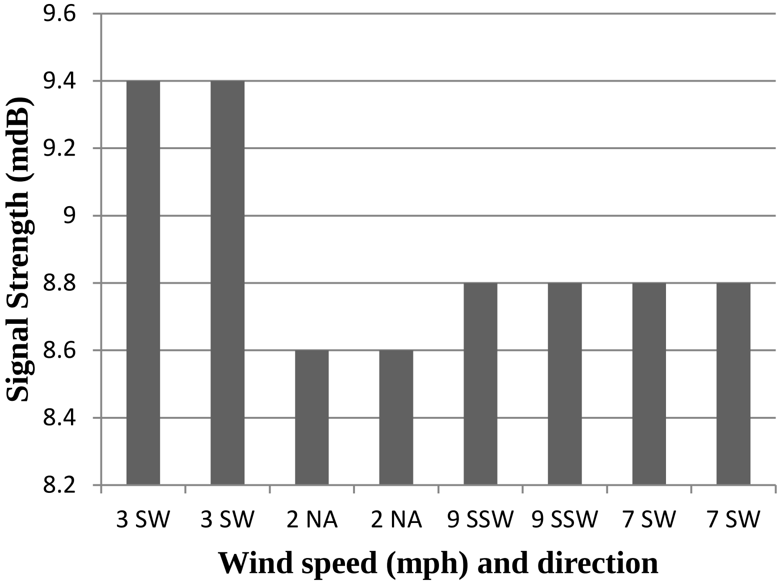


Figure 7: Signal strength versus wind speed and direction at uniform temperature of 80 (± 1.0) ^{0}F, uniform pressure of 29.85 inHg and uniform humidity of 89 %.

TABLE 7
Signal strength versus wind speed and direction at uniform temperature of 77 ^{0}F, at uniform pressure of 29.91 inHg and humidity of 100 %

Signal strength (mdB)	**Wind speed and direction (mph) N**	**Atmospheric temperature (^{0}F)**	**Atmospheric pressure (inHg)**	**Reiative humidity (%)**
8.6	2 WW	77	29.91	100
8.6	2 WW	77	29.91	100
8.8	0 NA	77	29.91	100
8.8	0 NA	77	29.91	100

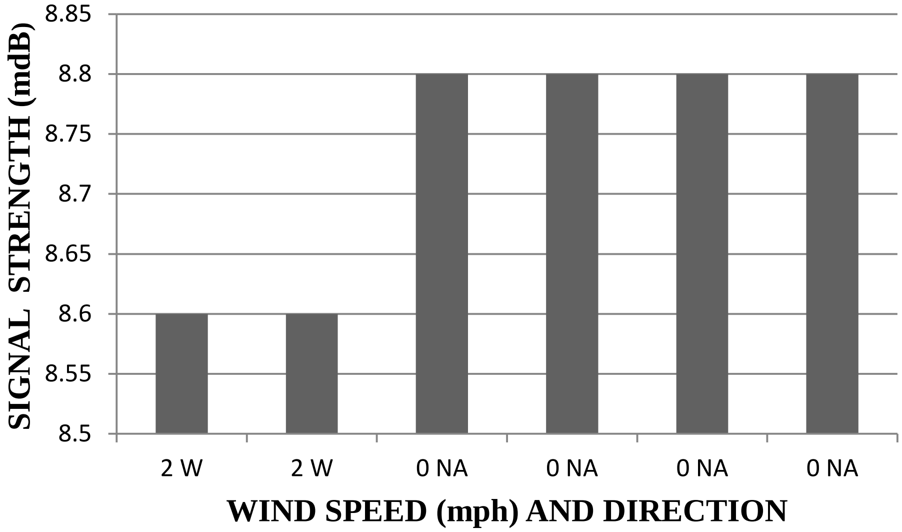


Figure 8: Signal strength versus wind speed and direction at uniform temperature of 77 ^{0}F, at uniform pressure of 29.91 inHg and humidity of 100 %.

Figure 1 shows the relationship between signal strength and atmospheric temperature, at a uniform humidity of 94%, uniform atmospheric pressure of 29.93 ($\pm$ 0.02) inHg and uniform wind speed and direction of 0 mph NA. The signal strength decreased with a slight rise in temperature. Mathematically, the correlation between the two parameters is -0.94 in value. Hence, the higher the temperature: the lower the signal strength. In other words, the signal strength is inversely proportional to temperature, provided that other weather components, atmospheric pressure, relative humidity and wind speed and direction are observed constant.

Figure 2 shows the relationship between signal strength and relative humidity, at a uniform atmospheric temperature of 77^{o}F, uniform atmospheric pressure of 29.91inHg and uniform wind speed and direction of 0 mph NA. The signal strength decreased with increase in relative humidity. Mathematically, the correlation between the parameters is -0.93. Therefore, the higher the humidity: the lower the signal strength. Hence, the signal strength is inversely proportional to relative humidity, provided atmospheric pressure and temperature and wind speed and direction are observed constant.

Figure 3 shows the relationship between signal strength and atmospheric pressure, at uniform atmospheric temperature and relative humidity of 77 ^{o}F and94 % respectively and wind speed and direction of 0 mph NA. The signal strength decreased with increase in pressure. The numerical value of the correlation between the 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 constant.

Figure 4 shows the location diagram of the residential area (Etta-abgor) and the CRBC-TV where the signal was transmitted. It is obvious from their longitudes and latitudes; the residence is lying to the south east of the TV station. Also, they are 2 km apart in a direct or line of sight direction.

Figure 5 shows a graphical representation of the signal strength against the wind in the residence at uniform temperature, pressure and humidity of 77 ^{0}F, 29.88 ($\pm$ 0.03) inHg and 94% respectively. It was observed that the maximum reading of the signal strength were recorded when there was no impact from the wind, which is 0 NA mph. There is a degradation of the signal strength as the wind speed increased. The signal degradation was lesser at 3 S mph, higher at 5 WSW mph and highest at 7 WSW mph. This is owing to the fact that the speed of the wind in the southern direction is 3 mph, lesser than that of the west south western directions which are 5 mph and 7 mph respectively. Also, the southern direction is close or next to the south east, this is the direction where the receiver was positioned. For the 5 mph WSW and 7 mph WSW, the degradation was higher in the latter because the former has a lower wind speed.

Figure 6 shows a graphical representation of the signal strength against the wind in the residence at uniform atmospheric temperature, pressure and humidity of 79 ^{0}F, 29.68 ($\pm$ 0.24) inHg and 94% respectively. The maximum signal strength captured was at 2 E mph. This is due to the signal transmitted, propagating in a near similar direction as the wind, since the receiver lied south east of the transmitter. The signal degraded at 5 WSW mph and 9 W mph since the direction of the wind is near opposite the direction of the propagating signal. None the less, the degradation of the signal was similar, despite the difference in the speed of the latter from the former where the latter is higher, even though the western direction is farther from the west south western direction.

Figure 7 shows a graphical representation of the signal strength against the wind in the residence at uniform temperature, pressure and humidity of 80 ($\pm$ 1.0) ^{0}F, 29.85 inHg and 89 % respectively. Here, the signal strength was a maximum at 3 SW mph since it was close to the direction of propagation of the wave which is in the south eastern direction. There is an equal degradation of the signal at 9 SSW mph and 7 SW mph despite the difference in speed and direction. This is in consequence of the former running close to the direction of the traveling signal path to the transmitter than the latter, but latter possessing a lesser speed. However, the maximum signal degradation was registered at 2 NA mph by virtue of omni-directional transmission of the wind and there was heavy fluctuation.

Figure 8 shows a graphical representation of the signal strength against the wind in the residence at uniform temperature, pressure and humidity of 77 ^{0}F, 29.91 inHg and 100 % respectively. The Cable analyzer registered the highest value at 0 NA mph, but less at 2 W mph which is near opposite the propagating path of the radio wave i.e. south eastern direction.

If S, P, T and H symbolize signal strength, atmospheric pressure, atmospheric temperature and relative humidity respectively, it can be postulated that $S \propto \frac{1}{PTH}$ or SPTH=K or $S_1P_1T_1H_1=S_2P_2T_2H_2$ for the same wind direction and speed, where K is a constant and $S_1P_1T_1H_1$ and $S_2P_2T_2H_2$ are the initial and final state weather or atmospheric conditions.

SUMMARY AND CONCLUSION

a. Summary

Increase in atmospheric temperature results in the degradation of signal strength, observing other weather components constant. The correlation between the signal strength and atmospheric temperature was found to be r = -0.94. The phenomenon that explains this is that there is a collision between increasing raining particles of light from the sun as temperature increases with the radio signals (since both waves are electromagnetic waves), this attenuates the signal strength.

More so, increase in relative humidity affects the signal strength negatively. In other words, signal strength is inversely proportional to relative humidity, provided that other weather componets are observed constant, here r =-0.93. The phenomenon that explains this is that the water particulate content of the atmosphere can cause diffraction, reflection and scattering of radio waves and hence attenuation [8].

And, the atmospheric pressure impacts negatively on signal strength provided that other weather parameters are observed constant and the correlation between them is r = -0.99. Pressure is a negative influence against the signal. In other words, pressure is a force per unit area that the signal must overcome as it travels through the atmospheric channel.

Finally, it has been erected that wind has a marked effect on radio signal. The signal transmits better if the wind propagates in a similar path as the signal, but worse in the contrary directions. Also, the speed of the wind aids signal travel to some little extent if it is coursing parallel to the signal, but becomes detrimental when tangential or anti-parallel.

b. Conclusion

In conclusion, it was observed from the residential area in Etta-agbor, Calabar-Nigeria, that the atmospheric temperature, atmospheric pressure and relative humidity were inversely proportional to the signal strength, provided for any of the aforementioned weather components, the others were observed constant including wind speed and direction, since it has been erected that wind has a marked negative effect on UHF radio signal.

REFERENCES:

[1] American Friends of Tel Aviv University. (2013). Radio waves carry news of climate change: Surprising tool to measure our changing climate. *Science Daily*. Retrieved March 30, 2016 from www.sciencedaily.com/releases/2013/07/130730123421.htm.

[2] Atmospheric attenuation due to humidity (2011). In Electromagnetic waves. Retrieved November 1, 2015, from cdn.intechopen.com/pdfs-wm/16080.pdf.

[3] Farmoriji, J. O. & Oyeleye, M. O. (2013). A test of the relationship between refractivity and radio signal propagation for particulates. *Research desk*. 2(4), 334-338.

[4] Ian, P. (Ed.) (2015a). Radio signal path loss. In Radio-electronics. Retrieved April 3, 2015, from www.radio-electronics.com.

[5] Ian. P. (Ed.) (2015b). Radio propagation and the atmosphere: Antennas and propagations. Retrieved November 1, 2015, from Http://www.raadioelectronics.com/info/propagation/common/atmosphere.php.

[6] Jari, L. & Ismo, H. (2015). Effect of temperature and humidity on radio signal strength in outdoor wireless sensor. *Proceedings of the federated conference on computer science and information systems*. 5, 1247 – 1255.

[7] Meng, Y. S., Lee, Y. H. & Ng, B. C. (2013). The effects of tropical weather on radio wave propagation over foliage channel. *IEEE transaction on vehicular technology*, 58(8), 4023 - 4030.

[8] Rappaport, T. S. (1996). *Wireless communications*. New Jersey: Pearson Prentice Hall, 495 -502.

[9] Troposphere (2015). In Earth's atmosphere. Retrieved November 1, 2015, from web.physics.ucsb.edu/~Igrace/chem123/troposphere.htm.

[10] Wayne T. (2001). *Electronic communications systems, fundamentals through Advanced*. New Jersey: Prentice-Hall, 39.

[11] Weather (2004). In Concise Oxford English Dictionary (11th ed.). Oxford: Oxford University Press.

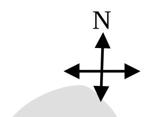
[12] Weather parameters (2015). Retrieved November 10, 2015, from cees.tamiu.edu/cees/weather/parameters.html.

[13] Weather versus propagation (2015), Introduction to wave propagation, Transmission lines, and Antrennas. Retrieved November 5, 2015 from www.tpub.com/neets/book10/40c.htm. Port Richey-Hwy: Integrated publishing inc.

[14] Yeeken, O. O. & Michael, O. K. (2011). Signal strength dependence on atmospheric particulates.*International Journal of electronics and communication engineering*, 4(3), 283 – 286.

Appendix

Half-hourly measurement of Signal strength and Weather components in the residential area in Calabar metropolis (Etta-abgor)

Signal strength (mdB)	Temperature (^oF)	Pressure (inHg)	Humidity (%)	Wind (Mph) 	Time (hrs)
9.5	77.0	29.91	94	0 NA	5:30
8.5	77.0	29.91	94	7 WSW	6:00
8.5	77.0	29.91	94	7 WSW	6:30
8.6	77.0	29.91	94	5 WSW	7:00
8.7	77.0	29.91	94	5 WSW	7:30
9.0	78.5	29.94	94	0 NA	8:00
9.3	78.0	29.94	94	0 NA	9:30
8:4	78.0	29.94	94	2 W	9:00
8.1	78.0	29.94	94	2 W	9:30
8.3	78.0	29.94	94	0 NA	10:00
8.3	78.0	29.94	94	0 NA	10:30
7.8	79.5	29.94	94	0 NA	11:00
7.8	79.5	29.94	94	0 NA	11:30
8.0	79.0	29.94	94	0 NA	12:00
9.3	77.0	29.94	94	0 NA	12:30
8.5	77.0	29.91	100	0 NA	13:00
8.5	77.0	29.91	100	0 NA	13:30
8.6	77.0	29.91	100	2 W	14:00
8.6	77.0	29.91	100	2 W	14:30
9.1	78.0	29.91	88	5 WSW	15:00
9.1	78.0	29.91	88	5 WSW	15:30
9.1	77.0	29.85	85	6 SSW	16:00
9.4	77.0	29.85	85	6 SSW	16:30
9.1	77.0	29.85	94	3 S	17:00
9.2	77.0	29.85	94	3 S	17:30

9.1	79.5	29.85	89	3 SW	18:00
8.7	79.0	29.85	89	3 SW	18:30
8.6	79.5	29.85	89	2 NA	19:00
8.6	79.0	29.85	89	2 NA	19:30
9.4	79.5	29.85	80	0 NA	20:00
9.2	79.0	29.85	80	0 NA	20:30
9.3	77.0	29.84	100	0 NA	21:00
9.4	77.0	29.84	100	0 NA	21:00
9.5	77.0	29.91	94	0 NA	22:00
9.4	77.0	29.91	94	0 NA	22:30
9.4	77.0	29.91	94	0 NA	23:00
9.4	77.0	29.91	94	0 NA	23:30
9.7	77.0	29.88	94	0 NA	24:00
9.6	77.0	29.91	90	0 NA	0:30
9.8	77.0	29.85	94	0 NA	6:00
9.8	77.0	29.85	94	0 NA	6:30
9.7	77.0	29.88	89	0 NA	7:00
9.7	77.0	29.91	89	0 NA	7:30
9.4	79.0	29.81	89	0 NA	8:00
9.4	79.0	29.81	89	0 NA	8:30
8.5	79.0	29.94	84	0 NA	9:00
8.5	81.0	29.94	84	0 NA	9:30
10.0	81.0	29.81	94	0 NA	5:30
9.5	77.0	29.85	74	12 SW	15:00
9.5	86.0	29.85	74	12 SW	15:30
9.4	86.0	29.85	74	12 SW	16:00
9.4	84.0	29.85	74	12 SW	16:30
8.7	82.0	29.85	79	9 SW	17:00
8.7	82.0	29.85	79	9 SW	17:30
8.8	81.0	29.85	89	9 SSW	18:00
8.8	81.0	29.85	89	9 SSW	18:30

8.8	79.0	29.85	89	7 SW	19:00
8.8	79.0	29.85	89	7 SW	19:30
8.8	79.0	29.88	94	9 W	20.00
8.8	79.0	29.88	94	9 W	20.30
8.8	79.0	29.91	94	5 WSW	21.00
8.8	79.0	29.91	94	5 WSW	21.30
8.8	77.0	29.91	100	0 NA	22.00
8.8	77.0	29.91	100	0 NA	22.30
9.0	79.0	29.44	94	2 E	23.00
9.0	79.0	29.44	94	2 E	23.30
10.0	77	29.91	82	0 NA	24.00