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Effect of Temperature (T) on Frequency Modulated Radio Signal Strength (FMRSS) in Broadcasting System with Osun State Broadcasting Cooperation (OSBC), FM 104.5 MHz as a Reference Station

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Abstract:- A frequency modulated radio signal strength (FMRSS) and radio refractivity (RRF) meter was used to simultaneously synchronize temperature and frequency modulated radio signal strength during a broadcasting station operation. The meter was tuned to Osun State Broadcasting Cooperation (OSBC) at FM 104.5 MHz for a total of 66 days, from November 23, 2021 to December 5, 2021, December 17, 2021 to December 31, 2021, and January 1, 2022 to February 5, 2022. The data were analyzed to determine the relationship between temperature and the strengths of frequency modulated radio signals. The results of the analyses severally indicate that temperature and frequency modulated radio signal strength are directly proportional reference time of the day as equally shown by their variation trend-lines.

Keywords:- *Temperature, Signal, Strength, Frequency, Modulation, Synchronize, Tuned Broadcasting and Trend-Line.*

I. INTRODUCTION

In an accurate examination of the contributive effect of atmospheric parameters on FM radio signals, there is need to have a field strength meter that can simultaneously access radio frequency modulated signal strength and radio refractivity with its parameters such temperature, relative humidity and pressure. Most past researchers based on manual measurements, while it is necessarily important to conduct a continuing logging for proper examination of the effects of the necessary atmospheric parameters on the FM signals. Temperature and frequency modulated (FM) radio signal strength were simultaneously synchronized through a frequency modulated radio signal strength and radio climatological parameters meter to acquire data for this research work.

Wireless communication companies and radio stations depend on the received signals from the signal transmitter, which rests mostly on site location as a function of atmospheric parameters of the area to conclude on the most proficient points in placing their cellular towers. Broadcasters wish to place their transmitters at proficient points to cover wide range during a broadcast. communication technology. The signal strength is function of transmitter power output, source antenna position reference the transmitting antenna (3) (4) and importantly, the variations in the atmospheric conditions as it travels through atmosphere (5). Information on the compositions and state of the earth's atmosphere assists in understanding radio waves propagation and the kind of communication system (receiver and transmitter) to be developed (6). The atmospheric parameters within the troposphere are very important and these include temperature, pressure, relative humidity and wind (5). These factors lead to reflection, refraction, diffraction and scattering and absorption of FM radio signal. Also, signal frequency may be shifted between the transmitter and receiver due to relative motion, which shows clearly that radio waves propagation is a space-time-frequency phenomenon. Therefore, it is crucial to understand that the propagation effects cannot be quantified in any accurate sense, but can only be explained on the basis of their statistics (7).

II. METHODOLOGY

The method used involved a direct acquisition of values for both temperature and frequency modulated radio signal strength using a self-developed frequency modulated radio signal strength meter. The meter was installed at Owode-Ede, Ede North Local Government Area, Osun State, a position near Osun Secretariat, Osogbo. The was tuned to Osun State Broadcasting Cooperation (OSBC),FM 104.5 MHz for the required data over period 66 days from 23/11/2021 to 05/12/2021, 17/12/2021to 31/12/2021 and 01/01/2022, 02/02/2022 and 04/02/2022 respectively.

The data were processed and the result viewed to infer the relationship between temperature and frequency modulated radio signal strength. Seven days data were reported from the whole processed data for this publication to avoid unnecessary lengthy tables and curves in our report. Days used include 23/11/2021,01/12/2021, 17/12/2021, 31/12/2021, 01/01/2022 , 1/2/2022 and 04/02/2022 labelled as table 1 to table 7.

T able 1: Data for day 23/11/2021

Date	Time	FM	T	SS
11/23/2021	11:27:43	10405	31.1	18
11/23/2021	11:29:13	10450	31.42	40
11/23/2021	11:31:04	10450	31.86	43
11/23/2021	11:41:05	10450	32.19	39
11/23/2021	11:54:31	10250	34.53	26
11/23/2021	11:55:58	10450	34.48	39
11/23/2021	12:06:00	10450	34.6	32
11/23/2021	12:16:02	10450	35.44	37
11/23/2021	12:26:04	10450	35.95	35
11/23/2021	12:36:06	10450	36.3	38
11/23/2021	12:46:08	10450	36.53	38
11/23/2021	12:56:10	10450	36.65	38
11/23/2021	13:06:11	10450	36.9	38
11/23/2021	13:16:13	10450	37.02	41
11/23/2021	13:26:15	10450	37.1	41
11/23/2021	13:36:17	10450	37.3	41
11/23/2021	13:46:19	10450	37.35	41
11/23/2021	13:56:21	10450	37.56	42
11/23/2021	14:06:23	10450	37.67	40
11/23/2021	14:16:25	10450	37.78	41
11/23/2021	14:26:26	10450	37.8	41
11/23/2021	14:36:28	10450	37.89	41
11/23/2021	14:46:30	10450	37.99	40
11/23/2021	14:56:32	10450	38.09	42
11/23/2021	15:06:34	10450	38.16	41
11/23/2021	15:16:36	10450	38.21	41
11/23/2021	15:26:38	10450	38.31	40
11/23/2021	15:36:40	10450	38.52	40
11/23/2021	15:46:41	10450	38.57	40
11/23/2021	15:56:43	10450	38.53	40
11/23/2021	16:06:45	10450	38.48	40
11/23/2021	16:16:47	10450	38.52	40
11/23/2021	16:26:49	10450	38.52	41
11/23/2021	16:36:51	10450	38.72	40
11/23/2021	16:46:53	10450	38.72	40

Table 2: Data for day 01/12/2021

Date	Time	FM	T	SS
12/1/2021	6:39:10	10450	33.03	26
12/1/2021	6:49:12	10450	33.13	27
12/1/2021	6:59:14	10450	33.91	27
12/1/2021	7:03:44	10450	34.39	19
12/1/2021	7:13:45	10450	34.48	26
12/1/2021	7:23:47	10450	34.06	26
12/1/2021	7:33:49	10450	33.8	27
12/1/2021	7:43:51	10450	33.66	29
12/1/2021	7:53:53	10450	33.57	28
12/1/2021	8:03:55	10450	33.44	29
12/1/2021	8:13:57	10450	33.43	32
12/1/2021	8:23:58	10450	33.89	31
12/1/2021	8:34:00	10450	33.84	30
12/1/2021	8:44:02	10450	33.64	30
12/1/2021	8:54:04	10450	33.48	32

12/1/2021	9:04:06	10450	33.38	29
12/1/2021	9:14:08	10450	33.39	30
12/1/2021	9:24:09	10450	33.33	29
12/1/2021	9:34:11	10450	33.34	31
12/1/2021	9:44:13	10450	33.89	32
12/1/2021	9:54:15	10450	34.34	32
12/1/2021	10:04:17	10450	34.57	32
12/1/2021	10:14:19	10450	34.75	32
12/1/2021	10:24:20	10450	34.83	32
12/1/2021	10:34:22	10450	34.94	30
12/1/2021	10:44:24	10450	35.06	32
12/1/2021	10:54:26	10450	35.21	31
12/1/2021	11:04:28	10450	35.36	30
12/1/2021	11:14:30	10450	35.61	29
12/1/2021	11:24:32	10450	36.05	29
12/1/2021	11:34:34	10450	35.93	30
12/1/2021	11:44:35	10450	36.02	29
12/1/2021	11:54:37	10450	35.9	29
12/1/2021	12:04:39	10450	36.26	28
12/1/2021	12:14:41	10450	36.24	28
12/1/2021	12:24:43	10450	36.07	30
12/1/2021	12:34:45	10450	36.36	26
12/1/2021	12:44:47	10450	36.48	30
12/1/2021	12:54:48	10450	36.45	29
12/1/2021	13:04:50	10450	36.43	27

Table 3: Data for day 17/12/2021

Date	Time	Station x 10^4 (MHz)	Temperature(oC)	Signal Strength(dB)
12/17/2021	21:02:30	10450	31.2	22
12/17/2021	21:12:32	10450	31.39	27
12/17/2021	21:22:34	10450	33.28	26
12/17/2021	21:32:35	10450	34.08	26
12/17/2021	21:42:37	10450	34.08	25
12/17/2021	21:52:39	10450	33.88	24
12/17/2021	22:02:41	10450	33.88	25
12/17/2021	22:12:43	10450	33.69	25
12/17/2021	22:22:45	10450	33.44	25
12/17/2021	22:32:47	10450	33.36	3
12/17/2021	22:42:48	10450	33.05	4
12/17/2021	22:52:50	10450	32.96	4
12/17/2021	23:02:52	10450	32.89	4
12/17/2021	23:12:54	10450	32.87	5
12/17/2021	23:22:56	10450	33	5
12/17/2021	23:32:58	10450	33.06	4

Table 4: Data for day 31/12/2021

Date	Time	Station x 10^4 (MHz)	Temperature(oC)	Signal Strength(dB)
12/31/2021	7:21:10	10450	31.42	24
12/31/2021	7:31:12	10450	31.48	28
12/31/2021	7:41:13	10450	31.72	28
12/31/2021	7:51:15	10450	31.93	29
12/31/2021	8:01:17	10450	32.06	27
12/31/2021	8:11:19	10450	32.22	26
12/31/2021	8:21:21	10450	32.16	28

12/31/2021	8:31:23	10450	32.23	30
12/31/2021	8:41:24	10450	32.34	29
12/31/2021	8:51:26	10450	32.43	26
12/31/2021	9:01:28	10450	32.39	23
12/31/2021	9:11:30	10450	32.5	24
12/31/2021	9:21:32	10450	32.49	26
12/31/2021	9:31:34	10450	32.62	30
12/31/2021	9:41:36	10450	32.7	32
12/31/2021	9:51:38	10450	32.91	30
12/31/2021	10:01:39	10450	33.15	27
12/31/2021	10:11:41	10450	33.38	29
12/31/2021	10:21:43	10450	33.83	29
12/31/2021	10:31:45	10450	33.78	30
12/31/2021	10:41:47	10450	34.14	30
12/31/2021	10:51:49	10450	34.19	29
12/31/2021	11:01:51	10450	34.29	29
12/31/2021	11:11:52	10450	34.37	27
12/31/2021	11:21:54	10450	34.53	19
12/31/2021	11:31:56	10450	34.42	32

Table 5: Data for day 01/01/2022

Date	Time	Station x 10^4 (MHz)	Temperature(oC)	Signal Strength(dB)
1/1/2022	12:03:27	10450	29.81	17
1/1/2022	12:13:29	10450	29.89	27
1/1/2022	12:23:31	10450	32.54	27
1/1/2022	12:33:33	10450	34.29	28
1/1/2022	12:43:34	10450	35.27	32
1/1/2022	12:53:36	10450	35.76	30
1/1/2022	13:03:38	10450	35.57	28
1/1/2022	13:13:40	10450	35.38	28
1/1/2022	13:23:42	10450	35.48	26
1/1/2022	13:33:44	10450	35.64	28
1/1/2022	13:43:46	10450	35.76	28
1/1/2022	13:53:48	10450	35.96	28
1/1/2022	14:03:50	10450	36.77	28
1/1/2022	14:13:51	10450	36.6	32
1/1/2022	14:23:53	10450	36.57	31
1/1/2022	14:33:55	10450	36.62	31
1/1/2022	14:43:57	10450	36.54	29
1/1/2022	14:53:59	10450	36.68	28
1/1/2022	15:04:01	10450	36.82	28
1/1/2022	15:14:03	10450	36.9	27
1/1/2022	15:24:05	10450	36.97	25
1/1/2022	15:34:07	10450	36.99	26
1/1/2022	15:44:08	10450	36.97	23
1/1/2022	15:54:10	10450	36.94	21
1/1/2022	16:04:12	10450	37.03	25

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Table 6: Data for day 02/01/2022

Date	Time	Station x 10^4 (MHz)	Temperature(oC)	Signal Strength(dB)
1/2/2022	6:44:57	10450	28.83	30
1/2/2022	6:54:59	10450	28.96	28
1/2/2022	7:05:00	10450	30.93	26
1/2/2022	7:15:02	10450	31.83	32
1/2/2022	7:25:04	10450	32.31	32
1/2/2022	7:35:06	10450	32.58	33
1/2/2022	7:45:08	10450	32.7	31
1/2/2022	7:55:10	10450	32.83	34
1/2/2022	8:05:12	10450	32.91	35
1/2/2022	8:15:14	10450	33.05	35
1/2/2022	8:25:15	10450	33.84	34
1/2/2022	8:35:17	10450	34.03	36
1/2/2022	8:45:19	10450	34.14	35
1/2/2022	8:55:21	10450	34.17	35
1/2/2022	9:05:23	10450	34.36	34
1/2/2022	9:15:25	10450	34.5	34
1/2/2022	9:25:27	10450	34.48	31
1/2/2022	9:35:29	10450	34.52	31
1/2/2022	9:45:30	10450	34.77	33
1/2/2022	9:55:32	10450	34.86	32
1/2/2022	10:05:34	10450	34.87	33
1/2/2022	10:15:36	10450	34.93	33
1/2/2022	10:25:38	10450	34.82	31
1/2/2022	10:35:40	10450	35.11	32
1/2/2022	10:45:42	10450	35.4	30

Table 7: Data for day 04/01/2022

Date	Time	Station x 10^4 (MHz)	Temperature(oC)	Signal Strength(dB)
1/4/2022	8:58:02	10450	25.97	35
1/4/2022	9:08:04	10450	26.06	37
1/4/2022	9:18:05	10450	28.65	36
1/4/2022	9:28:07	10450	29.85	38
1/4/2022	9:38:09	10450	30.48	38
1/4/2022	9:48:11	10450	30.8	38
1/4/2022	9:58:13	10450	31.1	38
1/4/2022	10:08:15	10450	31.45	38
1/4/2022	10:18:17	10450	31.79	38
1/4/2022	10:28:18	10450	31.59	38
1/4/2022	10:38:20	10450	31.57	39
1/4/2022	10:48:22	10450	31.58	39
1/4/2022	10:58:24	10450	31.7	37
1/4/2022	11:08:26	10450	31.91	37
1/4/2022	11:18:28	10450	32.06	36
1/4/2022	11:28:29	10450	32.19	36
1/4/2022	11:38:31	10450	32.38	37
1/4/2022	11:48:33	10450	32.58	37
1/4/2022	11:58:35	10450	32.77	36
1/4/2022	12:08:37	10450	32.96	36
1/4/2022	12:18:39	10450	33.06	36
1/4/2022	12:28:41	10450	33.18	37
1/4/2022	12:38:42	10450	33.31	36
1/4/2022	12:48:44	10450	33.39	37
1/4/2022	12:58:46	10450	33.52	37

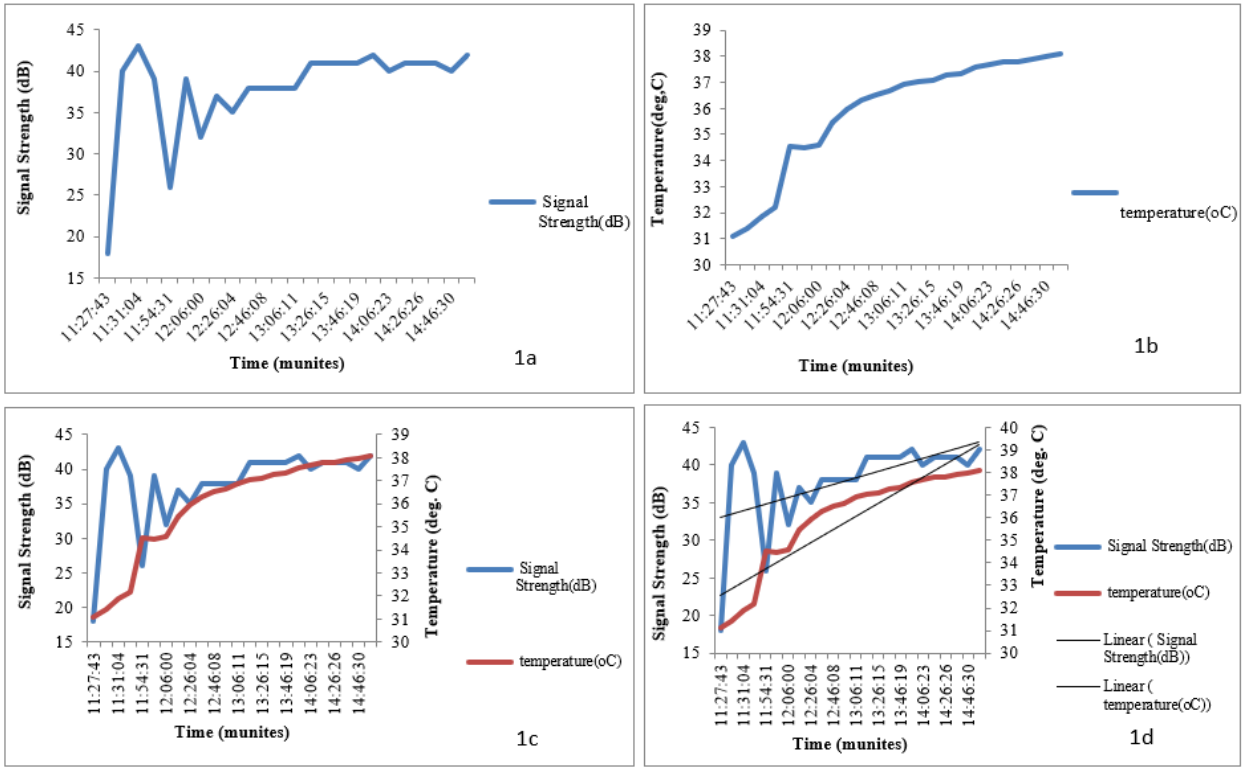

Fig 1: Time correlation of temperature and frequency modulated signal strength curves for OSBC on 23/11/2021.
(a) Variation of FMRSS with time as it propagates in atmosphere from transmitter to the recipient.
(b) Variation of temperature with time during FMRSS propagation in atmosphere from transmitter to the recipient.
(c) Comparison curves of both FMRSS and temperature of the broadcasting station for specified period.
(d) Shows the variation trend lines of FMRSS and temperature during the propagation.

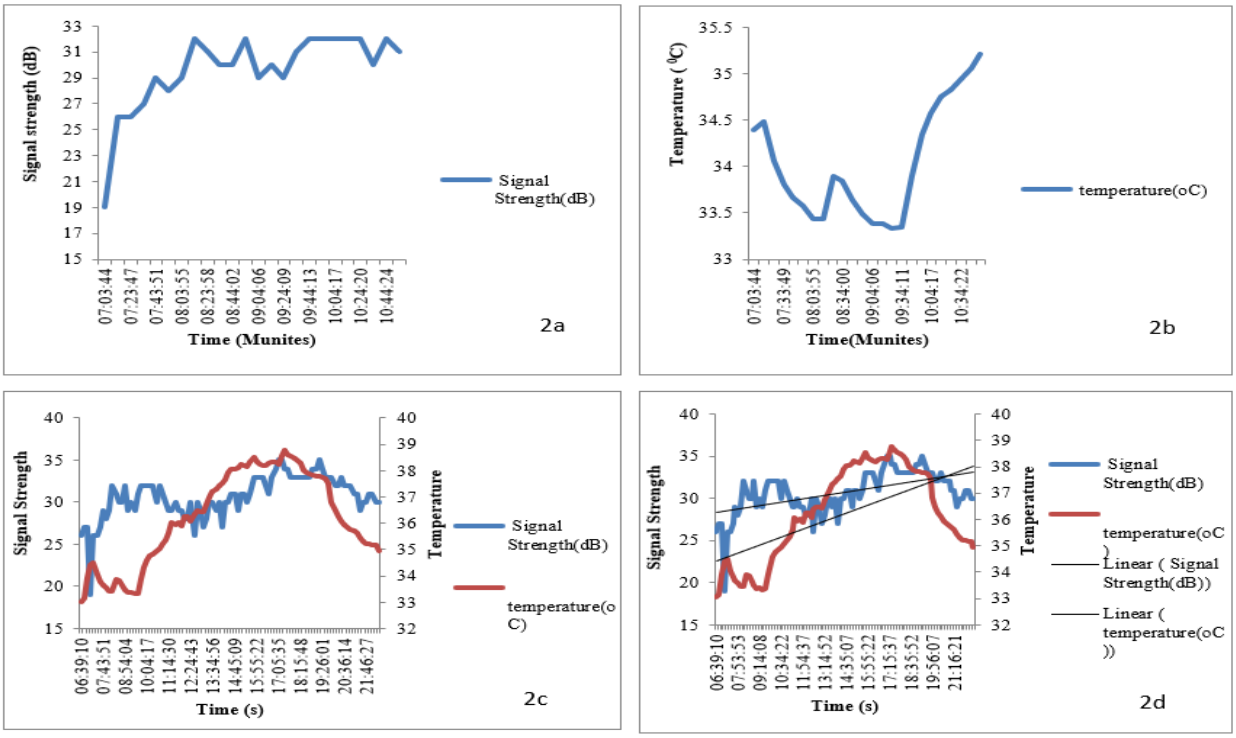

Fig 2: Time correlation of temperature and frequency modulated signal strength curves for OSBC on 01/12/2021.
(a) Variation of FMRSS with time as it propagates in atmosphere from transmitter to the recipient.
(b) Variation of temperature with time during FMRSS propagation in atmosphere from transmitter to the recipient.
(c) Comparison curves of both FMRSS and temperature of the broadcasting station for specified period.
(d) Shows the variation trend lines of FMRSS and temperature during the propagation.

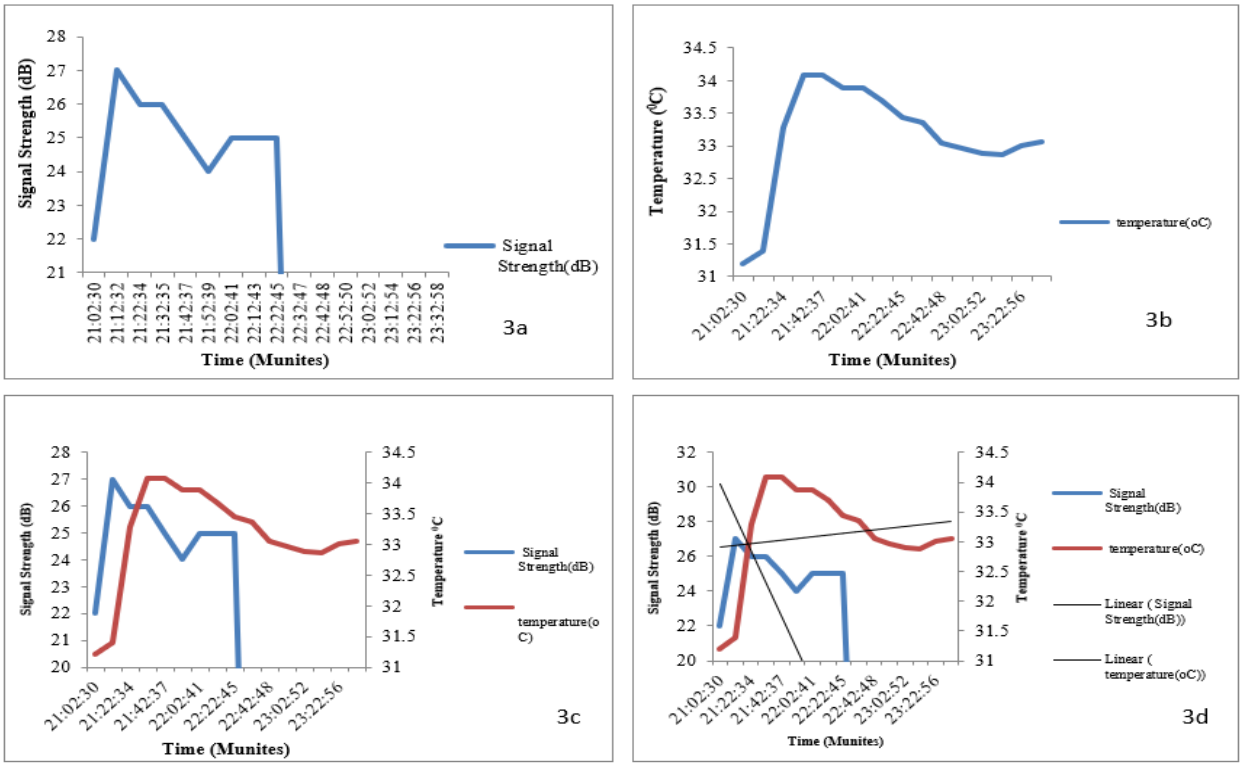

Fig 3: Time correlation of temperature and frequency modulated signal strength curves for OSBC on 17/12/2021.
(a) Variation of FMRSS with time as it propagates in atmosphere from transmitter to the recipient.
(b) Variation of temperature with time during FMRSS propagation in atmosphere from transmitter to the recipient.
(c) Comparison curves of both FMRSS and temperature of the broadcasting station for specified period.
(d) Shows the variation trend lines of FMRSS and temperature during the propagation.

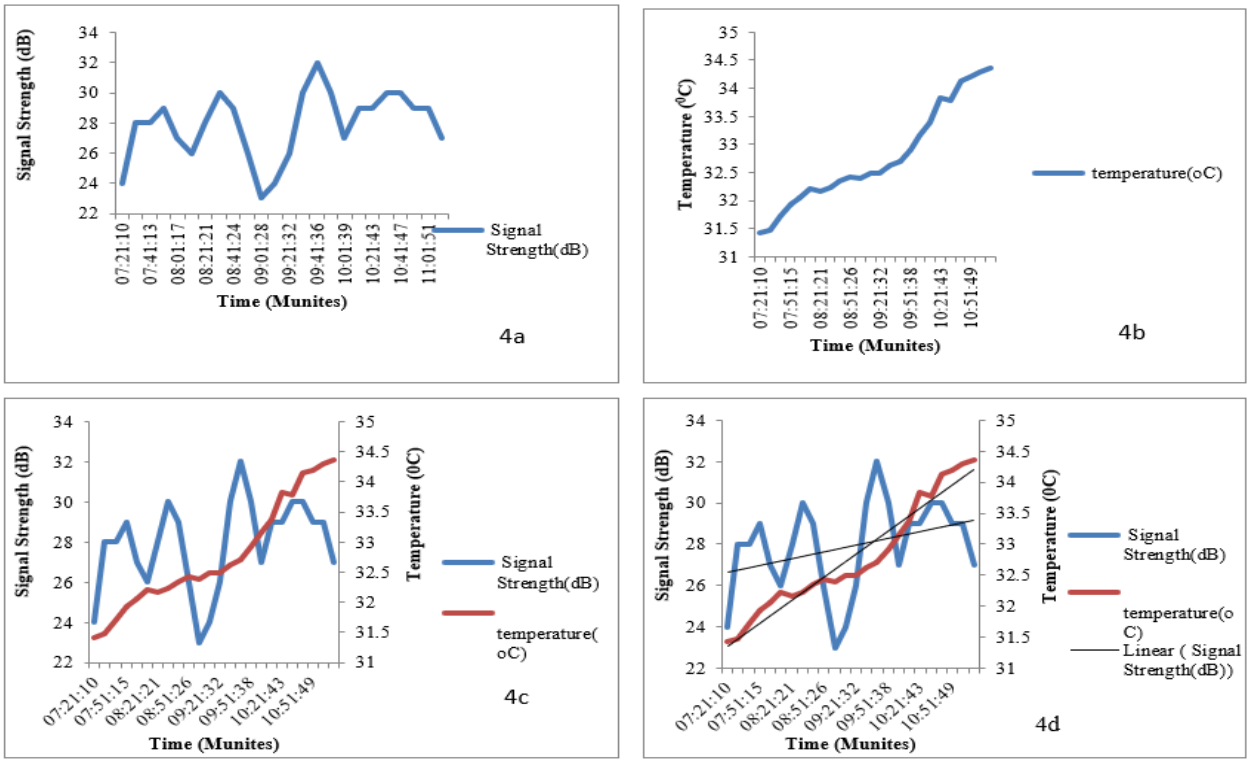

Fig 4: Time correlation of temperature and frequency modulated signal strength curves for OSBC on 31/12/2021.
(a) Variation of FMRSS with time as it propagates in atmosphere from transmitter to the recipient.
(b) Variation of temperature with time during FMRSS propagation in atmosphere from transmitter to the recipient.
(c) Comparison curves of both FMRSS and temperature of the broadcasting station for specified period.
(d) Shows the variation trend lines of FMRSS and temperature during the propagation.

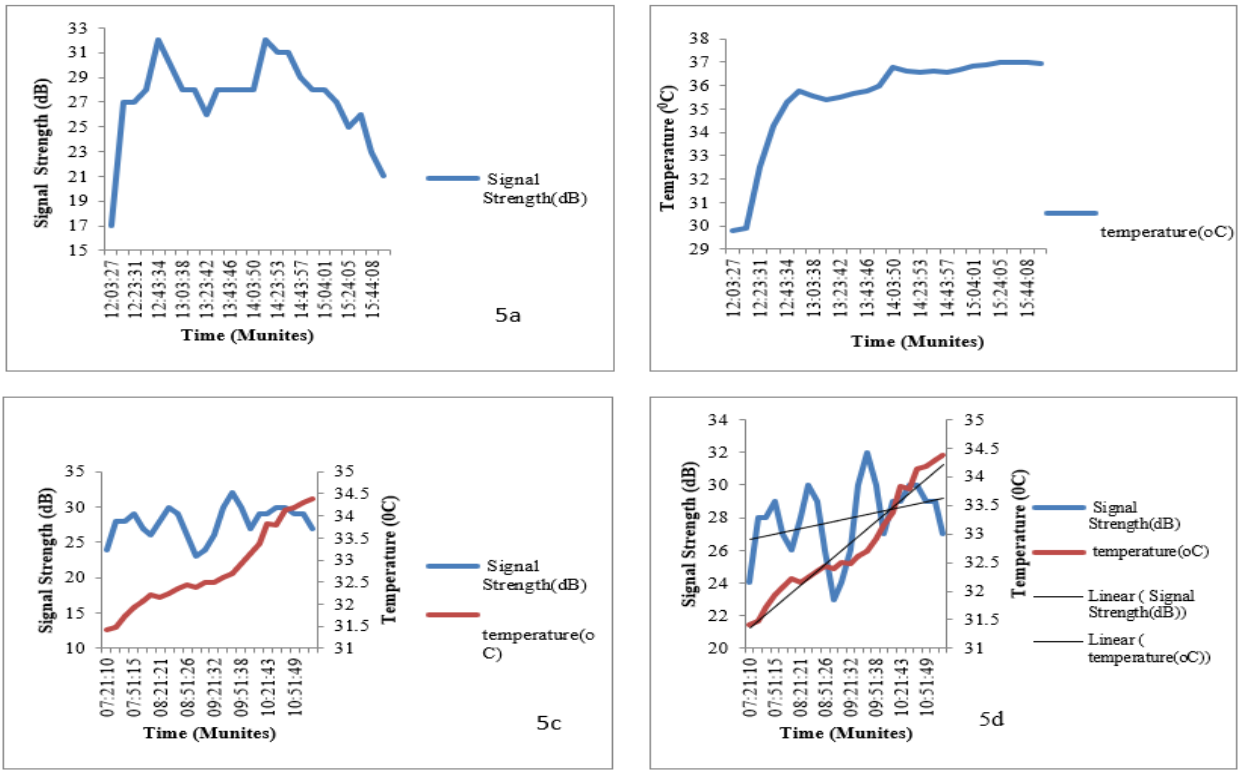

Fig 5: Time correlation of temperature and frequency modulated signal strength curves for OSBC on 01/01/2022.
(a) Variation of FMRSS with time as it propagates in atmosphere from transmitter to the recipient.
(b) Variation of temperature with time during FMRSS propagation in atmosphere from transmitter to the recipient.
(c) Comparison curves of both FMRSS and temperature of the broadcasting station for specified period.
(d) Shows the variation trend lines of FMRSS and temperature during the propagation.

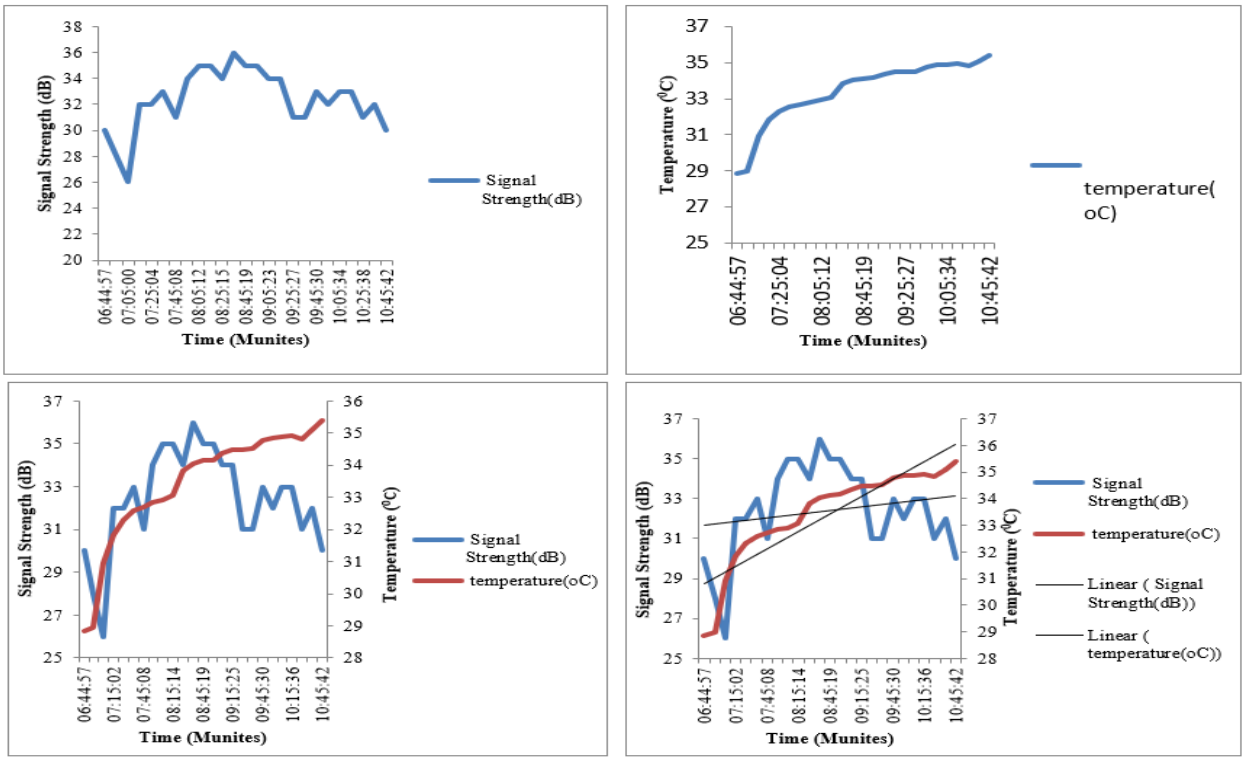

Fig 6: Time correlation of temperature and frequency modulated signal strength curves for OSBC on 02/01/2022.
(a) Variation of FMRSS with time as it propagates in atmosphere from transmitter to the recipient.
(b) Variation of temperature with time during FMRSS propagation in atmosphere from transmitter to the recipient.
(c) Comparison curves of both FMRSS and temperature of the broadcasting station for specified period.
(d) Shows the variation trend lines of FMRSS and temperature during the propagation.

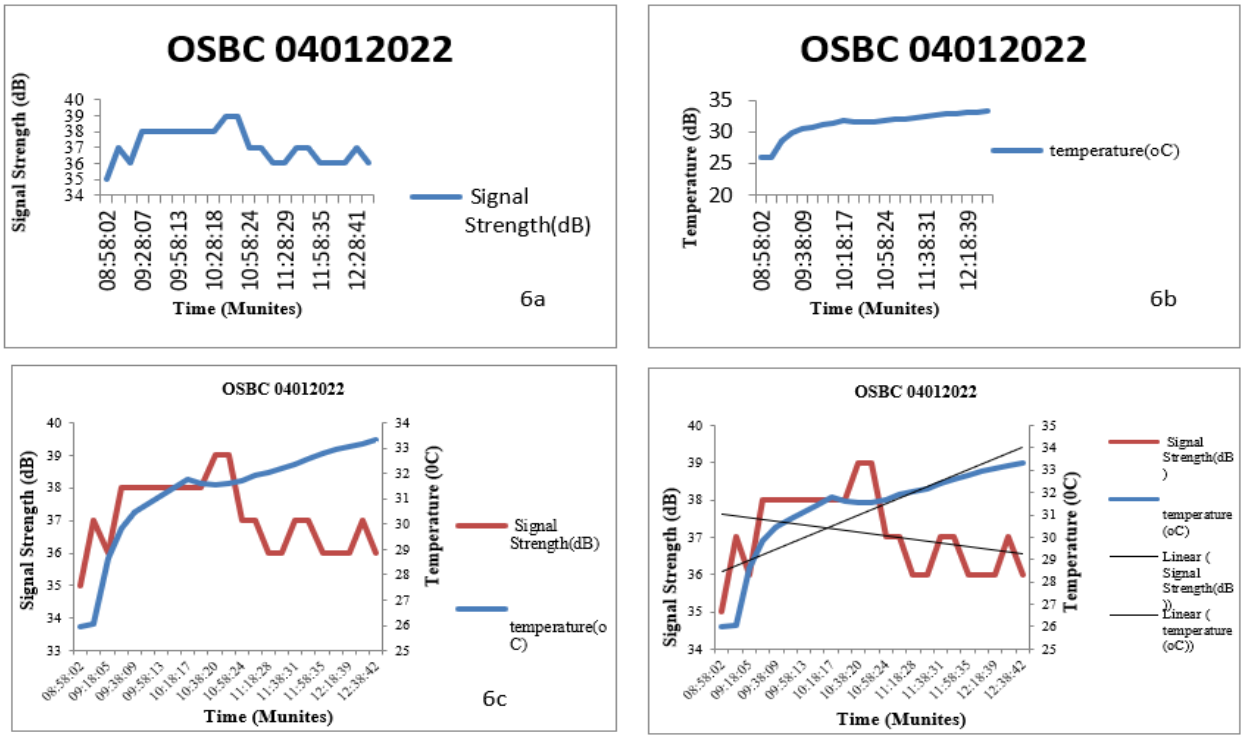

Fig 7: Time correlation of temperature and frequency modulated signal strength curves for OSBC on 04/01/2022.
(a) Variation of FMRSS with time as it propagates in atmosphere from transmitter to the recipient.
(b) Variation of temperature with time during FMRSS propagation in atmosphere from transmitter to the recipient.
(c) Comparison curves of both FMRSS and temperature of the broadcasting station for specified period.
(d) Shows the variation trend lines of FMRSS and temperature during the propagation.

III. DISCUSSION

At any day with a normal weather and good operating condition of the transmitting equipment of a frequency modulated radio broadcasting station, temperature and signal strength variations follow the same trend as observed from figures 1, 2, 4, 5 & 6; while the cases of figures 3 and 7 present different observations. For figure 3, it is clear that the transmitting station, Osun State Broadcasting Cooperation (OSBC),FM 104.5 MHz, has closed for the day within the largest period the data acquisition system was tuned to the station. That is the reason for the drop in signal from a pick to 0dB, while the temperature still maintained the positive trend despite the fact that it was at night which led to a reduction in the temperature between 21:22:45 and 23:02:52; which is normal. Signal strength fell drastically between 22:22:45 till 22:42:48 because OSBC Broadcasting Station has closed for the day, no transmission during this period.

In the case of figure 7, the curve for temperature is normal, its variation followed the sections of the day, morning (cold), afternoon (hot), evening (intermediate) and mid-night (fairly cold). The variation trend of the signal strength appears abnormal, a saw-tooth form of curve with sudden rises and falls of signal strength within short interval of time especially between 10:18:17 and 12:38:42. The observation may be any of the following: (i) OSBC equipment might not function well due to either an inefficient operation of the officer in charge, or malfunctioning of the equipment itself; (ii) reflection, absorption and deflection of the signal; (iii) interception by signals from other transmitters due to temperature inversion by high pressure that might have created a special transmission duct.

IV. CONCLUSION AND RECOMMENDATION

The analysis shows that at a normal condition temperature (T) and frequency modulated radio signal strength (FMRSS) always maintain the same variation trend line with time. That is, FMRSS and T have a direct variation to each other, which implies the higher the temperature the stronger the frequency modulated radio signal strength of a transmitting frequency modulated radio station.

Therefore, the recommendation maintains that best FMRSS reception is a function of high temperature, or functionally, a frequency modulated radio broadcasting station should always be sited in a good and clear weather region, preferably a temperate location.

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