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Abstract

In this data article, analysis of surface refractivity and water vapour density in Southeast, Nigeria were reported. The meteorological data were collected for the period of 39 years between 1973 and 2012 from National Oceanic and Atmospheric Administration (NOAA) Climatology Centre. Five locations considered in the study area includes: Enugu, Onitsha, Abakaliki, Aba and Ihiala. Descriptive statistics were used to show an increase in monthly variation of refractivity of about 299.8 N units at Enugu in January to peak value of about 385.81 N units at Abakaliki in May. Hence, the seasonal variation for South East indicate maximum value within the months of March to May in the rainy season and a minimum value around December to February which is the dry season. The results from this data will help engineers in proper design and planning of radiowave propagation and satellite communication systems in southeastern, Nigeria.

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### Value of the data

- The data could be useful for government in understanding of radio propagation within or around the lower atmosphere in the southeast region of Nigeria.
- The database could provide insights of radio refractivity and water vapour density for the five locations.
- The dataset will help engineers in siting good antenna reception at ground level for AM, FM, VHF, UHF bands in Nigeria.
- The data will be useful in understanding of the refractive index structure of the atmosphere through which the waves travel.

### 1. Data

The meteorological data for this article were obtained from National Oceanic and Atmospheric Administration (NOAA) Climatology center for the period of about thirty-nine years from 1973 through 2012 for five locations within southeast, Nigeria. The data input parameters such as pressure, temperature, and relative humidity were used for the calculation of surface radio refractivity (\(N\)) for all the location. The meteorological data assembled were based on one-minute to produce the daily average data and consequently to acquire the monthly. Therefore, the monthly means of the measurements, over the thirty-nine years is a good characteristic of the seasonal behavior of surface radio refractivity as revealed in Tables 1a–1e. The descriptive statistics summaries of the surface refractivity are presented tables. While, bar charts for the refractivity distribution are presented in figures.

Radio refractivity, \(N\), depends on meteorological parameters such as the pressure \(P\) (mbar), the absolute air temperature \(T\) (K), and the vapour pressure \(e\) (mbar) as given in Eq. (1).

\[
N = \frac{77.6P}{T} + 3.73 \times 10^5 \frac{e}{T^2} = N_{\text{dry}} + N_{\text{wet}}(N-\text{units})
\]

### Table 1a

Monthly refractivity values from Enugu State.

| Month | Jan  | Feb  | Mar  | Apr  | May  | Jun  | Jul  | Aug  | Sep  | Oct  | Nov  | Dec  |
|-------|------|------|------|------|------|------|------|------|------|------|------|------|
| Refractivity \(N\) units | 299.8 | 338.7 | 368.02 | 378.69 | 375.7 | 374.27 | 375.5 | 374.58 | 376.91 | 376.71 | 349.7 | 335.9 |
Ndry and Nwet are frequently denoted as dry and wet terms of atmospheric radio refractivity, respectively.

where: \( N_{dry} = \frac{77.6P}{T} \tag{2} \)

and

\( N_{wet} = 3.73 \times 10^5 \frac{e}{T^2} \tag{3} \)

The nature and usefulness of the data entails that it can be analyzed using different statistics techniques like ordinary least square regression analysis, simple correlation, multiple correlation analysis, analysis of variance, factor analysis and principal component analysis just to mention few.

### Table 1b
Monthly refractivity values from Anambra State.

| Month | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Refractivity N units | 373.3 | 381.5 | 384.63 | 385.17 | 384.6 | 381.07 | 374.51 | 374.29 | 377.99 | 379.06 | 379.9 | 373.6 |

### Table 1c
Monthly refractivity values from Ebonyi State.

| Month | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Refractivity N units | 370.6 | 380.3 | 383.11 | 385.51 | 385.8 | 382.41 | 379.05 | 378.44 | 379.8 | 380.57 | 380.9 | 372.2 |

### Table 1d
Monthly refractivity values from Abia State.

| Month | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Refractivity N units | 371.9 | 376.5 | 378.88 | 379.62 | 379.8 | 376.83 | 372.3 | 370.78 | 373.85 | 374.45 | 376.1 | 371.9 |

### Table 1e
Monthly refractivity values from Imo State.

| Month | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Refractivity N units | 377.3 | 381.5 | 384.01 | 384.49 | 384.4 | 380.07 | 374.83 | 372.86 | 376.85 | 378.36 | 378.7 | 376.7 |

### Table 2
Summary statistics of the Enugu state Refractivity data.

| Statistic | Value |
|-----------|-------|
| Mean      | 360.3698 |
| Std. Error of Mean | 7.09456 |
| Median    | 374.4201 |
| Mode      | 299.80 |
| Std. Deviation | 24.57628 |
| Variance  | 603.994 |
| Skewness  | -1.618 |
| Std. Error of Skewness | .637 |
| Kurtosis  | 2.230 |
| Std. Error of Kurtosis | 1.232 |
| Range     | 78.89 |
| Minimum   | 299.80 |
| Maximum   | 378.69 |
1.1. The summary statistics of the data from Enugu state

The summary statistics of the data collected from Enugu state is presented in the Table 2 below. The data was also presented in a bar chart in Fig. 1. The bar chart is a representation of the descriptive statistics which revealed the level of radio refractivity recorded monthly for the state.

1.2. The summary statistics of the data from Anambra state

The summary statistics of the data collected from Anambra state is presented in the Table 3 below. The data was also presented in a bar chart in Fig. 2. The bar chart is a representation of the descriptive statistics which revealed the level of radio refractivity recorded monthly for the state.

1.3. The summary statistics of the data from Ebonyi state

The summary statistics of the data collected from Ebonyi state is presented in the Table 4 below. The data was also presented in a bar chart in Fig. 3. The bar chart is a representation of the descriptive statistics which revealed the level of radio refractivity recorded monthly for the state.

**Table 3**
Summary statistics of the Anambra state Refractivity data.

| Statistics      | Value          |
|-----------------|----------------|
| Mean            | 379.1399       |
| Std. Error of Mean | 1.28354       |
| Median          | 379.4653       |
| Mode            | 373.30         |
| Std. Deviation  | 4.44630        |
| Variance        | 19.770         |
| Skewness        | -.012          |
| Std. Error of Skewness | .637          |
| Kurtosis        | -1.498         |
| Std. Error of Kurtosis | 1.232       |
| Range           | 11.87          |
| Minimum         | 373.30         |
| Maximum         | 385.17         |
| Sum             | 4549.68        |

**Fig. 1.** The bar chart showing the monthly refractivity for Enugu state.
Table 4
Summary statistics of the Ebonyi state refractivity data.

| Statistics          | Value     |
|---------------------|-----------|
| Mean                | 379.8946  |
| Std. Error of Mean  | 1.32606   |
| Median              | 380.4472  |
| Mode                | 370.63a   |
| Std. Deviation      | 4.59359   |
| Variance            | 21.101    |
| Skewness            | -.917     |
| Std. Error of Skewness | .637   |
| Kurtosis            | .633      |
| Std. Error of Kurtosis  | 1.232 |
| Range               | 15.18     |
| Minimum             | 370.63    |
| Maximum             | 385.81    |
| Sum                 | 4558.74   |
1.4. The summary statistics of the data from Abia state

The summary statistics of the data collected from Abia state is presented in the Table 5 below. The data was also presented in a bar chart in Fig. 4. The bar chart is a representation of the descriptive statistics which revealed the level of radio refractivity recorded monthly for the state.

1.5. The summary statistics of the data from Imo state

The summary statistics of the data collected from Imo state is presented in the Table 6 below. The data was also presented in a bar chart in Fig. 5. The bar chart is a representation of the descriptive statistics which revealed the level of radio refractivity recorded monthly for the state.

2. Materials and methods

Several researches have been conducted on surface radio refractivity in Nigeria [1–13]. However, this work is relevant with a focus on southeast zone, Nigeria where few research has been concluded. Hence, formed the uniqueness of this data and the analysis. Similar statistical tools on refractivity were applied by [14,15]. Radiosonde data for at least 39 years between 1973 and 2012 for 5 stations

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**Table 5**

Summary statistics of the Abia state refractivity data.

| Statistics             | Value      |
|------------------------|------------|
| Mean                   | 375.2337   |
| Std. Error of Mean     | .91972     |
| Median                 | 375.2667   |
| Mode                   | 370.78     |
| Std. Deviation         | 3.18600    |
| Variance               | 10.151     |
| Skewness               | .142       |
| Std. Error of Skewness | .637       |
| Kurtosis               | −1.409     |
| Std. Error of Kurtosis | 1.232      |
| Range                  | 9.02       |
| Minimum                | 370.78     |
| Maximum                | 379.80     |
| Sum                    | 4502.80    |

![Fig. 4. The bar chart showing the monthly refractivity for Abia state.](image)
within Southeast Nigeria were utilized for the computation. It was launched from National Oceanic and Atmospheric Administration (NOAA) Climatology center based in United State of America (USA). The variables contained in the meteorology data such as pressure, temperature, and relative humidity were used as input parameters for the outcome of this article.

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Transparency document. Supporting information

Transparency data associated with this article can be found in the online version at https://doi.org/10.1016/j.dib.2017.11.052.
Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at https://doi.org/10.1016/j.dib.2017.11.052.

References

[1] B. Adeyemi, Surface water vapour density and tropospheric radio refractivity linkage over three stations in Nigeria, J. Atmos. Sol.-Terr. Phys. 68 (2006) 1105–1115.
[2] B. Adeyemi, T.O. Aro, Variation in surface water vapour density over four Nigerian stations, Niger. J. Pure Appl. Phys. 3 (1) (2004) 37–43.
[3] A.T. Adedeji, M.O. Ajewole, Vertical profile of radio refractivity gradient in Akure, South-West Nigeria, Prog. Electromagn. Res. C 4 (2008) 157–168.
[4] G.O. Ajayi, Physics of the tropospheric radio propagation, in: Proceedings of the ICTP College on Theoretical and Experimental Radio Propagation Physics, Trieste, Italy, 6–24 February 1989.
[5] S.A. Akinwumi, T.V. Omotosho, A.A. Willoughby, J.S. Mandeep, M. Abdullah, Seasonal variation of surface radio refractivity and water vapour density for 48 stations in Nigeria, in: IEEE Proceeding of the 2015 International Conference on Space Science and Communication (Iconspace), Langkawi, Malaysia, 10–12 August 2015.
[6] B.G. Ayantunji, P.N. Okeke, J.O. Urama, Seasonal variation of surface refractivity over Nigeria, Adv. Space Res. 48 (2011) 2023–2027.
[7] M.T. Babalola, Studies on the vertical model of the radio refractivity in Nigeria, Afr. J. Sci. 2 (1) (1998) 1–10.
[8] B.R. Bean, B.A. Cahoon, Correlation of monthly median transmission loss and refractive index profile characteristics, J. Res. N. B. S 65D (1) (1961) 67–74.
[9] A. Safdar, A.M. Shahzad, S.A. Khurram, A.K. Shahid, L.A. Rana Statistical, estimation of tropospheric radio refractivity derived from 10 years meteorological data, J. Atmos. Sol.-Terr. Phys. 77 (2012) 96–103.
[10] E.K. Smith, S. Weintraub, The constants in the equation for atmospheric refractivity index at radio frequencies, Proc. Inst. Radio Eng. 41 (1953) 1035–1037.
[11] A.A. Willoughby, T.O. Aro, I.E. Owolabi, Seasonal variations of radio refractivity gradients in Nigeria, J. Atmos. Sol.-Terr. Phys. 64 (2002) 417–425.
[12] J.C. Wyngaard, M.A. LeMone, Behaviour of the refractive index structure parameters in the entraining convective boundary layer, J. Atmos. Sci. 37 (1980) 1573–1585.
[13] J.C. Wyngaard, S.S. Nelson, O. Martin, Xaio Di, E.G. Kenneth, Concepts, observations, and simulation of refractive index turbulence in the lower atmosphere, Radio Sci. 36 (2001) 643–669.
[14] ITU-R, The Radio Refractive Index: Its Formula and Refractivity Data, 2012, pp. 453–10.
[15] L.B. Kolawole, Statistics of radio refractivity and atmospheric attenuation in tropical climates, in: Proceedings of the URSI Commission F, Belgium, 1983, pp. 69–75.