Data Article
Dataset of surface water vapour density in southeast, Nigeria

Sayo A. Akinwumi, Temidayo V. Omotosho, Mojisola R. Usikalu, Oluwole A. Odetunmibi, Oluwafunmilayo O. Ometan, Mustapha O. Adewusi

Department of Physics, Covenant University, Ota, Nigeria
Department of Mathematics, Covenant University, Ota, Nigeria
Department of Physics, Lagos state University, Ojo, Lagos state, Nigeria

Abstract
In this data article, analysis of surface water vapour density in Southeast, Nigeria were reported. The meteorological data were obtained for the period of 39 years between 1973 and 2012 from National Oceanic and Atmospheric Administration (NOAA) Climatology Centre. Five stations considered in the research area includes: Enugu, Onitsha, Abakaliki, Aba and Ihiala. Descriptive statistics were used to show an increase in monthly variation of surface water vapour density (SWVD) minimum value of about 7.15 g/m³ at Enugu in January to maximum value of about 21.96 g/m³ at Onitsha in April. Hence, the seasonal variation for South East indicate peak value within the months of March to May in the rainy season and a lower 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.

© 2018 The Authors. Published by Elsevier Inc. This is an open access article under the CC BY license (http://creativecommons.org/licenses/by/4.0/).
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 surface 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 collected from National Oceanic and Atmospheric Administration (NOAA) Climatology center for the period of about thirty-nine years from 1973 through 2012 for five stations within southeast, Nigeria. The data input parameters such as pressure, temperature, and relative humidity were used for the calculation of surface water vapour density (SWVD) for all the zones. 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 SWVD as revealed in Tables 1a–1e. The descriptive statistics summaries of the SWVD are presented tables. While, bar charts for the SWVD distribution are presented in figures.

SWVD, g/m³, 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 Eqs. (1)–(3):

\[
SWVD = \frac{216.7e}{T}
\]  

Table 1a
Monthly Water Vapour Density values from Enugu State.

| Month | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| WVD (g/m³) | 7.151 | 14.8 | 19.588 | 21.425 | 20.82 | 20.196 | 20.26 | 20.044 | 20.617 | 20.631 | 16.38 | 13.66 |
The vapour pressure is also related to the relative humidity $H$ (%) as:

$$e = \frac{He_s}{100}$$  \hspace{1cm} (2)

$e_s$ is the maximum (or Saturated) vapour pressure at the given air temperature $t$ °C, and may be obtained from:

$$e_s = 6.11 \exp\left[\frac{17.502t}{(t+240.97)}\right]$$  \hspace{1cm} (3)

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

1.1. The summary statistics of the data from Enugu state

The summary statistics of the data collected from Enugu state is presented in 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 water vapor density 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 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 water vapor density recorded monthly for the state.
Table 2
Summary statistics of the Enugu state water vapor density data.

| Statistics          | Values   |
|---------------------|----------|
| Mean                | 17.9640  |
| Std. Error of Mean  | 1.22921  |
| Median              | 20.1199  |
| Mode                | 7.15*    |
| Std. Deviation      | 4.25810  |
| Variance            | 18.131   |
| Skewness            | −1.754   |
| Std. Error of Skewness | .637      |
| Kurtosis            | 2.922    |
| Std. Error of Kurtosis | 1.232     |
| Range               | 14.27    |
| Minimum             | 7.15     |
| Maximum             | 21.42    |

![Fig. 1](image_of_fig1.png)

Fig. 1. The bar chart showing the monthly water vapor density for Enugu state.

Table 3
Summary statistics of the Anambra state water vapor density data.

| Statistics          | Values   |
|---------------------|----------|
| Mean                | 20.7070  |
| Std. Error of Mean  | .26881   |
| Median              | 20.7449  |
| Mode                | 19.52    |
| Std. Deviation      | 4.25810  |
| Variance            | 18.131   |
| Skewness            | −1.754   |
| Std. Error of Skewness | .637      |
| Kurtosis            | 2.922    |
| Std. Error of Kurtosis | 1.232     |
| Range               | 14.27    |
| Minimum             | 7.15     |
| Maximum             | 22.01    |
| Sum                 | 248.48   |
1.3. The summary statistics of the data from Ebonyi state

The summary statistics of the data collected from Ebonyi state is presented in 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 water vapor density recorded monthly for the state.

1.4. The summary statistics of the data from Abia state

The summary statistics of the data collected from Abia state is presented in 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 water vapor density 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 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 water vapor density recorded monthly for the state.
Table 5
Summary statistics of the Abia state water vapor density data.

| Statistics                  | Values    |
|-----------------------------|-----------|
| Mean                        | 20.2443   |
| Std. Error of Mean          | .20471    |
| Median                      | 20.1597   |
| Mode                        | 19.14     |
| Std. Deviation              | .70913    |
| Variance                    | .503      |
| Skewness                    | .143      |
| Std. Error of Skewness      | .637      |
| Kurtosis                    | −1.211    |
| Std. Error of Kurtosis      | 1.232     |
| Range                       | 2.11      |
| Minimum                     | 19.14     |
| Maximum                     | 21.25     |
| Sum                         | 242.93    |

Fig. 3. The bar chart showing the monthly water vapor density for Ebonyi state.

Fig. 4. The bar chart showing the monthly water vapor density for Abia state.
Table 6
Summary statistics of the Abia state water vapor density data.

| Statistics           | Values  |
|----------------------|---------|
| Mean                 | 20.7765 |
| Std. Error of Mean   | .24662  |
| Median               | 20.6655 |
| Mode                 | 19.33   |
| Std. Deviation       | .85433  |
| Variance             | .730    |
| Skewness             | -.037   |
| Std. Error of Skewness | .637   |
| Kurtosis             | -.818   |
| Std. Error of Kurtosis | 1.232  |
| Range                | 2.64    |
| Minimum              | 19.33   |
| Maximum              | 21.96   |
| Sum                  | 249.32  |

Fig. 5. The bar chart showing the monthly water vapor density for Imo state.

2. Materials and methods

Several researches have been conducted on water vapor density [1–3,5–16]. Similar statistical tools were also applied by [4,17,18]. Radiosonde data for at least 39 years between 1973 and 2012 for 5 stations 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.

Acknowledgements

The authors acknowledge the Centre for Research, Innovation, and Discovery, (CUCRID) Covenant University, Ota, Nigeria for sponsorship of this article.
Transparency document. Supporting information

Supplementary data associated with this article can be found in the online version at http://dx.doi.org/10.1016/j.dib.2018.02.066.

Appendix A. Supplementary material

Supplementary data associated with this article can be found in the online version at http://dx.doi.org/10.1016/j.dib.2018.02.066.

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] 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, IEEE Proceeding of the 2015 International Conference on Space Science and communication (Iconspace), 10–12 AugustLangkawi, Malaysia, 2015.
[4] S.A. Akinwumi, T.V. Omotosho, O.A. Odetunmibi, Dataset of surface refractivity in Southeast, Nigeria 16 (2018) 470–477.
[5] AGU, American Geophysical Union’s Special Report on Water Vapour in the Climate System. Washington, D. C. P. 20009.
[6] G.O. Ajayi, Physics of the tropospheric radio propagation. Proceedings of the ICTP College on theoretical and Experimental Radio Propagation Physics, 6–24 February 1989, Trieste, Italy.
[7] T.O. Aro, Determination of total atmospheric water vapour content from solar observations at millimetre wavelength, J. Atmos. Terr. Phys. 34 (1972) 305–314.
[8] T.O. Aro, Analysis of data on surface and tropospheric water vapour, J. Atmos. Terr. Phys. 38 (1975) 565–571.
[9] E.E. Balogun, J.A. Adedokun, On the variations in precipitable water over some West African stations during the special observation period of WAMEX, Mon. Weather Rev. 114 (1986) 772–776.
[10] M. Bevis, S. Businger, T.A. Herring, C. Rocken, R.A. Anthes, R.H. Ware, GPS meteorology: remote sensing of atmospheric water vapor using the Global Positioning System, J. Geophys. Res. 97 (15) (1992) 787–15,801.
[11] B.R. Bean, B.A. Cahoon, Correlation of monthly median transmission loss and refractive index profile characteristics, J. Res. NBS 65D (1) (1961) 67–74.
[12] 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.
[13] 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.
[14] 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.
[15] J.C. Wyngaard, M.A. Lebhole, Behaviour of the refractive index structure parameters in the entraining convective boundary layer, J. Atmos. Sci. 37 (1980) 1573–1585.
[16] J.C. Wyngaard, S.S. Nelson, O. Martin, Xiaod Di, E.C. Kenneth, Concepts, observations, and simulation of refractive index turbulence in the lower atmosphere, Radio Sci. 36 (2001) 643–669.
[17] ITU-R, The Radio Refractive index: its Formula and Refractivity Data, P. 453–10, 2012.
[18] L.B. Kolawole, Statistics of radio refractivity and atmospheric attenuation in tropical climates. Proceedings of the URSI Commission F, Belgium, pp. 69–75, 1983.