

# Monthly and annual variation of some atmospheric parameters over Aliero, Kebbi State, Nigeria

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Received 24th July, 2019; Accepted 7th October, 2019

**ABSTRACT:** Temperature changes, relative humidity and changes in annual rainfall can exert a negative effect on the agricultural productivity and radio refractivity in the atmosphere. In this study, the variation of some atmospheric parameters over Aliero town (Latitude 12.306 °N, Longitude 4.492 °E) was examined. The measured data concerns averages of maximum air temperature, relative humidity and amount of rainfall for Aliero. The Data used was obtained from the Meteorological Station of the Kebbi State University of Science and Technology Aliero, for the period of 3 years (2014 – 2016). The analysis was done based on the monthly and annual variations of all the parameters for each year. The results from this study, reveals that the monthly observations of maximum rainfall in Aliero ranges from ~ 17 to 22 mm and the peak occurs in the month of July, and that of relative humidity (~98 to 99%) the peak occurs in the month of August. Atmospheric temperatures in Aliero were observed to be relatively high, with peak values of about 40 to 41°C recorded in the month of April in all the three years considered. While the variation in rainfall and relative humidity were observed to be simultaneous; Air temperature reduces with increase in the amount of rainfall and relative humidity. Averagely, higher amount of rainfall and temperature were recorded in 2016 and that of relative humidity occurred in 2015. These results are of great significance in; understanding the atmospheric condition of Aliero, which has direct impact in agricultural production, tropospheric radio wave propagation and relevant research purposes.

**Keywords:** Air temperature, Aliero, rainfall, relative humidity, weather.

## INTRODUCTION

Weather is generally considered as the state of the atmosphere at a given time at any given location (Ogolo and Adeyemi, 2016). It may also be referred to as the aspect of the atmospheric state which is visible, experienced and affects human activities. The weather condition of any given location is often described in terms of the meteorological elements which include the state of the sky, temperature, wind, pressure, precipitation, and humidity. These factors initiate and influence the atmospheric processes (Ayoade, 1993).

Mitchell and Hulme (2000) have earlier shown that the mean annual air temperature was estimated for every country in our planet during 1901 to 1998. In the process, the linear trend for every country during 20th century was computed, and the trend for Nigeria is negative, -0.06°C. Although the trends of temperature variations are season dependent (IPCC, 2014), changes in temperature trends

bring about Global Warming. Temperature variations in Nigeria were observed to have higher values in the far north, attributed to the influence of Sahara Desert, which has less cloud cover and therefore is more transparent to solar irradiance, and lower values in the south, where there are more cloud cover and abundant vegetation (Amadi et al., 2014; Yusuf et al., 2017). More recent study of the variation of monthly mean values of air temperature in seven cities at the southern part of Nigeria revealed that the hotter cities are those with average temperature of 27.5°C (Anekwe and Onuchukwu, 2017).

Rainfall is highly variable in both time and space, particularly in sub-humid tropical regions like West-Africa. Most researches carried out base on the monthly analysis of rainfall revealed that the period of highest rainfall falls between June and July or between August and September for the locations nearest to the coast and those closer to

the Sahara desert respectively (Oyewole et al., 2014; Abdullahi et al., 2014). For example in the southern part of Nigeria, the rainfall exhibits double maxima with peaks in July and August (Uko and Tamunobereton, 2013). Whereas in Yola, the northern part of the country, the maximum annual rainfall is received in September with average annual relative humidity of 83.6% (Abdullahi et al., 2014). However, analysis of long time trends and decadal trends in the time series further suggest a sequence of alternately decreasing and increasing trends in mean annual precipitation (Akinsanola and Ogunjobi, 2014).

It is known fact that when air becomes saturated, condensation of water vapour (present in the air) occurs leading to the formation of tiny water droplets. Millions of such water droplets come together to form clouds. Under certain conditions such water droplets combine to form big rain drops which fall as rain due to gravity. Recently, Ukhurebor and Abiodun (2018) in their studies of variation in annual rainfall data of forty years for South-South, Nigeria have identified the range 2008 to 2017 as associated with much rainfall. There is a strong relationship between the relative humidity and rainfall – thus an increase in the relative humidity increases the possibility of cloud formation and subsequent precipitation (Oyewole et al., 2014). This implies that, higher values of relative humidity are recorded during rainy season.

Studies like Dobrica et al. (2009) and Morozova et al. (2005) have shown that the geographical variations of atmospheric parameters depends on the response of the troposphere to the solar activity forcing for different latitudinal and longitudinal regions. Other important factors which determine the variations of the atmospheric parameters are the effect of predominant local climatic conditions such as; vicinity of the sea or mountain ranges, air pollution and aerosol loading and the patterns of the atmospheric circulations (Morozova et al., 2005).

Weather and climate data play a very significant role in weather forecasting, agriculture and in socio-economic activities throughout Nigeria (Uko and Tamunobereton, 2013; Ogolo and Adeyemi, 2016). For instance, solar radiation is a determining factor in studying the natural potential of solar energy as a source of renewable energy. However, the availability of solar radiation usage on the earth surface and the efficiency of photo voltaic (PV) systems depend on the atmospheric parameters such as ambient temperature, relative humidity, rainfall and so on (Sanusi et al., 2014). Also, the hourly and diurnal variation of refractive index of air which is a result of the variations of meteorological parameters causes adverse effects such as multipath, fading and interference. For example, the variation in rainfall and relative humidity heavily affect radio refractivity in the lower atmosphere (Ukhurebor and Azi, 2018). These effects significantly impair radio communication, aero-space, environmental monitoring and disaster forecasting (Agbo et al., 2013; Edet et al., 2017). Further investigations revealed that, land surface temperature, air temperature and relative humidity are

some of the atmospheric parameters that show significant variations prior to occurrences of strong earthquake (Singh et al., 2010; Tronin et al., 2004; Jing et al., 2013; Pulinets and Dunajacka, 2007).

The objective of this study therefore is to investigate the relationship between air temperature, relative humidity and amount of rainfall at Aliero, North western Nigeria. The data from this station is relatively new, and has not appeared much in literatures.

## MATERIALS AND METHODS

The data used for this research were obtained from Kebbi State University of Science and Technology Aliero Meteorological Station (latitude 12.306 °N and longitude 4.492 °E). The data spans January, 2014 to December 2016. The parameters used for the analysis include maximum and minimum air temperature, maximum and minimum relative humidity and amount of rainfall. The monthly and hourly averages were computed using equation 1. The hourly averages were used to study the monthly and annual variations of each parameter for the entire period.

$$\text{Average} = \sum \frac{K_i}{N} \quad (1)$$

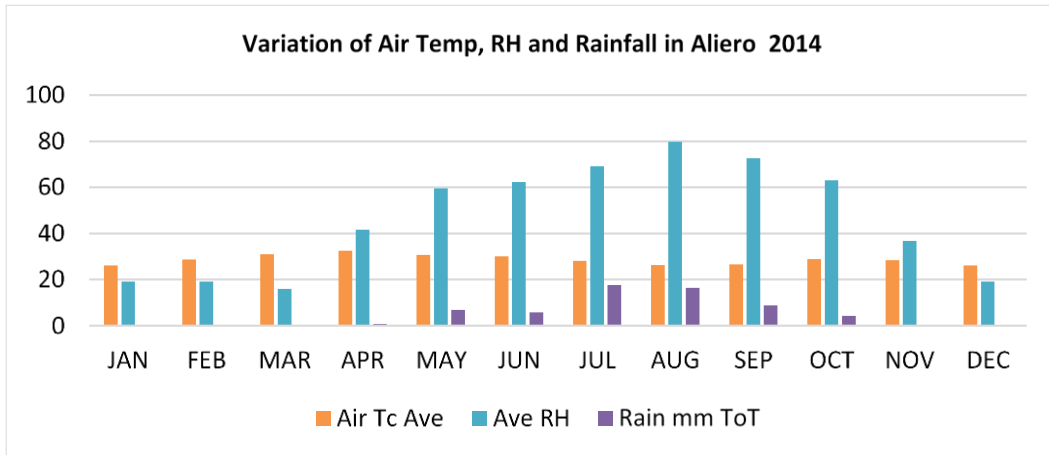
Where: K is the parameter,  $K_i$  are the data points and N is the number of data points.

## RESULTS AND DISCUSSION

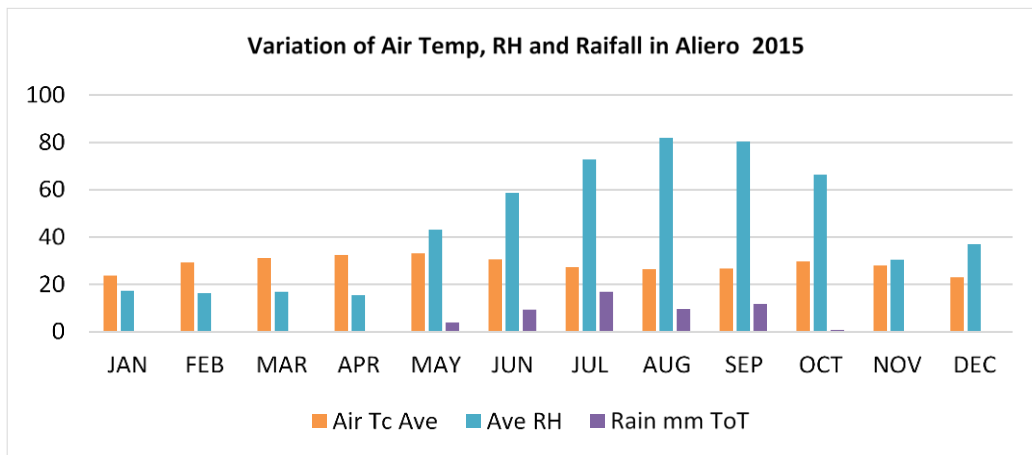
Figure 1a is the plot for monthly averages of the variation of air temperature (green bar), relative humidity (blue bar) and rainfall (yellow bar) for 2014. Similar plots are shown in Figures 1b and 1c for 2015 and 2016 respectively. The plots span from January to December of each of the years considered.

### Variation of air temperature, relative humidity and rainfall in Aliero

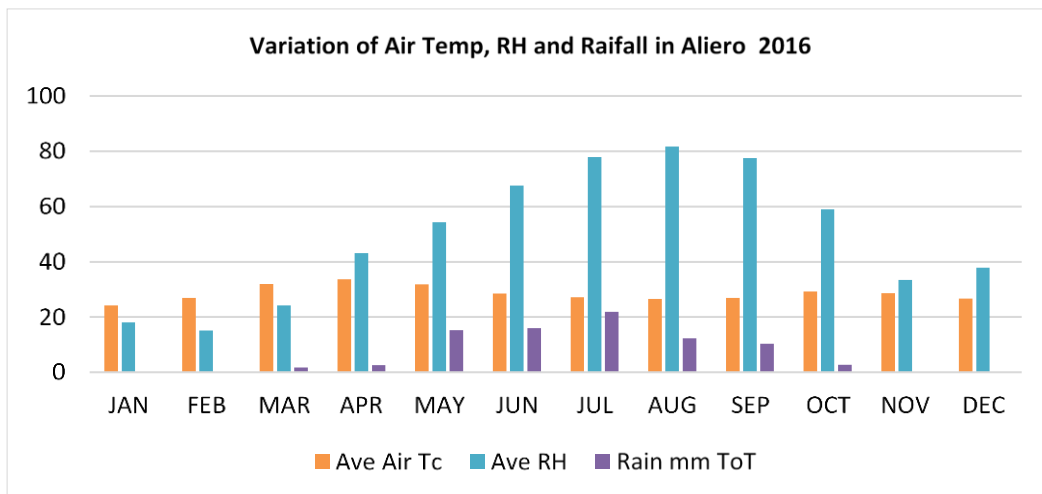
An observation from Figure 1a shows that the variations in relative humidity correspond well with that of rainfall. This is consistent with Oyewole et al. (2014) and Umoh et al. (2013). While the relative humidity and rainfall increases, the air temperature decreases which corresponds to the work of (Akinsanola and Ogunjobi, 2014). It is likely that the increase in relative humidity determines the rise in the amount of rainfall, since the relative humidity is known to serve as an index that indicates the presence of precipitation in the atmosphere. This is evident from the consistent rise in relative humidity observed mostly in this station from the months of April to the peak value of about 98% in the month of August (Figure 1a-1c). Although, the



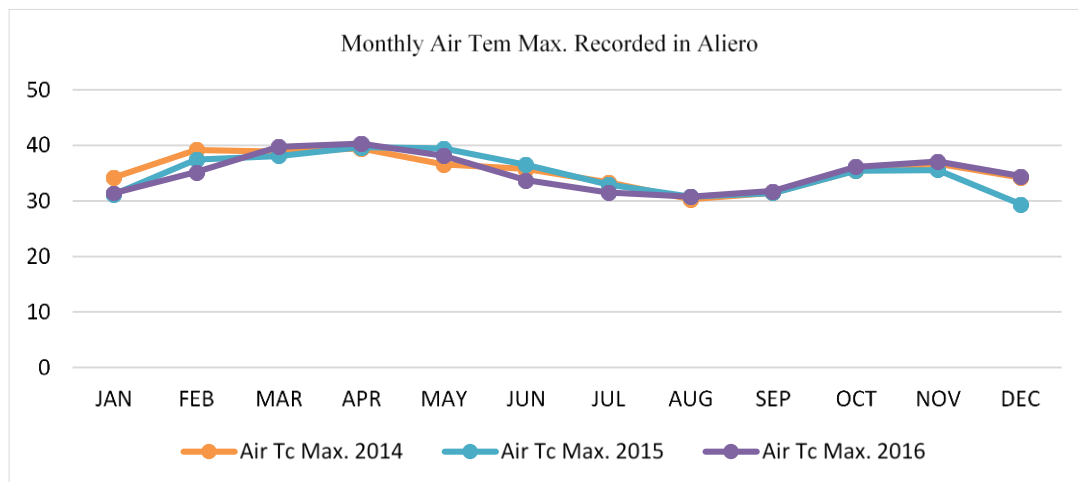
**Figure 1a.** Monthly variation of air temperature, relative humidity and rainfall for January to December 2014.



**Figure 1b.** Monthly variation of air temperature, relative humidity and rainfall for Jan. to Dec. 2015.



**Figure 1c.** Monthly variation of air temperature, relative humidity and rainfall for Jan. to Dec. 2016.



**Figure 2.** Monthly Variation of maximum air temperature in 2014, 2015 and 2016. The green line represents the temperature in 2014, blue line represents the temperature in 2015 and yellow line represent the temperature in 2016.

peak of the amount of rainfall precedes that of relative humidity, the trend of variation of the duo indicates that the rise in the relative humidity is a strong determinant of the increases in the amount of rain fall. However, it is not clear why the maximum amount of rain fall for these years (2014 to 2016) were recorded before that of the relative humidity (98%). The maximum amount of rainfall (~ 18 mm) for this station is mostly recorded in the month of August, in contrast to the findings of Uko and Tamunobereton (2013) and that of Abdullahi et al. (2014) who both reported the peak of rainfall in July/September and August/September respectively. These variations are attributed to the fact that the stations are located at different regional points apart from latitudinal differences (Oyewole et al., 2014). During these periods the atmospheric temperature was observed to be relatively low.

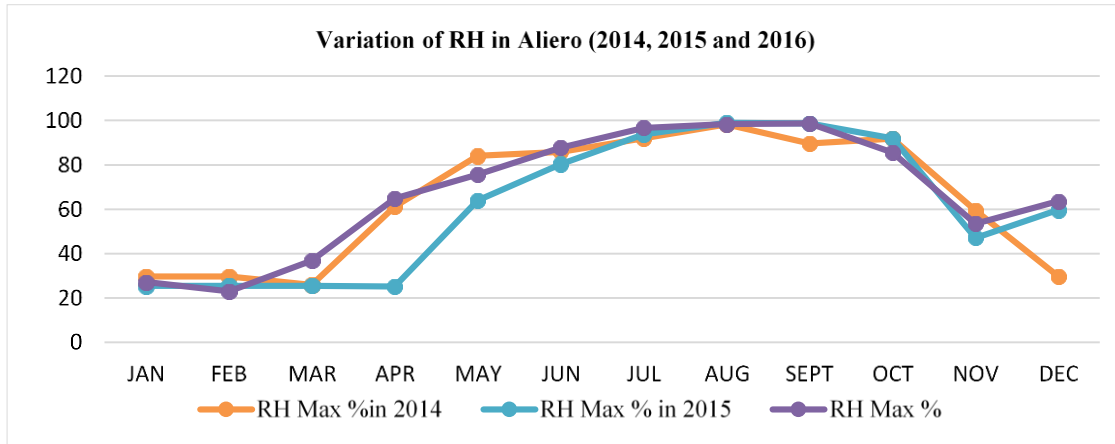
Figure 1b also shows that the variation in relative humidity and amount of rainfall is simultaneous. The plot also shows that the air temperature records lower values during the time of increased rainfall as expected. It is generally known that the increase in the amount of rainfall also indicates an increase in water molecules within the troposphere, thus cooling the atmospheric temperatures to a certain extent. This is in conformity with the reports of Amadi et al. (2014) and Yusuf et al. (2017). Further observations from this Figure reveal the end of rainfall in the month of September, 2015 although higher values of relative humidity were recorded in October, 2015; with the peaks of the relative humidity (99.5%) and amount of rainfall (~ 17 mm) observed in the month of August and July respectively. The air temperature was observed to be highest during the month of May, 2015 with a value of about 40°C, this is not strange considering the geographic and topographic location of Aliero.

Figure 1c shows that the rainfall in 2016 which started

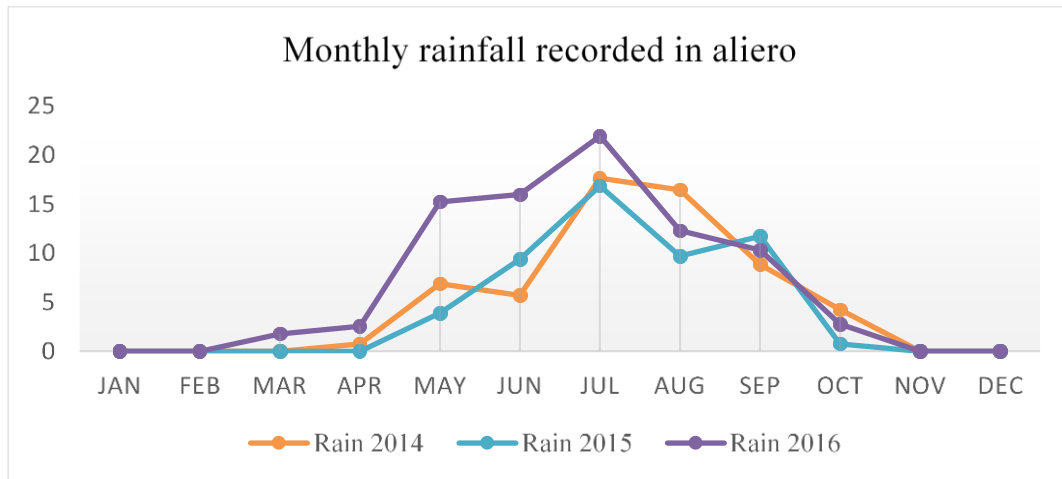
as early as March and extended to the month of October has its peak value of about 22 mm during the month of July (this is the highest value recorded in the three years considered). During this period of rainfall, the relative humidity maintained a consistent increase until it attained its peak in August (~ 99%) from which a gradual decrease was observed from September to November. The air temperature has been observed to be high in March, April and May as expected (Salau, 2016; Yusuf et al., 2017), during which the relative humidity was relatively low. It is evident from Figure (1a-1c) that the air temperature reduces with the increase in precipitation (relative humidity) and rainfall.

### Monthly variation of air temperature

Figure 2 shows a comparative analysis of the monthly variation of the maximum air temperature. The plot spans January 2014 to December 2016. The temperature was observed to be hottest in 2014 particularly during the month of January and February, and appeared to be coldest in 2015 during the month of December. Salau (2016) has shown that the temperature of a region is determined by changes in solar irradiance forcing and further influenced by the variations in rainfall patterns. Thus, the higher temperatures were mostly recorded during the dry seasons; when there was no rain. This is evident from the results of the variations in the rainfall and temperature earlier reported. Observations from Figure 2 have further shown that the trend of air temperature for 2014 and 2016 correspond well, particularly from the months of March to December. This cannot be unconnected with the trends of rainfall observed during the two years.



**Figure 3.** Monthly variation of maximum RH in 2014, 2015 and 2016. The green line represents the RH in 2014, blue line represents the RH in 2015 and yellow line represent the RH in 2016.



**Figure 4.** Monthly variation of the amount of rainfall in 2014, 2015 and 2016. The green line represents the RF in 2014, blue line represents the RF in 2015 and yellow line represent the RF in 2016.

**Monthly variation of relative humidity**

Figure 3 shows the variation of maximum relative humidity for the three years under study in Aliero. Observations from this Figure reveals a strong agreement in the relative humidity records of 2014 and that of 2016; with a strong variance observed in 2015 significantly during the months of April, May and June. Figure 3 further shows that the relative humidity is lowest at the beginning of every year and begins to rise from March or April, depending on the year. It peaks mostly in the month of August, and thereafter declines through November/December. These agrees strongly with the fact that the periods of June solstice (May - July) and September equinox (August - October) record the high relative humidity and March equinox (February - April) and December solstice (November - January) record

low relative humidity (Umoh et al., 2013; Adeyemi and Ogidan, 2015). In 2014, the relative humidity shows a uniform decrease during December while in 2015 and 2016 it shows a sudden increase during the month of December. Apart from rainfall, this little variation may affect other atmospheric parameters like aerosols loading, visibility and so on.

**Monthly variation of rainfall**

The rainfall in this region starts annually between March and April and stops around October of every year except in 2015 (Figure 4). The maximum rainfall for each of the three years under study occurred in the month of July. However, there was generally low rainfall in the year 2015 which is likely the consequence of the low relative humidity

experienced along the months of the year. The same reason (high relative humidity) may be attributed to the extremely high amount of rainfall received in 2016. This is consistent with the fact that the variation of rainfall and relative humidity is strongly simultaneous (Adeyemi and Ogidan, 2015, Umoh et al., 2013; Oyewole et al., 2014)

## Conclusion

From the study, it can be concluded that air temperature reduces with increase in the amount of rainfall and relative humidity. The maximum value of the amount of rainfall received in this station precedes that of the relative humidity. The variation in rainfall and relative humidity is simultaneous. The amount of rainfall for this station peaks in the month of July with an average value of 19 mm. The average maximum and minimum air temperature for the three years studied ranges between 21 to 40°C, 28 to 99% for relative humidity and that of rainfall is 5 to 22 mm.

## CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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