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Diurnal Distribution Of Absolute Humidity Over Four Selected Stations In West Africa Using Data Retrieved From Era – Interim

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***Abstract:** The absolute humidity (ρ) variation diurnally has been studied using yearly averages of air temperature and dew point temperature at four selected stations over West Africa, each represents the climatic region to which it is being grouped into, (Coastal, Derived , Guinea and Sahel) for the years 2005 to 2011 retrieved from ERA-Interim. The stations selected are as follows: PortHarcourt in the Coastal region, Kankan in the Derived region, Dakar in the Guinea Savannah region and Arlit in the Sahel Savannah region respectively. These stations were selected base on the peculiar weather characteristics associated with them and their location on the West African map. The hours of the day selected for the purpose of this research are, 00:00hr, 06:00hr, 12:00hr and 18:00hr of the day. These hours can likewise be known as the transition hours of a day. It was observed that over all the stations considered, ρ shows strong diurnal variation. Likewise, ρ decrease from 00:00hr in the midnight to 06:00hr in the morning. This is then followed by a sharp increase to 18:00hr in the evening at all stations in both the dry and wet season.*

***Keywords:** Diurnal, Evaporation, Absolute Humidity, dew point, temperature*

I. INTRODUCTION

Absolute humidity is a measure of the amount of water vapour that is present in the atmosphere. This is one of the ways by which humidity is being measured, aside from this is relative humidty. The absolute humidity has its S.I unit as g/cm^3. The water vapour that is being measured is extremely important to weather and climate as it brings about rain, clouds or snow. It is the gaseous phase of water and a stage of the water cycle of our planet. Adeyemi B, (1995) found out that as the earth warms, more water evaporates from the ocean and the amount of water vapour increases. Adeyemi and Aro, (2004) also observed that almost all atmospheric processes, radiative heating affecting climate on synoptic scales to local hydrological budgets as well as severe weather conditions are being influenced by water vapour. Consequently, a significant amount of work has been performed to develop systems and techniques for measurement of atmospheric water vapour, as well as to increase the spatial and temporal resolution of observed water vapour density profiles. Ayoade (2003), in his book, Introduction to Climatology for the Tropics, observed that the amount of water vapour in the air is an important factor influencing the rate of evaporation and evapo-transpiration. The transition of these molecules from liquid to gas is done by the absorption or release of kinetic energy which is defined as thermal energy and only occurs when there are variations in the temperatures of the molecules. Water molecules take a little heat with them as they turn to vapour. When evaporation occurs, this heat is taken from the water that remains in the liquid state, resulting in a cooler liquid. This process is called evaporative cooling (Mshellia, 2005). The amount of water vapour in the atmosphere determines how quickly each molecule returns back to the surface. Evaporative cooling is limited to atmospheric conditions. The condensation of water vapour is responsible for clouds, rain, snow, and other forms of precipitation that are all important elements of what we experience as weather. Fog and clouds form around cloud condensation nuclei. Without the nuclei, condensation would only occur at much lower temperatures. With global warming on the rise, this could possibly determine how future weather events shape the world atmosphere. Water vapour molecules remain in the troposphere for about 10 days of the water cycle. The water depleted from the troposphere is replenished by evaporation from the oceans, lakes, rivers, transpiration of plants, deposition of ice, and other geological processes, (Odjugo 2007).

II. METHODOLOGY

The data for air temperature and dew temperature for this research work were retrieved from ERA-Interim for twenty five stations as shown in figure 1, across West Africa and were further grouped into four climatic regions (Coastal, Derived, Guinea and Sahel) as studied by Adedokun, (1986) , Adeyemi and Abidoye, (2016). The absolute humidity is calculated and utilized for the stations and regions respectively, considerably at hours of the day,which are 00:00, 06:00, 12:00 and 18:00 taken on daily basis for five years between 2005 to 2009 at surface level.The data obtained in each stations were combined to a 365-day period for the purpose of this study. The selected stations are the representatives of the different climatic regions in West Africa.

The absolute humidity was calculated according to Aro (1975) as:

$$\rho = \frac{e_v}{R_v T_a} \quad (1)$$

According to Clausius Clapeyron, e_v is given as:

$$log_{10} e_v = 9.4051 - 2353 / T_d \quad (2)$$

Where, ρ = absolute humidity expressed in g/m^3, e_v = vapour pressure, T_a = air temperature, R_v (ideal gas constant) = 0.46004J/gK.

The diurnal distribution of absolute humidity were gotten from the average values over the five year period (2005-2009) where considerable months of the year such as November, January, April and July were selected to represent early dry season, late dry season, early rainy season and late rainy season months respectively.

Also, the seasonal distribution is gotten from the average of absolute humidity over the five year period from January to December.

III. RESULTS AND DISCUSSION

This section shows the diurnal distribution, seasonal distribution, variability of ρ averaged over five years for twenty five weather stations over West Africa.

DIURNAL DISTRIBUTION OF ABSOLUTE HUMIDITY

For all the stations considered, (figure 1.1), it was observed that ρ has its maximum value at the 00:00hr and minimum at the 06:00hr. This was as a result of the intensive evaporation that might have taken place during the day, most especially at the 12:00hr, by the time it gets to the 18:00hr (that is 6:00pm in the day) a considerable amount of water vapour would have been present in the atmosphere. This evaporative exercice continues till it get to the midnight of 00:00hr when water vapour would have been maximum in the atmosphere. At the 06:00hr, precipitation in form of dew, mist etc takes charge of the atmosphere, at this time little or no evaporation takes place leading to little presence of water vapour in the atmosphere. Hence, little absolute humidity is gotten at this hour. This was likewise observed by Adeyemi and Abidoye, (2016) where they said the decrease from midnight to morning period of 06:00hr observed in ρ value may be due to loss of of water vapour in the atmosphere due to condensation as the midnight temperature falls to or below the dew point temperature. This then increases the water vapour that passes into the layers of air nearest to the ground, (Adeyemi and Aro, 2004).

Moreover, the variation in the absolute humidity for the stations considered is not surprising. It was observed that Port Harcourt which was a coastal station has the highest value of absolute humidity compared to other stations over the selected months at the various hours considered. This was because Coastal region is full of forest and air temperature is always maintained as normal, dew falls at the right time and seasons are maintained as it is expected except on special reasons. Intensive evaporation takes place throughout the years, land and sea breeze due to the presence of rivers, streams and lakes. This station likewise experience condensation but yet has maximum value than others at the 06:0hr.

According to Adeyemi and Aro, (2004), they observed that at this region, air temperature near the surface are for most time of the year far above dew point. Likewise, Arlit being a Sahel Savannah station is characterized with low value of absolute humidity, it was observed that while other stations decreases from 00:00hr to 06:00hr, reverse is the case Arlit, it increases from 00:00hr to 06:00hr, this could be that little or no evaporation takes place during the day but characterized with condensation more than evaporation. From 06:00hr to 12:00hr of the day, the variation is considerable as it increases like other stations, but from 12:00hr to 18:00hr, the variation decreases, hence, reversed the observation in the other stations. This observation was peculiar to the months of November, January and April while reversed is the case for July as considerable variation was observed just like the other stations. This observation was as a result of the peculiarity of the month known as the rainy season month where heavy and intensive rainfall characterized with evaporation and condensation at the right time.

The minimum value observed in this station (Arlit) was as a result of loss of water from the air by condensation and the mid night temperature falls to or below the dew point temperature. (Adeyemi and Abidoye, 2016).

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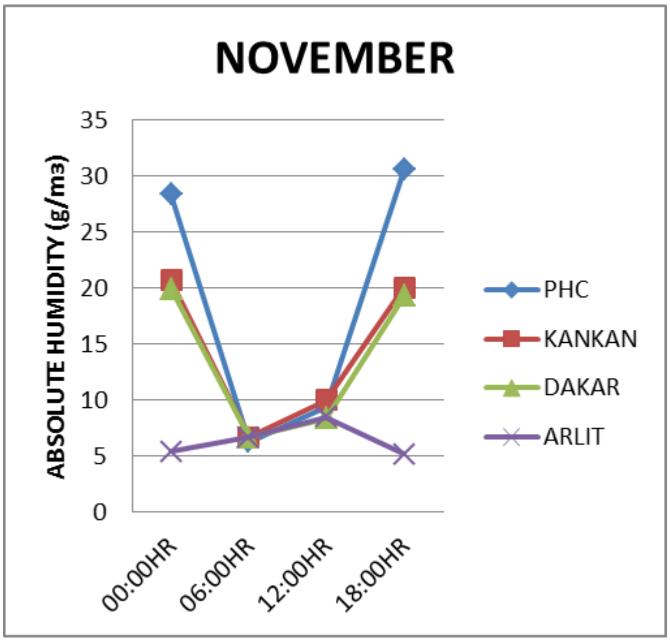
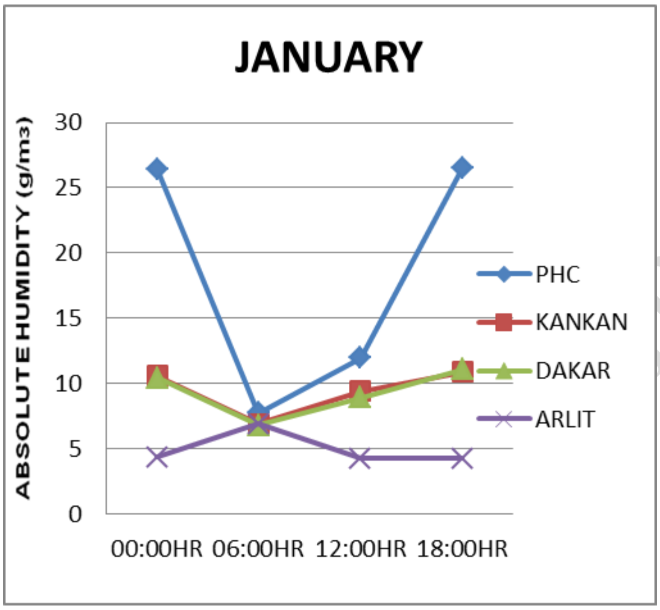
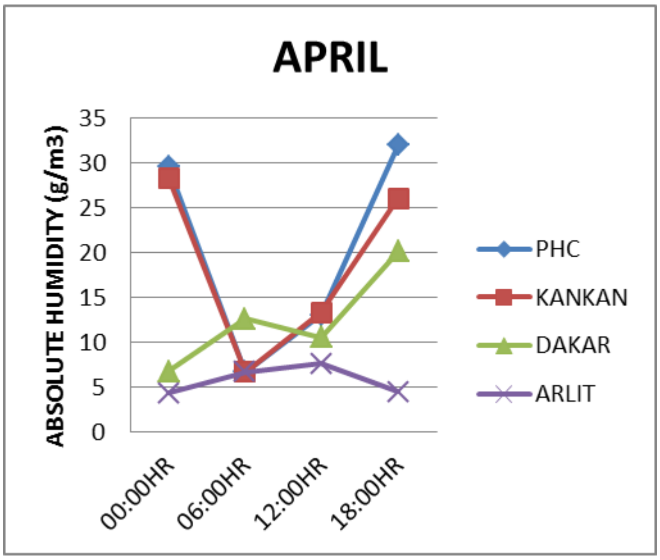






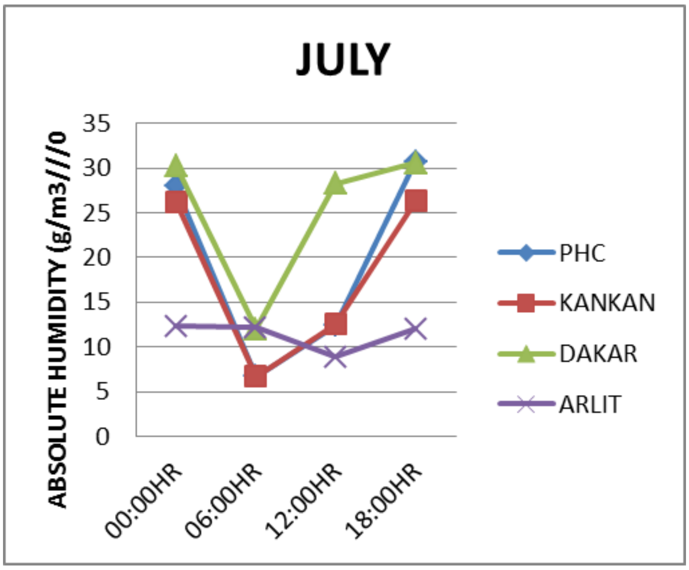
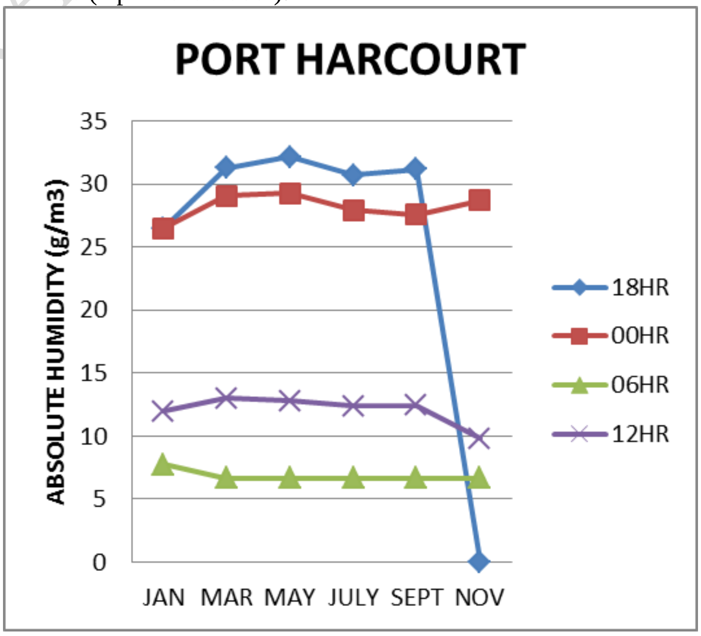


Figure 1:1 showing Diurnal distribution of ρ across the selected months of (i) November (ii) January (iii) April (iv)July

SEASONAL VARIATIONS OF ABSOLUTE HUMIDITY

Across the stations, (figure 1.2) which classified in into regions, it was observed that absolute humidity was minimum in the dry season months (January, February, March, November and December) and maximum in the wet season months (April to October).



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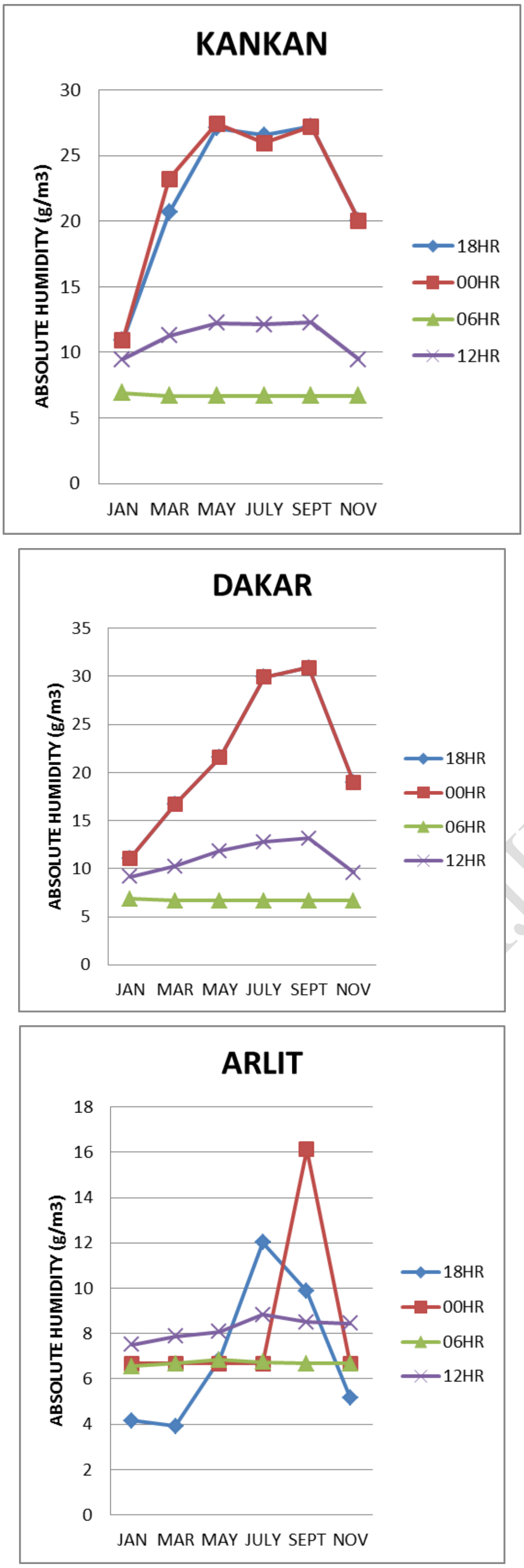

Figure 1.2 showing the seasonal variation of ρ across the stations and hours considered

IV. CONCLUSION

Some conclusions can be drawn based on the observed pattern of distribution in Absolute Humidity that eventually emerged from the synoptic hourly means of the five years data used. Absolute humidity observed over all the stations shows strong diurnal variations at all the stations and regions observed.The result of this research show that absolute humidity is highest for Coastal station (Port Harcourt) compared to the other regions and considerately low in the Sahel region (Arlit). Also, it was observed that there were considerable diurnal and seasonal variations in ρ over the four stations considered depicting each region. The distribution of absolute humidity with meterological variables for four stations which represent condition in West Africa shows that the linear combination of these variables can be used to predict absolute humidity. Analysis have shown that strong relationship exist between absolute humidity and all the meterological parameters at the selected stations.

The results of this research compared to researches from other surface data shows a linear relationship but the data collected from ERA-Interim has higher values of absolute humidity at the various hours considered especially for the Coastal station compared to other surface data.

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