Original Research Article

HYDROMETEOROLOGICAL STUDY OF SATURATED VAPOUR PRESSURE(SVP) OF WARRI, NIGERIA

ABSTRACT

The amount of water vapour present in the air is indirectly expressed through vapour pressure and for any given temperature there is a limit for water vapour that can be held by air. If the air is holding water vapour which is equal to the maximum that it can hold at a given temperature, then the air is said to be saturated. Hydrometeorological study was carried out using vapour pressure(VP)and maximum temperature data for Warri through 2009 – 2018 (10years) Saturation Vapour Pressure (SVP) were estimated.A graph is established showing the relationship between the Saturation Vapour Pressure (SVP) and the temperature also the graphical representation showing variational trend of SVP and VP were plotted. The study shows the dew point (T_d) ranging from 29.9^{O}C to 31.5^{O}C which explained the likely rainfall at any temperature below T_d. The study alsoconfirmed increase in SVP bringing increase in Temperature and the variational trend shows the same pattern all through.

Key words: *Vapour pressure, Saturated vapour pressure(SVP), Dew Point, Variational Trend.*

1. INTRODUCTION

Meteorologically, weather is used to describe the momentary atmospheric conditions at a certain place over a particular time. It is the condition of the atmosphere of a particular or specific place at any specific time. Weather describes the meteorological condition of the atmosphere over a short period of time. The climate of an area is known through the average or mean weather over a long period of time, say year to year, decade to decade or even century to century. In describing the atmospheric conditions of a given place at a given time, certain meteorological elements, parameters or variables must be known, measured and quantified (Wallace and Hobbs, 2006). Vapour pressure which is also known as equilibrium vapour pressure is the pressure exerted by a vapour in thermodynamic equilibrium with its condensed phases (solid or liquid) at a given temperature in an isolated system. It has to do with the tendency of particles to escape from either the liquid or solid.In meteorological term vapour pressure means the partial pressure of water vapour present in the atmosphere.We can either have the actual vapour pressure (***e***) orsaturated vapour pressure (e_s).We can estimatesaturated vapourpressure (SVP)from equation 3.1 (Monteith and Unsworth, 2013; Wallace and Hobbs, 2006):

Saturated vapour pressure(SVP) is defined as the pressure of water vapour above a surface of water, also the Saturation Vapour Pressure (SVP) is the pressure of a vapour when it is in equilibrium with the liquid phase and it is solely dependent on the temperature. As temperature rises the Saturation Vapour Pressure (SVP) rises as well. The amount by which the water vapour in the air must be increased to achieve saturation without changing the environmental temperature and pressure is Saturation deficit.

2. LITERATURE REVIEW

Hydrometeorological study which is mostly centred on the study of weather or climate to water is as old as the creation of mankind. It has always had a significant influence on the lives of people and shaped their cultures, beliefs, habits, attitudes, behaviour and their environments in general right from the beginning of creation (Akhilesh*et al.*, 2015; Ukhurebor*et al.*, 2017a).

Weather has always been a universal concern that plays a major role in our everyday lives (Donald, 2009; Wallace and Hobbs, 2006; Ukhurebor and Azi, 2018). Weather measurements, monitoring and analysis potentially help in keeping track of different meteorological variables such as temperature, relative humidity, atmospheric pressure, light intensity, wind speed, wind direction, precipitation, altitude, solar radiation, light intensity.Other meteorological variables aredew point temperature, specific humidity, absolute humidity, virtual temperature, evaporation and the other variables which hold great importance (Devaraju*et al.*, 2015. Theyhave several applications in agricultural, transportation, construction, military operations, radio signal transmission, power generation, solar devices and many other personal and industrial aspects of human lives (Ukhurebor*et al.*, 2017b).

Man has always try in finding out the causes of different meteorological conditions within his environs and possibly monitors what the weather would be at any given time. Appropriate studying of the meteorological conditions would make a difference for the survival and prosperity of the human race (Ukhurebor*et al.*, 2017c).There cannot be the study ofhydrometeorology nor its predictions without the knowledge of the prevailing conditions of the atmosphere on vapour pressure. Hence man has alwayshave devised means of measuring different variables of the weather. The advancement of technology has brought new methods and equipment been developed to measure, collect, monitor and analyse meteorological information. In meteorology, the weather variables measured are used for monitoring of the atmospheric conditions. Meteorology is the science that deals with the study of the atmosphere and its phenomena; especially those aspects that have to do with weather monitoring and predictions and its domain is mainly the lower atmosphere (troposphere) of the earth and its practice involves the daily cooperation of every action on the earth. Meteorology is a branch or sub-discipline in Atmospheric Science and other sub-disciplines of Atmospheric Science includes: Climatology, Atmospheric Physics and Atmospheric Chemistry (Wallace and Hobbs, 2006). Meteorological processes are observable climatic events that are illustrated using meteorological terms. These meteorological processes are described and their values/quantities are known by the weather variables or parameters of the earth's atmosphere as describe in first paragraph(Akinsanobi and Ogunjobi, 2014). The meteorological variables measured and collected are used in monitoring of the various atmospheric conditions; which are useful in one way or the other in the course of our daily activities (Ukhurebor*et al.*, 2017a; Akpan*et al*., 2016). Meteorological events studying which are related to environmental and geophysical observations are useful for variety of reasons.

It is worrisome that in Nigeria and some other developing countries of the world, research and study in Atmospheric Science are far behind due to lack of effective ground instruments and well to do technical manpower. This have invariably resulted in some meteorological induced environmental disasters that have caused a lot of harms to lives and properties.It also reduced agricultural productivities as it is being noticed in most parts of Delta State, Nigeria and other parts of the country (Ukhurebor and Abiodun, 2018).Researchers have tried to monitor meteorological characteristics using mathematical, statistical and numerical simulation methods and models. Some of these methods and models are more accurate than others, but in other to have appropriate and reliable meteorological information, there is a need for accurate ground rooted measurements and analysis of the various meteorological variables (Okhakhu, 2014; Ukhurebor*et al.*, 2017a; Folorunshoand Adesesan, 2012; Ukhurebor and Azi, 2018;Salack*et al.*, 2018).

3. METHODOLOGY

3.1 The Study Area

Warri (Fig.1) is in Delta State, Nigeria located on latitude 5.52^0Nand longitude 5.75^0E with an elevation above sea level of about 6.0 m having a population of over five hundred thousand. The city shares boundaries with Ughelli/Agbarho, Sapele, Okpe, Udu and Uvwie; however most of these places, notably Udu, Okpe and Uvwie, have been integrated to the larger cosmopolitan Warri. Effurun serves as the gateway to and the economic nerve of the city (Avwenagha, *et al.*, 2014).

Warri is predominantly Christian with mixture of African traditional religions like most of the Southern Nigeria. The city is known nationwide for its unique Pidgin English language (Avwenagha*et al.*, 2014).

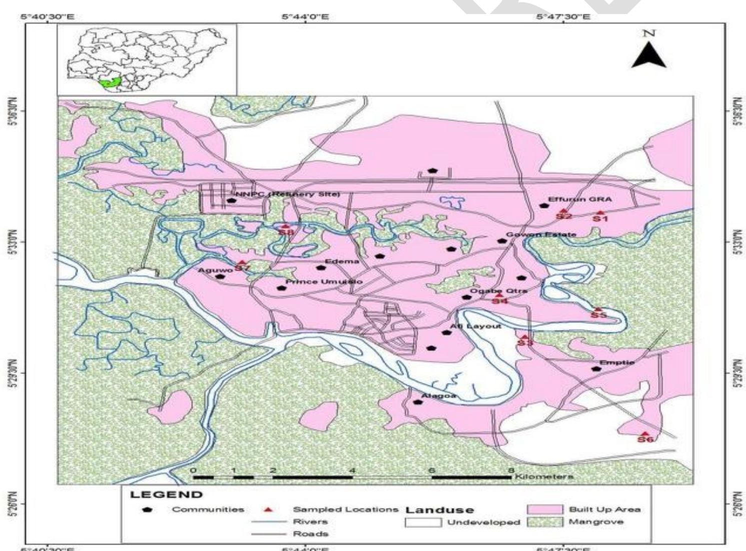

Fig.1: **Map of Warri, Delta State, Nigeria (Avwenagha*et al.*, 2014)**

3.2 Collection of Data

Monthly vapour pressure and maximum temperature data used were collected from the archive of the Nigerian Meteorological Agency(NIMET)Warri. In this study monthly maximum temperature (^{0}C), vapour pressure (kpa), for ten years (2009 to 2018) were used.

3.2.1 Determination of Saturation Vapour Pressure (SVP)

The Saturation Vapour Pressure (SVP)**e_s**, can be estimate from the formula given.(Monteith and Unsworth, 2013; Wallace and Hobbs, 2006):

$$e_s = 6.11\ exp\left[\frac{17.27T}{237.7+T}\right] \text{------------------} \quad (3.1)$$

Where T is the Monthly Maximum Temperature in ^{o}C

Saturation deficit is expressed as $(e_s\text{-}e)$where e is vapour pressure

Dew point is when vapour pressure is equal to the Saturation Vapour Pressure (SVP)**($e=es$)** i.e when humidity is 100%. A graph is established showing the relationship between the saturation vapour and the temperature.

4. RESULLTS AND DISCUSSIONS

A graph is established yearly showing the relationship between the saturation vapour and the temperature, and the Variational trend graph yearly showing trend between saturated vapour pressure and vapour pressure were plotted.

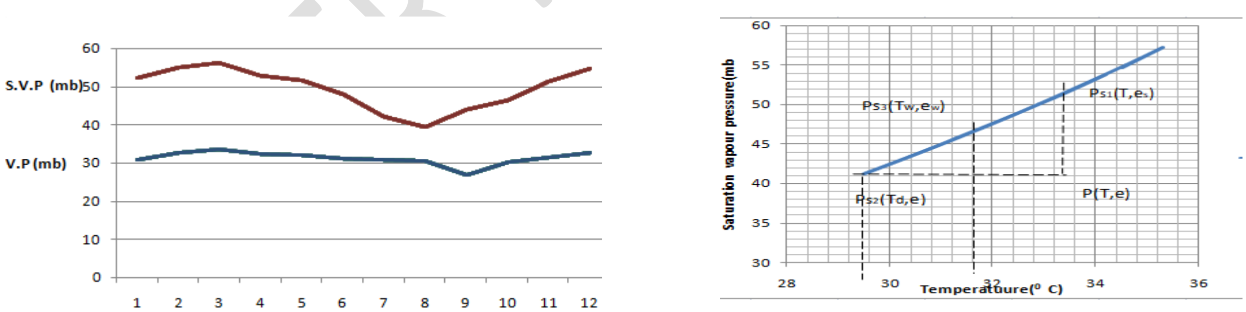

Fig. 2. (a) Variational trend graph and (b) Saturation Vapour Pressure (SVP) graph for 2009

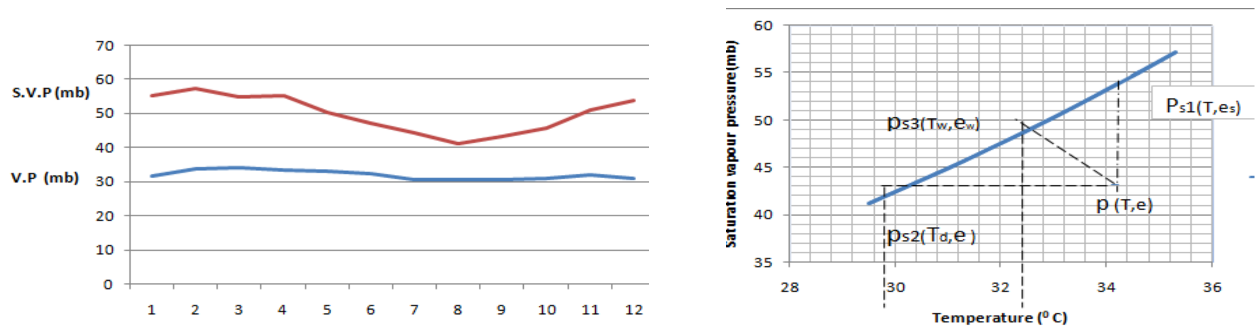

Fig. 3. (a) Variational trend graph and (b) Saturation Vapour Pressure (SVP) graph for 2010

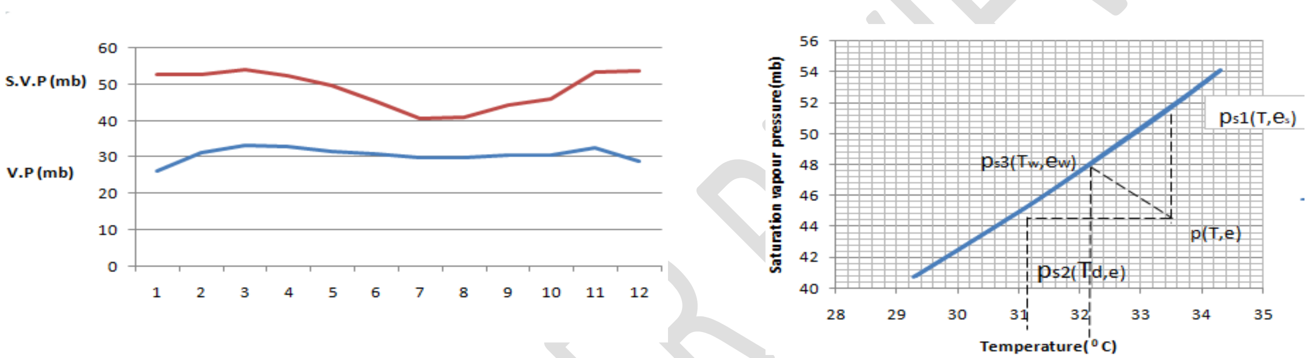

Fig. 4 (a) Variational trend graph and (b) Saturation Vapour Pressure (SVP) graph for 2011

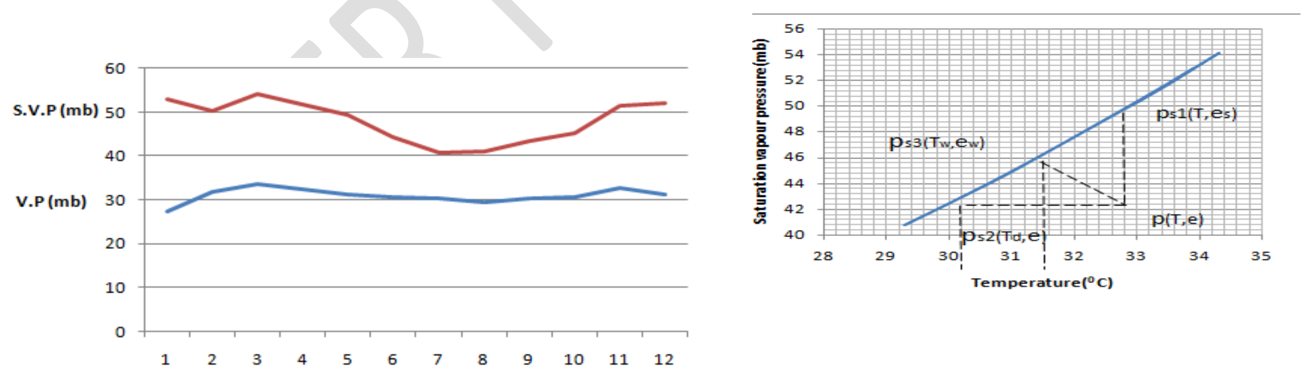

Fig. 5. (a) Variational trend graph and (b) Saturation Vapour Pressure (SVP) graph for 2012

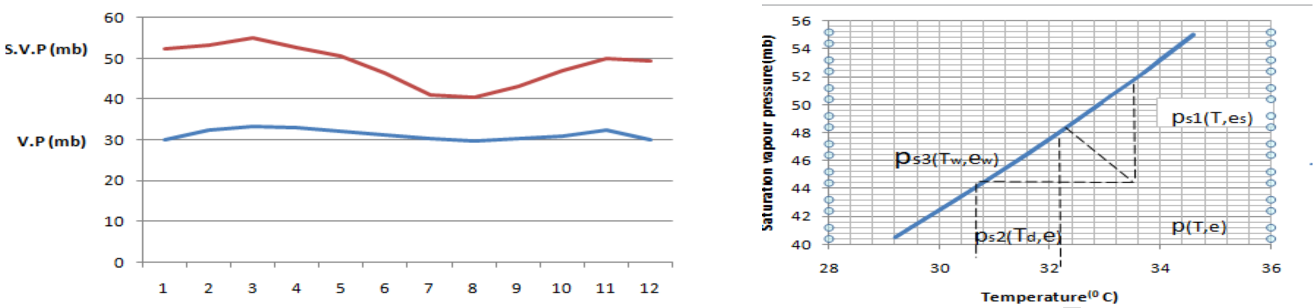

Fig. 6. (a) Variational trend graph and (b) Saturation Vapour Pressure (SVP)graph for 2013

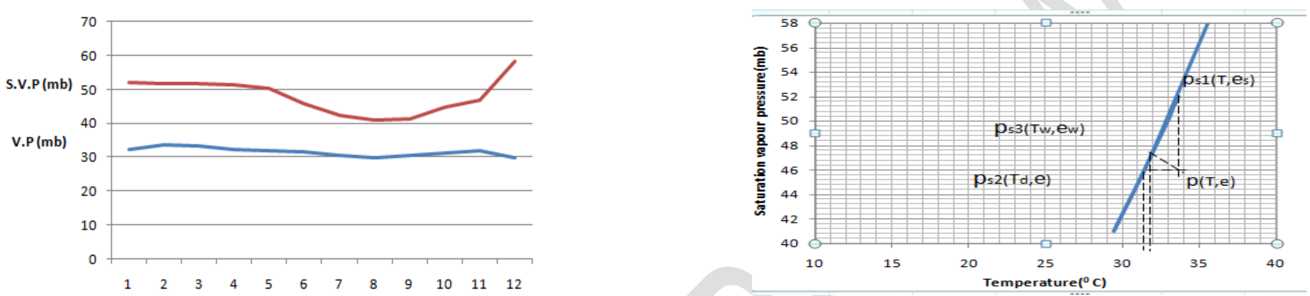

Fig. 7. (a) Variational trend graph and (b) Saturation Vapour Pressure (SVP)graph for 2014

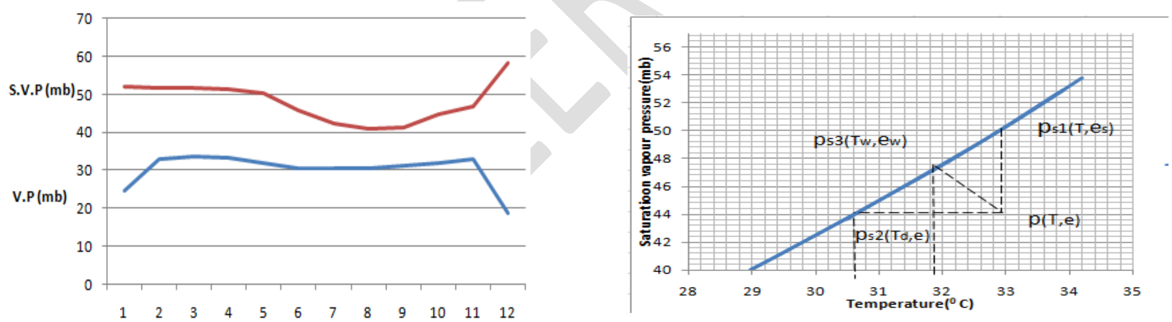

Fig. 8. (a) Variational trend graph and (b) Saturation Vapour Pressure (SVP)graph for 2015

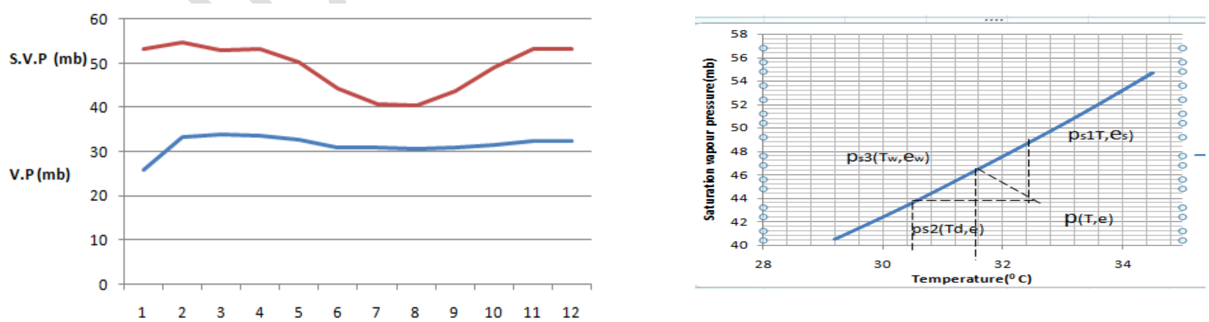

Fig. 9. (a) Variational trend graph and (b) Saturation Vapour Pressure (SVP) graph for 2016

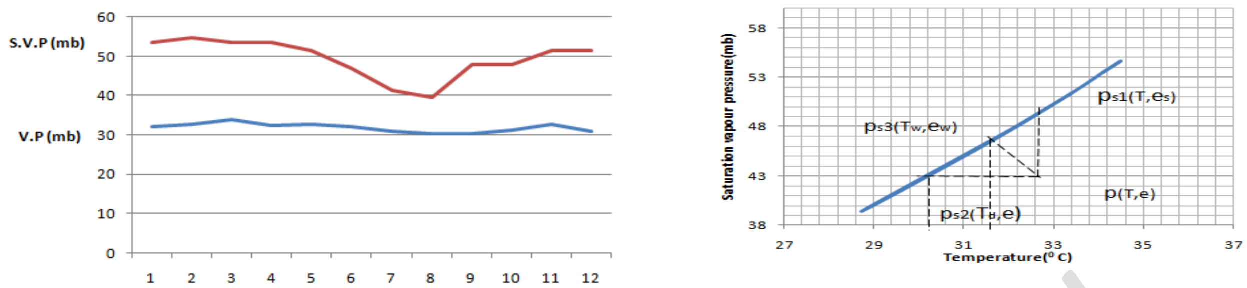

Fig. 10. (a) Variational trend graph and (b) Saturation Vapour Pressure (SVP) graph for 2017

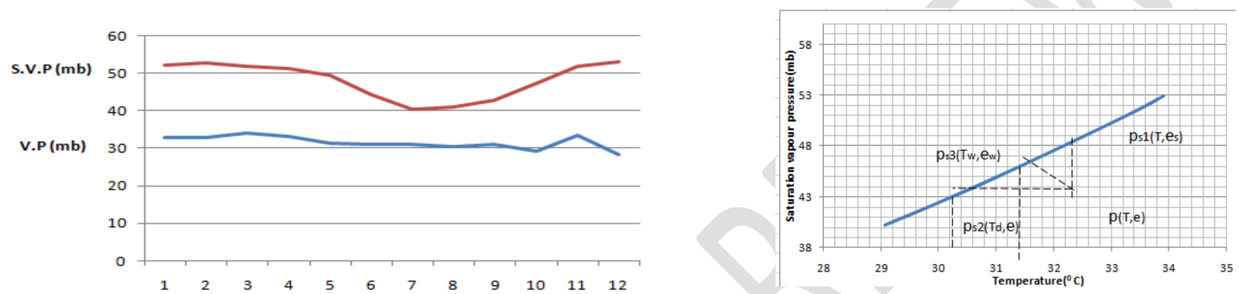

Fig. 11. (a) Variational trend graph and (b) Saturation Vapour Pressure (SVP) graph for 2018

Fig.2 shows theSaturation Vapour Pressure (SVP) (e_s) increases as Temperature increases, also the dew point temperature where ($e=e_s$), the dew point T_d= 29.9°C.

Fig.3 shows Saturation Vapour Pressure (SVP) increases as Temperature increases and graph shows Dew point TemperatureT_d to be 31.0°C

Fig.4shows the Temperature (T) and the Saturation Vapour Pressure (SVP) (es), the dew point temperature was gotten from the Saturation Vapour Pressure (SVP) and the vapour pressure. When (e=es), the dew point T_d = 31.5°C

Fig.5 shows the Temperature (T) and the Saturation Vapour Pressure (SVP) (e_s), the dew point temperature was gotten from the Saturation Vapour Pressure (SVP) and the vapour pressure. When ($e=e_s$), the dew point T_d = 30.6°C.

Fig.6 shows the Temperature (T) and the Saturation Vapour Pressure (SVP) (e_s), the dew point temperature was gotten from the Saturation Vapour Pressure (SVP) and the vapour pressure. When ($e=e_s$), the dew point T_d = 30.7°C.

Fig.7 shows the Temperature (T) and the Saturation Vapour Pressure (SVP) (e_s), the dew point temperature was gotten from the Saturation Vapour Pressure (SVP) and the vapour pressure. When ($e=e_s$), the dew point $T_d = 31.5^{o}C$.

Fig.8 shows the Temperature (T) and the Saturation Vapour Pressure (SVP) (e_s), the dew point temperature was gotten from the Saturation Vapour Pressure (SVP) and the vapour pressure. When (e=es), the dew point $T_d = 30.6^{o}C$.

Fig.9 shows the Temperature (T) and the Saturation Vapour Pressure (SVP) (e_s), the dew point temperature was gotten from the Saturation Vapour Pressure (SVP) and the vapour pressure. When ($e=e_s$), the dew point $T_d = 30.6^{o}C$.

Fig.10shows the Temperature (T) and the Saturation Vapour Pressure (SVP) (e_s), the dew point temperature was gotten from the Saturation Vapour Pressure (SVP) and the vapour pressure. When ($e=e_s$), the dew point $T_d = 30.0^{o}C$.

Fig.11shows the Temperature (T) and the Saturation Vapour Pressure (SVP) (e_s), the dew point temperature was gotten from the Saturation Vapour Pressure (SVP) and the vapour pressure. When ($e=e_s$), the dew point $T_d = 30.3^{o}C$.

4.1 Discussion of the graph

The graphical representation in figures two to eleven showed the variational trend of Saturation Vapour Pressure (SVP) and Vapour Pressure (VP) in the study area. As a result of the same pattern all through, this implies that as the temperature is increasing, the Saturation Vapour Pressure (SVP) is also increasing and this established the relationship between the Saturation Vapour Pressure (SVP) and the temperature. This increase does not occur throughout the year, the increase only occurs in first, second and fourth quarters of the year while only third quarter of the year shows decrease. It can also have deduced from the graphs in figures two to eleven that the dew point in the study area ranges from $29.9^{O}C$ to $31.5^{O}C$ and any temperature that falls below this range (i.e dew point) will result to falling of rain in the study area.

5. CONCLUSION

The study confirmed thatthe Saturation Vapour Pressure (SVP)to be increasing as Temperature also increases. The yearly dew point ranges from 29.9^{o}C to 31.5^{o}Cand this explained the occurrence of rainfall at any temperature below these dew points. The yearly Variational trend of SVP and VP followed the same pattern, increase in 1st, 2ndand 4th quarters of the year and decrease in all 3rd quarter of the year.

6. REFERENCES

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