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LATITUDINAL DEPENDENCE OF SOME METEOROLOGICAL PARAMETERS IN NIGERIA

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Abstract- Variations, trends and relationship of some meteorological parameters maximum temperature, minimum temperature, rainfall, relative humidity and wind speed; sunshine hour and solar radiation over three stations, Ikeja $06^0$36'N, $03^0$5'E, Ilorin 08.48^{0}N, 4.5^{0}E and Kano 12^0N, 8.30^{0}E of Nigeria have been studies using monthly mean data spanning from 1998 to 2008 obtained from the Nigeria meteorological agency Oshodi, Nigeria. Relationships between the meteorological parameters were examined by plotting pairs of the parameters against months. Pearson correlation coefficient was also used to quantify the relationship. The results show that the difference between the maximum and minimum air temperature increases from southwest (Ikeja) 7.36^{0}C to North West (Kano) 13.39^{0}C. Hence there has been an increase with altitude. Solar radiation increases with decrease in air temperature in all the stations and it decreases negatively with altitude (Ikeja, -0.74. Ilorin, -0.61 and Kano, -0.265). Both solar radiation and temperature are lower on rainy months than on dry months. Solar radiation increases as sunshine hour decreases in all stations and it decreases with altitude. Solar radiation decreases during the rainy season and increases during the dry season. Wind speed decreases as temperature increase Ikeja and Ilorin. But wind speed increases as the temperature increases Kano. The relationship became stronger with increasing altitude. Ikeja has the weakest relationship (-0.18) and Kano with the strongest relationship (0.19). Stronger winds are associated with relative humidity and light increase in rainfall for all the stations with the strongest relationship (0.75) kano and weakest relationship (0.28) at Ikeja. Hence the positive relationship between relative humidity and rainfall increase with altitude. Thus, meteorological parameter varies with altitude along western axes of Nigeria.

I. Introduction

The weather of a place represents the state of the atmospheric environment over a brief period of time. Integrated whether condition over several years is generally referred to as climate or more specifically, as the "macroclimate". The weather conditions of any given location is often described in terms of the meteorological elements which include the state of the sky, temperature winds, pressure, precipitations, and humidity. These factors initiate and influence the atmosphere processes (Ayoade, 1993). An analysis of the climate of a particular region can help in assessing the seasons or periods during different conditions. It experience comfortable or uncomfortable conditions. It further helps in identifying the climate elements, as well as their severity, that causes discomfort. The information helps a designer to build a house that filters out adverse climatic effects, while simultaneously allowing those that are beneficial. Discomfort and the corresponding energy demand for mechanical systems which can be significantly reduced by judicious control of the climate effects.

Many studies consider the long term structure of some meteorological parameters such as rainfall characteristics. Olaniran (1990) consider the changing pattern of rain-day in Nigeria between 1919-1985, Omogbi (2010) studies rain days in south western Nigeria between 1970 and 2006, Guhathakurta and Rajeevan (2006) study the trends of rainfall pattern over India between 1981-2002, Obot et al, (2011) also consider the trends of rainfall in Nigeria between 1981-2002 etc. although many findings consider northern Nigeria as falling into Sahel climate and insignificant trend in the south and other northern places outside the Sahel with steady regime of rainfall (Ati et al., 2009; Regab and Prudhome, 2002; Subyani 2004) and other climatic characteristic.

II. Study Areas

Ikeja lies in the low latitude 6^0 36^I and longitude 3^05^1E and situated at the forest grassland of southwest Nigeria, which is characterized by dry and wet seasons. The occurrence of which is greatly influenced by its latitudinal location. Between March and October, that is, during the rainy season period, the city is under the influence of moist maritime south-west monsoon wind which blows inland from the Atlantic Ocean. The dry season occurs from November to February during this time, the dry dust laden winds blow from the Sahara desert. This period is characterized with low humidity and high rate of evaporation.

Ilorin is located at latitude of 5.48^{0}N and 4.5^{0}E and altitude of 308m above sea level. Ilorin lies within the climate region called tropical savannah which is characterized with rainy seasons and dry season, cold and wet season, low and high pressure, low and high relative humidity. The prevailing winds in Ilorin as in the whole of the West African sub region are the south-westerly (SW) and the north-easterly (NE) trade wind. The south-western wind blows from the Atlantic ocean and brings rain to the west African coast, including Ilorin (this is the rainy season period). The north-easterly wind, a very dry wind, blows across the country between November and March, bringing harmattan dust with it (this is the dry season period).

Kano is located on latitude 12^0N and longitude 9.30^{0}E within the semi-arid sudden savannah zone of West Africa about 840km edge of the Sahara desert. Know has a mean height of about 472.5m above sea level. There are four seasons within the state; a dry and cool season (mid-November to February), marked by cool and dry weather plus occasional dusty haze; the dry and hot season (march to mid-way) when temperature climb up to 400c and which is a transition period between the harmattan and the wet season; the wet and warm season (mid-may to September) is the proper wet season when the lowest temperature is recorded; and a dry warm season (October to mid-November) marked by high humidity and high temperature.

III. Materials and Method

Monthly mean data of some meteorological parameters (maximum temperature, minimum temperature, rainfall, relative humidity and wind speed), sunshine hour and solar radiation for three stations, Ikeja ($06^0 36^l$N, 03^0'05^lE), Ilorin (08.48^0N, 4.5^0E) and Kano (12^0N, 8.30^0E) for 11 years (1990-2008) was obtained from the Nigeria Metrological Agency Oshodi, Nigeria. Relationships between the meteorological parameters were investigated by plotting pairs of the parameters against months. Pearson correlation coefficient was also used to quantify the level relationship.

IV. Results and Discussion

The stations (Ikeja and Kano) show high positive relationship between maximum and minimum temperature. The difference between the maximum and minimum air temperature (T_{max}-T_{min}) increases from southwest (Ikeja) to North West (Kano). Clear-sky conditions result in high temperature during the day T_{max} because the atmosphere is transparent to the incoming solar radiation and low temperature during the night (T_{min}) because less outgoing solar radiation is absorbed by the atmosphere. It was also observed that the difference between the maximum and minimum air temperature increases with altitude.

Ikeja and Ilorin has low positive significant relationship between solar radiation and rainfall while Kano has low negative relationships. The months of low solar radiation gave high rainfall that is characteristic of incessant cloud formation thereby depleting the amount of solar radiation reaching and earth's surface. During the dry seasons, solar radiation increases. This is due to prevailing climatic conditions of that period. The cloud and cloud formations are absent hence there is increase in temperature.

Solar radiation decreases with increase in maximum and minimum temperature at all the stations. The relationship decreases negatively with altitude. But sunshine hour and temperature has positive relationship in all the stations and relationship decreases positively with increases altitude. Solar radiation increases as sunshine hour decreases at all stations.

Relative humidity increases as the air temperature decreases for all the stations with the lowest at Kano (-0.19). The variation of relative humidity is the result of the fact that the saturation vapour pressure is determined by the air temperature.

Wind speed decreases as the temperature increases at Ikeja and Ilorin. But wind speed increases as the temperature increases at Kano. This is because wind speeds measured at different heights above the soils surface are different. Thus wind speed is slowest at the surface and increases with height. Since temperature and wind speed increases with altitude. Hence wind speed increases with air temperature. Ikeja has the lowest (-0.18) correlation and Kano with the highest correlation (0.19).

Wind speed increases as the relative humidity decreases at low values for the stations except Kano which has increase in wind speed as the relative humidity increases (0.111). Hence, strong winds are associated with low relative humidity and light winds are common with high relative humidity.

Relative humidity increases with increase in rainfall for all the stations with highest relationship at Kano (0.747) and lowest at Ikeja (0.283). Hence the positive relationship between relative humidity and rainfall increases with altitude. Both rainfall and relative humidity shows increasing trends during raining season. But sunshine hour decreases as relative humidity increases. The relationship between relative humidity and sunshine decrease with altitude.

V. Conclusion

It can be concluded that there exists relationship between some meteorological parameters (maximum temperature, minimum temperature, rainfall, relative humidity and wind speed), sunshine hour and solar radiation over the three stations (Ikeja, Ilorin and Kano) under studies. The relationship of these meteorological parameters also varies with altitude. The relationship did not agree with the existing seasonal (wet and dry seasons) relationship. This is because during seasons some meteorological parameter may be low or not existing at all.

The implications of the observed trends, variability and relationship of the parameters investigated includes assessing the seasons or periods during which a person may experience comfortable or uncomfortable conditions. It also helps in identifying the climatic elements, as well as their severity, that cause discomfort. The result helps a designer to build a house that filters out adverse climatic effects, while simultaneously allowing those that are beneficial.

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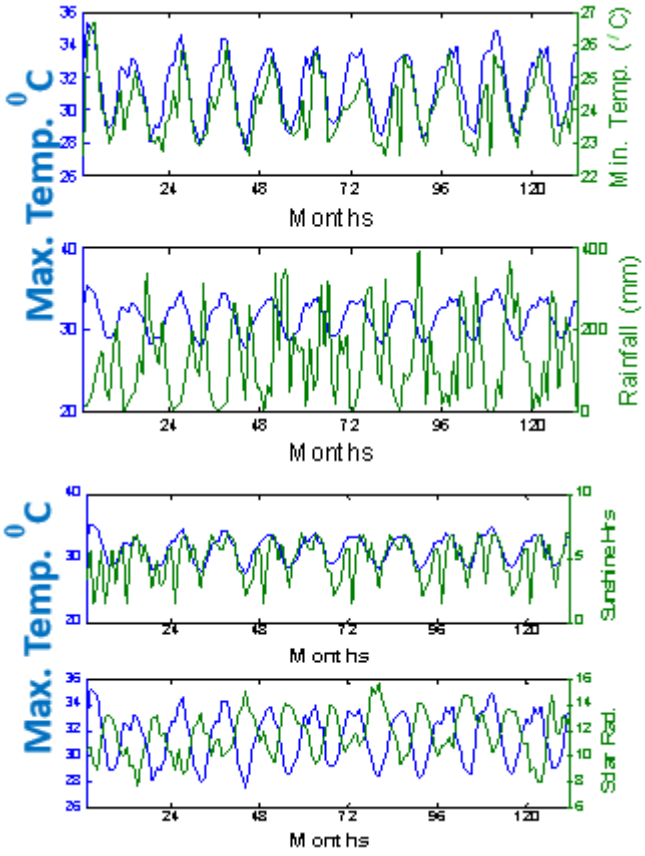
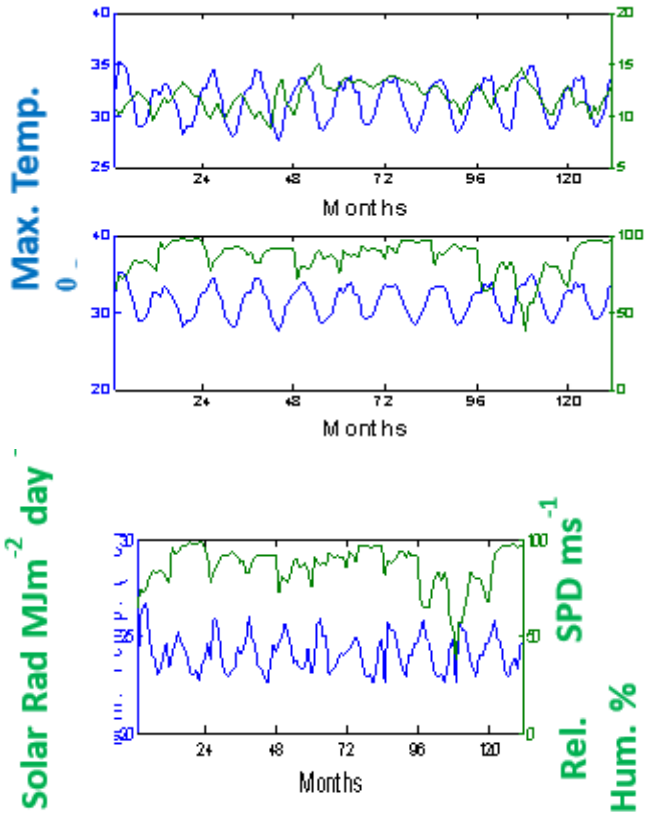
Table showing correlations at different stations

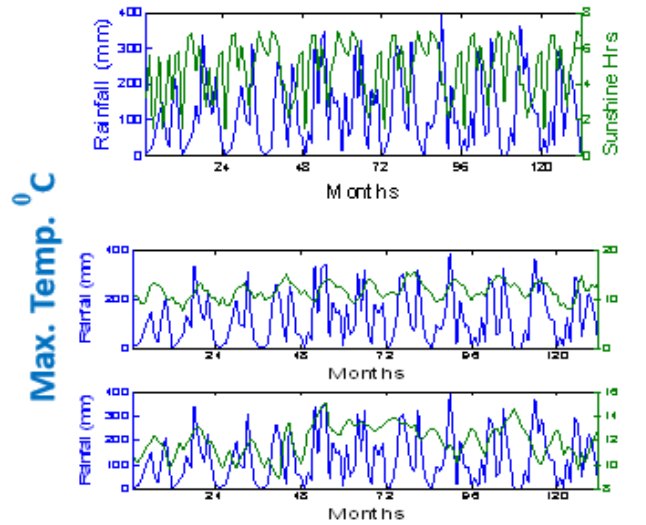
Pairs of meteorological parameters, solar radiation and sunshine	Correlation at stations Ikeja Ilorin Kano			Remark
Minimum temperature and maximum temperature	0.79	0.67	0.63	Decreases positively with latitude
Solar radiation and maximum temperature	-0.74	-0.61	-0.27	Decreases negatively with latitude
Sunshine hour and maximum temperature	0.47	0.44	0.20	Decreases positively with latitude
Solar radiation and sunshine hour	-0.34	-0.25	-0.04	Decreases negatively with latitude
Relative humidity and maximum temperature	-0.54	-0.44	-0.18	Decreases negatively with latitude
Wind speed and maximum temperature	-0.18	-0.12	0.09	Increases negatively with latitude
Wind speed and relative humidity	-0.05	-0.02	0.11	Increases negatively with latitude
Relative humidity and rainfall	0.28	0.56-	0.75	Increases positively with latitude
Solar radiation and minimum temperature	-0.71	0.38	-0.26	Decreases negatively with latitude

Comparison of the Climatic Parameters on all Stations

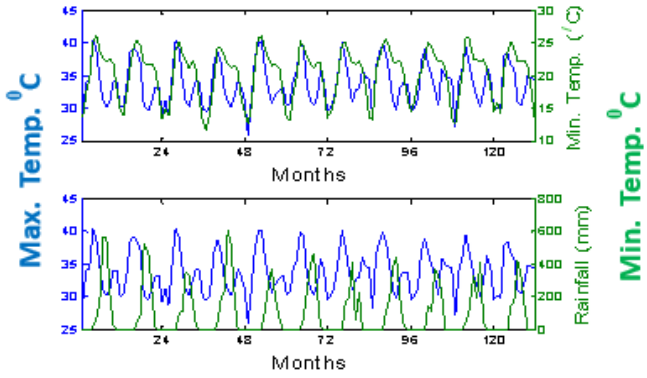
IKEJA

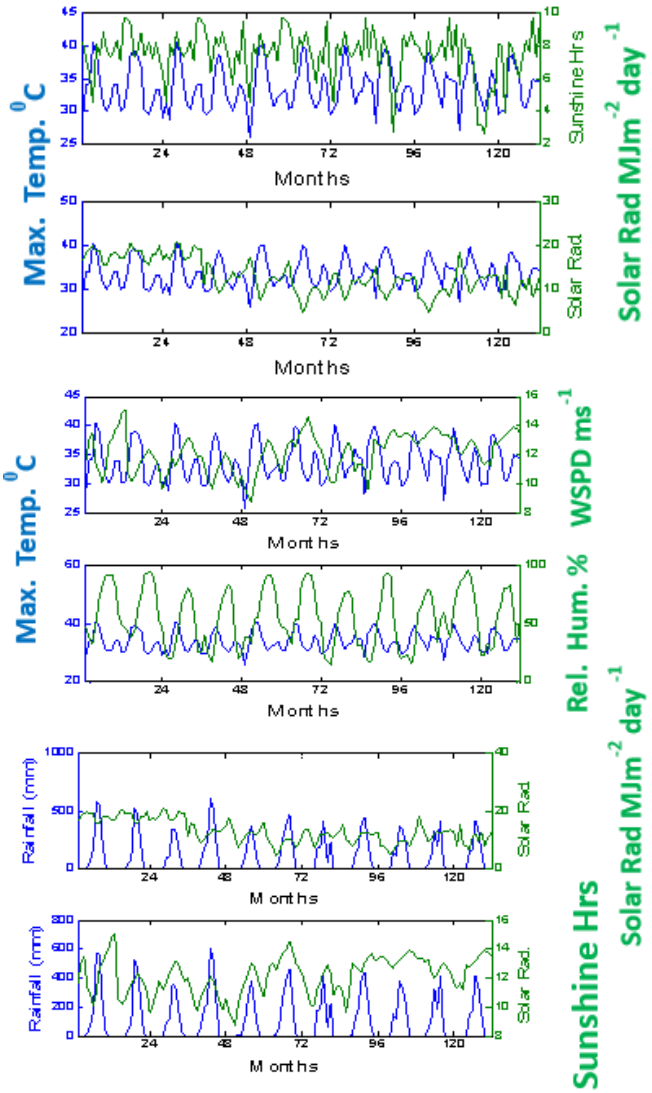


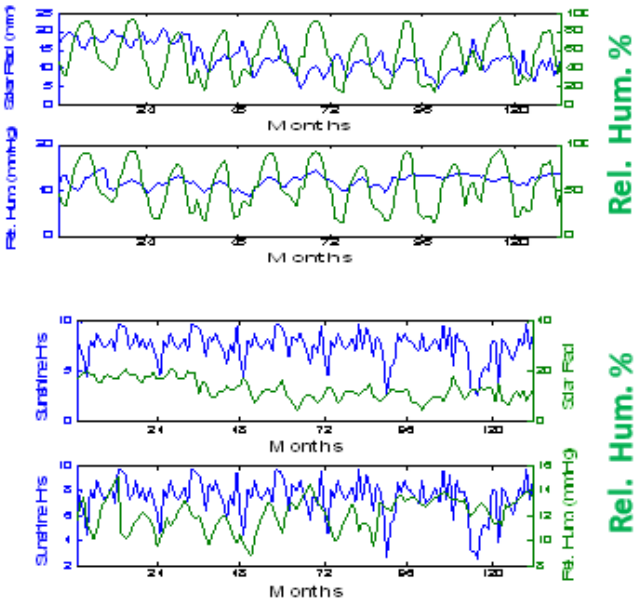




KANO




Max. Temp. ^{0}C
Sunshine Hrs
Solar Rad MJm^{-2} day^{-1}
Solar Rad
Months
Max. Temp. ^{0}C
WSPD ms^{-1}
Rel. Hum. %
Months
Rainfall (mm)
Solar Rad
Months
Sunshine Hrs
Solar Rad MJm^{-2} day^{-1}
Rainfall (mm)
Solar Rad
Months


Solar Rad (mm)
Months
Rel. Hum. %
Rel. Hum (mmHg)
Months
Sunshine Hrs
Solar Rad
Months
Rel. Hum. %
Sunshine Hrs
Rel. Hum (mmHg)
Months