SEASONAL VARIABILITY OF SOME METEOROLOGICAL PARAMETERS WITH RESPECT TO SOLAR ACTIVITY OVER SOME STATIONS IN NIGERIA.

[1]Falaiye, O. A.*, [2] Ijila, P.O. and [3] Abimbola, O.J.

[1]Department of Physics, University of Ilorin, P.M.B.1515, Ilorin.
[2]Department of Physics, Adeyemi College of Education, Ondo.
[3]Department of Physics, Federal University, Lafia, P.M.B. 146, Lafia.
*Corresponding Author'E-mail: sesantayo2001@yahoo.com

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ABSTRACT

In this study we investigated the effects of solar activity on periodic variability of some meteorological parameters for three meteorological stations in Nigeria, from 1980 to 2010. Maximum and minimum temperature, rainfall, relative humidity, evaporation, sunshine duration, solar radiation and windspeed data were used as climate parameters and sunspot numbers data as solar activity indicator. Time series plots of the climatic / meteorological parameters and sunspot numbers were made for each station in order to observe their trend of variations with respect to solar activity effects on the various climatic parameters. The correlation coefficients between the various meteorological variables and solar indices at each station were obtained and given for the considered locations. Results obtained showed that above 95% level of statistically significant correlations exist between sunspot numbers and some climatic parameters for all the locations considered.

Keywords: Meteorological, climate, solar indices, sunspot.

INTRODUCTION

The sun is by far the most important driving force of the climate system. However, only little is known about how variable this force is acting on different time scales ranging from minutes to millennia and how the climate system reacts to changes in this forcing. Changes of the global insolation can be related to the nuclear fusion in the core of the Sun, the energy transport through the radiative zone and the convection zone, the emission of radiation from the photosphere, and the distance between Sun and Earth (Beer et al., 2000). Earth's climate has changed often in the past; most of these changes occur gradually over thousands if not millions of years. The rise of agriculture and human civilization corresponds climatically to earth leaving the ice age about 1000 years ago. The present era called the Holocene, is characterized by relative mild global temperature and year-round ice-cover restricted to high elevation and Polar Regions (Moldwin, 2008).

Climate change has for long remained an object of keen intensive research. The climate of our own earth is rooted in the troposphere, a region which is the lowest layer of the Earth's atmosphere starting at the surface going up to between 7km at the poles and 17 km at the equator with some variation due to weather factors. Attempts have been made to establish a coupling effect among the various layers of Earth's atmosphere (Labitzke and Van Loon, 1988; Rabiu et al. 2005). Impact of solar activity on Earth's terrestrial environment is propagated from the hemisphere via interplanetary medium to the lower atmosphere which has troposphere at its lower end. Solar activity affects the dynamics of the troposphere and influence the weather of the Earth. Understanding the solar terrestrial interaction, including climatology and weather, starts within the context of Earth's connection to Sun's activity (Tobiska et al., 2000). It is warmer presently in many parts of the world than at any time during the past 1000 years, with possibilities of warmest years than the previous centuries occurring within the next few decades, this change occurring within the next few decades. This change in temperature usually lead to lower ozone levels near the earth surface and significant increase in smog problems in the cities where the release of carbon dioxide is greater (Obioha, 2008). There is therefore a need for proper understanding of the Sun-Earth connection as an external forcing of the Earth's climate; Rabiu (2004). The complexity of climate change in Nigeria makes it imperative for the understanding and evaluation of the various meteorological parameters and processes that forces them, so that we can take action when necessary to curb possible negative effects we might have control over. It will also assist the government to respond to early warning as a result of better preparedness. The cumulative effect will be seen in better and improved socio-economic activities.

Site Description

The study sites, in Nigeria, include the following stations, Ilorin, Ikeja, and Maiduguri, representing the various climatic belts in the country. Ikeja represents the coastal influence, Ilorin represents the savannah belt as well as the central point of the country and Maiduguri represents the extreme North East (see Figure 1). These locations all lies in the tracjetory-path of the North Easterly wind bringing in the harmattan dust across the country from the Bodele

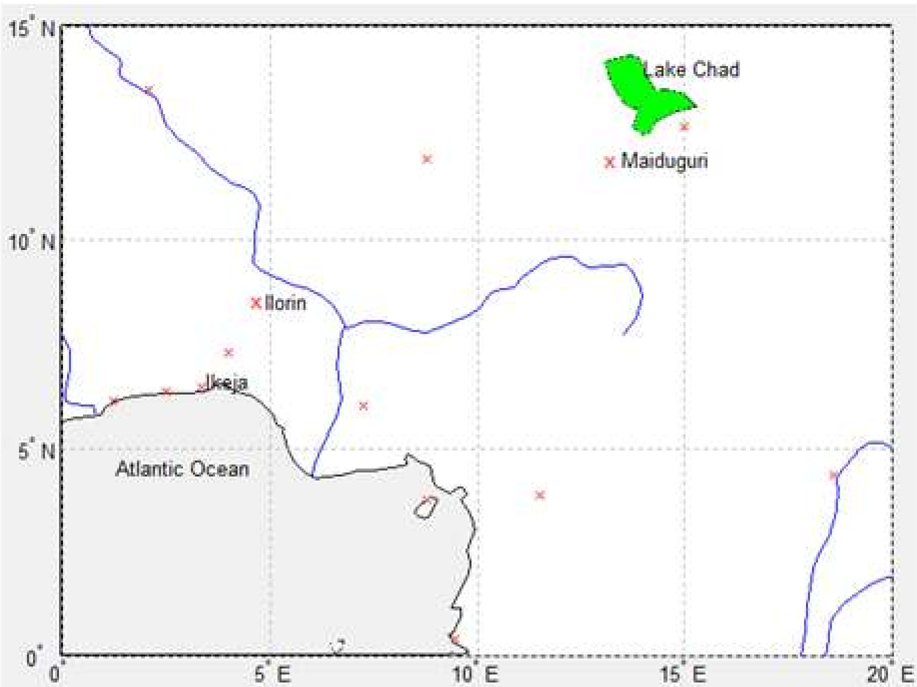

Figure 1: Geographical Locations of the study Sites in Nigeria

Table 1: The Geographical Coordinates of the Stations Used in this Study.

S/N	Stations(site)	State	Latitude(°N)	Longitude(°E)	Elevation(m asl)
1	Ikeja	Lagos	06.58	03.33	39.4
2	Ilorin	Kwara	08.48	04.58	307.4
3	Maiduguri	Borno	11.85	13.08	353.8

depression to the Atlantic.

METHODS

The monthly mean meteorological data for the period of Jan, 1980 to Dec, 2010 for eight meteorological parameters: Maximum Temperature, Minimum Temperature, Wind speed, Sunshine duration, Solar Radiation, Evaporation, Rainfall, Relative Humidity and Average Temperature were obtained from the Nigeria Meteorological Agency, Oshodi-Lagos. Also the solar indices data were obtained from NGDC, Boulder, Colorado through their website (http://www.pmodwrc.ch/pmod.php?topic=tsi/composite/SolarConstant) for the three synoptic meteorological stations covering the same period.

Time series plots (Fig.1 -3) of some meteorological parameters and sunspot numbers were made for each station to enable us study their trend of variations. Secondly, the correlation analyses were employed to determine the solar activity effect on the climatic parameters variation. Table 2 shows how the solar indices: sunspot numbers (Rs) varies with each of the eight climatic parameters at Ilorin, Ikeja and Maiduguri stations. The correlation coefficients and their statistical significant levels for the sunspot numbers and the eight climatic parameters are indicated in table 1 and discussed.

RESULTS AND DISCUSSIONS

Seasonal Variation of Meteorological Variables with Respect to Sunspot Number from 1980 to 2010

In Figures 1.0(a,b,c,d,e,f,g,h) to 3.0(a,b,c,d,e,f,g,h), the sunspot numbers(blue colour has been compared with time series of meteorological data(green colour) in order to extend the examination of the assumed association between climate and solar variability.

Figures 1.0(a,b,c,d,e,f,g,h) to 3.0(a,b,c,d,e,f,g,h) demonstrates a strong co-variation between the meteorological parameters and sunspot numbers in the stations for the period 1980 to2010. The green curve illustrates the different meteorological parameters which are generally varying in a systematic manner with a periodicity of similar to, but not exactly in phase with the variation of the magnitude of the sunspot number. The two time series had several features in common. Most noteworthy is the prominent minimum at a time, the steep rise to a maximum in another time, and a brief drop during another time and followed by a final rise.

However, the graph showed the following disparities: For Maximum Temperature ,there is a strong co-variation between sunspot number and maximum temperature at Ilorin and Ikeja while for all stations Minimum Temperature has similar variation with sunspot number.

Also for Evaporation Pitche, Ilorin and Maiduguri have similar curve pattern with sunspot number curve while only Ilorin have the co-variations of relative humidity with sunspot number.

Solar Radiation in Ilorin, Ikeja and Maiduguri demonstrate similar pattern with sunspot number, Wind Speed at Ikeja and Maiduguri have a strong co-variation with sunspot number, Sunshine Hour also demonstrate the same pattern with sunspot number at Ikeja and Maiduguri.

Correlations between Sunspot numbers and the climatic parameters

As seen on Table 2, the correlations between sunspot numbers and climatic parameters are not statistically significant in all the stations, except in some stations that will be stated: In Ikeja, there is a positive significant correlation between the sunspot numbers and both the wind speed and the minimum temperature. It can be inferred that the proximity of the water bodies in Ikeja influence wind pattern in such a way that some significant positive correlation between sunspot numbers and wind speed is detectable. The influence of rivers and influence of the neighboring oceans that helps in lowering the minimum temperature and this is responsible for the significant correlation between sunspot number and the wind speed and minimum temperature. Also there is a negative significant correlation between the sunspot number and both the relative humidity and rainfall.

In Ilorin, there is a positive significant correlation between the sunspot numbers and the wind speed. It can be inferred that the high amount of radiation in the region is therefore linked in such a way that some significant positive correlation between sunspot numbers and wind speed is detectable. Also there is a negative insignificant correlation between the sunspot number and other climatic parameters.

In Maiduguri, there is a positive significant correlation between the sunspot numbers and wind speed. It can be inferred that the due to the vegetation, it is therefore linked in such a way that significant positive correlation between sunspot numbers and wind speed is detectable. There is also negative insignificant correlation between the sunspot and some of the climatic parameters due to vegetation of the area.

CONCLUSIONS

It can be generally stated that sunspot numbers has positive correlation with minimum temperature in the stations, and negative correlation with maximum temperature. It also has some negative correlation with rainfall in some parts of the stations. Some parts of the regions on the other hand indicate slight positive correlation between sunspot numbers and rainfall.

Results show that above 95% level of statistically significant correlations exist between sunspot numbers and both minimum temperature and relative humidity in Ikeja, between sunspot numbers and wind speed in Ilorin, Ikeja and Maiduguri stations.

This implies that sunspot numbers have direct influences on some climatic parameters in Nigeria. This can also be ascertained from the seeming trends in the climatic parameters –sunspot numbers profiles.

ACKNOWLEDGEMENT

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SEASONAL VARIATION OF METEOROLOGICAL VARIABLES W.R.T SUNSPOT NUMBER FROM 1980 TO 2010:

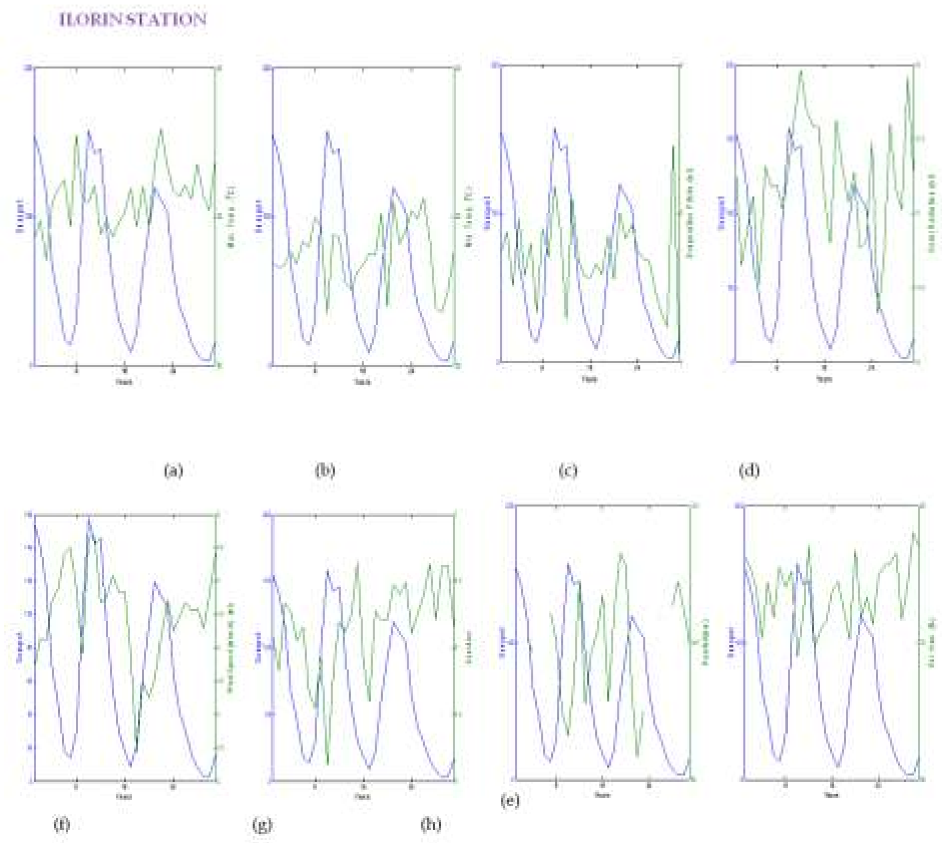

Figure 1.0(a): Seasonal variation of maximum temperature at Ilorin w.r.t sunspot number from 1980 to 2010. (b, c, d, e, f, g, h), same as (a) but for Minimum temperature, Evaporation, Solar radiation, Wind Speed, Sunshine Hour, Rainfall and Relative Humidity.

IKEJA STATION

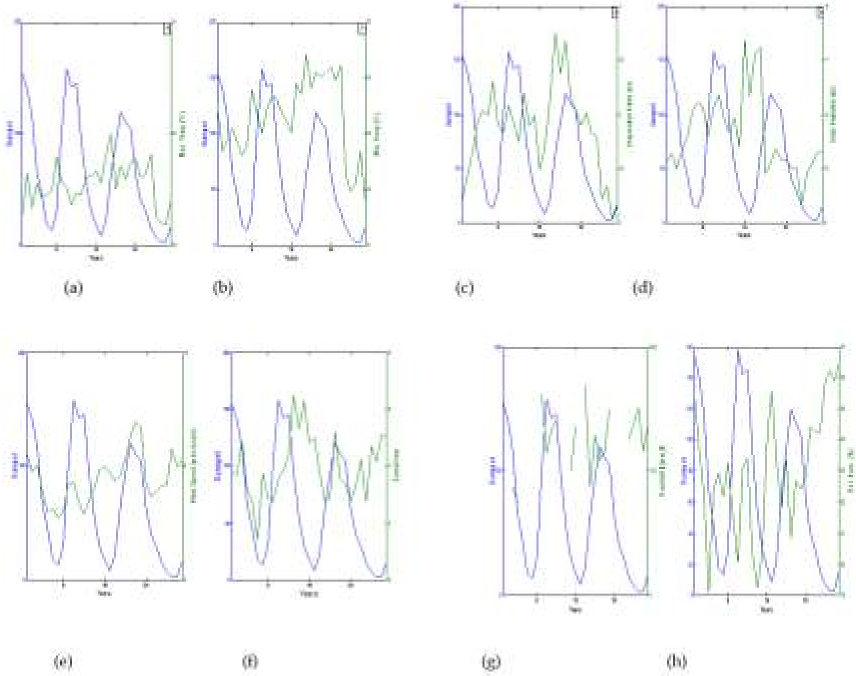

Figure 2.0(a): Seasonal variation of maximum temperature at Ikeja w.r.t sunspot number from 1980 to 2010. (b, c, d, e, f, g, h), same as (a) but for Minimum temperature, Evaporation, Solar radiation, Wind Speed, Sunshine Hour, Rainfall and Relative Humidity.

MAIDUGURI STATION

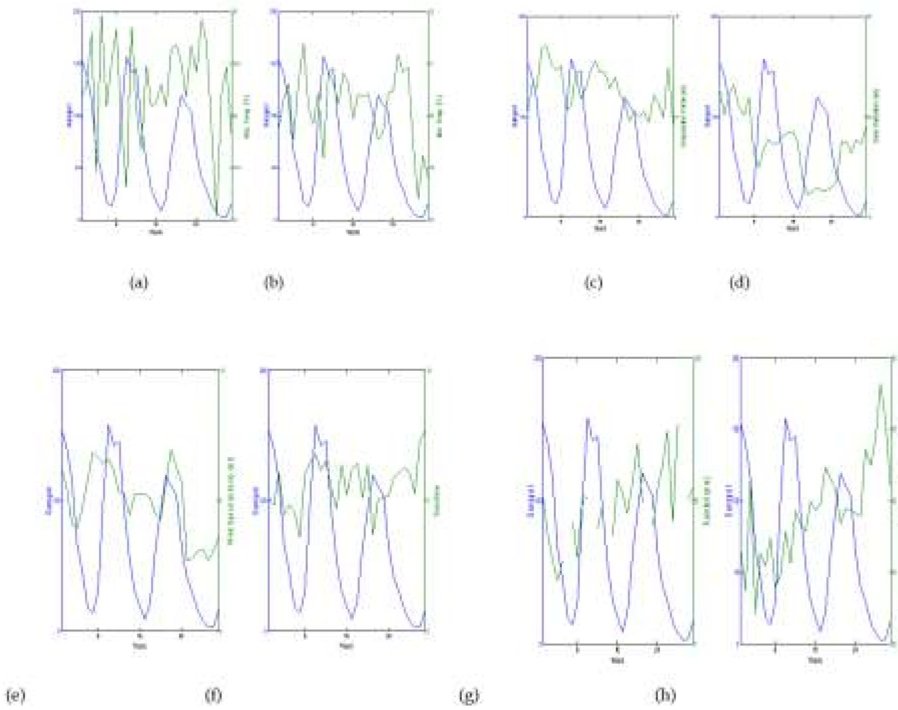

Figure 3.0(a): Seasonal variation of maximum temperature at Maiduguri w.r.t sunspot number from 1980 to 2010. (b, c, d, e, f, g, h), same as (a) but for Minimum temperature, Evaporation, Solar radiation, Wind Speed, Sunshine Hour, Rainfall and Relative Humidity.

Table 2.0: Correlations between Sunspot numbers and the climatic parameters (Correlation variables with score of 0.1 and above indicates significant correlation among the parameter of study)

CLIMATIC PARAMETERS	ILORIN	IKEJA	MAIDUGURI
Maximum Temperature	-0.0315	-0.0238	-0.0223
Minimum Temperature	0.0048	0.1469	0.0079
Relative Humidity	-0.0219	-0.1136	-0.0528
Rainfall	-0.0237	-0.1283	-0.0252
Wind speed	0.1705	0.1705	0.3386
Evaporation	0.0562	0.0626	-0.0893
Solar Radiation	-0.0135	-0.0408	-0.0375
Sunshine Hour	0.0085	0.0085	-0.0251

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