Variation Characteristic of Ultraviolet Light and Air Temperature at A Tropical Location in Ilorin, Kwara State, Nigeria

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***Abstract*: In this study, characteristic variation of ultraviolent light and air temperature were observed, this research work critically analyses some specific days with field data at an experimental site near the Physics/Electronics Unit Laboratory Ilorin, Nigeria between ultraviolet light and air temperature. For the field observations, an instrumented Meteorological Weather Smart System was set up at an experimental site near the Physics/Electronics Unit Laboratory Kwara State Polytechnic, Ilorin for a period of two weeks (*18th March-1st April, 2019*). The ultraviolet light and air temperature measurement from the Weather Smart System were recorded every 10 seconds and averaged over 2 minutes interval. The sampled data was then stored in the datalogger storage module. After the removal of spurious measurement values, the data stored was further reduced to hourly averages using the Microcal Origin (version 7.0) data analysis software. The results showed that the measured ultraviolent light, U_V during the daytime increases until 1200 hrs with maximum value of about 450 Wm^{-2} and minimum value of about 9 Wm^{-2} at 800 hrs (DOY 85). The measured air temperature, Ta value of 32.6 ^{0}C observed at 1200 hrs (DOY 85), represented the maximum value for the entire period of the study. The value of 193 Wm^{-2} was observed at1100 hrs (DOY 81), represented the minimum value for the entire period of the study due to the cloudy condition of the sky which reduces the amount of incoming solar radiation reaching the earth surface.**

***Keywords*: Air temperature, Cloudy, Field, Solar radiation and Ultraviolet light.**

I. INTRODUCTION

Electromagnetic radiation comes from the sun and transmitted in waves or particles at different wavelengths and frequencies. This broad range of wavelengths is known as the electromagnetic (EM) spectrum. The spectrum is generally divided into seven regions in order of decreasing wavelength and increasing energy and frequency. The common designations are radio waves, microwaves, infrared (IR), visible light, ultraviolet (UV), X-rays and gamma-rays.

Ultraviolet (UV), light falls in the range of the EM spectrum between visible light and X-rays. It has frequencies of about 8×10^{14} to 3×10^{16} cycles per second, or hertz (Hz), and wavelengths of about 380 nanometers (1.5×10^{-5} inches) to about 10 nm (4×10^{-7} inches). According to the U.S. Navy's "Ultraviolet Radiation Guide," UV is generally divided into three sub-bands:

- UVA, or near UV (315–400 nm)
- UVB, or middle UV (280–315 nm)
- UVC, or far UV (180–280 nm)

The guide goes on to state, "Radiations with wavelengths from 10 nm to 180 nm are sometimes referred to as vacuum or extreme UV." These wavelengths are blocked by air, and they only propagate in a vacuum.

Suntan and sunburn are familiar effects of over-exposure of the skin to UV, along with higher risk of skin cancer. Living things on dry land would be severely damaged by ultraviolet radiation from the Sun if most of it were not filtered out by the Earth's atmosphere (Haigh, 2007). More energetic, shorter-wavelength "extreme" UV below 121 nm ionizes air so strongly that it is absorbed before it reaches the ground (Holick, *2012*). Ultraviolet is also responsible for the formation of bone-strengthening vitamin D in most land vertebrates, including humans (specifically, UVB) (Mainster, 2006). The UV spectrum thus has effects both beneficial and harmful to human health.

Temperature is a physical quantity expressing hot or cold. It is measured with a thermometer calibrated in one or more temperature scales. The most commonly used scales are the Celsius scale (formerly called centigrade) (denoted °C), Fahrenheit scale (denoted °F), and Kelvin scale (denoted K). The Kelvin scale is widely used in science and technology.

This study, therefore, intends to measure and analysis the variation characteristic of ultraviolet light and air temperatures measured at a tropical location in Ilorin, Kwara state, Nigeria.

II. MATERIALS AND METHODS

UV effects most of the natural UV light people encounter come from the sun. However, only about 10 percent of sunlight is UV, and only about one-third of this penetrates the atmosphere to reach the ground, according to the National Toxicology Program (2012). The amount of solar UV energy that reaches the equator, 95 percent is UVA and 5 percent is UVB. No measurable UVC from solar radiation reaches the Earth's surface, because ozone, molecular oxygen and water vapor in the upper atmosphere completely absorb the shortest UV wavelengths. Still, "broad-spectrum ultraviolet radiation

(UVA and UVB) is the strongest and most damaging to living things," according to the NTP's "13th Report on Carcinogens."

Over the past several years, and with increasing regularity, coral reefs have been affected globally by a phenomenon known as coral bleaching, which involves either the mass expulsion of zooxanthellae or the loss of photosynthetic pigments within individual zooxanthellae (Glynn, 1993). These events closely follow periods of warming that elevate seawater temperatures to 30-33°C (Ogden and Wicklund, 1988 and Glynn, 1993).

Recent data describing global decreases in stratospheric ozone show a highly variable trend of — 1.2± 1.3% in the loss of ozone over equatorial regions (5°S) and — 2 to —4% at 20-30°N in the last decade (Madronich, 1992), suggesting that fluxes of UV-B radiation could increase in the future for this region. Because of the high transparency of tropical ocean waters, UV radiation penetrates to depths exceeding 20 m (Fleischmann et al., 1989). These wavelengths are known to have a detrimental effect on photosynthesis and growth in zooxanthellae (Jokiel and York, 1984; Lesser and Shick, 1989) and on survival of coral reef epifauna (Jokiel, 1980). The continued increase in the incidence of coral bleaching will result in a decrease in growth and reproduction, and an increase in mortality rates for corals repeatedly bleached (Glynn, 1993).

The natural concentration of ozone is thinnest near the equator (Cutchis, 1982); as such, tropical ecosystems have a long evolutionary history of exposure to greater fluxes of UV radiation than do ecosystems at higher latitudes (Frederick *et al., 1989*).

The terms "chemical rays" and "heat rays" were eventually dropped in favor of ultraviolet and infrared radiation, respectively (Hockberger, 2002).

III. METHODOLOGY

A Meteorological Weather Smart System was set up on site to measure ultraviolet light and air temperature respectively. The instrument was set up at an experimental site near the Physics/Electronics Unit Laboratory Kwara State Polytechnic, Ilorin for a period of two weeks (*18th March-1st April, 2019)*. The ultraviolet light and air temperature measurement from the Weather Smart System were recorded every 10 seconds and averaged over 2 minutes interval. The sampled data was then stored in the datalogger storage module. After the removal of spurious measurement values, the data stored was further reduced to 30 minutes averages using the Microcal Origin (version 7.0) data analysis software.

In this research, the acquisition of the data was achieved by using Weather Smart datalogger systems (measurement and control module). An RS232 connection to the computer for communication purposes was achieved by using a USB cable. The datalogger is wirelessly connected to all the sensing elements thereby accepting their respective signals. The transducers signals were then sampled, digitized and stored in the internal/expanded memory. The data which were collated in ASCII format were then reduced using a data reduction program, MicroCal Origin 7.0 Version.

IV. RESULTS AND DISCUSSION

Variation Characteristic of Ultraviolet Light and Air Temperature

On 18th March, 2019 (DOY 77), there was a clear sky with insolation in the afternoon. The daytime variation of both the ultraviolet and air temperature on this day was depicted in Figure 1. The ultraviolet light varies between 9 and 276 Wm^{-2}. It was observed that from 500 hrs to 800 hrs there were slight fluctuations between the ranges of 9 - 23 Wm^{-2}, a sharp increase between 800 hrs to 1300 hrs i.e. (23 to 276 Wm^{-2}) was observed due to an increase in the amount of solar radiation reaching the earth surface. From the 1400 hrs, the curve shows a decrease in the value due to the amount of insolation reaching the surface. The maximum ultraviolet light value, 276 Wm^{-2} was observed at about 1300 hrs. The air temperature value varies between 26.7 to 32.6 ^{0}C which is due to an increase in the amount of solar radiation reaching the surface. The maximum value of air temperature measured was 32.6 ^{0}C at about 1300 hrs and it fell to 26.7 ^{0}C around 2000 hrs due to no insolation at that particular period.

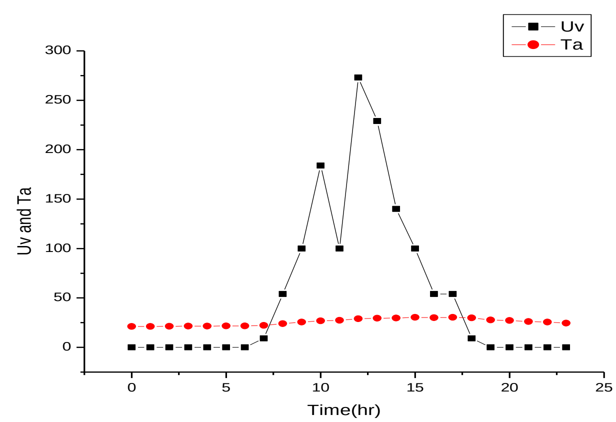

Figure 1: Characteristic variation of ultraviolet light and air temperature for 18th March, 2019 (DOY 77).

On 22nd March, 2019 (DOY 81), the characteristic variation of both the ultraviolet light and air temperature on this day was depicted in Figure 2. It was observed that there were slight fluctuations until around 1100 hrs where a sharp increase was observed and it represent the highest value obtained for the day under consideration. The day has a maximum and minimum value of 193 and 8 Wm^{-2} respectively.

The air temperature values observed in Figure 2 were found to be considerably lower than the period average due to the cloud cover on the 22nd of March, 2019. The maximum air temperature value, 31.5 ^{0}C was measured at about 1400 hrs, decrease to 25.7 ^{0}C at 2100 hrs due to the cloudy condition at that particular time.

Figure 3 shows the ultraviolet light and air temperature on 26th March, 2019. The ultraviolet light value of

10 Wm^{-2} was observed at about 800 hrs and an increase in the value continued until about 1200 hrs when it its value is about 450 Wm^{-2} due to the incoming solar radiation from the sun. The maximum ultraviolet light of 450 Wm^{-2} represents the highest value for the entire period of this research. The maximum value of air temperature measured was 32.6 ^{0}C at about 1200 hrs.

On 28th March, 2019 (DOY 87; Figure 4), the characteristic variation of ultraviolet light of 9 Wm^{-2} was observed at about 700 hrs which represented the lowest value for the day considered, and a gradual rise was observed until about 1000 hrs. Around 1200 hrs, a value of 370 Wm^{-2} was observed which represented the maximum value for the day considered while the maximum value of air temperature observed in Figure 4 was 31.7 ^{0}C at 1300 hrs.

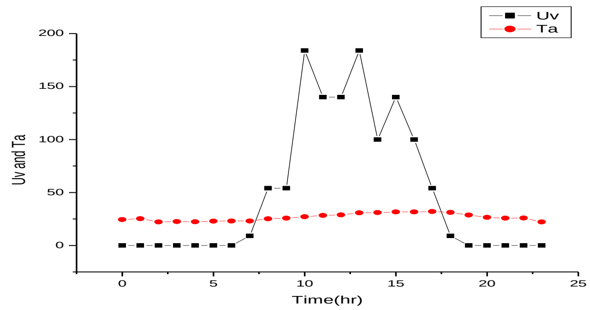

Figure 2: Characteristic variation of ultraviolet light and air temperature for 22nd March, 2019 (DOY 81).

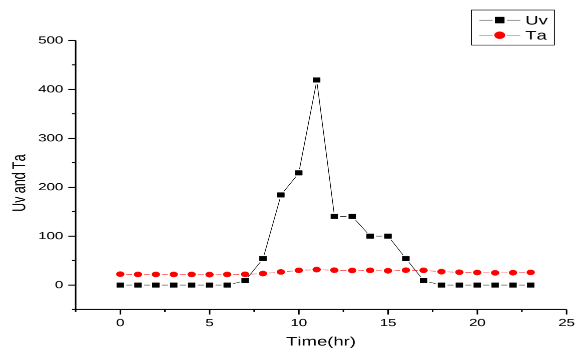

Figure 3: Characteristic variation of ultraviolet light and air temperature for 26st March, 2019 (DOY 85).

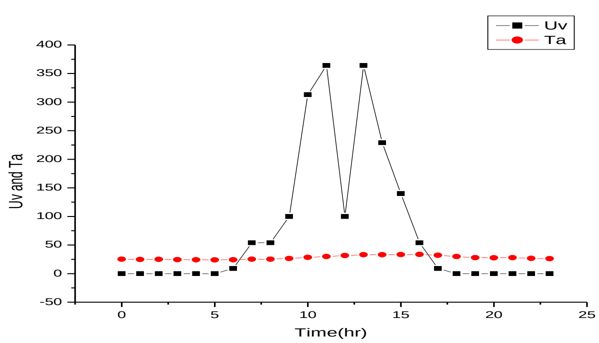

Figure 4: Characteristic variation of ultraviolet light and air temperature for 28th March, 2019 (DOY 87).

V. CONCLUSION

Continuous measurements of ultraviolet light and air temperature at an experimental site located at the Physics/Electronics Unit Laboratory, Kwara State Polytechnic, Ilorin, Nigeria, was carried out between 18th March and 1st April, 2019. Using the direct measurement technique, these datasets were used to investigate the variation characteristic of the ultraviolet light and air temperature.

The results showed that the measured ultraviolent light, U_V during the daytime increases until 1200 hrs with maximum value of about 450 Wm^{-2} and minimum value of about 9 Wm^{-2} at 800 hrs (DOY 85). The measured air temperature, Ta value of 32.6 ^{0}C observed at 1200 hrs (DOY 85), represented the maximum value for the entire period of the study. The value of 193 Wm^{-2} was observed at1100 hrs (DOY 81), represented the minimum value for the entire period of the study due to the cloudy condition of the sky which reduces the amount of incoming solar radiation reaching the earth surface.

REFERENCES

[1] Cutchis, P., 1982: A Formula for Comparing Annual Damaging Ultraviolet (DUV) Radiation Doses at Tropical and Mid-Latitude Sites. In: Calkins J (eds). The Role of Solar Ultraviolet Radiation in Marine Ecosystems. NATO Conference Series, Vol 7, Springer, Boston, MA.

[2] Fleischmann, M., S. Pons, and M. Hawkins, 1989: Measurement of γ rays from cold fusion. Nature 339, 667 pp.

[3] Frederick, J.E., H.E. Snell, and E.K. Haywood, 1989: Solar Ultraviolet Radiation at the Earth's Surface. Photochemistry and Photobiology. 50(4): 439-583.

[4] Haigh, J.D., 2007: The Sun and the Earth's Climate. Living Rev. Sol. Phys. 4, 2.

[5] Holick, M.F., 2012: Vitamin D: extrasekeletal health. Rheum Dis Clin North Am. 38(1): 141-160.

[6] Hockberger, P.E., 2002: A history of ultraviolet photobiology for humans, animals and microorganisms. Photochemistry and photobiology. 76 (6): 561-579.

[7] Glynn, P.W., 1993: Coral reef bleaching: ecological perspectives. Coral Reefs 12, 1-17.

[8] Jokiel, P.L., 1980: Solar Ultraviolet radiation and Coral Reef Epifauna. Science. 207 (4435): 1069-1071.

[9] Jokiel, P.L., and R.H.York Jr, 1984: Importance of ultraviolet radiation in photoinhition of microalgal growth. Limnology and Oceanography. 29 (1): 1-223.

[10] Lesser, M.P., and J.M. Shick, 1989: Effects of irradiance and ultraviolet radiation on photoadaptation in the zooxanthellae of Aiptasia pallid: primary production, photoinhition, and enzymic defenses against oxygen toxicity. Mar.Biol. 102, 243-255.

[11] Mainster, M.A., 2006: Violet and blue light blocking intraocular lenses: photoprotection versus photoreception. Br J Ophthalmol. 9 (6): 784-792.

[12] Madronich, S., 1992: Implications of recent total atmospheric ozone measurements for biologically active ultraviolet radiation reaching the Earth's Surface. Geophysical Research Letters. 19 (1): 1-12.

[13] Ogden, J., and R. Wicklund, 1988: Mass bleaching of Coral reefs in the Caribbean: a research strategy. NOAA's Undersea Res Prog, Res Rpt. 51, 2-88.