International Journal of Weather, Climate Change and Conservation Research

Vol.4, No.1, pp.1-7, February 2018

Published by European Centre for Research Training and Development UK (www.eajournals.org)

INVESTIGATING THE INFLUENCE OF COSMIC RAYS ON THE CLIMATE OF SOUTH-EAST AND SOUTH-SOUTH REGIONS OF NIGERIA USING SUNSHINE HOURS AND RELATIVE HUMIDITY

Okoye O.E.[1,2], Okeke F.N[2] and Ugonabo O.J[2] and Iheama N.B[3]

[1]Scientific Equipment Development Institute, Enugu
2Dept. of Physics and Astronomy, University of Nigeria, Nsukka.
[3]Dept. of Building, Faculty of Enviromental Sciences, Imo State University, Owerri.

ABSTRACT: *There is a rising concern about the agents and mechanisms of climate change. The contribution of anthropogenic greenhouse gases to global warming has long been accepted by most scientists, however, the impacts of some natural factors such as cosmic rays, sunspot and geomagnetic activities are yet to be established. This study investigated the effects of cosmic rays on the climate of south-east and south-south parts of Nigeria from 5 meteorological stations in the regions for a period of 48 years (1965-2012). Sunshine hours and relative humidity were used as weather parameters. No particular trend was found in the value of cosmic rays during the period; similarly, the sunshine hours and the relative humidity also produced very irregular patterns. A very low but positive correlation coefficient of 0.3 was found between cosmic rays and sunshine hours with almost no correlation (r = 0.1) between cosmic rays and relative humidity.*

KEYWORDS: Cosmic Rays, Sunshine Hours, Relative Humidity, Climate Change.

INTRODUCTION

Debate has continued among scientists about the agents of climate change and the mechanisms upon which they operate. Increase in the concentration of greenhouse gases by anthropogenic sources seems to be the most widely known cause of climate change with the Inter-governmental panel on Climate Change (IPCC) constantly predicting further increase in the global surface temperature by the next century (IPCC: 2001, 2007, 2013). However, there are concerns that some natural events such as cosmic rays and geomagnetic activities might have some influence on climate change (Usoskin and Kovalstar, 2003).

Cosmic rays; a stream of very high energetic particles emanating mainly from outside the solar system (Sharma, 2008) interact with the magnetosphere with a fraction of it penetrating inwards into the earth's atmosphere. Produced from various astrophysical processes, cosmic rays consist of 99% protons and alpha particles and approximately 1% of heavier nuclei (NASA, 2012). Trumbore (2000) reported that cosmic rays are responsible for continuous production of a number of unstoppable isotopes in the earth's atmosphere. This implies that there could be a possible relationship between cosmic rays and weather and by extension the climate.

Sunshine hours and relative humidity are two essential weather parameters which if measured over a number of decades could be used to determine the state of the climate of a place. The World Meteorological Organization (WMO) in 2008 gave a classified definition of sunshine hours to mean the period in hours the day when the direct solar irradiance exceeds a threshold of $120Wm^{-2}$. On the other hand the relative humidity is expressed as a ratio of moisture in the

Print ISSN: 2059-2396, Online ISSN: 2059-240X

atmosphere to the required saturation moisture content of the atmosphere at that temperature. This is expressed in equation 1.0

$$RH = \frac{AM}{SM} X \frac{100}{1} \qquad 1.0$$

Where RH is the relative humidity, AM is the atmospheric moisture content and SM is the saturation moisture content. The study seeks to investigate the influence which cosmic rays exerts on the climate of the south-east and south-south regions of Nigeria using these two parameters of great interest as the variables.

Svensmark and Christensen (1997) suggested that cosmic rays play a major part in climate change through ionization of the air forming aerosols which may grow into cloud condensation nuclei (CCN). This CCN exert a strong effect which can lower or raise the world's mean temperature (Sloan and Wolfendale, 2013), this shows that a possible connection exists between cosmic ray (CR) and temperature which is directly linked to sunshine hours and relative humidity.

Martin (2016) stated that cosmic rays interact with electromagnetic radiation generated by humans to induce global warming. Kitaba et al.(2017) added that this has greater impacts on continental climate than on oceanic climate. As a result of this concern of possible effect on climate change by cosmic rays, this study aims to investigate the influence of cosmic rays on the climate of south-east and south-south regions of Nigeria using sunshine hours and relative humidity as weather parameters.

This research is very essential as the findings would inform and assist the masses and especially government agencies in making policies for adaptation. Other weather parameters such as temperature and rainfall have been used to study the climate change in some regions of Nigeria, but relative humidity and sunshine hours although very essential parameters have often been neglected.

Data and method of Analysis

Sources of Data

The cosmic ray data used for this analysis are the hourly pressure corrected values by neutron monitors from Mcmurdo station with 77.9^0S and 166.6^0E as coordinates. They were supplied by the University of Delware Bartol research institute network of neutron monitors and supported by the national science foundation grant ATM-00000315. The data used spanned a period of 48 years (1965-2012).

Sunshine hours and relative humidity data were supplied by Nigeria Meteorological Agency (NIMET) Oshodi, Lagos. These data were collected from 5 meteorological stations from south-east and south –south regions of Nigeria with the coordinates as shown in Figure 2.1

Print ISSN: 2059-2396, Online ISSN: 2059-240X

Table 2.1: The coordinates of the analyzed stations

STATIONS	LATITUDE	LONGITUDE
ENUGU	6.47^0N	5.57^0E
BENIN	6.23^0N	5.60^0E
PORTHARCOURT	4.75^0N	7.00^0E
CALABAR	4.95^0N	8.32^0E
WARRI	5.52^0N	5.73^0E

Method of Analysis.

The daily mean values ($\bar{C}$) of cosmic rays was obtained from the hourly value (C_i) as published using equation 2.0

$$\bar{C} = \frac{1}{24}\sum_{i=1}^{24} C_i \qquad 2.0$$

Equation 3.0 and 4.0 were used to calculate the monthly and yearly means respectively.

$$\bar{C}_{mi} = \frac{1}{n}\sum_{i=1}^{n} \bar{C}_i \qquad 3.0$$

$$\bar{C}_Y = \frac{1}{12}\sum \bar{C}_{mi} \qquad 4.0$$

Similar methods were used to analyze for sunshine hours and relative humidity. Equation 5.0 was applied to obtain the monthly mean ($\bar{S}_{mi}$) from the daily value ($\bar{S}_{di}$) for the sunshine hours.

$$\bar{S}_{mi} = \frac{1}{n}\sum_{i=1}^{n} \bar{S}_{di} \qquad 5.0$$

Where n = number of days in a month. Using equation 6.0 the yearly mean was obtained.

$$\bar{S}_Y = \frac{1}{12}\sum_{i=1}^{12} \bar{S}_{mi} \qquad 6.0$$

The monthly and yearly means of relative humidity for the stations analyzed were obtained using equations 7.0 and 8.0 respectively.

$$\bar{RH}_m = \frac{1}{n}\sum_{i=1}^{n} \bar{RH}_{di} \qquad 7.0$$

Print ISSN: 2059-2396, Online ISSN: 2059-240X

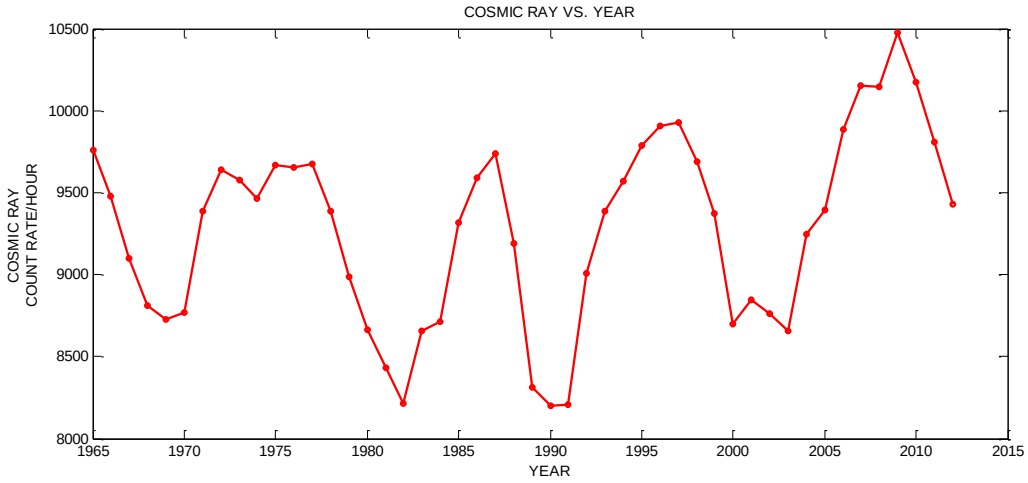
$$\overline{RH}_y = \frac{1}{12}\sum_{i=1}^{12}\overline{RH}_{mi} \qquad 8.0$$

Where ($\overline{RH}_{di}$) is the daily value of relative humidity and n is the number of days in a month.

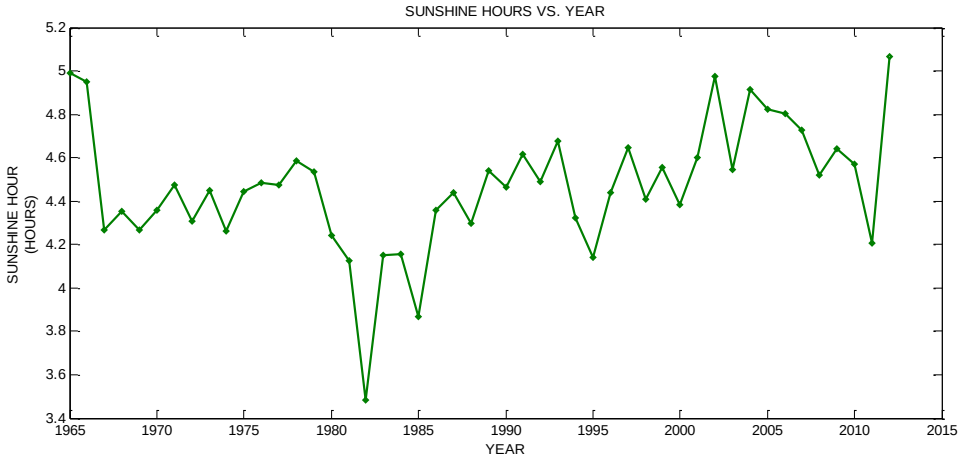
The Pearson's correlation coefficient (r) shown in equation 9.0 was used to test for the relationship between cosmic rays, sunshine hours and relative humidity.

$$r = \frac{\sum_{i=1}^{n}(X_i - \overline{X})(Y_i - \overline{Y})}{\sqrt{\sum_{i=1}^{n}(X_i - \overline{X})^2}\sqrt{\sum_{i=1}^{n}(Y_i - \overline{Y})^2}} \qquad 9.0$$

RESULTS AND DISCUSSION

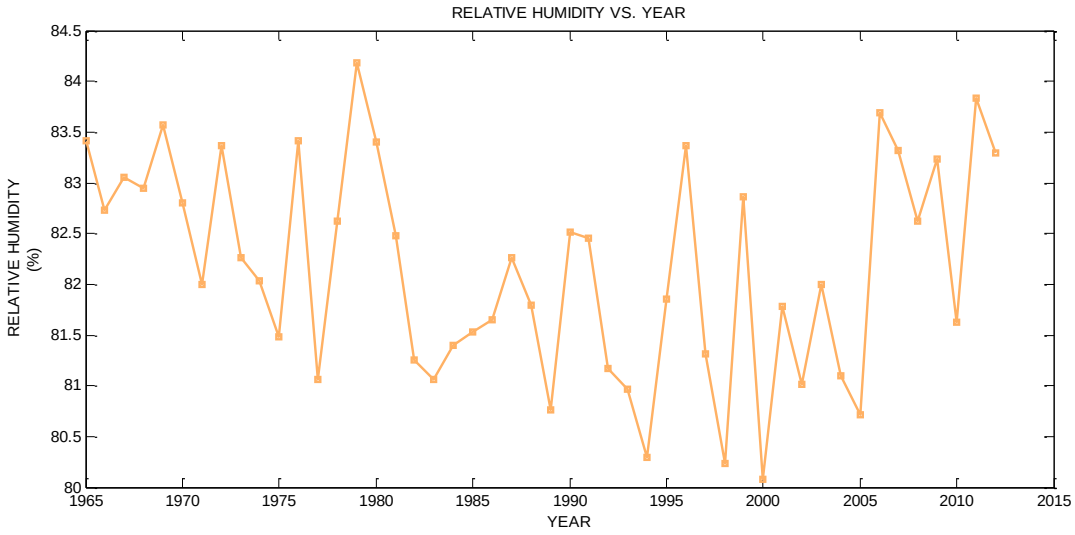


(a)



(b)

Print ISSN: 2059-2396, Online ISSN: 2059-240X



(c)

Fig. 1 (a-c): Plots of Cosmic rays, Sunshine hours and relative humidity against years respectively.

An irregular pattern was observed throughout the period of study for all the parameters plotted against the years. A comparison was made between cosmic rays and sunshine hours as shown in Figure 2. It was observed that there is a positive correlation between the cosmic ray and sunshine hours; however, the association is weak having a correlation coefficient of 0.3.

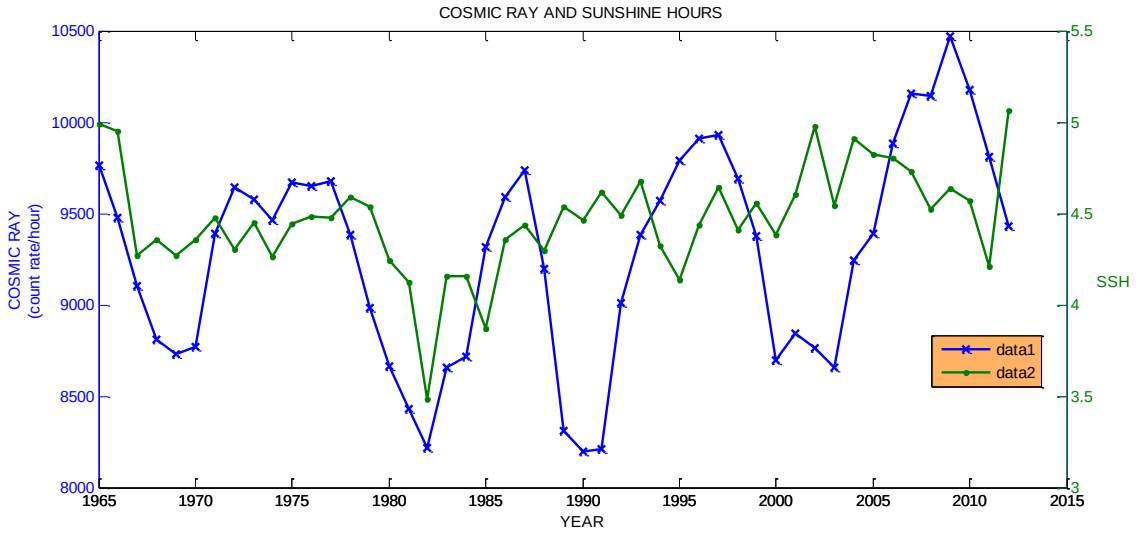


Fig. 2: The relationship between cosmic rays and sunshine hours

Figure 3 shows the relationship between cosmic rays and the relative humidity. It is seen that there is almost no association between the two. A small coefficient of 0.1 indicates a positive association however, this association is very weak.

Print ISSN: 2059-2396, Online ISSN: 2059-240X

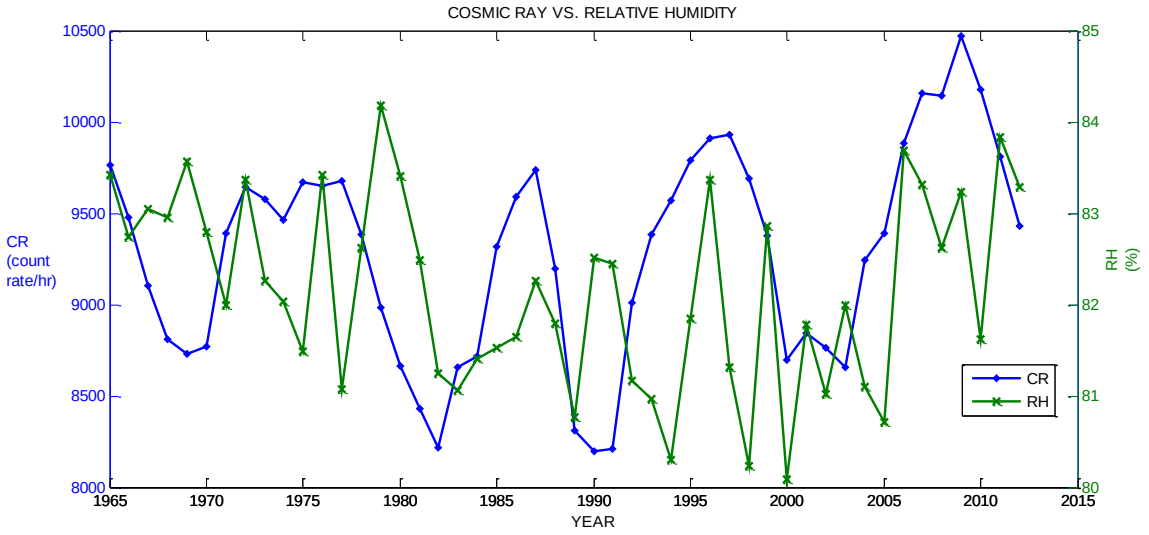


Fig. 3: The relationship between Cosmic rays and relative humidity.

CONCLUSION AND RECOMMENDATION.

The results from this study reveal that there is a relationship between cosmic rays and sunshine hours in the south-east and south-southern parts of Nigeria, the relationship is however very low with a correlation coefficient of 0.3. It was also found that almost no association existed between the cosmic rays and the relative humidity for the period studied. Where the Pearson's correlation coefficient was found to be 0.1. The implication of these results is that cosmic rays may be a factor influencing the climate of the regions under review although its impact might be little and weak. Further studies on the effects of cosmic ray on other weather parameters such as: rainfall, surface temperature, wind speed e.t.c are recommended to give better insight on this subject of interest.

REFERENCES

IPCC (2013). Third Assessment Report Chapter 7. Physical Climate Processes and Feedbacks (Atmospheric Processes and Feedbacks 7.2) *(Report). International Panel on Climate Change*. Retrieved August 24, 2013. *It has extensive coverage of cloud-climate interactions.*

IPCC, (2001). Climate Change 2001: The Scientific Basis. Contribution of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change Houghton, J.T.,Y. Ding, D.J. Griggs, M. Noguer, P.J. van der Linden, X. Dai, K. Maskell, and C.A. Johnson (eds.). Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 881pp.

IPCC, (2007). Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt,M. Tignor and H.L. Miller (eds.). Cambridge University Press, Cambridge, United Kingdom and New York, USA 996 pp.

Print ISSN: 2059-2396, Online ISSN: 2059-240X

Kitaba, I., Hyodo, M., Nakagawa, T., Katoh, S., Dettman, D. and Sato, H. (2017). Geological support for the Umbrella Effect as a link between geomagnetic field and climate. *Sci. Rep. Letters.* 7: 40682

Martin, W. (2016) KELEA, Cosmic Rays, Cloud Formation and Electromagnetic Radiation: Electropollution as a Possible Explanation for Climate Change. Atmospheric and Climate Sciences, **6**, 174-179. doi: 10.4236/acs.2016.62015.

National Aeronautics and Space Administration (2012). "What are cosmic rays?"., *Goddard Space Flight Center.*. Retrieved 31 October 2012

Sharma (2008). Atomic And Nuclear Physics. Pearson Education India. p. 478. ISBN 978-81-317-1924-4

Sloan,T and Wolfendale,, A.W. (2013) Cosmic rays, solar activity and the climate. *Environmental Research letters.* **8**:4

Svensmark, H. and Friis-Christensen, E.(1997) 'Variation of cosmic ray flux and global cloud coverage-a missing link in solar-climate relationships', *Journal of Atmospheric And Solar-Terrestrial Physics*. **59**: 1225

Trumbore, S. *(2000). Noller, J. S.; J. M. Sowers; W. R. Lettis, eds.* Quaternary Geochronology: Methods and Applications. *Washington, D.C.: American Geophysical Union. pp. 41–59.* ISBN 0-87590-950-7

Usoskin, G.I and Kovaltsov, G.A. (2008) Cosmic rays and climate of the earth: possible connection. *Computes Rendus Geoscience*. **340**: 441-450

Print ISSN: 2059-2396, Online ISSN: 2059-240X