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Earth's Environmental Pollution from Galactic Cosmic Rays Flux

A.E. Umahi

Department of Industrial physics (Astrophysics unit),
Faculty of Science, Ebonyi State University, Abakaliki, Nigeria

Abstract: When Galactic Cosmic Rays (GCRs) of high energetic particles originating from within and outside our universe impinges into the earth's atmosphere, the environment is polluted physically, chemically and biologically. The pollution of this GCRs in the earth's atmospheric environment was achieved statistically using excel spread sheets. The characterizations of the GCRs and the Surface Average Temperature (SAT) in the earth's environment were conspicuously shown. They indicate a simultaneous relationship which shows that the GCRs gives rise to SAT. The events showed correlation coefficient (r) levels ranging from 0.01 to 0.99, which showed that GCRs contributes significantly to the earth's environmental pollution.

Key words: Cosmic Rays · Solar Activity · Ionization and Surface Average temperature

INTRODUCTION

The pollution from galactic cosmic rays (GCRs) in the earth's atmosphere gives rise to a global controversy. The GCR comprises of high energy particles originating within and outside our solar system which are released towards the direction of the earth's atmosphere. The major composition of these radiations is protons as major and electrons are the minor. In addition, galactic cosmic rays include heavy, high energy ions of elements that had all their electrons stripped away as the journeyed through the galaxy at nearly the speed of light ($3.00 \times 10^8 ms^{-1}$). The radiation outside our solar system is known as cosmic rays (Grs) while the once within our solar system are solar radiations (SRs), such as solar flare, solar wind sunspot and coronal mass ejection. The cosmic ray particles are affected by the suns magnetic field in which their average intensity is highest during the period of minimum sunspot when the suns magnetic field is weak and lowest when the sun magnetic field is maximum.

When GCRs impinge on the Earth's atmosphere it pollutes the atmosphere physically, chemically and biologically. The physical pollution gives rise to ionization of atoms and produce an electromagnetic cascade also known as extensive air shower of charged particles where muon particles which are produced in the process undergoes energy loss basically due to ionization. The morphological structure affects the transparency of the troposphere. The atmospheric chemistry have significant implication due to the breaking down of bonds of N_2 and O_2 presence in the ozone layer in the upper atmosphere. The ionizing radiation has much energy to knock off electrons from the atom which can damage the atoms in human cells leading to further health problem such as cataract, cancer and central nervous system. They also have very different effect on human De-oxiraibonuclearic acid (DNA) and tissues [1 and 2].

The influence ofGCR in the Earth's atmosphere has been extensively monitored in the previous yearswith Balloons experiments [3], Rockets [4], Satellite and Ground based detectors [5 and 6].

The empirical profiles of the ionization effects have been reported [7]. The quantitative models were used to calculation the atmosphere ionization [8, 9 and 10]. The numerical study of direct ionization of cosmic ray (such as Sofia model for analytical approximation) has been done [11 and 12]. The Oulu Cosmic Ray Atmospheric Cascade (CRAS) and Ben(ATMOCOSMICS/PLANE TOCOSMICS Code) model investigates the ionization level [13, 14 and 15]. The COsmic Ray Ionization Model for Ionosphere and Atmosphere (COTIMIA) Mode was developed to calculate the electrons and ion production rate profiles [16]. The COsmic Rays Simulations for KAscade (CORSIKA) used simulation to model the atmospheric nucleonic- electromagnetic cascade [17]. The FLUKA package of CORSIKA simulated the low-energy nuclear interactions [18].

Corresponding Author: A.E. Umahi, Department of Industrial physics (Astrophysics unit), Faculty of Science, Ebonyi State University, Abakaliki, Nigeria.

Some authors have reported convective activity of thunderstorm and the temperature of the Earth's surface increased by ~0.6^{0}C [19 and 20]. Other authors have studied the relationship between northern hemisphere surface temperature and solar irradiance; and its result showed that the correlation coefficient is ~0.86 [21 and 22]. The eleven years average temperature variations in terms of percentage change in cosmic rays and sunspot number showed that the correspondence between solar activities and average temperature seems to be between the period of solar cycle length and the variation in cosmic ray flux [21]. In this publication, the source of galactic cosmic ray flux shall be cosmic ray and solar flare flux; in addition, the level of pollution of galactic cosmic rays flux in the earth's atmosphere has to be statistically investigated.

Atmospheric Chemistry: The atmospheric ionization changes the chemistry of the earth's atmosphere by breaking down the triple bond of N_2 and the double of bond of O_2 [23]. The photochemical model was applied to make a quantitative estimate of the atmospheric chemistry pollution when an average energy (≈ 35 eV) generates ion pairs [24]. The chemistry has significant pollution in the ozone layer of the upper atmosphere. The reactions in the upper atmosphere [25], are as follows:

$$NO + O_3 \rightarrow NO_2 + O_2 \quad (1)$$

$$NO_2 + O \rightarrow NO + O_2 \quad (2)$$

Therefore, the net atmospheric chemical reaction is given as

$$O_3 + O \rightarrow O_2 + O_2 \quad (3)$$

This pollution in the earth's atmosphere causes ozone depletion at the lower atmosphere (troposphere) and produces a number of oxides of nitrogen. During the rain, nitrates can be deposited on the earth's surface which enhances the fertilization of the soil at the earth's surface. This is very important in the field of agricultural science.

Further, the cosmic rays deposition of energy in the earth's atmosphere was used to compute the ion pairs using an extensive air shower stimulator of CORSIKA [17]. The calculated ion pairs correspond to the spectrum of any astronomical source [26 and 14].

Biological Effect in the Earth Atmosphere: The extensive air shower of CRs produces moun particles with energy loss due to ionization in the cause of its interaction in the earth atmosphere. Hence, the flux of moun at a given altitude has more significant effect than its energy for evaluating the biological damage. The moun flux from cosmic rays can also be modeled using CORSIKA with high accuracy [1]. The earth's atmosphere is a biosphere were muon posse a significant treat to astronauts and other space explorers. They can interact with the DNA and lead to mutilation and Cancerous diseases [27].

The major damage to the ozone depletion is the penetration of solar UVB (290-315nm), which is strongly absorbed by DNA and protein molecules. This damaging effect on organism such as phytoplankton which form the base of the food chain of oxygen production [28]. In addition, it have impact on the growth of higher plant life and damage the skin of animals [29].

Physical Appearance of the Earth's Atmosphere: The galactic cosmic rays composed of two major sources of radiations from GCRs and SRs, which enters our Earth's atmosphere and causes pollution. The GCRs influences the morphological processes in the Earth's Atmosphere. The effects include cloudiness density charges, atmosphere cloud coverage and control the variability of atmosphere transparency and therefore, affect high radiation flux reaching in the lower atmosphere [15]. The morphological effects of GCR and Solar protons induced ionization and only induced GCR are detailed in [15].

Materials and Result Analysis: Observatories data from the Solar Soft Data Centre (SSDC), Space Physics Interactive Data Resources (SPIDR) and National Space Research and development Agency, (NASRDA), Nigeria; for cosmic rays, solar flare and surface average temperature (SAT) of 2008 respectively are source of materials that was used for this work. These materials were used to study the statistically analysis of the earth's environmental pollution from galactic cosmic ray flux.

The main objective of this paper is to ascertain the possibility of GCRs causing atmosphere pollution and to find out the level of the pollution of GCRs in the environment. Therefore, the two major sources of GCRs in this work are cosmic ray (CR) and solar flare (SF). The GCRs has to be taken as a single source that causes variations in the surface average temperature (SAT). These data are initially arranged in excel spread sheet for the analysis. The percentage (%) of accommodation of the events of CRs and SF were obtained and the obtained values were summed to form a source of GCR into the earth's atmosphere. The % GCR and % SAT were grouped into three months events to form a phase for the characterization, that is, four phases have to be presented and studied in this work.

The purpose of these characterizations was to find out if the variations in GCR can cause a similar in any atmosphere parameters such as SAT. Thus, the variations of %GCR and % SAT(measured in counts) against time (measured in days) are graphically presented as shown from Fig. 1 to 4.

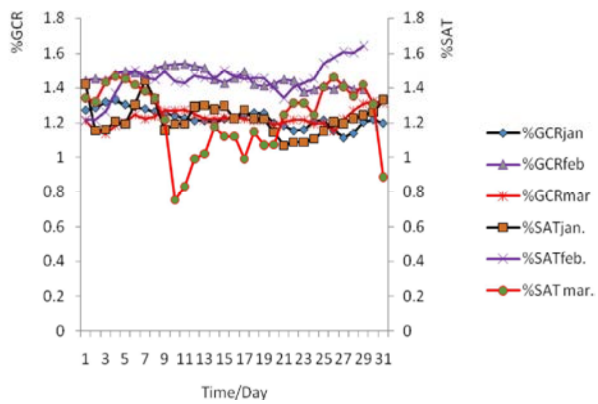

Fig. 1: Variations of Percentageof Galactic Cosmic Rays (%GCR) and Percentageof Surface Average Temperature (%SAT)against Time/days in the first phase. The symbols for %GCR and %SAT are shown on the key beside the graph.

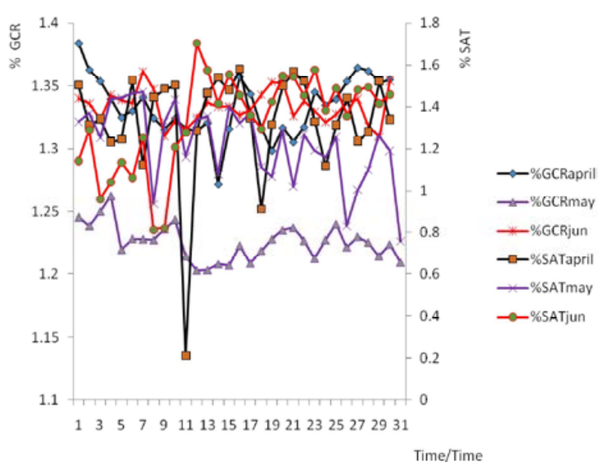

Fig. 2: Variations of Percentageof Galactic Cosmic Rays (%GCR) and Percentageof Surface Average Temperature (%SAT)against Time/days in the second phase. The symbols for %GCR and %SAT are shown on the key beside the graph.

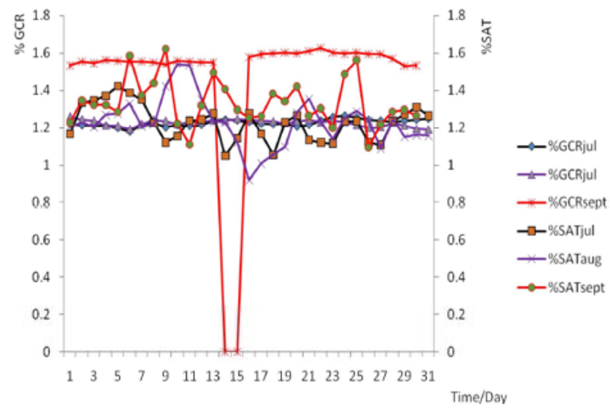

Fig. 3: Variations of Percentageof Galactic Cosmic Rays (%GCR) and Percentageof Surface Average Temperature (%SAT)against Time/days in the third phase. The symbols for %GCR and %SAT are shown on the key beside the graph.

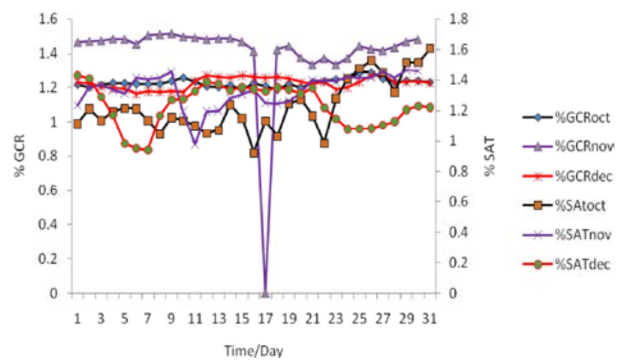

Fig. 4: Variations of Percentageof Galactic Cosmic Rays (%GCR) and Percentageof Surface Average Temperature (%SAT)against Time/days in the four phase. The symbols for %GCR and %SAT are shown on the key beside the graph.

In addition to the above characterization, the correlation analysis using Microsoft Excel programs were carried out in order to ascertain the levels of relationship between the GCRs and SAT. The magnitudes of the level of correlation coefficient (r)rangingfrom 0.00974 to 0.999.

DISCUSSION

The variations of GCRs entering the earth's atmosphere do affect the variations of the average surface atmospheric temperature as shown in the Fig. 2 to 5. The event variations are in agreement with some authors [15 and 16]. The observational image shown in Fig.1, indicates that the GCRs (induced solar protons and Cosmic Rays in the troposphere) identify varying rows of regions of bright and dark regions [15]. The majority of the results show that they are almost flat variations in GCRs in all the phases. Also, the average surface atmospheric temperature conspicuously showed very clear characterization in its variations in the earth's atmosphere in all the phases. These observations are in conformity with other authors [30, 19, 20, 22 and 31]. From fig.1 to 4 shows that the variations of GCRs against time (measured in day)leads to the variation SAT against time (measured in day). The levels of correlation coefficient, r, ranges from 0.01 to 0.99 which is in agreement with authors [22].

CONCLUSION

The characterization of the Galactic Cosmic Rays (GCRs) in the earth's atmosphere showed clear corresponding variations of the Surface Average Temperature (SAT). The high significant level of correlation associated in the events indicates that the GCRs cause pollution which gives rise to the variations of the SAT. Whereas the low significant level of correlation indicates that there may be attributed to other source of particles such as sunspot, solar wind, prominences and Coronal Mass Ejection (CME) that contributes to the variation of SAT infiltrating the earth's atmosphere which were not considered in this work. Also the sensitivity of the observatory instrument could result to the low correlation.

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