IMPACT: International Journal of Research in Engineering & Technology (IMPACT: IJRET)
ISSN(P): 2347-4599; ISSN(E): 2321-8843
Vol. 4, Issue 8, Aug 2016, 19-22

MONITORING OF GAMMA RADIATION AND METEOROLOGICAL PARAMETERS AT GROUND LEVEL IN SÃO JOSÉ DOS CAMPOS, BRAZIL

MARCELO PEGO GOMES, FRANKLIN ANDRADE DA SILVA,
INÁCIO MALMONGE MARTIN & BOGOS NUBAR SISMANOGLU
Department of Physics, Technological Institute of Aeronautics, Brazil

ABSTRACT

A pilot study has been conducted to determine the feasibility of using low-cost portable instrument to measure and characterize the background gamma radiation in São José dos Campos, SP, Brazil. A NaI(Tl) scintillator coupled to a photomultiplier and connected to a PC recorded variations of the local background gamma radiation over extended periods of time. The collected data show that there is a correlation between meteorological parameters and the radiation level. This correlation can be attributed to variations in the concentration of radon gas Rn-222 at ground level produced by these meteorological phenomena. Measurements of energy calibration, stability and reproducibility of system were made during the work.

KEYWORDS: Gamma Radiation, Radon, Nal(Tl) Scintilator, Meteorological Phenomena

INTRODUCTION

The environment is exposed to different radiation sources, e.g., radioactive isotopes of uranium, thorium, potassium (in the soil), radon gas (in the air and water wells), cosmic rays and anthropogenic sources (industry, energy production, medicine) [1]. All these sources contribute to the background gamma radiation. Natural factors such as meteorological [2], astronomical [3] geological [4] and even biological [5] phenomena can also interfere with the radiation background. In the region of São José dos Campos (SP, Brazil, 23°11′11″ S, 45° 52′ 43″ W; altitude, 660 masl) measurements or data on the radiation background are either scarce or based on historical mean values.

In the case of unforeseen natural events or human-caused accidents, the radiation count can change significantly in short time scales (minutes, hour or days) but depending on local conditions these unexpected changes can be masked by changes in the gamma radiation background caused by natural phenomena [1]. Hence, with aim of understanding how the background gamma radiation varies over time and is affected by natural phenomena, we established a pilot program to record time series of gamma radiation (energy, 0.03 to 10 MeV) measured at ground level using low-cost portable instruments.

METHODS

A NaI(Tl) scintillator crystal (dimensions, 7.5 x 7.5 cm) optically coupled to a photomultiplier tube (PMT), in a 2 mm thick aluminum cylinder was used to detect gamma radiation. The PMT is connected to a PC through an amplifier/digitizer interface (Aware Electronics INC., USA). Figure 1 shows the crystal/PMT housing and the amplifier/digitizer interface. To measure the atmospheric electric field were utilized sensors that are installed at the

Meteorological Phenomena Observation Tower of IAE. A quick type dish antenna was used to record the variations of the electric field caused by atmospheric electrical discharges. Through a weather station, the precipitation was collected data.

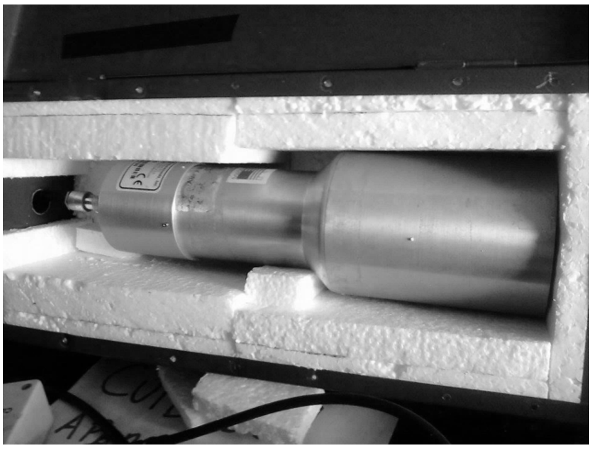

Figure 1: Nal (Tl) Scintilator/ PMT in Aluminum Housing and Amplifier

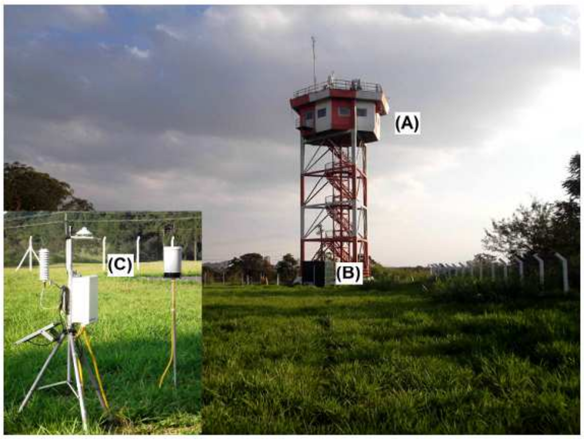

Figure 2: View of (A) ACA Tower in São José Dos Campos, SP, Brazil, (B) Instrument Trailer, and (C) Meteorological Station [6]

Data were sampled and recorded at one-minute intervals. Data were collected uninterruptedly for periods as long as 60 days. The detector was located inside a room on the second floor of a two-floor building with brick walls and clay roof tiles.

RESULTS AND DISCUSSIONS

Figure 3 shows an example of the data recorded. Data are presented in raw format, as they were collected. It was observed two important features can be noted in the graph. The diurnal variation of the intensity of the background radiation caused by changes in the concentration of radon gas (^{222}Rn) in the atmosphere near ground level, which is primarily controlled by small scale eddy dynamics of the low atmospheric boundary and variations of the temperature and humidity of the atmosphere and soil during the day (2). Significant and rapid increases in the radiation count caused by meteorological phenomena, especially rainfall were observed in the region. This rapid increase is produced by radon washout, which is a process whereby the radon present in the atmosphere is collected by rain and deposited on the ground. Other authors have also reported similar findings using more complex instruments [7, 8].

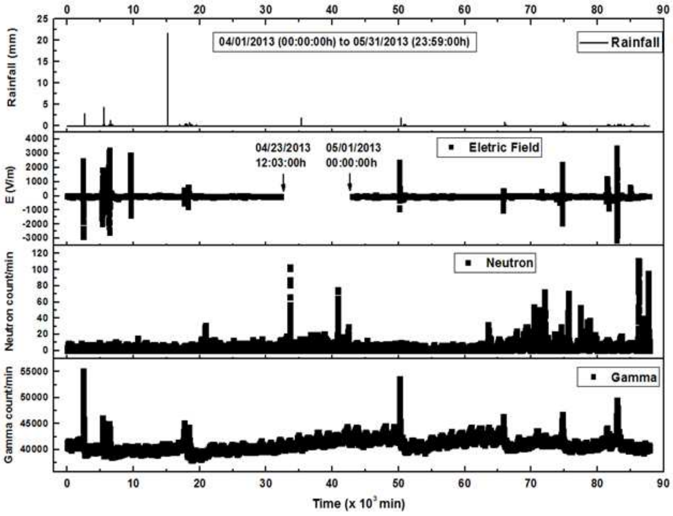

Figure 3: X- and Gamma Rays, Neutron Measurements and Atmospheric Electric Field, Rainfall Data from 04/01/2013 to 05/31/2013

It is possible to observe in Figure 3 that one good correlation exist between the variation of electric field (V/m) and low energy gamma ray measured (counts/min) in the same place. In regards of neutrons (counts/min) any correlations was observed in relation of rain, electric field and gamma radiation measurements in the same place. In the two long series of measurements (neutrons and gamma) one can observe value with more and and less one day periodicities. This variation on cycles over both radiations is just caused by insolation and humidity variation on the region with more or less radon gas exhalations from the Earth's crust. In Figure 4 and Figure 5 the measured data’s covering all series of neutrons and gamma (counts/min), the Fast Fourier Transform (FFT) calculation shows clearly those periodicities of one day.

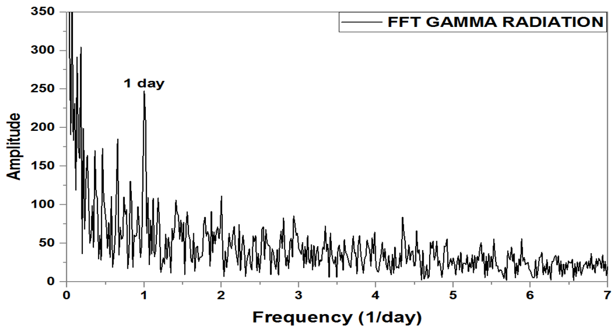

Figure 4: The Power Spectra (FFT) Obtained for the Period of Gamma

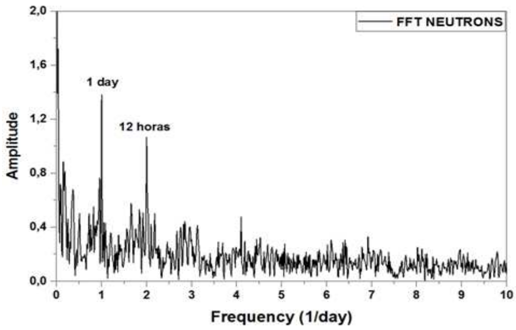

Figure 5: The Power Spectra (FFT) Obtained for the Period of Neutron

CONCLUSIONS

This is a pilot study still in its development phase. We plan to add to our set of instruments, meteorological instruments with more precision on time measurement to record the variation of atmospheric pressure, precipitation, wind speed and intensity, air temperature and humidity so that it will be possible to characterize more precisely how atmospheric phenomena can affect the gamma radiation background, and specially the concentration of radon gas at ground level over time. Still, the data we have collected demonstrate that it is possible to observe changes in the background radiation using portable and compact instruments. Additionally, this type of study emphasizes the importance of continuous monitoring of background radiation in view of recent nuclear accidents; changes in the background radiation can be affected by meteorological phenomena and can disrupt the normal monitoring of radiation in nuclear facilities, hospitals and the industry.

ACKNOWLEDGEMENTS

The author thanks Institute Technological of Aeronautics (ITA), CAPES and CNPq research agencies for extending Financial and fellowship support to implement the project ATMOSRAD.

REFERENCES

1. Akoroda, M. O., Dixon, A.G.O., Ilona, P., Ogbe, F., Okechukwu, R., Ezedinna C., Sanni, L. O., Lemchi, J. and Okoro, . (2004). *Sustainable Commercial Cassava Cultivation: the case of Nigeria. Proceedings of the Ninth Triennial Symposium Int. Soc. for Tropical Root Crops – Africa branch Kenya* Pp 193-199.
2. Food and Agricultural Organization (FAO) (2010). Production Year Book
3. Fresco, P (1993). *The dynamics of Cassava in Africa. An Outline of Research Issue* COSCA working paper no. 9.
4. Iraud, E (1993). *Physiologique et Enzymologique d' une Novele Souche de Lactobacillus Plantarum Amylolytique en Relation avec la Crooissance e Degradation des Composes Cynogeniques du Manioc et la Production d'acide Lactique*. Ph.D. Thesis, University of Provence, France.
5. Hahn, S. K., Terry, E. R., Leuschner, K., Akobundu, I. O., Okali, C. and Lal, R. (1979). *Cassava improvement in Africa*. *Field Crops Res* (2):193-226.
6. Martin, I. M., Gomes, M. P., Ferro, M. A. S., Pinto, M. L. A. and Antonio, F.C. (2013). *Measurements of X- and Gamma Radiation at Ground Level and their Correlation with Atmospheric Electric Discharges and Rainfall in São José dos Campos, SP, Brazil*. *World Environment* 3(4): 138-141.
7. Munyuli, T. M., Tete B., Tshinsinda., and Kashosi, K. (2004). *Preliminary inventory of local market incentives for the improvement of cassava productivity and production in eastern of Democratic Republic of Congo. Proceedings of the Ninth Triennial Symposium Int. Soc for Tropical Root Crops – Africa branch Kenya* pp. 48-58.
8. Nweke, FI, Spencer, DS and Lyman, JK (2002). The Cassava Transformation Africa's Best-Keep Secret. East Lansing, Michigan State University Press