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MONITORING OF GAMMA RADIATION IN SÃO JOSÉ DOS CAMPOS CORRELATING WITH RAINFALL INTENSITY IN THE LOCAL

Inácio Malmonge Martin[*1], Franklin Andrade da Silva[1] and Diogo M. Custódio[2]
[*1]Technological Institute of Aeronautics – ITA, SP, Brazil
[2]Aeronautical and Space Institute – IAE, SP, Brazil

ABSTRACT

During 06/28/2017 to 10/16/2017, low energy gamma rays and rainfall were monitored every minute in São José dos Campos region. In this period it was possible to see the dynamic process that occurs between the presence of low energy ionizing radiation (gamma rays 200 keV to 10 MeV) and the rain intensity variation in mm / min in the same region. This rain / radiation correlation is perceptible in the tropical region of Brazil, which is certainly due to the presence of the disintegration of Uranium ^{238}U to Radium ^{226}Ra and reaching the Radon ^{222}Rn with emission of α particles and low energy gamma radiation. The rain interferes with the presence of the local exhalation of the radon gas causing the washing of this gas in the low atmosphere so increasing the intensity of radiation measured in the local. This work shows the dynamics observed in this period of 2017 that there was a rainy and dry climate at the site of measurements (ITA).

Keywords: *gamma rays, ionizing radiation, rainfall, radon gas*

I. INTRODUCTION

At the ground / air interface of the Earth's surface, ionizing radiation is composed mainly of radon gas, soil telluric radiation, primary and secondary cosmic ray radiation [1,2]. However, it is difficult to separate over time the intensity of the ionizing radiation emanating from each component as the energies overlap.Gamma ray spectra have relatively low wavelengths (λ), on the order of picometers, which increases their penetration power in the environment. Due to its high energy rate, this radiation has an ionizing effect, so it can cause damage to the cellular nucleus of living beings.The telluric radiation is given by ^{238}U, ^{235}U, ^{40}K and ^{232}Th disintegration's constant for each region. The radon gas comes from the ^{238}U in Earth's crust to ^{226}Ra and ^{222}Rn reaching the stables isotopes ^{214}Pb, ^{214}Po and ^{214}Bi giving α and gamma radiation. The primary cosmic radiation consists mainly of galactic, extragalactic, and very high energy Sun protons that interact with Earth's atmosphere producing the EAS (Extensive Air Showers) [3,4].The efficiency of this interaction is highest when it occurs at altitudes between 15 and 17 km in the tropics that form secondary cosmic rays with muonic, mesonic and neutronic components that reach the surface of the Earth in the region. These radiations can cause health problems for crew and passengers in civil aviation. At that altitude considered beginning of the stratosphere is called Pfotzer maximum. However, this component contributes less to the concentration of ionizing radiation on the Earth's surface [5,6].

II. METHOD & MATERIAL

A portable detector was used to measure gamma radiation in the energy range of (200 keV to 10 MeV), composed of a 3"x3" Sodium Iodide crystal scintillator, doped with Thallium. This crystal is directly coupled to a photomultiplier (PM) (set to operate at 1,700 VDC). This PM records pulses from the scintillator, makes amplification, and a digital analog converter (ADC) circuit allows you to record and save these measurements using a computer. The scintillator is surrounded by a thin layer of aluminum for its protection; the set (scintillator + associated electronics + data acquisition) only requires a PC with a charged battery to measure the radiation for 5 continuous hours[7]. However for long series of measurements it uses electrical network or photovoltaic energy. The scintillator and associated electronics were calibrated in terms of energy and counting intensity per minute at the experimental teaching physics laboratory of ITA using radioactive sources and a gamma spectral analyzer of counts versus energy in the range of

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0.2 to 10 MeV (Million Volt Electron) [8] . The rainfall intensity in (mm/min.) was measured with a bascule type rain gauge and a data logger for data acquisition developed in ITA according to international recommendations[9].

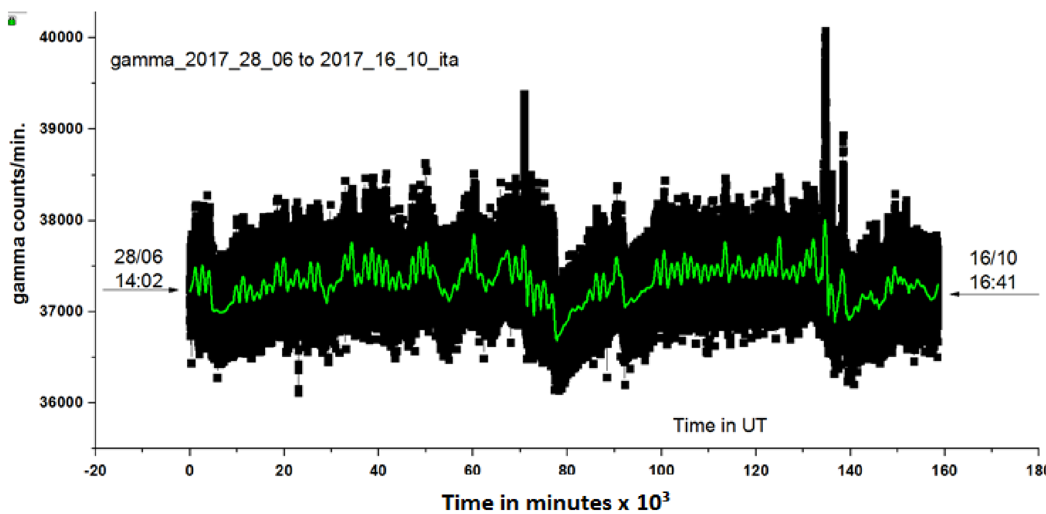
Figure 1:

Tower where the scientific devices are installed

III. RESULT & DISCUSSION

The measurements were performed between June 28, 2017 to October 16, 2017 in the same location shown in Figure 1, in the 25-meter high ACA tower. The interval between each measurement was chosen in 1 minute. Thus it was possible to verify times with rains and the dynamics of the ionizing radiation in the region in this interval. Figure 2 shows throughout this period, 12 rains seen through the peaks of gamma radiation measured.

Figure 2:



Measurements of gamma rays in the range of 06/28/2017 to 10/16/2017. Green line is smoothed curve of 1day

The following figure shows a "zoom" obtained in the range of 66000 minutes to 78000 minutes. The graph observed is obtained through the measurements made by the rain gauge referring to the period from 12/08 to 21/08, in which there is a strong rainfall on August 16. Other weaker rains on the later days were also measured and observed on the gamma radiation plot. The arrival of heavy rain caused a significant increase in the gamma ray count due to the washing of the radon gas to the soil. The comparison of the two graphs shows that the peaks of gamma radiation were generated exactly at the same time that rains occurred in the region. Green curve is smoothed of 1 day.

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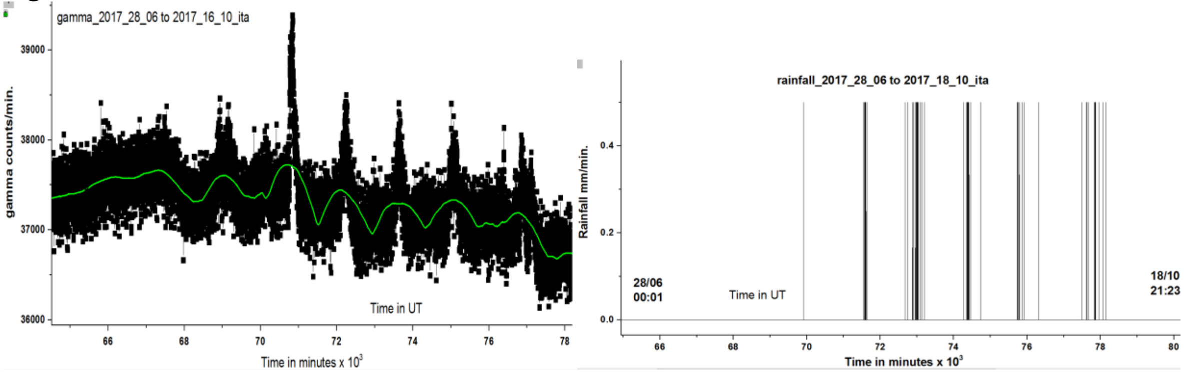
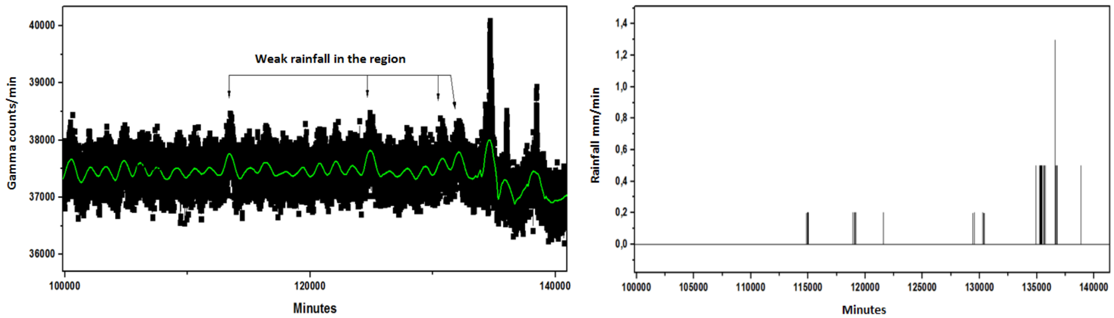
Figure 3:



Monitoring of gamma radiation and rainfall in the period from 08/08 to 23/08 of 2017

During the period from 100000 minutes to 140000 minutes referring to 09/30 to 10/03 in the graph below, a long dry period is observed except for four small moderate rains identified below, with the gamma radiation picture oscillating in the passage days and nights. Note that the radiation is more intense during the day. This occurs from the origin of the greatest exhalation of radon gas from the soil. Exactly on 09/29 there was a strong rainfall observed in the highest peak of gamma radiation shown in figure 4, and another two moderate rains in the later days.

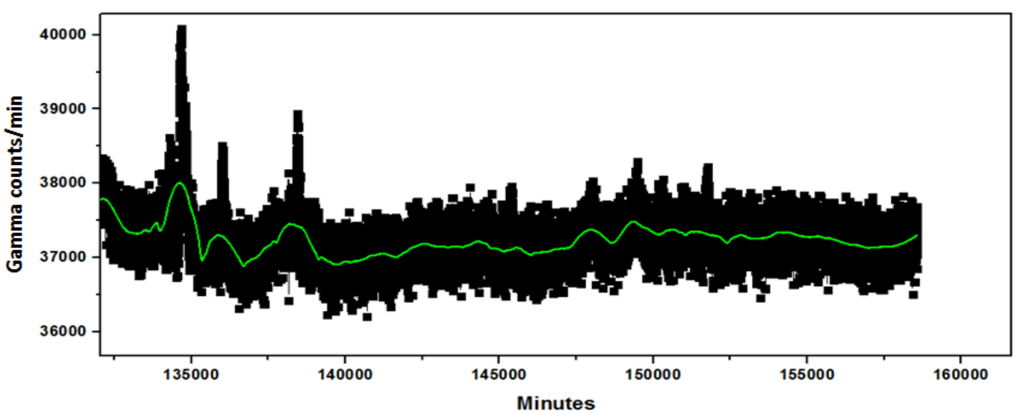
Figure 4:



Drought period in the range of 100000 to 130000 minutes followed by heavy rain. Green line is 1 day smoothed

Soon after the rainfall of 135000 minutes, the gamma radiation begins to stabilize, as well as the standard regime of rain in the region of São José dos Campos, as shown in figure 5.

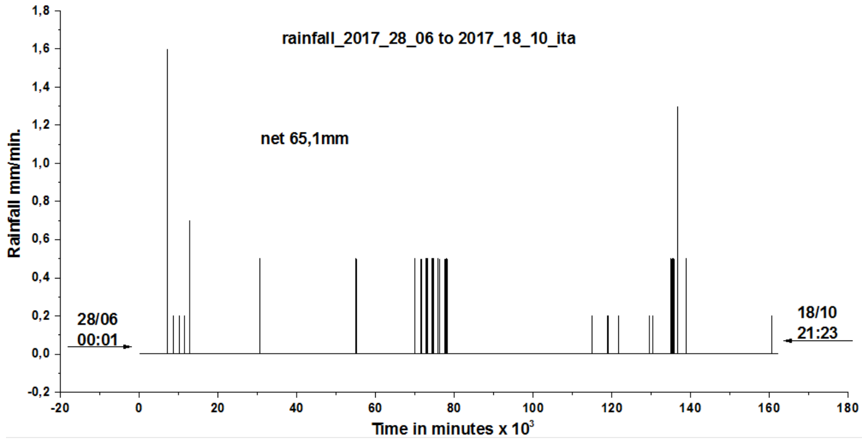
Figure 5:



Measuring period after rains occurring around 135000 minutes. Green line is 1 smoothed day

Analyzing the dynamics of gamma radiation measured from minute to minute as a function of time at a fixed location, one can also observe the dynamics of the variation of rainfall occurring in the same place. Figure 6 shows the rainfall spectrum as a function of time measured in the same period and in the same place always with a one-minute interval between each measurement performed.

Figure 6:



Spectrum in function of the time of the rains occurred every minute between 06/28 to 10/16 of 2017

IV. CONCLUSION

In this study using a gamma ray detector in the energy range (0.2 to 10.0 MeV) it was possible to correlate measurements of this gamma radiation with measurements of rainfall of the region, performed in the period 06/28 to 10/16 of 2017. This rainfall / radiation correlation is very noticeable in the tropical region of Brazil, which is certainly due to the presence of the decay of Uranium ^{238}U in the Radium ^{226}Ra and decaying in the Radon ^{222}Rn with emissions of α particles and low energy gamma radiation.Once calibrated between the intensity of rain and the intensity of gamma radiation at the site it becomes possible to measure rain intensity by monitoring the gamma radiation in the region. Another work is being carried out in order to show this calibration (rainfall/radiation) with tests carried out in the ITA laboratory.

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