RESEARCHERID
THOMSON REUTERS

[Martin, 5(9): September 2018] ISSN 2348 – 8034
DOI- 10.5281/zenodo.1412382 Impact Factor- 5.070

GLOBAL JOURNAL OF ENGINEERING SCIENCE AND RESEARCHES

GAMMA RAYS INTENSITY VARIATION FROM APRIL TO AUGUST 2018 IN SÃO JOSÉ DOS CAMPOS, BRAZIL REGION

Inácio Malmonge Martin
Technological Institute of Aeronautics – ITA, SP, Brazil

ABSTRACT

During the period from April 23 to August 29, 2018, the intensity of low energy gamma ray (200 keV to 10.0 MeV) were measured at the ITA campus in the region of São José dos Campos, SP, Brazil. On this occasion between local autumn and winter, there were only one intense rainfallsperiod and some covers of temporally clouds in the region. The gamma ray was monitored each 1 minute intervals and averaged for one day, throughout the net time interval considered in this study. A portable low energy gamma ray scintillator detector was usedmanufactured by Ludlum Enterprises from USA. This system, which consists of a gamma scintillator crystal of (3" x 3") NaI(Tl) and one photomultiplier with High Tension (HV) andwith data acquisitionsoftware, was tested in the experimental ITA Physics laboratory. The detector show good performance and resolution in detecting gamma photons in the energies released by radioactive sources of Cesium (^{137}Cs) in 662 keV pick and Cobalt (^{60}Co) in 1,17 MeV and 1,33 MeV picks. The dynamics of these intensities of gamma rays was studied during thenet period in this tropical region of Brazil. Maximum value measured in the period comings to 41500 counts/min. and minimum arrives to 37000 counts/min, depending of rain, clouds and local temperatures. Mean value during the day is higher than during night in the region. On dry and hot days, the increase on measured gamma ray intensity was clearly visible, revealing greater exhalation of the radon gas of the region's soil. Discussion on this dynamics of low energy gamma rays and radon gas presence in the region was discussed in this article.

Keyword: *gamma rays, rainfalls, radon gas.*

I. INTRODUCTION

At the ground level interface of the Earth's surface, ionizing radiation it is composed mainly of gamma ray, soil telluric radiation, primary and secondary cosmic ray radiation [1, 2,3]. However, it is difficult to separate over time the intensity of the ionizing radiation emanating from each component as the energies overlap.The telluric radiation is given by ^{238}U, ^{235}U, ^{40}K and ^{232}Th disintegration's series that are constant for each region. The gamma ray coming from radon gas arrivingthrough the ^{238}U in Earth's crust disintegration to ^{226}Ra and ^{222}Rn reaching the stables isotopes ^{214}Pb, ^{214}Po and ^{214}Bi.Radioactive elements such as Uranium, Thorium and Potassium are found in almost all types of rocks, sands, soils and water [4]. The Radium ^{226}Ra and its decay products are responsible for a major fraction of the dose of internal emissions received by humans. ^{226}Ra has a half-life of 1,600 years, and decays to Radon ^{222}Rn, which has a half-life of 3.82 days. The decay of ^{222}Rn is followed by successive disintegration of short half-life alpha, beta and gamma ray emitters. After decay stages, the radioactive chain ends with stable lead ^{206}Pb. With regard to soils and rocks, the ^{226}Ra is present in virtually all soils and rocks in varying amounts. Areas with high levels of background radiation found in some soils are due to geological conditions and geochemical effects and cause increased terrestrial ionizing radiation. Researches in the world, and specifically in Brazil, show these conditions. Several studies report variations throughout the day of radon concentrations. Maximum concentrations are observed in the first hours of the day and the lowest values are found late near afternoon, when concentrations are about one third of morning values. The same profile is observed with the gamma ray intensity variation in the tropics region. However, it is likely that variations in concentrations in localities of gamma ray intensity are dependent on local meteorological parameters (rain, wind, pressure, temperature and cloudiness) in the gamma ray detector site [5, 6].Electrical discharges in low atmosphere of the region also can contribute with production of low energy gamma raynear ground level.

II. METHOD & MATERIAL

To monitor the gamma radiation in interval between 200 keV to 10.0 MeV, it has been used a portable system detector composed of sodium Iodide scintillator activated with Thallium NaI(Tl).This crystal 3” x 3” inches (diameter and height) placed in a thin cylinder of aluminium foil and coupled with a PM (photomultiplier) with source power circuit settled in 1500 VDC and with data acquisition system provided by the company (Aware Electronics-Inc., USA)[7]. Detector and associated electronics of gamma ray were previously calibrated in ITA (Technological Institute of Aeronautics) laboratory using radioactive sources Cs- 137 and Co-60 in terms of energy from emitted photons 662 keV and 1,17 MeV, 1,33 MeV respectively [8]. The data acquisition in terms of gamma radiation and intensity of rainfall was performed using 1-minute time interval between each measurement. This detail contributes to verify possible correlations between variation of rain intensity, and local ionizing radiation. The set of devices were installed at a room 25 meters high from the ground where it was monitored gamma rays and all associated electronics [9]. The rain detector is placed on the outside on top of the room with electrical and electronic interface while cables connected in computers and data logger inside room. Figure 1 shows the structure of the tower on the outside view, closed, with controlled room temperature of 20 degrees Celsius.

Fig. 1–Outdoor view of tower where the gamma ray detectorare installed.

III. RESULT & DISCUSSION

The measurements were performed between April 23, to August 29, 2018in one room of tower in 25 meters high viewed in Figure 1.The counts /min. in function of time for each minute is presented in Figure 2. During the monitoring period of gamma, radiation between the start up to 140 x 10^3 minutes there was no rain. This fact is shown in the gamma radiation monitoring chart showing day / night variation. This variation was caused by the exhalation of the radon gas in the region due to the variation of the soil depicted in zoom 1 (Figure3).

ISSN 2348 – 8034
Impact Factor- 5.070

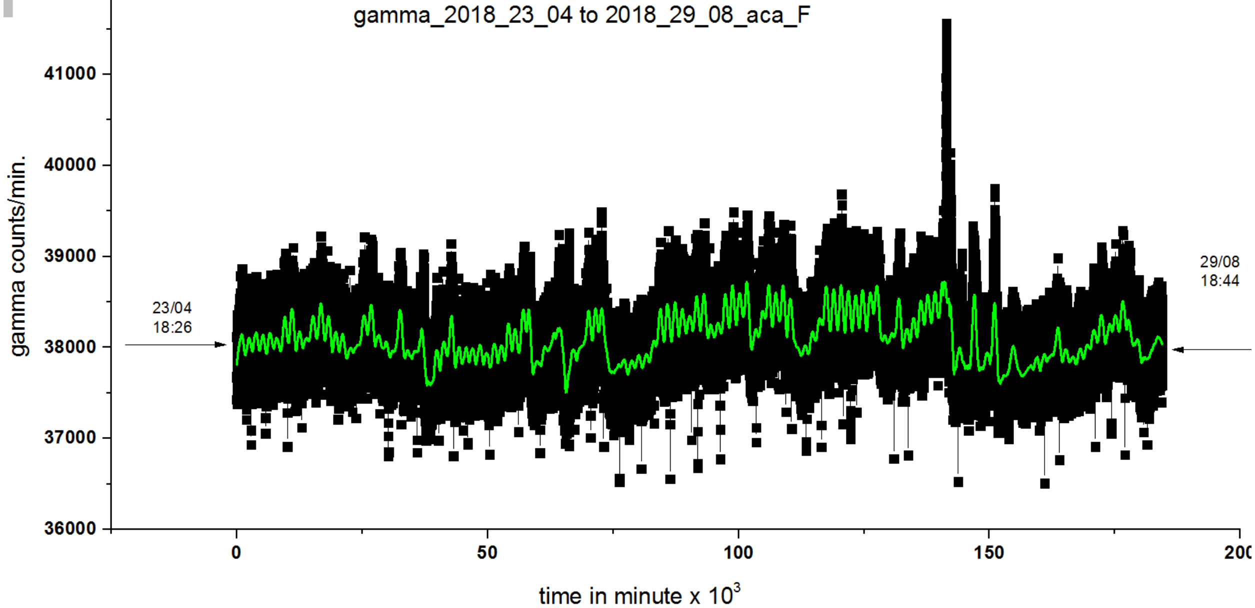

Fig. 2 – Gamma radiation (counts /min.) in function of time during all period from 23/04 to 29/08 of 2018. The green line correspond smoothed curve of one day

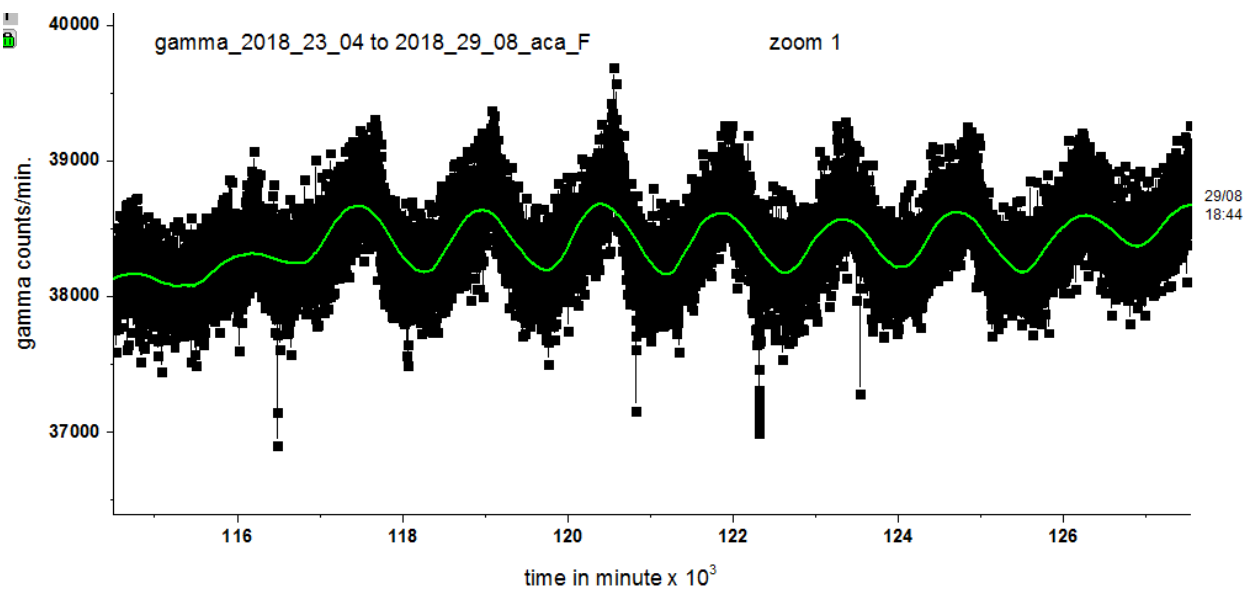

Fig. 3 –Monitoring of gamma radiation (counts/min.) during time of 116 x 10^3 to 127 x 10^3 with clear day/night variation. Green line corresponds of 1 day smoothed values

Figure 4 shows the monitoring of gamma radiation between the time intervals from 140 x 10^3 to 152 x 10^3 minutes, where there were heavy and weak rains in this weak. There was an increase in gamma radiation at the time when these intense rains occurred. The first pick of gamma radiation corresponding to a rainfall of 27 mm.

[Martin, 5(9): September 2018]
DOI- 10.5281/zenodo.1412382

ISSN 2348 – 8034
Impact Factor- 5.070

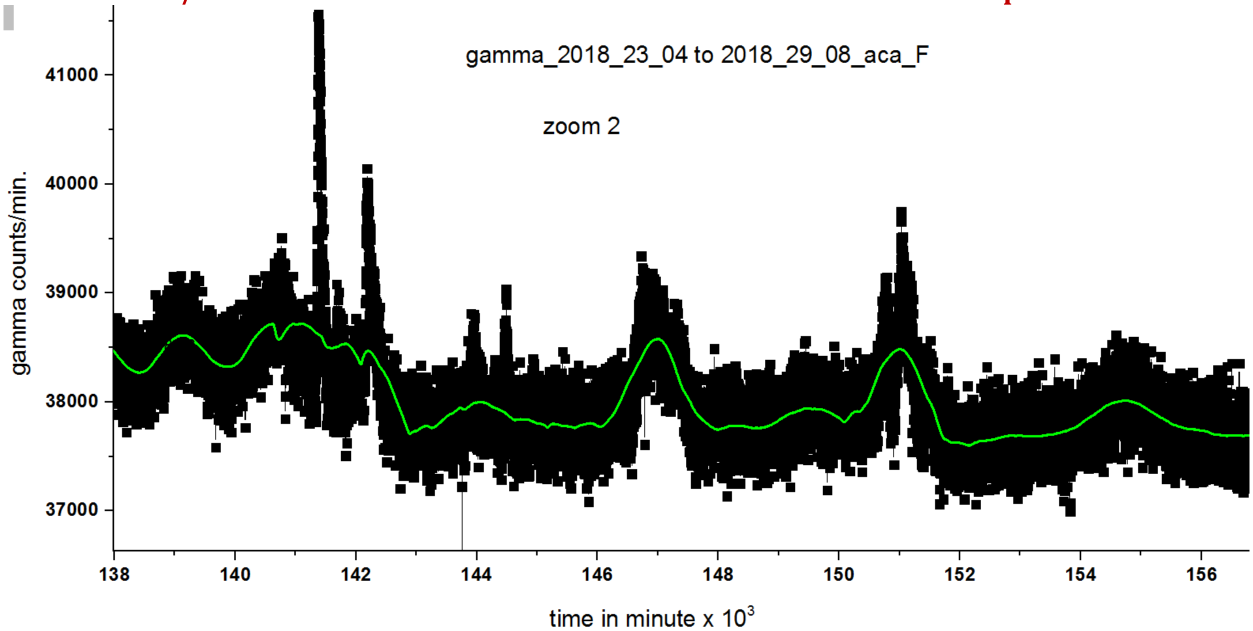

Fig. 4 –Increasing of gamma radiation during rainfalls occurred in this period. Green line correspond 1 day smoothed curve. The intensity of rain net on zoom 2 period correspond to 58 mm

Figure 5 shows the monitoring of the gamma radiation during the period 160 x 10^3 to 180 x 10^3 after the rains, thus returning the day / night variation due to the exhalation of the radon gas in the site.

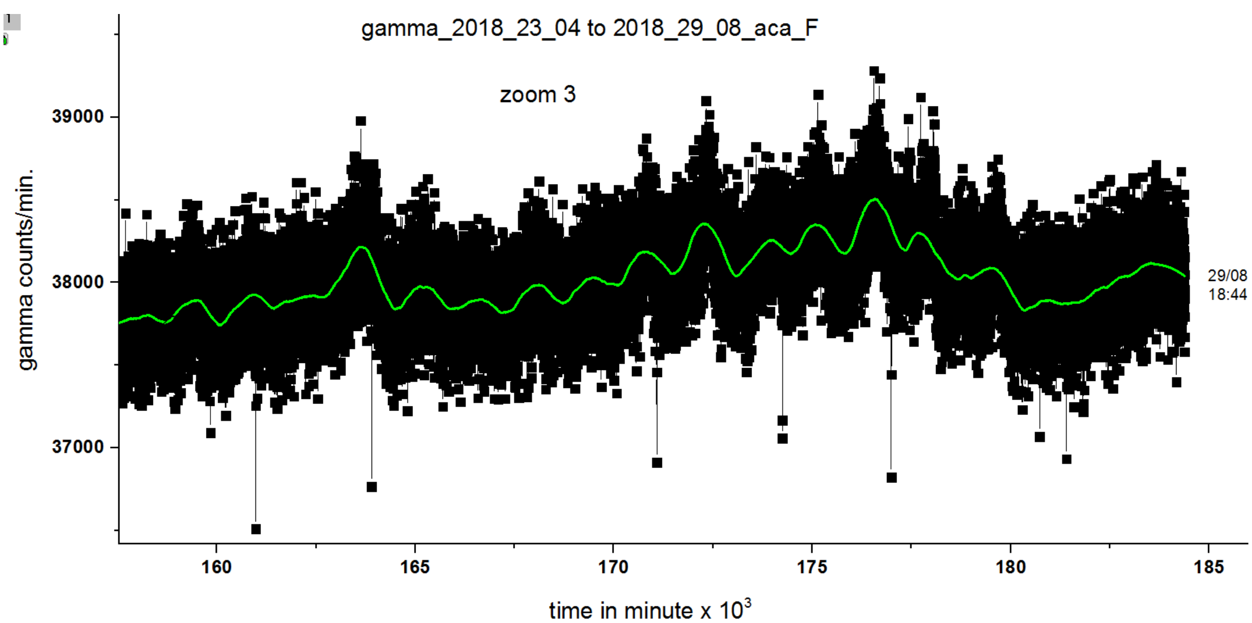

Fig. 5 –Monitoring of gamma radiation on zoom 3 periods after rainfalls in the region. The green line correspond theone day smoothed curve

Throughout this range of measurements in gamma radiation at the site from 04/23 to 08/29 of 2018 was observed according to Figure 2, three sub-periods zoom1, zoom2 and zoom3 who there were typical variations in the monitoring of local radiation. These changes in the intensity and morphology of gamma radiation were altered by distinct meteorological parameters in the region.

The zoom1 sub period corresponds to clear cloudless days with temperatures of 25^0 C during the day and 15^0 C during the night. Under these conditions, the measured gamma radiation presents greater intensity during the day due to the greater exhalation of the local radon gas. This dynamic of variation is very noticeable in Figure 3.

The measurement of the gamma radiation contained in the time corresponding to the sub period zoom 2 was with clouds and rains more and less intense. In this case during the rainfall there is an increase in gamma radiation due to the washing of the radon gas from the clouds to the surface of the Earth. In this range of measurements day / night variation is not observed.

The radiation measurements shown in the sub-period zoom 3 vary day / night but not as well defined as zoom 1 shows. This is because in this zoom period 3 stratified clouds remain in the low atmosphere of the region.

IV. CONCLUSION

During the monitoring period of gamma radiation between 23/04 and 29/08 there was a week with strong variable rainfall. The whole period before and after the rains, was dry with temperatures varying between day and night of 30^0 C and 15^0 C of maximum and minimum values? Then it is verified that in the tropical region as São Jose dos Campos. SP, Brazil the intensity of gamma rays between 0.2 and 10.0 MeV reflects the perfect exhalation of the radon gas from the Earth's surfaces. During a rainy period the radon gas contained in the lower atmosphere is washed and falls in the soil increasing in the first occurrence of rain and increasing the intensity of gamma radiation. After the first occurrence of rain the exhalation of radon gases decreases and the presence of gamma radiation decreases and does not clearly present the day / night cycle variation.

Checking the data series of Figure 2, which contains an uninterrupted 180000 minutes of gamma radiation measurements, it is possible to identify: dry and humidity period, number of cold fronts that have passed in the region, intense and weak rains occurring in the region. This simple and very easy operation can be used for measurements of meteorological parameters in a tropical region.

V. ACKNOWLEDGEMENTS

Thanks to CNPq (National Counsel of Technological and Scientific Development) and CAPES (Coordination for the Improvement of Higher Education Personnel) by the fellowships grants support to the group's researchers and the ITA Division of Fundamental Sciences for supporting this research.

REFERENCES

1. *Fujinami, N. 2009. "Study of Radon Progeny Distribution and Radiation Dose Rate in the Atmosphere." Japan Journal Health Physics 44 (1): 88-94.*
2. *Bui, Van, N. A., Martin, I. M., and. Júnior, A. T. 1988. "Measurements of Natural Radioactivity at Different Atmospheric Depths." Geophysics Magazine 28: 262-266.*
3. *Grieder, P.K.F. 2010. Extensive Air Showers, Book Springer: Verlag Berlin Heidelberg.*
4. *Inacio M. Martin, Douglas C. Vilela and Marcelo P. Gomes; "Dynamics in Times of Ionizing Radiation and Rainfalls in Tropical Region of Brazil"Asian Review of Environmental and Earth Sciences, Vol.4, No. 1, pag. 7-11, 2017, Doi: 1020448/jornal.506.2017.41.7.11*
5. *Inacio M. Martin, Anatoli A. Gusev and Franklin A. Silva; " Dynamics of Radon Gas Near Ground Level in São José dos Campos Region During April-May 2018" Global Journal of Engineering Science and Researches, Vol. 5 pag. 117-120, DOI: 10.5281/zenodo.1288483, June 13, 2018.*
6. *Marcelo Pego Gomes, Franklin Andrade Silva, Inacio Malmonge Martin and Bogos Nubar Sismanoglu; "Monitoring of Gamma Radiation and Meteorological Parameters at Ground Level in São José dos Campos,*

[Martin, **5(9): September 2018]** **ISSN 2348 – 8034**
DOI- 10.5281/zenodo.1412382 **Impact Factor- 5.070**

Brazil" IMPACT: International Journal of Research in Engineering & Technology, Vol.4 No. 8, pag. 19-22, Aug. 2016

Boardman, B. J.: User's Page. 2015. Aware

7. *Electronic Corp. https://www.aw-el.com/Accessed in 07 September 2018.*
8. *Matheus Carlos Silva1, Douglas Carlos Vilela1, Victor G. Migoto1, Marcelo P. Gomes1, Inácio M. Martin1 and Silvério J. Germano1, Ionizing radiation measurements using low cost instruments for teaching in college or high-school in Brazil published to Physics Education, may 2017 see http://iopscience.iop.org/journal/0031-9120.*
9. *Martin, I. M., Gusev, A. A., Santos, T. A., and Sismanoglu, B. N. 2015. "Radon Gas and Increasing Intensity of Gamma Radiation Near Ground Level Interface on 2011 in Sao Jose dos Campos, SP, Brazil." International Journal of Research in Engineering & Technology 3: 31-8.*