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[Martin, 5(6): June 2018] ISSN 2348 – 8034
DOI- 10.5281/zenodo.1288483 Impact Factor- 5.070

GLOBAL JOURNAL OF ENGINEERING SCIENCE AND RESEARCHES

DYNAMICS OF RADON GAS NEAR GROUND LEVEL IN SÃO JOSE DOS CAMPOS REGION DURING APRIL-MAY 2018

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ABSTRACT

During the months of April and May 2018, continuous monitoring of radon gas was carried out in an open room of the laboratory of Experimental Physics of the ITA, with which it was possible to determine the dynamics of this gas in this period. These months were totally dry with no rain alternating cold nights and hot days with a few mornings of fog and clouds. Radon gas was monitored at 10-minute intervals and averaged for 1 hour through a Smart Radon Detector (RadonEye RD200) ionization chambre. The accuracy of this chamber was of (0.06 pCi / l) in these measurements. Day / night cycles were well delineated in almost every measurement period except when there was heavy fog in the morning or when the sky was 70 to 100% overcast. It was verified in the measurements that the intensity of measured radon gas was higher always in the period from 3 to 7 o'clock in the morning and minimum between 14 and 17 o'clock in the afternoon. The maximum intensity in the period reached 3.2 pCi / l or ~ 110 Bq / m3. The mean intensity of the period was ~ 45 Bq / m3 equivalent ~ 1 pCi / l. On dry and hot days the increase in measured intensity was very visible, revealing greater exhalation of the radon gas of the region's soil. Discussion of this dynamics of radon gas presence in the region was carried out in this article.

Keywords: *radon gas, alpha particles, meteorological parameters.*

I. INTRODUCTION

Anywhere near the earth's surface, the low energy ionizing radiation up to 10.0 MeVis practically all coming from the exhalation of radon gas from the earth's crust [1]. Radon gas comes from the decay of ^{238}U present on earth since its formation. Radioactive elements such as uranium, thorium and potassium are found in almost all types of rocks, sands, soils and water [2]. The Radium ^{226}Ra and its decay products are responsible for a major fraction of the dose of internal emissions received by humans [3]. ^{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 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 [4]. The isotope ^{222}Rn, with a half-life of approximately 3.82 days, has a greater opportunity than the short half-life isotopes of escaping the atmosphere. The great importance attributed to this isotope in relation to human exposure is related to the fact that it has a longer half-life [5]. 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 in the afternoon, when concentrations are about one third of morning values. Over the course of a year, the ^{222}Rn levels tend to peak in the fall or winter months and have lows in the spring. This variation is consistent with atmospheric turbulence patterns, which tend to be higher in the spring [6]. However, it is likely that variations in concentrations in localities are dependent on local meteorological factors (rain, wind, coefficient are related to the grain size, which determines how much radium is close enough to the surface to allow radon to escape into the pores. In general, the radon emanation factor is inversely proportional to the grain size [7]. Radon emanation is also related to grain density, their porosity and the partition coefficient between air and water, which is the ratio between the concentrations of radon in air and water. The factors influencing this like temperature, pressure, etc., which influence the rate of exhalation of the soil gases and dispersion in the atmosphere. Thus, the exhalation rate of the soil can increase during periods when the atmospheric pressure decreases. The fraction of radon atoms released by the radium in the pores of rocks and soil is called the emanation coefficient.

II. MATERIAL AND METHODS

According to Tell, I., et al. [5], more than 60% of the radon found in indoor environments comes from the soil of the foundation and the soils around the building. Based on this experimental claim and knowing that radon decays into particles α followed by gamma radiation, both of energy lower than 10.0 MeV, in this work, it was decided to monitor the variation of gamma radiation at the site [8,9]. Then at the same time and even site, an alpha particle detector and a Geiger counter were used to monitor charged particles and gamma rays at that energy interval. The radon gas detector is a portable ionization chamber as shown in Figure 1. It is powered with 110 or 220 VAC with a source that releases + 12 VDC to the ionization chamber. It can measure hourly counts between 0.00 and 10000.00. These counts can be transformed into pCi / l or by Bq / m^3 directly by the FTLab application software that is acquired jointly the detector. To acquire the data you need to download the Radon Eye FTLab application with an iPhone PC connecting or Android Smart appliances. This application can generate files on each download and can be saved in txt. All instructions are given in reference [10].

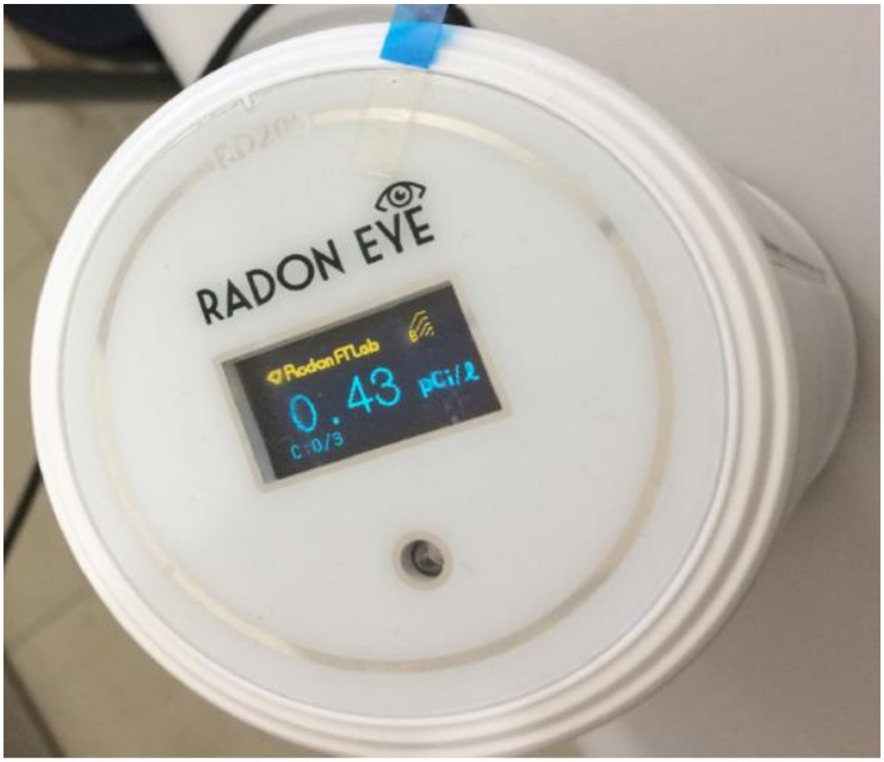

Fig. 1 – Top view of the RD200 RadonEye ionization chamber used to monitor radon gas

The gamma ray detector and charged particles is a Geiger made with a tube (G-M) of Russian manufacture. The tube is constructed of metallized ceramic material inside of the tube and cylindrical in shape. In this way, it only allows passage of charged particles with energies greater than 5.0 MeV. This G-M tube Geiger is powered with 500 VDC and data acquisition made via circuits of the Arduino electronic system. The minimum sampling time is 1 minute, where the file can be saved to SD cards or PC. Figure 2 shows this detector along with the graph of its measurements on a PC monitor. These three detectors were placed on the campus of the ITA near the Department of Physics, Laboratory of Experimental Physics. The measurements were carried out outdoors in the months of April and May of 2018, with no rainfall occurring during this period.

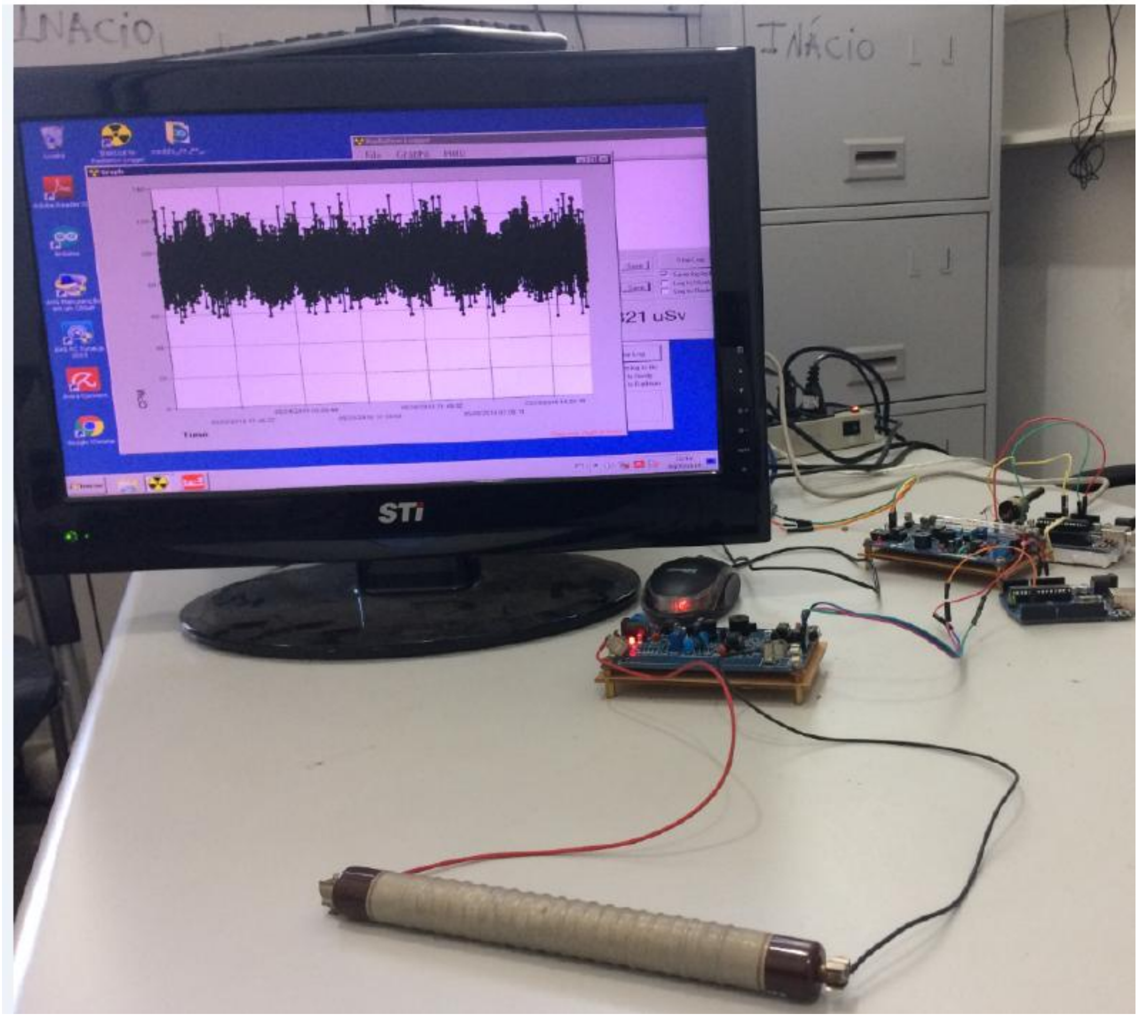

Fig.2 Front view of Russian GM tube, associated electronics and graphic recorded on a PC.

III. RESULTS AND DISCUSSION

The radon gas detector (RadonEye RD200) was installed next to the Department of Physics - Laboratory of Experimental Physics local open protected from the sun and rain. In the period from April to May 28, 2018 was monitored hourly continuously without human interference always in the same place. Figure 3 shows the curve profile with day / night variation in general with maximums between 05:00 - 07:00 hours and minimum between 14:00 - 17:00 hours local time. During foggy mornings days this normal profile is modified as shown in Figure 4.

ISSN 2348 – 8034
Impact Factor- 5.070

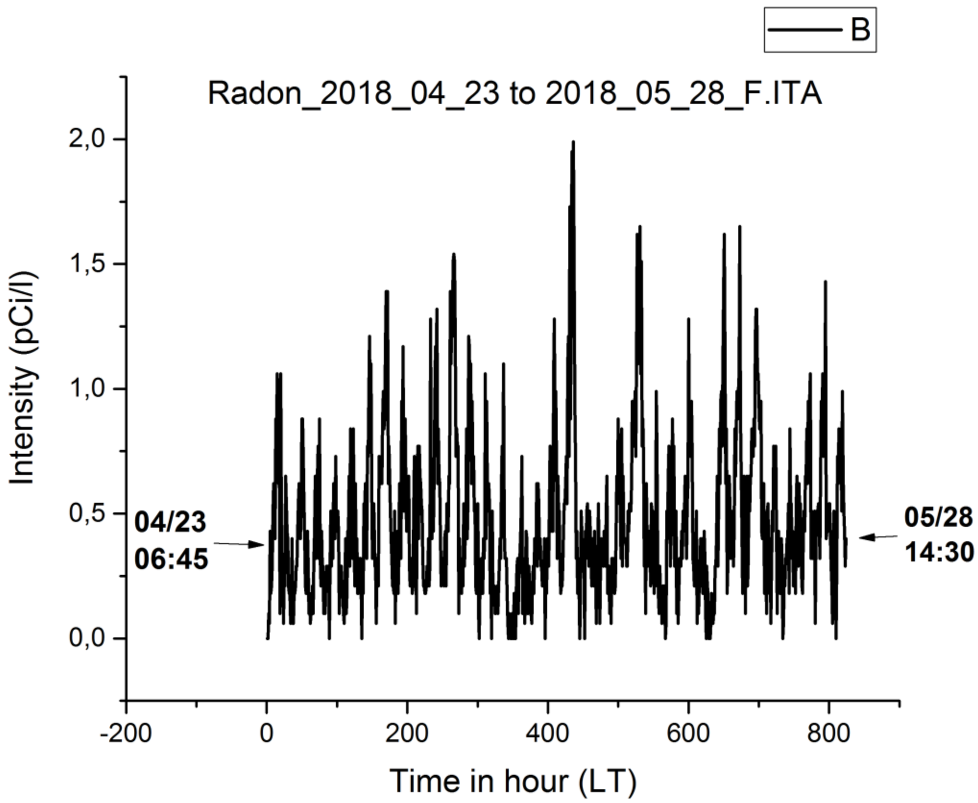

Fig. 3 – Monitoring of radon gas in outdoor region of ITA physics laboratory

During the time of 05:00 to 08:00 minutes in morning intense fog occurred during 01/05 to 03/05 of 2018. So the intensity of radon gas was modified relative to a normal day. It is showed in figure 4 one zoom part of end of Figure 3 where this fog are present near ground level of region.

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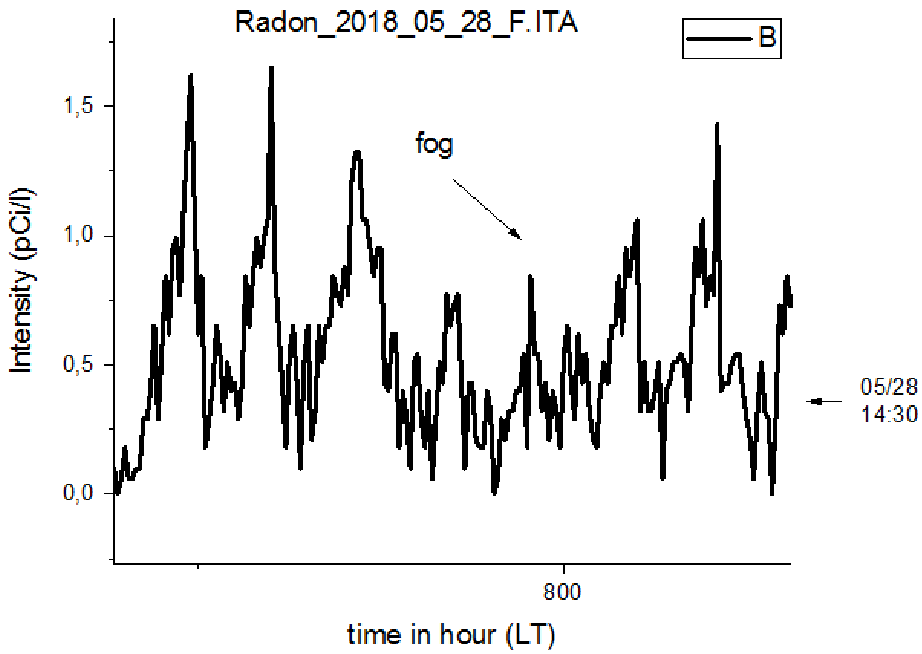

Fig. 4 – Monitoring radon gas during morning fog days in the region.

This figure 4 is a part of Figure 3 where a "zoom" was highlighted showing this phenomenon.

In the Figure 5it is plotted the ionizing radiation curve during the same period of these measurements of radon gas. These monitoring it was realized using a Geiger-Muller Russian tube Geiger counter justin the same site of radon gas monitoring.

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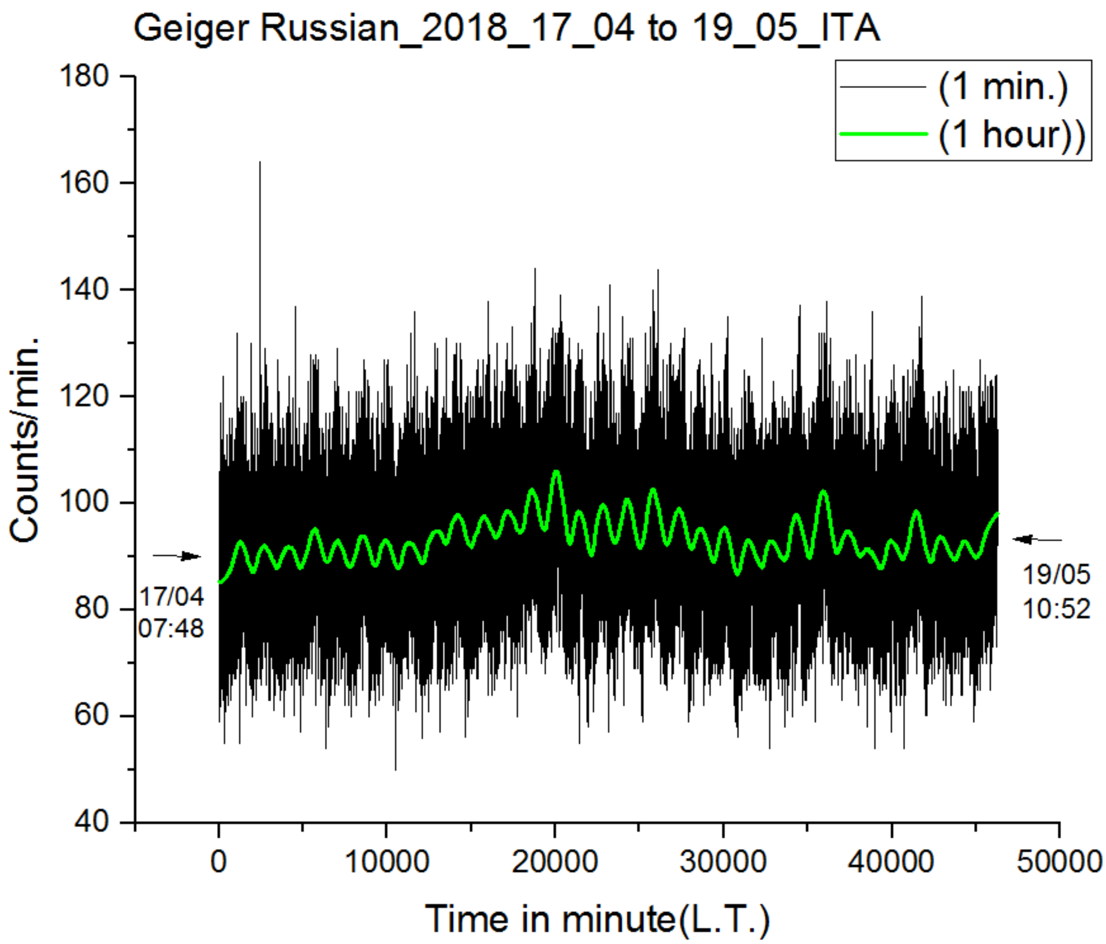

***Fig.5 – Monitoring from Geiger Russian during 17/04 to 19/05 of 2018.Green line is smoothed curve of 1 hour*.**

It can be seen in the measurements of ionizing radiation (gamma rays and charged particles) that the day / night cycles presented in the monitoring of Figures 5 and 6 are correlated and similar in time with measurements of radon gas monitoring of Figure 3.Really the May 2018 was the more dryer month during a period of 60 years on the past of region. For this reason it was very noticeable during this period that the exhalation of radon gas caused a well-known cyclic variation of 1 day in the region. The presence of this gas as of the ionizing radiation at the ground level interface of the region had seen for the first time in Brazil correlated.

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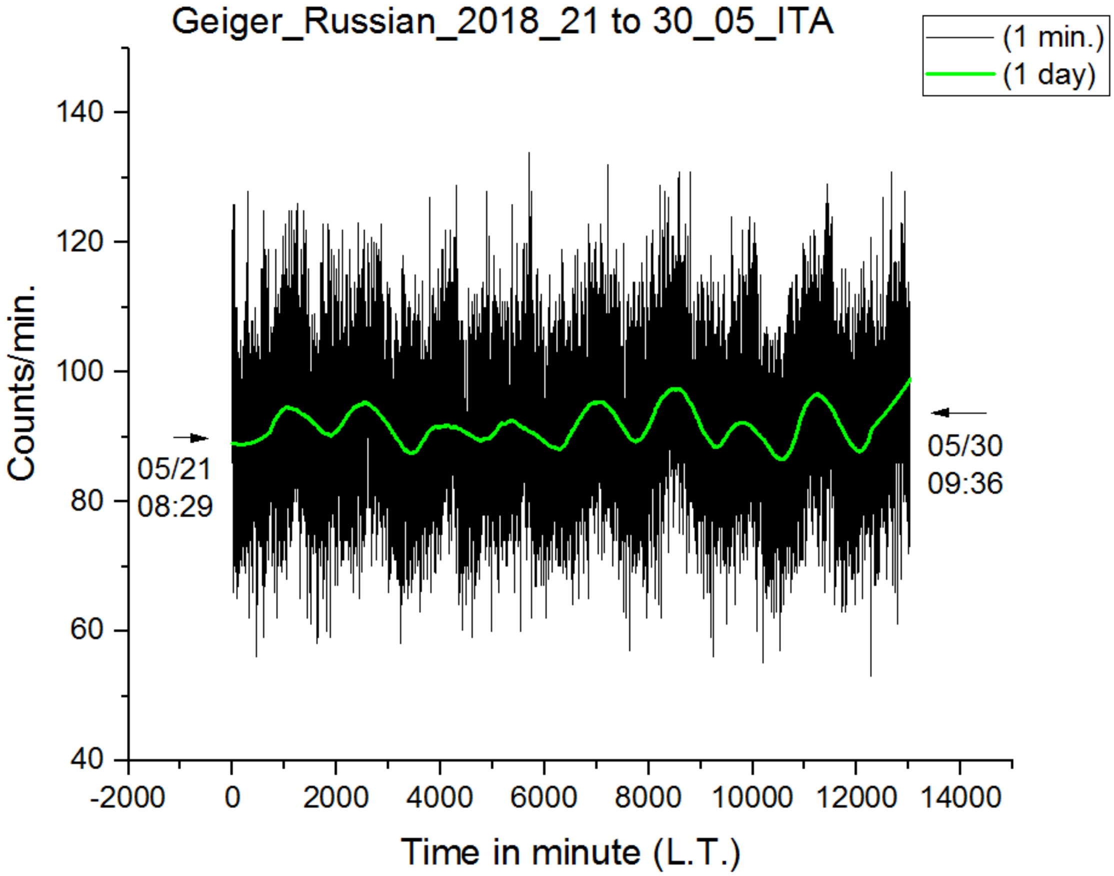

Fig. 6 – Monitoring from Russian Geiger during 05/21 to 05/30 of 2018.

IV. CONCLUSION

The intensity of radon gas and the variation of the flux of the ionizing radiation in the São José dos Campos region, SP, Brazil, were monitored during the dry months of April and May of 2018. The high insolation rate during dry days and low relative humidity caused the exhalation of the radon gas from the soil during the morning. In the afternoon with higher temperature and greater turbulence of the fresh air, it brought less intensity of the radon gas. This dynamics was observed using measurements of both radon gas, gamma radiation and charged particles using a Russian-made Geiger Muller Counter. Both instruments are portable and easy to operate, allowing them to be explored for teaching and research in secondary and higher schools in Brazil

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