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RADON GAS INTENSITY VARIATION FROM APRIL TO JULY 2018 IN SÃO JOSÉ DOS CAMPOS, BRAZIL REGION

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ABSTRACT

During the period from April 23 to July 23, 2018, the intensity of radon gas was measured at the ITA campus in the region of São José dos Campos, SP, Brazil. On this occasion between autumn and winter there were no rains, but covers of temporally clouds and drizzles in the region. Radon gas was monitored each 10-minute intervals and averaged for one hour, throughout the time interval considered in this study. A portable radon detector was usedmanufactured by RadonEye RD200 from South Korea. This system, which consists of an ionization chamber, was tested in the experimental ITA Physics Laboratory, showing good performance in detecting alpha particles in the energies released by radon gas with minimum intensity precision of 0,06 pCi/l. The dynamics of this gas was studied during the period in this region of Brazil. Maximum value observed in the period comings to 2, 0pCi/l and minimum arrives to 0.06 pCi/l in that region of Brazil. Mean value during the day stay in 0,6 pCi/l during these periods of monitoring.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 on this dynamics of radon gas presence in the region was carried out in this article.

Keywords: *radon gas, alpha particles, monitoring radon gas.*

I. INTRODUCTION

At the ground level interface of the Earth's surface, ionizing radiation it is composed mainly of radon gas, 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 and are constant for each region. The radon gas comes from the ^{238}U in Earth's crust in disintegration to ^{226}Ra and ^{222}Rn reaching the stables isotopes ^{214}Pb, ^{214}Po and ^{214}Bi giving **α** and **gamma** radiation. 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 [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 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. 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. METHOD & MATERIAL

According to reference[7], 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 archive type extension in(txt). All instructions are given in reference [10].

Fig. 1 – Top view of RadonEye RD200 ionization chamber used for monitoring radon gas

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Fig. 2 –Outdoor view of tower where the scientific device including RD200 are installed.

III. RESULT & DISCUSSION

The measurements were performed between April 23, to July 23, 2018in one room of experimental laboratory of Physics of ITA and in 25 meters high in the ACA tower viewed in Figure 2.

Figure 3 shows the monitoring of radon gas in an open room of an ITA Physics Laboratory from April 23 to May 28, 2018. The maximum intensity measured during this period was ~ 2 pCi / l or ~ 80 Bq / m^3.

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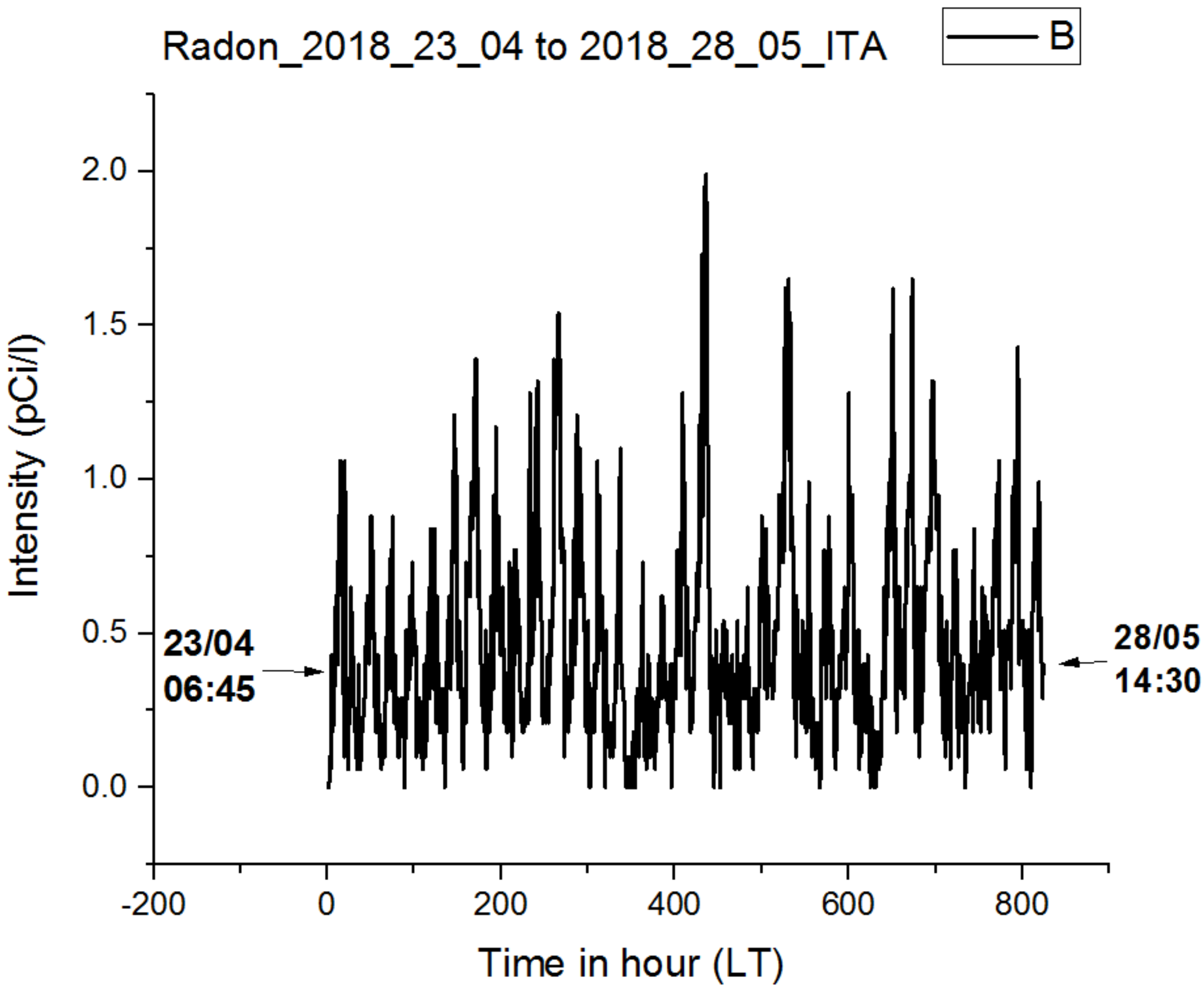

Fig. – 3 Radon gas intensity monitoring during 23/04 to 28/05, 2018 in ITA room laboratory

The periodic variation of the intensity of radon gas at the measurement site is well noticed having maxima at night, mornings, and minimum during local afternoon. The mean value measured during this period time stay in 0.5 pCi/l. No weak or intense rain was recorded at this site during the period. In the period from 28/05 to 11/06 of 2018 the RD200 detector was transferred to the top of a tower with 25 meters of height and placed in an open room. As Figure 4 shows, there were changes in the intensities measured during this period by the passage of a cold front with clouds and drizzles. The day / night period was well highlighted showing maximums near the local dawn and minima in intensity between 10-18 hours local.

Figure 5 shows the monitoring also with the RD200 detector placed in the tower at 25 meters high in the period 11/06 to 23/07 of 2018. In this period also without rain the maximum intensity recorded was 2 pCi / l and minimum of 0.06 pCi / l. There were three intervals with clouds without rain or drizzles that decreased the intensity of the measured radon gas.

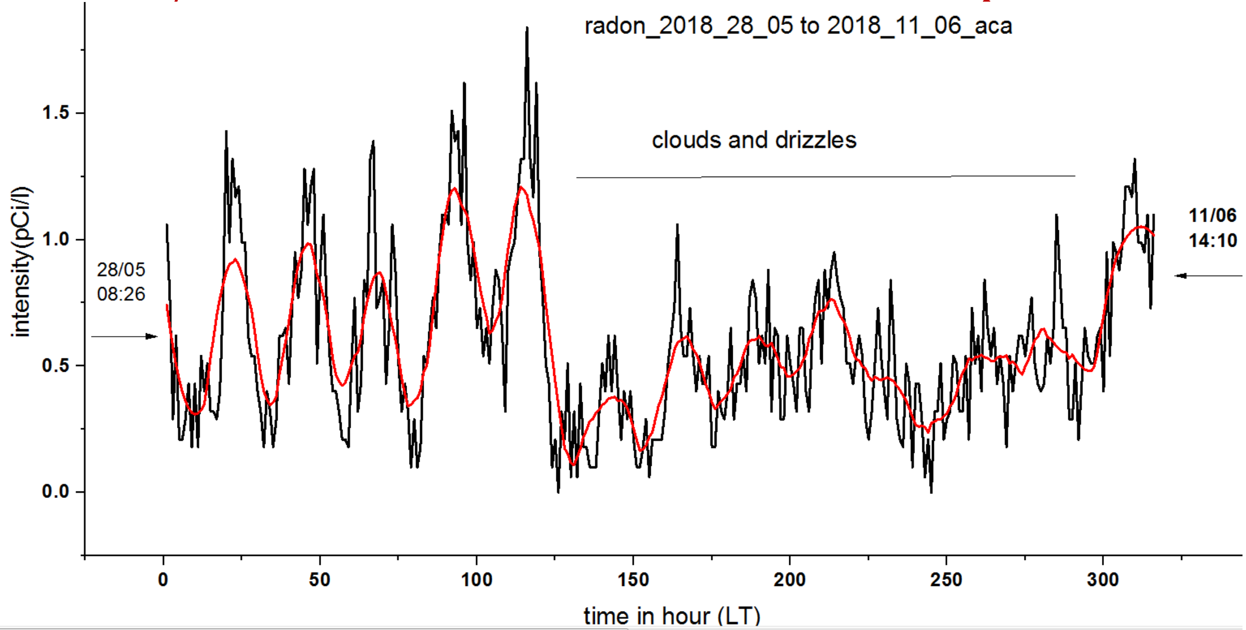

Fig. 4 –Radon gas monitoring in the tower of 25 meters high during 28/05 to 11/06 2018. Red line is smoothed curve of 1-day period.

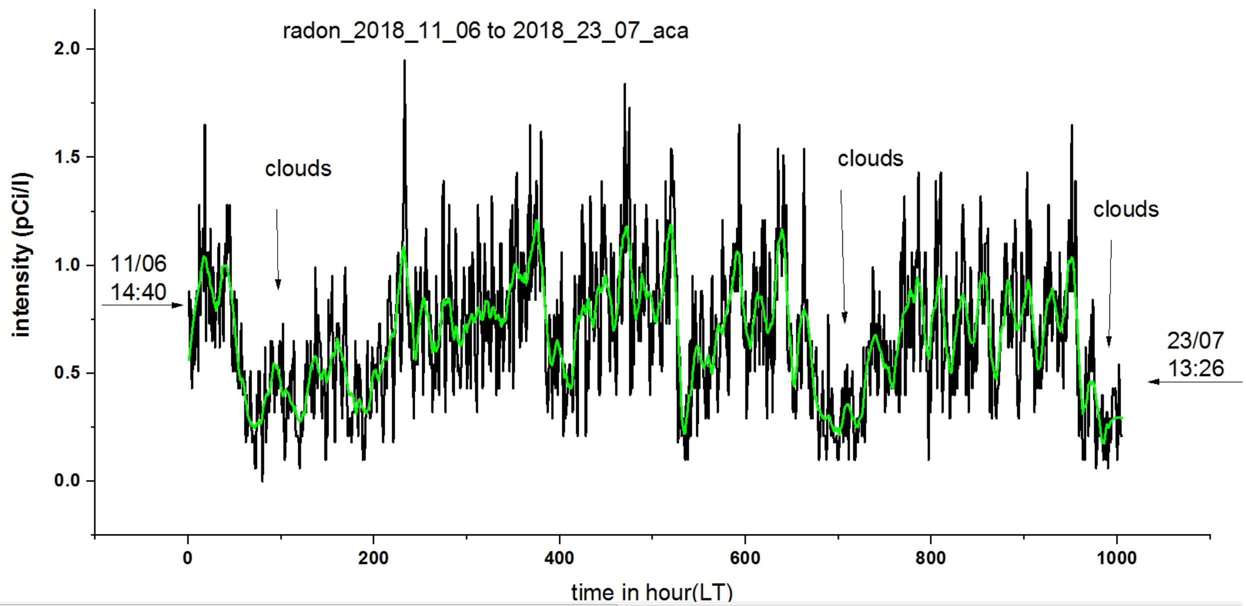

Fig. 5 – Measurements of radon gas in the tower during 11/06 to 23/07, 2018. Green line is 1 day smoothed curve

Between 790 and 990 hours of measurements, the weather was clear and with constant temperature during night (17^0 C) and day (25^0 C) variation. The periodicity day/night was very clear in that period like shows the Figure 6.

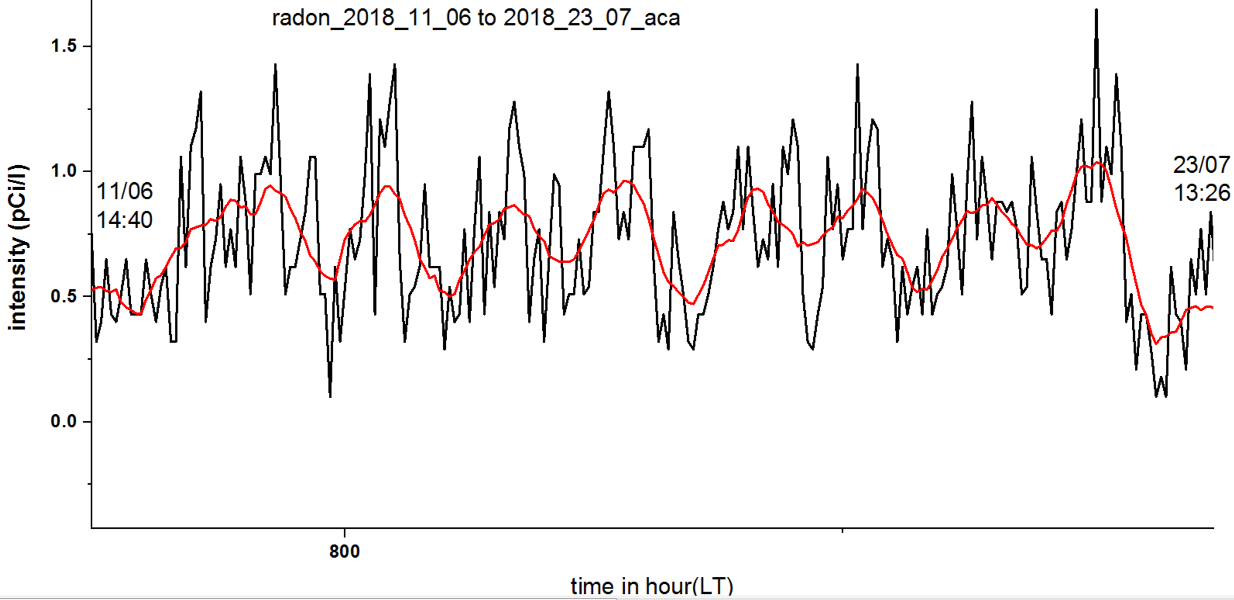

Fig. 6 – Monitoring of radon gas during the 790 to 990 hours take with zoom in the Figure 5. The red line is 1 day smoothed curve of measurements in one hour.

It can be observed in Figure 5 and Figure 6 the different variations of the level of intensity of the radon gas provoked by the variation of the temperature in the soil and by the presence of low clouds in the local low atmosphere sky.The measurements of radon gas carried out between April 23 and July 23, 2018 at the ITA campus in the region of São José dos Campos, SP, Brazil, showed:

1. The heat in the soil is the main source of increase of this gas in the site of the measurements,
2. Total absence of clouds in the region's sky is also a source of gas increase according to the measurements made,
3. Presence of low clouds and drizzles lower the intensities of radon gas at the measurement site.

It was also verified that measurements made in open rooms close to the ground as in the height of 25 meters in the tower did not present significant changes in the intensity and periodicity of the radon gas. As there were no rains in this period of time it was not possible to verify the influence of rainfall in this monitoring region.

IV. CONCLUSION

It was measured at the ITA campus in the region of São Jose dos Campos, SP, Brazil, the intensity variation of the radon gas near the ground. Measurements were performed and saved at one-hour intervals from day 23/04 to 23/07, 2018 without interruption.A newly developed RD200 portable ionization chamberfrom South Korean company called RadonEye was used. This chamber has very good sensitivity between intensities of 0.06 to 10 pCi / l.During the period from 04/23 to 07/23, 2018, with no rain the intensity measured was at least 0,06 to the maximum of 2 pCi / l in the region.In an average interval of one hour at each measurement throughout the period a 24-hour (day / night) periodicity was observed. The maximum measured intensities were verified between 03:00 to 10:00 local hours and minimum between 11:00 to 19:00 local time. The presence of clear sky increases intensities and low clouds and drizzles decreases intensities of the radon gas in the region.

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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, Brazil" IMPACT: International Journal of Research in Engineering & Technology, Vol.4 No. 8, pag. 19-22, Aug. 2016*
7. *TellI.,Bensryd,I.,Rylander,L.,JonssonG.,andDaniel,E.1994."GeochemistryandGroundPermeabilityasDeterminantsofIndoorRadonConcentrationsinSouthernmostSweden."AppliedGeochemistry9(6):647-55.*
8. *Ravisankar, R., Vanasundari, K., Chandrasekaran, A., Rajalakshmi, A., Suganya, M.,Vijayagopal, P.&Meenakshisundaram, V. (2012). Measurement of natural radioactivity in building materials of Namakkal, Tamil Nadu, India using gamma-ray spectrometry. Applied Radiation and Isotopes, 70 (4): 699-704.*
9. *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.*
10. *Smart Radon Detector RD200 RadonEye - https://www.amazon.com/Radon-Detector-Home-Owner-Plus/dp/B07864XVBH accessed 06/06/2018.*