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HOURLY MEASUREMENTS OF GAS RADON INTENSITY THROUGHOUT 2020 YEAR IN SÃO JOSE DOS CAMPOS, BRAZIL

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ABSTRACT

The objective of this article was to show the monitoring of intensity of the radon gas in the ground level interface of earth in São José dos Campos, region of Brazil. The physics laboratory of electromagnetism experiments and the tower ACA both located at the Technological Institute of Aeronautics (ITA) have been choose like monitoring site. During the period of 01/27/2020 to 12/31/2020, monitoring was made at each hours in that region, continuously. Radon gas is present on every land surface of earth, accounting for approximately half of the ionizing radiation exposed to humans. To monitor the intensity of radon gas the detector used was a RadonEye RD200 ionization chamber, where the intensity in the region was obtained in the range of 0 to 3.0 [pCi / l] pico-Curie par liter of air, each hour. The results obtained from these experimental observations system during complete year of 2020, as well as discussions, correlations and suggestions, are presented in this article.

I. INTRODUCTION

Radon gas near the surface of the Earth can be measured through its radioactive decay products (alphas particles). It is estimated that about 48% of the ambient ionizing radiation dose at this ground level interface is coming from radon gas exhaling from Earth [1]. The radioactive series in Earth of (^{238}U) disintegrates in the order of 1600 years the (^{226}Ra) and arrives to radon-222 (^{222}Rn) that in 3.82 days with emission of alphas particles of 5,49 MeV of energy [2]. Radon is a noble gas, alpha emitter, produced in the natural decay series of uranium ^{238}U, which occur at varying concentrations in geological materials, especially rocks, soils and water [3]. By diffusion and convection, radon migrates from rocks and soils into the atmosphere through cracks, holes and pipes, entering homes and other constructions. Thus an easy way to measure radon gas variation at any location is to monitor the presence of alpha particles of that energy in the desired region. This can be done with one portable ionization chamber [4].

In practice, only the isotopes radon (^{222}Rn) is relevant from the point of view of radiological protection or environmental and geological interest [5].

Radon (^{222}Rn) has a half-life of 3.82 days, which allows significant mobility to escape from the rock in which it is generated. Radon occurs naturally in soils in the typical range of 0.1 to 40 kBq / m^3 and in the atmosphere near the earth in the typical range of 0.01 to 50 Bq/m^3. It is estimated that in Brazil the average annual concentration of ^{222}Rn in air varies from 0.6 to 30 kBq/.m^3 [6].

According to the recent measurements, for daytime variations, there are high levels of radon in the morning, at which point the atmospheric turbulence is accentuated, maximizing in the seasonal scale, high concentrations of radon tend to occur in the autumn and winter [7]. However, the radon intensity at the ground level interface varies with temperature, rainfalls, winds and dynamic of cold fronts arriving on measurements site.

II. MATERIAL & METHODS

To monitor the variation of radon gas at the ground level interface it is choose the detector consisting of a RadonEye RD200 portable ionization chamber manufactured in South Korea. The RD200 has sensitivity 20 times higher than other portable radon detectors and has the system in which it releases dual-structure pulses and a highly accurate

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detection circuit designed by FTLab's own technology. A first reliable 1 hour data view is required, where its sensitivity is 1.35 counts per minute equivalent to 0.5 Becquerel / m3. The measurements were performed in the ACA tower at 25 meters high from the ground level and other at the physics laboratory of ITA Institute, both located at the Technological Institute of Aeronautics (ITA). Data acquisition is possible through the available RadonEye application, only on smartphones. Power was supplied via 120 or 220 V to 12 VDC source connected to the detector, where the setting starts automatically. With an Iphone device, the data generated by the RadonEye RD200 detector was transferred through the Itunes software. One Origin 1.5 software was used to graph the curves measurements of the radon intensity versus time realized on ITA campus [8].

Fig.01. ACA tower room at 25 m high above ground level (author)

Fig.02. Data collection of radon gas made with an IPhone in 12/31/2020 (author)

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III. RESULTS & DISCUSSIONS

During the period from January 27, 2020 to December 31, 2020, the radon gas intensity was monitored at the ground level interface in campus of ITA in the region of São José dos Campos, Brazil, (23:17 S.45:88 W). Figure 3 shows the intensity of radon gas as a function of time (hour) during the analysis period carried out in the ITA physics experimental laboratory. In which it is possible to analyze the radon gas intensity variation on the ground level interface at each hour in black line displayed in same figure.

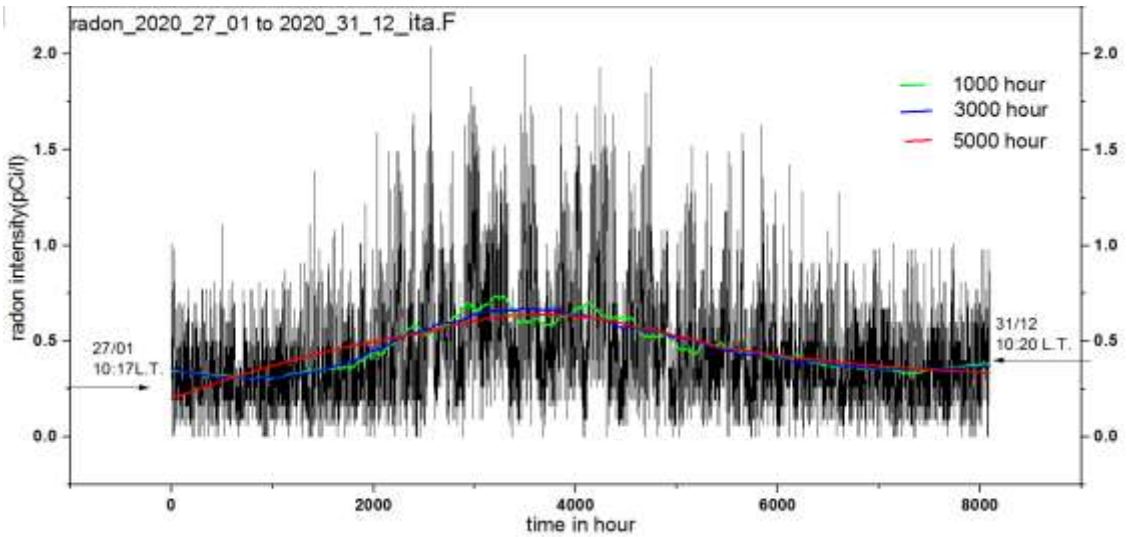

Fig. 03 - Variation of radon gas intensity versus time in hours from 01/27/2020 to 12/31/2020 in ITA laboratory, green line smoothed 1000-hour, blue line 3000 hour and red line 5000 hour (author).

In parallel with the monitoring of the intensity of radon gas in the surface in the laboratory of ITA, the same type and time was made with another RadonEYE RD200 placed at 25 meters high in ACA tower showed in Figure 01 above, correspondence in units [(pCi/ 1)=37 (Bq/m^3)].

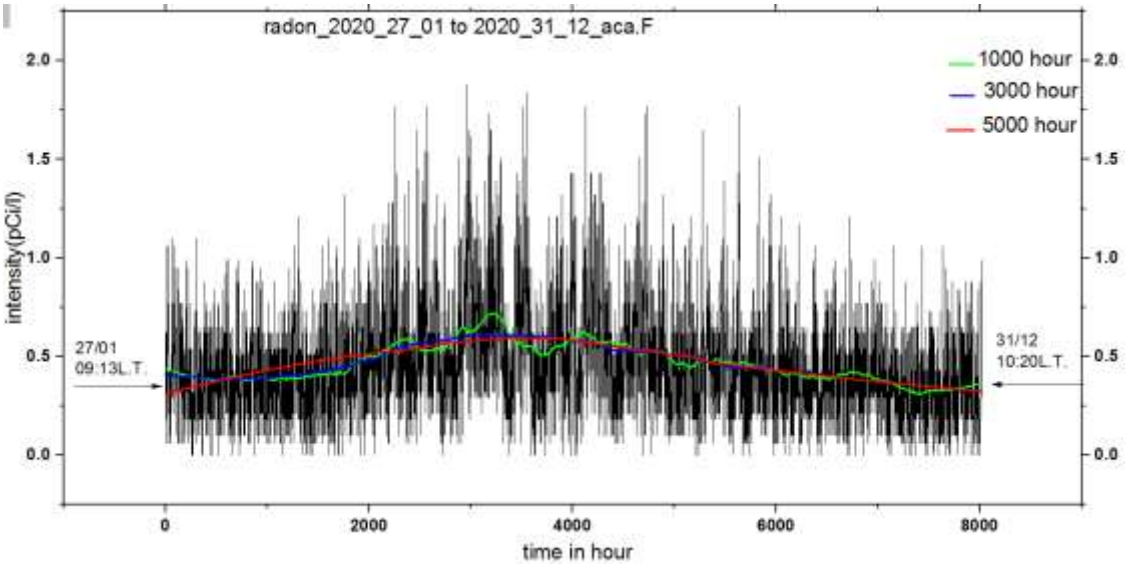

Fig.04 - Variation of radon gas intensity versus time in hours from 01/27/2020 to 12/31/2020 in ACA tower, green line smoothed 1000- hour, blue line 3000 hour and red line 5000 hour (author).

The measurements carried out inside the ACA tower located at 25 m height are shown in Figure 4, with the radon gas intensity monitored during the period from 01/27/2020 to 12/31/2020. The dynamics of the two measurements in time is equal in intensity and format. Really is outdoor measurements but in ACA the high from surface level is 25 meters. In correlation to the measurement time observed in figures 3 and 4, it is possible to notice 3 distinct intervals of these measurements, 0-2000 hours, 2000-5000 hours and 5000-8000 hours, always originating at the beginning time of the measurement. Between 0-2000 hours correspond to the months of January, February and March (summer). This is a rainy season, but this summer (2020) the rain rate was half the expected average. Even so, the intensity of radon gas remained constant and low increased in time. In the range of 2000-5000 hours is perceived the highest measures intensities and still a great variability. It is the season of autumn and winter. Soon more insolation and dry land in this period. In the period of 5000-8000 hours corresponding to spring, autumn and summer, there was a lot of rain twice as much as the normal average, leaving the land very wet in the region and with little variation of radon gas exhalation from ground. Soon there is a correlation between rain, sunshine and dry land with exhalation of radon gas in this region studied in that period.

IV. CONCLUSION

This paper presents the analysis of the radon gas that exists on the surface of the earth in the region. Having as origin from the soil, through the decay of the radioactive disintegration of element Uranium (^{238}U). For this measurements was used a fully portable equipment alpha ionizing chamber (RadonEye RD200), which it allows to monitor the intensity of radon gas each hour. He can be connected to a smartphone in order to acquire and collect the data. By analyzing Figure 3 and Figure 4 it can be stated that the intensity of radon gas at the earth's surface in the region is higher in times of greater insolation and dryer surface. By means of the high temperature in which the soil is on that period the exhalation of the radon gas, becomes greater. In the night period, with the absence of the sun, the molecules of the radon gas in the atmosphere are no longer expanded, so they descend to near the ground. During the whole year of measurements of radon gas there was always a (day/night) variation whose intensity of this cycle depends on meteorological parameters occurring in the site.

V. ACKNOWLEDGEMENTS

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