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MONITORING TO IDENTIFY RADON GASINTENSITY OSCILLATIONS NEAR GROUND LEVEL DURING JANUARY TO APRIL 2020 IN TROPICAL REGION OF BRAZIL

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ABSTRACT

Radon is a mysterious radioactive gas existing in environment near ground level of Earth. Understand its existence and how to monitoring in time at each hour is important for students and society. In this paper will be discussed an experimental set to analyze radon gas intensity oscillations in indoor and outdoor places during a time period of 4 months in 2020 in São José dos Campos, tropical region, Brazil. Thus, we compare parameters to analyze the emission of radon gas in different weather conditions as dry and rainy periods and day/night oscillations. The final analysis shows that outdoor places are less dangerous to health in cloudy and drizzly days with almost 50% less radon gas intensity that in normal day with great insolation.These measurements carried out in this region of Brazil show very low gas radon intensity and do not interfere with the health of humans.

I. INTRODUCTION

Radon is a natural radioactive gas without odour, colour or taste. It cannot be detected without special equipment. Radon is a product of ^{238}U(uranium decay). Uranium is a natural radioactive material found in different amounts of soil and bricks. It occurs everywhere on earth, water and especially in rocky and hilly areas.

Radon is an unstable radionuclide that disintegrates through short lived decay, approximately 3,82 days, from ^{226}Ra(Radium)products before eventually reaching the end product of stable lead. The short lived decay products of radon are responsible for most of the hazard by inhalation in humans and animals [1].

Radon and its decay products called radon daughters or radon progeny emit highly ionizing alpha-particle and low energy gamma radiation. Decay products are suspended in the air which we breathe. Although the risk is very low when radon is diluted to extremely low concentrations in the open, radon in room air typically contributes up to 50% to the background radiation [2,3].

A - Indoor and outdoor cases

In places such as caves and mines, it can accumulate up to dangerous concentrations and may cause substantial health damage after long-term exposure. Radon can also be found in drinking water and in these cases can sometimes present a hazard. Certain types of geology, such as granite and volcanic soils, as well as aluminous shales, are more likely to contain radon. Conversely, low concentrations of this gas are expected in sedimentary rocks.

For example, case-control studies have been used to investigate lung cancer and indoor radon correlation. For cases with lung cancer and appropriately selected control persons without lung cancer, exposure histories based on residential radon measurements were constructed and compared, and individual information on other important risk factors, such as smoking history and occupational exposure, were used in the analysis. Case-control studies from different countries were later pooled to obtain more statistical power [D1, K4]. Other examples include case control studies of thyroid cancer after the Chernobyl accident [A3, K1] [4].

Indoor radon and thoron concentrations, and also thoron progeny, were measured in 259 dwellings of the Karunagappally taluk: 183 in HNBR areas and 76 in low-background-radiation areas [O3]. Internal doses due to ingested and inhaled radionuclides were not considered in the cumulative dose estimation, but measurements were made to evaluate them. This survey used the passive monitoring device named raduets, which has a twin-cup monitor with two CR-39 solid-state nuclear track detectors to measure indoor thoron and radon gas concentrations separately. Indoor thoron progeny concentrations (equilibrium equivalent thoron concentrations) were also determined; using a passive device with CR-39 solid-state nuclear track detectors to count alpha particles emitted only from deposited thoron progenies. The monitors were deployed for about six months. Indoor radon gas concentrations in the study area were low (table 14), below 10 Bq m−3 in most houses [O3]. Indoor radon gas and thoron gas concentrations had no correlation. Similar results were obtained in the second series of the survey [5].]

The median effective annual dose from indoor radon and its progeny was estimated as 0.1 and that from thoron decay products as 0.4 mSv a−1 (table 15). It is also noted that radon and thoron gas concentrations and thoron progeny concentration were not correlated with the indoor air kerma rate obtained from instantaneous measurements by a semiconductor detector with electrostatic collection, grab sampling of thoron progenies and a NaI(Tl) scintillation survey meter. The absence of significant correlation could be explained with the fact that building material contained uranium decay series nuclides, thorium decay series nuclides and 40K, which are major contributors to air kerma rate in the study area. However, the magnitude of their contributions can vary from house to house. Another explanation may be that the rate of entry of thoron in a dwelling is highly variable according to the building material and to the flooring. Mean indoor concentrations of radon and thoron progeny are also slightly lower in HNBR areas than in other areas.

A small survey (N=215) using radopots was conducted in 2003 to measure indoor radon concentrations [O3]. The average indoor radon concentration was 37 Bq m−3 (SD=44; range=3, 284). In a recent radon and thoron survey, using raduets, of 59 houses in four hamlets in Yangxi and Yangdong counties (HNBR areas) during about six months, indoor radon and thoron concentrations showed wide variations from house to house. The mean indoor radon concentration was 124 Bq m−3 (median 115) and the average indoor thoron concentration was 1,247 Bq m−3 (median 859) [K20]. The radopot and the raduet used in those surveys were passive monitoring devices with CR-39 solid-state nuclear track detectors [6].

B - Health, Lung Cancer and Radon Gas

It is believed that the relationship between radon and risk of lung cancer is linear. In other words, doubling the exposure doubles the risk and halving the exposure halves the risk. Doubling of the risk means much more for a smoker, who is already at high risk of lung cancer, than for a non-smoker with a very small base line risk. Lung cancer risk from residential radon exposure is substantially lower since the exposure in homes is much lower than in mines, although the risk increases with radon concentration level and duration of exposure. For life-time exposure to radon of 20 Bq/m3 level at home the risk of lung cancer is estimated to be 0.3% (or 3 deaths in 1000 people). For comparison, risk of accidental death at home is 0.7% (or 7 in 1000). It has been suggested that other effects of radon exposure include increased risk of nonmalignant respiratory diseases but this is much less clearly established than the lung cancer risk. It is still not clear whether children are more sensitive to radon exposure. Studies on childhood leukaemia (the most common form of cancer in childhood) have not found clear evidence of risk associated with radon concentrations in homes[7].

II. METHODOLOGY

1- How is radon gas measured?

How radon is measured Radioactivity of a radionuclide, for instance radon, is reported in becquerels, Bq. 1 becquerel (1 Bq) = 1 disintegration of atom per second Radon concentrations in the air are measured as the amount of radioactivity (Bq) in a cubic meter of air (Bq/m3). The average radon level outdoors is 5 Bq/m3 and in the homes of the United Kingdom, for instance, is 20 Bq/m3 of air.

It is possible for one house to have elevated levels of radon while a neighbouring one does not. Measurement is the only reliable way to determine levels of radon in a house. Measurements are normally carried out using passive detectors which are left in the home for periods from days to months. Because radon levels vary from day to day and from season to season, measurements over several months are better than short-term measurements for estimating annual average radon levels. Detectors can be purchased from testing companies, but must be returned to them for assessment. To accurately reflect people's true exposure to radon, detectors must be placed in rooms where people spend most of the time (living room, bedrooms, offices). Instructions should be followed carefully when installing the detectors. They should not be placed in rooms that are rarely used. There are three main types of passive radon detector:

• Etched track (or alpha track) detectors are normally placed for a period of one to 12 months.

• Electret ion chambers are available with different sensitivities, some being suitable for measurements over a few days and some being suitable for measurements over months.

• Charcoal detectors measure average radon levels over a few days, so give less accurate estimates of annual average radon levels. They may be used for screening measurements.

III. MATERIALS AND METHODS

1 - Experimental Set

We realized an experimental set in São Jose dos Campos, as São Paulo – Brazil during first 4 months in 2020.
Our experiment is set at 25 meters heigh tower with several particles sensors as neutron, gamma, geiger and radon as shown in Figure 1. This place is free from any local human interference.

Fig. 1 – Aerial and ground view of the tower ACA and his environmental field region, GPS coordinates: São José dos Campos, SP, Brazil (23° 12'45" S, 45° 52'00" W).

2 - Radon gas RD 200 RADON EYE

The radon gas detector is a portable ionization chamber as shown in Figure 2. It is powered with 110 or 220 V. It can measure hourly counts between 0.00 and 10000.00. These counts can be transformed into (pCi/l) or by (Bq/m³) directly by the FTLab application software coming jointly with the detector to acquire the data in Android Smart appliances. This application can generate files on each download and can be saved in .txt extension. All instructions are given for that on reference [8].

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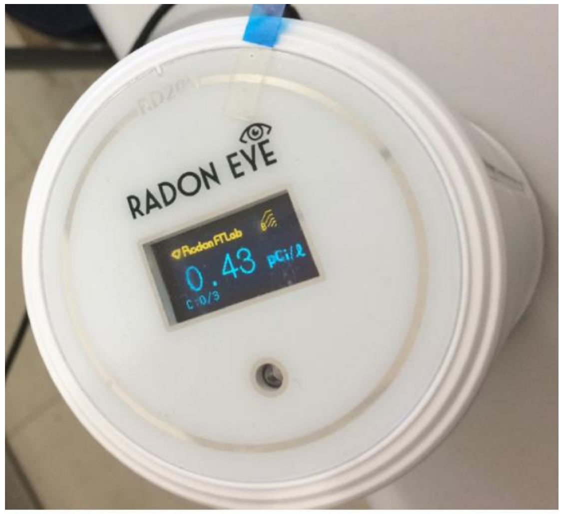

Fig 2 – Top view of RD200 Radon Eye ionization chamber used for monitoring radon gas [8]

In Figure 3we present series variations that occurred in the measurements of the ACA made on January 27 to April 20 of 2020. These measures are shown here giving insight into how easy the RD200 Radon Eye is operated about obtaining, storing and manipulating data. In Figure 2 above is shown the Radon Eye RD200 measuring on a table in open space in ITA. The view count of 0.43 (pCi / l) or 15,9 (Bq/m^3) represents the value at the last hour that the ionization chamber made measurements.

By means of an ITunes software installed on an IPhone you get the data that is already plotted on the screen of the IPhone as indicated by Figures 3. A maximum time of measurements for the Radon Eye RD200 can be considered up to six months in hourly sequence as shown in Figure 3 obtained in ACA via IPhone on April 20, 2020. For periods longer than 6 months, both the acquisition data and download of measures are very slow in time.

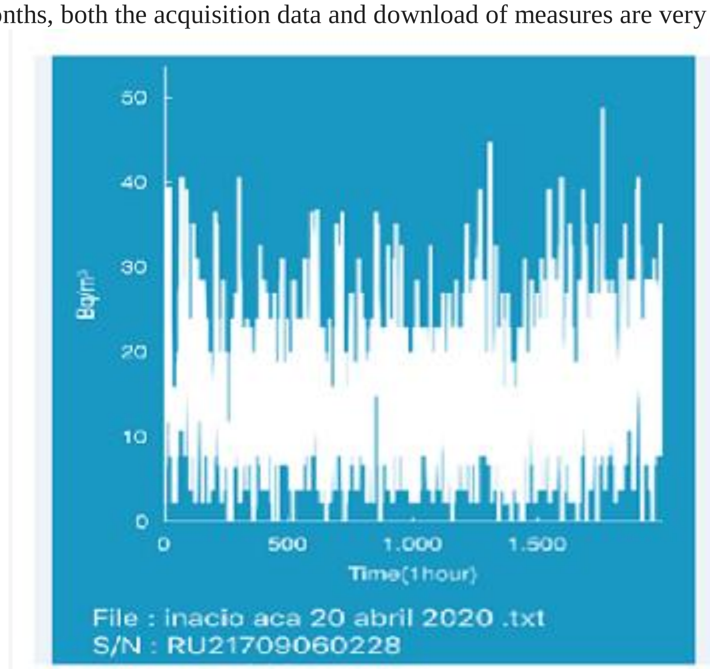

Fig. 3 – Monitoring of 2000-hour series from Radon Eye RD200 in ACA tower using (Bq/m^3) unit from January 27 to April 20 of 2020

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The same data can be showed in Bq/m^{3}in ITA campus region. In order to make clearer that variation in time it is possible to use the software ORIGIN 2015 and make the graph of all period of measurements. For example, the Figures 4 and 5shows the maxima, minimum values, and one day smoothed curve (blue) for the net period of about 84 days measured in ITA and ACA campus during 27 January to April 20, 2020.

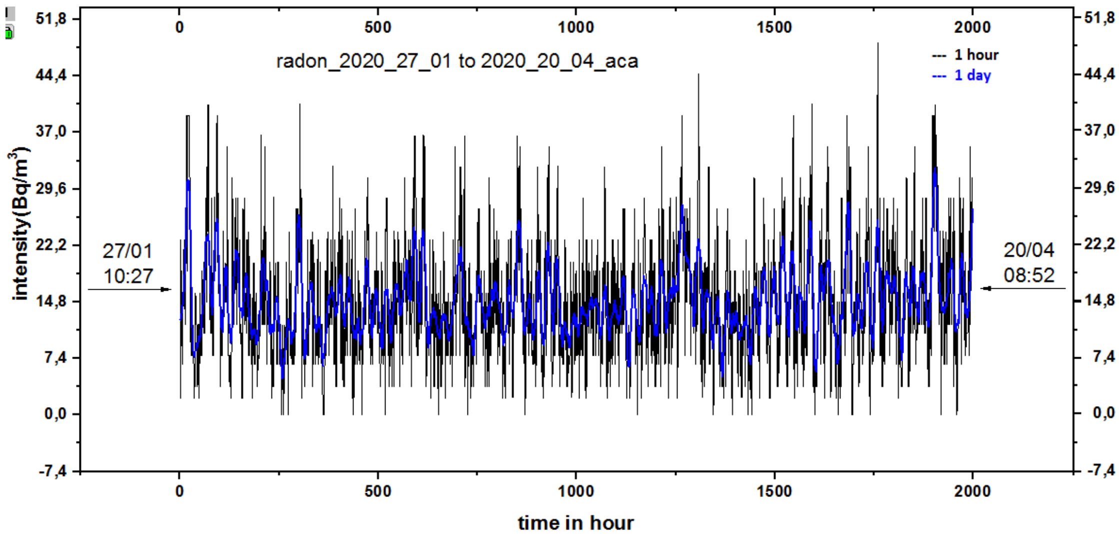

Fig. 4 – Monitoring of about 2000-hour series from Radon Eye RD200 in ACA tower using (Bq/m³) unit. The blue curves corresponding smoothed values in one day

The next figure 5 represents the graph of the monitoring of radon gas in the same period and in the ITA campus.

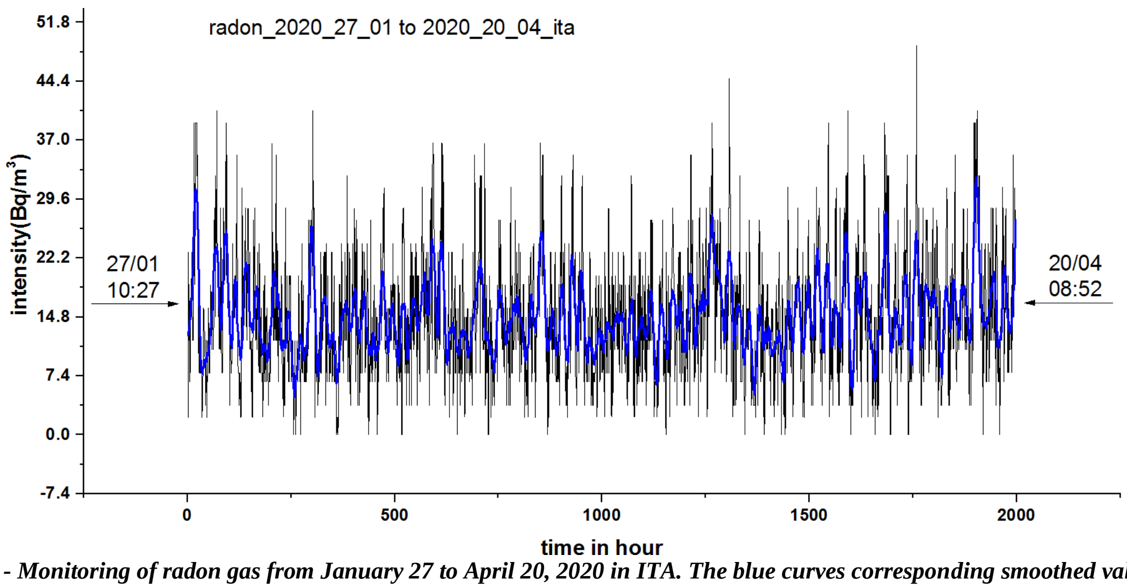

Fig.5 - Monitoring of radon gas from January 27 to April 20, 2020 in ITA. The blue curves corresponding smoothed values in one day

It can be seen in figures 4and 5 an increase in the intensity of radon gas after 1250 hours from the beginning of the measurements. This happens in two locations, with the ACA tower 25 meters high and the ITA, 2 meters above the ground surface [9]. See a zoom obtained in this region and observation time with the details of the variation of the radon gas in figures 6 and 7.

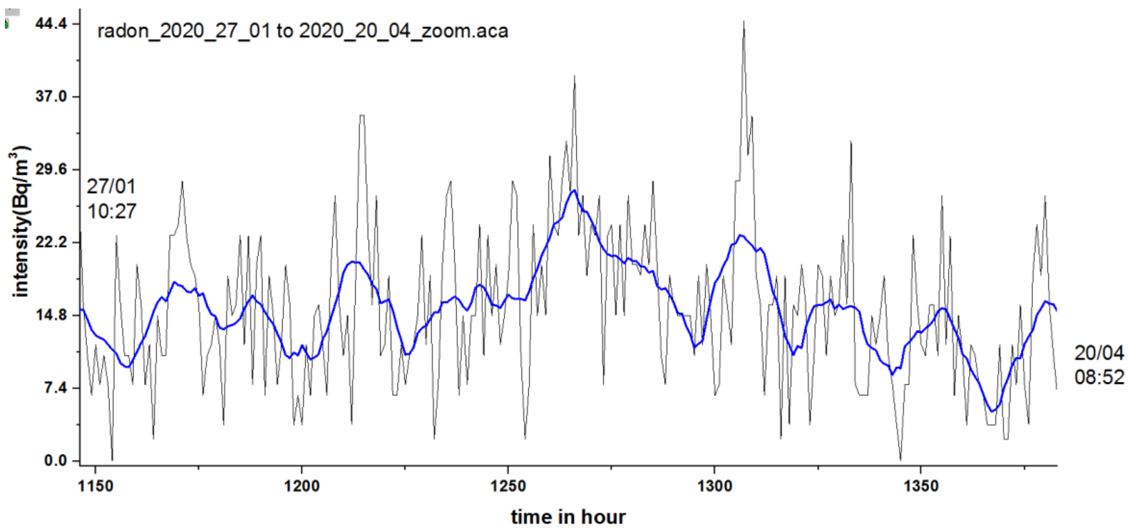

Fig.6 - Increased verification of the interval between measurements from 1000 to 1500 hours seen in figure 4. The variation of radon gas is observed every hour and every day

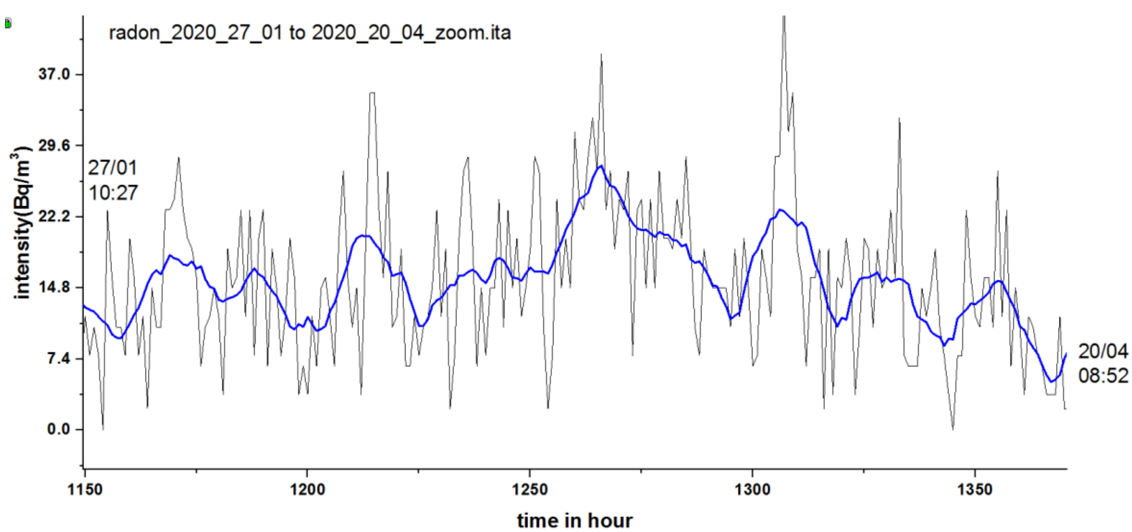

Fig. 7 - Increased verification of the interval between measurements from 1000 to 1500 hours seen in figure 5

The variation of radon gas was observed every hour and every day during the time interval. During the entire measurement period, there were no major differences between the observations made close to the ground and in the Tower with 25 meters of altitude, as shown in figures 6 and 7.

IV. CONCLUSION

The continuous flow of radon gas was measured at two different altitudes at ground level, being 2 meter at ITA and 25 meters at the aca tower. The detectors and units of measurement in outdoor condition were the same giving comparisons between flows that were very close. The maximum reached in that period in both places was around 37 (Bq / m3) and the minimum was 0.6 (Bq / m3). The night / day variations were very noticeable. Soon this work shows an easy and low cost way to monitor radon gas in tropical regions.

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