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Radon (222Rn) time series: short and long term variations at Furnas Volcano (Azores)

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Furnas Volcano is one of the three active polygenetic volcanoes with caldera located on São Miguel Island, the biggest of the Azores archipelago. Furnas Volcano eruptive activity has been essentially explosive, emitting magmas with trachytic (s.l.) composition. The last eruption occurred in 1630 and since then Furnas Volcano shows a moderate seismic activity and an intense hydrothermal activity, with four main fumarolic fields, thermal springs, CO_2-rich springs, several soil diffuse degassing areas (CO_2 and 222Rn), as well as occasional hydrothermal explosions.

The intense degassing at Furnas Volcano, even in quiescent periods of volcanic activity, can represent a threat to the population installed at Furnas Village, placed inside Furnas Volcano Caldera. Radon when dispersed in atmospheric air does not seem to represent danger for human health, however, when it accumulates in confined spaces, as in dwellings, it can represent a serious threat. As a radioactive gas, radon can emit radiation (alpha particles) that can cause damage in lung cells. When inhaled at high concentrations for a long period of time, the damage produced in the cells can be so severe that can conduct to the development of lung cancer.

In order to understand radon short and long term variations at Furnas Volcano, a Radon Scout Plus equipment was installed in a building located near Furnas Village fumarolic field. As soil diffuse degassing processes are highly influenced by changes in environmental parameters, the equipment installed also measures air temperature, barometric pressure and air relative humidity. Spectral analysis, using Fast Fourier Transform (FFT), was applied to the data obtained between January 2017 and November 2018. The radon values varied between 0 and 14864 with an average value of 368 Bq/m3. From the total of 16168 measurements performed, 98% were above 100 Bq/m3, the annual average recommended by the World Health Organization (WHO), and 38% were above 300 Bq/m3, the maximum annual average accepted by WHO, recommended by European Union and established by the Portuguese law.

Spectral analysis allowed identifying one cycle per day (cpd) variation that seems related with air temperature and air relative humidity variations. Radon variation showed a correlation of 86% and 85% with air temperature and air relative humidity, respectively, with a response delay of 11 and 9 hours.

Spectral analysis also allowed identifying long term variations, with a clear cyclic variation during summer time (1 cpd), that could not be identified in the spectrogram during winter periods. The low frequencies analysis allowed recognizing other 3 cyclic variations related with a recurrence of 28, 171 and 341 days, similar to the lunar month, semi-annual and annual cycles.

The study performed allowed to better understand radon time series variation, identifying the external variables that can have influence on this variation and making easier to identify changes related with the volcanic system. On another hand, this study also shows that the intense degassing observed at Furnas Volcano can represent a threat to the resident population since the radon that is being released can accumulate inside buildings in concentrations above the recommended ones.