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ANALYSIS OF RADON TIME SERIES BY MEANS OF CONTINUOUS WAVELET TRANSFORM

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1.Summary

The abnormal radon exhalation from the earth crust, as a precursory phenomenon related to seismic events, is an important research topic [1, 2]. The radon exhalation is related to the variability of local meteorological parameters. In the present study, a continuous RTM 2200 / SARAD monitor was used to measure time series of radon concentration in the soil and meteorological parameters. These measurements were made in 4 wells at EMHU-PUCP for two weeks with 15-minute cycles. The nature of these temporal variations was characterized by means of continuous wavelet transformation (CWT) [3], performing a spectral analysis in the time-frequency domain. Also, a correlation analysis was performed between the different time series. An analysis is made of the potential influence of ambient temperature on radon concentration measurements.

2.Introduction

The monitoring of soil radon emission is today a topic of interest because of the risk that this element poses to human health but also for its relationship with several geological-environmental processes. it is studied as a tracer of tectonic activity and earthquake precursor. The dynamics governing the movement of the radon are complex and dependent on many factors. In the present study, we characterize the nature of the temporal variations of radon measurements every fifteen minutes at four sites of the continuous monitoring station.

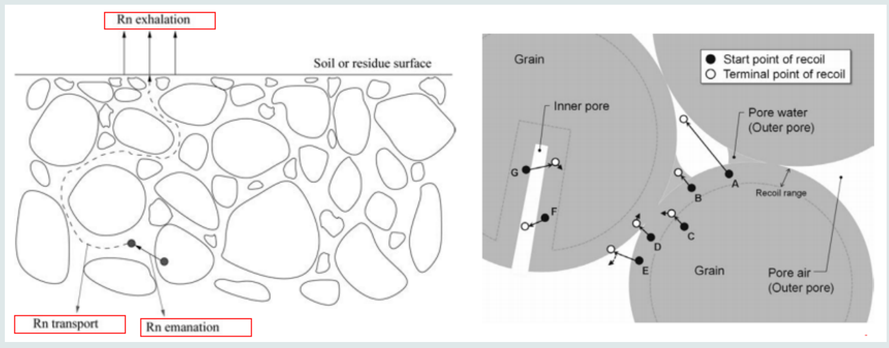

Figure: a) Processes leading to radon release to the atmosphere (Ishmori et al. 2013). b) chematic diagram of radon emanation (Sakoda et al. 2011).

3.Methodology

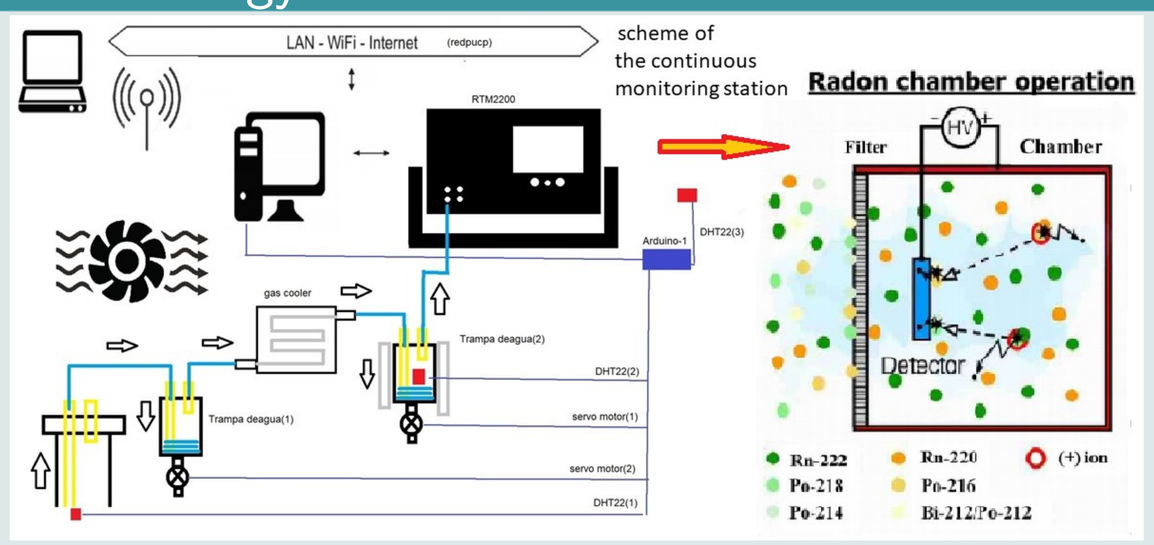

Figure: (left) Radon gas continuous monitoring station. (right) radon chamber operation

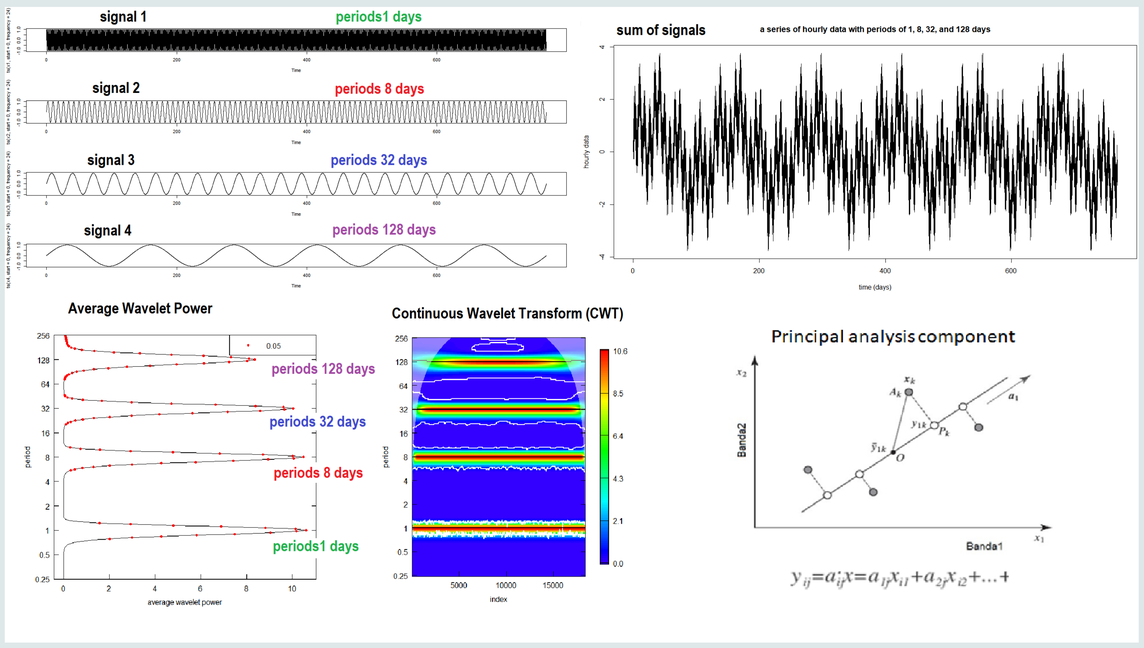

Figure: (left) example of continuous wavelet transform for a series composed of four signals. (right) Principal analysis componet

4.Results

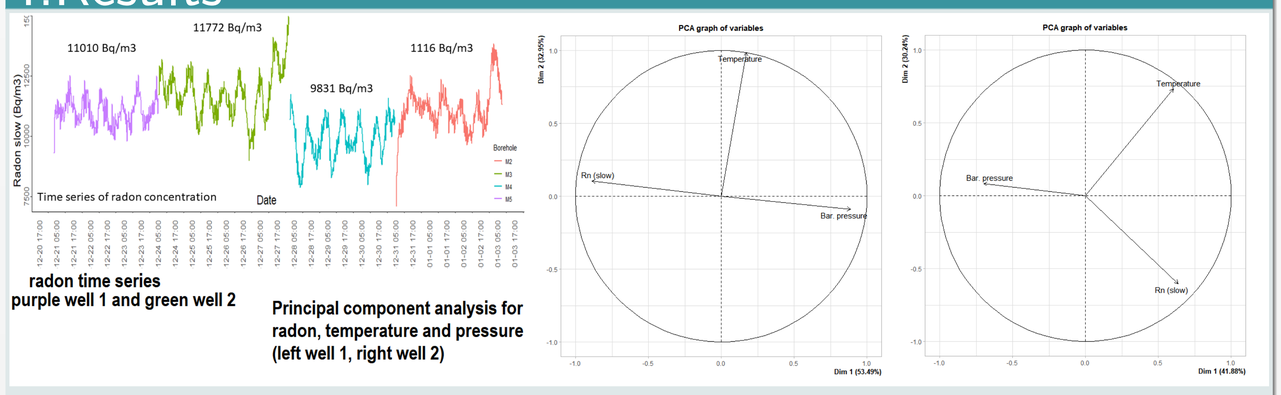

Figure: (left) radon time series in four wells at the EMHU-PUCP station (12 / 2019-01 / 2020). (right) Principal Component Analysis for Well One and Well Two.

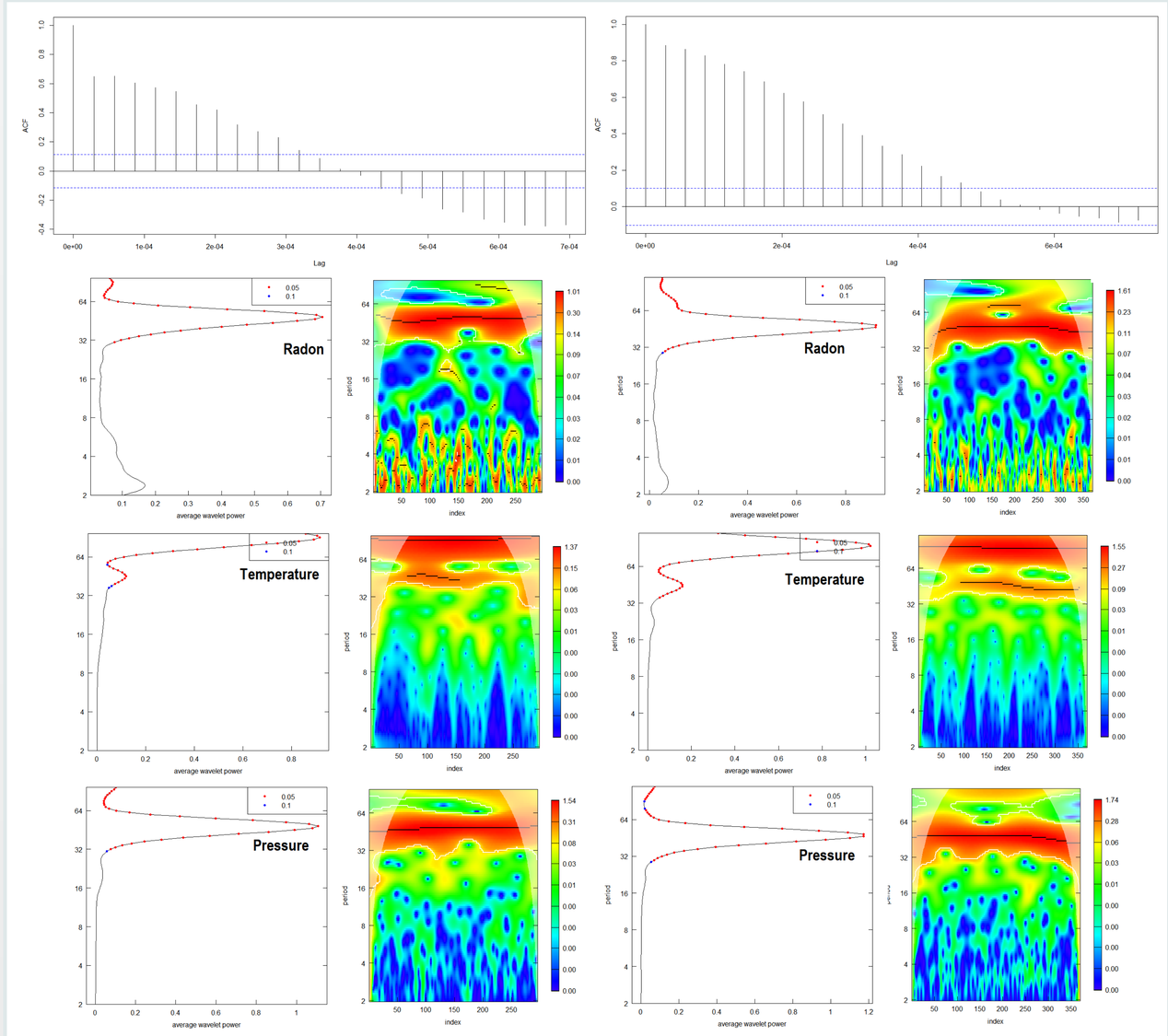

Figure: a) autocorrelation function of a non-stationary function, b) Continua wavelet transform (CWT), c) Average wavelet power. Wells one and two

5.Conclusion

The CWT analysis in the time-frequency domain allowed the identification of patterns of variation in different periods for radon, temperature and pressure, as well as an existing relationship between the variations of radon in the soil pores, pressure and temperature. With PCA it can be observed that there is a greater correlation between radon and temperature.

Reference

[1] Donner, R. V., Potirakis, S. M., Barbosa, S. M., Matos, J. A., Pereira, A. J., Neves, L. J. (2015). Intrinsic vs. spurious long-range memory in high-frequency records of environmental radioactivity. The European Physical Journal Special Topics, 224(4), 741-762.

[2] Barbosa, S. M., Zafrir, H., Malik, U., Piatibratova, O. (2010). Multiyear to daily radon variability from continuous monitoring at the Amram tunnel, southern Israel. Geophysical Journal International, 182(2), 829-842.

[3] Siino, M., Scudero, S., Cannelli, V., Piersanti, A., D'Alessandro, A. (2019). Multiple seasonality in soil radon time series. Scientific reports, 9(1), 1-13.