Outdoor Radon in Osijek: Temporal Variability and Relationships with Temperature, Relative Humidity, Atmospheric Pressure, and PM_{10}

Koncentracija aktivnosti radona u vanjskom zraku u Osijeku: vremenska promjenjivost i povezanost s temperaturom, relativnom vlažnošću zraka, atmosferskim tlakom i PM_{10}

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INTRODUCTION

Radon (222-Rn) in outdoor air originates primarily from soil exhalation and is strongly influenced by atmospheric stability and air mixing. Stable conditions and weak winds can favour radon accumulation, while stronger mixing enhances its dispersion. Simultaneous monitoring of radon, meteorological parameters and PM_{10} can help explain short-term concentration variability. This study investigates hourly outdoor radon concentrations in Osijek and their relationships with temperature, relative humidity, atmospheric pressure, PM_{10} and wind speed.

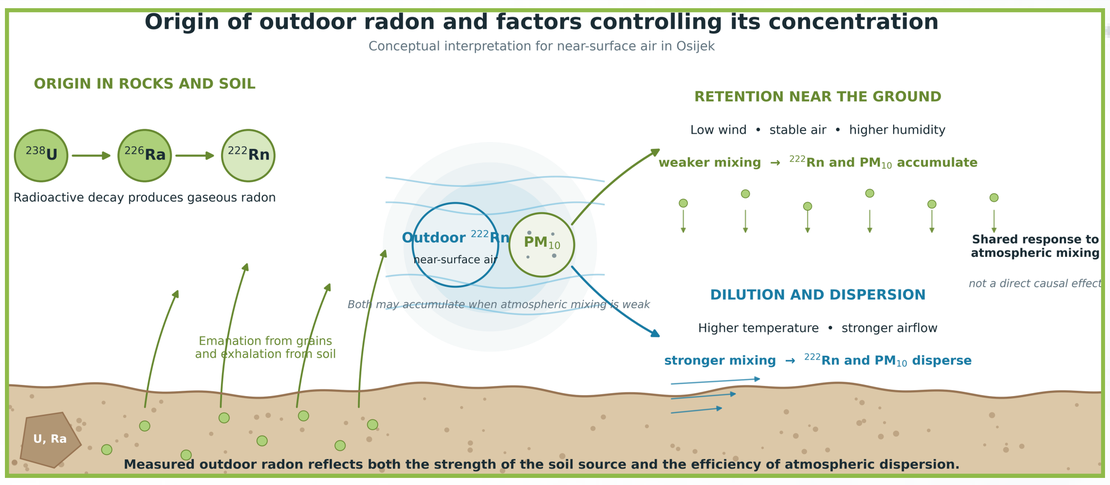


Figure 1. Schematic representation of radon emanation and atmospheric dipsersion.

MATERIALS AND METHODS

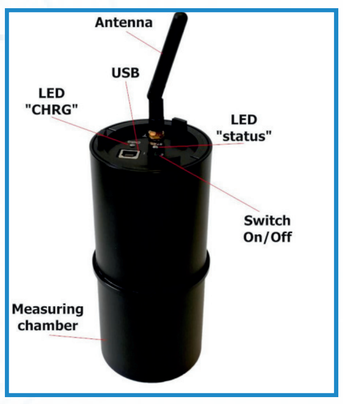


Figure 2. TERA/TESLA radon detector used for the monitoring of radon.

Outdoor radon activity concentrations were measured using TERA Tesla TSR 3 and TSR 4, continuous active semiconductor detectors from Piketronic (https://www.piketronic.cz) .



Figure 3. Meteorological station installed at the Josip Juraj Strossmayer University of Osijek, Physics Department .

Air temperature, relative humidity, atmospheric pressure and wind speed were recorded by a small automatic meteorological station installed at the Department. PM_{10} concentrations were obtained from the permanent air-quality monitoring station in Osijek, located at the intersection of cara Hadrijana street and Biljska road. Data collected from (https://iszz.azo.hr/iskzl/index.html).



Figure 4. Permanent air quality monitoring station "Osijek-1" .

Data Collection

21 July - 21 August 2026 for a total of 726 complete hourly observations.

Descriptive statistics were calculated, followed by Spearman's rank correlation between radon and environmental variables (Fig. 5). Spearman analysis showed that radon was negatively correlated with temperature and positively correlated with relative humidity and PM_{10} . Statistical calculations were performed and checked using the Statistics Kingdom online platform [1].

RESULTS

Table 1. Descriptive statistics of radon, meteorological parameters, and PM_{10} during the study period.

	222-Rn (Bq/m^3)	T (°C)	p (hPa)	H (%)	PM_{10} (µg/m^3)
Median	10	26	1014	44	22
IQR	(0-117)	(13-47)	(1006-1024)	(14-89)	(6-147)

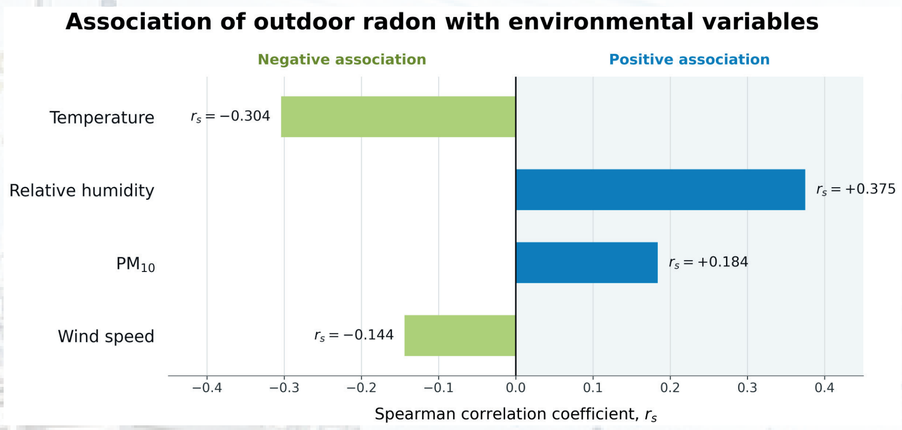


Figure 5. Spearman rank correlation coefficients between outdoor Rn activity concentrations and other metereological parameters.

Outdoor radon activity concentrations showed substantial short-term variability during the monitoring period. Lower wind speeds were associated with higher activity concentration values, highlighting the role of atmospheric dispersion.

Hourly variations reveal distinct diurnal patterns for radon activity concentration, relative humidity, temperature, and wind speed. Wind speed shows regular daily peaks, promoting atmospheric mixing and supporting the negative correlation with Rn activity concentration.

Lower atmospheric mixing

Greater radon detention near the ground surface

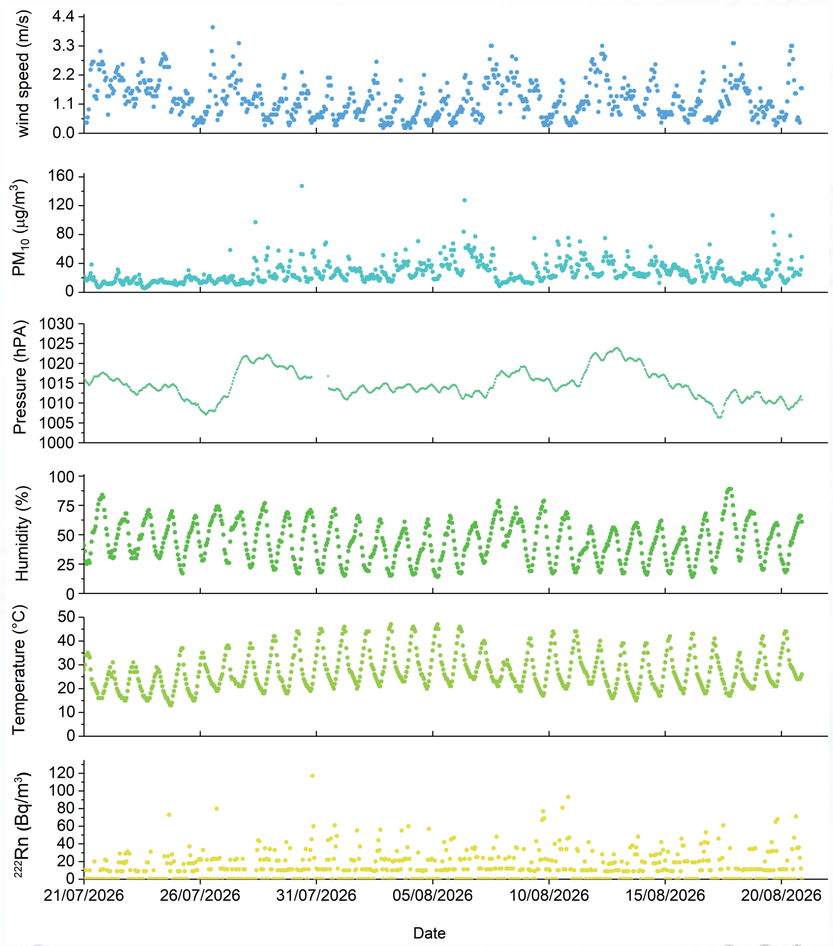


Figure 6. Hourly variation in outdoor radon concentration, temperature, relative humidity, atmospheric pressure, and PM_{10} during the study period (21 July–21 August 2026).

CONCLUSIONS

Short-term outdoor radon variability in Osijek was primarily associated with atmospheric mixing and near-surface dispersion. Higher radon concentrations occurred under humid, low-wind conditions and alongside elevated PM_{10} concentrations, whereas higher temperatures and stronger winds favoured radon dilution. PM_{10} and wind speed remained the most consistent predictors after accounting for the other environmental variables, serial autocorrelation and the diurnal cycle. The radon–PM_{10} association most likely reflects their simultaneous accumulation during periods of weak atmospheric mixing rather than a direct causal relationship. These findings highlight the value of simultaneous radon, meteorological and air-quality monitoring in urban environments.

BIBLIOGRAPHY

[1] Statistics Kingdom. Statistics calculators [Internet]. Melbourne, Australia: Statistics Kingdom; 2017 [cited 11 September 2026]. Available from: https://www.statskingdom.com/.