What have we learned from the extensive radon measurements?

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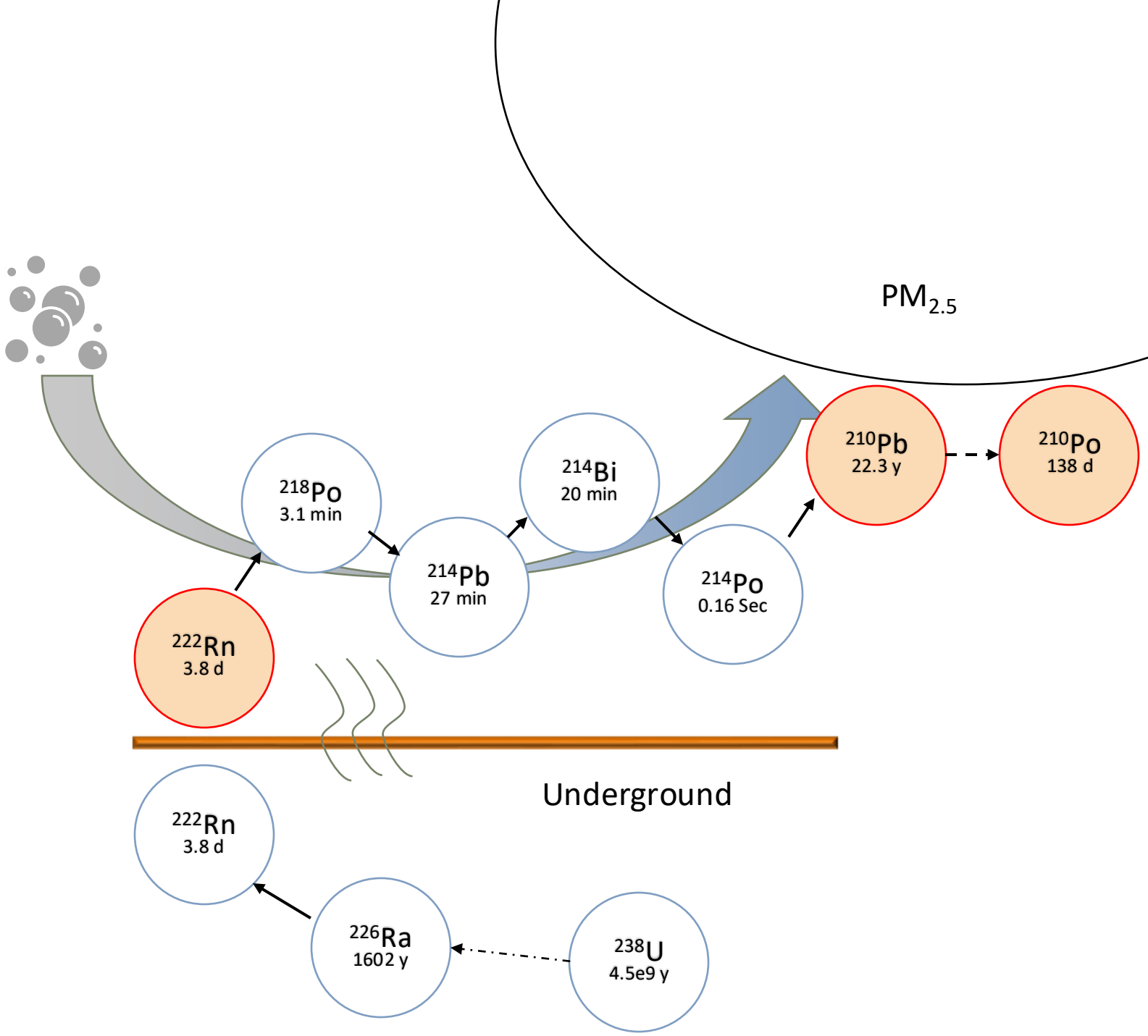
Radon

- A radioactive indoor air pollutant.
- Decay product of U-238, underground.
- Most of radon are not exhaled into atmosphere.

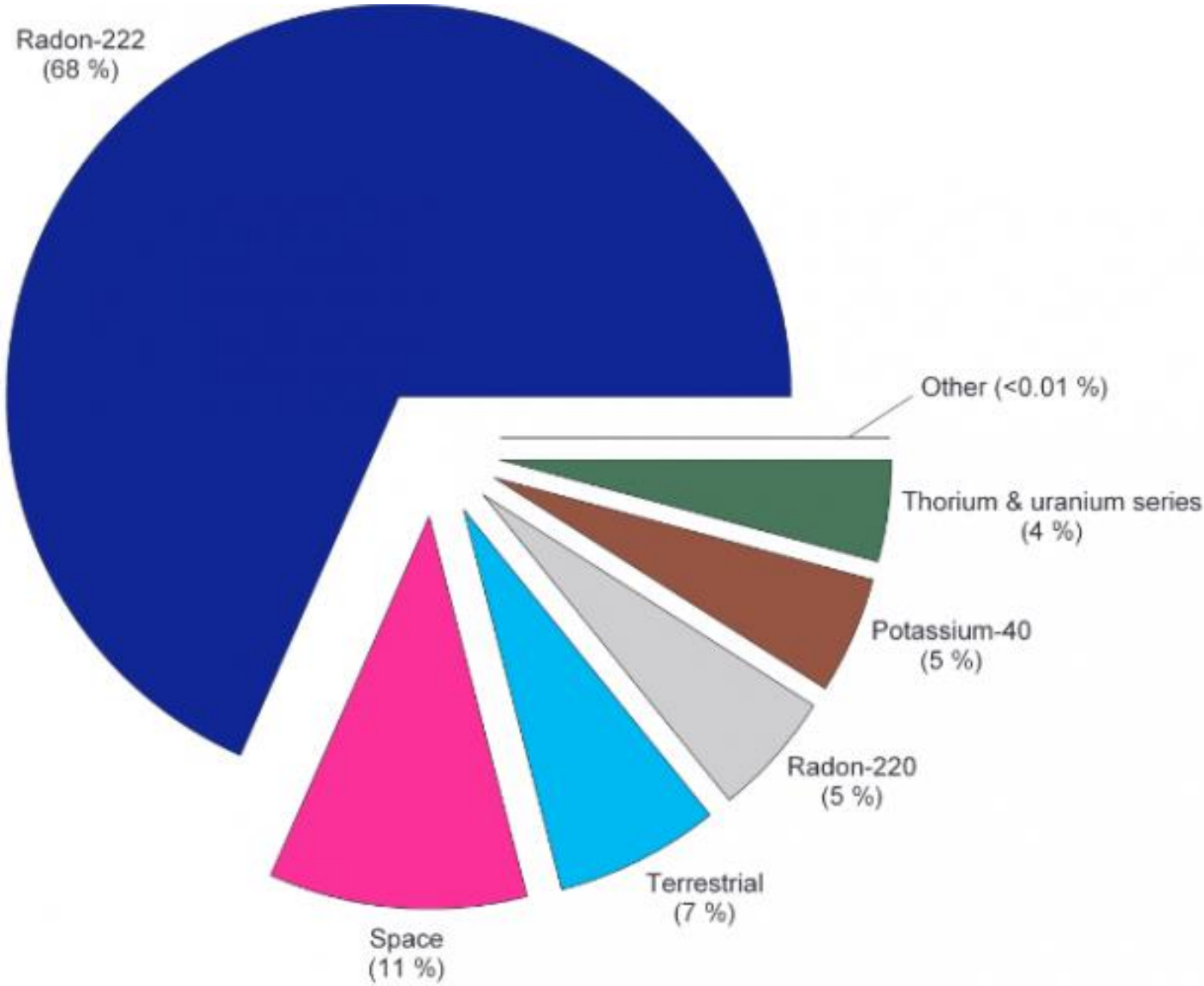


Radon

- Radon and some of its decay products are alpha-emitting radionuclides.
- Alpha particles are of super-high energy.

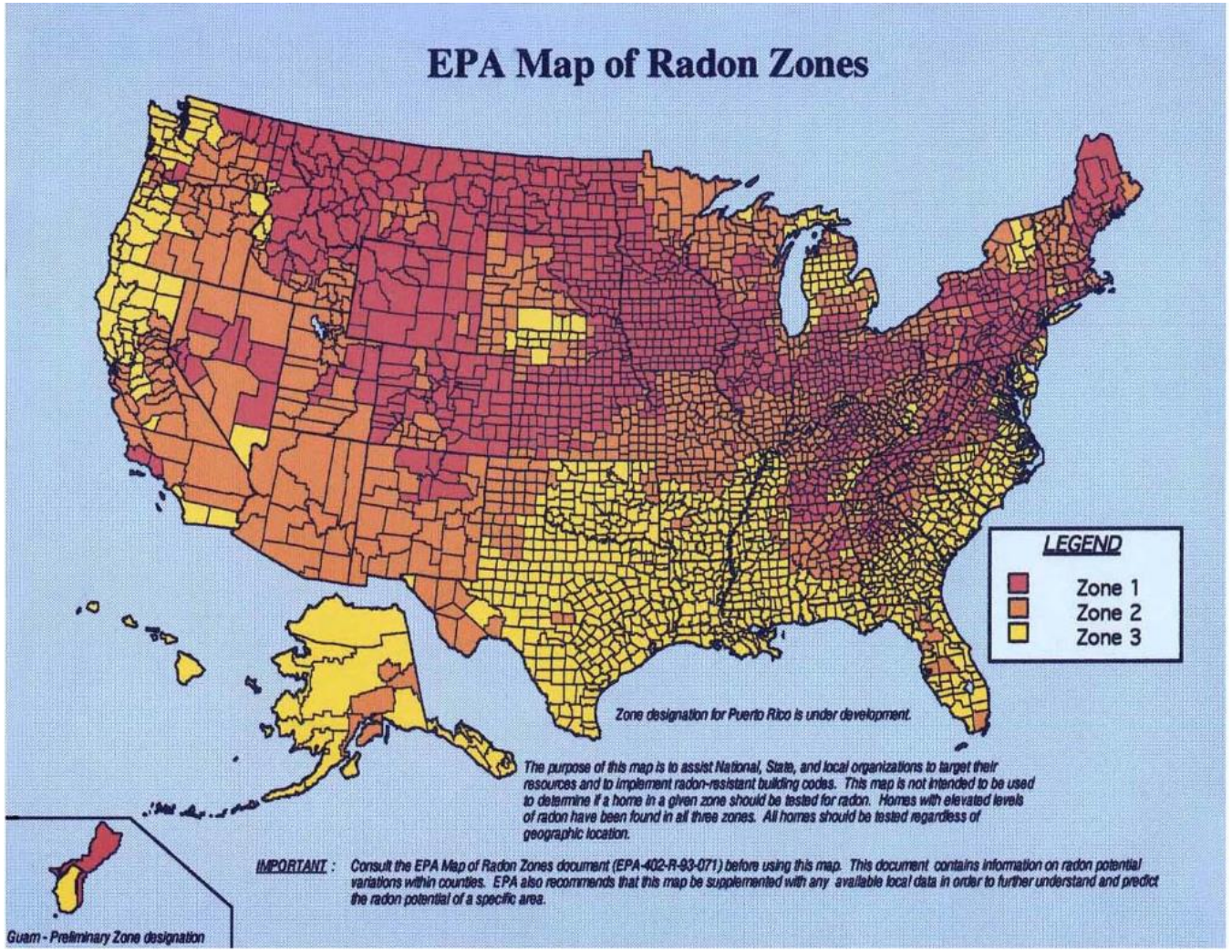
Radon

- Major source of radiation dose, on average.
- 2nd leading cause of lung cancer (15k death/year).
- An action level of 148 Bq/m^3 **(4 pCi/L)** was proposed in the **1986**.



Background

- Two national radon surveys(SRRS and NRRS) were conducted in the late 1980s.
- EPA's radon map was published in 1993 (with the help of USGS).
- It is the go-to place for property agents, concerned homeowners, etc.



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Our Contributions

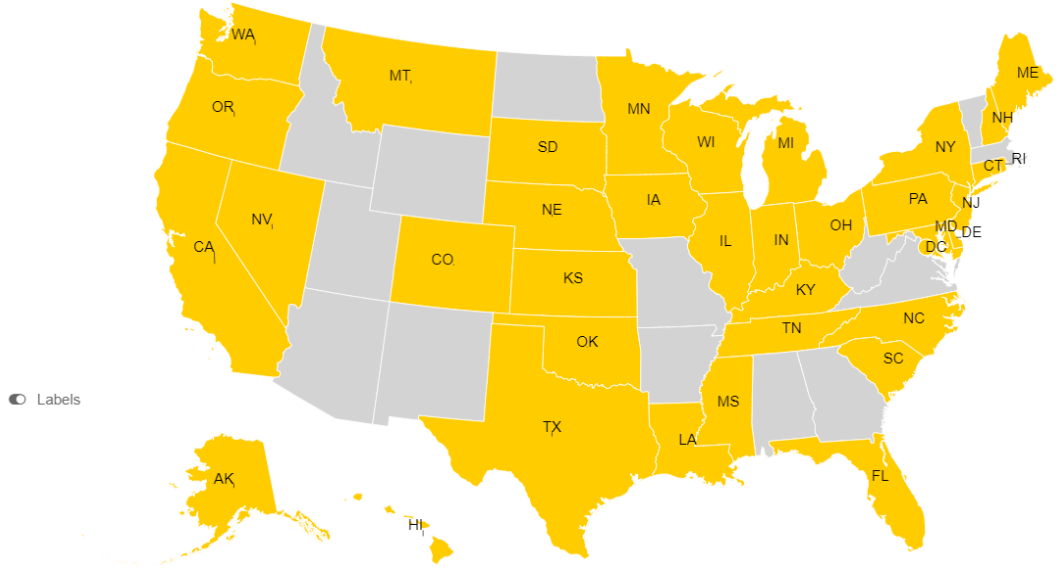
Compiled a national database of radon measurements conducted by radon analytical laboratories.

Justified the usage of short-term radon measurements in exposure assessments.

Have Applied the tested method to develop a national model to predict monthly ZIP Code-level radon concentrations.

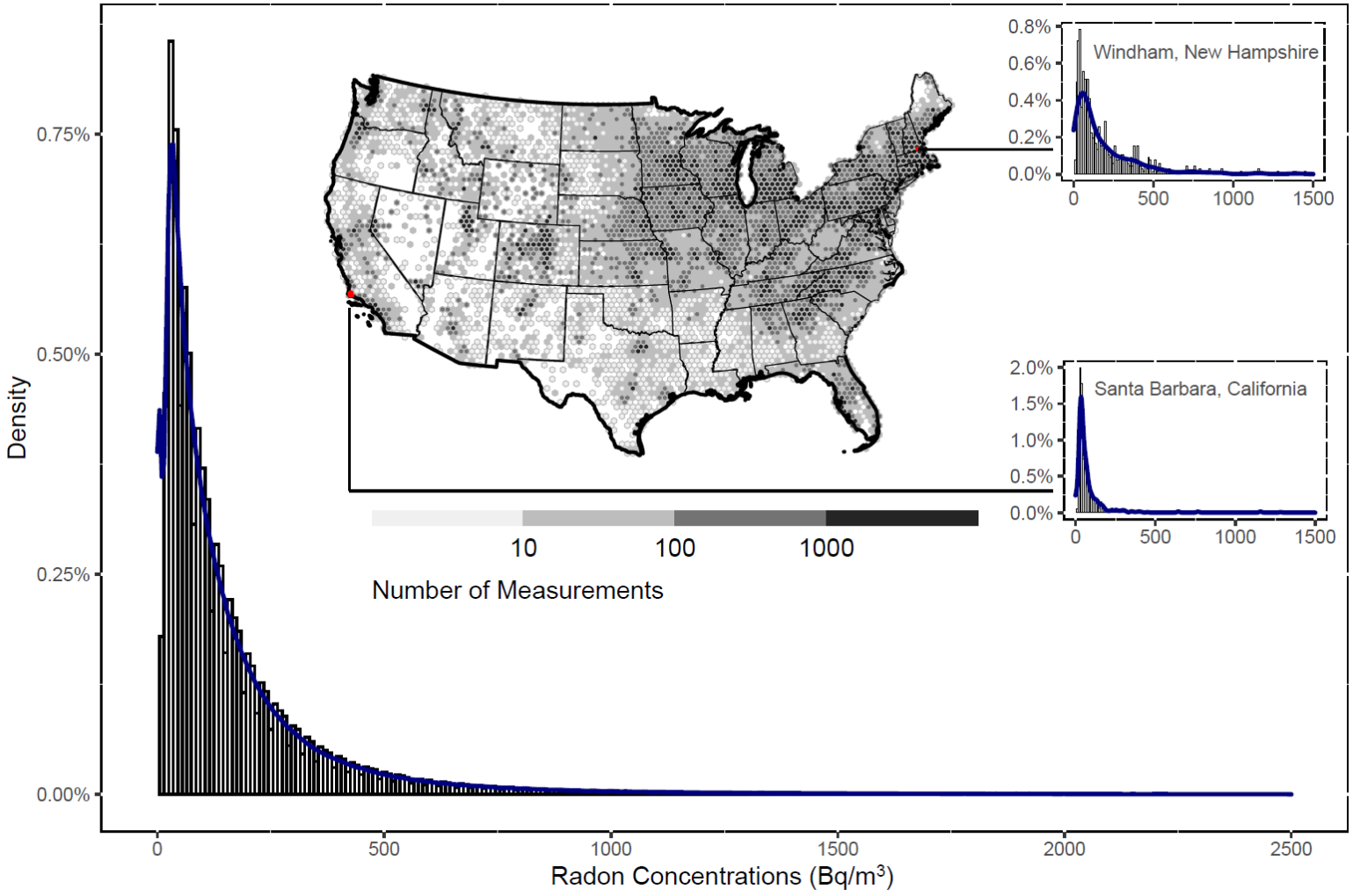
Radon Measurements in the U.S

- 35 of our lower 48 states required radon disclosure during property transection.
- Short-term detectors were used and sent back to laboratories after 2-7 days.
- We collected measurements from laboratories and assimilated them.



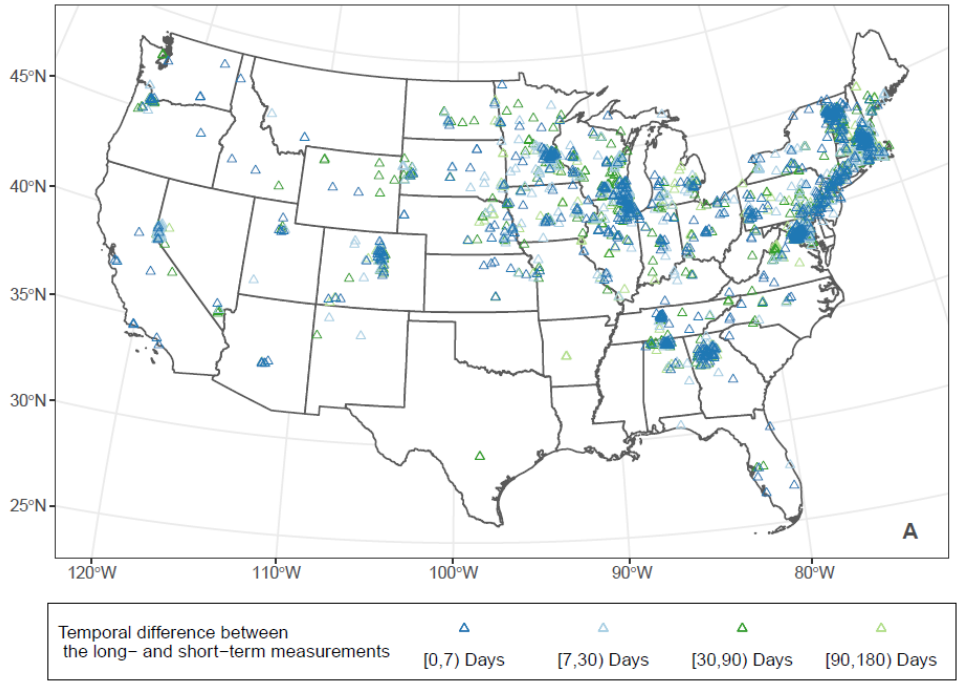
Radon Measurements in the U.S

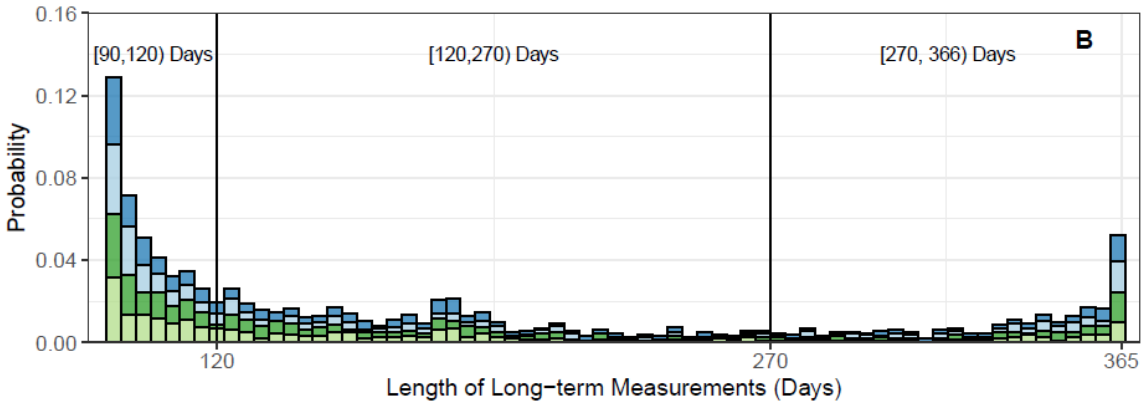
- Over 10 millions measurements, covering all population centers;
- Heavily skewed distributions.



Short-term vs Long-term Measurements

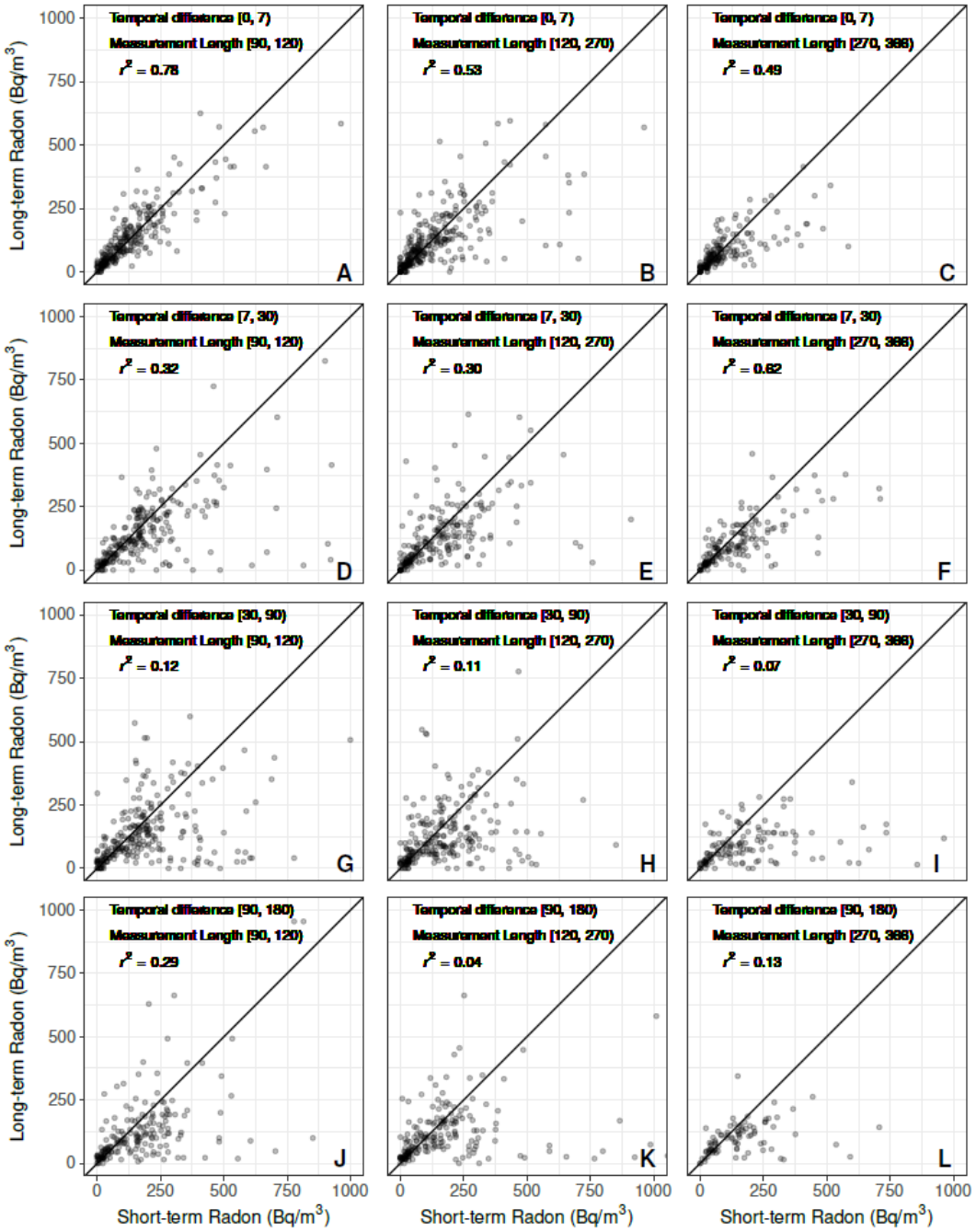
- Q1: is short-term radon measurement a “good” proxy to the long-term one?
- Q2: which factor(s) are driving the mismatch between the collocated short- and long-term measurements?
- 2,245 pairs of collocated short- and long-term radon measurements





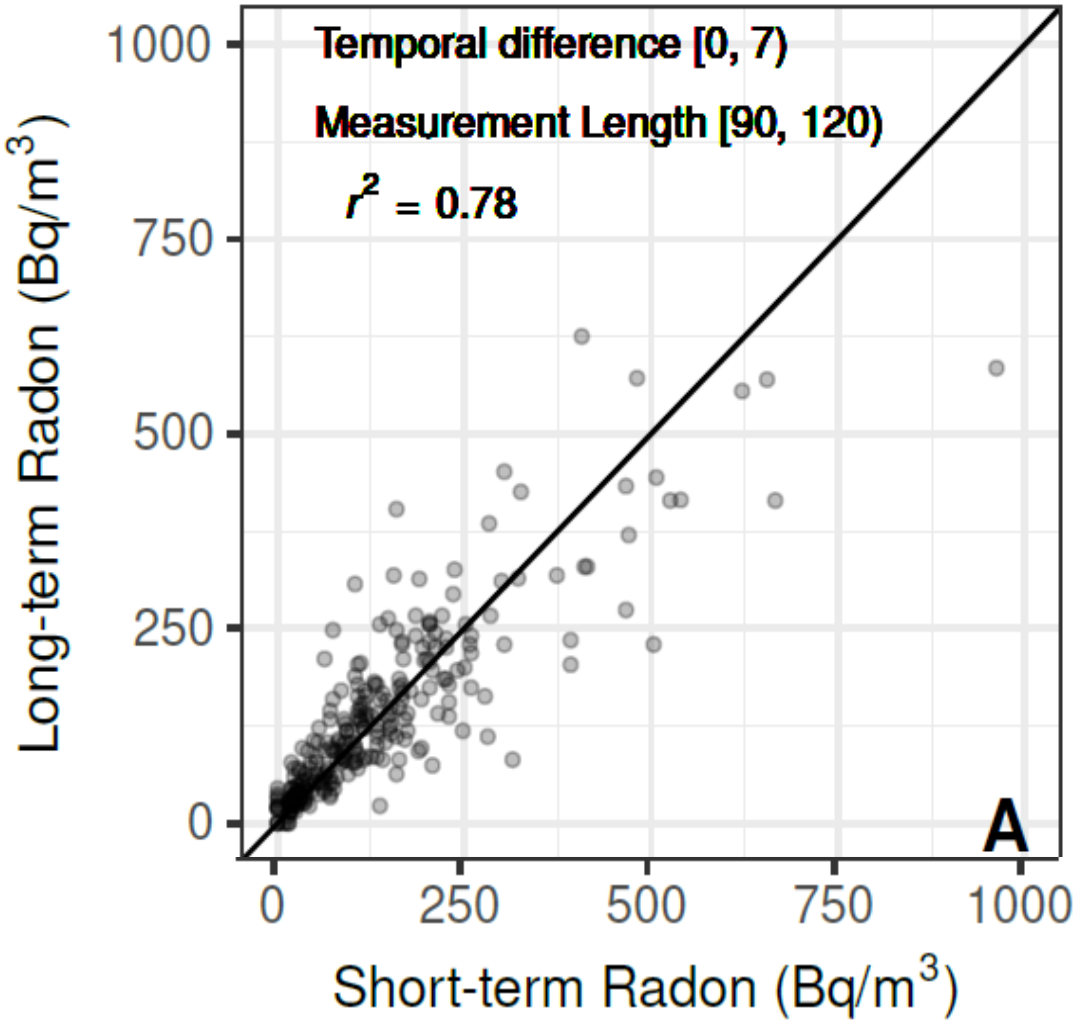
Short-term vs Long-term Measurements

- We stratified the pairs of measurements based on two factors: duration and difference.
- The predictability of long-term measurement is calculated.
- Predictability varies across stratifications.



Short-term vs Long-term Measurements

- The overall correlation is only **0.27.**
- The correlation can be as high as 0.78 when the temporal difference is small, and duration of long-term measurement is not that long.
- The mismatch is mostly caused by variations, no quality issues.



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Materials

- A database of radon predictors.
- Proportion of measurements in basement vs aboveground floors enabled us to model floor-dependent variation.
- Proportion of measurements in each brand enabled us to remove pattern due to varying market share.

Radon Predictors

Detector-related Trends: Proportions of detectors in the basement/upstairs; Proportions of 4 types of detectors.

Geological Factors: Surficial concentrations of U-238 and Th-226; Geological Radon potential; Geological provinces; Distance to a geological fault; Elevation and topographic slope; Soil features; Magnetic abnormity; Gravity abnormity.

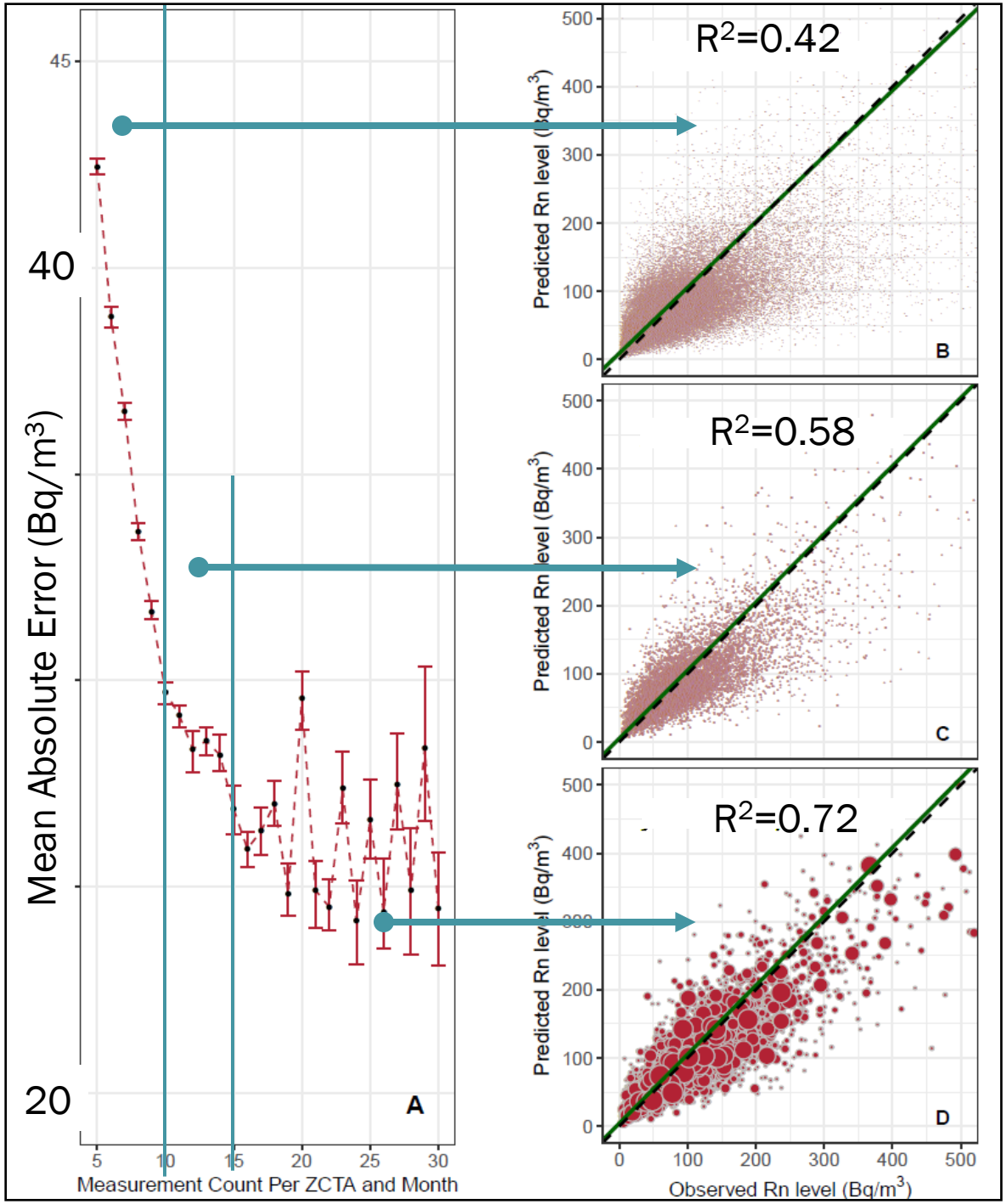
Architectural Factors: Structure type of unit; Building age; Number of rooms; Number of bedrooms; Heating fuel.

Meteorological Factors: Snow depth; Accumulated precipitation; Barometric pressure; Gravitational and volumetric soil moisture; Soil temperature; Wind velocity; Air temperature; Gross beta radiation.

Socioeconomical Factors: Household income; Property value; Percent of unit occupied by owner; Percent of residents living below poverty line.

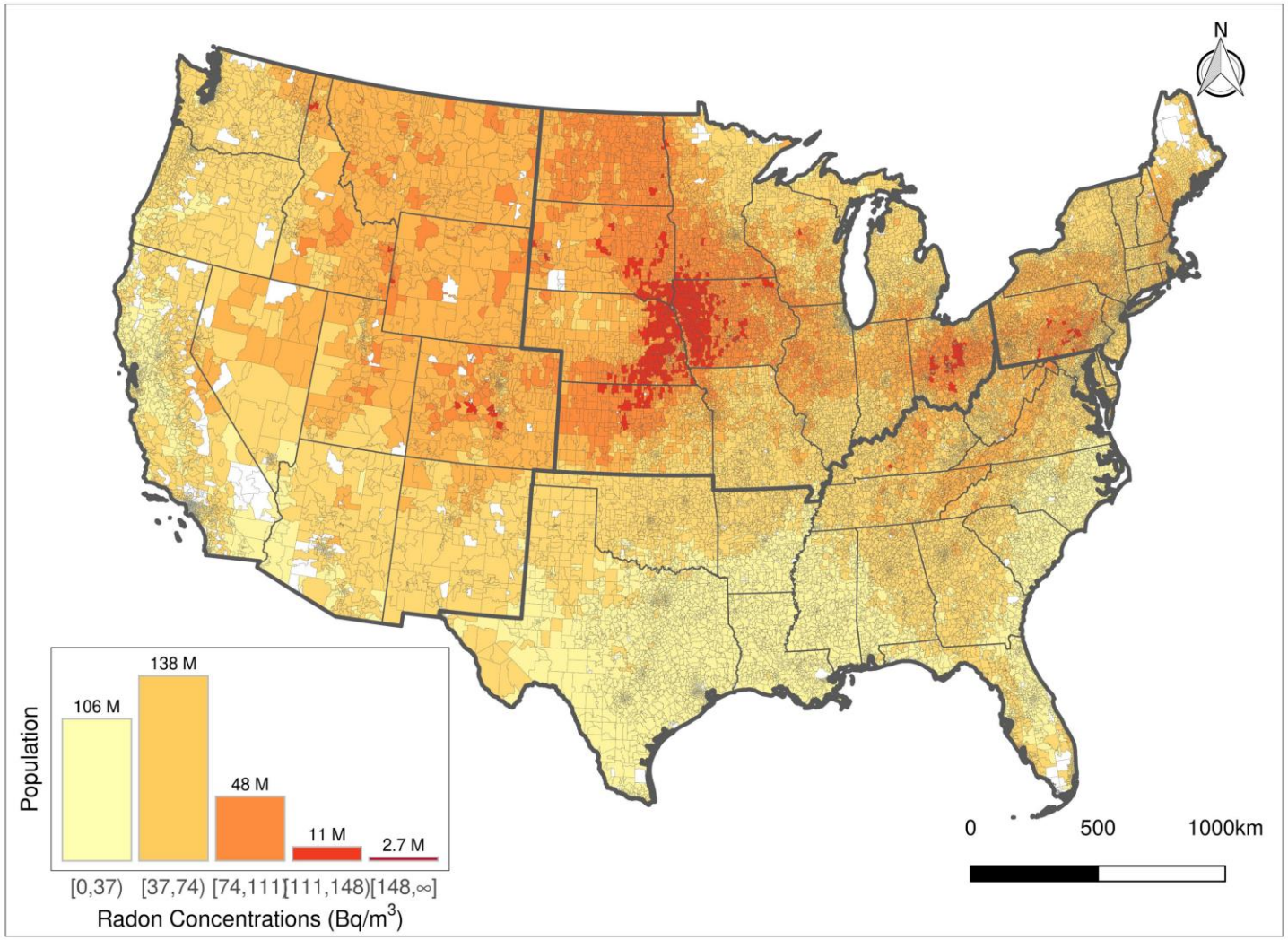
Results

- For ZIP Code-level observations based on larger samples, the agreement is better.
- For ZIP Code-level observations based on >15 measurements, the Mean Absolute Error is 25.2 Bq/m^3 (26.3% of the mean value, R^2=0.72).
- Collaboration leads to better model.



Improved Radon Map

- ZIP Code-level map, showing more granular information.
- Relatively few residents live in high radon zones.



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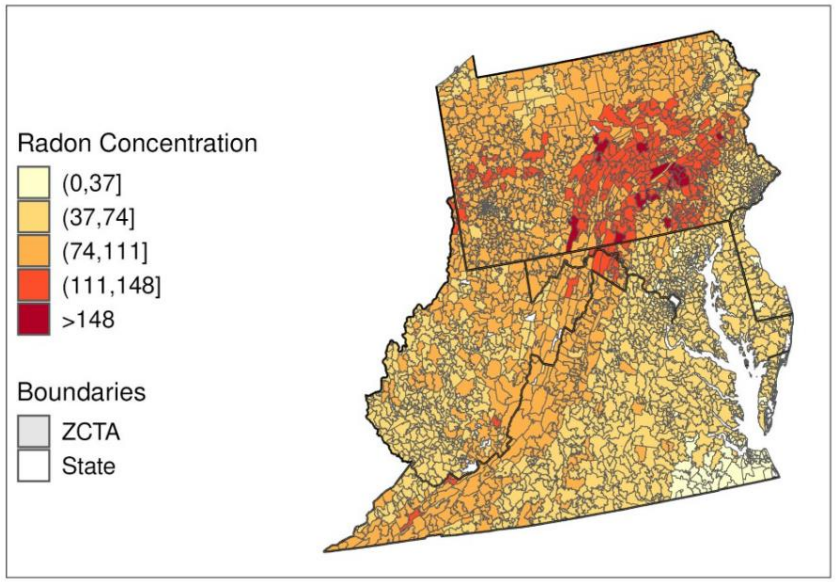
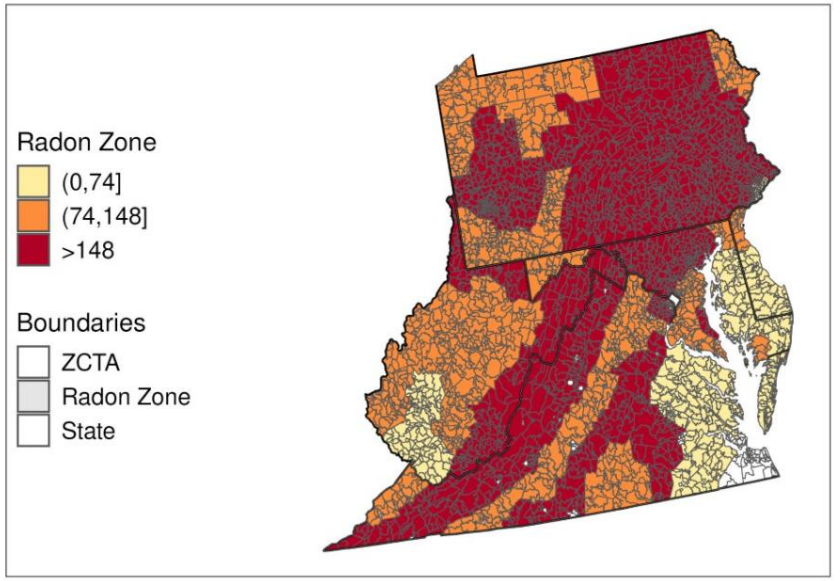
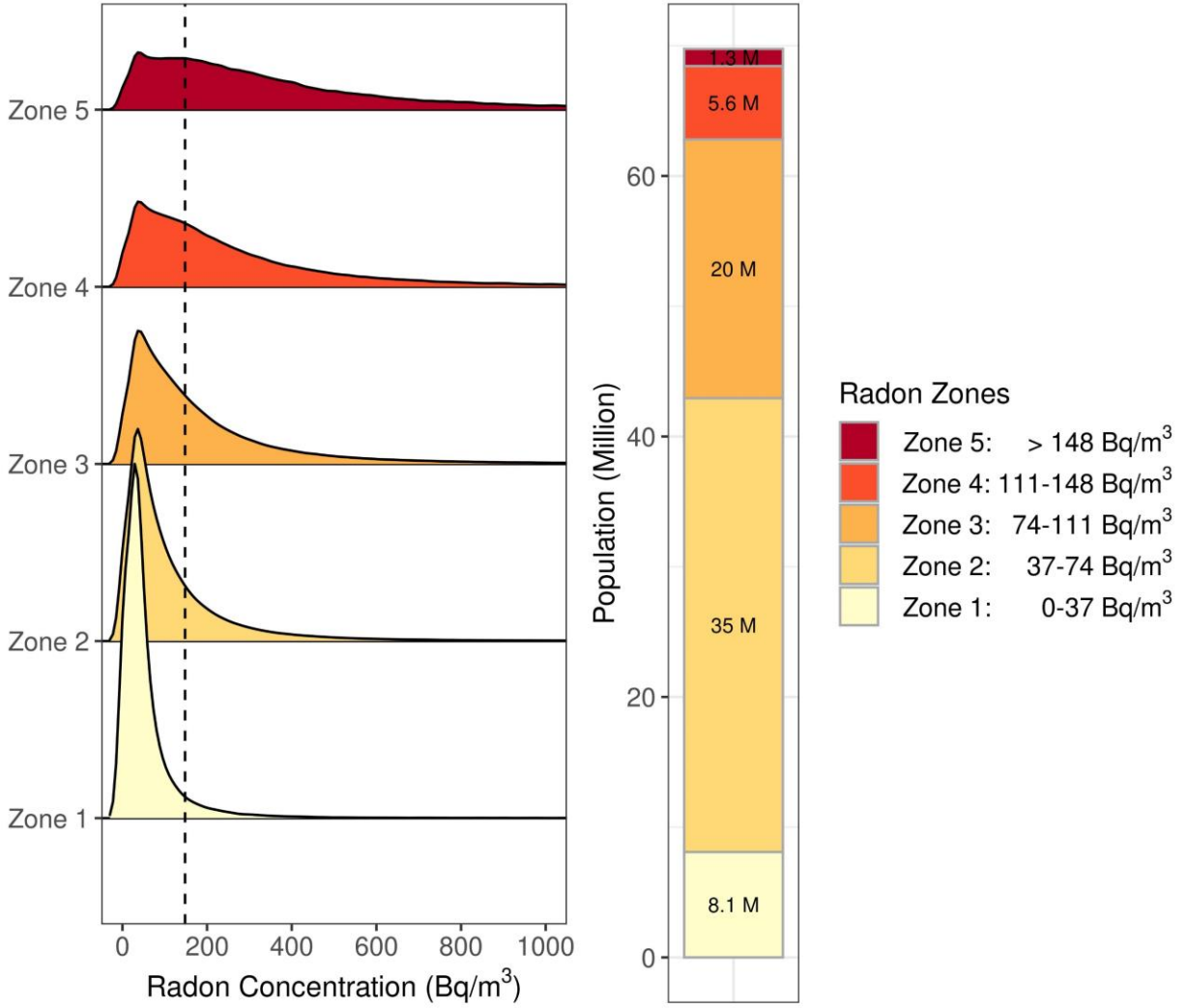
- The area of “high radon” zone is smaller than previously estimated.
- Average value misrepresent the prevailing exposure level.





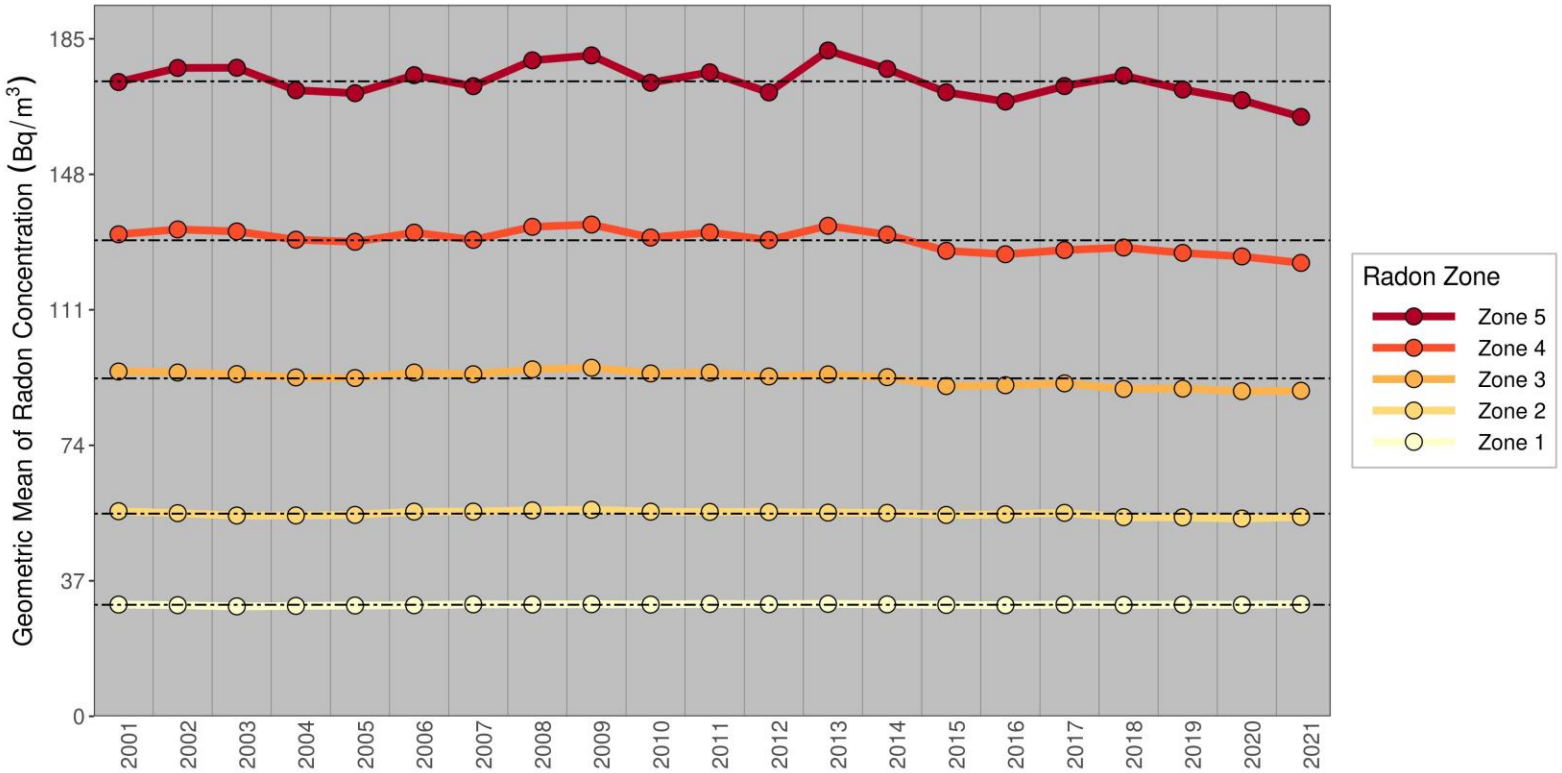
Residents at Risk

- Over 73 million people are living in residence with radon > 4 pCi/L.
- Most of them are living in “low-radon” zones.



Temporal Trends

- Slight decrease in radon levels of “high-radon” zones.
- No obvious trends in radon levels of “low-radon” zones.



Takeaway points

Our radon maps

- Based on massive representative radon measurements.
- Can model the spatial, temporal, and floor-dependent variation with high accuracy.
- Can be used in other studies for other health outcomes.

Thank you

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