

Atmospheric Radon-related Radioactivity Affected by a Change in the Manner of Ventilation

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Abstract

The present author had kept observation for concentrations of atmospheric radon, radon progeny and thoron progeny for several years at the campus of Fukushima Medical University. In the midst of this observation term, the facility management group of the university changed a strategy for the manner of ventilation, probably because of a recession: (I) tidy everyday ventilation of 7:30-24:00 into (II) shortened weekday ventilation of 8:00-21:00 and weekend discontinuation. This change of ventilation brought a clear alteration for radon related natural radioactivity in indoor air. This presentation gives the analyses for these two groups of data observed under the condition of (I) and (II).

INTRODUCTION

Research for natural radioactivity and natural radiation is meaningful for medical students and doctors. The present author has kept measurements of natural radiation and/or natural radioactivity especially radon-related radioactivity in air. This presentation deals with the effect of ventilation strategy on concentrations of atmospheric radon, radon progeny and thoron progeny. A change in the manner of ventilation occurred in February 2002, probably because of a recession. This change brought a considerable change for these concentrations.

MATERIALS AND METHOD

Pylon TEL (active static-collecting type of Lucas cell, 0.5 L/min) detected radon concentration, and Pylon WLx (spectroscopic method for continuously filtering with a membrane filter, 0.5 L/min) detected radon and thoron progeny concentrations. Both monitors were set to output concentrations every one hour.

Measurement was performed in a room of the author's office (named 2nd Lab). The size of the room was 3.75 m * 6.5 m * 2.7 m. The window of the room was never opened and the doors were shut to the utmost during the measurement. The ventilation system of the university introduces outdoor air through a pre-filter and a main filter made of polyester and moda-acrylic fiber. The ventilation rate was 130 m³/hour. Probably because of this strong ventilation system, radon- and thoron-progeny concentrations in indoor air were found to be less than those in outdoor air ^{1,2)}.

To see the effect of ventilation change, the data from February 2002 to January 2003

were used. Just in the center of this term, the ventilation changed: (I) tidy everyday ventilation of 7:30-24:00 into (II) shortened weekday ventilation of 8:00-21:00 and weekend discontinuation. Figure 1 and Figure 2 show typical temporal variation of radon concentration in term (I) 2002-02-01 to 2003-01-31 and term (II) 2003-02-01 to 2004-01-31, respectively. Radon concentrations seem to be a good index for the state of ventilation.

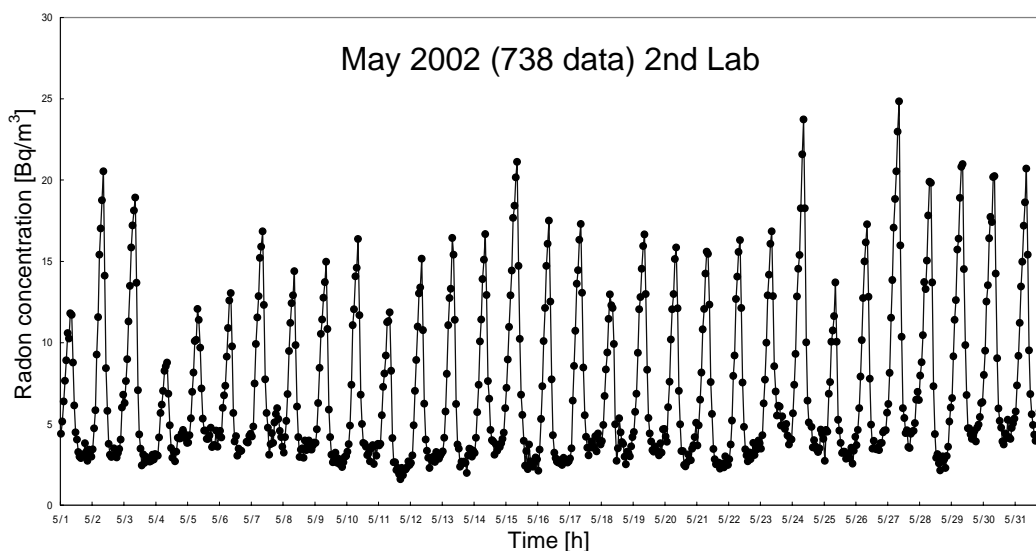


Figure 1: Temporal variation of atmospheric radon concentration before the change of ventilation system. Tidy everyday ventilation of 7:30-24:00 is indicated from the sudden decrease of concentration every morning.

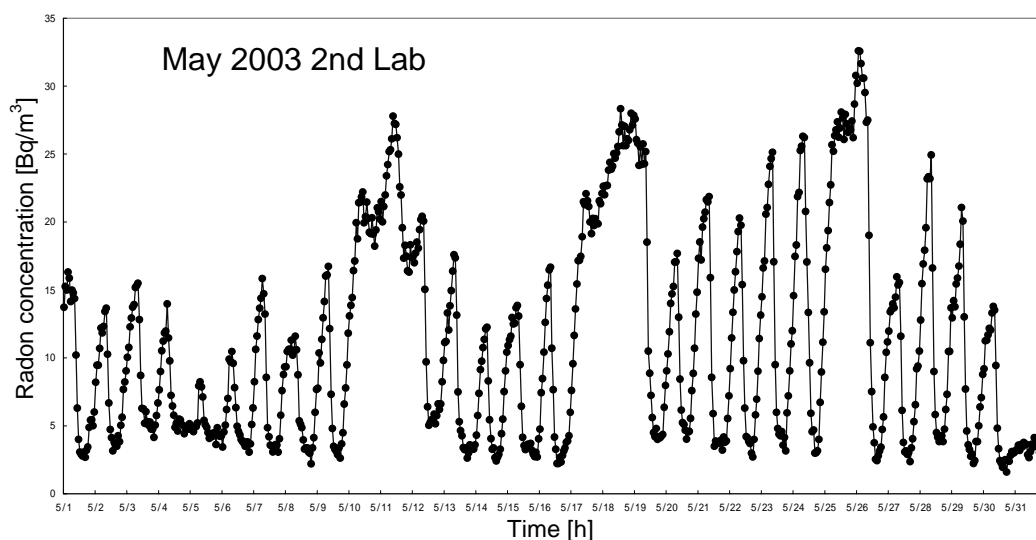


Figure 2: Temporal variation of atmospheric radon concentration after the change of ventilation system. Shortened weekday ventilation of 8:00-21:00 and weekend discontinuation are clearly indicated.

RESULTS AND DISCUSSION

Table 1 shows basic statistics of radon, radon progeny and thoron progeny before and after the change of ventilation system. The average concentrations of radon and its progeny rose slightly after the ventilation change, whereas that of thoron progeny increased drastically.

Table 1: Basic statistics for concentrations of radon (Rn), equilibrium equivalent radon progeny (ECRn), and equilibrium equivalent thoron progeny (ECTn). Before and after denotes before and after the change of the manner of ventilation system, respectively.

		#	Average	Std. Dev.	Max.	Min.
Before	Rn	365	7.82	1.91	15.65	0.64
	ECRn	365	1.47	0.79	4.48	0
	ECTn	361	0.02	0.03	0.24	0
After	Rn	365	10.69	4.36	28.44	3.10
	ECRn	365	2.02	1.25	8.33	0.08
	ECTn	365	0.09	0.11	0.50	0

Figure 3 shows the temporal variation of daily averaged concentration for radon, radon progeny and thoron progeny. In Figure 3, the occasion of the change of the ventilation manner is indicated as an arrow; the difference between before and after the change of ventilation system is obvious.

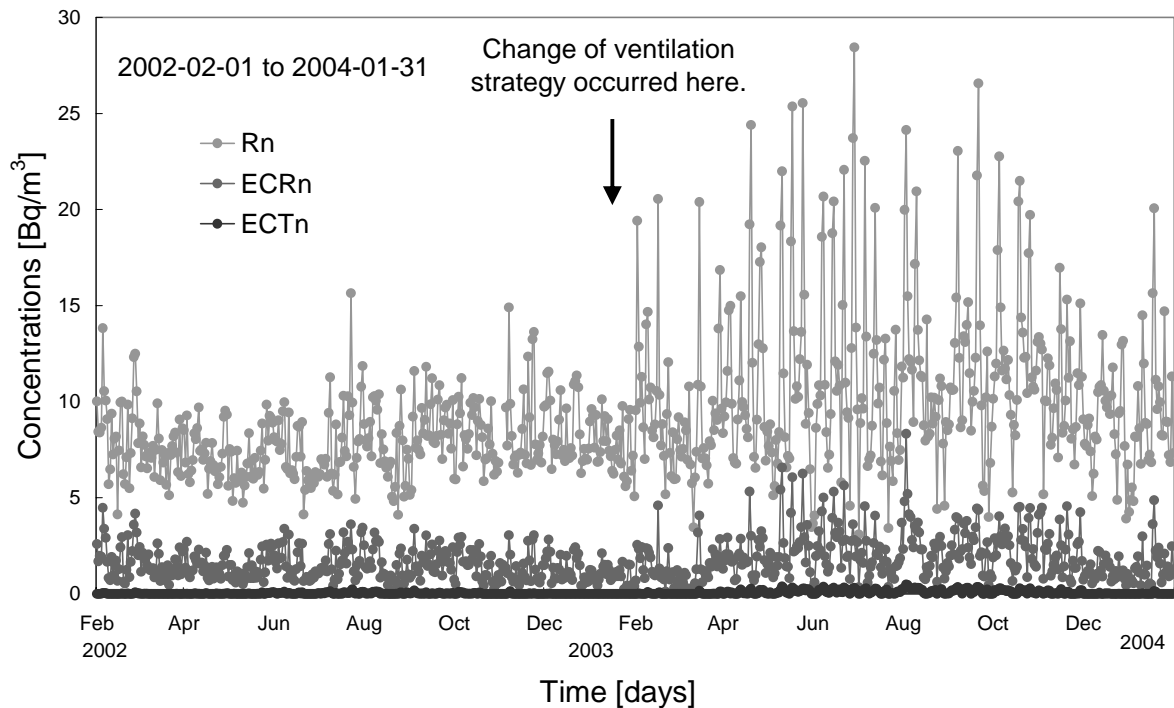


Figure 3: Temporal variation of daily averaged concentration of atmospheric radon, radon progeny and thoron progeny. Change of the ventilation manner is indicated as an arrow. Difference originated from the ventilation change is obvious.

Because of the quite small quantity of thoron progeny, ECTn indicates only slight appearance after the change of ventilation.

Figure 4 shows the temporal variation of monthly averaged concentration for radon, radon progeny and thoron progeny separately. Figure 4 again indicates slight increase of radon and drastic increase of thoron progeny. To see the seasonal variation, data were

separated into four seasons, i.e., spring (March to May), summer (June to August), fall (September to November) and winter (December to November). Essentially the same seasonal dependency was observed for the term (I) and (II), namely the concentration of radon and radon progeny were high in fall, whereas that of thoron progeny was high in summer.

Although the existence of strong ventilation system, filters cannot prevent entry of radon into the room because radon is an inert gas. Thus introduction of the outdoor air can be one of the origin of radon in air at the room, whereas thoron will not come from outdoor because of the short half live of ^{220}Rn and the long route to the room. Filters can prevent radon and progeny effectively, resulting a less concentration of indoor than that of outdoor^{1,2)}.

Filters can also hinder thoron progeny. Why concentrations of thoron progeny are high in summer, unlike concentrations of radon and radon progeny? The origin of atmospheric thoron in the room is considered to be the materials of the room itself, i.e., the floor, wall, ceiling, etc. The dissipation of thoron from these materials may depend on temperature. High temperature in summer may probably increase the dissipation rate of thoron. Ventilation carries out thoron from the room to outside through exhaust pipes, etc. Thus, change of the ventilation system strongly affected thoron concentration.

Observation of the change of the radon-related three concentrations before and after the change of ventilation manner gave us a chance to speculate about the tendency and/or origin of radon-related radioactivity.

REFERENCES

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- 2) Tsuneo Kobayashi: Temporal variation of radon progeny ratio in outdoor air. *Health Phys.* **83** (2): 287-292; 2002.

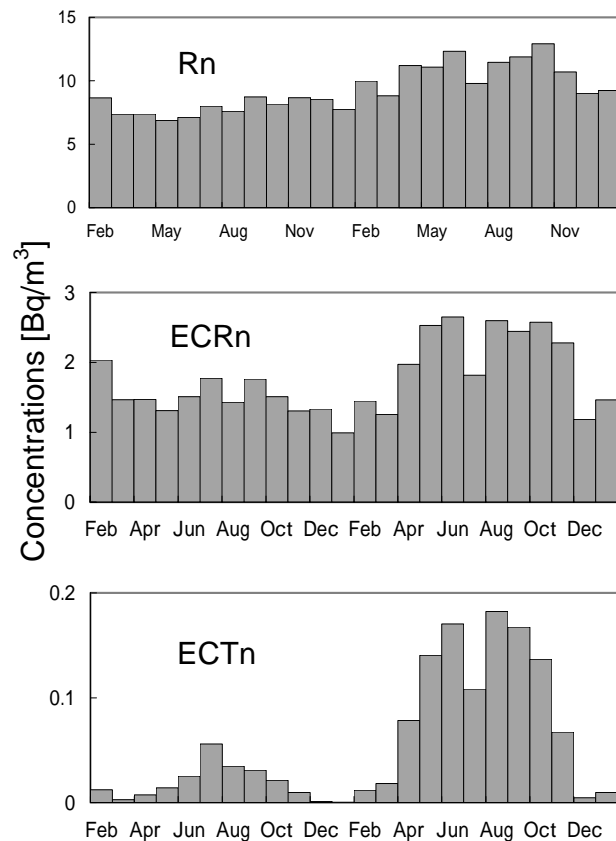


Figure 4: Temporal variation of monthly averaged concentration of atmospheric radon (Rn), radon progeny (ECRn) and thoron progeny (ECTn).