Climatic and Seasonal Influence on Radon Time-Series in Environment of Low Anthropogenic Activity

C.J. Groves-Kirkby, R.G.M. Crockett, A.R. Denman and P.S. Phillips

School of Science and Technology
University of Northampton, Northampton UK

tony.denman@northampton.ac.uk

THE UNIVERSITY OF NORTHAMPTON
School of Science and Technology

1: Introduction

- Seasonal Correction Factors (SCFs) are used to convert radon concentration over a sub-year period to a notional annual mean, although it is recognised that this approach is not universally valid.
- Miles (1998) showed that the mean monthly domestic radon concentration was a linear function of the mean external temperature, *T* (degrees C).
- Ibrahimi and Miles (2009) presented a general formula relating mean annual radon concentration, *R*, (units of Bq.m^{-3}), in a dwelling to the occupancy-weighted mean radon concentration, *C*, observed during a 2-week measurement period and the mean external temperature, *T*, during this period:

$$R = (C - 4) \times (1 / [1.645 - 0.063T]) + 4 \qquad [1]$$

- These concepts were tested using data from an extended radon monitoring exercise in Northampton, UK

2: Method

- Between June 2003 and March 2008 (1766 days), radon concentration and ambient temperature were monitored at hourly intervals in an environmentally-stable, rarely-visited partially-subterranean store-room in a public-service building (Figure 1).
- Sampling periods totalled 1025 days, the longest continuous sampling period and interval between sampling periods being 335 and 271 days respectively.
- Mean daily, monthly (calendar) and annual concentrations and temperatures were derived. For each calendar month, averages over corresponding months of at least three separate years were calculated.
- Similar statistics were generated from daily meteorological data collected 10 km from the measurement site (Figure 2).
- Overall mean and standard deviation (SD) radon concentrations were 73.0 Bq.m^{-3} and 62.7 Bq.m^{-3} respectively, corresponding mean and SD internal temperatures being 26.2 C and 1.7 C, respectively.

3: Results

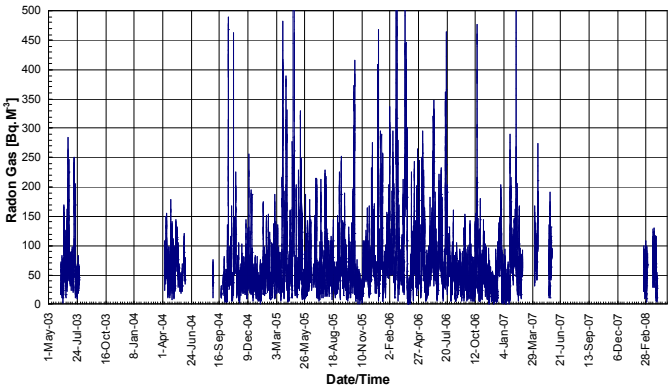

Fig. 1 - Radon Concentration Time-Series, June '03 – March '08.

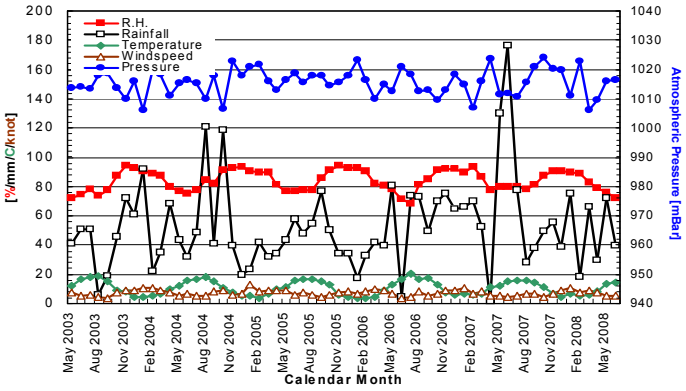

Fig.2 - Climate Time Series, March '03 – May '08

4: Discussion

- Pearson Correlation factors between mean monthly radon concentrations and corresponding climatic parameters were determined.
- Surrogate SCF sets were derived directly from monthly mean radon concentration and from external temperature and internal-external temperature-difference (both using Eq. 1).
- These were correlated with each other and with the UK 1-month SCF set to quantify goodness-of-fit.

Table 1 - Pearson Correlation Matrix for Radon and Climatic Parameters

	Radon	Temp. Internal	Temp. Difference	Temp. External	Atmos. Pressure	Rainfall	Wind-speed	Relative Humidity	1-month SCF
Radon	1.00	-0.16	0.23	-0.24	0.07	-0.36	-0.15	-0.19	-0.17
Temp. Internal	-0.16	1.00	-0.43	0.61	-0.37	0.65	-0.48	-0.41	0.61
Temp. Difference	0.23	-0.43	1.00	-0.98	0.08	-0.32	0.66	0.71	-0.88
Temp. External	-0.24	0.61	-0.98	1.00	-0.16	0.43	-0.69	-0.72	0.92
Atmos. Pressure	0.07	-0.37	0.08	-0.16	1.00	-0.46	-0.10	0.02	-0.09
Rainfall	-0.36	0.65	-0.32	0.43	-0.46	1.00	-0.18	-0.13	0.39
Wind-speed	-0.15	-0.48	0.66	-0.69	-0.10	-0.18	1.00	0.42	-0.58
Relative Humidity	-0.19	-0.41	0.71	-0.72	0.02	-0.13	0.42	1.00	-0.78
1-month SCF	-0.17	0.61	-0.88	0.92	-0.09	0.39	-0.58	-0.78	1.00

5: Conclusions

- Radon concentration shows minimal or zero correlation with the three temperature parameters, atmospheric pressure and wind-speed, limited correlation with rainfall and minimal correlation with relative humidity.
- Relatively good correlation (|*r*| = 0.59) exists between radon seasonality and the internal-external temperature difference, but poorer correlation with external temperature (|*r*| = 0.18), using the temperature-based formula (Eq. 1).
- Formula-derived SCFs based on external temperature correlate well (|*r*| = 0.98) with the 1-month SCF set.

Table 2 - Pearson Correlation Matrix for Surrogate SCF set.

	UK 1-month SCF set	Radon-derived SCF	Temperature, using Eq. 1		
			External Temp.	Temp. Difference	Internal Temp.
HPA 1-month SCF	1.00	-0.17	0.97	0.79	0.35
Radon-derived SCF	-0.17	1.00	-0.18	-0.59	0.15
External Temp.	0.97	-0.18	1.00	0.82	0.32
Temp. Difference	0.789	-0.59	0.82	1.00	0.20
Internal Temp.	0.35	0.15	0.32	0.20	1.00

6: References

- Miles JCH (1998). *Mapping radon-prone areas by lognormal modelling of house radon data.* Health Phys. **74**:370-378.
- Ibrahimi ZF, Miles JCH (2009). *An etched track detector for short-term screening measurements of radon.* J. Rad. Prot. **29**:139–146.