

## Supplementary Materials

Influence of precipitation on the spatial distribution of  $^{210}\text{Pb}$ ,  $^7\text{Be}$ ,  $^{40}\text{K}$  and  $^{137}\text{Cs}$  in moss

Kayla Wilkins<sup>1</sup>, Hazel Cathcart<sup>1</sup>, Padraig Hickey<sup>2</sup>, Olwyn Hanley<sup>2</sup>, Luis León Vintró<sup>3</sup> and Julian Aherne<sup>1\*</sup>

<sup>1</sup> School of Environment, Trent University, Peterborough, Ontario K9L 0G2, Canada

<sup>2</sup> Office of Radiation Protection and Environmental Monitoring, Environmental Protection Agency, Dublin D14 YR62, Ireland

<sup>3</sup> UCD School of Physics, University College Dublin, Dublin D04 N2E5, Ireland

\*Correspondence: jaherne@trentu.ca

### Supplementary Materials: Tables and Figures

Table S1. Site ID,  $^{210}\text{Pb}$ ,  $^{137}\text{Cs}$ ,  $^7\text{Be}$  and  $^{40}\text{K}$  activity concentration ( $\text{Bq kg}^{-1}$ ) in moss (*Hylocomium splendens* (Hedw.) B.S.G.) tissue (n = 24). See Table S2 for location (co-ordinates) of study sites. Uncertainty (unc) quoted at 1 sigma.

Table S2: Site ID, location (easting and northing in Irish Grid (m)), elevation (E), precipitation (P), temperature (T), lead-210 ( $^{210}\text{Pb}$ ) activity concentration, and lead (Pb) concentration in moss tissue.

Equation S1: Normalized Median Absolute Deviation (NMAD).

Figure S1. Photograph of *Hylocomium splendens* (Hedw.) B.S.G. showing a 'stair-step' shape, which is indicative of annual biomass growth. The green shoots are sampled and typically represent the last 2 to 3 years of growth.

Figure S2: The  $^{40}\text{K}$  activity concentration ( $\text{Bq kg}^{-1}$ ) versus  $^7\text{Be}$  activity concentration ( $\text{Bq kg}^{-1}$ ) in *Hylocomium splendens* (Hedw.) B.S.G. across the study sites in Ireland (n = 8,  $r^2 = 0.43$ ,  $p < 0.07$ ).

Figure S3: Predicted against observed (measured) radionuclide activity concentration ( $\text{Bq kg}^{-1}$ ) for  $^{210}\text{Pb}$  (n=24) and  $^7\text{Be}$  (n=8). Independent variables in multiple linear regression equations are precipitation (P), temperature (T) and elevation (E).

Figure S4: Semivariogram (fitted with a Matern model with M. Stein's parameterisation) for  $^{137}\text{Cs}$  found in *Hylocomium splendens* (Hedw.) B.S.G. across the 24 study sites in Ireland (16 sites with observations above DL).

Table S1. Site ID,  $^{210}\text{Pb}$ ,  $^{137}\text{Cs}$ ,  $^7\text{Be}$  and  $^{40}\text{K}$  activity concentration ( $\text{Bq kg}^{-1}$ ) in moss (*Hylocomium splendens* (Hedw.) B.S.G.) tissue (n = 24). See Table S2 for location (co-ordinates) of study sites. Uncertainty (unc) quoted at 1 sigma.

Site ID	$^{210}\text{Pb}$ activity	$^{210}\text{Pb}$ unc	$^{137}\text{Cs}$ activity	$^{137}\text{Cs}$ unc	$^7\text{Be}$ activity	$^7\text{Be}$ unc	$^{40}\text{K}$ activity	$^{40}\text{K}$ unc
L680472	446.06	76.13	12.54	2.52	.	.	109.28	41.02
Q598077	838.22	50.52	41.38	4.40	.	.	.	.
F869162	876.43	61.64	21.17	3.03	412.75	83.71	61.47	34.93
L821699	697.50	71.17	.	.	.	.	.	.
V925828	511.93	55.37	26.52	3.11	.	.	73.32	30.54
V870580	947.93	58.25	9.68	2.34	339.62	100.36	103.95	29.66
M174035	515.07	46.02	5.28	2.16	.	.	57.17	24.51
R170499	298.20	40.18	.	.	484.79	109.81	119.64	35.00
W078805	835.92	60.94	7.48	2.99	335.64	112.79	116.43	36.84
W024681	725.47	63.40	9.60	2.92	305.22	111.40	96.00	36.95
M372970	347.59	37.82	12.34	2.55	.	.	.	.
M402154	296.51	37.85	.	.	.	.	.	.
G969806	515.14	49.27	18.99	3.22	283.10	99.44	78.12	25.71
G777484	968.04	88.90	.	.	604.35	105.07	121.23	25.68
M950441	345.76	45.14	3.06	1.40	.	.	81.97	35.02
C259354	431.02	41.57	6.94	2.79	599.99	121.99	155.42	23.31
H576776	336.66	44.69	.	.	.	.	137.05	32.08
H713148	336.09	44.63	.	.	.	.	81.52	24.77
S814479	435.87	52.66	21.35	3.47	.	.	99.90	34.37
S986202	277.54	51.03	.	.	.	.	81.02	29.01
N534681	225.51	38.50	.	.	.	.	85.07	32.91
J114168	539.21	57.19	9.20	2.55	.	.	78.12	44.93
T103962	779.54	59.12	8.08	2.37	.	.	.	.
R274984	468.16	50.19	11.13	2.32	.	.	.	.

Measured radionuclide activity concentrations ( $\text{Bq kg}^{-1}$ ) were corrected for dry weight, and  $^{210}\text{Pb}$  activity concentration was also corrected for self attenuation.

Table S2: Site ID, location (easting and northing in Irish Grid (m)), elevation (E), precipitation (P), temperature (T), lead-210 ( $^{210}\text{Pb}$ ) activity concentration, and lead (Pb) concentration in moss tissue.

Site ID	Easting	Northing	E (m)	P (mm)	T (°C)	$^{210}\text{Pb}$ activity (Bq kg <sup>-1</sup> )	Pb (mg kg <sup>-1</sup> )	$^{210}\text{Pb}/\text{Pb}$ (Bq mg <sup>-1</sup> )
L680472	68027.6	247171.9	14.75	1503.30	10.48	446.06	0.4284	1041.1
Q598077	59844.4	107700.9	209.25	2177.21	9.13	838.22	2.5837	324.4
F869162	86860.4	316187.9	72.46	1480.73	9.37	876.43	1.0712	818.2
L821699	82109.4	269902.0	65.16	2198.01	9.81	697.50	1.4580	478.4
V925828	92456.8	82811.3	22.07	2181.18	10.52	511.93	0.5331	960.4
V870580	86984.0	58041.0	141.23	2779.97	9.88	947.93	0.9222	1027.9
M174035	117355.4	203490.7	201.79	1780.49	9.35	515.07	0.3994	1289.6
R170499	116983.3	149867.2	2.26	1129.20	10.52	298.20	0.5314	561.1
W078805	107788.2	80502.2	70.79	2065.52	9.93	835.92	1.1351	736.4
W024681	102428.6	68140.1	139.53	2392.01	9.75	725.47	0.8608	842.8
M372970	137232.3	296971.9	54.54	1258.51	9.55	347.59	0.1380	2518.0
M402154	140232.6	215408.4	20.08	1045.40	10.30	296.51	0.4513	657.1
G969806	196867.2	380564.7	35.81	1632.50	9.46	515.14	1.9989	257.7
G777484	177741.8	348432.0	197.89	1853.73	7.86	968.04	1.3644	709.5
M950441	195025.2	244096.8	70.14	978.99	9.60	345.76	0.5048	685.0
C259354	225926.1	435431.7	100.49	1233.45	9.14	431.02	0.6485	664.7
H576776	257605.4	377645.8	180.00	1281.73	8.35	336.66	2.1733	154.9
H713148	271260.3	314789.6	248.63	1067.99	8.49	336.09	1.3278	253.1
S814479	281410.2	147896.2	218.00	1052.57	9.02	435.87	2.4227	179.9
S986202	298566.9	120183.4	175.29	1213.40	9.70	277.54	1.4668	189.2
N534681	253436.2	268116.6	95.72	996.04	9.30	225.51	0.5926	380.5
J114168	311378.9	316814.3	264.95	1182.42	8.46	539.21	2.3375	230.7
T103962	310329.0	196173.0	130.77	1913.57	8.90	779.54	2.9154	267.4
R274984	127375.8	198393.0	166.95	1630.44	9.45	468.16	1.2696	368.7

$^{210}\text{Pb}$  activity concentration (Bq kg<sup>-1</sup>) was corrected for dry weight and self attenuation.

Equation S1: Normalized Median Absolute Deviation (NMAD) was calculated as

$$\text{Median} [ABS(x_1 - y), ABS(x_2 - y) \dots ABS(x_{24} - y)] \div y \times 100\%$$

where ABS is absolute value, x is the individual value of the variable of interest, and y is the median of the variable of interest.



Figure S1. Photograph of *Hylocomium splendens* (Hedw.) B.S.G. tissue showing a 'stair-step' shape, which is indicative of annual biomass growth. The green shoots are sampled and typically represent the last 2 to 3 years of growth. [Photo credit: Phaedra Cowden]

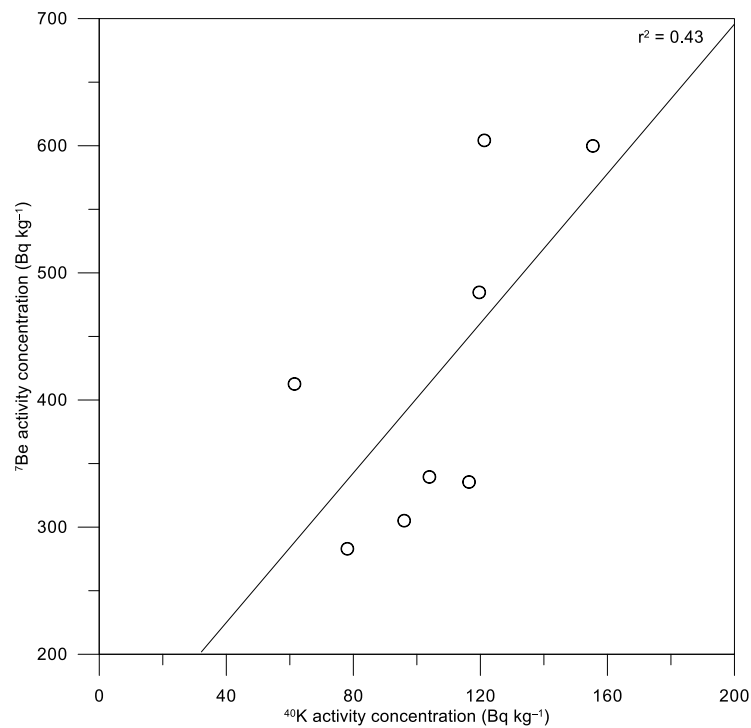


Figure S2: The  $^{40}\text{K}$  activity concentration (Bq kg<sup>-1</sup>) versus  $^7\text{Be}$  activity concentration (Bq kg<sup>-1</sup>) in *Hylocomium splendens* (Hedw.) B.S.G. across the study sites in Ireland ( $n=8$ ,  $r^2 = 0.43$ ,  $p < 0.07$ ).

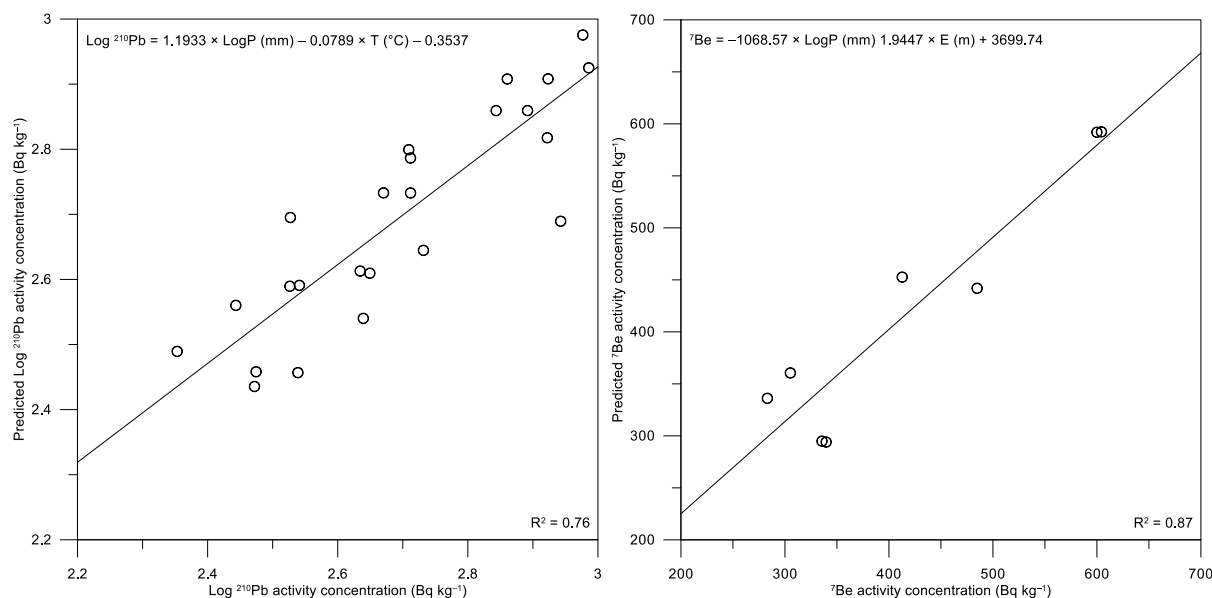


Figure S3: Predicted against observed (measured) radionuclide activity concentration (Bq kg<sup>-1</sup>) for <sup>210</sup>Pb (n=24) and <sup>7</sup>Be (n=8). Independent variables in multiple linear regression equations are precipitation (P), temperature (T) and elevation (E).

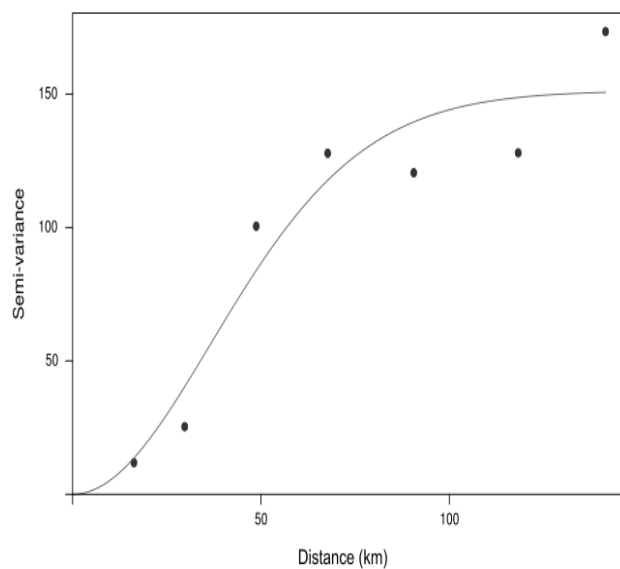


Figure S4: Semivariogram (fitted with a Matern model with M. Stein's parameterisation) for <sup>137</sup>Cs found in *Hylocomium splendens* (Hedw.) B.S.G. across the 24 study sites in Ireland (16 sites with observations above DL).