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Global distribution of ^{7}Be. ^{210}Pb and ^{210}Po in the surface air (with Appendix A-E)

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Abstract

In the effort of modelling the global distribution ^{7}Be, ^{210}Pb and ^{210}Po in surface air, the results from exploration of radioactivity exploration from the Arctic to the Antarctic during 1980 to 1996 are compiled with the results reported by other authors. Partial least square regression modelling PLS-regression, predict missing ^{7}Be, ^{210}Pb and ^{210}Po values of air concentration or annual deposition. All available data of air concentration and deposition, of these radionuclides are then correlated with geophysical parameters.

The results indicate that the global latitudinal distribution of ^{7}Be air concentration was rather flat, with an overall global average of 4.2 (SE 0.4) mBq.m^{-3}, although with a slight dip at the equator and decrease towards high latitudes. The corresponding latitudinal distribution was also flat, and decreased slightly at high and low altitudes, with overall global average of ^{7}Be annual deposition was 1500 (SE 100) Bq.m^{-3}.a^{-1}.

The ^{7}Be deposition rate estimated from reported annual mean air concentration and annual deposition is 13.4 ± 1.7 (SE) mm.s^{-1}. By using PLS-r modelling of either air concentrations or annual depositions, the average deposition rate of ^{7}Be was estimated to 12.3 ± 1.6 (SD) mm.s^{-1}.

The ^{7}Be deposition-rate don´t vary significantly with longitude, latitude or geometrical average year of sampling date. Linear regression with height, however, is negative with a coefficient of - 0.02. At sea level, the ^{7}Be deposition-rate was estimated to 13 mm.s^{-1}, while at a height of 800 m it was predicted to be 7 mm.s^{-1}. The 16 values of ^{7}Be deposition rate, reported in the literature, are widely scattered (SD = 18) with an average of about 18 mm.s^{-1}.

The latitudinal distribution of the activity concentration of ^{210}Pb in air showed a maximum of about 600 ± 200 µBq.m^{-3} around 45 °N with a steady decrease towards higher and lower latitudes. Minimum values of 400 µBq.m^{-3} and 80 µBq.m^{-3} were estimated at 90 °N and at 90 °S respectively. The latitudinal distribution of all ^{210}Pb air concentration values (µBq.m^{-3}) is given by the following equation: $\log_{10}[^{210}Pb] = 2.52 + 0.0083\cdot(\text{Latitude}) - 9.87.10^{-5}\cdot(\text{Latitude})^2$.

The latitudinal distribution of all ^{210}Pb annual deposition values ($Bq.m^{-2}.a^{-1}$) showed a maximum of about 200 ± 100 $Bq.m^{-2}.a^{-1}$ around 45 °N, with a steady decrease towards higher and lower latitudes. A minimum of 100 $Bq.m^{-2}.a^{-1}$ was predicted at 90 °N, although a value of 17 ± 4 $Bq.m^{-2}.a^{-1}$ has been recorded at 84.4 °N 2.3 °W. At 90 °S the predicted ^{210}Pb annual deposition was 3 $Bq.m^{-2}.a^{-1}$.

The ^{210}Pb deposition rate was estimated 12.5 ± 0.7 $mm.s^{-1}$ with no significant variation with latitude, height, or average of interval of sampling date. With longitude, however, the ^{210}Pb deposition rate varied significantly (linear k=0.02) R=0.99.

The values of ^{210}Po air concentration around 20 - 45 °N ranged between 50 – 1000 $\mu Bq.m^{-3}$ with a mean of 200 $\mu Bq.m^{-3}$, and the ^{210}Po annual deposition ranged between 20-800 $Bq.m^{-2}.a^{-1}$ with a mean of 100 $Bq.m^{-2}.a^{-1}$. The longitudinal distribution of the $^{210}Po/^{210}Pb$ activity ratios follow a narrow linear relation from 0.2 at 90 °W to 1.0 at 170 °E. While the ^{210}Po air concentration and annual deposition are widely distributed along the longitudes with a slight decrease west of the Greenwich meridian.

Keywords: ^{7}Be, ^{210}Pb, ^{210}Po, surface air, activity concentration, annual deposition, deposition rate

A. Introduction

A1. The natural origin of ^{7}Be

Beryllium-7 (^{7}Be) is a naturally produced radionuclide, originated in the upper atmosphere through spallation of oxygen and nitrogen nuclei by cosmic rays. The use of ^{7}Be as a tracer for the transport of aerosols in the atmosphere has been extensively studied (Peters, 1959, Viezee and Singh, 1980). It has also been used in studies of the residence time and deposition of aerosols from the troposphere (Rosner et al., 1996, Papastefanou and Ioannidou, 1991, Papastefanou and Ioannidou, 1996b, Papastefanou and Ioannidou, 1996a, Liu et al., 2001, Liu et al., 2013, Baskaran et al., 1993, Baskaran and Shaw, 2001, Baskaran and Swarzenski, 2007, McNeary and Baskaran, 2003, McNeary and Baskaran, 2007).

A2. The natural origin of ^{210}Pb and ^{210}Po

The radioactive isotopes Lead-210 (^{210}Pb) and Polonium-210 (^{210}Po) are naturally produced as result of the decay of ^{238}U and its daughters. The first 6 decays in the ^{238}U decay-chain take place in the ground or in water deposits containing uranium, and ends with Radon-222:

$$^{238}U > ^{234}Th > ^{234}Pa > ^{234}U > ^{230}Th > ^{226}Ra > \mathbf{^{222}Rn}(3.82\ d) >$$

Radon-222 diffuses partly from the earth´s crust to the atmosphere where it´s concentration decrease monotonly with altitude. $\mathbf{^{222}Rn}$ decays with a half-life of 3.82 days in a decay chain of short-lived radon daughters that ends with $\mathbf{^{214}Po}$:

$$>\mathbf{^{218}Po}\ (RaA\ 3.10\ min) > \mathbf{^{214}Pb}\ (RaB\ 26.8\ min) > \mathbf{^{214}Bi}\ (RaC\ 19.9\ min) > \mathbf{^{214}Po}\ (RaC'\ 164.3\ \mu s).$$

In the atmosphere, these decay products attach to airborne aerosol particles and deposit as dry and wet deposition on the earth´s surface. The decay products following $\mathbf{^{214}Po}$ are long-lived radionuclides, which ends with stable lead $\mathbf{^{206}Pb}$:

$$\mathbf{^{210}Pb}\ (RaD\ 22.20\ a) > \mathbf{^{210}Bi}\ (RaE\ 5.01\ d) > \mathbf{^{210}Po}\ (RaF\ 138.4\ d) > \mathbf{^{206}Pb}\ (stable).$$

The final radioactive isotope in this decay-chain is **^{210}Po** of which the specific activity is 0.166 GBq.µg^{-1} (166·10^{12} Bq.g^{-1} = 0.166·10^{9} Bq.µg^{-1}). **^{222}Rn** is exhaled from the ground at a rate of 18 mBq^{-2}.s^{-1} or 48·10^{18} Bq per year (48 EBq.a^{-1}) which corresponds to production of atmospheric **^{210}Pb** at a rate of 23·10^{15} Bq.a^{-1} (23 PBq.a^{-1}) (Persson, 1970).

The source of **^{210}Pb** in the stratosphere is the ascending air at the equator, which carries not only **^{210}Pb** but also **^{222}Rn** and its daughter-products. From the decay of **^{222}Rn** in the air, **^{210}Pb** and **^{210}Po** will be formed. The air concentration of **^{210}Pb** increase sharply in the vicinity of the tropopause (Burton and Stuart, 1960). The annual precipitation **^{210}Pb** varies from a few Bq.m^{-2} in the Antarctic to several hundred Bq.m^{-2} over large land masses (Roos et al., 1994, El-Daoushy, 1988, Eldaoushy and Garciatenorio, 1988). The amount of **^{210}Pb**-deposition depends on the surrounding surface of the earth and the possibilities for exhalation of **^{222}Rn**. The exhalation over sea is small due to the low concentration of ^{226}Ra in sea-water which is only about 1-2 mBq.l^{-1}. The annual deposition of **^{210}Po** in central Sweden has been estimated to about 63 Bq.m^{-2}.a^{-1} (Persson, 1970). Further out in the Arctic Ocean the depositional flux of ^{210}Pb around Longitude 154^{o}W (150-156) is around 16-22 Bq.m^{-2}.a^{-1} extrapolated from published data (Baskaran and Naidu, 1995).

A3. Aim of this review

The first measurements of air concentrations of ^{222}Rn (radon) and its long-lived daughters ^{210}Pb and ^{210}Po 1980 over the North Atlantic and Arctic Ocean was done during the Ymer-80 expedition (Samuelsson et al., 1986, Persson et al., 2015a). During succeeding expeditions arranged by the Swedish Polar Research Secretariat to the Antarctica (1988-89) “Swedarp”, the “Arctic Ocean-91” and “Tundra Ecology-94” along the coast line of Siberia, the air concentrations of ^{210}Pb. ^{210}Po as well as ^{7}Be in surface air were studied (Persson et al., 2015a, Persson et al., 2015b, Persson et al., 2015c, Persson et al., 2015d).

In the present review air concentrations and deposition data of ^{7}Be. ^{210}Pb. and ^{210}Po reported by others has been added to the data generated by the polar expeditions, are given in Appendix A, B and, C of this publication. In the present review, this database is used to analyse and model the global distribution of air concentrations and deposition pattern and deposition velocities of these radionuclides.

Partial least square regression modelling (PLS-r) was performed to predict missing data of air concentration at locations where only deposition values are available, and vice versa. In the PLS-r modelling, air concentration and deposition, values are used as dependent Y-variables, and height, latitude, longitude, and geometric average of time-period (GAT) as explanatory X-variables. Details about partial least square regression modelling (PLS-r) are given in the following references: (Tenenhaus et al., 2005, Wold et al., 1996, XLSTAT, 2015).

B. Air Concentration and Annual deposition of ^{7}Be

B1. Air Concentration of ^{7}Be

The global distribution of all reported values (see Appendix A) of the global ^{7}Be air concentration is displayed in **Figure B-1**.

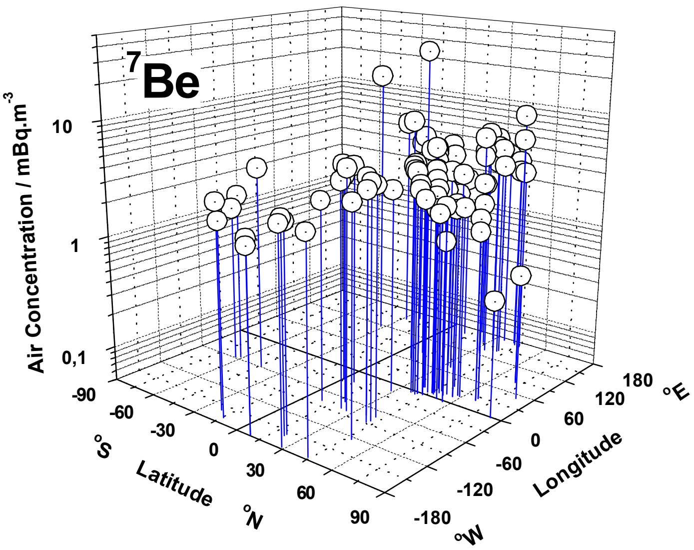

Figure B-1
Global distribution of ^{7}Be air concentration ($mBq.m^{-3}$)

The equation of the PLS-r model of ^{7}Be air concentration ($mBq.m^{-3}$) thus obtained is as follow:

$$C_{7Be} = -15.46 + 0.00951 \times GAT + 0.000659 \times Height + 0.000914 \times Lat. - 0.000708 \times Long.$$

where
GAT is the geometric average of the annual time-period (a)
Height is the height (m) above sea level
Lat. is the latitude (-°S, +°N)
Long. is the longitude (-°W, +°E)

In **Figure B-2** is given the latitudinal distribution the reported values of ^{7}Be air concentration ($mBq.m^{-3}$) given in Appendix A as well as those predicted by PLS-regression and by using Concentration / Deposition ratios. A nonlinear regression analysis of the data of the air concentration of ^{7}Be ($C_{Be\text{-}7}$) resulted in the following equation:

$$\log_{10}(C_{Be\text{-}7}) = 0.55 - 1.83 \cdot 10^{-3}(Lat.) + 8.56 \cdot 10^{-5}(Lat.)^2 + 1.05 \cdot 10^{-6}(Lat.)^3 - 3.51 \cdot 10^{-8}(Lat.)^4$$

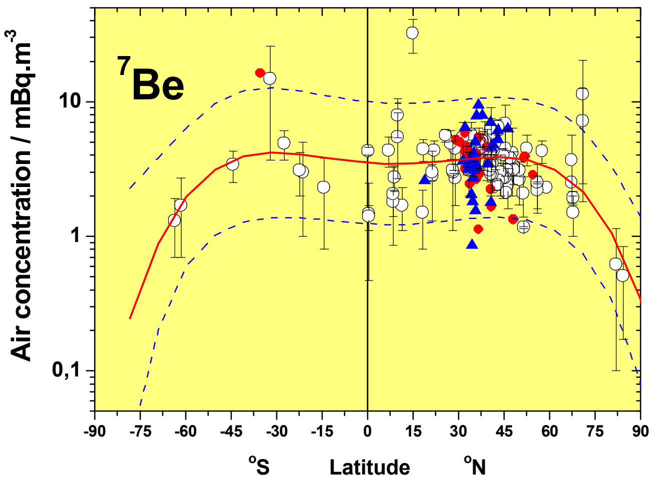

Figure B-2
Latitudinal distribution of ^{7}Be air concentration.
Unfilled circular dots: reported values given in Appendix A
Blue triangular dots: predicted by PLS-regression
Red circular dots: predicted by using Concentration / Deposition ratios

B2. Annual deposition of ^{7}Be

The global distribution of all reported values (see Appendix A) of the annual deposition of ^{7}Be is displayed in **Figure B-3**.

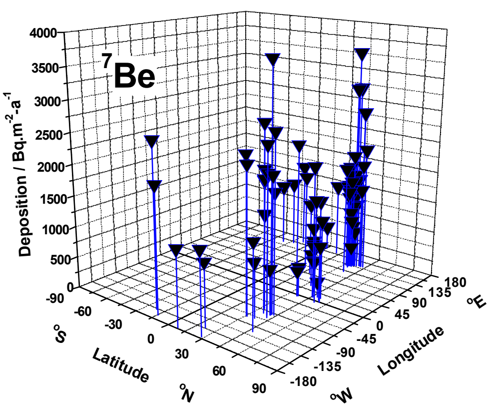

Figure B-3
Global distribution of all reported ^{7}Be annual deposition values (Φ_{7Be} Bq.m^{-2}.a^{-1}) at various locations given in Appendix A

By using the reported paired values of air concentration and average annual deposition rate (Φ_{7Be}) as training set, the missing data was predicted using partial least square modelling (PLS). The data on rainfall, height, latitude and longitude was used as X/Explanatory variables in the PLS model.

As result of the PLS modelling of Φ_{7Be} ($Bq.m^{-2}.a^{-1}$), the total flux of the ^{7}Be to the earth's surface, the following equation was obtained:

$$\Phi_{7Be} = \mathbf{7.166 - 0.0106{\times}Height - 0.0507{\times}Lat. - 0.0147{\times}Long.+0.00445{\times}Rainfall}$$

Goodness of fit statistics (Variable Dep. Rate):

Observations 26; R^2 =0.361. Std. deviation 6.4

MSE 37.933

RMSE 6.159

where

Rainfall is the geometric average of the annual precipitation ($mm.a^{-1}$)

Table B-1

Average of the various group of data

Group of ^{7}Be data	Air concentration $mBq.m^{-3}$		Annual deposition $Bq.m^{-2}.a^{-1}$	
Pairwise reported	4.1	±3.5	1502	±777
Predicted Deposition	4.1	±2.9	*Predicted* 1447	±796
Predicted Air Concentration	*Predicted* 4.2	±2.1	1945	±3016
All Average Reported and predicted	4.1	±2.9	1631	±1856

In **Figure B-4** all values of the ^{7}Be Deposition rate (Φ_{7Be} $Bq.m^{-2}.a^{-1}$) is plotted at the various latitudes.

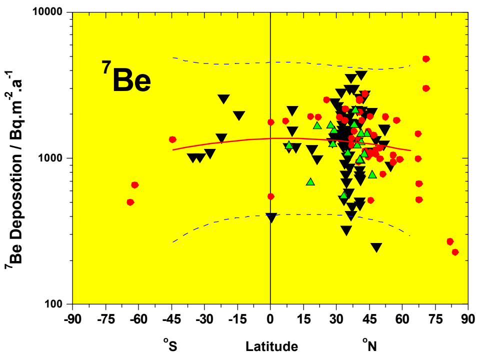

Figure B4

Latitudinal distribution of ^{7}Be annual deposition N=80

Black triangle dots: reported values given in Appendix A

Red triangular dots: predicted by PLS-regression

Red circular dots: predicted by using Concentration / Deposition ratios

A nonlinear regression modelling of ^{7}Be annual deposition Φ_{7Be} resulted in the following equation:

$$\mathbf{\log_{10}(\Phi_{7Be}) = 3.13 - 4.68{\cdot}10^{-4}{\times}(Lat.) - 2.76{\cdot}10^{-5}{\times}(Lat.)^2; \quad (Bq.m^{-2}.a^{-1})}$$

$R^2(COD) = 0.002$

C. Air Concentration and Annual Deposition of ^{210}Pb

C1. Air Concentration of ^{210}Pb

The global distribution of all the reported values of ^{210}Pb air concentration given in Appendix B are displayed in **Figure C-1**.

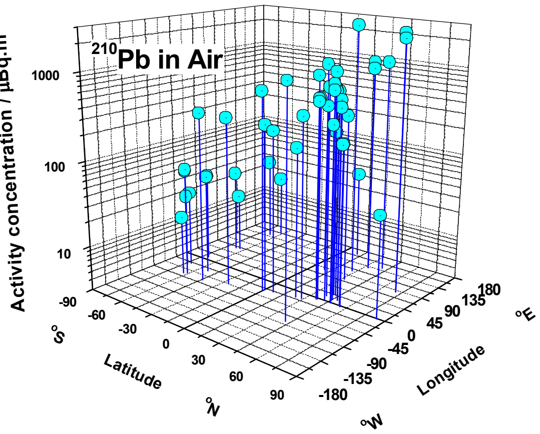

Figure C-1
Global distribution pf Activity concentration of ^{210}Pb in air with all 51 reported experimental values (Appendix B)

The Latitudinal distribution of all the reported values of ^{210}Pb air concentration given in Appendix B is displayed in **Figure C-2.**

Polynomial Fit of 91 values of ^{210}Pb activity concentration (C_{210Pb}) in surface air (µBq.m^{-3}) reported and those predicted by PLS-modelling from deposition values, resulted in the following equation:

$$\mathbf{log_{10}(C_{210Pb}) = 2.52 + 0.0083\times(Lat.) - 9.87.10^{-5}*(Lat.)^2 ; \quad (\mu Bq.m^{-3})}$$

R^2(COD) =0.58 $p<0.0001$

A partial least square regression modelling (PLS-r) was performed in order to predict missing data of ^{210}Pb annual deposition values at locations where only air concentration values are reported. The data on GAT (geometric average of the time period). Height. Latitude. Longitude and annual ^{210}Pb-Deposition (Φ_{210Pb}) was used as X / Explanatory variables.

The Equations of the model of ^{210}Pb activity concentration (C_{210Pb}) thus obtained:

$$\mathbf{C_{210Pb} = -12896 + 6.591\times GAT - 0.016\times Height + 1.798\times Lat. + 0.0350\times Long. + 0.60\times\Phi_{210Pb}}$$

By using the 91 reported values given in Appendix B, and values predicted from deposition by PLS regression equation (red dots in the figure C2), the following logarithmic equation for the Latitudinal distribution of ^{210}Pb activity concentration in surface air was obtained;

$$\log_{10}(C_{210Pb}) = 2.55 + 0.0089\times(\text{Lat.}) - 9.59.10^{-5}*(\text{Lat.})^2 \; ; \quad (\mu Bq.m^{-3})$$

R^2(COD)= 0.67 $p<0.0001$.

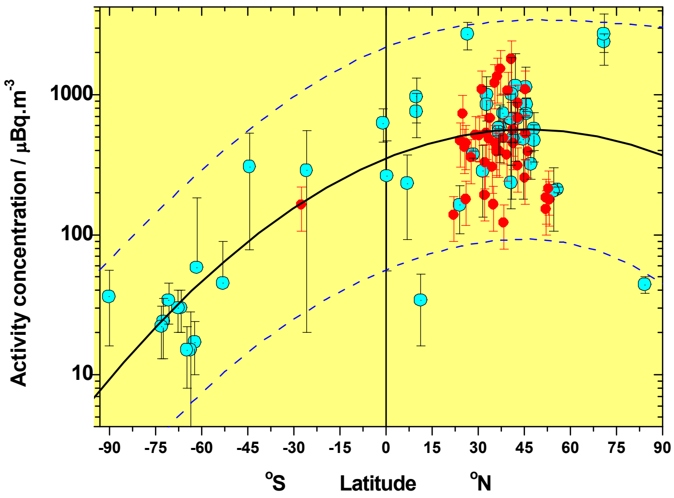

Figure C-2
Latitudinal distribution of the 91 reported ^{210}Pb activity concentration values (green dots) in surface air given in Appendix B with all and including values (red dots) predicted from deposition by PLS regression modelling.

C2. Annual Deposition of ^{210}Pb

The global distribution of all reported values (see Appendix B) of the ^{210}Pb annual deposition ($Bq.m^{-2}.a^{-1}$) is displayed in **Figure C-3**.

By using the 76 reported ^{210}Pb annual deposition vales given in Appendix B. and missing values predicted by PLS regression modelling the following equation is obtained:

$$\Phi_{210Pb} = -7869 + 4.008\times GAT - 0.00028\times Height + 1.135\times Lat. + 0.439\times Long. + 0.056\times C_{210Pb}$$

Reported data and predicted values of ^{210}Pb annual deposition (Φ_{210Pb}) [$Bq.m^{-2}.a^{-1}$] distribution are displayed in **Figure C-4** and a polynomial fit of all the data result in the equation:

$$\log_{10}(\Phi_{210Pb}) = 2.11 + 0.0084\times(\text{Lat.}) - 1.0\cdot10^{-4}\times(\text{Lat.})^2 \; ; \quad [Bq.m^{-2}.a^{-1}]$$

R-Square(COD) 0.59; $p<0.0001$

Polynomial Fit of the 76 reported values of ^{210}Pb annual deposition (Φ_{210Pb}) [$Bq.m^{-2}.a^{-1}$] resulted in the equation:

$$\log_{10}(\Phi_{210Pb}) = 2.09 + 0.0083\times(\text{Lat.}) - 0.96\cdot10^{-4}\times(\text{Lat})^2 \; ; \quad [Bq.m^{-2}.a^{-1}]$$

R-Square(COD) 0.67; $p<0.0001$

The two equations are quite similar that indicate that the predicted values are a reasonable estimate for the annual deposition values of ^{210}Pb.

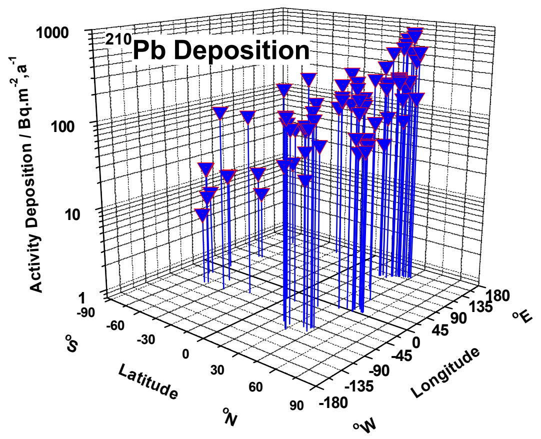

Figure C-3
Global distribution of the 79 reported ^{210}Pb annual deposition values (Bq.m^{-2}.a-1) given in Appendix B.

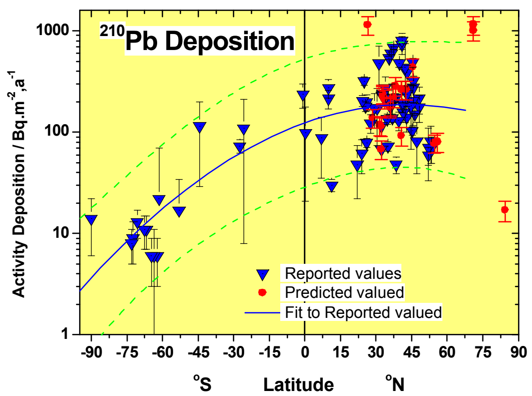

Figure C-4
Latitudinal distribution of Annual deposition of ^{210}Pb with 76 reported data ▼ (Appendix B) and values predicted from deposition ◆ by PLS regression equation.

D. Air Concentrations and Annual Deposition of Polonium-210

The latitudinal and longitudinal distribution of the $^{210}Po/^{210}Pb$ activity ratio was modelled by PLS regression analysis of the values recorded at the Swedish Polar Research expeditions (Persson and Holm, 2014). The PLS regression modelling of the $^{210}Po/^{210}Pb$ activity ratio with latitudes and longitudes resulted in following equation:

$$^{210}Po/^{210}Pb = 0.542 + 1.13 \cdot 10^{-3} \times (Lat.) + 2.85 \cdot 10^{-3} \times (Long.)$$

By using this equation, the air concentrations and deposition values are estimated from reported ^{210}Pb values of either air concentration or annual deposition. The results given in Appendix C are displayed in **Figure D-1.**

As seen in **Figure D-1a** the latitudinal distribution of ^{210}Po air concentration and annual deposition follow the same pattern as that of ^{210}Pb. The ^{210}Po/^{210}Pb activity ratios, however, seems to be widely spread along the latitudes with a slight tendency to increase towards the northern latitudes. But, as seen in **Figure D-1b** the longitudinal distribution of the ^{210}Po/^{210}Pb activity ratios follow a narrow linear relation from 0.2 at 90 °W to 1.0 at 170 °E. While the ^{210}Po air concentration and annual deposition are widely distributed along the longitudes with a slight decrease west of the Greenwich meridian.

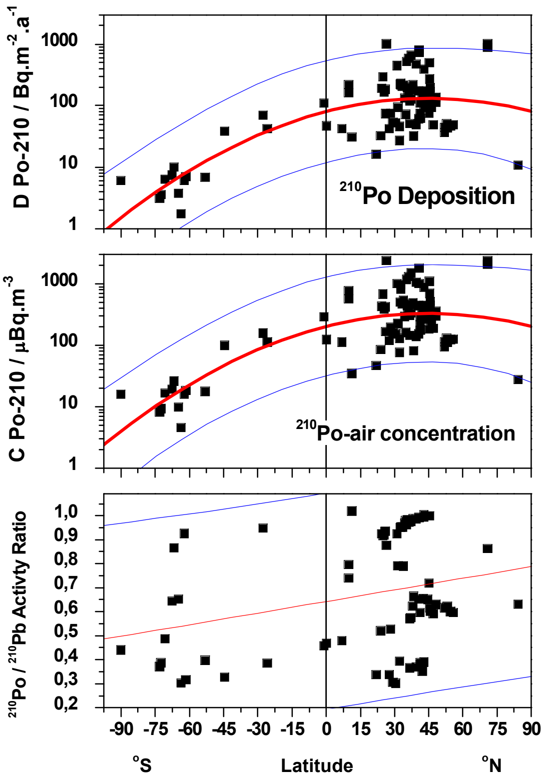

Figure D-1a
Latitudinal distribution of ^{210}Po and the ^{210}Po/^{210}Pb activity ratio.

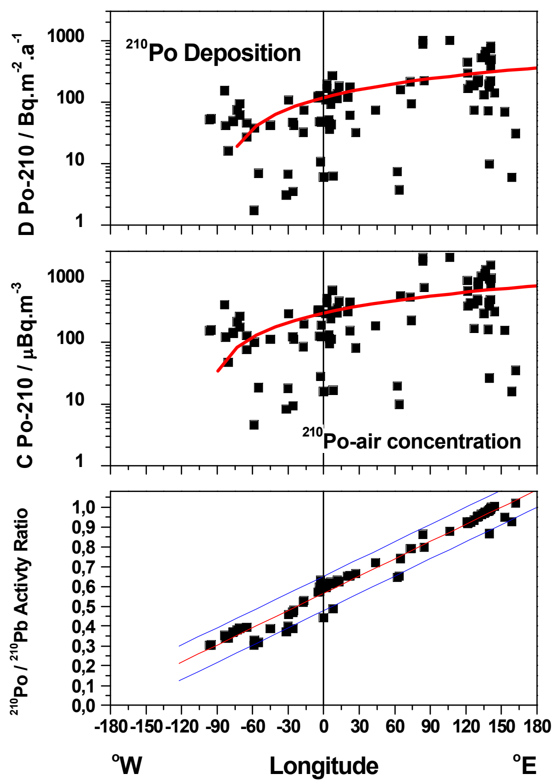

Figure D-1b
Longitudinal distribution of ^{210}Po and the ^{210}Po/^{210}Pb activity ratio.

The values of ^{210}Po air concentration around 20 - 45 °N ranged between 50 – 1000 µBq.m^{-3} with a mean of 200 µBq.m^{-3} and the ^{210}Po annual deposition ranged between 20-800 Bq.m^{-2}.a^{-1} with a mean of 100 Bq.m^{-2}.a^{-1}.

E. Residence time and deposition rate

Both ^{7}Be and ^{210}Pb are used to study the environmental processes such as aerosol particle transport and residence times in the troposphere (Papastefanou, 2006, Papastefanou, 2009a, Papastefanou, 2009b, Papastefanou and Bondietti, 1991, Papastefanou and Ioannidou, 1991, Papastefanou and

Ioannidou, 1995, Papastefanou and Ioannidou, 1996a), particle deposition velocities (Young and Silker, 1980, Fogh et al., 1999), and particle trapping above ground vegetation (Bondietti et al., 1984). As the sources of ^{210}Pb and ^{7}Be are known, these radionuclides can also be used as tools for validating atmospheric transport models (Koch and Rind, 1998, Koch et al., 1996, Rehfeld and Heimann, 1995)

The average deposition rate (V_d) can be derived from the ratio between the total annual deposition, (Φ; $Bq.m^{-2}.a^{-1}$) and the annual average of the concentration of the radionuclide in air at the sampling site (C_{air}; $Bq.m^{-3}$) and transformed into the unit mm/s (Papastefanou and Bondietti, 1991, Papastefanou and Ioannidou, 1991, Todd et al., 1989, Turekian et al., 1983). The relation gives the total flux Φ ($Bq.m-2.a^{-1}$), of the radionuclides to the earth's surface:

$$\mathbf{\Phi = C_{air} \cdot V_d \cdot 3.17 \cdot 10^{-8} \quad (Bq.m^{-2}.a^{-1})}$$

where:

Φ	($Bq.m^{-2}.a^{-1}$)	is total flux of the radionuclides to the earth's surface
V_d	($mm.s^{-1}$)	is total (wet and dry) deposition velocity.
C_{air}	($Bq.m^{-3}$)	is the concentration of the radionuclide in air at the sampling site

In the present review, the following equation is used to estimate the deposition velocities reported and predicted values of deposition rates ($Bq.m^{-2}.a^{-1}$) and air concentrations ($Bq.m^{-3}$).

$$\mathbf{V_d = 3.15 \cdot 10^{7} \cdot \Phi / C_{air} \quad (mm.s^{-1})}$$

E1. Deposition Rate of ^{7}Be

The ^{7}Be deposition rate estimated from 27 reported data-pair (Appendix A) of annual mean air concentration and annual deposition is displayed in **Figure E-1**, with an average of 13.4 ± 1.7 (SE) $mm.s^{-1}$.

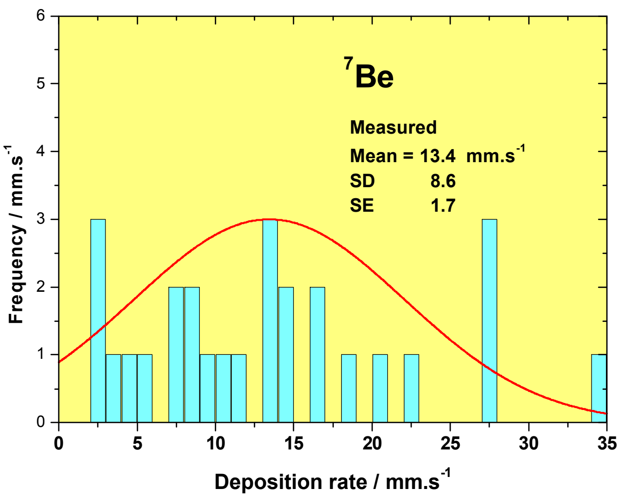

Figure E-1
Distribution of ^{7}Be deposition rate $\mathbf{V_d}$ estimated from 27 reported data-pair of annual mean air concentration and annual deposition.

Missing data of either annual mean air concentration or annual deposition of ^{7}Be predicted with PLS regression. By using these predicted values, 141 ^{7}Be deposition rate values is estimated and are displayed in **Figure E-2**. The average of 12.3 ± 1.6 (SD) mm.s^{-1} is in good agreement with the average estimated from the reported pair values.

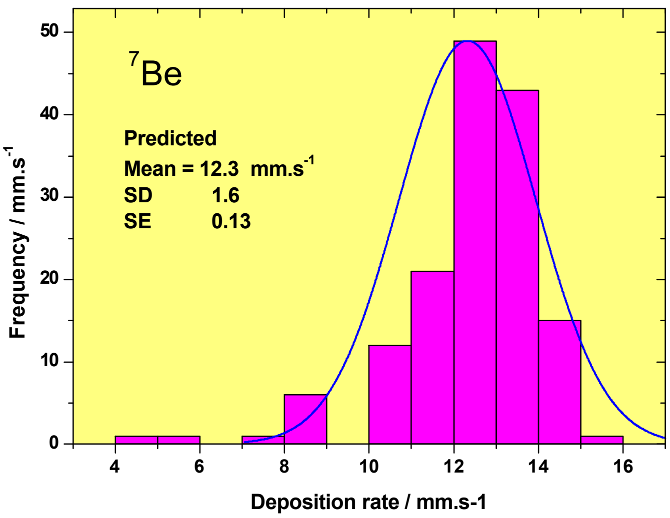

Figure E-2
Distribution of 141 ^{7}Be deposition rate values $\mathbf{V_d}$ predicted with PLS regression from all data of annual mean air concentration and annual deposition

In **Figure E-3** are displayed the distribution of ^{7}Be deposition rate $\mathbf{V_d}$ versus Longitude. Latitude, height and time with the corresponding coefficients in the table below.

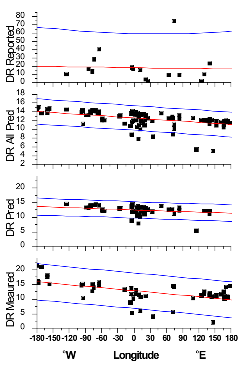

Figure E-3a
Regression with Longitude.

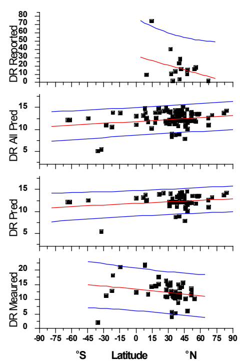

Figure E-3b
Regression with Latitude.

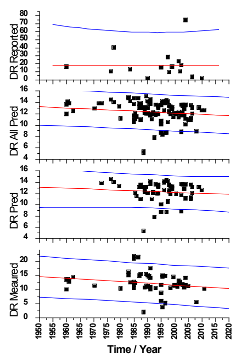

Figure E-3e
Regression with Time.

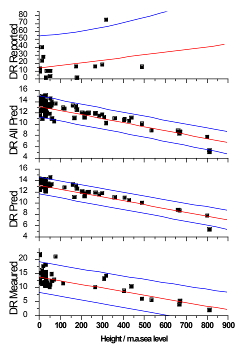

Figure E-3c
Regression with Height.

Table E1

Linear correlation of ^{7}Be deposition rate versus Longitude. Latitude, height and time (X) with the corresponding linear fitting coefficients . $\mathbf{V_d = A+K1 \cdot X}$

X = Longitude	**A**	**sd**	**K1**	**sd**	**R**	**N**
DR measured	12,88	0,40	-0,017	0,003	-0,56	62
DR Predict	12,54	0,17	-0,006	0,002	-0,31	88
All Predict	12,63	0,12	-0,008	0,001	-0,48	150
Mean This work	**12,68**	**0,18**	**-0,010**	**0,006**		
Reported	18,15	4,74	-0,009	0,057	-0,04	16
X = Latitude	**A**	**sd**	**K1**	**sd**	**R**	**N**
DR measured	13,40	0,80	-0,037	0,023	-0,20	62
DR Predict	11,84	0,29	0,012	0,006	0,20	88
All Predict	11,82	0,23	0,015	0,006	0,21	150
Mean This work	**12,36**	**0,91**	**-0,003**	**0,029**		
Reported	32,15	11,62	-0,371	0,282	-0,33	16
X = Height	**A**	**sd**	**K1**	**sd**	**R**	**N**
DR measured	13,74	0,40	-0,013	0,002	-0,67	61
DR Predict	13,13	0,10	-0,007	0,000	-0,86	88
All Predict	13,16	0,09	-0,007	0,000	-0,82	149
Mean This work	**13,34**	**0,35**	**-0,009**	**0,003**		
Reported	13,89	5,87	0,034	0,031	0,28	16
X-1990 = Time	**A**	**sd**	**K1**	**sd**	**R**	**N**
DR measured	12,28	4,67	-0,059	0,025	-0,29	62
DR Predict	12,36	4,70	-0,018	0,023	-0,08	88
All Predict	12,37	4,70	-0,023	0,010	-0,18	150
Mean This work	**12,33**	**0,05**	**-0,033**	**0,022**		
Reported	18,01	6,84	0,001	0,363	0,00	16

E2 Deposition Rate of ^{210}Pb

The ^{210}Pb deposition rate V_d estimated from 33 reported pairs of annual mean air concentration and annual deposition (Appendix B) is displayed in **Figure E4**, with an average of 12.2 ± 0.7 (SE) mm.s^{-1}.

Missing data of either annual mean air concentration or annual deposition of ^{210}Pb predicted with PLS regression. These 58 predicted values of ^{7}Be deposition rate are displayed in **Figure E5**. The average of 12.8 ± 1.2 (SD) mm.s^{-1} is in good agreement with the average estimated from the paired reported values.

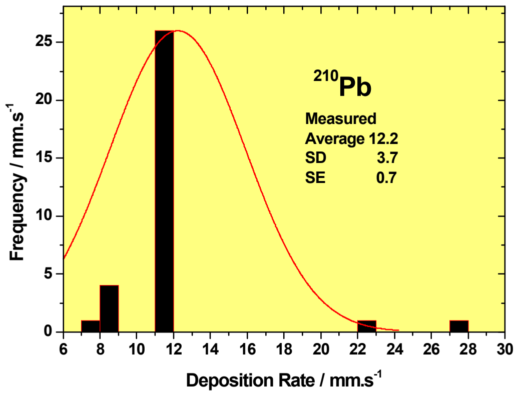

Figure E-4
Distribution of ^{210}Pb deposition rate V_d estimated from 33 reported data-pair of annual mean air concentration and annual deposition wing the average of 12.3 ± 3.7 (SD) 0.7 (SE) mm.s^{-1}

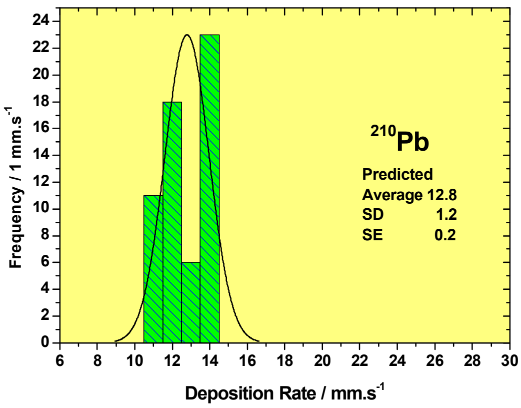

Figure E-5
Distribution of ^{210}Pb deposition rate estimated from 58 data-pair of annual mean air concentration and annual deposition with the missing data predicted using PLS-regression.

Table E2
^{210}Pb deposition rate versus Longitude, Latitude, height and time with the corresponding linear fitting coefficients

X = Longitude	A ±sd	K1 ±sd	R	N
DR Meas	11,88 ±0,65	0,0159 ±0,0091	0,3	33
DR Pred	12,09 ±0,02	0,0142 ±0,0002	1	58
All DR Pred	12,05 ±0,02	0,0146 ±0,0002	0,99	94
Mean this work	**12,01 ±0,11**	**0,0149 ±0,0009**		
DR Rep	20,25 ±3,47	-0,0256 ±0,0451	-0,18	12

X = Latitude	A ±d	k ±sd	R	N
DR Meas	12,24 ±0,66	0,0024 ±0,0135	0,03	33
DR Pred	13,21 ±0,44	-0,0108 ±0,0107	-0,13	58
All DR Pred	12,51 ±0,14	0,0071 ±0,0032	0,23	94
Mean this work	**12,65 ±0,5**	**-0,0004 ±0,0093**		
DR Rep	12,87 ±9,42	0,1867 ±0,2315	0,25	12
X = Height	A ±sd	**k ±sd**	**R**	**N**
DR Meas	12,27 ±0,71	-0,0002 ±0,0011	-0,03	33
DR Pred	12,79 ±0,17	0,0000 ±0,0004	0	58
All DR Pred	12,71 ±0,13	-0,0002 ±0,0003	-0,09	94
Mean this work	**12,59 ±0,28**	**-0,0002 ±0,0001**		
DR Rep	20,72 ±4,32	-0,0099 ±0,0338	-0,09	12
X = Time	A+k1*1990 ±sd	**k ±sd**	**R**	**N**
DR Meas	12,73 ±7,13	-0,1254 ±0,0746	-0,29	33
DR Pred	12,43 ±6,96	0,0459 ±0,0181	0,32	58
All DR Pred	12,44 ±6,97	0,0372 ±0,0141	0,27	94
Mean this work	**12,58 ±0,21**	**-0,0398 ±0,1211**		
DR Rep	19,90 ±11,1	0,0209 ±0,2732	0,02	12

In **Figure E-6** are displayed the distribution all values of ^{210}Pb deposition rate V_d versus Longitude. Latitude, height and time with the corresponding coefficients in the table below.

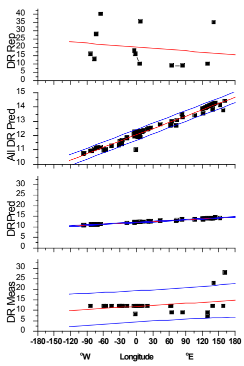

Figure E-6a
^{210}Pb deposition rate $\mathbf{V_d}$ regression with Longitude.

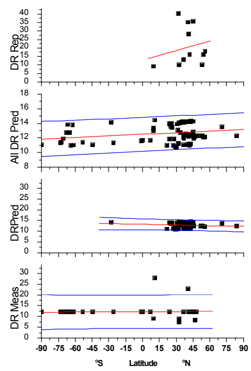

Figure E-6b
^{210}Pb deposition rate $\mathbf{V_d}$ regression with Latitude.

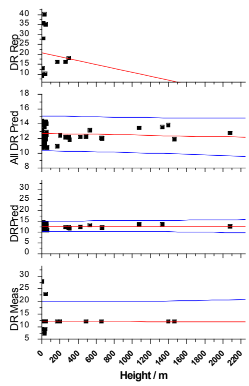

Figure E-6c
^{210}Pb deposition rate $\mathbf{V_d}$ regression with Height.

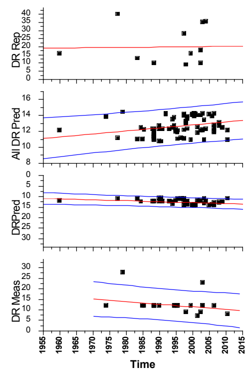

Figure E-6d
^{210}Pb deposition rate $\mathbf{V_d}$ regression with Time.

The average of the ^{210}Pb deposition rate is 12.5 ± 0.7 mm.s^{-1}. No significant regression of was found with latitude, height, or average interval of sampling date. But the ^{210}Pb deposition rate varied significantly (linear k=0.02) with longitude R=0.99. The 12 values reported in the literature are widely scattered (SD = 11.5) with an average of about 20 mm.s^{-1}.

F. Discussions

F1. Air concentration and Deposition of ^{7}Be

As previously reported, deposition of ^{7}Be should be strongly dependent on the location of sample collection, particularly regarding the latitude, the local climate, and the time of season. The precipitation scavenging mechanism of ^{7}Be in air may depend on the precipitation mode. e.g. rain or snow (Hasegawa et al., 2007, Kim et al., 1999, Kim et al., 2000, Ioannidou and Papastefanou, 2006). The predominant process in the entire precipitation phenomenon of ^{7}Be in air is identified as rainout (Ishikawa et al., 1995)- A relationship between precipitation and the washout ratio of ^{7}Be deposition was noted in a high-rainfall area in New Zealand (Harvey and Matthews, 1989).

In the present review, however, the latitudinal distribution of ^{7}Be air concentration was found to be rather flat at low and mid latitudes and, decreasing toward extreme high and low latitudes. The overall average ^{7}Be air concentration was about 4.2 ± 0.4(se) mBq.m^{-3}

The following equation describes the polynomial fit of the ^{7}Be air concentration (mBq.m^{-3}) in logarithmic scale with latitudinal distribution derived from all 161 values (experimental and, predicted):

$$\mathbf{\log_{10}(C_{Be\text{-}7}) = 0.55 - 1.83\cdot10^{-3}\cdot(lat.) + 8.56\cdot10^{-5}\cdot(lat.)^2 + 1.05\cdot10^{-6}\cdot(lat.)^3 - 3.51\cdot10^{-8}\cdot(lat.)^4}$$

R^2(COD) = 0.23

A recent study of the influence of precipitation on ^{7}Be concentrations in air as measured by CTBTO global monitoring system resulted in an annual average of 3.12 ± 1.24(SD) mBq.m^{-3} (Kusmierczyk-Michulec et al., 2015). A multi-regression analysis of the latitudinal variation resulted in the following equation for the annual mean

$$C_{7Be} = 3.13 - 0.00102 \times \text{Latitude}° \quad [\text{mBq.m}^{-3}].$$

A minimum value of 1.72± 0.29 mBq.m^{-3} was recorded at the equator and decreasing values toward extreme high and low latitudes. The maximum values were 5.32±1.25 mBq.m^{-3} at 30°N and 4.76±1.03 mBq.m^{-3} at 30°S. The following equation describes the latitudinal distribution of the ^{7}Be air concentration (mBq.m^{-3}) in logarithmic scale derived from the data presented by (Kusmierczyk-Michulec et al., 2015):

$$\mathbf{\log_{10}(C_{Be\text{-}7}) = 0.4279 - 0.00316\cdot(lat.) + 2.34\cdot10^{-4}\cdot(lat.)^2 + 2.5\cdot10^{-6}\cdot(lat.)^3 - 8.3\cdot10^{-8}\cdot(lat.)^4}$$

R^2(COD) = 0.87

The fitted equations of the data displayed in **Figure F-1** show a good agreement with the latitudinal distribution of 7B derived of the present review and corresponding distribution derived from the data of (Kusmierczyk-Michulec et al., 2015):

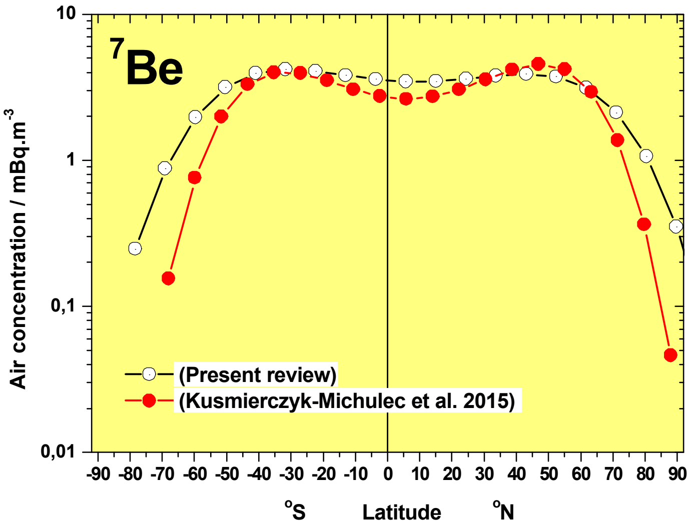

Figure F-1
Latitudinal distribution of 7Be air concentration derived in the present review in unfilled circles and the distribution derived from the CTBTO data in read circles (Kusmierczyk-Michulec et al., 2015).

The latitudinal distribution of ^{7}Be annual deposition (Bq.m^{-2}.a^{-1}) derived in the present review also decreased slightly at high and low altitudes according to the following equation of the logarithmic distribution:

$$\mathbf{\log_{10}(^7Be\ [Bq.m^{-2}.a^{-1}]) = 3.13 - 4.68{\cdot}10^{-4}{\times}Latitude - 2.76{\cdot}10^{-5}{\times}Latitude^2;}$$

R^2(COD) = 0.002, with an overall average of 1500 ± 100(se) Bq.m^{-3}.a^{-1}

The overall global average of ^{7}Be annual deposition is 1500 ± 100(se) Bq.m^{-3}.a^{-1} and the ^{7}Be deposition rate estimated from paired reported values of annual mean air concentration and annual deposition is 13.4 ± 1.7(se) mm.s^{-1}. By using PLS-r modelling to predict missing values of either air concentrations or annual depositions, the average deposition rate of ^{7}Be was estimated to 12.3 ± 1.6(sd) mm.s^{-1}.

No significant variation of the ^{7}Be deposition rate with Longitude, Latitude or geometric average interval of sampling date was found. But a significant negative regression coefficient of -0.02 with height was found. At sea level, the ^{7}Be deposition rate was about 13 mm.s^{-1} while at a height of 800 m it was predicted to be 7 mm.s^{-1}. The values reported in the literature are widely scattered (SD = 18) with an average of about 18 mm.s^{-1}.

F2. Air concentration and Deposition of ^{210}Pb

Modelling of global Latitudinal activity concentration of ^{210}Pb in air including all data reported as well as those predicted from reported deposition values, resulted in a maximum of about 600 ± 200 $\mu Bq.m^{-3}$ around 45 °N. The distribution, however, steadily decrease towards higher and lower latitudes. A minimum of 400 $\mu Bq.m^{-3}$ was estimated at 90 °N, but a lower value of 44 ± 6 $\mu Bq.m^{-3}$ is recoded at 84,4 °N 2,3 °W (Persson and Holm, 2014). At 90 °S the estimated value was 80 $\mu Bq.m^{-3}$.

The following equation describes the logarithmic distribution of ^{210}Pb air concentration ($\mu Bq.m^{-3}$) derived from all 91 values (experimental and, predicted):

$$\log_{10}(^{210}Pb\ [\mu Bq.m^{-3}]) = 2.52 + 0.0083\times(Lat) - 9.87.10^{-5}*(Lat)^2\ ;$$

R^2(COD) =0.58 $p<0.0001$

The global distribution of ^{210}Pb annual deposition ($Bq.m^{-2}.a^{-1}$) with all reported values (see Appendix B) and values predicted by PLS- modelling from deposition showed a maximum of about 200 ± 100 $Bq.m^{-2}.a^{-1}$ around 45 °N with a steady decrease towards higher and lower latitudes. A minimum ^{210}Pb annual deposition of about 100 $Bq.m^{-2}.a^{-1}$ was predicted at 90 °N, but a value of 17 ± 4 $Bq.m^{-2}.a^{-1}$ is recorded at 84,4 °N 2,3 °W. At 90 °S the predicted deposition value was as low as 3 $Bq.m^{-2}.a^{-1}$.

The ^{210}Pb deposition rate estimated from reported annual mean air concentration and annual deposition is 12.3 ± 0.7(se) $mm.s^{-1}$. By using PLS-r modelling to predict missing values of either air concentrations or annual depositions, the average deposition rate of ^{7}Be was estimated to 12.8 ± 0.2 (se) $mm.s^{-1}$.

No significant regression of ^{210}Pb deposition rate was found with latitude, height, or average interval of sampling date. But the ^{210}Pb deposition rate varied significantly (linear k=0.02) with longitude R=0.99. The 12 ^{210}Pb deposition rate values reported in the literature are widely scattered (SD = 11.5) with an average of about 20 $mm.s^{-1}$.

F3. Air concentration and Deposition of ^{210}Po

The values of ^{210}Po air concentration around 20 - 45 °N ranged between 50 – 1000 $\mu Bq.m^{-3}$ with a mean of 200 $\mu Bq.m^{-3}$. The ^{210}Po annual deposition ranged between 20-800 $Bq.m^{-2}.a^{-1}$ with a mean of 100 $Bq.m^{-2}.a^{-1}$. The longitudinal distribution of the $^{210}Po/^{210}Pb$ activity ratios follow a narrow linear relation from 0.2 at 90 °W to 1.0 at 170 °E. While the ^{210}Po air concentration and annual deposition are widely distributed along the longitudes with a slight decrease west of the Greenwich meridian.

G. Summary and Conclusions

G1. Air concentration and Deposition of ^{7}Be

In the present review, the latitudinal distribution of ^{7}Be air concentration was rather flat with an overall global average of 4.2 (SE 0.4) mBq.m^{-3}. The corresponding latitudinal distribution of ^{7}Be annual deposition also decreased slightly at high and low altitudes with an overall global average of 1500 ± 100 (se) Bq.m^{-3}.a^{-1}.

The ^{7}Be deposition rate estimated from reported annual mean air concentration and annual deposition is 13.4 ± 1.7(se) mm.s^{-1}. By using predicted missing values of either air concentrations or annual depositions the average deposition rate of ^{7}Be was estimated to 12.3 ± 1.6 (sd) mm.s^{-1}.

No significant variation of the ^{7}Be deposition rate, with Longitude, latitude or average interval of sampling date was found. But a significant negative linear regression coefficient of -0.02 with height was found. At sealevel the value was about 13 mm.s^{-1} while at a height of 800 m it was predicted to be 7 mm.s^{-1}. In the literature 16 values of the ^{7}Be deposition rate is reported, however, widely scattered (SD = 18) with an average of about 18 mm.s^{-1}.

G2. Air concentration and Deposition of ^{210}Pb

The latitudinal distribution of the activity concentration of ^{210}Pb in air showed a maximum of about 600 ± 200(sd) µBq.m^{-3} about 45 °N, with a steady decrease towards higher and lower latitudes. A minimum of 400 µBq.m^{-3} was estimated at 90 °N, and at 90 °S the estimated value was 80 µBq.m^{-3}. The distribution of the logarithmic ^{210}Pb air concentration (µBq.m^{-3}) is given by the following equation: $\log_{10}(^{210}\text{Pb}) = 2.52 + 0.0083\times(\text{Lat}) - 9.87.10^{-5}*(\text{Lat})^2$.

The global distribution of ^{210}Pb annual deposition (Bq.m^{-2}.a^{-1}) with all reported values included, showed a maximum of about 200 ± 100 Bq.m^{-2}.a^{-1} around 45 °N with a steady decrease towards higher and lower latitudes. A minimum of 100 Bq.m^{-2}.a^{-1} is estimated at 90 °N. But a value of 17 ± 4 Bq.m^{-2}.a^{-1} is predicted at 84.4 °N, 2.3 °W. At 90 °S the estimated deposition value was estimated to be as low as 3 Bq.m^{-2}.a^{-1}.

The ^{210}Pb deposition rate was estimated 12.5 ± 0.7 mm.s^{-1} with no significant variation with latitude, height, or average interval of sampling date. But the ^{210}Pb deposition rate varied linearly with longitude (k=0.02, R=0.99).

G3. Air concentration and Deposition of ^{210}Po

The values of ^{210}Po air concentration around 20 - 45 °N, ranged between 50 – 1000 µBq.m^{-3} with a meanvalue of about 200 µBq.m^{-3} and, the ^{210}Po annual deposition ranged between 20-800 Bq.m^{-2}.a^{-1} with a mean of 100 Bq.m^{-2}.a^{-1}. The longitudinal distribution of the ^{210}Po/^{210}Pb activity ratios follow a narrow linear relation from 0.2 at 90 °W to 1.0 at 170 °E. While the ^{210}Po air concentration and annual deposition are widely distributed along the longitudes with a slight decrease west of the Greenwich meridian.

Acknowledgement
I dedicate this review to Elis Holm and Rafael Garcia-Tenorio, whom resurrected my engagement for ^{210}Pb and ^{210}Po in the biosphere.

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Appendix A: ^{7}Be in surface air

Loction	Time Average	Height a.s.l m	Latitud N+; S-	Long E+; W-	Be-7 Conc. mBq.	SD m^{-3}	Be-7 Deposit. Bq.m^{-2}	SD a^{-1}	Rainfall mm	Ref
Monaco	2004	15	45,52	7,51	6,89	±2,58	1117	±1268		[1]
Málaga, Sprain	1995	12	36,72	-4,47			412		308	[2]
Malage, Spain	2004	12	36,72	-4,47	4,80	±1,60	412	±137	308	[3, 4]
Thessaloniki, Greece	1994	52	40,70	22,54	5,02	±2,49				[5]
Thessaloniki, Greece	1989	52	40,70	22,54			736	±260		[6]
Thessaloniki, Greece	2006	52	40,70	22,54	6,12					[7]
Thessaloniki, Greece	1990	52	40,70	22,54			776		430	[8]
Thessaloniki, Greece	1987	52	40,70	22,54	6,30		841			[9]
Thessaloniki, Greece	1988	52	40,70	22,54	5,70		510			[9]
Thessaloniki, Greece	1989	52	40,70	22,54	4,20		483			[9]
Edinburgh, UK	2002	300	55,95	-3,22	2,50	±0,04				[10]
Barcelona, Spain	2003	32	41,35	2,17	3,48				500	[11]
New Haven, Conneticut	1997	20	41,31	-72,92	4,43		3783			[12, 13]
Ljungbyhed, Skåne	1994	43	56,08	13,23	2,45	±0,97				[14] [15, 16]
Visby, Gotland	1994	58	57,63	18,32	4,30	±0,82				[14]
Kiruna	1987	408	67,84	20,32	1,94	±0,22				[14-16]
Grindsjön	1987	44	59,07	17,82	2,30					[15, 16]
Prague, Tjeckien	1994	235	50,05	14,25	3,10					[15, 16]
Dijon	1993	235	47,20	5,02	3,80					[15, 16]
Palermo	1998	34	38,70	13,12	5,10	±2,00			75	[17]
Belgrade, Serbia	1993	205	44,78	20,53	4,00	±0,50				[18]
Belgrade, Serbia	2006	205	44,78	20,53	2,70	±0,80				[19]
Detriot, USA	1999	175	42,23	-83,33	4,87	±1,76	2608	±2260		[20]
Argonne, Illinois	1979	160	41,68	-87,97	4,31	±0,31				[21]
Granada. Spain	1997	670	37,17	-3,05	4,45	±1,35				[22]
Granada. Spain	1996	671	37,17	-3,05			469	±145	452	[23]
Antarctica	1989	30	-63,52	-58,64	1,30	±0,60				[24]
Antarctica-Montevideo	1989	30	-44,33	-58,25	3,40	±0,90				[24]
South Atlantic	1989	30	-61,47	-54,60	1,70	±1,00				[24]
Equator	1989	30	0,29	-26,00	4,30	±0,30				[24]
Montevideo>> Gothenburg	1989	30	7,00	-25,02	4,35	±1,09				[24]
Arcitic Ocean	1991	30	82,07	51,00	0,62	±0,52				[24]
Arcitic Ocean	1991	30	84,36	-2,32	0,51	±0,33				[24]
N Sibirean coast	1994	30	71,00	84,00	11,44	±8,99				[24]
N Sibirean coast	1994	30	71,00	84,00	7,20	±5,40				[24]
Bratilslava-Kolibsa	1986	286	48,17	17,11	3,12	±0,33				[25]
Sodankylä, Finland	2010	180,00	67,37	26,63	3,69	±1,94				[26]
Thessaloniki, Greece	2009	52	40,70	22,54	6,02	±3,01				[27]

Ljungbyhed, Skåne	2006	43,00	56,08	13,23	2,20	±0,60				[28]
Kiruna	2006	408,00	67,84	20,32	1,50	±0,50				[28]
Damascus, Syria	1995		33,00				528	±102	153	[29]
B. Mt. Canberra, Australia	1988	812	-35,27	146,10			1030	±100	660	[30]
Portsmouth, New hampshire	1997	1	43,05	-70,70			2767	±277		[31]
Woods Hole Massachusetts	1997	23	41,53	-70,65			2133	±213		[31]
Bermuda	1977		33,00				2850			[12, 13]
Galveston, Texas, USA	1990	11	29,30	-94,80			2451	±1253	1167	[32]
College Station, Txas USA	1990	59	30,58	-96,37			2308	±271	1220	[32]
Westwood, USA	1960	20	40,99	-74,03			717		787	[33]
Arkansas, USA	1980	440	36,07	-94,17			867		1071	[34]
Chilton, UK	1960	267	54,66	-1,56			898	±21	822	[35]
Milford Haven UK	1960	33	51,71	-5,03			1618	±43	1328	[35]
Heidelberg, Germany	1970	114	51,52	9,92	1,16	±0,02	1249		810	[36]
Bombay, India	1962	14	18,90	72,82			1168	±283	2096	[37]
Rijswijk Netherlanda	1961	1	52,00	4,00			1583		905	[38]
Ansai, Shaanxi, China	2011		36,86	109,32			1759	±416	502	[39]
Tsukuba, Japan	1989	33	36,06	140,13			1322		1362	[40]
TudorHill, Bermuda	1987	30	32,24	-64,87			1997	±567	1430	[41]
TudorHill, Bermuda	1987	30	32,24	-64,87			2850		1700	[41]
TudorHill, Bermuda	1996	30	32,24	-64,87			1483		1400	[41]
TudorHill, Bermuda	1995	30	32,24	-64,87			2167		1260	[41]
Tsukuba, japan	2000	31	36,05	140,13			1479	±463	1368	[42]
Tsukuba, japan	2001	31	36,05	140,13			1059	±315	1217	[42]
Nagasaki, Japan	2000	36	32,75	129,85			1410	±263	1466	[42]
Kumamoto, Japan	2002	32	32,80	130,72	3,98	±0,70	1710	±821	1900	[43]
Neuherberg, Germany	1995	490	48,22	11,60	3,33	±0,90				[44]
Hokkaido, Japan	1992	32,30	43,08	140,53			2020	±357		[45]
Kanagawa, Japan	1992	32,35	35,45	139,52			1212	±150		[45]
Niigata, Japan	1992	32,35	37,83	138,93			3024	±758		[45]
Toyama, Japan	1992	32,35	36,70	137,10			3587	±498		[45]
Fukui, Japan	1992	32,35	36,07	136,27			3003	±477		[45]
Yamanashi, Japan	1992	32,35	35,67	138,55			587	±136		[45]
Shizuoka, Japan	1992	32,35	35,00	138,38			1575	±306		[45]
Aichi, Japan	1992	32,35	35,20	136,92			1183	±194		[45]
Mie, Japan	1992	32,35	34,73	136,52			1304	±175		[45]
Kyoto, Japan	1992	32,35	34,92	135,75			1038	±118		[45]
Osaka, Japan	1992	32,35	34,67	135,53			692	±232		[45]
Shimane, Japan	1992	32,35	35,47	133,02			1913	±269		[45]
Okayama, Japan	1992	32,35	34,58	133,87			327	±379		[45]
Yamaguchi, Japan	1992	32,35	34,15	131,43			1471	±254		[45]
Kagawa, Japan	1992	32,35	34,33	134,07			781	±92		[45]
Ehime, Japan	1992	32,35	33,83	132,75			929	±157		[45]
Saga, Japan	1992	32,35	33,27	130,27			1210	±207		[45]
Oita, Japan	1992	32,35	33,18	131,62			1326	±176		[45]
Kagoshima, Japan	1992	32,35	31,58	130,57			1388	±202		[45]
Tsoruba, Japan	1990	32,5	36,05	140,13			1257	±283		[40]
Osaka, Sakai, Japan	1990	32,5	34,32	125,30	5,38	±0,76	1310	±444	1165	[46]

Quillayute, Washington,USA	1976	54	47,91	-124,64	4,17	±2,17	1348	±1213		[47]
Norfolk, VA, USA	1983		36,88	-76,30	5,06		2075		132	[48]
Palermo, Italy	1998	34	38,12	13,37	5,06	±0.99			45	[17]
Barcelona, Spain	2003	32	41,35	2,17	3,48				500	[11]
Bilbao, Spain	2003	20	43,26	-2,92	2,60					[49, 50]
La Laguna, Teneriffa, Spain	2001	310	28,44	-16,47	3,00	±0,07			2300	[51]
Madrid, Spain	2002	662	40,38	-3,72	3,40					[49, 50]
Sevillia	2002	10	40,38	-3,72	3,10					[49, 50]
Granade	1995	670	37,17	-3,05	5,00	±0,40				[52]
Monaco	1993	15	45,52	7,51	4,49	±1,69				[53]
Chilton	2000	268	51,50	-1,50	2,08	±0,69				[54]
Berlin	1998	35	52,52	13,38	4,50	±1,17				[55]
Toulon, France	1998	32	43,13	5,92	6,50	±0,83				[55]
Krakow, Poland	1998	220	50,06	34,56	2,63	±0,92				[56]
Miami	1996	3	25,78	-80,21	5,63	±0,64				[57]
Cienfuegus, cuba	1996	25	22,05	-80,44	4,36	±0,78				[57]
Perto Rico	1972	12	18,45	-66,10	4,43	±0,81				[57]
Panama	1973	3	8,98	-79,53	2,75	±0,58				[57]
Versoix, Schwitzerland	1997	428	46,27	6,17			2087	±23		[58]
Kaiga, India	2004	320	14,96	74,73	32	±9			3500	[59]
Neuherberg, Germany	1995	490	48,22	11,60			250	±42	110	[60]
Caceres, Spain	1995	405	39,51	-6,34	4,40	±1,80			850	[61]
Islamabad. Pakistan	2008	536	33,38	73.10	3,10	±1,10			600	[62]
Rokkasho, Aomori, Japan	2003	13	40,57	141,21			2626	±489	1541	[63]
Pershawar, Pakistan	2003	15	34,01	71,55	4,50	±0,40				[64]
Lahore, Pakistan	2003	217	31,55	74,34	5,40	±1,62				[64]
Brisbane, Australia	2005	15	-27,471	153,02	4,88	±1,20	1098	±57	1186	[65]
Bay of Bengal, India	1998	5	10	85,00	5,49	±2,82	1560			[66]
Arabian Sea. India	1998	5	10	65,00	7,95	±2,54	2155			[66]
Chesapeak Bay, Maryland USA	1995	10	39,54	-76,08			2167		1304	[67]
Rokkasho, Aomori, Japan	2001	13	40,57	141,21	4,15	±0,1	2626	±489	1541	[63]
Sondrino	1992	360	46,17	9,87	3,10					[68]
Brunate	1993	800	45,82	9,10	2,10					[68]
Milan	1994	120	45,47	9,17	2,70					[68]
Yamagata, Japan	2004	168	38,25	140,35	4,35	±0,28				[69]
Osaka, Japan	1985	32	34,32	135,30	5,70	±1,30				[70]
Kumamoto, Japan	2002	35,8	32,80	130,72	3,55	±0,70	1590	±35	1780	[43]
Nauru, Micronesia	1985	61	0,50	167,00	1,40	±0,30			2097	[65]
Funafuti, Tuvalu	1986	3	8,50	-179,20	1,80	±0,40			3398	[65]
Fiji, Melanesia	1999	30	18,20	178,50	1,50	±0,70			3041	[65]
Cook Islands, South Pacific	1991	20	21,30	-159,80	3,00	±0,40			1838	[65]
Brisbane, Australia	2003	30	27,50	153,00	4,90	±1,20			1186	[65]
Norfolk. Island, Australia	1991	30	29,00	168,00	4,50	±1,10			1308	[65]
Kaitaia, New Zealand	1991	30	35,10	173,30	3,20	±0,40			1337	[65]
Cape Grim, Australia	1989	30	40,70	144,80	2,90	±0,90			1079	[65]
Lower Hutt, New Zealand	1993	30	41,20	174,90	2,90	±0,80			1249	[65]
Hokitika, New Zealand	1991	30	42,70	171,00	2,40	±0,20			2876	[65]
Chatham Island, New Zeeland	1989	30	43,90	-176,00	3,00	±1,00			864	[65]

Invercargill, New Zealand	1991	50	46,40	168,40	2,40	±0,80			1115	[65]
Midway	1983	13	28,20	-177,40	3,10	±2,00		1300	1100	[71]
Oahu, Hawaii	1983	5	21,35	-156,07	2,80	±1,50		1000	650	[71]
Enewatak, Marshall islands	1985	5	11,50	162,33	1,70	±0,60		1200	1470	[71]
Nauru, Micronesia	1985	61	0,50	167,00	1,47	±1,00		400	2060	[71]
Funafuti, Tuvalu	1985	3	8,50	-179,20	2,06	±1,20		1200	3540	[71]
American Samoa	1985	77	-14,25	-170,57	2,30	±1,50		2000	3520	[71]
Rarotonga, Cooks Islands	1885	30	-21,23	-159,78	3,00	±2,00		2600	2060	[71]
New Caledonia	1985	71	-22,27	166,45	3,10	±1,10		1400	2310	[71]
Norfolk. Island, Australia	1985	30	29,00	168,00	2,70	±1,00		1400	1220	[71]
Yamagata, Japan	2004	168	38,25	140,35	4,35	±0,28				[69]

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Appendix B: ^{210}Pb in surface air

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Location	Time Ave.	Height a.s.l. m	Lat N+; S-	Long E+; W-	^{210}Pb Conc. mBq.m-3		^{210}Pb Deposit. Bq.m^{-2}.a^{-1}		Rain-fall mm	Referen
Arcitic Ocean	1991	30	84,36	-2,32	44	±6				[1]
N Sibirean coast	1994	30	71,00	84,00	2373	±364				[1]
N Sibirean coast	1994	30	71,00	84,00	2712	±1079				[1]
Edinburgh, UK	2002	300	55,95	-3,22	210	±10				[2]
Chilton, UK	1960	267	54,66	-1,56	204	±98			822	[3];[4]
Groningen, Netherlanda	1988	8	53,30	6,58			69	20	805	[5]
Texel , Netherlanda	1993	3	53,02	4,80			82	33	751	[5]
Blthoven, Netherlanda	1988	17	52,13	5,19			71	38	820	[5]
de Bilt, Netherlanda	1990	4	52,12	5,20			59		603	[5]
Milford Haven UK	1960	33	51,71	-5,03					1328	[3]
Neuherberg, Germany	1995	490	48,22	11,60	470	±140	178	53		[6]
Neuherberg, Germany	1985	490	48,22	11,60	570	±170	216	64		[7]
Nantes, France	2010	30	47,16	-1,64	320	±70	82	43		[8]
Versoix, Schwitzerland	1997	428	46,27	6,17			150	3		[9]
Puy de Dôme, France	2006	1465	45,77	2,97	850	±90	322	34		[10]
Opme France	2006	660	45,72	3,07	730	±220	276	83		[10]
Monaco	2004	15	45,52	7,51			204	87	622	[11]
Monaco	2004	15	45,52	7,51	1130	±440			657	[12]
Wakkanai	2000	40	45,42	141,68			490	50		[13]
Bordeaux,France	2006	54	45,25	43,83			103	10		[14]
Belgrade, Serbia	2006	205	44,78	20,53	480	±300	182	114		[15]
Portsmouth, New hampshire	1997	3	43,05	-70,70			238			[16]
Sapporo	2000	36	43,05	141,33			390	70		[13]
Kushiro	2000	17	42,98	144,40			140	40		[13]
Tessaloniki, Greece	2009	52	42,69	22,53	671	±213				[17]
Detriot, USA	1999	175	42,23	-83,33	1152	±818	436	310		[18]
Woods Hole Massachusetts	1997	23	41,53	-70,65			158			[16]
Barcelona, Spain	2003	6	41,35	2,17	487	±34	184	13		[19]
New Haven, Conneticut	1997	20	41,31	-72,92			196		1482	[20, 21]
Aomori	1992	32,35	40,88	141,28						[22]
Iwate	1992	32,35	39,70	141,15						[22]
Tokyo	1992	32,35	35,70	139,70						[22]
Rokkasho, Aomori, Japan	2003	43	40,95	141,35	1010	±830	731	147		[23]

Rokkasho, Aomori, Japan	2006	43	40,95	141,35			805	144	1441	[24]
Thessaloniki, Greece	1994	52	40,70	22,54	664	±350				[25]
Thessaloniki, Greece	1984	52	40,70	22,54	234	±80			430	[26]
Thessaloniki, Greece	2009	52	40,70	22,54	671	±213				[17]
Akita	2000	20	39,72	140,10			480	40		[13]
Chesapeak Bay, Maryland USA	1995	10	39,54	-76,08			130		1304	[27]
Palermo, Italy	1998	34	38,12	13,37	737	±280			75	[28]
Izmir (Aegean sea-Turkey)	2001	30	38,46	27,23			48	9		[29]
Sendai	2000	45	38,27	140,90			220	20		[13]
Wajima	2000	9	37,38	136,90			680	20		[13]
Granade	1995	670	37,17	-3,05	585	±258				[30]
Huelva, Spain	2009	34	37,00	-7,00	591	±103	59	39		[31]
Norfolk, VA, USA	1983	10	36,88	-76,30			138	12	132	[32]
Malaga, Spain	2003	21	36,72	-4,47	580	±210	219	79		[33]
Malaga, Spain	1995	21	36,72	-4,47	540	±30	204	11		[34]
Tatsunokuchi	2000	30	36,38	136,43			600	20		[13]
Tsukuba, Japan	2000	31	36,05	140,13			176		1368	[35]
Tsukuba, Japan	2001	31	36,05	140,13			182		1217	[35]
Kokyo, Tokyo	2000	18	35,68	139,60			200	10		[13]
Yonago, Japan	2000	10	35,43	133,35			540	20		[13]
Odawa, Japan	1997	10	35,00	139,00			73	8		[36]
Osaka, Japan	2000	16	34,68	135,52			135	15		[13]
Murree, Pakistan	2008	2081	33,94	73,23			271	81	1450	[37]
Fukuoka, Japan	2000	10	33,58	130,38			215	25		[13]
Islamabad. Pakistan	2008	536	33,38	73,10	284	±150	1137	341		[37, 38]
Kumamoto, Japan	2001	32	32,80	130,72	1000		226		1900	[39]
Kumamoto, Japan	2002	35,8	32,80	130,72	850		240		1780	[39]
Nagasaki, Japan	2000	36	32,75	129,85			234		1466	[35]
Bermuda	1977	33	32,30	-64,78			115		1699	[20, 21]
TudorHill, Bermuda	1996	30	32,24	-64,87			68		1400	[40]
Islamabad, Pakistan	2008	536	31,55	74,34	284	±150				[38]
Shanghai, China	2006	20	31,23	121,40			479	230	1080	[41]
College Station, Txas USA	1990	59	30,58	-96,37			172	98	1170	[42]
Galveston, Texas, USA	1990	11	29,30	-94,80			175	65	1220	[42]
La Laguna, Teneriffa, Spain	2001	310	28,44	-16,47	374	±23			2300	[43]
Tampa, USA	2003	7	27,75	-82,50			123	25		[44]
Guiyang, China	2003	1080	26,57	106,72	2700	±600				[45]
Akajima, Japan	1997	52	26,05	127,00			78.5	8		[36]
TsuYazaki, Japan	1997	5	26,00	127,00			197	35		[36]
Peng-Chia Yü, Taiwan	1998	1330	25,65	122,18			180	20		[46]
Nankang. Taiwan	1998	15	25,02	121,63			320	30		[46]
Ishigaki, Japan	2000	15	24,33	124,17			205	25		[13]
North Atantic	1988	30	24,08	-17,17	163	±61	62	23		[1]
Cienfuegos, Cuba	2010	23	22,05	-80,48			48	26		[47]

Enewetak	1979	2	11,33	162,33	34	±18	30	4		[48]
Bay of Bengal, India	1998	5	10,00	85,00	970		275			[49]
Arabian Sea. India	1998	5	10,00	65,00	760		215			[49]
Montevideo>> Gothenburg	1989	30	7,00	-25,02						[1]
Montevideo>> gbg	1988	30	7,00	-25,02	232	±140	88	53		[1]
Equator	1989	30	0,29	-26,00						[1]
Equator	1988	30	0,29	-26,00	262	±207	99	78		[1]
Equator	1988	30	-0,83	-29,42	626	±169	237	64		[1]
Gbg-Montevideo	1988	30	-25,75	-44,67	288	±268	109	101		[1]
Brisbane, Australia	2005	15	-27,47	153,02			73	11	1127	[50]
Antartica-Montevideo	1988	30	-44,33	-58,25	305	±227	115	86		[1]
Montevideo-Antactica	1988	30	-53,00	-29,80	45	±45	17	17		[1]
South Atlantic	1988	30	-61,47	-54,60	58	±126	22	48		[1]
Marsh, Antartica	1994	1400	-62,18	158,98	17	±7	6	3		[51]
Antartica	1988	30	-63,52	-58,64	15	±13	6	5		[1]
Palmer, Antartica	1994	2	-64,77	64,07	15	±7	6	3		[51]
Dumont, Antartica	1974	2	-66,67	140,02	30	±10	11	4		[52]
Mawson, Antartica	1990	2	-67,60	62,55	30	±10	11	4		[51]
Neumayer, Antartica	1995	44	-70,65	8,25	34	±11	13	4		[53]
Antartica	1988	30	-72,43	-25,74	24	±11	9	4		[1]
Antartica	1988	30	-73,00	-31,27	22	±9	8	3		[1]
South Pole, Antartica	1985	2860	-90,00	0,00	36	±20	14	8		[51]

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Appendix C: ^{210}Po in surface air

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Time period Average	Location	Height a.s.l. m	Latitude N+; S-	Longitude E+; W-	^{210}Po Conc. mBq.m^{-3}	SD	Ref
1991	Arctic Ocean	30	84.36	-2.32	38	± 5	[1]
1994	N. Siberian coast	30	71.00	84.00	37	±8	[1]
1988	North Atlantic	30	24.08	-17.17	36	±9	[1]
1979	Eniwetok	2	11.33	162.33	1	±0.3	[2]
1988	Montevideo>> Gbg	30	7.00	-25.02	60	±44	[1]
1988	Equator	30	0.29	-26.00	69	±60	[1]
1988	Equator	30	-0.83	-29.42	132	±45	[1]
1988	Gbg-Montevideo	30	-25.75	-44.67	63	±58	[1]
1988	Antarctica-Montevideo	30	-44.33	-58.25	61	±58	[1]
1988	Montevideo-Antarctica	30	-53.00	-29.80	21	±17	[1]
1988	South Atlantic	30	-61.47	-54.60	14	±27	[1]
1988	Antarctica	30	-63.52	-58.64	6	±4	[1]
1988	Antarctica	30	-72.43	-25.74	13	±14	[1]
1988	Antarctica	30	-73.00	-31.27	9	±3	[1]

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Air concentration ($\mu Bq.m^{-3}$)] and Annual Deposition $Bq.m^{-2}.a^{-1}$ of ^{210}Po estimated from reported ^{210}Pb data by using the PLS regressing equation of $^{210}Po/^{210}Pb$ ratio.

Time	Location	Height m	Lat °N; -°S	Long °E; -°W	$^{210}Po/^{210}Pb$	Air Conc. ^{210}Po	Ann. Dep. ^{210}Po
1991	Arcitic Ocean	30	84,36	-2,32	0,63	28	11
1994	N Sibirean coast	30	71,00	84,00	0,86	2044	870
1994	N Sibirean coast	30	71,00	84,00	0,86	2336	994
2002	Edinburgh, UK	300	55,95	-3,22	0,60	125	48
1960	Chilton, UK	267	54,66	-1,56	0,60	122	47
1988	Groningen, Netherlanda	8	53,30	6,58	0,62	110	43
1993	Texel , Netherlanda	3	53,02	4,80	0,62	130	51
1988	Blthoven, Netherlanda	17	52,13	5,19	0,62	113	44
1990	de Bilt, Netherlanda	4	52,12	5,20	0,62	94	36
1985	Neuherberg, Germany	490	48,22	11,60	0,63	359	136
1995	Neuherberg, Germany	490	48,22	11,60	0,63	296	112
2010	Nantes, France	30	47,16	-1,64	0,59	189	48
1997	Versoix, Schwitzerland	428	46,27	6,17	0,61	239	92
2006	Puy de Dôme, France	1465	45,77	2,97	0,60	511	194
2006	Opme France	660	45,72	3,07	0,60	439	166
2004	Monaco	15	45,52	7,51	0,61	324	126
2004	Monaco	15	45,52	7,51	0,61	694	269
2000	Wakkanai	40	45,42	141,68	1,00	1088	489
2006	Bordeaux,France	54	45,25	43,83	0,72	183	74
2006	Belgrade, Serbia	205	44,78	20,53	0,65	312	118
1997	Portsmouth, New hampshire	3	43,05	-70,70	0,39	263	92
2000	Sapporo	36	43,05	141,33	0,99	864	387
2000	Kushiro	17	42,98	144,40	1,00	312	140
2009	Tessaloniki, Greece	52	42,69	22,53	0,65	439	173
1999	Detriot, USA	175	42,23	-83,33	0,35	405	153
1997	Woods Hole Massachusetts	23	41,53	-70,65	0,39	174	61
2003	Barcelona, Spain	6	41,35	2,17	0,59	289	110
1997	New Haven, Conneticut	20	41,31	-72,92	0,38	213	75
1992	Aomori	32,35	40,88	141,28	0,99	0	0
1992	Iwate	32,35	39,70	141,15	0,99	0	0
1992	Tokyo	32,35	35,70	139,70	0,98	0	0
2003	Rokkasho, Aomori, Japan	43	40,95	141,35	0,99	1001	725
2006	Rokkasho, Aomori, Japan	43	40,95	141,35	0,99	1780	798
1984	Thessaloniki, Greece	52	40,70	22,54	0,65	153	60
1994	Thessaloniki, Greece	52	40,70	22,54	0,65	433	170
2009	Thessaloniki, Greece	52	40,70	22,54	0,65	437	172
2000	Akita	20	39,72	140,10	0,99	1057	473
1995	Chesapeak Bay, Maryland USA	10	39,54	-76,08	0,37	138	48

2001	Izmir (Aegean sea-Turkey)	30	38,46	27,23	0,66	80	32
2000	Sendai	45	38,27	140,90	0,99	485	217
1998	Palermo, Italy	34	38,12	13,37	0,62	459	179
2000	Wajima	9	37,38	136,90	0,97	1485	663
1995	Granade	670	37,17	-3,05	0,57	336	127
1983	Norfolk, VA, USA	10	36,88	-76,30	0,37	145	50
2003	Malaga, Spain	21	36,72	-4,47	0,57	331	125
1995	Malaga, Spain	21	36,72	-4,47	0,57	308	117
2000	Tatsunokuchi	30	36,38	136,43	0,97	1309	583
2001	Tsukuba, Japan	31	36,05	140,13	0,98	400	179
2000	Tsukuba, Japan	31	36,05	140,13	0,98	386	173
2000	Kokyo, Tokyo	18	35,68	139,60	0,98	438	196
2000	Yonago, Japan	10	35,43	133,35	0,96	1169	520
1997	Odawa, Japan	10	35,00	139,00	0,98	160	72
2000	Osaka, Japan	16	34,68	135,52	0,97	293	131
2008	Murree, Pakistan	2081	33,94	73,23	0,79	533	214
2000	Fukuoka, Japan	10	33,58	130,38	0,95	462	205
2001	Kumamoto, Japan	32	32,80	130,72	0,95	952	215
2002	Kumamoto, Japan	35,8	32,80	130,72	0,95	809	228
2000	Nagasaki, Japan	36	32,75	129,85	0,95	502	222
1977	Bermuda	33	32,30	-64,78	0,39	128	45
1996	TudorHill, Bermuda	30	32,24	-64,87	0,39	76	27
2008	Islamabad, Pakistan	536	31,55	74,34	0,79	224	93
2006	Shanghai, China	20	31,23	121,40	0,92	1009	442
1990	College Station, Txas USA	59	30,58	-96,37	0,30	153	52
1990	Galveston, Texas, USA	11	29,30	-94,80	0,30	157	53
2001	La Laguna, Teneriffa, Spain	310	28,44	-16,47	0,53	197	73
2003	Tampa, USA	7	27,75	-82,50	0,34	120	42
2003	Guiyang, China	1080	26,57	106,72	0,88	2365	1000
1997	Akajima, Japan	52	26,05	127,00	0,93	167	73
1997	TsuYazaki, Japan	5	26,00	127,00	0,93	418	184
1998	Peng-Chia Yü, Taiwan	1330	25,65	122,18	0,92	387	165
1998	Nankang. Taiwan	15	25,02	121,63	0,92	670	293
2000	Ishigaki, Japan	15	24,33	124,17	0,92	431	189
1988	North Atantic	30	24,08	-17,17	0,52	85	32
2010	Cienfuegos, Cuba	23	22,05	-80,48	0,34	47	16
1979	Enewetak	2	11,33	162,33	1,02	35	31
1998	Arabian Sea. India	5	10,00	65,00	0,74	561	159
1998	Bay of Bengal, India	5	10,00	85,00	0,80	772	219
1988	Montevideo>> gbg	30	7,00	-25,02	0,48	111	42
1988	Equator	30	0,29	-26,00	0,47	122	46
1988	Equator	30	-0,83	-29,42	0,46	286	108
1988	Gbg-Montevideo	30	-25,75	-44,67	0,39	111	42
2005	Brisbane, Australia	15	-27,47	153,02	0,95	155	69
1988	Antartica-Montevideo	30	-44,33	-58,25	0,33	99	38
1988	Montevideo-Antactica	30	-53,00	-29,80	0,40	18	7
1988	South Atlantic	30	-61,47	-54,60	0,32	18	7

1994	Marsh, Antartica	1400	-62,18	158,98	0,92	16	6
1988	Antartica	30	-63,52	-58,64	0,30	5	2
1994	Palmer, Antartica	2	-64,77	64,07	0,65	10	4
1974	Dumont, Antartica	2	-66,67	140,02	0,87	26	10
1990	Mawson, Antartica	2	-67,60	62,55	0,64	19	7
1995	Neumayer, Antartica	44	-70,65	8,25	0,49	17	6
1988	Antartica	30	-72,43	-25,74	0,39	9	3
1988	Antartica	30	-73,00	-31,27	0,37	8	3
1985	South Pole, Antartica	2860	-90,00	0,00	0,44	16	6

Appendix D: ^{7}Be Deposition rate V_d

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Height m	Lat N+; S-	Long E+; W-	Be-7 mBq.m^{-3}	Be-7 Bq.m^{-2}.a^{-1}	Pred Drain mm	V_d mm.s-1	References
30	84,36	-2,32	0,5	226	448	14,20	[1]
30	82,07	51,00	0,6	268	432	13,68	[1]
30	71,00	84,00	11,4	4760	416	13,18	[1]
30	71,00	84,00	7,2	2997	416	13,18	[1]
408	67,84	20,32	1,9	667	345	10,92	[2-4]
408	67,84	20,32	1,5	517	345	10,92	[5]
180	67,37	26,63	3,7	1462	396	12,53	[6]
180	67,37	26,63	2,5	989	396	12,53	[6]
44	59,07	17,82	2,3	978	425	13,47	[3, 4]
58	57,63	18,32	4,3	1809	421	13,34	[2]
43	56,08	13,23	2,5	1042	425	13,47	[2] [3, 4]
43	56,08	13,23	2,2	935	425	13,47	[5]
300	55,95	-3,22	2,5	925	370	11,72	[7]
267	54,66	-1,56	2,8	898	315	11,92	[8]
35	52,52	13,38	4,5	1913	425	13,46	[9]
1	52,00	4,00	3,9	1583	405	13,79	[10]
33	51,71	-5,03	3,8	1618	428	13,63	[8]
114	51,52	9,92	1,2	1249	1077	12,89	[11]
268	51,50	-1,50	2,1	777	374	11,86	[12]
220	50,06	34,56	2,6	985	374	11,86	[13]
235	50,05	14,25	3,1	1168	377	11,94	[3, 4]
490	48,22	11,60	3,3	1056	317	10,04	[14]
490	48,22	11,60	1,3	250	188	10,04	[15]
286	48,17	17,11	3,1	1133	363	11,50	[16]
54	47,91	-124,64	4,2	1348	324	14,50	[17]
235	47,20	5,02	3,8	1436	378	11,97	[3, 4]
50	46,40	168,40	2,4	765	319	11,83	[18]
428	46,27	6,17	6,3	2087	332	10,52	[19]
360	46,17	9,87	3,1	1075	347	10,98	[20]
800	45,82	9,10	2,1	513	244	7,74	[20]
15	45,52	7,51	4,5	1919	428	13,54	[21]
15	45,52	7,51	6,9	1117	162	13,54	[22]
120	45,47	9,17	2,7	1087	403	12,75	[20]
205	44,78	20,53	4,0	1516	379	12,01	[23]
205	44,78	20,53	2,7	1023	379	12,01	[24]
30	43,90	-176,00	3,0	1463	488	15,07	[18]
20	43,26	-2,92	2,6	1113	428	13,56	[25, 26]

32	43,13	5,92	6,5	2747	423	13,39	[9]
32	43,08	140,53	5,3	2020	384	12,16	[27]
1	43,05	-70,70	6,1	2767	452	14,31	[28]
30	42,70	171,00	2,4	1066	444	11,89	[18]
175	42,23	-83,33	4,9	2608	535	13,13	[29]
160	41,68	-87,97	4,3	1806	419	13,27	[30]
23	41,53	-70,65	4,8	2133	446	14,12	[28]
32	41,35	2,17	3,5	1471	423	13,39	[31]
32	41,35	2,17	3,5	1287	370	13,39	[31]
20	41,31	-72,92	4,4	3783	853	14,16	[32, 33]
30	41,20	174,90	2,9	962	332	11,83	[18]
20	40,99	-74,03	1,7	717	433	14,17	[34]
32	40,88	141,28	4,6	1747	382	12,11	[27]
52	40,70	22,54	5,0	2068	412	13,05	[35]
52	40,70	22,54	6,1	2521	412	13,05	[36]
52	40,70	22,54	6,0	2480	412	13,05	[37]
30	40,70	144,80	2,9	974	336	12,10	[18]
52	40,70	22,54	5,7	510	89	13,05	[38]
52	40,70	22,54	4,2	483	115	13,05	[38]
52	40,70	22,54	6,3	841	133	13,05	[38]
52	40,70	22,54	1,8	736	412	13,05	[39]
52	40,70	22,54	2,2	776	348	13,05	[40]
13	40,57	141,21	4,2	2626	633	12,25	[41]
13	40,57	141,21	7,0	2626	375	12,25	[41]
662	40,38	-3,72	3,4	942	277	8,78	[25, 26]
10	40,38	-3,72	3,1	1330	429	13,59	[25, 26]
32	39,70	141,15	3,5	1321	382	12,09	[27]
10	39,54	-76,08	4,6	2167	473	14,23	[42]
405	39,51	-6,34	4,4	1219	277	10,68	[43]
34	38,70	13,12	5,1	2130	418	13,23	[44]
168	38,25	140,35	4,4	1521	350	11,08	[45]
168	38,25	140,35	4,4	1521	350	11,08	[45]
34	38,12	13,37	5,1	1685	333	13,22	[44]
32	37,83	138,93	7,9	3024	381	12,08	[27]
670	37,17	-3,05	5,0	1366	273	8,65	[46]
670	37,17	-3,05	4,5	1216	273	8,65	[47]
671	37,17	-3,05	2,9	469	162	8,65	[48]
3	36,88	-76,30	5,1	2075	162	14,24	[49]
1370	36,86	109,32	5,4	1759	325	12,57	[50]
12	36,72	-4,47	4,8	412	86	13,52	[51, 52]
12	36,72	-4,47	1,1	412	367	13,52	[53]
32	36,70	137,10	9,4	3587	381	12,08	[27]
440	36,07	-94,17	2,7	867	327	11,16	[54]
32	36,07	136,27	7,9	3003	381	12,08	[27]
33	36,06	140,13	3,7	1322	357	12,04	[55]
31	36,05	140,13	4,1	1479	358	12,05	[56]
31	36,05	140,13	3,0	1059	348	12,05	[56]
33	36,05	140,13	3,3	1257	380	12,04	[55]

32	35,70	139,70	3,5	1318	380	12,04	[27]
32	35,67	138,55	1,5	587	380	12,05	[27]
32	35,47	133,02	5,0	1913	382	12,09	[27]
32	35,45	139,52	3,2	1212	380	12,03	[27]
32	35,20	136,92	3,1	1183	381	12,05	[27]
30	35,10	173,30	3,2	1086	339	11,74	[18]
32	35,00	138,38	4,1	1575	380	12,04	[27]
32	34,92	135,75	2,7	1038	381	12,06	[27]
32	34,73	136,52	3,4	1304	380	12,05	[27]
32	34,67	135,53	1,8	692	381	12,06	[27]
32	34,58	133,87	0,9	327	381	12,07	[27]
32	34,33	134,07	2,1	781	381	12,06	[27]
33	34,32	125,30	5,4	1310	244	12,14	[57]
32	34,32	135,30	5,7	2169	381	12,06	[58]
32	34,15	131,43	3,9	1471	382	12,09	[27]
15	34,01	71,55	4,5	1812	403	12,76	[59]
32	33,83	132,75	2,4	929	381	12,07	[27]
668	33,51	36,29	4,3	528	123	8,25	[60]
536	33,38	73,10	3,1	548	177	8,88	[61]
32	33,27	130,27	3,2	1210	381	12,08	[27]
32	33,18	131,62	3,5	1326	381	12,07	[27]
32	32,80	130,72	4,0	1710	430	12,07	[62]
36	32,80	130,72	3,6	1590	448	12,04	[62]
36	32,75	129,85	3,8	1410	369	12,05	[56]
12	32,27	-64,78	6,5	2850	442	13,99	[32, 33]
30	32,24	-64,87	4,2	1997	470	13,86	[63]
30	32,24	-64,87	5,8	2850	489	13,86	[63]
30	32,24	-64,87	3,2	1483	468	13,86	[63]
30	32,24	-64,87	4,7	2167	459	13,86	[63]
32	31,58	130,57	3,6	1388	380	12,05	[27]
217	31,55	74,34	5,4	1909	353	11,20	[59]
59	30,58	-96,37	5,0	2308	463	13,90	[64]
11	29,30	-94,80	5,2	2451	474	14,22	[64]
30	29,00	168,00	4,5	1535	341	11,68	[18]
30	29,00	168,00	2,7	1400	519	11,68	[65]
310	28,44	-16,47	3,0	1241	414	11,28	[66]
13	28,20	-177,40	3,1	1300	419	14,93	[65]
30	27,50	153,00	4,9	1670	341	11,79	[18]
3	25,78	-80,21	5,6	2500	445	14,08	[67]
25	22,05	-80,44	4,4	1905	437	13,85	[67]
5	21,35	-156,07	2,8	1000	357	14,68	[65]
20	21,30	-159,80	3,0	1657	552	14,60	[18]
14	18,90	72,82	2,6	1168	451	12,49	[68]
12	18,45	-66,10	4,4	1922	434	13,76	[67]
30	18,20	178,50	1,5	683	455	11,39	[18]
320	14,96	74,73	32,0	14294	447	10,14	[69]
5	11,50	162,33	1,7	1200	706	11,61	[65]
5	10,00	65,00	8,0	2155	271	12,47	[70]

5	10,00	85,00	5,5	1560	284	12,28	[70]
3	8,98	-79,53	2,8	1196	435	13,78	[67]
3	8,50	-179,20	1,8	1217	676	14,68	[18]
3	8,50	-179,20	2,1	1200	583	14,68	[65]
30	7,00	-25,02	4,3	1792	412	13,05	[1]
61	0,50	167,00	1,5	400	272	10,96	[65]
61	0,50	167,00	1,4	545	390	10,96	[18]
30	0,29	-26,00	4,3	1757	409	12,94	[1]
77	-14,25	-170,57	2,3	2000	870	13,65	[65]
30	-21,23	-159,78	3,0	2600	867	13,78	[65]
71	-22,27	166,45	3,1	1400	452	10,49	[65]
15	-27,47	153,02	4,9	1099	225	10,93	[18]
812	-32,00	115,83	14,8	1030	70	5,31	[71]
812	-35,27	146,10	16,2	1030	63	4,97	[71]
30	-44,33	-58,25	3,4	1336	393	12,45	[1]
30	-61,47	-54,60	1,7	650	382	12,11	[1]
30	-63,52	-58,64	1,3	497	382	12,11	[1]

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Appendix E: ^{210}Pb Deposition rate V_d

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Height a.s.l. m	Latitude	Longitude	Pb-210 Concentration µBq m^{-3}	Pb-210 Deposition Bq.m^{-2}.a^{-1}	Ratio Dep./Conc. 10^{6}.m.a^{-1}	Deposition Velocity mm.s^{-1}	Reference
30	84,36	-2,32	44	17	0,39	12,3	[1]
30	71,00	84,00	2373	1010	0,43	13,5	[1]
30	71,00	84,00	2712	1154	0,43	13,5	[1]
300	55,95	-3,22	210	80	0,38	12,1	[2]
267	54,66	-1,56	204	78	0,38	12,1	[3];[4]
8	53,30	6,58	177	69	0,39	12,3	[5]
3	53,02	4,80	212	82	0,39	12,3	[5]
17	52,13	5,19	184	71	0,39	12,3	[5]
4	52,12	5,20	152	59	0,39	12,3	[5]
490	48,22	11,60	570	216	0,38	12,2	[6]
490	48,22	11,60	470	178	0,38	12,2	[7]
30	47,16	-1,64	320	82	0,26	12,2	[8]
428	46,27	6,17	390	150	0,38	12,2	[9]
1465	45,77	2,97	850	322	0,38	11,9	[10]
660	45,72	3,07	730	276	0,38	12,1	[10]
15	45,52	7,51	527	204	0,39	12,3	[11]
15	45,52	7,51	1130	438	0,39	12,3	[12]
40	45,42	141,68	1091	490	0,45	14,2	[13]
54	45,25	43,83	255	103	0,40	12,8	[14]
205	44,78	20,53	480	182	0,38	12,4	[15]
3	43,05	-70,70	676	238	0,35	11,1	[16]
36	43,05	141,33	869	390	0,45	14,2	[13]
17	42,98	144,40	311	140	0,45	14,3	[13]
52	42,69	22,53	671	264	0,39	12,5	[17]
175	42,23	-83,33	1152	436	0,38	10,9	[18]
23	41,53	-70,65	450	158	0,35	11,1	[16]
6	41,35	2,17	487	184	0,38	12,2	[19]
20	41,31	-72,92	560	196	0,35	11,1	[20, 21]
43	40,95	141,35	1010	731	0,72	14,2	[22]
43	40,95	141,35	1796	805	0,45	14,2	[23]
52	40,70	22,54	234	92	0,39	12,5	[24]
52	40,70	22,54	664	262	0,39	12,5	[25]
52	40,70	22,54	671	264	0,39	12,5	[17]
20	39,72	140,10	1072	480	0,45	14,2	[13]
10	39,54	-76,08	373	130	0,35	11,1	[26]

30	38,46	27,23	121	48	0,40	12,5	[27]
45	38,27	140,90	491	220	0,45	14,2	[13]
34	38,12	13,37	737	287	0,39	12,3	[28]
9	37,38	136,90	1524	680	0,45	14,1	[13]
670	37,17	-3,05	585	221	0,38	11,9	[29]
10	36,88	-76,30	396	138	0,35	11,0	[30]
21	36,72	-4,47	580	219	0,38	12,1	[31]
21	36,72	-4,47	540	204	0,38	12,1	[32]
30	36,38	136,43	1346	600	0,45	14,1	[13]
31	36,05	140,13	407	182	0,45	14,2	[33]
31	36,05	140,13	393	176	0,45	14,2	[33]
18	35,68	139,60	447	200	0,45	14,2	[13]
10	35,43	133,35	1215	540	0,44	14,1	[13]
10	35,00	139,00	164	73	0,45	14,2	[34]
16	34,68	135,52	303	135	0,45	14,1	[13]
2081	33,94	73,23	676	271	0,40	12,7	[35]
10	33,58	130,38	486	215	0,44	14,0	[13]
32	32,80	130,72	1000	226	0,23	14,0	[36]
36	32,80	130,72	850	240	0,28	14,0	[36]
36	32,75	129,85	529	234	0,44	14,0	[33]
33	32,30	-64,78	326	115	0,35	11,2	[20, 21]
30	32,24	-64,87	193	68	0,35	11,2	[37]
536	31,55	74,34	284	117	0,41	13,1	[38]
20	31,23	121,40	1093	479	0,44	13,9	[39]
59	30,58	-96,37	508	172	0,34	10,7	[40]
11	29,30	-94,80	516	175	0,34	10,7	[40]
310	28,44	-16,47	374	139	0,37	11,8	[41]
7	27,75	-82,50	357	123	0,34	10,9	[42]
1080	26,57	106,72	2700	1142	0,42	13,4	[43]
52	26,05	127,00	178	79	0,44	13,9	[34]
5	26,00	127,00	447	197	0,44	13,9	[34]
1330	25,65	122,18	421	180	0,43	13,6	[44]
15	25,02	121,63	731	320	0,44	13,9	[44]
15	24,33	124,17	467	205	0,44	13,9	[13]
30	24,08	-17,17	163	62	0,38	11,8	[1]
23	22,05	-80,48	138	48	0,34	10,9	[45]
2	11,33	162,33	34	30	0,88	14,4	[46]
5	10,00	65,00	760	215	0,28	13,0	[47]
5	10,00	85,00	970	275	0,28	13,3	[47]
30	7,00	-25,02	232	88	0,38	11,7	[1]
30	0,29	-26,00	262	99	0,38	11,6	[1]
30	-0,83	-29,42	626	237	0,38	11,6	[1]
30	-25,75	-44,67	288	109	0,38	11,3	[1]
15	-27,47	153,023	164	73	0,45	14,1	[48]
30	-44,33	-58,25	305	115	0,38	11,0	[1]
30	-53,00	-29,80	45	17	0,38	11,4	[1]
30	-61,47	-54,60	58	22	0,38	11,0	[1]
1400	-62,18	158,98	17	6	0,38	13,8	[49]

30	-63,52	-58,64	15	6	0,38	10,9	[1]
2	-64,77	64,07	15	6	0,38	12,7	[49]
2	-66,67	140,02	30	11	0,38	13,8	[50, 51]
2	-67,60	62,55	30	11	0,38	12,7	[49]
44	-70,65	8,25	34	13	0,38	11,9	[52]
30	-72,43	-25,74	24	9	0,38	11,4	[1]
30	-73,00	-31,27	22	8	0,38	11,3	[1]
2860	-90,00	0,00	36	14	0,38	11,0	[49]

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