



^{210}Pb and ^7Be concentrations in moss samples from the region of Northern Greece

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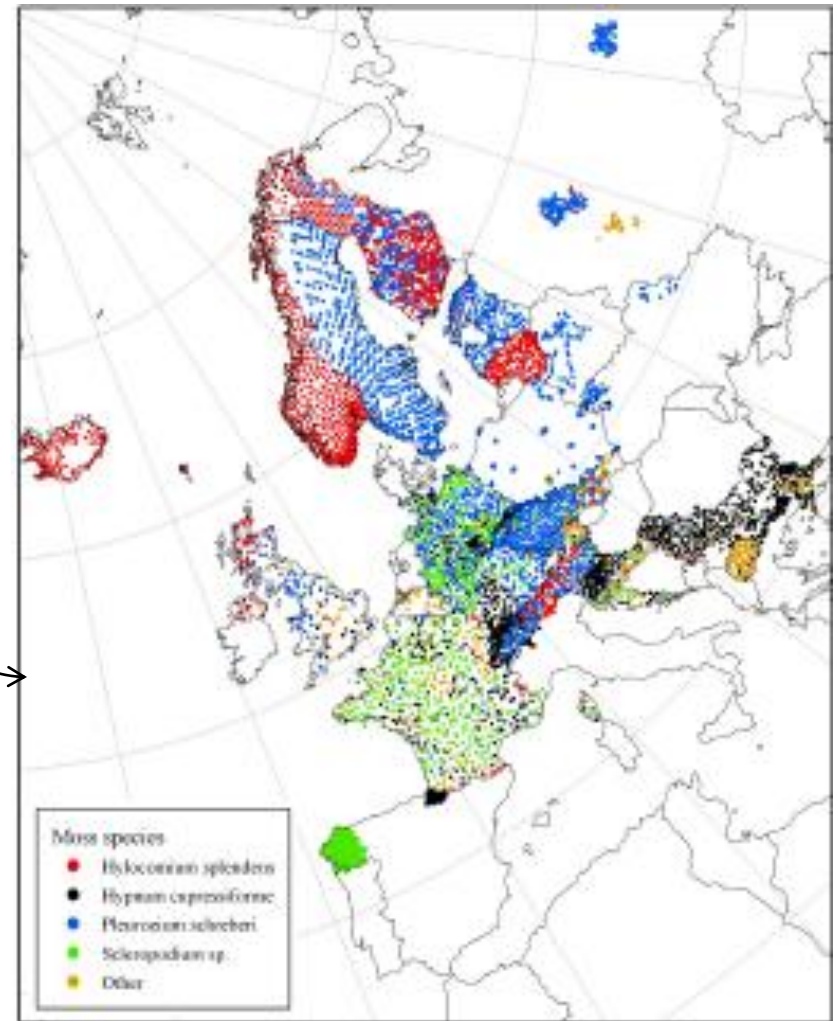
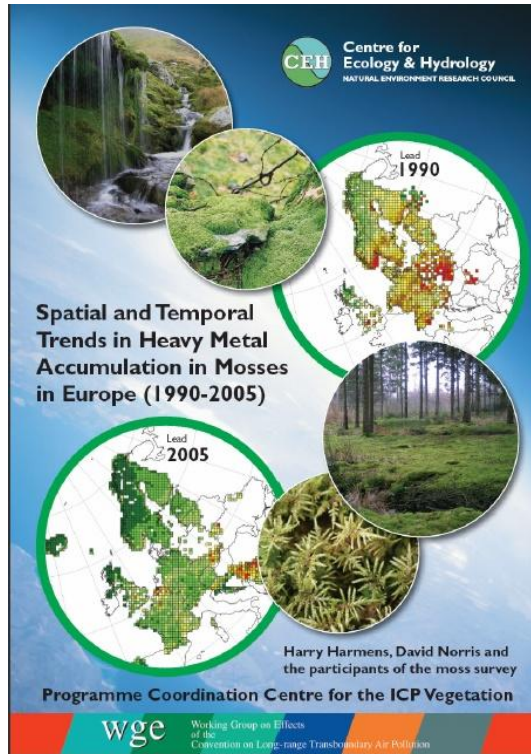
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Mosses:

- Ideal bioindicators
- Simple sample collection
- High sampling density
- Economic sampling medium





Lithotopos, Serres



Fteri, Pieria

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Neo Petritsi, Serres

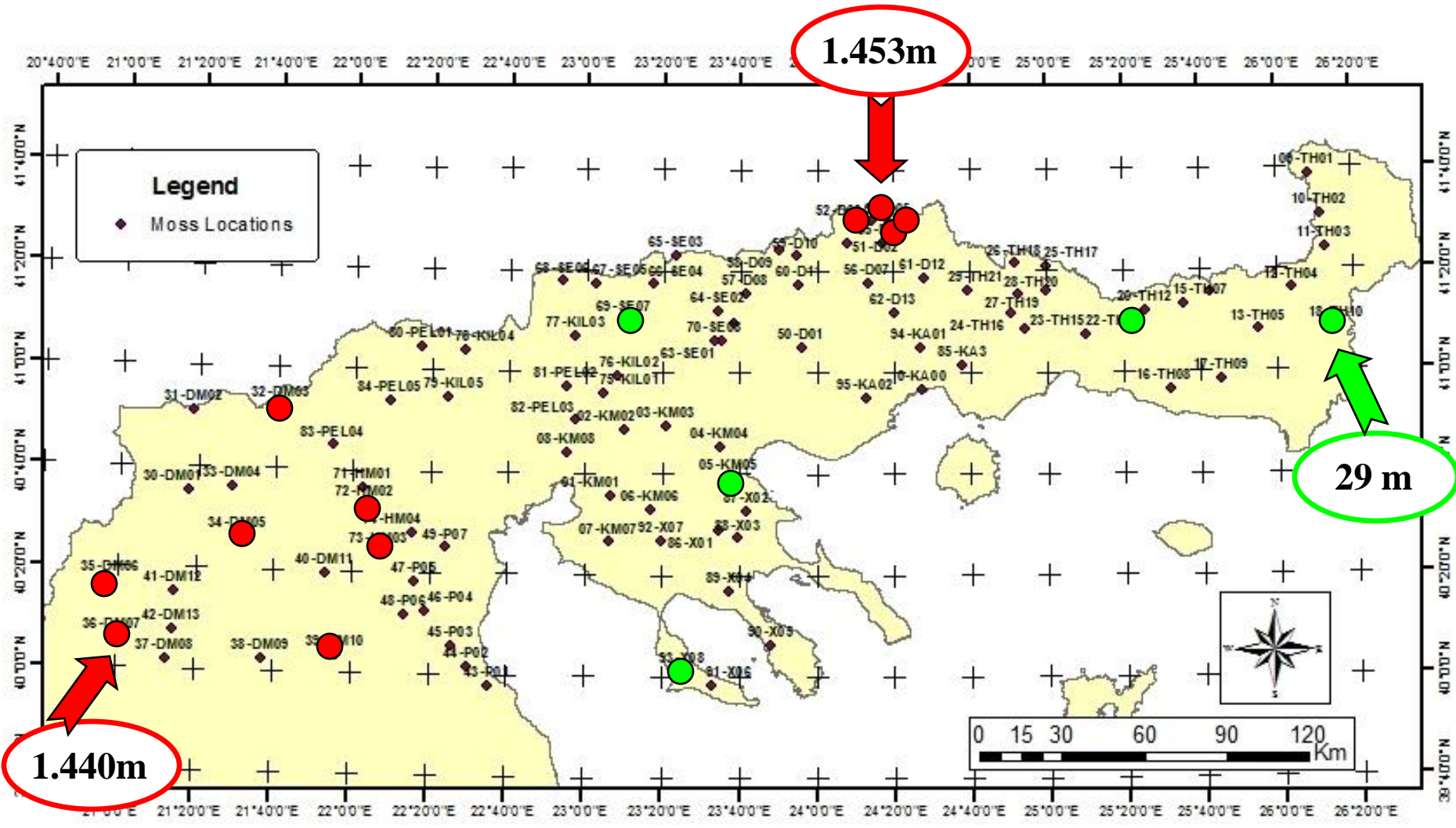


Ano Poroia, Serres



Samples of the moss *Hypnum cupressiforme* Hedw. were collected from **95 sampling sites** in Northern Greece, covering the Regions of West, Central and East Macedonia and Thrace, with sampling taking place from mid July till end of September 2016.

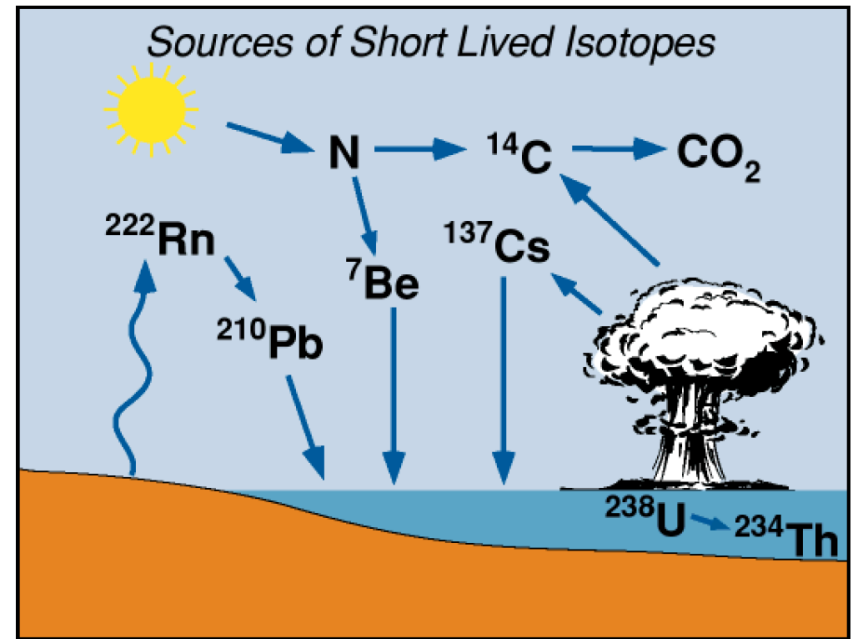
Study area - 95 collections sites in Northern Greece



Environmental radioactivity

◇ *Natural*

◇ *Artificial*



^7Be and ^{210}Pb are powerful tools for studying environmental processes, residence time of aerosols in the atmosphere, deposition velocity etc

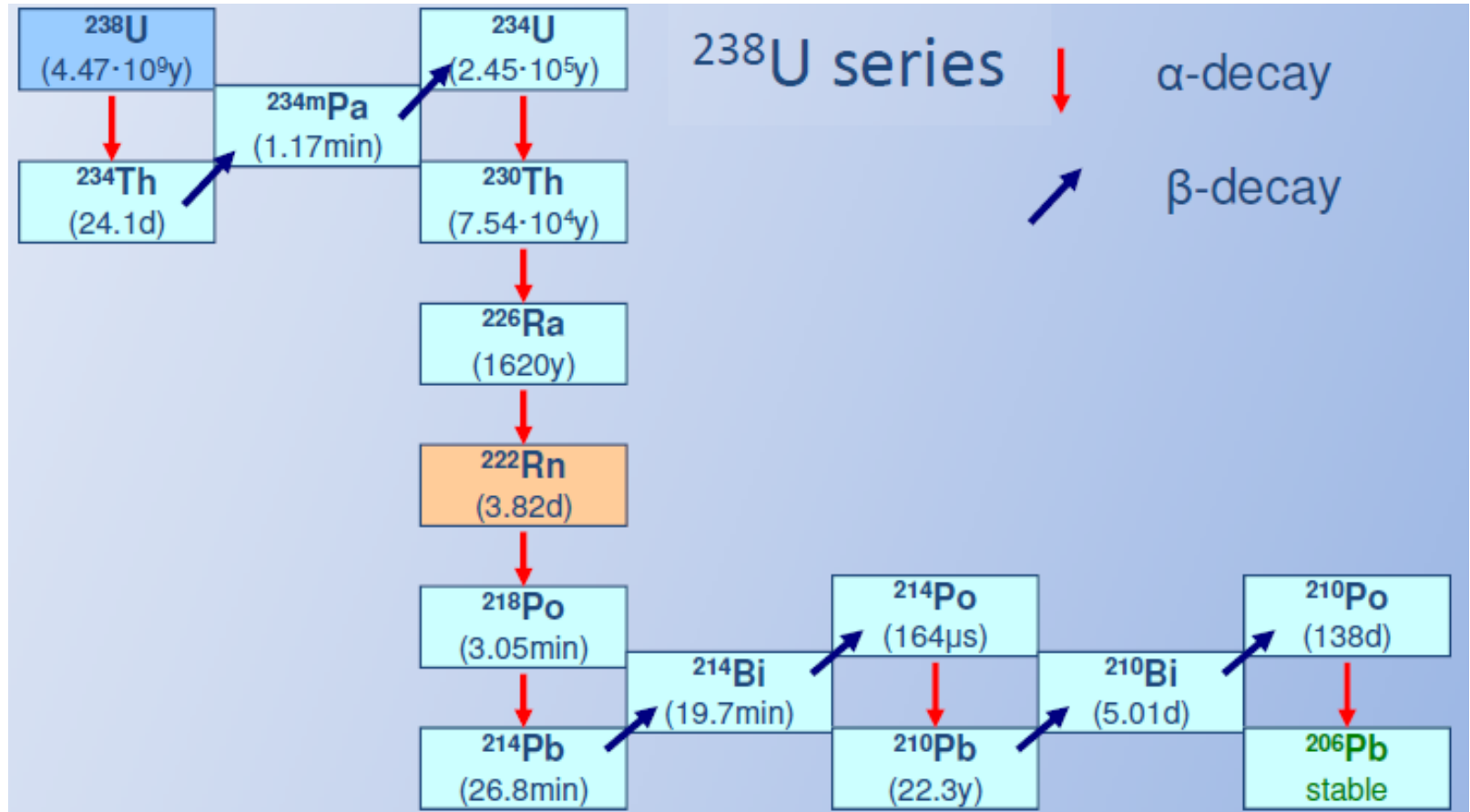
^7Be cosmogenic radionuclide

- formed in the upper troposphere and lower stratosphere by spallation reactions of cosmic rays with nitrogen and oxygen of atmosphere.
- Once it is formed, it is attached to aerosol particles and their fate is becoming the fate of their carrier aerosol particles.
- is deposited on the ground surface mainly through wet deposition which accounts more than 90% from total wet and dry deposition.
- ^7Be production rate depends on latitude, altitude and 11-year solar cycle.
- For a specific region its concentrations show a seasonal variation with maximum during warm summer months and minimum during winter period.
- half life ~53.3 days**

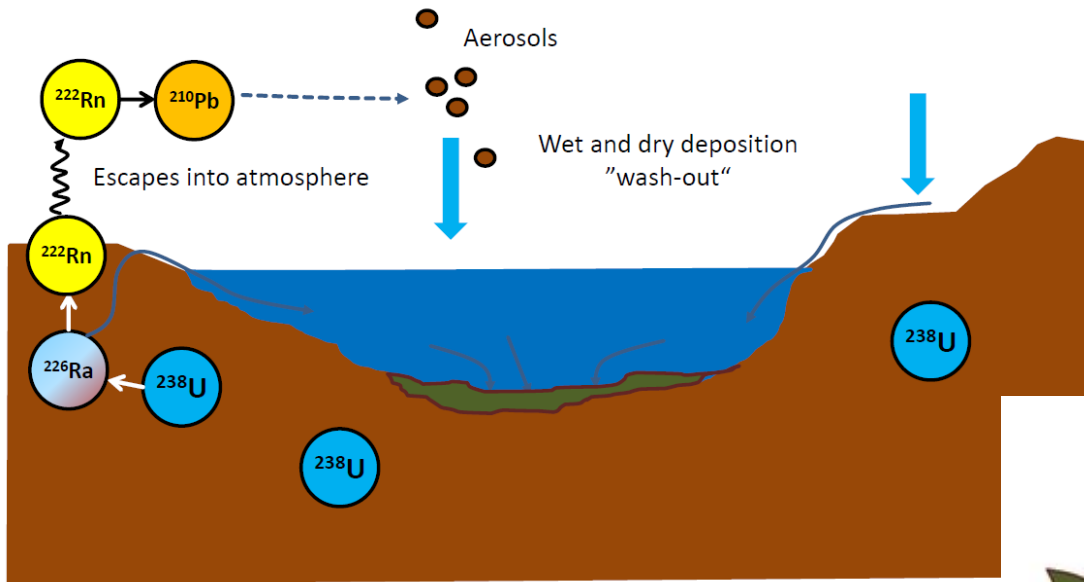
^{210}Pb isotope

- widely found in the terrestrial environment
- final long-lived radionuclide of the ^{238}U chain
- produced by the *decay of ^{222}Rn* which enters in the atmosphere from the soil ($^{210}\text{Pb}_{\text{unsupported}}$)
- it is also released from *industrial processes* such as the sintering of ores containing some amount of ^{238}U , the *burning of coal* or the production and use of agricultural *fertilizers*
- **Half life ~ 22 years**

^{238}U series



^{210}Pb supported & ^{210}Pb unsupported



in sediments as well as in other matrix where ^{226}Ra isotope can be found

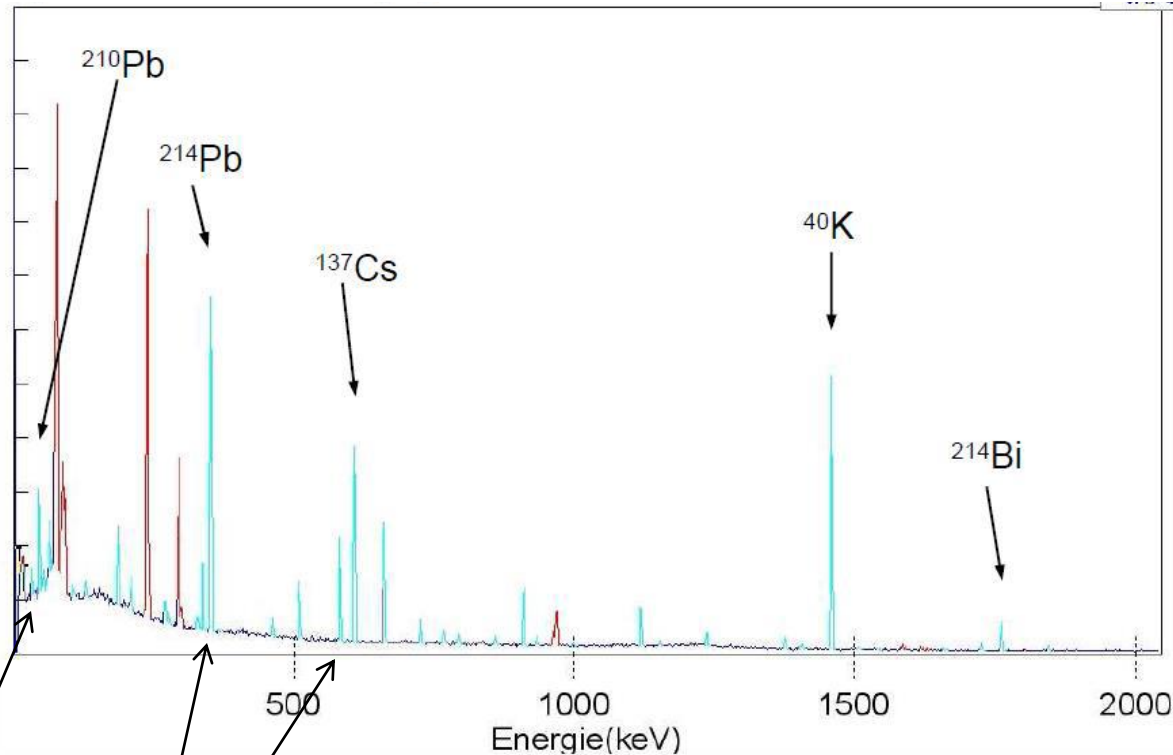


Supported $^{210}\text{Pb}_{\text{sup}}$:
- in situ from ^{226}Ra decay in sediment

Unsupported (excess) $^{210}\text{Pb}_{\text{xs}}$:
- dry or wet deposition of ^{210}Pb generated by ^{222}Rn decay in the air or
- by ^{222}Rn decay in water column

- Measurements of $^{210}\text{Pb}_{\text{total}}$ and $^{210}\text{Pb}_{\text{sup}}$
- ^{214}Pb and ^{214}Bi determination as an indicator of ^{226}Ra
 - $^{210}\text{Pb}_{\text{uns}} = ^{210}\text{Pb}_{\text{total}} - ^{210}\text{Pb}_{\text{sup}}$

^{210}Pb unsupported



$^{210}\text{Pb}_{\text{total}}$

$^{210}\text{Pb}_{\text{supported}}$

Measurements of $^{210}\text{Pb}_{\text{total}}$ and $^{210}\text{Pb}_{\text{sup}}$

- ^{214}Pb and ^{214}Bi determination as an indicator of ^{226}Ra
- $^{210}\text{Pb}_{\text{uns}} = ^{210}\text{Pb}_{\text{total}} - ^{210}\text{Pb}_{\text{sup}}$

Sample preparation for gamma-spectrometry

After sampling, mosses were dried at 105°C for 24 hours and all the impurities were removed manually.

After the preparation, mosses were put in two cylindrical plastic containers, diameter 67 mm and height 31 mm. A mass of 11-24gr is contained in each container, so ~22-48 gr total per sample.



For detector efficiency:
-IAEA 372 (grass)
-IAEA 330 (spinach)
-IAEA 447 (moss-soil)

- High resolution gamma spectrometry measurements can be carried out with the moss technique, without any chemical treatment of the samples.

Gamma spectrometry

All samples were measured in a low-background HPGe detector with relative efficiency 36%, shielded by 16cm of lead and 1.5mm inner Cu shield was used.

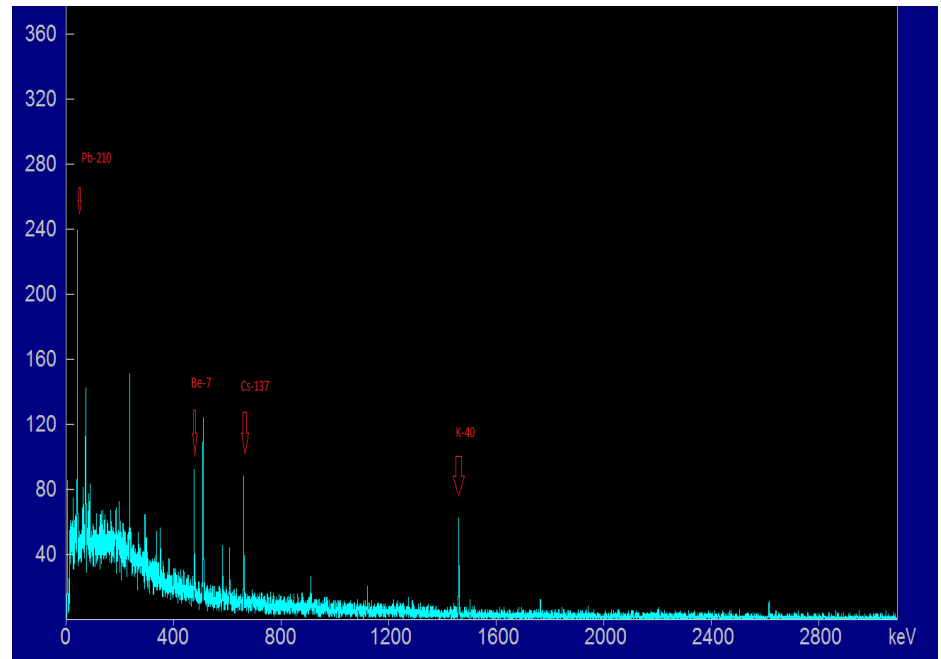
Next measurements were carried out using extended range HPGe detector equipped by Be window to get evidence about ^{210}Pb concentration. Statistical uncertainty of 46.5 keV ^{210}Pb line was up to 5%, too.



Gamma spectrometry



95 moss samples



Gamma radionuclides

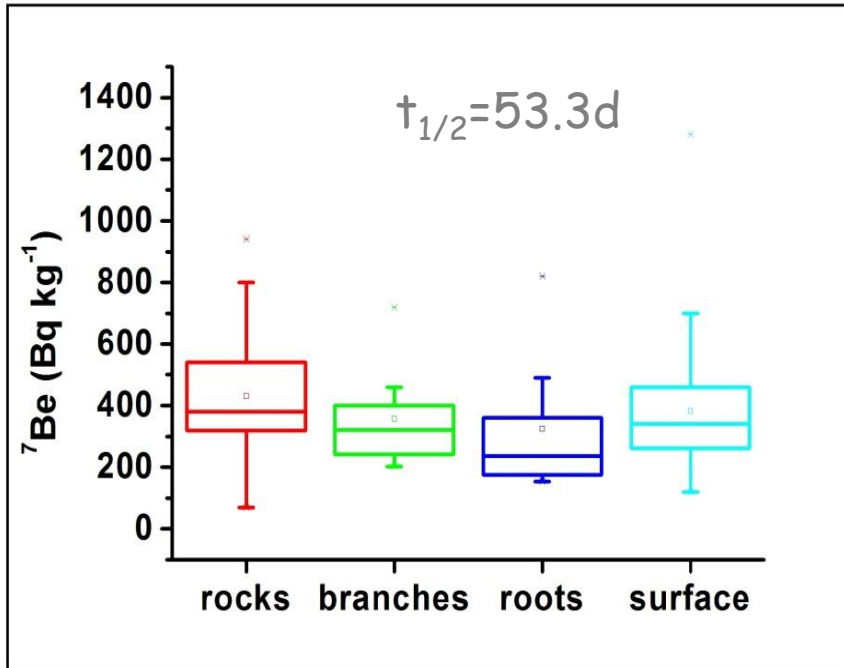
^{210}Pb , ^7Be , ^{137}Cs , ^{40}K

^{137}Cs ,	$t_{1/2} = 30.04$ years	(661.65 keV)
^{40}K ,	$t_{1/2} = 1.25 \times 10^9$ y	(1460.75 keV)
^7Be ,	$t_{1/2} = 53.3$ days	(475.5 keV)
^{210}Pb ,	$t_{1/2} = 22.23$ y	(46.5 keV)

Sampling July-Sept 2016

~1 half-life of ^{137}Cs after the Chernobyl accident 1986

^7Be activity concentrations



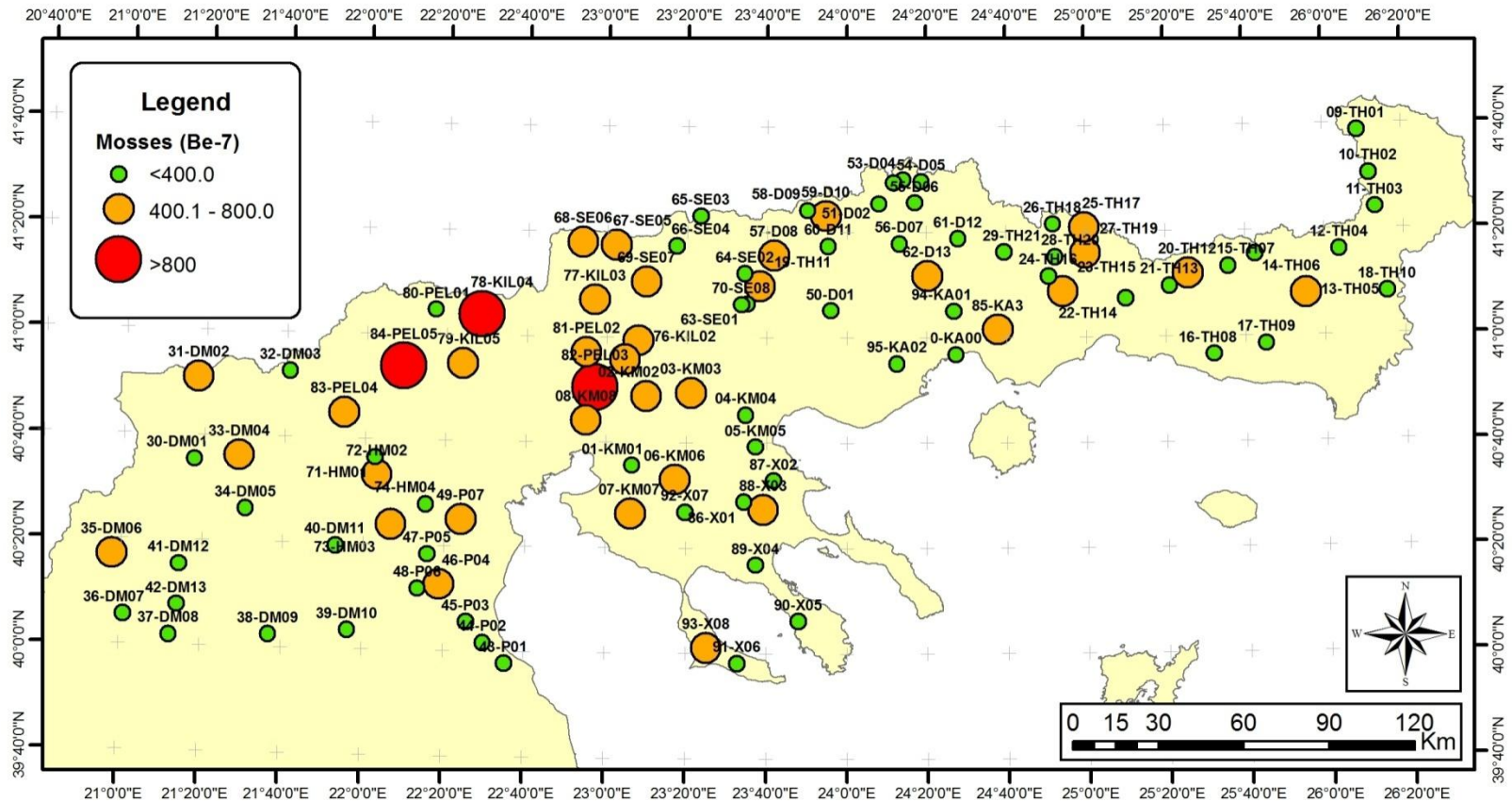
^7Be (Bq kg ⁻¹)	
Max	1280
Min	69
mean	392

collected from different surface type

$$\frac{A_{\text{surface}}}{A_{\text{roots}}} = 1.5$$

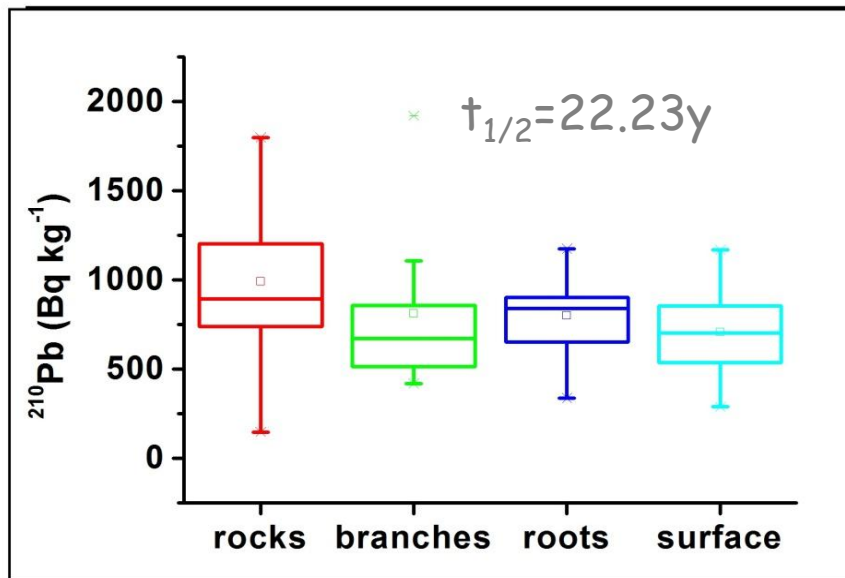
no variances in concentrations due to different altitudes

^7Be activity concentrations in mosses July-Sept 2016



^{210}Pb activity concentrations

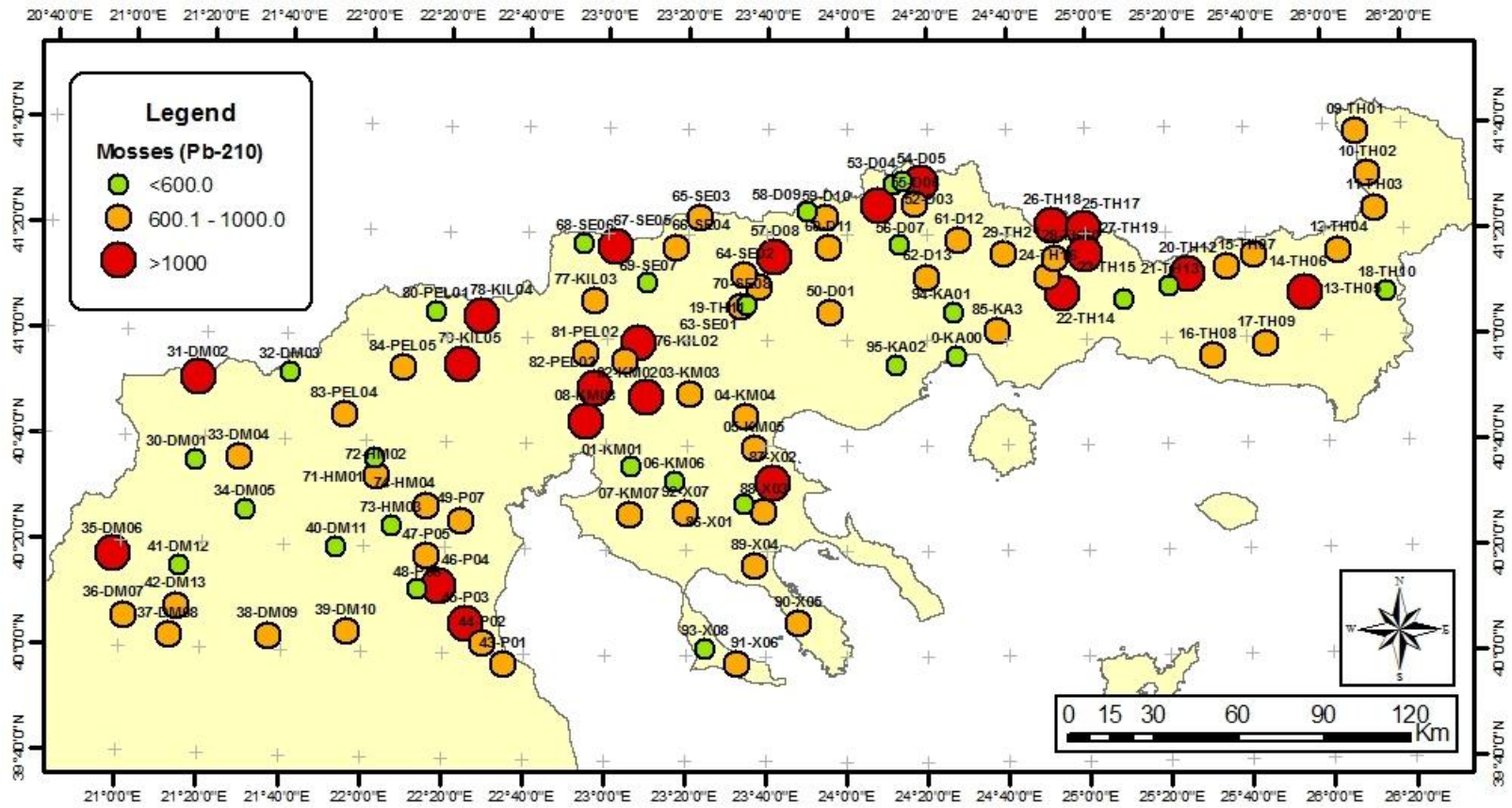
collected from different surface type



^{210}Pb (Bq kg ⁻¹)	
Max	2049
Min	147
mean	830

$$\frac{A_{\text{surface}}}{A_{\text{roots}}} = 0.87$$

^{210}Pb activity concentrations in mosses July-Sept 2016



Concentrations of ^7Be & ^{210}Pb in other countries

- In October 2005 in Serbia, the concentration of ^7Be ranged between 95-360 Bq kg⁻¹ with mean value of 195 Bq kg⁻¹ (Krmrmar,2007)
- During the summer of 2008 in Serbia the mean value of ^7Be was measured at 314 Bq kg⁻¹ and of ^{210}Pb at 695 Bq kg⁻¹ (Krmrmar,2013)
- In Slovakia during the summer of 2006 and 2007 the concentration of ^{210}Pb ranged between 330-1521 Bq kg⁻¹ and in Belarus ranged between 163-575 Bq kg⁻¹ (Yu.V.Aleksiayenak, 2013)

Our results:

^7Be : 69-1280 Bq kg⁻¹ (mean:392)
 ^{210}Pb : 147-2049 Bq kg⁻¹ (mean:830)

Conclusions

- ^{210}Pb , ^7Be activity concentrations determined in 95 moss samples collected from Northern Greece
- Small discrepancies exist between samples collected from different surface matrix (rocks, roots etc) in ^7Be concentrations in contrast to ^{210}Pb concentration
- no variances were observed in ^7Be and ^{210}Pb concentrations due to different altitudes
- usually there are seasonal variances in ^7Be concentrations, but our sampling occurred only in summer of 2016
- the activity of ^{210}Pb in mosses can vary from region to region due to the different soil structure
- the majority of ^{210}Pb in mosses has arrived from aerosol deposition (e.g. dust that contains ^{238}U daughters)
- No correlation was found between ^7Be and ^{210}Pb

Next steps:

- Determination of heavy metals concentrations in mosses
- Study of the transboundary transport of heavy metals
- Study of the influence of meteorological conditions on the deposition of airborne radionuclides
- Transfer factor of ^7Be and ^{210}Pb from the atmosphere to the mosses
- Correlation between the ^{210}Pb , ^{137}Cs , ^{40}K in soil and mosses

Thank you!