The use of continuous gamma-spectrometry monitoring to assess soil water content

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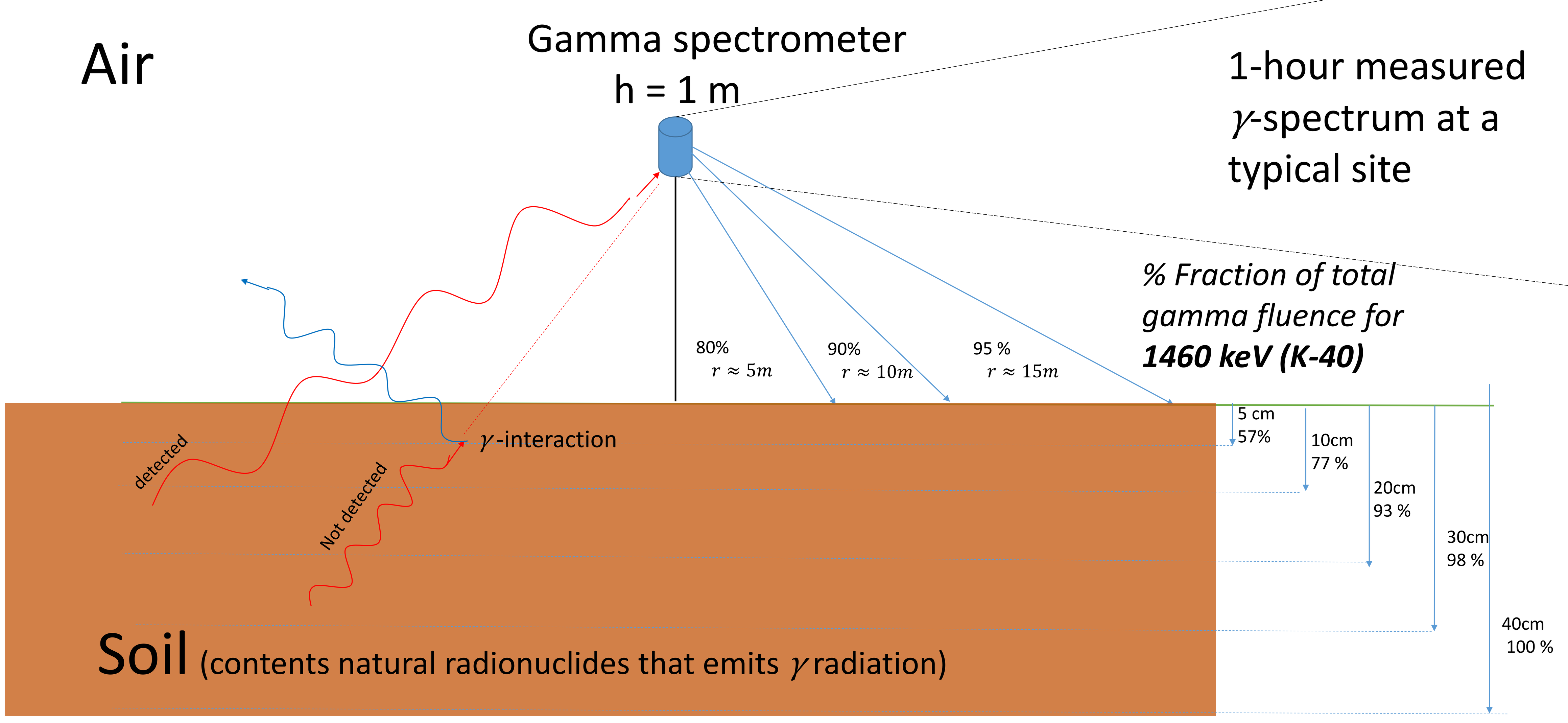
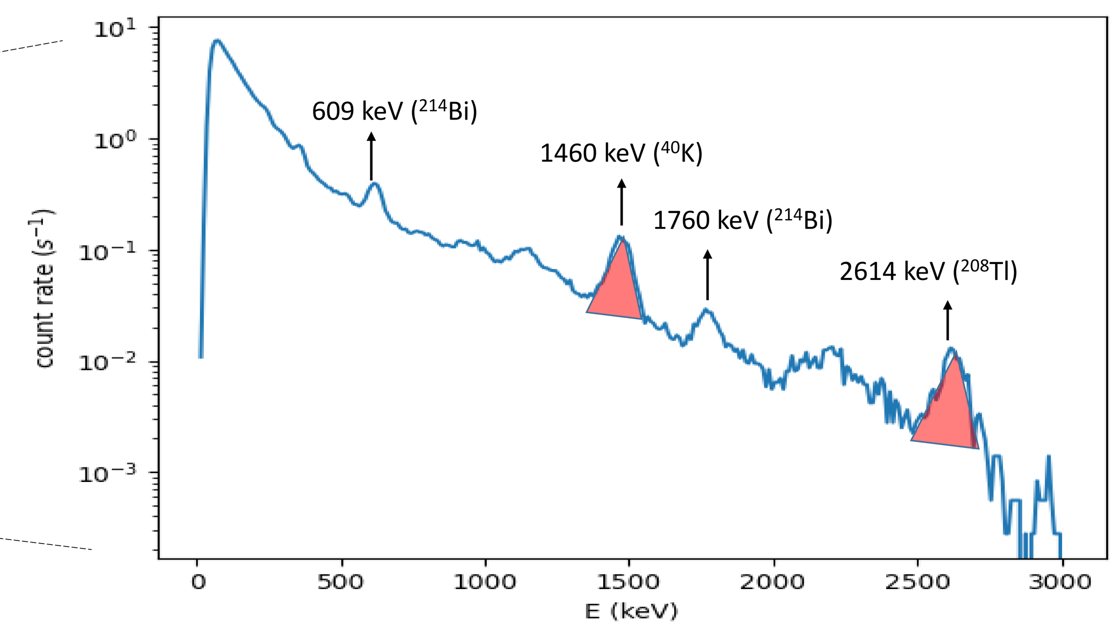
Introduction - basics

Soil water content is a crucial parameter that influences, among others physicochemical soil process, the radon flux



The count rate in the **1460 keV and 2614 keV energy peaks (in red)** are inversely correlated to the soil water content



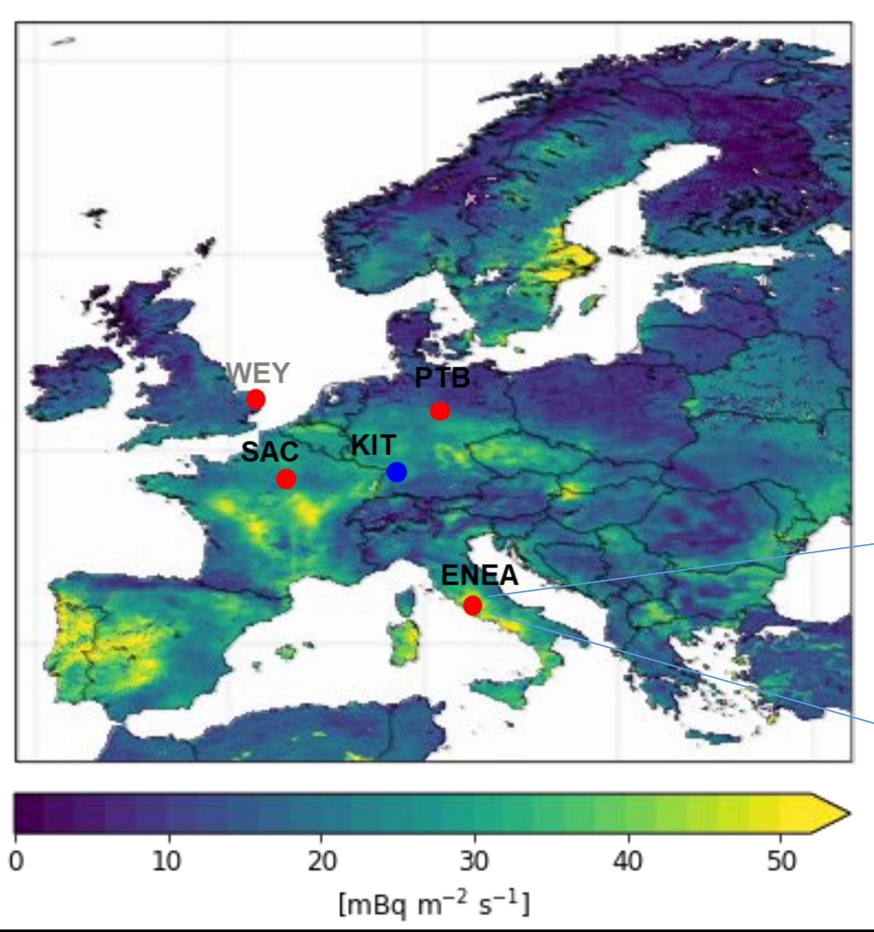
The following simplified equation (Baldoncini et al. 2018) represents the attenuation for both the 1460 keV and 2614 keV energy lines:

$$VWC(t) = \frac{S^{cal}}{S(t)}(0{,}9 + VWC^{cal}) - 0{,}9$$

VWC^{cal} = volume water content at the calibration time
S^{cal}[cps] = count rate at the calibration time
$S(t)$ [cps] = count rate at the time t

Sites - 3-month campaign per site

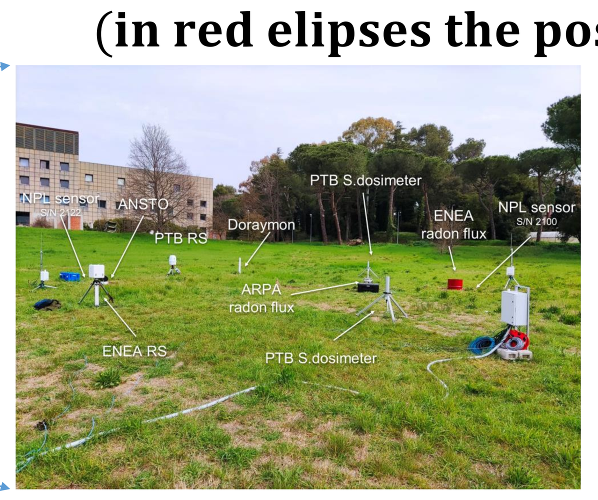
Radon Flux map. See oral presentation 23 by Karsten et al. (red dots are campaign sites)

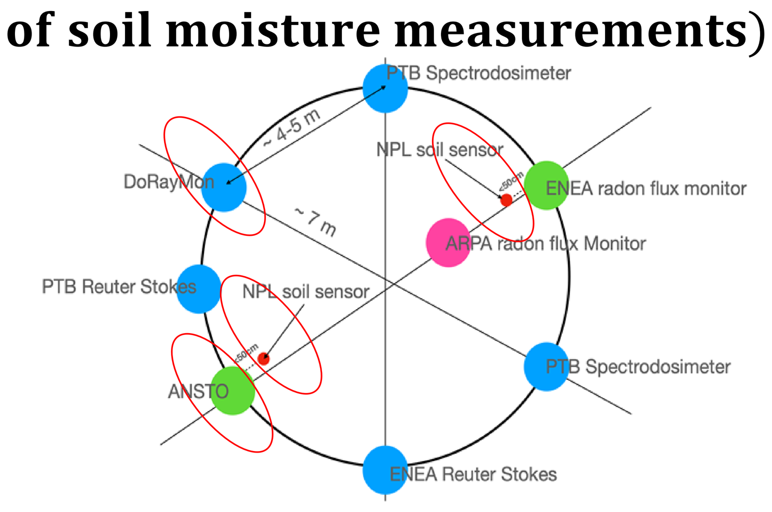


Soil water content are determined by different method at the sites:

- 2 x Soil moisture profile probes : SoilVUE10 and datalogger from Campbell Scientific (**NPL**)
- Soil moisture probes included in the ANSTO radon Flux monitor: CS655-12 cm water reflectometer from Campbell Scientific (**ANSTO**)
- Soil samples (0-10): samples are weighted before and after dried (**gravimetric**).
- Spectrometer: based on the R2D-NaI-2 detector from BridgePort (**DoRayMon)**

Example of deployed instruments at ENEA site
(in red elipses the position of soil moisture measurements)



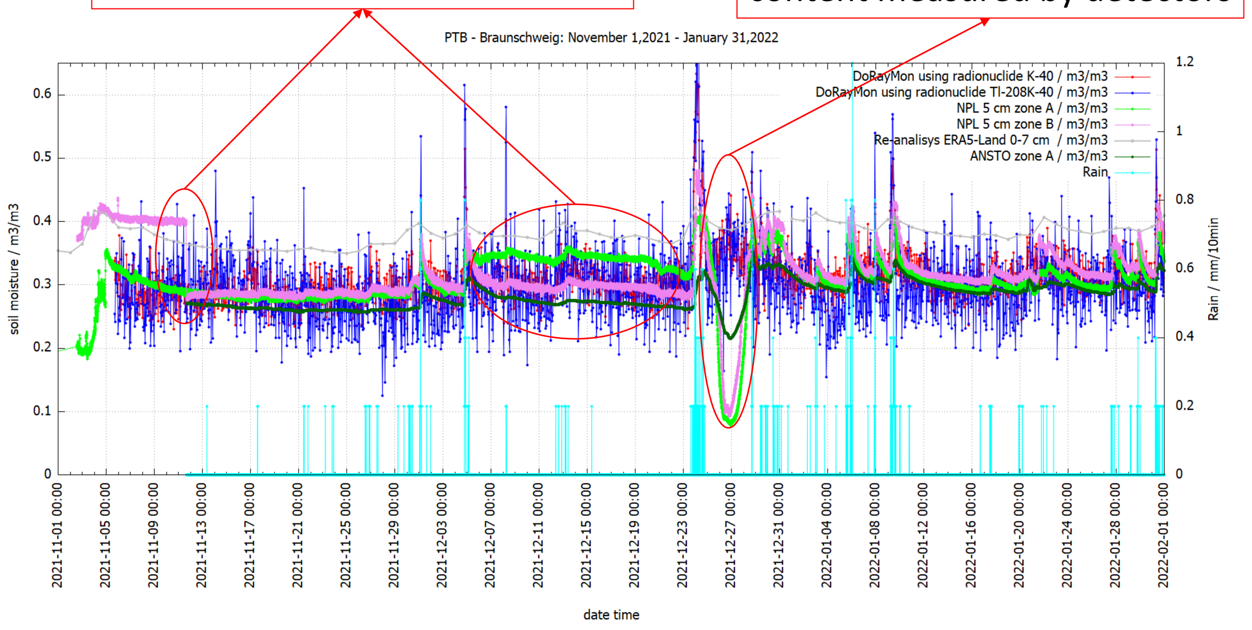


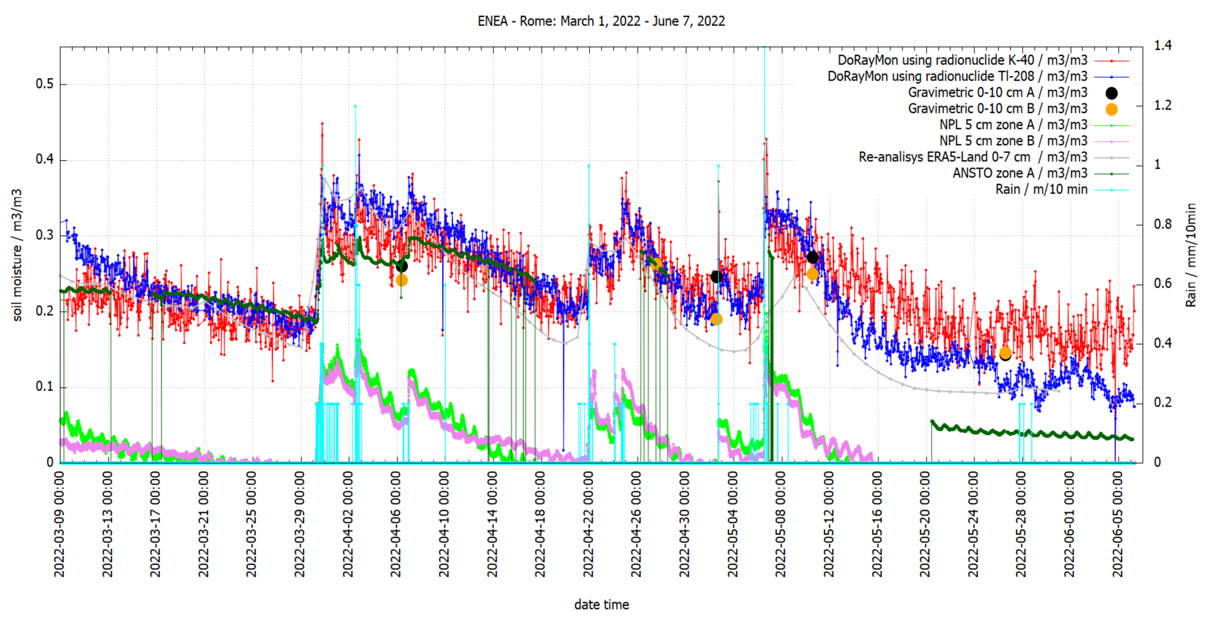
Results

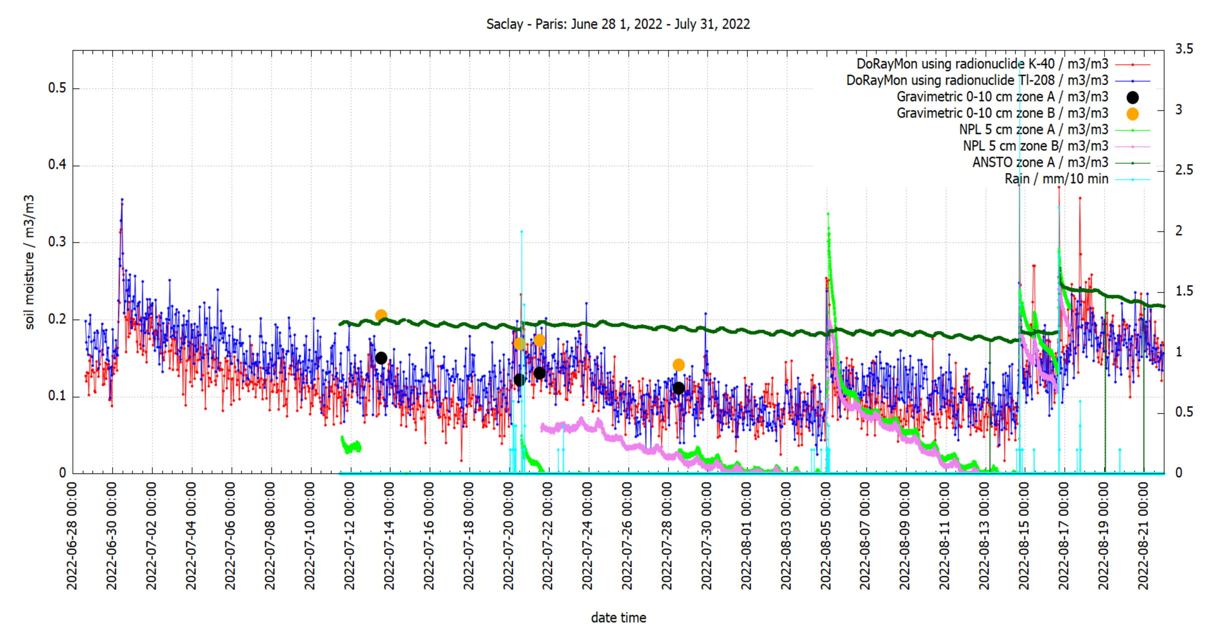
- DoRayMon was calibrated by NPL sensors at PTB because there were no gravimetric measurements carried out.
- Re-analysis results from ERA5-land 0-7 cm (daily average values) are included at PTB and ENEA plots.
- Results at Saclay are ongoing.
- The data from the sensors are not calibrated at each station. The analysis of the acquired data form such sensors is on-going.

Detector installation and calibration at each site are crucial

Ice effect: increase of gamma attenuation, decrease of water content measured by detectors







Conclusions

- Spectrometric detectors have been proven to be able to estimate the average soil water content in measurement campaigns at different sites.
- The spectrometric methodology is easy to implement and seems to be more robust than soil moisture detectors.
- Spectrometric detectors are being installed in the national radiological surveillance networks, and therefore they can be useful to generate continuous soil moisture maps.

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