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The EMPIR initiative is co-funded by the European Union's Horizon 2020 research and innovation programme and the EMPIR Participating States

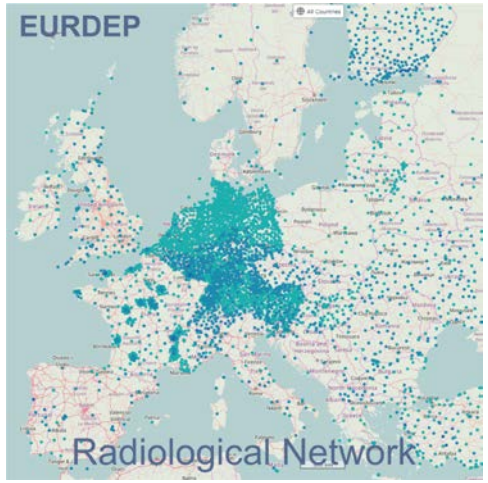
Radon metrology for use in climate change observation and radiation protection at the environmental level

19ENV01 traceRadon

Coordinator: Annette Röttger

EURAMET TC-IR annual meeting 2022

Introduction - 1



Climate change is one of the greatest challenges of our time.

The temperature rise of the atmosphere of our planet, due to the greenhouse effect, is caused by the increase of GHG emissions.

- ICOS: Monitoring of GHG emissions, the dispersion of GHGs and the resulting GHG concentrations in air, is of utmost importance for appropriate climate change mitigation measures.
- EURDEP: Collection and exchange of radiological monitoring data between participating countries of the radiation in the environment.

Both networks could profit from radon measurements at the outdoor level. But **traceability to the SI system** is not established yet.

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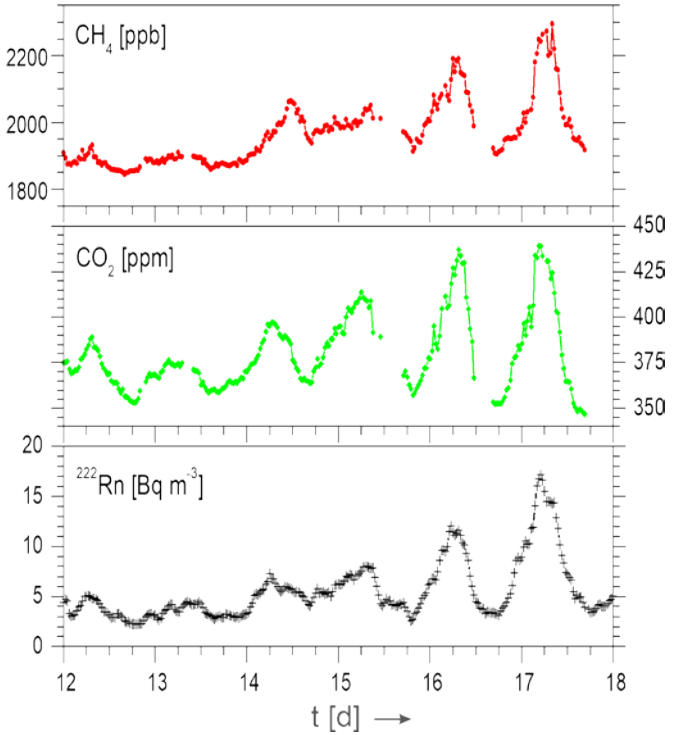
Introduction - 2

Why is Radon an issue in **climate observation**?

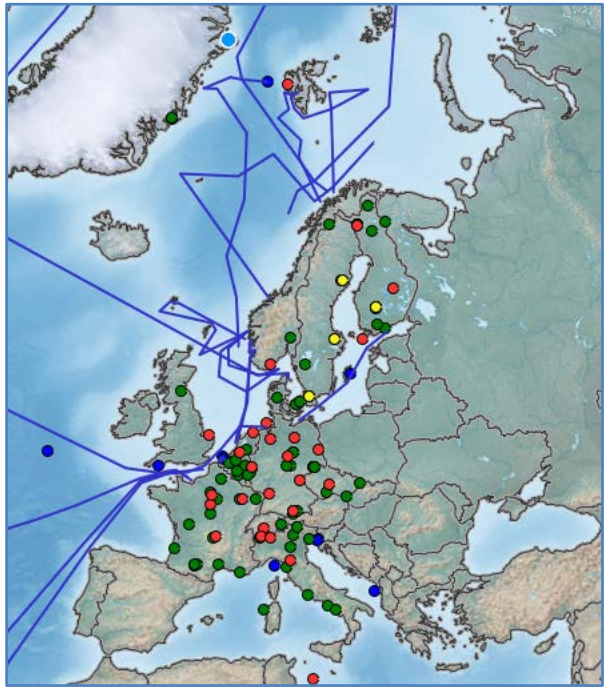
- GHG **flux measurements** are difficult though GHG concentration measurements are established.
- With radon activity concentration and radon flux measurements GHG fluxes can be **traced**!



ICOS Atmospheric Station Specifications:

Radon monitor: "At the present stage, Radon-222 measurements are not mandatory in ICOS. However, Radon-222 is recognized as a very valuable measurement, in particular for trace gas flux estimates."

- Determine source terms of GHG



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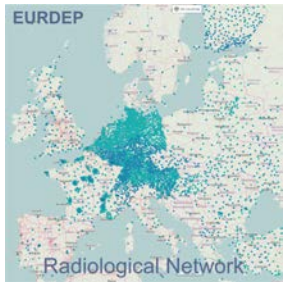
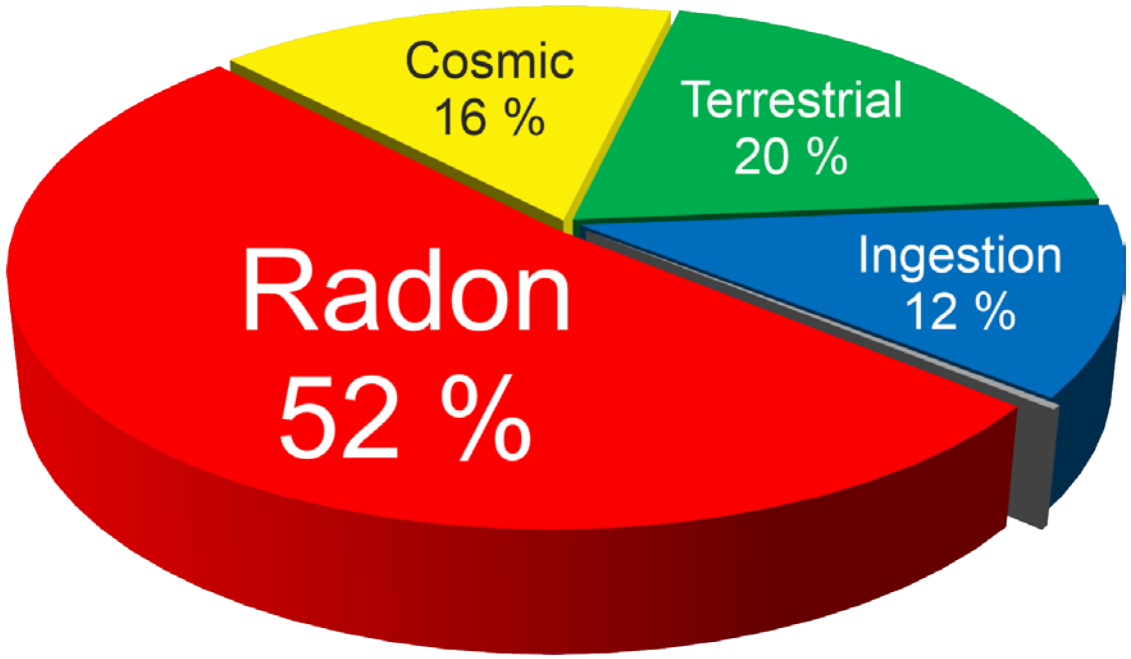
Objectives - Overview



1. To develop traceable methods for the measurement of **outdoor low-level radon activity concentration** in the range of **1 Bq m^{-3} to 100 Bq m^{-3}**, with uncertainties of **10 % for k = 1**, to be used in climate monitoring (…).
2. (…).
3. (…) To support the validation with dosimetric and spectrometric data from the **radiological early warning networks in Europe** (…).
4. To provide **easy to use dynamic radon and radon flux maps** for radiation protection in line with Council Directive 2013/59/EURATOM, including their use to identify **RPA** and **radon wash-out peaks** (…).

UNSCEAR, 2008:
Radon and its progeny contribute about half of the natural radiation dose to the public.

Public exposure to natural radiation:
Total average individual dose:
3 mSv a^{-1}



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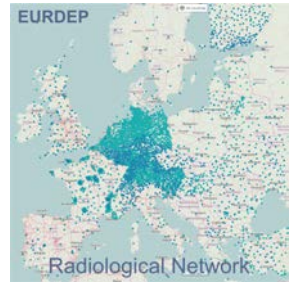
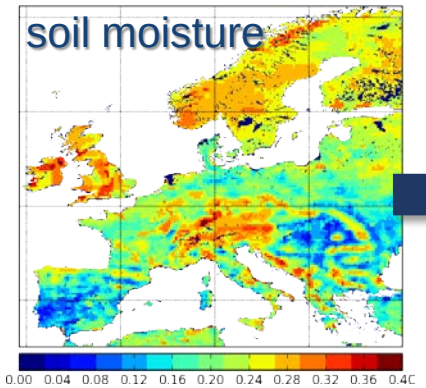
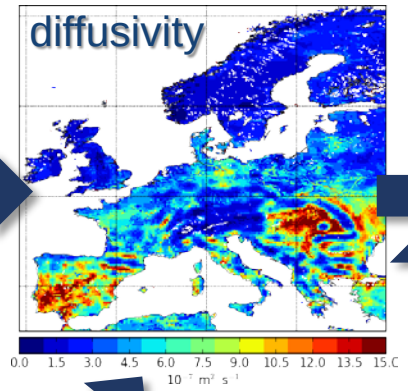
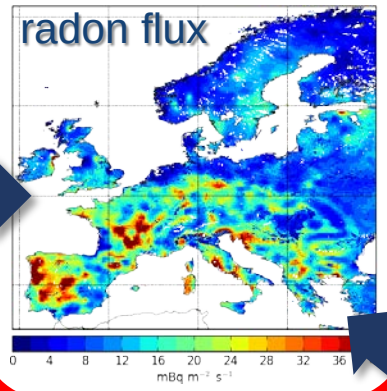
Objectives – Joining forces

Our task: Joining forces in the field of radon



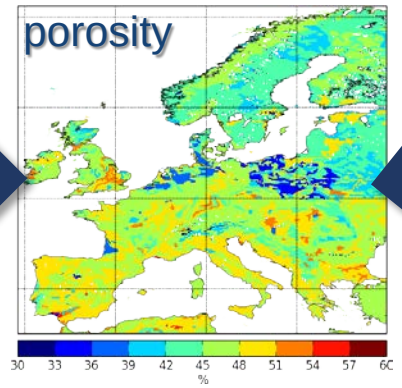


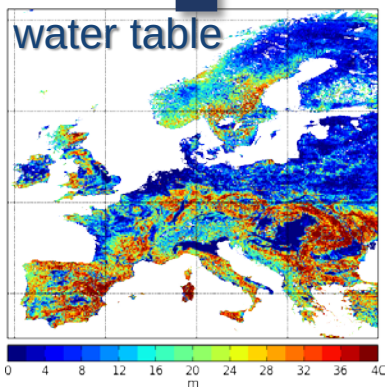


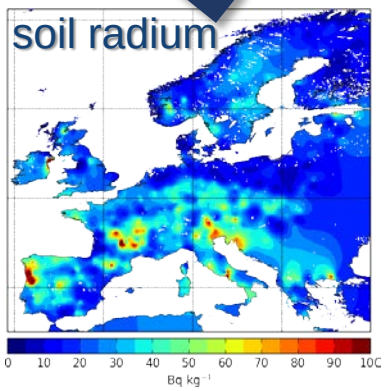


soil texture
% clay
% sand
% slit

bulk density







based on Karstens et.al. 2015

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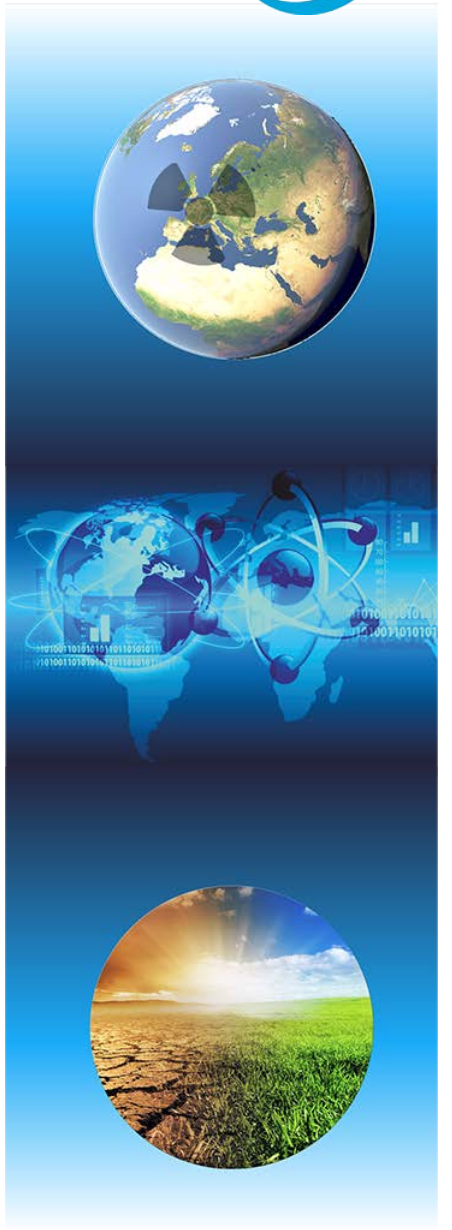

Achievements – 1: New traceability

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IOP Publishing
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Meas. Sci. Technol. 32 (2021) 124008 (13pp)
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New metrology for radon at the environmental level

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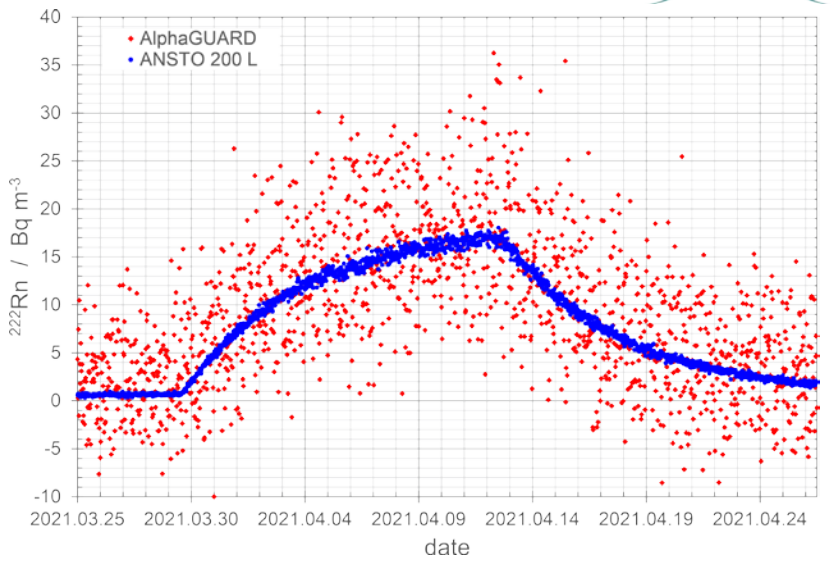

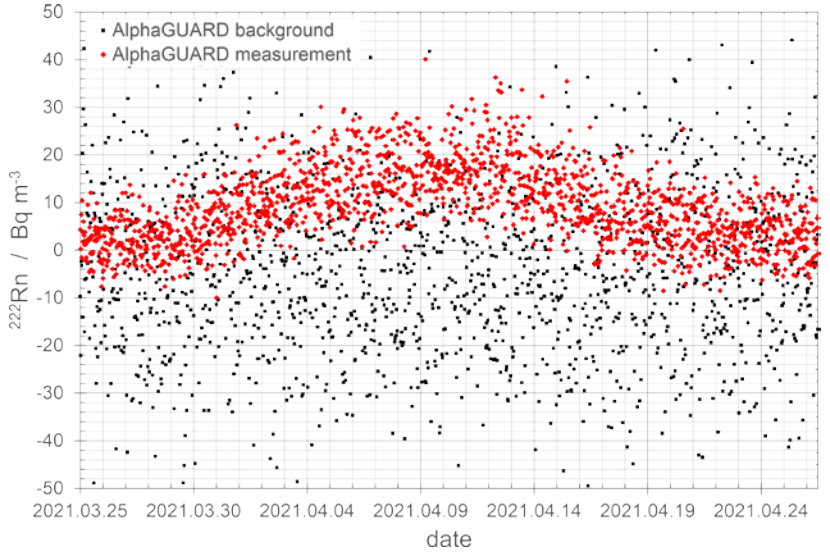

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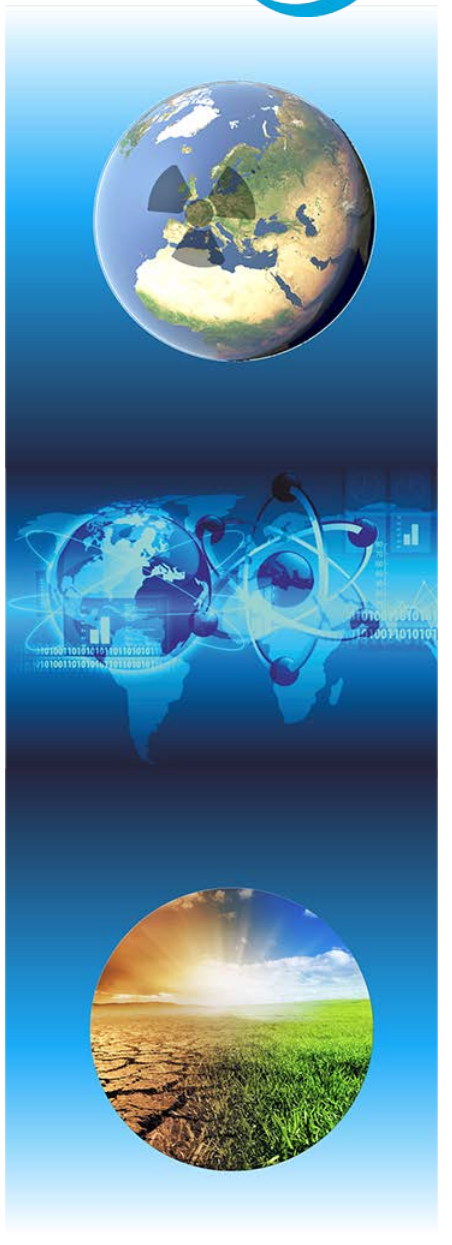


Achievements – 2: New sources

Electrode posited

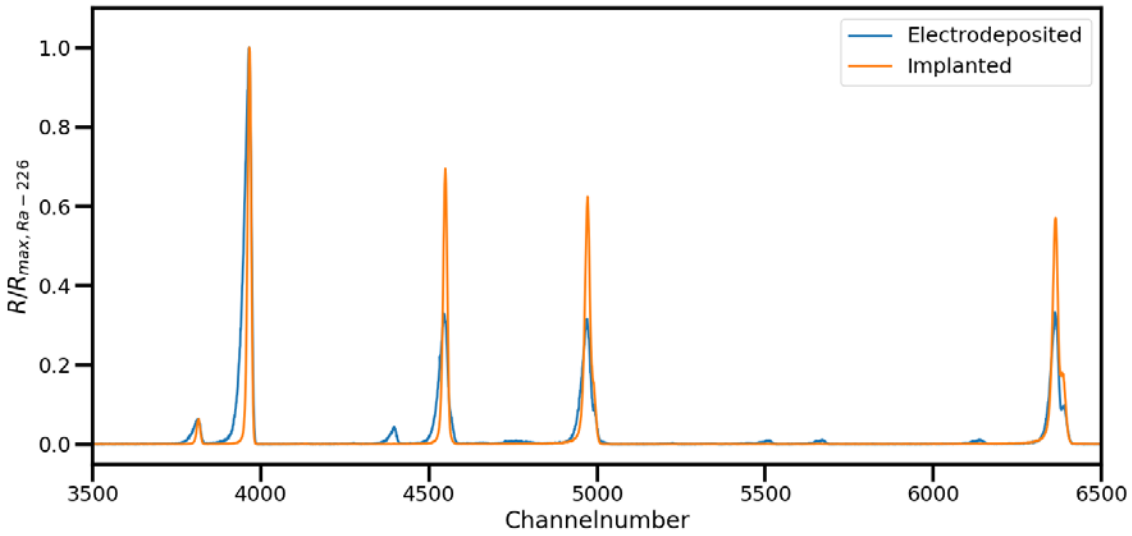
Deposition at 30 V < U < 200 V

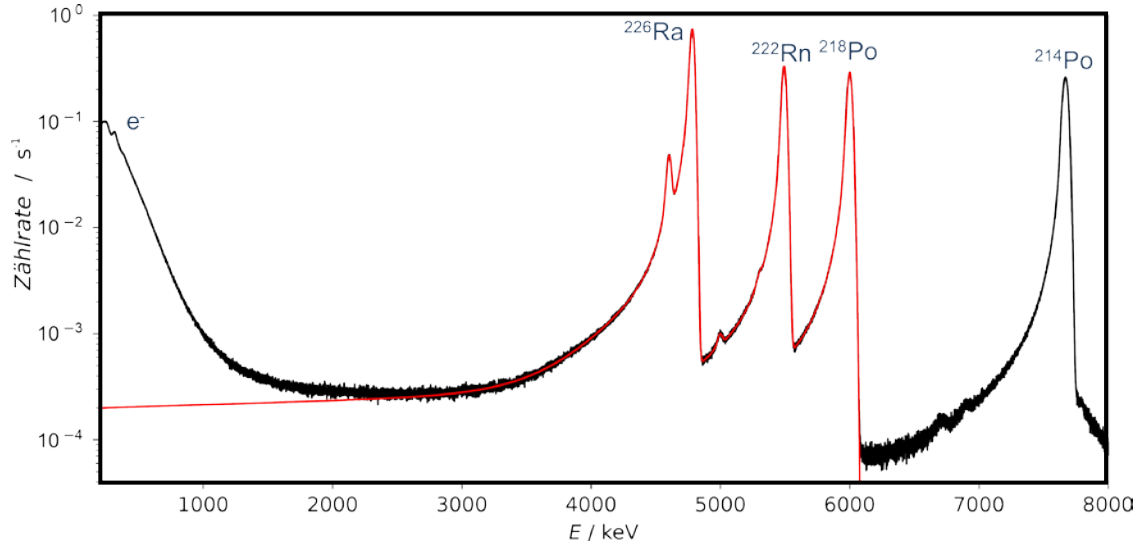
Implanted

Implantation of Ra-226 into W / Al after mass separation

PIPS

450 mm², 300 µm with 150 Bq ^{226}Ra layer





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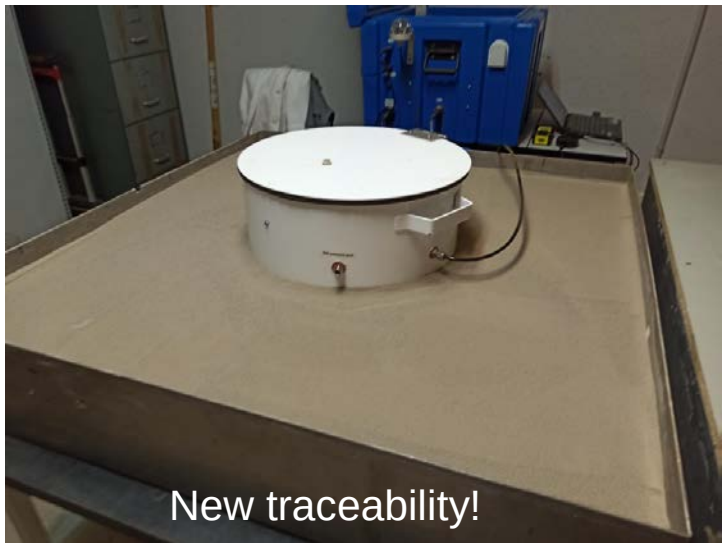
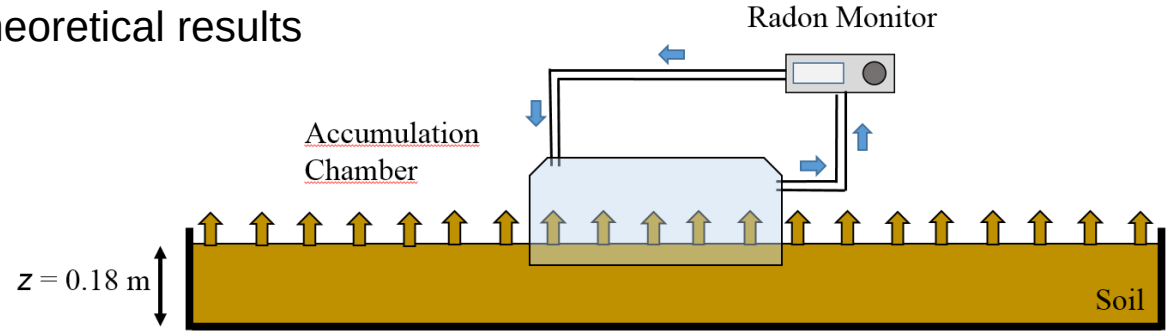
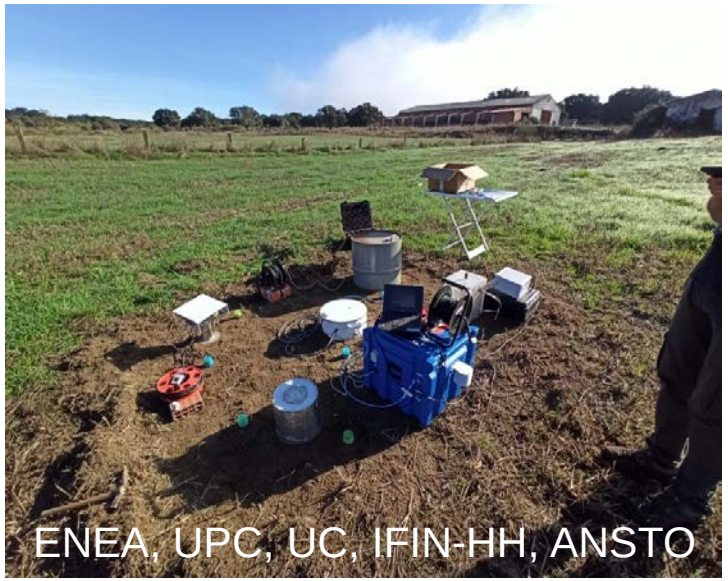
Achievements – 3: Radon flux



Calibration

Continuous radon flux systems according the experimental and theoretical results





Inter-comparison

- Good agreement between participants
- Static period is used to determine the leakages of the system and the applicability of linear assumption
- Integration time and device sensitivity are key to determine the radon flux

Next steps:

- Further data analyis (increasing period), optimize the methodology, check the time of linear assumption
- Produce the guidelines to installation and operation in field (A2.2.5)

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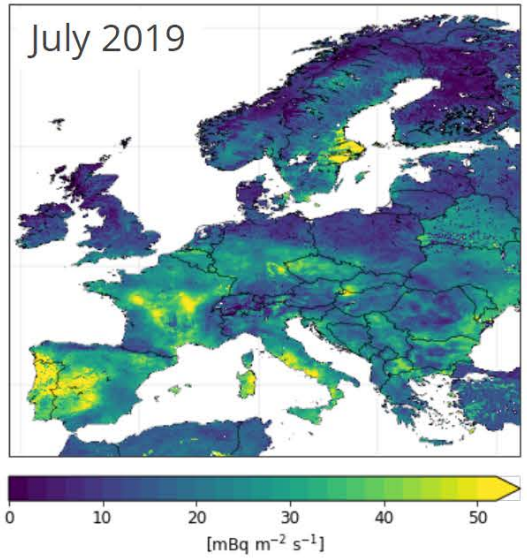
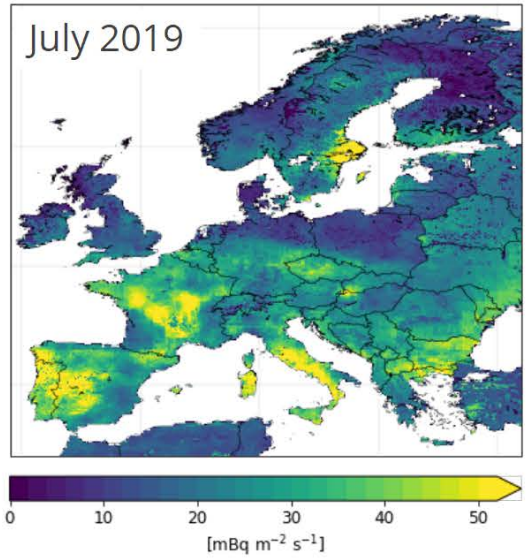
Achievements – 4: Data reanalysis

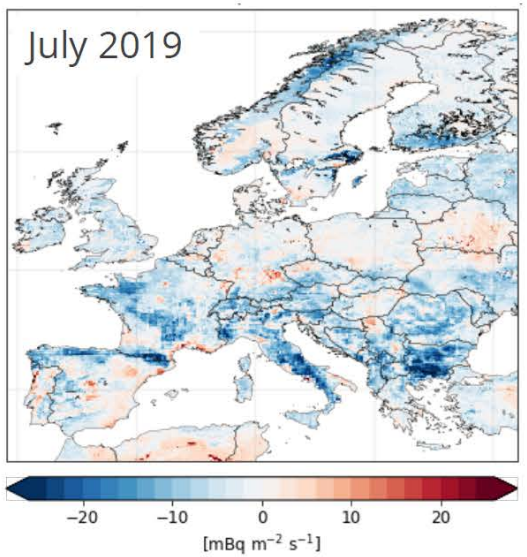
Radon flux based on GLDAS-Noah v2.1 soil moisture

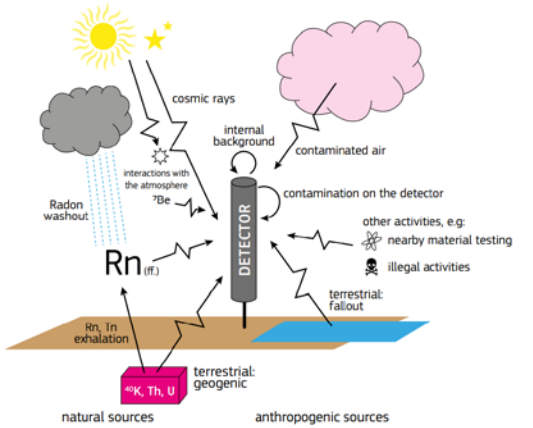


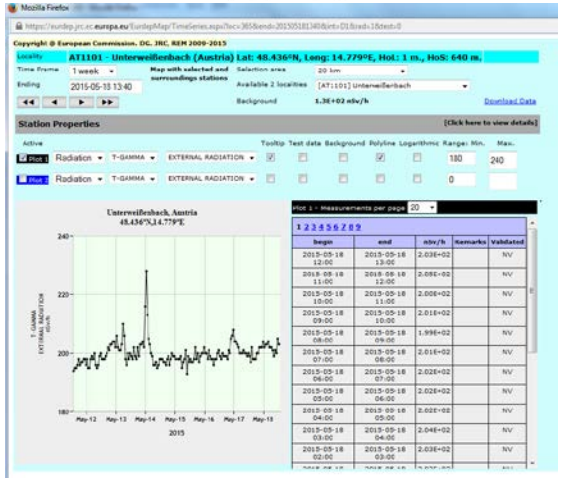
Radon flux based on ERA5-Land soil moisture



Radon flux difference ERA5-Land – GLDAS-Noah







The identification of the right origin of Ambient Dose Equivalent Rate (ADER) peaks is a crucial issue to prevent the impact of false alarm in the population.

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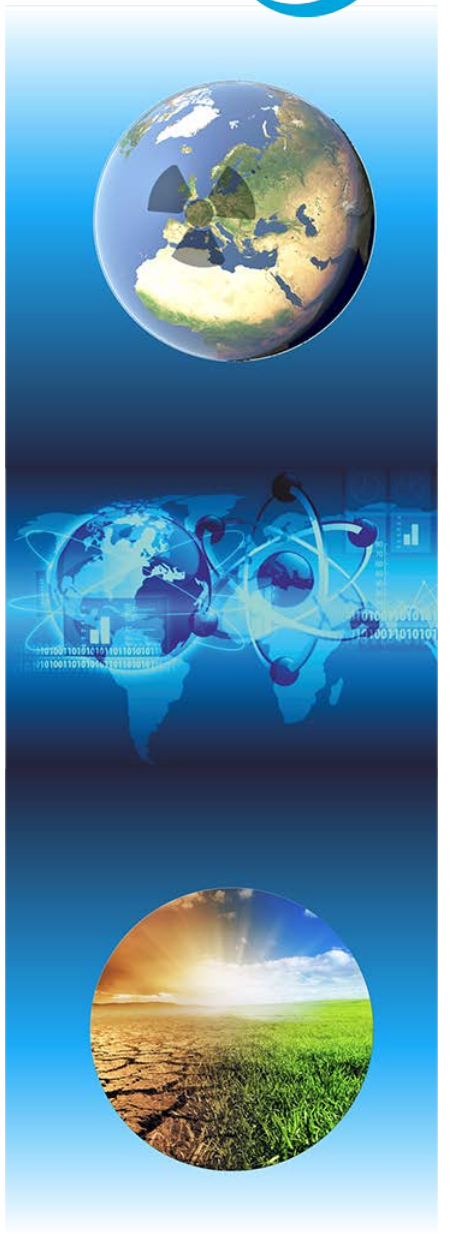
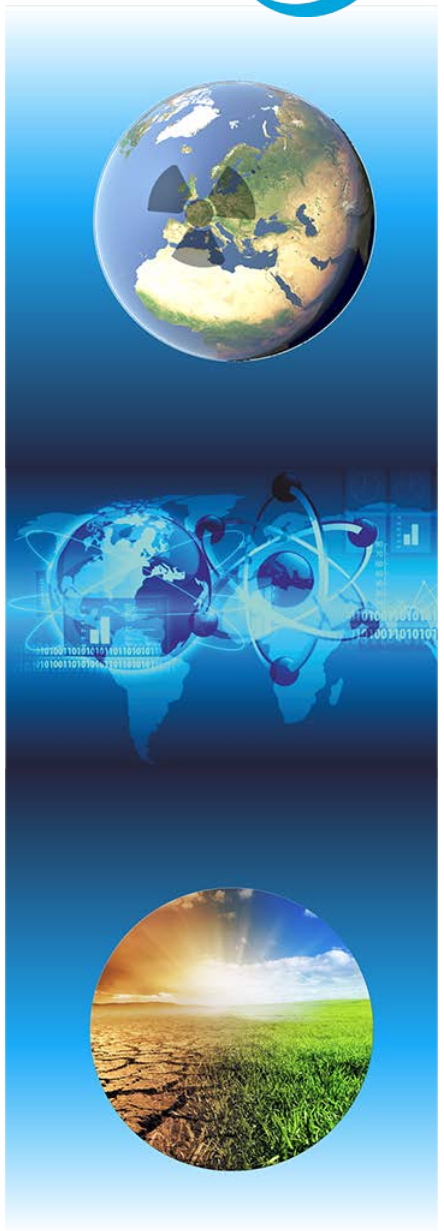


Publications at mid-term

1. Mertes, F et. al.: D3.3 Approximate sequential Bayesian filtering to estimate Rn-222 emanation from Ra-226 sources from spectra, https://doi.org/10.5162/SMSI2021/D3.3
2. Röttger, A. *et al: New metrology for radon at the environmental level 2021 Meas. Sci. Technol.* 32, 124008, https://doi.org/10.1088/1361-6501/ac298d
3. Radulescu, I et al.: Inter-comparison of commercial continuous radon monitors responses, Nuclear Instruments and Methods in Physics Research Section A, Volume 1021, 2022, 165927, https://doi.org/10.1016/j.nima.2021.165927
4. Mertes, F. et. al.: Ion implantation of ^{226}Ra for a primary ^{222}Rn emanation standard, Applied Radiation and Isotopes, Volume 181, March 2022, 110093, https://doi.org/10.1016/j.apradiso.2021.110093
5. Čeliković, I. et. al.: Outdoor Radon as a Tool to Estimate Radon Priority Areas - A Literature Overview, Int. J. Environ. Res. Public Health 2022, 19, 662, https://doi.org/10.3390/ijerph19020662
6. Mertes, F et. al.: Development of 222Rn emanation sources with integrated quasi 2π active monitoring, Int. J. Environ. Res. Public Health 2022, 19, 840, https://doi.org/10.3390/ijerph19020840

This list is also available here: https://www.euramet.org/repository/research-publications-repository-link/



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Summary

The key targets to be reached by the end of this project (and to be exploited in the 5 years that follow the end of the project) are as follows:

- **New SI traceability** for measurement quantities used in climate observation and radiation protection;
- **New customer calibration services** for new types of measurement and new types of device. To develop a first standard protocol for the application of the radon tracer method (RTM) to enable retrieval of greenhouse gas fluxes at atmospheric climate gas monitoring stations and to use radon flux data for the identification of Radon Priority Areas (RPA);
- To **validate current radon flux models and inventories** by the new traceable measurements of radon activity concentration and radon flux. To support the validation with dosimetric and spectrometric data from the radiological early warning networks in Europe;
- To provide easy to use **dynamic radon and radon flux maps** for climate change research and radiation protection in line with Council Directive 2013/59/EURATOM, including their use to identify RPA and radon wash-out peaks;
- To facilitate the **take up of the technology and measurement infrastructure**.

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Thanks…

… to the traceRadon-project partners:

… to the traceRadon-project collaborators:

… to the traceRadon-project Stakeholder Committee, Stakeholders, MSU, EURAMET,

… and for your attention!