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

Introduction to traceRadon

Scientific Workshop: EMPIR 19ENV01 traceRadon 20th October 2020

This project 19ENV01 traceRadon has received funding from the EMPIR programme co-financed by the Participating States and from the European Union's Horizon 2020 research and innovation programme.

***19ENV01 traceRadon** denotes the EMPIR project reference.*

Annette Röttger, Coordinator of 19ENV01 traceRadon Scientific Workshop

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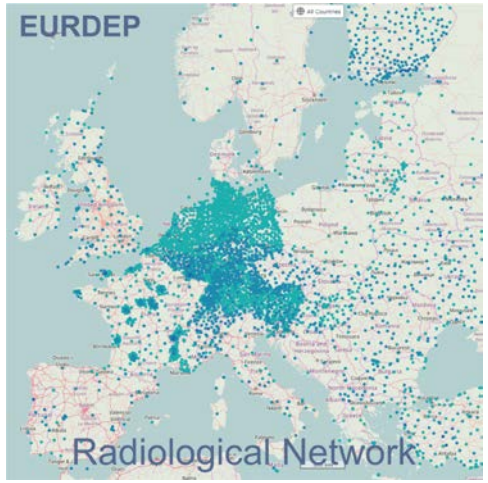

Climate change is one of the greatest challenges of our time.

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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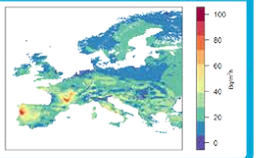
EURAMET

Traceability to the SI system

Radon and radon flux in maps for radiation protection issues — WP4

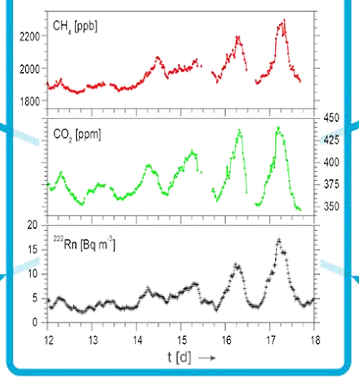
- Identification of RPA
- Quantifying the radon wash-out peak
- Data accessibility and public engagement



Validation of radon flux models and inventories using radon flux and terrestrial data — WP3

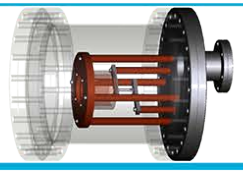
- Radon flux maps in GHG and climate change studies
- Inclusion of data from radiological early warning systems
- Validation of radon flux maps using radon flux measurements and outdoor radon activity concentrations

$$j_{CH_4} = j_{Rn} \cdot \frac{\Delta c_{CH_4}}{\Delta c_{Rn}}$$



Traceable measurements of outdoor radon activity concentrations — WP1

- Traceable low-level radon sources
- Development of a transfer standard
- Calibration and long-term stability

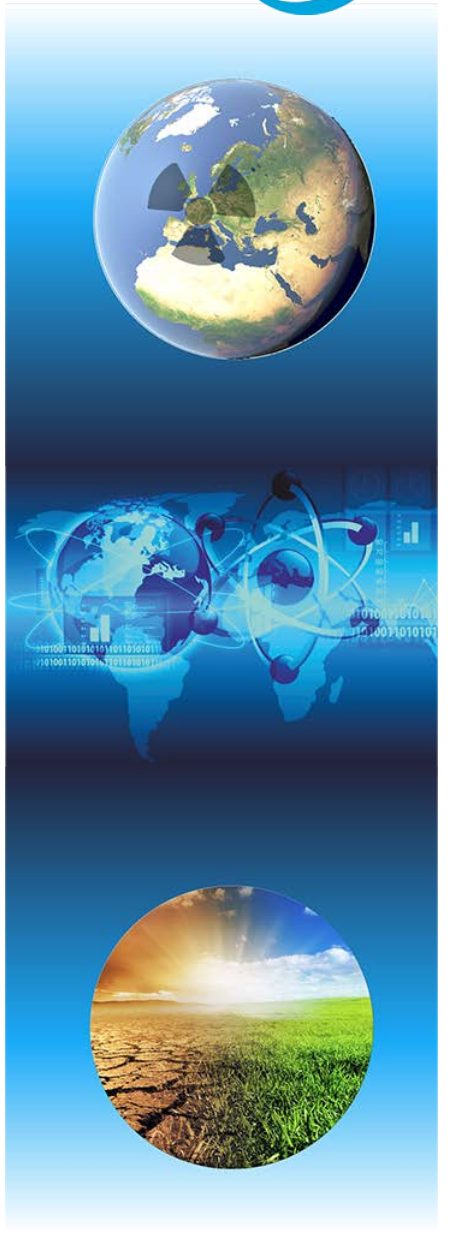


Radon flux measurements — WP2

- Development of a reference radon flux monitor
- Test under field conditions
- Measurement campaigns
- RTM application

Management and coordination — WP6

Seven leading European NMI/DI in the field of climate observation and ionising radiation. ICOS, JRC and other stakeholders directly involved as JRP-partners. Sufficient further external partners with high-level expertise to cover the broad spectrum of two scientific communities. High interest by stakeholder community, expressed by 65 letters of support and a large group of 34 potential collaborators.



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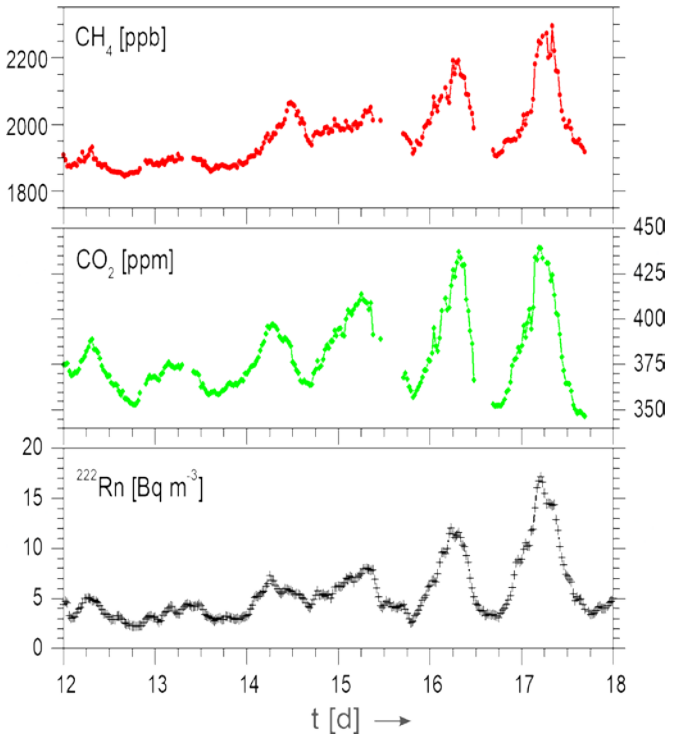
Why is Radon an issue in **climate observation**?

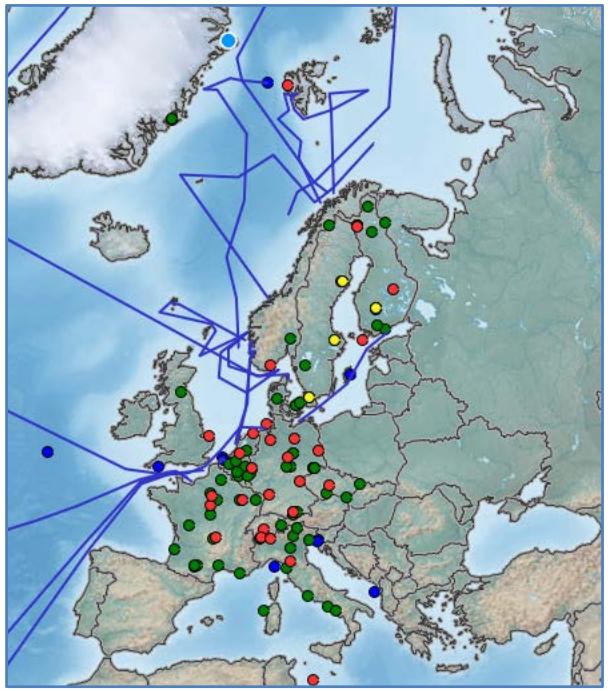
- GHG **flux measurements** are difficult though GHG concentration measurements are established.
- With radon activity concentration and radon flux measurements GHG fluxes can be **traced**!



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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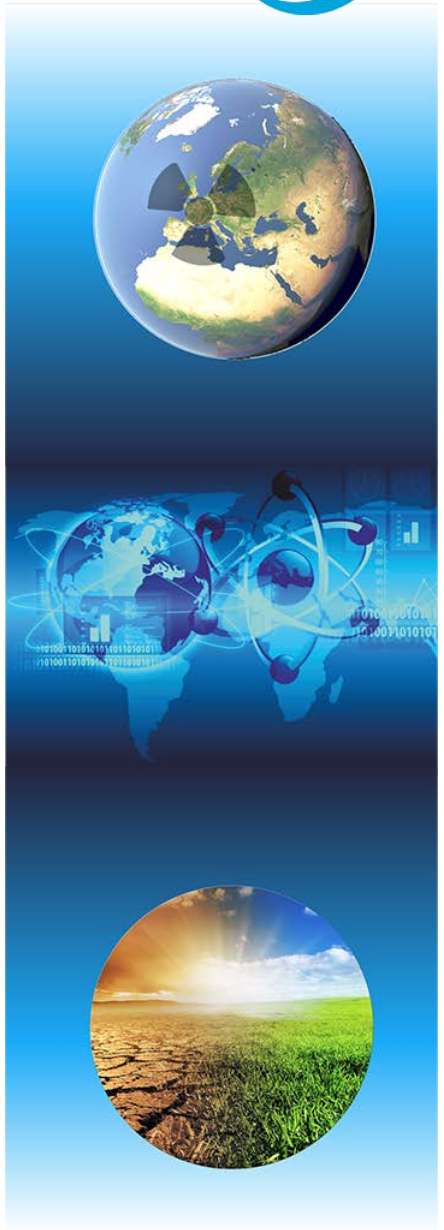
1. To develop traceable methods for the measurement of **outdoor low-level radon activity concentration** in the range of **1 Bq m^{-3} to 100 Bq m^{-3}**, with uncertainties of **10 % for k = 1**, to be used in climate monitoring (…) .
2. To develop the capability for traceable **radon flux measurements in the field**, based on the development of a radon exhalation reference system “exhalation bed” and a transfer standard (…) .

Flux ⟷ Concen-tration

$$j_{\mathrm{CH_4}} = j_{\mathrm{Rn}} \cdot \frac{\Delta c_{\mathrm{CH_4}}}{\Delta c_{\mathrm{Rn}}}$$

3. To **validate current radon flux models and inventories** by the new traceable measurements of radon activity concentration and radon flux (…).



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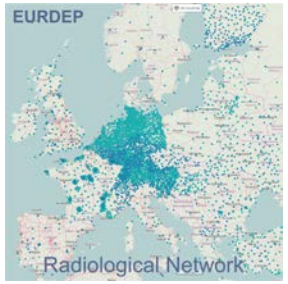
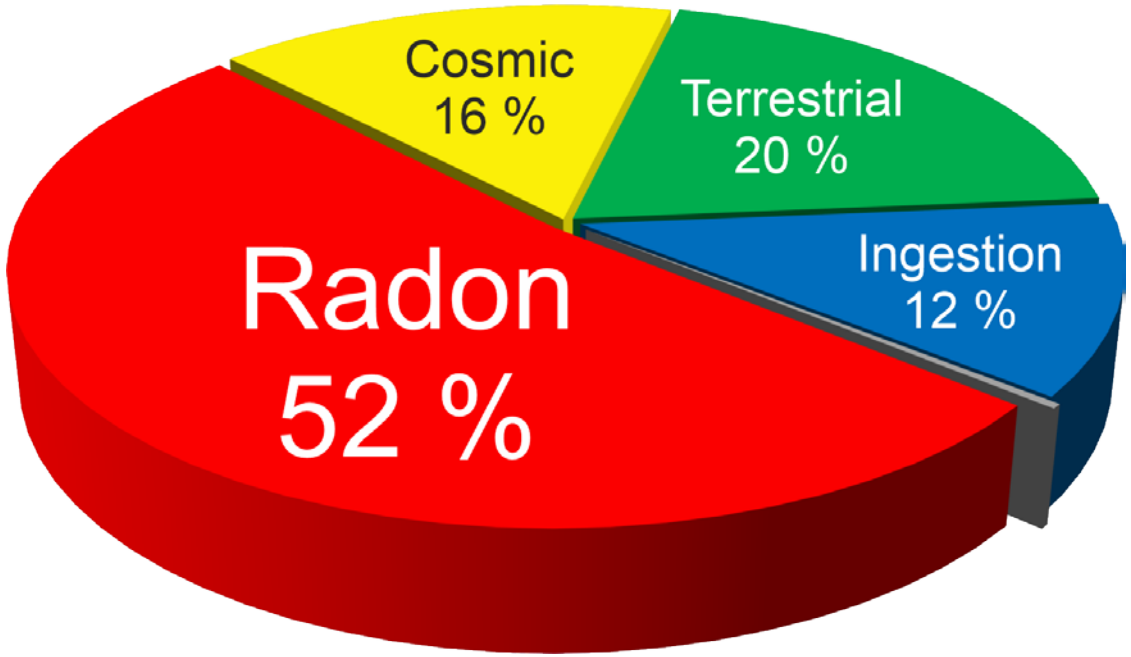
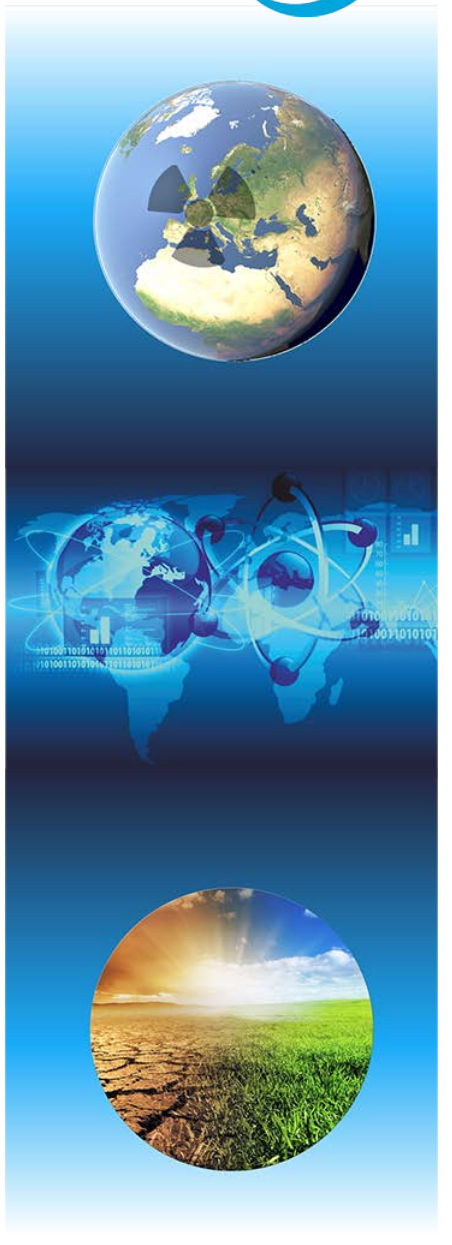


1. To develop traceable methods for the measurement of **outdoor low-level radon activity concentration** in the range of **1 Bq m^{-3} to 100 Bq m^{-3}**, with uncertainties of **10 % for k = 1**, to be used in climate monitoring (…).
2. (…).
3. (…) To support the validation with dosimetric and spectrometric 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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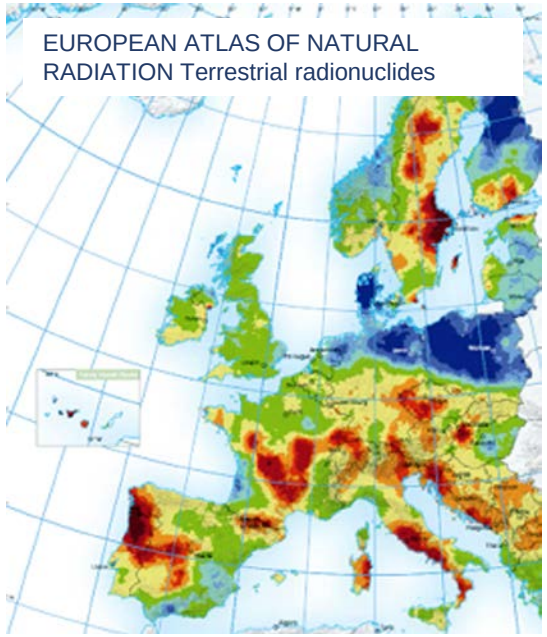
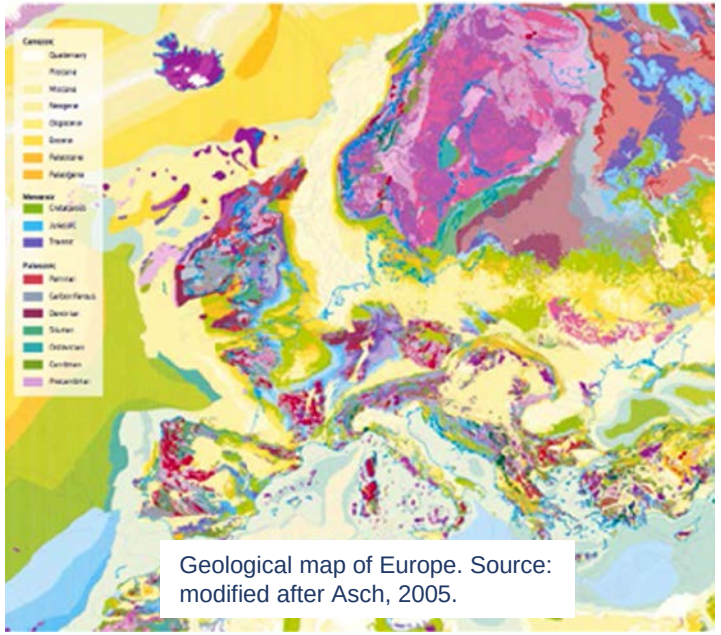
Static maps:

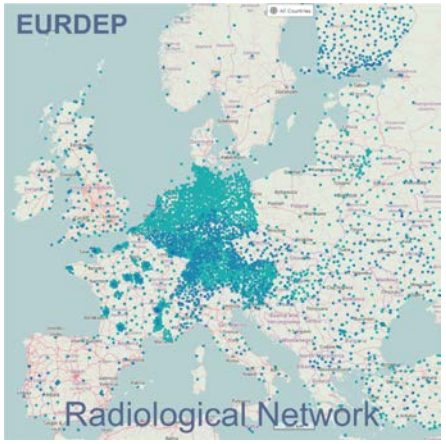


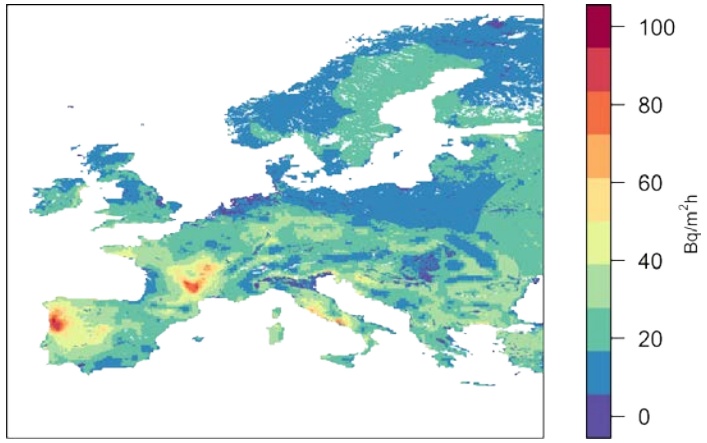


Geological map of Europe. Source: modified after Asch, 2005.

Dynamic maps:

The early warning network shows online data for the dose rate. But **outdoor radon concentration** or even better online data on **radon flux** (emission) is missing!





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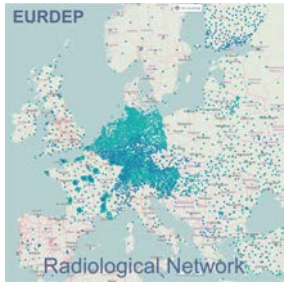
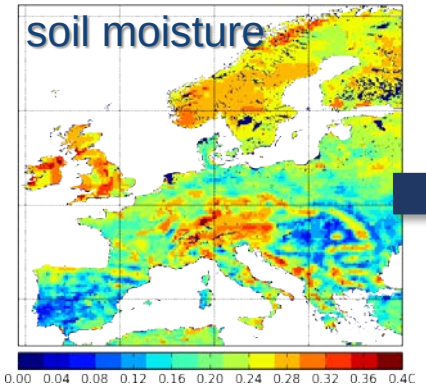
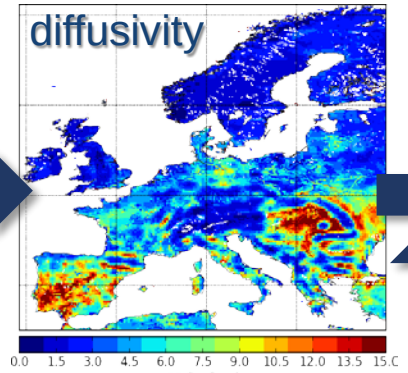
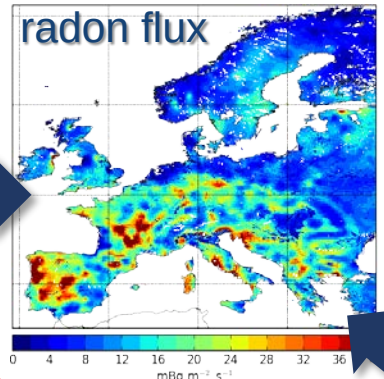
Our task: Joining forces in the field of radon



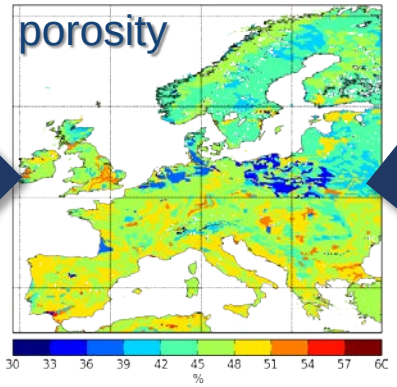


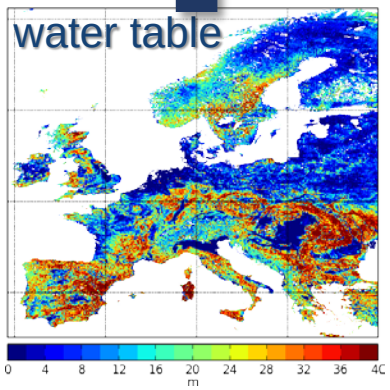


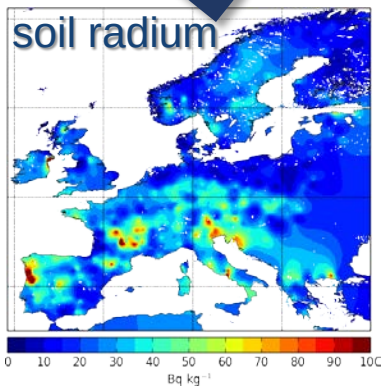


soil texture
% clay
% sand
% slit

bulk density







based on Karstens et.al. 2015

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traceRadon serves the purpose to establish a **metrological base** which supports environmental **outdoor radon measurements** for the use in climate observation and in radiation protection for the public.

- Development of traceable methods for the measurements of outdoor low-level radon activity concentration in air in the range of 1 Bq/m³ to 100 Bq/m³ (WP1)
- To improve radon flux measurements for RPA and to develop standard protocols for radon tracer method to retrieve GHG fluxes (WP2)
- To validate existing radon flux inventories and models with new data from the radiological early warning networks in Europe as well as traceable radon activity concentration and radon flux measurements (WP3)
- To provide dynamic radon and radon flux maps (WP4)
- To facilitate the take up of the technology and measurement infrastructure developed in the JRP (WP5)

traceRadon will provide the **metrology for the growing radon measurement needs** for different purposes that influence all parts of modern society and facilitate the use of this data in industry, scientific communities, standard organisations and all kinds of end users like decision makers or the public.

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Deliverables of traceRadon:

1. Calibration method for the creation of a temporally consistent **Rn-222 atmosphere below 100 Bq m^{-3}** with uncertainties of 10 % (k=1) (…)
2. Calibration **procedure** for the traceable measurement of atmospheric Rn-222 activity concentration **in the field** (…)
3. Validation report for the use of a calibrated **radon flux Transfer Standard** (TS) to calibrate radon flux measurement systems, including guidelines for the installation, calibration and operation of the radon flux monitor
4. Good Practice Guide including a standard protocol for the **measurement of radon flux and atmospheric activity concentration** for application in the **radon tracer method (RTM)** (…)
5. Summary report on online available **process-based radon flux maps** with high temporal (daily) resolution
6. Report on the **intercomparison** and validation of radon flux maps and inventories using radon flux measurements (…)
7. Summary report on methodology for **the characterisation of RPA** including outdoor radon and radon flux data
8. Summary report on **methodology** for estimating the **radon wash-out peak in the gamma dose rate**

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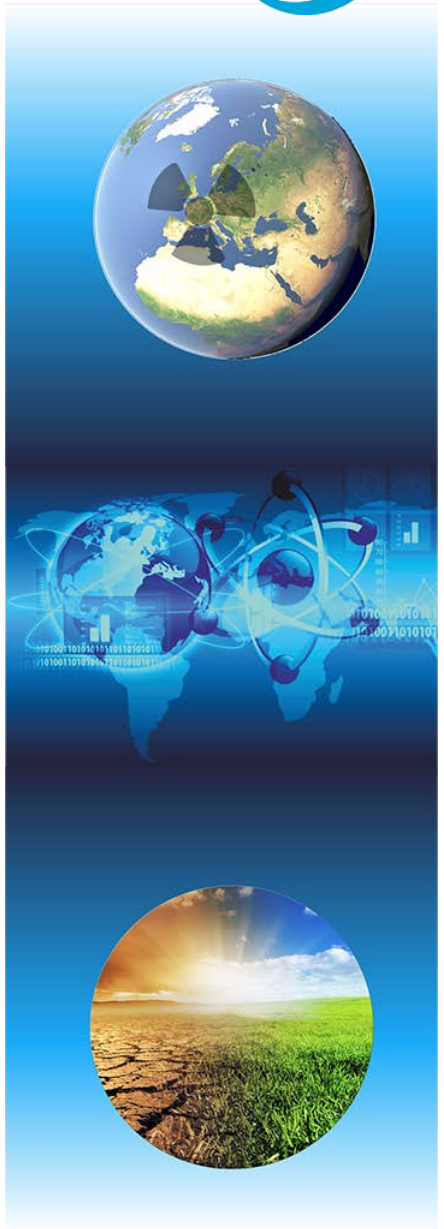
Bringing scientific achievements together for the benefit of two large Stakeholder groups:

- **Climate research** and **radiation protection research** needs support of traceable low-level outdoor radon measurements according to the needs of UNFCCC and the Council Directive 2013/59/Euratom.
- Radon and radon flux data is needed to estimate regional GHG emissions fluxes and radon priority areas (RPA) but the uncertainties are too large due to missing metrological capabilities.
- Working on the distinction from anthropogenic and natural GHG emissions!



This presentation includes material from publications / presentations from partners and collaborators of the EMPIR 19ENV01 traceRadon project.
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