Integrated non-CO_2 Greenhouse gas Observing System

InGOS – Integrated non-CO_2 Observing System

1. Radon flux and soil measurements in Egham

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Project duration:
16.9.2013
1 working day

Infrastructure:
The equipment which is necessary for the measurements is shipped from Heidelberg to Egham. After the measurements it will be shipped back again.
For reaching the different measurement sites in Egham, we will need a car.

2. Background

The radioactive noble gas radon-222 can be used as tracer for various processes in the soil and atmosphere.
Atmospheric radon concentration measurements are used for estimating the height of the atmospheric boundary layer and the origin of air masses. In this way they can help to understand the variation of atmospheric greenhouse gas concentrations better.
Soil radon concentration and flux measurements can on the one hand be used for the parameterization of fluxes of other gases from the soil to the atmosphere. On the other hand the soil radon flux is important as the source term for the atmospheric radon inventory.

Up to know many models for atmospheric radon concentration used a constant radon flux from the soil of 1 atom/(cm^2 s) ([1], [2]) or assumed a northwards decreasing radon flux ([2], [3]).
Since these assumptions are not very satisfying for modern atmospheric models, more detailed information about the radon flux in different regions is necessary. Ingeborg Levin, my supervisor, and Ute Karstens are therefore working on a more detailed radon flux map for Europe.

This map is based on the uranium content of the soil which is received from the geochemical atlas of Europe [4]. From the uranium content the content of radium-226, the parent nuclide of radon-222, can be calculated. Moreover, the grain size distribution, the porosity and the changing soil moisture of the single soils are considered in the map.
In order to have validation data for this map, I am doing radon flux and soil measurements at various locations as part of my master's thesis. At our test site near Heidelberg, the temporal evolution of the radon flux, which is due to the changing soil moisture content, is investigated.
In addition, I am also doing measurements at different sites in Europe to have more spatial information about the radon flux. To have a direct benefit from this measurement campaign, locations where the atmospheric concentration of radon is already measured were chosen. Thus, the results of the measurements can be directly applied for a better understanding of the changes in the atmospheric concentration of radon.

3. Objectives

The objective of the measurements is to have more validation data for the radon flux map, which is produced from Ingeborg Levin and Ute Karstens. Information about the radon flux and the soil composition from different soil types in different regions can help to check, whether the different inputs (radium content of the soil, grain size distribution, porosity and soil moisture) for the radon map are adequate or not.
The station in Egham is equipped with a radon monitor that measures the atmospheric radon concentration. In this way the results of the radon flux measurements can be directly used for a better understanding of the fluctuations of the atmospheric radon concentration at the station in Egham.

For the measurements, flux chambers for measuring the radon flux are used and soil samples are taken for analyzing the property and the composition of the soil. More detailed information to the measurement procedure is given in chapter 4.

4. Methods and materials (legal and ethical issues)

a. Radon flux measurements:
   For the radon flux measurements, two quadratic metallic frames (length: 50 cm, height: 25 cm) are used. These two frames are put ca. 5-10 cm deep in the soil. For the measurements, the frames are closed with a metallic cover. Radon diffuses from the soil into the "chamber" (frames + cover) and the radon concentration increases. After half an hour an air sample is taken from the chamber and is analyzed for its radon concentration in the laboratory. From the concentration,

the time of sampling and the volume of the "chamber" the radon flux can be calculated.

b. Radium concentration measurements:
A soil sample is taken with a core cutter and divided into pieces. Afterwards it is dried in the laboratory and analyzed for its radium content with gamma spectroscopy.

c. Soil moisture content and porosity:
A soil sample is taken with a core cutter with known volume. It is weighted and then dried in an oven. After drying, it gets weighted again. From the mass difference, the moisture content of the soil can be calculated.
Furthermore, the porosity of the soil can be known by measuring the grain density of the soil sample.

d. Grain size distribution:
A representative soil piece is analyzed for its grain size distribution. After destroying the organic carbon and removing the calcium carbonate, the soil sample is dried in an oven. With sieves with different sizes the single grain fractions are separated.

All the measurements in Egham do not require electricity and can be done without machines. The permit to the sites is provided by the staff from the Department of Earth Science in Egham (contact: Rebecca Fisher).

5. Implementation: timetable, budget, distribution of work

Table 1: Time table of the measurements. There are three different sites, where the measurements will be done.

	Radon flux	Radium concentration	Soil moisture and porosity	Grain size distribution
Number of measurements	4 at each site	1 at each site	2 at each site	1 at each site
Duration	30 min. per measurement	15 min. per measurement	15 min. per measurement	15 min. per measurement

The soil samples can be taken during the radon flux measurements. If no unexpected problems arise, the whole sampling procedure can be done within one day.

Table 2: Budget overview

Issue	Amount	Comment
Train tickets Heidelberg-London and back	196 €	
Shipment of the equipment from Heidelberg to Egham	75 €	
Shipment of the equipment from Egham to Heidelberg	75 € (expected)	Not yet fixed
Accommodation in Egham and London (2 nights)	70 GBP (≈ 84 €)	
Sum	430 €	

No other specific needs are required.

6. Expected results and possible risks

The results of the measurements help to see whether the flux calculated from the radon flux map under various assumptions (radium concentration, pore size distribution, porosity and soil moisture) is in agreement with the directly measured radon flux. In this way, the direct radon flux measurements are a very important quality control for the radon flux map.
Moreover, the measured radon fluxes can provide useful information about the radon flux for the Egham atmospheric radon concentration measurements.

All measurements are done within the research for my master's thesis and will be part of my thesis.

7. Key literature

[1] Turekian K. K. et al.; Geochemistry of atmospheric radon and radon products, Annu. Rev. Earth Planet. Sci., 5, 1977, 227-255
[2] Robertson L.B., et al.; Test of a northwards-decreasing 222Rn source term by comparison of modelled and observed atmospheric 222Rn concentrations, Tellus, 57B, 2005, 116-123
[3] Conen F. and Robertson, L.B.; Latitudinal distribution of radon-222 flux from continents, Tellus, 54B, 2002, 127-133
[4] Forum of European Geological Surveys (FOREGS), FOREGS Geochemical Atlas of Europe, 11.9.2013, http://weppi.gtk.fi/publ/foregsatlas