

European ²²²Rn flux map for atmospheric tracer applications

A first draft...

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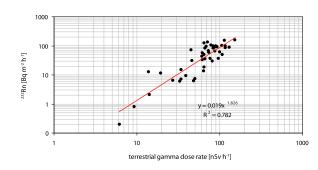
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Project description

Observations of atmospheric ²²²Rn are widely used in the evaluation of climate models simulating transport, transformation and removal processes of gases and aerosols. Used in inverse mode, these models can provide information on location, extent and strength of sources and sinks of greenhouse gases based on the measurement of changes in their atmospheric concentrations. Such models are validated using ²²²Rn as a tracer, assuming uniform flux from continents. We attempt to generate a spatially differentiated flux term. The approach is based on relating ²²²Rn flux to a widely measured proxy (gamma dose rate; Schery et al. 1998), for which spatial data is already available for the entire region of interest.

Source function

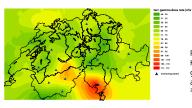
A source function is needed to describe ²²²Rn flux with terrestrial gamma dose rate. Simultaneous measurements of both parameters at Swiss field sites (MétéoSuisse) have been made. Additionally soil samples have been taken for a better description of outliers (e.g. soil texture, geology, radionuclides).



Correlation of terrestrial gamma dose rate and 222Rn flux. Almost 80% of the variation in 222Rn flux can be described by the variation of terrestrial gamma dose rate.

Gamma Ray Mapping

Gamma dose rates in Switzerland are monitored by NAZ (Swiss National Emergency Operations Center).



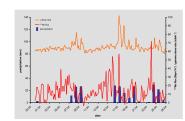
Kriging methods were used to establish a gamma dose rate map based on the available Swiss data as a base map for the 222Rn flux map.



137Cs map of Switzerland (Rybach et al., 2002), Cosmic and artificial parts can be subtracted from total gamma dose rate to obtain the terrestrial component.

Soil moisture & precipitation

Precipitation and gamma dose rate in Rünenberg (CH) in April 2005. Heavy rainfall leads to a temporary decrease of both parameters and increases with drver soil conditions.



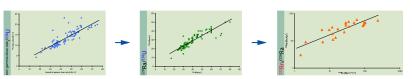
Soil moisture is the most influencing parameter of temporal variations

High soil moisture decreases diffusivity and ²²²Rn flux. It also shields part of the γ -rays. Thus, ²²²Rn and gamma dose rate vary simultaneously. Exceptions are the few hours immediately following rainfall when gamma dose rate is enhanced by deposition of ²²²Rn daughters. Therefore effects on soil moisture resp. rainfall events on ²²²Rn flux can

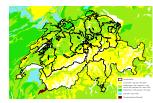
be assumed to be considered when using gamma dose data.

Soil & geological properties

The source of ²²²Rn is ²²⁶Ra, a radionuclide of the ²³⁸U decay chain. ²²²Rn diffuses through air filled pores in the soil to the surface. Air filled pore volume therefore is as important as the ²²⁶Ra content. Soil texture may be used as an approximation for soil porosity. The mother nuclide ²³⁸U is linearly linked to ²²⁶Ra, geological parameters are possible evidences for the ²³⁸U content.



Left: ²³⁸U dose rate is an almost constant part of the terrestrial gamma dose rate Middle: ²³⁶Ra and ²³⁸U content (data from SUER). ²²⁶Ra is directly linked to the 238U content in soils as a part of its decay chain. Right: 226Ra content and 222Rn flux of soils in Switzerland and Scotland (Robertson et al. 2002).



The soil texture map ("European Soil Database (v. 2.0), European Soil Bureau Network & European Commission," EUR 19945 EN) gives an approximation of the soil porosity.

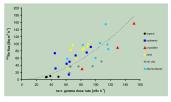
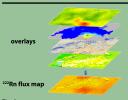


Fig. 7 A correction factor is needed to improve the model (e.g. sandy soils are underestimated whereas clay soils are overestimated with the established source function (dotted line, see also Fig. 1).

Swiss model for European 222 Ru map



This model will then be used to establish a 222Rn flux map for Europe as well as for the entire Russian Federation. The Swiss model will be validated now and improved. At regions of interest (Tall Tower Network, CHIOTTO) the ²²²Rn flux map must be thoroughly verified. The map will be finished no later than in 2007, a draft will be available by mid 2006.

All informations will be adapted as overlays that leads to the 222Rn flux map.

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References

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