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Predicting terrestrial ^{222}Rn flux using gamma dose rate as a proxy

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Abstract. ^{222}Rn is commonly used as a natural tracer for validating climate models. To improve such models a better source term for ^{222}Rn than currently used is necessary. The aim of this work is to establish a method for mapping this source term by using a commonly measured proxy, the gamma dose rate (GDR). Automatic monitoring of GDR has been networked in 25 European countries by the Institute for Environment and Sustainability at the Joint Research Centre (JRC IES) in Ispra, Italy, using a common data format. We carried out simultaneous measurements of ^{222}Rn flux and GDR at 63 locations in Switzerland, Germany, Finland and Hungary in order to cover a wide range of GDR. Spatial variations in GDR resulted from different radionuclide concentrations in soil forming minerals. A relatively stable fraction (20%) of the total terrestrial GDR originates from the ^{238}U decay series, of which ^{222}Rn is a member. Accordingly, spatial variation in terrestrial GDR was found to describe almost 60% of the spatial variation in ^{222}Rn flux. Furthermore, temporal variation in GDR and ^{222}Rn was found to be correlated. Increasing soil moisture reduces gas diffusivity and the rate of ^{222}Rn flux but it also decreases GDR through increased shielding of photons. Prediction of ^{222}Rn flux through GDR for individual measurement points is imprecise but un-biased. Verification of larger scale prediction showed that estimates of mean ^{222}Rn fluxes were not significantly different from the measured mean values.

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