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Simultaneous monitoring of soil radon concentration and gamma radiation in air

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Radon (Rn-222) is ubiquitous at the Earth's surface being generated within mineral grains by alpha decay from radium (Ra-226). Due to its recoil energy, radon is able to migrate into air or water filled interstices of the porous media and further escape into the atmosphere. Radon is therefore an appealing proxy for the investigation of surface-atmosphere interactions, since the exhalation of radon from the surface into the atmosphere is dependent on the many interacting factors (temperature, pressure, water content) influencing diffusive and advective transport processes in the pore space, while when airborne the radon concentration is dependent on the thermal and mechanical stability of the atmosphere.

For improving understanding on surface-atmosphere interactions, a short-term campaign for simultaneous measurement of soil radon concentration and gamma radiation was set-up at the SMEAR II station (Station for Measuring Ecosystem Atmosphere Relations) in Hyytiälä (Finland). The campaign took place from June to the end of November 2017, with support from ENVRIplus Trans National Access funding. The soil radon concentration was measured every 2-hours with a Si diode by direct counting of alpha particles from Rn-222, Po-218 and Po-214. Gamma radiation was measured every 5-minutes with a NaI(Tl) scintillator by total count of gamma rays in the energy range from 475 keV to 3 MeV, thus including both contributions from terrestrial radionuclides (K-40, U-238, Th-232) as well as radon progeny (Pb-214 and Bi-214). In addition to the radioactivity measurements from the campaign, routine meteorological and surface data from the SMEAR II station are considered including air pressure, temperature, wind, rainfall, snow, soil temperature, soil water content, runoff, drainage and soil heat flux.

The temporal variability of soil radon concentration during the monitoring period is characterized by stable values of about 2500 Bq/m3 in the summer, and large oscillations (> 2000 Bq/m3) in autumn (October and November). Gamma radiation displays a decreasing trend after mid-September, likely associated with increased soil water content, as well as very localized peaks in gamma count rates associated with precipitation events.