Numerical study on sorption kinetics affecting vertical profile of radiocesium in soil and air dose rates

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Despite its affinity for binding to soil, radiocesium gradually migrates deeper into the ground over time. This results in a faster rate of reduction of air dose rates than would be expected by radioactive decay. Field measurements of the activity profile of radiocesium with depth in soil generally show exponential-shapes, which are often followed by a long tail at large depths. The vertical migration of radiocesium in soil has been successfully reproduced with the modified Diffusion-Sorption-Fixation (mDSF) model, which is based on an advection-dispersion equation coupled with kinetic models of reversible/irreversible sorption. Using radiation transport methods, this study calculated the trajectory of air dose rates over time given the evolution in the depth profile predicted by the model. The results indicate a faster reduction in dose rates than the rate of radioactive decay in the first ten years following fallout, as there is a gradual migration of radiocesium in soil over this period. The rate of reduction of dose rates over the following years is then set by the rate of radioactive decay alone as the majority of the radiocesium has become fixed to the soil matrix.

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