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Non-Equilibrium Model of Multi-Phase Radionuclide Transport in Lake Water-Sediment System

The advanced implementation of the multi-phase model, which uses radioactive material as a contaminant, and the evaluation of parameter values are discussed in the work. A semi-analytical solution of the simulation of the contaminant transport dynamics in the lake water and one-dimensional sediment solute transport including non-equilibrium processes is presented. The model includes a concept of contaminant sorption dynamics in the lake water and sediment compartments, considering the specific porous structure of sediments, the contaminant material exchange between the liquid and solid phases of sediments. The key processes included in the model are sedimentation, resuspension, diffusive exchange of solute at the lake water-sediment interface and advection-diffusion in sediment solute. Special attention was paid to the contamination balance between the two spheres in the interface area. The ranges of boundary and initial conditions were extended and the final results were obtained using an accurate and robust numerical inversion calculation based on the De Hoog algorithm. Therefore, the model can be used in experimental measurements interpreting the contaminant profile in lake sediments as well as a part associated with the comprehensive determination of the volumetric activity in the estimation of irradiation doses due to radionuclides released into the lake water.

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