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Scavenging of radioactive gases due to adsorption by atmospheric nanoaerosols

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Abstract
We analyze an influence of radioactive decay and kinetic effects on the rate of trace gas scavenging due to adsorption by an ensemble of solid porous nanoparticles. When the size of a particle have the same order of magnitude as a mean free path, the Fickian diffusion approach for the analysis of reactant molecules transport is not applicable. We overcome this difficulty applying the flux-matching theory (see, e.g. Elperin et al. 2013). We employ a one-dimensional model of scavenging of radioactive gases by an ensemble of porous particles which is valid for uniform distribution of concentration of adsorbed gas inside particles. It is demonstrated that evolution of concentration of adsorbed gas inside particles is determined by an ordinary differential equation of the first order. Calculated temporal dependences of adsorbed amount of radioactive gas by particles are compared with experimental results of Naguchi et al. 1990 for gaseous Iodine-131 adsorption by carbon based atmospheric nanoaerosols. Theoretical predictions are in good agreement with experimental results. We also showed that when an approximation of uniform distribution of concentration of adsorbed gas inside particles is not valid, temporal evolution of concentration of an active trace gas in a gaseous phase is governed by an integro-differential equation.

Keywords: Radioactive gases; Scavenging; Gas adsorption; Atmosphere; Kinetic effects

References

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