Geophysical Research Abstracts
Vol. 16, EGU2014-16641, 2014
EGU General Assembly 2014

A coupled model of the airborne and surface concentration of radionuclides considering the resuspension-deposition process

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We propose a new model of estimating the long-term behavior of both the airborne and the surface concentrations of radionuclides in the vicinity of 30 km of Fukushima plant. Our model consists of the following simultaneous equations:

$$\frac{\partial C}{\partial t} = v_i \frac{\partial C}{\partial x_i} + \lambda_{up} S - \lambda_{down} C - \lambda_{dec} C \quad (1)$$

$$\frac{\partial S}{\partial t} = -\lambda_{up} S + \lambda_{down} C - \lambda_{env} S, \quad (2)$$

where C is the airborne concentration of a specific nuclide, S the surface concentration, the suffix i is 1 or 2 (2 dimensional), v the effective wind velocity which migrates the radionuclides in the air, λ_{up} the rate constant of resuspension process, λ_{down} of deposition process, λ_{dec} the decay constant, and λ_{env} is the rate constant of the surface concentration decrease due to environmental factors such as runoff, washoff, infiltrations, and the vegetation effects. These equations are based on our former study (Hatano and Hatano, 1997; Hatano et al., 1998) which successfully reproduce the long-term decrease of airborne concentration of the Chernobyl data such as Cs-137, Cs-134, Ce-144, and Ru-106 over nearly a decade. The first equation of the present study is essentially the same as our previous studies, besides that we added a new term for deposition. The second equation is newly added in the present study which describes the behavior of the surface concentration. In Fukushima case, we found that the radiation risk is much higher than the airborne concentration. That is why we add the second equation.

Since the new model requires parameter values of λs we need to estimate these values from actual data. In order to do so, we apply the method of inverse problem and thereby estimate the values. We also do the spectral analysis of the dose rate (mainly from Cs-137, -134) and study if it is possible to estimate the resuspended amount from the ground surface.