Japan Geoscience Union Meeting 2010
(May 23-28 2010 at Makuhari, Chiba, Japan)

AAS001-10 Room: 201B Time: May 28 11:30-11:45

Long-term prediction of radionuclides derived from the Chernobyl accident

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In those days, environmental problems are taken up as the societal issues. In the past time, the studies about material transfer were popular, but the term of the prediction is short because the purposes of the studies were emergency escape. Because some radio nuclides affect human being and ecological system for a long time, necessity of the long-term prediction is increasing. In addition, radionuclides have so high specificity in nature that they play the rolls of the diffusion behavior tracer when the contamination happened. So this study is important to get the primary knowledge about air diffusion behavior. This study also expects to make a contribution about other environmental pollutant. The following equation is the model for the long-term (more than 1 0 years) prediction of the air concentration at a fixed site.
$C(t)=A\exp(-Lt)t^{-4/3}$.
C (t) is the air concentration of a radionuclide at a fixed site and t is days after the accident. A and L are the parameters obtained from fitting. In the previous study, the fittings of this equation with measured data of Cs-137 within 1~3km from the contaminant source, the Chernobyl nuclear power plant, were successful. However, in exploratory analysis, the model was found to be unsuitable at distant sites from the reactor and the problem became apparent. The problem is that the predicted concentration is decreasing from the time at some distant sites. This problem is that L (L is the primary reaction factor such as radioactive decay, vegetation uptake and run off, etc) became a negative number. When L is a negative number, the equation indicates that a radio nuclide continues to be released from the environment. The long-term environment uptake of the radionuclide changes to release is an impossible case when release of the radionuclide was only the Chernobyl accident. For this reason, this model cannot express actual air diffusion behavior in case of a large-scale prediction. Therefore, we propose the following long-term prediction model in this study.
$C(t)=A\exp(-L_{decay}t)t^{-m}$
where t is the days since the accident, and L_{decay} is the physical decay. The parameter A corresponds to the initial concentration at the particular point, and the parameter m is the sum of kinetics removing nuclides from vegetation uptake, run off, etc. In the fitting process, the parameters A and m were estimated from the measured data. Whereas the quantity of radionuclides removed by the environment is time-independent in the previous model, that quantity is considered to decrease by time.
To suggest the predictive ability of the formula, the present model is compared with the measured data. As a result, fittings with the measured data of Cs-137 within 30 km from the contaminant source are successful. In addition, fittings with the measured data of Sr-90, Ru-106 and Ce-144 are also successful. From the values of the parameters A and m obtained by fittings, it is found the relation between ln(A) and m is a positive correlative relationship. That is the more quantity of the radionuclide fall in the site, the faster the radionuclide is removed from the site. When the values of A of four radionuclides compare according to the sites, some sites make the value of A large relatively regardless type of the radionuclide. Therefore, it is found to that the speed of removing from the environment is various at sites. The difference of the speed for 10 years is considered

about 7 times tops. In addition, when values of A of four radionuclides compare according to their types, some types make the value of A large relatively regardless sites. It can be said the radionuclide whose speed of removing from the environment is fast can distinct from other radionuclides. The difference of the speed for 10 years according to types is considered about 90 times tops. In this study, it is found that the speed of removing from the environment differs greatly with location and the type of radionuclide.

Keywords: radionuclide, air pollution, long-term prediction, Chernobyl, power-law