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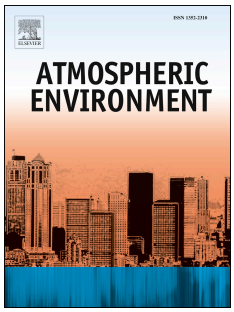

Stochastic model for the fluctuations of the atmospheric concentration of radionuclides and its application to uncertainty evaluation

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PII: S1352-2310(14)00978-9

DOI: 10.1016/j.atmosenv.2014.12.030

Reference: AEA 13480

To appear in: *Atmospheric Environment*

Received Date: 7 July 2014

Revised Date: 12 December 2014

Accepted Date: 13 December 2014

Please cite this article as: Ichige, H., Fukuchi, S., Hatano, Y., Stochastic model for the fluctuations of the atmospheric concentration of radionuclides and its application to uncertainty evaluation, *Atmospheric Environment* (2015), doi: 10.1016/j.atmosenv.2014.12.030.

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Atmospheric Environment
Manuscript Draft

Title: Stochastic model for the fluctuations of the atmospheric concentration of radionuclides and its application to uncertainty evaluation

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Keywords: Chernobyl, risk assessment, stochastic process, time-series analysis, radionuclide

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Abstract:
We propose a new model of the atmospheric concentration of a radionuclide with the inclusion of fluctuations of the concentration. The model is a stochastic differential equation and we derive the analytic solution of the equation. The solution agrees very well with the Chernobyl Cs-137 data. The advantage of the model is that the uncertainty in radiation exposure risk, with regard to the concentration fluctuations, can be quantitatively estimated. We show the range of fluctuations of $\pm\sigma$, $\pm2\sigma$, $\pm3\sigma$ in the 10-year measurement of the atmospheric concentration in Chernobyl and confirmed the validity of the model.

1. Introduction

In major nuclear power plant accidents, such as Chernobyl or Fukushima, a huge amount of radionuclides have been released into the atmosphere. In such accidents, long-lived radionuclides, cesium-137 and strontium-90, for example, pose a serious problem. Radionuclides carried in the initial plume were deposited on the ground, and they keep imposing a risk to the public health for a long period of time. In the Chernobyl case, it is believed that the resuspension-deposition cycle contributes significantly to the airborne concentration of radionuclides (Klug et al., 1992; Ishikawa, 1995; Nicholson, 1998; Ould-Dada and Nasser, 1992). Since the resuspended nuclides make the atmospheric concentration increase, it is considered one of the most important processes in the long-term radiation risk assessment. In this accident, health effects on the humans, such as leukemia and genetic abnormalities have been confirmed (IAEA, 2006; Arkhipov et al., 1994; Lazjukd et al.,

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