Investigation on distribution of radioactive substances in Fukushima (9) Analysis of temporal changes in ambient dose equivalent rates in forests over 6 years following the FDNPP accident

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Abstract

We analyzed changes in ambient dose equivalent rates ($\dot{H}$*(10)) between 2011 and 2017 in forests in Fukushima Prefecture. PHITS was used to calculate the effect of re-distribution of ^{134}Cs and ^{137}Cs over time within forests on $\dot{H}$*(10). Transfer of radiocesium from the crowns of evergreen coniferous trees to the forest floor appeared to cause slower declines in $\dot{H}$*(10) at 1 m height initially after March 2011 than expected by the rate of radiocesium decay.

Keywords: forest, environment, ambient dose equivalent, radiocesium, ^{134}Cs, ^{137}Cs, FDNPP accident, PHITS, Monte Carlo, simulation

1. Introduction

Ambient dose equivalent rates ($\dot{H}$*(10)) have been observed to decrease more slowly in forests than in other areas since the 2011 Fukushima Daiichi Nuclear Power Plant (FDNPP) accident [1]. Moreover, between 2011 and 2013, $\dot{H}$*(10) at 1 m above the ground in some forests decreased slower than the rate of radioactive decay of the radiocesium fallout [2]. The reasons for this behavior were examined by using radiation transport simulations.

2. Methods

Forests in Fukushima Prefecture monitored by FFPRI [3] were modelled with the PHITS code [4]. We calculated the contributions to $\dot{H}$*(10) at 1 m above the ground from ^{134}Cs and ^{137}Cs in the canopy, trunks, organic layer, and soil layers separately. The results were compared to $\dot{H}$*(10) measurements from hand-held survey meters.

3. Results

Yearly fluctuations in the measured ^{134}Cs and ^{137}Cs inventories in forests meant the inventories had to be normalized to a common baseline to understand the effects of re-distribution of ^{134}Cs and ^{137}Cs within forests on $\dot{H}$*(10). The results show that changes in the distribution of ^{134}Cs and ^{137}Cs on the centimeter scale within the organic layer and soil affect the temporal trends of $\dot{H}$*(10) in forests.

4. Conclusions

The slower decreases in $\dot{H}$*(10) in forests compared to other land uses was a consequence of the high retention of ^{134}Cs and ^{137}Cs by forests, and the tendency of ^{134}Cs and ^{137}Cs to remain near the top surface of forest soil. Radiocesium transfer from the crowns of evergreen coniferous trees to the forest floor explained a slower rate of decline in $\dot{H}$*(10) between 2011 and 2013 than expected by the rate of radioactive decay.

References

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