F-TRACE Project (15): Tool for calculating air dose rates from arbitrary radiocesium depth profiles and spatial distributions for Fukushima Prefecture

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Air dose rates across Fukushima Prefecture are determined by the spatial distribution and depth profile of radiocesium in soil. We have developed a tool to model these variables and predict dose rates. Overall the predictions correlate well with measurements from within the Prefecture. Individual predictions are on average within 50% of the measurements.

Keywords: air dose rate, ^{134}Cs, ^{137}Cs, soil activity, gamma, simulation

1. Introduction

To understand future changes in dose rates in Fukushima Prefecture and the performance of decontamination, it is necessary to understand the relationship between the radiocesium distribution within the environment and the air dose rate.

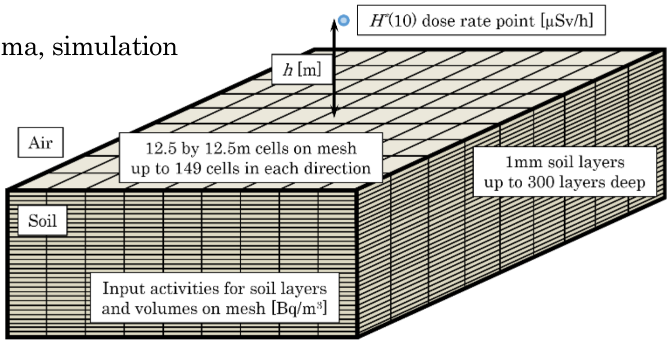

Fig. 1: Tool to model activity distribution and predict $H^*(10)$.

2. Methods

The tool splits the ground up into numerous volumes of soil. The ^{134}Cs and ^{137}Cs activity concentration is entered for each volume of soil – Fig. 1. Conversion factors derived with the PHITS Monte Carlo code [1] are multiplied by each of the activities to find the contribution of γ-rays from that volume of soil to the air dose rate. The tool was used to make predictions for the air dose rate by inputting soil activity measurements from Fukushima Prefecture [2]. The predicted dose rates were compared against dose rates measured in the field with handheld survey meters.

3. Results and Conclusion

The predictions correlate well with the measured dose rates from uncontaminated (~0.05 μSv/h) to highly contaminated (~20 μSv/h) land – Fig. 2. In the worst cases individual predictions were a factor of three higher or lower than the measured dose rates. These errors were mainly caused by the uncertainty in using a small soil sample to represent the activity of the large volume of soil that contributes to the dose rate. More accurate predictions were obtained by modeling spatial variations in the Cs distribution than assuming a uniform distribution. It is possible to use modeling methods like this to calculate the effects of decontamination and changes in $H^*(10)$ due to Cs migration in soil.

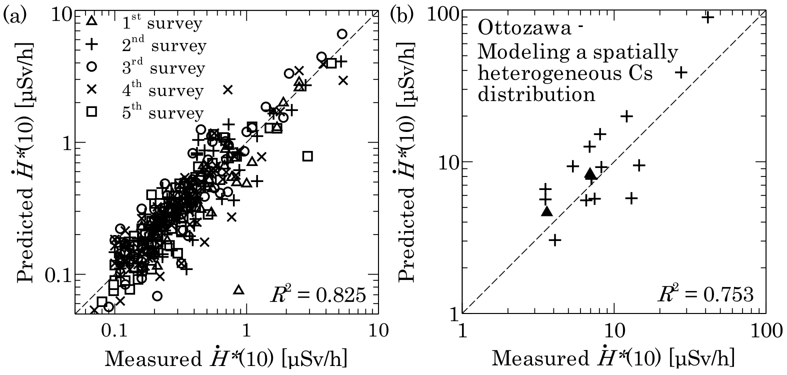

Fig. 2: (a) Predictions for dose rates from soil samples taken within 100 km of Fukushima Daiichi. (b) Model taking into account spatially varying Cs activity distribution at Ottozawa.

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[1] T. Sato et al. 2013. Particle and Heavy Ion Transport code System… *J.Nucl. Sci. Technol.* 50(9) 913-923.

[2] N. Matsuda et al. 2015. Depth profiles of radioactive cesium in soil… *J. Environ. Radioactiv.* 139 427-434.