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Altitude dependent radioactive contamination in the mountain area of Tochigi and Fukushima prefectures

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Introduction

During the accident of Fukushima Dai-ichi Power Plant (FDNPP), the discharged radionuclides into the air were transported to the wide area of Eastern Japan and contaminated land and marine environments. For the plain areas where most population resides, the horizontal distribution contamination has been surveyed intensely. On the other hand, in the mountain areas where less populated, the studies were limited. Airborne surveys conducted by the Ministry of Education, Culture, Sports, Science, and Technology, have mapped the contaminated are in Eastern Japan widely, but the obtained horizontal resolution is relatively low, i.e., the horizontally averaged value from a diameter ranging between 300 and 1,500 m underneath the aircraft.

We measured the altitude and horizontal distribution of ambient gamma dose-rate (GDR) in mountain areas of Tochigi and Fukushima prefectures on foot by use of a portable gamma ray detector carried along. With the results, the contamination patterns are categorized and the possible mechanisms that formed them are proposed.

Results and Discussion

Instrumentation used in the survey is described in Kaneyasu and Hososhima (2015). According to the altitudinal distribution of ambient GDR and the location where the contamination is intense, we classified the contamination pattern into four categories.

[Type A] In Nikko-Kirifuri mountainous area, ambient GDR distributions have same altitudinal pattern showing the maxima around 900-1400 m (ASL). In particular, sharp peaks were observed at approx. 1,040-1,080 m ASL at Mt. Nakimushi-yama, Kirifuri Highland, Mt. Gassan, and Mt. Bizen-tateyama. This area is about 20km in width and located approx. 120 km north of the central part of Tokyo and 160 km southwest of FDNPP. The variance of GDR is large at the GDR peaks. A hypothesis on the formation mechanism is presented in the separate presentation in the oral session (Kaneyasu and Hososhima, 2015).

[Type B] In Aso-Maenikko mountain area, the altitudinal distribution pattern of GDR is vague and showed constant value with small variance.

[Type C] In Mt. Takahata-yama and Mt. Gonta-kurayama (located in the southern end of Oh-u mountain range), the contamination intensity was intermediate, and any particular altitudinal distribution pattern was not observed.

[Multiple types integrated and other formation mechanism] In Abukuma mountain range, which is located closer to the FDNPP, several patterns are identified. Sharp peaks in the altitudinal distribution of GDR exist in Mt. Kamakura-dake and Mt. Yomogida-dake (Type A). The mountain ridge between Mt. Kittoya-san Mt Futatsuya-san, significantly high GDR values were observed (similar to Type A). However, the south-southwest face of Mt. Futatsuya-san (the opposite side from the FDNPP), the GDR was smaller one order of magnitude than the ridge and had constant values with small variance (Type B). In the other mountains in Abukuma mountain range, the ridge of the mountains were often contaminated intensely. In some mountains, Type A contamination were observed with an additional contamination localized in the upper part of valleys.

Simple dichotomy paradigm of dry and wet deposition is not enough to explain the formation of these various types of distribution. We presume that Type A is caused by cloud/fog deposition (Kaneyasu and Hososhima), Type B is the result of dry deposition, and Type C is formed by wet deposition. In Abukuma mountain range, where is close to the FDNPP, the integration of Type A, B, and C may have occurred in many mountains due to the arrivals of several waves of radionuclides in the form of clouds, aerosol state (dry deposition), and precipitations, followed by the modification due to experiencing 'weathering effect'.

References

Kaneyasu, N. and Hososhima M. (2015), A new insight into the deposition mechanism of airborne radionuclides from the Fukushima accident, Proceedings of JpGU 2015.

Keywords: cloud/fog deposition, occult deposition, altitude dependent radioactive contamination, ambient gamma dose-rate

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