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Atmospheric Radionuclides from the FDNPP Accident-Four years' observations in Tsukuba, Japan and immediate resuspension

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The accident of Fukushima Dai-Ichi Nuclear Power Plant (FDNPP) of the Tokyo Electric Power Corporation arisen by the hit of great earthquake and tsunami in March 11, 2011, emitted abundant fresh radioactive material to the atmospheric environment. With 4-years' observation for the Fukushima radioactivity at the Meteorological Research Institute, Japan (MRI) the persisting resuspension has been observed. The resuspension seems still in difficulty to give forecast by computer modeling; the observations are indispensable bodies of the research even in the future.

As a primary approach, immediate re-suspension factors were roughly estimated with modeled deposition amounts by the first plume to the Kanto district and the observed minimum activity concentration between two plume events, i.e. Mar 17 09JST to Mar. 20 09JST, by assuming mass closure between re-suspension from the contaminated surface and outflow by horizontal advection and turbulence vertical mixing as follows:

$$\frac{D_i k_i}{\Delta z} = U\frac{\Delta C_i}{\Delta x} + K_z\frac{\Delta^2 C_i}{\Delta z^2},$$

where i indicates radionuclides namely ^{137}Cs and ^{131}I, $D_i$indicates modeled total (gas+aerosol) cumulative deposition (Bq/m^2) by Mar 17 09JST, k_i is the re-suspension factor (/s), U and K_z are modeled space- and time- averaged horizontal wind speed (m/s) and vertical turbulent diffusivity (m^2/s), respectively, C_i indicates time-averaged observed concentration of radionuclides (9.75×10^{-4} and 3.14×10^{-1} Bq/m^3 for ^{137}Cs and ^{131}I, respectively), and Δx and Δz are horizontal and vertical length of space where the above mass closure is obtained. In order to obtain the horizontal and vertical gradient terms on the right hand of the equation, concentrations outside the space are assumed zero (no inflow to the space).

The re-suspension factors for ^{137}Cs and ^{131}I are 7.0×10^{-6} and 5.3×10^{-4} (/s), respectively, for the smallest volume of space (Δx and Δz are 3 km and 100 m, respectively). Those for ^{137}Cs and ^{131}I varied 1.6×10^{-6}–1.5×10^{-5} (6.1×10^{-6} on average) and 5.3×10^{-4}–1.3×10^{-3} (4.6×10^{-4} on average), respectively, for the various spaces of horizontally plus-minus zero, one, or two grids from the grid center (i.e. Δx = 3, 9, or 15 km) and vertically plus zero, one, or two grids from the bottom (Δz = 100, 200 or 400 m).

In summary, the immediate re-suspension factors for ^{137}Cs and ^{131}I are estimated in the order of 10^{-6}–10^{-5} (/s) and 10^{-4}–10^{-3} (/s) respectively and then that of ^{131}I is approximately two orders of magnitude larger than that of ^{137}Cs.