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Improvements and limitations on understanding of atmospheric processes of Fukushima Daiichi NPS radioactivity

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Understanding on the release of radioactivity into the atmosphere from the accidental units of Fukushima Daiichi Nuclear Power Station have been improved owing to recent analyses of atmospheric concentrations of radionuclide. Our analysis of gamma-ray spectra from monitoring posts located about 100 km to the south of the site revealed temporal changes of atmospheric concentrations of several key nuclides including noble gas Xe-133 in addition to radio-iodine and cesium nuclides, including I-131 and Cs-137, at a 10 minute interval. By using the atmospheric concentration data, in combination with an inverse atmospheric transport modelling with a Bayesian statistical method, a modification was proposed for the widely used Katata's source term. A source term for Xe-133 was also proposed. Although the atmospheric concentration data and the source terms help us understand the atmospheric transport processes of radionuclides, they still have significant uncertainty due to limitations in availability of the concentration data.

There still remain limitations in the atmospheric transport modeling. The largest uncertainty in the model is in the deposition processes. It had been pointed out that, in the 100 km range from the accidental site, there were locations at which the ambient dose rate significantly increased a few hours before precipitation detectors recorded the start of rain. According to our analysis, the dose rate increase was not directly caused by the air-borne radioactivity but by deposition. This phenomenon can be attributed to a deposition process in which evaporating precipitation enhances efficiency of deposition even in a case where no precipitation is observed at ground level.