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Release rate estimation of both long- and short-lived radionuclides for the Fukushima Daiichi nuclear accident based on local-scale observations

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Many efforts have been devoted to estimate the release rate of the radionuclide emission in the Fukushima Daiichi nuclear accident using regional scale observations. Because of the radioactive decay, regional scale observations may not provide information of short-lived radionuclides, which contributes the majority of radiation exposure in the early stage. In this study, the local-scale gamma dose rates data were used to estimate the atmospheric release rates of both long- and short-lived radio nuclides.The proposed method uses reactor physics to obtain an a priori radionuclide composition and a reverse source term estimate as an a priori release rate. A weighted additive model is developed, which uses the local-scale gamma dose rates to handle the conflicts between the two priors and to simultaneously incorporate them into the source inversion. The proposed method is validated against both the local-scale gamma dose rates and the regional concentration measurements of Cs-137. The results prove that the retrieved a posteriori source term combines the advantages of both priors and substantially improves the predictions of the on-site gamma dose rates. Given a detailed priori release rate, this approach also improves the regional predictions of both airborne and deposited Cs-137 concentrations.