Unsteady source term estimation of the Fukushima dai-ichi release using contributed radiological measurements

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A new methodology is presented for reconstructing the unsteady release rate of an atmospheric nuclear release using a Lagrangian atmospheric transport and dispersion (T&D) model, contributed concentration measurements, and stochastic search techniques. The methodology was applied to the reconstruction of the 2011 Fukushima nuclear release using an atmospheric T&D model and contributed radiation data from the Safecast citizen science project.
First, the Safecast contributed measurements were compared to official aerial surveys completed by the Department of Energy (DOE) and the National Nuclear Security Administration (NNSA) in 2011. It is shown that the Safecast data provides a reliable spatial estimation of radiation concentration when compared to official data.
Then a T&D model is run to simulate the nuclear release using high resolution terrain and meteorological data. The model simulates multiple sequential releases with a constant rate. The model values are decayed to the dates for which Safecast data are present, and an error is then computed between the observed and simulated concentrations. A statistical process is performed to find scalar multipliers that minimize the error between observed and simulated values.
The outcome of the optimization is the non-steady release rate concentration for the Fukushima nuclear release over land. This is because the release rate is estimated for primarily land-based data so the estimation does not include consideration for the plume of radiation that spread over the ocean. Environmental concerns and human impacts can be better addressed with long-term monitoring that confirms the prediction of models representing dynamic behavior of radionuclides dispersed in the environment.

Keywords: dispersion, radiation, fukushima, spatio-temporal analysis

