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Using meteorological ensembles for atmospheric dispersion modelling of the Fukushima nuclear accident

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Dispersion models are used in response to an accidental release of radionuclides of the atmosphere, to infer mitigation actions, and complement field measurements for the assessment of short and long term environmental and sanitary impacts. However, the predictions of these models are subject to important uncertainties, especially due to input data, such as meteorological fields or source term. This is still the case more than four years after the Fukushima disaster (Korsakissok et al., 2012, Girard et al., 2014).

In the framework of the SAKURA project, an MRI-IRSN collaboration, a meteorological ensemble of 20 members designed by MRI (Sekiyama et al. 2013) was used with IRSN's atmospheric dispersion models. Another ensemble, retrieved from ECMWF and comprising 50 members, was also used for comparison. The MRI ensemble is 3-hour assimilated, with a 3-kilometers resolution, designed to reduce the meteorological uncertainty in the Fukushima case. The ECMWF is a 24-hour forecast with a coarser grid, representative of the uncertainty of the data available in a crisis context.

First, it was necessary to assess the quality of the ensembles for our purpose, to ensure that their spread was representative of the uncertainty of meteorological fields. Using meteorological observations allowed characterizing the ensembles' spread, with tools such as Talagrand diagrams. Then, the uncertainty was propagated through atmospheric dispersion models. The underlying question is whether the output spread is larger than the input spread, that is, whether small uncertainties in meteorological fields can produce large differences in atmospheric dispersion results. Here again, the use of field observations was crucial, in order to characterize the spread of the ensemble of atmospheric dispersion simulations. In the case of the Fukushima accident, gamma dose rates, air activities and deposition data were available. Based on these data, selection criteria for the ensemble members were designed. Finally, the total uncertainty, including source term and model parameterization, was propagated through the model. Results were compared with the meteorological-induced uncertainty, and between the two sets of meteorological data.