EGU2020-7132
https://doi.org/10.5194/egusphere-egu2020-7132
EGU General Assembly 2020

Take one dispersing plume and add some precipitation: using ensembles to simulate deposition uncertainty

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In the event of an accidental airborne release of radioactive material, dispersion models would be used to simulate the spread of the pollutant in the atmosphere and its subsequent deposition. Typically, meteorological information is provided to dispersion models from numerical weather prediction (NWP) models. As these NWP models have increased in resolution their ability to resolve short-lived, heavy precipitation events covering smaller areas has improved. This has led to more realistic looking precipitation forecasts. However, when traditional statistics comparing precipitation predictions to measurements at a point (e.g. an observation site) are used, these high-resolution models appear to have a lower skill in predicting precipitation due to small differences in the location and timing of the precipitation with respect to the observations. This positional error is carried through to the dispersion model resulting in predictions of high deposits where none are observed and vice versa; a problem known as the double penalty problem in meteorology.

Since observations are not available at the onset of an event, it is crucial to gain insight into the possible location and timing errors. One method to address this issue is to use ensemble meteorological data as input to the dispersion model. Meteorological ensembles are typically generated by running multiple model integrations where each model integration starts from a perturbed initial state and uses slightly different model parametrisations to represent uncertainty in the atmospheric state and its evolution. Ensemble meteorological data provide several possible predictions of the precipitation that are all considered to be equally likely and this allows the dispersion model to produce several possible predictions of the deposits of radioactive material.

As part of the Euratom funded project, CONFIDENCE, a case study involving the passage of a warm front, where the timing of the front is uncertain in relation to a hypothetical nuclear accident in Europe was examined. In this study a ten-member meteorological ensemble was generated using time lagged forecasts to simulate perturbations in the initial state and two different model parameterisations. This meteorological ensemble was used as input to a single dispersion model to generate a dispersion model ensemble. The resulting ensemble dispersion output and methods to communicate the uncertainty in the deposition and the resulting uncertainty in the air concentration predictions are presented. The results demonstrate how high-resolution meteorological ensembles can be combined with dispersion models to simulate the maximum impact of precipitation and the uncertainty in its position and timing.