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Verification of long term micro-scale atmospheric dispersion simulation of radionuclide emission

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The German Federal Office for Radiation Protection (BfS) is obligated to report annually on the radiation exposure for the population through the emission of radioactive substances from nuclear facilities. First, based on the meteorological data of a nuclear site, the transport processes of the derived radioactive substances in the atmosphere are calculated using a dispersion model. Then a radio-ecological model is used to determine the radiation dose of the population caused by these emissions.

For the calculation of atmospheric propagation, BfS developed a Gaussian propagation model (Long-time Atmospheric dispersion of Radionuclides (LAR) and a Lagrangian particle model (Atmospheric Radionuclide Transport Modell, ARTM). Both models are optimized for the simulation of long-term dispersion properties by averaging out fine spatial structures of the plume, but differ in their concept. While LAR can only use averaged weather statistics for the considered period, ARTM allows a temporal evolution of the weather parameters. In addition, ARTM, in contrast to LAR, can take into account the influence of terrain and buildings, the temporal variation of important parameters such as the emission term as well as the plume rises, and furthermore the meteorological stability of the atmosphere.
As a result, the Lagrangian propagation simulation should yield a much more realistic image than the Gaussian model simulations, especially for time-dependent problems. The question however is, whether this statement is also valid for long-term simulations in which the finite spatial variation of the plume is smoothed out?

In this work, the influence of dispersion modeling on the activity concentrations in ground air calculated with ARTM and LAR are presented. Additionally, the derived radiation exposures are systematically investigated and the results of the two models are compared. For this purpose, several locations with different conditions were examined regarding to the variability of the source term, the exhaust gas plume rises, and the topography.
This work presents the spatial distributions of the activity concentrations and the calculated radiation exposure as well as their assessment.