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Inverse modelling of radionuclide release rates using gamma dose rate observations

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Severe accidents in nuclear power plants such as the historical accident in Chernobyl 1986 or the more recent disaster in the Fukushima Dai-ichi nuclear power plant in 2011 have drastic impacts on the population and environment. Observations and dispersion modelling of the released radionuclides help to assess the regional impact of such nuclear accidents.
Modelling the increase of regional radionuclide activity concentrations, which results from nuclear accidents, underlies a multiplicity of uncertainties. One of the most significant uncertainties is the estimation of the source term. That is, the time dependent quantification of the released spectrum of radionuclides during the course of the nuclear accident. The quantification of the source term may either remain uncertain (e.g. Chernobyl, Devell et al., 1995) or rely on estimates given by the operators of the nuclear power plant. Precise measurements are mostly missing due to practical limitations during the accident.
The release rates of radionuclides at the accident site can be estimated using inverse modelling (Davoine and Bocquet, 2007). The accuracy of the method depends amongst others on the availability, reliability and the resolution in time and space of the used observations. Radionuclide activity concentrations are observed on a relatively sparse grid and the temporal resolution of available data may be low within the order of hours or a day. Gamma dose rates, on the other hand, are observed routinely on a much denser grid and higher temporal resolution and provide therefore a wider basis for inverse modelling (Saunier et al., 2013).
We present a new inversion approach, which combines an atmospheric dispersion model and observations of radionuclide activity concentrations and gamma dose rates to obtain the source term of radionuclides. We use the Lagrangian particle dispersion model FLEXPART (Stohl et al., 1998; Stohl et al., 2005) to model the atmospheric transport of the released radionuclides. The inversion method uses a Bayesian formulation considering uncertainties for the a priori source term and the observations (Eckhardt et al., 2008, Stohl et al., 2012). The a priori information on the source term is a first guess. The gamma dose rate observations are used to improve the first guess and to retrieve a reliable source term. The details of this method will be presented at the conference.
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