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# MCMC methods applied to the reconstruction of the autumn 2017 106Ru atmospheric contamination source term

Joffrey Dumont Le Brazidec (1), Marc Bocquet (2), Olivier Saunier (3), and Yelva Roustan (2)

(1) IRSN, PSE-SANTE, SESUC, BMCA, Fontenay-aux-Roses, France / CEREA, joint laboratory École des Ponts Paris Tech and EDF R&D, Université Paris-Est, Champs-sur-Marne, France ( joffrey.dumontlebrazidec@irsn.fr), (2) CEREA, joint laboratory École des Ponts Paris Tech and EDF R&D, Université Paris-Est, Champs-sur-Marne, France (marc.bocquet@enpc.fr), (3) IRSN, PSE-SANTE, SESUC, BMCA, Fontenay-aux-Roses, France (olivier.saunier@irsn.fr)

In case of an accidental radioactive release, the Institute for Radiological Protection and Nuclear Safety (IRSN) uses atmospheric dispersion models to assess radiological consequences for human health and environment. The accuracy of the models results is highly dependent on the meteorological fields and the source term, including the location, the duration, the magnitude and the isotopic composition of the release.

Inverse modeling methods have proven to be efficient in assessing source term. The authors have developed an inverse method based on a variational approach and applied it to the Fukushima accident using dose rate measurements and air concentration measurements.
The method has been extended to deal with minor detection events where the source location is usually unknown.

Variational methods are suitable in operational use since they are able of quickly providing an optimal solution. However, unlike Bayesian methods, the quantification of the uncertainties of the source term assessed is usually not easily accessible. Indeed, Bayesian inverse methods are developed in order to efficiently sample the distributions of the parameters of the source, thus allowing to get a complete characterization of the source.

In September 2017, small amounts of 106Ru have been observed in Europe without knowledge on the origin of the release. Although concentrations levels were too low to pose any health and environmental issues, the widespread detection suggested that the source term must have been quite high. Monte Carlo Markov Chains (MCMC) have been applied to reconstruct the 106Ru source using Metropolis Hastings (MH) algorithms based on the Bayesian inference. The distributions of the parameters associated to the source and the observations errors are presented. Convergence analysis of the MCMC methods have been studied and point out that chains with small number of parameters are drawing distributions consistent with the results obtained using variational methods. Moreover, the computational time required by the method is suitable for operational use. Nevertheless, chains of large number of parameters are providing problems of convergence. In particularly, chains can stuck in local minima during the localization of the source, notably because of the unequal distribution of the observations over the continent.
To overcome this difficulty, other Bayesian methods are proposed to accelerate the convergence of the MCMC algorithm.