Geophysical Research Abstracts
Vol. 15, EGU2013-11966, 2013
EGU General Assembly 2013

The Fukushima releases: an inverse modelling approach to assess the source term by using gamma dose rate observations

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The Chernobyl nuclear accident and more recently the Fukushima accident highlighted that the largest source of error on consequences assessment is the source term estimation including the time evolution of the release rate and its distribution between radioisotopes.

Inverse modelling methods have proved to be efficient to assess the source term due to accidental situation (Gudiksen, 1989, Krysta and Bocquet, 2007, Stohl et al 2011, Winiarek et al 2012). These methods combine environmental measurements and atmospheric dispersion models. They have been recently applied to the Fukushima accident. Most existing approaches are designed to use air sampling measurements (Winiarek et al, 2012) and some of them use also deposition measurements (Stohl et al, 2012, Winiarek et al, 2013). During the Fukushima accident, such measurements are far less numerous and not as well distributed within Japan than the dose rate measurements. To efficiently document the evolution of the contamination, gamma dose rate measurements were numerous, well distributed within Japan and they offered a high temporal frequency. However, dose rate data are not as easy to use as air sampling measurements and until now they were not used in inverse modelling approach. Indeed, dose rate data results from all the gamma emitters present in the ground and in the atmosphere in the vicinity of the receptor. They do not allow one to determine the isotopic composition or to distinguish the plume contribution from wet deposition. The presented approach proposes a way to use dose rate measurement in inverse modeling approach without the need of a-priori information on emissions.

The method proved to be efficient and reliable when applied on the Fukushima accident. The emissions for the 8 main isotopes Xe-133, Cs-134, Cs-136, Cs-137, Ba-137m, I-131, I-132 and Te-132 have been assessed. The Daiichi power plant events (such as ventings, explosions...) known to have caused atmospheric releases are well identified in the retrieved source term, except for unit 3 explosion where no measurement was available. The comparisons between the simulations of atmospheric dispersion and deposition of the retrieved source term show a good agreement with environmental observations. Moreover, an important outcome of this study is that the method proved to be perfectly suited to crisis management and should contribute to improve our response in case of a nuclear accident.