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Source Determination and Localization by Atmospheric Transport Modelling

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Monitoring of noble gases, in particular Krypton-85, can be used to detect signatures from undeclared plutonium production and reprocessing activities. Based on Atmospheric Transport Modelling, it is possible to localize sources and, if a source localization hypothesis already exists, to determine the strengths of the releases.

In the last decade, the methods have been very much improved, especially by introducing Lagrangian modelling systems. Eulerian gridded approaches required the introduction of adjoint models, which is technically demanding, and the adjoint model simulations are CPU time consuming. In the Lagrangian world, the adjoint model is the same as the normal model, only the integration is performed with a negative time step. The introduction of so-called source-receptor sensitivity fields allowed separating the ATM calculations from the source localization task, making computations less demanding from the CPU perspective.

SRS fields can be used in different ways to investigate sources, either with simple trial and error schemes where emission scenarios are tested, or using inverse modelling algorithms. Such methods have been tested in various applications, including the detection of the nuclear tests of DPRK, the source estimates for the Fukushima nuclear accident 2011 or the Eyjafjallajökull volcano eruption in 2010. In all cases, results were promising. Also in more complicated domains, for example the assessment of complex emissions of air pollutants, it was shown that inverse modelling schemes work properly and accurately. Depending on the application, emission estimates are accurate at least on the order of magnitude. Also in the IAEA application area, source localization/determination methods were already investigated, and found to be very useful to investigate reprocessing activities.

In the presentation, atmospheric and backtracking methods are explained, and examples for their application are shown. In particular, there will be a reference to the applicability in the IAEA safeguards domain.

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