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Radioxenon analysis methods and atmospheric transport modeling to distinguish anthropogenic from nuclear explosion signals

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The noble gas component of the Comprehensive Nuclear-Test-Ban Treaty Organisation (CTBTO) International Monitoring System (IMS) uses - amongst other things - xenon as an indicator to trace a specific sample back to the origin of a nuclear explosion. The CTBT foresees the worldwide monitoring of different xenon isotopes to identify a nuclear explosion and the use of atmospheric transport modeling (ATM) to locate its origin.

Several difficulties impede the goal of identifying and locating the source of a specific sample: civilian sources of radioxenon produce a heterogeneous background around the globe, often with unknown time dependencies. This makes the ability necessary to distinguish between legitimate civilian sources and nuclear explosions. In order to reach this different approaches have been followed so far, namely: (a) isotopic activity ratios can be used to separate a nuclear reactor domain from the parameter space that is specific for a nuclear explosion. This is especially relevant for sampling at an early stage after the release. After several days the difference becomes less visible; (b) anomalous concentrations with respect to the history of the measurement site – some sampling stations may repeatedly detect radioxenon from known civilian sources, while others not; (c) correlation with source-receptor-sensitivities related to known civilian sources. Here ATM can be used to determine the relation between possible origins, legitimate civilian sources and the xenon sampling site; (d) feedback induced by local meteorological patterns on the equipment and on the sampling procedures to improve a possible event categorisation scheme.

While each approach can give hints to the character of the samples origin, the combination of these four methods is naturally the next step and promising for the optimization of the analysis process. Furthermore, the combination of these methods leads to an automation of the analysis. This project foresees to develop algorithms to standardize and unite the four methods, including testing them under various realistic and "worst case" conditions. The Lagrangian atmospheric transport model FLEXPART will play a crucial role in this. Another cornerstone of the work will be the acquisition of measurement data for experimental verification. These will most likely come from the INGE (International Noble Gas Experiment) group. Also the possibilities of applying GRID computing in the field of ATM will be investigated, and the basic methods and first insights will be presented.