Radioxenon Atmospheric Transport Modeling: From Worldwide Impact of Nuclear Power Plants to CTBTO event screening categorization

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The International Monitoring System (IMS), which is currently built up by the Comprehensive Nuclear-Test-Ban Treaty Organization (CTBTO), continuously takes environmental measurements including atmospheric concentrations of several radionuclides. The characterization of the existing and legitimate background, which is produced mainly by Nuclear Power Plants (NPPs) and Isotope Production Facilities (IPFs), is of high interest to improve the capabilities of the monitoring network. Over 400 reactors at NPPs are currently in operation worldwide, while only five IPFs are considered to be continuously emitting relevant activity levels. Nevertheless, the emission strengths of typical nuclear power reactors are below the emission strengths of these IPFs; a typical IPF usually emits radioxenon in the order of magnitude or above the total of all operational NPPs together. Therefore, the long-term global radioxenon background is a result of many weak and a few strong sources.

The emissions from legitimate sources can usually only be estimated. However, historic source terms of ^{133}Xe emissions from the IPF at ANSTO, Sydney (Australia), have been made available in a daily resolution, and then applied together with Atmospheric Transport Modelling (ATM) to predict the concentration time series at two radioxenon monitoring stations: Melbourne (Australia) and Chatham Island (New Zealand).

Moreover, following the Fukushima NPP accident, detections of ^{133}Xe have been made in various locations. Using results of these remote measurements, the Fukushima ^{133}Xe source term has been reconstructed and compared with previously estimated ^{137}Cs and ^{131}I source terms.

Finally, feedback induced by local meteorological patterns on the equipment and on the sampling procedures has been included in the analysis to improve CTBTO event screening categorisation. The occurrence probability of radioxenon outliers has been estimated with a time series approach characterising and avoiding the influence of local meteorological patterns.