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A simple approach to reveal the potential influence of regional sources in support of a radioxenon event categorization scheme

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In brief: In this paper a simple approach to derive three dimensional (one time, two horizontal) stations specific frequency distributions of xenon detections is proposed and discussed along with results calculated for a choice of high background radioxenon stations being member of the 40 station International Noble Gas Experiment (INGE) network. The approach is to fold the measurements at a station with the source-receptor sensitivity fields yielding the time dependent distributions that can be aggregated as needed to support the radioxenon event categorization scheme currently under development.

Additional detail: The existing categorization scheme to detect particulate borne traces in International Monitoring System built up by the Provisional Technical Secretariat (PTS) of CTBTO Preparatory Commission (IMS, Schulze et al., 2000) is one-dimensional and can be applied on the measurement data only. To the contrary the corresponding 40 station radioxenon (INGE) network needs to employ a multi-dimensional scheme involving at least the two horizontal dimensions defining the influence region ('Field of Regard') from where known but CTBT irrelevant sources might interfere the measurement.

The categorization of CTBT relevant ('abnormal') peaks is only possible if this interference from known sources is considered. 'Abnormal' xenon peaks might be substantially lower than historical peaks caused by known sources. For example the October 2006 radio-xenon detections at Yellowknife, Canada (Saey et al., 2007) would not have been identified as an ‘abnormal’ outlier based on a one-dimensional times series analysis of the measurements taken so far at this station (Plastino, 2007). This case demonstrated that atmospheric backtracking is required for each station at appropriate geo-temporal resolution in order to understand how the release of isotopes related to a treaty relevant event is mixed with other treaty irrelevant xenon releases.

Scaling the problem: Depending on the locations of the 40 INGE station the interference problem is more or less severe as can be derived e.g. from site specific frequency distributions of xenon detections at INGE stations (Zaehringer, 2008), from direct investigations of the release behaviour of nuclear facilities (Saey, 2008) and finally the folding of well developed xenon-133 emission inventories (Tuma and Kalinowski, 2008) with station specific source-receptor sensitivity fields. Wotawa et al. (2008) applied this for the global scale on basis of the standard backtracking systems’ source-receptor sensitivity calculations performed at the PTS. The closer, however, the non CTBT relevant xenon sources are located to the measuring station the more the temporal course of the release become important, and the higher the demand on the geo-temporal resolution of the emission inventory itself.

Tackling the problem: We propose here a simple approach, namely to increasing the dimension of the aforementioned station specific frequency distribution of measurements from one to three. This is done by involving the two horizontal dimensions so desperately needed for the xenon event categorizations scheme. Technically this is realized by folding the station specific network coverage information yielded by aggregation of the station specific source-receptor sensitivity field data with the actual measurements encountered throughout the integration period regarded (e.g. on month or one year). The result yields an emission inventory that would be consistent with the backtracking results of the station regarded, and that would explain the measurement scenario encountered at the station. Finally this backtracking based emission inventory can be compared with those derived directly from investigations of the known sources. Moreover step-wise enhancement of the resolution of the SRS data yields a sensitivity study to determine the resolution requirements of the backtracking model that shall resolve all potentially sources interfering sources.

The advantages of this approach are its simplicity and its independence from highly uncertain emission inventories (which are output instead of input). The approach is challenged by the high trust that is put into the backtracking modelling. Unless the current uncertainties of the xenon emission inventories are not substantially reduced, however, this challenge is comparatively small.

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