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Evaluation of Radioxenon Isotopic Ratio Flags and Possible Optimizations

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In the context of CTBT verification, radioxenon ratios can be used to discriminate between nuclear weapons domain signatures and nuclear facilities as plausible sources of the observed atmospheric radioactivity. This discrimination is accomplished by setting a screening flag threshold beyond which a radioxenon sample can be considered as being possibly of relevance from a nuclear explosion monitoring perspective. The goal of this study was to evaluate the currently implemented method for setting screening flag thresholds and to explore potential enhancements. First, a data set was analysed comprising approximately 35 000 samples of International Monitoring System (IMS) radioxenon data. Using activity concentrations and reported uncertainties, the ratios Xe-135/Xe-133, Xe-133m/Xe-133, Xe-133m/Xe-131m and Xe-133/Xe-131m were quantified for each IMS sample using two different methods for handling uncertainty and three different confidence intervals. The sets of obtained ratios were then used to determine new thresholds based on three different false positive rates. To test the performance of each screening flag, signatures of a hypothetical explosion were combined with observations from IMS samples and the resulting radioxenon ratios were compared to the newly established threshold. The detection rate for each of the 18 screening flag threshold calculation methods was quantified to enable the selection of the most suitable method.

E-mail

emily.gordon@austin.utexas.edu

Promotional text

Two calculation methods, three levels of statistical uncertainty, and three false positive rates were used to set new thresholds of Xe isotopic ratio flags for automated IMS data screening. The flags were scored using combined real IMS data and hypothetical explosion signatures.

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Primary authors: GORDON, Emily (The University of Texas at Austin); GHEDDOU, Abdelhakim (CTBTO Preparatory Commission); KUSMIERCZYK-MICHULEC, Jolanta (CTBTO Preparatory Commission); Mr LIU, Boxue (CTBTO Preparatory Commission); SCHOEPPNER, Michael (University of Natural Resources and Applied Life Sciences (BOKU)); Mr KALINOWSKI, Martin B. (CTBTO Preparatory Commission)

Presenter: GORDON, Emily (The University of Texas at Austin)

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