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Comparing Nonparametric Change-Point Control Charts for Detecting Radioxenon Anomalous Concentrations

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The detection of anomalous radioxenon atmospheric concentrations is an important activity, carried out by the International Data Centre (IDC) of the Comprehensive Nuclear Test-Ban Treaty Organization (CTBTO), for revealing both underground nuclear explosions and radioactive emissions from nuclear power plants or medical isotope production facilities. The radioxenon data are validated by IDC in Vienna and independently analysed by the Italian National Data Centre–Radionuclides (NDC-RN) at the ENEA Bologna Research Centre, in order to look for signals that may be related to a nuclear test or atmospheric releases due to civil sources. The distribution of the radioxenon data is strongly asymmetric and currently for its task the Italian NDC uses an interquartile filter algorithm based on descriptive thresholds. Therefore, it could be suitably supplemented with an inference-based method able to identify multiple change points in the sequence of observations. In this work we compare several nonparametric change-point control charts for detecting shifts in the monitored radioxenon above its natural background and provide an in-depth discussion of the results. The aim is to assess whether these methodologies can be used by Italian NDC alongside the interquartile filter method. More in details we considered and compared distribution-free change point control charts based on the recursive segmentation and permutation method, the Cramer-von-Mises, Kolmogorov-Smirnov and Mann-Whitney statistics. Preliminary results open interesting perspectives since allow a better characterisation of the monitored phenomenon. The views expressed herein are those of the authors and not necessarily reflect the views of the CTBTO.

Keywords

Change Detection; Nonparametric tests; Statistical Process Control; Radioactivity

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