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Enhancing Source Estimation in CTBTO Web-Grape

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INTRODUCTION AND MAIN RESULTS

The estimation of a source in the CTBT context is an ill-posed problem that is highly sensitive to small variations in data, whether meteorological information or radionuclide concentration values. The current version of the Web-Grape software includes three methods for identifying possible source regions. The first two methods rely on the correlation between measured concentration values and corresponding modeled values, employing two distinct correlation measures: Spearman and Pearson. The third method uses the number of source-receptor sensitivities (SRS) exceeding a threshold value as an indicator of potential source areas. Notably, while Spearman correlation is more robust than Pearson correlation, the robustness of both depends on the number of data points used for estimation. To address this, we propose a new statistical method that combines correlation and SRS counts to improve the accuracy of identifying possible source regions.

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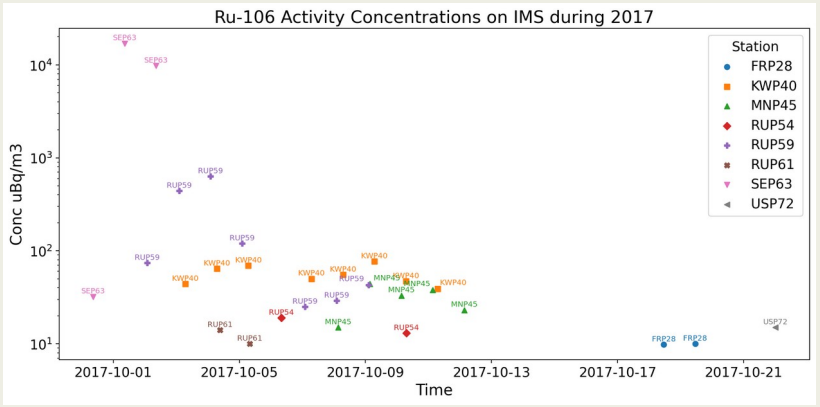
Abstract

The estimation of a source in the CTBT context is an ill-posed problem that is highly sensitive to small variations in data, whether meteorological information or radionuclide concentration values. The current version of the Web-Grape software includes three methods for identifying possible source regions. The first two methods rely on the correlation between measured concentration values and corresponding modeled values, employing two distinct correlation measures: Spearman and Pearson. The third method uses the number of source-receptor sensitivities (SRS) exceeding a threshold value as an indicator of potential source areas. Notably, while Spearman correlation is more robust than Pearson correlation, the robustness of both depends on the number of data points used for estimation. To address this, we propose a new statistical method that combines correlation and SRS counts to improve the accuracy of identifying possible source regions.

Case Study

Anomalous Ru-106 appeared in 30 samples across eight IMS stations during late September–23 October 2017 (see Fig. 1). This cluster is exceptional: after a detection-free period since 2011, it represents roughly one-quarter of all detections over 25 years.



Some challenges in Current Web-Grape

Activity concentrations in this case vary widely—from about 10 µBq m^{-3} (FRP28, 19 October) to 1,700 µBq m^{-3} (SEP63, 2 October)—a spread exceeding two orders of magnitude. Since correlations are not robust to such extremes, we remove the largest values to improve the reliability of correlation-based source identification. Moreover, because SRS fields encompass only 14 days of backward runs, a 23-day detection sequence is only partially usable in Web-Grape, favoring the most recent observations. Finally, Web-Grape does not use non-detections, even though they are valuable for narrowing the possible source region.

Some Results