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Array Solutions for Radioxenon Monitoring

Ansgar Wehrhahn, Viktor Thorén, Maksym Luchkov, Bernhard Flierl

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INTRODUCTION AND MAIN RESULTS

The SAUNA QUBE represents a major advancement in radioxenon monitoring. It offers high performance at significantly lower costs than its predecessors, allowing the creation of dense monitoring networks.

Here we present tools to plan and analyze this array data using atmospheric transport models and source reconstruction. Highlighting the advantages of an array over a single station.

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The SAUNA QUBE Array

The SAUNA QUBE is a mini radioxenon monitoring station, with high performance but significantly lower cost than the SAUNAIII or other Next-Generation systems.

This allows the creation of measurement arrays consisting of several stations, which improves detection probability as well as source localization capabilities (Ringbom et al. 2023).

To manage this data, we integrated it into the Network Monitoring Centre (NMC), which collects data from multiple QUBEs in one central location. We can then monitor the stations and analyse the data.

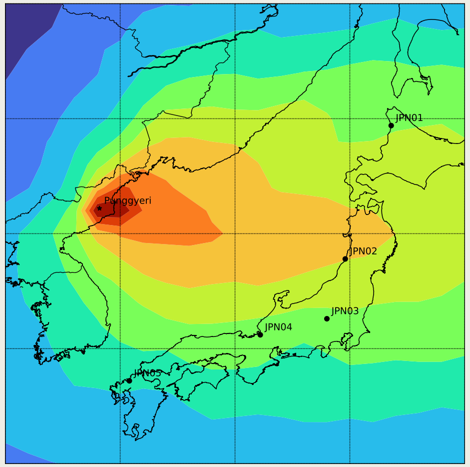
Here we investigate the situation of a Xenon release from the North Korean Nuclear Weapons Test Site Punggyeri, and how a QUBE array would detect it. For the simulations we are using the HYSPLIT (Stein et al. 2015) dispersion model with GDAS1 weather data (NOAA Air Recources Laboratory, 2021).

Plan Your QUBE Array

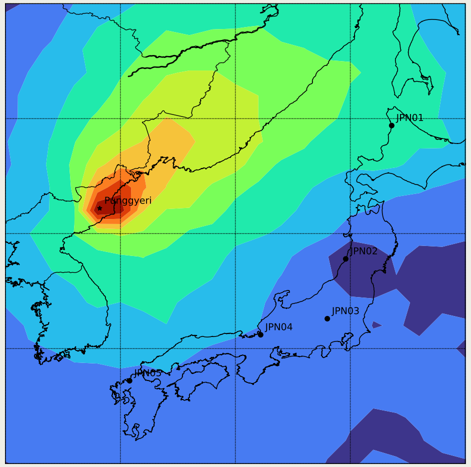
When deciding on QUBE locations, we want to maximize the detection probability (DP) for radioxenon releases for the whole array. Meanwhile, the DP at individual stations can be used to inform the installation order.

Based on the methodology developed by Ringbom et al (2023), we calculate the average Plume Hit Probability (PHP) for each radioxenon source in the area. We can then investigate the effect each station location has on the detection probability of the array and propose additional station locations to further improve its capabilities.

While the exact effects depend on the release location, we consider here an example with 5 potential stations spread over Japan and a release. This first plot shows the overall DP. We can see that the PHP is highest for JPN02, making this the most important location for this source.

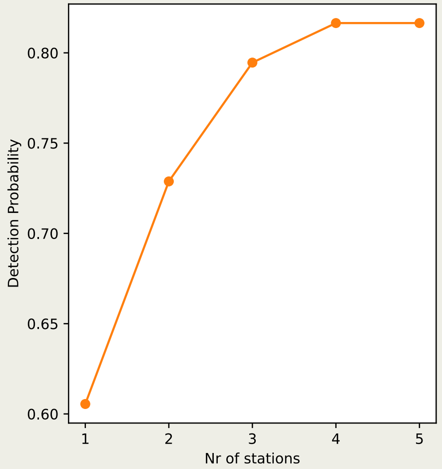


Plan Your QUBE Array



The second plot shows the remaining PHP for releases not detected in JPN02. This shows that JPN01 is the second most important location for increasing the DP. Continuing this process for the remaining stations gives us the ideal installation order.

As expected, the DP increases with more stations. While the initial station covers about 60% of the releases each further station adds around 10% coverage up to the maximum of 80%. The remaining plumes travel northward without passing any of the 5 stations.



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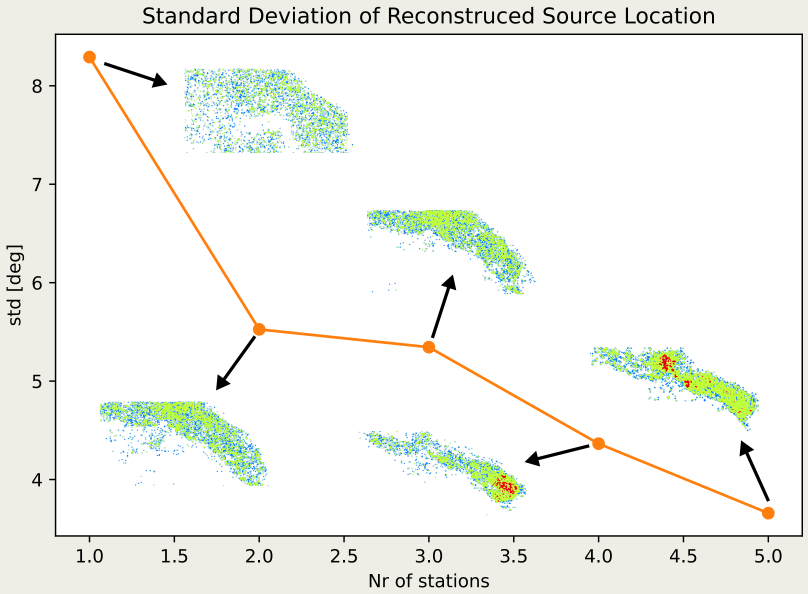
Improved Source Reconstruction

In addition to simply improving the detection probability, additional stations also improve the source reconstruction capabilities. Additionally, even non detections in single stations become powerful tools for excluding potential source locations, as usually a plume does not pass all stations of the array.

Here we investigate the effect of multiple stations on the recovered source location using the Bayesian source reconstruction framework FREAR (De Meutter, P., & Hoffman, I., 2020). As expected, the spread of the solution decreases significantly as more stations are participating in the array.



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The SAUNA QUBE is just one of our products, which integrate with the NMC platform. We also produce various Gamma probes for measuring radioactivity, both stationary and mobile.

Contact us at our booth or per e-mail, for personalized assistance with your QUBE array or any of our other products.

References

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A. F. Stein, R. R. Draxler, G. D. Rolph, B. J. B. Stunder, M. D. Cohen, and F. Ngan, 'NOAA's HYSPLIT Atmospheric Transport and Dispersion Modeling System', *Bulletin of the American Meteorological Society*, vol. 96, no. 12, pp. 2059–2077, Dec. 2015.

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