Atmospheric transport modelling analyzing source regions for recurring peak detections of radioxenon at RN38 and the Pacific

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INTRODUCTION AND MAIN RESULTS

At RN 38 Takasaki, several episodes of recurring peaks with elevated radioxenon activity were observed in 2024/2025. Backward atmospheric transport modelling investigates the potential source region of those peaks by determining areas of coincident sensitivity.

The presence of the prominent background source in the region increases the challenge of detection and attribution of radioxenon from nuclear test explosions.

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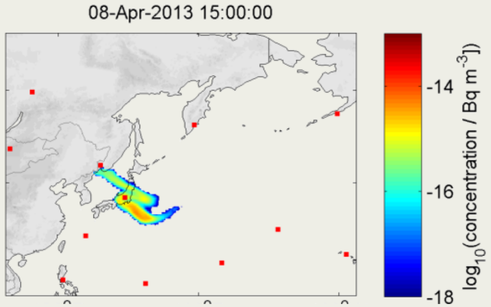
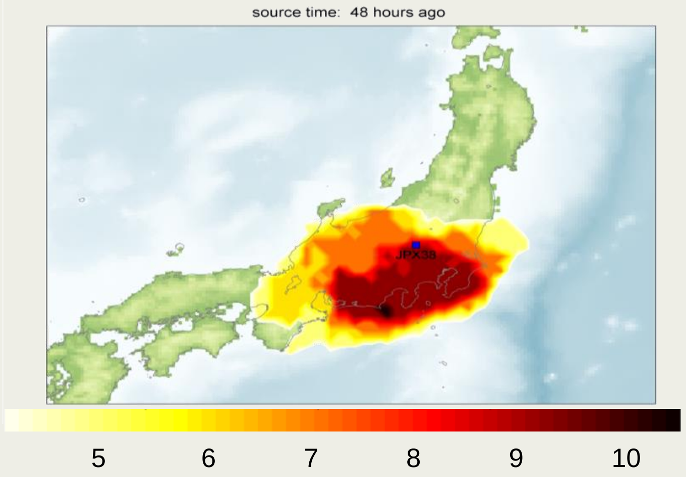
Xe from North Korean nuclear tests at RN38

The delayed detection of $^{131m}Xe/^{133}Xe$ in a ratio matching the timing 54 days after the Feb 2013 North Korean nuclear test explosion was well explained by forward ATM.



After the Jan 2016 North Korean nuclear test explosion ^{133}Xe was measured at RN38 at a level typical for the station. ATM indicated that North Korea was a possible source region. In contrast, the SRS fields of five comparable peaks of about 1 mBq/m³ during 2015 coincided at Japanese sites as shown below.

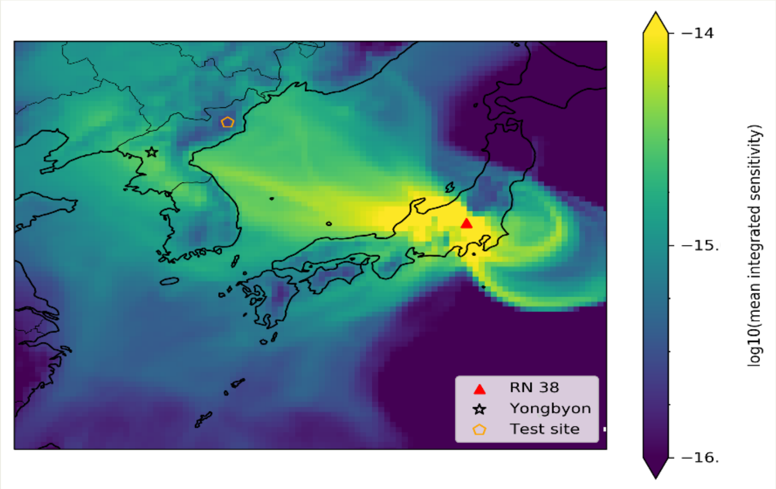


Backward ATM for recent detections at RN38

Since late 2023 the occurrence of radioxenon at RN38 has significantly increased. From Jan 2024 to Aug 2025 there were 115 samples containing >8 mBq/m³ ^{133}Xe. For those samples backward ATM using the NOAA-HYSPLIT* model was performed.

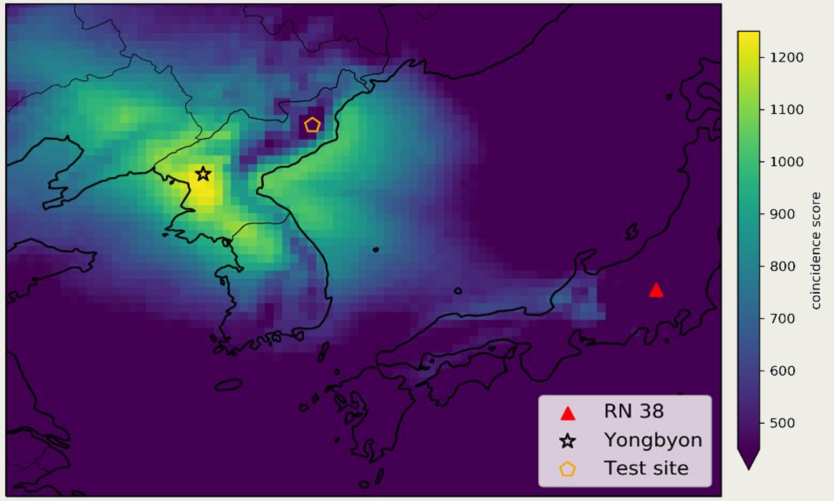
Meteorological data:	NCEP-GFS 0.25°
Sensitivity grid:	0.25°, layer up to 500 m AGL
Simulated time:	144 hours
Lagrangian particles:	360.000

The total mean integrated sensitivity calculated for all 115 samples generally indicates airflow from the west. Even when the wind arrives locally at the station from the east, there is some dynamic turning structure.



Spatially coincident sensitivity

For identifying a common source not in the direct vicinity of the station, a coincidence score was defined counting all sensitivity time steps in the range from 1E-17 to 1E-14 per m³ between 1 and 4 days transport time.



The plot indicates the Yongbyon area as a common sensitivity spot. This aligns with open-source information from the IAEA and 38north.org that a new Light Water Reactor has been in operation at Yongbyon since October 2023. The results allow us to rule out a common origin from the test site, but attributions of detections in the region is now even more challenging.

*Stein, A.F.,et al. (2015). NOAA's HYSPLIT atmospheric transport and dispersion modeling system, Bull. Amer. Meteor. Soc., 96, 2059-2077

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