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Radioxenon emissions from nuclear power plants and medical isotope production facilities measured in the Source Term Analysis of Xenon project

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INTRODUCTION

The STAX project is investigating the sources of radioxenon that enter the atmosphere that are subsequently detected in the IMS. An initial evaluation of sources from nuclear power plants and fission based medical isotope production facilities is presented.

METHODS/DATA

STAX data from three facilities will be presented including one fission based medical isotope production facility and two nuclear power plants, an advanced gas cooled reactor and a boiling water reactor.

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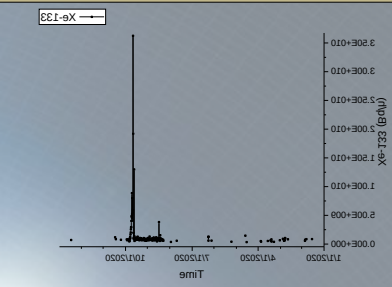
P2.4-341

RESULTS



Release profiles are not episodical and on the same time scale.

CONCLUSION

Modeling of radioxenon releases should include the periodic nature of the releases.

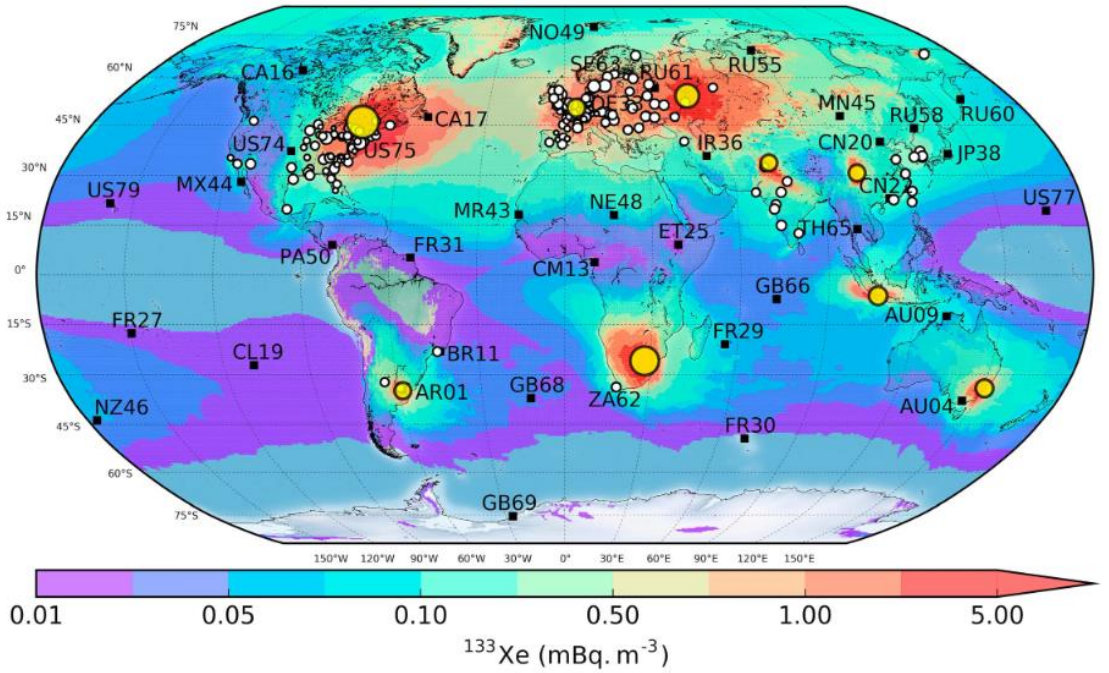
Facility information on releases is important in understanding when the releases occur.

STAX project introduction

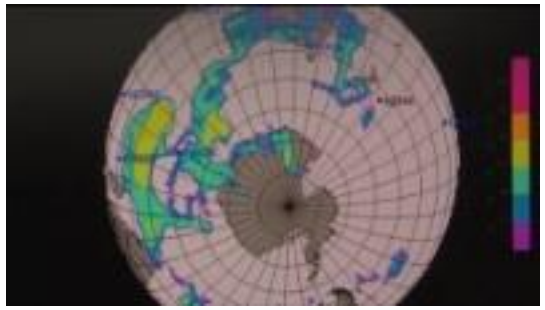
- Since the late 1990's, large concentrations of radioactive xenon isotopes have been detected in many measurements
- It was proposed that the radioxenon sources were from the dissolution of nuclear targets used to make radioisotopes for medical treatments and from nuclear power plants
- Further investigation showed backgrounds to be a worldwide phenomena
- The International Monitoring System detects radioactive xenon every day from civil and industrial processes that make radionuclide screening difficult

Average backgrounds of radioactive xenon in the atmosphere

From Generoso, 2017



Overview videos of the worldwide radioxenon background



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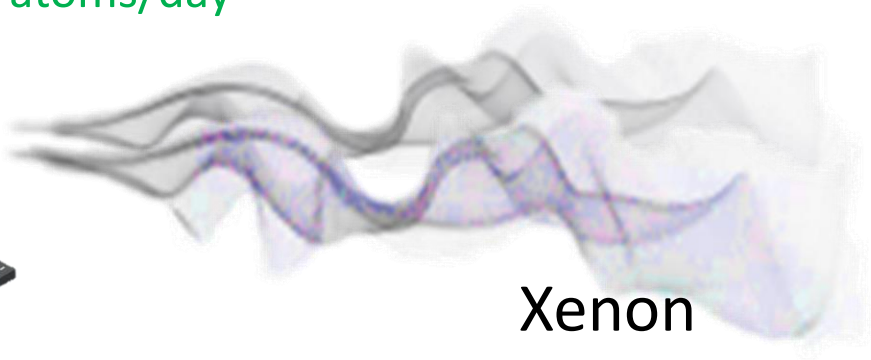
P2.4-341

INTRODUCTION
OBJECTIVES
METHODS/DATA
RESULTS
CONCLUSION

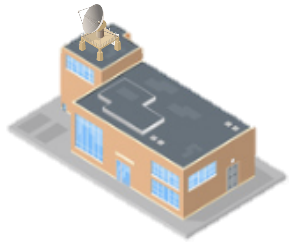
How radioxenon background impact can be minimized

Emission Level
Atoms Released
10^{18} atoms/day



Xenon

(Predictable) IMS
Station Detection
Atoms Detected
10^{4} atoms/day



- Use a mathematical model (atmospheric transport model) to determine the expected concentration at the IMS station

IMS Station

Measurement at station
A Bq/m³

Stack measurement
B Bq/second → C Bq/m³
ATM calculation

Net Signal ~ A – C

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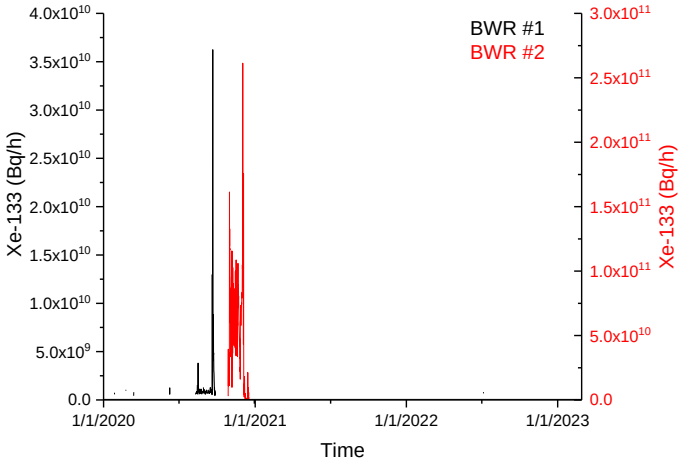
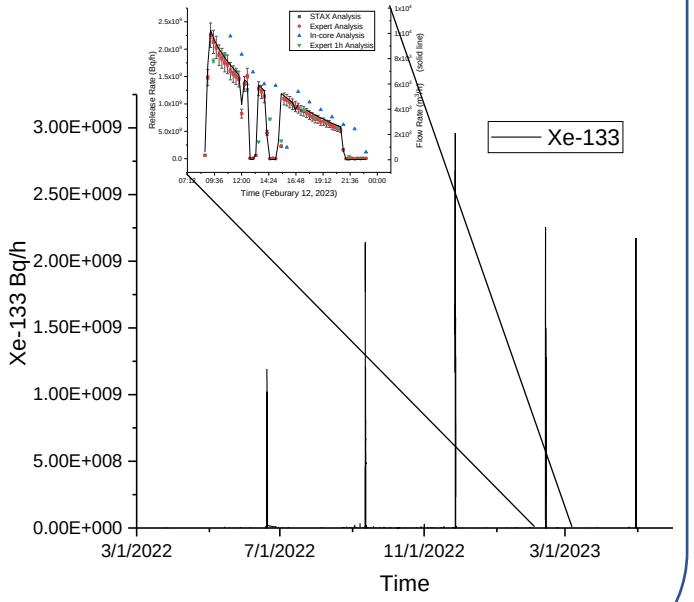
Source radioxenon data from two different nuclear power reactors and a medical isotope production facility

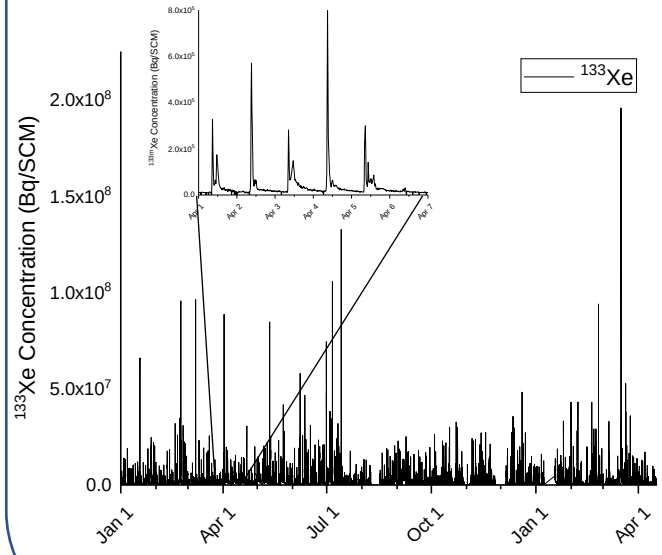
Over two years of radioxenon data from two BWR reactors



One year of radioxenon data from two AGR reactors



1.5 years of radioxenon data from one medical isotope production facility



INTRODUCTION
OBJECTIVES
METHODS/DATA
RESULTS
CONCLUSION

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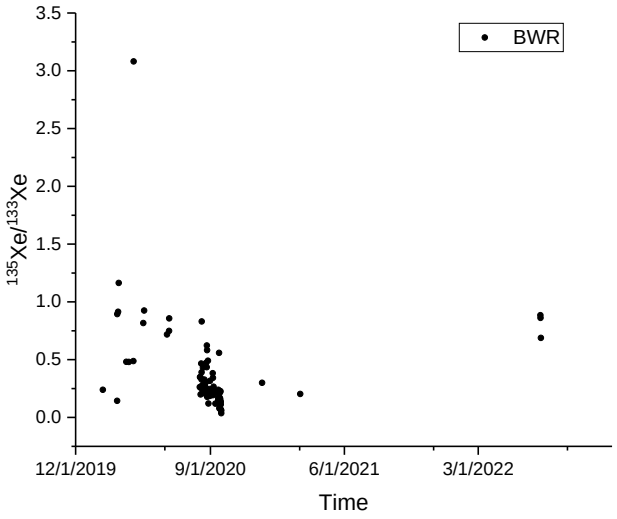
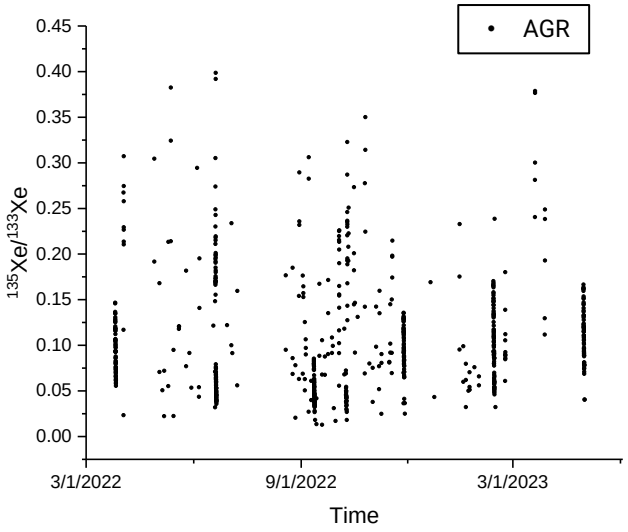
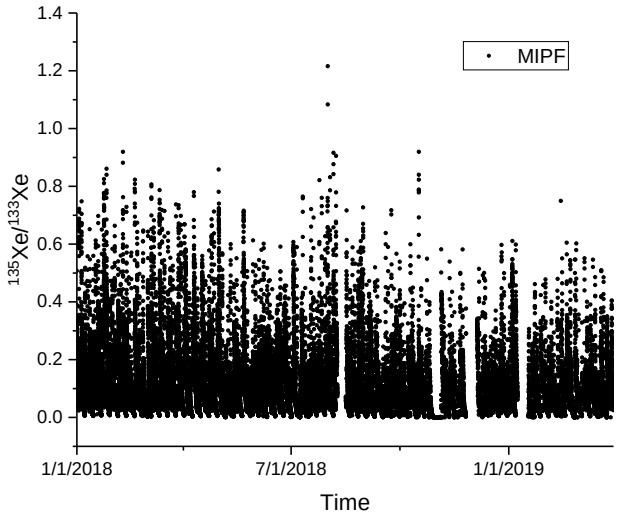
Radioxenon isotopic ratios







$^{135}Xe/^{133}Xe$ ratio	BWR (n=79)	AGR (n=627)	MIPF (n=8253)
Maximum	3.08	0.40	1.22
Minimum	0.037	0.013	0.0001
Average	0.39	0.11	0.12
Median	0.26	0.09	0.089

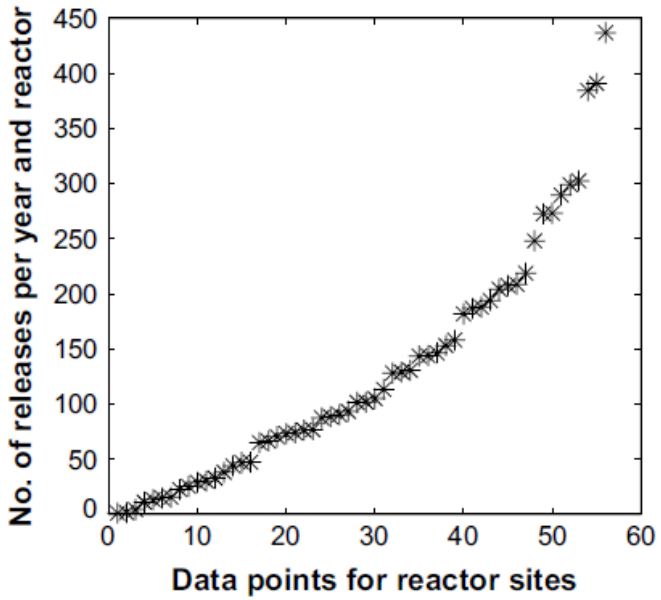
INTRODUCTION
OBJECTIVES
METHODS/DATA
RESULTS
CONCLUSION

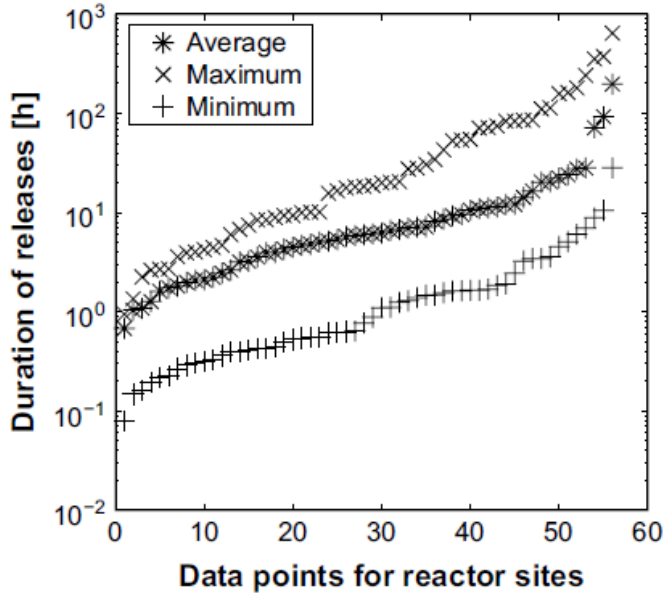
Place your QR Code here after removing this text box!

Conclusions

- The release profile for two different nuclear power reactors are different and dependent on the reactor type
  - The releases from these two nuclear power reactors are dependent on activities at the reactor as no detectable radioxenon is measured during typical steady state operations
- NPP release profiles are significantly different from MIPF, both in the routine and amount released
- The key $^{135}Xe/^{133}Xe$ ratio is not significant different across the two reactor types and MIPF

M.B. Kalinowski, M.P. Tuma / Journal of Environmental Radioactivity 100 (2009) 58–70





The frequency of the data reported from these two nuclear power reactors allow close characterization of the release profiles.

This data is consistent with previously published estimates.

INTRODUCTION
OBJECTIVES
METHODS/DATA
RESULTS
CONCLUSION

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- Global radioxenon emission inventory based on nuclear power reactor reports
  - Martin B. Kalinowski, Matthias P. Tuma, Journal of Environmental Radioactivity 100 (2009) 58–70

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  - Gerhard Wotawa, Andreas Becker, Martin Kalinowski, Paul Saey, Matthias Tuma, Matthias Zahringer, Pure Appl. Geophys. 167 (2010), 541–557

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  - Martin Kalinowski, Pouneh Tayybi, Michael Lichermann, Halti Tatlisu, Pure Appl. Geophys. 178 (2021), 2711–2739

- STAX Poster at SnT23 P2.4-367

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