

Abstract

Reliable measurements of radioxenon isotopes are essential for the International Monitoring System (IMS) as required for the Comprehensive Nuclear-Test-Ban Treaty (CTBT). IMS measures continuously the four Xenon isotopes of interest for CTBT verification: ^{131m}Xe , ^{133m}Xe , ^{133}Xe and ^{135}Xe . The characterization of the global Xe isotopes background is very important for the accuracy of IMS measurements and hence for the CTBT verification. In this work, we thoroughly analyze the global distribution of the four Xe isotopes depending on data measured by the IMS noble gas stations from 2010 to 2016. The ratios between different Xe isotopes were calculated for all the available stations. The ratios between different Xe isotopes were drawn and compared to the separation line between the nuclear explosion regime and civil regime according to Kalinowski graph. Then, we focused on studying stations with the highest Xe concentrations.

Xenon Background

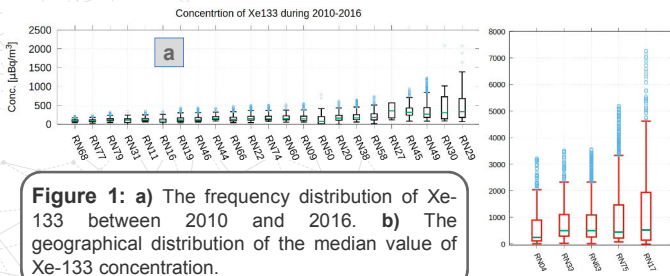
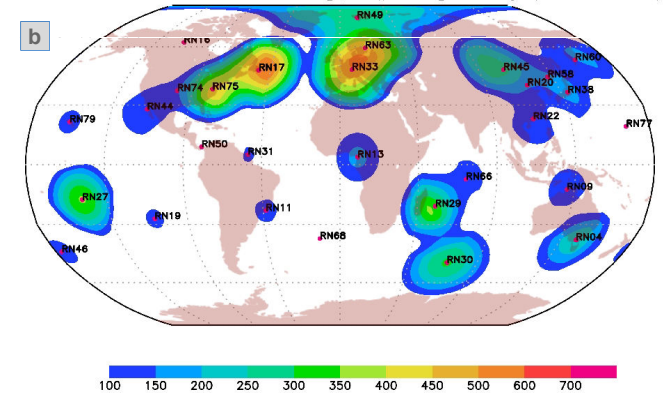


Figure 1: a) The frequency distribution of Xe-133 between 2010 and 2016. b) The geographical distribution of the median value of Xe-133 concentration.

The Median of Xe-133 Conc. [$\mu\text{Bq}/\text{m}^3$] during (2010–2016)



- Most of stations have lognormal distribution.
- The geographical distribution of the median value of Xe-133 concentration is consistent with the distribution of nuclear facilities.

Xe-Isotopic Graph

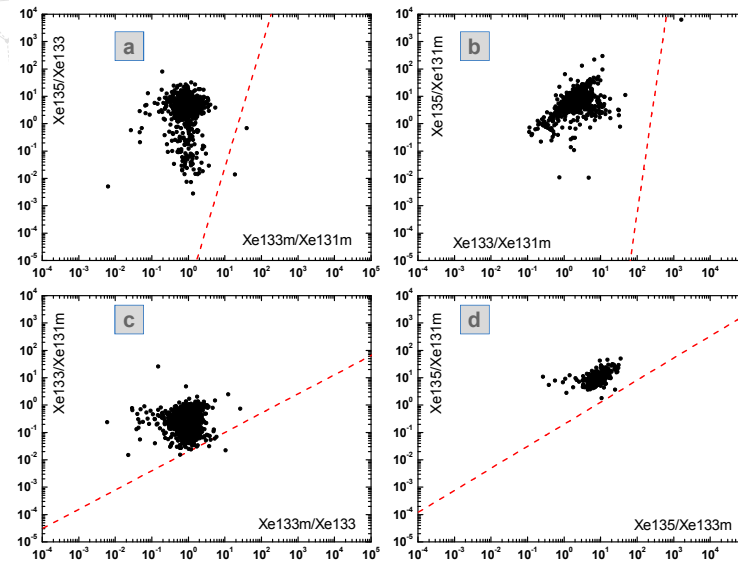


Figure 2: Xenon isotopes ratios.

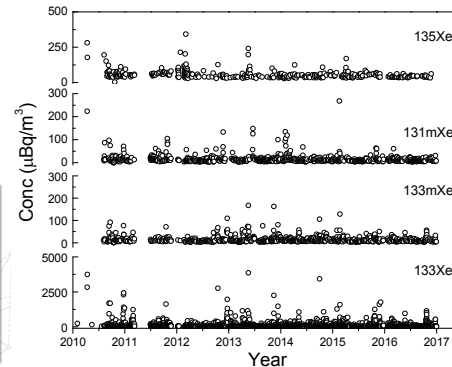
Dates	Station	Figure
20 Jul 2013	RN22	Fig. 3a
13 Dec 2014	RN04	Fig. 3a
27 Oct 2014	RN44	Fig. 3b
23 Jan 2014	RN09	Fig. 3c
7-8 May 2014	RN63	Fig. 3c
24 Nov 2015	RN63	Fig. 3c

Xenon isotopic ratios are calculated and the separation line between the nuclear explosion regime and civil regime is drawn according to Kalinowski¹.
 ❖ Only 7 alarm events (below separation line).
 ❖ Kalinowski²: some events under separation lines, which are related to nuclear reactors. These exceptional events may happen during the refuel process or new fuel cycle.

Station: RN63

Figure 2: The 4 Xenon isotopes concentration for RN63 from 2010 to 2016

^{131m}Xe , ^{133m}Xe , ^{133}Xe and ^{135}Xe are regularly recorded in the period from 2010 - 2015



Xe-Isotopic Ratio: RN63

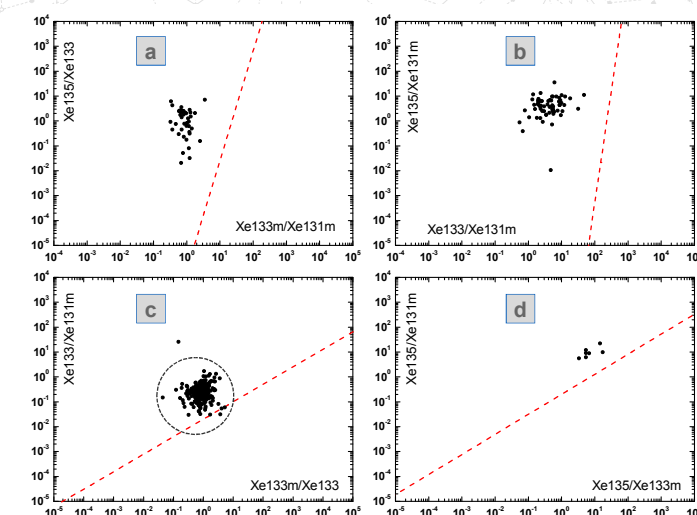
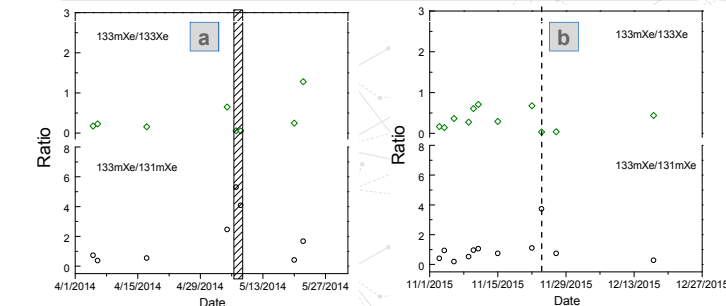


Figure 3: Xenon isotopes ratios for RN63.

Xenon isotopic graph for station RN63:

❖ All 3 alarm events appear on Xe133/Xe131m vs Xe133m/Xe133 graph (Fig. 3c)

Figure 4: Time dependence of Xe133/Xe131m and Xe133m/Xe133 ratio (a) Apr. – May 2014. (b) Nov. – Dec. 2015.



References

- M. B. Kalinowski and C. Pistner. Isotopic signature of atmospheric xenon released from light water reactors. *Journal of Environmental Radioactivity*, 88(3):215–235, 2006.
- M. B. Kalinowski et al. Discrimination of Nuclear Explosions against Civilian Sources Based on Atmospheric Xenon Isotopic Activity Ratios. *Pure and Applied Geophysics*, 167(4-5):517–539, 2010.

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