Global Observations of Iodine-131 by the International Monitoring System of the CTBTO

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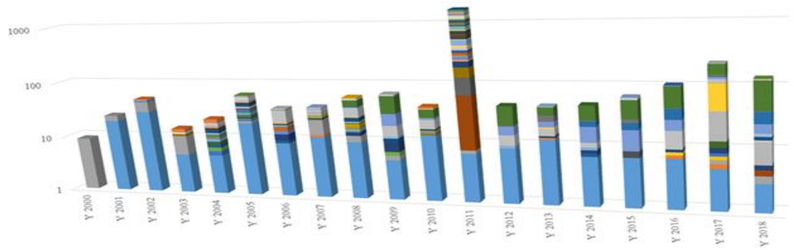
INTRODUCTION

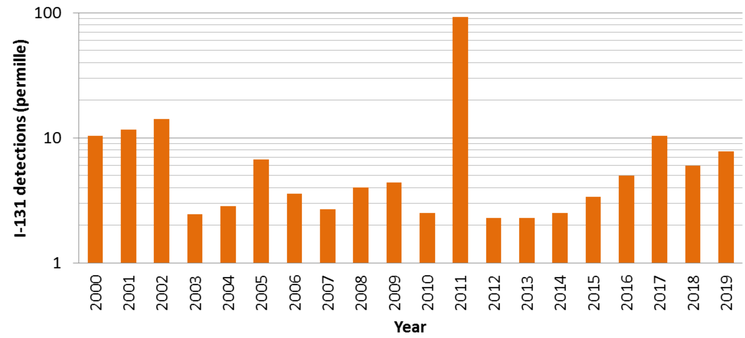
For the purpose of global monitoring for nuclear explosion signatures under the Comprehensive Nuclear-Test-Ban Treaty (CTBT), a unique International Monitoring System (IMS) with 80 radionuclide stations is being established. The analysis reports focus on 83 CTBT-relevant radionuclides including I-131 but also I-135, I-133 and I-130, being all fission products.
I-131 is a CTBT-relevant isotope with high significance. It is a direct precursor of Xe-131m which is most relevant for possible detection of underground nuclear tests. This poster summarizes the experience with I-131 observations (Figure 1) and discusses its relevance for nuclear explosion monitoring.

Development over time for annual detections of atmospheric I-131.

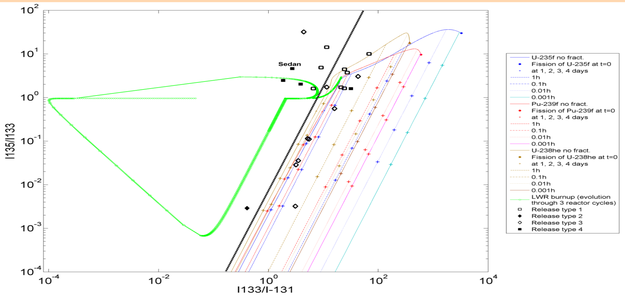


Slices of the histogram bars show the share of individual stations.
Please note the logarithmic scale.

Time development of I-131 detections at all IMS stations - up to 21st June 2019 (total of 2 944 cases out of 278 987 samples)



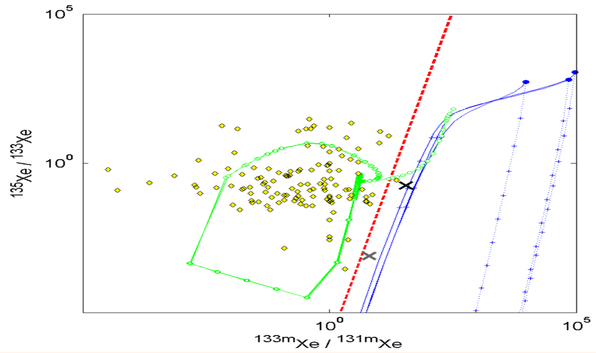
I-131 is important for CTBT verification. Isotopic activity ratios specifically with I-135 and I-133 can be used for characterizing the source.



Kalinowski, M.B.; Pistner, C.; Liao, Y-Y (2014): Discrimination of Nuclear Explosions against Civilian Sources Based on Atmospheric Radioiodine Isotopic Activity Ratios. Pure and Applied Geophysics: Volume 171/3 (2014), 669-676.

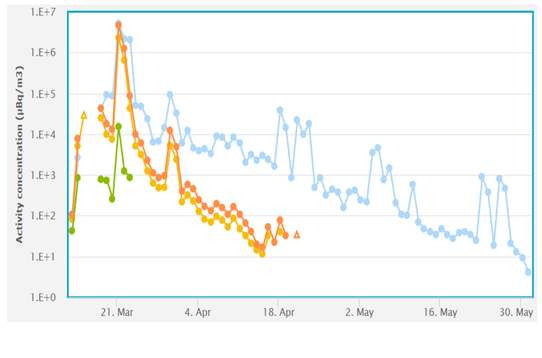
Radioiodine sources are important to be known for interpreting the four CTBT-relevant radioxenon isotopes (Xe-135, Xe-133, Xe-133m, and Xe-131m).

Adding Xe-131m, the decay product of an I-131 source, can push the ratios across the red discrimination line.

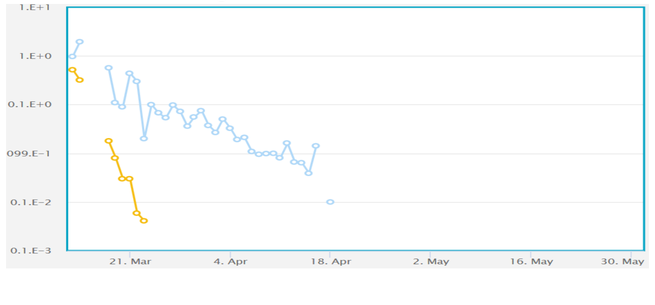


In the nuclear debris from the Fukushima accident the first three radioiodine isotopes were observed:

- ***I-131 (8.02 d)***
- ***I-132 (2.30 h)***
- ***I-133 (20.8 h)***
- ***I-135 (6.61 h)***
- ***Te-132 (76.3 h)***



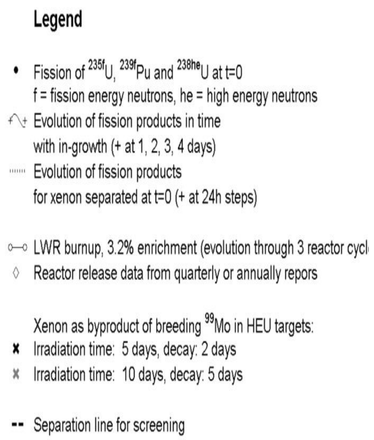
After the Fukushima accident the isotopic ratios decreases with time according to the half-lives.

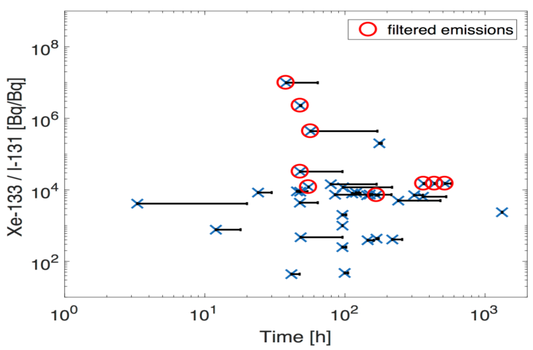


Stoehlker, U.; Nikkinen, M.; Gheddou, A., 2011: Detection of radionuclides emitted during the Fukushima nuclear accident with the CTBT radionuclide network. 2011 Monitoring Research Review: Ground-Based Nuclear Explosion Monitoring Technologies, 715-724.
https://www.ldeo.columbia.edu/res/pi/Monitoring/Doc/Srr_2011/PAPERS/04-15.PDF

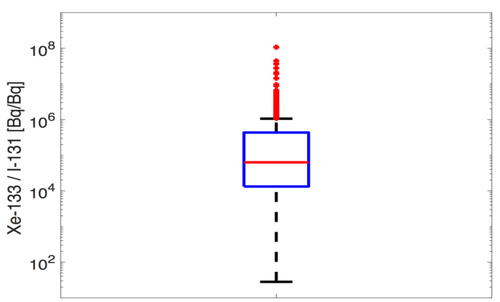
CONCLUSION

For I-131 observations, there is no clear historic trend. Most detections are caused by normal operational releases from nuclear facilities in the close vicinity of IMS stations. Therefore, I-131 detections are typically local and no global pattern can be deduced. Only the Fukushima accident in 2011 caused many observations of several radioiodine isotopes including I-132 across the Northern hemisphere.
Isotopic ratios of I-135, I-133, and I-131 are useful for CTBT verification (Kalinowski et al., 2014). This poster also highlights the significance of I-131 for interpreting the four CTBT-relevant radioxenon isotopes (Xe-135, Xe-133, Xe-133m, and Xe-131m).
The isotopic activity ratio of the most frequently detected radioxenon isotope (Xe-133) and most frequently detected radioidine (I-131) is investigated and seems to be suitable as a discriminator between nuclear facilities and nuclear tests, if the release from the latter is unfiltered.





Emissions from underground test effluents (Schoengold et al, 1996)



Distribution of nuclear reactor emissions (RADD, 1995-2003)

European Commission RAdioactive Discharges Database, RADD (http://europa.eu/radd/).

SCHOENGOLD, C.R., DEMARRE, M.E. and KIRKWOOD, E.M. (1996), Radiological effluents released from U.S. continental tests 1961 through 1992, United States Department of Energy—Nevada Operations Office, DOE/NV-317 (Rev.1) UC-702, Las Vegas, August 1996