Geophysical Research Abstracts,
Vol. 11, EGU2009-9491-2, 2009
EGU General Assembly 2009

Evaluation of environmental radioxenon isotopical signals from a singular large source emitter

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Abstract

In the framework of the verification of the Comprehensive Nuclear-Test-Ban Treaty (CTBT) the atmospheric background of environmental radioxenon is been studied near areas that could be affected by man-made sources. It was recently shown that radiopharmaceutical facilities (RPF) make a major contribution to the general background of ^{133}Xe and other xenon isotopes both in the northern and southern hemisphere. The daily IMS noble gas measurements around the globe are influenced from such anthropogenic sources that could mask radioxenon signals from a nuclear explosion.

To distinguish a nuclear explosion signal from releases from civil nuclear facilities, not only the activity concentration but also the ratio of different radioxenon isotopes (^{131m}Xe, ^{133m}Xe, ^{133}Xe and ^{135}Xe) plays a crucial role, since the ratios can be used to discriminate source types.

Theoretical release and ratio studies were recently published, but no measurements close to radiopharmaceutical facilities have ever been performed.

The world's fourth largest radiopharmaceutical facility, NTP Radioisotopes Ltd, is located in Pelindaba, South Africa. Other than a small nuclear power plant, located 1300 km southwest, near Cape Town and a small research reactor in the DR of Congo, located 2700 km northwest, this is the only facility that is known to emit any radioxenon on the African continent south of the Equator. This source is likely very dominant with respect to xenon emission. This makes it a point source, which is a unique situation, as all other worldwide large radiopharmaceutical facilities are situated in regions surrounded by many other nuclear facilities.

Between 10 November and 22 December 2008, radioxenon was measured continuously with a radioactive xenon measurement system, at the North-West University, Mafikeng, South Africa, which is situated 250 km northwest of Pelindaba. Fifty-six 12-hour samples were measured with a beta-gamma coincidence detector, of which 55 contained ^{133}Xe with values between 0.11 and 27.1 mBq/m^3. Eleven samples contained ^{135}Xe and three samples ^{133m}Xe. It is furthermore worth mentioning that none of the samples contained ^{131m}Xe.

In parallel, stack samples were taken at the NTP facility on an almost daily basis and measured with a high purity germanium gamma detector nearby at a local laboratory of NECSA. These stack measurements correspond to a daily release of around 1-10 TBq. This is consistent with typical release rates published for this type of facility and well below exposure guidelines thus not dangerous to the public. On the other hand it is expected to be high enough to increase the radioxenon background in wide regions around such facilities and has a potential impact on the monitoring capability of the highly sensitive CTBT xenon monitoring systems.

This paper will report on the activities measured at the facility stack and in Mafikeng, which allows for analysis and comparison with activity predictions based on atmospheric transport modelling. Finally the activity ratios measured shall be discussed in view of their implication for the xenon monitoring capability of the CTBT verification regime.

Disclaimer

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Acknowledgement

This project is performed in the framework of European Council Joint Action no. 2007/468/CFSP on support for activities of the Preparatory Commission of the Comprehensive Nuclear-Test-Ban Treaty Organisation (CTBTO) monitoring and verification capabilities in the framework of the implementation of the European Union Strategy against Proliferation of Weapons of Mass Destruction.