**Observed Atmospheric 133Xe Concentrations in the Arctic and North Atlantic Oscillation (NAO)**

Weihua Zhang, Jing Yi, Kurt Ungar and Eric Pellerin

Radiation Protection Bureau of Health Canada

Morten Sickel

NORSAR, Norway

It is well known that the background radiation of radioactive xenon in the global air mainly comes from radiopharmaceutical production facilities. At present, the 133Xe emissions from some major 99Mo and other medical isotope production plants are an order of magnitude higher than the emissions from about 450 nuclear power reactors in the world. These production facilities are located in limited areas of the world, such as Canada (MDS Nordion, which stopped producing 99Mo on March 31, 2018), the Netherlands (Tyco healthcare), Belgium (IRE), South Africa (NTP) and other regions. They account for 38%, 26%, 16%, 16% and 4% of the total global 99Mo production, respectively (Zahringer et al., 2009).

The global radioxenon background is not negligible and continues to interfere with the IMS’s radioxenon monitoring in the CTBT’s verification regime. In order to understand the radioxenon background, three radioxenon monitoring stations were selected in the Arctic, an area believed to be free of local radioxenon contamination. Two of them are located in the North American Arctic region, namely Yellowknife (62.5oN), Resolute (74.7oN), and the other is located in Spitsbergen Norway (78oN)

The daily activity concentration of 133Xe observed at these stations from 2013 to 2020 show strong seasonal variation characteristics, that is, most of the observed 133Xe appear in the winter and spring season from October to April of the following year, and are 30 to 50 times higher in winter than in summer; the 133Xe activity concentration observed in Spitsbergen is about 10 times that observed in Yellowknife and Resolute Island, and there is a certain time lag between the 133Xe observed at the North American station and the 133Xe observed in Norway (Zhang et al. 2022).

Many studies have recognized that various pollutants, including sulfur, nitrogen compounds, persistent organic pollutants, can be transported from the lower latitude Eurasian industrial zone to the Arctic during winter and spring (Arnold et al. 2016). These patterns are mainly controlled by the North Atlantic Oscillation (NAO) with obvious seasonal variation.

Therefore, these 133Xe observations can also be interpreted as the result of long-range transport by air masses. In this study, we investigated how NOA controls the transport of radioactive xenon to the Arctic, especially during winter and spring. The results show that the monthly mean 133Xe concentrations are positively correlated with the NAO index.

More interestingly, as a noble gas, 133Xe is not affected by air chemistry and deposition processes, and can be used as a tracer with a half-life of 5.24 days. Its surface concentrations during the Arctic winter and spring are estimated to increase by more than several hundred percent compared to concentrations occasionally observed during summer.

This study is the first international report on 133Xe observed at three Arctic monitoring stations Yellowknife, Resolute, and Spitsbergen. It is believed that the 133Xe observed at these stations is correlated and comes from the same source. A deeper analysis of these monitoring data will strengthen our understanding of the dispersal atmospheric transport models.

**References**

M. Zahringer, A. Becker, M. Nikkinen, P. Saey, G. Wotawa, CTBT radioxenon monitoring for verification: today’s challenges, J Radioanal Nucl Chem (2009) 282:737–742, DOI 10.1007/s10967-009-0207-3.

Weihua Zhang, Jussi Paatero, Ari-Pekka Leppanen, Bredo Møller, Louise Kiel Jensen, Kjartan Gudnason, Mikhail Sofiev, Pål Anderson, Morten Sickel, Agnieszka Burakowska, Marek Kubicki, Amanda Anderson, Evaluation of 137Cs, 133Xe and 3H activity concentrations monitored in the Arctic atmosphere (2022) Journal of Environmental Radioactivity Volumes 253–254, 107013.

Arnold, S. R., K. S. Law, C. A. Brock, J. L. Thomas, S. M. Starkweather, K. von Salzen, A. Stohl, S. Sharma, M. T. Lund, M. G. Flanner, T. Petaja, H. Tanimoto, J. Gamble, J. E. Dibb, M. Melamed, N. Johnson, M. Fidel, V. –P. Tynkkynen, A. Baklanov, S. Eckhardt, S. A. Monks, J. Browse, and H. Bozem (2016), Arctic air pollution: Challenges and opportunities for the next decade, Elementa: Science of the Anthropocene, 4:000104, https://dx.doi.org/10.12952/journal.elementa.000104