10-1 Toward Enhancement of Monitoring Capability for Nuclear Tests
— Evaluating the Impact of MIPF on Observational Results at CTBT Radionuclide Stations —
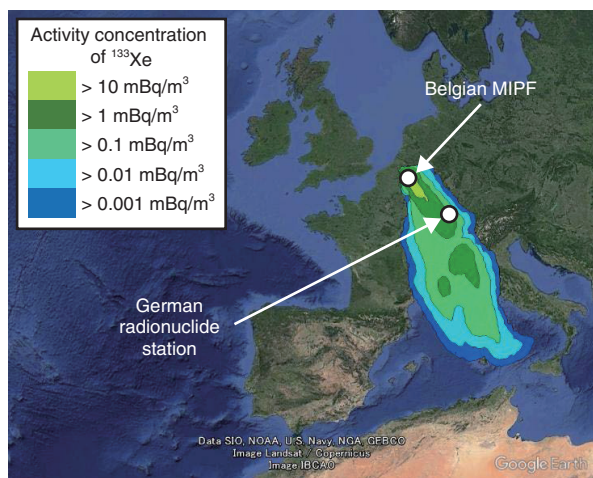

Fig.10-2 Atmospheric dispersion simulation of Xenon-133 (^{133}Xe) emitted from a Belgian medical radioisotope production facility (MIPF)
As part of the study, we simulated the atmospheric dispersion of ^{133}Xe emitted from a stack at the MIPF of the Institute for Radioelements (IRE) in Belgium using the stack monitoring data. The emitted ^{133}Xe reaches the German radionuclide station. (An atmospheric transport modelling (ATM) analysis software (HYSPLIT) developed by the National Oceanic and Atmospheric Administration (NOAA) was used.)

Fig.10-3 Comparison of ^{133}Xe activity concentrations observed at the German radionuclide station and calculated in simulations by the JAEA
When the observed ^{133}Xe activity concentrations at the German radionuclide station were high, the values calculated in simulations by the JAEA were also high. This correlation confirms that the MIPF of the IRE in Belgium is a dominant emission source of the ^{133}Xe observed at the German radionuclide station during this period.

Although the Comprehensive Nuclear-Test-Ban Treaty (CTBT) that bans nuclear tests in any space has not yet entered into force, approximately 85% of the international monitoring system of nuclear testing, comprising 337 monitoring facilities worldwide, has established and operated provisional measures.

Among the relevant radionuclides to be monitored by the CTBT is radioxenon, which is generated in large amounts by a nuclear test. Because noble gases are chemically inert, radioxenon is more likely than other radionuclides to seep to the surface after an underground nuclear test. Therefore, radioxenon is an important detection-indicator of an underground nuclear test. Radioxenon is observed at 30 radionuclide stations worldwide (as of May 2017), including the Takasaki station in Japan, under the international monitoring system. Previous observation results showed that the radioxenon isotope ^{133}Xe is frequently detected with high activity concentrations at some stations. MIPFs are considered as the dominant emission sources of ^{133}Xe, as they produce radioisotopes for nuclear medical examinations by nuclear fission reactions. To discriminate whether the observed ^{133}Xe originates from civil nuclear facilities or nuclear testing, one must evaluate the impact of the ^{133}Xe emitted from MIPFs on the observational results at radionuclide stations.
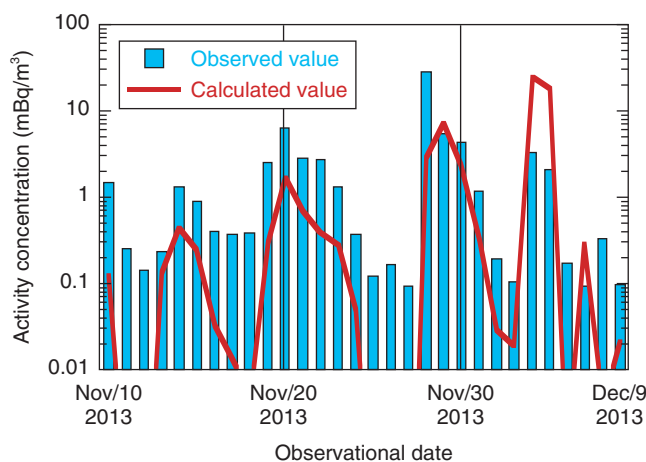
The impact of MIPFs was investigated in an ATM simulation analysis. Implemented in 2015, this project involved seven nations, including us and the CTBT Organization (CTBTO). In the ATM simulations, we analyzed and evaluated the activity concentration of ^{133}Xe arriving at the German radionuclide station using the stack monitoring data (acquired from November 10th to December 9th, 2013) of the MIPF of the IRE in Belgium. Figs.10-2 and 10-3 show an ATM simulation result and a comparison between the observed and simulated results at the station, respectively. The observed and calculated values on days of high ^{133}Xe activity concentration were well correlated, confirming that the MIPF of the IRE was a dominant emission source of ^{133}Xe. Conversely, on some days (when the observed ^{133}Xe activity concentration was low), the MIPF of the IRE was an unlikely emission source of ^{133}Xe.

We are continuing our ^{133}Xe observations in cooperation with the CTBTO and with specialized institutions in other countries. By evaluating the impact of emissions from civil nuclear facilities on the observational results, we hope to enhance the capability of monitoring nuclear-test emissions.

Reference
Eslinger, P. W., Kijima, Y. et al., International Challenge to Predict the Impact of Radioxenon Releases from Medical Isotope Production on a Comprehensive Nuclear Test Ban Treaty Sampling Station, Journal of Environmental Radioactivity, vol.157, 2016, p.41-51.