SnT 2019
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High-density configuration experiment of noble gas measurement systems in Japan

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HISTORY OF RADIOXENON MEASUREMENT CAMPAIGNS

The Commission is carrying out radioxenon measurements with very sensitive systems operated as part of the International Monitoring System (IMS). The ability of the noble gas measurements to detect nuclear explosions depends on understanding background concentrations of radioxenon originating from other sources like medical isotope production facilities and nuclear power plants.

In order to ensure the quality and the accuracy of the noble gas measurements capabilities, the noble gas background that can be expected in various regions of the world must be characterized. Field measurement campaigns are an important way to advance methods for the noble gas monitoring component of the IMS.

Mobile measurement campaigns are funded through voluntary contributions from States Signatories.

Through a contribution from the European Union, European Council Decision III (2008-2012) the Commission purchased two transportable Noble Gas monitoring systems, the SAUNA-TXL2 and the SPALAX-DR, able to measure 133Xe, 135Xe, 133mXe and 131mXe at ultra low concentration like at IMS stations.

From 2008, short background measurement campaigns of several weeks have been performed around the world using portable equipment. From 2012, measurement campaigns started to be performed using integrated mobile systems for a duration of at least one year to cover seasonal variations.

THE SYSTEMS

JPX81 Horonobe
- TXL3-SAUNA mobile system
- Data transmission started in January 2018
- Expected campaign duration: 2 years

MUX88 Mutsu
- TXL2-SAUNA mobile system
- Data transmission started in March 2018
- Expected campaign duration: 2 years

JPX82 Fukuoka
- SPALAX-DR mobile system
- Expected installation and data transmission: September 2019
- Expected campaign duration: 1 year

JPX38 Takasaki IMS system
- SAUNA IMS system
- Certified in 2004

HIGH DENSITY CONFIGURATION EXPERIMENT

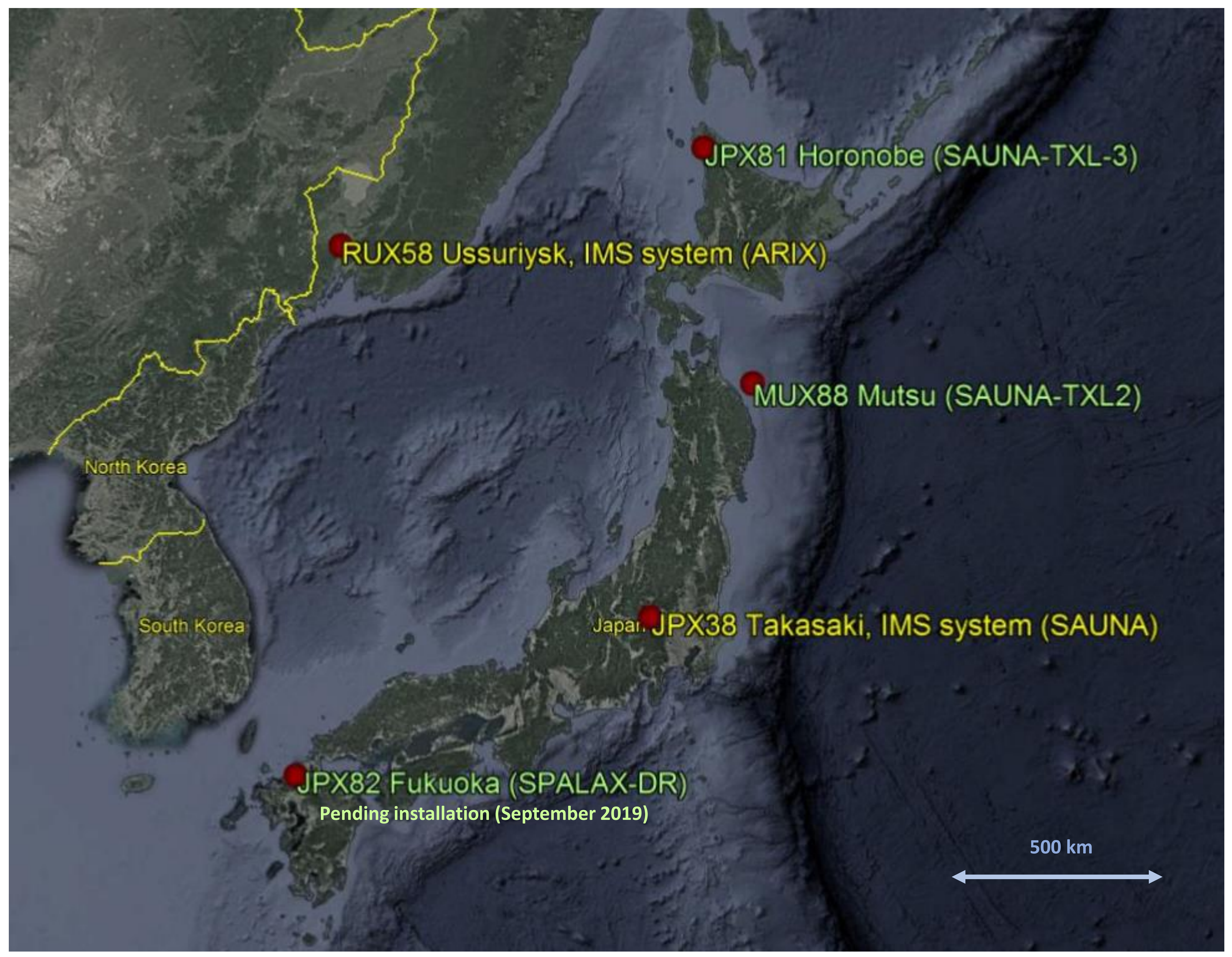
In February 2017, Japan made a voluntary contribution to the Commission to enhance xenon background measurement campaigns through two projects:
- Purchase and installation of a new system, TXL3-SAUNA, at Horonobe, Japan
- Hosting the TXL-2 SAUNA system at Mutsu, Japan

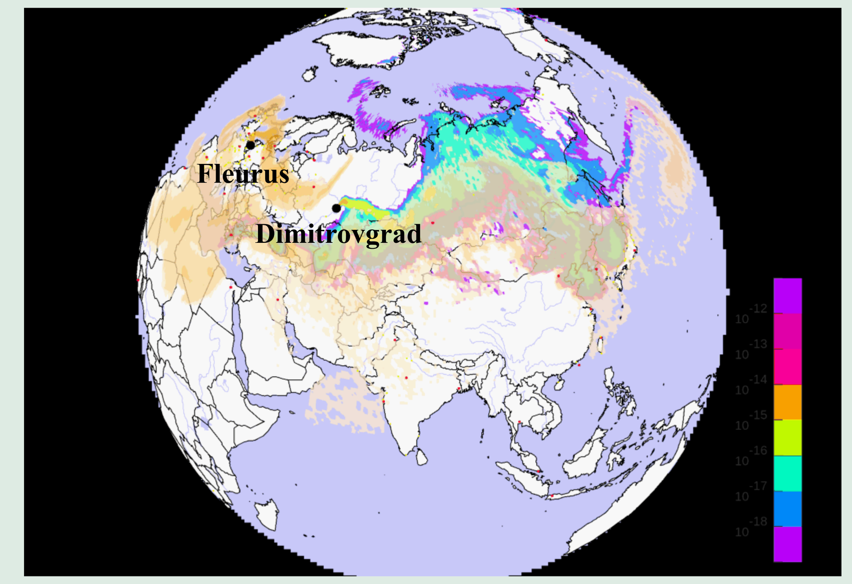
In 2018, the PTS decided to deploy the SPALAX-DR at Fukuoka, Japan in order to extend the temporary high capability configuration using three mobile systems in a range of ~1000 km from the IMS noble gas system RN38 in Takasaki, Japan.

This unique configuration in the network will enable a better understanding of anomalous detections at the IMS noble gas stations, especially JPX38, Takasaki, and RUX58, Ussuriysk.

These data will be used to develop and test methods for understanding the background and contribution of known sources across Eurasia that are frequently observed at JPX38.
This configuration will enable the observation of the same event release at different locations and therefore testing and optimizing source location algorithms and obtaining a better understanding of level C episodes. The optimization and advance of screening methods as an outcome of this campaign will be implemented in the IDC analysis, not only with regard to JPX38 data, but also for data of the other IMS noble gas systems .

Data collected by the mobile systems will be used to advance methods for IMS noble gas monitoring, specifically:
- validate and improve scientific methods for understanding of the impact of well-characterized sources (controlled source-receptor experiments),
- gain knowledge that can be used for future decisions about the IMS network (sampling time duration, additional up to 40 sites)
- explore enhancements and new approaches for event analysis and source location (high-density network) including further developments of atmospheric transport modelling (ATM).





The radioxenon background in Japan is largely influenced by civilian facilities releases over Europe and Russia

To illustrate this, this map shows atmospheric transport modelling simulation of the plumes produced by continuous emissions from the two largest MIPFs, Fleurus (Belgium) and Dimitrovgrad (Russia) after 10 days.

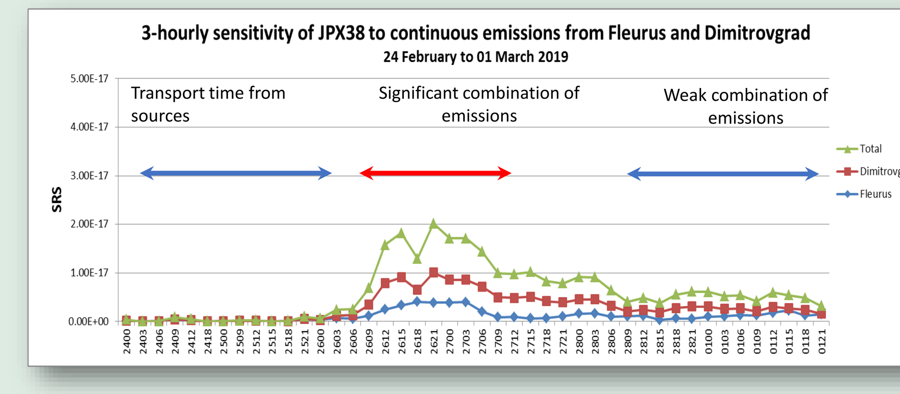
Because mean winds blow from the west, eastern Asia is often under the influence of xenon-emitting installations concentrated in western Europe/western Russia.

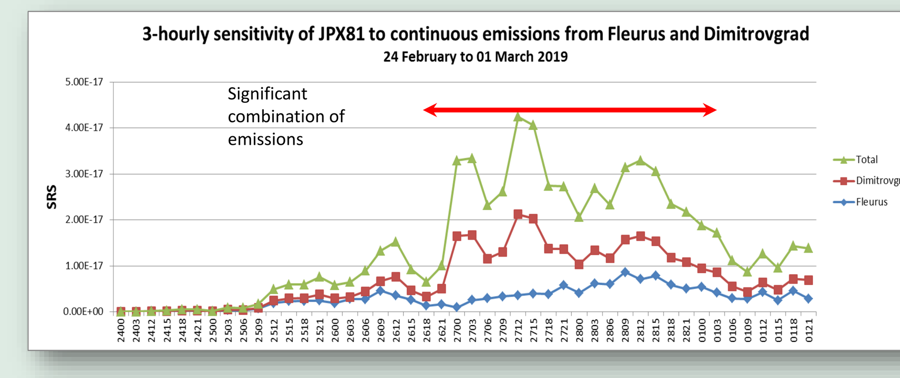
Occasionally, wind patterns cause emissions to combine, creating high Xe values over Japan. Other wind patterns can lead to very low values, thus explaining the large variability of Xe background over this area. This is illustrated by these simulated time series for each site.

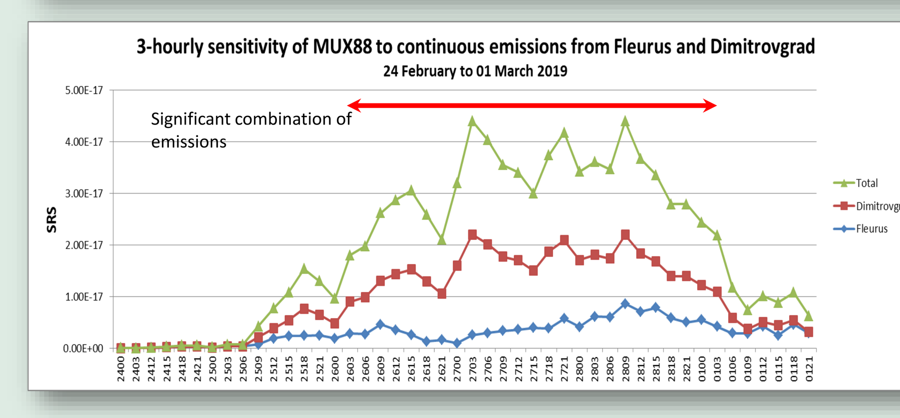
Even if the sources are far away (~10,000 km), significant differences in the detections can be expected between stations (IMS, mobile campaign) located less than ~1000 km away.

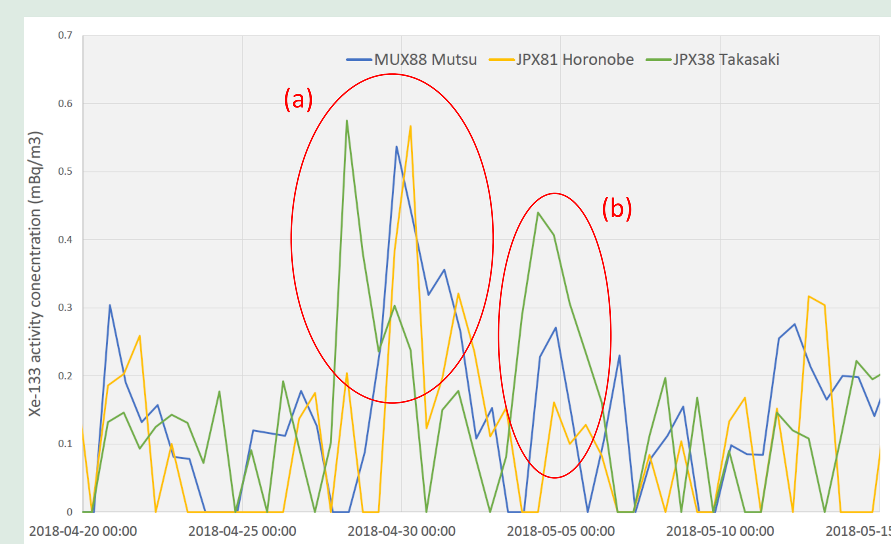
The plume is not as uniform as could be expected, there variability is observed at IMS stations. The high density radioxenon measurement system allows to observe this variability both in time and space.

Of course, there may be the influence of weaker but closer local/regional sources.









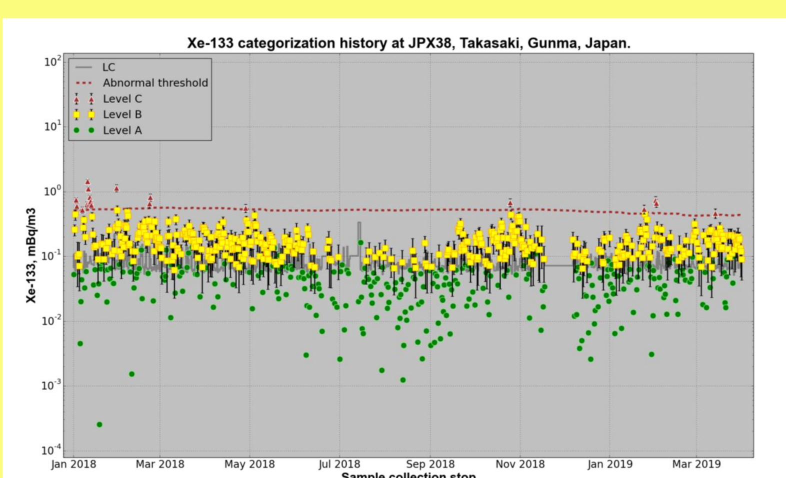
To illustrate this, here is a typical time series of Xe133 concentrations measured at 3 sites over a period of 25 days. These data were extracted from the data acquired in 2018 (bottom left plots).

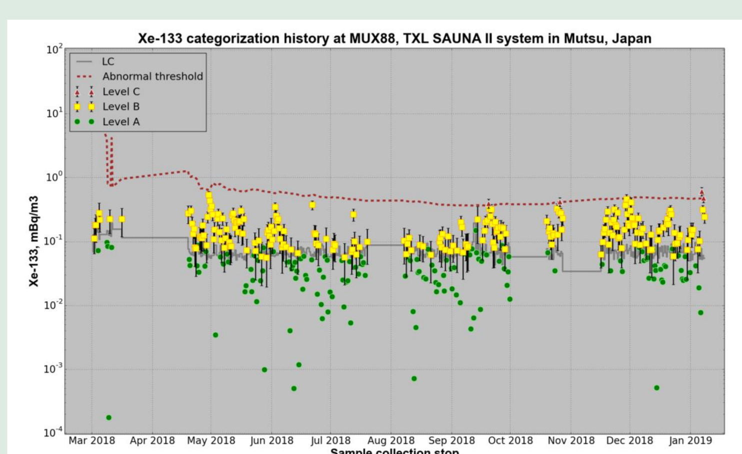
(a) These peaks detected at the 3 stations have very similar shape. However, it was detected at JPX38 two days before detection at JPX81 and MUX88.

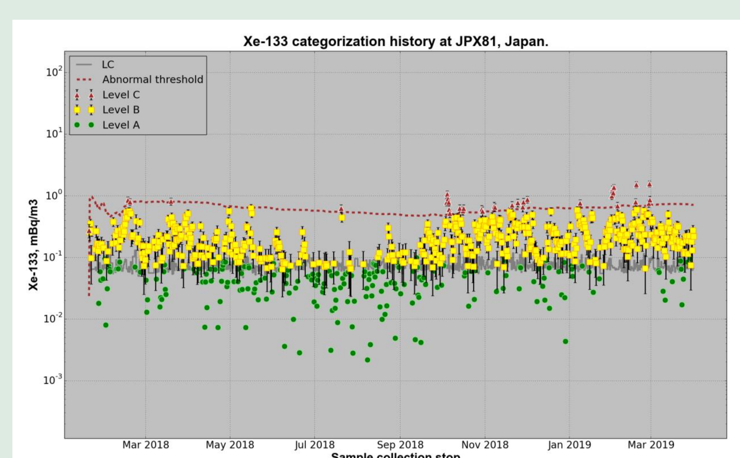
(b) Theses peaks were detected at the same time but with a different intensity.

Data collected during mobile campaigns helps (1) understanding this variability and (2) will allow developing improved ATM-related tools and methods for IMS noble gas monitoring.

Xe133 Concentration and categorisation at this high density configuration







JPX82 (installation planned in September 2019)

DATA SHARING

Data are made available to authorized users of States Signatories via the PTS secure web portal
https://swp.ctbto.org/web/swp/2018-ng-background-measurement-campaigns

And to the scientific community via vDEC
http://www.ctbto.org/specials/vdec
Contact: vdec@ctbto.org