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The 8th Workshop on Signatures of Man-Made Isotope Production

June 20-24th, 2022 in Stockholm, Sweden

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Overview of WOSMIP-VIII

June 20-24th, 2022 Stockholm Sweden

Introduction

The Eighth Workshop on Signatures of Man-Made Isotope Production (WOSMIP-VIII) was held June 20-24th, 2022 in Stockholm Sweden, co-hosted by the Swedish Defence Research Establishment (FOI). The workshop had a total of 106 participants; 72 in-person and 34 virtual attendees. The detailed agenda and presentations for the workshop and the attendance list are located at https://www.wosmip.org/wosmip-viii-stockholm-sweden.

WOSMIP-VIII consisted of four main topical areas: monitoring network backgrounds, isotope production, facility stack and near-field monitoring, and atmospheric transport. Each topical area consisted of presentations and dedicated roundtable discussion periods. During the workshop, there was a tour of the Scienta Sensor Systems facility, where the SAUNA Qb and the production and testing areas for the SAUNA Qb and SAUNA-3 were presented to participants. While at Scienta Sensor Systems, there was also a demonstration of the software used as part of the Source Term Analysis of Xenon (STAX) project developed by ISTI.

Workshop participants agreed that the workshop is vital to the community and helps to advance the understanding of radioxenon backgrounds and event identification.

Backgrounds of Radionuclides in the Atmosphere

The presence and observation of backgrounds from nuclear power plants and medical isotope production was highlighted, noting that more background campaigns are needed. During discussions on current background observations, there were several potential new background sources identified. New information was presented that due to supply chain issues in the availability of Kr-85, some industries were moving to Xe-133 as a well logging tracer. More information about this new source usage, such as frequency of use, locations, and size of release should be investigated. Additionally, new sources of background radioxenon were discussed with observations of non-fission radioxenon isotopes at the Spallation Neutron Source (SNS) in Oakridge, Tennessee, and potential new sources from molten salt reactors.

The continued observation of background sources and potential new unstudied sources highlighted the importance of background campaigns and the need for the background campaigns to focus on locations near sources of radioxenon (ideally with stack monitors) to aid in source-receptor atmospheric transport calculations (ATM). The prevalence of background radioxenon signals also highlighted the need for the use of measurements of additional isotopes to better discriminate sources, such as using radioargon or particulate measurements to discriminate the production mechanisms for potential radioxenon sources. The inclusion of the other non-xenon systems in background campaigns (such as Argon-37 and non-noble gas isotopes) is important to fully understand the discrimination power of the other techniques and when they can be employed. If a future background campaign is performed at a location where a prior campaign was performed, it is important to include the additional measurement systems for a complete picture of backgrounds at that location.

Stack Monitoring

Isotope production with stack monitoring and the power of understanding the sources of radioxenon releases was discussed at length in the second session of WOSMIP-VIII. The use of stack monitoring data was highlighted by the STAX project, where data from medical isotope producers and nuclear reactors are being compiled and are now being utilized by the National Data Centers (NDCs) to better understand radioxenon events that are detected at IMS stations. An important part of NDCs and users using the stack monitoring data is to verify the quality of the data as it comes out of a facility. This is especially true when the data may come directly from a facility and isn't always the same type of measurement system. Monitoring of different types of facilities was highlighted with presentations about medical isotope production (MIP) and nuclear power plant stack monitoring.

Discussions on backgrounds highlighted the need for stack monitoring at facilities that aren't necessarily covered under current efforts; this included facilities such as spallation neutron sources, advanced reactors, and research reactors. It was also emphasized that the community needs a consolidated list of all source facilities around the world. The list would initially include locations but could also include stack monitoring detector types and data as the information became available. Understanding the types of facilities and locations would allow for estimates of backgrounds based on the type of facilities, for example a light water reactor (LWR) may have a more consistent release of radioxenon than other types of nuclear reactors (e.g., the Hartlepool advanced gas cooled reactor nuclear reactor in the United Kingdom). Further stack monitoring studies at a range of facilities would allow for a more generalized model of backgrounds to be incorporated into event analysis techniques.

The use of stack monitoring data is currently providing atmospheric transport modelers the opportunity to perform routine experiments with new source data that is acquired each day. The comparison of the forward model to what is seen at stations allows for a large comparison data set. This discussion was then tied back to the overarching background question of "Where should the next STAX monitor go?" With 400+ reactors, MIPs, and new source facility types, there is no shortage of need for stack monitors. The first step in getting a stack monitor in and utilizing the data for background measurements and ATM experiments is to develop the relationship with the facility. WOSMIP interactions and demonstrations serve as an important step in building that relationship with facilities.

Xenon Measurement Equipment

During a visit to the Scienta Sensors Systems facility participants had a discussion on the benefit of additional measurement systems to identify the source locations. With new radioxenon monitoring systems being available, the rate of installations in the International Monitoring System (IMS) will need to increase to implement the new generation of systems throughout the IMS in a reasonable amount of time – before the first installations are obsolete. Systems such as the SAUNA Qb and Xenon International array could also prove to be beneficial both for the IMS systems and background measurements.

In addition to the site visit, there were extensive discussions around the topics presented in the poster sessions. Posters covered topics including background campaigns, isotope production, stack monitoring, field experiments, laboratory operations, ATM studies, and many more.

Atmospheric Transport Modeling

On the final day of the workshop, presentations and discussions focused on atmospheric transport exercises and research. With the importance of high-resolution ATM modeling (e.g., the Weather Research and Forecasting Model (WRF)) for small scales, understanding how to bridge the distance scales between models is important and may be important in future atmospheric transport exercises. In the CTBTO ATM exercise using 2014 data, the results showed missing the mark of 90% identification of hypothetical nuclear tests identified, but it was noted that not all of the IMS noble gas stations were operating in 2014. The results do raise the question: how can we improve identification numbers and integrate background measurements? Additionally, with IMS stations on the ground, what is the impact of vertical plume distributions and are there experiments possible to test the theory and models of vertical sampler distributions? Future experiments may be needed to fully answer these questions.

Recommendations and Observations

Experts at WOSMIP had a few recommendations for further work in this area including:

1) The monitoring community should create and maintain a list of potential sources of airborne radioactivity available to all so that recreation of lists does not have to be continually done, and so that analyses of the network performance can be completed consistently. If possible, the list could simply contain a list of the coordinates of the emission points, though more information could be linked if available such as refueling schedule, available historical documents, and stack monitoring data.

2) Participants felt that volunteer stack monitoring of nuclear facilities was important and a successful activity that should continue to improve the performance of the IMS. The voluntary supply of stack monitoring data has occurred from several facilities and more partners are being sought to supply data.

3) In addition to xenon noble gas backgrounds, participants felt that additional data and measurements are needed on backgrounds of Argon-37 and particulate isotopes.

4) Participants discussed the possibility that local atmospheric activity concentration backgrounds may have a different vertical dependence than distant sources of radioactivity. This might be possible to employ in eliminating local sources of background if there is enough vertical variation in concentrations at achievable collection altitudes above the surface (<100-200 meters). We encourage experiments and atmospheric transport modeling calculations to test this hypothesis.

5) Participants were impressed with new attempts to define uncertainties for ATM. Although this stochastic process does not lead to clear methods for establishing error bars on ATM calculations, this is something that is needed to be consistent with verification measurements and therefore a topic where we encourage additional research.

6) Participants noted that “non-traditional” sources of man-made background need more study. The usual sources of radioactivity include nuclear reactors and medical isotope production facilities, though sources such as hospitals, spallation neutron sources, and industrial uses are not well documented and could be significant sources of background.

Conclusions

Two awards were given at WOSMIP-VIII (WOSTER/WOZZIE), the WOSTER for best poster and the WOZZIE for overall contribution to the community. The WOSTER was given to Matt Goodwin from the Atomic Weapons Establishment (AWE) for the description of a regional environmental monitoring campaign outside the Hartlepool nuclear reactor; and the WOZZIE award for outstanding contributions to understanding ATM and associated uncertainties was given to Sylvia Generoso from Commissariat à l'énergie atomique et aux énergies alternatives (CEA) in France.