Contract No:

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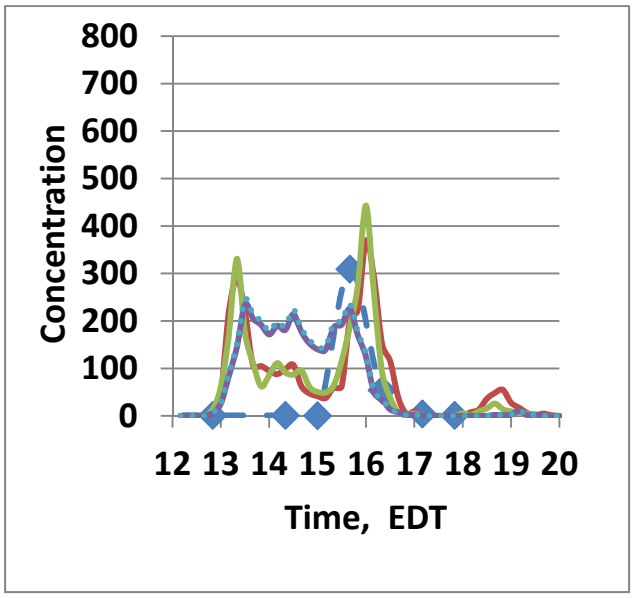
Disclaimer:

Optimized Sampling Strategies for Non-Proliferation Monitoring: Report

Project Highlight: The figure shows the measured surface concentration at 5km downwind (dotted line) and 4 of 10 model simulations in an ensemble. The model simulations were adjusted in time to produce a best fit with the data, from which the source strength (Ci/sec) and its uncertainty were calculated. The uncertainty was 1/3 previous estimates.

The results show how downwind concentrations can be used to infer the history of chemical release from a denied site with improved accuracy.



Awards and Recognition

Intellectual Property Review

This report has been reviewed by SRNL Legal Counsel for intellectual property considerations and is approved to be publically published in its current form.

SRNL Legal Signature

Signature **Date**

Optimized Sampling Strategies for Non-Proliferation Monitoring~~: Report~~

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Subcontractor: None

Thrust Area: ST1

Project Type: National Security

Project Start Date: Ap 27, 2015, 2013
Project End Date: September 30, 2015

Abstract: Concentration data collected from the 2013 H-Canyon effluent reprocessing experiment were reanalyzed to improve the source term estimate. When errors in the model-predicted wind speed and direction were removed, the source term uncertainty was reduced to 30% of the mean. This explained the factor of 30 difference between the source term size derived from data at 5 km and 10 km downwind in terms of the time history of dissolution. The results show a path forward to develop a sampling strategy for quantitative source term calculation.

FY2015 Objectives

- Reanalyze data from the 2013 H-Canyon effluentexperiment.
- Evaluate a new technique to calculate the source term.
- Evaluate sampling strategies for future experiments and global non-proliferation applications.

Introduction

The purpose of the 2013 H-Canyon effluent experiment was to characterize reprocessing operations based on downwind surface radionuclide measurements. An important objective was to compare the measured concentrations with values estimated from atmospheric transport models, with emphasis on realistic situations with limited data.

The analysis presented in the Project report considered only maximum values and lower limit estimates of the source term, which resulted in large uncertainties. We reexamined the data with an ensemble of model simulations to reduce the uncertainty and better define the time history of the dissolution process in H-Canyon. A further objective was to critique the sampling strategy followed in the field experiment to select optimal sampling for estimating the source term.

Approach

We corrected errors in the model wind direction and speed by adjusting the simulated plumes to fit the measurements in a least-square sense. The ensemble of simulations encompassed the range of variability seen in the real atmosphere during the experiment and quantified the uncertainty. Figure 1 shows the measured concentration and four model simulations. (The first lobe in the model plots has no observational counterpart).

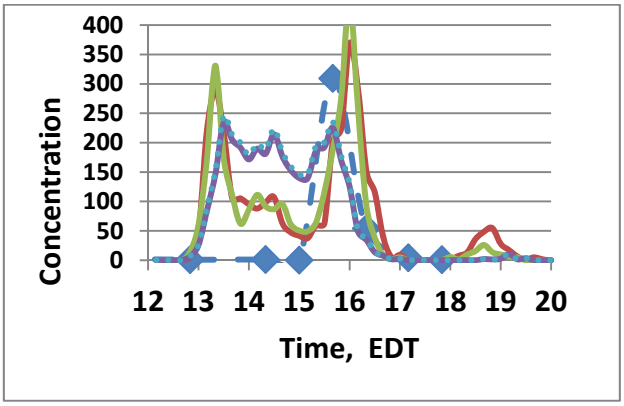

Figure 1: Measured (dashed) and model-simulated concentrations at 5 km downwind.

Results/Discussion

The research produced robust uncertainty estimates equal to ~30% of the mean, compared to the >100% values obtained in the previous analysis. This improvement permitted attribution of measurements at 5 km and 10 km downwind to different points in the dissolution process and explained the factor of 30 difference between them. The 5 km results were assigned to the period before the maximum release whereas the 10 km were associated with the period during maximum release.
The results also highlighted the relative value of several short (1 minute) samples versus extended samples (>4 hours). Short samples permit model plume adjustment for an optimized fit to the data, while long term samples reduce experimental error but can be ambiguous if an unknown portion of the plume is captured in the sample.

FY2015 Accomplishments

- The results are a major step in our efforts to elevate the analysis of downwind radionuclide measurements to a quantitative tool in non-proliferation analysis.
- The research also outlined a method to apply ensemble simulations to find uncertainty estimates in locations with limited data, i.e., to suspected nuclear processing sites throughout the world.
- The work employed a technique we have applied to the detection of low-level Xenon concentrations measured following the 2013 underground nuclear test in North Korea.

Future Directions

- Future directions will include the use of special data sets of opportunity, including wind and concentration measurements at various locations around the release andmeasurement sites
- A presentation, similar to the PowerPoint summary prepared for this QuickHit will be prepared for potential offsite customers.

FY 2015 Publications/Presentations

This method was outlined in a presentation made to the Nuclear Weaponization and Material Production Detection Review Meeting (MPD 2015) at the Los Alamos National Laboratory, April 28-30, 2015.

References

None

Acronyms

None

Intellectual Property

None

Total Number of Post-Doctoral Researchers

None