J4.3 NATIONAL ATMOSPHERIC RELEAES ADVISORY CENTER DISPERSION MODELING IN RESPONSE TO THE FUKUSHIMA DAIICHI ACCIDENT

G. Sugiyama*, J.S. Nasstrom, K. Foster, B. Pobanz, M. Simpson,
P. Vogt, F. Aluzzi, and S. Homann

Lawrence Livermore National Laboratory, University of California
Livermore, California

1. INTRODUCTION

On March 11, 2011, the U.S. Department of Energy/National Nuclear Security Administration (DOE/NNSA) activated the National Atmospheric Release Advisory Center (NARAC) at Lawrence Livermore National Laboratory to respond to the accident at the Fukushima Daiichi nuclear power plant. NARAC is the atmospheric dispersion modeling center for DOE/NNSA emergency operations and one of the components of the Consequence Management Home Team (CMHT). Its primary mission is to provide detailed assessments of the dispersion and potential downwind consequences of atmospheric releases of hazardous materials (Nasstrom et al. 2007; Sugiyama et al. 2010).

Through the end of May, NARAC supported a wide range of requests for the Fukushima Daiichi accident providing:

- Daily weather forecasts for U.S. personnel deployed to Japan
- Estimates of possible dose in Japan for hypothetical scenarios developed in conjunction with DOE/NNSA and the U.S. Nuclear Regulatory Commission (NRC) at White House request
- Predictions of possible plume arrival times and dose for U.S. locations
- Source estimation and model refinement based on available measurement data

A more detailed discussion of NARAC's response activities can be found in Sugiyama et al., 2012a and 2012b.

2. SOURCE RECONSRUCTION

During the response, NARAC source reconstruction efforts focused on March 14-16 as this was determined to be the most likely period during which deposition produced a high dose-rate area to the northwest of the Fukushima Daiichi plant, seen in DOE/NNSA Aerial Measuring System surveys. Accurate simulations of winds and precipitation were important in source estimation, with wet deposition critical to modeling the northwest hot zone. Arguably, the best NARAC meteorology was provided by the Weather Research and Forecasting (WRF) model in Four-Dimensional Data Assimilation mode at 1-3 km resolution. As only dose-rate data were available to NARAC, *a priori* assumptions were made regarding the primary radionuclide contributors to dose. The radionuclides modeled were ^{133}Xe, ^{131}I, ^{132}I, ^{132}Te, ^{137}Cs, and ^{134}Cs, with relative activity ratios of 100:20:20:20:1:1 and 100:10:10:10:1:1 derived from limited field measurement data and reactor scenario analyses. Release rates were determined by optimization of the overall fit between model results and data paired in space and time, using both statistical (percentage of values with factor R, bias, etc.) and graphical metrics. Although NARAC found that a range of emission rates and quantities were consistent with the available data, all source estimates were within a factor of three of each other for the period of interest. These release amounts were similar to other studies that used different source estimation methodologies and radiological measurement data (Chino et al., 2011: GOJ 2011a-c; Stohl et al., Atmos. Chem. Phys. Discuss. **11**, 28319–28394).

Fukushima source and dose estimation remains a challenging problem, due to multiple releases of long duration, rapidly changing reactor conditions, highly-variable meteorology, complicated geography, off-shore flow periods for which limited to no monitoring data are available, and the limited availability of measurement data during the early days of release, when the most significant releases are likely to have occurred.

3. CONCLUSION

The releases from the Fukushima Dai-ichi nuclear power plant are still incompletely characterized due to the long-term duration of the event, the rapidly changing and still unknown reactor and spent fuel conditions at multiple units, the complicated geography of the region, the highly-variable meteorological conditions, and the relatively limited data available during the early stages of the event when the most significant releases are likely to

* *Corresponding author address*: Gayle Sugiyama, L-103, LLNL, P.O. Box 808, Livermore, CA 94550, USA; e-mail: sugiyama1@llnl.gov

have occurred. The Fukushima data set needs to be further analyzed and used to improve and evaluate meteorological and dispersion modeling, data assimilation, dose assessment, and source reconstruction methodologies in order to improve capabilities for responding to future events of a similar scale and complexity.

ACKNOWLEDGEMENTS

This work was performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under Contract DE-AC52-07NA27344. The authors would like to express their appreciation to collaborators in this effort including the rest of the NARAC staff; CMHT collaborators at RSL, SNL, LANL, and LLNL; LLNL's Radiological Triage group; the DOE Nuclear Incident Team, and the Nuclear Regulatory Commission. This paper has been released as LLNL-PROC-614492.

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