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Atmospheric Release Assessment Program (ARAP) Science and Technology Base Development

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Atmospheric Release Assessment Program (ARAP)
Science and Technology Base Development

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ARAP s integrated suite of research, development, and operational programs is focused on the creation of capabilities for predicting the consequences of atmospheric releases of hazardous materials. The foundation of ARAP lies in its science and technology base in multi-scale meteorological and dispersion modeling, field experiments, and software systems (databases, real-time data acquisition software, and remote-access tools). Scientific and technological advancements are integrated into DOE/NNSA s operational National Atmospheric Release Advisory Center (NARAC) at LLNL to support emergency response, pre-event planning, preparedness, and consequence analysis. Some recent ARAP development highlights are described below.

Urban Field Experiments. DOE/NNSA's Chemical and Biological National Security Program (CBNP) supported the multi-institutional URBAN 2000 dispersion field experiment conducted in Salt Lake City in October, 2000. Data from this experiment have been collected and archived on a LLNL web site (http://urban.llnl.gov) for distribution to participants. For the nocturnal conditions of this study, meteorological and dispersion complexity have been shown to result from the strong interaction of mesoscale flows with the urban area. Planning is currently underway for a second CBNP field experiment to study day-time convective conditions in Oklahoma City during the summer of 2003.

Urban Models. ARAP has developed a suite of models to simulate the effect of urban areas on atmospheric flow and dispersion:

- an urban parameterized version of the ADAPT diagnostic model, based on modification of the winds and turbulence in the urban roughness sublayer (coupled to the LODI dispersion model),
- an urban canopy version of the COAMPS weather forecast model, which incorporates drag, turbulent production, anthropogenic and rooftop heating, and modifications to the radiation balance, and
- a computational fluid dynamics model FEM3MP which explicitly resolves buildings.

The urban models are being evaluated against data from DOE s URBAN 2000 field experiment. The ADAPT/LODI urban parameterization yields statistical improvement over non-urban simulations. The COAMPS urban canopy model also dramatically improves wind and LODI plume predictions, and captures important wind directional shifts. Sensitivity studies are being conducted to determine the effects of model resolution, land-use, and urban model inputs. Improvements are needed to capture the exact timing of wind shifts and the lingering of the plume in the urban area. FEM3MP building scale model calculations show good agreement with the near-source tracer data. The sensitivity of FEM3MP results to inflow conditions and turbulence models is being analyzed.

LDRD Projects. ARAP currently has support for four LDRD projects to develop:

- Precipitation scavenging models coupled to NEXRAD precipitation data, with evaluation against detailed data available from the Atmospheric Radiation Measurement Program
- A multi-scale modeling system for integrated global-, regional-, urban-, and building-scale meteorological and dispersion simulations

- A prototype sensor-driven modeling system for determining source characteristics and optimizing plume predictions, based on a methodology which combines Bayesian statistical comparisons and an efficient Monte Carlo sampling technique
- Integration of chemistry models into atmospheric transport and fate simulations

Atmospheric Radiation Measurement (ARM) Inter-comparison Study. ARAP staff led an international model inter-comparison effort to evaluate convective cumulus parameterizations used in climate models. The study made use of data from the DOE ARM Program and identified critical features of the parameterizations, such as triggering mechanisms. Improvements in such features will lead to more accurate simulation of convective process and associated clouds in climate models.

NARAC Remote-Access Technologies. NARAC is developing and deploying a suite of Internet and Web tools, which provide access to combined deployable rapid-response and reach-back central-system modeling capabilities. Three remote-access capabilities are being provided:
- the NARAC iClient, a Java software tool that permits users to enter release information and request and receive automated detailed predictions from NARAC s state-of-the-science meteorological and dispersion modeling system at LLNL,
- the NARAC Web Product Distribution system, which distributes NARAC products to multiple authorized users through a password-controlled Web page, and
- a new NARAC Web capability to provide a simplified Web-based interface for NARAC simulation requests (new development effort).

Homeland Security Support. Pilot projects are underway in Seattle and Albuquerque to develop approaches for integrating NARAC capabilities with local emergency management and response centers. NARAC is also engaged in a collaboration to couple Argonne National Laboratory s CB-EMIS subway modeling system for the Washington DC Metro system with NARAC models.

NARAC Operational Support. NARAC was extensively used for DOE/DoD threat-response support during the heightened alert following the events of September 11, 2001. Simulations were also performed during the decontamination of the Hart Senate Office Building in January, 2002. NARAC deployments supported the Presidential State-of-the-Union Address (January, 2002) and the Salt Lake City Winter Olympics (January-February, 2002).

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We are Developing CB Urban Dispersion Capabilities for Counter-terrorism Applications

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Multi-Scale NARAC Response to Sept. 30, 1999 Tokaimura, Japan Criticality Accident

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NARAC Response to Cerro Grande Fire at Los Alamos National Laboratory

Wind Field Forecasts Helped Keep Deployed Teams Out of Dense Smoke and Harms Way

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