Overview of National Atmospheric Release Advisory Center (NARAC) and 2005 Update of Activities

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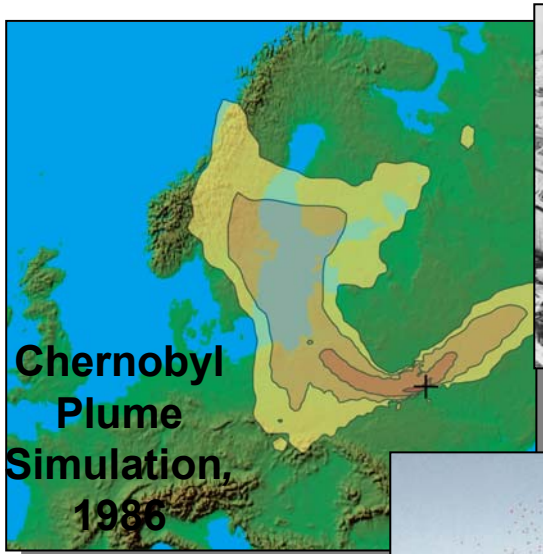
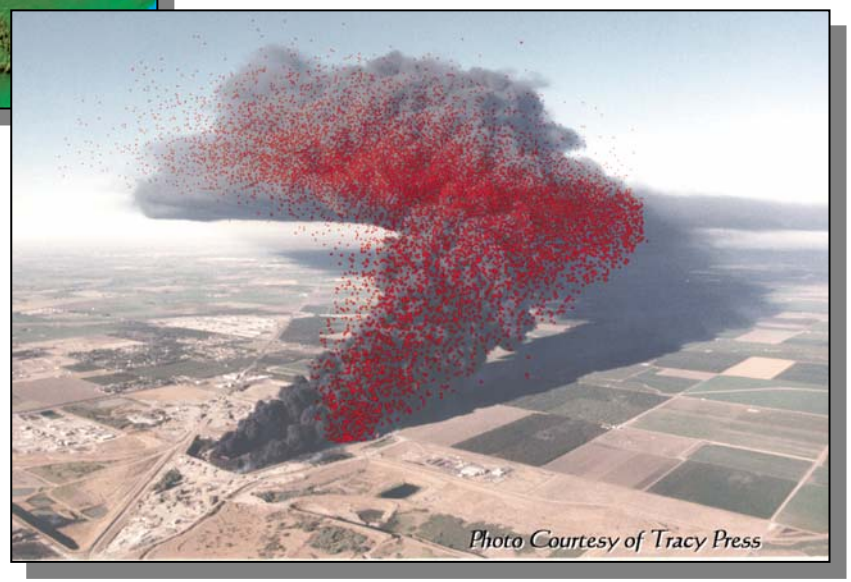
NARAC Can Provide Predictions for Assessing a Wide Range of Atmospheric Hazards

- Explosive dispersal of radiological material
- Nuclear explosions
- Toxic industrial chemical spills
- Fires
- Biological agents
- Chemical agents
- Nuclear power plant accidents

What is the hazard?
Where is it going?
Who is at risk?
How do we respond?

Example NARAC 3-D Dispersion Model Simulations





NARAC Simulation (red) and Smoke Plume Photograph, Tire Dump Fire, *Tracy, California, August 7, 1998*

Example Responses

- Three-Mile Island
- Chinese nuclear tests
- Chernobyl
- Richmond, CA chemical Cloud
- Desert Storm, Kuwait oil fires
- Mt. Pinatubo Volcano
- Cerro Grande, NM Fire
- Tokaimura, Japan, Uranium accident
- Staten Island, NY Fire
- Conyers, GA Fire

NARAC Provides Consequence Management Tools, Services & Products

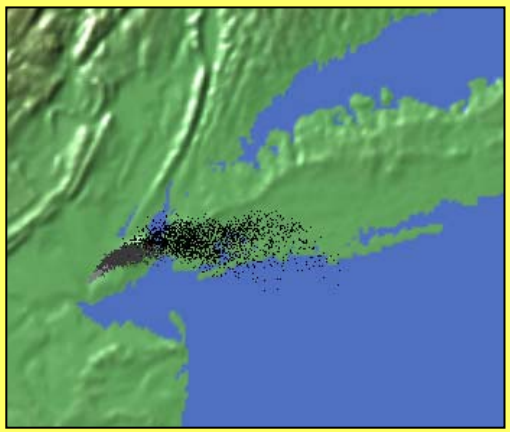
NARAC
National Atmospheric Release Advisory Center

Event information

- Weather data
- Nuclear, radiological, chemical, biological source information
- Sensor data

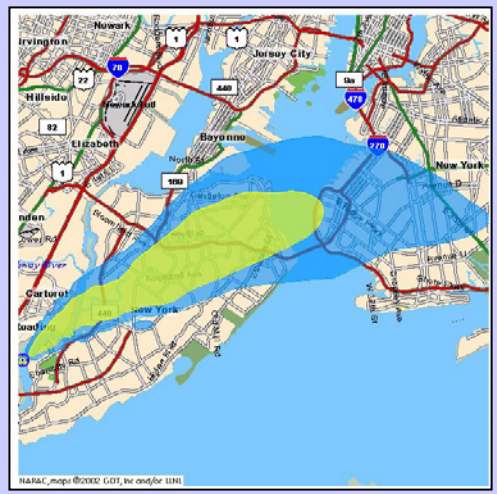
Plume Models and Expertise

- Advanced, automated 3-D plume modeling anywhere in real-time
- Scientific and technical staff provides training/assistance and detailed analysis 24 hrs x 7 days

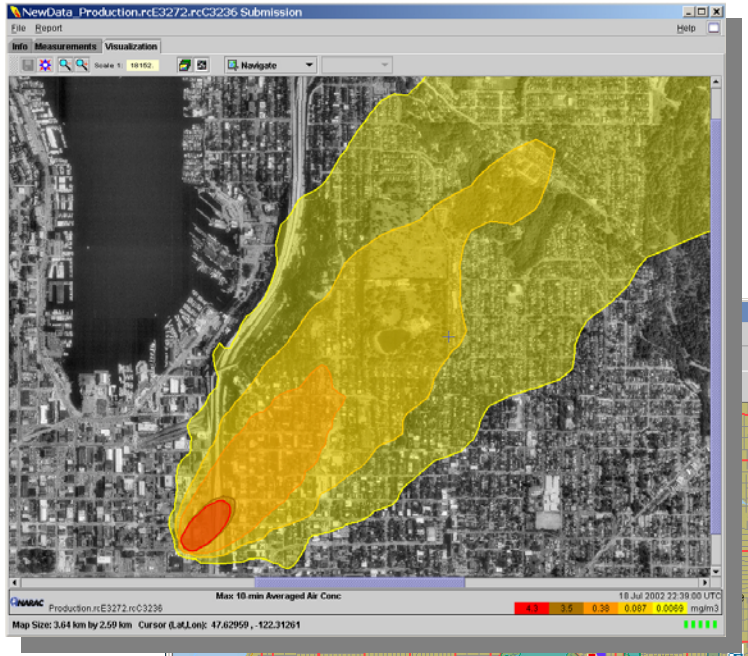


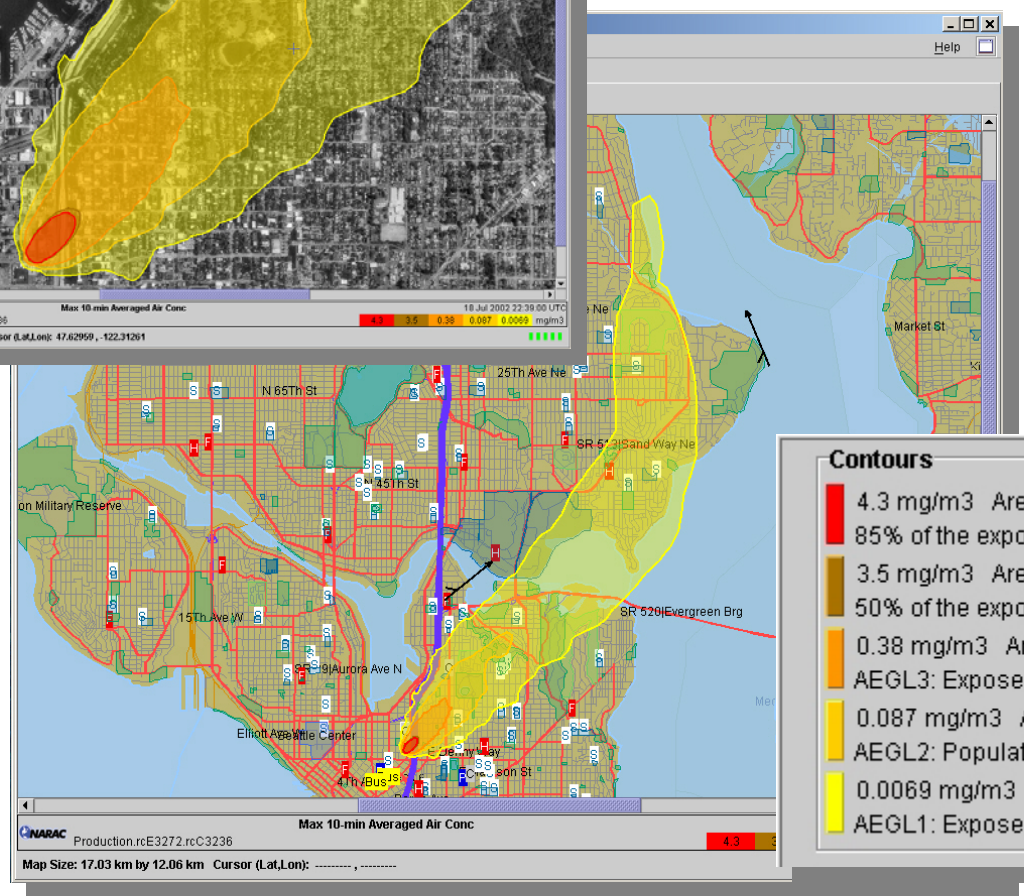
Incident Management Information

- Health effects, exposed population and facilities
- Casualty/fatality/damage estimates
- Response strategies
- Protective action recommendations
- Geographical information



NARAC Products





Contours

4.3 mg/m3 Area: 0.038 sq km Population: 30
85% of the exposed population could receive a lethal dose.

3.5 mg/m3 Area: 0.046 sq km Population: 30
50% of the exposed population could receive a lethal dose.

0.38 mg/m3 Area: 0.378 sq km Population: 3356
AEGL3: Exposed population could experience life-threatening effects.

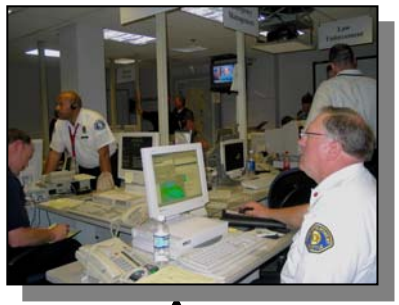
0.087 mg/m3 Area: 1.450 sq km Population: 7482
AEGL2: Population could experience serious long-lasting effects.

0.0069 mg/m3 Area: 15.249 sq km Population: 33001
AEGL1: Exposed population could experience notable discomfort.

- Plume hazard areas
- Affected population counts
- Health effects
- Protective Action Guidelines
- Map features

Internet- and Web-based Software Tools Provide Easy Access and Distribution of Predictions

Local/State Emergency Operations Center



Information distribution & decision making

Local, Regional, State Responders

Internet, dial-up, satellite or wireless communication

Web-based information Distribution (NARAC Web)

- **Fast-running local models**
- **Access to advanced models (*NARAC iClient*)**

- **Advanced modeling tools**
- **Scientific support and analyses**

Collaborating City, County, State & Federal Agencies

Modeling reach-back support is available throughout response & recovery phases

- **Initial Response (less than ~1 hour)**
  - Limited information on source characteristics
  - Initial rapid dispersion prediction using simple models and/or generic source term for immediate guidance on approach / evacuation routes and command post siting
  - Initial simulations based on limited information obtained from direct observations and local weather data
- **Refined Response (~ 30 minutes - 24 hours)**
  - Simulations used as guidance for deployed field and aerial monitoring teams deployed
  - More detailed simulations and event characterization analyses that utilize specific information about airborne release obtained from “on scene” observations and measurements
- **Extended Response and Recovery (~ 24 hours and beyond)**
  - Incorporate “on scene” measurements for event / source term reconstruction
  - Revise estimates of population exposure
  - Estimate food contamination, if applicable

NARAC and Related Programs Sponsors

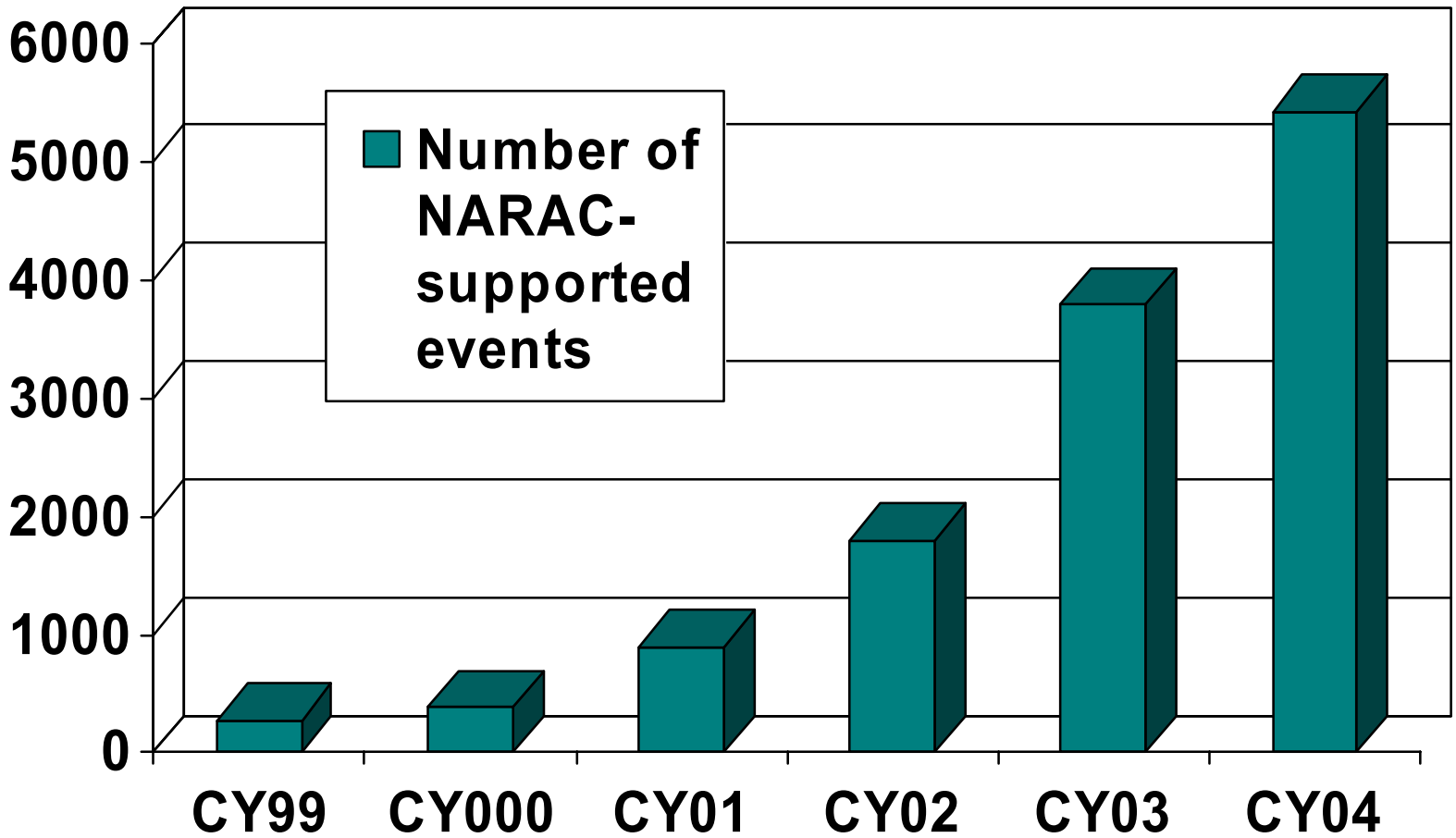
Sponsors

- **DOE NA-40 Emergency Operations — Atmospheric Release Advisory Capability (ARAC) Program**
- **DHS S&T EP&R Portfolio — Inter-agency Modeling and Atmospheric Analysis Center (IMAAC)**
- **DOD/DOE Naval Reactor sites emergency response**
- **DHS S&T Biological-Chemical Countermeasures Portfolio (Urban and CB Plume Modeling Research and Development, Local Integration of NARAC with Cities (LINC) demonstration project)**
- **DOE NA-23 Office of International Emergency Management and Cooperation — International nuclear emergency response**
- **LLNL NAI/HSO projects (supporting DHS, DOE, DOD)**

Organizations supported

DOE Headquarters Operations Center (OC)
DOE Nuclear Incident Response Teams (RAP, NEST, NRAT, JTOT, CM, OTS)
Federal Radiological Monitoring and Assessment Center (FRMAC)
DHS Headquarters Homeland Security Operations Center (HSOC)
FEMA National Response Coordinating Center
40 DOE, Naval Reactor and DoD Sites
5 DHS LINC Demonstration Cities (NY, Seattle, Ft. Worth, Cincinnati, Albuquerque)
100+ collaborating local, State, and Federal Agencies

Rapid Growth in NARAC-Supported Events



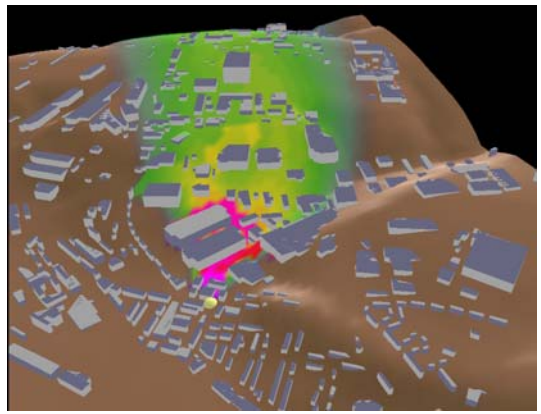
Number of NARAC-supported events (tests, drill, exercises, responses) has increased dramatically because of easier Internet/Web-based tools and new sponsors

Future Directions: R&D Will Create Advanced Tools for Detection, Characterization, Response Actions

- **Complex urban environments (UK DSTL, LBL)**
  - Indoor exposures and indoor-outdoor coupling
  - Urban tool development and integration into operations (turbulence, geometry-to-grid capabilities, supporting databases, computational performance)
- **Data-driven simulation for incident characterization**
  - Event reconstruction
  - Design of sensor network architectures for facilities, special events, wide-area monitoring
  - Real-time data assimilation for high-density meteorology and remote sensing data
- **Uncertainty**
  - Probabilistic risk assessment
  - End-to-end uncertainty estimation and interpretational products
- **Customer products**
  - Enhanced GIS capabilities (automated plug-in to ESRI tools, address look-up)
  - Improved health effects prediction by age, shelter type, population movement
- Advanced nuclear explosion modeling: Near-term and long-term effects (SNL)
- Other threats: Agricultural applications, Waterborne transport modeling, Fire and smoke emission modeling, Decision support systems

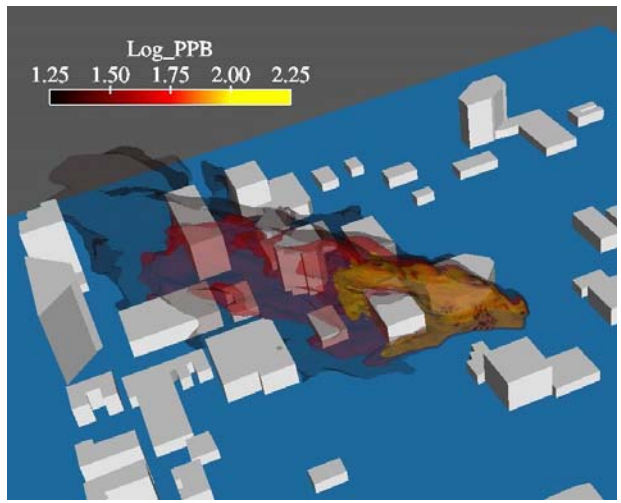
Ongoing Development: Building-scale Flow and Dispersion Models

- Fast-running empirical UDM urban model (developed by UK DSTL)



UDM Model

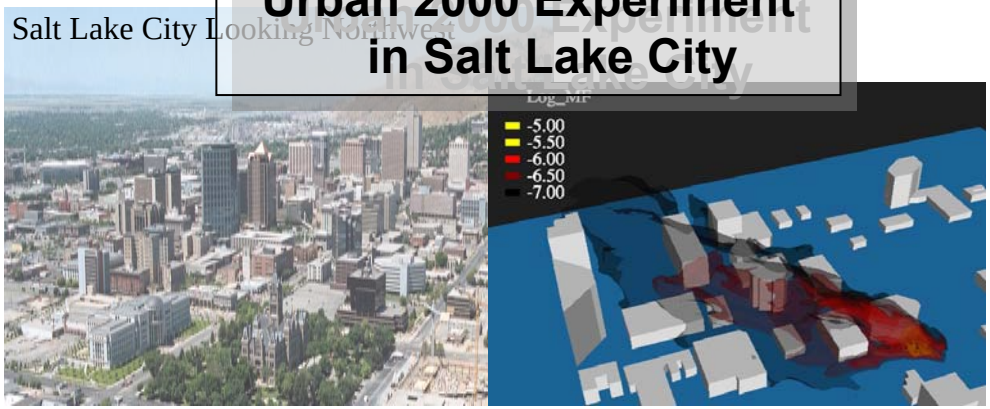
- High-resolution building-scale computational fluid dynamics model (FEM)



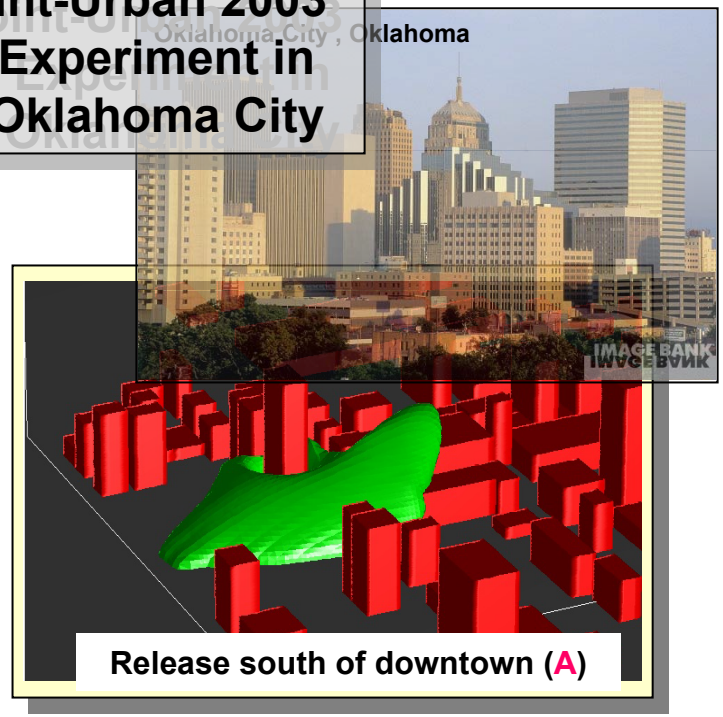
FEM Model

LLNL is Collaborating with Multiple Agencies on Urban Experiments to Test and Develop Urban Flow and Dispersion Models

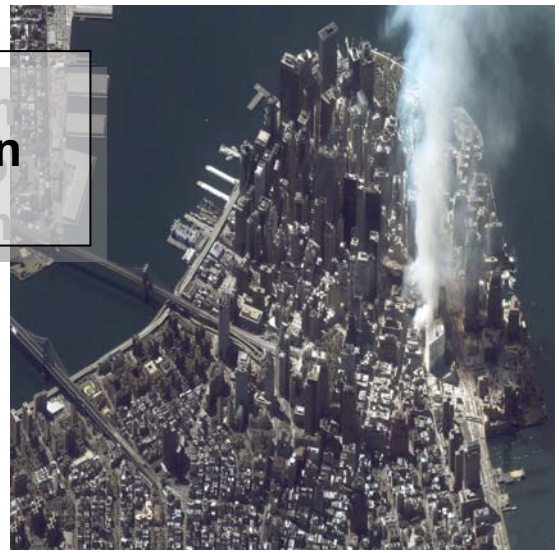
Urban 2000 Experiment in Salt Lake City



Joint-Urban 2003 Experiment in Oklahoma City



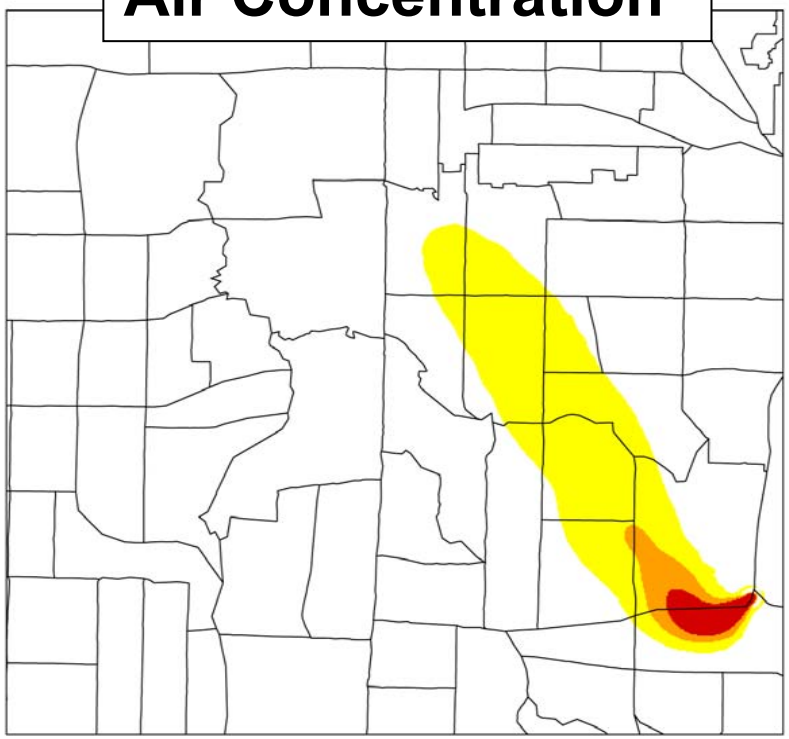
NYC Urban Dispersion Program

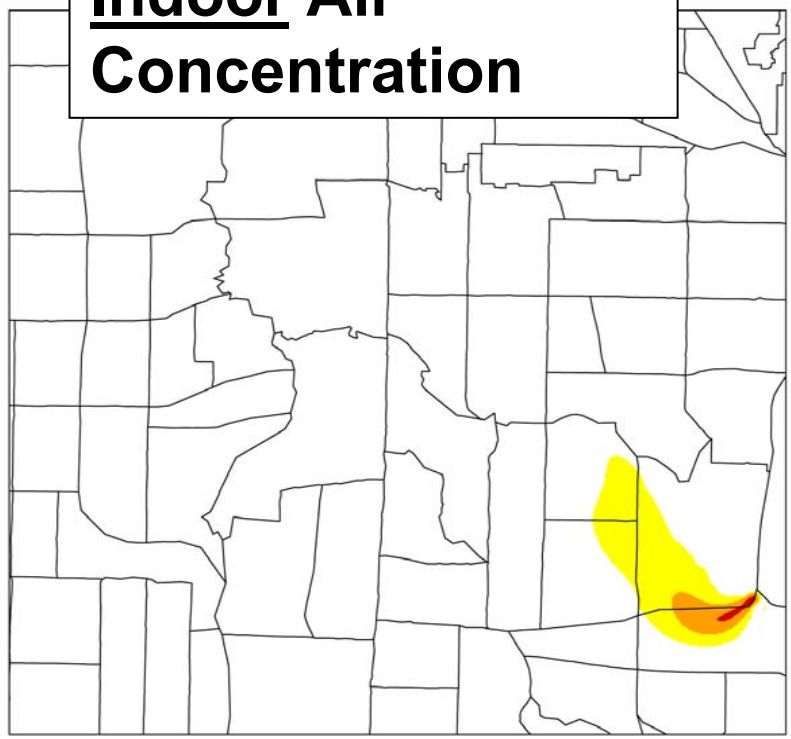


NARAC and Sandia are Integrating Source Term, Modeling, and Effects Prediction Tools

- Source term data and algorithms for radioactive material dispersal (explosions, sprayers) from Sandia
- Standardized model products
- Standardized methods for calculating dose, number of injuries and fatalities using population databases, and prompt effects (blast, thermal, radiation) from nuclear and conventional explosions

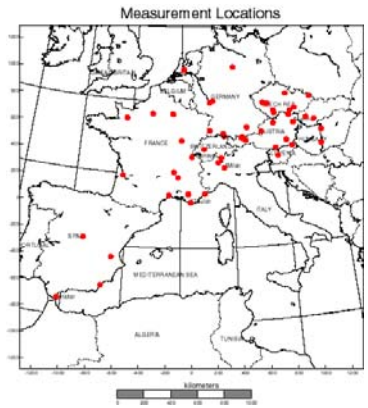
NARAC is Integrating LBNL Research on Outdoor-Indoor Infiltration Models

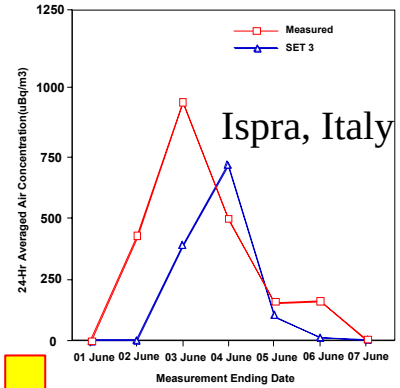




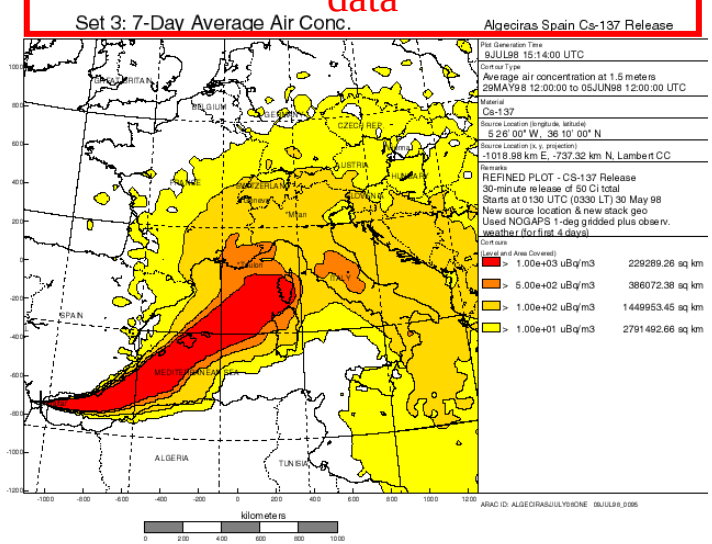
LLNL is Developing Data-Driven Modeling Tools For Event Reconstruction

- Event reconstruction tools answer the critical questions What? Where? When? How much?
  - Backwards analyses to determine probabilistic distribution of unknown source characteristics
  - Optimal forward predictions for consequence assessment
  - Dynamic reduction in uncertainty as additional data become available
- Approach: couple data and simulation via Bayesian inference, stochastic sampling, and optimization methods
- Reduce dependence on first responders to estimate source terms and utilize increasing number of deployed sensor networks and field measurement data

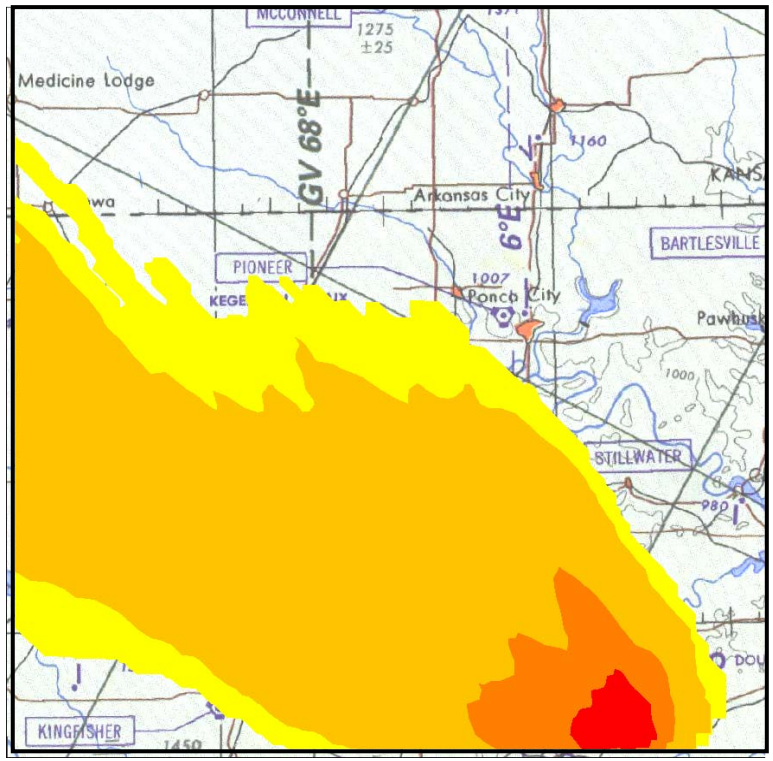




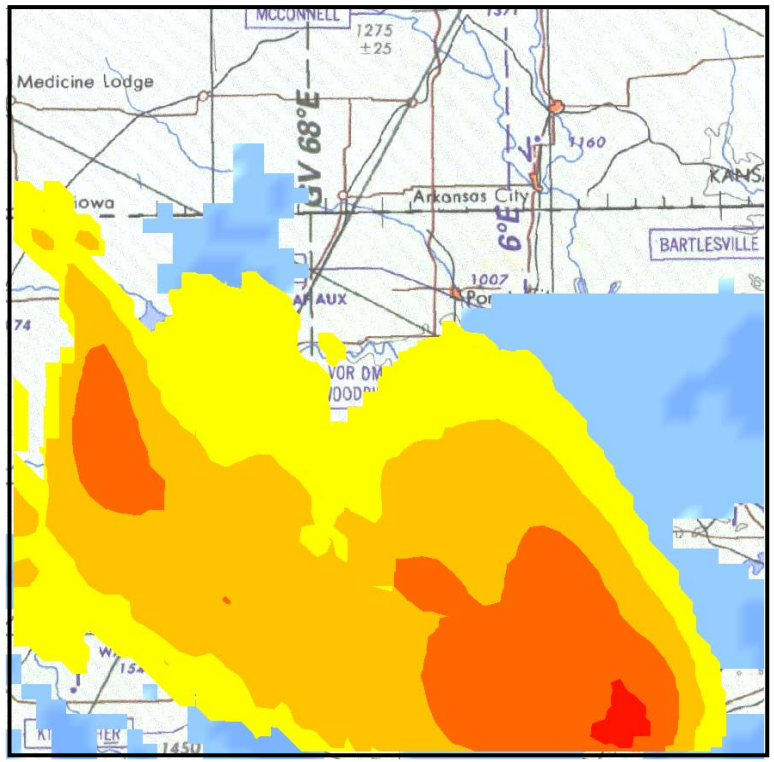
Reconstruction of Algeciras steel mill Cs-137 release from sensor data



High-resolution Weather Radar data and NARAC/LODI Precipitation Scavenging Model Will Be Able to Simulate Wet Deposition Hotspots



Wet deposition pattern from a continuous source using a <u>uniform constant rain rate</u> (30mm/hr)



Wet deposition pattern using <u>high-resolution weather radar (NEXRAD) precipitation data</u>: Precipitation (blue) creates wet deposition hot spots (yellow-red contours) during a convective storm

For more information see

http://narac.llnl.gov