NARAC Developments

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UCRL-PRES
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Outline of Presentation

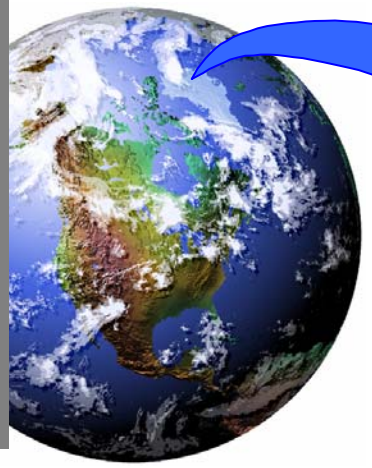
- NARAC background information
- Recent and upcoming *NARAC Web* and *NARAC iClient* software features
- Research and development on new modeling capabilities

National Atmospheric Release Advisory Center (NARAC)

Real-time Weather Data, Plume Model Predictions and Expertise

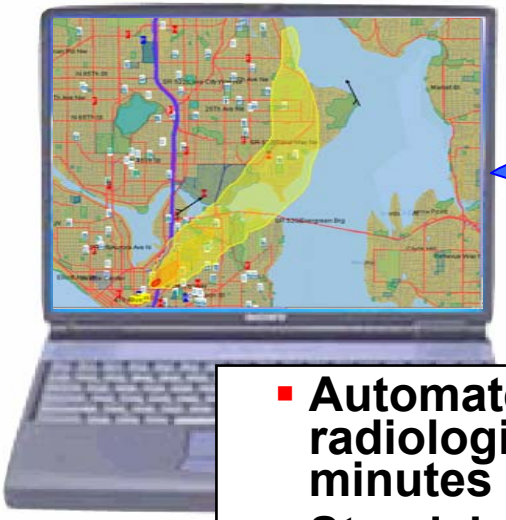
Access to world-wide weather data and geographical information:

- Observed & forecast weather data
- Terrain & land surface
- Maps
- Population



National Atmospheric Release Advisory Center (NARAC):

- Computer systems for 3-D plume simulations
- Un-interruptible, backup power
- 24x7 scientific & technical support



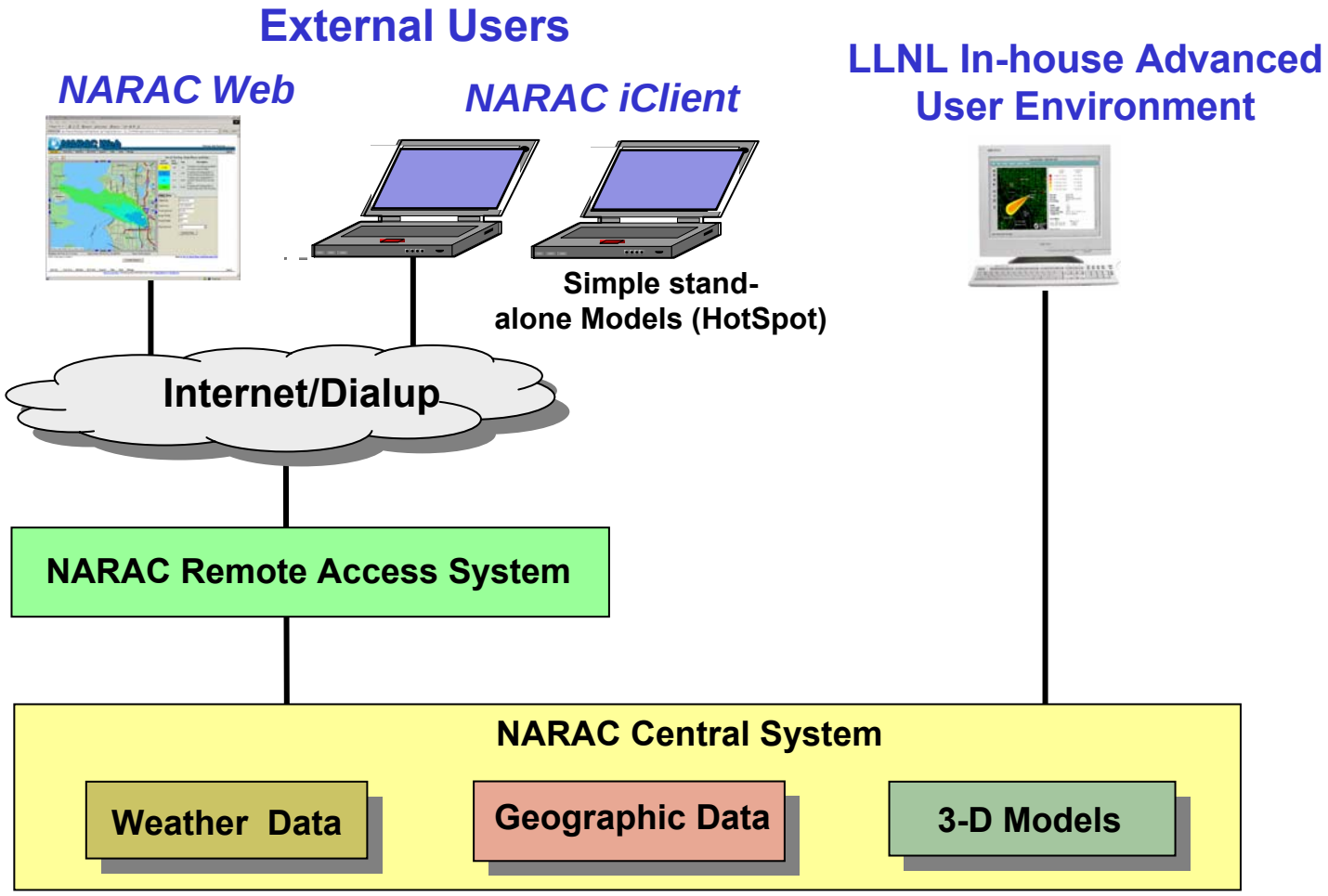
- Automated real-time 3-D plume model predictions for nuclear, radiological, chemical or biological releases available in minutes from national center using Internet/Web tools
- Standalone simple plume modeling tools for end-user's computer require no connection to NARAC

Interagency Modeling and Atmospheric Assessment Center — IMAAC

- **Under DHS leadership, IMAAC coordinates dispersion modeling for atmospheric chemical/biological/nuclear hazard predictions among federal agencies**
- **MOU signed by 8 federal agencies: DHS, DOC/NOAA, DOD, DOE, EPA, HHS, NASA and NRC**
- **IMAAC roles are codified in *National Response Plan* (NRP) and *National Exercise Program* (NEP)**
- **NARAC has been designated the primary initial provider of IMAAC capabilities**
- **Interagency working groups are developing Standard Operating Procedures (SOPs). Agency-specific MOU annexes are being written**
- **Integrate the best available scientific capabilities and data from federal, state, and local agencies**
- **IMAAC doesn't replace or supplant atmospheric modeling activities that are currently in place to meet agency-specific mission needs**

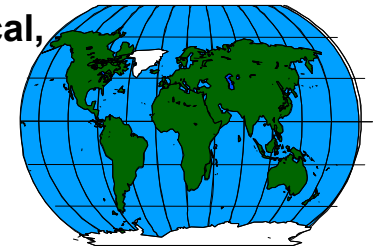
"IMAAC provides a single point for the coordination and dissemination of Federal dispersion modeling and hazard prediction products that represent the Federal position during actual or potential incidents requiring Federal coordination" *National Response Plan*, May 2006

Component-based LLNL NARAC Computer Systems Support External and In-house Users, Simple and Advanced Models

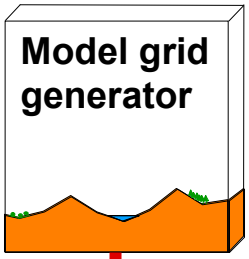


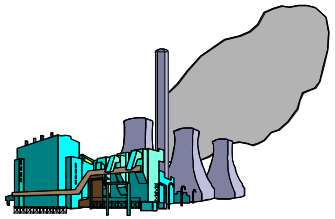
NARAC Central Modeling System Provides 3-D Plume Model Predictions

Geographical, Terrain Elevation, Population Databases



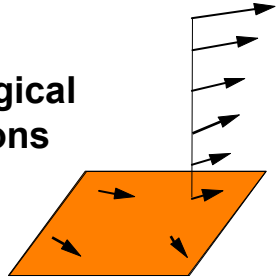
Model grid generator



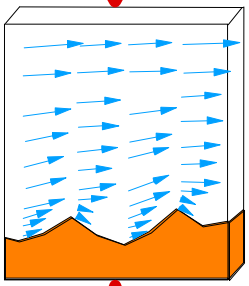


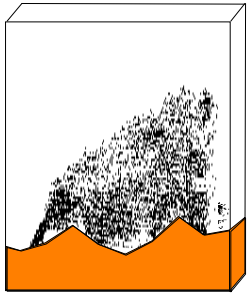
Source characteristics

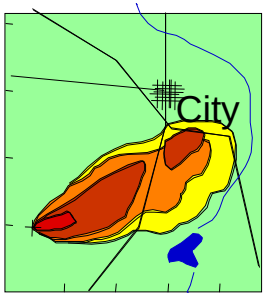
Meteorological Observations



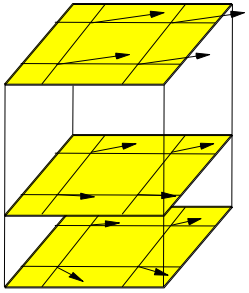
Data assimilation model (ADAPT)



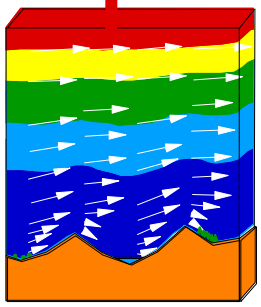




Large-scale forecast models (Navy, NWS)



Regional Forecast Model (Navy COAMPS)



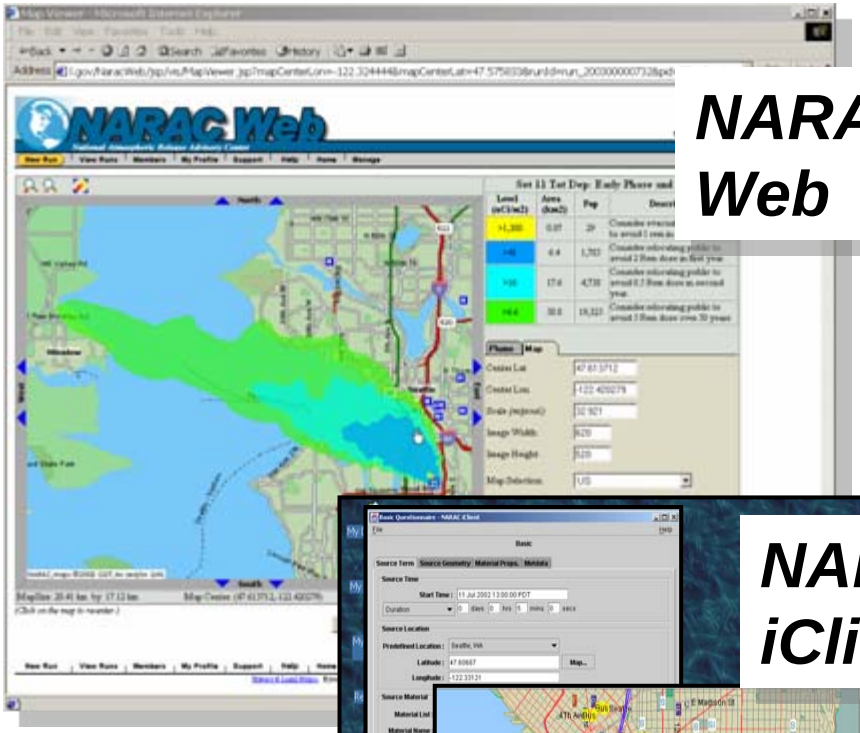
Lagrangian Operational Dispersion Integrator (LODI)

Air and ground contamination, Dose, Protective Actions Guidelines, acute health effects

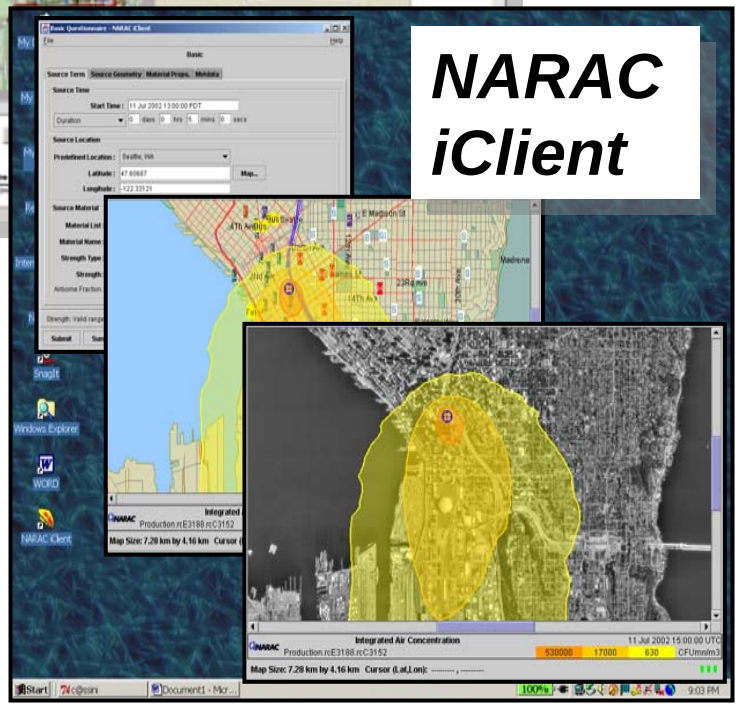
NARAC's modeling system is fully automated and works for any location in the world in real-time

NARAC Web and *iClient* Software Tools Provide Remote Users with Access to NARAC Predictions

- Automated reach-back to plume modeling with real-time weather data
- Sharing of predictions with other users or groups of users through *IMAAC/NARAC Web*
- Output formats
  - GIS Shape files
  - PDF
  - HTML/XML
  - PowerPoint
  - JPG/PNG graphics
  - Consequence reports
- *iClient*: Stand-alone capabilities: Simple Models and geographical information displays



NARAC Web



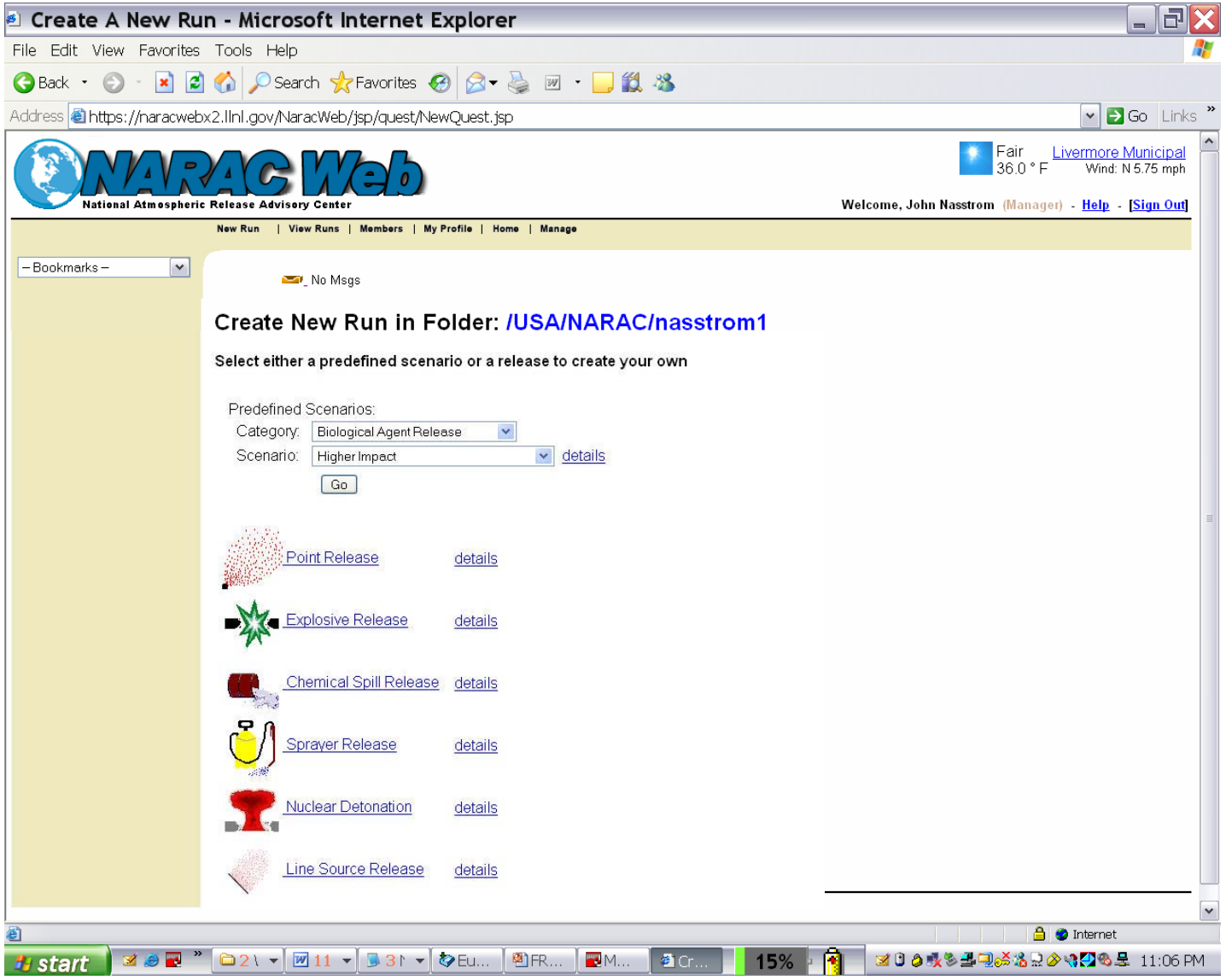
NARAC iClient

Recent NARAC Enhancements

- NARAC Web upgrades
  - Meteorology (observed or gridded forecasts) viewable as a layers in NARAC Web and NARAC iClient map displays
  - Added Web logs for incident information tracking and sharing
  - Rubber banding zooming in map displays
  - Added Predefined Scenarios for RDDs (from Sandia), Biological and Chemical Releases (including spills, sprayers)
  - Centerline, meteorological and field Measurement Data may displayed and downloaded from a Table
  - Added field measurement visualization layer in map displays
  - More detailed reports and interpretation guides for plume predictions with Sandia
  - Save plume model maps and reports as .ppt, .pdf, .png or .jpg
  - Nuclear detonation scenario option
  - Map distance scale bar in map displays

- Streamlined use of measurement data:
  - FRAMC/AMS data exchange format (XML)
  - Faster tools for LLNL staff to update model predictions with measurement data

NARAC Web: Scenario Options



More Recent NARAC Enhancements

NARAC Central System

- Version 16.3 – June 2006
  - Upgraded to run the models on LINUX
  - Updated Nuclear Detonation capabilities
- Version 16.4 – Nov/Dec 2006
  - Upgraded to run the central system software on LINUX
  - Expanded Consequence Report (not yet available via Web/iClient)
  - Prototype of advanced nuclear fallout model LODI-FOC implemented

NARAC Web

- Version 1.13 – Oct 2006
  - Line Source release type
  - Find location by street address look-up
  - DOE Site maps
  - Search capability for runs
  - Improved error checking for chemical spills

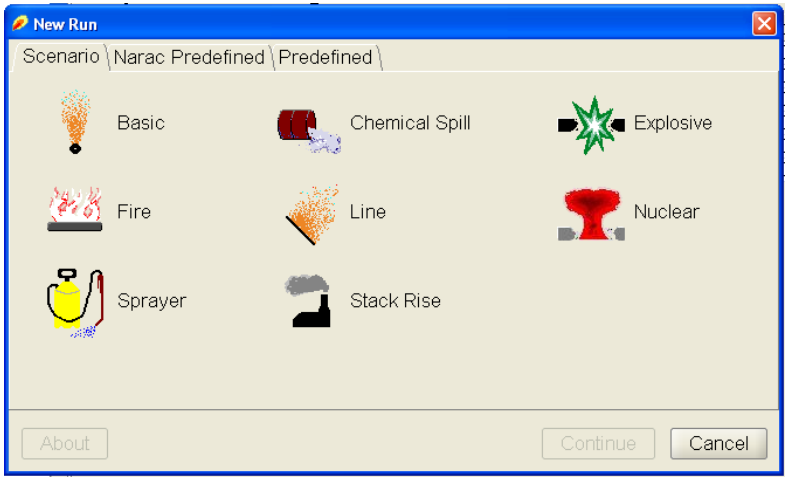
Future NARAC Updates

- ***NARAC Central System –*** Version 16.5 – June 2007
  - Structure to make all AEGL time periods available
  - Structure to make both FGR11 and FGR13 dose conversion factors available
- ***NARAC Web –*** Version 1.14 – May/June 2007
  - Re-designed top menus: easier to navigate to Home folder or Recent runs, and Search for runs
  - Managing named location list is easier
  - Better management of groups of users
  - Auto Refresh – automatically updates NARAC model run status

Future NARAC iClient 2.0 Features

Beta version of NARAC iClient 2.0 includes

- Basic, Explosive, Fire, Chemical Spill, Stack Plume Rise, Sprayer, Line and Nuclear Detonation scenarios
- Pre-defined and user-defined Scenarios
- Visualization of plume, observed and forecast meteorology, field measurements
- Plume probing, map annotation
- World-wide plus site-specific maps
- Reports: 1 page and multi-page
- Ability to organize runs
- Improved Error Reporting
- Integration with the NARAC Web
- Expanded user preferences
- Radiological mixtures
- Import/Export Runs
- Run Hotspot/EPIcode (non-interactive)
- User plot output control



NARAC iClient 2.0 Status

- Planned for FY08
  - Field Measurement entry user interface
  - Deployment to DOE sites and regional/national teams

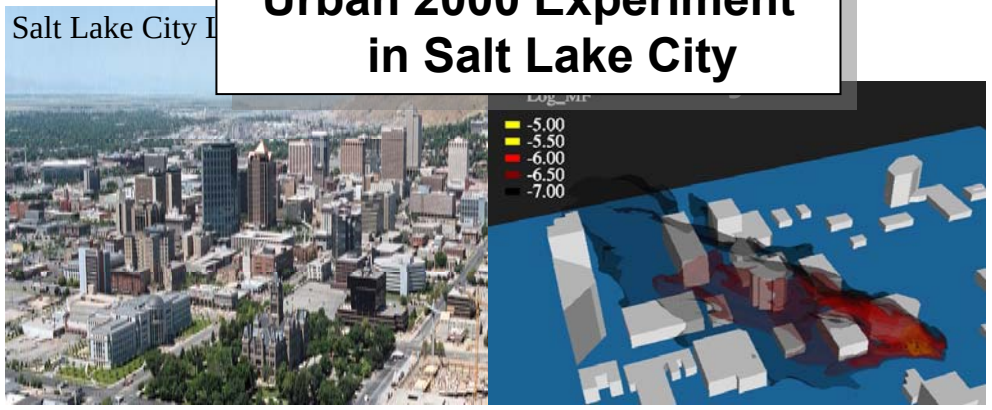
- Future development
  - Moving Sources
  - Map Probing
  - Run Hotspot/EPIcode interactively

Current LLNL NARAC/IMAAC Research Areas

- Urban dispersion
  - Fast-running empirical urban plume models (UDM, Urban ADAPT/LODI)
  - High-resolution simulation (FEM3), including dense gas effects
  - Infiltration into residential and commercial buildings (with LBNL)
- Event reconstruction: rapid inclusion of sensor data, probabilistic predictions
- New dispersion and fallout models:
  - LLNL and Sandia working to merge existing dispersion and nuclear fallout codes (KDFOC, ERAD, LODI) into a single model (LODI)
  - Faster LODI runs using simpler horizontal diffusion algorithm (Monte Carlo particle method still used in the vertical direction)
  - Improve both conventional detonation and nuclear detonation source descriptions
- Complex chemical reaction in dispersion codes

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

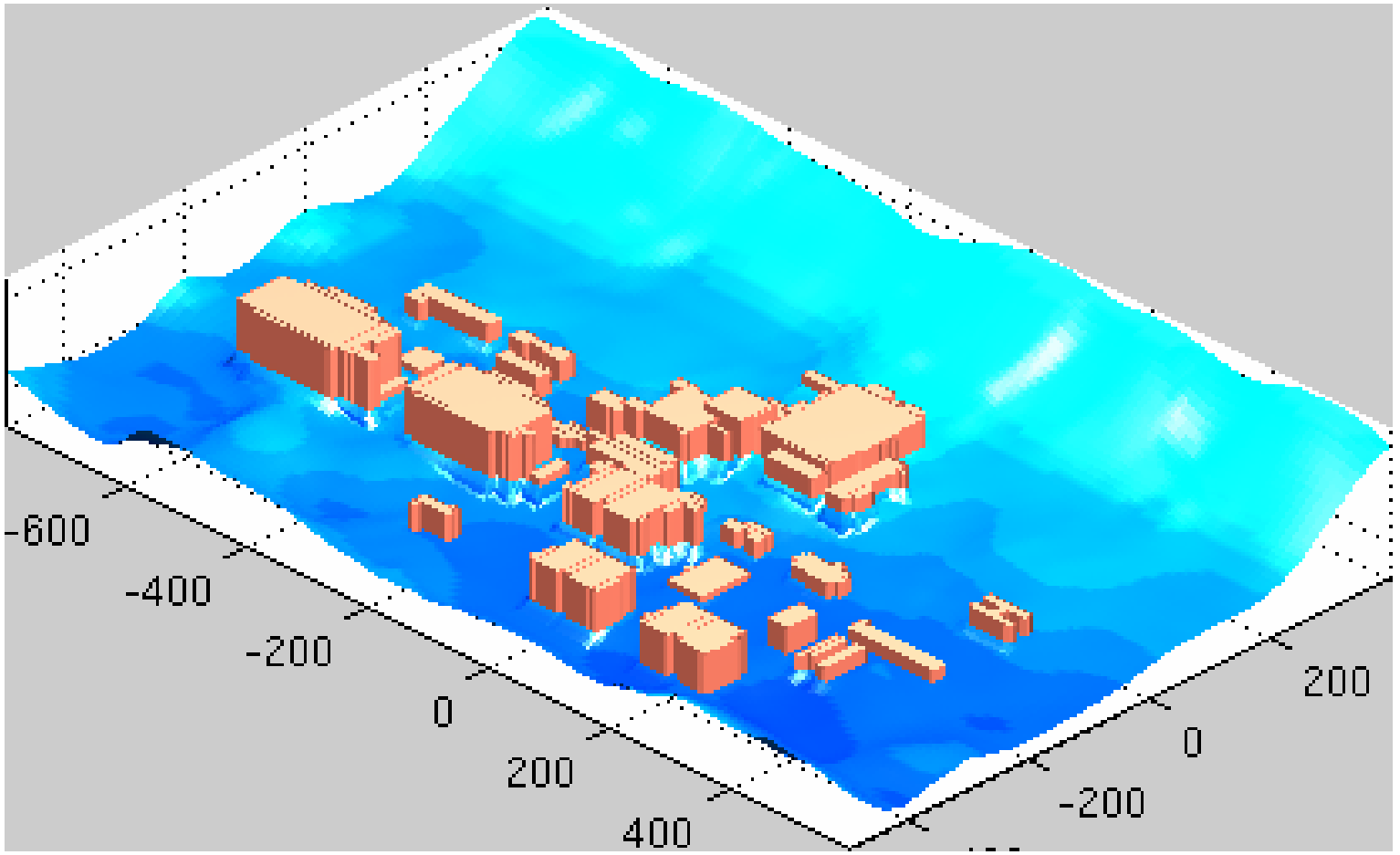
Urban 2000 Experiment in Salt Lake City



Joint-Urban 2003 Experiment in Oklahoma City

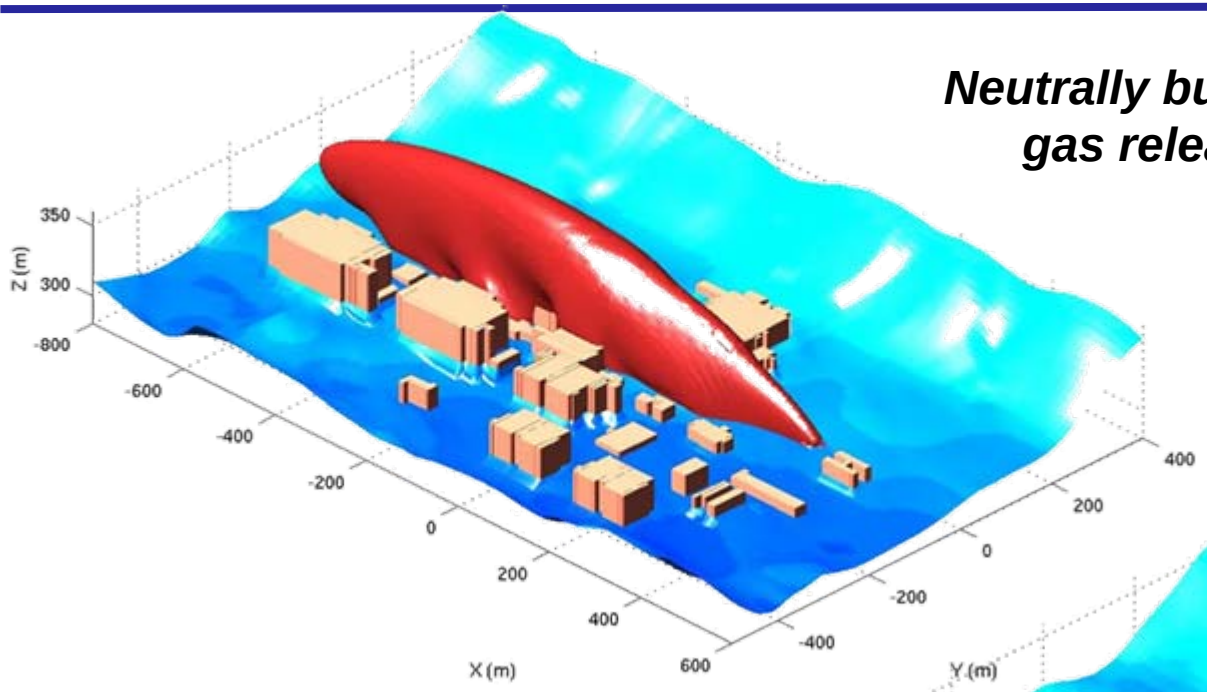
NYC Urban Dispersion Program

FEM3 Simulation of Dense Gas Dispersion in Building Complex with Terrain Slope



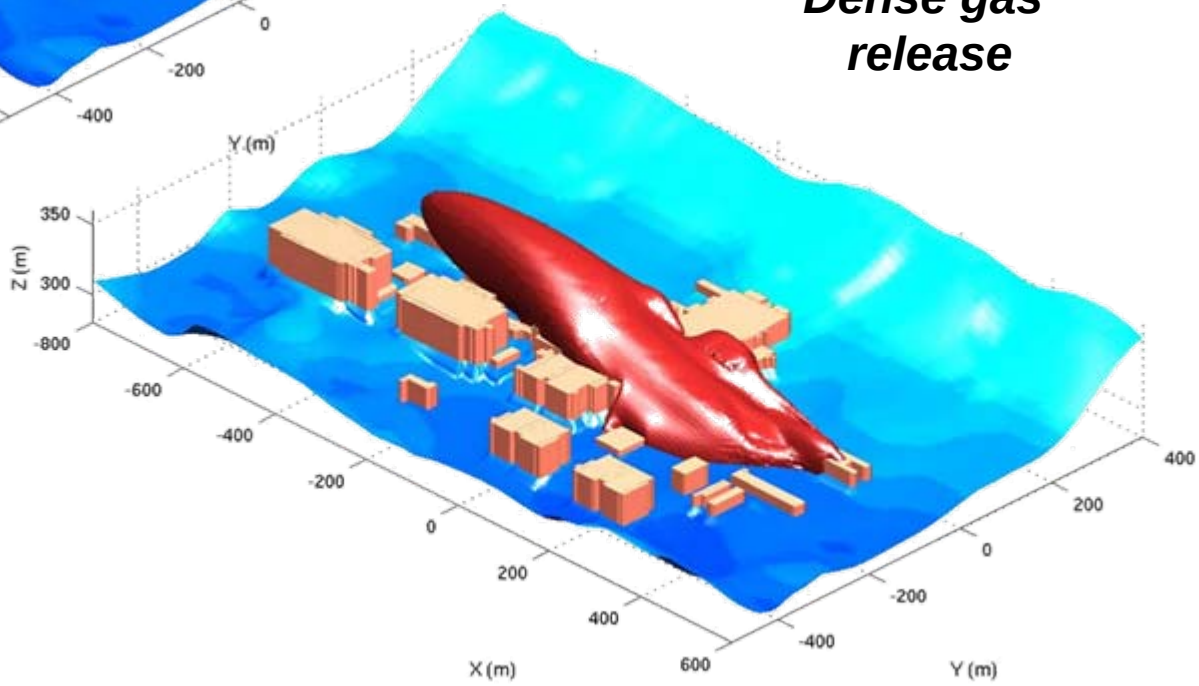
Dense gas release: Molecular weight 5x air, density 40% higher at release point

Density reduces vertical mixing, increases lateral spreading near the source, and induces downslope transport



Neutrally buoyant gas release

Dense gas release

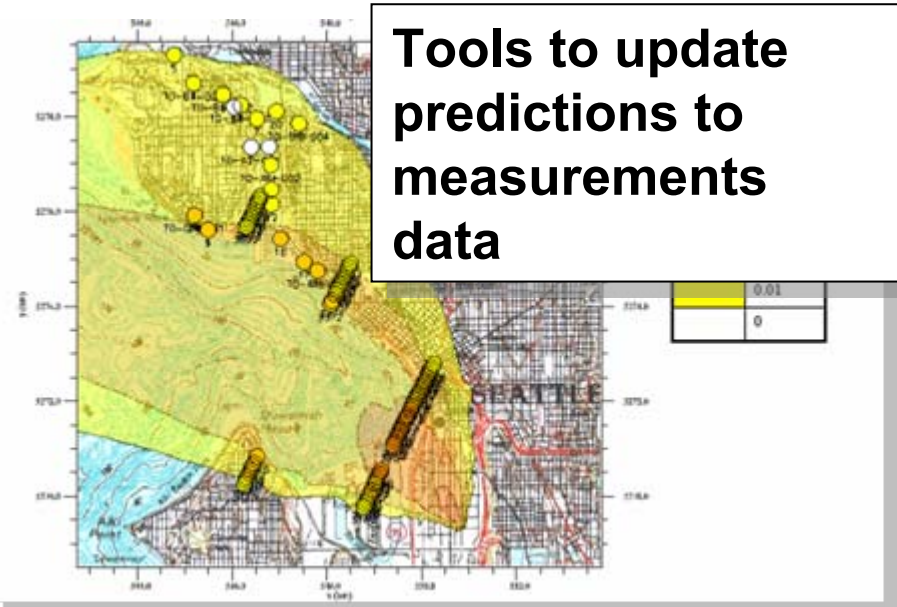


Isosurfaces of 200 mg/m³ 10 minutes after release

LLNL Collaborates with Other Agencies to Automate Processing of Data for Updating Model Predictions

- Extensible Markup Language (XML) file for storing and Web-based sharing of measurement data — self-describing text format defines measurement data, instrument, units, time, location, etc.
- Measurement data maps and visualization
- Measurement data filtering, grouping and outlier elimination
- Measurement-to-calculation ratio comparison, statistical analysis, and determination of improved source term for plume model
- Radiological measurements from DOE RAP, AMS, DOE/EPA FRMAC
- Chemical/radiological measurements from EPA SCRIBE (underway)

XML Measurement Data File



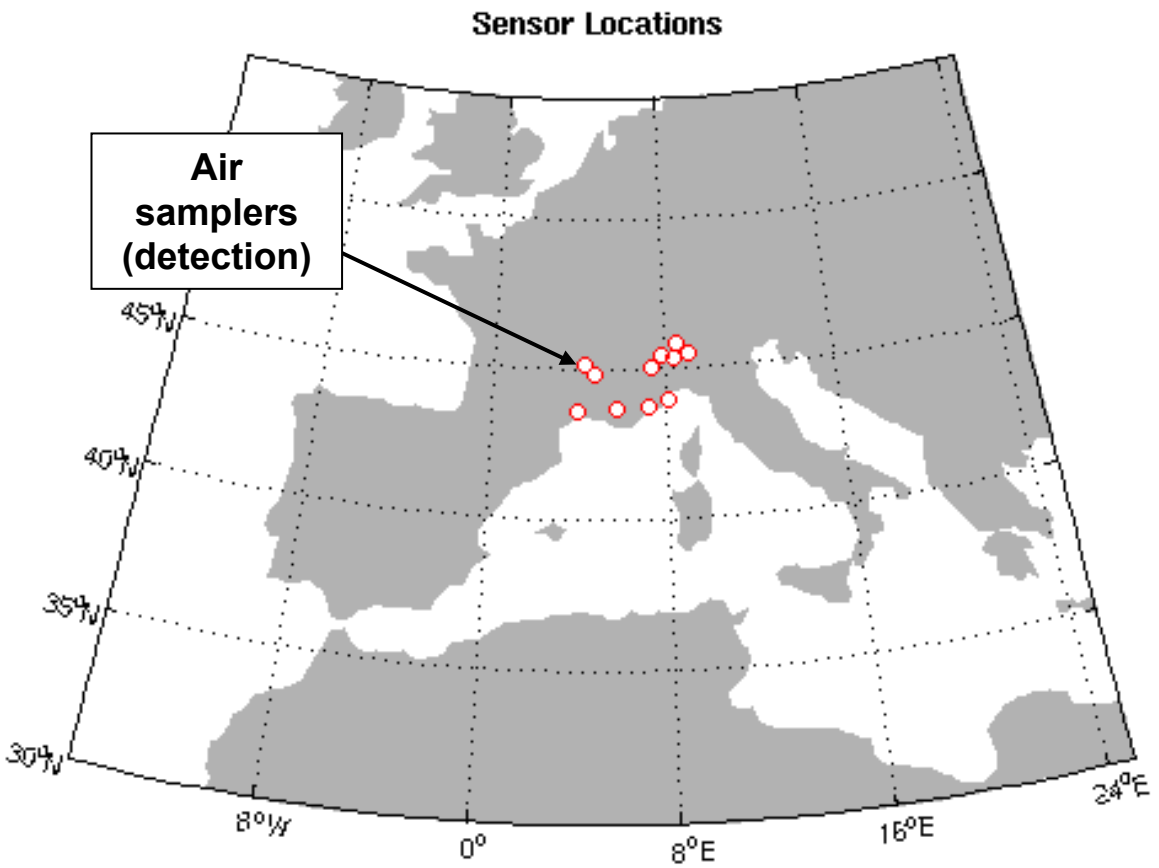
Tools to update predictions to measurements data

LLNL is Developing a Rigorous Method for Inverse Modeling and Event Reconstruction

- Goal: Automate the utilization of sensor field measurements to estimate source terms and optimize predictions

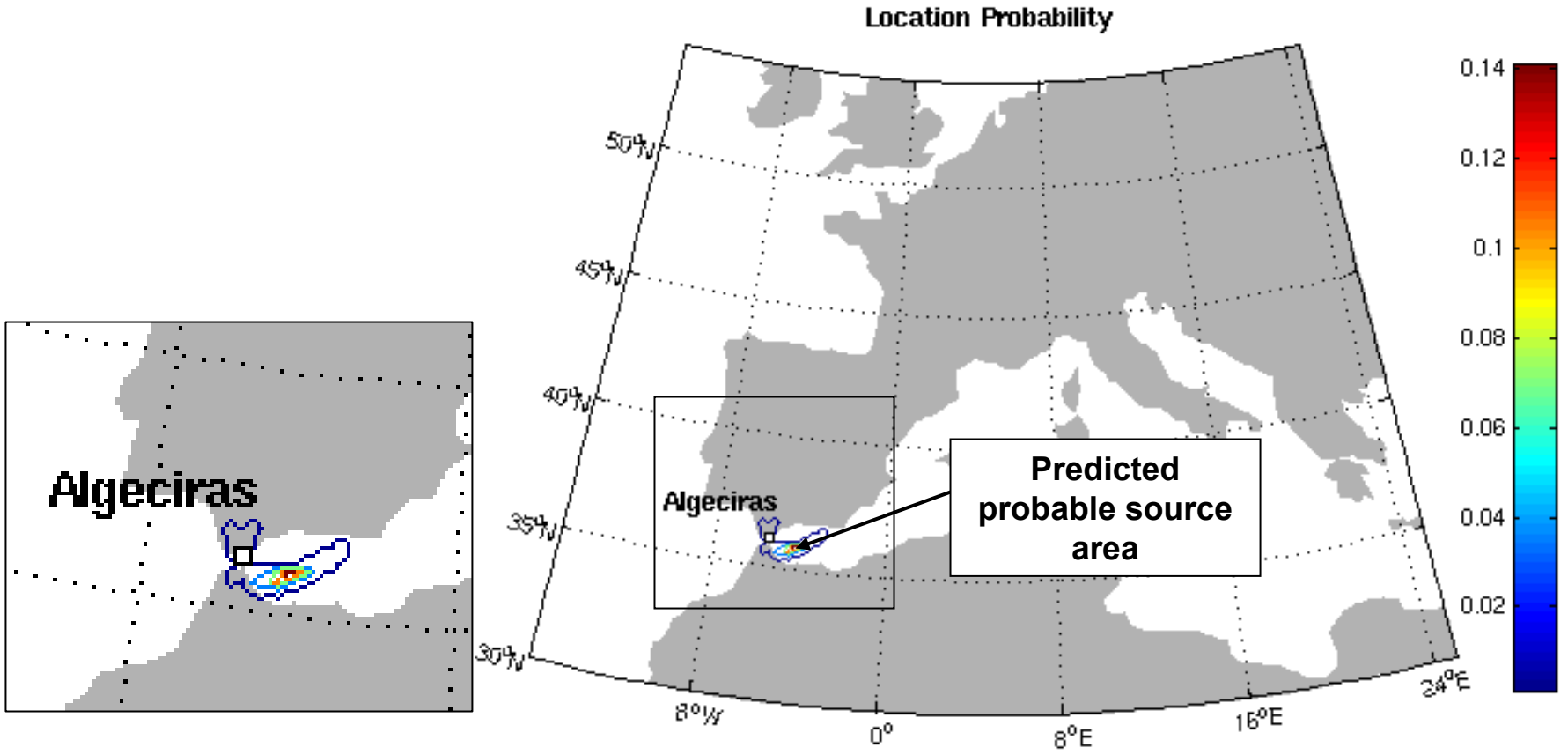
- Approach: Use sensor data and multiple forward plume model predictions to efficiently estimate unknown source parameters (e.g., release location, amount), using Bayesian inference, stochastic sampling, and optimization methods

Automated Event Reconstruction Modeling for Airborne Radiological Incident

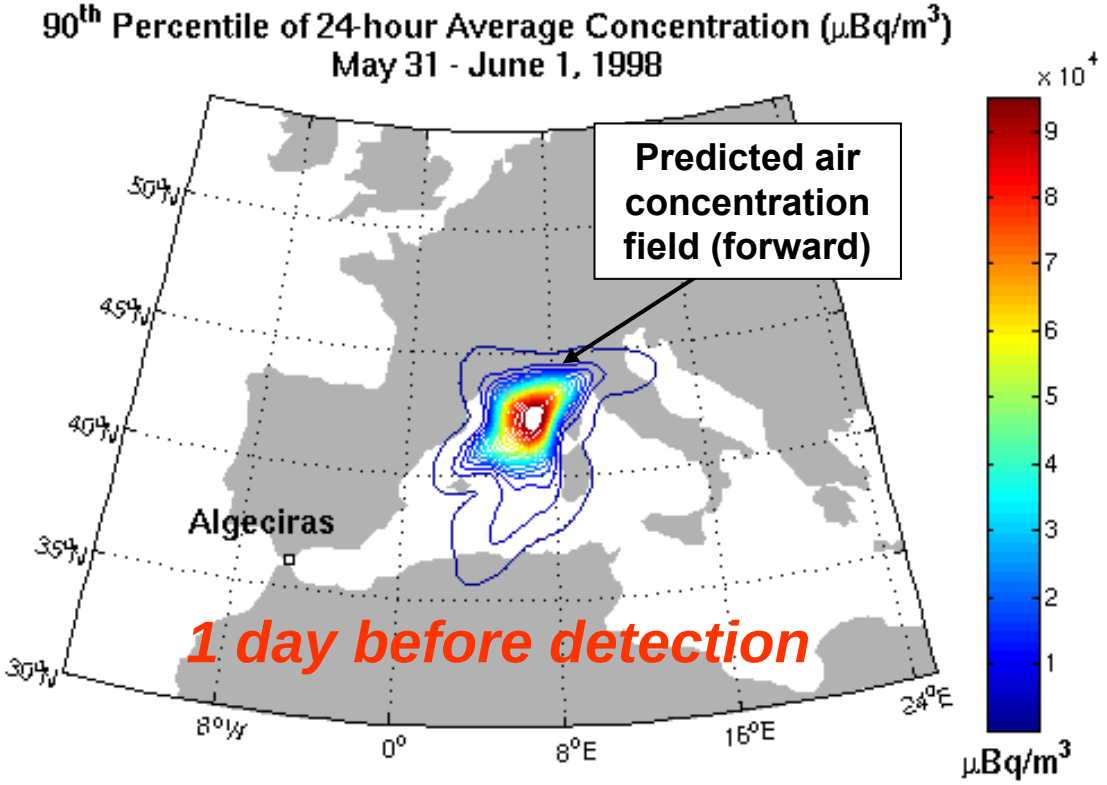


June 13, 1998, radioactivity was detected in air-monitoring systems in France and Italy

The Event Reconstruction model can help identify location and emission amounts for sources of contaminants

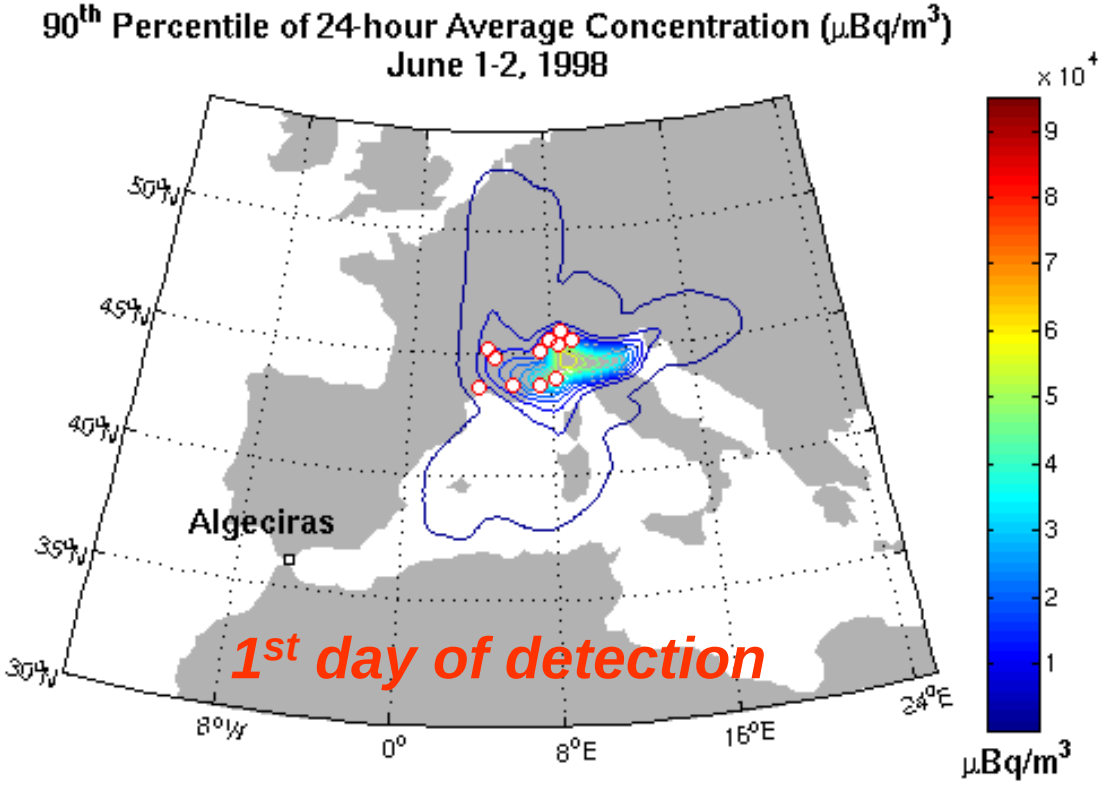


Using our stochastic event reconstruction tool we can locate the likely release area (~1500 km upwind)



Predicted concentrations

(90% confident that concentration will not exceed this levels)



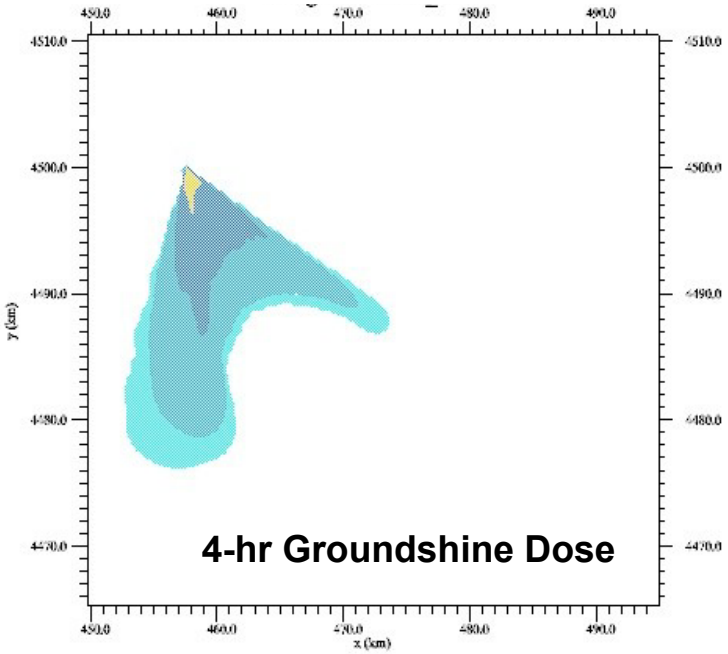
The plume was reconstructed using known winds and sensor data

LLNL-Sandia Model Development Project

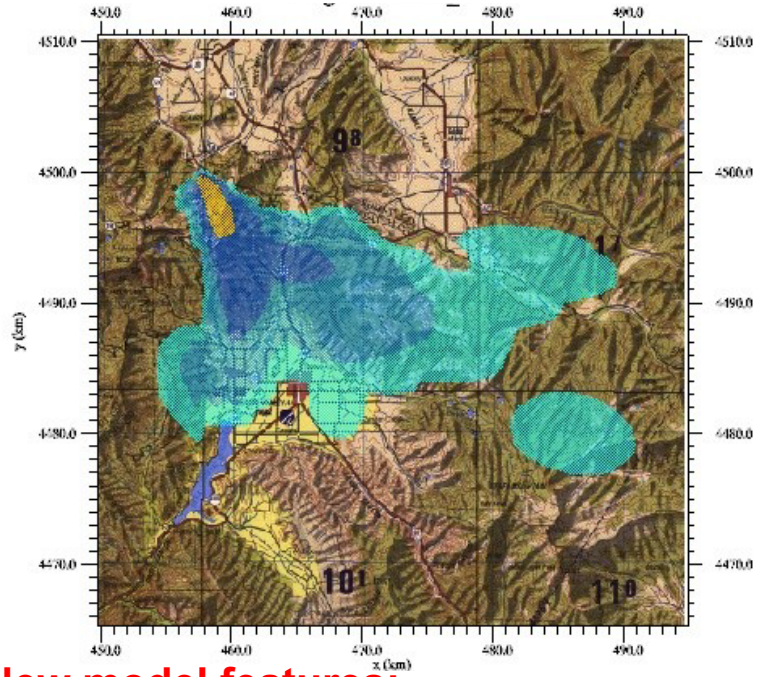
- Goal – Develop a unified LLNL and SNL atmospheric dispersion and fallout model:
  - Merge existing radiological dispersion and nuclear fallout codes into a single model useable by both LLNL and SNL
  - Decrease run time for use as a field-deployable version
  - Improve both conventional detonation and nuclear yield source descriptions
- Capabilities from these codes are being merged within the LODI model framework:
  - Transport and Diffusion Codes
    - LLNL LODI
    - SNL ERAD (dynamic explosive puff rise model)
  - Nuclear Fallout Code: LLNL KDFOC3

Advanced LLNL-Sandia Nuclear Fallout Model Prototype Developed

Existing Operational Model (KDFOC)



New Model (LODI-FOC)



Existing model features:

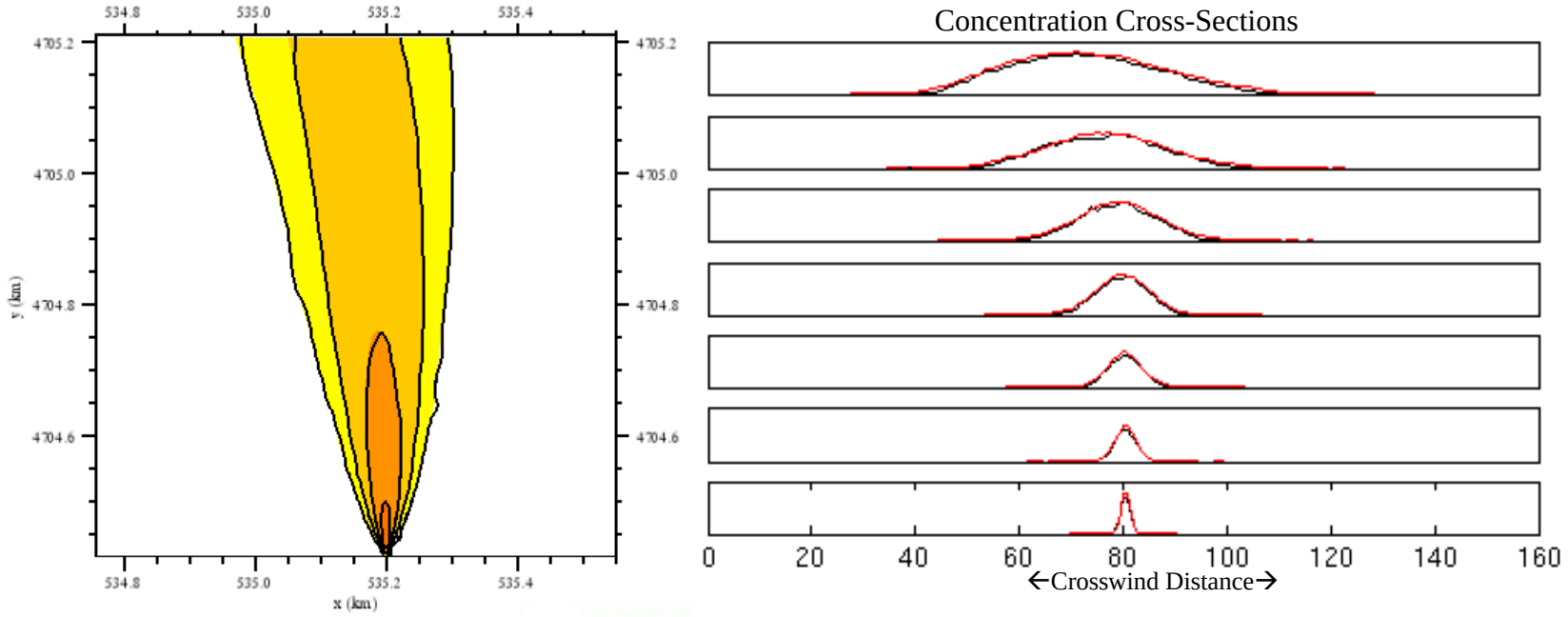
- 1-D (vertical) wind variation
- Large fallout particles
- Gross activity
- Groundshine
- Buried, surface or air burst

New model features:

- 4-D wind variation & terrain effects
- Large and respirable particles
- Gross activity & specific nuclides
- Groundshine, cloudshine & inhalation doses
- Rainout
- Long-range transport
- Buried, surface or air burst; Multi-bursts

Faster LODI Simulations with Gaussian horizontal Diffusion Compared to Full Monte Carlo Particle Dispersion Prediction

Prairie Grass Experiment 21: 5000 disks vs. 200,000 particles
(Disks: Black Lines; Particles: Colored Contours/Lines)



- Ongoing Testing:
  - Analytical solution tests
  - Field experiment: Prairie Grass (stable, unstable, neutral conditions, and Savannah River MATS (time-series, rolling terrain)
  - Will continue to investigate behavior as function of meteorological/terrain complexity
- **Testing indicates up to an order-of-magnitude decrease in runtime**

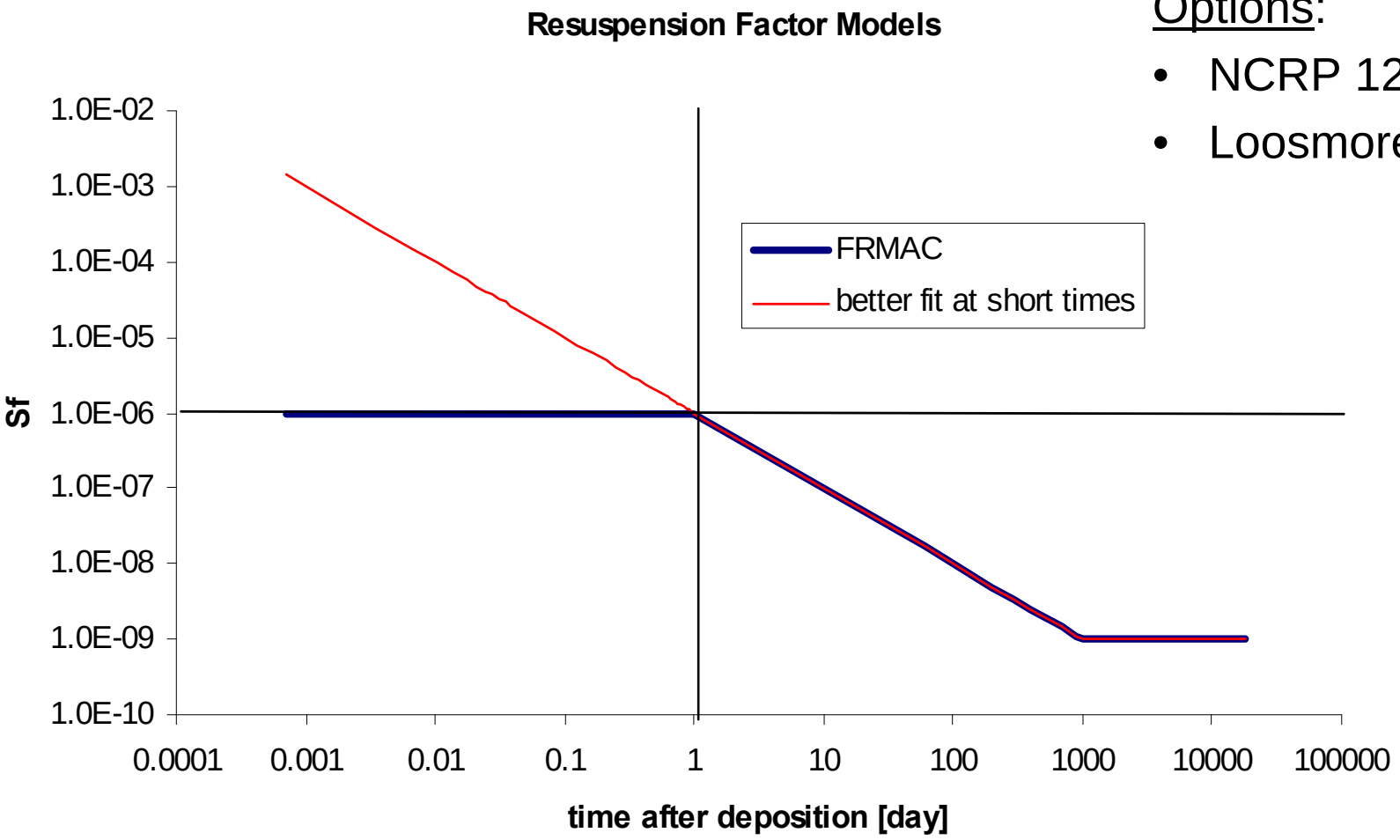
For more information

Web: http://narac.llnl.gov

Email: narac@llnl.gov

NARAC will host a DOE User Training Course at LLNL, August 15-16, 2007, and User's Group Meeting to be held at the NARAC facility on August 17, 2007

NARAC and HotSpot Resuspension Upgrades



Options:

- NCRP 129 (FRMAC)
- Loosmore (2003)

Loosmore, G.A., *Evaluation and Development of Models for Resuspension of Aerosols at Short Times After Deposition.* Atmospheric Environment, 2003. **37:** 639-647

NARAC and Hotspot Weathering Factor Upgrades

Options:

- WASH 1400
- Anspaugh (2002)