NARAC/HotSpot User Group Meeting

EMI SIG Annual Meeting
Seattle, WA
May 15, 2012

John Nasstrom, Brenda Pobanz, Fernando Aluzzi, Steve Homann

Lawrence Livermore National Laboratory

National Atmospheric Release Advisory Center
NARAC

This work was performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under contract DE-AC52-07NA27344. Lawrence Livermore National Security, LLC

LLNL-PRES-560417

Agenda

- Introductions
- *HotSpot:* New and upcoming features
- *NARAC Web* and NARAC modeling system*:* New and upcoming features
- NARAC/HotSpot training opportunities
- NARAC analysis of Fukushima accident
- Questions and feedback: How can NARAC and HotSpot better meet your needs?

NARAC and HotSpot: Tools for Your Modeling Toolbox

- HotSpot:
  - PC-based tool for Emergency Planning Hazard Assessments and Safety Analysis
  - Initial consequence assessment modeling
- NARAC:
  - Automated runs by authorized end-users using *NARAC Web* access to NARAC 3-D central modeling system at LLNL
  - Consequence assessment plume modeling analysis from LLNL/NARAC scientists for drills, exercises and emergencies – including use of measurement data to refine models

- DOE sites that have potential for a General Emergency or a Site Area Emergency due to an atmospheric release of a hazardous material must have access to NARAC under DOE Order 151.1C (Section IV.3.b.5 and Attachment 2, Section 13)
- Level of use of NARAC modeling tools can be tailored to site needs, to complement other modeling tools used in your organization

NARAC and HotSpot Models Have Been Modified to Better Simulate Ballistic Particles (>100 μm) Generated by an Explosion

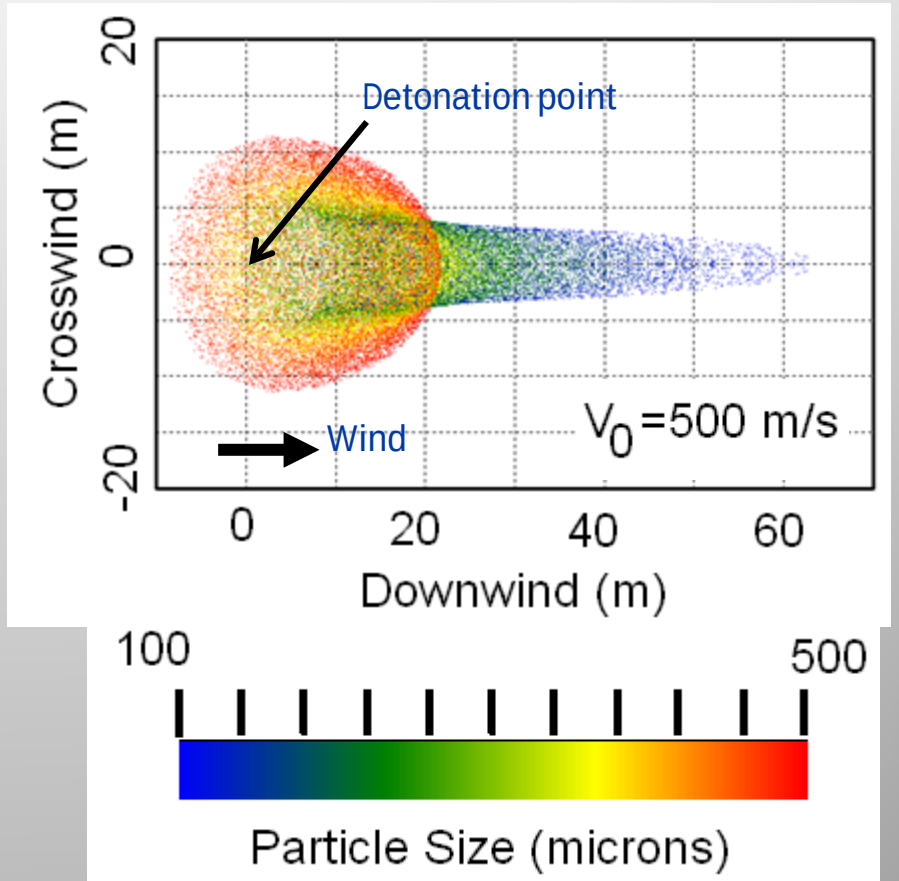
Source: Dr. Fred Harper, Sandia National Laboratories

Ballistic particles are ejected and leave the influence of the thermally buoyant cloud faster than previously assumed

Sandia *ScatterMe* Code Calculation Results Have Been Used to Develop Ballistic Particle Deposition Parameterizations

- *ScatterMe* model (developed by Dr. M. Larsen, Sandia National Laboratories)
  - Numerically solves the equations of motion to find landing spot of a ballistic particle
  - Predicts the aggregate effects of deposited ballistic particles
- Parameterizations based on *ScatterMe* are being used for NARAC's *LODI* and *HotSpot* atmospheric dispersion models

ScatterMe code predictions of Particle Deposition on Ground

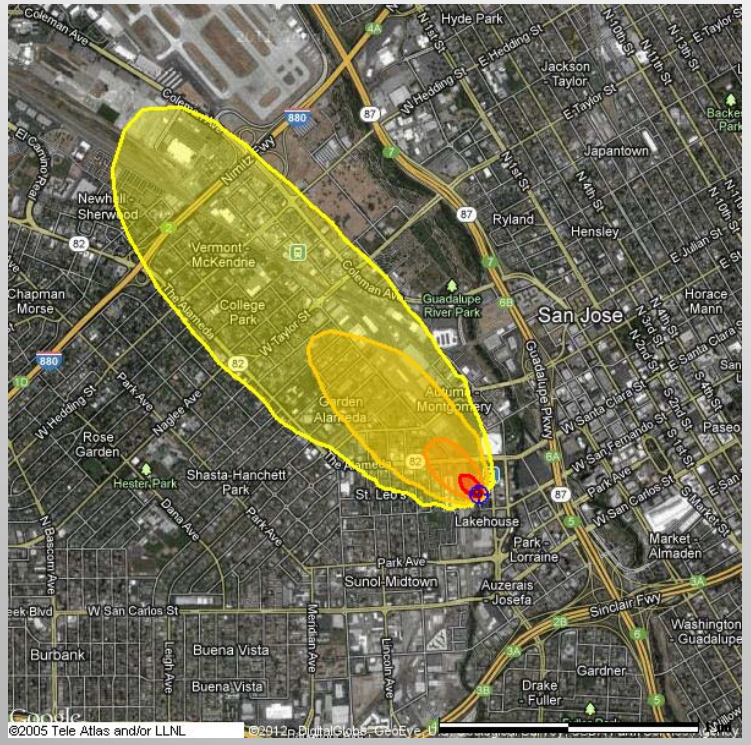


25000 particles, 100-500 micron aero, Wind=3 m/s Density = 4.0 gm/cc

New ballistic particle modeling methods in LODI and HotSpot can produce significantly improved predictions of ground deposition and ground shine dose

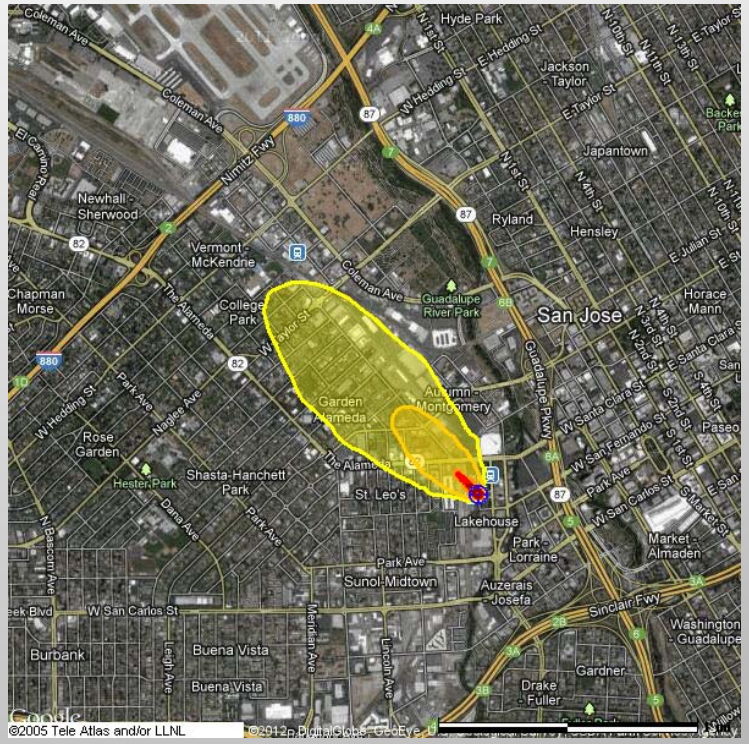
Predicted ground–shine dose

Old model



- All radioactive material (ballistic and non-ballistic) affected by thermally buoyant cloud rise

New model



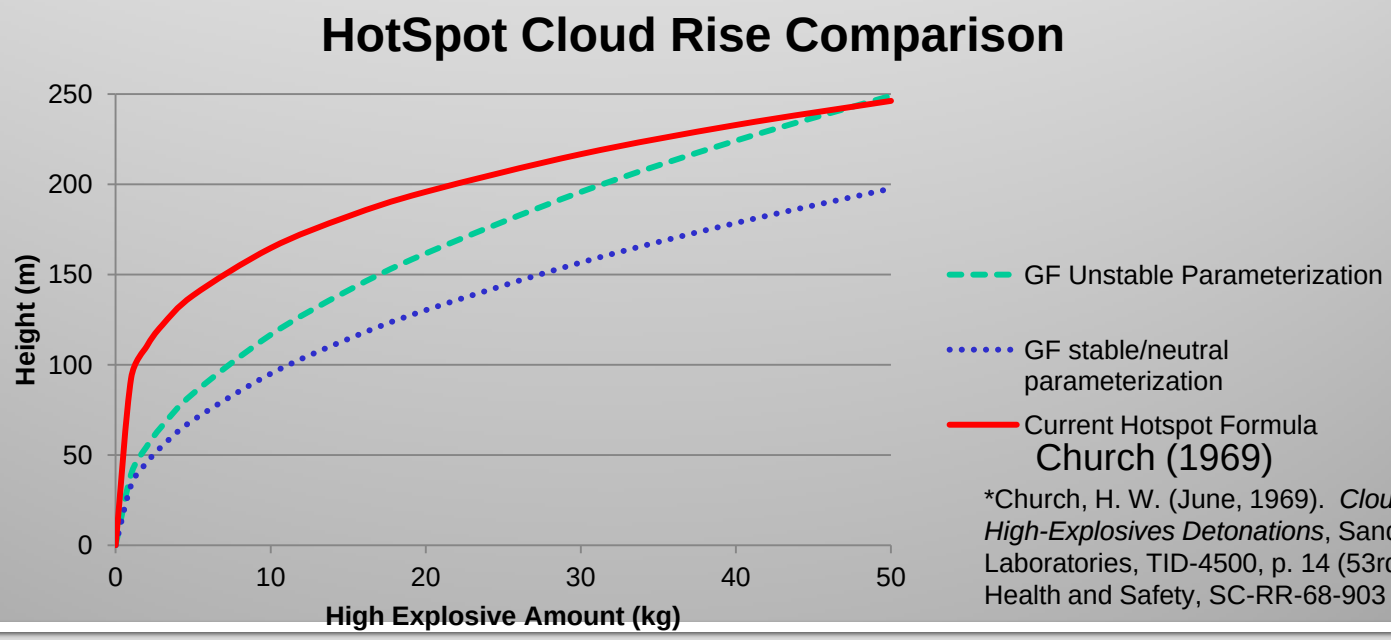
- Ballistic particles quickly leave the thermally buoyant cloud and deposit on ground
- Non-ballistic particles are affected by buoyant cloud rise

Percent of activity versus particle size assumed in this example (depends on material/design of explosive device):

30% 0.1-100 micrometers
70% 100-1000 micrometers

Church (1969) Explosive Cloud Height Parameterization Used in HotSpot code Under-predicts Green Field Experiment Cloud Heights for High Explosive Amounts Less than 50 kg

- The HotSpot model currently uses the formula developed by Church (1969)*, which is atmospheric stability independent: $H=76w^{0.25}$, where H is height in meters, and amount of high-explosive in pounds of TNT-equivalent is w.
- Two (unstable and stable/neutral conditions) Greenfield (GF) cloud height parameterizations are based on Israel experiment data.
- GF parameterizations predict a lower stabilized cloud top for all atmospheric stability conditions for high-explosive amounts less than 50 kg.

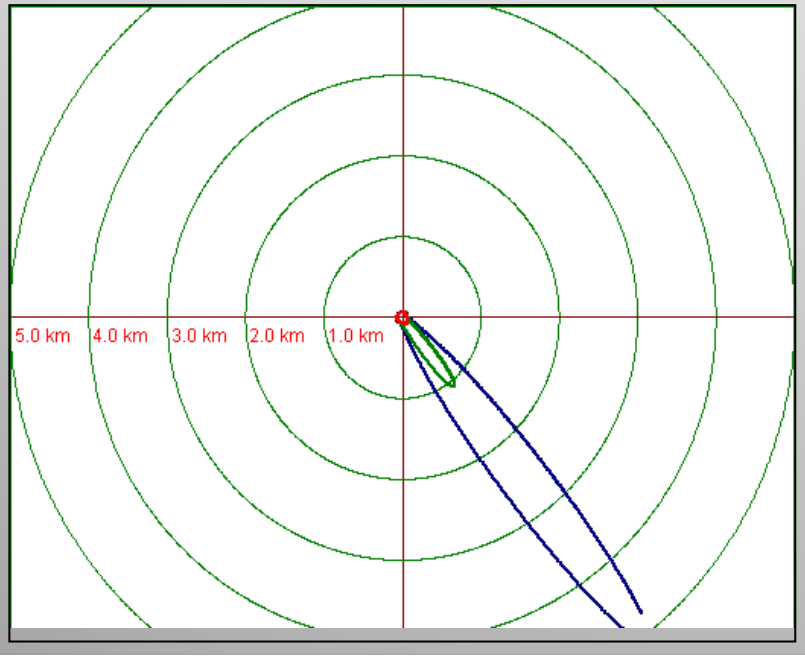


*Church, H. W. (June, 1969). *Cloud Rise from High-Explosives Detonations*, Sandia Laboratories, TID-4500, p. 14 (53rd ed., UC-41, Health and Safety, SC-RR-68-903

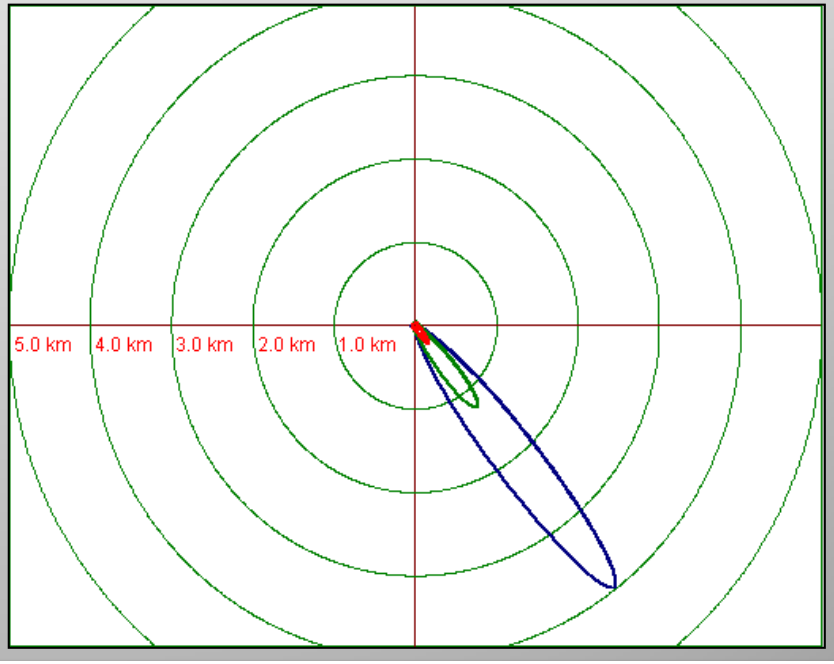
Using New Green Field Cloud Top Parameterization Changes HotSpot-Predicted Deposition

- New HotSpot results show noticeable differences in calculated surface concentrations due to lower GF cloud tops vs. those predicted by current algorithm.
- The deposition contours below show comparisons between the original HotSpot (Church, 1969) and HotSpot with GF-predicted stabilized cloud top for GF shot c5 (50 kg HE).

HotSpot Large-particle Deposition: Church cloud height



HotSpot Large-particle Deposition: GF cloud height



Newer Features Available in HotSpot Version 2.07.2

- Full Vista and Windows 7 compatibility: Follows Microsoft Windows 7 requirement to use a user's "Documents and Settings" as opposed to "..\Program Files" folder for any file input or output.

- Automatic Batch Mode: Allows HotSpot to be run in a "background" mode that produces Table output and Google Earth .KML files without displaying the graphical user interface. When this mode is enabled HotSpot can be launched at the command prompt or from a batch file. The created files are placed in the HotSpot "Output" folder.

- Revised (Maxwell and Anspaugh) Resuspension Factor:

  $$RF = 1E\text{-}05 \exp(-0.07t) + 7E\text{-}09 \exp(-0.002t) + 1E\text{-}09 \quad (t \text{ in years})$$

Newer Features Available in HotSpot Version 2.07.2 (Cont.)

- Expanded MACCS2 meteorological file support: Supports MACCS2 meteorological file input in both “wind from” and “wind towards” format. These site-specific meteorological data are input into HotSpot for calculation of percentile dose values

  Input file format: Sequential hourly data (in MACCS2 code format) (1-5 years):

  Date/Time

  Wind speed (wind-from or wind-towards option)

  Wind direction

  Stability Class (A-G)

- New optional Explosive Release ballistic particle method improves predictions for particles with aerodynamic diameters greater than 100 micrometers
- New optional cloud rise formulas are most appropriate for detonations of about 100 pounds or less. (Previous Church cloud height formula is still used above 100 pounds, even when the new option is selected)

HotSpot 2.07.1 is current DOE Safety Software Central Registry code
HotSpot 2.07.2 has been submitted for inclusion in DOE Safety Software Central Registry

HotSpot Web Site

https://narac.llnl.gov/HotSpot/HotSpot.html

- User Registration
- Download HotSpot software and user guide
- Past problem reports
- Submit question

Current HotSpot Development – Future Version 2.08

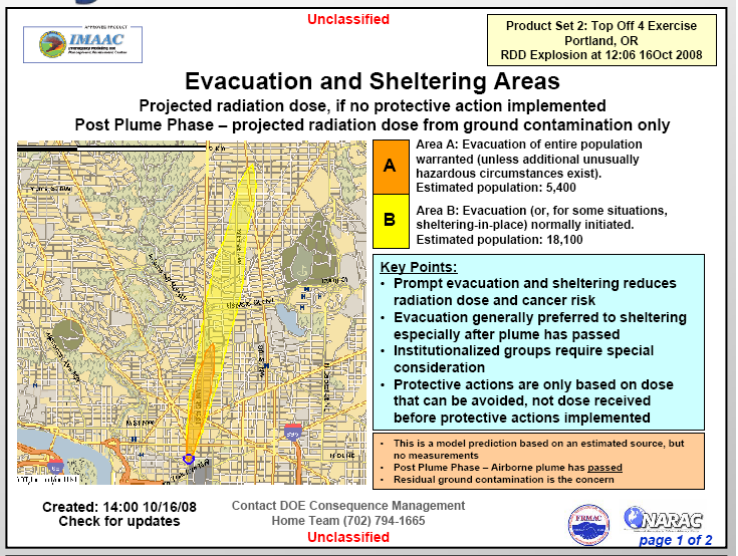
We are currently migrating HotSpot code from Visual Basic 6 (VB6) to Visual Basic 2008/2010 (.NET Framework)

- **Necessary due to Microsoft phasing out support of VB6 -** Starting in 2002, support has gradually decreased

- **Many software development benefits from the migration to Visual Basic 2008/2010**
  - Improved software development tools
  - Improved stability across different computer platforms
  - Fully Object-Oriented language
  - Improved Interoperability with Software written in other languages
  - Run time benefits such as automatic memory disposal/handling
  - Miscellaneous improvements: better building databases, XML support

New Briefing Versions of NARAC Products Are Being Deployed

- DOE and DHS supported the development and interagency review of "Briefing Product" versions of NARAC/IMAAC and FRMAC products
- Products intended to help subject matter experts brief decision-making officials
- Explain possible actions, like sheltering and evacuation, that need to be considered and why
- Communicate protective action guides in plain, non-technical language
- NARAC software quickly produces PowerPoint versions of briefing products



Unclassified

IMAAC

Product Set 2: Top Off 4 Exercise
Portland, OR
RDD Explosion at 12:06 16Oct 2008

Evacuation and Sheltering Areas

Projected radiation dose, if no protective action implemented
Post Plume Phase – projected radiation dose from ground contamination only

A — Area A: Evacuation of entire population warranted (unless additional unusually hazardous circumstances exist). Estimated population: 5,400

B — Area B: Evacuation (or, for some situations, sheltering-in-place) normally initiated. Estimated population: 18,100

Key Points:
- Prompt evacuation and sheltering reduces radiation dose and cancer risk
- Evacuation generally preferred to sheltering especially after plume has passed
- Institutionalized groups require special consideration
- Protective actions are only based on dose that can be avoided, not dose received before protective actions implemented

- This is a model prediction based on an estimated source, but no measurements
- Post Plume Phase – Airborne plume has passed
- Residual ground contamination is the concern

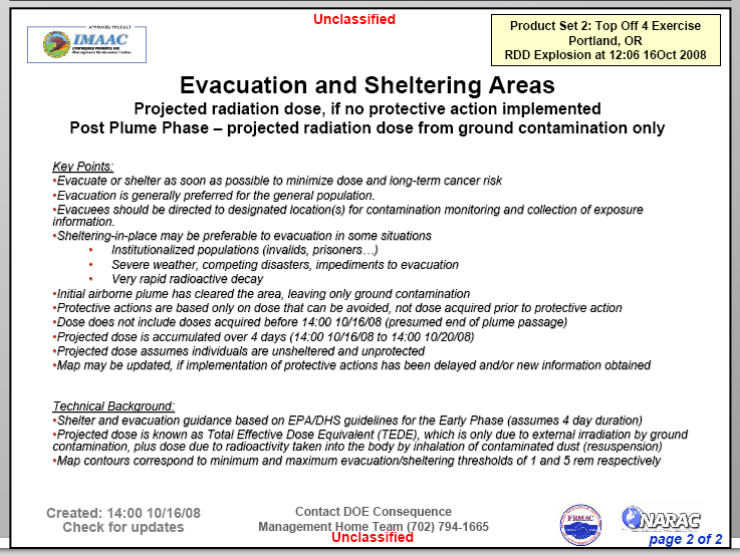
Created: 14:00 10/16/08
Check for updates

Contact DOE Consequence Management Home Team (702) 794-1665

Unclassified

FRMAC NARAC

page 1 of 2



Unclassified

IMAAC

Product Set 2: Top Off 4 Exercise
Portland, OR
RDD Explosion at 12:06 16Oct 2008

Evacuation and Sheltering Areas

Projected radiation dose, if no protective action implemented
Post Plume Phase – projected radiation dose from ground contamination only

Key Points:
- *Evacuate or shelter as soon as possible to minimize dose and long-term cancer risk*
- *Evacuation is generally preferred for the general population.*
- *Evacuees should be directed to designated location(s) for contamination monitoring and collection of exposure information.*
- *Sheltering-in-place may be preferable to evacuation in some situations*
  - *Institutionalized populations (invalids, prisoners…)*
  - *Severe weather, competing disasters, impediments to evacuation*
  - *Very rapid radioactive decay*
- *Initial airborne plume has cleared the area, leaving only ground contamination*
- *Protective actions are based only on dose that can be avoided, not dose acquired prior to protective action*
- *Dose does not include doses acquired before 14:00 10/16/08 (presumed end of plume passage)*
- *Projected dose is accumulated over 4 days (14:00 10/16/08 to 14:00 10/20/08)*
- *Projected dose assumes individuals are unsheltered and unprotected*
- *Map may be updated, if implementation of protective actions has been delayed and/or new information obtained*

Technical Background:
- *Shelter and evacuation guidance based on EPA/DHS guidelines for the Early Phase (assumes 4 day duration)*
- *Projected dose is known as Total Effective Dose Equivalent (TEDE), which is only due to external irradiation by ground contamination, plus dose due to radioactivity taken into the body by inhalation of contaminated dust (resuspension)*
- *Map contours correspond to minimum and maximum evacuation/sheltering thresholds of 1 and 5 rem respectively*

Created: 14:00 10/16/08
Check for updates

Contact DOE Consequence Management Home Team (702) 794-1665

Unclassified

FRMAC NARAC

page 2 of 2

2011-2012 NARAC Software Upgrades

NARAC Web (V2.6, 2.7, 2.8) and NARAC Central System (NCS V18.4, 18.5, 18.6, 18.7)

- Check boxes in Web to select reports to display (technical, briefing, user created, response time phase)
- Web run users have new option to generate IND or RDD briefing versions of NARAC prediction map products
- Report of total amount of activity contributing to each NARAC plot/product for radiological releases, and reporting of fractions of respirable- and ballistic-size particles
- Initial implementation of Web-based Mission Planning Tool (dose to monitoring team, simulated instrument reading)
- New documentation on NARAC default Dose Conversion Factors and assumptions available under Web “Help”
- Ability to “Download All” files from a Web book as a zip file
- Ability for Advanced Web users to request particle output to create animations
- Ability to resubmit a Web run with a radiological mixture created by another user
- Improved Web plume probing

2011-2012 NARAC Software Upgrades (continued)

NARAC Web (V2.6, 2.7, 2.8) and NARAC Central System (NCS V18.4, 18.5, 18.6, 18.7)

- *Sliding* time interval for finding peak 15-min average chemical air concentration
- For chemical weapon agents, automatic updating of median 50% Lethal Dose (LD50) value based on exposure period and toxic load effect (DHS sponsored)
- Breathing rates (for radiological doses) – are now age-dependent and activity-level-dependent
- Holdup time can be used for decay of radioactivity before atmospheric release for nuclear reactor scenarios
- Ground roughness shielding factor (0.82) updated to be consistent in all groundshine dose calculations
- Updated resuspension factors for radiological material based on recent Maxwell & Anspaugh paper

National Atmospheric Release Advisory Center
NARAC

15 New Msgs | Signed in as **nasstrom1-usa** | Your Account | Sign out

Home | New Run | View ▾ | Members ▾ | Bookmarks ▾ | Tools ▾ | Help ▾ | Manage ▾

Recent Web Upgrades

Description: Irradiator-Russian Seed Explosive Scenario using 50lbs HE. Select material: 5000Ci Radiological-Hybrid: RDD Cs-137 Russian Seed Irradiator.

Created: May 11, 2012 10:21:23 PM UTC

Last Modified: May 11, 2012 11:20:59 PM UTC

Creator: nasstrom1-usa

Summary | **Files (0)** | **Measurements (0)** | **Manage**

Run Again | Share | Delete | Move | Help ▾

Mission Planning | Interactive Map | Downloads

Expires: Never

Status: Completed Details

Model: NARAC

Material Released: 5000 Ci of RDD Cs-137 Russian Seed Irradiator (50% respirable, 36% ballistic)

Total Strength: 5,000 Ci
More Details

Release Start Time: May 11, 2012 10:00:00 PM UTC

Release End Time: May 11, 2012 10:00:01 PM UTC

Location: 47.604299 N, 122.334946 W

Reports

Find

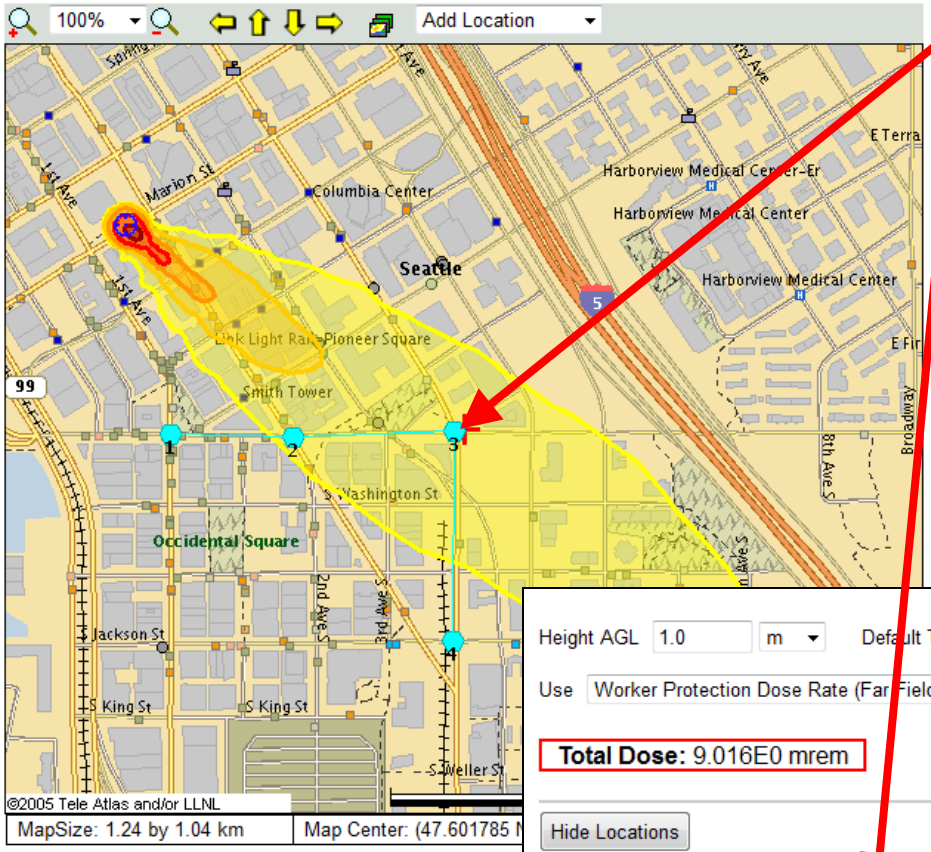
- ☑ Briefing
- ☑ Early Phase
- ☑ Intermediate Phase
- ☑ Technical

- Consequence Report
- Blast Overpressure Effects from 50 lb High Explosives
- Deposition at 12 hrs
- Early Phase Dose (0-96 hrs)
- Intermediate Phase Relocation PAGs
- Worker Protection Dose Rate at 12 hrs (Far Field)
- Worker Protection Dose Rate at 12 hrs (Near Field)
- BriefProd#2_Evac_Shelter_0-4days
- BriefProd#4_Worker_Protection
- BriefProd#5_Relocation

Denotes a standard (NARAC generated) report.

NARAC Web Mission Planning Tools

Select Route Locations



1) Click on monitoring route points
2) Enter arrival times and transit speed
3) Dose rate and dose, instrument reading is computed

exposure for 5 hours or less.	799m2	
Limit for all occupational		

Height AGL 1.0 m Default Transit Speed 30.0 mi/hr Instrument CST AN UDR13 [Cs-137]

Use Worker Protection Dose Rate (Far Field) to Calculate Dose

Total Dose: 9.016E0 mrem

Hide Locations

	Location	Arrival Time	Stay	Transit Time	Dose Rate At Location (mrem/hr)	Dose at Location (mrem)	Dose in Transit (mrem)	Instrument Reading (cGray/hr)
1)	(47.601762 N, 122.334169 W)	05/14/2012 06:05:48 UTC	1:00:00	0:00:00	5.4835E-2	5.484E-2		5.484E-5
2)	(47.601713 N, 122.331961 W)	05/14/2012 07:05:53 UTC	1:00:00	0:00:05	2.9826E0	2.983E0	2.536E-3	2.983E-3
3)	(47.601768 N, 122.329060 W)	05/14/2012 08:06:00 UTC	1:00:00	0:00:07	5.2104E0	5.21E0	1.324E-2	5.21E-3
4)	(47.599213 N, 122.329119 W)	05/14/2012 09:06:09 UTC	1:00:00	0:00:09	7.447E-1	7.447E-1	7.946E-3	7.447E-4

Remove Locations

Planned NARAC Upgrades

NARAC Web 2.9 (Scheduled for September 2012)

- Decision-maker Briefing versions of products for Nuclear Power Plants (funded by DHS)
- Chem/Bio Briefing Products (funded by DHS)
- Completed Mission Planning Tool

NARAC Central System 18.8 (Scheduled for Sep. 2012)

- Chemical Protective Action Criteria (PAC) TEEL database update to Rev 27
- Additional NARAC scientist tools to run suite of model runs (with range of values for various input parameters), and visually and statistically compare results for a suite of runs
- New chemical product – showing explosive/flammability limit

DOE/NNSA Has Sponsored Procurement and Installation of 288-Processor Compute Cluster at NARAC Facility

- Faster computing hardware is needed to provide rapid predictions of long-running and/or high-resolution simulations that model the transport and fate of radiological material released into the atmosphere (e.g., nuclear power plant accidents).
- NARAC software is being modified and optimized to fully utilize cluster
- Run-time of NARAC's primary atmospheric transport and dispersion models for complex , long-duration problems reduced from 1-3 hours down to 10 minutes.
- Expected Completion: September 30, 2012

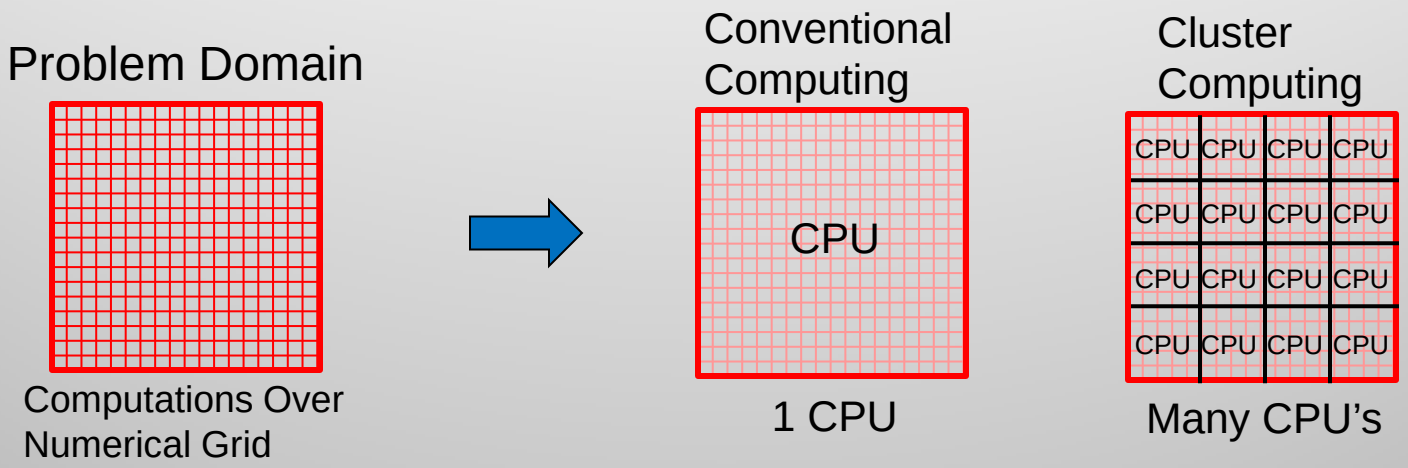
Appro Inc. Cluster Configuration

- 288 processor cores (3.46 GHz Intel 5690 chipset)
- 1152 GB total memory (4 GB/processor)
- High-speed communications network/switch (40 Gbit QDR)
- Linux-based system. Vendor cluster management software

Compute Clusters Reduce Model Run-Times

A “Compute Cluster” is a collection of tightly coupled individual CPU processors that work together to rapidly solve large problems

Each CPU of a compute cluster solves a segment of a larger problem



Cluster sizes range from 2 to 1,600,000 CPU processors

NARAC is installing a 288-processor cluster

NARAC/HotSpot Training and Meetings in 2012

- ***May 17, 2012*** – HotSpot Training Workshop, EMI SIG Meeting, Seattle, WA

- ***October or November 2012*** – NARAC Classroom Training Course at LLNL, Livermore, CA

- ***On-line*** - NARAC training currently available on EOTA Web site
  - Two interactive training modules:
    1. NARAC Dispersion Modeling - "NARAC101"
    2. Use of NARAC Web - "NARAC102"
       (*NARAC 102 recently updated for NARAC Web 2.x*)
  - http://eota.doeal.gov/

National Atmospheric Release Advisory Center (NARAC) Support for the Fukushima Dai-ichi Nuclear Accident

April 2012

Gayle Sugiyama, John Nasstrom,
Brenda Pobanz, Kevin Foster, Matthew Simpson,
Phil Vogt, Fernando Aluzzi, and Michael Dillon

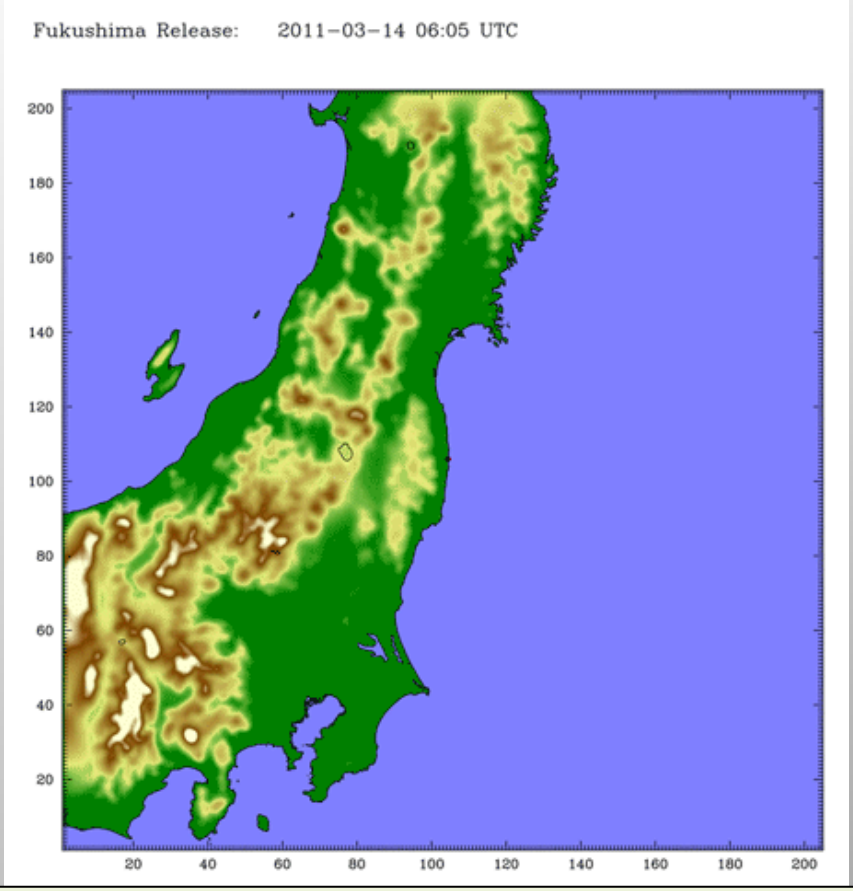
Lawrence Livermore National Laboratory

National Atmospheric Release Advisory Center
NARAC

This work was performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under contract DE-AC52-07NA27344. Lawrence Livermore National Security, LLC

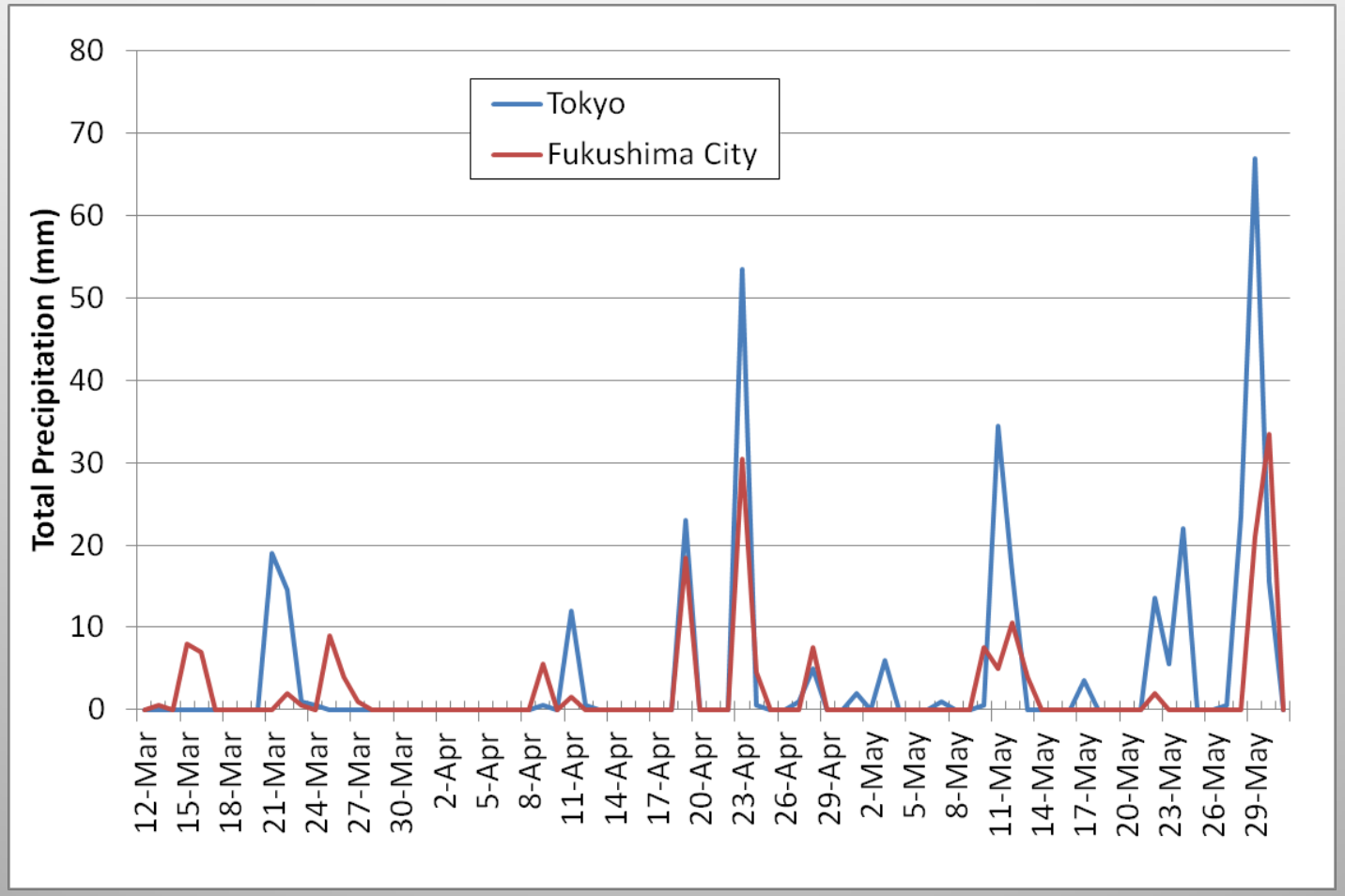
Rapidly changing wind and precipitation patterns generated a complex dispersion pattern during the critical March 14-16 time period

- Winds primarily off-shore until March 14 – March 16 when winds rotated clockwise during key period for contamination on land
- Winds remained primarily off-shore until March 21
- Initial forecasts captured overall pattern of winds and occurrence of precipitation
- Higher resolution (3-km) WRF FDDA meteorological model simulations provided increased accuracy in modeling the timing of the wind shifts and precipitation patterns

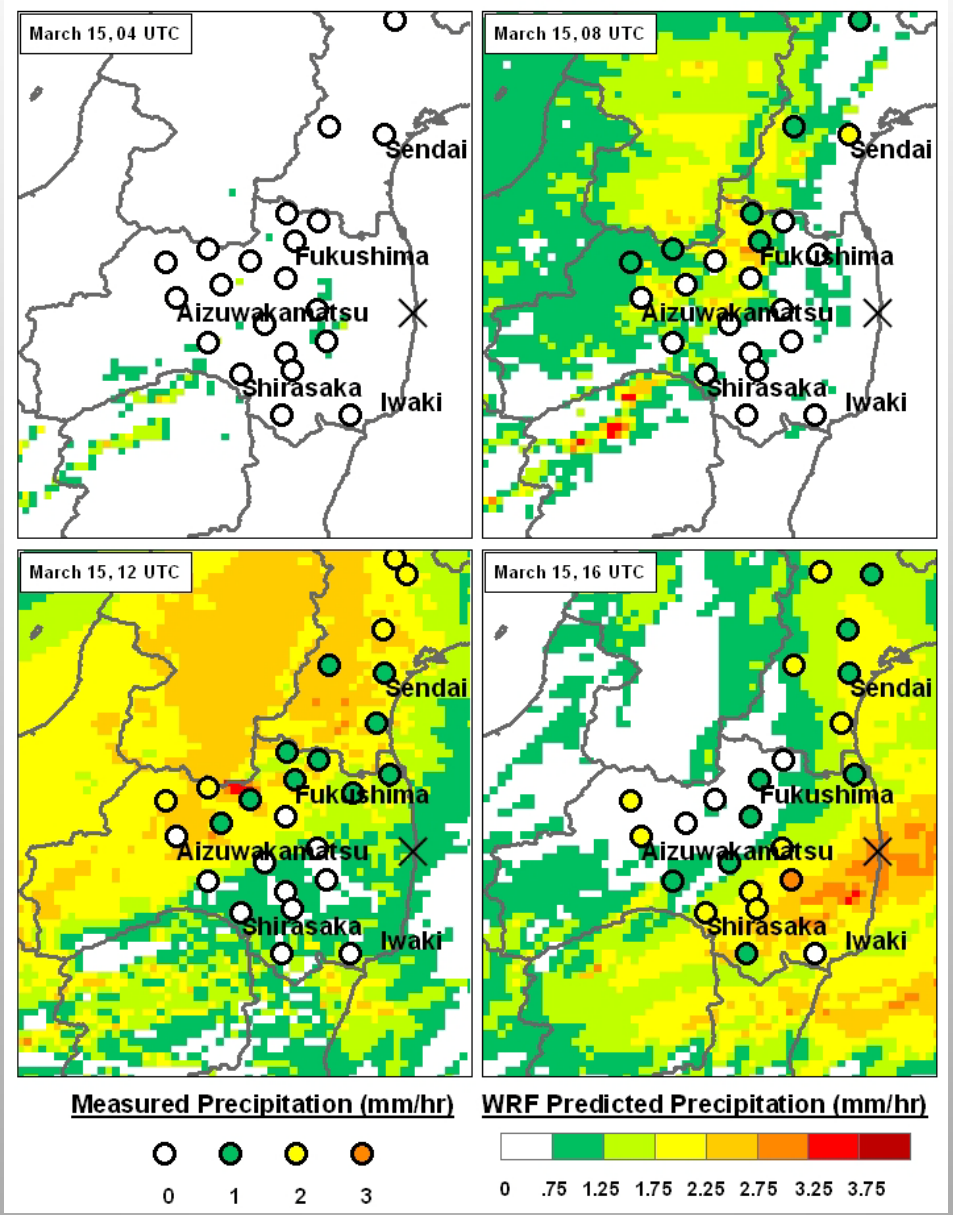


Particle animation for hypothetical constant release rate
(March 14 00 UTC - March 16 00 UTC)

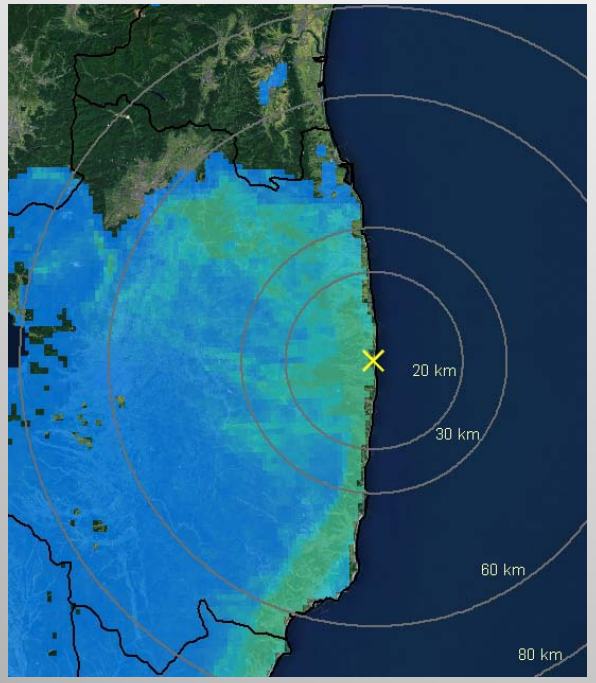
Episodic Rainfall Occurred Throughout the Release Period (Measurements at Two Cities)



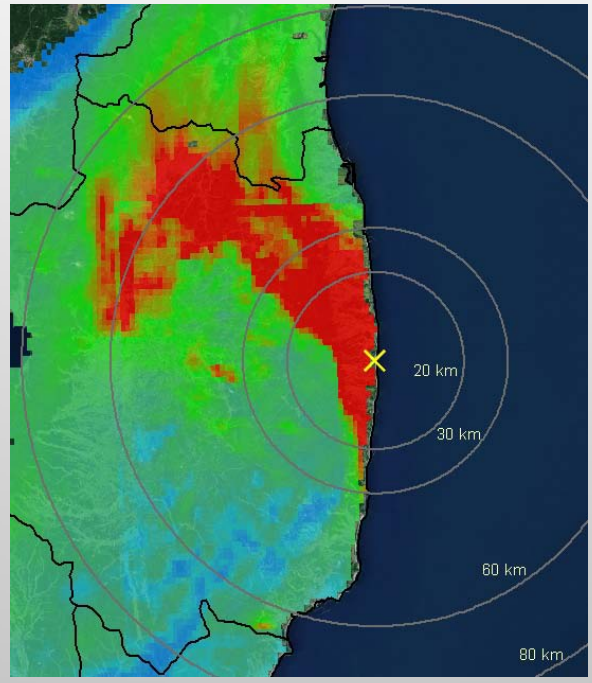
Periods of significant precipitation (and wet deposition) occurred during onshore wind transport on March 15



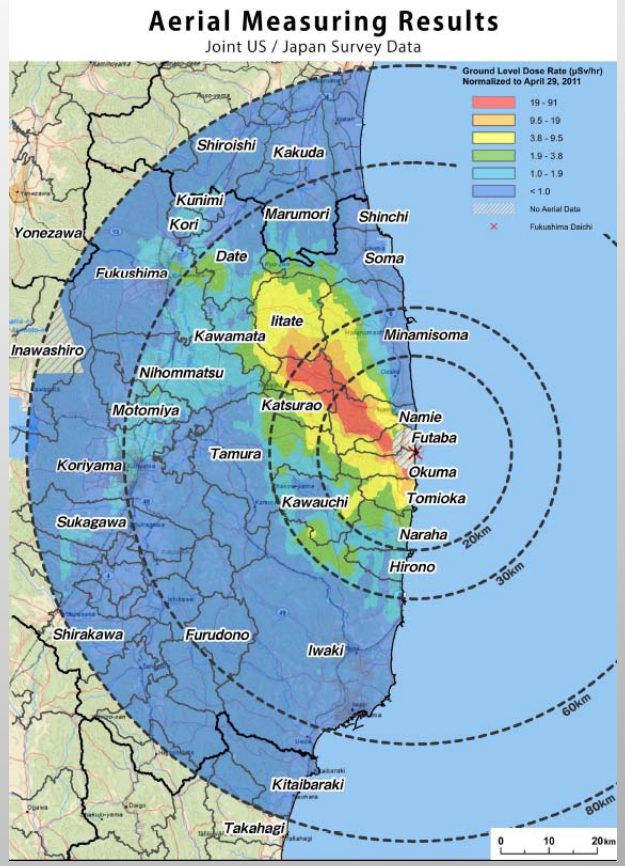
Precipitation Scavenging is Key to Accurate Predictions of Measured Ground Deposition



Predicted relative ground deposition pattern with dry deposition, but **no precipitation**



Predicted relative ground deposition pattern **with spatially and temporally-varying precipitation**

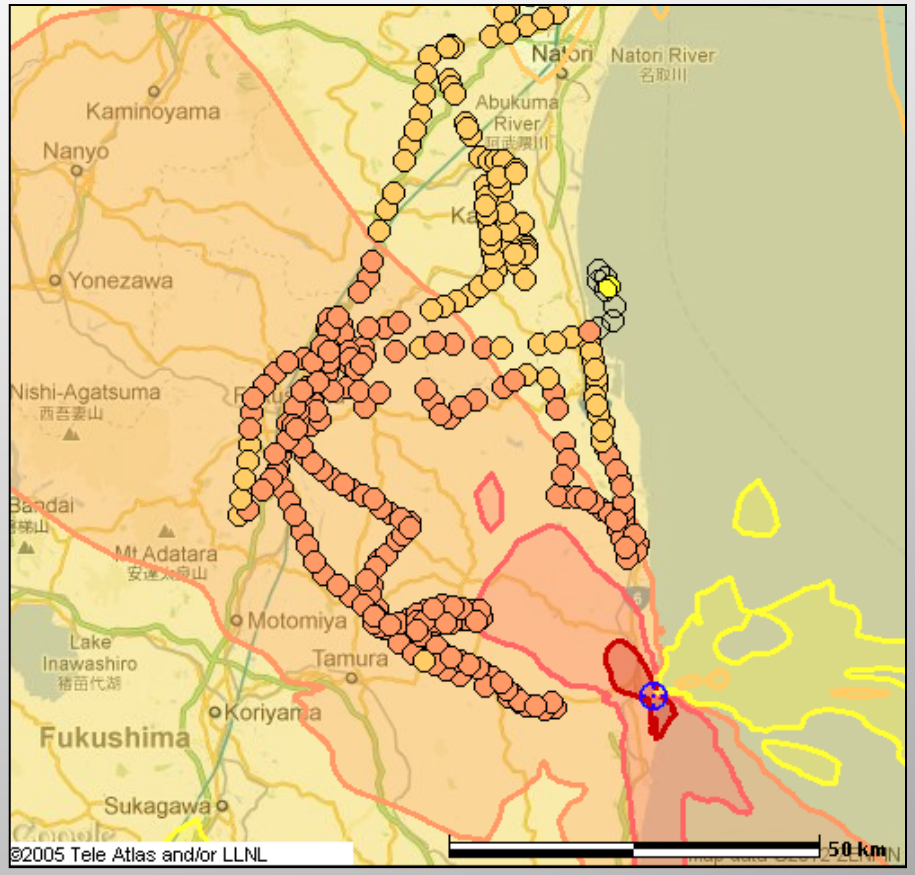


Measured AMS groundshine dose rate pattern

NARAC simulations using Flexpart and WRF-generated winds and constant release

NARAC dispersion model simulations were refined using radiological measurements to estimate release amounts

- Focused on key onshore release period: March 14-16
- NARAC primarily used DOE Aerial Measuring System (AMS) ground shine dose rates and Japan MEXT air/ground dose rate measurements
- Source estimates for off-shore-wind times are significantly more speculative due so sparser and longer-range off-shore measurements



NARAC modeled dose rate levels (contoured areas) overlaid with **March 26** AMS data (circles)

Fukushima Dai-ichi Release Estimates and Evacuation Zones

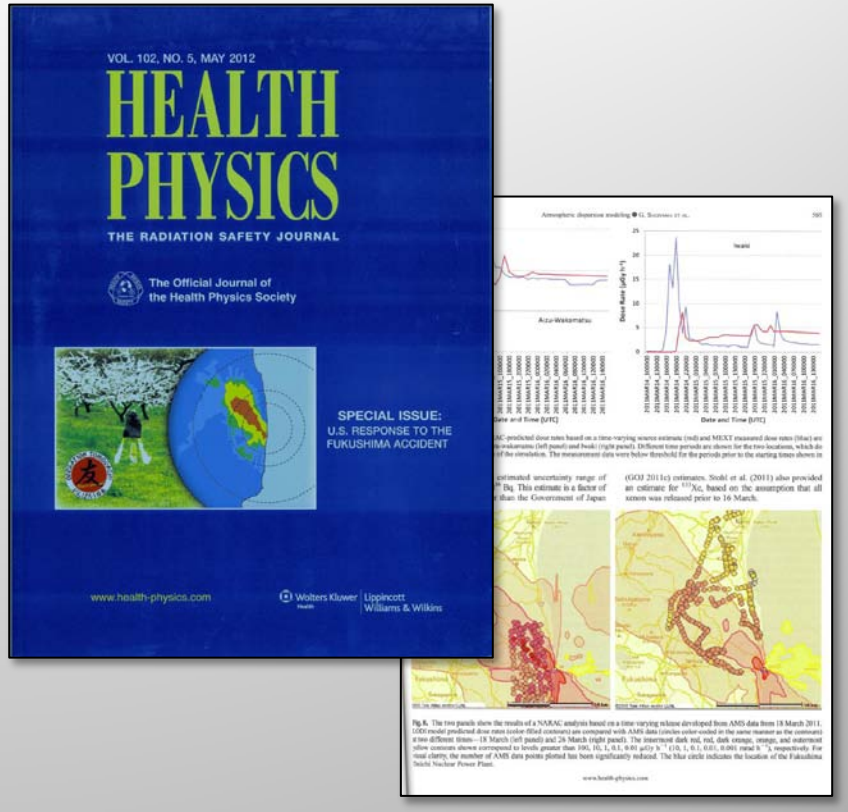
- IAEA Event Rating:
  - The IAEA Rating of the International Nuclear and Radiological Event Scale (INES) assessed at highest level, Level 7, equivalent Iodine-131 release:1 x 10^{16} Bq
    (News Release from Japan Ministry of Economy, Trade and Industry, April 12, 2011)
  - Chernobyl accident was also INES Level 7. However, the estimated amount of radioactivity released from Chernobyl is approximately 10 times the Fukushima accident
- Radioactivity Release Estimates:
  - GOJ Fukushima *total* released radioactivity estimates:
    - Cesium-137 1.1-1.5 x 10^{16} Bq
    - Iodine-131 1.3-1.6 x10^{17} Bq
  - NARAC baseline release estimate for critical on-shore-wind release period (March 14-16)*:
    - Cesium-137 3.7 x 10^{15} Bq (1 x 10^{5} Ci)
    - Iodine-131 7.4 x 10^{16} Bq (2 x 10^{6} Ci)
  - NARAC radioactivity release estimates consistent with other published estimates (e.g., Chino et al. 2011; GOJ 2011a, 2011b, and 2011c; Stohl et al. 2011) within expected uncertainties
- Japan evacuation/relocation zones:
  - Japan Evacuation/Restricted area: 20 km (12 mi)
  - Japan prepare to shelter/evacuate area (in case of emergency) 20-30 km (12-19 mi)
  - US NRC initial precautionary evacuation area for US citizens 83 km (50 mi)
  - Japan Deliberate Evacuation (relocation) zone up to approximately 45 km to North West (areas with 20 mSv, 2 rem dose in one year)

*Sugiyama, G; Nasstrom, J; Pobanz, B; Foster, K; Simpson, M; Vogt, P; Aluzzi, F; Homann, S (2012) Atmospheric Dispersion Modeling: Challenges of the Fukushima Daiichi Response, *Health Physics*, 102, p 493–508

NARAC Fukushima Study Published in Special Issue of *Health Physics* Journal

- Peer-reviewed journal article summarizing NARAC response to the Fukushima Dai-ichi nuclear power plant accident.
  - Daily weather forecasts and atmospheric transport predictions to inform planning for field monitoring operations and to provide U.S. government agencies with on-going situational awareness of meteorological conditions.
  - Estimates of possible dose in Japan based on hypothetical U.S. Nuclear Regulatory Commission scenarios of potential radionuclide releases to support protective action planning for U.S. citizens.
  - Predictions of possible plume arrival times and possible dose levels at U.S. locations.
  - Source estimation and plume model refinement based on atmospheric dispersion modeling and available monitoring data.
- First publication of NARAC release estimate for primary release period (March 14-16).
  - Cesium-137 3.7×10^{15} Bq (1×10^{5} Ci)
  - Iodine-131 7.4×10^{16} Bq (2×10^{6} Ci)

  NARAC radioactivity release estimates consistent with other published estimates (e.g., Chino et al. 2011; GOJ 2011a, 2011b, and 2011c; Stohl et al. 2011) within expected uncertainties.



Sugiyama, G; Nasstrom, J; Pobanz, B; Foster, K; Simpson, M; Vogt, P; Aluzzi, F; Homann, S (2012) Atmospheric Dispersion Modeling: Challenges of the Fukushima Daiichi Response, *Health Physics*, 102, p 493–508.

Questions and Feedback

How can NARAC or HotSpot better meet you needs?

For more information:

Web: http://narac.llnl.gov

To contact NARAC or submit a request:

Email: narac@llnl.gov

Phone: 925-422-9159

National Atmospheric Release Advisory Center

NARAC

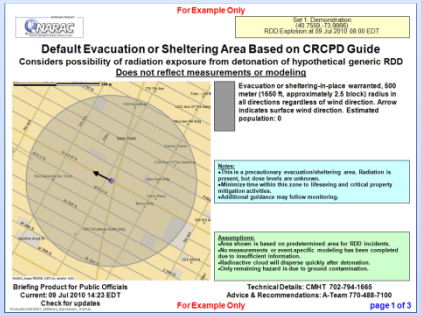
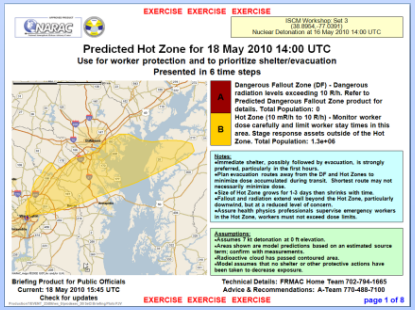
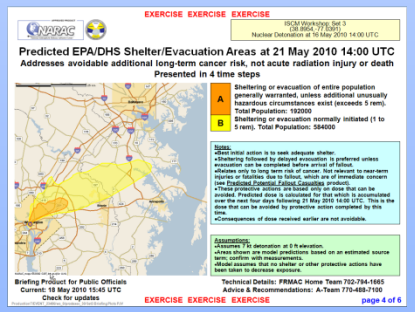
Web: narac.llnl.gov

Email: narac@llnl.gov

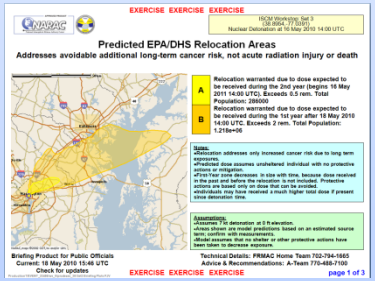
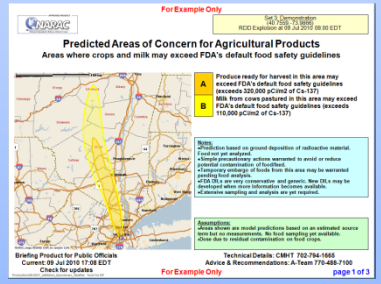
Lawrence Livermore National Laboratory

Additional Information

Types of Briefing Products:
Early Phase

Time Phase	Product		Purpose
Early (minutes to hours)	Default Evacuation or Sheltering Area (RDD)		• Guide precautionary sheltering and evacuation decision • Guide access control and monitoring
Early (hours to days)	Predicted Hot Zone /Worker Protection Areas (IND/RDD)		• Use for worker protection and stay time guidance • Determine access control area • Presented for multiple times, as fallout rapidly decays • > 10 mR/hr
	Predicted EPA/DHS Sheltering/ Evacuation Areas (RDD, IND, NPP in development)		• Guide sheltering and evacuation decisions • Assess avoidable additional long-term cancer risk, not acute radiation injury or death (1-5 Rem, >5 Rem in 4 days) • Presented in multiple times

Types of Briefing Products: *Intermediate and Late Phases*

Time Phase	Product		Purpose
Intermediate (days to months) and Late Phases (months to years)	Predicted EPA/DHS Relocation Areas (RDD, IND) (NPP in development)		• Guide population relocation decisions • Assess avoidable additional long-term cancer risk, not acute radiation injury or death (2 Rem in first year, 0.5 Rem in subsequent or later year)
	Predicted Areas of Concern for Agricultural Products (RDD, IND) (NPP in development)		• Guide crop sampling • Guide crop/food control decisions • Predict areas where crops and milk may exceed FDA's food safety guidelines based on fallout

Possible future HotSpot Upgrades

Planned/Current

1. Upgrade HotSpot source code to most current version of Microsoft's .NET Framework. Theoretically should not change the user interface or HotSpot capabilities from 2.07.2. Done to preserve HotSpot's sustainability and to improve code maintenance and development.

Possible

1. Incorporate additional meteorological file formats for the Dose Percentile module as was done for MACCS2.
2. Incorporate NRC/ARCON96 building wake option into HotSpot for calculations near buildings
3. Upgrade and document HotSpot Exercise data generation module
4. Develop a HotSpot web based, on-line training course
5. Add additional daughter products to ground shine

Please suggest other new features to meet your needs

DOE/NA-40 Sponsors of NARAC & HotSpot

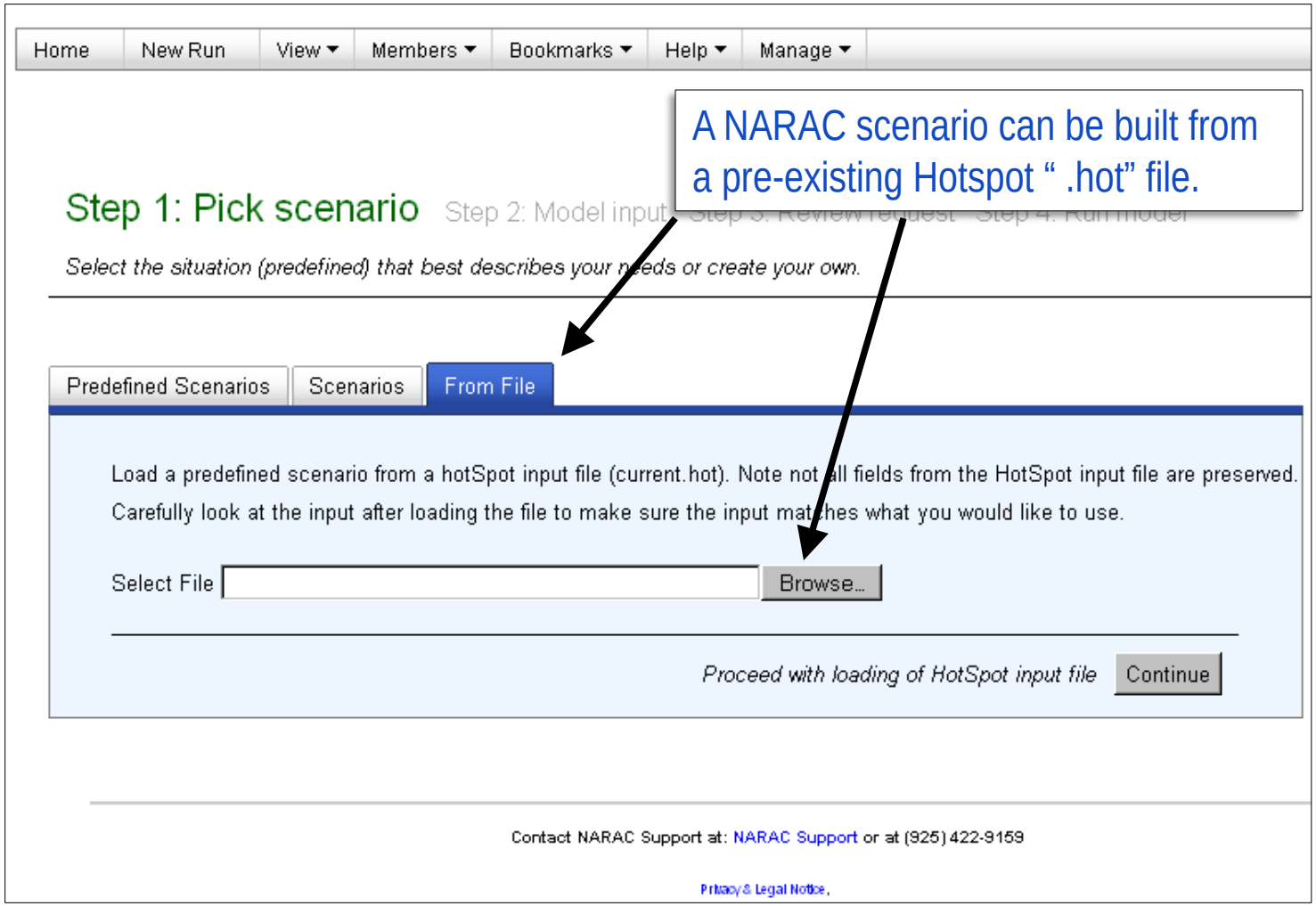
- DOE NA-42:
  - Base maintenance, development and readiness of NARAC systems, facilities, personnel, software, and computer models
  - Operational support for drills/exercises/response

- DOE NA-41:
  - Development and maintenance of NARAC/HotSpot modeling tools needed by DOE/NNSA sites
  - Training material tailored for DOE/NNSA sites

2010-2011 NARAC Web Upgrades (v2.2, 2.3, 2.4, 2.5)

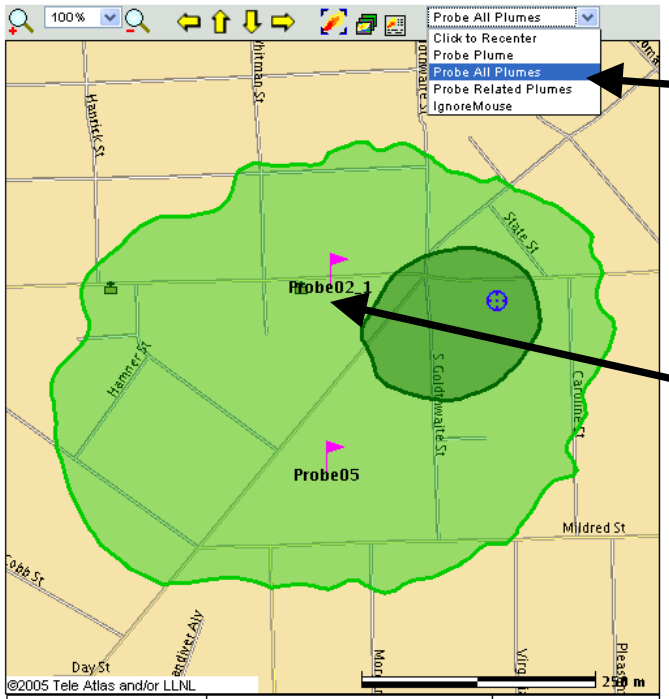
- Fire and Stack emission scenarios to the NARAC web
- Ability to Probe the Plume to get point values
- "Advanced" tab, allowing DOE sites the ability to control aerosolized/respirable fraction and plot output
- Ability to upload HotSpot scenario for NARAC model run
- Google Map Layers in NARAC Web plume displays: street, satellite, hybrid
- New download options:
  - Expanded GIS Shape files
  - KMZ file for display of NARAC results in *Google Earth*
  - NARAC ASCII concentration data file for use with HotSpot exercise data generation tool
- User-specified distances in centerline table output
- Import source term scenario from a HotSpot ".hot" file to a NARAC model run
- Example measurement Excel .csv file provided as a template for uploading measurements to NARAC for model refinement
- PAC TEEL database Rev 26 (NARAC Central Modeling System, January 2011)

NARAC Web: New Features
Importing Source From Hotspot



NARAC Web: New Features
Plume Probing Extension: “Probe All Plumes”

National Atmospheric Release Advisory Center NARAC



Back to: Example

Effects and Actions

	Description	(rem Ext Are
	Below health effect guidelines. Possibly contaminated area. Use to confirm with monitoring surveys.	>1.00 151m 23,484
	Below health effect guidelines. Possibly contaminated area. Use to confirm with monitoring surveys.	>1.00 501m 220,19

Note: Areas and counts in the table are
Population Source = LandScan USA V1

Effects or contamination at October 03,
or near ground level

Probe Results

Select	Probe name	Latitude	Longitude	Value	Unit	Product
☐	Probe05	32.371613 N	86.316356 W	2.839461E-7	rem/hr	Ground Exposure Dose Rate
☐	Probe02_1	32.373425 N	86.316298 W	2.056048E0	uCi/m2	Total Deposition
☐	Probe05_1	32.371613 N	86.316356 W	1.192508E0	uCi/m2	Total Deposition
☐	Probe02_2	32.373425 N	86.316298 W	6.551804E1	rem	Total Effective Dose Equivalent
☐	Probe05_2	32.371613 N	86.316356 W	3.907028E1	rem	Total Effective Dose Equivalent

Export options: CSV | Excel

1) Select the “Probe All Plumes” mode in an interactive session

2) Click on your map.

3) Each click generates:

i) a marker at the selected point along with its latitude and longitude in the results table.

ii) The concentration at that point for ALL the plumes in the run.

NARAC Web: New Features
Example Measurements CSV File

National Atmospheric Release Advisory Center
NARAC

Back to Sample DOE Site Run

Add Field Measurements using the form below:

- **Format** The type of format the field measurements are stored in:
  - NARAC -- Either NARAC standard XML format or iClient 1.6 format
  - FRMAC -- Format created by FRMAC RAMS system
  - NARAC CSV -- NARAC Comma Separated Value (Show format)
- **File** The File containing the field measurements.
- **Send Measurements** If checked, send the measurements to an assessment scientist so they improve the results. Otherwise the field measurements will just be used as a visualization layer

Measurement File: [ ] Browse...

Format: NARAC CSV Details

Example File

Number of Header Lines: 1

Separator: ,

Quote Character: "

Send Measurements: ☐

Add Measurements

To facilitate the entry of field measurement data in NARAC's CSV (Comma Separated Values) format, a sample file is provided in the Measurements (Measurements → Add Measurements) section of a run.

The example file can be edited in Excel or any text editor. Using this template helps eliminate time formatting issues that can arise along with other formatting issues.

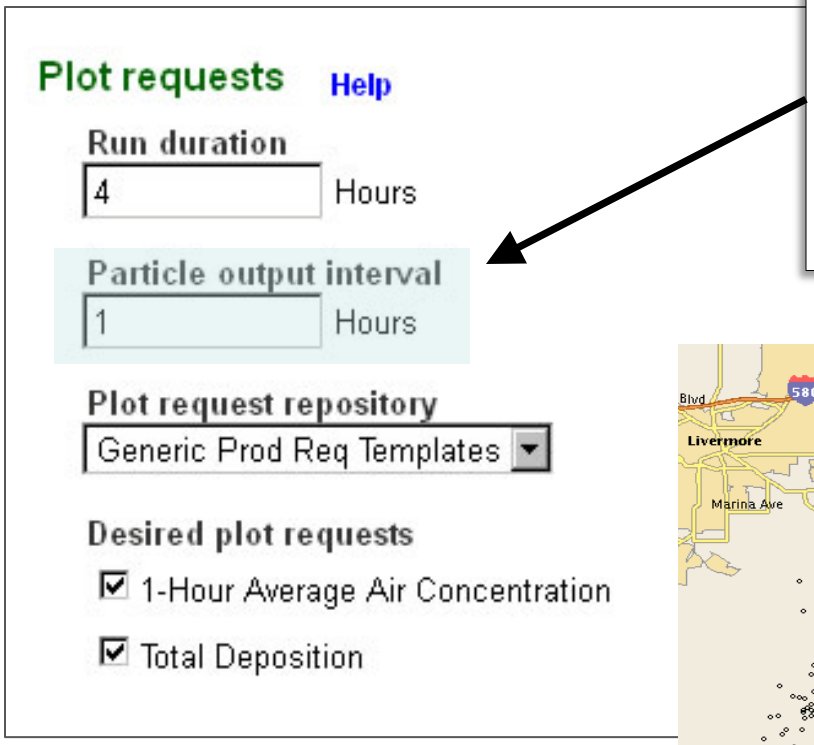
A	B	C	D	E	F	G	
Lat	Lon	Date	Time	Val	Units	LocationName (optional)	Material
37.12345	-127.12345	8/14/2006	17:55:00 PST	40	mrem/hr	Sample 1	CS-137
37.12346	-127.12346	8/14/2006	17:56:00 PST	0	mrem/hr	My Backyard	
37.12347	-127.12347	8/14/2006	17:57:00 UTC	0.012	mrem/hr		
37.12348	-127.12348	8/14/2006	17:57:00	0.008	mrem/hr		

sampleFieldMeasurements

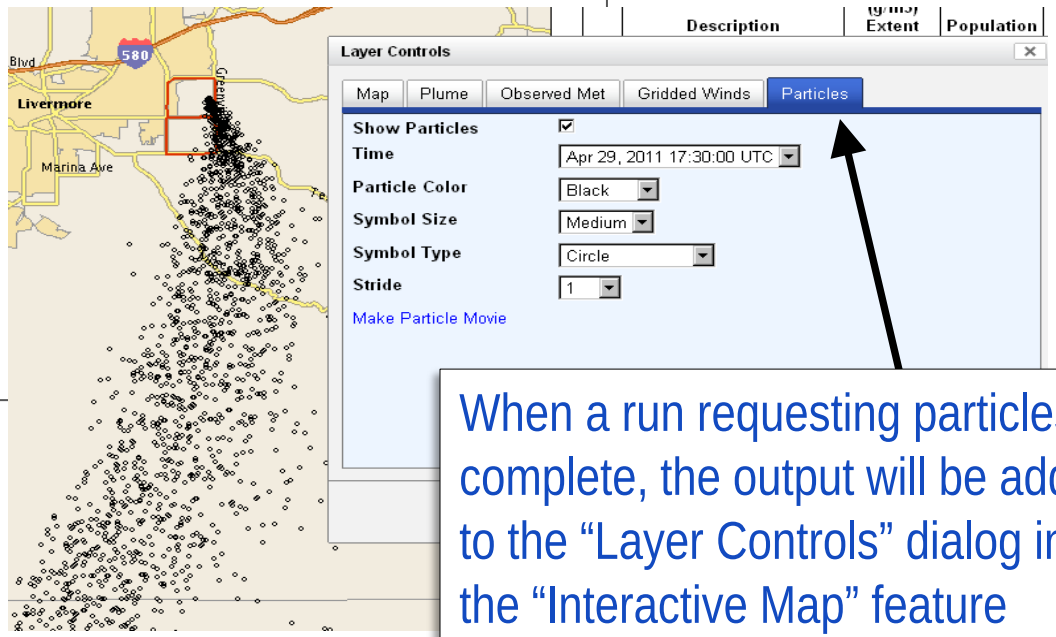
Average: 9144.2804

NARAC Web: New Features
Particle Output

Step 2: Model input (Advanced Options)



In the "Advanced" section of the model input form, a new field called "particle output interval" allows designated users to request particle output from NARAC's 3-dimensional dispersion model.



When a run requesting particles is complete, the output will be added to the "Layer Controls" dialog in the "Interactive Map" feature

Component-based LLNL NARAC-IMAAC Computer Systems Support In-house and External Users

National Atmospheric Release Advisory Center NARAC

LLNL Computer Systems

Central System: Automated model set-up and execution software

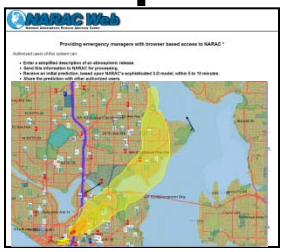
- Weather Data & Forecasts
- Geographic/Terrain Data
- CBRN Material Property Data
- Dose/Risk Factor Data
- Measurement Data
- Source models
- 3-D Meteorological, Dispersion and Fallout Models
- Prompt Effects Models
- Data-driven modeling tools
- Mapping and product generation software
- Population, casualty and fatality estimation

Remote Access Computer System

User interfaces and Analysis Tools for LLNL scientists

Internet/Intranet

External User Tools



***IMAAC/CM/NARAC Web* tools**

Standalone models and mapping

HotSpot

- Over 400 software applications
- 50 databases
- 3 million lines of computer code
- 28 servers
- 8 data storage systems

Component-based LLN
Systems Support In-ho

LLNL Computer Systems

Central Syste: Au

Weather Data & Forecasts

Geographi Da

Source models

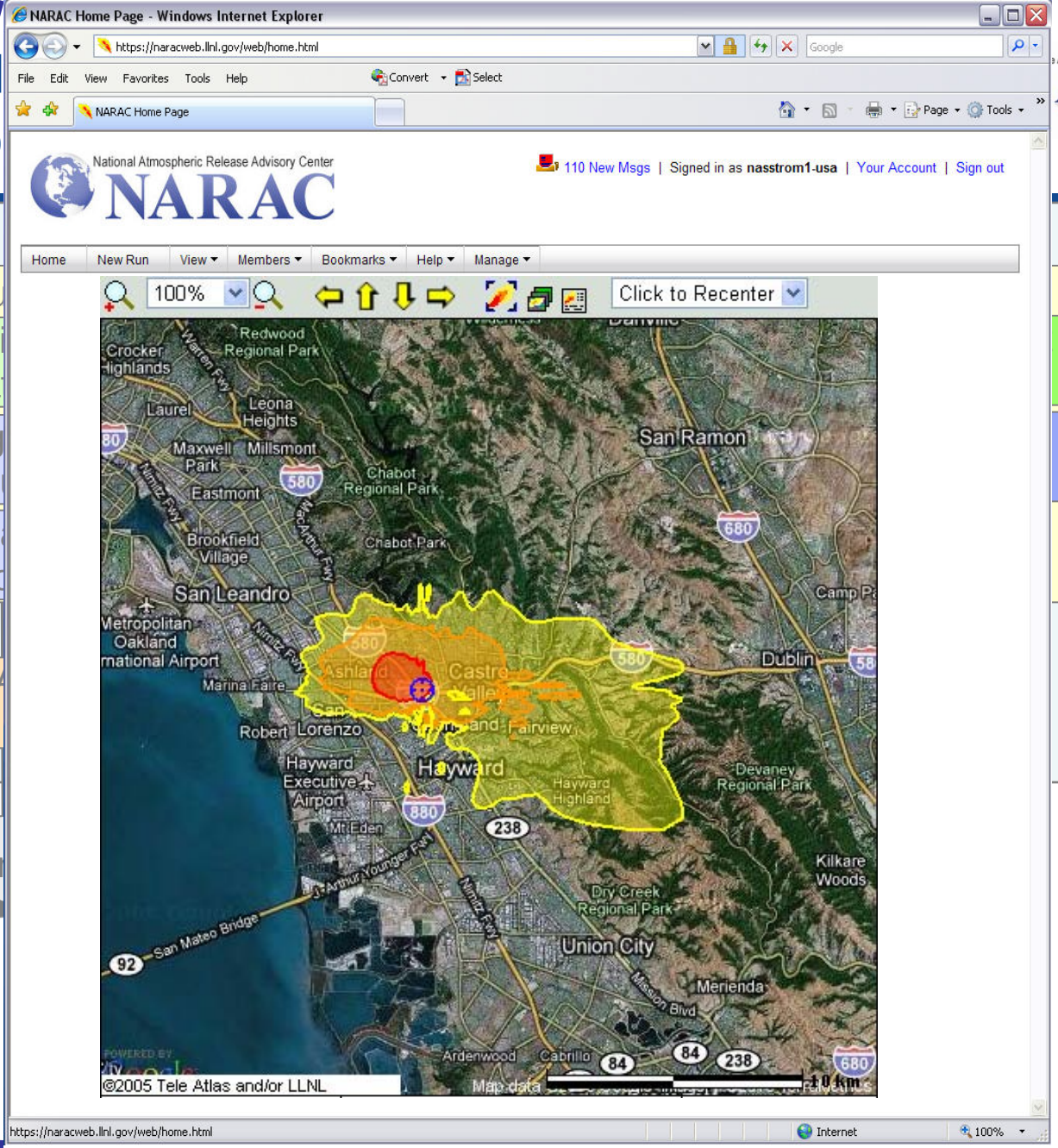
3-D Meteorolog and Fallo

Mapping generatio

Remote A Computer

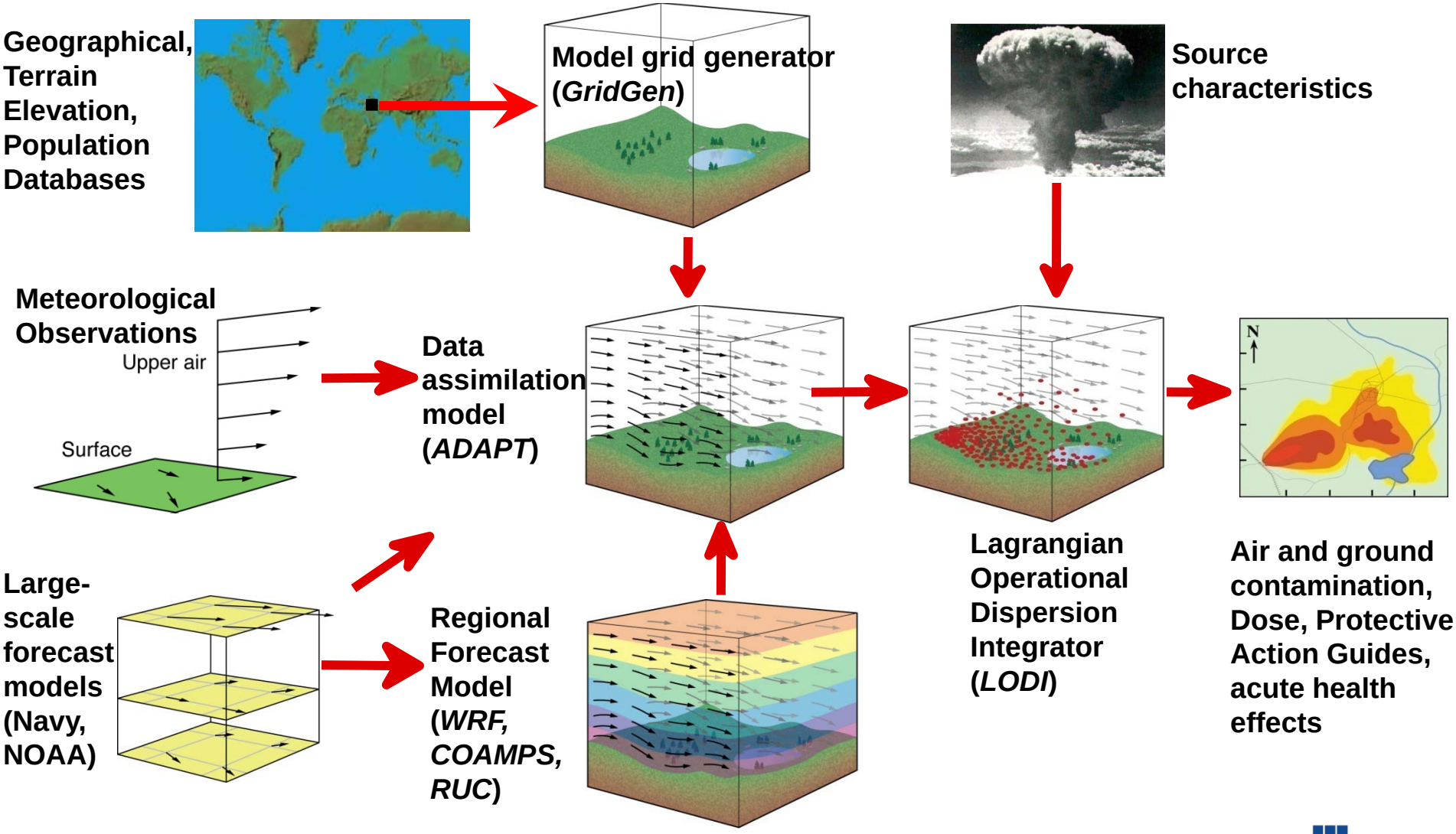
Inter

External User Tools

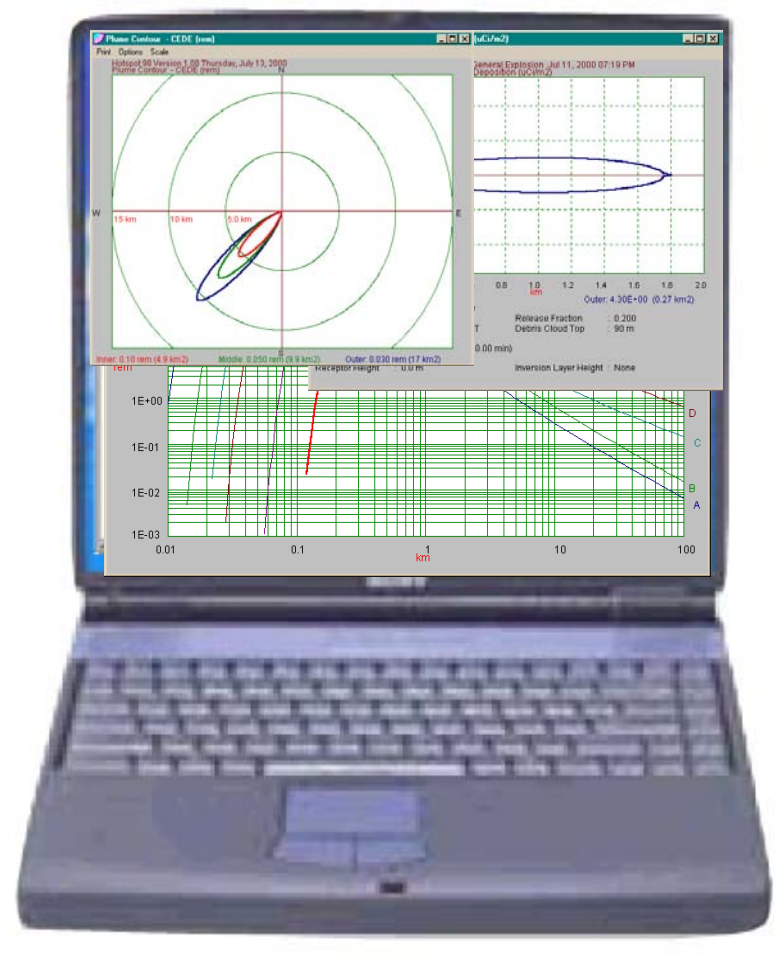


IMAAC/CM/NARAC Web tools

NARAC/IMAAC Central Modeling System Provides Automated 3-D Worldwide Plume Model Predictions



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

Hotspot Provides Quick Dose Estimates for Radiological and Nuclear Releases

- Fast-running PC-based plume, fallout and prompt effects models
- Multiple release scenarios: explosive, fire, general plume, nuclear detonation, resuspension
- Air and ground contamination and dose output as contours, tables and Google Earth format (.kml)
- Exercise data measurement simulation using NARAC or HotSpot model output and GPS device coordinates
- Historical weather data file used to compute 95th percentile dose