Air Plume Modeling… Planning or Diagnostic Tool

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Sample of REAC Air Dispersion Modeling Capabilities

Modeling at Superfund Sites

Superfund activities produce many different release scenarios. Because the emissions originate from various source types and have different levels of urgency, there are different methods for modeling the dispersion. Three major modeling categories include:

Contingency modeling is performed prior to sampling to provide possible downwind concentrations for specific emission rates which may be encountered on site.

Accidental release modeling is performed when results are needed immediately. Accidental release models that assist in providing warnings are best when real-time solutions are essential. These models provide worst case results but cannot account for near-field concentration patchiness.

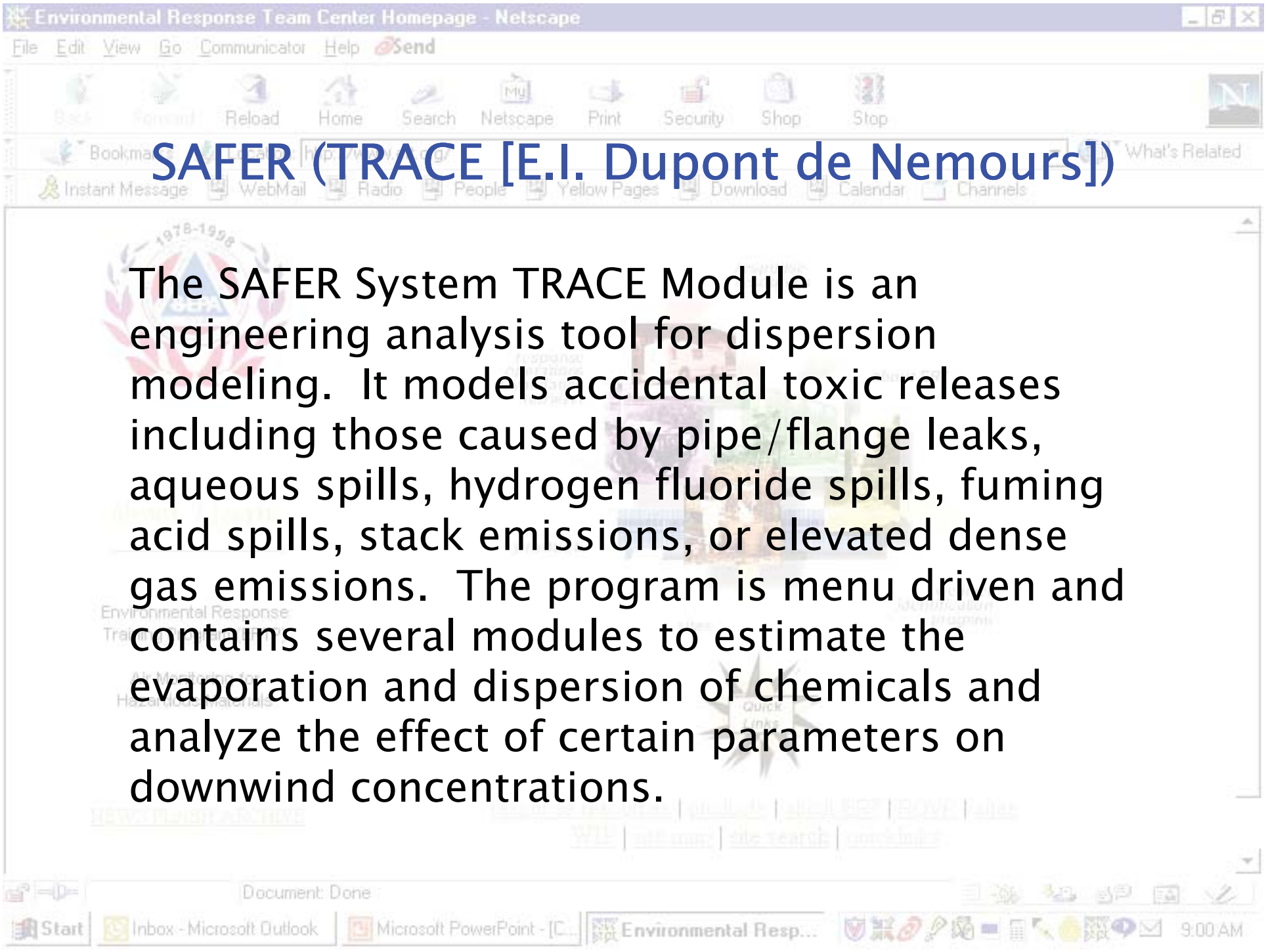
Short-term site assessment modeling is used to calculate concentrations which have occurred over periods of a year or less. These models provide detailed results of downwind concentrations at several receptors and are used most often for risk assessments.

Description of Selected REAC Models

- CHARM™ (Radian Corporation)
- SAFER (TRACE [E.I. Dupont de Nemours])
- ISC3 (U.S. EPA)
- CALPUFF (Earth Tech)
- AERMOD (U.S. EPA)
- ALOHA (NOAA/U.S. EPA)
- INPUFF (U.S. EPA)
- TSCREEN (U.S. EPA)
- SCREEN3 (U.S. EPA)
- SLAB (U.S. EPA)
- ARCHIE (FEMA/U.S. DOT/U.S. EPA)

CHARM™ (Radian Corporation)

The Complex Hazardous Release Models (CHARM) is a proprietary Gaussian puff model for continuous and instantaneous releases of gases or liquids. The model is configured to handle chemicals which are buoyant, neutrally buoyant, or heavier-than-air. CHARM can estimate the emission rates of chemicals based on a modification of the SHELL spill model and a multi-phase pressurized gas release model.



SAFER (TRACE [E.I. Dupont de Nemours])

The SAFER System TRACE Module is an engineering analysis tool for dispersion modeling. It models accidental toxic releases including those caused by pipe/flange leaks, aqueous spills, hydrogen fluoride spills, fuming acid spills, stack emissions, or elevated dense gas emissions. The program is menu driven and contains several modules to estimate the evaporation and dispersion of chemicals and analyze the effect of certain parameters on downwind concentrations.

ISC3 (U.S. EPA)

The Industrial Source Complex Model (ISC3) is a U.S. Environmental Protection Agency (U.S. EPA) regulatory-approved steady-state Gaussian plume air quality dispersion model. It is often used to estimate the impact of various types of industrial sources. The model has been developed primarily for use in regulatory compliance modeling applications to demonstrate that a new or modified source will not produce air quality impacts that are above the state or federal Ambient Air Quality Standards (AAQS).

CALPUFF (Earth Tech)

CALPUFF is a Lagrangian puff model. The model is programmed to simulate continuous puffs of pollutants being emitted from a source into the ambient wind flow. As the wind flow changes from hour to hour, the path each puff takes changes to the new wind flow direction. Puff diffusion is Gaussian and concentrations are based on the contributions of each puff as it passes over or near a receptor point.

AERMOD (U.S. EPA)

A committee, the AERMIC (American Meteorological Society/Environmental Protection Agency Regulatory Model Improvement Committee), was formed to introduce state-of-the-art modeling concepts into the EPA's local-scale air quality models. The AERMIC's focus was on a new platform for regulatory steady-state plume modeling. This platform would include: 1) air dispersion fundamentally based on planetary boundary layer turbulence structure, scaling and compliance; 2) treatment of both surface and elevated sources; and, 3) incorporate simple and complex terrain.

ALOHA (NOAA/U.S. EPA)

The Areal Locations of Hazardous Atmospheres (ALOHA) model, developed through a joint venture between the National Oceanographic and Atmospheric Administration (NOAA) and the U.S. EPA, is an emission estimation and air quality dispersion model for estimating the emission rate, movement, and dispersion of gases released into the atmosphere. The model estimates pollutant concentrations downwind from the source of a spill taking into account the toxicological and physical characteristics of the spilled material.

INPUFF (U.S. EPA)

INPUFF is a single source Gaussian dispersion model which performs calculations for stationary and moving sources of neutrally buoyant materials in the air. INPUFF (Integrated PUFF) uses a Gaussian puff dispersion equation in stationary or temporally and spatially varying wind fields provided by the users. The model does not estimate rates for chemicals, but accepts emission data and source parameters as part of an input file.

TSCREEN (U.S. EPA)

TSCREEN, a Model for Screening Toxic Air Pollutant Concentrations is an air quality dispersion model which implements the procedures in "A Workbook of Screening Techniques for Assessing Impacts of Toxic Air Pollutants," EPA-450-88-009. The TSCREEN model is an atmospheric dispersion model which uses the dispersion algorithms of SCREEN, Release Valve Discharge (RVD), and PUFF models. It automatically selects the worst-case simulated meteorological conditions based on the criteria presented in the workbook.

SCREEN3 (U.S. EPA)

The U.S. EPA Screening Procedures for Estimating the Air Quality Impacts of Stationary Sources (U.S. EPA, 1988) contains screening techniques for chemically stable gases or fine particulate pollutants. Those techniques have been computerized into a computer model called SCREEN3. The program provides a quick method to determine worst-case downwind concentrations from point, area, and volume sources when emissions data are available. SCREEN3 runs interactively on the PC, meaning that the program asks the user a series of questions in order to obtain the necessary input data.

SLAB (U.S. EPA)

SLAB is a computerized dense-gas model designed specifically for computing concentrations from releases that exhibit dispersion characteristics of plumes that are denser than their surroundings. REAC developed a FORTRAN-compiled interface for the SLAB. The interface guides the user through the model setup by using explicit commands that allow the interface program to make logical decisions in order to design an input card that controls the flow of the SLAB program.

ARCHIE (FEMA/U.S. DOT/U.S. EPA)

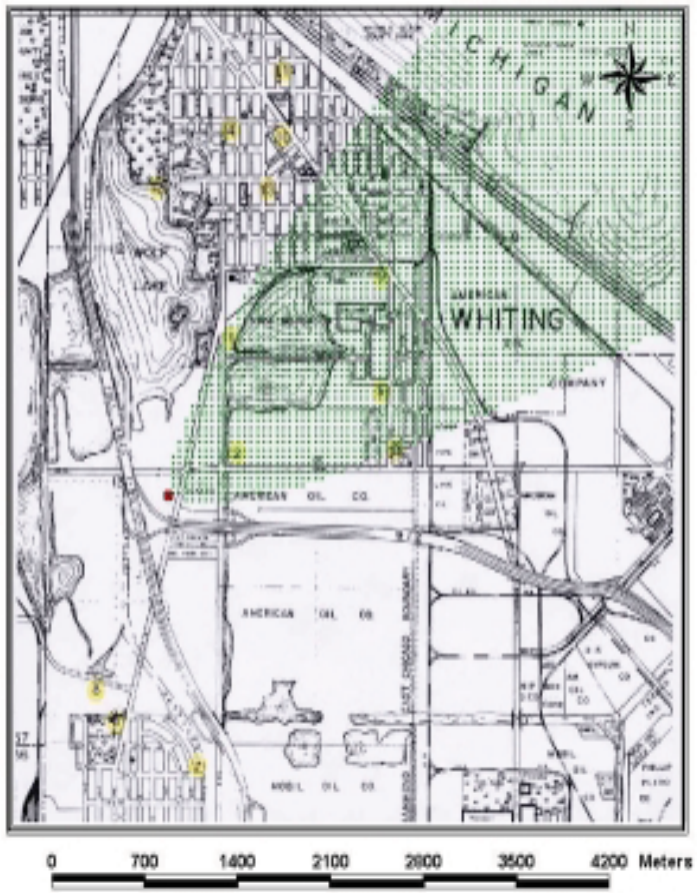
The Automated Resource for Chemical Hazard Incident Evaluation (ARCHIE) model is an emission estimation and atmospheric dispersion model which can be used to assess the vapor dispersion, fire, and explosion impacts associated with episodic discharges of hazardous materials into the environment. The model can estimate the emissions and duration of liquid/gas releases from tank, pipelines and liquid pools, and the associated ambient concentrations downwind of these releases.

Short-term site assessment model: Hammond, IN

A dispersion modeling analysis was performed to calculate the extent of the plume resulting from stack emissions on November 18, 1999, from a known source in Hammond, IN. For this analysis, the plume edge was defined as 1% of the maximum predicted concentration. The dispersion modeling was performed utilizing EPA's Industrial Source Complex Short Term (ISCST3) model.

The dispersion modeling was performed for the same period of time that ambient sampling was being conducted in the area. The ISCST3 model was run utilizing meteorological data collected at the facility. The plume was overlaid on a map of the area with sampling locations identified to determine if the sampling was conducted in an area the plume may have impacted during the sampling period.

Model Used: ISC3 (U.S. EPA)



Contingency modeling: Isla de Cabras site

A dispersion modeling analysis was performed to calculate the extent of the plume resulting from the controlled incineration of pyrotechnic material at the Isla de Cabras site in San Juan, Puerto Rico. The purpose of this analysis was to help determine what time of day the incineration activities should take place in order to minimize the potential impact on nearby residential areas. Five years of recent hourly meteorological data from San Juan was used for this analysis. The modeling was conducted in one-hour increments from 6 AM through 6 PM and figures depicting the maximum one-hour impact were generated. Since specific emission rates were unknown, the contours on the figures were created to indicate a percentage of the maximum predicted impact (based on a unity emission rate). Therefore, relative areas of higher impacts could be more easily identified.

The dispersion modeling revealed a prevalent seabreeze that develops in the late morning resulting in a plume that travels toward nearby residential areas. Based on the modeling, it was determined that early- to mid-morning would be the best time to conduct the incineration activities. The model results were also used to determine the monitor/sample locations to be used during the incineration.

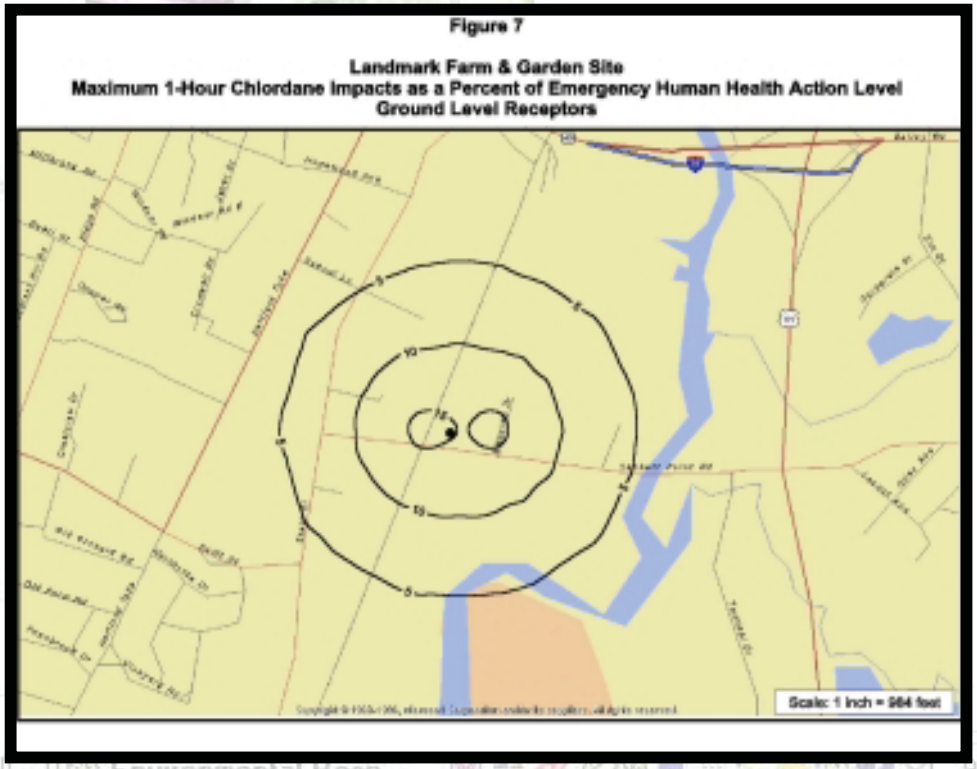
Model Used: ISC3 (U.S. EPA)

Contingency modeling: Landmark Farm & Garden

A dispersion modeling analysis was performed to calculate the magnitude and extent of the plume resulting from the demolition of a structure containing various amounts of pesticides/herbicides. The purpose of this analysis was to help determine what areas, if any, may potentially be exposed to impacts exceeding the associated emergency human health action levels as a result of the demolition activities. Modeling was conducted utilizing EPA's 52 pre-determined worst-case meteorological conditions in order to determine the maximum potential impact in the surrounding community. The contours on the figures were created to indicate a percentage of the emergency human health action levels that would result from the worst-case scenario.

The dispersion modeling results were used to help identify any areas that potentially would need to be evacuated during the demolition. The model results were also used to determine the monitor/sample locations to be used during the demolition.

Model Used: ISC3 (U.S. EPA)

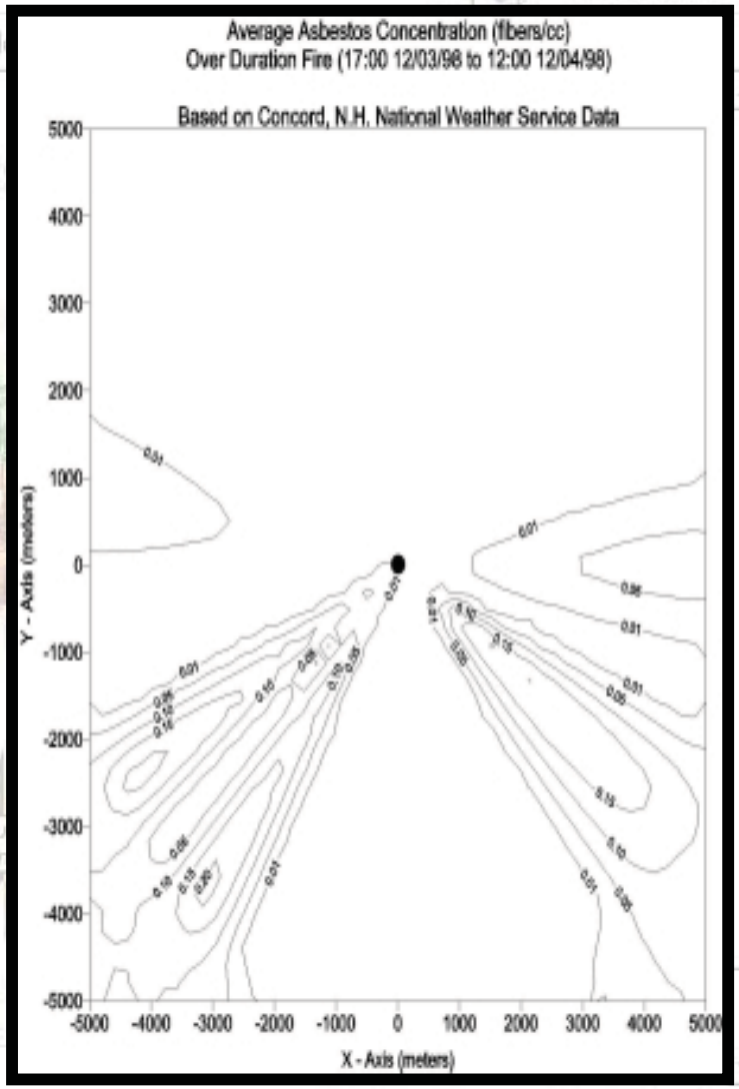


Short-term site assessment model: Northfield, NH

A dispersion modeling analysis was performed to calculate the potential maximum downwind concentrations of lead and asbestos resulting from the December 3-4, 1998 fire at the Surrette Battery site in Northfield, NH. The dispersion modeling was performed utilizing EPA's Industrial Source Complex Short Term (ISCST3) model.

The dimension of the burned structure was approximately 300 ft. x 200 ft. with a roof height of 100 ft. The roof was composed of a roofing paper containing approximately 25% asbestos, by weight. Modeling for lead impacts was done assuming both one and five tons of lead emissions. The ISCST3 model was run utilizing hourly meteorological conditions from the National Weather Service in Concord, NH. Maximum predicted impacts were calculated out to a distance of 5000 meters from the fire.

Based on the modeling results, sampling was concentrated in areas where the model predicted maximum impacts to have occurred.



Model Used: ISC3 (U.S. EPA)