United States
Environmental Protection
Agency

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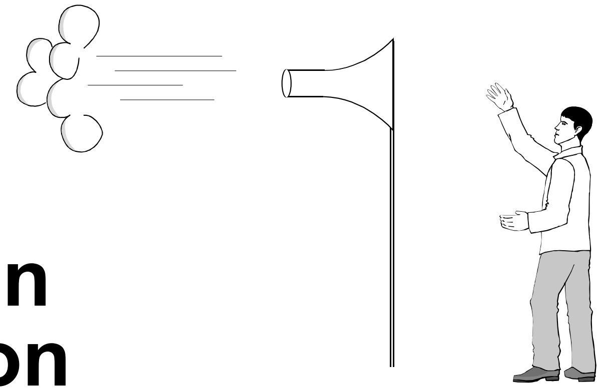
Computer Air Modeling — A Valuable Tool in Site Characterization and Remediation



Introduction

The U.S. EPA and the U.S. DOE are involved in characterization and remediation of contaminated sites that have been or are currently releasing contaminants into the atmosphere and pose a public health threat to surrounding communities from exposure to ground deposited contaminants. The sites may have released contaminants from industrial process stacks (e.g., old battery factory or mine smelter) or from suspension (wind or mechanical) of surficial contaminants in waste disposal areas (e.g., mine tailings or hazardous waste spill areas).

Through an interagency agreement with the Idaho National Engineering and Environmental Laboratory, EPA's Technology Support Center for Monitoring and Site Characterization is providing refined air modeling technical support for these sites for a variety of purposes. These applications include 1) the planning, layout, and prioritization of soil sampling grids, 2) determining the likely contribution of the modeled source emissions to measured soil contaminant levels when background or other sources are present, 3) assessing the relative contribution of multiple sources to cumulative impacts at a particular location which may help prioritize individual site remediation, and 4) identifying the best locations for

Modeling Results

Air modeling predicts the relative location and magnitude of time-averaged (long term or worst-case short term) air concentrations (μg m^{-3}) and ground deposition rates (μg m^{-2} $time^{-1}$). These results are plotted as concentration isopleths on regional maps which will show the spatial variation and magnitude of predicted impacts relative to the locations of critical human receptors (e.g., residential areas). Often geographical information systems (GIS) software is used to "mate" the modeling results with digitized topographic maps.

Model Input Requirements

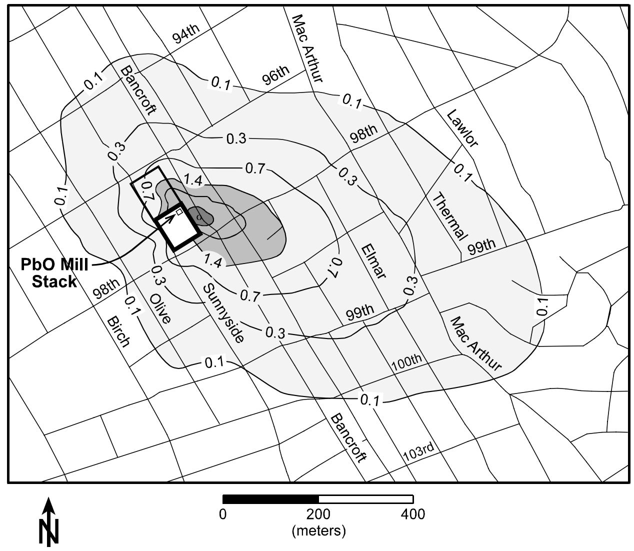
Three basic types of information are needed to perform air modeling: source data, meteorological transport data, and receptor data. Source geometry may be determined from on-site inspections or reconstructed using historic aerial photos. Source emissions data are usually calculated outside of the air model and may be reconstructed from past facility operating information and published emissions factors or calculated using theoretical or empirical equations. Airport meteorological data is readily available from NOAA's National Climatic Data Center for many locations around the country, or site-specific measurements at the site may be available. Receptor locations and elevations are usually obtained through USGS digital map sources.

Model Accuracy

Modeling results are mathematical predictions with associated uncertainty ranges that result from imperfect model structure and uncertainty in the parameter values used for model input. Often this may result in prediction errors ranging from factors of two to ten or more. This may be adequately addressed by performing a model uncertainty analysis where ranges of parameter values are assessed to provide lower- and upper-bound model predictions. Also, *relative* impacts (μg m^{-2} $year^{-1}$ deposition per g s^{-1} released) may be modeled. This avoids all uncertainties associated with the source emission rate while still providing critical information on the relative shapes and locations of the concentration isopleths (for use in sample grid layout or remediation prioritization).

Examples

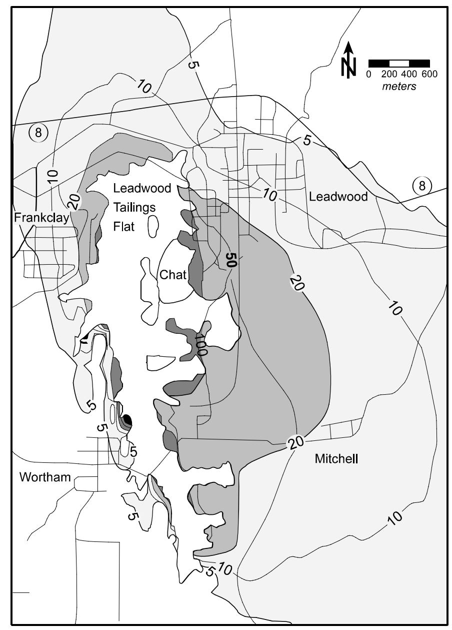
EPA Region IX required information on the potential source of measured soil lead levels in residential areas surrounding a Superfund site that had been contaminated by 40 years of stack emissions from an old battery factory. "Relative" (unit release) air concentrations and deposition rates in the area were assessed using the EPA Industrial Source Complex Long Term (ISCLT3) air dispersion model, five years of meteorological data from a nearby airport, and USGS digital topographic information. The major deposition area extended primarily in an east-southeast trend out to a distance of about 1 km with the point of maximum impact occurring 50 meters from the old stack location. "Relative" deposition rates were subsequently scaled to total deposition using historical battery production records, published EPA emissions factors, and the 40-year operating time of the lead oxide mill. The modeled results were then compared to measured soil concentrations to help identify the source of the contamination.



Relative lead deposition rates (g m^{-2} yr^{-1} per lb/hr released) around a battery factory stack.

EPA Region VII requested air modeling to characterize regional deposition rates of windblown lead contamination at the Big River Mine Tailings Superfund site in southeast Missouri. A modeling study was completed which assessed site-specific wind erosion rates from seven large tailings sites, performed deposition modeling using the Fugitive Dust Model (FDM), and produced detailed maps of cumulative deposition rates across a 110 square mile region. Results indicated that lead deposition rates in impacted areas might be as high as 175 mg m^{-2} yr^{-1} and up to 1 mg m^{-2} $hour^{-1}$ during periods of high winds. A comparison between model predictions and measured lead concentrations at four air samplers that border one of the sites indicated reasonably good agreement. The modeling results are currently being used to 1) help identify the source of lead found in residential soil samples, 2) provide a rationale for expanded sampling plans, and 3) prioritize remediation of the different sites.

Lead deposition rates (λg m^{-2} hr^{-1}) from wind suspension of mine tailings. ➔



For Further Information

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