Air Resources Laboratory

Atmospheric Tracer Technology

Improving Understanding of Atmospheric Transport and Dispersion of Harmful Material

Understanding how and where harmful material released into the air is transported and dispersed is essential to handling important problems, such as air pollution and an accidental or intentional chemical release. The Air Resources Laboratory (ARL) provides data necessary to develop, test, and improve dispersion and air quality models. Dispersion models are primary tools used by emergency managers and first responders to determine appropriate responses (e.g., approach routes, evacuation routes, shelter in place) to chemical, biological, and nuclear incidents. Air quality models are used by regulatory agencies to determine appropriate pollutant emissions controls. The models must be validated with "real data" to determine their accuracy. Since actual toxic material cannot be released into the atmosphere during an experiment, surrogate benign material (tracers) that mimic a real threat are used instead. Tracer experiments yield a host of critical information that are then used to determine chronic and acute exposure risks to humans, should an event occur. ARL's tracer technology is best suited for scales ranging from individual buildings to the size of a city. Although, the technology has been used successfully to study dispersion on much larger scales.

ARL Capabilities

The Atmospheric Tracer Technology employed by ARL's Field Research Division (FRD) involves a small amount of a stable, non-toxic, invisible, odorless, and easily detectable substance (known as a tracer) that is released into the air. The air in the surrounding area is then sampled and the concentration of the tracer is measured. By combining the concentrations with meteorological information, FRD scientists can develop and test theories and models of atmospheric transport and dispersion. Current capabilities include the use of continuous analyzers, time integrated sampling, and automated tracer release mechanisms.

__Continuous Analyzers__

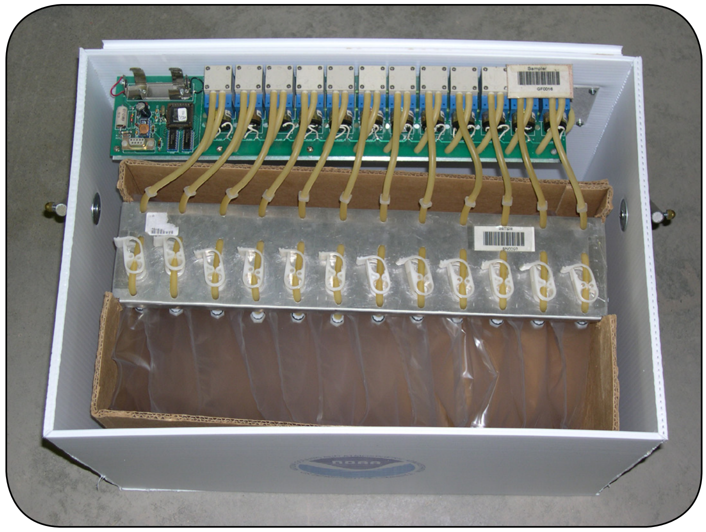
The continuous (near real time) sulfur hexafluoride (SF_6) analyzers are portable systems that make measurements of atmospheric SF_6 concentrations with a response time of just under one second. The rapid response time and mobility of the analyzers suit them ideally for measurements of plume widths and structure. They have been utilized in experiments measuring both across wind and along wind diffusion parameters commonly used in Gaussian plume transport and dispersion models.

The SF_6 analyzers include a computer controlled calibration system and an integrated global positioning system (GPS) that tags each data point with sampling time and location. The systems can be used in cars, boats, aircraft, and buildings. The current configuration easily sits in an automobile or aircraft passenger seat and attaches with standard seat belts.

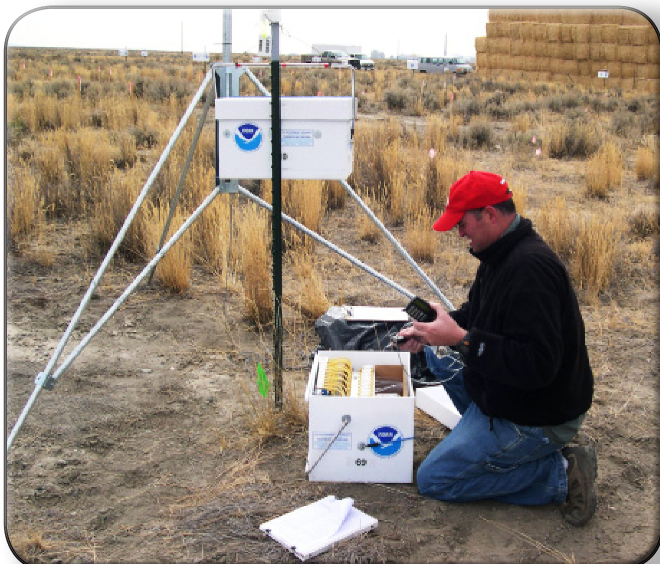
A fast response analyzer that measures tracer concentrations every second. The analyzer is easily carried on a seat of a vehicle. Photo: NOAA/ARL

__Time Integrated Sampling__

This sampling system provides average tracer concentrations over specified time intervals at specific sampling locations. The system involves Programmable Integrating Gas Samplers (PIGS) that are placed at pre-selected points prior to the start of the experiment and programmed to collect samples over the period of the experiment. The PIGS contain 12 Tedlar® bags that collect 12 samples sequentially. After the experiment is over, the samples are analyzed with an Automated Tracer Gas Analysis System —an autosampler and gas chromatograph used to analyze the gas mixture in each bag. The bags can be exchanged in the PIGS so sampling can continue while the analysis takes place. ARL has found that by placing a relatively large number of PIGS (e.g., 100) on a grid across the experimental area, a good footprint of the tracer plume can be determined for each sampling period. The system allows many simultaneous measurements to be made and also offers the advantage of easy comparison to model predictions, since atmospheric transport and dispersion models commonly produce time averaged concentrations at specific points. The system was designed primarily for SF_6, but has been adapted to measure perfluorocarbon tracers.



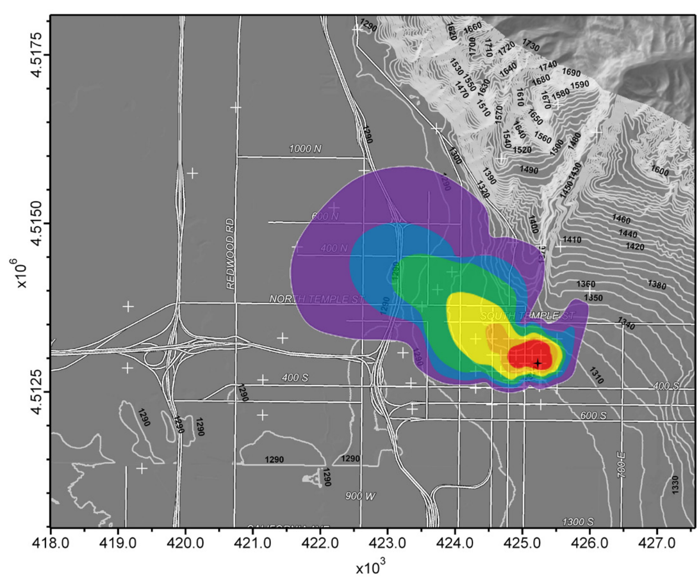
Example of PIGS. Photo: NOAA



FRD meteorologist programming one of the tracer samplers used in a U.S. EPA roadway study. Photo: NOAA

Atmospheric Tracer Release Mechanisms

The FRD designs, builds, and operates tracer release systems for a wide variety of atmospheric tracer experiments. These include systems for SF_6, perfluorocarbons, and other materials and cover a wide range of release rates. Each system is configured to meet the specific needs of the experiment it is designed for. All release systems are computer-controlled, with redundant release rate measurement and control.



An example of contour plume plot using tracer concentration data. Warm-colors (red, orange, yellow) show areas with higher concentrations. Image Source: ARL/FRD

Field Research Division
www.noaa.inel.gov/
FRD's Atmospheric Tracer Technology
www.noaa.inel.gov/capabilities/tracers/tracers.htm
Air Resources Laboratory
www.arl.noaa.gov

For More Information, Contact:

NOAA, Air Resources Laboratory
Field Research Division
1750 Foote Drive
Idaho Falls, ID 83402

Phone: (208) 526-2329

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