EML

Environmental Measurements Laboratory

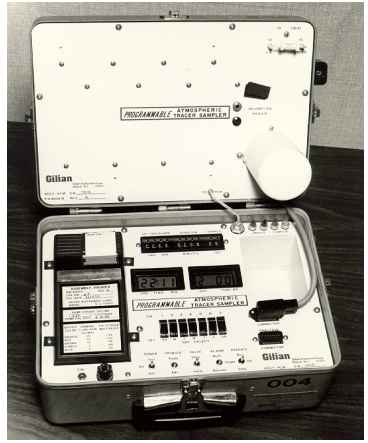
"A Federal Resource"

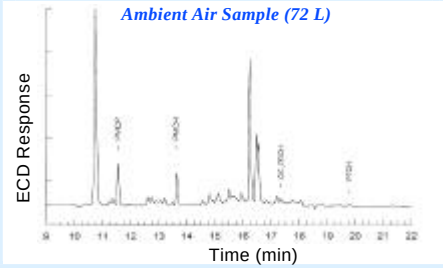
Atmospheric Tracer Technology

The Environmental Measurements Laboratory (EML) has for many years been a leader and innovator in atmospheric tracer technology. This technology provides empirical data used to evaluate mathematical models of atmospheric transport and dispersion of pollutants over distances as far as 3000 kilometers from the source. Controlled and measured quantities of inert, nontoxic, perfluorocarbon compounds are released into the atmosphere under well documented meteorological conditions. During the release, the tracers are collected in adsorbent tubes contained in air samplers arranged in a network along the anticipated tracer plume trajectory. The tracer quantities in each sample are subsequently measured by gas chromatography with electron-capture detection. The tracer concentrations of each sample along with their sampling locations, and date and time of collection are combined to form a unique data set that provides dynamic modelers with a tool for testing or modifying their computer models. Up to five different tracers may be simultaneously released from different locations. Atmospheric tracer concentrations as low as 7 parts in 10^{17} v/v (0.07 fL/L) are measured.

Surface Air Sampling

The programmable atmospheric tracer sampler (PATS) is used to collect surface air samples. It consists of two sections, a lid (air flow module) and a base (power control module). The lid contains 23 adsorbent filled stainless steel tubes and a multiport valve for directing sample air to a selected adsorbent tube. The base contains batteries, constant flow pump system, LCD, and controls. For the analysis, the lid is pnuematically and electrically coupled to a gas chromatograph for the automated thermal desorption, purification, separation, and quantitation of the tracers.





Analysis:

The electron capture detector chromatographic scan from the analysis of ambient air samples represents global atmospheric background concentrations for four tracers

- perfluoromethylcyclopentane (PMCP, 4.2 fL/L)
- perfluoromethylcyclohexane (PMCH, 3.8 fL/L)
- ortho(cis)dimethylcyclohexane (OC_PDCH, 0.4 fL/L)
- perfluorotrimethylcyclohexane (PTCH, 0.07 fL/L)

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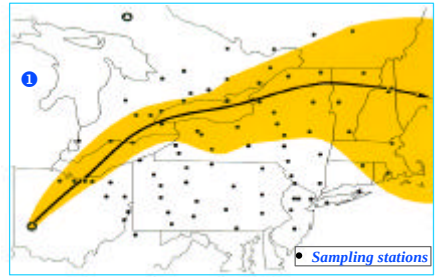
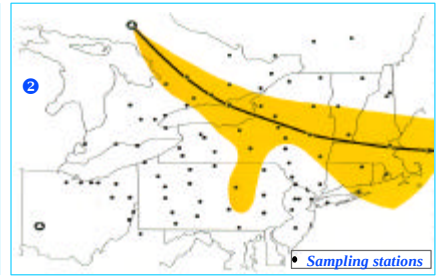
The two illustrations shown below represent selected results from a series of 1000 km scale tracer release experiments. PMCH was released from: (1) Akron, Ohio, and (2) the stack of a large smelter located in Sudbury, Ontario. These locations were selected because they were suspected as sources of sulfur dioxide (acid rain) to the northeastern United States.

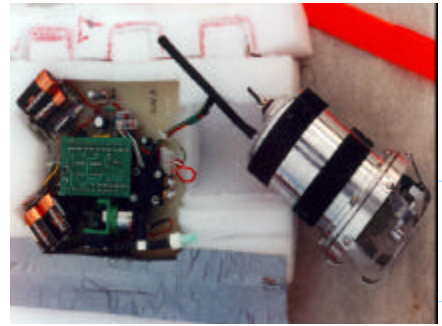




Vertical Tracer Concentration Profiles

EML has developed unique sampling systems for collecting vertical samples using tethered balloons or pilotless aircraft as sampling platforms. Surface samples provide the concentration data to define the tracer plume trajectory and growth rate from horizontal diffusion. However, vertical sampling is needed to resolve the spatial and temporal descriptions of plume heights and vertical diffusion.

The tethered air pump system (TAPS) is a rugged, lightweight constant flow sampler, which is easily attached to a balloon tetherline. The unit holds one adsorbent tube. Up to 10 of these units may be attached to a balloon tetherline.



The Polyport is a second generation vertical sampling unit which holds 12 sequentially operated adsorbent tubes. In addition to a constant flow pump, the system includes sensors for the measurement of atmospheric pressure, temperature and relative humidity at the sampling altitudes and an onboard computer for control and data storage.