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Project Summary

Comprehensive Experimental Design Plan to Relate Pollutant Sources to Acidic Deposition

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Because verifiable numerical models that incorporate all processes determining the dispersion, transformations, and deposition of emitted pollutants associated with acidic deposition from the atmosphere are only now under development, it was deemed worthwhile to determine whether other methods might be available to empirically relate acidic deposition to precursor emissions. After determining that the most promising direct approaches, large-scale source modulation and use of reactive tracers would not be feasible, an indirect experimental plan named the combined experimental approach was developed. This approach consists of three major components: long-range tracer experiments; short-range experiments, including reactive tracers, local deposition experiments, and local source modulation; and routine monitoring of aerometric parameters. Analyses of data would provide estimates of source contributions to deposition at receptor sites. The collected data would also be used for developing and testing upgraded regional models and model components.

This report describes the workshop used to develop the general experimental design and the follow-up analyses of the various components. Some of the design sections describe experiments that will yield data for evaluation of acid deposition models. Finally, the costs of the various experimental efforts are described.

This Project Summary was developed by EPA's Atmospheric Sciences Research Laboratory, Research Triangle Park, NC, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

Introduction

The comprehensive field study plan to relate pollutant sources to acid deposition was developed under the sponsorship of the U.S. Environmental Protection Agency Environmental Sciences Research Laboratory by a research team headed by TRC Environmental Consultants, Inc. and consisting of TRC, Brookhaven National Laboratory (BNL), and Systems Applications Inc. (SAI).

The objectives of the plan are to design experiments which will:

1) Relate empirically the mass transfer from acid pollutant (and precursor) source areas to acidic deposition.
2) Provide a data base to aid in the development and evaluation of regional acidic deposition models.

In designing these experiments, TRC convened a workshop to provide a consensus opinion on potential experimental concepts and guidance to the team on details of the design. The workshop was held at Brookhaven National Laboratory in May 1984.

Workshop participants identified a number of experimental approaches which could serve as the core of the program. The most technically promising of these approaches for *directly* determining source attribution with confidence were source modulation experiments and

isotopic reactive tracer experiments. Several *indirect* approaches for determining source attribution were also identified. They included inert tracers, emulators, process evaluation, and integration of existing data. Subsequent to the workshop, it was determined that economic and logistical constraints would not permit source modulation experiments on a regional scale. The reactive tracer experiments were likewise determined to be infeasible due to the expected adverse public reactions to releases of an unstable (radioactive) isotope and the limited availability and high cost of stable isotopes.

Because of constraints on direct experiment approaches, the design team decided to pursue an indirect experimental approach, which for this plan, is named the combined experiment approach. The name is meant to convey the concept of a collection of interactive experimental components which together provide data for determination of quantifiable source/receptor relationships and a data base for model evaluation.

It is expected that relationships developed from the combined experiment will provide an improvement on current source attribution techniques, but uncertainties associated with the combined experiment cannot be quantified without pilot and uncertainty studies. Because of the complexity of the combined experiment, the adequacy of the experiment cannot be determined at this time. To compensate for not having an estimate of uncertainties, the experimental plan uses redundancy of tasks in staged experiments. The staged approach provides pilot studies prior to the main experimental program to refine techniques, estimate uncertainties and establish feasibility as well as providing the sponsor with milestones for program control. Results of initial studies are given in this report. Results of preliminary uncertainty analyses are given in a comparison report.

Combined Experiment

The combined experiment is designed on the basis of a transmittance approach consisting of three major components. Transmittance refers to the method by which source attribution is determined. First, the vertical pollutant distribution in the vicinity of a receptor is determined from the fractional transmittance of mass as it is transported between a source and receptor. In this context, fractional transmittance is that fraction of pollutant mass which is not lost en route due to deposition. Second, the mass distribution in combination with the local deposition rate determines the contribution of a source to deposition at a receptor. Fulfilling the data needs of the transmittance approach and the secondary objective of providing a data base for model evaluation, leads to a program with the following components:

Long Range Tracer Experiments

The major objectives of the long range tracer study are to simulate transport and dispersion of pollutants using inert tracers and to determine the mass distribution and mass balance of the tracers in a receptor area. Tracer releases will be made at major emission source areas. These will be selected for study on the basis of SO_2 emissions and forecast meteorological conditions (i.e. expected transport routes). The source areas are located 500 to 1000 km from the Adirondacks Region of New York State which was identified as the primary receptor area for the study although alternative areas could be selected as the focus of the experiments. From these source areas, inert tracers will be released and tracked by means of a ground network of sampling sites throughout the Northeast. A fine resolution ground level sampling grid will be established in the Adirondack Region where aircraft sampling will be conducted to support studies of deposition and transmittance in a small area.

Short Range Experiments

A series of short range experiments is proposed to provide information on plume depletion. This is an important process in the transmittance approach. Current estimates are only available on a local scale and are associated with a high degree of uncertainty. To overcome these uncertainties, a combination of three types of experiments are proposed:

- *Reactive Tracer Deposition Experiments* — Sulfur-34 tracer studies will be performed to provide information on deposition and plume depletion. The experiments will represent a variety of meteorological and surface conditions. Experiments will include releases of sulfur-34 and two additional inert tracers. The tracer samples will provide deposition estimates by plume depletion and tracer ratio techniques.
- *Deposition Experiments* — Experiments will be conducted to determine deposition rates using fixed deposition monitoring sites in conjunction with aircraft eddy correlation techniques for ozone. Fixed site data will be used to determine the relationships of ozone and sulfur and nitrogen oxide fluxes. These data will then be available for use in extrapolating aircraft ozone eddy correlation measurements to estimate sulfur and nitrogen oxide deposition for large areas.
- *Source Modulation Experiments* — The last type of short range experiments proposed are local source modulation experiments. Data from these studies will provide a direct measure of local source attribution and plume depletion as a test for derived source/receptor relationships.

Routine Monitoring and Support Data Collection

This component of the combined experiment will provide the primary data base for model evaluation. It will provide wind and concentration data to help determine transport trajectories and transmittances associated with long-range transport. In addition, the data will be used to study the variability of acidic species and precursors as a function of meteorological and emissions patterns and to provide a historical perspective for these patterns relative to past or ongoing programs. An important role of the data collected under the routine monitoring component will be to provide a limited data set for analysis of the chemistry of deposition processes. Support meteorological and emissions data from other programs will be collected as part of this component.

Analysis

Analyses of the data collected by the three components will characterize deposition episodes. More importantly they will provide fractional transmittance functions, tracer transport statistics, and deposition estimates. Combination of these derived values will provide an estimate of the mass arriving at a receptor and the potential for depositing that mass, thus completing the source/receptor relationships.

Conclusions

The combined experimental program is designed to meet the data requirements of a transmittance approach. Data collected under the program will also be sufficient for additional parallel analyses including analyses using upgraded versions of current regional models, and analyses by statistical inference.

The plan utilizes some untested methods and unproven combinations of

techniques. Therefore, success of the design must be gauged in pilot experiments and uncertainty assessments examining these approaches.

Costs associated with the various components are described in the report. Implementation of the full design and subsequent analysis would cost in excess of $100 million.

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The complete report, entitled "Comprehensive Experimental Design Plan to Relate Pollution Sources to Acidic Deposition," (Order No. PB 87-140 950/AS; Cost: $24.95, subject to change) will be available only from:

National Technical Information Service
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Telephone: 703-487-4650

The EPA Project Officer can be contacted at:

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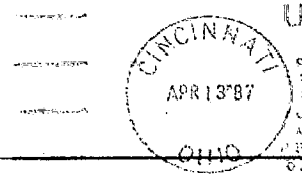

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