



Project Summary

A Computer Data Base from EPA's Complex Terrain Field Studies: Description of a SAS Computer Data Base from Tracer Field Studies at Cinder Cone Butte, ID, Hogback Ridge, NM, and the Tracy Power Plant, NV

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As part of the U. S. Environmental Protection Agency's effort to develop and demonstrate a reliable model of atmospheric dispersion for pollution emissions in irregular mountainous terrain under stable atmospheric conditions, the Complex Terrain Model Development Program was initiated in 1980. Field tracer studies at three locations in mountainous terrain were designed and directed by the model developers to test model estimates of plume impaction with observed tracer concentrations. The first study was conducted in October-November 1980 at Cinder Cone Butte, a roughly axisymmetrical, isolated 100-m hill near Boise, Idaho, and the second study was performed along a 1.5-km section of Hogback Ridge, a 90-m high ridge near Farmington, New Mexico, in October 1982. In both studies, tracer gases, SF₆ and CF₃Br, were released upwind of the targeted terrain from a source suspended from a mobile crane or from a level on a 150-m tower. A 150-m tower was erected and instrumented to record profiles of wind and temperature, and several 10-m and 30-m towers were installed on the slopes of the targeted terrain. Meteorological instrumentation also included tethered sonde and pibal

observations. An array of approximately 100 Tedlar bag samplers on the targeted terrain recorded 1-hourly values of tracer concentrations.

The tracer field study at a third location, the Tracy Power Plant near Reno, Nevada, entitled the Full Scale Plume Study, differed since SF₆ tracer gas was injected into the base of the smokestack of a warm, active electric power plant, and CF₃Br tracer was emitted from a level on a 150-m tower. Meteorological instrumentation from a specially erected 150-m tower and smaller towers was similar to the first two studies, with the addition of sonic anemometers, vertical doppler acoustic sounders, and two radar-tracking balloon wind systems. A lidar system was also employed to determine effective plume height of the SF₆ tracer as emitted from the smokestack.

To facilitate analysis of this great amount of data, tape files from the three tracer field studies were converted into SAS (Statistical Analysis System) data sets and stored on the IBM computer system at EPA, Research Triangle Park, North Carolina. The various SAS data sets are described in this report.

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 extensive development of energy resources, especially in the mountainous terrain of the western United States, has generated concern about the resulting impact on air quality (as well as on water and land quality). Even in relatively simple situations, it has been difficult to produce reliable calculations of atmospheric transport and diffusion. In complex terrain, the mathematical modeling problem is compounded because the physical processes are more complicated and meteorological measurements are less representative than in level terrain settings. Responding to this fundamental problem, the U.S. Environmental Protection Agency (EPA) has embarked upon the Complex Terrain Model Development program (CTMD), a major effort to develop and demonstrate reliable models of atmospheric dispersion for emissions in mountainous terrain.

An early step in the development of this program was the convening of a workshop on problems in modeling atmospheric dispersion over complex terrain. In concert with recommendations in the workshop report, EPA's CTMD Program developed a coordinated effort in mathematical model development, field experimentation, and scaled physical modeling. The program's basic objective focused on the problem of stable plume impaction/interaction with elevated terrain. This phenomenon was singled out because of the likelihood of relatively high concentrations and because models now in use have been challenged on this point. The approach has been to study stable plume interactions first in relatively simple terrain settings and subsequently in more complex situations.

EPA's prime contractor for carrying out the CTMD program was Environmental Research and Technology, Inc., (ERT). Significant contributions were also provided by EPA's Fluid Modeling Facility (FMF), by the National Oceanic Atmospheric Administration's (NOAA) Air Resources Field Research Division (ARLFRD) and Wave Propagation Laboratory (WPL). ARLFRD

conducted flow visualization, tracer experiments, and operated the real-time data acquisition and analysis systems. WPL contributed with their sophisticated measurement capabilities with optical and acoustic anemometers and lidar instruments.

Tracer field studies at three locations were designed and directed by the model developers to test model estimates of plume impaction on elevated terrain with observed tracer concentrations. Usually, two tracer gases and a visible oil-fog were emitted simultaneously to impinge on a targeted terrain feature instrumented with a network of gas samplers. A meteorological monitoring system based on a 150-m tower recorded profiles of wind, temperature and turbulence concurrently with tracer releases.

The first study, Small Hill Impaction Study No. 1 (SHIS #1), was conducted in October-November 1980 at Cinder Cone Butte (CCB), a roughly axisymmetrical, isolated, 100-m hill near Boise, Idaho. Eighteen quantitative tracer experiments were conducted, each lasting 8 hrs at night or early morning. Two tracer gases, SF₆ and CF₃Br (Freon), were released from sources suspended from a mobile crane upwind from a network of gas samplers on the targeted terrain. Tracer gas source data (emission rates, locations and heights of tracer and oil-fog releases), tracer concentrations and meteorological data from the 150-m tower, five 10-m towers on the hill slopes, tethersonde and pibal systems were subsequently delivered to EPA to form an accessible computer data base.

The second tracer field study, SHIS #2, in October 1982, was conducted along an approximately 1.5-km section of the 90-m Hogback Ridge (HBR) near Farmington, New Mexico, to extend the modeling data base to include a study of wind flow and dispersion around a two-dimensional ridge. Eleven quantitative 8-hr tracer experiments were performed at night or early morning. Two tracer gases, SF₆ and CF₃Br (Freon), were released from sources suspended from a mobile crane or from a level on a 150-m tower upwind from a network of samplers on the targeted terrain, HBR. Meteorological data from a 150-m tower, three smaller towers of 60-m, 30-m and 10-m heights, two tethersondes, three crosswind optical anemometers, and tracer concentrations of SF₆ and CF₃Br were assembled into a computer data base.

The third location for CTMD tracer field studies was the Tracy Power Plant

near Reno, Nevada, where a tracer gas SF₆ was injected into the base of a warm, active electric power plant in a region of irregular and complex terrain. A preliminary field experiment was performed in November 1983 as a modest feasibility study for the more comprehensive experiment to follow, but enough usable data were collected to support additional model development and evaluation.

The final CTMD tracer field study, the Full Scale Plume Study, (FSPS), was conducted at the Tracy Power Plant with a total of 14 experiments from August 1 to 27, 1984, mainly during the late evening or early morning hours. Study hours encompassed a variety of conditions ranging from very stable with light winds to morning inversion breakup and fumigation. Meteorological data recorded on the 150-m tower included wind and temperature data from six levels and sonic anemometer data from three levels. Four 10-m towers and two electronic weather stations were located on terrain surrounding the power plant. Two vertical doppler acoustic sounding systems were operated near the smokestack. Tethersonde ascents were flown near the 150-m tower to complement data from the tower and nearby doppler acoustic sounder. Two radar-tracking balloon systems obtained wind profiles up to 4 km during period of tracer release. A lidar system was used to sample quasi-perpendicular transects through the oil-fog plume emitted with the SF₆ tracer to determine effective height of tracer release and plume spreading. Meteorological data were assembled into a computer data base that included tracer concentration data of over 11,000 hourly samples was assembled for both tracer gases.

The objective of this report is to describe the assemblage of data from all CTMD tracer field studies into a new data base applicable to the Statistical Analysis System (SAS) of computer software. SAS System software is used to read tapes with data from all three CTMD tracer field studies and organize the values into a series of SAS data sets to form a new data base. SAS data sets are automatically self-documenting since they contain both the data values and their descriptions. Now, the new data base of CTMD tracer field studies would be available to SAS software program found on most university mainframe computer systems where SAS software products such as graphics and statistical analysis procedures could be utilized to full advantage. This report assumes

reader familiarity with the SAS System. It describes the various SAS data sets associated with each tracer study and identifies data variables included in each SAS data set.

Results

Tracer Field Study at Cinder Cone Butte, Idaho

All data are contained in five SAS data sets:

1. LETCTM1.CCBTMPWN
 - Meteorological data recorded as 5-min averages of temperature, wind components turbulence scales (sigma-u, -v, -w) at 8 levels on a 150-m tower, and at 2 levels on five 10-m towers located on the targeted terrain.
2. LETCTM1.CCBTETH
 - Tethersonde meteorological data of instantaneous measures of wind, temperature, relative humidity, mixing ratio, pressure and height, one sounding per hour.
3. LETCTM1.CCBPBL
 - Pilot balloon data of wind direction and speed, one sounding per hour.
4. LETCTM1.CCBCONC
 - Tracer concentrations of SF6 and CF3Br gas recorded as sequential 1-hr or 10-min samples, (ppt).
5. LETCTM1.CCBMDA
 - Modelers' Data Archive data set contains meteorological variables estimated at release height for SF6 or CF3Br tracer, tracer source data, and observed 1-hr averaged tracer concentration data.

Tracer Field Study at Hogback Ridge, New Mexico

All data are contained in five SAS data sets:

1. LETCTM1.HBRWNTMP
 - Meteorological data recorded as 5-min averages of temperature, wind components, turbulence scales (sigma-u, -v, -w) at 10 levels on a 150-m tower.
2. LETCTM1.HBRTWRS
 - Meteorological data recorded as 5-min averages of temperature, wind components, turbulence scales (sigma-u, -v, -w) at 5 levels on a 30-m tower, 3 levels on a

10-m tower, and 2 levels on a 60-m tower.

3. LETCTM1.HBRTETH
 - Tethersonde meteorological data as instantaneous measures of wind, temperature, relative humidity, mixing ratio, pressure and height, one sounding per hour at site 1. Tethersonde data of wind and temperature from point of tracer release, site 2.
4. LETCTM1.HBROPTA
 - Optical anemometer data as 10-min path-averaged crosswind speeds from three paths aligned along the base, slope and crest of Hogback Ridge.
5. LETCTM1.CONCS
 - Tracer concentrations of SF6 and CF3Br gas recorded as sequential 1-hr or 10-min samples, normalized values (ns/m³).

Tracer Field Study at the Tracy Power Plant, Nevada

All data are contained in nine SAS data sets:

1. LETCTM1.FSPSTW
 - Meteorological data recorded as 5-min averages of temperature, wind components, turbulence scales (sigma-u, -v, -w) at 6 levels on a 150-m tower.
2. LETCTM1.FSPSONIC
 - Sonic anemometer data as 5-min averages of temperature, wind components and turbulence scales (sigma-u, -v, -w) at 3 levels on a 150-m tower.
3. LETCTM1.FSPSDAS
 - Doppler acoustic sounder data as 10-min averages of wind direction and speed at 25-m height intervals from 50 m to 400 m.
4. LETCTM1.FSPSRBL
 - Radar balloon data as instantaneous wind data two profiles per hour to 3 km.
5. LETCTM1.FSPSTETH
 - Tethersonde meteorological data as instantaneous measures of wind, temperature, relative humidity, mixing ratio, pressure and height, 2 profiles per hour.
6. LETCTM1.FSPSTW10
 - Meteorological data recorded as 5-min averages of temperature, wind components,

turbulence scales (sigma-u, -v, -w) at 1 level on four 10-m towers on surrounding terrain.

7. LETCTM1.FSPSELWX
 - Electronic weather station data as 1-hr averages of temperature, wind direction and speed from two sites in surrounding terrain.
8. LETCTM1.FSPSC0NC
 - Tracer concentrations of SF6 and CF3Br gas recorded as sequential 1-hr samples, (ppt).
9. LETCTM1.FSPSMDA
 - Modeler's Data Archive data set contains meteorological variables estimated at the height of SF6 tracer release, plume height determined by lidar measure, and at the height of CF3Br from a 150-m tower.

Conclusion

This report describes the data recorded during three tracer field studies conducted as part of EPA's Complex Terrain Model Development program. Data are contained in a series of SAS data sets, and, utilizing the self-documentation feature of SAS software, tables are presented to identify all variables recorded. Additional tables in the report present tracer release data and other information needed for testing various dispersion models or other applications.

The SAS data sets are arranged on magnetic tape so that acquisition is easily accomplished by any user with interactive computer access to the IBM computer at the National Computer Center at Research Triangle Park or with access to a computer capable of reading standard nine-track magnetic tape. Tape copies are available upon request to the author.

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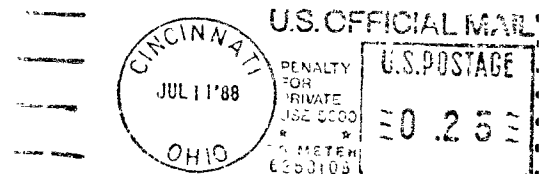
The complete report, entitled "A Computer Data Base from EPA's Complex Terrain Field Studies: Description of a SAS Computer Data Base from Tracer Field Studies at Cinder Cone Butte, ID, Hogback Ridge, NM, and the Tracy Power Plant, NV," (Order No. PB 88-191 424/AS; Cost: \$19.95, subject to change) will be available only from:

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