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EPA

Project Summary

EPA Complex Terrain Model Development: Description of a Computer Data Base from Small Hill Impaction Study No. 2, Hogback Ridge, New Mexico

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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 pollutant emissions in irregular mountainous terrain, the Complex Terrain Model Development Program was initiated in 1980 with Environmental Research and Technology, Inc., as the prime contractor. In October 1982, a field experiment, Small Hill Impaction Study #2 (SHIS #2), was conducted along an approximately 1.5-km section of the Hogback Ridge near Farmington, New Mexico, to extend the modeling data base to include a study of flow and dispersion around a two-dimensional ridge. Eleven quantitative 8-h tracer experiments were performed, at night or early in the morning. Meteorological data were recorded at two instrumented towers upwind of the ridge and at two towers on the slope. Data consisted of direct and derived measurements of wind, turbulence, and temperature averaged at 5-min and 1-h intervals. Hourly profiles of wind, temperature, pressure, and humidity were recorded at one tethersonde upwind of the ridge while wind and temperature were recorded at 13-s intervals at another tethersonde held level at the point of tracer release. Three sets of optical crosswind anemometers measured path-averaged wind speed across the base, slope, and crest of the ridge. Thirty-minute averages of solar and net radiation were also recorded.

Tracer gas concentrations, SF6 and Freon 13B1, were detected by a network of 110 samplers located on the slopes of the ridge. The system used to collect the data and the operational procedures used to run the system are presented along with values of 1-h normalized tracer concentrations. Concentrations were also recorded from collocated samplers to establish comparative data for quality control, samplers operating at 10-min intervals and samplers operating at different heights on two towers on the slope of the ridge. Tables of tracer gas release data, emission rates, and heights and locations of release have been included to assist any modeling effort. All meteorological and tracer gas concentration data have been edited and recorded on magnetic tape and are now available upon request from the National Computer Center, Research Triangle Park, North Carolina, either as hard copies or by interactive computer access.

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. For complex terrain, mathematical modeling is confounded because physical processes are more complicated and meteorological measurements are less "representative" than for level terrain settings. Responding to this fundamental problem, the U.S. EPA has initiated the Complex Terrain Model Development (CTMD) Program, 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. Following recommendations of the workshop report, EPA's, CTMD Program involves a coordinated effort in mathematical model development, field experimentation, and scaled physical modeling. The program's basic objective is to produce practical models with demonstrated reliability. Initially, the CTMD Program 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 on the slopes of hills and ridges and because models that are in use have been challenged extensively. The approach has been to study stable plume interactions in relatively simple terrain settings first, and then to study them in more complex situations.

EPA's prime contractor for the CTMD Program is Environmental Research and Technology, Inc. (ERT). Significant contributions are also being provided by EPA's Fluid Modeling Facility (FMF), the National Oceanographic and Atmospheric Administration's (NOAA) Wave Propogation Laboratory (WPL) through their sophisticated measurement capabilities, and NOAA's Air Resources Laboratory Field Research Division, which conducted the flow visualization and tracer experiments and operated the real-time data acquisition and analysis system. The first phase, a comprehensive tracer field study designated as Small Hill Impaction Study No. 1 (SHIS #1) was carried out on Cinder Cone Butte (CCB), a roughly axisymmetric, isolated 100-m hill near Boise, Idaho, during the autumn of 1980. The SHIS #1 tracer gas source data (emission rates, locations, and heights of SF6, Freon 13B1 (CF3BR), and oil-fog releases), concentration data, and meteorological data from six towers, a tethersonde, and free balloons were subsequently delivered to EPA to form an accessible computer data base.

In October 1982, the second phase of the CTMD program, Small Hill Impaction Study #2 (SHIS #2), was conducted along Hogback Ridge in New Mexico.

This summary describes the data collected during the second phase of CTMD, SHIS #2, a field study conducted along an approximately 1.5-km section of the Hogback Ridge near Farmington, New Mexico, to extend the modeling data base to include a study of flow and dispersion around a two-dimensional ridge. It is expected that these new data will provide a good basis for testing and extending the impingement and neutral models and the dividing streamline concept for two-dimensional ridges.

This summary describes the setting of Hogback Ridge, the experimental approach, and the following types of data archived on magnetic tape in five sets of data files:

- Tower meteorological data,— recorded at 5-min and 1-h averages of wind, temperature, and turbulence scales (sigma-u,-v,-w): 150-m tower instrumented at 10 levels, a 30-m tower instrumented at 5 levels, a 10-m tower instrumented at 3 levels, and a 60-m tower instrumented at 2 levels.
- Tracer gas concentrations — recorded at 10 min and 1 h averages of SF_6 and Freon 13B1 (CF3BR).
- Wind speed — recorded by three optical crosswind anemometers 10-min averages.
- Height, wind temperature, relative humidity and mixing ratio — recorded at two tethersonde sites, one operated at source elevation to document meteorological conditions in vertical soundings at the source of tracer release and one operated upwind and near the base of the ridge to measure vertical profiles.
- Surface meteorological data from ten stations operated by Public Service Company of New Mexico — recorded at 20-min averages of wind speed and direction at all sites and temperature, solar, and net radiation at one site on the crest of Hogback Ridge.

Tables of tracer gas release data, emission rates, and locations and heights of release are included. Although lidar measurements and extensive photographs were made of the oil-fog plumes, those data are not available for this publication.

Results

Meteorological Tower Data

Four sets of meteorological tower data are stored on magnetic tape files. The first set of files, numbers 1 to 176, records data from levels on the 150-m tower A, which was located east of Hogback Ridge to determine an upwind profile of wind, temperature, and turbulence. Data are presented as 5-min averages.

The second set of files, numbers 177 to 352, contains data recorded at tower B, a 30-m tower located on the slope of Hogback Ridge; tower C, a 10-m tower on the crest of Hogback Ridge; and tower P, a 60-m tower operated by Public Service Company of New Mexico and located 3.6 km east of tower A. Data are values of wind, temperature, and turbulence averaged at 5-min intervals.

The third set of files, numbers 353 to 363, contains 1-h averages of data from tower A. The data are the same as those used in the first set of files.

The fourth set of files, numbers 364 to 374, are 1-h averages of data from towers B, C, and P. The data are the same as those used in the second set of files.

Tracer Gas Concentration Data

Tracer gas concentrations recorded by a network of 110 samplers on the slopes of Hogback Ridge as 1 h or 10-min values are recorded on two sets of tape files, numbers 375 to 385 and 386 to 396.

The first set lists concentrations of SF_6; the second set lists concentrations of Freon 13B1 (CF3BR). Concentrations are presented both as normalized values, CHI/Q, and as measured values, Chi. Each tape record also presents the tracer emission rate, Q.

Optical Anemometer Data

Three files, numbers 397 to 399, contain path-averaged crosswind anemometer data. The first file lists data from path-

A, aligned across the base of Hogback Ridge; the second file lists data from path B, aligned the east slope of Hogback Ridge and the third file lists data from path C, aligned on the crest.

Tethersonde Data

The first set of files, numbers 400 to 412, contains tethersonde data from profile soundings taken upwind of Hogback Ridge. Data are values of height, wind, temperature, relative humidity, and mixing ratio.

The second set of files, numbers 413 to 423, contains tethersonde data from instruments held stationary at the point of tracer release. Data are values of wind and temperature.

Public Service Company of New Mexico Data

Public Service Company of New Mexico maintains a network of meteorological stations around Hogback Ridge, and these data were made available by the company for inclusion in this data base as half-hour averages for the month of October 1982 from all ten stations in the network. Data are presented on four files, numbers 424 to 427, and consists of values of wind, temperature, and solar and net radiation at one station.

Conclusion

All data files are stored at the National Computer Center, Environmental Research Center, Research Triangle Park, North Carolina, on the Sperry UNIVAC 1100/83 system's magnetic tape: nine track, odd parity, ASCII-quarter word mode, density 6250 BPI, tape number 004972. UNIVAC users or users of interactive computers may assign the tape with UNIVAC Executive Control Language statement @ASG,T HBR,U9S //////Q,004972. Copies of the tape can be produced and translated into formats acceptable to any computer using nine-track tape drives.

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The complete report, entitled "EPA Complex Terrain Model Development: Description of a Computer Data Base from Small Hill Impaction Study No. 2, Hogback Ridge, New Mexico," (Order No. PB 86-144 870/AS; Cost: $11.95, subject to change) will be available only from:

National Technical Information Service
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The EPA Project Officer can be contacted at:

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