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Project Summary

Pollution Episodic Model User's Guide

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The Pollution Episodic Model (PEM) is an urban-scale model designed to predict short-term average ground-level concentrations and deposition fluxes of one or two gaseous or particulate pollutants at multiple receptors. The two pollutants may be nonreactive or chemically coupled through a first-order chemical transformation. Up to 300 isolated point sources and 50 distributed area sources may be considered in the calculations. Concentration and deposition flux estimates are made using hourly mean meteorological data. Up to a maximum of 24 hourly meteorology scenarios may be included in an averaging period. The computer program of the Texas Episodic Model (TEM) was used as a framework for the development of PEM.

This Project Summary was developed by EPA's Environmental 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 Pollution Episodic Model (PEM) is an urban-scale model designed to predict short-term ground-level concentrations and deposition fluxes of one or two gaseous or particulate reactive atmospheric pollutants in an urban area with multiple point and area sources. The PEM uses point and area-source concentration algorithms that explicitly account for the effects of dry deposition, gravitational settling, and a first-order chemical transformation. These algorithms, derived analytically from a gradient-transfer model, are based on Gaussian plume modeling assumptions. The surface concentrations and deposition fluxes of both the primary (reactant) and the secondary (reaction product) pollutants are calculated.

The PEM is based on the Texas Episodic Model (TEM) of the atmospheric dispersion of nonreactive pollutants over a perfectly reflecting surface developed by the Texas Air Control Board. In the limit, when the deposition and settling velocities and the chemical transformation rate are zero, the point-source concentration algorithms used in the PEM reduce to the familiar Gaussian plume dispersion algorithms used in the TEM. As this limit is approached, the new area-source concentration algorithms used in the PEM give essentially the same values for ground-level concentrations of pollutants as does the TEM. The two models share the same framework for calculations.

The complete report contains information directed to the model user and the programmer. It presents an overview of the PEM's capabilities, assumptions, and limitations. Detailed technical discussions on the theoretical basis of the model are presented. Details of the program's input and a guide to output are included. Input and output for three test examples using the various features of the PEM, flow diagrams, and a complete listing of the computer program are also included.

Theoretical Basis

The concentration algorithms used in the PEM are specially developed to account for the effects of dry deposition, sedimentation, and a first-order chemical transformation. The Gaussian plume type algorithms for point sources are derived from analytical solutions of a gradient-

transfer model. The concentration algorithms for area sources are derived from an innovative approach based on mass balance considerations. These algorithms are simple, efficient, and accurate.

Input and Output Assumptions

1. It is an urban-scale model applicable to downwind distances of up to 60 km.
2. It calculates short-term (1 to 24 h) average ground-level concentrations and deposition fluxes of one or two gaseous or particulate pollutants.
3. The two pollutants may be nonreactive or chemically coupled through a first-order chemical transformation.
4. Either or both of the pollutants may be gaseous or particulate species. There is no restriction on pollutant particle size.
5. If only one pollutant concentration is calculated, the effects of a first-order chemical decay can be considered.
6. The chemical transformation or decay rate may vary from 0.1 to 100 percent per hour.
7. The deposition (and settling) velocities of the two species may be equal or different.
8. Direct emission of the secondary pollutant may be zero or nonzero for point and area sources.
9. Up to a maximum of 300 point sources and 50 area sources can be included in the model inputs to estimate concentrations at a maximum of 2500 receptors located on a 50 x 50 square receptor grid.

Differences from the TEM

Although the PEM is based on the TEM, there are several important differences between the two models:

1. The PEM uses standard EPA values for 1-h average dispersion parameters for point sources. These correspond to the values of the 10-min average dispersion parameters used in the TEM.
2. For averaging periods longer than 10 min, TEM uses a power law to adjust the values of σ_y to account for the greater horizontal plume meander due to fluctuations in wind direction. This is not done in PEM, since its σ_y values are assumed to represent 1-h average dispersion of the plume.
3. The TEM has eight averaging time options; the PEM has only three: 1-h, 24-h, and N-h ($1 < N < 24$) averaging options.
4. The TEM uses the area-source algorithms given by Gifford and Hanna to calculate ground-level concentrations. The area-source algorithms used in the PEM are derived from an innovative alternate approach based on mass balance considerations. These efficient new algorithms do not require additional subroutines in the program.
5. The TEM uses a fast numerical technique in which the horizontal and vertical diffusion functions in the equation for relative concentration from a point source are precalculated for selected values of model parameters and stored in large arrays. For multiple sources and receptors, this technique considerably reduces computation time at the expense of some accuracy. Because of the large number of model parameters, the PEM does not use this tabular data technique.
6. Input data in the TEM can be specified in metric or British units; the PEM uses only metric units.

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The complete report, entitled "Pollution Episodic Model User's Guide," (Order No. PB 84-164 128; Cost: $17.50, subject to change) will be available only from:
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