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Research and Development

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Project Summary

INPUFF 2.0—A Multiple Source Gaussian Puff Dispersion Algorithm User's Guide

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INPUFF is a Gaussian Integrated PUFF model. The Gaussian puff diffusion equation is used to compute the contribution to the concentration at each receptor from each puff every time step. Computations in INPUFF can be made for a single or multiple point sources at up to 100 receptor locations. In practice, however, the number of receptors should be kept to a minimum. In the default mode, the model assumes a homogeneous wind field. However, the user has the option of specifying the wind field for each meteorological period at up to 100 user-defined grid locations. Three dispersion algorithms are utilized within INPUFF for dispersion downwind of the source. Optionally the user can incorporate his own subroutines for dispersion and plume rise. Removal is incorporated through deposition and gravitational settling algorithms. A software plotting package is provided to display concentration versus time for a given receptor and the puff trajectories after each simulation time.

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

INPUFF is a Gaussian Integrated PUFF model with a wide range of applications. The implied modeling scale is from tens of meters to tens of kilometers. The model is capable of addressing the accidental release of a substance over several minutes, or of modeling the more typical continuous plume from a stack. Several requests to the Meteorology Division for assistance in modeling the air quality downwind of incineration ships prompted the development of an integrated puff model. INPUFF is, therefore, capable of simulating moving point sources as well as stationary sources.

Computations in INPUFF can be made for multiple point sources at up to 100 receptor locations. In practice, however, the number of receptor locations should be kept to a minimum to avoid excessive run time. INPUFF is primarily designed to a model a single event during which one meteorological transition period may occur, such as, going from afternoon to evening conditions. Up to 144 separate meteorological periods of the same length may be used to characterize the meteorology during the event; this provides a time resolution that ranges from minutes to an hour. The user has the option of specifying the wind field for each meteorological period at up to 100 grid locations or allowing the model to default to a homogeneous wind field.

Three dispersion algorithms are used within INPUFF for dispersion downwind of the source. The user may select the Pasquill-Gifford (P-G) scheme or the on-site scheme for short travel time dispersion. The on-site scheme, so named be-

cause it requires specification of the variances of the vertical and lateral wind direction. The long travel time scheme is the third dispersion algorithm in which the growth of the puff becomes proportional to the square root of time. Optionally, the user can incorporate his own subroutine for estimating atmospheric dispersion.

INPUFF utilizes the deposition algorithms based on analytical solutions of a gradient-transfer model. In the limit when pollutant settling and dry deposition velocities are zero, these expressions reduce to the Gaussian diffusion algorithms.

A software plotting package has also been provided to display concentrations versus time for a given receptor and the puff trajectories after each simulation period.

Features and Limitations

Several requests to the Environmental Operations Branch for assistance in modeling the air quality downwind of incineration ships stimulated the development of INPUFF, a model capable of simulating a moving point source in a spatially variable wind field. The model also possesses the following features which increase its flexibility and range of application:

- Optional stack-tip downwash,
- Wind speed extrapolated to release height,
- Temporally variable source characteristics,
- Temporally and spatially variable wind field,
- Up to 100 receptors,
- Some consideration of terrain effects through the wind field,
- Optional buoyancy induced dispersion,
- Optional deposition and settling,
- Optional user-supplied dispersion parameters,
- Optional user-supplied plume rise, and
- Optional graphics display.

Although INPUFF has several advantages over its continuous plume counterparts, it still retains several limitations, including:

- Wind direction constant with height,
- No consideration of chemical reactions,
- No explicit treatment of complex terrain,
- No consideration of building wake or cavity effects.

Data Requirements

INPUFF requires data on user options, grid dimensions, sources, meteorology, receptors, and plotter control. The user must indicate whether the following options are to be employed:

- Stack-tip downwash,
- Source update,
- User-supplied wind field,
- Intermediate concentration output,
- Puff information output,
- Buoyancy induced dispersion,
- User-supplied dispersion algorithm, and
- User-supplied plume rise algorithm.

The dimension of the modeling grid must be specified. If the user-supplied wind field option is implemented, then the dimension of the meteorological grid along wth the size of each grid rectangle must also be indicated. It is recommended that both grids be given a common origin. If a puff travels outside the modeling region, it is deleted from futher consideration. If it travels outside the meteorological grid, but is still within the modeling region, the wind at the nearest grid point to the puff is used to advect it further.

Information on the source includes the following:

- Location (km),
- Emission rate (g/sec),
- Physical stack height (m),
- Stack gas temperature (K),
- Stack diameter (m),
- Stack gas velocity (m/sec),
- Stack gas volume flow (m^3/sec),
- Initial dispersion parameters (m), and
- Deposition and gravitational settling velocities (cm/sec).

Also, the direction and speed of the source, if it is moving, must be provided as input.

The meteorological data needed for the computations are as follows:

- Wind direction (deg),
- Wind speed (m/sec),
- Mixing height (m),
- Stability class (dimensionless),
- Standard deviation of elevation angle (radians),
- Standard deviation of azimuth angle (radians),
- Ambient air temperature (K), and
- Anemometer height (m).

The user has the option of updating the meteorological information after each meteorological time period. The location and height of each receptor must be indicated. If dispersion is characterized by the on-site scheme, then the standard deviations of the azimuth and elevation angles are required.

The following information is required by the plot routines:

- Type of plot desired,
- Location of concentration versus time plots, and
- Plotting grid.

The plot routines were developed on a UNIVAC 1110 and use CALCOMP plotting software.

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The complete report, entitled "INPUFF 2.0—A Multiple Source Gaussian Puff Dispersion Algorithm: User's Guide," (Order No. PB 86-242 450/AS; Cost: $18.95, subject to change) will be available only from:

National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
Telephone: 703-487-4650

The EPA Project Officer can be contacted at:

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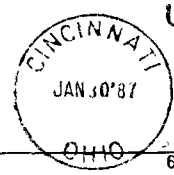

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