	General Characteristics	
1	**Abstract of Model Capabilities**	The Complex Terrain Dispersion Model Plus Algorithms for Unstable Situations (CTDMPLUS) is a refined air quality model for use in all stability conditions for complex terrain applications. Improvements made to the CTDMPLUS code which is only for stable and neutral conditions include: (1) the ability to model daytime, unstable conditions, and (2) a number of additional capabilities for improved user friendliness. The code calculates on an hourly (or appropriate steady averaging period) basis how the plume trajectory (and, in stable/neutral conditions, the shape) is deformed by each hill. The computed concentration at each receptor is then derived from the receptor position on the hill and the resultant plume position and shape.
2	**Sponsor and/or Developing Organization**	Atmospheric Sciences Research Laboratory Office of Research and Development U.S. Environmental Protection Agency Research Triangle Park, NC 27711
3	**Last Custodian/ Point of Contact**	Atmospheric Sciences Research Laboratory Office of Research and Development U.S. Environmental Protection Agency Research Triangle Park, NC 27711
4	**Life-Cycle**	CTDMPLUS for stable and neutral conditions. CTDMPLUS can also model daytime, unstable conditions and has a number of additional capabilities for improved user friendliness.
5	**Model Description Summary**	The Complex Terrain Dispersion Model Plus Algorithms for Unstable Situations (CTDMPLUS) is a refined air quality model for use in all stability conditions for complex terrain applications. It contains, in its entirety, the technology of CTDMPLUS for stable and neutral conditions. However, CTDMPLUS can also model daytime, unstable conditions, and has a number of additional capabilities for improved user friendliness. Its use of meteorological data and terrain information is different than current EPA models; considerable detail for both types of input data is required and is supplied by preprocessors specifically designed for CTDMPLUS. CTDMPLUS requires the parameterization of individual hill shapes using the terrain preprocessor and the association of each model receptor with a particular hill (except for receptors in flat terrain which CTDMPLUS can also model). In modeling stable to neutral conditions, a central feature of CTDMPLUS is its use of a critical dividing-streamline height to separate the flow in the vicinity of a hill into two separate layers. Flow in the upper layer has sufficient kinetic energy to pass over the top of the hill, while streamlines in the lower layer are constrained to flow in a horizontal plane around the hill. Two separate components of CTDMPLUS compute ground-level; concentrations resulting from plume material in each of these flows: In modeling unstable (convective) conditions, the model relies on a probability density function description of the vertical velocities to estimate the vertical distribution of pollutant concentration. Terrain distortions of plume parcel trajectories are accounted for, as are deflections of the daytime mixed layer height.
6	**Application Limitation**	See No. 7.
7	**Strengths/ Limitations**	Principal strength of the CTDMPLUS is its capability to model dispersion over complex terrain. Lack of the ability to accommodate dense gas dispersion is a weakness.
8	**Model References**	! "User's Guide to the Complex Terrain Dispersion Model Plus Algorithms for Unstable Situations (CTDMPLUS): Vol. 1. Model Description and User Instructions," EPA/600/8-89/041 (March 1989). ! "User's Guide to the Complex Terrain Dispersion Model: Vol. 1," EPA-600/8-87-058a, (1987).
9	**Input Data/Parameter Requirements**	There are five required input files and two optional input files for CTDMPLUS: ! A general file of program specifications, which consist of program switches, source data, meterological tower coordinates and hill surface roughness lengths; ! A terrain data file which is obtained directly from the terrain preprocessor; ! A file containing receptor names, locations, and the associated hill numbers; ! A surface meterological data file which is obtained directly from the meteorological preprocessor program; ! A user-created meterological profile data file which contains conventional meterological data measured by multiple levels; ! An optional file of hourly emissions parameters; ! An optional file containing upper air data from rawinsonde data

10	**Output Summary**	Input meteorological data; ! Stack data for each source; ! Meteorological variables at plume height; ! Geometrical relationships between the source and the hill; ! Plume characteristics at each receptor for stable hours; (1) distance in along-flow and cross-flow directions; (2) effective plume-receptor height difference; (3) effective sigma y, sigma z values, both for flat terrain and the hill-induced case; and (4) concentration components. Plume characteristics at each receptor for unstable hours; (1) distance in along-flow and cross-flow directions; (2) horizontal distribution function; (3) sigma y; and (4) crosswind integrated concentration.
11	**Applications**	N/A
2	**User-Friendliness**	Alphanumeric, command line interface. The code is considered to be user friendly even though the meteorological and topological files are the required inputs.
13	**Hardware-Software Interface Constraints/ Requirements**	**Operating system:** IBM-PC **Disk space required:** 640 K-bytes for menu driven and 360 K bytes for non-menu driven **Run execution time for typical problem (CPU or Real Time):** 2-3 minutes **Programming language:** FORTRAN 77 **Interface with other codes:** Requiring a math co-processor chip **Portability:** Extremely portable
14	**Operational Parameters**	Yes, several spread throughout the code.
15	**Surety Considerations**	**All quality assurance documentation:** NA **Benchmark runs:** None **Validation calculations:** NA **Verification with field experiments that has been performed with respect to this code:**
16	**Runtime Characteristics**	Set up time 5 or 10 minutes.

Specific Characteristics

Part A: Source Term Submodel Type

A1	**Source Term Algorithm?**	__YES ✔ NO

Part B: Dispersion Submodel Type

B1	**Gaussian**	**✔ Straight-line plume __Segmented plume __ Statistical plume __ Statistical puff**

Part C: Transport Submodel Type

C2	**Deterministic**	Yes
C4	**Frame of Reference**	**✔ Eulerian __ Lagrangian __ Hybrid __ Eulerian-Lagrangian**

Part D: Fire Submodel Type (Not Applicable)

Part E: Energetic Events Submodel Type (Not Applicable)

Part F: Health Consequence Submodel Type

F1	**For Chemical Consequence Assessment Models**	**Health effects: __ fatalities __ cancers __ latent cancers __ symptom onset** **Health criteria** **__ IDLH __ STEL __ TLV __ TWA** **__ ERPG __ TEEL __ AEGL __ WHO** **Zones with flammable limits: __ UFL __ LFL** **Blast overpressure regions:** **Fire radiant energy zones:** **Risk qualification:** **Concentration: ✔ single value ✔ time-history __ integrated dose** **Probits:**

Part G: Effects and Countermeasures Submodel Type (No Information Provided.)

Part H: Physical Features of Model		
H2	**Release Elevation**	**_✔_ ground _✔_ roof**
H4	**Horizontal Plume Meander**	Accounted for by measurement of lateral turbulence intensity.
H6	**Mixing Layer**	**_✔_ trapping __ lofting __ reflection _✔_ penetration** **__ inversion breakup fumigation __ temporal variability**
H7	**Cloud Buoyancy**	**_✔_ neutral [passive] __ dense [negative] _✔_ plume rise [positive]**
H13	**Temporally and Spatially Variant Mesoscale Processes**	**Urban heat island:** **Canopies:** **Complex terrain (land) effects: _✔_ mountain-valley wind reversals** **__ anabatic winds __ katabaic winds** **Complex terrain (land-water) effects: __ seabreeze airflow trajectory reversals** **__ Thermally Induced Boundary Layer definition __ seabreeze fumigation** **__ landbreeze fumigation** **Thunderstorm outflow:** **Temporally variant winds:** **High velocity wind phenomena: __ tornado __ hurricane __ supercane __ microburst**
Part I: Model Input Requirements		
I1	**Radio(chemical) and Weapon Release Parameters**	**Release rate: _✔_ Continuous __ Time dependent __ Instantaneous** **Release container characteristics: __ vapor temperature __ tank diameter** **__ tank height __ tank temperature __ tank pressure __ nozzle diameter** **__ pipe length** **Jet release: __ initial size __ shape** **__ concentration profile at end of jet affected zone** **Release dimensions: _✔_ point __ line __ area** **Release elevation: _✔_ ground _✔_ roof _✔_ stack**
I2	**Meteorological Parameters**	**Wind speed and wind direction: __single point _✔_ single tower/multiple point** **__ multiple towers** **Temperature: __ single point _✔_ single tower/multiple point __ multiple towers** **Dew point temperature: __ single point __ single tower/multiple point** **__ multiple towers** **Precipitation: __ single point __ single tower/multiple point ___ multiple towers** **Turbulence typing parameters: __ temperature difference _✔_ sigma theta** **_✔_ sigma phi _✔_ Monin-Obukhov length _✔_ roughness length** **_✔_ cloud cover __ incoming solar radiation __ user-specified** **Four dimensional meteorological fields from prognostic model:** See above.
Part J: Model Output Capabilities		
J4	**Tabular at Fixed Downwind Locations**	Yes
Part K: Model Usage Considerations (See Items 5 and 7.)		