United States
Department of
Agriculture

Forest Service

**Southern
Research Station**

Research Paper
SRS-6

Users Guide to VSMOKE-GIS for Workstations

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Contents

Abstract

VSMOKE-GIS was developed to help prescribed burners in the national forests of the Southeastern United States visualize smoke dispersion and to plan prescribed burns. Developed for use on workstations, this decision-support system consists of a graphical user interface, written in Arc/Info Arc Macro Language, and is linked to a FORTRAN computer program. VSMOKE-GIS combines a graphics display of a forest with a dashboard of five icons. By clicking the mouse on these icons, a fire manager can interactively affect the appearance of a smoke plume. Once appropriate files have been created, more than one smoke plume can be viewed at once, and different aspects of the forest, such as stands of trees, rivers, or soil types, can be viewed together or separately. This users guide provides a complete tour of the VSMOKE-GIS, including a history of its development; a tutorial of the steps used in creating, viewing, and manipulating plumes; system definitions; descriptive figures; and instructions on acquiring and personalizing the system for an individual forest.

Keywords: Plume definition, prescribed burn, smoke dispersion, smoke plume, smoke plume parameters, VSMKGS, VSMOKE-GIS dashboard.

Introduction

Fire has always been a key ingredient in forest health. By suppressing fire, land managers removed a natural mechanism that promoted biodiversity. When these managers recognized the importance of fire, they began to duplicate natural fire cycles by burning areas of the forest using prescribed fire intensities and time schedules. Prescribed burning became an important component of land and resource management.

But demographic changes in the United States have affected prescribed burning. Today, forest managers must consider the human element when planning a prescribed fire. Smoke from forest burning can reduce visibility. Low visibility can increase driving hazards on roads within or near forest boundaries. Land managers must assess the risk of prescribed fire producing smoke that increases driving hazards.

Dispersion Index and Low Visibility Occurrence Risk Index are numerical weather indices forest managers can use to make this assessment. Dispersion Index (Lavdas 1986) describes the overall efficiency of atmospheric dispersion in reducing smoke concentrations over an area of about 1,000 square miles. Low Visibility Occurrence Risk Index (Lavdas and Hauck 1991) numerically ranks, in relative terms, the likelihood of general weather conditions contributing to reduced visibility.

These indices are part of VSMOKE, a FORTRAN 77 computer program (Lavdas, 1997) designed as a steady-state Gaussian plume smoke dispersion model that estimates the effects of a prescribed forestry burn on air quality and visibility. Using VSMOKE, air quality specialists with a background in atmospheric dispersion modeling are able to provide forest managers with information useful in evaluating the visibility risks of a given prescribed fire.

Based on VSMOKE, VSMOKE-GIS was developed to help fire managers in the national forests of the Southeastern United States visualize smoke dispersion from prescribed burns. VSMOKE-GIS is a decision-support system for prescribed

burning operations on flat or rolling plains, assuming a uniform wind field. A manager can input hypothetical or actual burn data and produce smoke plumes on a given national forest.

Once appropriate files have been created, more than one smoke plume can be viewed at once and different aspects of the forest, such as stands of trees, rivers, or soil types, can be viewed together or separately. These different views of the forest will help the user to more clearly study the location of the fire and what it affects. By studying and analyzing these plumes, the fire manager can plan a prescribed burn with a low risk of producing smoke that might increase roadway hazards.

The user can install this dashboard-driven system on any workstation running Arc/Info with access to a FORTRAN compiler. The PAN, ZOOM IN, and ZOOM OUT utilities allow close scrutiny of each plume, either on screen or printed. VSMOKE-GIS includes other important features:

- On-line help windows and pop-up messages assist the user.
- Errors in data entry are recognized, and the user is prompted to enter acceptable data.
- Default values are provided, but users can change them to better describe a given prescribed burn.
- Multiple plumes may be viewed concurrently.

Arrangement of Users Guide

This guide is arranged to facilitate the following activities:

- Understanding the general concepts behind VSMOKE-GIS,
- Getting started,
- Reading step-by-step instructions for running VSMOKE-GIS,
- Previewing most screen displays,
- Operating windows, and
- Understanding dashboard icons.

Because the Francis Marion National Forest in South Carolina was used to develop VSMOKE-GIS, it appears in figures throughout this guide. The green lines represent stand boundaries and the brown lines represent roads.

Overview

VSMOKE-GIS integrates a process model, VSMKGS, with a Geographic Information System (GIS), Arc/Info. A graphical user interface was developed in Arc/Info, written in Arc Macro Language. It collects the necessary input data to run VSMKGS. The input is passed on to VSMKGS, which runs external to the GIS. VSMKGS, a customized version of VSMOKE, calculates isopleths of equal smoke concentration, which are passed back to Arc/Info for display. A simplified

map to the VSMOKE-GIS, a flowchart (fig. 1) follows the stream of logic through UNIX, Arc/Info, and VSMOKE-GIS during smoke plume creation. It also demonstrates the interaction necessary between each process.

Technical Bases

Emissions Parameters

VSMOKE generates particulate matter emissions from user input values for acres burned, fuel load, duration of smoke emissions, and fuel/fire type. The fuel/fire type is used to estimate an emission factor (i.e., pounds of particulate matter generated per ton of fuel consumed). The emission factor is multiplied by fuel load and acres burned to obtain the mass of emissions generated. This product is divided by duration of smoke emissions to obtain the emission rate. This rate is assumed applicable for the analysis period represented by the VSMOKE-GIS display. With all other input remaining the same, a doubling of emissions results in a doubling of smoke concentrations due to the fire.

VSMOKE generates heat emissions from user input values for acres burned, fuel load, and duration of fire. A 3,500 calorie per gram heat value is assumed for forest fuels and is multiplied by acres burned and fuel load to obtain a heat value. This heat value is divided by duration of fire to obtain the heat release rate. This rate is converted to a sensible heat flux which with atmospheric stability class and transport windspeed allows an estimate of plume rise. With all other input remaining the same, plume rise reduces ground level concentrations. Plume rise increases with increasing sensible heat flux. It decreases with increasing atmospheric stability and increasing transport windspeed.

Meteorological Parameters

VSMOKE is a steady-state Gaussian plume dispersion model. As such, it assumes that weather conditions, including wind, are steady and constant over the area of consideration and during the time smoke moves from source to receptor. As a Gaussian plume model, VSMOKE assumes that a mean windflow with dispersion occurs as a result of small, random deviations of the wind at right angles to the mean flow. As an example, the mean wind may be blowing from the west, with deviations from the south and north (causing horizontal dispersion) as well as from below and above (causing vertical dispersion).

In VSMOKE, the relative strength of these deviations is controlled primarily by the atmospheric stability class. Stability class is an expression of thermally driven turbulence and ranges from extremely unstable (class 1) to near neutral (class 4) to extremely stable (class 7). During fair weather regimes, stability class undergoes a diurnal cycle, with unstable classes occurring in midday and stable classes occurring at night. Cloudy or very windy conditions cause the classes to tend toward neutral. The timing of the analysis period (day or night) exerts a secondary control over these deviations. Figure 2 shows a smoke plume with relatively large deviations (extremely unstable conditions). Note that this plume is relatively short and wide. Figure 3 shows a smoke plume under extremely stable conditions, causing a long, narrow plume.

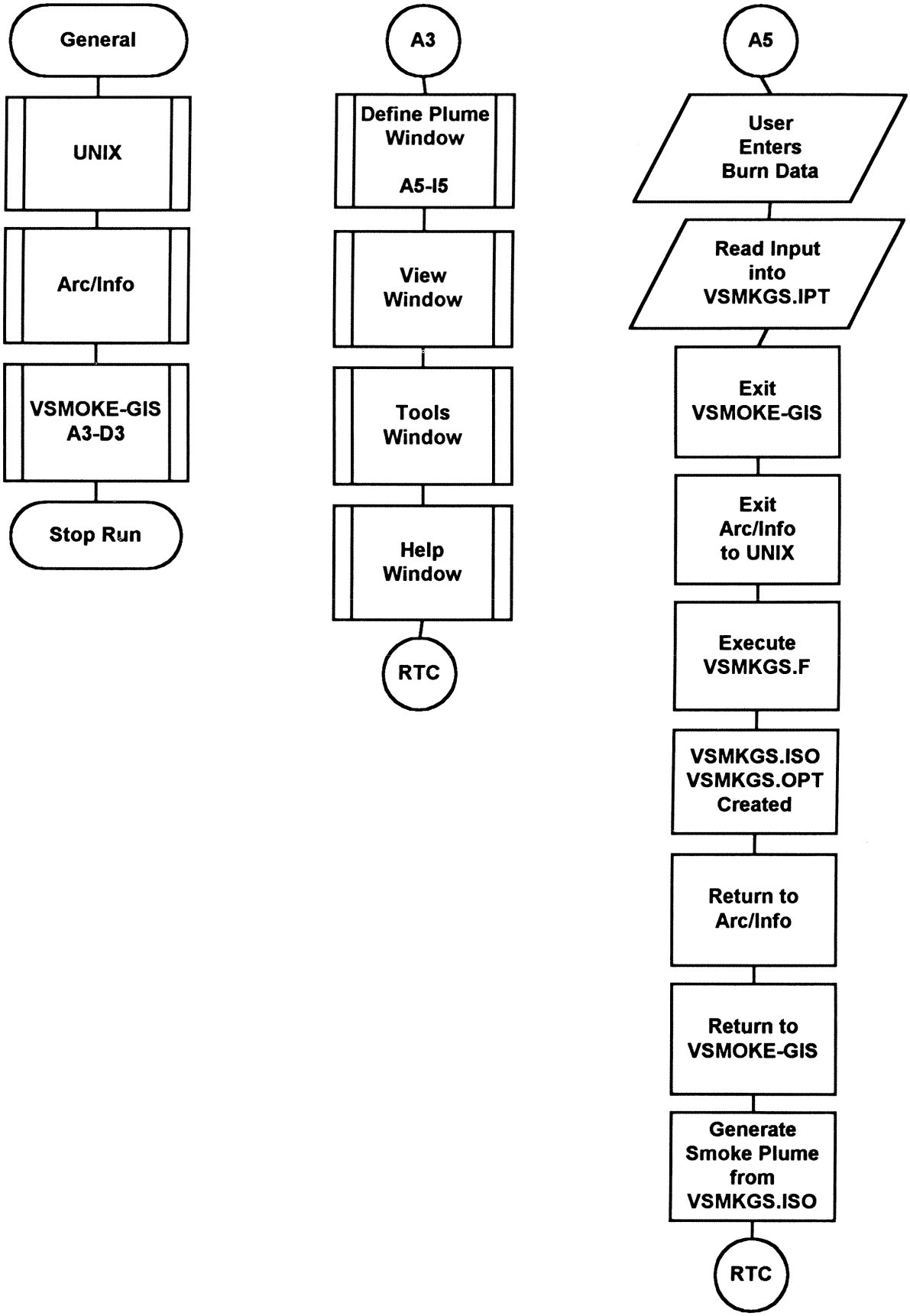

Figure 1—VSMOKE-GIS logic flow.

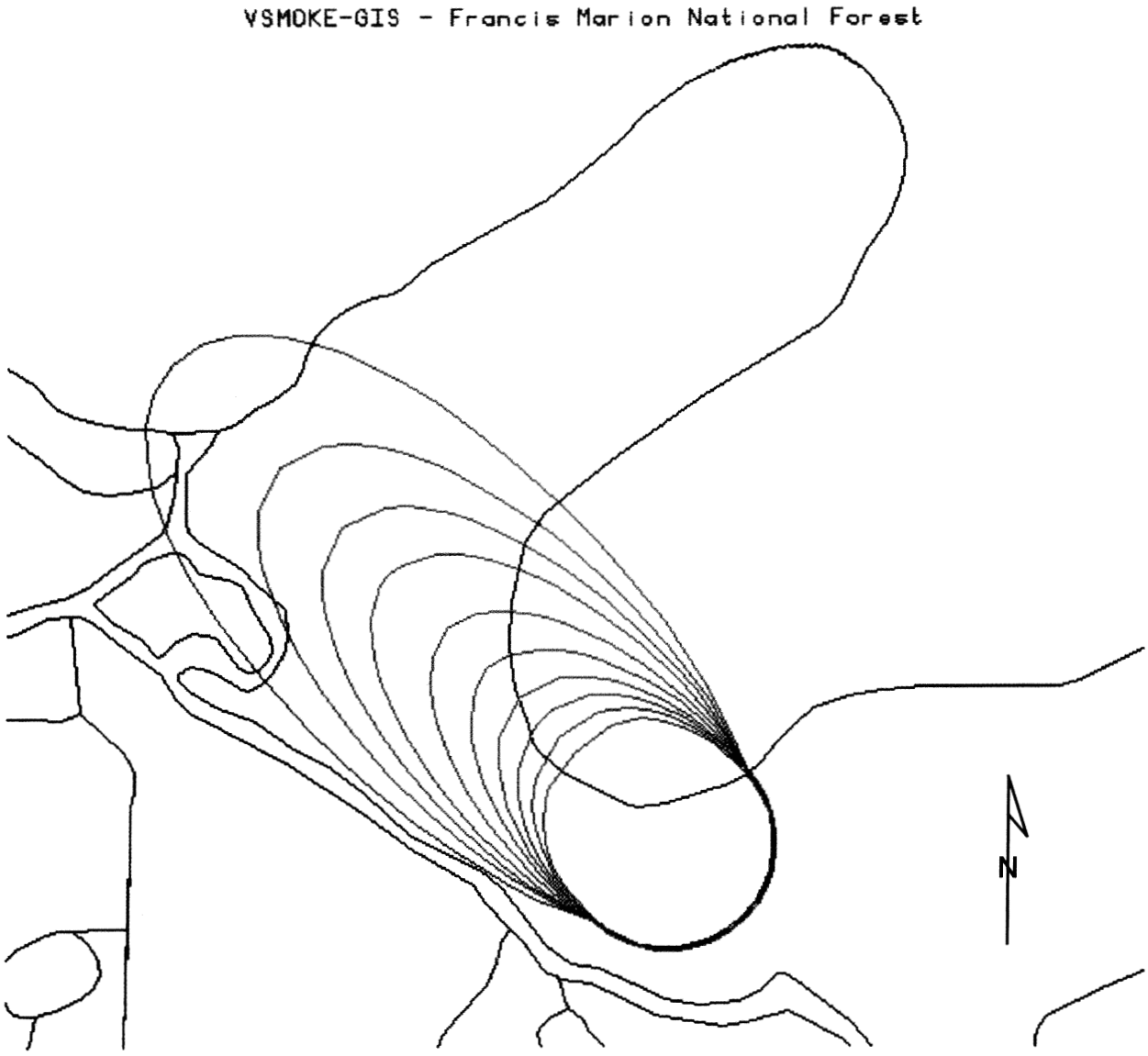

Figure 2—Zoom in of stability class 1.

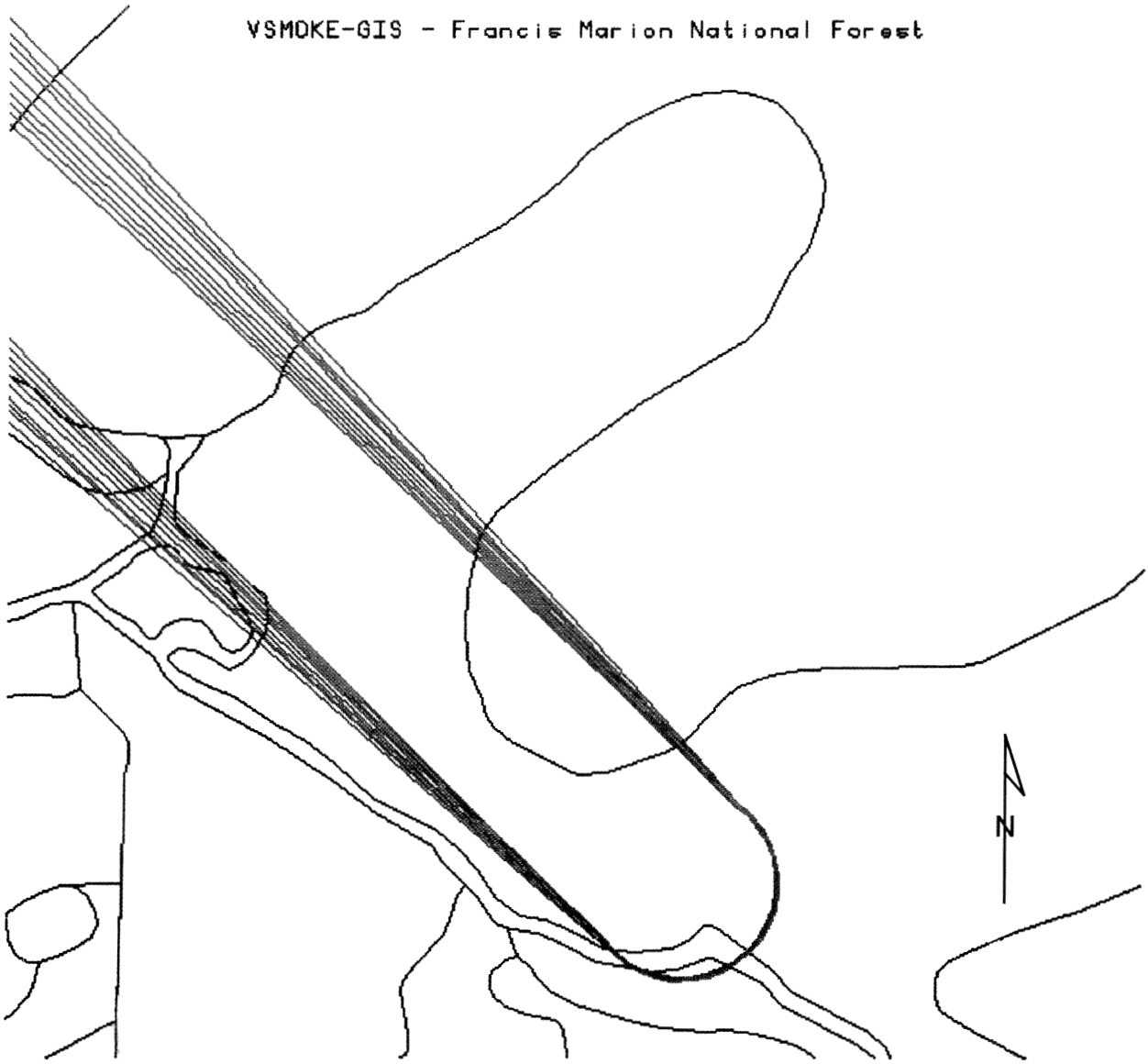

Figure 3—Zoom in of stability class 7.

VSMOKE smoke concentrations are restricted in the depth of the atmosphere they occupy by the height of the mixing layer. In VSMOKE, the atmospheric stability as expressed by stability class applies from the ground to the top of the mixing layer (or mixing height). Above this height, vertical motions are assumed so small that dispersion can be neglected. Thus, the mixing height acts as a "lid" above which no smoke can penetrate. A high mixing height allows smoke to freely mix within the lower atmosphere. A low mixing height traps smoke near the ground, causing higher concentrations, especially at long distances from the fire. Mixing height tends to undergo a diurnal cycle with low heights at night and early morning and high heights at midday and afternoon.

VSMOKE mean wind is expressed by the transport windspeed and wind direction. Transport windspeed applies at all elevations from the ground to the mixing height, and directly dilutes smoke concentrations. Transport windspeed can undergo a diurnal cycle; winds near the ground are often low at night, but pick up around midmorning as the mixing height increases and the atmosphere becomes more unstable. Transport windspeeds are often at a maximum in early and midafternoon and drop off rapidly around sunset.

Concentration Estimates

VSMOKE-GIS concentration estimates are presented in the form of several isopleths, i.e., lines of equal concentration values. The specialized VSMOKE program, VSMKGS, generates coordinate values for isopleths from its estimates of downwind smoke concentration and a knowledge of the mathematical behavior of model concentrations as horizontal distances at right angles to the centerline increase. VSMKGS generates a coordinate pair (x,y) in which x is crossplume distance and y is downwind distance from the central point of the fire. VSMKGS then converts the (x,y) pairs to (X,Y) values appropriate for a north-south, east-west coordinate system. The pre-set smoke concentration isopleth values in the VSMKGS.IPT input file can be modified (see appendices). The Universal Transverse Mercator (UTM) coordinate system is used throughout for ease of calculation.

Getting Started

Requirements include a workstation environment running X Windows and Arc/Info, and access to a FORTRAN compiler for the particular hardware.

System Requirements

VSMOKE-GIS was developed on a Hewlett-Packard 9000 720 workstation and executes a FORTRAN program to process the smoke plume parameters. It consists of 35 files, a workspace for containing the smoke plumes, and an informative readme.txt file. The number of programs, and, therefore, the amount of disk space, depend on the types of forest coverages and projections. The Francis Marion VSMOKE-GIS requires 195 kilobytes of disk space without the forest and smoke plume coverages. A color plotter produces the best printed display.

Obtaining VSMOKE-GIS

To receive a copy of VSMOKE-GIS, the user can download it from the Environmental Systems Research Institute, Inc. Home page on the World Wide Web (http://www.esri.com). By using the search engine and the following

keywords, it can be easily accessed: prescribed burn, smoke dispersion, smoke plume, VSMOKE-GIS. The downloaded file will be in tar format and will contain all VSMOKE-GIS files.

Because of its design, the VSMOKE-GIS system must be tailored to each location. Each national forest may have different requirements that will affect the number of programs necessary and the amount of disk space required. The user must supply the name of the forest and its geographic coordinate system. The exact names and feature classes of road and stand coverages, or two alternate coverages to be displayed, are also necessary. VSMOKE-GIS projects between the UTM and forest coordinate systems. Providing the forest UTM zone and other required projection information, such as zone, units of measure, shift, and datum, ensure that each specific location will own a finished product.

Installing VSMOKE-GIS

The root user owned the VSMOKE-GIS files when they were initially copied to tape. All other users had read, and sometimes execute, permission only. When the tar file is downloaded, the user should install it under a directory that will be accessible to all of the users. Retaining the ownership and permission parameters will help protect the system from accidental changes.

To install VSMOKE-GIS:

1. As the root user, change to the directory that contains the VSMOKE-GIS downloaded tar file.

2. Restore this file to the current directory by entering the following:

   tar xvf <tar file name>

Substitute "<tar file name>" with the file name of the downloaded tar file. Press Return.

3. Compile the FORTRAN program, vsmkgs.f, and name the resulting executable file vsmkgs.out.

To compile vsmkgs.f, consult the workstation FORTRAN user manual or the "Recompile Source" section under "VSMOKE-GIS Editing Instructions" in the appendices.

4. Edit the other programs as needed. Refer to the flowchart (fig. 1) and the appendices for guidance. The "VSMOKE-GIS Editing Instructions" provide detailed assistance.

Users Guide

At the start of a VSMOKE-GIS session, a forest is graphically displayed in an ArcPlot Window and a dashboard with five icons appears (fig. 4). The forest display should consist of coverages, such as roads or stand boundaries, that are

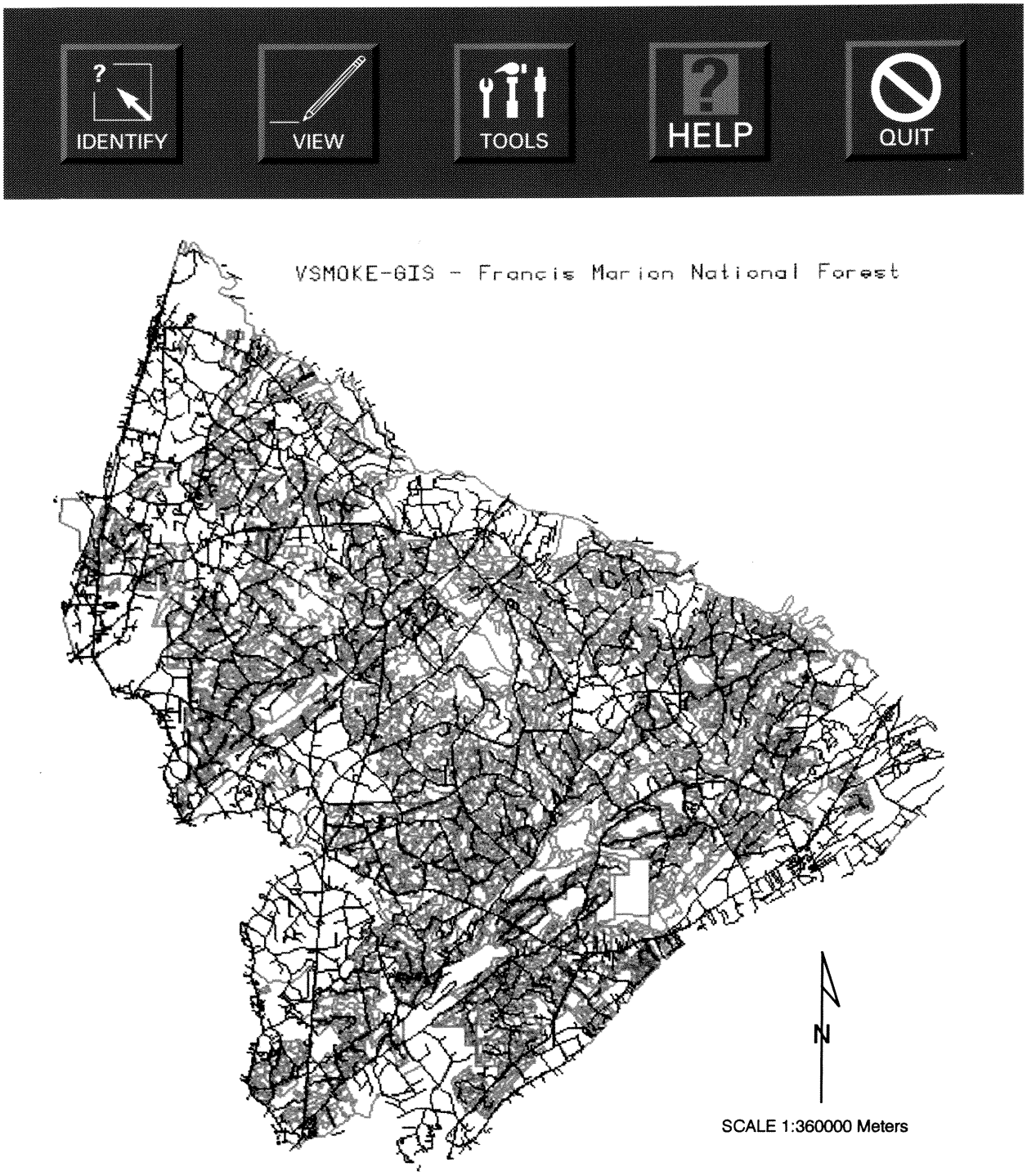

Figure 4—VSMOKE-GIS initial display.

important in studying smoke dispersion. The dashboard is the main menu and stretches across the top of the forest display. The five selections, or icons, help a user define the fire parameters, view the resulting plume, and perform utility operations.

Any of the five dashboard icons may be selected, including IDENTIFY, or plume definition; VIEW; TOOLS; HELP; and QUIT. Typically, a user would choose the IDENTIFY, VIEW, TOOLS, and QUIT icons, in that order, and the HELP icon as needed. The Plume Definition Window, executed from the first, or IDENTIFY, icon, is the primary input gathering mechanism for VSMOKE-GIS. The remaining dashboard choices are less complicated, but they do depend on the Plume Definition Window to create the smoke plumes. The VIEW option allows the user to visually study the plumes while the TOOLS option provides several different viewing capabilities and some standard utilities. The HELP icon provides descriptions and the QUIT icon allows the user to exit the system and return to Arc/Info.

Tutorial

To run VSMOKE-GIS, enter the commands displayed in bold and press the Return key after each command.

Change to the vsmoke.gis directory by typing:
cd <substitute full pathname to vsmoke.gis>/vsmoke.gis
Start Arc/Info by typing:
arc
Start VSMOKE-GIS by typing:
&run vsmoke

The resulting display should be similar to figure 4.

By following each step in this tutorial, the user will learn how and when to use each icon. The figures, and the "Windows Operations" and "VSMOKE-GIS Dashboard Glossary" sections provide a more complete explanation.

HELP Icon

1. Click on the fourth icon from the left (the HELP icon). The contents of this pop-up window describe the function of each icon on the VSMOKE-GIS dashboard (fig. 5).

2. Click on the QUIT button in the lower right corner to return to the VSMOKE-GIS dashboard.

IDENTIFY Icon

A. Initial Display

Displaying a plume involves a common group of actions performed throughout VSMOKE-GIS. The user should remember names and locations of smoke plumes chosen for display so these plumes can be redisplayed when needed.

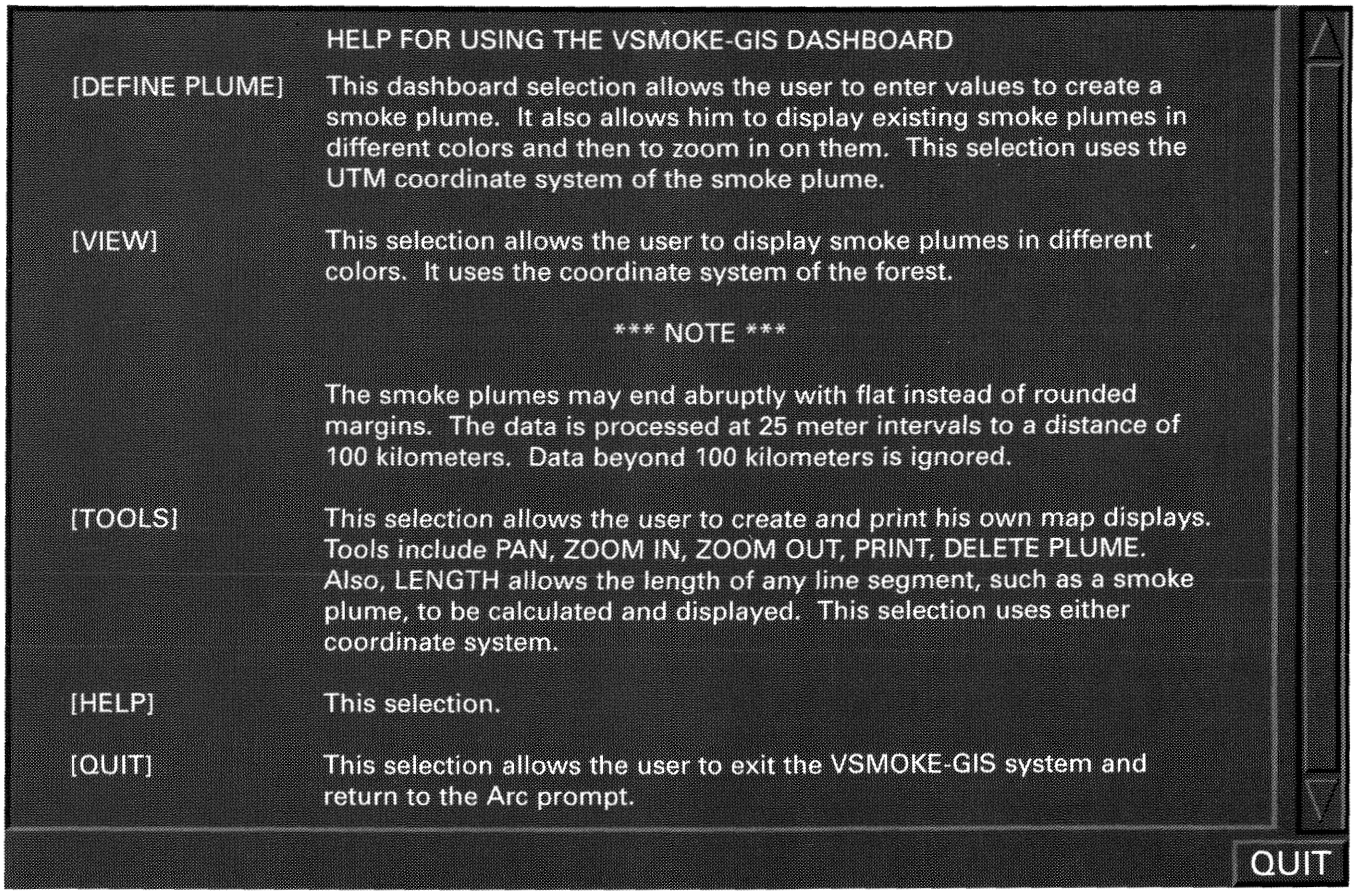

Figure 5—Help Window for VSMOKE-GIS dashboard.

Figure 6—Select Plume Window (with no plume names).

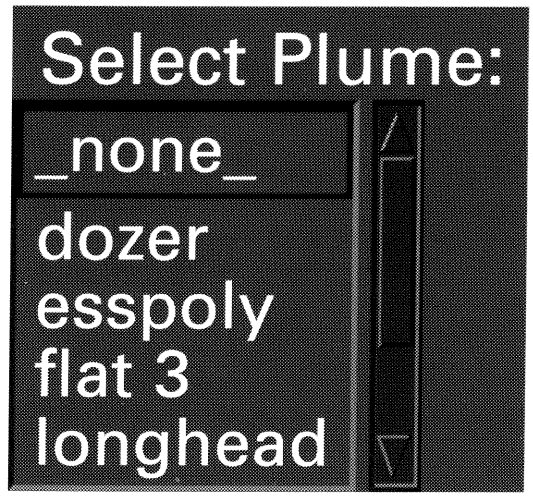

Figure 7—Select Plume Window (with plume names).

1. Click on the first dashboard icon, the IDENTIFY icon, and the "Select Plume:" pop-up window appears (fig. 6 and fig. 7).

   a. If a window like figure 6 appears, click on the OK button and continue to part 'B. "?" Help.'

      A window with no smoke plume names appears if VSMOKE-GIS has just been installed, all existing smoke plumes have been deleted, or no smoke plumes have been created.

   b. If a window similar to figure 7 appears, click on the scroll bar down arrow to view all the plume names. After viewing them all, click on the chosen one to display.

      This window appears if smoke plumes have been previously created.

      After a plume name is clicked on, the forest is redisplayed and the plume is drawn in the initial default color, red.

   c. Click on "_none_" for no more smoke plumes to display when the Select Plume: Window (fig. 7) reappears.

      The Plume Definition Window now displays (fig. 8) to the left of the forest. The title, "DEFINE PLUME," is shown across the top of this window on the computer screen.

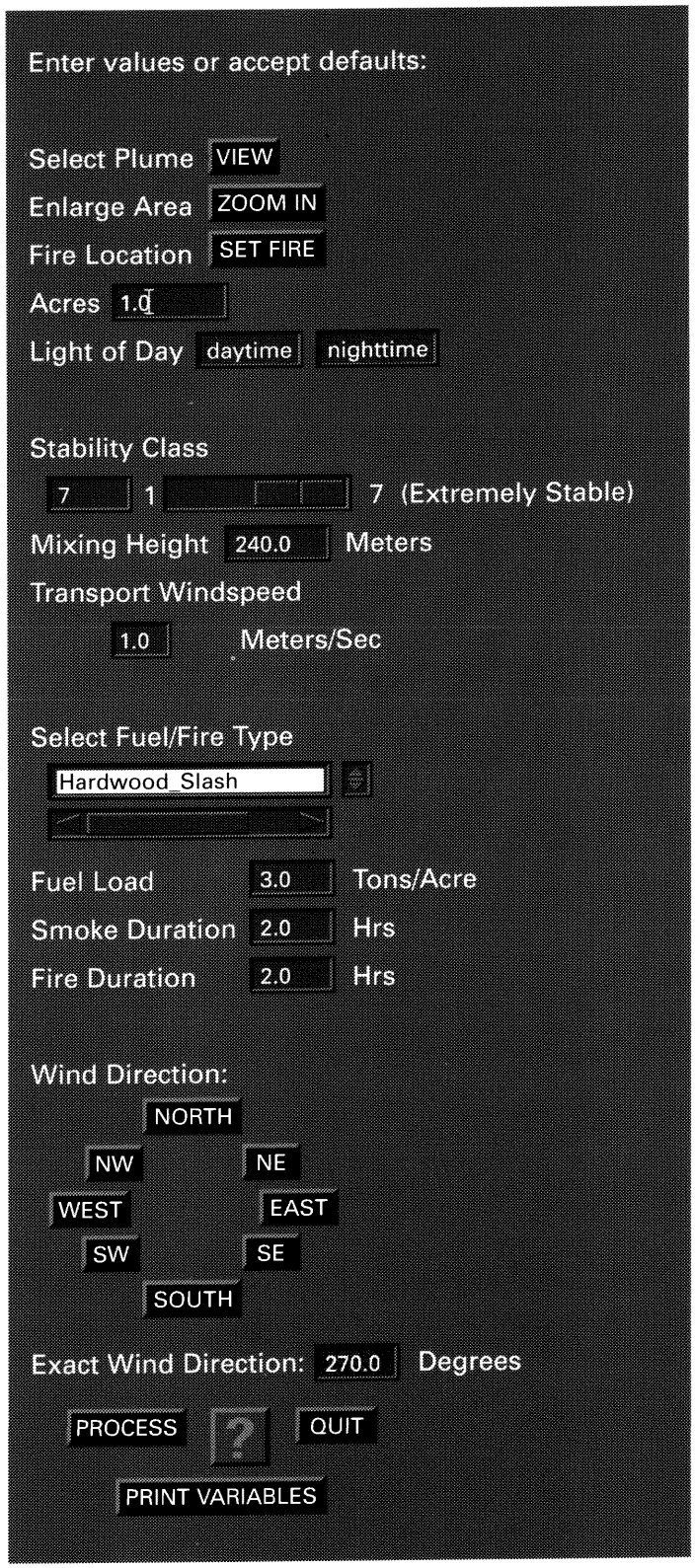

Figure 8—Plume Definition Window.

Note: The initial forest display (fig. 4) always clears the screen so the next forest display can use the UTM coordinate system for burn-site selection.

B. "?" Help

1. Click on the "?" icon at the bottom center of the Plume Definition Window and scan the contents of the pop-up window (fig. 9). Use the CONTINUE button or scroll bar.

2. Click on the QUIT button in the lower right corner to return to the Plume Definition Window.

3 Press mouse button three on any entry in the window to discover the type of entry required.

4. Enter a question mark in any input box and press Return to discover the acceptable numerical range for that entry.

C. Input Values for Creating a New Smoke Plume

1. Click on SET FIRE (third button from the top) to select a burn site.

   a. Move the mouse cursor onto the map.

   b. Position the cursor, or the center of the crosshairs, and click on the site of the burn.

2. Enter the number of acres to burn.

3. To select the time of day for the burn, click on the daytime or nighttime button.

4. Enter the stability class.

5. Enter the mixing height.

6. Enter the transport windspeed.

7. Select and click on a fuel/fire type.

8. Enter the fuel load.

9. Enter the smoke duration.

10. Enter the fire duration.

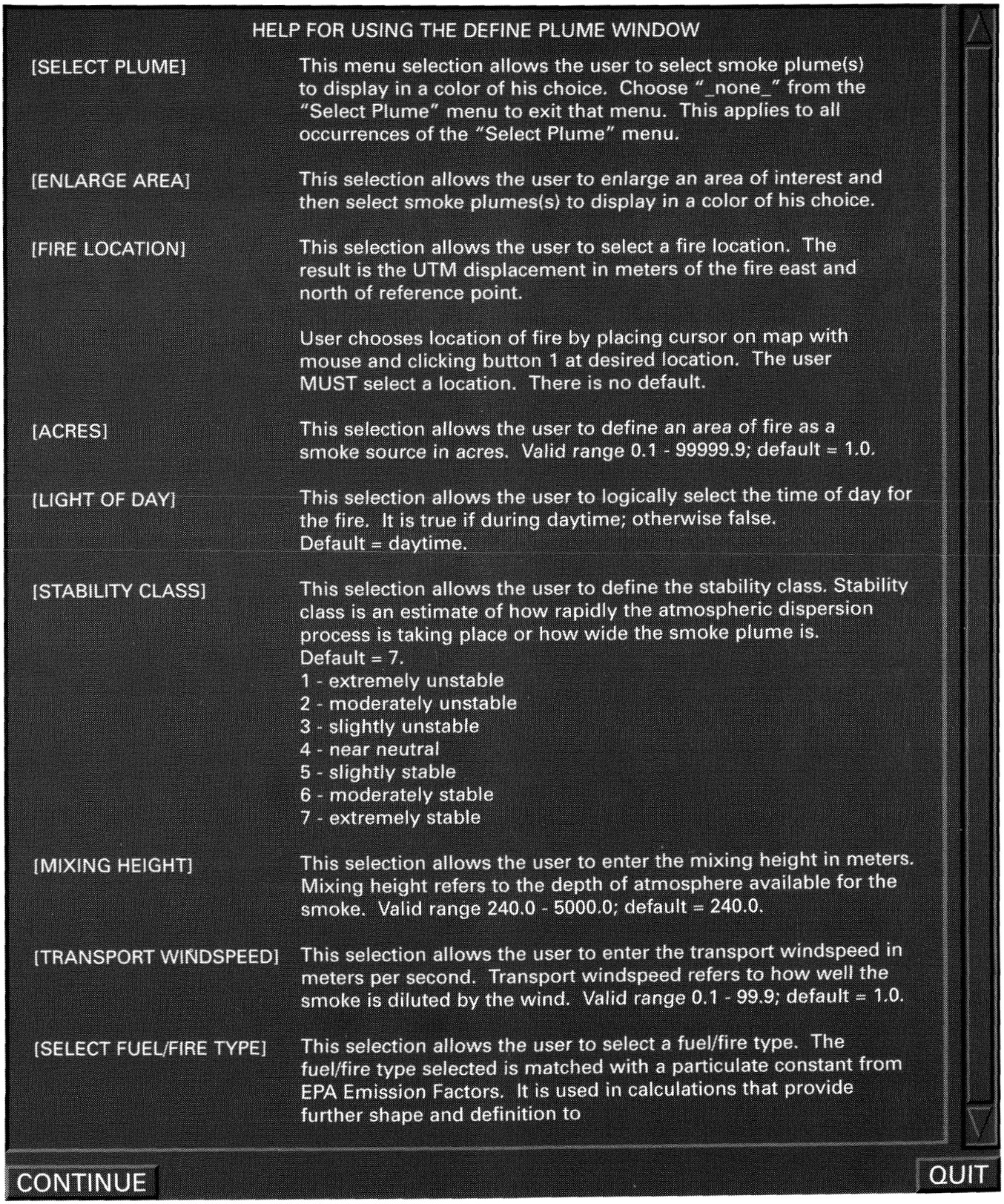

Figure 9—Help Window for Plume Definition Window.

11. Click on a compass button for the wind direction.

12. For a more precise wind direction, enter a more exact number, in degrees, in the Exact Wind Direction input box.

D. Creation of the New Smoke Plume

1. Click on the PROCESS button.

   a. A pop-up window of all the variables used to create the new smoke plume appears. It includes all the parameters the user has just entered, as well as constants further defining the plume. (The data from this window create the variable listing in figure 10. To exit, the user must click on the QUIT button.

   b. When the Response Window, "Enter name of smoke plume." appears, enter the new smoke plume name.

   c. Click on the OK button to exit. The smoke plume name always translates into lower case.

E. Viewing the New Smoke Plume

1. Click on VIEW in the Plume Definition Window and then click on the name of the new smoke plume from the pop-up Select Plume: Window.

   After the forest is redrawn, the new smoke plume displays in red (fig. 11).

2. To return to the Plume Definition Window when the Select Plume: Window reappears, click on "_none_."

F. For a Closer View

1. Click on the ZOOM IN button to enlarge the new smoke plume for closer inspection. The message, "Define the box," appears in the Arc Window.

   a. Position the mouse cursor on the display.

   b. Point and click on the lower left and upper right of an "imaginary box" surrounding the plume.

      General information on current map scale, map extent, and other map descriptors is displayed in the Arc Window.

Smoke Plume Parameters

Local:	
XEND	100.0
XBGN	0.0
LGRISE	T
FNUM	40
NISO	10
EMTQPM	98.33979403794
OPENSTAT	0
NEWTOL	0.1
QUOT	1
CHIISOTOL10	'1000.000 0.1'
BKGPM	30.0
EMTQH	108.9886147978
X	2126585.851936
Y	19512
EMTQR	-0.75
OYINT	5.0
OZINT	5.0
XNTVL	0.025
CHIISOTOL1	'100.000 0.1'
CHIISOTOL2	'150.000 0.1'
CHIISOTOL3	'200.000 0.1'
CHIISOTOL4	'260.000 0.1'
CHIISOTOL5	'375.000 0.1'
CHIISOTOL6	'500.000 0.1'
CHIISOTOL7	'625.000 0.1'
CHIISOTOL8	'750.000 0.1'
CHIISOTOL9	'875.000 0.1'
DIVI	10000.0
Global:	
.MXHTNUM	240.0
.TNACRE	10.0
.DUTMFE	-12752.37743386
.ACRNUM	16
.FILEUNIT	1
.WINDIR	242.0
.DUTMFN	18176.86930024
.SMKDUR	8.2
.TRSPDNUM	1.0
.TIMEOFDAY	T
.FIREDUR	5.42
.FOUND	.FALSE.
.COLOR	red
.COVER	' '
.STABILITY	2
.FTYPE	Long_Needle_Conifer_Slash
Program:	
:PROGRAM	ARCPLOT

Figure 10—Smoke plume parameters.

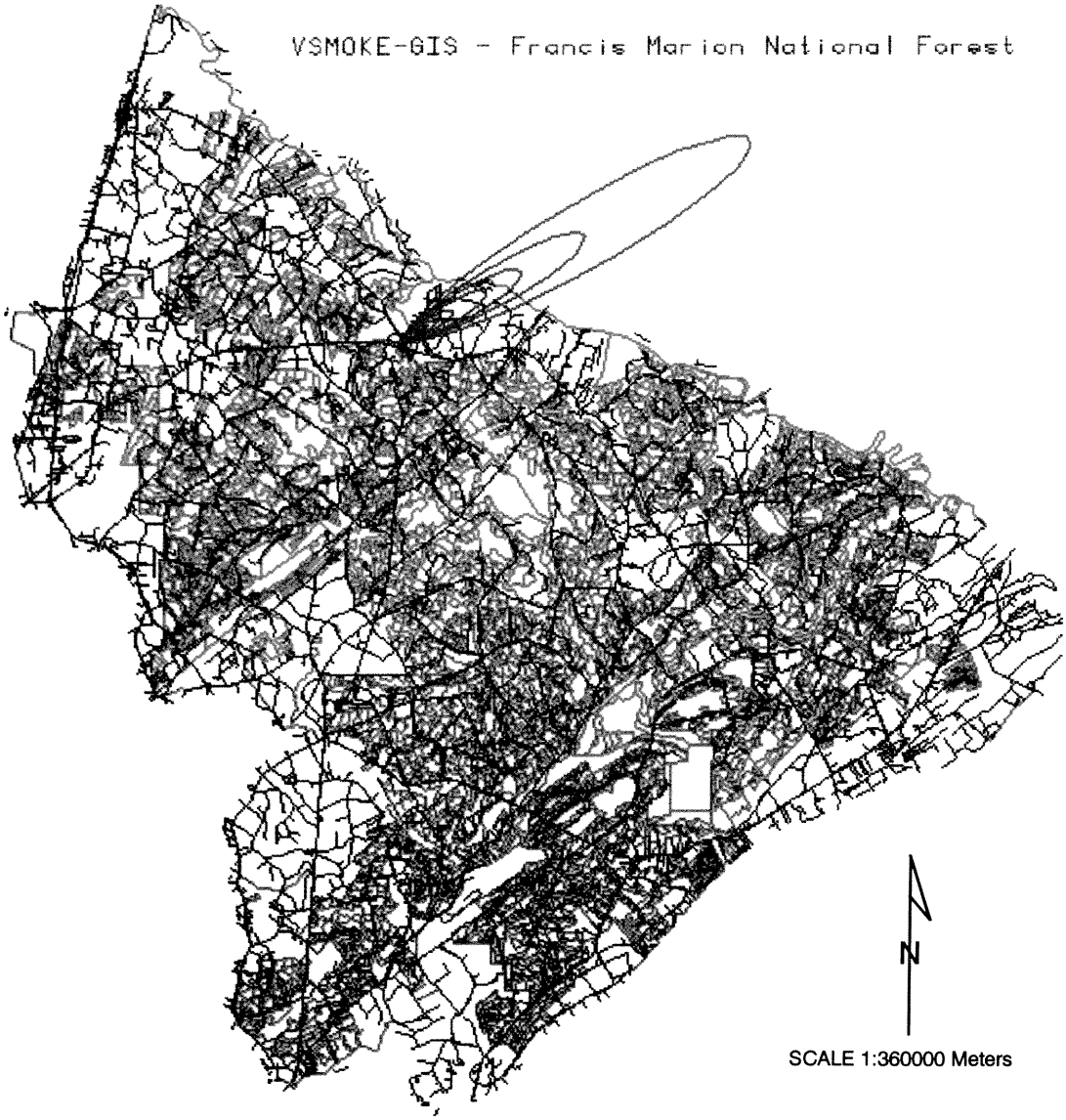

Figure 11—New smoke plume.

c. Click on a forest polygon coverage from the Select POLY Coverage: Window.

d. Click on a color for the coverage from the Forest Colors Window and QUIT to exit.

e. Click on "_none_" to exit the Select POLY Coverage: Window when it returns.

f. Click on a forest line coverage from the Select LINE Coverage: Window.

g. Click on a color from the Forest Colors Window for the coverage and QUIT to exit.

h. Click on "_none_" to exit the Select LINE Coverage: Window when it returns.

i. Click on the name of the new smoke plume from the Select Plume: Window.

j. Click on a color for the plume from the Plume Colors Window and QUIT to exit.

k. Click on "_none_" to exit the Select Plume: Window and to return to the Plume Definition Window.

The enlarged plume displays in the selected color (fig. 12). In figure 12, red was chosen to emphasize that the plume is the same as in figure 11.

G. Printing of Input Values

1. Click on the PRINT VARIABLES button for a printed list of the smoke plume parameters just entered in part "C." (fig. 10).

   Click on it only after the final smoke plume processing when the main dashboard, Plume Definition Window, and blank ArcPlot Window all appear, but before creating another smoke plume. The values are saved after processing, but erased when defining another plume.

2. At this point, the user can return to creating new smoke plumes and printing input values.

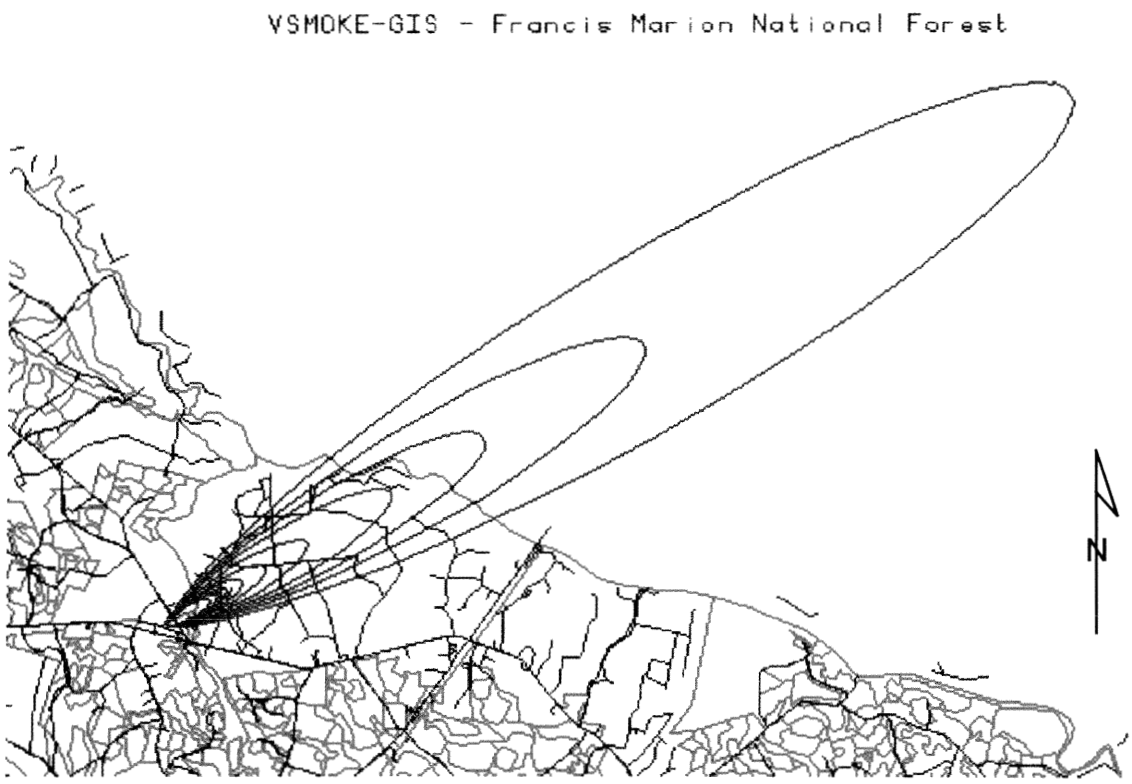

Figure 12—A closer view of the new smoke plume.

H. Exiting

1. Click on the QUIT button to return to the VSMOKE-GIS main dashboard.

VIEW Icon

A. Viewing Any Smoke Plume

1. Click on the second dashboard icon, the VIEW icon.

2. When the pop-up Select Plume: Window appears, click on the name of the smoke plume to be viewed. Use the scroll bar as needed. After the forest is redrawn, the plume displays in the red default color (fig. 11).

3. The Select Plume: Window reappears for another selection. Click on another smoke plume name; otherwise, click on "_none_" to exit.
   a. Click on a color selection for this plume from the color pop-up window and QUIT to exit.

b. When the Select Plume: pop-up window appears, click on "_none_" to exit.

TOOLS Icon

To examine different aspects of the newly created smoke plume, click on the third dashboard icon, the TOOLS icon. The Tools Window appears to the left of the forest display (fig. 13).

This icon can be used with any smoke plume on display. Before using the TOOLS icon, the user must begin with the VIEW icon to use the forest coordinate system or begin with the IDENTIFY icon to use the smoke plume coordinate system.

A. "?" Help

1. Click on the next-to-last selection (the "?" icon).

2. Scan the contents of the Help Window using the CONTINUE button or the scroll bar.

3. Click on the QUIT button to return to the Tools Window.

B. PAN

1. Click on the first selection (the PAN icon) to shift the forest and plume display.

   a. Position and click the mouse cursor, or crosshairs, on the upper part of the plume. Refer to the PAN description in the "VSMOKE-GIS Dashboard Glossary."

   b. Select a forest polygon and line coverage and their colors, when their windows appear. Click on the QUIT button to exit each window.

   c. Select the smoke plume and its color. Notice the shift in display (fig. 14).

C. ZOOM IN

1. Click on the second selection (the ZOOM IN icon) to enlarge the plume for closer examination. The message, "Define the box," appears in the Arc Window.

   a. Position the mouse cursor on the display.

   b. Point and click on the lower left and upper right of an imaginary box surrounding the plume to be enlarged.

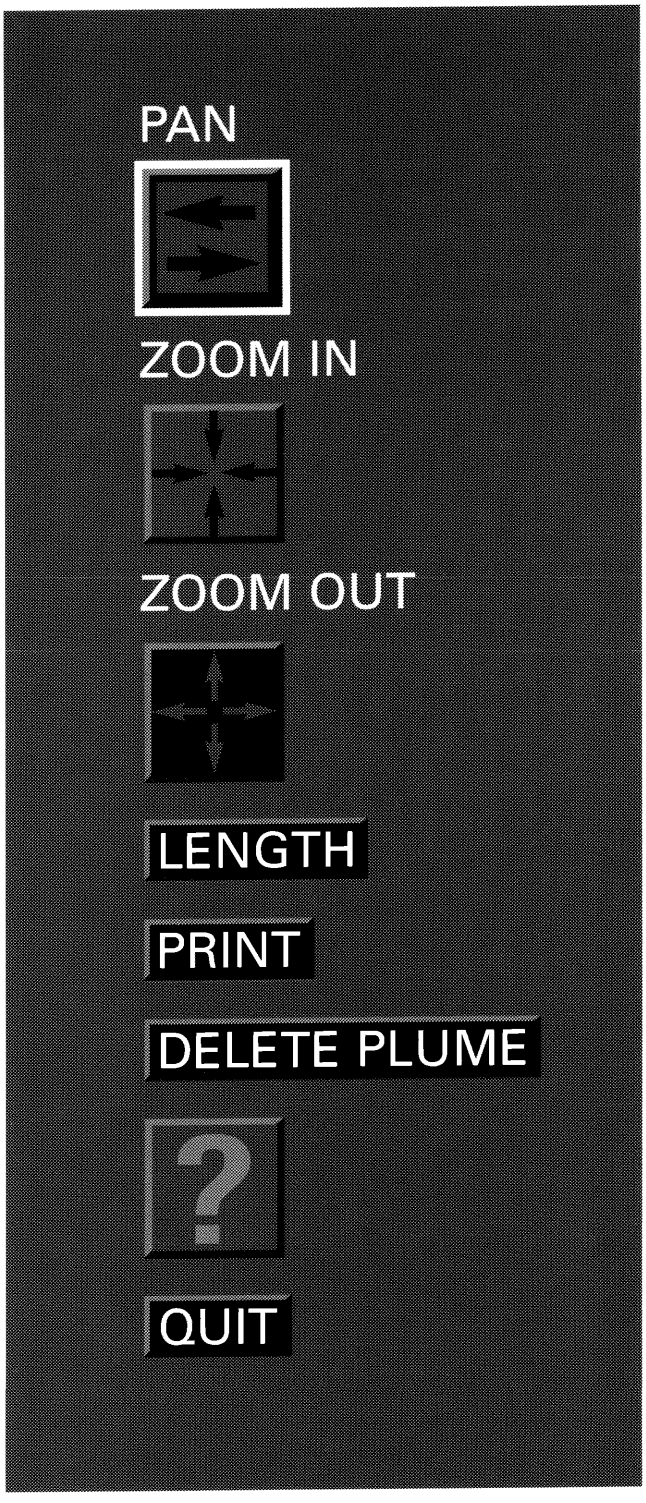

Figure 13—Tools Window.

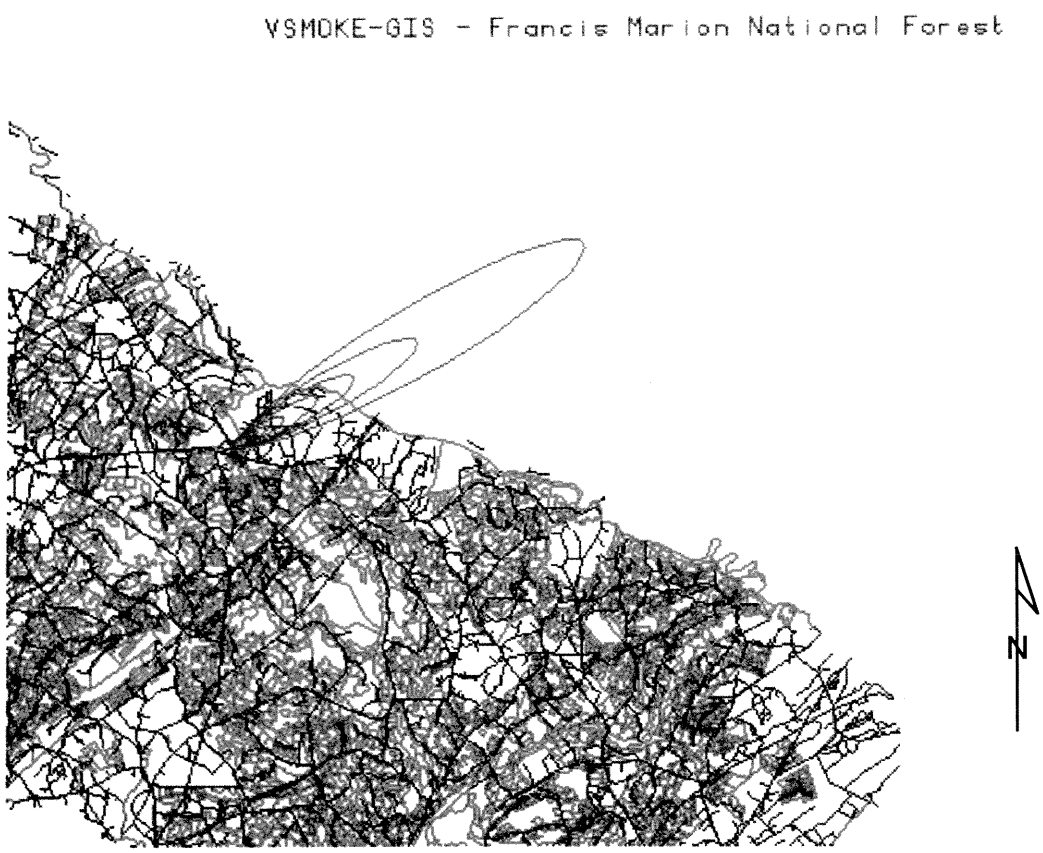

Figure 14—Pan view of new smoke plume.

General information on current map scale, map extent, and other map descriptors displays in the Arc Window. Refer to the ZOOM IN description in the "VSMOKE-GIS Dashboard Glossary."

c. Click on "_none_" when the Select POLY Coverage: Window appears.

d. Click on a forest line coverage from the Select LINE Coverage: Window.

e. Click on a color for the coverage and QUIT to exit.

f. Click on "_none_" to exit the Select LINE Coverage: Window when it returns.

Only one forest coverage was chosen in this example to show that any number of forest, as well as plume, coverages can be chosen for display.

g. Click on the name of the smoke plume to be enlarged from the Select Plume: Window.

h. Click on a color for the plume and QUIT to exit.

I. Click on "_none_" to exit the Select Plume: Window.

The enlarged plume displays in the selected color against one forest coverage. Figure 15 displays the plume against the roads coverage.

D. ZOOM OUT

1. Click on the third selection (the ZOOM OUT icon) to return the plume to a smaller size.

   a. Position and click the mouse cursor, or crosshairs, on the center of the plume. Refer to the ZOOM OUT description in the "VSMOKE-GIS Dashboard Glossary."

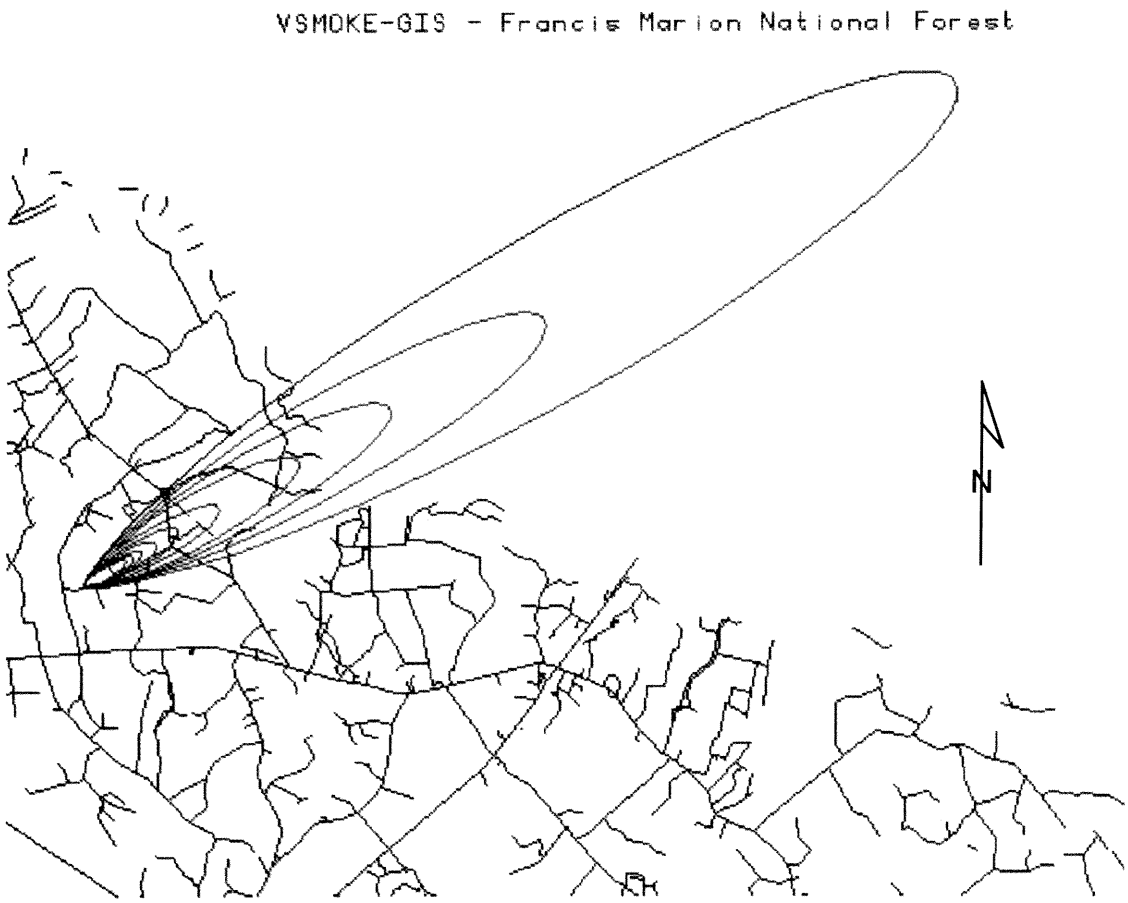

Figure 15—Zoom-in view of new smoke plume.

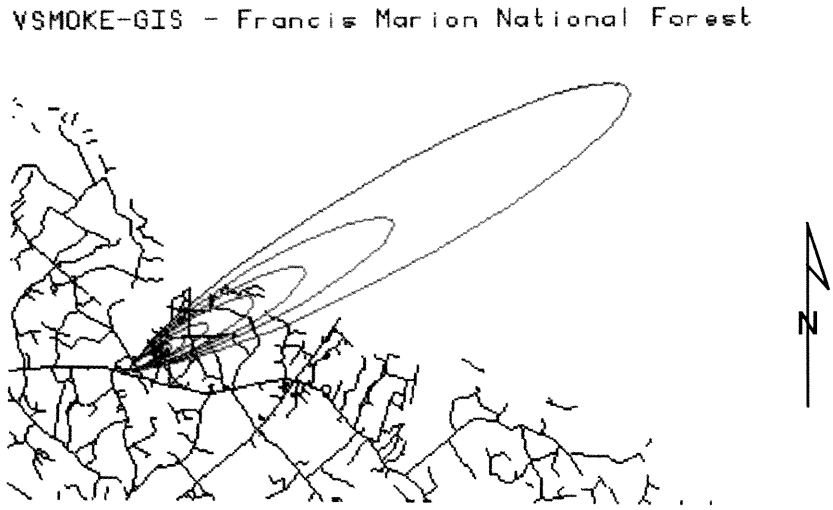

Figure 16—Zoom-out view of new smoke plume.

b. Click on a forest polygon coverage from the Select POLY Coverage: Window.

c. Click on a color for the coverage from the Forest Colors Window and QUIT to exit.

d. Click on "_none_" to exit the Select POLY Coverage: Window when it returns.

e. Click on a forest line coverage and a color. (See the ZOOM IN section above for help.)

f. Click on the smoke plume name and a color. A reduced form of the plume is displayed (fig. 16).

E. LENGTH

1. Click on the LENGTH button to display the length of the plume.

   a. Position and click the mouse cursor, or crosshairs, on the beginning and end of a smoke plume line segment. Refer to the LENGTH description in the "VSMOKE-GIS Dashboard Glossary."

   b. Press the CONTROL button and mouse button three simultaneously to complete the command. The measurement appears in a pop-up window (fig. 17).

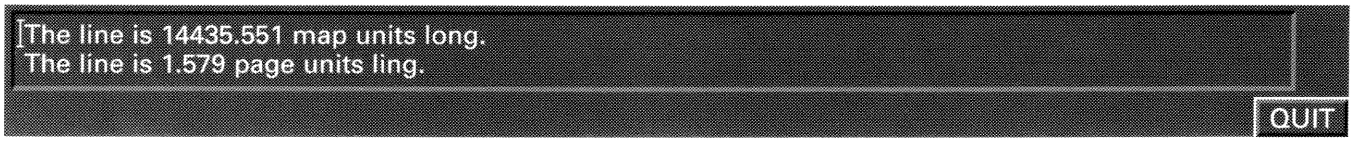

Figure 17—Length window.

c. Click on the QUIT button to exit.

F. PRINT

1. Click on the PRINT button for a printed copy of the display.

   a. Enter a descriptive title for the smoke plume in the Enter Plume Title Window.

   b. Click on the OK button to exit.

   c. When the mouse cursor changes to "+," click on the display to print the view.

   Figures 14 through 16 were produced using the PRINT button. Unlike the options of the Plume Definition Window, the tools utilities can manipulate the smoke plume and forest coverage displays until the desired view is achieved and then print the view with a heading defined by the user.

G. DELETE PLUME

1. Click on the DELETE PLUME button to delete the smoke plume.

   a. In the Select Plume: Window that appears, click on the name of the smoke plume just created.

   "Killed <name of smoke plume> with the ARC option" appears in the Arc Window, verifying the deletion.

H. QUIT

1. Click on the last selection (the QUIT button) to exit the Tools Window and return to the dashboard.

QUIT Icon

A. Ending a VSMOKE-GIS session

1. Click on the last dashboard icon (the QUIT icon) to return to Arc/Info.

Error Checking

Error checking is provided throughout the system. Windows are correctly initialized by VSMOKE-GIS each time a dashboard icon is selected. A default value is provided for every input box. To ensure correct processing, the default is used when the user does not actively choose a value. Entered numbers must be within the ranges of acceptable values. If an invalid value has been entered, an error message appears as a pop-up window, or at the bottom of the active window. Click on the QUIT button to exit the pop-up window and continue. Explanations of some VSMOKE-GIS error messages follow.

- "Smoke plume could not be created."

  If a smoke plume could not be generated because of incorrect or incompatible values, this error message will appear in a pop-up window. VSMOKE-GIS checks the validity of the individual values, but not their effects on each other.

- "Error in generating file list."

  This message appears when no smoke plumes exist. The file list, or smoke plume directory, is empty; therefore, it cannot be generated or listed. This message occurs when the user is asked to provide a name for a smoke plume just created. If the user deletes all of the smoke plumes or has just loaded the system, this message occurs.

- "Smoke Plume exists. Enter another name."

  If the user has entered an existing smoke plume name for a newly created plume, this message appears. The smoke plume directory, or file list, is searched for a match to the name entered by the user. If a match is found, the user must enter another name.

- "Error! Print variable list AFTER processing."

  If the user attempts to print a listing before he has clicked on the PROCESS button in the Plume Definition Window, this message appears.

Output Interpretation

Figure 18 shows normal smoke plumes and a smoke plume that has a flat margin. The data that form the smoke plumes are processed in VSMKGS in 25-meter intervals to 100 kilometers. Any data beyond 100 kilometers are eliminated and the plume becomes flat. Without this end range, the plumes could continue out of bounds and double back on themselves, producing incorrect results.

Different aspects of the plumes may be viewed and printed with varying combinations of the PAN, ZOOM IN, and ZOOM OUT selections in the Tools Window. Figure 18 resulted from a combination of all three.

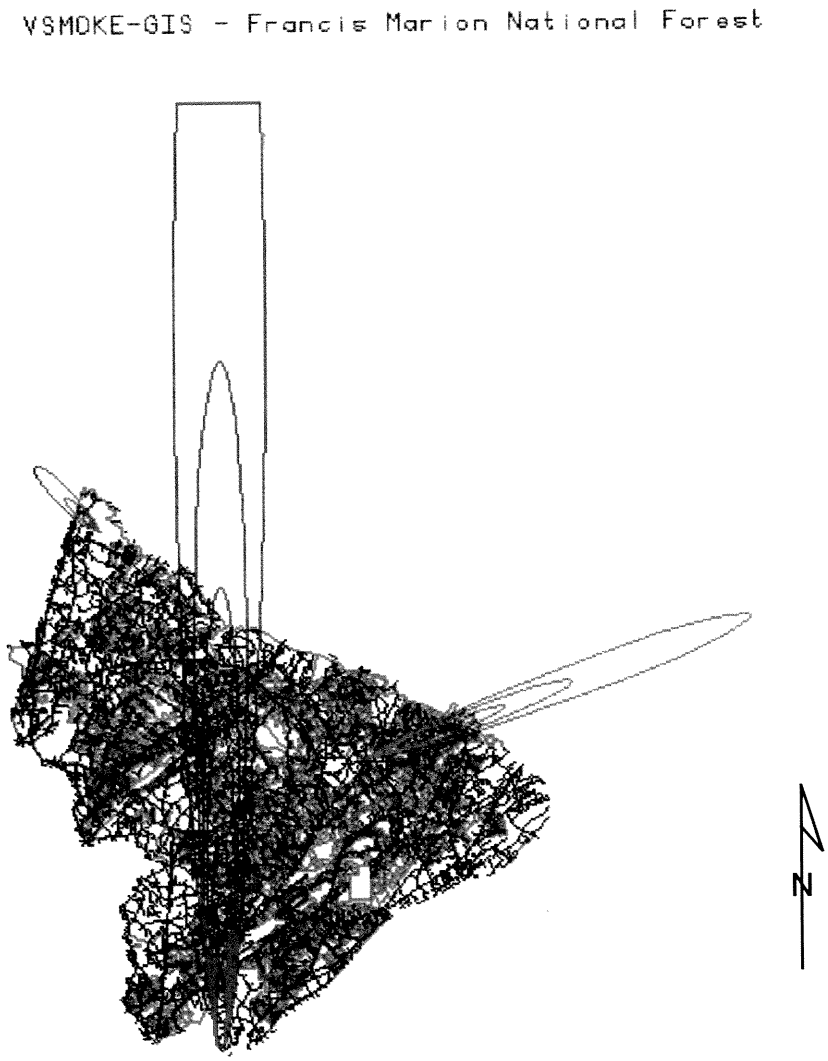

Figure 18—Flat and normal smoke plumes.

Windows Operations

Color Window

This pop-up window appears after the user selects a smoke plume from the Select Plume: Window. The first plume chosen defaults to red in the plume definition initial display and view selection and in the view selection of the VSMOKE-GIS main dashboard. Colors must be selected for smoke plumes at any other time. Choosing different colors for the smoke plumes allows the user to distinguish between plumes.

To select a color, click on the color name. Click on QUIT to exit. The Color Window does not appear if a smoke plume has not been selected.

A Color Window with different colors from the smoke plume colors exists for the forest coverages. A color must always be chosen because no default exists for forest coverages.

Response Window

When this pop-up window appears in the top of the window frame, the user must respond. After the response is entered, click on the OK button to exit.

Scrolling List

This pop-up window contains many choices, but only a few are displayed at one time. A vertical scroll bar with arrow heads on the right side of the window frame allows the user to view all the choices. Clicking on mouse button three results in a pop-up scrolling list with more choices displayed at one time.

To make a selection from a scrolling list, place the mouse cursor on the scroll bar. Then, pressing mouse button one, move the mouse up or down on the scroll bar to scroll through the list. When a selection is made, move the cursor to it and click on it. The selection is highlighted in the input box.

For a scrolling list with only one choice displayed, click on the up or down arrow to scroll through the list, one item at a time.

Select Plume Window

This pop-up scrolling list contains the names of all of the smoke plumes created. To view them all, use the scroll bar. To select one, choose a plume name and click on it. After a plume is drawn, the window always reappears. Until "_none_" is clicked on, the window keeps reappearing, allowing the selection and display of as many smoke plumes as desired, one at a time. Click on "_none_" when no more smoke plumes are desired.

These same actions are used with the Select POLY Coverage: and the Select LINE Coverage: scrolling lists.

Slider Bar

This horizontal scroll bar selects an input value based on a vertical sliding scale that the user manipulates. Place the mouse cursor on the bar, and pressing mouse button one, move, or slide, the bar. Values are displayed in the input window as the bar is moved. Releasing mouse button one saves the displayed value.

VSMOKE-GIS Dashboard Glossary

Plume Definition Window

When the IDENTIFY icon is first selected, the Select Plume: Window appears. Smoke plumes may be chosen as needed. By displaying some existing plumes, the user can better define and locate plumes that will be created. The forest is then displayed. This is the initialization procedure for the Plume Definition Window. It ensures that all the burn locations chosen from the screen will use the UTM coordinate system. After this initial display, the Plume Definition Window appears.

Most of the selections in this window have defaults. They always appear when the window is first chosen and remain for processing if no changes are made. The Help Window selection provides specific information.

Model Input Variables

Select Plume: The Select Plume: pop-up scrolling list contains the names of all smoke plumes. The user can display any smoke plumes created while remaining in the Plume Definition Window.

Enlarge Area: The user can view an enlarged, more detailed portion of the map display. Position and click the mouse cursor, or crosshairs, on the lower left corner of an imaginary box on the display that includes the area of interest. Click the mouse cursor again on the upper right corner of this box. Only the area inside that box is displayed. Forest and plume coverages and colors must be chosen when their pop-up windows appear.

Fire Location: The site of the planned burn is chosen by the user who points and clicks the mouse on a preferred site on the display map. UTM x,y coordinates are saved when the user clicks on the display location. This location is the UTM displacement in meters of the fire east and north of the reference point. A burn site must always be chosen because default coordinates are not provided.

Acres: An area of fire as a smoke source is defined in acres. Valid range 0.1 to 99999.9; default is 0.1.

Light of Day: The time of day for the fire is defined as a logical value of day or night. Daytime is the time after sunrise and before sunset; nighttime, the time after sunset and before sunrise. Default is daytime.

Stability Class: The rate of atmospheric dispersion is defined as anywhere from extremely unstable to extremely stable. Stability class affects the width of the smoke plume.

A stability class can be input in one of two ways: (1) Using the horizontal slider bar, which operates like the vertical scroll bar, the user releases button one when the value in the input box reaches the correct class; and (2) the user manually enters a number between 1 and 7 in the input box. Default is 7.

1–extremely unstable
2–moderately unstable
3–slightly unstable
4–near neutral
5–slightly stable
6–moderately stable
7–extremely stable

Mixing Height: Entered in meters, mixing height is the depth of atmosphere available for the smoke. Valid range is 240.0 to 5000.0; default is 240.0.

Transport Windspeed: Entered in meters per second, this value refers to the average windspeed in the mixing layer, or how well the smoke is diluted by the wind. Valid range 0.1 to 99.9; default is 1.0.

Select Fuel/Fire Type: Fuel and fire types are displayed, one at a time, in a scrolling list. When a type is selected from this list, it is matched with a particulate constant from Environmental Protection Agency Emission Factors. Fuel/fire type is used in calculations that provide further shape and definition to the smoke plume. Default is Hardwood_Slash.

Fuel Load: Entered in tons per acre, the amount of fuel to be burned is used to calculate heat emission rate. Fuel load also helps determine the mass of smoke generated by the fire. Valid range 0.1 to 999.0; default is 3.0.

Smoke Duration: Entered in hours, the duration of smoke emissions is used to calculate the smoke emission rate. Valid range 0.1 to 24.0; default is 2.0.

Fire Duration: Entered in hours, the length of time the fire burns is used to calculate the heat emission rate. Valid range 0.1 to 24.0; default is 2.0.

Wind Direction: The value represents the direction from which the wind blows the smoke. The plume grows in the opposite direction. Each button corresponds to a wind direction in degrees. Valid range 45.0 to 360.0 in increments of 45.0 degrees; default is 270.0.

Exact Wind Direction: The user can manually enter a more specific wind direction in degrees. Valid range 0.01 to 360.0; default is 270.0.

Help and Model Processing

PROCESS: This selection processes all of the variables defined under Plume Definition Window and then generates a new smoke plume. The processing can take a few minutes executing VSMKGS and generating the new plume. The flowchart (fig. 1) and the following paragraphs describe the logic flow.

After all the variables are entered or defaults accepted, the user should check them for accuracy. If a value needs to be changed, the user can position the mouse cursor at that point and reenter the value. If satisfied, the user should click on the PROCESS button. To exit without accepting any of the values, the user can press the QUIT button to return to the dashboard. Once the PROCESS button is selected, the new plume will be formed with the given data.

At this point, the variables, and constants further defining the plume, will appear in a pop-up window for user inspection. They are also written to a formatted file. This file becomes the input to VSMKGS. The VSMOKE-GIS and Arc/Info relinquish control to the UNIX operating system so VSMKGS can be executed with its new input file. As a result, an output file consisting of x,y coordinates is built to create the particular smoke plume. A Response Window, "Enter name of smoke plume," appears during processing requesting a name for the smoke plume. If necessary, this name automatically converts into lower case letters for Arc/Info usage.

Control is then returned to Arc/Info and VSMOKE-GIS where a coverage is created from the data output of VSMKGS. Topology is constructed. VSMOKE-GIS is brought back to the screen, including the Plume Definition Window, the dashboard, and a blank ArcPlot Window.

"?" (HELP): Each entry of the Plume Definition Window is explained in the pop-up window that appears, including its definition and the range and default values. Use the scroll bar or the CONTINUE button to read the entire window. Click on the QUIT button to exit.

QUIT: The user exits the Plume Definition Window and returns to the VSMOKE-GIS main dashboard.

PRINT VARIABLES: A printed record of the variables entered is provided and used to create a smoke plume. All processing, culminating in the creation of the smoke plume, must be completed before the user can receive a printed copy. The error message, "Error! Print variable list AFTER processing." appears if the user clicks on this button before processing is fully complete. Read the "PROCESS" description above for more detail on smoke plume creation.

VIEW Icon

The forest and smoke plume coverages displayed on this window, as well as the Plume Definition and Tools Windows, draw very slowly because either the forest coverages or the plume coverages are temporarily converting to the coordinate system of the other.

A smoke plume can be viewed in one of two ways. Using the VIEW icon on the VSMOKE-GIS dashboard, the user can view the smoke plume and then continue with other activities. The VIEW icon of the main dashboard uses the forest coordinate system and, therefore, provides a more realistic picture of the forest and its smoke plumes than the VIEW option in the Plume Definition Window. Using the VIEW button at the top of the Plume Definition Window, the user can remain in the window to display the newly created plume, then plan another burn. The user can continue to create and view plumes in the UTM burn-site map projection until the session is completed.

Tools Window

The PAN, ZOOM IN, and ZOOM OUT options can be used together to create a specific view.

PAN: To view a portion of the map that is not completely visible, position the mouse cursor, or crosshairs, on the ArcPlot display so that the crosshairs are at the center of an area including the unseen portion. This may involve positioning the crosshairs at the edge of the display. Click on it. General information on the current map scale, map extent, and other map descriptors is displayed in the Arc Window. The ArcPlot Window then clears, leaving a blank display. The map shifts and the selected area will be displayed in the center of the window after the coverages and colors are selected.

Select polygon coverages for the forest from the Select POLY Coverage: Window and line coverages from the Select LINE Coverage: Window. Select colors for the coverages from the Forest Color Window, then QUIT to exit.

Next, select a line coverage for the forest from the Select LINE Coverage: Window and "_none_" to exit. Select a color for the coverage from the Color Window, then QUIT to exit.

Selecting "_none_" from either coverage window without selecting a forest coverage is possible. The fewer the forest coverages selected, the easier it is to view the smoke plumes.

Select the smoke plume to be viewed from the Select Plume: Window or "_none_" to exit. Select a color for the plume from the Color Window and QUIT to exit. For further instruction, read the Select Plume Window and Color Window descriptions.

ZOOM IN: To display an enlarged, more detailed portion of the map display, position the mouse cursor, or center of the crosshairs, in the ArcPlot Window. Imagine a box encompassing the area of interest, and click on the lower left corner. The message, "Define the box," appears in the Arc Window.

Position the mouse cursor at the upper right corner of the box. The box appears as white lines on the display and changes size as the cursor is moved. Click on the upper right corner. Now, only the area surrounded by the white lines displays.

General information on the current map scale, map extent, and other map descriptors is then displayed in the Arc Window. Follow the instructions under PAN to display the forest and plume coverages and colors.

ZOOM OUT: To display a smaller, wider coverage map, position the mouse cursor, or crosshairs, on the center of the area of interest in the ArcPlot Window and click on it. General information on current map scale, map extent, and other map descriptors will be displayed in the Arc Window. The map is shifted and redisplayed at a smaller scale, with the selected area at the center of the display. Follow the instructions under PAN for selecting coverages and colors.

LENGTH: To discover the length of any line segment, position the mouse cursor, or center of the crosshairs, on the ArcPlot display and click on the beginning of the intended line segment. General information on current map scale, map extent, and other map descriptors is displayed in the Arc Window. The message, "Define the line <1,2 to enter, 4 to remove last point, 5 to remove line, 9 to end>," displays underneath.

Next, drag the mouse to the end of the line segment and click on it. Finally, press the Control key and mouse button three to end the command.

The completed segment appears as a white line on the display. The length of the line, in current map and page units (meters, inches), is displayed in a pop-up Window. Click on the QUIT button to exit.

PRINT: To receive a printed copy of a map display, enter a descriptive title, and click on the OK button in the Response Window, "Enter plume title."

If no title is entered, no title appears on the printed copy. When the mouse cursor changes to "+," click on the display, and the view is printed.

DELETE PLUME: This Arc command deletes a smoke plume coverage and its related files. Click on the plume name from the Select Plume: Window that appears. The Arc message, "Killed <full pathname of the smoke plume coverage> with the ARC option." verifies smoke plume deletion. Delete plume deletes only one smoke plume at a time. The Tools Window and a blank ArcPlot Window return after each deletion. Selecting "_none_" from the Select Plume: Window returns the user to the Tools Window.

"?" (HELP): A pop-up window containing a complete description of each of the tools selections is displayed. Use the scroll bar or the CONTINUE button to read the entire window. Click on the QUIT button to return to the Tools Window.

QUIT: This selection exits the Tools Window and returns the user to the VSMOKE-GIS main dashboard.

"?" (HELP) Window

A complete description of all the dashboard icons appears in a pop-up window. Use the scroll bar or the CONTINUE button to read the entire window. Click on the QUIT button to return to the VSMOKE-GIS main dashboard.

QUIT Icon

This selection exits the VSMOKE-GIS system, causing the display to disappear, and returns control to the Arc prompt.

Literature Cited

Lavdas, Leonidas G. 1997. VSMOKE—A users guide. Gen. Tech. Rep. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 147 p.

Lavdas, Leonidas G. 1986. An atmospheric dispersion model for prescribed burning. Res. Pap. SE-256. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southeastern Forest Experiment Station. 33 p.

Lavdas, Leonidas G.; Hauck, Charles A. 1991. Climatology of selected prescribed fire highway safety parameters for Florida. In: Proceedings of the 11th conference on fire and forest meteorology; 1991 April 16-19; Missoula, MT. Bethesda, MD: Society of American Foresters: 564-571.

Southern Forest Fire Laboratory Staff. 1976. Southern forestry smoke management guidebook. Gen. Tech. Rep. SE-10. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southeastern Forest Experiment Station. 140 p.

Appendix I—VSMKGS.IPT File Structure

File VSMKGS.IPT contains information (direct and derived) from the VSMOKE-GIS user input process. It also contains additional data needed to control the execution of program VSMKGS, which generates the data from which the VSMOKE-GIS isopleths are drawn. Modifying the VSMKGS.IPT file can change the isopleth values drawn by the program and alter other assumptions upon which the model is based. In most cases, the VSMOKE Users Guide (Lavdas 1997) should be consulted before changing any of the values in VSMKGS.IPT.

List of variables in VSMKGS.IPT:

Line 1:

KTITLE—title of program run, for identification purposes only, must be surrounded by apostrophes ('), e.g., 'RUN 013'

Line 2:

LGRISE—flag (T or F), set to T if smoke plume rises gradually as it moves away from the fire, set to F if it immediately attains complete plume rise; ordinarily set to T

ACRES—acres burned by fire (see "VSMOKE-GIS Dashboard Glossary ")

EMTQPM—particulate matter emission rate in grams per second (see "Select Fuel/Fire Type" in the "VSMOKE-GIS Dashboard Glossary")

EMTQH—heat emission rate in megawatts (see "Fuel Load" and "Fire Duration" in the "VSMOKE-GIS Dashboard Glossary")

EMTQR—an expression of how much smoke rises, as dictated by the value of EMTQH; the absolute value indicates the amount of smoke attaining full plume height; a positive value indicates the rising smoke goes up in a well-defined column; a negative value indicates this smoke forms a "curtain" from plume height to the ground; very limited research indicates a value of -0.75 best accounts for observed vertical profiles of smoke from low- to moderate-intensity prescribed fires in the Southeast

Line 3:

LTOFDY—flag (T or F) set to T if day, F if night (see "VSMOKE-GIS Dashboard Glossary")

ISTAB—value 1 to 7 for stability class (see "VSMOKE-GIS Dashboard Glossary")

AMIX—mixing height in meters (see "VSMOKE-GIS Dashboard Glossary")

U—transport windspeed in meters per second (see "VSMOKE-GIS Dashboard Glossary")

WDIR—wind direction in degrees (see "VSMOKE-GIS Dashboard Glossary")

OYINT—initial standard deviation of smoke in the horizontal (not counting fire line or area geometry effects) in meters; helps account for initial dispersion; value of 0.0 meters was used by Southern Forest Fire Laboratory Staff (1976) and recommended in VSMOKE (Lavdas 1997), but is not tractable in a GIS for some sources; 5.0 meters is suggested for use in VSMKGS and VSMOKE-GIS

OZINT—initial standard deviation of smoke in the vertical (not counting plume curtain or split plume rise effects) in meters as controlled by EMTQR; helps account for initial dispersion; value of 0.0 meters was used by Southern Forest Fire Laboratory Staff (1976) and recommended in VSMOKE (Lavdas 1997); 5.0 meters is suggested for use in VSMKGS and VSMOKE-GIS

BKGPM—background concentration of particulate matter in micrograms per cubic meter; in clean air conditions, a value of 30 may be a reasonable estimate; BKGPM is roughly inversely related to visibility if the air is not humid (RH < 70 percent); 1 mile implies BKGPM may be about 725, 7 miles implies BKGPM of about 100

Line 4:

DUTFME—east coordinate of fire in meters (see "VSMOKE-GIS Dashboard Glossary")

DUTFMN—north coordinate of fire in meters (see "VSMOKE-GIS Dashboard Glossary")

XBGN—beginning downwind distance of isopleth analysis in kilometers; should ordinarily be set to 0.0 kilometers

XEND—ending downwind distance of isopleth analysis in kilometers; should ordinarily be set to 100.0 kilometers

XNTVL—interval for downwind distances for isopleth analysis in kilometers; a value of 0.025 kilometers (25 meters or about 80 feet) yields a smooth analysis with reasonably quick execution times resulting in both workstation and PC environments

NISO—number of isopleths analyzed; set to 10 in VSMKGS and VSMOKE-GIS

Line 5ff:

CHIISO(J)—smoke concentration values in micrograms per cubic meter considered in the isopleth analysis; values used in VSMOKE-GIS are: 100, 150, 200, 260, 375, 500, 625, 750, 875, and 1000

CHITOL(J)—mathematical tolerances in micrograms per cubic meter accepted in solving for the (x,y) coordinates through which the isopleths pass; a value of 0.100 micrograms per cubic meter is used in VSMOKE-GIS for all values of CHIISO

Appendix II— Input File Example

This is an example of the file, VSMKGS.IPT, which provides the input for VSMKGS. The highlighted values represent those values input by the user. They are entered in the Plume Definition Window and then written to VSMKGS.IPT. The other values are constants, provided by a separate VSMOKE-GIS program.

'VSMKGS.IPT'
T **1.000** 6.804 5.538 -.750
T 1 240.000 0.100 270.000 5.000 5.000 30.000
2169.129 6164.525 0.000 100.000 0.025 10
100.000 0.100
150.000 0.100
200.000 0.100
260.000 0.100
375.000 0.100
500.000 0.100
625.000 0.100
750.000 0.100
875.000 0.100
1000.000 0.100

The highlighted values are as follows:

Line 1: acres

Line 2: light of day, stability class, mixing height, transport windspeed, wind direction

Line 3: x,y burn site coordinates

Appendix III—Complete VSMOKE-GIS Program Listing

Menus
- forcolor.menu
- plumcolor.menu
- plumedef.menu
- tools.menu
- vsmoke.menu

AMLs
- delplume.aml
- fortran.aml
- length.aml
- panzoom.aml
- printcov.aml
- printlv.aml
- process.aml
- readin.aml
- showpoly.aml
- showutm.aml
- vsmkgap.aml
- vsmoke.aml
- zoom.aml
- zoomplu.aml

Help Screens
- help.plu
- help.tls
- help.vsm

Projections
- polyconic.prj
- utm.prj

Map Elements
- north.mrk

FORTRAN Source
- vsmkgs.f

Menu Icons
- display.icon
- help.icon
- help_32.icon
- identify.icon
- pan32.icon
- quit.icon
- tools64.icon
- zi.icon
- zo.icon

Appendix IV—VSMOKE-GIS Logic Listing

VSMOKE-GIS Startup and Dashboard
- vsmoke.aml
  - vsmkap.aml
    - north.mrk
  - vsmoke.menu
    - identify.icon
    - display.icon
    - tools_64.icon
    - help.icon
    - quit.icon

Identify.icon Dashboard Selection
- plumedef.menu
- showutm.aml
  - utm.prj
  - north.mrk
  - plumcolor.menu
- zoomplu.aml
- process.aml
  - readin.aml
  - fortran.aml
    - vsmkgs.f
- printlv.aml
- help_32.icon
  - help.plu

Display.icon Dashboard Selection
- showpoly.aml
  - polyconic.prj
  - plumcolor.menu
  - north.mrk

Tools_64.icon Dashboard Selection
- tools.menu
- pan32.icon
  - panzoom.aml
    - zoom.aml
      - forcolor.menu
      - plumcolor.menu
      - north.mrk
- zi.icon
  - panzoom.aml
    - zoom.aml
      - forcolor.menu
      - plumcolor.menu
      - north.mrk
- zo.icon
- panzoom.aml
  - zoom.aml
    - forcolor.menu
    - plumcolor.menu
    - north.mrk
- length.aml
- printcov.aml
- delplume.aml
- help_32.icon
  - help.tls

Help.icon Dashboard Selection
- help.vsm

Quit.icon Dashboard Selection
Quit VSMOKE-GIS, return to Arc/Info prompt

Appendix V— VSMOKE-GIS Editing Instructions

The user may also want to edit the comments in each of these programs to reflect his changes.

1. vsmkap.aml, showutm.aml, showpoly.aml, vsmoke.menu
   a. Change the forest coverage names, coverage features, and colors.
   b. Change the position and forest name of the VSMOKE-GIS title.
   c. Change the map scale and map scale title and position.
   d. Change the north arrow position relative to the position of the map scale title.
2. showpoly.aml
   a. Change the program name to the name of the coordinate system of your forest.
      Example: cp showpoly.aml showstate.aml <return>
   b. Edit the "Program:" line in the program, itself, to reflect the new name.
      Example: change "Program: SHOWPOLY.AML" to "Program: SHOWSTATE.AML."
   c. Change the program name in the error message at the end of the bailout routine to the new program name.
   d. Change the command "mapprojection polyconic.prj" in the program to the coordinate system your forest is projected in.
      Example: change the command "mapprojection polyconic.prj" to "mapprojection statepln.prj."
3. polyconic.prj
   a. Change the program name to the name of the coordinate system your forest is projected in.
      Example: cp polyconic.prj statepln.prj <return>
   b. Edit the "Program:" line in the program, itself, to reflect the new name.
      Example: change "Program: POLYCONIC.PRJ" to "Program: STATEPLN.PRJ."
4. polyconic.prj, utm.prj
   a. Change the UTM zone in the programs to the correct UTM zone for your forest.
   b. Change "projection polyconic" to your forest projection.
   c. Change the polyconic units of measure to the units of your forest projection, if necessary.
   d. Change or delete the latitude, longitude, false easting, and false northing parameters under the polyconic, or forest, projection code.
   e. Add any additional projection parameters necessary, such as datum and shift, for your forest and smoke plume coverages to display in the UTM and forest coordinate systems.
5. zoom.aml
   a. Change the position and forest name of the VSMOKE-GIS title.
   b. Change the position of the north arrow.

6. forcolor.menu, plumcolor.menu
   a. Change or add colors to both menus to reflect the forest and smoke plume coverages.
7. fortran.aml
   a. Change the path of the vsmkgs.out executable to the path to be used.
   b. See the "Recompile Source" section for further information.
8. printlv.aml, printcov.aml
   a. Change the printer names.
      A LaserJet III (coded "-dlaser " and a PaintJet XL300)
      (coded "-device pjetxl," "-dpaint ") are used.
   b. Reposition the plume title if the VSMOKE-GIS title was moved.

Recompile Source

The vsmkgs.f program was written in FORTRAN 77.

1. Compile vsmkgs.f, calling the executable file "vsmkgs.out."
   "F77 vsmkgs.f -o vsmkgs.out" was the command used on the HP 720.
2. Vsmkgs.f and all related files must be in the same directory as the rest of your VSMOKE-GIS system. All of these files must be in lower case.

   These files are:
   vsmkgs.f
   vsmkgs.out
   vsmkgs.ipt
   vsmkgs.iso
3. The object file vsmkgs.o, may be removed to save disk space.
   Example: rm vsmkgs.o <return>

Miscellaneous Information

1. To alter the menu colors and font, create a file called "Arcinfo" in your home directory:
   a. Copy the original Arcinfo file to the user home directory. Arcinfo should be located in the main Arc/Info executable directory under the Xenv directory.
      Example: cp /arcexe702/Xenv/Arcinfo <user home directory> <return>
   b. Edit the Arcinfo file in the user home directory.
      Example: vi Arcinfo <return>
   c. Change its color and font names as needed.
2. Definitions of vsmoke.gis subdirectories and files:
   a. icons—directory of menu icons
   b. utmiso—directory of UTM smoke plume coverages that are created
   c. plume—file created from the Tools Window of the map view to be printed
   d. vars—file created when the plume definition variables are printed.

Harms, Mary F.; Lavdas, Leonidas G. 1997. Users guide to VSMOKE-GIS for workstations. Research Paper SRS-6. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southern Research Station. 41 p.

VSMOKE-GIS was developed to help prescribed burners in the national forests of the Southeastern United States to visualize smoke dispersion and to plan prescribed burns. Developed for use on workstations, this decision-support system consists of a graphical user interface, written in Arc/Info Arc Macro Language, and is linked to a FORTRAN computer program. VSMOKE-GIS combines a graphics display of a forest with a dashboard of five icons. By clicking the mouse on these icons, a fire manager can interactively affect the appearance of a smoke plume. Once appropriate files have been created, more than one smoke plume can be viewed at once, and different aspects of the forest, such as stands of trees, rivers, or soil types, can be viewed together or separately. This user's guide provides a complete tour of the VSMOKE-GIS, including a history of its development; a tutorial of the steps used in creating, viewing, and manipulating plumes; system steps used in creating, viewing, and manipulating plumes; system definitions; descriptive figures; and instructions on acquiring and personalizing the system for an individual forest.

Keywords: Plume definition, prescribed burn, smoke dispersion, smoke plume, smoke plume parameters, VSMKGS, VSMOKE-GIS dashboard.