Smokeview, A Tool for Visualizing Fire Dynamics Simulation Data Volume III: Verification Guide

Glenn P. Forney

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Smokeview, A Tool for Visualizing Fire Dynamics Simulation Data Volume III: Verification Guide

Glenn P. Forney
Fire Research Division
Engineering Laboratory

U.S. Department of Commerce
Gina M. Raimondo, Secretary

National Institute of Standards and Technology
Laurie E. Locascio, NIST Director and Undersecretary of Commerce for Standards and Technology

Preface

This guide is part of a three volume set of companion documents describing Smokeview. Volume I, the Smokeview User's Guide [1], describes how to use Smokeview. Volume II, the Smokeview Technical Reference Guide [2], gives technical details of how the visualizations are performed. Volume III, the Smokeview Verification Guide [3] presents example cases verifying the various visualization capabilities of Smokeview. Details on the use and technical background of the Fire Dynamics Simulator is contained in the FDS User's [4] and Technical reference guide [5] respectively. This guide is Volume III the Smokeview Verification guide.

Smokeview is a software tool designed to visualize numerical calculations generated by fire models such as the Fire Dynamics Simulator (FDS), a computational fluid dynamics (CFD) model of fire-driven fluid flow or the Consolidated Fire and Smokeview Transport (CFAST) model, a zone fire model. This Guide is Volume 3 of the Smokeview Reference Guides. This guide presents a series of images derived from FDS and Smokeview. The intent is to verify that the algorithms used by Smokeview for visualizing data are implemented correctly. These images are generated automatically through the use of scripts by first running FDS on a series of input cases and then running Smokeview, again using a set of scripts. The correctness of Smokeview may then be verified more easily as FDS and Smokeview are updated since the reference figures in this document may be generated simply and automatically.

Smokeview and associated documentation for Windows, Linux and Mac OS X may be downloaded from http://pages.nist.gov/fds .

About the Author

Glenn Forney is a computer scientist at the Engineering Laboratory of NIST. He received a bachelor of science degree in mathematics from Salisbury State College and a master of science and a doctorate in mathematics from Clemson University. He joined NIST in 1986 (then the National Bureau of Standards) and has since worked on developing tools that provide a better understanding of fire phenomena, most notably Smokeview, a software tool for visualizing Fire Dynamics Simulator data.

Disclaimer

The US Department of Commerce makes no warranty, expressed or implied, to users of Smokeview, and accepts no responsibility for its use. Users of Smokeview assume sole responsibility under Federal law for determining the appropriateness of its use in any particular application; for any conclusions drawn from the results of its use; and for any actions taken or not taken as a result of analysis performed using this tools.

Smokeview and the companion program FDS is intended for use only by those competent in the fields of fluid dynamics, thermodynamics, combustion, and heat transfer, and is intended only to supplement the informed judgment of the qualified user. These software packages may or may not have predictive capability when applied to a specific set of factual circumstances. Lack of accurate predictions could lead to erroneous conclusions with regard to fire safety. All results should be evaluated by an informed user.

Throughout this document, the mention of computer hardware or commercial software does not constitute endorsement by NIST, nor does it indicate that the products are necessarily those best suited for the intended purpose.

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Chapter 1

Overview

Smokeview is a scientific software tool designed to visualize numerical predictions generated by fire models such as the Fire Dynamics Simulator (FDS), a computational fluid dynamics (CFD) model of fire-driven fluid flow [4, 5] or the Consolidated Fire and Smoke Transport (CFAST) model, a zone model of compartment fire phenomena [6].

The feature set and user interface for Smokeview is complex making it difficult to adequately test all of its features manually. A scripting capability has been added to solve this problem. Many of Smokeview's features may now be run without user intervention through the use of scripts. A script is simply a text file containing one or more commands. Smokeview may then read the script commands and perform the actions listed. Some of these actions are loading data files, setting view points, setting times and most importantly rendering images. By designing a set of scenarios and corresponding images that demonstrate Smokeview's feature set, one may test Smokeview running a series of scripts (one script for each test case) and examining the resulting images to ensure that the fire model generating the results and Smokeview are working as expected.

This document then verifies that various Smokeview features are working as intended by presenting a series of simulation results in the form of Smokeview images. These images are generated using the various visualization features of Smokeview such as tracer particles, 2D or 3D contours, or realistic smoke.

Verification in the context of Smokeview is a process to check the correctness of the visualization. Verification does not imply that the underlying data is correct, only that the data is presented or visualized correctly. A separate document, the FDS Verification Guide [7], describes the verification process of FDS. One set of scripts is used to run FDS cases and a second set of scripts is used by Smokeview to generate images. The verification process then becomes much easier to accomplish since the use of scripts (i.e., non-manual methods) guarantees that consistent figures (same view points, same time points, same data files loaded, etc.) are produced as new versions of this verification document are generated using updated versions of FDS and/or Smokeview. Another way of looking at this verification process is to consider this document and the FDS Verification Guide [7] as being a *live* (not a static) document, easily updated as algorithms in FDS and/or Smokeview are enhanced and improved.

Details on setting up and running FDS cases may be found in the FDS User's Guide [4]. Details on visualizing FDS simulated data using Smokeview may be found in the Smokeview User's Guide [1]. Details on some of the technical aspects used to implement algorithms in Smokeview may be found in the Smokeview Technical Guide [2].

The FDS version used to run the cases illustrated in this document is

```
./Run_SMV_Cases.sh: line 197:
    /home2/smokevis2/smokebot/FireModels_clone/fds/Build/impi_intel_linux_64/fds_impi_intel_linux_64:
    No such file or directory
```

The Smokeview version used to generate the verification figures in this document is

```
Smokeview   - Jun 27 2022

Revision         : SMV6.7.21-0-gccbc561da-release
Revision Date    : Thu Jun 23 17:26:14 2022 -0400
Compilation Date : Jun 27 2022 20:12:40
Compiler         : Intel(R) oneAPI DPC++/C++ Compiler 2022.1.0 (2022.1.0.20220316)
Platform         : LINUX64
```

FDS generated data is presumed to be correct. FDS has its own set of verification cases to test the correctness of the data. The purpose of the cases used here is to confirm that data is drawn or visualized correctly. In particular, these cases confirm that correct files are loaded, data is scaled and drawn correctly, geometry is drawn correctly, etc. Three types of verification cases are presented. The first set are the most important. Those cases verify that data is drawn correctly. The second set of cases verify that various geometric elements are drawn correctly and the third set verifies that the various options and underlying features are implemented and perform properly.

The FDS input files used for the verification cases are documented in Appendix A. The Smokeview scripts used to generate the verification figures are documented in Appendix B. Note that these input files and scripts are located in the FDS GIT repository. In fact, the entries in the appendices are included directly from the repository, and will therefore be up to date as this document is regenerated.

Chapter 2

Data File Tests
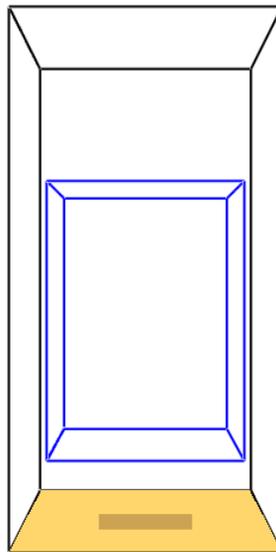
Figure 2.1: The temperatures in the plume5c.fds case are initialized to 600 °C within the region outlined in blue.

The tests in this chapter verify whether visualization types such as surface contours (boundary files), isosurfaces, particles, slice files, 3D smoke files and PLOT3D files are working as intended. These verification tests all use the same FDS input file, `plume5c.fds` (see Appendix A.4), to generate the simulation data. The case models a simple fire plume with two blockages. The upper blockage is initialized to 600 °C. The lower blockage is initialized to 20 °C. The gas phase is initialized to 600 °C within an interior region colored blue as illustrated in Fig. 2.1 and 20 °C everywhere else. This is done in order to verify that a known temperature is converted to the proper color (as shown in the color bar).

The verification figures are generated automatically using the Smokeview script file, `plume5c.ssf` (see Appendix B.4). The use of scripting allows the figures and hence this document to be updated easily as changes are made in FDS, Smokeview or the FDS input data files. This allows the verification process to be ongoing.

2.1 Surface contours (Boundary Files)

Figure 2.2 presents images verifying the display of surface contours or boundary file data. A series of boundary file images are drawn at 2 s (approximately), 10 s and 30 s seconds. The temperature of the upper obstacle is initialized to 600 °C hence the red colors for the $t = 0$ s images. The first column of images colors data at cell nodes using temperatures averaged at surrounding cell centers. The second column of images colors data using data values at cell centers.
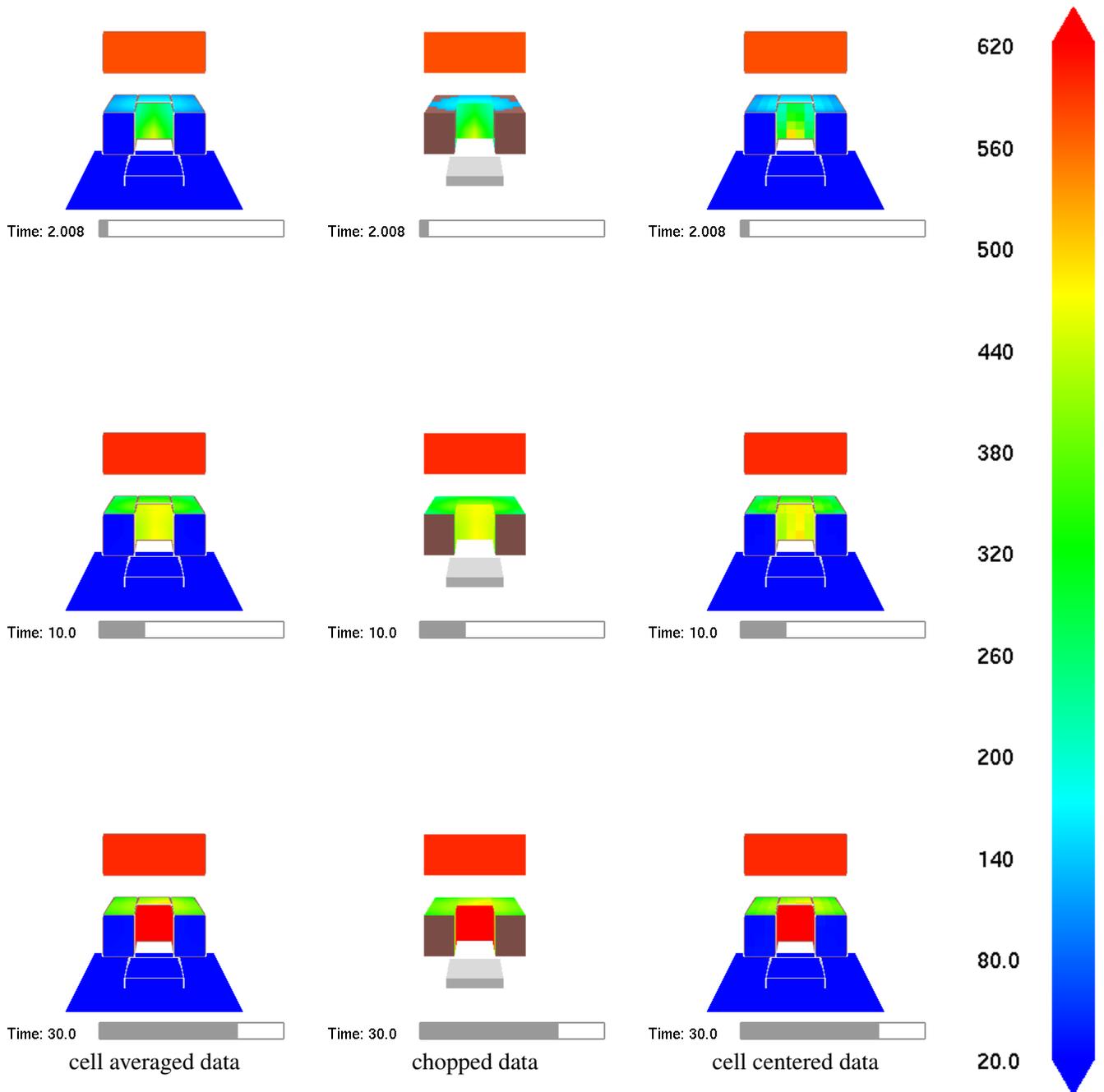
Figure 2.2: Boundary file test of shaded and chopped contours at 2 s, 10 s and 30 s. The upper obstacle is initialized to 600 °C and should be red for the $t \approx 2$ s images. For the chopped contours, the color near the chop boundary should match the color near 140 °C in the colorbar.

2.2 Iso-surfaces

An isosurface is a three-dimensional surface that defines constant values of a dependent variable. Figures 2.3 and 2.4 present images verifying the display of isosurfaces. A series of temperature isosurfaces are drawn at 0 s, 10 s and 30 s. A portion of the interior gas temperature is initialized to 600 °C. This results in the rectangular block that appears in the first row of images. The first column in Fig. 2.3 presents the iso-surface using points. The second column presents the iso-surface using triangulated outlines. The third column presents the iso-surface using a solid surface. Figure 2.4 demonstrates color customization using the `ISOCOLORS` .ini keyword.
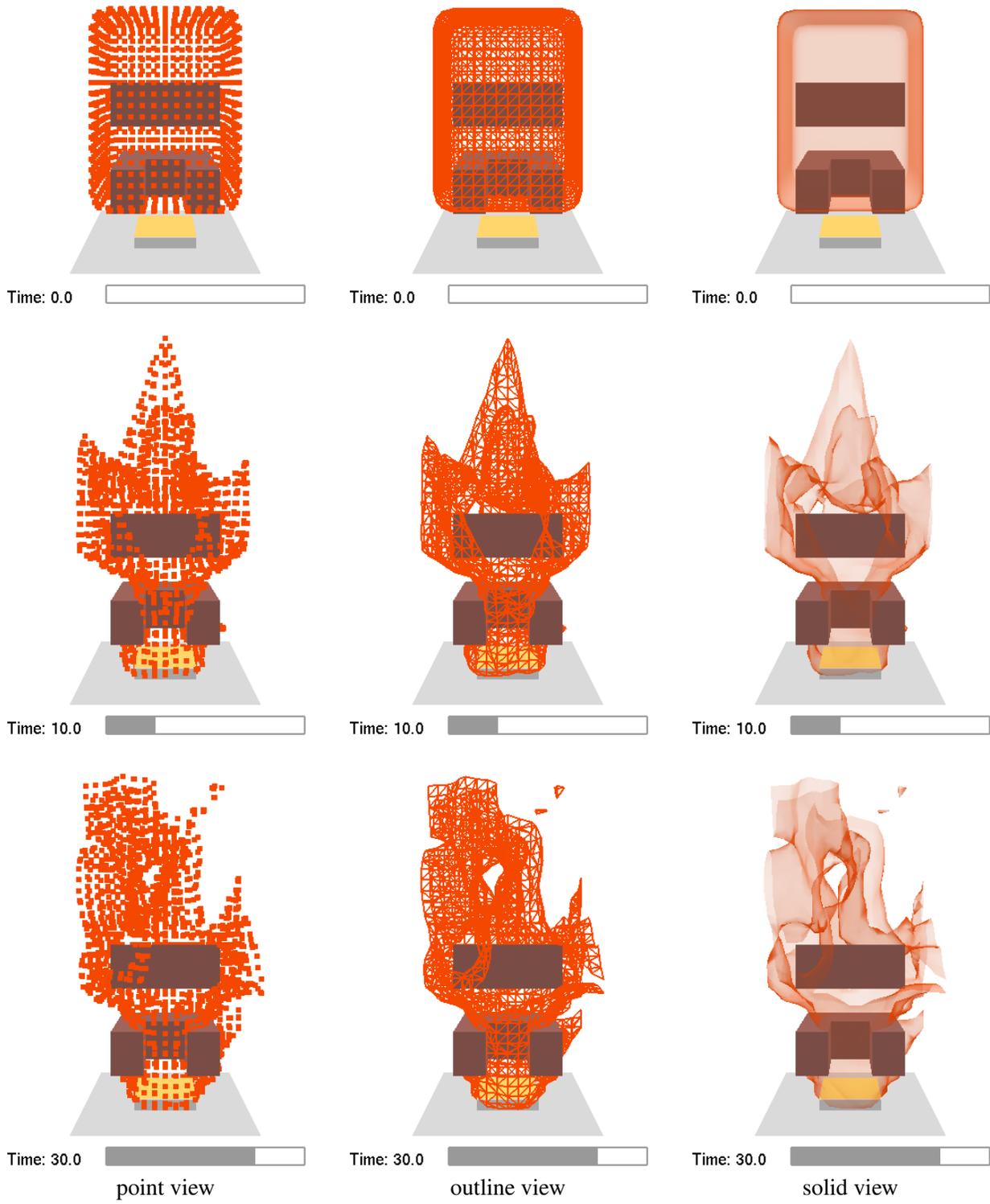
Figure 2.3: A test showing an isosurface enclosing a region initialized to 600 °C at 0 s, 10 s and 30 s. The isosurface should surround this region for the $t = 0$ s images.
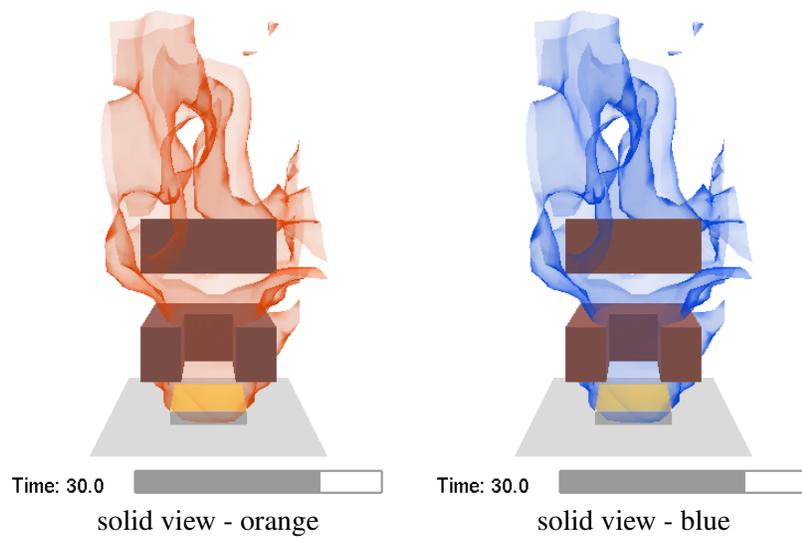
Figure 2.4: A test showing isosurfaces colored orange and blue using the ISOCOLORS .ini keyword at 30 s. The two isosurfaces are colored orange and blue using the ISOCOLORS .ini keyword.

2.2.1 Sensitivity Analysis
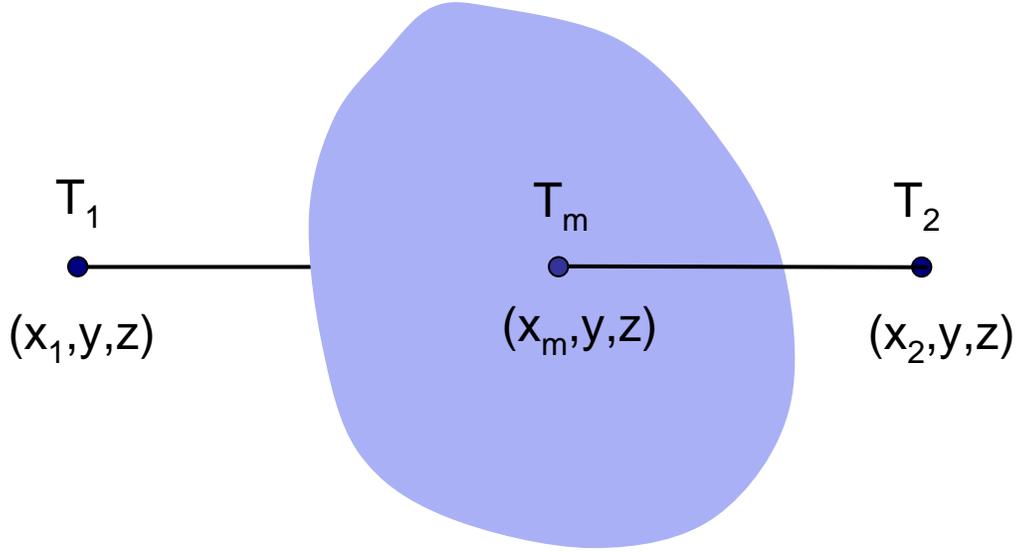
Figure 2.5: A portion of an iso-surface defined by $f(x,y,z) = T_m$ (for some arbitrary function f) crossing a line segment at the point (x_m, y, z).

Given that data used to generate an isosurface has uncertainty, an important question to consider is how sensitive is the isosurface location to uncertainty in the data used to define it? Figure 2.5 shows a portion of an iso-surface, $f(x,y,z) = T_m$, passing through a line segment at (x_m, y, z). The line segment is defined by endpoints (x_1, y, z) and (x_2, y, z). The key step in constructing an isosurface is solving an inverse interpolation problem. That is, determining the location, (x_m, y, z), between two grid nodes, (x_1, y, z) and (x_2, y, z), where interpolated data takes on a particular value (the isosurface level, T_m, being constructed).

Suppose, as illustrated in Fig. 2.6, that (x_1, y, z), T_1 and (x_2, y, z), T_2 represent two known data location, data value pairs and that T_m is also known satisfying $T_1 \le T_m \le T_2$. The inverse interpolation problem then is to find the location (x_m, y, z) that takes on the data value T_m. The location x_m is given by

$$x_m = (1 - \alpha)x_1 + \alpha x_2 \tag{2.1}$$

where

$$\alpha = \frac{T_m - T_1}{T_2 - T_1} \tag{2.2}$$

The sensitivity of x_m due to a change ΔT_1 in T_1 and to a change ΔT_2 in T_2 is given by

$$\Delta x_m = \frac{\partial x_m}{\partial T_1} \Delta T_1 + \frac{\partial x_m}{\partial T_2} \Delta T_2 \tag{2.3}$$

where

$$\frac{\partial x_m}{\partial T_1} = \frac{\partial x_m}{\partial \alpha} \frac{\partial \alpha}{\partial T_1} \tag{2.4}$$

$$\frac{\partial x_m}{\partial T_2} = \frac{\partial x_m}{\partial \alpha} \frac{\partial \alpha}{\partial T_2} \tag{2.5}$$

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and

$$\frac{\partial x_m}{\partial \alpha} = x_2 - x_1 \tag{2.6}$$

$$\frac{\partial \alpha}{\partial T_1} = \frac{T_m - T_2}{(T_2 - T_1)^2} \tag{2.7}$$

$$\frac{\partial \alpha}{\partial T_2} = -\frac{T_m - T_1}{(T_2 - T_1)^2} \tag{2.8}$$

Equation (2.3) may be re-written using terms in equations (2.4) through (2.8) to obtain

$$\frac{\Delta x_m}{x_2 - x_1} = \frac{T_m - T_2}{(T_2 - T_1)^2}\Delta T_1 - \frac{T_m - T_1}{(T_2 - T_1)^2}\Delta T_2 = -\left((1-\alpha)\frac{\Delta T_1}{T_2 - T_1} + \alpha\frac{\Delta T_2}{T_2 - T_1}\right) \tag{2.9}$$

Equation (2.9) relates the relative error of x_m to the relative errors of T_1 and T_2 in terms of the interpolation parameter α. The error Δx_m may then be bounded to obtain

$$|\Delta x_m| \leq |x_2 - x_1|\frac{\max(|\Delta T_1|, |\Delta T_2|)}{|T_2 - T_1|} \tag{2.10}$$

Uncertainty in isosurface location is then proportional to the magnitude of data uncertainty, $\max(|\Delta T_1|, |\Delta T_2|)$, and inversely proportional to the data variation, $|T_2 - T_1|$.
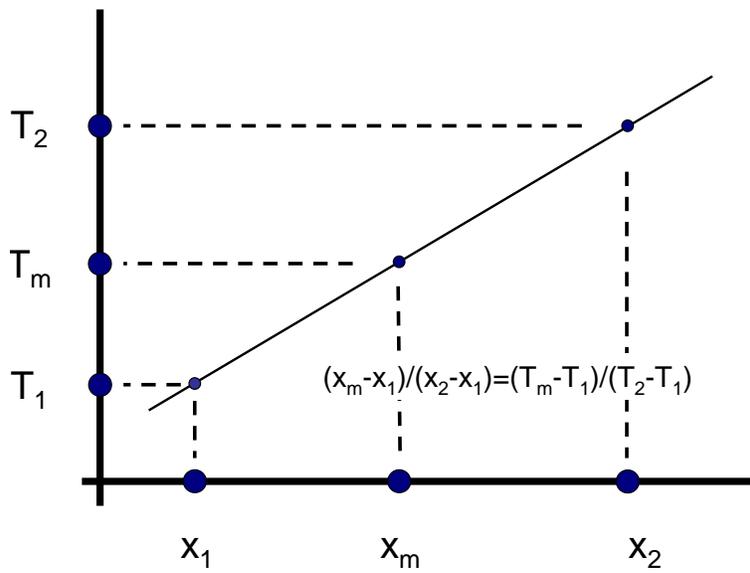
Figure 2.6: Diagram setting up an inverse linear interpolation calculation. The dependent data values T_1 and T_2 are known at locations x_1 and x_2. The inverse interpolation problem is to find the location x_m that has value T_m. This is found noting that $(x_m - x_1)/(x_2 - x_1) = (T_m - T_1)/(T_2 - T_1)$.

2.3 Particles

Figure 2.7 presents images verifying the display of particles and streaks. Images are drawn at 1 s, 10 s and 30 s. The first column shows particles while the second and third columns shows streaks with duration 0.5 s and 1 s. Streaks are a good way of visualizing motion in a still image (i.e., on paper) since the streak shows a history of where the particle has been.

Figure 2.8 presents an image verifying the display of particle colors. The case has four meshes. Particle temperatures in these meshes are initialized to 100 °C, 200 °C, 300 °C and 400 °C respectively. The particle colors in each meshes should match the color corresponding to the particle temperatures in the horizontal colorbar shown below the four meshes.

Time: 1.005

Time: 1.005

Time: 1.005

Time: 10.0

Time: 10.0

Time: 10.0

Time: 30.0

Time: 30.0

Time: 30.0

points

0.5 s streaks
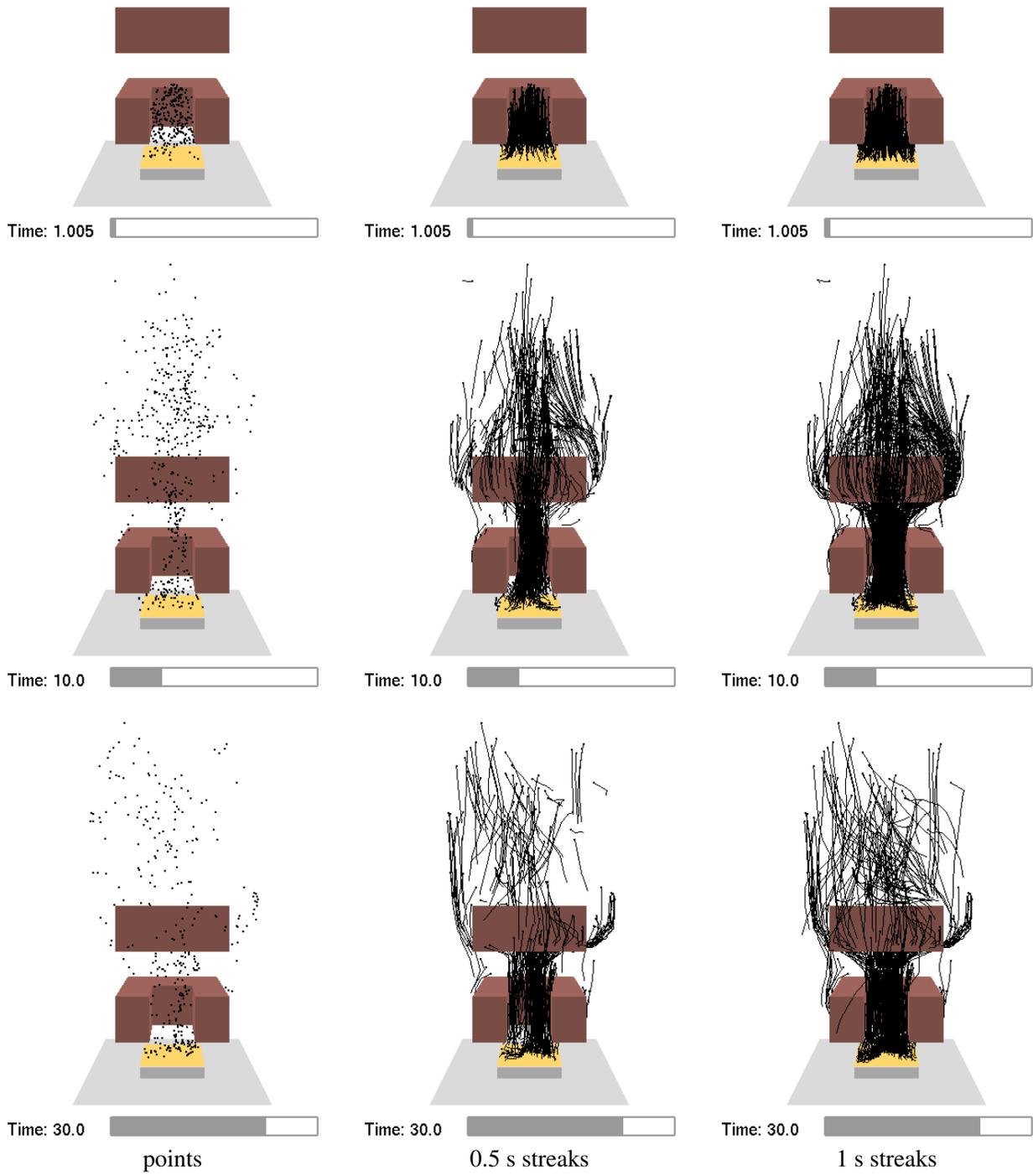
1 s streaks

Figure 2.7: A test showing particles and particle streaks at 1 s, 10 s and 30 s

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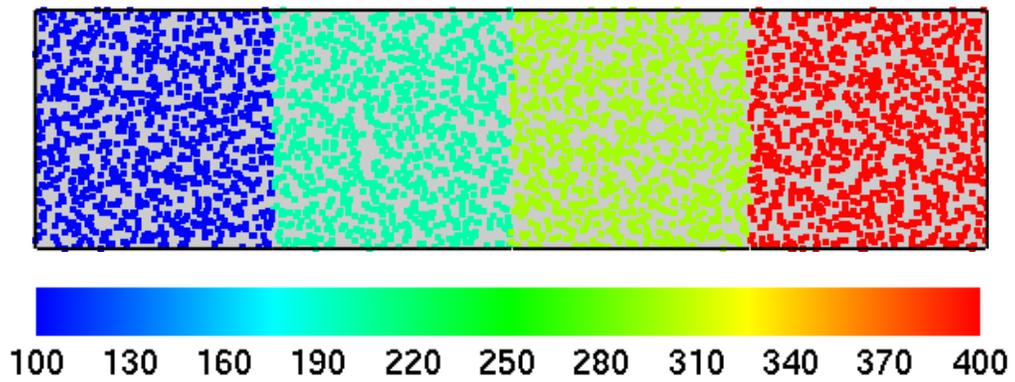
Figure 2.8: A test verifying particle color assignment. Particles in the four meshes (from left to right) have temperatures 100 °C, 200 °C, 300 °C and 400 °C respectively. Colors are assigned using the horizontal colorbar shown below the particles.

2.4 Slices

Figure 2.9 presents images verifying the display of node centered data slices. Images are drawn at 0 s, 10 s and 30 s. A portion of the interior gas temperature is initialized to 600 °C corresponding to the red rectangular block appearing in the first row. The first column visualizes all of the data in the slice. The second column discards or chops data below 140 °C. Note that the color near the chopped boundary should match the color in the color bar near 140 °C.

Figures 2.10 and 2.11 present images verifying the display of cell centered data. Images in Fig. 2.10 are drawn at 0 s, 10 s and 30 s. Images in Fig. 2.11 tests the transfer of data from FDS to Smokeview.

Figure 2.12 and 2.13 presents images verifying that node and cell centered slices are masked properly when drawn through or near blockages. Images are drawn at 10 s.

Figure 2.14 present images verifying the display of vector slices. Again, vector slice file images are drawn at 0 s, 10 s and 30 s. The first column draws all vectors while the second column discards or chops vectors below 140 °C.

Figure 2.15 presents slice file images verifying the computation of fractional effective dose (FED). FED is a measure of human incapacitation or hazard due to combustion gases[8]. Images are drawn at 30 s, 60 s and 120 s and 240 s. The FED is computed using three data slices with concentration of 1000 ppm for CO and volume fractions of 0.02 and 0.07 for CO_2 and O_2 respectively. These values result in FED values of 1.5 at 30 s, 3.0 at 60 s, 6.0 at 120 s and 12.0 at 240 s.

Figure 2.16 presents images of 3D slices oriented in two different ways. Images are drawn at 0 s, 10 s and 30 s. Figure 2.17 presents images of 3D vector slices oriented in two different ways. Images are drawn at 0 s, 10 s and 30 s.

Figure 2.18 presents images from data differenced by Smokediff. Smokediff computed the difference between two similar FDS cases and generated slice files. Difference contours from these slice files are displayed at 0 s, 10 s and 15 s.
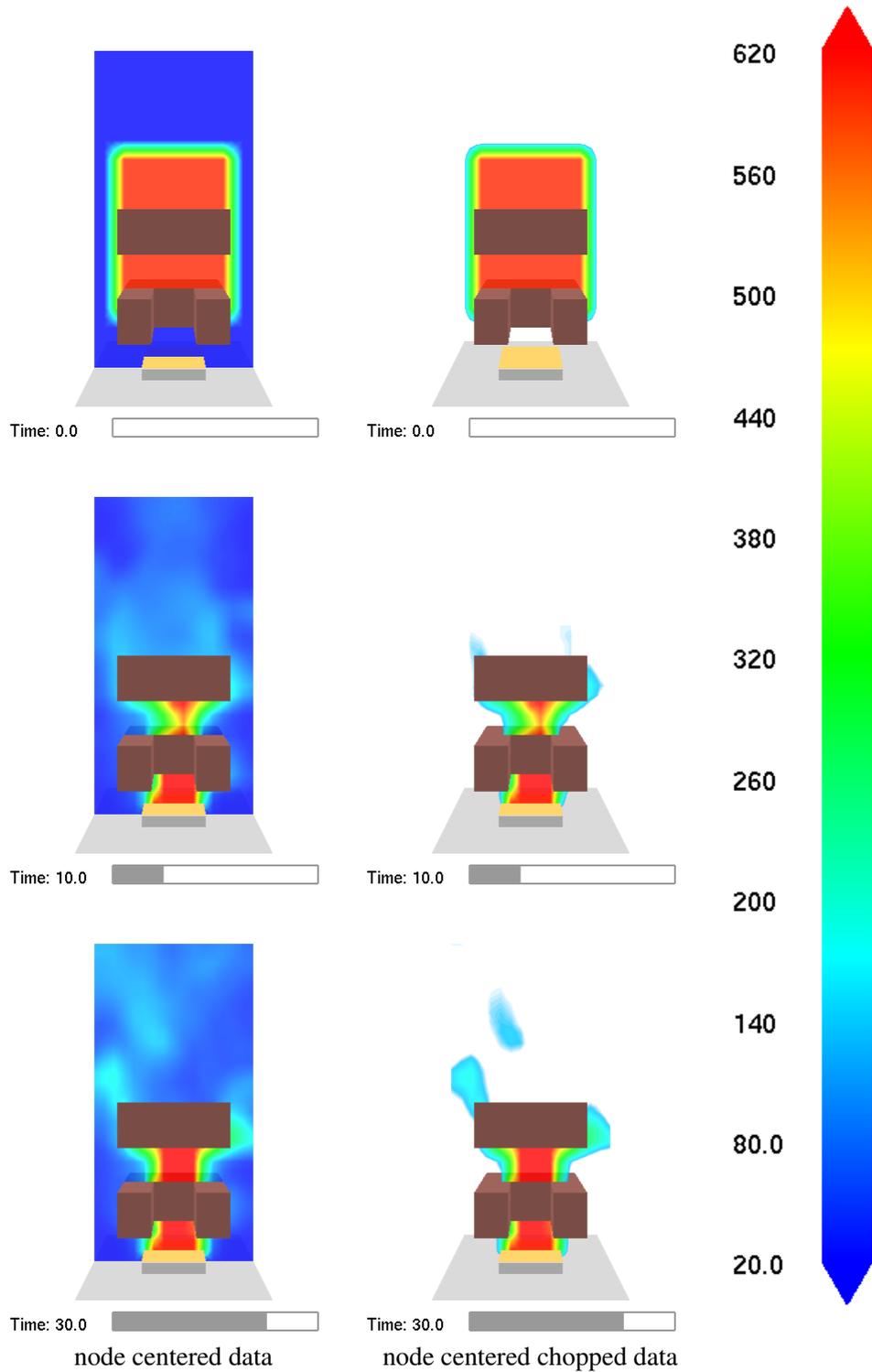
Figure 2.9: A test showing shaded and chopped contours of node centered slice file data at 0 s, 10 s and 30 s. A portion of the interior gas temperature is initialized to 600 °C. The slice file in this region should be red for the $t = 0$ s images. For the chopped contours, the color near the chop boundary should match the color near 140 °C in the colorbar.
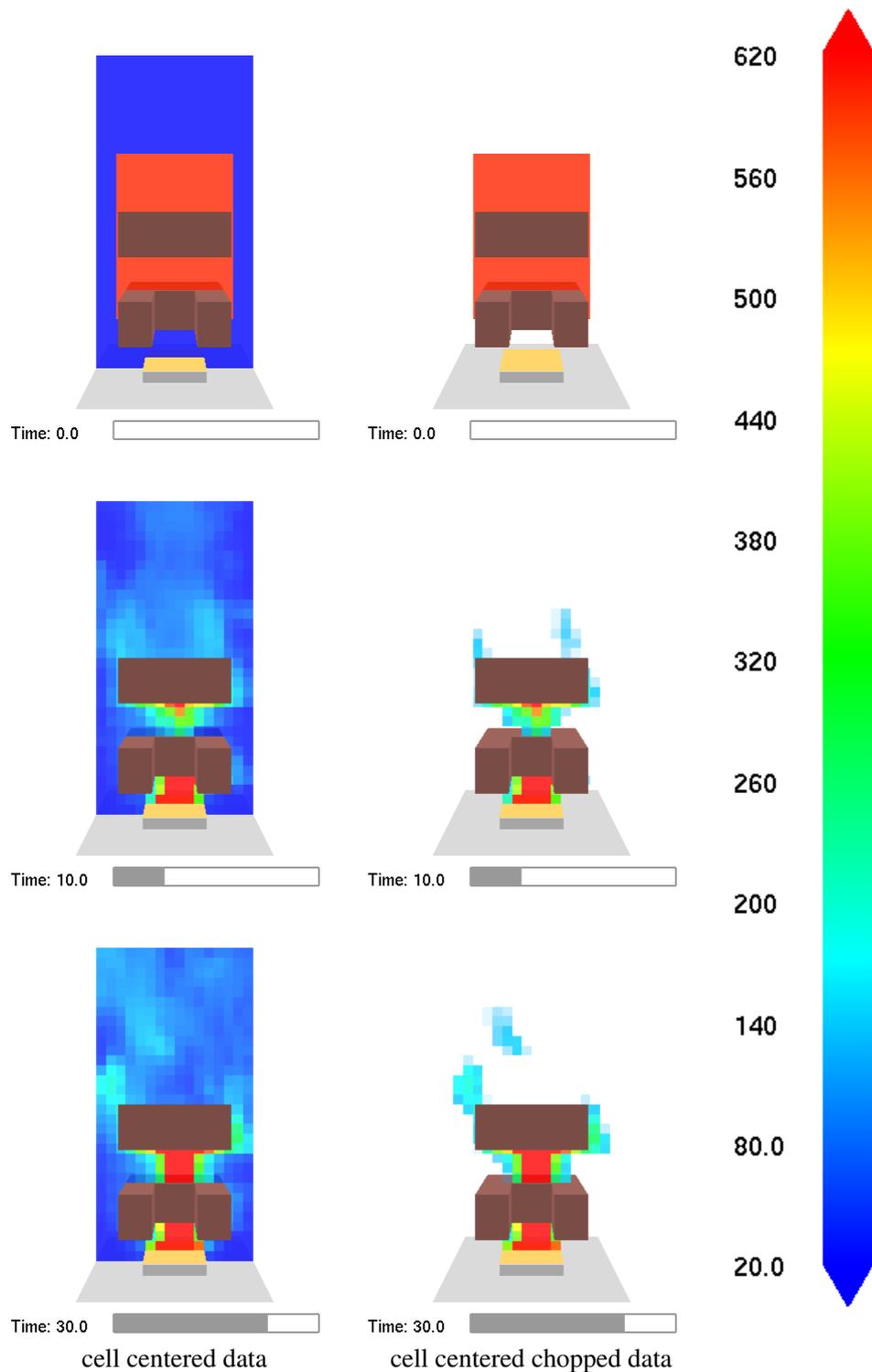
Figure 2.10: A test showing shaded and chopped contours of cell centered slice file data at 0 s, 10 s and 30 s. A portion of the interior gas temperature is initialized to 600 °C. The slice file in this region should be red for the $t = 0$ s images. For the chopped contours, the color near the chop boundary should match the color near 140 °C in the colorbar.

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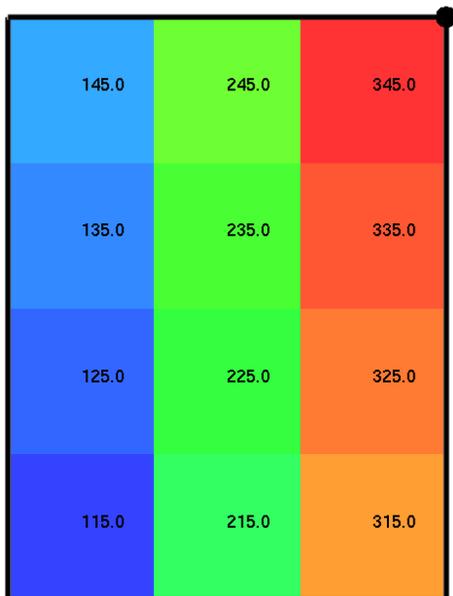
a) plan view (top slice)
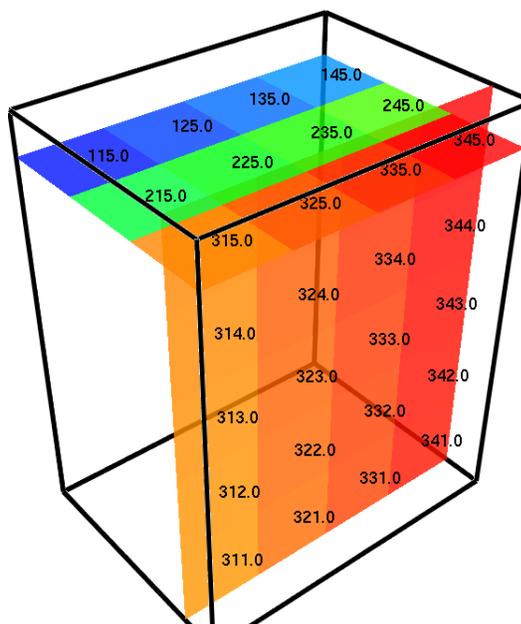
b) 3D view
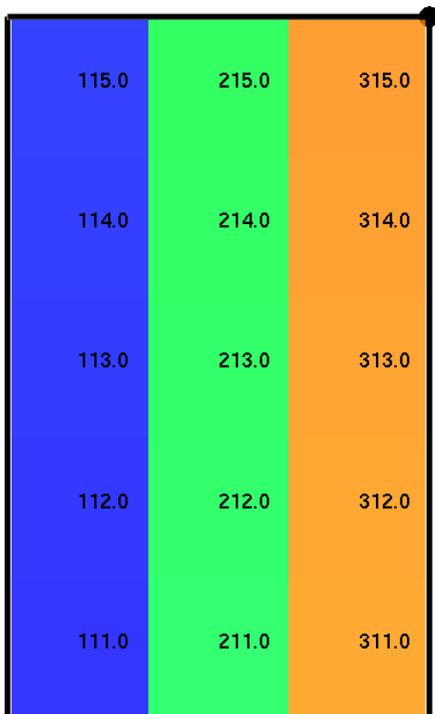
c) elevation view (front slice)
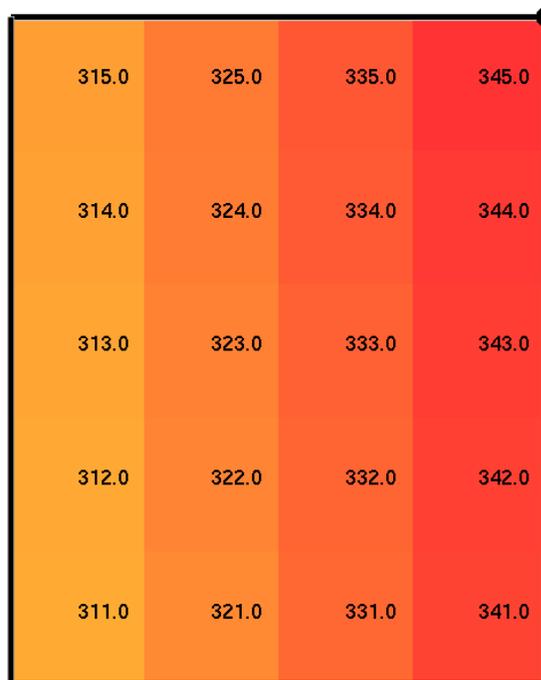
d) side view (right slice)

Figure 2.11: A test to demonstrate that cell centered slice file data is transferred to Smokeview properly. Cell values are initialized in FDS to $100*i + 10*j + k$ where $1 \leq i \leq 3$, $1 \leq j \leq 4$ and $1 \leq k \leq 5$. Cell values displayed should match the (i, j, k) grid cell indices. The three plots in the 3D view correspond to the plan, elevation and side view plots.

below

below on boundary

above on boundary

above
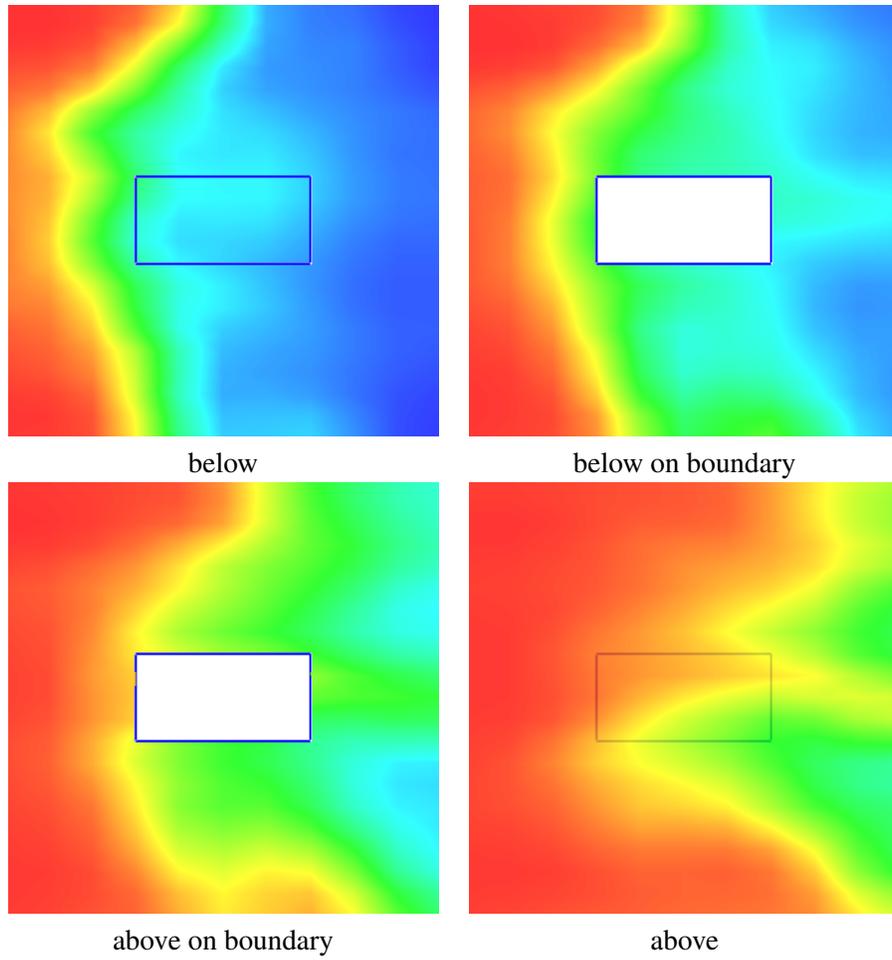
Figure 2.12: A test to demonstrate that node centered slice files are masked properly when drawn through or near blockages.

below

through

above
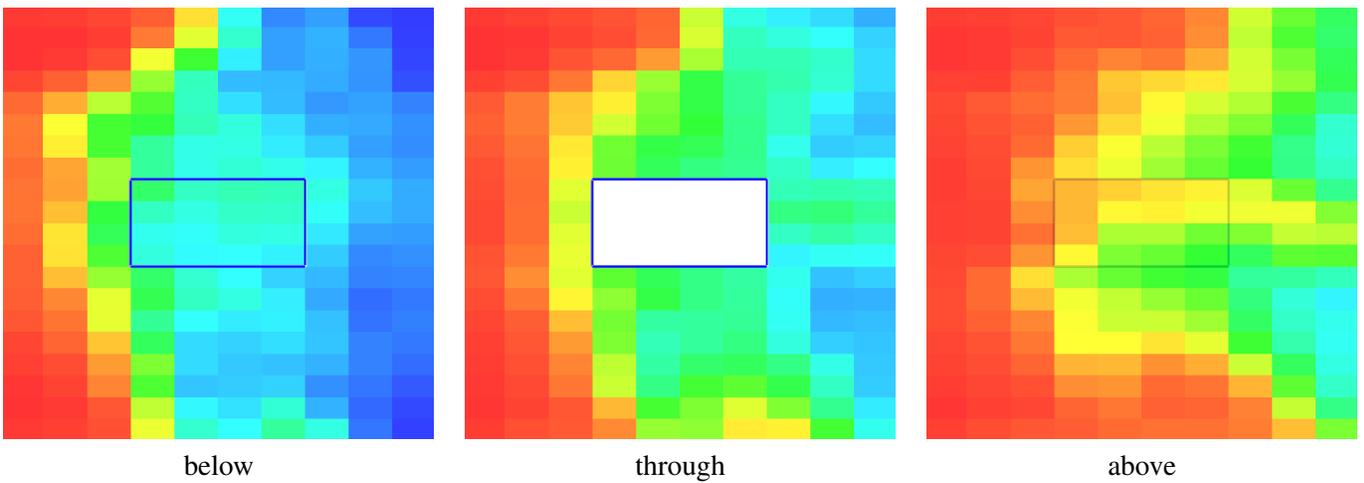
Figure 2.13: A test to demonstrate that cell centered slice files are masked properly when drawn through or near blockages.
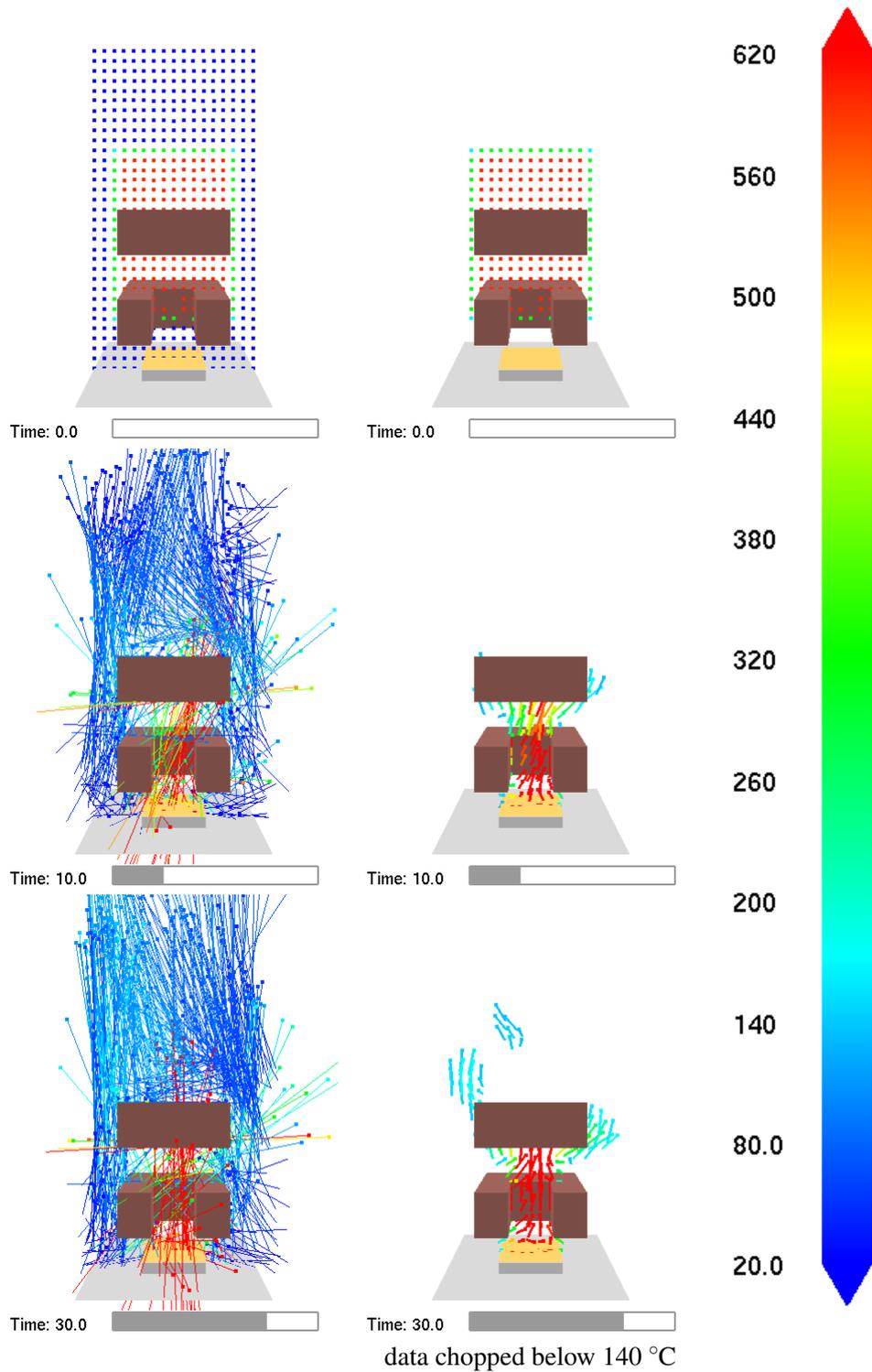
Figure 2.14: A test showing vector slice file data at 1 s, 10 s and 30 s. A portion of the interior gas temperature is initialized to 600 °C. The vectors in this region should be red for the $t = 0$ s images. For the chopped contours, the color near the chop boundary should match the color near 140 °C in the colorbar.
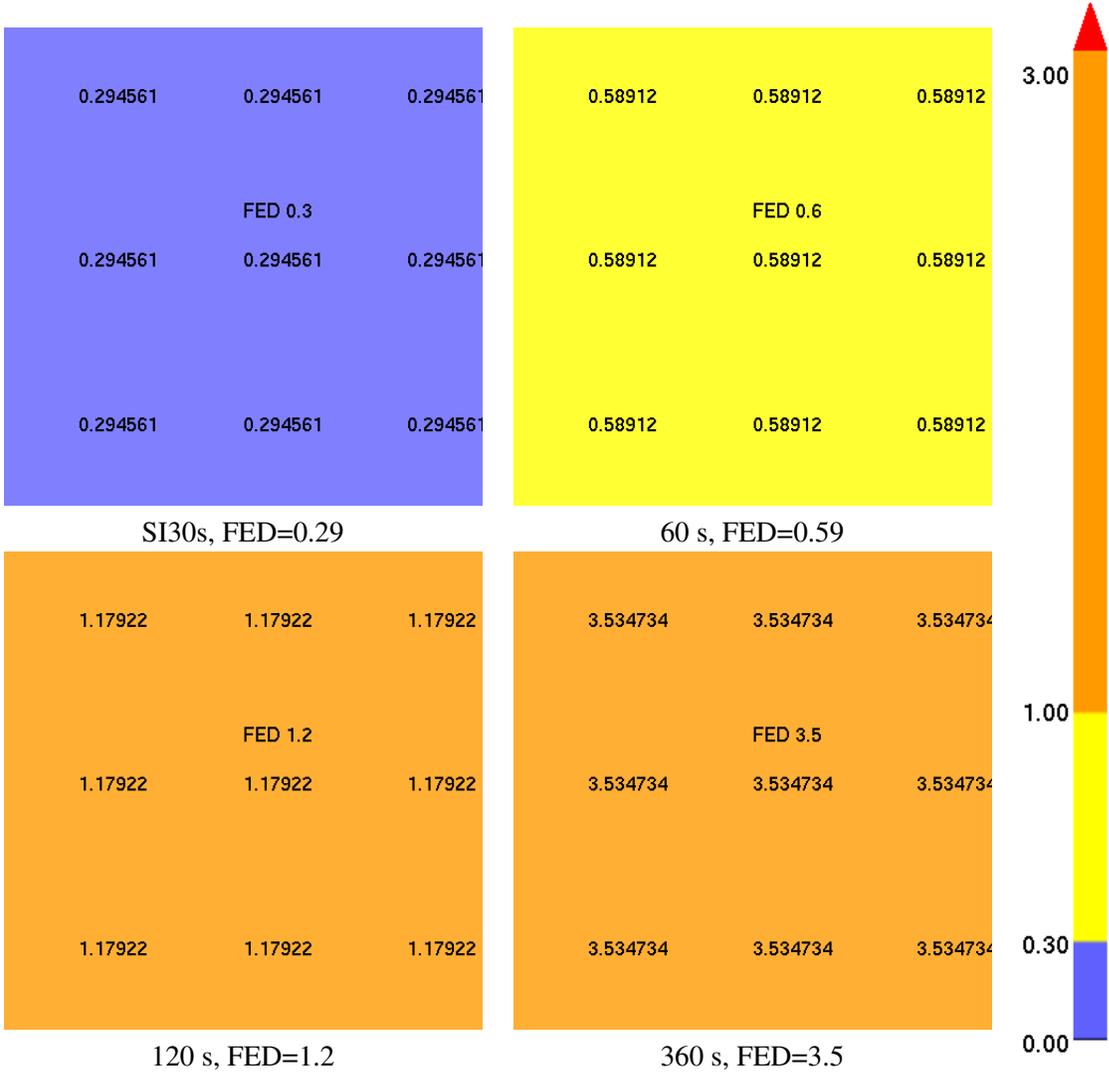
Figure 2.15: A test showing cell centered FED slice file data. These contours were generated using CO, CO_2 and O_2 data slices.
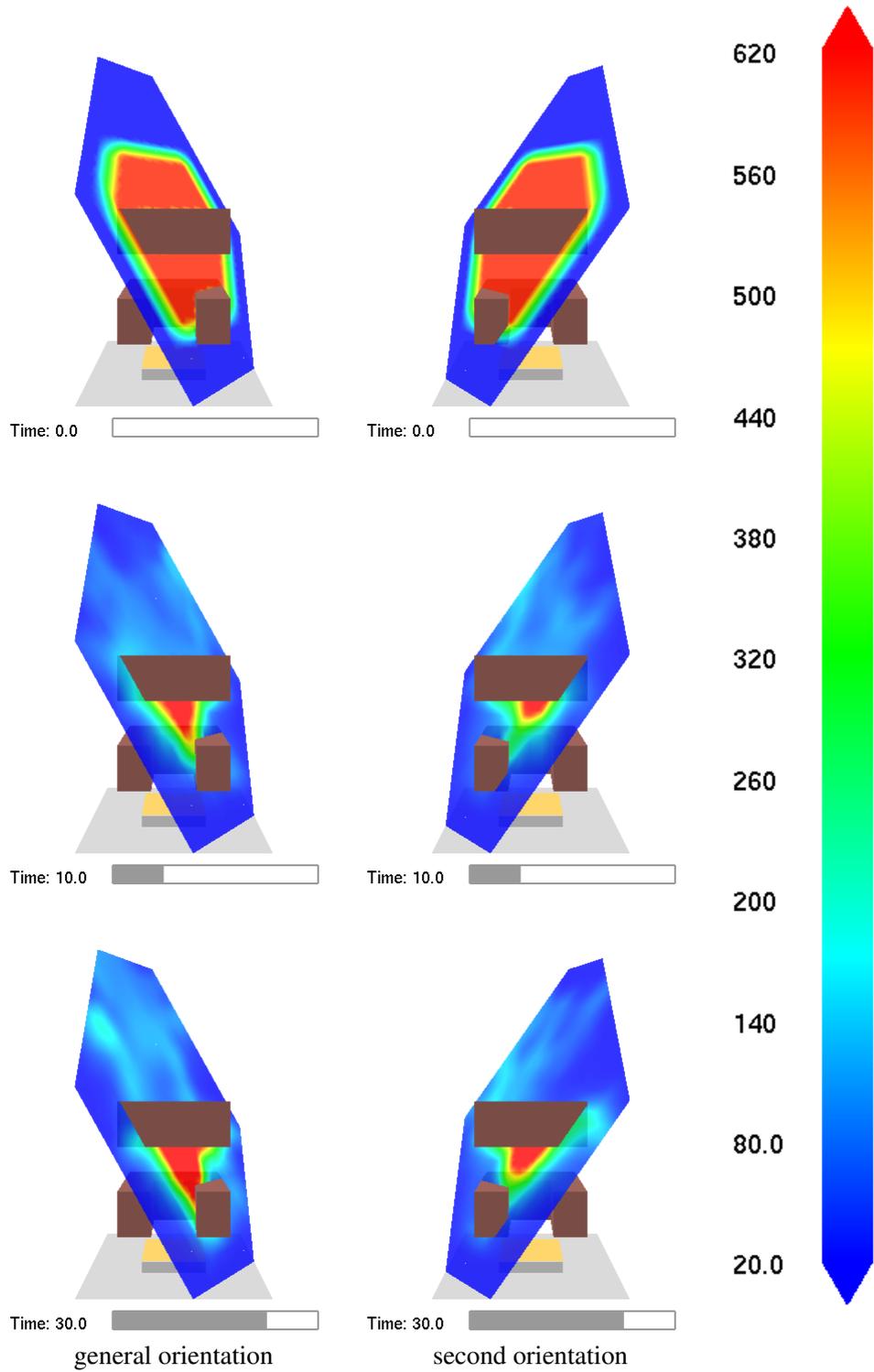
Figure 2.16: A test showing arbitrarily oriented slice file planes generated from 3D slice files at 0 s, 10 s and 30 s. Two orientations are shown at three time steps.
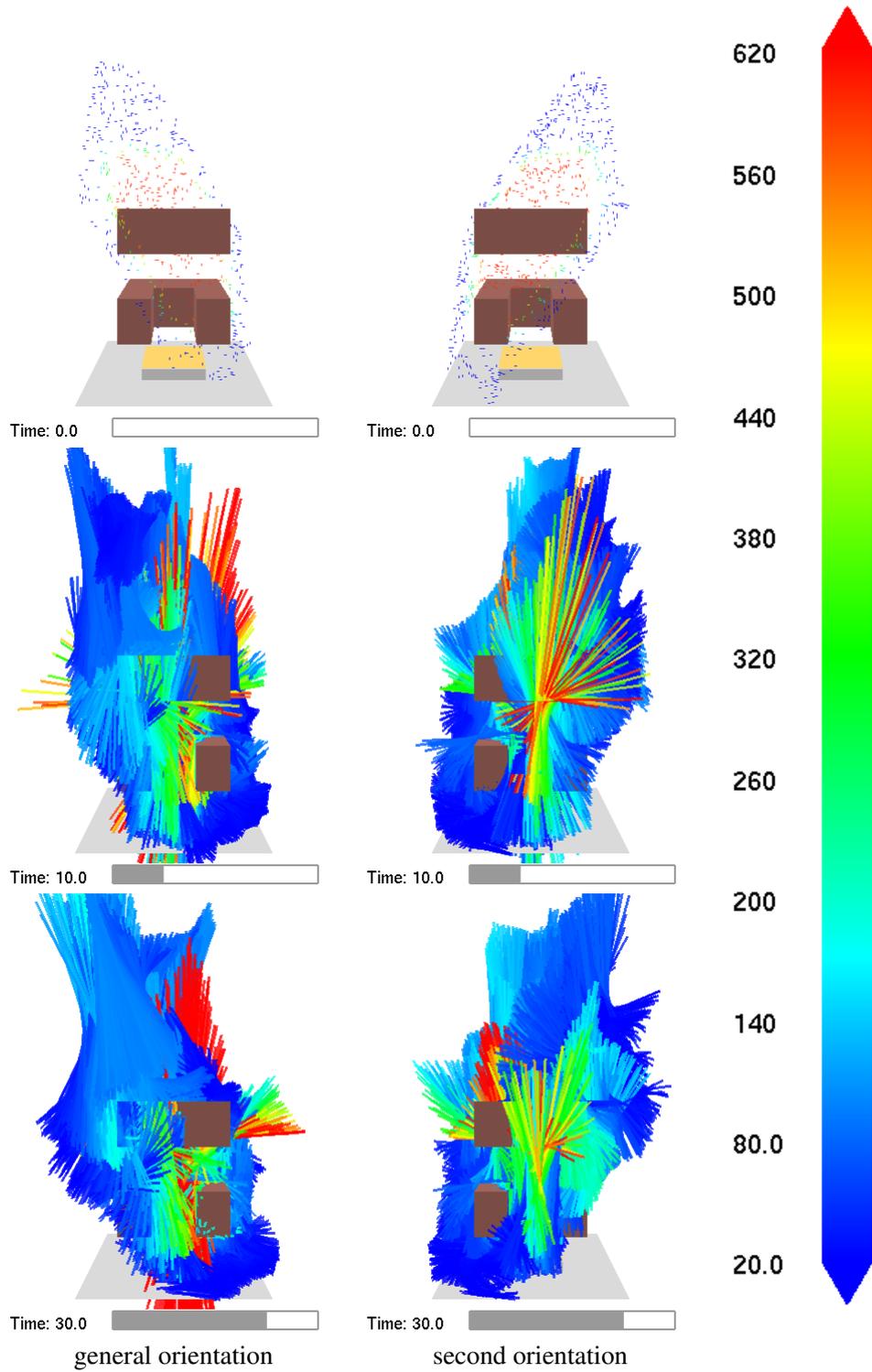
Figure 2.17: A test showing arbitrarily oriented vector slice file planes generated from 3D slice files at 0 s, 10 s and 30 s. Two orientations are shown at three time steps.
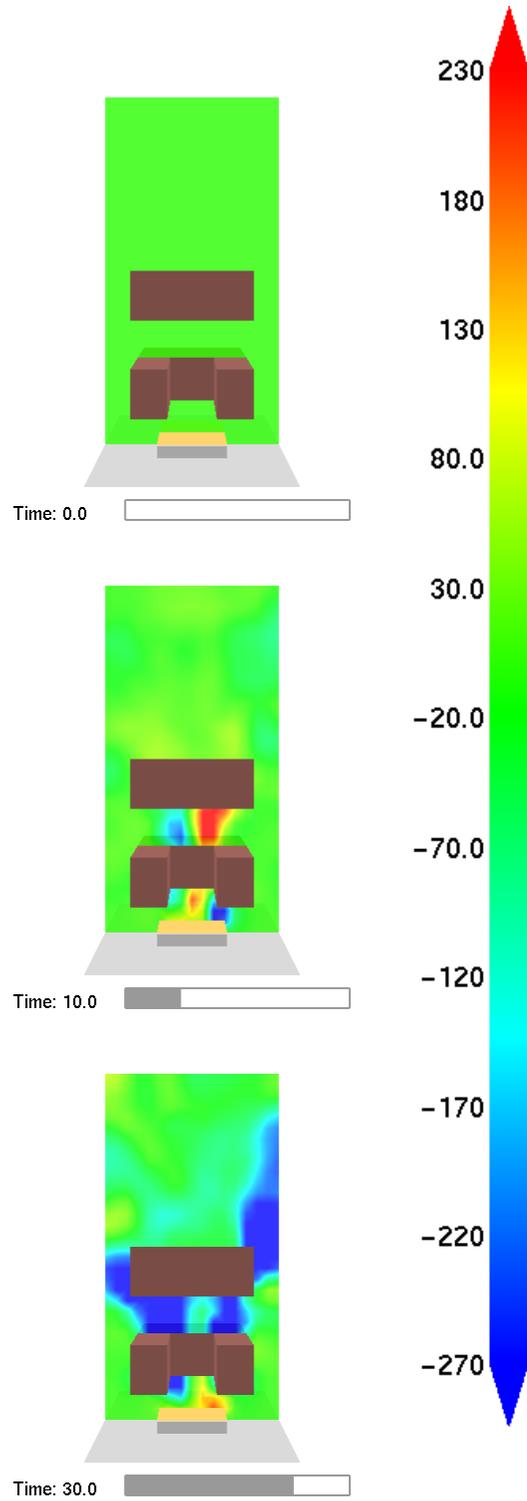
Figure 2.18: A test showing slice contours generated by differencing two cases with Smokediff at 0 s, 10 s and 30 s.

2.5 3D Smoke

Figure 2.19 presents images verifying the display of 3D smoke and fire (heat release rate per unit volume or HRRPUV). A series of 3D smoke images are drawn at 1 s, 10 s and 30 s. The images contain semi-transparent slices derived from both soot density and HRRPUV data.
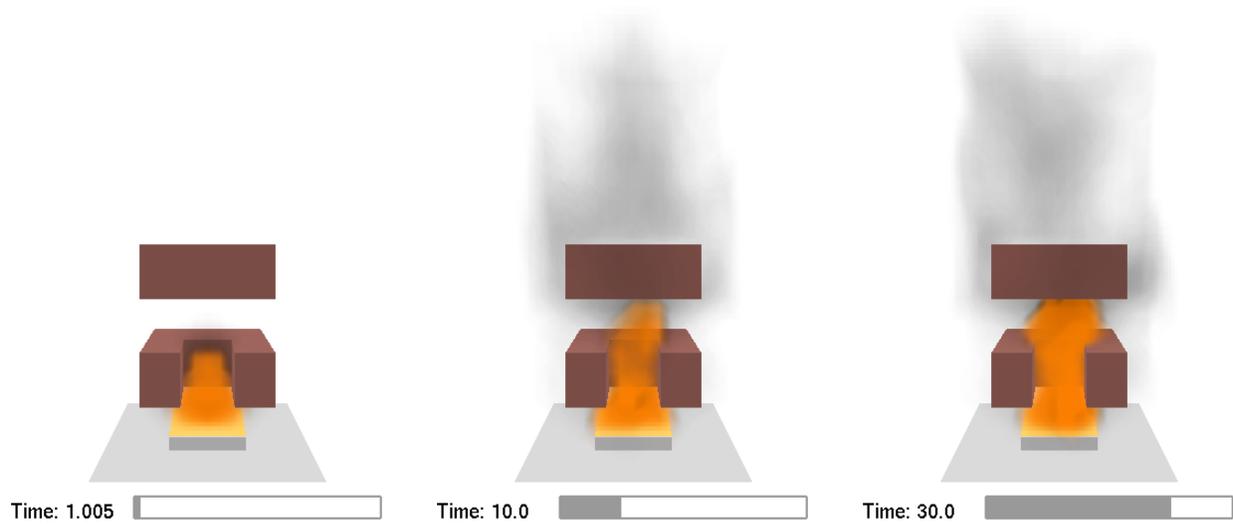
Figure 2.19: A test showing 3D smoke drawn at 1 s, 10 s and 30 s

2.6 Plot3D

Figure 2.20 presents images verifying the display of PLOT3D contours. Three types of contours are available for visualizing PLOT3D data: stepped, continuous and narrow band. This figure shows stepped and continuous contours. Figure 2.21 shows stepped contours in at four positions along the y axis. Figure 2.22 shows narrow band contours at four positions front to back. Figure 2.23 shows velocity vectors at the same four positions as in Figure 2.21. Figure 2.24 shows PLOT3D iso-surfaces for 50 °C, 230 °C, 410 °C and 590 °C.

step contours   continuous contours
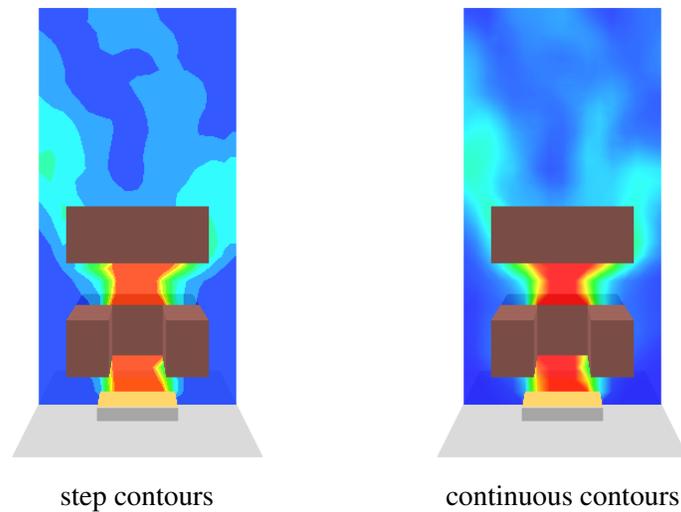
Figure 2.20: A test showing PLOT3D stepped and continuous temperature contours.
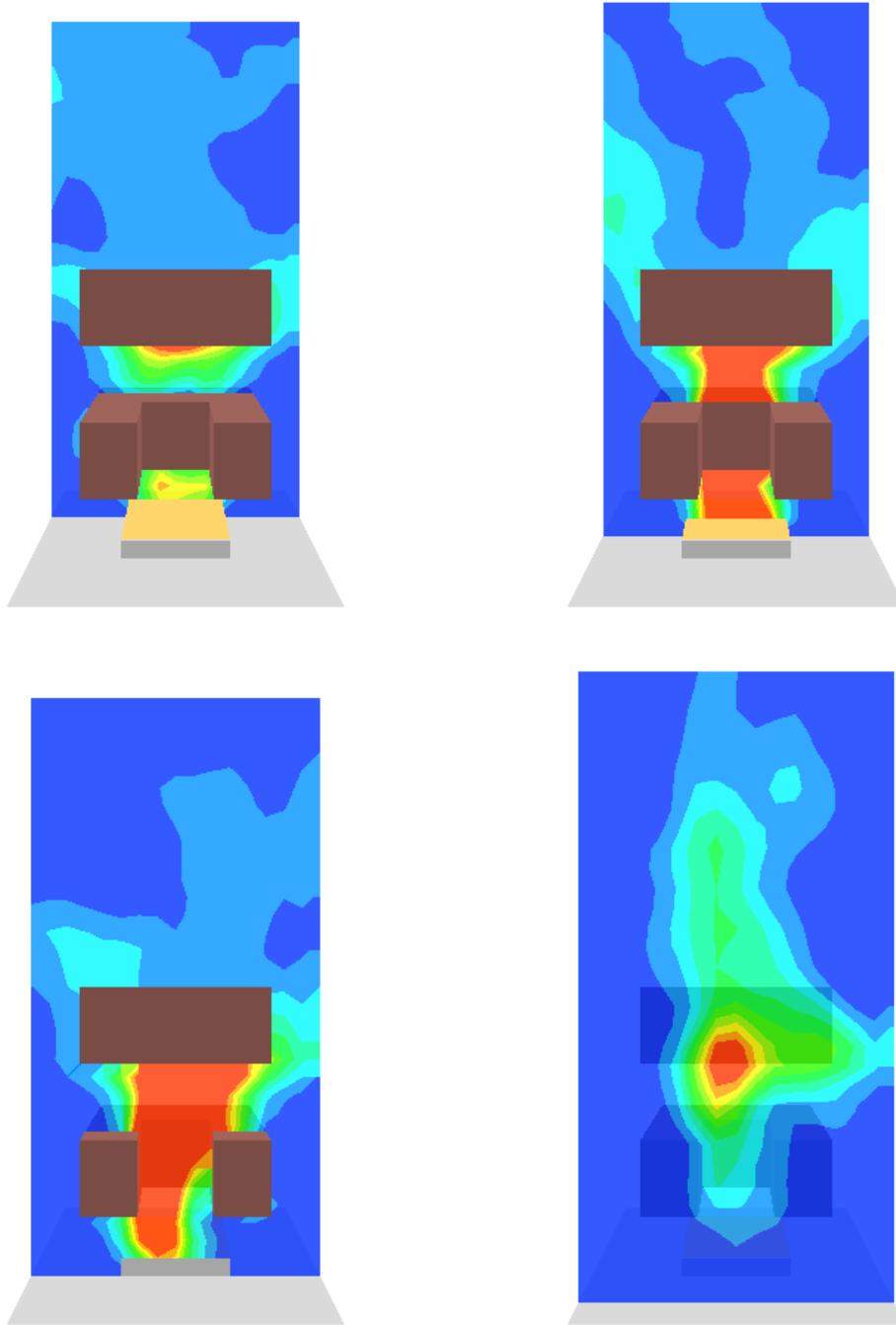
Figure 2.21: A test showing PLOT3D stepped contours at four positions along the y axis.
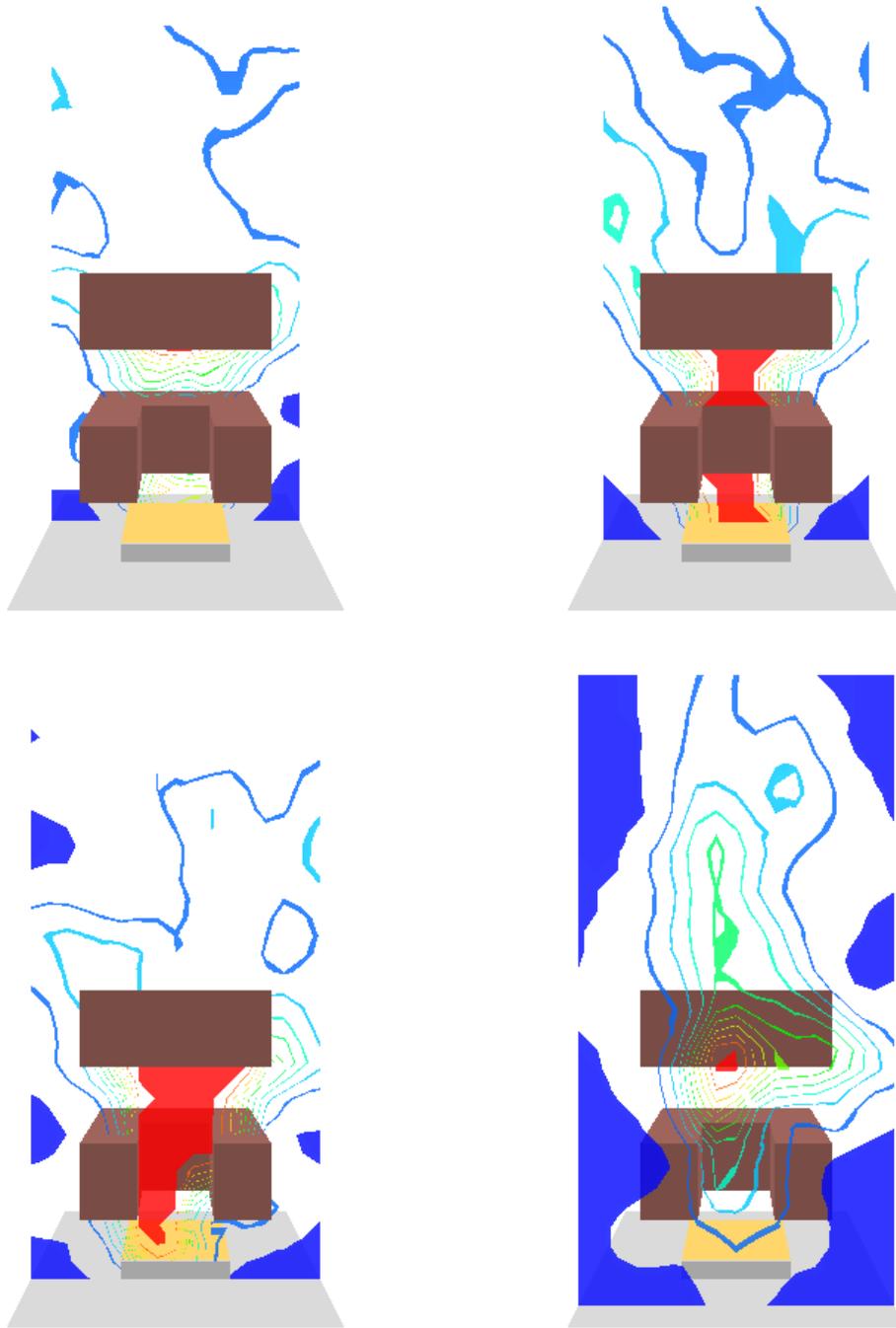
Figure 2.22: A test showing PLOT3D narrow band contours at four positions along the y axis.
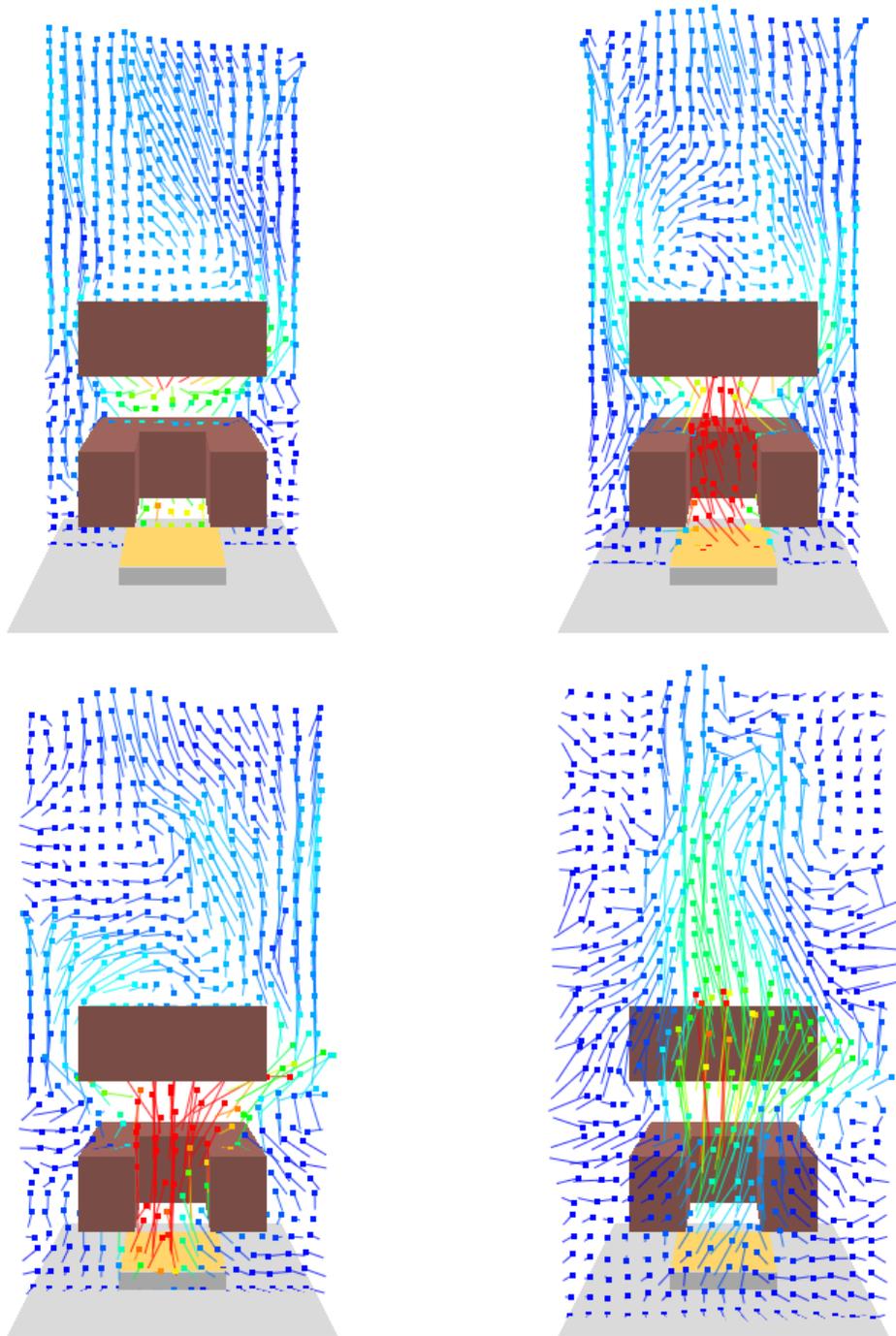
Figure 2.23: A test showing PLOT3D vectors shaded by temperature at four positions along the y axis.
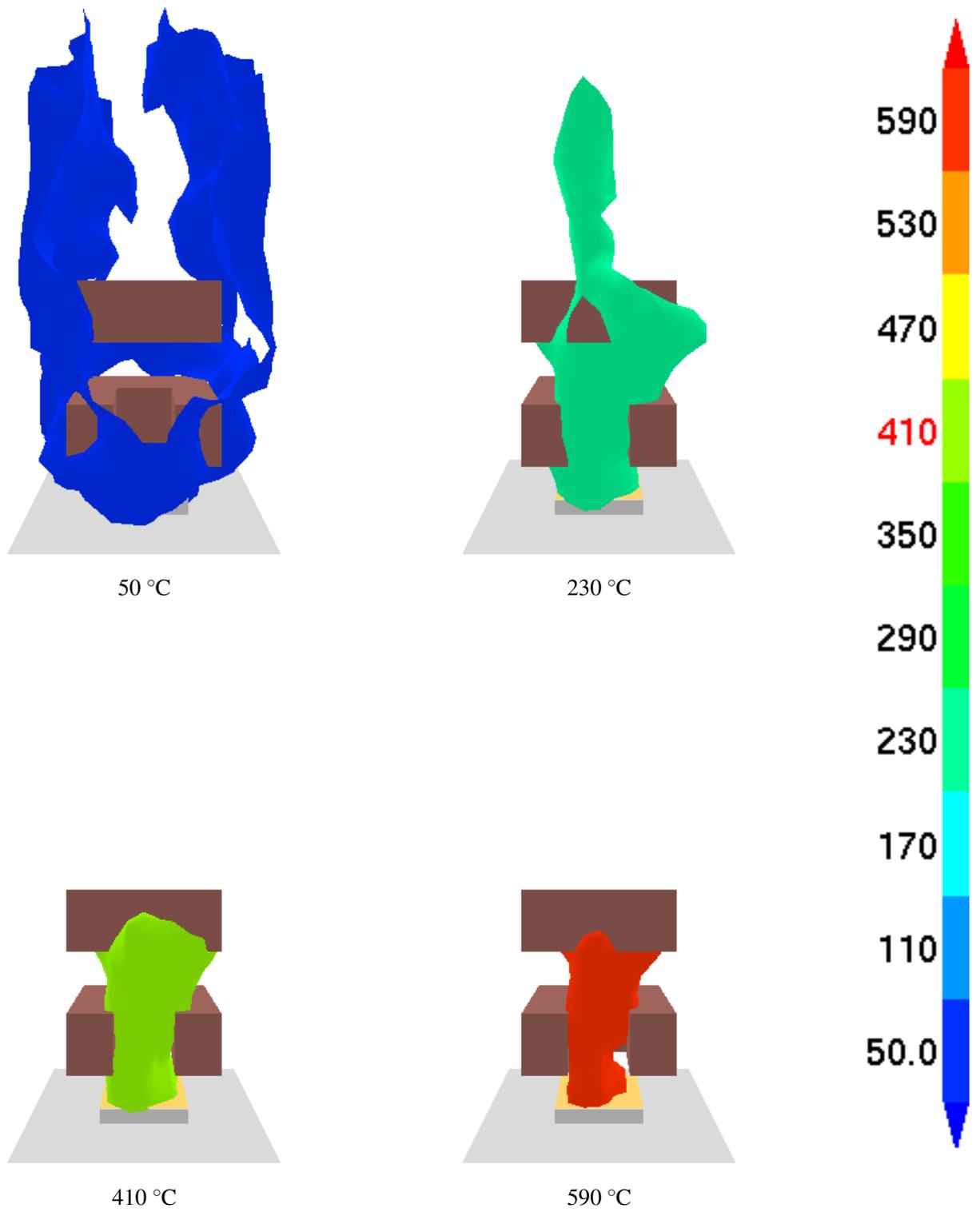
Figure 2.24: A test showing PLOT3D iso-surfaces for 50 °C, 230 °C, 410 °C and 590 °C.

Chapter 3

Smoke Visualization Tests

Correct smoke visualization requires that smoke flow be both computed and drawn correctly. The FDS Verification Guide [7] addresses computation in terms of soot/smoke production, transport, etc. A verification of how smoke is drawn is addressed in this chapter. More precisely, given a known density and distribution of soot, does the smoke drawn by Smokeview match how *theory* predicts it should appear. Presently, the main interest is in how smoke obscures objects in the background. Visualization effects due to light scattering are not modeled.

The smoke drawing verification problem is split into two steps. The first step, documented in Section 3.1, is to verify that Smokeview can record the correct grey level of smoke as it is drawn on the screen. This step is necessary because screen colors, in this case the smoke obscuration levels to be verified, are not directly accessible to Smokeview. They must be retrieved from the video card buffers. The second step, documented in Section 3.2, is to verify that Smokeview can draw the correct shade of grey given a known soot density level within the scene.

3.1   Recording Smoke Levels

Smokeview does not have direct access to colors drawn on the screen. Smokeview passes vertex colors to the video driver. The video driver then interpolates colors within these vertices. Smokeview must then 'read' them back in after they are drawn. A further complication is that smoke is drawn in Smokeview using a physical coordinate system. The smoke opacity levels are retrieved using the screen coordinate system, ie. at particular pixel locations. It is this transformation process, from physical to screen coordinates, that is verified in this step.

In the case of 3D smoke visualization, these colors represent smoke opacity levels. To obtain these levels and thereby verifying that they are correct, Smokeview makes use of a special sensor or device named *smokesensor* which Smokeview uses to obtain color values at the sensor location. This device behaves like other FDS devices but has the additional property that when used by Smokeview, it displays the grey level as viewed by the observer. This grey level is displayed as a number between 0 and 255.

The user places a device of type `smoke_sensor` at a particular (x, y, z) location using statements such as

```
&PROP ID='smoketest' SMOKEVIEW_ID='smokesensor' /
&DEVC XYZ=1.8,0.55,2.00, QUANTITY='VISIBILITY', ID='vis1' PROP_ID='smoketest' /
```

Smokeview displays the sensor as a white disk with color (255,255,255) at location $(1.8, 0.55, 2.00)$ always oriented towards the observer. When drawing smoke that resides between the sensor and the observer (your eye), the smoke sensor is partially obscured by the smoke. Smokeview then alters the smoke

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sensor color according to how much and how thick the intervening smoke is. It does this by blending each smoke plane, one plane at a time, using the color and opacity levels of that plane. The grey level is simply Smokeview's computation of the integrated *smoke thickness* along a path between the sensor location and the eye. The colors displayed are the result of computations performed by the video card using OpenGL, the graphics library used by Smokeview to visualize FDS scenarios.

Figure 3.1 illustrates an initial test of this process. It verifies that Smokeview can transform the sensor location from physical or FDS coordinates to screen coordinates (pixel locations) and further can correctly record the grey level at those screen coordinates even when surrounded by other objects with different colors. In this case, the smoke sensor is white and there is no intervening smoke. The background is a neutral grey with grey level of 128. The value displayed over the sensor then should always be 255 not 128 no matter how the scene is oriented. If Smokeview made an error determining the sensor screen coordinates the grey level displayed would be 128 (grey level of the adjacent grey background) not 255 (grey level of the sensor).

Figure 3.1: A test verifying that Smokeview can correctly transform the physical (x,y,z) location of the smoke_sensor object to its equivalent screen coordinates where the underlying smoke obscuration level is retrieved. A small white (255,255,255) smoke_sensor appears in front of a grey (128,128,128) obstacle. The value displayed should be 255, the value recorded by Smokeview. If the physical to screen transformation is performed incorrectly a value of 128 will be displayed (since it will pick up a color elsewhere).

3.2   Verifying Smoke Transparency

Smoke transparency is verified by setting up a scenario with uniform smoke density and comparing observed transparency levels with transparency levels calculated using a scaled form of Bouguer's Law,

$$\tau = 255 \ \exp(-K_m S \Delta x), \tag{3.1}$$

where τ is the transparency[1] scaled from 0 (completely opaque) to 255 (completely transparent), $K_m = 8700 \ \mathrm{m}^2/\mathrm{kg}$ [9] is the mass extinction coefficient, S is the soot density and Δx is the path length through which transparency is observed. This equation is then used to place blockages so that known transparency levels result.

---

[1]Smokeview, as all do OpenGL programs, draw objects in terms of opaqueness the inverse of transparency, $\alpha = 255 - \tau$.

The soot density required to obtain a transparency of $\tau = 128$ for a path length of $\Delta x = 1.0$ m is found by solving Eq. (3.1) for S to obtain

$$S = -\frac{\ln(\tau/255)}{K_m \Delta x} = 7.922 \times 10^{-5} \, \text{kg/m}^3 \tag{3.2}$$

This soot density is converted to a soot mass fraction for use in the FDS input file by dividing by the air density $\rho_{\text{air}} \approx 1.196$ kg/m^3 to obtain

$$Y_{\text{soot}} = S/\rho_{\text{air}} = 6.624 \times 10^{-5} \, \text{kg/kg} . \tag{3.3}$$

For this value of soot density, Eq. (3.2) can used to simplify Eq. (3.1) after noting that $128/255 = \exp(-K_m S)$ to obtain

$$\tau = 255 \left(\frac{128}{255}\right)^{\Delta x} \tag{3.4}$$

which is then used to find transparencies for path lengths of $\Delta x = 5$ m, 4 m, 3 m, 2 m, 1 m, 0.5 m which are approximately $\tau = 8, 16, 32, 64, 128$ and 181 . These transparency levels can then be compared to observed levels when viewing the case.
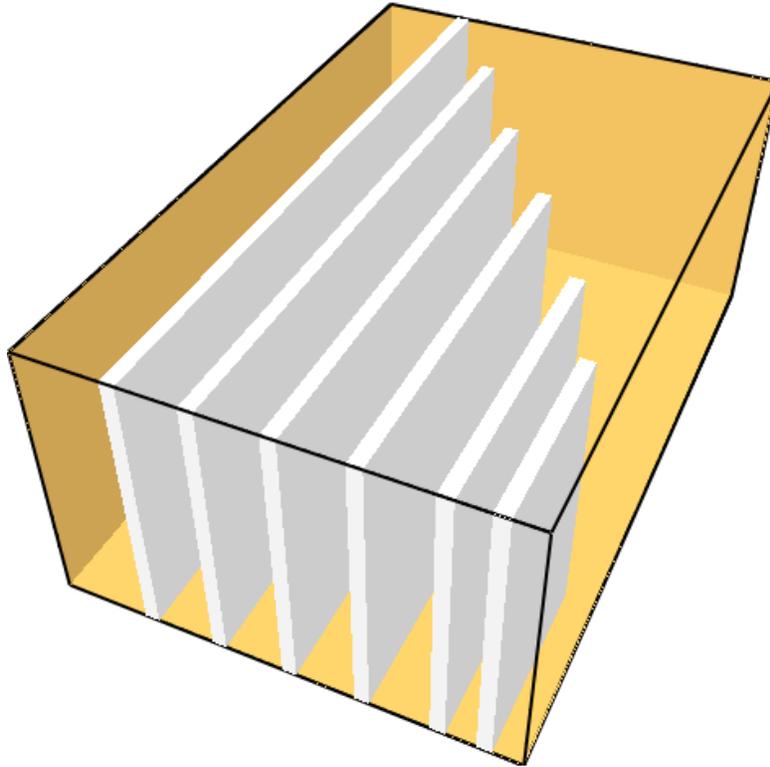
Figure 3.2: Side view of the numerical smoke test compartment. Blockages are placed at 0.5 m, 1 m, 2 m, 3 m, 4 m , 5 m from the front of the domain to make the scaled transparency levels have values 181, 128, 64, 32, 16 and 8 respectively.

Figure 3.3 shows quantitative tests of the smoke transparency calculation performed in Smokeview for three grid resolutions. This figure also gives the expected transparency levels based upon the specified soot

densities, mass extinction coefficient and path lengths. The smoke visualization algorithm is verified then if the expected shades of grey match the corresponding predicted shades of grey. Each shaded rectangle is accompanied by a numerical value that can also be used to judge whether the visualization is verified.

The numbers displayed in the upper row of the 0.125 m, 0.25 m and 0.50 m resolution images in Fig. 3.3 represent the computed smoke transparency levels (ranging from 0 to 255). These numbers may be verified by using a program that reports pixel values of this rectangular region. The numbers are verified when they match the reported pixel values. The numbers displayed in the lower row of both resolution images represent the expected transparency levels.

actual:	181	127	63	33	17	9
expected:	181	128	64	32	16	8

0.125 m grid

actual:	182	131	68	36	18	9
expected:	181	128	64	32	16	8

0.25 m grid

actual:	181	127	65	33	15	7
expected:	181	128	64	32	16	8

0.5 m grid

Figure 3.3: A test verifying smoke transparency for three grid resolutions. This test fills the space with a uniform distribution of soot so that blockages placed 0.5, 1.0, 2.0, 3.0, 4.0 and 5.0 m from the front of the domain result in in grey levels of 181, 128, 64, 32, 16 and 8 respectively.

Chapter 4

WUI Test Cases

This chapter presents techniques added to Smokeview [2] applicable for visualizing WUI (wildland urban interface) and wild fire scenarios. Two techniques involve 1) visualizing changing terrain using satellite images with modeling results overlayed and 2) making use of geometric objects for representing modeling elements such as trees or building structures. These two techniques use data generated by fire models such as FDS [10]. A third technique involves visualizing experimentally derived data rather than modeling data. Wind sensor data is visualized using flow vectors along with visual indicators of data uncertainty. Smokeview images are displayed in the following figures to illustrate these techniques.

Figure 4.1 presents contours of a level set computation. The level set contours are drawn on a sloped terrain. These level set contours represent a fire line. A fire line is used with wildland fire simulations as an efficient method for visualizing the motion of a fire across the simulation. A fire line in the context of Smokeview is just a special case of a temperature slice contour. The thin red line represents the location where burning is currently taking place. The grey region represents where burning has occurred and the green region represents where burning has not occurred. Level sets are used to quickly (relative to a complete computational fluid dynamic calculation) model fire spread and fire line locations. In this particular case, images are drawn at 30 s, 60 s, 90 s and 120 s. The test verifies that the level set slices follow the sloped terrain.

Figure 4.3 presents images of temperature contours drawn on a terrain geometry. The scenario consists of a small hill parallel to the vertical axis of the scene. Images are drawn at 15 s, 30 s, 45 s and 60 s. The test verifies that temperature contours follow the sloped terrain and that the red blockage (a non-terrain blockage representing a structure) is drawn correctly along with the terrain.

Smokeview typically visualizes data generated by software such as FDS [10] or CFAST [11]. Figure 4.4 presents a visualization of data obtained from wind measuring sensors rather than simulation data. Smokeview can use the wind sensor data to visualize velocity profiles and variability and uncertainty present in the experimental data. The vertical array of green spheres represent the measurement locations. The distance from these spheres to the green or red spherical shells gives a relative measure of the wind speed. The shell diameter gives a measure of the wind direction measurement uncertainty. Likewise the shell thickness give a measure of the wind velocity measurement uncertainty.

Figure 4.5 shows an example of trees drawn as Smokeview objects. The tree is drawn as a cylinder colored brown and a cone colored green. Tree objects may change appearance as a simulation progresses as illustrated in Fig. 4.6. Tree states are a normal view, partially burned, partially burned (canopy burned
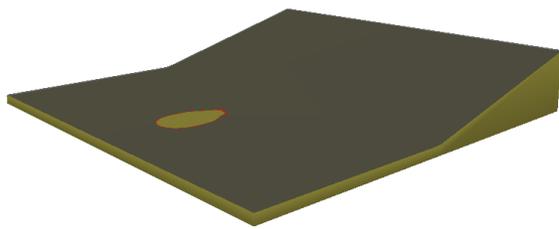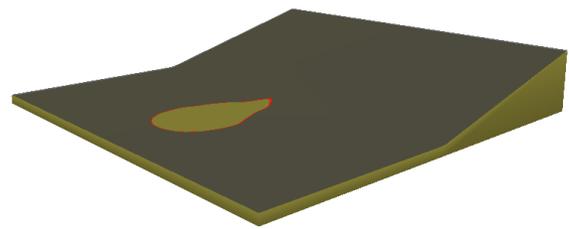
30 s   60 s
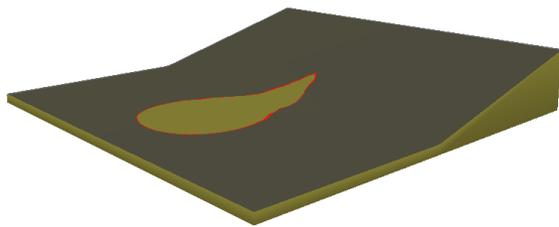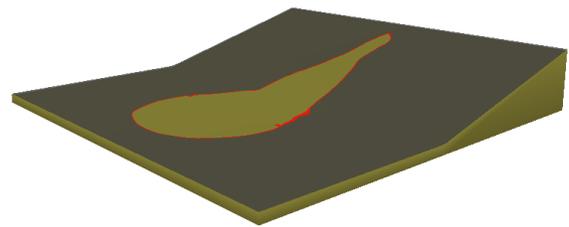
90 s   120 s

Figure 4.1: A test showing level set slices drawn along a sloped terrain at 30 s, 60 s, 90 s and 120 s. The test verifies that level set slices follow the sloped terrain. The thin red line represents where burning is currently taking place. The grey and green regions represent where burning has and has not occurred respectively.

30 s
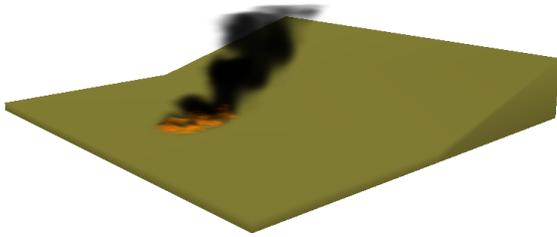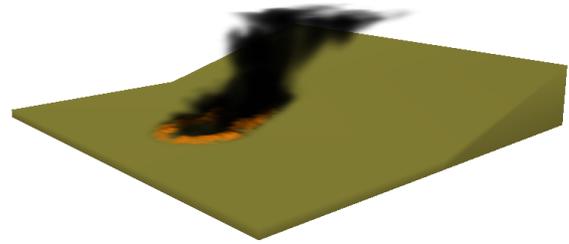
60 s
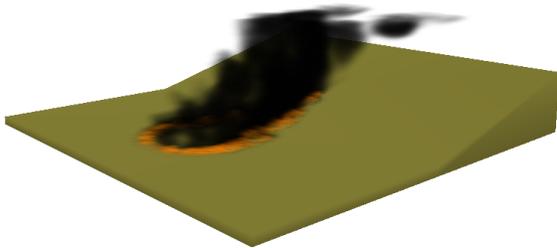
90 s
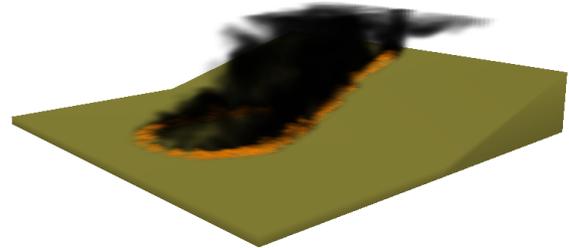
120 s

Figure 4.2: A test showing 3D smoke flowing along a sloped terrain at 30 s, 60 s, 90 s and 150 s.
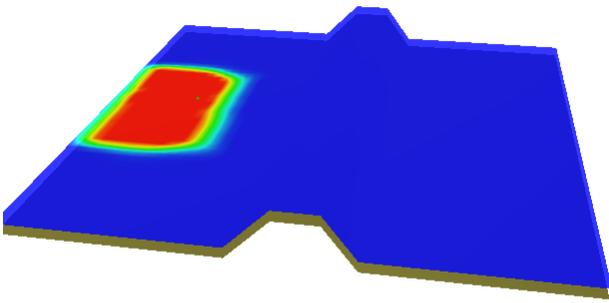
15 s
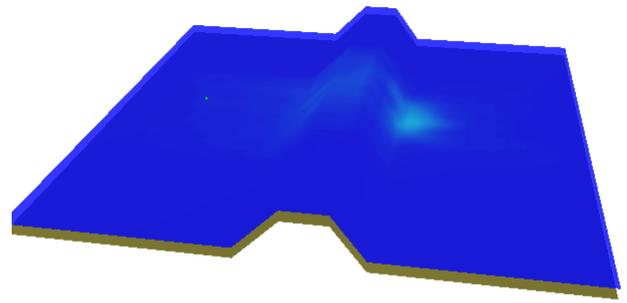
30 s
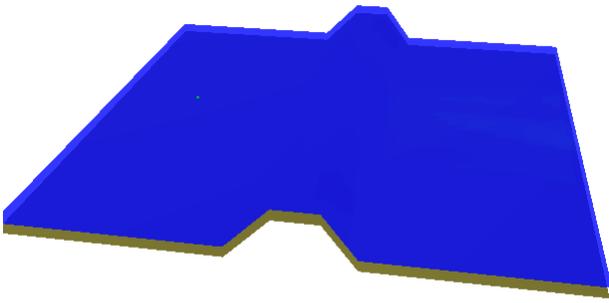
45 s
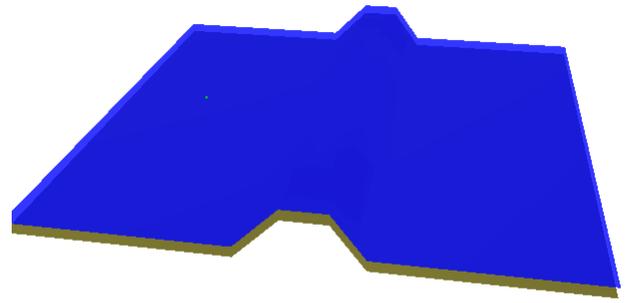
60 s

Figure 4.3: A test showing temperature slices drawn along a sloped terrain at 15 s, 30 s, 45 s and 60 s. The test verifies that the temperature slices follow the sloped terrain and that the non-terrain red blockage (representing a structure) is drawn with the terrain.
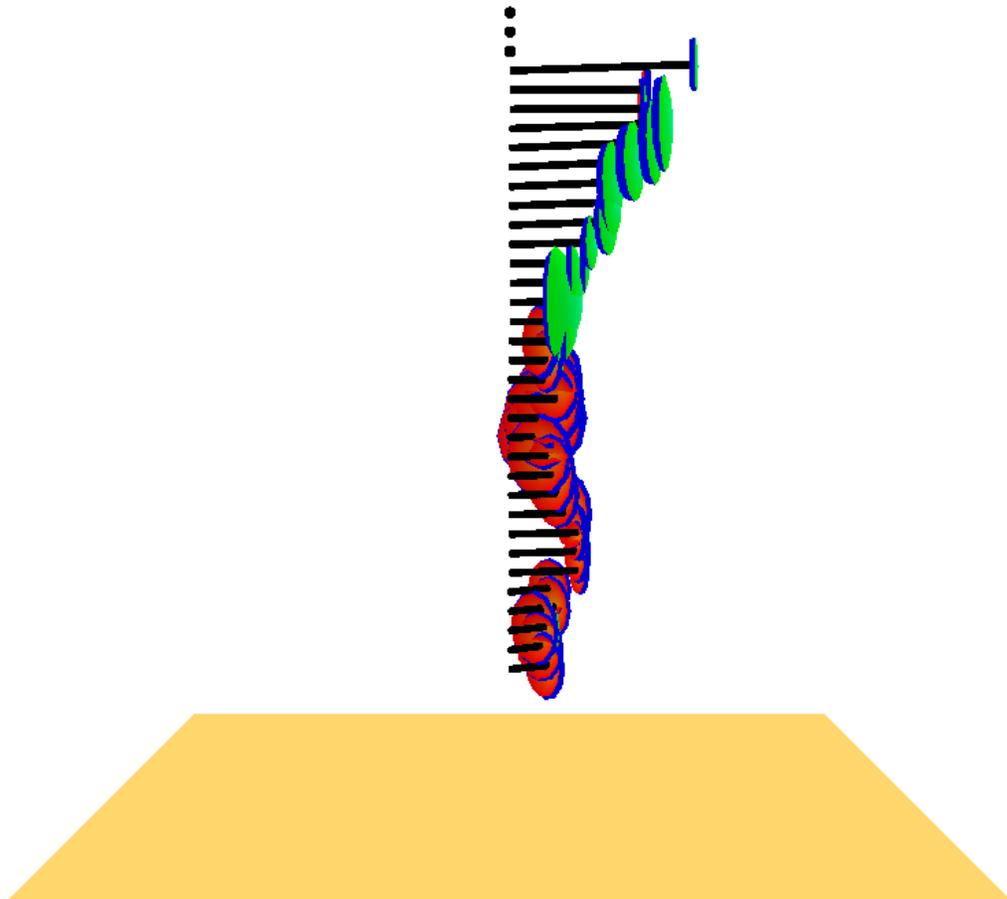
Figure 4.4: A test showing wind vectors drawn using data obtained from a wind sensor. The line segments represent wind speed and direction. The spherical shells represent uncertainty in wind direction (shell diameter) and wind speed (shell thickness).

away) and completely burned.

Figure 4.7 shows an example of a tree drawn as particles and an isosurface. Particle represent small units of fuel. Particle color represents temperature. As particles use up fuel they disappear. When many trees are simulated, it is difficult to discern individual trees when drawn as particles. The second column of images in Fig. 4.7 shows an equivalent view using an isosurface. The isosurface location is determined from the boundary (between particle and non-particle regions in the simulation) of the particle cloud. Figure 4.8 show a particle file drawn using canopy objects. The objects are colored according to the particle color as computed by FDS.
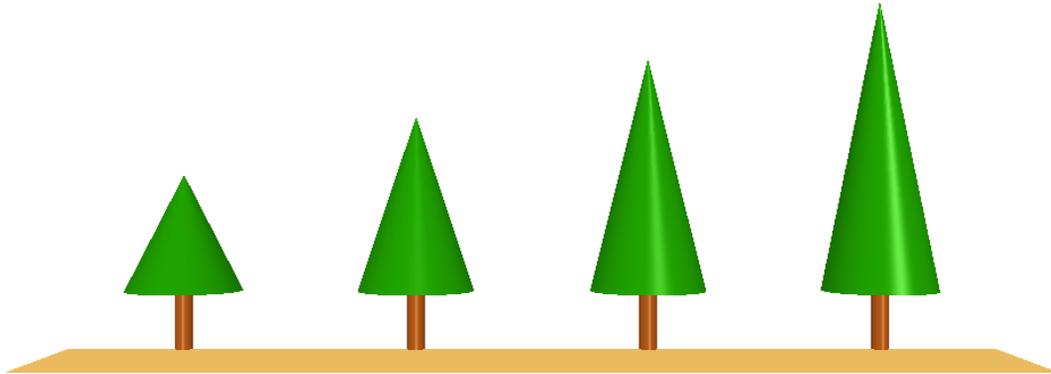
Figure 4.5: A test showing trees drawn as Smokeview objects. The tree canopy is colored green drawn as a cone, the tree trunk is colored brown drawn as a cylinder.

| state 1 | state 2 | state 3 | state 4 |
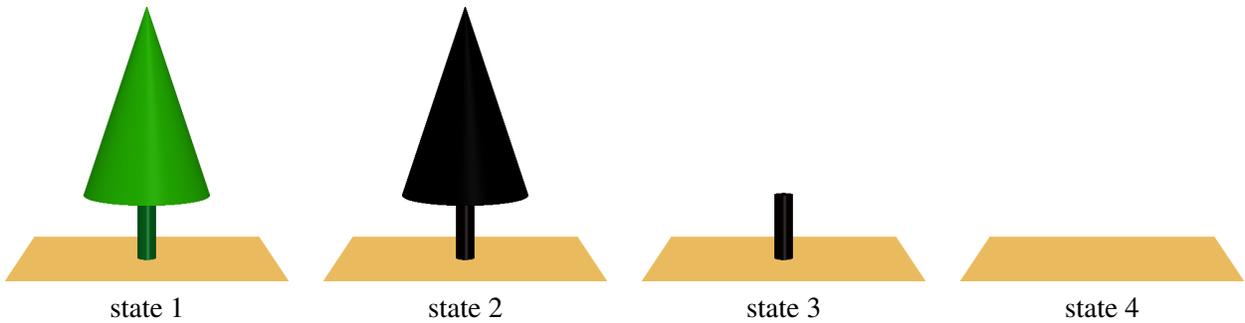
Figure 4.6: A test showing four states of the smokeview trunk and canopy objects. The states are unburned trunk and canopy, burned trunk and canopy, burned trunk (canopy burned away), both canopy and trunk burned away.
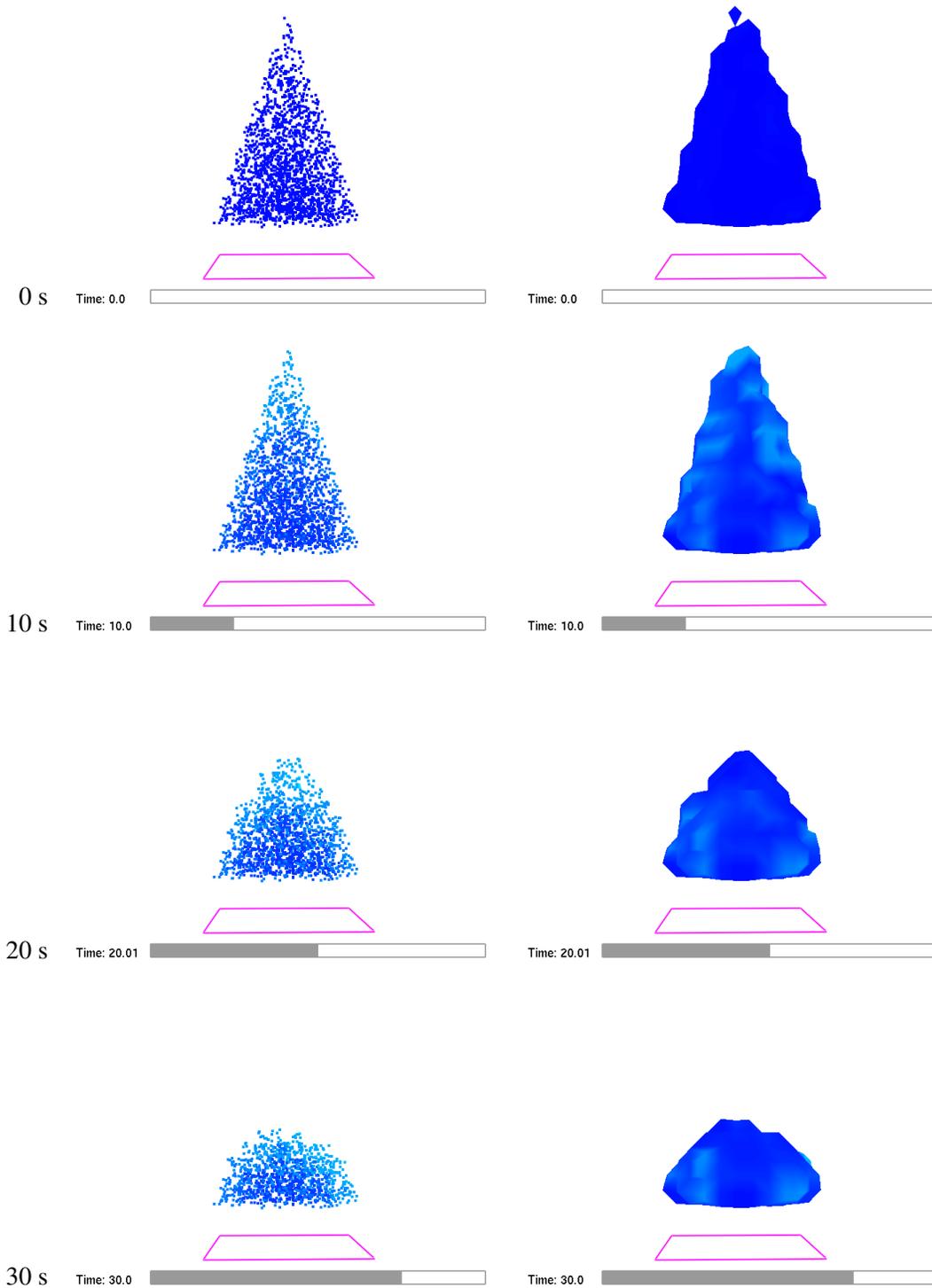
Figure 4.7: A test showing trees drawn as particles and isosurfaces at 0 s, 10 s, 20 s and 30 s. Particle represent small units of fuel. Particle color represents temperature. As particles use up fuel they disappear.
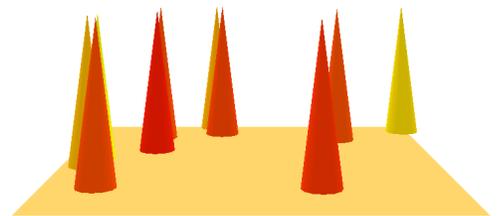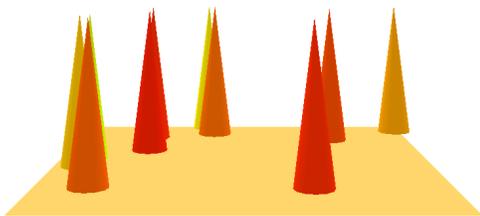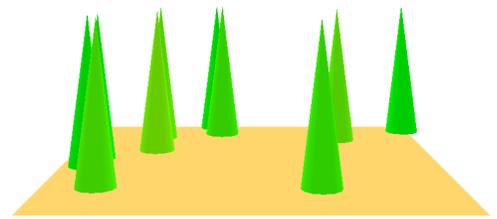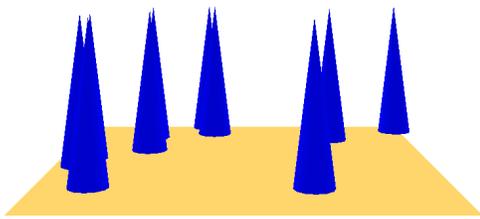
Figure 4.8: A test showing particles drawn as canopy objects at 0 s, 3 s, 6 s and 9 s. The canopy is colored according to temperature.

Chapter 5

Other Tests

5.1 Obstacles

Figures 5.1 and 5.2 test different methods for displaying obstacles. Figure 5.1 shows obstacles drawn as solids, as outlines or hidden. Figure 5.2 shows obstacles drawn transparently. The left view shows the opaque obstacle drawn in front (and blocking) a portion of the transparent obstacle behind. The center view shows both obstacles unobscured. The right view shows the transparent blockage drawn in front with the opaque blockage visible behind. The images for this test were created automatically by running the Smokeview script, `plume5c.ssf` (see Appendix B.4).

solid view of obstacles   outline view of obstacles   obstacles hidden
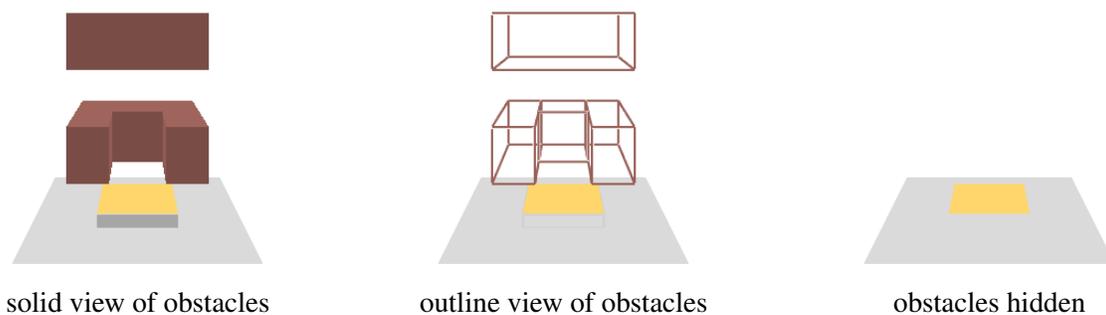
Figure 5.1: A test showing 3 drawing modes for representing blockages: solid, outline and hidden
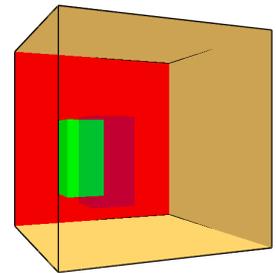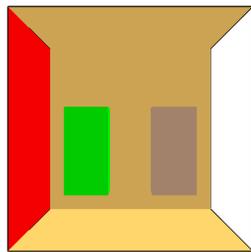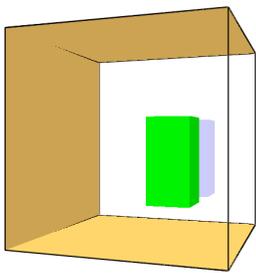
left view - opaque obstacle in front   center view - both obstacles visible   right view - transparent obstacle in front

Figure 5.2: A test showing that transparent objects are drawn properly

5.2 Devices

The case illustrated in Fig. 5.3 tests how well Smokeview can display many devices. This figure shows a series of sprinklers with three different levels of detail. Smokeview should be able to smoothly rotate this scene on computers with good video cards. The images for this test were created automatically by running the Smokeview script, `sprinkler_many.ssf` (see Appendix B.9).
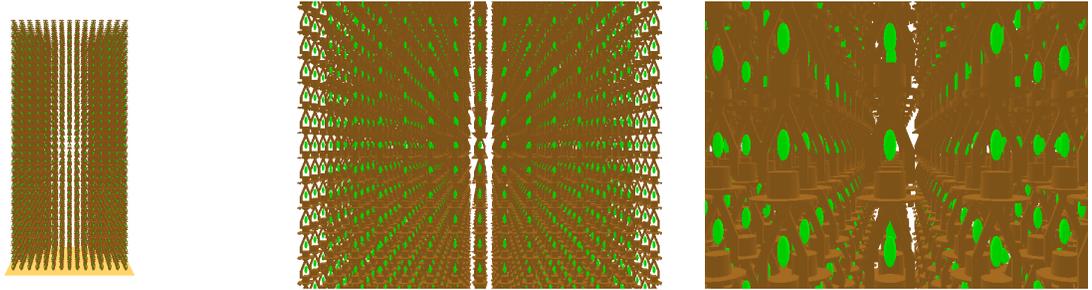
Figure 5.3: A test showing that devices are drawn properly

5.3 Vents

Figure 5.4 tests vent display. This figure shows three different levels of vent visibility: all vents displayed, only non-open vents displayed and all vents hidden. The images for this test were created automatically by running the Smokeview script, plume5c.ssf (see Appendix B.4). Figure 5.5 shows circular vents drawn on the sides of a blockage. The circular vents are drawn as requested by the user (a circle) and as implemented within FDS. Figure 5.6 shows circular vents drawn on exterior boundary. The circular vents are drawn as requested by the user (a circle) and as implemented within FDS.

show all vents   hide open vents   hide all vents
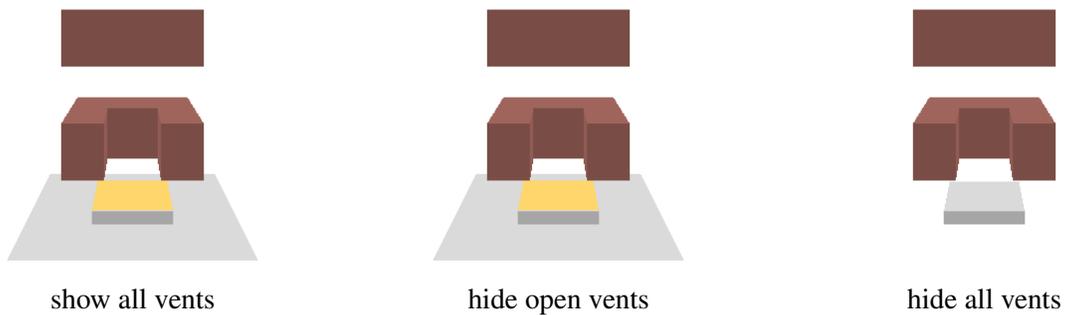
Figure 5.4: A test showing 3 modes for drawing vents: show all vents, hide open vents and hide all vents

user specification   FDS implementation
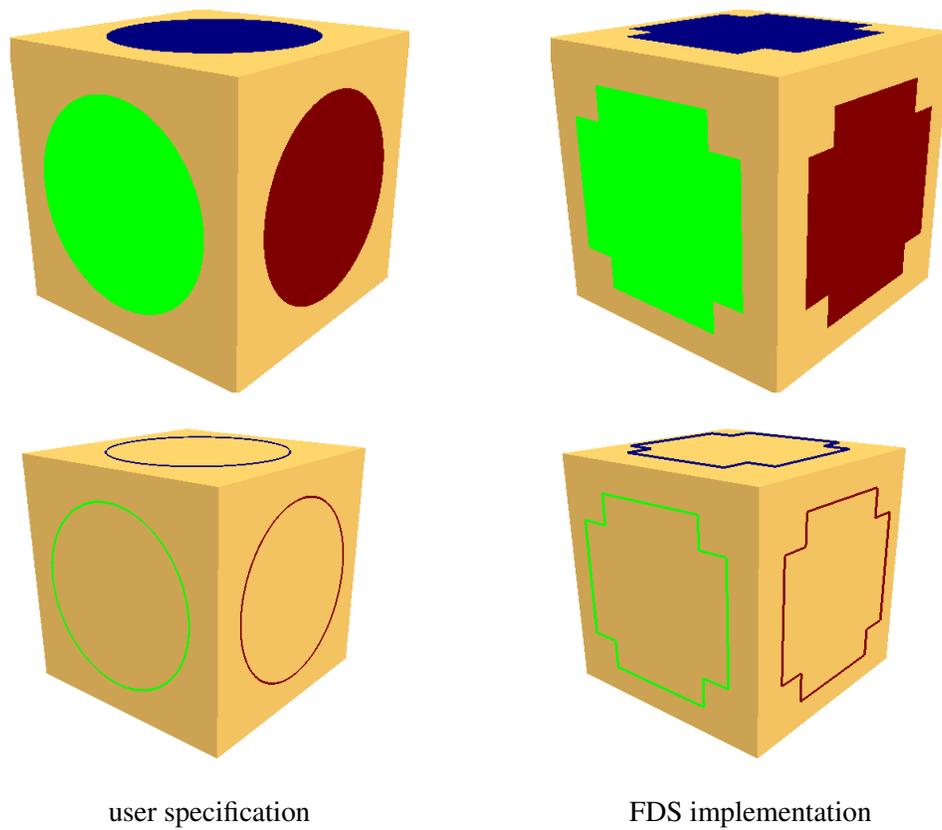
Figure 5.5: A test showing circular vents applied to a blockage. Vents in the top row are displayed as solid. Vents in the bottom row are displayed as outlines.

user specification · FDS implementation
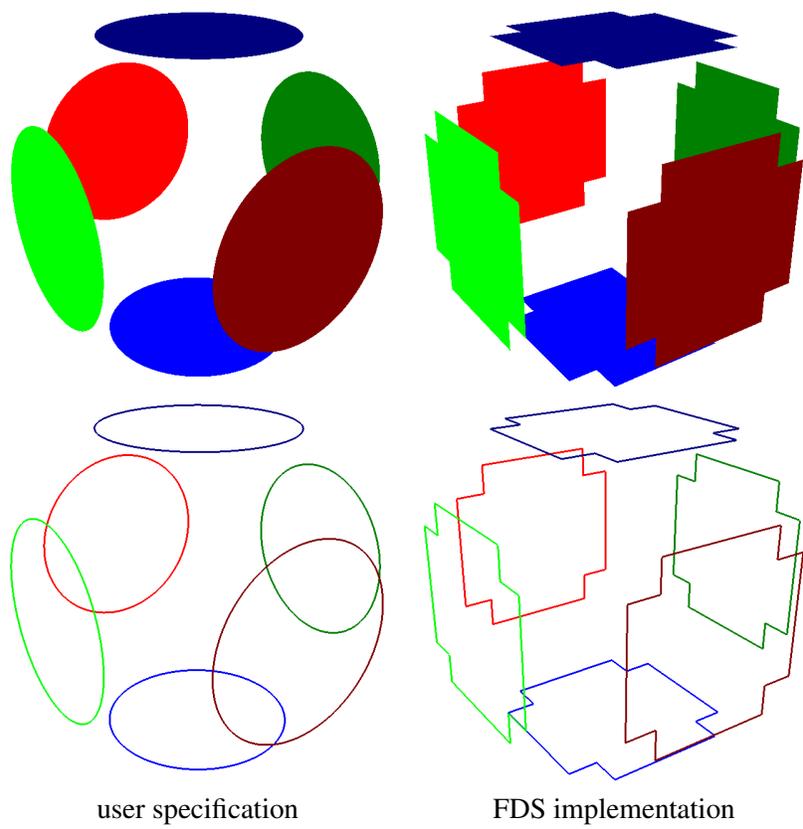
Figure 5.6: A test showing circular vents applied to an external boundary. Vents in the top row are displayed as solid. Vents in the bottom row are displayed as outlines.

5.4   Conversion to Color

Smokeview converts data values obtained from an FDS calculation to color using a linear scaling of the form

$$C_i = 255 \, \frac{V_i - V_{\text{min}}}{V_{\text{max}} - V_{\text{min}}} \tag{5.1}$$

where C_i is an index into a color table between 0 and 255, V_{min} and V_{max} are data bounds, and V_i is a data value to be converted. Figure 5.7 presents images verifying the conversion of data to colors. The input file, `colorconv.fds` (see Appendix A.2), was set up so that initially the left half of the domain (it is a 2D case) is 20 °C and the right half is 100 °C. The images for this test were created automatically by running the Smokeview script, `colorconv.ssf` (see Appendix B.2).

A second color conversion test involves the use of the colorbar to highlight portions of the data. The case was set up so that the vertical slice aligns with the colorbar. The gas temperatures were defined to increase from 20 °C to 100 °C from the floor to the ceiling. As a result, when one selects the colorbar, the selected region in the colorbar should match the selected region in the vertical slice. The images for this test were created automatically by running the Smokeview script, `colorbar.ssf` (see Appendix B.1).
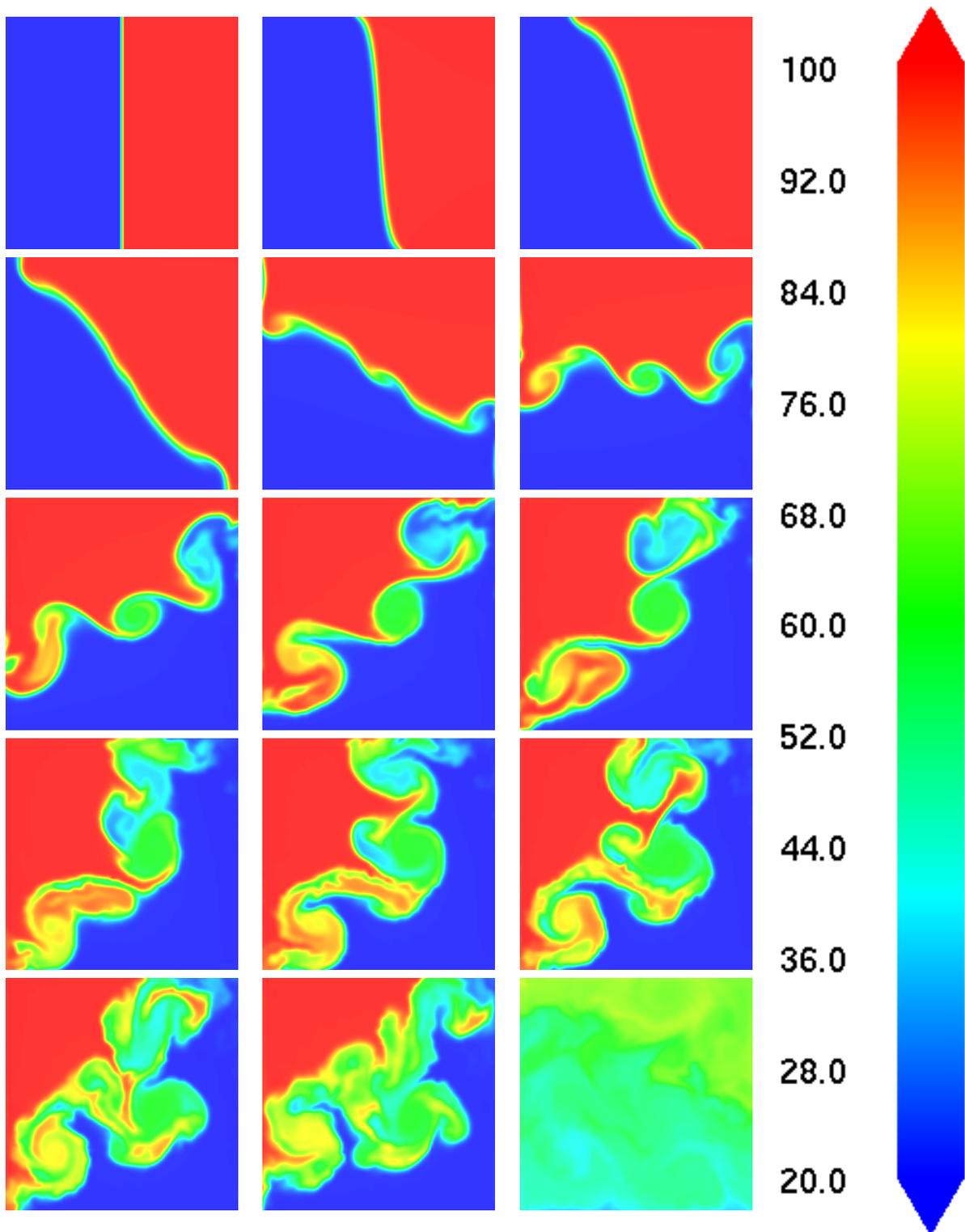
Figure 5.7: A test showing that data is converted to color properly. Temperature between 20 °C and 100 °C are converted to colors between blue and red.
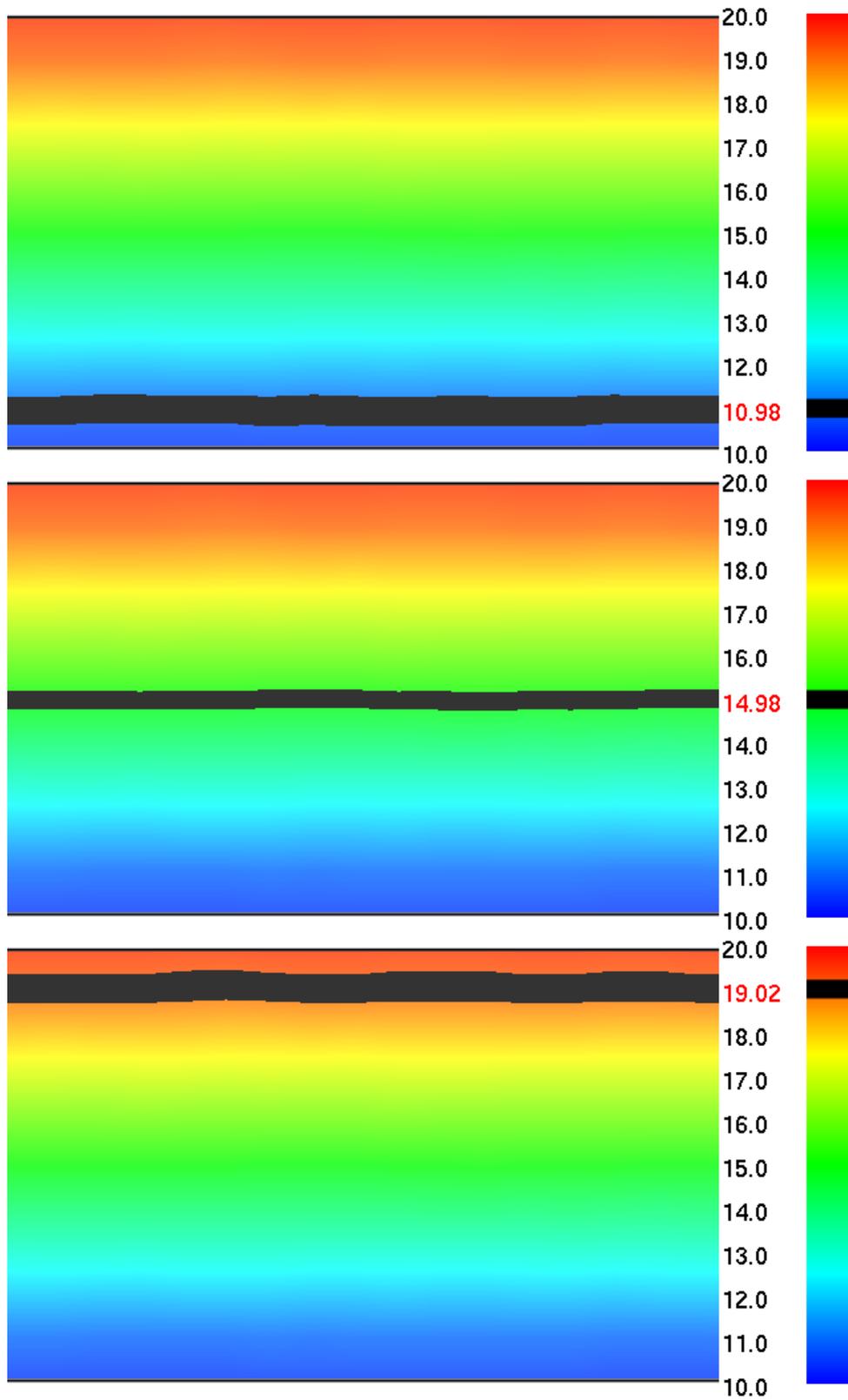
Figure 5.8: A test showing that data is converted to color properly. Temperature between 20 °C and 100 °C are converted to colors between blue and red. The highlighted region in the colorbar matches the highlighted region in the vertical slice.

5.5 GPU Test

Figure 5.9 tests whether Smokeview produces similar images when using the GPU and CPU for drawing 3D smoke. The first column shows CPU generated images at 5 s, 10 s and 30 s while the second column shows GPU generated images at the same times. The corresponding images in each column should be similar.

Time: 5.001

Time: 5.001

Time: 10.0

Time: 10.0

Time: 30.0

Time: 30.0

CPU generated

GPU generated
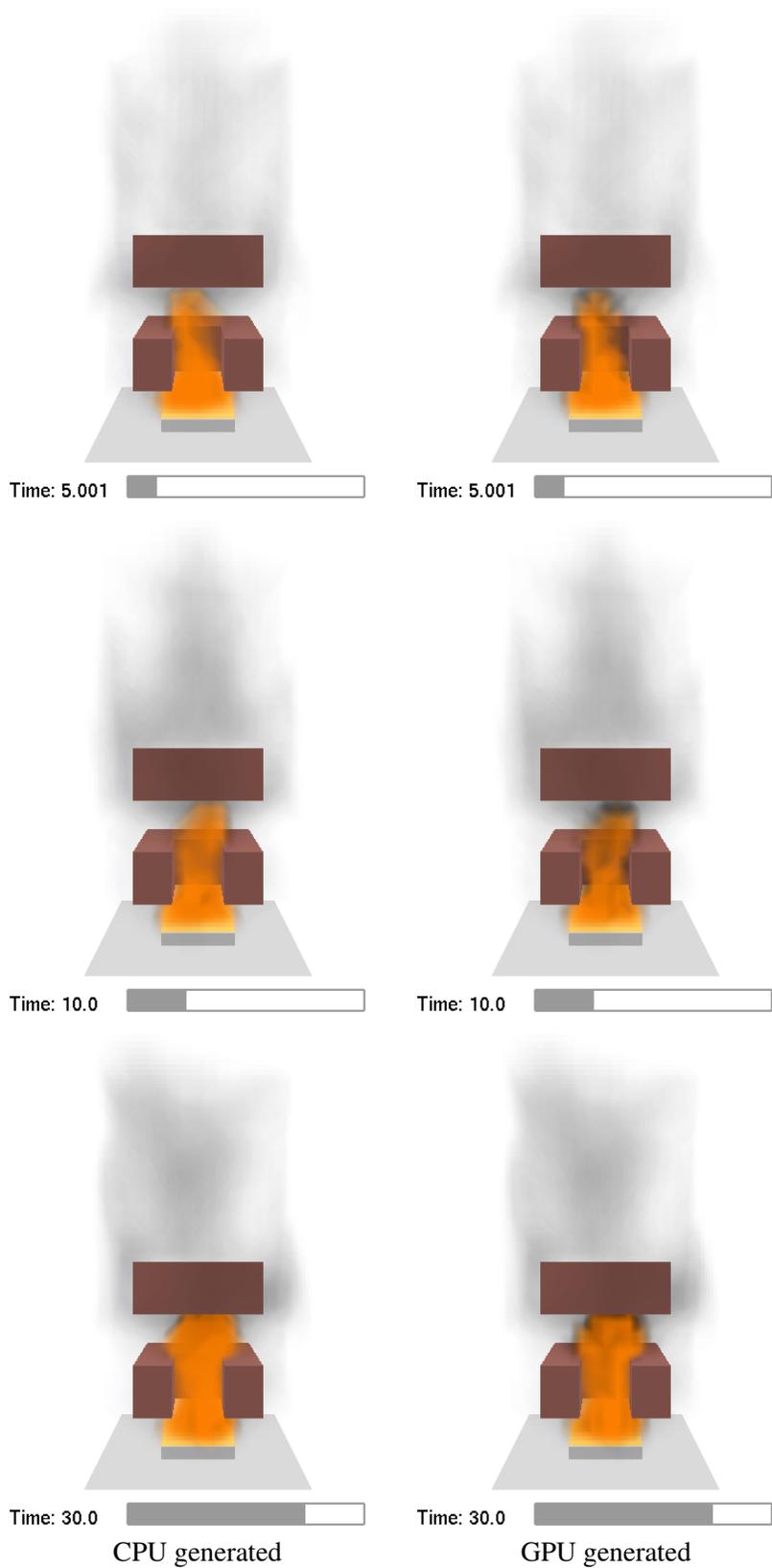
Figure 5.9: A test showing that the GPU is properly used to draw smoke

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5.6 Stereo View Test

Figures 5.10, 5.11 and 5.12 test whether Smokeview outputs stereo images properly. Figure 5.10 shows a left/right stereo pair. Figure 5.11 shows a red/blue stereo pair. Figure 5.12 shows a red/cyan stereo pair.
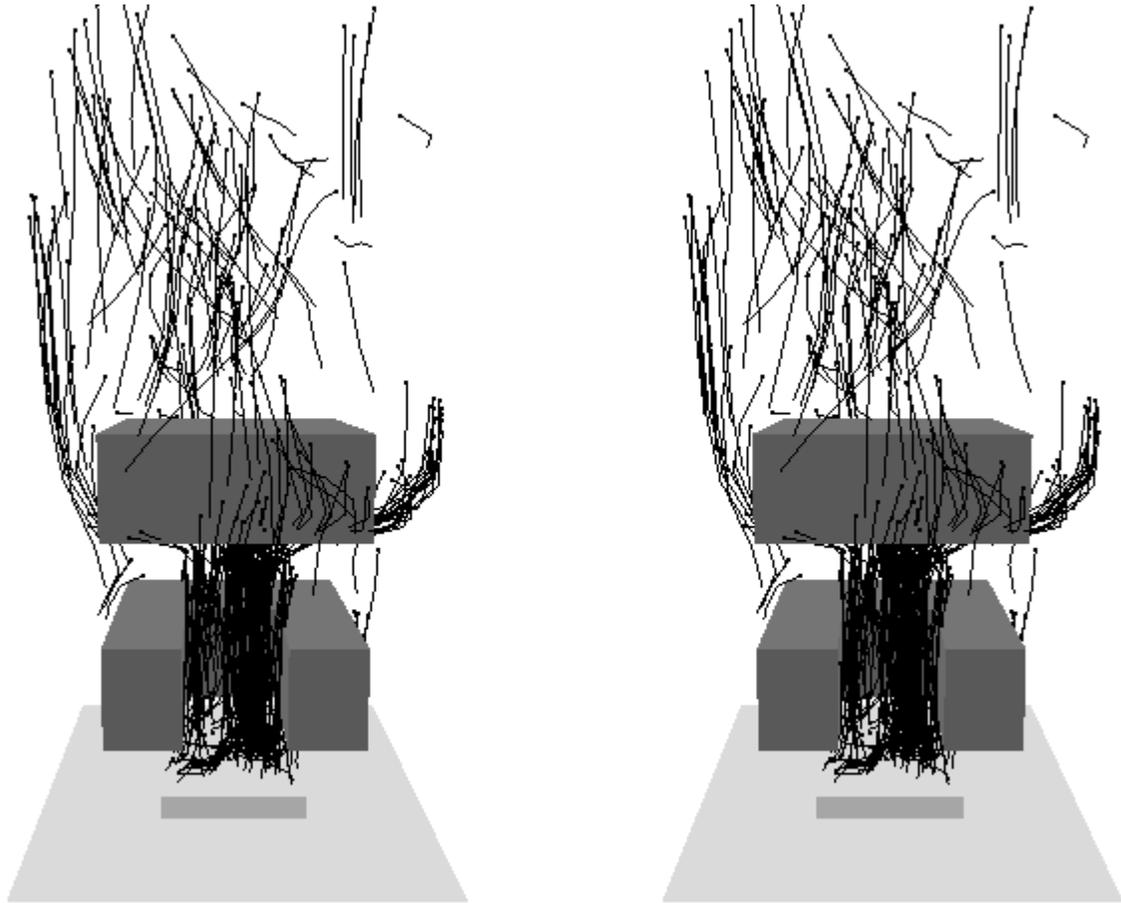
Time: 30.0

Figure 5.10: Stereo pair view. To aid in viewing the stereo effect, place a finger in front of each image. Relax your eyes allowing your two fingers and stereo pair images to merge into one.
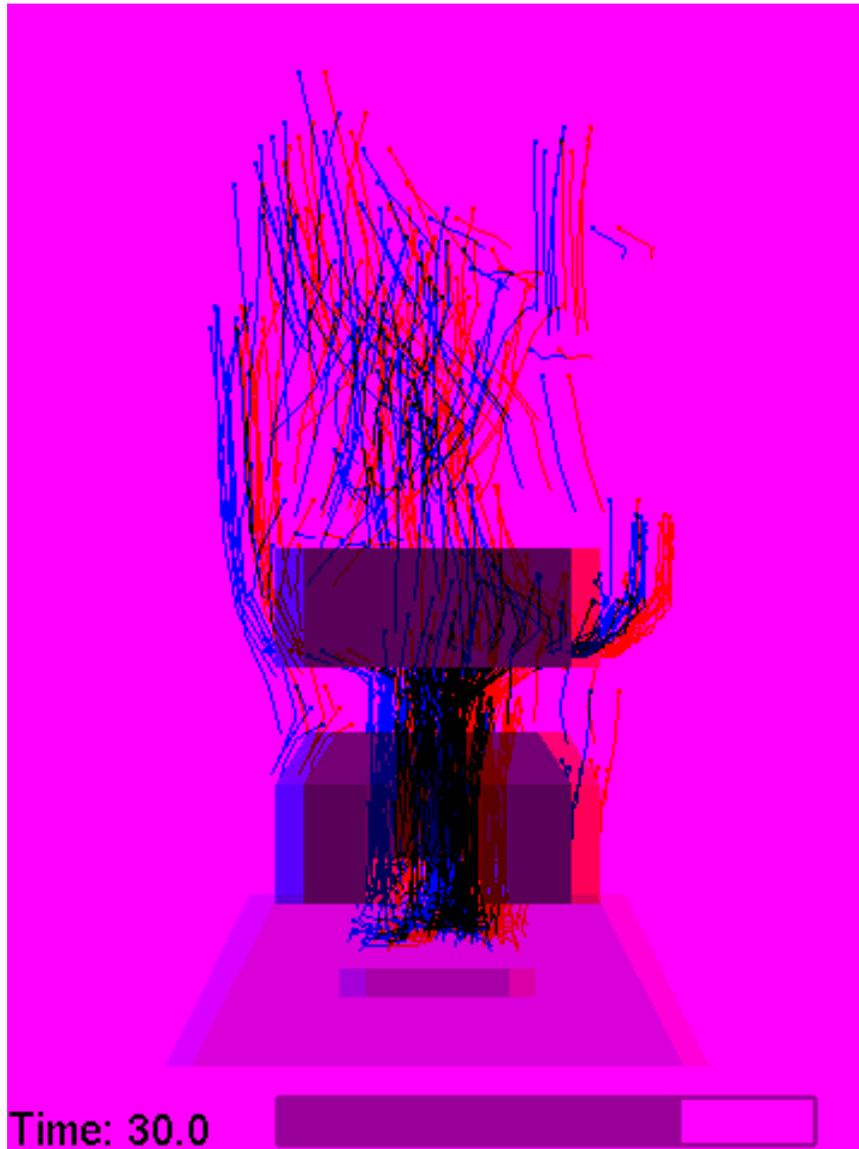
Figure 5.11: Red/blue stereo pair view. Red/blue glasses are required to see the 3D stereo effect.
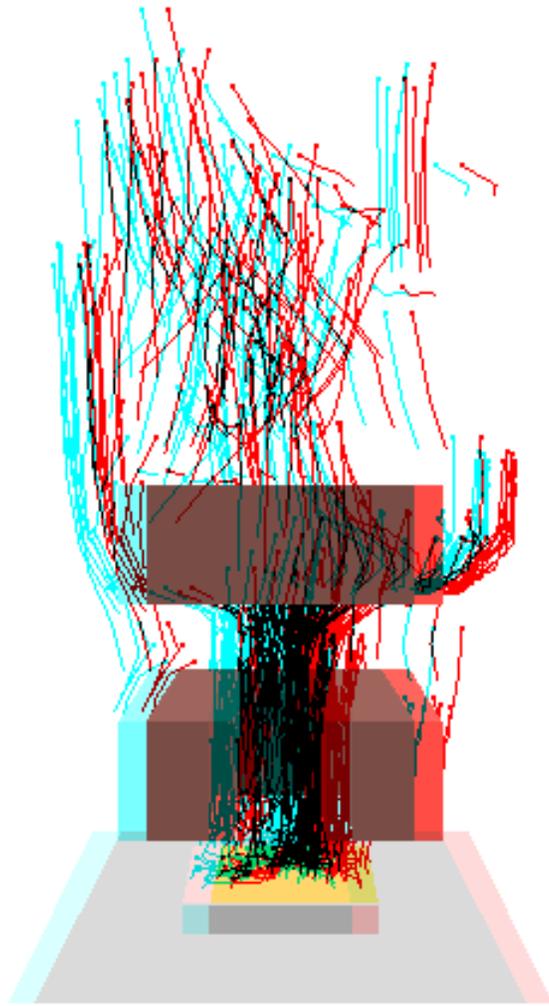
Time: 30.0

Figure 5.12: Red/cyan stereo pair view. Red/cyan glasses are required to see the 3D stereo effect.

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Appendix A

Input Files

A.1   colorbar

```
&HEAD CHID='colorbar', TITLE='Test of colorbar selection' /
REM This test case is used to test Smokeview's ability to
REM correctly select the colorbar and shade the appropriate
REM region black.

REM To do this,
REM  1) press "g" to turn on the grid.
REM  2) "Page Up" and put a horizonal grid slice "somewhere"
REM  3) select the colorbar, centering the resulting black band
REM     on the horizontal grid plane. Note the value.
REM  4) Use the File/BOunds dialog box to change the min and or max
REM     setting for the temperature slice file.
REM  5) repeaset setp 3.  Value noted should remain the same.

&MESH IJK=20,10,10, XB=0.0,2.0,0.0,1.0,0.0,1.0 /

&TIME T_END=10.0 /

&MISC  TMPA=10. /
&WIND  LAPSE_RATE=10.0 /

&RADI RADIATION=.FALSE./

&SLCF PBY=0.6, QUANTITY='TEMPERATURE' /

&VENT MB='XMAX', SURF_ID='OPEN' /
&VENT MB='YMAX', SURF_ID='OPEN' /
&VENT MB='ZMAX', SURF_ID='OPEN' /
&VENT MB='XMIN', SURF_ID='OPEN' /
&VENT MB='YMIN', SURF_ID='OPEN' /
&VENT MB='ZMIN', SURF_ID='OPEN' /


&TAIL /
```

A.2   colorconv

A simple two-dimensional case testing data to color conversion

```
&HEAD CHID='colorconv', TITLE='Test data to color conversion' /
&DUMP NFRAMES=800 /

&MESH IJK=100,1,100, XB=0.0,100.0,-1.0,1.0,0.0,100.0 /
```

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```
&SURF ID='COOLWALL' TMP_FRONT=20.0 /
&SURF ID='HOTWALL' TMP_FRONT=100.0 /
&SURF ID='INSWALL' ADIABATIC=.TRUE. /
&MISC FLUX_LIMITER='CHARM', CFL_VELOCITY_NORM=1, CHECK_VN=.FALSE. /

&TIME T_END=200.0 /

&RADI RADIATION=.FALSE. /
&INIT XB= 0.0, 50.0,-2.0,2.0,0.0,100.0, TEMPERATURE=20. /
&INIT XB=50.0,100.0,-2.0,2.0,0.0,100.0, TEMPERATURE=100. /

&VENT XB=   0.0, 100.0, -1.0, 1.0,     0.0,   0.0, SURF_ID='COOLWALL' /
&VENT XB=   0.0, 100.0, -1.0, 1.0,   100.0, 100.0, SURF_ID='HOTWALL' /
&VENT XB=   0.0,   0.0, -1.0, 1.0,     0.0, 100.0 SURF_ID='INSWALL' /
&VENT XB= 100.0, 100.0, -1.0, 1.0,     0.0, 100.0 SURF_ID='INSWALL' /

&SLCF PBY=0.0, QUANTITY='TEMPERATURE' /

&TAIL /
```

A.3   fed_test

```
&HEAD CHID='fed_test', TITLE='Check FED computation in smokeview'/

&MESH XB=0.0,1.0,0.0,1.0,0.0,1.0, IJK=3,3,3 /

&TIME T_END=360.0, DT=0.1 /
&DUMP NFRAMES=2880 /

&SPEC ID='NITROGEN', BACKGROUND=.TRUE. /
&SPEC ID='OXYGEN' /
&SPEC ID='CARBON DIOXIDE' /
&SPEC ID='CARBON MONOXIDE'/

&INIT XB=0.0,1.0,0.0,1.0,0.0,1.0
      MASS_FRACTION(1)=0.078322, SPEC_ID(1)='OXYGEN',
      MASS_FRACTION(2)=0.030769,SPEC_ID(2)='CARBON DIOXIDE'
      MASS_FRACTION(3)=0.000979,SPEC_ID(3)='CARBON MONOXIDE' /

&DEVC ID='DEV1A', XYZ=0.5,0.5,0.6, QUANTITY='FED' /

&SLCF PBY=0.5,QUANTITY='VOLUME FRACTION' SPEC_ID='CARBON DIOXIDE' /
&SLCF PBY=0.5,QUANTITY='VOLUME FRACTION' SPEC_ID='CARBON MONOXIDE' /
&SLCF PBY=0.5,QUANTITY='VOLUME FRACTION' SPEC_ID='OXYGEN' /
&SLCF PBY=0.5,QUANTITY='VOLUME FRACTION' SPEC_ID='CARBON DIOXIDE', CELL_CENTERED=.TRUE. /
&SLCF PBY=0.5,QUANTITY='VOLUME FRACTION' SPEC_ID='CARBON MONOXIDE', CELL_CENTERED=.TRUE. /
&SLCF PBY=0.5,QUANTITY='VOLUME FRACTION' SPEC_ID='OXYGEN', CELL_CENTERED=.TRUE. /

&TAIL /
```

A.4   plume5c

```
&HEAD CHID='plume5c',TITLE='Plume whirl case' /

  same as plume5a except there is a blockage in the middle of the scene to block the flow
  The purpose of this case is to demonstrate the curved flow (via streak lines) that results.

&MESH IJK=16,16,32, XB=0.0,1.6,0.0,1.6,0.0,3.2 /

&MISC IBLANK_SMV=.TRUE. /

&DUMP NFRAMES=400 DT_PL3D=8.0, DT_SL3D=0.1 /
```

```
&INIT XB=0.2,1.4,0.2,1.4,0.5,2.2  TEMPERATURE=600.0 /

&TIME T_END=40. /  Total simulation time

&MATL ID                 = 'FABRIC'
      FYI                = 'Properties completely fabricated'
      SPECIFIC_HEAT      = 1.0
      CONDUCTIVITY       = 0.1
      DENSITY            = 100.0
      N_REACTIONS        = 1
      NU_SPEC            = 1.
      SPEC_ID            = 'PROPANE'
      REFERENCE_TEMPERATURE = 350.
      HEAT_OF_REACTION     = 3000.
      HEAT_OF_COMBUSTION   = 15000. /

&MATL ID                 = 'FOAM'
      FYI                = 'Properties completely fabricated'
      SPECIFIC_HEAT      = 1.0
      CONDUCTIVITY       = 0.05
      DENSITY            = 40.0
      N_REACTIONS        = 1
      NU_SPEC            = 1.
      SPEC_ID            = 'PROPANE'
      REFERENCE_TEMPERATURE = 350.
      HEAT_OF_REACTION     = 1500.
      HEAT_OF_COMBUSTION   = 30000. /

&SURF ID           = 'UPHOLSTERY_LOWER'
      FYI          = 'Properties completely fabricated'
      RGB          = 151,96,88
      BURN_AWAY    = .FALSE.
      MATL_ID(1:2,1) = 'FABRIC','FOAM'
      THICKNESS(1:2) = 0.002,0.1
/

&SURF ID           = 'UPHOLSTERY_UPPER'
      FYI          = 'Properties completely fabricated'
      RGB          = 151,96,88
      BURN_AWAY    = .FALSE.
      TMP_FRONT    = 600.0
/
&REAC SOOT_YIELD=0.01,FUEL='PROPANE'/
&SURF ID='BURNER',HRRPUA=600.0,PART_ID='tracers' /  Ignition source

&VENT XB=0.5,1.1,0.5,1.1,0.1,0.1,SURF_ID='BURNER' /  fire source on kitchen stove

&OBST XB=0.5,1.1,0.5,1.1,0.0,0.1 /
&OBST XB=0.3,1.3,0.3,1.3,0.4,0.8 SURF_ID='UPHOLSTERY_LOWER'/
&HOLE XB=0.6,1.0,0.2,0.8,0.3,0.9 /
&OBST XB=0.3,1.3,0.3,1.3,1.2,1.6 SURF_ID='UPHOLSTERY_UPPER' /

&VENT MB='XMIN',SURF_ID='OPEN'/
&VENT MB='XMAX',SURF_ID='OPEN'/
&VENT MB='YMIN',SURF_ID='OPEN'/
&VENT MB='YMAX',SURF_ID='OPEN'/
&VENT MB='ZMAX',SURF_ID='OPEN'/

&ISOF QUANTITY='TEMPERATURE',VALUE(1)=100.0 /  Show 3D contours of temperature at 100 C
&ISOF QUANTITY='TEMPERATURE',VALUE(1)=200.0 /  Show 3D contours of temperature at 200 C
&ISOF QUANTITY='TEMPERATURE',VALUE(1)=620.0 /  Show 3D contours of temperature at 620 C
&ISOF QUANTITY='TEMPERATURE',VALUE(1:2)=200.0,400.0 /  Show 3D contours of temperature at 200 C

&PART ID='tracers',MASSLESS=.TRUE.,
   QUANTITIES(1:3)='PARTICLE U','PARTICLE V','PARTICLE W'
   SAMPLING_FACTOR=10 /  Description of massless tracer particles. Apply at a
                                                solid surface with the PART_ID='tracers'
```

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```
 X slices

&SLCF PBX=0.8,QUANTITY='TEMPERATURE',VECTOR=.TRUE. /  Add vector slices colored by temperature
&SLCF PBX=0.8,QUANTITY='TEMPERATURE',CELL_CENTERED=.TRUE. /

 Y slices

&SLCF PBY=0.8,QUANTITY='VISIBILITY' /
&SLCF PBY=0.8,QUANTITY='TEMPERATURE',VECTOR=.TRUE. /
&SLCF PBY=0.8,QUANTITY='VOLUME FRACTION' SPEC_ID='PROPANE' /
&SLCF PBY=0.8,QUANTITY='VOLUME FRACTION' SPEC_ID='OXYGEN' /
&SLCF PBY=0.8,QUANTITY='VOLUME FRACTION' SPEC_ID='CARBON DIOXIDE' /
&SLCF PBY=0.8,QUANTITY='VOLUME FRACTION' SPEC_ID='CARBON MONOXIDE' /
&SLCF PBY=0.8,QUANTITY='TEMPERATURE',CELL_CENTERED=.TRUE. /

 Z slices

&SLCF PBZ=0.4,QUANTITY='TEMPERATURE',VECTOR=.TRUE. /
&SLCF PBZ=0.4,QUANTITY='TEMPERATURE',CELL_CENTERED=.TRUE. /
&SLCF PBZ=1.6,QUANTITY='TEMPERATURE',VECTOR=.TRUE. /
&SLCF PBZ=1.6,QUANTITY='TEMPERATURE',CELL_CENTERED=.TRUE. /
&SLCF PBZ=3.2,QUANTITY='TEMPERATURE',VECTOR=.TRUE. /
&SLCF PBZ=3.2,QUANTITY='TEMPERATURE',CELL_CENTERED=.TRUE. /

 3d slices

&SLCF XB=0.0,1.6,0.0,1.6,0.0,3.2,QUANTITY='TEMPERATURE' ,VECTOR=.TRUE. /
&SLCF XB=0.0,1.6,0.0,1.6,0.0,3.2, QUANTITY='TEMPERATURE',CELL_CENTERED=.TRUE.  / 3D slice
&SLCF XB=0.0,1.6,0.0,1.6,0.0,3.2,QUANTITY='VOLUME FRACTION' SPEC_ID='CARBON DIOXIDE' /
&SLCF XB=0.0,1.6,0.0,1.6,0.0,3.2,QUANTITY='VOLUME FRACTION' SPEC_ID='CARBON MONOXIDE' /
&SLCF XB=0.0,1.6,0.0,1.6,0.0,3.2,QUANTITY='VOLUME FRACTION' SPEC_ID='OXYGEN' /
&SLCF XB=0.0,1.6,0.0,1.6,0.0,3.2, QUANTITY='DENSITY',SPEC_ID='SOOT',CELL_CENTERED=.TRUE.  / 3D slice

&SLCF XB=0.4,1.2,0.0,1.6,0.0,3.2,QUANTITY='TEMPERATURE' /
&SLCF XB=0.0,1.6,0.4,1.2,0.0,3.2,QUANTITY='TEMPERATURE' /
&SLCF XB=0.0,1.6,0.0,1.6,0.8,2.4,QUANTITY='TEMPERATURE' /

&SLCF PBY=1.6,QUANTITY='VOLUME FRACTION' SPEC_ID='CARBON DIOXIDE' /
&SLCF PBY=1.6,QUANTITY='VOLUME FRACTION' SPEC_ID='CARBON MONOXIDE' /
&SLCF PBY=1.6,QUANTITY='VOLUME FRACTION' SPEC_ID='OXYGEN' /

&BNDF QUANTITY='GAUGE HEAT FLUX' /   Common surface quantities. Good for monitoring fire spread.
&BNDF QUANTITY='BURNING RATE' /
&BNDF QUANTITY='WALL TEMPERATURE' /
&BNDF QUANTITY='WALL TEMPERATURE' CELL_CENTERED=.TRUE. /

&DEVC XYZ=1.2,0.8,0.0 QUANTITY='U-VELOCITY' /
&DEVC XYZ=1.2,0.8,0.6 QUANTITY='U-VELOCITY' /
&DEVC XYZ=1.2,0.8,1.2 QUANTITY='U-VELOCITY' /
&DEVC XYZ=1.2,0.8,1.8 QUANTITY='U-VELOCITY' /
&DEVC XYZ=1.2,0.8,2.4 QUANTITY='U-VELOCITY' /
&DEVC XYZ=1.2,0.8,3.0 QUANTITY='U-VELOCITY' /

&DEVC XYZ=1.2,0.8,0.0 QUANTITY='V-VELOCITY' /
&DEVC XYZ=1.2,0.8,0.6 QUANTITY='V-VELOCITY' /
&DEVC XYZ=1.2,0.8,1.2 QUANTITY='V-VELOCITY' /
&DEVC XYZ=1.2,0.8,1.8 QUANTITY='V-VELOCITY' /
&DEVC XYZ=1.2,0.8,2.4 QUANTITY='V-VELOCITY' /
&DEVC XYZ=1.2,0.8,3.0 QUANTITY='V-VELOCITY' /

&DEVC XYZ=1.2,0.8,0.0 QUANTITY='W-VELOCITY' /
&DEVC XYZ=1.2,0.8,0.6 QUANTITY='W-VELOCITY' /
&DEVC XYZ=1.2,0.8,1.2 QUANTITY='W-VELOCITY' /
&DEVC XYZ=1.2,0.8,1.8 QUANTITY='W-VELOCITY' /
&DEVC XYZ=1.2,0.8,2.4 QUANTITY='W-VELOCITY' /
&DEVC XYZ=1.2,0.8,3.0 QUANTITY='W-VELOCITY' /

&DEVC XYZ=1.2,0.8,0.0 QUANTITY='TEMPERATURE' /
```

```
&DEVC XYZ=1.2,0.8,0.6 QUANTITY='TEMPERATURE' /
&DEVC XYZ=1.2,0.8,1.2 QUANTITY='TEMPERATURE' /
&DEVC XYZ=1.2,0.8,1.8 QUANTITY='TEMPERATURE' /
&DEVC XYZ=1.2,0.8,2.4 QUANTITY='TEMPERATURE' /
&DEVC XYZ=1.2,0.8,3.0 QUANTITY='TEMPERATURE' /

&DEVC XYZ=1.2,0.8,0.0 QUANTITY='VISIBILITY' /
&DEVC XYZ=1.2,0.8,0.6 QUANTITY='VISIBILITY' /
&DEVC XYZ=1.2,0.8,1.2 QUANTITY='VISIBILITY' /
&DEVC XYZ=1.2,0.8,1.8 QUANTITY='VISIBILITY' /
&DEVC XYZ=1.2,0.8,2.4 QUANTITY='VISIBILITY' /
&DEVC XYZ=1.2,0.8,3.0 QUANTITY='VISIBILITY' /

&TAIL /
```

A.5   sillytexture

```
&HEAD CHID='sillytexture', TITLE='Silly Test Case' /
&MISC TEXTURE_ORIGIN=0.1,0.1,0.1 /

&MESH IJK=20,20,20, XB=0.0,1.0,0.0,1.0,0.0,1.0 /
&TIME T_END=0. /
&SURF ID      = 'TEXTURE 1'
      TEXTURE_MAP= 'nistleft.jpg'
      TEXTURE_WIDTH=0.6
      TEXTURE_HEIGHT=0.2 /

&SURF ID      = 'TEXTURE 2'
      TEXTURE_MAP= 'nistleft.jpg'
      TEXTURE_WIDTH=0.4
      TEXTURE_HEIGHT=0.2 /

&OBST XB=0.1,0.3,0.1,0.7,0.1,0.3, SURF_ID='TEXTURE 1'  /
&OBST XB=0.5,0.9,0.3,0.7,0.1,0.5, SURF_ID='TEXTURE 2',
      TEXTURE_ORIGIN=0.5,0.3,0.1  /

&VENT XB=0.0,0.0,0.2,0.8,0.2,0.4, SURF_ID='TEXTURE 1',
      TEXTURE_ORIGIN=0.0,0.2,0.2 /
&VENT XB=0.3,0.9,0.0,0.0,0.3,0.5, SURF_ID='TEXTURE 1',
      TEXTURE_ORIGIN=0.9,0.0,0.3 /
&TAIL /
```

A.6   smoke_sensor

```
&HEAD CHID='smoke_sensor', TITLE='Test smokesensor device' /

  A small white (255,255,255) smokesensor appears over top a grey (128,128,128) obstacle.
  A red dot indicates where the smoke opacity is recorded and should appear in the middle of the
  sensor.  Another check is that the sensor should display 255 (the color fo the sensor) not
  128 (the color of the background).

&MESH IJK=100,64,40, XB=0.0,10.0,0.0,6.4,0.0,4.0 /

&TIME T_END=1.0 /

&SPEC ID='SOOT',MASS_FRACTION_0=0.00007967/ DENSITY=1.0/

&OBST XB=0.0,10.0,6.3,6.4,0.0,4.0 RGB=128,128,128/
&PROP ID='smoketest' SMOKEVIEW_ID='smokesensor' /
&DEVC XYZ=8.5,6.0,0.50, ID='vis1' QUANTITY='TEMPERATURE' PROP_ID='smoketest' /

&TAIL /
```

A.7   smoke_test

```
&HEAD CHID='smoke_test', TITLE='Verify Smokeview Smoke3D Feature' /

   A quantitative test of the smoke opacity calculation in Smokeview.  This test simplifies
   the general case by assuming a uniform distribution of smoke.  Smoke grey levels are computed
   using

      grey level (GL) = 255*exp(-K*S*DX)

   where K=8700 m2/kg is the mass extinction value, S=7.922 * 10**-5 kg/m3 is the soot density
   and DX is the path length through the smoke.  This equation is inverted to obtain

     DX = -LN(GL/255)/(K*S)

   and is used to place smoke sensors at 0.5, 1, 3, 4 and 5 meters so that the predicted
   grey levels are 181, 128, 64, 32, 16 and 8 .

&MESH IJK=80,52,32, XB=0.0,10.0,0.0,6.5,0.0,4.0 /

&TIME T_END=1.0 /

&SPEC ID='SOOT'/
&SM3D QUANTITY='DENSITY', SPEC_ID='SOOT' /
&INIT XB=0.0,10.0,0.0,6.4,0.0,4.0,MASS_FRACTION=0.00006624,SPEC_ID='SOOT' /

&OBST XB=0.0,2.6, 0.5,0.7,1.0,4.0, RGB=255,255,255 /
&OBST XB=0.0,4.0, 1.0,1.2,1.0,4.0, RGB=255,255,255 /
&OBST XB=0.0,5.6, 2.0,2.2,1.0,4.0, RGB=255,255,255 /
&OBST XB=0.0,7.0, 3.0,3.2,1.0,4.0, RGB=255,255,255 /
&OBST XB=0.0,8.6, 4.0,4.2,1.0,4.0, RGB=255,255,255 /
&OBST XB=0.0,10.0,5.0,5.4,1.0,4.0, RGB=255,255,255 /

&OBST XB=0.0,2.6, 0.0,1.0,0.0,1.0, RGB=181,181,181 /
&OBST XB=2.6,4.0, 0.0,1.0,0.0,1.0, RGB=128,128,128 /
&OBST XB=4.0,5.6, 0.0,1.0,0.0,1.0, RGB=64,64,64 /
&OBST XB=5.6,7.0, 0.0,1.0,0.0,1.0, RGB=32,32,32 /
&OBST XB=7.0,8.6, 0.0,1.0,0.0,1.0, RGB=16,16,16 /
&OBST XB=8.6,10.0, 0.0,1.0,0.0,1.0, RGB=8,8,8 /


&PROP ID='smoketest' SMOKEVIEW_ID='smokesensor' /
&DEVC XYZ=1.8,0.55,2.00, QUANTITY='VISIBILITY', ID='vis1' PROP_ID='smoketest' /
&DEVC XYZ=3.2,1.05,2.00, QUANTITY='VISIBILITY', ID='vis2' PROP_ID='smoketest' /
&DEVC XYZ=4.8,2.05,2.00, QUANTITY='VISIBILITY', ID='vis3' PROP_ID='smoketest' /
&DEVC XYZ=6.2,3.05,2.00, QUANTITY='VISIBILITY', ID='vis4' PROP_ID='smoketest' /
&DEVC XYZ=7.8,4.05,2.00, QUANTITY='VISIBILITY', ID='vis5' PROP_ID='smoketest' /
&DEVC XYZ=9.2,5.05,2.00, QUANTITY='VISIBILITY', ID='vis6' PROP_ID='smoketest' /

&SLCF PBX=5.0, QUANTITY='DENSITY',SPEC_ID='SOOT' /
&SLCF PBY=5.0, QUANTITY='DENSITY',SPEC_ID='SOOT' /
&SLCF PBZ=2.0, QUANTITY='DENSITY',SPEC_ID='SOOT' /
&SLCF XB=0.0,10.0,0.0,6.5,0.0,4.0,QUANTITY='DENSITY',SPEC_ID='SOOT' /
&SLCF XB=0.0,10.0,0.0,6.5,0.0,4.0,QUANTITY='TEMPERATURE' /

&SLCF XB=0.0,10.0,0.0,6.5,0.0,4.0, QUANTITY='DENSITY',SPEC_ID='SOOT',CELL_CENTERED=.TRUE.  / 3D slice
&SLCF XB=0.0,10.0,0.0,6.5,0.0,4.0, QUANTITY='TEMPERATURE',CELL_CENTERED=.TRUE.  / 3D slice

&TAIL /
```

A.8   smoke_test2

```
&HEAD CHID='smoke_test2', TITLE='Verify Smokeview Smoke3D Feature' /

   A quantitative test of the smoke opacity calculation in Smokeview.  This test simplifies
```

the general case by assuming a uniform distribution of smoke. Smoke grey levels are computed
using

   grey level (GL) = 255*exp(-K*S*DX)

where K=8700 m2/kg is the mass extinction value, S=7.922 * 10**-5 kg/m3 is the soot density
and DX is the path length through the smoke. This equation is inverted to obtain

  DX = -LN(GL/255)/(K*S)

and is used to place smoke sensors at 0.5, 1, 3, 4 and 5 meters so that the predicted
grey levels are 181, 128, 64, 32, 16 and 8 .

```
&MESH IJK=40,26,16, XB=0.0,10.0,0.0,6.5,0.0,4.0 /

&TIME T_END=1.0 /

&SPEC ID='SOOT'/
&SM3D QUANTITY='DENSITY', SPEC_ID='SOOT' /
&INIT XB=0.0,10.0,0.0,6.4,0.0,4.0,MASS_FRACTION=0.00006624,SPEC_ID='SOOT' /

&OBST XB=0.0,2.6,  0.5,0.7,1.0,4.0, RGB=255,255,255 /
&OBST XB=0.0,4.0,  1.0,1.2,1.0,4.0, RGB=255,255,255 /
&OBST XB=0.0,5.6,  2.0,2.2,1.0,4.0, RGB=255,255,255 /
&OBST XB=0.0,7.0,  3.0,3.2,1.0,4.0, RGB=255,255,255 /
&OBST XB=0.0,8.6,  4.0,4.2,1.0,4.0, RGB=255,255,255 /
&OBST XB=0.0,10.0,5.0,5.4,1.0,4.0, RGB=255,255,255 /

&OBST XB=0.0,2.6,  0.0,1.0,0.0,1.0, RGB=181,181,181 /
&OBST XB=2.6,4.0,  0.0,1.0,0.0,1.0, RGB=128,128,128 /
&OBST XB=4.0,5.6,  0.0,1.0,0.0,1.0, RGB=64,64,64 /
&OBST XB=5.6,7.0,  0.0,1.0,0.0,1.0, RGB=32,32,32 /
&OBST XB=7.0,8.6,  0.0,1.0,0.0,1.0, RGB=16,16,16 /
&OBST XB=8.6,10.0, 0.0,1.0,0.0,1.0, RGB=8,8,8 /


&PROP ID='smoketest' SMOKEVIEW_ID='smokesensor' /
&DEVC XYZ=1.8,0.55,2.00, QUANTITY='VISIBILITY', ID='vis1' PROP_ID='smoketest' /
&DEVC XYZ=3.2,1.05,2.00, QUANTITY='VISIBILITY', ID='vis2' PROP_ID='smoketest' /
&DEVC XYZ=4.8,2.05,2.00, QUANTITY='VISIBILITY', ID='vis3' PROP_ID='smoketest' /
&DEVC XYZ=6.2,3.05,2.00, QUANTITY='VISIBILITY', ID='vis4' PROP_ID='smoketest' /
&DEVC XYZ=7.8,4.05,2.00, QUANTITY='VISIBILITY', ID='vis5' PROP_ID='smoketest' /
&DEVC XYZ=9.2,5.05,2.00, QUANTITY='VISIBILITY', ID='vis6' PROP_ID='smoketest' /

&SLCF PBX=5.0, QUANTITY='DENSITY',SPEC_ID='SOOT' /
&SLCF PBY=5.0, QUANTITY='DENSITY',SPEC_ID='SOOT' /
&SLCF PBZ=2.0, QUANTITY='DENSITY',SPEC_ID='SOOT' /
&SLCF XB=0.0,10.0,0.0,6.5,0.0,4.0,QUANTITY='DENSITY',SPEC_ID='SOOT' /
&SLCF XB=0.0,10.0,0.0,6.5,0.0,4.0,QUANTITY='TEMPERATURE' /

&SLCF XB=0.0,10.0,0.0,6.5,0.0,4.0, QUANTITY='DENSITY',SPEC_ID='SOOT',CELL_CENTERED=.TRUE.  / 3D slice
&SLCF XB=0.0,10.0,0.0,6.5,0.0,4.0, QUANTITY='TEMPERATURE',CELL_CENTERED=.TRUE.  / 3D slice

&TAIL /
```

A.9   transparency

```
&HEAD CHID='transparency', TITLE='Test of transparent vents' /
&MESH IJK=10,10,10, XB=0.0,1.0,0.0,1.0,0.0,1.0 /

&TIME T_END=0.0 /

&SURF ID='BURNER',HRRPUA=600.0 /
&REAC SOOT_YIELD=0.01,FUEL='PROPANE'/
&MISC TMPA=10. /
```

```
&WIND LAPSE_RATE=10.0 /
&RADI RADIATION=.FALSE./
&SLCF PBY=0.6, QUANTITY='TEMPERATURE' /

&VENT MB='XMIN', SURF_ID='BURNER' RGB=255,0,0 TRANSPARENCY=0.6/
&VENT MB='XMAX', SURF_ID='OPEN' /

&OBST XB=0.2,0.4,0.2,0.4,0.2,0.6 RGB=0,255,0/
&OBST XB=0.6,0.8,0.2,0.4,0.2,0.6 RGB=0,0,255 TRANSPARENCY=0.2 /



&TAIL /
```

A.10 tree_test2

```
&HEAD CHID='tree_test2', TITLE='Test for showing tree objects' /

&MESH IJK=10,10,10, XB=0.0,1.0,0.0,1.0,0.0,1.0 /
&MISC HUMIDITY=0., Y_O2_INFTY = 0.01/
&TIME T_END=10., DT=0.01, WALL_INCREMENT=1 /

&VENT XB=0.0,0.0,0.0,1.0,0.0,1.0, SURF_ID='OPEN'/
&VENT XB=1.0,1.0,0.0,1.0,0.0,1.0, SURF_ID='OPEN'/
&VENT XB=0.0,1.0,0.0,0.0,0.0,1.0, SURF_ID='OPEN'/
&VENT XB=0.0,1.0,1.0,1.0,0.0,1.0, SURF_ID='OPEN'/
&VENT XB=0.0,1.0,0.0,1.0,1.0,1.0, SURF_ID='OPEN'/

&REAC FUEL = 'GLUCOSE'
      C = 6.
      H = 12.
      O = 6.   /

&SPEC ID='WATER VAPOR' /

&SURF ID='HOT WALL', TMP_FRONT=1000., DEFAULT=.TRUE. /

&SURF ID                       = 'wet vegetation'
      MATL_ID(1,1:2)           = 'PINE','MOISTURE'
      MATL_MASS_FRACTION(1,1:2) = 0.8,0.2
      THICKNESS                = 0.00025
      LENGTH                   = 0.1
      GEOMETRY                 = 'CYLINDRICAL' /

&MATL ID = 'PINE'
      DENSITY = 500.
      CONDUCTIVITY = 0.1
      SPECIFIC_HEAT= 1.0
      N_REACTIONS = 1
      REFERENCE_TEMPERATURE = 300.
      NU_MATL = 0.2
      NU_SPEC = 0.8
      SPEC_ID = 'GLUCOSE'
      HEAT_OF_REACTION= 1000
      MATL_ID  = 'CHAR' /

&MATL ID = 'MOISTURE'
      DENSITY = 1000.
      CONDUCTIVITY = 0.1
      SPECIFIC_HEAT= 4.184
      N_REACTIONS = 1
      REFERENCE_TEMPERATURE = 100.
      NU_SPEC = 1.0
      SPEC_ID = 'WATER VAPOR'
      HEAT_OF_REACTION= 2500. /
```

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```
&MATL ID = 'CHAR'
      DENSITY  = 200.
      CONDUCTIVITY = 1.0
      SPECIFIC_HEAT = 1.6 /


&PART ID='pine needles', SAMPLING_FACTOR=1, SURF_ID='wet vegetation', PROP_ID='wood image'
      QUANTITIES='PARTICLE TEMPERATURE','PARTICLE MASS','PARTICLE DIAMETER', STATIC=.TRUE. /

&INIT PART_ID='pine needles', XB=0.,1.,0.,1.,0.,0.01, N_PARTICLES=10, MASS_PER_VOLUME=1.  /

&PROP ID='wood image', SMOKEVIEW_ID='CANOPY', SMOKEVIEW_PARAMETERS='CANOPY_D=0.1','CANOPY_H=0.4' /

&DUMP MASS_FILE=.TRUE. /

&DEVC XB=0.,1.,0.,1.,0.,1., QUANTITY='DENSITY', ID='fuel gas mass', STATISTICS='VOLUME INTEGRAL', SPEC_ID='GLUCOS
&DEVC XB=0.,1.,0.,1.,0.,1., QUANTITY='DENSITY', ID='water vapor mass', STATISTICS='VOLUME INTEGRAL', SPEC_ID='WAT
&DEVC XB=0.,1.,0.,1.,0.,1., QUANTITY='MPUV', PART_ID='pine needles', ID='solid mass', STATISTICS='VOLUME INTEGRAL

&SLCF PBY=0.5, QUANTITY='MASS FRACTION', SPEC_ID='WATER VAPOR' /
&SLCF PBY=0.5, QUANTITY='RELATIVE HUMIDITY' /

&TAIL /
```

A.11   vcirctest

```
&HEAD CHID='vcirctest', TITLE='Xin_velocity_specified' /

&MESH IJK=20,20,20, XB=0,2,0,2,0,2 / single coarse mesh for testing

&TIME T_END=10/

&MISC TMPA=15.
      TURBULENCE_MODEL = 'DEARDORFF'
      CHECK_VN=.TRUE. /

&REAC FUEL='METHANE'
      C=1.
      H=4.
      HEAT_OF_COMBUSTION=50350.
      RADIATIVE_FRACTION=0.1
      SOOT_YIELD=0.01 /

&SURF ID='FLAME', COLOR='ORANGE' , VEL = -0.0314, MASS_FRACTION(1) = 1.0, SPEC_ID(1) = 'METHANE'/

&SURF ID='XMIN' RGB=255,0,0 /
&SURF ID='XMAX' RGB=128,0,0 /
&SURF ID='YMIN' RGB=0,255,0 /
&SURF ID='YMAX' RGB=0,128,0 /
&SURF ID='ZMIN' RGB=0,0,255/
&SURF ID='ZMAX' RGB=0,0,128 /

&VENT MB='XMIN', SURF_ID='OPEN'/
&VENT MB='XMAX', SURF_ID='OPEN'/
&VENT MB='YMIN', SURF_ID='OPEN'/
&VENT MB='YMAX', SURF_ID='OPEN'/
&VENT MB='ZMAX', SURF_ID='OPEN'/


&OBST XB=0.6,1.4,0.6,1.4,0.6,1.4 /
&VENT XB=0.6,0.6,0.6,1.4,0.6,1.4, XYZ=0.6,1.0,1.0,RADIUS=0.3, SURF_ID='XMIN' /
&VENT XB=1.4,1.4,0.6,1.4,0.6,1.4, XYZ=1.4,1.0,1.0,RADIUS=0.3, SURF_ID='XMAX' /
&VENT XB=0.6,1.4,0.6,0.6,0.6,1.4, XYZ=1.0,0.6,1.0,RADIUS=0.3, SURF_ID='YMIN' /
&VENT XB=0.6,1.4,1.4,1.4,0.6,1.4, XYZ=1.0,1.4,1.0,RADIUS=0.3, SURF_ID='YMAX' /
&VENT XB=0.6,1.4,0.6,1.4,0.6,0.6, XYZ=1.0,1.0,0.6,RADIUS=0.3, SURF_ID='ZMIN' /
&VENT XB=0.6,1.4,0.6,1.4,1.4,1.4, XYZ=1.0,1.0,1.4,RADIUS=0.3, SURF_ID='ZMAX' /
```

```
&VENT MB='ZMIN', SURF_ID='OPEN'/

&SLCF PBY=.05, QUANTITY='VELOCITY', VECTOR=.TRUE./
&SLCF PBY=.05, QUANTITY='MASS FRACTION', SPEC_ID='METHANE', CELL_CENTERED=.TRUE./

&BNDF QUANTITY='WALL TEMPERATURE' /
&BNDF QUANTITY='NET HEAT FLUX' /
&BNDF QUANTITY='RADIATIVE HEAT FLUX' /
&BNDF QUANTITY='WALL CELL COLOR',CELL_CENTERED=.TRUE./

&TAIL /
```

A.12 vcirctest2

```
&HEAD CHID='vcirctest2', TITLE='SMV-Test for RADIUS-Vent' /

&MESH IJK=10,10,10, XB= 0.0,1.0,0.0,1.0,0.0,1.0/

&TIME T_END=0.0/

&SURF ID='BURN'/

&VENT XB=0.0,0.0,0.0,1.0,0.0,1.0,RADIUS=0.3,XYZ=0.0,0.5,0.5,SURF_ID='BURN',RGB=255,0,0/
&VENT XB=1.0,1.0,0.0,1.0,0.0,1.0,RADIUS=0.3,XYZ=1.0,0.5,0.5,SURF_ID='BURN',RGB=128,0,0/
&VENT XB=0.0,1.0,0.0,0.0,0.0,1.0,RADIUS=0.3,XYZ=0.5,0.0,0.5,SURF_ID='BURN',RGB=0,255,0/
&VENT XB=0.0,1.0,1.0,1.0,0.0,1.0,RADIUS=0.3,XYZ=0.5,1.0,0.5,SURF_ID='BURN',RGB=0,128,0/
&VENT XB=0.0,1.0,0.0,1.0,0.0,0.0,RADIUS=0.3,XYZ=0.5,0.5,0.0,SURF_ID='BURN',RGB=0,0,255/
&VENT XB=0.0,1.0,0.0,1.0,1.0,1.0,RADIUS=0.3,XYZ=0.5,0.5,1.0,SURF_ID='BURN',RGB=0,0,128/

&VENT PBX=0.0, SURF_ID='OPEN' /
&VENT PBX=1.0, SURF_ID='OPEN' /
&VENT PBY=0.0, SURF_ID='OPEN' /
&VENT PBY=1.0, SURF_ID='OPEN' /
&VENT PBZ=0.0, SURF_ID='OPEN' /
&VENT PBZ=1.0, SURF_ID='OPEN' /

&TAIL /
```

Appendix B

Smokeview Scripts

B.1   colorbar

```
RENDERDIR
 ..\..\Manuals\SMV_Verification_Guide\SCRIPT_FIGURES
// LOADFILE
//   colorbar_01.sf
LOADSLCF
 QUANTITY='TEMPERATURE' PBY=0.6
LOADINIFILE
 colorbar_low.ini
SETVIEWPOINT
 view 1
SETTIMEVAL
 9.961175
RENDERONCE
 colorbar_low

LOADINIFILE
 colorbar_med.ini
SETVIEWPOINT
 view 1
SETTIMEVAL
 9.961175
RENDERONCE
 colorbar_med

LOADINIFILE
 colorbar_high.ini
SETTIMEVAL
 9.961175
SETVIEWPOINT
 view 1
RENDERONCE
 colorbar_high
```

B.2   colorconv

```
RENDERDIR
 ..\..\Manuals\SMV_Verification_Guide\SCRIPT_FIGURES
LOADINIFILE
 colorconv_slice.ini
LOADSLCF
 QUANTITY='TEMPERATURE' PBY=1.0
RENDERCLIP
 1 100 100 20 20
SETTIMEVAL
```

```
 0.000000
RENDERONCE
 colorconv_slice_00000
SETTIMEVAL
 2.557976
RENDERONCE
 colorconv_slice_00025
SETTIMEVAL
 5.039277
RENDERONCE
 colorconv_slice_00050
SETTIMEVAL
 7.506437
RENDERONCE
 colorconv_slice_00075
SETTIMEVAL
 10.023949
RENDERONCE
 colorconv_slice_00100
SETTIMEVAL
 12.538355
RENDERONCE
 colorconv_slice_00125
SETTIMEVAL
 15.063926
RENDERONCE
 colorconv_slice_00150
SETTIMEVAL
 17.526268
RENDERONCE
 colorconv_slice_00175
SETTIMEVAL
 20.040606
RENDERONCE
 colorconv_slice_00200
SETTIMEVAL
 22.521618
RENDERONCE
 colorconv_slice_00225
SETTIMEVAL
 25.042652
RENDERONCE
 colorconv_slice_00250
SETTIMEVAL
 27.545835
RENDERONCE
 colorconv_slice_00275
SETTIMEVAL
 30.060387
RENDERONCE
 colorconv_slice_00300
SETTIMEVAL
 32.531887
RENDERONCE
 colorconv_slice_00325
SETTIMEVAL
 200.0
RENDERONCE
 colorconv_slice_02000
UNLOADALL
```

B.3   fed_test

```
RENDERDIR
 ..\..\Manuals\SMV_Verification_Guide\SCRIPT_FIGURES
XSCENECLIP
```

```
 0 -0.001000 0 1.001000
YSCENECLIP
 0 -0.001000 0 1.001000
ZSCENECLIP
 0 -0.001000 0 1.001000
SCENECLIP
 0
RENDERCLIP
 1 175 175 95 95
// LOADFILE
//   fed_test_05_fed.sf
LOADSLCF
 QUANTITY='Fractional effective dose' CELL_CENTERED=T PBY=0.5
SETTIMEVAL
 30.000000
RENDERONCE
 fed_test_030
SETTIMEVAL
 60.000000
RENDERONCE
 fed_test_060
SETTIMEVAL
 120.099998
RENDERONCE
 fed_test_120
SETTIMEVAL
 360.0
RENDERONCE
 fed_test_360
```

B.4   plume5c

```
// put rendered files in specified directory

RENDERDIR
 ..\..\Manuals\SMV_Verification_Guide\SCRIPT_FIGURES

UNLOADALL
LOADINIFILE
 plume5c_notexturebar.ini
LOADSLCF
 QUANTITY='TEMPERATURE' PBY=0.8
SETTIMEVAL
 0.5
RENDERONCE
 plume5c_notexturebar
KEYBOARD
 T
RENDERONCE
 plume5c_texturebar
KEYBOARD
 (


// render slice files

UNLOADALL
LOADINIFILE
 plume5c_slice.ini
LOADSLCF
 QUANTITY='TEMPERATURE' PBY=0.8
SETTIMEVAL
 0.0
RENDERONCE
 plume5c_slice_00
SETTIMEVAL
```

```
 10.0
RENDERONCE
 plume5c_slice_10
SETTIMEVAL
 30.0
RENDERONCE
 plume5c_slice_30

// render general slice 1

UNLOADALL
LOADINIFILE
 plume5c_gslice.ini
LOADSLCF
 QUANTITY='TEMPERATURE' PB3D=T
KEYBOARD
 *
KEYBOARD
 w
SETTIMEVAL
 0.0
RENDERONCE
 plume5c_gslice_00
SETTIMEVAL
 10.0
RENDERONCE
 plume5c_gslice_10
SETTIMEVAL
 30.0
RENDERONCE
 plume5c_gslice_30

// render general slice 2

UNLOADALL
LOADINIFILE
 plume5c_gslice2.ini
LOADSLCF
 QUANTITY='TEMPERATURE' PB3D=T
KEYBOARD
 *
KEYBOARD
 w
SETTIMEVAL
 0.0
RENDERONCE
 plume5c_gslice2_00
SETTIMEVAL
 10.0
RENDERONCE
 plume5c_gslice2_10
SETTIMEVAL
 30.0
RENDERONCE
 plume5c_gslice2_30

// render general vector slice 1

UNLOADALL
LOADINIFILE
 plume5c_gslice.ini
// LOADVFILE
//  plume5c_30.sf
LOADVSLICEM
 TEMPERATURE
 0 0.000000
 1
KEYBOARD
```

```
  *
KEYBOARD
 w
SETTIMEVAL
 0.0
RENDERONCE
 plume5c_vgslice_00
SETTIMEVAL
 10.0
RENDERONCE
 plume5c_vgslice_10
SETTIMEVAL
 30.0
RENDERONCE
 plume5c_vgslice_30

// render general vector slice 2

UNLOADALL
LOADINIFILE
 plume5c_gslice2.ini
// LOADVFILE
//  plume5c_30.sf
LOADVSLICEM
 TEMPERATURE
 0 0.000000
 1
KEYBOARD
 *
KEYBOARD
 w
SETTIMEVAL
 0.0
RENDERONCE
 plume5c_vgslice2_00
SETTIMEVAL
 10.0
RENDERONCE
 plume5c_vgslice2_10
SETTIMEVAL
 30.0
RENDERONCE
 plume5c_vgslice2_30

// render cell centered slice files

UNLOADALL
LOADINIFILE
 plume5c_slice_cell.ini
// LOADFILE
//  plume5c_14.sf
LOADSLCF
 QUANTITY='TEMPERATURE' CELL_CENTERED=T PBY=0.85
SETTIMEVAL
 0.0
RENDERONCE
 plume5c_slice_cell_00
SETTIMEVAL
 10.0
RENDERONCE
 plume5c_slice_cell_10
SETTIMEVAL
 30.0
RENDERONCE
 plume5c_slice_cell_30

// render cell centered slice files
```

```
UNLOADALL
LOADINIFILE
 plume5c_slice_cellchop.ini
LOADSLCF
 QUANTITY='TEMPERATURE' CELL_CENTERED=T PBY=0.85
SETTIMEVAL
 0.0
RENDERONCE
 plume5c_slice_cellchop_00
SETTIMEVAL
 10.0
RENDERONCE
 plume5c_slice_cellchop_10
SETTIMEVAL
 30.0
RENDERONCE
 plume5c_slice_cellchop_30

// render slice files with data chopping

UNLOADALL
LOADINIFILE
 plume5c_slicechop.ini
LOADSLCF
 QUANTITY='TEMPERATURE' PBY=0.8
SETTIMEVAL
 0.0
RENDERONCE
 plume5c_slice_chop_00
SETTIMEVAL
 10.0
RENDERONCE
 plume5c_slice_chop_10
SETTIMEVAL
 30.0
RENDERONCE
 plume5c_slice_chop_30

// render vector slice files

UNLOADALL
LOADINIFILE
 plume5c_vslice.ini
// LOADVFILE
//  plume5c_06.sf
LOADVSLICEM
 TEMPERATURE
 2 0.800000
 1
SETTIMEVAL
 0.0
RENDERONCE
 plume5c_vslice_00
SETTIMEVAL
 10.0
RENDERONCE
 plume5c_vslice_10
SETTIMEVAL
 30.0
RENDERONCE
 plume5c_vslice_30

// render vector slice files with chopping

UNLOADALL
LOADINIFILE
 plume5c_vslicechop.ini
// LOADVFILE
```

```
//   plume5c_06.sf
LOADVSLICEM
 TEMPERATURE
 2 0.800000
 1
SETTIMEVAL
 0.0
RENDERONCE
 plume5c_vslicechop_00
SETTIMEVAL
 10.0
RENDERONCE
 plume5c_vslicechop_10
SETTIMEVAL
 30.0
RENDERONCE
 plume5c_vslicechop_30

// render iso files (solid)

UNLOADALL
UNLOADALL
LOADINIFILE
 plume5c_iso.ini
// LOADFILE
//   plume5c_01.iso
LOADISOM
 TEMPERATURE: 100.0 řC
 1
SETTIMEVAL
 0.0
RENDERONCE
 plume5c_iso_solid_00
SETTIMEVAL
 10.0
RENDERONCE
 plume5c_iso_solid_10
SETTIMEVAL
 30.0
RENDERONCE
 plume5c_iso_solid_30

LOADINIFILE
 plume5c_iso2.ini
// LOADFILE
//   plume5c_01.iso
LOADISOM
 TEMPERATURE: 100.0 řC
 1
SETTIMEVAL
 30.0
RENDERONCE
 plume5c_iso2_solid_30

// render iso files (outline)

LOADINIFILE
 plume5c_iso_outline.ini
UNLOADALL
// LOADFILE
//   plume5c_01.iso
LOADISOM
 TEMPERATURE: 100.0 řC
 1
SETTIMEVAL
 0.0
RENDERONCE
 plume5c_iso_outline_00
```

```
SETTIMEVAL
 10.0
RENDERONCE
 plume5c_iso_outline_10
SETTIMEVAL
 30.0
RENDERONCE
 plume5c_iso_outline_30

// render iso files (points)

LOADINIFILE
 plume5c_iso_points.ini
UNLOADALL
// LOADFILE
//   plume5c_01.iso
LOADISOM
 TEMPERATURE: 100.0 řC
 1
SETTIMEVAL
 0.0
RENDERONCE
 plume5c_iso_points_00
SETTIMEVAL
 10.0
RENDERONCE
 plume5c_iso_points_10
SETTIMEVAL
 30.0
RENDERONCE
 plume5c_iso_points_30

// render particle files using points

LOADINIFILE
 plume5c_part.ini
UNLOADALL
LOADPARTICLES
PARTCLASSCOLOR
 Uniform color
SETTIMEVAL
 1.05
RENDERONCE
 plume5c_part_01
SETTIMEVAL
 10.0
RENDERONCE
 plume5c_part_10
SETTIMEVAL
 30.0
RENDERONCE
 plume5c_part_30
RENDERONCE
 plume5c_part

// render particle files using streaks

UNLOADALL
LOADINIFILE
 plume5c_part_streak.ini
LOADPARTICLES
PARTCLASSCOLOR
 Uniform color
SETTIMEVAL
 1.05
RENDERONCE
 plume5c_part_streak_01
SETTIMEVAL
```

```
 10.0
RENDERONCE
 plume5c_part_streak_10
SETTIMEVAL
 30.0
RENDERONCE
 plume5c_part_streak_30
RENDERONCE
 plume5c_streak

// render particles using streaks (different length)

UNLOADALL
LOADINIFILE
 plume5c_part_streak2.ini
LOADPARTICLES
PARTCLASSCOLOR
 Uniform color
SETTIMEVAL
 1.05
RENDERONCE
 plume5c_part_streak2_01
SETTIMEVAL
 10.0
RENDERONCE
 plume5c_part_streak2_10
SETTIMEVAL
 30.0
RENDERONCE
 plume5c_part_streak2_30

// render boundary files

UNLOADALL
LOADINIFILE
 plume5c_bound.ini
// LOADFILE
//  plume5c_03.bf
LOADBOUNDARYM
 WALL TEMPERATURE
 1
SETTIMEVAL
 2.0
RENDERONCE
 plume5c_bound_00
SETTIMEVAL
 10.0
RENDERONCE
 plume5c_bound_10
SETTIMEVAL
 30.0
RENDERONCE
 plume5c_bound_30

// render cell centered boundary files

UNLOADALL
LOADINIFILE
 plume5c_bound_cellcenter.ini
// LOADFILE
//  plume5c_04.bf
LOADBOUNDARYM
 WALL TEMPERATURE(cell centered)
 1
SETTIMEVAL
 2.0
RENDERONCE
 plume5c_bound_cell_00
```

```
SETTIMEVAL
 10.0
RENDERONCE
 plume5c_bound_cell_10
SETTIMEVAL
 30.0
RENDERONCE
 plume5c_bound_cell_30

// render chopped boundary files

UNLOADALL
LOADINIFILE
 plume5c_bound_chop.ini
// LOADFILE
//   plume5c_03.bf
LOADBOUNDARYM
 WALL TEMPERATURE
 1
SETTIMEVAL
 2.0
RENDERONCE
 plume5c_bound_chop_00
SETTIMEVAL
 10.0
RENDERONCE
 plume5c_bound_chop_10
SETTIMEVAL
 30.0
RENDERONCE
 plume5c_bound_chop_30

// render 3D smoke files

UNLOADALL
LOADFILE
 plume5c_1_1.s3d
LOADFILE
 plume5c_1_2.s3d
SETTIMEVAL
 1.05
RENDERONCE
 plume5c_smoke_01
SETTIMEVAL
 10.0
RENDERONCE
 plume5c_smoke_10
SETTIMEVAL
 30.0
RENDERONCE
 plume5c_smoke_30

// render PLOT3D line contours

UNLOADALL
LOADINIFILE
 plume5c_plot3d_line.ini
LOADPLOT3D
 1 40.0
SETVIEWPOINT
 external
RENDERONCE
 plume5c_plot3d_line

// render PLOT3D stepped contours

UNLOADALL
LOADINIFILE
```

```
 plume5c_plot3d_step.ini
LOADPLOT3D
 1 40.0
SETVIEWPOINT
 external
RENDERONCE
 plume5c_plot3d_step

// render PLOT3D continuous contours

UNLOADALL
LOADINIFILE
 plume5c_plot3d_shaded.ini
LOADPLOT3D
 1 40.0
SETVIEWPOINT
 external
RENDERONCE
 plume5c_plot3d_shaded


// render OBSTs using solid view

UNLOADALL
LOADINIFILE
 plume5c_solid.ini
SETVIEWPOINT
 external
RENDERONCE
 plume5c_solid

// render OBSTs using outline view

LOADINIFILE
 plume5c_outline.ini
SETVIEWPOINT
 external
RENDERONCE
 plume5c_outline

// render geometry using hidden view (ie don't draw OBSTs)

LOADINIFILE
 plume5c_hidden.ini
SETVIEWPOINT
 external
RENDERONCE
 plume5c_hidden

// render vents - hide open vents

LOADINIFILE
 plume5c_noopenvents.ini
SETVIEWPOINT
 external
RENDERONCE
 plume5c_noopen

// render vents - don't show any vents

LOADINIFILE
 plume5c_novents.ini
SETVIEWPOINT
 external
RENDERONCE
 plume5c_novents

// render vents - show all vents
```

```
LOADINIFILE
 plume5c_allvents.ini
SETVIEWPOINT
 external
RENDERONCE
 plume5c_allvents

// render 3D smoke GPU off

UNLOADALL
LOADINIFILE
 plume5c_nongpu.ini
LOADFILE
 plume5c_1_1.s3d
LOADFILE
 plume5c_1_2.s3d
SETTIMEVAL
 5.05
RENDERONCE
 plume5c_smoke_nongpu_05
SETTIMEVAL
 10.0
RENDERONCE
 plume5c_smoke_nongpu_10
SETTIMEVAL
 30.0
RENDERONCE
 plume5c_smoke_nongpu_30

// render 3D smoke GPU on

UNLOADALL
LOADINIFILE
 plume5c_gpu.ini
LOADFILE
 plume5c_1_1.s3d
LOADFILE
 plume5c_1_2.s3d
SETTIMEVAL
 5.05
RENDERONCE
 plume5c_smoke_gpu_05
SETTIMEVAL
 10.0
RENDERONCE
 plume5c_smoke_gpu_10
SETTIMEVAL
 30.0
RENDERONCE
 plume5c_smoke_gpu_30

// render PLOT3D contours

UNLOADALL
LOADINIFILE
 plume5c_plot3d.ini
LOADPLOT3D
 1 40.0
SHOWPLOT3DDATA
 1 1 1 0 0.800000
SHOWPLOT3DDATA
 1 2 1 1 1.100000
SHOWPLOT3DDATA
 1 3 1 0 1.600000
SHOWPLOT3DDATA
 1 4 1 0 6
PLOT3DPROPS
```

```
 1 0 6 1
RENDERONCE
plume5c_plot3d_y1
SHOWPLOT3DDATA
 1 1 1 0 0.800000
SHOWPLOT3DDATA
 1 2 1 1 0.800000
SHOWPLOT3DDATA
 1 3 1 0 1.600000
SHOWPLOT3DDATA
 1 4 1 0 6
PLOT3DPROPS
 1 0 6 1
RENDERONCE
plume5c_plot3d_y2
SHOWPLOT3DDATA
 1 1 1 0 0.800000
SHOWPLOT3DDATA
 1 2 1 1 0.500000
SHOWPLOT3DDATA
 1 3 1 0 1.600000
SHOWPLOT3DDATA
 1 4 1 0 6
PLOT3DPROPS
 1 0 6 1
RENDERONCE
plume5c_plot3d_y3
SHOWPLOT3DDATA
 1 1 1 0 0.800000
SHOWPLOT3DDATA
 1 2 1 1 0.200000
SHOWPLOT3DDATA
 1 3 1 0 1.600000
SHOWPLOT3DDATA
 1 4 1 0 6
PLOT3DPROPS
 1 0 6 1
RENDERONCE
plume5c_plot3d_y4

// render PLOT3D vectors

LOADINIFILE
 plume5c_plot3dvector.ini
LOADPLOT3D
 1 40.0
SHOWPLOT3DDATA
 1 1 1 0 0.800000
SHOWPLOT3DDATA
 1 2 1 1 1.100000
SHOWPLOT3DDATA
 1 3 1 0 1.600000
SHOWPLOT3DDATA
 1 4 1 0 6
PLOT3DPROPS
 1 1 -1 1 20.0
RENDERONCE
plume5c_plot3d_v1
SHOWPLOT3DDATA
 1 1 1 0 0.800000
SHOWPLOT3DDATA
 1 2 1 1 0.800000
SHOWPLOT3DDATA
 1 3 1 0 1.600000
SHOWPLOT3DDATA
 1 4 1 0 6
PLOT3DPROPS
 1 1 -1 1 20.0
```

```
RENDERONCE
plume5c_plot3d_v2
SHOWPLOT3DDATA
 1 1 1 0 0.800000
SHOWPLOT3DDATA
 1 2 1 1 0.500000
SHOWPLOT3DDATA
 1 3 1 0 1.600000
SHOWPLOT3DDATA
 1 4 1 0 6
PLOT3DPROPS
 1 1 -1 1 20.0
RENDERONCE
plume5c_plot3d_v3
SHOWPLOT3DDATA
 1 1 1 0 0.800000
SHOWPLOT3DDATA
 1 2 1 1 0.200000
SHOWPLOT3DDATA
 1 3 1 0 1.600000
SHOWPLOT3DDATA
 1 4 1 0 6
PLOT3DPROPS
 1 1 -1 1 20.0
RENDERONCE
plume5c_plot3d_v4

// render PLOT3D iso-surface

SHOWPLOT3DDATA
 1 1 1 0 0.800000
SHOWPLOT3DDATA
 1 2 1 0 0.400000
SHOWPLOT3DDATA
 1 3 1 0 1.600000
SHOWPLOT3DDATA
 1 4 1 1 0
PLOT3DPROPS
 1 0 6 1
RENDERONCE
plume5c_plot3d_i1
SHOWPLOT3DDATA
 1 1 1 0 0.800000
SHOWPLOT3DDATA
 1 2 1 0 0.400000
SHOWPLOT3DDATA
 1 3 1 0 1.600000
SHOWPLOT3DDATA
 1 4 1 1 3
PLOT3DPROPS
 1 0 6 1
RENDERONCE
plume5c_plot3d_i2
SHOWPLOT3DDATA
 1 1 1 0 0.800000
SHOWPLOT3DDATA
 1 2 1 0 0.400000
SHOWPLOT3DDATA
 1 3 1 0 1.600000
SHOWPLOT3DDATA
 1 4 1 1 6
PLOT3DPROPS
 1 0 6 1
RENDERONCE
plume5c_plot3d_i3
SHOWPLOT3DDATA
 1 1 1 0 0.800000
SHOWPLOT3DDATA
```

```
 1 2 1 0 0.400000
SHOWPLOT3DDATA
 1 3 1 0 1.600000
SHOWPLOT3DDATA
 1 4 1 1 9
PLOT3DPROPS
 1 0 6 1
RENDERONCE
plume5c_plot3d_i4


// render PLOT3D line contours

LOADINIFILE
 plume5c_plot3dline.ini
SHOWPLOT3DDATA
 1 1 1 0 0.800000
SHOWPLOT3DDATA
 1 2 1 1 1.100000
SHOWPLOT3DDATA
 1 3 1 0 1.600000
SHOWPLOT3DDATA
 1 4 1 0 6
PLOT3DPROPS
 1 0 6 2
RENDERONCE
plume5c_plot3d_l1
SHOWPLOT3DDATA
 1 1 1 0 0.800000
SHOWPLOT3DDATA
 1 2 1 1 0.800000
SHOWPLOT3DDATA
 1 3 1 0 1.600000
SHOWPLOT3DDATA
 1 4 1 0 6
PLOT3DPROPS
 1 0 6 2
RENDERONCE
plume5c_plot3d_l2
SHOWPLOT3DDATA
 1 1 1 0 0.800000
SHOWPLOT3DDATA
 1 2 1 1 0.500000
SHOWPLOT3DDATA
 1 3 1 0 1.600000
SHOWPLOT3DDATA
 1 4 1 0 6
PLOT3DPROPS
 1 0 6 2
RENDERONCE
plume5c_plot3d_l3
SHOWPLOT3DDATA
 1 1 1 0 0.800000
SHOWPLOT3DDATA
 1 2 1 1 0.200000
SHOWPLOT3DDATA
 1 3 1 0 1.600000
SHOWPLOT3DDATA
 1 4 1 0 6
PLOT3DPROPS
 1 0 6 2
RENDERONCE
plume5c_plot3d_l4

// render two left/right stereo images

UNLOADALL
LOADPARTICLES
```

```
LOADINIFILE
 plume5c_lr_stereo.ini
SETTIMEVAL
 30.000000
SETVIEWPOINT
 view 1
RENDERONCE
 plume5c_iso_lr_stereo

// render two stereo images

LABEL
  render two stereo images

LOADINIFILE
 plume5c_rc_stereo.ini
SETTIMEVAL
 30.000000
RENDERONCE
 plume5c_iso_rc_stereo

// render two stereo images

LABEL
  render two stereo images

LOADINIFILE
 plume5c_rb_stereo.ini
SETTIMEVAL
 30.000000
RENDERONCE
 plume5c_iso_rb_stereo
```

B.5   sillytexture

```
RENDERDIR
 ..\..\Manuals\SMV_User_Guide\SCRIPT_FIGURES
SETVIEWPOINT
 external
RENDERONCE
 sillytexture
```

B.6   smoke_sensor

```
RENDERDIR
 ..\..\Manuals\SMV_Verification_Guide\SCRIPT_FIGURES
SETVIEWPOINT
 view 1
RENDERONCE
 smoke_sensor
```

B.7   smoke_test

```
RENDERDIR
 ..\..\Manuals\SMV_Verification_Guide\SCRIPT_FIGURES
UNLOADALL
LOADFILE
 smoke_test_1_1.s3d
SETTIMEVAL
```

```
 0.159000
RENDERCLIP
 1 3 3 113 113
RENDERONCE
 smoke_test_all
SHOWSMOKESENSORS
RGBTEST
 1.8 0.0 2.1 181 181 181 5
RGBTEST
 3.4 0.0 2.1 128 128 128 5
RGBTEST
 4.8 0.0 2.1  64  64  64 5
RGBTEST
 6.2 0.0 2.1  32  32  32 5
RGBTEST
 7.6 0.0 2.1  16  16  16 5
RGBTEST
 9.4 0.0 2.1   8   8  8  5
```

B.8 smoke_test2

```
RENDERDIR
 ..\..\Manuals\SMV_Verification_Guide\SCRIPT_FIGURES
UNLOADALL
LOADFILE
 smoke_test2_1_1.s3d
SETTIMEVAL
 0.159000
RENDERCLIP
 1 3 3 110 110
RENDERONCE
 smoke_test2_all
RGBTEST
 1.8 0.0 2.1 181 181 181 5
RGBTEST
 3.4 0.0 2.1 128 128 128 5
RGBTEST
 4.8 0.0 2.1  64  64  64 5
RGBTEST
 6.2 0.0 2.1  32  32  32 5
RGBTEST
 7.6 0.0 2.1  16  16  16 5
RGBTEST
 9.4 0.0 2.1   8   8  8  5
```

B.9 sprinkler_many

```
RENDERDIR
   ..\..\Manuals\SMV_Verification_Guide\SCRIPT_FIGURES
SETVIEWPOINT
 view1
RENDERONCE
 sprink_many_view1
RENDERONCE
 sprink_many_view1
SETVIEWPOINT
 view2
RENDERONCE
 sprink_many_view2
SETVIEWPOINT
 view3
RENDERONCE
 sprink_many_view3
```

B.10   transparency

```
RENDERDIR
 ..\..\Manuals\SMV_Verification_Guide\SCRIPT_FIGURES
SETVIEWPOINT
 view_left
RENDERONCE
 transparency_left
RENDERONCE
 transparency_left
SETVIEWPOINT
 view_center
RENDERONCE
 transparency_center
SETVIEWPOINT
 view_right
RENDERONCE
 transparency_right
```

B.11   tree_test2

```
RENDERDIR
 ..\..\Manuals\SMV_Verification_Guide\SCRIPT_FIGURES
XSCENECLIP
 0 -0.001000 0 1.001000
YSCENECLIP
 0 -0.001000 0 1.001000
ZSCENECLIP
 0 -0.001000 0 1.001000
SCENECLIP
 0
LOADPARTICLES
PARTCLASSCOLOR
 PARTICLE TEMPERATURE
SETTIMEVAL
 0.000000
RENDERONCE
 tree_test2_part_00
SETTIMEVAL
 3.000000
RENDERONCE
 tree_test2_part_03
SETTIMEVAL
 6.000000
RENDERONCE
 tree_test2_part_06
SETTIMEVAL
 9.000000
RENDERONCE
 tree_test2_part_09
```

B.12   vcirctest

```
RENDERDIR
 ..\..\Manuals\SMV_Verification_Guide\SCRIPT_FIGURES
XSCENECLIP
 0 -0.002000 0 2.002000
YSCENECLIP
 0 -0.002000 0 2.002000
```

```
ZSCENECLIP
 0 -0.002000 0 2.002000
SCENECLIP
 0
RENDERCLIP
 1 87 126 36 34
SETVIEWPOINT
 view 1
RENDERONCE
 vcirctest_fds
KEYBOARD
 q
RENDERONCE
 vcirctest_circ
LOADINIFILE
 vcirctest_outline.ini
SETVIEWPOINT
 view 1
SETVIEWPOINT
 view 1
RENDERONCE
 vcirctest_fds_outline
KEYBOARD
 q
RENDERONCE
 vcirctest_circ_outline
```

B.13   vcirctest2

```
// put rendered files in specified directory

RENDERDIR
 ..\..\Manuals\SMV_Verification_Guide\SCRIPT_FIGURES
XSCENECLIP
 0 -0.001000 0 1.001000
YSCENECLIP
 0 -0.001000 0 1.001000
ZSCENECLIP
 0 -0.001000 0 1.001000
SCENECLIP
 0
RENDERCLIP
 1 217 187 81 71
RENDERONCE
 vcirctest2_circ
KEYBOARD
 q
RENDERONCE
 vcirctest2_fds
LOADINIFILE
 vcirctest2_outline.ini
RENDERCLIP
 1 217 187 81 71
RENDERONCE
 vcirctest2_circ_outline
KEYBOARD
 q
RENDERONCE
 vcirctest2_fds_outline
```