

AOS 452 Lab 11 Handout

Vis5D I: The Basics

UNIX Tip of the Day: You can use the <Tab> key whenever you're typing a command or filename, and the computer will fill in as much of the rest of the command or filename as it can.

Introduction

Today, we'll begin exploring another powerful analysis tool – Vis5D. Vis5D is a data visualization program that provides highly interactive 3D displays. (The other two “dimensions” in 5D are time and the meteorological variables.) Vis5D is a homegrown product, developed in this building at the Space Science and Engineering Center (SSEC). Vis5D can produce isosurfaces, contour line slices, colored slices, parcel trajectories, and more, all in a 3D box that you can rotate and animate. So, without further ado...

Vis5D Overview

Vis5D Variables:

<u>NAME</u>	<u>Quantity (units)</u>
U	East/West Wind Speed (m/s)
V	North/South Wind Speed (m/s)
W	Vertical Wind Speed (m/s)
SPEED	3-d wind speed (m/s)
PRES	Pressure (hPa)
MSLP	Mean Sea Level Pressure (hPa)
T	Temperature (K)
THETA	Potential Temperature (K)
THETA E	Equivalent Potential Temperature (K)
QV	Water Vapor Mixing Ratio (g/kg)
QZ	Vertical comp of Absolute vorticity (*.1 /sec)
PZ	Potential Vorticity (PVU)
PCPT	Total Precipitation (mm)
U-GEO	U Component of Geostrophic Wind (m/s)
V-GEO	V Component of Geostrophic Wind (m/s)
U-AGEO	U Component of Ageostrophic Wind (m/s)
V-AGEO	V Component of Ageostrophic Wind (m/s)
QV CNV	Q Vector Convergence
QV-PHI	QV Phi
QVXP	X component of Q vector (for -wind2 QVXP QVYP)
QVYP	Y component of Q vector (for -wind2 QVXP QVYP)
FRNT2D	2-d total frontogenesis (deg/m/s)
FRNT2DH	2-d frontogenesis by horizontal wind (deg/m/s)

FRNT2DV 2-d frontogenesis by vertical wind (deg/m/s)

We will be using a Vis5D file from the most recent GFS 12z model run showing North America. Type in the following at the terminal prompt:

```
vis5d /ef5/raid6/class/fall11/mbreeden/Desktop/00_LATEST_GFS_12.v5d
```

Vis5D requires significant computational resources. As a consequence, it may run slowly at times. Be patient and give Vis5D time to respond to your commands. Do not click things repeatedly just because a response is not immediately forthcoming.

As with GEMPAK, **NEVER** click the 's to close a window or quit Vis5D. Processes will continue to run on your machine, making subsequent runs of Vis5D slower. Eventually, your computer will become unstable and crash. Instead, always click on **EXIT** to end your Vis5D session.

Once Vis5D is running, you'll see two primary windows. On the right is the 3D display window. All of the plots you create will appear here. On the left is the control panel, which contains three sections.

Vis5D Control Panel Sections

Top: *General controls*

This section has a number of buttons that control the overall operation of Vis5D. Particularly useful buttons include ANIMATE, STEP, EXIT, TOP, SOUTH, WEST, MAP, REVERSE, and SAVE PIC. Some of these buttons behave in the opposite sense when right-clicked (e.g., left-clicking on WEST gives you a view from the west, but right-clicking on WEST gives you a view from the east.)

Middle: *Viewing modes*

Vis5D has several modes under which you can analyze and manipulate the plots in the display window. A brief description of each mode follows:

- Normal:** Rotate, zoom, and pan the graphics in the display window
- Trajectory:** Create and display trajectories (deferred until Lab 12 handout)
- Slice:** Reposition horizontal and vertical slices (cross-sections)
- Label:** Create and edit text labels in the display window
- Probe:** Inspect individual grid values (deferred until Lab 12 handout)
- Sounding:** Display a vertical sounding on a Skew-T (deferred until Lab 12 handout)
- Clipping:** Adjust clipping planes to change the viewing volume (deferred until Lab 12 handout)

To the right of the mode menu is a white box showing the function of each mouse button when used in the display window. Different modes have different mouse-button

functions.

Bottom: *Vector and scalar field selection*

Vector and scalar variables that you will be able to display on your plots are given in the bottom section of the control panel. The vector variable options are found in a horizontal line immediately below the viewing mode section. The horizontal and vertical wind options (Hwind1, Vwind1, Hwind2, and Vwind2) depict wind values by drawing small arrows that point in the direction of the wind. The horizontal and vertical streamline options (Hstream, Vstream) depict wind values by drawing streamlines in the horizontal and vertical planes.

Below the vector variable options are six columns with scalar variables. Each column corresponds with the display type to be shown in the display window. Here is a brief description of each of these modes:

<i>Isosurface:</i>	Shows a 3D volume bounded by a particular value of the field selected
<i>Contour Slice Horiz.:</i>	Shows horizontal contours
<i>Contour Slice Vert.:</i>	Shows contours on a vertical cross-section
<i>Colored Slice Horiz.:</i>	Shows horizontal color-filled contours
<i>Colored Slice Vert.:</i>	Shows color-filled contours on a vertical cross-section
<i>Volume:</i>	Shows a 3D field as a semi-transparent fog

The scalar variables available for plotting vary with each Vis5D file. For this case there are up to 25 variables available.

Rotate, zoom, and translate

One of the great features of Vis5D is the ability to rotate, zoom, and translate (that is, slide) the plot in the display window. You will find that the “standard” views (TOP, SOUTH, and WEST) often do not provide the best perspective for viewing data.

- 1) To rotate, zoom, or translate, you must be in Normal mode.
- 2) Rotation is controlled with the left mouse button. To rotate the plot, click and hold the left mouse button with the pointer on the plot, then move the mouse. The plot can be rotated in all directions, even upside down.
- 3) Zooming is controlled with the center mouse button. To zoom in, click and hold the center mouse button with the pointer on the plot, then move the mouse away from you. To zoom out, click and hold the center mouse button and move the mouse towards you. Zooming is focused on the center point of the display window.
- 4) Translation is controlled with the right mouse button. Click and hold the right mouse button, and as you move the mouse, the plot will slide along with you.
- 5) If you want to return to the original top view, simply click on the TOP button in

the control panel.

Now it's your turn!

Click the MAP button so that a map of a portion of North Pacific appears in the graphics window. Practice a bit with the zoom, rotate, and translate options, following the instructions above.

Creating Vis5D Plots

A) Horizontal Plots

When generating plots in GEMPAK, you mainly used pressure as the vertical coordinate. In Vis5D, however, the vertical coordinate is height. As a result, we cannot make our customary plots of geopotential height on an isobaric surface. Don't worry, though! Contouring variables on a constant-height surface is quite analogous. For example, we can make contours at 5.5 km in lieu of 500 mb. Let's try making this plot.

- 1) Bring up the map by clicking on the MAP button.
- 2) Click on the THETA button under Contour Slice Horiz. with the left mouse button.
- 3) A contour interval window will pop up, and can be toggled with the middle mouse button when clicked on THETA. Change to interval to 3 (units are kelvin). This window also lets you pick the vertical level. Slide the red diamond to 5.5 km.
- 4) If you want to change the color of the contours, click the right mouse button on THETA. A color format window with slide bars for red, green, and blue should appear near the bottom of the screen. Adjust the colors as you wish.

We will now loop through the available times in the Vis5D file. For this file, 41 times are available. Two different looping options exist:

STEP: A left (right) mouse click on the STEP button advances the loop one frame forward (backward). A middle mouse click brings you to the first time step.

ANIMATE: Use the left or middle mouse button for forward animation and the right mouse button for backward animation. To make the animation faster (slower), hold down the Shift key and press F (S) while the display window is selected. To stop the loop, click ANIMATE with any mouse button.

Try working with other variables in the Contour Slice Horiz. column. To remove variables from the plot, click again on the highlighted boxes.

B) Wind Vectors

Experiment with wind vectors following these directions:

- 1) Remove all variables from the display window, leaving just the background map.
- 2) Click on the Hwind1 button near the middle of the control panel. You should see a plethora of arrows in the display window.
- 3) The density of these arrows may be too high. We can adjust the density of the arrows by changing the density setting. After clicking on Hwind1, a panel should appear near the bottom of the screen that has settings for scale and density. If the panel did not appear, move the cursor to the Hwind1 button and click the middle mouse button. Enter a density value of 0.5 and press <Enter>. A lesser number of arrows should be in the display window.
- 4) You can also adjust the size of the arrows by changing the scale factor. Enter 0.75 for the scale factor. The size of the arrows should be smaller.
- 5) To change the height at which the arrows are plotted, you can either move the slider in the bar below the scale and density settings or go into Slice mode, described below.

C) Vertical Cross-Sections

Vertical cross-sections are easy to create in Vis5D. For this example, we are going to create a vertical cross-section of potential temperature.

- 1) Clear all previous plots, leaving just the background map. Make sure that you are in the TOP view.
- 2) Select the Slice mode.
- 3) Left click on THETA in the third column. The line along which a vertical cross-section is drawn appears in the display window. You can move this line by right-clicking at the endpoints of the line (in Slice mode only). Try moving this line to a new position.
- 4) Once you are done moving the line, click on the SOUTH button with the left mouse button. You will be looking at the vertical cross-section from the south.
- 5) Click on the THETA button with the left mouse button to bring up a panel that allows you to change the contour interval. For this profile, make the contour interval 4 K. After hitting <Enter>, more contours should be plotted.
- 6) Deselect THETA in the third column and return to Normal mode. In addition, click the TOP button with the left mouse button to return to the top view.

D) Isosurfaces

One very nice feature of Vis5D is its ability to create isosurfaces. For this lab, let's experiment with the 290 K isosurface of potential temperature.

- 1) Make sure you're in Normal mode.
- 2) Left-click on the THETA button under the Isosurf column. A bar should appear near the bottom of the screen that allows you to set the value of the isosurface. (If the bar does not appear, click on THETA with the middle mouse button.) Set the value at 290 K and click OK.
- 3) Step or animate through the different times to see how 290 K theta evolves

through time. Use the zoom and rotate options to view the isosurface from different angles. Neato!

- 4) Click on the THETA button in the first column with the right mouse button. A color format box will appear near the bottom of the screen. Change the opacity to 0.5. The theta isosurface should become more transparent.
- 5) Now, click on the pres button in the second column (under contour horiz.) and set the level to 1.0 km. Adjust the color and interval of the contours to make them more clearly visible.
- 6) Step or animate through the available times, and enjoy watching how the isosurface and (perturbation) pressure field change with time.
- 7) Here's where it gets really exciting. You can color isosurfaces based on the value of some other field. Let's color our isosurface by water vapor mixing ratio. Right-click on THETA in the first column, and then click QV in the isosurface color control panel that pops up. You will see the isosurface change colors based on the water vapor mixing ratio at each point on the isosurface.

Miscellaneous Information

Changing color rainbow

For certain plots like isosurfaces colored by another field, you can alter the contrast and transition point of the colors. First, make sure you have selected the control panel that contains the RGB intensity lines.

- To increase contrast, press the down arrow button on your keyboard.
- To decrease contrast, press the up arrow button.
- To make colors bluer, press the right arrow.
- To make colors redder, press the left arrow.

You can also click on the red (left-click), green (middle-click), and blue (right-click) lines to make more personalized changes, but it takes a while to get the hang of it.

Adding text

Text labels are used to annotate the images in the display window. You can add a title, your name, the date, or text highlighting particular features in the display.

- 1) You must be in Label mode to add text
- 2) To enter text, move the cursor somewhere in the display window and press the left mouse button. A vertical bar will appear at that location. Type in the desired text. When you are finished, press <Enter>.
- 3) To move text, point at it with the mouse, hold down the middle button, and move the mouse.
- 4) To delete text, move the cursor to the text and press the right mouse button. Once deleted, the text can only be restored through retyping.

Saving and printing Vis5D plots

- 1) If you plan to print out the Vis5D plot, reverse the colors in the display window by clicking the REVERSE button. The main background will change from black to white. Unlike GEMPAK, Vis5D does not automatically reverse colors for printing, so failing to perform this step will waste much toner. You may need to change the color of the contours after the color reversal to make the contours visible.
- 2) Select SAVE PIC.
- 3) Save the file as anything you desire. For example, select GIF and enter an appropriate filename (e.g., name_of_file.gif).
- 4) After saving an image from Vis5D, you will need to open the image using **xv** from the Unix prompt. Then, right-click on the image to get the control panel for **xv**. Click on the print button. Before clicking OK, make sure the image is set to grayscale. You may want to print the image in landscape or portrait mode, so select either option. Finally, make sure that the size of the image is small enough to print on a 8.5" x 11" sheet. If not, use the dials in the upper right of the control panel to adjust. Click on OK to print the image.

Saving and restoring Vis5D environment settings(VERY USEFUL!!!)

- 1) To save the settings you have now created in vis5d simply press the "save" button in the top control area. Mouse over the dialog box and choose an appropriate name, then click "save". This will now save all the modifications you have made to isosurfaces, cross sections, horizontal variables, etc.
- 2) To restore these settings simply click the "restore" button in the top controls area, type in the name of the file and click "ok". This will allow you to quickly load up old settings, making it easy for you to load a few plots for future weather discussions and greatly enhancing the discussion!!!

Exiting Vis5D

To exit Vis5D, click the EXIT button. Do not exit out of Vis5D by trying to close the control panel and display windows!

Vis5D Resources

The following web pages have useful Vis5D information and data:

-  <http://www.emc.ncep.noaa.gov/gmb/wd23ja/vis5d.html> - Vis5D files for current NCEP model runs
-  The AOS Forecast Model Page has links to the most recent model runs in Vis5D

format.

-  <http://vis5d.sourceforge.net/doc/ch06.html> - Vis5D user guide
-  <http://www.ssec.wisc.edu/~billh/vis5d.html> - Original Vis5D web site

Additional Vis5D files are located in the /research/vis5d directory or on the AOS webpage maintained by Pete Pokrandt. (Big thanks to Pete for making these readily available in real time!)