



FSI

Four-dimensional Stormcell Investigator

**D-2D Extension
And
Graphical User Interface**

Guide for Users

Version **OB7.2 alpha**

Second Version: April 17, 2007

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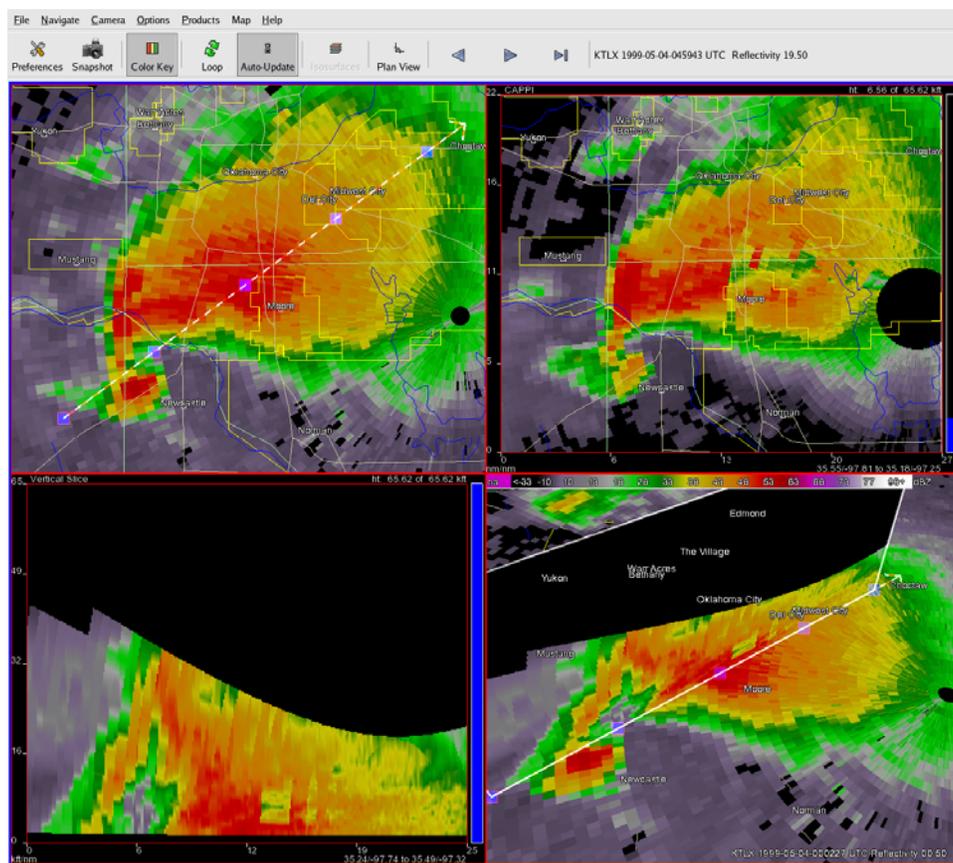
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-INTRODUCTION-

The **F**our-dimensional **S**tormcell **I**nvestigator (FSI) is an innovative base radar data display application that is based on the National Severe Storms Laboratory (NSSL) Warning Decision Support System – Integrated Information (WDSSII) graphical user interface (wg). This technology allows users to create and manipulate dynamic cross-sections (both vertical and at constant altitude), such that one can “slice and dice” storms and view these cross-section data in three-dimensions and across time. The FSI is a 4-panel display depicting base radar data from a variety of linked two- and three-dimensional representations. An AWIPS D-2D extension is used to launch this application into an independent window.



We will make this user guide as comprehensive as possible – sort of an “FSI for Dummies” document. Accompanying this lengthy user guide will be a short [FSI Quick Reference Guide](#) which can be used to access the most commonly used functionality of the FSI.

Also bear in mind that this user guide only describes the knobology of the FSI. Information about how to scientifically analyze severe storms in three-dimensions for warning decision making is part of the training materials prepared by the [NWS Warning Decision Training Branch](#).

Once Upon A Time...

In the pre-WSR-88D era, many radar consoles allowed operational meteorologists to manually control the radar beam, including some rudimentary capabilities to view vertical cross-sections (e.g., the Range-Height Indicator, or RHI). These radar display and control capabilities allowed research and operational meteorologists to amass expertise in the horizontal and vertical structure and evolution of severe storms, and allowed for the development of the first operational guidelines for diagnosing base radar data in identifying supercell storms (a.k.a. the “Lemon Technique”). The WSR-88D operates using automated volume coverage patterns, and display techniques to convert elevation scan data into vertical cross-sections is not very user friendly.

The Future of Radar Analysis is here...

The many benefits of the FSI are as follows:

- Improved vertical cross-sections: Dynamic placement and re-position of a cross-section reference line showing real-time updates to the cross-section data. Cross-sections are no longer a one-time requested RPG product, and are instead generated on-the-fly using 8-bit data.
- Constant Altitude cross-sections (CAPPIs): 8-bit radar data plotted at constant altitude eliminates the need to sample elevation scan data for altitude or reset elevation angle choices in four-panel displays. Cross-section control is also dynamic, showing real-time updates to the cross-section data.
- 3D visualization: 8-bit radar data from elevation scans, vertical cross-sections, and CAPPIs are plotted as 2D textures in 3D space. A forecaster can zoom, pan, pitch, yaw, and fly about the data in 3D.
- Virtual Volumes: No volume scan is incomplete. As new elevation scans are updated, they replace the old elevation scans in the virtual volume one-by-one. This means that there are full volumes of data available at all times for cross-sections and data perusal.
- Access to a much larger data inventory: An “All-Tilts” product only allows the forecaster to peruse a sequential order of elevation scan frames. For a 64 frame limit in VCP12, that only comprises 5 volume scans. The FSI allows the user to access any elevation scan in the radar data inventory RPS list for up to 2 hours of 8-bit data for all elevation scans.

-THE FSI EXTENSION IN D-2D-

Loading the Extension

The FSI extension is loaded and automatically made editable by selecting the **FSI** selection at the top of the drop down **Radar** menu.

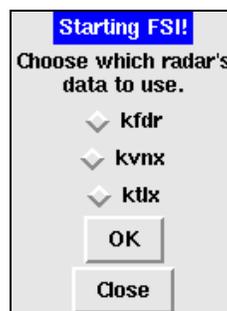


You unload the FSI extension in the normal way you unload any depictable on the D-2D pane – by holding the right mouse button over the depictable legend until the pop-up table appears, then select “Unload”.

Launching the FSI

Center your cursor over the storm of interest on your D-2D pane, and click the Right mouse button. If your WFO only has one dedicated radar, the FSI window will automatically open, with the data already centered on your storm of interest, using the radar data matching either your WFO’s dedicated radar.

If your WFO uses more than one dedicated radar, or your backup radars are turned on for SCAN, a radar selection GUI will open. Choose the radar you wish to observe, and click the “ok” button.



The following FSI display attributes will be reset to these values each time you launch or re-launch the FSI from the D-2D:

- Product = Reflectivity at 0.5° at the latest time
- Location = centered in latitude/longitude of mouse click on the D-2D
- Zoom Altitude = 50 meters (about the size of a large supercell storm)
- CAPPI Altitude = 2 km (~6.5 kft)

Vertical Cross-Section Altitude = 20 km (~65 kft)
3D Rotate = 360° (pointing north)
3D tilt = 0.75 (slightly tilted off the vertical)
Storm Motion Vector = as set by Radar Product Controls

All other display preferences (e.g., loop parameters) will be retained from the previous FSI session. These preferences are unique to each individual username.

NOTE: The new LX workstations are equipped with two video graphics cards, one which supports 2D applications, and the other which supports 3D applications such as the FSI. The FSI alpha will run on both video cards, but it will run much faster on the card supporting the 3D applications. You may need to determine which two of the LCD display monitors are connected to the 3D video card, and be sure the FSI window is launched from a D-2D on one of those monitors. For the OB8.2 version, we will ensure that FSI cannot be launched on the 2D display.

NOTE: Only one FSI display is designed to running at any one time per D-2D. If you attempt to launch another FSI display using another mouse click to the D-2D pane, the original FSI window will reconfigure to the new mouse click settings.

-THE FSI WINDOW-

A Summary of the FSI Components

- Linked four-panel design, with a constant elevation angle panel, a CAPPI panel, a Vertical Cross-section panel, and a panel displaying the data in three-dimensions.
- D2D All-Tilts “look and feel” radar volume browsing controls.
- Animation (looping) controls for the added 4th dimension.
- Keyboard shortcuts (“hotkeys”) for selection of elevation angles, volume scan times, radar products, and other navigation short-cuts (e.g., reset to zenith view).
- Rapid panning, zooming, pitch and yaw of 3D data.
- Dynamic cross section capabilities (vertical and horizontal). Users can manipulate the location of a cross section reference line using mouse controls, and cross-section textures will dynamically update on-the-fly in the other panels.

What do you see when the FSI is launched?

Menu Bar

At the very top of the FSI window, you will see a series of drop-down menu selections (**File, Navigate, Camera, Options, Products, Map, Help**). A Left Mouse click on any of these words will drop down its corresponding menu. A second Left Mouse click on any of the selections will execute the action specified.

Note that for most of the selections in the drop-down menus, the list will include two columns. The left-hand column is a description of the action taken. The right-hand column is a corresponding Hotkey. For any command that has a corresponding Hotkey, that command can alternatively be executed by pressing that key or combinations of keys (if combined with Shift, Ctrl, or Alt) on the keyboard. You will find that for many of the menu selections, the Hotkey controls will be the preferred method for selection, as they require fewer mouse clicks to execute which allows for more rapid selection and rapid successive selections.

We will describe only a few of these menu options in this section. The other menu options are described in later sections, and can be accessed by clicking the menu word above (these are links to future sections in this user guide).

File

Save Settings: This action will save your current settings to a configuration file that is stored on your user account, without exiting the FSI. **Note:** only one configuration file is available per user.

Reset Settings to Default and Exit: This action will restore the FSI default settings, and overwrite these default settings to your personal configuration file. It will then exit the FSI, since the configuration file can only be loaded upon launching the FSI. Users will need to relaunch the FSI for the default settings to take effect.

Exit: This action will save your current settings to a configuration file that is stored on your user account, and exit the FSI.

Help

About FSI: This shows a pop-up window containing information about the FSI. This pop-up window is closed using its **Close** button.

NOTE: A link to a PDF version of this user guide may be added here in the future.

Button Panel

The second row in the FSI window begins on the left with a series of button selections (**Preferences, Snapshot, Color Key, Loop, Auto-Update, Isosurfaces, Plan View**). After that there are three navigation buttons (**Back, Next, Latest**).



A Left Mouse click on any of these will execute the button action. Some of these buttons are toggle buttons. If the action is toggled, the background color of the button will turn to a darker gray.



This button will open up the **Edit Preferences** pop-up window. More information about setting preferences is provided in the [Setting Preferences](#) section.



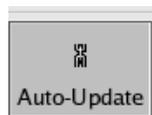
This button will open up the **Take Snapshot** pop-up window. More information about taking and saving screen image captures is provided in the [Taking Snapshots](#) section.



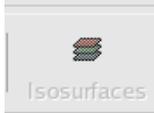
This button toggles the color key off/on at the top of the [3D Flier](#) window. Its default position is on.



This button toggles looping (animation) off/on. [Looping Preferences](#) can be changed using the **Edit Preferences > Loop** tab. Its default position is on.

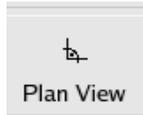


This button toggles the automatic updating of radar data off/on. Any time the currently browsed elevation angle is updated, the display will update to show the new data (without changing elevation angle). Its default position is on upon startup of the FSI. Any time the user navigates back in time away from the latest [virtual volume scan](#), the Auto-Update button automatically turns off. Any time the user navigates forward in time back to the latest virtual volume scan, the Auto-Update button automatically turns back on. The **“A” Hotkey** also toggles the Auto-Update.



Isosurfaces

This button toggles 3D isosurfaces off/on. Its default position is off, and is currently disabled pending future development of the application.



Plan View

This button resets the viewing angle of the [3D Flier](#) window to be from 90° elevation (zenith view, top down), and positions North to point straight up. Its default position is on. Anytime the user changes the viewing angle in the 3D Flier window, the button will automatically turn off. The **“P” Hotkey** also toggles the Plan View.



Back

This button steps the display back one volume scan interval while maintaining constant elevation scan. If you move the mouse over the button without pressing it, a pop-up window will display a preview of the date and time of the elevation scan that you would navigate to if you press the button.



Next

This button steps the display forward one volume scan interval while maintaining constant elevation scan. If you move the mouse over the button without pressing it, a pop-up window will display a preview of the date and time of the elevation scan that you would navigate to if you press the button.



Latest

This button steps the display forward one or more volume scan intervals to the latest volume scan while maintaining constant elevation scan. If you move the mouse over the button without pressing it, a pop-up window will display a preview of the date and time of the elevation scan that you would navigate to if you press the button.

Radar Status Bar

To the right of these buttons is **Radar Status Bar**. This is a continuously-updating readout showing the date, time, and elevation angle of the most recently-completed elevation scan from the radar and product being viewed.



NOTE: if you resize the FSI window smaller than the default dimensions, the Radar Status Window may disappear. Stretch the FSI window horizontally just enough in order for it to reappear.

Plan Position Indicator (PPI) Panel

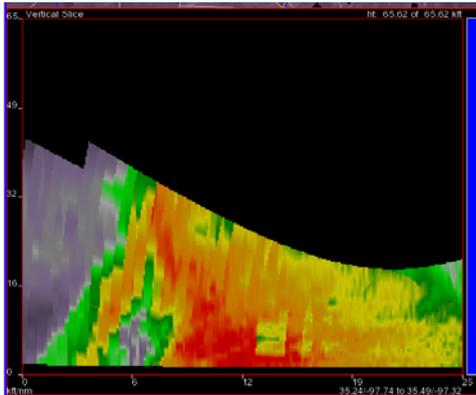
Underneath the menu and button rows are the four main FSI panels. The upper left panel displays the base radar data at a constant elevation scan. In old radar parlance, the “Plan Position Indicator”, or PPI, was the electronic scope that displayed the live radar data on a plan view, as viewed from top-down. This method of viewing radar data became the *de facto* standard in the WSR-88D and AWIPS world. In other words, the PPI panel displays the radar data in the way that is most familiar with meteorologists. The viewing angle within this angle is fixed at 90° (top-down) with north facing up. The radar data and map overlays are projected “flat earth”, which is a plane at zero-altitude (above radar level) to avoid parallax. Continuous pan and zoom controls are available. Within this window is the vertical cross-section control tool, which is used to control the vertical cross section texture location. More information on how to use the [PPI panel](#) and the [cross-section control tool](#) is given later.



Vertical Dynamic Cross Section (VDX) Panel

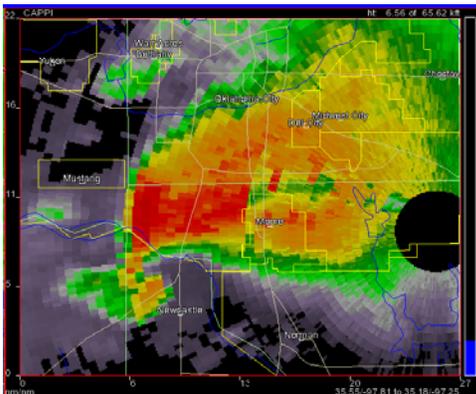
The lower left panel displays the base radar data sampled from each elevation scan along a vertical plane that is represented by the [vertical cross-section control tool](#) in the PPI window. The cross-section tool allows the user to change the location of the cross-section, and the data in this display will dynamically update on the fly. This panel

displays radar data vertically from the side, and the view is locked perpendicular to the plane of the cross-section. More information on how to use the [VDX panel](#) is given later.



Constant Altitude Plan Position Indicator (CAPPI) Panel

The upper right panel displays the base radar data at a constant altitude above the radar elevation. Just prior to the advent of the WSR-88D network, a digital radar processor was added to several of the old radars which sampled the base radar data from within a constant altitude horizontal cross-section from whichever elevation scans intersected it. Now this capability is back in the hands of the radar meteorologist, but with one added feature – the CAPPIs are dynamic, allowing the user to change the sampling altitude on the fly. The viewing angle within this angle is fixed at 90° (top-down) with north facing up. Continuous pan and zoom controls are available. More information on how to use the [CAPPI panel](#) is given later.



Three-Dimensional Flier (3DF) Panel

The radar data in this panel will be plotted in true 3D earth coordinates. Shown will be the selected elevation angle of data in the PPI panel plotted on a conical surface, as well as any vertical or horizontal cross-section planes that are being displayed in the VDX and CAPPI panels respectively. All the surfaces will be represented in 3D space. These three data surfaces can be independently toggled off or on. The user will have continuous

zoom and pan controls, as well as continuous 3D rotation controls. The view can be quickly reset to a zenith viewing angle at any time. Within this window is the [vertical cross-section control tool](#), which is used to control the vertical cross section texture location. More information on how to use the [3DF panel](#) is given later.



PPI Panel Usage

The Data Area

The main portion of this panel contains the radar data viewing area. The radar data are plotted using polar coordinates (azimuth versus range), at the highest available resolution data as defined by the AWIPS RPS list (8-bit, or even Super-Resolution data when available).

Zoom

Hold down the **Middle** mouse button to initiate a continuous zoom function. Push the mouse away from you to zoom in for a closer view. Pull the mouse toward you to zoom out for a wider view. Release the mouse button when completed. Note that any zoom action is simultaneously repeated in the CAPPI and 3DF panels.

Pan

Hold down the **Left** mouse button to initiate a continuous pan function. Drag the mouse to “pull” the image to the desired location. Release the mouse button when completed. Note that any pan action is simultaneously repeated in the CAPPI and 3DF panels.

Vertical Cross-Section Control Tool

Move the mouse to one of the Blue Boxes on the red and white dashed arrow and hold down the **Left** mouse button to begin interacting with the tool. Drag the mouse to “pull” the blue box to the desired location. Release the mouse button when completed.

Interacting with the following blue boxes will provide these actions:

End Boxes

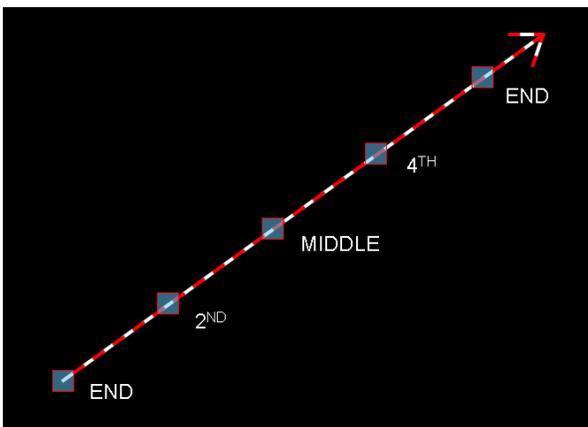
This will move the cross section line keeping the opposite end box position constant.

Middle Box

This will move the entire cross section line, keeping the line parallel to its previous positions.

Second and Fourth Boxes

This will rotate the cross section line keeping the middle box position constant.



Note that the arrow will always point to the east, and represents the data on the right side of the VDX panel.

VDX Panel Usage

The Data Area

The main portion of this panel contains the radar data viewing area. These data are derived by computing the “intersection” of an imaginary vertical plane of data with a complete “[virtual volume](#)” of base radar data. The data are derived from the polar-coordinates, and thus are the highest resolution available. Note that this vertical plane of data actually wraps the curved 3D surface of the earth, like a ribbon, in order to maintain constant altitudes along the section. This can be illustrated by viewing very long cross-sections in the 3DF panel.

When the cross-section coordinates are in the process of dynamically changing through the various actions available, the data will temporarily “down-sample” to a rectilinear grid. The resolution of this grid is set to 80 x 80 pixels by default (this can be changed using the [Preferences](#) button). Once the re-positioning of the cross-section is completed, the data will re-draw at the highest resolution available, in polar coordinates.

Reading the Legends

The upper right portion of this panel contains a height legend, showing the current height and the maximum allowable height in kft.

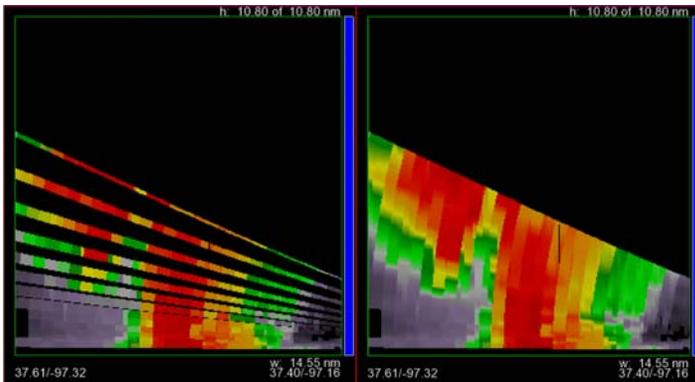
The Y-axis also contains tick marks and labels for the height in kft.

The X-axis contains tick marks and labels for the horizontal distance in nm. Note that the 5 tick marks correspond to the 5 blue boxes on the Vertical Cross-Section Control Tool.

The lower right portion of the panel shows the latitude/longitude coordinates of the End Boxes of the cross-section, in decimal degrees.

Interpolation Toggle

The **“T” Hotkey** will toggle interpolation on and off on the vertical cross-sections and the CAPPIs simultaneously. The default state of the FSI is for interpolation to be toggled on. The interpolation scheme will “fill in” the data between the elevation scans in order to present a “more complete” cross-section. However, turning the interpolation scheme off gives the user a better idea of which locations in space the radar is actually scanning. There are significant gaps in coverage since the radar beam is 1.0° wide (in the horizontal and vertical), and elevation angle differences can frequently be greater than 1.0°, especially at higher elevations. The figure below shows the effect of interpolation off (left) and on (right).



The interpolation scheme in the vertical between adjacent beam centerlines, and is not an image smoothing technique. This is important for the CAPPI cross-sections (described later).

Change Vertical Height

Move the cursor to the vertical blue bar on the right hand side of this panel. Then, hold down the **Left** mouse button and drag the top of the blue bar up or down to change the height of the vertical cross-section window. Release the mouse button when completed. The cross-section vertical height will simultaneously change in both the VDX and the 3DF panels (**NOTE:** The viewing angle in the 3DF panel must be anything other than

90° (top-down) in order to view these changes in that window). As you change the vertical height, note the changes in the upper right legend and the Y-axis values.

Change Horizontal Width

CAUTION: This action is very sensitive to small mouse movements, and is typically not the desired way to change the length of the cross-section. Instead, we suggest using the [Vertical Cross-Section Control Tool](#).

Move the cursor to any position within the VDX “data area”. Then, hold down the **Middle** mouse button to initiate the horizontal width change function. Push the mouse away from you to narrow the horizontal width. Pull the mouse toward you to widen the horizontal width. Release the mouse button when completed. The cross-section horizontal width will simultaneously change in both the PPI, VDX, and 3DF panels. As you change the horizontal width, note the changes in the X-axis values.

Change Position

CAUTION: This action is very sensitive to small mouse movements, and is typically not the desired way to change the position of the cross-section. Instead, we suggest using the [Vertical Cross-Section Control Tool](#).

Move the cursor to any position within the VDX “data area”. Then, hold down the **Left** mouse button to initiate the position change function. Drag the mouse to “pull” the cross-section to the desired location. Release the mouse button when completed. The cross-section position will simultaneously change in the PPI, VDX, and 3DF panels.

CAPPI Panel Usage

The Data Area

The main portion of this panel contains the radar data viewing area. These data are derived by computing the “intersection” of an imaginary constant altitude surface with a complete “[virtual volume](#)” of base radar data. The data are derived from the polar-coordinates, and thus are the highest resolution available. Note that this surface of data actually wraps the curved 3D surface of the earth, like the surface of a hollow sphere, in order to maintain constant altitudes above the earth. This can be illustrated by viewing very large CAPPIs in the 3DF panel.

When the CAPPI height or position is being dynamically changed, the data will temporarily “down-sample” to a rectilinear grid. The resolution of this grid is set to 80 x 80 pixels by default (this can be changed using the [Preferences](#) button). Once the re-positioning of the CAPPI is completed, the data will re-draw at the highest resolution available, in polar coordinates.

Reading the Legends

The upper right portion of this panel contains a height legend, showing the current height and the maximum allowable height in kft.

The X- and Y-axes contain tick marks and labels for the horizontal distance in nm.

The lower right portion of the panel shows the latitude/longitude coordinates of the upper-left and lower-right corners of the CAPPI, in decimal degrees.

Change Vertical Height

Move the cursor to the vertical blue bar on the right hand side of this panel. Then, hold down the **Left** mouse button and drag the top of the blue bar up or down to change the height of the CAPPI. Release the mouse button when completed. The CAPPI height will simultaneously change in the 3DF panel (**NOTE:** The CAPPI surface must be toggled on in the 3DF panel in order to view those changes in that window). As you change the vertical height, note the changes in the upper right legend.

Zoom

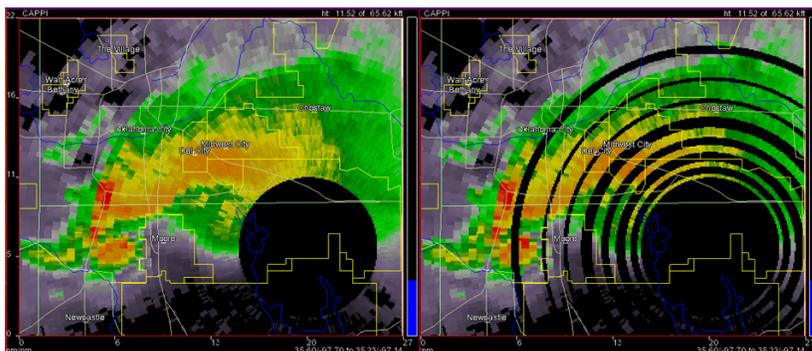
Hold down the **Middle** mouse button to initiate a continuous zoom function. Push the mouse away from you to zoom in for a closer view. Pull the mouse toward you to zoom out for a wider view. Release the mouse button when completed. Note that any zoom action is simultaneously repeated in the CAPPI and 3DF panels.

Pan

Hold down the **Left** mouse button to initiate a continuous pan function. Drag the mouse to “pull” the image to the desired location. Release the mouse button when completed. Note that any pan action is simultaneously repeated in the CAPPI and 3DF panels.

Interpolation Toggle

The **“I” Hotkey** will toggle interpolation on and off on the vertical cross-sections and the CAPPIs simultaneously. The default state of the FSI is for interpolation to be toggled on. The interpolation scheme will “fill in” the data between the elevation scans in order to present a “more complete” cross-section. However, turning the interpolation scheme off gives the user a better idea of which locations in space the radar is actually scanning, and more importantly, where the radar is not scanning. There are significant gaps in coverage since the radar beam is 1.0° wide (in the horizontal and vertical), and elevation angle differences can frequently be greater than 1.0°, especially at higher elevations.



The interpolation scheme in the vertical between adjacent beam centerlines, and is not an image smoothing technique. This is important for the CAPPI cross-sections since there can be significant gaps in coverage. These gaps are filled in by data just above and below these gaps. If they were filled in from the “sides” (horizontally), significant visualization errors would result.

3DF Panel Usage

The Data Area

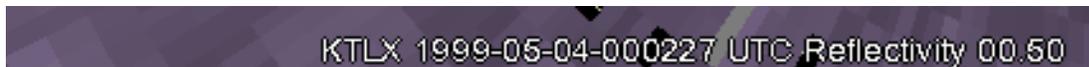
The main portion of this panel contains the radar data viewing area. All data shown in this panel is plotted in three-dimensional space, using an earth-centric coordinate system where the origin is located at the center of the earth “sphere”. The radar data are represented as two-dimensional surfaces, or “textures” plotted in 3D space with latitude, longitude, and altitude coordinates. For example, the earth’s surface is plotted as a sphere, and a low-resolution image can be toggled using the [Maps](#) function if a user desires to easily illustrate this. Radar data is plotted at constant elevation angle (as “cones”), constant altitude (as a section of a sphere at a higher altitude than the earth sphere), and vertical cross section “ribbons”. The user can zoom, pan, pitch, yaw, and fly about and through the data in 3D.

Reading the Legends

The upper portion of this panel contains a color key legend, showing data values and corresponding colors used to plot the data at those values. This color key is shared by all four panels.



The lower right portion of the panel shows the 4-letter radar ID, the date and time in UTC (YYYYMMDD-HHMMSS.SSS), the radar product (Reflectivity, Velocity, Storm-Relative Velocity, or Spectrum Width), and the elevation angle in degrees. The extra information within the brackets can be ignored.



Toggling the cross-section surfaces

You can toggle the two cross-section surfaces off and on independently.

Vertical Cross-Section Surface

The “**X**” **Hotkey** will toggle this surface on or off. The default state is for this surface to be turned on.

CAPPI Surface

The “**C**” **Hotkey** will toggle this surface on or off. The default state is for this surface to be turned off.

Vertical Cross-Section Control Tool

In the 3DF panel, at the base of the Vertical Cross-Section Surface is another vertical cross-section control tool with Blue Boxes on a red and white dashed arrow. This tool is used exactly like the [vertical cross-section tool](#) in the [PPI window](#).

NOTE: If the viewing angle in the 3DF Panel is set to a 90° plan view, the Vertical Cross-Section Surface will appear as just the Vertical Cross-Section Control Tool (since you are looking straight down on the vertical surface from the top).

3D Rotate

In the “3D world”, the rotate function changes your viewing angle while maintaining a constant viewing distance and constant viewing location.

Hold down **Shift** key and **Left** mouse button to initiate the rotate function. Slide mouse toward you to increase viewing angle, away to decrease viewing angle, left to rotate view clockwise, or right to rotate counterclockwise. Release the mouse button when completed. Note that any rotate action produces no affect in the PPI and CAPPI panels.

The North Arrow

In the “3D world” it is very important for the user to have a sense of their orientation in both the vertical and horizontal. Therefore, the FSI provides a “North Arrow”. This cursor only remains visible while rotating, zooming, or panning, and on the PPI, CAPPI, and 3DF panels. Note that the North Arrow never changes position or orientation on the PPI or CAPPI panels, as these are 2D data panels. On the 3DF panel, the North Arrow will point in the direction of the North Pole. The cursor is also always plotted to be tangent to the earth’s “flat” surface, so if the image is tilted from a 90° viewing angle, the cursor will appear “squashed”. With a little practice, you will see how this cursor will aid you in your orientation.

3D Zoom

In the “3D world”, the zoom function changes your viewing distance while maintaining a constant viewing angle and constant viewing location.

Hold down the **Middle** mouse button to initiate a continuous zoom function. Push the mouse away from you to zoom in for a closer view. Pull the mouse toward you to zoom out for a wider view. Release the mouse button when completed. Note that any zoom action is simultaneously repeated in the PPI and CAPPI panels.

3D Pan

In the “3D world”, the pan function changes your viewing location while maintaining a constant viewing angle and constant viewing distance. This is similar to the view a “flying airplane” would have if they flew without changing altitude.

Hold down the **Left** mouse button to initiate a continuous pan function. Drag the mouse to “pull” the image to the desired location. Release the mouse button when completed. Note that any pan action is simultaneously repeated in the PPI and CAPPI panels.

Resetting to a Plan View

The “**P**” hotkey, or the **Plan View button** will reset the 3DF view to a fixed at 90° (top-down) with north facing up.

Changing Radar Products

RPS List

NOTE: In order to view any 8-bit base radar products from all elevation angles, your AWIPS RPS list must include the Z, V, and SW products from all of these elevation angles for each of your dedicated radars. Although the SRM product is not required to be in the RPS list (it is computed on the fly in the FSI), it is also recommended to be included. You may need to raise your RPS limit to 99 products (the maximum allowed) in order to include these products.

Reflectivity (Z)

When the FSI is launched, the 8-bit Reflectivity data at 0.5° is automatically loaded. But if you are ever browsing one of the other radar products, the “**Z**” hotkey will select the Reflectivity product. Alternatively, the “**1**” hotkey on the alphanumeric keyboard (not the numeric keypad) will also select Reflectivity.

Velocity (V)

The “**V**” hotkey will select the ground-relative 8-bit Velocity product. Alternatively, the “**2**” hotkey on the alphanumeric keyboard (not the numeric keypad) will also select Reflectivity.

Storm-Relative Velocity Map (SRM)

The “**S**” hotkey will select the ground-relative 8-bit Velocity product. Alternatively, the “**3**” hotkey on the alphanumeric keyboard (not the numeric keypad) will also select Reflectivity.

Spectrum Width (SW)

The “**W**” hotkey will select the ground-relative 8-bit Velocity product. Alternatively, the “**4**” hotkey on the alphanumeric keyboard (not the numeric keypad) will also select Reflectivity.

Z/SRM8 toggle (Cycle)

As with D-2D, the decimal key on the numeric keypad (and **not** the period key on the alphanumeric keyboard) will toggle the display between the Reflectivity (Z) and the Storm Relative Velocity Map (SRM) product. NOTE: There is no method for fading between these two products in the FSI. Unfortunately, the OpenGL graphics libraries that FSI is built upon do not allow this feature.

Browsing the Radar Data

Virtual Volume Scans

Radars scan in sets of elevation angles known as “volume scans”. In the current paradigm of WSR-88D algorithms, any products created using data from every elevation scans are created after the last elevation angle of every volume scan. This includes the rudimentary cross-section product than can be requested from the ORPG. These volume scan products are only available once per volume scan, and update only as fast as the volume scan update rate.

Virtual volume scans, on the other hand, are comprised of the latest elevation angle at any one time, such that a complete set of elevation angles is available for processing all the time. For example, consider a radar that begins scanning at the 0.5° elevation angle, and continues upward through all elevation angles until the 19.5° elevation angle. Once all of the elevation angles have been scanned, the first “traditional” volume scan is completed. Next, the radar will now scan the 0.5° elevation angle again to start the next “traditional” volume scan. In the virtual volume scan world, that new 0.5° elevation angle will replace the previously scanned 0.5° elevation angle. The virtual volume scan now updates, and will be comprised of this new 0.5° angle, and the remaining elevation angle data from the previous traditional volume scan. At this point, radar and display applications can be recalculated using this virtual volume of data. Next, the second elevation angle will be scanned, and it will replace the previous data at that same elevation angle, once again updating the virtual volume scan, and radar and display applications run again (in rapidly updating fashion).

In the FSI, the vertical cross-sections and the CAPPis are all built using the latest virtual volume scan when the user is perusing data on the current virtual volume scan. Users will note that both of these cross-sections will re-draw upon the receipt of a new elevation scan, about every 15-30 seconds.

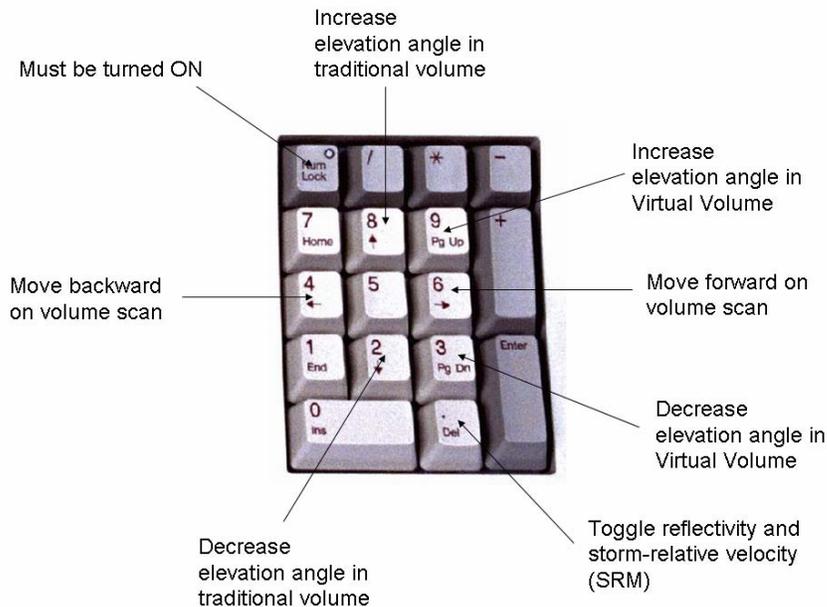
However, if the user decides to browse past data, or elevation scans which are not on the current virtual volume scan, then that cross-section data will represent the data for the traditional volume scan matching the elevation angle being browsed.

AutoUpdate

The AutoUpdate feature is automatically switched from the on position to the **off** position when the user browses out of the current virtual volume. The AutoUpdate feature will automatically switch back to the **on** position if the user returns to the current virtual volume while browsing. Note that at any time, the user can [manually toggle the AutoUpdate feature](#) back on while browsing older data, and if so, the display will automatically move forward to the latest virtual volume while maintaining a constant elevation angle. Note that any time the currently browsed elevation angle is “AutoUpdated”; the display will update to show the new data without changing elevation angle.

Numeric Keypad

The numeric keypad is mapped as the main volume browser. **In order for the keypad to operate, the NumLock must be toggled to the ON position.** Note that when referring to hotkeys on the numeric keypad, we will refer to the **non-numeric and numeric** designations of that key, to avoid confusion with the numbered keys along the top row of the main computer keyboard. The figure below shows a mapping of the functionality of the volume browsing controls.



Changing Elevation Angle

As with cross-sections using the virtual volume scans, browsing that data is dependent on the choice of browsing hotkeys as well as the elevation angle that is currently being browsed. The user can change the elevation angle of the data within the current “live” virtual volume scan, or within past traditional volume scans with a different set of hotkey functions.

Pg Up (9)

This increases the elevation angle within the current virtual volume scan. When the most recent elevation angle (as shown in the [Radar Status Bar](#)) is reached via browsing, another PgUp command will move up to the next elevation angle from the previous traditional volume scan. Continuing PgUp commands will eventually “wrap” through the entire virtual volume. This means that a PgUp command executed on the highest elevation angle in the virtual volume (e.g., 19.5°), will bring you to the 0.5° elevation angle within the virtual volume.

Note the times of the products when browsing the virtual volume scan. They will always increase in time while using the PgUp command, except when moving between the most recent elevation angle in the virtual volume, to the next higher elevation angle.

Pg Dn (3)

This decreases the elevation angle within the current virtual volume scan. This has the exact opposite effect of the PgUp command, always moving down in elevation scan through the current virtual volume.

Note the times of the products when browsing the virtual volume scan. They will always decrease in time while using the PgDn command, except when moving between the most recent elevation angle in the virtual volume, to the next lower elevation angle.

Up Arrow (8)

This increases the elevation angle within a traditional volume scan, and is used for browsing data from past (not current) volume scans. The times of the products will always increase in time while using the Up Arrow command, including when moving from the highest elevation angle in the traditional volume scan (e.g., 19.5°) to the lowest elevation angle (0.5°), such that the browser will move forward to the next traditional volume scan. Note that once the most recent elevation scan as depicted in the Radar Status Bar is reached, the Up Arrow key will have no effect (at least, until the next elevation scan comes in).

Down Arrow (2)

This decreases the elevation angle within a traditional volume scan, and is used for browsing data from past (not current) volume scans. This has the exact opposite effect of the Up Arrow command, always moving down in elevation scan and backwards in time through past traditional volume scans.

Changing Scan Time At Constant Elevation Angle

Right Arrow (6)

This moves **forward** in time exactly one volume scan interval while maintaining constant elevation angle. Once the browser is on the most current virtual volume scan, this arrow will have no effect.

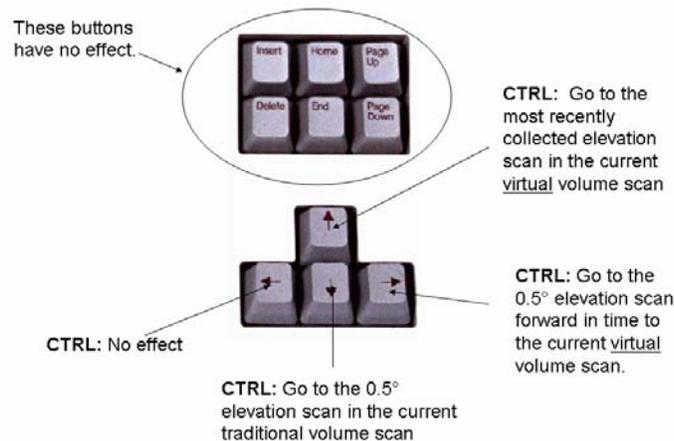
Left Arrow (4)

This moves **backward** in time exactly one volume scan interval while maintaining constant elevation angle.

Special Volume Browsing Hotkeys

NOTE: These special volume browsing keys use the arrow keys that are **not part of the numeric keypad**. They will be referred to without a corresponding

numeric key designation. The figure below shows a mapping of the functionality of the volume browsing controls. You must hold the **Ctrl** key along with these arrow keys for the following functionalities.



Ctrl-ArrowDown

This moves the display to the 0.5° elevation scan in the traditional volume scan you are currently viewing. If you are within the current virtual volume scan, this moves the display to the 0.5° elevation scan in that virtual volume.

Ctrl-ArrowRight

This moves the display to the 0.5° elevation scan forward in time to the current virtual volume scan. If you are already within the current virtual volume scan, this moves the display down to the 0.5° elevation scan in that virtual volume. This key will toggle the **AutoUpdate** feature on if it is off.

Ctrl-ArrowUp

This moves the display to the most recently collected elevation scan in the current virtual volume scan, the elevation scan that matches that shown in the **Radar Status Bar**. This key will toggle the **AutoUpdate** feature on if it is off.

Ctrl-ArrowLeft

This hotkey has no effect.

More Hotkeys and the rest of the Menu Bar

Navigate

A full list of the traditional volume navigation hotkeys, and some alternative volume browsing hotkeys, is obtained by clicking the **Navigate** selection on the [Menu Bar](#). You can also select any of these functions by left clicking the menu selection.

Camera

A list of some alternative display navigation hotkeys is obtained by clicking the **Camera** selection on the [Menu Bar](#). You can also select any of these functions by left clicking the menu selection.

Options

A list of additional display option hotkeys is obtained by clicking the **Options** selection on the [Menu Bar](#). You can also select any of these functions by left clicking the menu selection.

Products

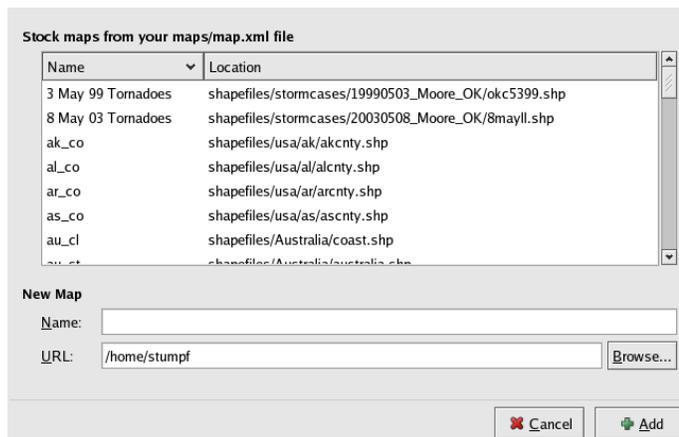
A list of the product selection hotkeys is obtained by clicking the **Products** selection on the [Menu Bar](#). You can also select any of these functions by left clicking the menu selection.

Map

Map overlays can be added, hidden, and removed using the **Map** selection on the [Menu Bar](#). Individual Map overlay attributes can also be changed here, such as map colors and line thickness.

Clicking this menu selection will bring up a drop-down menu listing all the currently loaded maps (if any). For any maps which are already loaded, you can left click on the map name, and a sub-menu will appear allowing you to make the map invisible or visible (without unloading the map from the display), or remove (unload) the map completely from the display. For some maps, you may also be able to change the map color and the map line thickness.

At the bottom of the menu is the **Add Map** selection. Clicking **Add Map** opens the **New Map GUI**, which allows user to select maps from the list, type in an explicit map file location, or browse to a map file to load new maps. After making the selection, the **Name** field must contain an (arbitrary) map name, if not already specified. Note that the FSI only displays shapefile (.shp) formatted maps.



Setting Preferences

This button will open up the **Edit Preferences** pop-up window. The following preference tabs are available:

Snapshot

These preferences determine where and how your screen snapshots are saved.

Output Location > Directory

The user may use the **Browse** button to choose a directory in which to save snapshot images, or simply write the directory path in the dialog window.

Output Location > Filename

This string determines the format of the snapshot image file name. The **Help** button will provide a list of the Substitution codes that are preceded by the percent (%) symbol.

Dimensions > Use Custom Size for Snapshots

Clicking this toggle button will allow you to set a custom size for your snapshot images. Otherwise, they will be saved in the native resolution of your display. You can set the **Width** and the **Height** (in pixels) of your snapshot size here.

Display

These preferences determine the resolution of your display.

Drawing > Font Size

The user can select the font size of the labels on the display here. The default setting is 10 pixels.

Drawing > Radial Set Accuracy

We recommend that the users do not change this setting. The default setting is 2 radials per degree.

Dynamic Slice > Minimum Sample Drag Resolution

When the CAPPIs and Vertical Dynamic Cross-Sections coordinates are in the process of dynamically changing through the various actions available, the data will temporarily “down-sample” to a rectilinear grid. Once the re-positioning of the cross-section is completed, the data will re-draw at the highest resolution available, in polar coordinates.

This preference allows the user to change the resolution of the down-sample grid. The default setting is 80, for an 80 x 80 pixel resolution. Making this value larger will improve the resolution of the down-sampled dynamic cross-sections,

but at a cost of reduced performance (“choppier” dynamic slicing). Making this value smaller will reduce the resolution of the down-sampled dynamic cross-sections, but will improve the performance of the dynamic slicing (more fluid).

Cache

These preferences control the texture memory cache. **It is recommended that only advanced users use these preferences**, as they will affect the amount of texture memory storage space on the LX workstation, and could affect the entire workstation performance. No other information will be provided here. For more information, please contact the FSI developers.

Loop

These preferences control the animation settings of the FSI.

Preview

This data graphically displays the animation settings below. The bar at the top shows the number of frames in white, and the first and last frame dwell time in blue. Underneath lists the amount of time that one loop will animate in real-time. Under that lists the amount of data, in minutes, that one loop represents. Note that none of these fields are interactive with the mouse, and only change based on settings changed in the fields described next.

Data > Frame Interval

This sets the number of minutes per radar frame in the loop. It is recommend that this value is set to the approximate volume scan update time for the particular VCP you are viewing (5 min for VCP 11, 4 min for VCP 12, 6 min for VCP 21, and 10 min for VCPs 31 or 32).

It is important to note that the FSI animation controls have been designed for multiple sources of data (multiple radars and sensor), and are not keyed to individual single radar volume scan times. The frame intervals essentially “take a snapshot” of the radar state at those particular times. For example, if the volume scan update rate is 5 minutes, and the Frame Interval is set to 2 minutes, then the following results:

- Frame 1: 0 min, volume scan 1
- Frame 2: 2 min, volume scan 1
- Frame 3: 4 min, volume scan 1
- Frame 4: 6 min, volume scan 2
- Frame 5: 8 min, volume scan 2
- Frame 6: 10 min, volume scan 3
- Frame 7: 10 min, volume scan 3
- Frame 8: 10 min, volume scan 3
- Frame 9: 10 min, volume scan 4
- Frame 10: 10 min, volume scan 4
- Frame 11: 10 min, volume scan 5
- ...and so on...

Data > Number of Frames

This sets the number of frames you want in the loop.

Speed > Frame Display Time

This sets the number of milliseconds that a single frame is shown in real-time during the loop.

Speed > First Frame Dwell

This sets the length of the first frame dwell in seconds.

Speed > Last Frame Dwell

This sets the length of the last frame dwell in seconds.

Options > Rock Loop

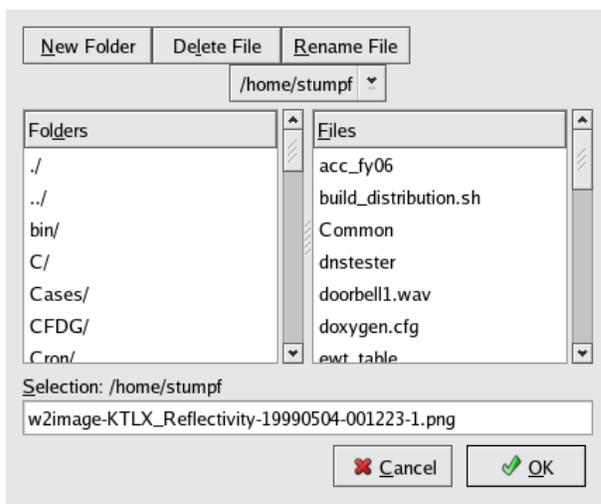
If checked, the loop will rock forward and backward in time. If not checked, the loop will only operate in forward time.

Close

Clicking this button at the bottom of the GUI will close the **Edit Preferences** GUI and save all your settings.

Taking Snapshots

Clicking the Snapshot key in the Button Panel opens the **Snapshot GUI**. A default filename selection will be first given, based on the parameters set in the Snapshot Preferences. However, you can save the file as any name, to any folder, using the browsing tools in the GUI. FSI saves images in PNG (.png) image format only.



-AWIPS CONFIGURATION-

Choice of Products

px1:\$FXA_HOME/data/FSIproducts.txt

Editing this file on **px1** will determine which radar products will be used for the base Reflectivity, Velocity, and Spectrum Width data in FSI. Users have a choice of 4-bit, 8-bit, and super-resolution base radar data in FSI. Although 4-bit data is not recommended due to its low resolution, it is available as a choice if needed. 8-bit data are preferred and are set as the default products.

The alpha version of FSI will be fielded prior to the inclusion of super-resolution data in ORPG. However, the fielded OB8.2 version of FSI will support the display of super-resolution data when it does become available on the ORPG in Build 10.

NOTE: In order to display any of the above data in FSI, they must be included in your RPS list. Of particular note, in order to display full volumes of data in FSI, you must have every elevation scan in the VCP in the RPS list.

NOTE: You can only define one type of each of the three base radar moment products!

Radar List

The alpha version of FSI is designed to allow display of base products only from your WFO's dedicated radar list. You can also display radar products from your WFO's backup radar list as well. To add more radars, ask your ITO to edit:

/data/fxa/tstorm/scanBackupRadarList.txt

and change the third number on each row from a 0 (off) to a 1 (on) to include it for FSI. Start a backup radar request via the RMR if needed. Your ITO should then restart the **FSIprocessor**.

NOTE: The alpha version and fielded OB8.2 versions of FSI will not have the capability to display any Terminal Doppler Weather Radars (TDWR) your WFO may have access to. This capability will hopefully be added to future versions.

Individual User Configuration

Default Configuration

For first time users of FSI, the program will first start up using a default configuration preference file. As individual users begin to change their preferences, these new preference will be saved into their user configuration file, so that when FSI is restarted on the user account, those preferences will be loaded.

NOTE: The alpha version of FSI only allows one configuration file per user account.

File > Reset Settings to Default and Exit

This action will restore the FSI default settings, and overwrite these default settings to your personal configuration file. It will then exit the FSI, since the configuration file can only be loaded upon launching the FSI. Users will need to relaunch the FSI for the default settings to take effect.

-TROUBLESHOOTING-

Incomplete volume scans

Check to see if you have all the elevation angles in your VCPs defined in your RPS list.

No storm motion

AWIPS users choose the storm motion vector (SRM) from the AWIPS **Radar Display Controls**. If the user chooses “Average Storm Motion from STI”, the STI product must be included in the RPS list. Otherwise, if the user chooses to use a “Custom Storm Motion”, the storm motion must be set to something other than zero.

-WHAT FSI MAY OFFER IN THE FUTURE-

The alpha version of FSI will be upgraded in the future to include additional capabilities. Some of the upgrades are tentative based on resource and budget allocation within the AWIPS program.

FSI1.0 (OB8.2)

Readout (Data Sampling)

Readout is a continuous data sampling capability using a linked cursor on the four panels. Data readouts on the CAPPI or Vertical Cross Section panels will show a corresponding readout “box” on the 3D flier, in three-dimensions. The readout will be similar to that in D-2D, except that the readout “box” will color fill with the same color as the sampled data value corresponding to the product color map. Also, the attributes shown in the radar will be user adaptable.

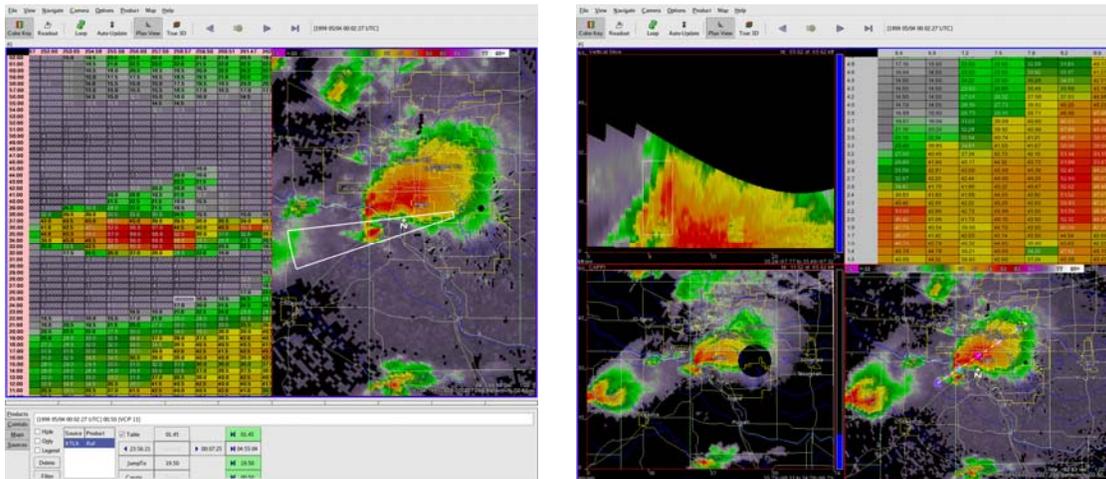
NOTE: Readout capability may be added to FSI alpha before the end of the alpha test. In the meantime, WDTB suggested using a 4-bit color table for the Reflectivity and Velocity products so that it would be easier to visually estimate data values. Once the Readout capability is added, the 4-bit color tables will be replaced with 8-bit color tables.

Super-resolution Data

Support for the display of super-resolution reflectivity, velocity and spectrum width data when they become available in ORPG10. Users will have the choice of displaying the base radar moment data in traditional resolution or super-resolution data.

“B-Scan”

A unique data readout capability opens a new window that shows the individual sample volume values (color coded) on a Cartesian grid. The values are continuously sampled as the cursor moves over the data. This can be done in the PPI, CAPPI, Vertical Cross Section panels. A prototype example of a PPI and Vertical Cross Section B-scans are shown in the next two figures.



FSI2.0 (OB9.x)

Terminal Doppler Weather Radar (TDWR)

Support for the display of TDWR data, and its unique interlaced volume coverage pattern.

Polarimetric Data

Support for new polarimetric radar data moments (Z_{DR} , ρ_{hv} , KDP) as well as Hydrometeor Classification Algorithm (HCA) output at all elevation angles.

BCD format map files

In addition to shapefile map support, support for AWIPS’s own BCD format map files.

Beyond... (AWIPS2?)

3D Volume Rendering and Isosurfaces

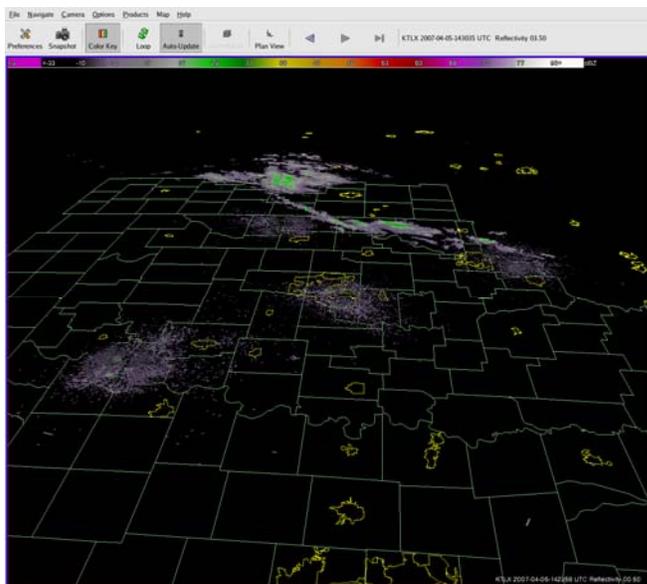
True 3D capabilities! Radar data is represented on 3D isosurfaces in 3D space, with dynamic isosurface selection. 3D Volume Rendering with continuous “alpha” (transparency) settings for any data level, for multiple semi-transparent isosurfaces and “lit volumes”.

Elevation Scan Data Advection

Time-to-space correction for elevation scan data to remove the artificial “drift” of radar data due to the time differences between collection of elevation scan data. All elevation scans in the virtual volumes will be time-to-space corrected to one of the elevation scans (either the latest, or the 0.5° elevation angle tilt). This will allow the user to analyze the true storm core tilt, and removes the spatial discontinuities seen between the latest and earliest elevation scans in the virtual volume.

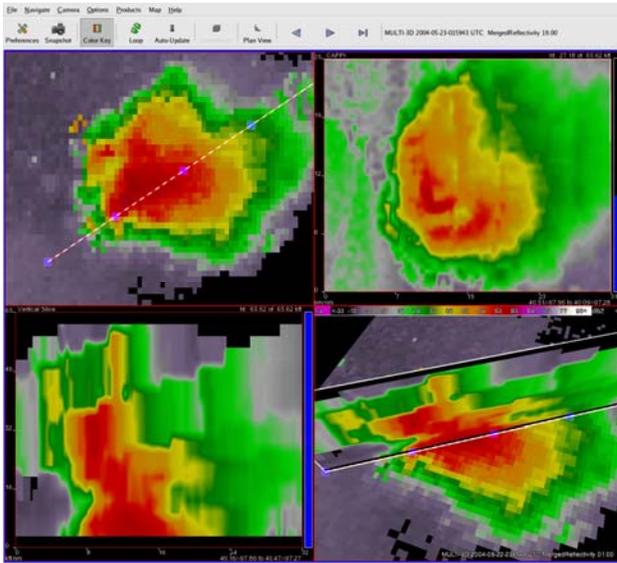
Display of single radars from multiple locations concurrently

Currently, the FSI is set up to view radar data from a single radar source only. The foundation application of FSI, the WDSSII GUI (wg), is capable of displaying multiple data sources, including multiple sources of single-radar data. See example below with KTLX, KINX, KVNK, and KFDR.



3D grids of Multiple-Radar data

The National Mosaic Quantitative Precipitation Estimation (NMQ) project is underway, and soon, 3D grids of data combined from multiple-radars will be available as a data stream from NCEP and made available to AWIPS for flood applications. The WDSSII GUI is capable of displaying these multiple-radar grids, and the FSI will be capable of slicing and dicing these grids as well. See example below.



Near-Storm Environment (NSE) thermodynamic data integration

Adding the capability to include NSE thermodynamic data in the cursor readout, as well as including temperature data on the vertical cross-sections (e.g., the height of the melting level). A novel concept may also be introduced – the Constant Temperature PPI (CTPPI), which would allow the user to dynamically change the height of a constant temperature surface using a slider bar similar to the CAPPI. These capabilities would be highly desirable for analysis of polarimetric variables in relation to updraft development/strength and winter storm analysis.

-FURTHER READING-

- 22nd AMS Severe Local Storms Conference [Paper](#), [Presentation](#)
- 32nd AMS Radar Conference [Paper](#), [Presentation](#)
- 1st NWS [Severe Weather Warning Technology](#) Workshop [Presentation](#)
- NWS Operational Services Improvement Plan (OSIP) [Statement of Need](#) (SON), [Project Plan](#) (PP), and [Concept of Operations](#) (ConOps).

-POINTS OF CONTACT-

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[Tom Filiaggi](#), NWS/MDL, Boulder, CO, 303-497-6578

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[Mike Magsig](#), NWS/WDTB, Norman, OK, 405-325-2995

APPENDIX A: FSI QUICK REFERENCE GUIDE

Action	Procedure
CAMERA VIEW MANIPULATION	
PAN	PPI, CAPPI, VDX, 3DF: Hold Left Mouse, drag image
ZOOM	PPI, CAPPI, VDX, 3DF: Hold Middle Mouse; slide toward (away) from you to zoom in (out)
CAPPI HEIGHT	CAPPI: Left Click and drag blue bar on right of panel
3D ROTATE	3DF: Hold Shift-Left Mouse, slide toward (away) to increase (decrease) viewing angle; slide mouse left (right) to rotate view clockwise (counterclockwise)
INTERPOLATE	CAPPI, VDX, 3DF: Hit “I”
PLAN VIEW	3DF: Hit “P”
TOGGLE VERTICAL CROSS-SECTION	3DF: Hit “X”
TOGGLE CAPPI	3DF: Hit “C”
VERTICAL CROSS SECTION POSITION	
SWING ENDPOINTS	Left Click and drag blue box on either end
MOVE LINE	Left Click and drag the middle blue box
ROTATE	Left Click and drag the 2nd or 4th blue box
PRODUCT SELECTION	
REFLECTIVITY	Hit “Z” or Hit “1”
VELOCITY	Hit “V” or Hit “2”
SRM	Hit “S” or Hit “3”
SPECTRUM WIDTH	Hit “W” or Hit “4”
Z/SRM8 TOGGLE	Hit “.” (the decimal key on the numeric keypad)
VIRTUAL VOLUME BROWSING (*NUMLOCK MUST BE ON)	
UP ELEVATION	Numeric Keypad: Pg Up (9)
DOWN ELEVATION	Numeric Keypad: Pg Dn (3)
LATEST 0.5° TILT	Arrow Keypad: Ctrl-ArrowRight
LATEST TILT	Arrow Keypad: Ctrl-ArrowUp
FORWARD IN TIME	Numeric Keypad: Right Arrow (6)
BACK IN TIME	Numeric Keypad: Left Arrow (4)
TRADITIONAL VOLUME BROWSING (*NUMLOCK MUST BE ON)	
UP ELEVATION	Numeric Keypad: Up Arrow (8)
DOWN ELEVATION	Numeric Keypad: Down Arrow (2)
DOWN TO 0.5° TILT	Arrow Keypad: Ctrl-ArrowDown
MANAGING THE APPLICATION	
TOGGLE AUTO UPDATE	Hit “A”
SAVE SETTINGS	From Menu Bar: File > Save Settings
EXIT	From Menu Bar: File > Exit