

# McIDAS-V Tutorial

## Displaying Level II Radar Imagery

updated November 2023 (software version 1.9)

McIDAS-V is a free, open source, visualization and data analysis software package that is the next generation in SSEC's 50-year history of sophisticated McIDAS software packages. McIDAS-V displays weather satellite (including hyperspectral) and other geophysical data in 2- and 3-dimensions. McIDAS-V can also analyze and manipulate the data with its powerful mathematical functions. McIDAS-V is built on SSEC's VisAD and Unidata's IDV libraries. The functionality of SSEC's HYDRA software package is also being integrated into McIDAS-V for viewing and analyzing hyperspectral satellite data.

More training materials are available on the McIDAS-V webpage and in the Getting Started chapter of the McIDAS-V User's Guide, which is available from the Help menu within McIDAS-V. You will be notified at the startup of McIDAS-V when new versions are available on the McIDAS-V webpage - <https://www.ssec.wisc.edu/mcidas/software/v/>.

If you encounter an error or would like to request an enhancement, please post it to the McIDAS-V Support Forums - <https://mcidas.ssec.wisc.edu/forums/>. The forums also provide the opportunity to share information with other users.

In this McIDAS-V Tutorial, some exercises will be explained using local data files included in pre-loaded data bundles. If you have access to your own real-time ADDE servers, you may also use those, but be aware that different server configurations may make the explanations in this document not quite applicable to all data that you may load.

This tutorial assumes that you have McIDAS-V installed on your machine, and that you know how to start McIDAS-V. If you cannot start McIDAS-V on your machine, you should follow the instructions in the document entitled *McIDAS-V Tutorial – Installation and Introduction*.

## Terminology

There are two windows displayed when McIDAS-V first starts, the **McIDAS-V Main Display** (hereafter **Main Display**) and the **McIDAS-V Data Explorer** (hereafter **Data Explorer**).

The **Data Explorer** contains three tabs that appear in bold italics throughout this document: *Data Sources*, *Field Selector*, and *Layer Controls*. Data is selected in the *Data Sources* tab, loaded into the *Field Selector*, displayed in the **Main Display**, and output is formatted in the *Layer Controls*.

Menu trees will be listed as a series (e.g. *Edit -> Remove -> All Layers and Data Sources*).

Mouse clicks will be listed as combinations (e.g. *Shift+Left Click+Drag*).

## Displaying Level II radar images: 2D and 3D reflectivity swaths

The **Radar Sweep View in 2D** display creates a 2-dimensional display of 3-dimensional radar data at individual elevation angles. While only data from only one elevation angle can be displayed at once, you can cycle through different elevation angles to help to determine the 3-dimensional characteristics of the data.

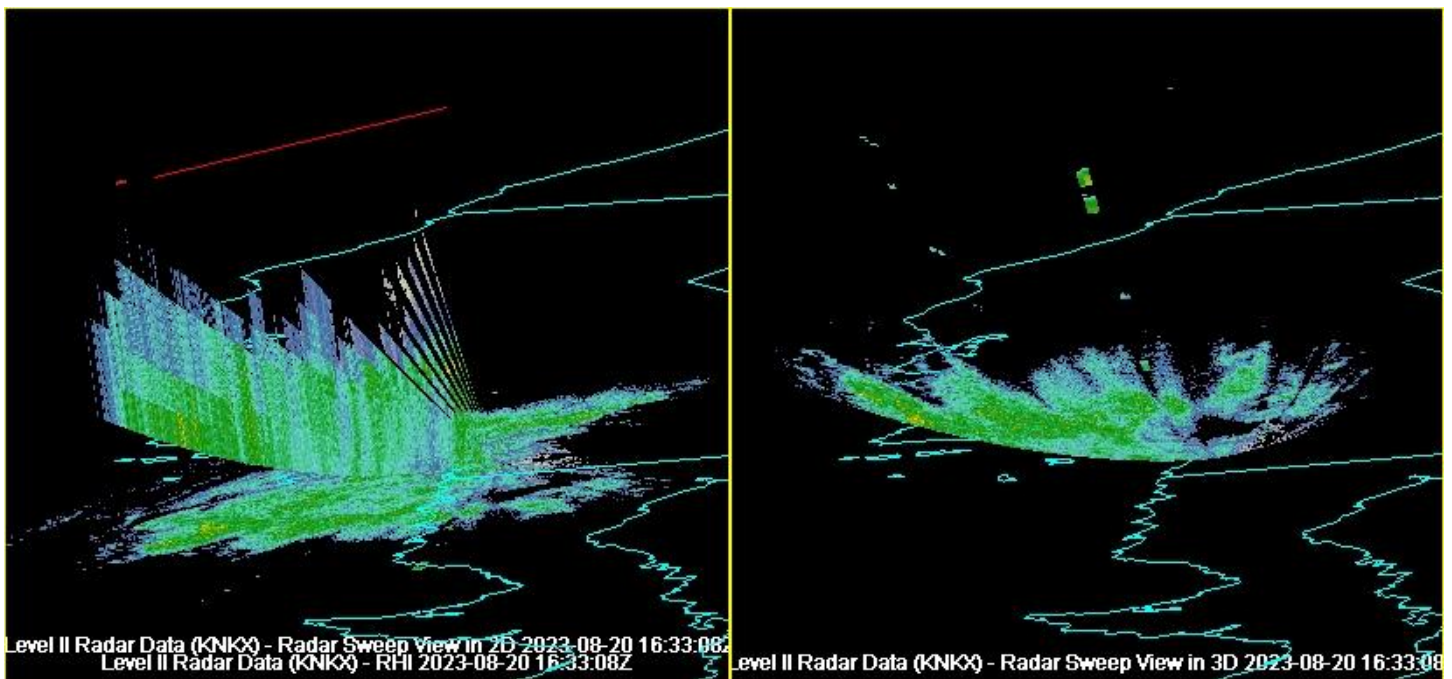
The **Radar Sweep View in 3D** display creates a 3-dimensional display of radar data at individual elevation angles. While only data from only one elevation angle can be displayed at once, you can cycle through different elevation angles to inspect the 3-dimensional characteristics of the data. This display appears to be identical to the **Radar Sweep View in 2D** display until the image is rotated, giving a perspective of altitude of the data.


1. From the **Data Explorer**, navigate to the **Radar -> Level II -> Local** chooser.
2. Navigate to the `<local path>/Data/Radar` directory. Use *Shift+Left-Click* to select all of the KNKX\* files.
3. Verify that *I'm Feeling Lucky* is selected from the **Station** dropdown.
4. Click **Add Source**.
5. Open a two panel map display and change the color of the outline around the active panel.
  - a. In the **Main Display**, select **File -> New Display Tab -> Map Display -> Two Panels** menu item.
  - b. By default, the right panel is highlighted by a blue box, which means this is where the data will be displayed. Click the left panel, and you should see the blue box outline the panel display, indicating it is the active panel. Any displays created will be added to the active panel.
  - c. To change the outline color, select **Edit -> Preferences**. Under the **Display Window** tab, there is a **Color Scheme** section on the right side. To the right of *Selected Panel*, click the blue box to bring up the **Set Selected Panel Border Color** window. Select a new color from the swatches and click **OK**. Click **OK** to close the **User Preferences** window. Switch between panels to refresh the box to the selected color.
6. Display the reflectivity data using the **Radar Sweep View in 2D** display type in the left panel.
  - a. Select the left panel of the **Main Display**, and return to the **Field Selector** tab of the **Data Explorer**.
  - b. Under **Fields**, select **Reflectivity**. The available displays will list under **Displays**. Choose the **Radar Displays -> Radar Sweep View in 2D** display type.
  - c. Click **Create Display**.
7. Display the reflectivity data using the **Radar Sweep View in 3D** display type in the right panel.
  - a. Select the right panel of the **Main Display**, and return to the **Field Selector**.
  - b. Under **Fields**, select **Reflectivity**. The available displays will list under **Displays**. Choose the **Radar Displays -> Radar Sweep View in 3D** display type.
  - c. Click **Create Display**.

8. There is no visible difference between the two layers until the view is rotated away from the top. *Right Click+Drag* or use the navigation toolbar in the left side of the **Main Display** to rotate the display. Turn looping on and off as you navigate through the 3D reflectivity image.
9. A default for multi-panel displays is shared views, which means that as one panel's navigation changes, they all move in sync. To turn this feature off, go to a panel and uncheck **Projections -> Share Views**.

## Displaying Level II radar images: RHI

The **RHI** (Range-Height Indicator) display is utilized to observe the 3-dimensional characteristics of radar data at various elevation angles. Every elevation angle included with the data will be used to create this display. This display creates a chart that has distance as the x-axis, and altitude as the y-axis. The distance component of the display is derived from the transect line, which has one endpoint at the location of the radar, and another at a user-defined latitude/longitude location.



10. Display the reflectivity data using the **RHI** display type in the left panel.
  - a. In the **Main Display**, select the left panel, turn the looping off, and return to the **Field Selector**.
  - b. Under **Fields**, select **Reflectivity**. The available displays will list under **Displays**. Select the **Radar Displays -> RHI** display type. Click **Create Display**.
  - c. Rotate to the **Top Viewpoint** by clicking on the  button on the left toolbar.
  - d. *Left Click+Drag* on the square at the end of the line in the **Main Display** to change the position of the RHI line. The 2D display in the **Layer Controls** will automatically update as the RHI line moves.

- e. *Right Click+Drag* in the left panel of the **Main Display** to visualize the vertical component of the **RHI** display.
11. Rotate the reflectivity azimuth in both the **Main Display** and the *Display* tab of the **Layer Controls**.
    - a. In the *Settings* tab of the **Layer Controls** for RHI, click **Start** next to **Autorotate RHI**. This will rotate the reflectivity azimuth in both the **Main Display** window and in the *Display* tab of the **Layer Controls**.
    - b. When you are done, go back to the *Settings* tab of the **Layer Controls** and click **Stop** next to **Autorotate RHI**.
  12. Remove the “RHI” display from the panel on the left.
    - a. Float the **Legend** for the panel on the left by navigating to the *View -> Displays ->Float Legend* menu item in the **Main Display** window.
    - b. In the **Display Legend** window, remove the top *Level II Radar Data (KNKX)* listed under **Radar Displays** by clicking on the trash can icon to the right of it.
    - c. Close the **Display Legend** window by clicking on the ‘x’ in the upper corner of the window.


## Displaying Level II radar images: Radar Cross Section

The **Radar Cross Section** display is very similar to the **RHI** display. This display type is useful for observing the 3-dimensional characteristics of radar data at various elevation angles. Every elevation angle included with the data will be used to create this display. This display creates a chart that has distance as the x-axis, and altitude as the y-axis. The distance component of the display is derived from the transect line. Each endpoint of this transect line is at a user-defined latitude/longitude location, so neither endpoint is necessarily designated as the location of the radar.

13. In the same tab used in the last example, select the left panel to activate it and return to the *Field Selector*.
14. Display the reflectivity data using the **Radar Cross Section** display type.
  - a. Under **Fields**, select *Reflectivity*. The available displays will list under **Displays**. Select the *Radar Displays -> Radar Cross Section* display type.
  - b. Click **Create Display**.
15. In the **Main Display**, *Left Click+Drag* the endpoints of the cross section to reposition them. You can also drag the entire cross section line by *left clicking + dragging* the triangle in the middle of the line. Use *Right Click+Drag* to navigate through the display in the 3D. Note that the display is duplicated in the **Layer Controls** tab of the **Data Explorer**.


## Displaying Level II radar images: Radar Sweep as Topography

The **Radar Sweep as Topography** display is a unique display type that helps to better visualize 2-dimensional radar data. This display type derives a 3-dimensional display from 2-dimensional data, making the display have various high and low vertical components based upon the numerical value of the parameter you are displaying. Only one elevation angle of radar data is used to create this display.

16. Open a new tab by clicking on the  button in the **Main Toolbar**.
17. Close any previously existing tabs.
18. Display the reflectivity data at the 0.5 degree elevation angle using the **Radar Sweep as Topography** display type.
  - a. In the **Field Selector** tab of the **Data Explorer**, open the **Reflectivity** tree in the **Fields** panel to see the individual elevation angles.
  - b. Select the top **Reflectivity Elevation Angle .5** field. The available displays will list under **Displays**. Select the **Radar Sweep as Topography** display type.
  - c. Click **Create Display**.
19. **Right Click+Drag** in the **Main Display** to observe the 3D features of the display.

## Displaying Level II radar images: CAPPI


The **CAPPI** (Constant Altitude Plan Position Indicator) display is used to visualize the 2-dimensional characteristics of radar data at various altitudes. Every elevation angle included with the data will be used to create this display. Dependent on the altitude you select to display, you may see various rings of data. These rings indicate the radar display created from different elevation angles at the user-defined altitude.

20. Open a new tab by clicking on the  button in the **Main Toolbar**.
21. Close any previously existing tabs.
22. Display the reflectivity data using the **CAPPI** display type.
  - a. In the **Field Selector** tab of the **Data Explorer**, under the **Fields** panel, select **Reflectivity**. The available displays will list under **Displays**. Select the **Radar Displays -> CAPPI** display type.
  - b. Click **Create Display**.
23. In the **Layer Controls** tab, change the **Levels** menu item to change the vertical level displayed in the **Main Display**. You can also click the **Cycle** checkbox to animate through the levels in the vertical.

The **Display Mode** can be changed to Mesh or Points. This can make it easier to see any display that may otherwise be hidden underneath the radar display.


## Displaying Level II radar images: Volume Scan

The **Volume Scan** display is used to visualize the 3-dimensional characteristics of radar data in all directions from the location of the radar. Every elevation angle included with the data will be used to create this display. This is similar to the **Radar Sweep View in 3D** display, with the exception that this display plots data for every elevation angle at once. In order to be able to visualize data from various elevation angles at once, the data is displayed as points instead of as a solid surface.

24. Open a new tab by clicking on the  button in the **Main Toolbar**.
25. Close any previously existing tabs.
26. Display the reflectivity data using the **Volume Scan** display type.
  - a. In the **Field Selector** tab of the **Data Explorer**, under the **Fields** panel, select **Reflectivity**. The available displays will list under **Displays**. Select the **Radar Displays -> Volume Scan** display type.
  - b. Select only one image time by selecting the **Use Selected** menu item in the **Times** tab of the **Field Selector**, and choose one time.
  - c. Click **Create Display**.
27. **Right Click+Drag** in the **Main Display** to observe the 3D view of all radar elevation angles at once.
28. In the **Layer Controls**, enable the checkbox next to **Clip Displayed Range** and click **Change**. In the **Change Visible Range** window, set the **From** value to 35 and click **OK**. Notice how the display has been updated to only show reflectivity values of 35 and greater. This feature allows the user to easily identify regions of higher reflectivity.

## Displaying Level II radar images: Radar Isosurface


The **Radar Isosurface** display is used to visualize 3-dimensional characteristics of radar data in all directions from the location of the radar. Every elevation angle included with the data will be used to create this display. Instead of plotting data at all numerical values, a solid surface of only one user-defined data value will be displayed. One example use of this display would be selecting a high reflectivity value that may be indicative of hail, which can help to possibly identify the hail core of a thunderstorm.

29. Open a new tab by clicking on the  button in the **Main Toolbar**.
30. Close any previously existing tabs.
31. Display the reflectivity data using the **Radar Isosurface** display type.
  - a. In the **Field Selector** tab of the **Data Explorer**, under the **Fields** panel, select **Reflectivity**. The available displays will list under **Displays**. Select the **Radar Displays -> Radar Isosurface** display type.
  - b. Select every image time by selecting the **Use Selected** menu item in the **Times** tab of the **Field Selector**, and choose every time.

- c. Click **Create Display**.
32. Add range rings to the display by selecting the **Display -> Add Range Rings** menu item in the **Main Display**.
30. Change the format of the range rings.
- a. Click on *Range Rings* in the **Legend** of the **Main Display** window to take you to the **Layer Controls** for the range rings. Navigate to the **Settings** tab. Any changes in this tab will be automatically applied to the display.
  - b. Change the **Range Ring Spacing** to *100*, **Color** to *white*, and **Line Width** to *2*.
  - c. Change the **Radial Spacing** to *60*, **Color** to *white*, and **Line Width** to *2*.
  - d. Change the **Labels Color** to *white* and **Line Width** to *2*.
- Note that several of these menu items are linked by default. Because of this, changing the color and line width of the Range Rings applied these settings to the Radials and Labels as well.
33. Animate the display by pressing Play in the Time Animation Control widget. *Right Click+Drag* in the **Main Display** to observe the 3D characteristics of the Radar Isosurface display.
34. In the **Layer Controls** tab for the Radar Isosurface display, change the **Isosurface Value** to *30 dBz*. This will change the display to show only reflectivity values of 30 dBz.

## Displaying Realtime Level II Radar Data

The previous examples were intended to give you experience displaying archive radar. The following example works through loading and displaying realtime data.

35. Remove all layers and data sources from the session.
36. Open a new tab by clicking on the  button in the **Main Toolbar**.
37. Close any previously existing tabs.
38. Load a loop of remote radar data into the **Field Selector**.
- a. From the Data Explorer, navigate to the *Radar -> Level II -> Remote* chooser.
  - b. Verify that the default catalog of <https://thredds.ucar.edu/thredds/radarServer/catalog.xml> is listed.
  - c. If the **Collection** dropdown menu isn't active, click **Connect** next to **Catalog**.
  - d. In the **Collection** dropdown menu, verify that *NEXRAD Level II Radar from IDD* is selected.

- e. *Left-Click* on a station currently experiencing precipitation. Note that you can zoom in on the map using the navigation controls below the map or with *Left-Click+Drag*.
- f. In the **Relative** tab, enter a value of 5 into the **Number of times** field.
- g. Click **Add Source**.

39. Display reflectivity data.

- a. In the **Field Selector** tab of the **Data Explorer**, select **Reflectivity** under the **Fields** panel.
- b. In the **Displays** panel, select **Radar Displays -> Radar Sweep View in 2D**.
- c. Click **Create Display**.

40. Investigate the display using similar functionalities used earlier.



## Problem Sets

The previous examples were intended to give you a general knowledge of how to load and display radar data. The problem sets below are intended to introduce you to new topics related to the data, as well as challenge your knowledge of McIDAS-V. We recommend that you attempt to complete each problem set before looking at the solutions, which are provided below the problem set.

1. Load the KDDC bundle into McIDAS-V. This bundle contains radar data over Dodge City, Kansas from 2007, when an EF-5 tornado occurred. Create a three panel display that will help identify the location of the tornado. In the first panel, create a Radar Sweep View in 2D display of Reflectivity. In the second panel, create a Radar Sweep View in 2D display of Radial Velocity. Finally, in the third panel, create a Radar Sweep View in 2D display of Spectrum Width. Add county outlines to the map backgrounds in all three panels. Change the enhancement of the Radial Velocity to **Radar -> Base Radial Velocity**. Change the Spectrum Width data range to 0 – 20. Add a color bar to the top of each panel. Change the name of the tab to 'KDDX Radar Displays'. Change the name of each panel to represent the field that is being displayed (e.g. Reflectivity). Attempt locating the tornado by interrogating the displays. Probe the data with the middle mouse button.
2. Create a Data Probe/Time Series display of reflectivity data. Hint: To help position the data probe, first create a Radar Sweep View in 2D display.

## Problem Set #1 – Solution

Load the KDDC bundle into McIDAS-V. This bundle contains radar data over Dodge City, Kansas from 2007, when an EF-5 tornado occurred. Create a three panel display that will help identify the location of the tornado. In the first panel, create a Radar Sweep View in 2D display of Reflectivity. In the second panel, create a Radar Sweep View in 2D display of Radial Velocity. Finally, in the third panel, create a Radar Sweep View in 2D display of Spectrum Width. Add county outlines to the map backgrounds in all three panels. Change the enhancement of the Radial Velocity to **Radar -> Base Radial Velocity**. Change the Spectrum Width data range to 0 – 20. Add a color bar to the top of each panel. Change the name of the tab to ‘KDDX Radar Displays’. Change the name of each panel to represent the field that is being displayed (e.g. Reflectivity). Attempt locating the tornado by interrogating the displays. Probe the data with the middle mouse button.

1. Load in the *<local path>/Data/Radar/KDDC.mcvz* bundle through the **File -> Open File** menu item in the **Main Display**. In the **Open bundle** window, select *Replace session*. This will add the data to the **Field Selector**.
2. Create a three panel display via the **File -> New Display Tab -> Map Display -> Three Panels** menu item in the **Main Display**. Close any previously existing tabs.
3. Click the first panel on the left to make this panel active. Select the **Reflectivity** field and the **Radar Sweep View in 2D** display. Click **Create Display**.
4. Click in the middle panel to make this panel active. Select the **Radial Velocity** field and the **Radar Sweep View in 2D** display. Click **Create Display**.
5. Click on the third panel to make this panel active. Select the **Spectrum Width** field and the **Radar Sweep View in 2D** display. Click **Create Display**.
6. In the **Layer Controls** tab, go to the **Default Background Maps** controls for each panel. Check the box next to *U.S. County Outlines* for each panel to add county map outlines to each panel.
7. Add a color bar to each panel by individually going to the **Layer Controls** tab for each field. In the menus of the **Layer Controls**, select **Edit -> Properties**. In the **Properties** window, go to the **Color Scale** tab, click the **Visible** checkbox. Select the **Top Position**. Change the font size to 20, and the text to **Bold**. Click **Apply** and **OK**.
8. In the **Layer Controls** for Radial Velocity, under **Color Table**, select **Radar -> Base Radial Velocity**.
9. In the **Layer Controls** tab for Spectrum Width, change the range to 0 – 20. Do this by clicking on the button to the right of **Color Table**, and selecting **Change Range....** In the **From** field, enter 0. In the **To** field, enter a value of 20. Click **OK** to close the **Change Range** window.
10. **Double-click** on the **untitled** tab to change the name of the tab from ‘untitled’ to ‘KDDC Radar Displays’. This opens a **McIDAS-V – Rename Tab** window. Type ‘KDDC Radar Displays’ and click **OK**.
11. Change the name of each panel individually by going through the **View -> Properties** menu item. In the **Main** tab of the **Properties** window, change the **Name** of the first panel to ‘Reflectivity’. Use the same method to change the name of the second panel to ‘Radial Velocity’, and the third panel to ‘Spectrum Width’. You may need to increase the width of your window to see the panel names.
12. Interrogate the data in the three panels and attempt locating the position of the tornado. Play through the loop using the Time Animation Controls.

## Problem Set #2 – Solution

Create a Data Probe/Time Series display of reflectivity data. Hint: To help position the data probe, first create a Radar Sweep View in 2D display.

1. Remove all layers via the *Edit -> Remove -> All Layers* menu item in the **Main Display**.
2. Create a new, one panel tab via the *File -> New Display Tab -> Map Display -> One Panel* menu item in the **Main Display**.
3. Close any previously existing tabs.
4. In the *Field Selector* tab, select the *Reflectivity* field and the *Radar Sweep View in 2D* display type. Click **Create Display**.
5. In the *Field Selector* tab, select the *Reflectivity* field and the *Data Probe/Time Series* display type. Click **Create Display**. This will place a square probe in the **Main Display** overtop of the **Radar Sweep View** display. A time series at this probe location will be plotted in the *Layer Controls* tab of the **Data Explorer**.
6. Play through the loop of data in the **Main Display**, and position the probe at an interesting location with respect to the reflectivity. As you move the data probe via *Left Click+Drag*, the **Data Probe/Time Series** display will automatically change.
7. To get a valid range for the y-axis reflectivity values in the chart, after positioning the data probe over an interesting area, *double-click* on the *DDC Reflectivity Parameter* below the chart to open the **Properties** window. Next to **Range**, enter a value of 0 for **Min**, 80 for **Max**, and click **OK**.

## Zooming, Panning, and Rotating Controls

Zooming	Panning	Rotating
	Mouse	
<p><b>Shift-Left Drag:</b> Select a region by pressing the <i>Shift</i> key and dragging the left mouse button.</p> <p><b>Shift-Right Drag:</b> Hold <i>Shift</i> key and drag the right mouse button. Moving up zooms in, moving down zooms out.</p>	<p><b>Control-Right Mouse Drag:</b> Hold <i>Control</i> key and drag right mouse to pan.</p>	<p><b>Right Mouse Drag:</b> Drag right mouse to rotate.</p>
	Scroll Wheel	
<p><b>Scroll Wheel-Up:</b> Zoom Out.</p> <p><b>Scroll Wheel-Down:</b> Zoom In.</p>		<p><b>Control-Scroll Wheel-Up/Down:</b> Rotate clockwise/counter clockwise.</p> <p><b>Shift-Scroll Wheel-Up/Down:</b> Rotate forward/backward clockwise.</p>
	Arrow Keys	
<p><b>Shift-Up:</b> Zoom In.</p> <p><b>Shift-Down:</b> Zoom Out.</p>	<p><b>Control-Up arrow:</b> Pan Down.</p> <p><b>Control-Down arrow:</b> Pan Up.</p> <p><b>Control-Right arrow:</b> Pan Left.</p> <p><b>Control-Left arrow:</b> Pan Right.</p>	<p><b>Left/Right arrow:</b> Rotate around vertical axis.</p> <p><b>Up/Down arrow:</b> Rotate around horizontal axis.</p> <p><b>Shift-Left/Right arrow:</b> Rotate Clockwise/Counterclockwise.</p>