McIDAS-V Tutorial
Displaying Satellite Imagery
updated May 2012 (software version 1.2)

McIDAS-V is a free, open source, visualization and data analysis software package that is the next generation in SSEC's 35-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, and contains "Bridge" software that enables McIDAS-X users to run their commands and tasks in the McIDAS-V environment. 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 - http://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 - http://www.ssec.wisc.edu/mcidas/forums/. The forums also provide the opportunity to share information with other users.

In this McIDAS-V Tutorial, some exercises will be explained using different methods of data access: local data files, pre-loaded data bundles and real-time access to default remote servers. 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*).

Loading Geostationary Satellite Images and Loops

1. Create a local dataset to access the imagery files on your local machine. If you want to load real-time data, skip to step 3.

   a. In the **Main Menu Bar** in the **Main Display** window of McIDAS-V, select *Tools -> Manage ADDE Datasets.*

   b. In the **ADDE Data Manager**, select *File -> New Local Dataset.* Enter the following parameters to set up a dataset with the AREA files provided with this tutorial:

   - **Dataset** – MTSAT
   - **Image Type** – MTSAT satellite data
   - **Format** – McIDAS AREA
   - **Directory** – select the *<local path>/***Satellite/mtsat_dust** directory
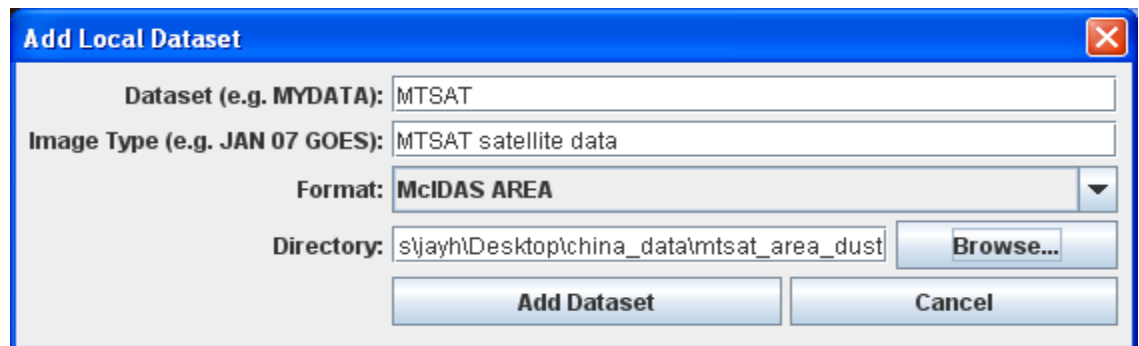
   c. Close the **ADDE Data Manager** by clicking **Ok** or select *File -> Close*.

2. To load the data in this local dataset, follow these steps.

   a. Click on the [button icon] button in the main toolbar to go to the *Data Explorer*.

   b. Select the *Satellite -> Imagery* chooser from the *Data Sources* tab.

   c. Select **<LOCAL-DATA>** for **Server:**, select MTSAT for **Dataset:**, click **Connect**.

   d. Choose the *MTSAT satellite data* **Image Type** and select an **absolute** time of 04:30 UTC.

   e. Click **Add Source** to show the *Field Selector*.

   f. Select *0.73 um VIS Cloud and Surface Features -> Brightness.*

   g. Click **Create Display**. The 04:30 UTC 0.73 μm image is displayed in the **Main Display** window.
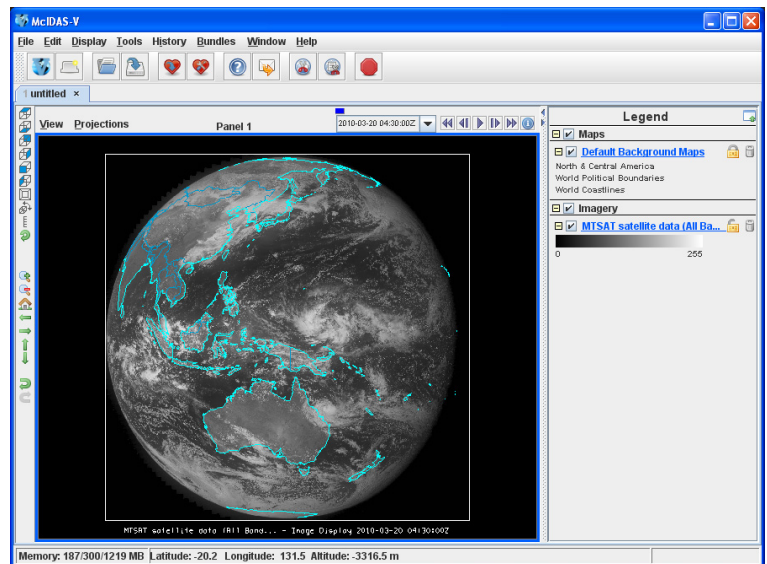
3. To load real-time data, follow these steps. If you have already loaded the data in step one and two, proceed to step 4.

   a. Click on the button in the main toolbar to go to the **Data Explorer**.

   b. Select the **Satellite -> Imagery** chooser from the **Data Sources** tab.

   c. If you're using the default servers in McIDAS-V, you can connect to the adde.ucar.edu server with the dataset RTIMAGES.

   d. Choose the *GE-VIS - GOES-East 0.65 μm Visible* **Image Type** and select an **absolute** time of 17:45 UTC from the previous day. (This step may be slow, because when choosing absolute times, McIDAS-V needs to query the ADDE server for all available times.)

   e. Click **Add Source** to show the **Field Selector**.

   f. Select *0.65 um VIS Cloud and Surface Features -> Brightness*

   g. Click **Create Display**. The 17:45 UTC 0.65 μm image is displayed in the **Map Display** window.

4. Use the zooming and panning controls in the left toolbar to inspect the image.

   a. Reset the display projection by clicking on the icon below the zooming buttons on the left toolbar.

   b. Turn off the **Auto-set Projection** option under the **Projections** menu. When this option is checked, the projection will automatically change to the native projection of the new layer. When this option is unchecked, all new layers will be reprojected into the current projection.

5. Edit the maps in the display by using the options in the **Layer Controls**.

   a. Click on *Default Background Maps* in the **Legend** to go to the **Layer Controls**. The map controls will have two tabs. The first **Maps** tab lists the available maps, and the second **Settings** tab allows the user to control latitude and longitude lines, as well as the Z level of the maps in the 3D display.

   b. In the **Maps** tab, you can remove a map, change its visibility, line width, style and color. Use these options to create your own map display.

   c. If you choose, also add latitude and longitude lines in the **Settings** tab.

   d. To save a map configuration as the default, in the **Layer Controls** select **File -> Default Maps -> Save as the Default Map Set**. The next time you open a new tab, window, or start McIDAS-V, the defaults will reflect what you selected.

6. Return to the **Field Selector** to load an infrared image. To load real-time data skip to step 7.

   a. Select *10.8 um IR Surface/Cloud-top Temp -> Temperature*.

   b. Click **Create Display.**

7. If you are using real-time data, follow the steps below.

   a. Go to the Data Sources tab and select the *GE-IR – GOES-East 10.7 μm IR* **Image Type** and select an **absolute** time of 17:45 UTC from the previous day.

   b. Click **Add Source** to show the *Field Selector*.

   c. Select *10.7 um IR Surface/Cloud-top Features -> Temperature* . Click **Create Display**.

8. The 10.8 μm temperature image is overlaid on top of the visible image. To see the visible image, turn off the top *MTSAT Satellite Data (All Bands...)* checkbox in the **Legend**. Turn the image back on and click and drag the middle mouse button to activate the **Cursor/Data Readout** option. This option brings up a latitude, longitude, and data value readout below the display. Since there are two layers in the main display, there are two different readouts with the appropriate values and units.

9. Change the font and color of the labels on the **Main Display**.

   a. Choose *Edit -> Preferences*. Click on *Display Window*.

   b. In the right column under *Layer List Properties,* change *Font:* to Arial/Plain/14. Change the *Color:* to a yellow hue. Click **OK**. Return to the **Main Display** to see the changes.

10. Notice the labels are the same in the **Legend** and on the **Main Display**. This can be customized.

    a. *Right click* on the top **Legend** label, *MTSAT satellite data (All Bands...)*. (Note: the label will be different when using real-time data.)

    b. Choose *Edit -> Properties...* Enter the following for the **Legend Label** and **Layer Label**:
       - **Legend Label** – *MTSAT data – 10.8 um*
       - **Layer Label** - *%datasourcename% - 10.8 um %timestamp%*
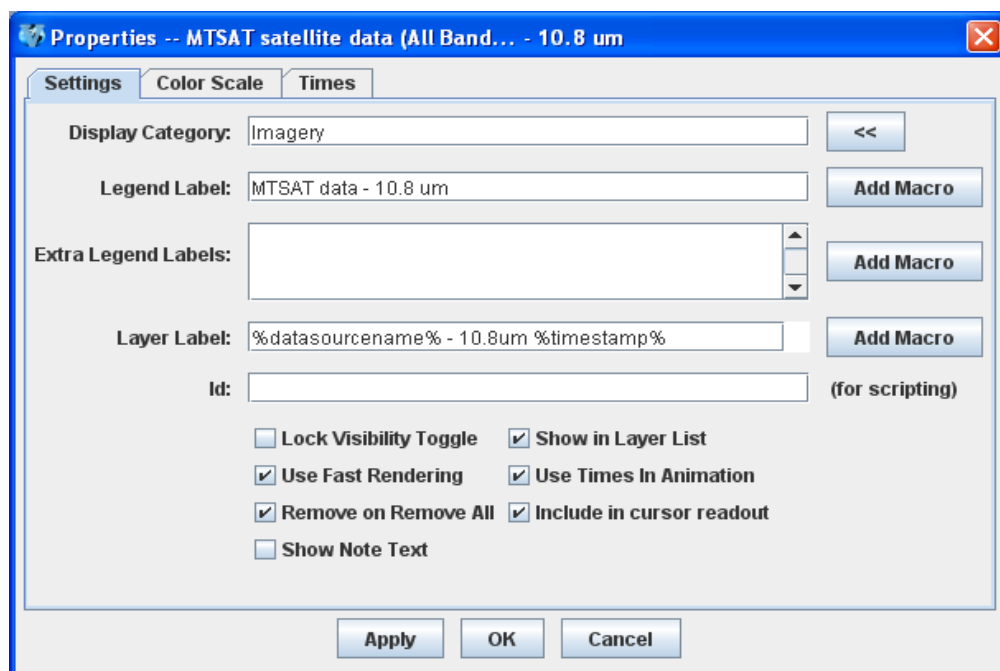
11. In the Layer Controls, you can view a histogram of the displayed imagery. Go to the *Layer Controls* and click on the **Histogram** tab for the 10.8 μm image. You can zoom in on a range of data and the display window will correspondingly change. *Left Click + Drag* on the histogram to create a box of data to inspect closer. Note the range of the data in the image display changes to match the range on your histogram. Click **Reset** if you wish to return to the original histogram and to the original image.

12. Create a local dataset to access other imagery files on your local machine. To load real-time data skip to step 14.

    a. In the **Main Display**, select *Tools -> Manage ADDE Datasets.*

    b. Set up datasets with the FY2E AREA files provided with this tutorial. In the ADDE Data Manager, select **File -> New Local** Dataset, and enter the following parameters:

    Dataset: MEGI_VIS **Image Type:** FY2E VIS satellite data **Format:** McIDAS AREA. Under **Directory:**, select the *<local path>/***Satellite/fy2e_vis_megi** directory. **Add Dataset.**

    Dataset: MEGI_IR **Image Type:** FY2E IR satellite data **Format:** McIDAS AREA. Under **Directory:**, select the *<local path>/***Satellite/fy2e_ir_megi** directory. **Add Dataset.**

    c. Close the **ADDE Data Manager** by clicking **Ok** or select *File -> Close.*

13. Remove the satellite image layers from the display, and create a 4 panel display.

    a. Select *Edit -> Remove -> All Layers and Data Sources.*

    b. Open a new 4 panel tab by selecting *File->New Display Tab->Map Display->Four Panels* from the main menu.

        i. By default, the last panel created will be the active panel. The lower right panel will be highlighted with a default color of blue. Click on the top left panel to activate this panel for the next data load.

        ii. Double click on the "2 untitled" tab name and enter "FY2E 4-panel*"* in the entry box and click **OK** to change the tab name.

    c. From the *Satellite -> Imagery* chooser select **<LOCAL-DATA>** for **Server:**, select MEGI_VIS for **Dataset:**, click **Connect.**

    d. Choose the *FY2E VIS satellite data* **Image Type** and select a **relative** time of 5 most recent images. Check the **Create Preview Image** box. Click **Add Source** to show the *Field Selector*.

    e. Select *0.73 um VIS Cloud and Surface Features -> Brightness*.

    f. Under **Displays** click on the **Advanced** tab. Change the **Lat**: to 20 and **Lon**: to 124, the **Image Size**: to 700 X 1100, the **Magnification** to -5 X -5, and click **Create Display**. (The **Magnification** of -5 X -5 will reduce the amount of data downloaded. The data is sampled with every fifth line and fifth element being sent from the server. Also note that the number of lines and elements chosen may not fit into the display window. Zoom out to display all the pixels requested.)

g. Click on the top right panel to make it the active tab. Repeat steps 13c-e using the MEGI_IR dataset and load the FY2E 10.8 µm brightness. Under **Displays** click on the **Advanced** tab. Change the **Lat**: to 20 and **Lon**: to 124. Change the **Image Size**: to 700 X 1100 and the **Magnification** to 1 X 1, and create the display. (The **Magnification** of 1 X 1 downloads the full resolution of the data. Since this is lower resolution infrared data, the region displayed will be similar to the visible image.)

h. Repeat step 13g for FY2E 6.8 µm in the bottom left panel, and FY2E 3.8 µm in the bottom right panel.

14. If you are using real-time data, follow the steps below.

   a. Select *Edit -> Remove -> All Layers and Data Sources*.

   b. Open a new 4 panel tab by selecting *File->New Display Tab->Map Display->Four Panels* from the main menu.

      i. By default, the last panel created will be the active panel. The lower right panel will be highlighted with a default color of blue. Click on the top left panel to activate this panel for the next data load.

      ii. Double click on the "2 untitled" tab name and enter "GOES 4-panel*"* in the entry box and click **OK** to change the tab name.

   c. Go to the *Data Sources* tab and select the GOES-East 0.65 µm Image Type in the satellite image chooser. In the Relative Times tab, select the *5 most recent* images. Click **Add Source** to show the *Field Selector*.

   d. Select *0.65 um VIS Cloud and Surface Features -> Brightness*

   e. Under **Displays** click on the **Advanced** tab. Change the **Image size** to 900 X 1800 and the **Magnification** to 1 X 1, and create the display.

      i. A warning message may pop up about the amount of data you will be loading; click **OK**.

   f. Click on the top right panel to make it the active tab. Repeat step 14c using GOES-East 3.9 µm in the top right panel, GOES-East 6.5 µm in the bottom left panel, and GOES-East 10.7 µm in the bottom right panel.

15. Because the four tabs all have shared views, using the animation controls and zooming and panning in one panel will make the corresponding changes in the other panels.

   a. In one of the panels, animate the image loop and zoom in on an interesting weather feature. The other panels should also begin looping and zoom in on the same geographical location.

   b. You may remove one of the panels from updating with the other panels by selecting *Projections -> Share Views* in that panels Projections menu.

16. Another feature for real-time data is data polling which allows the data and display to be updated when a new image exists. To turn this on, go to the *Field Selector* tab and *right click* on the GOES-East 0.65 µm data source and select **Properties**. (Note: The option would function for local datasets if files are updated in the local dataset's directory.)

    a. Under *Polling* click on the **Automatically Reload: Active** checkbox.

    b. Click on the **Reload Displays** checkbox at the bottom of the window.

    c. Click **Apply** and **OK**. Every 10 minutes (the default polling time) a check will be made for a new image and if one exists, the satellite loop will be automatically updated in your display.

    d. Repeat this step for the remaining three datasets.

Creating RGB images using formulas

1. Create a local dataset to access a MODIS hdf file on your local machine.

    a. In the **Main Display**, select *Tools -> Manage ADDE Datasets*.

    b. In the ADDE Data Manager, select **File -> New Local Dataset.** To set up a dataset with a MODIS hdf files provided with this tutorial enter the following parameters: **Dataset:** MODIS **Image Type:** MODIS half km file. **Format:** MODIS MOD 02 – Level 1B Calibrated Geo-located Radiances. Under **Directory:**, select the *<local path>*/**Satellite/modis_files** directory. **Add Dataset**.

    c. Remove all layers and data sources.

    d. From the *Satellite -> Imagery* chooser select **<LOCAL-DATA>** for **Server:**, select MODIS for **Dataset:**, click **Connect**.

    e. Choose the *MODIS half km file* **Image Type** and select the most recent image. Click **Add Source**.

2. Define the Red, Green, and Blue channels of your image display.

    a. Click on **Formulas** under the **Data Sources** listed in the *Field Selector*.

    b. Select *Imagery -> Three Color (RGB) Image*, and click **Create Display**.

    c. In the pop up box, select *MODIS half km file -> 0.6465 um -> Brightness* as red, *MODIS... -> 0.5537 um -> Brightness* as green, and *MODIS... -> 0.4656 um -> Brightness* as blue and click **OK**.

3. Create an RGB display from NASA's high resolution Earth imagery, the *Big Blue Marble(BBM) red, green and blue channels*.

   a. Select ***File -> Open File…*** select the *<local path>/***Satellite/Sat-RGB-BBM.mcvz** file to open. Select **Replace session** when prompted.

   b. Follow the same procedure to select the red, green, and blue images from left to right and click **OK.**

4. Save this as a favorite bundle in the toolbar.

   a. Select ***File -> Save Favorite…***

   b. Under *Category* select **Toolbar** and under *Name* enter in **BBM**.

   c. Make sure the Save as zipped data bundle option is checked and click **OK**.

   d. In the Save Data window check the **All** option.

   e. To the right of the toolbar buttons, there should be a **BBM** button.

5. Remove all layers and data sources and click on the **BBM** button to see the bundle load.

Problem Sets

The previous examples were intended to give you a general knowledge of how to load and display satellite 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 5 most recent FY2E 10.8 µm IR Temperature images from the Zhou Qu mudslide event and change the enhancement to **System -> Inverse Grayscale**. Change the range to enhance the colder clouds, create a color enhancement that has values from 190 to 273 interpolated between blue and green, and values greater than 273 interpolated to yellow, add a color bar to the image display window, and save the loop as an animated gif.

2. Create a Parameter default for temperature images so all FY2E Temperature images use the same enhancement and range as in Problem 1. Then, load several different bands of temperature (10.8 µm, 3.8 µm, etc.) and loop through the different bands.

3. Display a loop of FY2E 10.8 µm brightness images from the Zhou Qu mudslide event and overlay a 6.8 µm brightness image. Load a data transect for each image and sync them together. Load a data probe/time series for the 10.8 µm temperature values with the 6.8 µm temperatures on the same graph.

Problem Set #1 – Solution

Load the 5 most recent FY2E 10.8 µm IR Temperature images from the Zhou Qu mudslide event and change the enhancement to **System -> Inverse Gray shade**. Change the range to enhance the colder clouds, create a color enhancement that has values from 190 to 273 interpolated between blue and green, and values greater than 273 interpolated to yellow, add a color bar to the image display window, and save the loop as an animated gif.

1. The following instructions are the solution to Problem 1 from above.

   a. In the ADDE Data Manager, select **File -> New Local Dataset.** To set up a dataset with the Infrared AREA files provided with this tutorial enter the following parameters: **Dataset:** ZQ_IR **Image Type:** FY2E IR satellite data **Format:** McIDAS AREA. Under **Directory:**, select the *<local path>*/**Satellite/fy2e_ir_zhouqu**. Close the ADDE Data Manager.

   b. Select *Edit -> Remove -> All Layers and Data Sources*.

   c. Return to the *Data Explorer* by clicking on the button in the main toolbar.

   d. From the *Satellite -> Imagery* chooser select **<LOCAL-DATA>** for **Server:**, select ZQ_IR for **Dataset:**, click **Connect.**

   e. Choose the *FY2E IR satellite data* **Image Type** and the *5 most recent times*. Click **Add Source** to show the *Field Selector*.

   f. Select *10.8 µm IR Surface/Cloud-top Temp -> Temperature*.

   g. Under **Displays** go to the **Advanced** tab. Move the magnification sliders to 1x1. Click in the **Region** tab. *Shift+left click* in the map display to choose China as the selected display region. Click **Create Display**.

2. In the *Legend*, *right-click* on the *FY2E IR satellite data*'s color table and select *System -> Inverse Gray Scale*.

3. *Right-click* on the color table again and select **Change Range...** Edit the values to focus on the colder clouds. Change the range to 180 to 290 K and click **OK**.

4. To create a color enhancement, *right-click* on the color table and select **Edit Color Table**. The inverse gray scale color table will be loaded in with the 180 to 290 K range.

   The editor uses "breakpoints" which are used for a number of things: showing the data value at a point along the color table and changing the colors (fill, interpolation or transparency) directly below the breakpoint by dragging the breakpoint and changing colors through a popup menu. Breakpoints are indicated along the top of the color legend bar with little triangles and a number.

   a. Create a new breakpoint at 273 K by *right-clicking* on or near the color table and selecting *Add Breakpoint->At Data Point*. Enter in 273 and click **OK**. By default, this breakpoint will be active.

b. The Color Chooser in the lower half of the editor window allows you to select any possible color. Use the slider bar to choose a green hue. Once you have chosen a hue, *left click* in the color display to choose a specific color, which should also update the color of the breakpoint.

c. Click on the 180 breakpoint to make it active and use the same method to select a dark blue color.

d. Interpolate the colors from 180 to 273 by right-clicking on the 180 breakpoint and selecting ***Edit Colors -> Interpolate->Right.*** The enhancement on the images will automatically update.

e. Click on the 290 breakpoint, select a yellow color, and interpolate left to interpolate between 273 and 290.

f. Save the color table as *IR Temps* in the Satellite category.

   i. At the top right of the editor, select *Satellite* from the **Category** pull down list.

   ii. Select ***File->Save As...***, enter in *IR Temps* and click **OK**. This color table will now show up in the list of color tables as ***Satellite->IR Temps***. Close the **Color Table Editor**.

5. Add a color bar to the top of the image.

   a. In the ***Legend***, *right-click* on the ***FY2E IR satellite data*** and select ***Edit -> Properties...***

   b. In the Properties window chose the ***Color Scale*** tab. Click the **Visible***:* checkbox. Change the **Font:** size to **18**.

6. In the **Main Display** select *View -> Capture -> Movie* to bring up the Movie Capture window.

   a. Make sure that the main display window is not obscured by any other window, including the ***Data Explorer*** and the Movie Capture window.

   b. Click the **Time Animation** button. Each time in the loop will be automatically captured.

   c. When the capture is complete, a Save window will pop up. Select "Animated GIF" from the **Files of Type** pull down menu, enter in a file name, and click **Save**.

7. Click **Close** to close the Movie Capture window.

8. View the movie file in a browser window or movie application.

Problem Set #2 – Solution

Create a Parameter default for temperature images so all FY2E Temperature images use the same enhancement and range as in Problem 1. Then, load several different bands of temperature (10.8 µm, 3.8 µm, etc.) and loop through the different bands.

1. Select *Tools -> Parameters -> Defaults* from the **Main Display** to bring up the Parameter Defaults Editor.

    a. Select *File -> New Row* from the editor menu.

    b. Click the double down arrows to the right of the Parameter entry box and select "Current Fields -> FY2E IR satellite data-> 37_Band2_TEMP".

    c. Modify the Parameter name and replace "37" and "2" with an asterick followed by a period "*.". The final result should be: *._Band*._TEMP

    d. Check the Color Table option and select *Satellite -> IR Temps.*

    e. Check the Range option and enter in a range of 180 to 290.

    f. Click **OK**.

    g. Click **Close** in the Parameter Defaults editor.

2. Remove all layers and data sources, and from the *Satellite -> Imagery* chooser select **<LOCAL-DATA>** for **Server:**, select MEGI_IR for **Dataset:**, click **Connect**.

    a. Choose the *FY2E IR satellite data* **Image Type** and select the most recent time. Click **Add Source**.

    b. Select *10.8 µm IR Surface/Cloud-top Temp -> Temperature*

    c. Click **Create Display**. The Typhoon Megi image should have the same range and enhancement as the Zhou Qu loop did in the previous problem.

3. Repeat using other FY2E Infrared bands with Temperature Data Types with the saved parameter default.

    a. Load the 12.0 µm, 6.8 µm and 3.8 µm images in the same display

    b. Use the *View -> Bring to Front* menu option in the Layer Controls for each band to bring the display to the front.

4. To loop through the different bands, in the **Main Display** use the *View -> Displays -> Visibility Animation -> On* option.

Problem Set #3 – Solution

Display a loop of FY2E 10.8 μm temperature images from the Zhou Qu mudslide event and overlay the 6.8 μm temperature images. Load a data transect for each image and sync them together. Load a data probe/time series for the 10.8 μm temperature values with the 6.8 μm temperatures on the same graph.

1. Remove all layers and data sources, and from the **Satellite -> Imagery** chooser select **<LOCAL-DATA>** for **Server:**, select ZQ_IR for **Dataset:**, click **Connect**.

   a. Choose the *FY2E IR satellite data* **Image Type** and select the *5 most recent times*. Click **Add Source**.

   b. Select **10.8 μm IR Surface/Cloud-top Temp -> Temperature,** and in the **Region** tab select a region over China. Click **Create Display**.

   c. Repeat these steps for the *6.8 μm IR (Water Vapor)* band.

2. Go back to the **Field Selector** and select the "Data Transect" Display type for the 10.8 μm image and click **Create Display**.

3. Repeat the data transect for the 6.8 μm image.

4. Move the red and cyan data transects in the **Main Display**. *Shift+Left Click+Drag* on the triangle in the center to move the whole transect. *Shift+Left Click+Drag* on the "+" or "box" to move the endpoints of the transect. The transect will update in the **Layer Controls**.

5. In the **Legend**, *Right Click* on both transects (under "Cross sections") and select **Edit -> Sharing -> Sharing On.**

6. In the **Layer Controls**, click on each transect layer and select **View -> Undock from Data Explorer** to remove the transects from the **Data Explorer**.

   a. Turn off the FY2E imagery by clicking off the checkbox in the **Legend**.

   b. Move the WV transect line, keeping it within the bounds of the image. Once you move one of the transects in the main display window, both transects will align and move to the same points.

7. Return to the **Field Selector** and select the **10.8 μm IR Surface/Cloud-top Temp -> Temperature.**

   a. In **Displays** select **Data Probe/Time Series** and click **Create Display**. The data probe appears in the **Main Display** and the time series is in the **Layer Controls**. Animate the display to see the data probe time indicator (small black triangle at the top of the graph) and the values in the table below the graph changing with time.

   b. In the **Main Display** move the probe over a cloud with a *Left Click+Drag*. In the **Layer Controls** for the Data Probe, *Right Click* on the parameter name 37_Band2_TEMP, choose **Add Parameter…**

   c. In the new Field Selector window choose **6.8 μm IR Mid-level Water Vapor -> Temperature**. Click **OK**. The cyan 6.8 μm values are added to the graph.

Zooming, Panning, and Rotating Controls

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