

## LAB – Investigating Wildfires with SEVIRI and MODIS

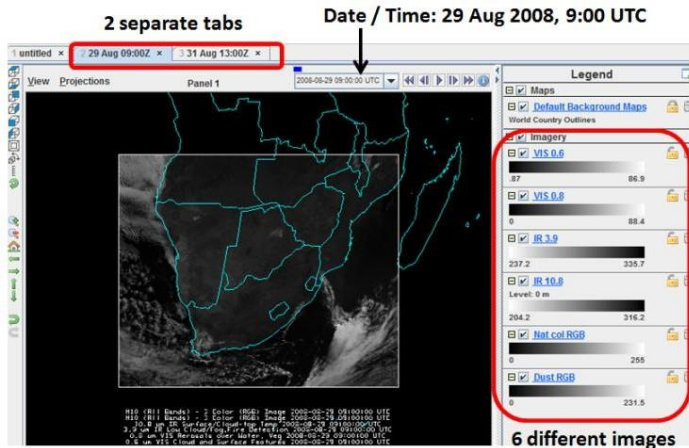
Here are the goals of this lab:

1. New McIDAS-V skills:
  - a. How to open a bundle
  - b. How to compare several bands of satellite imagery both visually and quantitatively
  - c. How to set color scale ranges and change enhancement tables
  - d. How to use a Formula (this lets you do quantitative calculations with satellite data!)
2. Key concepts:
  - a. Interpretation of visible and infrared imagery of wildfires, smoke and burn scars
  - b. Brightness temperature
  - c. Differences between  $3.9\mu\text{m}$  and  $10.8\mu\text{m}$  channel when looking at fires

Here are step-by-step instructions for this lab (key questions are in **yellow**):

### **PART I:**

1. **Read in the bundle** which includes MSG SEVIRI data to start the lab:
  - a. Open McIDAS-V
  - b. In the Map Window, click **File** → **Open File**
  - c. Locate a file called “**fires\_2tabs.mcvz**” under the directories **McV\_data** → **bundles** and click **Open**
  - d. Click **OK** a few times, leaving the default options alone
  - e. In the **Select Input** window, select **0** (minrefl) and **40** (maxrefl) and click **OK**
  - f. Wait, it takes some time to load this “big” bundle
  - g. The display should look like this (the VIS0.6 image is the top image):

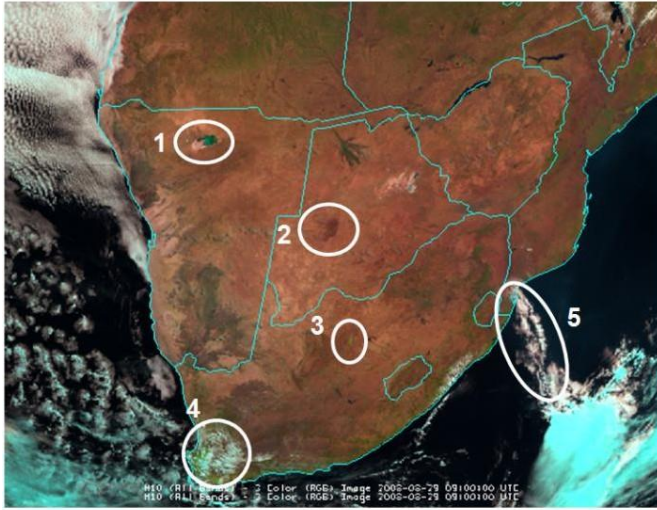


- h. **Try to find out what type of weather situation do we have?**

2. Many channels and RGBs of SEVIRI imagery have now been loaded and are displayed in 2 separate tabs: the **29 Aug 2008, 09:00 Z** tab and the **31 Aug 2008, 13:00 Z** tab. Here is a list of everything you have:
  - i. 0.6  $\mu\text{m}$  (visible) reflectance
  - ii. 0.8  $\mu\text{m}$  (visible) reflectance
  - iii. 3.9  $\mu\text{m}$  brightness temperature
  - iv. 10.8  $\mu\text{m}$  brightness temperature
  - v. Red/Green/Blue (RGB) “Natural Colour” composite
  - vi. Red/Green/Blue (RGB) “Dust” composite

You can choose which display is visible at any moment by clicking the checkboxes on the right side of the map window.

3. Look at 29 Aug 09:00 UTC visible imagery
  - a. First display the **RGB Natcol Composite** (see image below)



Questions: Can you identify the features 1 to 5? Are these 5 features also visible in the infrared channels / Dust RGB?

- b. Focus on feature 2 in Botswana and have a look at the **VIS0.6** and **VIS0.8** channels. Change the range of these two channels to **0 to 25 %** reflectance. **Which channel does show a better contrast for feature 2? Could this dark feature be flooded area?**
- c. Display the **HRV channel** 29.08.2008 at 09:00 UTC for Botswana to see more details of feature 2 and compare it to the other VIS channels. The description of how to display the HRV images (from local data) is given in Lab 1. Use the same range (0 to 25%) as for the VIS0.6 and VIS0.8 images. **Is the HRV image brighter or darker than the other VIS images?**

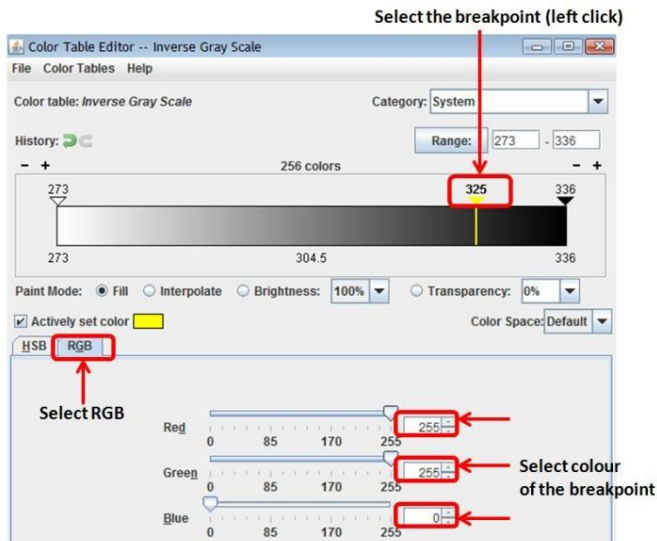
4. Look at the 29 Aug 09:00 UTC infrared imagery

- a. Now take a quick look at the IR3.9 and IR10.8 Brightness Temperature infrared imagery
- b. Enhance these IR images by changing the temperature range: **273 to 336 K** for both the IR3.9 image and the IR10.8 image
- c. Now both IR image have the same colour enhancement table so that you can visually compare the values
- d. Focus on the feature 2 in Botswana (see IR3.9 image below)

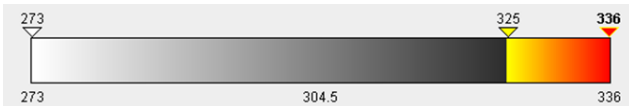


- e. Compare the 2 IR images qualitatively by toggling the images: which image has higher brightness temperatures? Why? Which IR image better detects thin Cirrus? Why? What are the black spots in the IR3.9 image?
- f. Please, toggle the IR3.9 and the RGB Natcol images: what do you think is the wind direction in this part of Botswana? For this question, check the position of the hot spots and the eventual presence of smoke plumes!
- g. Now, let us create a colour table where the black spots appear in colour: **Right-click** on the colour bar of the IR3.9 image, select **Edit Colour Table**

- h. A new **Colour Table Editor** window will pop up
- i. Add a new breakpoint in the colour table by **right-clicking** on the colour bar and selecting **Add Breakpoint** → **At Data Point** → **Value = 325**, and then clicking **OK**
- j. Then, select the new breakpoint 325 K by **left-clicking** on the symbol
- k. Select the colour for this breakpoint by clicking on the **RGB** tab
- l. Select **Red=255, Green=255, Blue=0** (which makes yellow), see screenshot below:



- m. Do the same for the breakpoint **336 K** and select **Red (255,0,0)**
- n. Now, to interpolate between these breakpoints, you have to: **Right-click** on the **336 K** breakpoint, and select from the drop down list: **Edit Colours** → **Interpolate** → **Left**
- o. The colour bar should look like this:

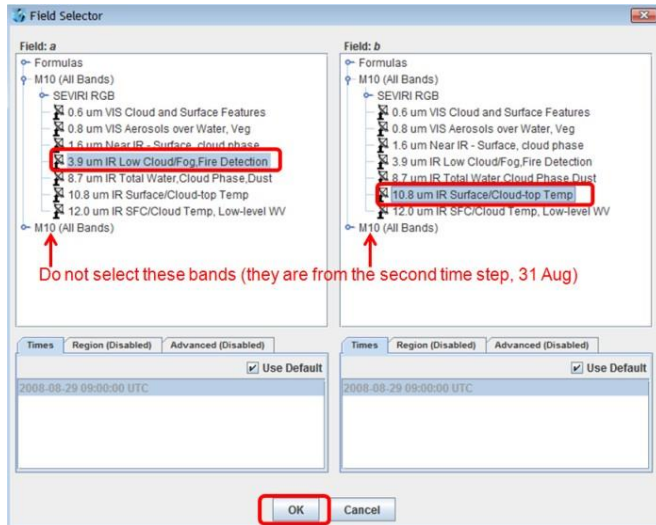


- p. Save the new colour table by clicking **File** → **Save As** → Select name (e.g. "Hotspots")
- q. Click **OK**
- r. The black spots now appear in colour: from yellow (hot pixels) to red (very hot pixels). This makes them more evident. **Can you see other areas with hot pixels?**

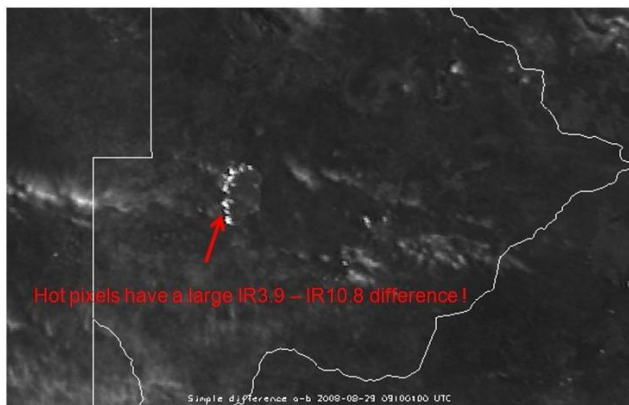
#### 5. (Extra lab) Difference between IR3.9 and IR10.8 imagery (daytime)

- a. To compare the brightness temperature values quantitatively, you can click the middle mouse button on any pixel. This will allow you to compare the actual values of each pixel.
- b. **Compare the 2 channels for: Namib desert, Kalahari, vegetated land, burned land, hot spots, water (ocean), thin cirrus clouds, thick ice clouds, low level water clouds. Create a table. For each target try to explain the difference.**
- c. Make a "difference image" of the IR3.9 and IR10.8 channels. This will nicely highlight the pixels that contain an actively burning fire
- d. In the map window, select **File** → **New Display Tab** → **Map Display** → **One Panel**
- e. A new McIDAS-V window tab will appear (untitled)
- f. Rename this new tab to "Difference" (double click the tab for renaming)
- g. Go to the **Data Explorer** window
- h. Click the **Field Selector** tab
- i. On the left side of the window, click **Formulas**
- j. In the **Fields** panel, click the arrow next to **Miscellaneous** and select **Simple difference a-b**
- k. Select **Imagery** → **Image Display** in the **Displays** panel
- l. Click **Create Display**, and a new window pops up

- m. For **Field a** select the **first M10 (All Bands)** → **3.9 um IR** (see example below)
- n. For **Field b** select the **first M10 (All Bands)** → **10.8 um IR** (see example below)



- o. Click **OK**. All we have done here is created an image of the difference between the IR3.9 and IR10.8 brightness temperatures!
- p. Change the range of the difference image to **-5...+30 K**
- q. Now, the difference image should look like this:

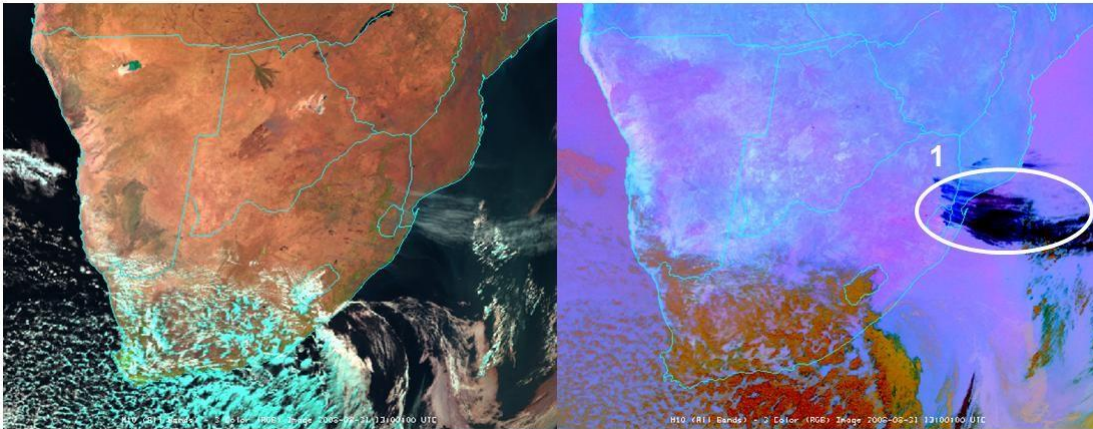


- r. The hot pixels in Botswana have a large positive difference IR3.9 – IR10.8. **Why? Thin Cirrus clouds also have a positive difference. Why?**
- s. Explore the difference image in more detail. Use the middle mouse button to quantitatively determine the brightness temperature difference between the IR3.9 and IR10.8 channels. **What is the largest difference you can find?**

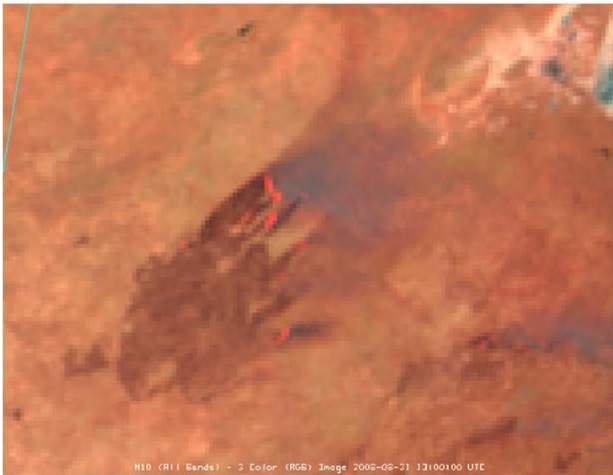
## PART II:

### 6. Situation two days later on 31 August 13:00 UTC - second tab in McV

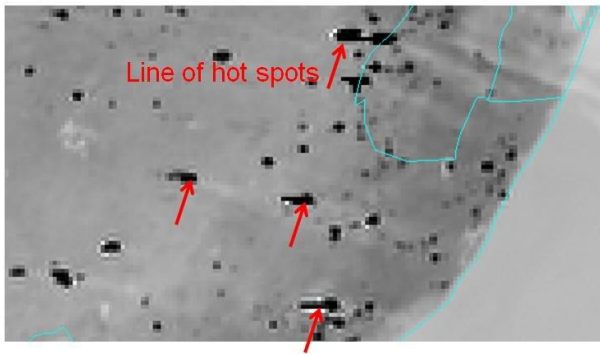
- a. First, change the ranges of the displayed VIS and IR images: **273 K to 336 K** for IR, **0 to 25%** for VIS images
- b. Then display/toggle the **RGB Natcol and Dust Composites** (see image below)



- c. **Can you identify feature 1? What synoptic situation do we have?**
- d. You may display the WV6.2 image (from local data) to check the synoptic situation (using conceptual model analysis)
- e. **What is the surface wind situation over Botswana, northern RSA and Swaziland? Has it changed compared to the previous case (29 August)? Are there areas with strong surface winds? How can you confirm this (hint: check the Dust RGB)?**
- f. Now focus again on the dark area in central Botswana (see image below) and look at the RGB Natcol, the IR3.9 and the IR10.8 images

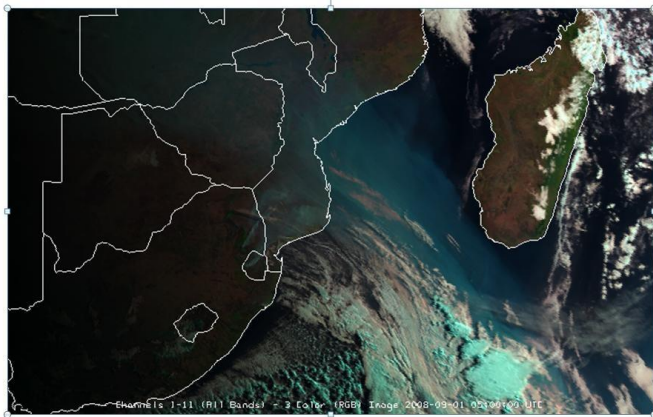


- g. **Has the wind direction changed compared to two days ago? What are the red dots in the Natcol RGB?**
- h. Zoom out and select the IR3.9 image: **Where can you detect new hot spots? Which are the hottest pixels (in IR3.9)?** Check also the IR10.8 and the Natcol RGB.
- i. **Some hot pixels form lines of several east-west pixels (see screenshot below). Why? Are these fires which extend east-west over many kilometers?** Check again also the IR10.8 and Natcol RGB!



## 7. Situation one day later on 1 September 5:00 UTC

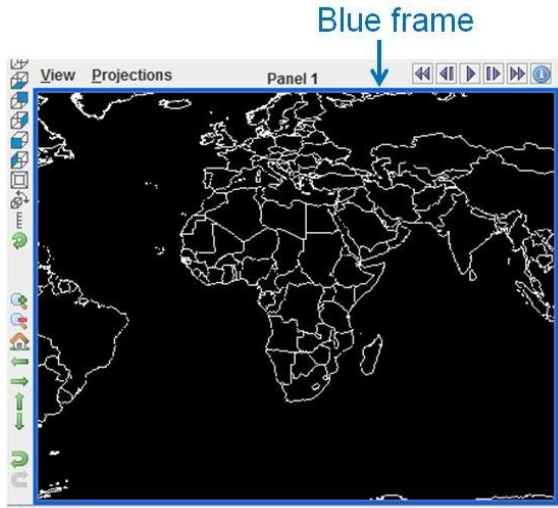
- a. We have to open the images manually (from local data on) as they are not included in the bundle that we have opened
- b. In the McIDAS-V window, select **File** → **New Display Tab** → **Map Display** → **One Panel**
- c. A new McIDAS-V window tab will appear (untitled)
- d. Rename this new tab to “**1 Sep 5:00Z**” (double click the tab for renaming)
- e. In the Data Explorer window, select the **Data Sources** tab
- f. Select **Imagery** under **Satellite** in the panel on the left side
- g. Select **Server:** <LOCAL-DATA>
- h. Select the **Dataset:** MSG, click **Connect** and wait
- i. Select the **Image Type:** Channels 1-11
- j. Go to the **Absolute** tab and select the image at **2008-09-01 05:00:00 UTC**
- k. Click **Add Source**
- l. In the **Field selector** tab, select **SEVIRI RGB standard** → **NCOL (natural colours)**
- m. Select **3 Color (RGB) Image** in the **Displays** panel
- n. When prompted: For **minrefl put 0% and for maxrefl put 40%**.
- o. Choose corresponding channels / RGB components (B-R-G in fact) from list of **Channels 1-11 (Reflectivity)**
- p. Select the **Advanced tab** (last channel only) and put the Magnification slider to the maximum
- q. Go to the **Region** tab and select a large area that includes South Africa and Madagascar
- r. Click **Create Display**. This is an early morning image, which should look pretty dark, like this:



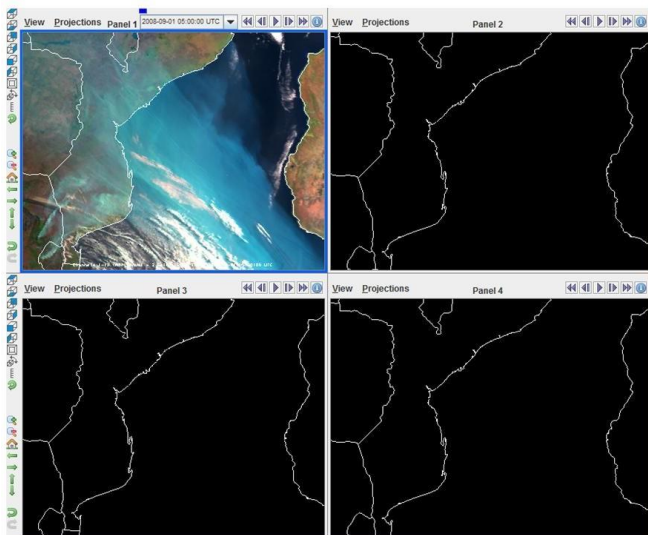
- s. What is the bluish (cyan) feature over the Ocean (Mozambique Channel)?
- t. Try to enhance the RGB image by re-creating the RGB with a range of 0 to 15%. Has the contrast become better?
- u. Now, open also some infrared images: IR3.9, WV6.2, IR10.8 and Dust RGB (for the same area)
- v. Is the bluish feature over the Ocean also seen in one of the infrared channels or the Dust RGB? Why? Why not?
- w. Looking at the WV6.2 image, what is the synoptic situation of this case? Where is the jet? Where is the upper-level trough? What is the wind situation at low levels?

## 8. Multi Panel display of the Natural Colour RGB

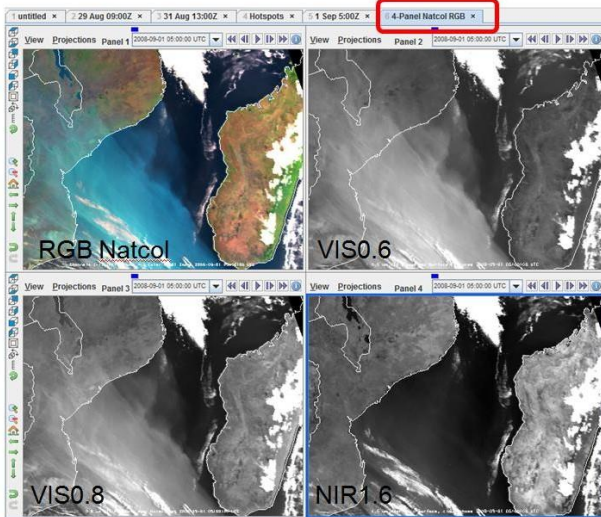
- a. To understand why smoke plumes appear bluish (cyan) in the Natural Colour RGB we may open the RGB and its 3 components in a 4-panel display
- b. In the map window, select **File** → **New Display Tab** → **Map Display** → **Four Panels**
- c. A new McIDAS-V window tab will appear (untitled)
- d. Rename this new tab to “**4-Panel Natcol RGB**” (double click the tab for renaming)
- e. Select (left click) the **upper left panel**. A blue frame appears around the selected panel (see example below)



- f. Go to the **Data Explorer** window, and in the **Field Selector** tab, select **SEVIRI RGB** → **NCOL (natural colors)**
- g. Put Magnification to 1 and select a small region around the Mozambique Channel
- h. For the reflectivity range select again **0 to 15%**, zoom on the Mozambique Channel (note that all 4 panels zoom at the same time), the image should look like this:



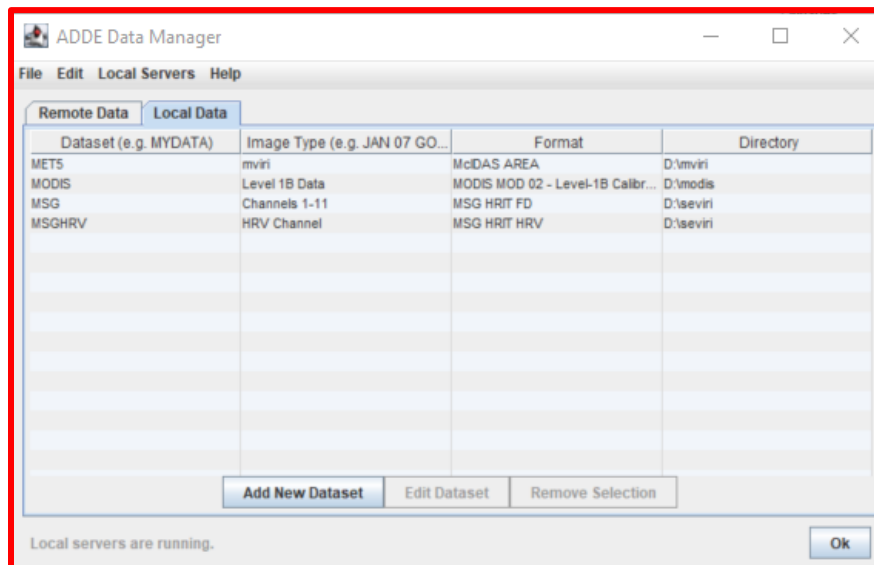
- i. Now let us load the 3 solar channels in the 3 remaining panels
- j. Select the **upper right** panel and load the **VIS0.6** channel (reflectivity)
- k. Select the **lower left** panel and load the **VIS0.8** channel (reflectivity)
- l. Select the **lower right** panel and load the **NIR1.6** channel (reflectivity)
- m. Change the range for all three images to **0 to 15%**: to display the legend of the displays, you have to click on the **View** menu of the corresponding panel (upper left corner of the panel) and select **Display** → **Float Legend** and then change the range by **right-clicking** on the legend and selecting **Change Range**
- n. The 4-panel display should look like this.



- o. Now that we have displayed the Natcol RGB and its 3 inputs (Red=NIR1.6, Green=VIS0.8, Blue=VIS0.6), can you explain why the colour of the smoke plume is cyan?
- p. Which channel has strongest signal for smoke, which the weakest?

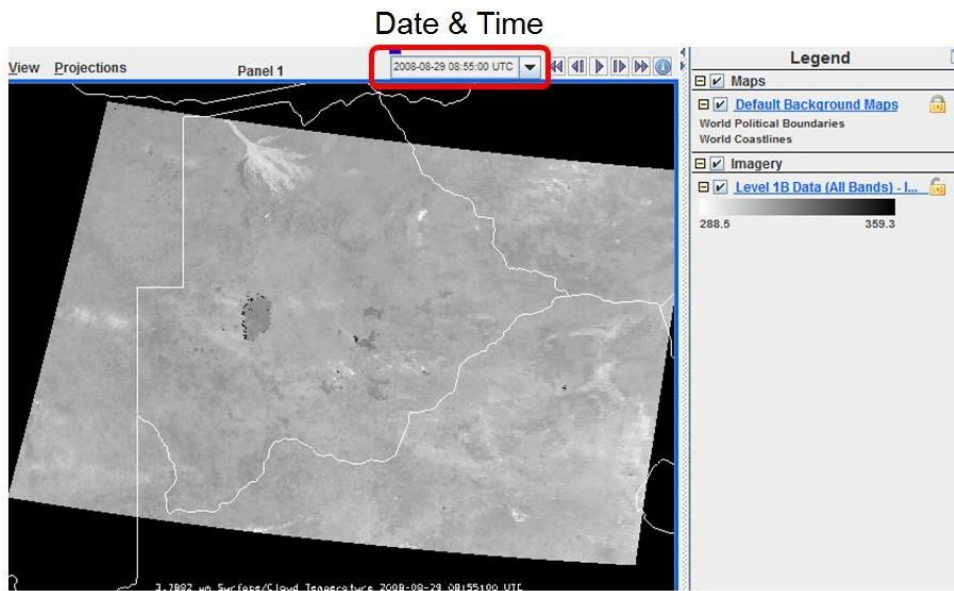
## 9. Comparison of SEVIRI and MODIS images

- a. To prepare for MTG (Meteosat Third Generation), let us look at the same scene (29 August) with high-resolution (1 km) MODIS data
- b. First you need to add MODIS data (Tools → Manage ADDE Datasets → Local Data → Add New Dataset) – same as in the Introduction LAB
- c. Insert Dataset, Image Type and choose Format as in the image below:

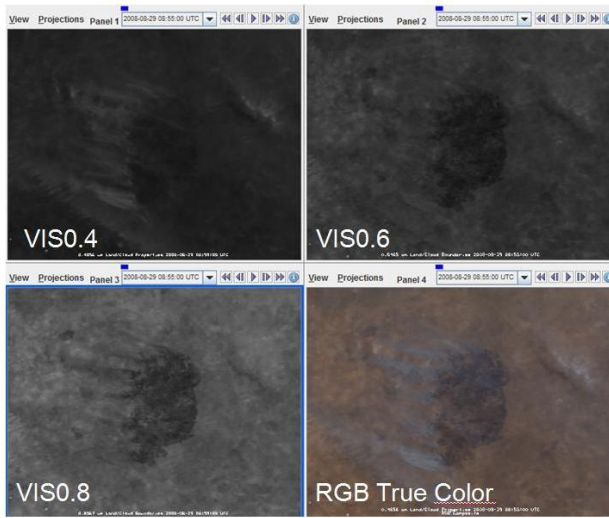


- d. In the map window, select **File** → **New Display Window** → **Map Display** → **One Panel**
- e. A new McIDAS-V window will appear (untitled)
- f. Rename this new tab to “MODIS” (double click the tab for renaming)
- g. In the Data Explorer window, select the **Data Sources** tab
- h. Select **Imagery** under **Satellite** in the panel on the left side
- i. Select **Server:** <LOCAL-DATA>
- j. Select the **Dataset:** MODIS, click **Connect** and wait
- k. Select the **Image Type:** Level 1B Data
- l. Go to the **Absolute** tab and select the image at **2008-08-29 08:55:00 UTC**
- m. Click **Add Source**
- n. In the Field selector tab, select **3.7882 um** → **Temperature** (MODIS Band 20, IR3.7)

- o. Select **Imagery** → **Image Display** in the Displays panel
- p. Select the **Advanced** tab and put the Magnification slider to the maximum (1)
- q. Go to the **Region** tab and select an area that includes Botswana
- r. Click **Create Display**, wait
- s. Create an appropriate “fire” enhancement table for this MODIS IR3.7 image, the result should look like this:



- t. **Zoom on the fires in Botswana and compare to the SEVIRI IR3.9 image: which instrument detects more fires?**
  - u. The MODIS instrument has 4 bands in the IR3.9 region. Let us display the “fire” band (band 21)
  - v. In the **Field Selector** tab of the **Data Explorer** window, select **3.9921 um** → **Temperature** (MODIS Band 21, IR3.9) and **Create Display**
  - w. Again, create an appropriate enhancement table
  - x. **What is the difference to the MODIS IR3.7 image?**
10. (Extra lab) Let us also display the MODIS solar bands to compare them to the SEVIRI solar bands
- a. In the Map window, select **File** → **New Display Tab** → **Map Display** → **Four Panels**
  - b. In the upper left panel display the **0.4656 um** → **Reflectance** (MODIS Band 3)
  - c. In the upper right panel display the **0.6465 um** → **Reflectance** (MODIS Band 1)
  - d. In the lower left panel display the **0.8567 um** → **Reflectance** (MODIS Band 2)
  - e. In the lower right panel display the MODIS True Colour RGB
  - f. In the **Field Selector** tab of the **Data Explorer** window select **Formula** in the left panel and then in the **Fields** panel select **Imagery** → **Three Color (RGB) Image (Auto-scale)**
  - g. Select **RGB Composite** in the **Displays** panel and click **Create Display**
  - h. A new input window pops up
  - i. For **red** select **Level 1B Data** → **0.6465 um** → **Reflectance**
  - j. For **green** select **Level 1B Data** → **0.5537 um** → **Reflectance**
  - k. For **blue** select **Level 1B Data** → **0.4656 um** → **Reflectance**
  - l. Click **OK**, the 4-panel display should look like this:



- m. Play around with the enhancement tables of all 4 images
- n. In which MODIS band is smoke best detected? Is MODIS better than SEVIRI for smoke detection?