Lab: The new NIR1.3 micron channel

1. McIDAS-V skills:
   a. Display data from bundles
   b. Manipulate visualized imagery
   c. Create RGB products
   d. Scatterplots of IR channels

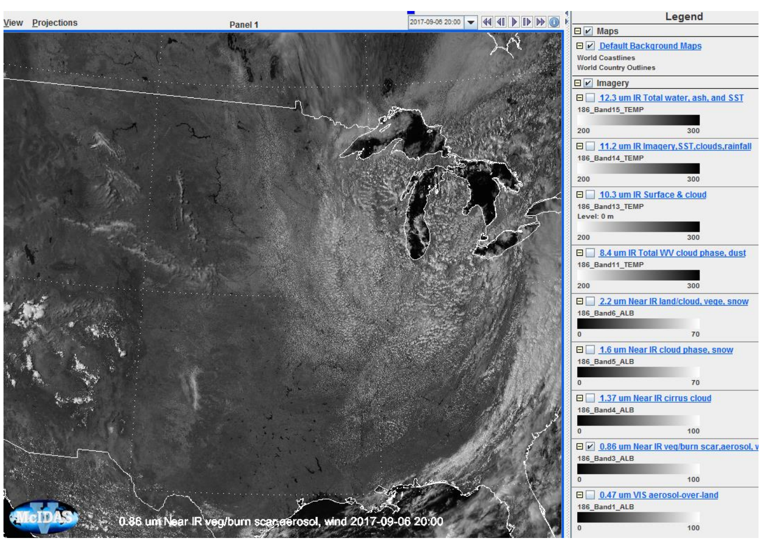
2. Key concepts:
   a. Typical features seen in NIR1.3 channel
   b. Enhancements of NIR1.3 channel
   c. New cloud type RGB product
   d. Comparison with other imager channels and know RGBs

I. Case 6 September 2017 (polar airmass)

In this example, we will explore some invisible, high-level clouds, in some ways, observed by ABI on 6 September 2017.

1. Display GOES-16 ABI imagery on 6 September 2017, 20:00 UTC (over "CONUS" area, USA)

   a. Open McIDAS-V (version 1.8)
   b. In the McIDAS-V window, go to **File → Open File**
   c. Open the bundle "abi_20170906_g16_vis_ir.mcvz" in the directory **/data/** bundles
   d. If asked, select **Merge with active tab(s)** (default option) and **Write to temporary directory** (default option)
   e. Wait until all frames are loaded, the display window should look like this (VIS0.8 image should be in front):



   f. The following bands should be displayed: VIS0.4 (band 1), VIS0.8 (band 3), NIR1.3 (band 4), NIR1.6 (band 5), NIR2.25 (band 6), IR8.4 (band 11), IR10.35 (band 13), IR11.2 (band 14) and IR12.4 (band 15), using standard ranges [0-100% for VIS bands, 0-70% for NIR bands and 200-300

K for IR bands].

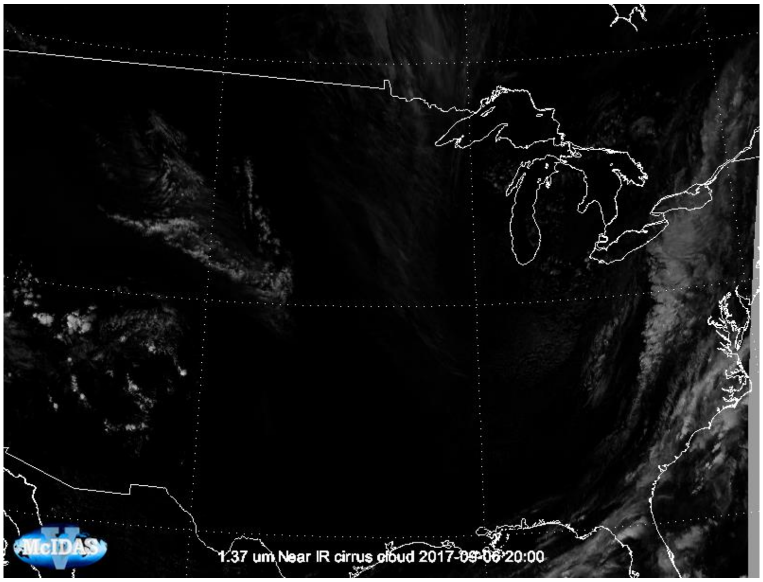
g. Note that ABI has no VIS0.5 band (this is why it is not displayed)

h. Note also that the VIS0.6 (band 2) is not displayed, as it has higher (500 m) resolution

i. Explore the scene by toggling the different bands. Which cloud systems can you identify?

j. Can you imagine what is the synoptic situation of this early September case, why are there so few clouds over the central part of the US?

k. Now let us focus for a moment on the NIR1.3 band. It is very dark (see below), why?. Try to find an appropriate reflectance range and Gamma to enhance the NIR1.3 image. To change the Gamma simply Right mouse click on the colour bar and choose: **Satellite → Square Root Visible Enhancement**



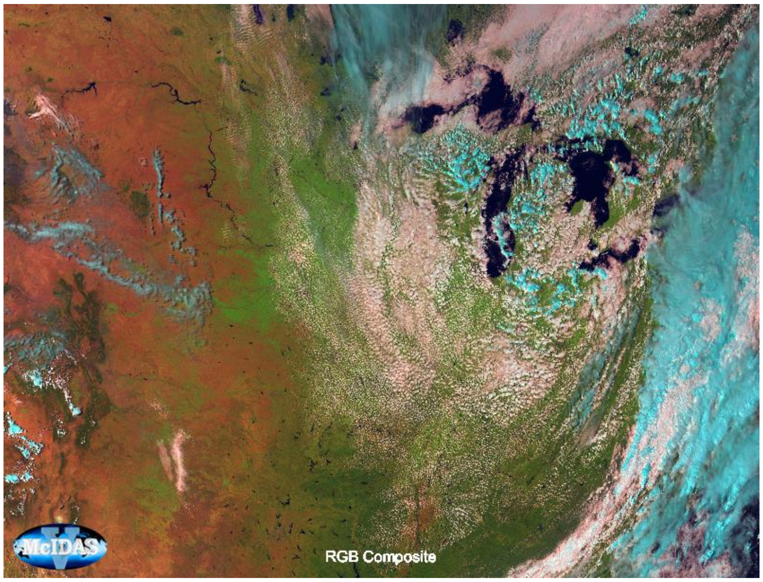
l. Now, let us create the Natural Colour RGB image: in the **Data Explorer** window, under the **Field Selector** tab, click on **Formulas**

m. Then in the **Fields** panel, click on the flag **Imagery**, and choose **Three Color RGB Image (Auto-scale)**

n. Select **RGB Composite** in the **Displays** panel and click **Create Display** at the bottom.

o. Then a separate window will appear and you can select the ABI bands that are displayed in the red, green and blue 'guns' (click on the flag next to second '**FD – All GOES-16 Full Disk Images**' to expand the available channels). Select the channels: 1.6 um for red, 0.8 um for green and 0.4 um for blue. After selection simply click **OK**.

p. To get a good image, enhance the RGB image by changing the RGB ranges, in the **Data Explorer** window, **Layer Controls** choose 0-50% for red, 0-80% for green and 0-80% for blue. After changing the numbers in the boxes, simply press **Apply**. The RGB should look like this (in case you do not see borders any more please right-click on the Default Background Maps in the Legend to the right and press **View → Bring To Front**):



q. Zoom into the region around 45 latitude and -95 longitude (**lat/lon position** of the cursor is displayed in the bottom bar, below image). Do you see clouds in this area?

r. Let us compare this to the NIR1.3 channel observations. Click off all displays but the RGB and the 1.3 micron image, and toggle back and forth. What differences can you see?

s. As above, create the Cloud Type RGB with NIR1.3 on red (0-10%, Gamma = 0.4), VIS0.4 on green (0-60%, Gamma = 1.0), NIR1.6 on blue (0-50%, Gamma = 1.0)

t. Which colours do you get for thick ice clouds and for thin ice clouds? What is the colour for low-level water clouds? What would be the colour for snow (not shown in this scene)?

u. Zoom again on the region 45 N -95 E (see below), what are the red strait lines that cross the image (mostly SE-NW orientated)?

v. Toggle the Natural Colour RGB and the Cloud Type RGB and compare both images.

2. Have a closer look at GOES-16 ABI infrared images and related RGBs (Dust RGB) for the same case

a. Zoom in again on the thin ice clouds west of Lake Michigan. Look at the 4 IR channels: they are nearly the same, but there are small (but very important) differences. Which IR channel gives the best contrast for thin cirrus clouds?

b. Compute the brightness temperature difference 10.35-12.3 um. In the **Field Selector** tab in the

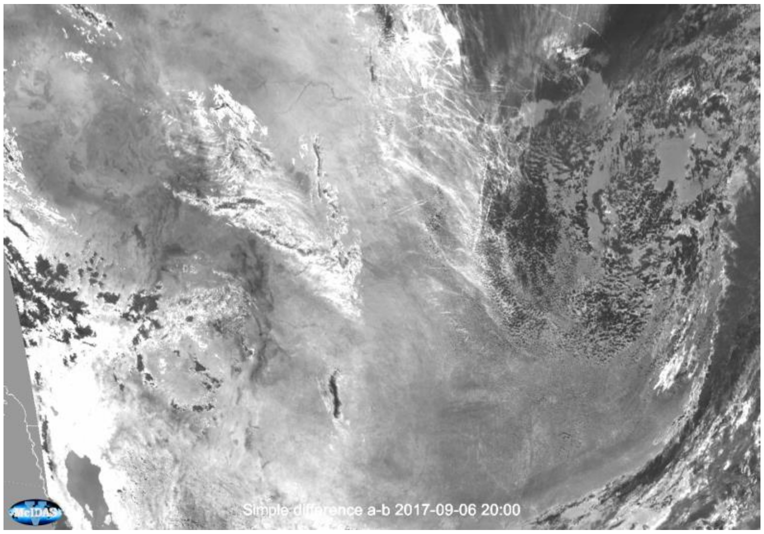
Data Explorer window, highlight **Formulas** in the **Data Sources** panel

c. Select **Miscellaneous** → **Define a formula** → **Image Display** → **Create Display**. In the **Select Input** window that opens write simple formula: **a-b**

d. A new window that pops up: select 10.3 um for field a and 12.3 um for field b

e. Click **OK**

f. Change the range of the difference image to -2 to +8 K. The result should look like this:



g. Which is the highest positive difference that you get?

h. Now, compare this IR difference image to the NIR1.3 image (or the Cloud Type RGB). Which one is better for thin cirrus detection?

i. Extra task: Generate the tuned Dust RGB image for this case (the ranges for the red and blue beams are slightly different from the standard ranges for the Dust RGB)

j. In the **Field Selector** tab in the **Data Explorer** window, highlight **Formulas** in the **Data Sources** panel

k. Select **Imagery** → **Three Color (RGB) Image (Auto-scale)** in the Fields panel

l. Select **RGB Image** in the Displays panel

m. Select **Formulas** → **Miscellaneous** → **Simple difference a-b** for the red field

n. Select **Formulas** → **Miscellaneous** → **Simple difference a-b** for the green field

o. Select **FD – All GOES-16** → **10.3 um** for the blue field

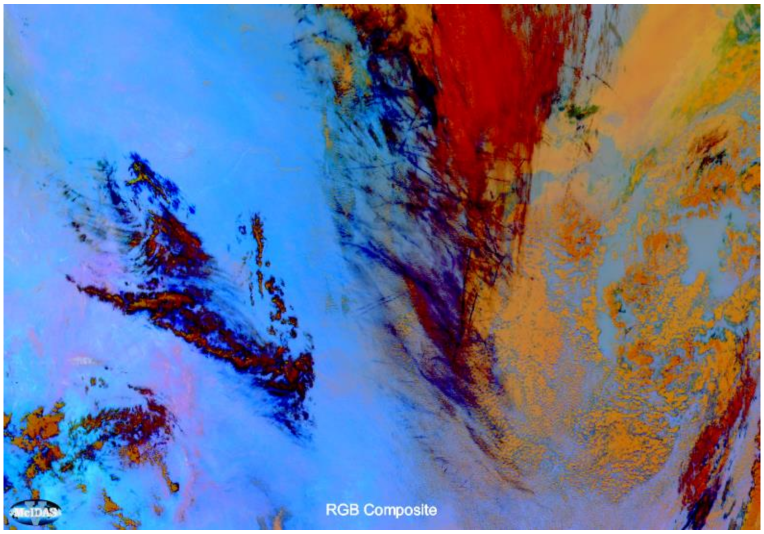
p. A new window pops up. Select 12.3 um for field a and 10.3 um for field b. Click **OK**

q. A new window pops up. Select 11.2 um for field a and 8.4 um for field b. Click **OK**

r. The Dust RGB for ABI is displayed, but we have to change the ranges and the Gammas in the Data Explorer Layer Controls window to get a better contrast

s. For red select -8 to +2 K, for green 0 to +15 (Gamma = 0.4) and for blue 261 to 300 K.

t. The RGB image should look like this:



u. In the Dust RGB, thick ice clouds are dark red, thin ice clouds dark blue to black, and mid level water clouds brownish (ochre).

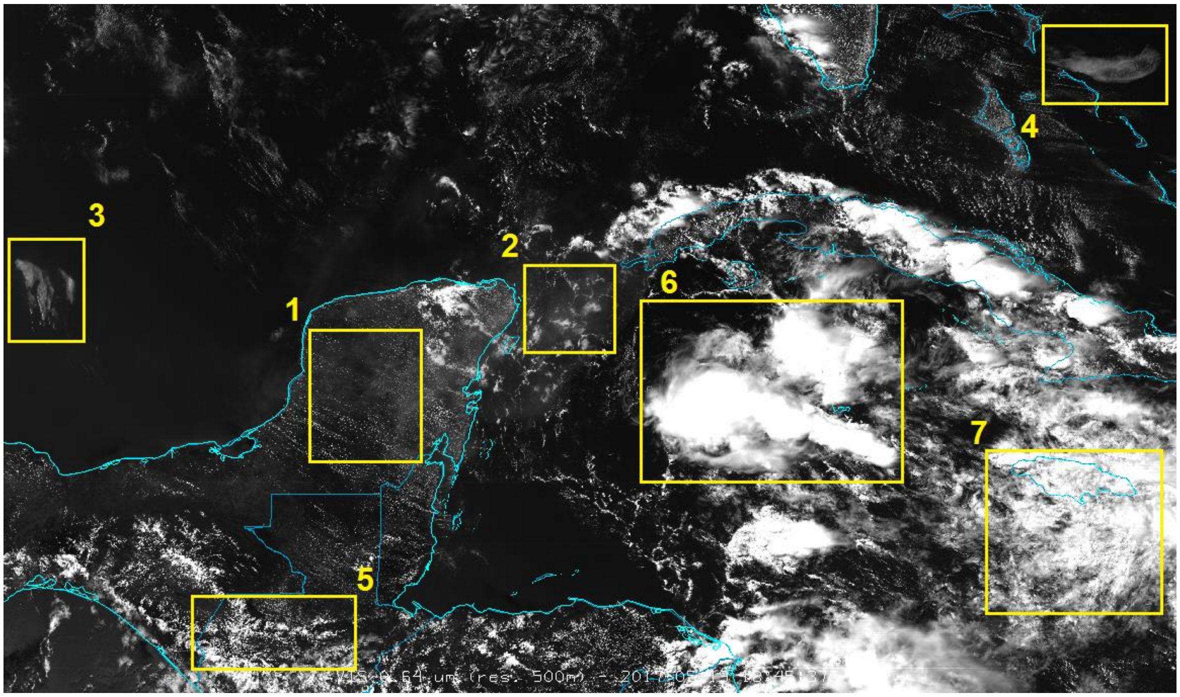
v. Compare the Dust RGB to the Cloud Type RGB (and Cloud Type RGB with NIR1.6 on red (0-50%, Gamma = 1), NIR2.25 on green (0-50%, Gamma = 1.0), VIS0.4 on blue (0-70%, Gamma = 1.0)).

II. Case 19 May 2017 (tropical airmass)

In this example, we will explore thick / thin high-level clouds, observed by ABI on 19 May 2017.

3. Display GOES-16 ABI imagery on 19 May 2017, 18:45 UTC (over the Gulf of Mexico)

   a. Close and Re-Open McIDAS-V (version 1.8)
   b. In the McIDAS-V window, go to **File** → **Open File**
   c. Open the bundle "abi_20170519_g16_yucatan.mcvz" in the **bundles** directory (wait!!)
   d. Click **OK** if error message appears
   e. If asked, select **Merge with active tab(s)** (default option) and **Write to temporary directory** (default option)
   f. Wait until all frames are loaded, the display window should look like this (VIS0.6 image should be in front). Notice the very advanced resolution of this channel, namely 500 m. Please **DO NOT** open other rendered images which are hidden for now.



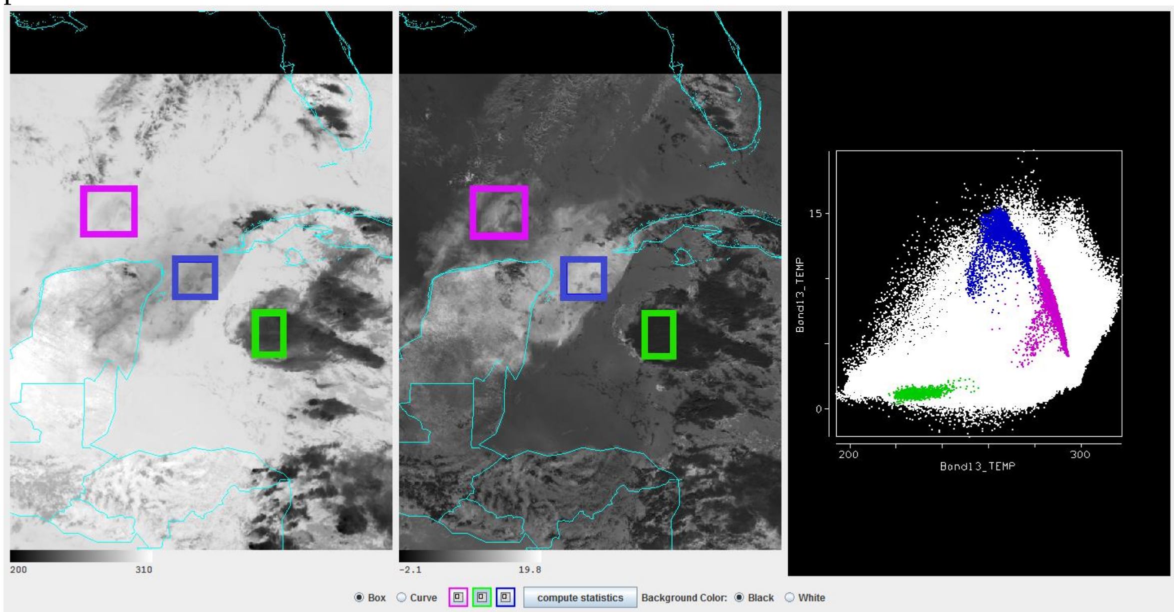
g. Q: Can you guess the type and height (low/middle/high) of the clouds for 7 different enclosed areas
h. Now open/display the Dust RGB image. Q: Can you say something more about the clouds in the enclosed areas (e.g. type, microphysics)? Do you think you have full picture about the height and type of the clouds, or you think additional imagery is needed to assess this?
i. Q: Do the thin (area 2, optical thickness 5-10) and very thin Cirrus clouds (area 1, optical thickness 1-3) have the same RGB colour in Dust RGB? Compare to BTD image (difference between channel IR10.4 and IR12.3).
j. Finally, open the NIR 1.37 µm channel. Q: One more time try to describe the clouds in enclosed areas. Did you improve your assessment of the clouds now?

4. Investigate the scatter plot between 10.4 µm channel and BTD (10.4 - 12.3 µm) on the pixel level

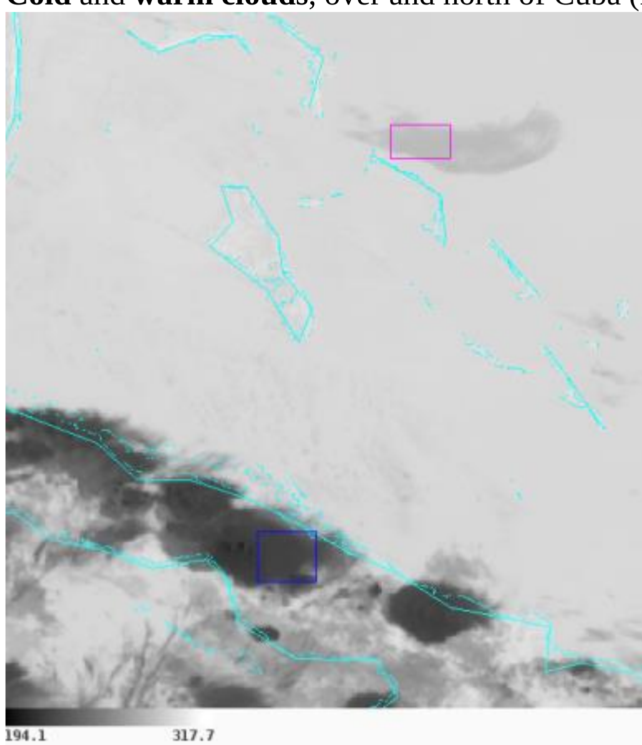
a. Open the **Field Selector** tab in the **Data Explorer** window, highlight the **FD - All GOES-16 Full Disc Images** in the **Data Sources** panel
b. Select **10.3 µm** in the **Fields** panel (this wavelength will be plotted on the x-axis of your scatter diagram)
c. In the **Displays** panel, select **Imagery → Scatter Analysis** and click **Create Display**
d. That will open a second window, where you can select **Formulas → Define a formula → Image Display → Create Display.** In the **Select Input** window that opens write simple formula: **a-b**.
e. This will open a new **Field Selector** window where you should, from the **FD - All GOES-16 Full Disk images (All Bands)**, choose **10.3 um** channel for the **field 'a'** and **12.3 um** channel for the **field 'b'**. This should plot 10.35 µm - 12.3 µm channel difference on the y-axis.
f. Click **OK** to get a third window open that will show the images, in native projection and the scatter diagram for the entire scene.
g. If you then click on one of the colored boxes, and **draw a box around a section** of your image (using shift+left mouse button), you can relate the selected portion of the scene to those points on the scatter diagram (and interactively vice versa!). You can draw a **box or hand draw** in a region. If you point to a window, you can also zoom in with the mouse scroll, or **move the scene** by holding down the right mouse button. You can also **play with the colour scheme** or ranges by right-clicking on the colour bar below image(s).

h. Try to **replicate scatter plots below:**

i. high clouds around Yucatan (magenta box for **very thin cirrus** cloud, blue box for **thick cirrus** cloud, green box for **thick ice cloud**), not necessarily selecting the same cloud patches:



ii. **Cold** and **warm clouds**, over and north of Cuba (Bahamas), respectively:



i. Q: Can you interpret the scatter plot on the right - why are the pixels grouped with these particular patterns? Are these patterns unambiguously associated to certain types of clouds? You can assist your discussion with all available imagery from the bundle.

j. Similarly, compare the IR10.4 channel against NIR1.37 using scatter plot. Any additional piece of information contained in that plot?

More about this case: https://www.eumetsat.int/thin-cirrus-seen-new-goes-16-abi-13-micron-band