

Landsat 8: Greater than 1 Reflectance Values

When the DN values were converted to the TOA reflectance values, there were pixels with reflectivity greater than 1. Unlike negative reflectivity, objects that have reflectivity greater than 1 are not unnatural. Circumstances that would lead to the observance of reflectivity greater than 1 are: 1. Nearby thunderstorm clouds that provide additional illumination from reflected solar radiation. 2. The area receiving solar radiation is directly perpendicular to the sun. Further work has yet to be completed as to whether which of these circumstances are responsible for reflectivity greater than 1.

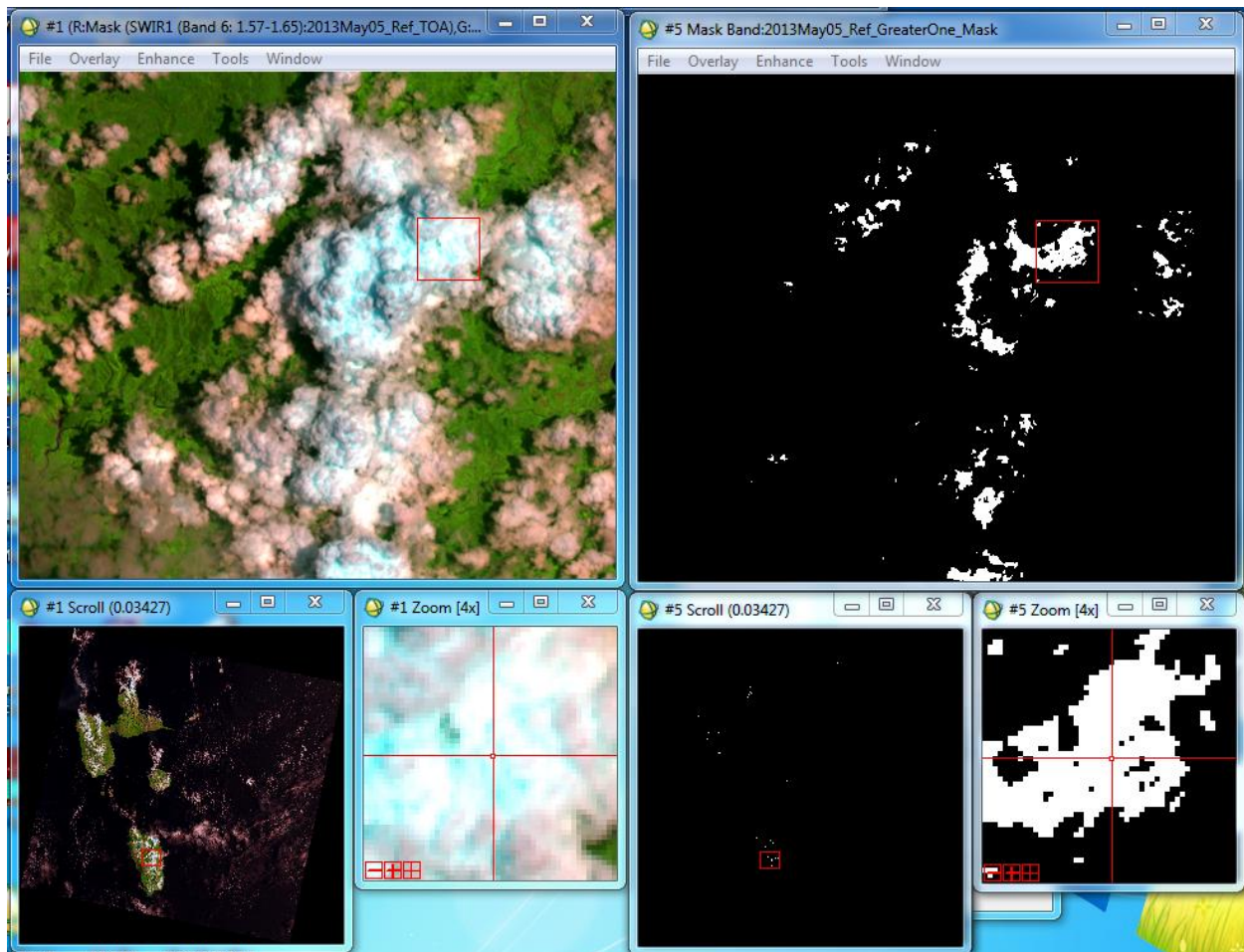
Pixels with reflectance value greater than 1 correspond with the cloud pixels. These identified cloud pixels are near cyan spots of the clouds. Sometimes they are aligned with these cyan pixels, but sometimes they are not as it is the case for the Mississippi image.

❖ *Dominica: 2013May05_Ref_TOA*

Enhance: [Image] Linear 2%

Left: 654 – RGB

Right: 2013May05_GreaterOne_Mask

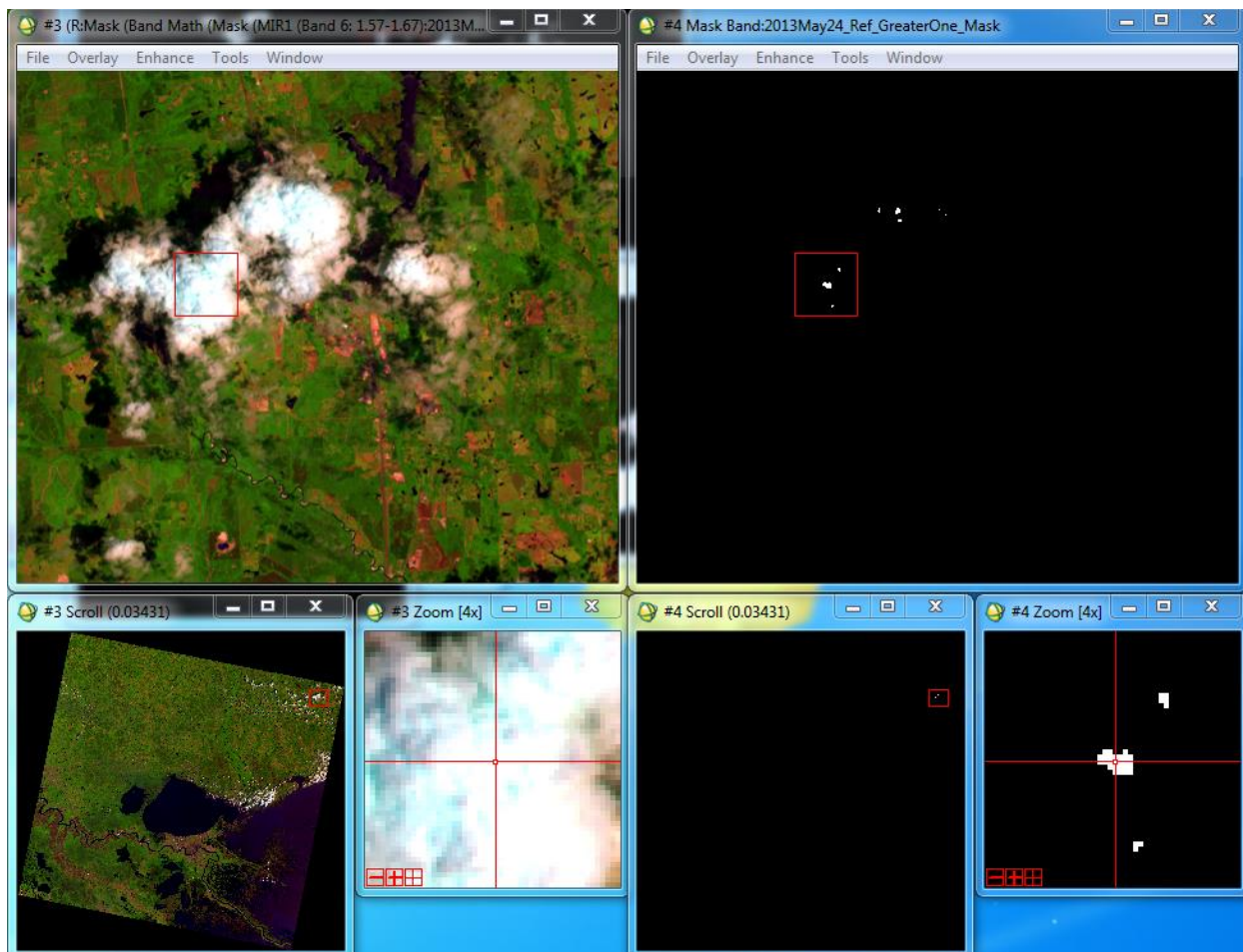


❖ *Mississippi: 2013May24_Ref_TOA*

Enhance: [Image] Linear 2%

Left: 654 – RGB

Right: 2013May24_GreaterOne_Mask



Note: No comparative analysis was conducted for the cirrus band since the maximum reflectance values did not exceed 1.

❖ *Dominica: 2013May05_Ref_TOA*

| | MODE | | | MAXIMUM | | |
|---------------|-------------|-------|-------------|-------------|-------|-------------|
| | Reflectance | DN | # of Pixels | Reflectance | DN | # of Pixels |
| Band 1 | 1.001898 | 51334 | 94 | 1.190295 | 60047 | 1 |
| Band 2 | 1.000127 | 51252 | 276 | 1.257111 | 63137 | 1 |
| Band 3 | 1.003319 | 51400 | 259 | 1.308963 | 65535 | 1 |
| Band 4 | 1.003319 | 51400 | 491 | 1.308963 | 65535 | 12 |
| Band 5 | 1.003319 | 51400 | 1352 | 1.308963 | 65535 | 64 |
| Band 6 | 1.027111 | 52500 | 1 | 1.027111 | 52500 | 1 |
| Band 7 | N/A | N/A | N/A | N/A | N/A | N/A |

❖ *Mississippi: 2013May24_Ref_TOA*

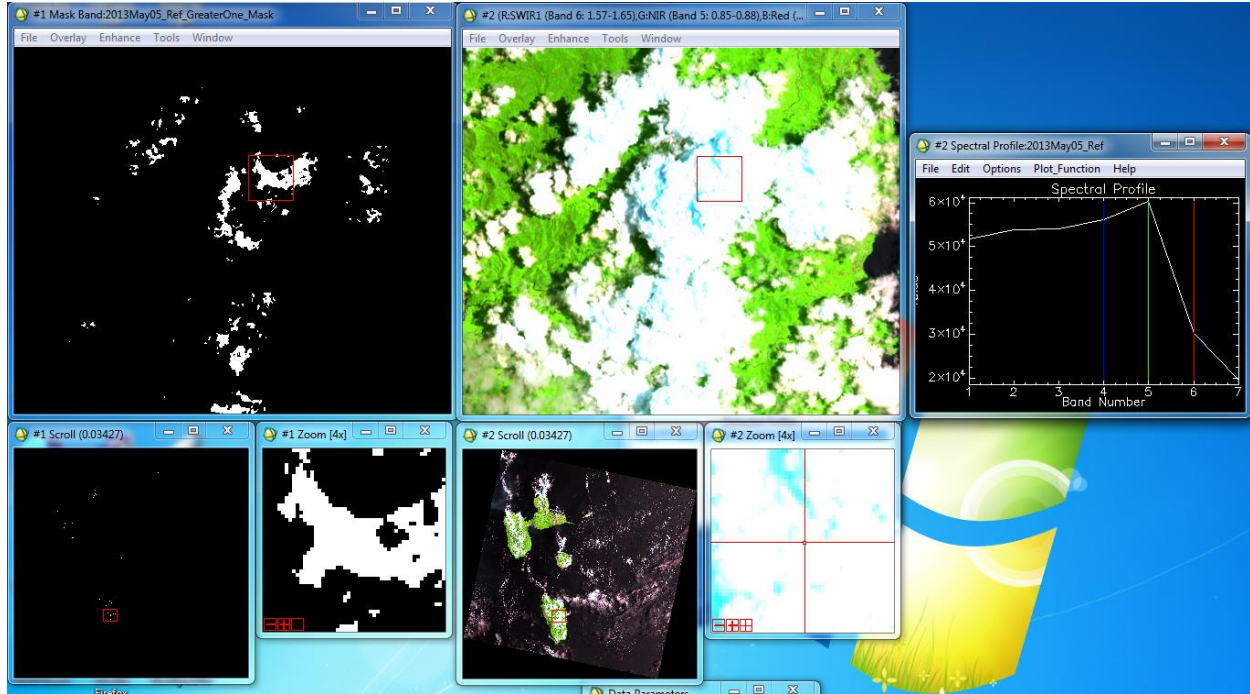
| | MODE | | | MAXIMUM | | |
|---------------|-------------|-------|-------------|-------------|-------|-------------|
| | Reflectance | DN | # of Pixels | Reflectance | DN | # of Pixels |
| Band 1 | N/A | N/A | N/A | N/A | N/A | N/A |
| Band 2 | 1.003719 | 51882 | 2 | 1.124454 | 57521 | 1 |
| Band 3 | 1.009516 | 52152 | 3 | 1.164041 | 59370 | 1 |
| Band 4 | 1.004411 | 51914 | 11 | 1.290529 | 65278 | 3 |
| Band 5 | 1.004748 | 51930 | 54 | 1.269205 | 64282 | 1 |
| Band 6 | 1.002449 | 51822 | 4 | 1.273059 | 64462 | 1 |
| | 1.013274 | 57506 | 4 | - | - | - |
| Band 7 | 1.124129 | 52328 | 4 | 1.174382 | 59853 | 1 |

Note: There are two modes for Band 6; all other bands have one mode.

For Landsat 8 images, the DN value of 65535 is the maximum possible value, and there are a lot of pixels with DN=65535 that are clustered in the Dominica image (See images below). This leads to the assumption that there are some saturated pixels.

❖ *Dominica: 2013May05_Ref_TOA*

Left: Mask for greater than 1 reflectivity Middle: 654- RGB Right: Z-profile of one of the clustered pixels with DN= 65535 in the Band 5.



From the tables on the previous page, one wonders if the pixels with greater than one reflectivity in the MIR bands also have greater than one reflectivity in the visible bands. To answer this question, a mask for reflectance greater than 1 on either Band 6 or Band 7, or both was created for the Mississippi image where there are more than 10 pixels had greater than one reflectivity on either MIR band.¹

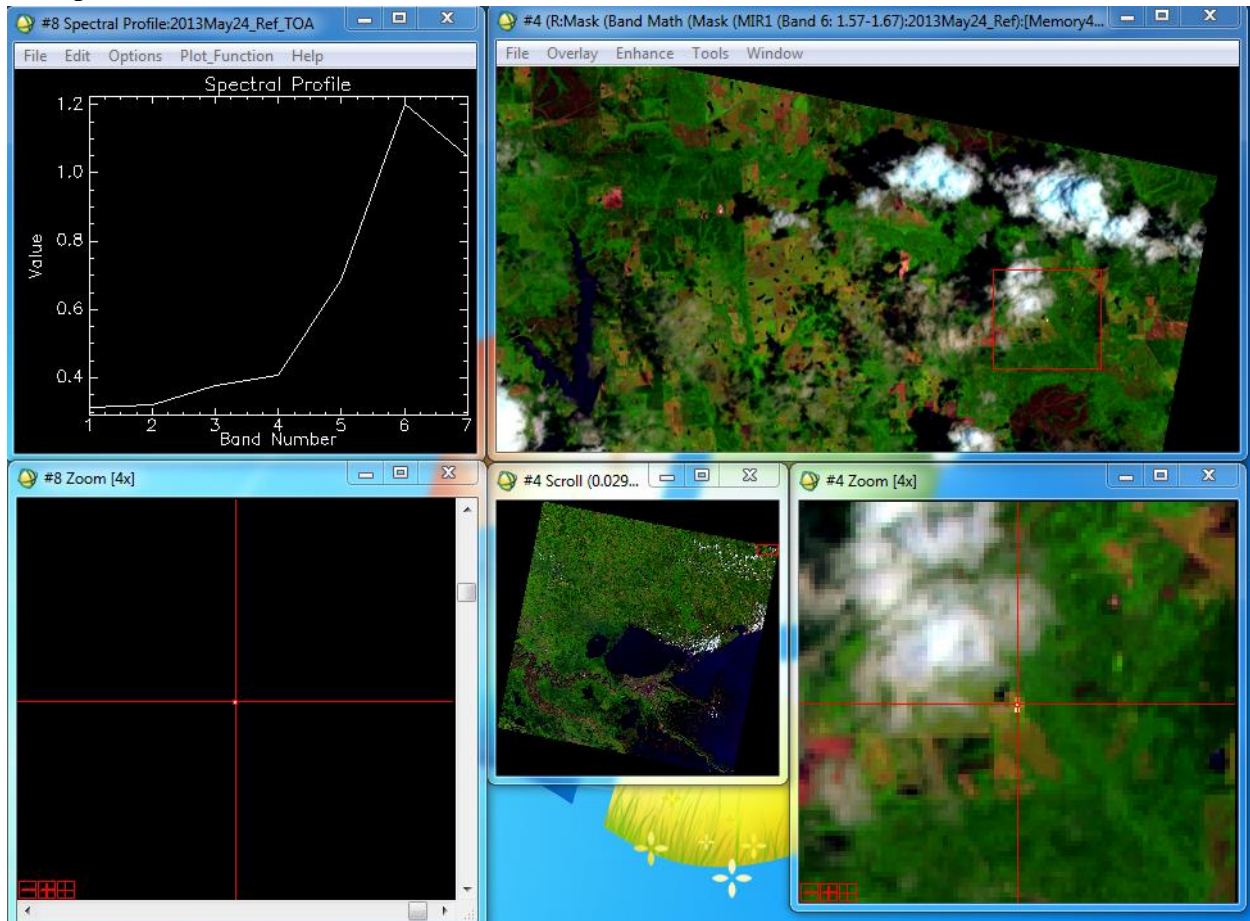
The Z-profiles of the identified pixels from the mask show greater than one reflectivity in only the MIR bands, not also the visible bands. While these pixels are near clouds, they are not cloud pixels themselves. These pixels are identified as those with pale pink hue. In Google Earth, these pixels were located on a diverse set of objects: white rooftops, grass field, and construction ground. At this point, I am at a loss for why these particular pixels have greater than 1 reflectivity in only the MIR range.

¹ No comparative analysis done for the Dominica image because only one pixel was identified as having greater than one reflectivity on either Band 6 or 7.

❖ *Mississippi: 2013May24_Ref_TOA*

Top Left: Z-Profile Bottom Left: Mask for pixels >1 in Reflectivity for either Band 6 or 7
Right: 654 – RGB (Enhance: [Image] Linear 2%)

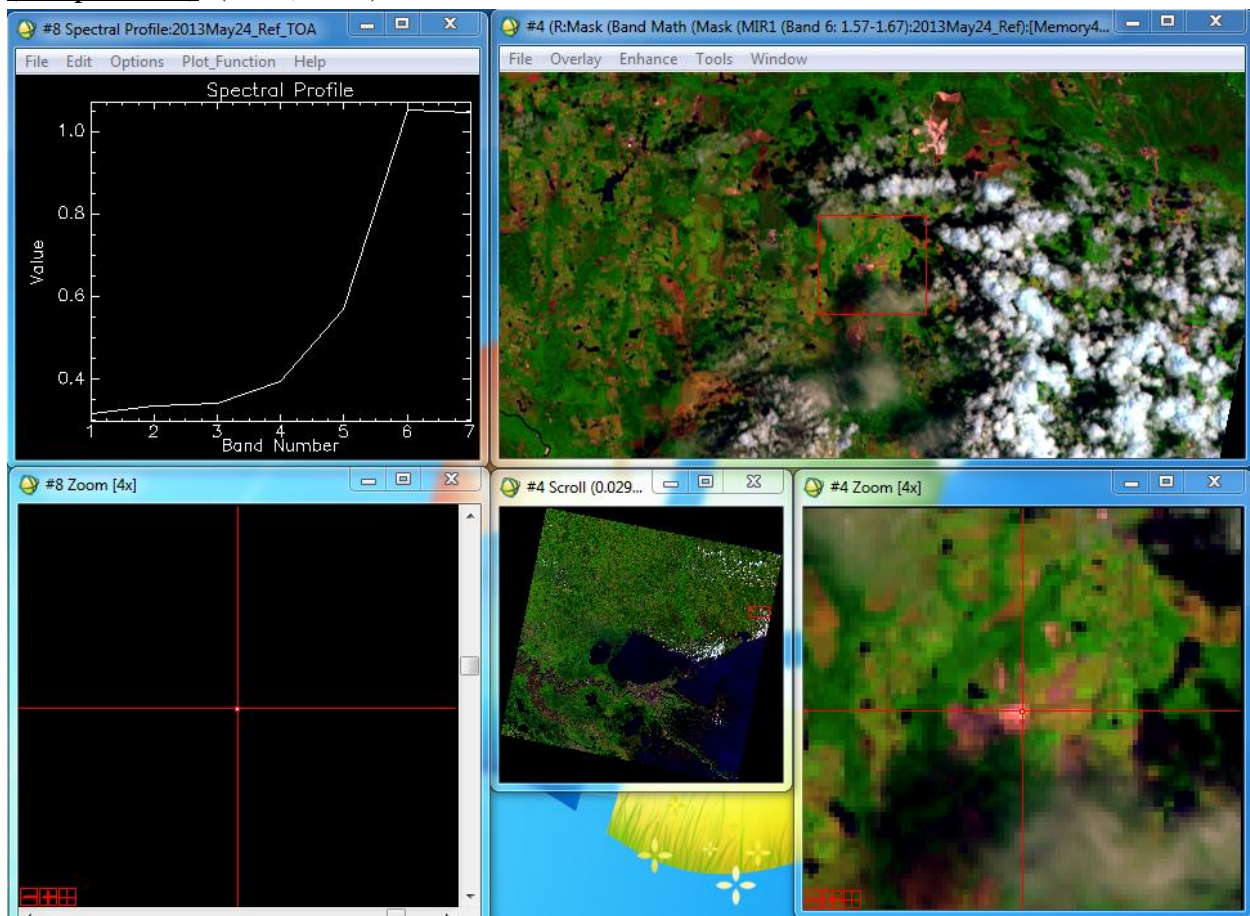
(Sample, Line): (7312, 1356)



Google Earth View: White Rooftop



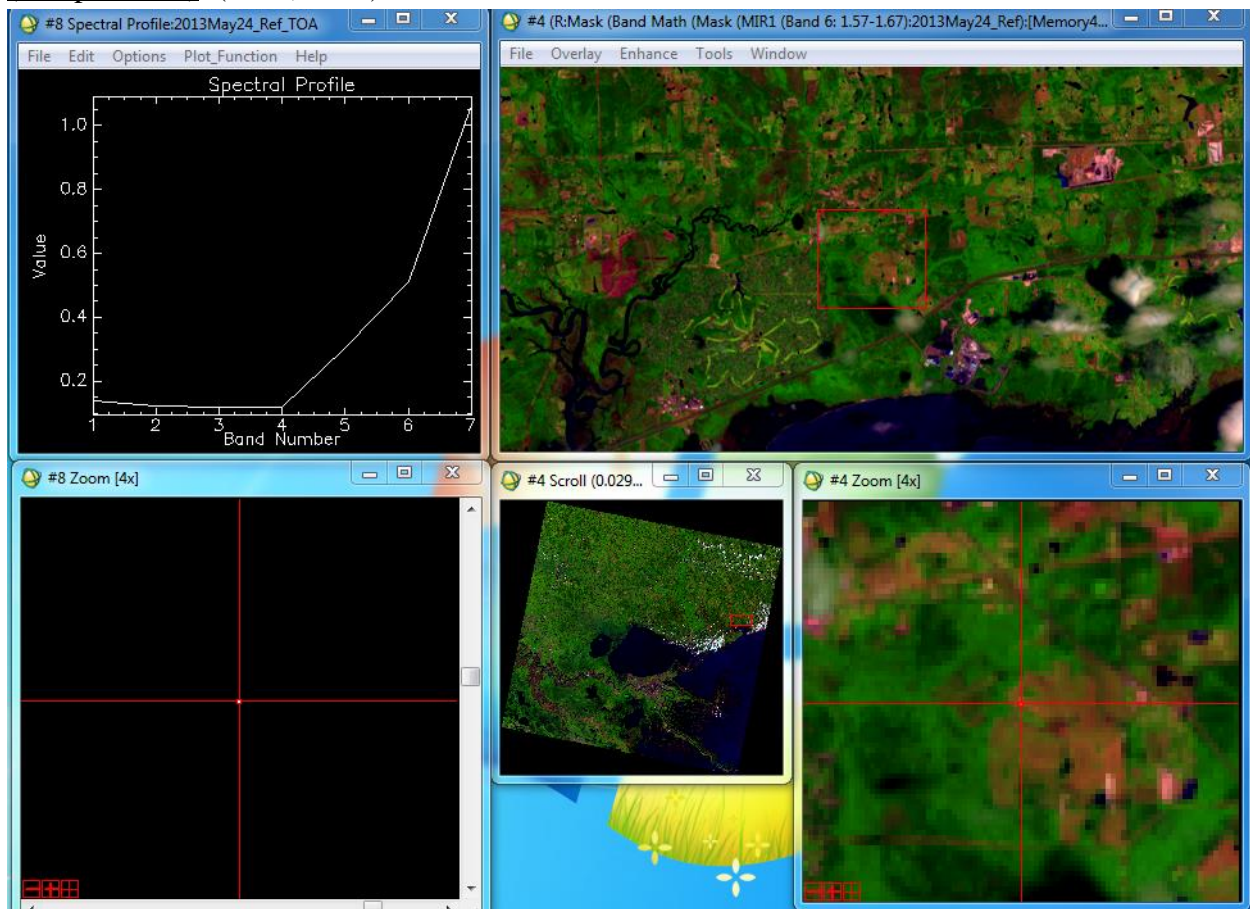
(Sample, Line): (6837, 2778)



Google Earth View: White Rooftop



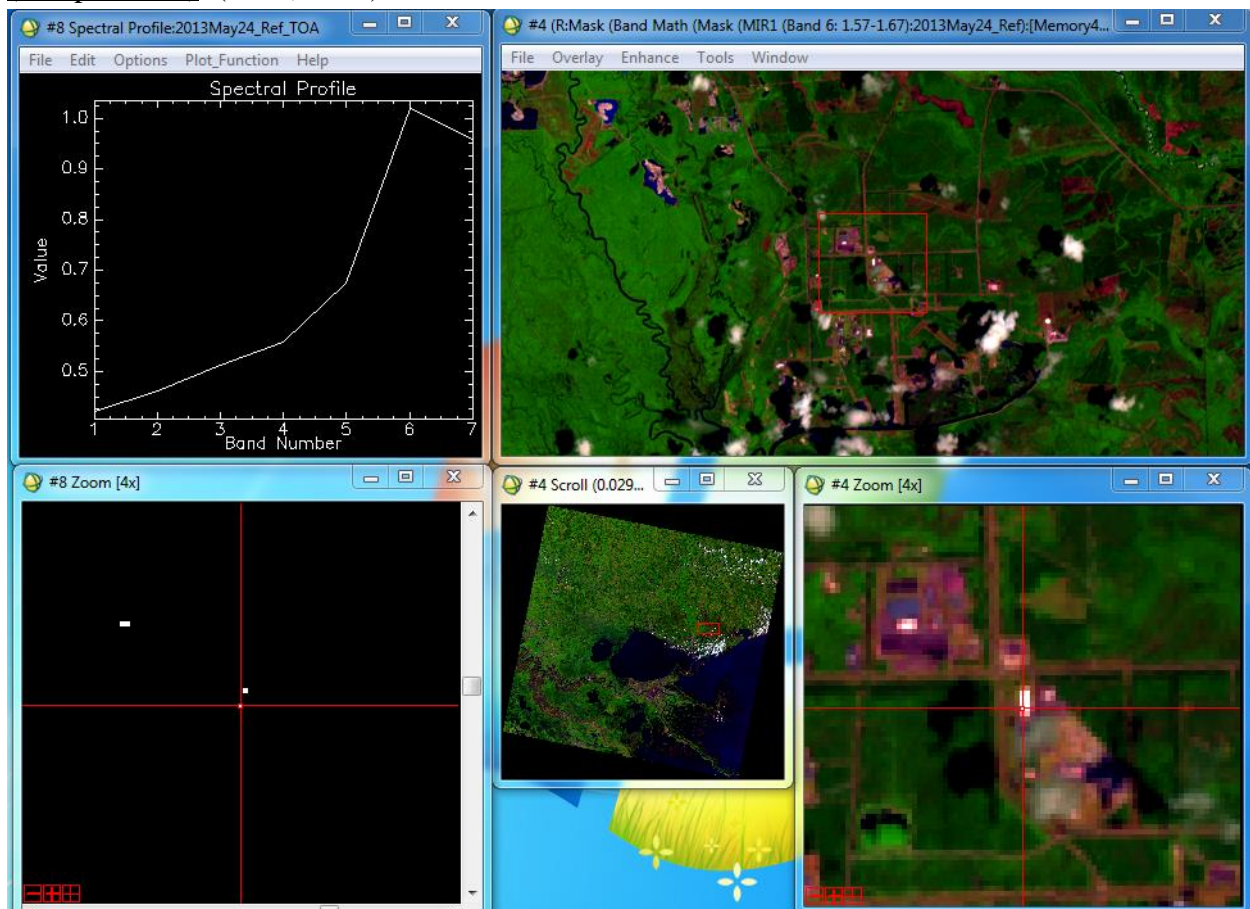
(Sample, Line): (6361, 3170)



Google Earth View: Grass Field



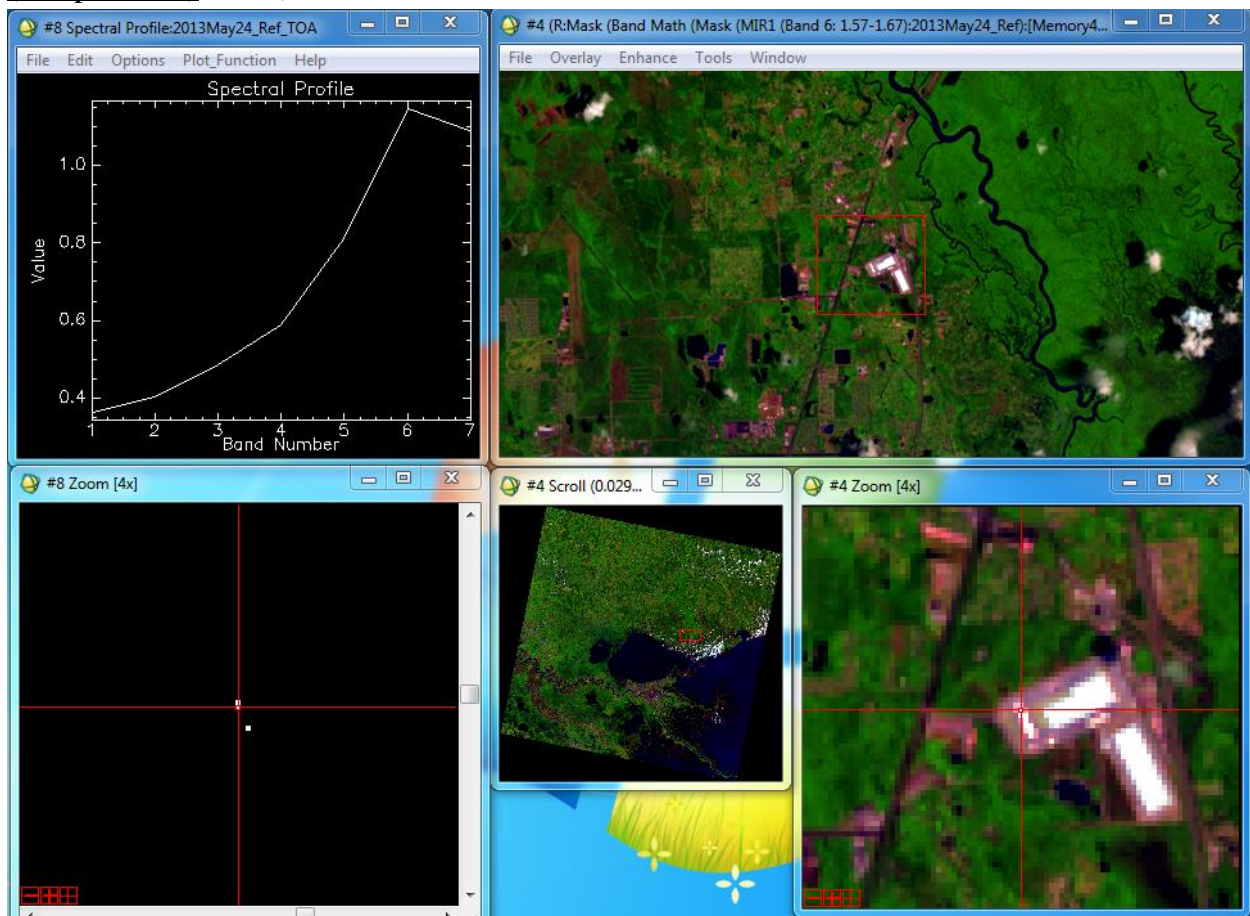
(Sample, Line): (5472, 3267)



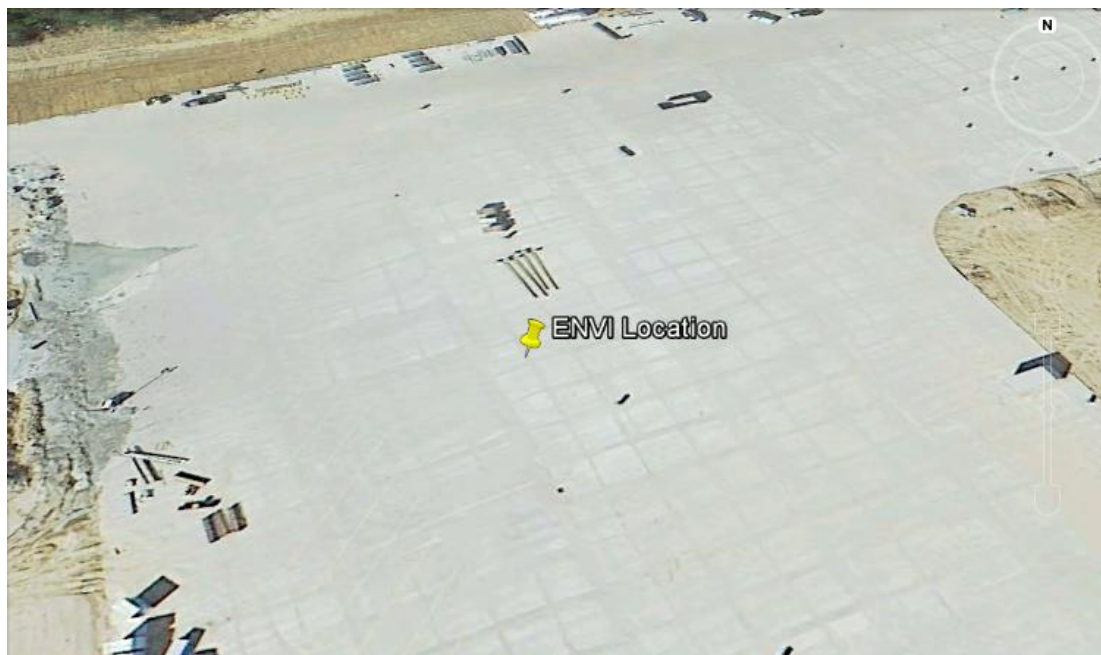
Google Earth View: White Rooftop



(Sample, Line): 5026, 3415



Google Earth View: White Construction Ground (Concrete?)



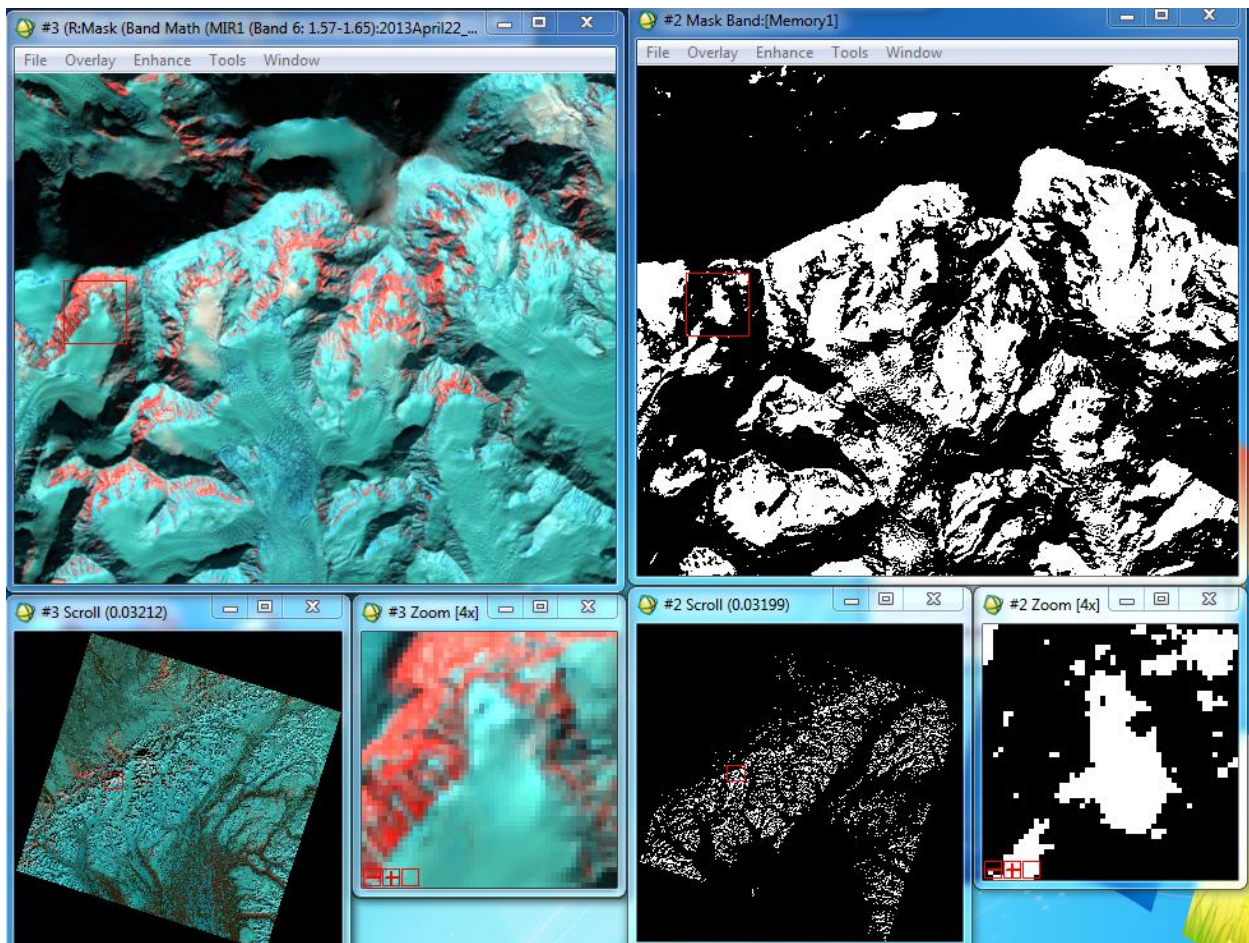
Next, the following two scenes were examined in order to investigate into the possible issues of sensor saturation due to: snow caps in the Mt. McKinley mountain range in Alaska and tall thunderstorm clouds along Florida's coastline.

❖ *Alaska: 2013April22_Ref_TOA*

Enhance: [Image] Linear 2%

Left: 654 – RGB

Right: 2013April22_GreaterOne_Mask

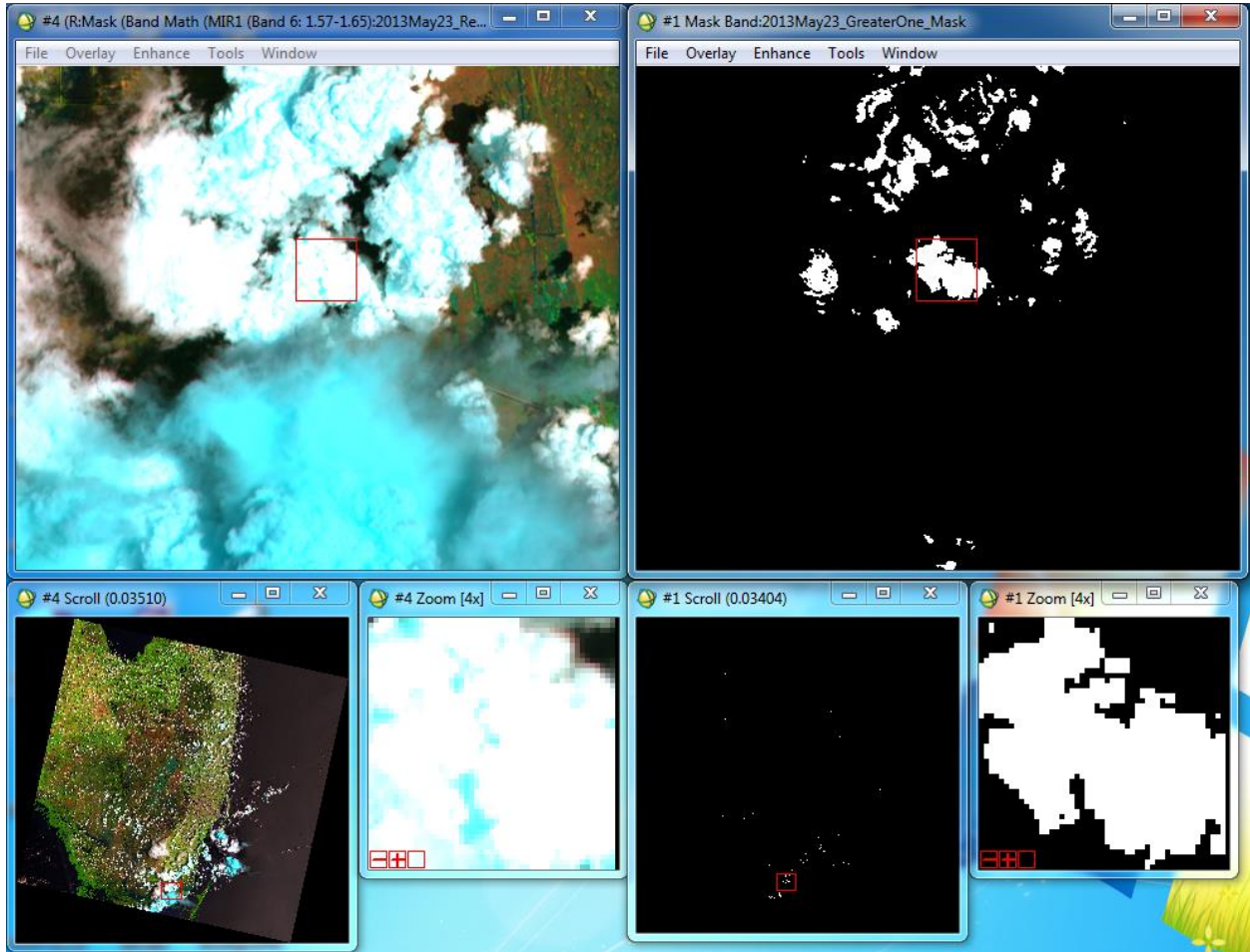


Pixels with greater than one reflectivity seem to be in the areas with ice surface (greenish blue). They are conspicuously absent from the red areas, which are the mineral/soil surfaces. This has yet to be confirmed with the TIR bands analysis.

❖ *Florida: 2013May23_Ref_TOA*

Left: 654 – RGB

Right: 2013April22_GreaterOne_Mask



In the Florida image, pixels with greater than one reflectivity are found amongst the cloud pixels, specifically near cyan pixels.

❖ *Alaska: 2013April22_Ref_TOA*

| | MODE | | | MAXIMUM | | |
|---------------|-------------|-------|-------------|-------------|-------|-------------|
| | Reflectance | DN | # of Pixels | Reflectance | DN | # of Pixels |
| Band 1 | 1.006418 | 36868 | 163664 | 1.500768 | 52521 | 1 |
| Band 2 | 1.004747 | 36815 | 179911 | 1.565794 | 54580 | 1 |
| Band 3 | 1.004691 | 36813 | 126737 | 1.519933 | 53128 | 2 |
| Band 4 | 1.003018 | 36760 | 154863 | 1.583480 | 55140 | 1 |
| Band 5 | 1.000746 | 36688 | 132248 | 1.540118 | 53767 | 1 |
| Band 6 | N/A | N/A | N/A | N/A | N/A | N/A |
| Band 7 | N/A | N/A | N/A | N/A | N/A | N/A |

❖ *Florida: 2013May23_Ref_TOA*

| | MODE | | | MAXIMUM | | |
|---------------|-------------|-------|-------------|-------------|-------|-------------|
| | Reflectance | DN | # of Pixels | Reflectance | DN | # of Pixels |
| Band 1 | N/A | N/A | N/A | N/A | N/A | N/A |
| Band 2 | 1.003719 | 52014 | 2 | 1.124454 | 57670 | 1 |
| Band 3 | 1.009516 | 52286 | 3 | 1.164041 | 59524 | 1 |
| Band 4 | 1.004411 | 52047 | 11 | 1.290529 | 65449 | 3 |
| | 1.009913 | 52304 | 11 | - | - | - |
| Band 5 | 1.004748 | 52063 | 54 | 1.269205 | 64450 | 1 |
| | 1.010145 | 52315 | 54 | - | - | - |
| Band 6 | 1.002449 | 57955 | 4 | 1.273059 | 64630 | 1 |
| | 1.013274 | 52462 | 4 | - | - | - |
| Band 7 | 1.124129 | 57654 | 4 | 1.174382 | 60008 | 1 |

Also in the Florida image, big clusters of cyan pixels, which look like blue cloud masses, seem to be the thunderstorm clouds (See image on the next page). One clue is the shadow these blue cloud masses cast on the clouds of lower elevation, indicating these blue cloud masses are taller than other white cloud masses.

According to the Z-Profile, these cyan pixels are high in NIR and Blue bands and low in the MIR band, suggesting perhaps that these pixels are “wetter” or “icier” – the water will then absorb the longer wavelength of the MIR range.

