Suomi-NPP VIIRS Imagery: RGB Applications and Product Development at CIRA

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2. Introduction

- The VIIRS Imagery and Visualization Team members at CIRA/Colorado State University are involved in verifying the high quality of VIIRS imagery and promoting the many uses of VIIRS imagery products

- VIIRS has 5 high-resolution imagery bands, 16 moderate resolution bands and the Day/Night Band (ranging from 0.41 µm to 12.0 µm)

- Many previously developed RGB products may be applied to VIIRS, and several new RGB products have been developed

- VIIRS RGB products are useful for detection of fires, floods, snow/ice, smog, volcanic ash, dust, cloud phase, and much more…

3. Methodology

The method is simple: combine multiple VIIRS channels together to create useful RGB products.

Table 1. VIIRS channels.

Band number/gain	VIIRS wavelength (μm)	VIIRS nadir pixel size along track × cross track (km)	Primary application
M1, dual	0.412	0.742 × 0.259	Ocean color, aerosols
M2, dual	0.445	0.742 × 0.259	Ocean color, aerosols
M3, dual	0.488	0.742 × 0.259	Ocean color, aerosols
M4, dual	0.555	0.742 × 0.259	Ocean color, aerosols
I1, single	0.640	0.371 × 0.387	Imagery, vegetation
M5, dual	0.672	0.742 × 0.259	Ocean color, aerosols
M6, single	0.746	0.742 × 0.776	Atmospheric correction
I2, single	0.865	0.371 × 0.387	Vegetation
M7, dual	0.865	0.742 × 0.259	Ocean color, aerosols
DNB, multiple	0.7	0.742 × 0.742	Imagery
M8, single	1.24	0.742 × 0.776	Cloud particle size
M9, single	1.38	0.742 × 0.776	Cirrus cloud cover
M10, single	1.61	0.742 × 0.776	Snow fraction
I3, single	1.61	0.371 × 0.387	Binary snow map
M11, single	2.25	0.742 × 0.776	Clouds
M12, single	3.70	0.742 × 0.776	Sea surface temperature (SST)
I4, single	3.74	0.371 × 0.387	Imagery, clouds
M13, dual	4.05	0.742 × 0.259	SST, fires
M14, single	8.55	0.742 ×0.776	Cloud-top properties
M15, single	10.76	0.742 × 0.776	SST
I5, single	11.45	0.371 × 0.387	Cloud imagery
M16, single	12.01	0.742 × 0.776	SST

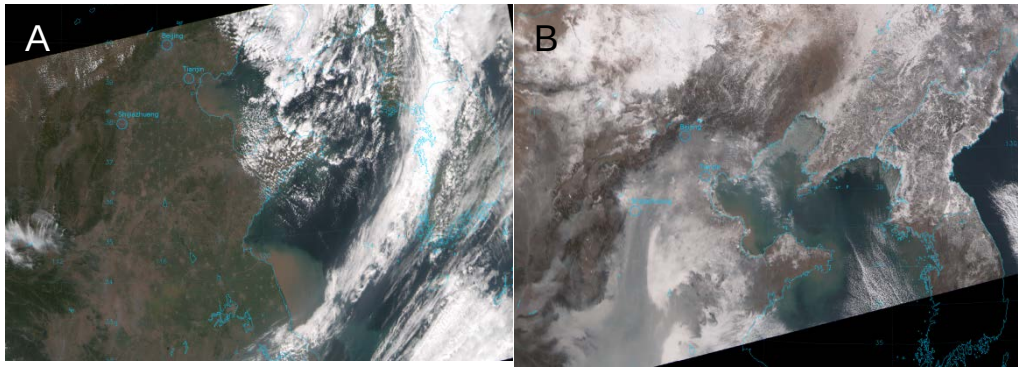
From Lee et al. (2006), BAMS

4. True Color vs. Natural Color RGB

- "True Color" RGB is M-3, M-4, M-5.
  - Useful for detecting ash clouds or smog which show up gray, compared to white clouds and snow.
  - At right: clear autumn day over Eastern China (A), compared to winter smog (B)

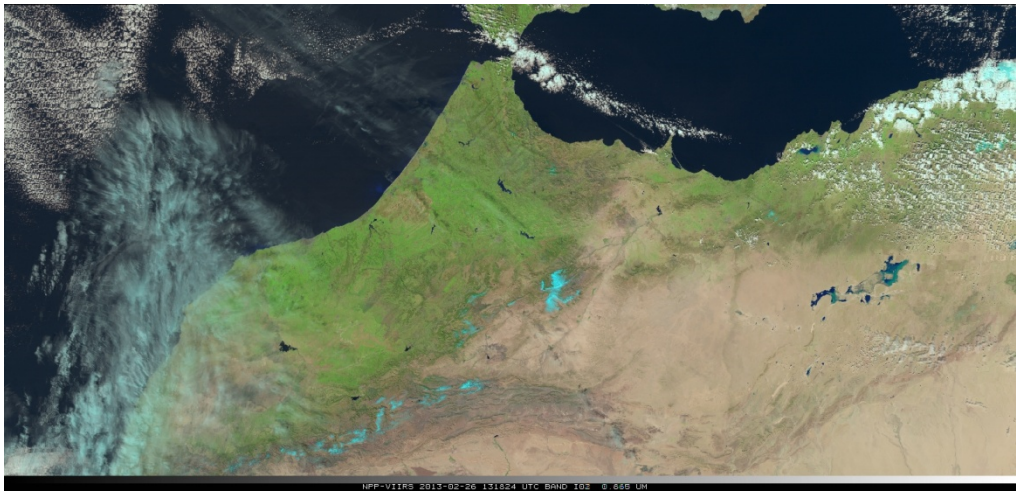
- "Natural Color" RGB is M-5, M-7, M-10 or I-01, I-02, I-03.
  - Developed by EUMETSAT for Meteosat
  - VIIRS produces high resolution and moderate resolution versions
  - Useful for discriminating ice/snow from low clouds
  - Ice clouds, snow, sea ice appear cyan, liquid clouds appear white, vegetation is green, bare ground is brown, water nearly black
  - At right: Morocco with low clouds, cirrus clouds, snow-covered mountains, desert and vegetation.

Eastern China /Yellow Sea in True Color



05:21 UTC 28 September 2012 04:32 UTC 26 January 2013

Morocco in Natural Color



13:18 UTC 26 February 2013

True Color and Natural Color imagery produced in near-real time: http://rammb.cira.colostate.edu/ramsdis/online/npp_viirs.asp

5. RGB Products for Fire Detection

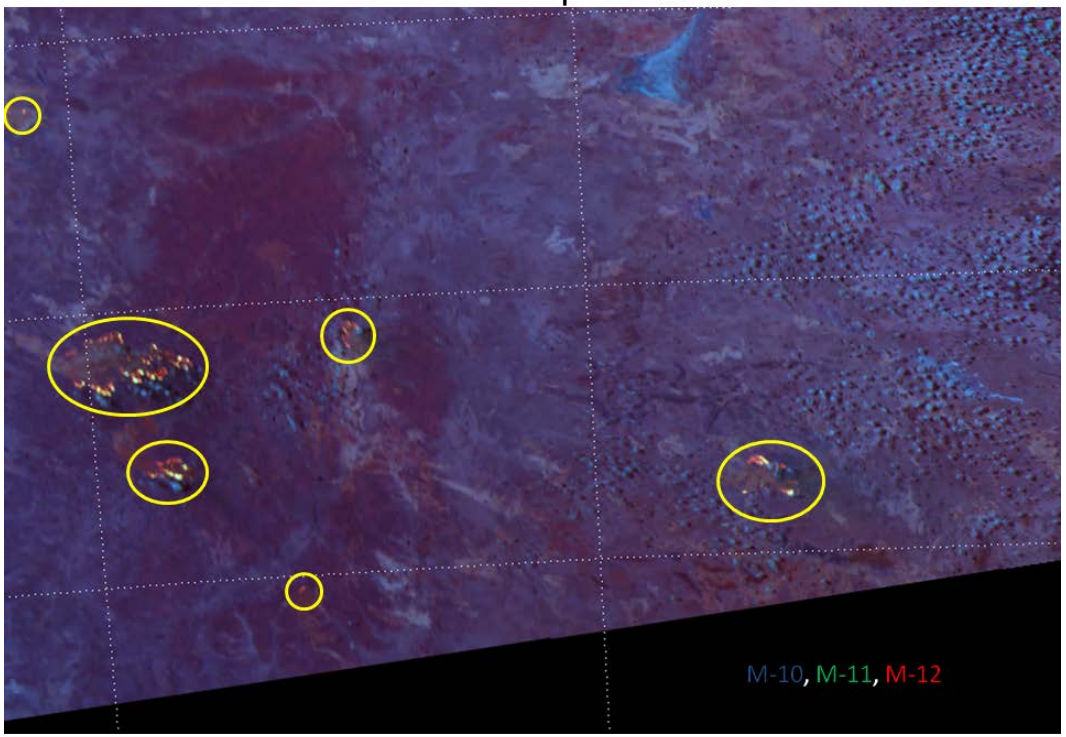
- Numerous fires visible in 3.9 μm image (M-13) of the Australian Outback

- "Natural Color" RGB detects hot active fires as red pixels

- "Natural Fire Color" RGB composite of M-5, M-7 and M-11

- "Fire Power" RGB composite of M-10, M-11 and M-12

04:34 UTC 19 September 2012



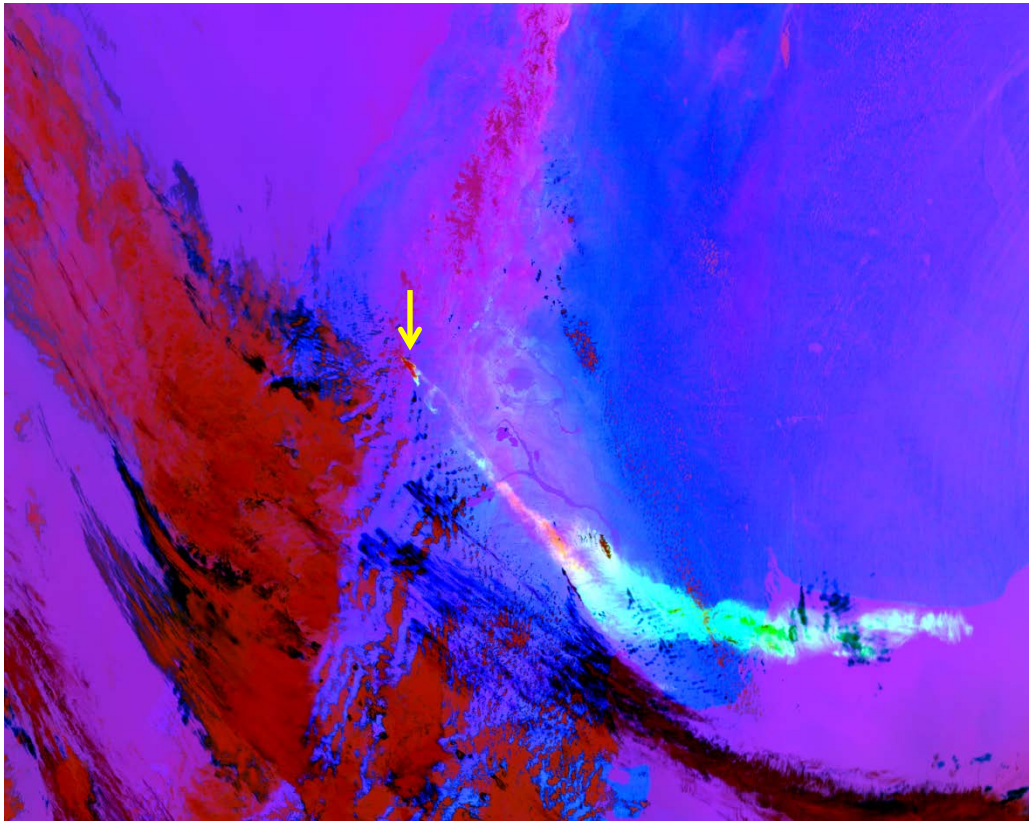
- "Natural Fire Color" RGB is similar to the "Natural Color" RGB, except fires show up more easily (bright red pixels), detects lower temperature fires

- "Fire Power" RGB has fires show up as white, yellow, or orange (depending on temperature) against maroon-to-purple background

6. Volcanic Ash and SO_2 Detection

- Eruption of Copahue volcano, Chile/Argentina
- True Color image identifies ash plume as gray/brown cloud near volcano (yellow arrow)
- EUMETSAT "Dust" RGB detects SO_2 plume extending far away from volcano
  - M-15
  - M-15 – M-14
  - M-16 – M-15

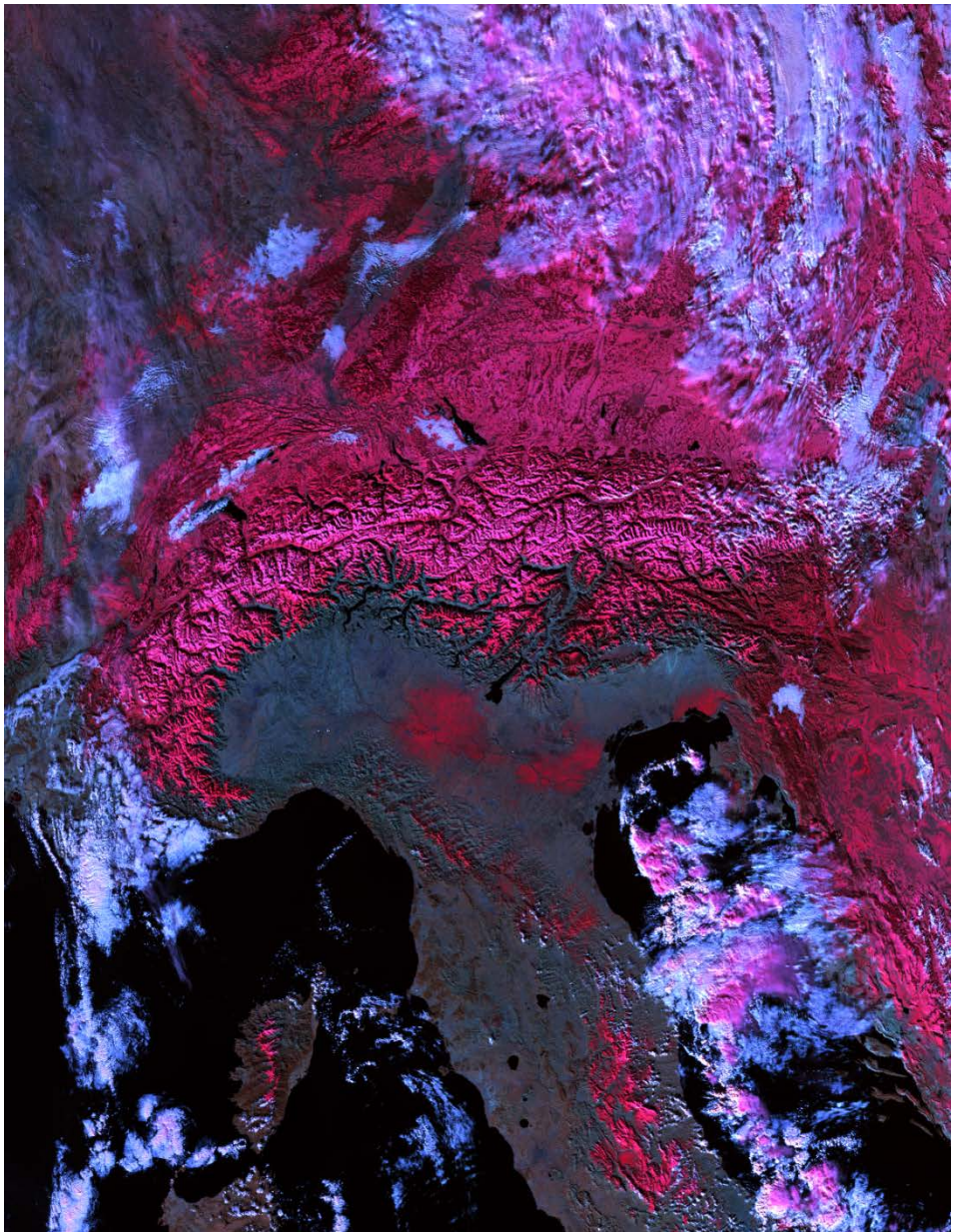
18:38 UTC 22 December 2012



- The "Dust" RGB was developed by EUMETSAT to detect Saharan dust plumes, but is useful for detecting volcanic ash as M-14 is sensitive to SO_2, a common by-product of volcanic eruptions

7. Snow/Ice Discrimination

- True Color RGB of the Alps
  - What is snow and what is cloud?
- Natural Color RGB discriminates snow and ice from liquid cloud easily
  - some ice cloud present, not so easy to discriminate
- “Snow” RGB highlights snow (red) against ice clouds (pale pink)
  - M-11, M-10, M-7
  - Variation of “Snow RGB” from EUMETSAT (replaces M-12 with M-11)



12:03 UTC 12 December 2012

8. Flooding

- “Natural Color” RGB composite is capable of detecting large scale flooding

- Before and after images show the extent of flooding caused by Hurricane Isaac (2012)

- The isthmus between Lake Pontchartrain and Lake Maurepas disappears under water

- Flooding also visible along the Mississippi River below New Orleans, and along the Gulf Coast

1 September 2012

9. Path to Operations and Future Work

- The primary source of VIIRS data has a latency of 6-8 hours, limiting the usefulness of these observations in operations
  - The University of Wisconsin Direct Broadcast feed receives VIIRS data over CONUS directly from the satellite and produces the data files in ~90 minutes
  - Solving latency issues is necessary before VIIRS data significantly impacts operations
- True Color and Natural Color imagery is being produced in near-real time, available on RAMSDIS Online. Future work will be to add additional RGB products.
- We continue to investigate these and new VIIRS RGB products to aid operations
- Developing method to produce synthetic True Color imagery for GOES-R.
  - GOES-R lacks a band in the green portion of the visible spectrum.
- GOES-R will be capable of producing these RGB products:
  - Natural Color
  - Natural Fire Color*
  - Fire Power*
  - Snow
  - Dust/Volcanic Ash
  - And many more…

* Lower spatial resolution of GOES-R ABI may limit the usefulness of the Natural Fire Color and Fire Power RGBs as fire detection is highly dependent on resolution

10. Publication List

- Journal article in press:
  - Hillger et al. (2013), First-Light Imagery From Suomi NPP VIIRS, *BAMS*, in press

- True Color and Natural Color imagery produced in near-real time:
  - http://rammb.cira.colostate.edu/ramsdis/online/npp_viirs.asp

- JPSS Imagery and Visualization Team blog (with additional examples)
  - http://rammb.cira.colostate.edu/projects/npp/blog/

- JPSS Imagery and Visualization Team website:
  - http://rammb.cira.colostate.edu/projects/npp/