RGB Imagery: Applications and Decision Aids in AWIPS II

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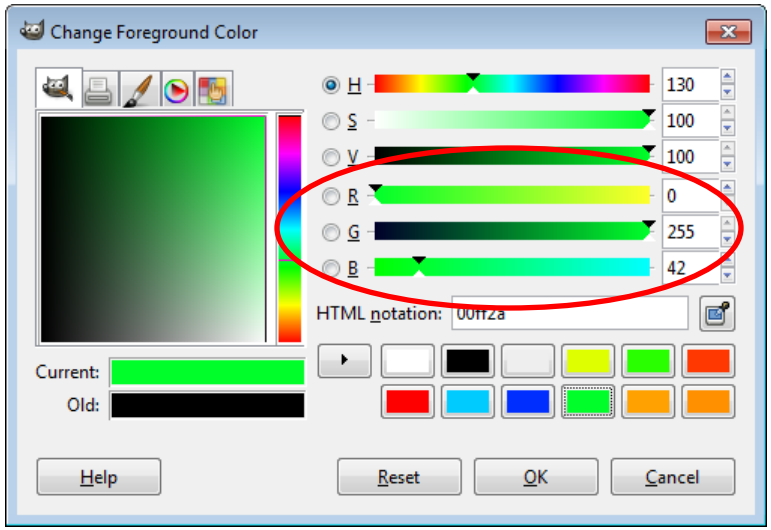
NOAA Satellite Science Week 2013

RGB Basics

- Every color on a computer monitor may be expressed as 1-byte (8-bit) values of red, green and blue (0-255)
- RGB composites take three different values (channels or channel differences, for example), scale them from 0-255 and assign them to red, green or blue

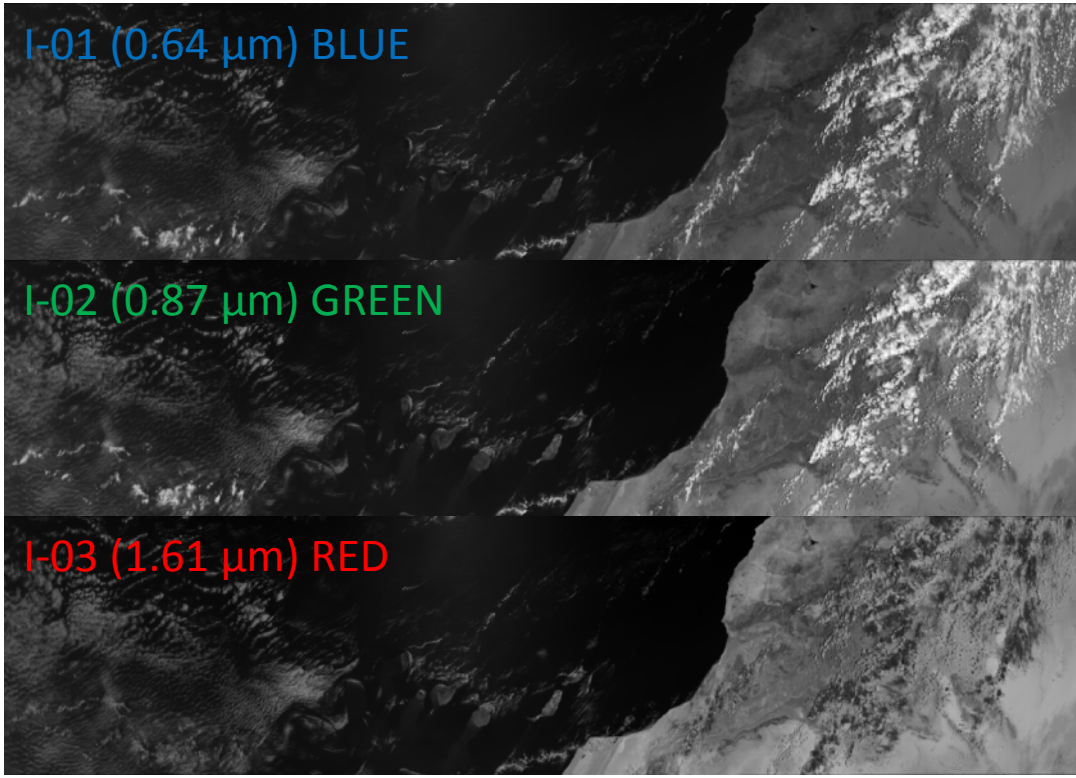


- Thus, three different images are combined to produce one color image

RGB Basics

Example: Take the VIIRS band I-01, I-02 and I-03 reflectances (on a scale from 0-1), scale them from 0-255, then assign them to blue, green and red as at right.

When you combine them into a single image, you get more information than any single channel can provide…

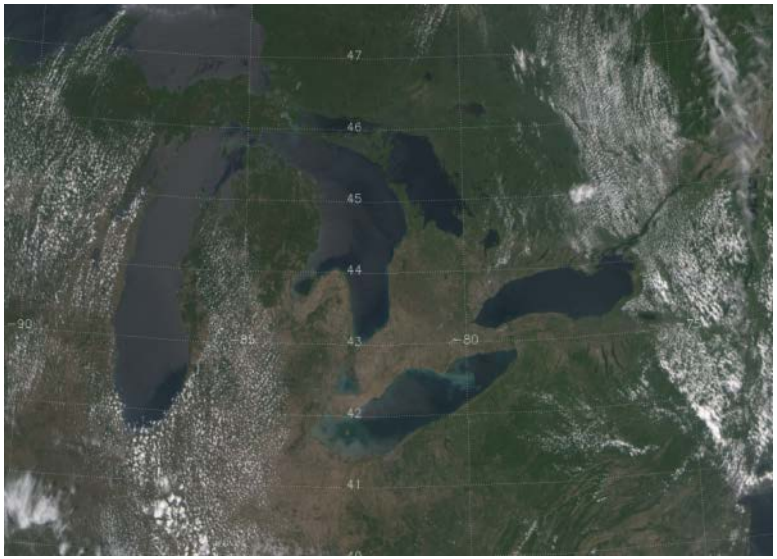


RGB

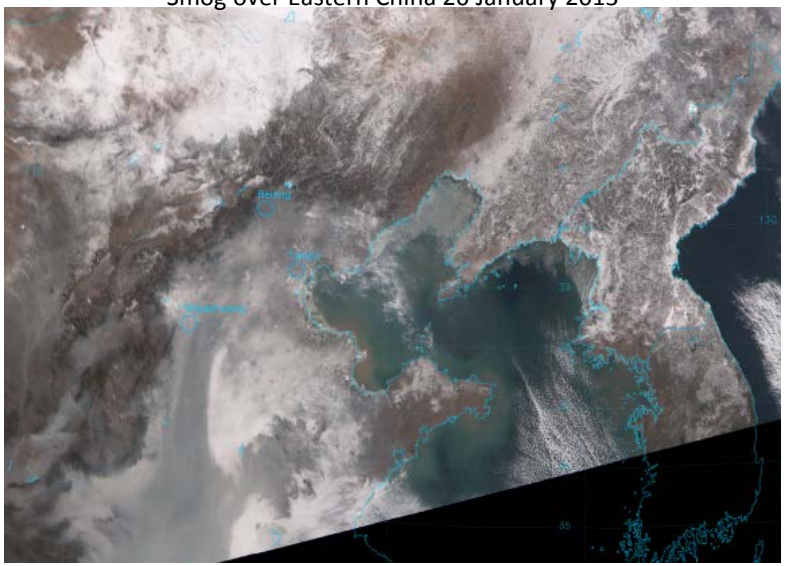
True Color RGB

MODIS, VIIRS

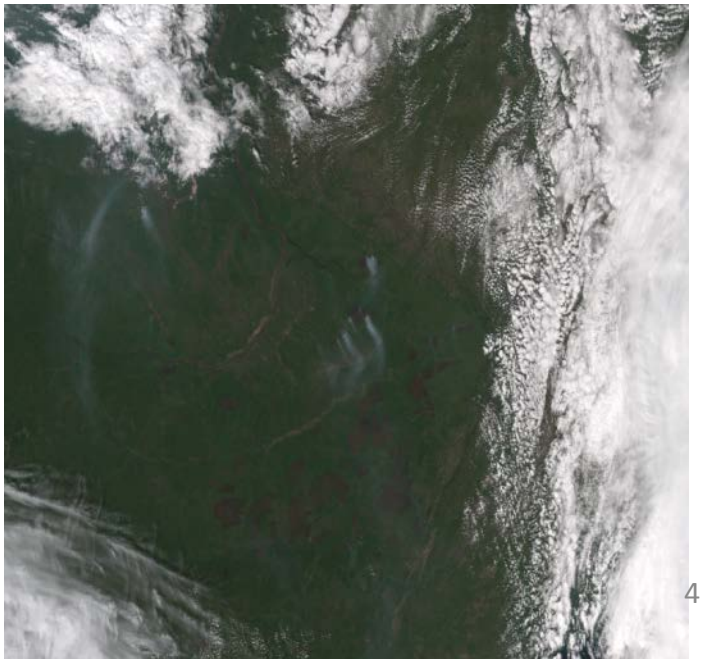
Great Lakes 10 June 2012



Smog over Eastern China 26 January 2013



Fires in Siberia 7 August 2012



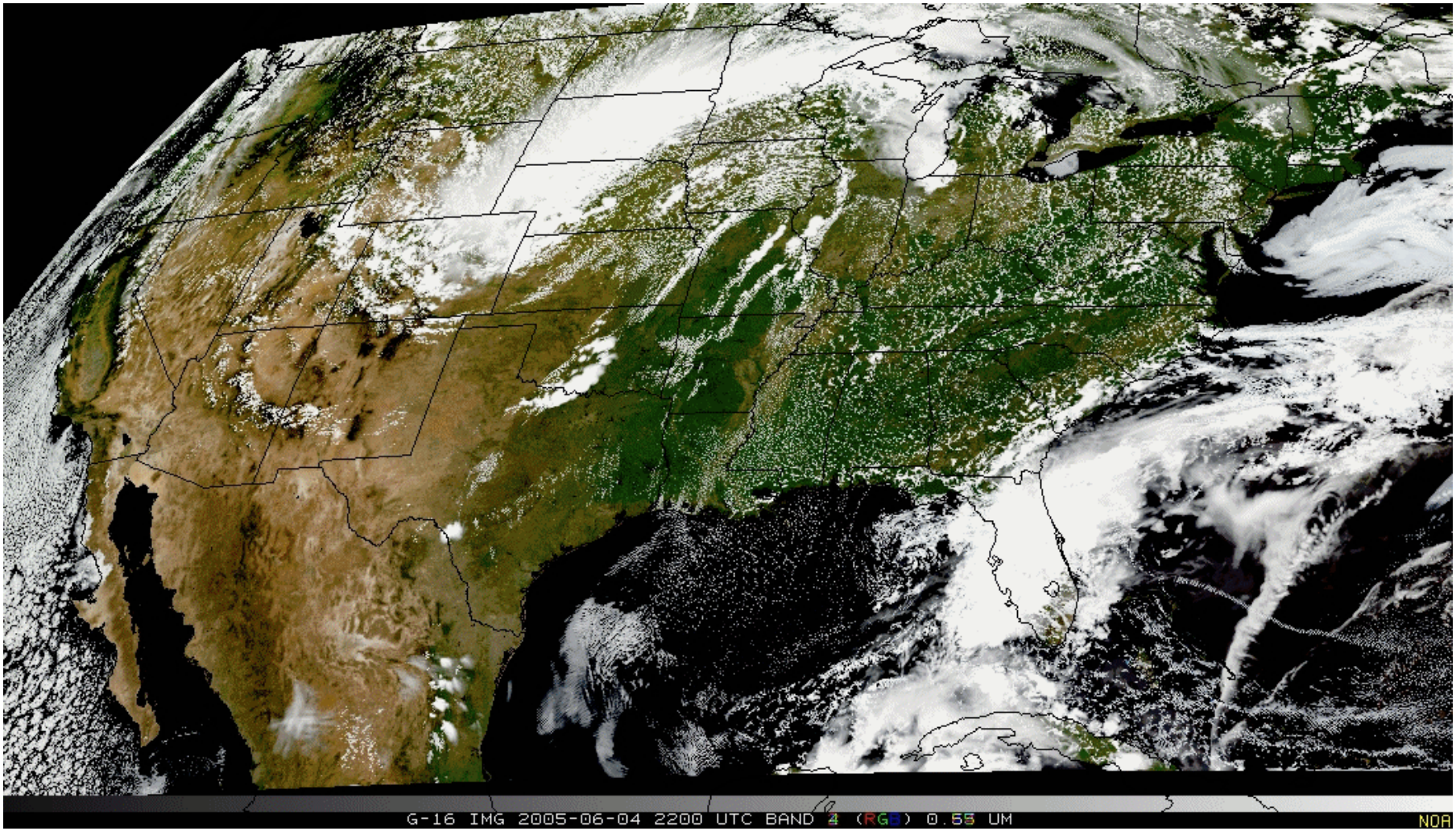
When you combine channels in the blue, green, and red portions of the visible spectrum, you get the "True Color" RGB. (0.488 µm, 0.555 µm, 0.672 µm)

The true color image represents what an astronaut would see from the International Space Station – the "true color" of the objects.

Very useful for detecting smoke, haze, smog, dust, water turbidity, vegetation health.

Synthetic True Color for GOES-R

GOES-R ABI*

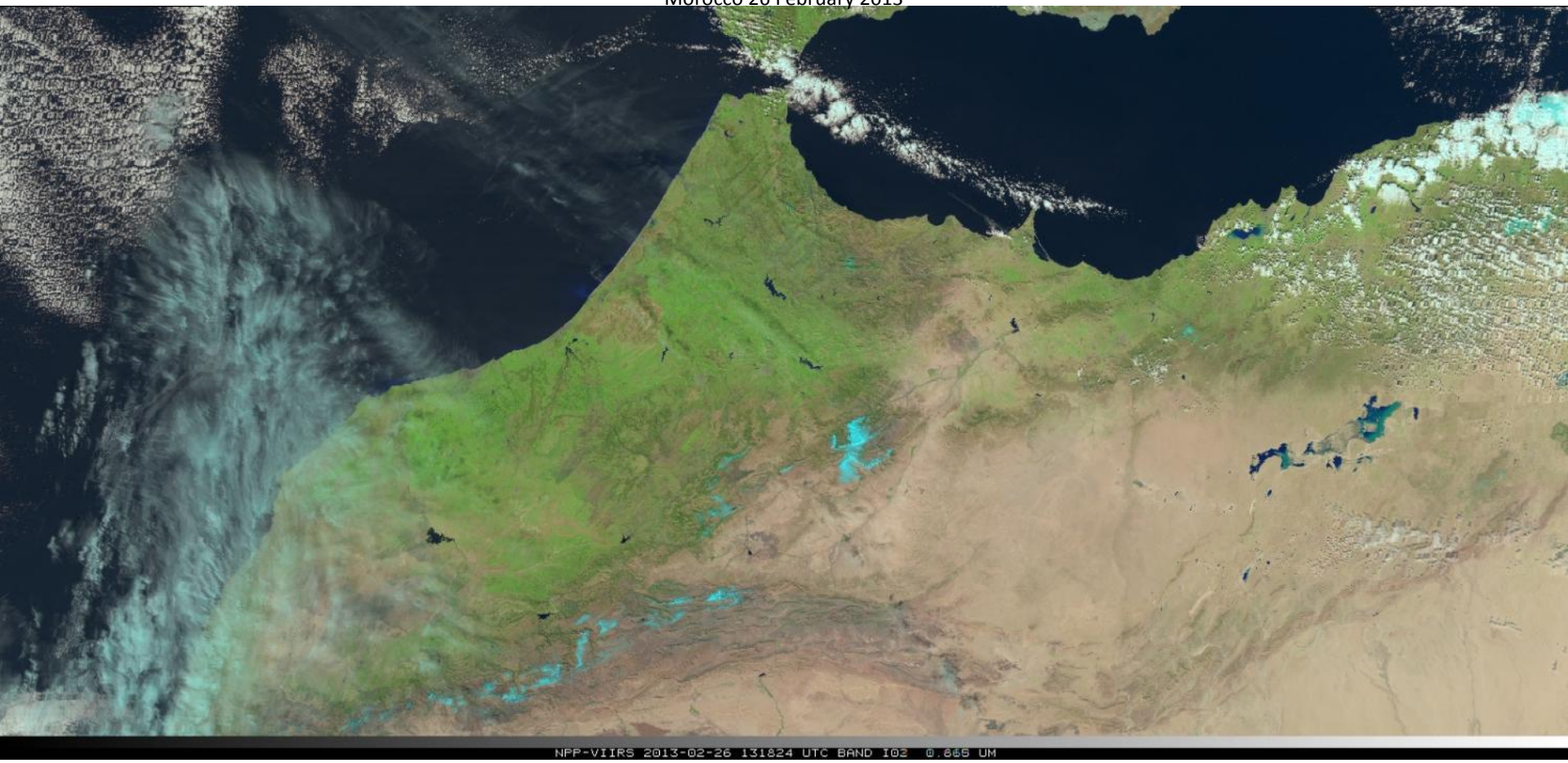


GOES-R ABI will not have a band in the green portion of the visible spectrum. CIRA has developed a method to produce a synthetic green band for use in a “True Color” RGB, such as this image created using simulated ABI radiances provided by CIMSS.

Natural Color RGB

SEVIRI, VIIRS, GOES-R ABI

Morocco 26 February 2013



Originally developed by EUMETSAT, the Natural Color RGB is 0.67 µm, 0.86 µm, and 1.61 µm.

Similar to True Color, except snow/ice/ice clouds appear cyan/deep cyan/pale blue; water appears nearly black. Strong vegetation signal. No atmospheric correction needed. Very useful for snow/ice discrimination, cloud phase discrimination, vegetation health.

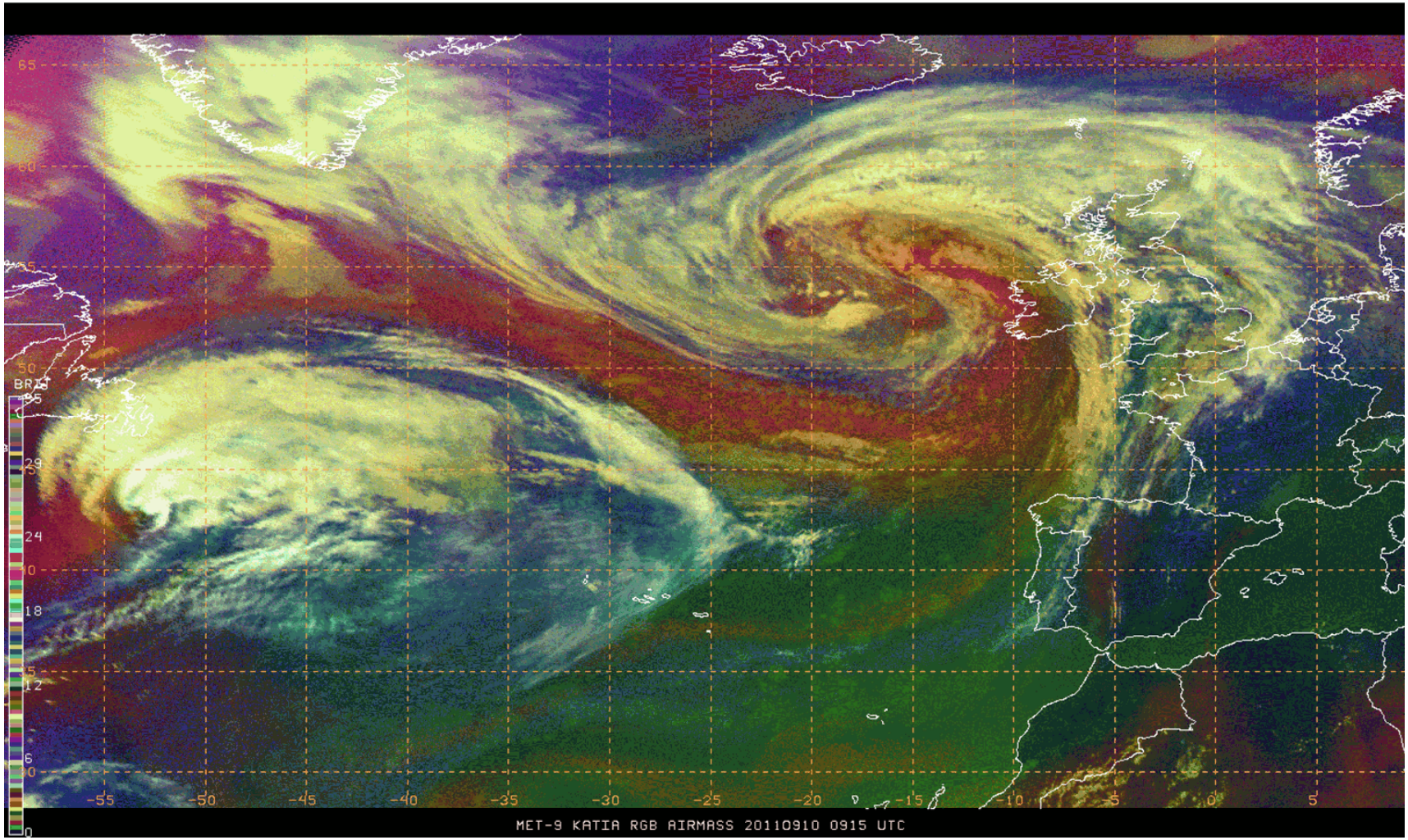
See example of flooding detected by VIIRS Natural Color RGB in our poster.

RGB Air Mass

SEVIRI, GOES Sounder, GOES-R ABI

6.2 µm
9.7 µm – 10.8 µm
6.2 µm – 7.3 µm

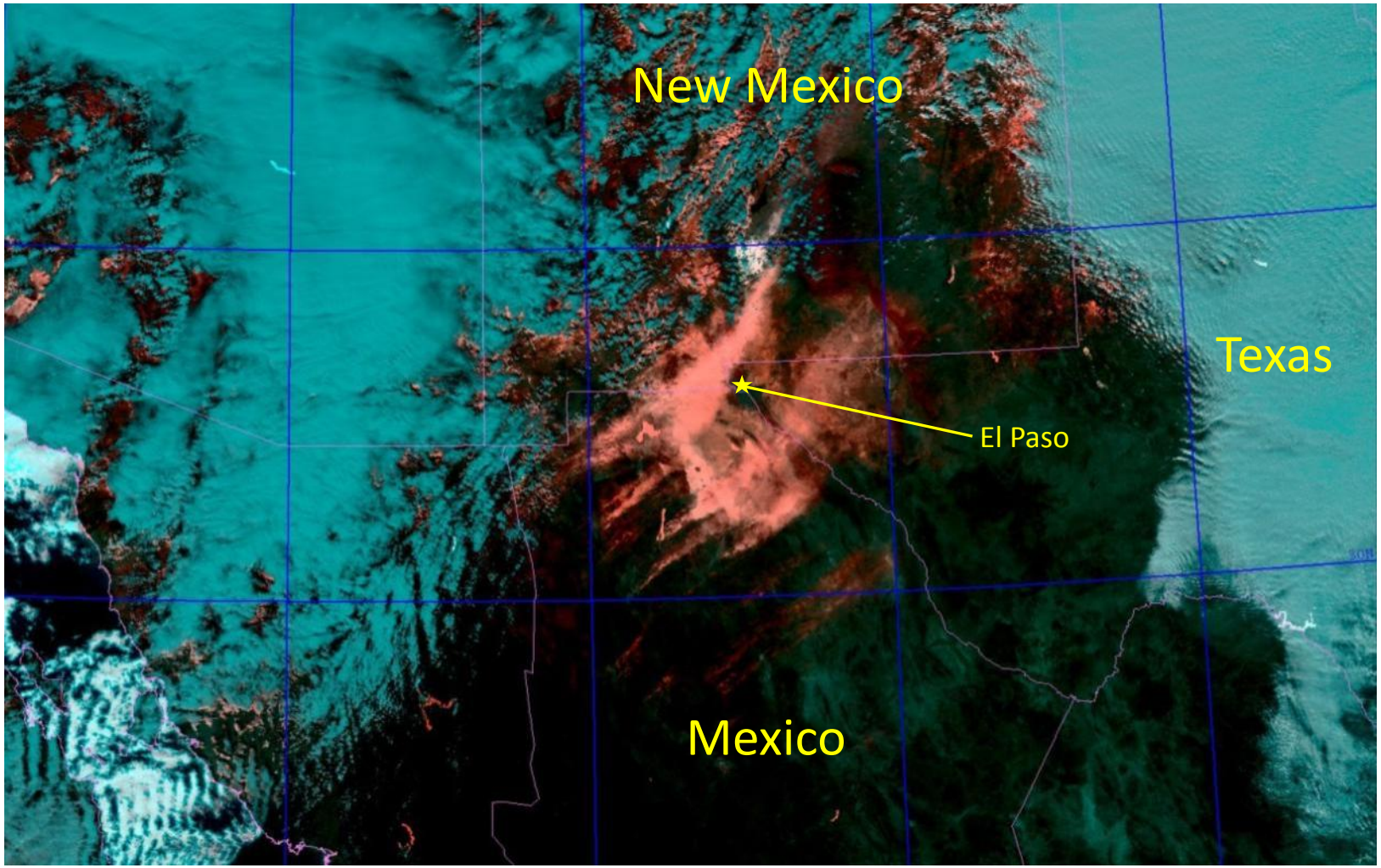
As the name implies, the Air Mass RGB is useful for identifying different air masses and synoptic scale motions. Developed originally by EUMETSAT. Example image of Hurricane Katia (2011) as seen by SEVIRI.



Dust Enhancement Product

MODIS, VIIRS

Dust storm over northern Mexico/southwest United States



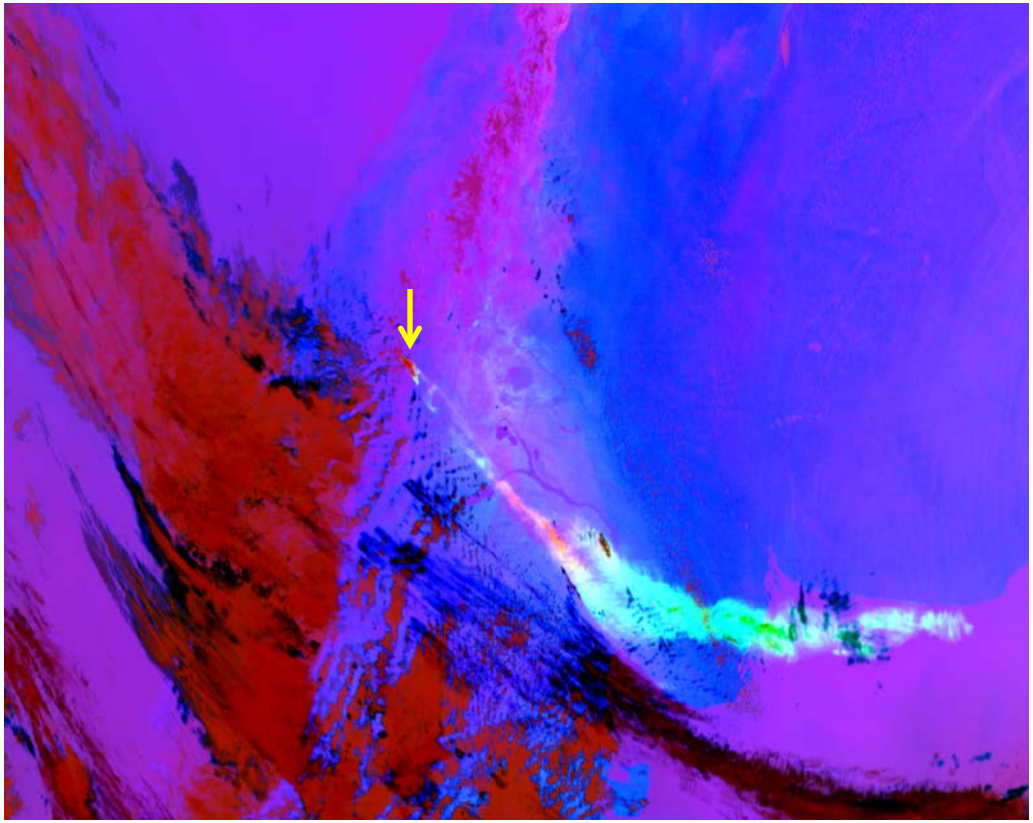
- Dust is difficult to see in single channel images as well as the “True Color” RGB
- The Dust Enhancement product is developed at CIRA and uses information from 7 bands in the VIS/NIR/thermal-IR portions of the spectrum to highlight dust

Volcanic Ash and SO_2 Detection

SEVIRI, MODIS, VIIRS, GOES-R ABI

- 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
  - (10.7 µm)
  - (10.7 µm) – (8.5 µm)
  - (12.0 µm) – (10.7 µm)

Copahue volcano, Chile/Argentina 18:38 UTC 22 December 2012



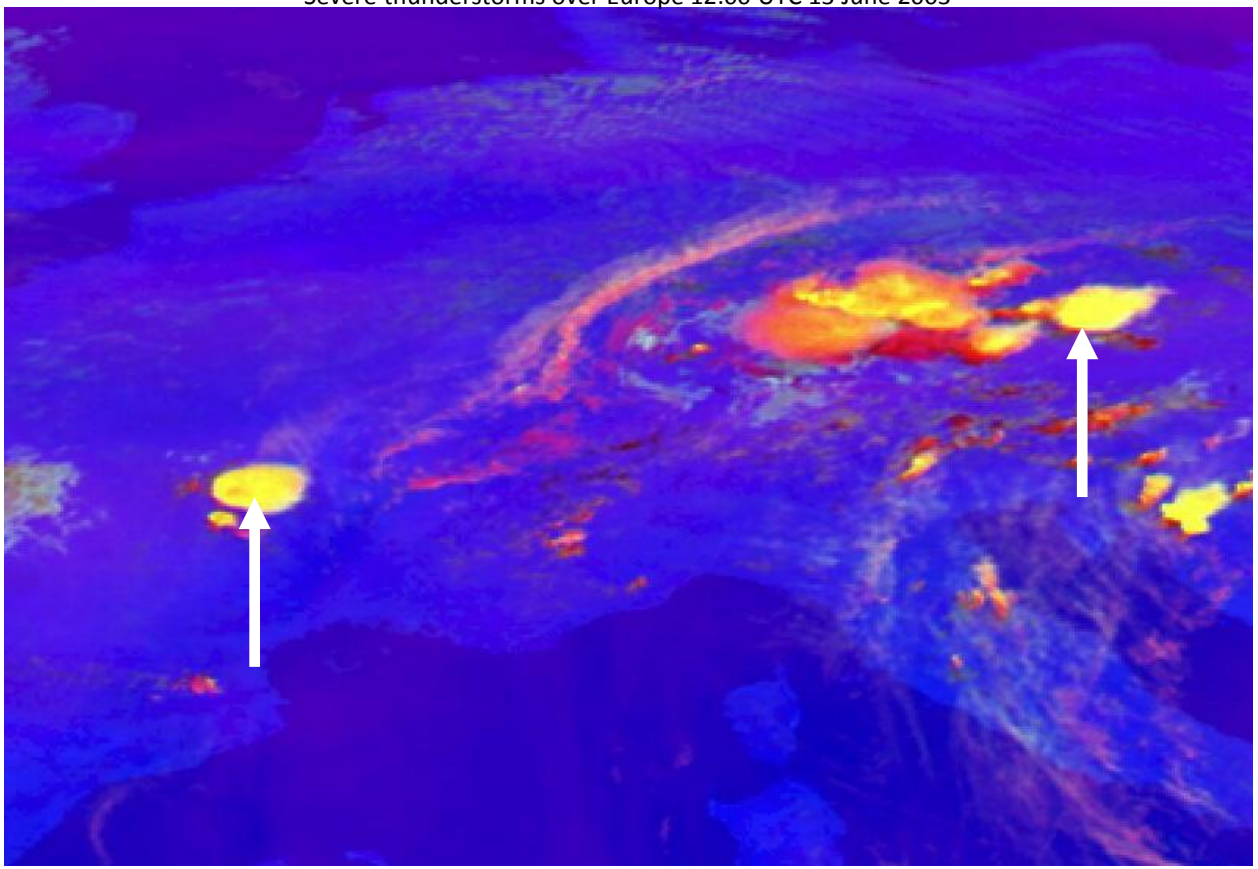
- The "Dust" RGB was developed by EUMETSAT to detect Saharan dust plumes, but is useful for detecting volcanic ash as an 8.5 µm channel is sensitive to SO_2, a common by-product of volcanic eruptions

Daytime Convection RGB

SEVIRI, GOES-R ABI

Severe thunderstorms over Europe 12:00 UTC 13 June 2003

1.6 µm – 0.6 µm
3.9 µm – 10.8 µm
6.2 µm – 7.3 µm



Developed by EUMETSAT, the Daytime Convection RGB is the combination of three channel differences.

Identifies deep precipitating convective clouds as yellow, orange or red, with yellow representing storms more likely to be severe. (Arrows point to two severe storms over western and central Europe.)

RGB products for Fire Detection

VIIRS, GOES-R ABI

Fires in the Australian Outback 04:34 UTC 19 September 2012

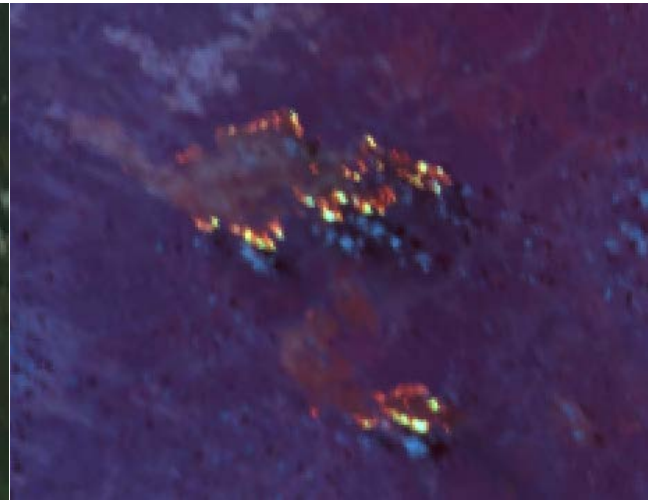
SW-IR Image (3.9 µm)

- Numerous fires visible in 3.9 µm image (black hot spots)

"Natural Fire Color" RGB

- CIRA's "Natural Fire Color" RGB composite of 0.67 µm, 0.86 µm and 2.25 µm

"Fire Temperature" RGB



- CIRA's "Fire Temperature" RGB composite of 1.61 µm, 2.25 µm and 3.7 µm

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

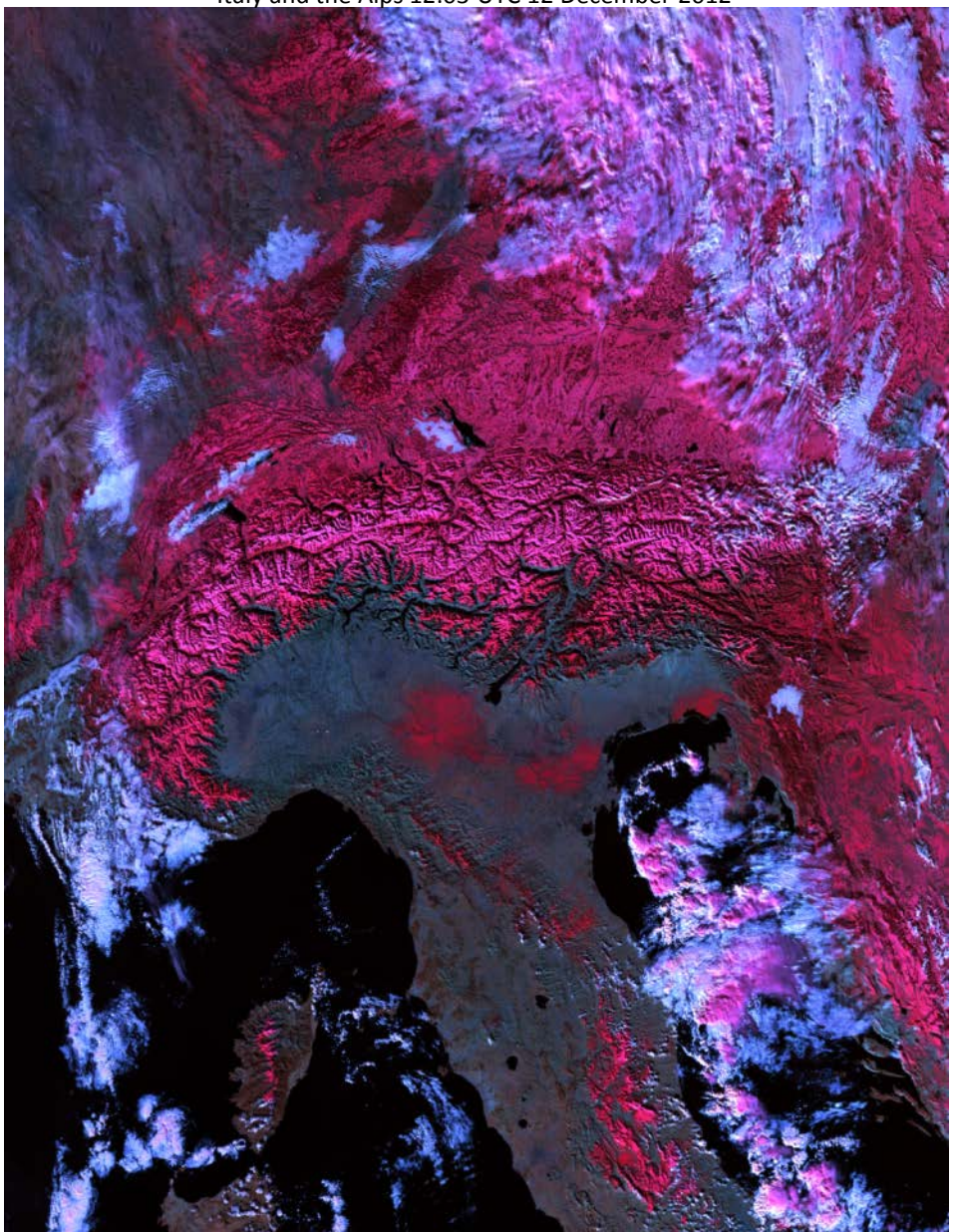
- "Fire Temperature" RGB has fires show up as white, yellow, orange or red (depending on temperature) against maroon-to-purple background

Snow/Ice Discrimination

SEVIRI, VIIRS, GOES-R ABI

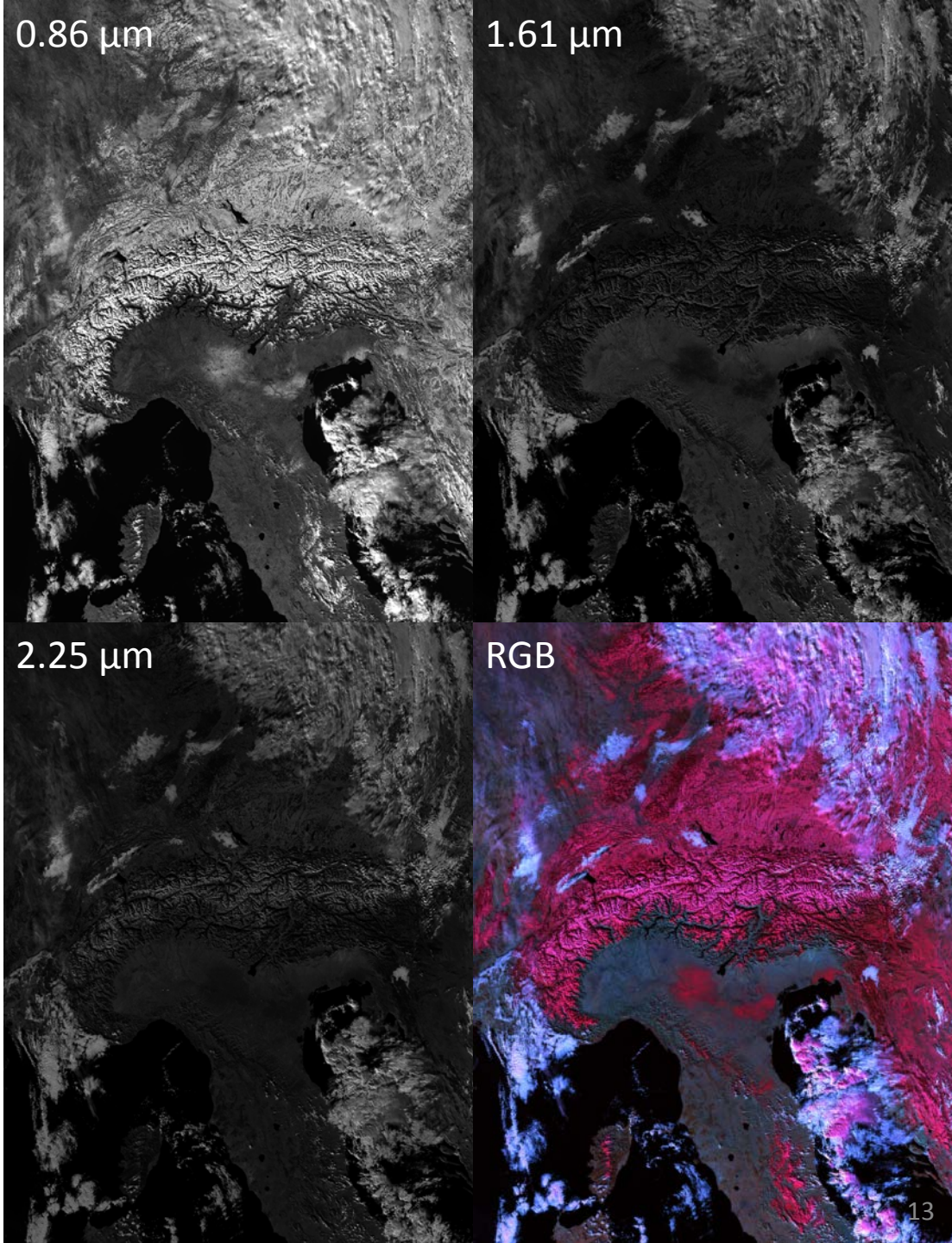
- True Color RGB of the Alps
  - What is snow and what is cloud?
- Natural Color RGB discriminates snow and ice from liquid cloud easily
  - some ice cloud present, not so easy to discriminate
- "VIIRS Snow" RGB highlights snow (red) against ice clouds (pale pink)
  - 2.25 µm, 1.61 µm, 0.86 µm
  - Variation of "Snow RGB" from EUMETSAT, which uses 3.9 µm band in the place of the 2.25 µm band

Italy and the Alps 12:03 UTC 12 December 2012



Poll Question

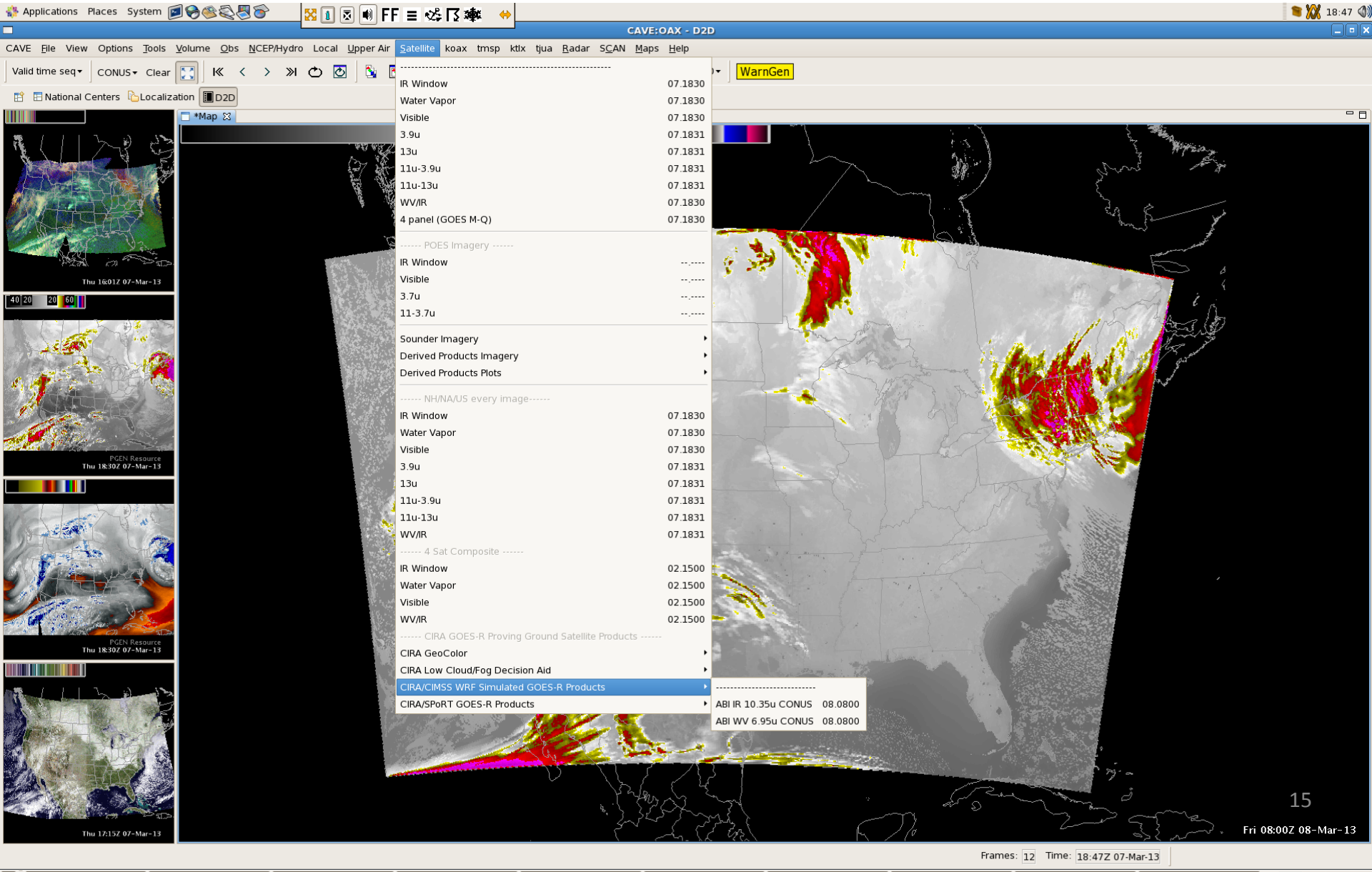
- Would you prefer to use an RGB product or the individual channels? See the surface snow detection RGB as an example.
  - A) I prefer images of the individual channels. I don't think the RGB adds any useful information.
  - B) I like the RGB, but don't think it is worth the extra effort/bandwidth required.
  - C) I like the RGB better. It is worth the extra effort and bandwidth to display it.
  - D) I like the RGB, but I want to have the individual component images to go along with it.
  - E) I don't care what it takes, I will never look at a single channel image again! I want nothing but RGB!



Summary

- Long heritage of RGB imagery products from MODIS and SEVIRI (Meteosat) may be applied to VIIRS and/or ABI (GOES-R)
  - “RGB Air Mass”, “True Color”, “Natural Color”, “Daytime Convection”, “Dust Enhancement”, “EUMETSAT Dust”, “EUMETSAT Snow”
- Several new VIIRS RGB imagery products/decision aids in development at CIRA will also apply to the ABI
  - “Natural Fire Color”, “Fire Temperature”, “VIIRS Snow”
- RGB products have a wide range of uses
  - Improving image interpretation
  - Severe storms, tropical and extra-tropical cyclones
  - Identifying/monitoring dust storms, volcanic ash, smoke, smog
  - Distinguishing air masses
  - Snow and ice detection/discrimination from clouds
  - Cloud phase determination/cloud microphysics
  - Vegetation health, flooding, drought
- Now, on to the efforts involved in utilizing RGB imagery in AWIPS II…

CIRA AWIPS II Status



CIRA AWIPS II Status

- Currently running OB 12.1
- Automated conversion of real-time CIRA AWIPS I PG products to AWIPS II has been implemented
- The most requested AWIPS II products (**SIMWRF imagery**, **GeoColor, Low Cloud/Fog Decision Aid**) are transmitted via new CIRA LDM real-time data distribution system
  - Working with Central Region HQ (Matt Foster), Omaha and Boulder SOOs (Dan Nietfeld & Eric Thaler) to implement at FO's
  - SIMWRF already in use at CRHQ
- Efforts underway to develop single full-CONUS AWIPS II products instead of transmitting converted AWIPS I east & west CONUS products

Other Interactions

- Raytheon Developer's Forum
  - Bi-weekly telecon provides opportunity to communicate PG development needs & information to Raytheon and to each other

- SPoRT led Experimental Product Development Team
  - Participation in bi-weekly WebEx ADE plugin development training sessions
  - CIRA sent a representative to the SPoRT EPDT hands-on plugin development workshop in Huntsville, Alabama

- NDE-NPP AWIPS II NWSTG (NOAAPORT SBN) Data
  - Real-time ingest of products from CIRA NOAAPORT has been implemented
  - Monthly NDE-AWIPS working group telecons provides technical staff communication regarding problems associated with high volume data flow and implementation of S-NPP data from NDE into AWIPS II

Future Plans

- CIRA OCONUS Products in AWIPS II
  - Still need to implement Pacific Region AWIPS I ORI product.

- AWIPS I & WES Support
  - New AWIPS I & WES procured & configured to replace aging existing workstations
  - AWIPS I product dissemination and client support will continue in parallel to AWIPS II product dissemination and client support as long as necessary

- Expansion of CIRA AWIPS II Capabilities
  - Hardware has been procured for:
    - additional NOAAPORT ingestor
    - real-time AWIPS II workstation for the CIRA Weather Lab
    - additional development & display workstations
  - Additional programming support has been hired for AWIPS II application development

CIRA AWIPS II RGB Product Development

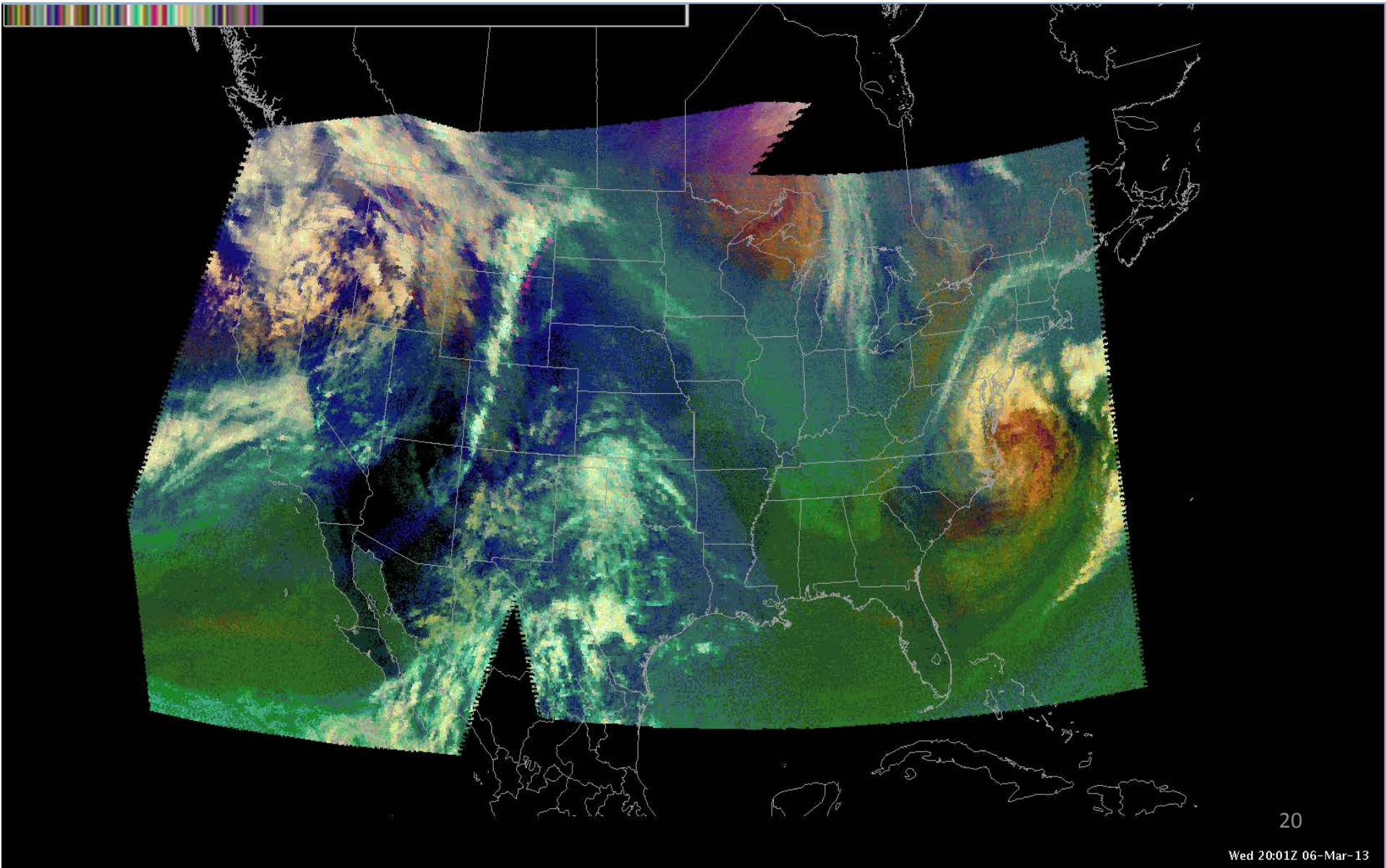
- RGB products require full 24 bit color + 8 bit transparency for overlays

- AWIPS I and N-AWIPS have very limited color selections
  - ~ 250 for AWIPS I, ~ 90 for N-AWIPS
  - Color tables have been modified to provide best fit
  - Can introduce artifacts that impact product utility

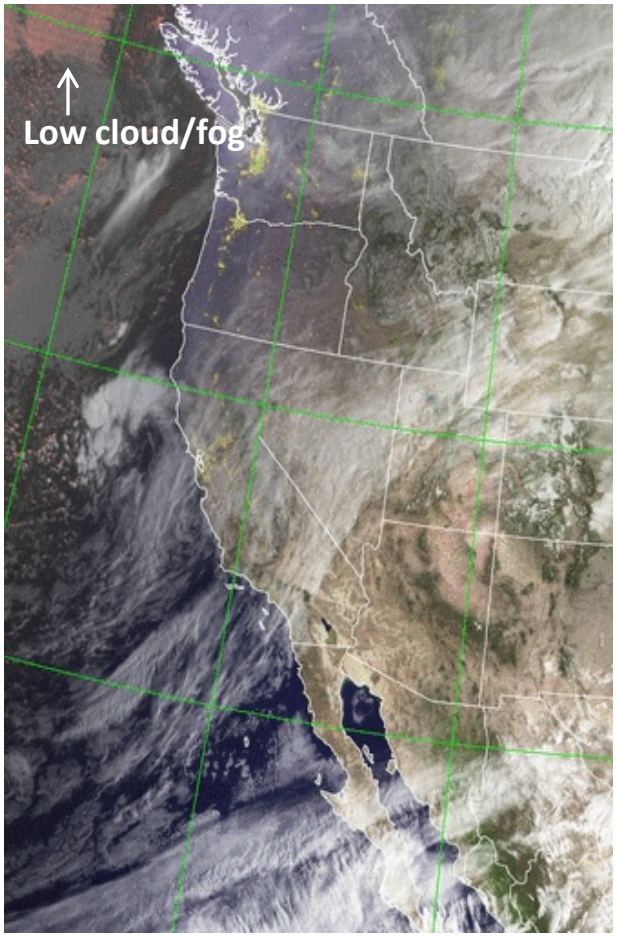
- Current CIRA/SPoRT GOES Sounder RGB Air Mass product in AWIPS I & N-AWIPS
  - Red, green & blue component imagery (McIDAS format) created at CIRA *outside* of current operational systems sent to SPoRT; must transmit 3 images for 1 product
  - Optimal 95 bit color scale reduction generated at SPoRT
  - Final color-reduced products delivered to NWS for evaluation
  - Not a viable option for high temporal & spatial resolution data like GOES-R ABI

Real-time RGB Air Mass Product in AWIPS II

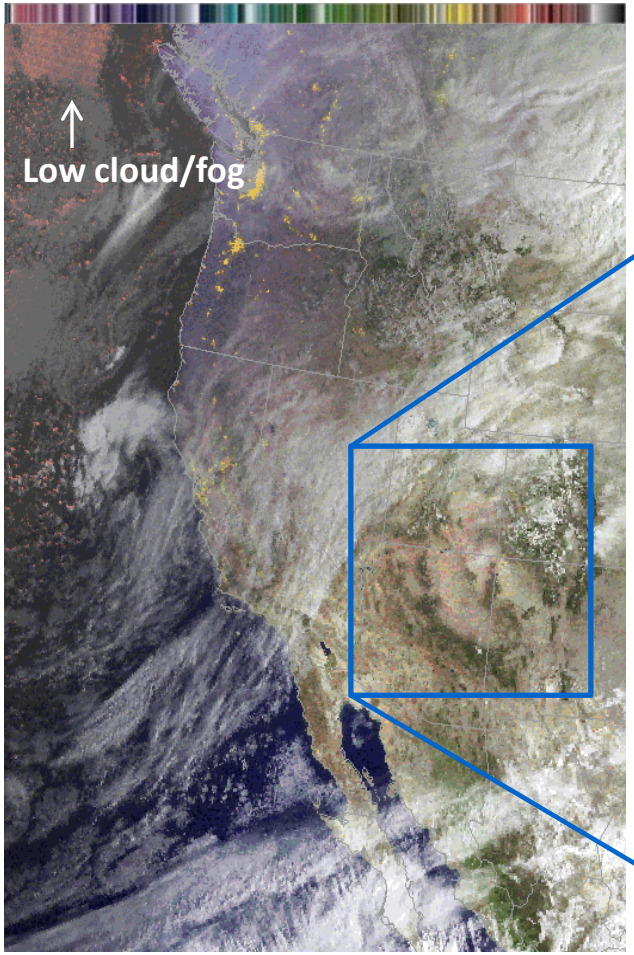
Example of CIRA/SPoRT GOES Sounder 8 bit (95 color) image



Artifacts in 8 bit AWIPS I/II GeoColor Product Due to Color Sampling



8 bit image of 24 bit GeoColor Product



8 bit AWIPS II GeoColor Product

Color limitation artifact showing low clouds/fog where none exists

Capabilities Needed For Creation of True RGB Products

- Mathematical operations on imagery
  - Channel differences, additions
  - Truncation of range or reversal of scale
  - Nonlinear scaling (“gamma” factor) to enhance certain range of values
- Ability to assign R, G and B intensities
- Ability to assign transparency level for product overlays
- RGB products often defined in terms of “recipes”
  - Channel combinations, thresholds and scaling factors for R, G and B
  - The “how-to guide” to convert the data to color intensity values

AWIPS II RGB Needs

- Hardware & software supports full 24 bit color display and 8 bit transparency layer

- RGB product generation capabilities not currently part of standard AWIPS II software
  - Raytheon widget in standard build?
  - National Center Perspective has capacity to overlay several images
  - External plugin development

- New GOES-R Risk Reduction project to develop RGB capabilities for AWIPS II
  - Eliminate the need for external generation/transmission of some products
  - Allow forecaster enhancements?
  - **Forecaster ease of use is critical**

GOES-R3 RGB AWIPS II Project

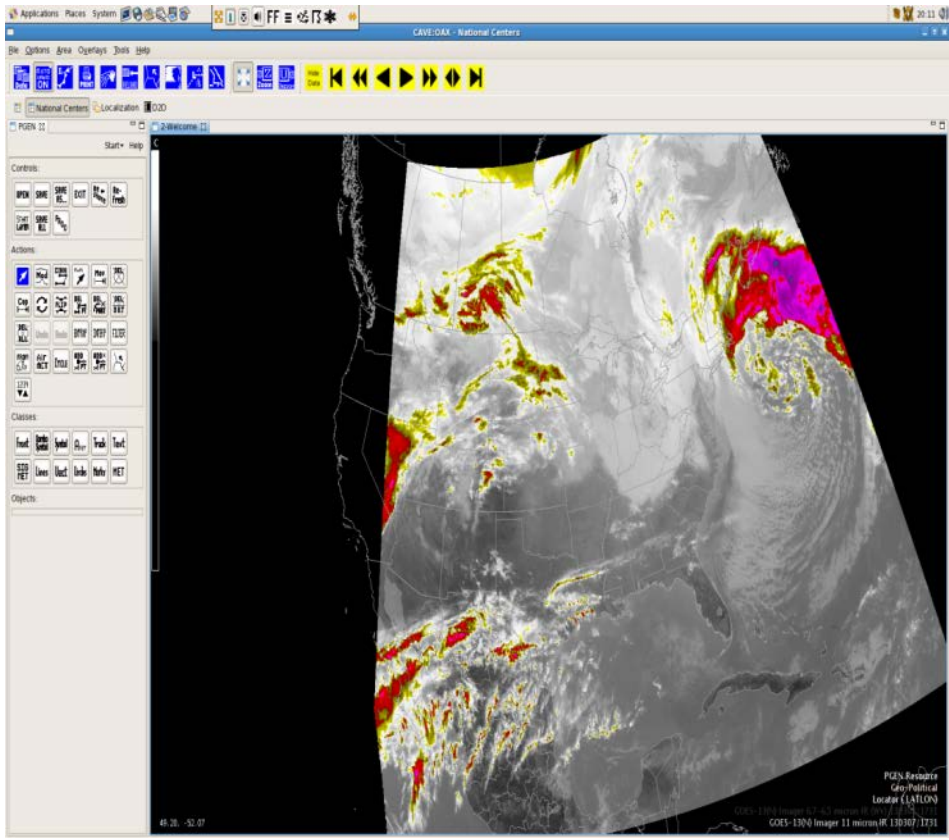
- Initial 2013-14 start-up funds for SPoRT and CIRA
  - SPoRT will focus on plugin development
  - CIRA will focus on National Centers Perspective baseline image overlay tools and enhancements
    - GOES Air Mass and legacy fog decision tools as prototypes
    - Evaluate & provide feedback on utility, recommendations for future development efforts

- Larger proposal expected in FY14
  - SPoRT, CIRA and CIMSS
  - AWIPS II path, plugin maintenance and governance issues should be clearer

CIRA GOES-R3 RGB AWIPS II Project

- NC perspective is very different from D2D perspective
  - Still uses McIDAS format imagery
  - Will have to learn data ingest, display & database access to implement experimental products
- Requires additional CIRA AWIPS II workstation due to build updates & new 'features' introduced with experimentation
- 2013-14 Goals
  - *Learn data ingest, display & database access to implement experimental products
  - Implement Air Mass and legacy fog product ingest & display
  - Evaluate existing image overlay/combine capabilities
  - Provide feedback for future development efforts

*Thanks to Tiros Lee for info provided to date

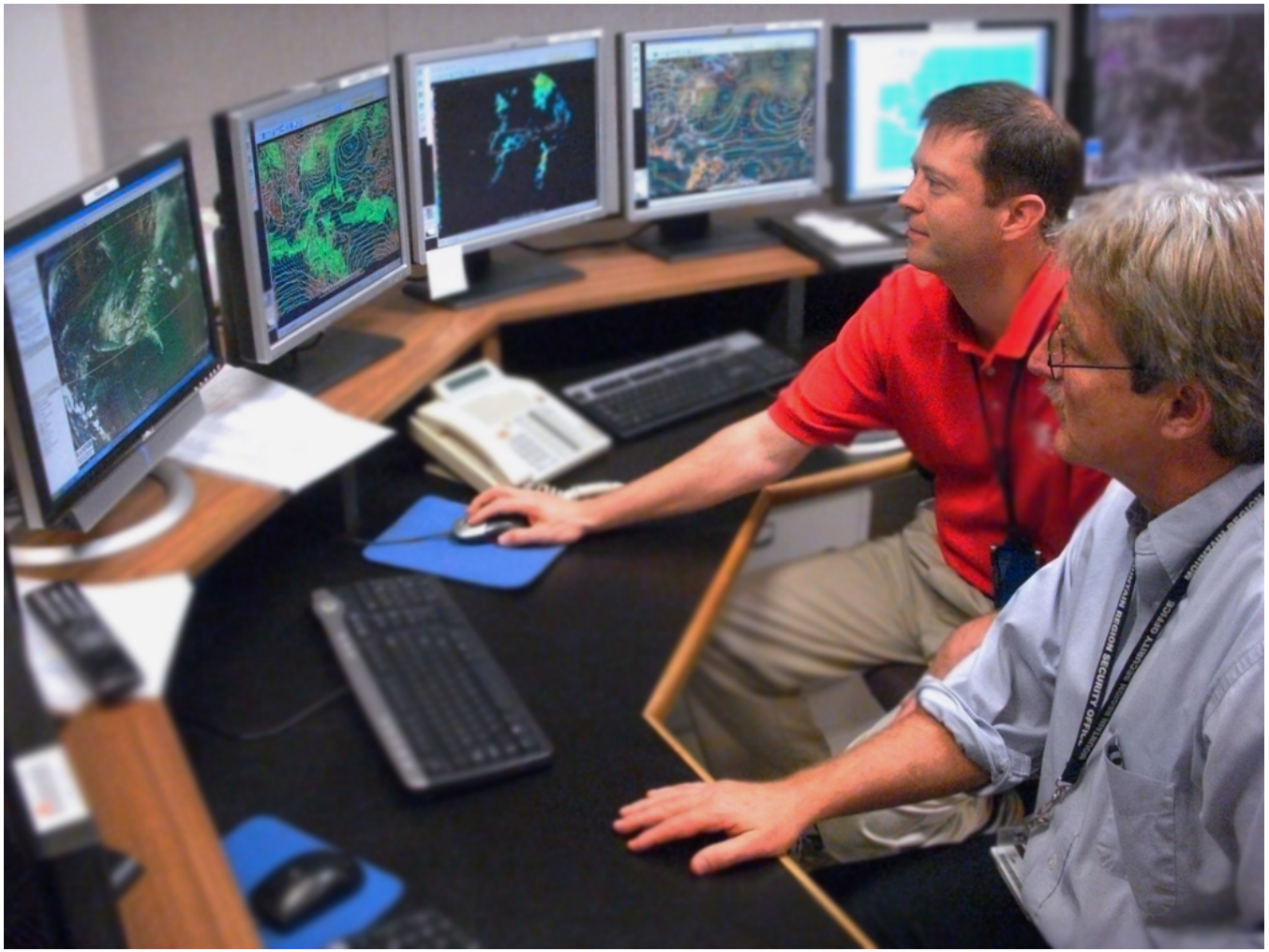


AWIPS II National Centers Perspective

Summary

- 24 + 8 bit (three 8 bit image + one 8 bit overlay layers) RGB imagery can enhance additional information available from the new GOES-R ABI instrument
- Existing 24 bit images reduced to current 8 bit displays can loose information
- AWIPS II has the hardware and software capabilities to implement 32 bit imagery
- No applications exist in AWIPS II to easily utilize 24+8 bit capabilities
- CIRA and SPoRT will develop, test and evaluate 2 possible AWIPS II RGB methodologies in 2013-2014
- Goal is to make all of the useful RGB imagery products/decision aids available in AWIPS II

Thanks for listening!



Mark DeMaria (NESDIS/StAR) and Daniel Brown (NHC Forecaster) looking at the RGB Air Mass Product