Products Development: Multi-Spectral Imagery (RGB)

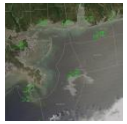
Science Advisory Committee Meeting

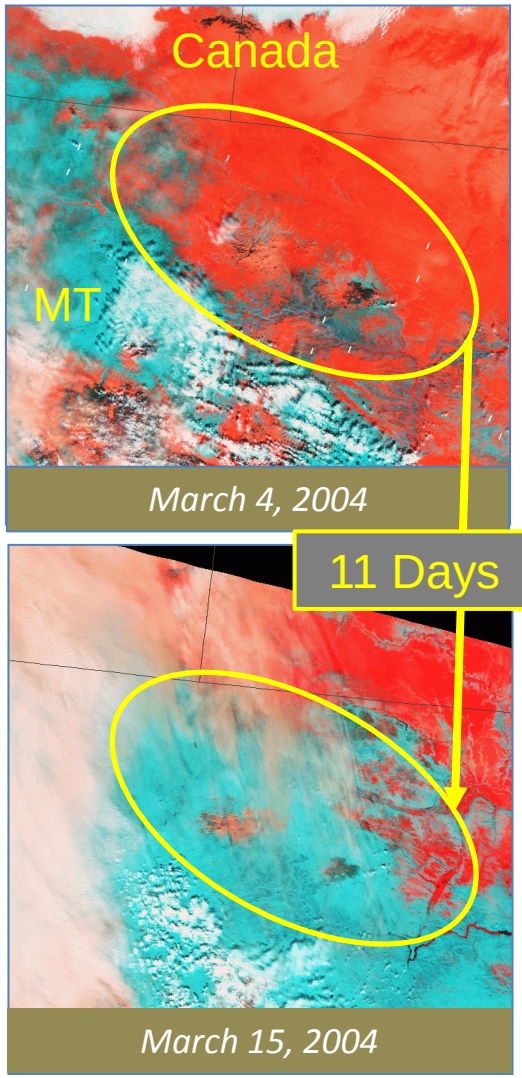
26 – 28 August, 2014

National Space Science and Technology Center, Huntsville, AL

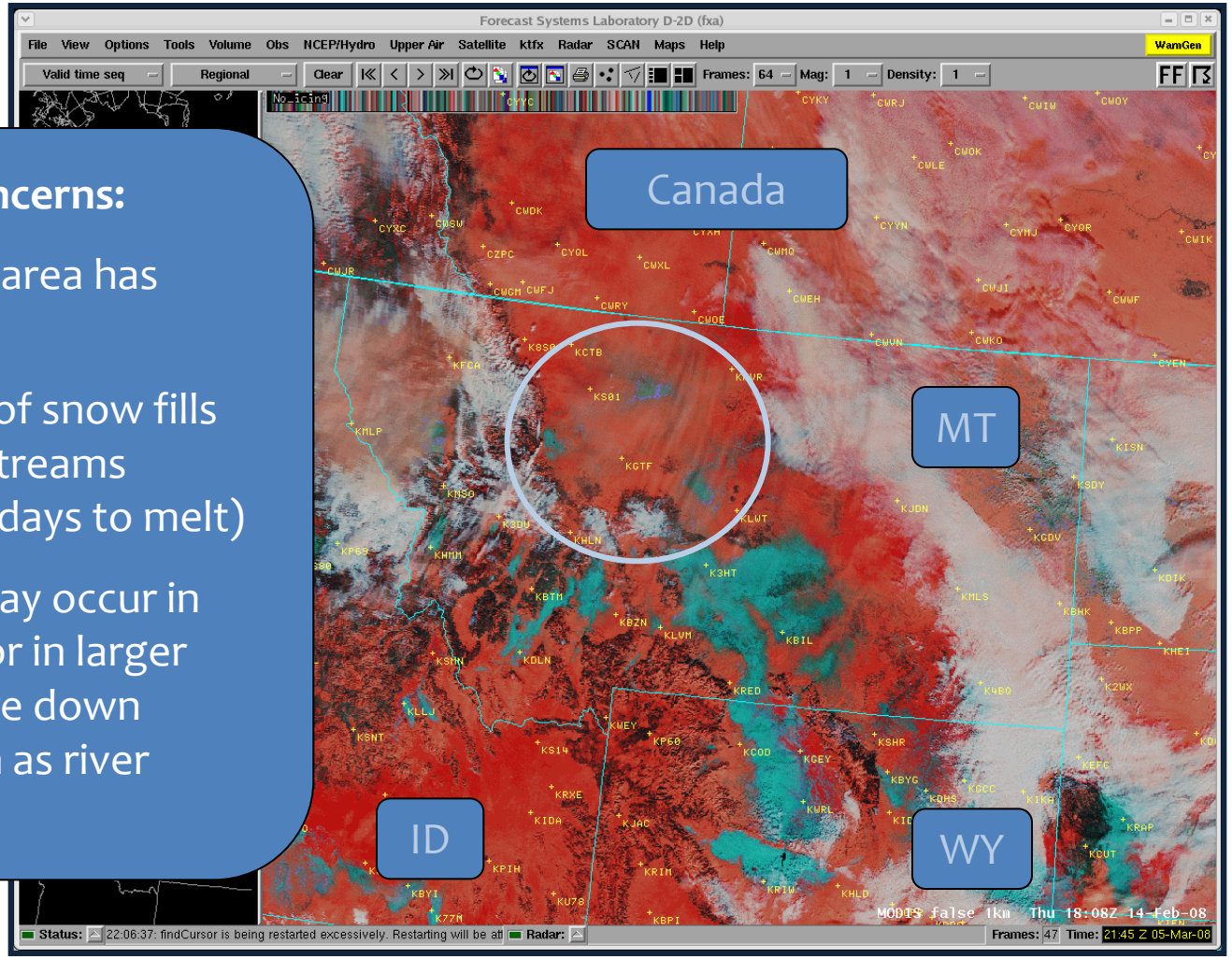
Why Multi-Spectral (i.e. RGB) imagery is important?

- Unique NASA products for specific problems
- Near real-time capability that demonstrates future NOAA GEO/LEO instruments
- Fusing of base data into a derived product
- Proven Value
  - Great Falls WFO, Snow melt monitoring 2004. By 2008 considered RGB to be of "normal" operations.
  - Mobile WFO, 2010 Deep Water Horizon oil slick
  - Albuquerque WFO, record wild fire/smoke 2011 via True Color RGB published on public graphicast
- Supplemental Value
  - VIIRS Day-Night Band RGB includes IR channel which provides cloud locations during periods of very low light





MODIS False Color - GFX



Forecast Concerns:

- How much area has melted?
- Rapid melt of snow fills creeks and streams (only took 2 days to melt)
- Flooding may occur in small areas or in larger areas that are down stream, such as river valleys

What? Who? Why?

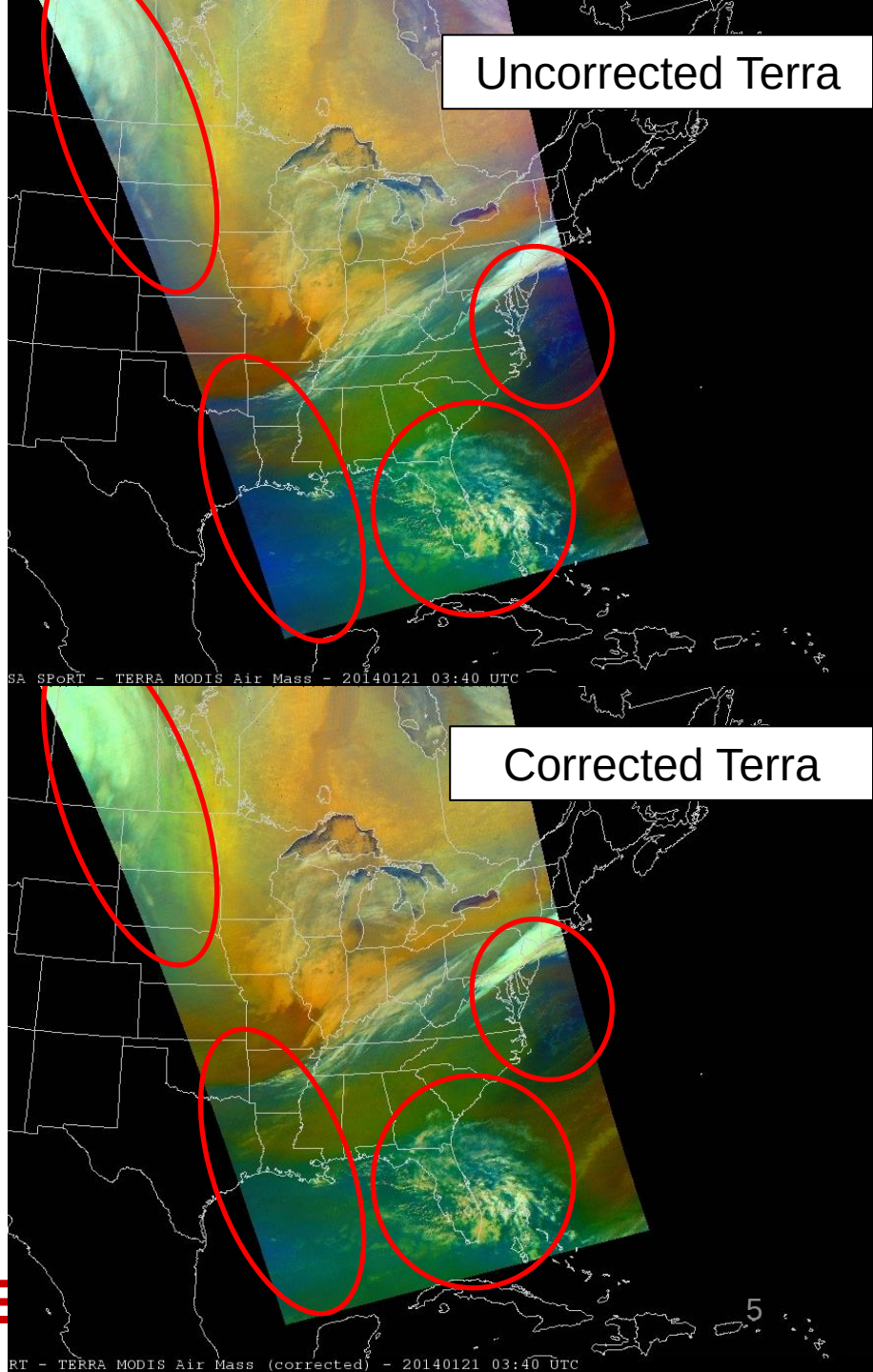
RGB	Who's using	Forecast/Analysis Challenges
Snow-Cloud	West WFOs, NCs	Snow cover, Flooding from snow melt
True Color	WFOs, NCs	Fire/Smoke, Land & Sea surface changes
Air Mass	NCs	Cyclone dynamics, jet streak
Dust	West WFOs, NCs	Dust storms and plumes, BL moisture
Nighttime Micro.	WFOs, AWC, WCP	Cloud type/height delineation, Fog vs low cloud, precipitating clouds below radar
24-hr Micro.	Alaska WFOs	Fog vs low clouds in cold envir.
Daytime Micro.	NHC	Tropical Cyclone structure, particle phases
Conv. Storms	NHC	Convection intensity via ice particle size
Day-Night Band	WFOs, NCs	Cloud analysis, fog, light changes, snow cover
37 & 89GHz	WCP, NHC	Convection

NCs = National Centers; WCP = Weather and Climate Prediction centers

Air Mass RGB

- WFOs noted Terra was very different from Aqua
- Right: Air Mass RGB uses water vapor and ozone channels. BT cooling at limb due to greater path length and absorption.
  - Work by grad. student (Nicholas Elmer) to develop empirical corrections for limb cooling and bias adjustments
  - Terra, Aqua, NPP adjusted to be consistent with SEVIRI at nadir
  - Corrected RGB going to end users

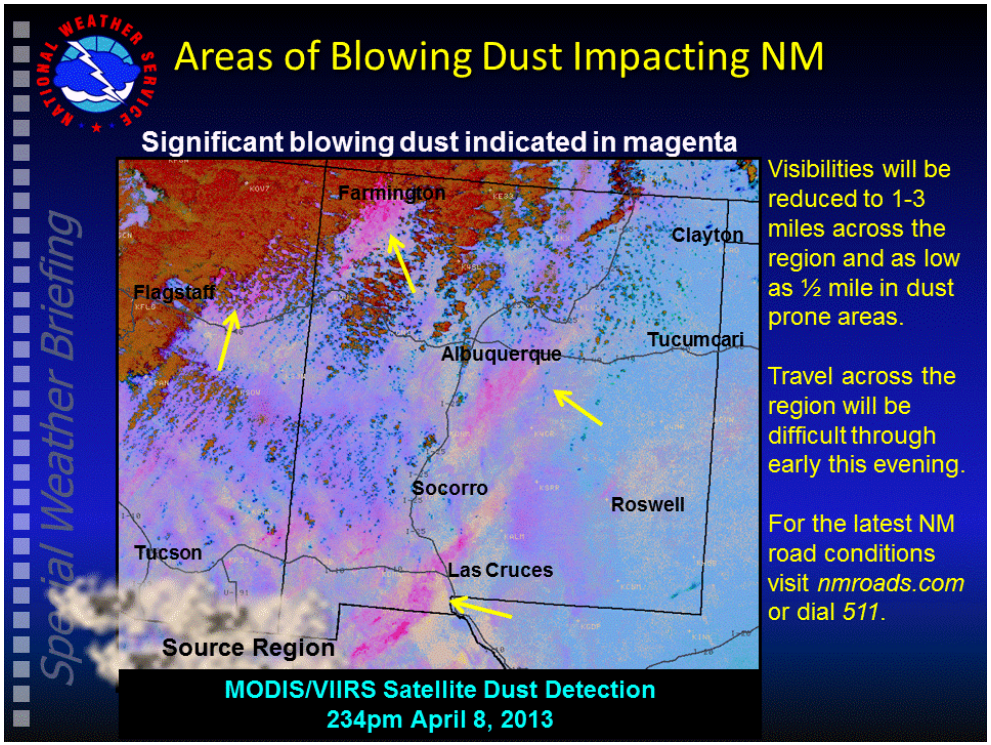
Color	Band / Band Diff.
Red	6.7 - 7.3
Green	9.7- 10.8
Blue	6.7



Dust RGB

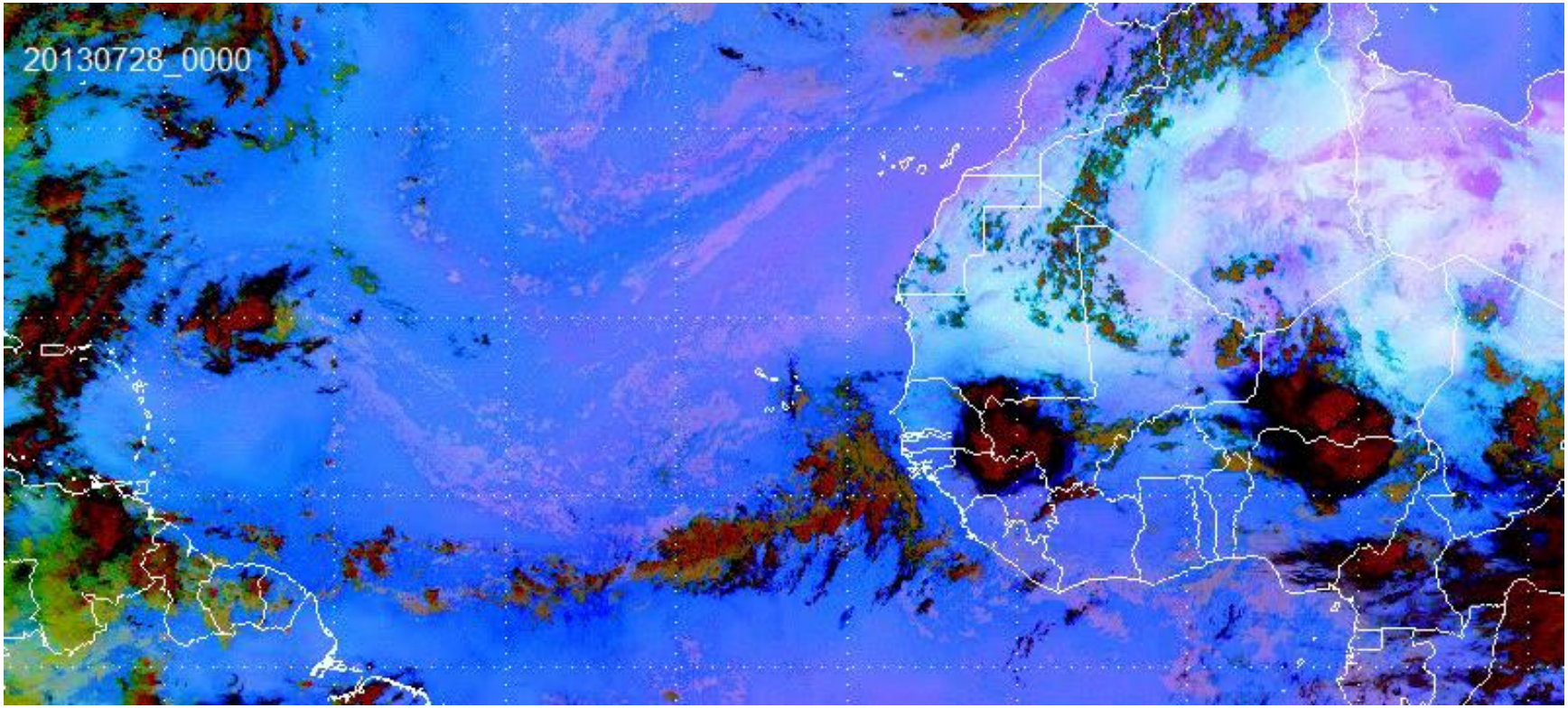
Color	Band / Band Diff.
Red	12.0 – 10.8
Green	10.8 – 8.7
Blue	10.8

- Highest impact is to Aviation ceiling/vis updates
  - More clearly detect vs. Vis.
  - More confidence regarding coverage vs. point obs.
  - Nighttime detection
- Lead to "Dust Storm Warning" and changes to "Blowing Dust Advisories"
  - (Publication with Brian Guyer of ABQ)
- Similar limb & bias correction work for 8.7µm per user request



RGB integrated into Graphicast (above) and other social media. ABQ: "Power users eager for this information". (i.e. Improves communication method to the public)

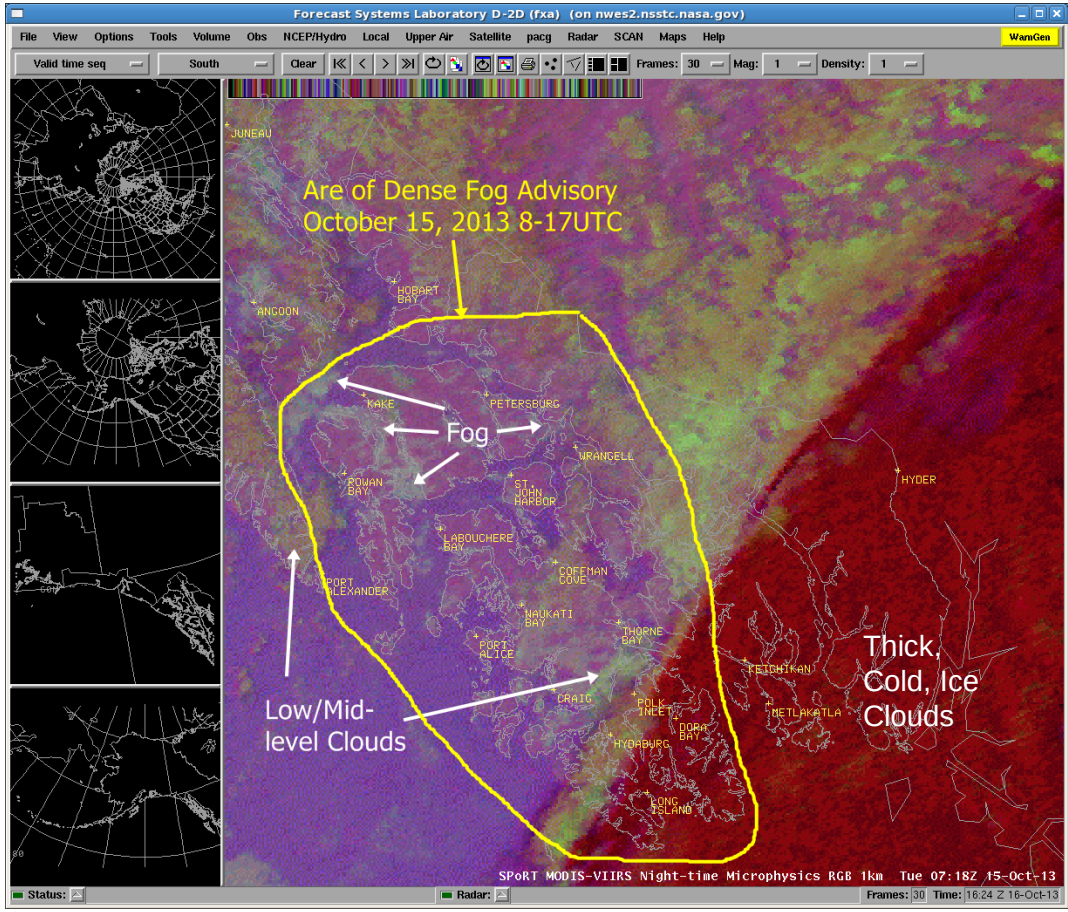
SEVIRI RGB Imagery for National Centers



Nighttime Microphysics RGB

Color	Band / Band Diff.
Red	12.0 – 10.8
Green	10.8 –3.9
Blue	10.8

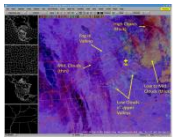
- Next step in aviation support for fog vs. low clouds
  - GOES LCB, 11-3.9, NtMicro RGB
- Have evaluated with several user groups, including AK
  - Planning test of 24hr Micro for AK due to extreme cold
- Many examples of impact from WFOs (see reports)
- Uses extend beyond fog
  - Analysis of precipitating clouds below radar beam (West U.S.)
  - Publication with Paul Nutter (TFX)



Juneau, AK. 15 October 2013 the NtMicro RGB assists with analysis of fog in the area where Dense Fog Advisory was issued.

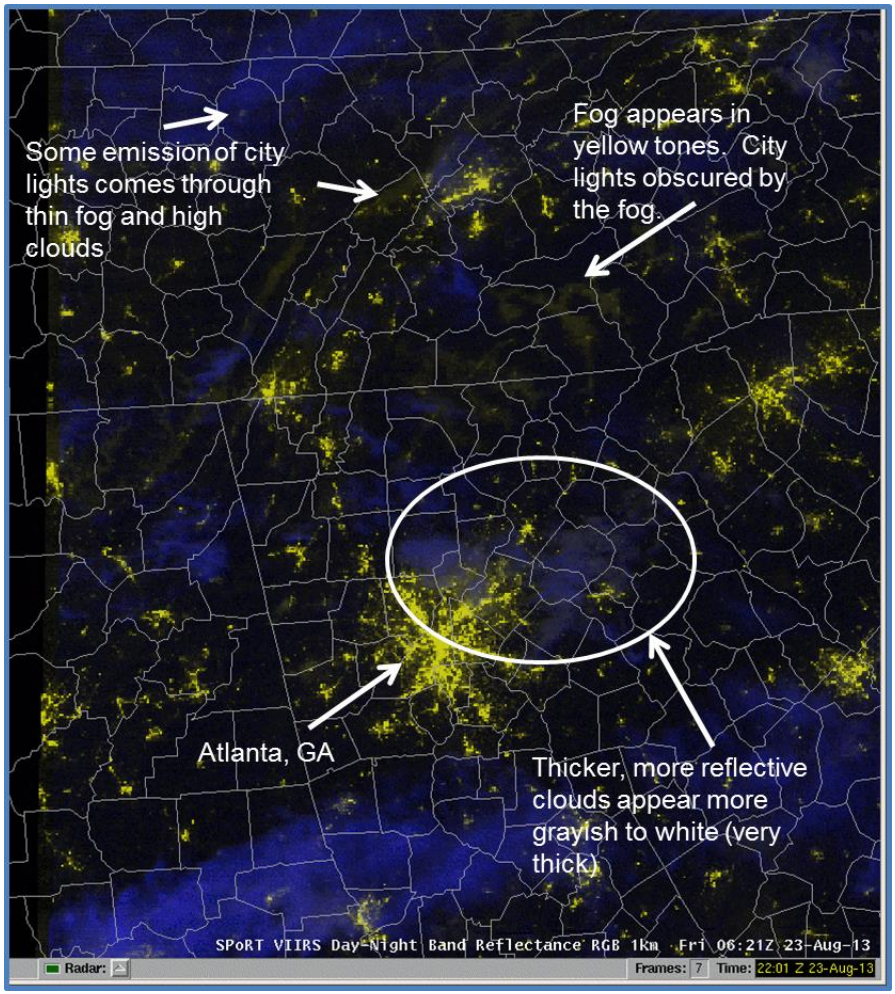
RGB Imagery Assessments by Inland (Sep/Oct 2013) and Coastal (Dec/Jan) WFOs from ER and SR

- Fall/Winter 2013/14: Inland and coastal WFOs (Southern CONUS)
  - 8 WFOs, 51 submissions
- 51 official feedback forms
  - RAH provided 23
- 2/3rd of user cited NtMicro as primary product for fog analysis and positive impact
- However limitations in experience and product availability resulted in 1/3rd of responses indicating small to very small impact of NtMicro
- Recommendations to developers included an RGB case library, enhanced sampling tools for RGB imagery, and increased use of addition of international satellites to increase product frequency



VIIRS Day-Night Band RGB

- DNB uses reflected moon light to see atmospheric and land features.
  - NRL code used to create a “reflectance” product. Normalized by moon phase/angle to provide consistent object brightness over time.
- DNB sensitive to surface-based emission sources
  - City Lights, wild fires and smoke, gas wells, snow cover
- RGB Imagery (Radiance & Reflectance)
  - Red: Day-Night Band
  - Green: Day-Night Band
  - Blue: 11µ (longwave IR)
    - Provides cloud height and/or location

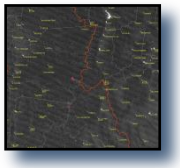


VIIRS RGB Imagery Assessment
(Front Range Collaboration 2013)

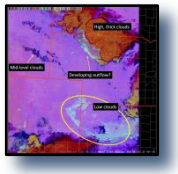
Operational issues

- Smoke and hot spot detection
- Dust observations
- Fog and cloud composition
- Utility of day-night band

User Applications / Feedback



- VIIRS 3.9µm and DNB Radiance rated high for fire detection, limited smoke use
- User comments indicated application of DNB for fire growth estimates. Desire for automated color coding of fires in DNB imagery.



- DNB used to look for obscured city lights for analysis of low clouds / fog
- Nighttime Microphysics rated high to very high for cloud analysis
- RGBs not intuitive to user group, additional training requested

RGB Product – Summary

- Current MODIS and VIIRS RGBs have proven value to operations now for short-term, mesoscale situations
  - Can be infrequent, but high-impact events: Fires, oil spill, dust, snow melt, etc.
  - Takes training and assessment over time before fully integrated
- Opportunity within Proving Ground for users to gain experience with RGB imagery before GOES-R.
  - Comfort level with application of RGBs varies per user
- Assessments help developers to understand if RGBs are meeting user needs for given issue
  - Adjustments to “recipes”, additional tools or display techniques
  - Possible new RGBs to create
  - Additional training examples that might be needed or can be captured

EXTRA SLIDES AFTER THIS POINT

How RGB products are created at SPoRT

- MODIS and VIIRS are “bowtie corrected”, SEVIRI used as is
- Passive Microwave data from NRL and (??? GPM)
- Quantize code made modular by Andrew Molthan, used to reduce number of colors to needs of user’s display system
- EUMETSAT “Best Practices” RGB recipes from SEVIRI experiences used within modular code
  - RGBs created on SPoRT hardware and UAF GINA virtual machines in Alaska
- Output is made ready for AWIPS I & II, NAWIPS, Google Earth
- Users provided pre-defined color table per quantized RGB