Suomi NPP Non-NCC VIIRS Imagery EDR Product Review - Provisional

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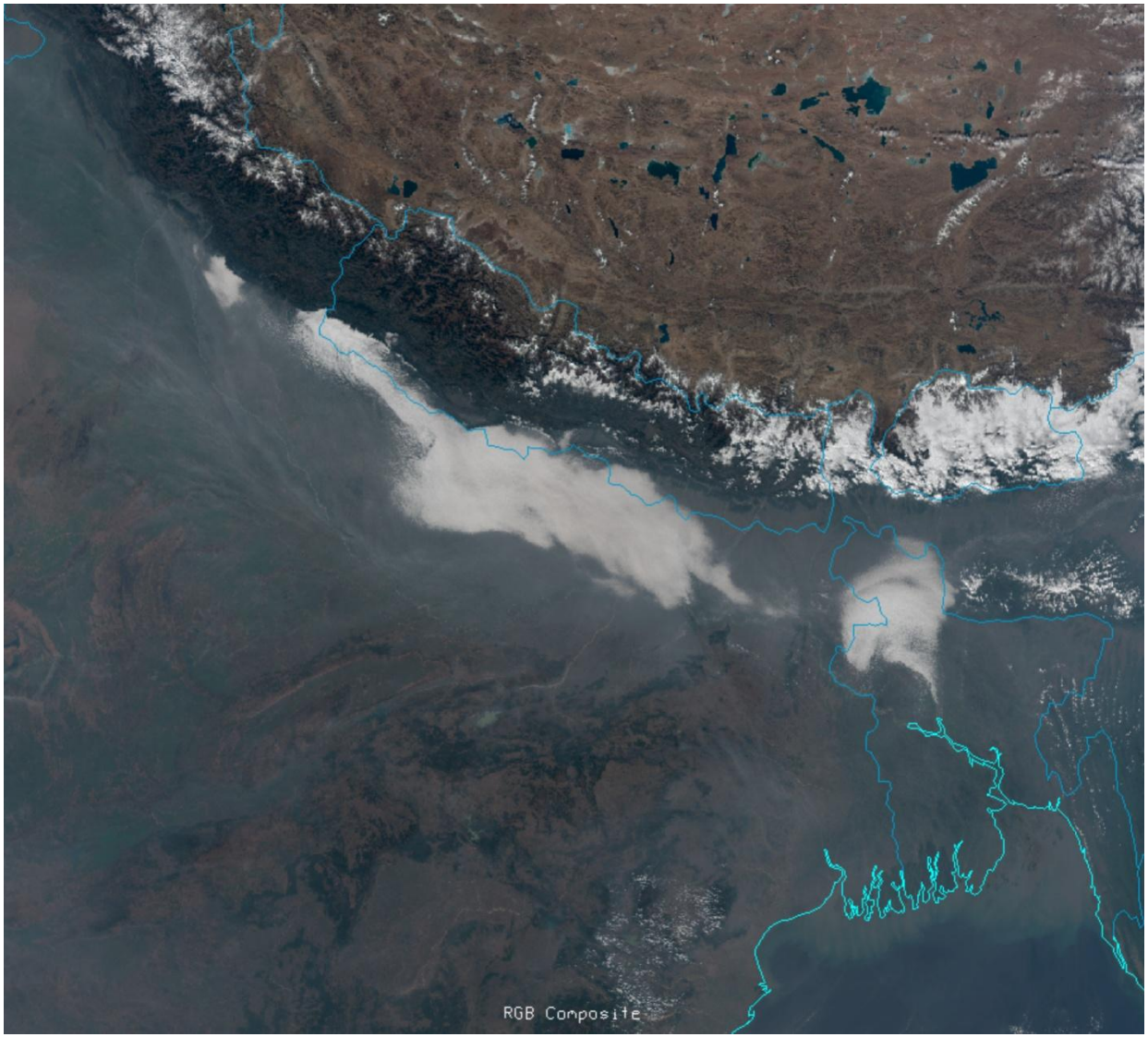
VIIRS EDR Imagery (and Visualization) Team

- NESDIS/StAR (D. Hillger, D. Molenar, D. Lindsey, T. Schmit – GOES liaison)
- CIRA/CSU (S. Miller, S. Kidder, S. Finley, H. Gosden, R. Brummer, C. Seaman)
- CIMSS/SSEC (T. Jasmin, T. Rink, W. Straka)
- Aerospace (T. Kopp, J. Feeley)
- NOAA/NGDC (C. Elvidge)
- NRL (J. Hawkins, K. Richardson, J. Solbrig, T. Lee)
- AFWA (J. Cetola)
- Northrop Grumman (K. Hutchison, R. Mahoney)
- NASA (W. Thomas, P. Meade)
- NOAA/OSPO (A. Irving)
- NASA/SPoRT (G. Jedlovec, M. Smith)



VIIRS true-color image from bands M3 (0.488 µm), M4 (0.555 µm), and M5 (0.672 µm) over northern India and Tibet on 14 December 2011 at 0725 UTC. Note the large contrast in aerosol scattering between the cooler and drier and shallower air mass to the north of the Himalayan chain and the warm and humid and deeper air mass to the south.

VIIRS Environmental Data Record (EDR)s

VIIRS Band	Central Wavelength (µm)	Bandwidth (µm)	Wavelength Range (µm)	Band Explanation	Spatial Resolution (m) @ nadir
M1	0.412	0.02	0.402 - 0.422	Visible	750 m
M2	0.445	0.018	0.436 - 0.454		
M3	0.488	0.02	0.478 - 0.488		
M4	0.555	0.02	0.545 - 0.565		
M5 (B)	0.672	0.02	0.662 - 0.682		
M6	0.746	0.015	0.739 - 0.754	Near IR	
M7 (G)	0.865	0.039	0.846 - 0.885		
M8	1.240	0.020	1.23 - 1.25	Shortwave IR	
M9	1.378	0.015	1.371 - 1.386		
M10 (R)	1.61	0.06	1.58 - 1.64		
M11	2.25	0.05	2.23 - 2.28		
M12	3.7	0.18	3.61 - 3.79	Medium-wave IR	
M13	4.05	0.155	3.97 - 4.13		
M14	8.55	0.3	8.4 - 8.7	Longwave IR	
M15	10.763	1.0	10.26 - 11.26		
M16	12.013	0.95	11.54 - 12.49		
DNB	0.7	0.4	0.5 - 0.9	Visible	750 m across full scan
I1 (B)	0.64	0.08	0.6 - 0.68	Visible	375 m
I2 (G)	0.865	0.039	0.85 - 0.88	Near IR	
I3 (R)	1.61	0.06	1.58 - 1.64	Shortwave IR	
I4	3.74	0.38	3.55 - 3.93	Medium-wave IR	
I5	11.45	1.9	10.5 - 12.4	Longwave IR	

Notes:

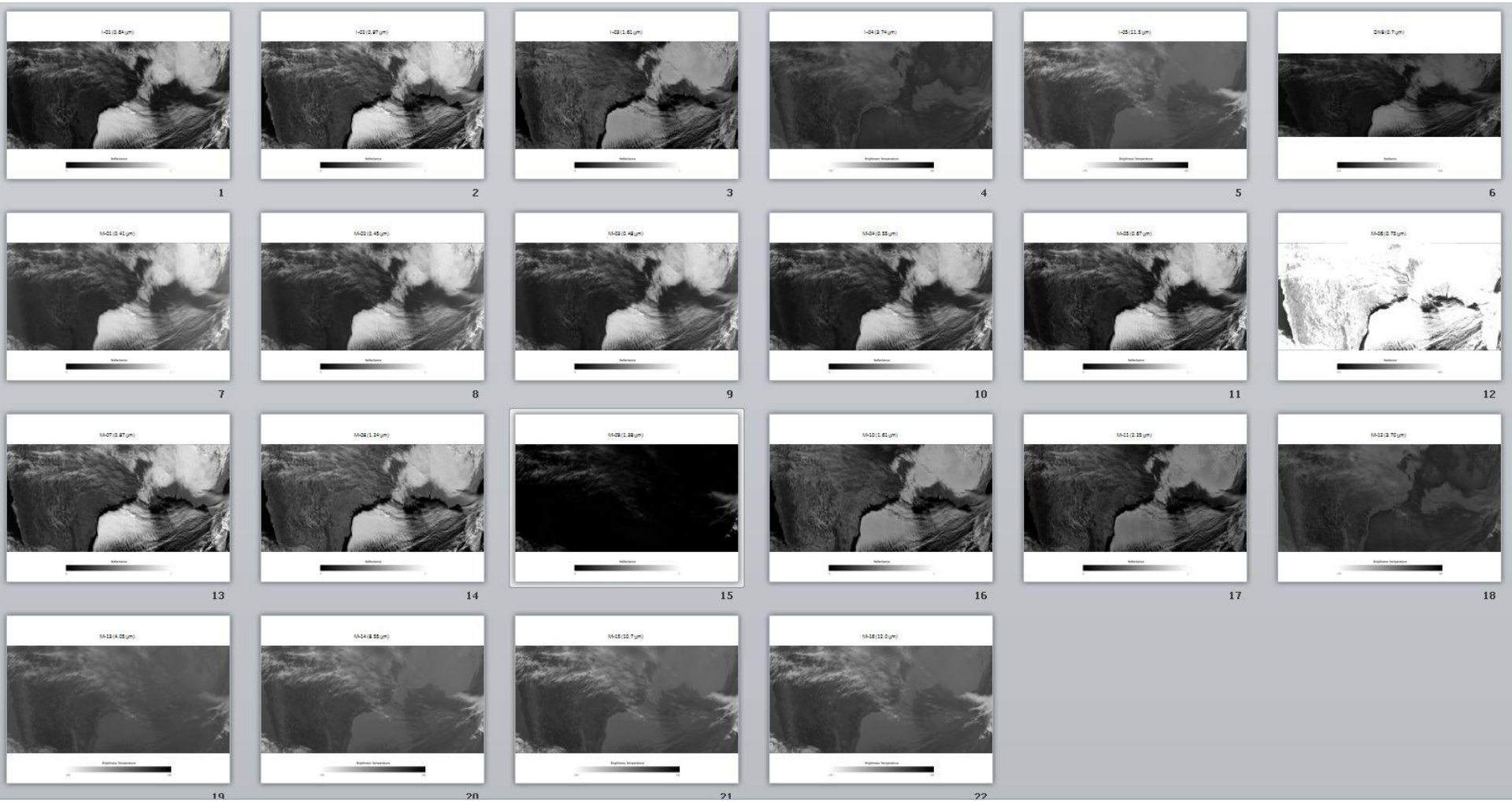
M-bands highlighted in pale yellow are available as EDRs, in addition to SDRs.

True-color component bands are highlighted in red, green, and blue.

Natural-color component bands are noted with R, G, and B.

M6 on Suomi NPP has a high radiance fold-over issue with many saturated pixels.

VIIRS bands (I1-I5, DNB/NCC, M1-M16)



NPP/JPSS data sources

- **GRAVITE**[1] (Suitland, 7-hour delay)
- **NOAA CLASS**[2] (Asheville, 7-hour delay) – not actively used
- **Atmosphere PEATE**[3] (Wisconsin, 7-hour delay)
  - ADDE server for McIDAS-X
  - FTP and HTML
- **Direct Readout** (Wisconsin, minimal delay, but provides data only over North America, when the satellite is with sight of Madison)
- **AFWA IDPS**[4] (Omaha, near real-time)

[1]Government Resource for Algorithm Verification, Integration, Test and Evaluation
[2]Comprehensive Large Array-data Stewardship System
[3]Product Evaluation and Algorithm Test Elements
[4]*Air Force Weather Agency* Interface Data Processing Segment

VIIRS display tools

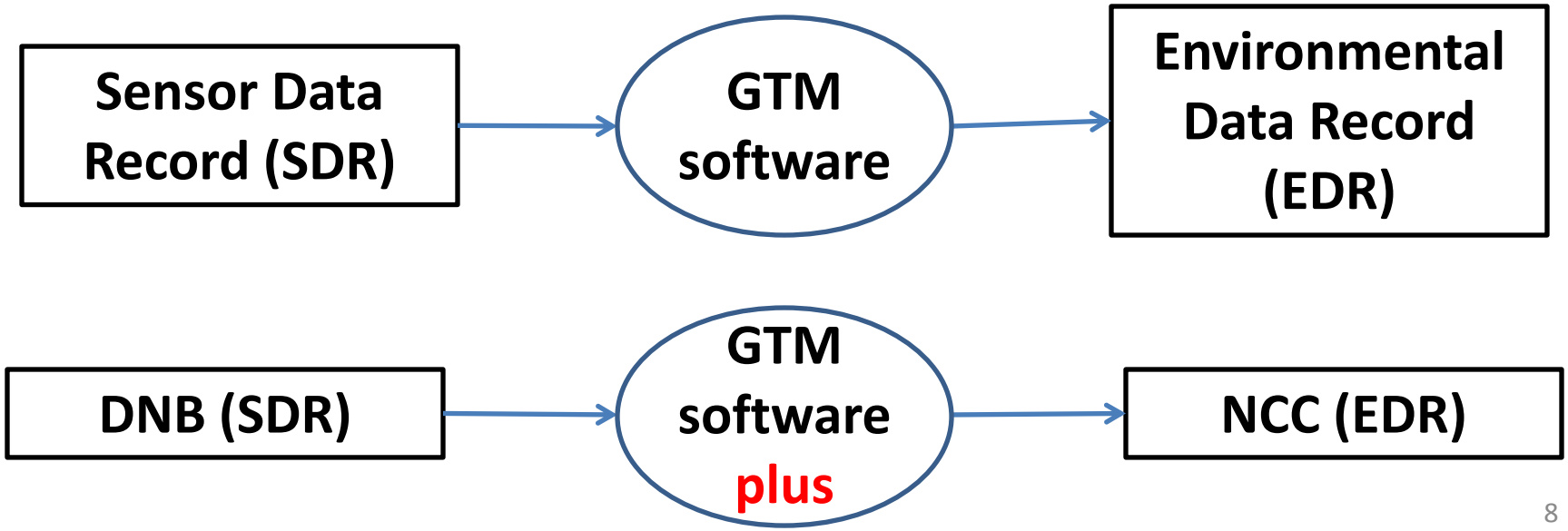
- **McIDAS-V** (VIIRS ready) – SSEC/CIMSS/Wisconsin
- **McIDAS-X** (VIIRS capabilities still under development) – SSEC/CIMSS/Wisconsin

- **TeraScan / NexSat** (web display) – NRL

- **IDL**

Sensor Data Record (SDR) to Environmental Data Record (EDR)

- **Ground Track Mercator (GTM)** remapping software.
  - GTM is a **remapping** of the data, but the **same radiances/reflectances** for Non-NCC bands only.
- For NCC imagery there is **additional radiance processing**



Suomi NPP Imagery and Visualization Team web page
http://rammb.cira.colostate.edu/projects/npp/

NOAA Satellites and Information
National Environmental Satellite, Data, and Information Service

NESDIS banner

Suomi NPP (National Polar-orbiting Partnership) VIIRS Imagery and Visualization Team

(Last updated: 2012-12-18)

The NESDIS/StAR Imagery and Visualization and Visualization Team is responsible for the checkout of EDR imagery (and data) from the NASA/NOAA **Joint Polar Satellite System (JPSS)** spacecraft, the **Suomi NPP (National Polar-orbiting Partnership).**

Date	Event
28 October 2011 @ 0948 UTC	NPP launch
21 November 2011 @ 1604 UTC	First visible/reflective images
19 January 2012 @ 0620 UTC	First infrared/thermal images
25 January 2012	NPP renamed Suomi NPP

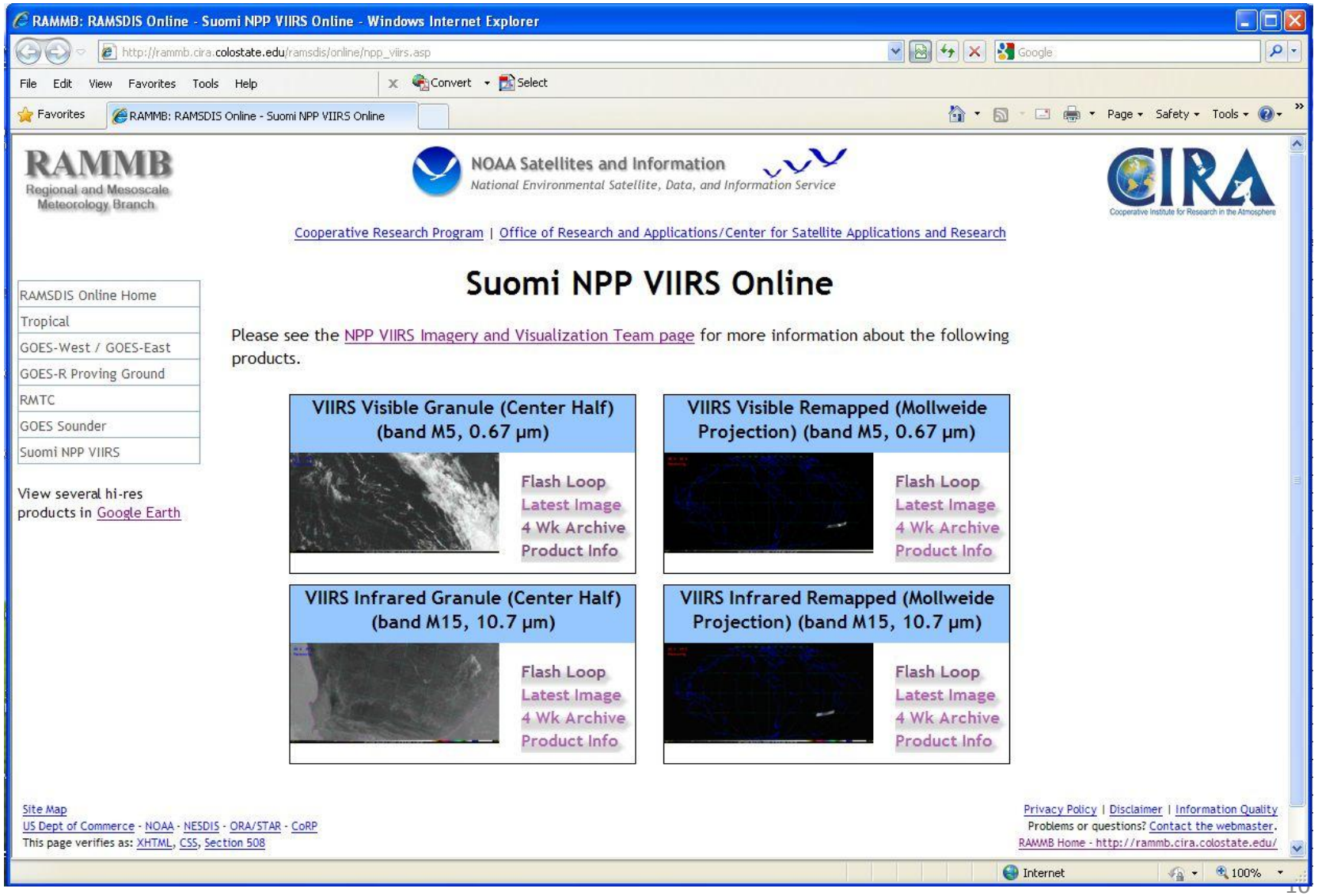
For a roster of VIIRS EDR Imagery Team members see JPSS_Imagery_and_Visualization_Team.docx.

For a list of VIIRS bands and band information see VIIRS_bands_and_bandwidths.pdf.

Website	URL
CIRA's **Suomi NPP Blog**	http://rammb.cira.colostate.edu/projects/npp/blog/
CIRA's **VIIRS granules**	http://rammb.cira.colostate.edu/ramsdis/online/npp_viirs.asp
NRL's **VIIRS imagery**	http://www.nrlmry.navy.mil/VIIRS.html
CIMSS' **Satellite Blog for VIIRS**	http://cimss.ssec.wisc.edu/goes/blog/archives/category/viirs
StAR-JPSS **ADP (Algorithm and Data Products)**	http://www.star.nesdis.noaa.gov/jpss/index.php
NOAA **CLASS**	http://www.class.ncdc.noaa.gov/

Suomi NPP VIIRS Online

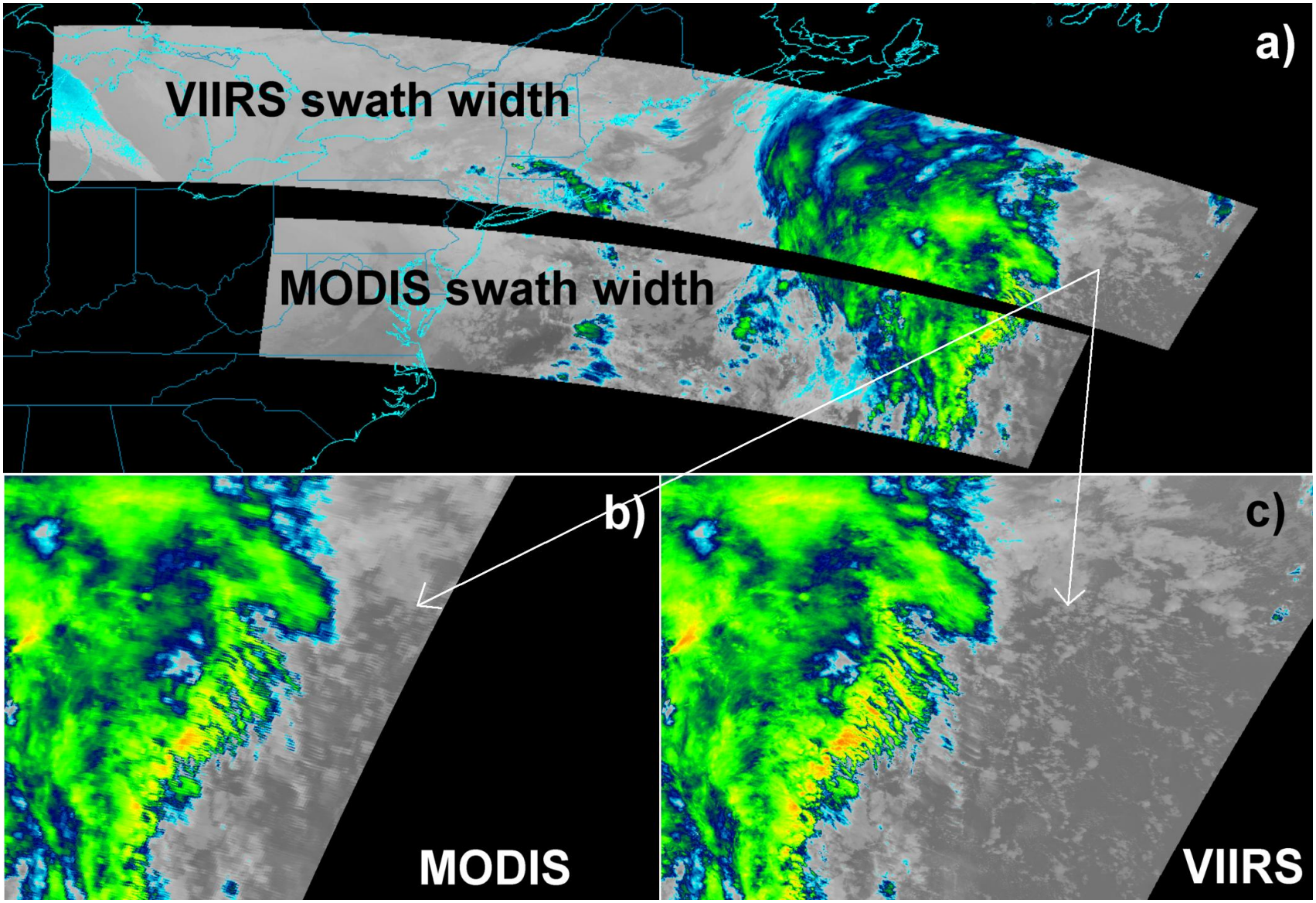
http://rammb.cira.colostate.edu/ramsdis/online/npp_viirs.asp



Unique features of VIIRS, as compared with its predecessors

- **Finer spatial resolution** for all bands (down to 375 m)
- **Finer spatial resolution at swath edge in particular**
  - A benefit of aggregation
  - Limit degradation of spatial resolution from nadir to edge-of-scan
- **Wider (3000 km) swath**, leaving no gaps between adjacent orbits

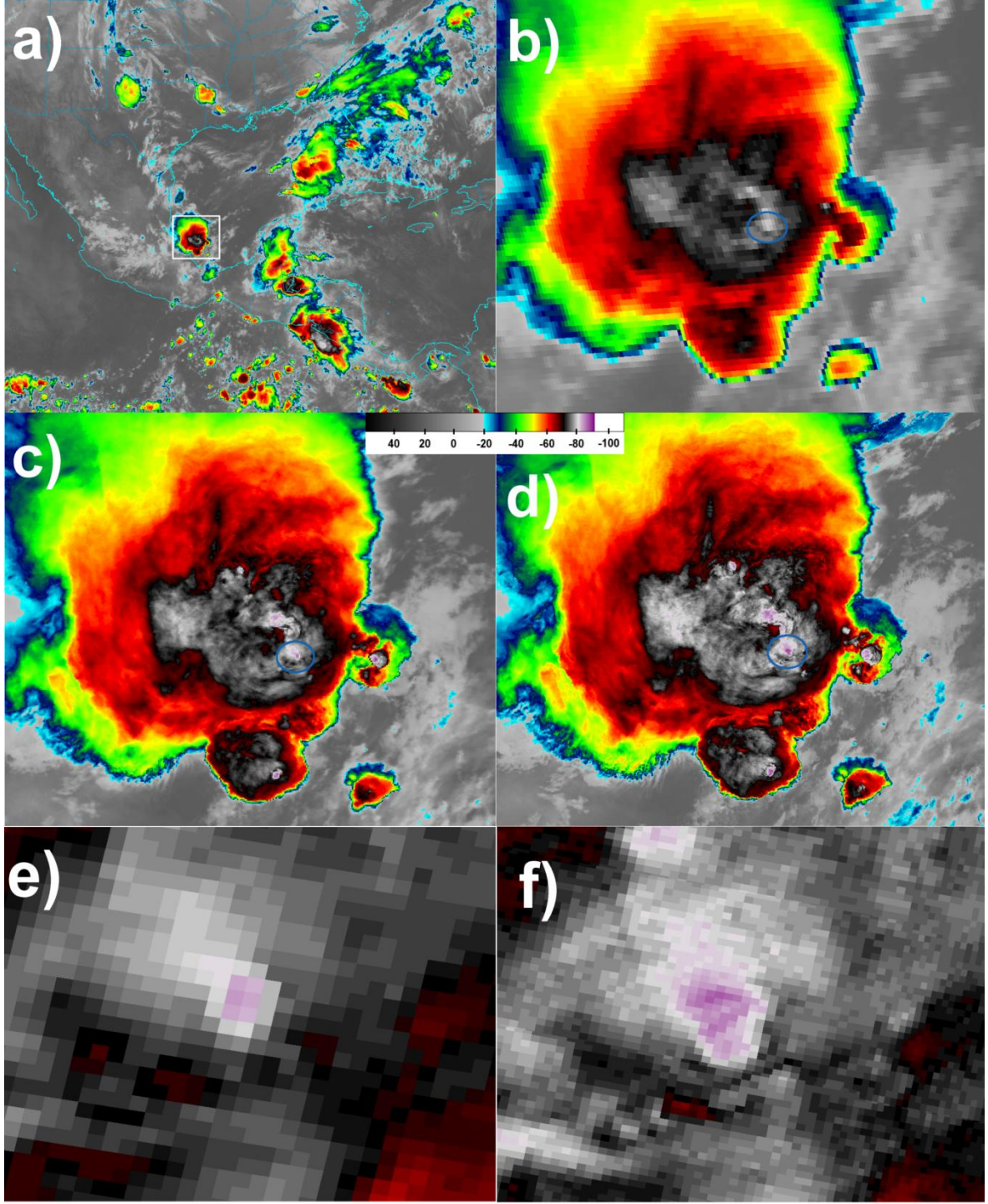
Better spatial resolution at swath edge



BAMS article to appear in 2013

- **Hillger, D.,** T. Kopp, T. Lee, D. Lindsey, C. Seaman, S. Miller, J. Solbrig, S. Kidder, S. Bachmeier, T. Jasmin, and T. Rink, 2013: **First-Light Imagery from Suomi NPP VIIRS.** Manuscript accepted by *BAMS*.

- Examples that follow are from that manuscript.



a) GOES-13 10.7 µm image from 0815 UTC on 6 June 2012

b) Zoomed-in **GOES** over the highlighted thunderstorm complex in the southwestern Gulf of Mexico,

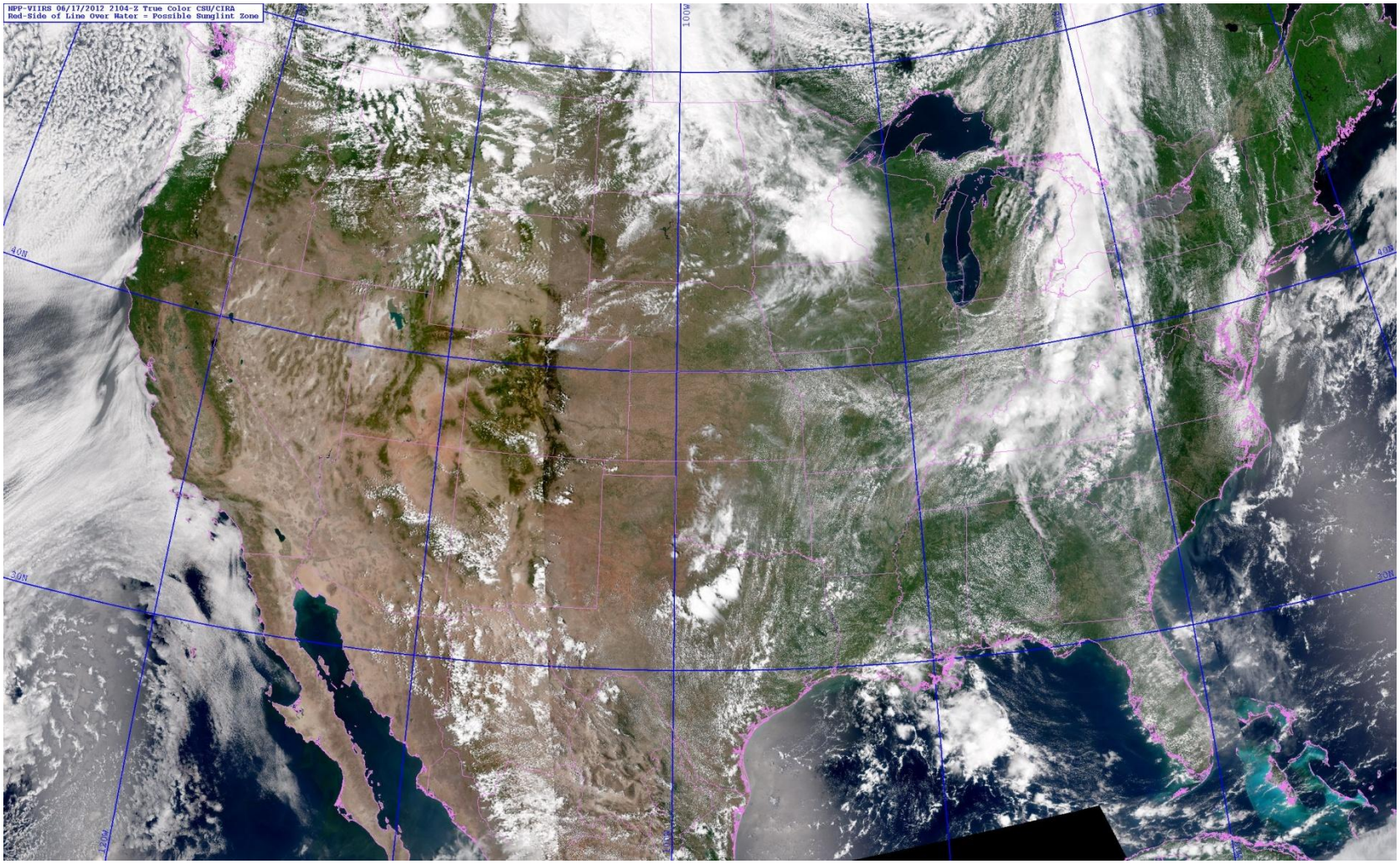
c) Aqua **MODIS** band 31 (11.0 µm) view of the same thunderstorm complex at 0816 UTC

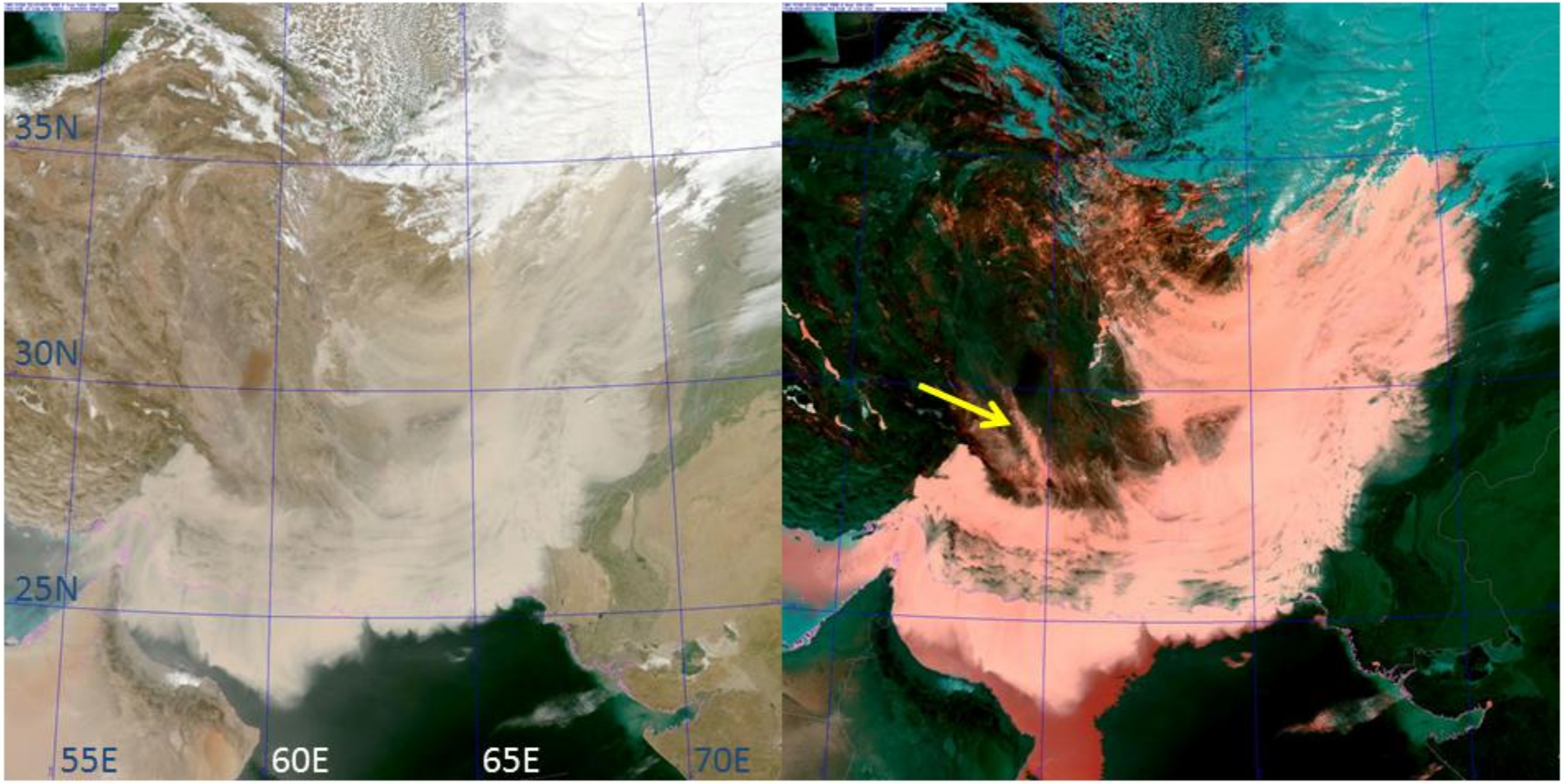
d) NPP **VIIRS** band I5 (11.45 µm) view at 0817 UTC.

e and f) **Extreme close-ups** approximately covering the circled region from the MODIS and VIIRS images.

NRL VIIRS true-color composite

http://www.nrlmry.navy.mil/VIIRS.html



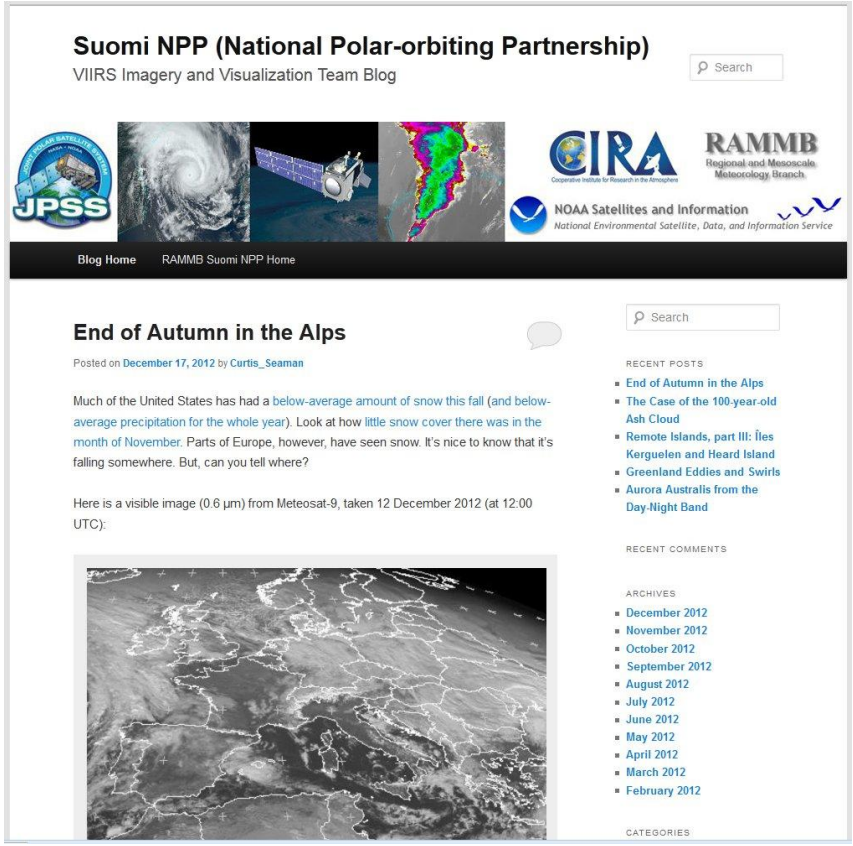


Suomi NPP VIIRS true color (left) and enhanced dust (right) imagery over Middle East. Dust appears as pink, clouds in cyan, and land in shades of green. Images are from 19 March 2012 at 0905 UTC. The enhanced imagery is particularly useful for identifying dust over bright land surface backgrounds, such as the narrow plume indicated in the enhancement by the yellow arrow.

JPSS/Suomi NPP VIIRS Imagery Blog

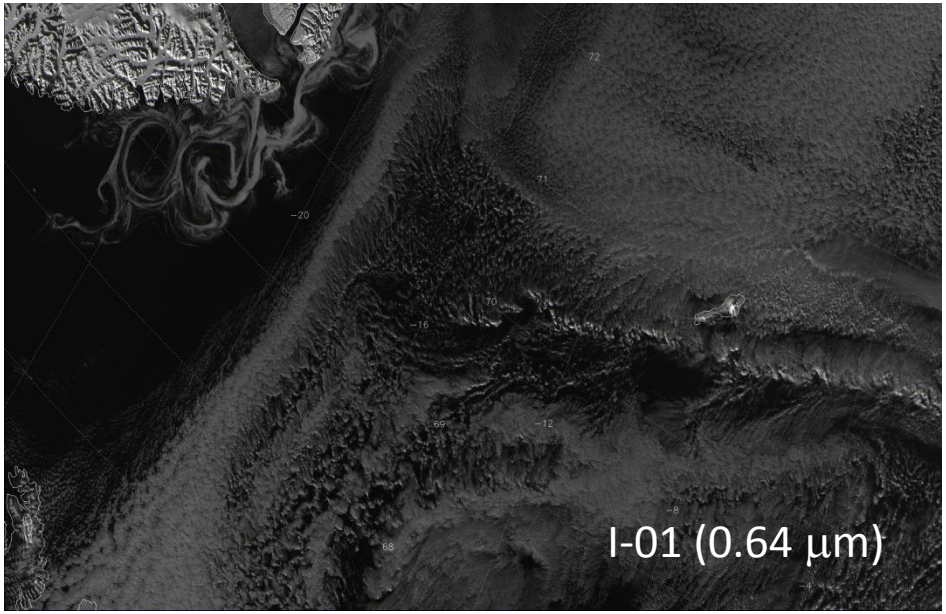
http://rammb.cira.colostate.edu/projects/npp/blog/

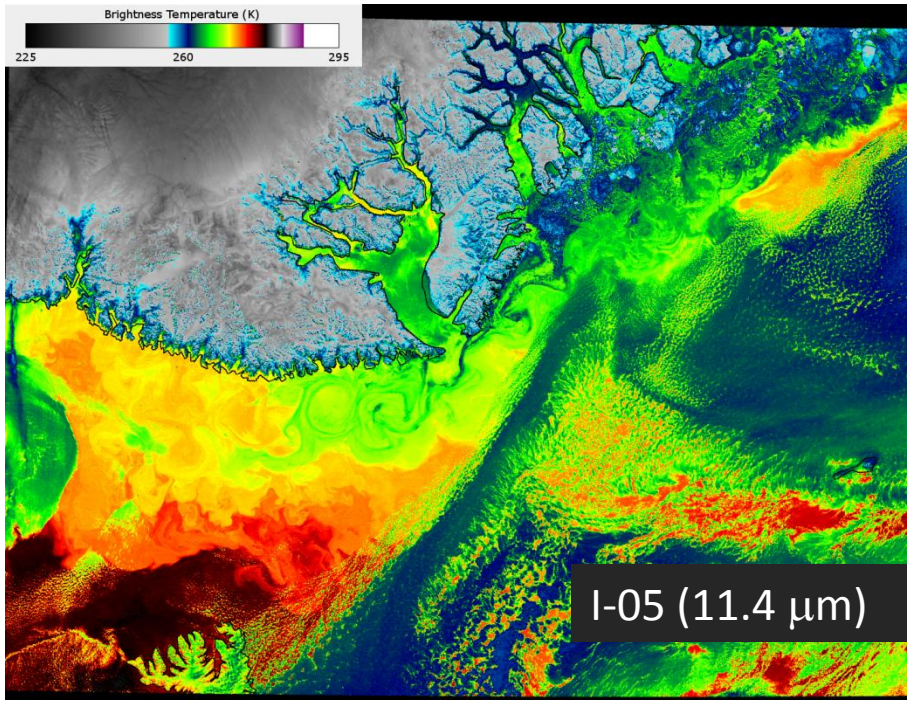
- Blog maintained at CIRA to **highlight capabilities of VIIRS** instrument.
- Designed to provide **education/outreach** of VIIRS imagery applications.
- Blog covers **wide range of topics:** tropical cyclones, severe weather, fire detection, auroras, volcanic eruptions, flooding, snow and ice detection, DNB applications, RGB composites and other interesting high-resolution imagery from VIIRS



Greenland Swirls

http://rammb.cira.colostate.edu/projects/npp/blog/





Visible and IR images from 12:43 UTC 18 October 2012 (C. Seaman)

- Interaction of East Greenland Current and North Atlantic Drift represented by swirling ribbons of ice (left) caught in eddies as a result of the SST contrast (right)

- Many details visible at ~375 m resolution

Fires in Australia

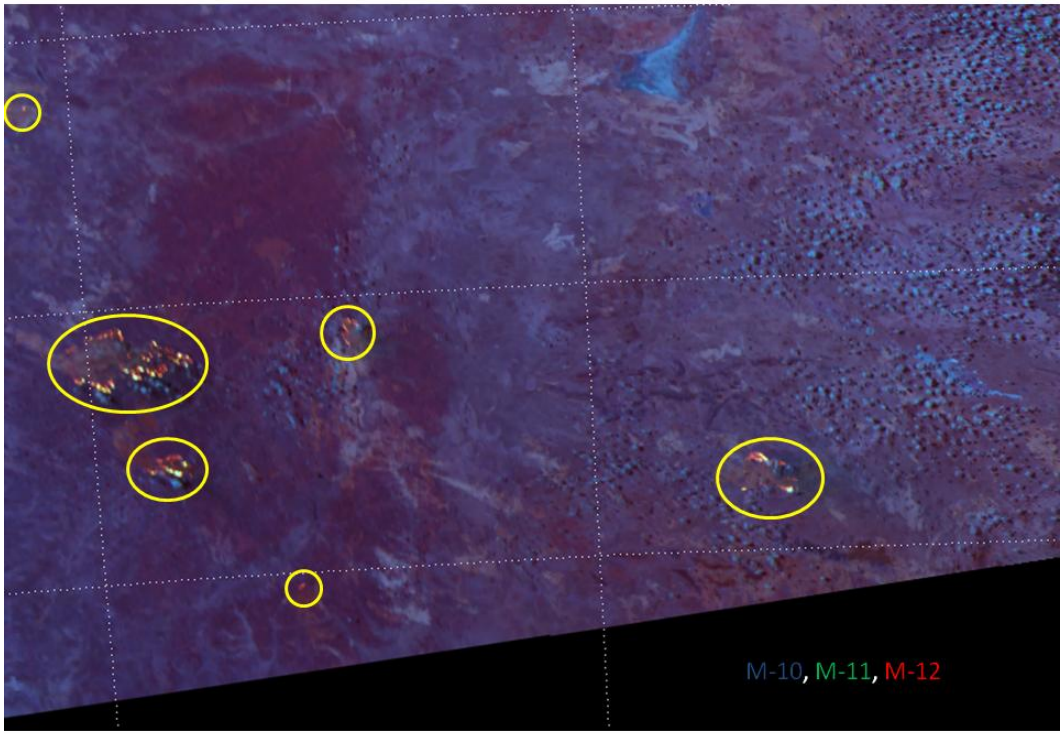
http://rammb.cira.colostate.edu/projects/npp/blog/

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

- "Natural Fire Color RGB" composite of 0.67 μm (M-5), 0.87 μm (M-7) and 2.25 μm (M-11)

- "Fire Power RGB" composite of 1.61 μm (M-10), 2.25 μm (M-11) and 3.7 μm (M-12)

04:34 UTC 19 September 2012



(C. Seaman)

- Exploring new RGB composites to aid in fire detection

- VIIRS has detected fires at wavelengths as short as 1.61 μm

Flooding from Hurricane Isaac

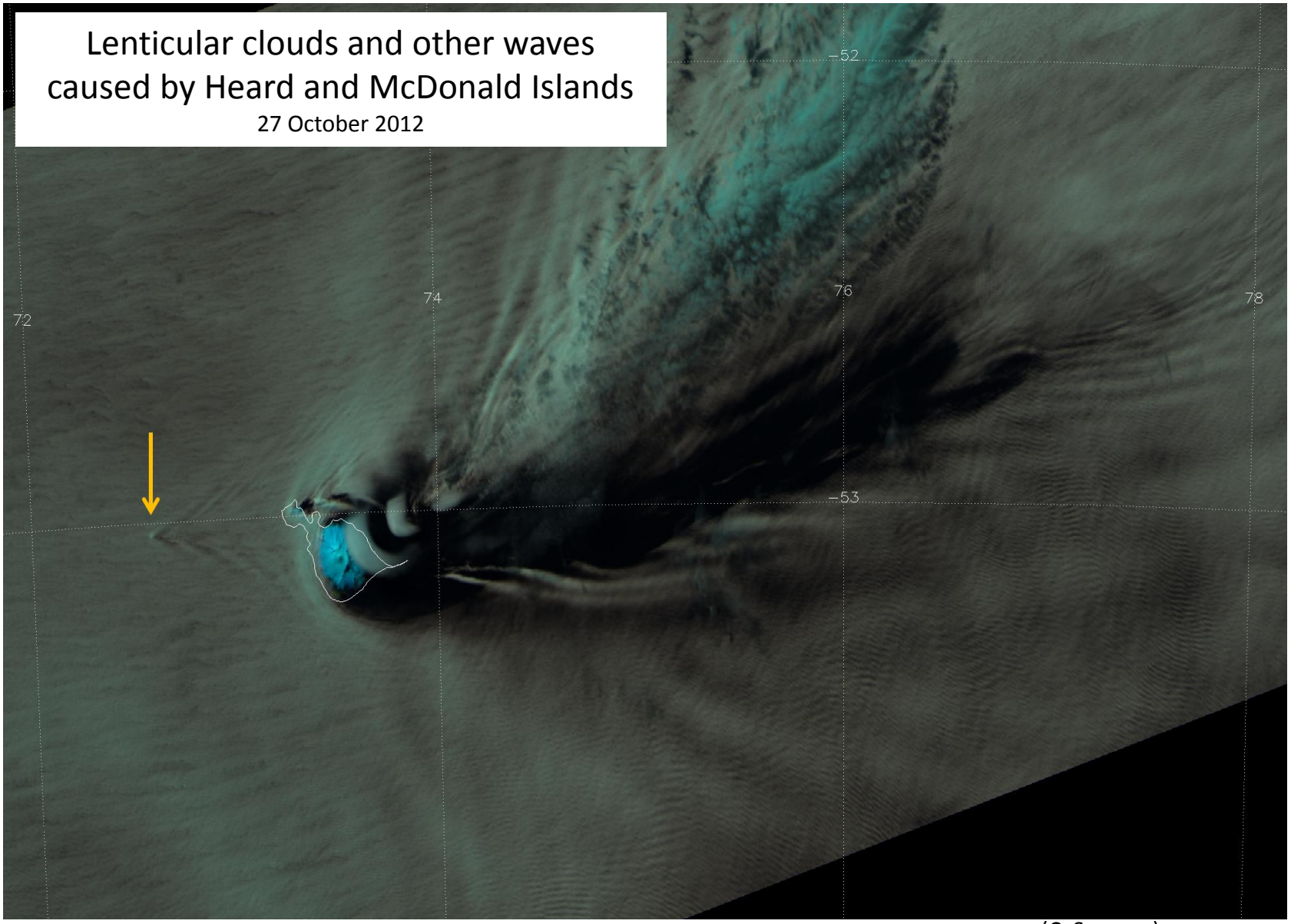
http://rammb.cira.colostate.edu/projects/npp/blog/

- "Natural Color" RGB composite (0.64 μm [I-01], 0.87 μm [I-02], 1.61 μm [I-03]) shows the extent of the flooding caused by Hurricane Isaac
- 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 (C. Seaman)

High-resolution Images of Remote Islands

http://rammb.cira.colostate.edu/projects/npp/blog/



(C. Seaman)

VIIRS imagery issues/problems so far:

- **Server (GRAVITE) issues**
  - Missing (or delayed) granules
  - Duplicate granules
- **Missing geo-location** values in granules
- **Missing data "triangles"** in granules
- **Padding stripes (fill values)** from the use of GTM and a constant array size

EDR Provisional Criteria – Imagery

Provisional Definition	Artifacts (Deliverables)	Imagery EDR
Product quality may not be optimal	**Product accuracy** is determined for a broader (but still limited) set of conditions. No requirement to demonstrate compliance with specifications.	**Clouds and sea ice edge at a minimum, but many others are possible**
Incremental **product improvements** are still occurring	Narrative, listing and discussing **known errors**. All DRs are identified and prioritized (1-5). Provisional readiness will address priorities 1-2. Pathway towards algorithm improvements to meet specifications is demonstrated.	**No known performance issues .** **DRs (mostly resolved for non-NCC imagery)**
Version control is in affect	Description of the development environment, algorithm version (IDPS build number), and LUTs/PCTs versions used to generate the product validation materials. **ATBDs** are accurate, up-to-date and consistent with the product running.	**ATBD is up-to-date, as is all other documentation**
General research community is encouraged to participate in the QA and validation of the product, but need to be aware that product validation and QA are ongoing	ADP STAR will request feedback from **appropriate users** for the product. The notification letter will include a Provisional Maturity disclaimer. DPA will send request to Project Science to post Provisional Maturity disclaimer on CLASS. DPA will submit readme document (#3 below) to CLASS.	**Some feedback from users already exists (NRL/McIDAS):** **- Minor near-noise-level striping has been noticed. Multi-spectral analysis is common** **- Comparison to (improvements over) other satellites**
Users are urged to consult the **EDR product status document prior** to use of the data in publications	**Warning of potential non-reproducibility** of results due to continuing calibration and code changes. **Identify known deficiencies** regarding product quality.	**Non-reproducibility is irrelevant, because imagery is not a climate product**
May be replaced in the **archive** when the validated product becomes available	Technical evaluation of limited **data reprocessing** is presented.	**Not directly relevant**
Ready for **operational evaluation**	**Key NOAA and non-NOAA end users** are identified and **feedback requested**	**Users are already involved (as seen by Imagery Team makeup)**

Non-NCC Imagery DRs

- DR 4579 – **Triangular fill regions** – closed.
- DR 4525 – OAD update to make a **unit superscripted** – In MX 7.
- DR 4468 – Imagery EDR has **inappropriate fill values** along edge of data – In MX7
- DR 4653 – Change L1 requirements to go **from 6 M bands to 16 M bands** – Deferred. Need users to state that they need/want the other bands
- DR 4775 – Non-NCC **Provisional** – Deferred

Beta and Provisional ReadMe Caveats

- Imagery **detector-to-detector striping**:
  - Relatively minor for most imagery
  - Most noticeable under high enhancement or for multi-spectral image differencing
- **Data latency**:
  - Not improved yet!
  - Hoping for improvement within NDE
- **Carryovers to Provisional ReadMe**
  - Continue data availability/latency issue

Path Forward to Operational Stage 1

- Continued **feedback from users**:
  - Expand to **additional users**
    - NIC
    - AFWA
    - NWS
- Quantitative analysis of EDR imagery **geo-location**
- Limited quantitative analysis of EDR **radiances and striping**
  - Especially related to **higher-order image products**
    - RGB combinations
    - Image products/differences

Summary

- **We've made excellent progress with VIIRS Imagery after 1 year!**

- NRL "user" presentation (to follow)