Suomi NPP Imagery EDR Team

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MUG meeting

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VIIRS EDR Imagery 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. Achtor, T. Jasmin, T. Rink)
- Aerospace (T. Kopp, J. Drake, J. Feeley)
- NOAA/NGDC (C. Elvidge)
- AFWA (J. Cetola)
- NIC (P. Clemente-Colon)
- Northrop Grumman (K. Hutchison, R. Mahoney)
- NASA (W. Thomas, P. Meade)
- NOAA/OSPO (A. Irving)
- NASA/SPoRT (G. Jedlovec, M. Smith)
- FNMOC (J. Tesmer)
- NRL (J. Hawkins, K. Richardson, J. Solbrig)
- Northrup Grumman (K. Hutchinson, P. Meade)
- NOAA/OSPO (A. Irving, M, Ruminski)

Suomi NPP VIIRS basics

- **2011-10-28: NPP launched**
- **2011-11-21: First visible/reflective images**
- **2012-01-19: First infrared/thermal images**
- **2012-01-25: NPP renamed Suomi NPP**
- **Imagery soon to me made publicly available.**

VIIRS bands and bandwidths

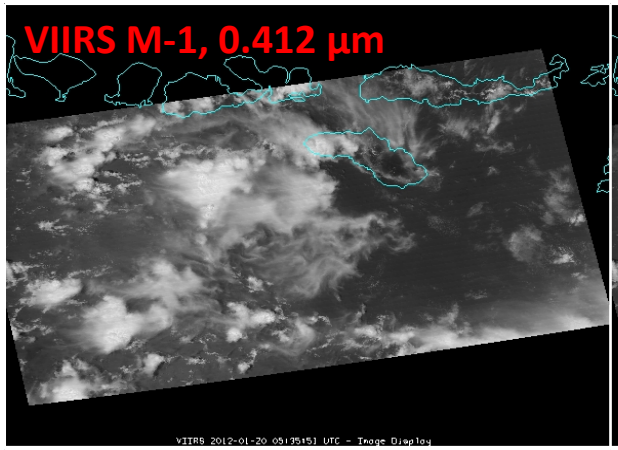
VIIRS Band	Central Wavelength (µm)	Bandwidth (µm)	Wavelength Range (µm)	Band Explanation	Spatial Resolution (m) @ nadir
M1	0.412	0.02	0.402 - 0.422	Visible	750 m
M2	0.445	0.018	0.436 - 0.454		
M3 (blue)	0.488	0.02	0.478 - 0.488		
M4 (green)	0.555	0.02	0.545 - 0.565		
M5 (red)	0.672	0.02	0.662 - 0.682		
M6	0.746	0.015	0.739 - 0.754	Near IR	
M7	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	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 (red)	0.64	0.08	0.6 - 0.68	Visible	375 m
I2	0.865	0.039	0.85 - 0.88	Near IR	
I3	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	

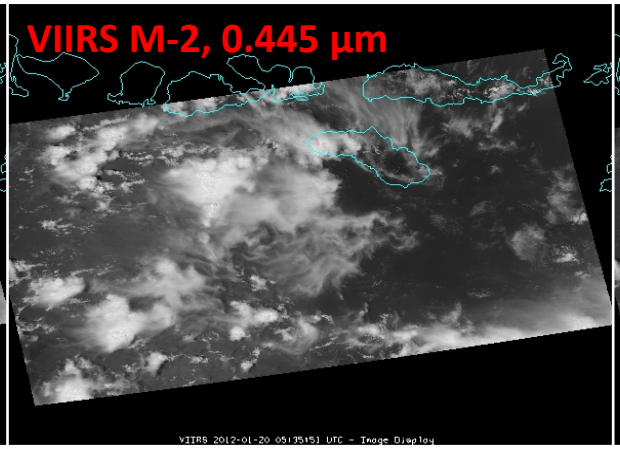
M bands highlighted in pale yellow are default EDRs (only 6 of 16 M bands).

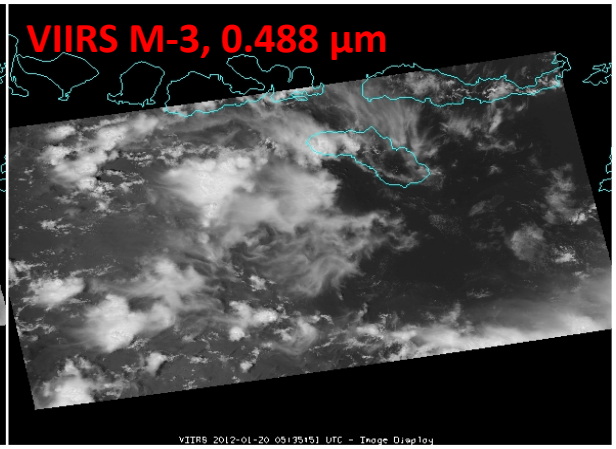
VIIRS Bands, Primary Purpose, Spectral Range

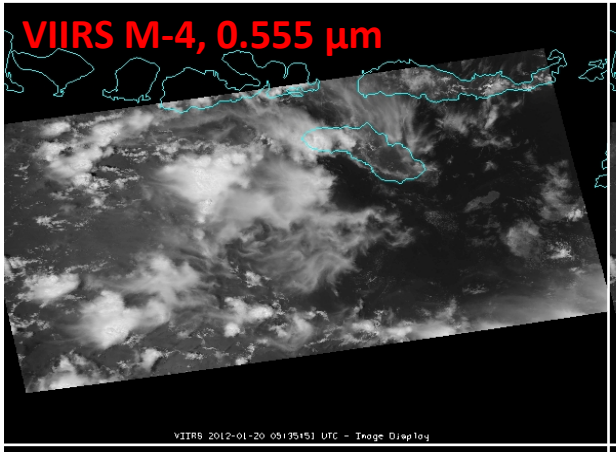
		Band No.	Driving EDR(s)	Specification: Spectral Range (um)	Specification: Horiz Sample Interval (km) (track x Scan)		Specification: Band Gain	Specification: Ltyp or Ttyp (Spec)	Specification: Lmax or Tmax	Specification: SNR or NEdT (K)	Measured SNR or NEdT (K)	SNR Margin (%)
Reflective Bands	VisNIR	M1	Ocean Color Aerosol	0.402 - 0.422	0.742 x 0.259	1.60 x 1.58	High Low	44.9 155	135 615	352 316	723 1327	105% 320%
		M2	Ocean Color Aerosol	0.436 - 0.454	0.742 x 0.259	1.60 x 1.58	High Low	40 146	127 687	380 409	576 1076	51.5% 163%
		M3	Ocean Color Aerosol	0.478 - 0.498	0.742 x 0.259	1.60 x 1.58	High Low	32 123	107 702	416 414	658 1055	58.2% 155%
		M4	Ocean Color Aerosol	0.545 - 0.565	0.742 x 0.259	1.60 x 1.58	High Low	21 90	78 667	362 315	558 882	54.1% 180%
		I1	Imagery EDR	0.600 - 0.680	0.371 x 0.387	0.80 x 0.789	Single	22	718	119	265	122.7%
		M5	Ocean Color Aerosol	0.662 - 0.682	0.742 x 0.259	1.60 x 1.58	High Low	10 68	59 651	242 360	360 847	49% 135%
		M6	Atmosph. Correct.	0.739 - 0.754	0.742 x 0.776	1.60 x 1.58	Single	9.6	41	199	394	98.0%
		I2	NDVI	0.846 - 0.885	0.371 x 0.387	0.80 x 0.789	Single	25	349	150	299	99.3%
		M7	Ocean Color Aerosol	0.846 - 0.885	0.742 x 0.259	1.60 x 1.58	High Low	6.4 33.4	29 349	215 340	545 899	154% 164%
	S/WMIR	M9	Cirrius/Cloud Cover	1.371 - 1.386	0.742 x 0.776	1.60 x 1.58	Single	6	77.1	83	247	197.6%
		I3	Binary Snow Map	1.580 - 1.640	0.371 x 0.387	0.80 x 0.789	Single	7.3	72.5	6	165	2650.0%
		M10	Snow Fraction	1.580 - 1.640	0.742 x 0.776	1.60 x 1.58	Single	7.3	71.2	342	695	103.2%
		M11	Clouds	2.225 - 2.275	0.742 x 0.776	1.60 x 1.58	Single	0.12	31.8	10	18	80.0%
Emissive Bands		I4	Imagery Clouds	3.550 - 3.930	0.371 x 0.387	0.80 x 0.789	Single	270	353	2.5	0.4	84.0%
		M12	SST	3.660 - 3.840	0.742 x 0.776	1.60 x 1.58	Single	270	353	0.396	0.12	69.7%
		M13	SST Fires	3.973 - 4.128	0.742 x 0.259	1.60 x 1.58	High Low	300 380	343 634	0.107 0.423	0.044 --	59% --
	LWIR	M14	Cloud Top Properties	8.400 - 8.700	0.742 x 0.776	1.60 x 1.58	Single	270	336	0.091	0.054	40.7%
		M15	SST	10.263 - 11.263	0.742 x 0.776	1.60 x 1.58	Single	300	343	0.07	0.028	60.0%
		I5	Cloud Imagery	10.500 - 12.400	0.371 x 0.387	0.80 x 0.789	Single	210	340	1.5	0.41	72.7%
		M16	SST	11.538 - 12.488	0.742 x 0.776	1.60 x 1.58	Single	300	340	0.072	0.036	50.0%

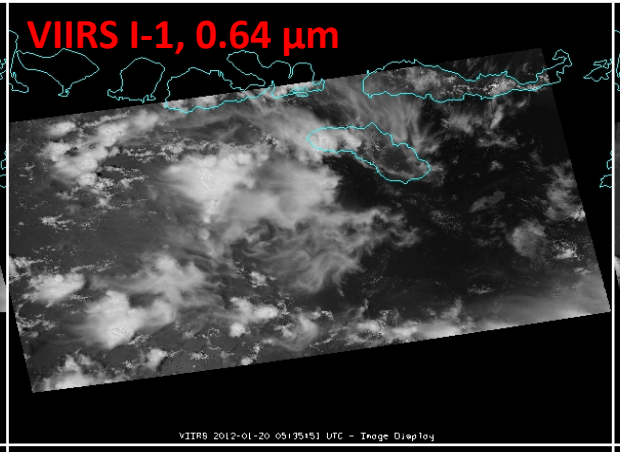
HSI uses 3 in-scan pixels aggregation at Nadir

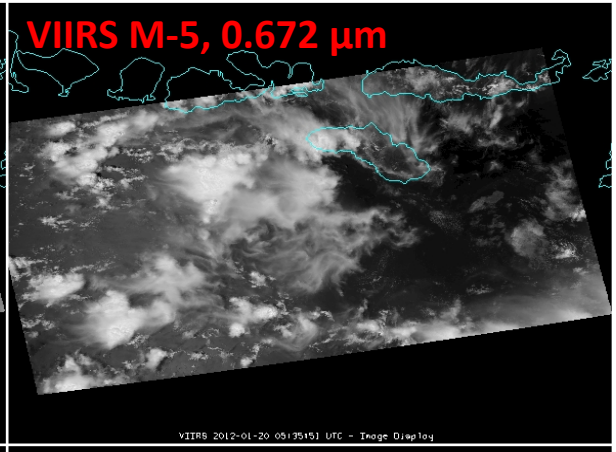

VIIRS M-1, 0.412 µm

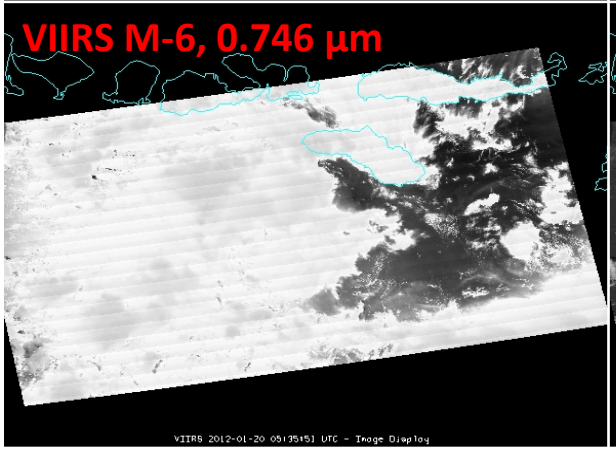

VIIRS M-2, 0.445 µm

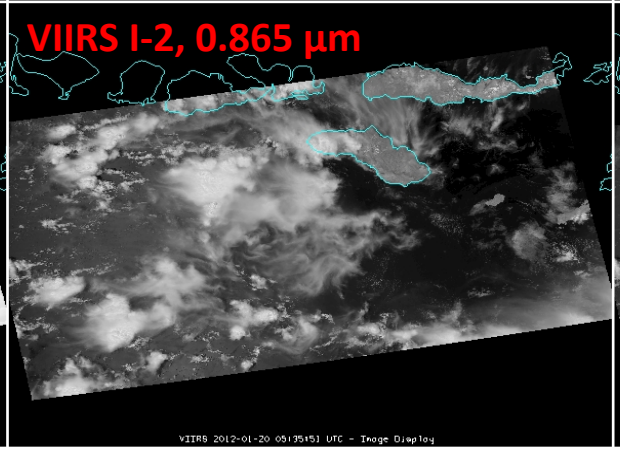

VIIRS M-3, 0.488 µm

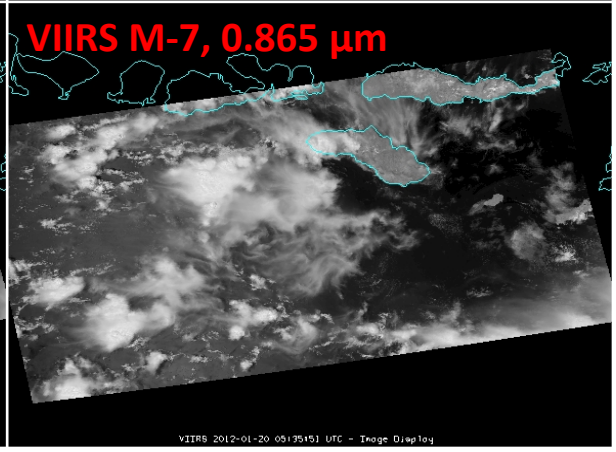

VIIRS M-4, 0.555 µm


VIIRS I-1, 0.64 µm


VIIRS M-5, 0.672 µm


VIIRS M-6, 0.746 µm

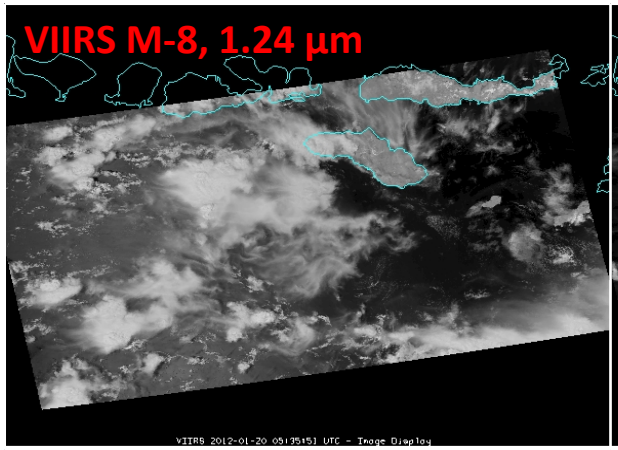

VIIRS I-2, 0.865 µm

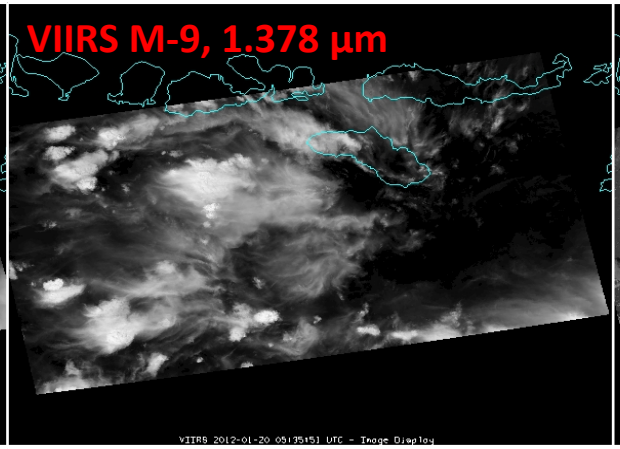

VIIRS M-7, 0.865 µm

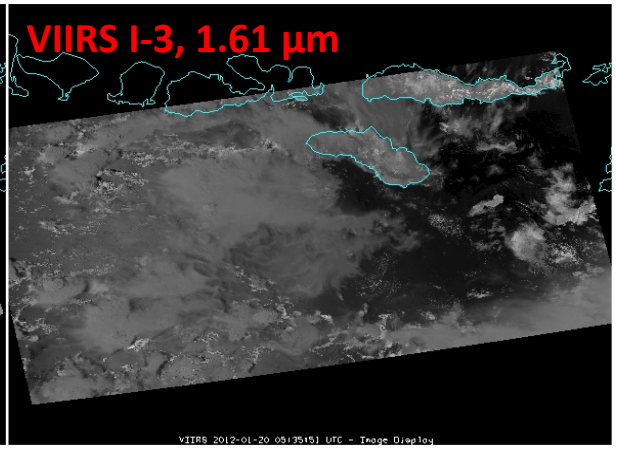
VIIRS Bands, Primary Purpose, Spectral Range

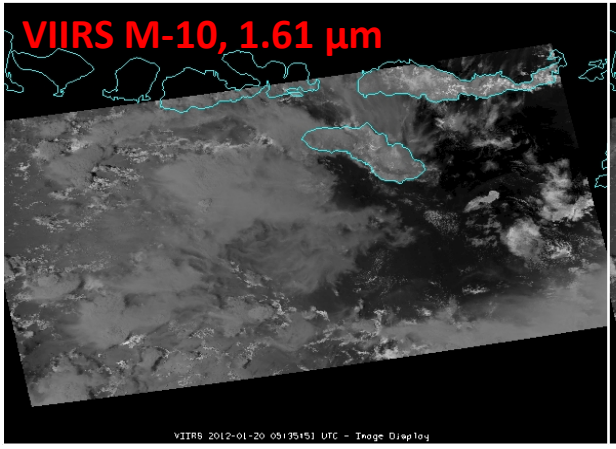
		Band No.	Driving EDR(s)	Specification: Spectral Range (um)	Horiz Sample Interval (km) (track x Scan): Nadir	Horiz Sample Interval (km) (track x Scan): End of Scan	Band Gain	Ltyp or Ttyp (Spec)	Lmax or Tmax	SNR or NEdT (K)	Measured SNR or NEdT (K)	SNR Margin (%)
Reflective Bands	VisNIR	M1	Ocean Color Aerosol	0.402 - 0.422	0.742 x 0.259	1.60 x 1.58	High Low	44.9 155	135 615	352 316	723 1327	105% 320%
		M2	Ocean Color Aerosol	0.436 - 0.454	0.742 x 0.259	1.60 x 1.58	High Low	40 146	127 687	380 409	576 1076	51.5% 163%
		M3	Ocean Color Aerosol	0.478 - 0.498	0.742 x 0.259	1.60 x 1.58	High Low	32 123	107 702	416 414	658 1055	58.2% 155%
		M4	Ocean Color Aerosol	0.545 - 0.565	0.742 x 0.259	1.60 x 1.58	High Low	21 90	78 667	362 315	558 882	54.1% 180%
		I1	Imagery EDR	0.600 - 0.680	0.371 x 0.387	0.80 x 0.789	Single	22	718	119	265	122.7%
		M5	Ocean Color Aerosol	0.662 - 0.682	0.742 x 0.259	1.60 x 1.58	High Low	10 68	59 651	242 360	360 847	49% 135%
		M6	Atmosph. Correct.	0.739 - 0.754	0.742 x 0.776	1.60 x 1.58	Single	9.6	41	199	394	98.0%
		I2	NDVI	0.846 - 0.885	0.371 x 0.387	0.80 x 0.789	Single	25	349	150	299	99.3%
		[illegible]	Ocean Color [illegible]	0.846 - 0.885	0.742 x 0.259	1.60 x 1.58	High	6.4	29	215	545	154%
	S/WMIR	M8	Cloud Particle Size	1.230 - 1.250	0.742 x 0.776	1.60 x 1.58	Single	5.4	165	74	349	371.6%
		M9	Cirrius/Cloud Cover	1.371 - 1.386	0.742 x 0.776	1.60 x 1.58	Single	6	77.1	83	247	197.6%
		I3	Binary Snow Map	1.580 - 1.640	0.371 x 0.387	0.80 x 0.789	Single	7.3	72.5	6	165	2650.0%
		M10	Snow Fraction	1.580 - 1.640	0.742 x 0.776	1.60 x 1.58	Single	7.3	71.2	342	695	103.2%
		M11	Clouds	2.225 - 2.275	0.742 x 0.776	1.60 x 1.58	Single	0.12	31.8	10	18	80.0%
Emissive Bands		I4	Imagery Clouds	3.550 - 3.930	0.371 x 0.387	0.80 x 0.789	Single	270	353	2.5	0.4	84.0%
		M12	SST	3.660 - 3.840	0.742 x 0.776	1.60 x 1.58	Single	270	353	0.396	0.12	69.7%
		M13	SST Fires	3.973 - 4.128	0.742 x 0.259	1.60 x 1.58	High Low	300 380	343 634	0.107 0.423	0.044 --	59% --
	LWIR	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
		M15	SST	10.263 - 11.263	0.742 x 0.776	1.60 x 1.58	Single	300	343	0.07	0.028	60.0%
		I5	Cloud Imagery	10.500 - 12.400	0.371 x 0.387	0.80 x 0.789	Single	210	340	1.5	0.41	72.7%
		M16	SST	11.538 - 12.488	0.742 x 0.776	1.60 x 1.58	Single	300	340	0.072	0.036	50.0%

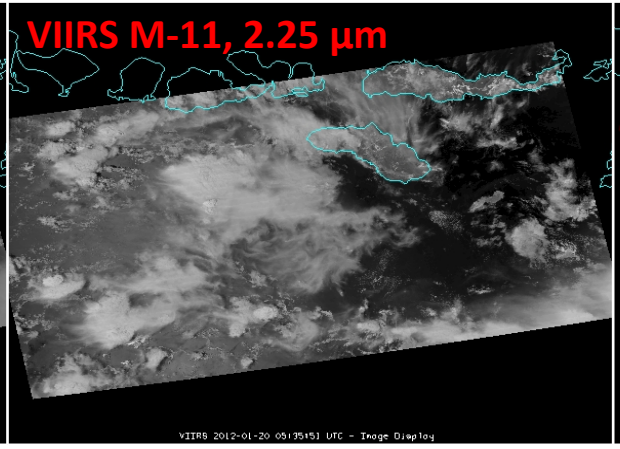
HSI uses 3 in-scan pixels aggregation at Nadir

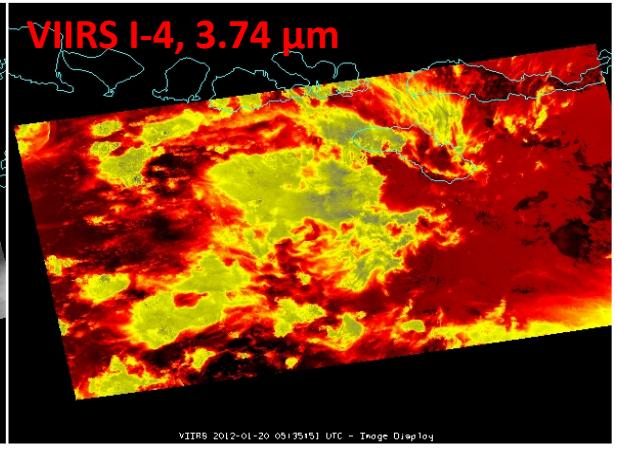

VIIRS M-8, 1.24 µm

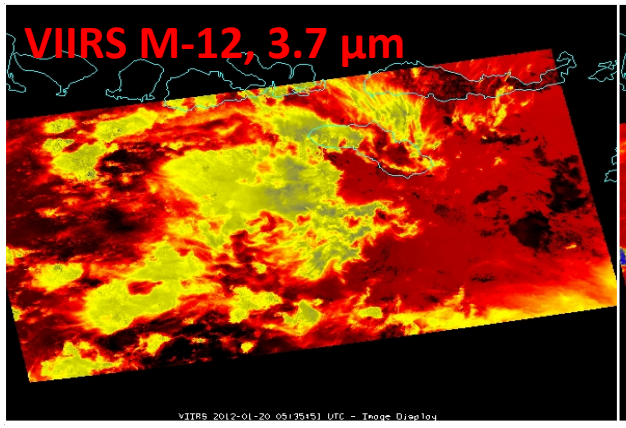

VIIRS M-9, 1.378 µm

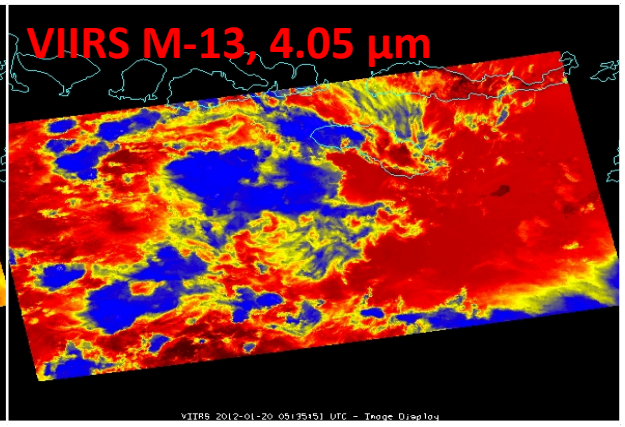

VIIRS I-3, 1.61 µm


VIIRS M-10, 1.61 µm


VIIRS M-11, 2.25 µm


VIIRS I-4, 3.74 µm


VIIRS M-12, 3.7 µm


VIIRS M-13, 4.05 µm

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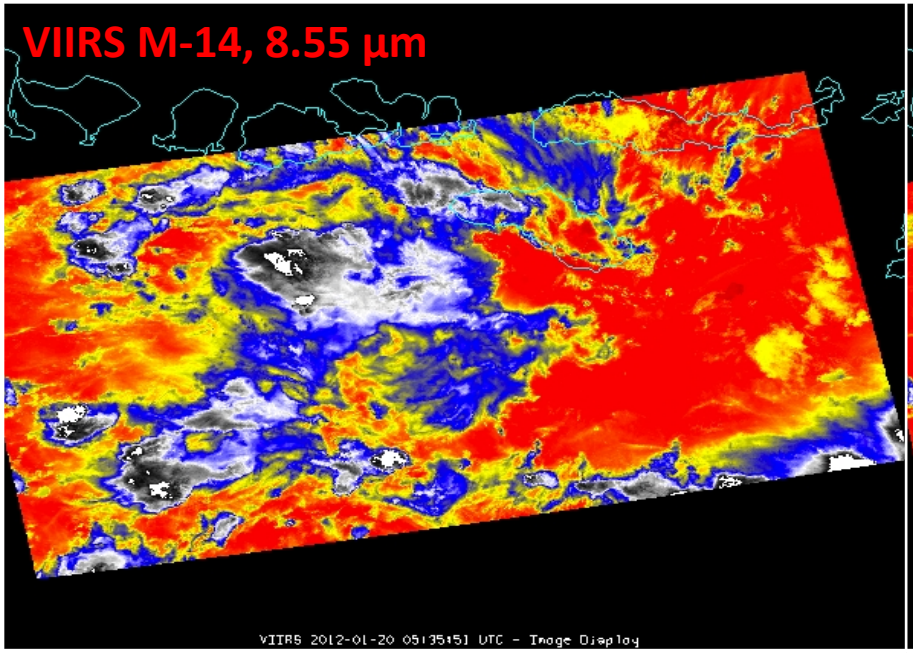
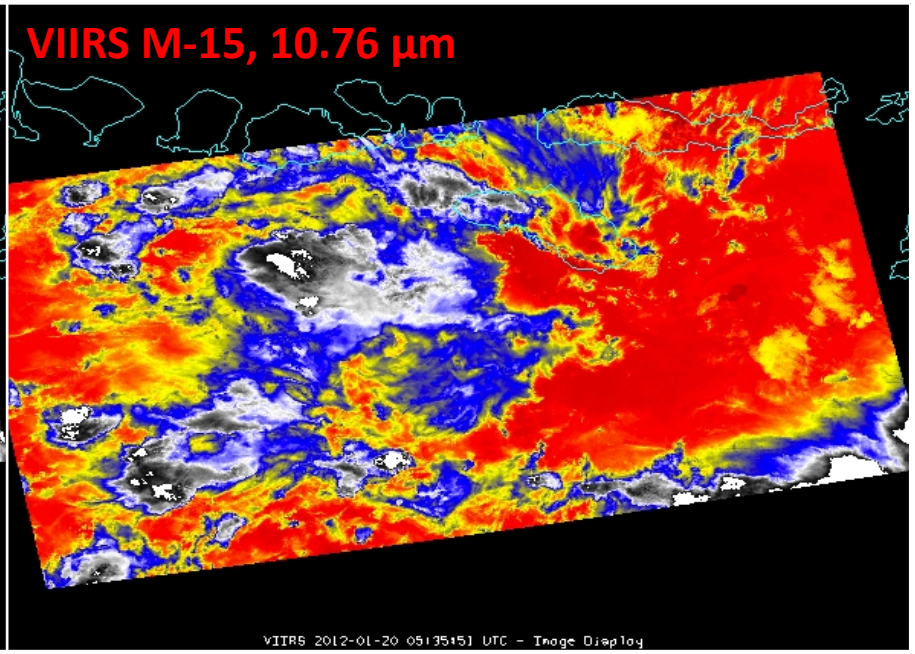
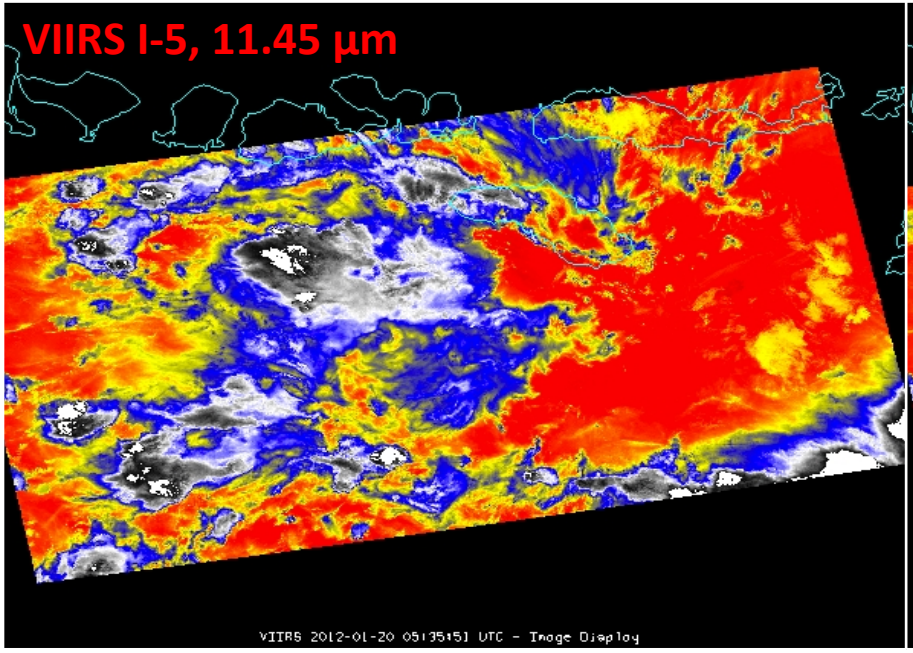
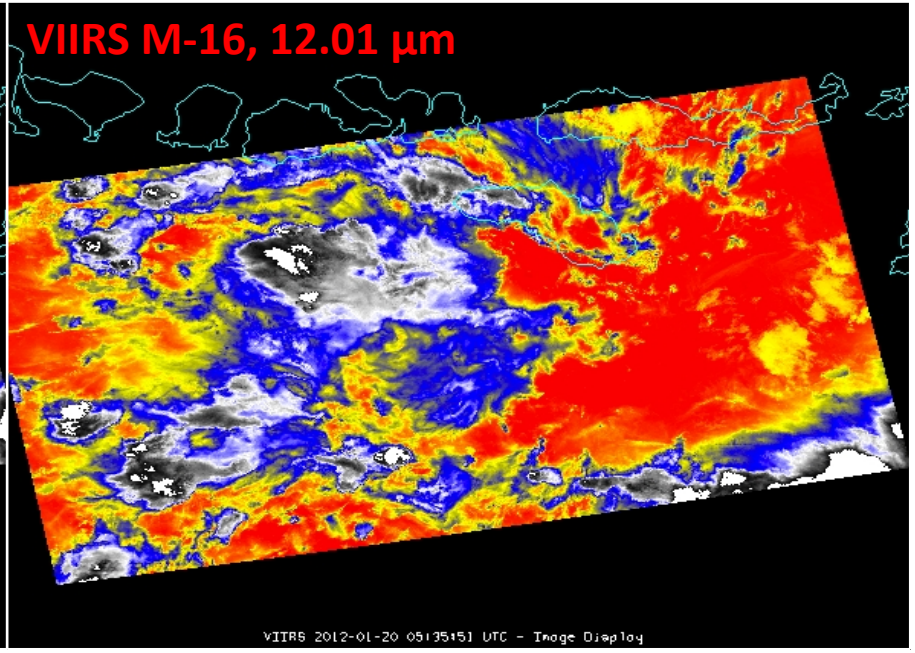

VIIRS M-14, 8.55 µm
VIIRS 2012-01-20 05:35:15 UTC - Image Display


VIIRS M-15, 10.76 µm
VIIRS 2012-01-20 05:35:15 UTC - Image Display


VIIRS I-5, 11.45 µm
VIIRS 2012-01-20 05:35:15 UTC - Image Display


VIIRS M-16, 12.01 µm
VIIRS 2012-01-20 05:35:15 UTC - Image Display

PEATE vs. GRAVITE data sources

- Analyzed data from 13 March 2012 over and near the CONUS
- GRAVITE has many **duplicate files**—earlier versions of reprocessed files. PEATE has only the final version of files.
- PEATE has **more files** than GRAVITE. All GRAVITE files have PEATE equivalents, but not vice versa.
- Final versions of files are **effectively identical** on PEATE and GRAVITE
- PEATE files are on average about **40% smaller** than GRAVITE files, probably due to slightly different file structures

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

NPOESS Preparatory Project (NPP)
VIIRS Imagery and Visualization Team

(Last updated: 2011-11-15)

The first of the **Joint Polar Satellite System (JPSS)** spacecraft, the **National Polar-orbiting Operational Environmental Satellite System (NPOESS) Preparatory Project (NPP)** satellite was successfully launched **at 0948 UTC on 28 October 2011**.

See NASA's NPP launch video.

The **first visible/reflective images** are expected on **Launch+24 Days (~21 November 2011)**.
The **first infrared/thermal images** are expected on **Launch+42 Days (~9 December 2011)**.

The NESDIS/StAR Imagery and Visualization and Visualization Team (co-led by Don Hillger @ NOAA and Tom Kopp @ Aerospace Inc.) will be responsible for the checkout of imagery (and data) from the **Visible/Infrared Imager Radiometer Suite (VIIRS)** instrument on NPP.

A RAMSDIS Online display of **simulated/proxy VIIRS data** is available at http://rammb.cira.colostate.edu/ramsdis/online/npp_viirs.asp. The selected images may vary widely in location and size.

NPP Orbital Passes | Reverse Chronology of NPP VIIRS Significant Events | NPP Reference Information/Websites

NPP Orbital Passes

The NPP predicted track is plotted on GOES-13 full-disk 10.7 μm imagery to assist with matching NPP data with meteorological features of interest. Since the full disk scans occur every 3 hours, only the track within +/- 90 minutes of each scan is plotted.

Imagery Team Suomi NPP Blog

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

Suomi NPP (National Polar-orbiting Partnership)

VIIRS Imagery and Visualization Team Blog

CIRA Cooperative Institute for Research in the Atmosphere

RAMMB Regional and Mesoscale Meteorology Branch

NOAA Satellites and Information

National Environmental Satellite, Data, and Information Service

Blog Home | RAMMB Suomi NPP Home

VIIRS view of Invest 97S at night

Posted on April 10, 2012 by Curtis_Seaman

On 5 April 2012, the Joint Typhoon Warning Center was watching an area of the Mozambique Channel for possible development of a tropical cyclone. This area was named Invest 97S. As 6 April 2012 was a full moon, this is a good case to test the capabilities of low-light visible imagery channels for detection of tropical cyclone development at night.

The Operational Linescan System (OLS) aboard the Defense Meteorological Satellite Program (DMSP) satellite F-18 has a low-light visible channel (that inspired the development of the Day-Night Band (DNB) for VIIRS). The image below is from this channel on F-18, taken at 17:22 UTC, 5 April 2012 (courtesy the Naval Research Laboratory).

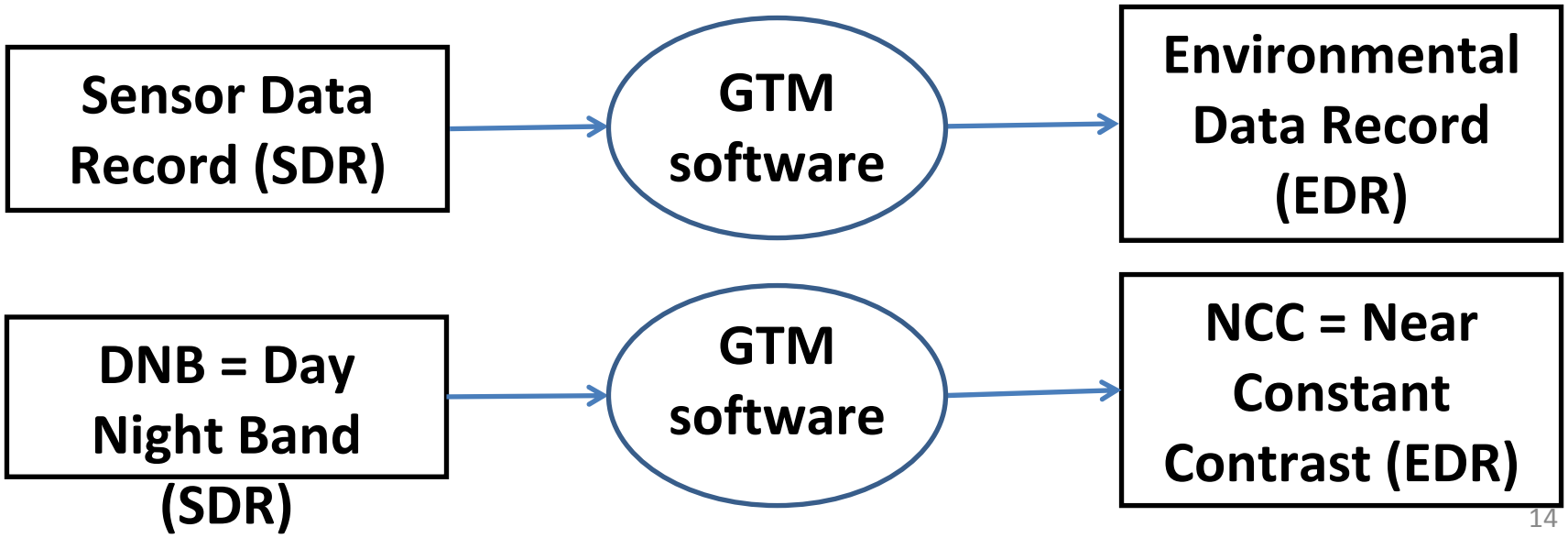
RECENT POSTS

- VIIRS view of Invest 97S at night
- Time-lapse of the Lower North Fork Fire
- I- and M- Band Views of the Heartstrong Fire
- Aurora Borealis from the Day-Night Band
- VIIRS View of March 2 Tornadic Storms

RECENT COMMENTS

SDR to EDR software

- **Ground Track Mercator (GTM)** remapping software.
- GTM is a **remapping** of the data, but the same radiances (temperatures or reflectances, except for DNB/NCC imagery where the radiances are changed.)

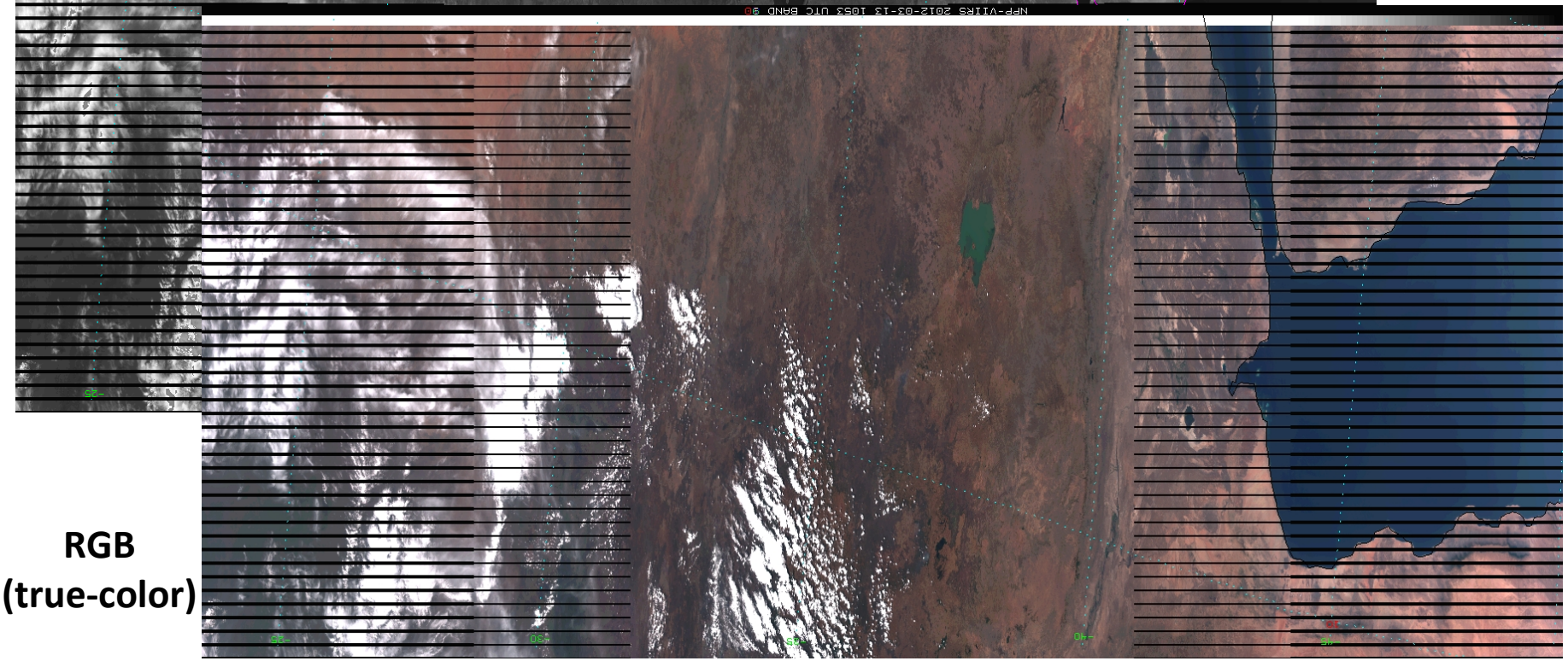


VIIRS display tools

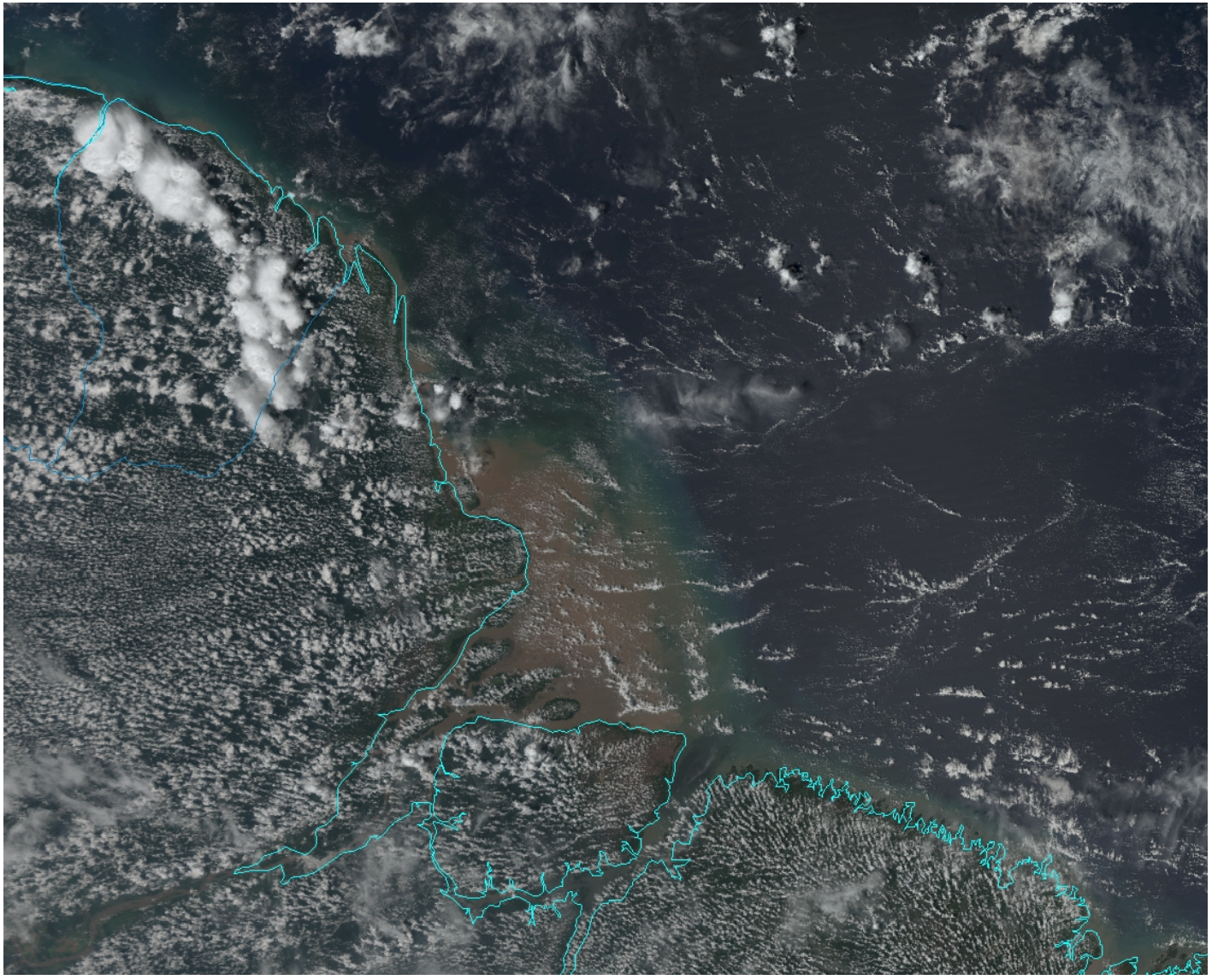
- **McIDAS-V**
  - VIIRS ready, a new version expected soon
  - Java based
  - Freely available to anyone (SSEC/CIMSS/Wisconsin)
  - http://www.ssec.wisc.edu/mcidas/software/v/
- **McIDAS-X**
  - VIIRS capabilities under development
  - VIIRS available via ADDE server (from PEATE)
  - Fortran and C-based
  - User group subscription service only (SSEC/CIMSS/Wisconsin)
  - http://www.ssec.wisc.edu/mcidas/software/x/
- **TeraScan / NexSat** (web display)
  - Currently used at NRL
  - CIRA has capabilities
- Other (IDL, ENVI, ?)

McIDAS-X and VIIRS
(SDR example from PEATE)
[not yet ready for prime time!]

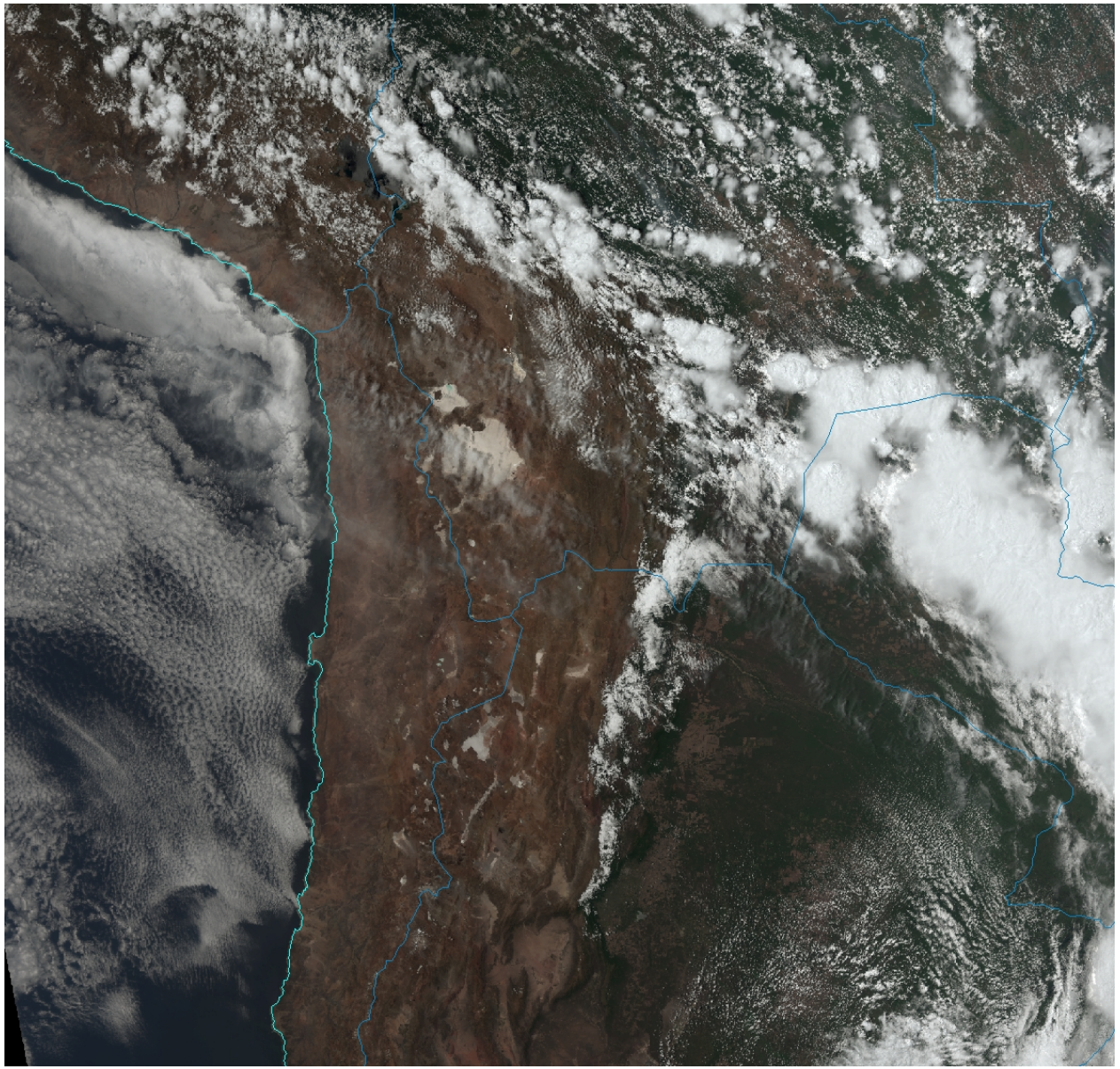
M5 band
(red)



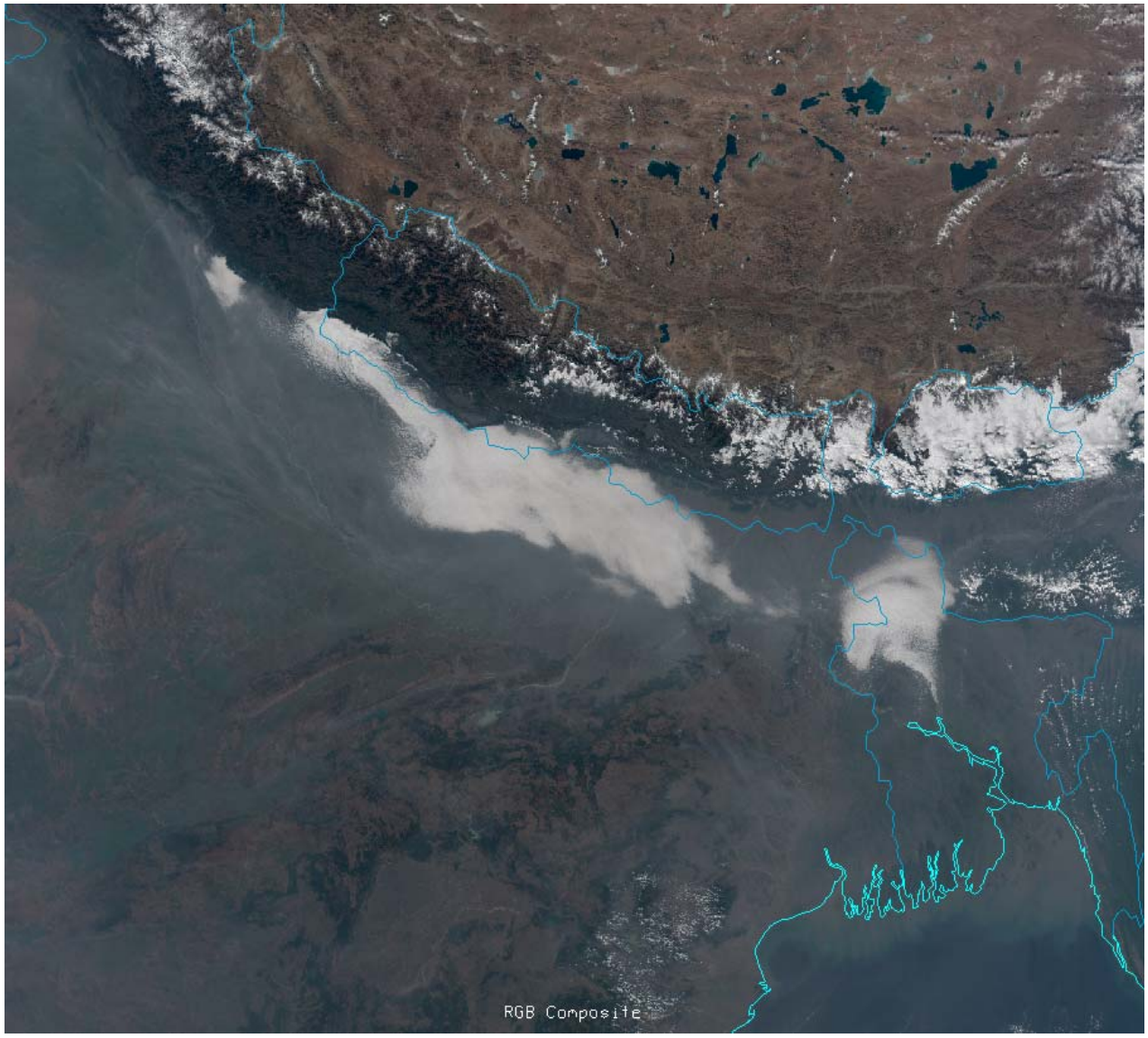
RGB
(true-color)



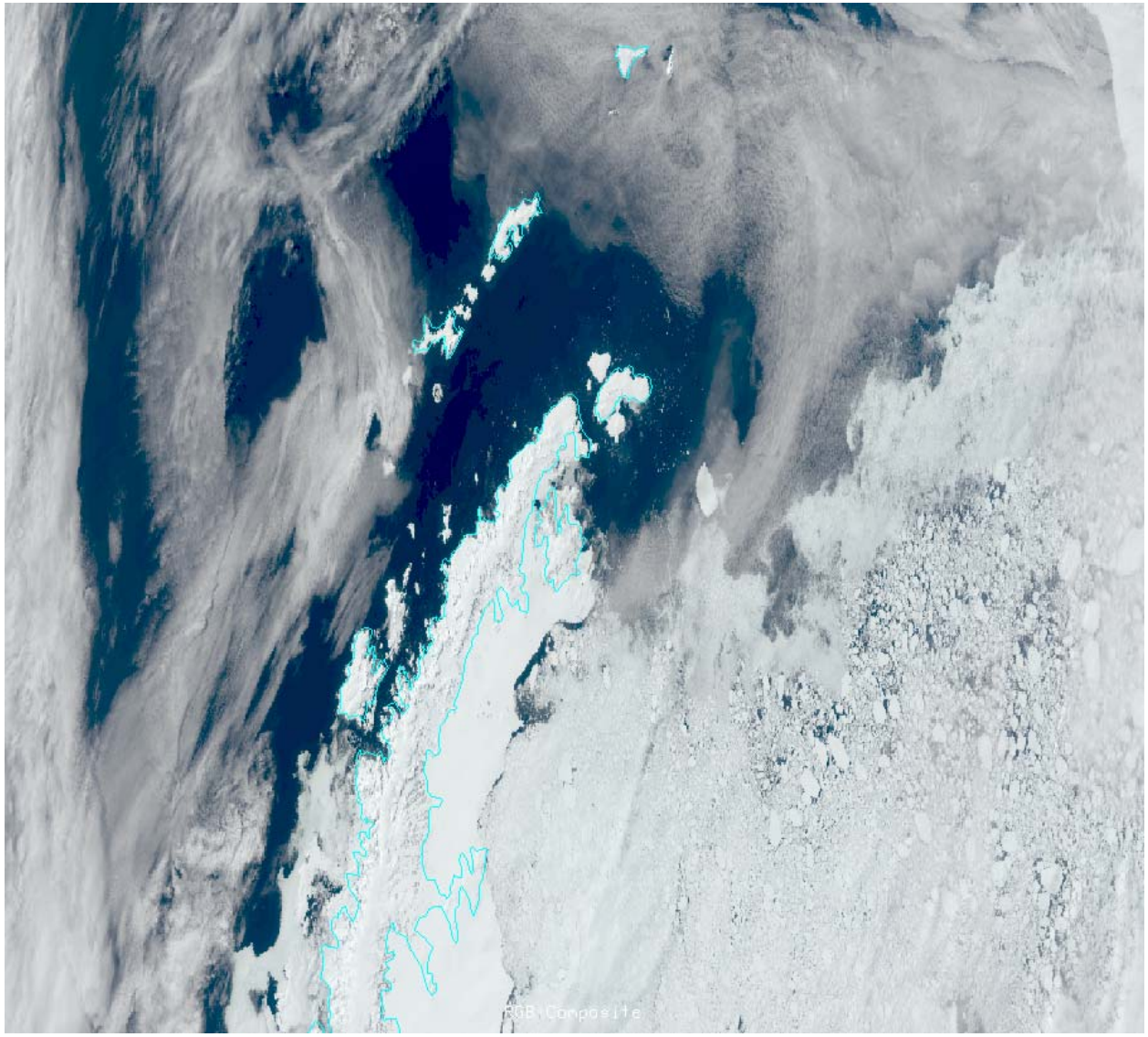
VIIRS M-band (750 m) true-color/RGB images created from the first data from VIIRS is this image of the Brazilian coast created using McIDAS-V. [Image courtesy of Tom Rink, CIMSS]



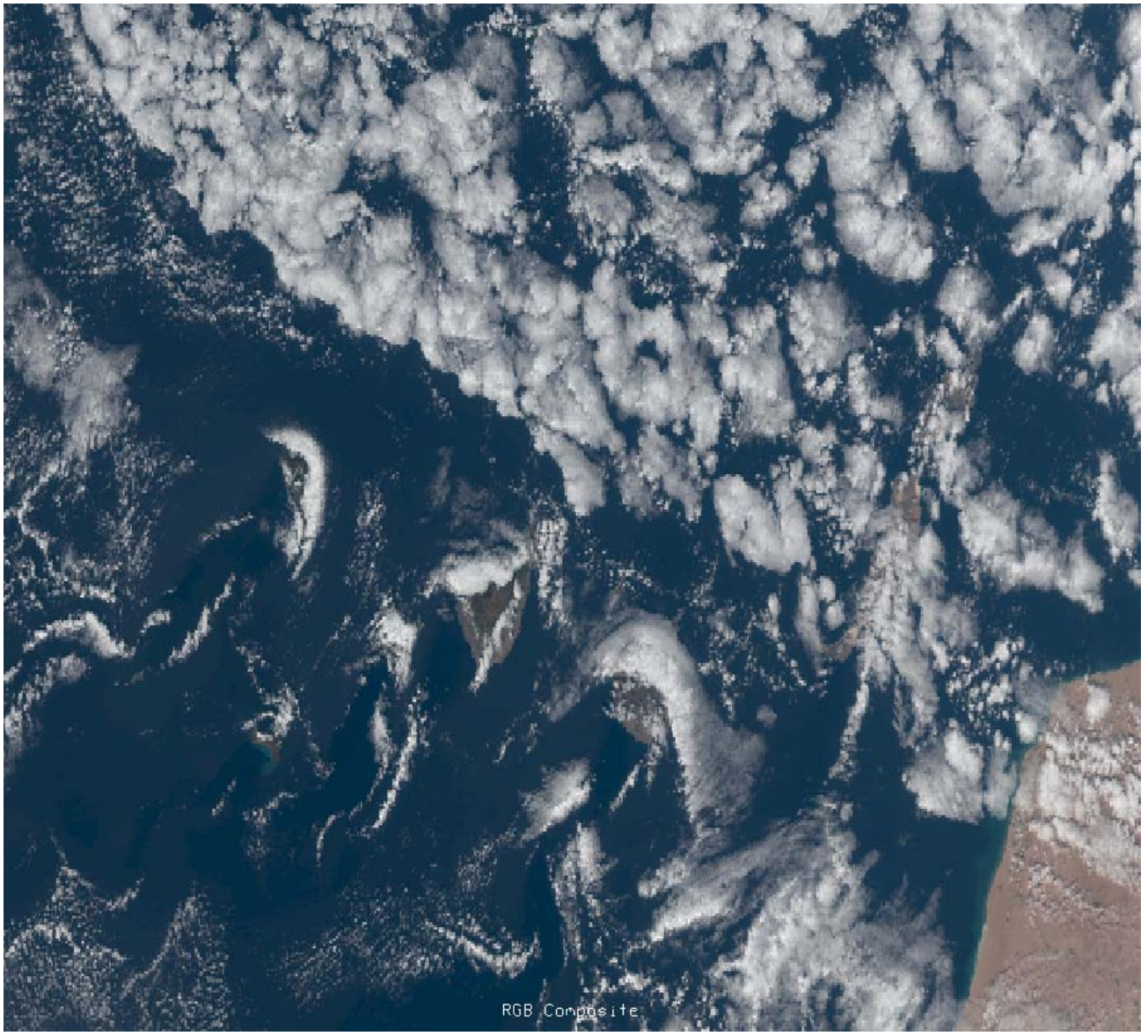
VIIRS M-band (750 m) true-color/RGB image of the western coast of South America. [Image courtesy of Tom Rink, CIMSS]



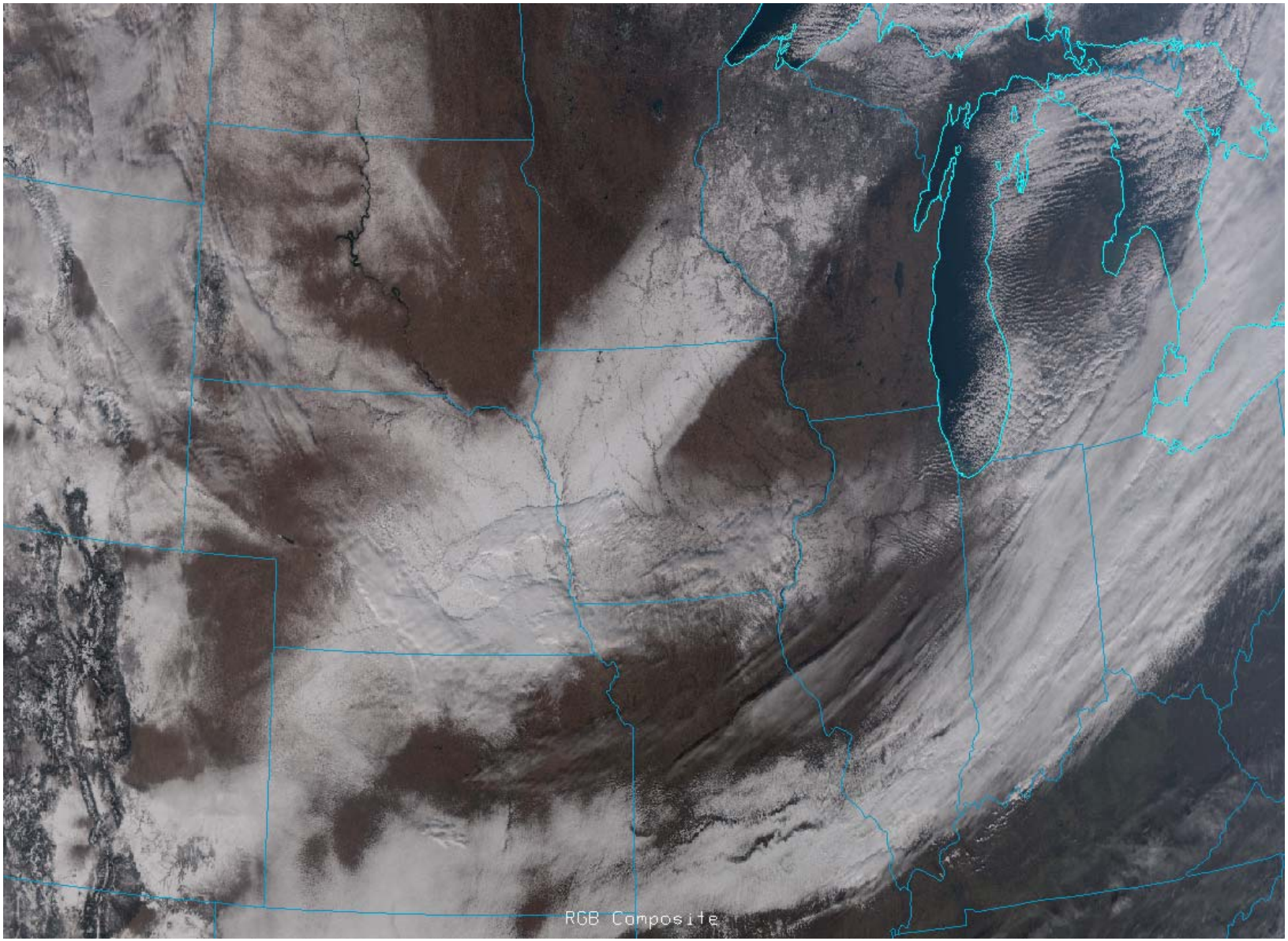
VIIRS M-band (750 m) true-color/RGB image (for 14 December 2011) over northeastern India and Nepal. Note the large amount of pollution over India relative to Tibet, and how the mountains keep it all to the south. [Image courtesy of Dan Lindsey, NOAA/StAR]



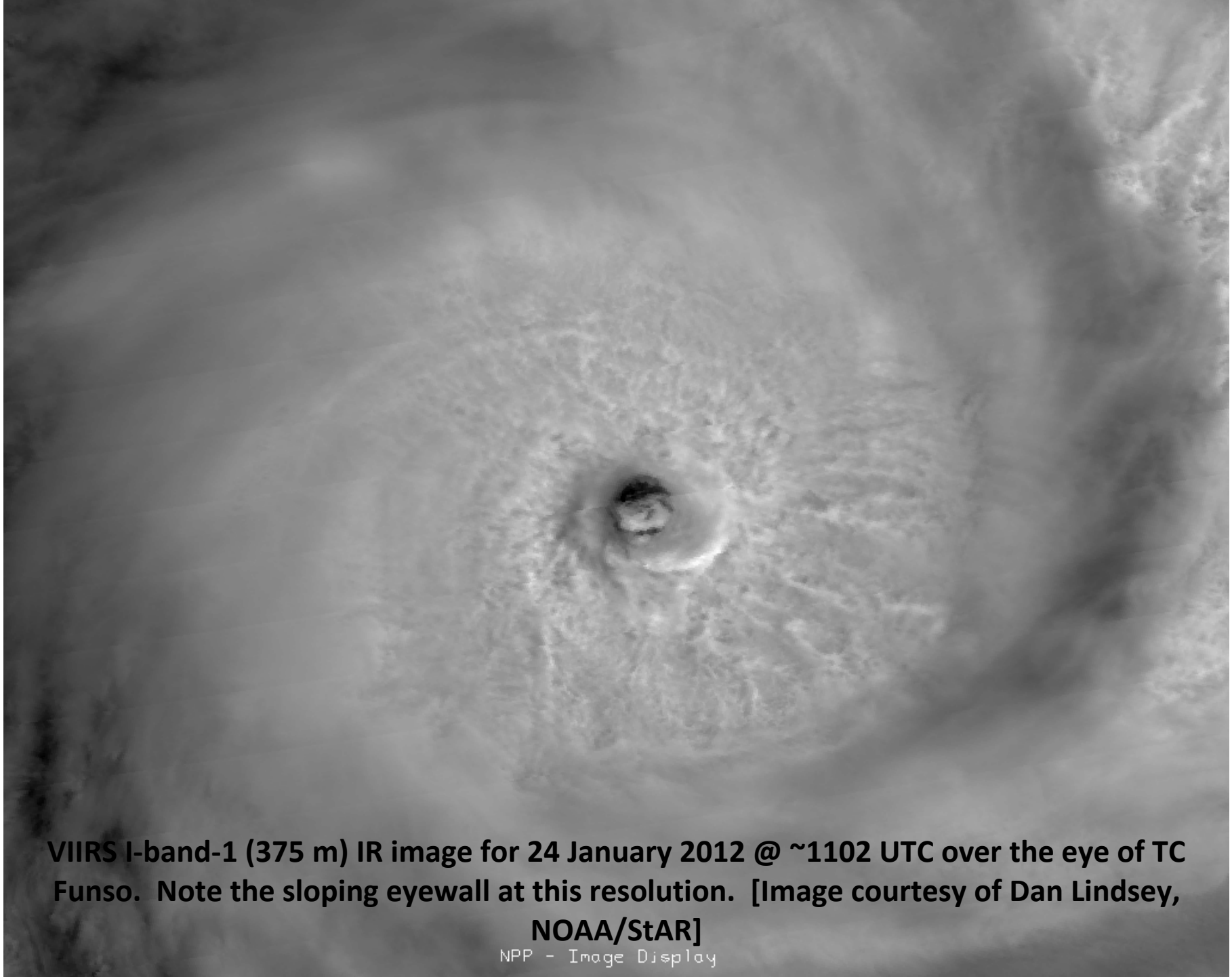
VIIRS M-band (750 m) true-color/RGB image (for 25 November 2011) with a nice contrast of the open ocean vs. ice. The map is the Antarctic Peninsula which extends toward the tip of S. America, and the Weddell Sea on the right in the image. [Image courtesy of Dan Lindsey, NOAA/StAR]



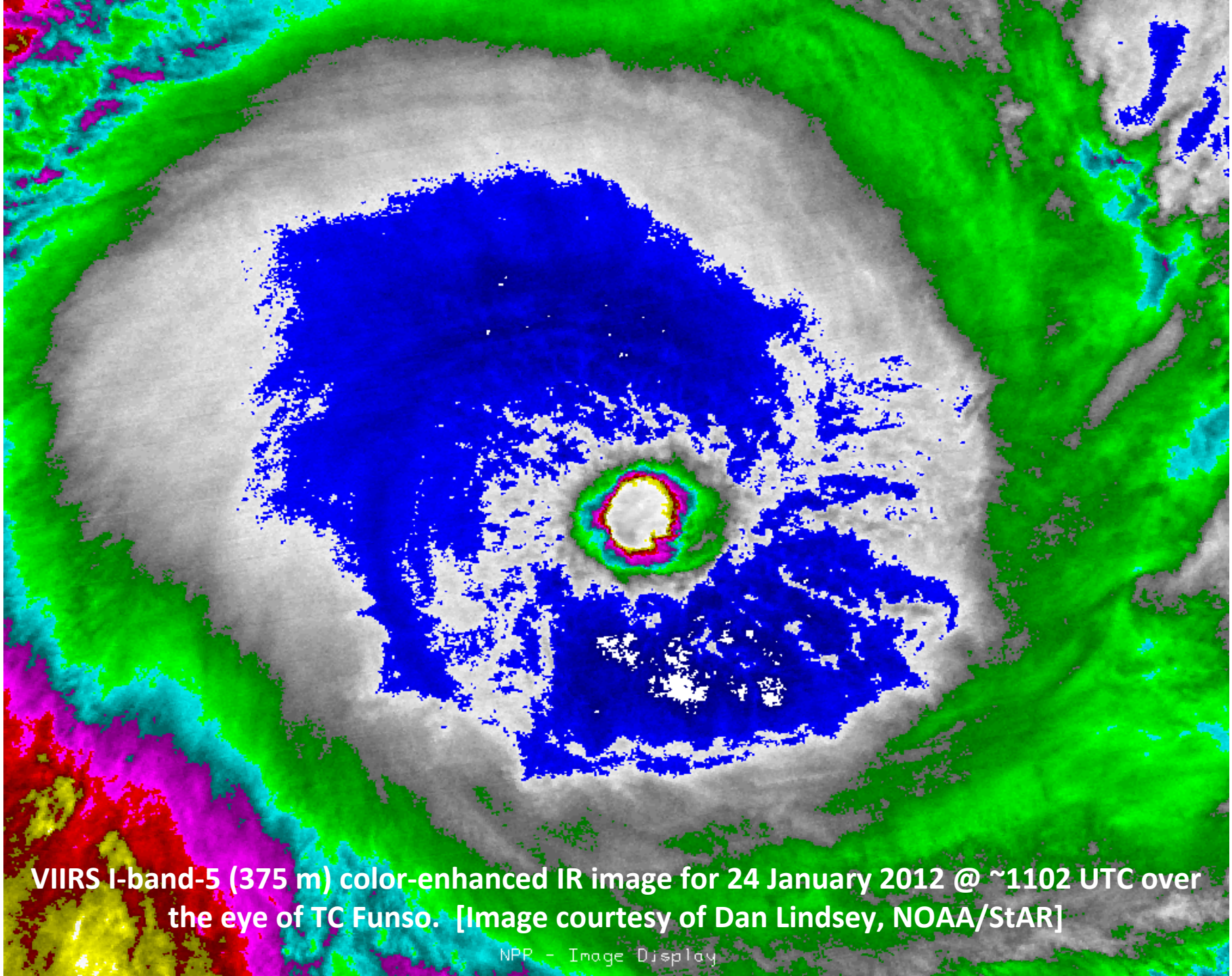
VIIRS M-band (750 m) true-color/RGB image (for 3 December 2011) with cloud vortices over the Canary Islands, just off of NW Africa. [Image courtesy of Dan Lindsey, NOAA/StAR]



VIIRS M-band (750 m) true-color/RGB image (for 9 December 2011) over the U.S. Upper Midwest. [Image courtesy of Dan Lindsey, NOAA/StAR]



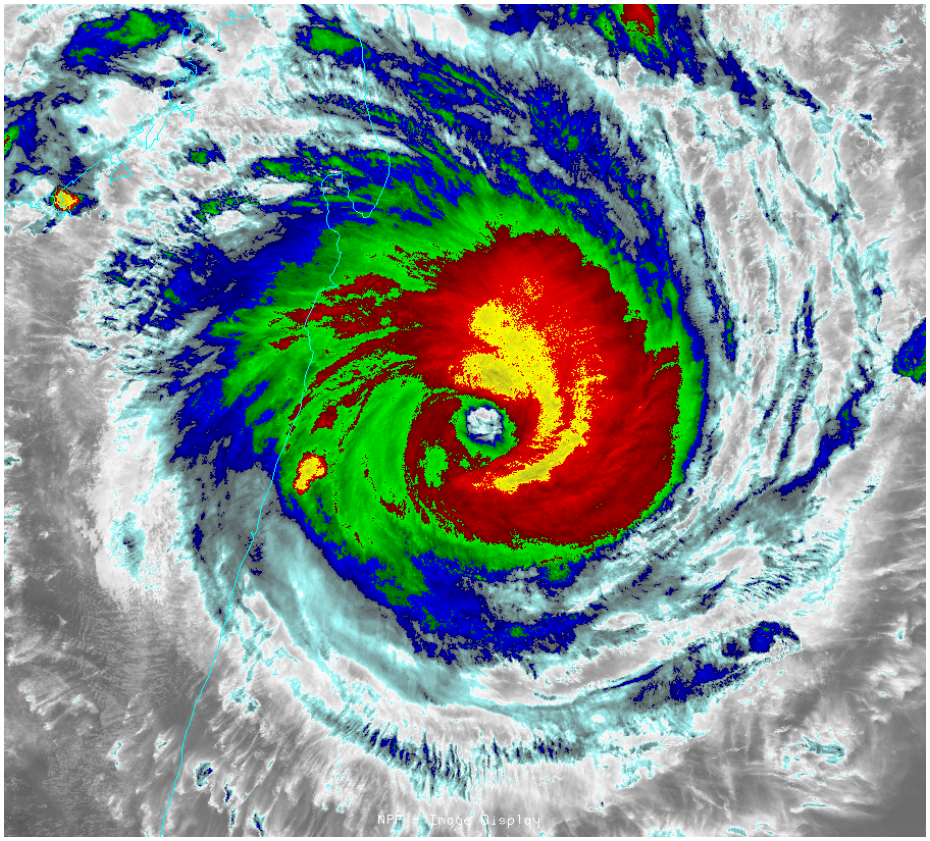
VIIRS I-band-1 (375 m) IR image for 24 January 2012 @ ~1102 UTC over the eye of TC Funso. Note the sloping eyewall at this resolution. [Image courtesy of Dan Lindsey, NOAA/StAR]



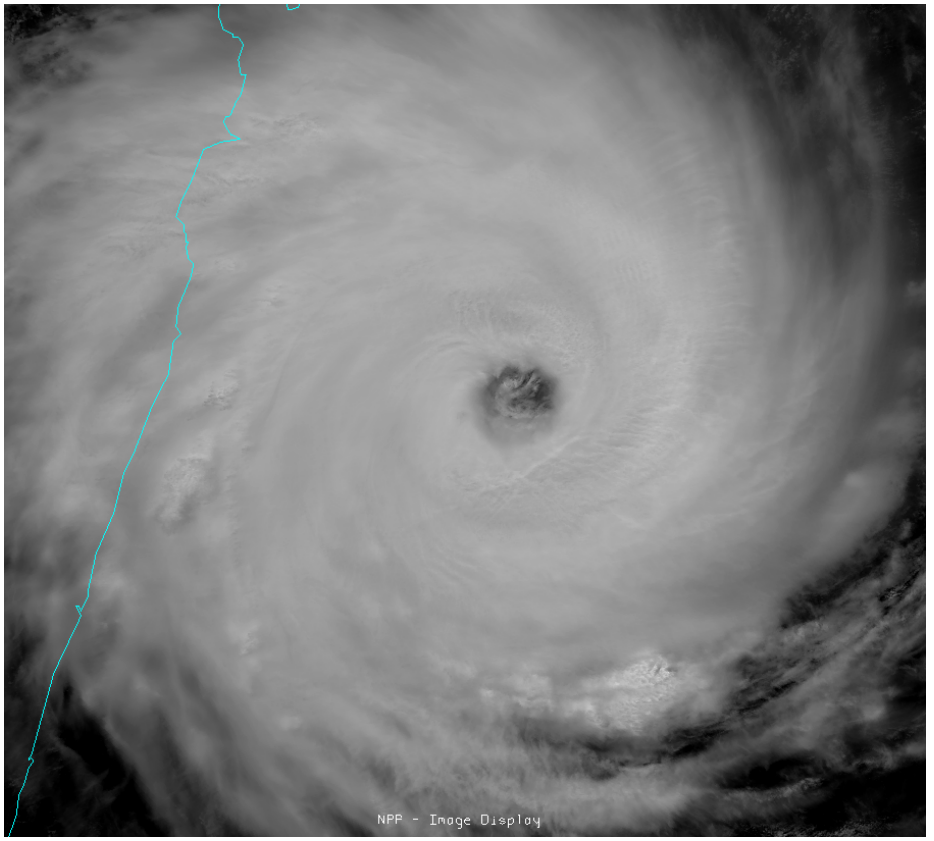
VIIRS I-band-5 (375 m) color-enhanced IR image for 24 January 2012 @ ~1102 UTC over the eye of TC Funso. [Image courtesy of Dan Lindsey, NOAA/StAR]

VIIRS Imagery Examples:

Tropical Cyclone Giovanna east of Madagascar
13 February 2012 at 0947 UTC



VIIRS channel I-5 (IR window, 11.45 µm)

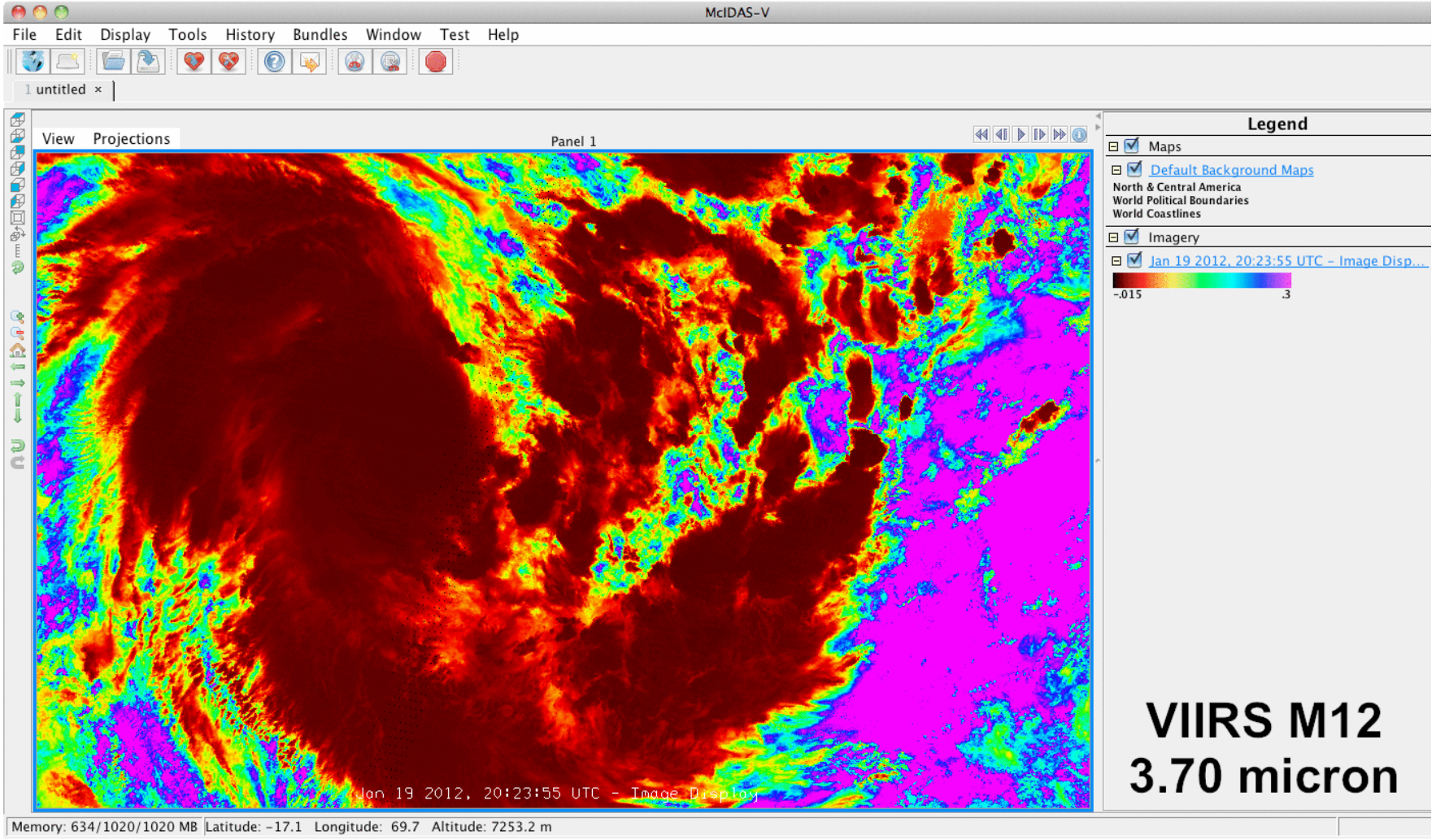


VIIRS channel I-1 (visible, 0.64 µm)

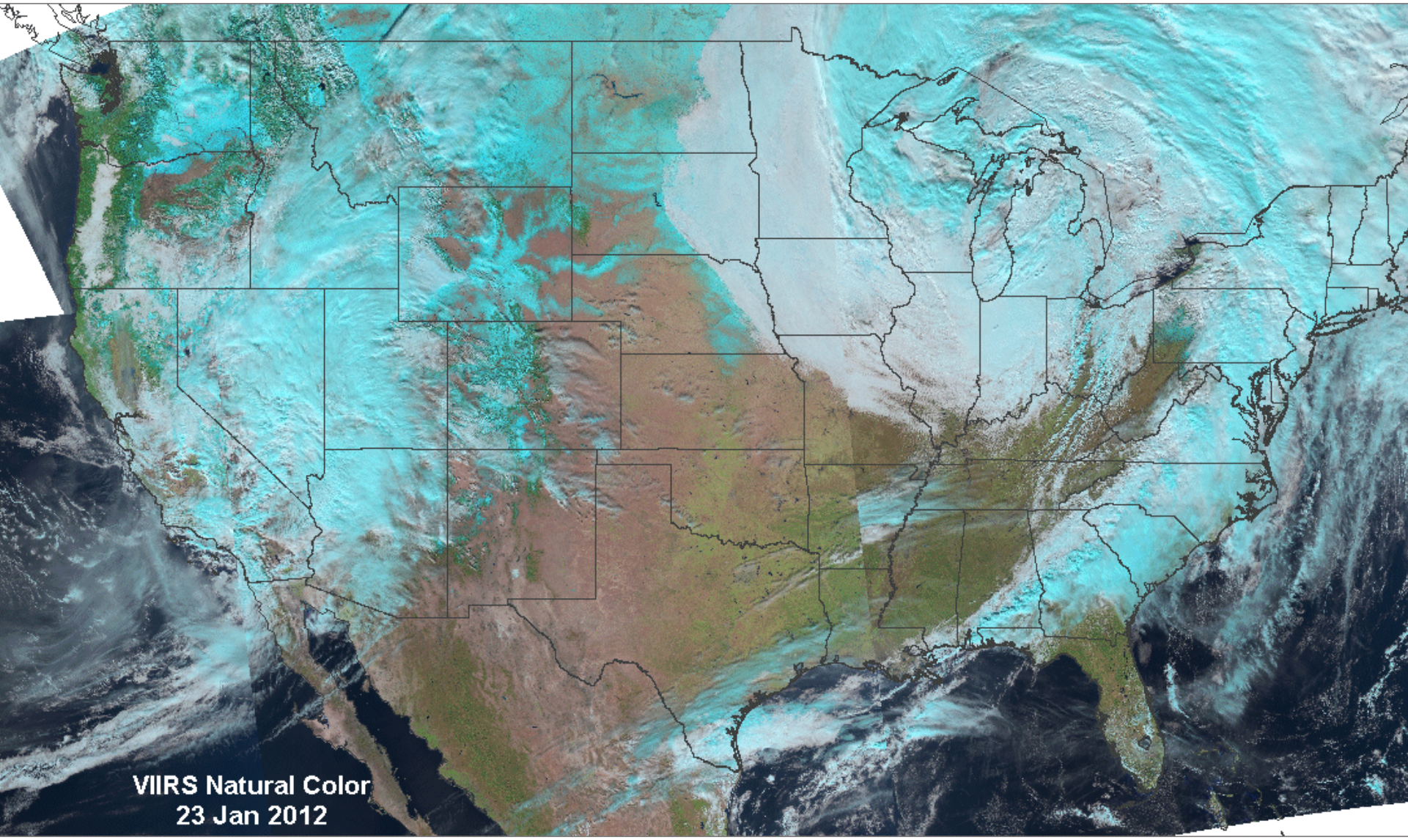
Courtesy of Dan Lindsey

VIIRS Imagery Examples:

Tropical Cyclone Ethyl, Indian Ocean

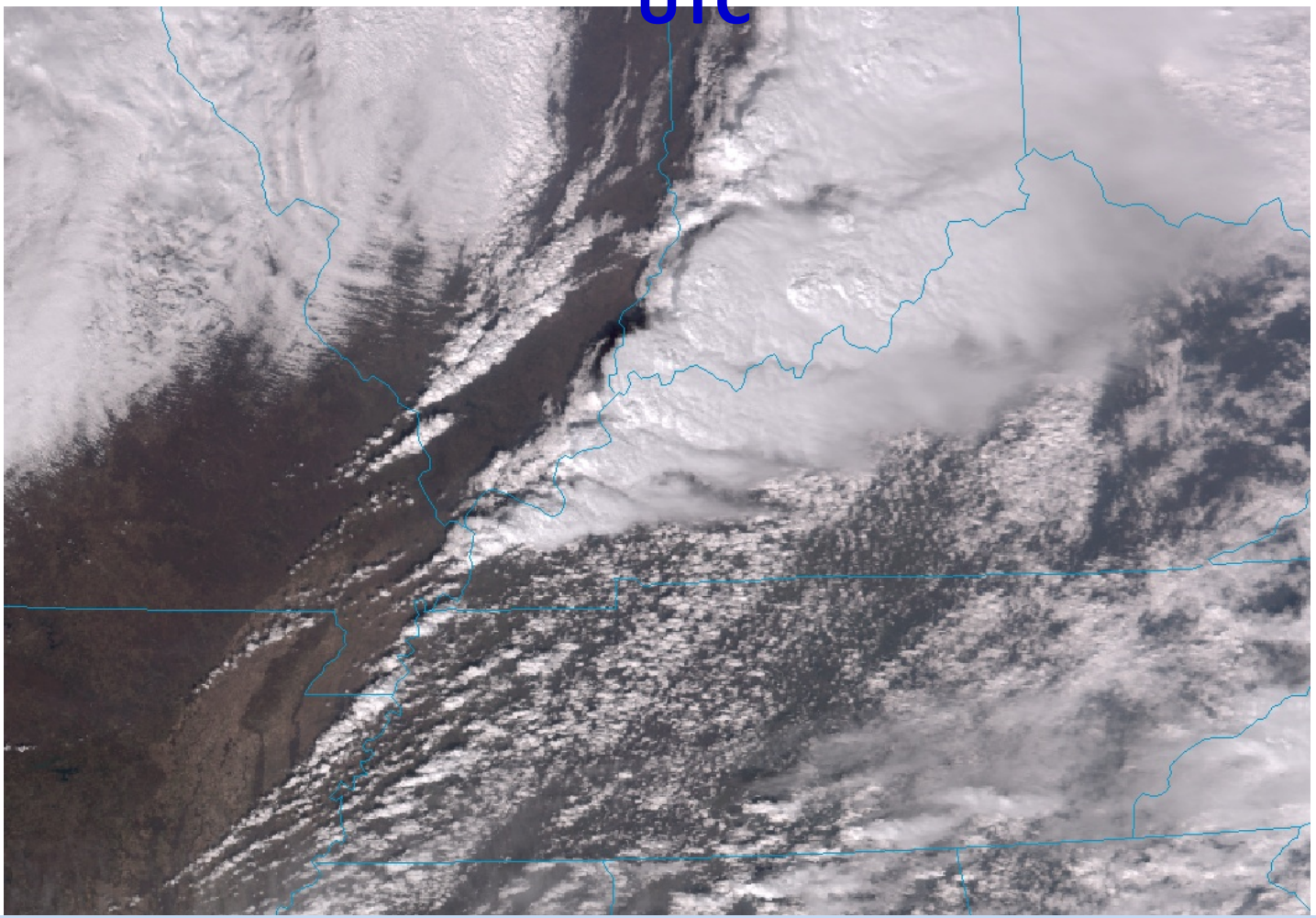


Courtesy of Tommy Jasmin



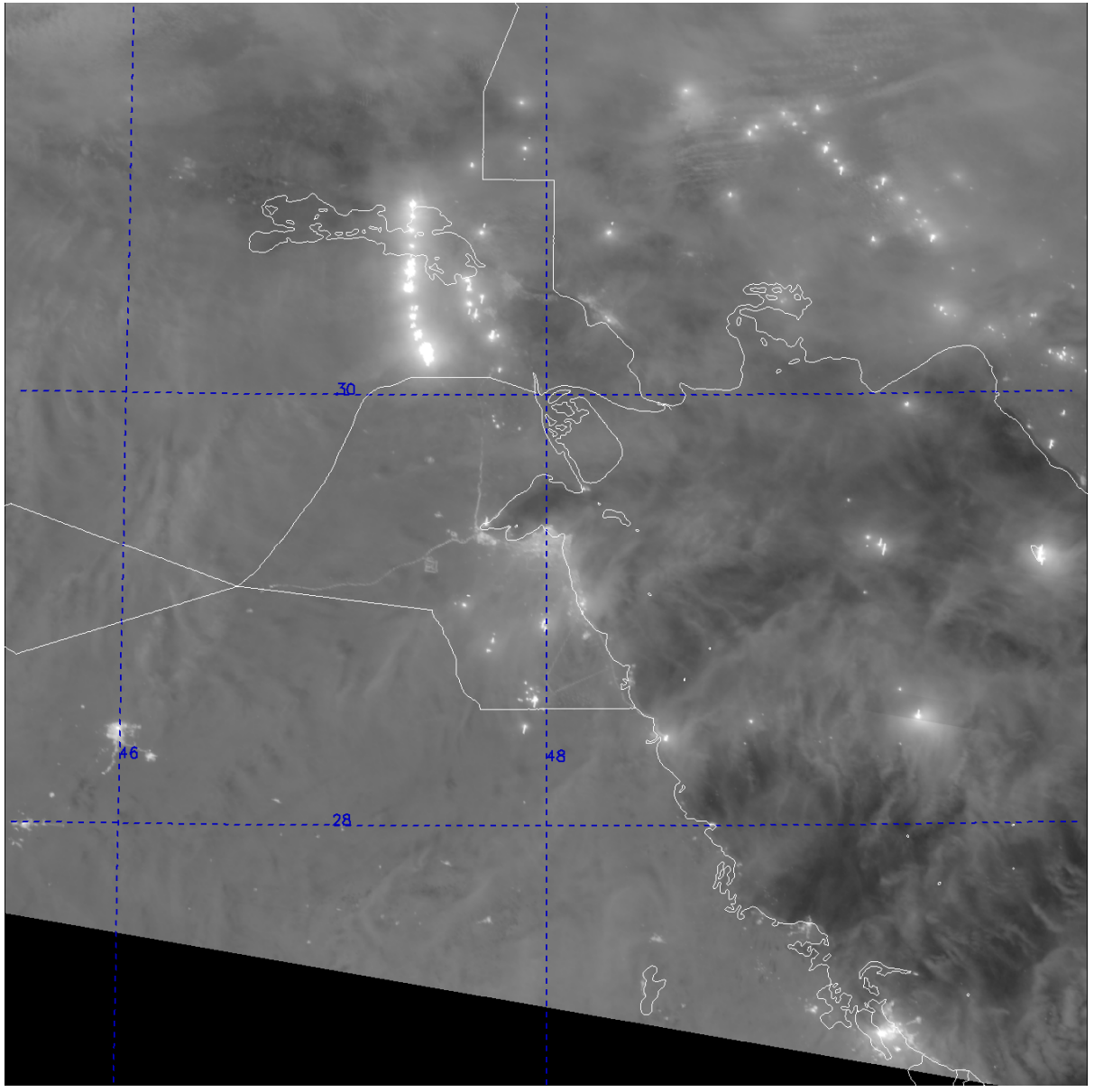
1.6/0.8/0.6 µm (R/G/B) "natural color" image for 23 January 2012. Advantages over true color: (a) less Rayleigh scattering, (b) vegetation shows up as unmistakable green, (c) cloud phase is indicated (cyan clouds are ice, white are liquid), and (d) snow on the ground is easy to distinguish from low clouds (but not from high clouds). [Image courtesy of Stan Kidder, CIRA]

VIIRS true color image: Severe storms over Indiana 2 March 2012 at 1935 UTC

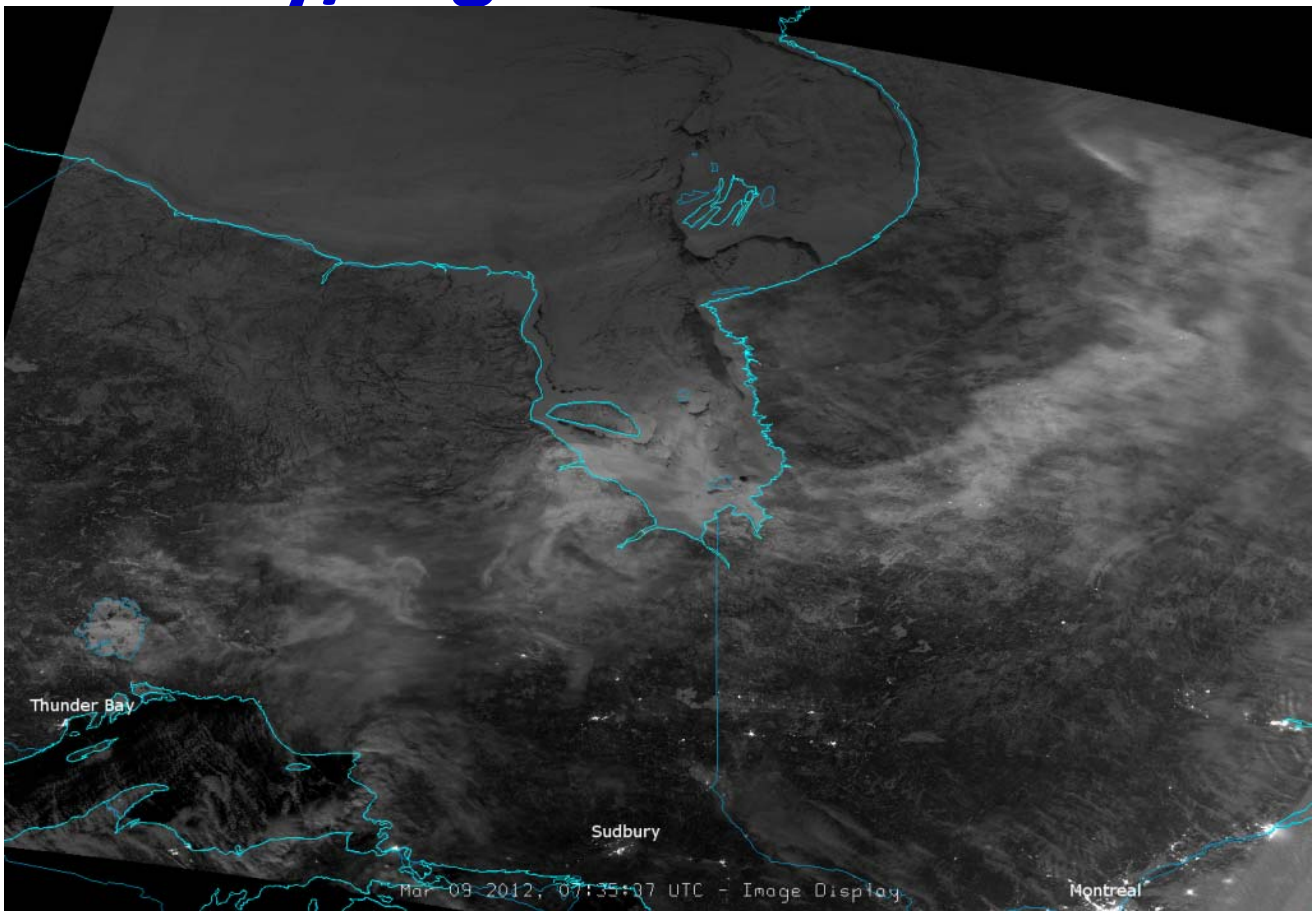


NPP/VIIRS passed over Southern Indiana on March 2 about thirty minutes before the most devastating tornadoes struck the towns of New Pekin and Henryville (among others). At 1935 UTC, a pair of rotating thunderstorms, also known as supercells, were advancing eastward across Indiana. The easternmost storm spawned the most damaging tornadoes. (*Courtesy of Curtis Seaman*)

DNB: Kuwait Gas Flares
2012-02-07 @ 2237

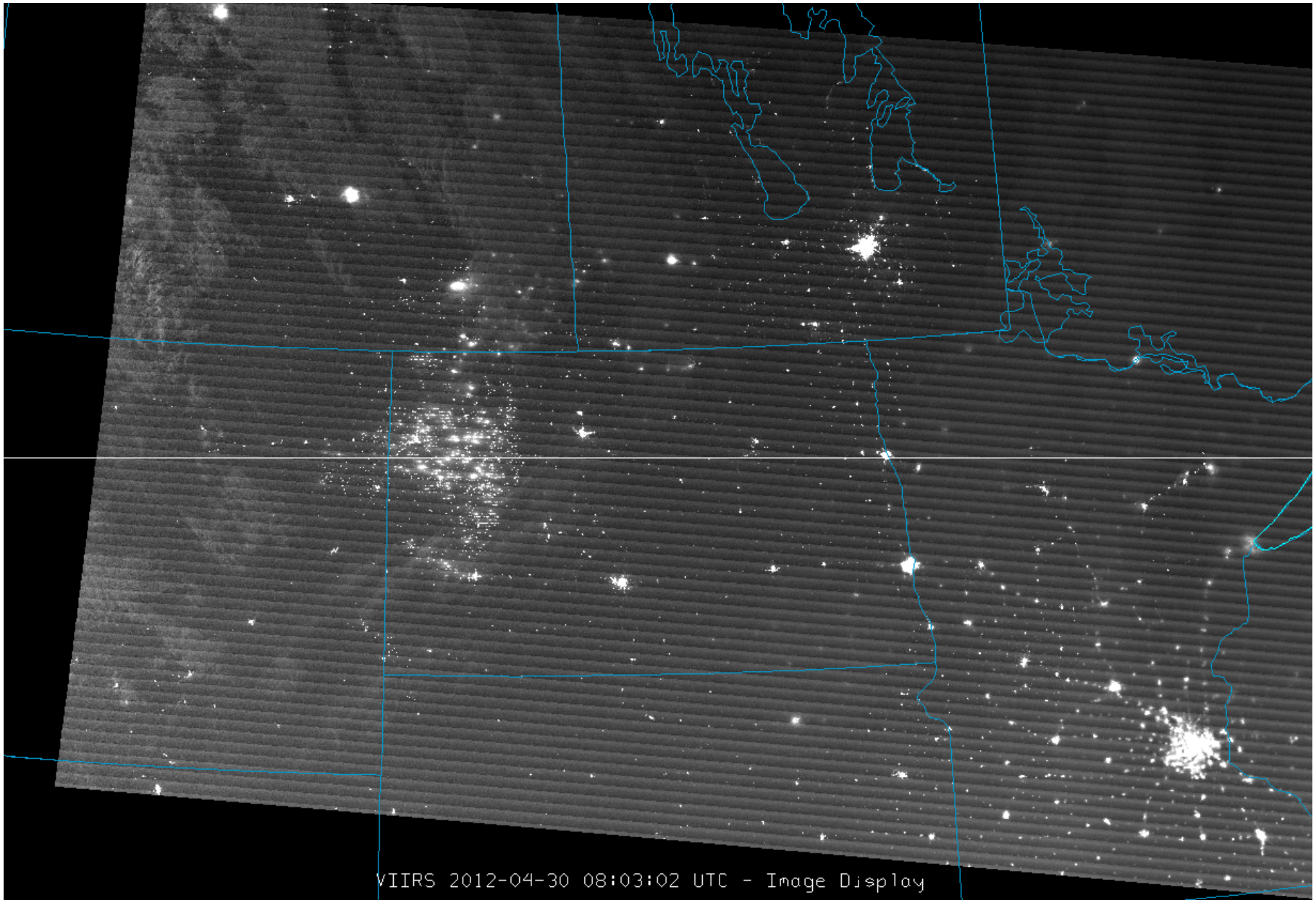


VIIRS Day/Night Band -9 March 2012

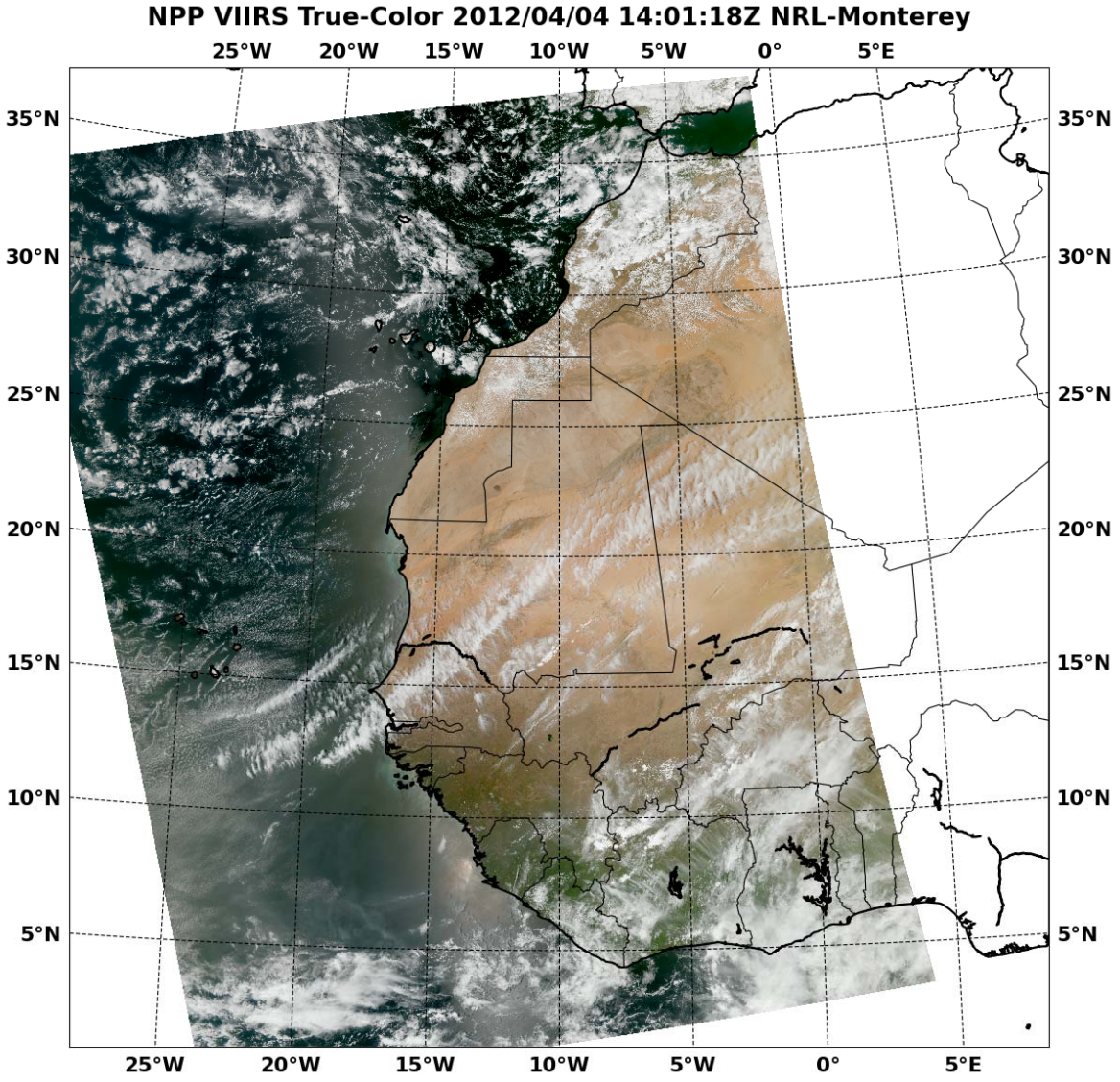


The Day/Night band (DNB) is a visible-wavelength band, centered at 0.7 µm, is highly sensitive to low levels of light, so that it behaves like a visible channel even at night when the moon is out. As seen in the image, the DNB clearly shows the location of towns and cities at night. Since 8 March 2012 was a full moon, clouds, snow and ice (particularly over Lake Winnipeg) are also visible. The brightest swirl, extending from north of Saskatoon, over Reindeer Lake and into northwestern Manitoba is the aurora borealis. *(Courtesy of Steve Miller)*

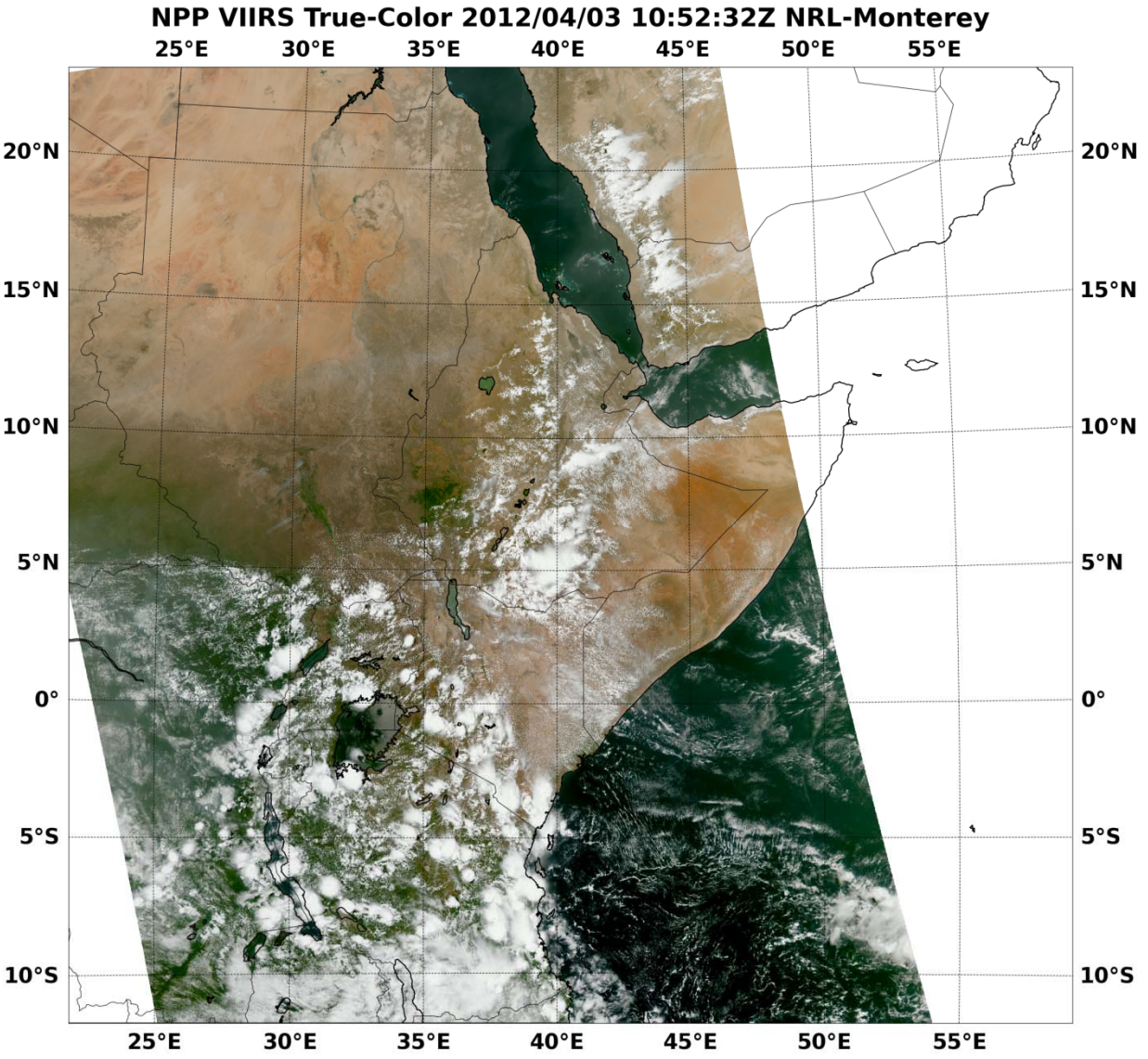
DNB: North Dakota oil boom, 30 Apr 2012



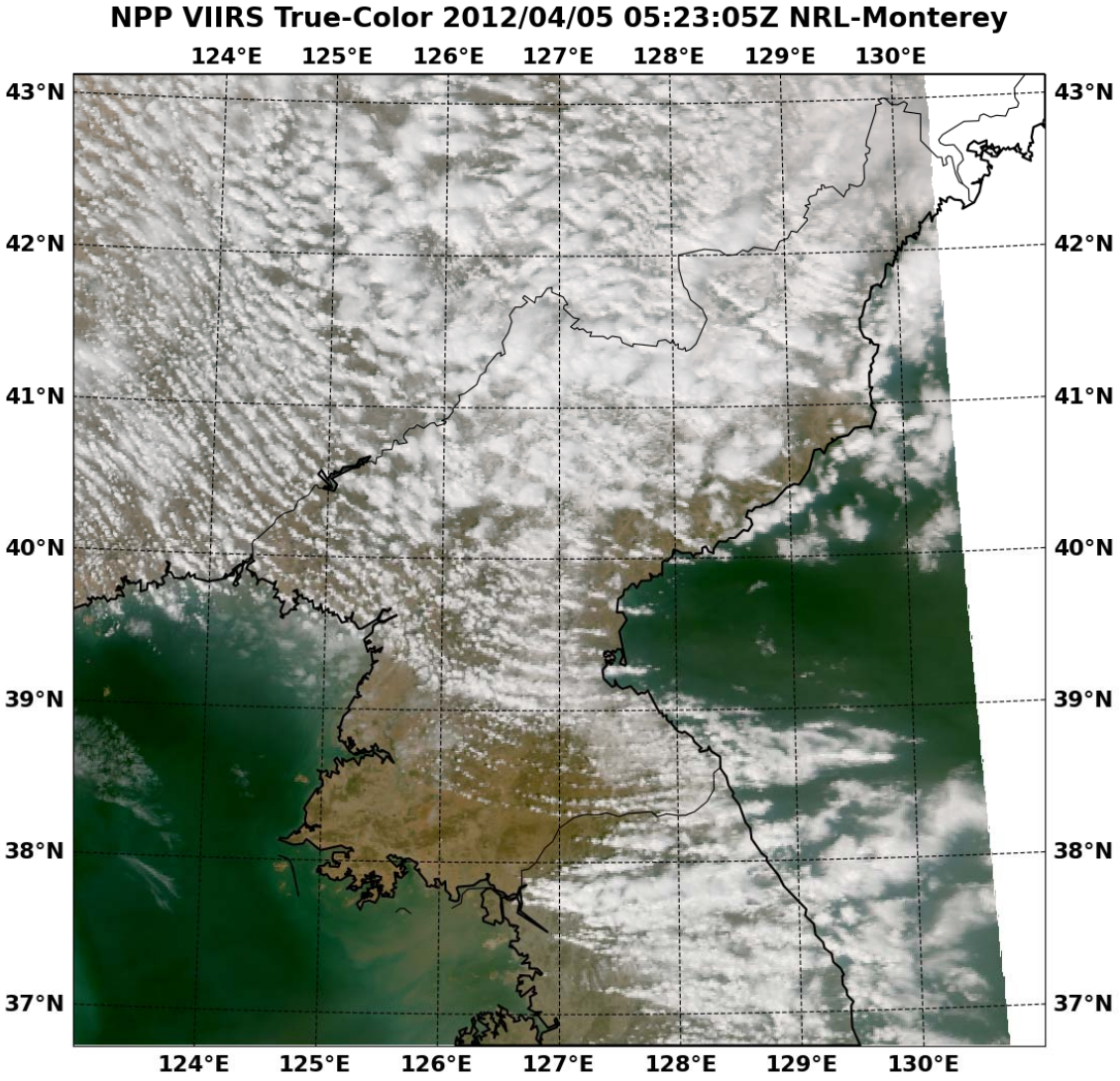
NRL true-color example – Northwest Africa



NRL true-color example – Horn of Africa



NRL true-color example – North Korea



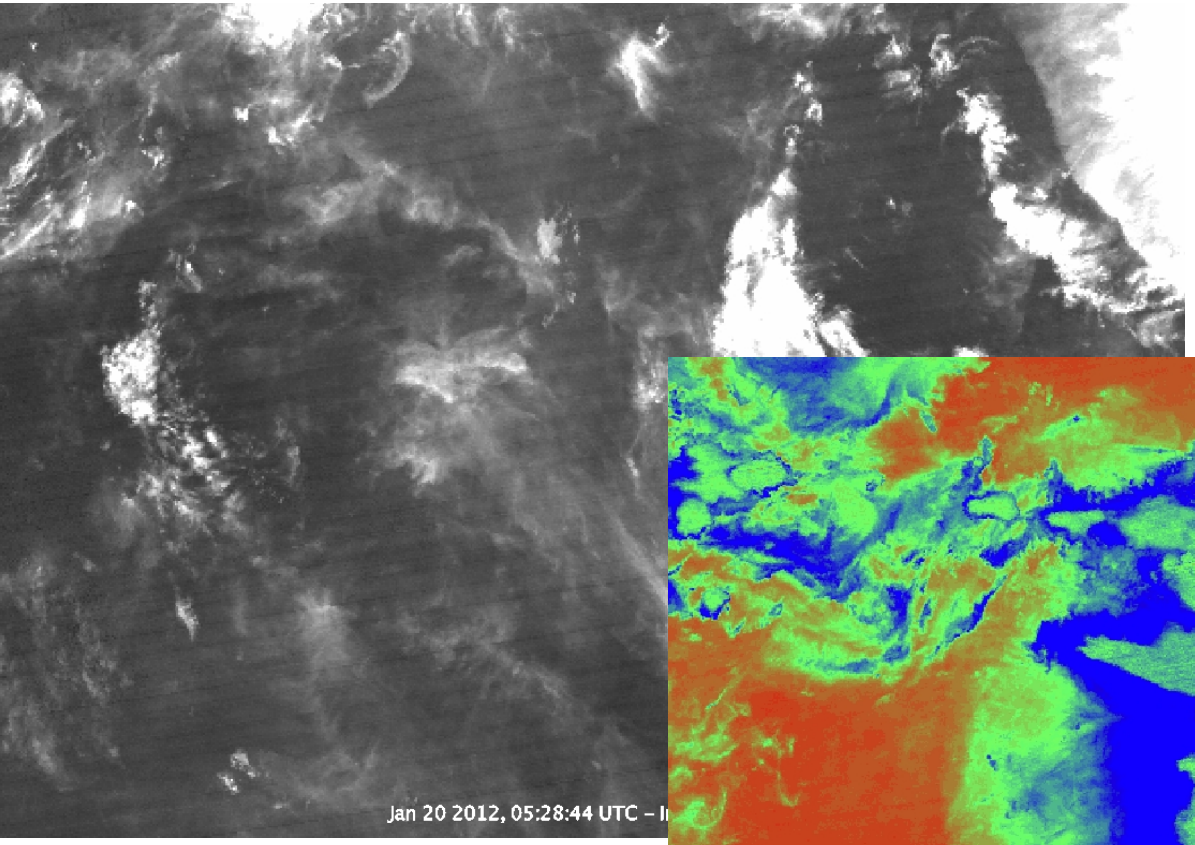
VIIRS imagery issues/problems so far:

- **Server (GRAVITE) issues**
  - Missing (or delayed) granules
  - Duplicate granules
- Lack of DNB EDR (NCC) imagery at night under conditions other than a full moon
- Padding stripes (fill values) from the use of GTM and a constant array size in the Imagery EDR
- Triangular regions of missing data due to remapping from SDRs to EDRs.
- **Long latency** due to complex data flow thru GRAVITE and CLASS.

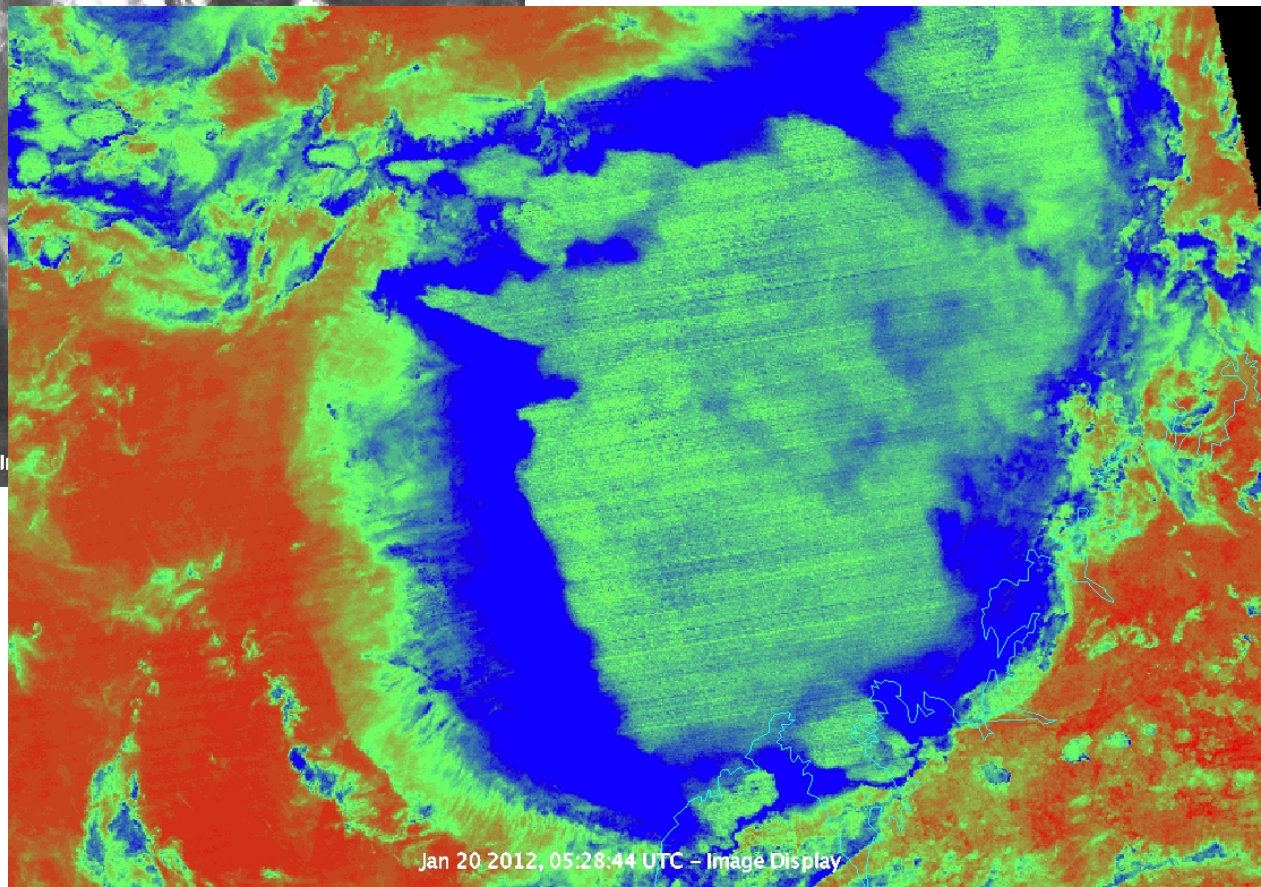
These issues are being addressed as **Discrepancy Reports**, and sent up the chain of command for resolution.

- Coordination with **VIIRS SDR Team**.
- Feedback to many other **EDR Teams.**
- **Eventual preparation for operational use of JPSS-1** (2016) and **JPSS-2** (2022)

Imagery issue: Striping noted by SST and Ocean Color Teams



Striping noted in these M14-M15 band-difference images



Question: where is the best place to do de-striping for all Teams?

Table of Normalized Deviations

Band	Range (max - min) of normalized deviation
M06	133.58
M13	9.45
M10	8.32
M03	4.52
M07	3.76
M01	3.52
M02	3.29
M08	3.25
M04	2.98
M05	2.86
M12	2.67
I03	2.56
I01	1.61
I02	1.60
M15	1.58
M16	1.47
I04	1.15
M14	0.86
M11	0.76
I05	0.66
M09	0.66

The VIIRS Imagery Team work continues

- **Quantitative** analyses:
  - Noise levels
  - Detector-to-detector striping
  - Inter-satellite comparisons
- **Overall imagery assessment**, for use as image products
- **Multi-spectral products**, as a means of assessing image quality, where signal-to-noise ratio is reduced.