Suomi NPP VIIRS
Near Constant Contrast (NCC) Imagery

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- Stellar Solutions (R. Williams)
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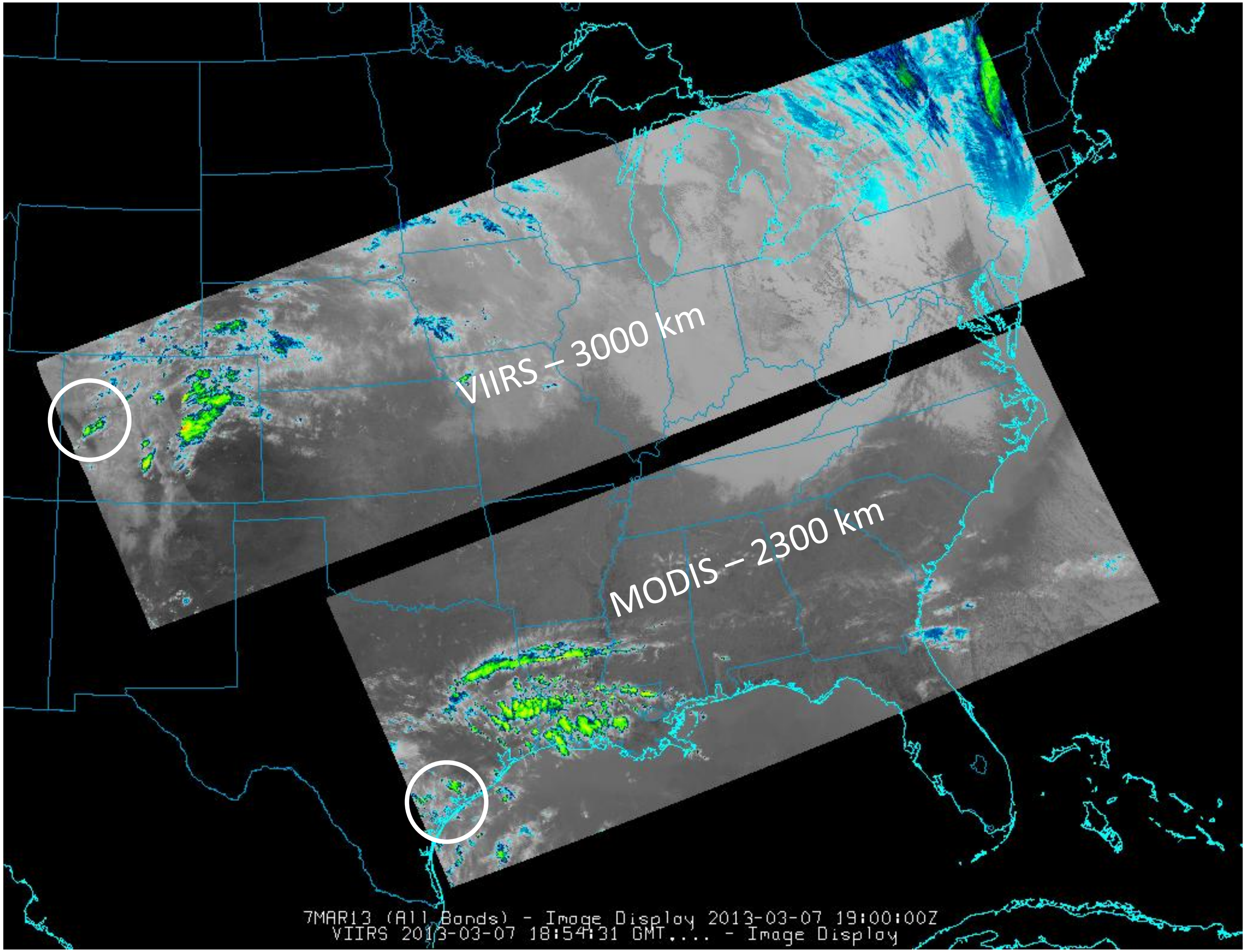
- NASA (W. Thomas, P. Meade)
- NOAA/OSPO (A. Irving)
- NASA/SPoRT (G. Jedlovec, M. Smith)

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**
- **Wider (3000 km) swath**, leaving no gaps between adjacent orbits
- **DNB / NCC enables visible light imagery under all natural and artificial illumination conditions**

(A)

VIIRS vs. MODIS swath width

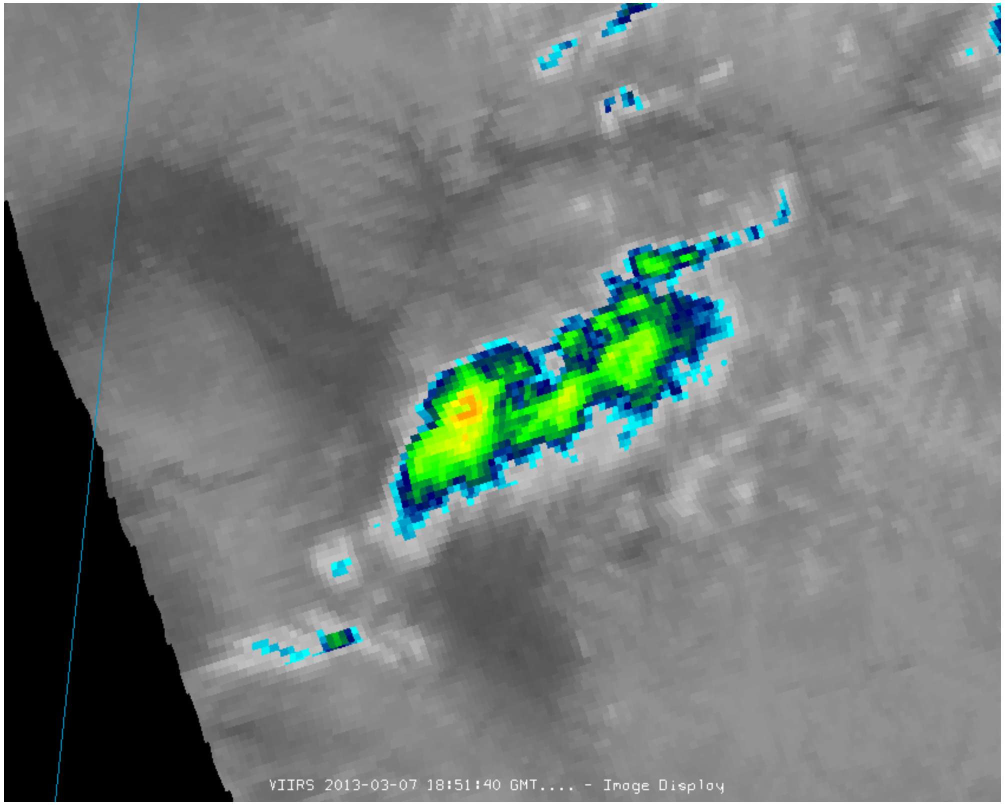


See next image for comparison of spatial resolution at swath edge (within white circles)

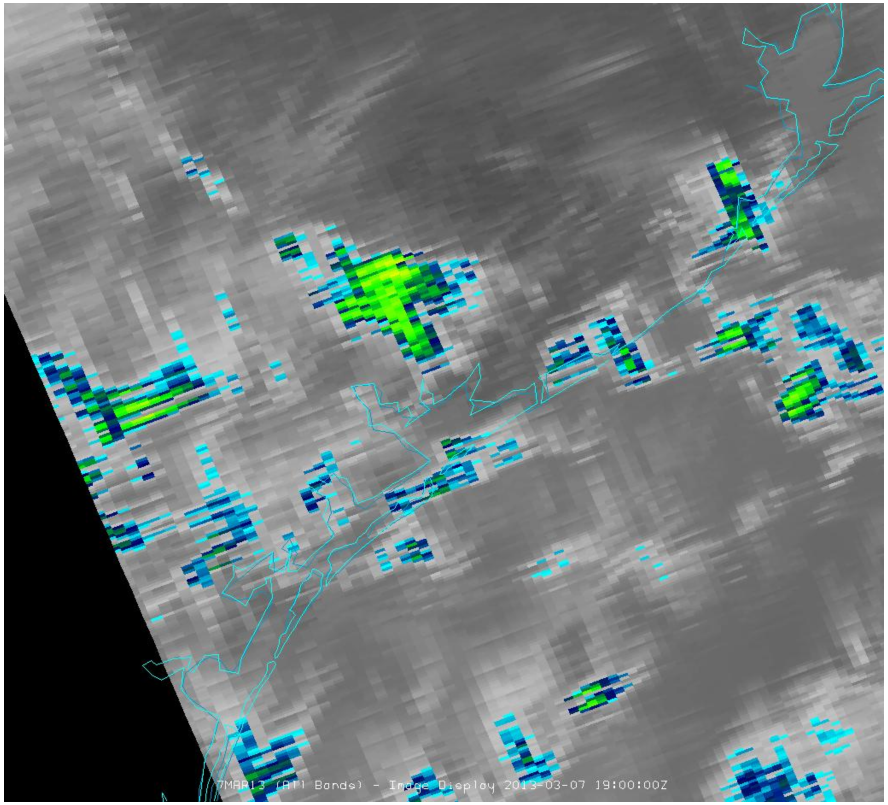
(B)

VIIRS vs. MODIS spatial resolution at swath edge

(blowup of images within white circles in previous slide)



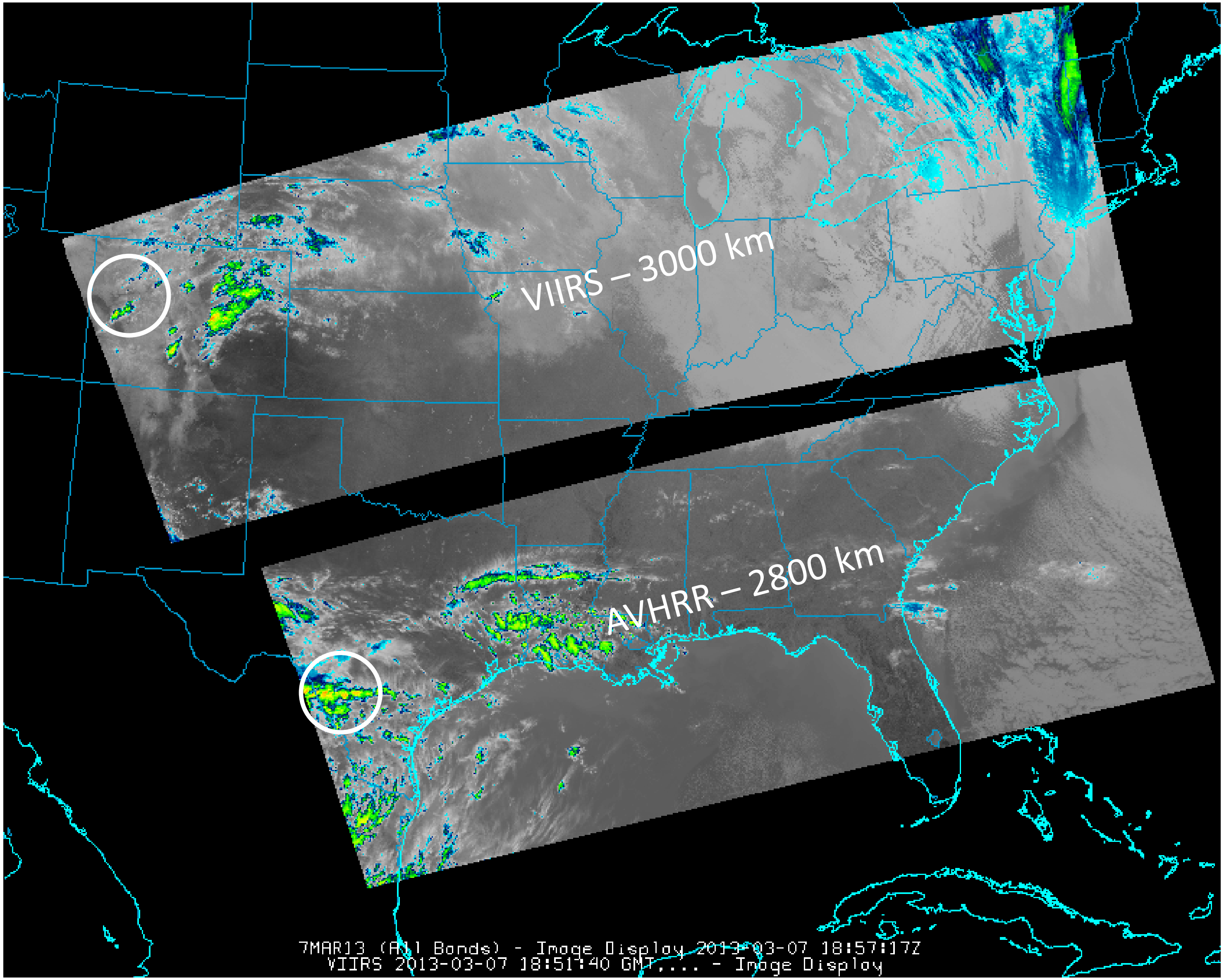
VIIRS – ~1.5 km @ swath edge
(M-band 750 m @ nadir)



MODIS – ~5 km @ swath edge
(1 km @ nadir)

Note that these images are <u>not</u> of the same clouds.

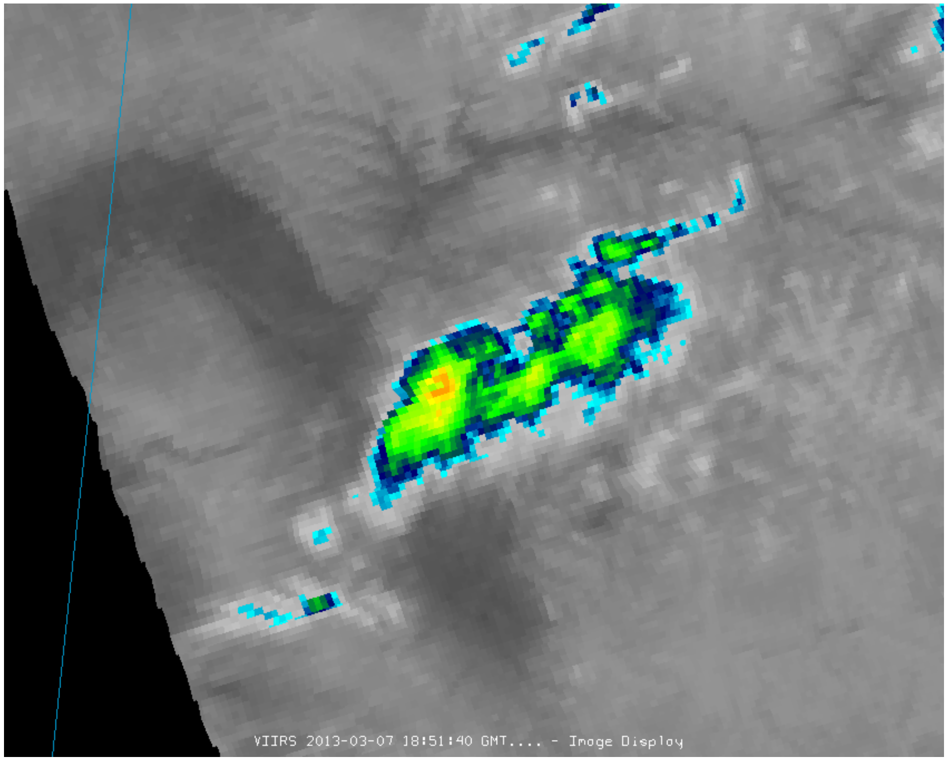
VIIRS vs. AVHRR swath width

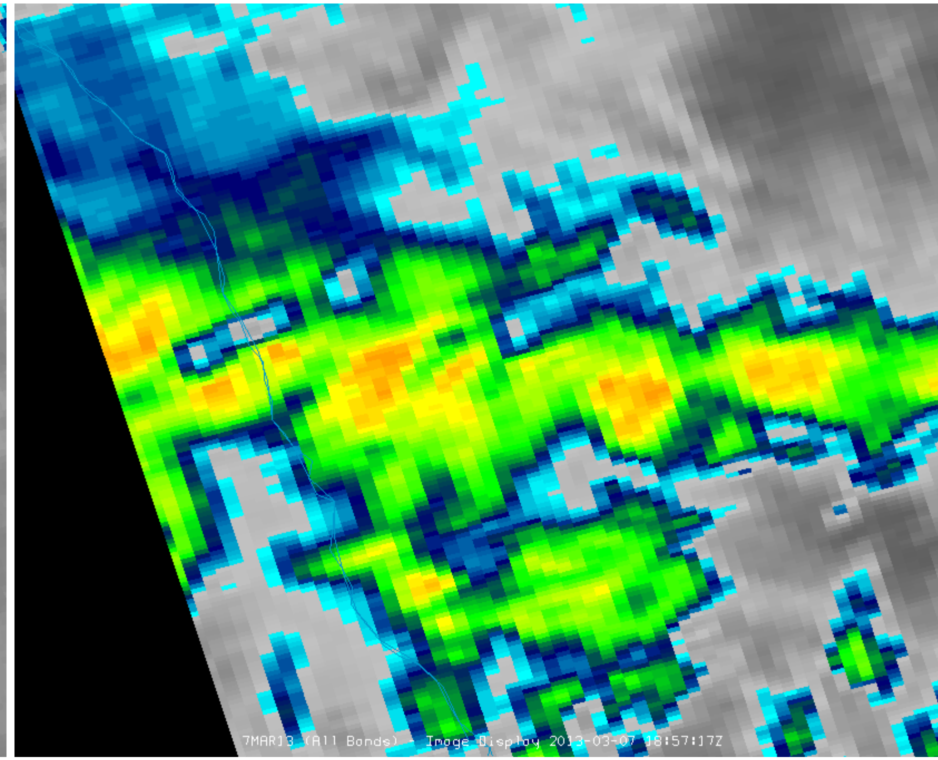


See next slide for comparison of spatial resolution at swath edge (within white circles)

VIIRS vs. AVHRR spatial resolution at swath edge

(blowup of images within white circles in previous slide)





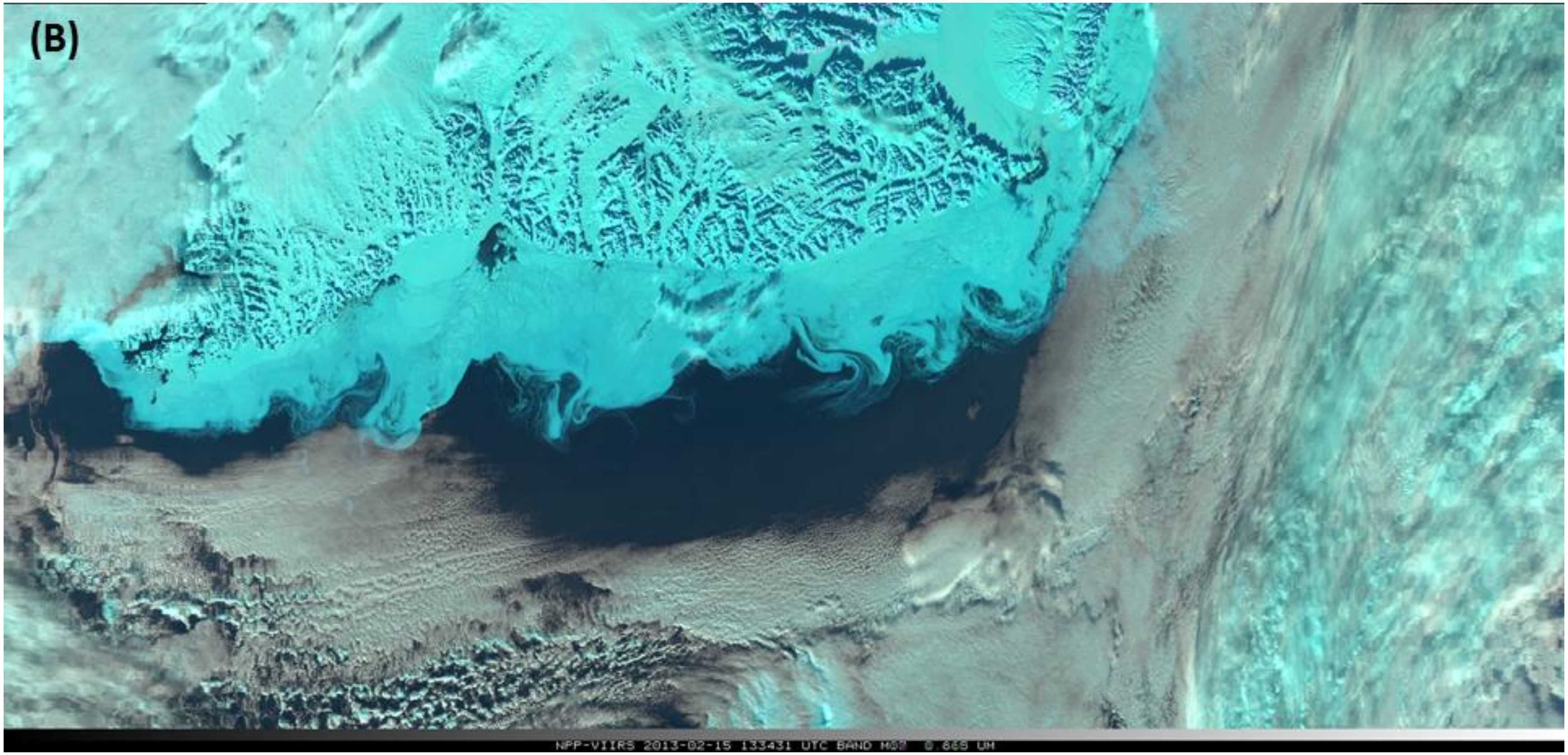
VIIRS – 1.5 km @ swath edge
(M-band 750 m @ nadir)

AVHRR – 5.5 km @ swath edge
(LAC 1.1 km @ nadir)

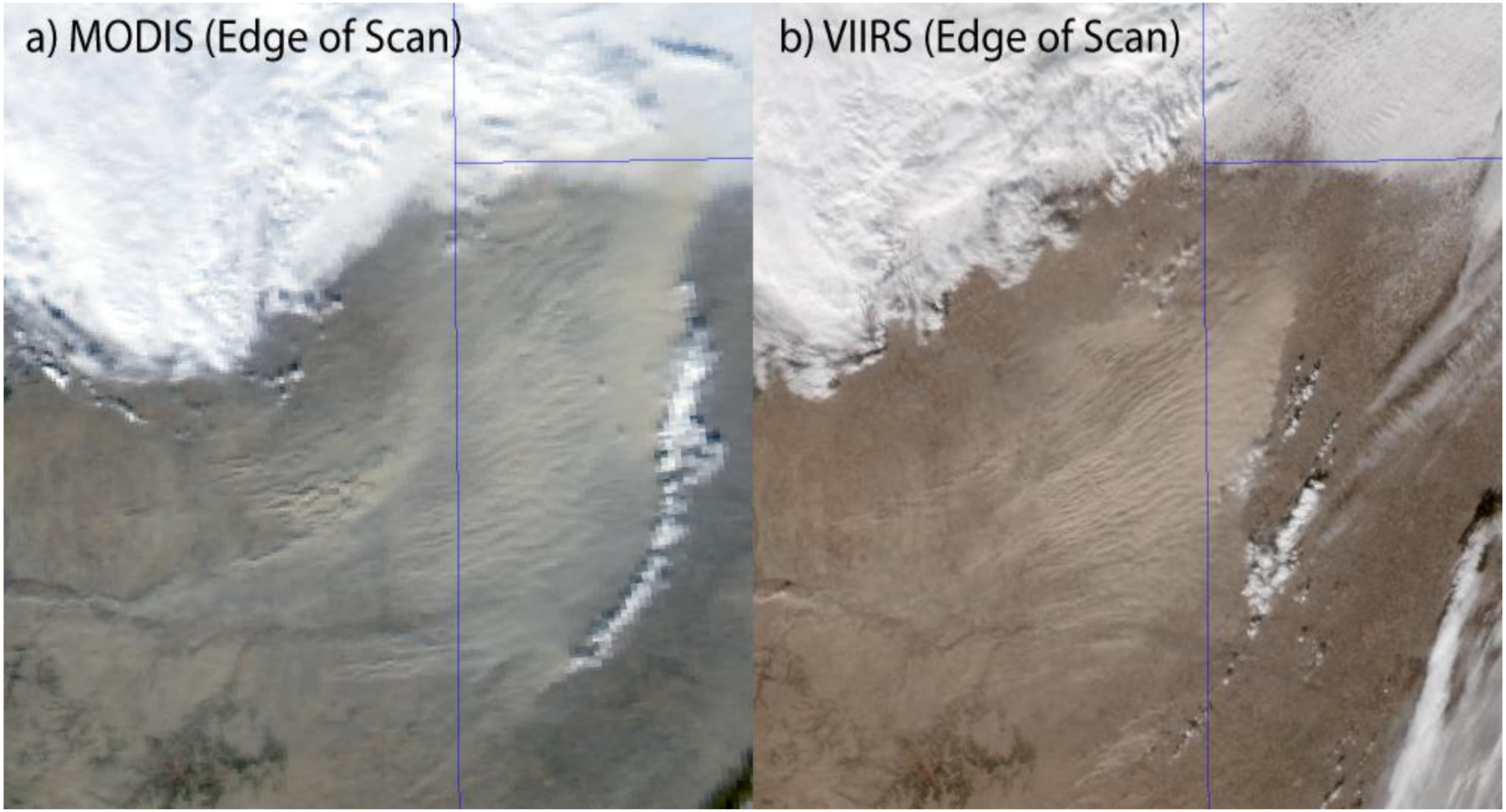
Note that these images are <u>not</u> of the same clouds, but are from similar scan angles.

Land (vegetated or not) and cloud

Ice, water, and cloud



Better resolution at swath edge



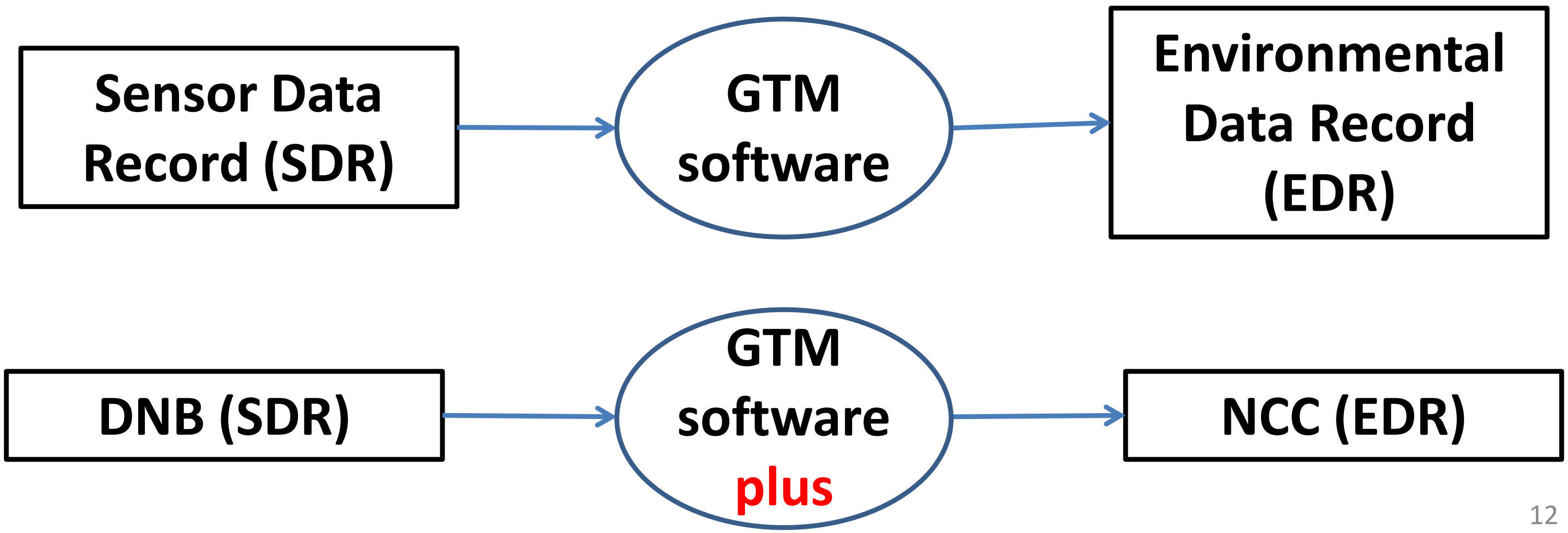
VIIRS Environmental Data Record (EDR)s

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

Bands highlighted in pale yellow are specifically-required Imagery EDRs.
Other Imagery EDRs are highlighted in grey.

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**



NCC (EDR) vs. DNB (SDR)

- What are the differences?

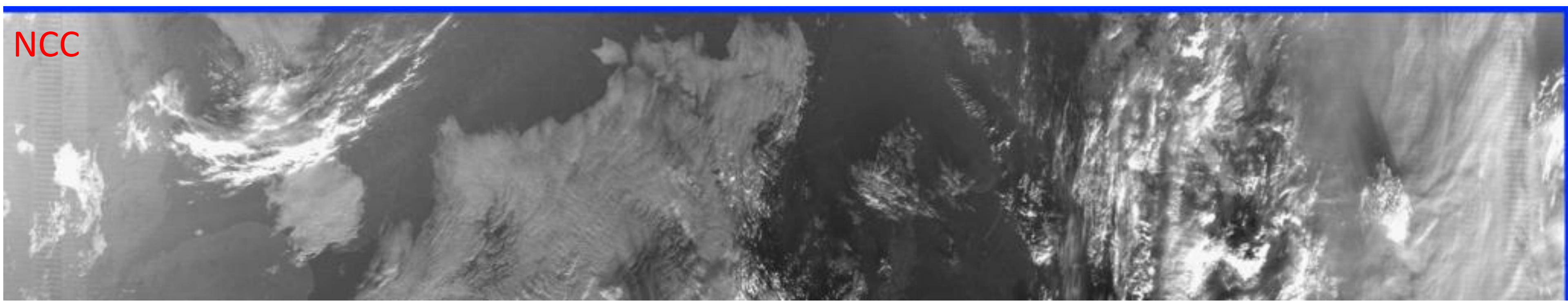
Product	xDR	Units	Mapping
DNB	SDR	Radiances	Raw
NCC	EDR	Pseudo-albedos	GTM

- Which is better?
- Answer: Depends on the usage!

Near Constant Contrast (NCC) Product

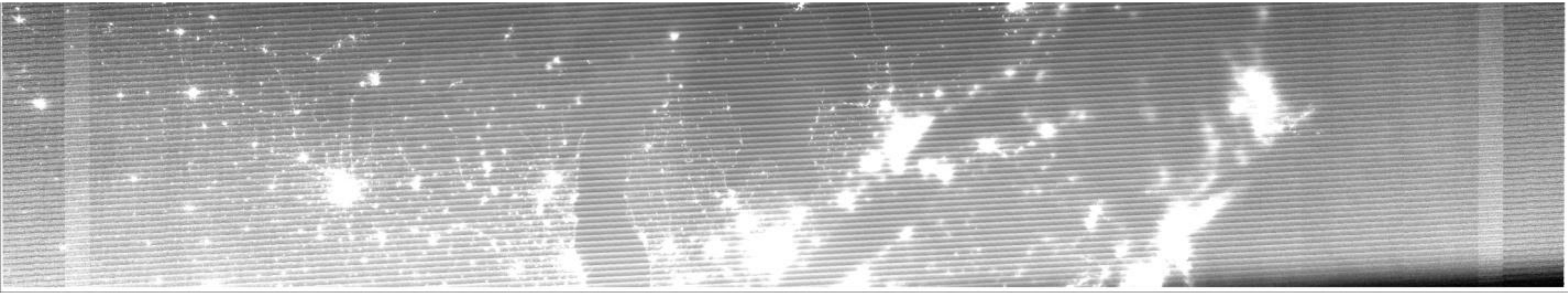
Example of NCC performance for a day/night terminator (non-lunar) case.

NCC extends constant contrast into the twilight portion of the granule swath.



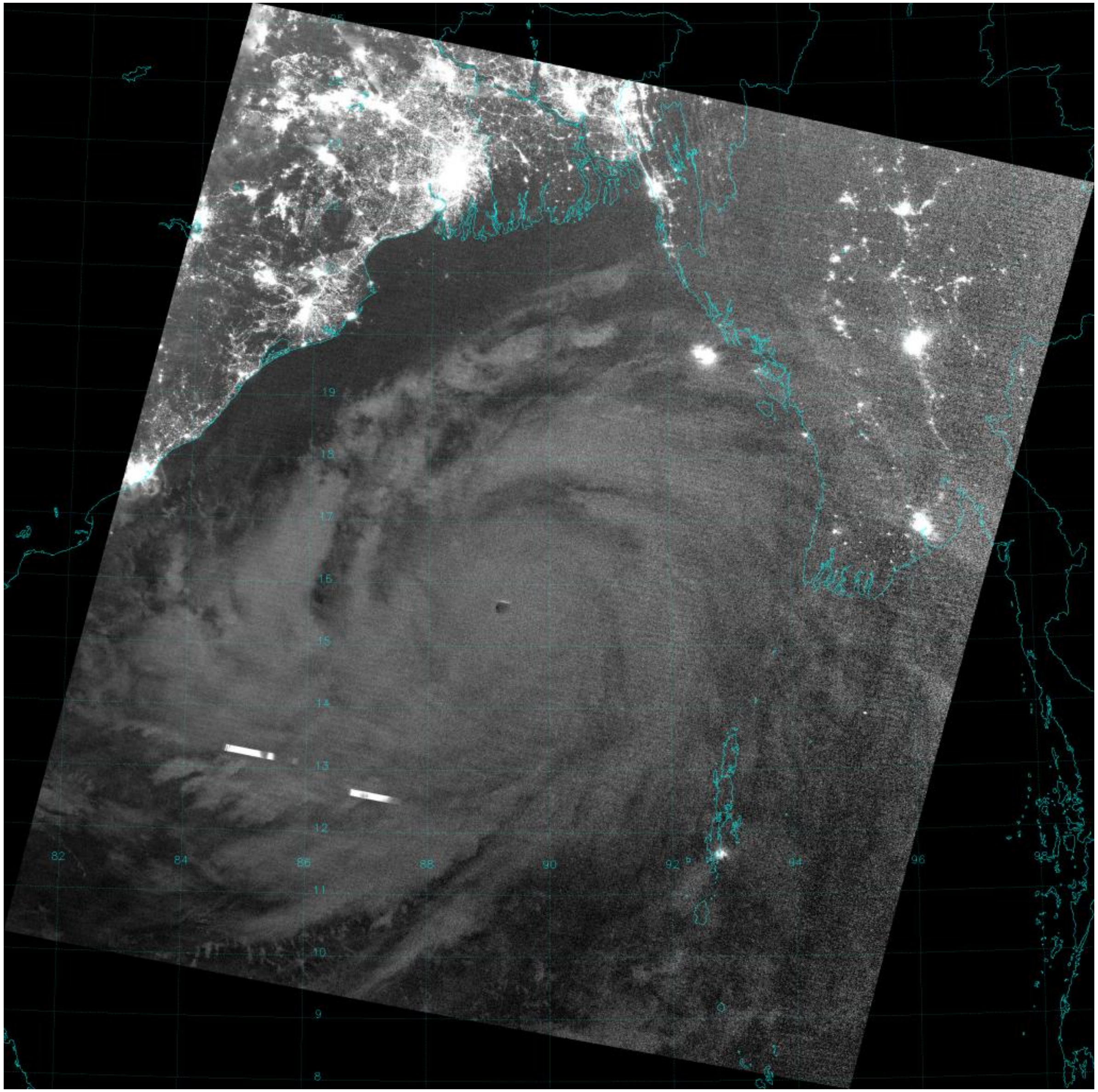
Cross-terminator DNB SDR (top) versus NCC Imagery EDR (bottom)

Stray light in NCC Imagery before (top) versus NCC after removal (bottom)



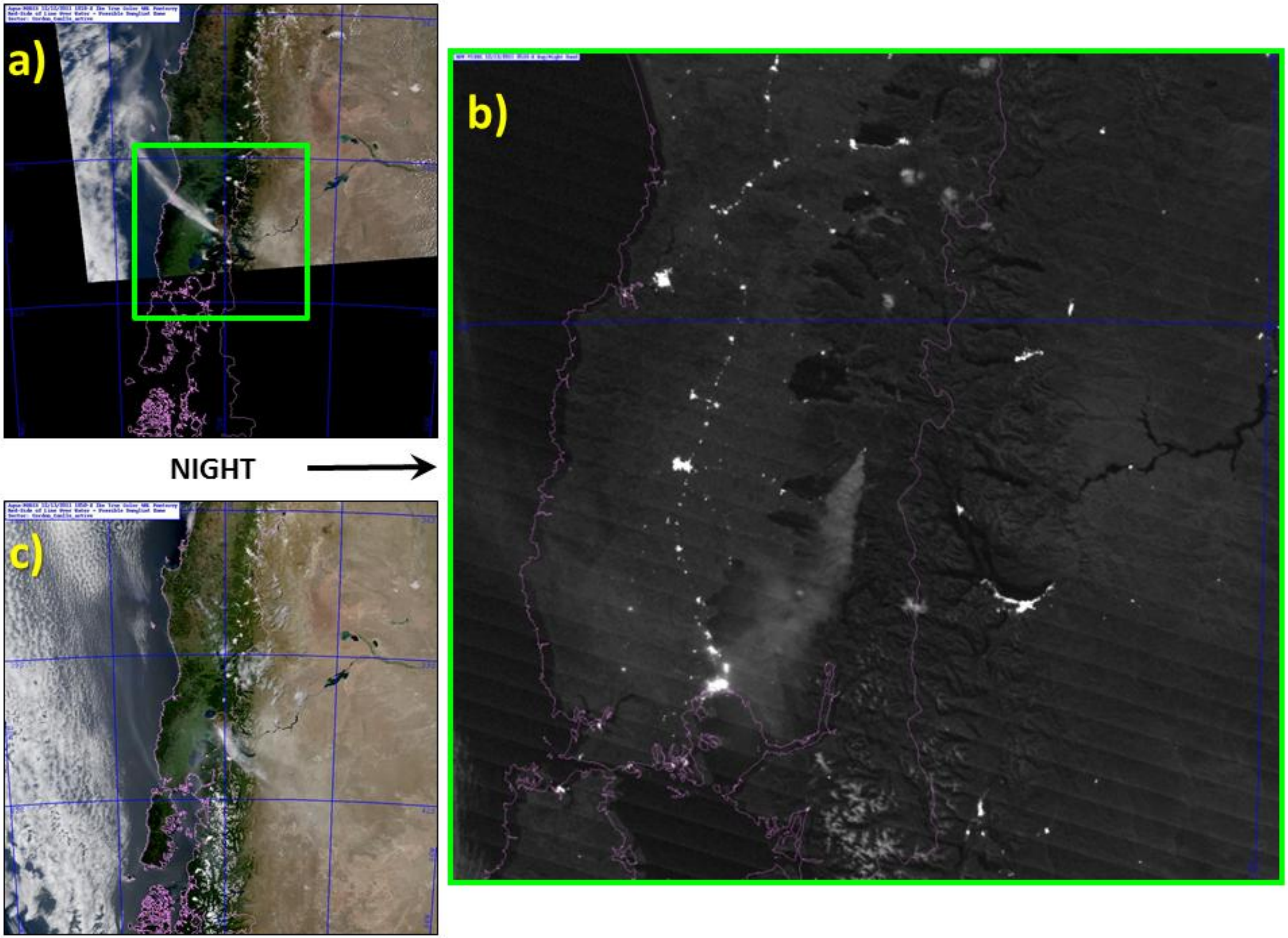
Artifacts in the DNB SDR are inherited by the NCC Imagery EDR. Before August 2013 the most significant of these was a stray light issue with the DNB on the dark side of the terminator. The DNB SDR algorithm was adjusted to correct for this error in August 2013. The impact on the NCC Imagery EDR was profound. The removal of the stray light is evident in the bottom image, taken from the granule over the upper Midwest of the United States on 9 August 2013. As a reference, Lake Michigan may be seen in the middle of the granule

NCC Imagery of Super Typhoon Phailin at night with no lunar illumination, 10 October 2013



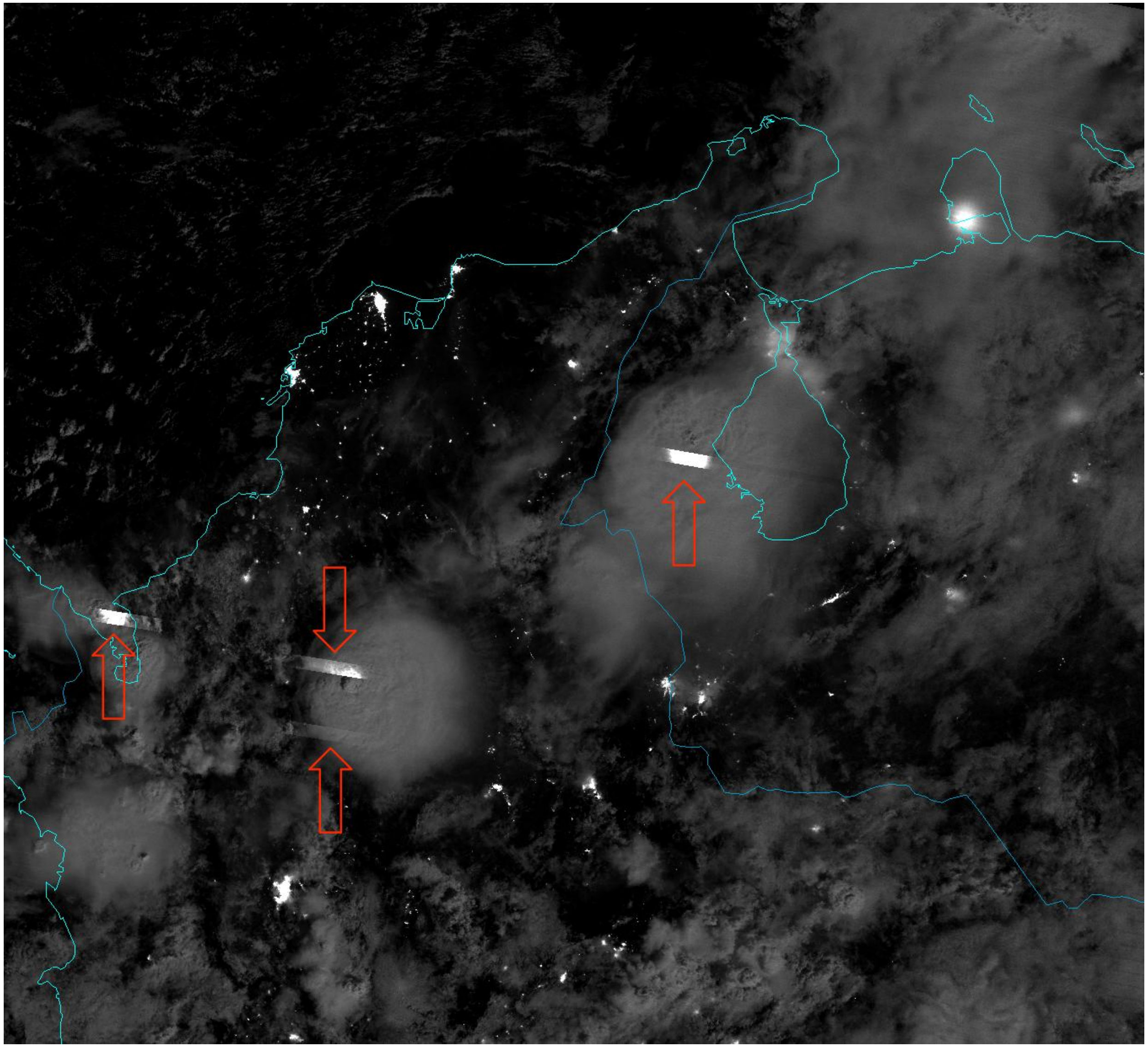
The NCC Imagery EDR is produced under all solar and lunar illumination conditions, including cases where there is no illumination from either the sun or moon (i.e. new moon phase). The DNB is sensitive enough that air glow is sufficient to create an image, although such an image appears quite noisy. Here is an example of NCC Imagery at night when the moon was below the horizon. The example is Super Typhoon Phailin taken on the night of 10 October 2013. The typhoon, along with convective elements and its eye, are evident despite the extremely low levels of radiance present in the DNB spectrum. This is, in essence, the “worst case” scenario for NCC Imagery. As lunar illumination increases, the SNR improves and the noisiness in the DNB SDR decreases, with subsequent benefits to the NCC Imagery EDR.

Multi-sensor imagery sequence over the Puyehue-Cordón Caulle volcanic chain in Chile during an ongoing eruption



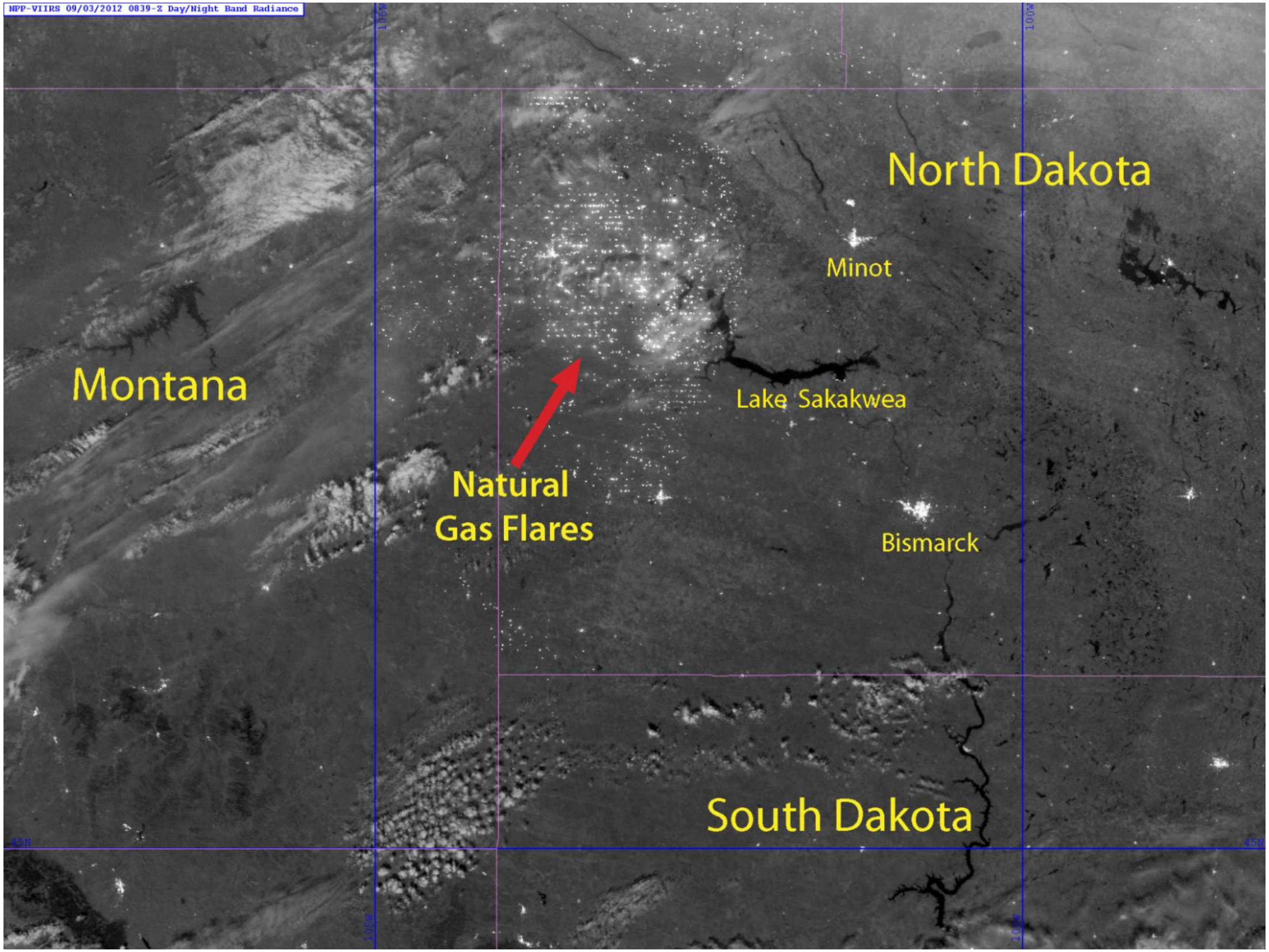
a) Aqua MODIS on 12 December 2011 at 1810 UTC, b) VIIRS DNB on 13 December at 0510 UTC for the inset box region of (a) , and c) Aqua MODIS on 13 December at 1850 UTC.

DNB image of lightning from thunderstorms over Colombia and Venezuela taken 0644 UTC, 10 May 2012



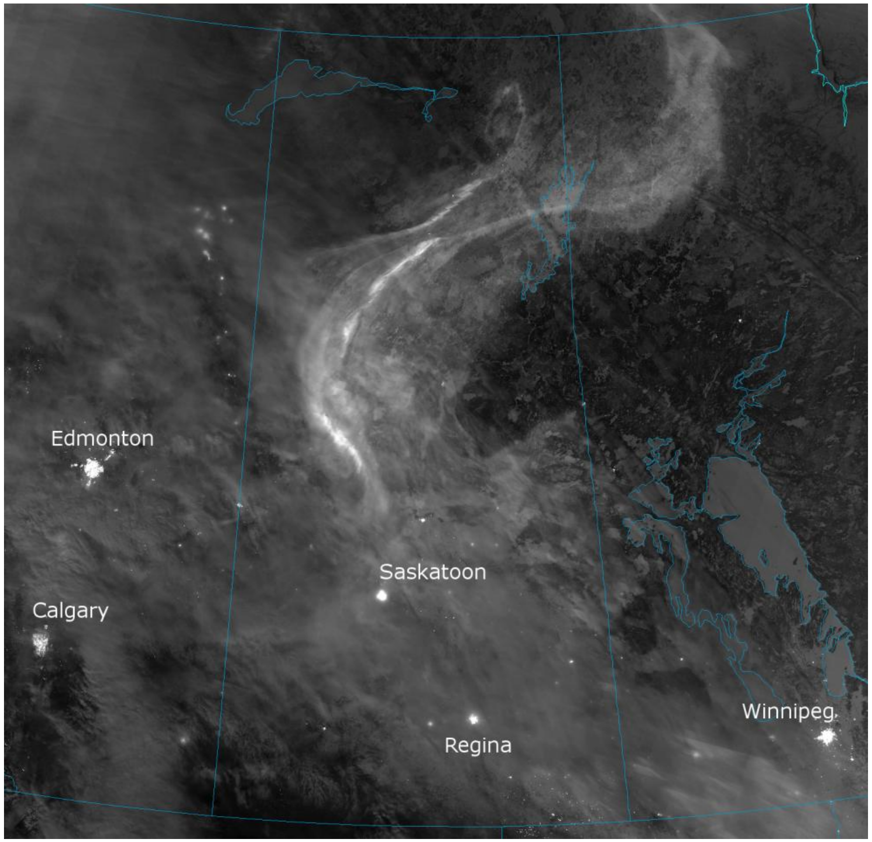
Lightning strikes are identified by the red arrows. At the time this image was taken, the moon was approximately 80% full.

Mostly cloud-free DNB image over the U.S. Upper Midwest, 3 September 2012 at 0839 UTC

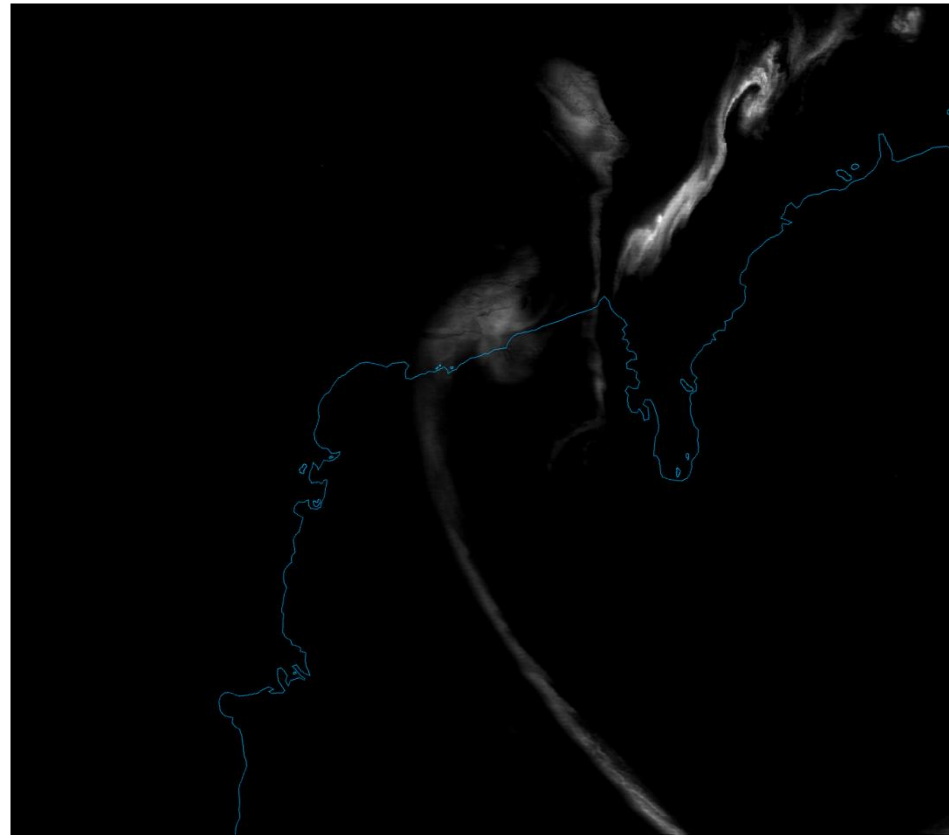


Note the lights from major cities, as well as a large cluster of oil flare signatures in northwestern North Dakota from the recently-developed Bakken formation.

Auroras in the DNB



(C. Seaman)

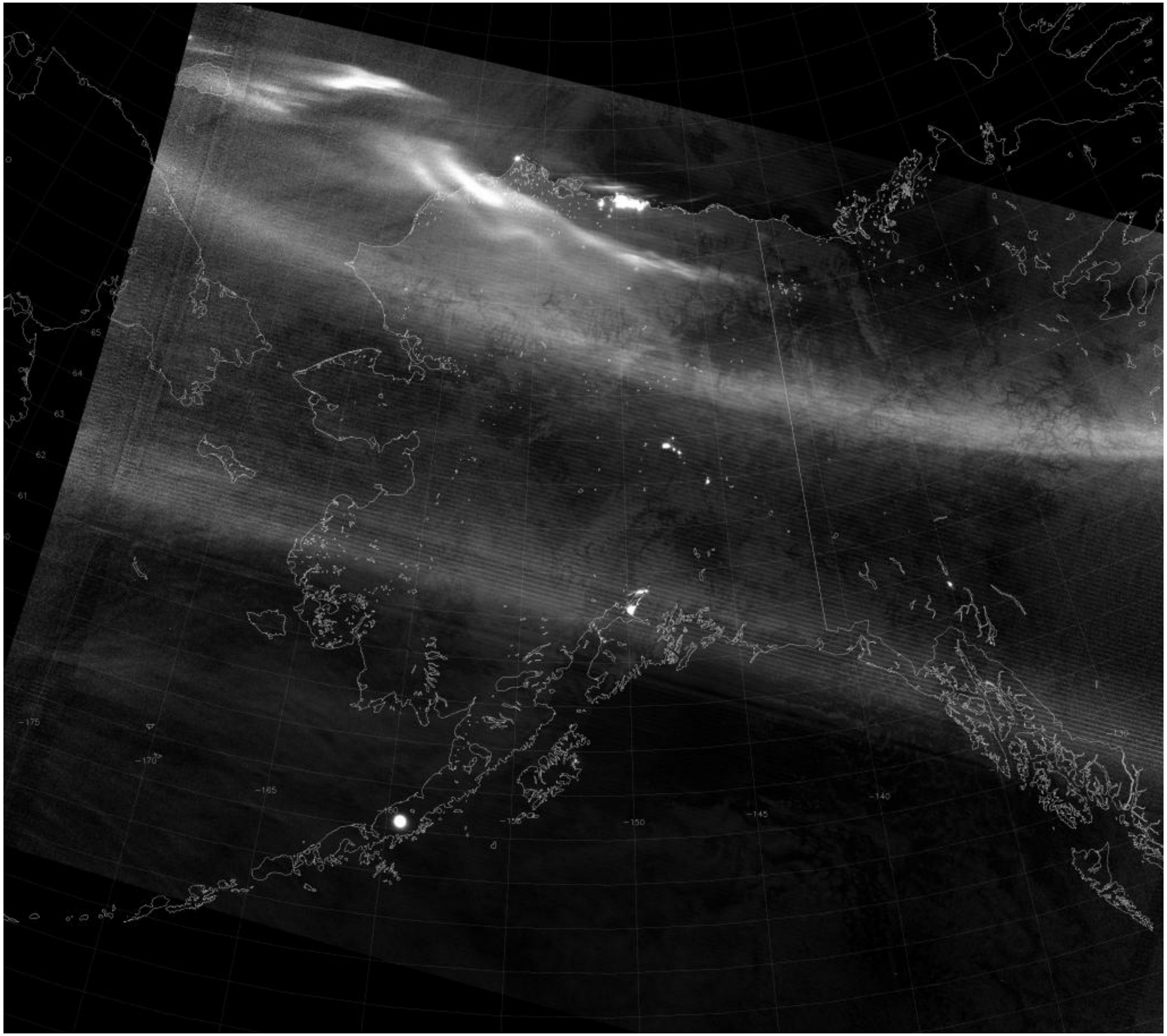


(C. Seaman)

Aurora Borealis over Saskatchewan, Canada on 9 March 2012, visible during a full moon!

Aurora Australis over Antarctica on 15 September 2012, during a new moon.

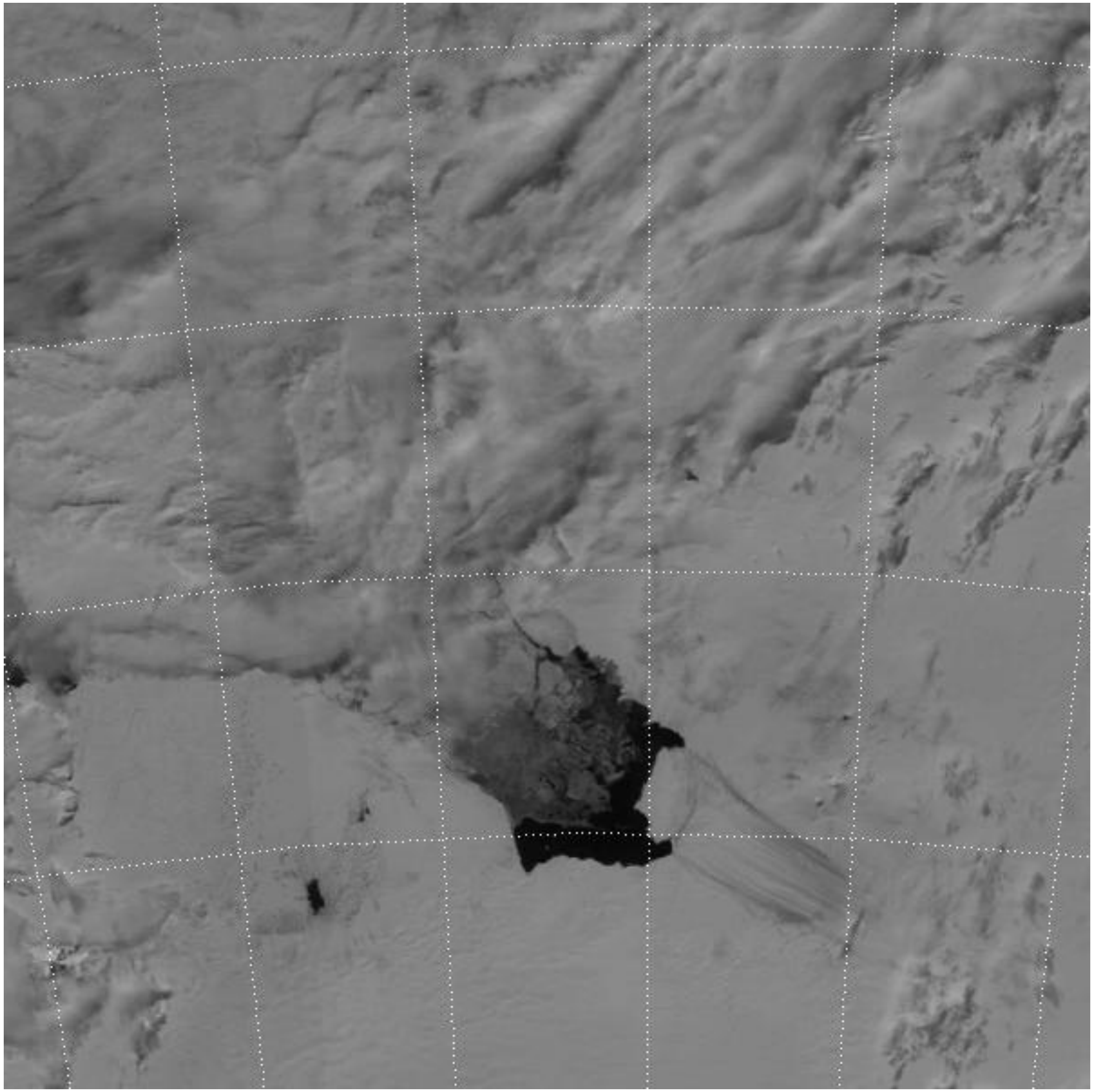
VIIRS DNB image, 1219 UTC, 7 October 2013



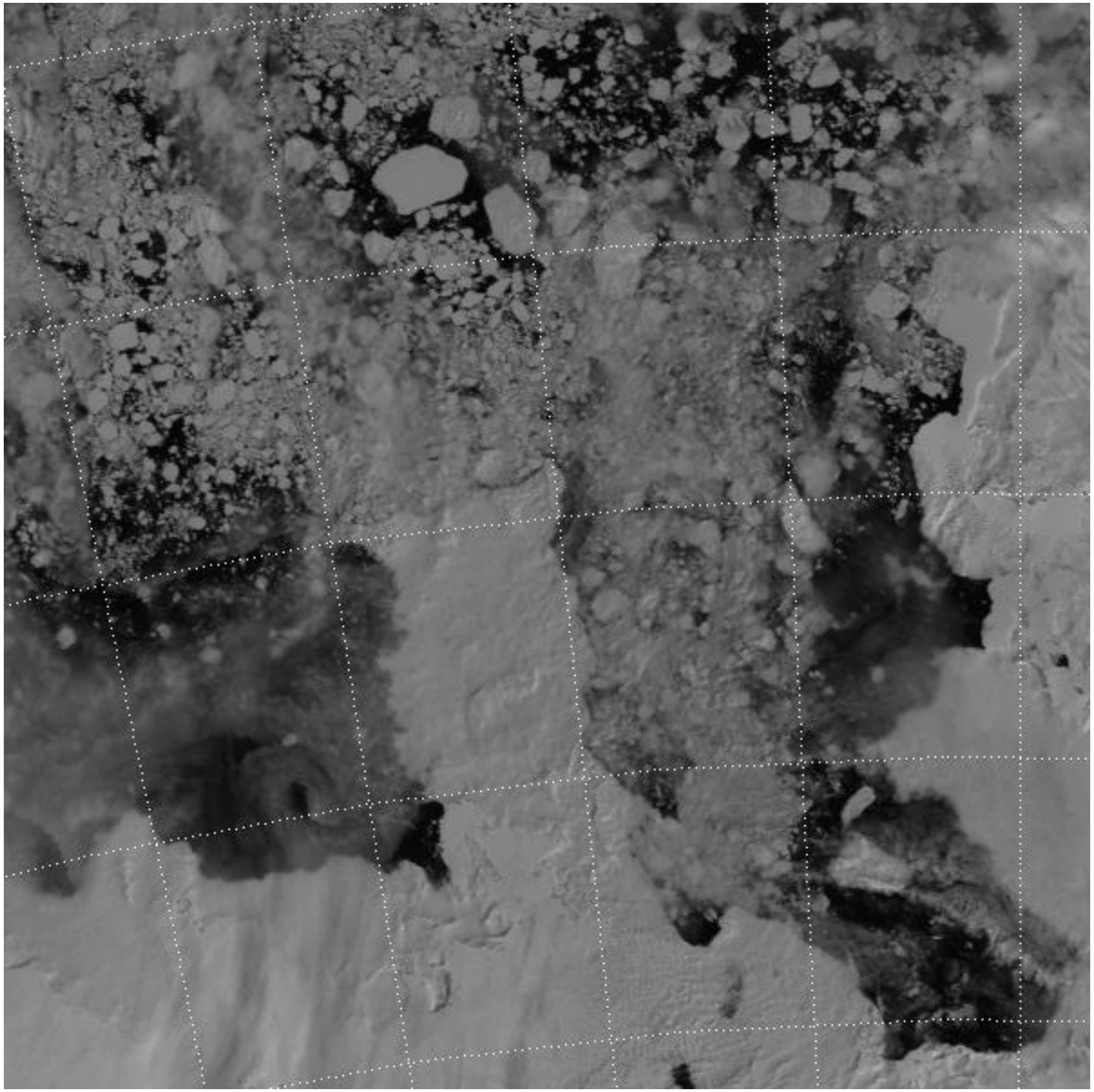
Note Aurora (as well as stray light), Prudhoe Bay lights, and Veniaminof volcano on Aleutian Islands

Animations of DNB/NCC Imagery

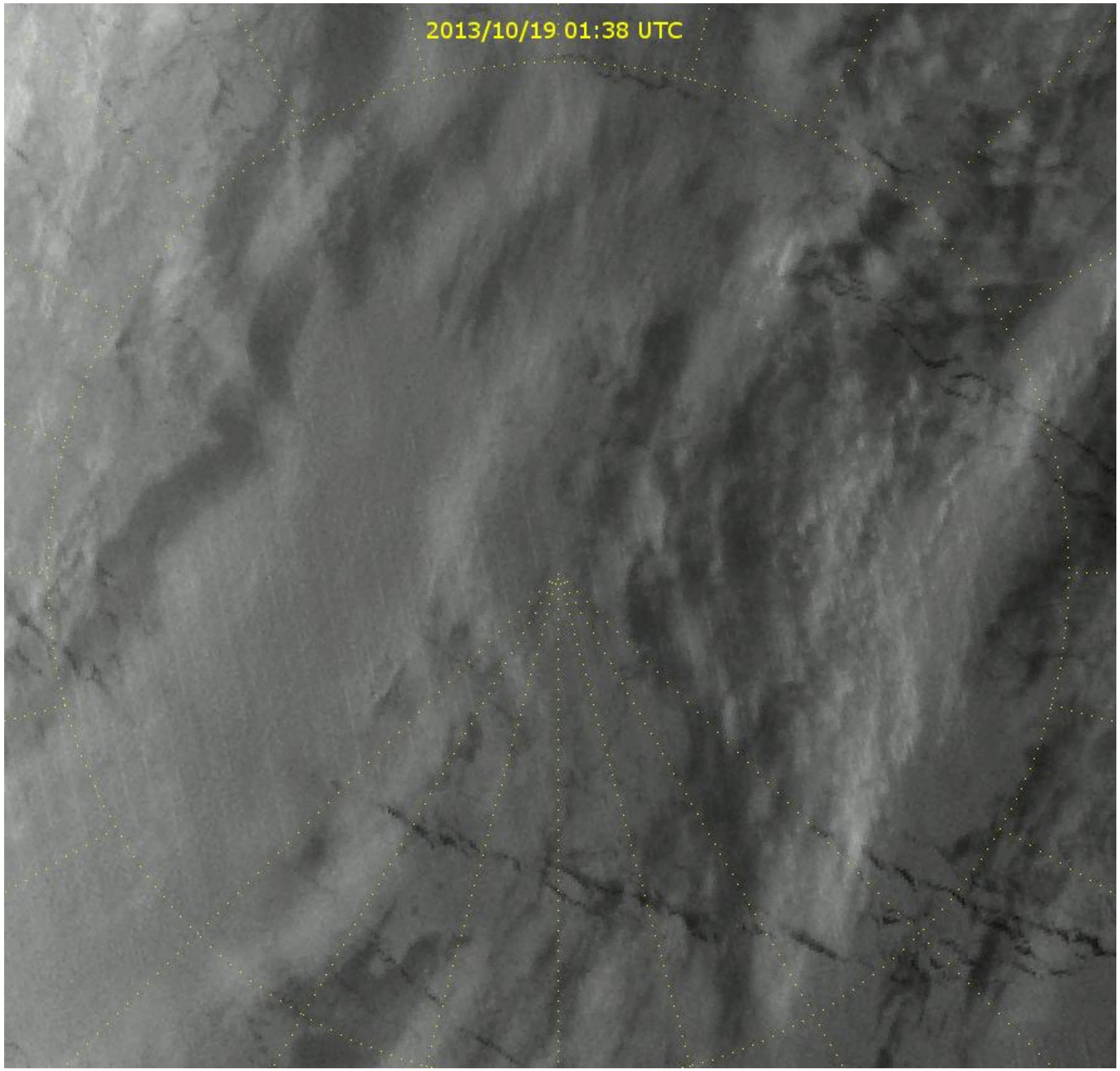
Animation of VIIRS NCC images of the Pine Island Glacier, 7-18 November 2013



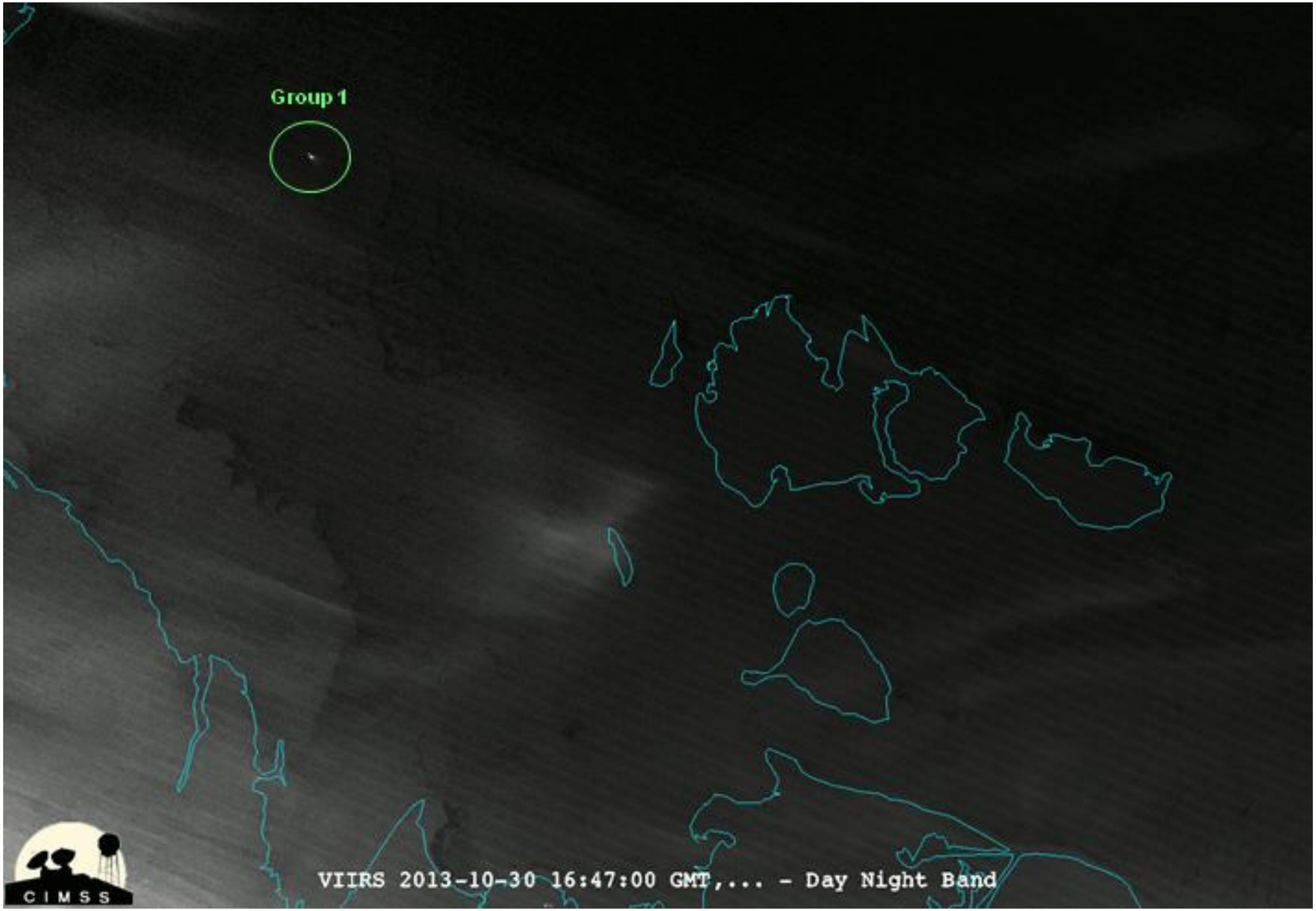
Animation of VIIRS NCC images of icebergs, 20-26 December 2013



Animation of VIIRS DNB images from 19-20 October 2013. The North Pole is located at the center of the image. Light from the ship carrying the 2014 Winter Olympic torch is visible.

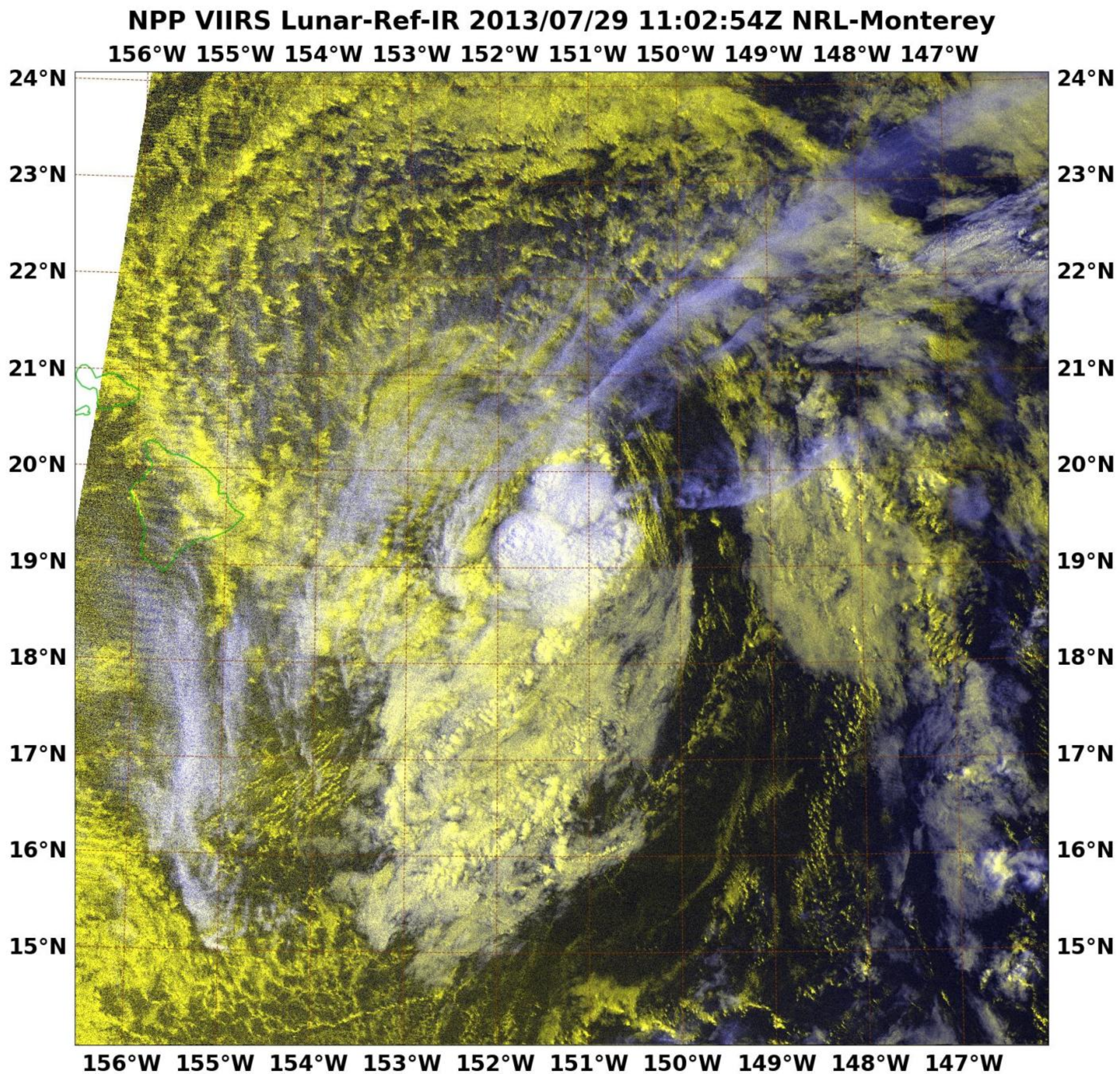


Animation of selected VIIRS DNB images from 30 October to 2 November 2013. Images courtesy William Straka III (CIMSS).



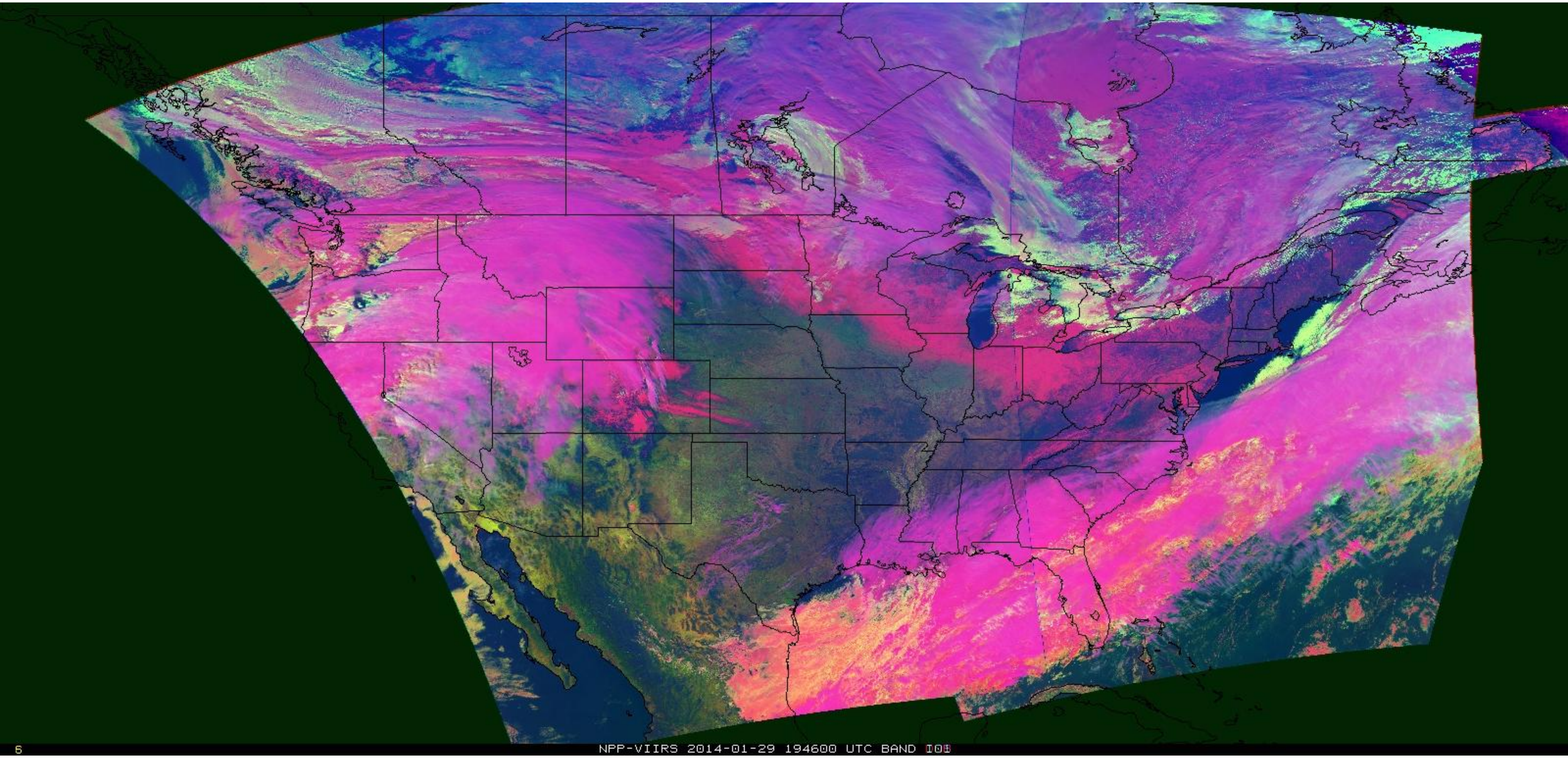
DNB/NCC Imagery in combination with non-NCC Imagery

DNB and IR combo @ night



~ 100 km difference between exposed low-level circulation center as denoted by VIIRS DNB and the sheared higher level convection further to the SE. Image courtesy of NRL-Monterrey.

3-color R/G/B (DNB/SWA/LWIR) @ day



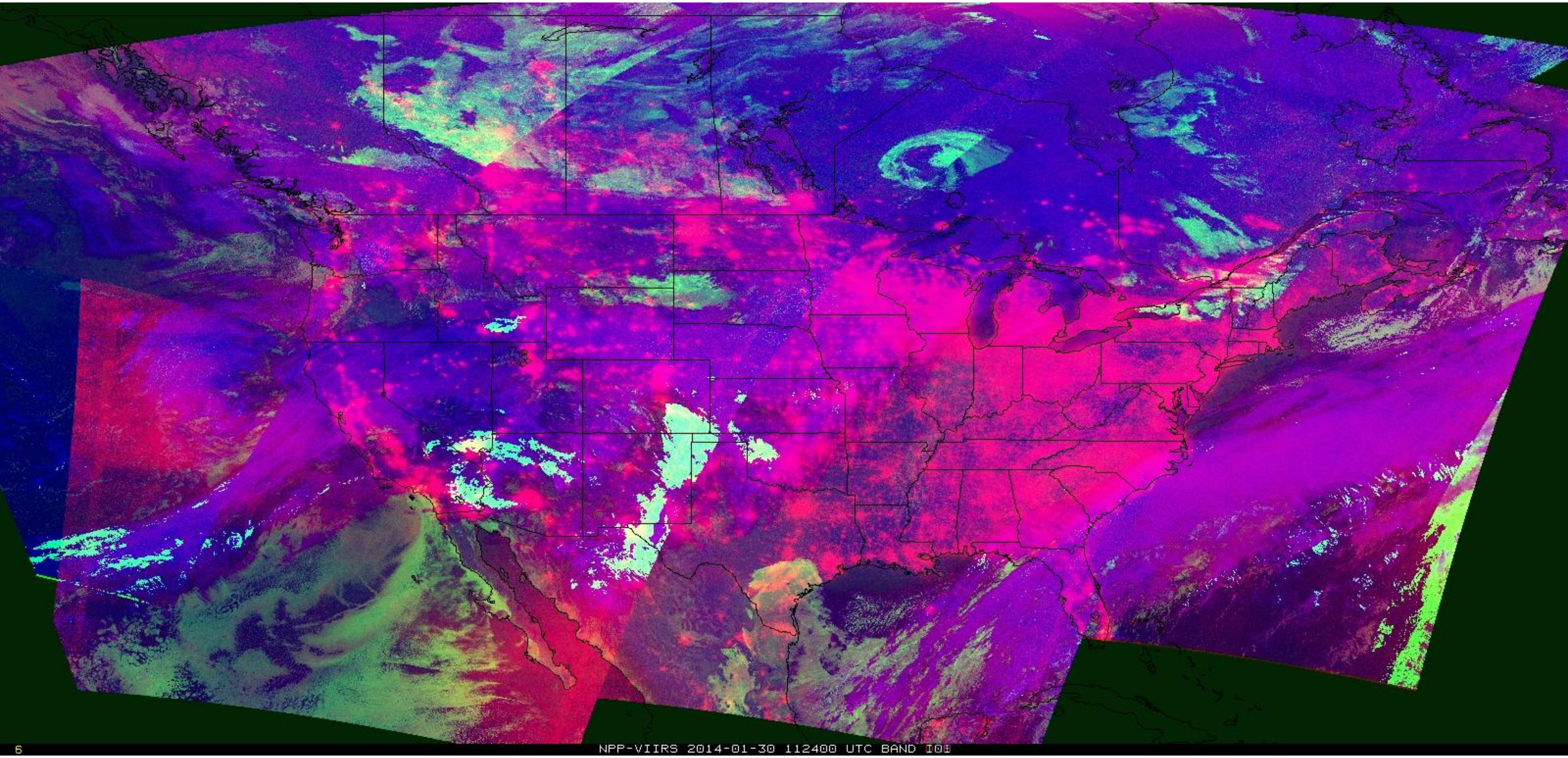
3-color/RGB combinations

	Red	Green	Blue
Day	I01/Visible	SW Albedo	LWIR
Day - alternative	DNB/NCC	SW Albedo	LWIR
Night	DNB/NCC	SW Albedo	LWIR

3-color/RGB product explanation

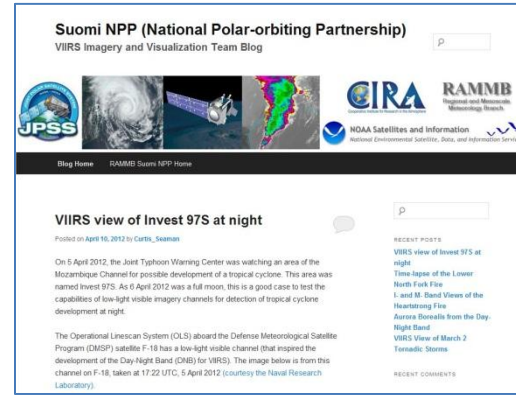
Color	Explanation
White/off-white	Low-clouds/stratus/fog
Green	Clear/land surfaces
Magenta-purple	Ice clouds
Magenta-red	Snow covered ground
Blue	Water surfaces

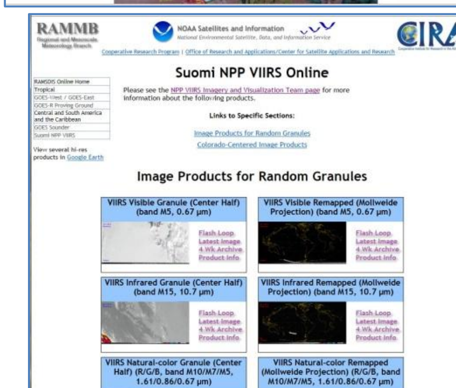
3-color R/G/B (DNB/SWA/LWIR) @ night



VIIRS Imagery outreach at RAMMB/CIRA

- VIIRS Imagery and image products outreach:
  - **VIIRS Imagery and Visualization Team Blog** (http://rammb.cira.colostate.edu/projects/npp/blog/)
  - **Seeing the Light: VIIRS in the Arctic** (http://rammb.cira.colostate.edu/projects/alaska/blog/)
  - **Suomi NPP VIIRS Online (including direct-broadcast imagery)** (http://rammb.cira.colostate.edu/ramsdis/online/npp_viirs.asp)
- NRL-Monterey uses of VIIRS:
  - **NexSat** http://www.nrlmry.navy.mil/NEXSAT.html
  - **VIIRS Cal/Val** http://www.nrlmry.navy.mil/VIIRS.html





Summary

- **VIIRS EDR Imagery (including NCC Imagery has reached the Validation 3 maturity stage in January 2014.**
- Feedback is still requested from users.
- **NCC** will continue as unique imagery on JPSS-1 and 2!
- Our only major concern is data latency for non-direct-broadcast users (~6 hours).

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