Suomi NPP VIIRS Imagery Update

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[3]The Aerospace Corporation
[4]Stellar Solutions
[5]Noblis

VIIRS Imagery Update

- **Imagery at Validation Maturity Stage 3**
- **VIIRS Imagery Users' Guide (to become a *NOAA Technical Report*)**
- **Low-latency (~1.5 h) VIIRS is available now**
  - **Also Direct Broadcast VIIRS (~20 min latency)**
- **DNB/NCC appear to be most popular band(s)**
  - **Sensitivity down to 2e-10 W cm^{-2} sr^{-1} at nadir (compared to the pre-launch specification of 3e-9 W cm^{-2} sr^{-1})**
- **New CIRA "Erf-dynamic-scaled (EDS)" DNB (potential NCC replacement?)**

VIIRS EDR Imagery to Validated 3 maturity stage

- VIIRS EDR Imagery was to reach the Validation 1 maturity stage, but was so successful as a product that **Validation 3 stage was attained**!
- **Both Non-NCC and NCC Imagery** attained this level simultaneously:
  - Non-NCC imagery has been well validated and ahead of NCC Imagery for months/years
  - NCC Imagery recently made significant advances in full coverage and stray light suppression (an SDR/DNB issue)
- The EDR Imagery Team has been tasked with **recommending requirements for VIIRS Imagery for JPSS-1 and 2**, in light of the current lax requirements that were largely eliminated in the transition from NPOESS to Suomi NPP.

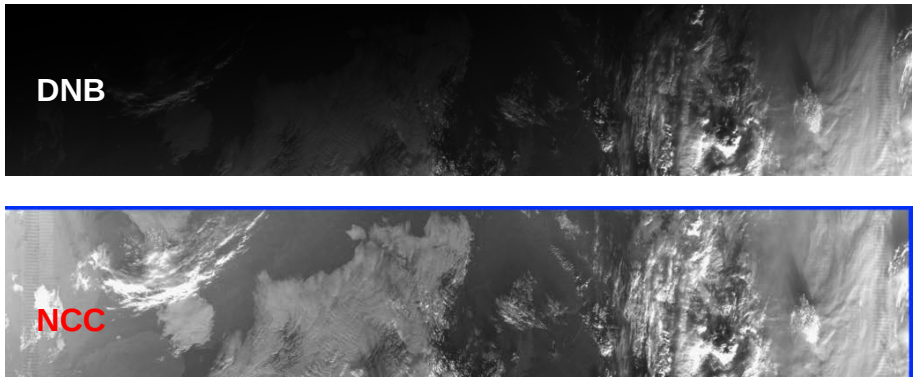


Figure: Comparison of DNB (SDR) with NCC (EDR) for a VIIRS granule that crosses the day/night terminator

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

Table: Comparison of DNB (SDR) with NCC (EDR) characteristics

Significance: VIIRS Imagery is ready for widespread operational use, with **the only major caveat being the long latency associated with VIIRS Imagery from non-direct-broadcast sources**.

(Courtesy of D. Hillger)

Sponsor: JPSS

Suomi-NPP VIIRS Imagery now with low latency (~1.5 – 2 hours)

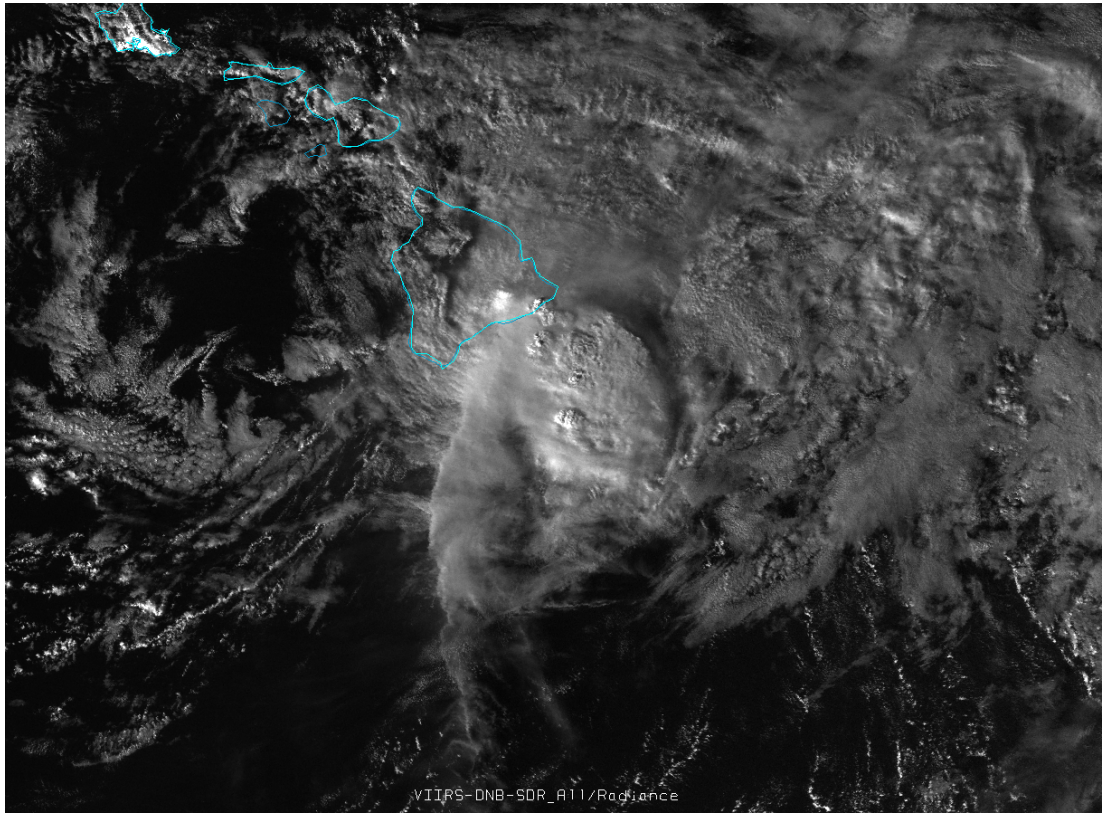
Suomi-NPP VIIRS Imagery now far more valuable to end users:

- I and M-band EDRs and both DNB and NCC Imagery
- Testing low latency thru November 2014, when it may end
- Gathering valuable low-latency uses in support of keeping it going
- DNB for Hurricane Iselle (Hawaii) [example at right]
- Posted to STAR JPSS website http://www.star.nesdis.noaa.gov/jpss/Iselle.php
- Imagery Team responds to VIIRS Imagery calls as needed

Next project is to work towards having all 16 M-bands turned into EDRs:

- Presently only 6 of the 16 M-bands are EDRs
- Working slowly thru the CCR process

(D. Hillger, D. Lindsey)



VIIRS DNB Image of Hurricane Iselle

8 August 2014, 1222 UTC.

Suomi-NPP VIIRS day-night visible/reflective imagery

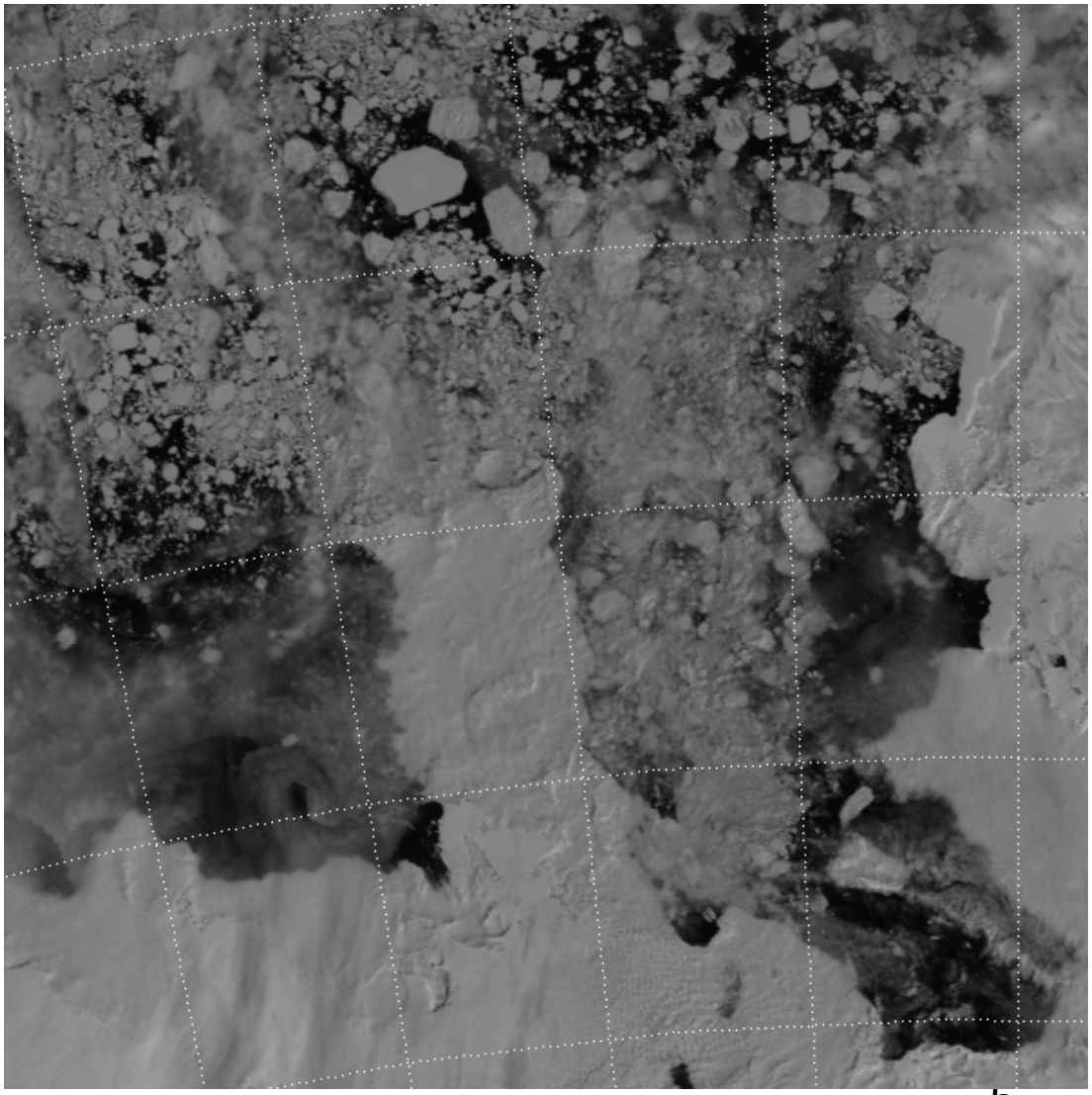
Suomi-NPP VIIRS Imagery:

- 16 Medium-resolution bands
- 5 Imagery-resolution bands
- Day-Night-Band (DNB)

Near-Constant Contrast (NCC) Imagery product:

- Derived from the DNB
- Reached the Validation 1 level in January 2014
- Fully "operational" and available to all users
- Highly valuable in northern latitudes
    - Visible/reflective imagery available during long dark periods in winter
    - Frequent views/passes in polar regions
- Only caveat is the long (~6 h) latency for non-direct-broadcast product

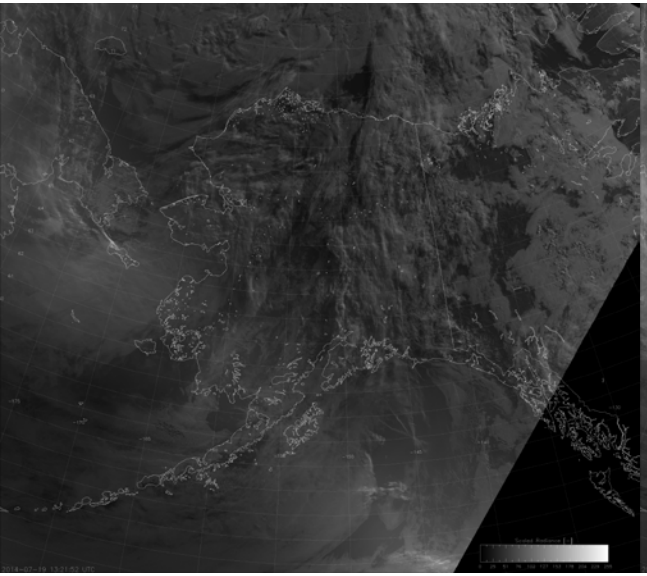
(Courtesy of D. Hillger, C. Seaman)



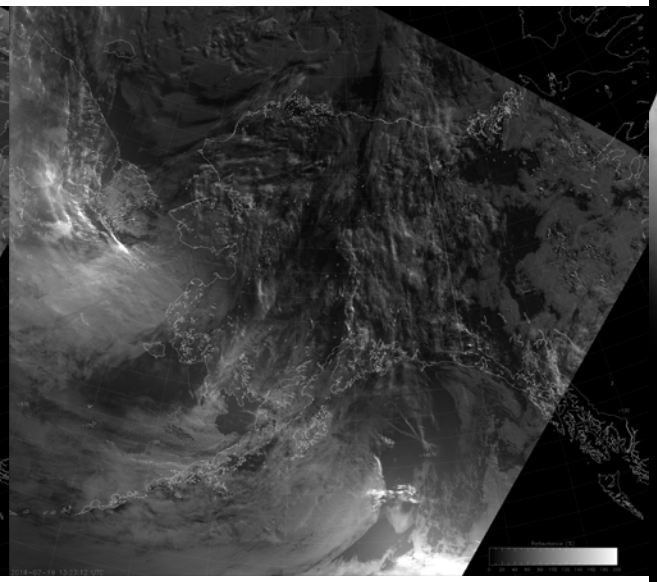
<u>Animation</u> of VIIRS NCC images of icebergs, 20-26 December 2013

13:22 UTC 19 July 2014

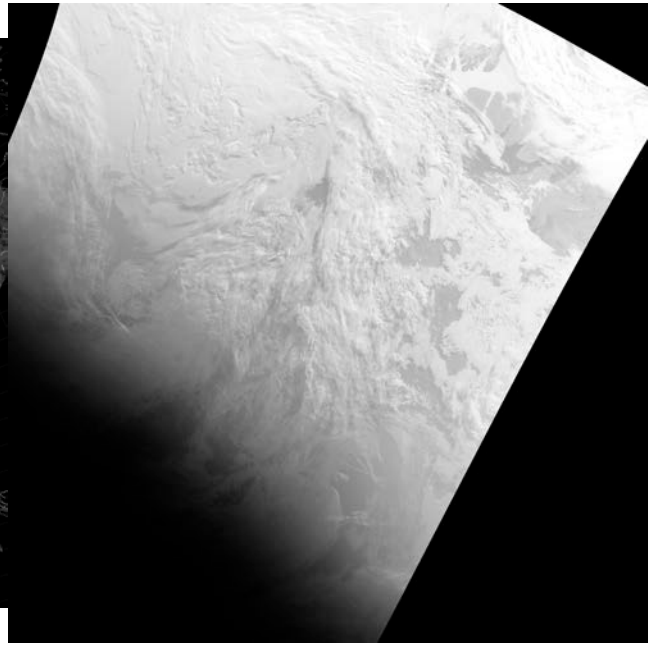
CIRA “ERF-scaled” DNB



NCC



CSPP/GINA DNB



Proposed CIRA method to produce NCC-type imagery from DNB
Transition from day (top right) to night (lower left) 1 night after last quarter

(Courtesy of C. Seaman, CIRA)

VIIRS EDR Imagery Basics

- The **Imagery EDR** is the projection of SDRs onto a **Ground Track Mercator (GTM)** layout (remapped)
  - For the non-DNB/NCC bands: the radiances or reflectances are the same
  - For the **DNB (SDR): the Near Constant Contrast (NCC) EDR** Imagery product has additional calculations involved
- Advantages of Imagery EDRs:
  - Bowtie-deletions eliminated
  - Overlapping pixels eliminated
- Current EDR Imagery:
  - 5 I-bands (all of them)
  - 6 of the 16 M-bands (default set, leaving 10 M-bands behind!)
  - An Imagery Team goal is to have all 16 M bands as EDRs.

SDRs and EDRs: What's the difference?

FILL VALUE LEGEND

Unmapped SDR and EDR granules from 08:14 UTC 24 October 2013

VIIRS Bands Created as EDR Imagery

Bands in bold and highlighted in grey are available as <u>Imagery EDRs</u>.

VIIRS Band	Central Wavelength (µm)	Wavelength Range (µm)	Band Explanation	Spatial Resolution (m) @ 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	0.672	0.662 - 0.682		
M6	0.746	0.739 - 0.754	Near IR	
M7	0.865	0.846 - 0.885		
M8	1.240	1.23 - 1.25	Shortwave IR	
M9	**1.378**	**1.371 - 1.386**		
M10	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 (NCC)	**0.7**	**0.5 - 0.9**	Visible	750 m across full scan
I1	**0.64**	**0.6 - 0.68**	Visible	375 m
I2	**0.865**	**0.85 - 0.88**	Near IR	
I3	**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	

NCC (EDR) vs. DNB (SDR)

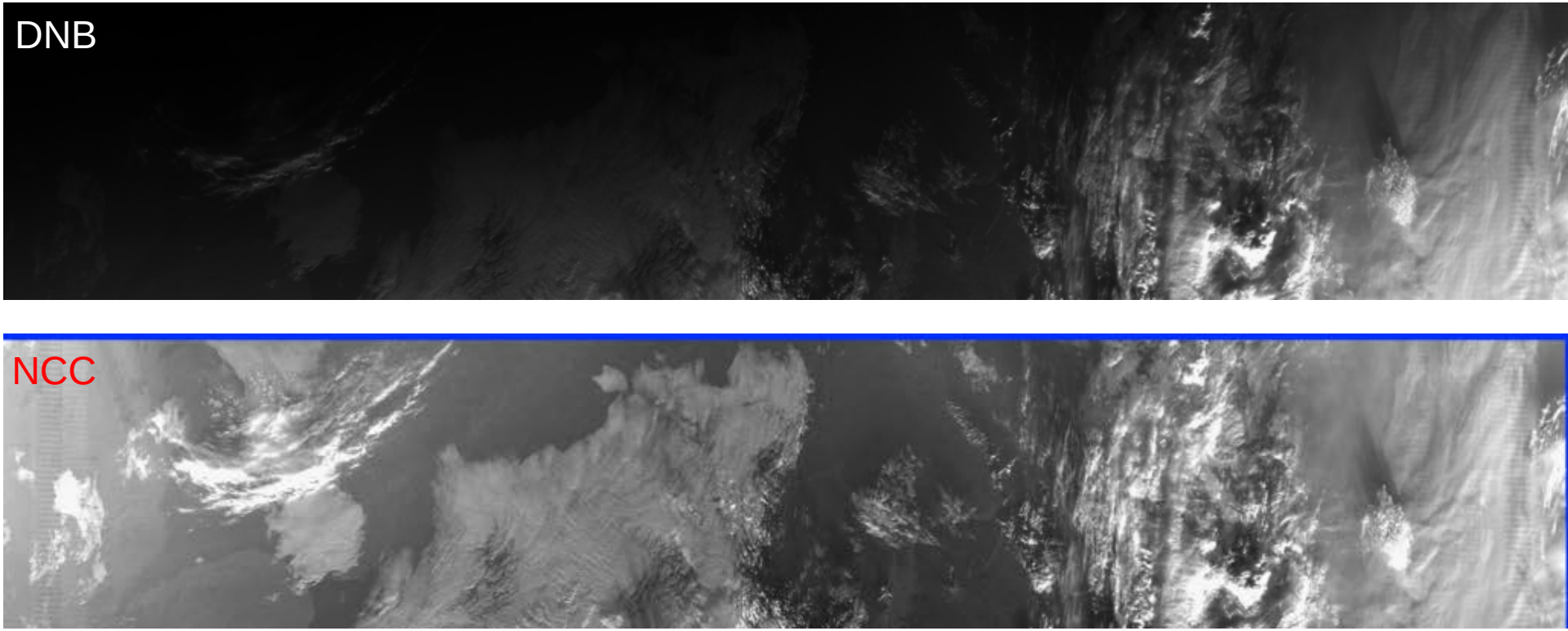
- **What are the differences?**

Product	xDR	Units	Mapping	Spatial Resolution
DNB	SDR	Radiances	Raw	750 m (across full scan)
NCC	EDR	Pseudo-albedos	GTM	750 m (across full scan)

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

Near Constant Contrast (NCC) Product

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



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

Algorithm Cal/Val Timeline (now into Long Term Monitoring (LTM))

Product	ICV			LTM
	Beta	Provisional	Validated (Validated-3)	
EDR ("non-NCC")	2012-05-30 (backdated to 2012-02-07)	2013-02-20 (backdated to 2013-01-18)	2014-04-23 (backdated to 2013-08-20)	Ongoing
EDR ("NCC")	2012-10-24 (backdated to 2012-07-18)	2013-09-04 (backdated to 2013-08-21)		

Notes:

"Non-NCC" Imagery includes all EDRs **except** NCC

"NCC" Imagery is the NCC EDR **only**

LTM Methods/Strategies

- **Capture VIIRS SDRs and EDRs from various sources:**
  - **Granule imagery (generally long latency, except by special request)**
  - **Direct Broadcast Imagery (low latency)**
- **Display VIIRS Imagery:**
  - **Individual bands**
  - **Multi-band products**
    - **True-color Imagery**
    - **Other 3-color/RGB Imagery**
  - **DNB and NCC**
- **Forward Imagery and Image products to selected users:**
  - **NWS via AWIPS-I and II**
  - **Alaska users**

S-NPP/JPSS data sources

- **GRAVITE[1]** (NSOF, Suitland, ~7-hour delay/latency)
- **NOAA CLASS[2]** (Asheville, ~7-hour delay) – not actively used
- **Atmosphere PEATE[3]** (Wisconsin, ~7-hour delay)
  - ADDE server for McIDAS
  - FTP and HTML
- **Direct Readout** (Wisconsin, ~0.5-hour delay, <u>only over North America</u>, when the satellite is with sight of Madison or Oregon)
  - ADDE server for McIDAS
  - FTP
- **AFWA IDPS[4]** (Omaha, near real-time) [to be discontinued]
- **NDE (NPP Data Exploitation)** (~1.5 hour delay)

[1]Government Resource for Algorithm Verification, Independent 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

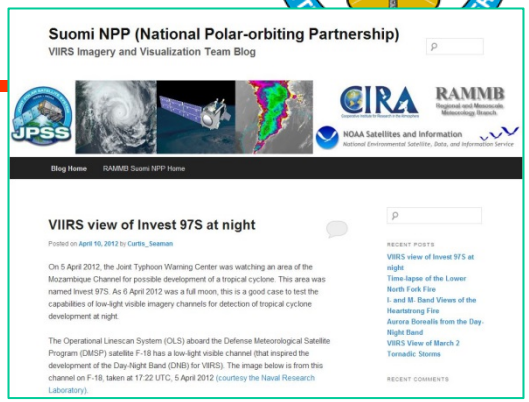
LTM Tools

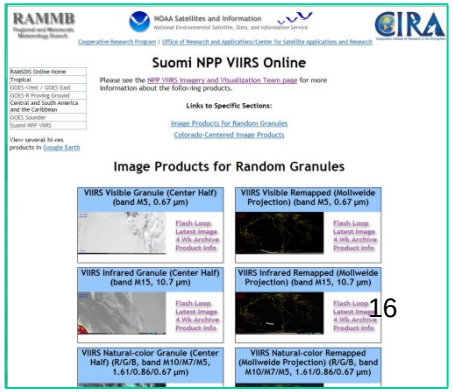
- **McIDAS:**
  - McIDAS-X
  - McIDAS-V
- **IDL (C. Seaman, S. Miller):**
  - Imagery for Realtime Display over Alaska
  - Imagery for VIIRS Blogs
  - NCC, DNB, and “EDS” DNB
- **TeraScan (S. Miller)**
  - Specialized products for dust, smoke, ash, etc.
  - DNB applications

VIIRS Imagery outreach at RAMMB/CIRA and others

- 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
- **NGDC Earth Observation Group (EOG):**
  - **VIIRS DNB** http://ngdc.noaa.gov/eog/viirs.html

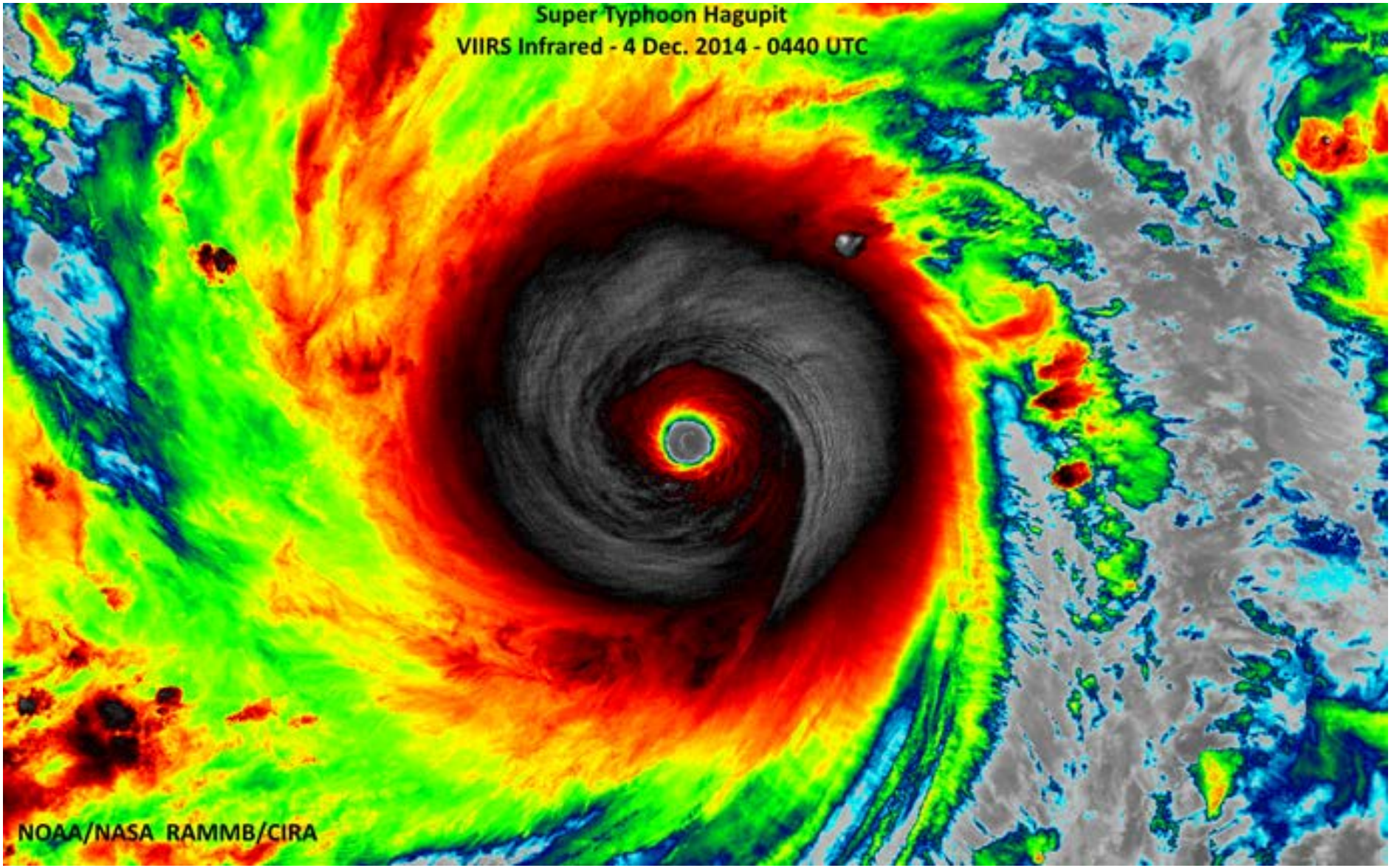




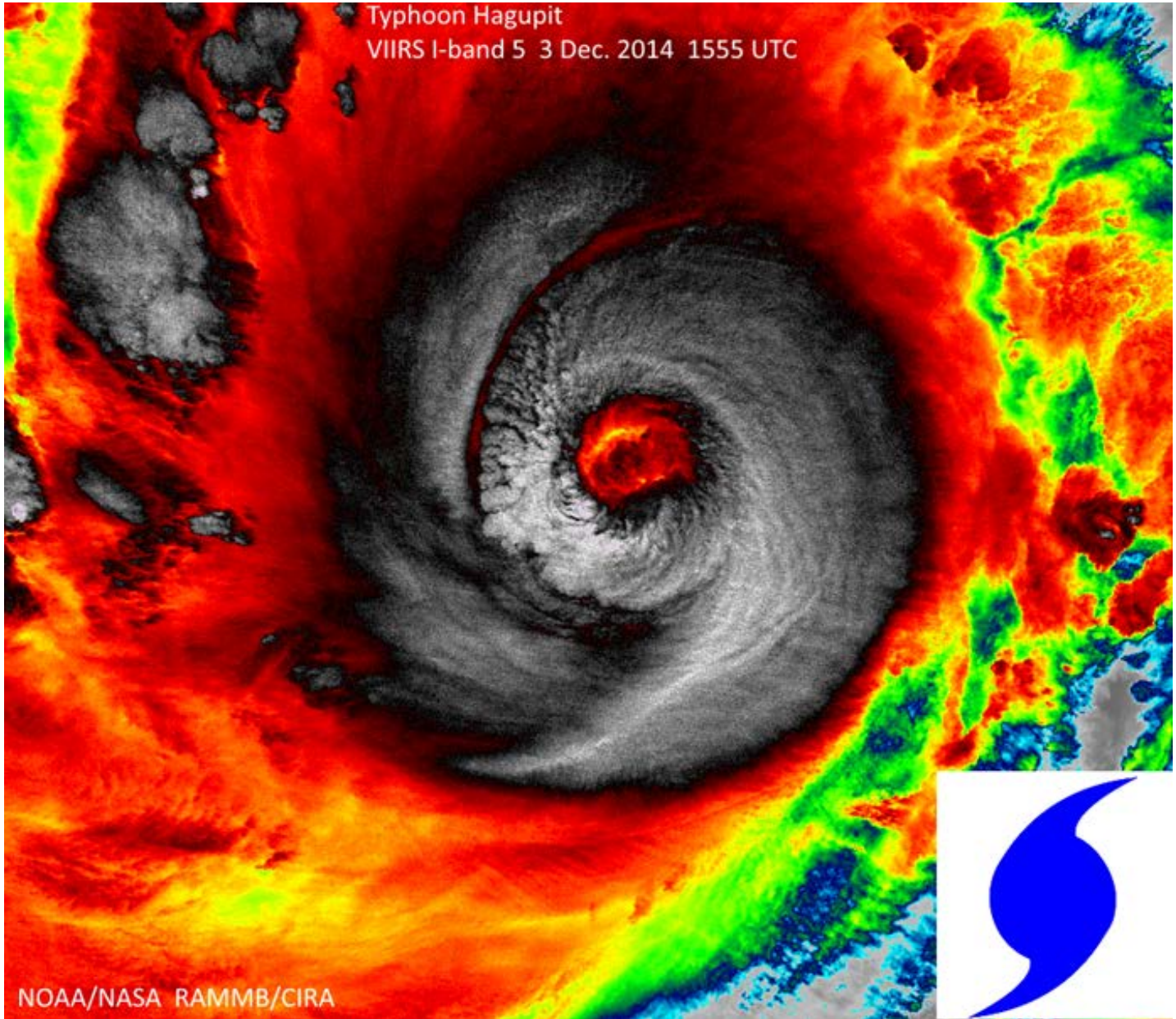
Imagery Enhancements

- **DNB (and NCC) are welcome additions**
  - **Added (visible/reflective) information at night not available previously (except from DMSP OLS)**
  - **Attracts new users and applications**
- **Enhanced "Erf-dynamic-scaled (EDS)" DNB in development**
  - **Product is a cross between DNB and NCC**
  - **Improved cross-terminator applications (in particular)**
- **Need additional M-band Imagery EDRs**
  - **Currently only 6 of 16 M bands are available as EDRs**
  - **SDRs have bowtie deletions and overlapping pixels**
- **Continue or expand low latency VIIRS availability**
  - **Imagery much less valuable when delayed**

VIIRS Imagery of Typhoon Hagupit



VIIRS Imagery of Typhoon Hagupit



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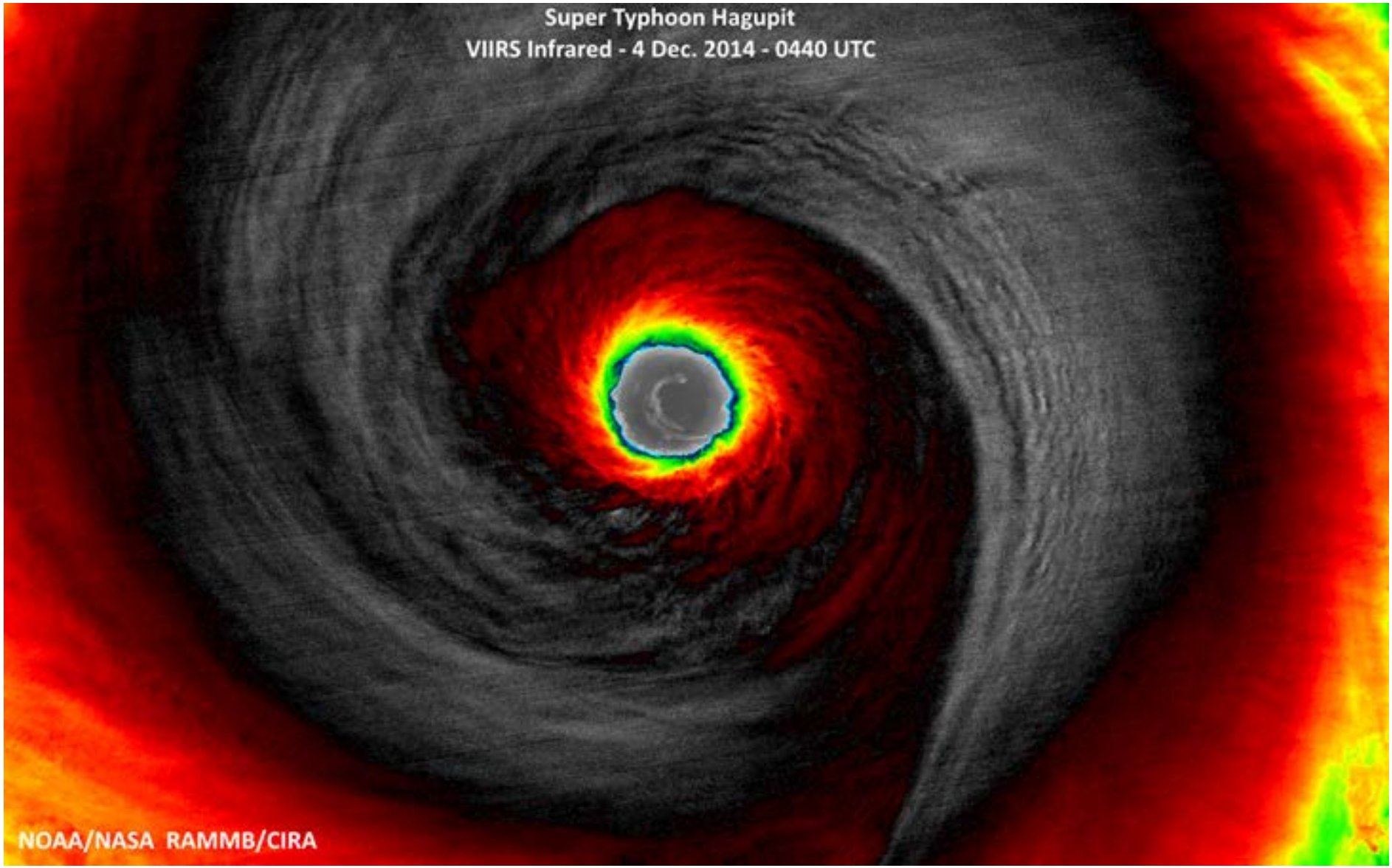
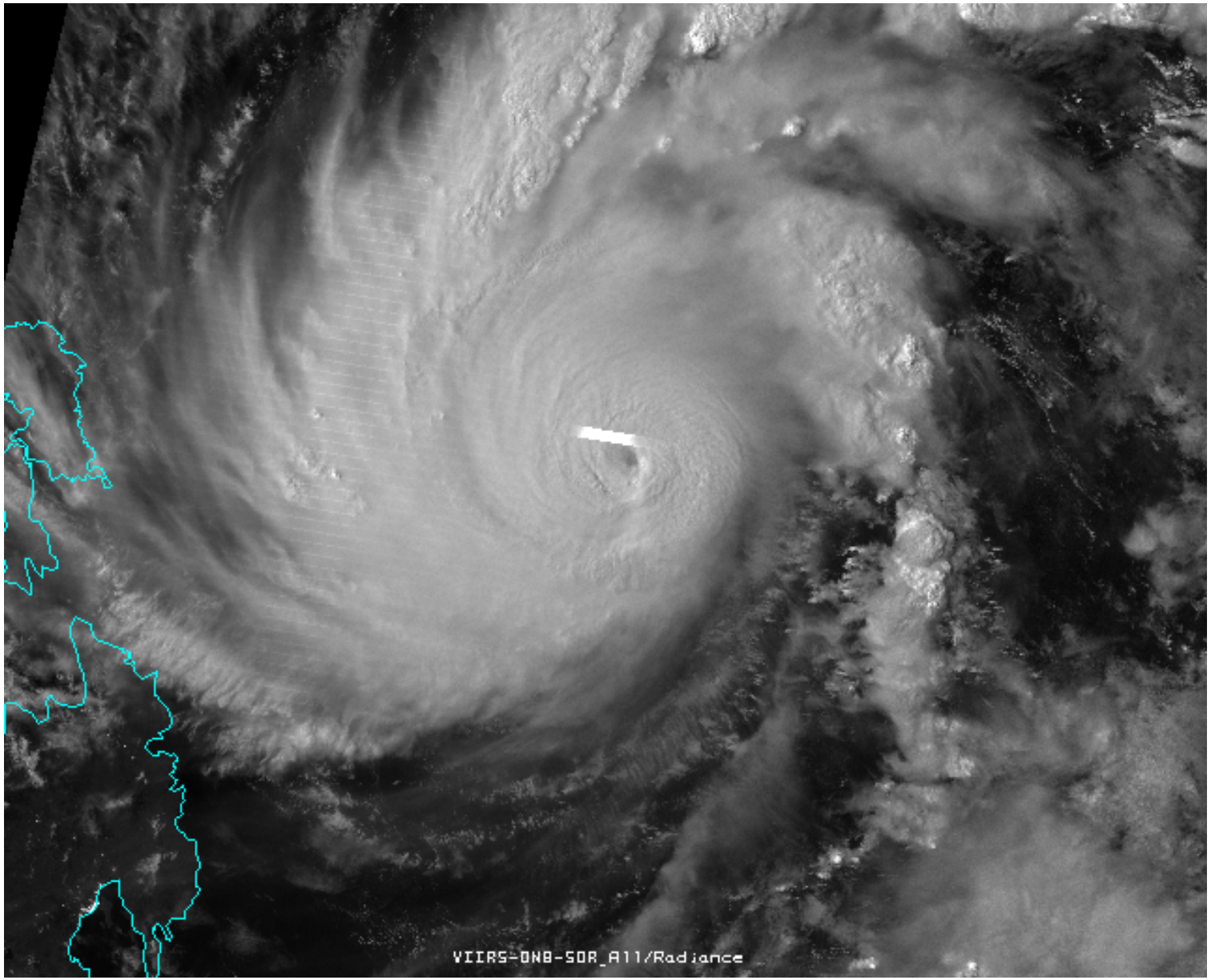
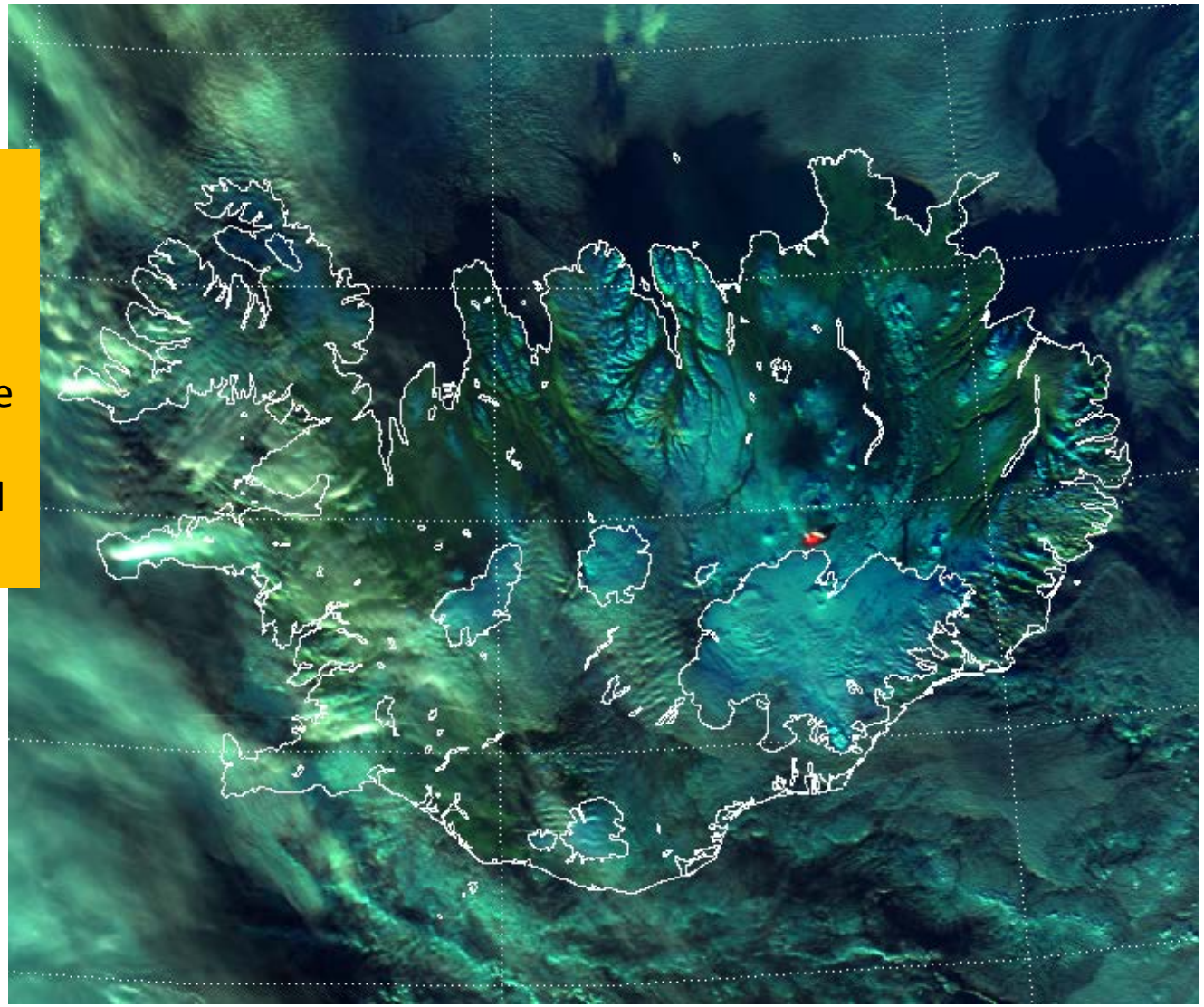


VIIRS Imagery of Typhoon Hagupit



The Eruption of Bárðarbunga

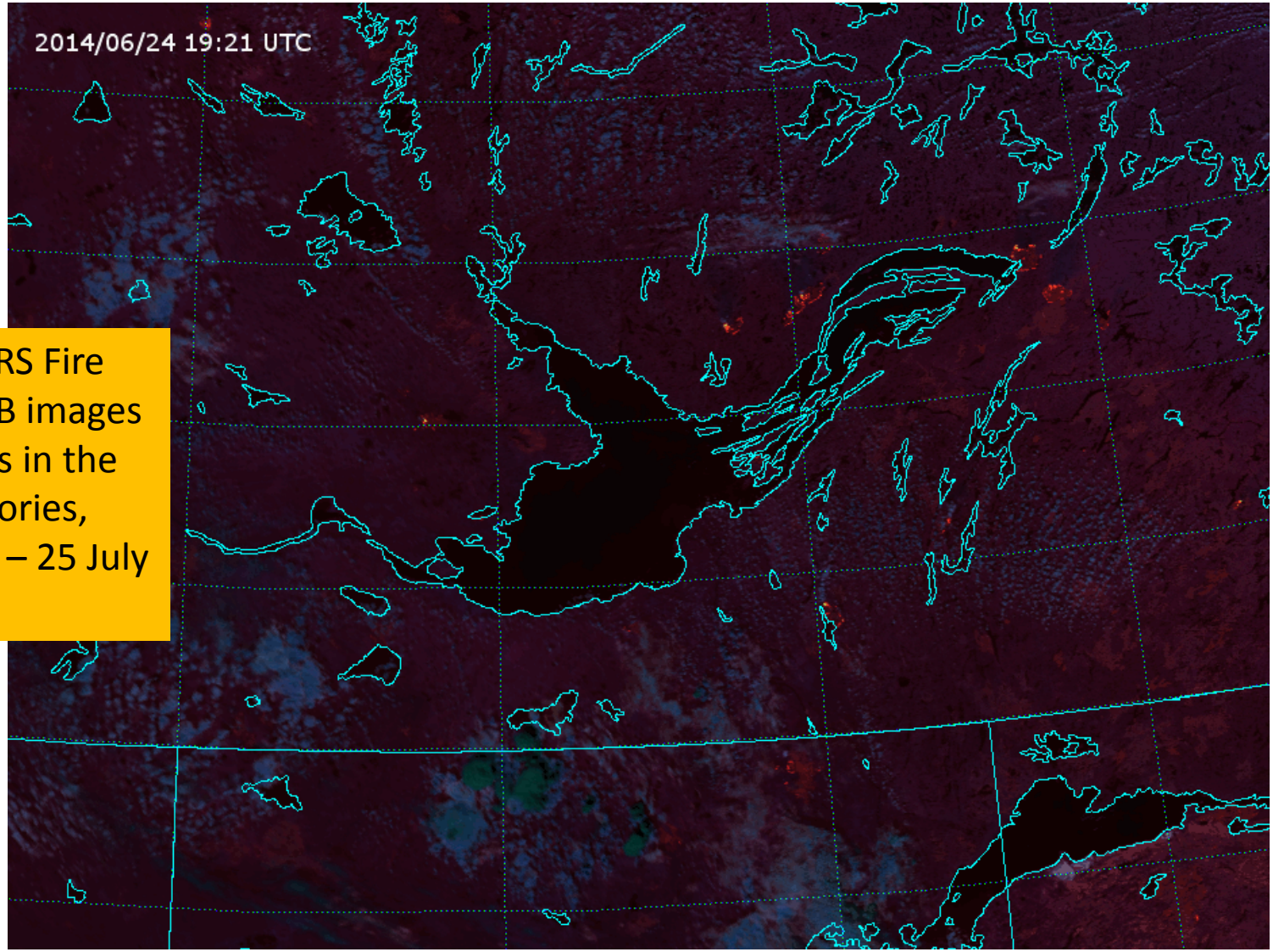
The Icelandic volcano, Bárðarbunga, has been erupting continuously since 28 August 2014. VIIRS captured this image showing the lava in red, snow and ice in cyan and vegetation in green.



M-4/0.55 µm, M-7/0.86 µm, M-11/2.25 µm 13:42 UTC 17 November 2014

http://rammb.cira.colostate.edu/projects/npp/blog/index.php/uncategorized/bardarbunga-the-toxic-tourist-trap/

A summer of wildfires in NWT, Canada



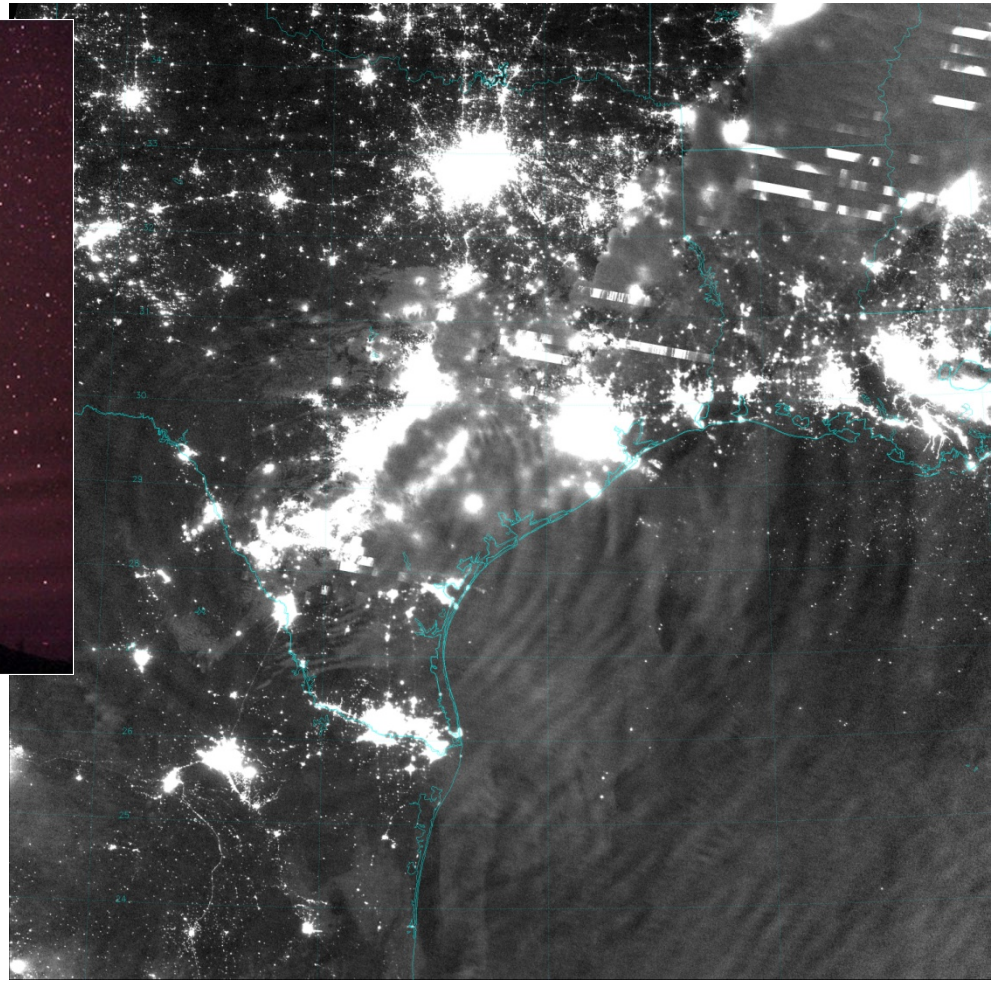
Animation of VIIRS Fire Temperature RGB images showing wildfires in the Northwest Territories, Canada (24 June – 25 July 2014).

M-10/1.61 µm, M-11/2.25 µm, M-12/3.74 µm

http://rammb.cira.colostate.edu/projects/npp/blog/index.php/uncategorized/when-canada-looks-like-china/

Mesospheric gravity waves in the DNB

Mesospheric bore (T. Ashcroft and W. Lyons)

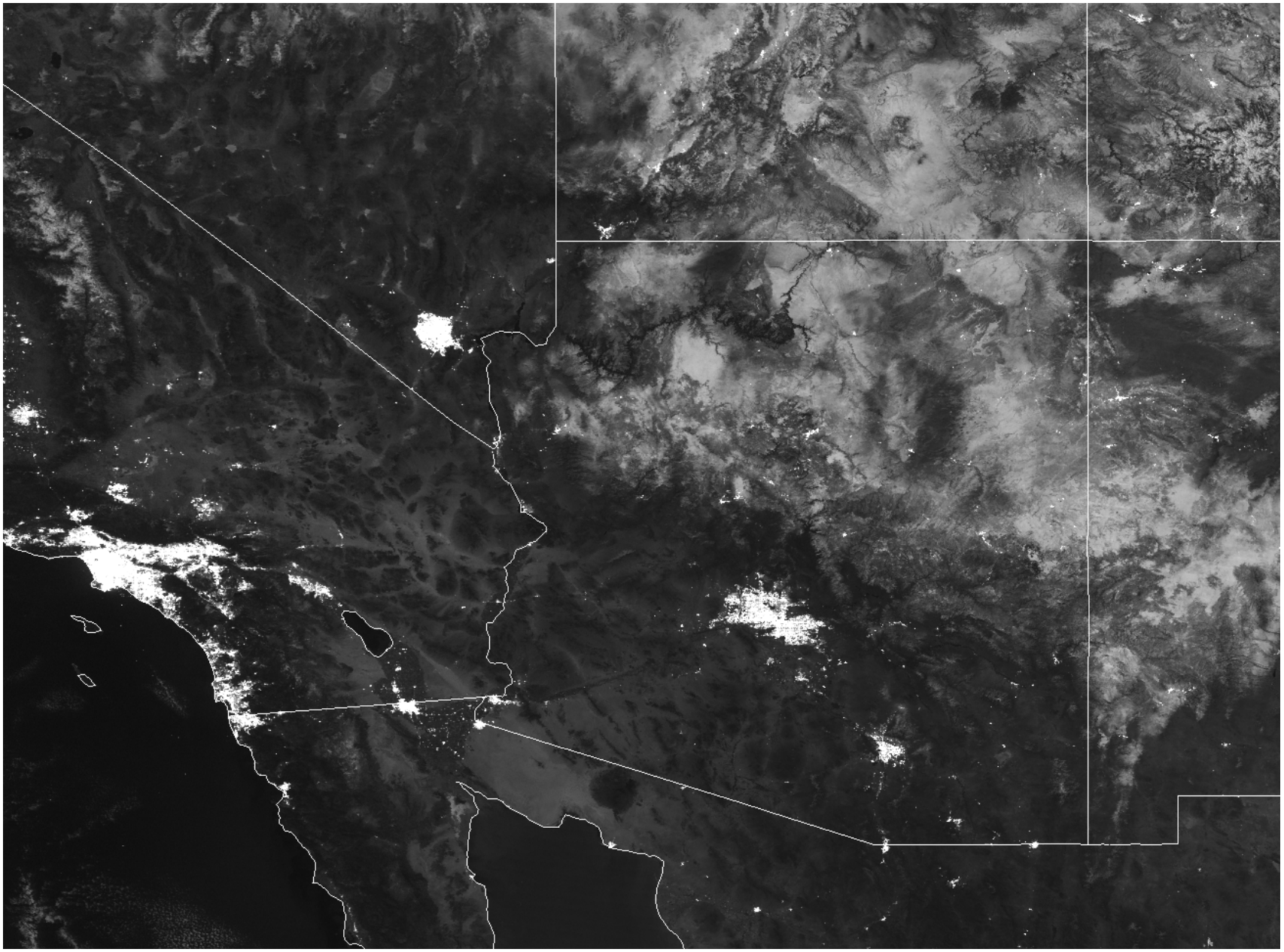


VIIRS DNB image (CIRA) 08:13 UTC 4 April 2014

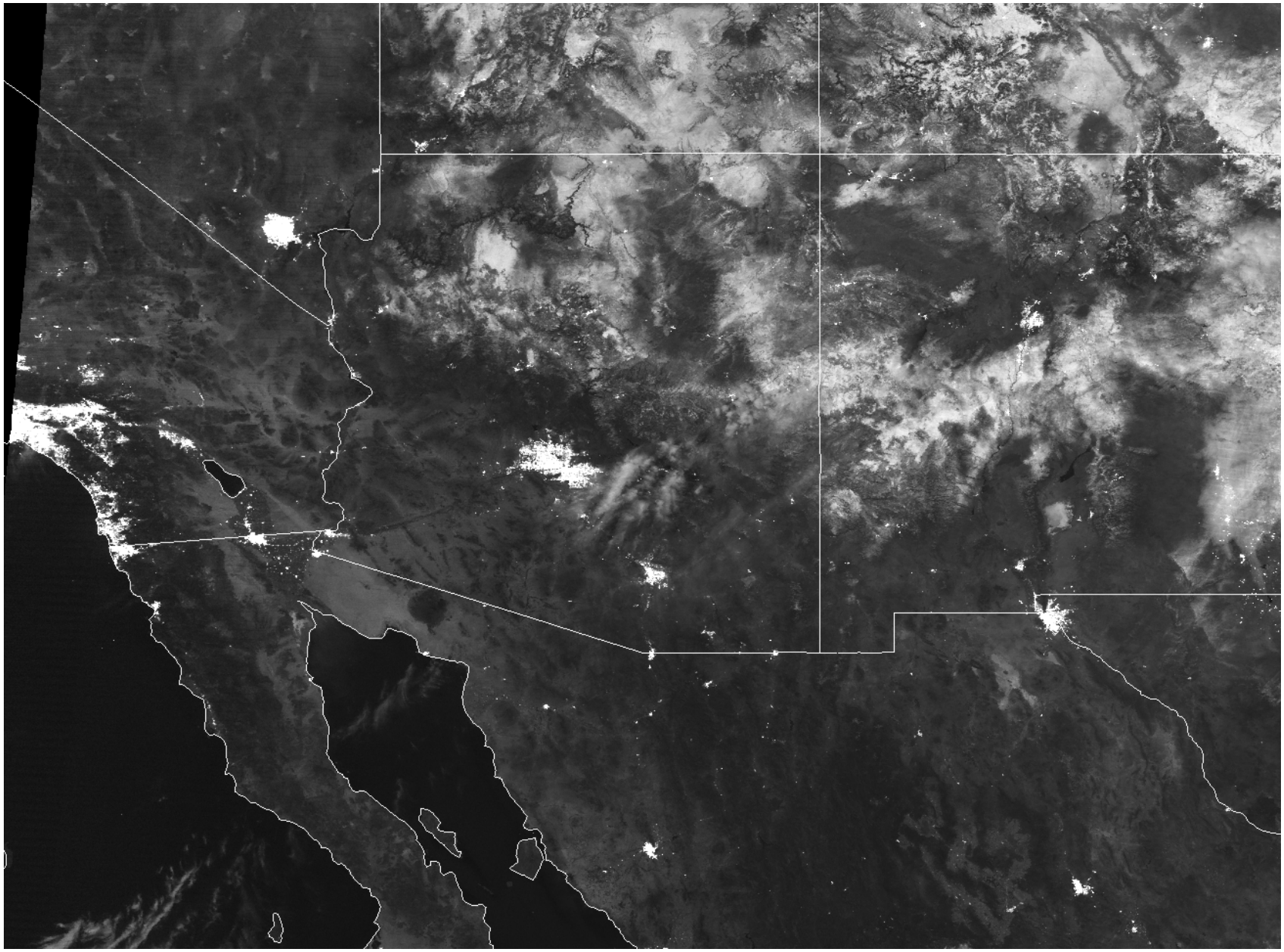
The VIIRS DNB is sensitive to airglow, which is affected by gravity waves in the mesophere. The waves seen in the DNB image were forced by a severe thunderstorm over Texas. The photo above shows mesospheric waves captured by low-light photography. These waves are important for global energy transport.

http://rammb.cira.colostate.edu/projects/npp/blog/index.php/uncategorized/severe-weather-in-the-mesosphere/

Phoenix – 4 January 2015



Phoenix – 5 January 2015



Summary

- **VIIRS Imagery is <u>excellent</u>:**
  - The I-bands provide <u>high-resolution imagery</u> of tropical storms, thunderstorms, RGB imagery, etc., depicting details in cloud formations or on the ground which were not seen before (as noted in many of the VIIRS Blogs and VIIRS Imagery provided as examples)
- **Users especially like <u>DNB</u> and/or <u>NCC</u>**
- **Some Improvements in VIIRS Imagery are possible:**
  - **<u>Improved "EDS" DNB product</u>**
  - **Additional (all 16) M-band EDRs desired**
- **<u>Data latency</u> is main realtime usage issue**