Validated Maturity Science Review For NOAA-20 EDR Imagery/NCC

Presented by Don Hillger, PhD
Date: 2018-08-22

Outline

- Algorithm Cal/Val Team Members
- Product Overview/Requirements
- Evaluation of algorithm performance
- User Feedback (Alaska, in particular)
- Documentation (Science Maturity Check List)
- Conclusion and Path Forward

Imagery Cal/Val Team Members/Major Contributors

Name	Organization	Major Task
Don Hillger	NESDIS/StAR	Imagery Product Lead
Tom Kopp	Aerospace	Imagery Cal/Val Lead
Curtis Seaman	CIRA	Imagery/DNB expert
Steven Miller	CIRA	DNB/Imagery expert
Jorel Torres	CIRA	JPSS Liaison / trainer
William Straka III	CIMSS/SSEC	Imagery/DNB expert
Steve Finley	CIRA	IT/data expert
Rosalie Marley	GST	Imagery JAM
Chris Elvidge	NCEI-Boulder	Operational DNB products online
Arunas Kuciauskas	NRL-Monterey	VIIRS Online (for Naval use in particular)
Eric Stevens, Melissa Kreller, Carl Dierking, Nate Eckstein, Jay Cable	Alaska: GINA and NWS	NWS (use in analysis and forecasting)
John Evans, John Paquette	NWS	AWIPS ingest and display

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	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 / NCC	0.7	0.4	0.5 - 0.9	Visible	750 m across full scan
I1	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 EDRs are highlighted in pale yellow, in addition to I-band EDRs.
True-color component bands are highlighted in red, green, and blue.

Requirement Check List – VIIRS Imagery (L1RDS-134)

Attribute	Requirement	Meet Requirement (Y/N)?
Applicable Conditions:	The Imagery EDR shall be delivered under all weather conditions, including any rain rate	Yes
a. Horizontal Spatial Resolution for visible and IR imagery resolution bands		
1. Nadir	0.4 km	Yes
2. Edge of Swath	0.8 km	Yes
3. Night-time visual, Nadir	2.6 km	Yes
b. Horizontal Spatial Resolution for moderate resolution bands		
1. Nadir	0.8 km	Yes
2. Edge of Swath	1.6 km	Yes
c. Mapping Uncertainty, 3 Sigma		
1. Nadir	1 km	Yes
2. Edge of Swath	3 km	Yes
3. Night-time visual, Nadir	TBS	Yes
d. Refresh for Visible and IR Bands	At least 90% coverage of the globe every 12 hours (monthly average)	Yes

Requirements (continued)

The **Imagery** product consists of:

- **Visible/IR radiances/reflectances** remapped to the **Ground Track Mercator (GTM**) grid, eliminating overlapping pixels and bowtie deletions.
  - I-band and M-band Imagery
- **NCC Imagery** that is a **pseudo-albedo** derived from the DNB, creating an image product that removes large contrasts in DNB from day to night across the terminator.

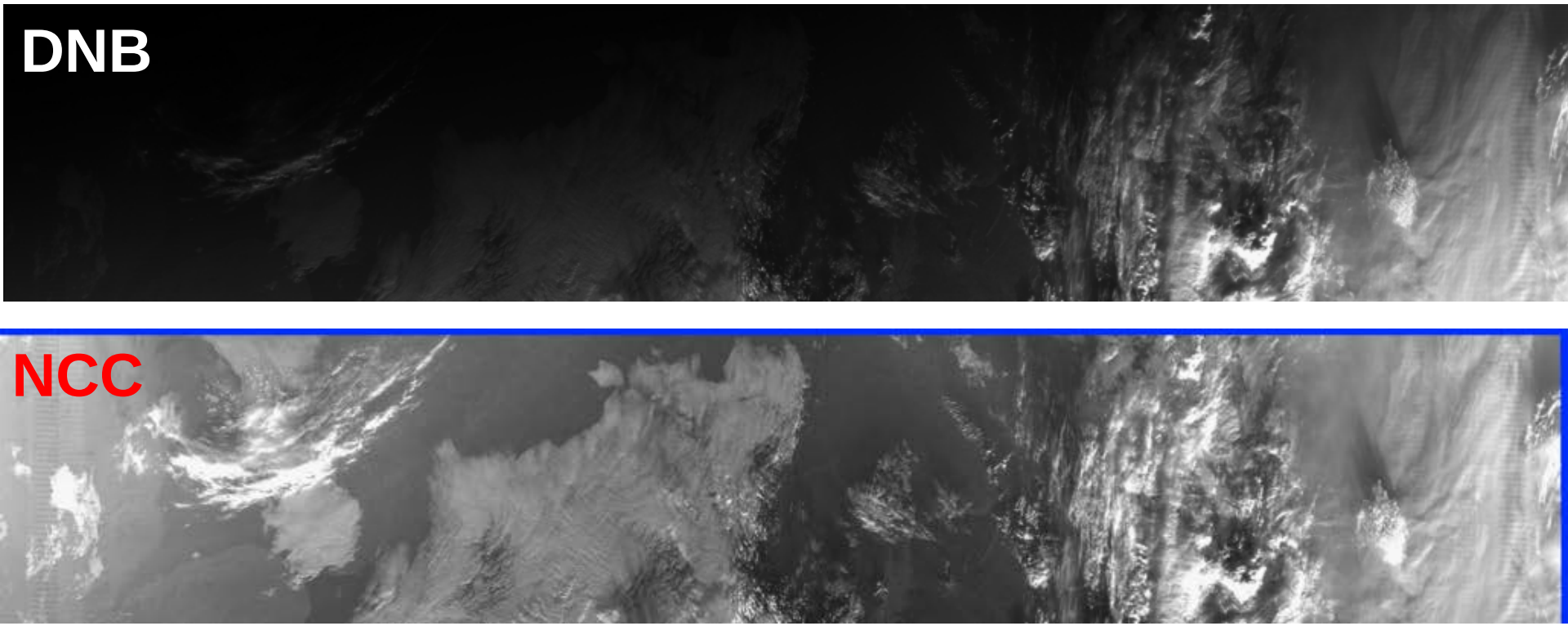
Imagery is a Key Performance Parameter (KPP)

VIIRS Imagery EDR for (8) bands I1, I3, I4, I5, M14, M15, M16, and DNB for latitudes greater than 60°N in the Alaskan region (I3 and DNB bands added post SNPP launch)

- There are **no (quantitative) Imagery requirements** that address the **quality** of the Imagery products.
- **Imagery users** decide if the quality is acceptable, therefore **including the users is a key consideration**

Near Constant Contrast (NCC) vs. Day-Night Band (DNB)

Example of NCC vs. DNB for a day/night terminator (non-lunar) case. NCC extends constant contrast into the twilight portion of the granule swath.



Curtis Seaman, CIRA

Processing Environment and Algorithms

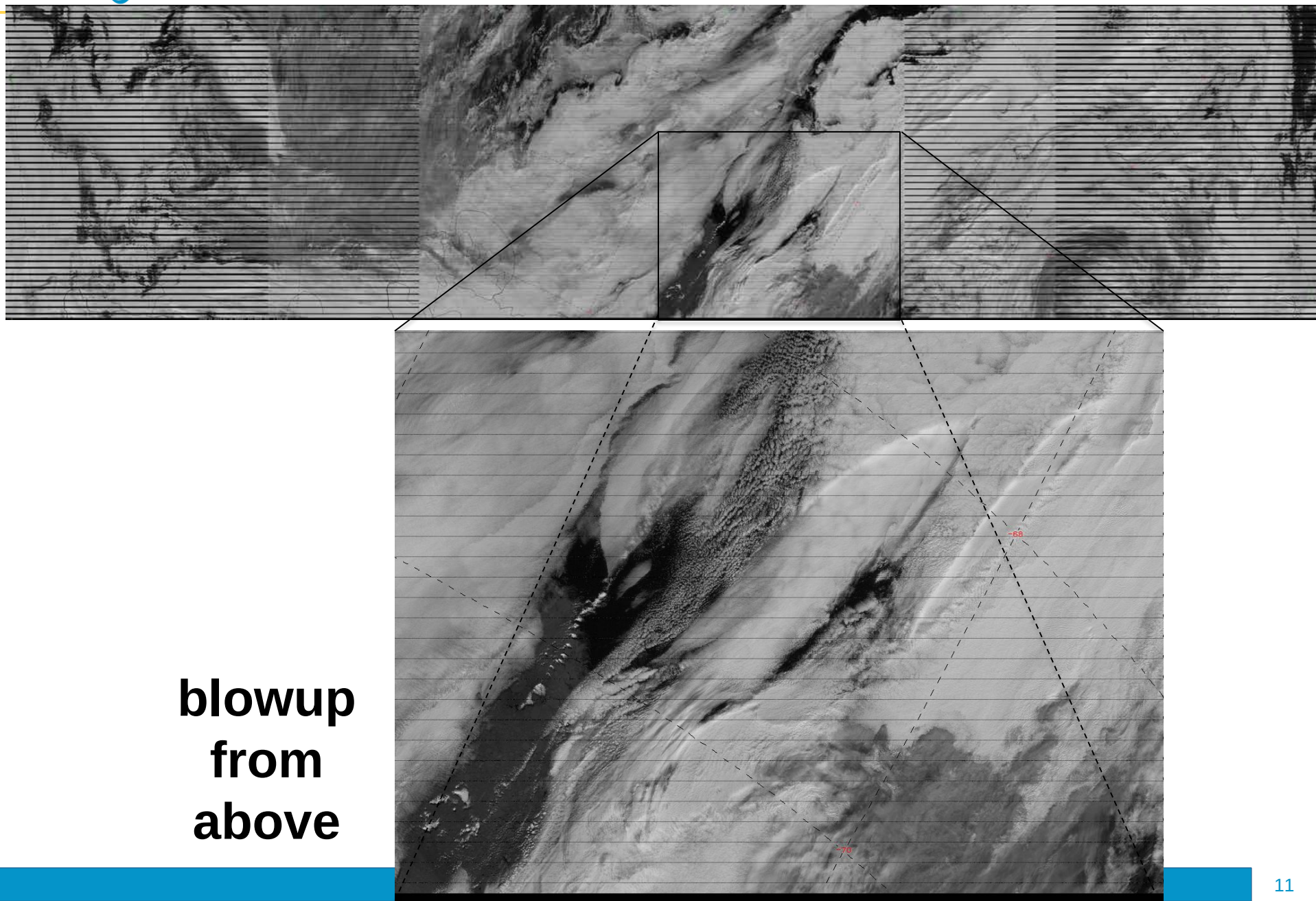
- Description of processing environment and algorithms used to achieve validated maturity stage:
  - **Algorithm** version (IDPS, Version I2.1.02)
  - Version of **LUTs** used (Gain Value Versus Scene Source Elevation (GVVSSE or “Goosey”) tables)
  - Version of **PCTs** used (none)
  - Effective date (22 August 2018)

Findings/Issues at Previous Reviews

- VIIRS **M-bands** (all good) – vis/IR bands
- VIIRS **I-bands i**ssues at **Beta** that were resolved,
  - **I3 bad detector**
    - Causing striping in the I3 SDR (CCR3742/ADR8560)
    - Imagery algorithm successfully removes striping from the I3 Imagery EDR
  - **I4 and I5 fill values**
    - I4/I5 blank images (CCR3742/ADR8559) - 80% of all granules were not usable
    - The former I4 and I5 issue of missing Imagery EDRs at beta no longer exists
- VIIRS **DNB/NCC** issues:
  - **Extended DNB granule processing** by NCC is working
  - **Geolocation issues** (resolved with LUT updates)
  - **Stray light (VIIRS SDR Team)**
    - Not unlike striping on SNPP DNB, except for extended granule
      - Extended granule is part of DNB, not part of NCC
    - Corrections for stray light began in February 2018 and are ongoing
- **Better together: NOAA-20 and SNPP** (50 min half-orbit separation examples)

NOAA-20 I3 bad detector (Now properly identified!)

I3 bad detector/striping (now properly identified!)

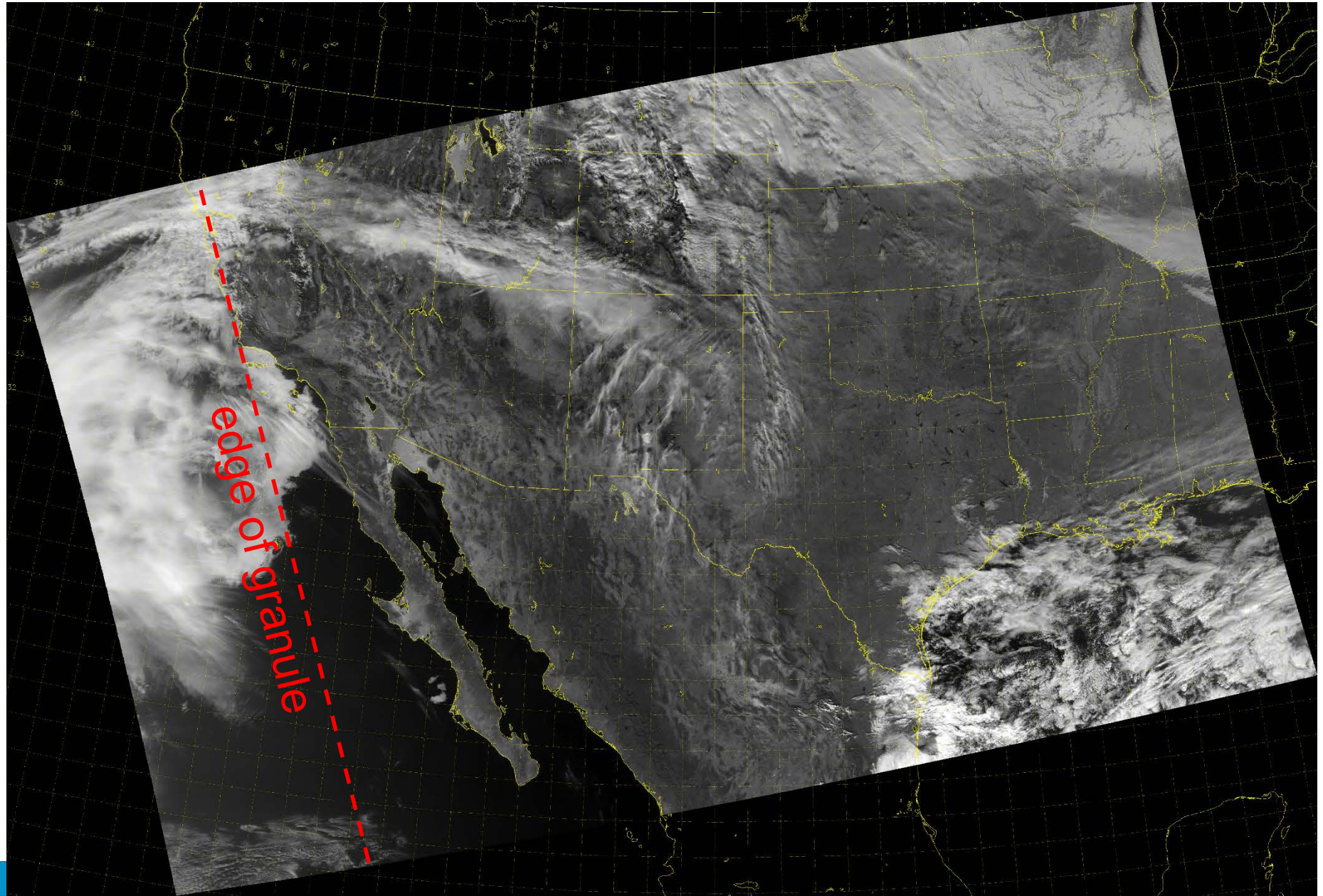


blowup from above

NOAA-20 DNB extended granule

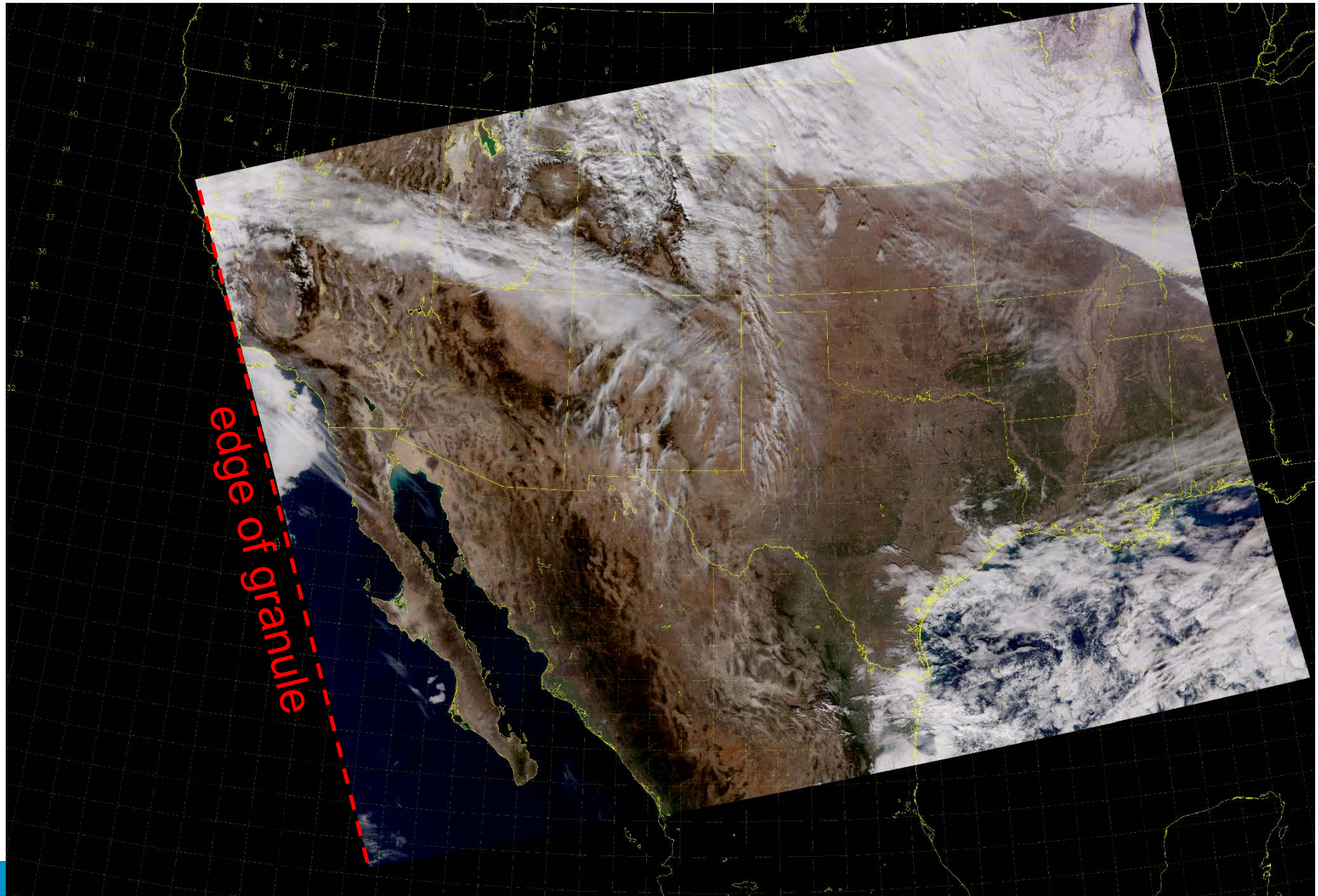
DNB Extended Granule – SW USA (2018-01-05)

(C. Seaman, CIRA)

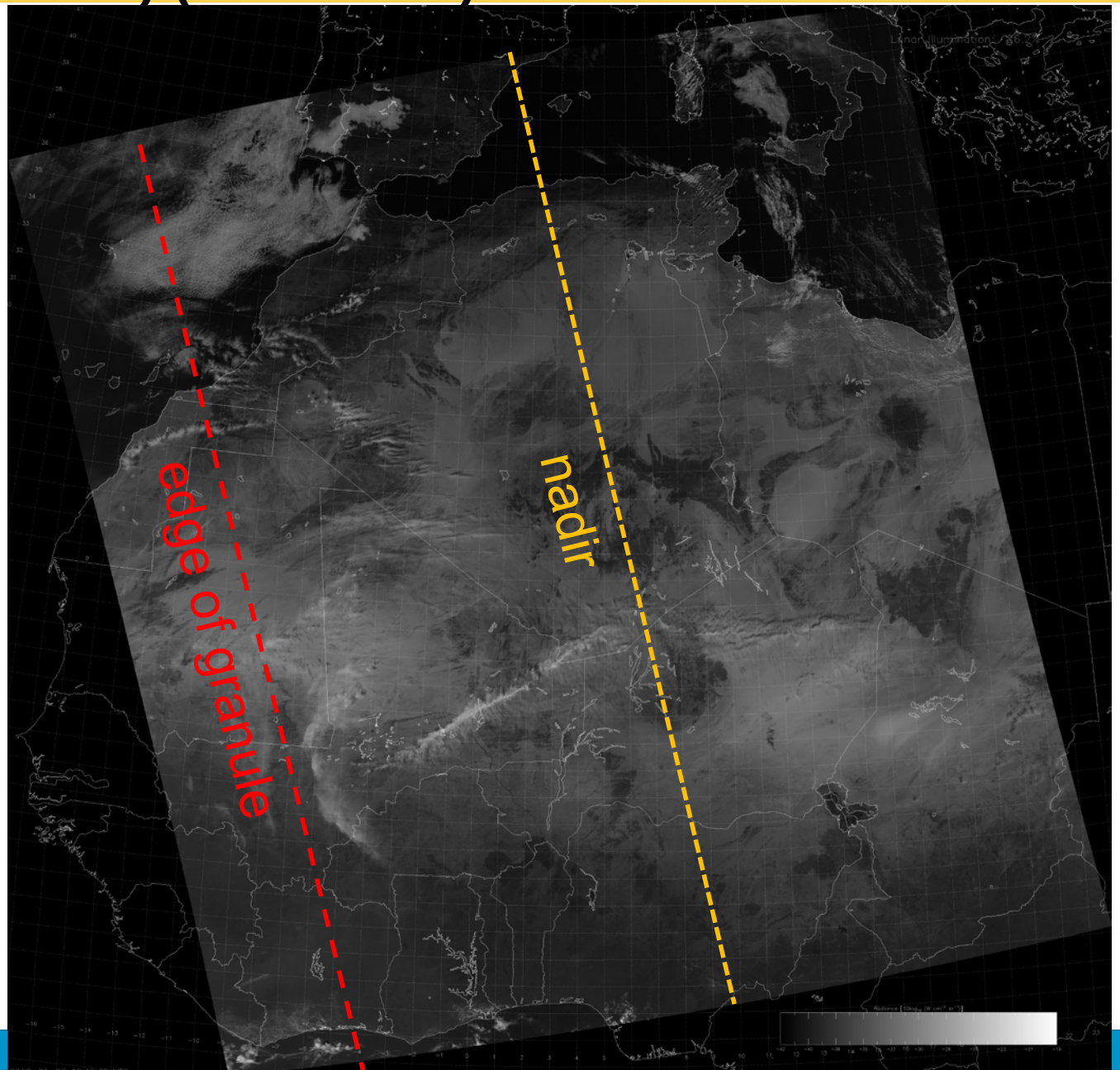


True-color RGB – SW USA (2018-01-05)

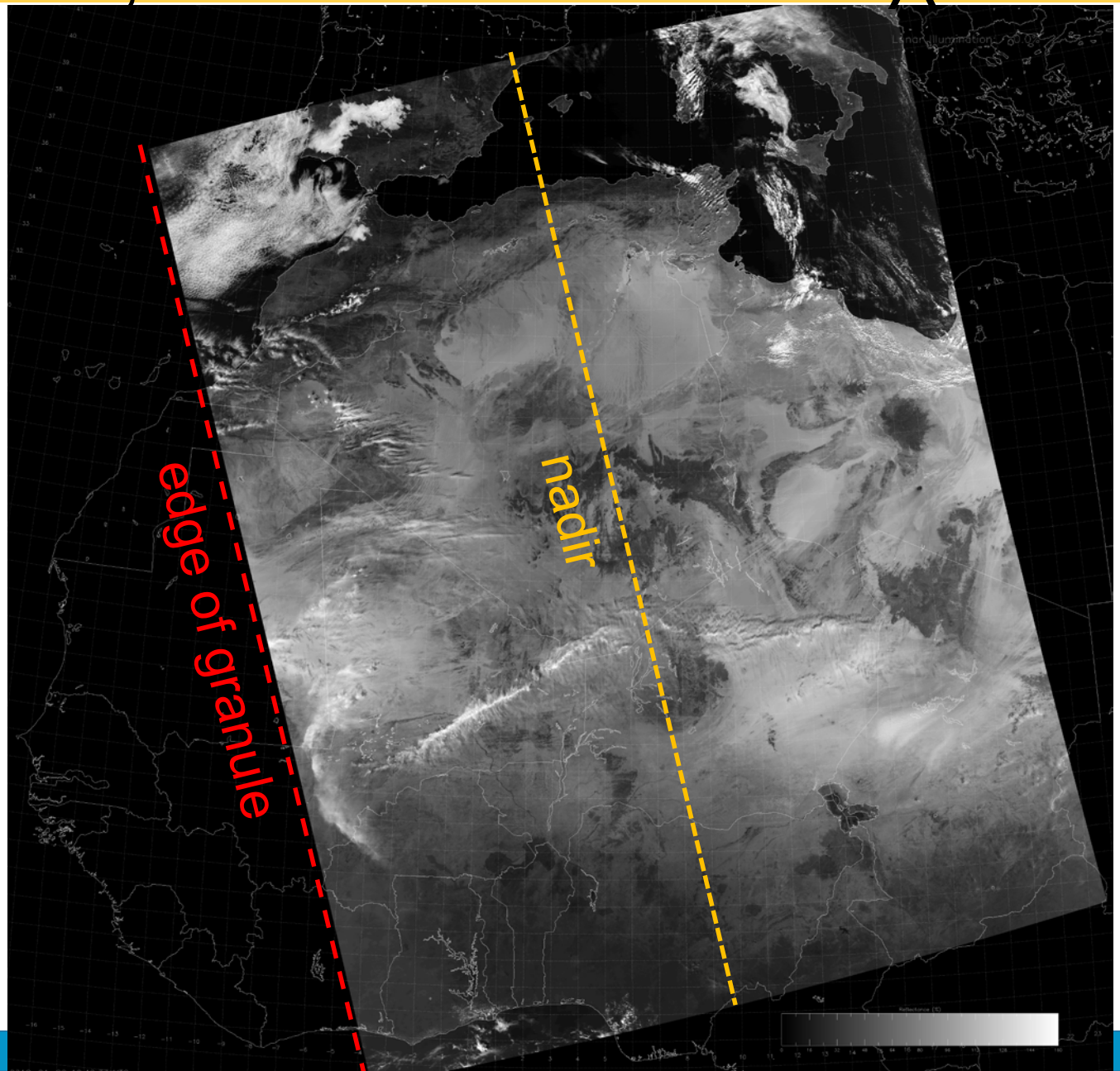
(C. Seaman, CIRA)



DNB (extended granule on left and nadir not at center) (2018-01-22)

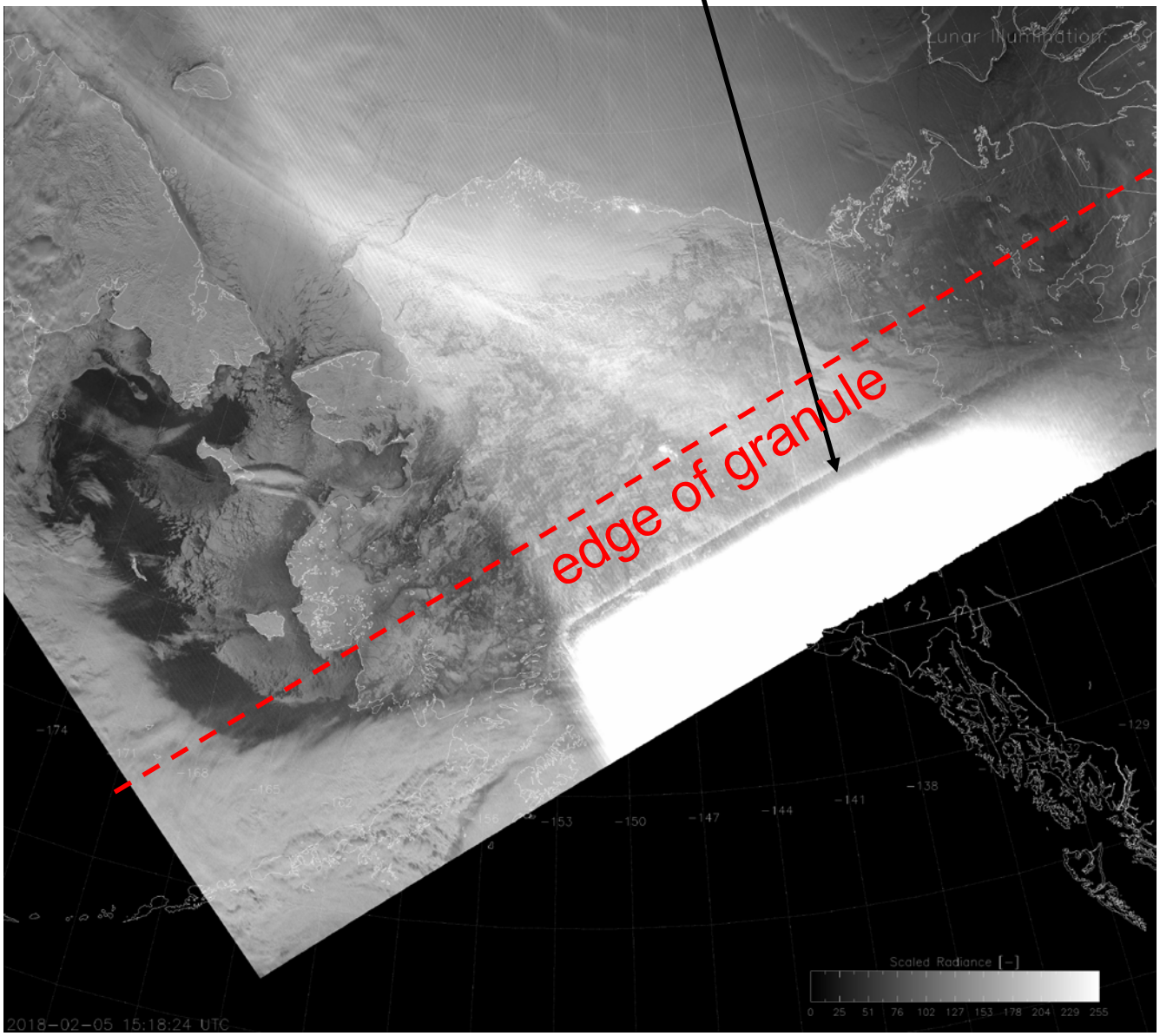


NCC (extended granule not included, and nadir at center, and better contrast than DNB) (2018-01-22)

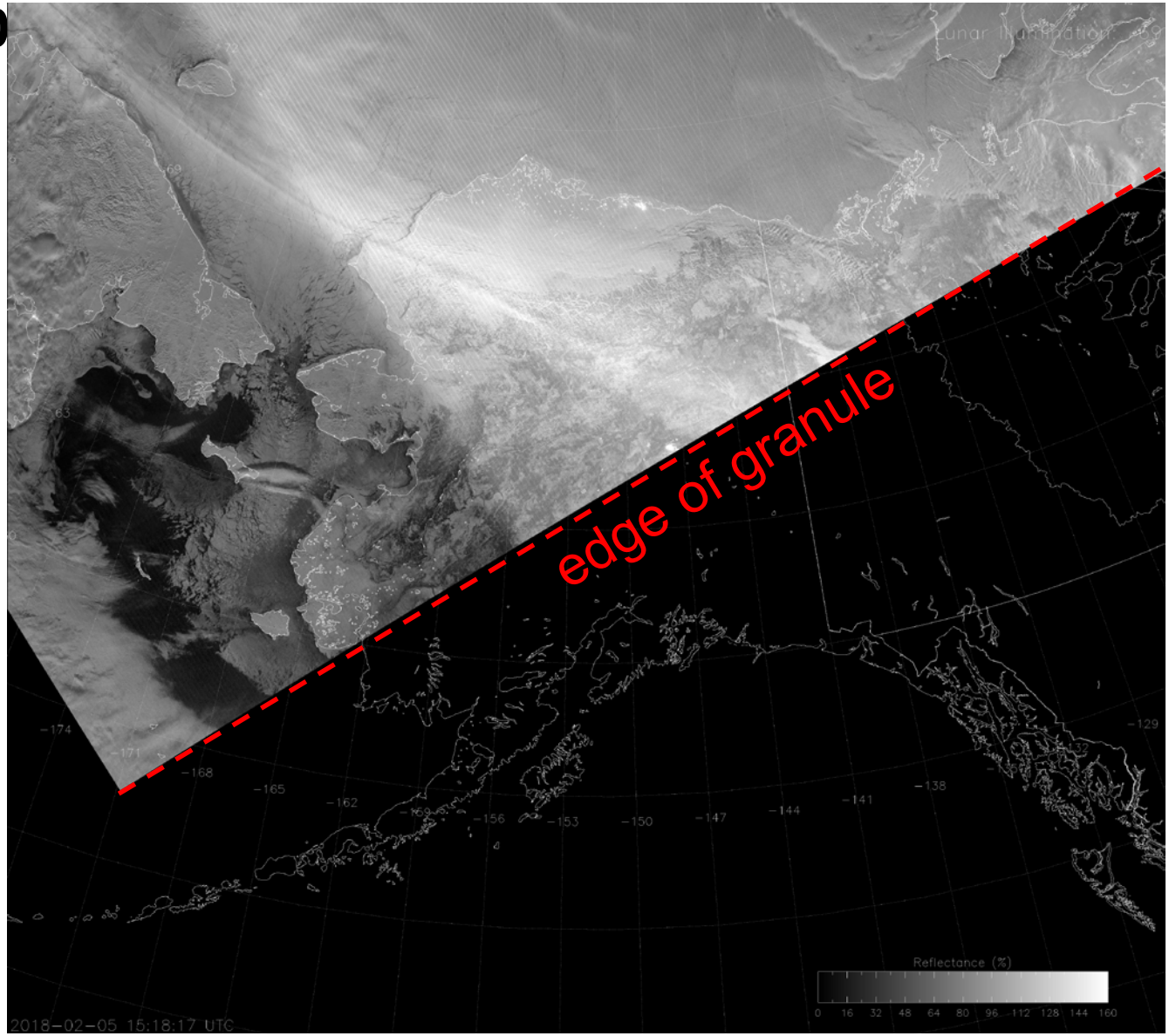


NOAA-20 DNB stray light

Extra strong patch of stray light in extended DNB granule (2018-02-05)



Extra strong patch of stray light not in NCC granule which cuts off extended portion of DNB (2018-02-0



Evaluation of the effect of required algorithm inputs

- Required Algorithm Inputs:
  - Primary Sensor Data (VIIRS Imagery EDRs: radiance/reflectance and Geo files)
  - Ancillary data (none)
  - Upstream algorithms/data (SDRs radiance/reflectance and Geo files)
  - LUTs / PCTs (to be updated at Provisional+1 year)
- Evaluation of the effect of required algorithm inputs:
  - Study / test cases (checking of test datasets as needed)
  - Results (reported to JPSS Program)

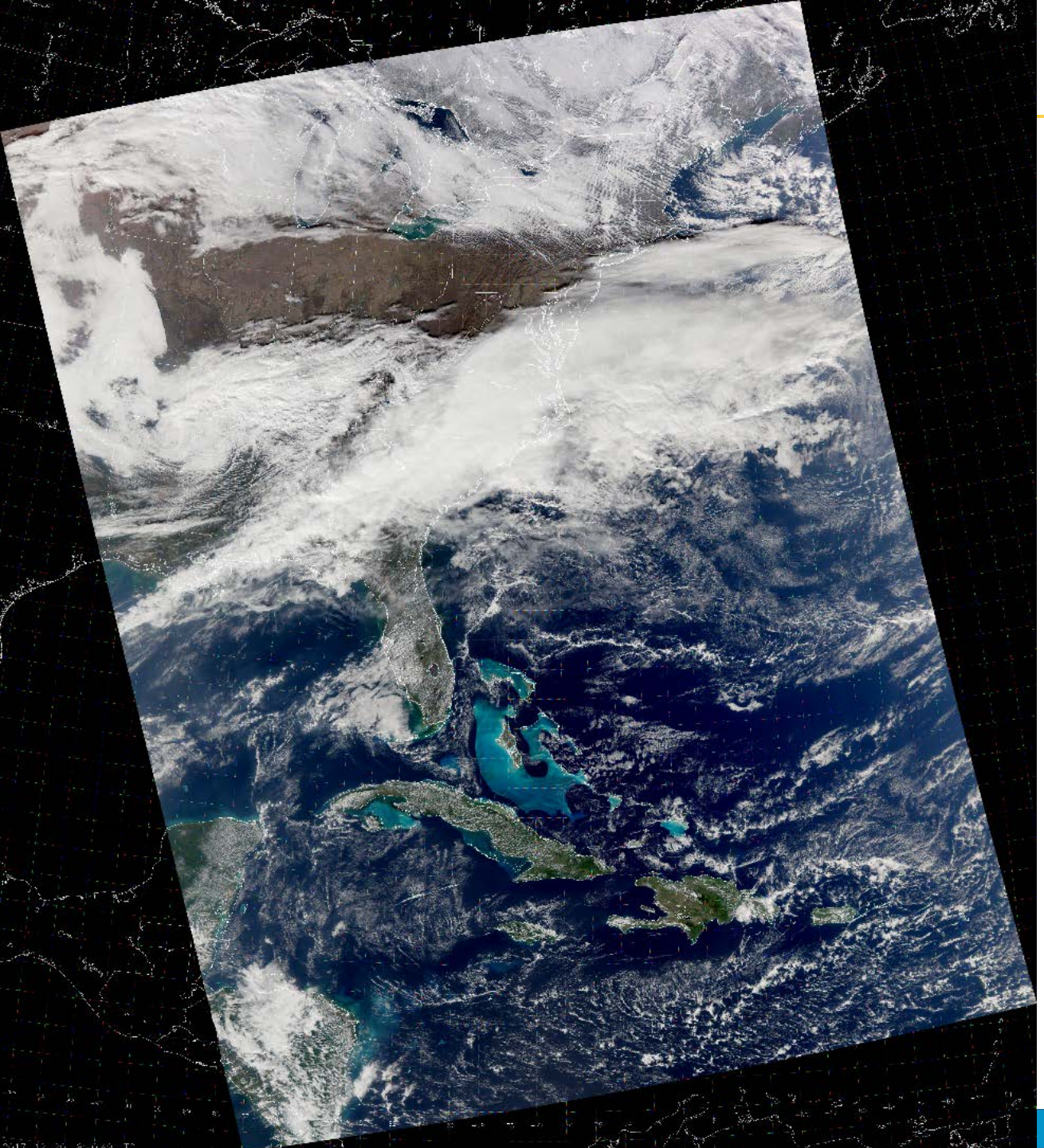
EDR Imagery work since Provisional

- **Provisional review** slides provided to J. Paquette for use in SPSRB presentation about declaring Imagery operational in AWIPS2
- **ReadMe** and updated **VIIRS EDR Imagery ATBD** provided to JPSS Program, revised to reflect specific changes with NOAA-20 compared to S-NPP.
- **Numerous test data checkouts (**acquired and tested for proper ingest and display in McIDAS-X, McIDAS-V, and IDL.**):**
  - **JPSS-1 JCT5 Test data**
  - **Block 2.0 test data** vs Block 1.2 data.
  - **J01 test data for Mx1 I&T**
  - **J2 DNB test data with modeled LSF (Line Spread Function) issue**
  - **Block 2.1 MX 2 I&T Deploy Regression Data** (excessive fill values in N20 I4 products from very cold scenes were found)
  - **Block 2.1 MX 3 SOL Deploy Regression Review/Checkout**
- **NOAA-20 VIIRS Imagery display (I-bands, M-bands, and DNB/NCC)**
  - **http://rammb.cira.colostate.edu/ramsdis/online/noaa-20_viirs.asp**

Quality flag analysis/validation

- Quality Flags
  - Flags for various **radiance/reflectance issues**
  - Flags for **fill values**
- Quality flag analysis/validation
  - Correct handling of **bad detector in I3** band
  - Flagged and replaced by using an average of adjacent “good” values in **I3 Imagery EDR**

NOAA-20 M-bands visible/IR bands



VIIRS True Color

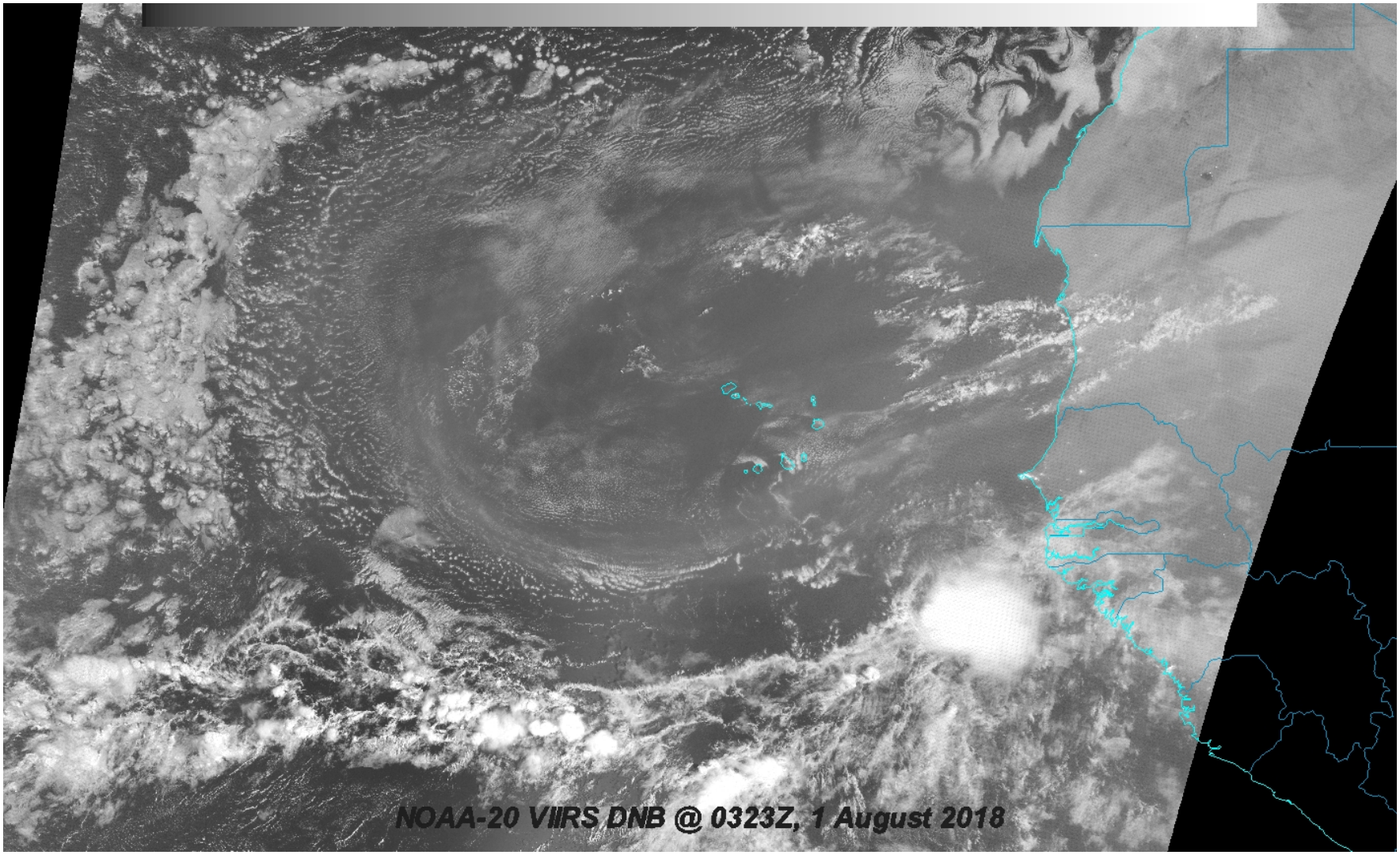
Eastern US (2017-12-20)

(C. Seaman, CIRA)

Day-Night-Band First Light CONUS (2017-12-14)
(S. Miller, CIRA; NOAA Facebook)

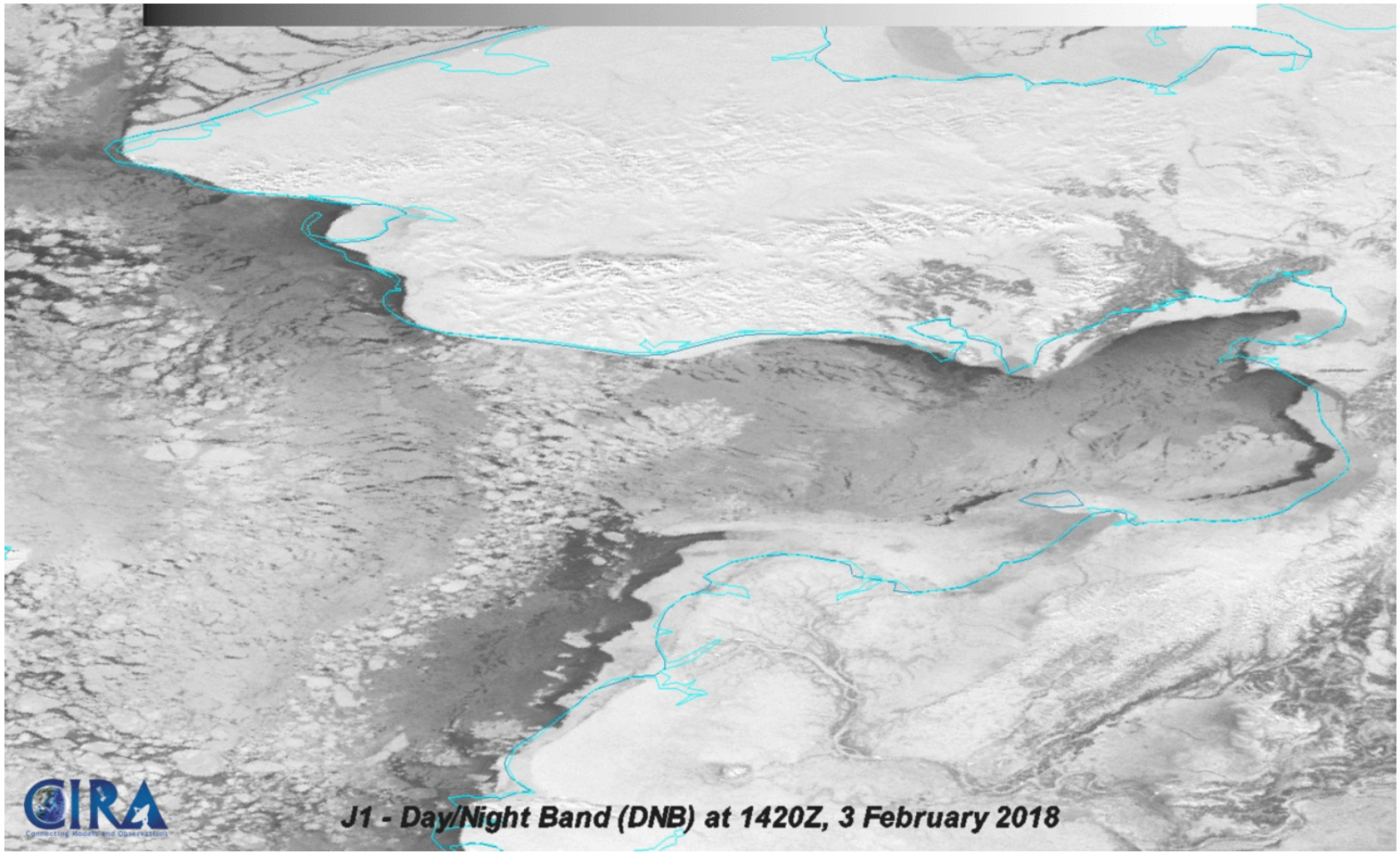
Recent DNB example

Large areal extent of dust, advecting west, along the African Coast.
1 August 2018 @ 0323 UTC.

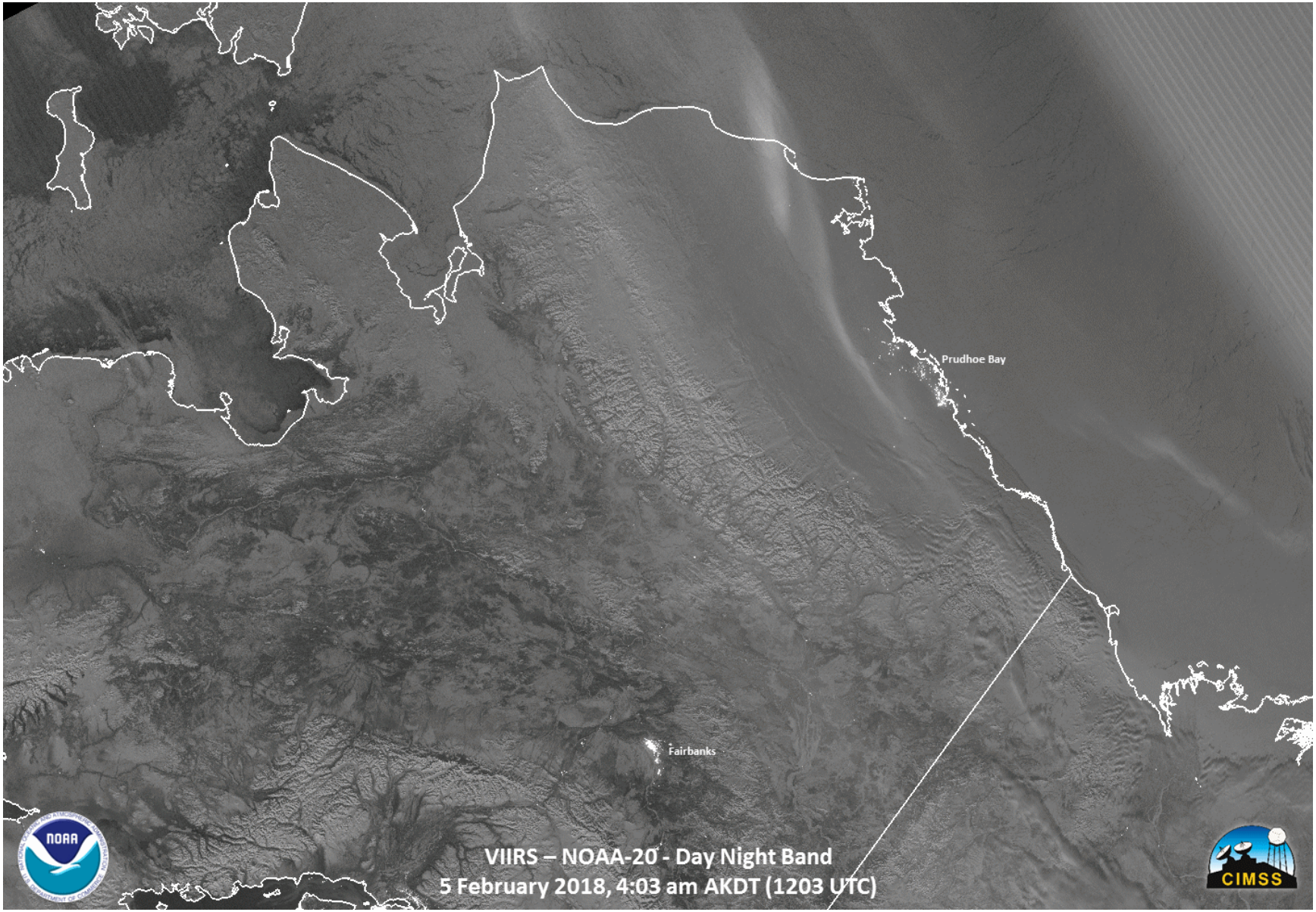


SNPP and NOAA-20 DNB comparisons (~50 minutes separation)

NOAA-20 DNB animation shows NW Alaska (near Nome, AK) of snow-covered areas, sea-ice edges and sea-ice motion over a period of 3 days: 3-5 February 2018. (J. Torres, CIRA)



NOAA-20/SNPP DNB animation of aurora – note how quickly the light show changes! (W. Straka, CIMSS/SSEC)



User Feedback

Name	Organization	Application	User Feedback - User readiness dates for ingest of data and bringing data to operations
Chris Elvidge	NCEI-Boulder	Worldwide DNB	Reports of JPSS Program and Imagery Team
Arunas Kuciauskas	NRL-Monterey	Worldwide VIIRS	Reports to JPSS Program
Eric Stevens, Melissa Kreller, Carl Dierking, Nate Eckstein, Jay Cable	Alaska: GINA and NWS	Alaska analysis and forecasting applications	See next presentation; also JPSS Annual Meeting presentation
John Evans, John Paquette	NWS	AWIPS2 ingest and display	To NDE and thru SBN

Documentations (Check List)

Science Maturity Check List	Yes ?
ReadMe for Data Product Users	Yes
Algorithm Theoretical Basis Document (ATBD)	Yes
Algorithm Calibration/Validation Plan	Yes
(External/Internal) Users Manual	Yes
System Maintenance Manual (for ESPC products)	NA
Peer Reviewed Publications (Demonstrates algorithm is independently reviewed)	Several (SNPP)
Regular Validation Reports (at least annually) (Demonstrates long-term performance of the algorithm)	NA

Check List - Validated Maturity

Validated Maturity End State	Assessment
Product performance has been demonstrated over a **large and wide range of representative conditions** (i.e., global, seasonal).	Yes
Comprehensive documentation of product performance exists that includes **all known product anomalies** and their recommended remediation strategies for a full range of retrieval conditions and severity level.	Yes
Product analyses are sufficient for full **qualitative** determination of product fitness-for-purpose.	Yes
Product is **ready for operational use** based on documented validation findings and user feedback.	Yes
Product validation, quality assurance, and algorithm stewardship **continue through the lifetime of the instrument**	Yes

Conclusion and Path Forward

- **Team recommends Validated Maturity for EDR Imagery**
  - Each VIIRS instrument is unique, involving both similar and unique issues
  - Imagery is good based heavily on Alaska user feedback

- Planned improvements, future cal/val activities and **milestones**
  - **NCC LUT Update**
  - **Terrain Corrected Geo-locations**

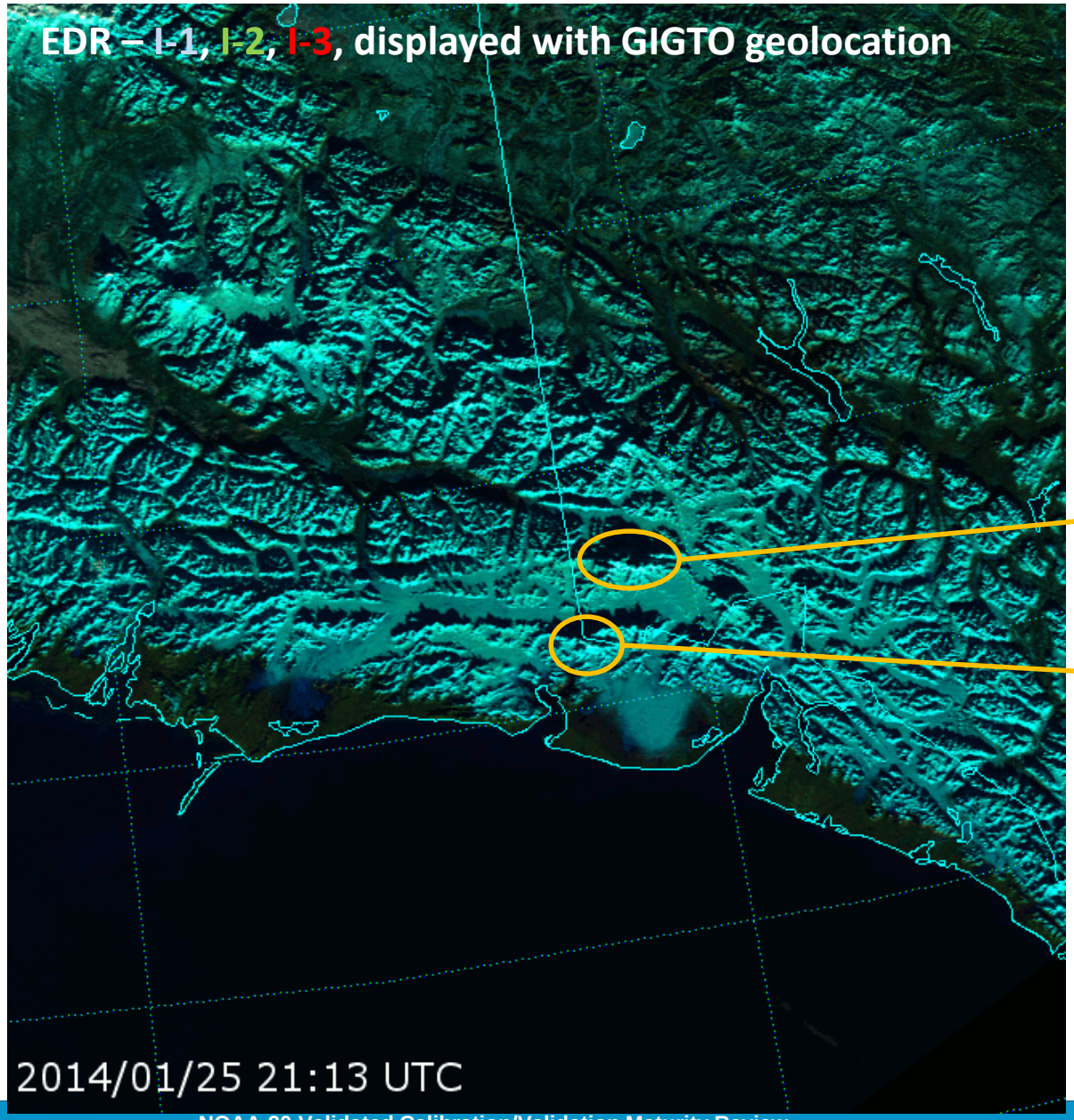
More about Path Forward

- NCC LUT “Goosey” Table Update:
  - **No** indication that an update is **needed**
  - Will update once for **JPSS-1** (for each satellite)
  - Update **tool/software** has been located, but is currently not installed on **GRAVITE**.
    - **Restore LUT update tool onto GRAVITE**
    - **GVVSSE/”Goosey” LUT update** (March 2019, enabled, but may not be needed)

More about Path Forward

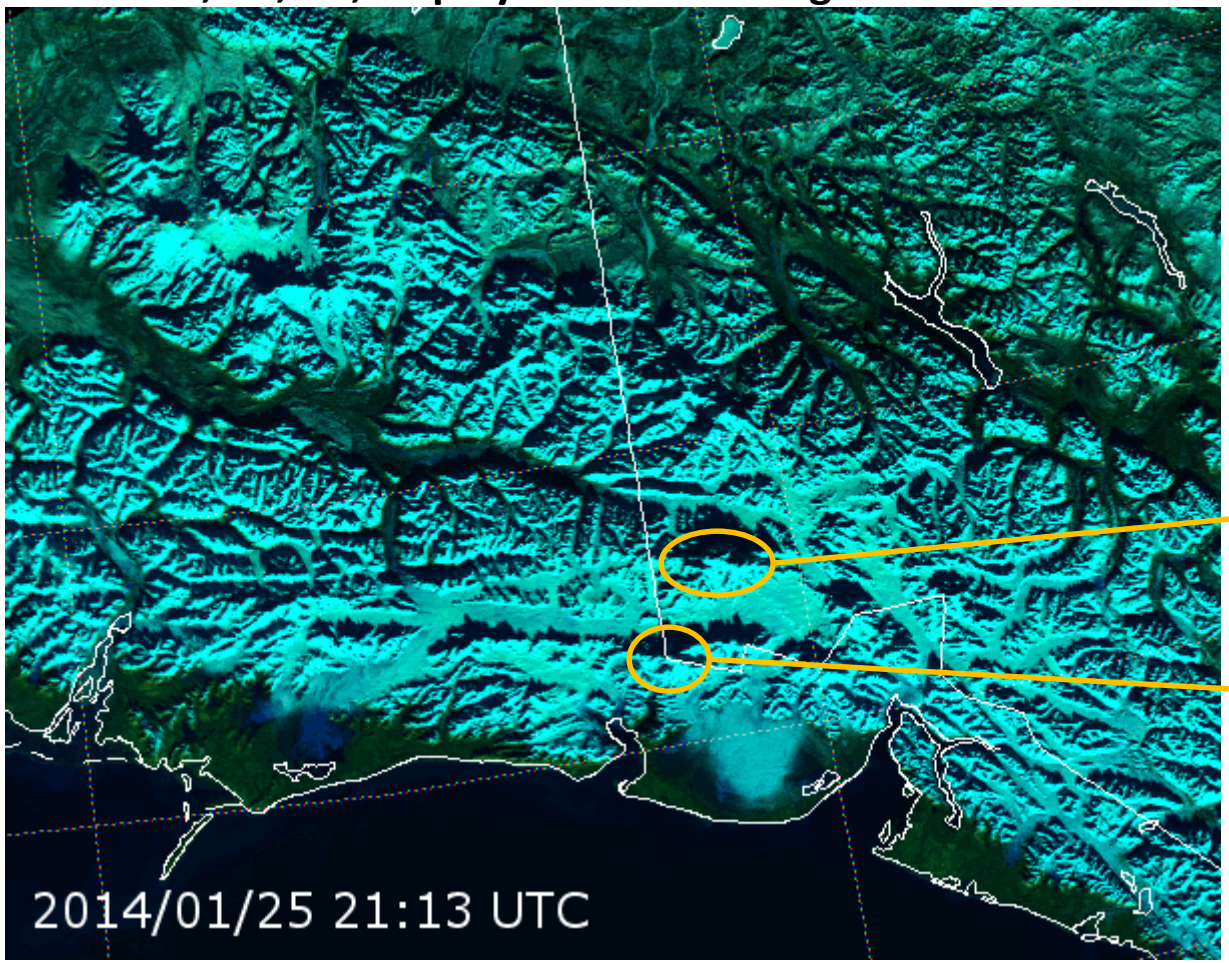
- Terrain Correction for EDR Imagery:
  - Terrain Correction **not** currently available for **VIIRS Imagery EDRs**.
  - **Requested** by VIIRS EDR Imagery users in **Alaska** (in particular)
  - Terrain Correction **required for MX3** (JPSS-2)
  - **Imagery Team** and VIIRS **Geo Team** are working together to address TC implementation
    - ADL testing via Imagery/Geo Team/AIT collaborations
    - Create necessary GRC_TC file for I-bands and NCC (never part of the processing to date)
    - **Terrain Corrected Imagery EDR code delivery** (Sep 2019)

Imagery EDRs are **not** Terrain Corrected!



Terrain Correction Works for SDRs!

SDR – I-1, I-2, I-3, displayed with GITCO geolocation



Mt. Logan
(6050 m MSL)

Mt. St. Elias
(5489 m MSL)


That's all Folks!