Beta Maturity Science Review For NOAA-21 VIIRS Imagery

Presented by Bill Line
Date: 02/23/2023

VIIRS Imagery Cal/Val Team (1 slide)

Algorithm Cal/Val Team Members

Name	Organization	Major Task
Bill Line	NESDIS/StAR	Imagery Product Lead
Curtis Seaman	CIRA	Imagery/DNB expert
Steven Miller	CIRA	DNB/Imagery expert
William Straka III	CIMSS/SSEC	Imagery/DNB expert
Jack Dostalek	CIRA	Imagery expert
Steve Finley	CIRA	IT/data expert
Kumar Gampa	CIRA	Programming expert
Cindy Combs	CIRA	Programming expert
Jorel Torres	CIRA	JPSS Liaison / trainer
CIMSS McIDAS Team	CIMSS	McIDAS X/V Development for VIIRS
Many Users		Imagery Feedback

Product Overview/Requirements (2 slides)

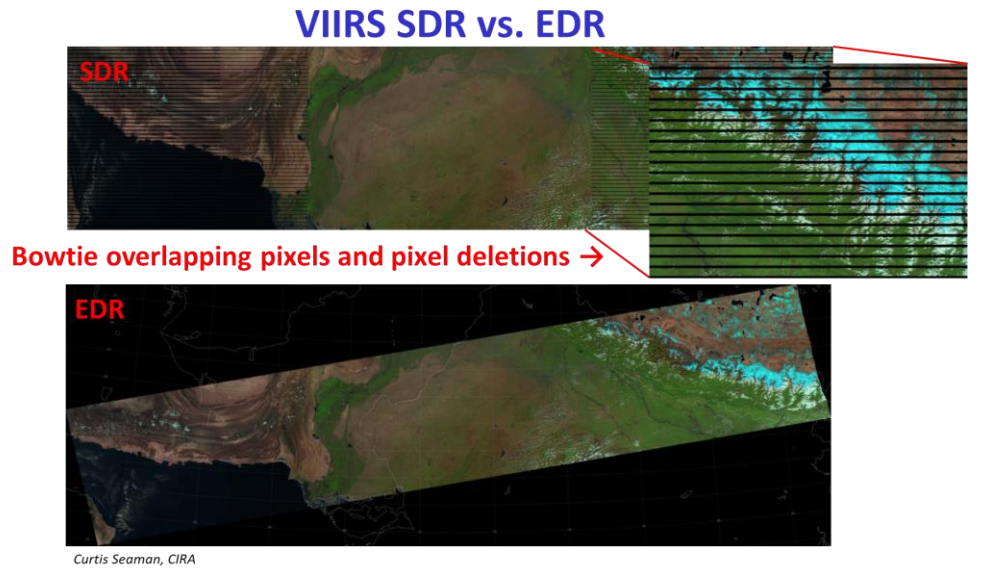
The **VIIRS Imagery EDR** product consists of:

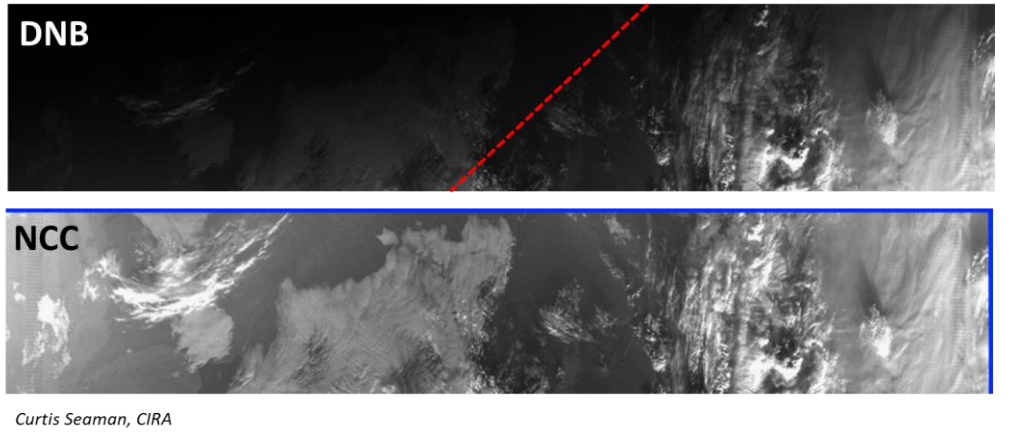
- **16 M-Bands (750 m) and 5 I-Bands (375 m)**
  - Visible and IR radiances/reflectances remapped to the Ground Track Mercator (GTM) grid, eliminating overlapping pixels and bowtie deletions seen in SDR granules.
- **NCC Imagery**
  - a pseudo-albedo derived from the DNB, an image product that normalizes contrasts in DNB radiances across the day-night terminator.

VIIRS Imagery as a **Key Performance Parameter (KPP)** reads as follows:

- VIIRS Imagery EDR for (8) bands I1, I3, I4, I5, M14, M15, M16, and NCC for latitudes greater than 60°N in the Alaskan region
- 87-Minute data latency

* There are no (quantitative) requirements that address the quality of the Imagery products. The Imagery user decides if the Image quality is acceptable, therefore including the users in the Cal/Val process for Imagery is a significant task/consideration.





Product Overview/Requirements (2 slides)

Product Requirements from JPSS L1RD

Attribute	Threshold	Objective
1. The Imagery EDR shall be delivered under all weather conditions.		
a. Horizontal Spatial Resolution for Imagery Resolution Bands		
1. Nadir	0.4 km	0.1 km
2. Edge of Swath	0.8 km	0.1 km
b. Horizontal Spatial Resolution for Moderate Resolution Bands (1)		
1. Nadir	0.8 km	NS
2. Edge of Swath	1.6 km	NS
c. Horizontal Spatial Resolution for Imagery derived from the Day-Night Band (DNB)		
1. Nadir	0.8 km	0.65 km
2. Edge of Swath	1.6 km	NS
d. Mapping Uncertainty, 3 Sigma		
1. Nadir	1 km	NS
2. Edge of Swath	3 km	0.5 km
f. Coverage	Global	NS
Notes:		
1. M-Band Imagery requirements are applicable any VIIRS Moderate Resolution band Imagery EDR that is produced by the system		

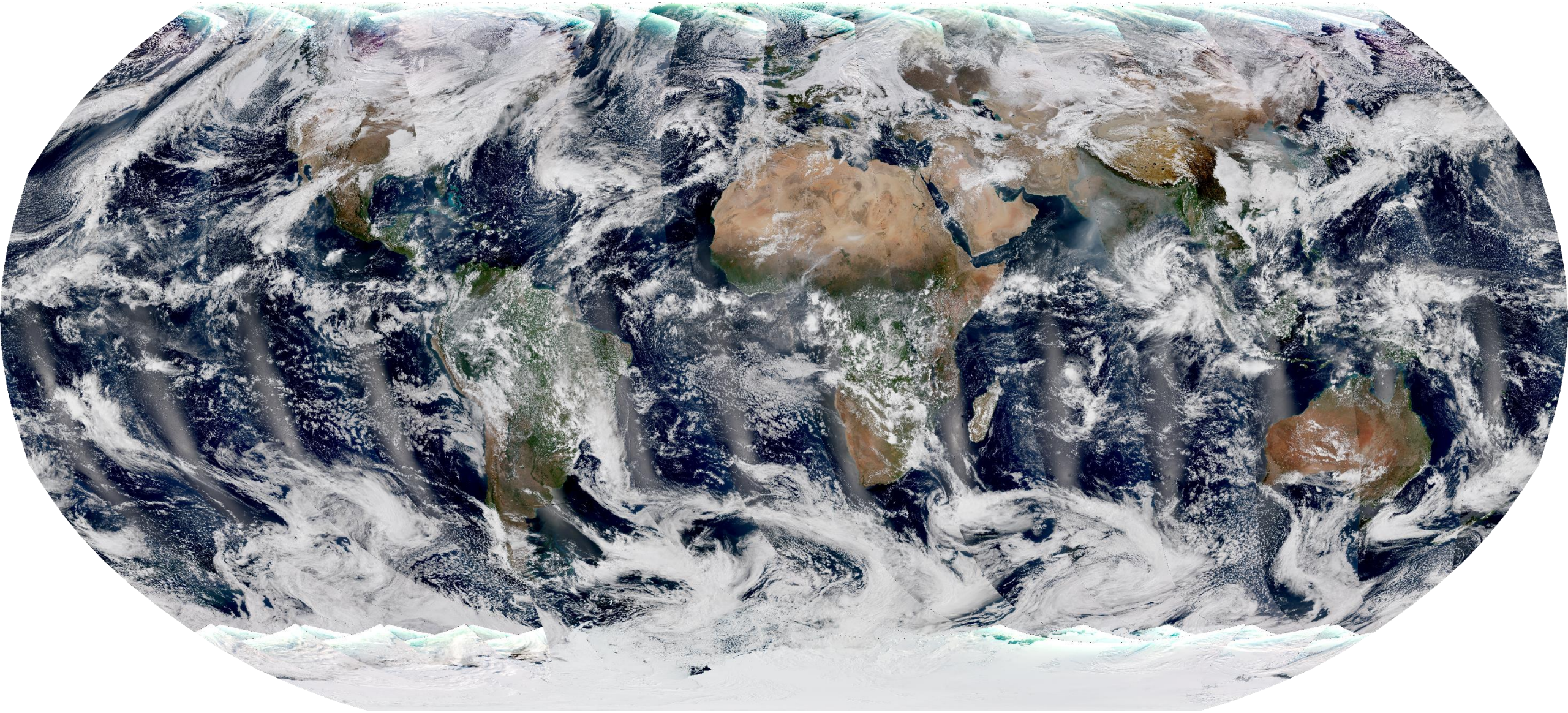
Imagery EDR Performance Evaluation

- Validation data sets (type, periods, coverage)
  - Time Period of Evaluation 2/9 – 2/22
  - All bands for EDR Imagery (KPPs and non-KPPs)
  - A variety of scenes
    - Ocean, Land, Coast, Ice, Deep Convection, Wildfires, Day/Night
- Validation strategies / methods
  - Qualitative Analysis of Imagery
  - Comparison with NPP and NOAA-20
- Validation results
  - Overall, results are very positive. Imagery looks great, is usable, compares well with S-NPP and NOAA-20
  - Of note (details on following slides):
    - IR band degradation on 2/9
    - Minor striping in M9, M11, M12, M13, I4, NCC
    - M6 and M9 Pixel Saturation
    - DNB Smearing
- Long term monitoring readiness
  - Numerous display capabilities for real-time and archived datasets
    - CIRA Polar Slider, McIDAS-X/V, AWIPS-II, IDL, Python
  - Data collection
    - GRAVITE, DB via GINA and SSEC, CLASS

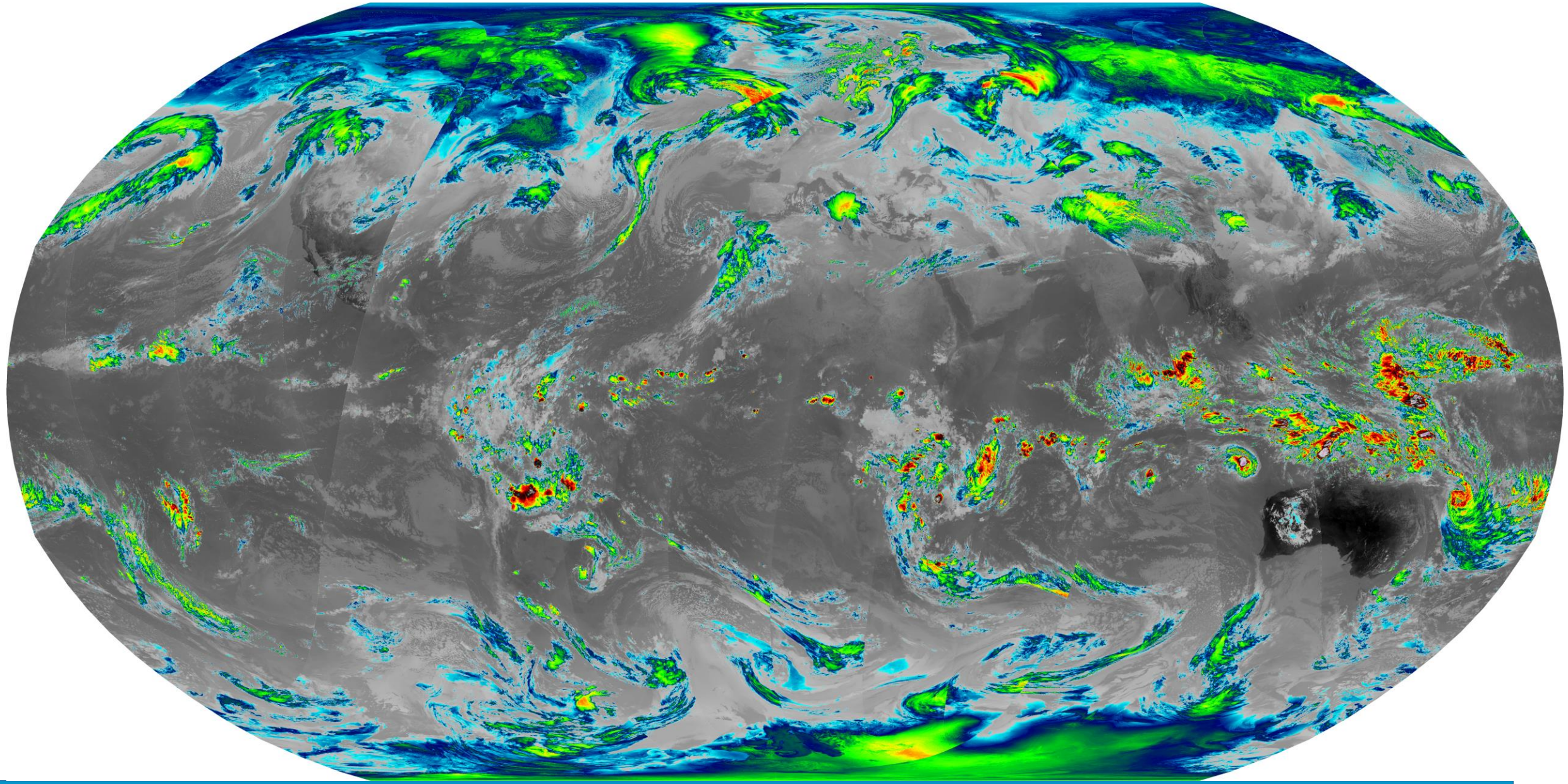
Select Imagery Examples

6 Dec 2022 NOAA-21 VIIRS True Color Imagery Global Composite

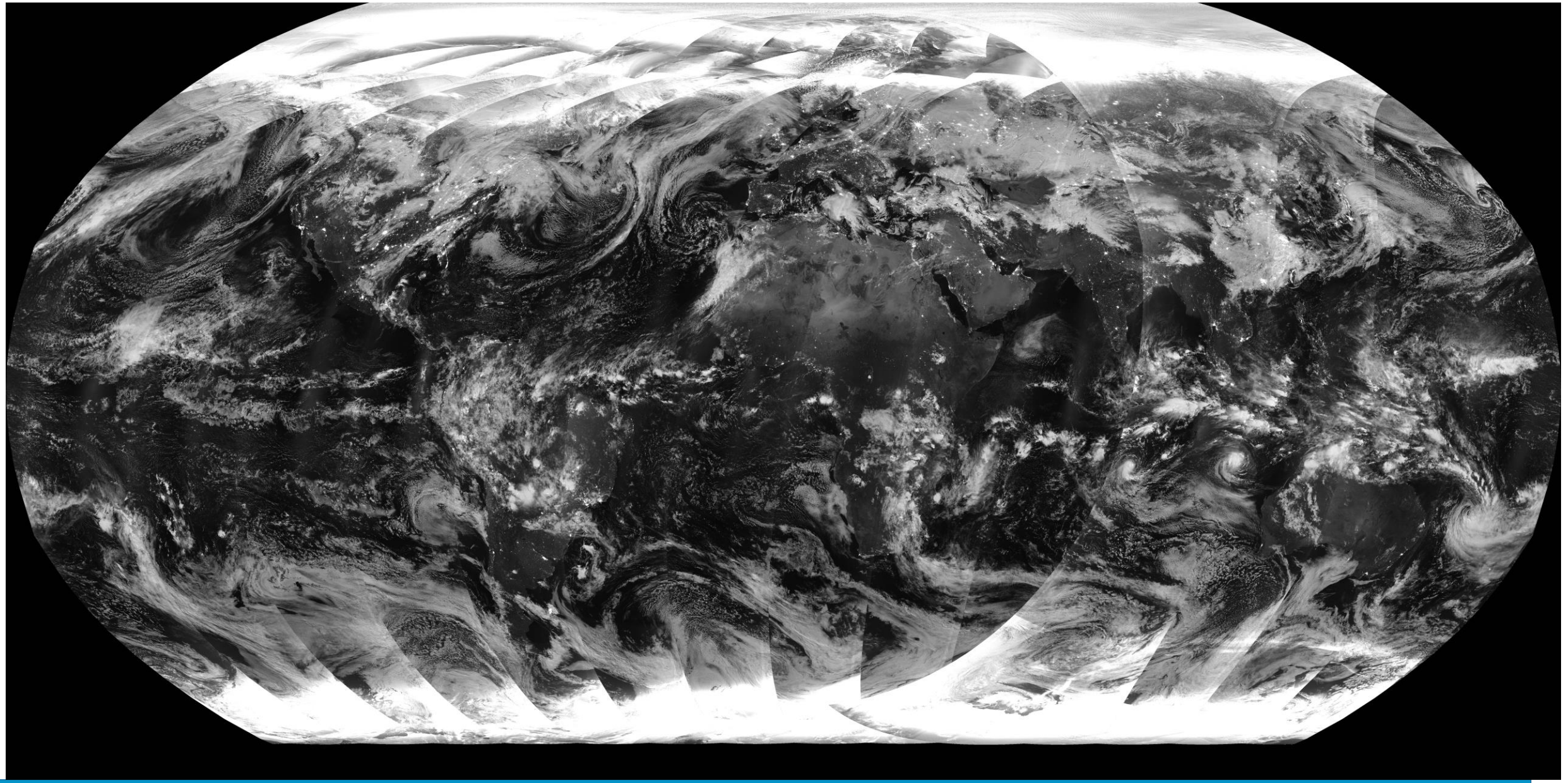
(M5, M4, M3)



10 Feb 2023 NOAA-21 VIIRS M15 Imagery Global Composite

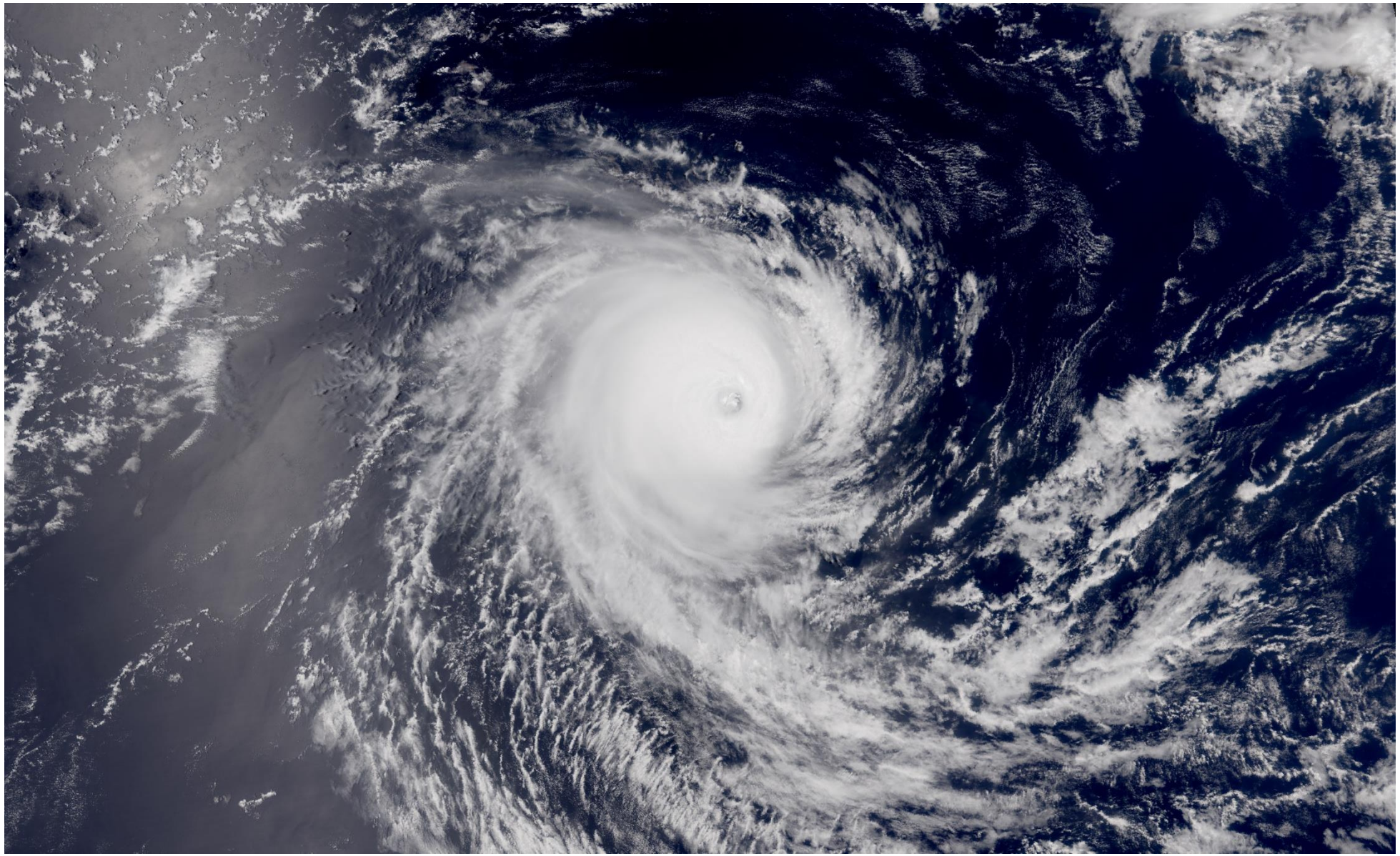


10 Feb 2023 NOAA-21 VIIRS NCC Imagery Global Composite



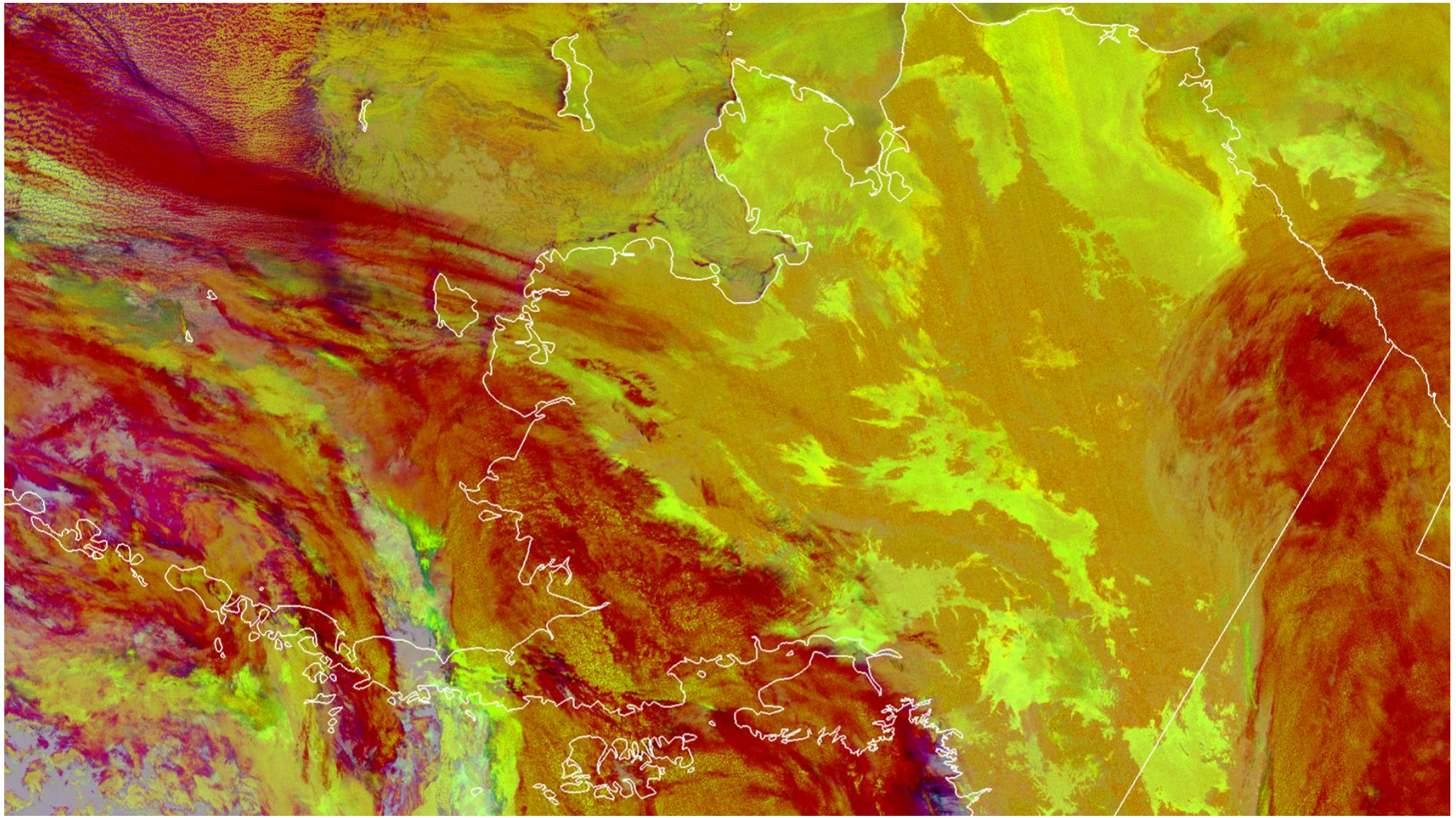
Tropical Cyclone Freddy

Tropical Cyclone Freddy (Indian Ocean)
20230215
NOAA-21
True Color Imagery



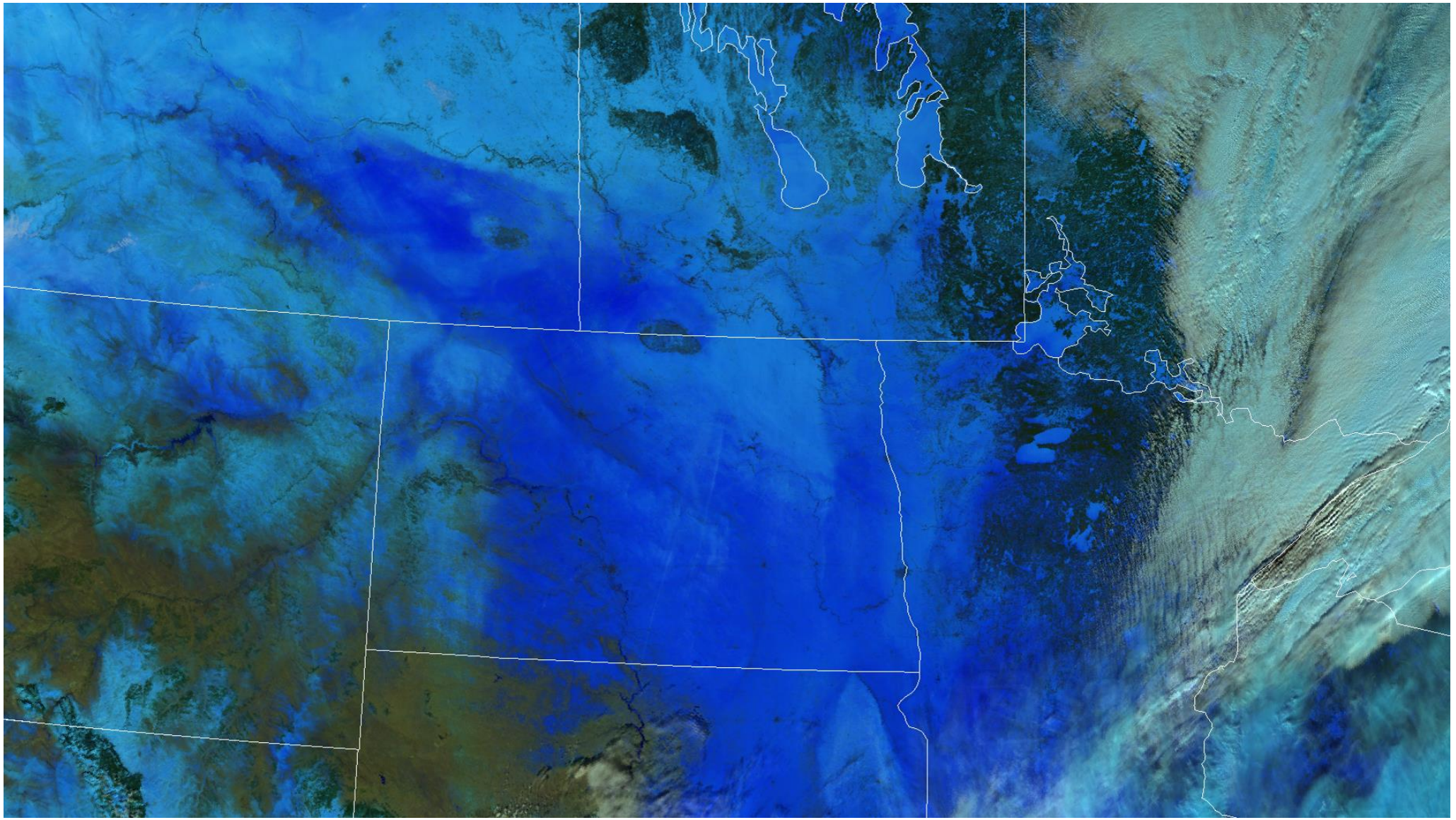
NOAA-21 VIIRS Nighttime Microphysics RGB

Alaska Nighttime Clouds
20230210
NOAA-21
Nighttime Microphysics RGB
(M16-M15, M15-M13, M15)



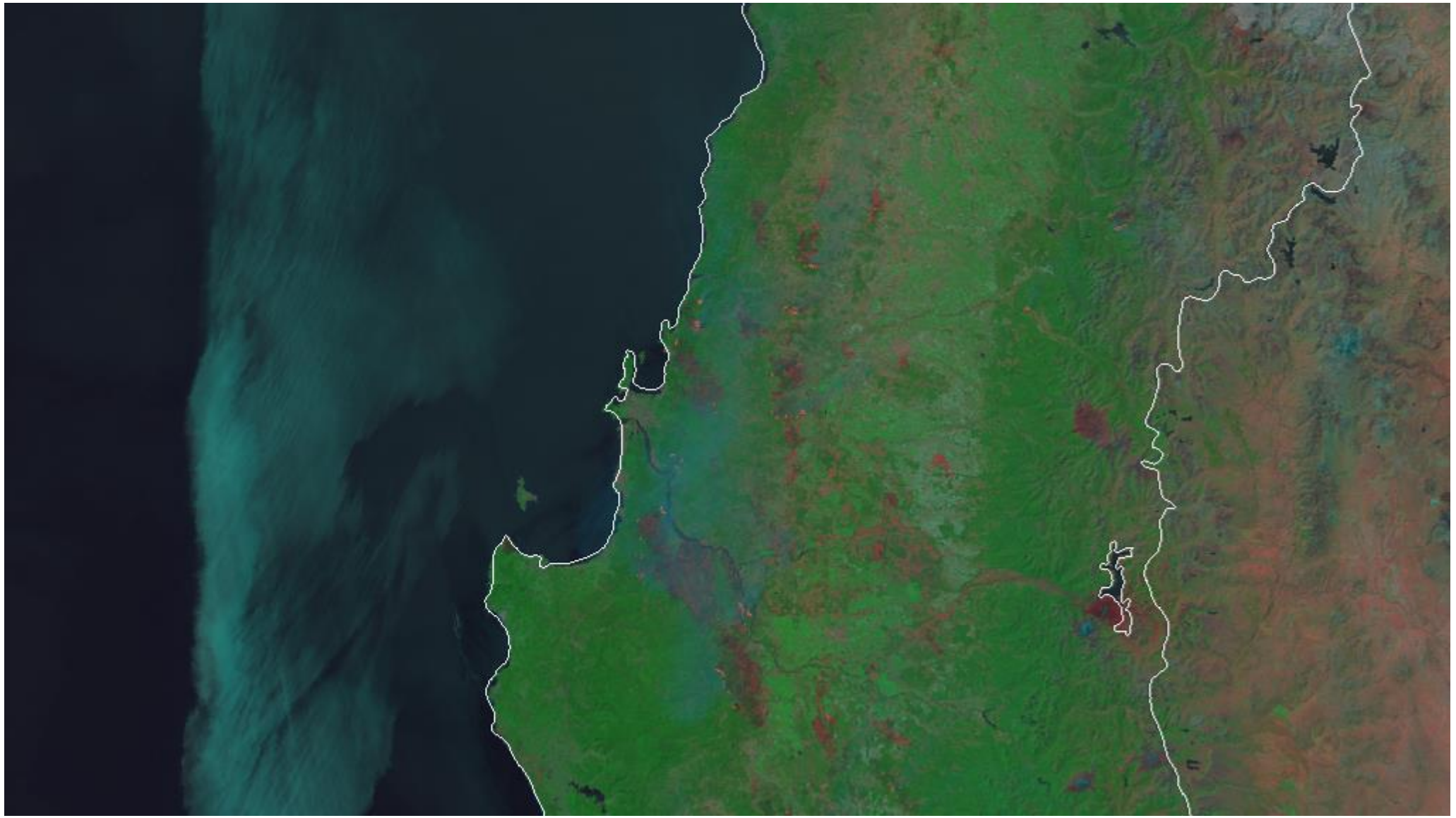
NOAA-21 VIIRS Snowmelt RGB

Northern US Plains Snow
20230209
NOAA-21
Snowmelt RGB
(M10, M8, M5)



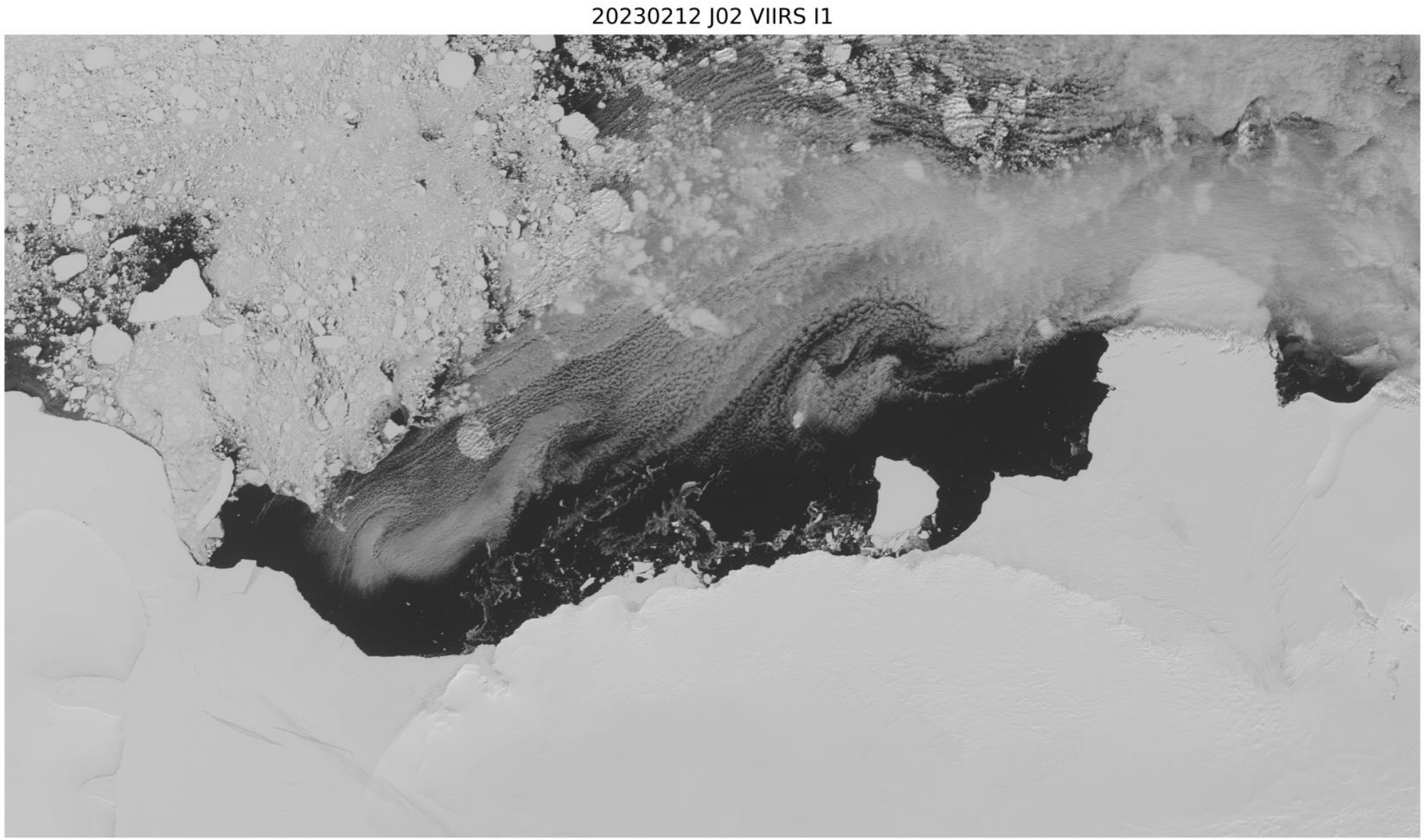
NOAA-21 VIIRS Day Fire RGB

Chile WIldfires
20230209
NOAA-21
Day Fire RGB
(I4, I2, I1)



All NOAA-21 VIIRS Bands over Antarctica

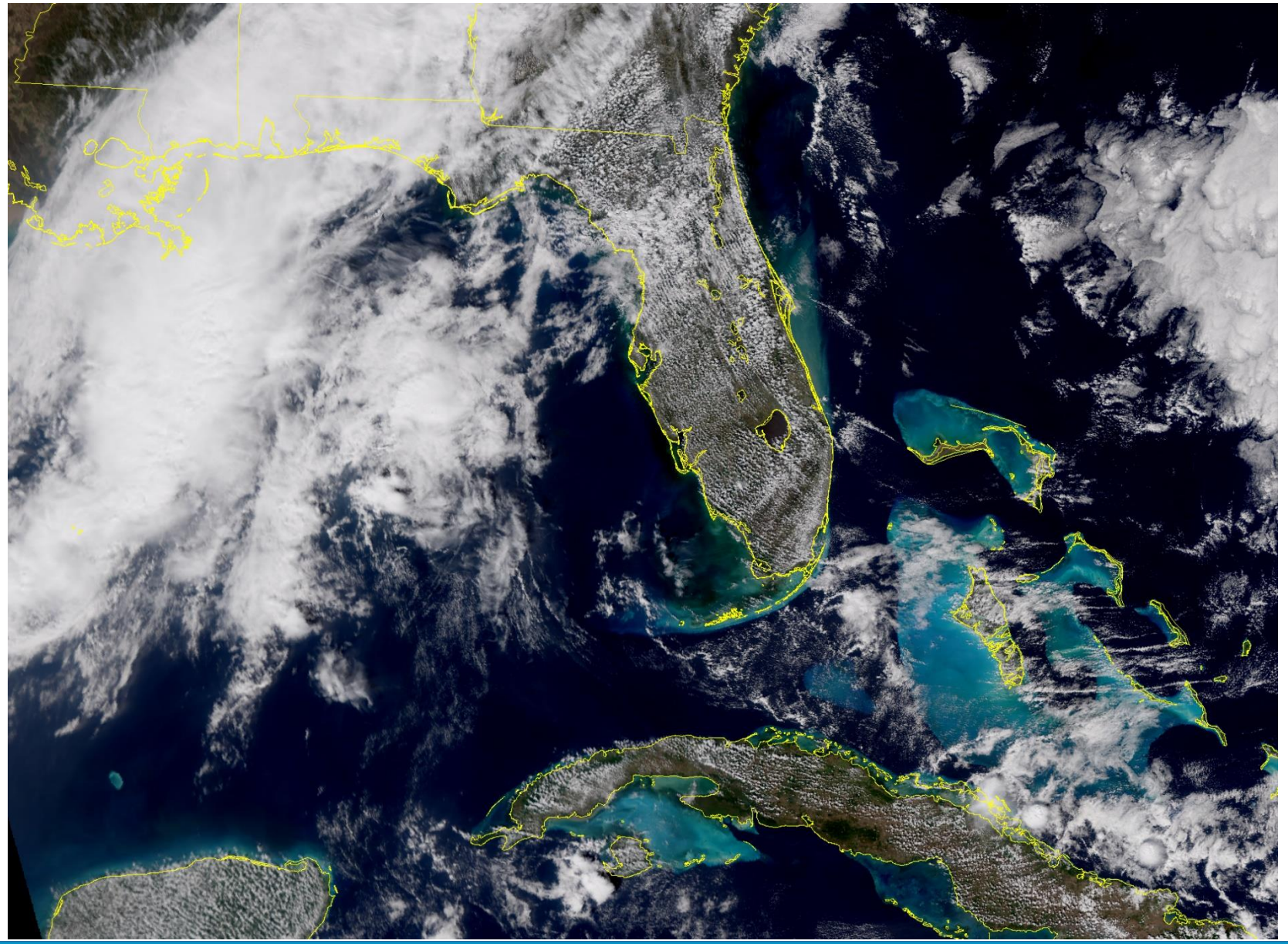
Antarctica
20230212
NOAA-21
All VIIRS Bands



Select Imagery Comparisons

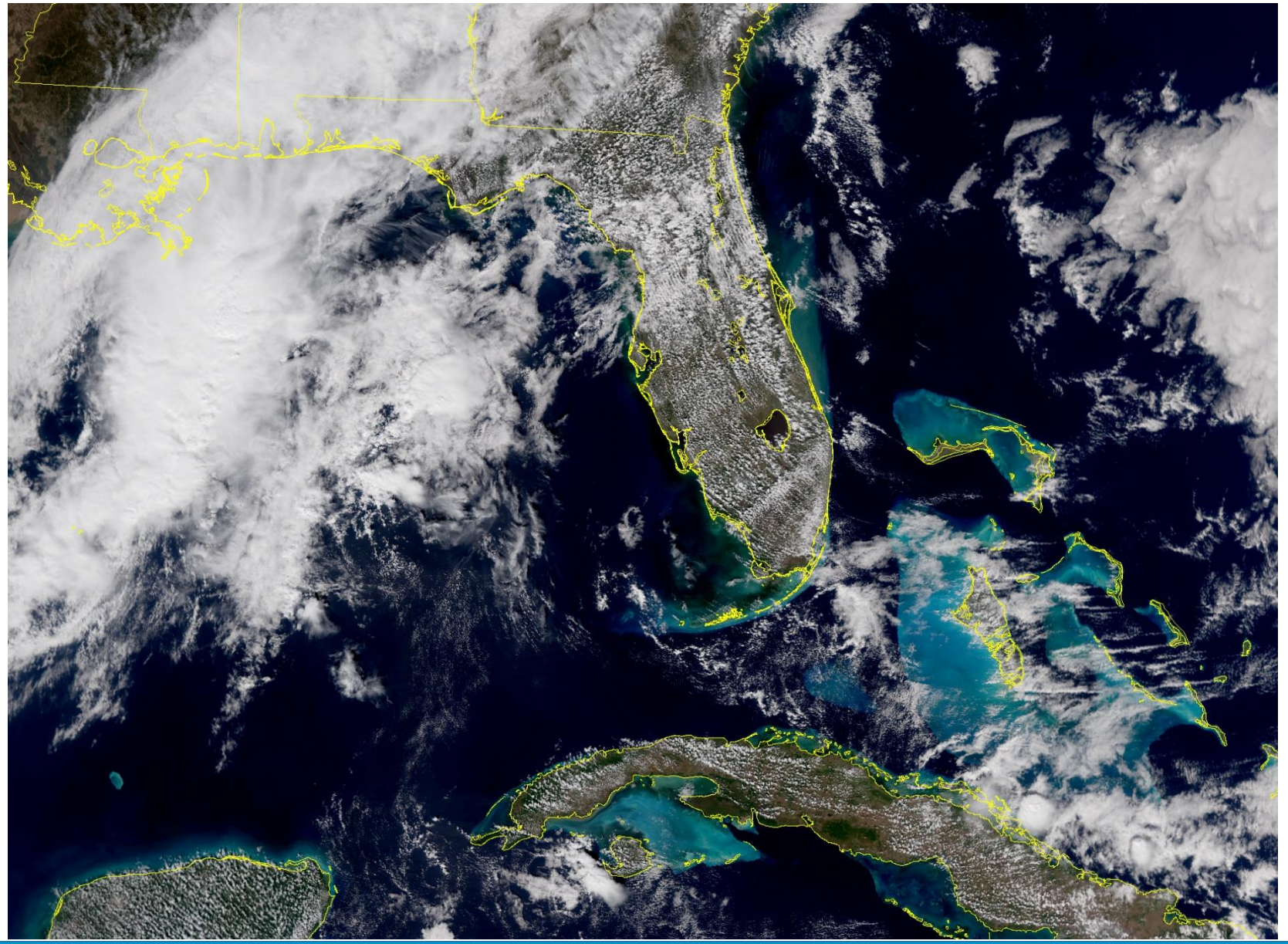
NOAA-21 Comparisons with NPP and NOAA-20

Florida and Surrounding Seas
20230209
NOAA-20
True Color Imagery



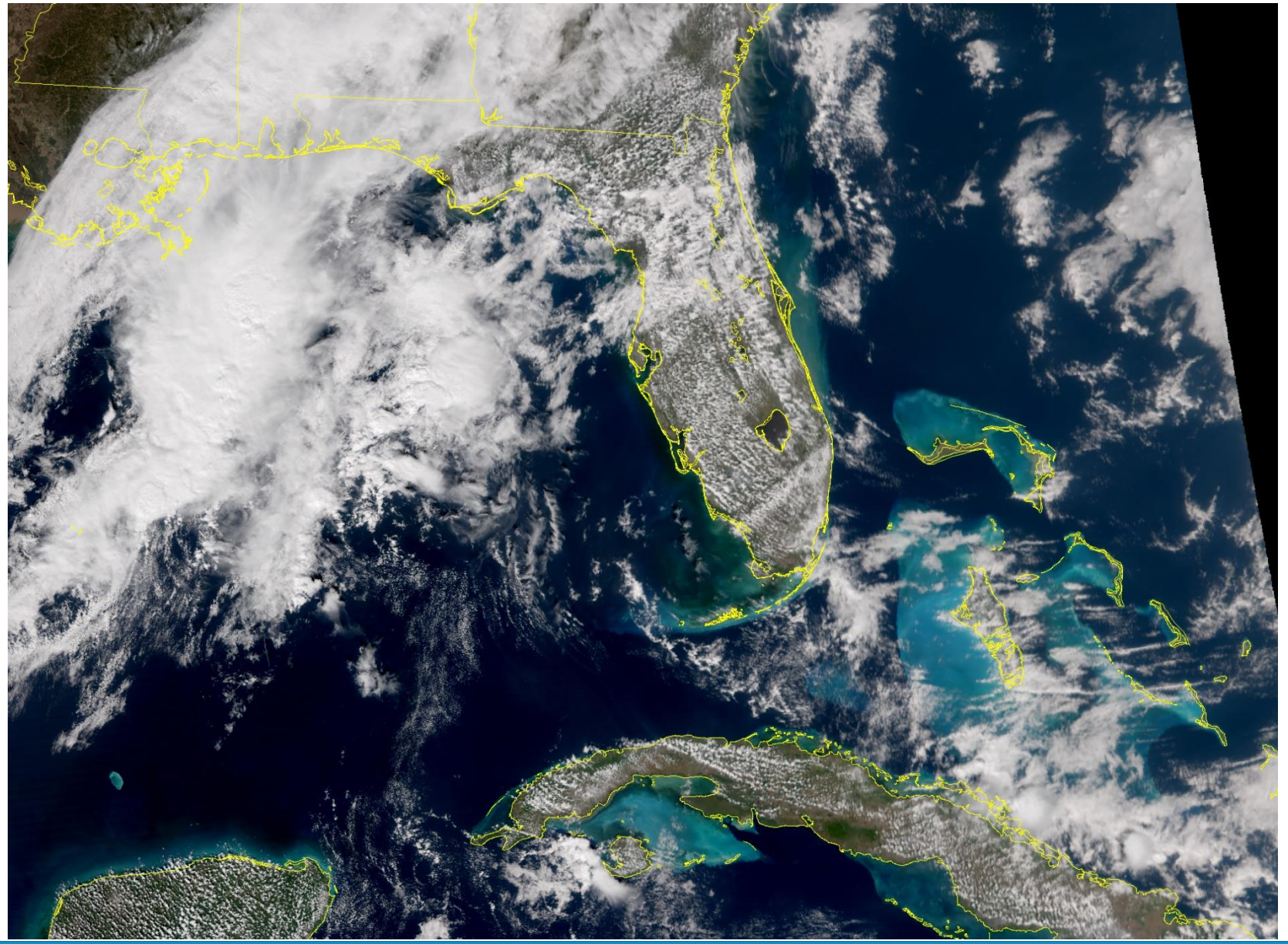
NOAA-21 Comparisons with NPP and NOAA-20

Florida and Surrounding Seas
20230209
NOAA-21
True Color Imagery



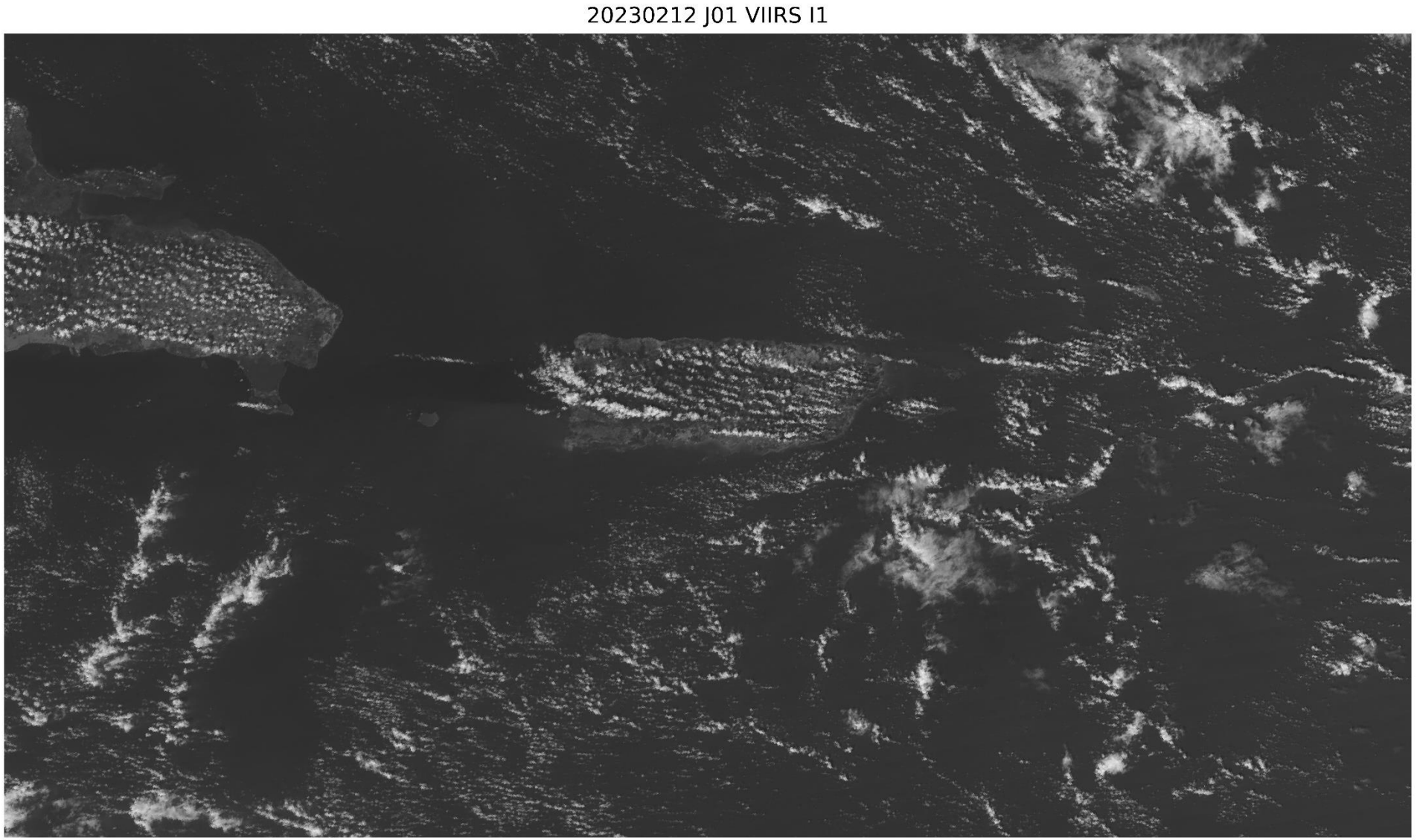
NOAA-21 Comparisons with NPP and NOAA-20

Florida and Surrounding Seas
20230209
S-NPP
True Color Imagery



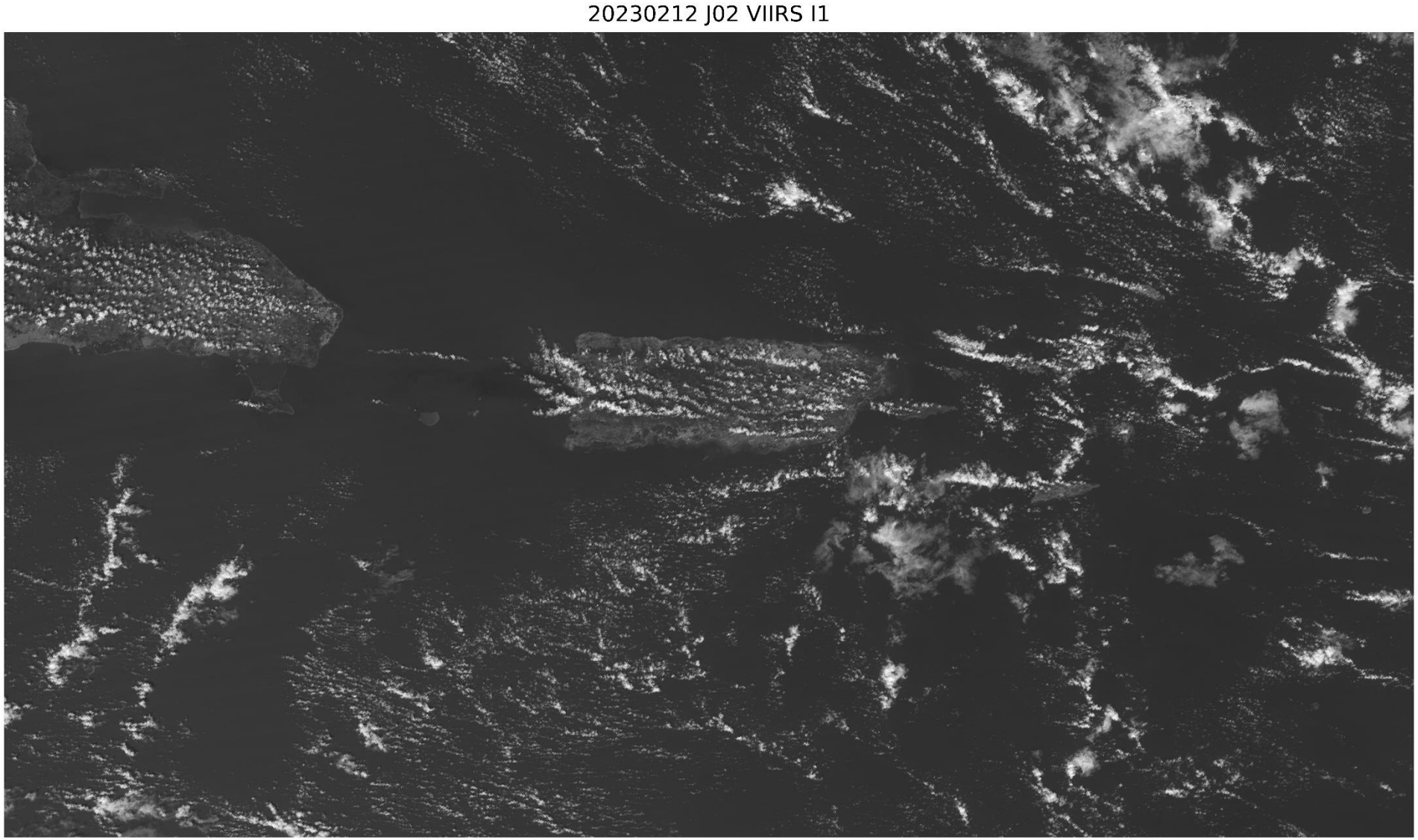
NOAA-21 Comparisons with NPP and NOAA-20

Puerto Rico
20230212
NOAA-20
I1



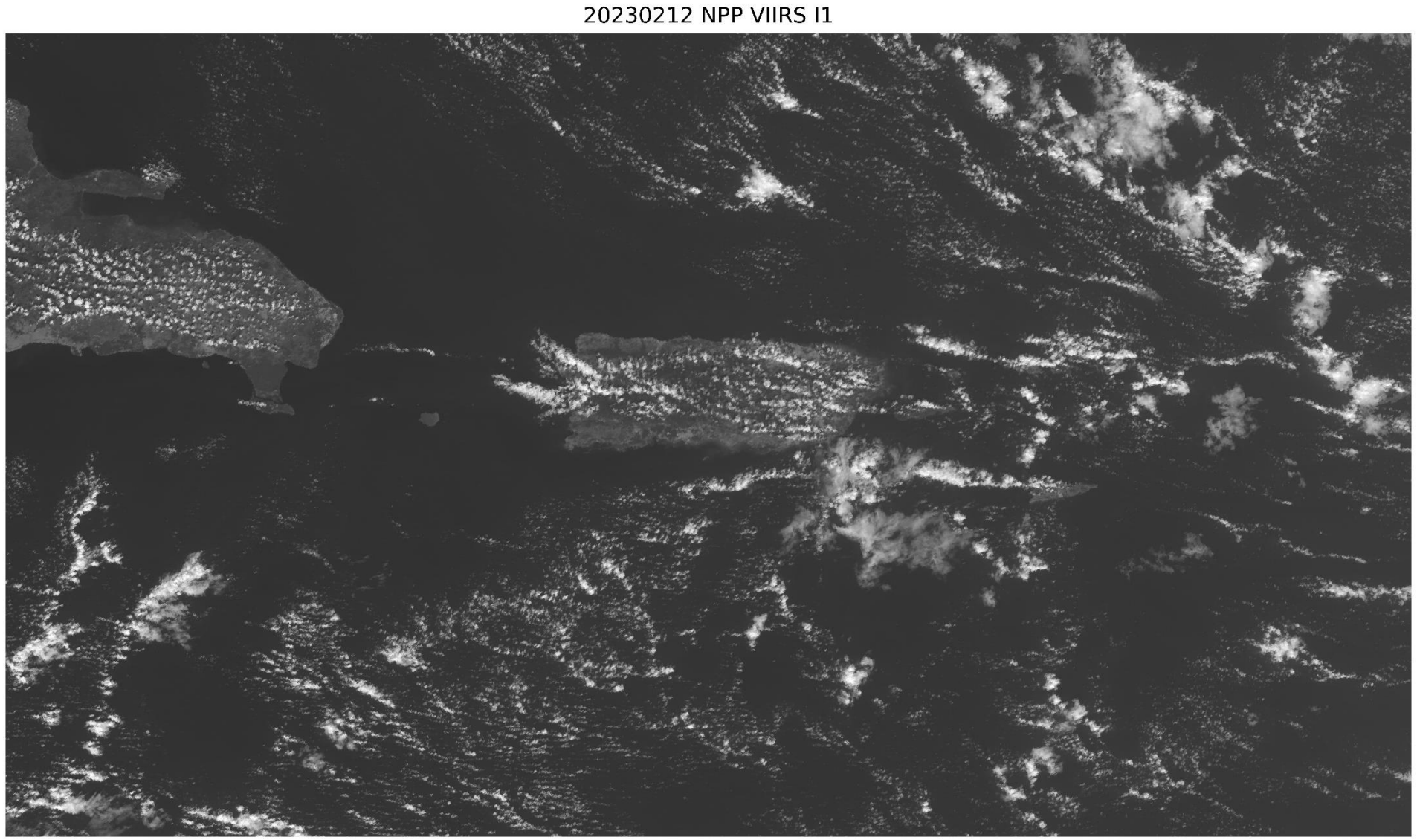
NOAA-21 Comparisons with NPP and NOAA-20

Puerto Rico
20230212
NOAA-21
I1



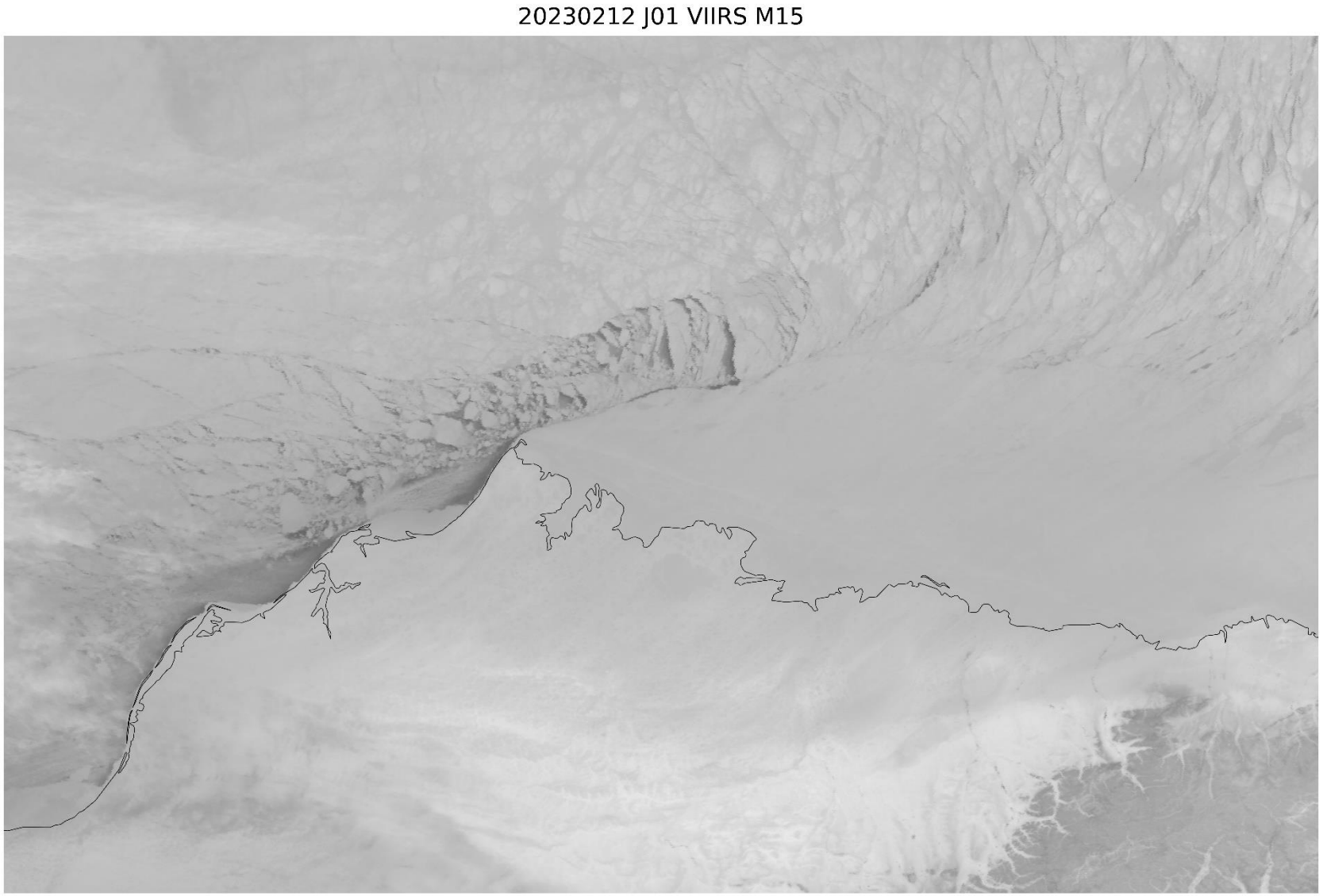
NOAA-21 Comparisons with NPP and NOAA-20

Puerto Rico
20230212
S-NPP
I1



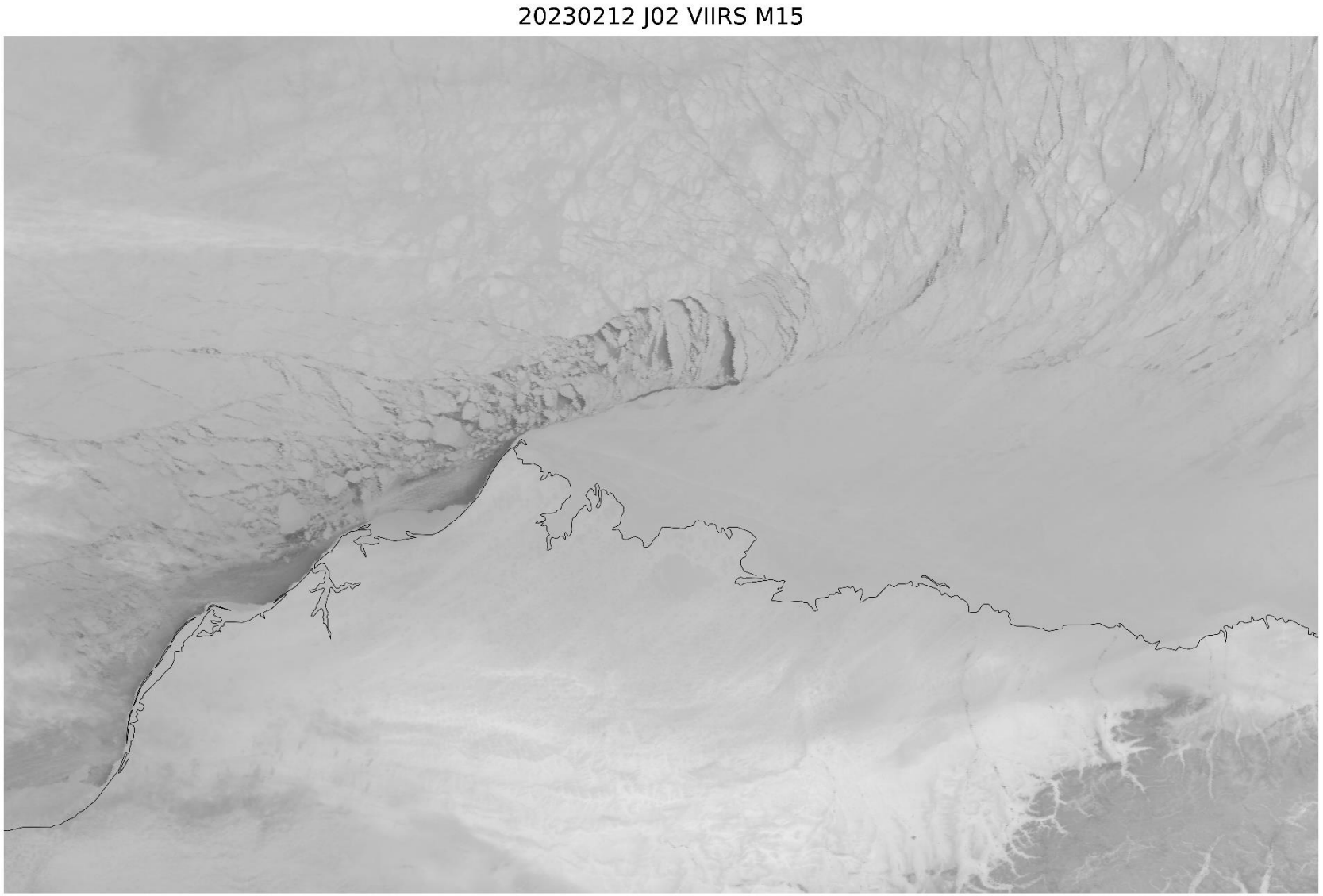
NOAA-21 Comparisons with NPP and NOAA-20

N Alaska
20230212
NOAA-20
M15



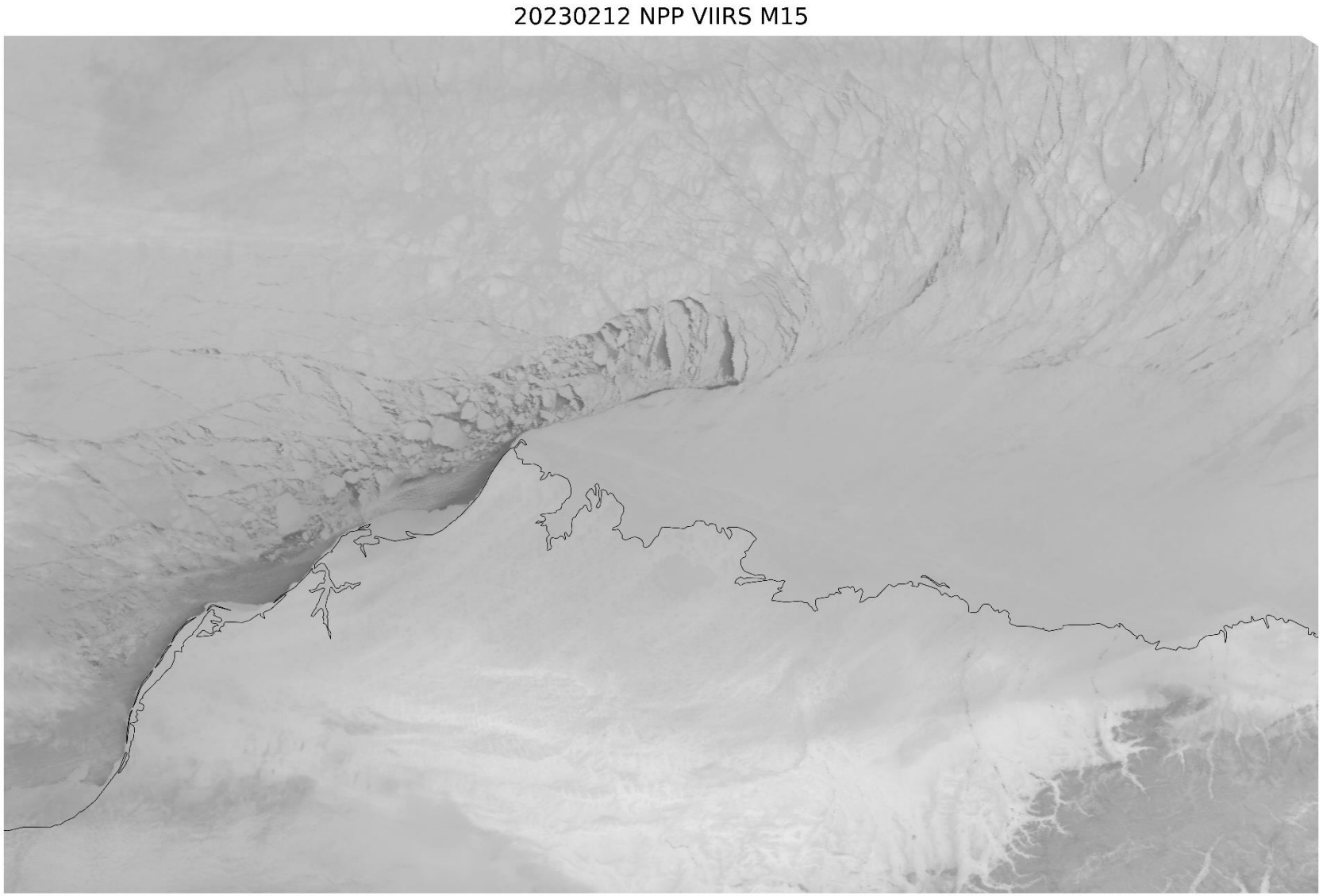
NOAA-21 Comparisons with NPP and NOAA-20

N Alaska
20230212
NOAA-21
M15



NOAA-21 Comparisons with NPP and NOAA-20

N Alaska
20230212
S-NPP
M15



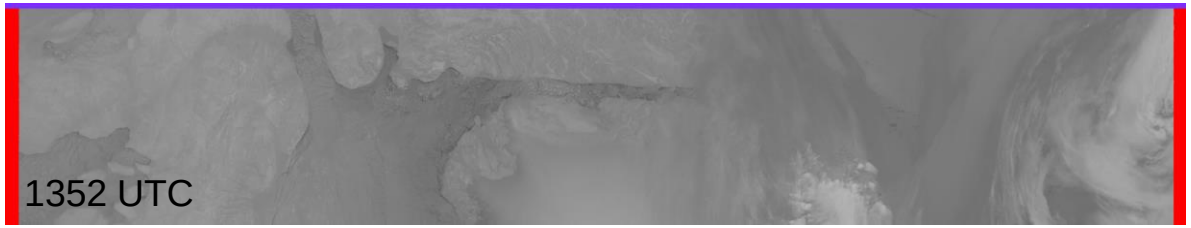
Imagery Artifacts

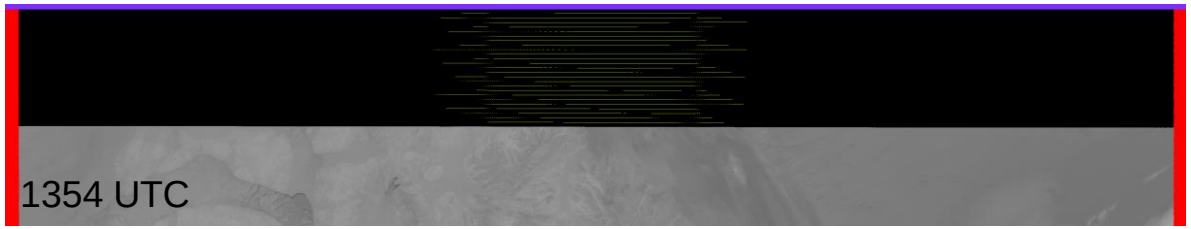
IR Band Degradation on 2/9

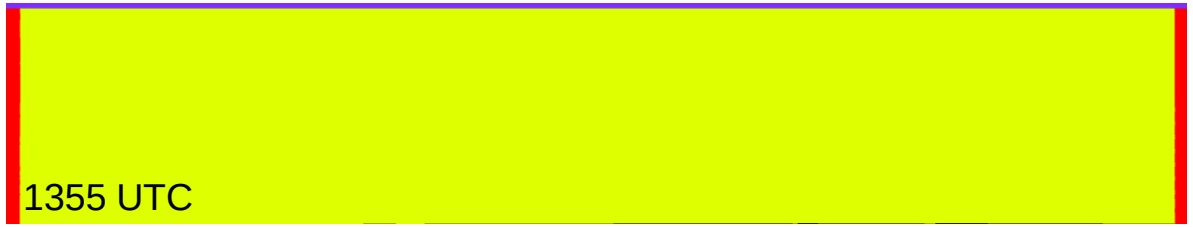
Issue: IR Band Degradation and subsequent return after Cryo Doors open on 2/9
1300-1700 UTC 9 Feb 2023 NOAA-21 VIIRS M15
No such issues since

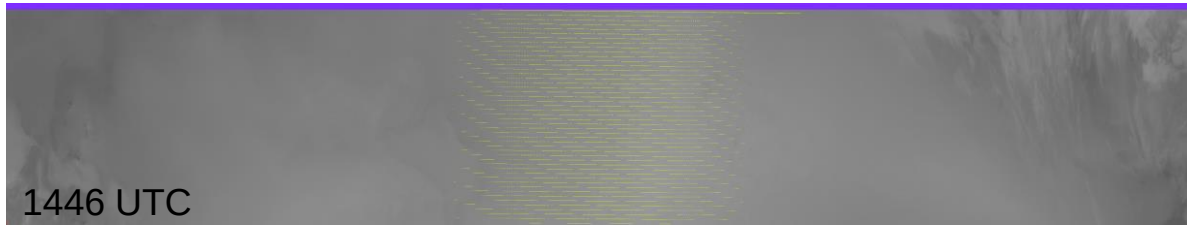
IR Band Degradation on 2/9

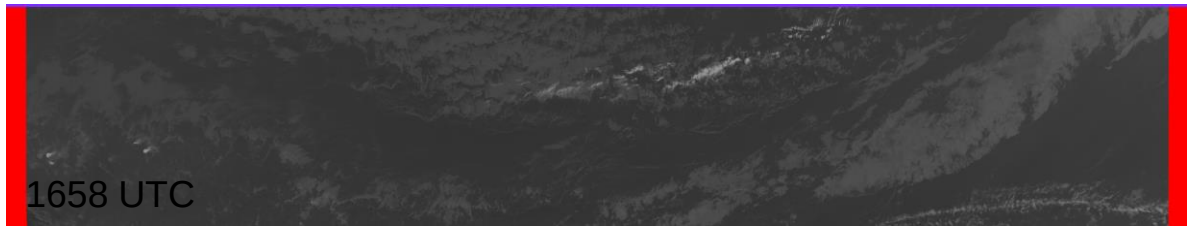
Issue: IR Band Degradation and subsequent return after Cryo Doors open on 2/9. No such issues since











Striping in M9 and M11

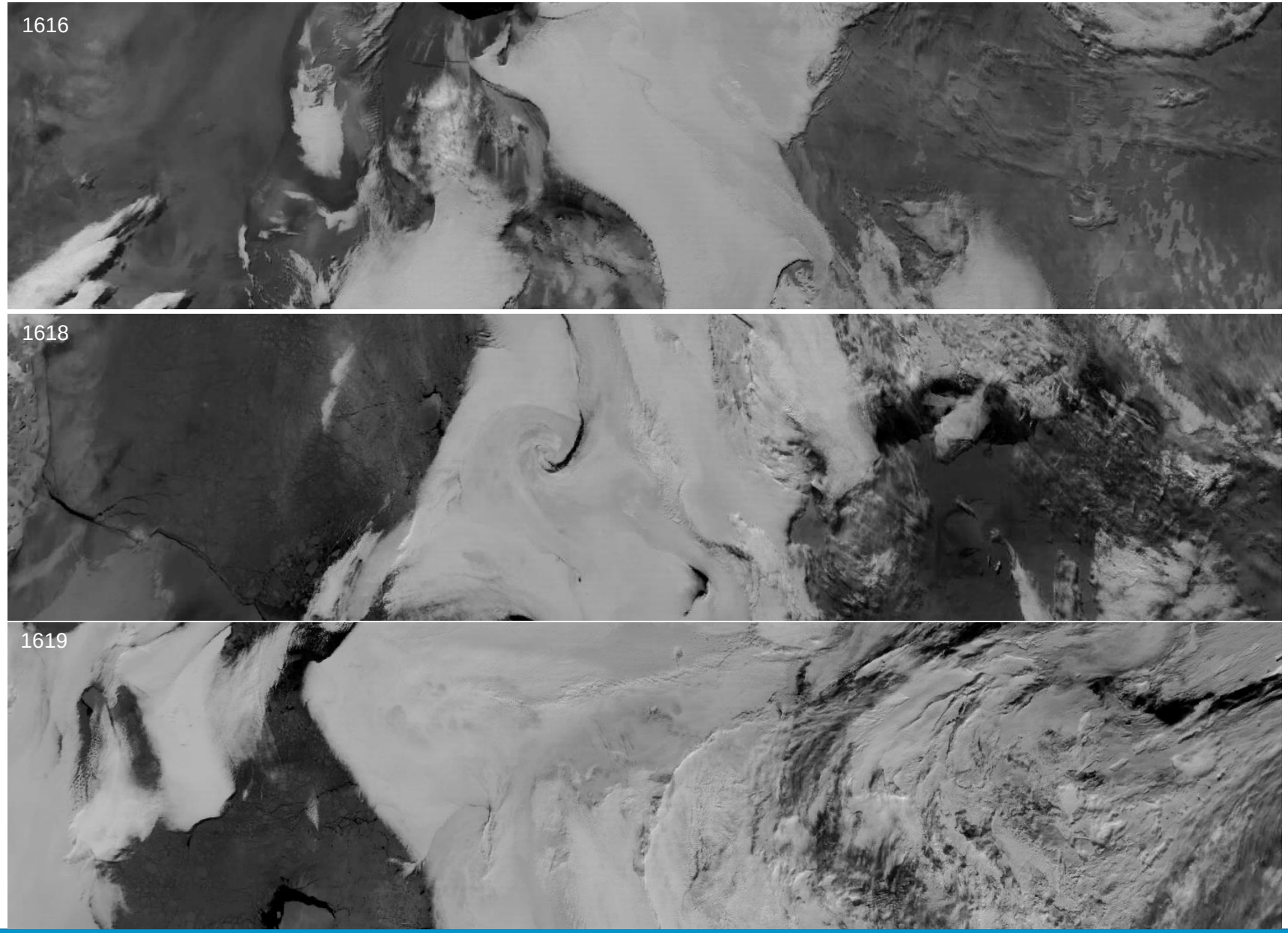
1616 UTC – 1619 UTC 20230215
NOAA-21
M9

Most apparent in highly reflective, uniform regions

Striping in M9 and M11

1616 UTC – 1619 UTC 20230215
NOAA-21
M11

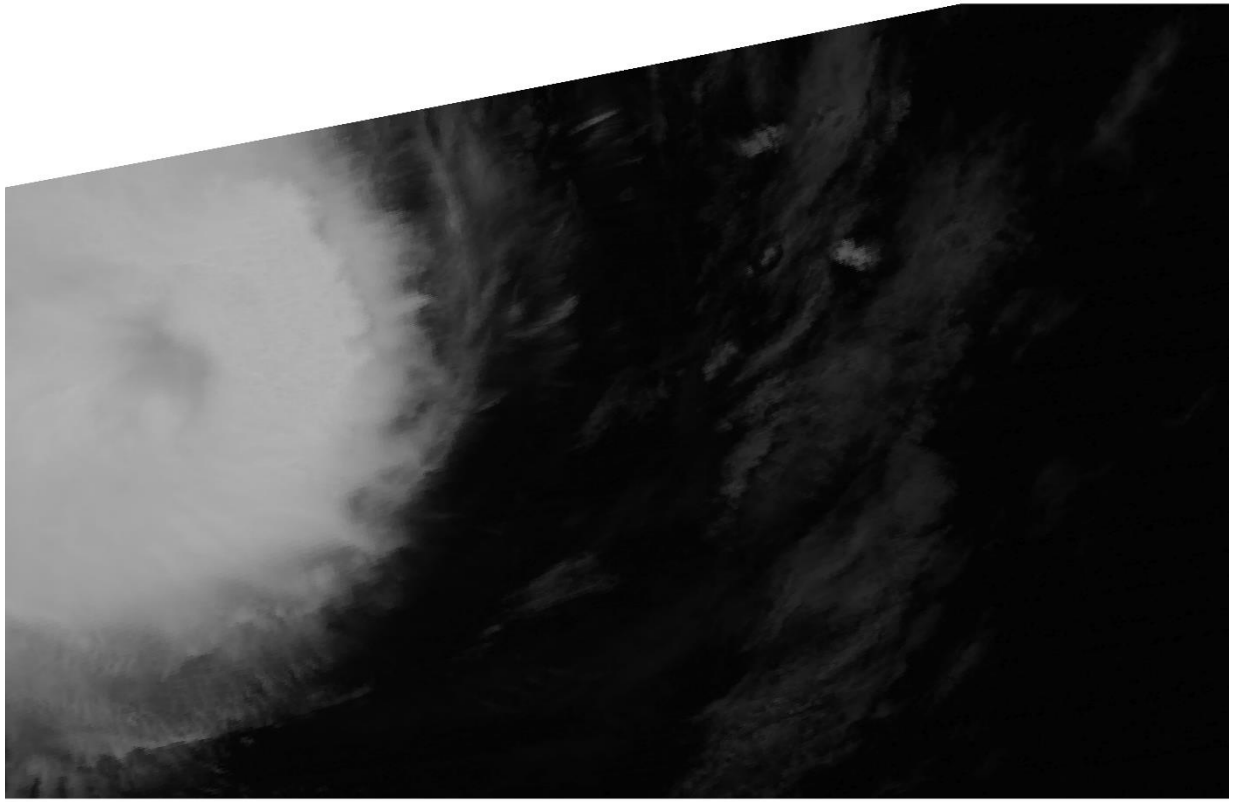
Most apparent in highly reflective, uniform regions



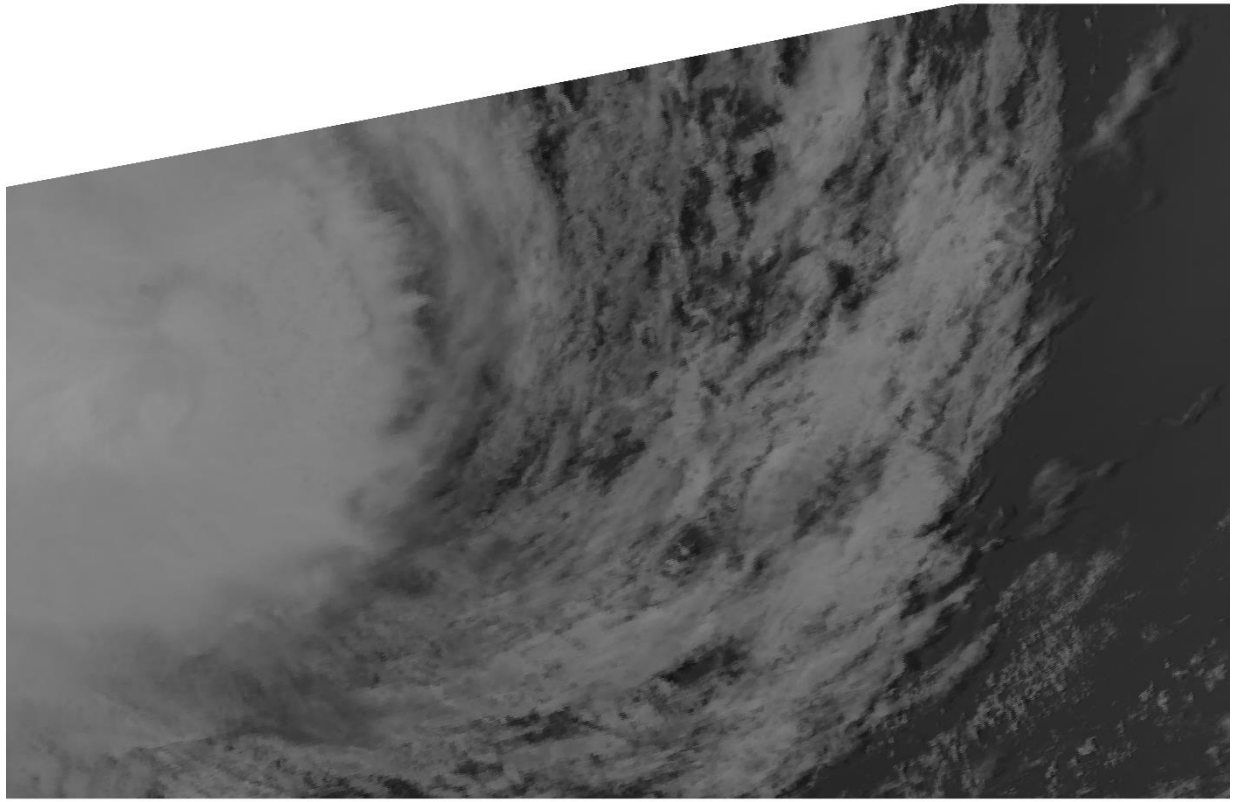
NOAA-21 Compared with NOAA-20 and S-NPP: M9 and M11

Hurricane Freddy
20230213
NOAA-20

20230213 J01 VIIRS M09



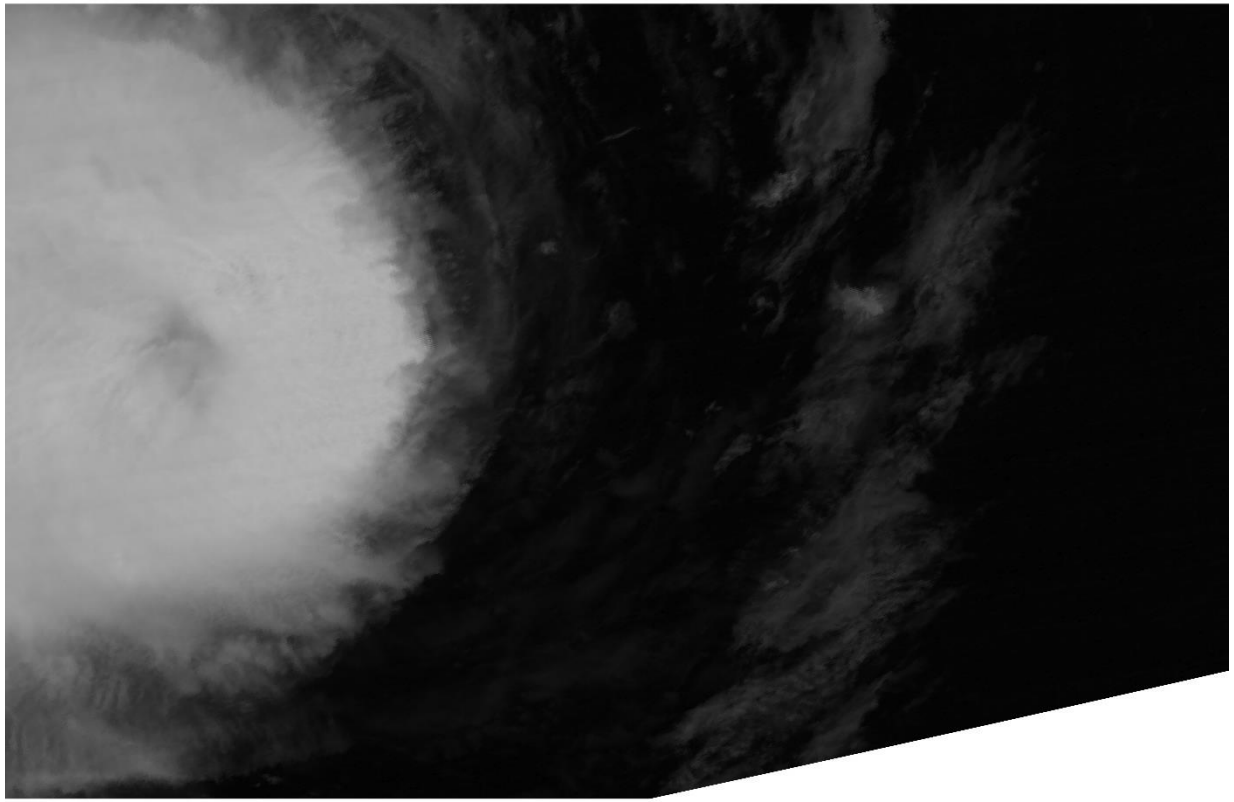
20230213 J01 VIIRS M11



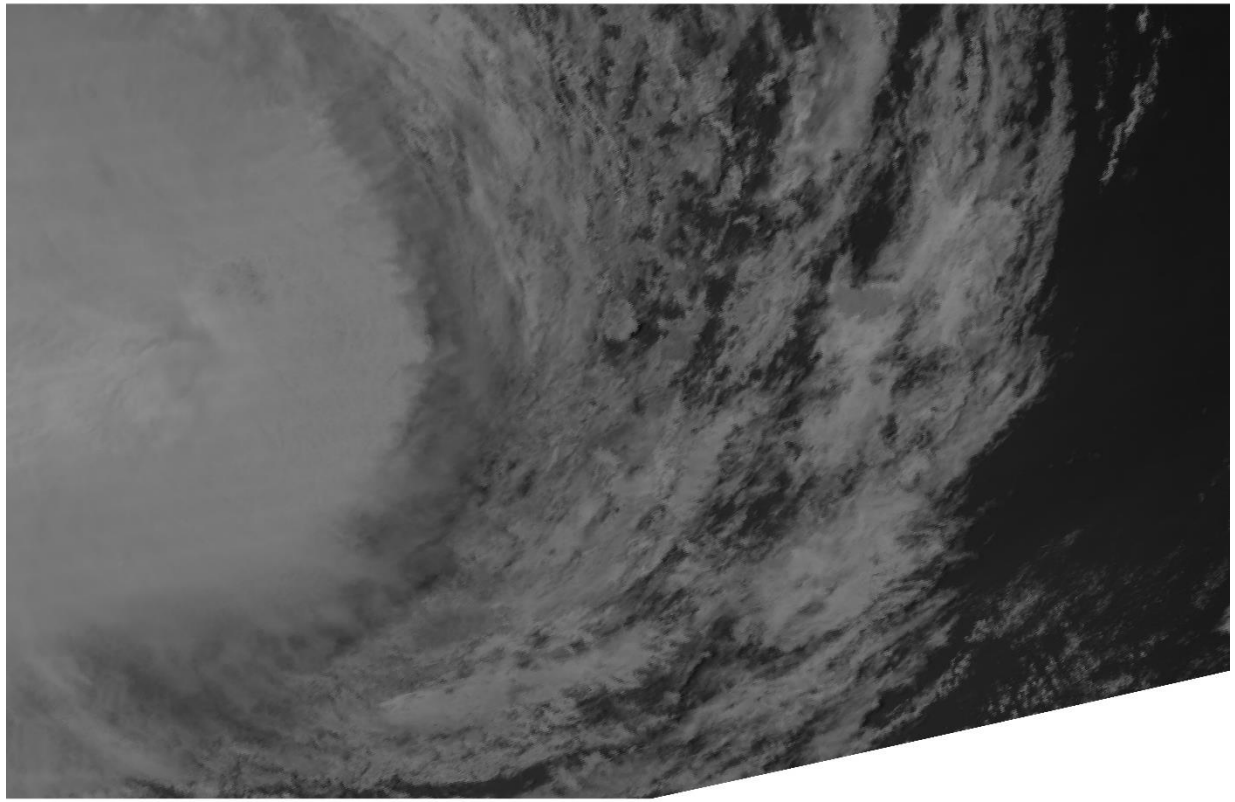
NOAA-21 Compared with NOAA-20 and S-NPP: M9 and M11

Hurricane Freddy
20230213
NOAA-21

20230213 J02 VIIRS M09



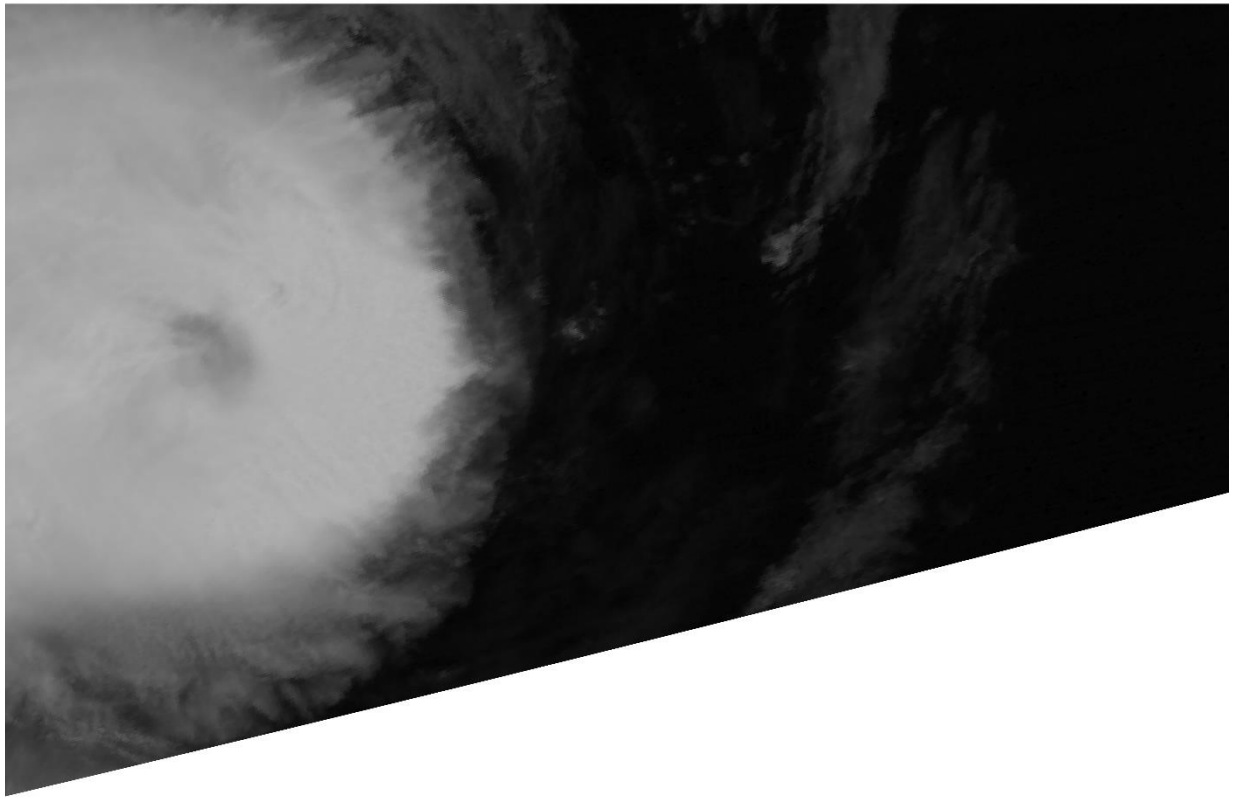
20230213 J02 VIIRS M11



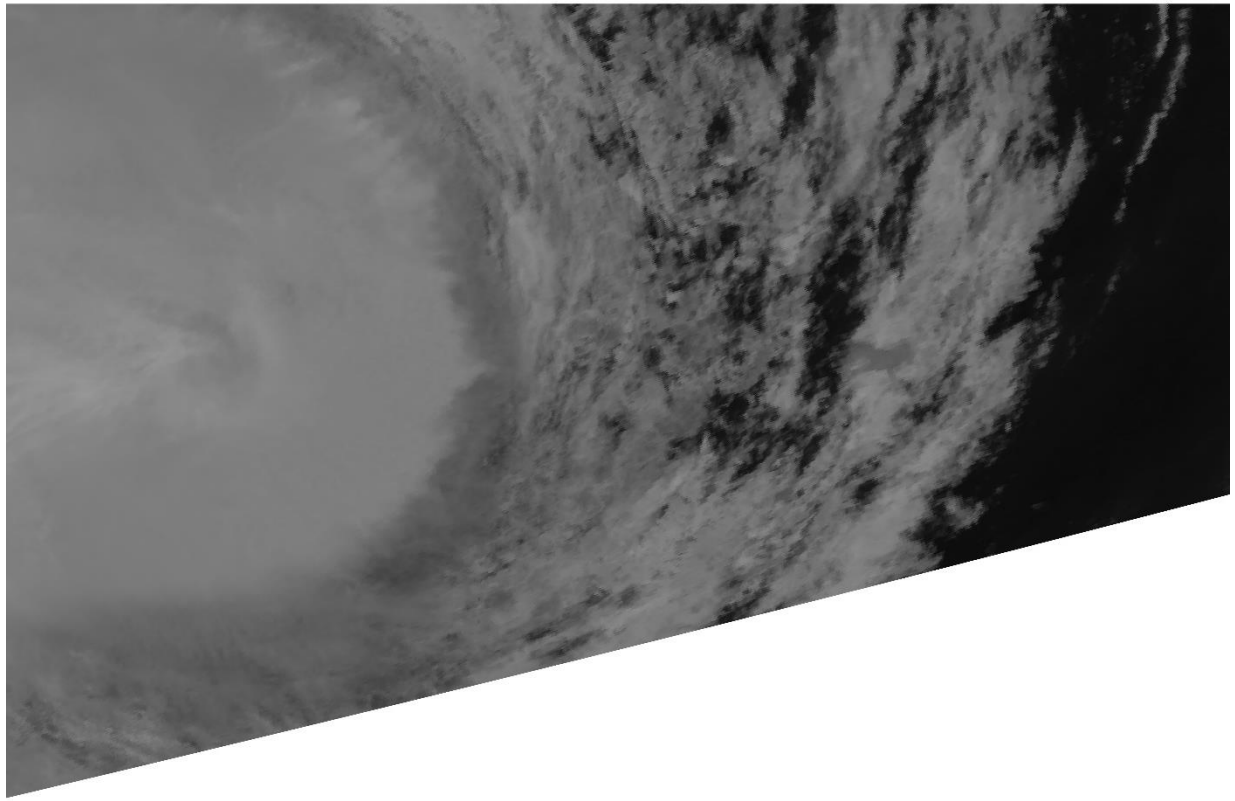
NOAA-21 Compared with NOAA-20 and S-NPP: M9 and M11

Hurricane Freddy
20230213
S-NPP

20230213 NPP VIIRS M09



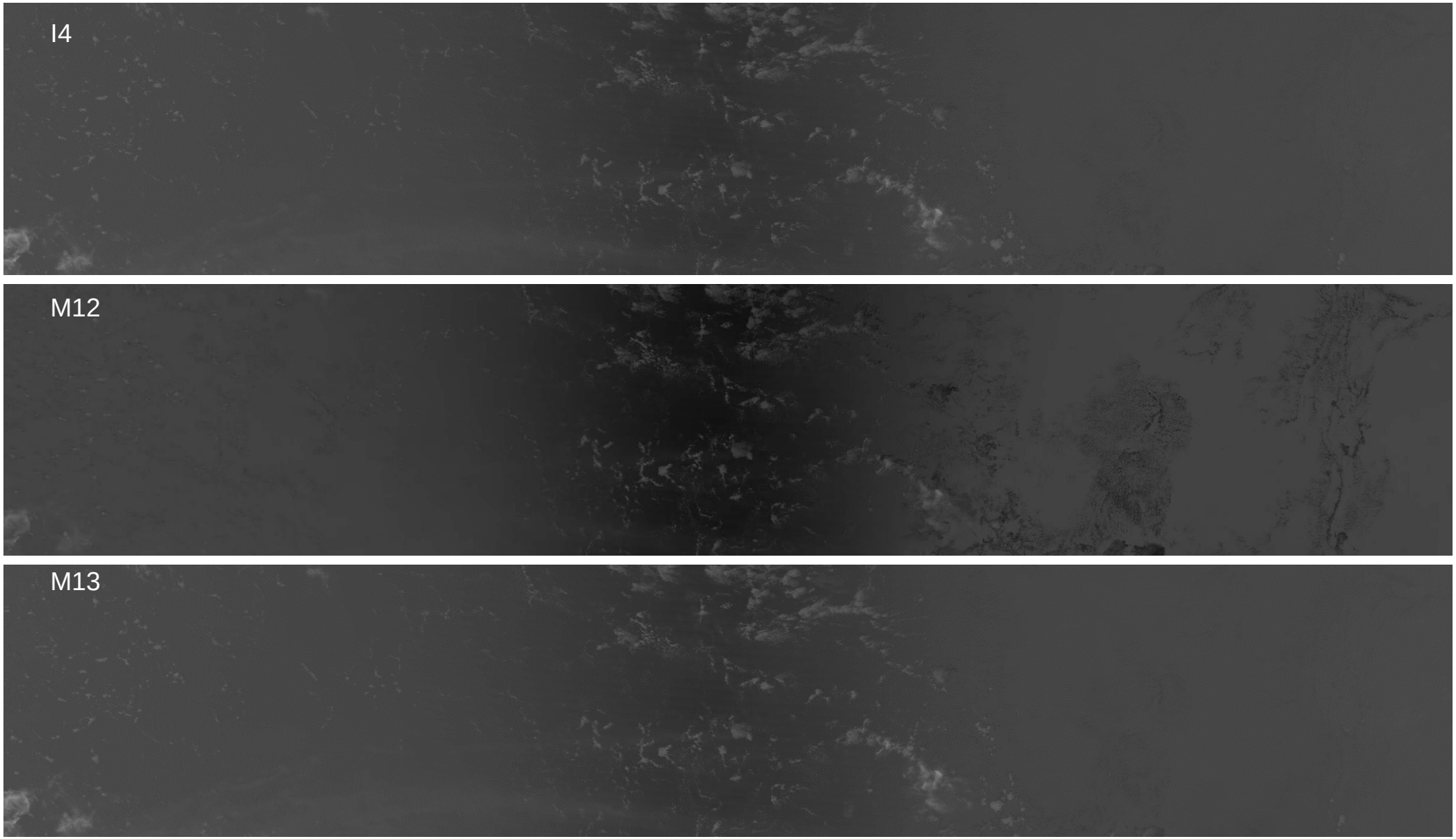
20230213 NPP VIIRS M11



Striping in I4, M12, M13

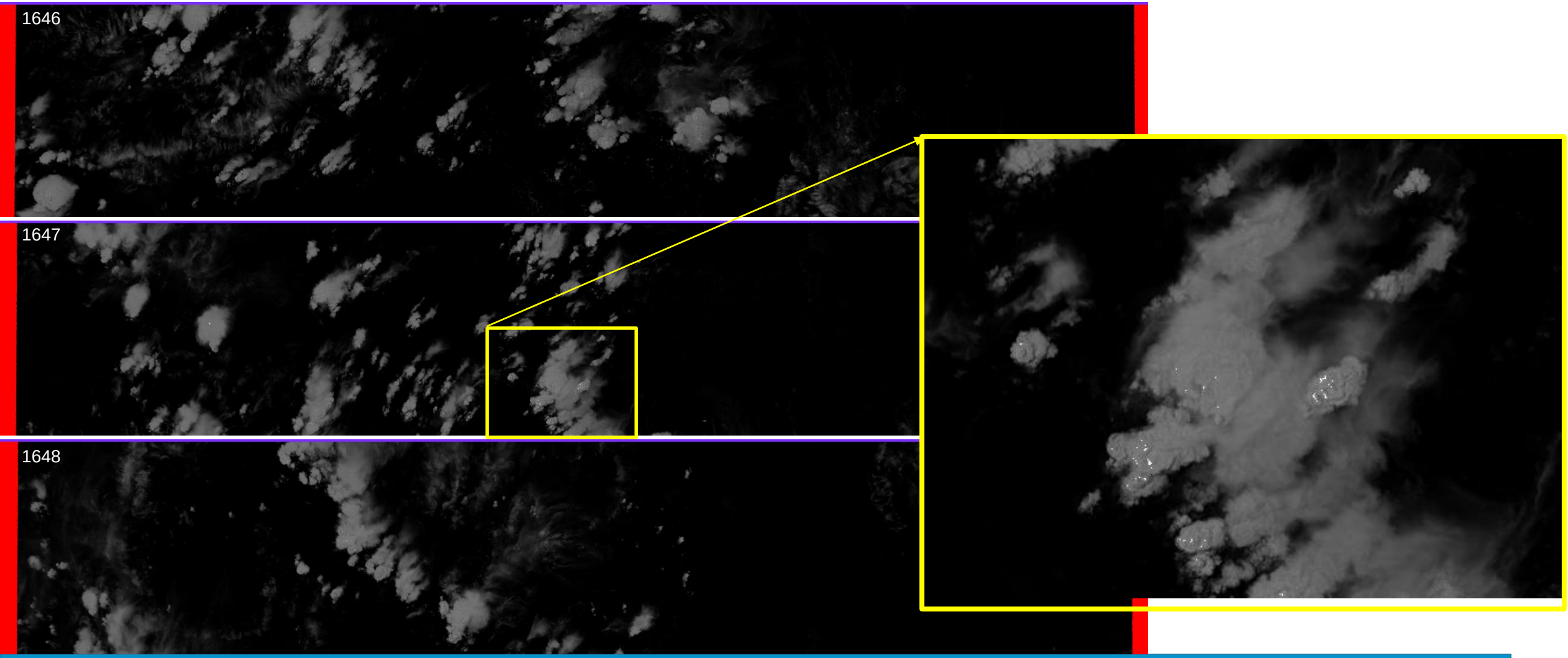
20230221
NOAA-21
I4, M12, M13

Most apparent in sunglint regions



M9 Speckles (Pixel Saturation)

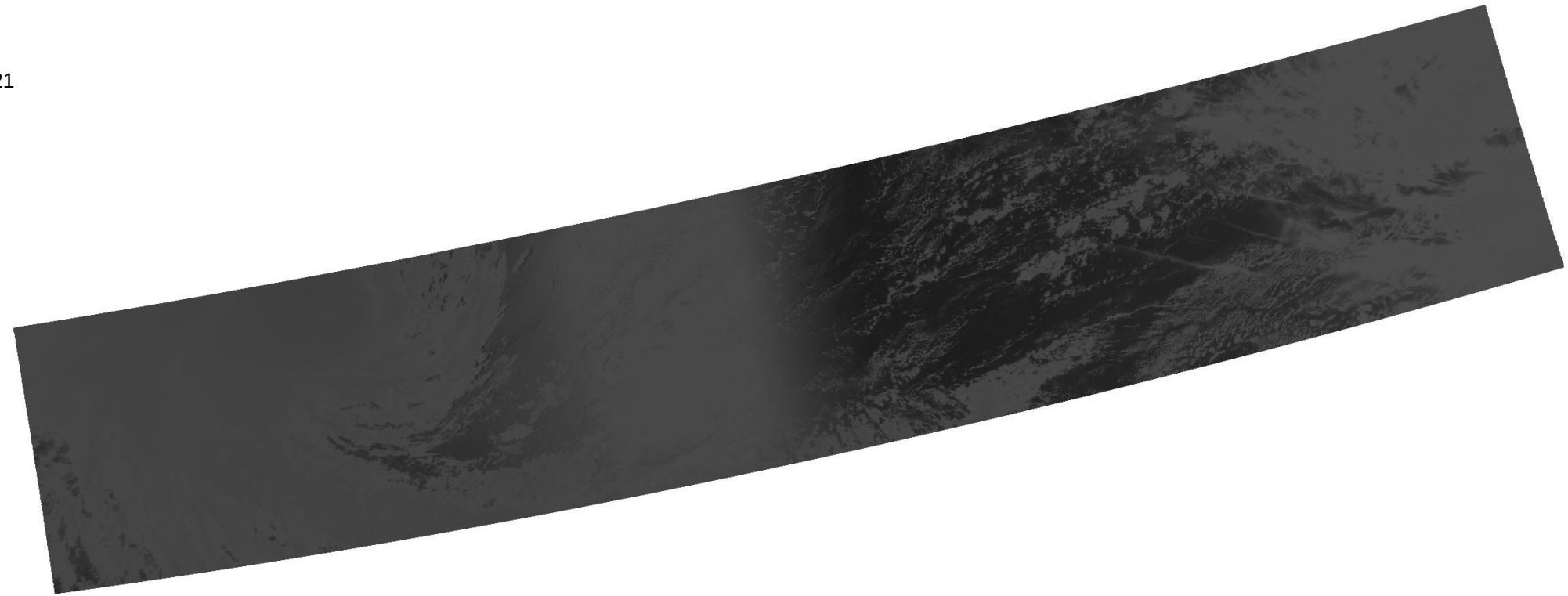
1646 UTC – 1648 UTC 20230212
NOAA-21
M9



Broader M6 Pixel Saturation

Tropical Cyclone Freddy
20230213
NOAA-20
M6

No Saturation Rollover for NOAA-21
like on NOAA-20 and S-NPP



Broader M6 Pixel Saturation

Tropical Cyclone Freddy
20230213
NOAA-21
M6

No Saturation Rollover for NOAA-21
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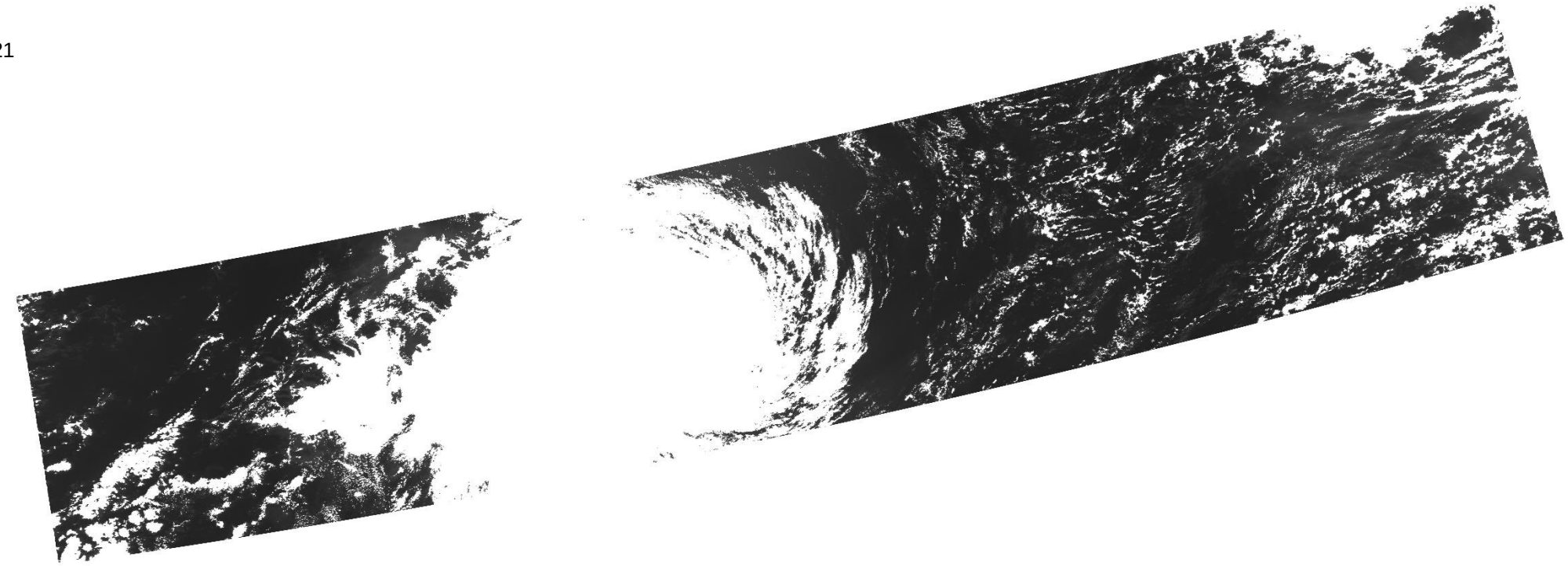

Broader M6 Pixel Saturation

Tropical Cyclone Freddy
20230213
S-NPP
M6

No Saturation Rollover for NOAA-21
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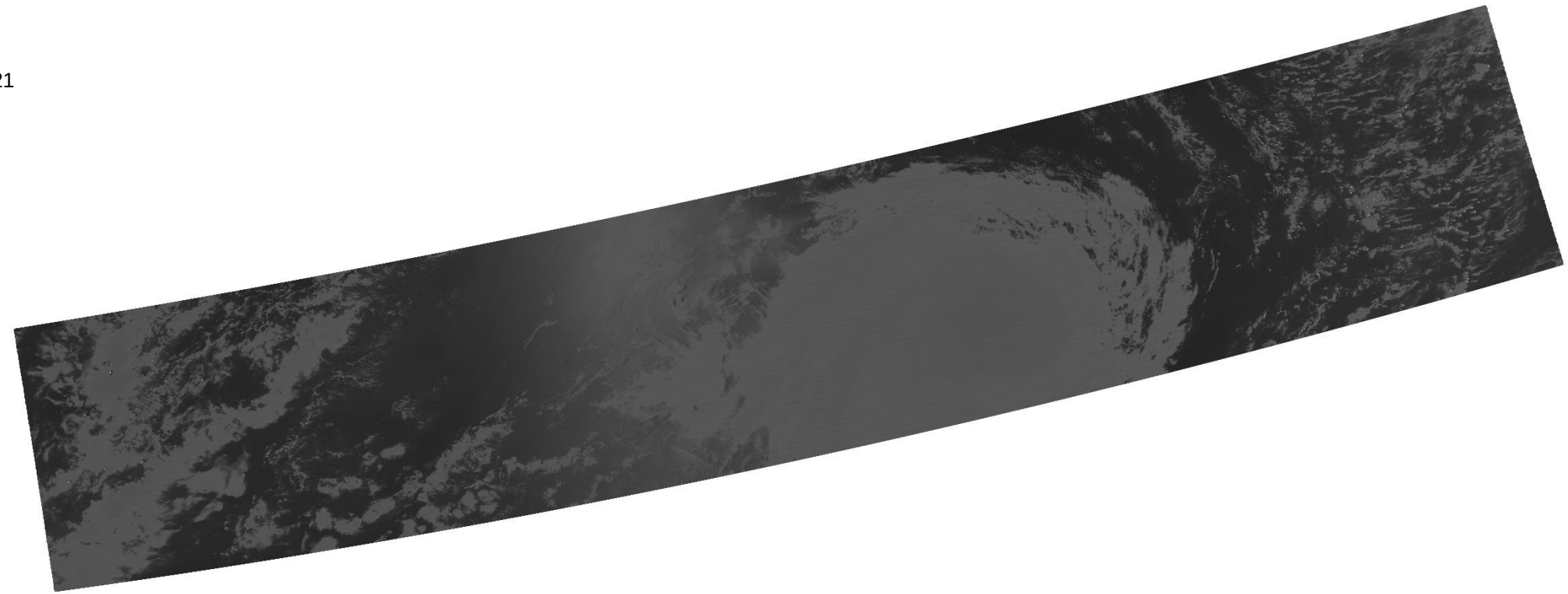
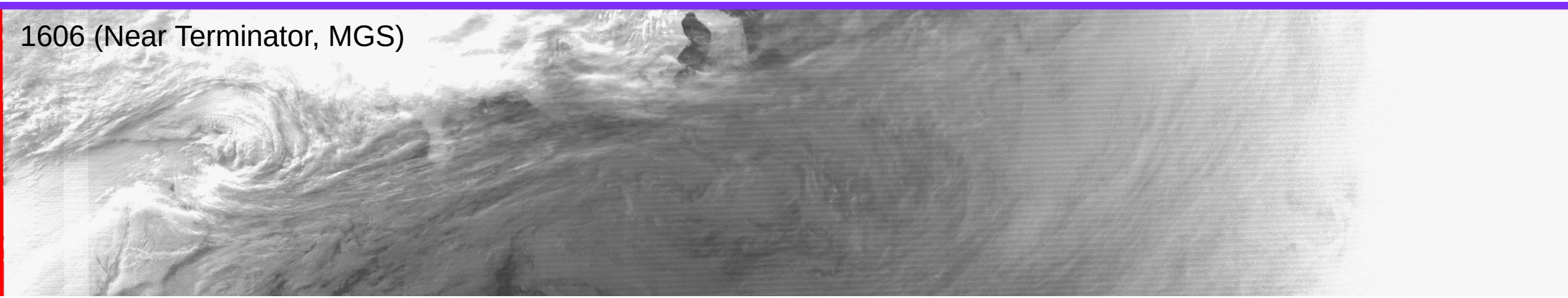


Striping in DNB/NCC

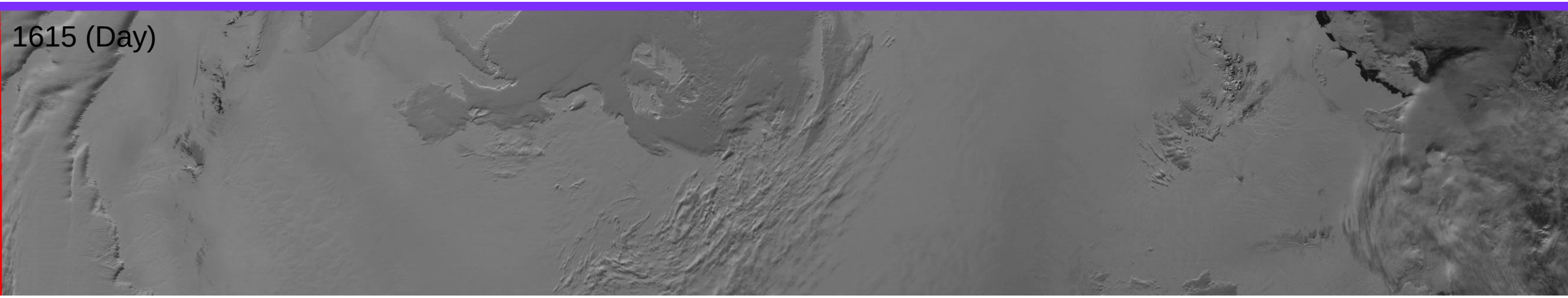
20230215
NOAA-21
NCC

Most apparent near terminator

1606 (Near Terminator, MGS)



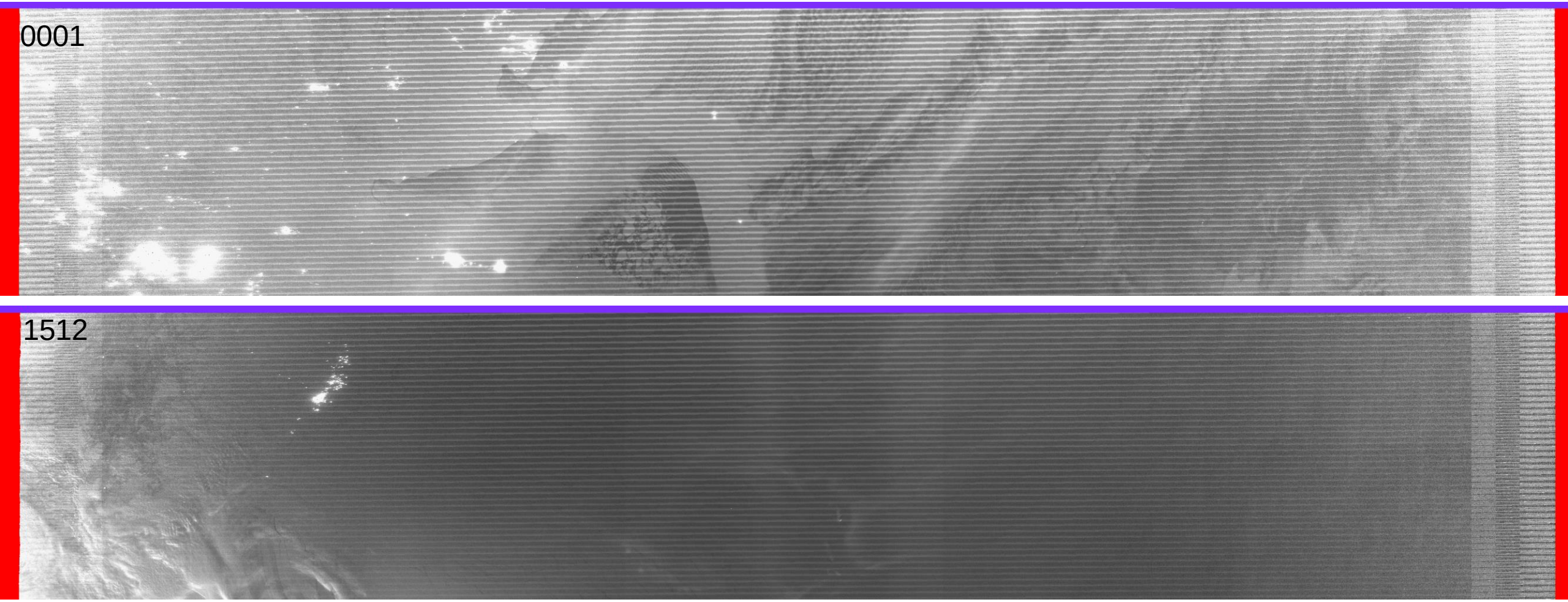
1615 (Day)



Striping in DNB/NCC

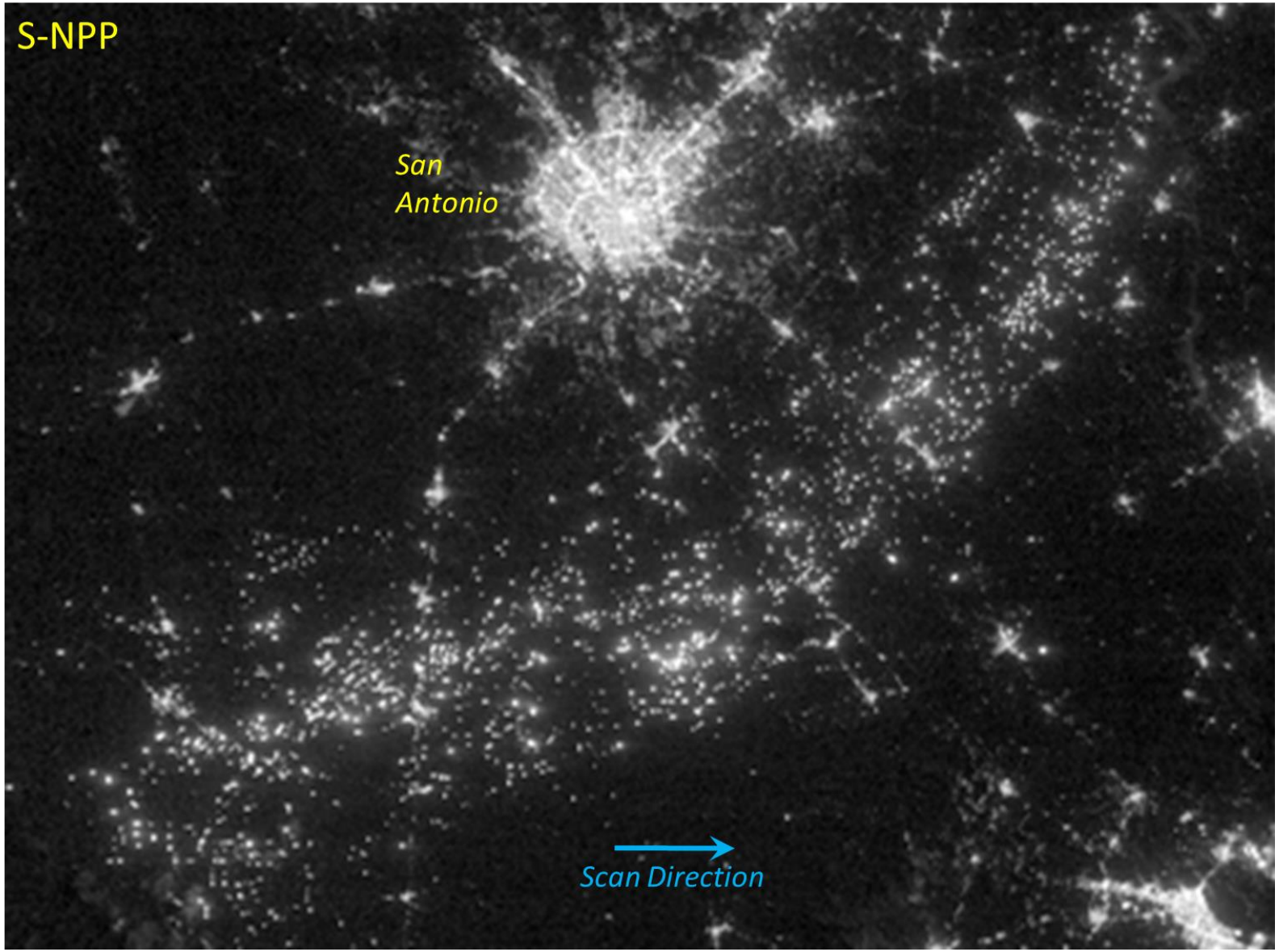
20230221
NOAA-21
NCC

Most apparent near terminator



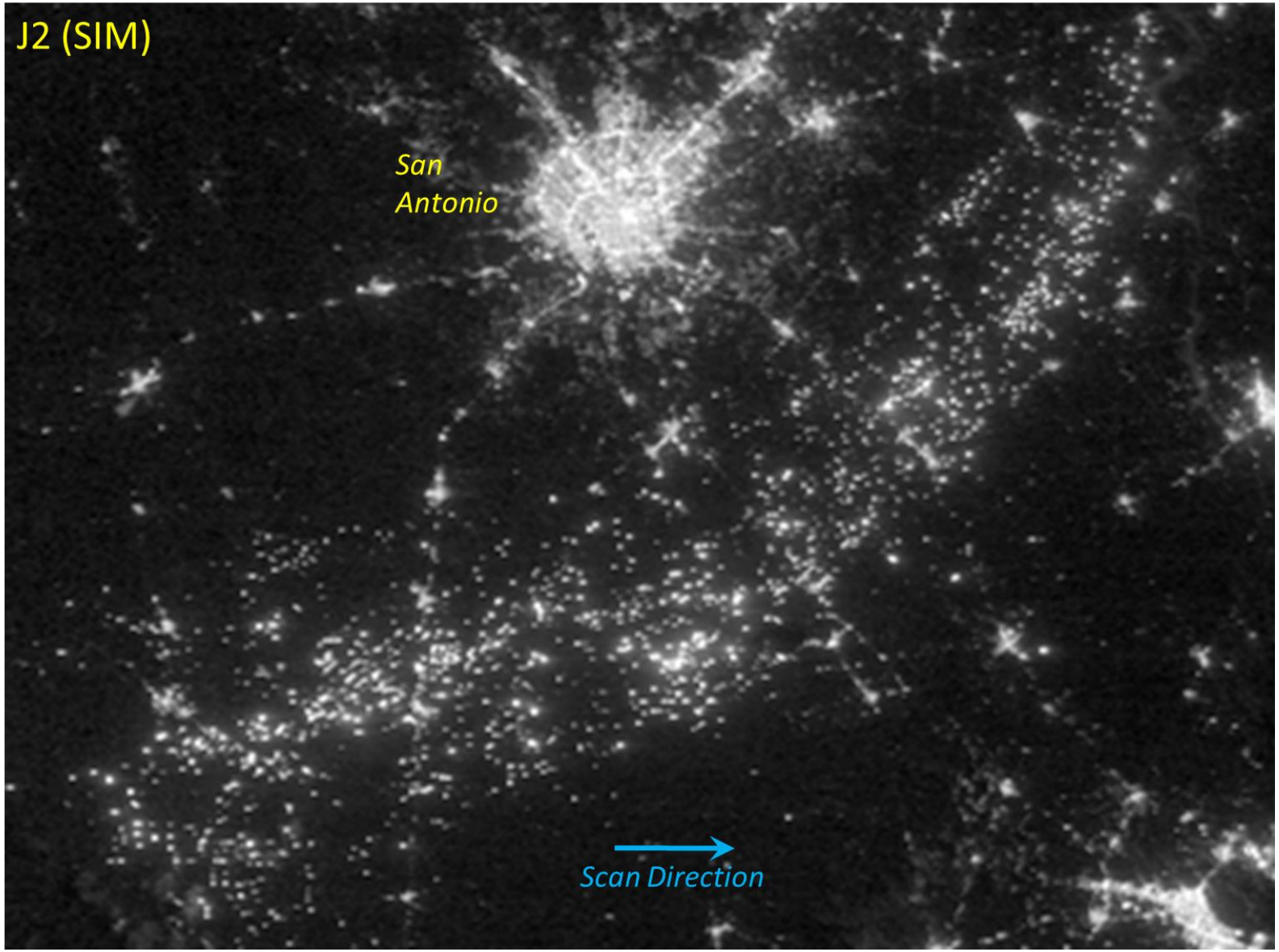
DNB Smearing

San Antonio Area City Lights
Pre-Launch Data
S-NPP
DNB



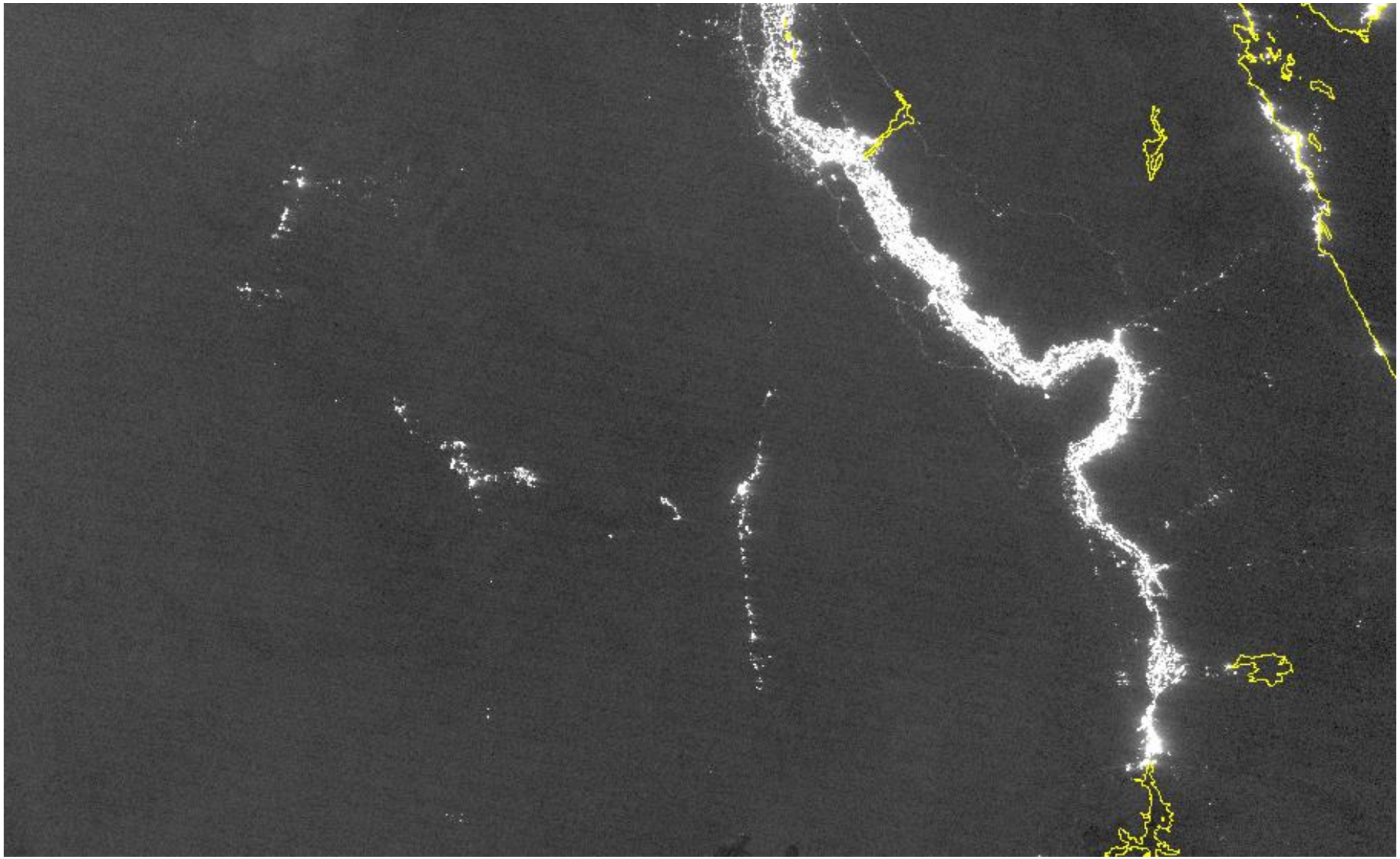
DNB Smearing

San Antonio Area City Lights
Pre-Launch Data
NOAA-21 Simulated
DNB



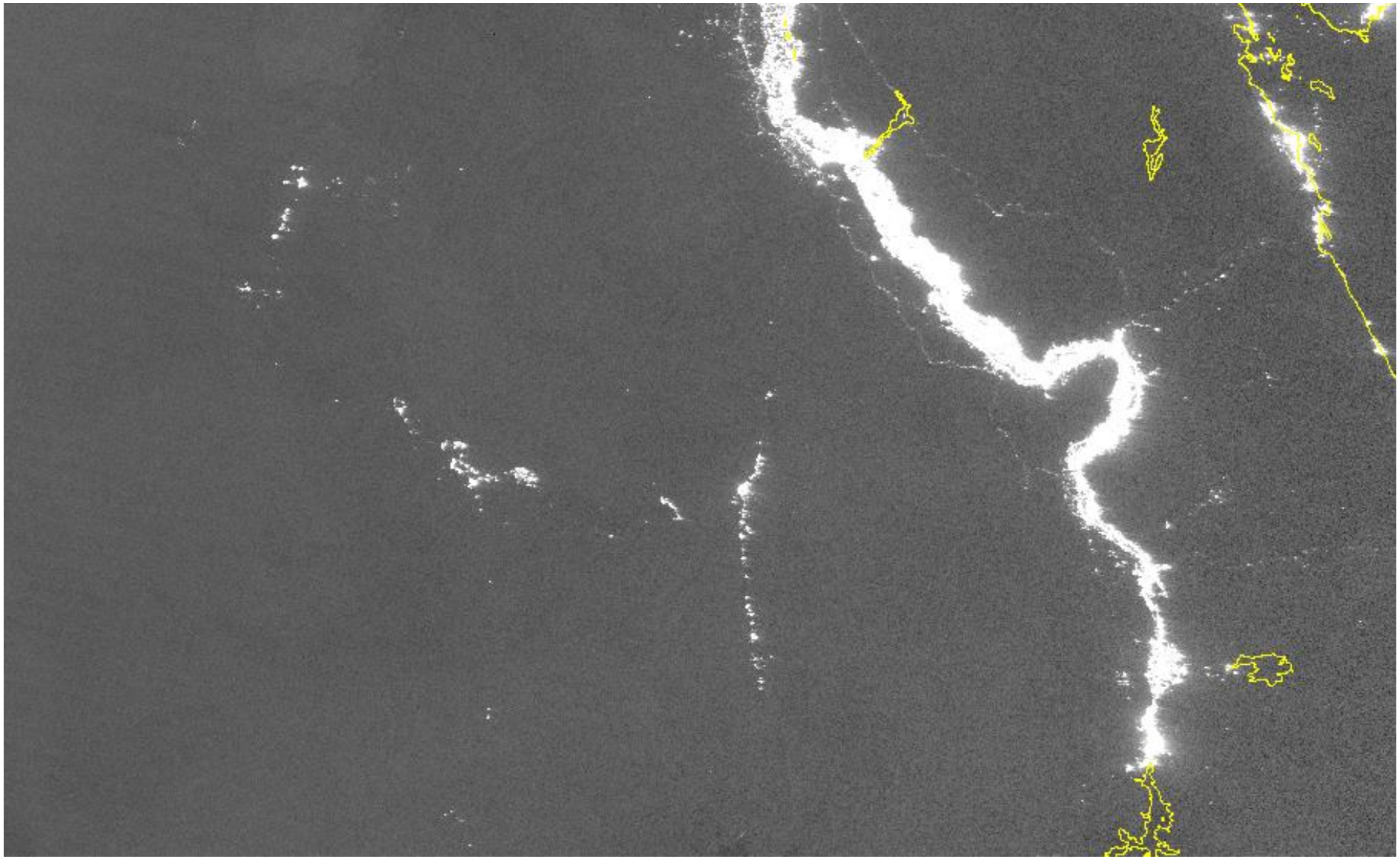
DNB Smearing

Egypt
20230215
NOAA-20
NCC



DNB Smearing

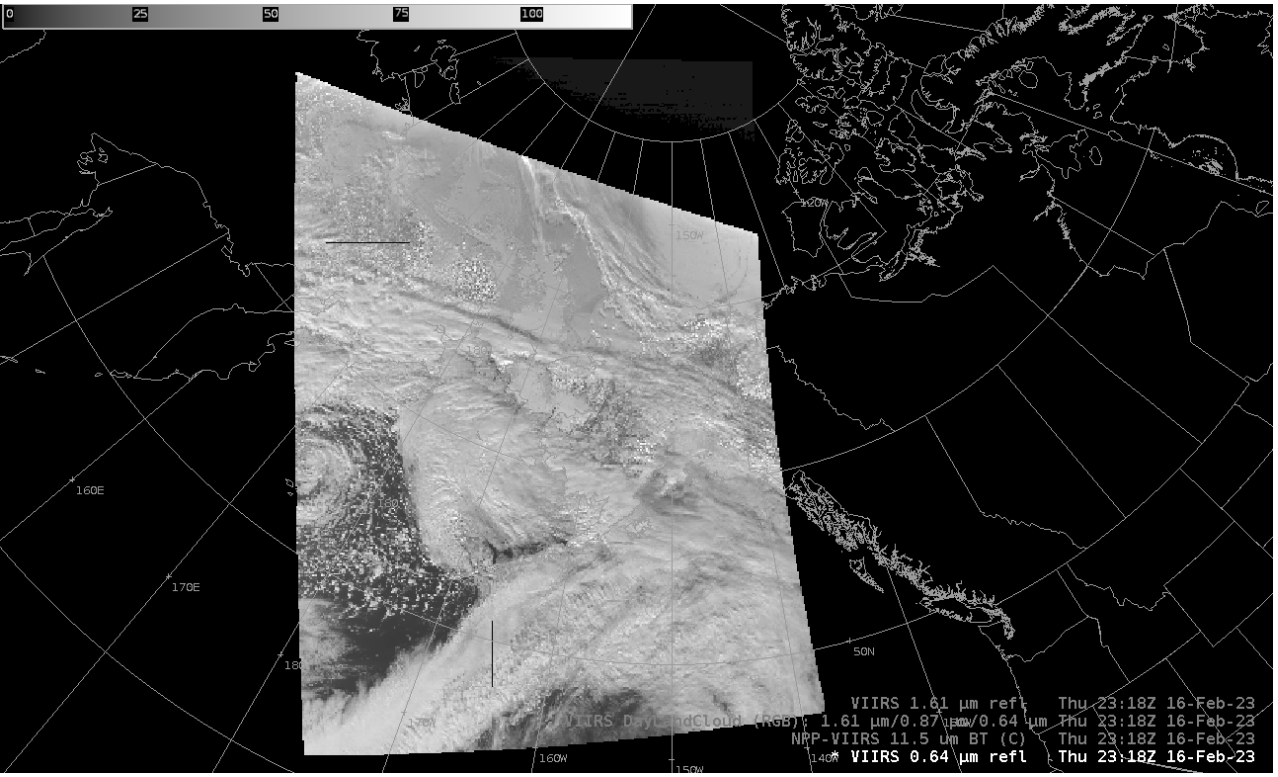
Egypt
20230215
NOAA-21
NCC



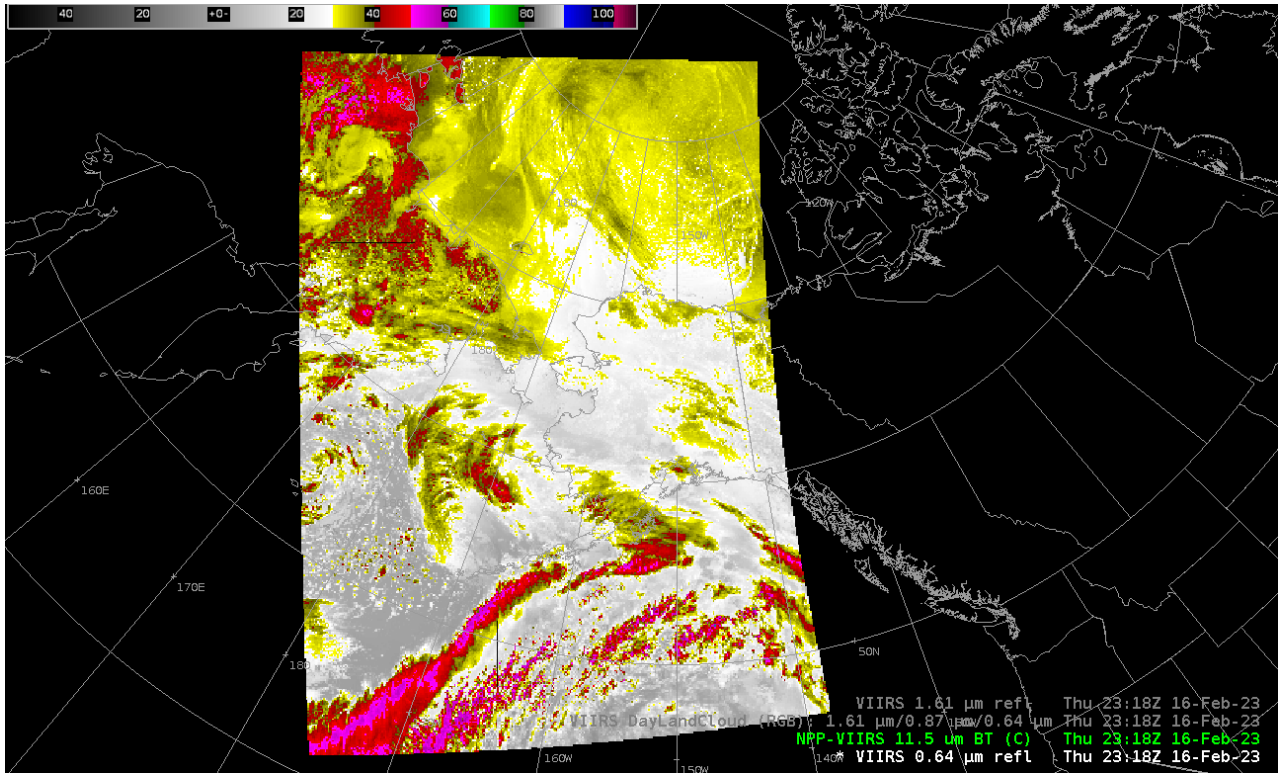
User Feedback

University of Alaska Geographic Information Network of Alaska (GINA)
Ingesting NOAA-21 VIIRS Imagery (VIS/NIR/IR) via Direct Broadcast
Successfully ingesting and displaying Imagery in local AWIPS
“[The Imagery is] looking really good from just occasional comparisons with other VIIRS pass data.”

AWIPS Display of NOAA-21 VIIRS I1



AWIPS Display of NOAA-21 VIIRS I5

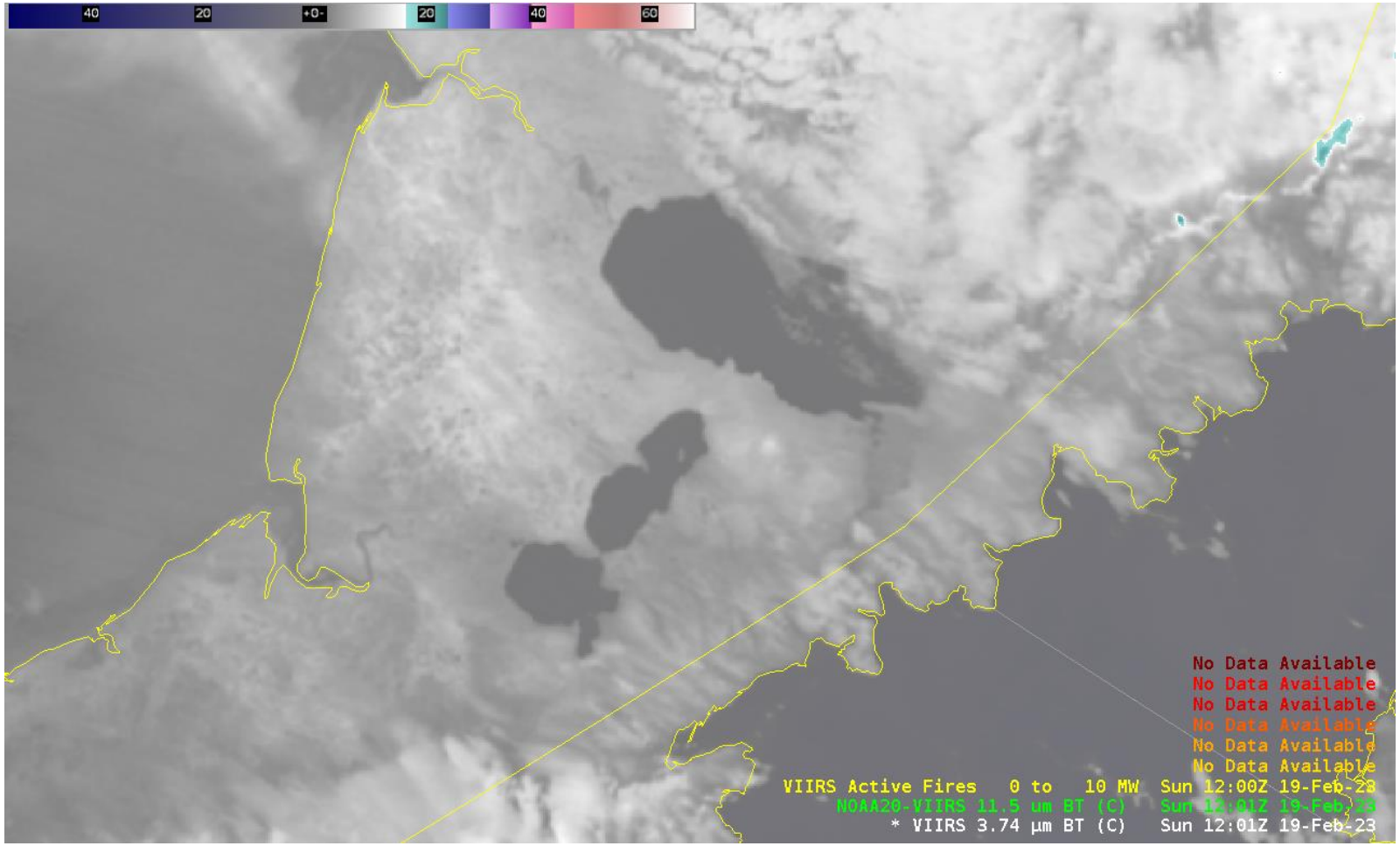


Carl Dierking, UAF GINA

User Feedback

University of Alaska Geographic Information Network of Alaska (GINA)
Noted Issue: Slight Geolocation offset in NOAA-21 Imagery
This appears to be unique to DB data. Offset is not apparent in SMD

Southwest Alaska
20230219
NOAA-20 (DB)
I5



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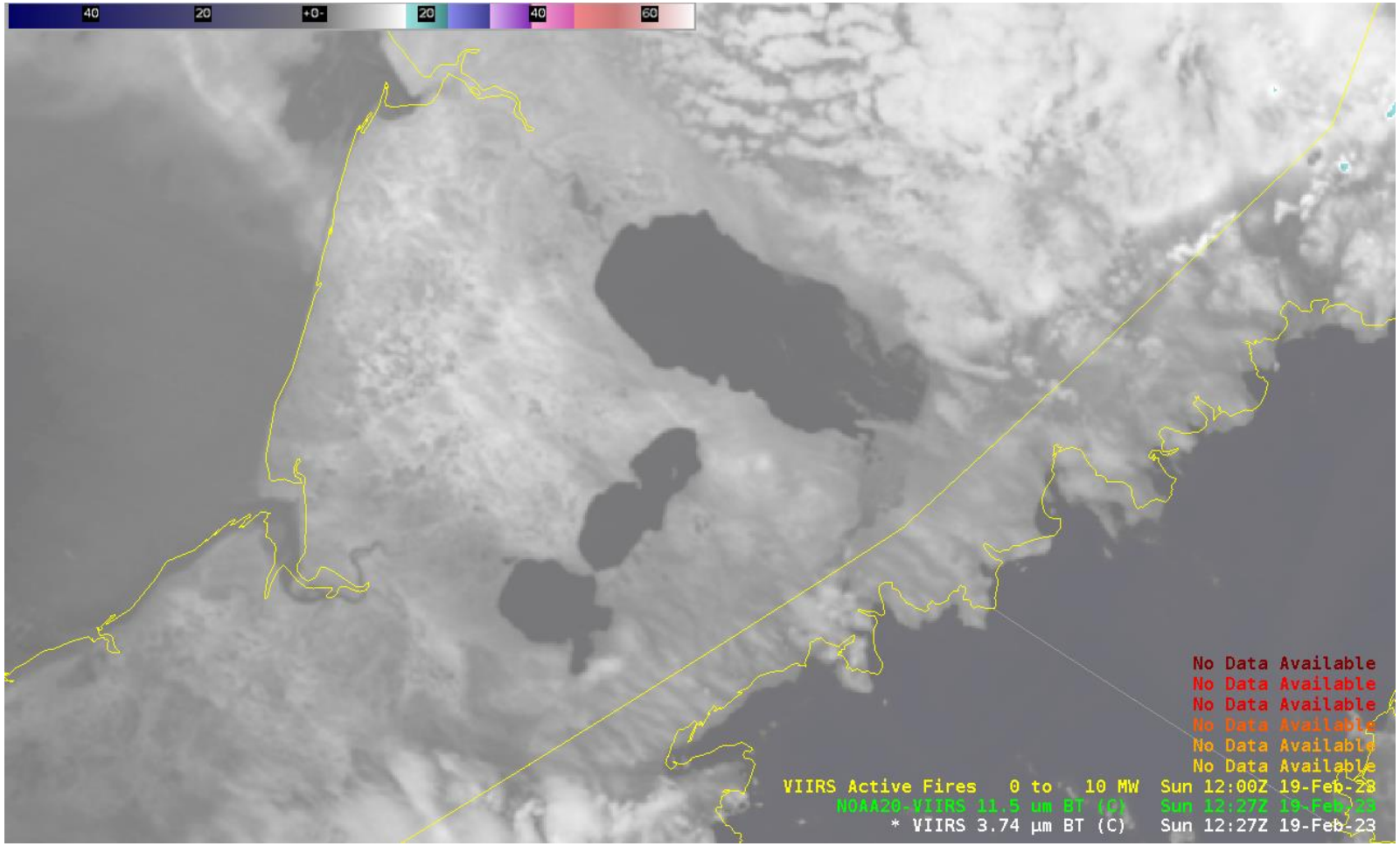
Southwest Alaska
20230219
NOAA-21 (DB)
I5



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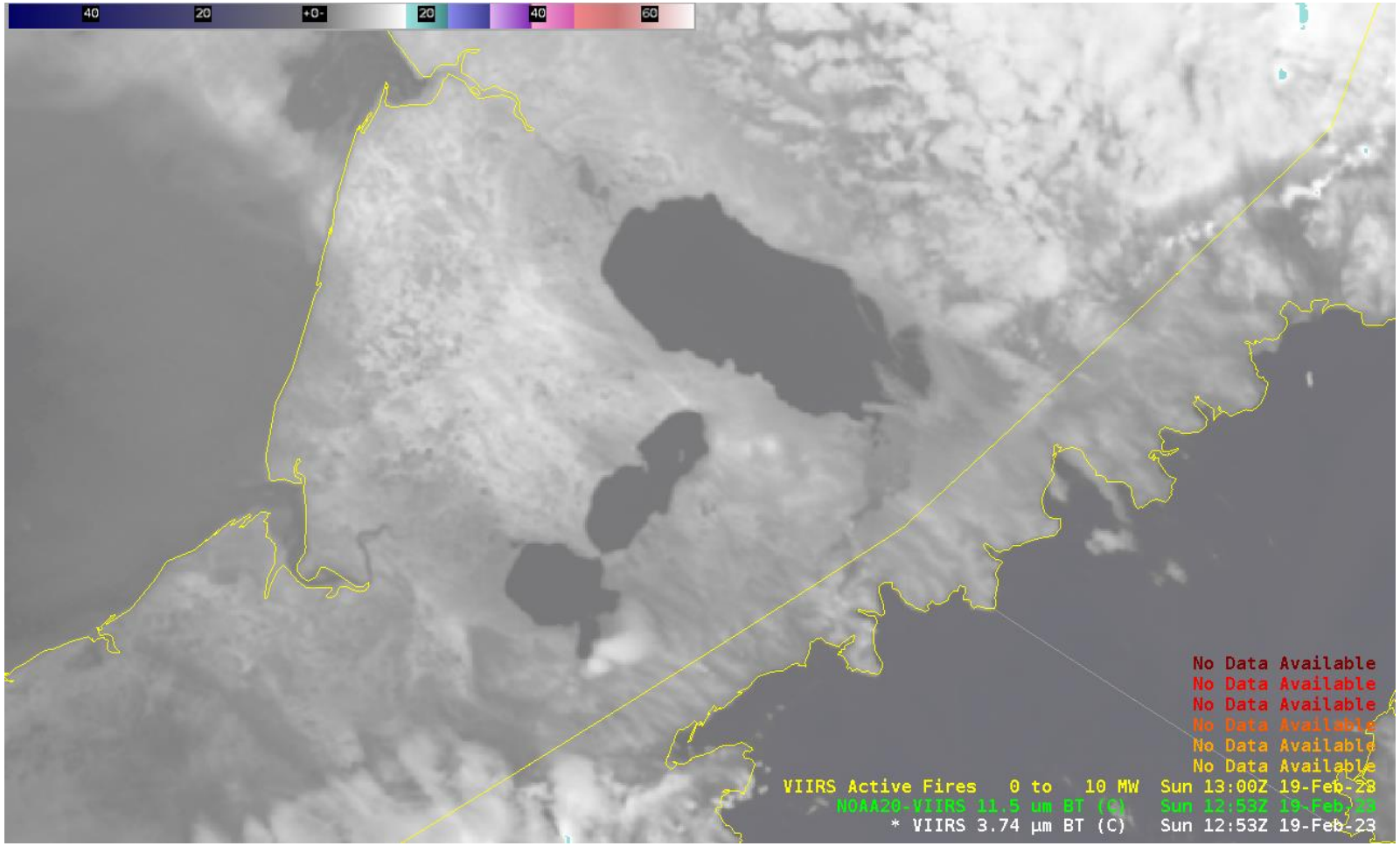
Southwest Alaska
20230219
S-NPP (DB)
I5



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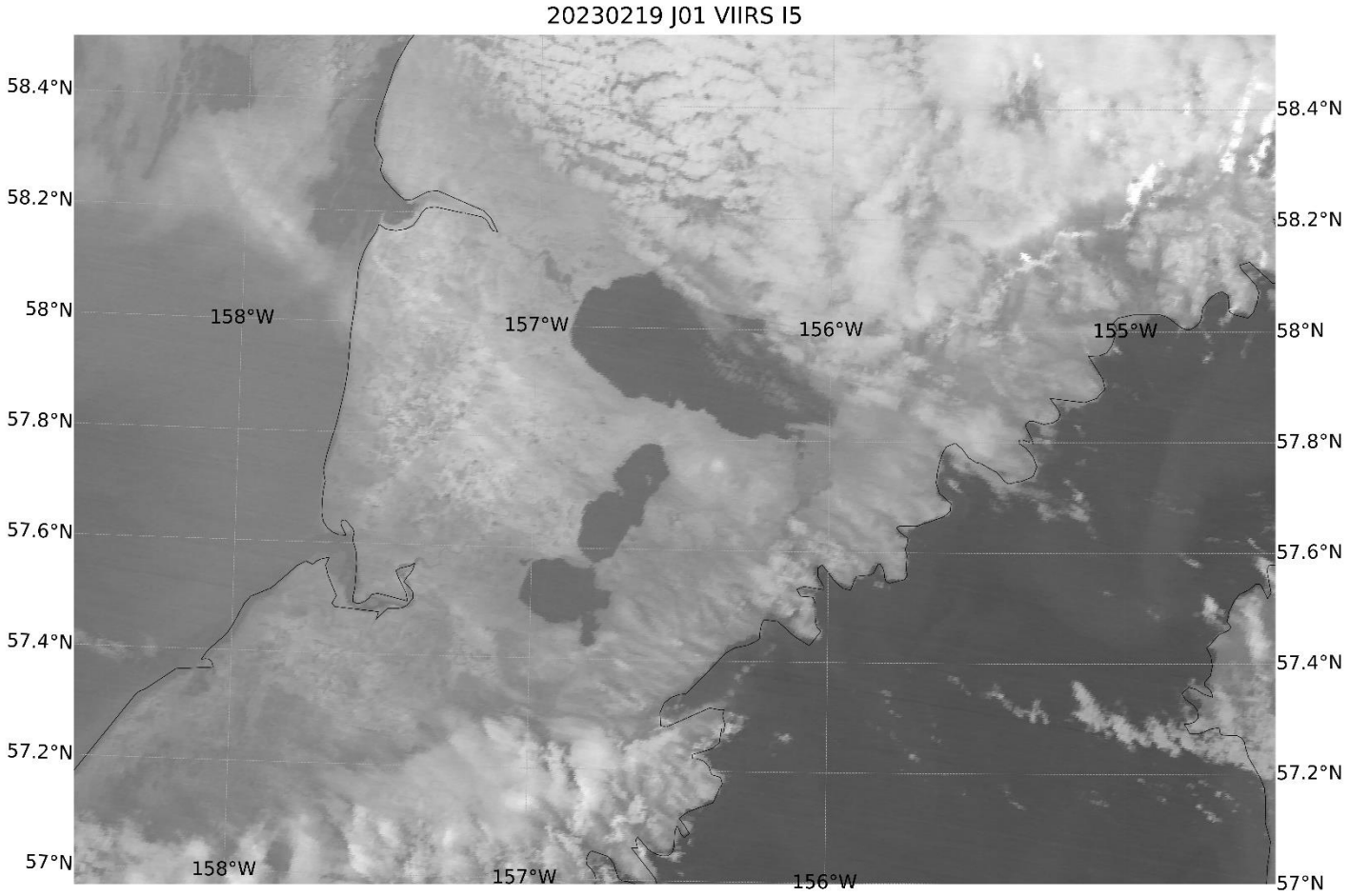
Southwest Alaska
20230219
NOAA-20
I5



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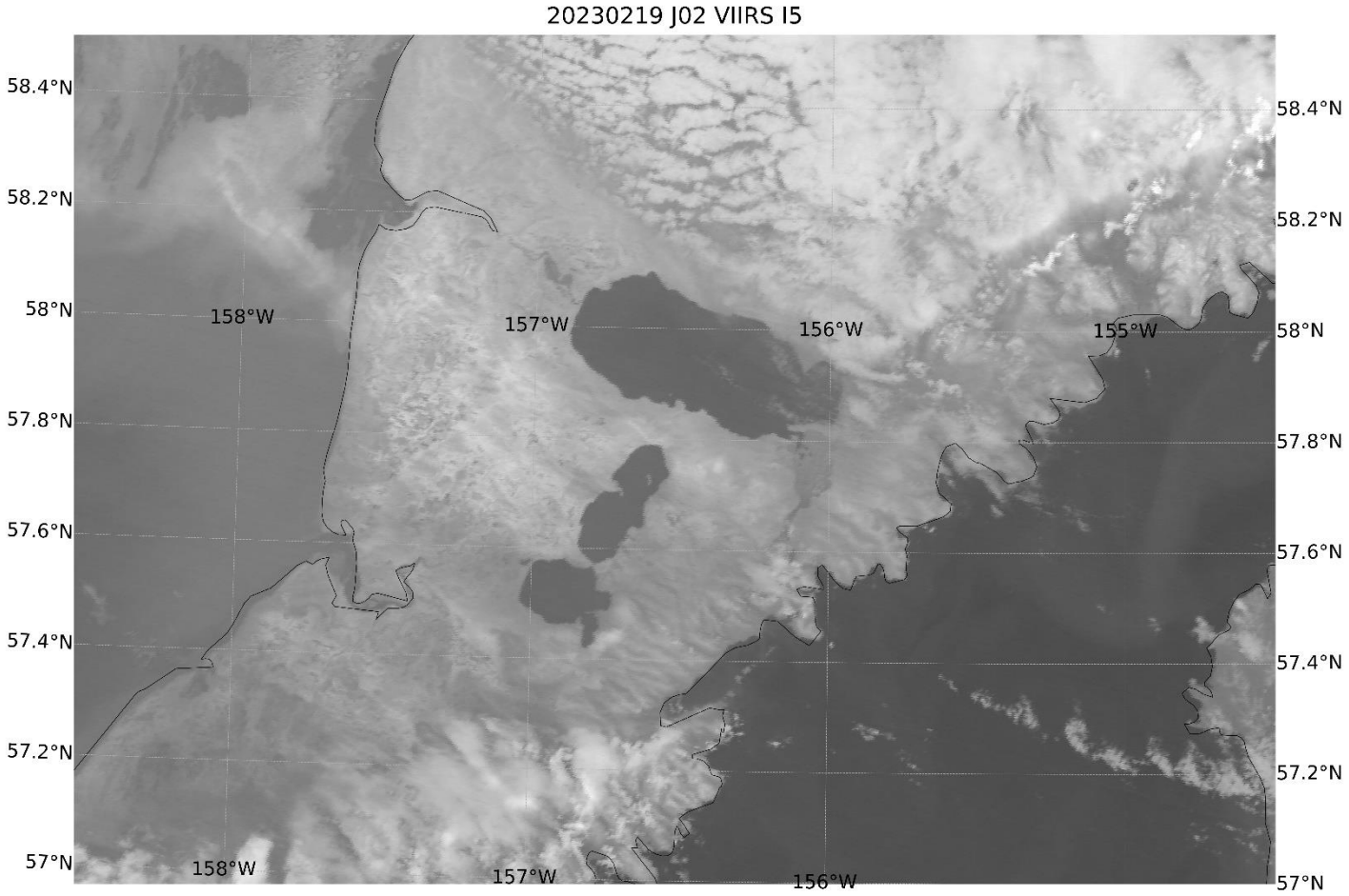
Southwest Alaska
20230219
NOAA-21
I5



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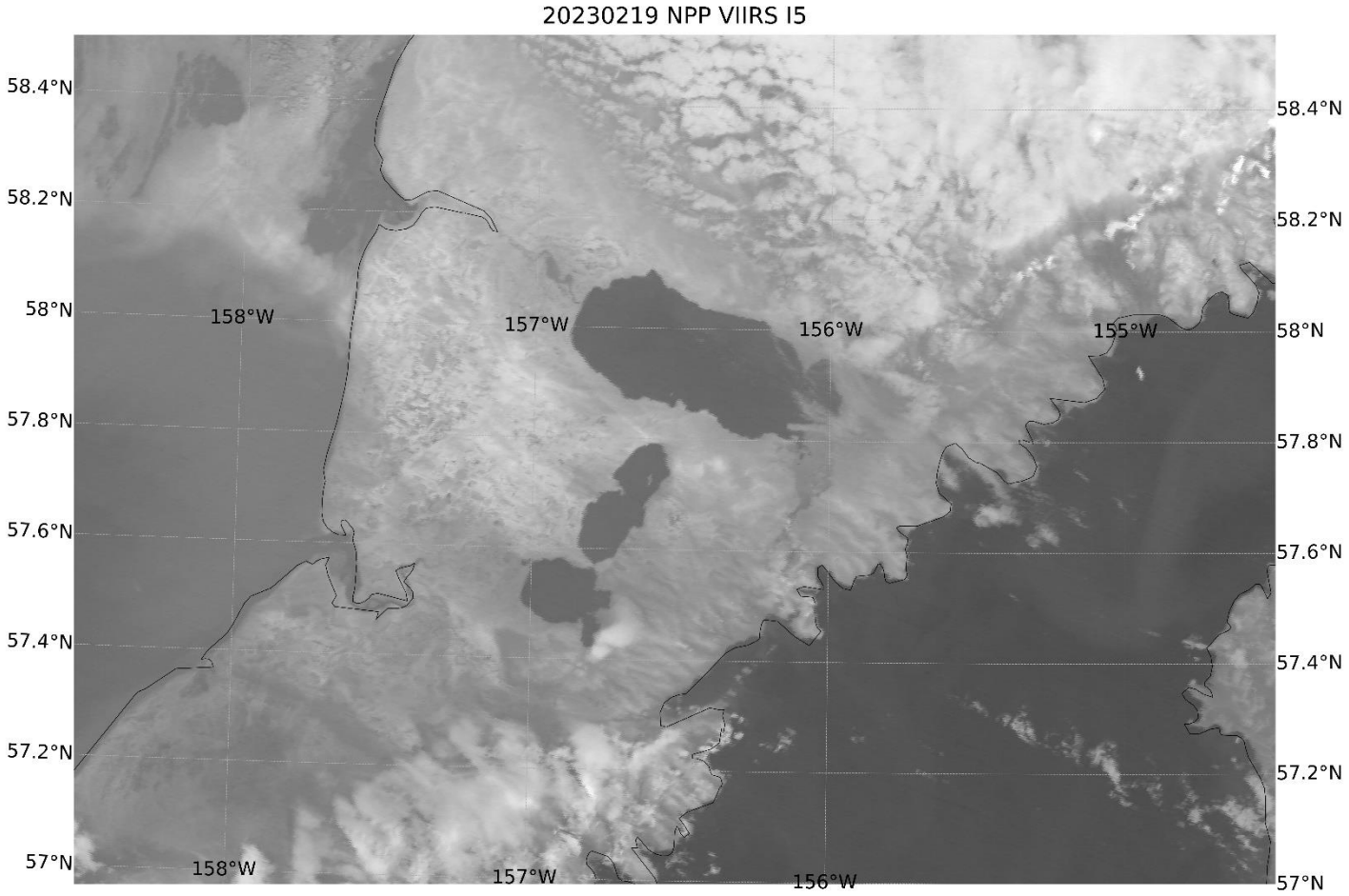
Southwest Alaska
20230219
S-NPP
I5



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Documentations (Check List, 1 slide)

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)	
Peer Reviewed Publications (Demonstrates algorithm is independently reviewed)	Yes
Regular Validation Reports (at least annually) (Demonstrates long-term performance of the algorithm)	Yes

Conclusion (1 slide)

- Cal/Val results summary:
  - Team recommends Beta Maturity for VIIRS EDR Imagery
  - Effective: **Feb. 10, 2023, 18:45 UTC, orbit 1313**
  - Final thoughts
    - DNB/NCC “Smearing” present, but less than anticipated from simulations
    - Some M9 pixel saturation in bright scenes
    - M6 pixel saturation (No Saturation Rollover like on other VIIRS; Mx8)
    - Calibration updates should improve striping in DNB and SWIR bands
    - Future CSPP updates to resolve DB geolocation errors

Path Forward (1-2 slides)

- Continued monitoring of imagery, especially post LUT updates
- Further analysis into character of DNB “Smearing”
- Continued interaction with users regarding quality of imagery, benefits of 3 VIIRS
- Display of NOAA-21 Imagery with S-NPP and NOAA-20 on CIRA Polar SLIDER

Potential Benefits of 3 JPSS Satellites (1 slide)

- Numerous operational benefits to having Imagery from 3 VIIRS vs 2
  - For High Latitudes: Features that evolve quickly are detected earlier, important developments are less likely to be missed between scans, user gains quicker understanding of situation
    - Clouds – CI, restrictive clouds near TAF sites
    - Wildfires - hot spot detection, fire perimeter mapping, smoke plumes evolution
    - Blowing Snow
    - Sea spray
    - Volcanic eruptions and resulting aerosol movement
  - For low latitudes: Improved VIIRS coverage may increase buy-in, especially if we continue to share best practices for using VIIRS together with ABI. Particular benefits may include:
    - Localized low cloud monitoring, especially at night, such as in river/mountain valleys
    - Initial hot spot detection for immature fires
    - Nighttime smoke detection