

Version 2 VIIRS/CrIS Fusion (FSNRAD) radiance product generation: Status and updates

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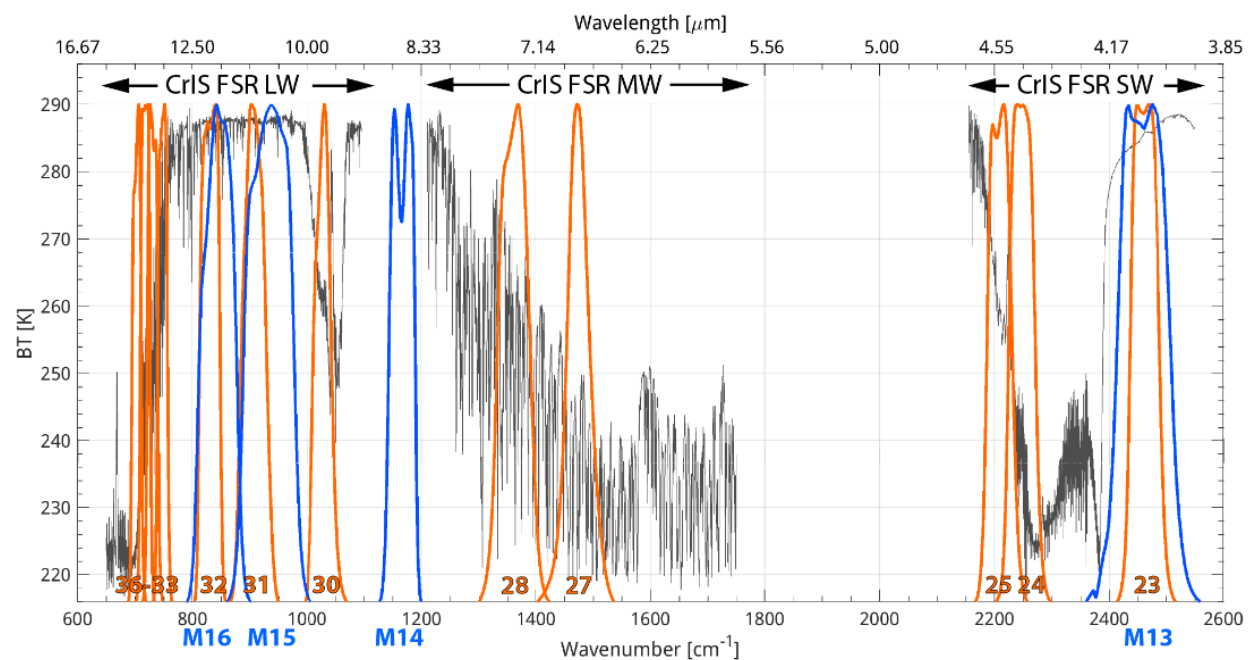
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Space Science and Engineering Center (SSEC)
University of Wisconsin-Madison, USA

OUTLINE

1. Project Objective/ Product Status
2. Overview of SNPP+NOAA-20 Fusion Approach to fill in the Missing SNPP FSNRAD Radiances
3. Evaluation on Four Global days
4. Summary

PROJECT MAIN OBJECTIVE



MODIS IR channels		VIIRS IR channels		MODIS-like FSNRAD IR channels	
Bands	Central WL [μm]	Bands	Central WL [μm]	Bands	Central WL [μm]
23	4.05	M13	4.05	M23	4.05
24	4.47	-	-	M24	4.47
25	4.52	-	-	M25	4.52
27	6.72	-	-	M27	6.72
28	7.33	-	-	M28	7.33
29	8.55	M14	8.55	-	-
30	9.73	-	-	M30	9.73
31	11.03	M15	10.76	M31	11.03
				M15 BTD (Measured minus Fusion)	
32	12.02	M16	12.01	M32	12.02
				M16 BTD (Measured minus Fusion)	
33	13.34	-	-	M33	13.34
34	13.64	-	-	M34	13.64
35	13.94	-	-	M35	13.94
36	14.23	-	-	M36	14.23

- TO develop a MODIS-like radiance product from VIIRS+CrIS Fusion Radiance (FSNRAD) products to provide a path for continuity of products based on the Terra, Aqua, SNPP, and NOAA-20 platforms.

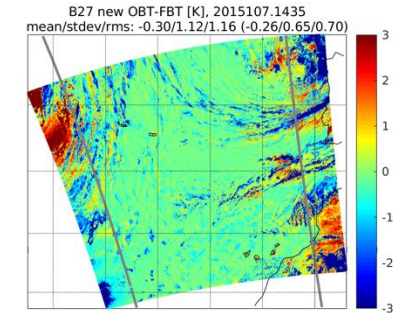
FSNRAD V2 STATUS

Product Name	Description	Status	Available at
FSNRAD_L2_VIIRS_CRIS_SNPP	S-NPP/VIIRS Fusion Radiances	Operational	LAADS DAAC
FSNRAD_L2_VIIRS_CRIS_NOAA20	NOAA20/VIIRS Fusion Radiances	Operational	LAADS DAAC
FSNRAD_L2_VIIRS_CRIS_SS_SNPP	S-NPP/VIIRS Subsetted Fusion	Operational	Atmosphere-SIPS
FSNRAD_L2_VIIRS_CRIS_SS_NOAA20	NOAA20/VIIRS Subsetted Fusion	Operational	Atmosphere-SIPS
FSNRAD_L2_VIIRS_CRIS_NOAA21	NOAA21/VIIRS Fusion Radiances	Tested	
FSNRAD_L2_VIIRS_CRIS_SS_NOAA21	NOAA21/VIIRS Subsetted Fusion	Tested	



UPDATE 1: developed pixel-level product uncertainty (*Borbis et al, 2026, submitted to JARS*)

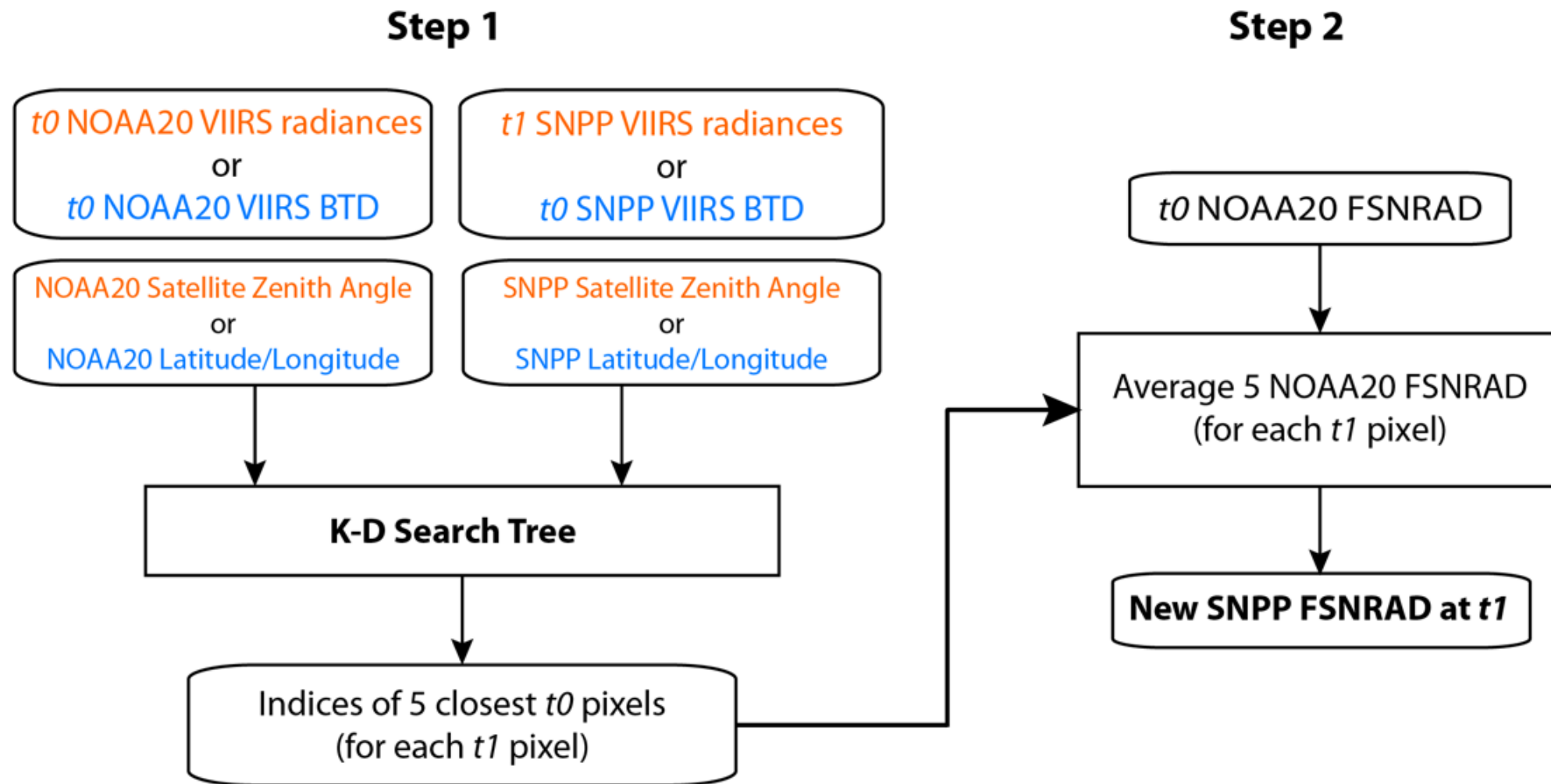
- Based on a statistical regression (equation and coefficients are provided)
- A MATLAB package implementing this calculation is available on the SSEC GitLab or can also be obtained upon request via email.



UPDATE 2: developed a SNPP + NOAA-20 fusion method which utilizes SNPP VIIRS together with NOAA-20 VIIRS and CrIS radiance information to produce SNPP FSNRAD fusion bands during the SNPP CrIS MW and LW band failing periods. (*Weisz et al. to be submitted*)

Periods	SNPP CrIS failure	Effects on FSNRAD products	Fix
03.26 - 06.24, 2019	Side 1 MW	Fill Value for Band 27 and 28	Switch from Side 1 → Side 2
05.21 - 07.12, 2021	Side 2 LW	Fill Value for Band 30-36	Switch from Side 2 → Side 1
07.13, 2021 – 08.29, 2023		Fill Value for Band 27 and 28	
08.29 - 08.31, 2023	Side 1 LW	Fill Value for Band 27-36	Switch from Side 1 → Side 2
08.31, 2023 - present		Fill Value for Band 30-36	

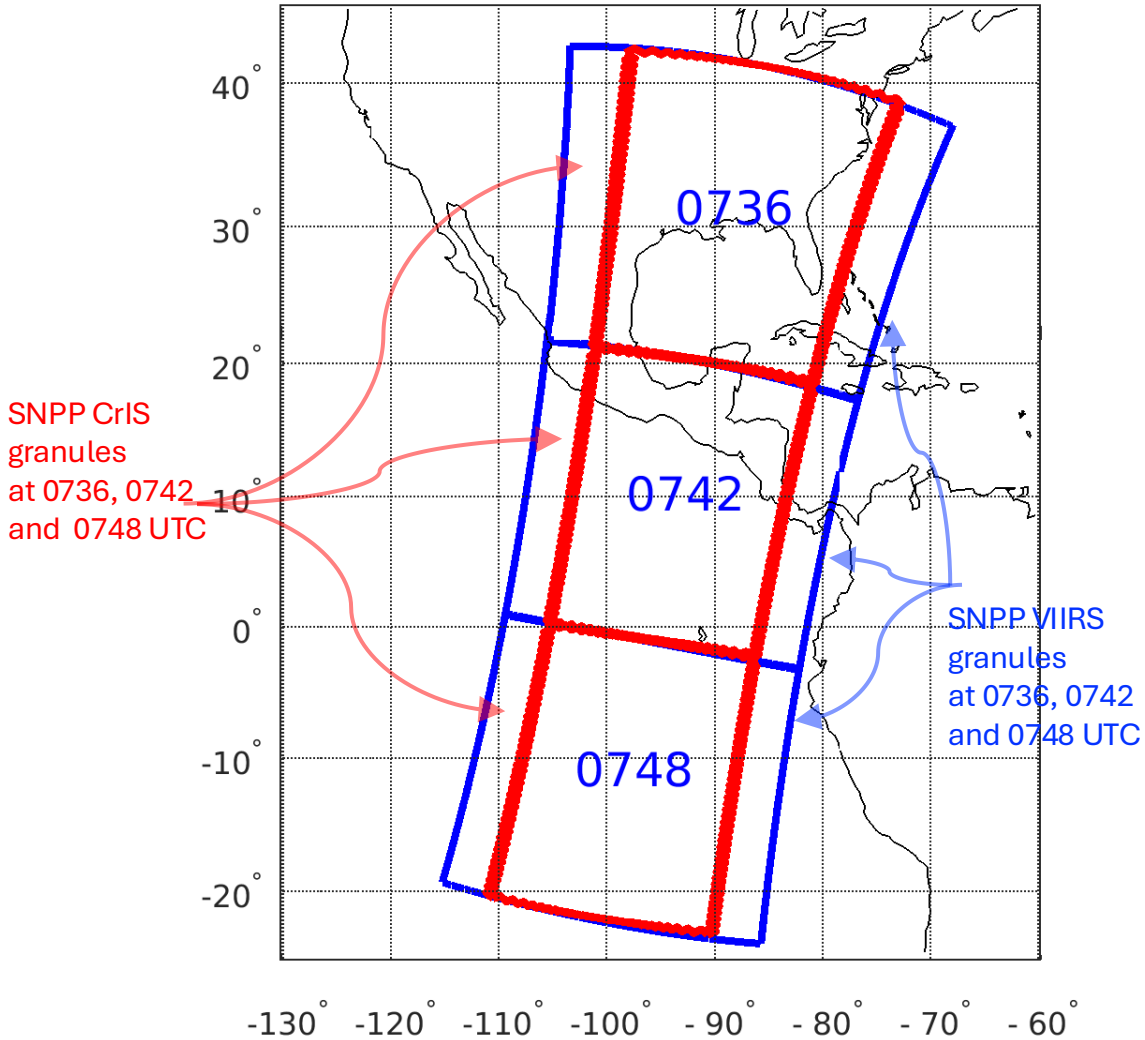
Schematic of the SNPP+NOAA-20 temporal fusion approach



SELECTION OF INPUT GRANULES for Granule 0742 UTC

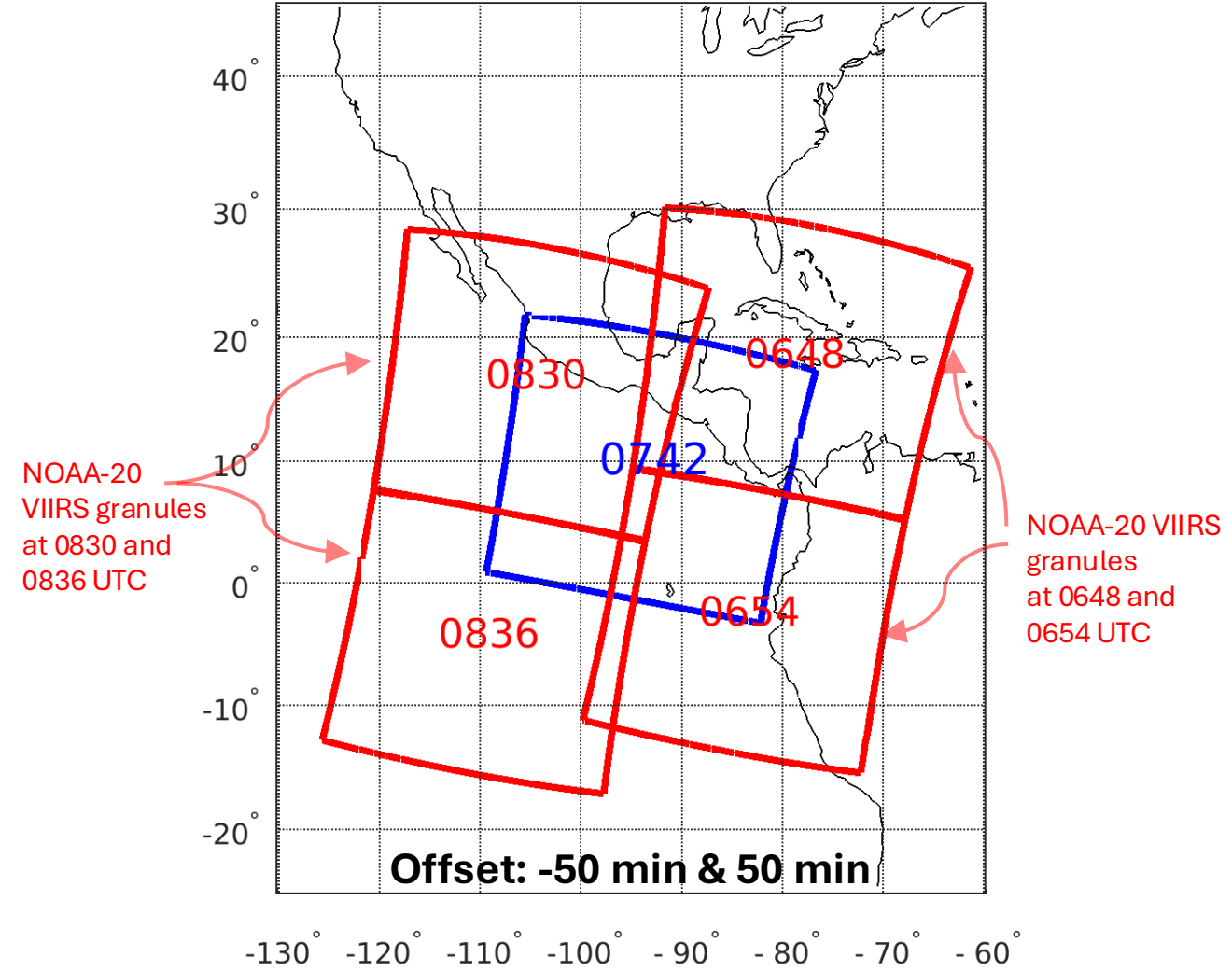
ORIGINAL SPATIAL FUSION (SNPP/VIIRS + SNPP/CrIS)

SNPP VIIRS 2018288.0742



TIME FUSION (SNPP/VIIRS+NOAA20/VIIRS+NOAA20/FSNRAD)

SNPP VIIRS 2018288.0742

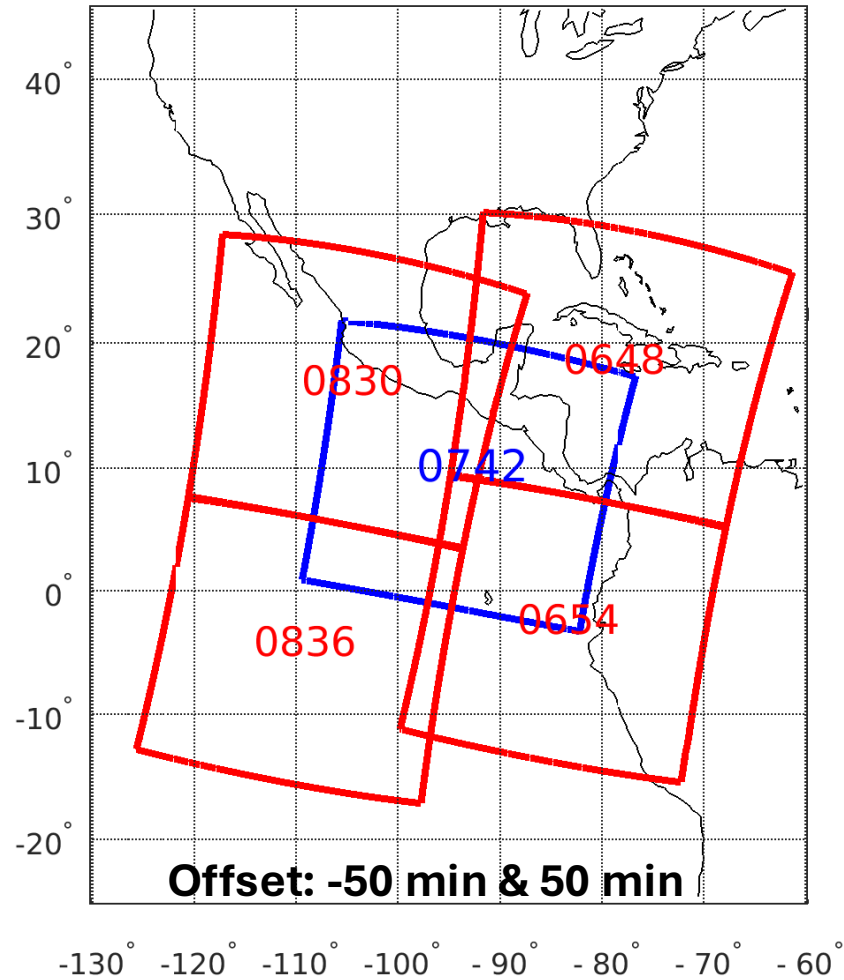


ADJUSTMENT FOR THE NOAA-20 REPHASING MANEUVER

The NOAA-20 satellite successfully underwent a rephasing maneuver between March 20, 2024 - April 4, 2024

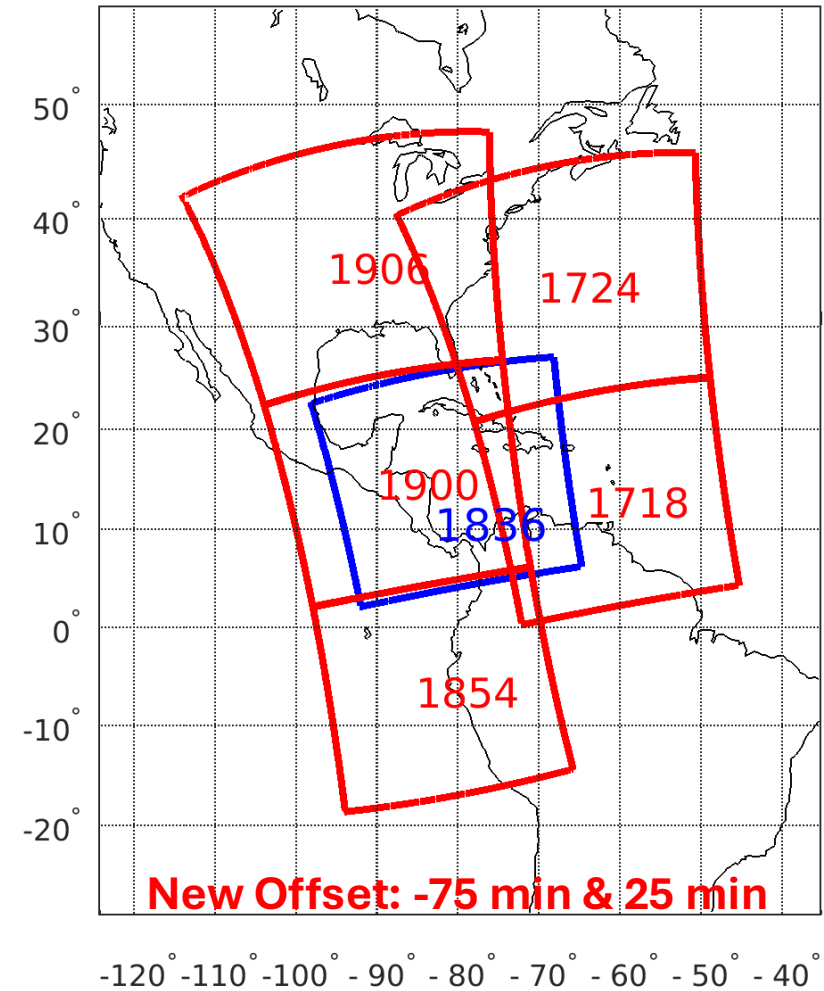
Before March 20, 2024

SNPP VIIRS 2018288.0742



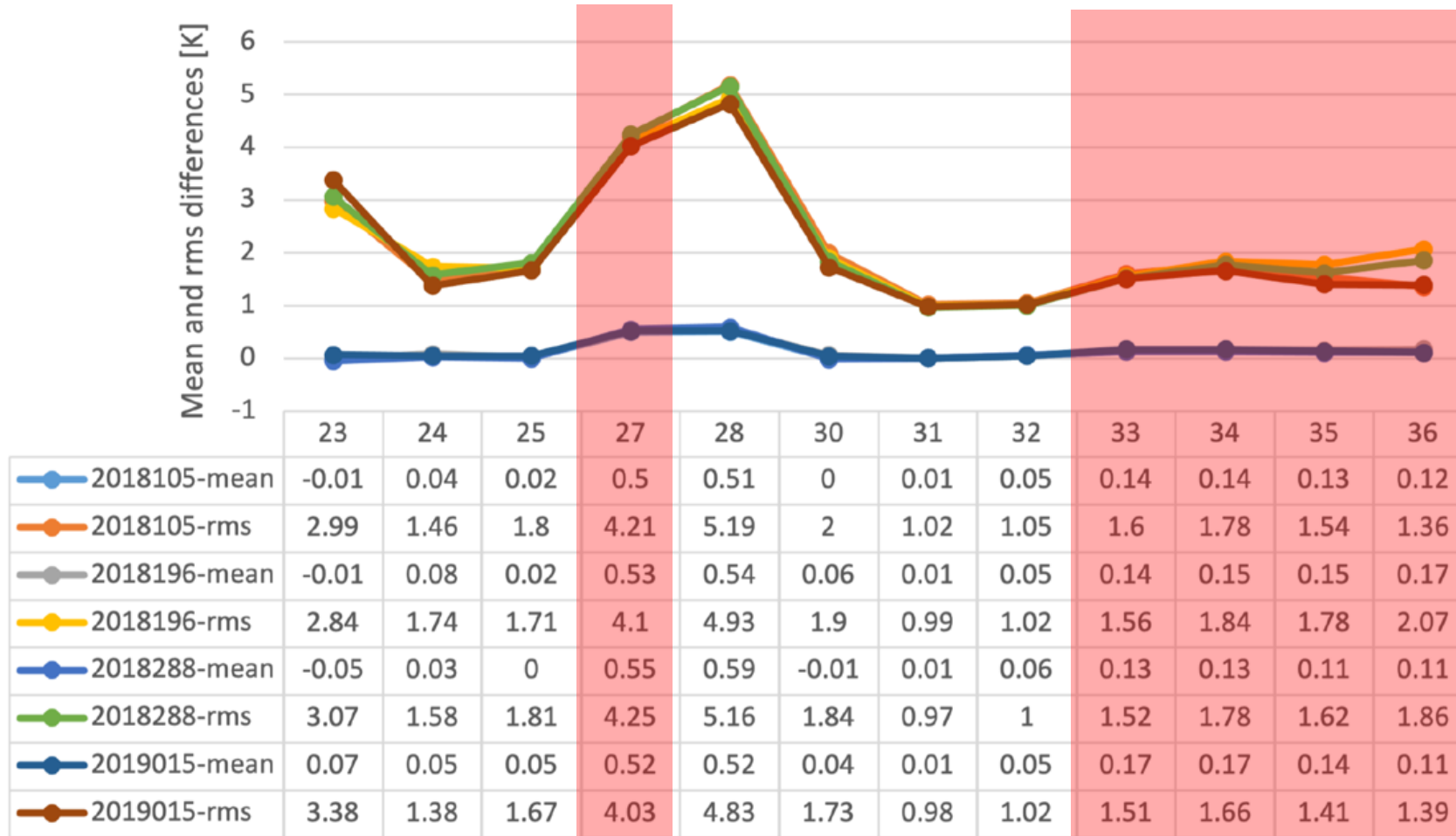
After April 4, 2024

SNPP VIIRS 2024247.1836



GLOBAL DAY EVALUATION

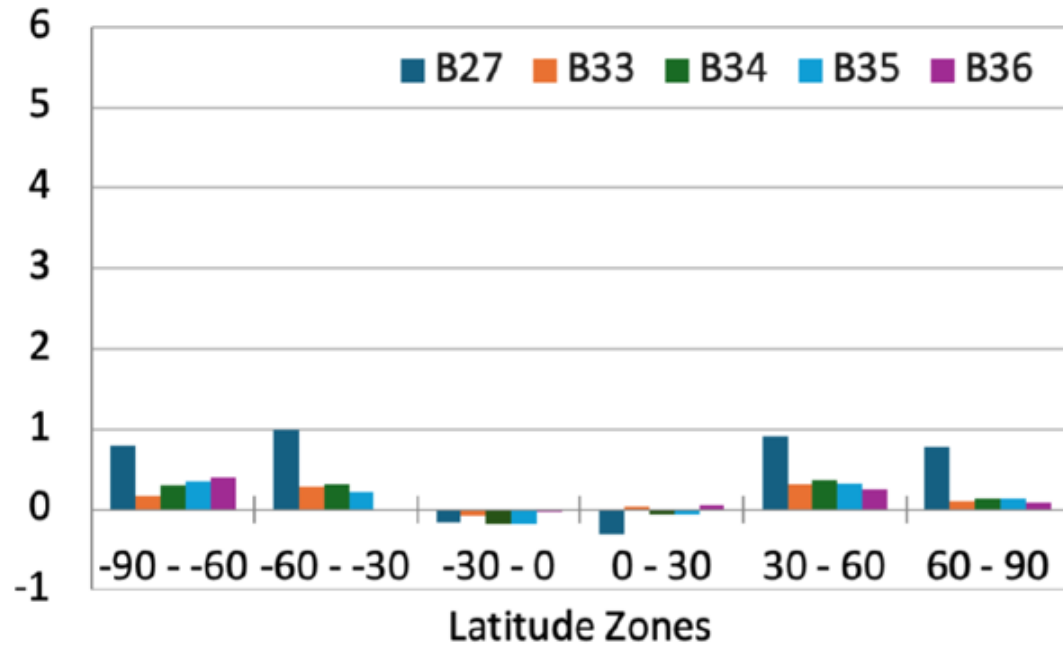
- Selected target days: 15 Apr 2018, 15 Jul 2018, 15 Oct 2018 and 15 Jan 2019
- SNPP+NOAA20 FSNRAD compared to the fully available SNPP FSNRAD
- SNPP+NOAA20 FSNRAD – SNPP FSNRAD



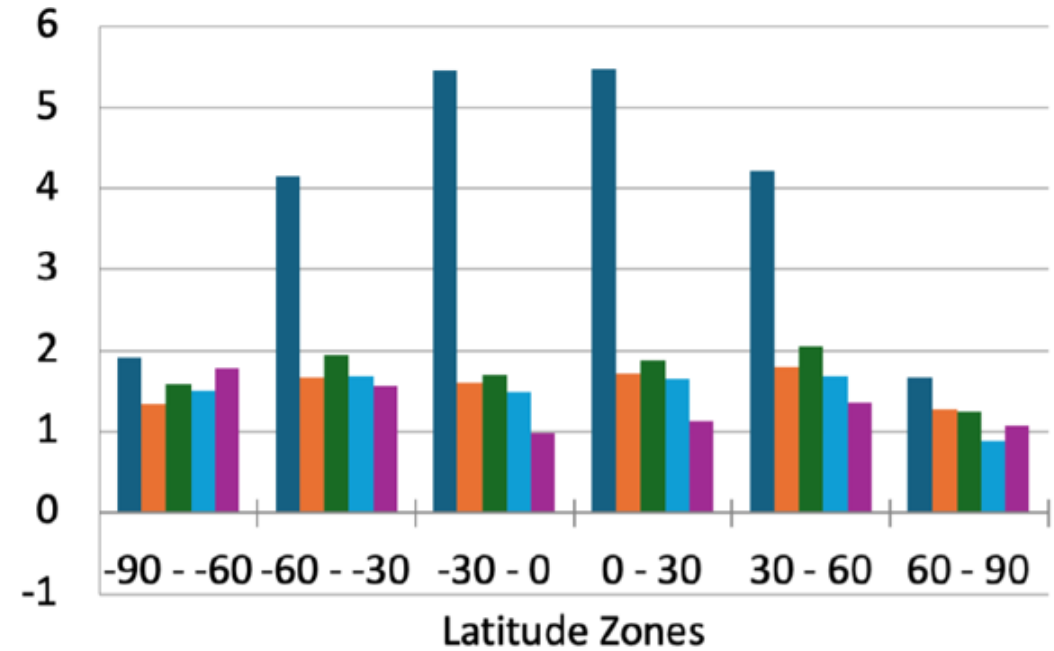
GLOBAL DAY EVALUATION (April 15, 2018) by latitude bands

SNPP+NOAA20 FSNRAD – SNPP FSNRAD

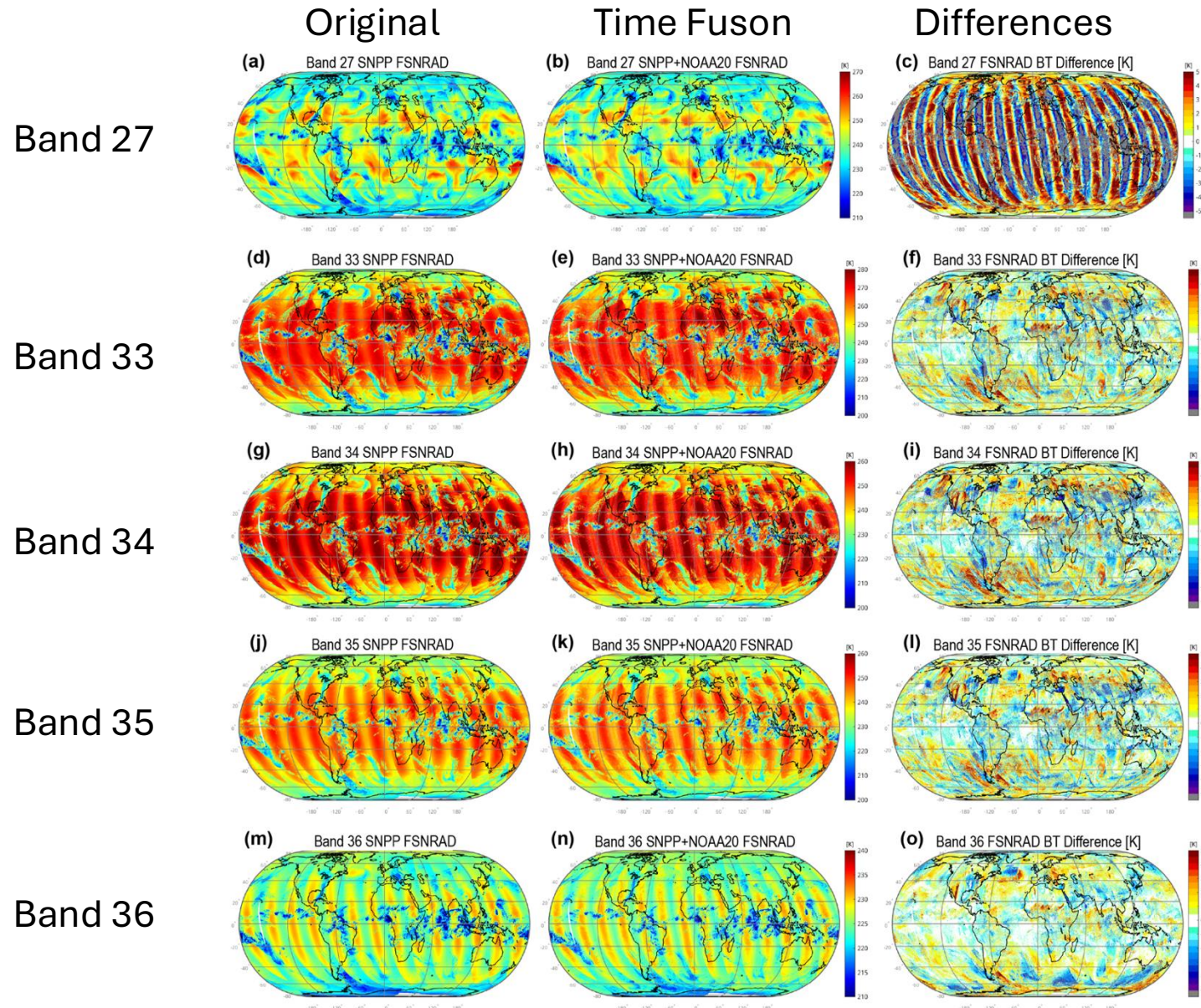
Mean



Standard Deviation

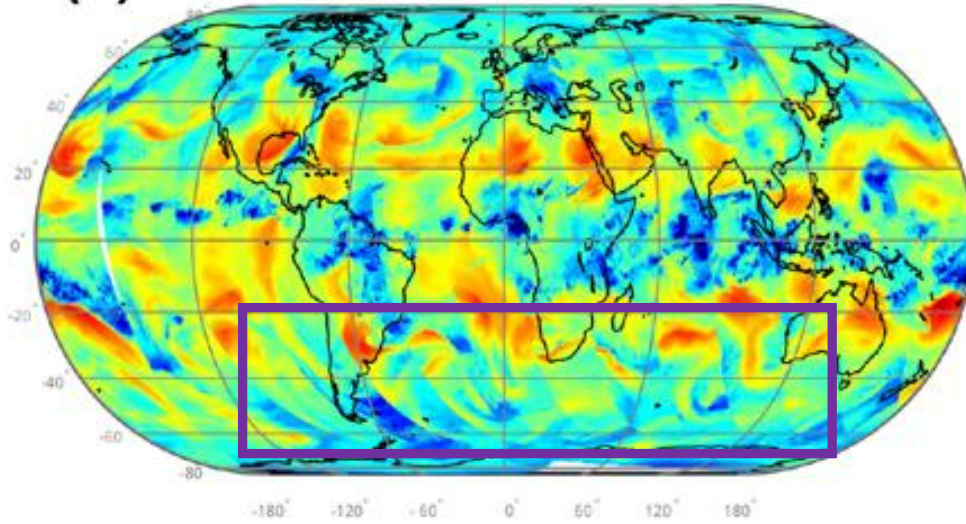


GLOBAL DAY EVALUATION (April 15, 2018)

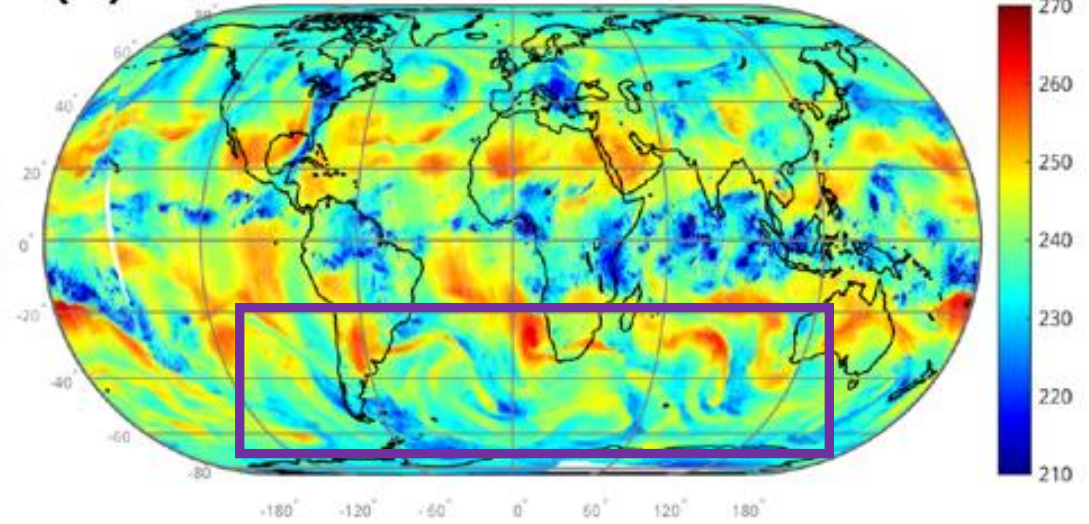


GLOBAL DAY EVALUATION (April 15, 2018)

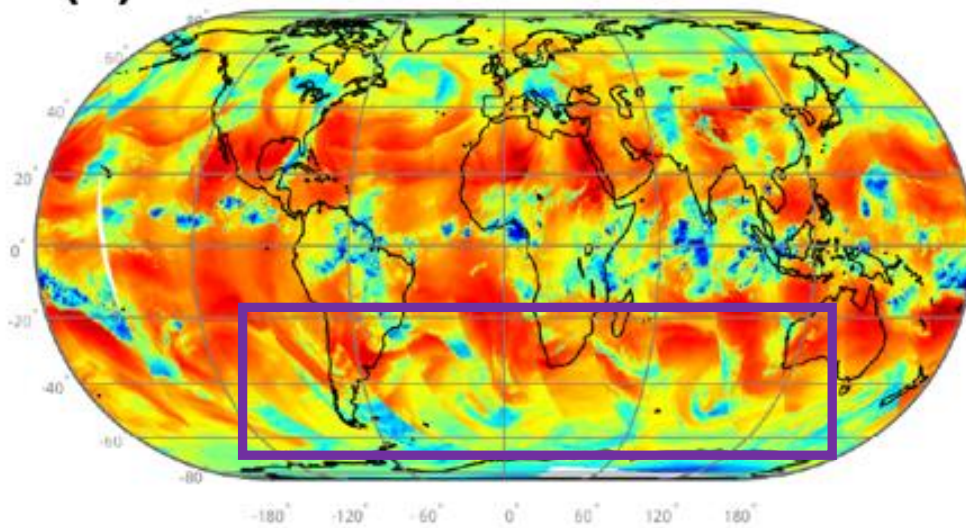
(a) Band 27 SNPP FSNRAD



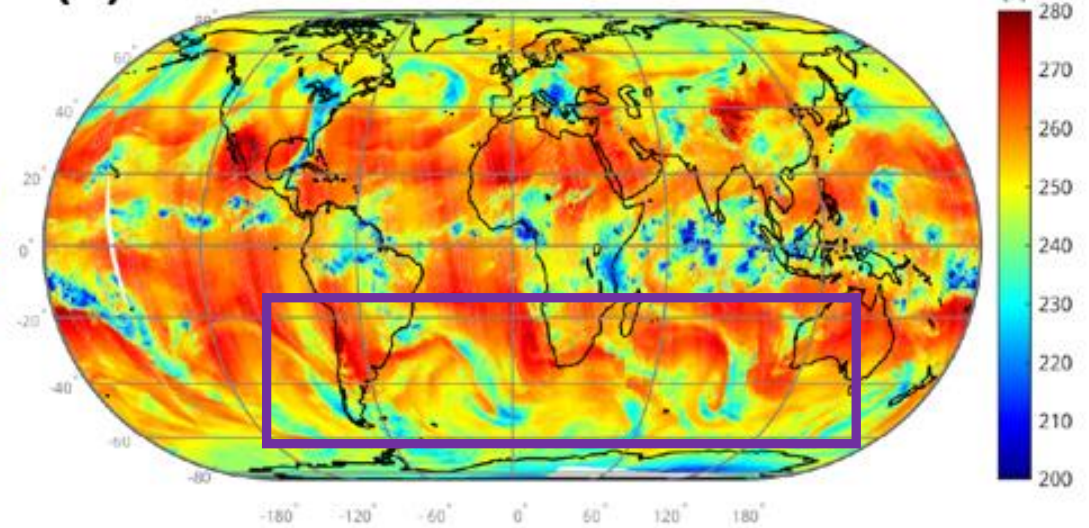
(b) Band 27 SNPP+NOAA20 FSNRAD



(d) Band 28 SNPP FSNRAD

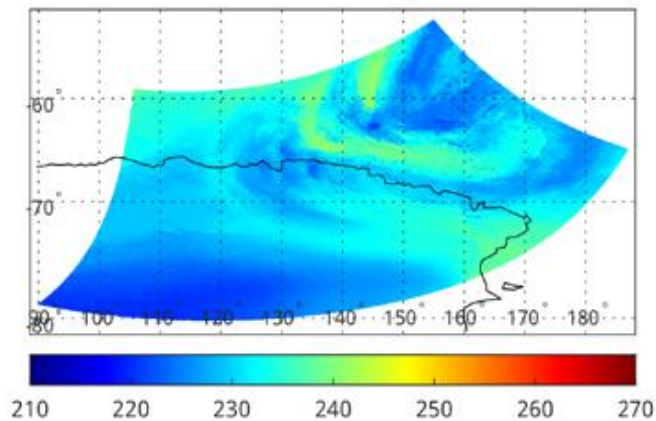


(e) Band 28 SNPP+NOAA20 FSNRAD

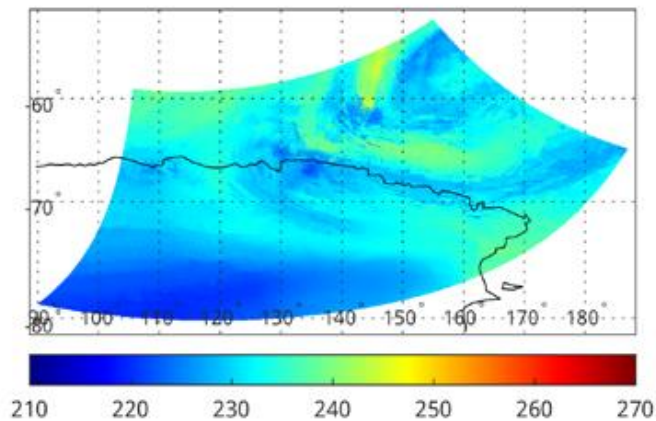


Band 27 and 33 on April 15, 2018 at 05:25 UTC

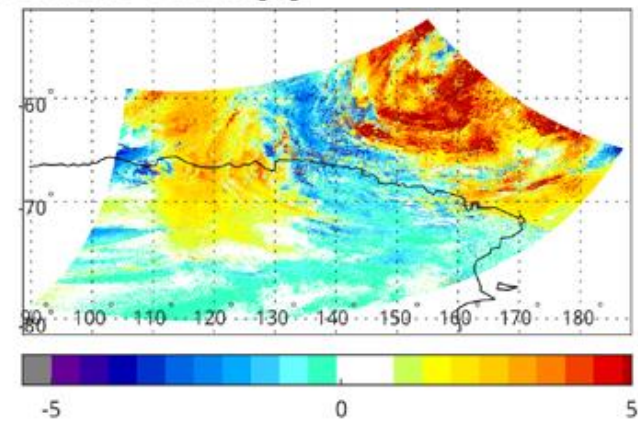
Band 27 SNPP FSNRAD (2018105.0524)



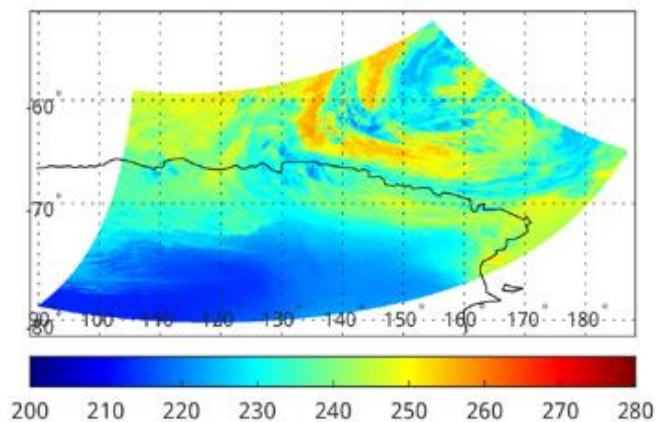
Band 27 SNPP+NOAA20 FSNRAD



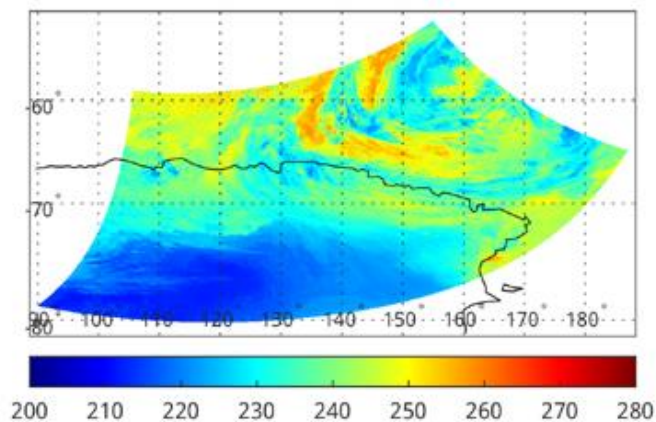
FSNRAD BT Diff [K]



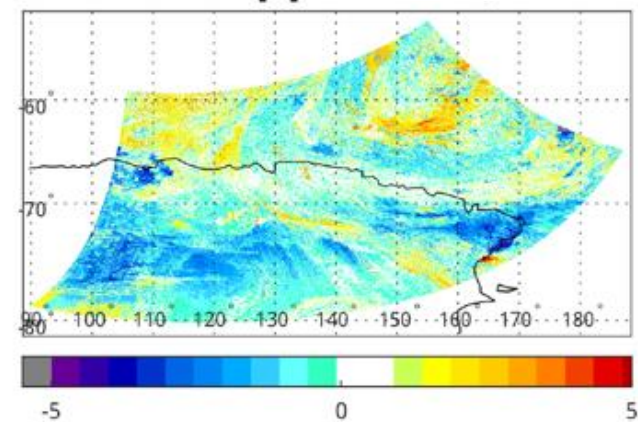
Band 33 SNPP FSNRAD (2018105.0524)



Band 33 SNPP+NOAA20 FSNRAD

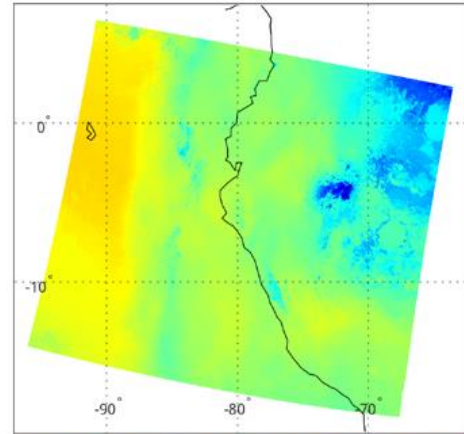


FSNRAD BT Diff [K]



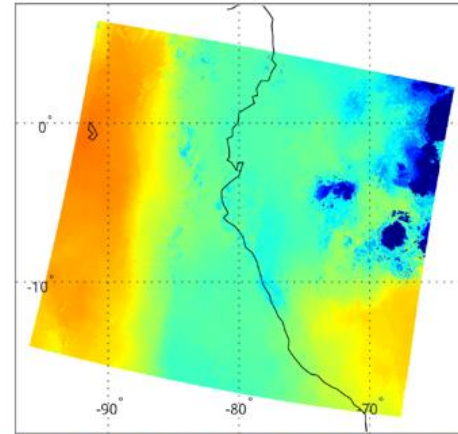
Band 27 and 33 on April 15, 2018 at 06:36 UTC

Band 27 SNPP FSNRAD (2018105.0636)



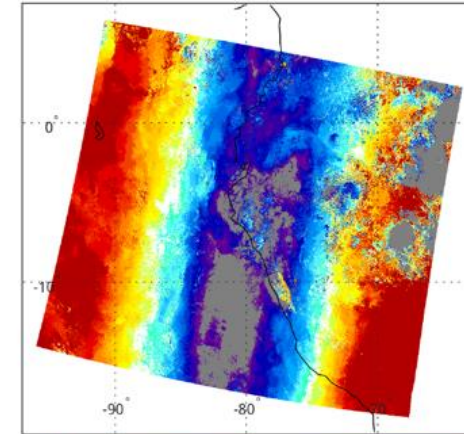
210 220 230 240 250 260 270

Band 27 SNPP+NOAA20 FSNRAD



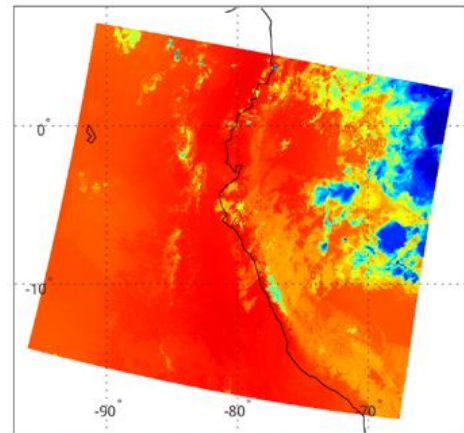
210 220 230 240 250 260 270

FSNRAD BT Diff [K]



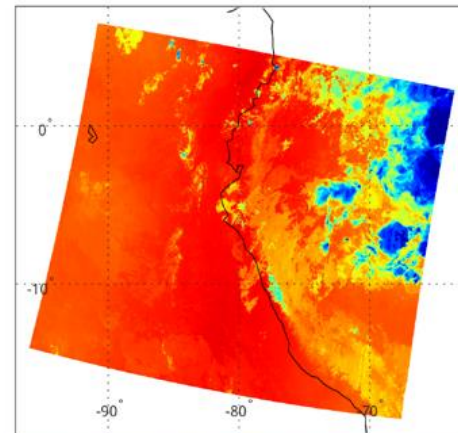
-5 0 5

Band 33 SNPP FSNRAD (2018105.0636)



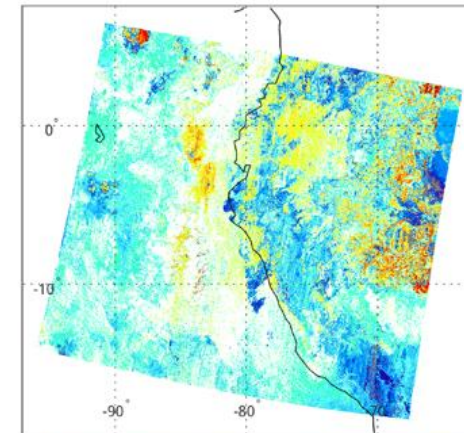
200 210 220 230 240 250 260 270 280

Band 33 SNPP+NOAA20 FSNRAD



200 210 220 230 240 250 260 270 280

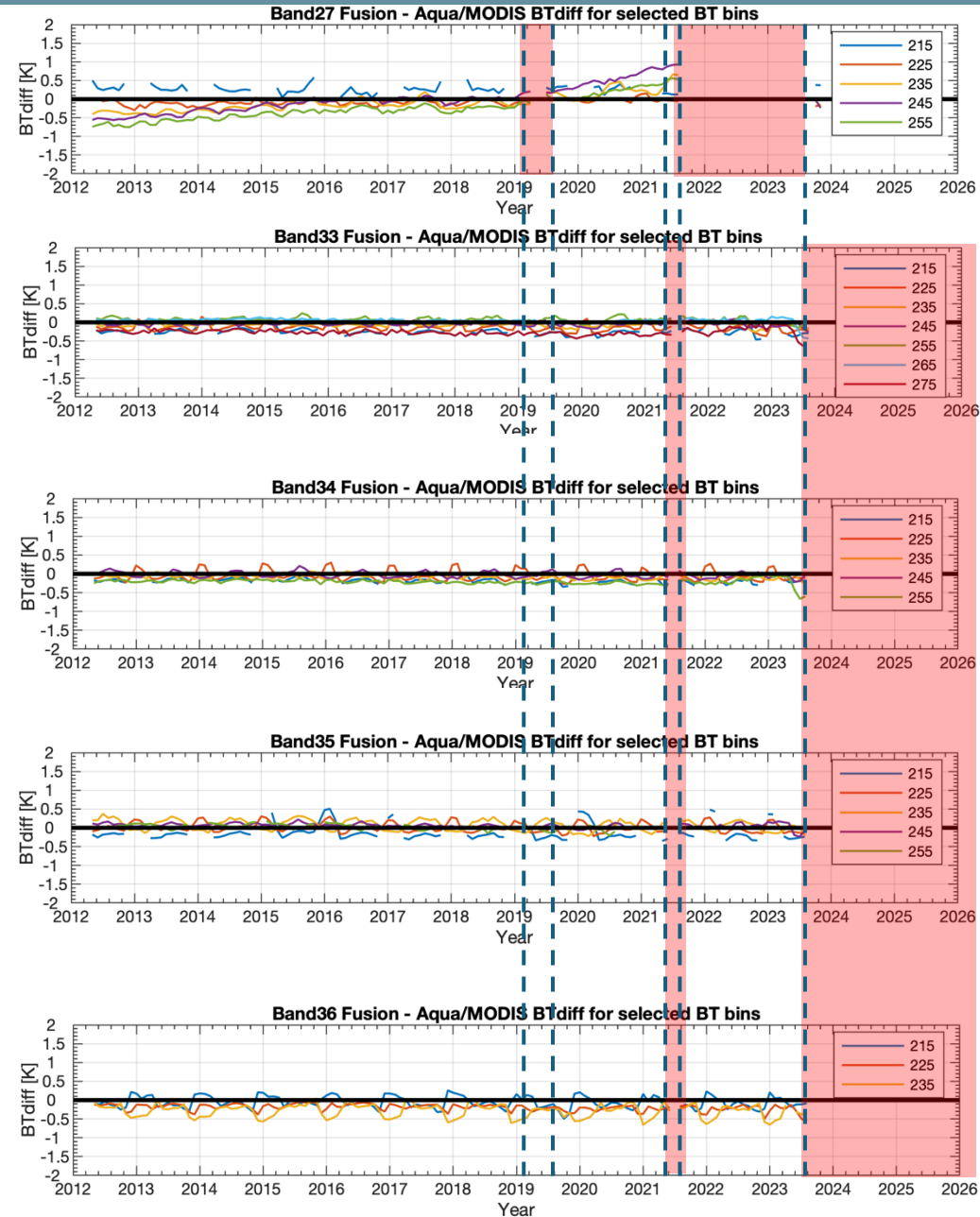
FSNRAD BT Diff [K]



-5 0 5

EVALUATION WITH C6.1 AQUA/MODIS SNOs (FSNRAD version 2.0.0dev)

SNPP/N20 time fusion
Version 2.0.3dev1



NEXT: SNOs with C7 A/MODIS
including SNPP/N20 time fusion

SUMMARY

- The MODIS-like V/C FSNRAD Version 2 products are available for both NOAA-20 and Suomi NPP (with missing bands) through NASA LAADS and Atmosphere-SIPS.
 - We presented the V2 fusion update which combines Suomi NPP VIIRS, NOAA-20 VIIRS, and NOAA-20 V/C FSNRAD data to generate V/C FSNRAD at the Suomi NPP granule coverage and observation time during the CrIS failure.
 - The Suomi NPP + NOAA-20 FSNRAD method accounts for multiple NOAA-20 granules per Suomi NPP granule, as well as limb-darkening effects at larger viewing angles. For example, satellite zenith angle is used as an additional predictor in the RAD k-d tree search instead of relying solely on latitude and longitude.
 - The Suomi NPP + NOAA-20 fusion method was evaluated for four selected days using Suomi NPP V/C FSNRAD data.
 - **In Oct 2025, the SNPP + NOAA-20 V/C fusion algorithm was delivered to A-SIPS for operational S-NPP FSNRAD production.**
 - **Suomi NPP FSNRAD full-granule and subsetter products were processed and made available through A-SIPS until March 20, 2024, prior to the NOAA-20 rephasing maneuver.**
 - **We are currently evaluating products generated after March 20, 2024.**
 - **C6.1 and C7 AQUA/MODIS SNOs are currently under processing and analysis.**
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Publications:

- Borbas, E.E., Weisz, E., Menzel, W.P., Moeller, C., Quinn, and Baum, B., 2026: Fusion of VIIRS and CrIS Observations to 1 Generate MODIS-Like Infrared Absorption Band Radiances at VIIRS spatial resolution: Version2 FSNRAD Product, Part I: pixel level uncertainty, *submitted to JARS on April 3, 2026*
- Weisz, E., Borbas, E.E., and Menzel, W.P., 2026: Fusion of VIIRS and CrIS Observations to Generate MODIS-Like Infrared Absorption Band Radiances at VIIRS spatial resolution: Version 2 FSNRAD Product, Part II: Backfilling Missing SNPP FSNRAD Data, *to be submitted to JARS in Jun 2026*

Presentations:

2026 AMS Radiation Conference, Aug 3-7, 2026, in Madison, WI:

Borbas, E.E., Weisz, E., and Menzel, W.P.: Fusion of VIIRS and CrIS Observations to Generate MODIS-Like Infrared Absorption Band Radiances with pixel level uncertainty estimates.

S-NPP FSNRAD SubSetter data access from NASA A-SIPS

FSNRAD_L2_VIIRS_CRIS_SS_SNPP:

TIME PERIOD	Version	FUSION METHOD	Missing bands in the original FSNRAD SS data were filled using SNPP/NOAA-20 time-fusion products
04.17.12 - 03.25.19	version 2.0.0dev	Original	NONE
03.26.19 - 06.23.19	version 2.0.3dev1	SNPP-N20 time fusion	B27
06.24.19 - 05.20.21	version 2.0.0dev	Original	NONE
05.21.21- 03.20.24	version 2.0.3dev1	SNPP-N20 time fusion	B33-36 - (05.21.21 - 07.12.21) B27 - (07.13.21 - 08.29.23) B27,33-36 - (08.30.23 - 08.31.23) B33-36 - (08.31.23 – present)

DOWNLOAD COMMANDS on the A-SIPS/sipssci1 machine:

```
asipscli files -p FSNRAD_L2_VIIRS_CRIS_SS_SNPP --version 2.0.0dev --satellite snpp -s 2012-04-01T00:00:00Z -e 2019-03-27T23:59:59Z -d .
asipscli files -p FSNRAD_L2_VIIRS_CRIS_SS_SNPP --version 2.0.3dev1 --satellite snpp -s 2019-03-28T00:00:00Z -e 2019-06-23T23:59:59Z -d .
asipscli files -p FSNRAD_L2_VIIRS_CRIS_SS_SNPP --version 2.0.0dev --satellite snpp -s 2019-06-24T00:00:00Z -e 2021-05-20T23:59:59Z -d .
asipscli files -p FSNRAD_L2_VIIRS_CRIS_SS_SNPP --version 2.0.3dev1 --satellite snpp -s 2021-05-21T00:00:00Z -e 2024-03-20T23:59:59Z -d .
```

YEAR	Version	Notes
2012-2023	version 2.0.0dev	Original
2023-2025	version 2.0.2	Original
2019, 2021-2026	version 2.0.3dev1	SNPP-N20 time fusion