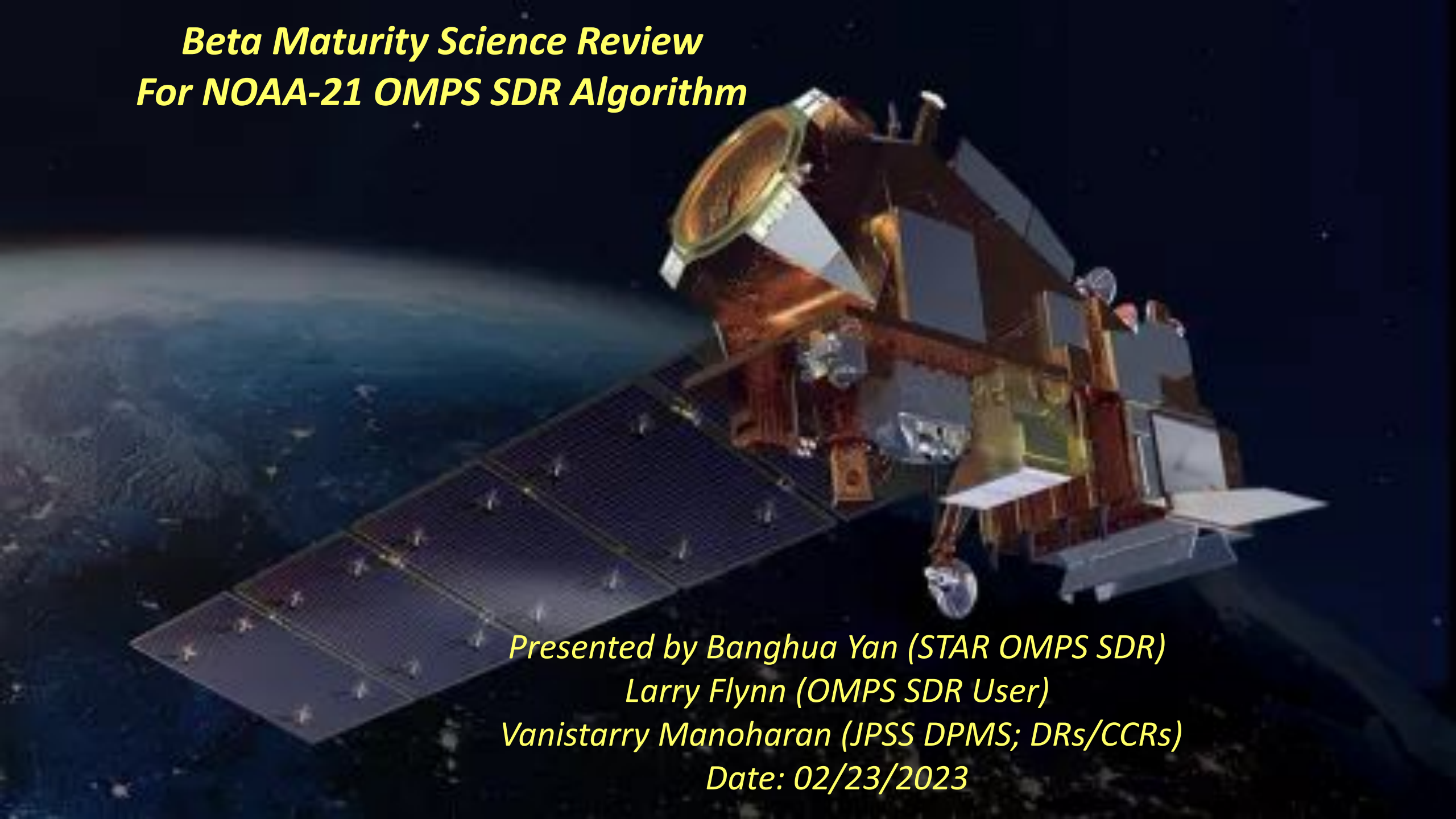
Beta Maturity Science Review For NOAA-21 OMPS SDR Algorithm



Presented by Banghua Yan (STAR OMPS SDR)
Larry Flynn (OMPS SDR User)
Vanistarry Manoharan (JPSS DPMS; DRs/CCRs)
Date: 02/23/2023

JPSS Data Product Validation Maturity Stages - COMMON DEFINITIONS (Nominal Mission)

1. Beta

- **Product is minimally validated, and may still contain significant identified and unidentified errors.**
- **Information/data from validation efforts can be used to make initial qualitative or very limited quantitative assessments regarding product fitness-for-purpose.**
- **Documentation of product performance and identified product performance anomalies, including recommended remediation strategies, exists.**

2. Provisional

- Product performance has been demonstrated through analysis of a large, but still limited (i.e., not necessarily globally or seasonally representative) number of independent measurements obtained from selected locations, time periods, or field campaign efforts.
- Product analyses are sufficient for qualitative, and limited quantitative, determination of product fitness-for-purpose.
- Documentation of product performance, testing involving product fixes, identified product performance anomalies, including recommended remediation strategies, exists.
- Product is recommended for potential operational use (user decision) and in scientific publications after consulting product status documents.

3. Validated

- Product performance has been demonstrated over a large and wide range of representative conditions (i.e., global, seasonal).
- 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.
- Product analyses are sufficient for full qualitative and quantitative determination of product fitness-for-purpose.
- Product is ready for operational use based on documented validation findings and user feedback.
- Product validation, quality assurance, and algorithm stewardship continue through the lifetime of the instrument.

Maturity Review - Entry Criteria

- Product Requirements
- Pre-launch Performance Matrix/Waivers
- Beta Maturity Performance Validation
  - NOAA-21 OMPS PLT Timeline
  - NOAA-21 OMPS NM and NP First Light Images
  - On-orbit instrument performance assessment
- Users/Downstream-Products feedback
- Risks, Actions, Mitigations
  - Potential issues, concerns
  - Mitigations
- Path forward towards the Provisional maturity stage
- Summary

Maturity Review - Exit Criteria

- Beta Maturity Performance is well characterized:
  - On-orbit instrument performance assessment
    - Provide summary for each identified instrument and product characteristic you have validated/verified as part of the entry criteria
    - Provide summary of pre-launch concerns/waivers mitigations/evaluation and address whether any of them are still a concern that raises any risk.
- Updated Maturity Review Slide Package addressing review committee's comments for:
  - Cal/Val Plan and Schedules
  - Product Requirements
  - Beta Maturity Performance
  - Risks, Actions, Mitigations
  - Path forward (to the next maturity stage)

BETA MATURITY REVIEW MATERIAL

Outline

- Algorithm Cal/Val Team Members*
- Product Overview/Requirements
- Pre-launch Performance Matrix/Waivers (Starry)
- OMPS PLT Timeline and First Light Images
- OMPS NM/NP Instrument and Data Performance Assessments from STAR
  - OMPS NM and NP instrument performance assessment
  - OMPS NM and NP Post-launch data performance assessment
  - OMPS NM and NP data quality long-term monitoring from ICVS
- User Feedback (Larry)
- Risks, Actions, and Mitigations
- Documentation (Science Maturity Check List)
- Conclusion
- Path Forward

* All sections without presenter assignment will be presented by Banghua

NOAA-21 OMPS SDR Algorithm Cal/Val Team

Name	Organization	Major Task
Banghua Yan (Project team lead)	NOAA/STAR/SCDAB	Project task plan and performance monitoring; OMPS instrument SDR cal/val science development and plan; monthly/quarterly/annual/review reports; ATBD update; first light image report
Trevor Beck	NOAA/STAR/SCDAB	Operational OMPS ADL code update and delivery with updated LUTs; OMPS RDR reader development; offline OMPS ADL code development; First light image report; ATBD update
Glen Jaross	NASA	OMPS instrument pre-launch calibration; OMPS SDR SCDB data set support; OMPS instrument performance maintenance support
Junye Chen	GST/SSAI	NOAA-21 OMPS wavelength registration; NOAA-21 NM and NP SDR calibration algorithm improvements; OMPS bi-weekly solar LUT derivation
Xin Jin (50%)	GST/SSAI	SNPP/NOAA-20/NOAA-21 OMPS dark, gain and nonlinearity calibration algorithm and code development; OMPS solar raw flux code development; weekly dark LUTs
Steven Buckner	GST/SSAI	OMPS data noise characterization analysis; OMPS solar LUTs; SNPP OMPS sensor degradation; Inter-sensor comparison with Tropomi; JSTAR weekly reports
Jingfeng Huang (50%)	GST/SSAI	VCRTM interface development for OMPS NM/NP radiance simulations; OMPS polarization impact assessment; validations of NOAA-21 OMPS SDR using RTMs
Likun Wang (~30%)	UMD/CISESS	OMPS NM SDR geolocation accuracy algorithm development; OMPS x-sensor radiometric calibration bias analysis among three missions; first light image support
Sirish Uprety	UMD/CISESS	OMPS solar calibration and NM wavelength shift algorithm developments; OMPS SDR calibration and data quality validation; OMPS inter-sensor radiometric calibration bias analysis with GEMS
Ding Liang (ICVS)	GST	OMPS RDR and SDR long-term monitoring via ICVS website system; inter-sensor comparison; first light image support
Vanistarry Manoharan	SAIC	OMPS SDR DRs/CCRs support

NOAA-21 NM SDR Requirements

Budget Term	Requirement/Allocation
Wavelength range	300-380
Horizontal cell size	≤ 17 km @ nadir
SNR radiance @17 x17km^2	≥300 (195 for NOAA-21 NM 10 x12km^2)
Irradiance uncertainty	*< 7%*
Wavelength registration accuracy	*<0.01 nm*
Intra-orbital wavelength variation	*<0.01 nm*
Radiance uncertainty	*< 8%*
OOB Stray Light	≤10%
Maximum Albedo Calibration	<2%
Geolocation Error	≤ 8.5 km @nadir (AT)

NOAA-21 NP SDR Requirements

Budget Term	Requirement/Allocation
Wavelength range	250-310
Horizontal cell size	≤ 50 km @ nadir
SNR radiance@50x50km^2	varies with wavelength λ
*Irradiance uncertainty**	*< 7%*
*Wavelength calibration**	*<0.01 nm*
*Intra-orbital wavelength variation**	*<0.01 nm*
*Radiance uncertainty**	*< 8%*
Maximum Albedo Calibration	<2%
OOB Stray Light	< 5%
Geolocation Error	≤ 25 km @nadir (AT)

*Follow NOAA-20 NP SDR requirement

Wavelength nm	SNR
250 - 273.6	7
273.6 - 283.1	20
283.1 -287.7	40
287.7-292	52
292-310	80

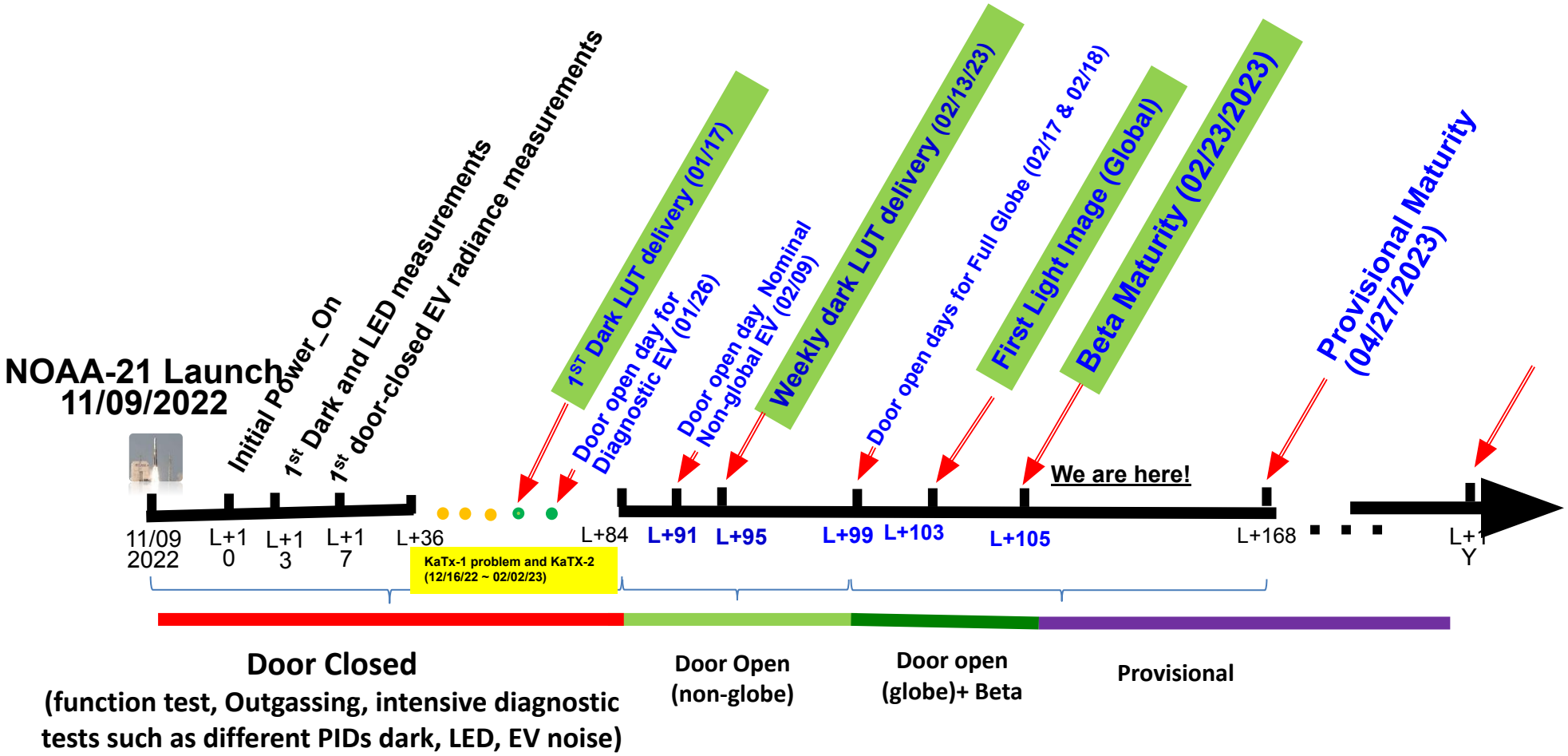
NOAA-21 OMPS NM/NP Pre-launch Performance Matrix (Presenter: Starry)

ADR	CCR	Title	Description	Projected Build	Status
9633	5577	NOAA-21 OMPS Nadir Mapper (NM) geolocation code change for off-nadir geolocation error correction	Correct the mistake in the formula for calculating the OMPS geolocation unit vectors	Mx7	In Operation 7/18/22
9905	5513	NOAA-21 OMPS Mounting Matrix Updates (pre-dynamic)	Update the J02 OMPS Mounting Matrix using NOAA-21 satellite pre-dynamic data	Mx7	In Operation 7/18/22
9908	5926	NOAA-21 OMPS Nadir Version Table Update N_TIM_PAT_VER Value	An update to the Nadir Version Table for OMPS-TBL-VERS-GND-PI_j02 is required to account for raw data record (RDR) from the redundant side of the instrument.	Mx7	In Operation 7/18/22
9959	TBD	NOAA-21 OMPS Nadir Mapper (NM) operational sample table includes 3 additional CCD spectral-columns that have no valid irradiance coefficients	1) NOAA-21 OMPS-NM operational sample table includes 3 additional CCD spectral-columns that have no valid irradiance coefficients. 2) NASA delivered new coefficients to NOAA STAR in January 2023	MX7	To be delivered (March)
9960	5997	NOAA-21 OMPS Nadir Mapper (NM) and NOAA-21 Nadir Profiler (NP) show significant/unacceptable discrepancies in albedo coefficients	1) NOAA-21 OMPS-NM and NOAA-21 OMPS-NP show significant/unacceptable discrepancies in albedo coefficients between 300-310 nm. 2) NASA delivered the updated NOAA-21 NM radiance coefficients in February 2023	MX	To be delivered (March)
10037	6101	NOAA-21 OMPS pre-launch LUTs update	10 OMPS LUTs needed to be updated pre-launch	At NOAA-21 launch	In Operation
10039	6112	NOAA-21 OMPS Total Column code change and OMPS-TC MACROPIX and EV-SAMPLE tables update	An incorrect table was used for the OMPS-TC MACROPIX and EV-SAMPLE tables for J02 TC-OMPS.	Mx9	Expected May 2023
10044	6135	NOAA-21 OMPS Mounting Matrix Coefficients Update (post dynamic)	NOAA-21 OMPS post TVAC sensor mounting matrix coefficients update	At NOAA-21 launch	In Operation

NOAA-21 OMPS NM and NP SDR Waivers

CCR	Title	Description
19-4768	OMPS Nadir Stray Light GSegDPS Waiver at 252nm	Waiver requesting relaxation of stray light requirement for NOAA-21 OMPS Nadir Profiler for 252nm from 5% to 7.3%. Rationale: The Nadir Profiler passes the stray light requirement of 5% at all wavelengths channel except for the shortest wavelength channel at 252nm.
19-1799	OMPS Nadir Stray Light PRD Waiver at 252 NM	Waiver requesting relaxation of stray light requirement O_PRD-11438 from 5% to 7.3% at 252nm only. Rationale: The Nadir Profiler passes the stray light requirement of 5% at all wavelength channels except for the shortest wavelength channel at 252nm.
19-0292	OMPS Nadir Stray Light MMSS and FSRD Waiver at 252nm	Waiver requesting relaxation of stray light requirement for NOAA-21 OMPS Nadir Profiler for 252nm from 5% to 7.3%. Artifacts regarding comparative performance to J1 and NOAA-21 OMPS instrument and relevant science impact are attached to 472-CCR-19-1799.
18-0246	Flow-Down of Approved NOAA-21 OMPS Nadir Resolution/SNR Requirements to the FSRD	The Flight Segment Requirements Document (FSRD) Rev B CCR (470-CCR-17-0195) included incorporation of approved mission-level changes to OMPS Nadir Mapper horizontal resolution (approved as NJO-2016-014 Rev C) and OMPS Nadir wavelength coverage requirement specifications (approved as NJO-2017-008 Rev B). This CCR has no impacts to Level 3 OMPS PRD requirements or to NOAA-21 SRD requirements.

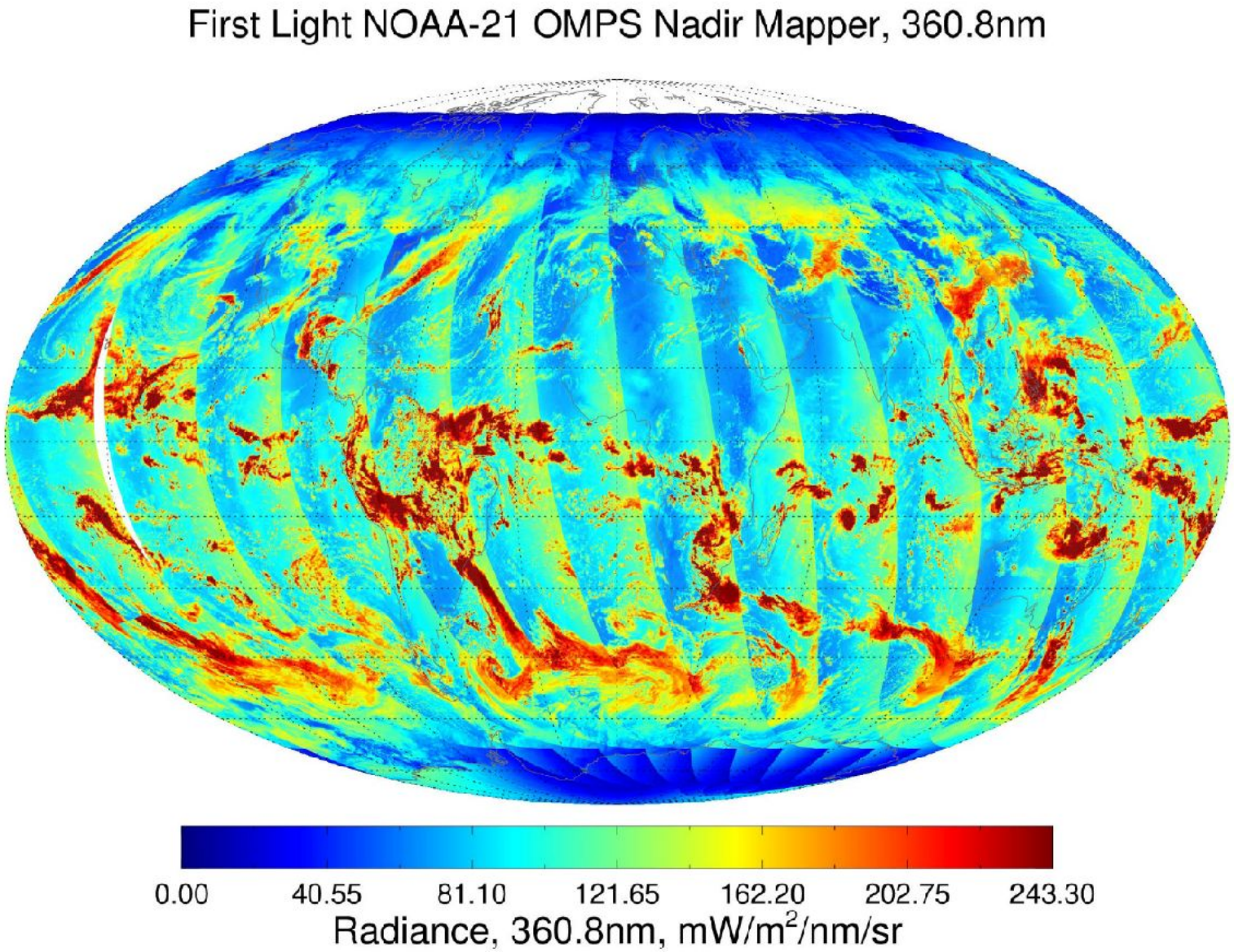
NOAA-21 OMPS Nadir Mapper and Nadir Profiler PLT Timeline[1,2]



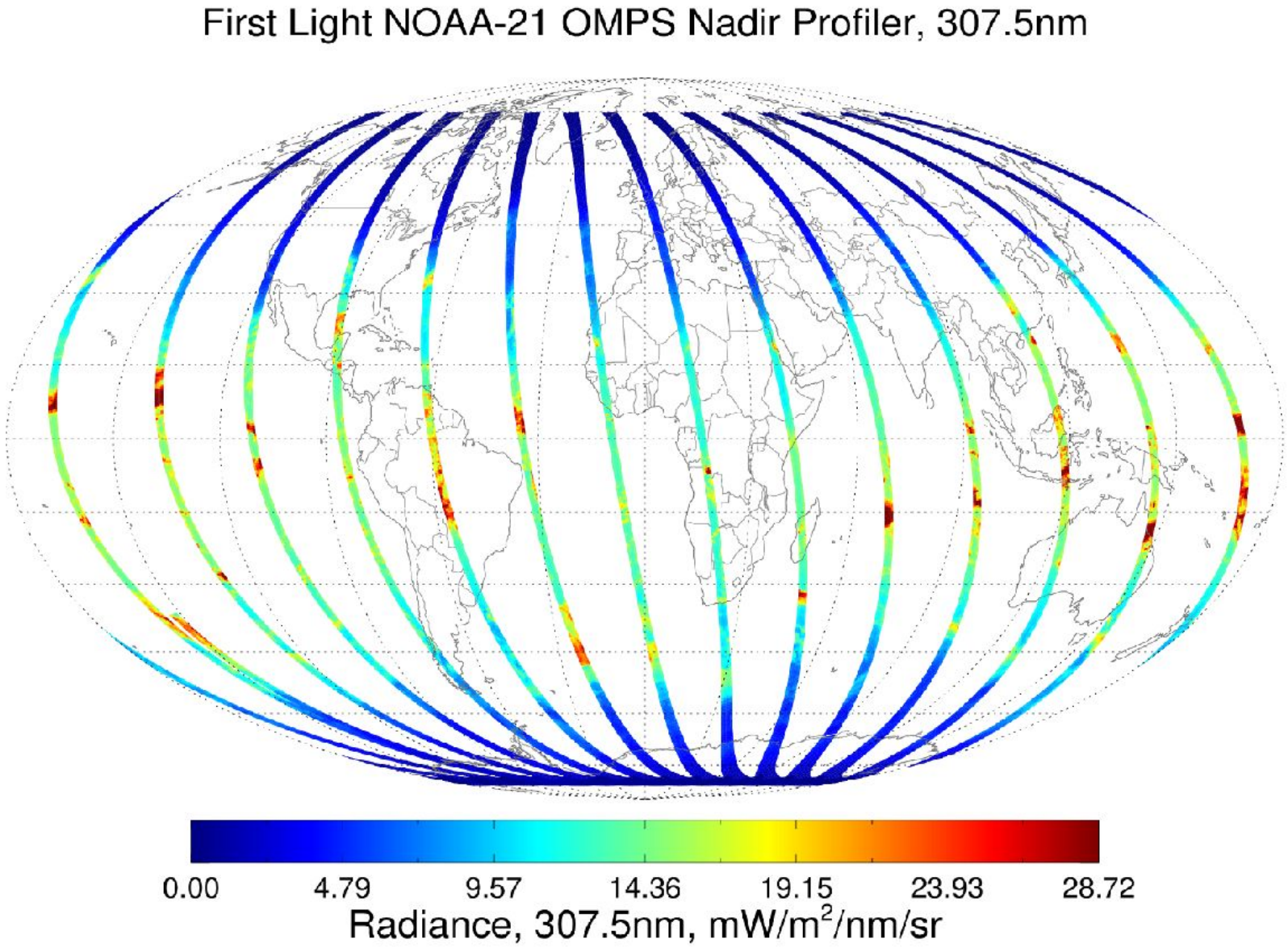
[1] Courtesy of NASA OMPS Group for sharing the NOAA-21 OMPS PLT Activity Schedule

[2] Timeline is not shown on scale

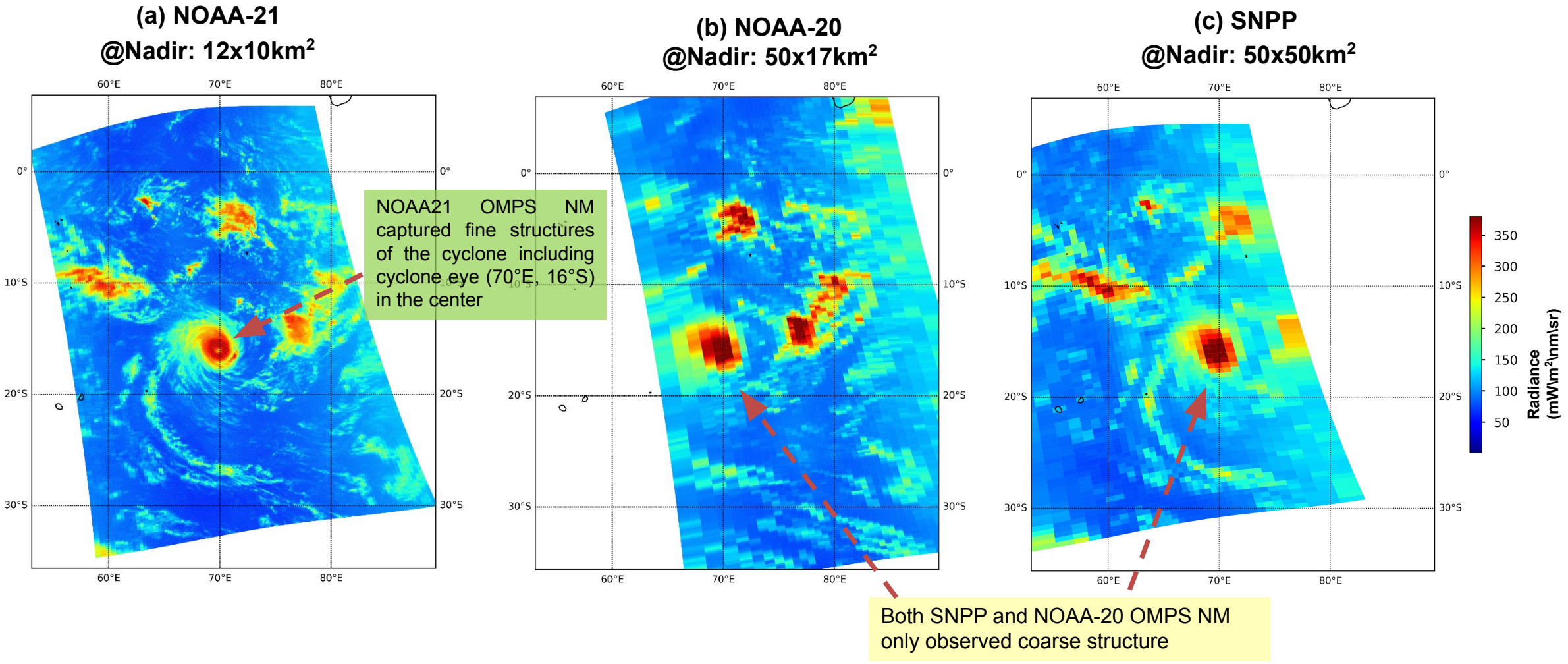
First Light Image on 02/18/2023: OMPS NM



First Light Image on 02/18/2023: OMPS NP



First Light Image on 02/18/2023: Tropical Storm in the Indian Ocean



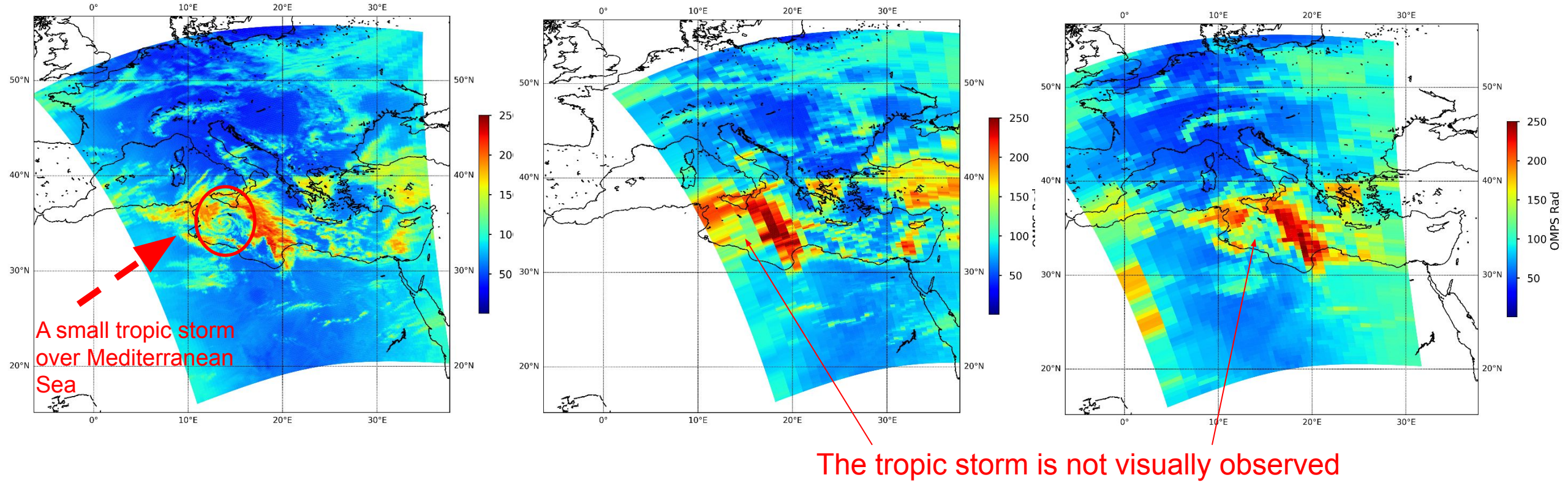
The NOAA-21 OMPS NM demonstrates a much-improved capability in capturing severe weather events due to its higher spatial resolution (around 7 times as NOAA-20 and 20 times as SNPP).

Door-Open for Non-Global Earth View Radiance: Small Tropic Storm on 02/09/2023

(a) NOAA-21 (10x12km^2@nadir)

(b) NOAA-20 (50x17km^2@nadir)

(c) SNPP (50x50km^2@nadir)

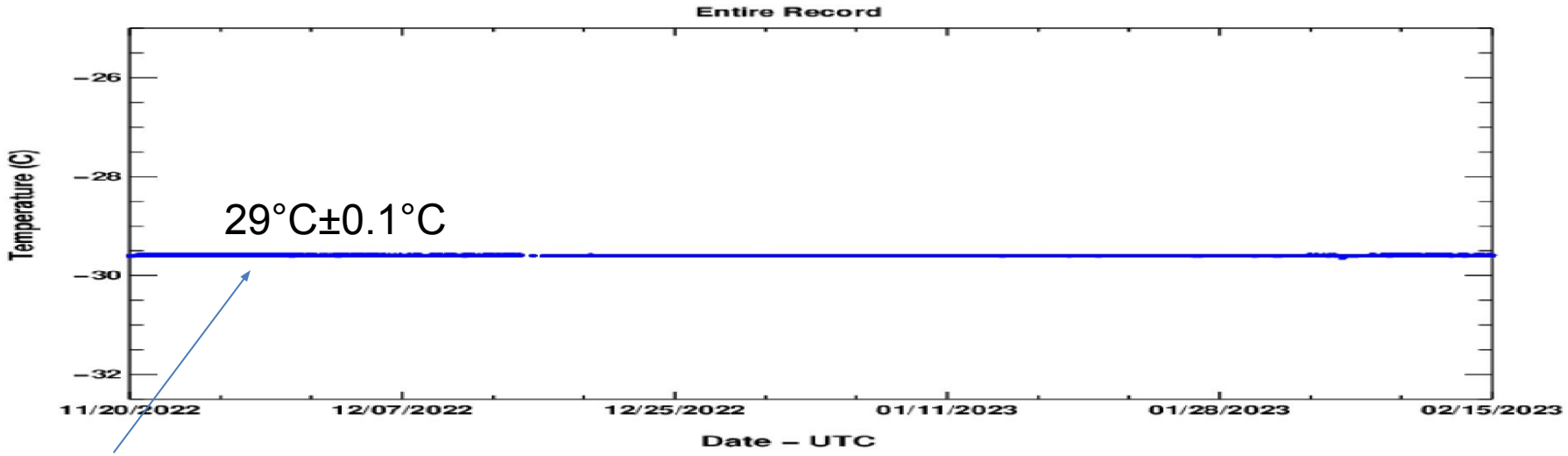


- The door-open for non-global NOAA-21 OMPS NM and NP earth view (EV) radiance measurements since 02/09/2023.
- NOAA-21 OMPS NM shows a much improved spatial resolution than SNPP and NOAA-20, thus capturing fine structure of a small tropic storm over Mediterranean Sea. This feature is not visually observed by both SNPP and NOAA-20

OMPS CCD Temperature Monitoring from ICVS

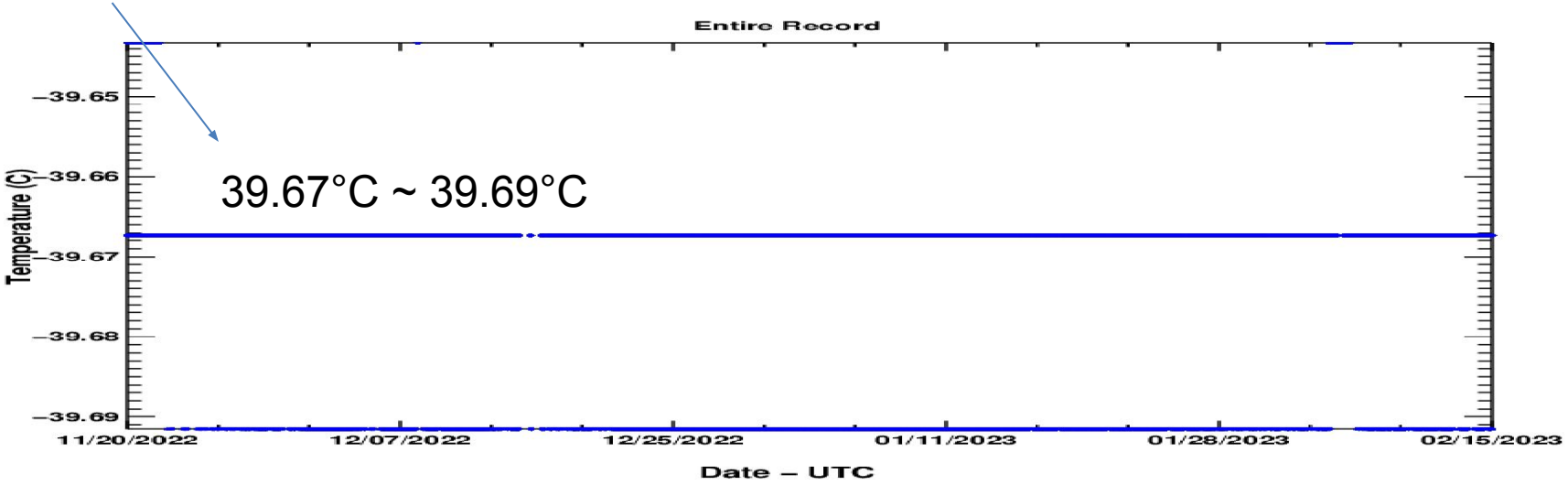
CCD Temperature

OMPS NM

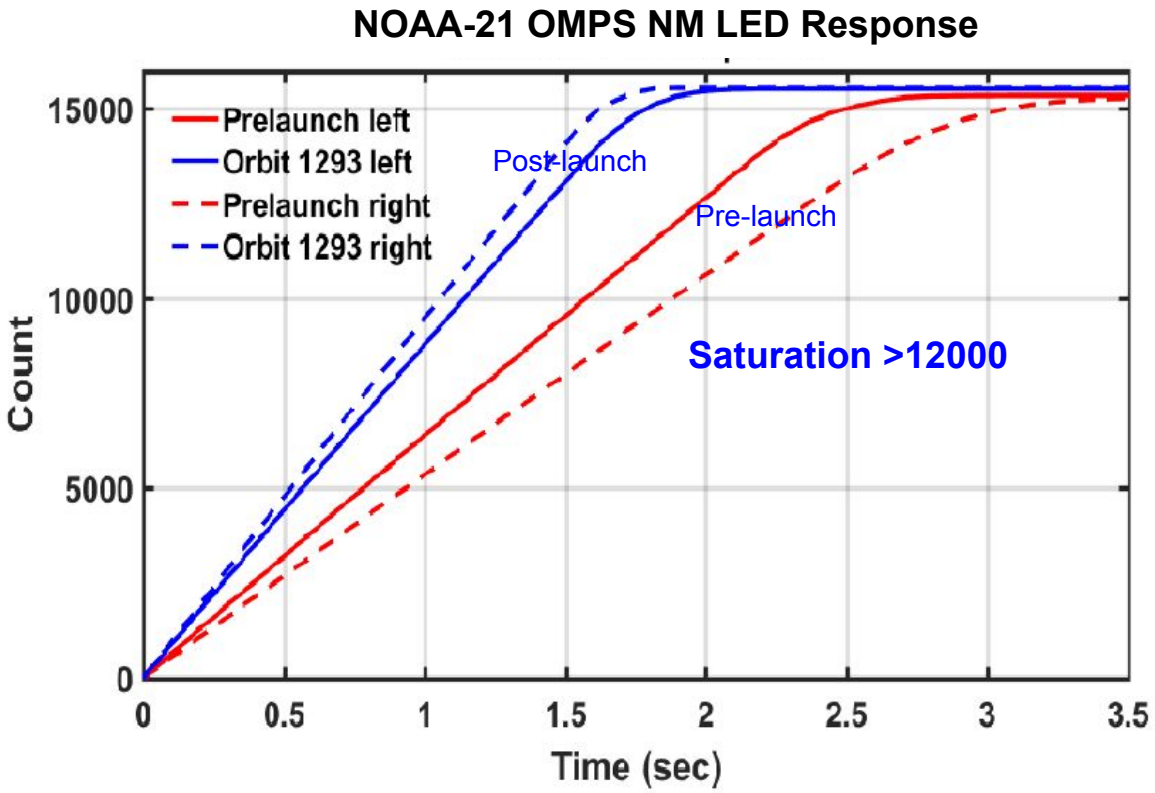


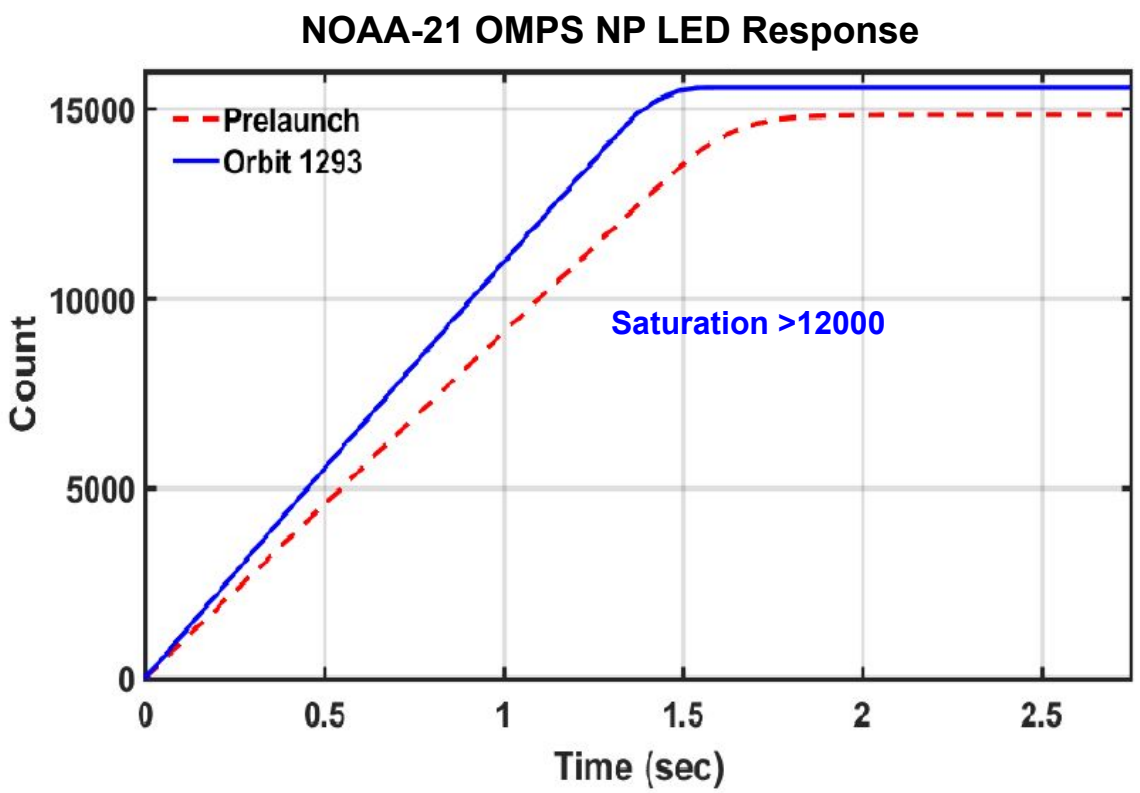
NOAA-21 OMPS NM/NP CCD temperatures are very stable

OMPS NP



OMPS Instrument Performance: CCD Signal Dynamic Range



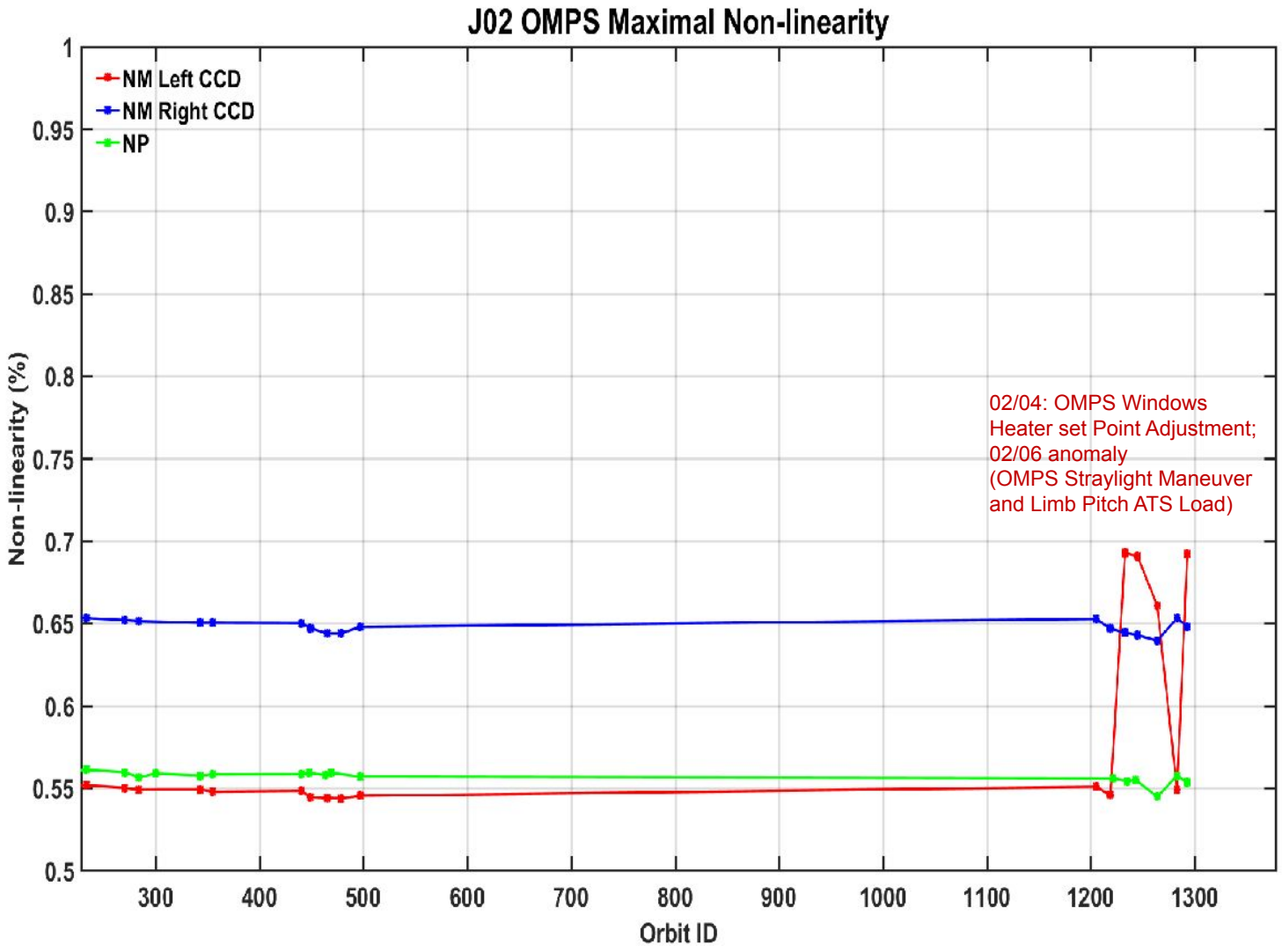


NOAA-21 OMPS CCD raw counts dynamic range:

- Saturation happens after 12000 counts

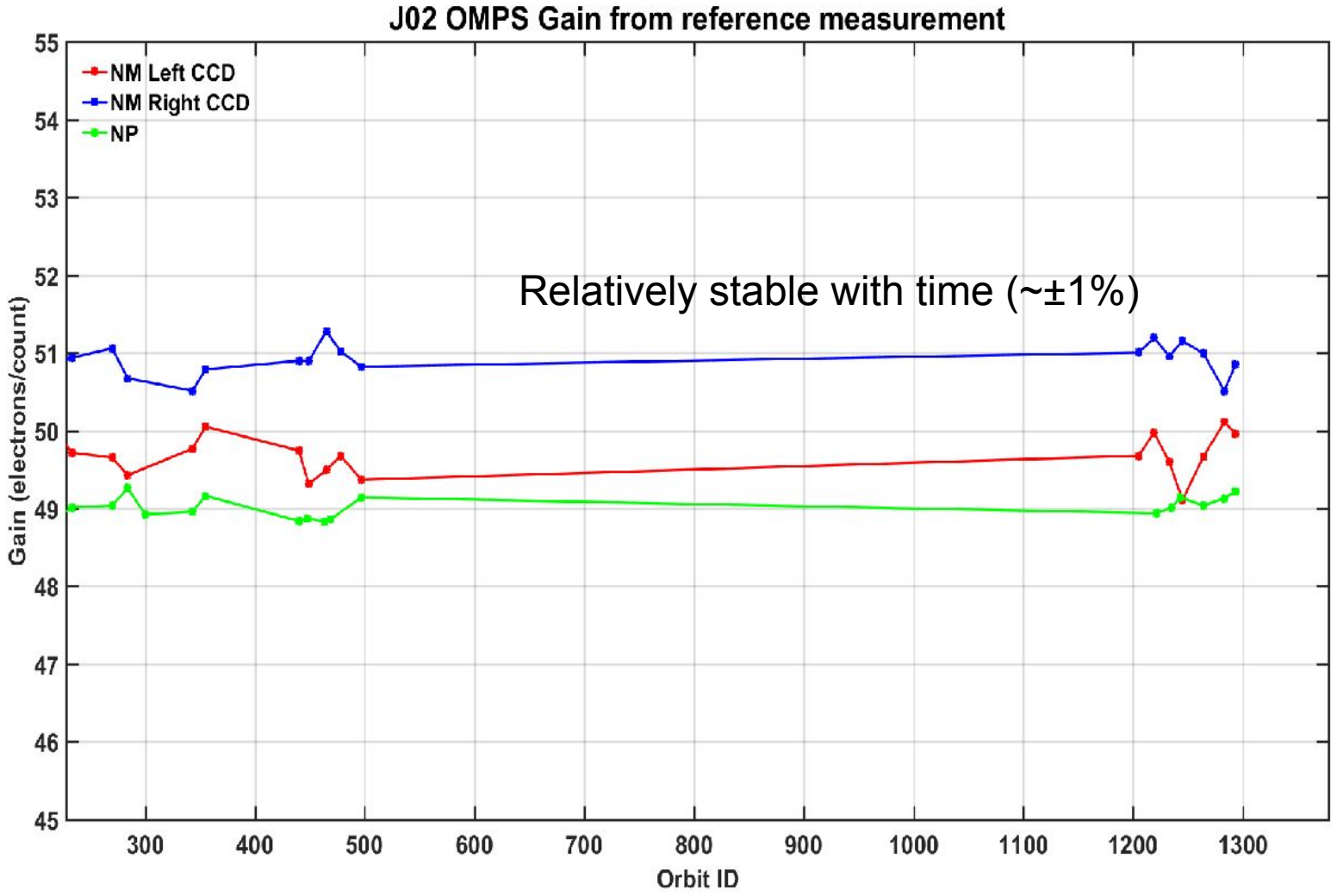
OMPS Nonlinearity Performance: Meet Requirement

- According to our analysis results,
  - The on-orbit OMPS nonlinearity performance is very comparable to the pre-launch (figure omitted)
  - The pre-launch and on-orbit NOAA-21 OMPS NM and NP system nonlinearity are less than 0.65%
  - On-orbit NM and NP show an improved nonlinearity than the pre-launch (figure omitted).
- Time series of maximum nonlinearity for the NOAA-21 OMPS NM (left and right CCD) and NP is shown in the figure.
  - The maximum nonlinearity is constantly smaller than 0.7%, within the requirement of 2%



OMPS Gain Performance: Stable

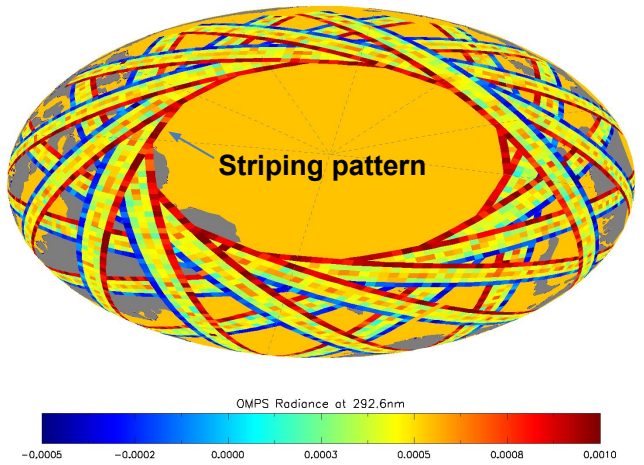
- The NOAA-21 OMPS NM and NP system gains (electron#/count) are assessed based on the LED data by using the mean variance method that was used in the SNPP and NOAA-20 OMPS (Kowalewski et al., 2012)
- Time series of the NOAA-21 NM and NP gains are showed in the figure, demonstrating a relatively stable gain with small offsets relative to the pre-launch TVAC values.



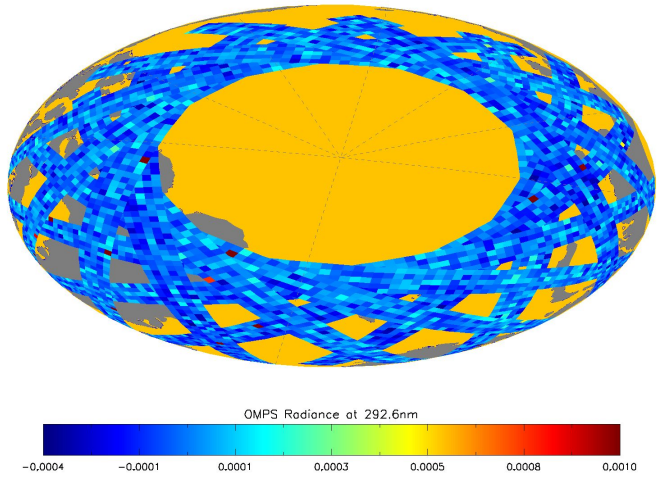
OMPS NM and NP Dark Calibration and LUT Development: Fixed Anomalous Patterns in Door-Closed Earth View Radiance

- The analysis showed that the pre-launch dark LUT caused anomalous features (striping pattern) in the door-close NOAA-21 OMPS NM and NP radiance data. An example for NP is given in Fig. a)
- With a postlaunch dark rate LUT, the above striping feature was significantly mitigated (see Fig. b)
- The first dark rate LUT was delivered on 01/17/2023
  - Fixed the striping and other unexpected features in the door-closed EV radiance image D (01/17)
  - Started the weekly dark LUT delivery since 02/13/2023

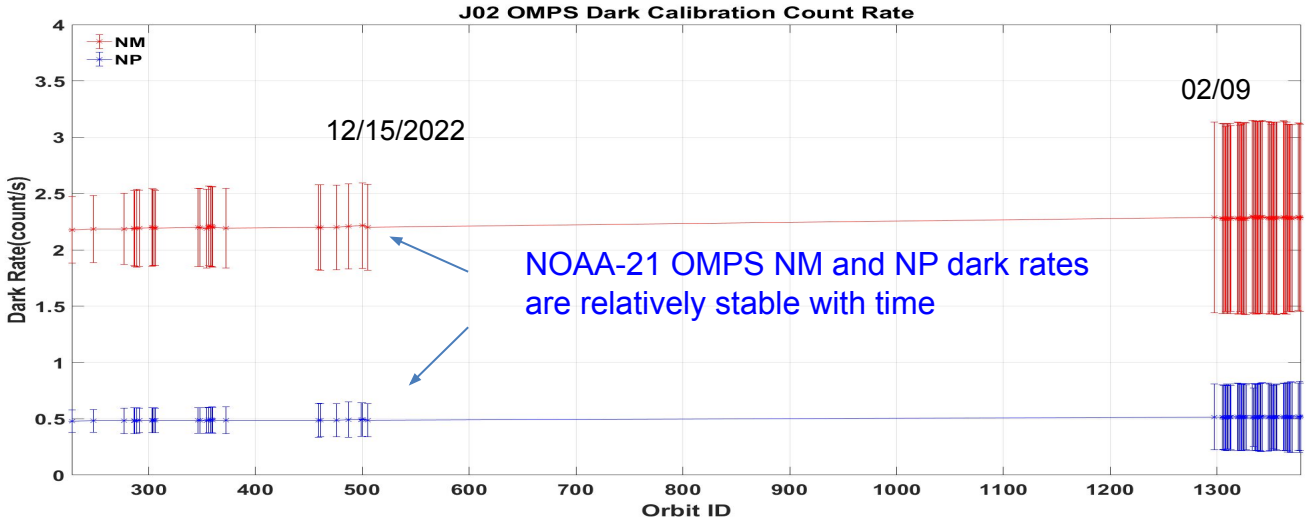
(a) Operational NOAA-21 OMPS NP Door-Close Radiance
(A prelaunch dark LUT or JCT3 TVAC version)



(b) NOAA-21 OMPS NP Door-Close Radiance
(A post-launch dark LUT based on on-orbit data)



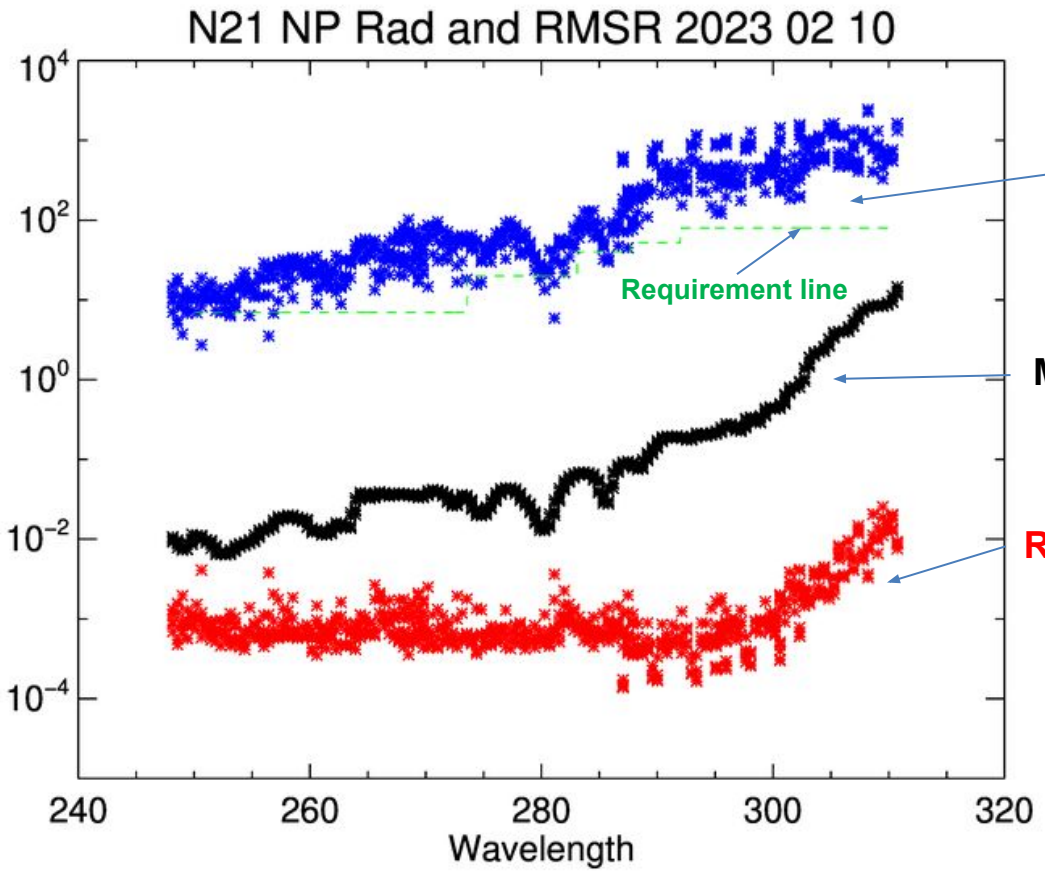
(c) NOAA-21 OMPS NM and NP Dark Rate Time Series



Earth View Noise Meets Requirements

(NP: 250 ~ 310nm; NM:305~380nm)

(a) NOAA-21 OMPS NP SNR

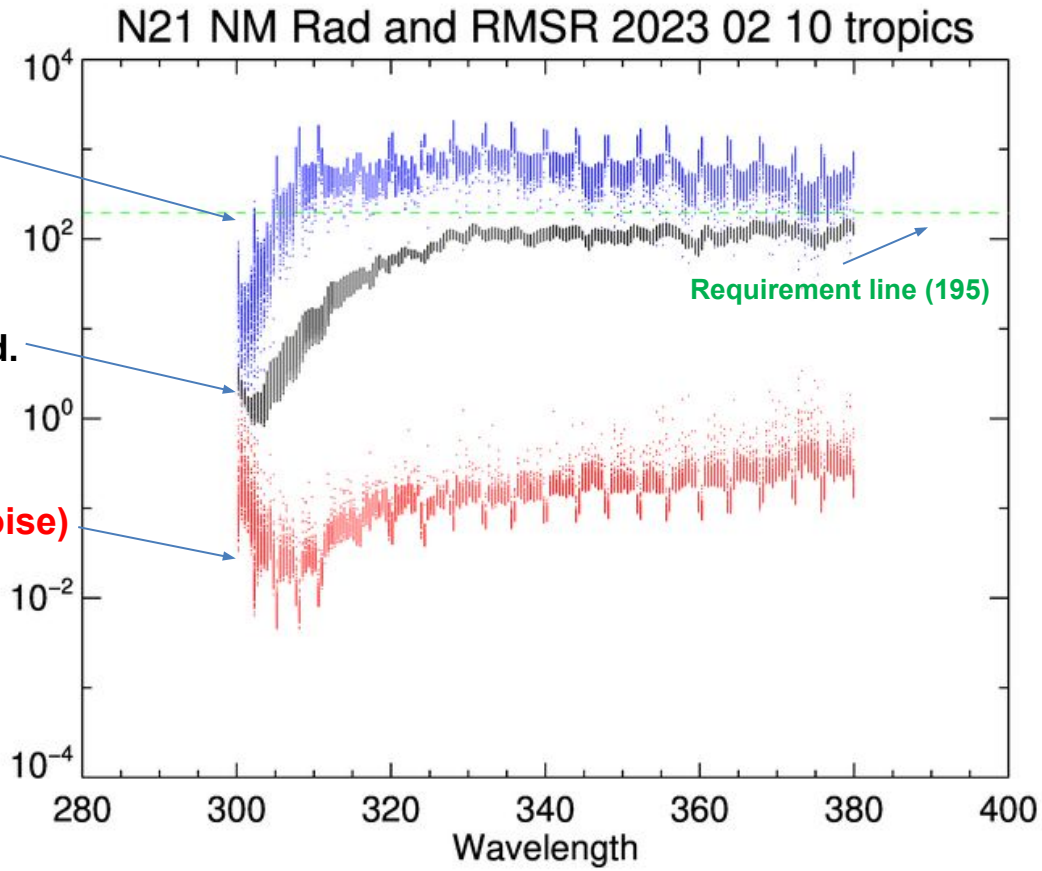


SNR

Mean Rad.

RMSR (Noise)

(b) NOAA-21 OMPS NM SNR

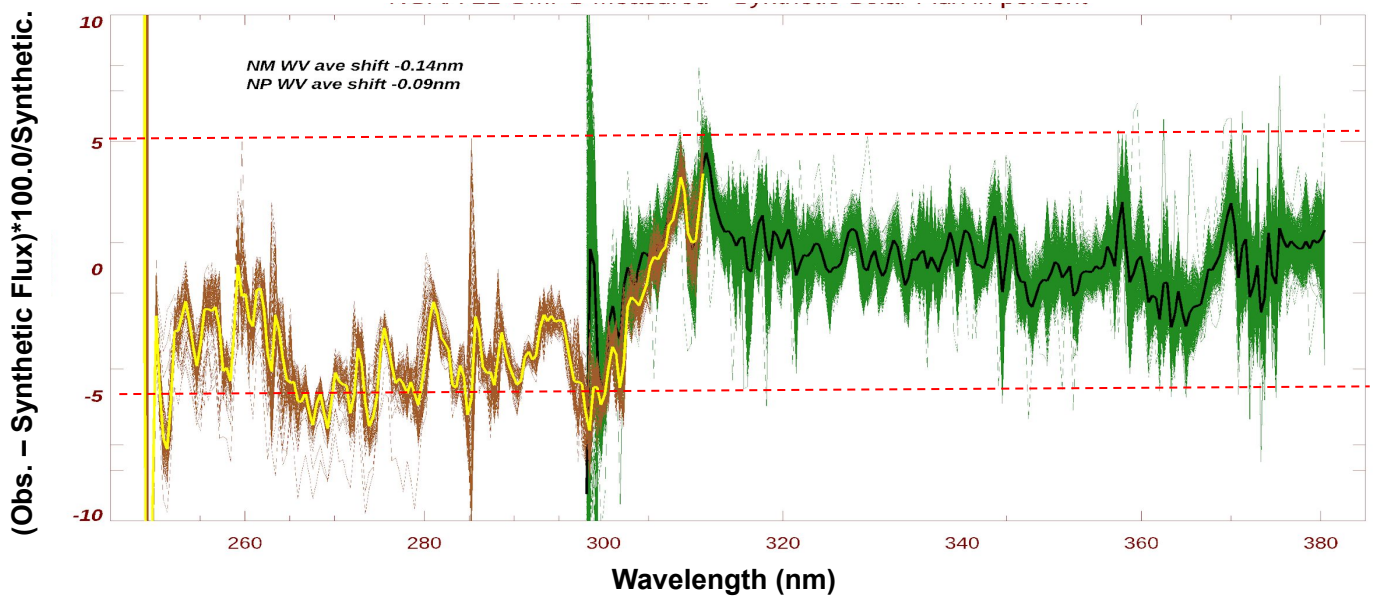


Both NOAA-21 OMPS NM and NP meet the SNR requirements except for part of the dichroic range (300 ~ 305nm) for NM

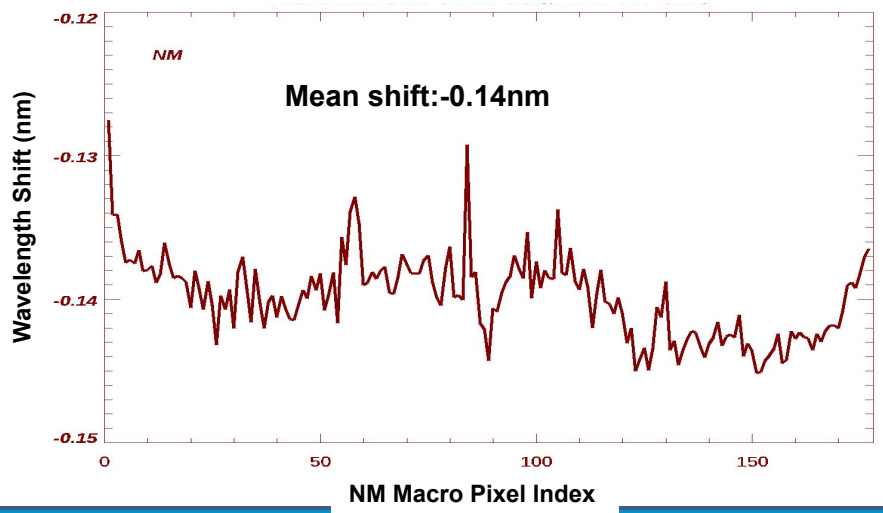
OMPS NM and NP Wavelength Registration Changes

- The NOAA-21 OMPS NM and NP wavelength registration is changed due to the instrumental thermal temperature change from ground to orbit.
- The NM/NP wavelength changes relative to the pre-launch (a synthetic solar spectrum) are determined based on the first solar diffusor measurement data. The methodology is similar to the OMPS ATBD methodology).
- The preliminary results show that the wavelength mean changes are **-0.14 nm for NM and -0.09 nm for NP**.
- Further improvement is needed to improve the calibration accuracy per sensor and consistency between NM and NP in 300-310nm.

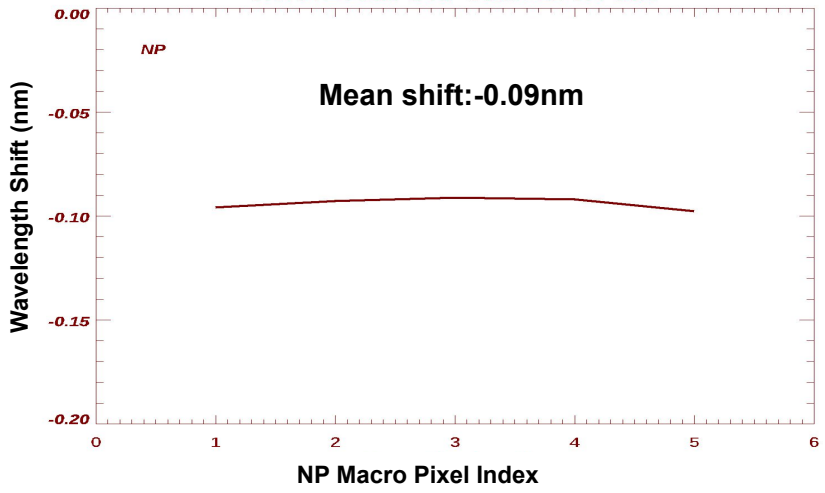
(a) NOAA-21 OMPS Nadir Solar Spectrum Difference between WV-Shifted Obs. and Synthetic (%)



(b) NM Wavelength Shift vs. Cross-Track Position



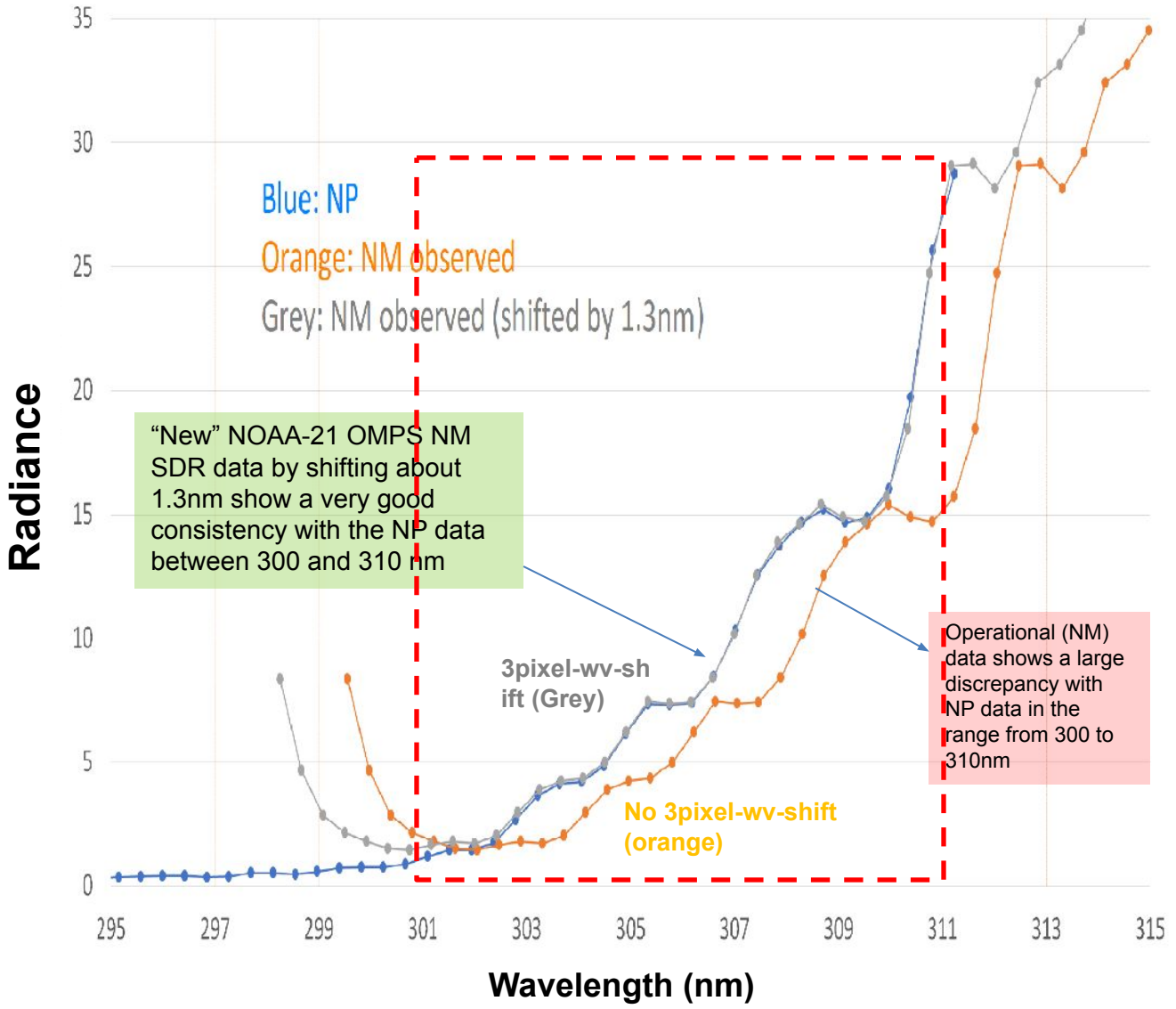
(c) NP Wavelength Shift vs. Cross-Track Position



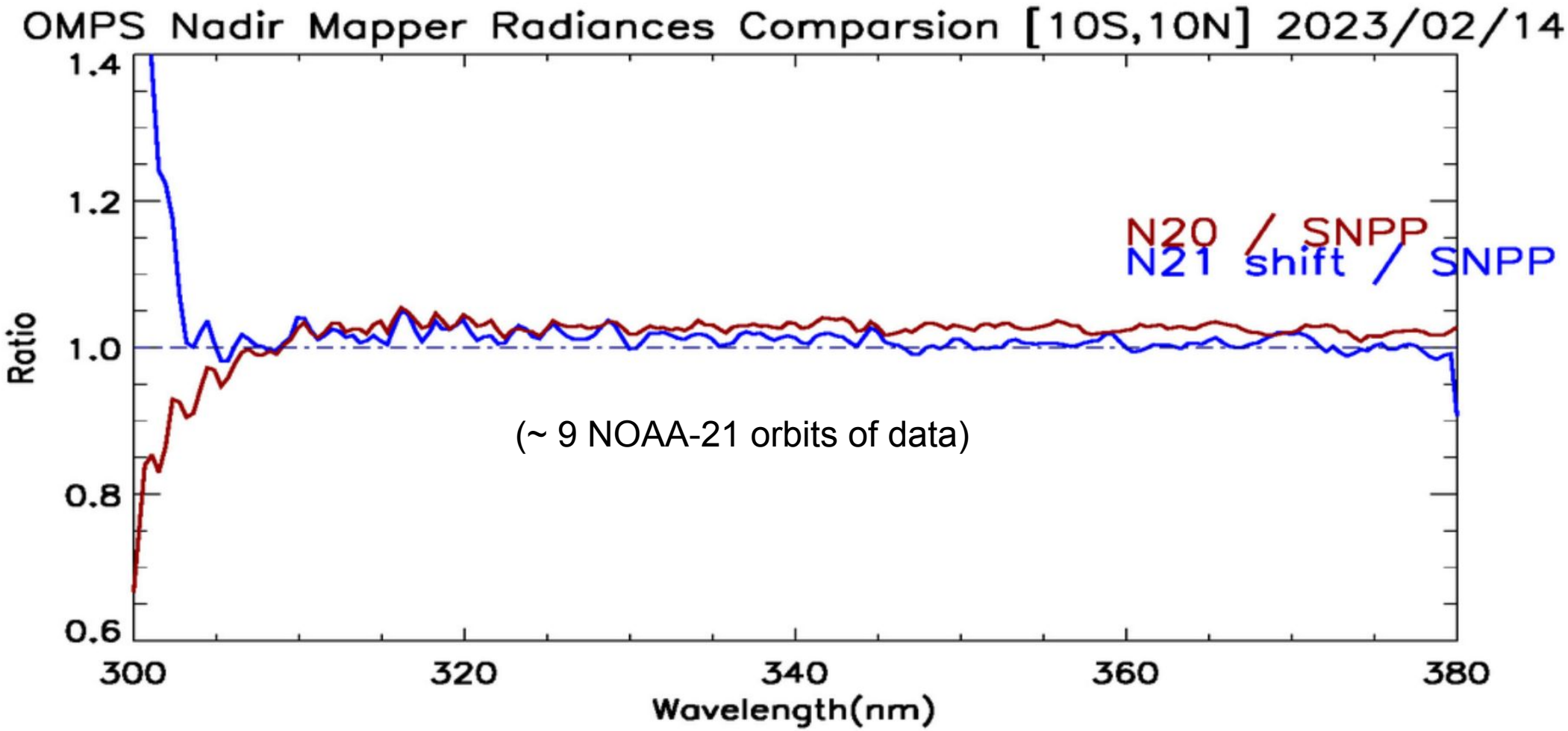
Courtesy of NASA solar diffusor calibration L1B data from the SIPS

NOAA-21 OMPS NM 3 Pixel-Position Wavelength Shift Issue

- A direct comparison was made between NM and NP (Orbit 1299)
  - Data coverage (relatively homogeneous)
    - LAT: 8.65°N~9.08 °N; LON: -104.98 °W ~ -104.52 °W
  - Matchup data set: one pixel from NM and nearly 30 pixels from NM
- According to the results, the operational NOAA-21 OMPS NM radiance shows a large discrepancy with NOAA-21 OMPS NP in the range from 300 to 310 nm.
- By shifting about 1.3nm, 'new' NOAA-21 OMPS NM data shows a much improved consistency with the NP data.
- According to our analysis, the inconsistency between the NOAA-21 OMPS NM and NP is primarily caused by the inconsistency in the used NOAA-21 OMPS NM wavelength table that has 3-pixel shift in the wavelength

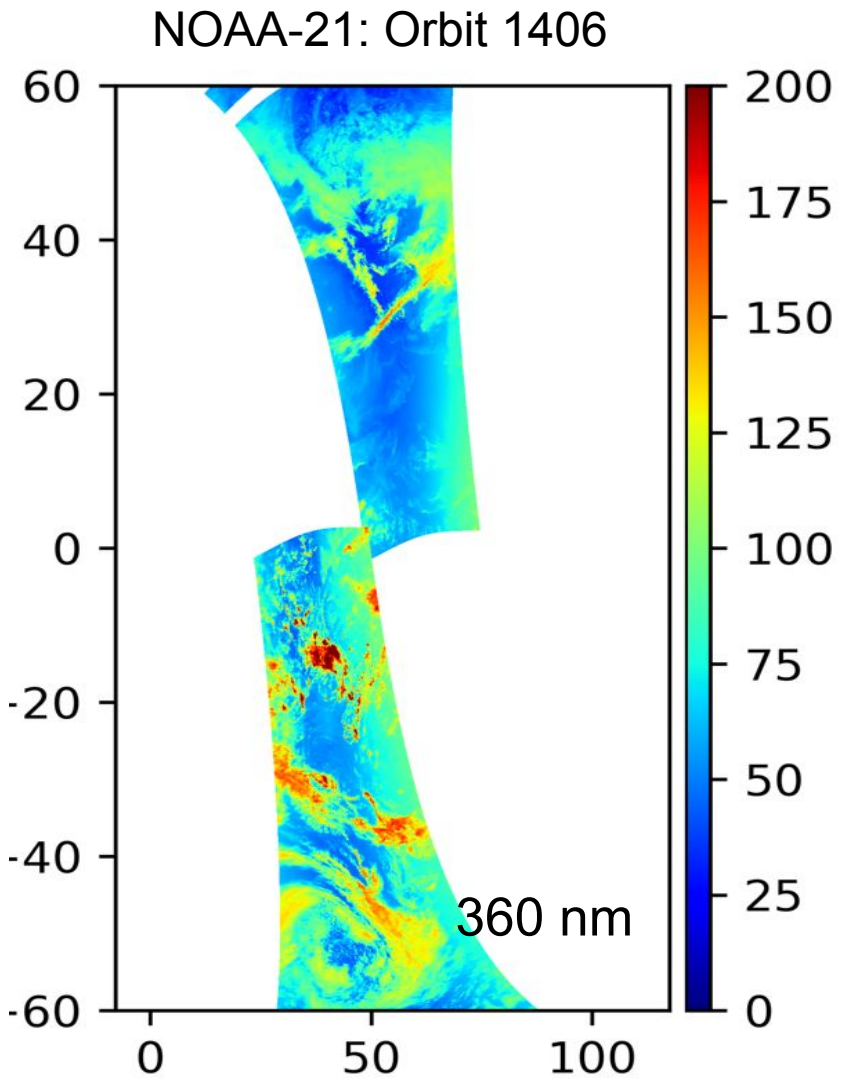


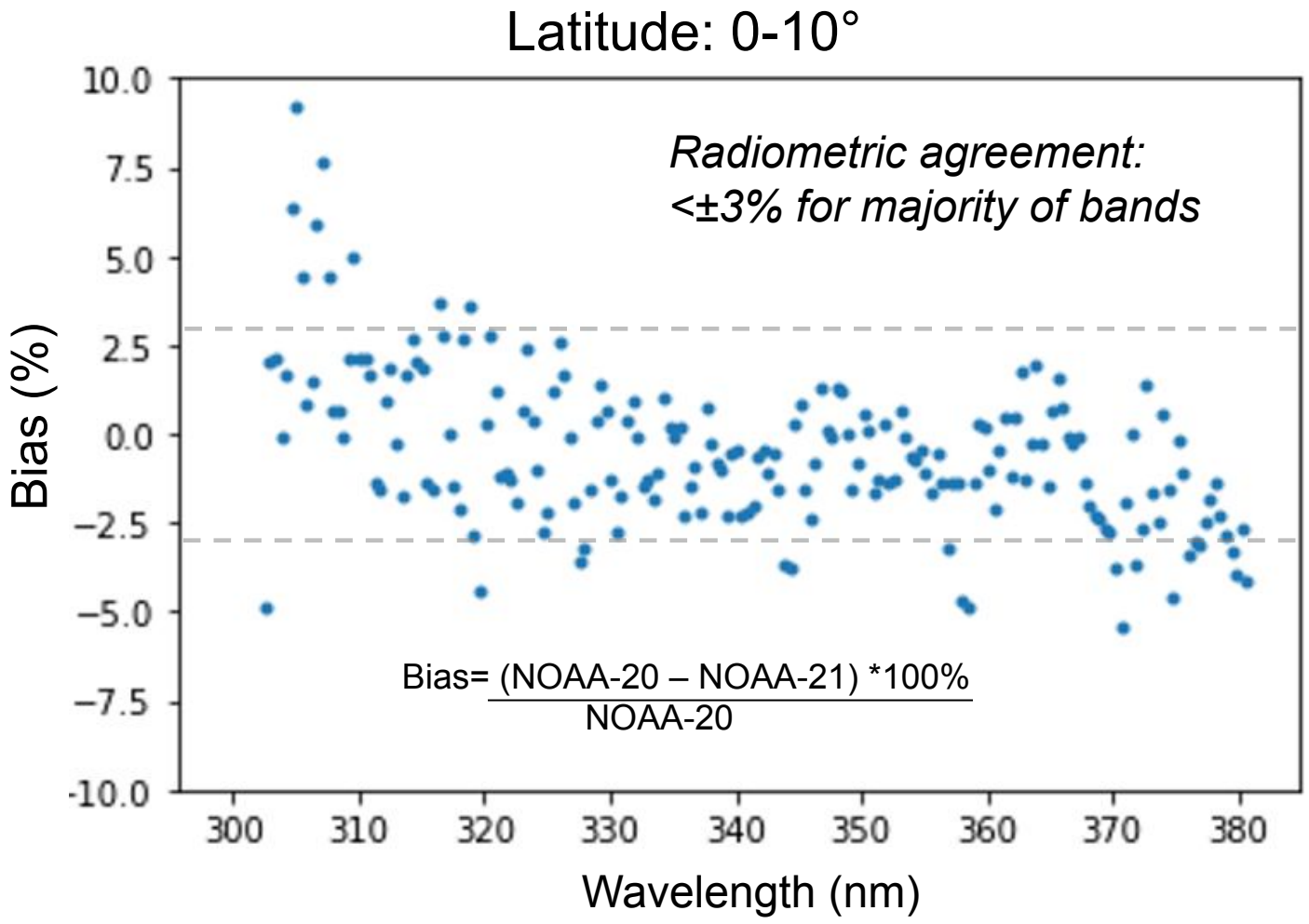
Inter-sensor Comparison of NOAA-21 OMPS NM Radiance with SNPP : Preliminary Analysis



NOAA-21 OMPS Radiance from 305 to 380 nm with about 3-pixel-wavelength shift is more comparable to SNPP (further analysis is needed to confirm this conclusion)

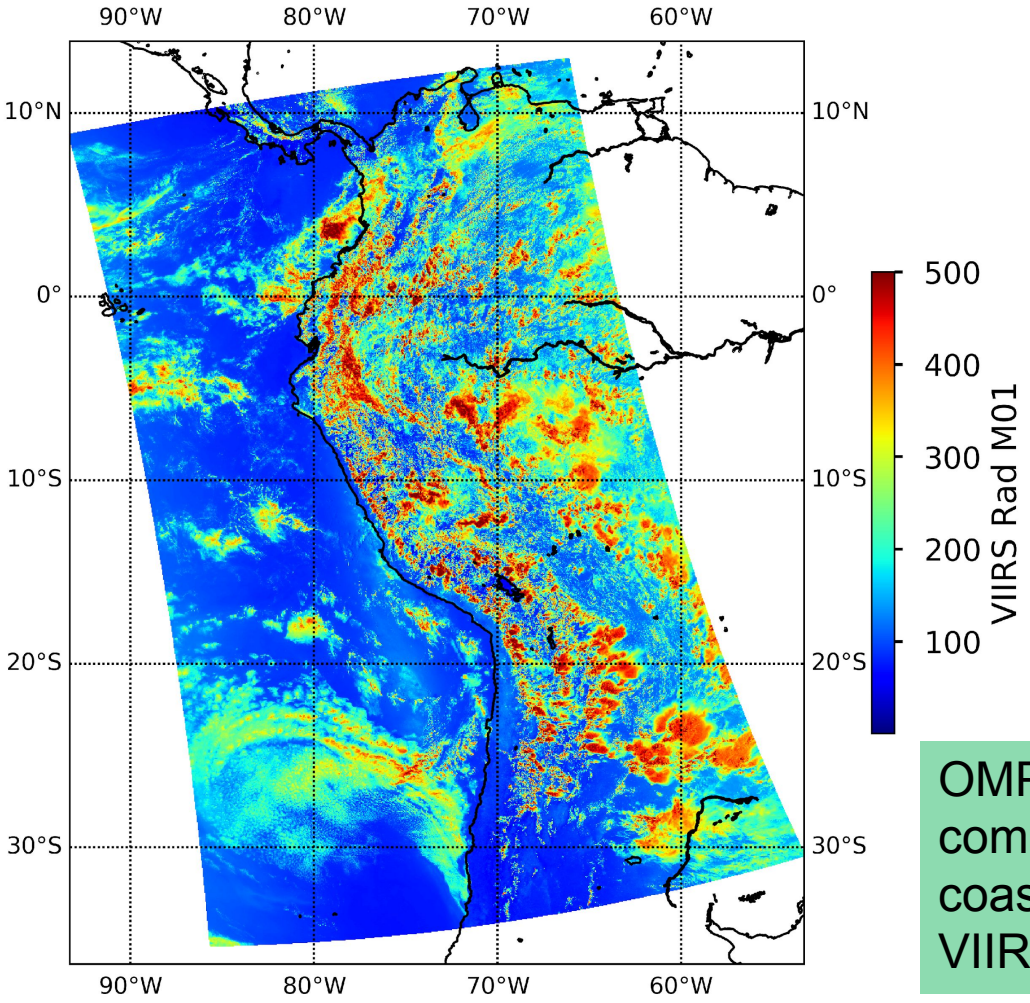
NOAA-21 and NOAA-20 OMPS NM Radiance Comparison



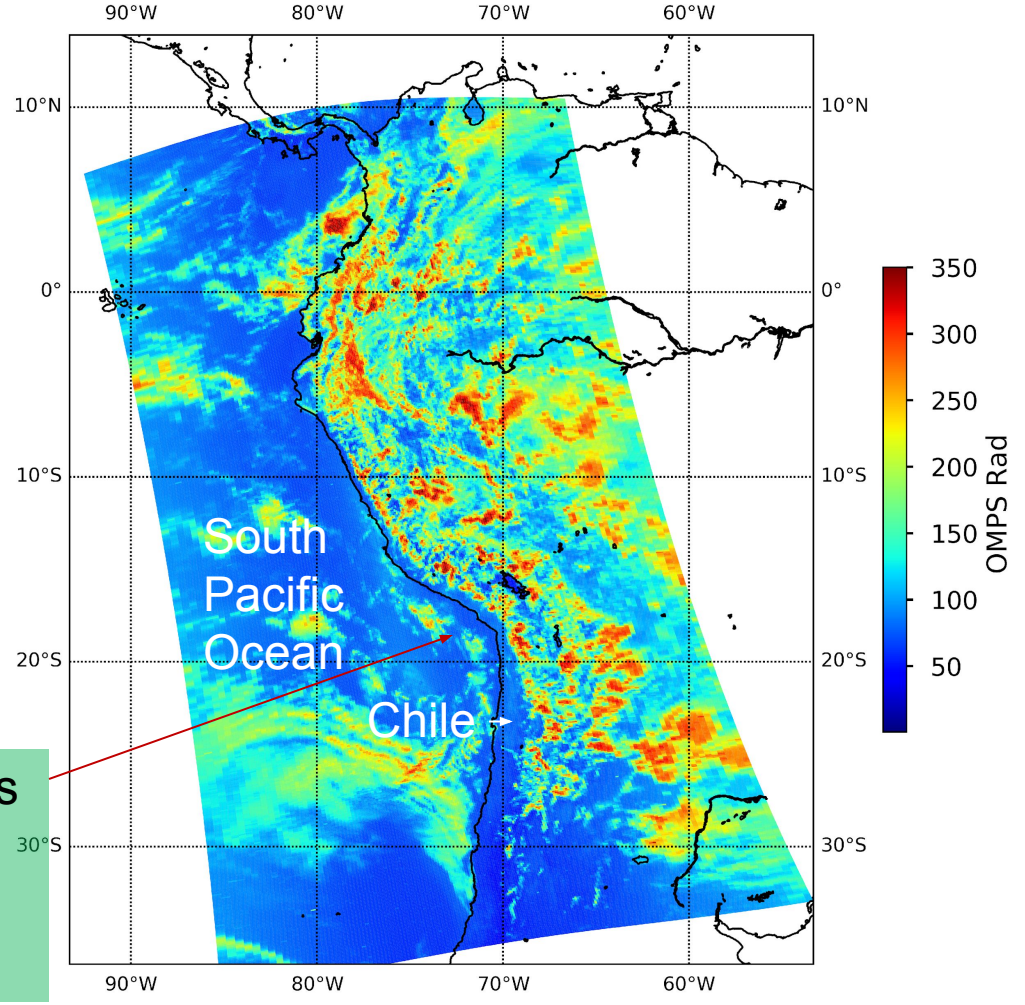


Note: For comparison, NOAA-21 data wavelength is shifted by 3 pixels (further analysis is needed to confirm this conclusion)

OMPS Geolocation Assessment (1/2): Visual Comparison with VIIRS



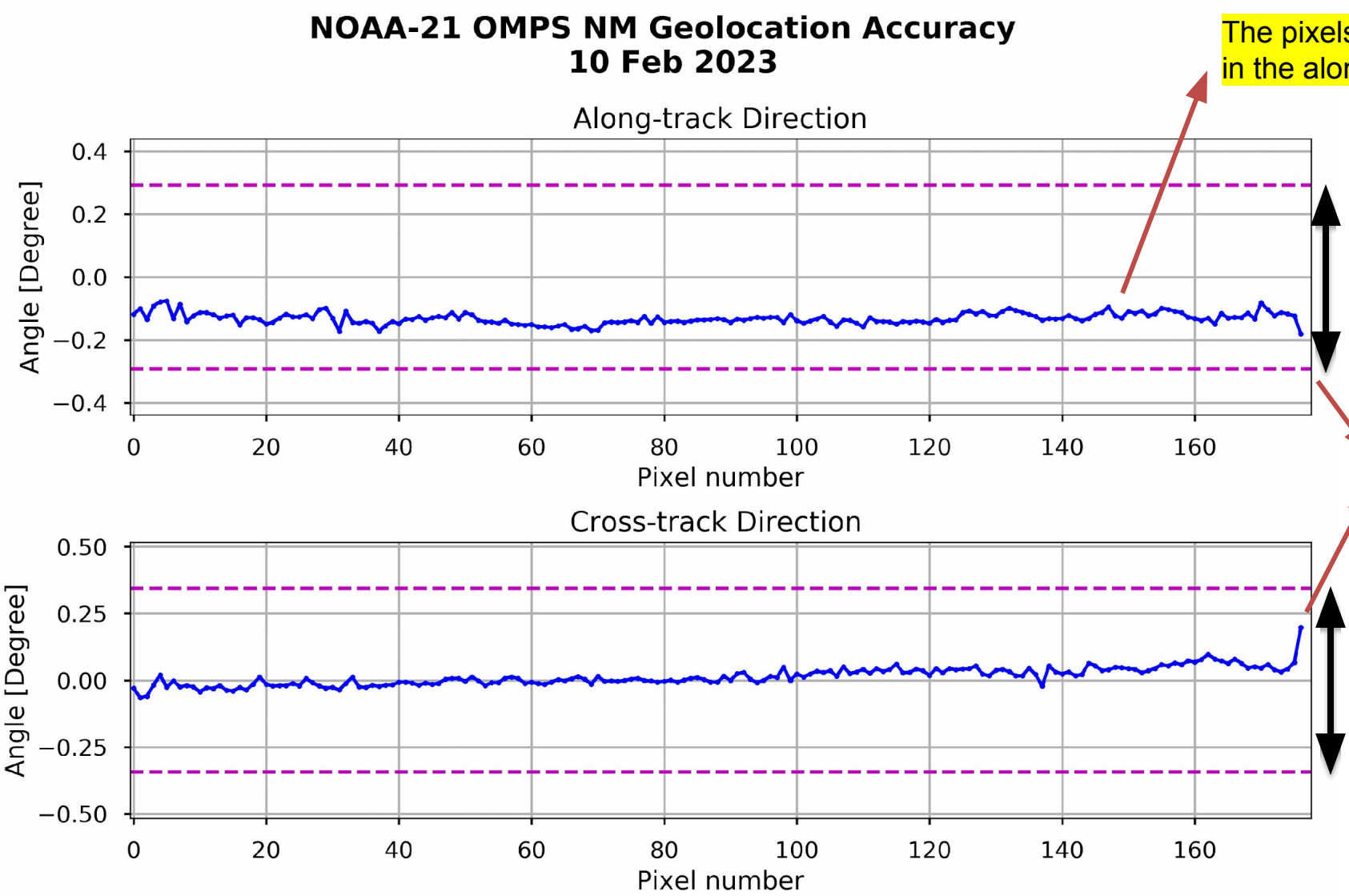
OMPS NM has comparable coastlines to VIIRS M1



NOAA-21 VIIRS M1 Band

NOAA-21 OMPS NM 380nm

NOAA-21 OMPS Geolocation Assessment (2/2): Geolocation Accuracy Relative to VIIRS*



The pixels were shifted ~0.1 degree (1.5 km at nadir) in the along-track direction

Corresponding to 8.5 km at nadir

The worst performance is at the edge pixel 176 (DR10039 code error)

Corresponding to 10.0 km at nadir

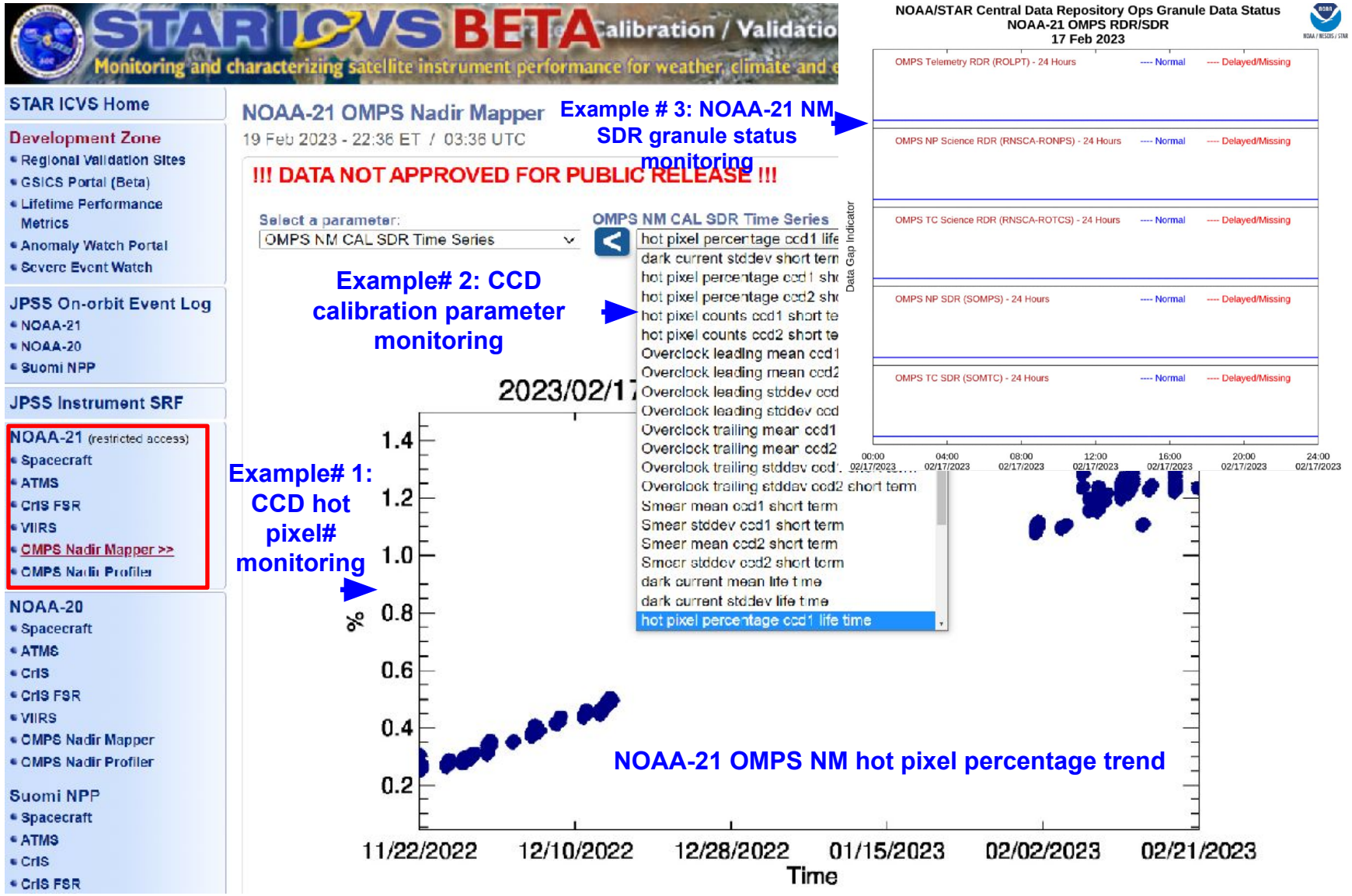
*Further assessment is needed in the future.
- Instruments are in the orbit test stage
- OMPS NM spectral calibration is not done yet.
- VIIRS geolocation evaluation is still undergoing.

Geolocoation accuracy relative to VIIRS within the subpixel level (~ less than half of pixel size)

(Reference: Wang et al. 2022)

Long-Term Monitoring of NOAA-21 OMPS NM and NP Data

- The ICVS has developed a beta version of the monitoring tool for NOAA-21 OMPS NM/NP instrument, calibration/telemetry RDR and SDR data quality in a near-real time mode (https://www.star.nesdis.noaa.gov/icvs-beta/status_J02_OMPS_NM.php).
- The monitoring parameters include the instrument performance (temperature, CCD dark, smear, hot pixel, etc.), EV-radiance, reflectance, data quality flag, and other calibration parameters.
- Examples are given on the right panel for the NOAA-21 OMPS NM CCD hot pixel percentage trend and others.



(Courtesy of ICVS D. Liang)

User Feedback

Name	Organization	Application	User Feedback - User readiness dates for ingest of data and bringing data to operations
Larry Flynn	NOAA/STAR/SMCD	OMPS Ozone retrieval	(1) The V8Pro ozone is reasonable but is impacted by the wavelength scale error as are the error flags. (2) The aerosol index and effective reflectivity maps look good at the eyeball level. (3) The SDR empirical wavelength scale has a cut-off of ±0.1 nm. There may have been a -0.11 nm shift from ground to orbit. (4) The wavelength scale appears to be off by three pixels relative to the Earth radiance and Solar Irradiance.

NOAA-21 OMPS NM and NP SDR Data User Feedback:

OMPS NOAA21 EDR from I&T

V8TOz-v4r2 and V8PRO-v4r2

(Presenter: Larry Flynn)

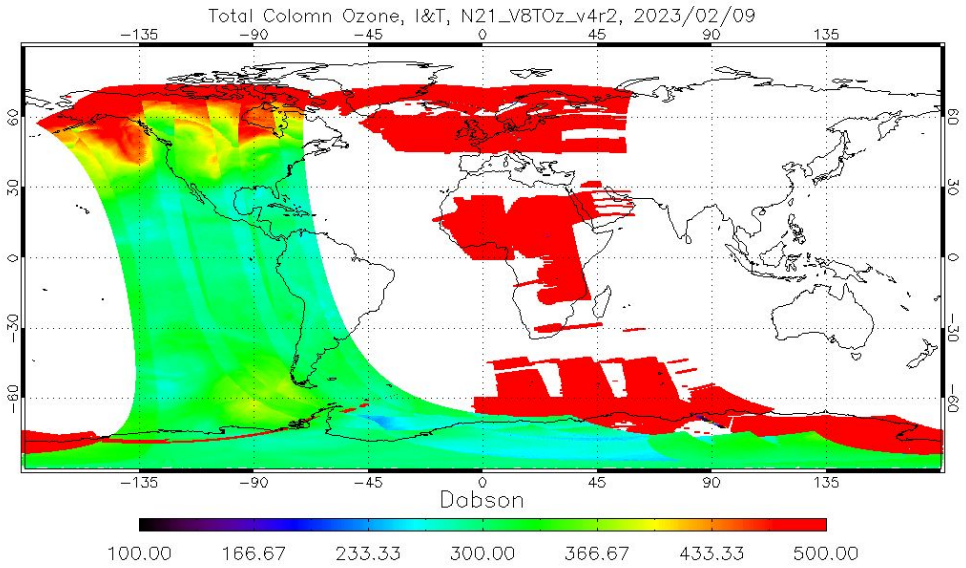
Contributors: L. Flynn and Z. Zhang with some ICVS materials

Summary of NOAA-21 OMPS NM findings

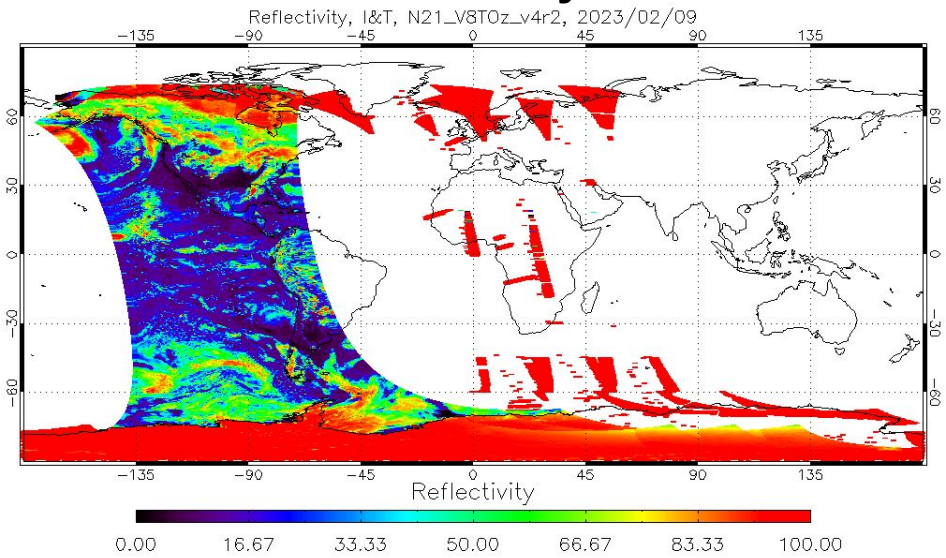
- Noise levels for the smaller FOVs look good.
- The SDR empirical wavelength scale has a cut-off of ±0.1 nm. There may have been a -0.11 nm shift from ground to orbit. Note: the SDR is not designed to perform such large shifts as the effective FWHM is increased in the interpolation.
- The wavelength scale appears to be off by three pixels relative to the Earth radiance and Solar Irradiance.
- The Rad/Irradiance values have structure that may be related to the solar irradiance wavelength scale shift or bandpass choices. A measured solar and wavelength scale should clear this up. There is a deviation below 303 nm which could be related to stray light correction tuning, or the 3-pixel shift or a -0.1 nm shift.
- The night side measurements show that the dark correction is pretty good and confirm the noise levels.
- The V8TOz ozone is reasonable but is impacted by the wavelength scale error as are the error flags.
- The aerosol index and effective reflectivity maps look good at the eyeball level.

V8TOz Retrievals, 2023/02/09

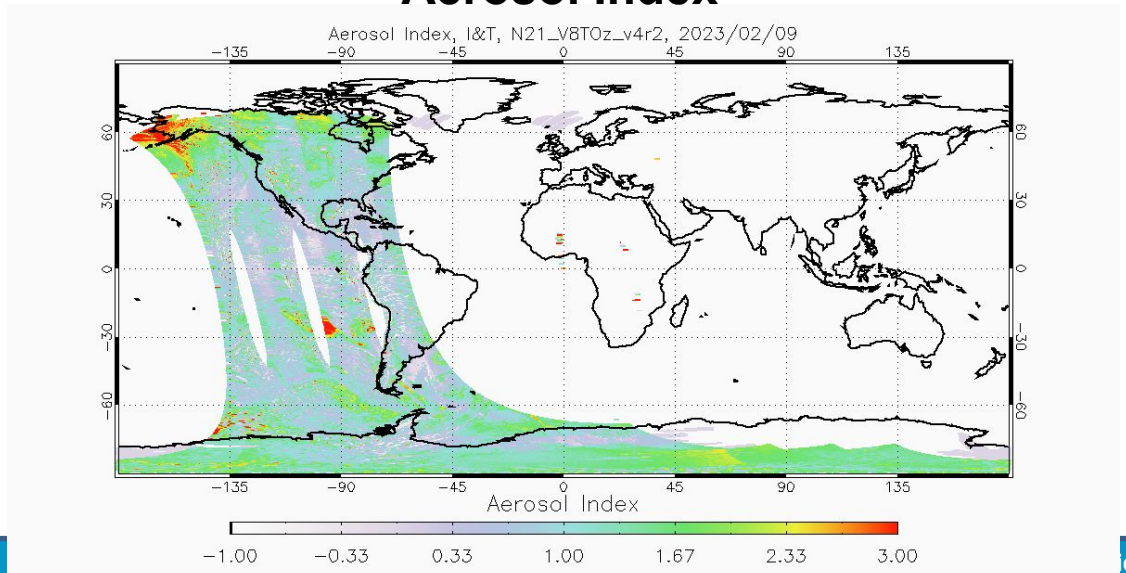
Total Ozone



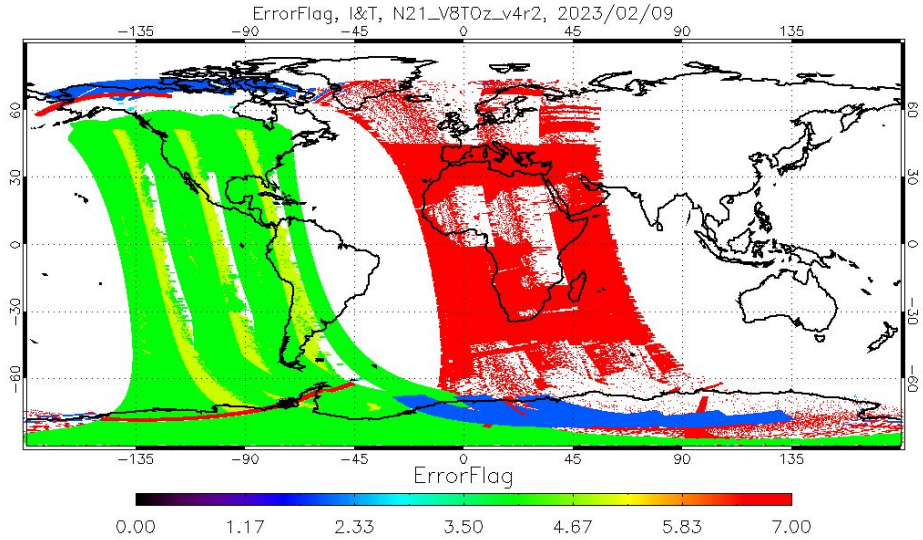
Reflectivity



Aerosol Index



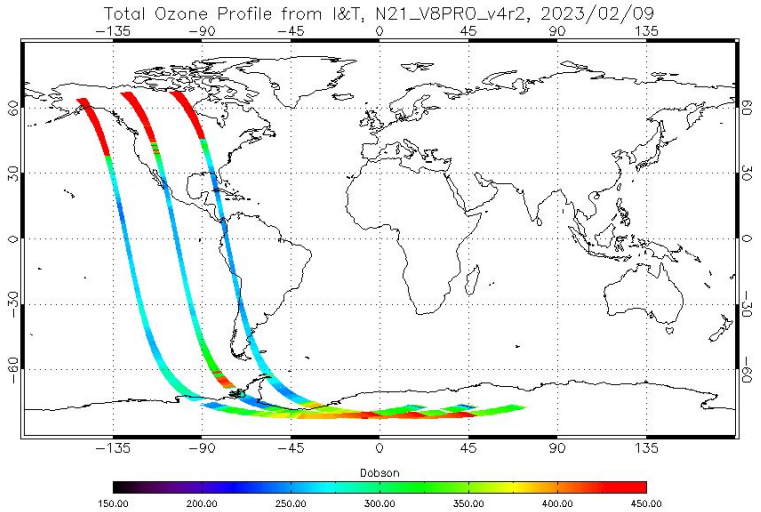
Error Flag



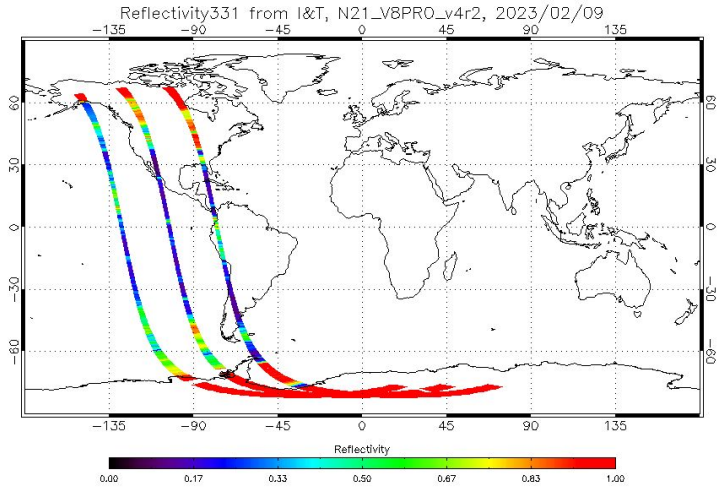
Summary of NOAA-21 OMPS NP findings from 02/09 SDR Data

- The ICVS Mg II Index suggest a shift of -0.07 nm between the prelaunch used for the solar the in-flight wavelength scale.
- The V8Pro ozone is reasonable but is impacted by the wavelength scale error as are the error flags.
- We have just started checking for stray light (both in-band and out-of-band).

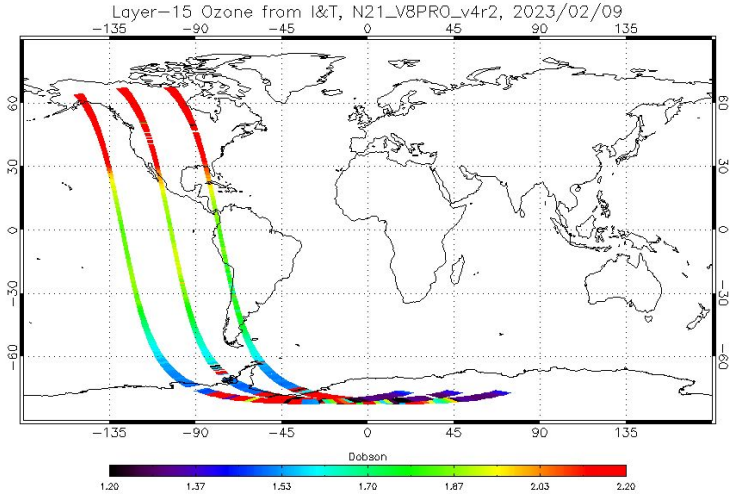
Total Ozone Profile



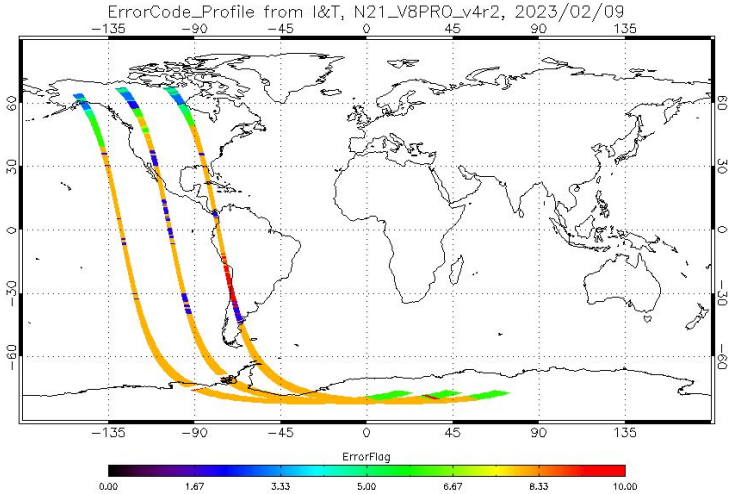
Reflectivity



Layer-15 Ozone



Error Flag



Risks, Actions, and Mitigations

- Provide updates for the status of the risks/actions identified during the previous maturity review(s); add new ones as needed

Identified Risk/Issue	Description	Impact	Action/Mitigation and Schedule
Issue # 1	Wavelength scale registration change	Big impact on NM and NP SDR data quality	A new DR to update the NOAA-21 NM/NP wavelength and osol LUTs (4 tables): TC_OSOL-LUT; TC_WAVELENGTH; NP_OSOL-LUT; NP_WAVELENGTH;
Issue # 2	NOAA-21 OMPS NM wavelength pixel-shift error	NOAA-21 OMPS NM data quality	A new DR is to be open to update the following four tables in combination with Issue # 1: TC_OSOL-LUT; TC_WAVELENGTH

Documentations (Check List, 1 slide)

Science Maturity Check List	Yes ?
ReadMe for Data Product Users	Draft is done (internal review)
Algorithm Theoretical Basis Document (ATBD)	The OMPS (SDR&EDR) ATBD exits but it needs to be updated: in progress (Target: by March)
Algorithm Calibration/Validation Plan	Yes
(External/Internal) Users Manual	N/A
System Maintenance Manual (for ESPC products)	N/A
Peer Reviewed Publications (Demonstrates algorithm is independently reviewed)	In plan
Regular Validation Reports (at least annually) (Demonstrates long-term performance of the algorithm)	Yes

Check List - Beta Maturity

Beta Maturity End State	Assessment
Product is minimally validated, and may still contain significant identified and unidentified errors	(1) The NOAA-21 OMPS NM and NP SDR data shows a good quality. The images are visually comparable with SNPP and NOAA-20. The data have no obvious geolocation errors. (2) The NOAA-21 OMPS NM SDR has about 7 (20) times spatial resolution as the NOAA-20 (SNPP), thus being capable of capturing fine clouds and ozone features (3) Product performance has been demonstrated through the analysis of about nine non-global data sets. (4) A preliminary comparison of NOAA-21 OMPS NM at 380 nm has been conducted with VIIRS M1 band for geolocation error assessment . (5) Two issues related to the instrument and SDR data quality have been identified (six calibration tables are to be updated soon).
Information/data from validation efforts can only be used to make initial qualitative or very limited quantitative assessments regarding product fitness-for-purpose	Yes (The NOAA-21 OMPS NM/NP SDR data are being tested in the OMPS EDR retrievals, showing a fine comparison with the SNPP/NOAA-20 products.)
Documentation of product performance and identified product performance anomalies, including recommended remediation strategies, exists	Yes

Conclusion

- Cal/Val results summary:
  - NOAA-21 OMPS NM and NP instrument performs stably, and the SDR data show a reasonable quality
    - NM (305 ~ 380nm) and NP SDR data meet the SNR requirements
    - NM SDR data meets geolocation requirement (geolocation error less than 0.5 pixel size)
    - OMPS NM and NP SDR data show a reasonable global distribution. Particularly, NM demonstrates a strong capability in visually capturing cyclone fine structure including storm eye due to its high resolution
    - Ozone products from NOAA-21 OMPS SDR data show a reasonable feature
  - Team recommends algorithm Beta maturity
    - Address pre-launch concerns/waivers: yes.
    - Caveats: six LUTs are to be delivered
      - #1: There is about -0.14nm ground-to-orbit wavelength shift for NOAA-21 OMPS NM and -0.09nm for NOAA-21 NP (4 LUTs are to be updated)
      - #2: There is a 3-pixel-wavelength-offset error in the NOAA-21 OMPS NM (2 LUTs are to be updated)

      (A new DR is to be opened to solve #1 and #2)
      - #3: There is an albedo calibration discrepancy between the NOAA-21 OMPS NM and NP in the wavelength range from 300 to 310nm (one calibration table about NM radiance calibration coefficient is to be updated) (DR#9960)
      - #4: The solar flux calibration coefficients in the three extra wavelengths are missed (solar calibration table is to be updated) (DR#9959)

Lessons and Planned Improvements

- Lessons learned for NOAA-21 Cal/Val
  - Update OMPS NM and NP dark LUT ASAP to ensure a reasonable feature in observed earth view radiance
  - Prepare offline ADL OMPS SDR processing with different sample table and resolutions to reprocess SDR data in support of new calibrations
  - Establish the solar irradiance radiometric calibration algorithm to speed up the OMPS SDR calibration/validation analyses
- Planned recent improvements (prior to the Provisional Review)
  - #1: Complete two approved DRs (9959 and 9960) along with a new DR (see #2)
  - #2: Open a new DR: simultaneously test and deliver 6 LUTs (OSOL solar, wavelength and radiance calibration coefficient tables for each of OMPS NM and NP)

Plan Future Cal/Val Activities towards Provisional Review

- Planned Detailed Cal/Val Activities towards Provisional review
  - Simultaneously test and deliver 6 LUTs (OSOL solar, wavelength and radiance calibration coefficient tables for each of OMPS NM and NP) (DR. # 9959, 9960 and a new DR)
  - Deliver the 1st wavelength and OSOL calibration tables (a new DR is needed?)
  - Investigate potential solar intrusion for NOAA-21 OMPS NP and develop a correction algorithm based on the existing NOAA-20 algorithm
  - Further improve the NOAA-21 OMPS NM and NP wavelength registration accuracy towards requirement
  - Continue evaluating the geolocation accuracy of NOAA-21 OMPS NM/NP data
  - Evaluate the performance of the current stray light correction table and improve it as needed.
  - Continue assessing the NOAA-21 instrument and data performance
  - Conduct the inter-sensor comparison of NOAA-21 OMPS NM with Tropomi and GEMS
  - Understand the solar calibration algorithm
  - Validate the NOAA-21 OMPS NM/NP SDR data quality using RTM such as TomRad, CRTM and Line-by-line RTM
- Future Cal/Val activities / milestones
  - Provisional review: April 2023

- backup

Potential Benefits of 3 JPSS Satellites

- Potential values and benefits to keep three JPSS satellites in conducting the following studies:
  - Conduct impact analysis of OMPS nadir instrument spectral (e.g., BPS) characterization differences on radiometric calibration accuracy (a sensitivity analysis is given in the figure)
  - Improve/develop the UV radiometric calibration methodology with different spatial resolutions
  - Identify uncertainty sources due to differences in instrument spectral features, resolution
  - Establish long-term climate OMPS NM and NP SDR data sets

OMPS SDR Tables/LUTs for Calibration Activities[1,2,3]

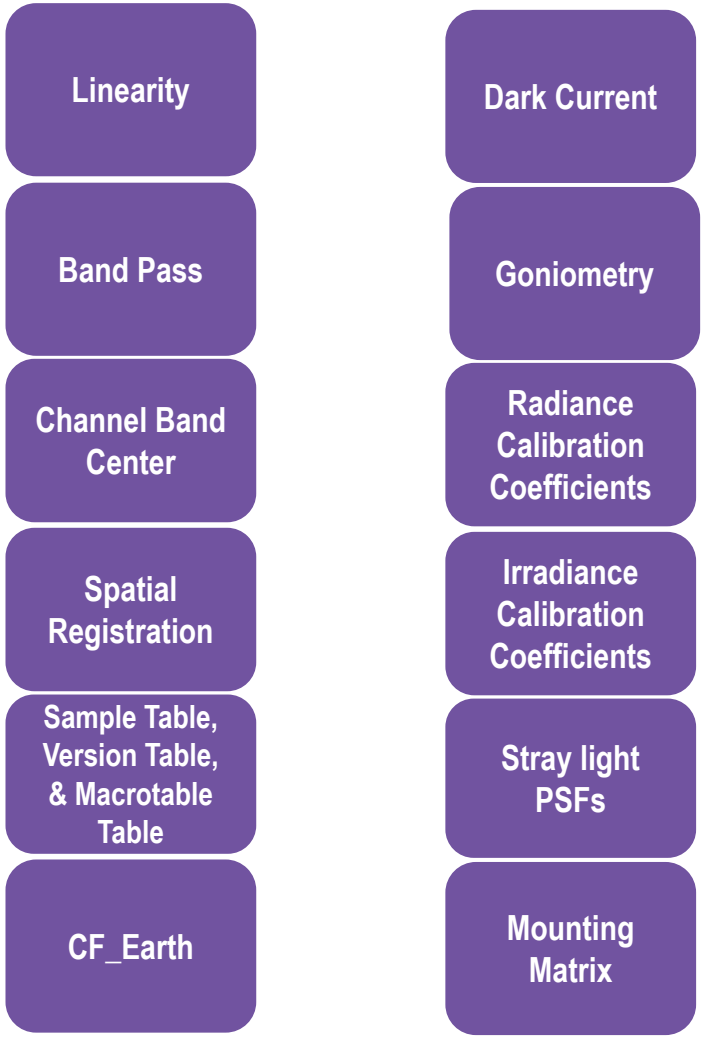
SDR Tables/LUTs for NM	SDR Tables/LUTs for NP
OMPS-TC-EV-SAMPLE-GND-PI	OMPS-NP-EV-SAMPLE-GND-PI
OMPS-TC-MACROTABLE-GND-PI	OMPS-NP-MACROTABLE-GND-PI
OMPS-TC-DARKS-GND-PI	OMPS-NP-DARKS-GND-PI
OMPS-TC-SAA-DARKS-GND-PI	OMPS-NP-SAA-DARKS-GND-PI
OMPS-TC-LINEARITY	OMPS-NP-LINEARITY
OMPS-TC-BRDFGRIDS	OMPS-NP-BRDFGRIDS
OMPS-TC-CF-EARTH-GND-PI	OMPS-NP-CF-EARTH-GND-PI
OMPS-TC-SIRR-LUT	OMPS-NP-SIRR-LUT
OMPS-TC-FAM-LUT	OMPS-NP-FAM-LUT
OMPS-TC-STRAYLIGHT-LUT	OMPS-NP-STRAYLIGHT-LUT
OMPS-OMPS-TC-WAVELENGTH	OMPS-OMPS-NP-WAVELENGTH
OMPS-TC-TIMING-PATTERN-GND-PI	OMPS-NP-TIMING-PATTERN-GND-PI
OMPS-TC-CALCONST-LUT	OMPS-NP-CALCONST-LUT
OMPS-TC-OSOL-LUT	OMPS-NP-OSOL-LUT

OMPS-VERSIONID-GND-PI for both NM and NP

1. Gain table uploaded to flight software is not listed;
2. Tables marked in blue should be updated upon calibration after the launch;
3. Mounting Matrix is not included.

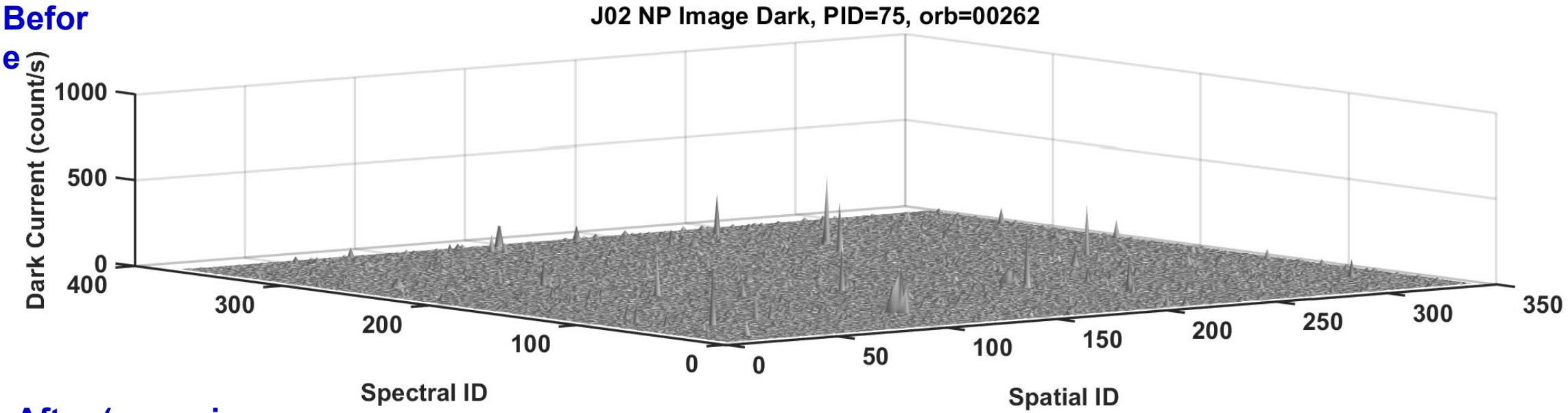
Example: OMPS NM SDR Algorithm Calibration Table (LookUp Table or LUT) Development

- **14** NOAA-21 NM/NP SDR algorithm LUTs (7 LUTs are related to spatial resolution)
  - Measurements from NASA : Version table, Sample Table, Macrotable, and Timing Pattern
  - Spectrometric LUTs: Spectral Response, Spectral Registration, Wavelengths
  - Radiometric LUTS: Calibration Coefficients, CF-Earth, Darks, Linearity, Stray Light, Solar Irradiance
  - Geolocation LUT: Mounting Matrix and Field Angle Map
  - Version table maps for OMPS NM measurement tables to SDR algorithm
- NOAA-21 OMPS NM algorithm lookup tables

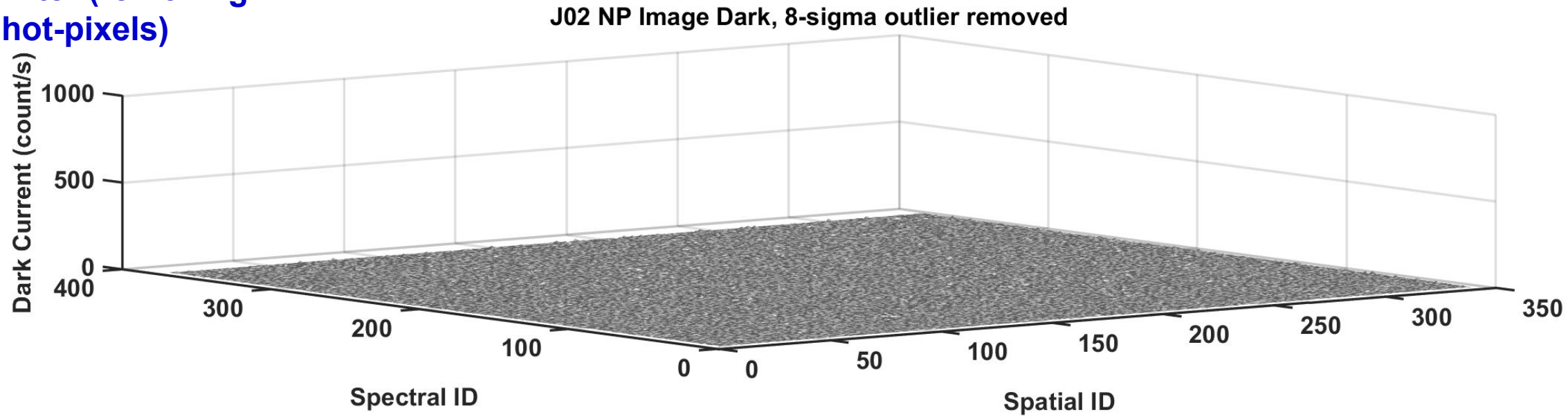


J02 OMPS NP Dark Calibration Analysis Example

Before

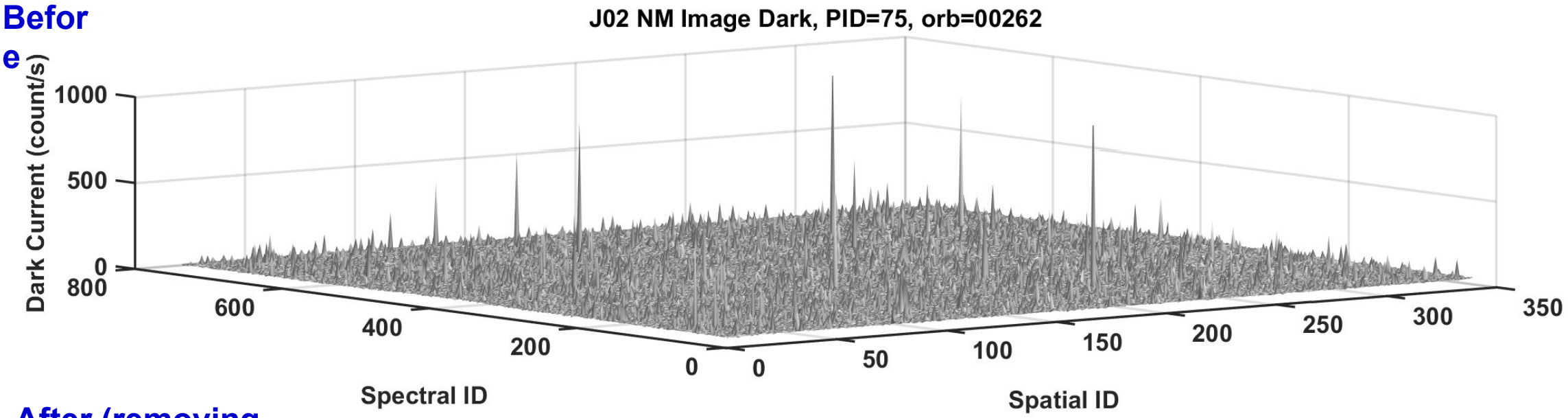


After (removing hot-pixels)

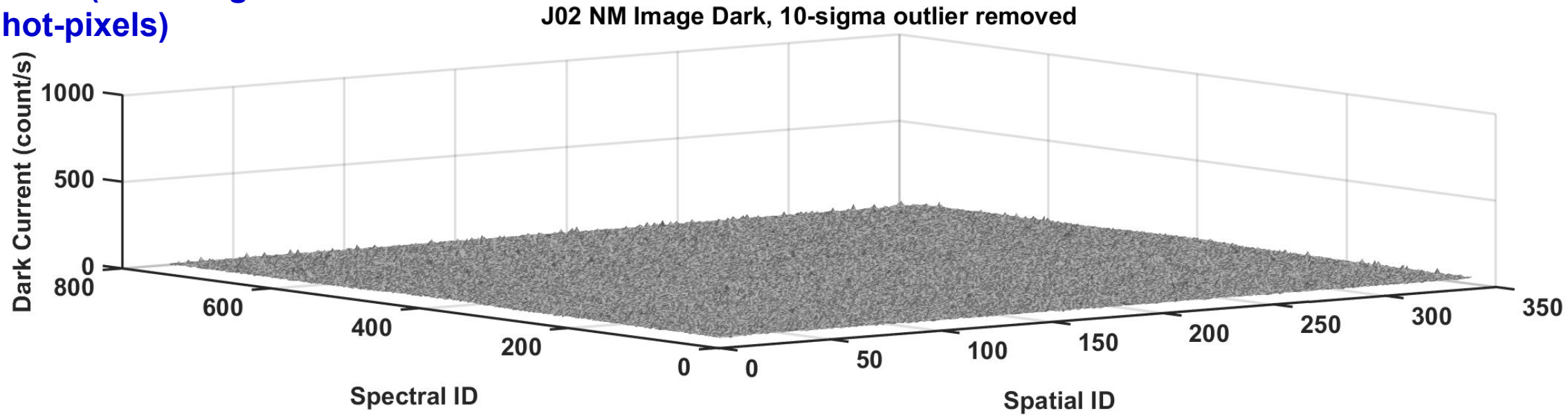


J02 OMPS NM Dark Calibration Analysis Example

Before



After (removing hot-pixels)



NOAA-21 OMPS NM Door Closed Dark Preliminary Analysis (PID.=