PROVISIONAL MATURITY REVIEW MATERIAL

Provisional Maturity Science Review For NOAA-20 OMPS SDR Algorithm

OMPS SDR Team

Feb. 20, 2018

Outline

- Algorithm Cal/Val Team Members
- Summary of pre-launch waivers mitigations and evaluation
- Evaluation of algorithm performance to specification requirements
  - OMPS Instrument performance in relation to SDR quality
  - OMPS SDR performance and status
  - Evaluation of the effect of required algorithm inputs
  - Quality flag analysis/validation
  - Error Budget
- User Feedback
- Documentations
- Summary and Conclusion
- Path Forward

NOAA-20 OMPS SDR Algorithm Cal/Val Team

PI Name	Organization	Primary Roles
Trevor Beck	NOAA/STAR	Budget and coordination; SDR algorithm implementation and operation
Chunhui Pan	NOAA/CICS-MD	OMPS SDR calibration and validation, TVAC data analysis. LUTs creation, and SDR data quality assessment
Glen Jaross	NASA/SIPS	TVAC data acquisition and analysis; PLT instrument calibration and validation
Bigyani Das	NOAA/ASSISTT	Designs and develops algorithm and LUTs processing suites/systems
Laura Dunlap	NOAA/AMP	Algorithm changes coordination; DR and issues tracking
Sara Lipsy	BATC	Instrument sciences; prelaunch test
Derek Stuhmer/ Daniel Cumpton	Raytheon	IDPS algorithm and operations

NP Waiver 21742-W-215

- Waiver 21742-W-215 Nadir Profiler Short Wavelength Throughput Loss 472-CCR-17-1378 (J1 Only)
- Waiver against O_PRD-11308 for Nadir Profiler to allow albedo accuracy to be increased from 0.5% to 3% for wavelengths between 250 and 260 nm.***472-CCR-17-1378***

Findings/Issues since Beta Review

DR#	CCR#	Date Opened	DR Title	CCR Status
8508	**18-3770**	10/25/17	Update NP Observed Solar Flux LUT and Wavelength Ground-PI	Approved & Delivered to RTN
8576	**18-3760**	01/16/18	Correction of TC Field Angle Map LUT	Approved & Delivered to RTN
8577	**18-3761**	01/16/18	Correction of NP Field Angle Map LUT	Approved & Delivered to RTN
8594	**18-3821**	02/06/18	Correction of sample/macro tables and the related LUTs (8 LUTs/Tables) for TC Provisional Maturity	Package is with RTN
8615	**18-3829**	02/12/18	Coding error of xtrack binning in NP SDR algorithm	Package was sent to DPES on Feb. 16
8616		02/12/18	16 scans per granule in some OMPS TC RDRs	
8617		02/12/18	OMPS NM/NP Mismatch for FOVs	

Delivered for provisional milestone

Non critical but to be fixed for validated milestone

NOAA-20 OMPS Instrument Status

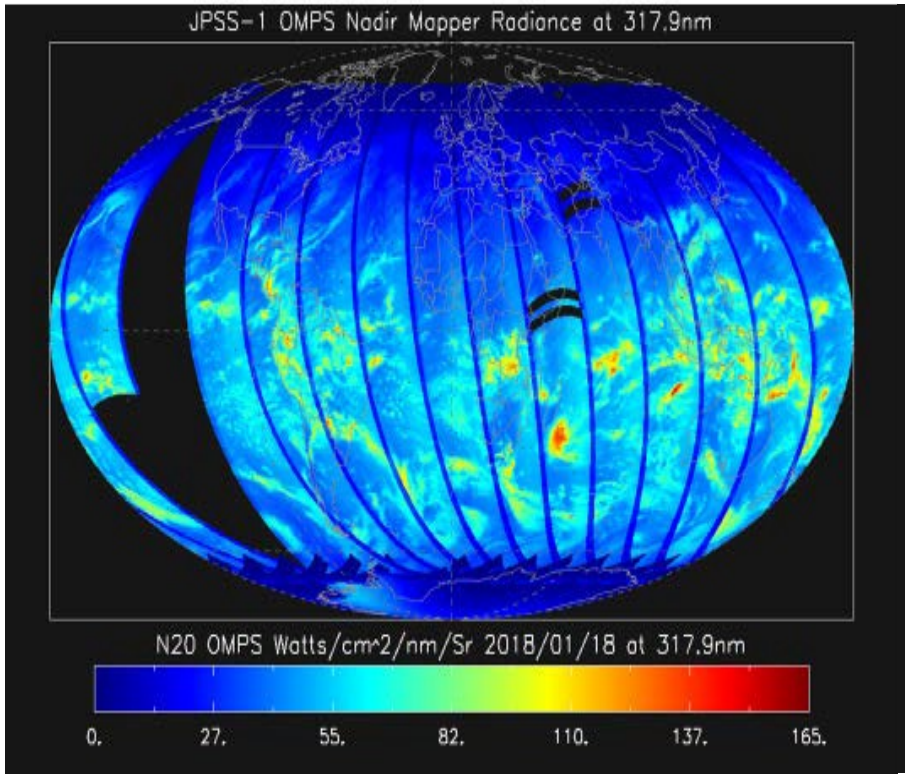
- ✓ The NOAA-20 OMPS on-orbit performances are doing well.
- ✓ Most of the OMPS KPP performance parameters meet our expectation.
- ✓ Sensor telemetry data show stable trends during nominal operation.
- ✓ Pre-launch found degradation in NP short wavelengths, but on-orbit data analysis shows no evidence of any degradations in either NP and NM.
- ✓ Changes of wavelength registration from ground to orbit in both Nadir Profiler and Nadir Mapper are expected.
- ✓ Dichroic spectral shifts in both Nadir Profiler and Nadir Mapper are expected.
- ✓ New foreign object debris (FOD) shows no impact on solar calibration and Earth view measurements.

NOAA-20 OMPS SDR Status

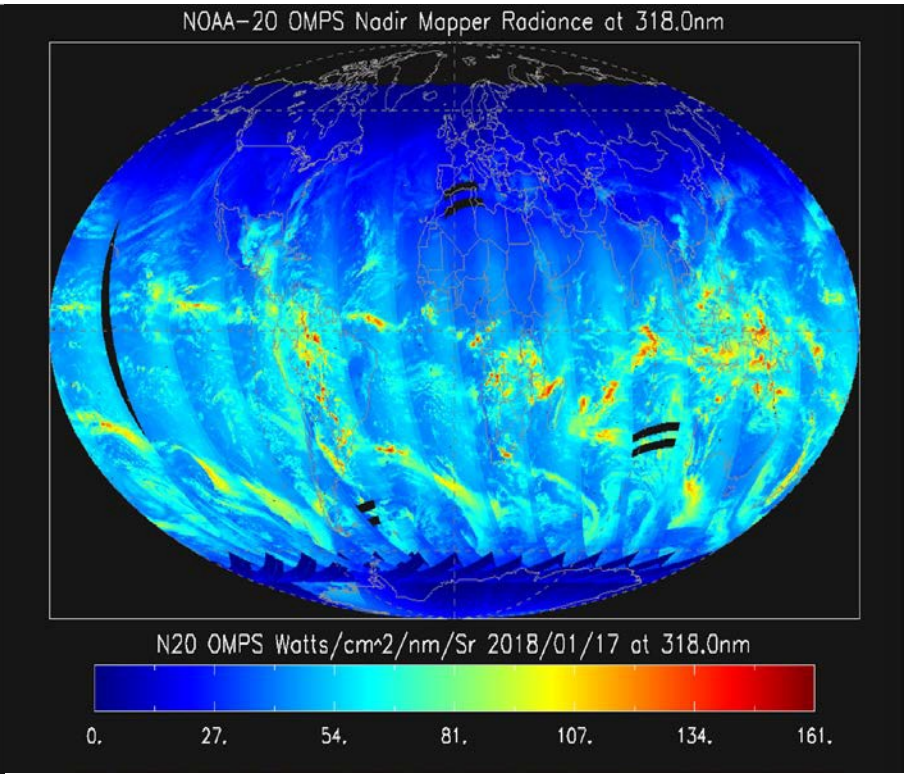
- ✓ Nadir Mapper (NM) provides 50 km cross-track x 17 km along track spatial resolution data. The in-house ADL produces the NM SDRs, from which, the EDRs are successfully retrieved.
- ✓ Nadir Profiler (NP) provides 50 km x 50 km spatial resolution data. Offline ADL produces the NP SDRs, from which, the EDRs are successfully retrieved.
- ✓ Provisional calibrations are applied to offline ADL to generate NM SDRs and NP SDRs. Both sensors' SDRs show good results for this stage of maturity.
  - ✓ All of the LUTs identified from the Beta SDR data assessment have been delivered to DPES.
  - ✓ Weekly dark calibration is applied to both NP and NM SDRs.
  - ✓ Critical code errors in NP SDR algorithm are fixed. The package has been delivered to DPES.
- ✓ Other non-critical issues and anomalies are identified and to be fixed prior to the validated maturity milestone.
  - Refine stray light calibration on short wavelengths for both NP and NM
  - Refine wavelength calibration to account for dichroic shifts

Updated NM Sample/Macro Tables

Before



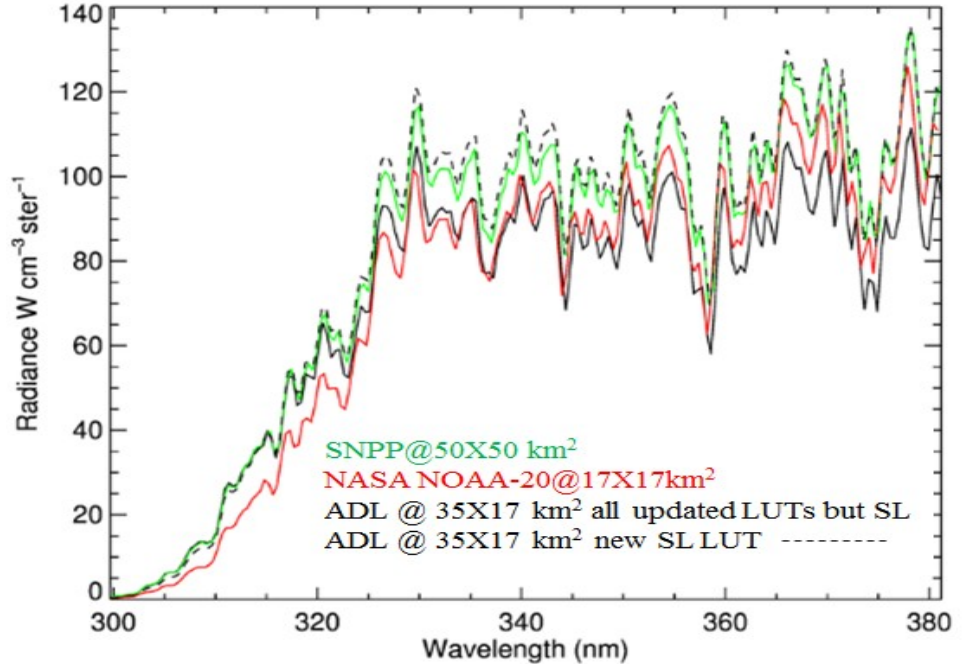
After

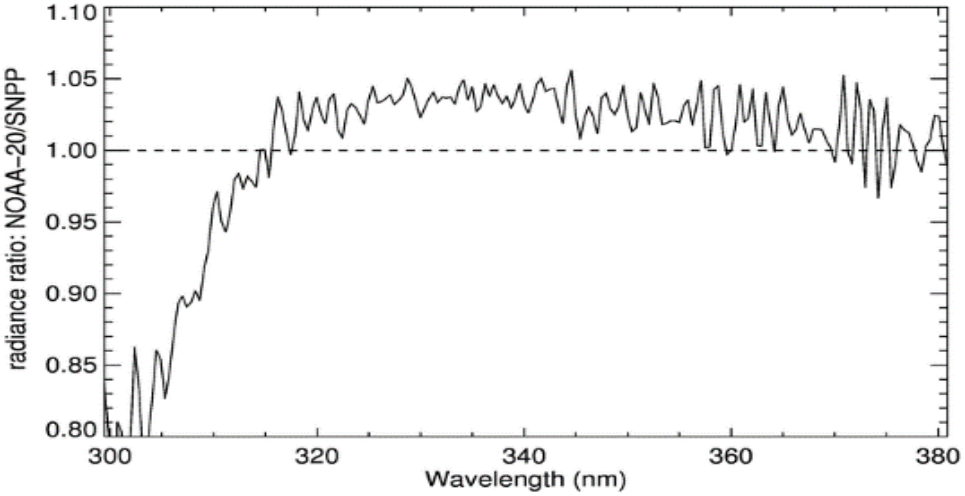


Before: Striping at cross-track position #1 and #35 was caused by inefficient pixels in the NM sample tables (includes macro table).
After: Updated sample table and macro table eliminated the striping.

Improved NM Earth View Radiance

- Data source: 15 orbits SDRs measured on 01/17/2018.
- SDRs with new stray light correction are generated via ADL on Feb. 13.
- Earth radiances are globe averaged. We expect consistent overall radiance level from different data resolution and different view condition
- After new stray light correction, differences between SNPP and NOAA-20 ~ 4% on wavelengths ≥ 310 nm.
- Radiance at wavelengths < 310 nm is to be improved by a further stray light correction and a dichroic spectral shift.





Credit: CICS-MD

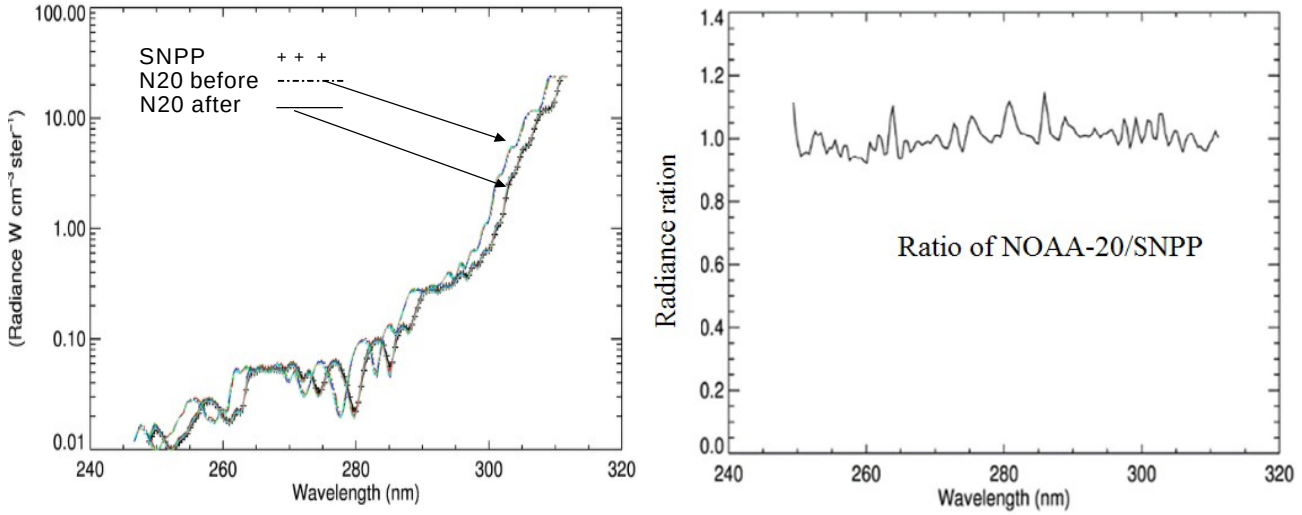
Data source: In-house ADL run on Feb 13, 2018

Improved NP Earth View Radiance

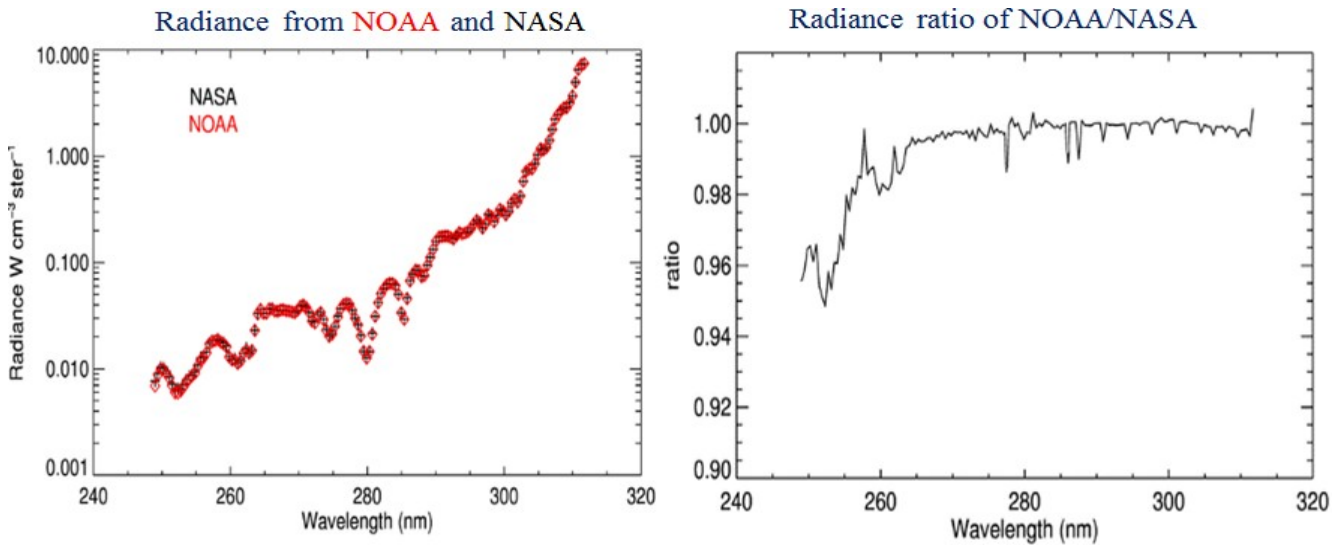
- Globe radiance comparison between NOAA-20 data and SNPP data shows < 6% difference on most of wavelength channels, indicates an overall consistent radiance level.

- Radiance comparison between NOAA data and NASA data at the same geo-location longitude and latitude indicates a possible stray light overcorrection in NOAA data.

NOAA-20 50x50 km^2 vs. SNPP 250x250 km^2



NOAA-20 IDPS 50x50 km^2 vs. SIPS 50x50 km^2

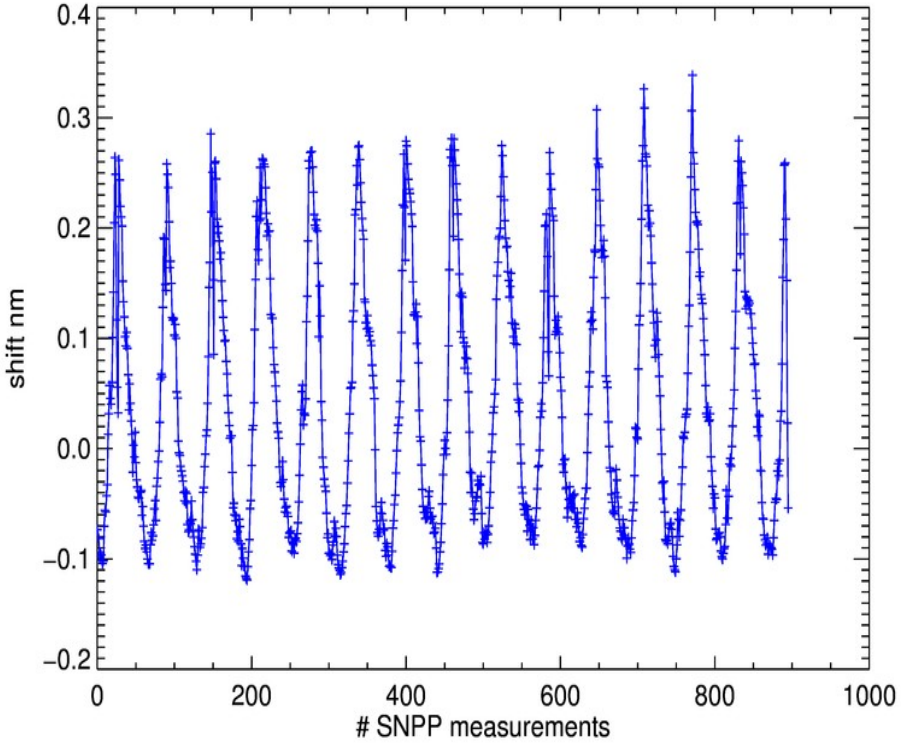


Credit: CICS-MD

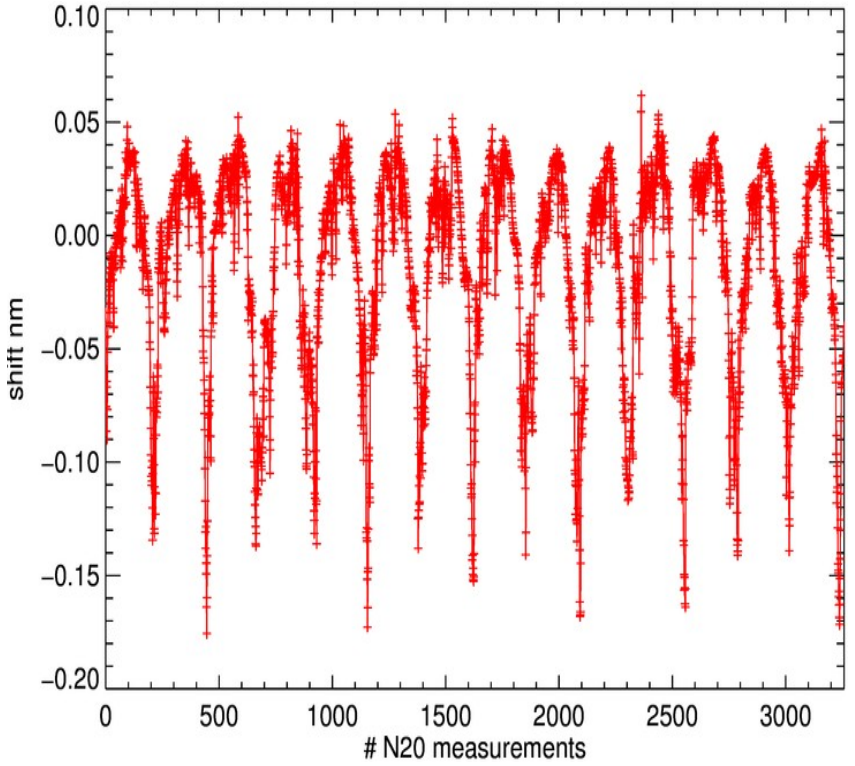
Data source: In-house ADL run on Feb 12, 2018

NP Intra-orbit Wavelength Variation Exceeds Requirement

SNPP



NOAA-20

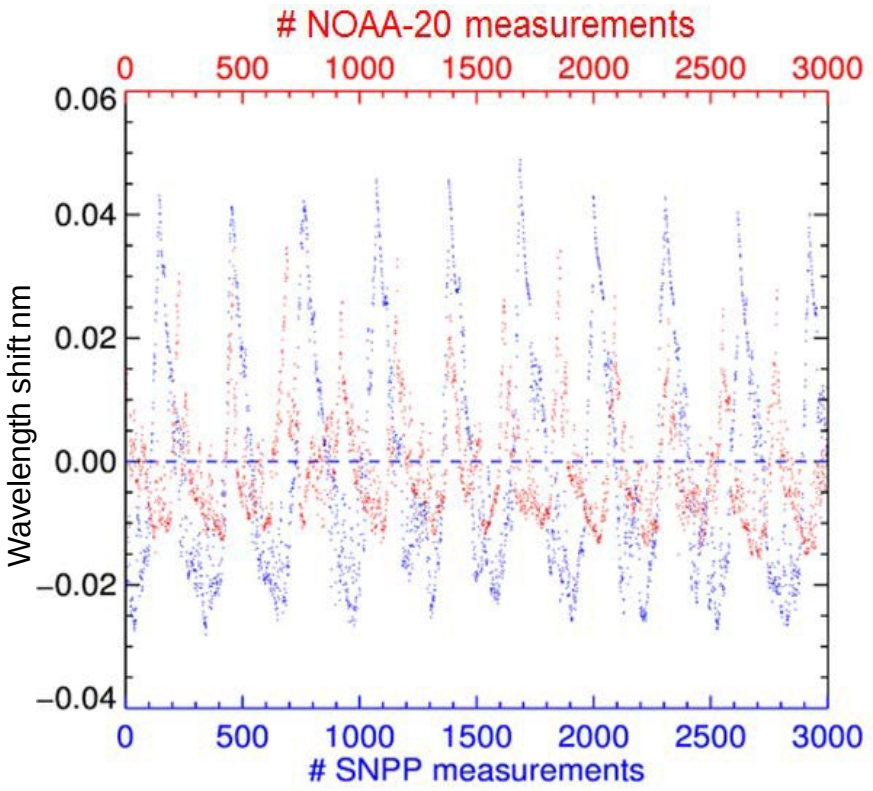


- Compared with SNPP, NOAA-20 NP shows much smaller intra-orbit variation.
- NOAA-20 NP SDR has intra-orbit variation ~ -0.015 – 0.05 nm, exceeds the requirement of ±0.02 nm.
- SNPP NP does not correct any intra-orbit wavelength variation.

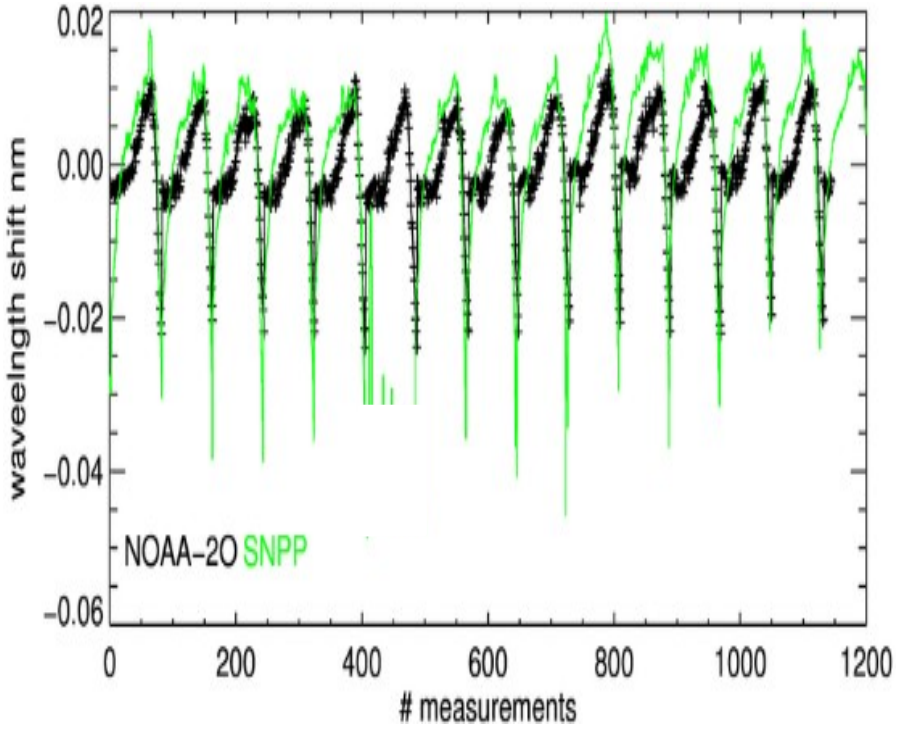
Credit: CICS-MD

NM Intra-orbital Wavelength Variation Meets Requirement

Intra-orbital wavelength variation for SNPP and NOAA-20



Corrected intra-orbital wavelength variation for SNPP and NOAA-20



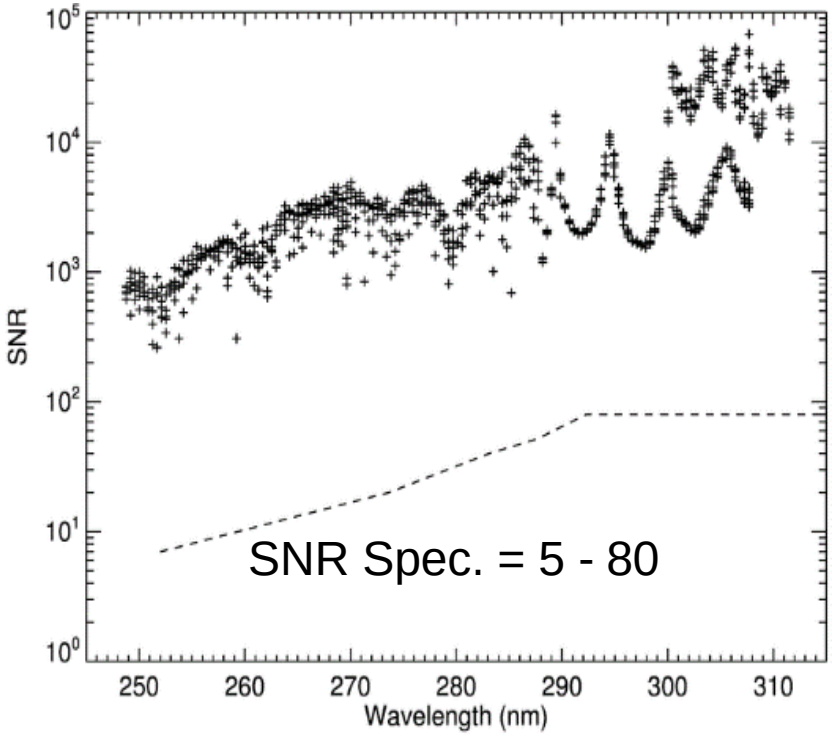
- NOAA-20 has intra-orbit variation -0.01 ~ 0.03 nm. SDR algorithm corrects -0.02 – 0.012 nm variation; overcorrected -0.01 nm. Calibration error is about -0.01 nm – 0.018 nm, meets ±0.02 nm requirement
- Compared to SNPP, NOAA-20 shows a better performance.

Credit: CICS-MD

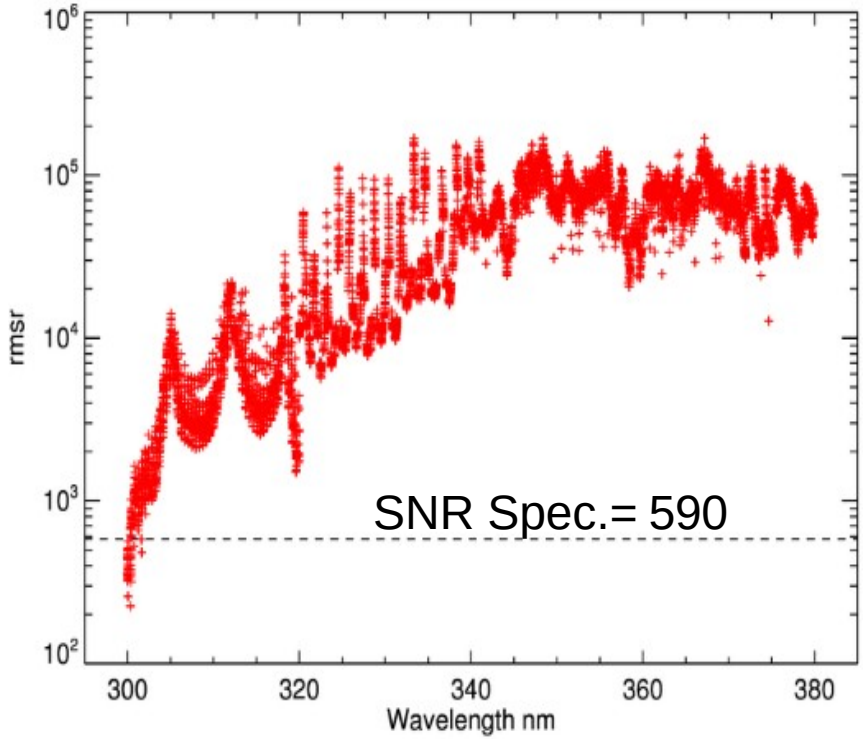
Right chart data source: In-house ADL run on Feb 13, 2018

Earth View SNR Meets Requirement

NP 50 km x 50 km



NM 50 km x 17 km

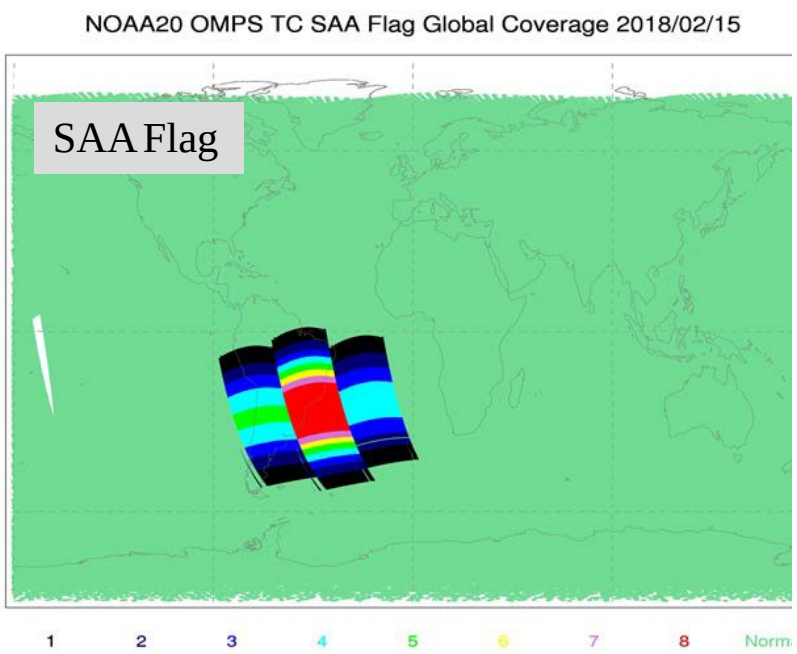


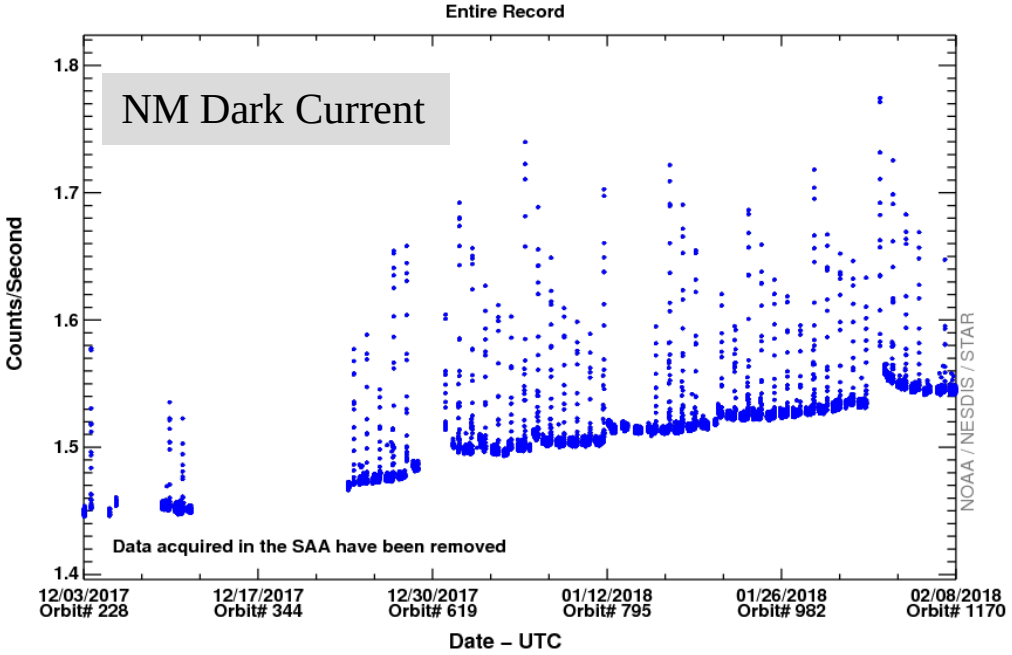
Dashed lines are the sensor specification. Exception is NM short individual wavelength where noise comes from stray light signal.

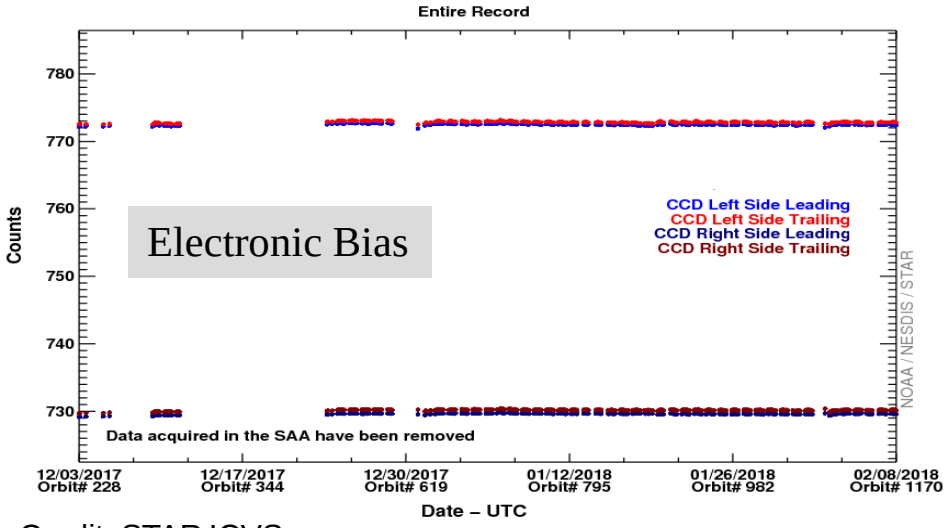
Credit: CICS-MD

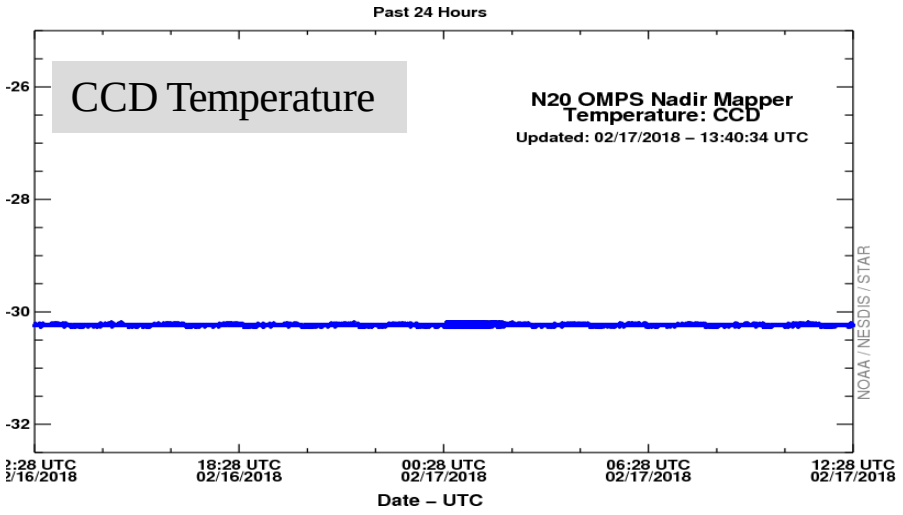
Right chart data source: In-house ADL run on Feb 11, 2018

NOAA-20 SDR KPP and Data Flag Monitoring



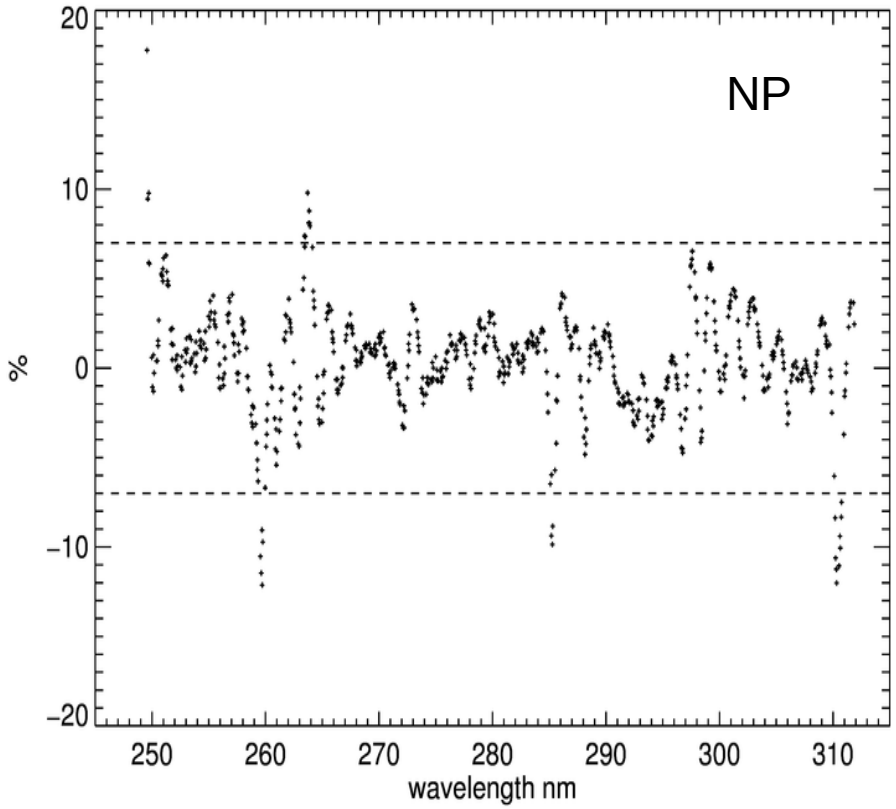


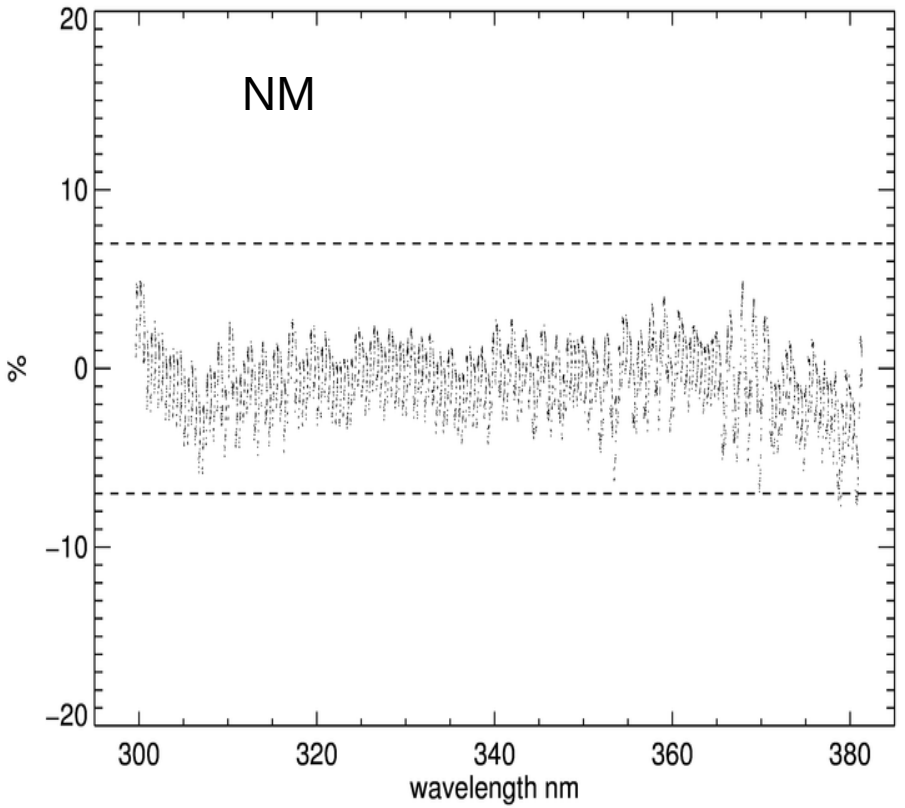




Credit: STAR ICVS

Absolute Irradiance Error Meets Requirement



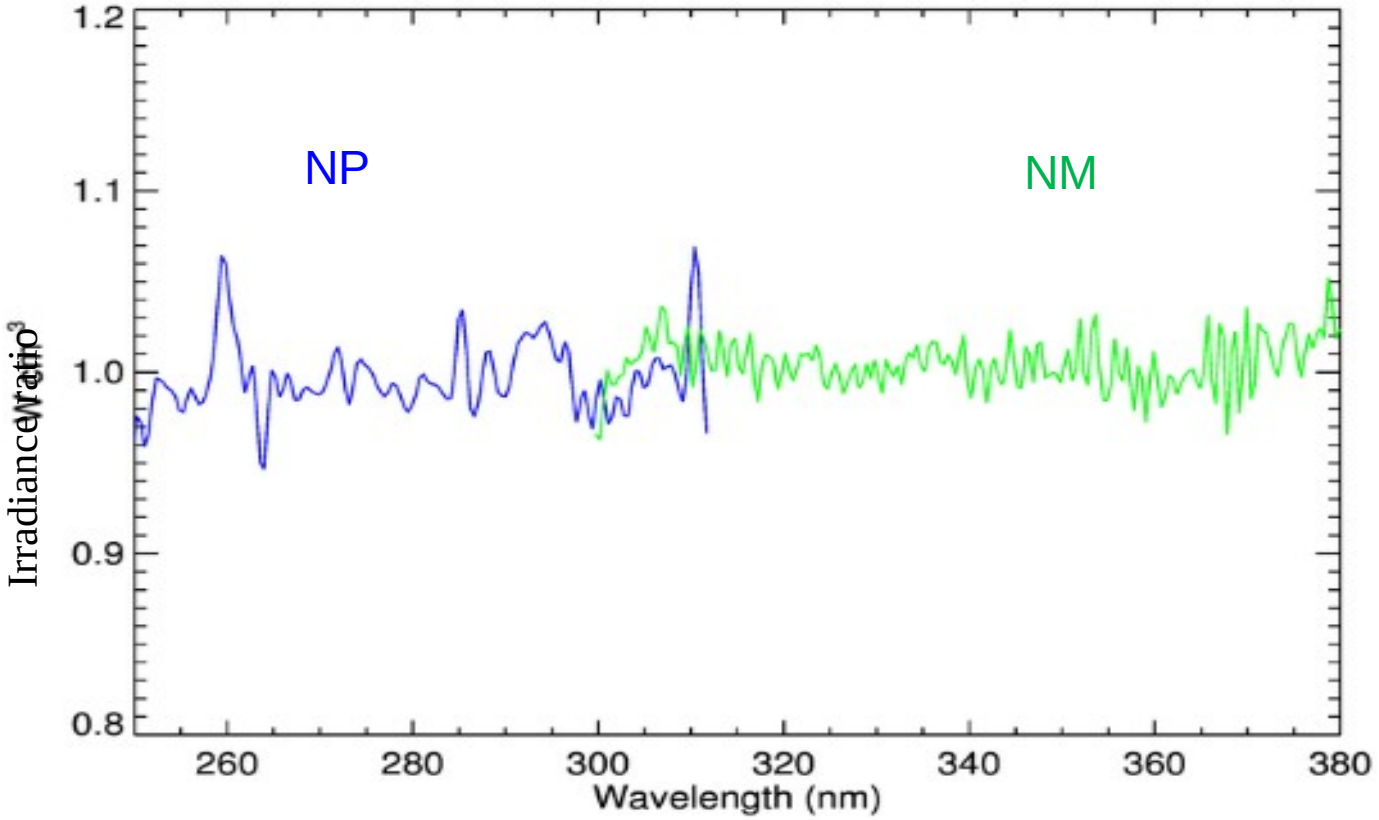


- ✓ NM irradiance error meets requirement of 7%
- ✓ NP irradiance error meets requirement of 7%, except for few individual channels.

Credit: CICS-MD

Spectral Shift in Sensor Dichroic Filter

Ratio of Measured Irradiance/Modeled Irradiance



Inconsistent normalized Irradiance between NP and NM indicates a small spectral shift < 0.02-0.03 nm in the sensor dichroic filter, which needs to be corrected

Rawflux data comes from NASA.
Analysis is done inside STAR SDR team

Credit: CICS-MD

Geo-location Validation

- Comparison of N20 OMPS w/r to S-NPP VIIRS RGB also indicates a small offset of < 5 km along track and < 3 km cross track (see within ellipses)
- OMPS reflectivity data from 15-55% overplayed on top of VIIRS image

Salar de Uyuni – 15 January 2018

Credit: NASA

NM SDR Performance Summary

Requirement: L1RDS-2293

Budget Term	Requirement/Allocation	Prelaunch Performance	On-Orbit Performance
Wavelength range	300-380, 420	300-380, 420	300-380, 420 nm
Bandwidth	<1.1 nm	<1.1 nm	< 1.1 nm
Samples/FWHM	>2.3 nm	>2.3 nm	>2.3 nm
Horizontal cell size	≤ 50 km @ nadir	≤ 50 km @ nadir	≤ 50 km @ nadir
Horizontal coverage	≥2800 km	≥2800 km	≥2800 km
SNR irradiance	1000	≥2698 irradiance	>2000
SNR radiance @50x17km^2	≥590	≥1924	> 590
Polarization sensitivity	<5%	≤2.2%	N/A
λ-registration	<0.01 nm	≤0.038 nm	>0.02 nm
λ-indpendent albedo calibration	<2%	≤1.4%	N/A
Pixel to pixel calibration	< 1.0%	≤ 0.7%	N/A
Albedo deviation error	< 1%	< 1%	N/A
OOB/OOF Stray Light	< 2% (305 – 380 nm)	< 0.5%	< 5%

NASA has demonstrated geo-location error < 5 km, meets requirement of 5 km

Credit: CICS-MD

NP SDR Performance Summary

Requirement: L1RDS-2541

Budget Term	Requirement/Allocation	Prelaunch Performance	On-Orbit Performance
Wavelength range	250-310	250-310	250-310
Bandwidth	<1.1 nm	<1.1 nm	< 1.1 nm
Samples/FWHM	>2.3 nm	>2.3 nm	>2.3 nm
Horizontal cell size	≤ 50 km @ nadir	≤ 50 km @ nadir	≤ 50 km @ nadir
Horizontal coverage	≥2800 km	≥2800 km	≥2800 km
SNR irradiance	1000	2240	>1400
SNR radiance@50x50km^2	35-400 (λ dependent)	≥914	> 200
Polarization sensitivity	<5%	≤2.8%	N/A
λ-registration	<0.01 nm	≤0.042 nm	> 0.02 nm
λ-indpendent albedo calibration	<2%	≤1.6%	N/A
Pixel to pixel calibration	< 0.5%	≤0.7%	N/A
Albedo deviation error	< 1%	< 1%	N/A
OOB/OOF Stray Light	< 2%	< 2.75%	< 5 %

Credit: CICS-MD

User Feedback from EDR Team

NOAA-20 OMPS Nadir Mapper

- Stray light – need to check overlap region 300 nm to 310 nm with NP
- 16-image granule error due to variable processing times
- Need 7-day averages to compute cross-track statistics

NOAA-20 OMPS Nadir Profiler

- New OMPS Nadir Mapper sample table needed to match FOV
- Dichroic effects on wavelength/bandpass not yet accounted for.
- SAA is large effect on 5x5 radiances – negative radiances found, some just outside of geographic flagged region.
- Some cases of negative radiances in the auroral oval
- Possible overcorrection for stray light (not shown)

Documentations

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)	ATBD, OAD, user data manual
Peer Reviewed Publications (Demonstrates algorithm is independently reviewed)	Yes. Annual meeting
Regular Validation Reports (at least. annually) (Demonstrates long-term performance of the algorithm)	Yes

Summary and Conclusion

- ✓ NOAA-20 NP SDR performance has been demonstrated the provisional data quality through in-house generated SDRs analyses. The SDR analyses are qualitatively and quantitatively sufficient for determination of product fitness.
- ✓ NOAA-20 NM SDR performance has been demonstrated the provisional data quality through in-house generated SDRs analyses. The SDR analyses are qualitatively and quantitatively sufficient for determination of product fitness.
- ✓ Documentation are available for the OMPS SDR performance, testing involving SDR fixes, identified SDR performance anomalies, including recommended remediation strategies.
- ✓ Both NP and NM SDRs are ready for potential operational use and in scientific publications after consulting product status documents.
- ✓ A way forwarded to validated SDR milestone is well planned and in progress.

Path Forward to Validated Maturity Milestone

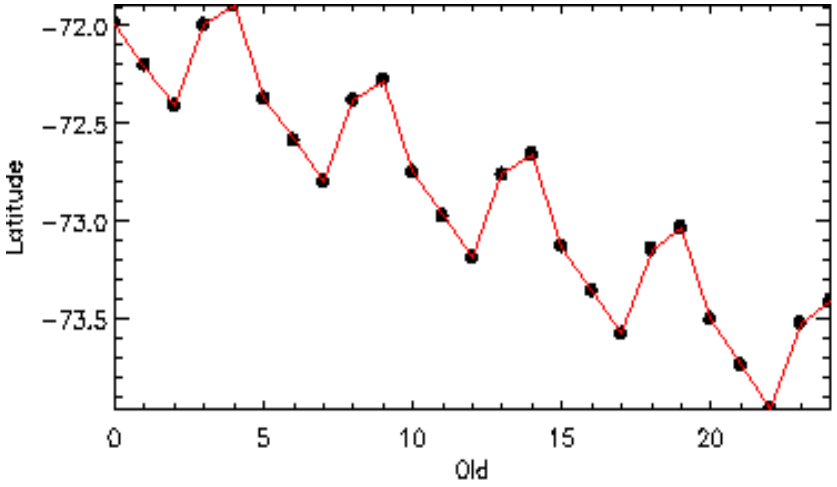
- Planned improvements
  - Refine stray light correction for both NM and NP on short wavelength channels
  - Refine wavelength calibration to account for the spectral shift in the dichroic filter for both NM and NP
  - Weekly calibrate dark current for both NP and NM sensors.
  - Update radiance and irradiance calibration coefficients
- Future Cal/Val activities / milestones
  - Stray light calibration and validation on short wavelengths for both NP and NM.
  - Routine calibration of dark for both NP and NM.
  - Routine calibration of NP solar & wavelength.
  - Albedo accuracy assessment via radiative transfer model.
  - Long term monitoring of sensor performance. Update LUTs as necessary.
  - New NM and NP sample tables are needed to FOV alignment, therefore, updates of related LUTs: wavelength, OSOL, stray light, version tables, macro-sample tables.

BACK UP

Correction of Macro-pixel Field Angle Map

Example from NP

Before



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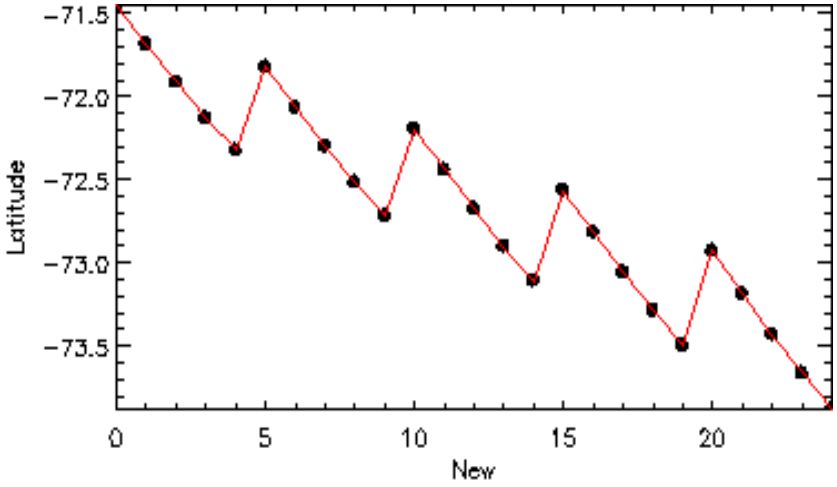
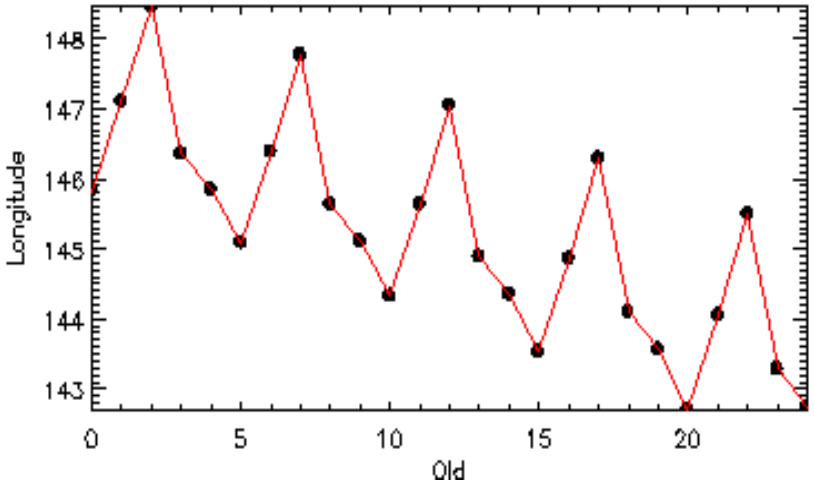
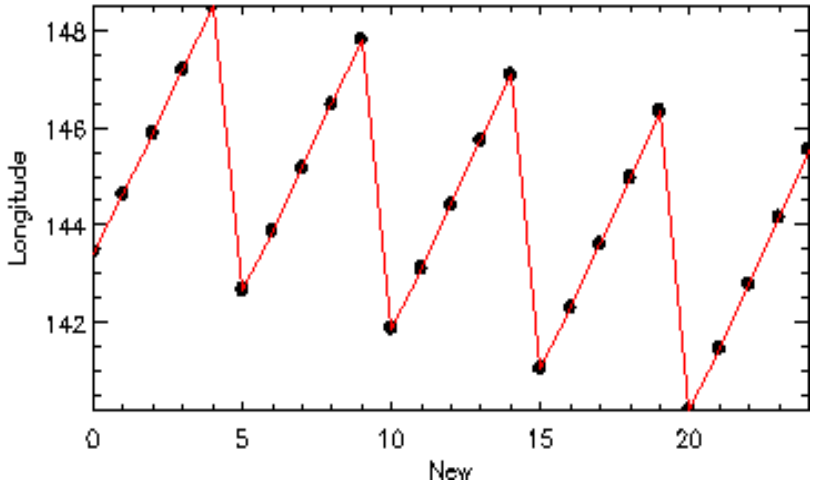
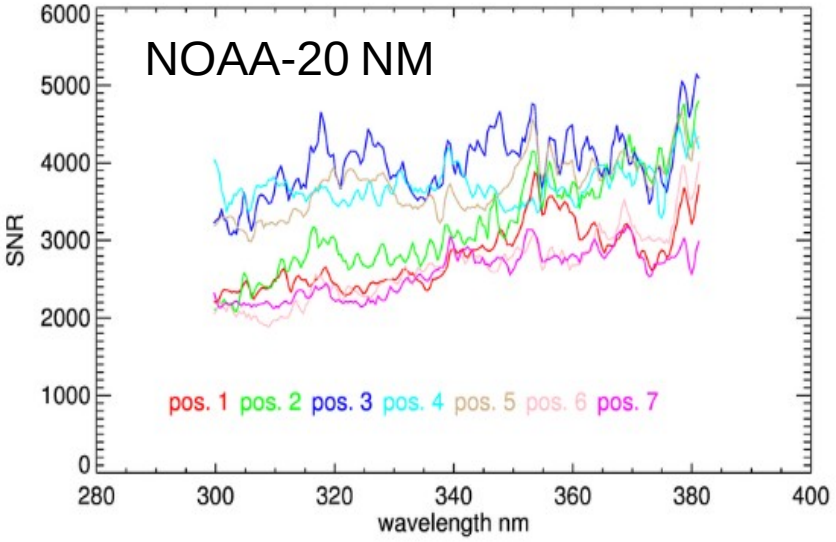


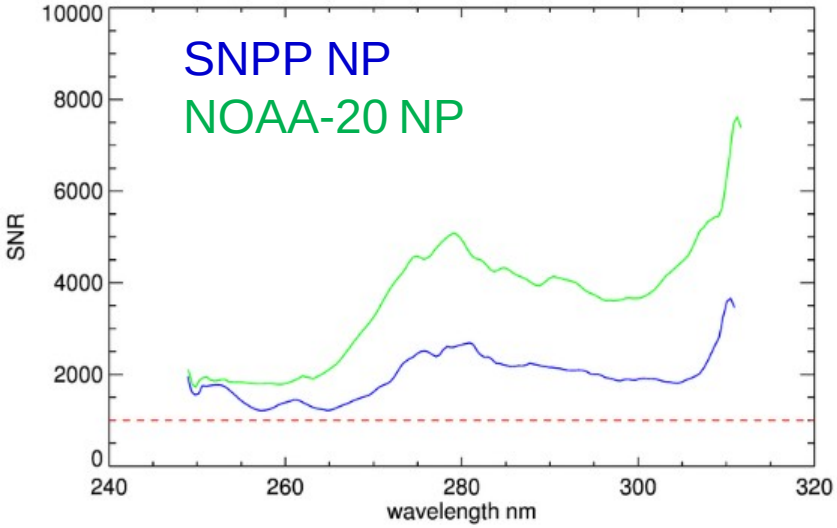




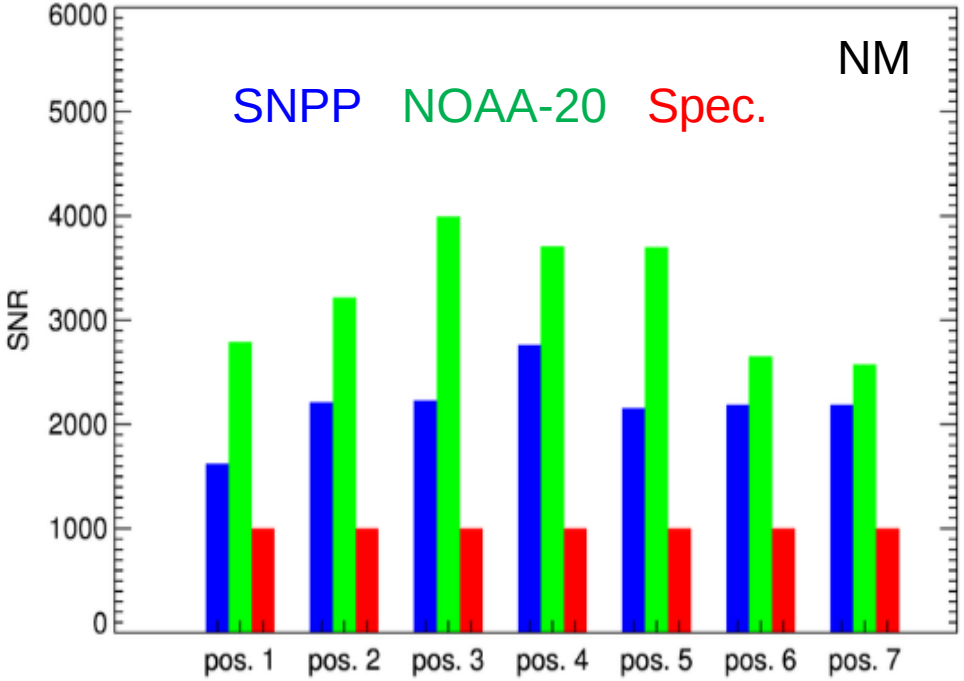
Corrected macro-pixel field angle mapping

Solar View Noise Meets Requirement





Both NOAA-20 and SNPP meet sensor spec. NOAA-20 shows a better SNR performance



Credit: CICS-MD