NOAA-21 Reflective Solar Bands (RSB) Calibration and Performance

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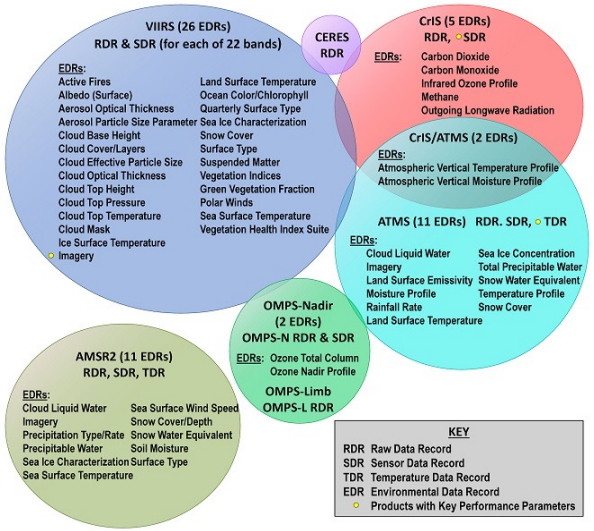
VIIRS Instrument

- **Visible Infrared Imaging Radiometer Suite (VIIRS)**
  - S-NPP: launched on Oct 28, 2011
  - JPSS-1: launched on Nov 18, 2017 (N-20)
  - JPSS-2: launched on Nov 10, 2022 (N-21)
  - JPSS-3: launch in 2033 (currently in observatory I&T)
  - JPSS-4: launch in 2027 (currently in sensor TVAC testing)
- **A broad range of applications and science products**
  - Multi-decadal environmental data records
  - New and unique applications from DNB



JPSS-2 launch on Nov 10, 2022

	Band	λc(nm)	Δλ(nm)	Spatial Resolution (m)
VisNIR	DNB	700	400	750
	M1	412	20	750
	M2	445	18	750
	M3	488	20	750
	M4	555	20	750
	M5	672	20	750
	I1	640	80	375
	M6	746	15	750
	M7	865	39	750
	I2	865	39	375
SMWIR	M8	1240	20	750
	M9	1378	15	750
	M10	1610	60	750
	I3	1610	60	375
	M11	2250	50	750
	I4	3740	380	375
	M12	3700	180	750
	M13	4050	155	750
LWIR	M14	8550	300	750
	M15	10763	1000	750
	I5	11450	1900	375
	M16	12013	950	750

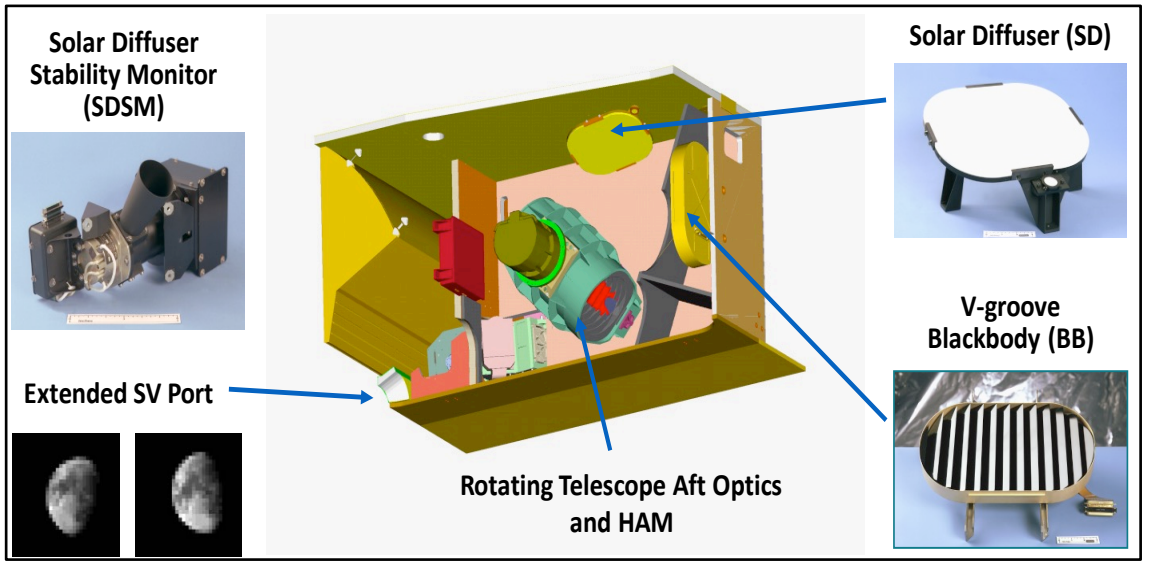
22 Bands: 14 RSB, 7 TEB, 1 DNB

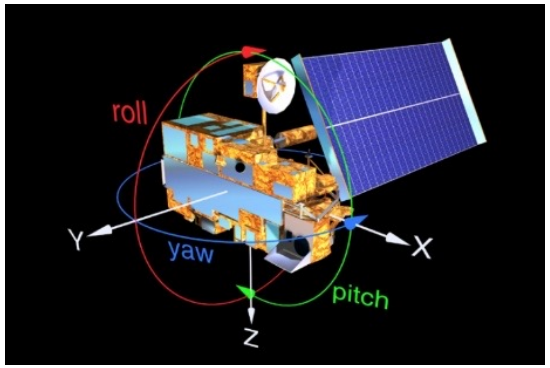
7 Dual Gain Bands: M1-M5, M7, M13

NOAA-21 VIIRS On-orbit Calibration Activities

Key events and calibration activities

- 11/10/22: JPSS-2 (N-21) spacecraft launch
- 11/20/22: VIIRS instrument turn on
- 12/05/22: nadir aperture door (NAD) open
- 12/16/22-02/02/23: KaTX-1 anomaly
- 02/08/23: cryoradiator cooler door open
- 02/20/23: first VROP (for DNB calibration)
- 02/23/23: mid-mission outgassing (MMOG)
- 03/02/23: first lunar collect via a roll maneuver
- 03/03/23: CFPA set point from 82 K to 80 K.
- 03/06/23: calibration yaw maneuvers
- 03/10/23: calibration pitch maneuver
- 03/10/23: first BB warm-up cool-down (WUCD)
- 08/11/23: KaTX-2 anomaly (all data recovered)





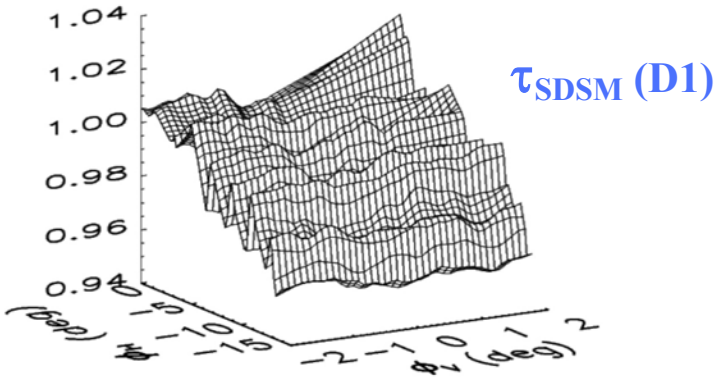
Calibration Maneuvers

- SD CAL: each orbit
- SDSM CAL: daily
- DNB VROP: monthly
- Lunar CAL: near-monthly
- BB WUCD: annually

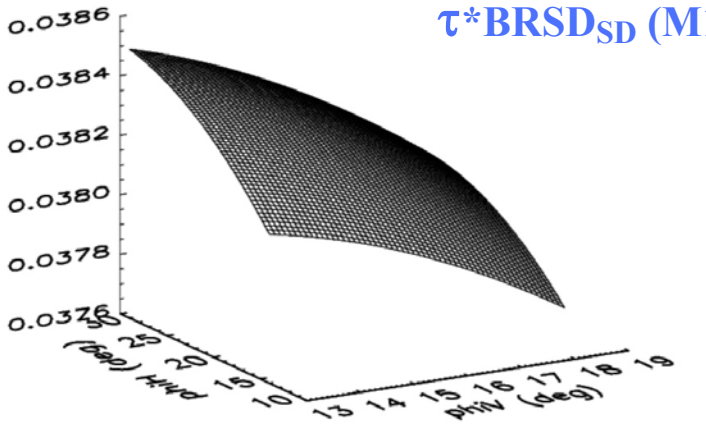
On-orbit Performance: Examples from Calibration Maneuvers

Yaw: SD and SDSM screen transmission characterization

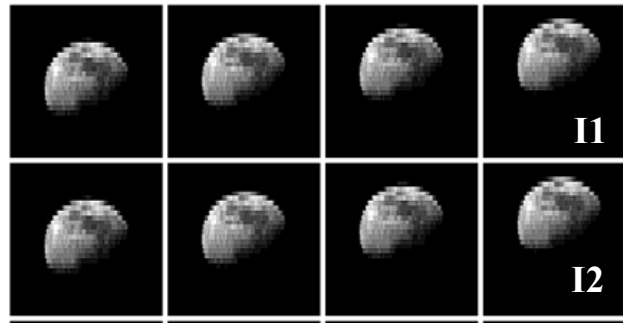
Roll: Lunar calibration

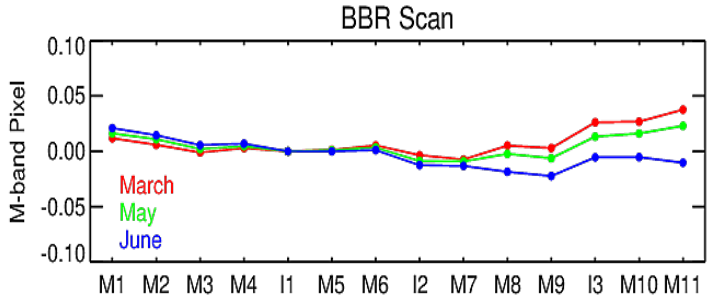


τ_{SDSM} (D1)



τ*$BRSD_{SD}$ (M1)





SDSM sun view screen transmission used for SD degradation monitoring

SD attenuation screen transmission and SD BRDF used for RSB calibration

$$H(\lambda,t) \propto [dc_{SD}/(\tau_{SAS}\cdot\cos(\theta_{SD}))]/[dc_{SUN}/\tau_{SUN}]$$

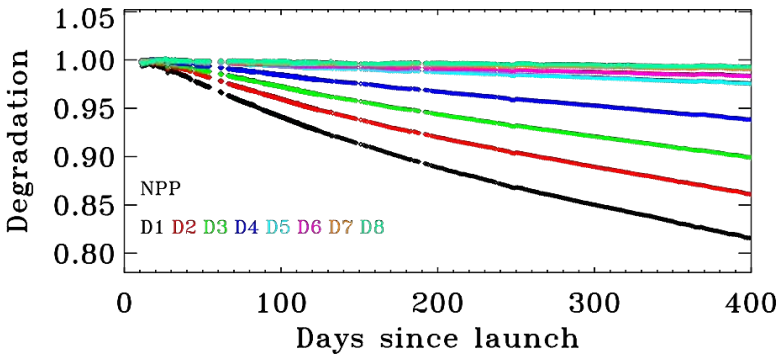
$$L_{SD} = [\tau_{SAS}\cdot\cos(\theta_{SD})/d^2]\cdot\int[RSR(\lambda)\cdot E_{SUN}(\lambda)\cdot BRDF(\lambda)\cdot d\lambda]/\int[RSR(\lambda)\cdot d\lambda]$$

Xiong et al., JGR, 2014

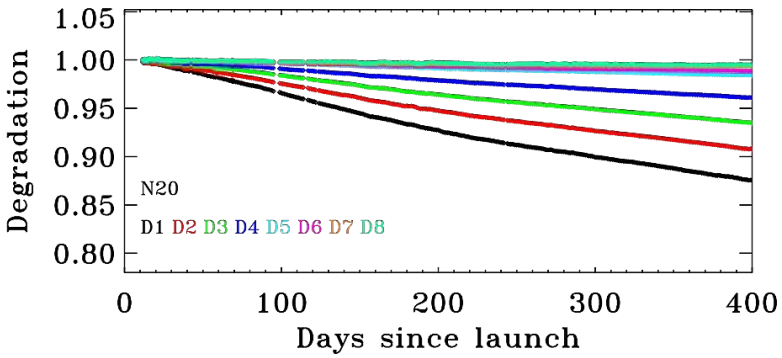
On-orbit Performance: SD Degradation

Similar wavelength dependent degradation: large degradation at short wavelengths

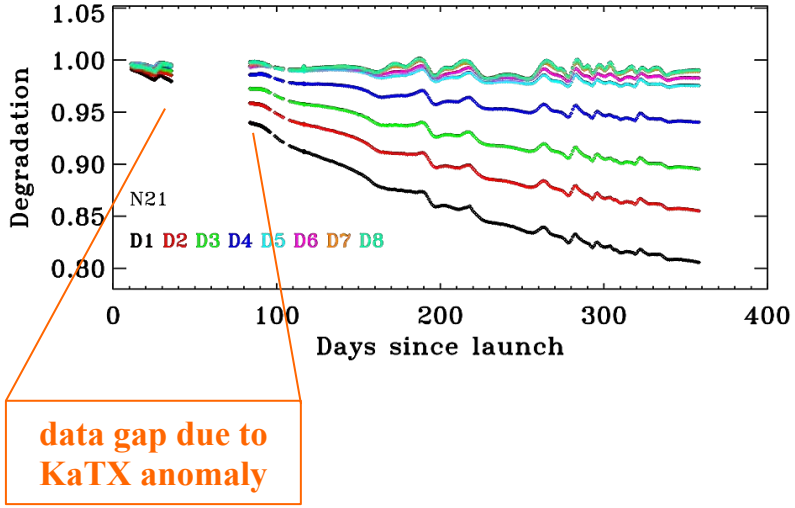
S-NPP



N-20



N-21



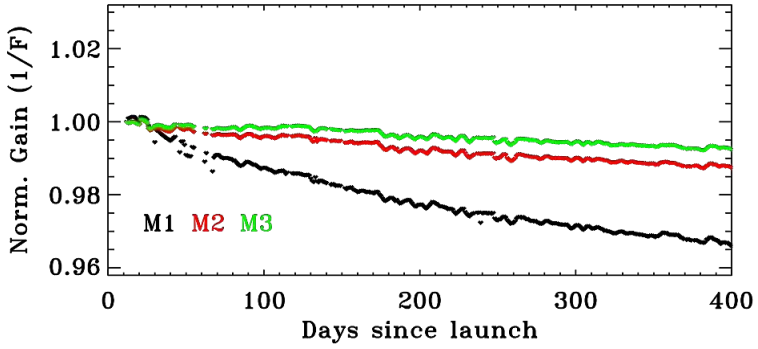
(D1 – D8 wavelength: 0.41 – 0.93 μm)

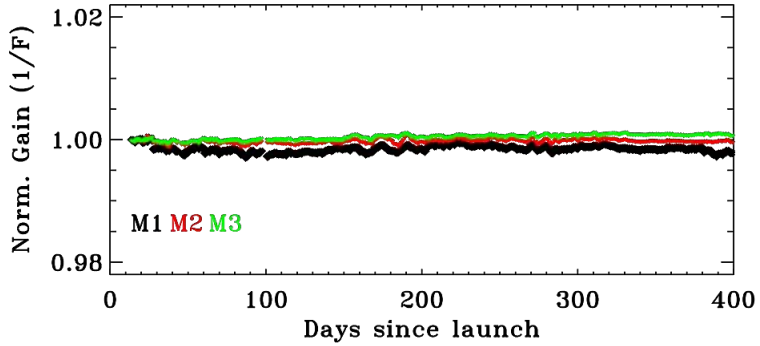
- Slightly larger SD degradation over the same period for N-21
- Noticeable features (common for all wavelengths) in N-21 can be reduced with an improved SDSM screen vignetting function (same process applied to S-NPP and N-20)

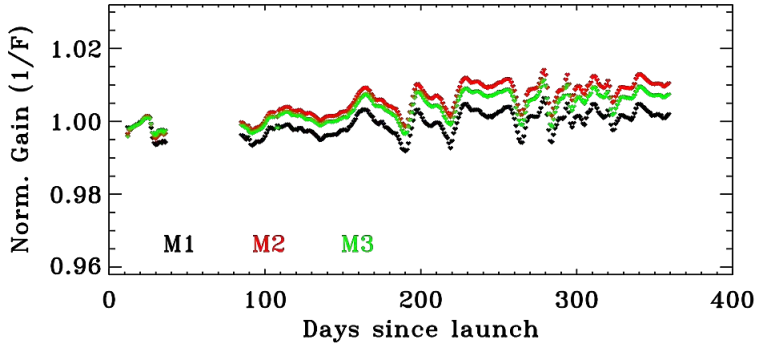
On-orbit Performance: Spectral Band Responses (VIS/NIR)

S-NPP **N-20** **N-21**

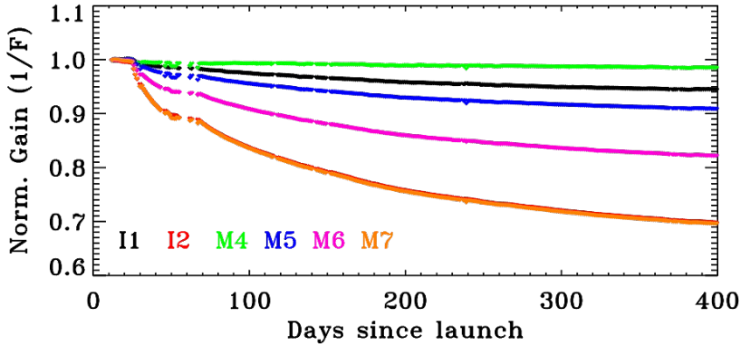
0.41 – 0.48 μm

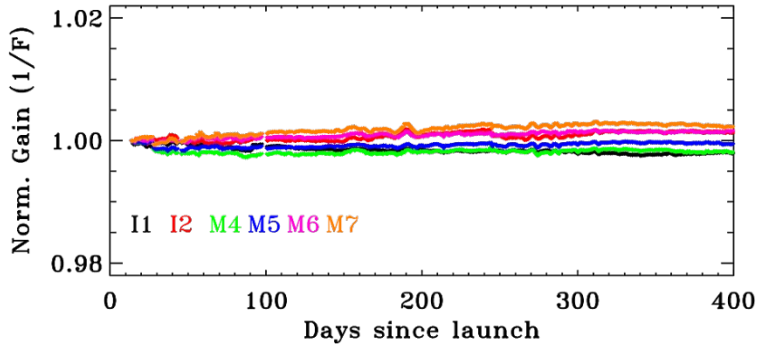


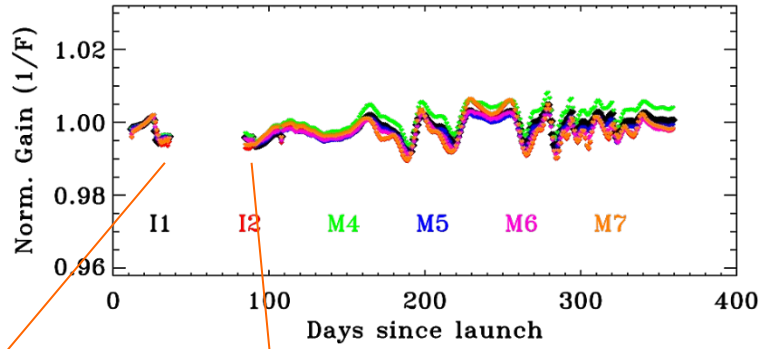




0.55 – 0.86 μm







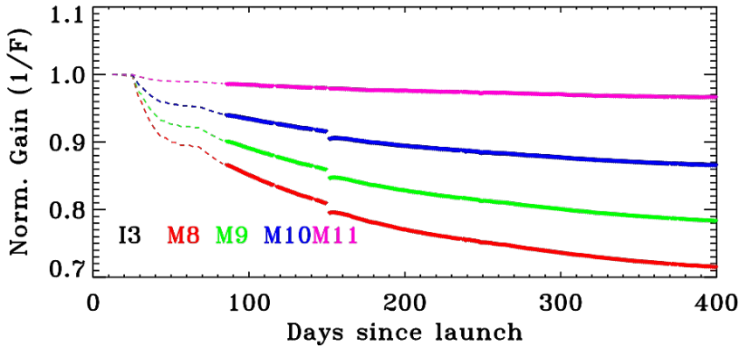
data gap due to KaTX anomaly

Common features in N-21 VIS/NIR bands are due to current SD degradation (can be removed with an improved SDSM screen vignetting function)

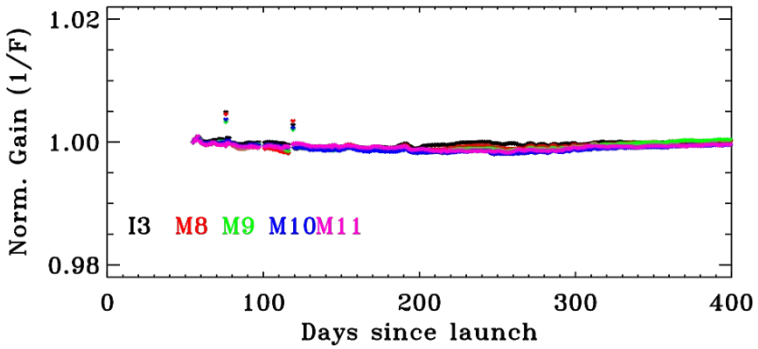
On-orbit Performance: Spectral Band Responses (SWIR)

1.24 – 2.25 μm

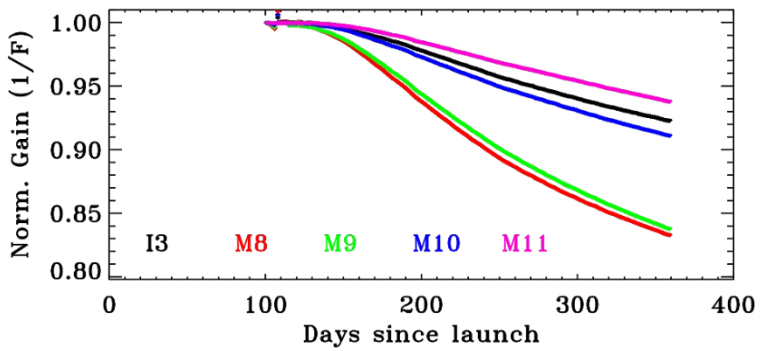
S-NPP



N-20



N-21

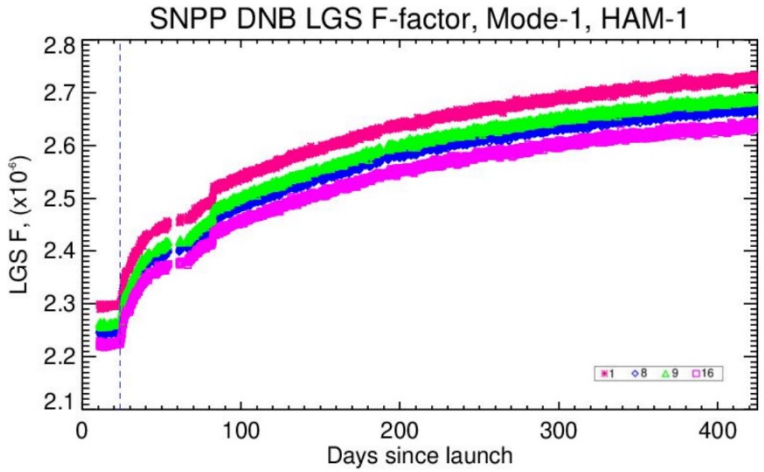


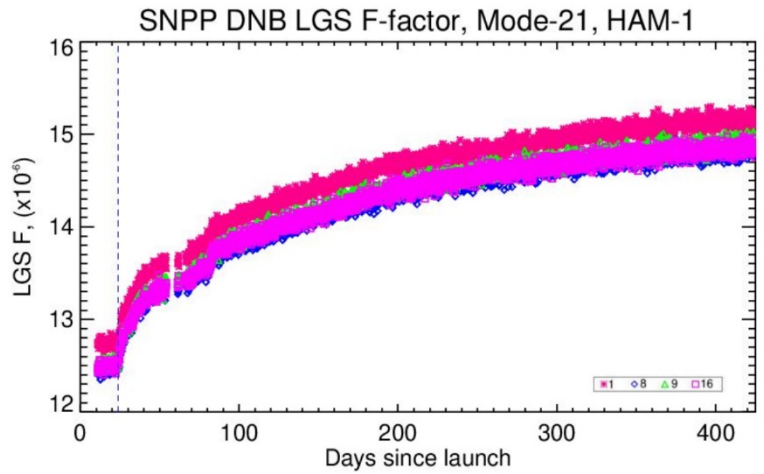
Noticeable and large gain decrease for bands on the SMIR CFPA

- Calibration and data quality maintained with frequent LUT updates for RSB and scan-by-scan calibration approach for TEB
- Another MMOG is being considered to restore the SMIR spectral band gains

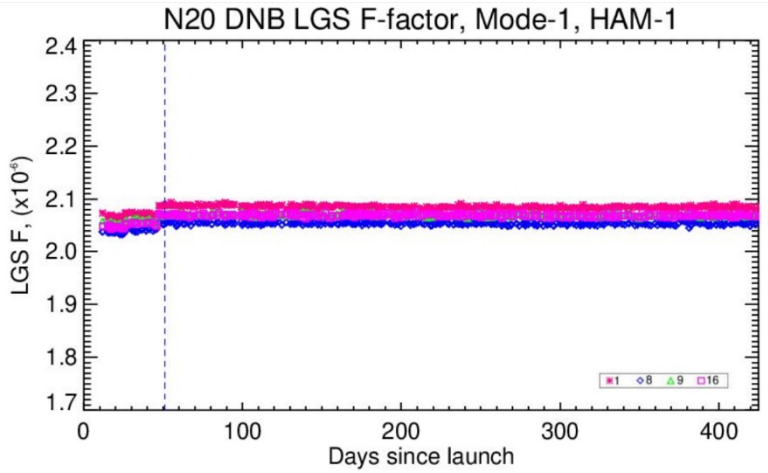
On-orbit Performance: Spectral Band Responses (DNB)

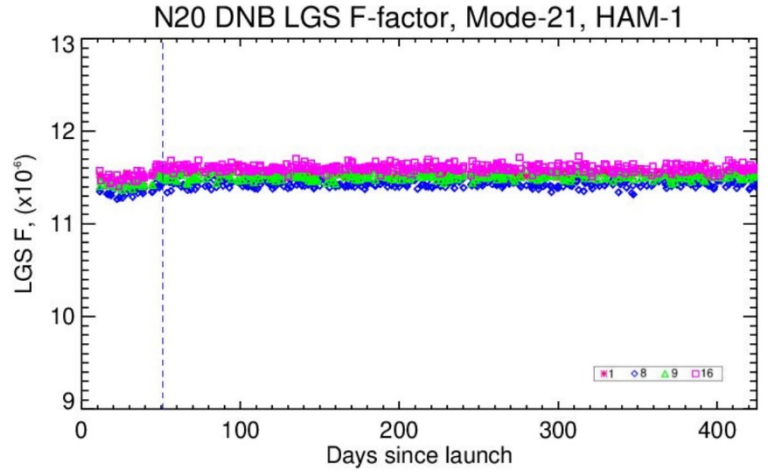
S-NPP



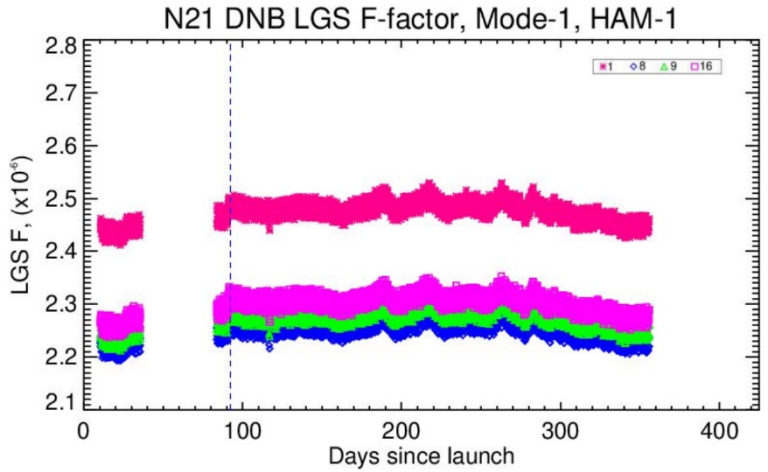


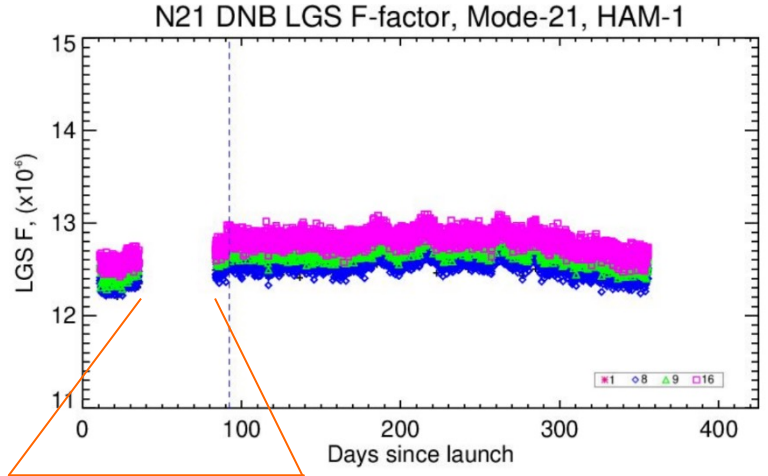
N-20





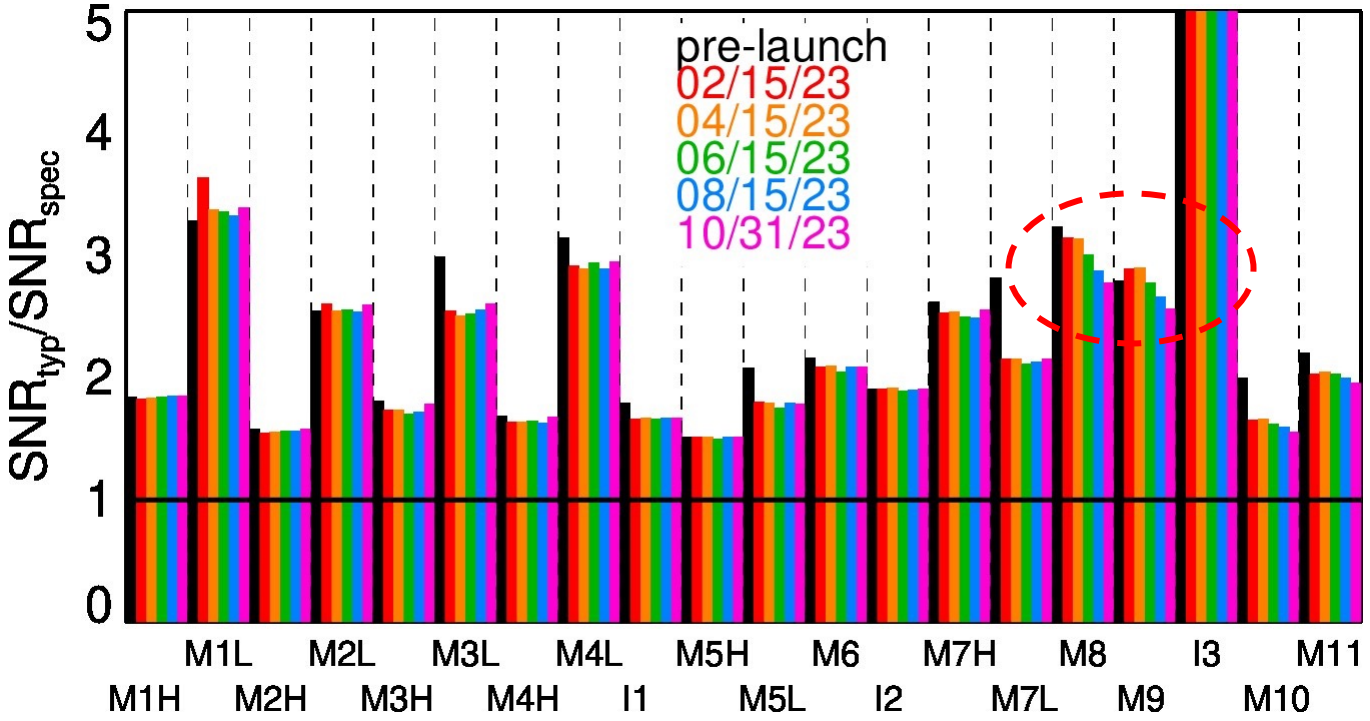
N-21





On-orbit Performance: SNR

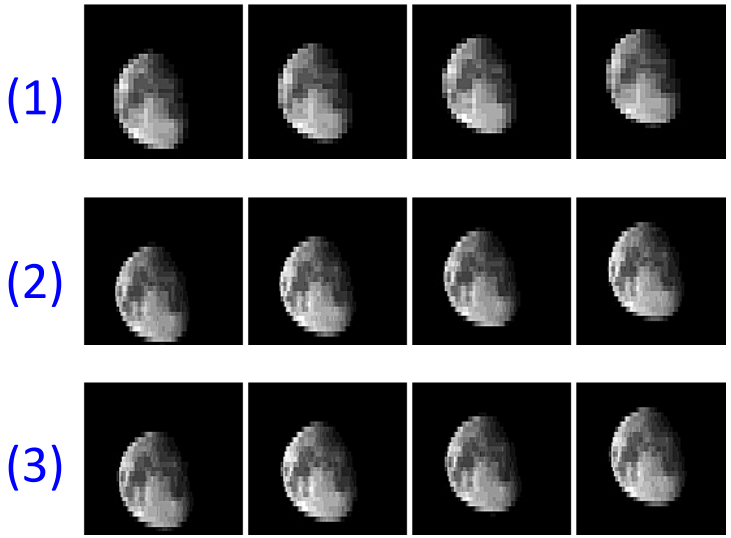
- RSB SNR characterized using detector responses at different SD signal levels
- All SNR meet design specifications with large margins and are consistent with the pre-launch calibration results



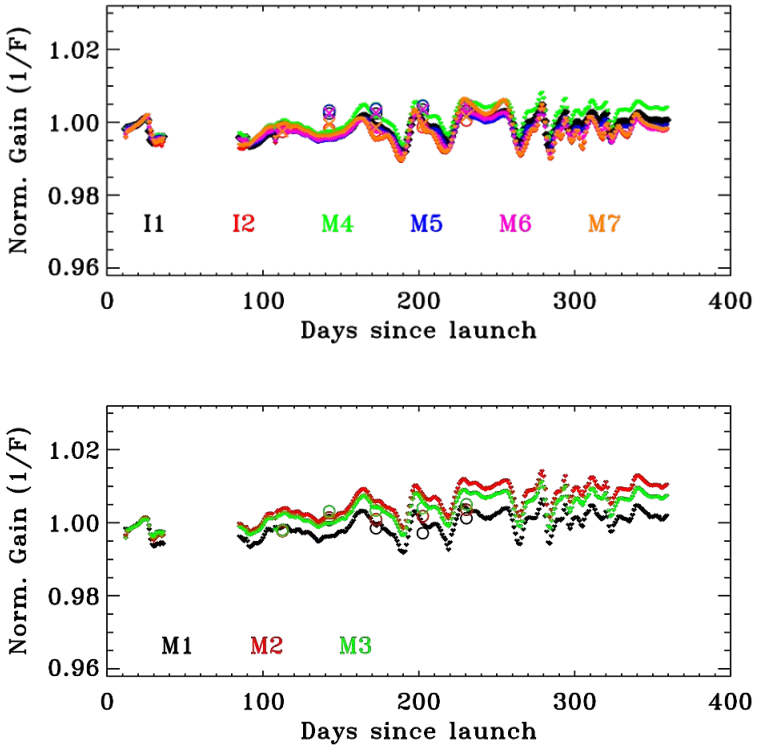
SWIR SNR has decreased since launch due to gain degradation but continues to be well above spec for all detectors

On-orbit Performance: Calibration Stability and Inter-comparison

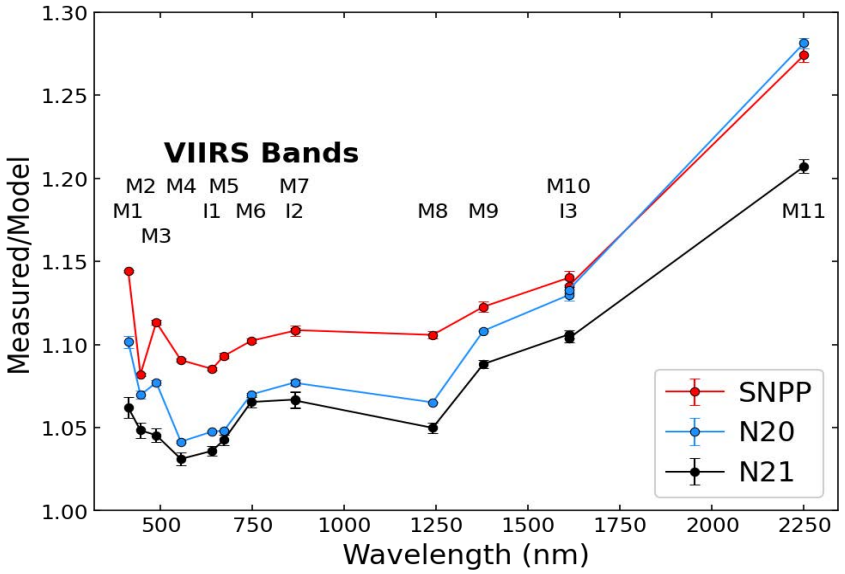
VIIRS I1 lunar images (5/31/23)
(1) S-NPP; (2) N-20; (3) N-21



N-21 SD and lunar calibration
(stability monitoring)



Calibration inter-comparison of
S-NPP, N-20 and N21 RSB



Summary

- **N-21 VIIRS first-year on-orbit calibration performance assessments**
  - Calibration maneuvers provided useful information in support of on-orbit calibration
  - Overall performance exceeds requirements except for a few minor non-compliances and is consistent with pre-launch performance assessments
  - Further improved DNB stray light performance
  - Noticeable gain degradation in SMIR – could be mitigated with a MMOG
- **First mission consistent L1B LUT delivery (07/14/23)**
  - Improved SD/SDSM parameters; on-orbit DN0 and stray light correction parameters
  - SD degradation adjustments based on lessons and strategies from S-NPP and N-20
- **Future improvements**
  - SD degradation (using improved screen parameters to be derived from yaw + on-orbit SD collects)
  - Spectral band response trends (SD + lunar trending)
  - Calibration consistency and mitigation strategy

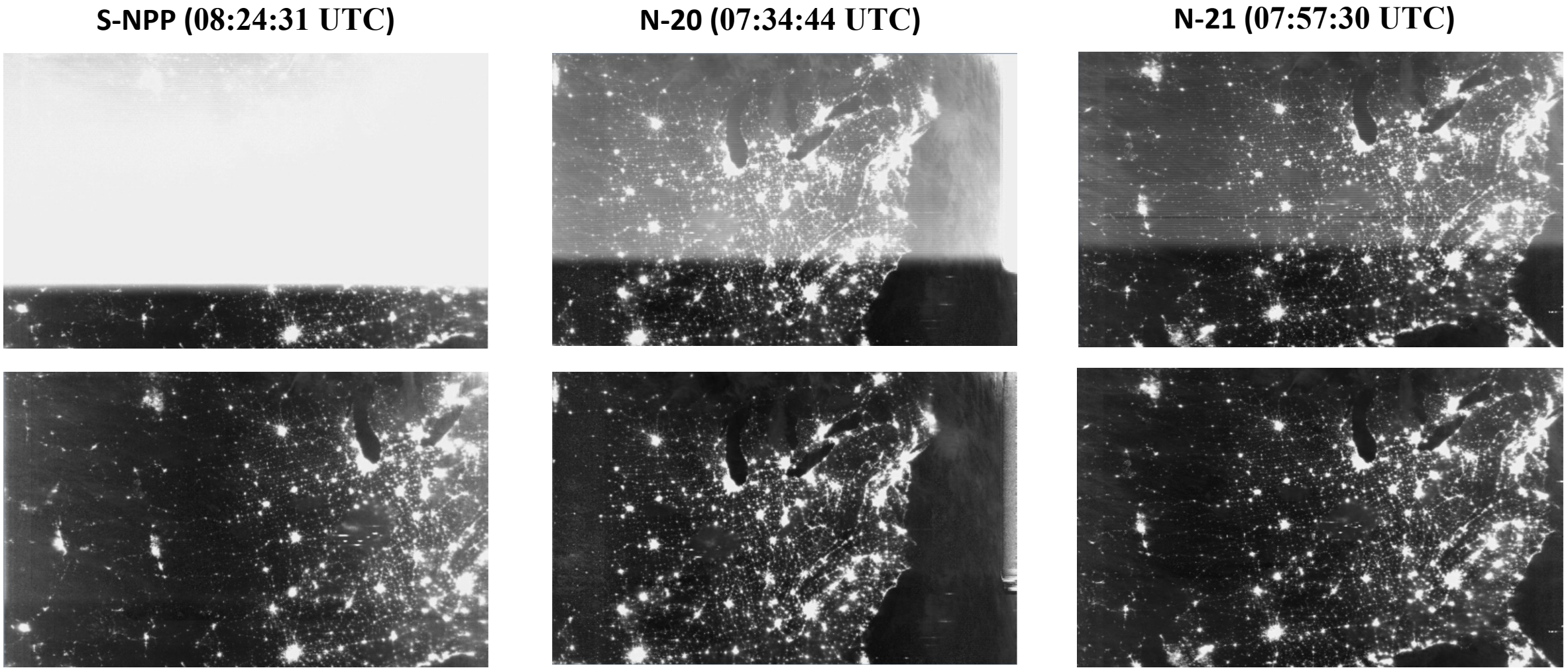
Acknowledgement

Contributions and Support:

- NOAA JPSS Program
- STAR VIIRS SDR Calibration Team
- S-NPP & JPSS Mission Operation Team (MOT)
- VIIRS Instrument Vendor

On-orbit Performance: DNB Stray Light Correction

(VIIRS nighttime images over northern hemisphere on July 17, 2023)



Reduced stray light effect and impact: S-NPP => N-20 => N-21; Effective on-orbit correction