
VIIRS DNB Calibration and Performance

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MODIS/VIIRS Calibration Workshop
(Presented by Junqiang Sun)

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❑ VIIRS DNB Calibration

- The day-night band (DNB) is a RSB.
- It is a unique panchromatic band, 0.5 to 0.9 μm , M4-M7
- Three gain stages: High gain (HG), middle gain (MG), low gain (LG),
- A radiometric dynamic range that spans over seven orders of magnitude
- Multiple aggregation mode (AM) in EV

❑ DNB Background Response (DN0)

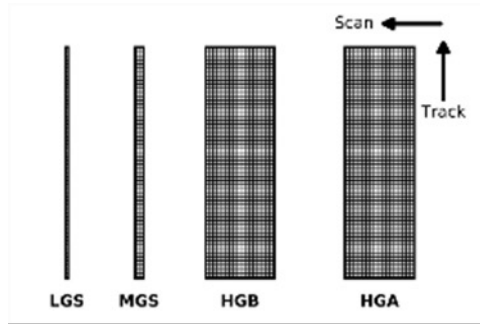
- OBC and EV DN0 Offsets
- DN0 Offsets Changes

❑ Straylight Correction

- Poster, Hongda Chen et al

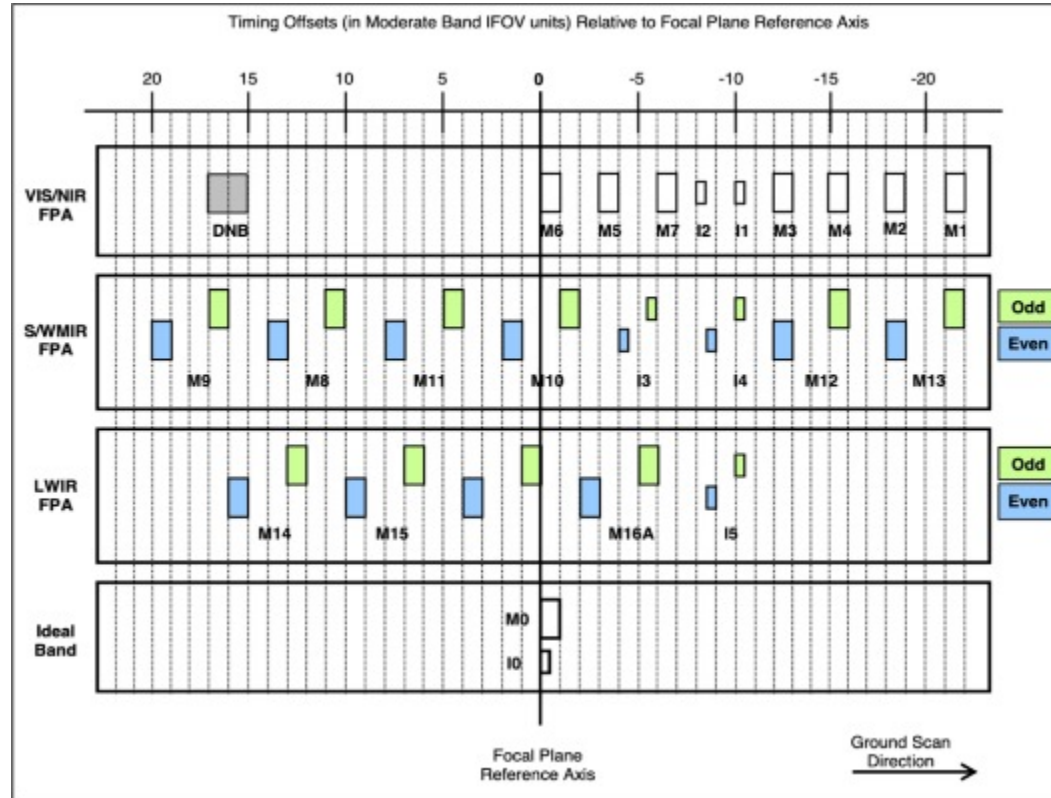
❑ Summary

VIIRS DNB Calibration



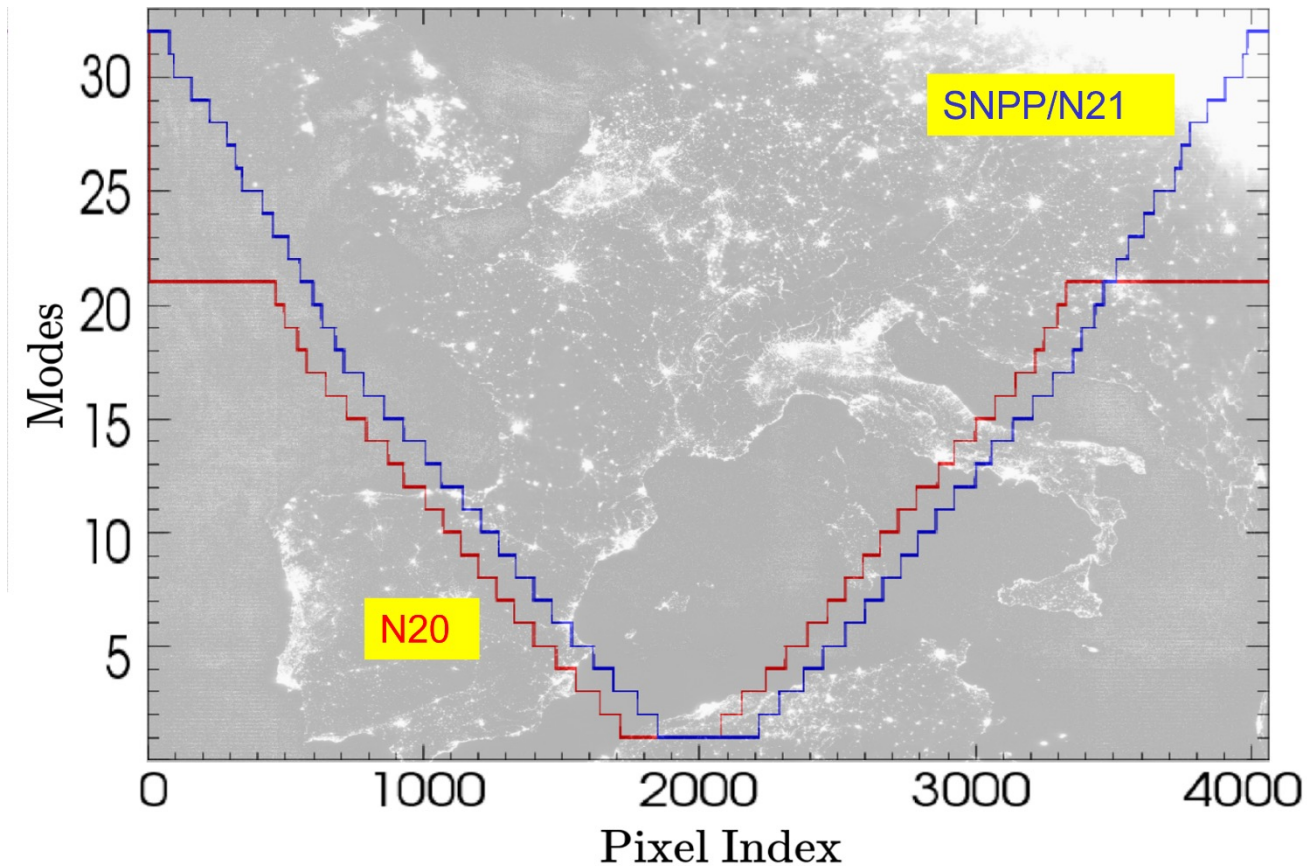
Provided by Truman Wilson

Four detector arrays: one for LGS, one for MGS, and two for HGS



VIIRS DNB Calibration

Aggregation Modes (AM)



- In view of OBCs: SV, SD, and BB, the DNB AM changes sequentially every two scans
- The three gain stages are all active in OBCs

- DNB Earth view is divided into multiple aggregation Zones, each corresponding to one Aggregation mode (AM)
 - SNPP and J2, 32; NOAA-20, 22
 - Each of them needs to be calibrated independently

Calibration Algorithm

- LGS Gain Calculation

- SD radiance:

$$L_{SD} = \cos \theta_{sd} \cdot RVS_{sd} \int BRF(\lambda) \tau_{sd} H(\lambda, t) RSR(\lambda) \frac{\Phi(\lambda)}{4\pi d^2} d\lambda$$

- SD-SUN angle, HAM relative response at SD AOI, transmittance of pinhole screen, SD degradation index, relative spectral response, solar spectral power distribution.

- Calculate LGS gain coefficient:

$$L_{SD} = c_1 \cdot dn$$

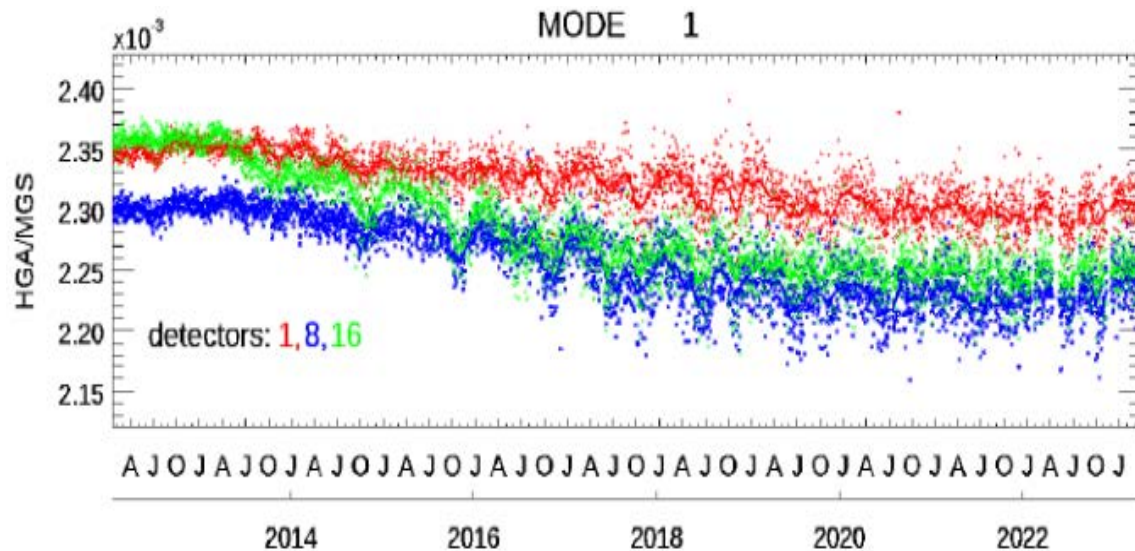
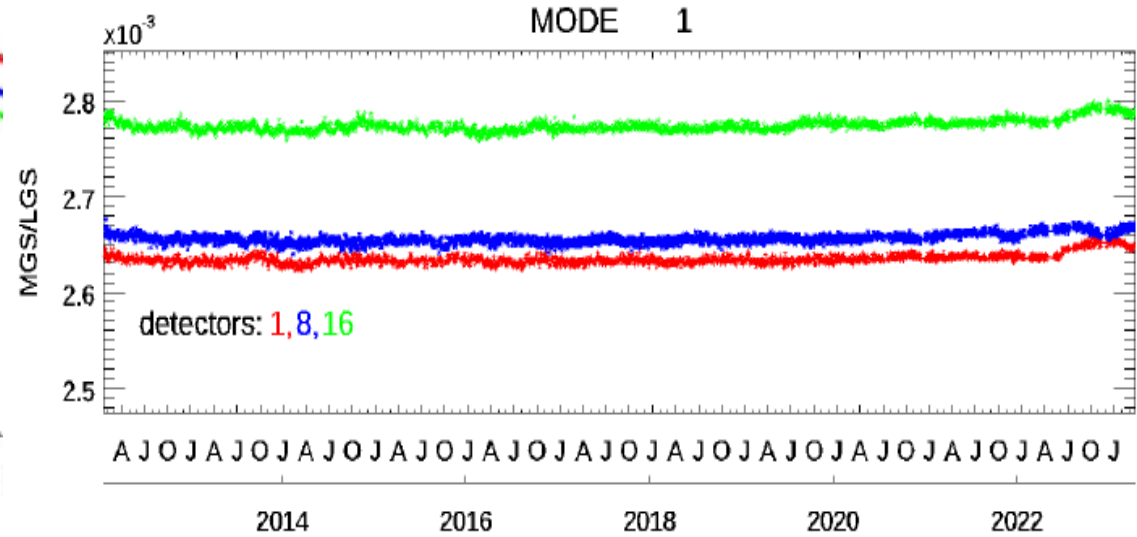
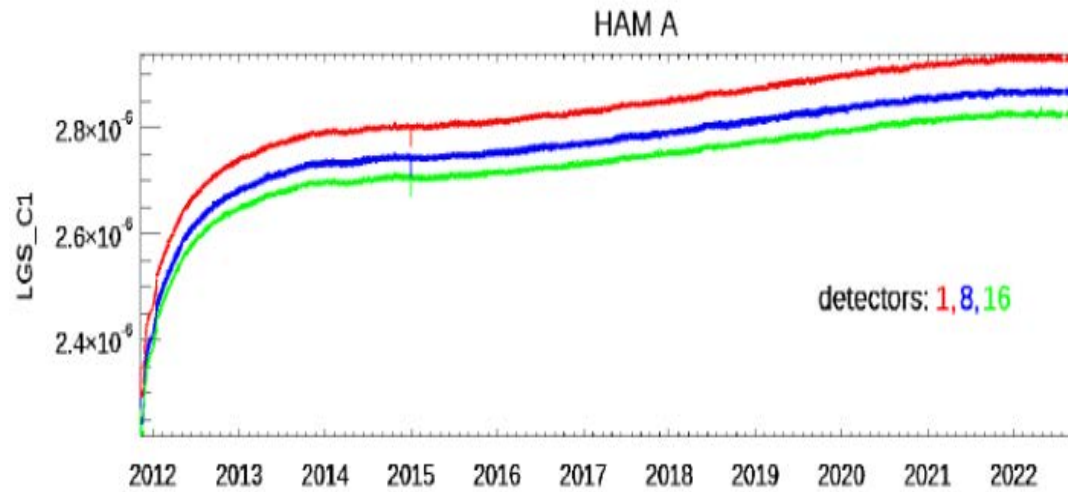
- MGS and HGS Gain Calibration

- Compute daily average gain ratio: MGS/LGS, HGS/MGS
- MGS gain = LGS gain * MGS/LGS
- HGS gain = MGS gain * (HGA/MGS + HGB/MGS)/2

SD

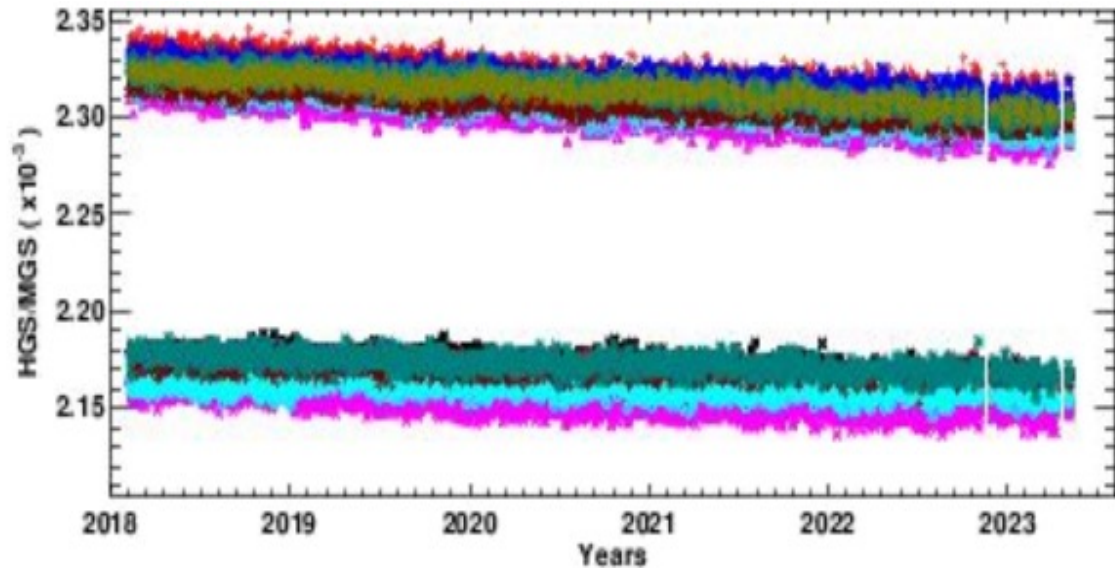
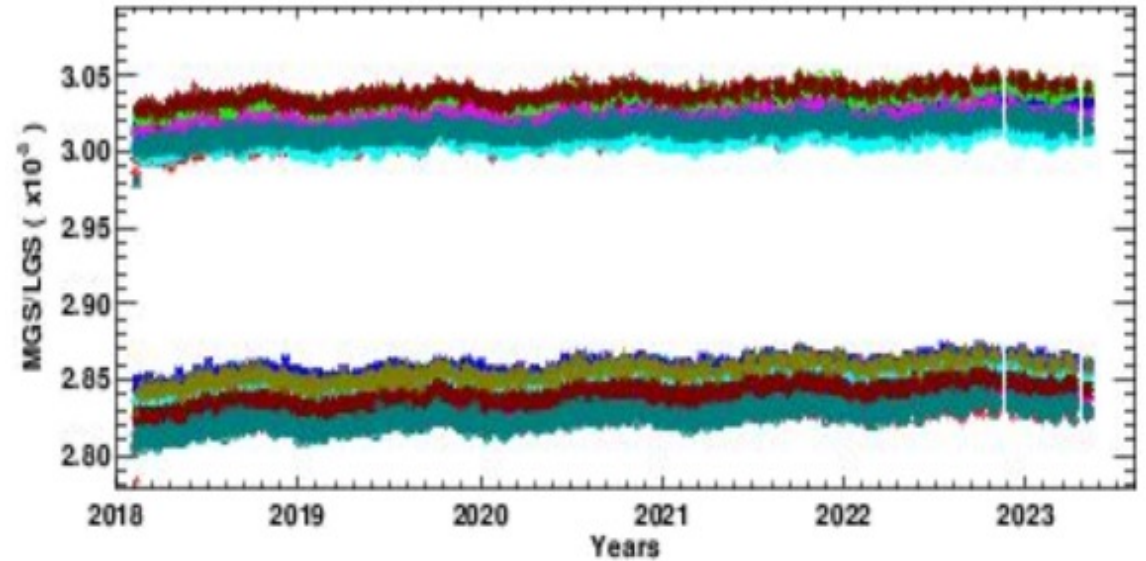
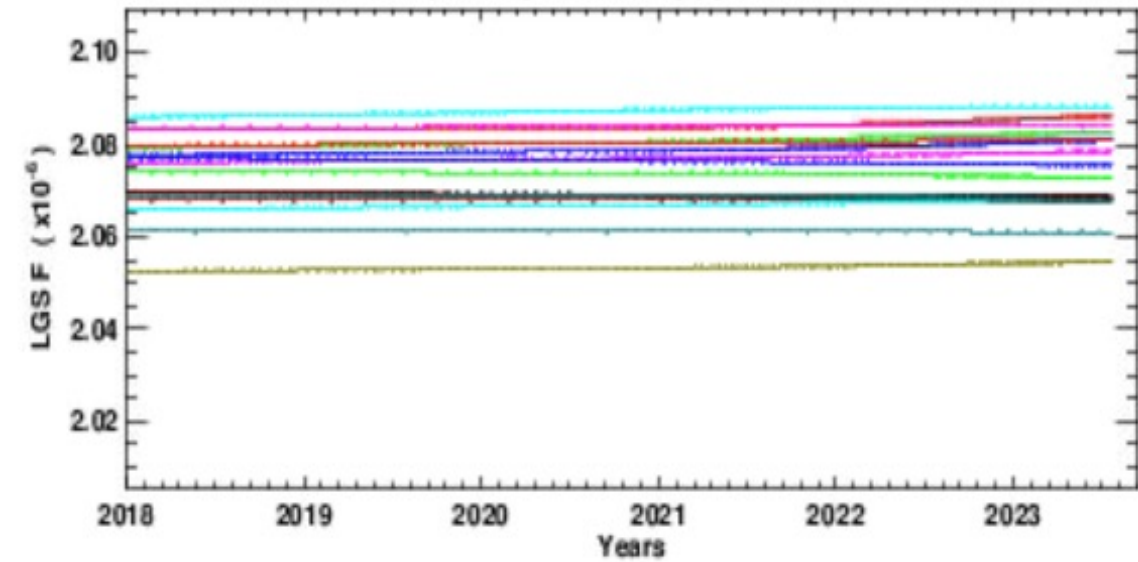


SNPP Calibration Performance



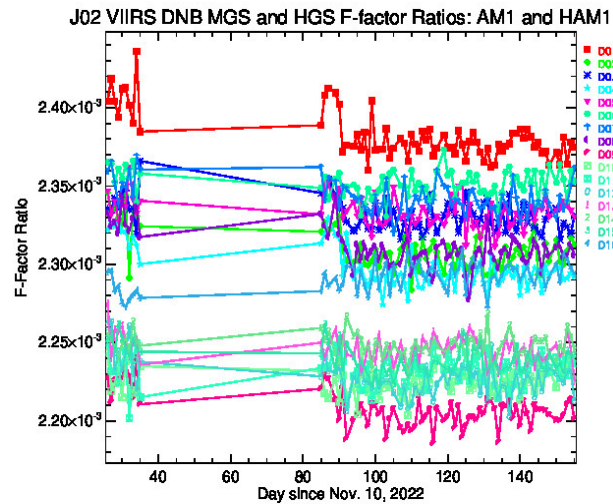
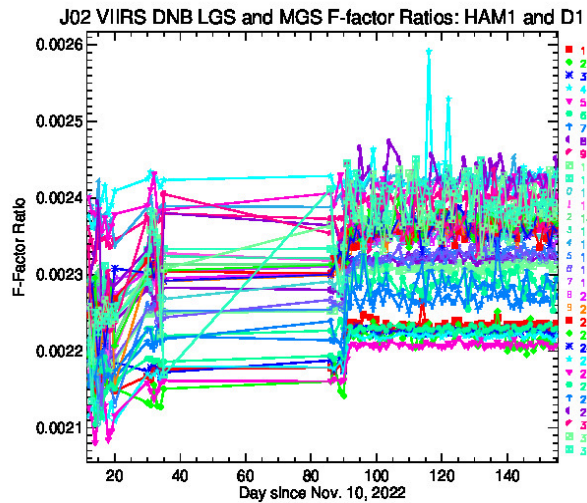
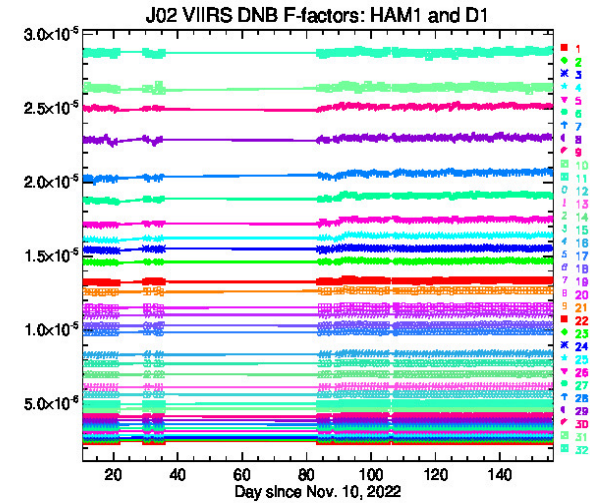
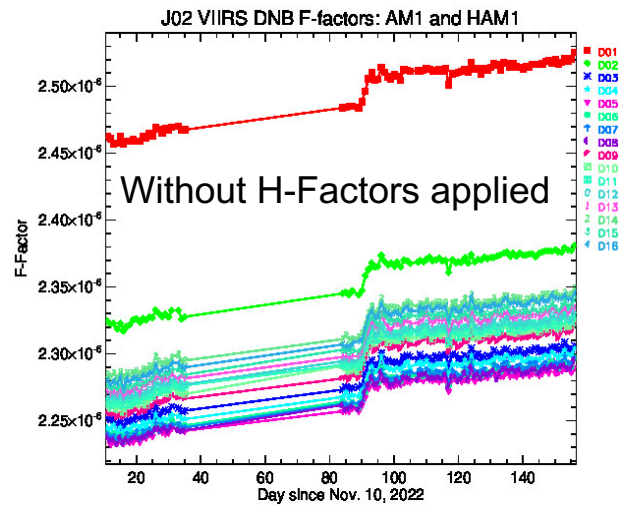
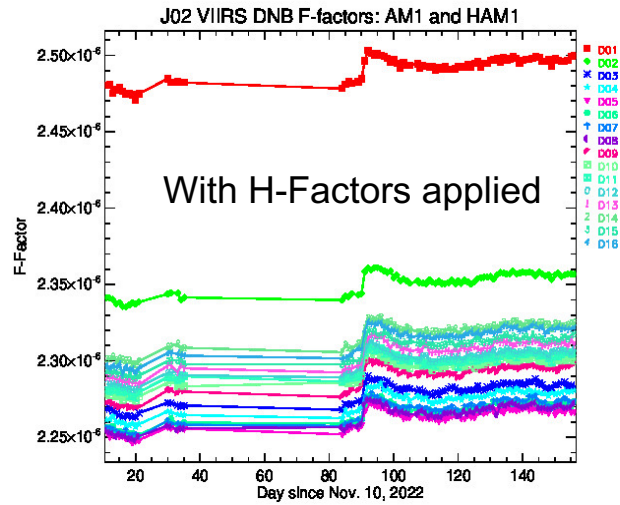
- SNPP LGS calibration coefficients trends (Mode/Detector/HAM) are stable.
- SNPP LGS calibration coefficients show a large increase in the early mission.
- Calibration coefficients ratios are comparably stable
- Anomalies have negligible impacts on the calibration coefficients

N20 Calibration Performance



- N20 LGS calibration coefficients trends (Mode/Detector/HAM) are very stable in entire mission
- Two families are observed in the ratios of MGS/LGS and HGS/MGS, mainly depending on detector locations.
- Gain ratios of HGS-to-LGS are roughly in one family for all detectors

J2 DNB Calibration Performance

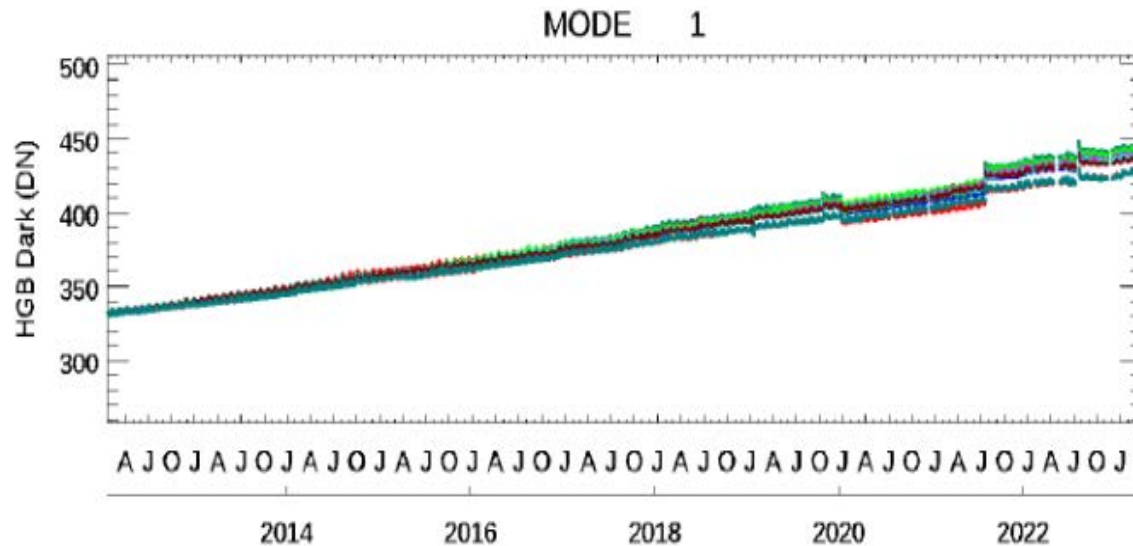
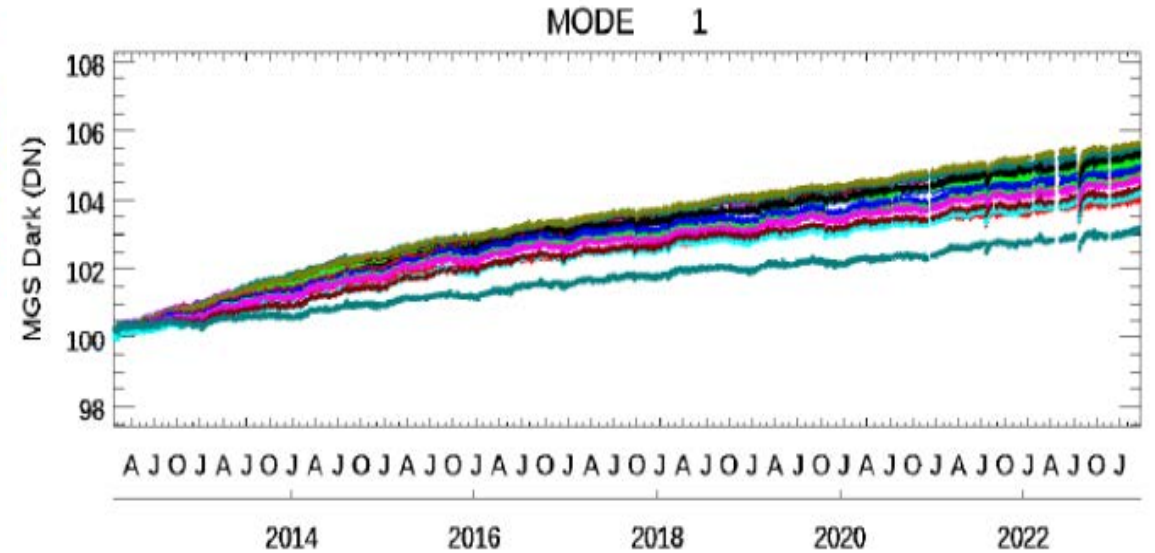
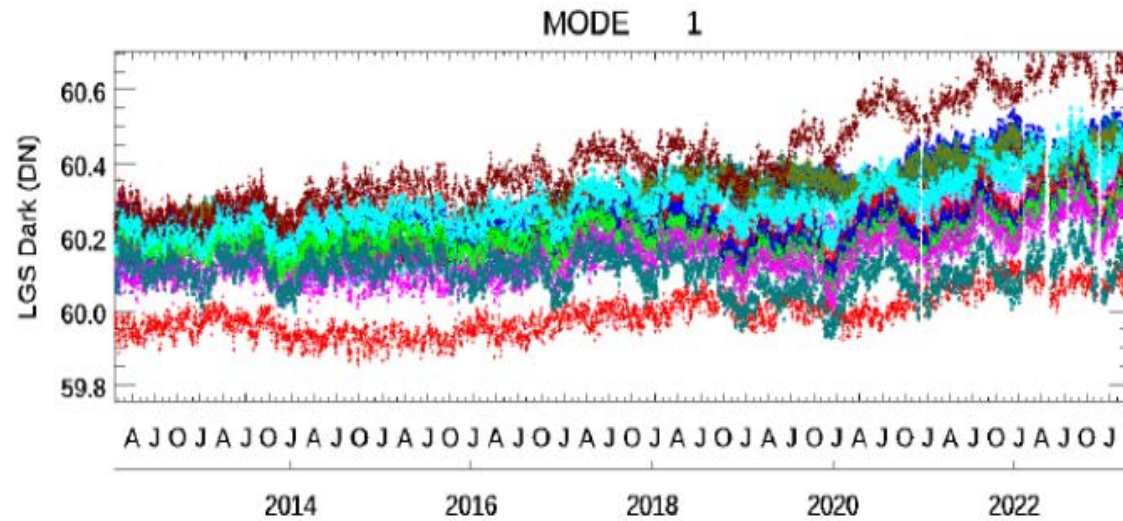


- J2 LGS/MGS/HGS F-factor trends (Mode/Detector/HAM) are stable.
- Small oscillations in LGS F-factor were mainly due to the oscillations in H-factors.

VIIRS DNB Dark Offset Determination Algorithms

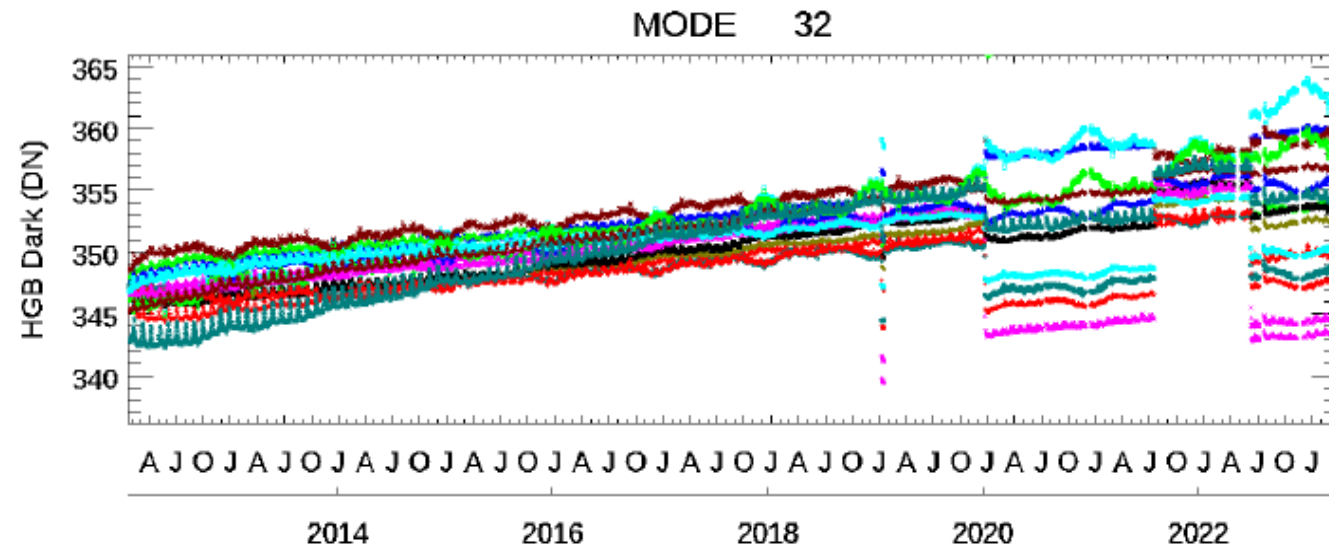
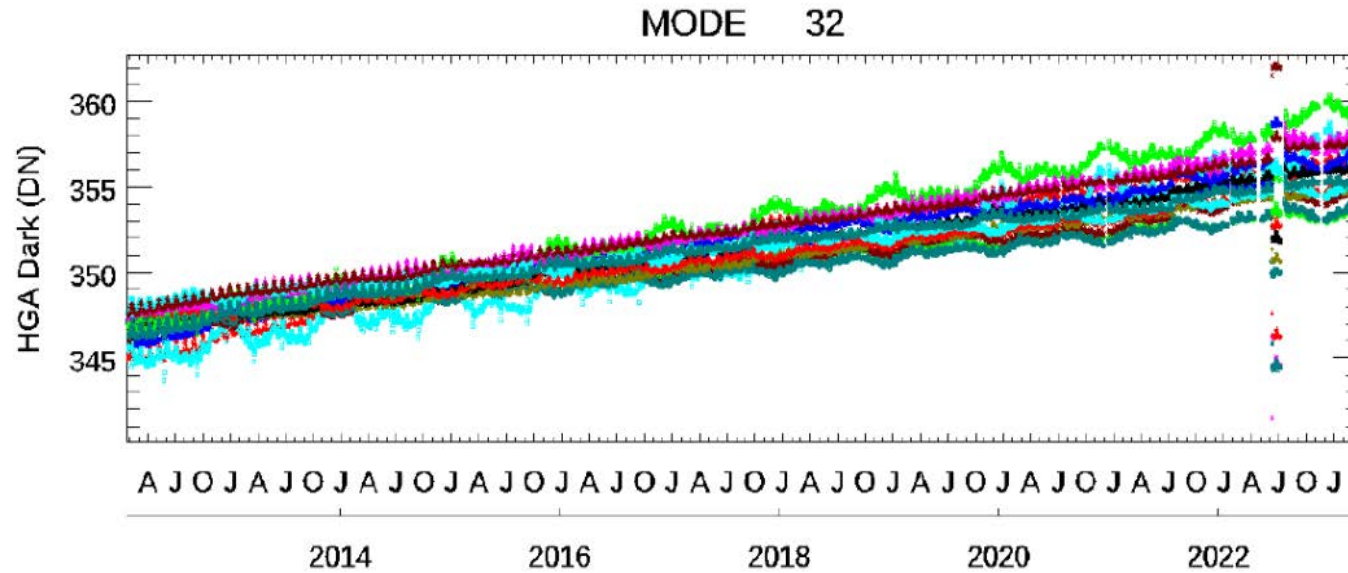
- Dark Offset
 - Calculate dark trend using the minimum of SV/BB/SD data in the sun declination angle range, 40~140 degree.
 - Normalize dark trend at the pitch maneuver value (Mode, Det, HAM, Gain) for each instrument.
 - VROP data are used for SNPP DN0 after safe mode anomaly in 2021.

SNPP Dark Offsets



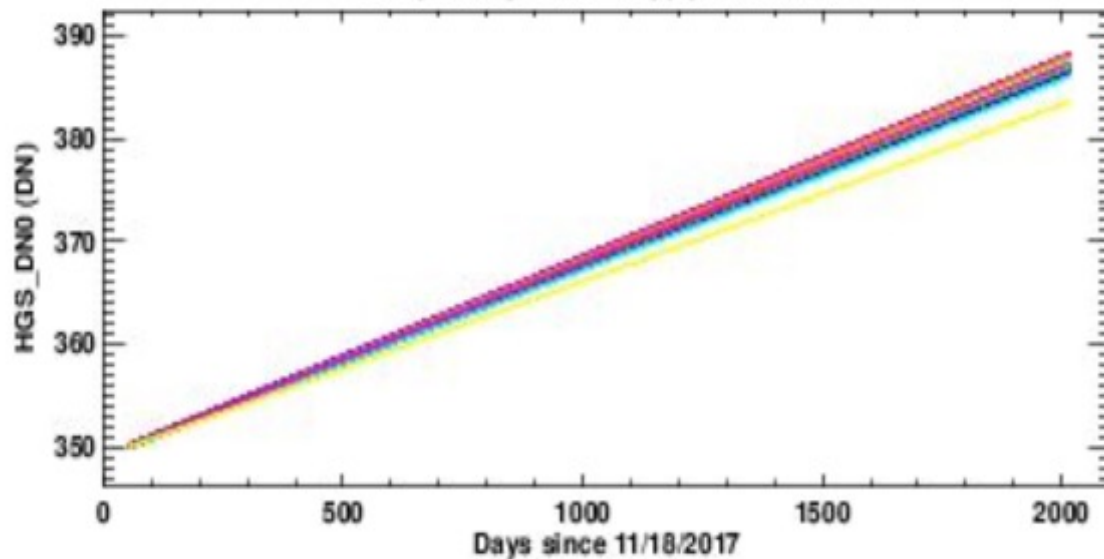
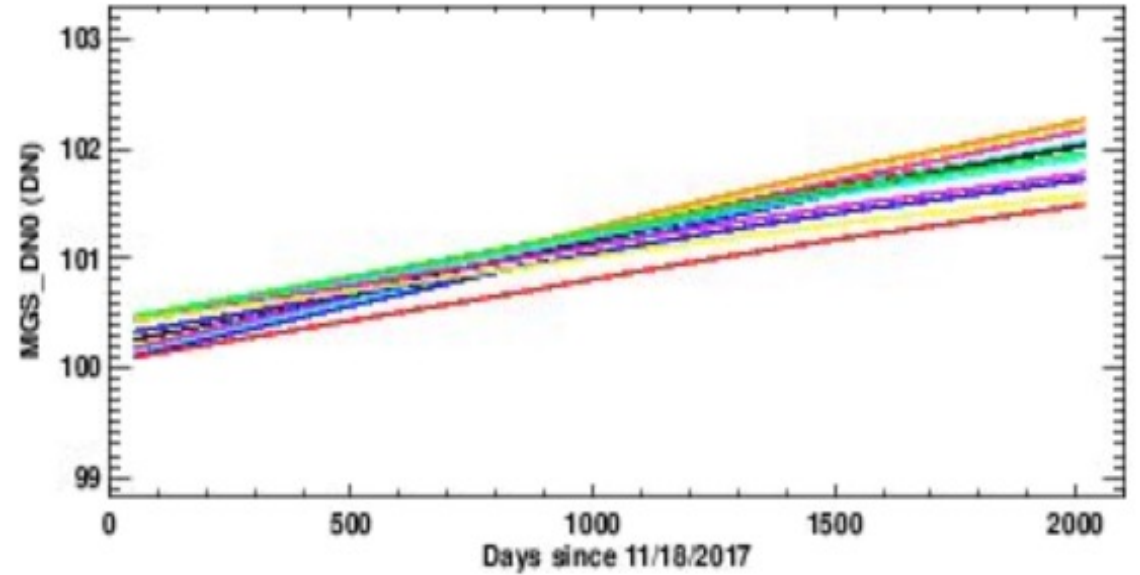
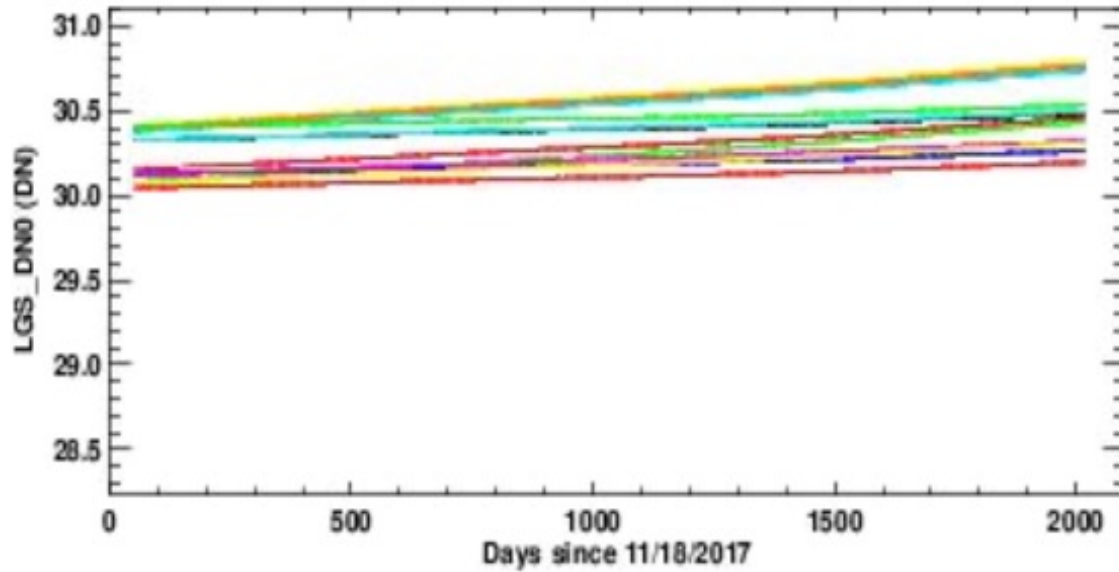
- Dark offsets are tracked using minimal values from OBC data, and then normalized to pitch maneuver values (February 20, 2012).
- Dark offsets show gradually increased for HGS and MGS.
- Dark offsets in LGS are relatively small, and the changes are in 0.5 digital count.

SNPP Dark Offsets



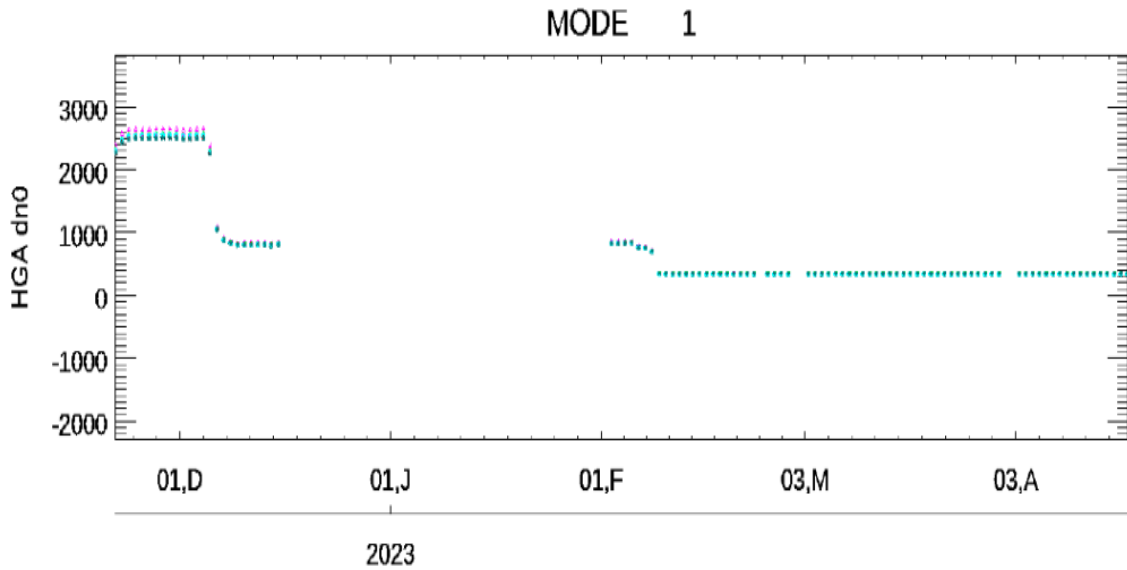
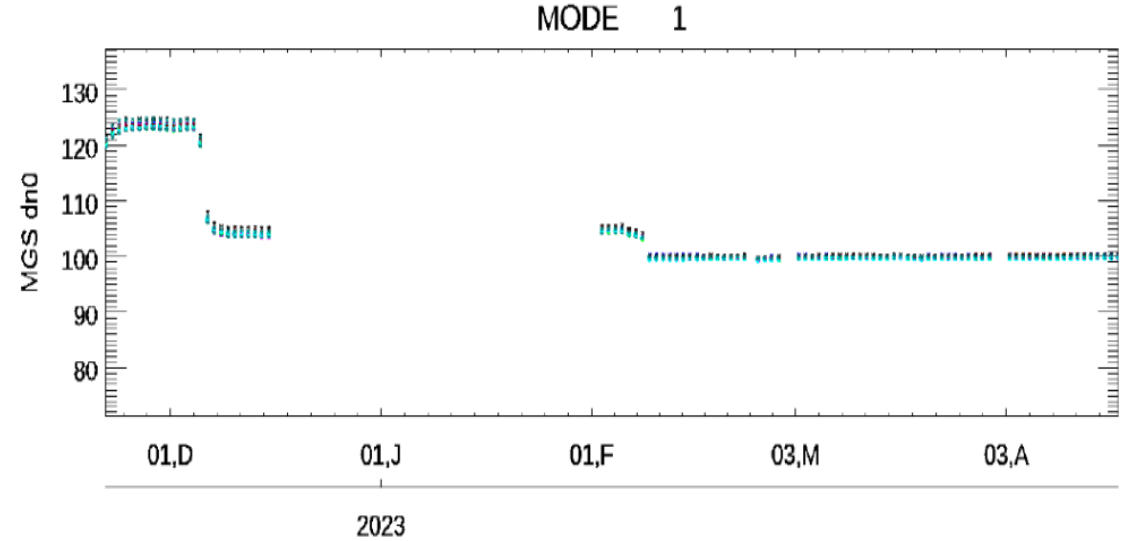
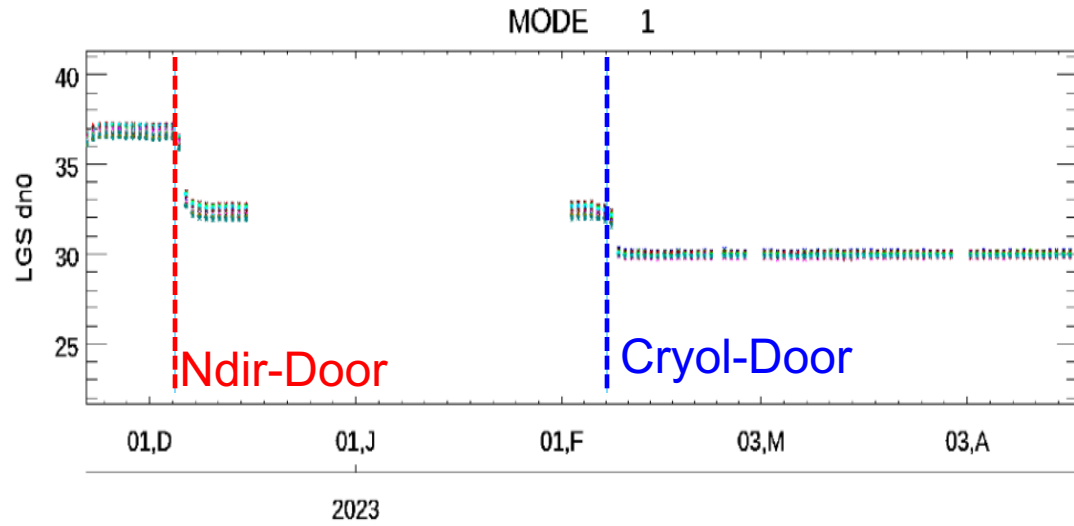
- The DN0 changes after each anomaly, especially in HGS large aggregation mode.
- The changes for HGA and HGB may be different.

N20 Dark Offsets



- Dark offsets are tracked using minimal values from OBC data, and then normalized to pitch maneuver values (January 31, 2018).
- Dark offsets show gradually increased for all gain stages

J2 Dark Offsets



- Dark offsets are tracked using minimal values from OBC data, and then normalized to pitch maneuver values (2023).
- Dark offsets are stabilized after Feb. 9, 2023

Summary

- SNPP/N20/J2 VIIRS DNB are in normal operations, and on-orbit calibration has been successfully performed.
- The DNB calibration coefficients for all detectors, HAM sides, gain stages, aggregation modes, and the three instruments, are stable and perform well.
- The DNB dark offsets perform well but may have discontinuities due to the instrument anomalies, especially for HGS.