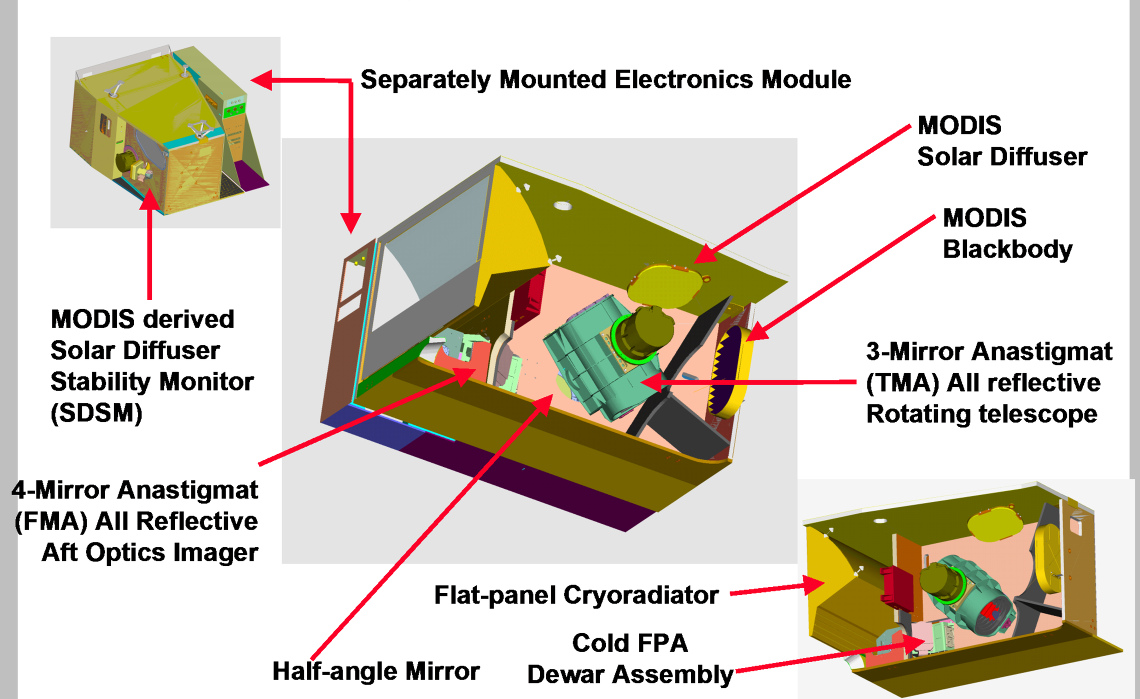
SNPP VIIRS Reflective Solar Bands On-Orbit Calibration and Performance

Junqiang Sun[1,2] and Menghua Wang[1]
[1]NOAA/NESDIS/STAR; [2]Global Science and Technology, Inc.

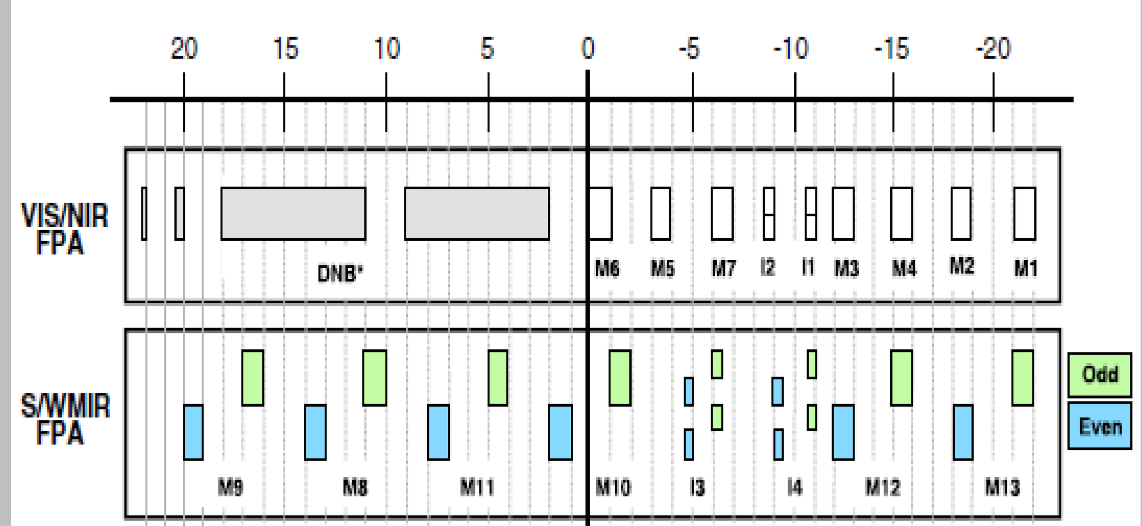
Introduction

- VIIRS is one of five instruments onboard the Suomi National Polar-Orbiting Partnership (S-NPP) satellite that launched from Vandenberg Air Force Base, Calif., on Oct. 28, 2011.
- The VIIRS is a whiskbroom radiometer that provides ±56.28 degree scans of the Earth view (EV) covering a 12 km (nadir) along track by 3060 km along scan swath each scan using a rotating telescope assembly and a double-sided half-angle mirror (HAM).
- VIIRS has 22 spectral bands, among which 14 reflective solar bands (RSB) ranging from 0.41 to 2.25 µm, with spatial resolution of 375 m (bands I1-I3) and 750 m (bands M1-M11).
- RSB are calibrated on-orbit using a Solar Diffuser (SD) with a Solar Diffuser Stability Monitor (SDSM) and near-monthly lunar observations.

VIIRS Instrument



Focal Plane Assemblies



Key Specifications

			Single Gain		Dual Gain			
					High Gain		Low Gain	
Band	Center Wavelength (nm)	Gain Type	Lmin	Lmax	Lmin	Lmax	Lmin	Lmax
M1	412	Dual	-	-	30	135	135	615
M2	445	Dual	-	-	26	127	127	687
M3	488	Dual	-	-	22	107	107	702
M4	555	Dual	-	-	12	78	78	667
M5	672	Dual	-	-	8.6	59	59	651
M6	746	Single	5.3	41.0	-	-	-	-
M7	865	Dual	-	-	3.4	29	29	349
M8	1240	Single	3.5	164.9	-	-	-	-
M9	1378	Single	0.6	77.1	-	-	-	-
M10	1610	Single	1.2	71.2	-	-	-	-
M11	2250	Single	0.12	31.8	-	-	-	-
I1	640	Single	5	718	-	-	-	-
I2	865	Single	10.3	349	-	-	-	-
I3	1610	Single	1.2	72.5	-	-	-	-

SDSM Calibration

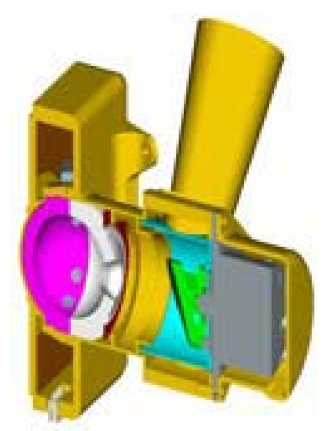
$$H(t)=\frac{\tau_{Sun}\cdot dc_{SD}}{\tau_{SD}\cdot\cos(\theta_{SD})\cdot BRF_{SDSM}\cdot dc_{Sun}}$$

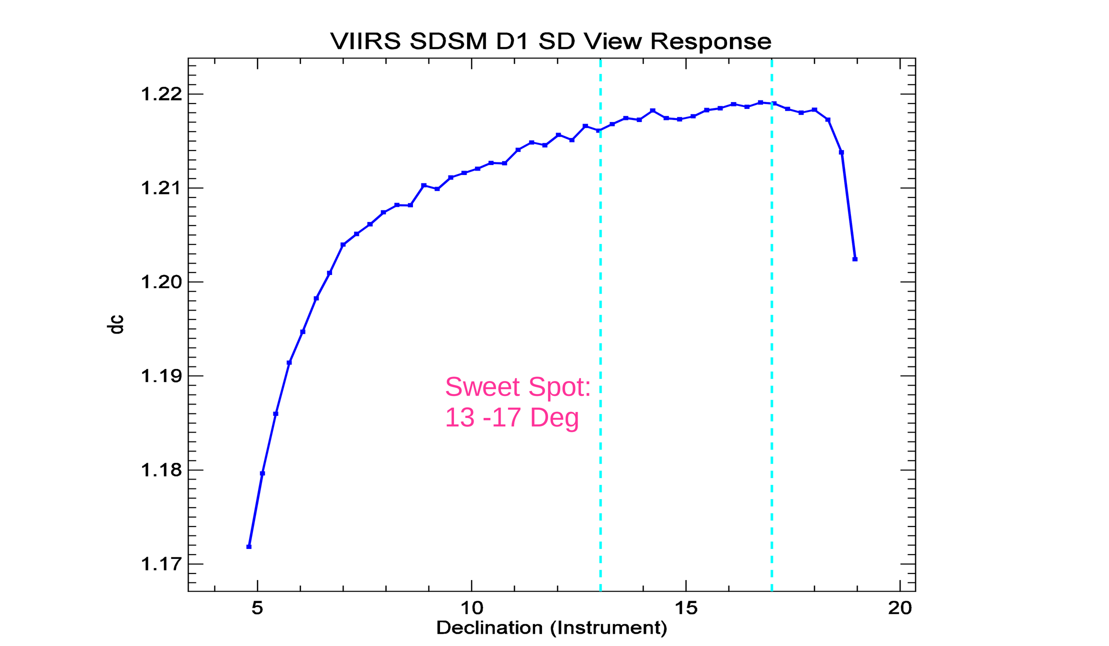
- BRF_{SDSM}: SD prelaunch BRF for SDSM view
- τ_{Sun}: VF of the sun view screen
- τ_{SD}: VF of the SD screen
- θ_{SD}: AOI on SD surface
- dc_{SD}: Background subtracted SDSM SD view response
- dc_{Sun}: background subtracted SDSM Sun view response

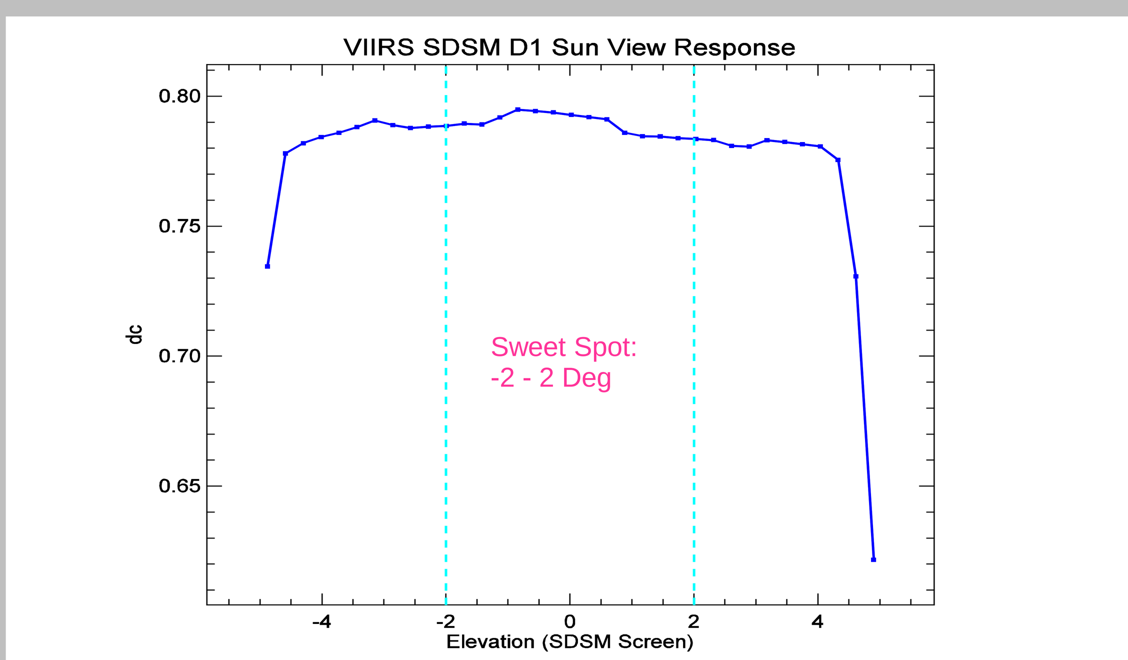
SD on-orbit degradation

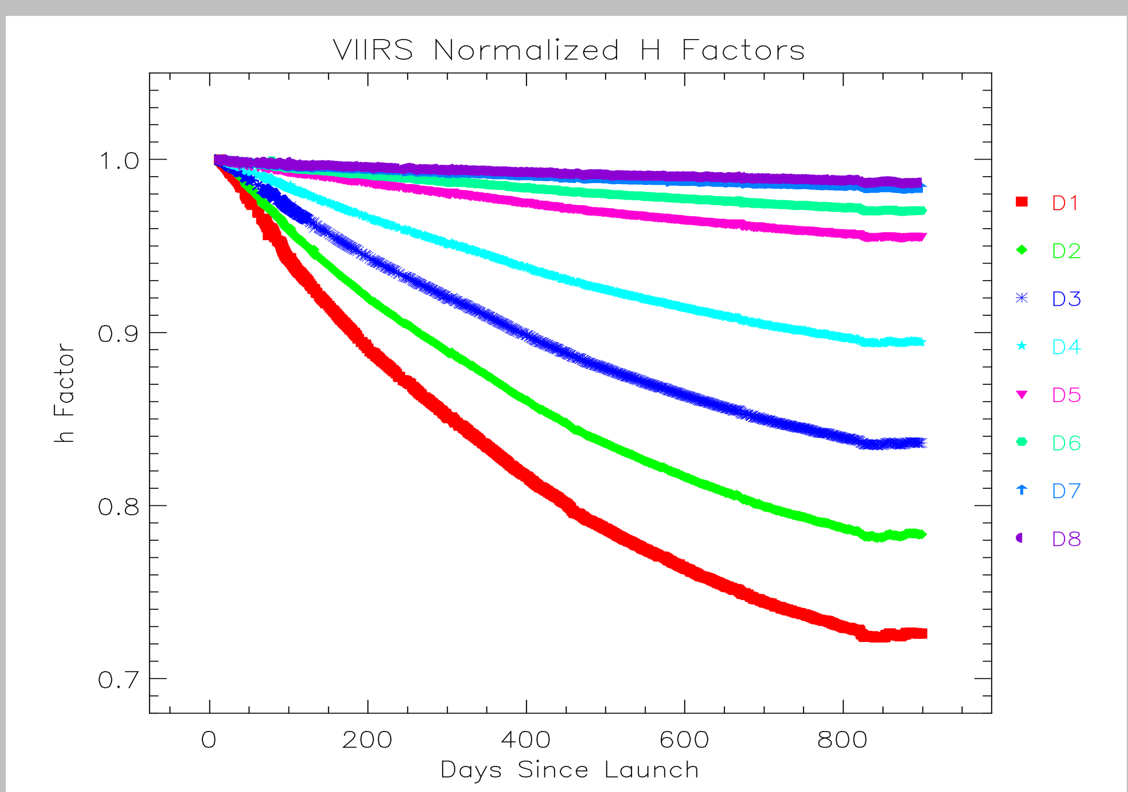
$$h(t)=H(t)/H(t_0)$$

SDSM









Improvements: Sweet spots and new VFs

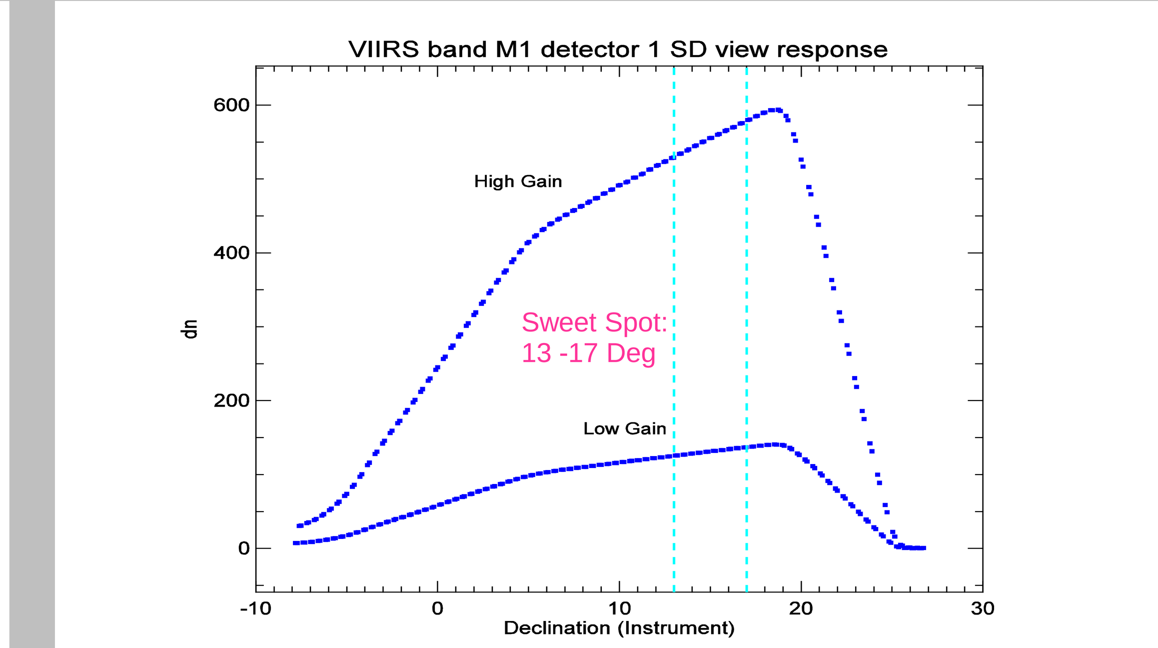
SD Calibration

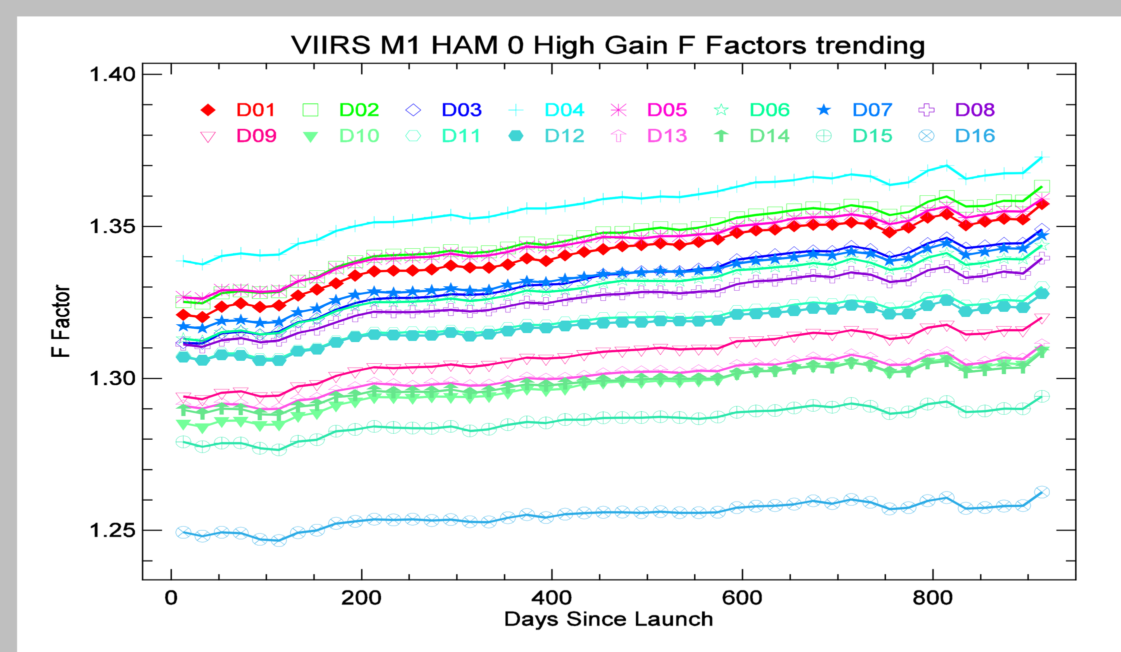
$$F(t)=\frac{RVS_{B,SD}\cdot\int RSR_B(\lambda)\cdot L_{SD}(\lambda)\cdot d\lambda}{\left(c_0+c_1\cdot dn+c_2\cdot dn^2\right)\cdot\int RSR_B(\lambda)\cdot d\lambda}$$

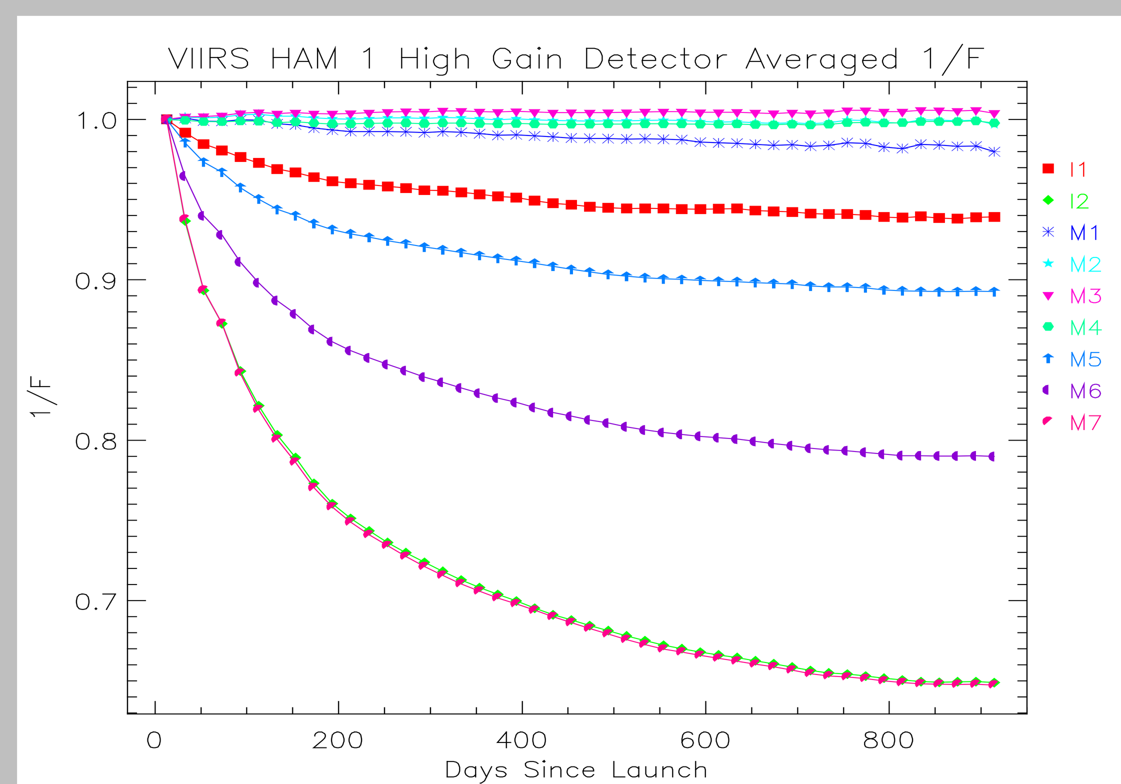
$$L_{SD}(\lambda)=I_{Sun}(\lambda)\cdot\tau_{SD}\cdot\cos(\theta_{SD})\cdot BRF_{RTA}\cdot h(\lambda)/d_{VS}^2$$

- BRF_{SD}: SD prelaunch BRF for RTA view
- RSR_B: Relative spectral response for band
- c_0, c_1, c_2 : Temperature effect corrected prelaunch calibration coefficients
- I_{Sun} : Solar irradiance
- dn: Background subtracted instrument response
- $RVS_{B,SD}$: Response Versus Scan angle at AOI of SD for band B
- d_{VS}: VIIRS-Sun distance

SD







Improvements: Sweet spot and new VF

Lunar Calibration

$$F(B,M,t)=\frac{g(B)\cdot N_M}{\sum_{D,S,n}L_{pl}(B,D,S,n)\delta(M,M_n)}$$

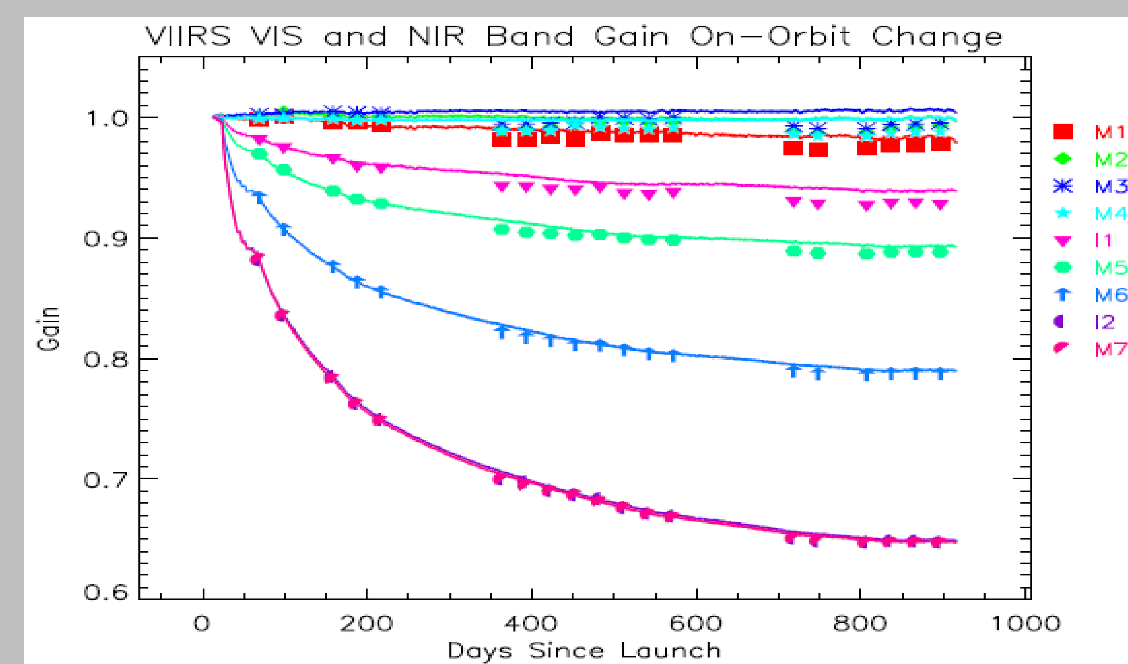
$$L_{pl}(B,D,S,n)=\sum_{j=0}^{2}c_j(B,D,M)dn_{Moon}(B,D,S,n)$$

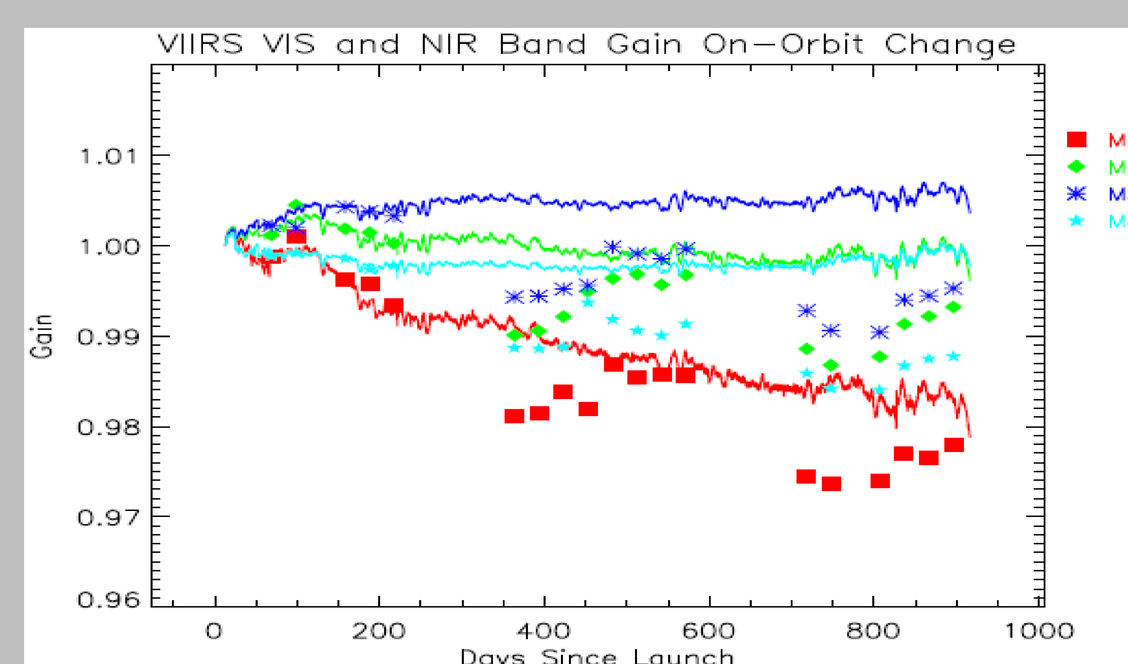
- B, D, S, n : Band, detector, sample, and HAM side
- dn_{BMoon} : Background subtracted instrument response
- N_M : Number of scan which views a full Moon with HAM M

Relative lunar F factor

$$f(B,M,t)=F(B,M,t)/F(B,M,t_0)$$

Lunar Image





Summary and Challenges

- The SD degradation has been tracked by the on-board SDSM since SNPP VIIRS launched. The SD degradation is strongly wavelength dependent and it has degraded about 28% at 412 nm in the past 2+ years.
- The SNPP VIIRS RSB are calibrated using the on-board SD. The RSB on-orbit change is also strongly wavelength dependent. The near infrared bands have largest gain decrease, which is about 35% for bands I2 and M7.
- The RSB response changes are also tracked using the scheduled approximately monthly lunar observations. The lunar calibration coefficients matches the SD results reasonably well except for the unexpected seasonal oscillations seen in lunar calibration coefficients.