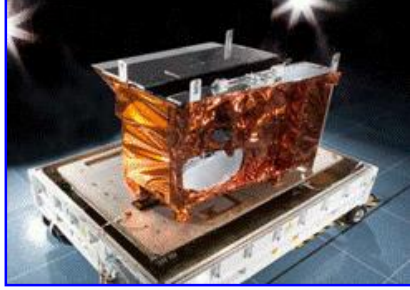


Improvements of VIIRS Reflective Solar Bands (RSB) Solar and Lunar Calibration

Jack Xiong[1], Ning Lei[2], Zhipeng Wang[2], Jon Fulbright[2], and Jim Butler[1]

Sciences and Exploration Directorate, NASA/GSFC, Greenbelt, MD 20771
Sigma Space Co., 4801 Forbes Boulevard, Lanham, MD 20706
VIIRS Characterization Support Team (VCST), NASA GSFC

Contents

- **VIIRS RSB Solar and Lunar Calibration**
  - Methodologies and Activities
- **Calibration Improvements**
  - SD Degradation (H-factor)
  - RSB Calibration Coefficients (F-factors)
  - RSB Relative Spectral Response (RSR)
  - DNB Calibration
- **Summary and Future Effort**

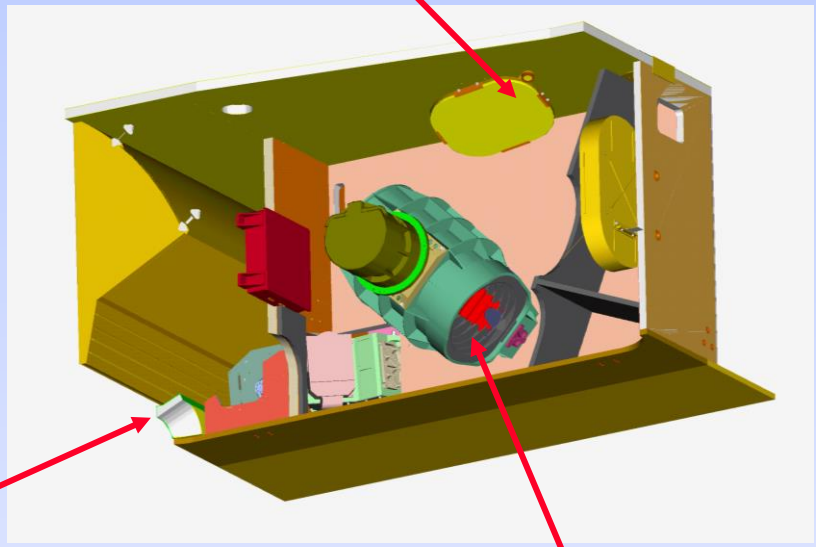
VIIRS RSB Solar and Lunar Calibration

15 RSB: M1-M11, I1-I3, DNB
H/L gains: M1-5 and M7
λ: 0.4-2.3 μm

Solar Diffuser
Stability Monitor

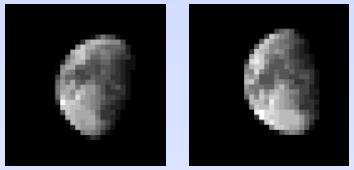
SD with a fixed screen
Calibration each orbit

Daily operation => 3 per week
(8 min => 5 min)
Future reduction of frequency
and operation time



8-9 / year

S/C roll
Same PA



Extended SV Port

Rotating Telescope Assembly (RTA)

VIIRS RSB Solar and Lunar Calibration

EV

$$L_{EV} = F \cdot \left(c_0 + c_1 \cdot dn_{EV} + c_2 \cdot dn_{EV}^2\right) / RVS(\theta_{EV})$$

SD

$$L_{SD\_Meas} \propto \left(c_0 + c_1 \cdot dn_{SD} + c_2 \cdot dn_{SD}^2\right)$$

$$L_{SD\_Comp} \propto E_{SUN} \cdot BRDF_{SD}(t) \cdot \tau_{SDS}$$

$$F_{SD} = \frac{L_{SD\_Comp}}{L_{SD\_Meas}}$$

SDSM Determine SD degradation

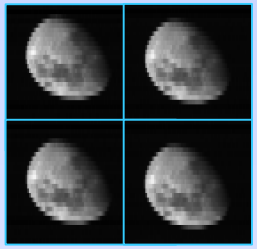
$$H_{SD} = \frac{dn_{SDSM\_SD}}{dn_{SDSM\_Sun}}$$

Moon

$$J_{Moon\_Meas} \propto \sum_{s,d} [c_0 + c_1 \cdot dn_{Moon}(s,d) + c_2 \cdot dn_{Moon}(s,d)^2]$$

$$J_{Moon\_Comp}$$ ***From ROLO***

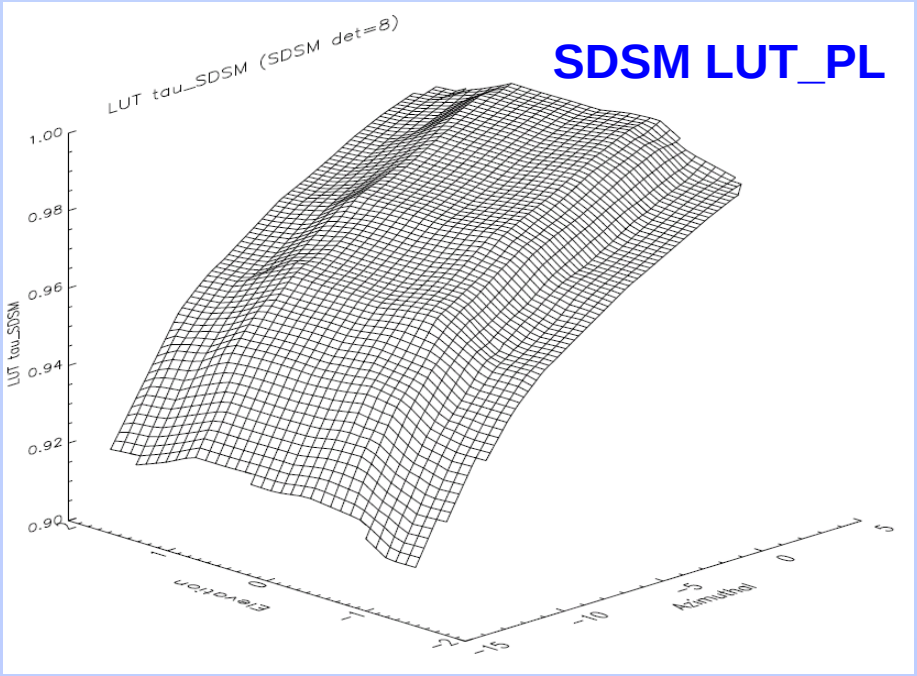
$$F_{Moon} = \frac{J_{Moon\_Comp}}{J_{Moon\_Meas}}$$

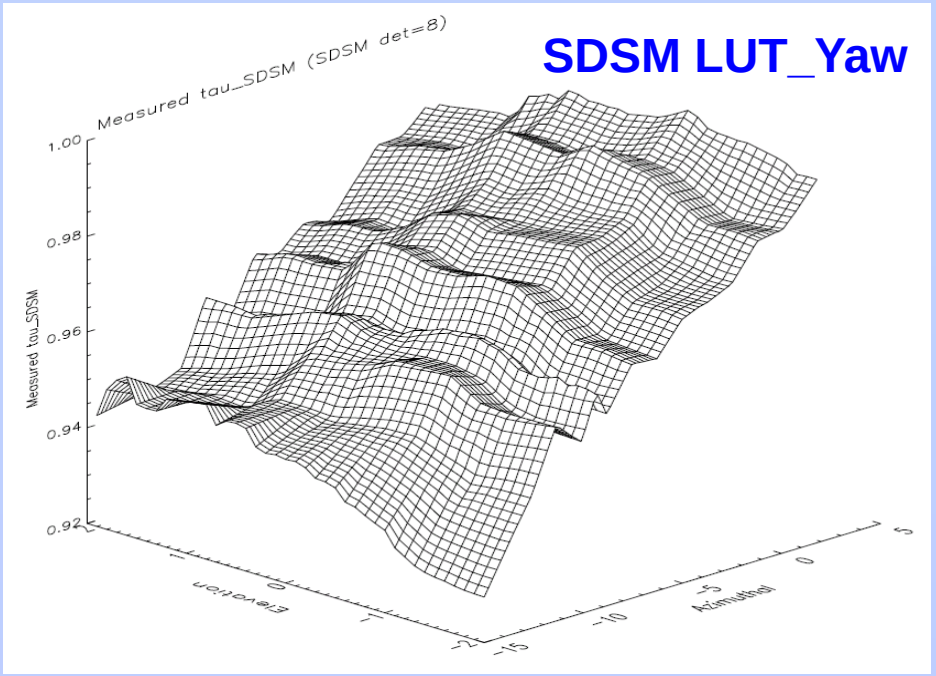


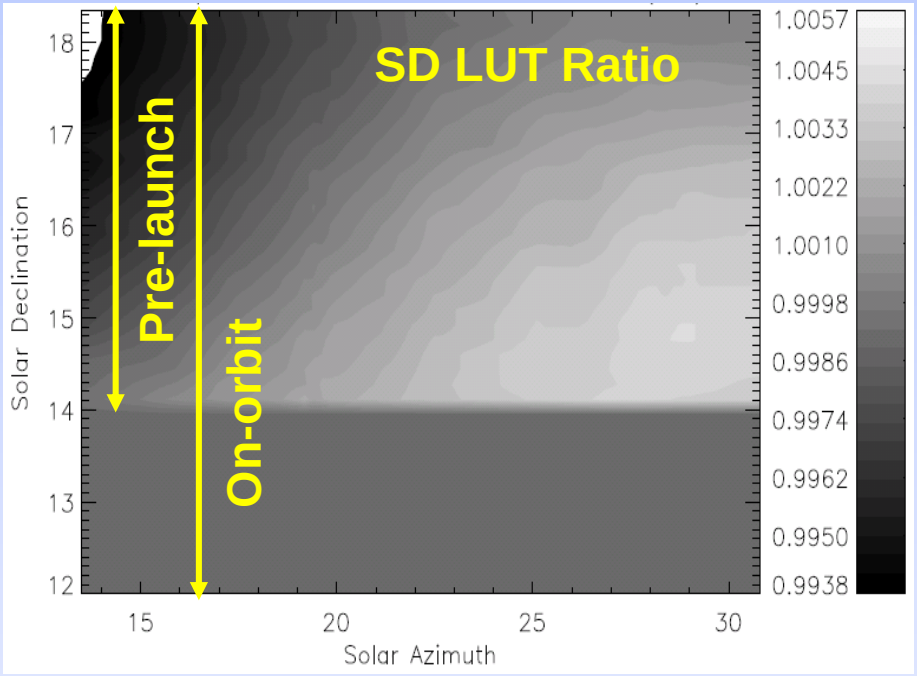
dn: VIIRS/SDSM detector "corrected" responses

Calibration Improvements

- **What**
  - SD Degradation (H-factor)
  - RSB Calibration Coefficients (F-factors)
  - RSB Relative Spectral Response (RSR)
  - DNB Calibration
- **How**
  - SDSM Screen (τ_{SDSM}) and SD Screen (τ_{SD}) and BRF
    - **Yaw maneuver data**
    - **Yaw maneuver and on-orbit data**
  - Modulated Relative Spectral Response (RSR)
    - **Wavelength dependent RTA mirror degradation**
  - Correction for the solar vector error (discovered in the IDPS SDR Geo library file) applied to all impacted calibration parameters



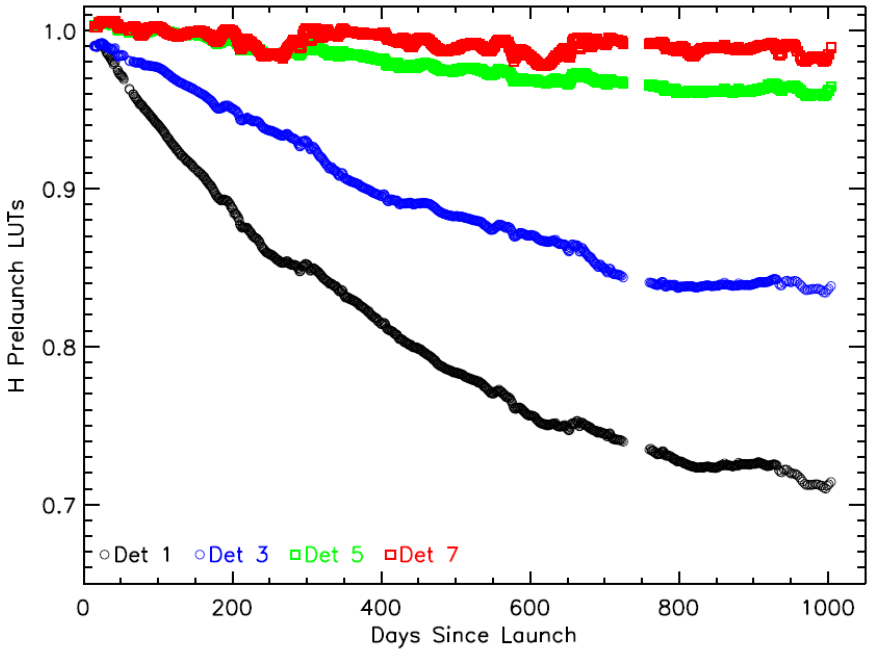


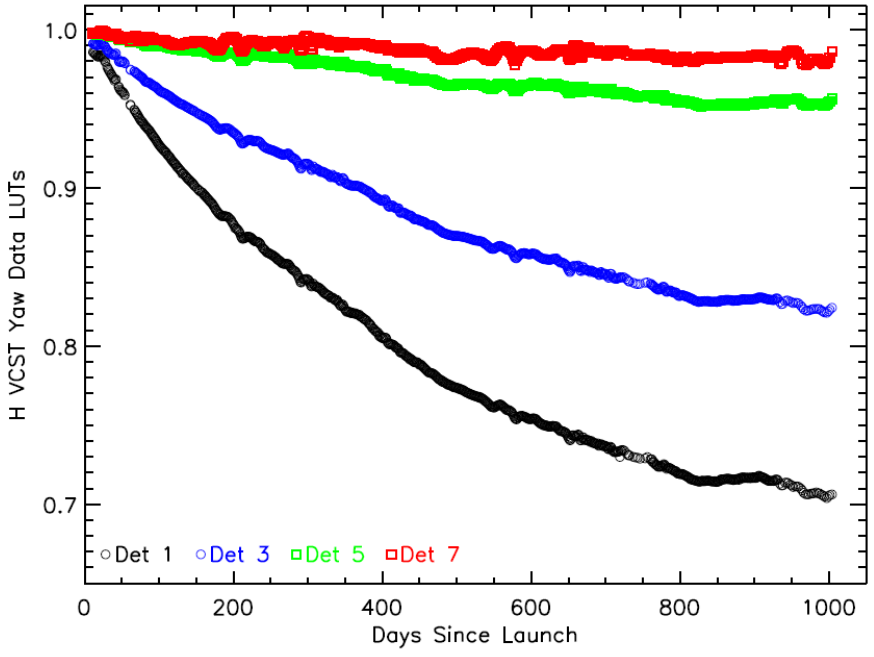


SD and SDSM LUTs derived from yaw maneuver data

Additional improvements made by adding SD calibration data to fill the gaps

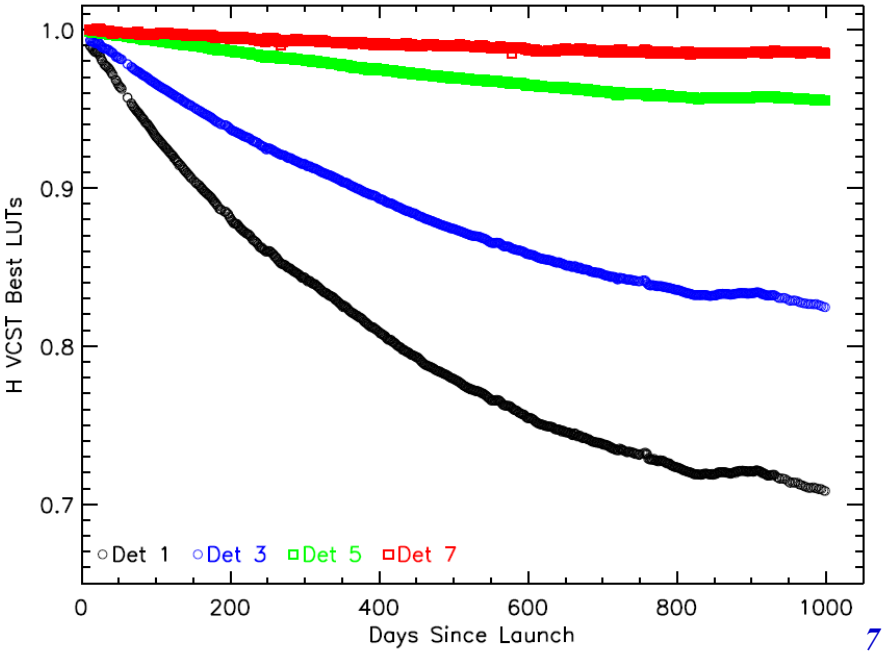
Larger range
Better resolution



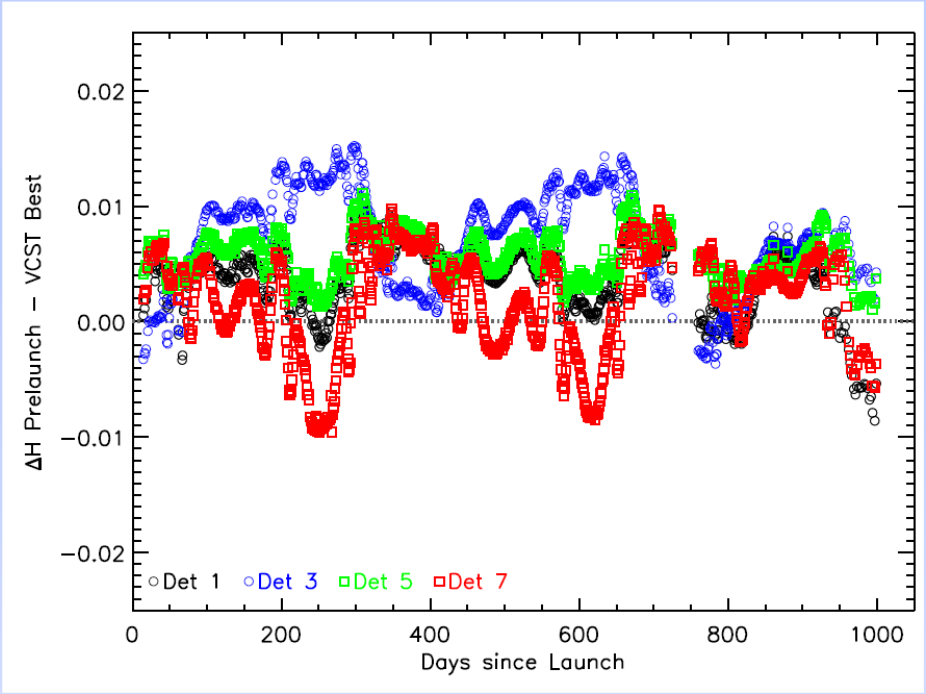


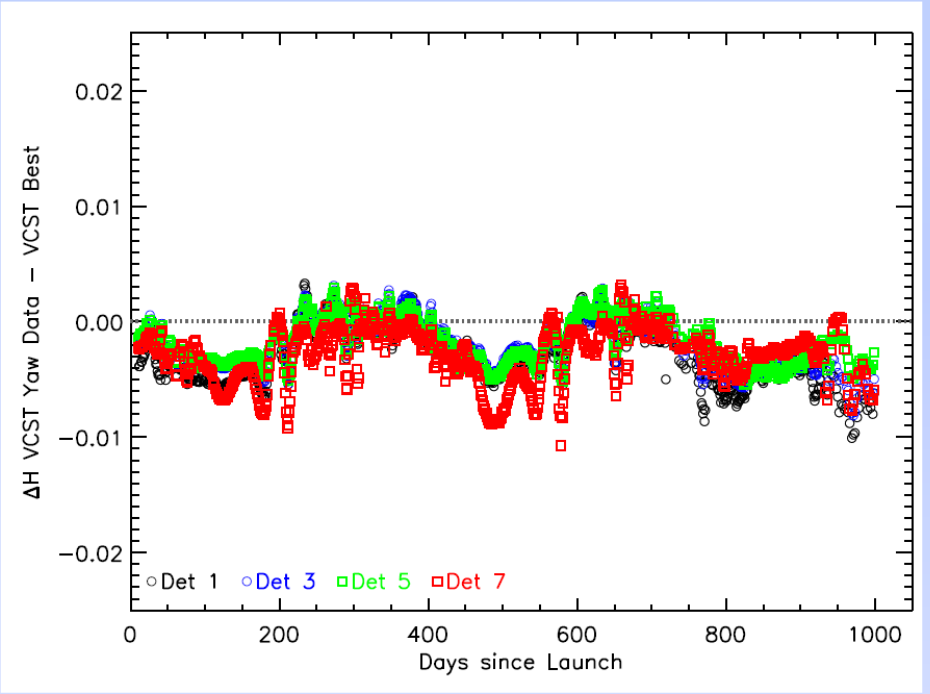
H-factors using LUTs derived from:

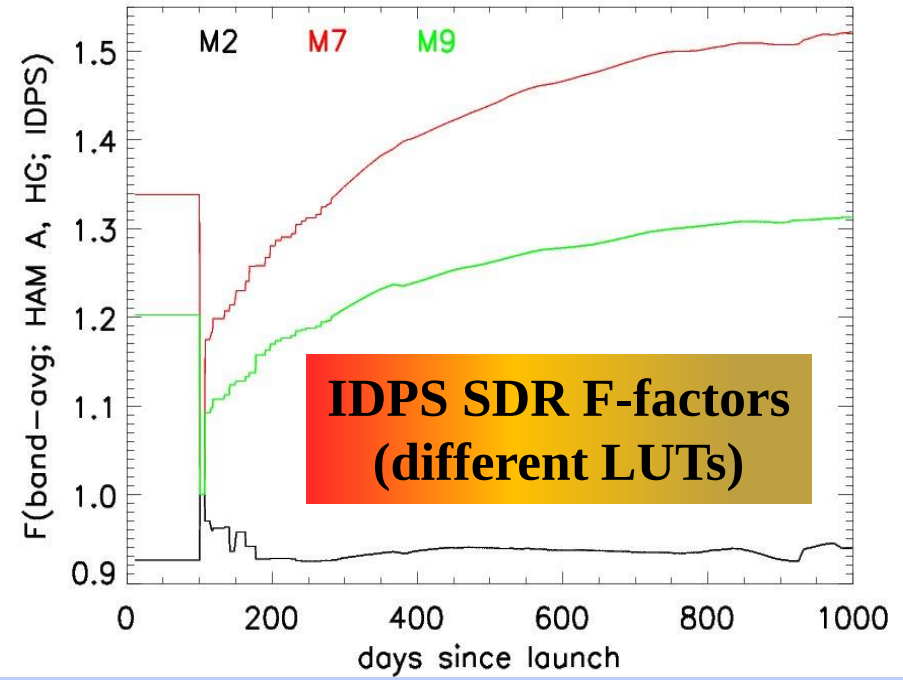
Pre-launch measurements
Yaw maneuver data
Yaw + selected on-orbit data

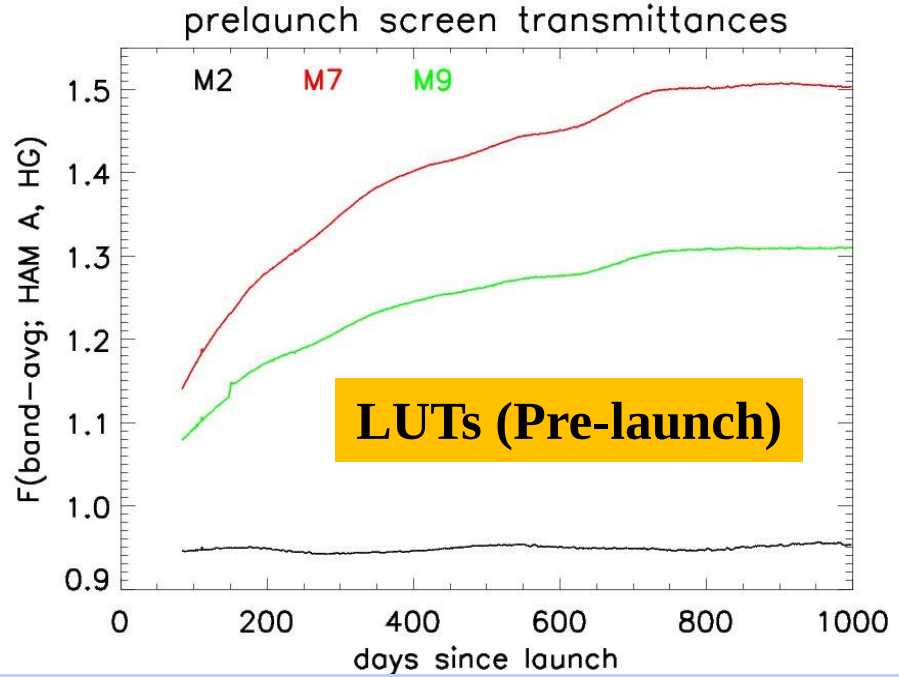


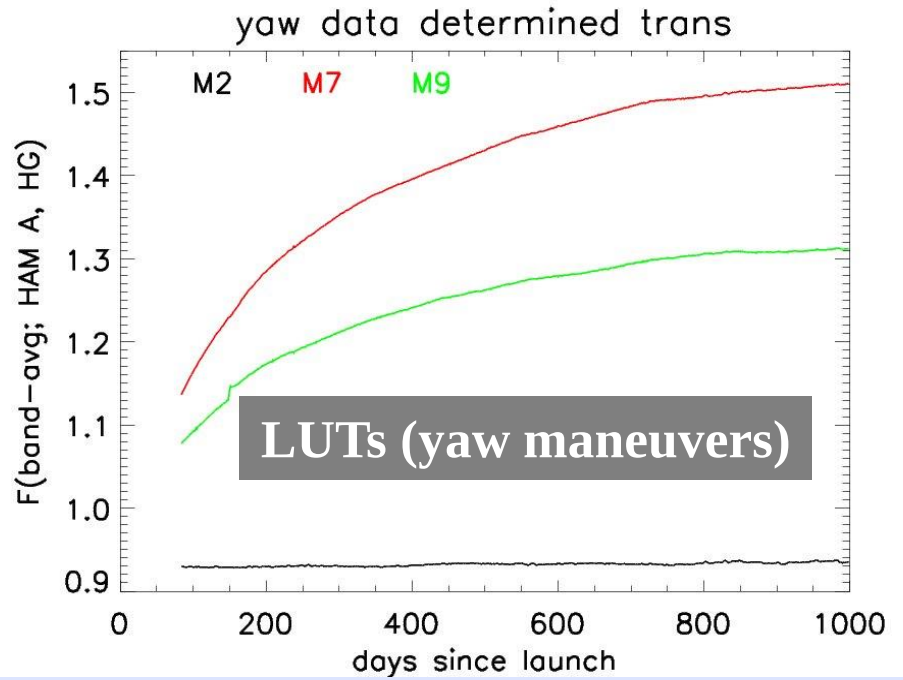
Comparison of H-factors derived from different LUTs

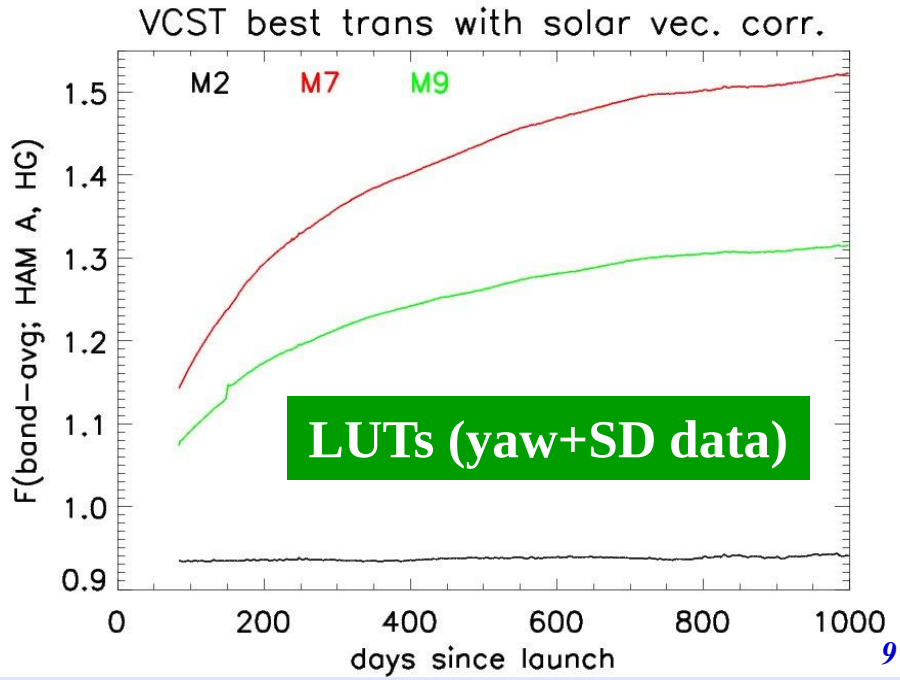


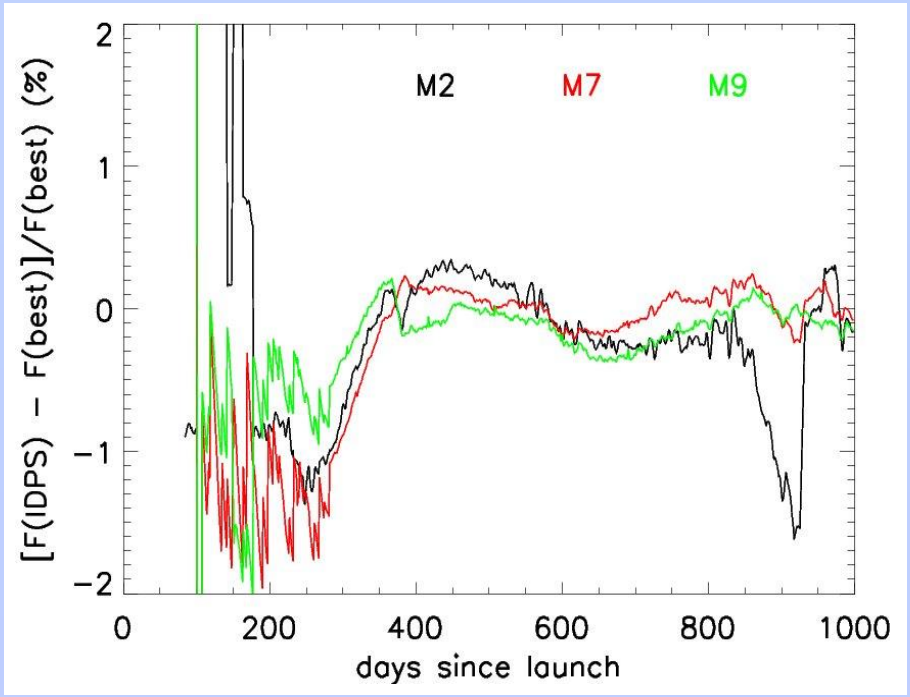


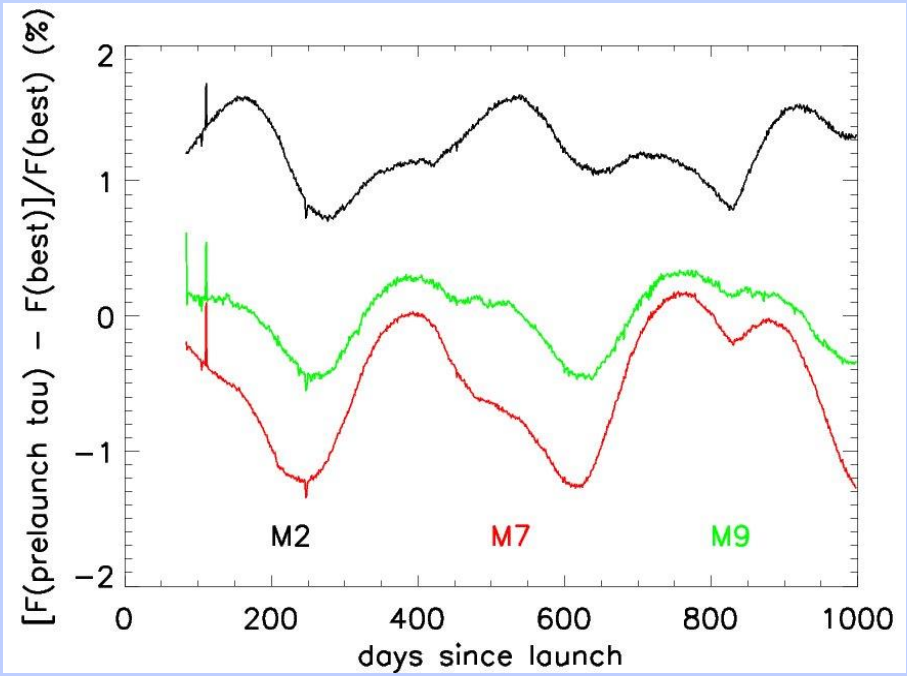

M2
M7
M9
F(band−avg; HAM A, HG; IDPS)
days since launch
IDPS SDR F-factors
(different LUTs)

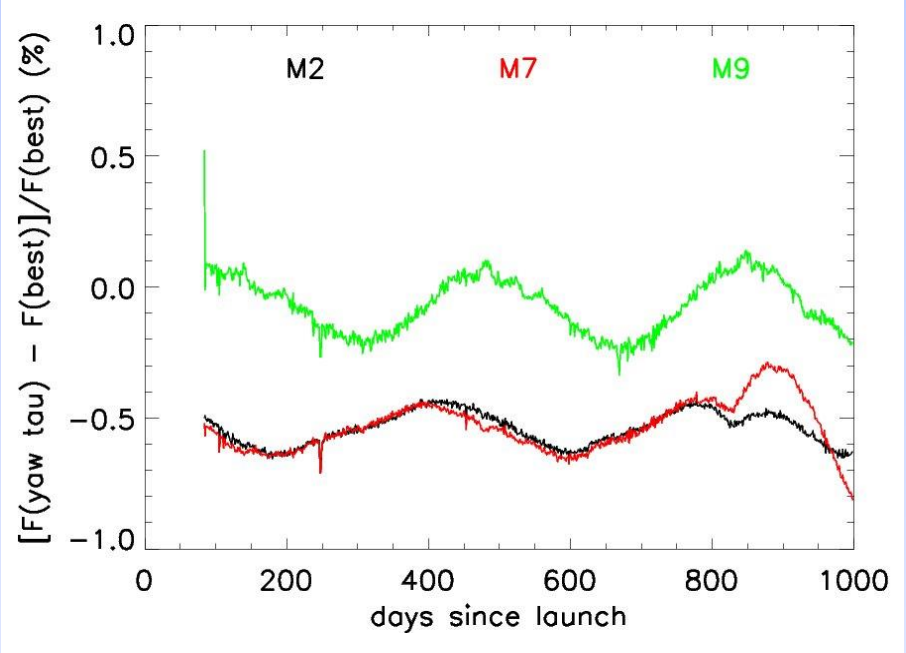

prelaunch screen transmittances
M2
M7
M9
F(band−avg; HAM A, HG)
days since launch
LUTs (Pre-launch)


yaw data determined trans
M2
M7
M9
F(band−avg; HAM A, HG)
days since launch
LUTs (yaw maneuvers)


VCST best trans with solar vec. corr.
M2
M7
M9
F(band−avg; HAM A, HG)
days since launch
LUTs (yaw+SD data)

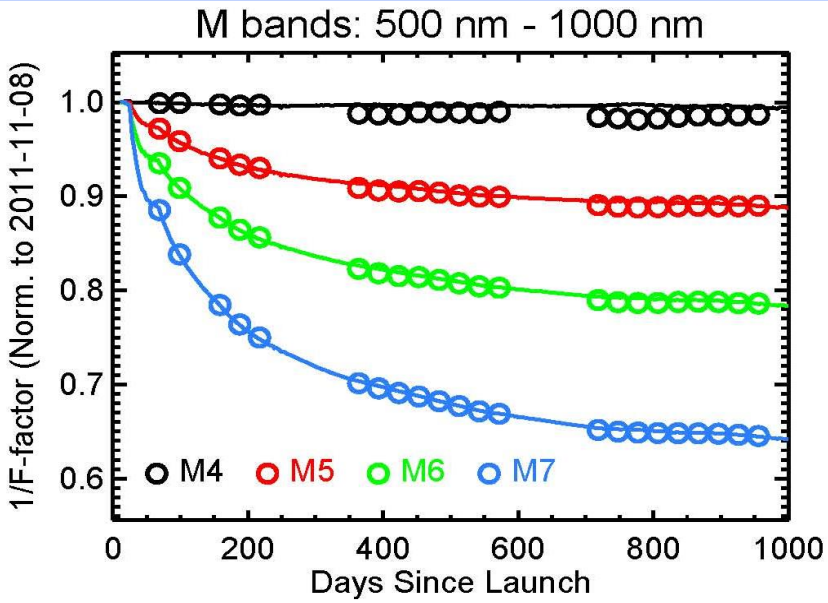


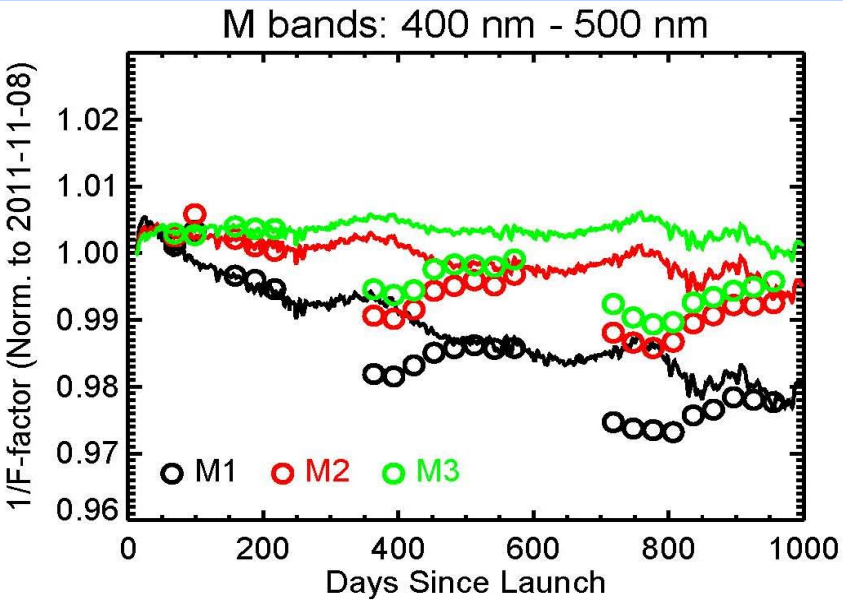


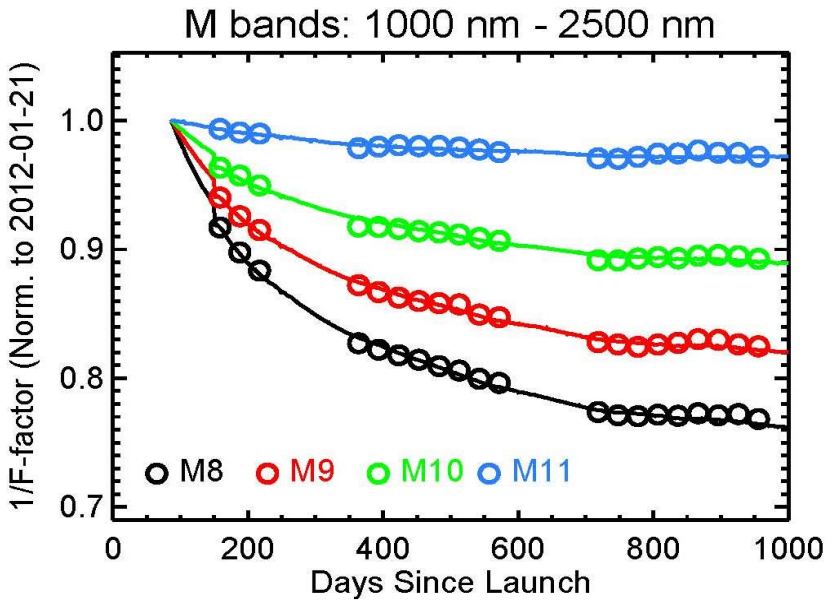


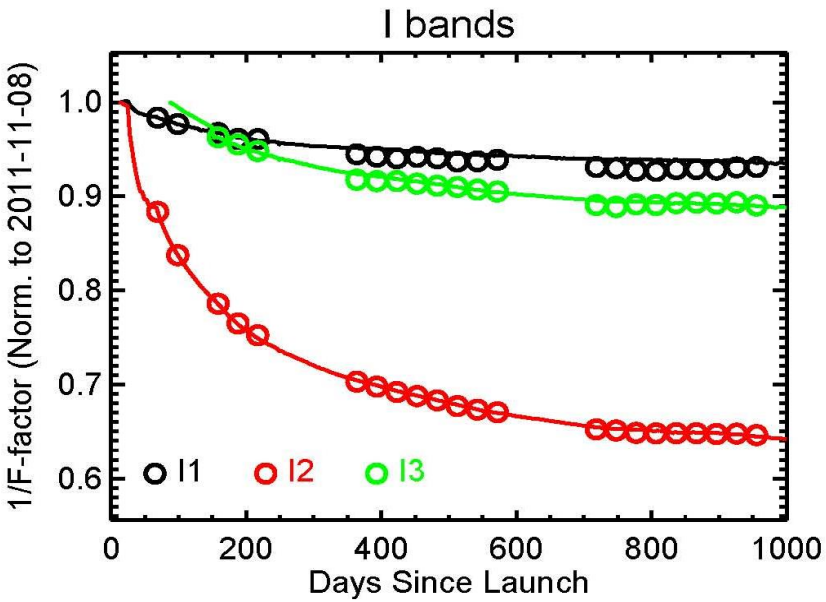
Comparison of F-factors derived using different LUTs

Comparison of F-factors from SD and Lunar Calibration





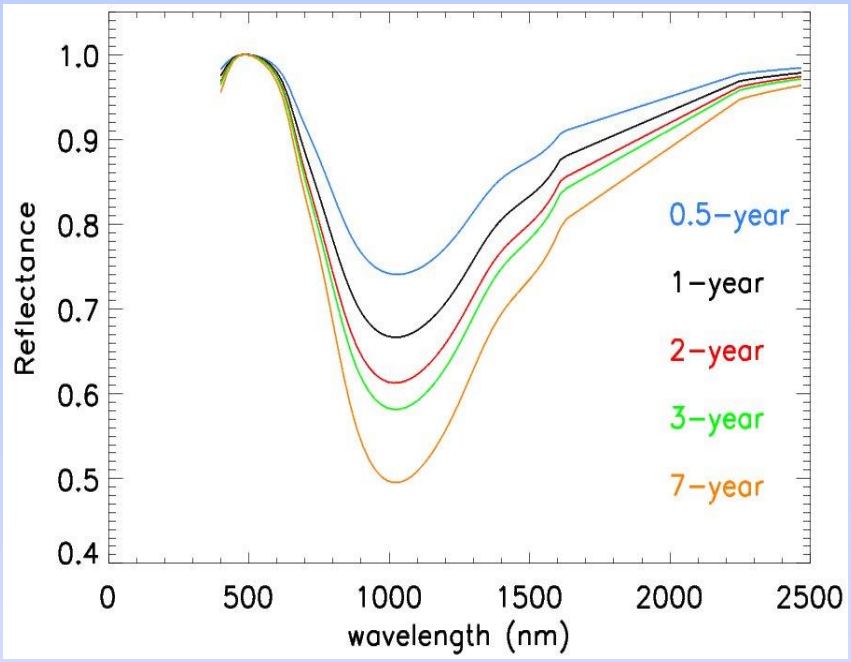


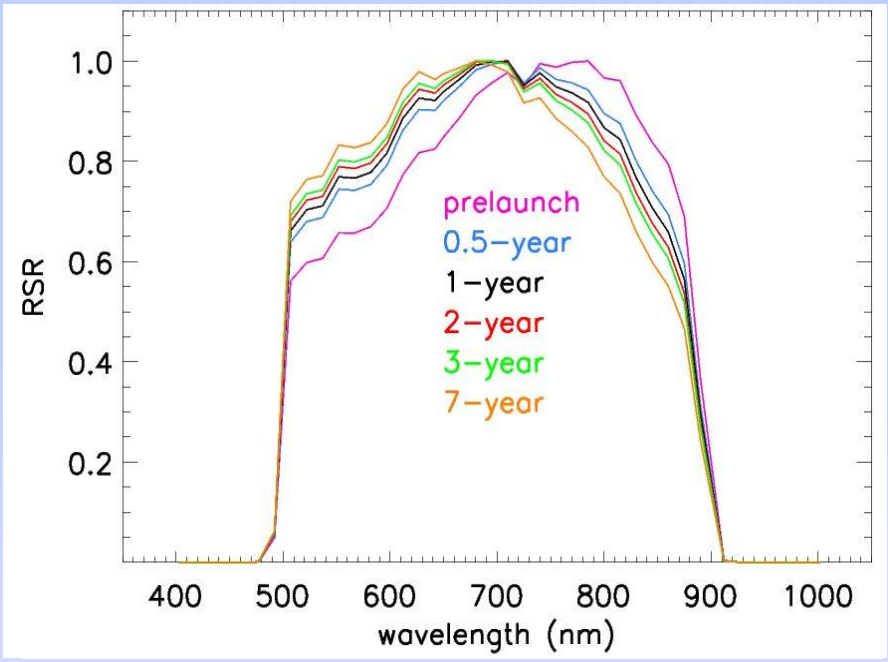


Modulated RSR and Calibration Impact

Mirror Degradation Impact on Sensor Relative Spectral Response (RSR) (IB and OOB)

Large impact for bands with broad bandwidths (e.g. DNB)



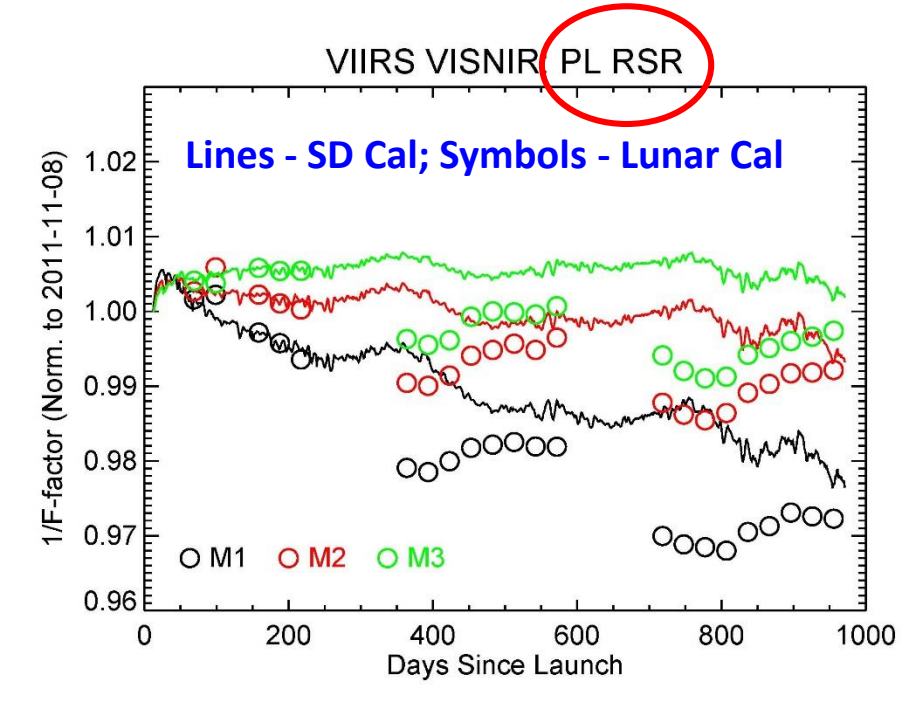


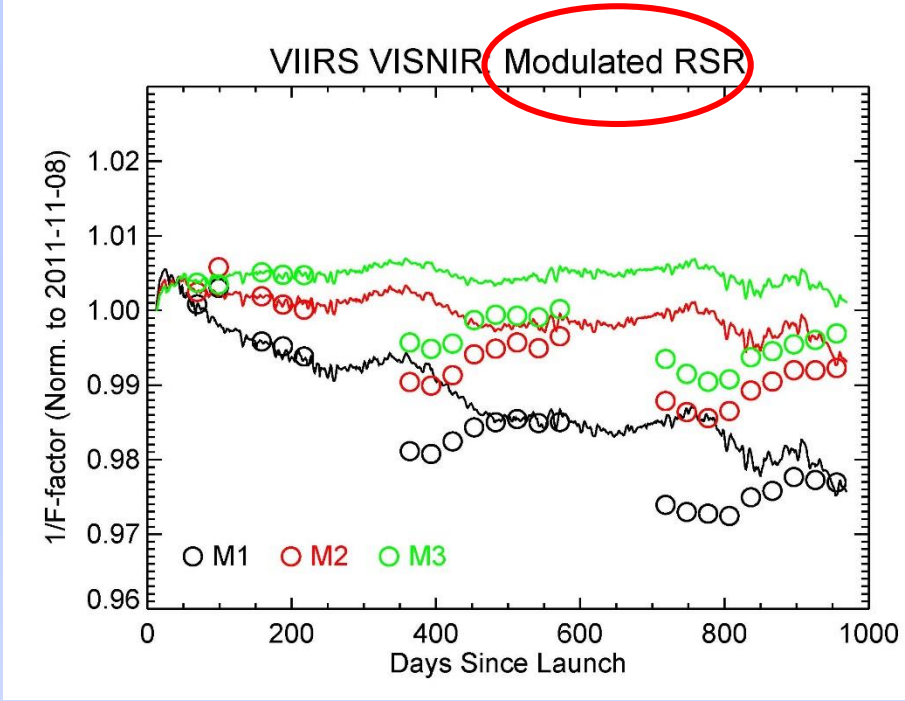
λ dependent optics degradation

Small impact for bands of narrow BW but with non-negligible OOB (e.g. M1)

Modulated RSR and Calibration Impact

Modulated RSR should be applied to both solar and lunar calibration



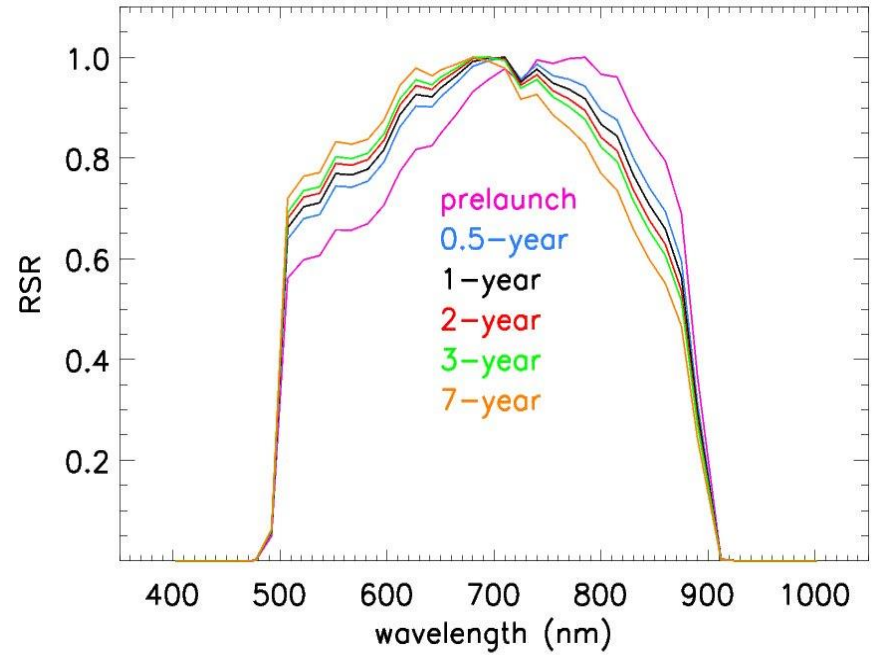


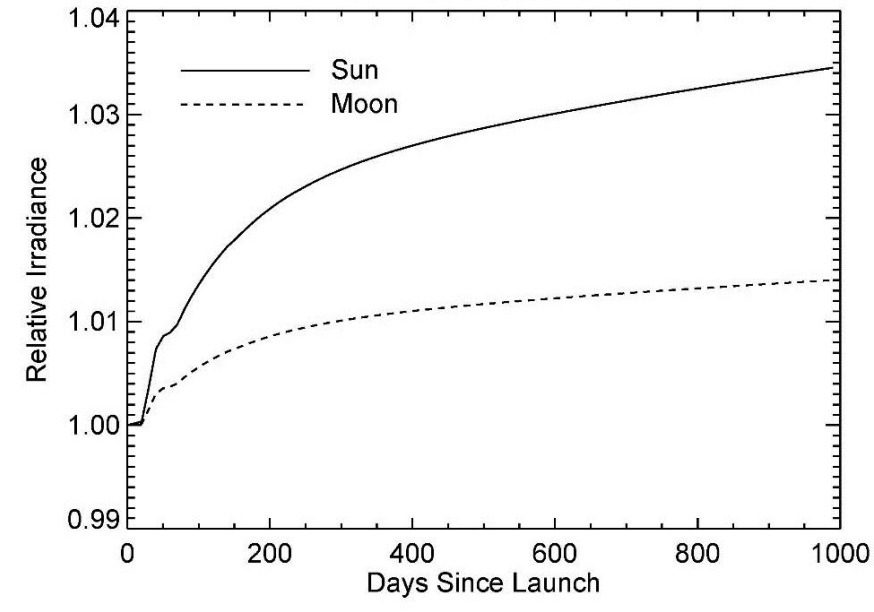
Future effort needed to resolve seasonal variations

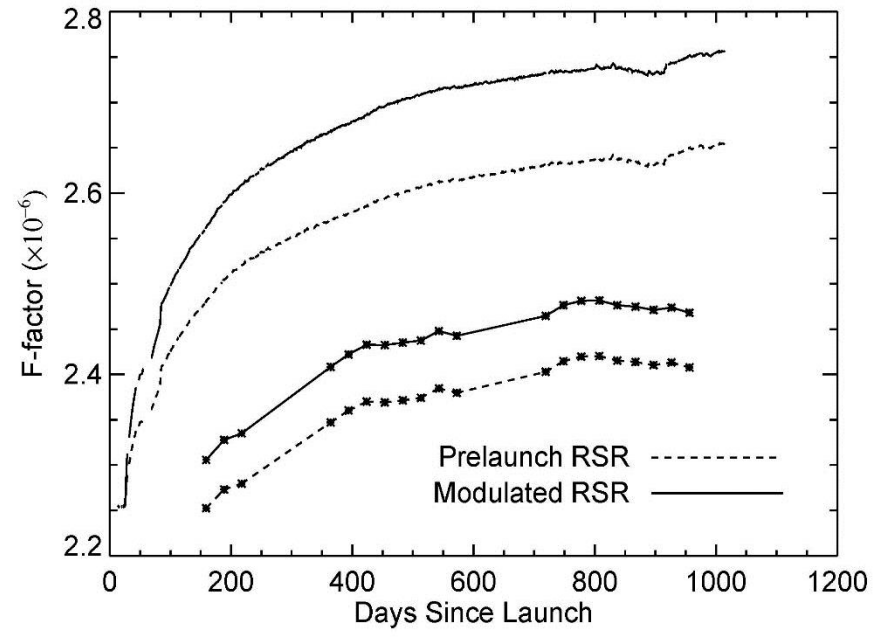
- Lunar model
- SD calibration

Modulated RSR and DNB (SD and Lunar) Calibration

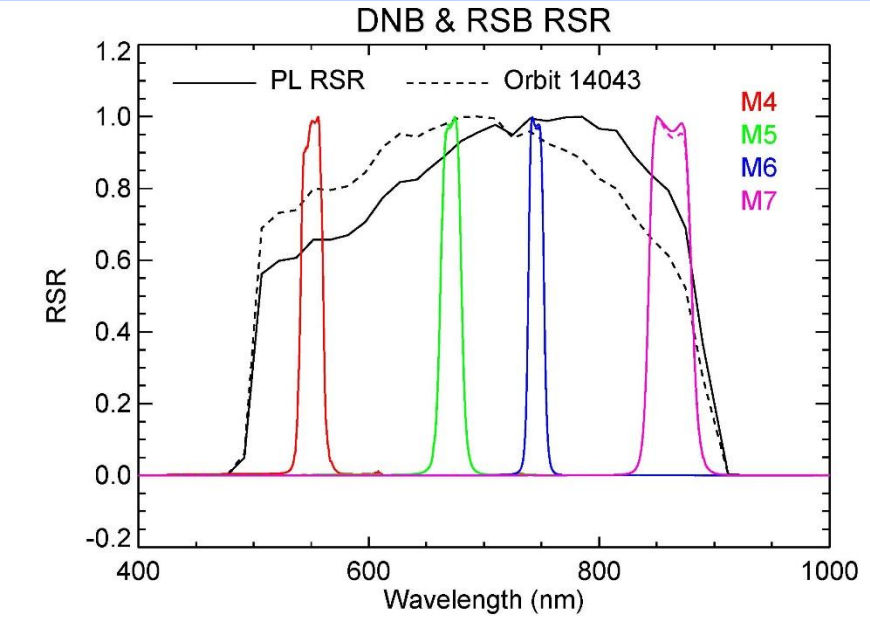
Different impact on solar and lunar irradiance (source)

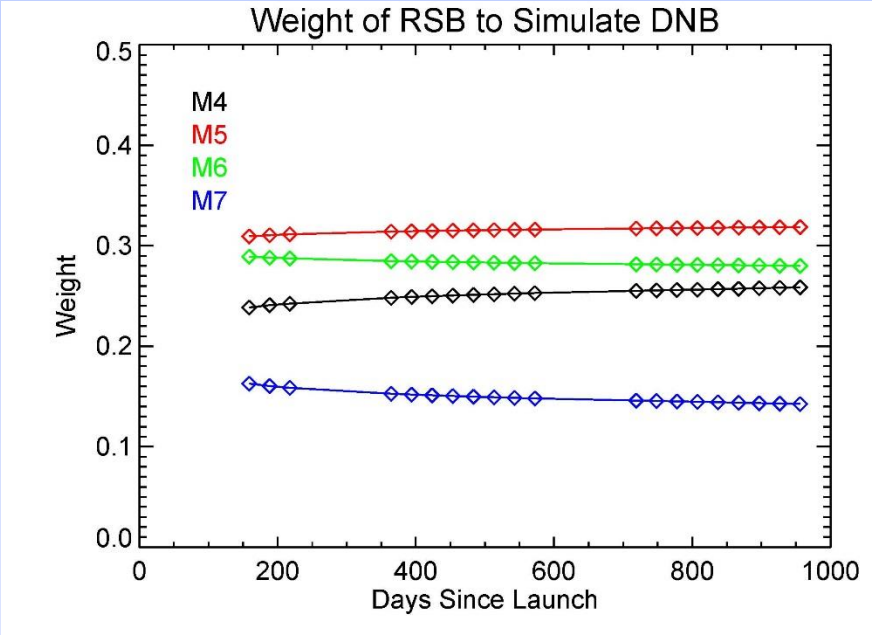


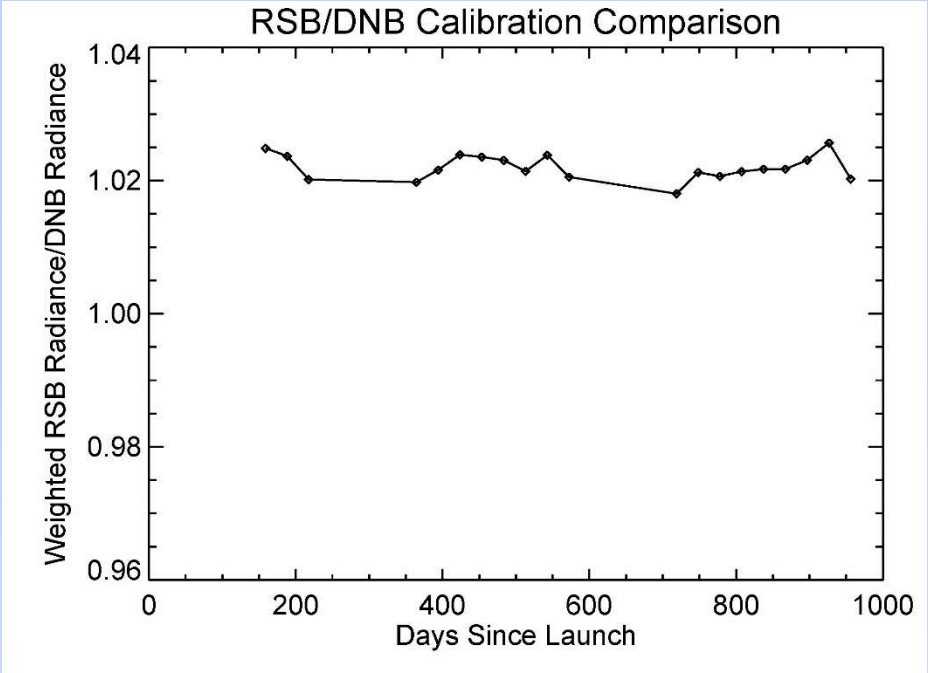




DNB and RSB Calibration Inter-comparison







Excellent Agreement!

Summary and Future Effort

- **A number of improvements have been made for S-NPP VIIRS RSB solar and lunar calibration**
  - SD degradation
  - RSB calibration LUTs (gains)
  - Modulated RSR (in SD and lunar calibration)
  - DNB lunar calibration

- **Future effort**
  - Understand and resolve small difference between SD and lunar calibration
  - Improve SWIR calibration
  - Investigate modulated RSR impact on calibration and calibration inter-comparisons using ground (EV) targets
  - Enhance DNB calibration
  - Develop consistent calibration LUTs for the entire mission