VIIRS Reflective Solar Bands On-Orbit Calibration

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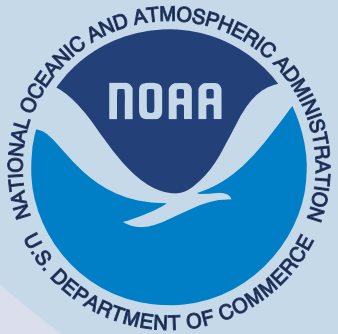
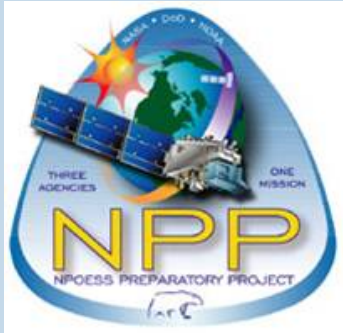
NOAA Ocean Color Team

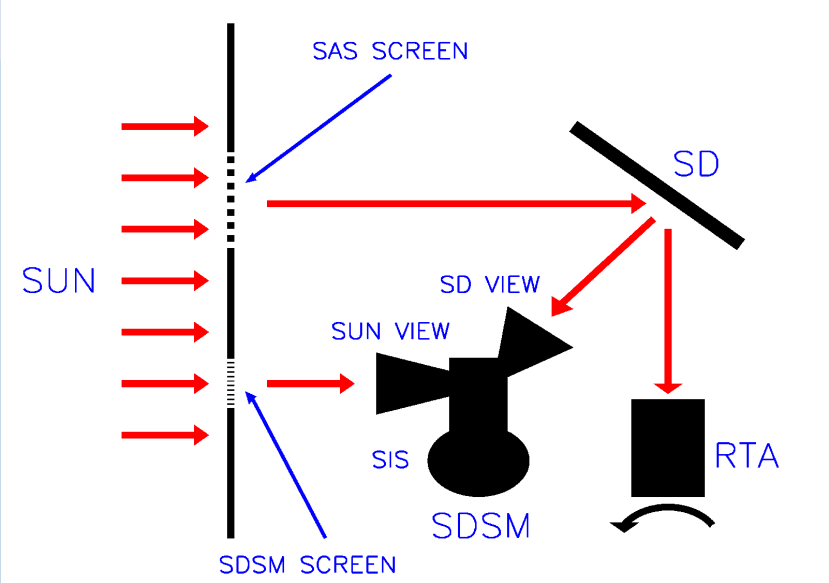




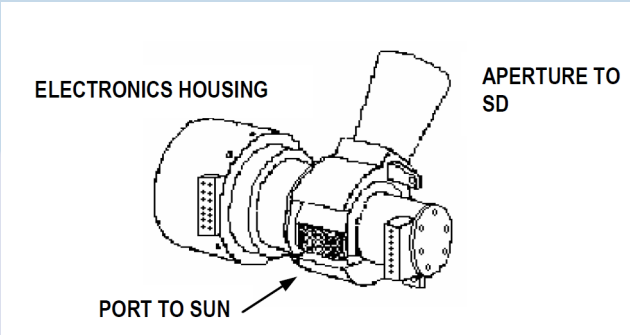
Outline

- SD/SDSM Calibration
- Lunar Calibration
- SD and Lunar F Factor Comparison
- Impact of the non-zero prelaunch C_0 and C_2

SD & SDSM System



Solar Diffuser (SD): Spectralon® plate provides radiometric ref. measurements for the 14 VIIRS RSB bands.



Solar Diffuser Stability Monitor (SDSM):
Rationing radiometer with 8 detector bands (0.41 to 0.94 μm). Seven bands have the same wavelength center as bands M1-M7.

SIS: Spherical Integrating Source
RTA: Rotating Telescope Assembly
SAS: Solar Attenuation Screen

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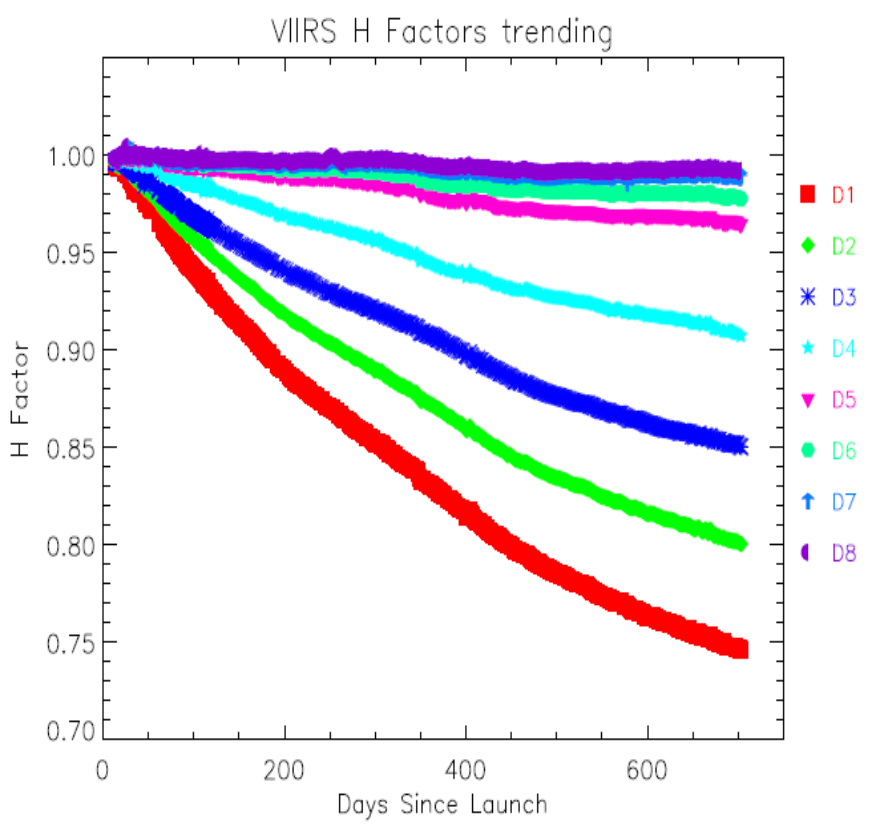
SD/SDSM Calibration

- SDSM Calibration
  - Obtain the SD on-orbit degradation namely H factors at the wavelengths corresponding to bands M1-M7 and 935 nm.
  - The SDSM is a ratioing radiometer that compares direct solar illumination with light transmitted by the solar attenuation screen (SAS) and then diffusely reflected off the SD.
  - The SDSM calibration is implemented every orbit early in mission and then once per day.
- SD Calibration
  - Obtain the calibration coefficients namely F factors for reflective solar bands (RSB), I1-I3 and M1-M11.
  - SD is a space-grade spectralon panel with its reflectance measured prelaunch and verified on-orbit.
  - The SD calibration is automatically operated every orbit when the VIIRS instrument passing over the south pole from the night side to day side of the Earth.

SD Degradation – H Factors



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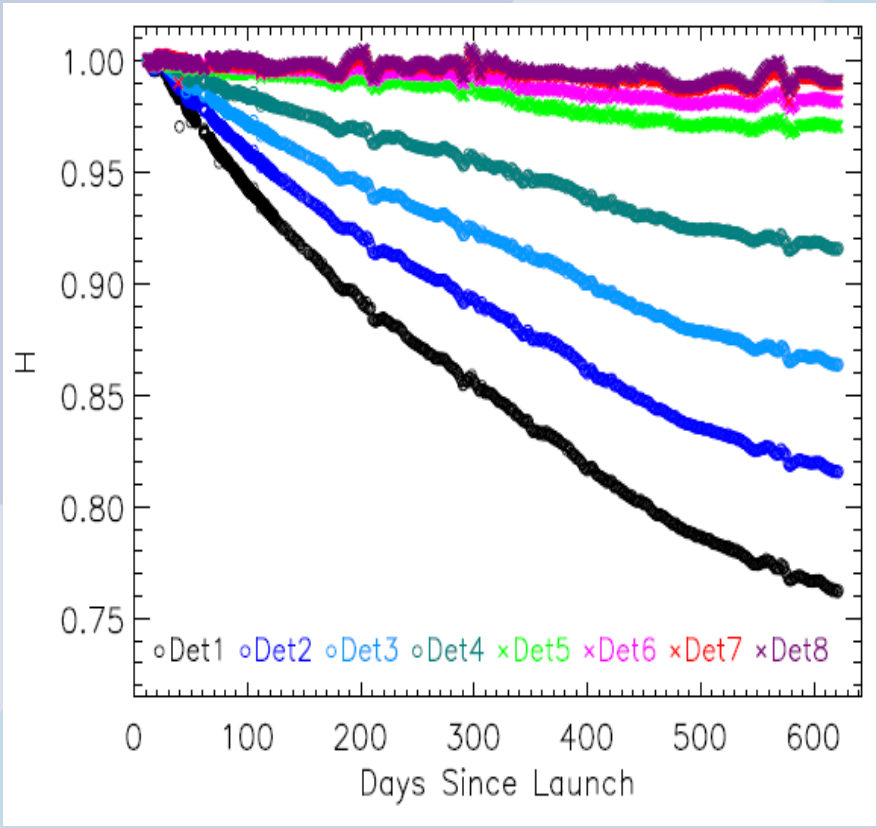

VCST VIIRS SD degradation trending, SPIE 2013, Fulbright et al.

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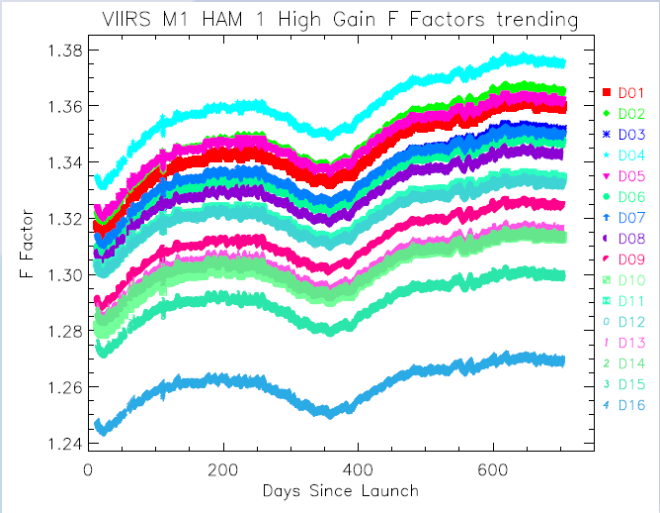
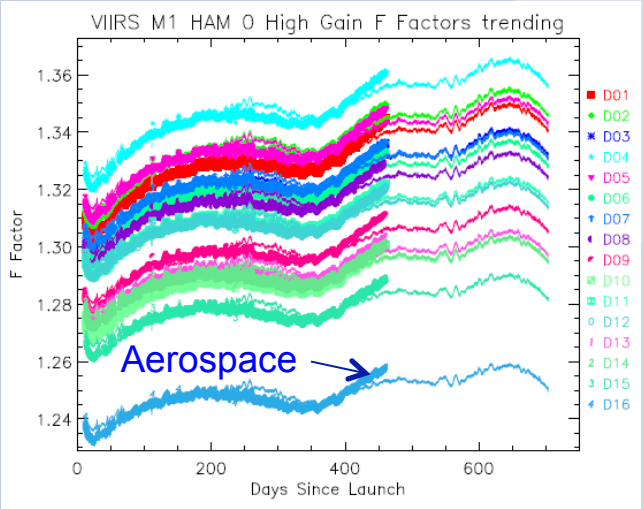
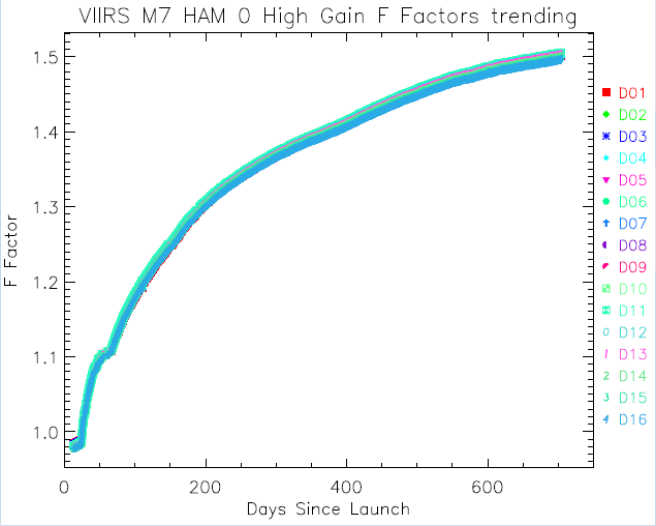
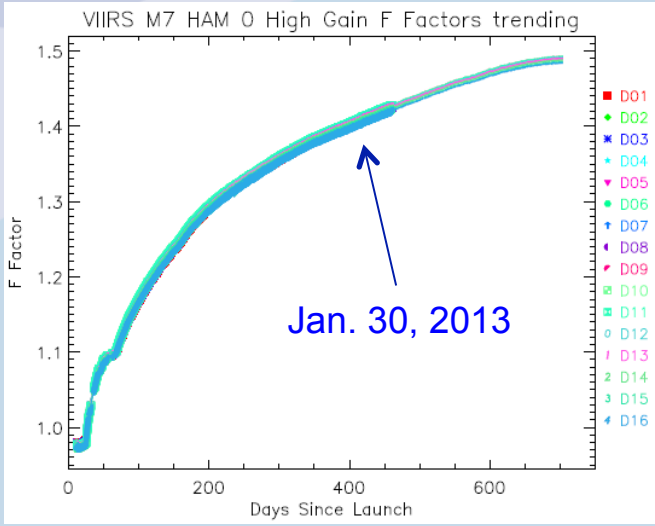
Calibration Coefficients – F Factors









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NOAA and Aerospace comparison

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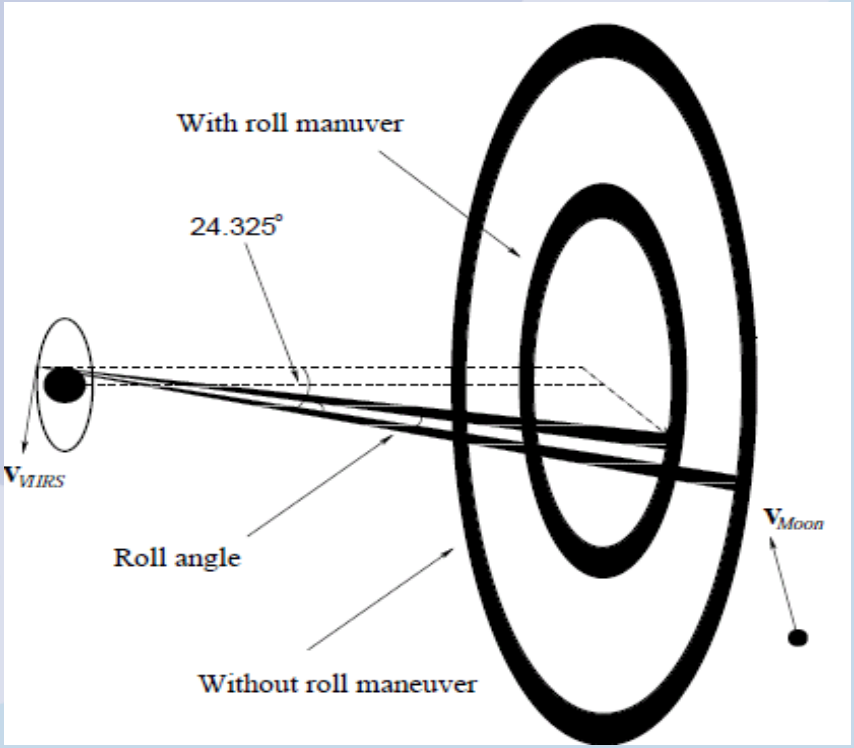
Lunar Calibration

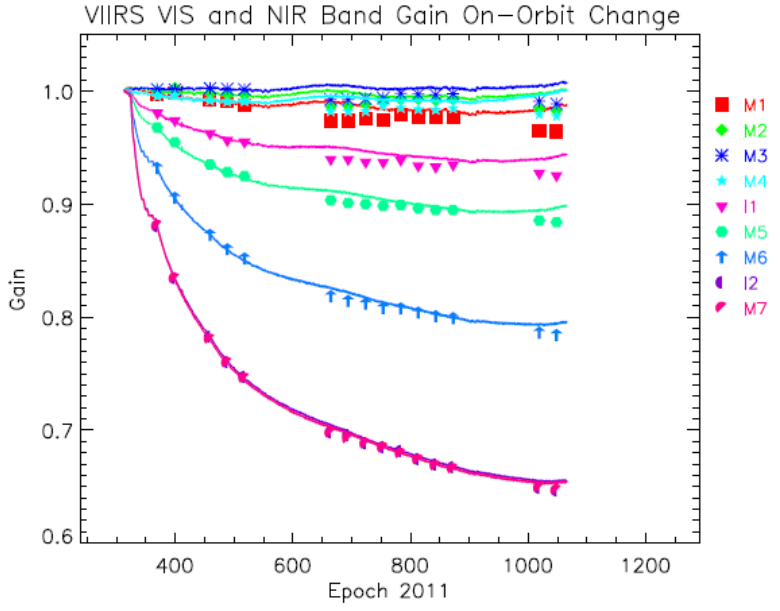
- Moon is an excellent radiometric reference
- Same as SD/SDSM calibration, Lunar measurements can provide VIIRS RSB calibration coefficients – F factors (normalized to first observation)
- VIIRS has been scheduled to view the moon monthly through its Space View (SV) since launch.
- The Moon can be observed in nine months each year
- For VIIRS, the Angle of Incidence of the SV is exactly the same as that of the SD.

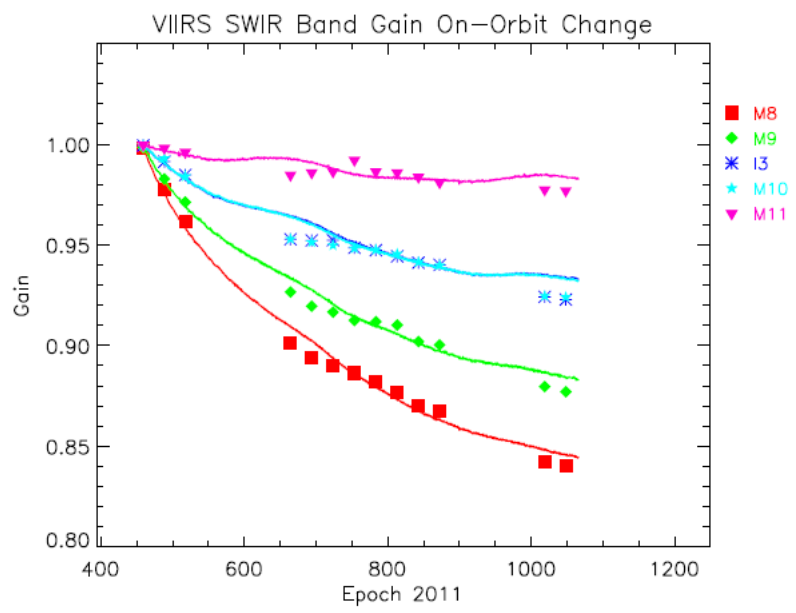


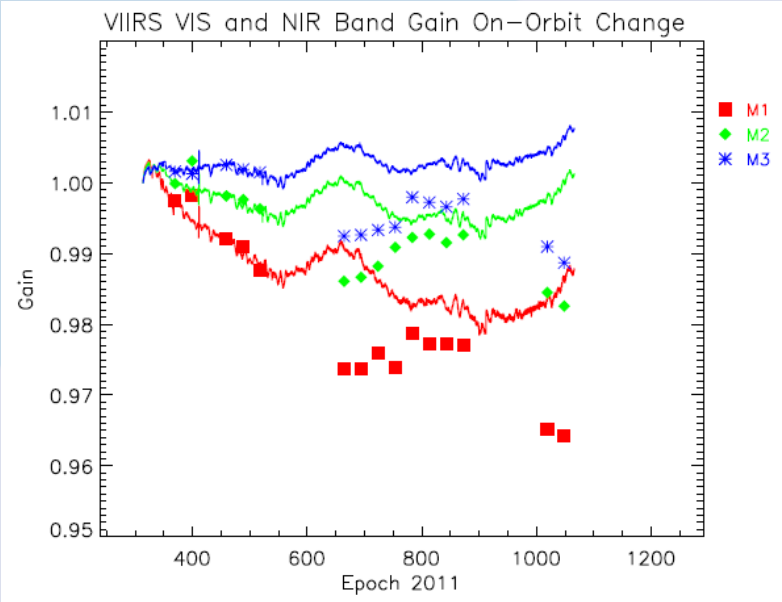
VIIRS Roll Maneuver
- Roll Angle: -14° --- 0°
- Phase Angle: -56° --- -55°; -51.5° --- -50.5°

So far, there are 16 successfully scheduled lunar calibrations

Calibration Coefficients – Lunar F Factors







- Symbols are lunar F Factors
- Curves are SD F factors
- Disagreement between SD and lunar calibration, especially in autumn-winter time period every year for short-wavelength bands
- No correction for on-orbit RSR change yet, which reduces the differences between the two sets of F factors

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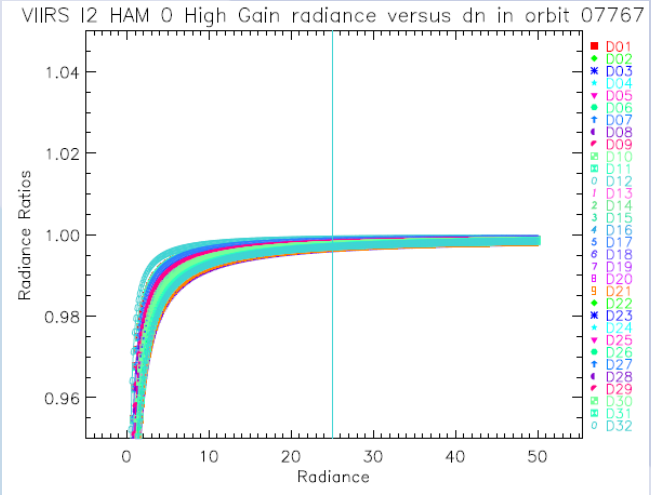
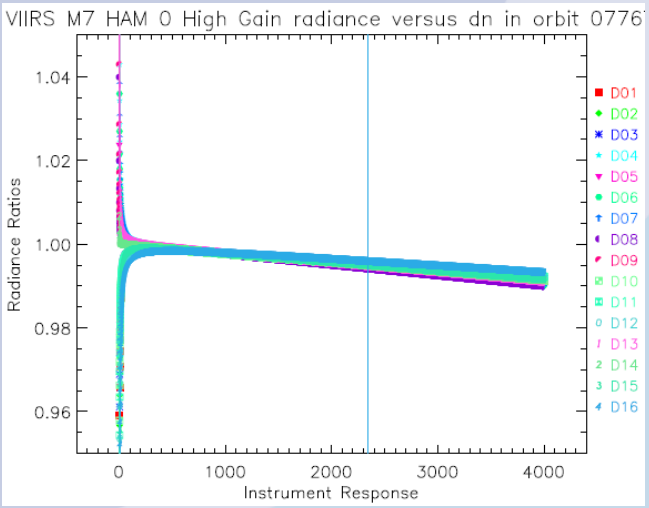
Impact of the non-zero C_0 and C_2





- F factors are calculated with prelaunch C_0 and C_2 and without them (force them to be zero), respectively
- Radiance are calculated with non-zero and zero C_0 and C_2 using the corresponding F factors, respectively
- The curves and symbols are the ratios of the two sets of radiance

- Prelaunch C_0 has large impact on I2 at low radiance. It may induce striping in the ocean surface images and large radiometric uncertainty , especially for dark ocean.
- Prelaunch C_0 has much less impact on M7 at low radiance while C_2 may have noticeable impact around typical radiance.

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Summary

- We have developed the capability to calculate ocean color sensor SD degradation – H Factors, which are consist with those obtained by other groups but are smother and more stable.
- We have also developed the capability to calculate RSB calibration coefficients – F Factors, which are consist with those obtained by other groups with same or better data quality.
- We have our own capability to calculate the F factors from the lunar observations.
- The SD and lunar F Factors are consistent but have some discrepancy around autumn time period every year for short wavelength bands.
- The non-zero prelaunch C_0 and C_2 may induce striping in EV images and large radiometric uncertainty at dark ocean regions, especially for image bands.