VIIRS Reflective Solar Bands Calibration Improvements with Hybrid Approach

Junqiang Sun[1,2] and Menghua Wang[1]

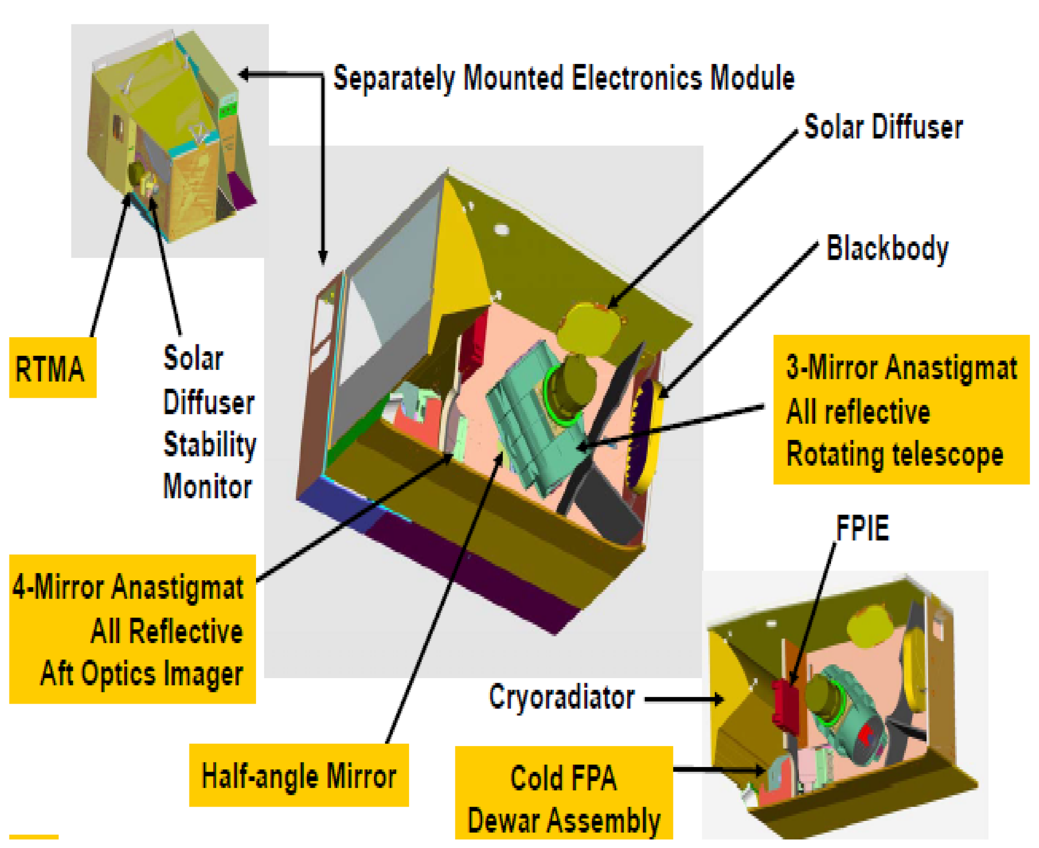
[1]NOAA/NESDIS/STAR, NOAA Science Center, College Park, MD; [2]Global Science & Technology, Greenbelt, MD

Introduction

Background

- VIIRS is one of five instruments onboard the S-NPP satellite that launched 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.
- RSB are calibrated on-orbit using a Solar Diffuser (SD) with a Solar Diffuser Stability Monitor (SDSM) and near-monthly lunar observations.
- The ocean color products have very stringent requirements for the RSB calibration, especially for long-term stability, with ~0.1%.

Instrument



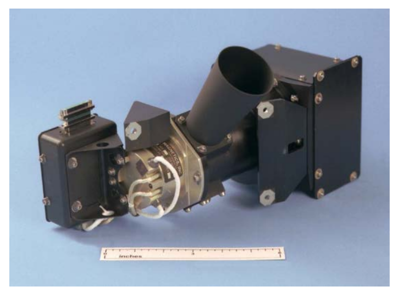
SDSM Calibration

Algorithm

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

- *BRFSDSM*: SD prelaunch BRF for SDSM view
- *τSun*: VF of the sun view screen
- *τSD*: VF of the SD screen
- *θSD*: AOI on SD surface
- *dcSD*: Background subtracted SDSM SD view response
- *dcSun*: background subtracted SDSM Sun view response

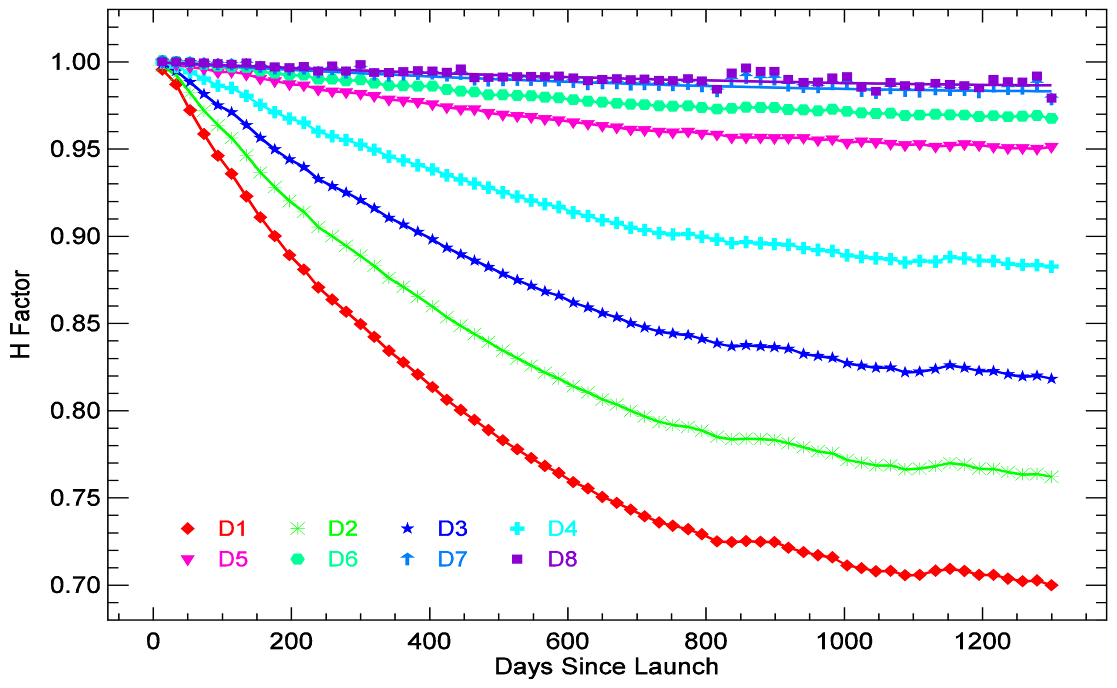
SDSM



SD on-orbit degradation

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

SD Degradation



SD Calibration

Algorithm

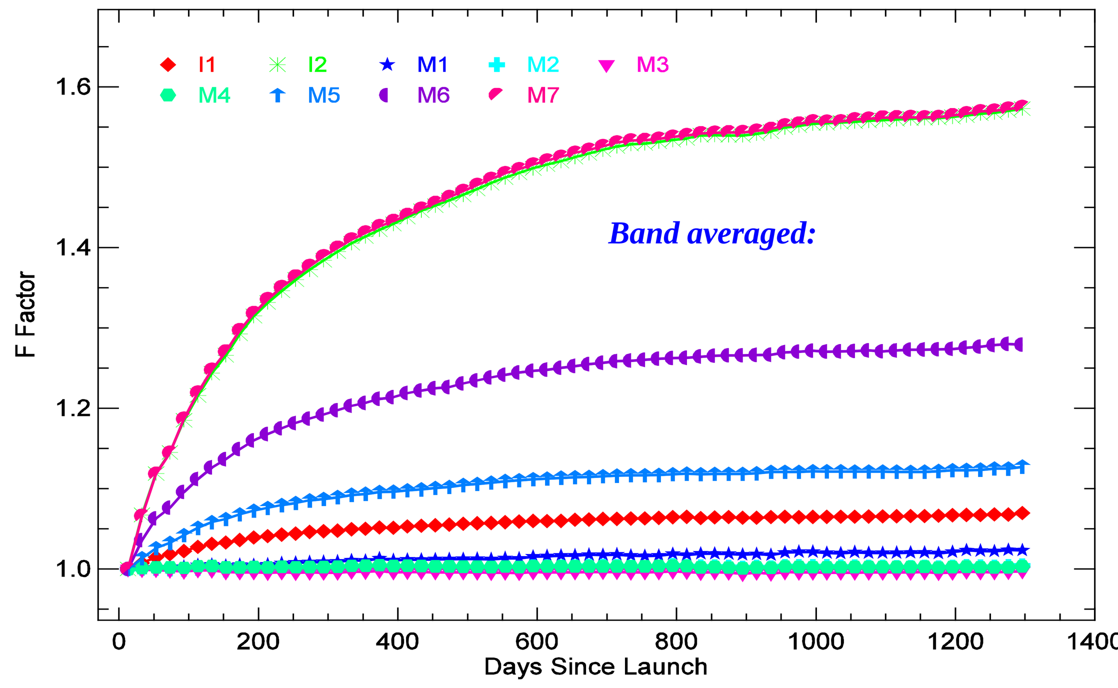
$$F(t)=\frac{RVS_{B,SD}\cdot\int RSR_B(\lambda)\cdot L_{SD}(\lambda)\cdot d\lambda}{\left(c_0+c_1\cdot dn+c_2\cdot dn^2\right)\cdot\int RSR_B(\lambda)\cdot d\lambda}$$

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

- *BRFSD*: SD prelaunch BRF for RTA view
- *RSRB*: Relative spectral response for band
- *c0, c1, c2*: Temperature effect corrected prelaunch calibration coefficients
- *ISun*: Solar irradiance
- *dn*: Background subtracted instrument response
- *RVSB,SD*: Response Versus Scan angle at AOI of SD for band B
- *dVS*: VIIRS~Sun distance

SD

Calibration Coefficients



Lunar Calibration

Algorithm

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

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

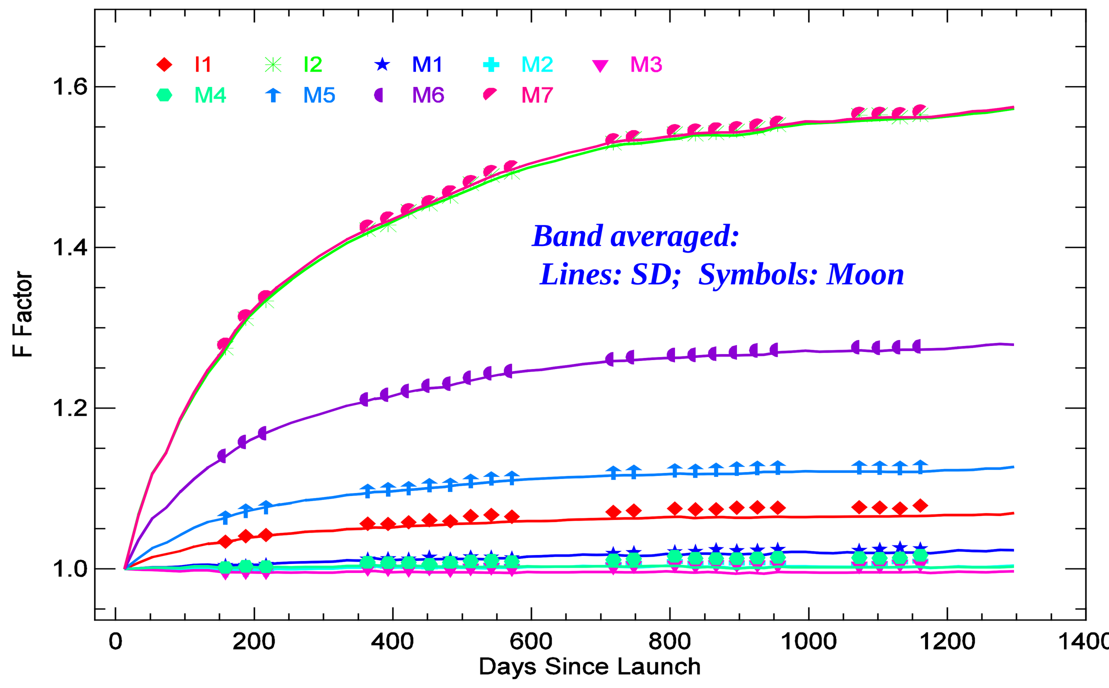
- *B, D, S, n*: Band, detector, sample, and HAM side
- *dnBMoon*: Background subtracted instrument response
- *NM*: Number of scan which views a full Moon with HAM M

Lunar Image

Relative lunar F factor

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

Calibration Coefficients



Hybrid Approach

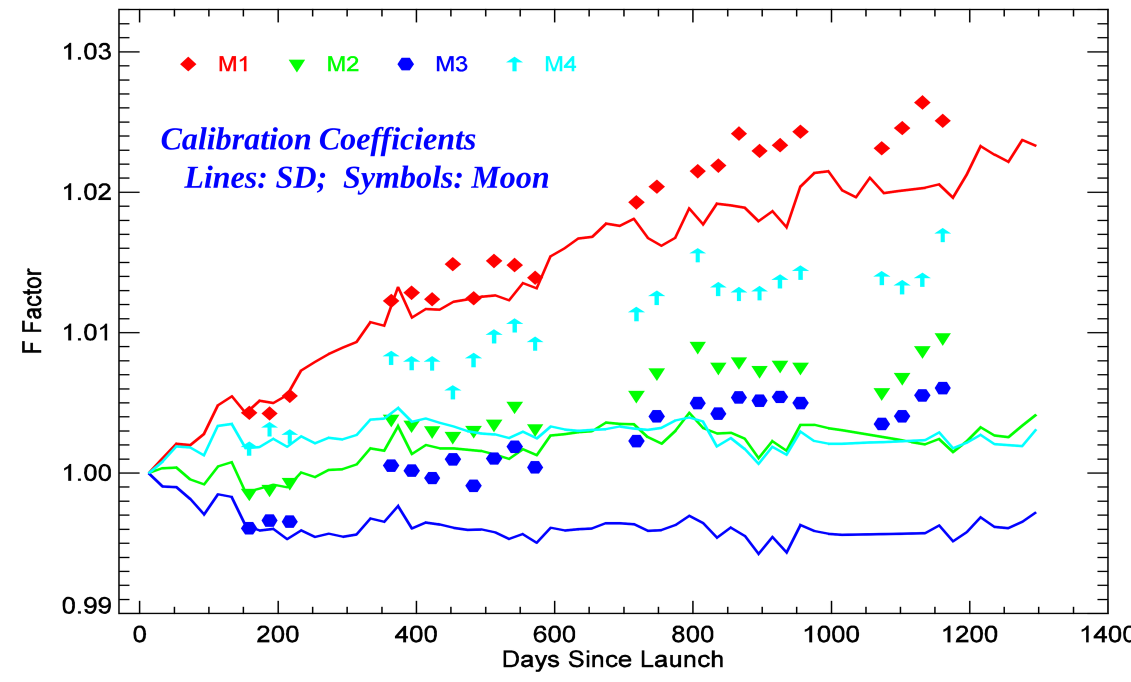
Algorithm

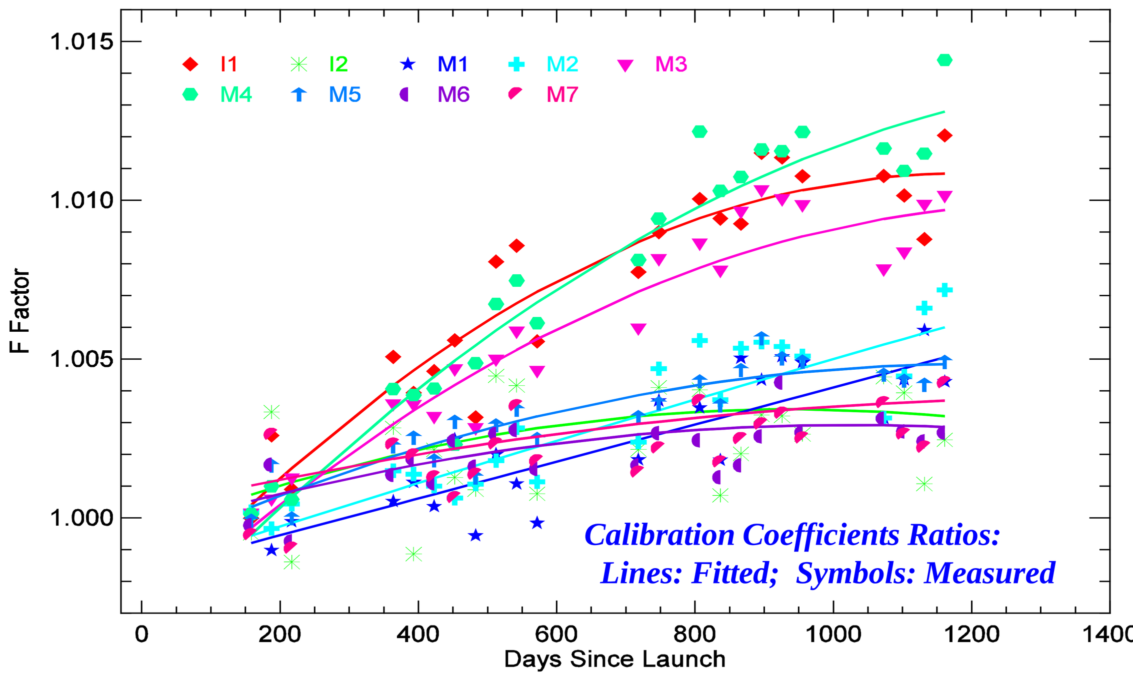
$$R(B,M,t)=f(B,M,t)/\left\langle F(B,D,M,0,t)\right\rangle_{D,t-15<t_i<t+15}$$

$$\mathcal{F}(B,D,H,G)=R(B,t)\cdot F(B,D,H,G)$$

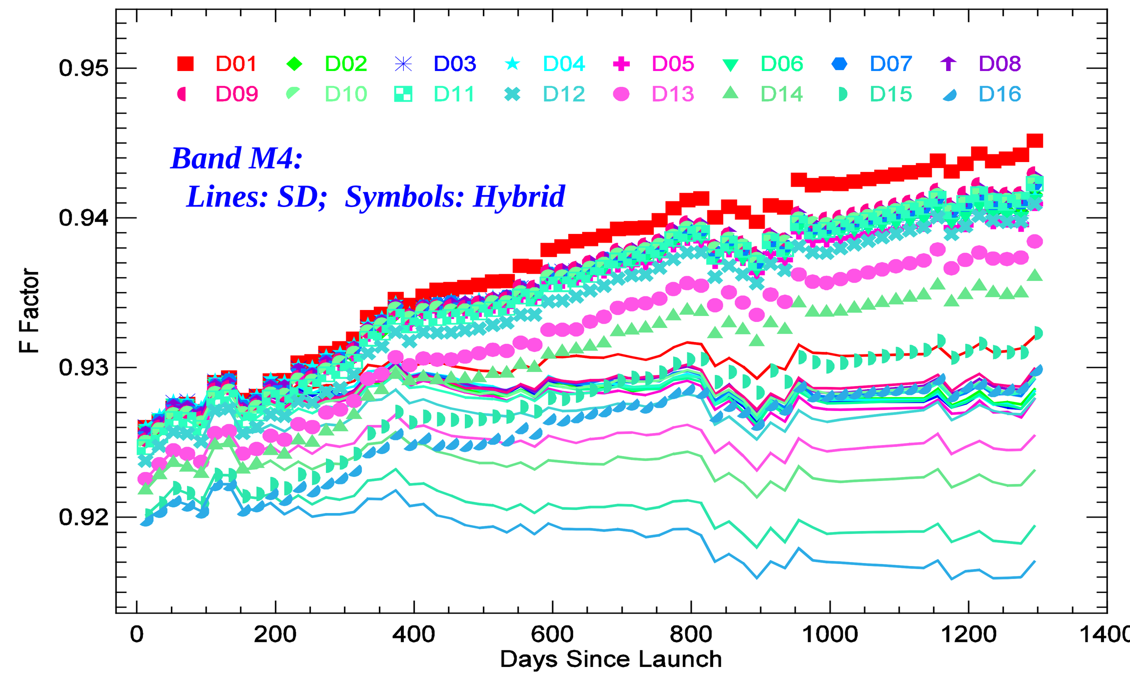
- Lunar calibration provides long-term baseline
- SD calibration provides smoothness and frequency

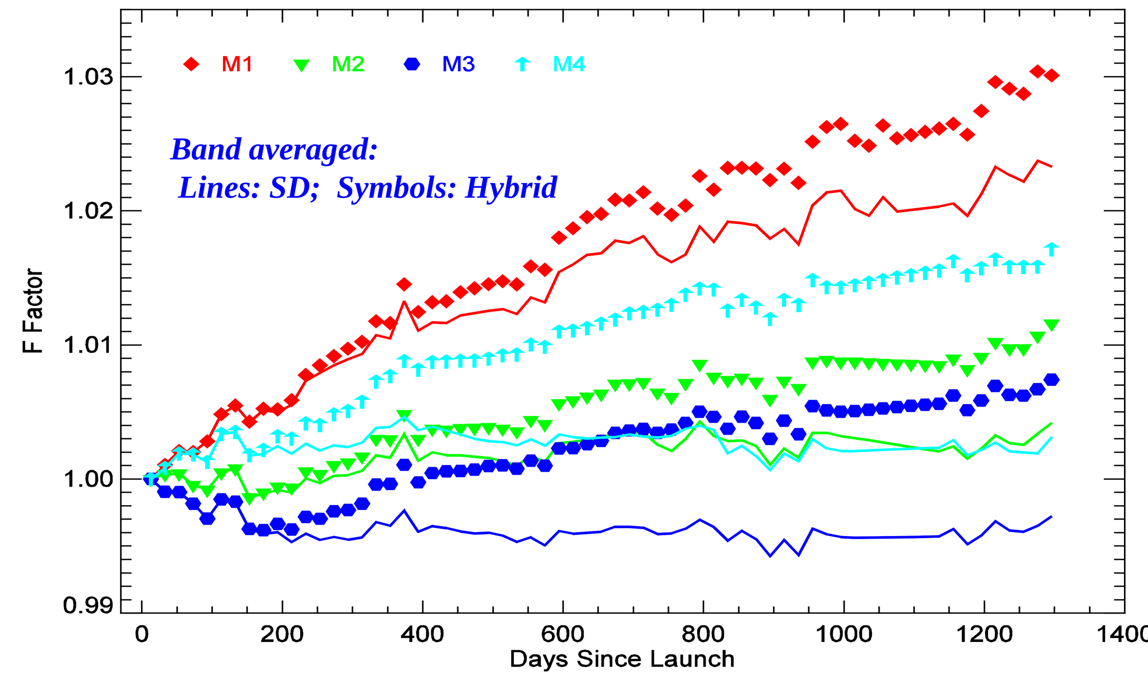
Difference and ratio





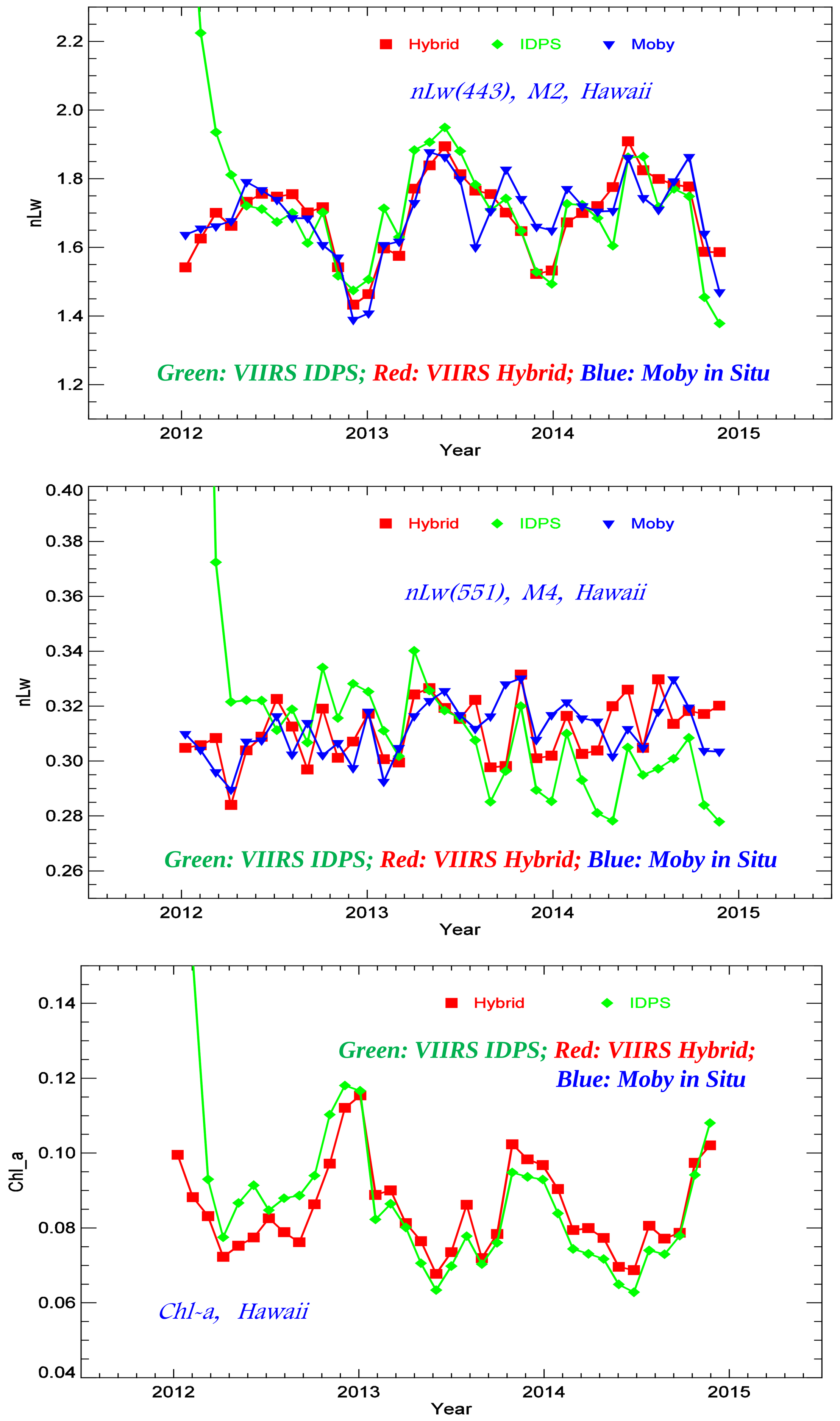
Hybrid Calibration Coefficients





Improvements in Ocean Color Products

VIIRS data were processed using MSL12 with SDR From IDPS and New Hybrid Method for Hawaii site



Conclusion

- A timely update of the current progress in the calibration of the VIIRS reflective solar bands is presented.
- It is shown that SD/SDSM calibration can provide stable and clean calibration coefficients with all carefully derived input components.
- The "degradation uniformity condition", a key assumption in SD/SDSM calibration methodology, has recently proved to be untrue, which may result in a long-term bias into the calibration coefficients.
- Lunar observation can also provide stable and clean calibration coefficients without facing the surface degradation issue even though lunar observations are infrequent.
- An hybrid approach properly combining the SD and lunar calibration coefficients restores the accuracy of the calibration coefficients from the non-uniformity issue and other various effects.
- The hybrid calibration coefficients have significantly reduced the long-term drift in the ocean color EDR products and improved the VIIRS ocean products to high quality, capable to support of the science research and various operational applications.

References

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