



NOAA Satellite Cal/Val Progress Update

- VIIRS Operational Update
- What's new
- Plan for the Future

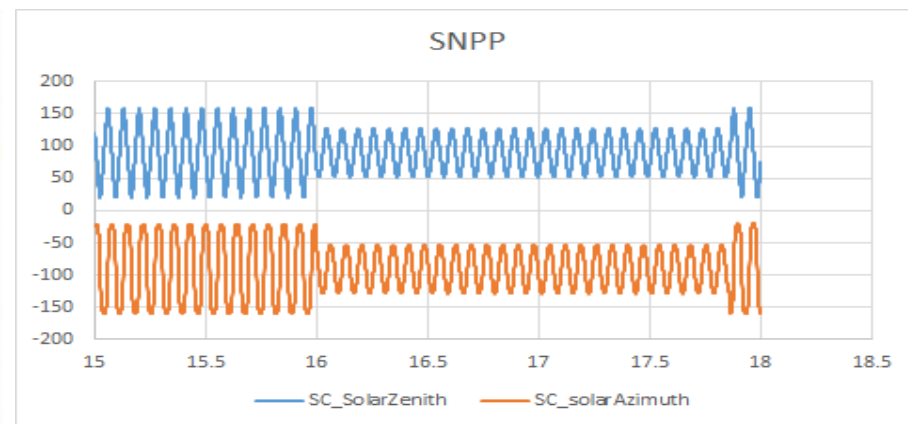
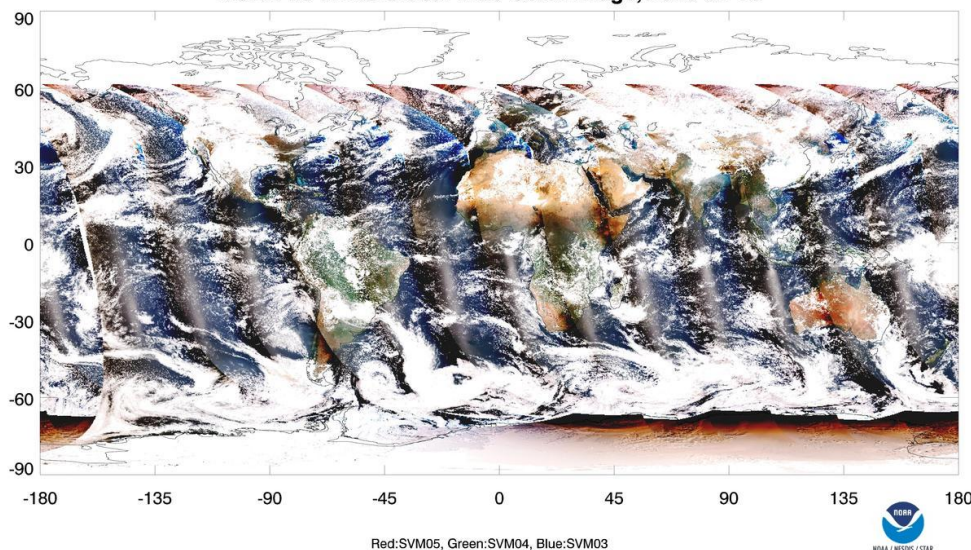
Changyong Cao (WGCV NOAA Rep.)
Presented by Jason Choi and Erin Lynch
NOAA/NESDIS/STAR

47th CEOS Working Group on Calibration and Validation (WGCV-47)
Virtual Meeting July 14-17, 2020

Suomi NPP and NOAA-20 VIIRS Solar Vector Anomaly (VIIRS operational Status)

- A major anomaly occurred in the operational JPSS IDPS processing on 01/16/2020 for both S-NPP and NOAA-20 VIIRS (first detected by NASA team) which affected all solar bands.
- A duplicated record in the JPL planetary ephemeris ancillary file led to a failure in indexing and time interpolation.
- Corrected the next day and all products became normal.

NOAA-20 VIIRS Global True Color Image, 2020-01-16



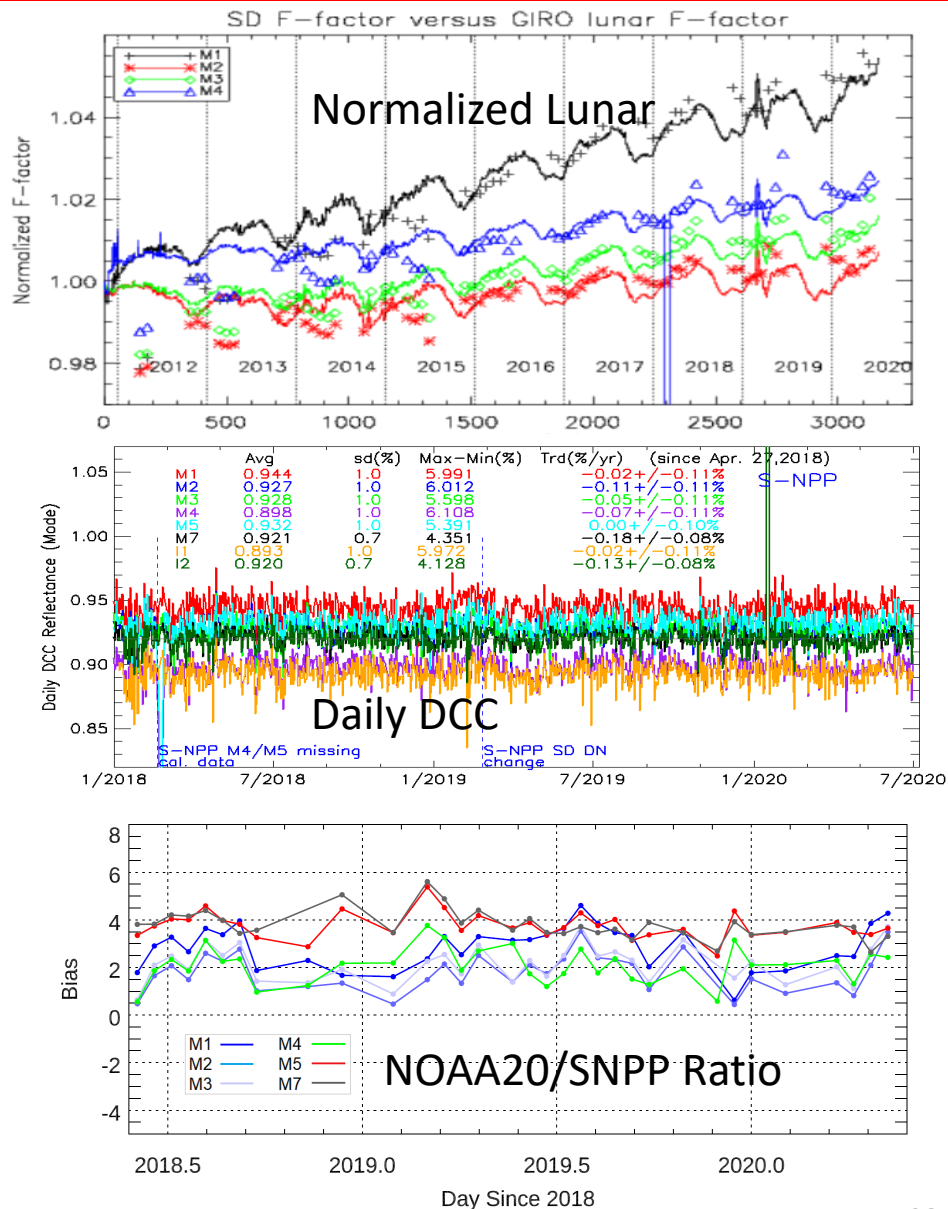
Starting 01/16, the modeled solar vector became abnormal

Suomi NPP VIIRS RSB (VIIRS operational Status)

- S-NPP has been performing very well
- Solar diffuser calibration is independently verified by Lunar, DCC, Desert observations (consistent within 1%)
- NOAA20 VIIRS solar band reflectance lower than those of Suomi NPP by 2-4% depending on channel
- Several studies show that NOAA-20 calibration is more consistent and stable
- Question remains which one has better absolute accuracy - the need for on-orbit absolute accuracy standard

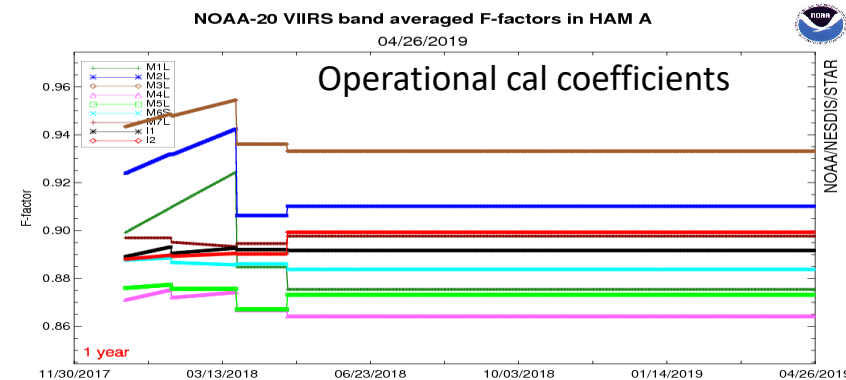
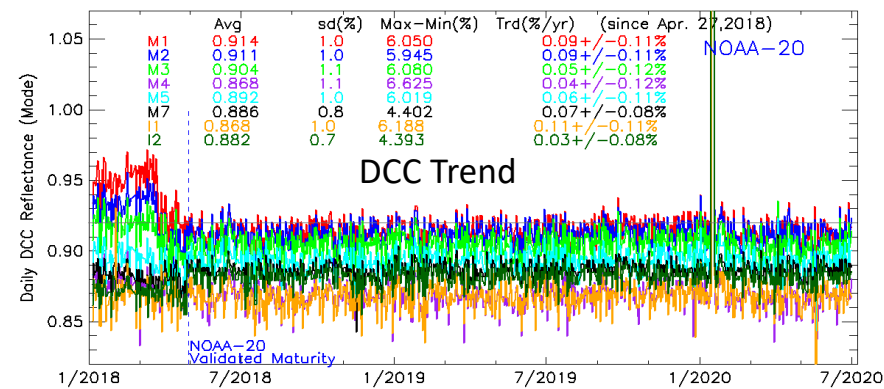
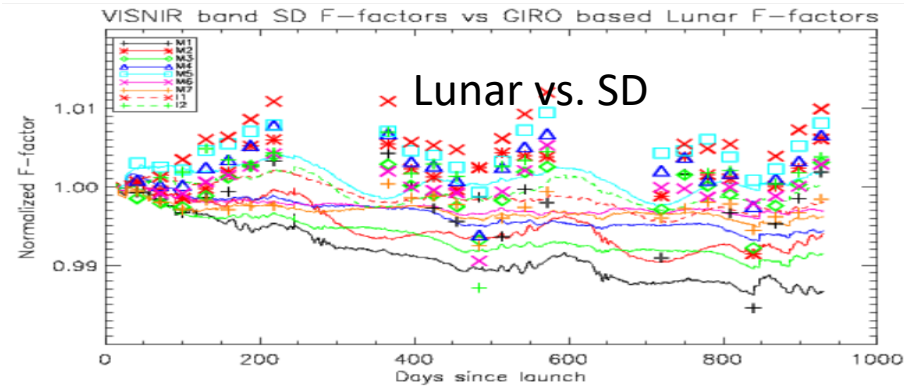
References:

- Uprety et al. 2020, JARS, 14(3)
- Wang & Cao, 2016, Remote Sens, 8



NOAA-20 VIIRS RSB (VIIRS operational Status)

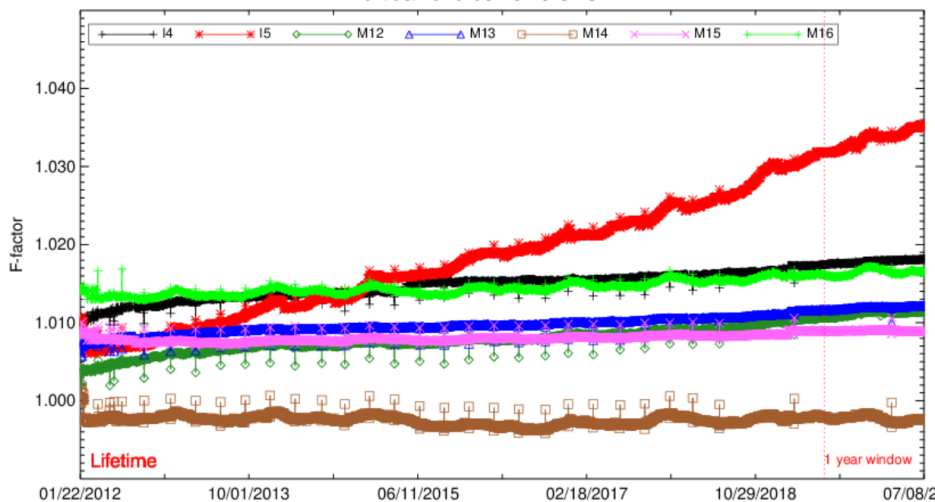
- NOAA-20 Reflective Solar Band show little signs of degradation 2+ years after launch
- The degradation has been closely monitored using all methods available (lunar, DCC, desert, SNO)
- As a result, calibration coefficients for the solar bands remain to be constants for now, till a clear trend emerges
- References:
 - Choi et al. TGARSS 2020
 - Wang&Cao, JSTAR 2020



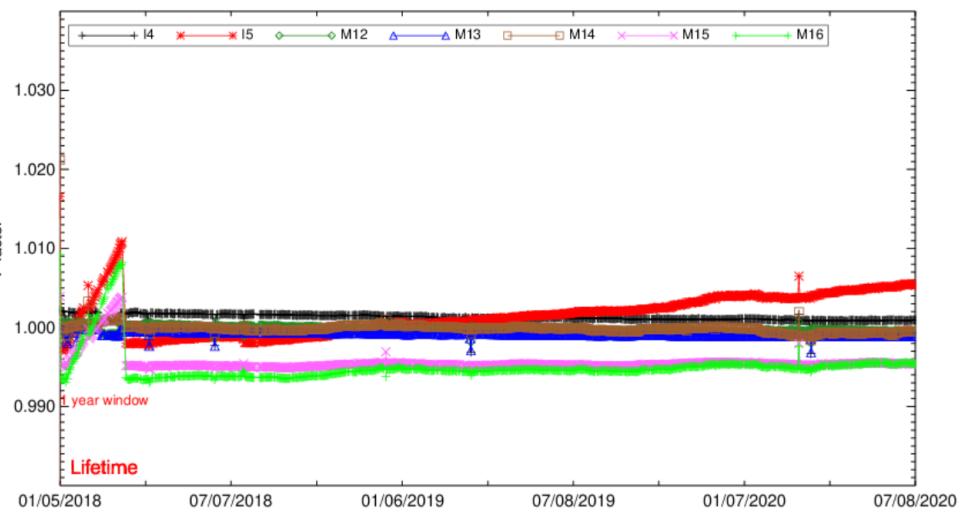
VIIRS Thermal Emissive Band Update (VIIRS operational Status)

- Both S-NPP and NOAA-20 VIIRS TEB F-factors (1/gains) have been very stable.
 - NOAA 20 initially had a faster than expected degradation ($\sim 0.5\%$ per week), which was resolved after Mid Mission Out Gassing (MMOG) 3/12 $\sim$ 24/2018.
 - After the MMOG, TEB gains became very stable, with a small trend for I5.

SNPP VIIRS TEB F-factors in HAM A
07/08/2020-08:26:13 UTC

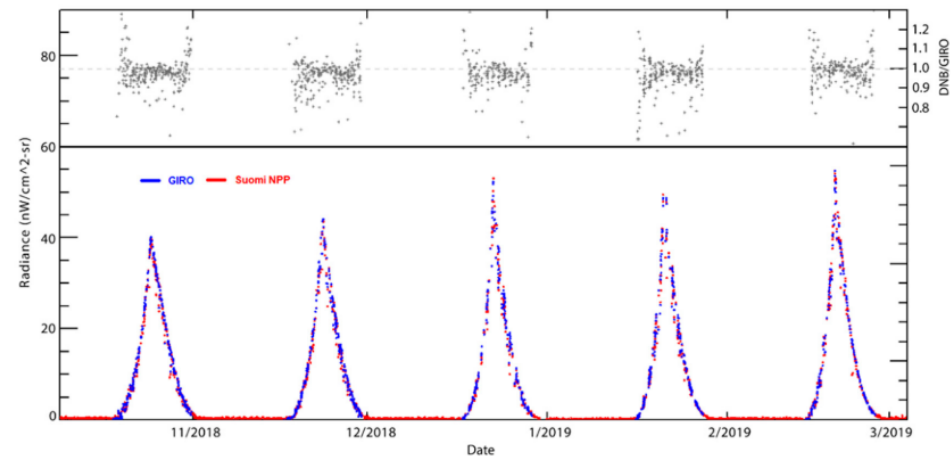
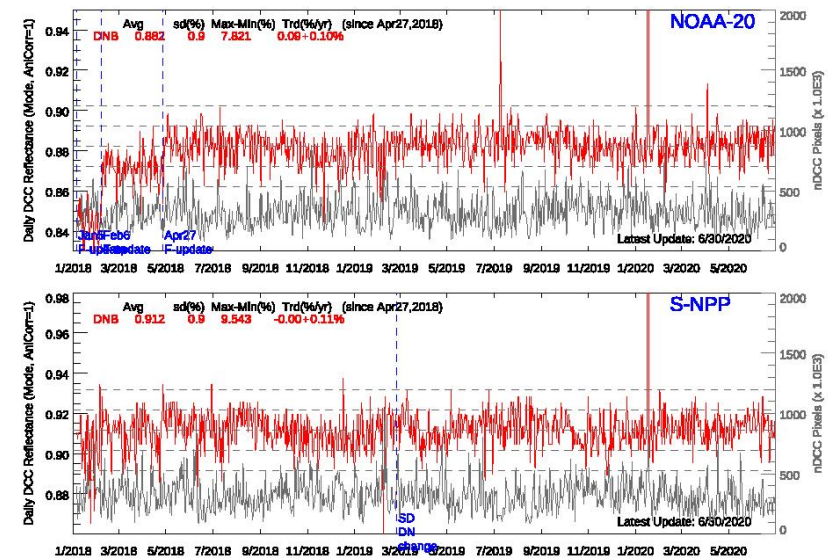


NOAA-20 VIIRS TEB F-factors in HAM A
07/08/2020-06:08:14 UTC



VIIRS DNB Update (VIIRS operational Status)

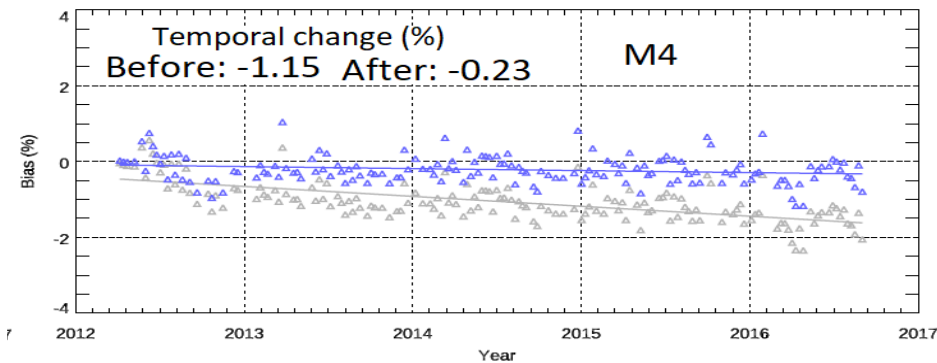
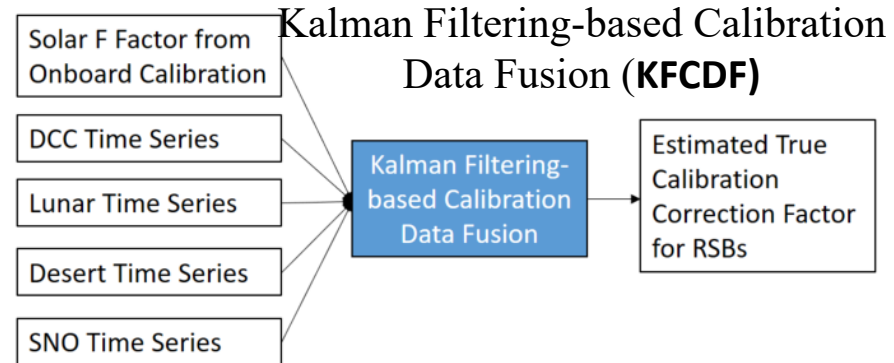
- Both SNPP and NOAA-20 VIIRS DNB are performing well within specification.
- Incremental improvements are still being made to remove artifacts (such as residual striping)
- SNPP and NOAA-20 DNB suggest very good radiometric consistency for low light observations
 - Daytime reflectance compared over DCC (<4%)
 - DCC Lunar F-factors are very stable over lifetime.
 - Night time DCC trends showed good radiometric consistency between NOAA-20 and S-NPP VIIRS (Cao et al. 2019, *Remote Sensing* **2019**, 11)



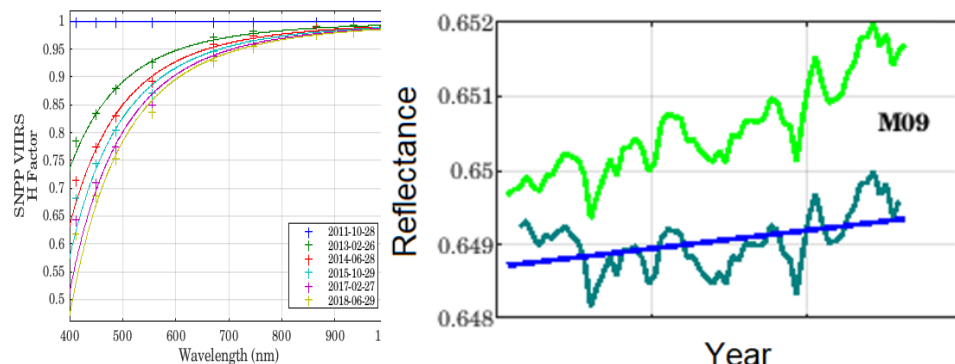
Suomi NPP VIIRS Recalibration

- Suomi NPP VIIRS data have been recalibrated using the latest algorithms developed by NOAA/STAR radiance science team; algorithm highlights for the solar bands:
 - Kalman Filtering-based Calibration Data Fusion (KFCDF) to accurately characterize solar diffuser degradation
 - Physics-based Surface Roughness Rayleigh Scattering (SRRS) model (Shao et al. [2016, 2019]); account for SD degradation in SWIR bands which is not monitored by SDSM
- Recalibrated data available (currently up to March 2017)

<https://ncc.nesdis.noaa.gov/VIIRS/index.php>
- Applications
 - Study of COVID-19 impact on Aerosols
 - Potential synergistic use with Sentinel-5p

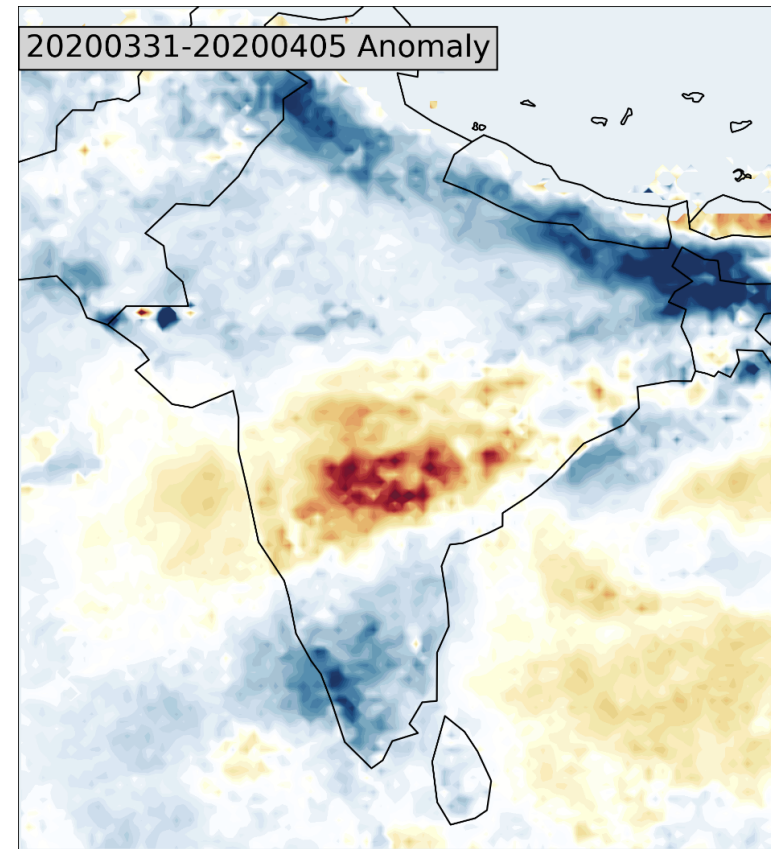


Surface Roughness Rayleigh Scattering (SRRS)



VIIRS for Aerosol Optical Depth Studies Related to COVID-19 by CEOS/ACC (Shobha Kondragunta)

- Suomi NPP VIIRS Aerosol Optical Depth (AOD) anomaly observed for March 31-April 5, 2020 (Weekly mean).
- Major reduction for India and neighboring countries due to lockdown (blue=AOD reduction relative to climatology; red=smoke aerosols from fires).
- AOD Climatology is from 2015, 2018, 2019 VIIRS observations
- NOAA is in the process of generating a long-term AOD record using reprocessed VIIRS sensor data record.

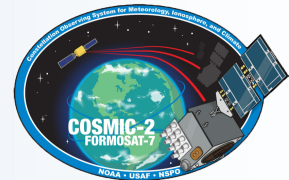


-0.5 -0.3 -0.1 0.1 0.3 0.5

AOD anomaly (weekly mean – climatology)



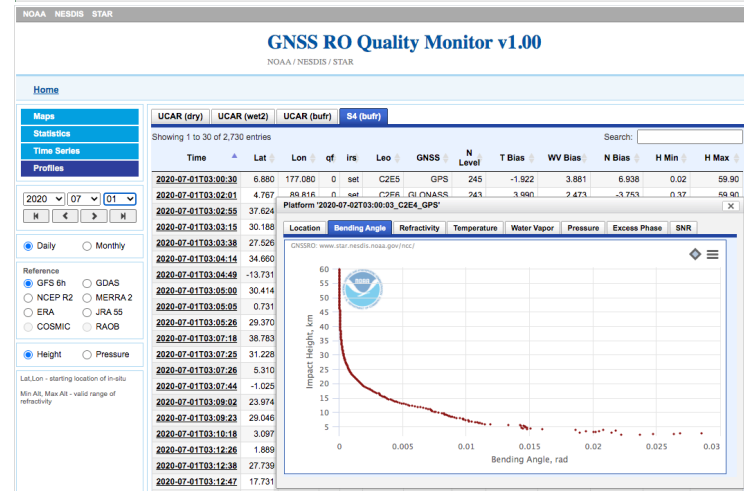
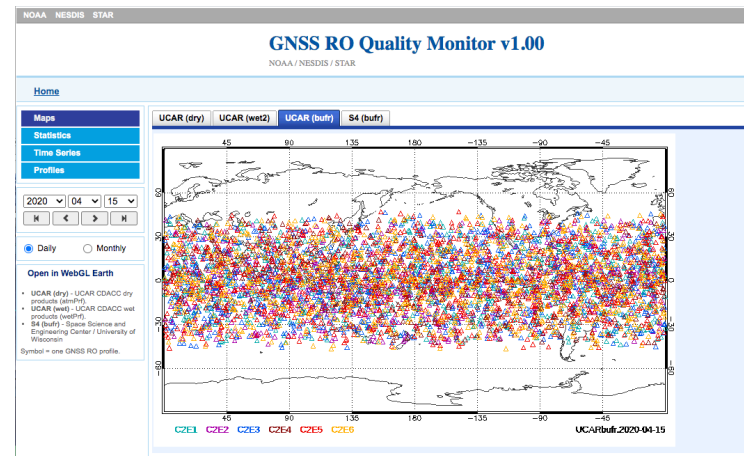
COSMIC2 mission success, data operationally used for NWP



- FORMOSAT-7/COSMIC-2 is a radio occultation (RO) mission lead by NOAA in partnership with the US Air Force, Taiwan's National Space Organization (NSPO), and the University Corporation for Atmospheric Research (UCAR).
- The constellation of 6 satellites in low-inclination LEO orbits collects atmospheric soundings between 45°N – 45°S. Next generation Tri-GNSS RO receivers (TGRS) track signals from both GPS and GLONASS to capture >4000 soundings per day.
- COSMIC-2 provides operational RO data for numerical weather prediction centers as well as atmospheric soundings (temperature and moisture) and ionospheric profiles for science applications.
 - Neutral Atmosphere Initial Operational Capability reached on 25 Feb. 2020 following intensive cal/val.
 - Assimilated operationally by NOAA/NCEP Global Forecast System (GFS) since 26 May 2020.

- Data available from UCAR:
<https://data.cosmic.ucar.edu/gnss-ro/cosmic2/>

Long-term monitoring: NOAA/STAR ICVS
https://www.star.nesdis.noaa.gov/smcd/ncc/GNSSRO/ICVS/monitor/GNSSRO_COSMIC2/



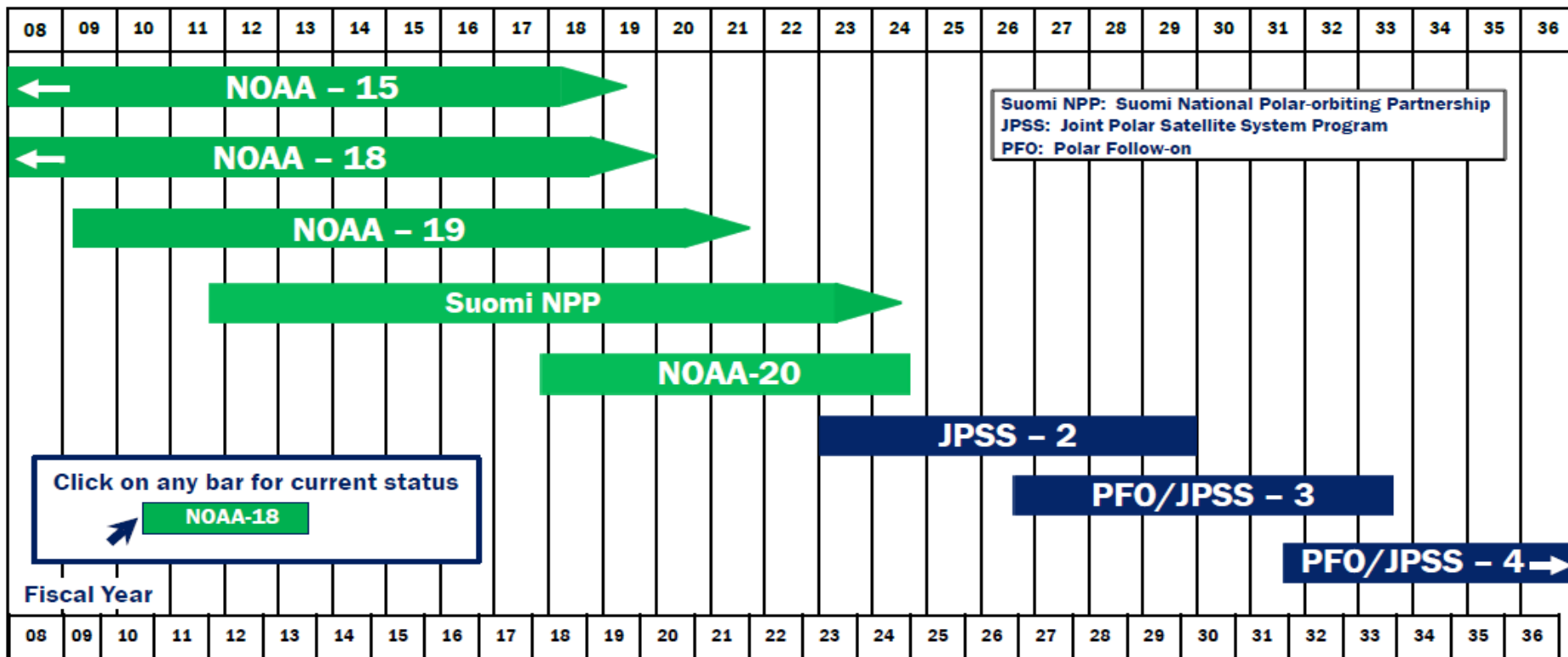


NOAA Polar Satellite Programs

Continuity of Weather Observations

Calendar Year

As of April 2019



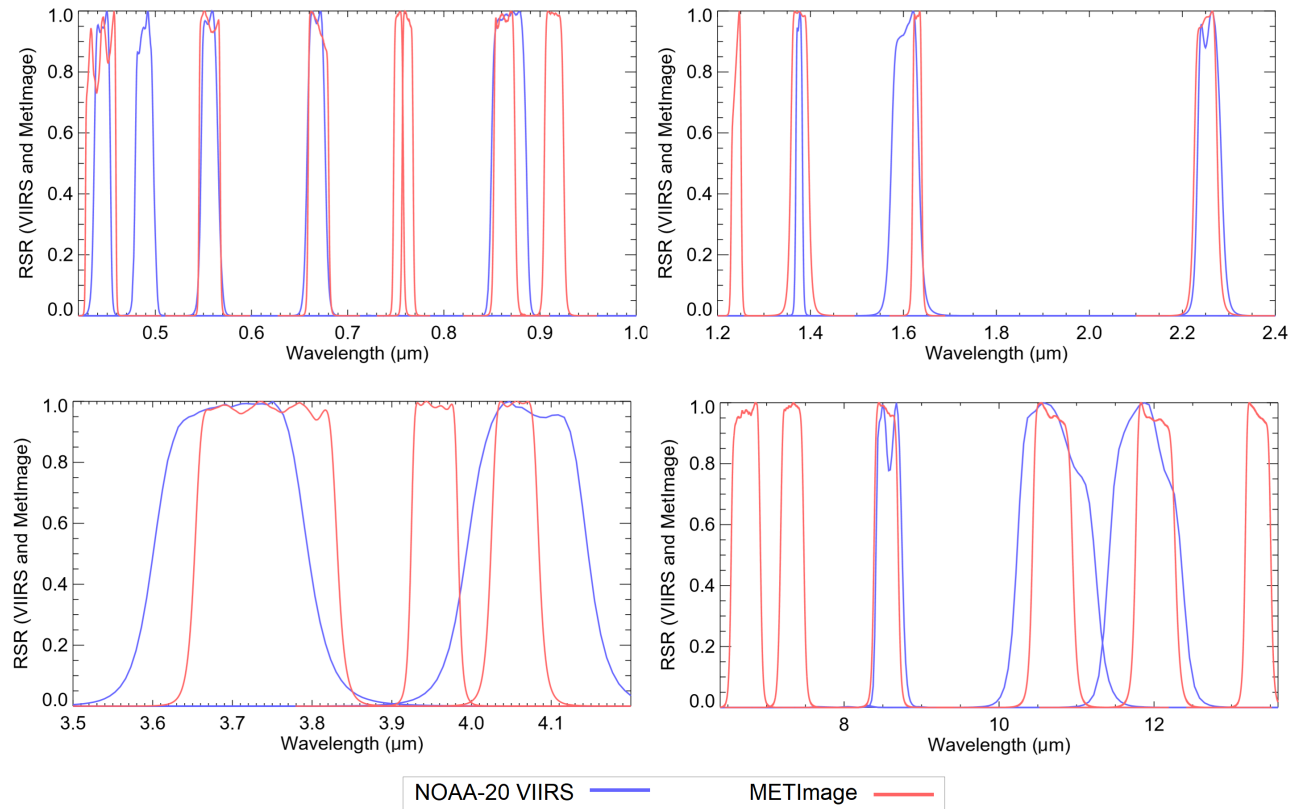
Approved:
Assistant Administrator for Satellite and Information Services



Year 2022 will be a very busy year, with planned launches of JPSS-2, MetOp-SG, and others

VIIRS and METImage (VII) Channels

- JPSS VIIRS in the PM orbit has many similar channels to those of METImage on MetOp-SG in the AM orbit
- METImage has several water vapor channels that VIIRS does not have
- However, METImage does not have Day/Night Band
- NOAA is getting ready to develop heritage products from METImage observations



VIIRS versus METImage Spectral Response Function Comparison

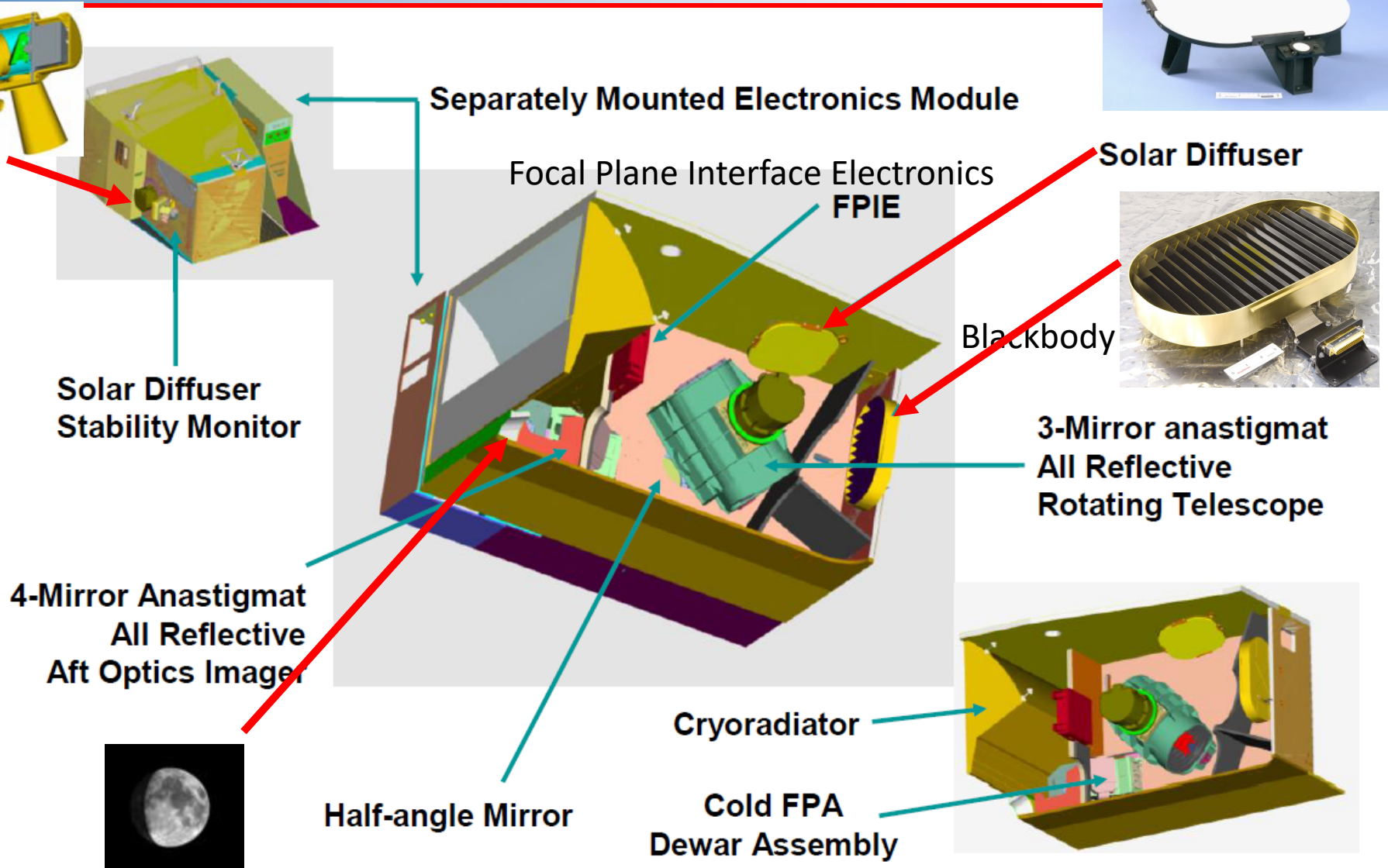
Summary

- Both Suomi-NPP & NOAA-20 VIIRS have been performing very well since launch.
- NOAA-20 VIIRS has no appreciable degradation since launch for the solar bands
 - Bias relative to Suomi NPP => need for on-orbit absolute standard
- Suomi NPP VIIRS recalibrated data available for a variety of studies, such as COVID-19 aerosol.
- NOAA is expanding radio occultation capabilities for NWP
- Preparing for future missions (JPSS2/VIIRS, MetOp-SG/METImage, & others)



- Backup slides

VIIRS On-orbit Calibration

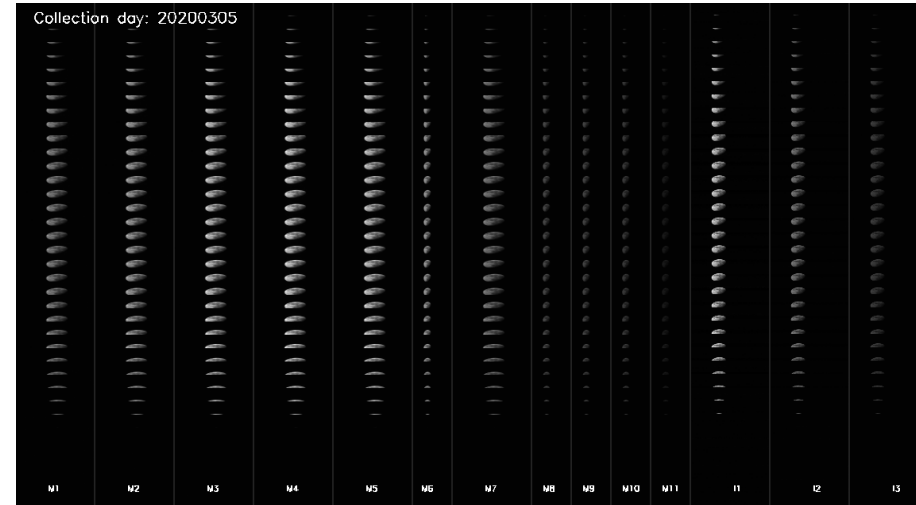


Source: VIIRS Radiometric ATBD.

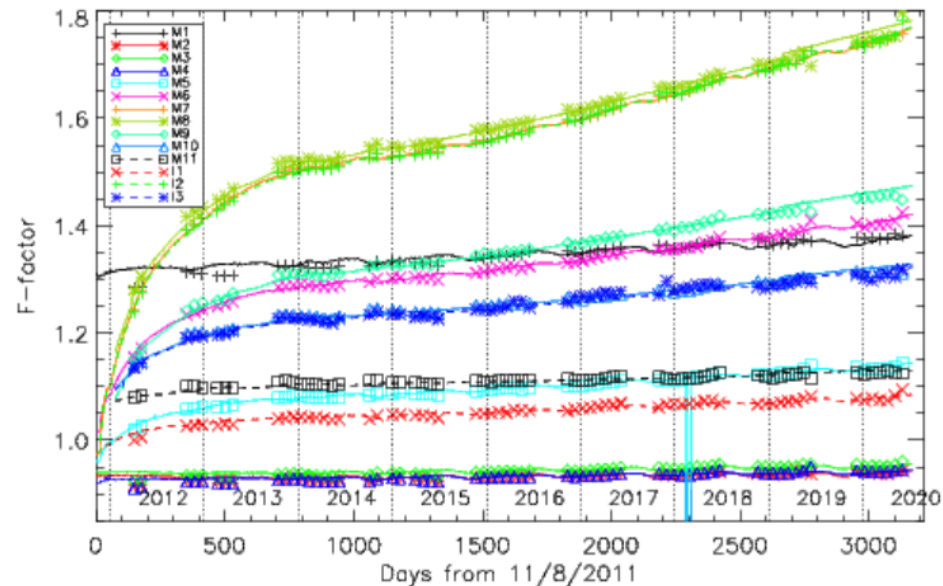
S-NPP VIIRS RSB (VIIRS operational Status)

- S-NPP has been performing very well.
- Lunar (symbol) and SD (lines) calibration validation
 - Short wavelength bands (M1~M4) showed mismatches in early lifetime.
 - The SD and lunar F-factors are consistent within 1%.

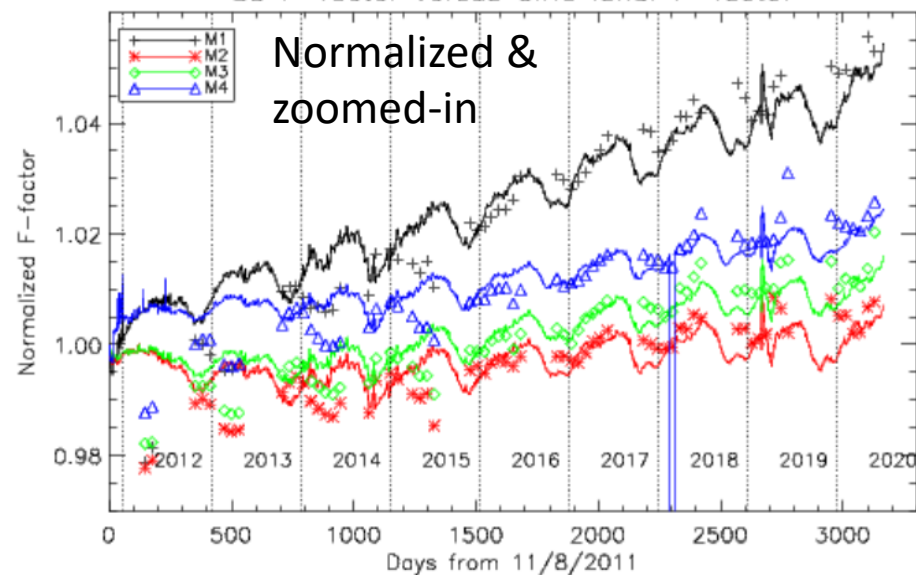
Lunar observation in RSB bands on 3/5/2020



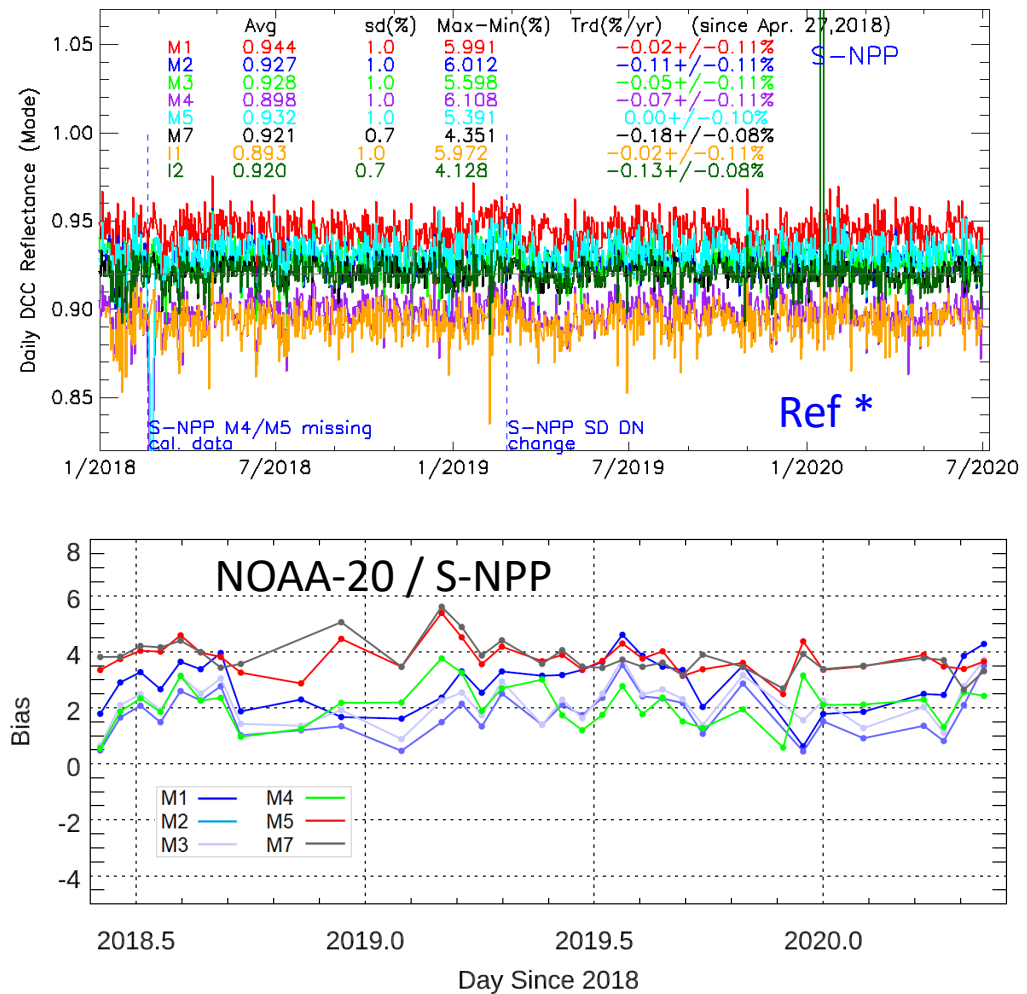
ICVS SD F-factor versus GIRO lunar F-factor



SD F-factor versus GIRO lunar F-factor



- Post processing check.
 - DCC trending results show very stable response from 2018 to 2020 in VISNIR bands.
 - Comparing VIIRS reflectance trending over pseudo-invariant calibration sites (PICS) S-NPP VIIRS indicated stable responses #.
 - Bias relative to NOAA-20, S-NPP showed on the order of 2-4%

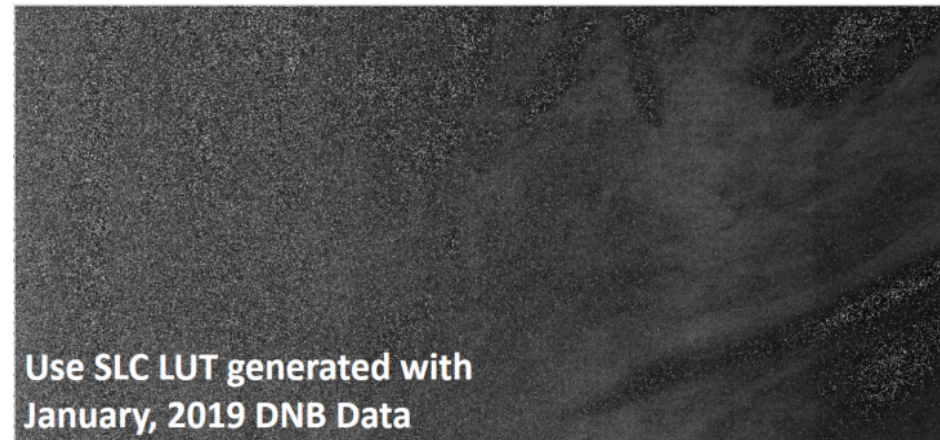
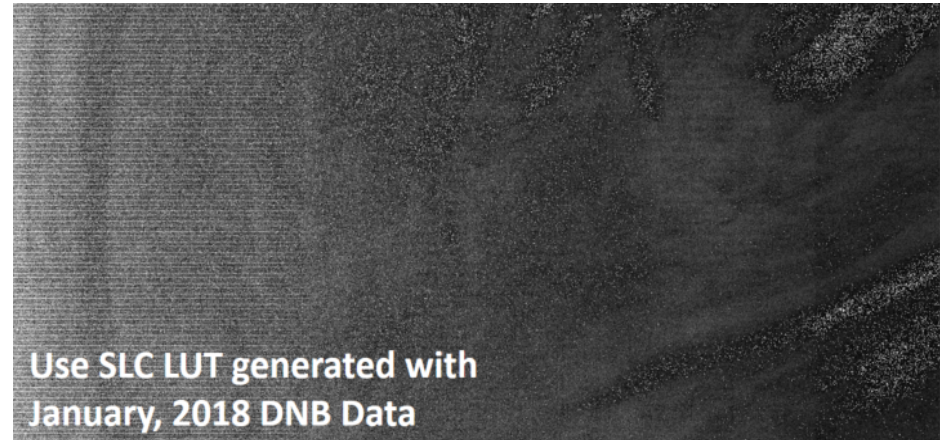


* Wang, W.; Cao, C. Monitoring the NOAA Operational VIIRS RSB and DNB Calibration Stability Using Monthly and Semi-Monthly Deep Convective Clouds Time Series. *Remote Sensing* **2016**, 8

Sirish Uprety, Changyong Cao, and Xi Shao "Radiometric consistency between GOES-16 ABI and VIIRS on Suomi NPP and NOAA-20," *Journal of Applied Remote Sensing* 14(3), 032407 (29 May 2020).

VIIRS DNB Update

- NOAA-20 VIIRS
 - Improved the algorithm for determining DNB Gain Ratios LUTs which corrects the biases due to detector nonlinearity.
 - The improved monthly DNB gain ratio LUTs have been implemented in the operational calibration since the new moon in November 2018.
 - Generated twelve (one full year) DNB stray light correction LUTs.



Example of striping removal in aggregation zone 21 of DNB image

* Gu, Y.; Uprety, S.; Blonski, S.; Zhang, B.; Cao, C. Improved algorithm for determining the Visible Infrared Imaging Radiometer Suite Day/Night Band high-gain stage dark offset free from light contamination. *Appl Opt* **2019**, 58, 1400-1407