



# ICVS Calibration and Processing Flow on S-NPP VIIRS

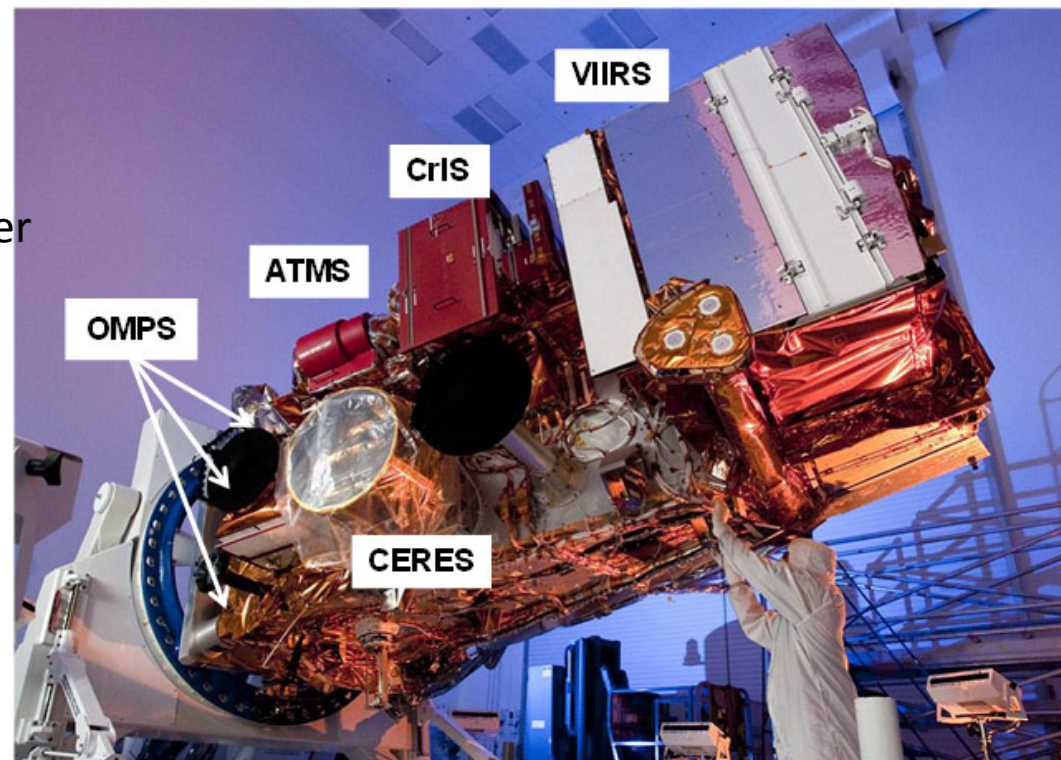
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## The Suomi National Polar-orbiting Partnership (S-NPP) Visible Infrared Imaging Radiometer Suite (VIIRS)

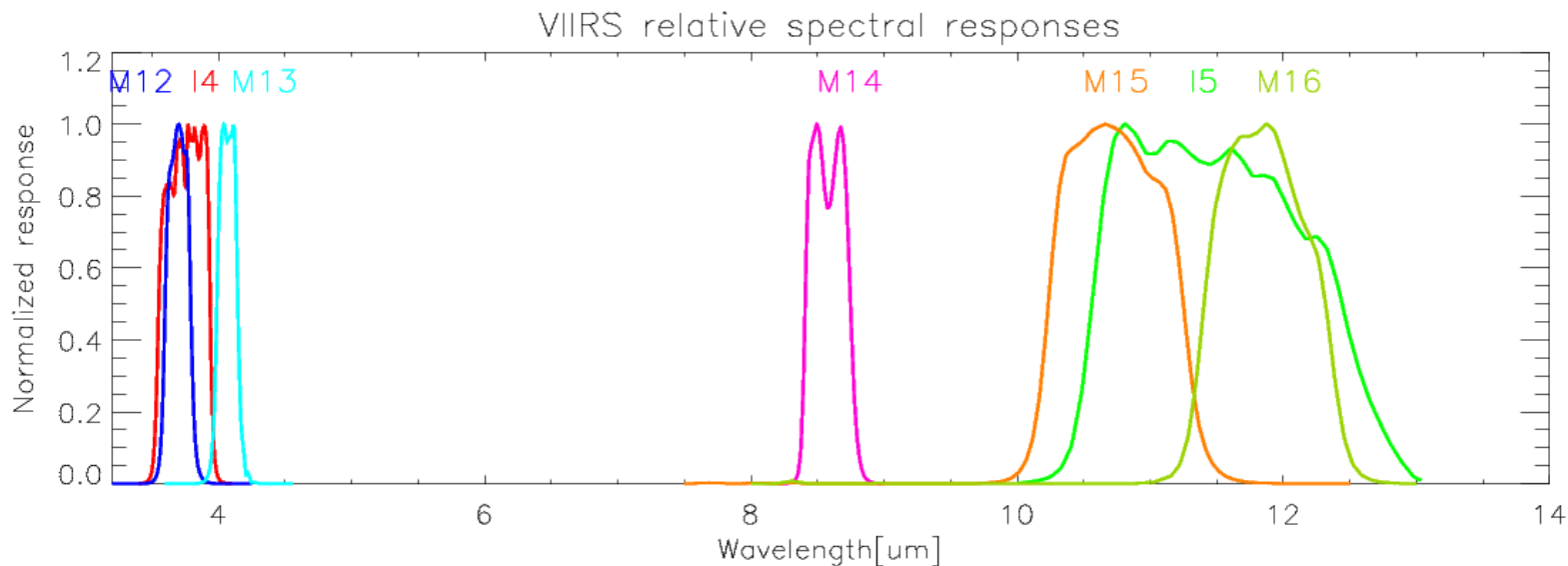
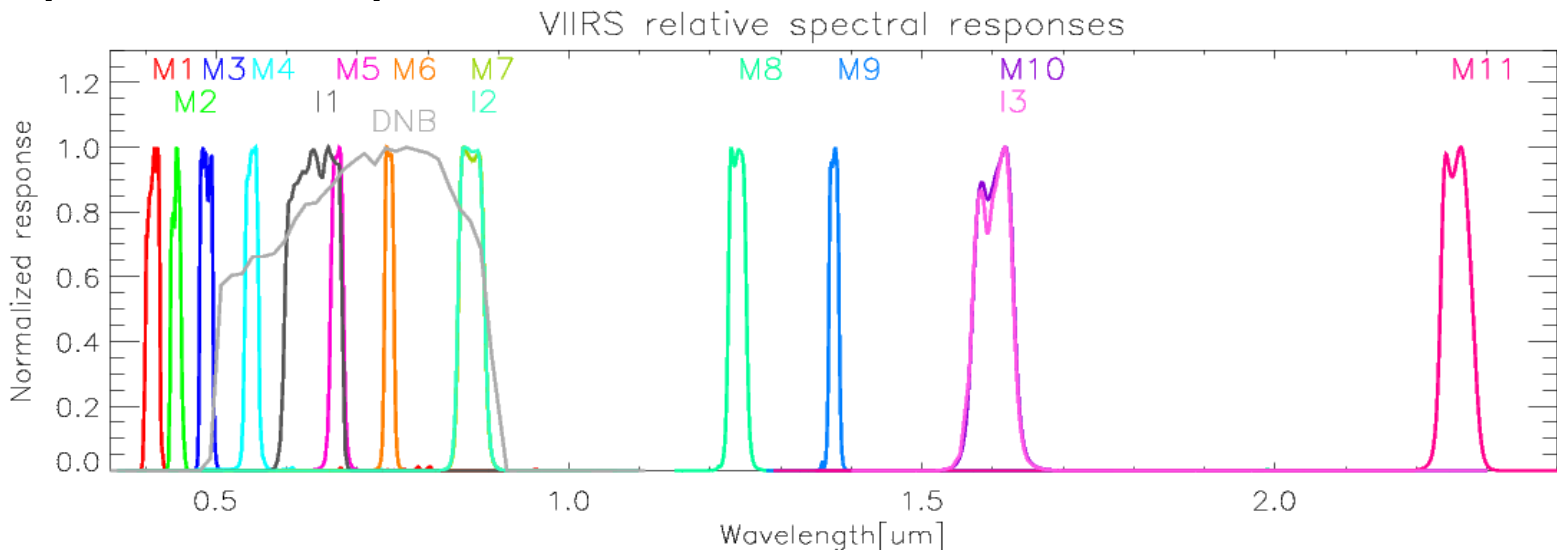
- Descriptions of S-NPP VIIRS
  - A whiskbroom scanning radiometer
  - Sun synchronous orbit
  - Field of view of  $112.56^\circ$
  - Nominal altitude of 829 km
  - A large scan coverage of 3060 km
  - Equator crossing local time of approximately 13:30 pm
  - 22 spectral bands



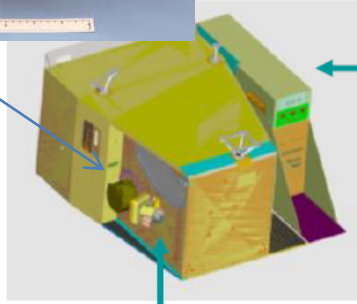
From ICVS webpage

<http://www.star.nesdis.noaa.gov/icvs/index.php>

- Spectral Responses of the VIIRS Bands



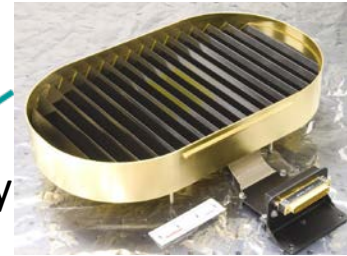
# Introduction



**Separately Mounted Electronics Module**

Focal Plane Interface Electronics  
**FPIE**

**Solar Diffuser**



**Blackbody**

**3-Mirror anastigmat  
All Reflective  
Rotating Telescope**

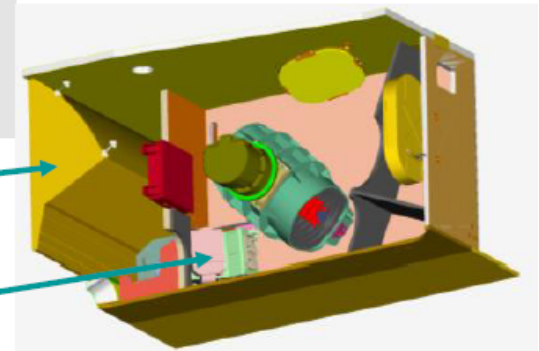
**Solar Diffuser  
Stability Monitor**

**4-Mirror Anastigmat  
All Reflective  
Aft Optics Imager**

**Half-angle Mirror**

**Cryoradiator**

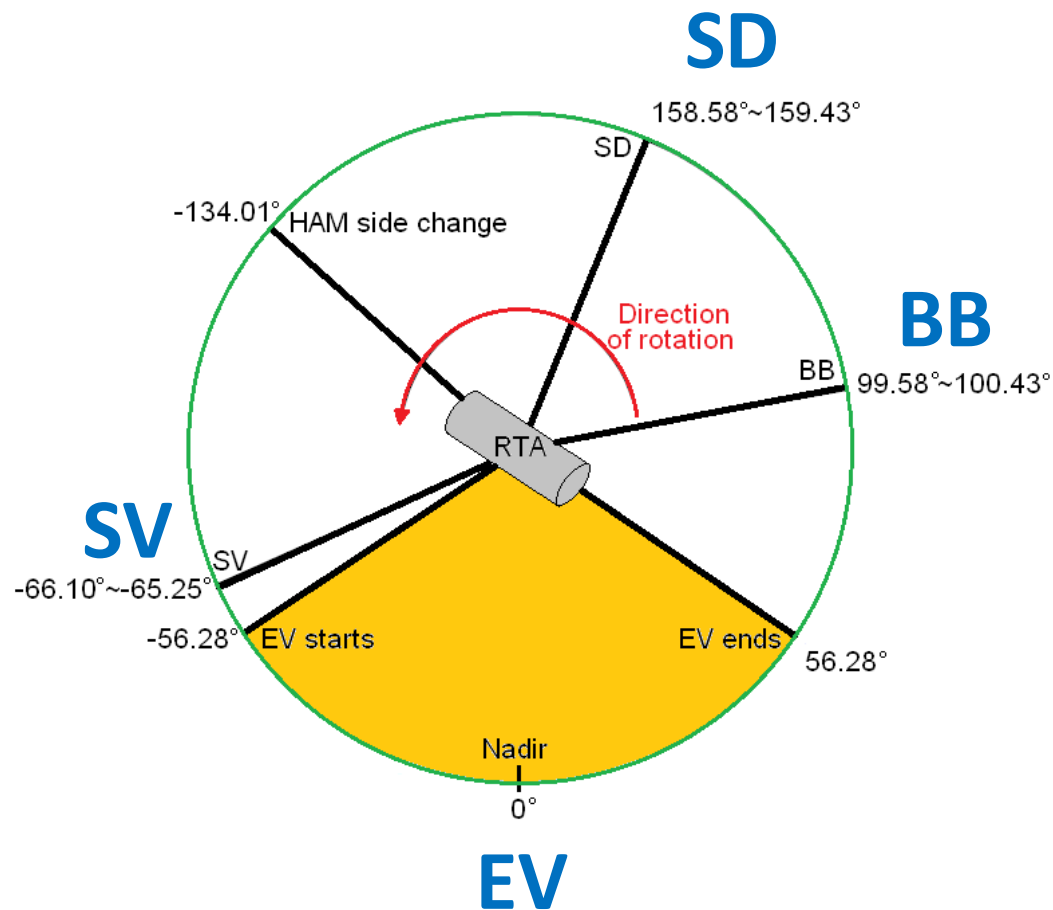
**Cold FPA  
Dewar Assembly**



From VIIRS Radiometric ATBD.

## Rotating Telescope Assembly (RTA) scan over four data sectors

- EV** = Earth View, the main data sector ( $\pm 56^\circ$  off nadir).
- BB** = Blackbody; used for TEB Cal.
- SD** = Solar Diffuser view; used for RSB Cal.
- SV** = Space View; used for bias removal  $\rightarrow$  **Moon observed at this position.**  
2.5 ms for SV scan



**1.7793 s/scan**



# Introduction

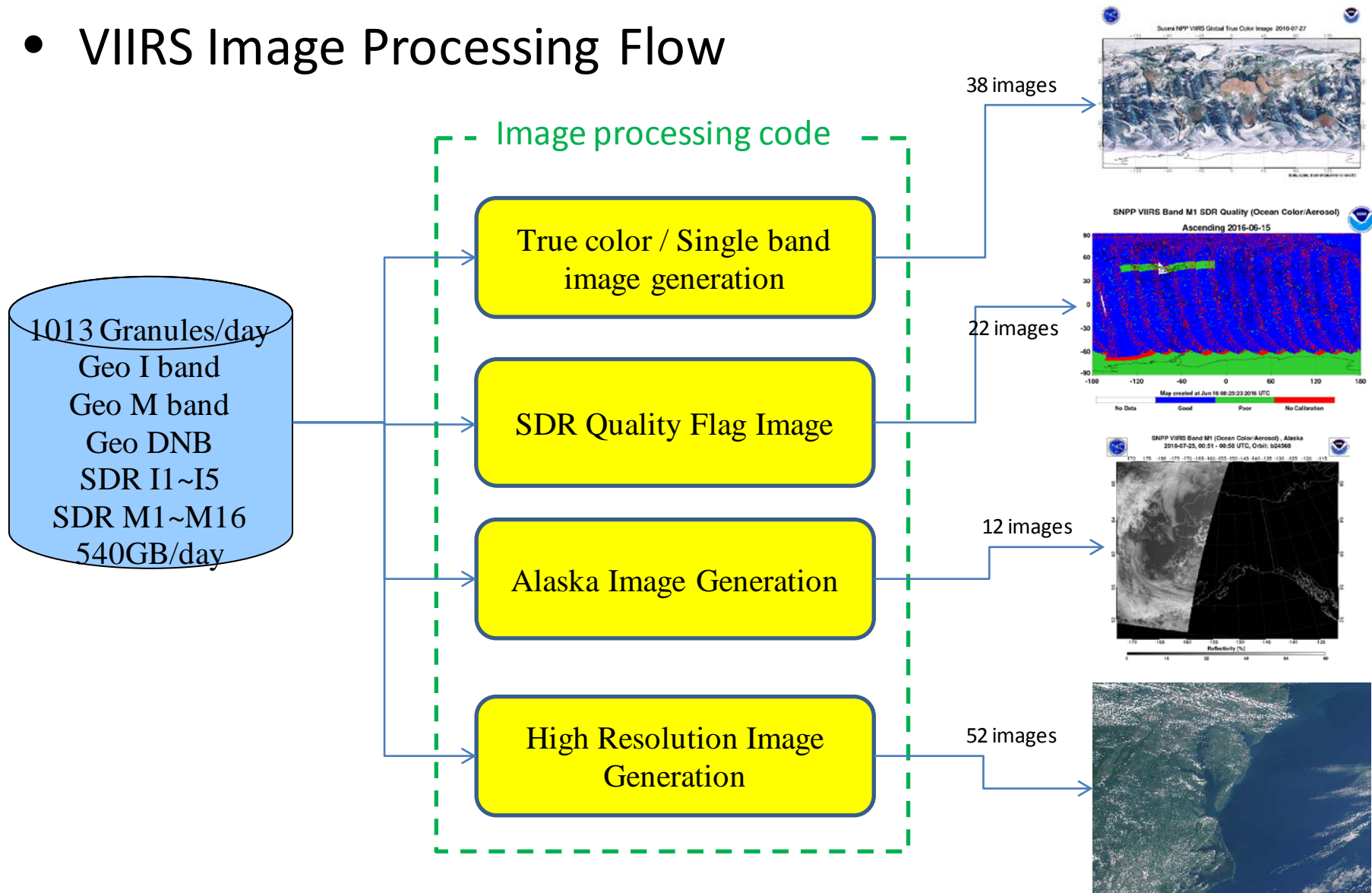


Parameters	Descriptions	Dimensions	Usage
Global Image	Global true color image and single band image	38	VIIRS Imagery/Products
Quality Flag Image	Global Quality Flag Images	22	VIIRS QF Check
<u>RSB &amp; TEB H / F –factors</u>	<u>RSB Calibration Coefficients including Lunar Cal.</u>	<u>66</u>	<u>Calibration Monitoring</u>
<u>DNB Gain, Bias, Gain Ratio</u>	<u>DNB Calibration Coefficients</u>	<u>18</u>	<u>DNB Cal. Monitoring</u>
Telemetry/Temperature	BB, RTA, cavity, HAM, FPA, cooler, Mainframe, Circuit Card Assembly, instrument current/voltage	41	Instrument Healthy status
SD Counts	VIIRS observation DN of Solar diffuser for band I1~I3, M1~M11, DNB over band average	14 bands	Degradation trending
SD NEΔN	Noise NEΔN for SD signal of solar bands	14 bands	SNR trending
SD Counts	VIIRS observation DN of Solar diffuser I1~I3, M1~M11, DNB over detector average	14 bands *32d	degradation for Detector uniform
SDSM signal	SDSM signal of SD and Sun in every orbit	8 bands	SD trending
SV Counts	VIIRS observation Space view DN for 22 bands	22 bands	Background signal trending
SV NEΔN	Dark Noise NEΔN for Space view signal	22 bands	Dark noise signal
BB Counts	VIIRS observation Blackbody DN for 22 bands	22 bands	IR gain derivation
BB NEΔN	Noise NEΔN for black body signal	22 bands	IR NEDT derivation
IR NEΔT	Noise equivalent temperature for IR bands M4, M5, M12-M16	7 IR bands	IR bands noise
<u>Alaska Images</u>	<u>Automatically Animated Images over Alaska</u>	<u>12 bands</u>	<u>Alaska Weather Monitoring</u>
<u>RTA &amp; HAM No-Sync</u>	<u>Checks Synchronization between RTA and HAM</u>	<u>1</u>	<u>Auto notification</u>

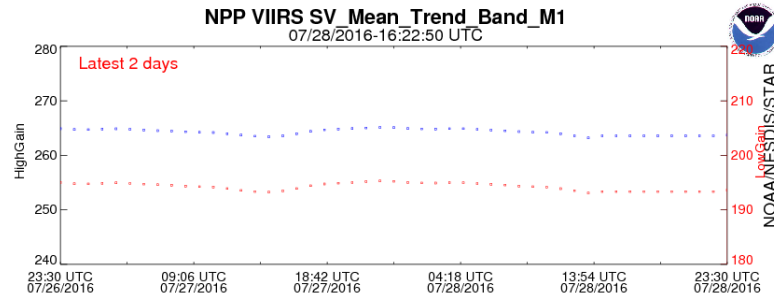
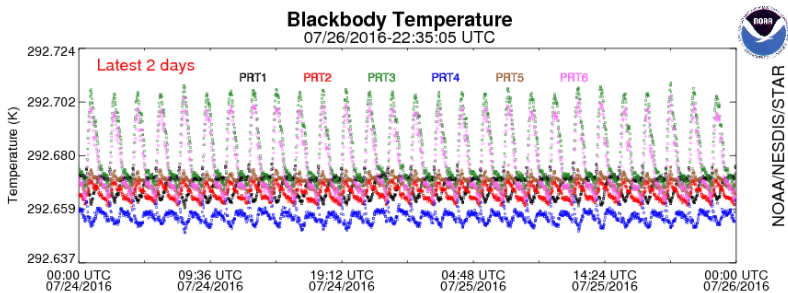
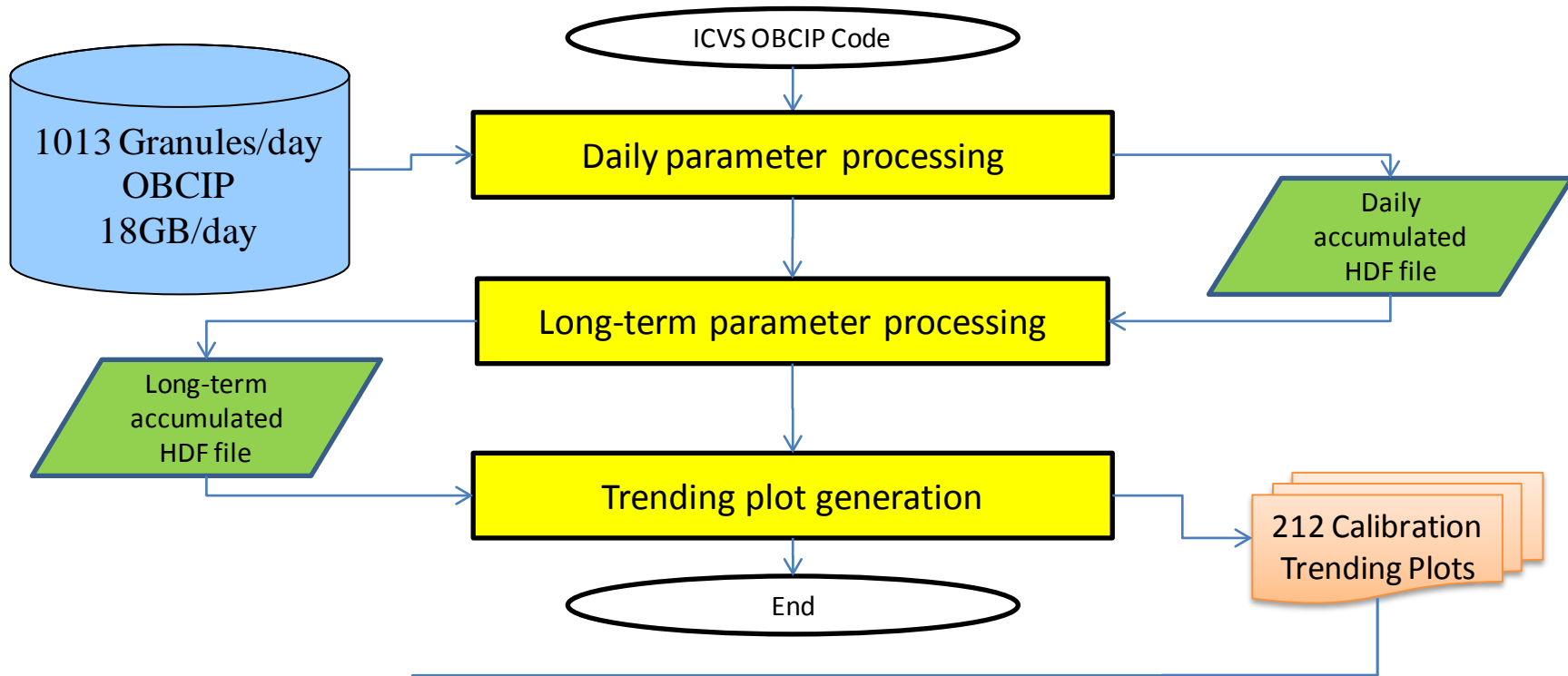
\* 351 trending plots are generated in near real time (+80 trending plots added since last year)



- VIIRS Image Processing Flow



- VIIRS On-board Calibrator Processing Flow





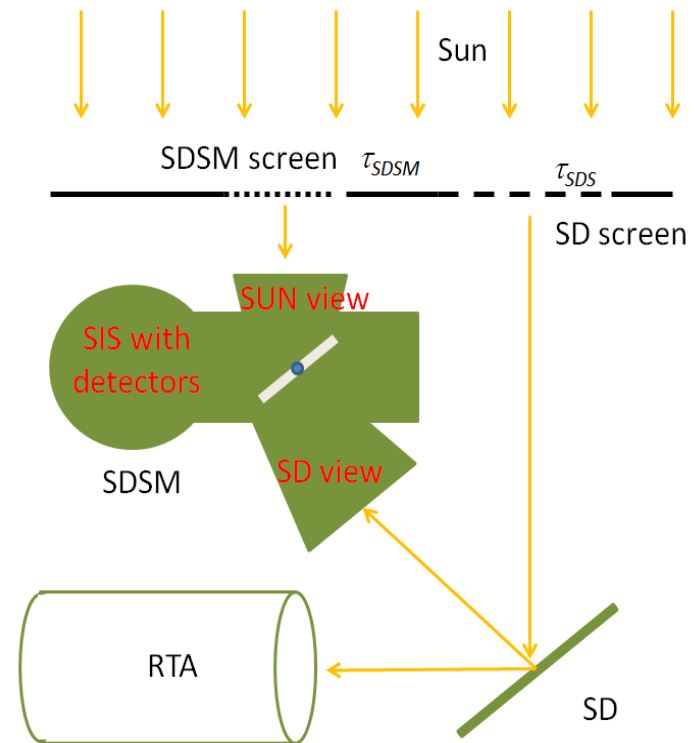
- VIIRS Reflective Solar Band Calibration Processing Flow
  - Sources of calibration :
  - Solar Diffuser (SD) and SD Stability Monitor (SDSM)

$$F = \frac{L_{Sun\_Model}}{L_{Sun\_Observation}} = \frac{Computed\_L_{Sun}}{Observed\_L_{Sun}}$$

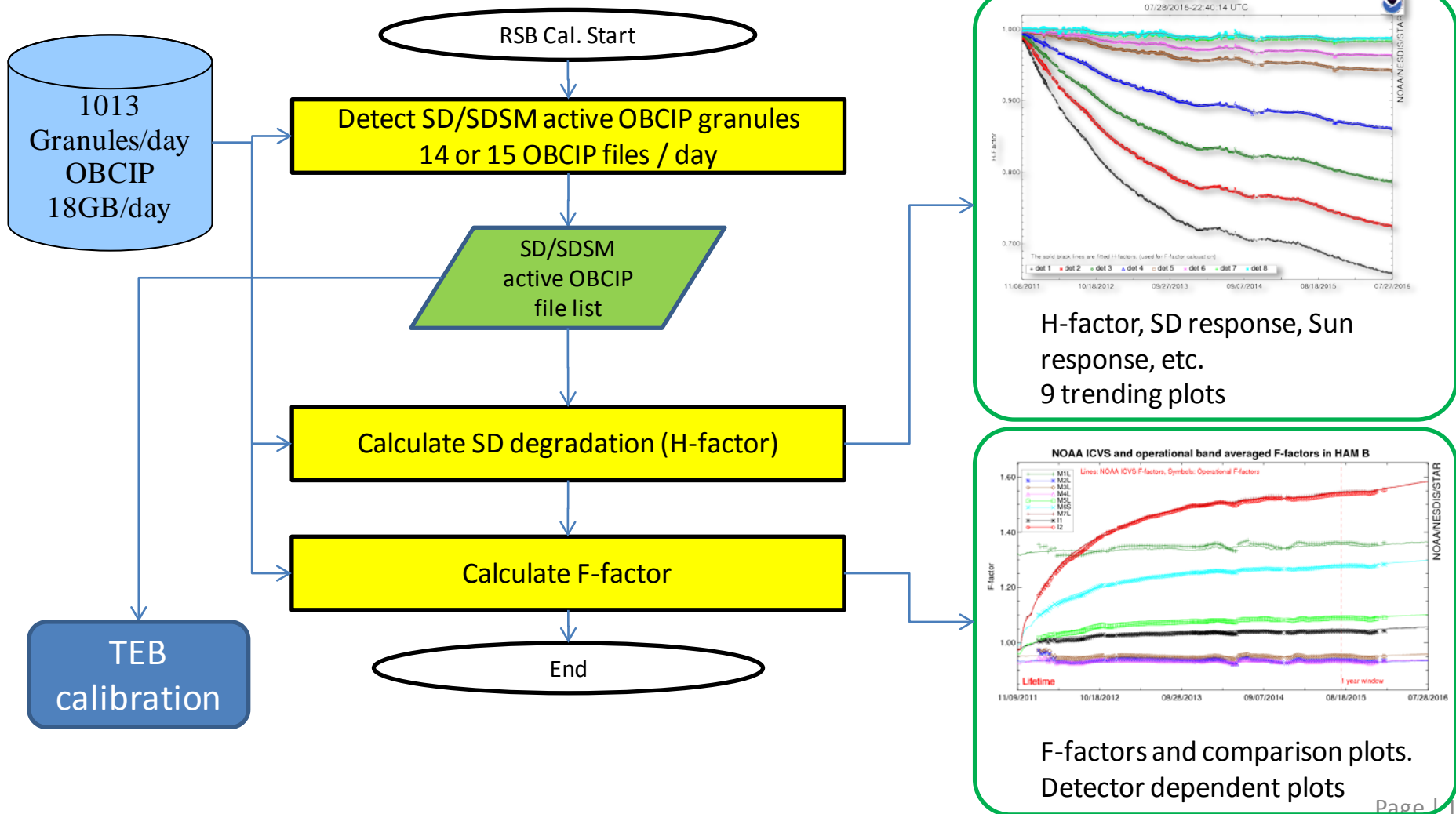
$$F = \frac{\cos(\theta_{inc}) \cdot [E_{sun} \cdot \tau_{sds} \cdot BRDF(t)] \cdot RVS_{SD}}{c_0 + c_1 \cdot dn_{SD} + c_2 \cdot dn_{SD}^2}$$

$$BRDF(t) = H_{Norm}(t) \cdot BRDF(t_0)$$

$$H_{Norm}(t) \propto \frac{SD\_response}{SUN\_response}$$



- VIIRS RSB Calibration Processing Flow



- Thermal Emissive Band Calibration:
  - Source of calibration: Blackbody (BB) and SV

$$F = \frac{L_{BB\_Model}}{L_{BB\_Observation}} = \frac{Computed\_L_{BB\_Obs}}{Observed\_L_{BB}}$$



BB Image is taken from <http://digitalcommons.usu.edu/cgi/viewcontent.cgi?article=1011&context=calcon>

Background Term

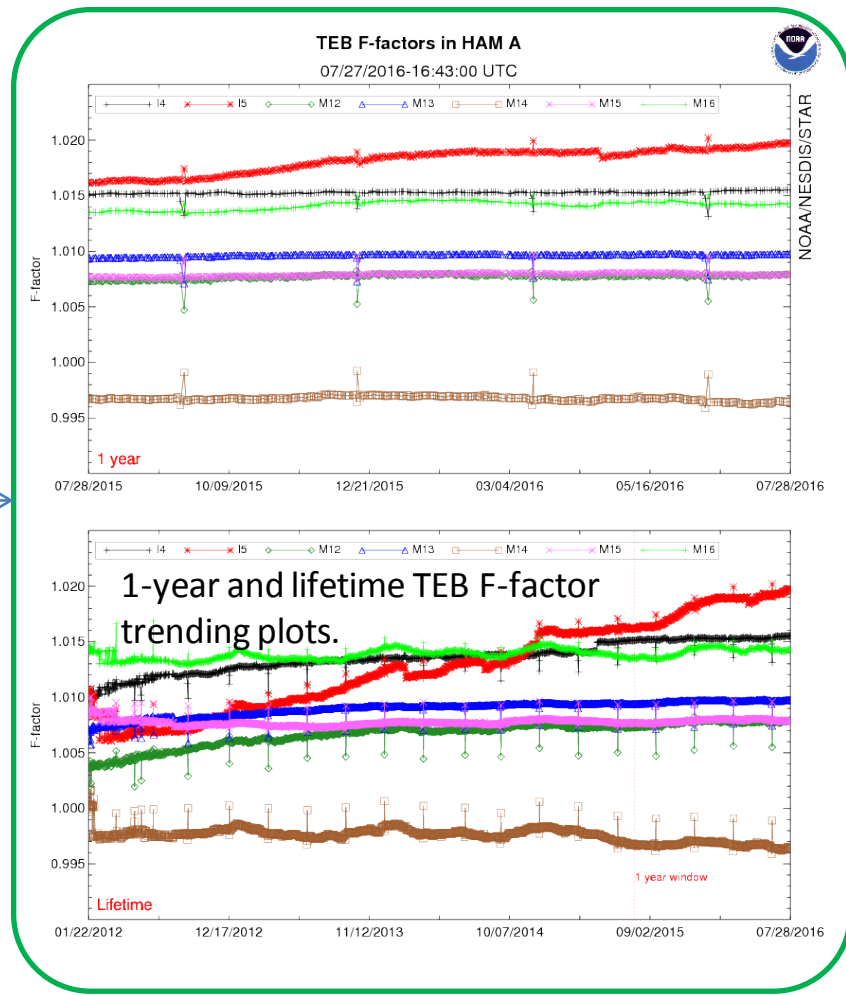
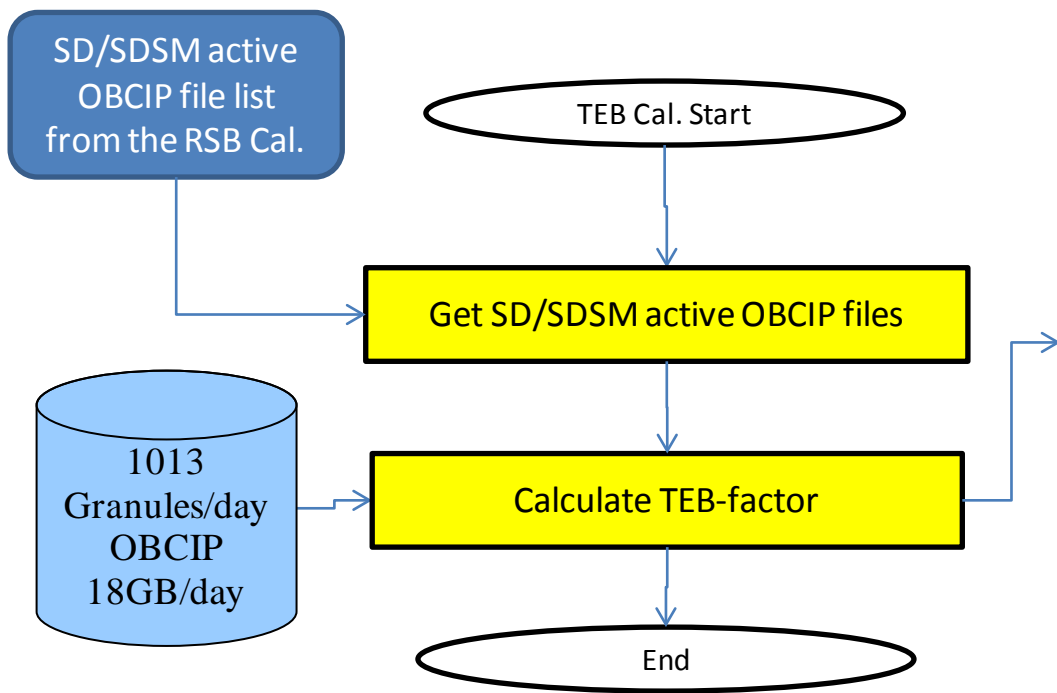
Blackbody

Blackbody Reflection

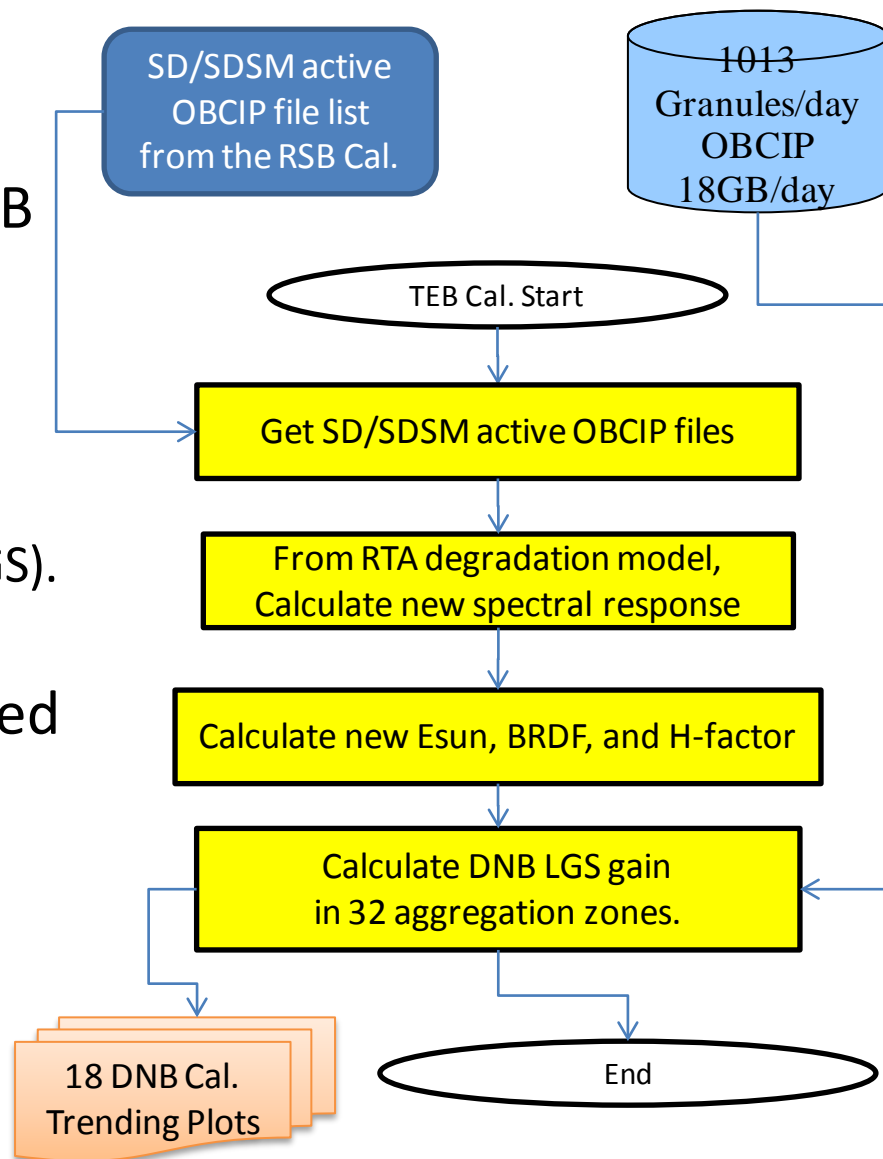
$$F = \frac{(RVS_{BB} - RVS_{SV}) \cdot \left[ \frac{(1 - \rho_{RTA})L_{RTA} - L_{HAM}}{\rho_{RTA}} \right] + RVS_{BB} \left\{ \varepsilon L_{BB} + (1 - \varepsilon)(F_{RTA}L_{RTA} + F_{BB\_SH}L_{BB\_SH} + F_{CAV}L_{CAV}) \right\}}{c_0 + c_1 \cdot dn_{BB} + c_2 \cdot dn_{BB}^2}$$

$$L_{EV\_ap} = \frac{(RVS_{SV} - RVS_{EV}) \cdot \left[ \frac{(1 - \rho_{RTA})L_{RTA} - L_{HAM}}{\rho_{RTA}} \right] + F \cdot (c_0 + c_1 \cdot dn_{EV} + c_2 \cdot dn_{EV}^2)}{RVS_{EV}}$$

- VIIRS TEB Calibration Processing Flow



- VIIRS Day-Night-Band (DNB) Calibration
  - DNB calibration is similar to RSB calibration.
  - DNB has 3 gain states and 32 aggregations zones.
    - Low Gain State (LGS), Mid Gain State (MGS), High Gain State (HGS).
  - The calibration coefficient is calculated in LGS and transferred to MGS and HGS by ratio LUTs.
  - RTA degradation model (by Tungsten contamination) is applied.





# Summary



- VIIRS imagery processing provides near real-time band images and quality flag information.
- Recently ICVS team added high resolution VIIRS image page including global and polar regions.
- OBCIP processing unit provides basic instrument status.
  - Temperatures, SD, SDSM, SV, and BB counts.
- RSB, TEB, and DNB processing units generate calibration coefficients and related trending plots.
- Sensor performance can be validated by comparing to the operational calibration coefficient.
- ICVS calibration results also supports future reprocessing.
- Current S-NPP ICVS processing unit will be applied to J1 VIIRS.