# Integrated Cal/Val System (ICVS) for OMPS

**Ding Liang, Ninghai Sun, Fuzhong Weng, Chunhui Pan, Trevor Beck**

August 15, 2017

# Outline

- OMPS performance monitoring at STAR ICVS
  - Calibration principle
  - Key performance parameters monitoring
    - Bias/Smear
    - Dark current/readout noise
    - Dark LUTs
    - Solar degradation
  - Instrument health and safety related parameters monitoring
  - Major anomalies
- J01 readiness
- S-NPP OMPS science Sensor Data Record (SDR) reprocessing results

# The NM/NP Calibration Principle

$$Q_{jk}^{c} = \frac{Q_{jk}^{ADC} - Q_0}{g\ m_{jk}} - Q_k^{s} - Q_{jk}^{dark} - Q_{jk}^{SL}$$

$Q_{jk}^{ADC}$ : raw counts at the output of the analog-digital-converter

$g$ : non-linearity of the electronics chain

$Q_{jk}^{dark}$ : observed dark

$Q_0$ : zero input response

$m_{jk}$ : relative pixel gain level

$Q_{jk}^{SL}$ : stray light

$Q_k^{s}$ : observed smear(contain the offset)

$$L_{jk}^{m} = \frac{Q_{jk}^{r} k_{jk}^{r}}{\tau_{jk}(t)}$$

$$E_{jk}^{m}(t) = \frac{Q_{jk}^{i} k_{jk}^{i}}{g_{jk}(\theta,\phi)\rho_{jk}(t)\tau_{jk}(t)}$$

$L_{jk}^{m}$ : Observed earth radiance

$Q_{jk}^{r}$ : corrected earth view counts

$k_{jk}^{r}$ : radiance calibration coefficient

$\tau_{jk}$ : sensor response changes

$E_{jk}^{m}$ : Observed solar irradiance

$Q_{jk}^{i}$ : corrected solar view counts

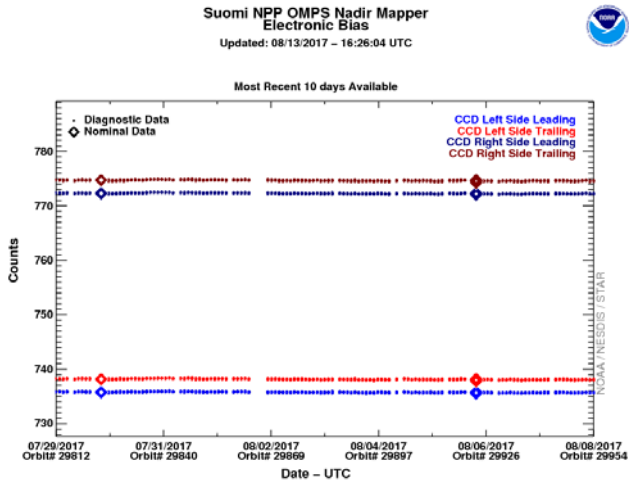
$k_{jk}^{i}$ : irradiance calibration coefficient

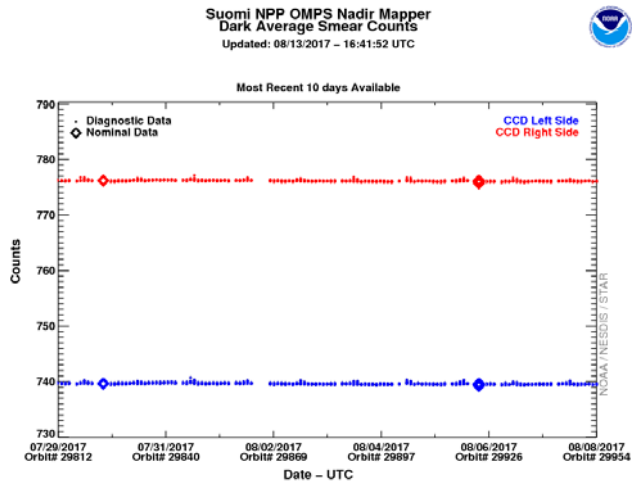
$g_{jk}$ : goniometric response

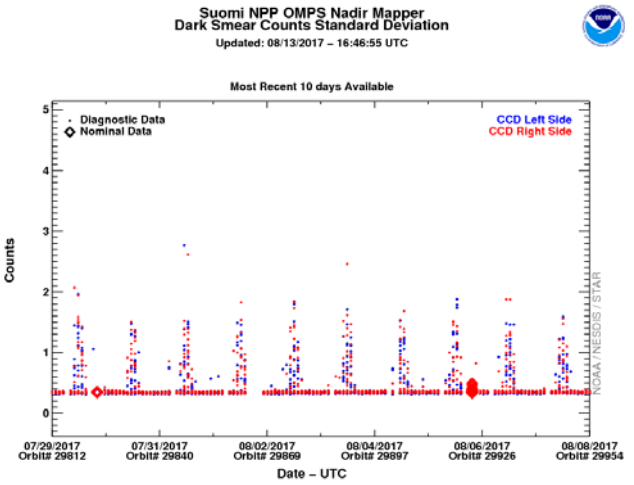
$\rho_{jk}$ : long-term solar diffuser reflectivity changes

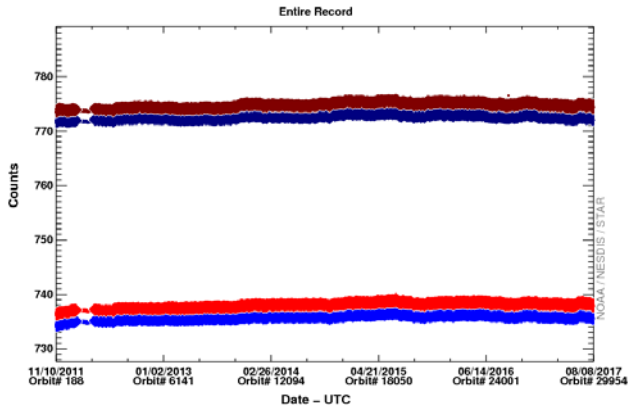
# Key Performance Parameters

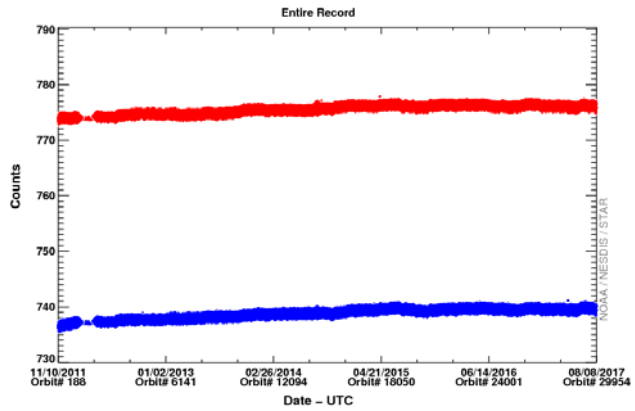
ICVS monitoring of NM electronic bias and mean value and standard deviation for smear

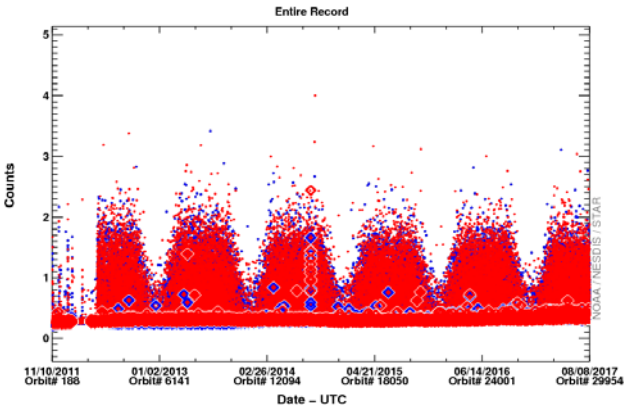


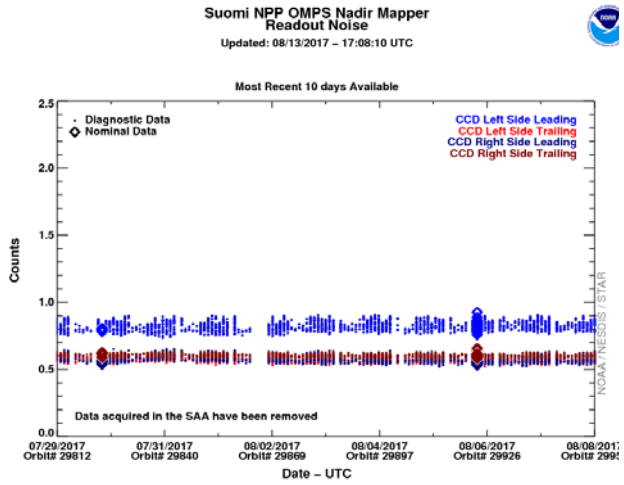



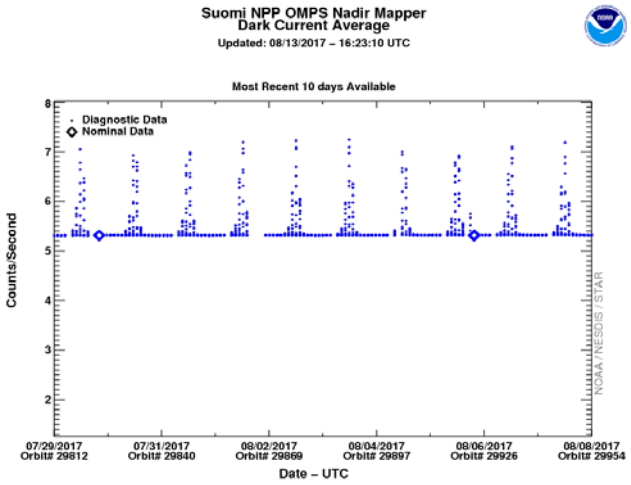



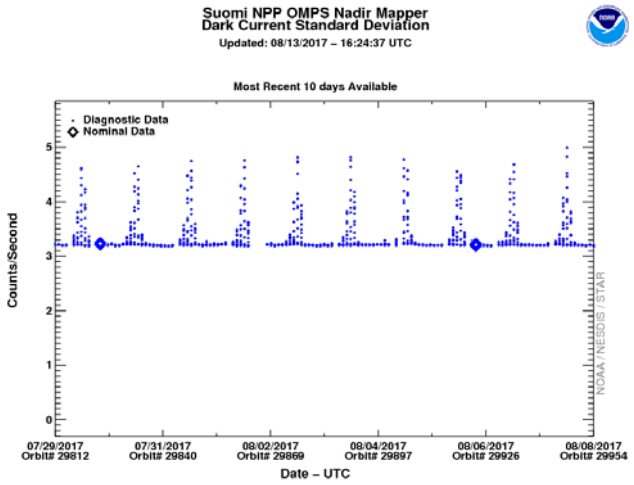



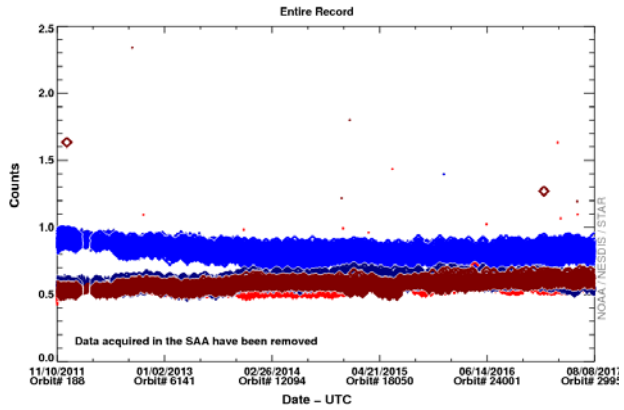
# Key Performance Parameters

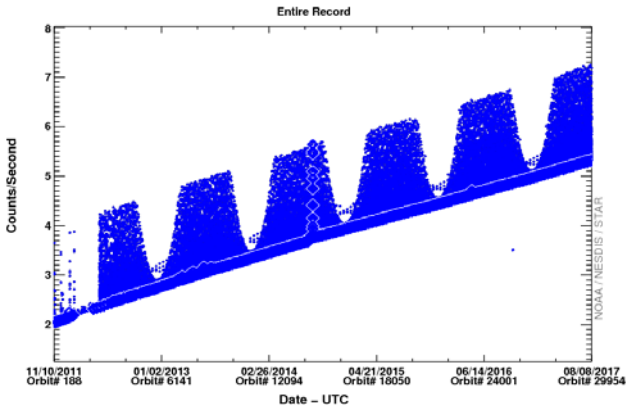
ICVS monitoring of readout noise and mean value and standard deviation for dark current

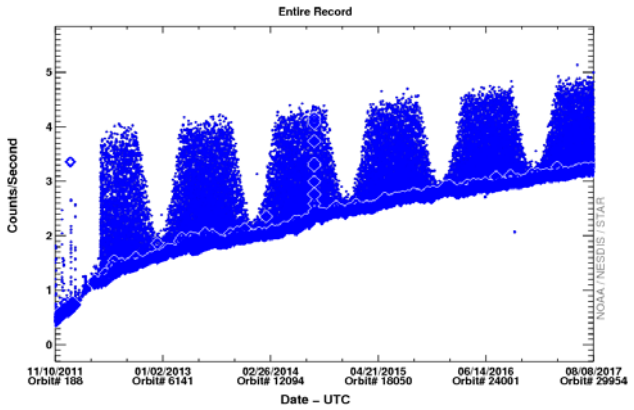


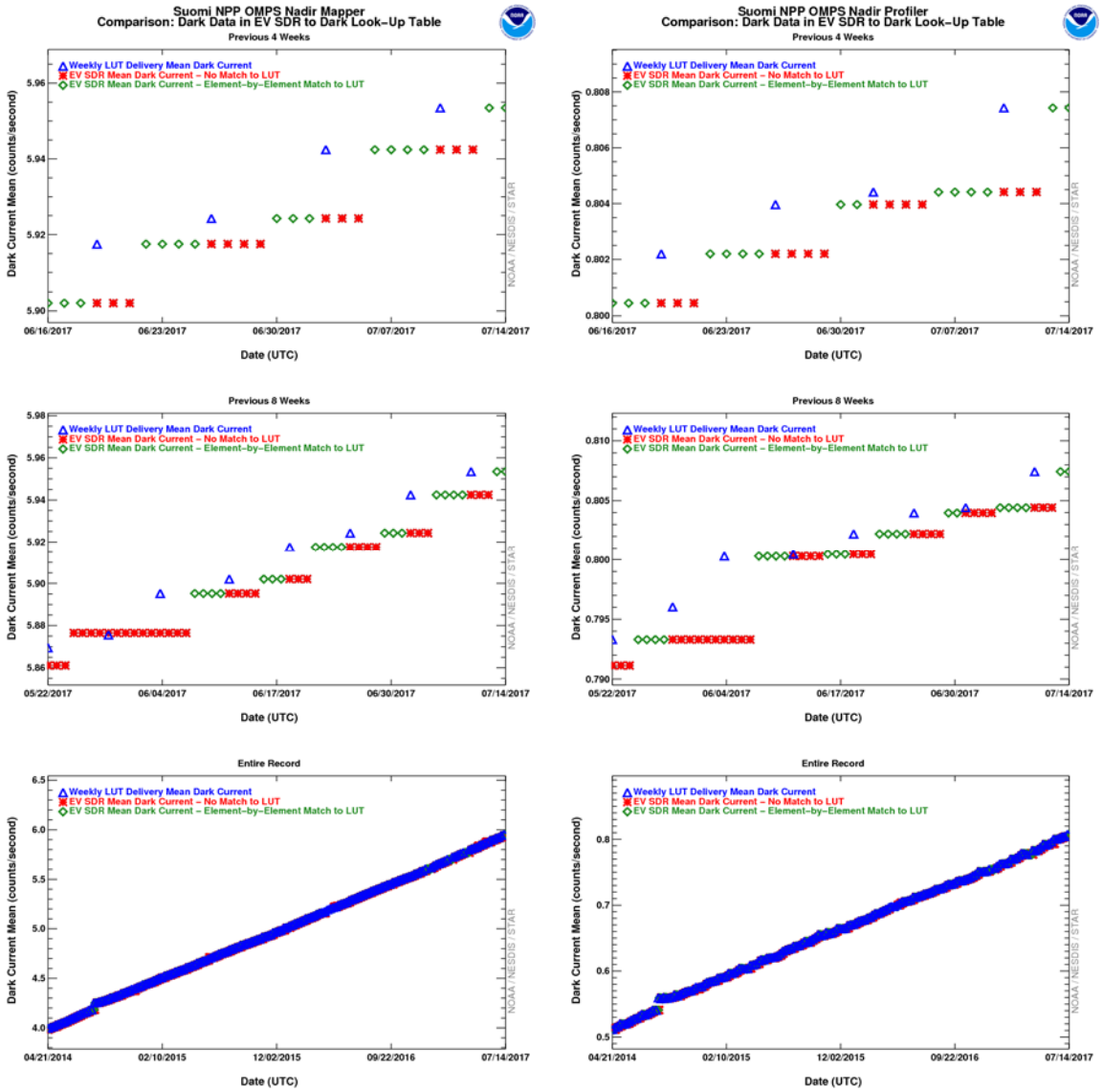



# NM/NP Dark Current LUT Updates

ICVS monitoring of NM/NP dark current LUTs:

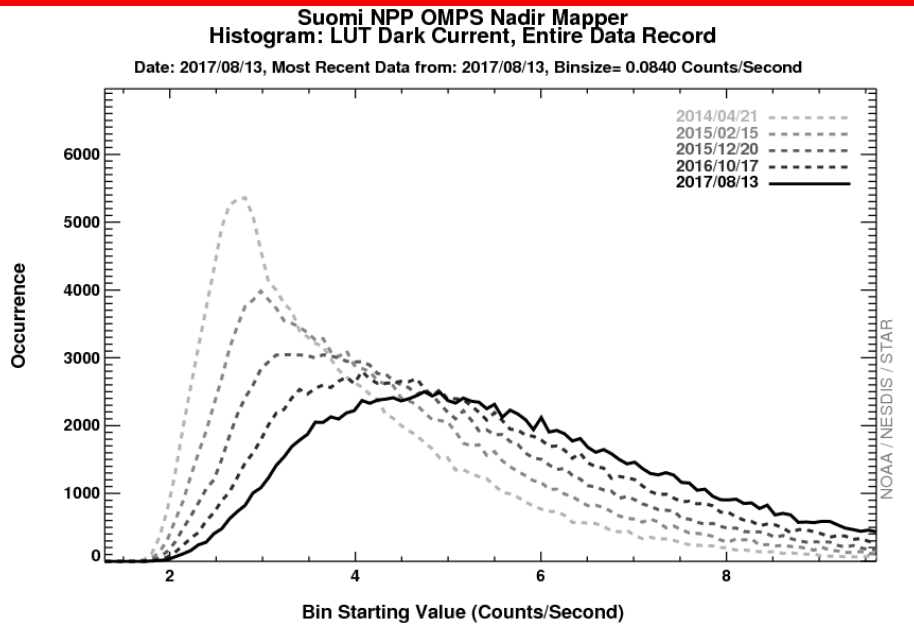
- Timely weekly updates of the dark current LUT for calibration (blue triangle)
- Implementation of the weekly dark LUT (transition from red to green) into the Earthview SDR
- Expected steady increase of the dark current (y-axis)

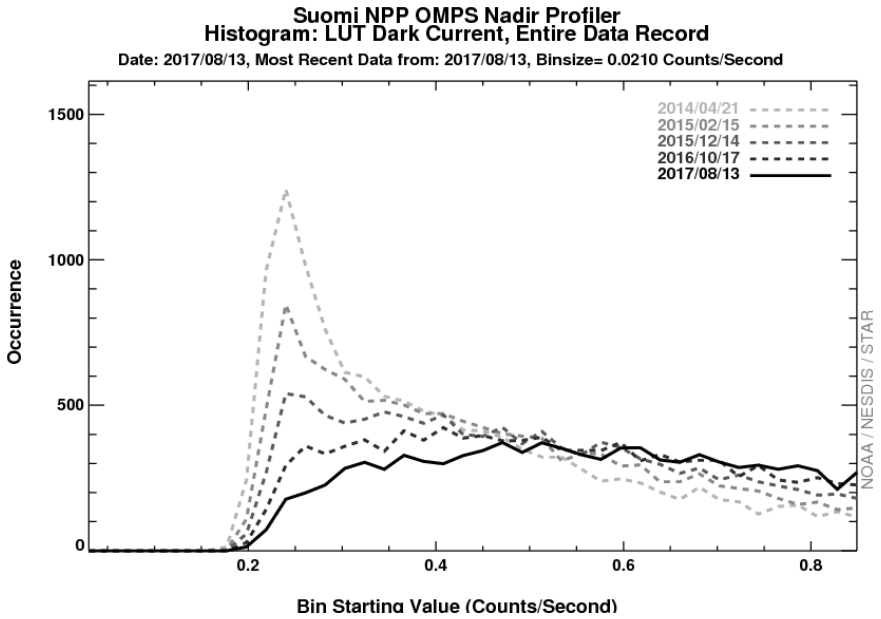


# NM/NP Dark Current LUT Updates

ICVS monitoring of NM/NP dark current histograms:

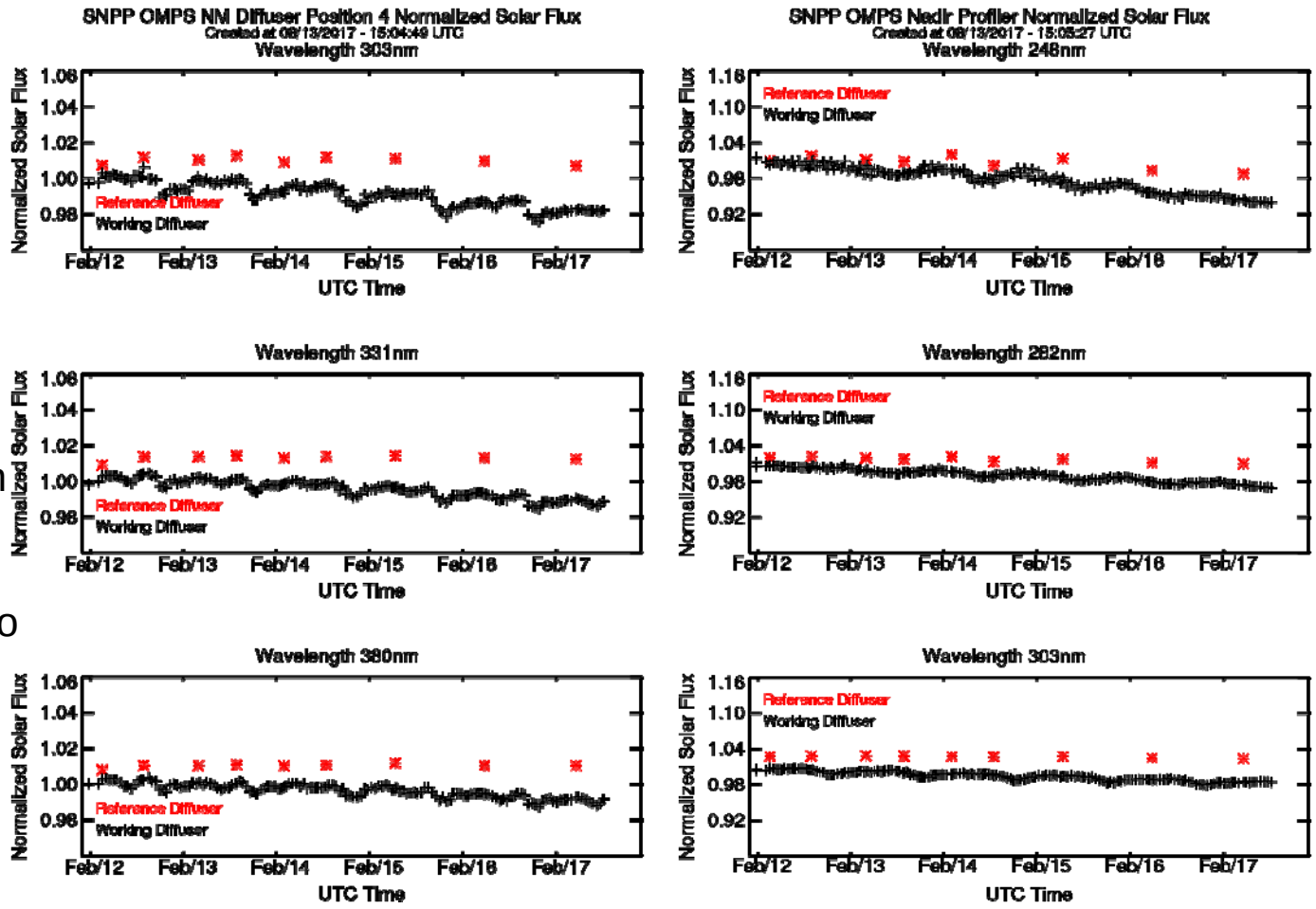
•Histograms of OMPS NM/NP Dark Current LUTs every 6 months from early 2014 until mid 2017



# Normalized Solar Flux for NM and NP

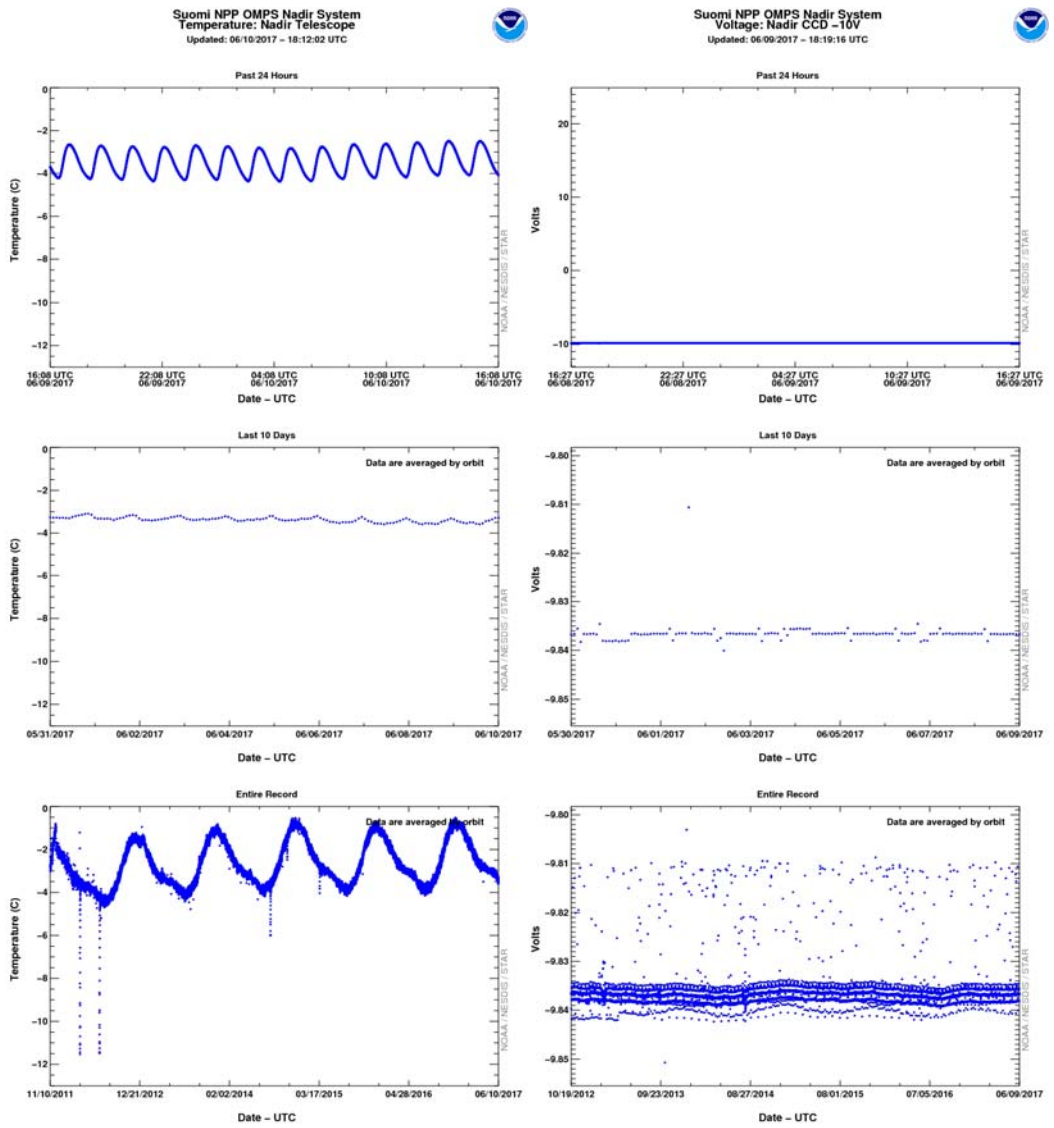
- Solar flux time series are used to monitor diffuser degradation as well as sensor optical degradation
- Working diffuser data reflects both diffuser and optical degradation
- Reference diffuser measurement is used to estimate optical degradation




Solar Flux value are normalized by the first day measurement. Solar Flux Measurements show minimal degradation in NM and NP.

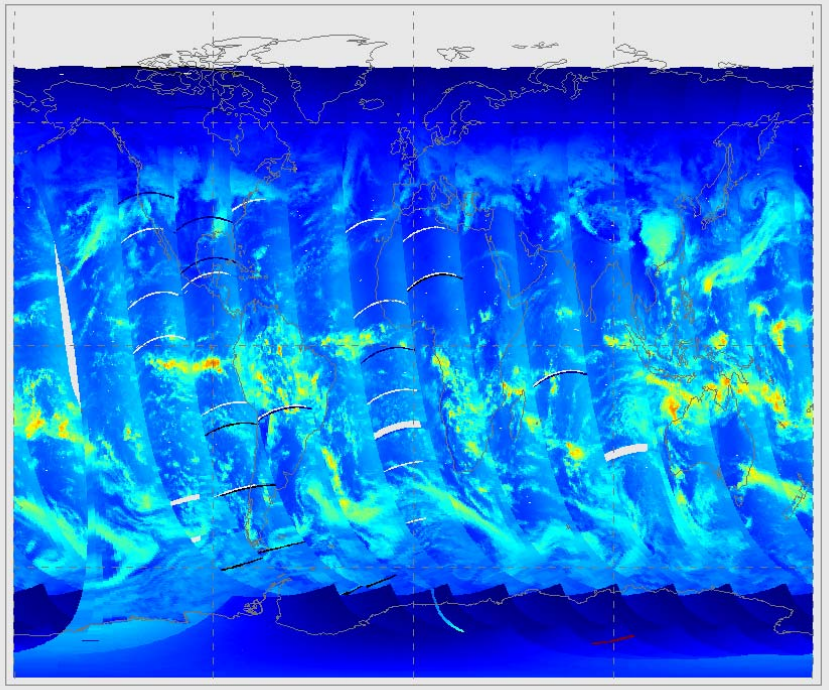
# Sensor Telemetry Monitoring

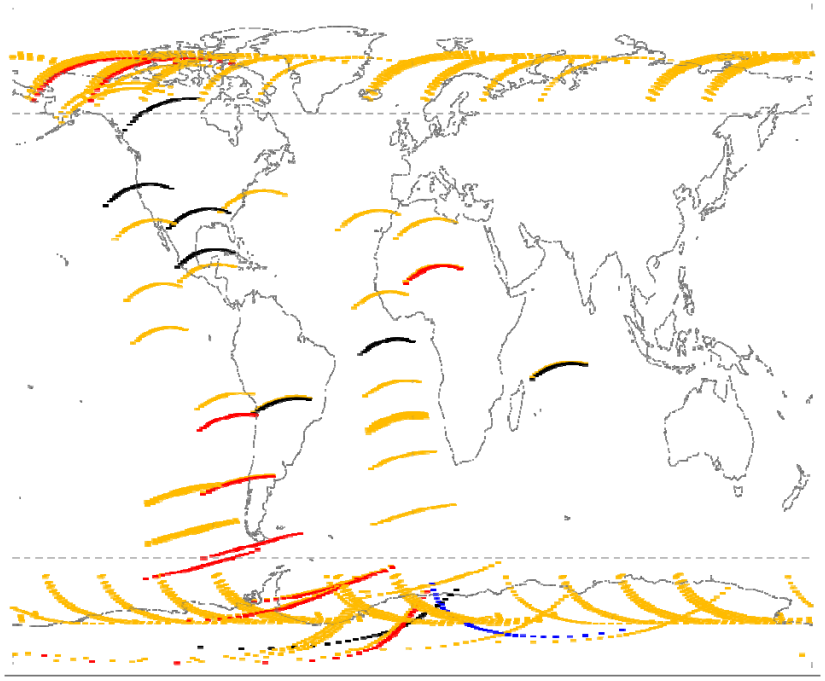
ICVS monitoring of parameters important to instrument health and safety, such as temperatures, electronic voltages and currents, and scan motor encoder output.



# OMPS Earth View Radiance Anomaly

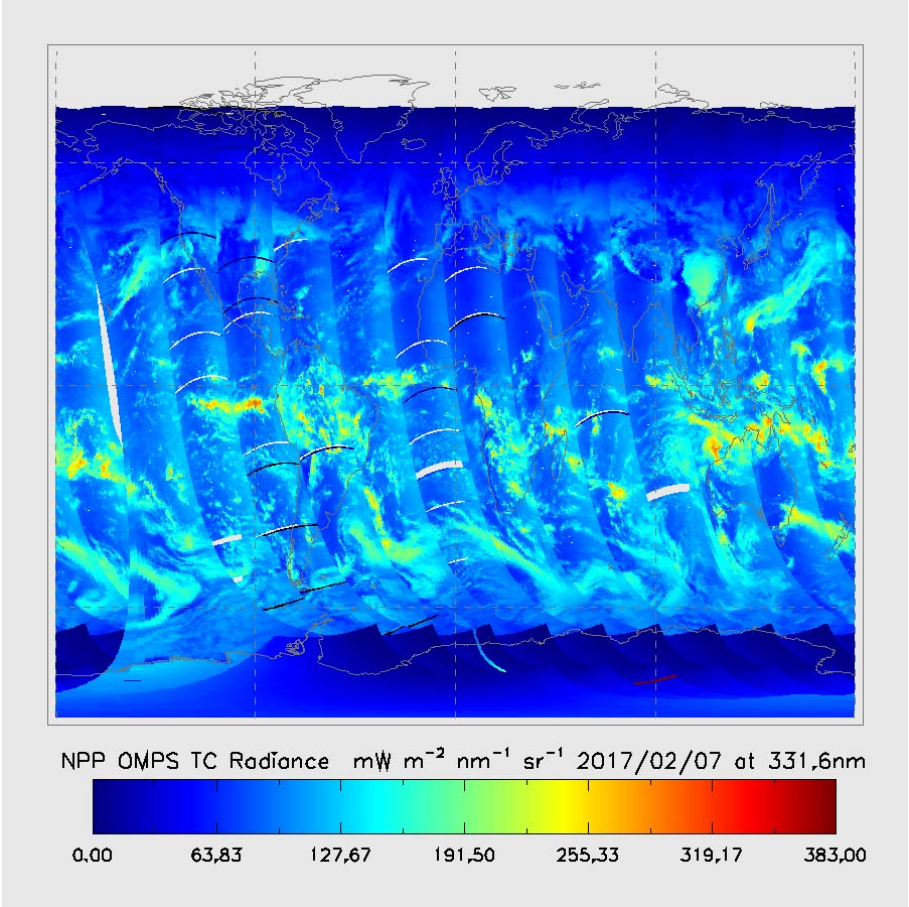
• Anomalous Nadir Mapper EV radiance with missing scans, zero radiance scans, NaN radiance scans, and abnormal high radiance scan were detected on 2/7/2017.

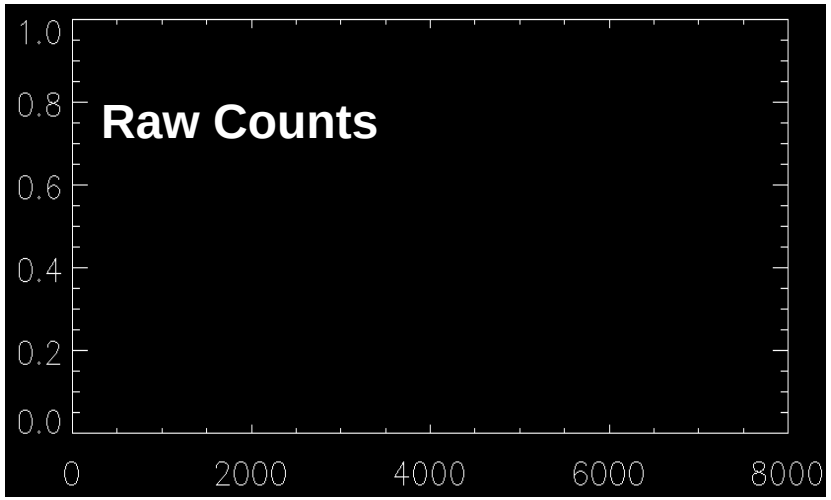


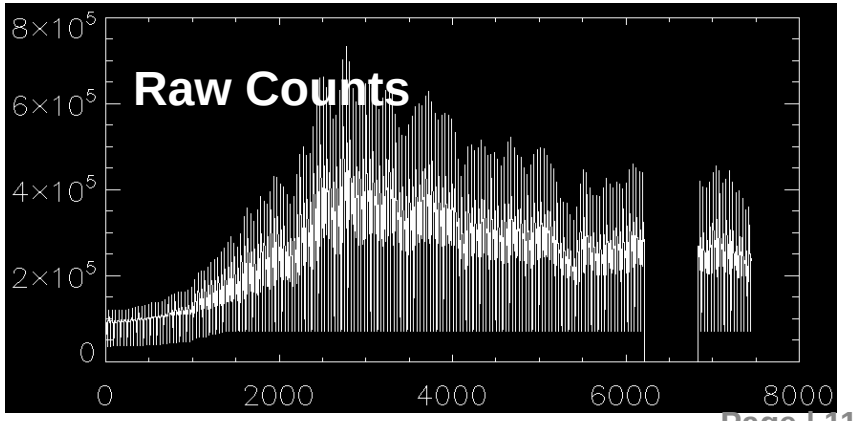



# OMPS Earth View Radiance Anomaly

• Anomalous Nadir Mapper EV radiance with missing scans, zero radiance scans, NaN radiance scans, and abnormal high radiance scan were detected on 2/7/2017.

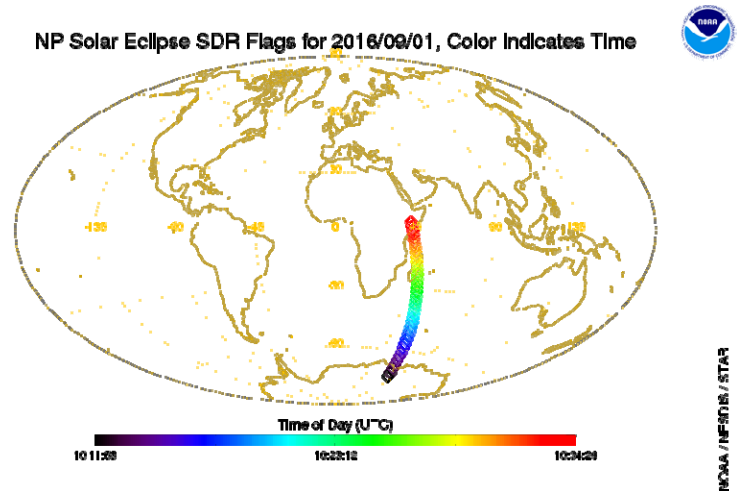


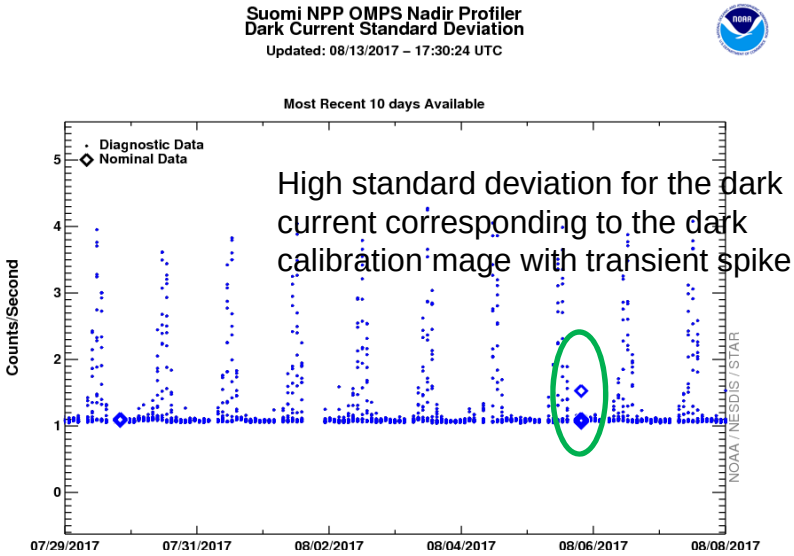



# Expected Anomaly Detection

Automated anomaly detection and email warnings are established for radiance and key performance parameters

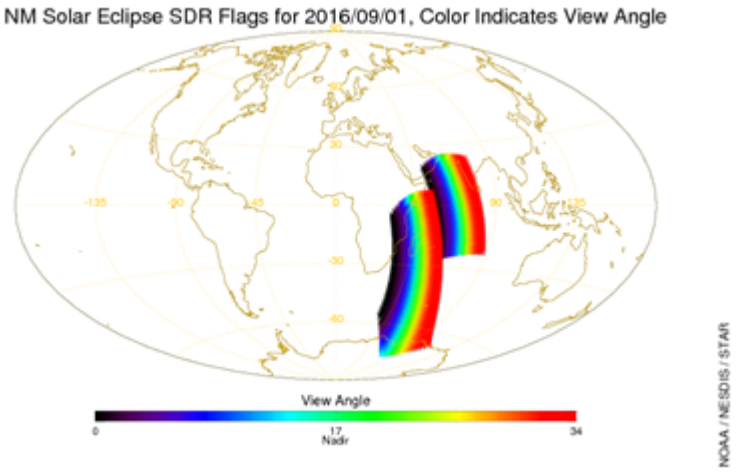



OMPS Solar Eclipse quality flag indicated a solar eclipse on September 1st, affecting OMPS data from 10:11:58 to 10:34:26 UTC.
A warning email was sent to the STAR S-NPP Cal/Val Team leads.




High standard deviation for the dark current corresponding to the dark calibration mage with transient spike

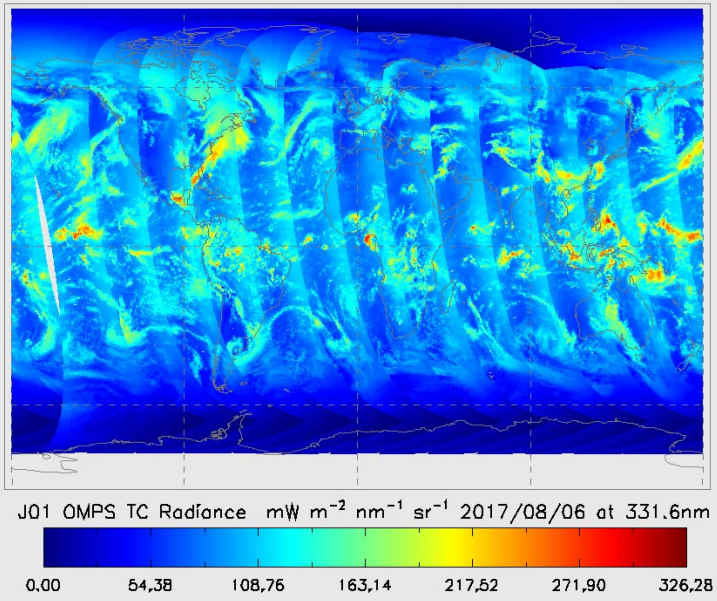
Time series of OMPS NP dark current STD for ten days

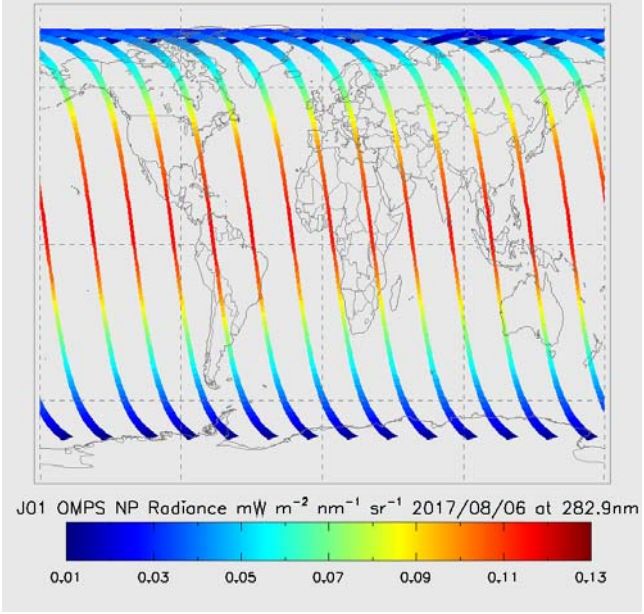


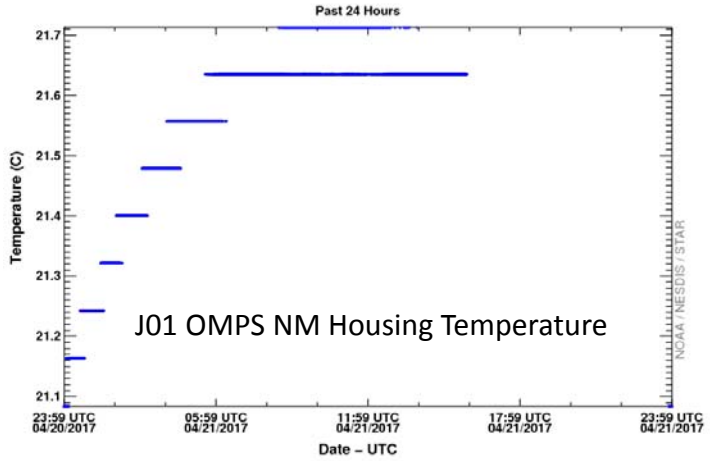

OMPS NM solar eclipse SDR quality flags for 2016/09/01 colored coded by view angle

# J01 Readiness

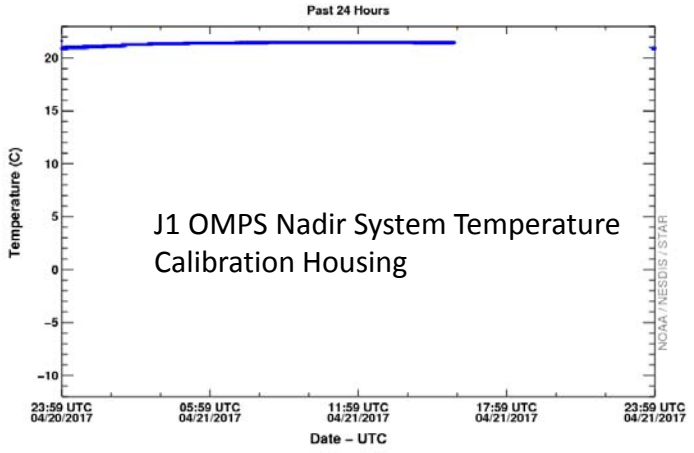
**SNPP, J01 OMPS TC and NP Radiance images at STAR ICVS BETA website:**
**http://www.star.nesdis.noaa.gov/icvs-beta/**



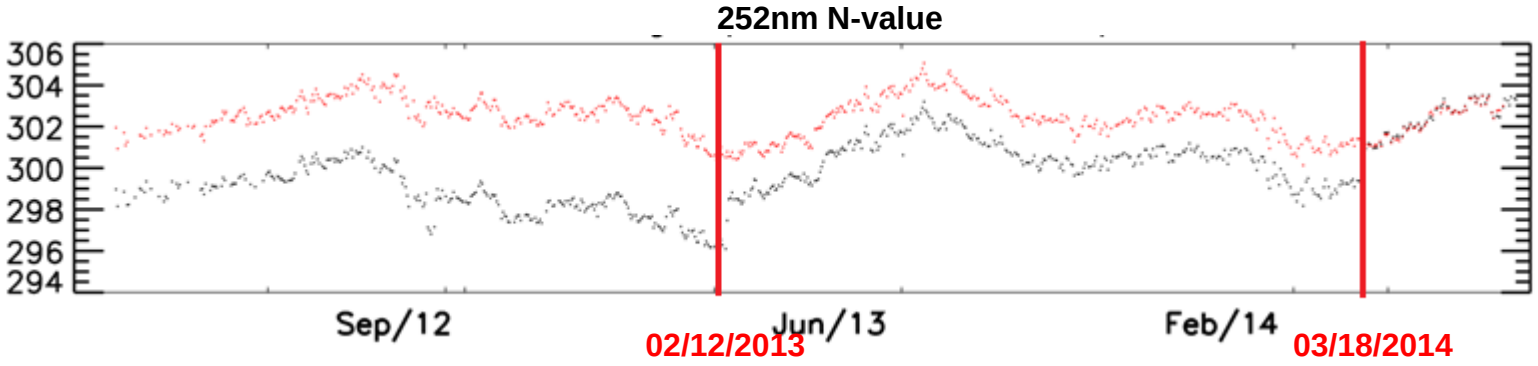
J01 OMPS NM Housing Temperature



J1 OMPS Nadir System Temperature Calibration Housing

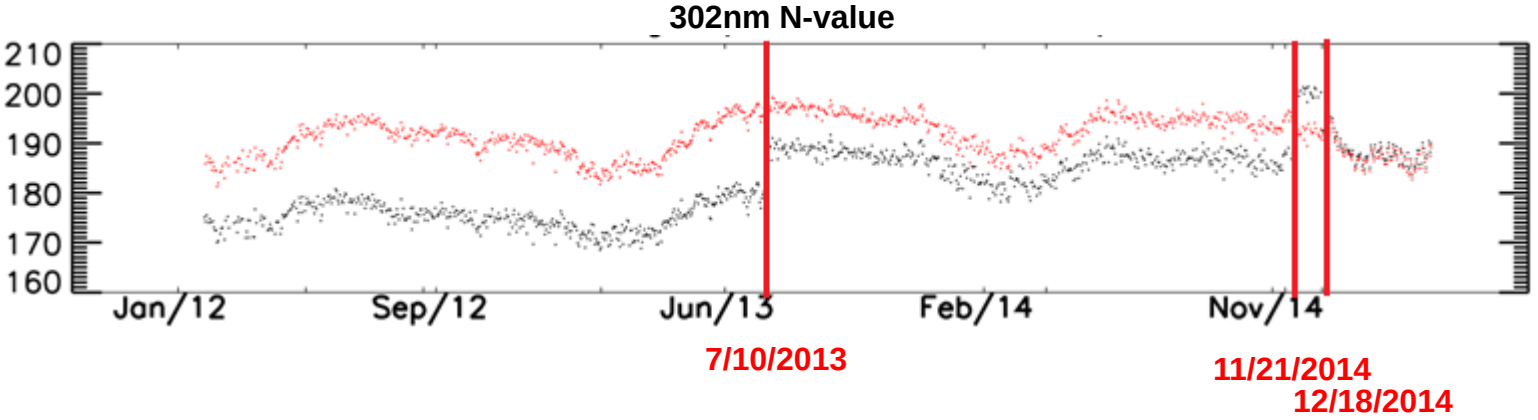
# OMPS SDR Reprocessing Results

- **ADL5.3 with up-to-date LUTs**
- **OMPS daily nadir view N-value trending**
  - **OMPS daily nadir view N-value over Tropical Pacific region (20S-20N,90W-180W).**




**02/12/2013: Start of weekly updates to NP dark LUT** **03/18/2014: NP Stray Light correction**

Fig. 1 OMPS NP daily nadir view N-value over Tropical Pacific region (20S-20N,90W-180W). Black: Operational; Red: Reprocessed




**7/10/2013: TC Stray Light temporary table update, 11/21/2014: TC Stray Light LUT update, 12/18/2014: TC Stray Light LUT update**

Fig. 2 OMPS TC daily nadir view N-value over Tropical Pacific region (20S-20N,90W-180W). Black: Operational; Red: Reprocessed

# Summary and Future Plan

- Comprehensive near real time and long term instrument status and performance monitoring
- Real time support for sensor calibration activities
- Automated anomaly detection and email warnings are established for radiance and key performance parameters
- New parameters will be monitored according to requirements from OMPS SDR team
- S-NPP and J01 OMPS will be monitored at STAR ICVS-beta website