Integrated Cal/Val System (ICVS) for OMPS and SNPP OMPS SDR Data Reprocessing

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Outline

- OMPS performance monitoring at STAR ICVS
  - Calibration principle
  - Key performance parameters monitoring
    - Bias/Smear
    - Dark current/readout noise
    - Dark LUTs
    - Solar degradation monitoring
  - Instrument health and safety related parameters monitoring
  - Alerts
- STAR ICVS-beta website for S-NPP and J01
- S-NPP OMPS science SDR reprocessing

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)

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

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

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

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

τ_{jk} : sensor response changes

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

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

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

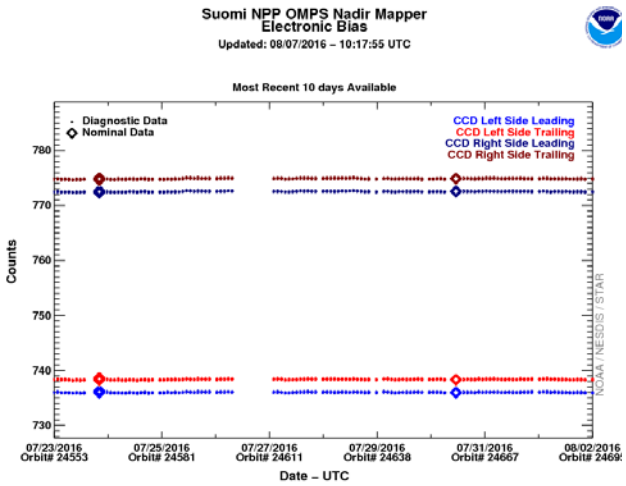
k_{jk}^{i} : irradiance calibration coefficient

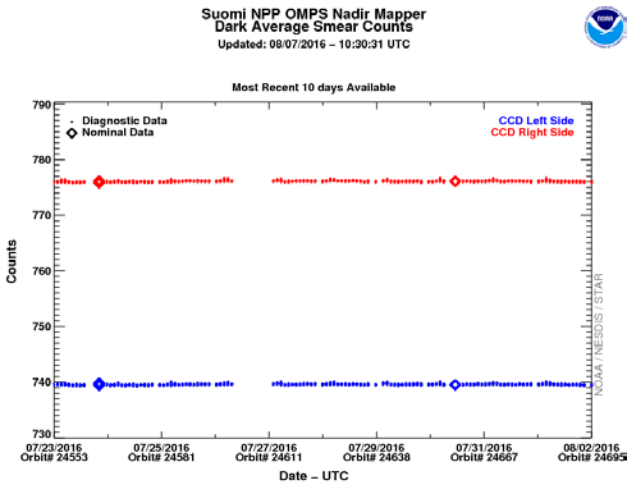
g_{jk} : goniometric response

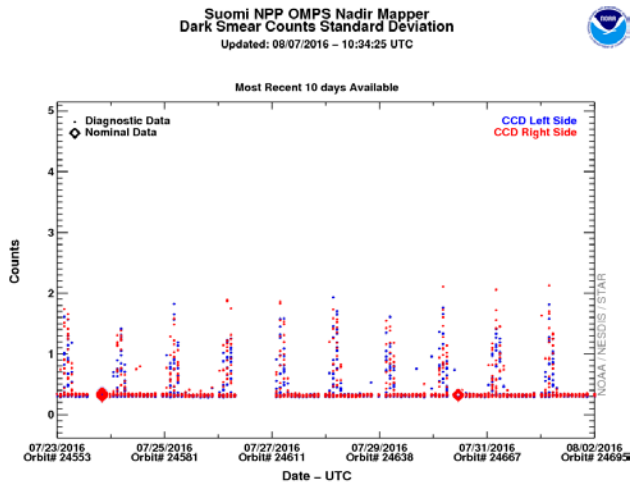
ρ_{jk} : long-term solar diffuser reflectivity changes

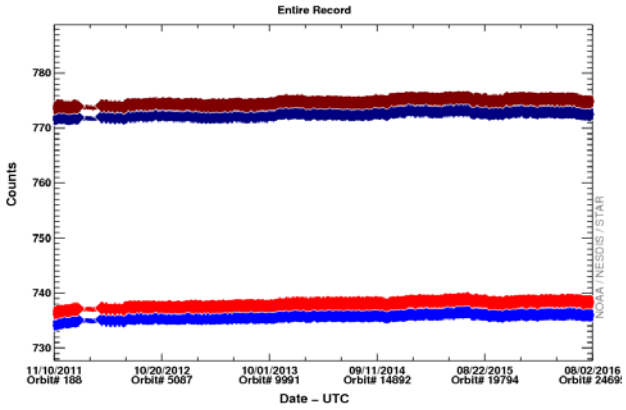
Key Performance Parameters

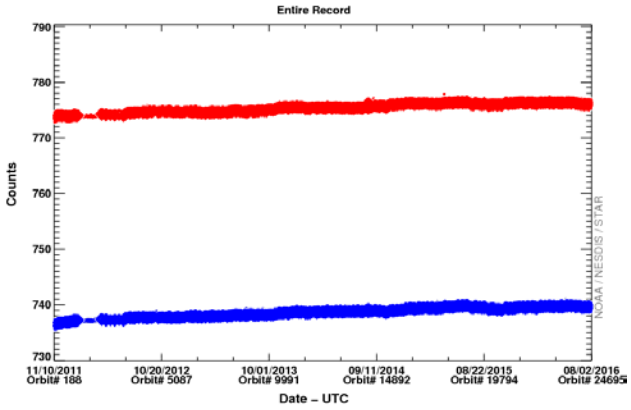
ICVS monitoring of electronic bias and mean value and standard deviation for smear

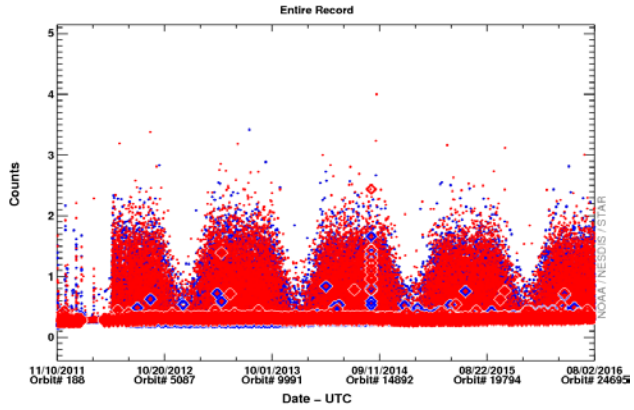






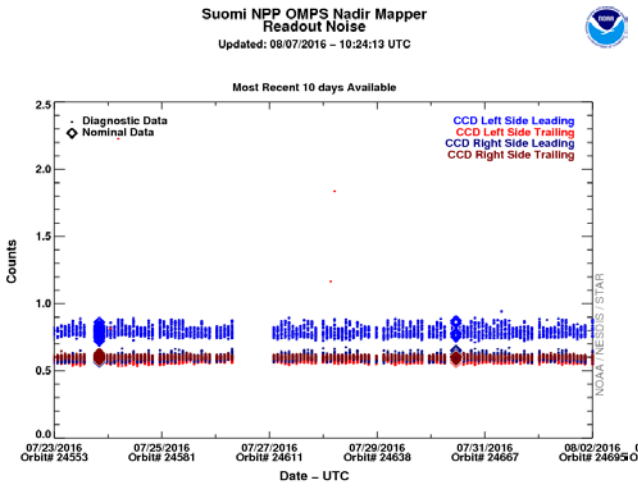


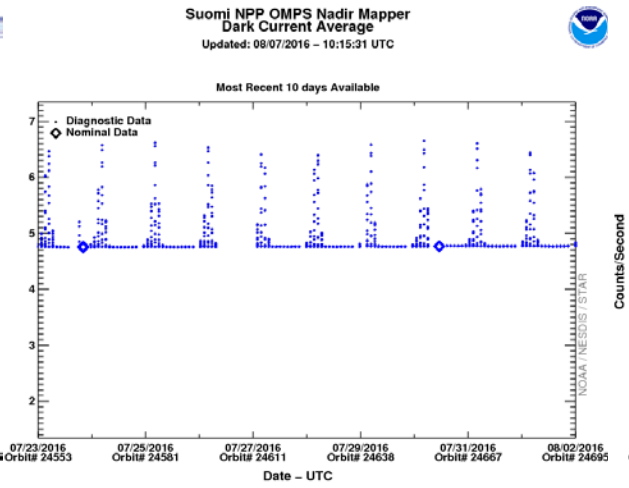


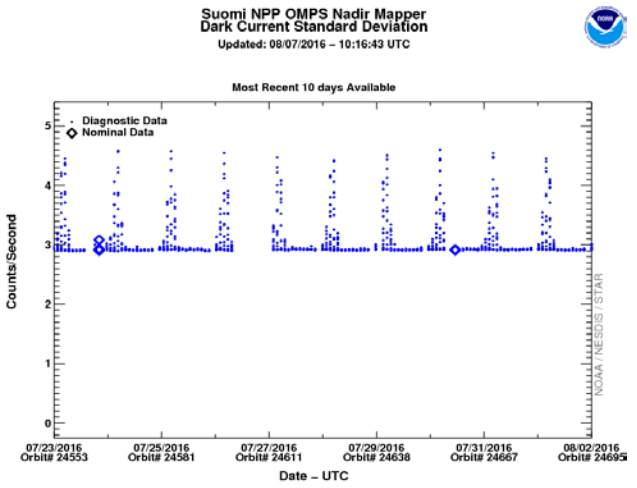


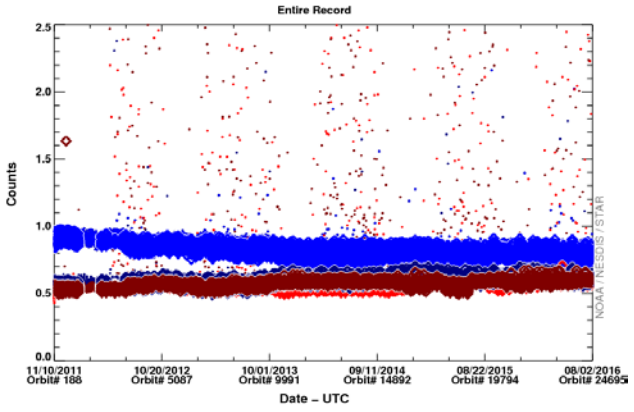
Key Performance Parameters

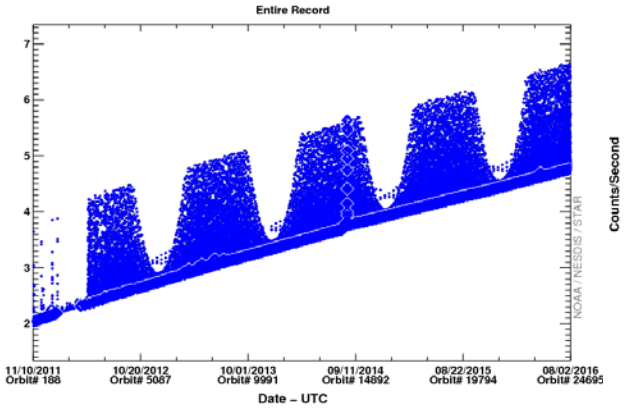
ICVS monitoring of readout noise and mean value and standard deviation for dark current

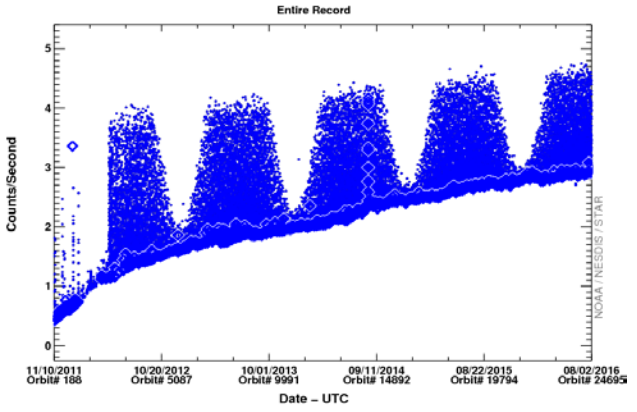








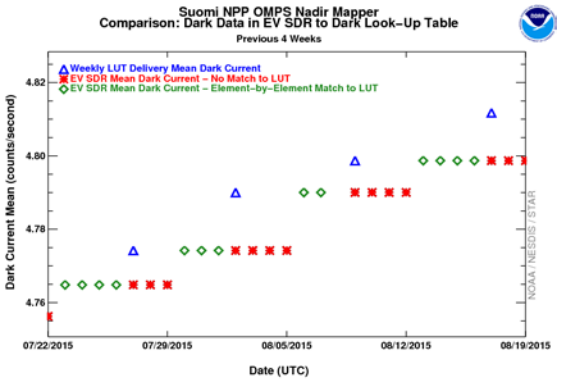


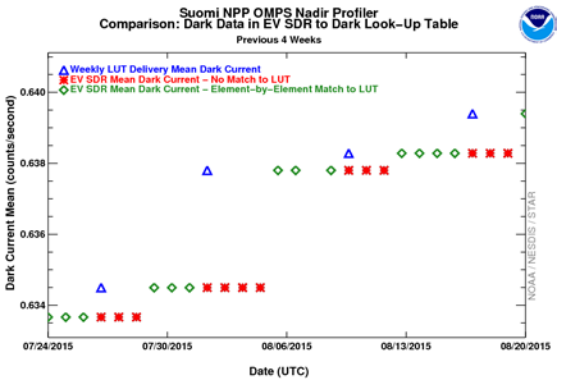


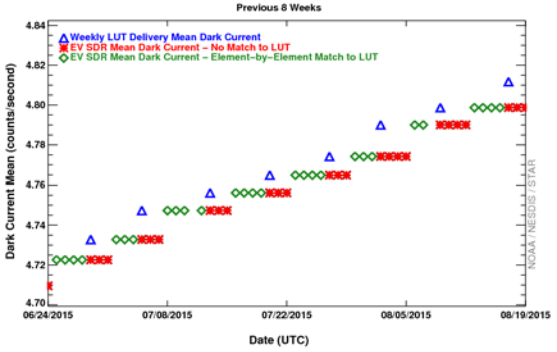
NM/NP Dark Current LUT Updates

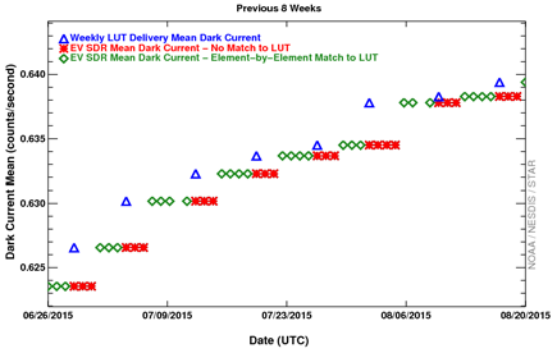
ICVS monitoring of NM/NP dark current LUT updates:

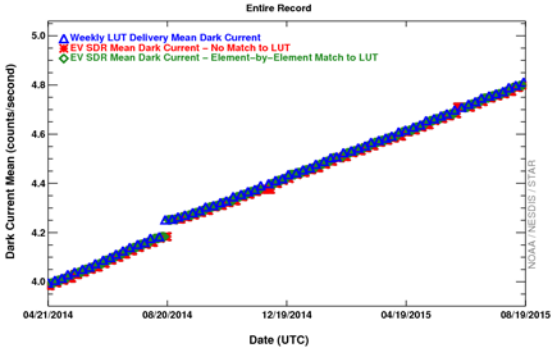
- Timely weekly updates of the dark current LUT for calibration
- Implementation of the weekly dark LUT (transition from red to green) into the Earthview SDR
- Expected steady increase of the dark current

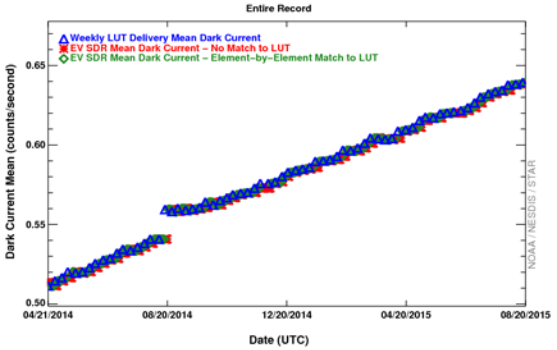








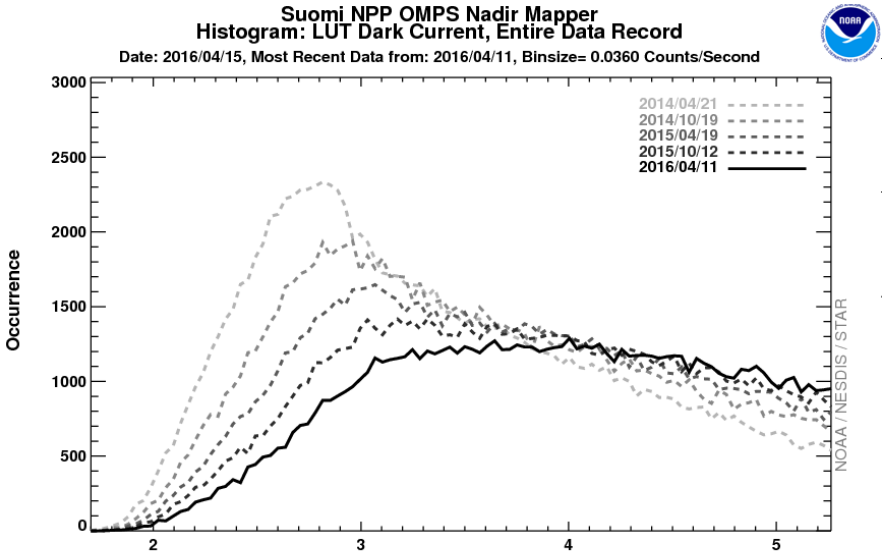


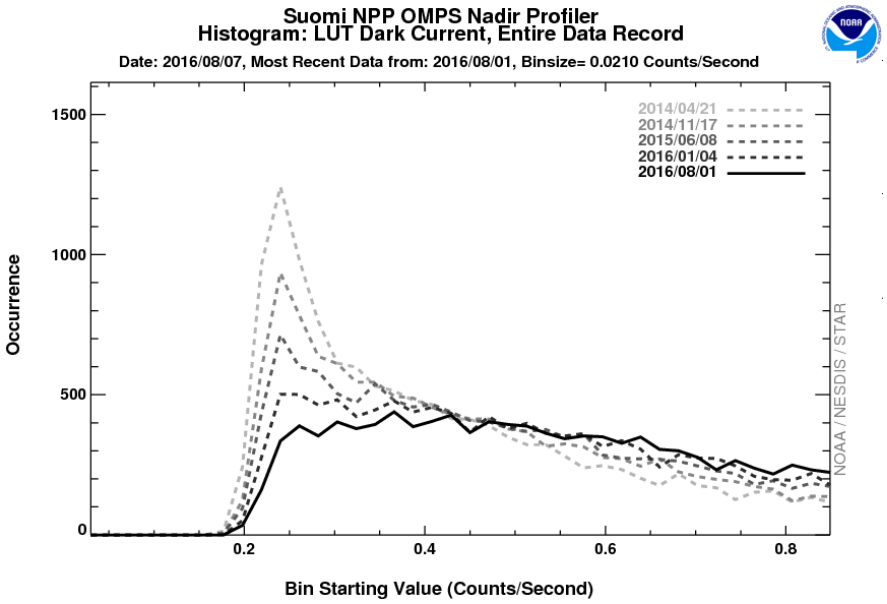


NM/NP Dark Current LUT Updates

ICVS monitoring of NM/NP dark current LUT updates:

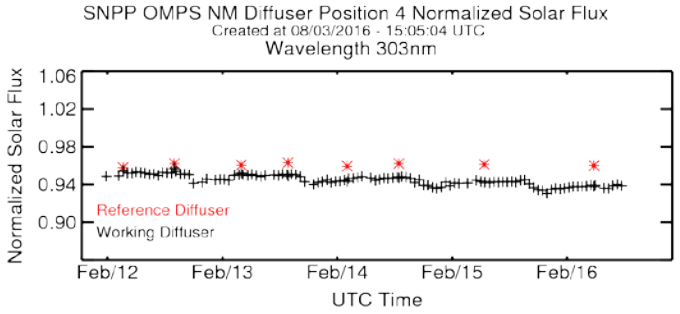
•Statistical plots and histograms are also included

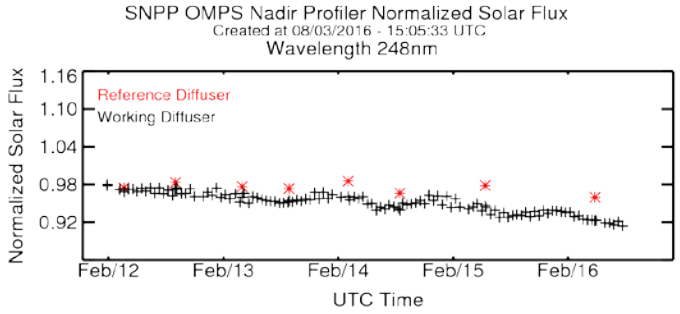


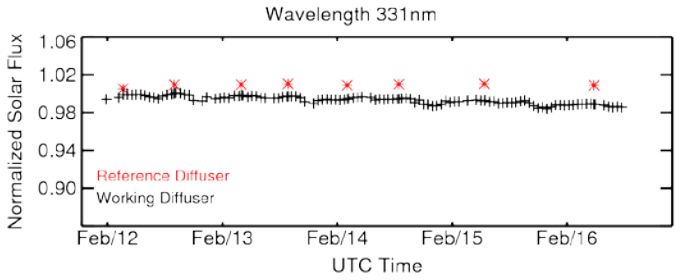


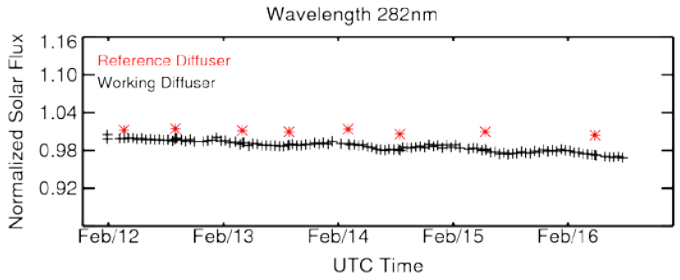
Normalized Solar Flux for NM and NP

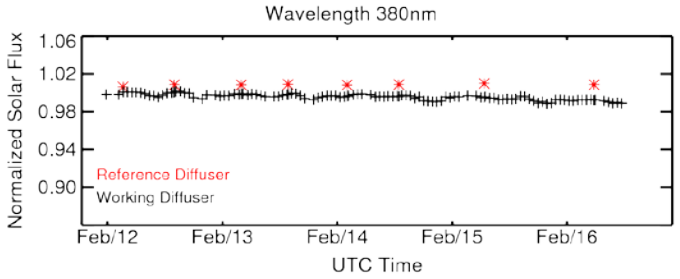
- Solar flux time series are used to monitor diffuser degradation as well as sensor optical degradation
- Working diffuser data reflects both diffuser and optical degradation
- Reference diffuser measurement is used to estimate optical degradation

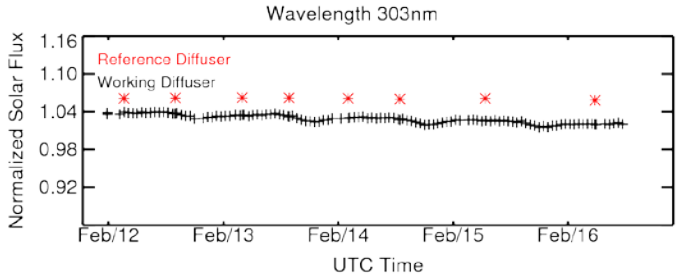






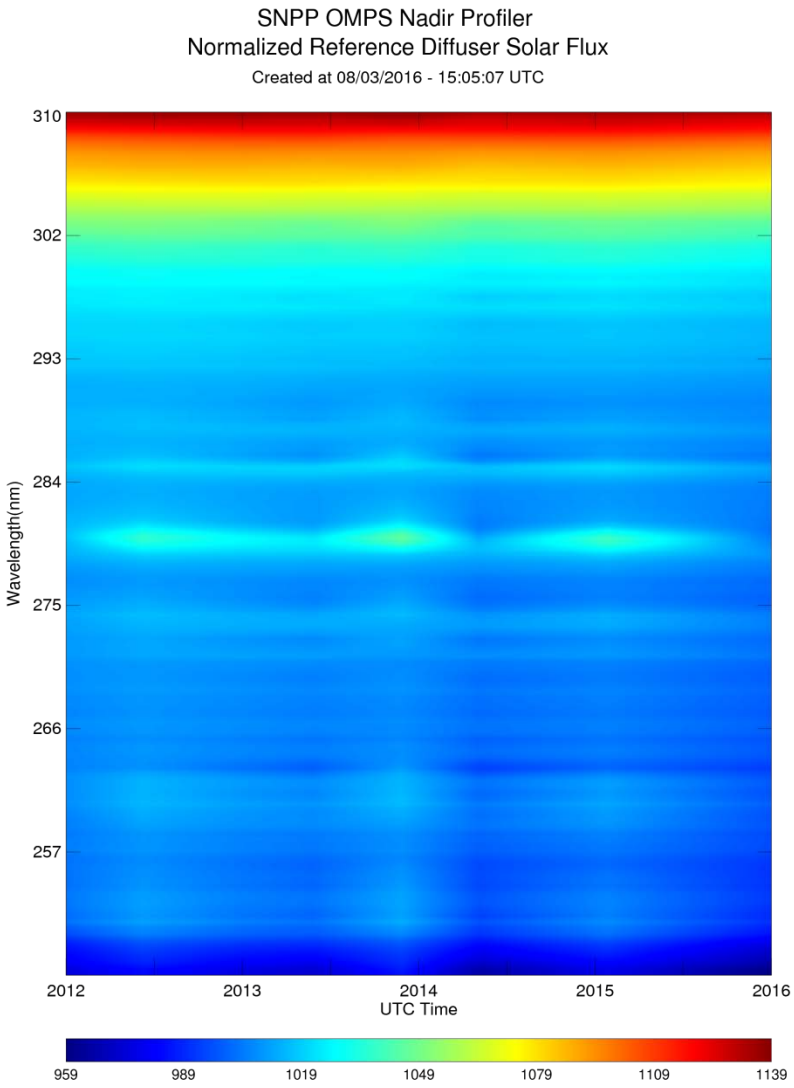


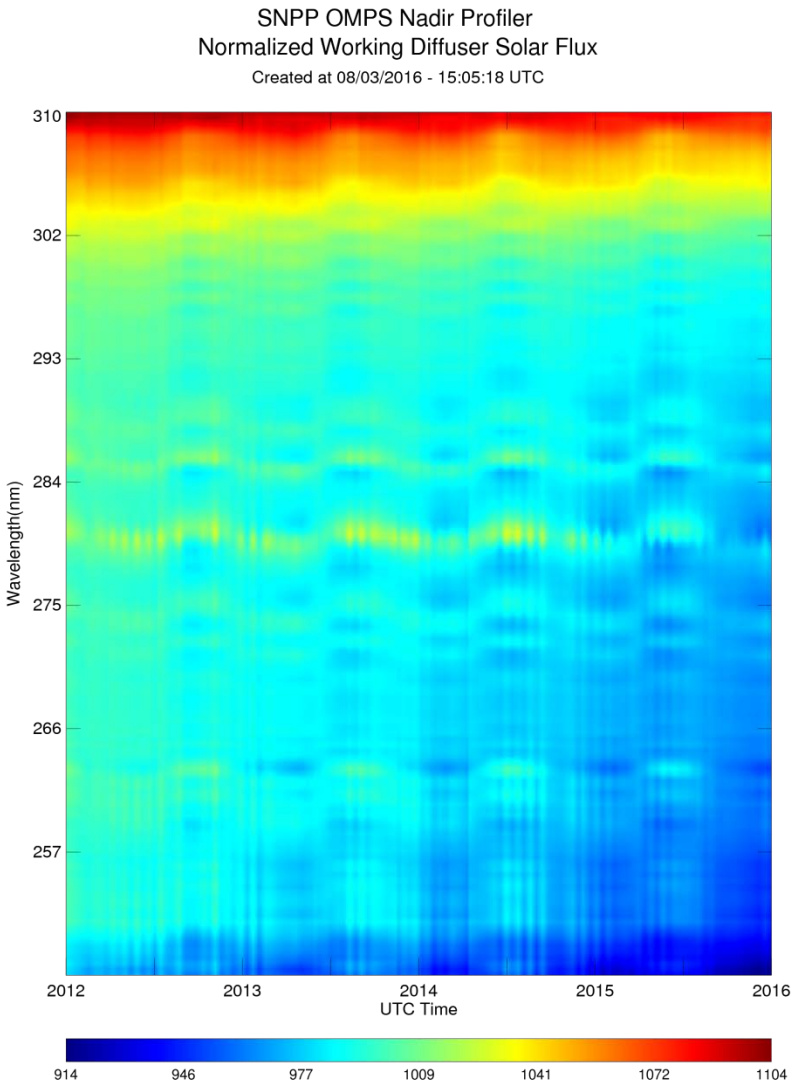




Solar Flux value are normalized by the first day measurement. Solar Flux Measurements show minimal degradation in NM and NP.

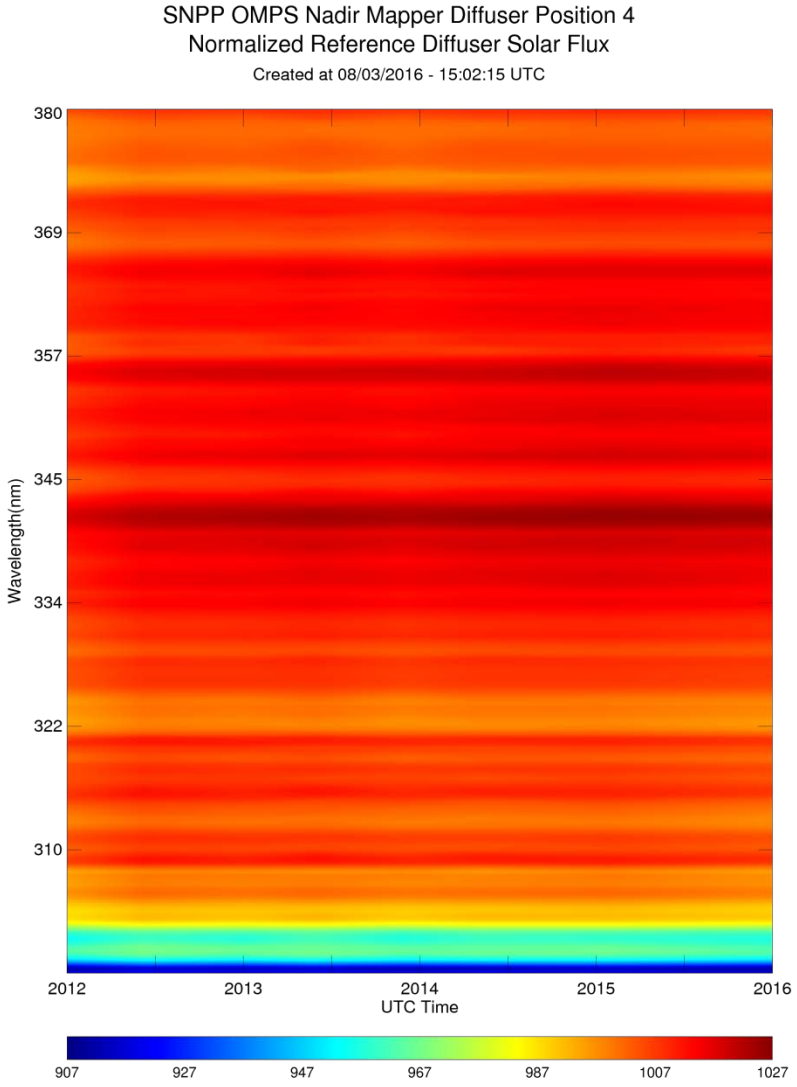
Normalized Solar Flux from NP Diffuser

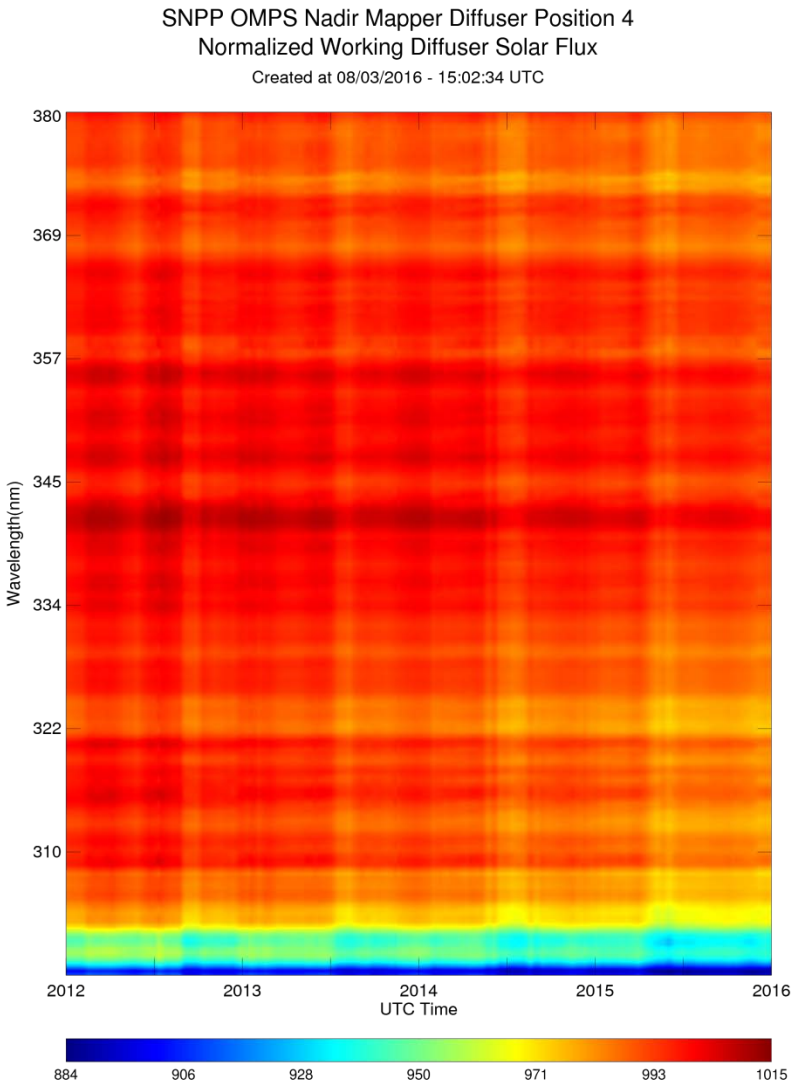




Solar Flux value are normalized by the first day measurement.

Normalized Solar Flux from NM Diffuser

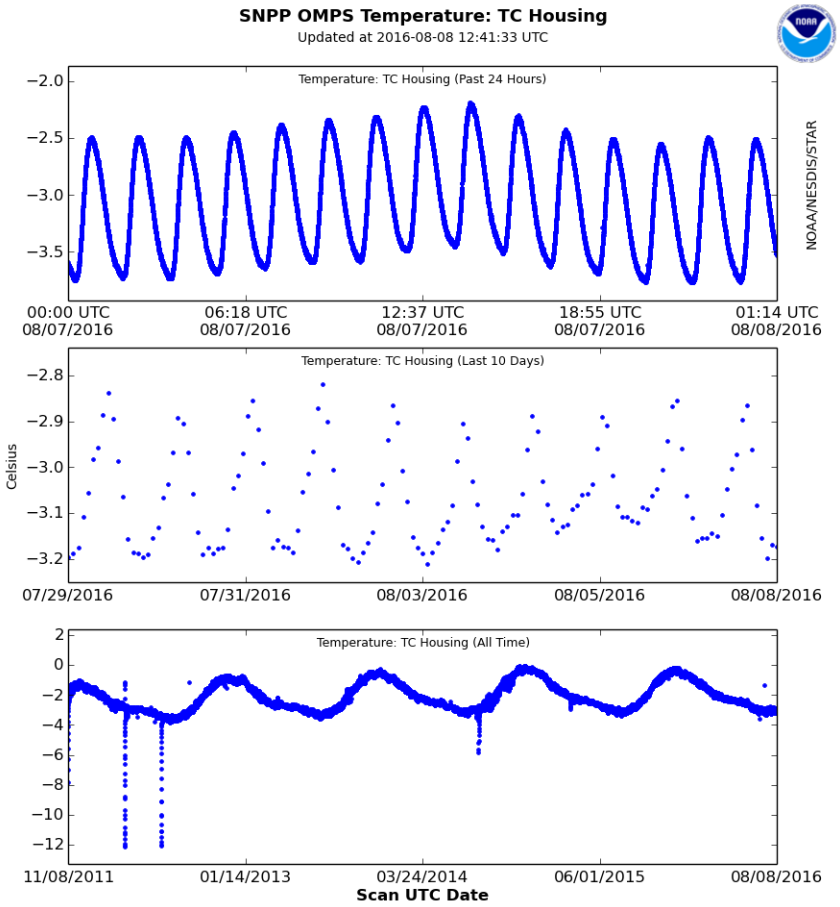


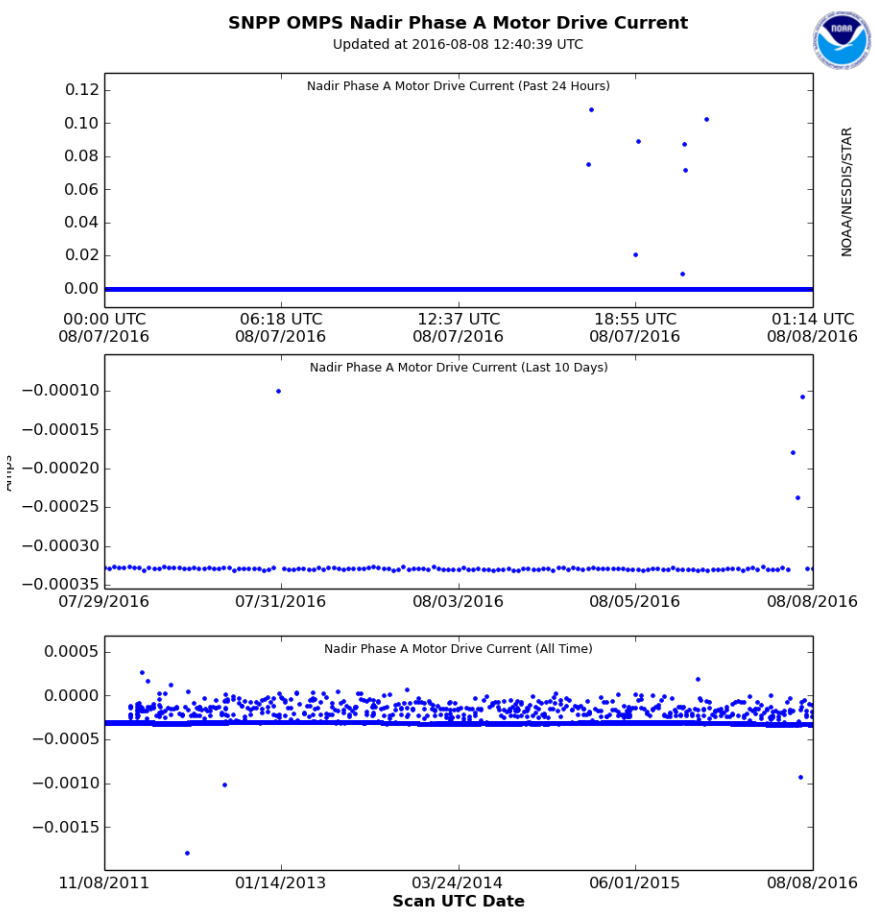


Solar Flux from NM diffuser position 1 and normalized by the first day measurement.

Senor Telemetry Monitoring

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





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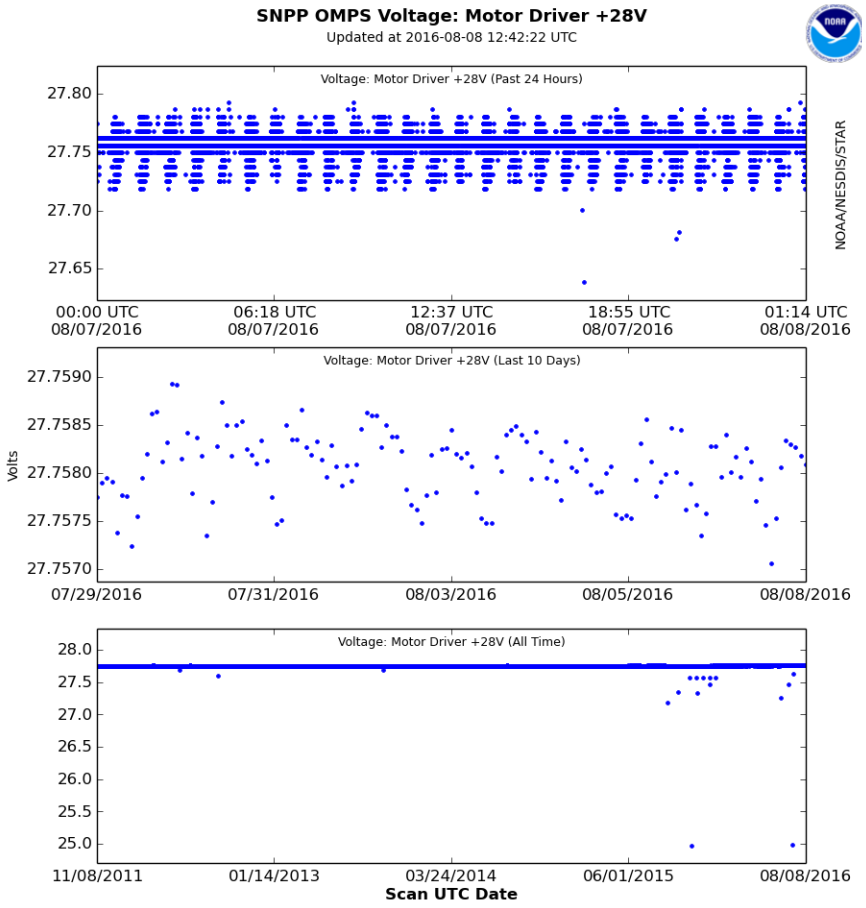
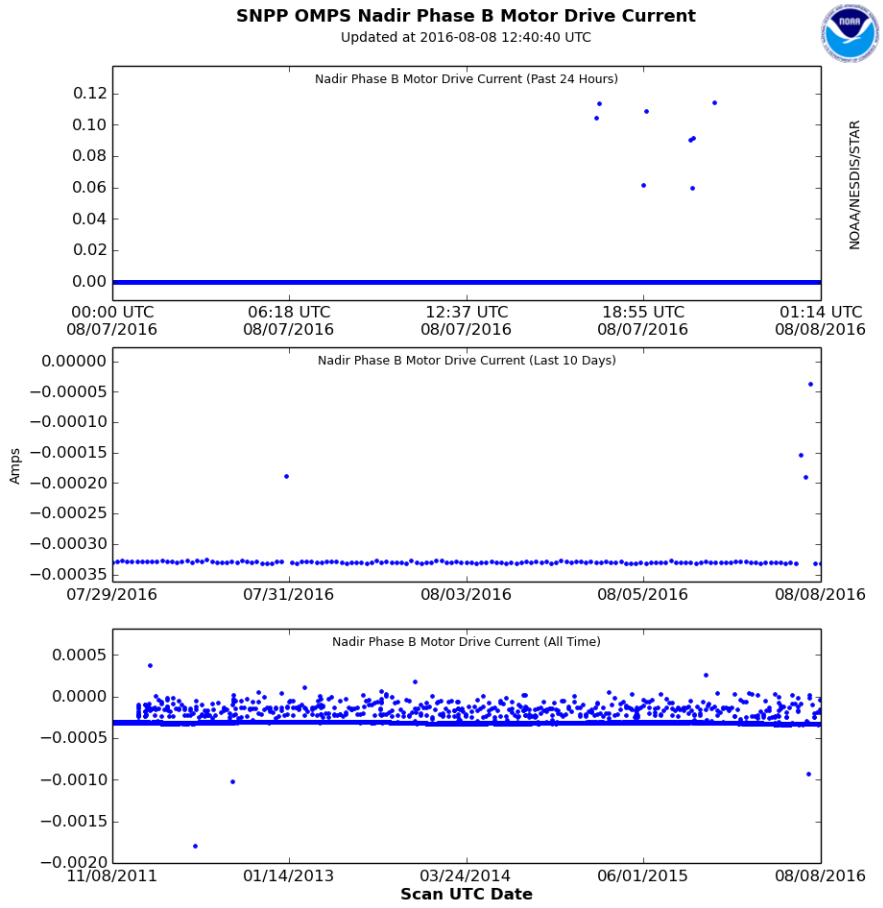




S-NPP OMPS Dark LUTs Anomaly

•Green symbols were missing since 3/31 indicating bad dark data. Incorrect version (LE) of the OMPS-TC-DARKS-GND-PI was delivered to OPS.

• IDPS reverted to table delivered on 3/21 and then re-used the old LUT back two weeks ago. (Fig. 2)

• A new function has been implemented in ICVS to send out email warnings when there is bad dark current in SDR

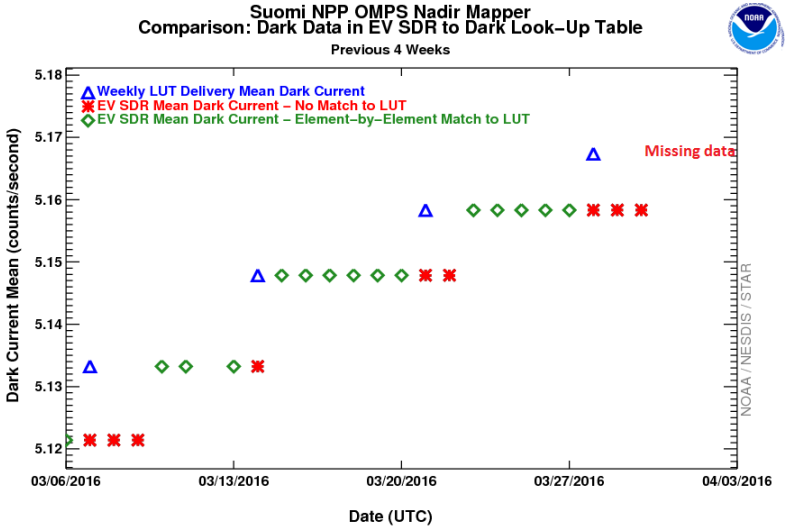


Fig. 1 Dark LUT mean plot on 4/4

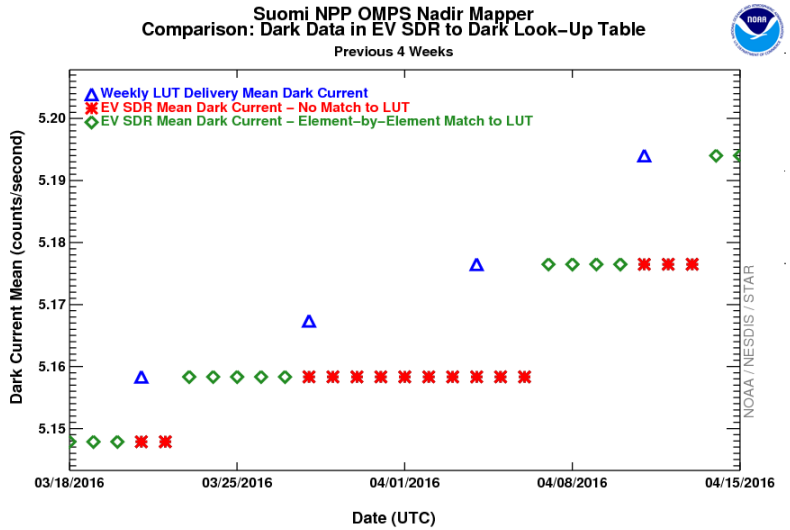
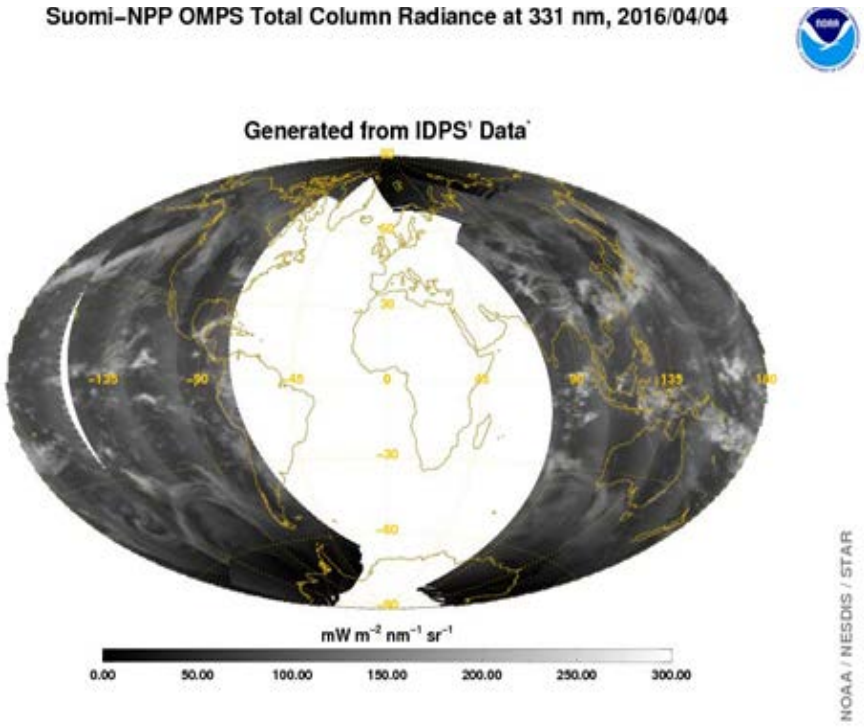


Fig. 2 Dark LUT mean plot on 4/15

OMPS EV Radiance Anomaly

• Anomalous EV radiance with many NAN values (blank in right map) was discovered on 4/4. The root cause is the little-endian TC dark LUT was accidently uploaded on 3/31.

•ICVS is implementing a near real-time monitoring algorithm to watch the quality of SDR products and send out email warnings when there is bad radiance in SDR



S-NPP OMPS TC "Missing" Scans

- ICVS is implementing a near real-time algorithm to monitor missing data, erroneous data and not-applicable data
- Filling value of -999.8 in radiance indicates missing data
- The granules with missing scans have none zero quality flag of N_Percent_Missing_Data
- Low latitude missing scan can be found in nearby granule

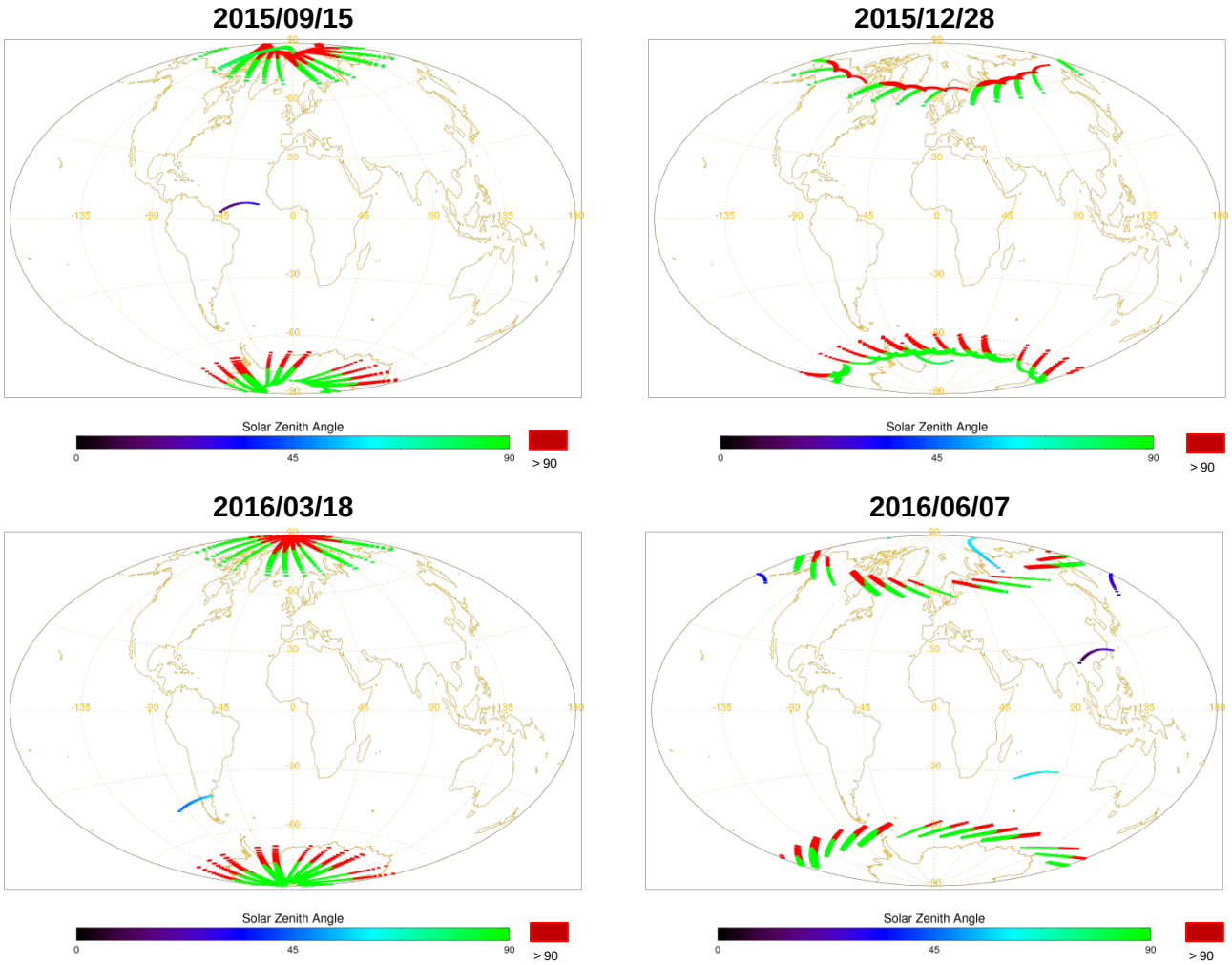
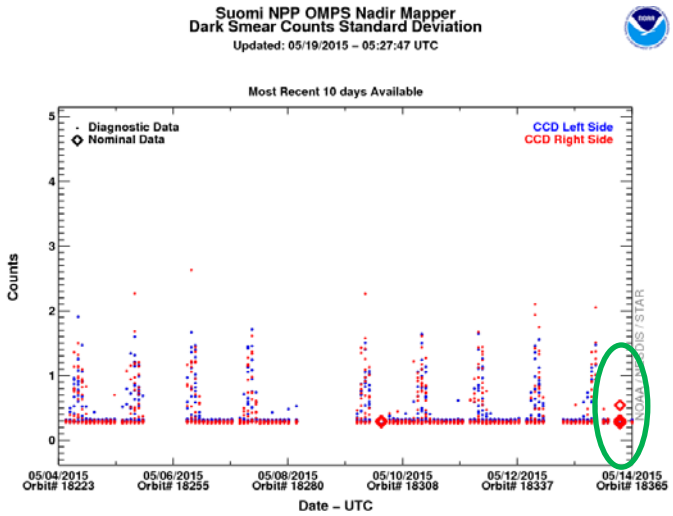


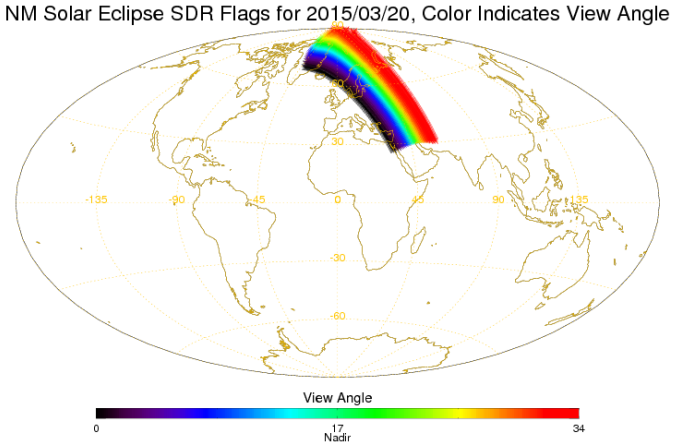
Fig 1. S-NPP OMPS TC missing scan color coded by solar zenith angle

Expected Anomaly Detection

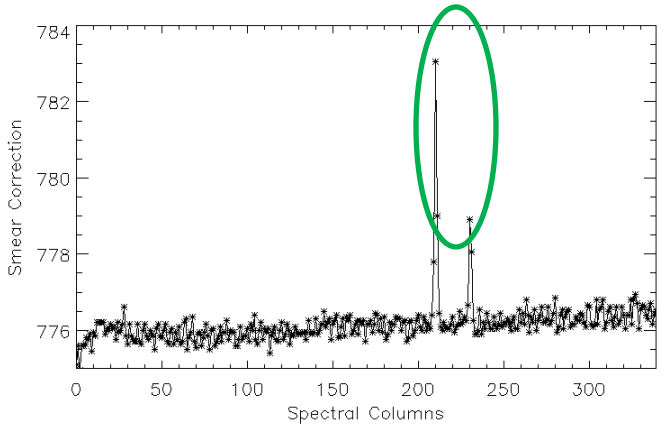
Automated anomaly detection and email warnings are established for radiance and key performance parameters



Time series of average OMPS NM dark smear counts for ten days



Solar eclipse as identified by OMPS eclipse flag



Transient in OMPS NP dark smear on orbit 18362 and image 24 for May 14, 2015

S-NPP Drag Maneuver

Many OMPS parameters exhibited atypical behavior during/after S-NPP drag maneuver on Aug. 8, 2014. For example, Fig. 1 shows the CCD temperature abnormal for both NP and NM on Aug. 10, 2014. Most parameters are back to normal after the S-NPP drag maneuver. However, dark current increases permanently for both NP and NM as show in Fig. 2.

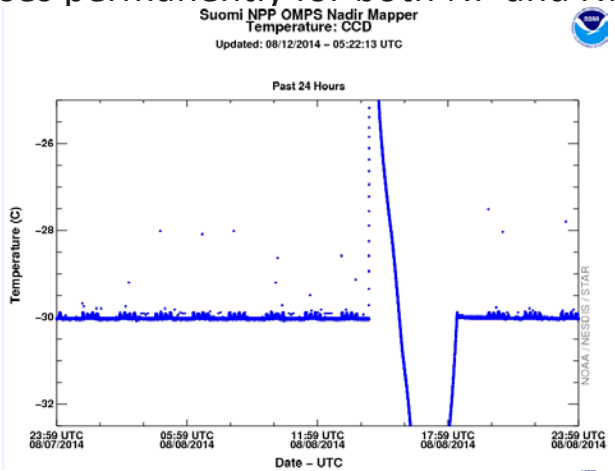


Figure 1. CCD temperature abnormal after Aug.10, 2014 S-NPP drag maneuver.

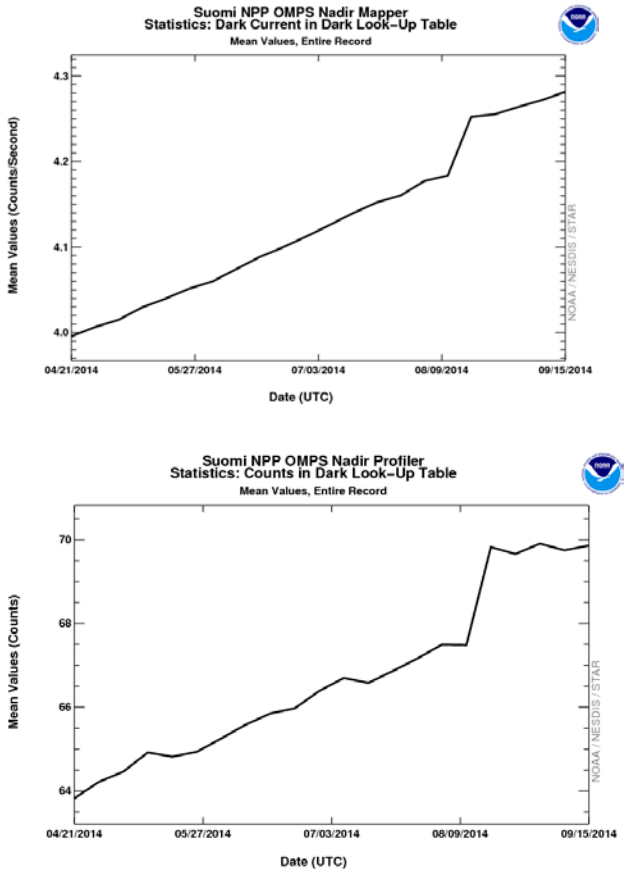
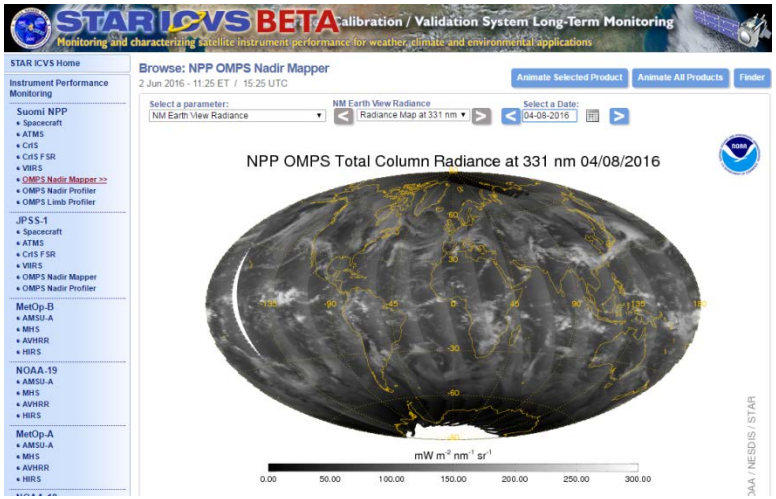
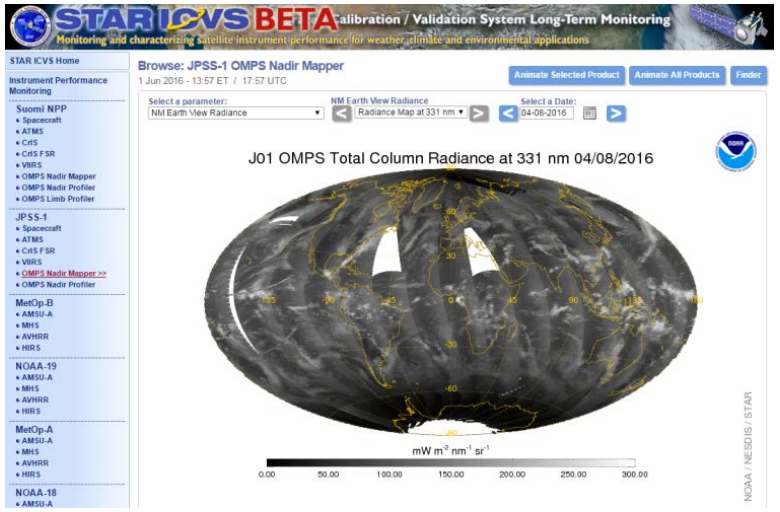


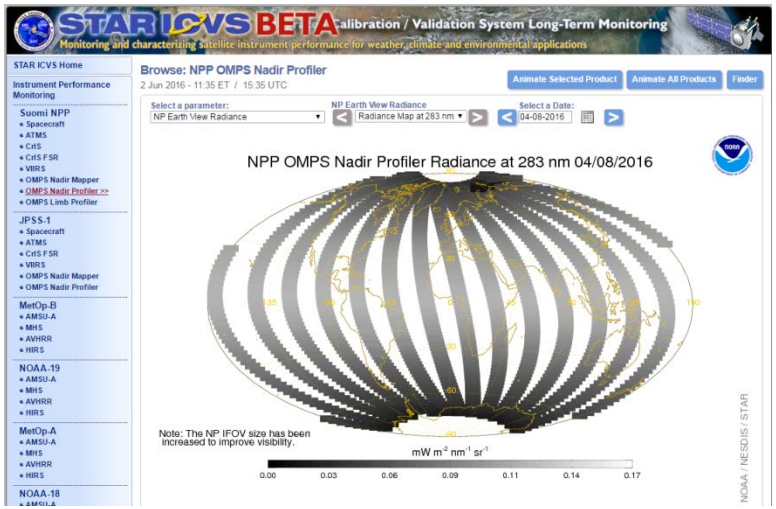
Figure 2. Dark current increases after Aug.10, 2014 S-NPP drag maneuver.

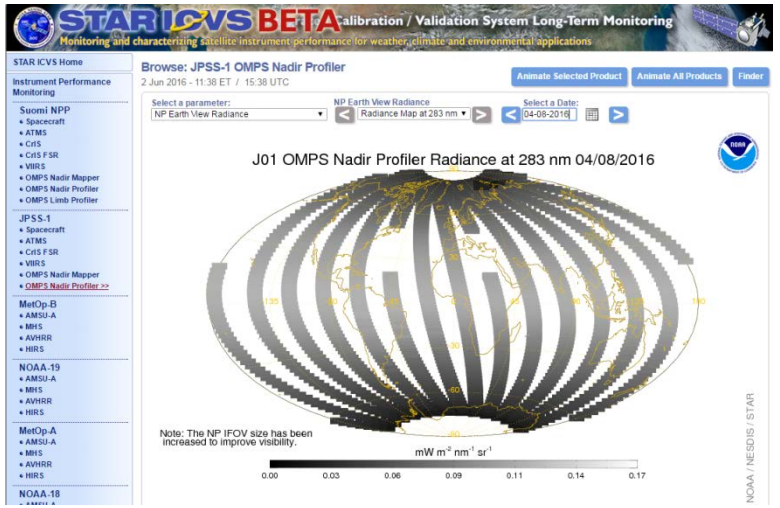
STAR ICVS BETA Website

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









OMPS Parameters Monitored by ICVS

Module	Parameters	Description
OMPS SDR	EV Radiance	Global radiance map
	Sensor Performance	Average and standard of Dark current, offset, smear
	Chasing Orbit Comparison	Reflectance comparison between SBUV/2 and OMPS
	SDR Quality Flags	solar eclipse events
	Dark Look-Up Table	Dark LUT statistics
	Linearity Calibration Reference LED	Reference LED counts statistics: left side, right side, earth view, full frame
	Solar Degradation	Solar flux Working diffuser and reference diffuse
OMPS RDR	SDR Data Flags	Linearity correction, gain correction, bin imager, reorder image
	Instrument Operational State	Fixed coadd count,
	SDR Table Version and ID	Gain correction, linearity correction, sample
	Instrument Temperatures	Housing, window, conduction bar, CCD
	Instrument Voltages	TEC error
	Instrument Currents	TEC, CCD output reset bias, CCD output drain bias
	OMPS Nadir System Operational State	Active Nadir Profile ID
	OMPS Nadir System Table Version and ID	Active timing pattern table version, timingpattern table ID
	OMPS Nadir System Temperatures	Signal board, timing board,telescope, calibration housing, diffuser motor
	OMPS Nadir System Voltages	CCD, signal board, timing board
	OMPS Nadir System Currents	Phase A motor drive, phase B motor drive
	OMPS Suite Software Version Control	Flight software version
	OMPS Suite Operational State	Calibration LED state, active main electronics box side
	OMPS Suite Temperatures	Motor driver board, SBC board, processor interface board
	OMPS Suite Voltages	TEC driver/reference, motor driver, CPE, motor/resolver electronics
	OMPS Suite Currents	Active calibration LED, CPE, TEC total

OMPS SDR Reprocessing

- ADL5.3
- Weekly updates of Dark LUTs
- Up-to-date static LUTs:

NP Table Name
OMPS-NP-OSOL-LUT
OMPS-NP-CALCONST-LUT
OMPS-NP-WAVELENGTH-GND-PI
OMPS-NP-BIAS-GND-PI
OMPS-NP-SDR-CC
OMPS-NP-CF-EARTH-GND-PI
OMPS-NP-STRAYLIGHT-LUT
OMPS-NP-LINEARITY-GND-PI
OMPS-NP-TIMING-PATTERN-GND-PI

TC Table Name
OMPS-TC-OSOL-LUT
OMPS-TC-CALCONST-LUT
OMPS-TC-WAVELENGTH-GND-PI
OMPS-TC-BIAS-GND-PI
OMPS-TC-SDR-CC
OMPS-TC-CF-EARTH-GND-PI
OMPS-TC-STRAYLIGHT-LUT
OMPS-TC-LINEARITY-GND-PI
OMPS-TC-TIMING-PATTERN-GND-PI

OMPS SDR Reprocessing Preliminary Results

- **Tested run ADL4.2 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).**

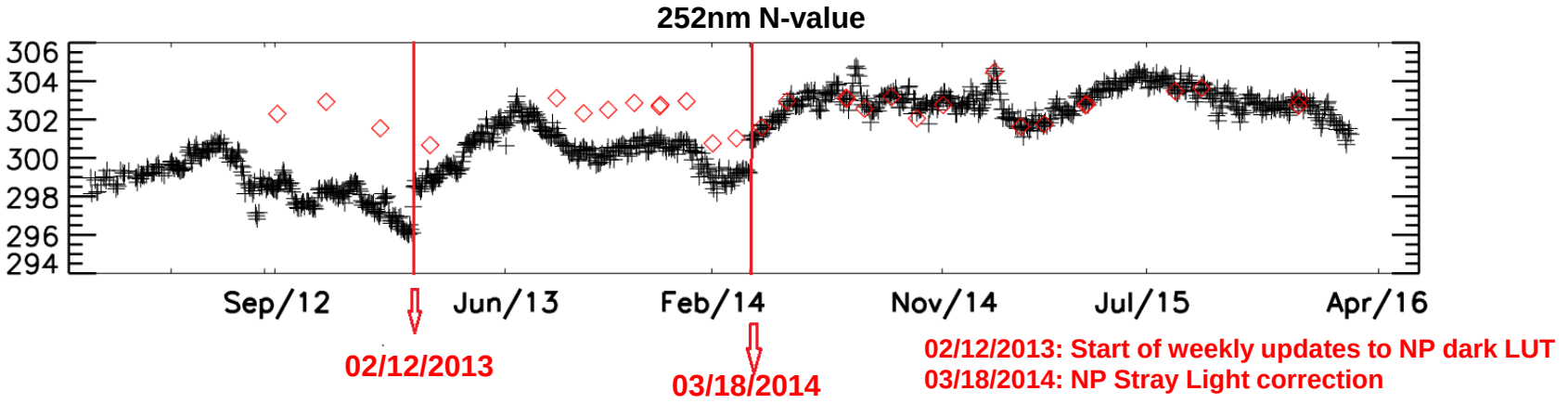


Fig. 1 OMPS NP daily nadir view N-value over Tropical Pacific region (20S-20N,90W-180W). Black: Operational; Red: Reprocessed

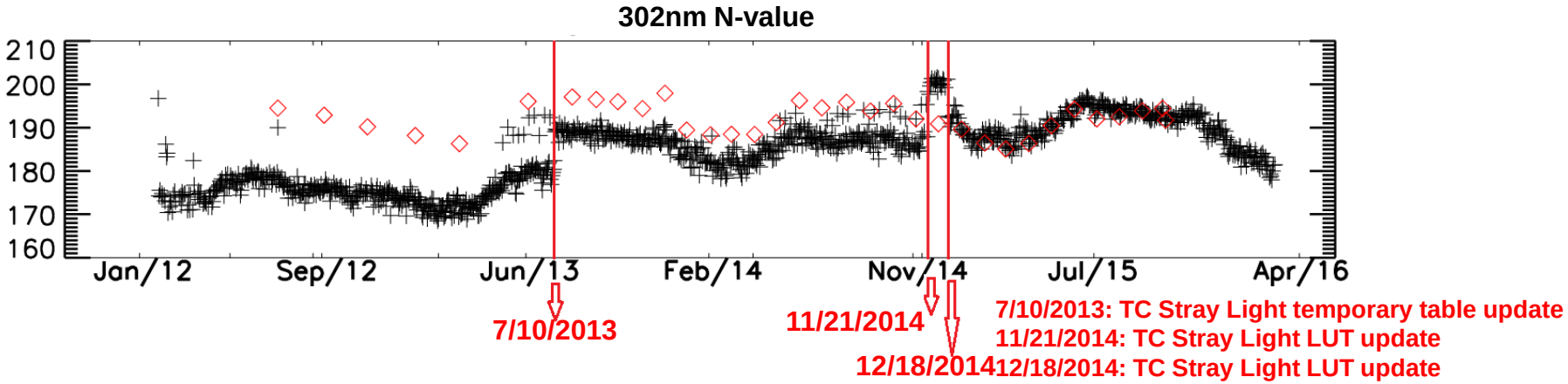


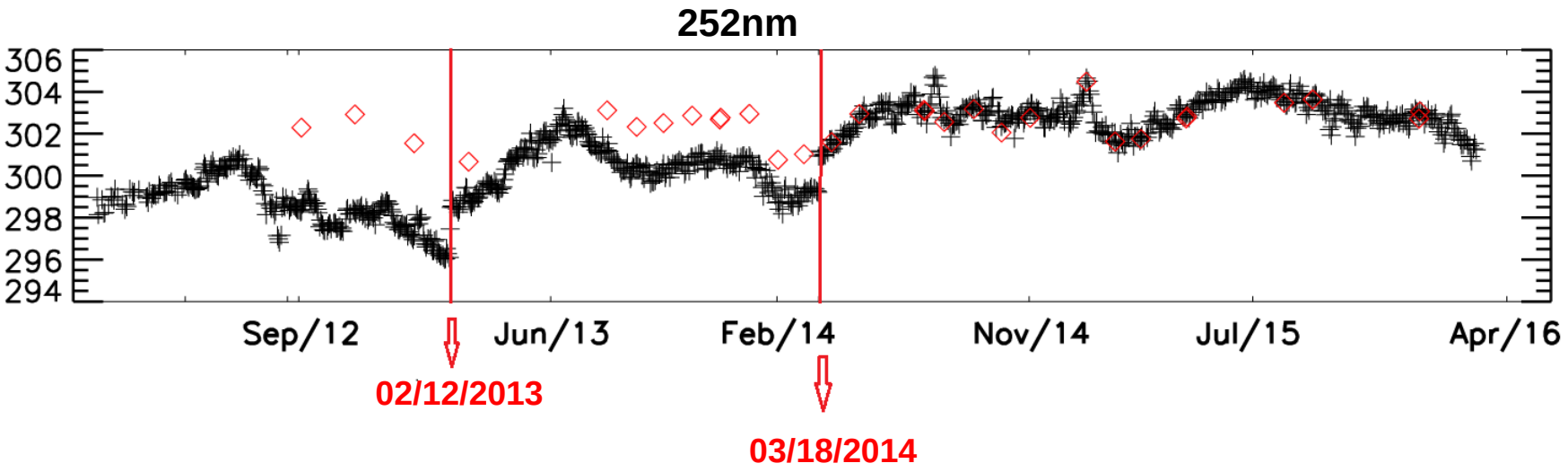
Fig. 2 OMPS TC daily nadir view N-value over Tropical Pacific region (20S-20N,90W-180W). Black: Operational; Red: Reprocessed

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
- ADL5.3 will be used in SNPP OMPS SDR Reprocessing

Impacts of OMPS NP SDR Algorithm Update on Data Quality

- Test run using ADL4.2 with up-to-date Look-Up-Tables.
- NP daily nadir view N-value over Tropical Pacific region
- N-value does not show obvious increasing with time after reprocessing.



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

NP daily nadir view N-value over Tropical Pacific region

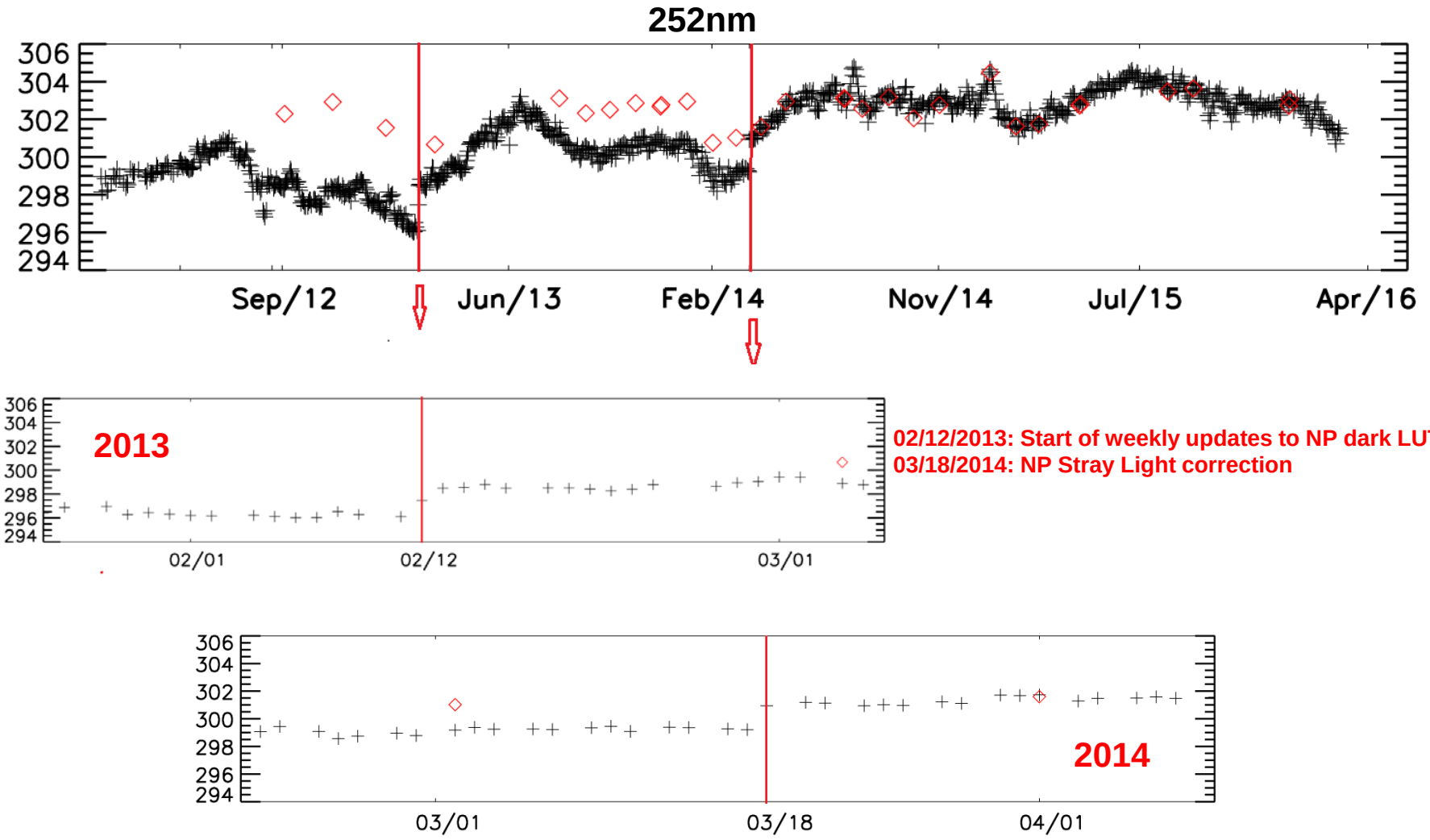


Fig. 1 OMPS NP daily nadir view N-value over Tropical Pacific region (20S-20N,90W-180W). Black: Operational; Red: Reprocessed

Impacts of OMPS TC SDR Algorithm Update on Data Quality

- Test run using ADL4.2 with up-to-date Look-Up-Tables
- TC daily nadir view N-value over Tropical Pacific region
- N-value does not show obvious increasing with time after reprocessing.

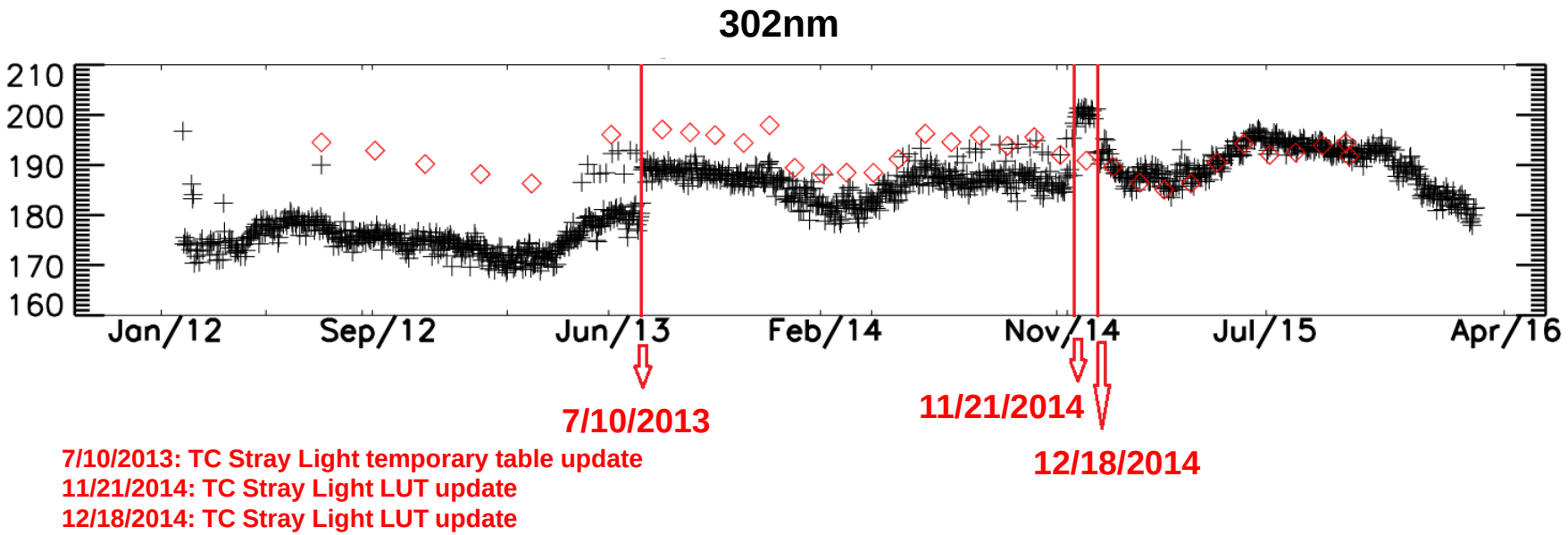
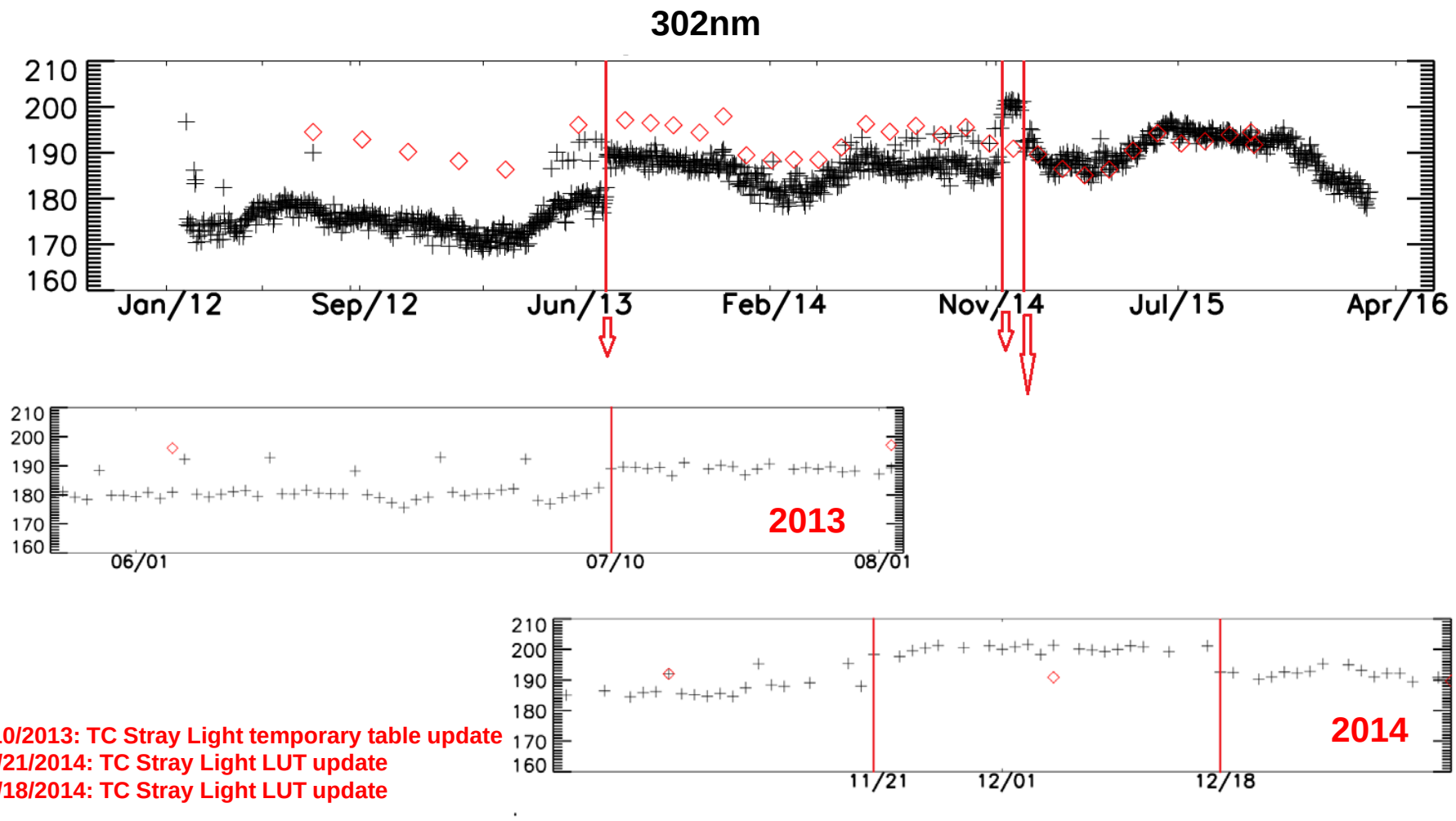


Fig. 2 OMPS TC daily nadir view N-value over Tropical Pacific region (20S-20N,90W-180W). Black: Operational; Red: Reprocessed

TC daily nadir view N-value over Tropical Pacific region

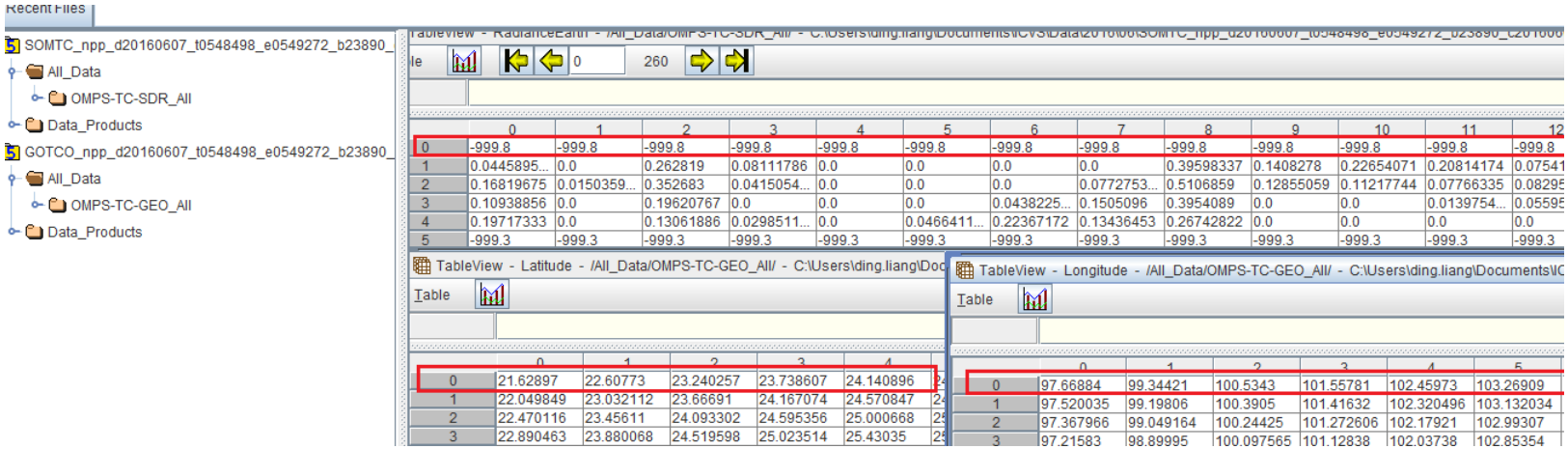


7/10/2013: TC Stray Light temporary table update
11/21/2014: TC Stray Light LUT update
12/18/2014: TC Stray Light LUT update

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

Some Missing Scan can be Found in nearby Granule

• Radiance and geolocation of a TC SDR granule with missing scan. Time stamp is d20160607_t0548498_e0549272_b23890



•The above missing scan can be found in a nearby granule. Time stamp is d20160607_t0548198_e0548572_b23890