



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

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- 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





$$Q_{jk}^{c} = \frac{Q_{jk}^{ADC} - Q_{0}}{g \ m_{jk}} - Q_{k}^{s} - Q_{jk}^{dark} - Q_{jk}^{SL}$$

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

*g* : non-linearity of the electronics chain

 $Q^{\scriptscriptstyle dark}_{\scriptscriptstyle jk}$ : observed dark

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

 $L_{jk}^{m}$ : Observed earth radiance  $Q_{jk}^{r}$ : corrected earth view counts  $k_{jk}^{r}$ : radiance calibration coefficient

 $au^{r}_{jk}$  : sensor response changes

 $Q_0$ : zero input response

- $m_{jk}$  : relative pixel gain level
- $Q_{ik}^{SL}$  : stray light

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

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

- $E_{jk}^{m}$  : Observed solar irradiance
- $Q_{jk}^{i}$  : corrected solar view counts
- $k_{jk}^{r^{n}}$ : irradiance calibration coefficient
- $g_{jk}$  : goniometric response
- $\rho_{jk}$ : long-term solar diffuser reflectivity changes





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







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



![](_page_5_Picture_0.jpeg)

## **NM/NP Dark Current LUT Updates**

![](_page_5_Picture_2.jpeg)

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

![](_page_5_Figure_7.jpeg)

![](_page_5_Figure_8.jpeg)

![](_page_6_Picture_0.jpeg)

## **NM/NP Dark Current LUT Updates**

![](_page_6_Picture_2.jpeg)

ICVS monitoring of NM/NP dark current LUT updates:

•Statistical plots and histograms are also included

![](_page_6_Figure_5.jpeg)

Bin Starting Value (Counts/Second)

![](_page_7_Picture_0.jpeg)

## **Normalized Solar Flux for NM and NP**

![](_page_7_Picture_2.jpeg)

• 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

![](_page_7_Figure_6.jpeg)

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

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#### **Normalized Solar Flux from NP Diffuser**

![](_page_8_Picture_2.jpeg)

![](_page_8_Figure_3.jpeg)

Solar Flux value are normalized by the first day measurement.

![](_page_9_Picture_0.jpeg)

## **Normalized Solar Flux from NM Diffuser**

![](_page_9_Picture_2.jpeg)

SNPP OMPS Nadir Mapper Diffuser Position 4 Normalized Reference Diffuser Solar Flux Created at 08/03/2016 - 15:02:15 UTC

![](_page_9_Figure_4.jpeg)

SNPP OMPS Nadir Mapper Diffuser Position 4 Normalized Working Diffuser Solar Flux Created at 08/03/2016 - 15:02:34 UTC

![](_page_9_Figure_6.jpeg)

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

![](_page_10_Picture_0.jpeg)

![](_page_10_Picture_2.jpeg)

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

![](_page_10_Figure_4.jpeg)

![](_page_11_Picture_0.jpeg)

![](_page_11_Picture_2.jpeg)

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

![](_page_11_Figure_4.jpeg)

### **S-NPP OMPS Dark LUTs Anomaly**

![](_page_12_Picture_1.jpeg)

•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.

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MENT OF

• IDPS reverted to table delivered on 3/21 and then reused 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

![](_page_12_Figure_5.jpeg)

![](_page_13_Picture_0.jpeg)

#### **OMPS EV Radiance Anomaly**

![](_page_13_Picture_2.jpeg)

• 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 realtime monitoring algorithm to watch the quality of SDR products and send out email warnings when there is bad radiance in SDR Suomi-NPP OMPS Total Column Radiance at 331 nm, 2016/04/04

![](_page_13_Picture_6.jpeg)

![](_page_13_Figure_7.jpeg)

![](_page_14_Picture_0.jpeg)

![](_page_14_Picture_2.jpeg)

•ICVS is implementing a near real-time algorithm to monitor missing data, erroneous data and notapplicable 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

![](_page_14_Figure_7.jpeg)

2015/12/28

![](_page_14_Figure_9.jpeg)

2016/06/07

![](_page_14_Figure_11.jpeg)

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

![](_page_15_Picture_0.jpeg)

#### **Expected Anomaly Detection**

![](_page_15_Picture_2.jpeg)

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

![](_page_15_Figure_4.jpeg)

uomi NPP OMPS Nadir Mapper Smear Counts Standard Deviation Updated: 05/19/2015 – 05:27:47 UTC

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

![](_page_15_Figure_6.jpeg)

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

NM Solar Eclipse SDR Flags for 2015/03/20, Color Indicates View Angle

![](_page_15_Figure_9.jpeg)

Solar eclipse as identified by OMPS eclipse flag

![](_page_16_Picture_0.jpeg)

#### **S-NPP Drag Maneuver**

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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.

![](_page_16_Figure_4.jpeg)

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.

![](_page_17_Picture_0.jpeg)

#### **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/

![](_page_17_Picture_4.jpeg)

![](_page_17_Picture_5.jpeg)

NESDI

![](_page_18_Picture_0.jpeg)

#### **OMPS Parameters Monitored by ICVS**

![](_page_18_Picture_2.jpeg)

| Module | Parameters                             | Description  |
|--------|--|--|
| OMPS   | EV Radiance                            | Global radiance map  |
| SDR    | 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   | SDR Data Flags                         | Linearity correction, gain correction, bin imager, reorder image               |
| RDR    | 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   |

![](_page_19_Picture_0.jpeg)

![](_page_19_Picture_2.jpeg)

- 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).

![](_page_20_Figure_4.jpeg)

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

![](_page_20_Figure_6.jpeg)

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

![](_page_21_Picture_0.jpeg)

![](_page_21_Picture_2.jpeg)

- 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

![](_page_22_Picture_0.jpeg)

![](_page_22_Picture_2.jpeg)

- 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.

![](_page_22_Figure_6.jpeg)

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

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#### NP daily nadir view N-value over Tropical Pacific region

![](_page_23_Picture_2.jpeg)

![](_page_23_Figure_3.jpeg)

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

![](_page_24_Picture_0.jpeg)

![](_page_24_Picture_2.jpeg)

- 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.

![](_page_24_Figure_6.jpeg)

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

![](_page_25_Picture_0.jpeg)

NOAA

![](_page_25_Picture_1.jpeg)

![](_page_25_Figure_2.jpeg)

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**

![](_page_26_Picture_1.jpeg)

# • Radiance and geolocation of a TC SDR granule with missing scan. Time stamp is d20160607\_t0548498\_e0549272\_b23890

| Recent Files                                  |     |            |                   |               |               |               |                |            |       |              |                |              |                      |                |                          |                            |  |
|---|-----|------------|-------------------|---------------|---------------|---------------|----------------|------------|-------|--------------|----------------|--------------|----------------------|----------------|--------------------------|----------------------------|--|
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| - C OMPS-TC-SDR_AII                           | -   |            |                   |               |               |               |                |            |       |              |                |              |                      |                |                          |                            |  |
| - 🛄 Data_Products                             |     |            | 0                 | 1             | 2             | 3             | 4              | 5          | <br>j | 6            | 7              | 8            | 9                    | 10             | 11                       | 12                         |  |
| GOTCO_npp_d20160607_t0548498_e0549272_b23890_ | 0   | -999       | 9. <mark>8</mark> | -999.8        | -999.8        | -999.8        | -999.8         | -999.8     |       | -999.8       | -999.8         | -999.8       | -999.8               | -999.8         | -999.8                   | -999.8                     |  |
| - 📹 All_Data                                  | 2   | 0.04       | 45895             | 0.0           | 0.262819      | 0.08111786    | 0.0            | 0.0        |       | 0.0          | 0.0            | 0.39598337   | 0.1408278            | 0.2265407      | 1 0.208141<br>44 0.07766 | 174 0.07541<br>335 0.08295 |  |
| - 🛍 OMPS-TC-GEO_AII                           | 3   | 0.10       | 938856            | 0.0           | 0.19620767    | 0.0           | 0.0            | 0.0        |       | 0.0438225    | . 0.1505096    | 0.3954089    | 0.0                  | 0.0            | 0.01397                  | 54 0.05595                 |  |
| Ci Data Products                              | 4   | 0.19       | 717333            | 0.0           | 0.13061886    | 0.0298511     | 0.0            | 0.0466     | 411   | 0.22367172   | 0.13436453     | 0.26742822   | 0.0                  | 0.0            | 0.0                      | 0.0                        |  |
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|   |     | 3          | 22.89046          | 3 23.8800     | 68 24.5195    | 98 25.0235    | 14 25.4303     | 35 25      | _     | 2 97.3       | 67966 99.0     | 49164 100.   | 24425 10             | 1.272606 10    | 2.17921 1                | 02.99307                   |  |

## •The above missing scan can be found in a nearby granule. Time stamp is d20160607\_t0548198\_e0548572\_b23890

Recent Files C:\Users\ding.liang\Documents\ICVS\Data\2016\06\GOTCO\_npp\_d20160607\_t0548198\_e0548572\_b23890\_c20160607135401837842\_noaa\_ops.h5

| GOTCO_npp_d20160607_t0548198_e0548572_b23890_ | Ta                                      | bleView - Radiar   | ceEarth - /Al  | I_Data/OMPS-  | TC-SDR_AII/  | C:\Users\ding.   | liang\Docume  | ents\ICVS\Data   | 12016\06\SON   | /TC_npp_d20   | 160607_t054  | 8198_e05485   | 72_b23890_0  | c20           |
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| SOMTC_npp_d20160607_t0548198_e0548572_b23890_ |   |  |  |   |  |  |   |  |  |   |  |   |  |               |
| 🔶 🗀 All Data                                  |   | 0  | 1  | 2   | 3  | 4  | 5   | 6  | 7  | 8   | 9  | 10  | 11   |               |
|   | (                                       | 0.0  | 0.0  | 0.0   | 0.0103088  | 0.03387222   | 0.07355685  | 0.29470938   | 0.17021659   | 0.4130888   | 0.1074232  | 0.24210186  | 0.37319085   | 0.5           |
| Bata_Houdes                                   |   | 0.0758452  | 9 0.0  | 0.0738879   | 0.1066324  | 0.14326485   | 0.21231396  | 0.3429808  | 0.21325015   | 0.35013413  | 0.0130790  | 0.1360765   | 0.32600096   | 0.4           |
|   |   | 0.0802957  | 0.0  | 0.1007555   | 0.2142829  | 0.24493544   | 0.0   | 0.0042584  | 0.0  | 0.07428974  | 0.0  | 0.0   | 0.09149242   | 0.1           |
|   |   | 0.0513132  | 0.0  | 0.2043158   | 0.1156075  | 9 0.0  | 0.0   | 0.0  | 0.0  | 0.22809802  | 0.0  | 0.18796074  | 0.22793753   | 0.1           |
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|   | Table<br>Table<br>0<br>1<br>2           | View - Latitude  | - /All_Data/Ol<br>1<br>20.9069<br>21.332344<br>21.757633                           | 2<br>21.530432<br>21.958115<br>22.38564                           | All/ - C:\User   | 4<br>22.418139 22<br>22.849028 22<br>23.279772 23                | 24 Tablev<br><u>Table</u><br>2. 0<br>3. 1<br>3. 2           | /iew - Longitu   | 1 1 99.91793 99.77616 99.63347   | a/OMPS-TC-G   | EO_AII/ - C:\\<br>3<br>102.11336/<br>101.97604<br>101.83781                          | Jsers\ding.liai   | 5<br>103.80759<br>103.67443<br>103.54039                           | s\IC          |
|   | Table<br>Table<br>0<br>1<br>2<br>3      | View - Latitude  | - /AII_Data/OI<br>20.9069<br>21.332344<br>21.757633<br>22.182726                   | 2<br>21.530432<br>21.958115<br>22.38564<br>22.812971              | All/ - C:\User<br>3<br>22.02166<br>22.45111<br>22.880407<br>23.309515              | 4<br>22.418139 22<br>22.849028 22<br>23.279772 22<br>23.71033 24 | u ∰ TableV<br><u>T</u> able<br>2. 0<br>3. 1<br>3. 2<br>4. 3 | View - Longitu<br>0<br>98.25319<br>98.10879<br>97.96351<br>97.81716              | de - /All_Dat  | a/OMPS-TC-G<br>2<br>101.09882<br>100.95931<br>100.81887<br>100.67741              | EO_AII/ - C:\L<br>3<br>102.11336<br>101.97604<br>101.83781<br>101.69856              | 4<br>5 103.00661<br>102.87141<br>102.7353<br>102.59823                | 5<br>103.80759<br>103.67443<br>103.54039<br>103.40542              | 34<br>2       |
|   | Table<br>Table<br>0<br>1<br>2<br>3<br>4 | 0<br>19.94211<br>20.364065<br>20.78588<br>21.207512<br>21.628649 | - /AII_Data/OI<br>1<br>20.9069<br>21.332344<br>21.757633<br>22.182726<br>22.607409 | 2<br>21.530432<br>21.958115<br>22.38564<br>22.812971<br>23.239933 | All/ - C:\User<br>3<br>22.02166<br>22.45111<br>22.880407<br>23.309515<br>23.738281 | 4<br>22.418139 22<br>23.279772 23<br>23.71032 22<br>24.140568 24 | 20  | View - Longitu<br>0<br>98.25319<br>98.10879<br>97.96351<br>97.81716<br>97.668945 | de - /All_Dat<br>99.91793<br>99.77616<br>99.63347<br>99.48972<br>99.344315 | a/OMPS-TC-G<br>2<br>101.09882<br>100.95931<br>100.81887<br>100.67741<br>100.53441 | EO_AIV - C:\L<br>3<br>102.11336:<br>101.97604<br>101.83781<br>101.69856<br>101.55791 | 4<br>5 103.00661<br>102.87141<br>102.7353<br>102.59823<br>5 102.45984 | 5<br>103.80759<br>103.67443<br>103.54039<br>103.40542<br>103.26919 | 94<br>94<br>9 |