Improvements to Ozone Mapping Profiler Suite (OMPS) Sensor Data Record (SDR)

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• OMPS is one of five instruments on board the SNPP satellite launched in Oct. 2011. The second OMPS onboard JPSS-1 satellite will launch in Summer 2017.
• The OMPS heritage sensors are SBUV/2 and TOMS. OMPS provides ozone total column and vertical profile data that continues ozone daily global data with higher calibration accuracy and higher spatial and spectral resolution since 2012.

**Onboard Calibrators**
- Light-emitting diode provides linearity calibration
- Reflective solar diffusers maintain calibration stability
Two UV imaging spectrometers in Nadir system: NM covers 300 - 380 nm; NP covers 250 - 310 nm
Measure back scattered earth radiance, as well as solar irradiance. On-orbit calibration maintains high quality SDRs

One orbit measured NM/TC normalized radiance (N-value) at 331.6 nm from NM Spatial resolution 50 km (35 IFOVs) in the cross-track direction
Improvements to SDRs

• Higher spatial resolution data is requested by OMPS users
  – SNPP OMPS acquires higher spatial science data weekly
  – The JPSS-1 will provides the ozone vertical profile data at 50 km x 50 km beginning at launch and 17 km x 17 km ozone total column data afterwards.

• On-orbit Spectral variation causes about 1.0% errors in ozone retrieval
  – Analysis of in-flight data shows the sensor spectral wavelength variation exceeded performance required 0.02 nm. An empirical wavelength correction has been applied to NM Sensor.
  – JPSS-1 OMPS missions will likely exhibit similar orbital variations that can be corrected using a similar methodology.

• JPSS-1 OMPS instrument designed changed for a better on-orbit performance
Algorithm Enhancement

Major changes

- Upgraded Flight Software
- Rice decompression
- Four new APID data
- J1 spacecraft ID
- J1 algorithm LUTs
- NM sparse ST process

New Codes

Existing codes

SDR processor

Verified RDR

Timing Patterns

Sample Tables

Ground PIs

SDR

Offline Processing/Archive

kDR

APID Filter

Decompressor

Aggregator

vRDR (Med-Res)

SDR processor Sparse Counts WL Shift

S-NPP Hi-Res compressed or standard EV

J01 Hi-Res compressed

Dark Correction

Smear Correction

Stray Light Correction

Convert Counts to Radiances

Adjust Solar Wavelength

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Wavelength Registration

- Spatial and spectral 2-D CCD
- Photosensitive region has 35 spatial EV cells and 196 spectral channels
- Split frame transfer, two halves identical CCD.
SO2 Index

• SO2 index cross-track IFOV variation

• Residual error are caused by EDR V7 TOZ algorithm

• Data comes from OMPS NM EDR products INCTO SO2 2015/07/01
Radiance error is the percent difference between OMPS and MLS flying on Aura.

Irradiance error is the percent difference between observed solar flux and modeled solar synthetic flux.
Wavelength Correction

- Computed wavelength shift

- Modeled wavelength shift

- Calibration error < 0.1 nm

Modeling Equation:
\[ f(x) = a_1 \sin(b_1 x + c_1) + a_2 \sin(b_2 x + c_2) + a_3 \sin(b_3 x + c_3) + a_4 \sin(b_4 x + c_4) \]

X: mission time (days)
F(x): wavelength shift

Correlation with thermal gradients (housing temperature change)
Linear model: \( f(x) = p_1 x + p_2 \)
Coefficients (@ 95% confidence bounds):
p1 = 32.68 and p2 = 0.006929

Goodness of fit:
SSE: 1.32
R-square: 0.8
RMSE: 0.1549
Solar Irradiance Calibration

\[ \bar{I}(\lambda_0) = \frac{\int I(\lambda) S(\lambda) d\lambda}{\int S(\lambda) d\lambda} \]

- \( \bar{I}(\lambda_0) \): slit-averaged values
- \( \lambda_0 \): central slit wavelength
- \( \lambda \): wavelength
- \( S(\lambda) \): spectral response function (slit function)
- \( I(\lambda) \): monochromatic irradiance

**Solar activity error**

**Wavelength registration error**

**Optical degradation error**
Solar Irradiance Errors

Before

After
Normalized Radiance Error

Previous Error

Current Error

Normalized Radiance Error %

-8.0  -6.0  -4.0  -2.0  0.0  2.0  4.0  6.0
J1 Instrument Re-Design

- The Limb Profiler will not be present for JPSS-1
- NM slit redesigned to reduce irregular edges
- Optical mounts redesigned to improve boresight stability
- Modified optical alignment permits wavelengths up to 420nm to be measured
- Reflective quasi-volume diffusers (QVD) maintains calibration stability

Ratios of solar flux measurements NM (left @solar position 4 ) and NP (right)
OMPS in-flight performance has been greatly improved through sensors’ on-orbit spectral calibration.

The calibration lessons learned from the SNPP OMPS present reasonable and feasible opportunities for improving the future JPSS-1 OMPS data products.

JPSS-1 OMPS is expected to provide science data with higher fidelity compared to the SNPP OMPS.
Any Questions?

... THANK YOU ...