OMPS SDR Overview

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SDR Products
OMPS SDR Team
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OMPS Algorithm Cal/Val Team PIs

PI Name	Organization	Primary Roles
Fuzhong Weng	NOAA/STAR	Budget and coordination; instrument and product performance monitoring; TOMRAD/VLIDORT modeling
Glen Jaross	NASA	Instrument scientist; TVAC data acquisition and analysis; SDR algorithm.
Chunhui Pan	NOAA/STAR	NOAA Technical Lead; OMPS SDR cal/val science, code development, TVAC data analysis; SDR algorithm.
Maria Caponi	Aerospace	Algorithm changes coordination; DR and issues tracking
Sarah Lipscy	BATC	Instrument scientist; prelaunch test; …
Wael Ibrahim	Raytheon	IDPS operations

OMPS J1 Instrument Overview

- **Enhanced spatial resolution with new timing patterns**
  - Provides Total Column ozone data w/ 17x17 km^2 IFOV at nadir
  - Provides ozone profiles in 5 ground pixels of 50x50 km^2 at nadir

- **Configuration**
  - Push-broom 110 deg. cross-track FOV telescope
  - Two grating spectrometers
    - » NM covers 300 – 420 nm
    - » NP covers 250 nm to 310 nm
  - CCD optical detector for each spectrometer

- **Onboard Calibrators**
  - Light-emitting diode provides linearity calibration
  - Reflective quasi-volume diffusers (QVD) maintains calibration stability

- **Products**
  - Provide globe maps every 24 hours of amount of ozone and volumetric concentration in a vertical column of atmosphere with a 4- days revisit
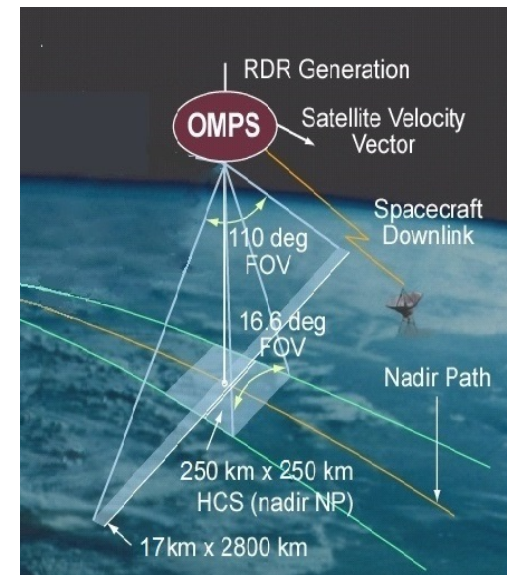
Spatial resolution will be altered to provide low, medium and high spatial resolution data

- The LP will not be present for J-1
- NM slit redesigned to reduce "puckering"
- Optical mounts redesigned to improve boresight stability
- Modified optical alignment permits wavelengths up to ~420nm to be measured -- potentially enhances science products and help to correct nadir geolocation and stray light OOB.
- Generation of three SDR products: EV SDRs, Cal. SDRs (offline), and GEOs

Instrument Specification

Dominant contribution to accuracy

Spatial Properties
- Cross-track MTF at nadir >.5 at .01cycles/Km
- Cross-track NP FOV >16.7 degrees
- Cross-track NM FOV >110 degrees

Radiometric Accuracy
- Pixel-pixel radiometric calibration <.5%
- Non linearity 2% full well
- NL knowledge <.5%
- On-orbit wavelength calibration .01 nm
- Stray Light signal <1%
- Intra-orbit wavelength stability .02 nm
- Band Pass Shape Knowledge 2%
- Solar Irradiance < 7%
- λ - normalized radiance <2%

Dominant contribution to precision

Radiometric Precision Terms
- SNR 1000 for TC, varies for NP
- Inter-orbital Thermal Wavelength Shift .02 nm

Geolocation Error Terms
- Boresight alignment knowledge uncertainty between nadir instrument interface and nadir alignment reference <160 arcsec
- Total cumulative boresight alignment shift (between final ground calibration and on-orbit operations <500 arcsec

Prelaunch calibration has verified that instrument characteristics match the sensor performance needed to meet the products requirements.

Prelaunch lab test shows that J1 OMPS calibration stability and accuracy meets science requirements

Source of Uncertainty	Absolute 1σ Fractional Uncertainty (%)				Albedo 1σ Fractional Uncertainty (%)			
	Radiance		Irradiance		λ - independent		λ - dependent	
	NP	TC	NP	TC	NP	TC	NP	TC
SNPP Goniometry	0	0	0.38	0.41	0.38	0.41	0.15	0.36
J1 Goniometry	0	0	0.21	0.21	0.21	0.21	0.1	0.11
OMPS NPP RSS Total	3.383	3.067	3.499	3.194	1.653	1.717	0.426	0.497
OMPS J1 RSS Total	2.637	1.646	2.731	1.8	1.587	1.389	0.405	0.437
Requirement	8.0	8.0	7.0	7.0	2.0	2.0	0.5	0.5

- OMPS EV SDR products maturity milestone
  - Beta maturity since March 2012
  - Provisional maturity since March 2013
  - Validated maturity since August 2015
- SNPP OMPS orbital performance is stable and SDRs meet validated maturity requirement
- A CCR is in preparation to move forward with an upgrade of the S-NPP OMPS FSW to v6.0. This upgrade improves capabilities for better products with the S-NPP OMPS measurements.
- OMPS long term monitoring via. STAR ICVS provides much of the information to characterize the S-NPP OMPS NM, NP and LP in their cal/val studies.

  http://www.star.nesdis.noaa.gov/icvs/status_NPP_OMPS_NM.php
  http://www.star.nesdis.noaa.gov/icvs/status_NPP_OMPS_NP.php
  http://www.star.nesdis.noaa.gov/icvs/status_NPP_OMPS_LP.php

OMPS J1 NM Algorithm Summary

OMPS J1 SDR algorithm is enhanced to process current SDR product content for medium spatial resolution. Additional capabilities include: FSW6 engineering headers, Rice decompression, APID filter capable to process new APIDs (four new APID values), J01 spacecraft ID, aggregation, sparse spectral data and new wavelength format table.
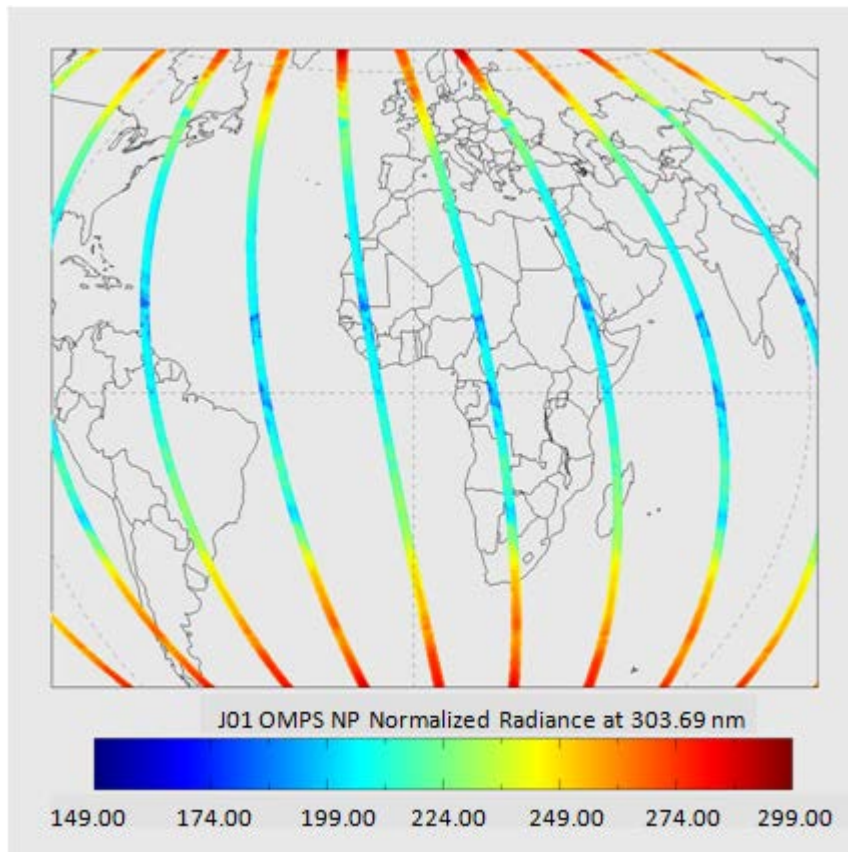

Legend:

New Code

Existing Code
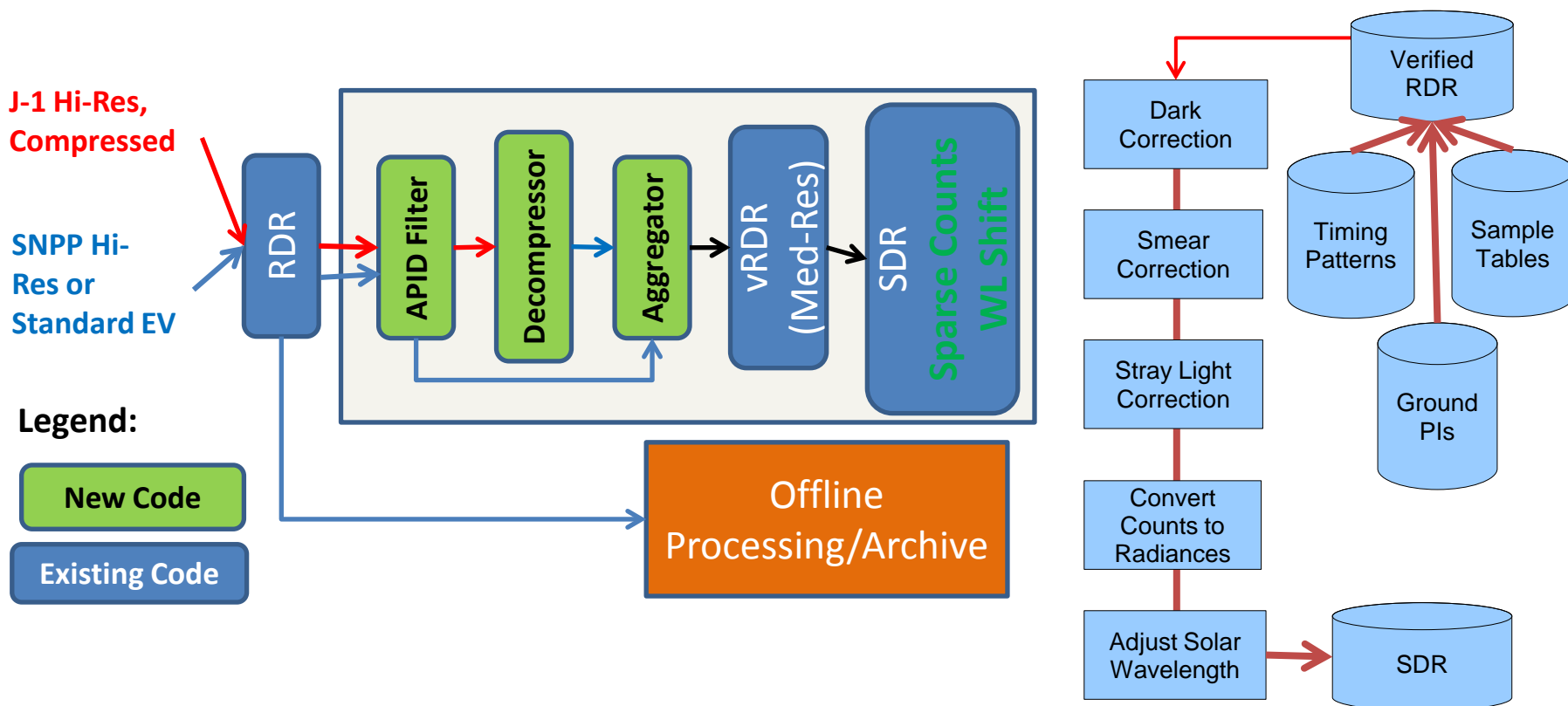
The J1 NP SDR required the following major changes:

- FSW6 engineering headers
- Rice decompression
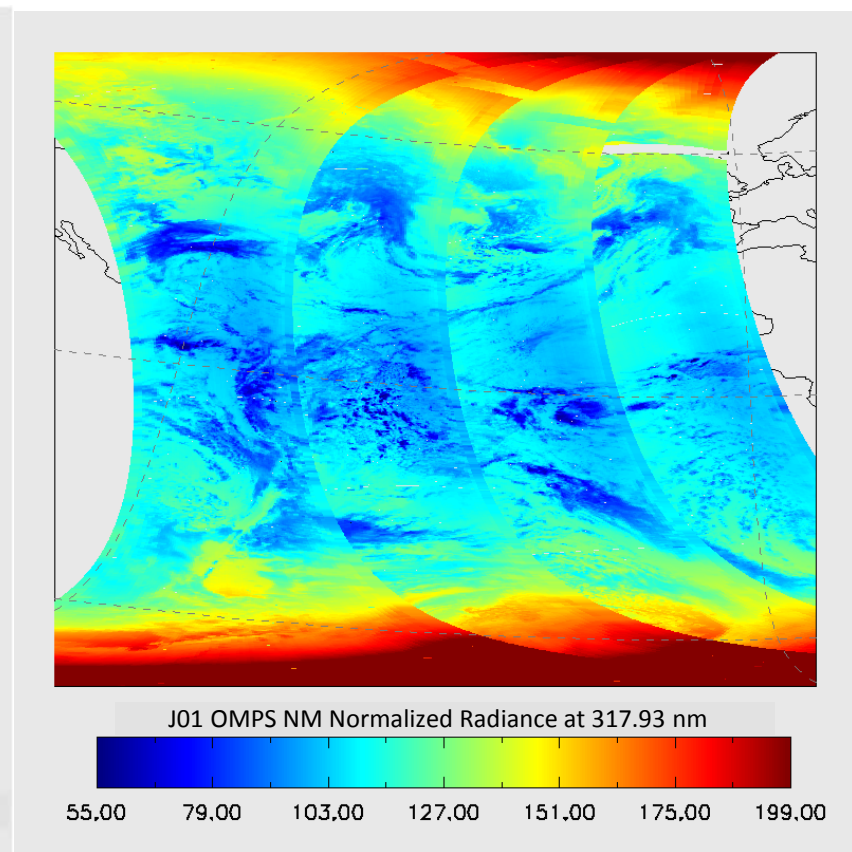- Four new APID values
- J01 spacecraft ID
- J1 algorithm LUTs
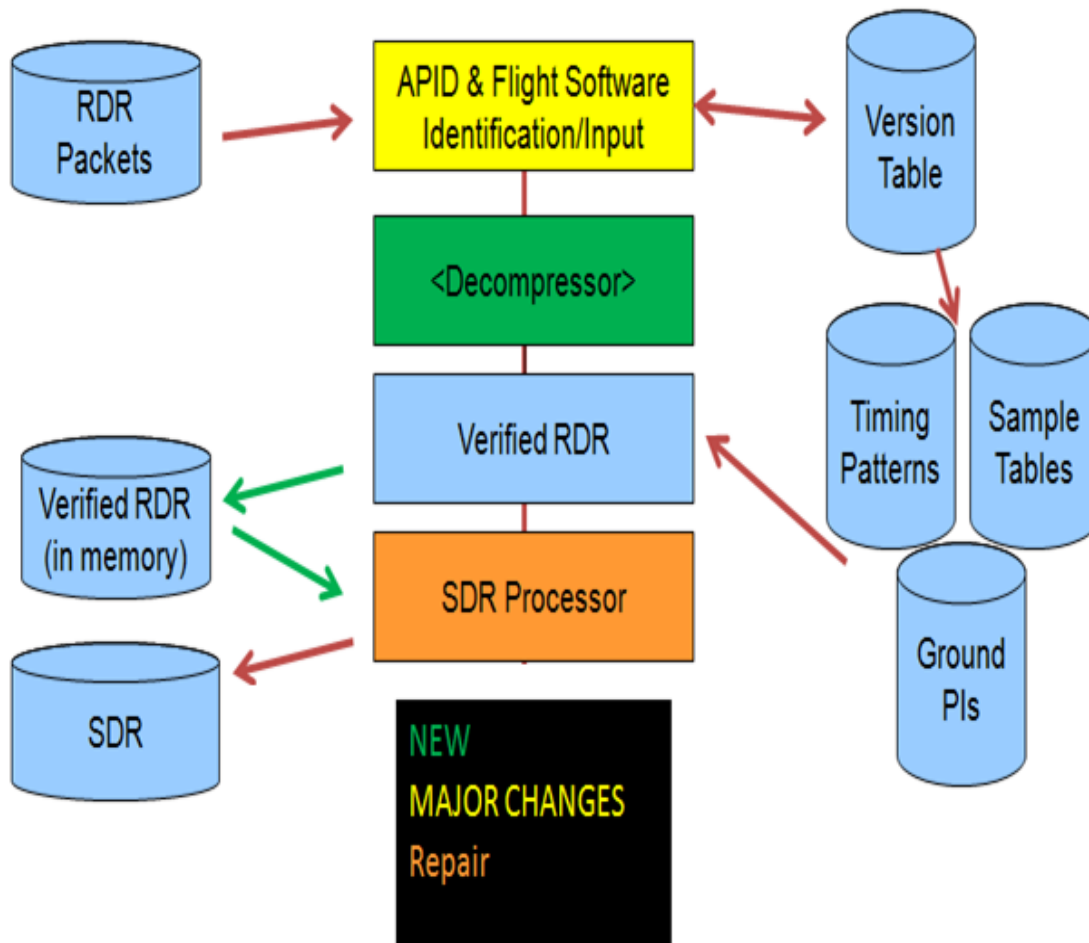
50x50 km resolution for NP

16.7x50 km resolution for NM

J1 algorithm was tested for software validation and geophysical validation. SNPP derived RDRs were used as inputs. Results were verified to have the correct data structure, engineering data, and science data

OMPS J1 Cal/Val Overview (1)

- SDR Maturity Timeline
  - "Beta" L+ 3M
  - "Provisional" around L+6M.
  - "Validated/calibrated" around L+12M
- Pre-Launch Calibration/Validation Plans

Year	Tasks/Activities	Deliverables
2015	• SDR Algorithm development and enhancement to meet required performance • Ground test data analysis and software development.	• Initial Pre-launch LUTs • Software code packages • Cal/Val documentation
2016	• Further analysis on pre-launch test data and refinement of LUTs. Establish sensor initial settings and parameters • Sensor and Algorithm Parameter Updates • SDR software tool develop to handle diagnostic data	• Improved version of Pre-launch LUTs • Revised Cal/Val documentation

J1 OMPS Cal/Val Overview (2)

- Post-Launch Calibration/Validation Plans

Year, Phase	Tasks/Activities	Deliverables
2017, PLT to ICV	• Execute the Cal/Val tasks described in the Calval. Plan • Baseline instrument parameters for nominal operation • Adjust instrument settings when necessary • Modify measurement sequences when needed • Update appropriate SDR LUTs and coefficients that optimize the sensor's performance. • Make the instrument and software properly staged for Intensive Cal/Val (ICV) activities.	Provisional SDR products
2018, ICV to LTM	• Improve the calibration; establish long term monitoring. • Validate the SDR products through verification and cross-comparison with external independent measurements and models. • Provide radiances that are stable and accurate to support EDR retrievals.	Validated SDR products

Major Accomplishments

19 CCRs were implemented into operation since May 2014.

- Updated 6 LUTs wavelength, solar flux and radiance coefficients for both NM and NP (CCR 15-2547/2548). SNPP NP and NM SDRs reach validated maturity requirement.
- OMPS J1 SDR algorithm has been implemented and tested and delivered to DPES for further testing and integration (CCRs 15-2482/2483, 15-2469, 2388).
- Updated SNPP NM stray light LUT (CCR 14-2100) to account for the OOB response.
- Completed transition of Dark Cal. SDRs to STAR and GRAVITE
- Evaluated, converted and formatted J1 SCDBs contents to J1 algorithm LUTs for both NM and NP.

Highlights Moving Towards J1

- Refinement and verification of J1 SDR algorithm LUTs and operation tables
- Test of integrated chain for J1 algorithm LUTs through RDR, SDR and EDR.
- Transition SNPP Solar Cal. SDRs to STAR and GRAVITE

From S-NPP experiences and initial evaluation of the J1 OMPS prelaunch data, the major challenges are sensor spectral wavelength calibration and bandpass calibration

Wavelength shifted ~ 0.15 nm from ground to orbit. The figure shows percent difference between observed and synthetic solar flux
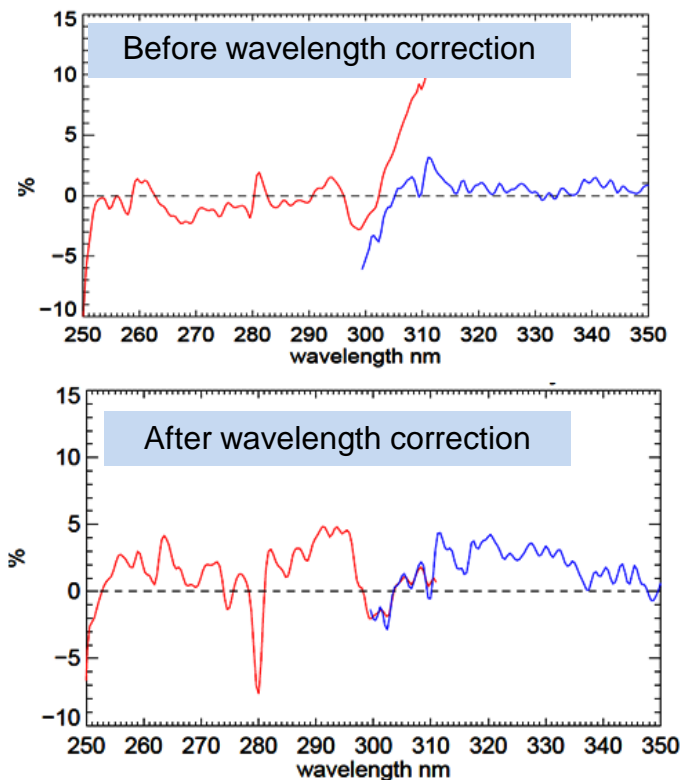
Wavelength dependent accuracy in cross-track scan direction exceed our expectation but can be corrected. The figure shows relative difference between measured and calculated NR
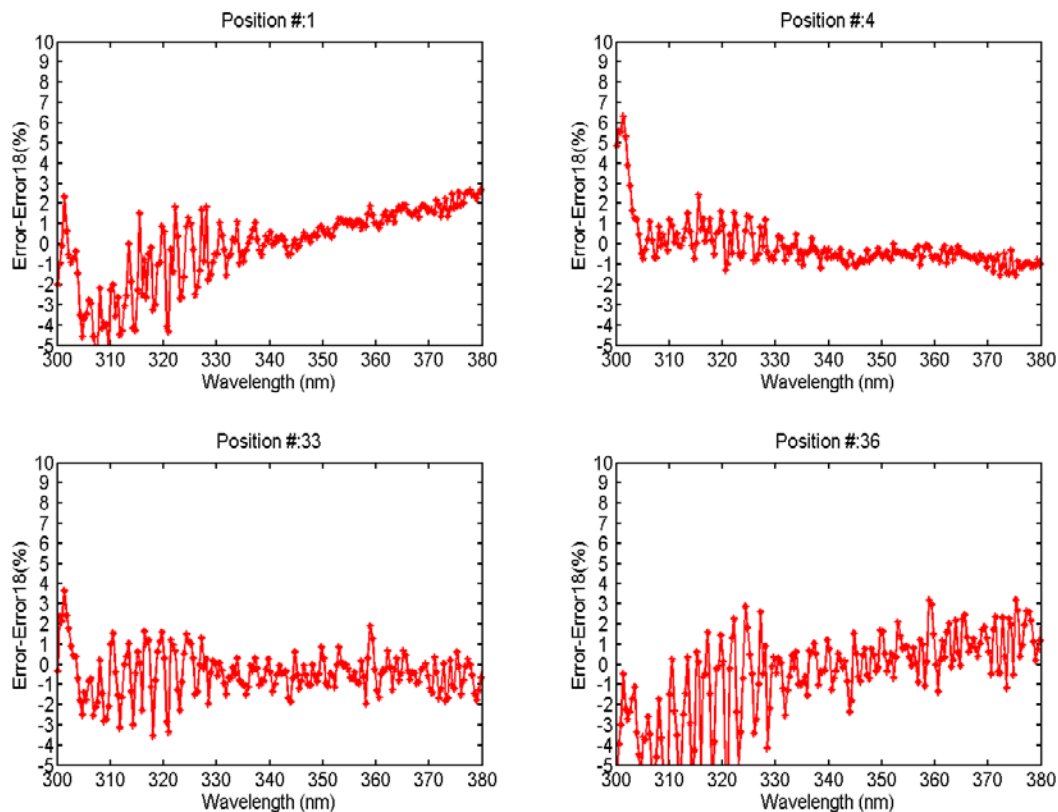
Stake Holder Interactions, Users and Impact Assessment Plans

- OMPS SDR users/stake holders
    - CPC Climate Prediction Center
    - NCEP National Centers for Environmental Prediction
    - NRL Naval Research Laboratory
    - USGS United States Geological Survey
    - EPA Environmental Protection Agency
    - NOAA ARL Air Resources Laboratory
    - NOAA VAAC Volcanic Ash Advisory Center
    - STAR Center for Satellite Applications and Research
    - CLASS Comprehensive Large Array-data Stewardship System

- The J1 OMPS products will be used by the users the same way as they use SNPP data.

- Users won't be negatively impacted with the J1 data that is of comparable quality as SNPP SDR and EDR products.

- The Version 8 Algorithms are in transition to become the operational EDR algorithms. The SDR and EDR team have significant interaction and cooperative planning and development at these algorithms move forward.

Summary & Path Forward

- OMPS SNPP NP and NM EV SDR products meet the validated maturity requirement. SDRs products are stable.
    - Our current strategy is to stabilize and monitor SDR products quality conditions at the already established product maturity that represent sensor attainable levels.
    - Utilize ADL and GADA for testing and validation of calibration tables and data anomaly analysis.
    - Deploy already established radio transfer model for cross-sensor calibration.
    - SNPP dark Cal. SDR has been transitioned to STAR and GRAVITE. The transition of solar Cal. SDR will be completed in FY2016.
- OMPS J1tasks and schedule are well defined and on schedule. Risk is low for SDR. performance.
    - Prelaunch calibration analysis shows OMPS J1 meets system requirement.
    - J1 algorithm LUTs were derived from SCDBs and will be refined and verified through a integrated test from RDR, SDR to EDR.
    - J1 algorithm is being implemented into IDPS Block 2.0. Results will be evaluated and reviewed by OMPS science team.

FY16 Milestones

- Establish sensor initial settings and parameters for J1 launch preparation
  - Further analysis on pre-launch test data and refinement of SDR algorithm LUTs
  - Sensor and Algorithm Parameter Updates
- Refine and verify SDR algorithm LUTs
  - Measurement: Sample Tables, Macrotable, Timing Pattern
  - Spectrometric LUTs: Spectral Response, Spectral Registration, Wavelengths
  - Radiometric LUTS: Calibration Coefficients, CF-Earth, Darks, Linearity, Stray Light, Solar Irradiance, Observed Solar, Predicted Solar
  - Geolocation LUT: Mounting Matrix and Field Angle Map
  - Table version LUT
- Complete integration test of J1 algorithm chain of RDR-SDR-EDR
  - Synthetic datasets will be used to test full range of spatial and spectral domain of J1 sensor beyond NPP sensor capabilities
- Develop SDR software tools to process diagnostic data and perform offline calibration
- Complete SNPP solar Cal. SDR transition to STAR and GRAVITE
- Revise and finalize Cal/Val documentations
- Outreach to Community: AMS, EUMETSAT, IGARSS, and CALCON.
- J2 and Beyond: OMPS Limb Profiler SDR algorithm preparation is on scheduled
  - Gridded measurements of atmospheric limb Earth-view for three Nadir orbital track.
  - Spectral coverage from 290 to 1000 nm at 1-km tangent height spacing.