Read-me for Data Users

MEMORANDUM FOR: The JPSS Program Record
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SUBJECT: NOAA-21 Product Provisional maturity status
DATE: 03/30/2023

Provisional maturity status declaration for J2 OMPS Nadir Mapper and Nadir Profiler SDR
Maturity Review Date: **03/30/2023**
Effective Date and Time: **04/13/2023 19:37:29 GMT**
Operational System: **MX 7 IDPS with At-launch OMPS LUTs and ADRs 9960, 10281, 10308**

The JPSS Algorithm Maturity Readiness Review Board approved the release of the J2 OMPS NM and NP SDR products to the NOAA SDR/EDR cal/val users with a provisional maturity level quality as of 04/13/2023 19:37:29 GMT (effective date and time), based on JPSS Validation Maturity Review held on 03/30/2023 (link to review artifacts).

1. **Background:**

The Joint Polar Satellite System-2 (JPSS-2) was successfully launch on November 9, 2022 and renamed NOAA-21 after reaching polar orbit. Ninety-one days after launch, on February 9, 2023, the NOAA-21 Ozone Mapper Profiler Suite (OMPS) started collecting operational non-global nominal science data. The first two days of global data were collected on February 17 and 18, 2023. With the same design as that of the Suomi NPP and NOAA-20 OMPS Nadir Suites, NOAA-21 OMPS consists of two spectrometers each with different spectral and spatial coverage. The nadir mapper (NM) has spectral coverage from 300nm to 380nm with 198 channels and 1.1nm bandpass. The nadir profiler (NP) has spectral coverage from 250nm to 310nm with 158 channels and 1.1 nm bandpass. The OMPS nadir suite provides global measurements of total ozone, ozone profile, sulfur dioxide, and an aerosol index. More importantly, the OMPS NM on NOAA21 enables us to detect, track and monitor atmospheric ozone UV-absorbing aerosols and other atmospheric gases important for air quality such as Sulfur Dioxide (SO2) and Nitrogen Dioxide (NO2) at better spatial resolution. Quantifying these atmospheric species is important for a variety of reasons including monitoring the Ozone Layer and its interactions with climate change, tracking volcanic SO2 and ash for air traffic safety, and identifying pollution sources and levels for general air quality health assessments.

The OMPS SDR team consists of experts from NOAA, University of Maryland/CISESS, NASA, GST Inc, SSAI., the Aerospace Corp., and industry partner Raytheon**.** The team has been working intensively on post-launch instrument performance optimization, OMPS SDR pre- and post-launch calibration and validation.

2. **Provisional maturity stage definition:**
    i. Product performance has been demonstrated through analysis of a large, but still limited (i.e., not necessarily globally or seasonally representative) number of independent measurements obtained from selected locations, time periods, or field campaign efforts.
    ii. Product analyses are sufficient for qualitative, and limited quantitative, determination of product fitness-for-purpose.
    iii. Documentation of product performance, testing involving product fixes, identified product performance anomalies, including recommended remediation strategies, exists.
    iv. Product is recommended for potential operational use (user decision) and in scientific publications after consulting product status documents.

3. **Justifications for declaring OMPS SDR data products provisional maturity:**

After NOAA-21 OMPS activation, OMPS SDR team members immediately started analysis of OMPS science RDR, telemetry RDR, SDR and GEO data products. After the beta maturity review on February 23, 2023, the team conducted more intensive post-launch calibration and validation analyses for the NOAA-21 OMPS NM and NP SDR instrument performance and data quality. In particular, the following assessments of the OMPS SDR products were performed prior to the Provisional Review.

1) Conducted a large, but still limited analysis about the data quality of the NOAA-21 OMPS NM and NP in comparison with Suomi NPP and NOAA-20. Particularly, validated the quality of the data w/wo the three calibration problems were fixed (CCRs #6439, 6463, 6475)
2) Improved the sensor wavelength registration algorithm and delivered 2nd version of the wavelength calibration tables.
3) Continued the analysis of NOAA-21 OMPS NM and NP dark current, gain and LED.
4) Assessed the geolocation accuracy of the OMPS NM data against VIIRS M1 band data.
5) Assessed the geolocation accuracy of the OMPS NP data against the NM data.
6) Analyzed the SNR performance of the OMPS NM and NP data.
7) Analyzed the NM intra-orbit wavelength shift feature analysis.
8) Evaluated the NP stray light effect.
9) Continued the weekly dark rate LUT delivery since February 23, 2023.
10) Continued the biweekly NP solar and wavelength LUT delivery since March 21, 2023.
11) Derived and delivered four additional calibrations tables to primarily fix two new calibration issues.

In addition, two additional improvements (4 LUTs) were implemented into the operational ADL processing. Two of the tables correct the wavelength shift in the solar data for the NP sensor. Two of the tables are to fix the wavelength shift discrepancy at the 84th to 86th cross-track positions for the NM sensor.

1) ADR10303/6463: the 12-pixel-shift, 5.1nm error in the NOAA-21 NP Solar flux table

Two updated NOAA-21 NP wavelength and solar OSOL tables were derived and implemented into operation on 03/23.

2) ADR10308/6475: the wavelength discontinuity problem in NOAA-21 NM at the 84-86 cross-track pixels

Two updated NOAA-21 NM wavelength and solar OSOL tables were derived and delivered to the ASSISTT team on 04/03/2023. The tables were implemented into the operation processing system at 04/13/2023 19:37:29 GMT.

Overall, the NOAA-21 OMPS NM and NP instrument performs well with stable CCD gain, nonlinearity and dark rate performance after the launch. The corresponding SDR data show a reasonable quality with a good agreement with SNPP and NOAA-20. They are in a family with SNPP and NOAA-20 OMPS. In addition. The NM demonstrates a strong capability in visually capturing cyclone fine structure including storm eye due to its high resolution. Below is a summary the NOAA-21 OMPS data quality performance.

i. On average, the SNR meet the requirements
ii. Geolocation accuracy meets the requirement
iii. NM and NP data consistencies in the range from 303 to 310 nm are mostly within ±5%.
iv. OMPS NM SDR data agree with both SNPP and NOAA-20 typically with margins of ±3 % for the channels above 305nm.
v. OMPS NP SDR data agree with both SNPP and NOAA-20 typically with margins of ±5 %.

Last but not least, the NOAA STAR EDR team has successfully used the NOAA-21 OMPS SDR data in total ozone and ozone profile retrievals. The results demonstrated that the products are of good quality with a few known/unknown concerns, which are generally consistent with the SDR calibration problems and caveats summarized in this readme. The detailed justifications for declaring OMPS SDR provisional maturity is provided in the attached presentation.

4. NOAA-21 OMPS SDR provisional maturity caveats

The following caveats are provided to the provisional product users:

1) Uncertainties exist in the currently derived NOAA-21 OMPS NM and NP solar ‘day-1’ data set since it has not considered impacts of the following factors: earth-sun-distance correction, satellite doppler wavelength shift correction, solar activity impact correction, and different solar reference data set. This will affect the derived sensor wavelength registration scale table and thus the spectral quality of the data.
2) The NOAA-21 OMPS NM radiance shows a relatively large discrepancy with NOAA-21 OMPS NP in the range from 300 to 303 nm. Residual stray light effects are thought to be the primary reason. The root cause analysis is still in investigation.

3) The SNR performance of the NOAA-21 NM and NP data is not well quantified in the dichroic range from 300 to 310nm by using the current algorithm. An improved SNR algorithm is desirable to better capture the SNR performance there.
4) There are certain inter-sensor radiance differences between the NOAA-21 OMPS NM and the SNPP/NOAA-20 radiance. The root cause is still in investigation.
5) The comparison of the NOAA-21 OMPS data with non-OMPS SDR data is still in a very preliminary stage due to limited OMPS data and analysis time. There are plans to make intensive inter-instrument comparisons with other UV sensors such as TropOMI, VIIRS, GEMS.
6) The correction of the solar intrusion is not applied to the NOAA-21 NP data currently (this correction is still turned off in the operational ADL processing). However, the NOAA-21 NP radiance data below 300 nm over the Northern Hemisphere is demonstrated to suffer from the solar intrusion effect when the solar zenith angles are high, as the NOAA-20 NP does. Further analysis and correction are desired.
7) The calibration accuracy of the NOAA-21 NM and NP data at short wavelengths need to be further quantified. For example, an improved CRTM is expected to better quantify the calibration radiometric errors of the data especially in the dichroic range from 300 to 310nm.

5. Path Forward

The team will work diligently to continue with the following planned cal/val tasks to promote the OMPS SDR data products to the validated maturity that is scheduled on March 2024:

1) Deliver the DR#10308 LUTs to the ASSISTT on 04/03 (wavelength shift discontinuity error) as the post-review-meeting action.
2) Continue the following analyses
    i. Regular deliveries for the NOAA-21 NM/NP dark and NP wavelength LUTs
    ii. NOAA-21 OMPS NM and NP wavelength registration accuracy improvement. A quick improvement is to apply the earth-sun-distance correction to the day-1 solar data set.
    iii. SNR calculation method improvement
    iv. Geolocation accuracy of NOAA-21 OMPS NM/NP data
    v. Solar intrusion effect for NOAA-21 NP
    vi. Stray light correction performance and improvement for the OMPS NM.
3) Further quantify the NOAA-21 data quality towards the scientific requirements using multiple methods
    i. NM and NP SDR data quality consistency

ii. Inter-sensor radiometric calibration uncertainties (e.g., JPSS instruments, TropOMI, GEMS)

iii. RTM simulations

4) Improve the simulation accuracy of the CRTM for OMPS NP and NM in coordination with the STAR CRTM team

5) Assess impact of a different solar reference spectrum (e.g., GSICS-recommended one) on NOAA-21 SDR data quality

6) Continue to update the OMPS SDR ATBD.

Additional information is available in the OMPS algorithm theoretical basis document (ATBD) and provisional maturity review briefing, which can be accessed at:
http://www.star.nesdis.noaa.gov/jpss/Docs.php

Pre-operational NOAA-21 OMPS near real time status and performance monitoring password protected web page is available using the following URL at:

https://www.star.nesdis.noaa.gov/icvs-beta/status_J02_OMPS_NP.php

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