



MEMORANDUM FOR: The JPSS Program Record
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SUBJECT: NOAA-20 OMPS Nadir Ozone Profile EDR Provisional Maturity Status
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1. Background:

The Joint Polar Satellite System-1 (JPSS-1) was successfully launch on November 18, 2017 and renamed NOAA-20 after reaching polar orbit. With the same design as that of the Suomi NPP OMPS Nadir Sensors, the NOAA-20 OMPS consists of two spectrometers each with different spectral and spatial coverage. The OMPS Nadir Mapper (NM) SDR has spectral coverage from 300 nm to 380 nm with 196 channels and 1.1-nm bandpass. The OMPS Nadir Profiler (NP) SDR has spectral coverage from 250 nm to 310 nm with 150 channels and 1.1-nm bandpass. The OMPS nadir suite provides global measurements of total ozone, ozone profile, sulfur dioxide, UV reflectivity and an aerosol index.

Forty-eight days after launch, on January 5, 2018, the NOAA-20 Ozone Mapper Profiler Suite (OMPS) opened its door and started collecting science data. The initial data was in a high-spatial-resolution limited-spectra mode and was not compatible with the operational EDR algorithms. Since February 13, 2018 the instrument has been operated in a medium resolution mode and the NDE processing of the IDPS SDRs has created ozone EDR products.

The OMPS Ozone EDR team consists of experts from NOAA, NASA, IMSG, and industry partner Raytheon. The team has been working OMPS EDR pre- and post-launch calibration and validation for the Total Column Ozone EDRs from the V8TOz and V8TOS algorithms, and the Ozone Profile EDRs from the V8Pro algorithm as processed operationally at NDE.

2. Provisional maturity stage definition:

- 1) 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.
- 2) Product analyses are sufficient for qualitative, and limited quantitative, determination of product fitness-for-purpose.
- 3) Documentation of product performance, testing involving product fixes, identified product performance anomalies, including recommended remediation strategies, exists.
- 4) Product is recommended for potential operational use (user decision) and in scientific publications after consulting product status documents.

3. Justifications for declaring OMPS EDR data products provisional maturity:

The OMPS SDR and EDR team members have been analyzing the OMPS science RDR, telemetry RDR, SDR and GEO and EDR data products for the last nineteen months. Based on their analysis the following assessments of the OMPS NM and NP SDRs and the V8Pro EDR products were compiled:

- The SDR team reported that the performance for the SDRs met provisional maturity starting on July 2, 2018. The SDR noise level are as expected and weekly updates are used to maintain them adequately to meet EDR precision requirements. Biweekly updates to the wavelength scale are provided to track the annual cycle. Additional improvements on the path to validated maturity are described in the OMPS NP Validated Maturity Briefing and Readme. Please see the caveats in those documents and the memo of record from March 20, 2018 and further caveats on the SDRs in this memo;
- The NOAA STAR EDR team has successfully used the SDR data in V8Pro ozone profile retrievals and are generally positive about the measurement quality;
- The product performances are now close to requirements for most parameters in the Equatorial region, however deficiencies are present in the latitude dependence versus S-NPP V8Pro results for all other latitudes;
- The product error flags are functioning as designed and are identifying deficient products and compromised viewing conditions with frequencies as expected for most flags except the total ozone error flag for aerosol is set too often;
- The NOAA-20 V8Pro EDR products from NDE and STAR off-line processing were compared to S-NPP EDR products – NOAA-20 ozone results are similar to those for S-NPP with differences and caveats as noted below and in the V8Pro provisional briefing;
- On-orbit SDR radiometric biases were estimated based on comparisons with Suomi NPP OMPS, EOS Aura OMI and NOAA-19 SBUV/2 EDR measurement residuals and retrieval product sensitivities. These were used to generate the initial EDR soft calibration adjustments. Further rounds of adjustments will be constructed and provided as the SDRs are modified for the problems and updates as noted below;
- The EDR Team has delivered revised algorithms and tables to NDE for implementation in the operational processing system to improve the product quality. The v3r2 for V8Pro is running on the I&T stream at NDE. The latest code changes and a new soft calibration adjustment table, v3r3, have been delivered to ASSISTT. The code contains several areas of improvement. Details are provided in Appendix B. The Provisional Maturity products will commence production and regular distribution once this v3r3 delivery is implemented at NDE; and
- NOAA-20 OMPS Nadir Ozone Profile EDR data products for the Equatorial zone after this update can be used for making qualitative and quantitative assessments of the product for applications and science.

The presentations and Readmes for the OMPS SDR and V8Pro Ozone EDR products justifying their advances to validated and provisional maturity, respectively, can be found at

<https://www.star.nesdis.noaa.gov/jpss/AlgorithmMaturity.php>

4. NOAA-20 OMPS Ozone EDR Provisional maturity caveats

The following caveats are provided to Provisional EDR product users:

- A fix to the calibration constant computations for the OMPS NP SDR cross-track macropixels (DR 8615) was implemented at IDPS on July 2, 2018;
- The OMPS NM SDR program dropped scans when the RDRs contain 16 scans in a granule. A fix to correct this problem (CCR 18-3829) transferred to operations with Block 2.1 Mx3 on September 24, 2018;
- The smaller FOVs for the NOAA-20 V8Pro EDRs lead to poorer performance (noisier retrievals from transient spikes) in the South Atlantic Anomaly (SAA) than is seen for

the S-NPP V8Pro EDRs. The SAA flag is not set for some of the affected retrievals beyond the edges of the currently defined region. The V8Pro v3r3 implements an information concentration and outlier screening process to reduce the measurement noise in the selected channels and identify the presence of outliers;

- While working on the next step to reduce the effects of noise and outliers, a discretization error from the nonlinearity correction formulation was discovered. The error creates solar zenith angle dependent biases in the measurements for the two shortest profile channels which provide information at the top of the retrieval. This discretization error will be reduced to a negligible level by implementing a new flight nonlinearity table and a new ground radiance calibration table (ADR 8730). The new table was provided along with new calibration coefficients. This update was implemented in IDPS on December 4, 2018;
- The first round of updates to the NOAA-20 OMPS sample tables do not provide good enough matchups between the NP and NM FOVs as needed by the V8Pro algorithm. A full set of SDR tables (including wavelength, solar, and stray light) have been developed for use with a new OMPS NM flight sample table. These new SDR and sample tables have been in use since April 19, 2019;
- The V8Pro EDR products described in this review will not be available from NDE until after delivery and implementation of the latest changes (v3r3). The NOAA-20 V8Pro adjustments give good agreement with the S-NPP V8Pro within 20° of latitude of the Equator but the retrievals deviate outside that range;
- There is an open question on the OMPS NP SDR wavelength scale. The SDR Team is working on a new wavelength scale but the EDR Team has not demonstrated that it will provide agreement over the full Latitude range.
- The OMPS NP SDR tables have been tuned for on-orbit performance. DR9093/CCR 19-4638 provides LUT updates for NOAA-20 OMPS NM & NP to reach Validated Maturity). This delivery is in progress. The quality of the products will change once the newest SDR tables are delivered and installed at IDPS. We will need to deliver new adjustment tables to obtain agreement between NOAA-20 and S-NPP in the Tropics; and
- The S-NPP OMPS NP SDRs were affected by small but significant degradation in the optical throughput and by an annual cycle in the wavelength scale exceeding the stability requirements. The wavelength scale variations for S-NPP led to the use of biweekly updates to the solar and wavelength scale tables. The SDR team has implemented similar biweekly updates for the NOAA-20 OMPS NP wavelength scale and solar to account for the annual cycle in wavelength scale. The SDR and EDR teams are monitoring the NOAA-20 OMPS NP SDR performance to see if degradation changes are present at levels requiring calibration updates.

5. Path Forward

The team will work to continue with the following planned calibration and validation tasks to promote the OMPS EDR data products to validated maturity:

- 1) Compare non-Equatorial regional means, zonal means and global statistics for V8Pro EDRs with those for S-NPP. Compare ozone profile products to ground-based measurements by using overpass data sets for Umkehr and Ozonesonde stations. Compare BUFR products to current assimilation forecasts;
- 2) Track the impact of continued improvements in the SDR as planned by the SDR team with particular attention to wavelength scales or bandpass changes which might cure the observed latitude dependence; and



Read-me for Data Users

- 3) Provide deliveries of adjustment tables and code changes for V8Pro to NDE as SDR maturity progresses and stabilizes, validation results are analyzed and throughput degradation is quantified.

Additional information is available in the OMPS V8TOz and V8Pro algorithm theoretical basis documents (ATBDs) and the SDR beta maturity review briefing, which can be accessed at:

<https://www.star.nesdis.noaa.gov/jpss/Docs.php>

and

<https://www.star.nesdis.noaa.gov/jpss/AlgorithmMaturity.php>

Beta and provisional NOAA-20 OMPS SDR near-real-time status and performance monitoring web page are available by using the following password protected websites:

https://www.star.nesdis.noaa.gov/icvs-beta/status_J01_OMPS_NP.php

https://www.star.nesdis.noaa.gov/icvs-beta/status_J01_OMPS_NM.php

Provisional NOAA-20 OMPS SDR near-real-time status and performance monitoring web page will become available at the open website:

<https://www.star.nesdis.noaa.gov/icvs/index.php>

Pre-operational NOAA-20 OMPS EDR near-real-time status and performance monitoring web pages will become available at the following websites:

Archive https://www.class.ncdc.noaa.gov/saa/products/search?datatype_family=JPSS_OZONE

Operations <http://www.ospo.noaa.gov/http://www.ospo.noaa.gov/Products/atmosphere/index.html>

Long-term <https://www.star.nesdis.noaa.gov/smcd/spb/OMPSDemo/proOMPSbeta.php>

Daily maps https://www.star.nesdis.noaa.gov/jpss/EDRs/products_ozone.php

Activity <https://ozoneaq.gsfc.nasa.gov/omps/n20/activity>

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Appendix A. Key items from OMPS SDR Provisional Memo. (Updates at this time)

- 1) There is a sub-optimal match in the CCD pixels for the OMPS-TC and OMPS-NP sample tables. The OMPS-TC and OMPS-NP are not viewing exactly the same spatial region within each FOV. A better alignment could be achieved. For example if a bright cloud fills one OMPS-TC FOV pixel but is cloud-free in an adjacent FOV pixel the OMPS-NP alignment will sample both the cloud and cloud free pixel. The alignment difference is small but could be significant in some cases. The difference in field of view will sometimes in the worst case combine the bright scene and dark scene in the NP pixel. There is a report on this issue, DR_8617, “FOV Mismatch between N20-OMPS-TC and N20-OMPS-NP”. **This was corrected as of April 19, 2019.**
- 2) In July 2018, the science team discovered the OMPS-NP non-linearity correction is causing a discretization error for low signal levels. The error is causing a signal level dependent 2% error at shorter channels. Our analysis shows the error can be removed by uploading a new non-linearity table to the NOAA-20 and updating the calibration coefficient file in the IDPS. DR_8730 was opened on this topic. **This was corrected as of February 2019.**
- 3) **Check for degradation in the OMPS-NP shortest spectral region. Monitoring is on-going. Solar reference measurements are made every six months.**

Appendix B. V8Pro Upgrades in v3r3

A. Dual Adjustment Tables

- Provides Old (Current) and New (Updated) soft calibration tables with the option to interpolate between them to smooth the transition at the request of data assimilation applications. File names will have creation dates.

B. Metadata improvements.

- Additional fields are added to metadata to be consistent with NDE requirements and to provide better information. These include the NDE production site, NDE production environment, and the adjustment table's file name.

C. Area-Weighted FOV Averages and Allow High Resolution OMPS NM SDRs

- When the NOAA-20 OMPS NM SDR goes to [10,10,10,10, 5,10, 5,10,10,10,10] or to [5, 5, 5, 5, 5, 5, 5, 5, 5,10, 5, 5, 5, 5, 5, 5, 5, 5, 5] pixel aggregation, we will want to have area-weighted values computed in the glueware. This refinement provides the code to calculate and use the relative sizes of the FOVs.

D. Remove the use of 340 nm channel for reflectivity.

- Code updates were made to switch from 340 nm channel to 331 nm channel for some reflectivity calculations for consistency with the NASA V8Pro implementation.

E. Code Fixes

- Averaging Kernels: Changes OMPS V8Pro product configuration for the averaging kernels to agree with the SBUV/2 relative response ones.
- Mixing Ratios: Corrects inconsistency in height order of mixing ratio amount and pressure.
- Surface Pressure: Extends Terrain Pressure maximum and minimum to include the Dead Sea and Mt. Everest.
- Descending Orbits: Descending orbit data were not processed – fixed by changing the geolocation corner order in the Glueware.

F. Change to handle OMPS NM SDR sizes up to 30 scans x 140 cross-track FOVs per granule.

- This refinement will read in the SDR granule sizes and properly select OMPS NM SDR FOVs for 5, 15 or 30 scan granules with up to 140 cross track granules to match up with the OMPS NP EDR FOV.

G. Outlier Detection Filter and Information Concentration (F&IC)

- Implements a combination of median filter and 10- to 12-wavelength polynomial fits of the radiance / irradiance ratios for the shorter ozone profile channels to reduce measurement noise, remove outliers and identify PMCs. A flag is set if the radiances have too many outliers.

Table 1-4b V8Pro Profile Error Code and Descriptions

Profile Error Code	Description
0.0	Good retrieval
1.0	SZA > 84 degrees
2.0	Step3O3 – Profile Total > 25 DU
3.0	Average Final Residual for retrieval channels > threshold
4.0	Final residue greater than 3 times instrument error
5.0	Retrieved - a priori greater than 3 times a priori error
6.0	Non-convergent solution
7.0	Stray light anomaly
8.0	Initial residue greater than 18.0 N-value units or upper level profile anomaly
9.0	Total ozone algorithm failure