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Product read-me for the collection 4 L1b data of the Ozone Monitoring Instrument

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1 Introduction

1.1 Identification

This document is identified by AURA-OMI-KNMI-L01B-0013-RP.

1.2 Purpose and objective

This L1b product README gives and overview of the known issues, restrictions and limitations of the Level 1b data products for OMI product collection 4. A detailed description of these Level 1b data products is provided in the IODS [1]. The metadata for the Level 1b data products are described in the MDS [2]. A description of the OMI L01b processor and the algorithms in this L01b processor can be found in the ATBD [3]. The README covers the L1b products that are intended for L2 processing, i.e. the radiance and irradiance products. The calibration products are out of scope for this document.

1.3 Document overview

An overview of the L1b products is given in Section 4. Section 5 gives an overview of the known issues, restrictions and limitations for the L1b data products.

2 Reference documents

[1] Input output data specification for the collection 4 L01b data processing of the Ozone Monitoring Instrument.
source: KNMI; **ref:** AURA-OMI-KNMI-L01B-0005-SD.

[2] Metadata specification for the collection 4 L01b data processing of the Ozone Monitoring Instrument.
source: KNMI; **ref:** AURA-OMI-KNMI-L01B-0007-SD.

[3] Algorithm Theoretical Basis Document for the collection 4 L01b data processing of the Ozone Monitoring Instrument.
source: KNMI; **ref:** AURA-OMI-KNMI-L01B-0002-SD.

[4] Algorithm theoretical basis document for the TROPOMI L01b data processor.
source: KNMI; **ref:** S5P-KNMI-L01B-0009-SD.

[5] Input/output data specification for the TROPOMI L01b data processor.
source: KNMI; **ref:** S5P-KNMI-L01B-0012-SD.

[6] Metadata specification for the TROPOMI L1b products.
source: KNMI; **ref:** S5P-KNMI-L01B-0014-SD.

[7] Q. Kleipool, N. Rozemeijer, M. van Hoek *et al.*; Ozone Monitoring Instrument (OMI) collection 4: establishing a 17-year-long series of detrended level-1b data. *Atmospheric Measurement Techniques*; **15** (2022) (11), 3527; 10.5194/amt-15-3527-2022. **url:** `https://amt.copernicus.org/articles/15/3527/2022/`.

3 Terms, definitions and abbreviated terms

Terms, definitions and abbreviated terms can be found in [3]. Terms specific to this document can be found below.

3.1 Terms and definitions

There are no terms and definitions specific to this document.

3.2 Acronyms and Abbreviations

There are no acronyms and abbreviations specific to this document.

4 OMI Level 1B Products Overview

4.1 Product version and applicability

This version of the L1b product README pertains to collection 4 L1b data products with version 04.01 (v0401).

4.2 L1b product types

For collection 4 there are 7 types of L1b data products, as described in Table 1. The 6 main products are the same as for collection 3. A new product type `OML1BICK` is introduced for collection 4 for dynamic key data for the NRT processing.

Shortname	Description
OML1BRUG	Level 1b radiance data at the nominal (global) spatial sampling for the UV detector (detector 1, band 1 and band 2)
OML1BRVG	Level 1b radiance data at the nominal (global) spatial sampling for the VIS detector (detector 2, band 3)
OML1BRUZ	Level 1b radiance data for high resolution (zoom-in) spatial sampling for the UV detector (detector 1, band 1 and band 2)
OML1BRVZ	Level 1b radiance data for high resolution (zoom-in) spatial sampling for the VIS detector (detector 2, band 3)
OML1BIRR	Level 1b irradiance data, based on the daily irradiance observations, matching the nominal resolution of the radiance measurements in the global OML1BRUG and OML1BRVG products, for all detectors / bands
OML1BCAL	Level 1b calibration data for all detectors / bands. The OML1BCAL are intended for expert users only and are not made publicly available.
OML1BICK	Level 1b in-flight calibration key data for all detectors / bands. This product is intended for internal usage in the OSIPS only and is not archived, nor made publicly available. The `OML1BICK` products are intended to carry in-flight calibration key data from the forward processing stream to the NRT processing stream.

Table 1: L1b product types.

4.3 Documentation

A detailed description of these Level 1b data products is provided in the IODS [1], which also provides an overview of the most important differences in the Level 1b products between collection 3 and collection 4. The metadata for the Level 1b data products are described in the MDS [2]. A description of the OMI L01b processor and its algorithms can be found in the ATBD [3].

4.4 Changes from collection 3 to collection 4

For collection 4, the OMI L01b processor was completely rebuild. This encompasses changes in the L1b product data format, the L01b algorithms and the calibration. The most important changes are:

- The collection 4 L1b products are in NetCDF-4 format instead of HDF-EOS2 (which was based on HDF-4). The products follow a completely different format structure, which is largely based on S5p/TROPOMI [4][5][6]. By having a high level of consistency between the OMI and TROPOMI L1b data products, the intention is to make it easy for users to work with data from both these missions.
- The L1b products now use a band numbering scheme instead of a band naming scheme, with band 1, 2 and 3 corresponding to the former UV-1, UV-2 and VIS respectively
- The units of the radiance and irradiance data have changed from photons.s^{-1}.nm^{-1}.cm^{-2}.sr^{-1} to mol.s^{-1}.nm^{-1}.m^{-2}.sr^{-1} and from photons.s^{-1}.nm^{-1}.cm^{-2} to mol.s^{-1}.nm^{-1}.m^{-2} respectively. To convert back to the collection 3 unit, multiply by $\frac{6.02214076\times10^{23}}{10000}$.

- Radiance and irradiance are stored in ascending order of wavelength. This means that for band 1 the spectral dimension is reversed compared to collection 3.
- Radiance and irradiance are corrected for Earth-Sun-distance, i.e. normalized to 1 au.
- Instead of storing a noise value directly, the noise is provided as a signal-to-noise-ratio on a dB scale. Given the signal S (stored in `radiance` or `irradiance`) and the signal-to-noise-ratio R (stored in `radiance_noise` or `irradiance_noise`), the noise (random error) N can be calculated as $N = \frac{S}{10^{R/10}}$.
- Radiance and irradiance data are no longer split into a separate mantissa and exponent.
- The absolute radiometric calibration is tied to detector pixels instead of wavelength, in order to reduce interpolation errors with fine spectral structures.
- The radiance and irradiance data are corrected for temporal trends in optical throughput, such as optical degradation. These corrections for both irradiance and radiance show irregular structures in the cross-track direction ((ground)pixel dimension). In the wavelength direction (spectral channel dimension), the correction is constant for radiance and a smooth function for irradiance, hence these corrections should not introduce any spectral features.
- The algorithm for the relative irradiance correction and the corresponding key data have been improved.
- Small improvements have been made to the analogue gain and non-linearity correction algorithms and corresponding key data.
- A new flagging approach / scheme is implemented. Several flagging algorithms have been improved and for specifically defective and RTS pixel flags, flagging thresholds have been revised to avoid overflagging. Based on user feedback and data analysis, it was established that data was flagged as defective or RTS in many cases, even if data quality was not affected. The updated flagging thresholds are intended to avoid this and leave more useable data. The row anomaly flags have been updated with based on a reanalysis of the entire mission. For these row anomaly flags, based on user feedback that too few data was flagged, flagging thresholds have been updated as well and now more data is flagged.
- In addition to the wavelength polynomial coefficients, wavelength annotation is provided as a map for each spectral pixel.
- The calibration data for the wavelength annotation has been improved, including temporal variations.
- The measurements are annotated with timestamps using a `time` and a `delta_time`. The time is stored as UTC seconds since the epoch 2010-01-01 00:00:00 UTC. `time` is a single value for each product group and always corresponds to the start of the day (00:00:00 UTC) of the beginning of the observations in the product. The observation time for each measurement is given as the `delta_time`, which is given as milliseconds relative to the `time`. As `time` is always at 00:00:00 UTC, the `delta_time` automatically provides the information that was stored in the `SecondsInDay` fields of the collection 3 L1b products. Be aware that since the epoch of `time` is 2010 and EOS-Aura was launched in 2004, the value in `time` can be negative.

More detailed information on the changes can be found in [7], the ATBD [3] and the IODS [1].

4.5 Changes from version 04.00 to version 04.01

The following changes were made to the OMI L01b processor from version 04.00 to version 04.01:

- The L01b processor no longer generate OML1BIRR products when the solar angles for the irradiance measurements in the solar port are outside the calibrated range; this way, L2 processing will not be affected towards the end of the Aura mission, in case the spacecraft will start drifting too much from the nominal orbit.
- Small robustness changes and minor bug-fixes. None of these should affect the data quality.

In addition to that, the following changes were to the Calibration Key Data (CKD), affecting the L1b data:

- Minor updates were made to the radiometric degradation correction coefficients for Earth radiance data.
- The row anomaly flags have been updated: For several ground pixels around nadir, the row anomaly has weakened in 2021. The flags have been updated to reflect this with a "slightly affected" quality indicator instead of "affected".
- The relative irradiance correction coefficients have been updated to remove spectral structure within each band.
- Major improvements of the Irradiance degradation correction coefficients have been made: Jumps between bands have been removed and the correction is more stable for extrapolated intervals.

5 Known issues, restrictions and limitations

5.1 General

The current version of the data products are intended for operational use. There are no known restrictions or limitations.

5.2 Algorithms and calibration key data

There are no known issues with respect to the algorithms or the calibration key data for the L01b processor.

5.3 L01b software and product format

There are no known issues with respect to the L01b processor software or the L1b product format.