

Definition of Level 1B Radiance product for OMI

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1. Introduction

The data format of the Level 1B radiance product for the Ozone Monitoring Instrument (OMI) on EOS Aura, as defined by the international OMI science team, is described.

1. The drivers for the Level 1B format are:
 - Information Content. No information shall be lost by storing the data
 - User accessibility. Easy access must be provided for all (potential) OMI users.
 - Size. Size reduction to reduce archiving and transport costs.
 - External Interface. HDF-EOS swath structure.

Note that these drivers may have conflicting interests. For example: user the accessibility and information content may drive to a larger data product, which is clearly in opposite direction of the size driver.

2. File Organization

OMI is an UV/VIS spectrometer. It has two CCD detectors, one for the ultra violet (UV) and one for the visible (VIS) wavelength range. The UV CCD is used to image two channels: UV-1 and UV-2. The VIS CCD is used for only one channel. Thus OMI has three channels: UV-1, UV-2, and VIS.

Most of the data products that are derived for the OMI Level 1B radiances use only a part of the spectrum within one of the channels. An exception is the UV-1: most data products that are derived from this channel will also use the UV-2. Therefore the OMI Level 1B radiances are split into two data products, one for the UV-1 and UV-2 (UV CCD), and one for the VIS channel (VIS CCD). The main advantage of having two products is that users that need only part of the spectrum reduces considerably on their storage and transportation costs. The UV OMI data product will use separate HDF-EOS swath structures for the UV-1 and the UV-2.

For each CCD readout discipline (global, spatial and spectral zoom-in) a separate product is created. Users that are interested in the zoom products can thus easily find, transport and store the data that they are interested in. Additionally, the zoom-in data is also re-binned to the binning factor of the global readout discipline and stored in the global readout discipline product. This is done for users that derive global products, so that they find all data of an orbit in one file and in one swath data structure. Note that using spectral or spatial zoom-in results in missing parts of the spectrum or missing parts of the swath. In the global readout discipline files, data from different readout discipline can be present. In this product a flag is used to indicate the used readout discipline.

3. Information Content

The OMI Level 1B radiance product contains three classes of information:

- Metadata
- Radiance data
- Geolocation data.

The information that shall be provided in each of the classes is listed below.

Metadata

ECS core metadata
GDPS version number
OPF version number
Auxiliary and ancillary files
Temporal coverage
Spatial Coverage
CCD Readout Discipline
CCD Readout Discipline Statistics (Global data products only)
Binning Factor
Co-addition factor
Integration time
DEM gain (factor and column)
ELU gain
ELU mode
Number of binned dark/smear rows
Number of skipped rows
Number of binned rows read
Number of readout register pixels skipped
Number of pixels per binned row read
Folding Mirror position
Solar port open/closed
Diffuser Position
WLS state
LEDs state
Day/night flag
Small pixel data column numbers
Quality Flag Statistics
Number of measurements

Radiance Data

Radiance Data
Small Pixel Data
Wavelength information
Quality Flags
CCD Readout Discipline

Geolocation Data

Latitude
Longitude
Time
Terrain Height
Solar Zenith Angle
Solar Azimuth Angle
Line-of-sight Zenith Angle
Line-of-sight Azimuth Angle
Spacecraft Latitude
Spacecraft Longitude
Spacecraft Altitude
Land/Sea/Ice flag
Sunglint flag

4. Packing of Data

The efficient packing of the data considerably reduces the costs for archiving and transportation. The bulk of the OMI data are the radiances and their precisions. If stored as 4 byte reals, the radiances and their precisions use 8 byte per (binned and co-added) pixel. Several options were investigated to store the information in less bytes. The packing method that uses the least bytes, without losing significant information is to store the mantissa of the radiance, the mantissa of the radiance precision and a shared exponent. (For example $469.7 \pm 1.1 \cdot 10^9$ is stored as 4697 (mantissa radiance, 2 byte integer), 11 (mantissa precision, 2 byte integer), 8 (shared exponent, 1 byte integer). In total 5 bytes are used to store the radiance and its precision, which is a reduction of 37.5% compared to the 8 bytes needed if stored as reals.

Each pixel of OMI data has its own wavelength registration. However, the result of the wavelength calibration algorithm of the Level 0→1B GDPS is a fourth order polynomial describing the relation between pixel number and the wavelength. This information is present for each pixel in the swath and for each of the channels. In the Level 1B radiance products, the five coefficients and their variances of the fourth order polynomials are stored.

5. Product Size

Based on the detailed definition given in appendix A, the size of the products for global modes are estimated as 500 MB for the UV product and 620 MB for the VIS products. These estimates are based on 2000 measurements per orbit, assuming 2/3 of the orbit to be sunlit. As the total number of entries is approximately the same, the size of the zoom mode products will only be slightly larger. The increase is caused by more geolocation information and more small pixel data.

6. Summary

The following are the major aspects concerning the OMI Level 1B radiance product:

1. The OMI Level 1B radiance product shall be orbit based
2. There shall be separate products for the UV and the VIS channels
3. Data from special measurement modes is stored as special products
4. Data from special measurement modes are re-binned to, and stored in, the global mode product

APPENDIX A Detailed Product Definition

UV PRODUCTS

Product short name:	Name convention OMu<ReadoutID>R1, OMu01R1B Global OMu02R1B Spectral zoom-in OMu03R1B Spatial zoom-in	
Product long name:	OMI/Aura Level 1B for UV-1 and UV-2 channel	
Product description:	This product contains the geolocated backscattered radiances for the OMI UV-1 (270-314 nm) and UV-2 (306-380 nm) channels. Also contained in this products are the Solar zenith and azimuth angles and viewing zenith and azimuth angles.	
Data format:	HDF-EOS	
Data structure	Simple swath structures for UV-1 and UV-2. Name UV1radiance, UV2radiance	
Dimensions in swath	nTimes	number of measurements
	nXtrack	number of OMI swath angles
	nWavel	number of wavelengths
	nTimesSmallPixel	number of small pixel data
	nWavelCoef	number of wavelength coefficients

VIS PRODUCTS

Product short name:	Name convention OMv<ReadoutID>R1, OMv01R1B Global OMv02R1B Spectral zoom-in OMv03R1B Spatial zoom-in	
Product long name:	OMI/Aura Level 1B for VIS channel	
Product description:	This product contains the geolocated backscattered radiances for the VIS channel (350 – 500 nm). Also contained in this products are the Solar zenith and azimuth angles and viewing zenith and azimuth angles.	
Data format:	HDF-EOS	
Data structure	Simple swath structures for VIS. Name VISradiance	
Dimensions in swath	nTimes	number of measurements
	nXtrack	number of OMI swath angles
	nWavel	number of wavelengths
	nTimesSmallPixel	number of small pixel data
	nWavelCoef	number of wavelength coefficients

SWATH CONTENTS

Metadata

Core Metadata
Product Specific Metadata

Radiance data

RadianceMantissa	(nTimes,nXtrack,nWavel)	2 byte integer
RadiancePrecisionMantissa	(nTimes,nXtrack,nWavel)	2 byte integer
RadianceExponent	(nTimes,nXtrack,nWavel)	1 byte integer
WavelengthCoefficient	(nTimes,nXtrack,nWavelCoef)	4 byte real
WavelengthCoefficientPrecision	(nTimes,nXtrack,nWavelCoef)	4 byte real
UVsmallPixelRadiance ¹	(nTimesSmallPixel,nXtrack)	4 byte real
VISsmallPixelRadiance ¹	(nTimesSmallPixel,nXtrack)	4 byte real
UVsmallPixelWavelength ¹	(nTimesSmallPixel,nXtrack)	4 byte real
VISsmallPixelWavelength ¹	(nTimesSmallPixel,nXtrack)	4 byte real
AutomatedFlags ²	(nTimes,nXtrack,nWavel)	2 byte integer
ReadOutDiscipline ³	(nTimes,nXtrack)	1 byte integer

Geolocation

Time ⁴	(nTimes)	8 byte double
SecondsInDay ⁴	(nTimes)	4 byte float
Latitude	(nTimes,nXtrack)	4 byte real
Longitude	(nTimes,nXtrack)	4 byte real
Terrain Height	(nTimes,n Xtrack)	2 byte integer
SolarZenithAngle	(nTimes,nXtrack)	4 byte real
SolarAzimuthAngle	(nTimes,nXtrack)	4 byte real
LOSzenithAngle	(nTimes,nXtrack)	4 byte real
LOSazimuthAngle	(nTimes,nXtrack)	4 byte real
SpacecraftLatitude	(nTimes)	4 byte real
SpacecraftLatitude	(nTimes)	4 byte real
SpacecraftLongitude	(nTimes)	4 byte real
SpacecraftAltitude	(nTimes)	4 byte real
GeoFlags ²	(nTimes,nXtrack)	2 byte integer

- 1) not in UV-1 swath
- 2) used for bitwise flag storage: 2 byte integer contains 16 flags.
- 3) Global measurement mode only.
- 4) Time is in TAI format (as required by HDF-EOS), SecondsInDay is in UTC format.