OMI Surface Reflectance Climatology README

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Prepared: Quintus Kleipool
Approved: Pepijn Veefkind

Overview

Retrieval of trace gases and cloud and aerosol properties in the Earth's atmosphere requires an accurate determination of the surface reflectance, often expressed as the Lambert Equivalent Reflectance (LER). This LER is defined as the required reflectance of an isotropic surface needed to match the observed top of the atmosphere (TOA) reflectance in a pure Rayleigh scattering atmosphere under cloud free conditions and no aerosols. The climatology product consists of global maps of the Earth's surface LER value at 23 wavelengths in the range 309—500 nm at a spatial resolution of 0.5 by 0.5 degrees. The LER is given for each calendar month, and a yearly minimum value is also provided. Both values are derived using two distinctly different methods. The first method is based on taking the absolute minimum value of all observation, while the second method uses a statistical analysis based on the temporal histograms of all observations. The first method is consistent with the methods used by Herman et al. [1997] (HC97) and Koelemijer et al. [2003] (KHS03). The second method has been introduced to address alleged issues in the former two data sets that led to underestimates of specific scene's reflectivity. The general approach is to build histograms of the various LER values that are observed in time over a certain ground scene. Cloudy observations will then populate the higher part of the histogram while the lower parts of the histograms are due to cloud-free conditions. Using a statistical algorithm the ground scene's LER is onwards determined from the histogram. The histograms for each ground scene are build using five years of OMI data, obtained between January 2005 and December 2009, both months included.

Algorithm Description

This is the second release of the data product. This update was made in order to include more OMI measurements than the original 3.5 years that was used in the first release. The current release uses 5 years of OMI data. Some modifications have also been made to the analysis software, however, the basic concept and approach are similar to the first release which is described in Kleipool et al. [2008].

Changes Since the Previous Release

The following sections will only describe the modifications with respect to the first release.

Date Range

The new release uses data acquired between January 1, 2005 to December 31, 2009. The total data range covers 5 complete years.

Histogram Filtering

Data affected by the row anomaly is discarded. Histograms are smoothed to reduce a noisy effect when calculating the mode of the histograms. In order to remove outliers, leading and trailing spurious measurements are removed from the histograms.

Row Anomaly

In the absence of measures against the effects of the row anomaly, all rows affected are deleted. In addition, all measurements, in which the surface reflectance at any wavelength is negative, are discarded. The following rows are cumulatively discarded in time:

- after 2007/06/25 rows 53 - 54
- after 2008/05/11 all aforementioned rows and 37 – 44 as well
- after 2009/01/24 all aforementioned rows and 27 – 44 as well

Methods of Histogram Analysis

The number of methods used to analyze the histograms is reduced. The new methods and flags are given in Table 3.

Digital Elevation Map

The land type map by De Fries is no longer used. The current release uses the Digital Elevation Map and land type map provided in the Level 1b data. This map is used solely to distinguish between land and water.

Nominal Ice and Snow Extent

The NISE data provided in the Level 1b is used to distinguish between permanent ice, snow and sea ice. Because the NISE map is not always completely accurate, the algorithm combines histogram information with the NISE data to detect snow.

Post Processing

No filtering is applied for cloudy land and cloudy water, in contrast to the previous version. This improves the seasonal dependence. The bad values filter only replaced 9.18% of all pixels

Residual Cloud Contamination

Forest scenes have surface reflectance values in the range of 0.04 to 0.06. In order to derive these values the cloud fraction must be very small. For example, assuming that the surface has a reflectivity of 0.05 and that the cloud has a reflectivity of 0.80, then the observed scene reflectance will be 0.125 at a 10% cloud fraction. The chance of obtaining an image over the Brazilian Amazon with less than 10% cloud cover is as low as 40% on an annual basis as reported by Asner [2001] , who studied cloud cover using Landsat data. The Northern parts of the Amazon are even unattainable at the 10% level according to this study, even at the 30 meter resolution of the Landsat imagers.

The observed cloud contamination over rain forest scenes in this product will reduce when more OMI data become available, but cloud contamination can never be completely avoided. Even though the derived LER values are too high to be caused by the underlying surface reflectance, they show that these clouds or ground mist patches are persistent and therefore could be considered to be an estimate of the scene's reflectance, representing a climatologically weighted average between ground and cloud reflectivity.

contact information

The primary contact for this product is :

Quintus L. Kleipool

Royal Dutch Meteorological Institute (KNMI)
Wilhelminalaan 10
3732 GK De Bilt
The Netherlands

tel: +31 30 2206573 / +31 30 2206 911
fax: +31 30 2210407
email: Kleipool@knmi.nl

Product Description

Product Long Name:
OMI/Aura Surface Reflectance Climatology Level 3 Global 0.5deg Lat/Lon Grid

Product Short Name:
OMLER

File Name Convention

<InstrumentId>	OMI-Aura
<DatatType>	L3-OMLER
<DataId>	2005m01-2009m12
<ProductCollection>	v003
<ProductionDateTime>	YYYYmMMDDtHHMMSS
<Version>	<ProductCollection>-<ProductionDateTime>
<Suffix>	he5

File Name:
<InstrumentId>_<DatatType>_<DataId>_<Version>.<Suffix>

Example:
`OMI-Aura_L3-OMLER_2005m01-2009m12_v003-2010m0503t063707.he5`

File Format:
HDFEOS5-grid

File Contents:
The product consists of a single grid named:
`EarthSurfaceReflectanceClimatology`

An overview of the data fields defined for this grid are given in Table 2. The monthly fields contain the climatology of the surface reflectance for each calendar month based on a three year period. The yearly fields contain the minimum observed value over the corresponding twelve months. Both the yearly and the monthly fields are derived using two methods. Those fields indicated with 'minimum' are based on the minimum value of the histograms; this method is consistent with the methods used by HC97 and KHS03. The other fields ('MonthlySurfaceReflectance' and 'YearlySurfaceReflectance') are based on a statistical analysis of the histograms. This approach leads to higher values over snow and ice covered scenes, as well as higher values over bare land types. An overview of the flags defined for the reflectance data fields in this grid are given in Table 3. These flags are only relevant for the 'MonthlySurfaceReflectance' and 'YearlySurfaceReflectance' fields.

References

Asner, G. P. (2001), Cloud cover in Landsat observations of the Brazilian Amazon, Int. J. Remote Sensing, Vol. 22, No. 18, pp. 3855—3862.

Herman, J. R. and E. A. Celarier (1997), Earth Surface reflectivity climatology at 340 – 380 nm from TOMS data, Journal of Geophysical Research, Vol. 102, No. D23, pp 28,003 – 28,011.

Kleipool, Q. L., M.R. Dobber, J.F. De Haan and P.F. Levelt (2008), Earth Surface Reflectance Climatology from Three Years of OMI Data, Journal of Geophysical Research, doi:10.1029/2008JD010290.

Koelemeijer, R. B. A., J. F. de Haan and P. Stammes (2003), A database of spectral surface reflectivity in the range 335-772 nm derived from 5.5 years of GOME observations, Journal of Geophysical Research, 108(D6), 4070, doi:10.1029/2002JD002429.

wavelength	source	purpose
309.3	UV2	calibration (0)
312.0	UV2	calibration (0)
320.0	UV2	delta ozone correction (0)
328.1	UV2	ozone (1)
335.0	UV2	ozone (2)
342.5	UV2	aerosol (1)
345.4	VIS	LER
354.0	VIS	aerosol (3)
367.0	VIS	aerosol (3)
372.8	VIS	LER (3)
376.5	VIS	calibration (3)
380.0	VIS	calibration (1) (2) (3)
388.0	VIS	aerosol
406.0	VIS	aerosol
416.0	VIS	aerosol (2)
418.2	VIS	LER
425.5	VIS	aerosol
440.0	VIS	NO_2 (2)
442.0	VIS	aerosol
452.0	VIS	aerosol
463.0	VIS	O_2-O_2, aerosol (2)
471.0	VIS	MODIS, aerosol
477.5	VIS	O_2-O_2, aerosol
488.0	VIS	aerosol
494.5	VIS	O_2-O_2, (2)
499.3	VIS	LER

Table 1: Wavelength bands for the surface reflectance. Wavelengths indicated with (0) have been calculated, but are not in the product. (1) identifies wavelengths that are also in the HC97. (2) identifies wavelengths that are also in KHS03. (3) indicates that the wavelength is also measured in the UV2 channel.

Data Field	Dimensions	Type	offset	scale factor
YearlySurfaceReflectance	Wavelength, Latitude, Longitude	INT16	0.0	0.001
YearlyMinimumSurfaceReflectance	Wavelength, Latitude, Longitude	INT16	0.0	0.001
YearlySurfaceReflectanceFlag	Latitude, Longitude	UINT8	n/a	n/a
MonthlySurfaceReflectance	Month, Wavelength, Latitude, Longitude	INT16	0.0	0.001
MonthlyMinimumSurfaceReflectance	Month, Wavelength, Latitude, Longitude	INT16	0.0	0.001
MonthlySurfaceReflectanceFlag	Month, Latitude, Longitude	UINT8	n/a	n/a
Wavelength	Wavelength	FLOAT32	n/a	n/a
Longitude	Longitude	FLOAT32	n/a	n/a
Latitude	Latitude	FLOAT32	n/a	n/a

Table 2: Data fields defined for the product.

Code	Description
255	NOT_ENOUGH_DATA
250	PERMANENT_ICE
240	SEA_ICE
230	SNOW
220	CLOUDY_WATER
210	CLEAR_WATER
195	CLOUDY_LAND
185	CLEAR_LAND
175	OTHER
100	OUT_OF_RANGE
090	NO_MATCH

Table 3: Flags defined in the product for the reflectance fields.