OMTO3 README File

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Overview

This document provides a brief description of the OMTO3 data product. OMTO3 comprises total ozone, aerosol index, and ancillary information produced from the TOMS Version 8.5 (V8.5) algorithm applied to OMI "global mode" measurements. In the global mode each file contains a single orbit of data. In each orbit OMI measurements cover approximately 2600 km wide cross-track swath from pole to pole (sunlit portions only). Currently, OMTO3 products are not produced when OMI goes into the "zoom mode" for one day every 32 days.

The accuracy and precision of the OMTO3 total ozone data is similar to the legacy Total Ozone Mapping Spectrometer (TOMS) data started in 1978, except over cloudy areas where OMTO3 data are more accurate than that of the TOMS. Since there are significant differences between the two products over cloudy areas, users should exercise caution in combining TOMS data with OMTO3 data for long- term trends. The TOMS project is planning to reprocess the entire TOMS record to make the dataset more consistent with OMTO3.

Algorithm Description

The basic algorithm uses 2 wavelengths (317.5 and 331.2 nm under most conditions, and 331.2 and 360 nm for high ozone and high solar zenith angle conditions). The longer of the two wavelengths is used to derive effective cloud fraction (fc) based on the Mixed Lambert Equivalent Reflectivity (MLER) model [Ahmad et al 2004] that was developed to model the effect of clouds on Rayleigh scattering. When fc becomes less than zero or when there is snow/ice, we assume that no cloud is present and use the Lambert Equivalent Reflectivity (LER) model described by Ahmad et al [2004] to derive the clear scene reflectivity R. When fc exceeds 1 we assume100% cloud cover and derive cloud reflectivity using the LER model. Given the fc/R the shorter (stronger ozone-absorbing) wavelength is used to derive total ozone.

An important difference between the V8.5 algorithm and previous versions, as well with the archived TOMS dataset, is the assignment of effective cloud height. It has been assumed in the previous algorithms that the absorption of backscattered solar radiation essentially stops at the cloud-top level when the clouds are optically thick. To estimate the total column amount, the "un-measured" column below the cloud-top (computed using climatology) is added to the measured column. Recent analysis of the OMI data in conjunction with CloudSat radar data [Vasilkov et al 2008] indicates that this assumption is invalid. Mie scattering calculations using CloudSat data indicate that in all cloudy scenes, including deep convective clouds, the UV radiation received at the satellite is sensitive to the ozone column below the nominal cloud-top pressure reported by thermal infrared sensors such as MODIS. Analysis shows that photons actually penetrate some distance into a cloud. In V8.5, we use the Radiative Cloud Pressure (RCP) inferred from Rotational-Raman Scattering

http://daac.gsfc.nasa.gov/Aura/OMI/omcldrr_v003.shtml

to derive the total column ozone. Since the pressure corresponding to RCP is usually significantly below the cloud-top pressure climatology assumed in the V8 algorithm, the V8.5 derived column amounts have decreased over clouds. The magnitude of the decrease depends on cloud fraction, location, and solar zenith angle. Please refer to release details at

http://jwocky.gsfc.nasa.gov/omi/OMTO3_Release_Details_v8_5.pdf

The effective cloud fraction (fc) derived from the MLER model is used to estimate the Radiative Cloud Fraction (RCF). RCF characterizes the fraction of measured radiation that is scattered by clouds. Mie scattering calculations indicate that the clear and cloudy ozone columns weighted by RCF provides a value very close to what one would get if one were to use the plane parallel Mie cloud model with the independent pixel approximation to account for mixed scenes. The advantage of the MLER model is that one doesn't need independent knowledge of geometrical cloud fraction to calculate the ozone column accurately in cloudy scenes

The algorithm also calculates the absorbing Aerosol Index (AI) from the radiance residuals at 360 nm. The AI is useful for tracking global transport of smoke and dust, for it can track these aerosols above and through clouds, as well as over snow/ice covered surfaces. Various studies have indicated that AI is very nearly proportional to the aerosol absorption optical depth at 360 nm. However, the proportionality constant varies with the altitude (of the center of mass) of the aerosol layer- the lower the altitude the smaller the constant. Most aerosols have stronger absorption in the UV than in the visible, including mineral dust from deserts and carbonaceous aerosols containing organic and black carbon. Since the AI is also affected by the spectral dependence of surface albedo caused by sea-glint and water–leaving radiance, and since there are residual errors in the MLER model in estimating Rayleigh scattering in presence of clouds, we recommend that only the AI values larger than +1 should be used for aerosol studies and areas contaminated by sea-glint should be avoided completely. Since absorbing aerosols cause the ozone derived from the basic algorithm to be overestimated, a parametric relationship based on AI is used to correct the ozone column derived from the basic algorithm. This relationship also appears to remove a large portion of errors caused by sea-glint.

Other than the three primary wavelengths mentioned above, the OMTO3 algorithm uses additional wavelengths for quality control and error correction in more restricted geophysical situations. These include correction for ozone profile shape errors at large solar zenith angles using 312.5 nm measurements, and the detection of strong sulfur-dioxide contamination using multiple wavelength pairs. For a more detailed description of the algorithm please refer to the Algorithm Theoretical Basis Document (ATBD) on http://eospso.gsfc.nasa.gov/eos_homepage/for_scientists/atbd/viewInstrument.php?instrument=13. This website contains a description of the most recent updates to the algorithm, along with other related documents related to this algorithm.

This algorithm is one of the two algorithms that derive total ozone values from OMI. The other is an algorithm based on the Differential Optical Absorption Spectroscopy (DOAS) approach that takes advantage of OMI's hyperspectral measurements. The DOAS algorithm is maintained by KNMI/The Netherlands. The DOAS ATBD is also on the above website. After the recent reprocessing of both data sets (Collection 3), the two datasets are in much better agreement than before, though some differences still exist in high latitudes and over snow/ice.

Data Quality Assessment

Overall the quality of total ozone and AI data produced by OMTO3 is similar to that from TOMS, except for cloudy observations, as discussed earlier. Based on experience with TOMS, the total ozone data provided in OMTO3 should have a root-mean squared error of 1-2%, depending on solar zenith angle, aerosol amount, and cloud cover. These errors are best described as pseudo-random: systematic over small areas with a unique geophysical regime, random over large areas containing a mixture of geophysical regimes. Preliminary analyses show that OMTO3 data compare about as well with Dobson and Brewer stations as did Nimbus-7/TOMS data. (The overall quality of EP/TOMS data is poorer compared to both Nimbus-7 TOMS and OMI. The EP/TOMS total ozone data have been reprocessed recently by applying an empirical correction, based on internal consistency criteria for ozone and surface reflectivity and comparisons with NOAA/SBUV-2 data, to remove the effect of several poorly understood instrument anomalies. The AI data from EP/TOMS, however, have not yet been corrected).

Product Description

A 2600 km wide OMI swath contains 60 pixels. Due to optical aberrations and small misalignment between the instrument optic axis with the spacecraft nadir, the pixels on the ground are not symmetrically aligned on the line perpendicular to the orbital plane. However, the latitude and longitude provided with each pixel represent the location of the center of each pixel on the ground to a fraction of a pixel.

The OMTO3 product is written as an HDF-EOS5 swath file. For a list of tools that read HDF-EOS5 data files, please visit these links:

http://disc.gsfc.nasa.gov/Aura/tools.shtml,
http://hdfeos.net/

A single OMTO3 file contains information retrieved from each OMI pixel over the sun-lit portion of one Aura orbit. The data are ordered in time. The information provided in these files includes latitude, longitude, solar zenith angle, reflectivity and total column

ozone, aerosol index, radiative cloud fraction and radiative cloud pressure from OMCLDRR algorithm, and a large number of ancillary parameters to assess data quality. The most important of these parameters is the "QualityFlags" field, which contains the processing error flag in its first byte. Most users should use data with a data quality flag = 0 (good sample) or 1 (glint contamination corrected) only. For a complete list of the parameters, please read the file specification:
http://toms.gsfc.nasa.gov/omi/OMTO3FileSpec.fs

For users not interested in the detailed swath information provided on OMTO3 level 2 dataset we are providing several gridded products. Presently, we grid OMTO3 data in a format similar to that used for TOMS (1˚ x 1˚ lat/long) and it is available through the TOMS website http://toms.gsfc.nasa.gov. However, to take advantage of the higher spatial resolution of the OMI products we also produce higher resolution gridded products for OMI datasets, including OMTO3. In addition, we make OMTO3 level 2 data available in a geographically ordered (rather than time-ordered) format http://daac.gsfc.nasa.gov/Aura/OMI/omto3g_v003.shtml that can be more easily subsetted and manipulated on-line prior to ordering. Please check the Goddard web site http://disc.gsfc.nasa.gov for current information on these products.

Full OMTO3 data, as well as subsets of these data over many ground stations and along Aura validation aircraft flights paths are also available through the Aura Validation Data Center web site (AVDC) at http://avdc.gsfc.nasa.gov to those investigators who are associated with the various Aura science teams. Bojan Bojkov (mailto:Bojan.R.Bojkov@nasa.gov)is the point of contact at the AVDC.

For questions and comments related to the OMTO3 algorithm and data quality please contact Kai Yang (mailto:Kai.Yang-1@nasa.gov). P.K. Bhartia mailto:Pawan.Bhartia@nasa.gov has the overall scientific responsibility for this product.

Reference

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