OMO3PR README

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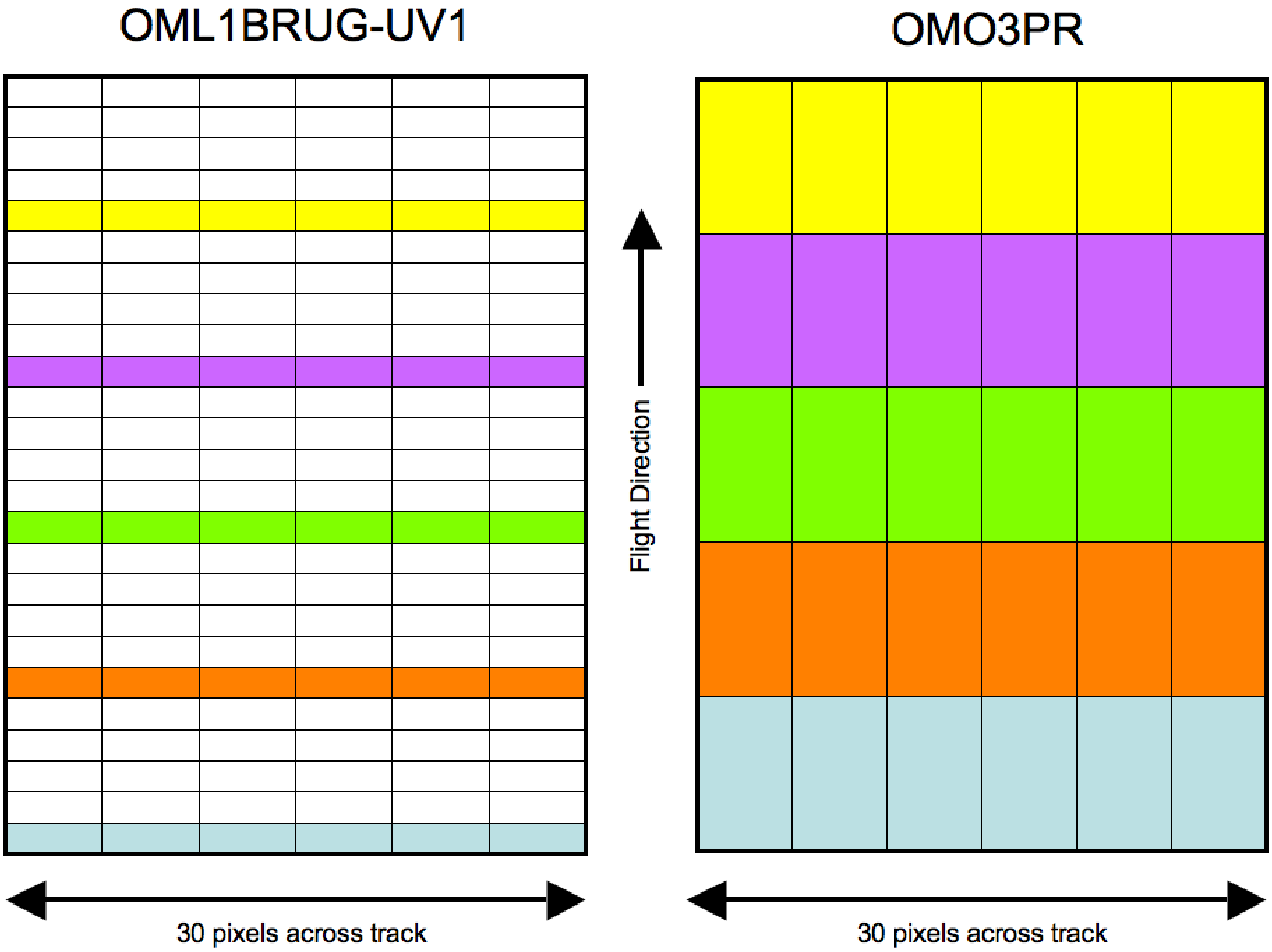
Overview

This document provides a brief description of the OMO3PR data product. OMO3PR contains the retrieved ozone profile and the corresponding a-priori ozone profile, error covariance matrix and averaging kernel. Further it contains ancillary information produced by the optimal estimation algorithm applied to OMI global mode measurements. An OMO3PR data file contains the measurements of the sunlit part of a single orbit, from the South to the North Pole. The OMI swath width is approximately 2600 km.

The ozone profile is given in terms of the layer-columns of ozone in DU for an 18-layer atmosphere. The layers are nominally bounded by the pressure levels: [surface pressure, 700, 500, 300, 200, 150, 100, 70, 50, 30, 20, 10, 7, 5, 3, 2, 1, 0.5, and 0.3 hPa.

In view of the calculation times involved about 20% of the pixels are processed. As shown in Figure 1, four out of five measurements in the flight direction are skipped.

Figure 1. *Schematic showing the sampling of the OML1BRUG UV1 data by the OMO3PR algorithm. In the flight direction OMO3PR processes one row of groundpixels and skips the next four. In the across track direction all 30 groundpixels are processed. The colors indicate the same rows for OML1BRUG and OMO3PR, white rows are skipped by OMO3PR.*



The ozone profile listed in the output file is in DU per layer. This can easily be converted to an average volume mixing ratio per layer using

<vmr>i = 1.2672 Ni / DPi

with Ni the layer-column in DU, DPi the pressure difference between the top and bottom of the layer in hPa and <vmr>I the average volume mixing ratio in ppmv.

In version 1.1.0 the temperatures and the altitudes at the interfaces between the layers are given in addition to the pressures.
You may refer to release specific information about OMO3PR for details about the software versions.

Algorithm Description

The retrieval algorithm is based on optimal estimation (Rodgers, 2000) with climatological a-priori information. Basically the amount of ozone in each atmospheric layer is adjusted such that the difference between the modeled and measured sun-normalized radiance is minimal. As the information content in the measured spectrum is not large enough to determine the ozone amount for all of the layers, a side-constraint is used by demanding that the retrieved profile does not differ too much from the climatological average. The measurements are taken from the UV1 channel (270 nm – 308.5 nm) and the first part of the UV2 channel (311.5 nm – 330 nm). Here two UV2 pixels are combined to obtain the spectrum of a pixel that corresponds to a pixel in the UV1 channel. Small differences in alignment are dealt with by assuming that the surface albedo or cloud albedo for the two channels can be different.

The algorithm uses the newly developed LABOS radiative transfer model, which replaces the 4/6 stream Lidort-A model that is currently used for GOME and GOME 2. LABOS includes an approximate treatment of rotational Raman scattering, pseudo spherical correction for direct sunlight, and corrections for the initial assumption that the atmospheric layers are homogeneous. Polarization is ignored in the RTM calculations and a LUT with polarization correction factors is used to compensate for this. Forward calculations are performed in the wavelength range 267 – 332 nm on a sufficiently fine grid such that after interpolation the error in the reflectance is less than about 0.2% for any wavelength considered. This facilitates convolutions with rotational Raman lines and convolutions with the OMI slit function after multiplication with a high-resolution solar spectrum. A Chebyshev expansion combined with a LUT is used to perform the convolution with the OMI slit function in an efficient manner.

The surface below the atmosphere is Lambertian and has an initial value taken from a surface albedo climatology. Depending on a threshold value for the cloud fraction, taken from taken from the OMCLDO2 algorithm, either the surface albedo or the cloud fraction (version 1.0.5) or cloud albedo (version 1.1.0) is fitted. Fitting the cloud albedo gives the algorithm more freedom to deal with optically thick clouds that cover the entire pixel.

As the residue of the fit contained clear Fraunhofer features for version 1.0.5, it was decided to fit stray light separately in the two spectral channels, which has been implemented in version 1.1.0.

The measurement errors used in optimal estimation are taken from the level 1b product. The Fortuin-Kelder climatology is used as a-priori in version 1.0.5, but is replaced by a-priori profiles taken from the McPeters and Labow climatology, a constant a-priori error, and a correlation lengths of 6 km for version 1.1.0 An exception holds for ozone hole conditions where a different a-priori error covariance matrix is used (see release specific information).

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Data Quality Assessment

The OMO3PR data have been assessed using MLS stratospheric ozone profiles and OMDOAO3 total ozone data. The tropospheric information has not been validated. *It is recommended to be extremely cautious with any conclusions on tropospheric ozone based on these data.*

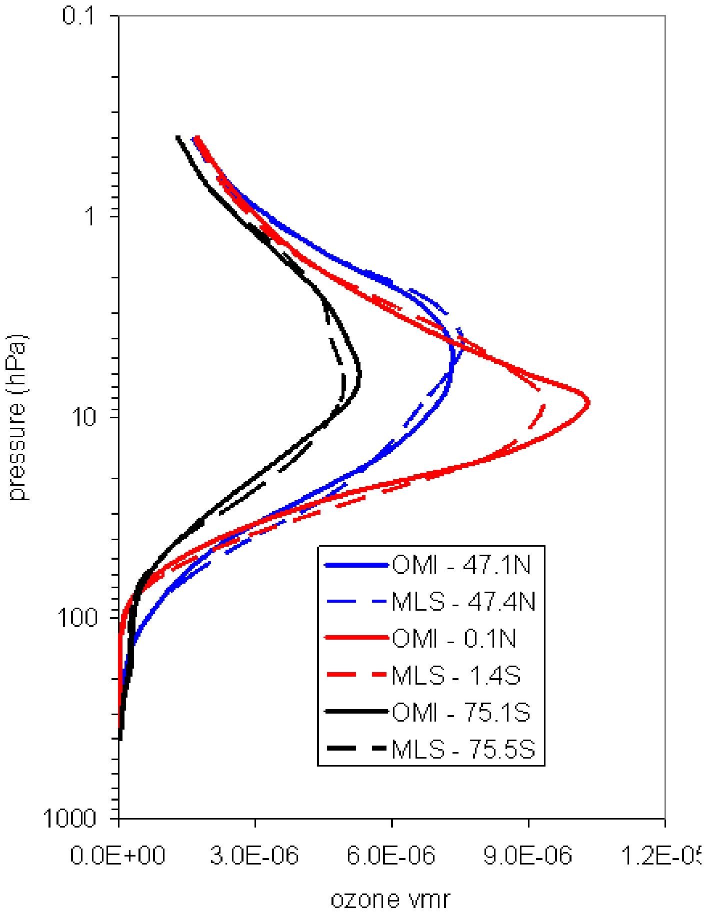
Comparison with MLS

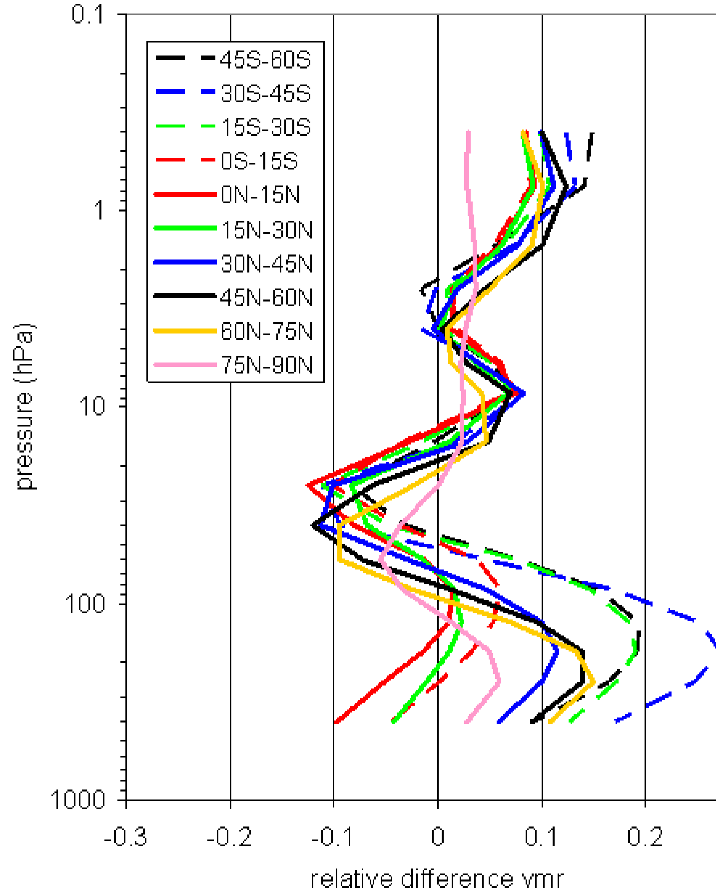
A comparison of the OMO3PR with MLS stratospheric ozone profile data can be found in a separate document. Figure 2 shows an example of comparisons with MLS for August 1, 2007.The main conclusions of these comparisons are:

1. Overall the OMO3PR optimal estimation results are as expected from simulated results. The averaging kernels are well behaved in the stratosphere. In the troposphere the averaging kernels are broad and approximately one piece of independent information is available for the troposphere. In the upper troposphere and lower stratosphere little profile information is contained in the UV spectrum.
2. Comparison with MLS for the pressure range up to 400 hPa (cf. Figure 2) show that the OMO3PR results agree very well with the MLS profiles. There remain some oscillations in the differences between the profiles, but the amplitude of these oscillations is reduced significantly compared to previous versions of OMO3PR, mainly due to the fitting of stray light and a change in the a-priori climatology. Relatively large differences occur for pressures of 100 – 200 hPa in the southern hemisphere, possibly due to differences in the a-priori climatology. The OMO3PR and MLS integrated ozone columns from the TOA until 300 hPa agree within a few percent.
3. The results presented in this document focus on the stratospheric profile and the total column. The tropospheric sub-column has not been evaluated.

Figure 2. Left: *Comparison of retrieved profiles from OMI (solid) and MLS (dashed) for three latitudes for OMI orbit 6754 in week 42 2005. The black curves pertain to a part of the ozone hole. The latitudes used are listed in the legend.* ***Right****: Average relative differences between ozone profile retrieved from OMI and MLS for week 30 2005 (OMI orbits 5428 – 5529). Results are given for different latitude bands and solid lines are for the northern hemisphere while dashed lines are for the southern hemisphere. For each latitude band about 2000 co-locations*

were used, except for 45S-60S where 681 co-locations were used.





Performance for Ozone Hole Conditions

In version 1.0.5 the Gasuss-Newton iteration method was used which converges very slowly if the a-priori differs strongly from the true profile, as happens often during ozone hole conditions. In version 1.1.0 a modified Levenberg-Marquardt iteration scheme is used which converges much faster when the a-priori differs strongly from the true profile. This led to a considerable improvement of the performance during ozone hole conditions.

Performance over Absorbing Aerosol Layers

Over elevated absorbing aerosol layers the ozone profile retrieval will put too much ozone in the troposphere. Therefore it is not recommended to use these data. The absorbing aerosol index can be used to identify such absorbing aerosol layers.

OMI Row Anomaly

Three anomalies (first starting June 25 2007, second starting May 11 2008, and third starting January 24 2009) have been observed in the OMI Measurements. The anomalies have been investigated. The ozone profiles can still be used, but only for those profiles where the field "refectanceCostFunction" in the OMO3PR product file has a value smaller than 30. Hence, it is essential to filter on this field, which is an excellent indicator of row anomaly issues.

Product Description

The OMO3PR product is written as an HDF-EOS5 swath file. The main parameters listed in the output product are: ozone profile, ozone profile error covariance matrix, ozone The main parameters listed in the output product are: ozone profile, ozone profile error covariance matrix, ozone a-priori profile, ozone a-priori error covariance matrix, ozone averaging kernel, number of iterations, pressure levels for the layers, temperatures at the interfaces between the layers, altitude grid for the layers, latitude, longitude, viewing direction and solar position.

A single file contains approximately 330 OMI measurements of 30 ground pixels each. Thus the data fields have a dimensions of approximately 330 in the flight direction, 30 in the across track direction and 18 pressure levels.

In order to reduce the file size some data is written as integer. Scaling information is provided by the attributes (part of properties) of a certain output field. The overall settings for the processing can be found under 'Additional', 'FILE_ATTRIBUTES', and the attributes of the properties. There the OPF (operational parameter file) settings are listed.

Detailed information about the various fields can be found in the file specification document