

OMPS Limb Profiler Aerosol Extinction Product AER675: Version 0.5 Data Release Notes

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Introduction

The Ozone Mapping and Profiler Suite (OMPS) Limb Profiler (LP) on the Suomi NPP satellite views the Earth's limb looking backwards along the orbit track, using three parallel vertical slits. One slit is aligned with the orbit track, and the other two slits are pointed 4.25° to each side, giving an effective cross-track separation of approximately 250 km at the tangent point. Each profile measurement takes approximately 19 seconds to complete, corresponding to along-track sampling of approximately 125 km. OMPS LP uses a 2-dimensional CCD detector that records atmospheric spectra covering the wavelength range 290-1000 nm at 1 km altitude intervals between 0 km and 80 km. These spectra are primarily used to retrieve vertical profiles of ozone and aerosol extinction coefficient. Additional description of the LP instrument is given in *Jaross et al.* [2014].

We have developed a new aerosol extinction coefficient retrieval algorithm for use with OMPS LP measurements. This algorithm applies a version of the Chahine non-linear relaxation technique [*e.g.* Chahine, 1968] to retrieve the aerosol extinction profile from radiance measurements at 675 nm. We construct aerosol scattering index (ASI) values to use in the retrieval, where ASI represents the difference between measured radiance and calculated radiance assuming a “clean” atmosphere:

$$\text{ASI}(\lambda, z) = [I_{\text{meas}}(\lambda, z) - I_{\text{Ray}}(\lambda, z)] / I_{\text{Ray}}(\lambda, z) \quad [1]$$

I_{Ray} is calculated assuming a pure Rayleigh scattering atmosphere, bounded by a Lambertian reflecting surface at 1013 hPa. The Lambert-equivalent reflectivity (LER) is calculated using $I_{\text{meas}}(675 \text{ nm}, 45.5 \text{ km})$ and assuming no aerosol scattering. The maximum LER value is set to 1.0. A single-mode log-normal size distribution is assumed, with mode radius $r_0 = 60 \text{ nm}$ and mode width $\sigma = 1.73$. Aerosol particles are assumed to be sulfate droplets with refractive index $s = 1.448 + 0i$. Atmospheric pressure and temperature profiles used in this retrieval algorithm are derived from NASA GSFC Global Modeling Assimilation Office (GMAO) Forward Processing-Instrument Team (FP-IT) GEOS 5.9.1 data. The nearest spatial grid point ($\Delta\text{latitude} = 0.5^\circ$, $\Delta\text{longitude} = 0.625^\circ$) to each LP profile is identified, and the temperature and pressure profiles for time steps bracketing the LP measurement ($\Delta t = 3 \text{ hours}$) are interpolated to the observation time. The solar irradiance spectrum is constructed from ATLAS-3 SUSIM data [Cebula et al., 1996] for 290-410 nm, and Kitt Peak National Observatory measurements [Chance and Kurucz, 2010] for 410-1000 nm.

The *a priori* data set for the aerosol retrieval is a single average extinction coefficient profile derived from SAGE II data between 20°S and 20°N , where data between May 1991 and August 1996 were excluded due to contamination from the Mt. Pinatubo eruption. These data

are used as the first guess in the aerosol retrieval, which is limited to a maximum of 3 iterations. The maximum extinction coefficient change between successive iterations is limited to a factor of 5 (either larger or smaller).

We have created a test OMPS LP aerosol product for evaluation purposes, called AER675, that covers the period January 2012 – December 2015. This product is designated as Version 0.5 (V0.5) to make its interim status clear to the user. Extinction coefficient profiles are provided over the altitude range 0.5-40.5 km at 1 km intervals. The presence of a cloud for any given profile is determined using the detection algorithm described in *Chen et al.* [2015, under review]. Additional information about the contents of the AER675 data set is given in the Product Description document available on this web site. Evaluation of other LP data products created from current LP Level 1 gridded (L1G) data suggests that the stray light correction functions can be improved at visible and near-IR wavelengths. For the creation of the AER675 product, an empirical adjustment was applied to the 675 nm radiance data between 30-55 km, using the following definition:

$$I_{\text{corr}}(675 \text{ nm}, z) = I_0(675 \text{ nm}, z) * \exp((-0.003 * (z-30))) \quad [2]$$

In order to limit the impact of remaining stray light errors on the retrieved aerosol profiles, only left slit data are provided in this V0.5 test data product.

Data Summary

Data Coverage. The first OMPS LP measurements were taken on January 10, 2012. LP data for January-March 2012 have numerous gaps due to variations in instrument operations and changes in sample tables. Regular operations began on April 2, 2012. Note that there is very little or no LP data on days when the OMPS Nadir Mapper conducts high-resolution measurements. This sequence occurs approximately one day per week, beginning in April 2012.

Cloud Screening. In general, we recommend that when a cloud is detected by the LP detection algorithm for a specific event, extinction coefficient values below the cloud altitude should not be used. However, users should be aware of the following qualifications to this recommendation.

- OMPS LP consistently identifies polar stratospheric clouds (PSCs) during winter months at latitudes greater than 50° and altitudes greater than 15 km.
- The LP cloud detection algorithm may report a positive detection when large stratospheric aerosol levels are present following a volcanic eruption, such as Kelut in February 2014 and Calbuco in April 2015.

In these situations, retrieved extinction coefficient profiles below the reported cloud level may be suitable for scientific use.

Data Quality. AER675 extinction values are set to a fill value at any altitude where the ASI(675 nm) value is less than 0.01. Extinction values less than $3 \times 10^{-6} \text{ km}^{-1}$ should be considered unreliable for evaluation of both individual profiles and ensemble averages. Initial comparisons of the AER675 Version 0.5 data product with OSIRIS v5.07 aerosol extinction data [*Bourassa et al.*, 2012] have been performed. While the OSIRIS extinction product is reported at 750 nm,

applying an adjustment to the AER675 product based on SAGE Angstrom exponent values gives typical agreement to approximately $\pm 20\%$. Further evaluation of the AER675 product is in progress.

References

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