OMPS Limb Profiler – Level 2
Products Update

Matthew DeLand (SSAI)
P. K. Bhartia (NASA/GSFC)
+ contributions from Ghassan Taha, Didier Rault, Philippe Xu, Natalya Kramarova, and other team members

STAR JPSS Science Team Meeting
College Park, MD   14 May 2014
LP Instrument Review

• LP makes limb scattering measurements viewing backwards along orbit.
• Wavelength range = 290-1000 nm, with variable resolution (1-25 nm).
• Altitude range = 0-80 km, 1 km sampling.
• Collect radiance spectrum simultaneously at each altitude.
• Specify (programmable) sample table of CCD pixels that are downloaded to meet data rate limits.
Major LP Data Products

• Gridded radiances (Level 1)
  – L1B pixels have variable wavelength, altitude sampling across CCD.
  – Interpolate radiances to regular grid for use in L2 retrievals.

• Ozone profile (UV wavelengths)
  – Retrieved profile covers stratosphere and lower mesosphere (28-60 km).

• Ozone profile (visible wavelengths)
  – Retrieved profile covers lower stratosphere (cloud top to 30-35 km).

• Aerosol extinction coefficient (visible, near-IR wavelengths)
  – Retrieve profiles at 5 wavelengths between 514-865 nm.
Processing Status

• Release 1 products (L1G radiances, center slit ozone profiles) initially released October 2012.

• Release 2 L1G processing completed (up to present) April 2014.

• Ozone reprocessing completed 12 May 2014. Evaluation in progress to support archival of data set at DAAC for public release.

• Aerosol reprocessing now in progress. Estimate completion by end of May 2014.
L1 Changes from Release 1

- Implement intra-orbit “dynamic” tangent height adjustment through OPF. Also implement additional 500 m “static” adjustment.
- Revise wavelength gridding in L1G product to use fixed grid for all events.
- Revise reference wavelength scale to use better data set.
- Implement intra-orbit and seasonal wavelength scale adjustments for each event.
- Eliminate merging of multiple gain/aperture values for determining radiance at each pixel.
- Prioritize data selection to use high gain sample for $\lambda < 500$ nm, low gain sample for $\lambda > 500$ nm.
- Revise ancillary data selection to use GMAO products for temperature, pressure, density. Profiles extended to 80 km with constant temperature lapse rate.
L2 Changes from Rel. 1 [1]

- Implement new ozone \textit{a priori} data set created from 2012 MLS data.
- Implement SUSIM data for UV portion of high-resolution solar irradiance spectrum.
- Exclude OH emission wavelengths (306.5-311 nm) from UV ozone profile retrieval.
- Add 1\% instrument error term to SNR noise term for retrieval.
- Modify VIS retrieval to use 510 nm and 673 nm as “guard” wavelengths for triplet formation, 549-633 nm as range to sample Chappuis band.
- Turn off explicit aerosol correction in ozone retrieval.
L2 Changes from Rel. 1 [2]

- Provide ozone retrieval data from all three slits.
- Limit altitude range of ozone product to $z_{\text{max}} = 60.5$ km.
- Report UV and VIS ozone retrieval results as separate products, in addition to combined profile.
- Combined ozone profile uses UV retrieval values from 60.5 km down to 27.5 km, uses VIS retrieval values from 26.5 km down to retrieval cutoff.
- Create mixing ratio ozone profile product on regular pressure grid for every event.
- Generate separate aerosol product data set using current retrieval algorithm.
Evaluation of GMAO vs. MLS

- LP retrieval algorithm uses GMAO FP-IT Np profiles for temperature and pressure (derived from geopotential height), interpolated to event location and time, as ancillary data.

- Compare zonal mean products with MLS data for selected days to evaluate accuracy and variability.

- Temperature profiles generally agree to ±5 K between 10-60 km.

- Pressure profiles generally agree to ±2% between 10-60 km.
GMAO vs. MLS – Temperature

Figure courtesy of Philippe Xu
GMAO vs. MLS – Pressure

Mean Pressure Difference (GMAO-MLS, 03/21/2013)

Mean Pressure Difference (GMAO-MLS, 06/21/2013)

Mean Pressure Difference (GMAO-MLS, 09/21/2013)

Mean Pressure Difference (GMAO-MLS, 12/21/2013)

Figure courtesy of Philippe Xu
Ozone Products

• Combined ozone density profile uses visible ozone retrieval for cloud top-27 km, UV retrieval for 28-60 km. No merging or adjustment at transition altitude.

• Mixing ratio profiles also created for user convenience.

• Development testing results shown here utilized set of 38 “golden days” during April-December 2012, where NPP orbit is closely aligned with Aura satellite (and MLS instrument).
Sample LP Profiles vs. MLS

2°S

76°S
LP vs. MLS - All Sample Orbits

Figure courtesy of Ghassan Taha
LP vs. MLS – Zonal Means

Figure courtesy Ghassan Taha
LP vs. Lidar - Overpass

Figure courtesy Natalya Kramarova

Haute Provence 31  Mauna Loa 10  Hohenpeissenberg 23  TableMountain 13

[44N, 5.7E];  [20N, 155W];  [48N, 11E];  [34N, 118W]
Comparison with CALIPSO and GOMOS

Comparison with CALIPSO
Bias < 7%, Variance = 27%

Comparison with GOMOS
Bias < 10%, Variance = 30%

Figure courtesy Didier Rault
LP Aerosol Product
Evolution over NPP mission

OMPS/LP Stratospheric aerosol retrieval
Mean aerosol extinction (532nm) between 17.5 and 21.5 km

February 2012 – August 2013

Figure courtesy Didier Rault
LP Aerosol – Kelut Volcano

LaRC Forecast 26 Feb 2014 (Duncan Fairlie)

Figure courtesy Didier Rault
LP Aerosol – Chelyabinsk bolide

20 m diameter, 10,000 metric tons, 18.6 km/s
Explosion at 23.3 km with energy release = 30 x Hiroshima; Dust plume rose to > 55 km

Unresolved Issues

• Accuracy of geopotential height profiles in mesosphere (60-80 km)
  – GMAO data currently extrapolated to 80 km with linear lapse rate for ancillary data.
  – MLS team claims 400 m uncertainty in both MLS and GMAO products at this altitude.

• Tangent height registration error along orbit
  – Stratospheric radiance values are very sensitive to tangent height location \( (dl/dz \approx -14\%/km) \).
  – Current analysis suggests remaining errors are ±300 m or less, but results from different techniques are not yet consistent.
Future Work

• Aerosol correction
  – Need to be consistent with current “clean” environment, accommodate local variability.
  – Need capability to handle future change in conditions.

• Polar mesospheric cloud (PMC) correction
  – Layers of ice crystals at 80-85 km during polar summer.
  – Affects radiance signal at lower altitudes due to LP viewing geometry.
  – Flagging approach in place for Release 2. Correction will be more complex to develop.

• Extend retrieved ozone profiles into troposphere.
• Derive improvements to GMAO profiles above 40 km using LP data.