Validation of OMPS LP ozone profile retrievals from NASA GSFC version 2.5 against correlative satellite measurements

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Key changes in version 2.5

OMPS-LP v2 algorithm

- 43 UV pairs and 17 VIS triplets;
- Radiances are normalized at 65 km for UV and 45 km for VIS ranges;
- Aerosol correction module is turned off

OMPS-LP v2.5 algorithm

- 3 UV pairs and 1 VIS triplet;
- Radiances are normalized at 55 km for UV and 40 km for VIS ranges;
- Include the explicit aerosol correction by using LP aerosol v1;
- Algorithm uses realistic a priori covariance matrices instead of Tikhanov regularization;

OMPS LP O₃ retrieval algorithm by [Rault and Loughman, 2013]

April-May 2017: Reprocessing LP data with the new 2.5 retrieval algorithm DONE
August 2017: Public release of the version 2.5 ozone profiles DONE
Sensor pointing corrections in version 2.5

- **Static corrections** of 1.12/1.37/1.52 km for the left/center/right slits, correspondently;

- **Time-dependent +0.1 km adjustments for all 3 slits** on April 25, 2013 and on September 5, 2014 due to the spacecraft pitch and inclination adjustment maneuvers, respectively;

- **Slit based, intra-orbital, seasonally varying TH corrections** of ~0.3-0.4 km.


<table>
<thead>
<tr>
<th>TH error, m</th>
<th>LEFT</th>
<th>CENTER</th>
<th>RIGHT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Version 2</td>
<td>0.58</td>
<td>1.18</td>
<td>1.75</td>
</tr>
<tr>
<td>Version 2.5</td>
<td>1.12</td>
<td>1.37</td>
<td>1.52</td>
</tr>
</tbody>
</table>

±200 m
Ozone Time Series
Ozone nd, altitude 22.5km, Slit center, boulder, [39N,105W]

Bias = 1.73% +/- 0.56%
StdDev = 8.47%

Differences with Sonde (%), altitude 22.5km, boulder, [39N,105W]

k = -0.23 +/- 0.52%/yr
k = -0.35 +/- 0.43%/yr
Disrupted QBO

Updated from Newman et al., 2016

OMPS-LP v2.5 Ozone [%], 5S-5N

Aura-MLS v4 Ozone [%], 5S-5N

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Ozone Seasonal Cycle

Seasonal Cycle LP v2.5 O3(%), 47S

Seasonal Cycle MLS v4 O3(%), 47S
## Overview of uncertainties in OMPS LP O3 retrievals [%]

<table>
<thead>
<tr>
<th>Altitude [km]</th>
<th>Vertical res. [km]</th>
<th>Precision</th>
<th>TH error ±200 m</th>
<th>Drift in TH ~80m RSAS [%/yr]</th>
<th>Syst. error in measurements</th>
<th>Backgroun aerosol effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;15 km</td>
<td>~2.0-6.0</td>
<td>~10-50</td>
<td>~5-10</td>
<td>~0.4-0.8</td>
<td>±3</td>
<td>??10-60</td>
</tr>
<tr>
<td>20 km</td>
<td>~1.6-2.8</td>
<td>6-10</td>
<td>~10</td>
<td>~0.8</td>
<td>±3</td>
<td>5</td>
</tr>
<tr>
<td>25 km</td>
<td>~1.7-2.2</td>
<td>5-8</td>
<td>~0</td>
<td>~0</td>
<td>±3</td>
<td>-</td>
</tr>
<tr>
<td>30 km</td>
<td>~1.8-2.8</td>
<td>6-9</td>
<td>~2</td>
<td>~0.16</td>
<td>±3</td>
<td>~&lt;1</td>
</tr>
<tr>
<td>35 km</td>
<td>~2.2-3.0</td>
<td>7-10</td>
<td>~5</td>
<td>~0.4</td>
<td>±3</td>
<td>n/a</td>
</tr>
<tr>
<td>40 km</td>
<td>~1.6-2.0</td>
<td>6-8</td>
<td>~5</td>
<td>~0.4</td>
<td>±3</td>
<td>n/a</td>
</tr>
<tr>
<td>45 km</td>
<td>~1.5-1.8</td>
<td>6-7</td>
<td>~5</td>
<td>~0.4</td>
<td>±3</td>
<td>n/a</td>
</tr>
<tr>
<td>50 km</td>
<td>~2.2-3.0</td>
<td>8-12</td>
<td>~5</td>
<td>~0.4</td>
<td>±3</td>
<td>n/a</td>
</tr>
</tbody>
</table>
Mean Biases UV

Mean Bias OMPS-LP v2.5 - Aura MLS v4, (%), center slit

Not consistent with TH-shift

Between 30-43 km biases within ±5%

LPv2.5-MLS; LPv2.5-OSIRIS; LPv2.5-ACE

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Between 18-30 km biases within ±5%

Low bias in SH mid-latitudes

Low bias in tropical UTLS

SL in NH

Mean Biases VIS

Mean Bias OMPS-LP v2.5 - Aura MLS v4, (%), center slit

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Relative drift against Aura MLS

UV LPv2.5, VIS LPv2.5
Systematic errors in LP version 2.5 (internal analysis):
✓ absolute sensor pointing error ±200 m (~5% above 35 km);
✓ quasi-random measurement errors (±3% everywhere);
✓ background aerosol (expected to be small after the explicit corrections in v2.5);
✓ drift in sensor pointing ~80m over 5 years (~0.4%/yr).

Comparisons with correlative satellite measurements:

OMPS LP v2.5 UV:
• within ±5% with Aura MLS, ACE-FTS and OSIRIS between 30-42 km;
• above 43 km bias of -6% – -12%, within quoted uncertainties for LP/MLS;

OMPS LP v2.5 VIS:
• within ±5% between 20 and 30 km, except for high NH latitudes where differences are larger due to instrumental errors;
• ~-15% differences in the SH mid-latitudes (20S-60S) below 18 km;
• ~-30% differences in the tropical UTLS;

Absolute TH registration: comparisons with correlative satellite instruments did not reveal patterns in O3 biases consistent with the TH shift.
Drift in TH registration: drift in O3 relative to MLS and OMPS NP ~0.5%/yr (or 2.5% over 5 years) at altitudes above 35 km. The pattern is consistent with the detected 80-meter drift in TH.