Application of Aura OMI L2G Products Compared with NASA MERRA-2 Assimilation

Introduction

- The Ozone Monitoring Instrument (OMI) is one of the instruments aboard NASA’s Aura satellite. It measures ozone total column and vertical profile, aerosols, clouds, and trace gases including NO$_2$, SO$_2$, HCHO, BrO, and O$_3$ using absorption in the ultraviolet electromagnetic spectrum (280 - 400 nm).
- OMI Level-2G (L2G) products are based on the pixel-level OMI granule satellite measurements and are not affected by time delays or small gaps within global 0.25° × 0.25° grids, therefore they conserve all the Level 2 (L2) spatial and temporal details for 24 hours of satellite measurements stored within global 0.25° grids.

OMI/AURA Daily Gridded Level 2G Products Archived at NASA/GES DISC

<table>
<thead>
<tr>
<th>OMT03G</th>
<th>OMDOA03G</th>
<th>OMAEROG</th>
<th>OMAERUVG</th>
<th>OMCLDO2G</th>
<th>OMCLEDRR</th>
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<td>UV aerosol index (UV-AI)</td>
<td>Aerosol reflectance</td>
<td>Aerosol optical depth (AOD)</td>
<td>Aerosol absorption coefficient</td>
<td>Aerosol single scattering albedo (SSA)</td>
<td>Aerosol size distribution</td>
<td>Aerosol AOD from single scattering</td>
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Characteristics of OMI L2G

- Benefits of OMI L2G Product
  - 24 UTC hours of OMI level-2 data (excluding zoom mode) in one file
  - Global coverage
  - In grid format with a 0.25° × 0.25° resolution, except for OMSO2G whose resolution is 0.125° × 0.125°.
  - Cloud fraction and pressure (O$_2$-O$_2$)
- What is special about OMI L2G Product?
  - OMI L2G products are not ‘traditional’ gridded data.
  - Understanding of Nandicadate: OMI L2G products have a unique dimension of Nandicadate in addition to the dimensions of longitude-grid and latitude-grid, which might cause confusion to new users. Because the candidate in one grid cell of OMI L2G products are sequenced according to their optical path, they do not correspond temporally, and thus choosing a single level of candidates does not represent the true global spatial distribution of the parameter in time, and should not be used to validate modeled parameters.
  - Comparing OMI L2G products with model simulations such as MERRA-2 is not straightforward.
- Best Features in OMI L2G Product Applications
  - Geographic subset at altitude
  - Equal or less storage space
  - Reduce file management in coding and loading files
  - With proper algorithm, L2G can be directly processed with model simulations or satellite level 3 products, with regressions such as the NASA OMI L2G Level 3/4 Regridder and Subsetter tools.

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In order to optimally utilize Aura OMI daily L2G aerosol products that have global coverage, an algorithm has been developed to create hourly OMI gridded data products from L2G in 24 hours. The hourly aerosol optical thickness (AOT) product can be compared to MERRA-2 hourly aerosols simulations directly, to emphasize the benefit of L2G products.
- Utilize OMI L2G products may not seem as straightforward as level 2 or level 3 products. The major difference between L2G and L3 is that each grid cell of L2G might contain multiple candidates from the level-2 products. Therefore, L2G from L2 is that L2G products no longer have the data at the pixel level. Finding optimal ways to utilize L2G products is critical in order to take full advantage of all the benefits of the L2G format.
- First of all, L2G is basically L2 because it includes all the necessary attributes that define L2 product features, such as pixel-level geographical and temporal information. As such, the easiest and most direct method is to test L2G as L2. Since it will not be representative if only one candidate is chosen from each grid cell, the drawback of this method is that it will lose the benefits of the gridded format, and is time-consuming.
- Another great aspect of L2G is global coverage. Users can easily subset the regions of interest without worrying about the size of the subset areas. This method helps to improve processing speed. Figure 1 demonstrates a dust storm episode which occurred in southwest Africa in July 2007 with a region size of 6° × 4°, showing the OMAERUVG UV aerosol index which can be used to identify aerosol types. Figure 2 shows the OMAERUVG product, the vertical column amount of sulfur dioxide in the lower stratosphere, when Mount Agung volcano erupted in the Indonesian island of Bali in late November 2017. One should pay close attention to the missing portion in lower stratosphere, when Mount Agung volcano erupted in the Indonesian island of Bali in late November 2017. This figure also illustrates applying Quality Flags is not only for high quality demand, but is also a necessity for data utility.
- The third method to get the best use of L2G data is to fully utilize both the L2 and L3 features in L2G. GES DISC has developed an algorithm to convert the daily L2G product to hourly L2G products, with the purpose of efficiently reducing the candidates in the grid cells, and preparing L2G data in the same format as for model simulations such as the MERRA-2 aerosol hourly reanalysis product M2TINXAR.
- A physics regressor is required to estimate aerosol optical thickness of aerosol products with different grid sizes, such as MERRA-2 and OMI L2G. GES DISC has also been developing regridding tools that can be used on various aerosol products to meet various purposes.

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  - All data are from “good” scenes.
  - Easy reversal to level 2.
- What is special about OMI L2G Product?
  - OMI L2G products are not ‘traditional’ gridded data.
  - Understanding of Nandicadate: OMI L2G products have a unique dimension of Nandicadate in addition to the dimensions of longitude-grid and latitude-grid, which might cause confusion to new users. Because the candidate in one grid cell of OMI L2G products are sequenced according to their optical path, they do not correspond temporally, and thus choosing a single level of candidates does not represent the true global spatial distribution of the parameter in time, and should not be used to validate modeled parameters.
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Summary

- This presentation demonstrates all of the OMI L2G products that are archived at NASA/GES DISC and suggests three ways to utilize OMI L2G optimally.
- The comparisons between daily mean MERRA-2 total extinction absorption optical thickness and OMAERUVG/OMAERGG show high agreement for both strong biomass burning and dust aerosol events. MERRA-2 simulated larger AOD values, especially larger absorption AOD. The closer the data is acquired to the sources of the events, the higher the agreement between products.
- The purpose of generating hourly L2G products is to utilize all the potential that L2G products provide, and to supply relatively more accurate satellite observations varying temporally and spatially. Comparing hourly L2G data to MERRA-2 hourly simulations will, in turn, help to verify model performances in a more accurate way.

Application Use Cases

- Figure 5: (a)-(b) show the comparisons between MERRA-2 daily mean total extinction AOT at 550nm and OMAERUVd AOD at 500nm for the wildfire episode in Figure 3 and 4. (c) show the comparisons between MERRA-2 aerosol absorption AOT at 550nm and OMAERUVg AOD at 500nm for the volcanic eruption case in Figure 4.