



Ozone Vertical Profile Satellite Measurements by S-NPP OMPS, Aura MLS, and Sentinel-5P TROPOMI

https://disc.gsfc.nasa.gov/

A43J-2959
AGU 2019
San Francisco, CA, USA
December 12th, 2019
Jian.Zeng@nasa.gov

NASA/Goddard Earth Sciences Data and Information Services Center (GES DISC)

Jian Zeng^{1,2}, Dana M. Ostrenga^{1,2}, James E. Johnson^{1,2}, Jennifer Wei¹, and David J. Meyer¹
¹Code 610.2, NASA Goddard Space Flight Center, Greenbelt, MD, USA ²ADNET Systems Inc., Lanham, MD, USA

Introduction

NASA has been monitoring ozone variations from space since 1970 with the launch of the Backscatter Ultraviolet instrument (BUV) on Nimbus-4. Ozone in the Earth's stratosphere and troposphere plays a crucial role in protecting life from harmful solar UV radiation, and it also influences Earth's climate. The vertical distribution of ozone is used in modeling forecasts, verifying model analysis and simulations, and improving the measurement of tropospheric ozone that is a toxic constituent of air pollution.

The Microwave Limb Sounder (MLS) on the EOS Aura spacecraft has been monitoring long-term continuous stratosphere ozone vertical behaviors since 2004. The Ozone Mapper Profile Suite (OMPS) on the Suomi National Polar-orbiting Partnership (S-NPP) was launched in 2011. Two of its three instruments, the Limb Profiler (LP) and the Nadir Profiler (NP), are designed to map ozone profiles with full global coverage (~6 days for NP) and a high level of vertical accuracy (1-km reporting record for LP) in the stratosphere and upper troposphere. The TROPospheric Monitoring Instrument (TROPOMI) on the Copernicus Sentinel-5 Precursor (S5P), launched in 2017, aims to retrieve ozone profiles in both the troposphere and up to top-of-atmosphere (TOA) by using UV radiation measurements in a spectral range of 270-320 nm. S5P/TROPOMI ozone profile products are planned to become available in April 2020.

This presentation will concentrate on satellite ozone vertical profile data collections from OMPS and MLS which are archived at the NASA Goddard Earth Sciences Data and Information Services Center (GES DISC). TROPOMI ozone vertical profiles for the troposphere and to top-of-atmosphere will become available at NASA GES DISC in 2020. The presentation briefly explores their potential complementary usability in determining three-dimensional ozone global distributions with high temporal and spatial resolutions.

Instrument

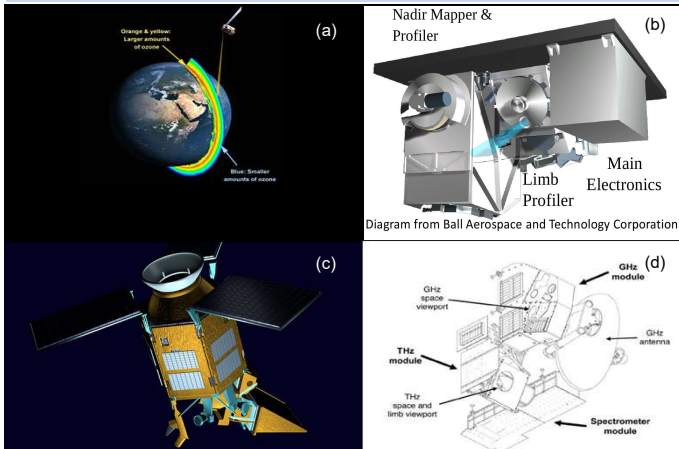


Figure 1: a) High vertical resolution measurement of ozone layer by S-NPP Limb Profiler; b) S-NPP OMPS diagram; c) Sentinel-5 Precursor TROPOMI platform; d) Aura MLS schematic line drawing.

Acknowledgment: The authors acknowledge the European Space Agency for the S5P/TROPOMI products. Acknowledgment also goes to S5P/TROPOMI, Aura/OMI MLS, and S-NPP/OMPS L2 Science Teams for the science algorithms.

Instrument Specification

Table 1: Instrument Specification Comparison of Sentinel-5P TROPOMI, Aura MLS, and S-NPP OMPS Nadir/Limb Profiler

| Satellite | Sentinel-5P | Suomi-NPP | Aura |
|--|---|---|--|
| Sensor | TROPospheric Monitoring Instrument (TROPOMI) | Nadir Profiler (NP) Limb Profiler (LP) | Microwave Limb Sounder (MLS) |
| Spectrometer Radiometer | Push-broom grating spectrometer 2D CCD | Push-broom grating spectrometer 2D CCD | Prism Spectrometer 2D CCD 3 vertical slits |
| Spectral coverage | UV-VIS: 270–495 nm NIR: 675–775 nm SWIR: 2305–2385 nm | 250 – 310 nm | 290 – 1000 nm |
| Spatial resolution | 5.5 km x 3.5 km near nadir (TPR) 16.5 km x 28 km (PR) | 250 x 250 km | 1-km reporting vertical resolution |
| Field-of-View | 108° (2600 km) | 16.6° | 1.95° |
| Spectral resolution | 0.23 – 0.5 nm | 1.1 nm | 1 - 40 nm (2 pixels/FWHM) |
| Ascending node equator local crossing time | ~13:30 | ~13:30 | ~13:30 |
| Data Available | Expected in April 2020 | 2011 - present | 2012 - present |

Aura MLS Ozone Vertical Profile

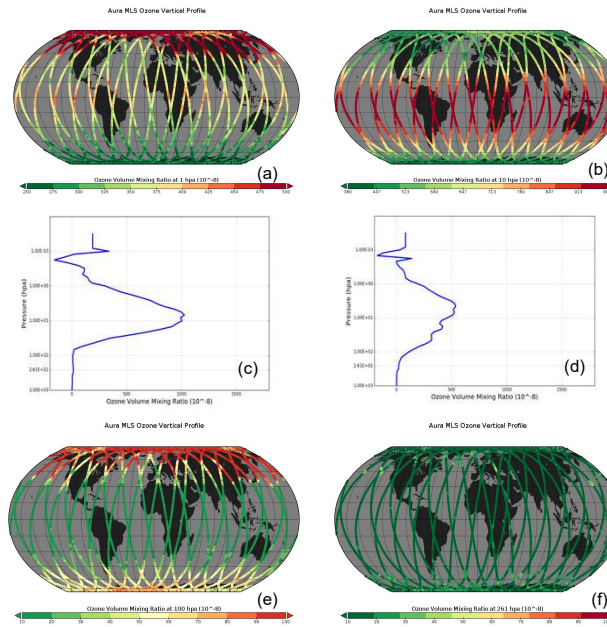


Figure 2: Aura MLS ozone vertical profiles observed on January 15, 2019. Daily ozone mixing ratio measurements are demonstrated at the vertical levels of a) 1 hpa, b) 10 hpa, e) 100 hpa, and f) 261 hpa. Single ozone vertical profiles along the prime meridian are shown at the Equator (c) and the Antarctic (d).

S-NPP OMPS LP & NP Ozone Profiles

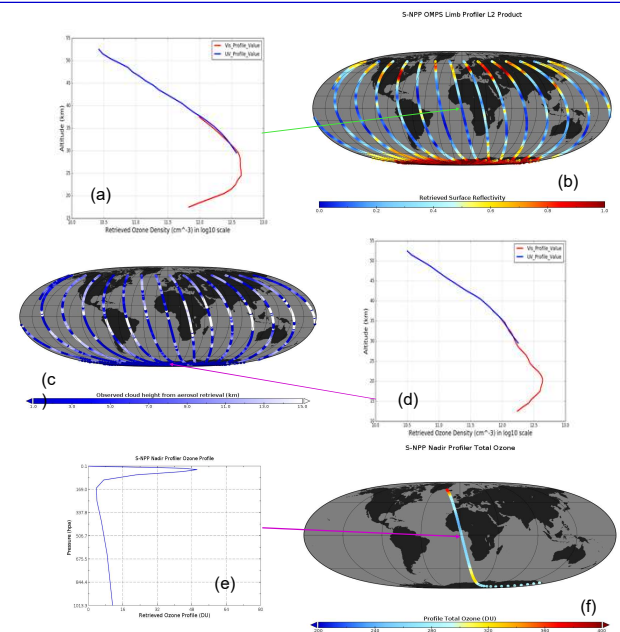


Figure 3: Suomi-NPP OMPS Limb Profiler (LP) and Nadir Profiler (NP) vertical profile products on January 15 of 2019 are shown in this figure. (a) and (d) are S-NPP LP ozone vertical profiles at the Equator and the Antarctic along the prime meridian. (b) and (c) are S-NPP OMPS LP daily retrieved surface reflectivity and observed cloud height from aerosol retrieval. (e) and (f) are S-NPP OMPS NP ozone vertical profile at Null Island (0°N 0°E), and one of the 14 orbital swaths of that day.

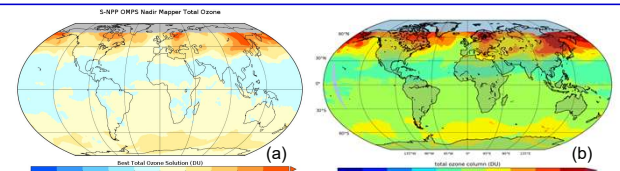


Figure 4: This figure displays total column ozone observed by a) S-NPP OMPS Nadir Mapper (NM) and b) Copernicus Sentinel-5P TROPOMI. It will be beneficial to global atmospheric environmental monitoring when S5P TROPOMI ozone profile products, especially the tropospheric ozone profile product, become available in 2020.

Future Work

S5P/TROPOMI ozone profile product availability has currently been postponed to April 2020. Further studies on the complementary roles of TROPOMI, OMPS and MLS data will be investigated and analyzed regarding ozone vertical profile regional and global distributions.

Reference:

- Waters, J. W. et al., 2006: The Earth observing system microwave limb sounder (EOS MLS) on the Aura satellite, IEEE Transactions on Geoscience and Remote Sensing, Volume 44, issue 5, <https://doi.org/10.1109/GRS.2006.873771>.
- Chen, Z., DeLand, M., and Bhartia, P. K., 2016: A new algorithm for detecting cloud height using OMPS/LP measurements, Atmos. Meas. Tech., 9, 1239–1246, <https://doi.org/10.5194/amt-9-1239-2016>.
- Kramarova, N. A., Bhartia, P. K., Jaross, G., Moy, L., Xu, P., Chen, Z., DeLand, M., Froidevaux, L., Livesey, N., Degenstein, D., Bourassa, A., Walker, K. A., and Sheese, P., 2018: Validation of ozone profile retrievals derived from the OMPS LP version-2.5 algorithm against correlative satellite measurement, Atmos. Meas. Tech., 11, 2837–2861, <https://doi.org/10.5194/amt-11-2837-2018>.