



Sentinel-5P/TROPOMI and S-NPP/OMPS Data Support at GES DISC

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

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Introduction

The TROPospheric Monitoring Instrument (TROPOMI) on the Sentinel-5 Precursor (Sentinel-5P) is the first of the Atmospheric Composition Sentinels orbited by the European Space Agency (ESA) that provides measurements of atmospheric chemistry, aerosols, and clouds at high spatial, temporal, and spectral resolutions. Sentinel-5P's early afternoon orbit provides strong synergy with the U.S. Suomi National Polar-orbiting Partnership (S-NPP) satellite, especially given that the S-NPP Ozone Monitoring and Profiling Suite (OMPS) facilitates high vertically resolved stratospheric and lower mesospheric ozone profiles.

The NASA Goddard Earth Sciences Data and Information Services Center (GES DISC) supports over a thousand data collections in the focus areas of Atmospheric Composition, Water & Energy Cycles, and Climate Variability. Both Sentinel-5P TROPOMI Level-1B (L1B)/Level-2 (L2) and S-NPP OMPS L1B/L2/Level-3 (L3) products are curated at GES DISC. Sentinel-5P data are provided by the European Union and the European Space Agency through an agreement between ESA and NASA.

Through its convenient and enhanced tools/services, such as OPeNDAP and L2 Subsetting, GES DISC offers the air quality remote sensing user community facile solutions for using complex Earth science data and applications.

This presentation will demonstrate TROPOMI and OMPS products including Earthview (EV) radiance, solar irradiance, and currently available L2 datasets, as well as easy ways to access, visualize and subset data.

S5P/TROPOMI and S-NPP/OMPS Products Available at NASA/GES DISC

S5P/TROPOMI		OMPS-NM	OMPS-NP	OMPS-LP
Level-1B:	Products coming soon:	Level-1B:	Level-1B:	Level-2:
<ul style="list-style-type: none"> EV Radiance in 8 Bands Solar Irradiance 	<ul style="list-style-type: none"> Sulphur Dioxide Formaldehyde Tropospheric Ozone Full Ozone profile Tropospheric Ozone profile Aerosol Layer Height 	<ul style="list-style-type: none"> EV Radiance Solar Irradiance 	<ul style="list-style-type: none"> EV Radiance Solar Irradiance 	<ul style="list-style-type: none"> UV retrieved profile VIS retrieved Ozone density vertical Ozone density profile Aerosol extinction coefficient (675nm) vertical profile Cloud height
Level-2:		Level-2:	Level-2:	
<ul style="list-style-type: none"> UV Aerosol Index (UVAI) Cloud Carbon Monoxide Nitrogen Dioxide Total Ozone Column 		<ul style="list-style-type: none"> Total column Ozone Total and Tropospheric column Nitrogen Dioxide Total column and Tropospheric Sulphur Dioxide by DVCF Total Column Sulphur Dioxide by PCA 	<ul style="list-style-type: none"> Ozone profile UV Aerosol Index Reflectivity 	
		Level-3:		
		<ul style="list-style-type: none"> Total Column Ozone 		

Methods to Access the Data

- Search the data via the GES DISC home page (<https://disc.gsfc.nasa.gov>), using keywords "S5P" or "s5p" or "OMPS" or "omps" to browse all the available products. This is the most direct and convenient way to find the data.
- For each specific data collection, users are able to:
 - See and download all the data files on GES DISC public data servers via HTTPS
 - Use Earthdata Search across multiple data centers
 - Search for specific regions and/or time periods by using GES DISC search engine
- Via OPeNDAP protocol

OPeNDAP is a Web-based visualization tool for online data in Data Pools. Users are able to view data field structures defined in the metadata. Users can also choose to download specific variable(s) in ASCII text format.

Application Use Case

Dust Storm and Wild Fire Events

In mid-August 2018, the western United States and Canada experienced deadly blazes that destroyed structures and affected the lives of millions of people. Figure 2a is the true color image from S-NPP VIIRS. S5P/TROPOMI detected high density of carbon monoxide (figure 2b, red box) and high positive UV Aerosol Index (figure 2c, red box), which could indicate absorbing black carbon aerosols caused by biomass burning. Huge Sahara dust plumes in late June and early July of 2018 passed over Mauritania, Senegal, Gambia, and Guinea-Bissau before moving out over the Atlantic Ocean. The dust plumes were clearly seen in the S5P/TROPOMI UV AI image (figure 2f) but did not appear in the carbon monoxide image (figure 2e), proving the absorbing aerosols are a non-smoke type. Figure 2d shows the NASA Goddard Earth Observing System Model, Version 5 (GEOS-5) model simulation of the dust plumes.

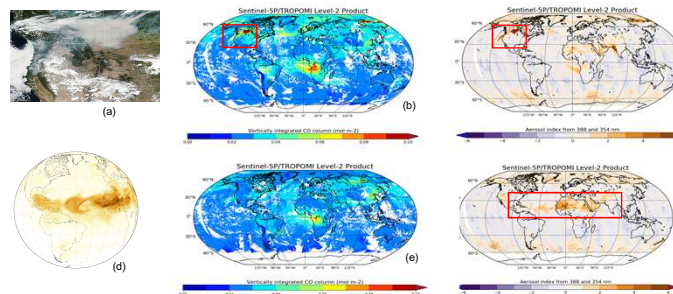


Figure 2: (a) – (c) demonstrate the wildfire event on August 15th, 2018 in northwestern United States and southwestern Canada. (a) is the S-NPP/VIIRS true-color image in the region of interest, (b) and (c) are the global distributions of S5P/TROPOMI CO and UVAI. (d) – (f) show the trans-Atlantic dust plumes (red box) on July 1st, 2018. (d) is the GEOS-5 simulation. (e) and (f) are S5P/TROPOMI CO and UVAI L2 products.

Total Column Ozone Comparison between TROPOMI and OMPS

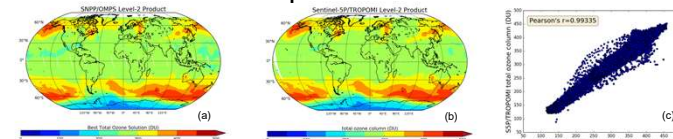


Figure 3: (a) S-NPP OMPS best total ozone solution on October 25th, 2018. (b) TROPOMI total ozone column product on the same day. (c) Total column ozone global distributions from TROPOMI and OMPS are so alike that only small differences can be seen, mainly over the Pacific Ocean. The Pearson's correlation coefficient reaches as high as 0.99335.

Instrument

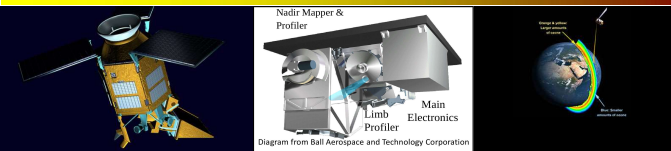


Figure 1: Sentinel-5 Precursor TROPOMI Platform (left), S-NPP/OMPS Diagram (middle), and high vertical resolution measurement of ozone layer by SNPP Limb Profiler (right)

Table 1: Sentinel-5P TROPOMI and S-NPP OMPS Instrument Specifications

Satellite	Sentinel-5P	S-NPP		
Sensor	TROPOMI	Nadir Mapper (NM)	Nadir Profiler (NP)	Limb Profiler (LP)
Spectrometer	Push-broom grating spectrometer 2D CCD	Push-broom grating spectrometer 2D CCD	Push-broom grating spectrometer 2D CCD	Prism spectrometer 3 vertical slits
Spectral coverage	UV-VIS: 270–495 nm NIR: 675–775 nm SWIR: 2305–2385 nm	300 – 380 nm	250 – 310 nm	290 – 1000 nm
Spatial resolution	7 X 3.5 km near nadir	50 X 50 km at nadir	250 X 250 km 6 – 8km vertical resolution	1-km reporting vertical resolution
Field-of-View	108° (2600 km)	110° (2800 km)	16.6°	1.95°
Spectral resolution	0.23 – 0.5 nm	1.1 nm	1.1 nm	1 - 40 nm (2pixels/FWHM)
Ascending equator local crossing time	~13:30	~13:30	~13:30	~13:30

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S-NPP OMPS LP Application

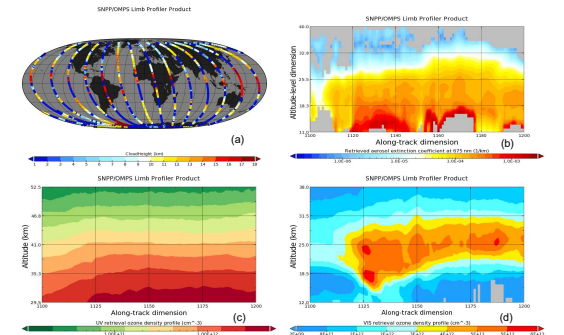


Figure 4: These are demonstrations of S-NPP OMPS L2 products. (a) Cloud height. (b) Retrieved vertical profile of aerosol extinction coefficients at 675 nm between the altitude of 11 – 40 km AGL. (c), (d) Retrieved vertical profiles of ozone density in lower, middle, and upper stratosphere, as well as lower mesosphere.

The ozone layer and its vertical distribution can be seen in Figure 4d. The Antarctic Ozone Hole's location and vertical and horizontal structures can be described with S-NPP OMPS sensors. Aerosol vertical profiles are essential to retrieve aerosol information accurately.

Summary and Future Work

S5P/TROPOMI is providing both the UV Aerosol Index and the vertical integrated carbon monoxide column products. The combination of these two products can be used to separate biomass burning aerosols from non-smoke aerosols.

Comparison of the global total column ozone distribution shows great agreement between S5P/TROPOMI and S-NPP OMPS measurements.

S-NPP OMPS-LP is able to provide high vertical resolution (1-km reporting) ozone vertical profiles between the tropopause and the lower mesosphere. S5P/TROPOMI will provide the full ozone profile, covering the entire atmosphere, with measurements in the spectral range of 270 nm to 320 nm. The tropospheric ozone profile retrieval will use the wavelength of 300 nm to 320 nm. Possible ozone profile synergy of S5P/TROPOMI and S-NPP OMPS-LP will be explored when the S5P/TROPOMI products become available in 2019.