Ozone from TROPOMI/S5P

D. Loyola, K.-P. Heue, J. Xu, P. Valks, W. Zimmer, F. Romahn: DLR
M. Van Roozendael, C. Lerot, N. Theys, I. De Smedt, J. van Gent: BIRA-IASB

CEOS AC-VC, NOAA, May 3rd, 2018

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Outlook

- TROPOMI/S5P – Operational L2 Products

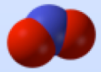
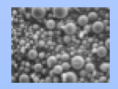
- Total Ozone
  - NRT DOAS
  - OFL GODFIT

- Tropospheric Ozone

- New Retrieval Algorithms

- Summary

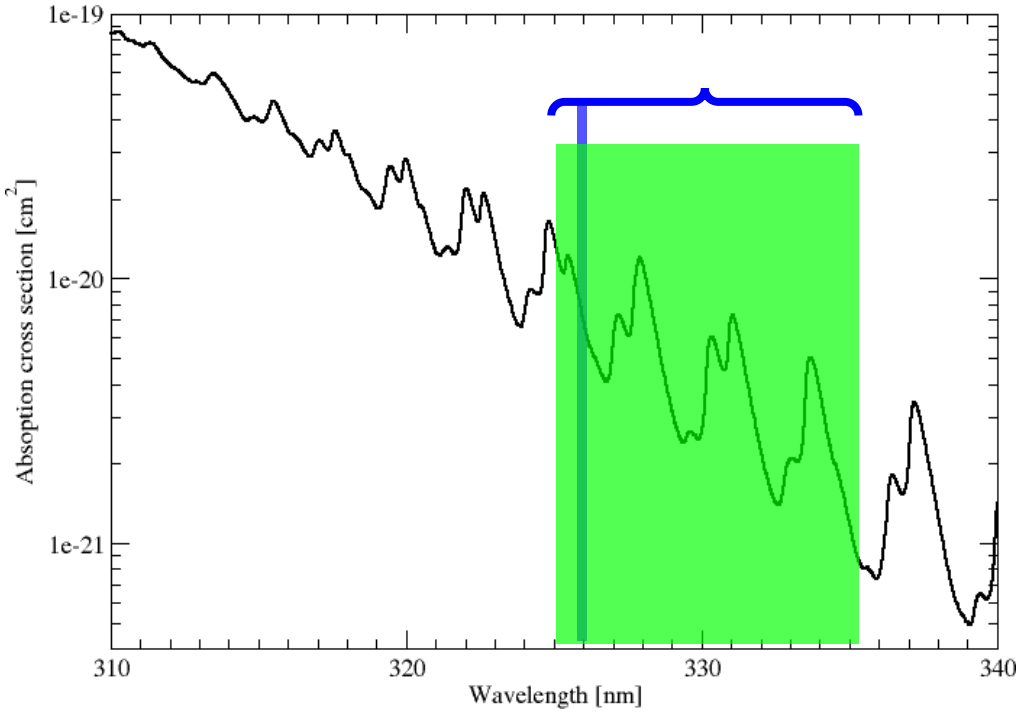
TROPOMI/S5P – Operational L2 Products

Parameter	Data Product	Vertical Resolution	Accuracy	Precision
Ozone 	Ozone Profile	6 km	10-30%	10%
	Total Ozone (NRT, OFL)	total column	3.5-5%	1.6-2.5%
	Tropospheric Ozone	trop column		
NO_2 	Stratospheric NO_2	strat column	< 10%	0.5e15
	Tropospheric NO_2	trop column	25-50%	0.7e15
SO_2 	SO_2 enhanced	total column	30%	0.15-0.3 DU
	Total SO_2	total column	30-50%	1-3 DU
Formaldehyde 	Total HCHO	total column	40-80%	1.2e16
CO 	Total CO	total column	15%	< 10%
Methane 	Total CH_4 **(offline)**	total column	1.5%	1%
Cloud 	Cloud Fraction	total column	< 20%	0.05
	Optical Thickness (albedo)	total column	< 20%	0.05
	Cloud Height (Pressure)	total column	< 20%	< 0.5 km (< 30hPa)
	SNPP VIIRS Cloud @ S5P			
Aerosol 	Aerosol Layer Height	total column	< 100hPa	< 50hPa
	Aerosol Type	total column	~1 AAI	< 0.1 AAI

TROPOMI/S5P – Total Ozone Algorithms Heritage

NRT: DOAS (GDP 4.x)

- DOAS fitting in the Huggins bands (325 to 335 nm)
  - O3 slant column and effective temperature
- Iterative AMF at 325.5 nm
- Lambertian cloud model (CRB)
- GOME/SCIAMACHY/GOME-2A/GOME-2B
  - EUMETSAT AC-SAF GOME-2 products



OFL: GODFIT (v 4)

- Direct fitting in the Huggins bands (325 to 335 nm)
  - O3 total column, effective temperature and albedo
- Effective scene located between ground and cloud
- GOME/SCIAMACHY/OMI/GOME-2A/GOME-2B
  - ESA CCI and Copernicus C3S

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TROPOMI/S5P – Total Ozone

- **NRT (GDP_CAL 5.0)**
  - **Polarization** correction for AMF calculation
    - Very important for large VZA
  - Improved *a priori* ozone profile **climatology**
    - Total O3-classified (Labow et al., 2015) and tropo. OMI/MLS (Ziemke et et al., 2011)
  - Optimal wavelength selection for AMF calculation
    - Change from 325.5 nm to **328.125 nm**
  - Cloud as layer (**CAL**) model
    - S5P OCRA/ROCINN cloud parameters (Loyola et al., 2018)
    - No need of ghost-column and intra-cloud corrections (Loyola et al., 2011)

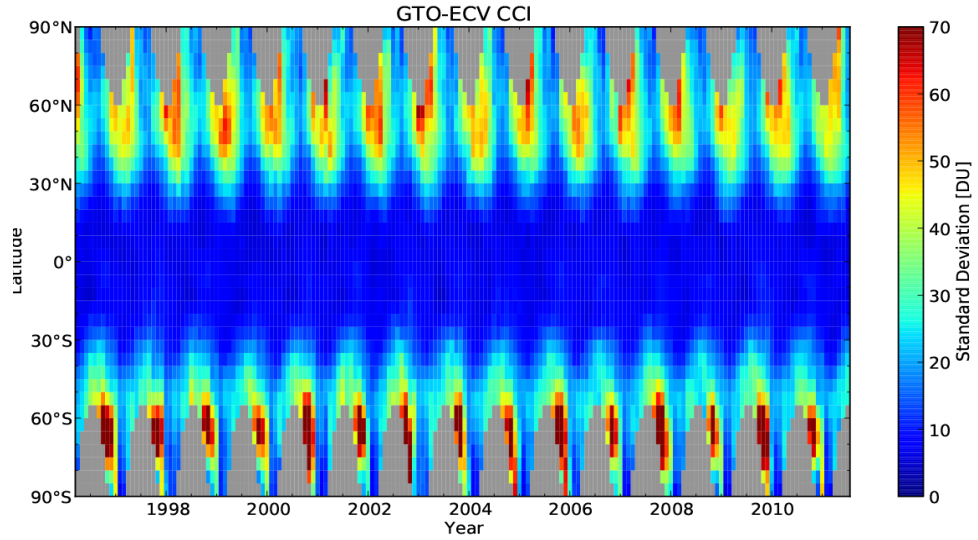
Atmosphere

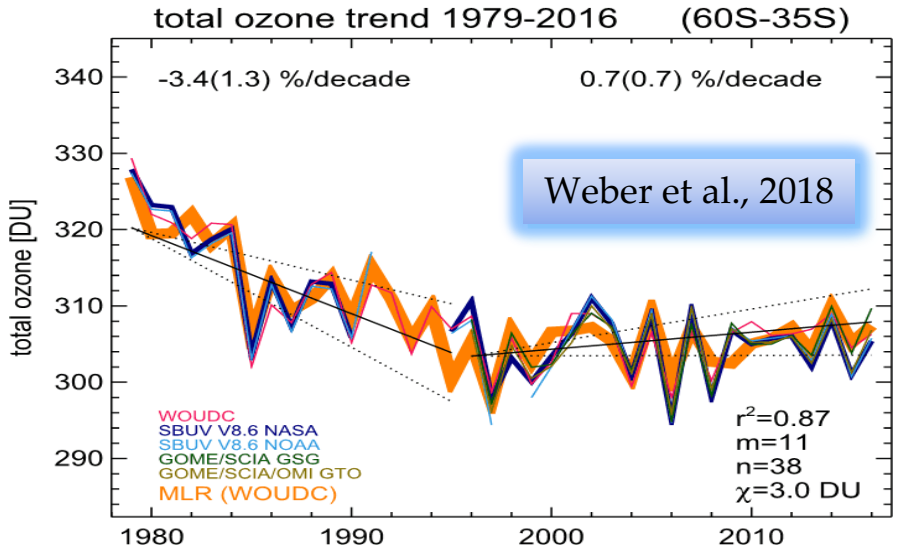
- **OFL (GODFIT 4.0)**
  - Use the latest version developed in the framework of ESA CCI (Lerot et al., 2014)
  - Two versions implemented:
    - On-the-fly LIDORT RTM
    - LUT version for speed

Climate

TROPOMI/S5P Total Ozone OFL – Continuation of GTO-ECV Dataset

- GOME-Type Total Ozone (GTO) ECV: 23 years of homogenized and merged data record from GOME, SCIAMACHY, OMI, GOME-2A, and GOME-2B
- GTO-ECV was developed in the framework of ESA Climate Change Initiative (CCI) and it is being updated in the EU Copernicus Climate Change Service (C3S)
- GTO-ECV used in quadrennial WMO Ozone Assessment , yearly AMS Bulletin, and a number of scientific publications
- **Very good agreement between GTO-ECV, SBUV and ground based ozone**





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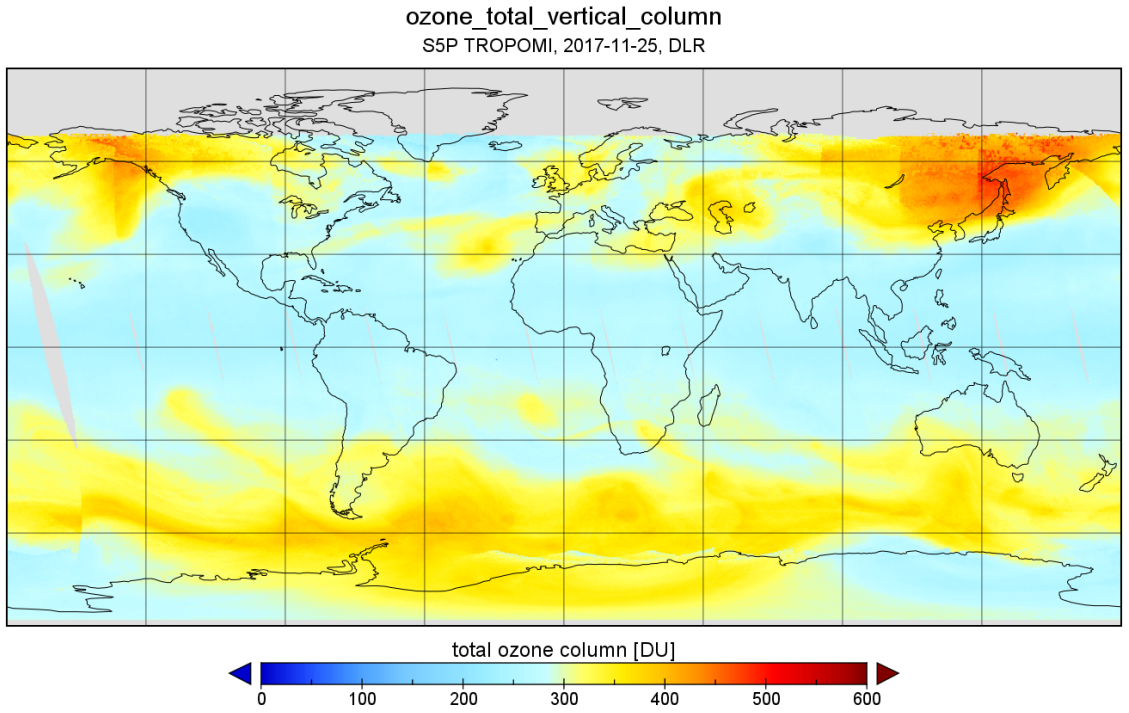
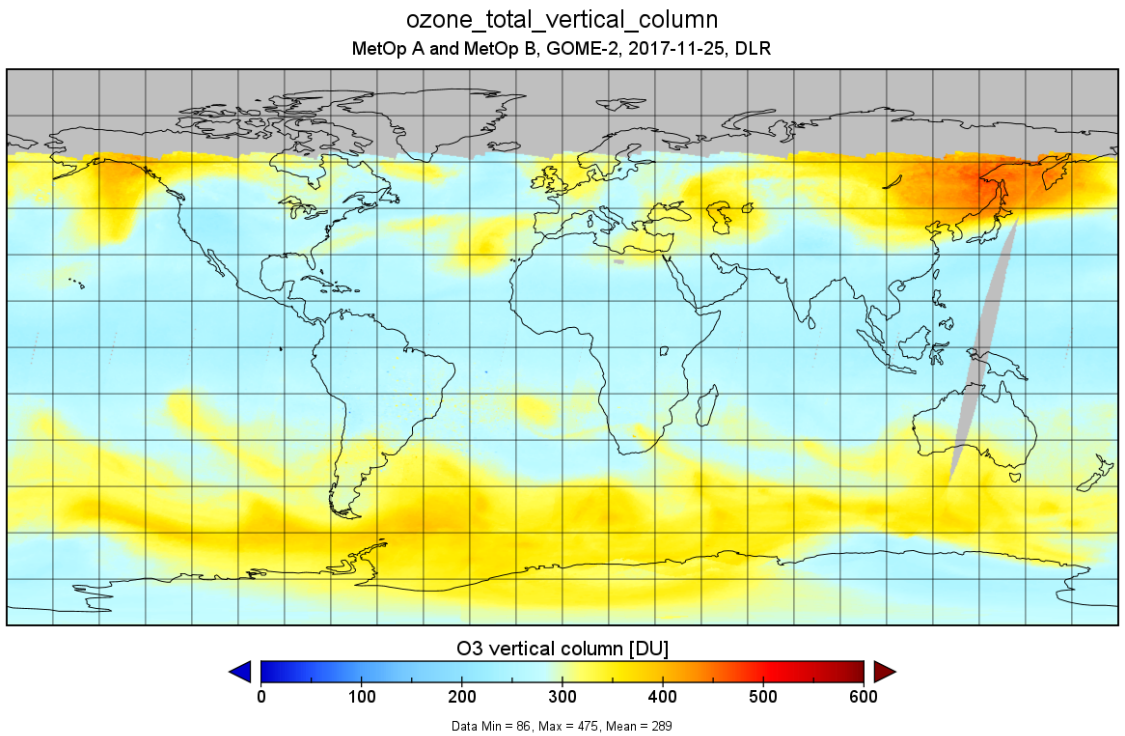
TROPOMI/S5P – Total Ozone GDP_CAL (NRT)





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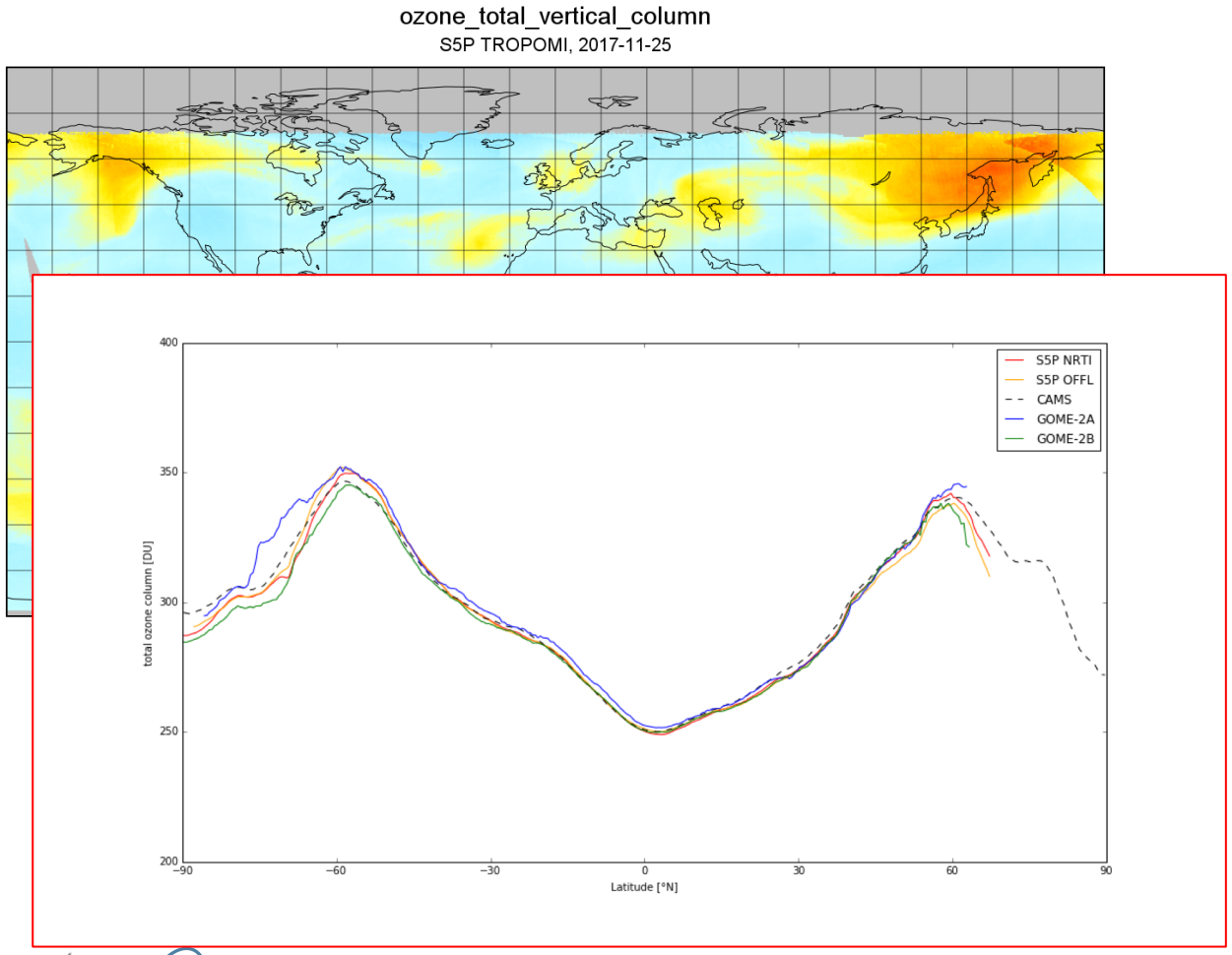
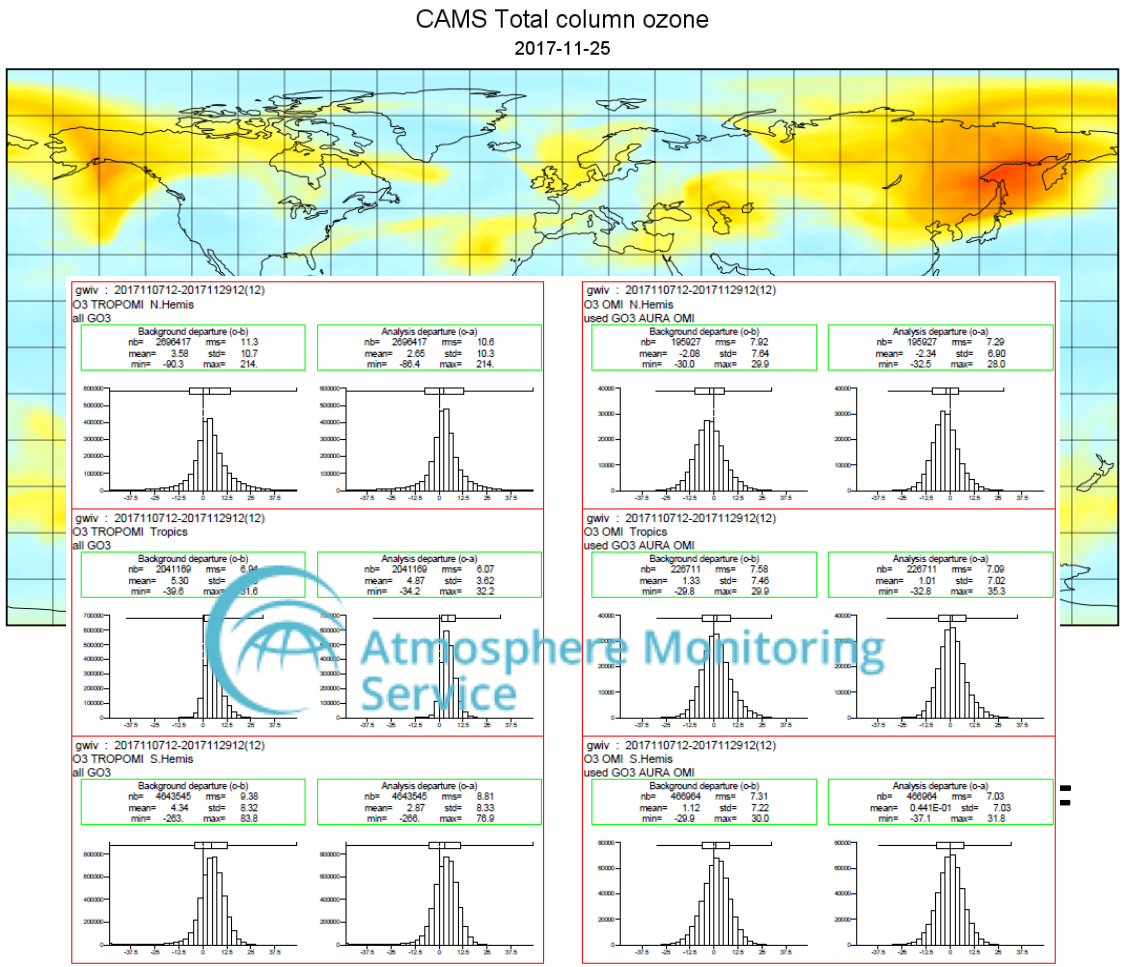
Loyola et al., 2011
Koukouli et al., 2012
Hao et al., 2014

TROPOMI/S5P – Total Ozone GODFIT (OFL)

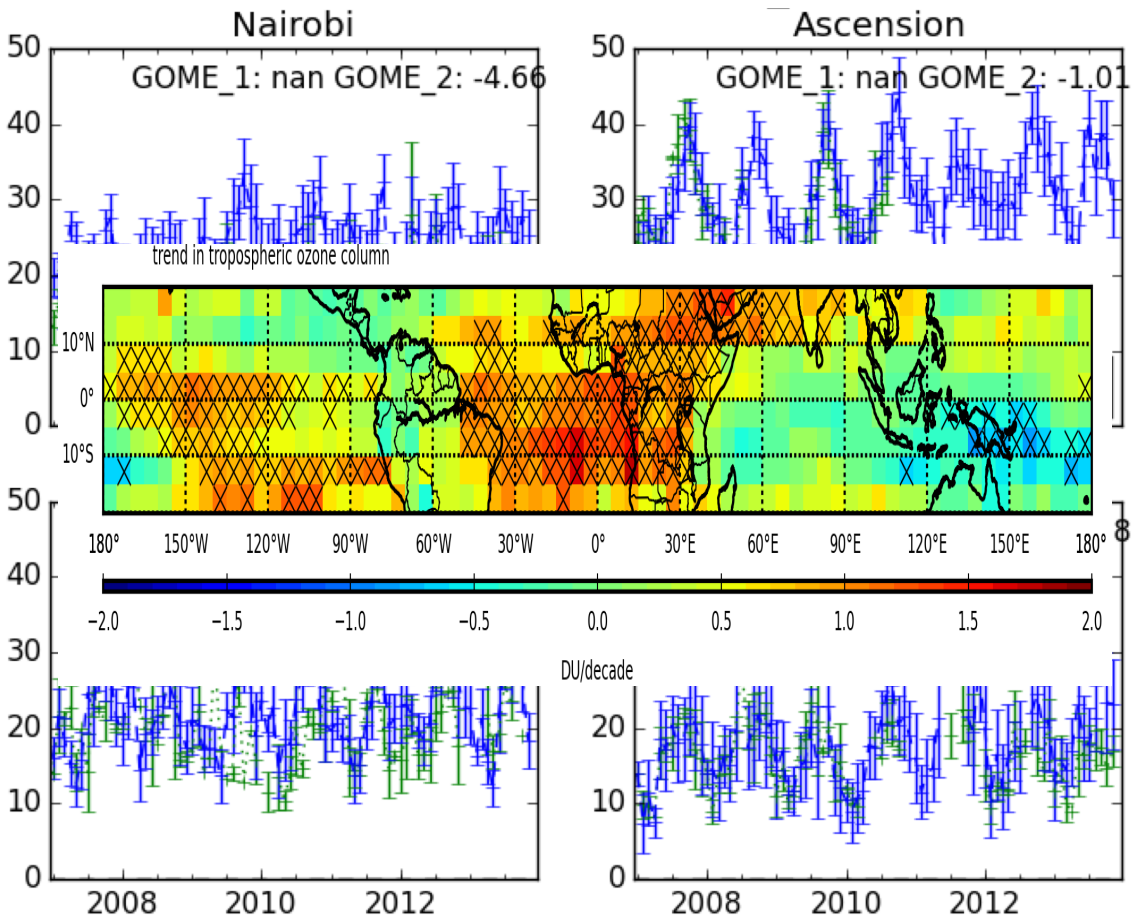




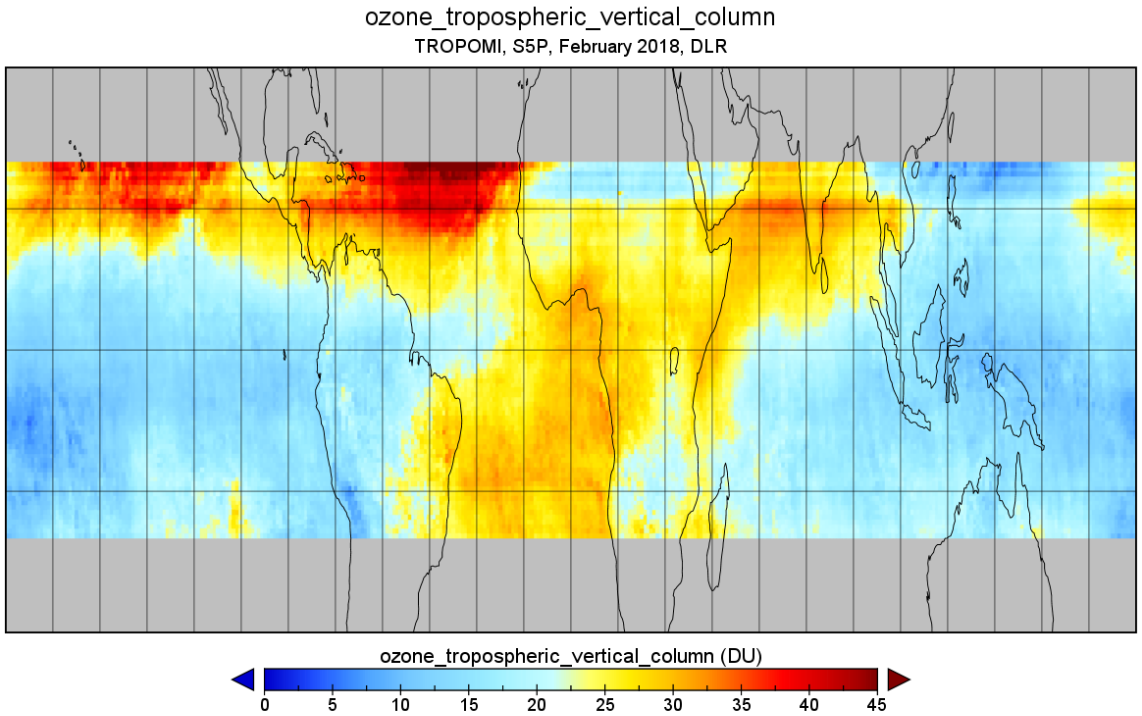
Courtesy Antje Inness

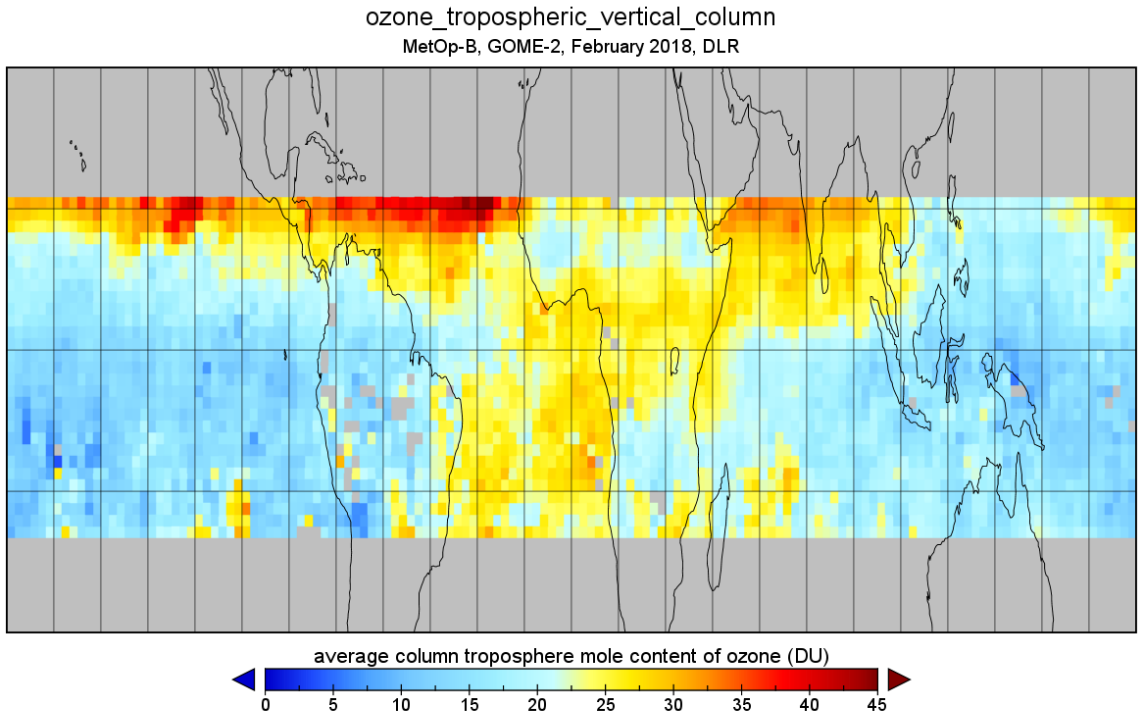
TROPOMI/S5P – Tropical Tropospheric Ozone Column

- CCD algorithm developed for TOMS
- Successfully adapted to GOME, SCIAMACHY, GOME-2A/B (Valks et al., 2014; Heue et al., 2016)
- Comparison with SCIAMACHY (limb-nadir matching)
  - Negative offset ~2 DU
- Comparison with sondes
  - Positive offset ~2 DU
  - Good agreement with annual cycle
- Adapted to TROPOMI (Heue et al., 2016)



TROPOMI/S5P – Tropical Tropospheric Ozone Column





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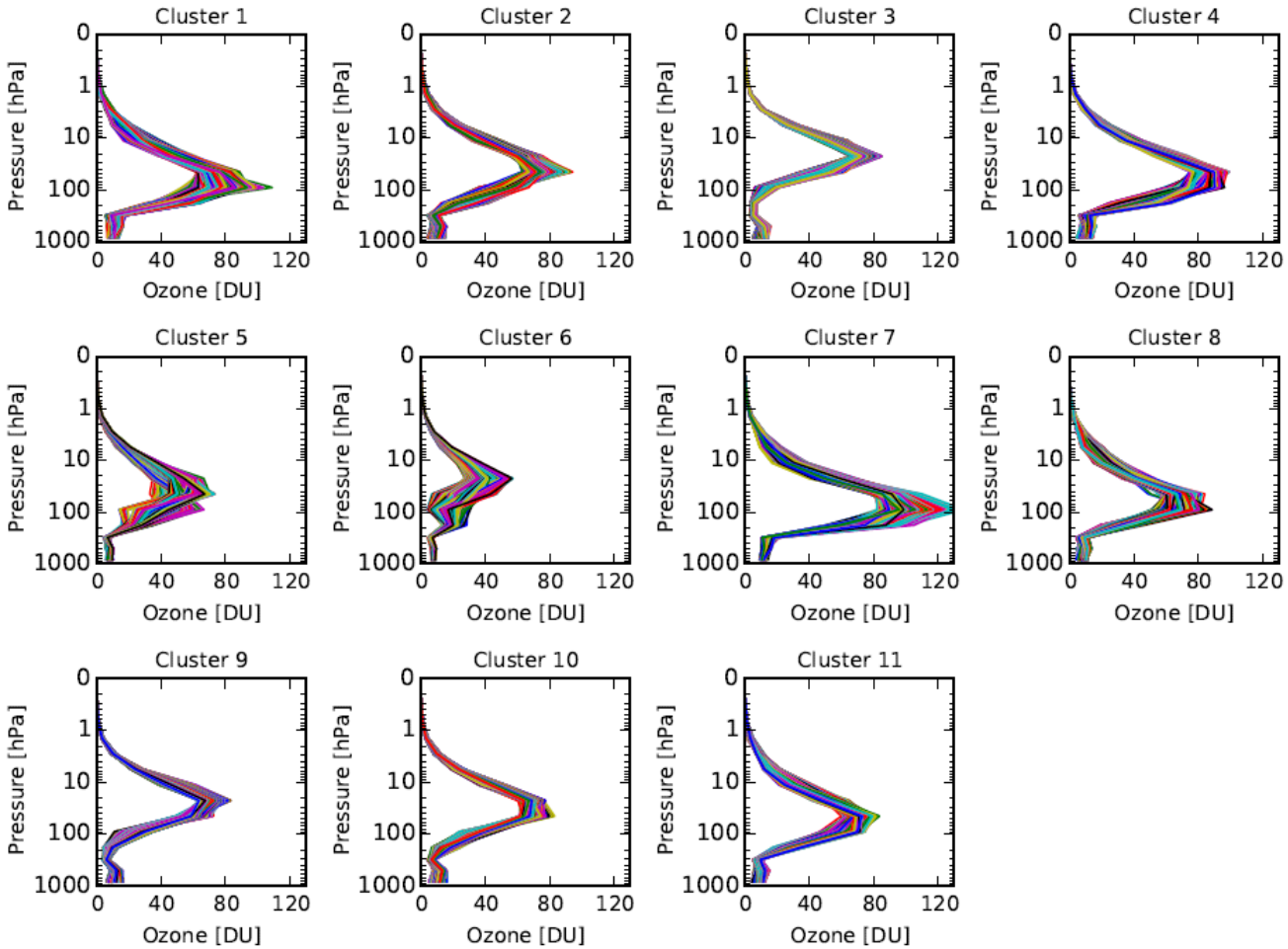
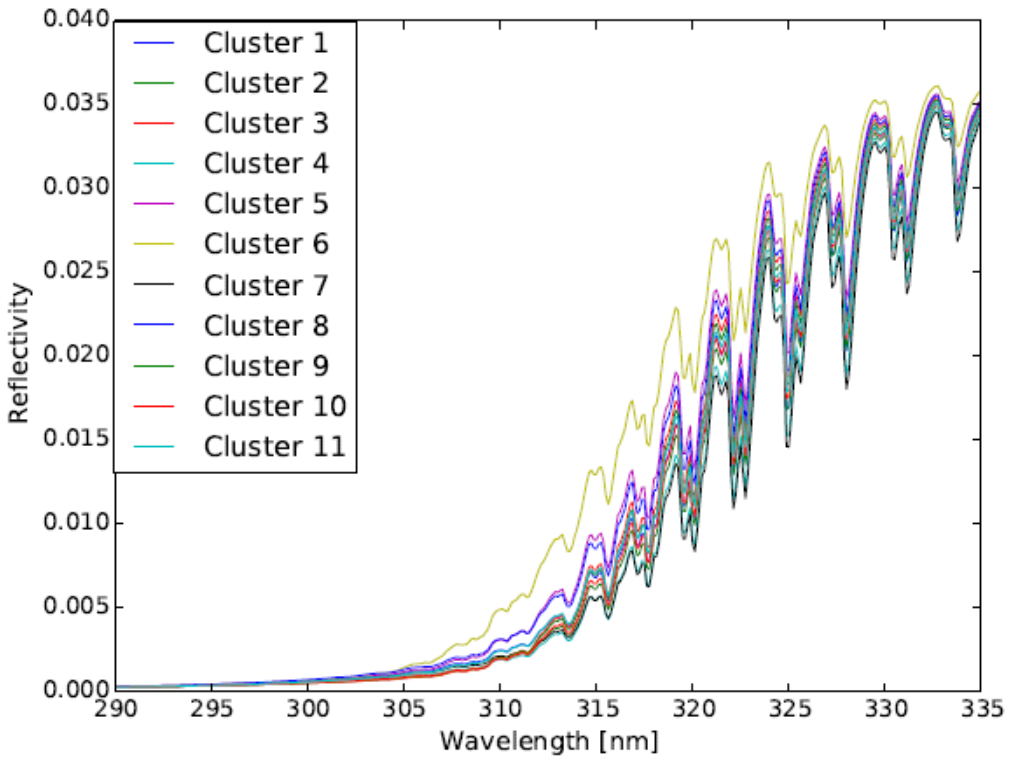
Ozone profile shape determination using machine learning

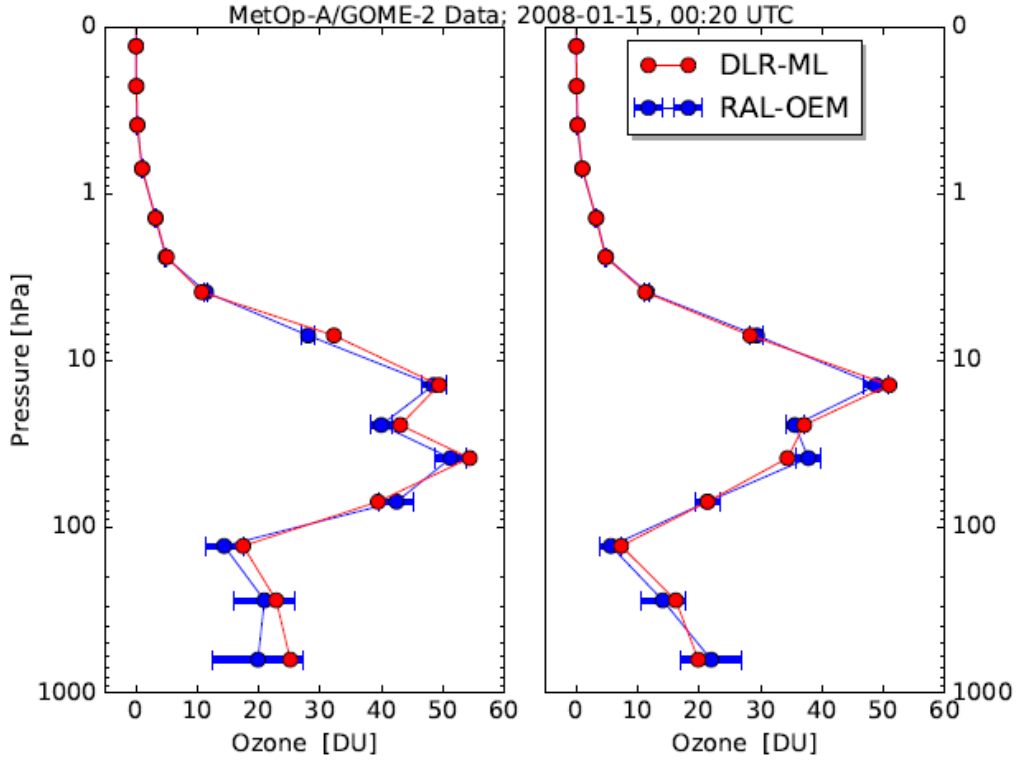
- Ozone profile algorithms from nadir UV satellites are based on Optimal Estimation
  - Iterative fitting of forward model simulations to the observations
  - Computational heavy

- Novel machine learning approach
  - Reformulate the ozone profile retrieval as a **classification problem**
  - Training using RTM simulations is very time consuming, but the application to satellite measurements is extremely fast.



FP-ILM for ozone profile shape retrieval





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A Novel Ozone Profile Shape Retrieval Using Full-Physics Inverse Learning Machine (FP-ILM)

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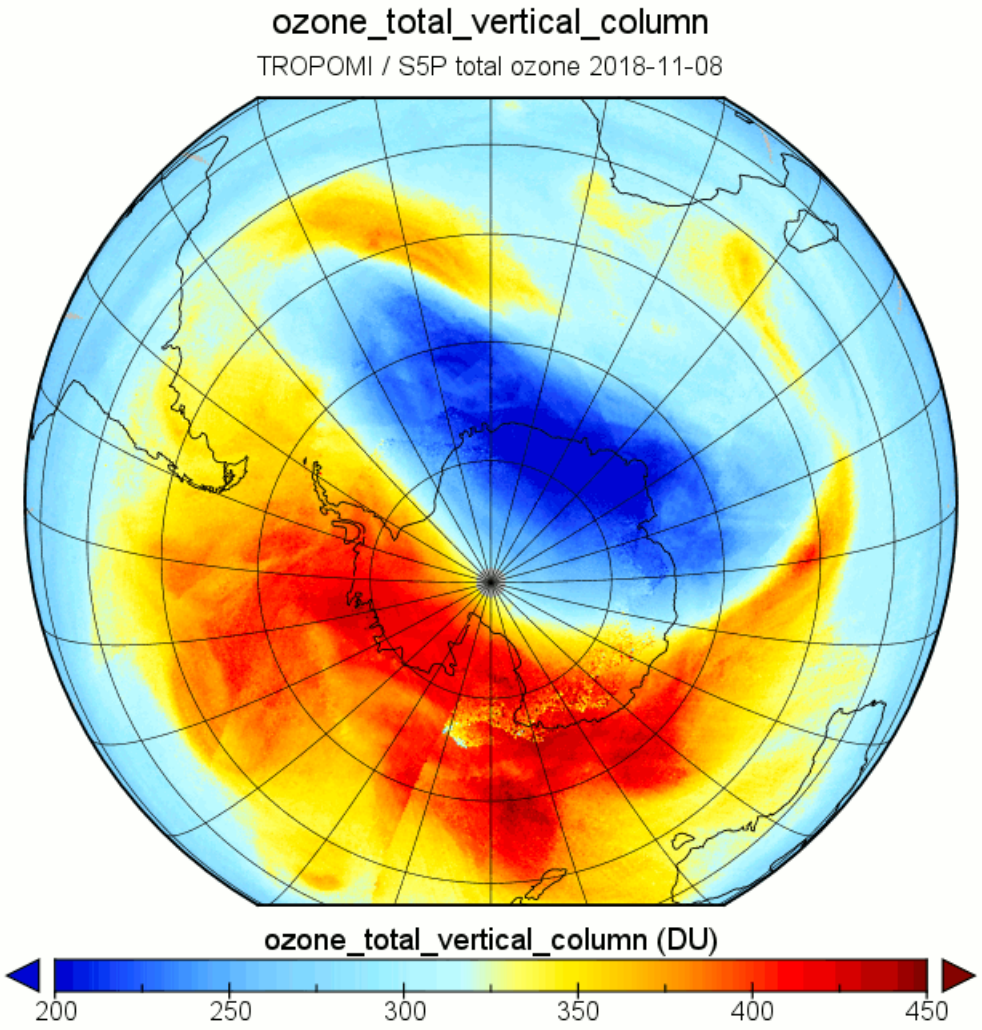
TROPOMI/S5P – Public Dissemination of Ozone Products

- NRT Total Ozone
  - June 2018
- Tropical Tropospheric Column
  - August 2018
- OFL Total Ozone
  - October 2018
- Ozone Profiles
  - December 2018



Disclaimer: The presented work has been performed in the frame of the Sentinel-5 Precursor Validation Team (S5PVT) or Level 1/Level 2 Product Working Group activities. Results are based on preliminary (not fully calibrated/validated) Sentinel-5 Precursor data that will still change.

Acknowledgement: Sentinel-5 Precursor is a European Space Agency (ESA) mission on behalf of the European Commission (EC). The TROPOMI payload is a joint development by ESA and the Netherlands Space Office (NSO). The Sentinel-5 Precursor ground-segment development has been funded by ESA and with national contributions from The Netherlands, Germany, and Belgium

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