TROPOMI/S5P Research Products

Diego Loyola and the TROPOMI/S5P teams at BIRA, DLR, IUP, MPIC, NASA, SRON

CEOS AC-VC 15, 11th June 2019

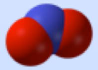
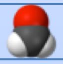
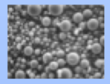
This presentation includes modified Copernicus data (2017-2019)

Outline

- Operational Products

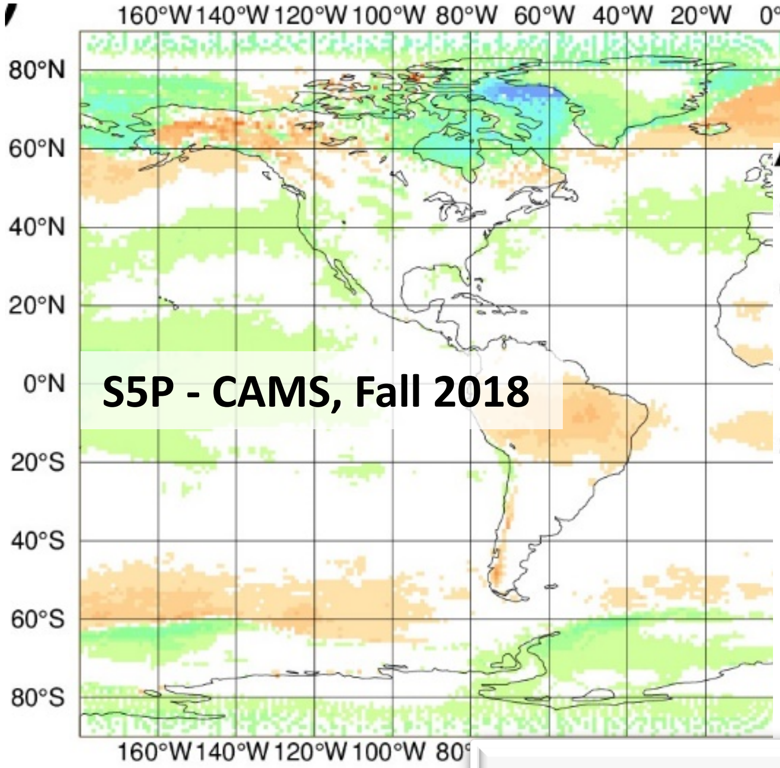
- Research Products
    - Effective Scene Albedo
    - Glyoxal
    - Bromine Monoxide
    - Chlorine Dioxide
    - Water Vapour
    - H2O/HDO
    - Sulphur Dioxide Layer Height
    - Aerosol Optical Depth
    - Erythemal Irradiance
    - Nitrous Acid

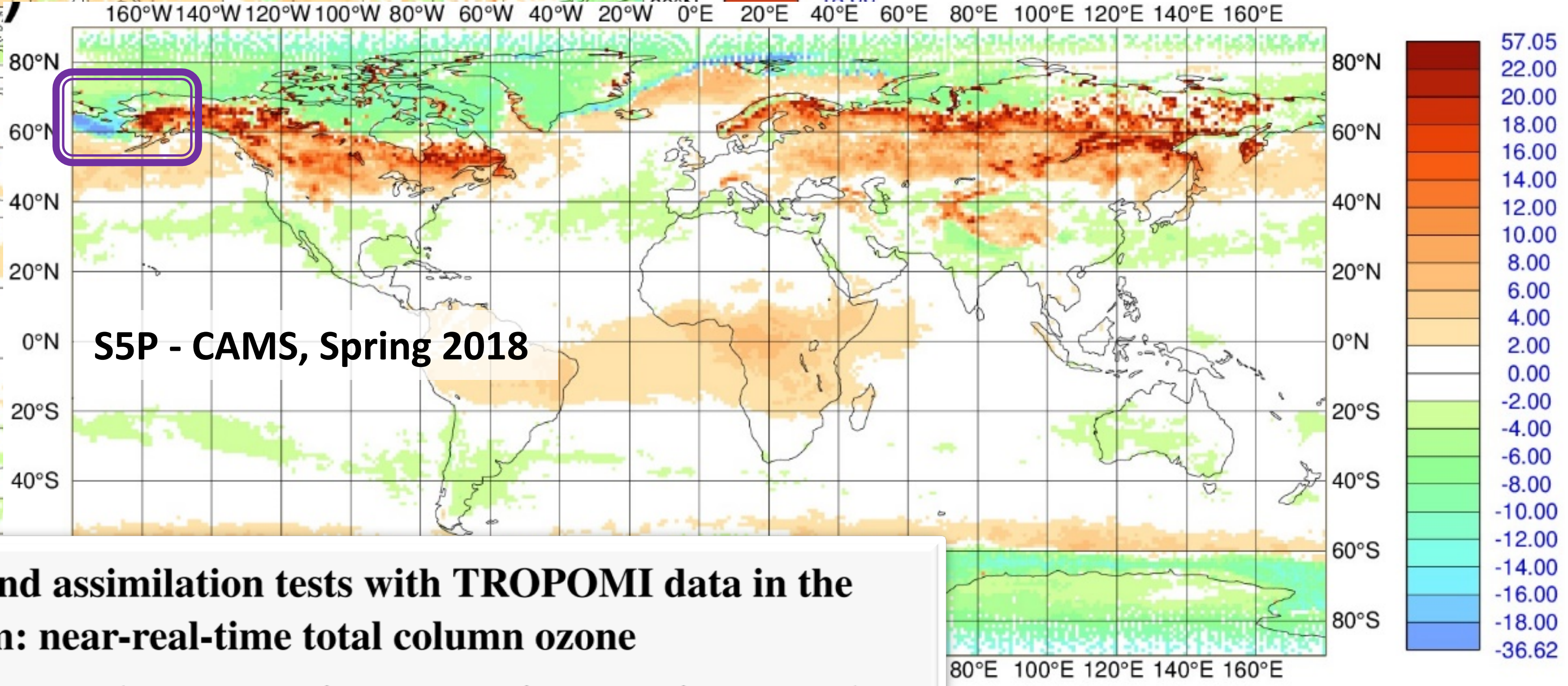
Sentinel-5 Precursor – Operational L2 Products

Parameter	Data Product	Vertical Resolution	Accuracy	Precision
Ozone 	Ozone Profile	6 km	10-30%	10%
	Total Ozone	total column	3.5-5%	1.6-2.5%
	Tropospheric Ozone	trop column	25%	25%
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	total column	1.5%	1%
Clouds 	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 Index	total column	~1 AAI	< 0.1 AAI

Sentinel-5 Precursor – O_3 Assimilation in CAMS/ECMWF

Atmosphere Monitoring Service





Monitoring and assimilation tests with TROPOMI data in the CAMS system: near-real-time total column ozone

Antje Inness[1], Johannes Flemming[1], Klaus-Peter Heue[2], Christophe Lerot[3], Diego Loyola[2], Roberto Ribas[1], Pieter Valks[2], Michel van Roozendael[3], Jian Xu[2], and Walter Zimmer[2]

[1]ECMWF, Shinfield Park, Reading, RG2 9AU, UK
[2]German Aerospace Centre (DLR), Remote Sensing Technology Institute, Oberpfaffenhofen, 82
[3]BIRA-IASB, Brussels, Belgium

Atmospheric Chemistry and Physics
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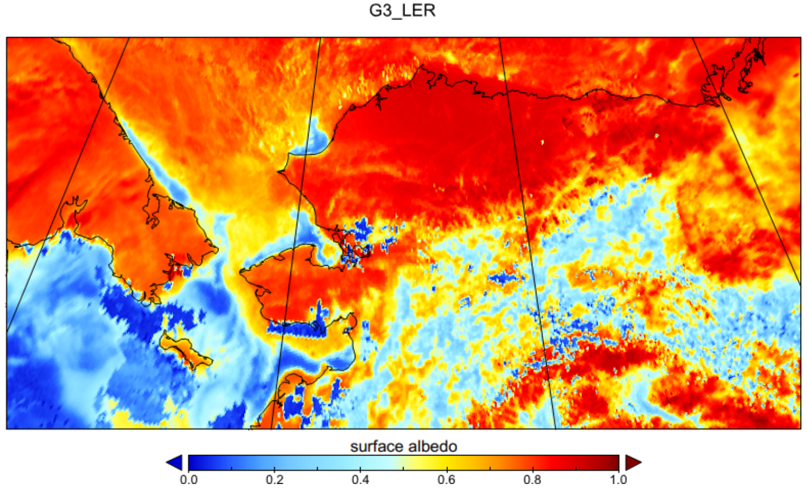
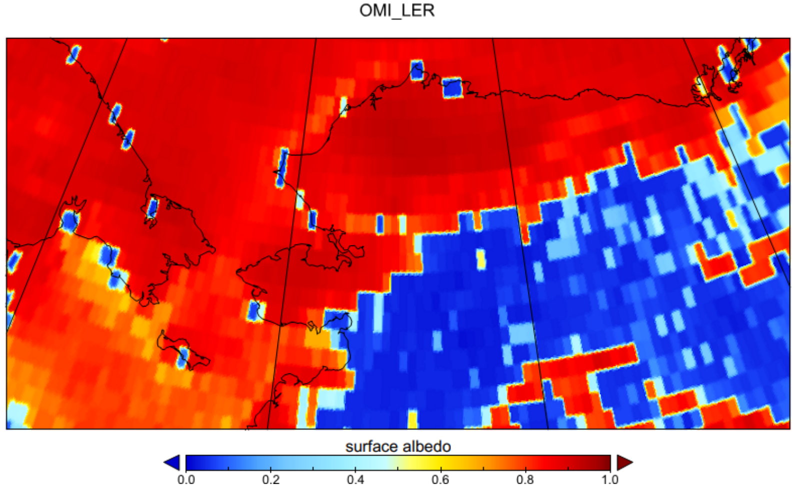
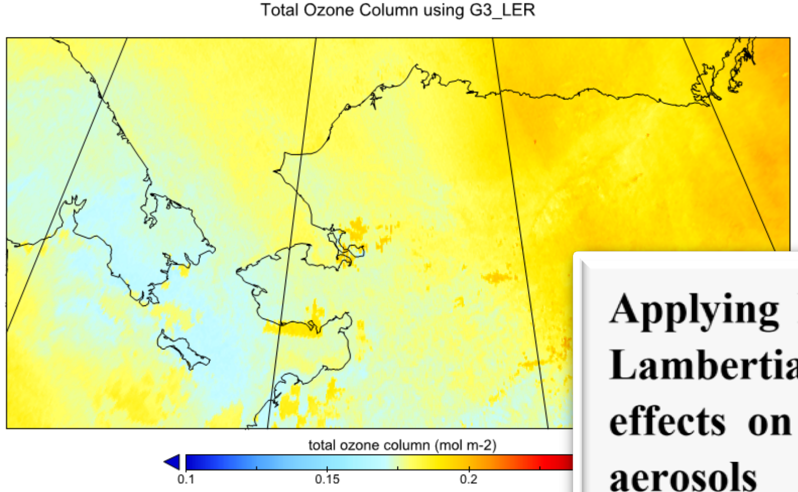
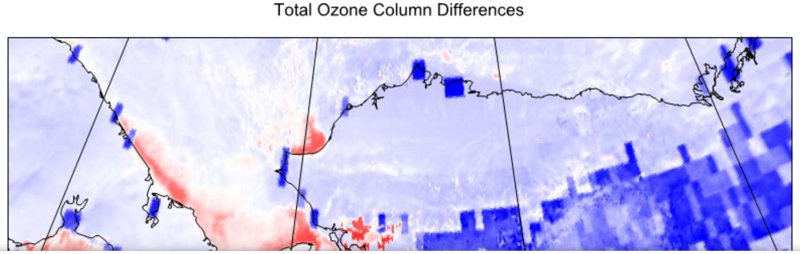
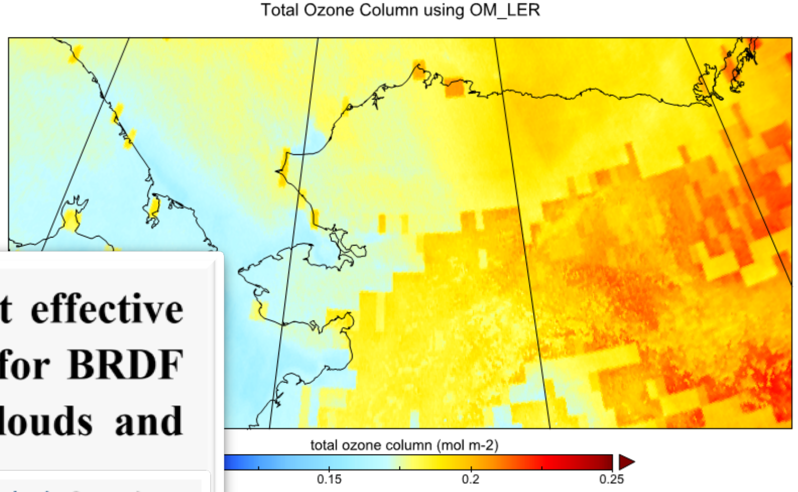
Sentinel-5 Precursor – FP_ILM Effective Scene Albedo











Applying FP_ILM to the retrieval of geometry-dependent effective Lambertian equivalent reflectivity (GE_LER) to account for BRDF effects on UVN satellite measurements of trace gases, clouds and aerosols

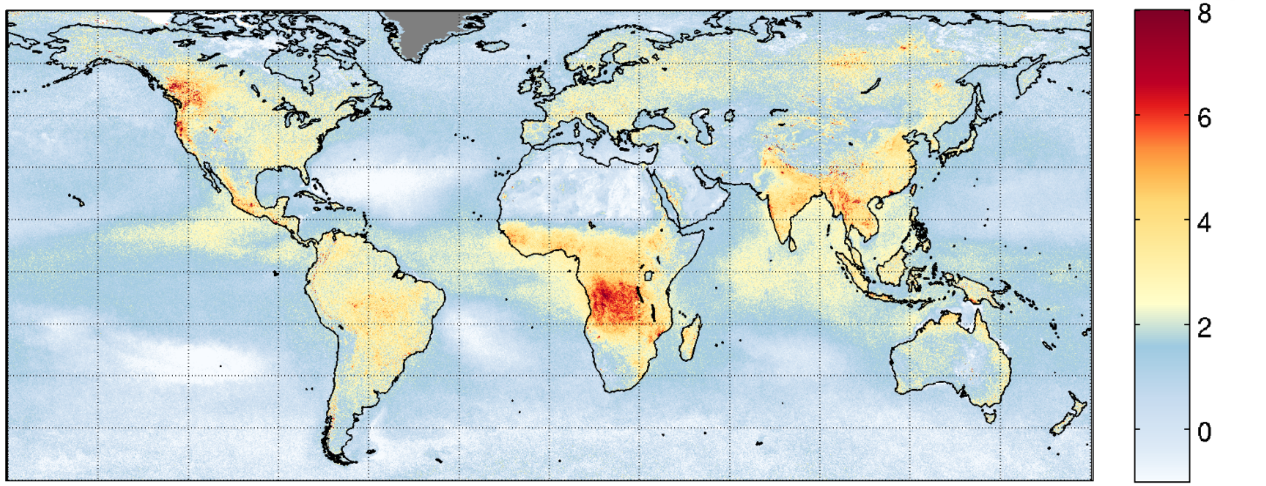
Diego G. Loyola[1], Jian Xu[1], Klaus-Peter Heue[1], Walter Zimmer[1]

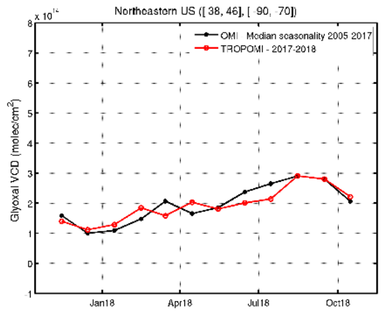
[1]German Aerospace Centre (DLR), Remote Sensing Technology Institute, Oberpfaffenhofen, 8223

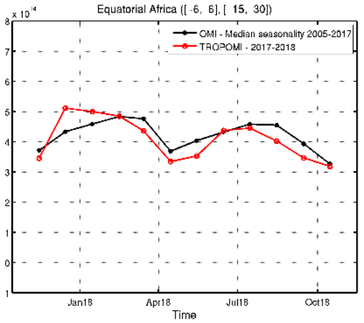
Atmospheric Measurement Techniques Discussions

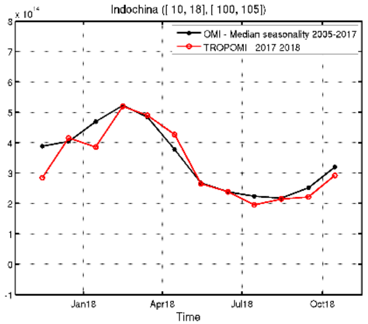
Sentinel-5 Precursor – Glyoxal (CHOCHO)

TROPOMI/S5p mean CHOCHO total columns (molec/cm^2)
11/2017-10/2018





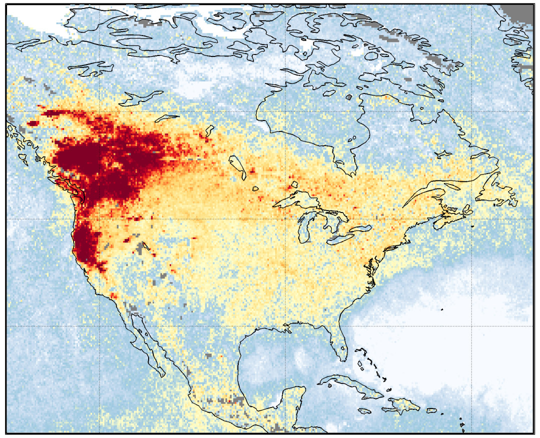




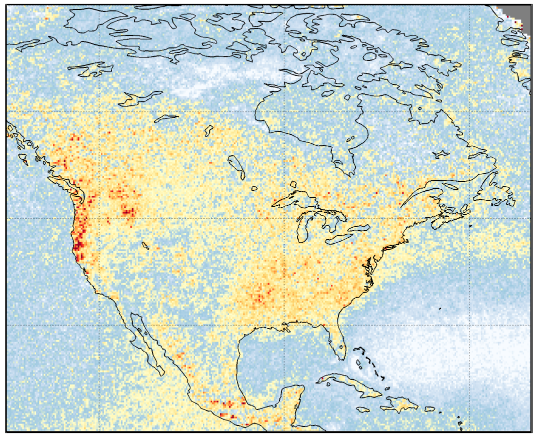
- Glyoxal is retrieved in the fit window 435-460 nm.
- Highly consistent with OMI.
- Very large columns observed in Northern America during 2018 Summer Wildfires.

2018 Northern America Wildfires

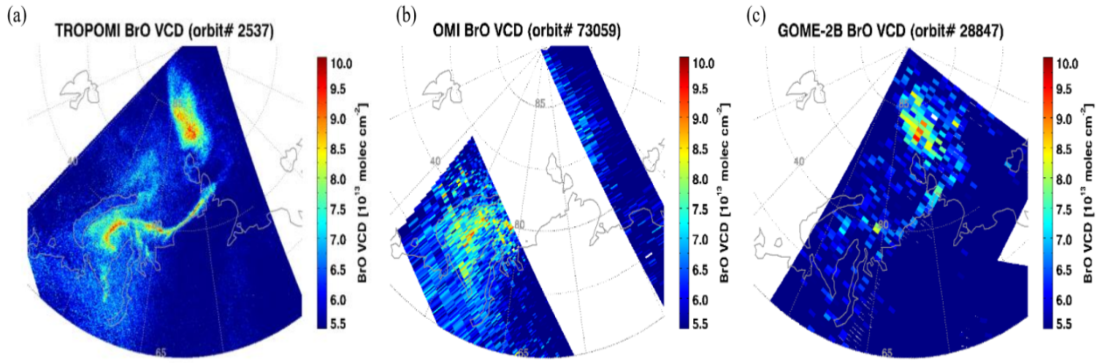
TROPOMI August 2018



Mean OMI August 2005-2017



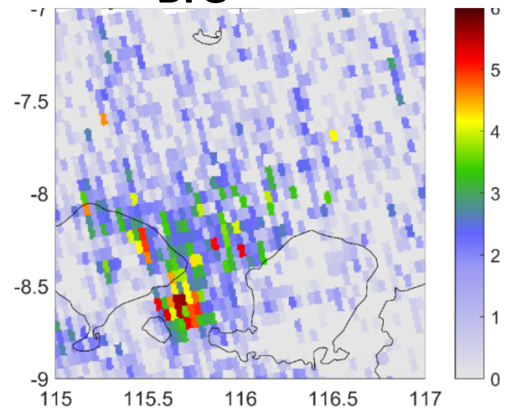
Sentinel-5 Precursor – Bromine Monoxide (BrO)

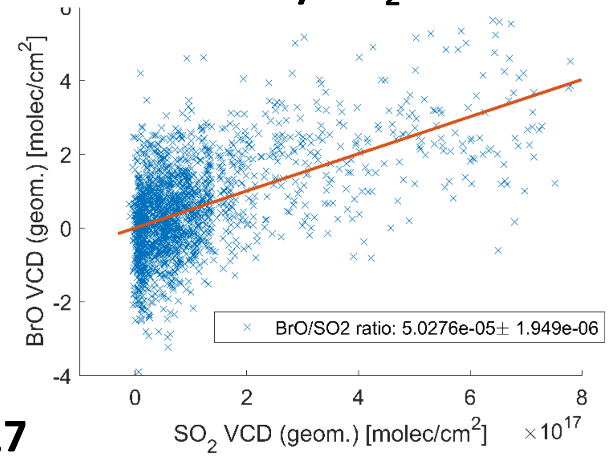


- BrO retrievals optimised for S5P data
- Global pattern is in agreement with other sensors
- Signal to noise is very good
- Nice localised events can be identified

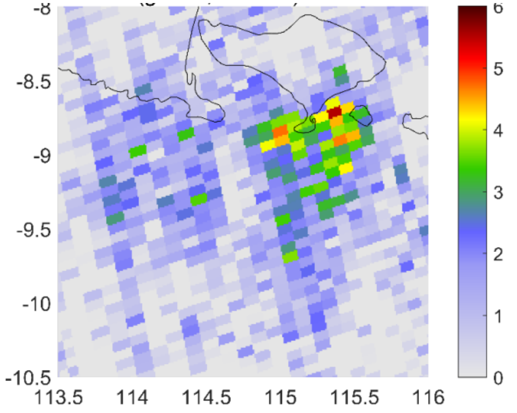
- Seo et al., AMT, 2019.

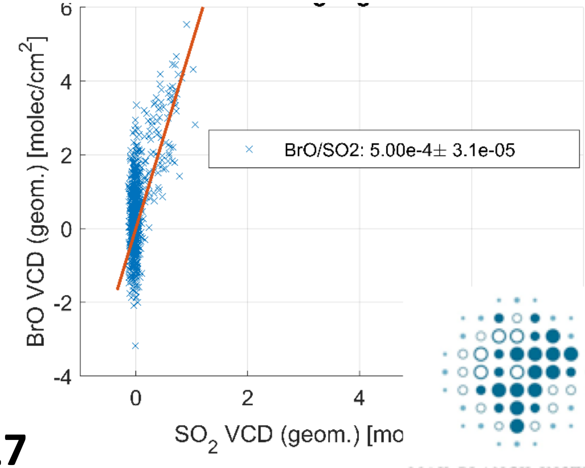
BrO **BrO / SO_2 ratio**





Agung, 27.11.2017

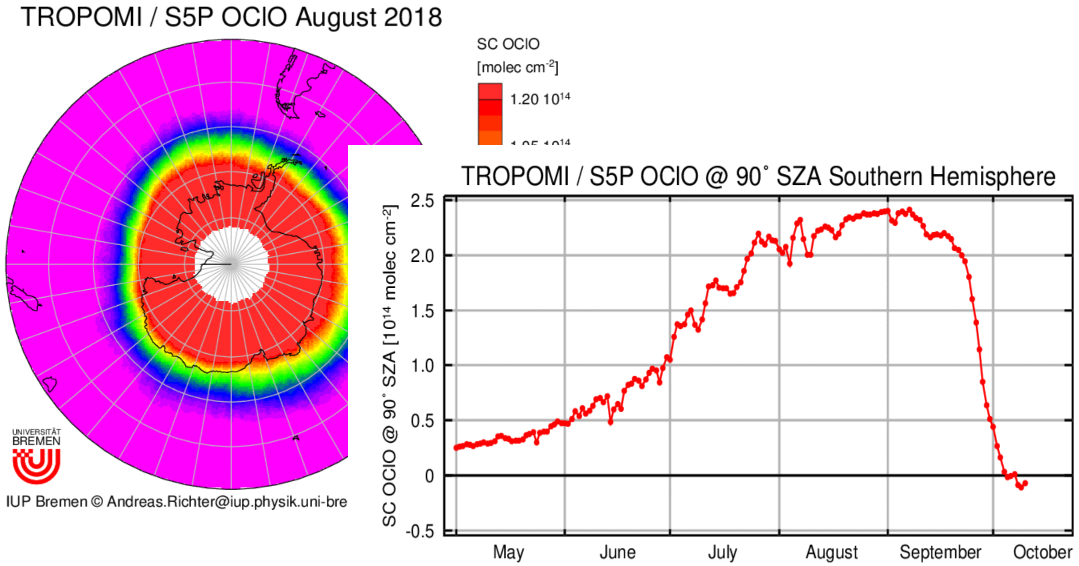




Agung, 29.11.2017

MAX-PLANCK-INSTITUT FÜR CHEMIE

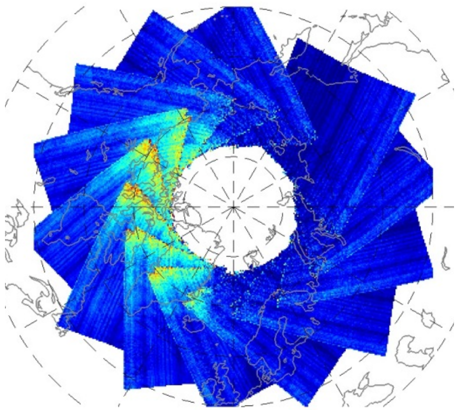
Sentinel-5 Precursor – Chlorine Dioxide (OClO)

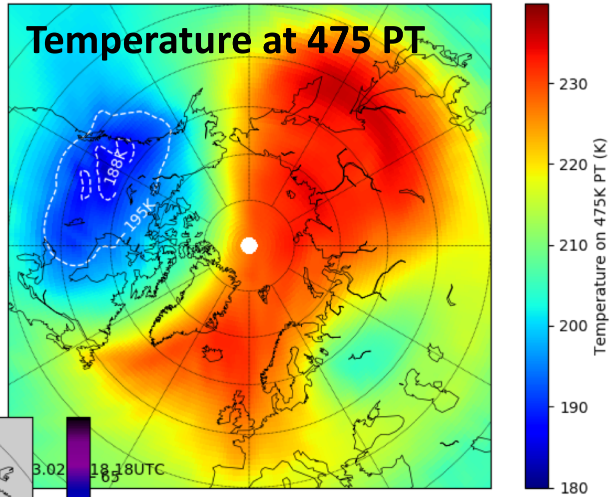


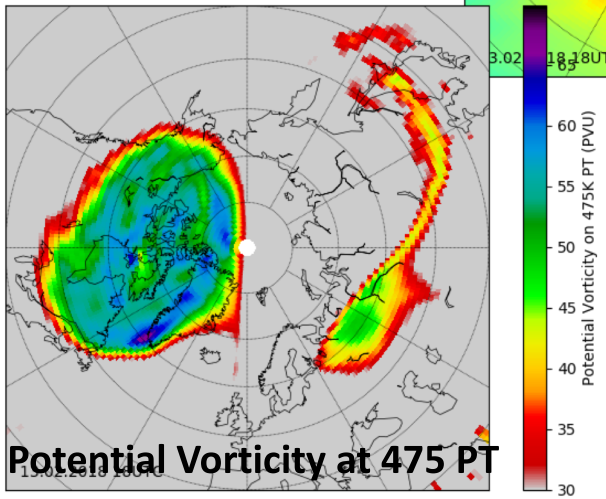
Chlorine activation in 2018

- Preliminary OClO retrievals on S5P data
- Global pattern is in agreement with other sensors
- Time evolution in Southern Hemisphere as expected
- Signal to noise is very good
- Some soft calibration probably needed

OClO SCD

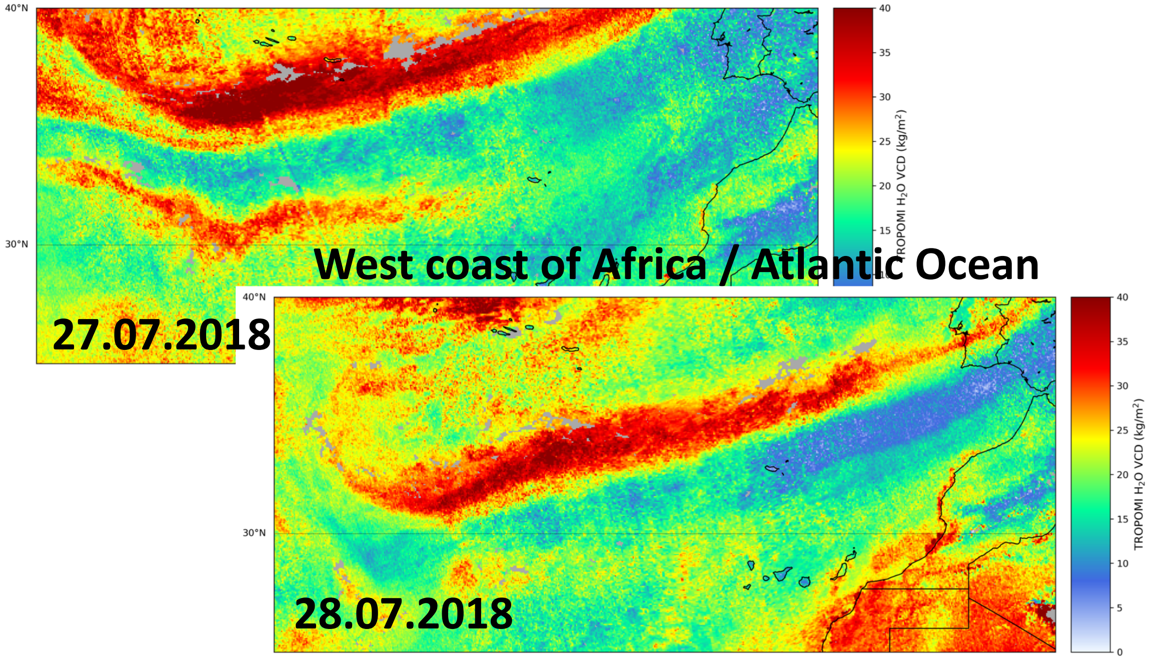






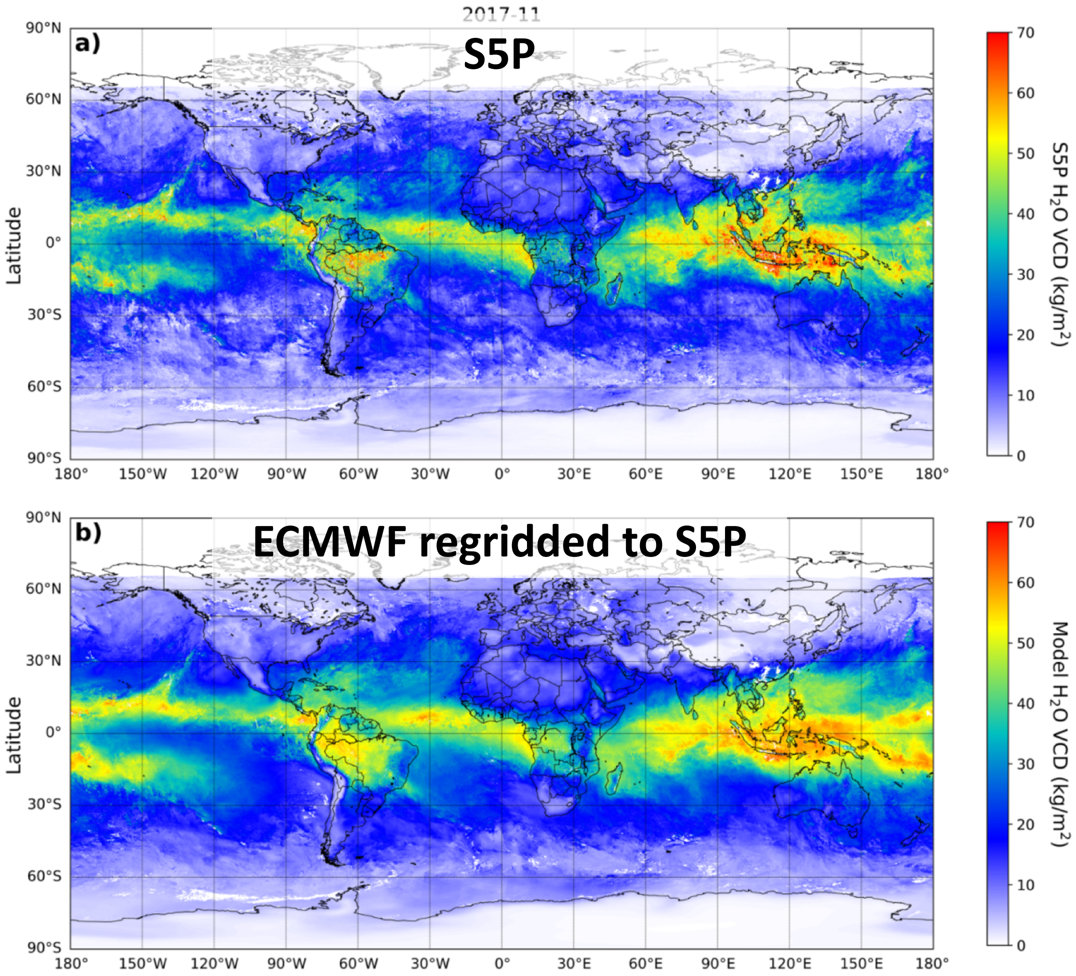
MAX-PLANCK-INSTITUT FÜR CHEMIE

Sentinel-5 Precursor – Water Vapour (H2O) in the “blue” band



TROPOMI enables the characterization and identification of fine Integrated Water Vapour structures (e.g. atmospheric rivers) on a daily basis with high spatial resolution

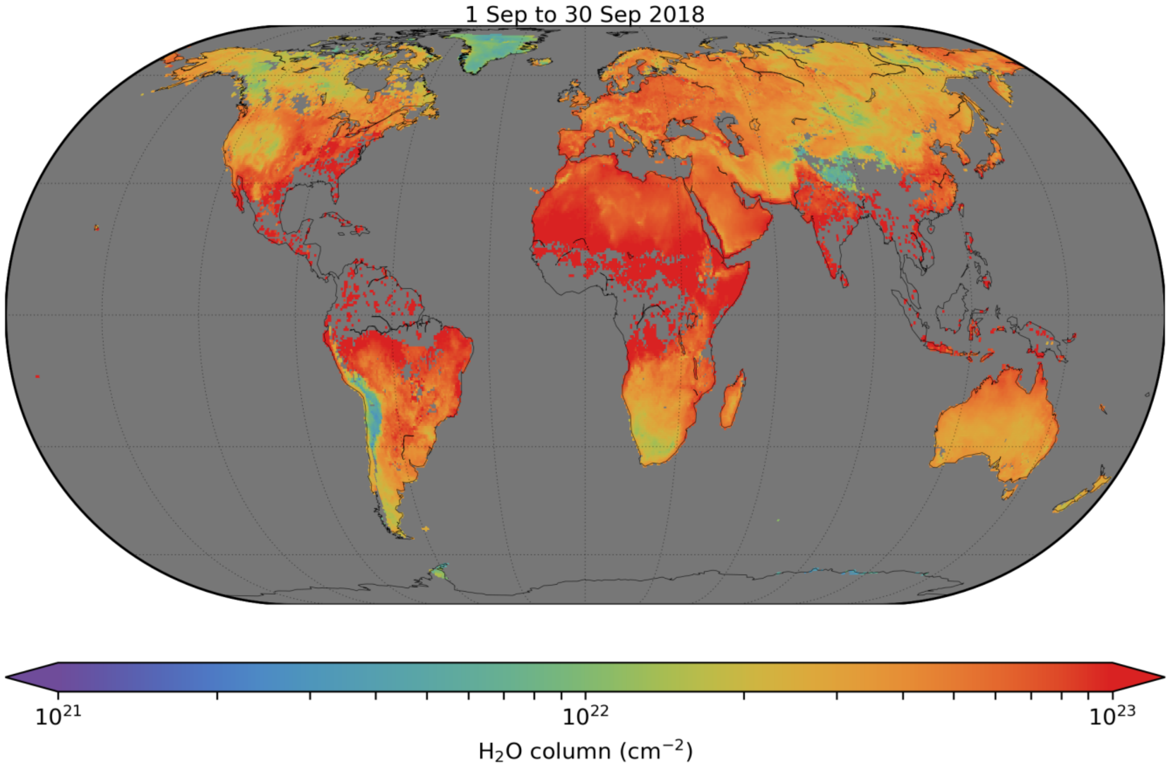
MAX-PLANCK-INSTITUT FÜR CHEMIE

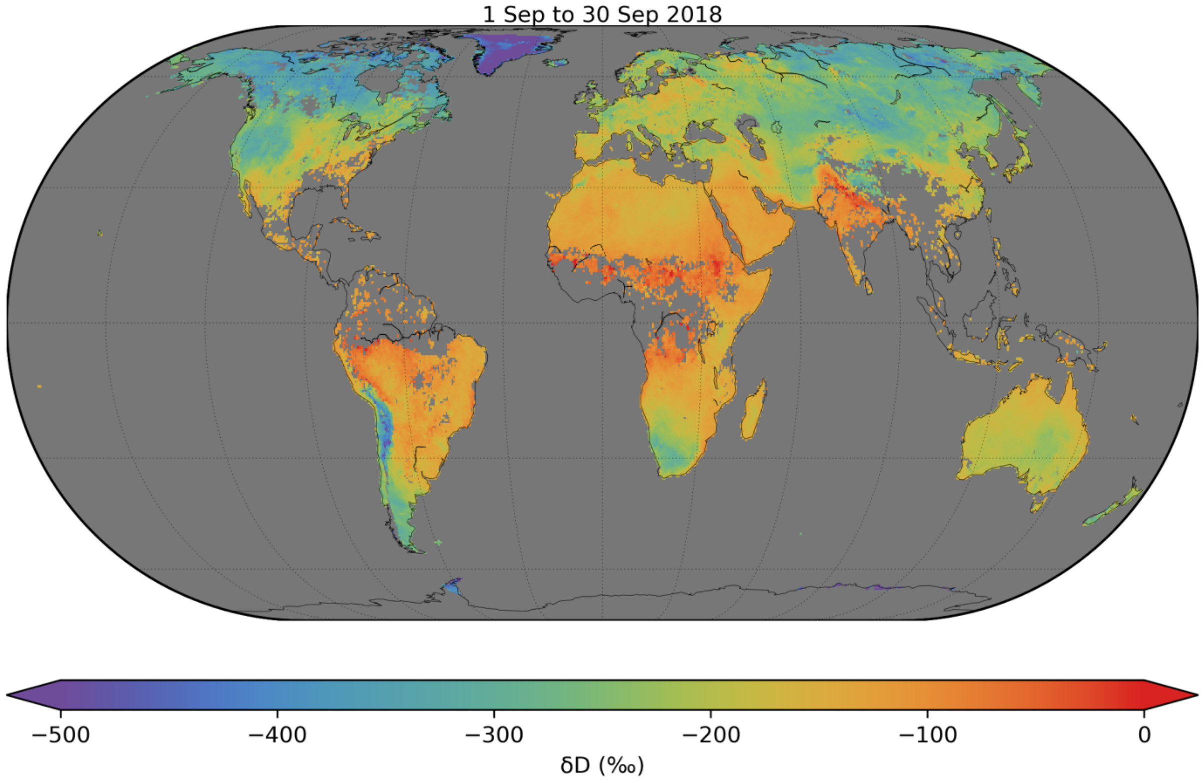


Chan et al., RSE, submitted 2019

DLR

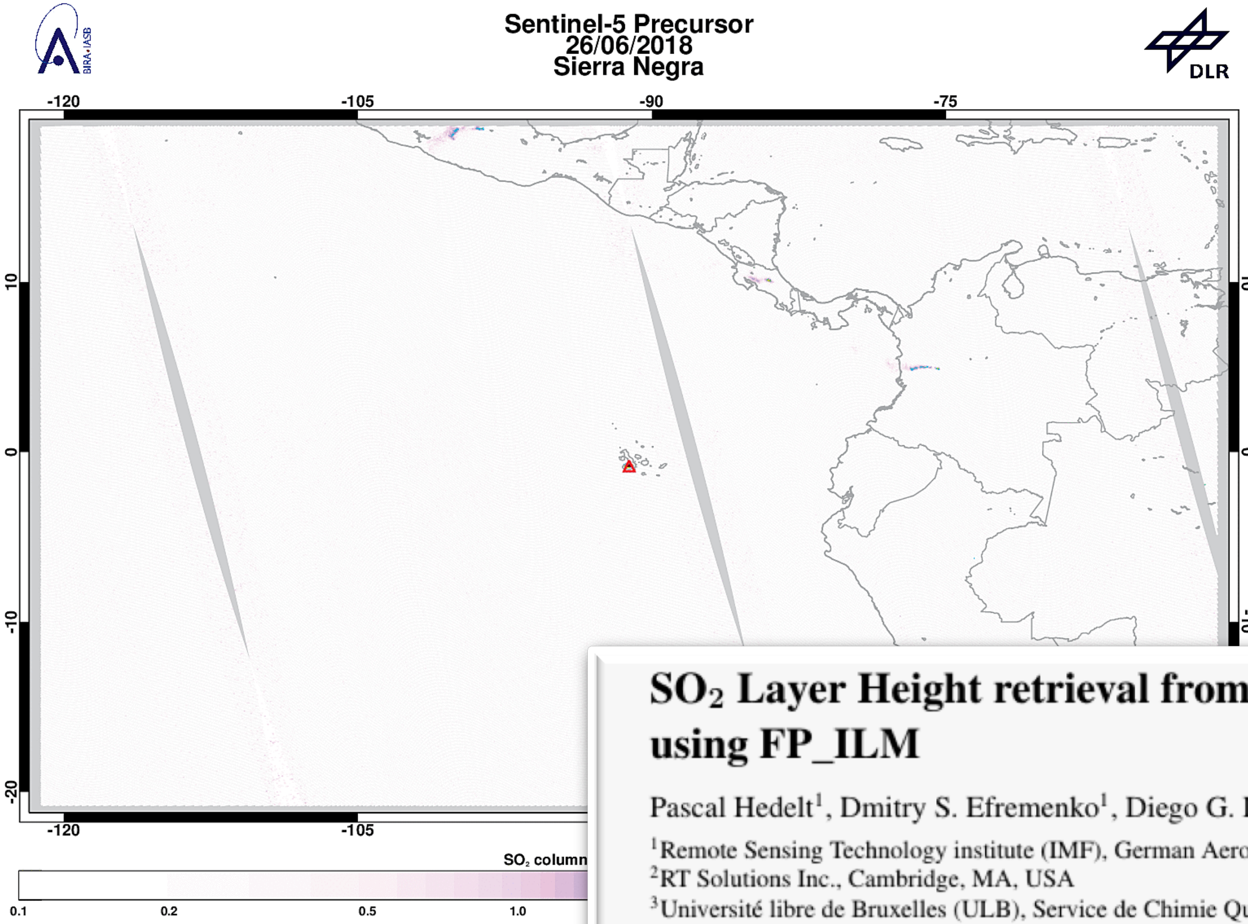
Sentinel-5 Precursor – H2O/HDO in the SWIR band





Sentinel-5 Precursor – Sulfur Dioxide (SO_2) Layer Height

Sierra Negra Volcano, Ecuador, 26th June to 3rd July 2018



SO_2 Layer Height retrieval from Sentinel-5 Precursor/TROPOMI using FP_ILM

Pascal Hedelt[1], Dmitry S. Efremenko[1], Diego G. Loyola[1], Robert Spurr[2], and Lieven Clarisse[3]

[1]Remote Sensing Technology institute (IMF), German Aerospace Center (DLR), Oberpfaffenhofen
[2]RT Solutions Inc., Cambridge, MA, USA
[3]Université libre de Bruxelles (ULB), Service de Chimie Quantique et Photophysique, Atmospheri
Belgium

Atmospheric Measurement Techniques Discussions
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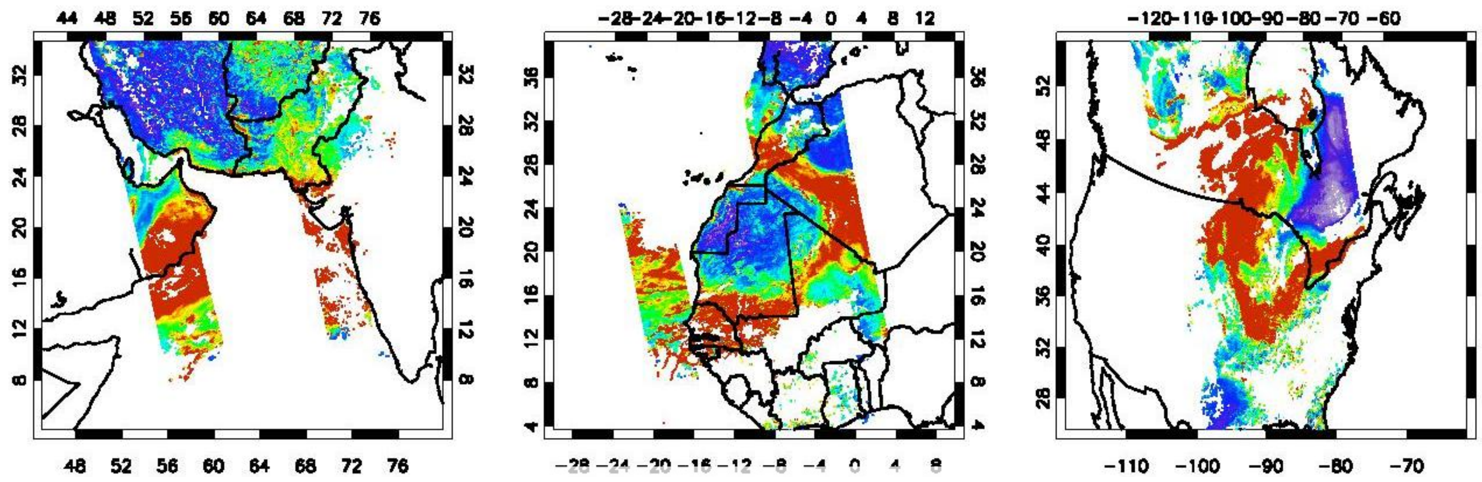
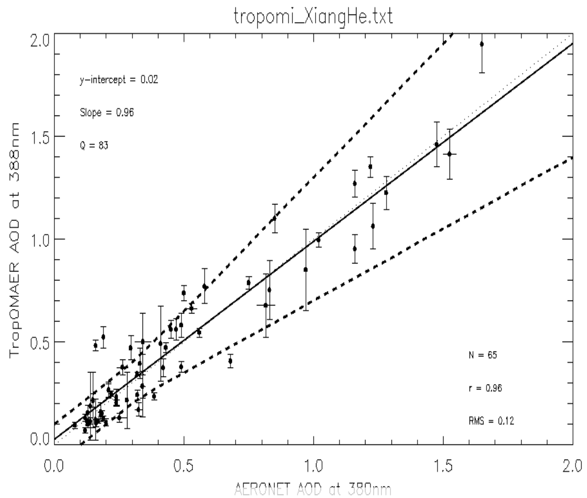
Sulphur Dioxide Concentrations [DU]
(S5P Operational Product)

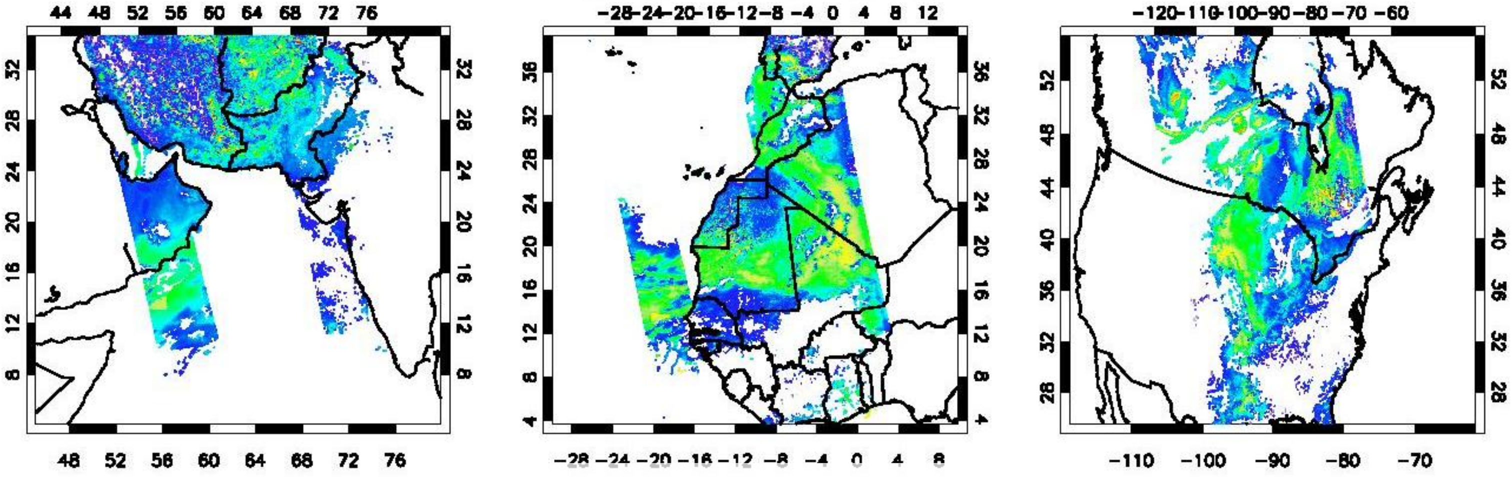
Sentinel-5 Precursor – Aerosol Optical Depth



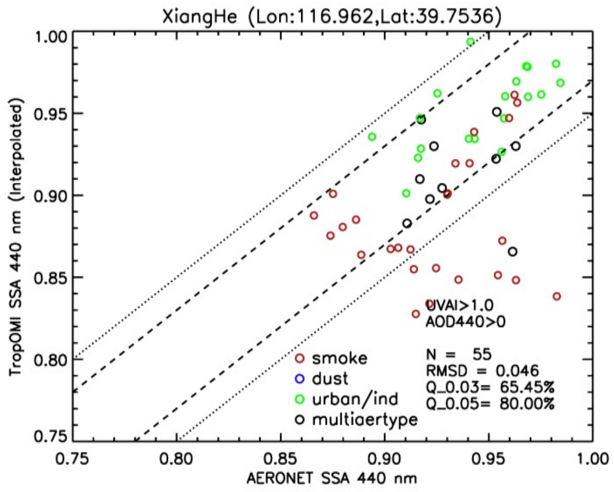
Aerosol Optical Depth



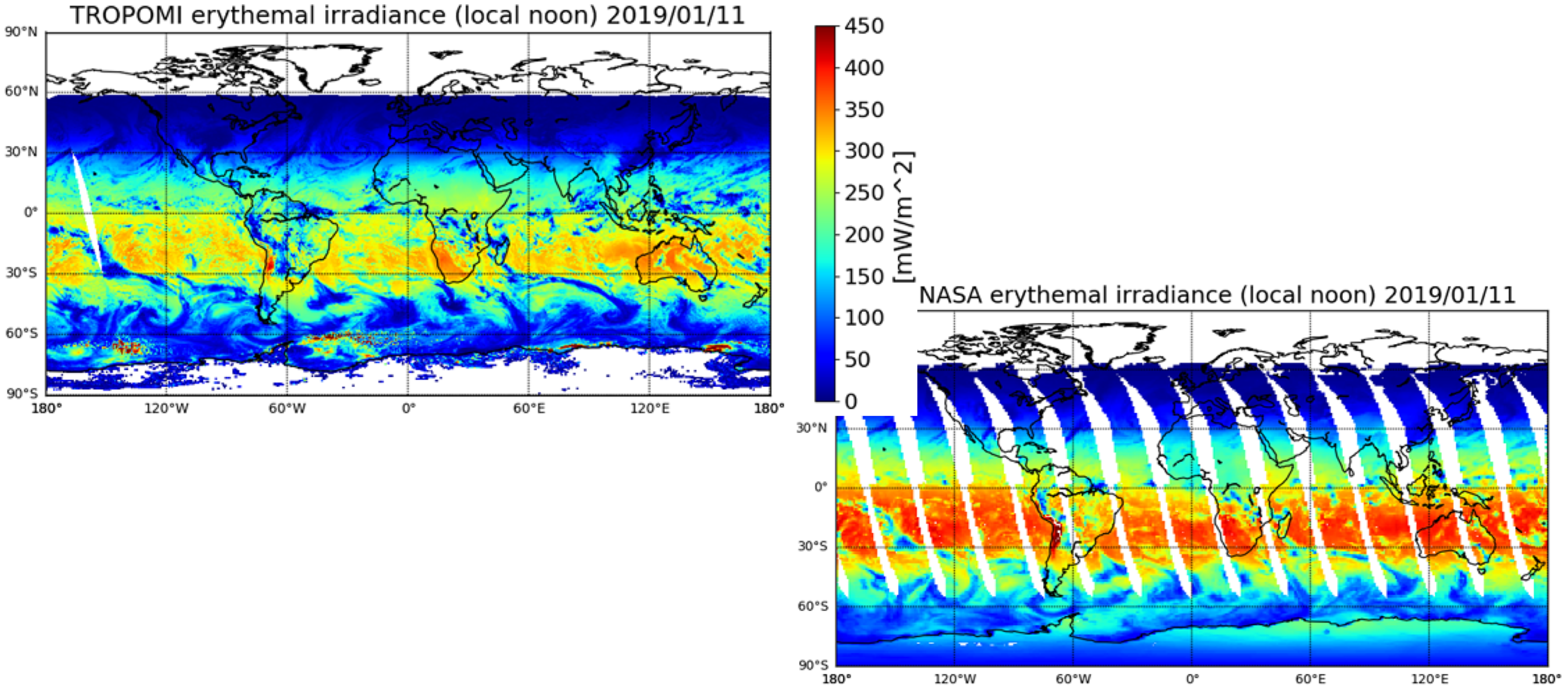
AERONET in XianHe, China



Single Scattering Albedo

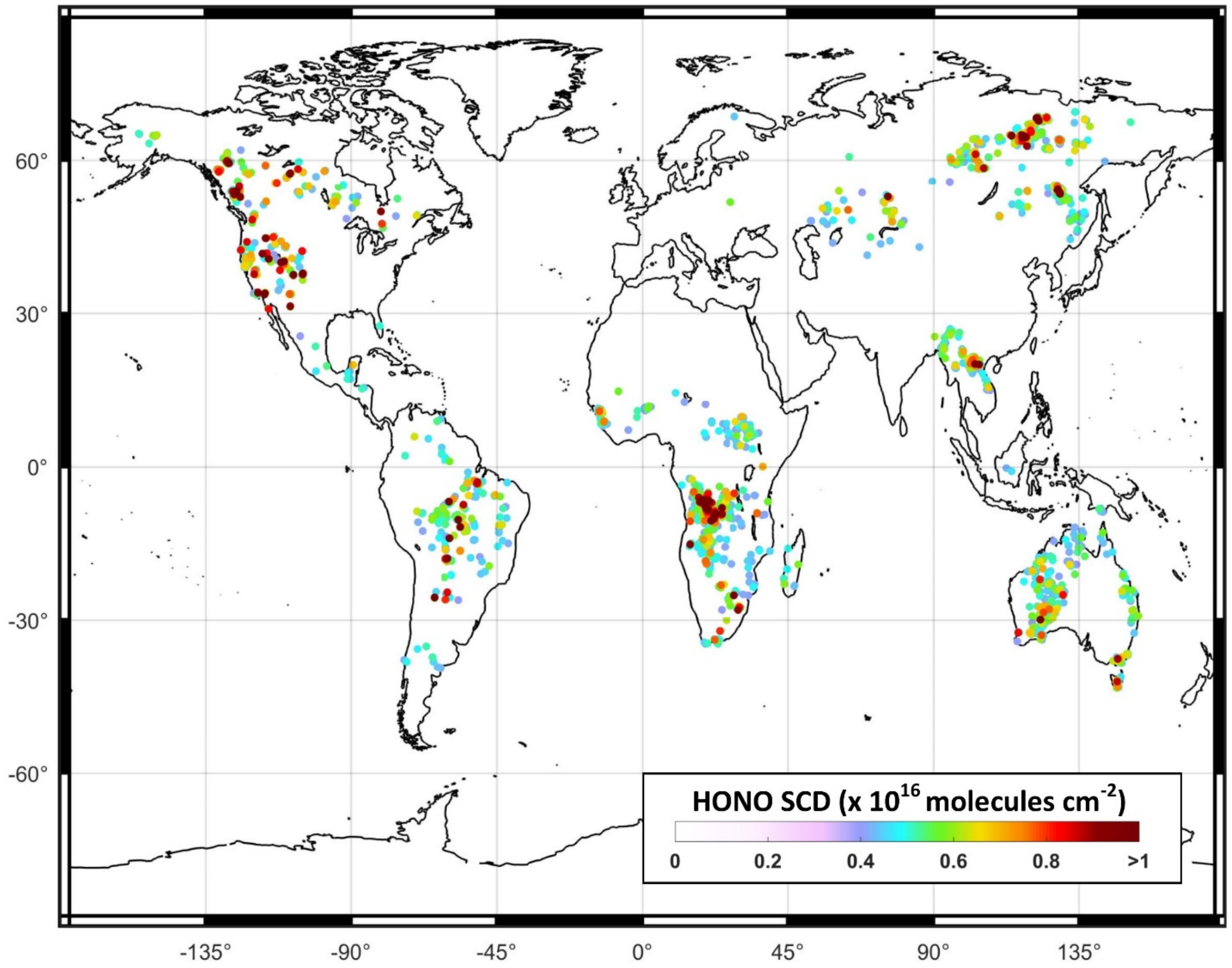


Sentinel-5 Precursor – Erythemal Irradiance (NRT)

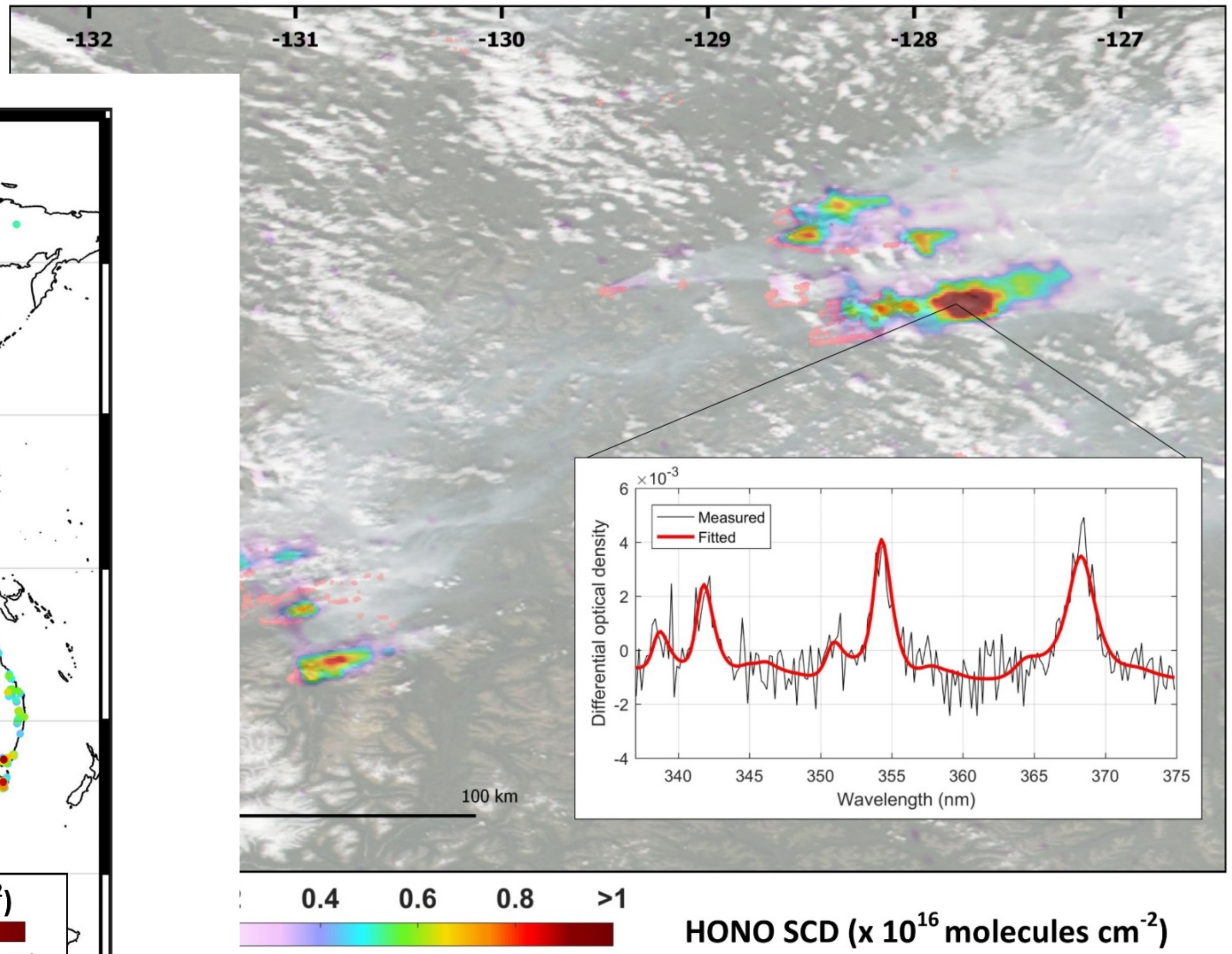


Sentinel-5 Precursor – Nitrous Acid (HONO)

May 2018 – April 2019



British Columbia, Canada 21 Aug 2018



Theys et al., manuscript in preparation