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23/11/2021

# The high spatial resolution total ozone derived using spaceborne spectral reflectance observations in the Chappuis bands

# Scope

The task of this work is to present recent advances in remote sensing of total ozone using high spatial resolution (10-300m) spaceborne observations over Antarctica.

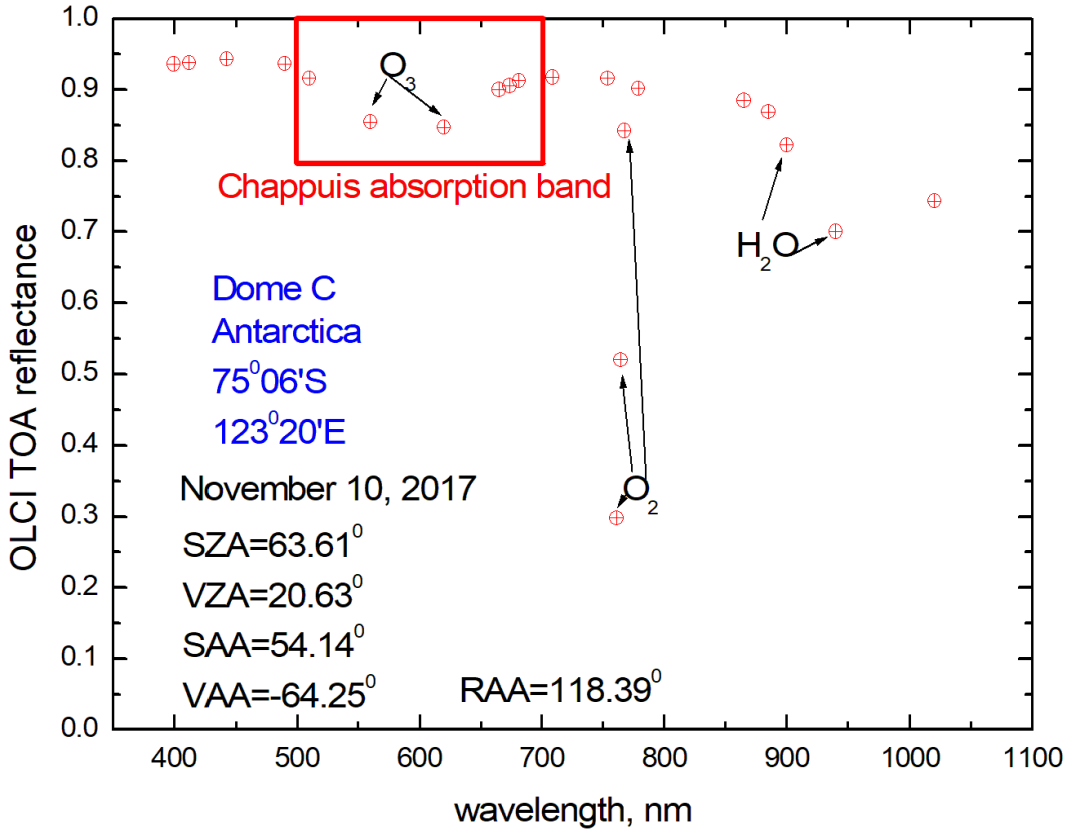
Instruments:

- MSI/S-2
- OLCI/S-3

Previous studies based on total ozone determination using the Chappuis absorption bands:

- AVHRR ( Boime at al., 1993)
- MERIS/ENVISAT (Jolivet et al., 2016)

# Approach




$$R_{meas} = T_g R$$

$$T_g = \exp(-A\tau_{O_3})$$

$$\tau_{O_3} = \frac{ln T_g^{-1}}{A}$$

$$N = \frac{\tau_{O_3}}{C_{abs}(z)}$$

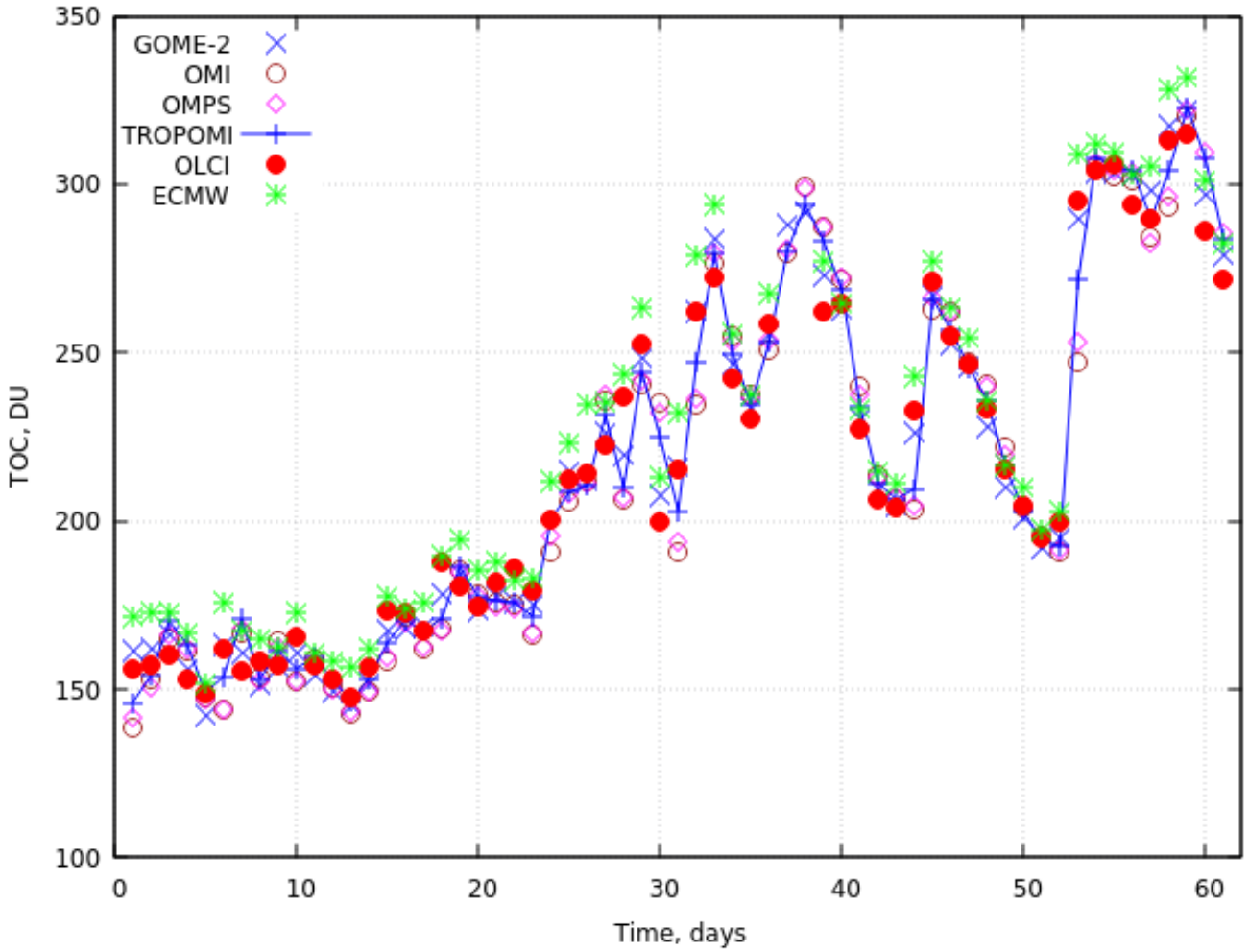
$$C_{abs}(620nm) = 3.9806 \times 10^{-21} \frac{cm^2}{molecule}$$

(Gorshelev et al., 2014; at $193K$)

# Validation using satellite datasets

| Instruments, spatial resolution | Links/algorithms used | Equator crossing time, UTC |
|---|---|---|
| **OLCI,** **0.3x0.3$km^2$** | https://scihub.copernicus.eu/ L1 dataset | 10:00 |
| **TROPOMI** **3.5x5.5$km^2$** | https://s5phub.copernicus.eu/ S5P_TO3_GODFIT | 13:30 |
| **OMI,** **13x24$km^2$** | https://acdisc.gesdisc.eosdis.nasa.gov/opendap/hyrax/HDF-EOS5/Aura_OMI_Level3/OMTO3d.003/ OMTO3d algorithm | 13:38 |
| **OMPS,** **50x50$km^2$** **(Nadir Mapper)** | https://disc.gsfc.nasa.gov/datasets/OMPS_NPP_NMTO3_L3_DAILY_2/summary NMTO3 algorithm | 13:30 |
| **GOME-2,** **80x40$km^2$** | http://atmos.caf.dlr.de/gome2 DOAS | 9:30 |

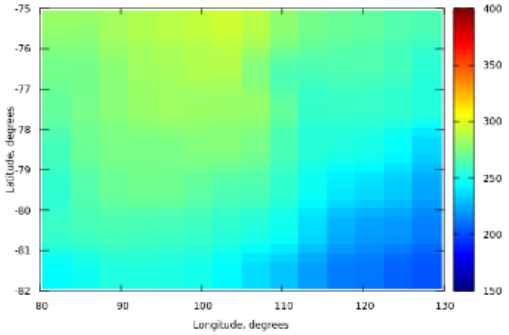
# Intercomparison with other satellite measurements



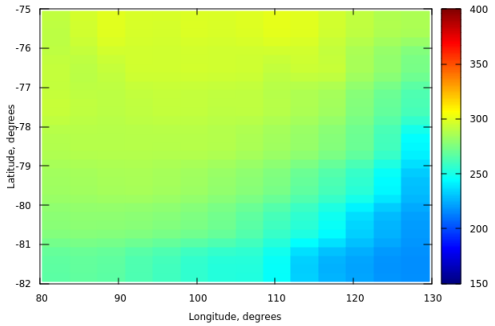

November - December 2020
Location: Dome C (Antarctica)

2020 ozone hole

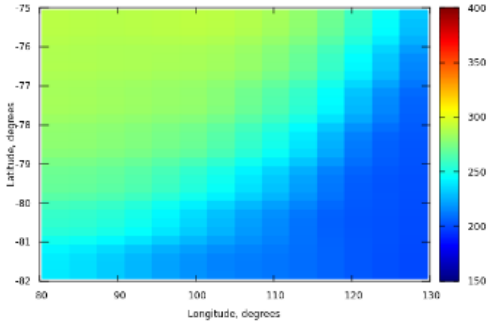
# Intercomparison with other satellite measurements




OLCI



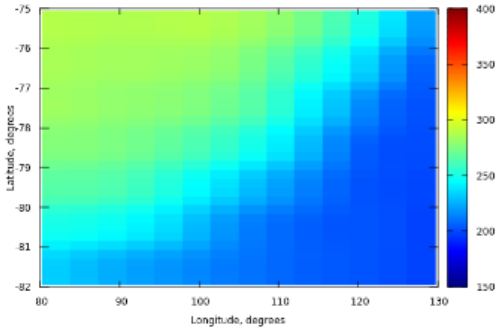

GOME-2



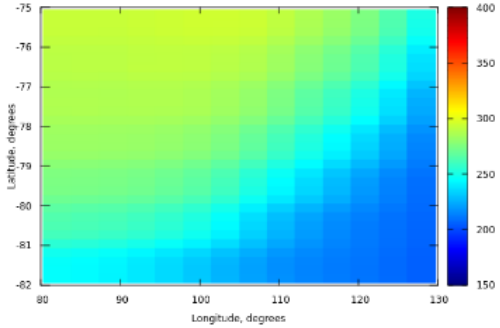

OMPS

Total ozone (DU)

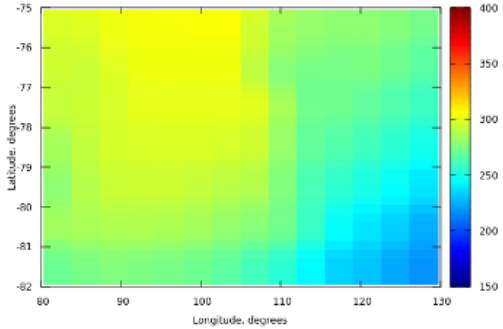
December 23, 2020




OMI



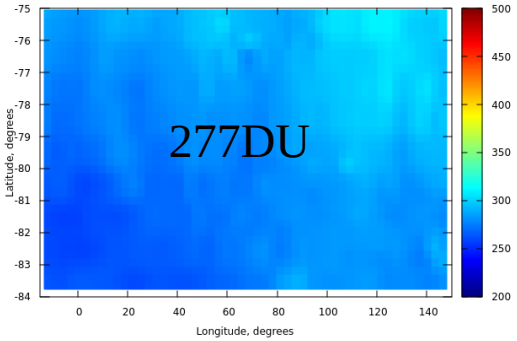

TROPOMI



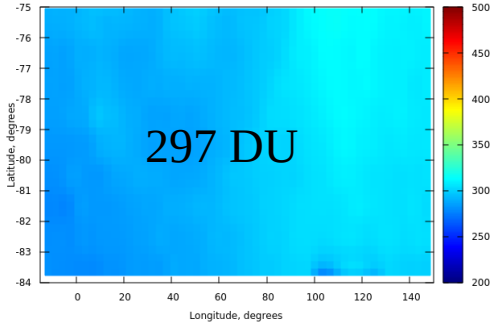

ECMWF

Location:
75-82S
80-130E

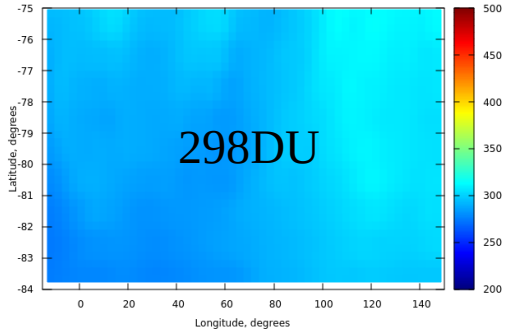
# Intercomparison with other satellite measurements




OLCI

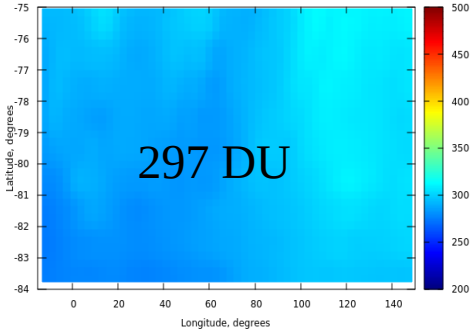



GOME-2

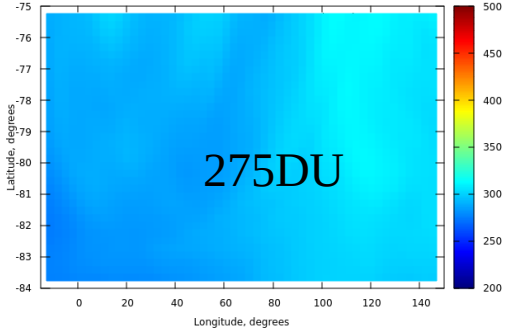



OMPS

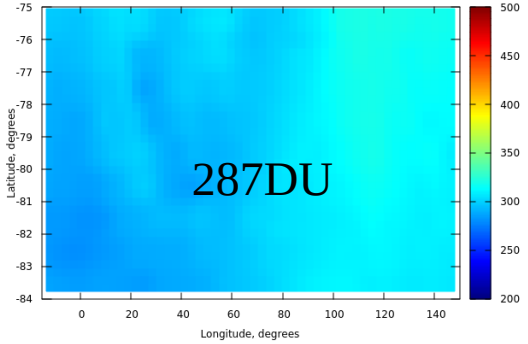
Total ozone (DU)
January 16, 2020




OMI

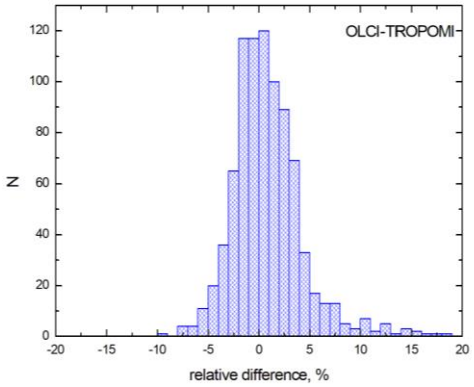


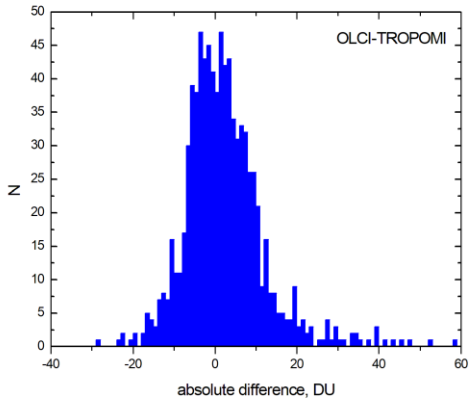

TROPOMI

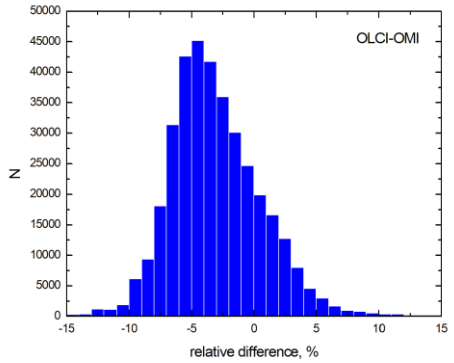


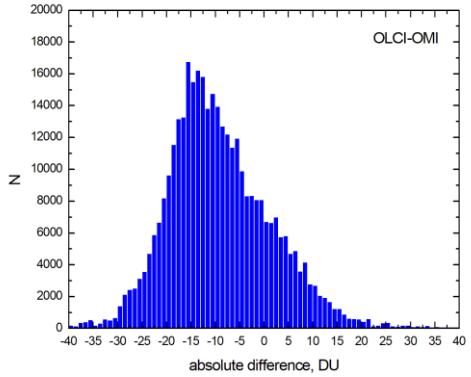

ECMWF

# Biases



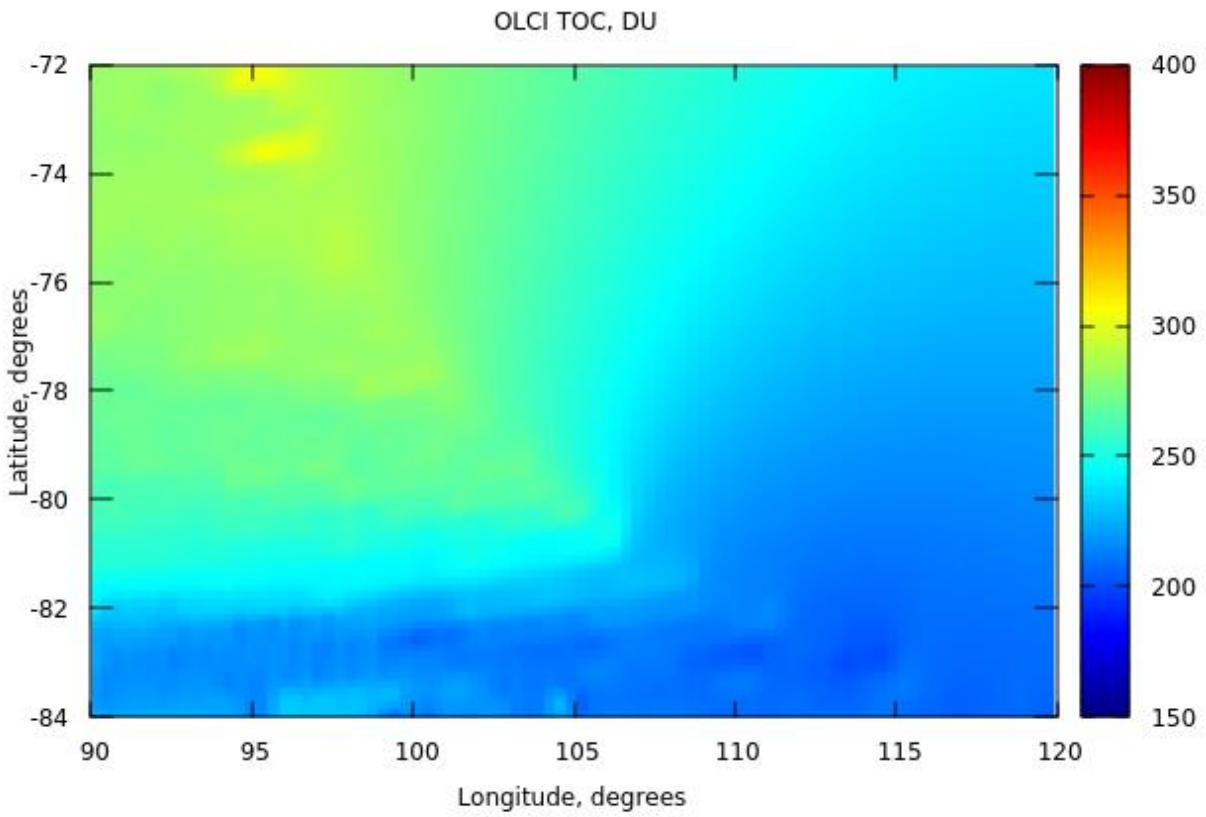



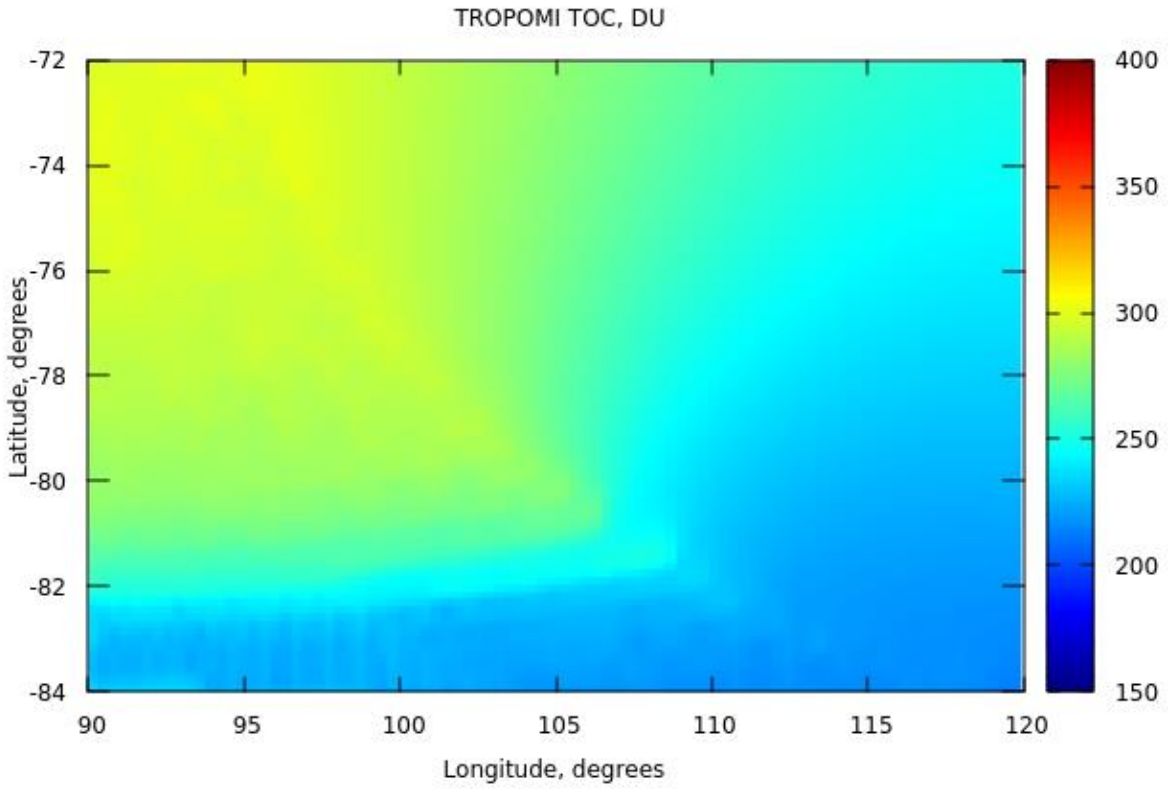




The average bias:

TROPOMI: 0.8%
OMI: -3.1%

# TROPOMI – collocated OLCI TOC measurements (maximal temporal mismatch is 5min)

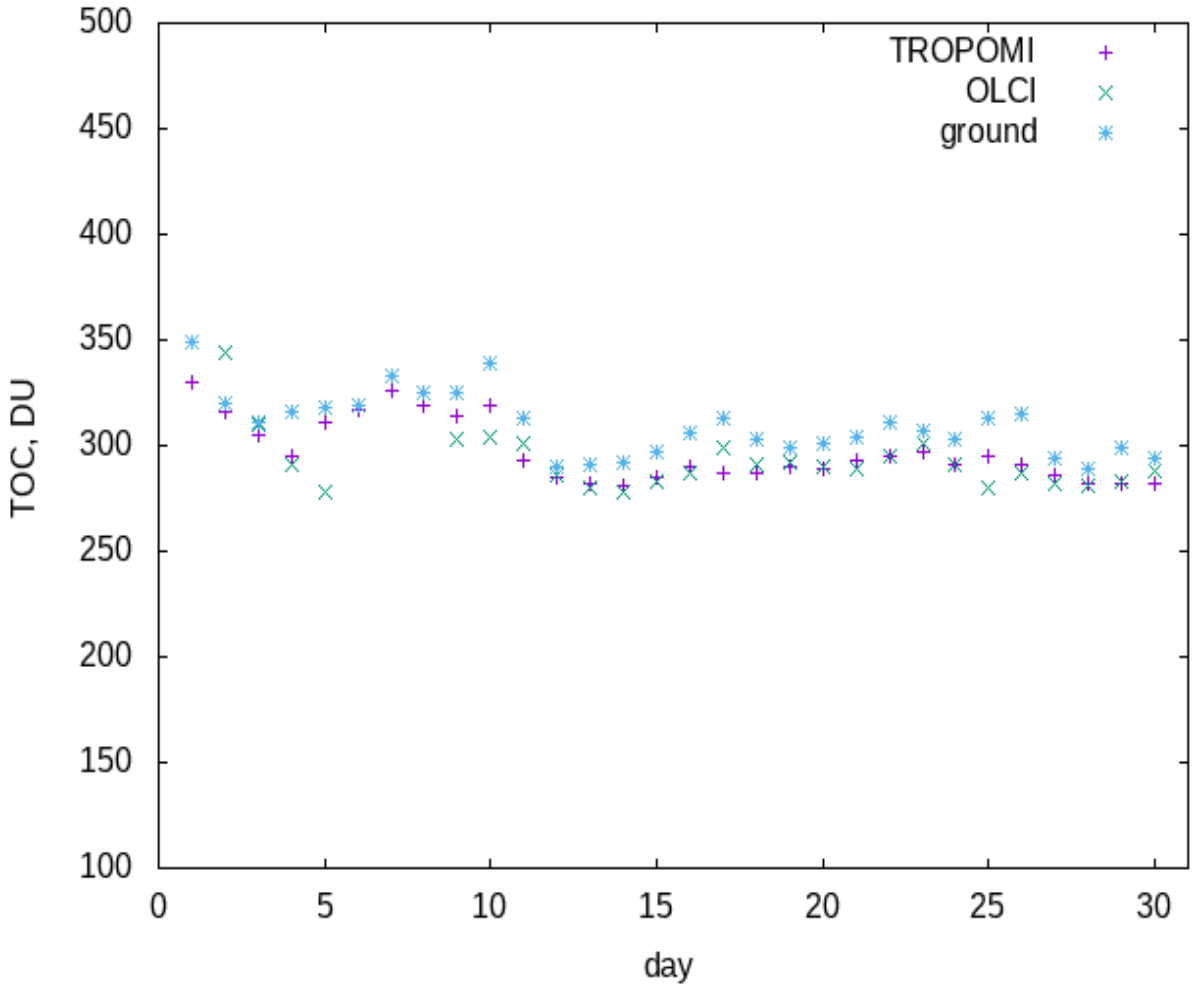


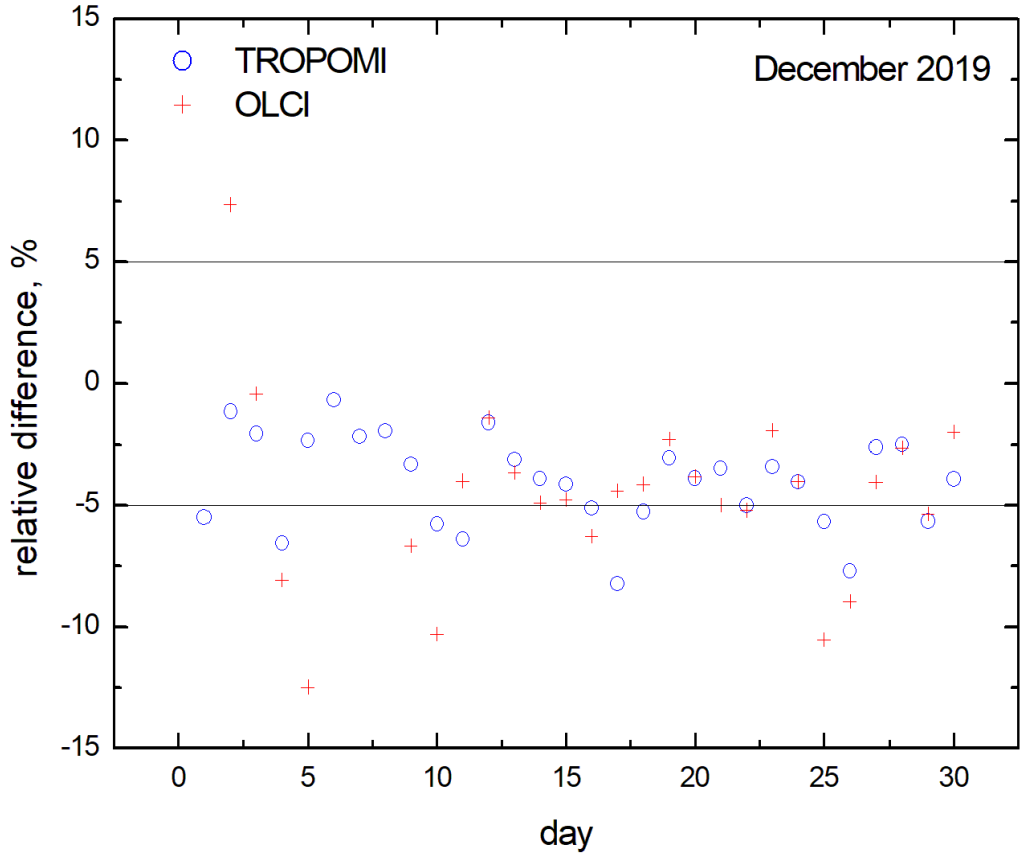






December 23, 2020 (20:00UTC)

# The intercomparison with ground measurements



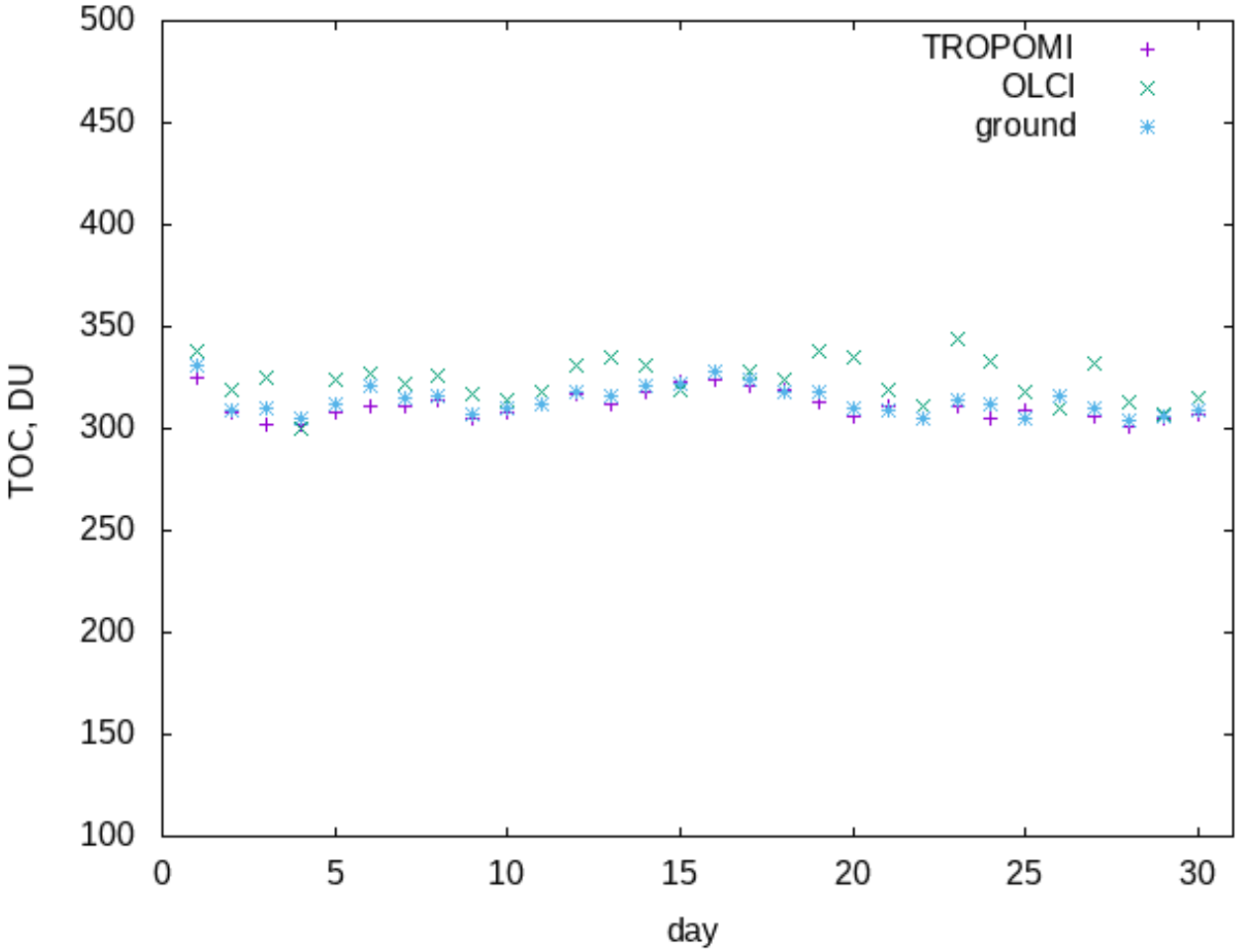



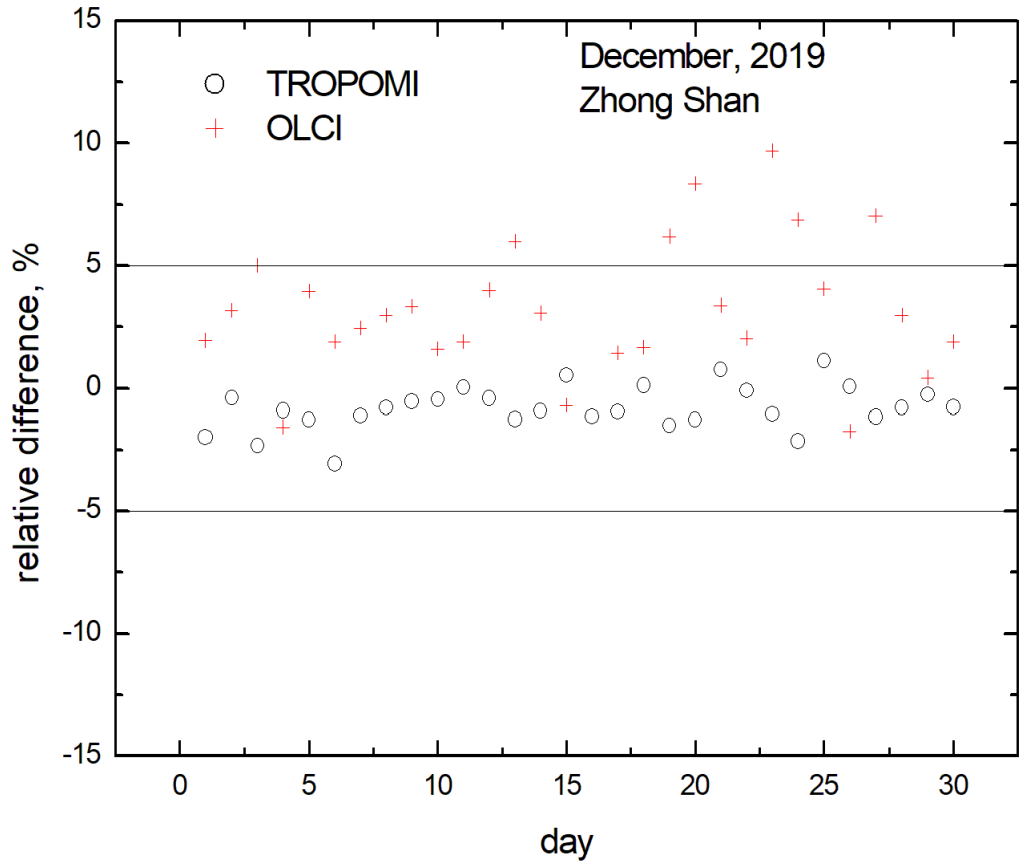



Dobson, Beck/73

December, 2019
Halley station (Antarctica)

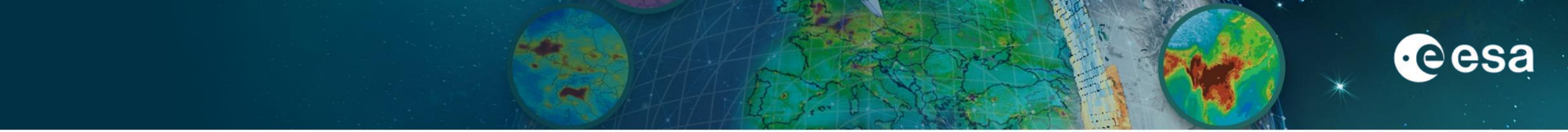
# The intercomparison with ground measurements



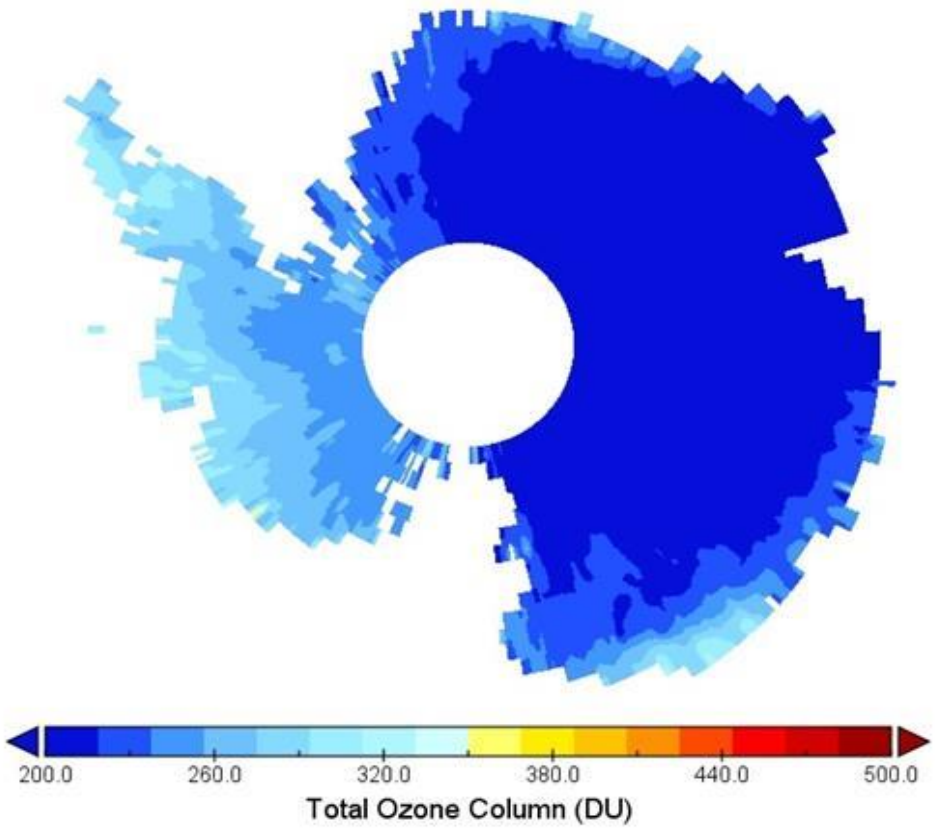




Brewer, MKIII/193

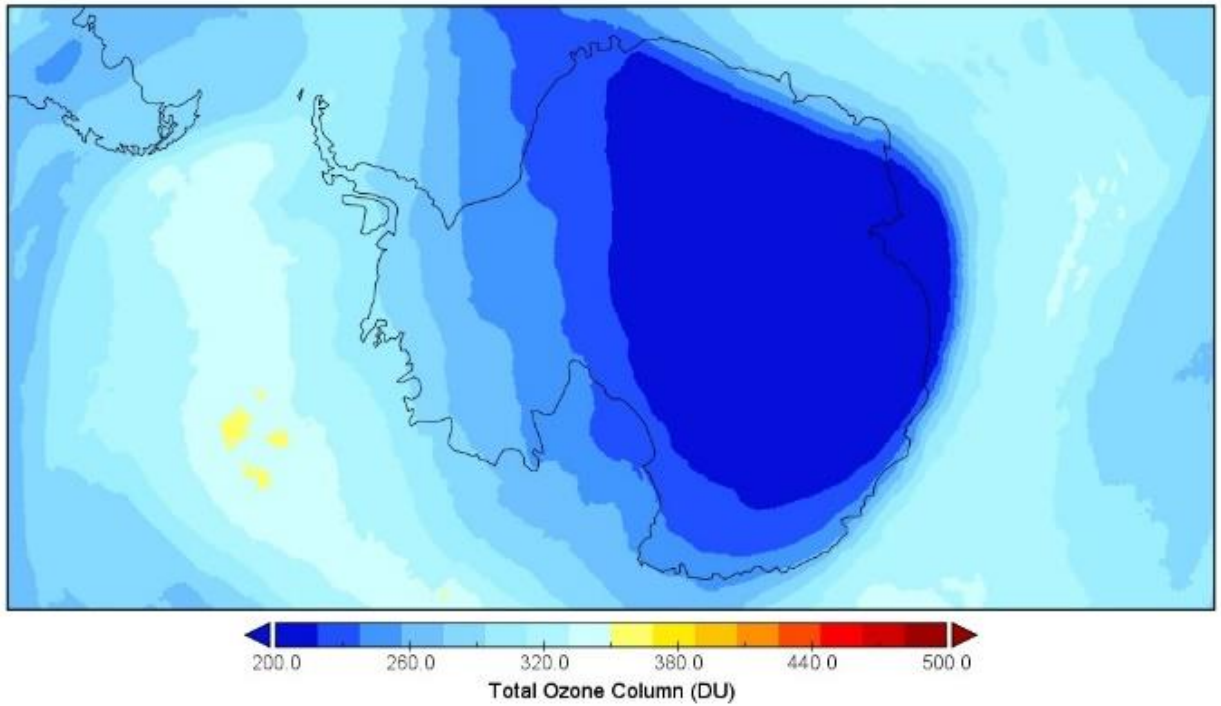
December, 2019
Zhong Shan (Antarctica)



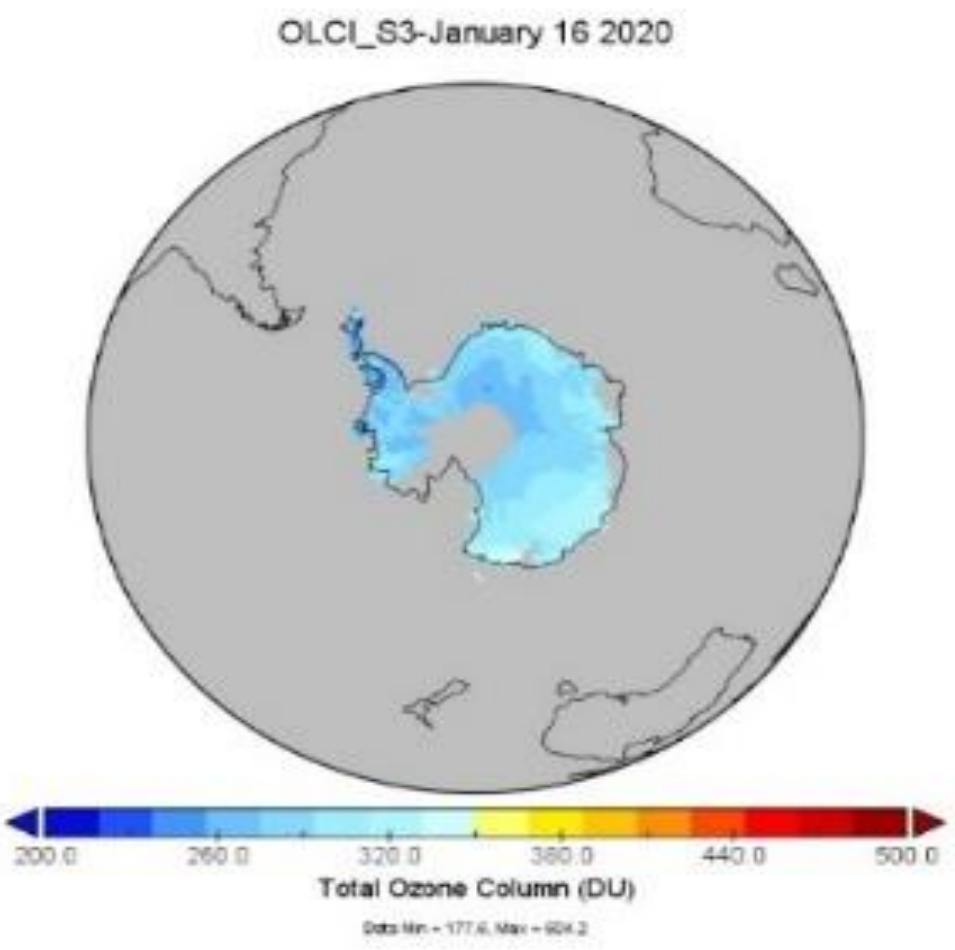
OLCI_S3-December 20 2020

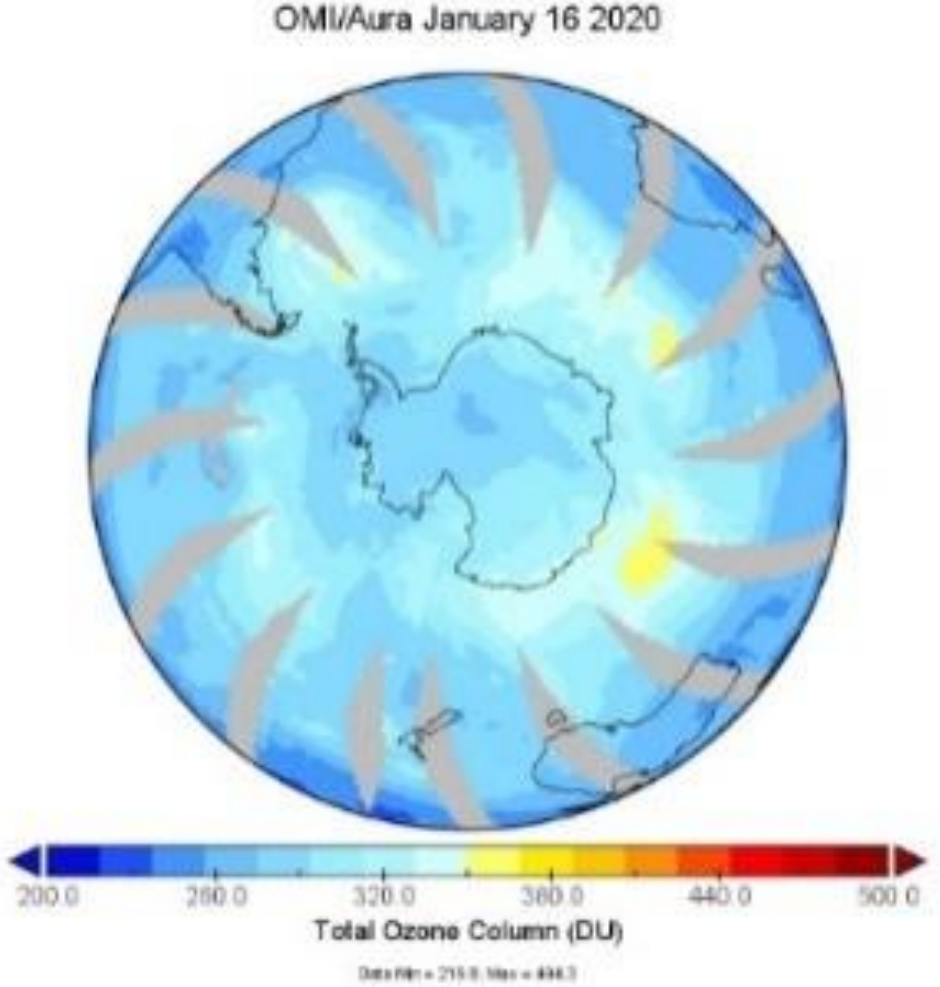



TROPOMI/S5P December 20 2020

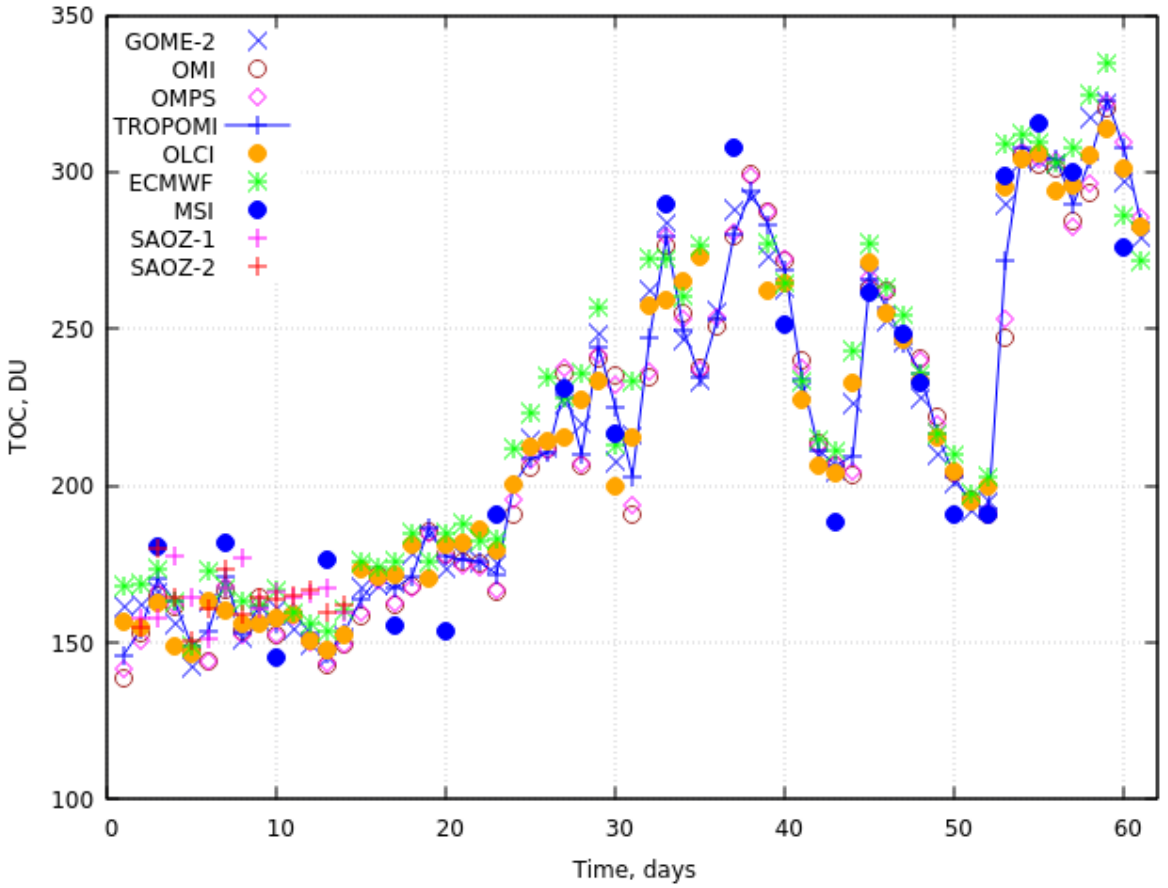



December 20, 2020


OLCI_S3-January 16 2020
200.0
260.0
320.0
380.0
440.0
500.0
Total Ozone Column (DU)


OMI/Aura January 16 2020
200.0
260.0
320.0
380.0
440.0
500.0
Total Ozone Column (DU)

# The MSI/S-2 total ozone




https://custom-scripts.sentinel-hub.com/sentinel-2/ozone_column_over_snow/

The script requires Sentinel-2 L1C images

Courtesy: M. Lamare



10m spatial resolution

December, 2019
Zhong Shan (Antarctica)

# Conclusions

- Simple analytical total ozone retrieval algorithm based on TOA reflecatnce measurements around 620nm has been proposed
- The derived total ozone has been compared to measurements performed by other ground – based and satellite measurements
- The algorithm has been applied to MSI/S-2, OLCI/S-3A,B

- The algorithm can be easily ported for processing TOA reflectances measured by other multispectral imagers operating in the ozone Chappuis absorption band

# References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Alexander Kokhanovsky, Filippo Iodice, Luca Lelli, Achim Zschaege, Nicola De Quattro, Daniele Gasbarra, Christian Retscher, Retrieval of total ozone column using high spatial resolution top-of-atmosphere measurements by OLCI/S-3 in the ozone Chappuis absorption band over bright underlying surfaces, Journal of Quantitative Spectroscopy and Radiative Transfer, Volume 276, 2021,107903, ISSN 0022-4073, https://doi.org/10.1016/j.jqsrt.2021.107903.

Kokhanovsky, Alexander, Simon Gascoin, Laurent Arnaud, and Ghislain Picard, 2021,
Retrieval of snow albedo and total ozone column from single-view MSI/S-2 spectral reflectance measurements over Antarctica, *Remote Sensing*, Volume 13, no. 21, 2021, 4404,
https://doi.org/10.3390/rs13214404

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