

Geophysical patterns in tropical tropospheric ozone by TROPOMI, OMI, GOME-2B and ozonesonde

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SSP MPC  

Intercomparison of satellite tropospheric O3 data in tropics

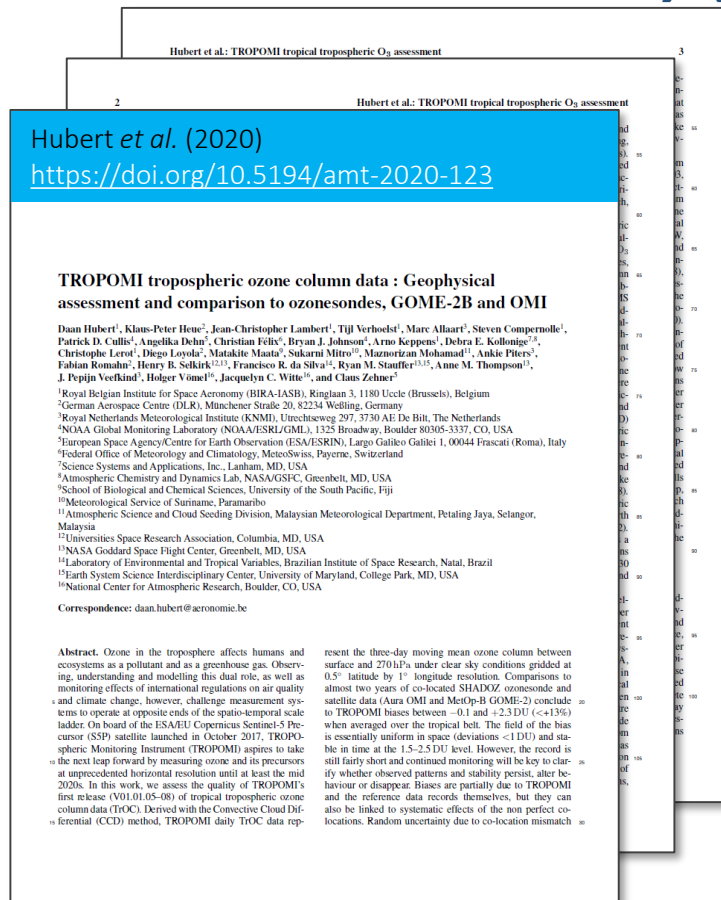
Convective Cloud Differential (CCD) technique

- Tropospheric O3 column derived from retrieved total O3 column and cloud information
- Assumptions are valid in tropics
- Ziemke *et al.* (1998), Heue *et al.* (2016), ...

For GOME-type sensors : the data represents

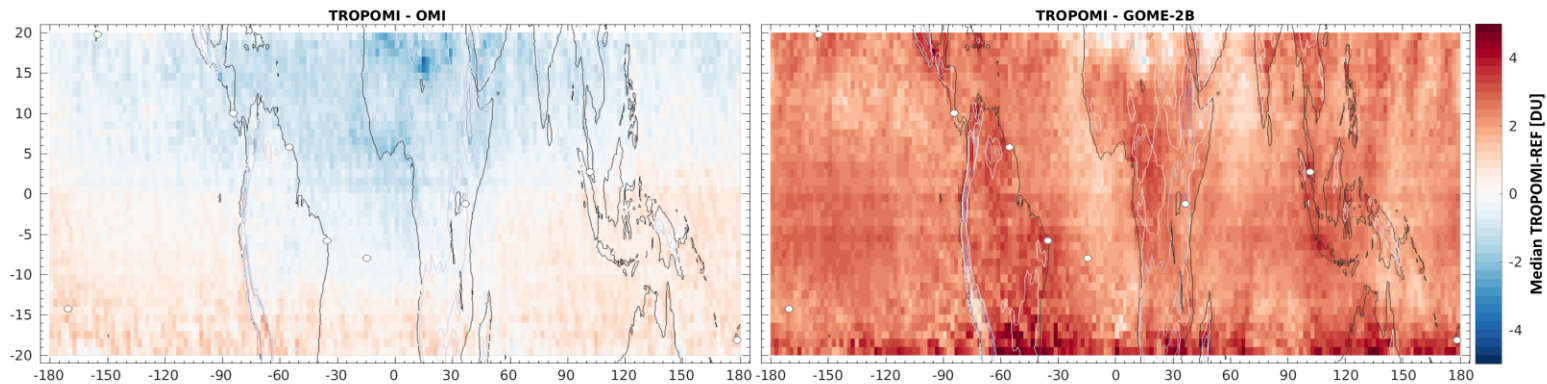
- (cloud-free) O3 column surface to 270 hPa
- 3-day (TROPOMI) or 5-day (GOME-2B/OMI) moving average, sampled daily
- 20°S-20°N, 0.5° x 1° (TROPOMI) or 1° x 2° (GOME-2B/OMI)

Objective : Assess value added by TROPOMI with respect to heritage missions

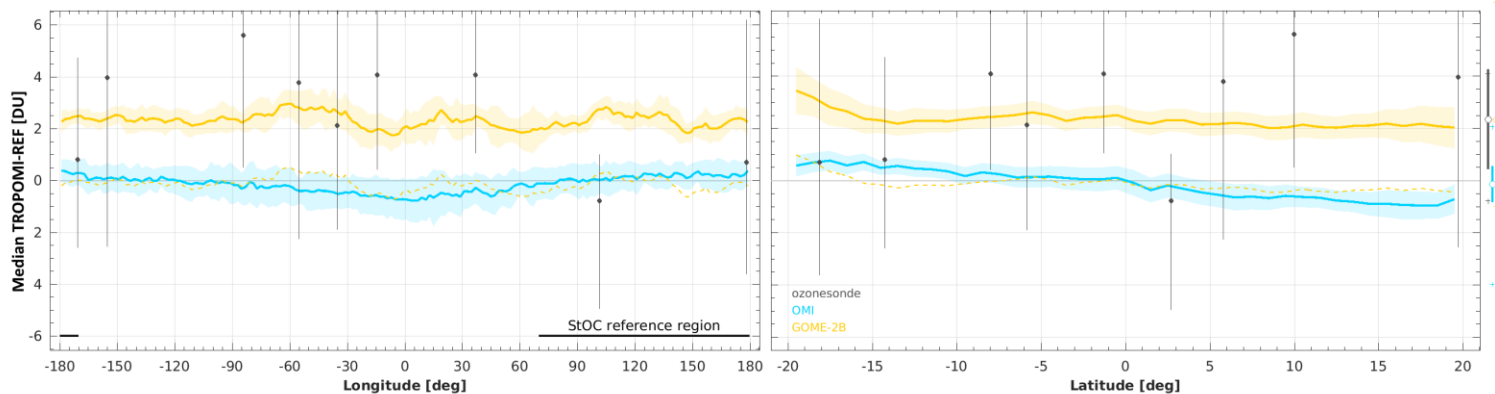


Bias estimates

TROPOMI and OMI agree < 0.1 DU, though with some spatial structure in bias.



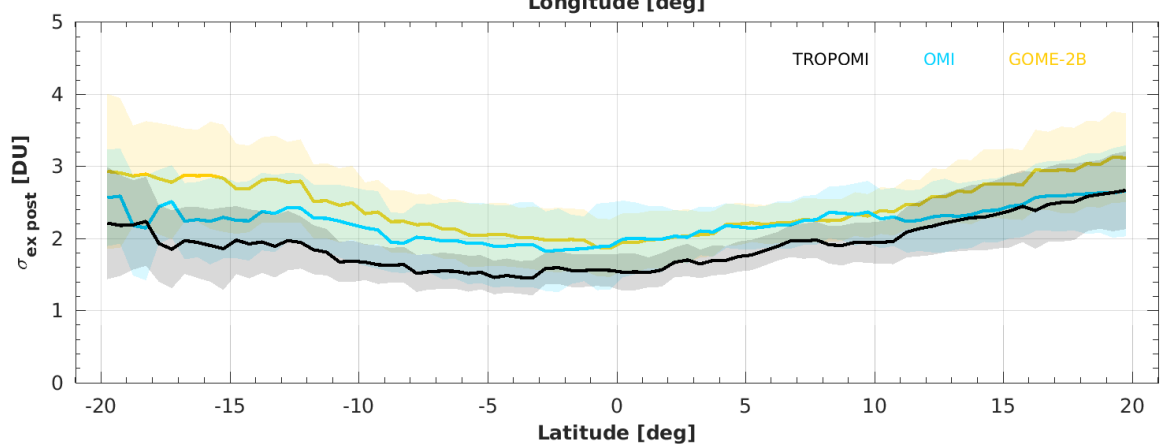
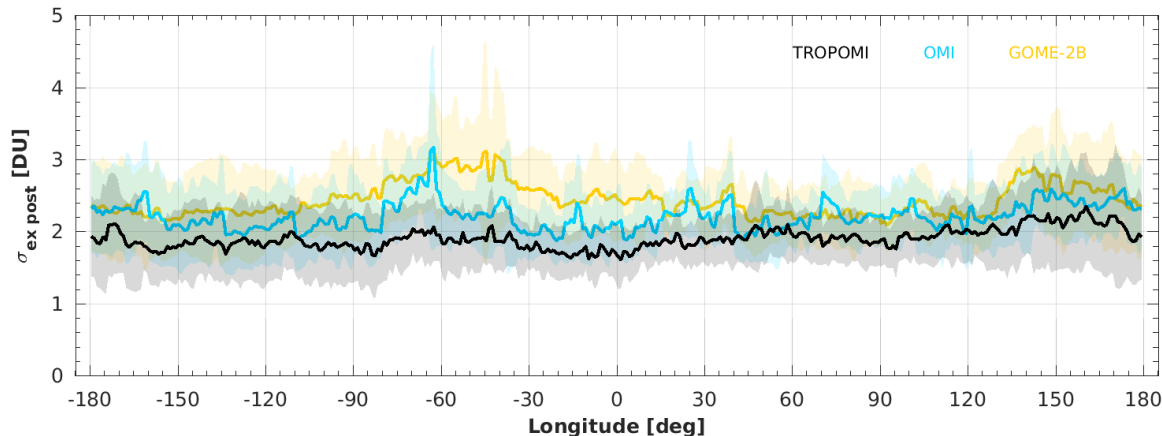
GOME-2B and ozonesonde have ~ 2.3 DU lower O₃ columns than TROPOMI/OMI.



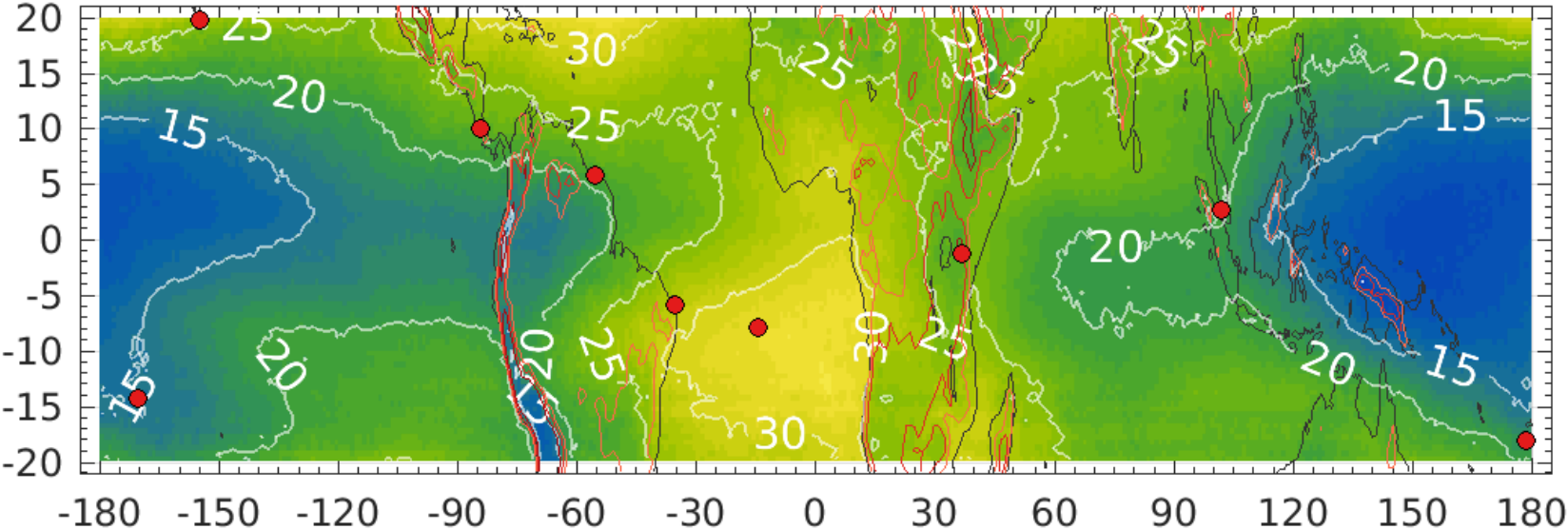
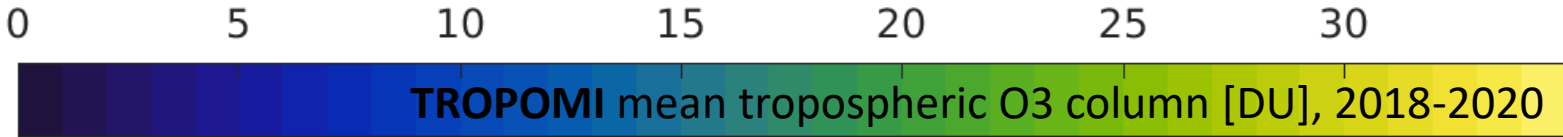
Precision estimates

Compared to other satellite records, TROPOMI has **~20-25% better precision** and **~6x better sampling resolution**

Latitudinal dependence of precision estimates partially caused by higher natural variability in extratropical tropospheric O₃ fields



Spatial structure : zonal wave-one

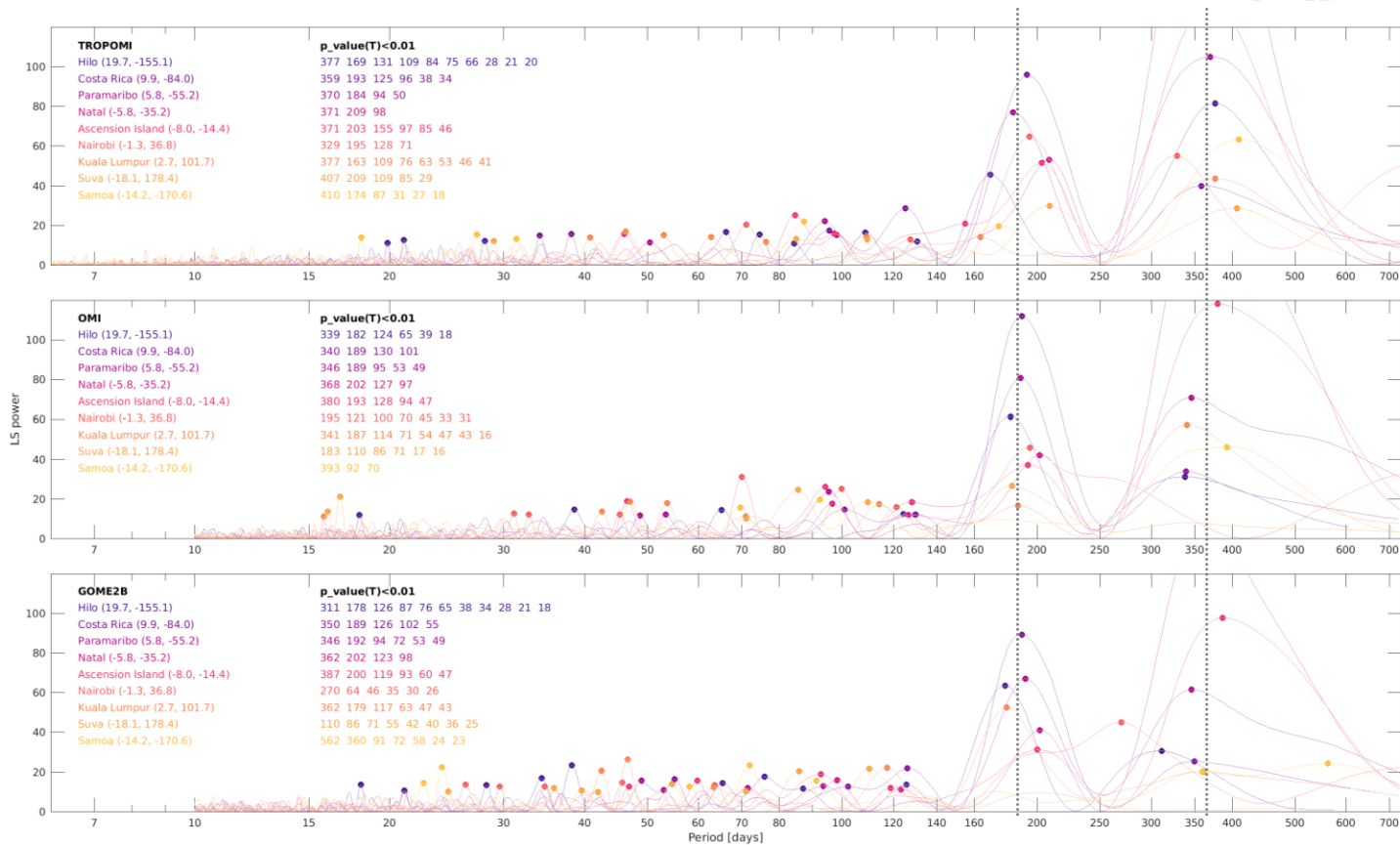


Search for periodic signals

Analysis of satellite time series over location of SHADOZ site

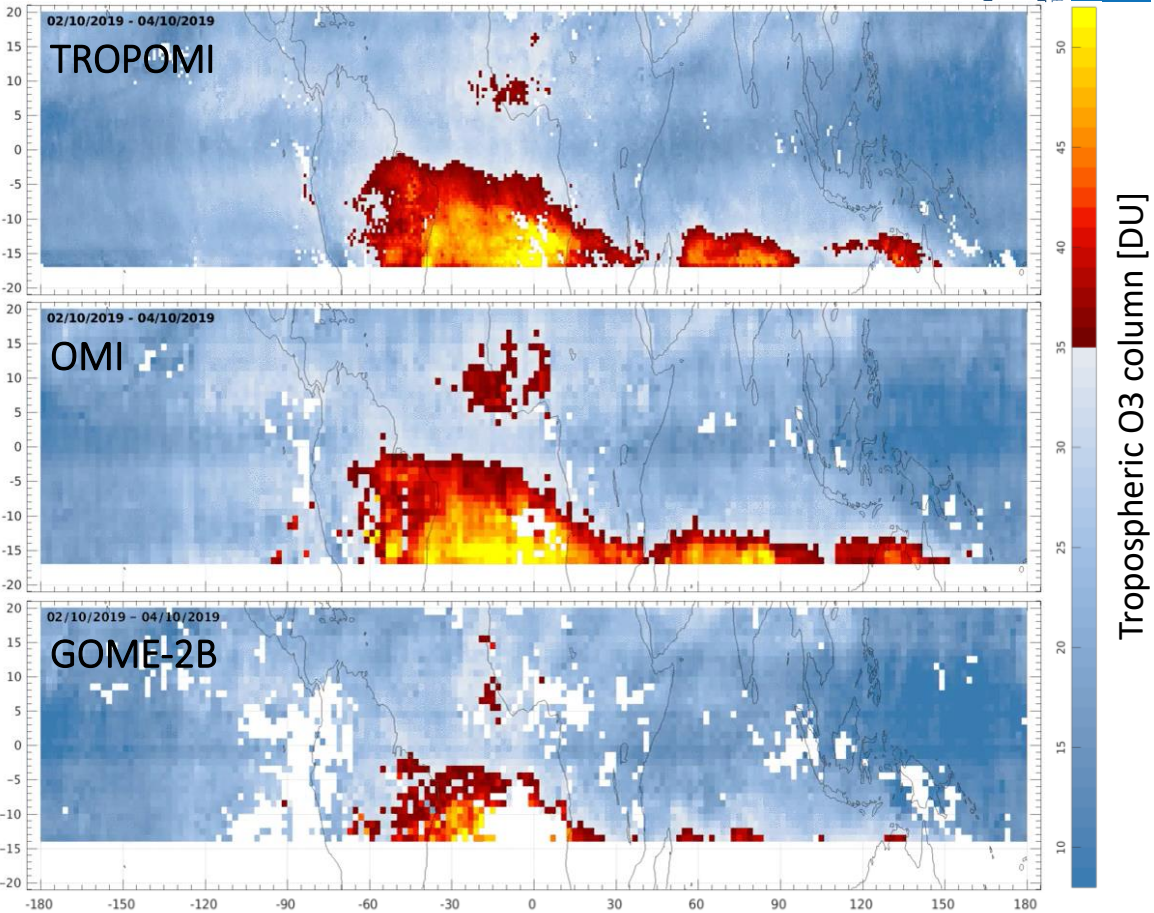
Pronounced **annual and semiannual cycle**

Less spectral power close to 20° latitude due to seasonally reoccurring data gaps



Biomass burning around the Atlantic basin

- Elevated levels of tropospheric O3 due to biomass burning, reoccurring each year.
- Sequence shows during 2019 burning season in Africa & South America (Aug-Nov).
- GOME-2B has 2 DU offset and appears different, but actually the spatio-temporal pattern is similar for all sensors.
- Resolution of TROPOMI data is clearly much better and there are less data gaps

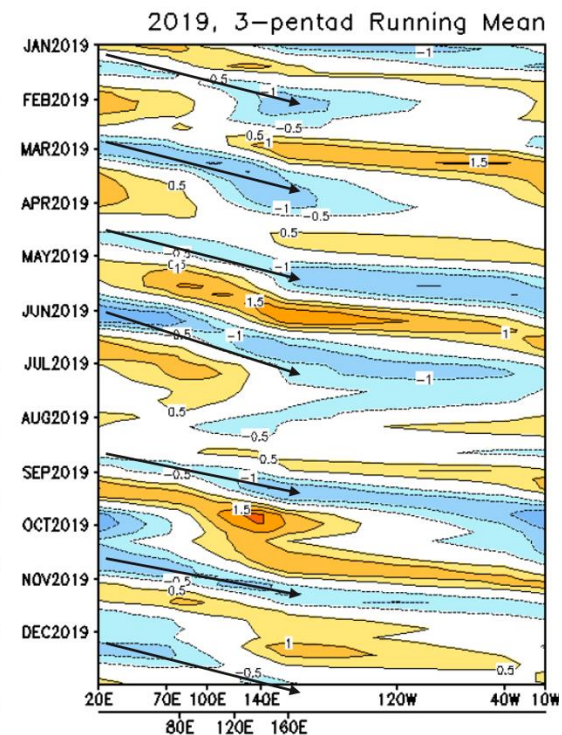
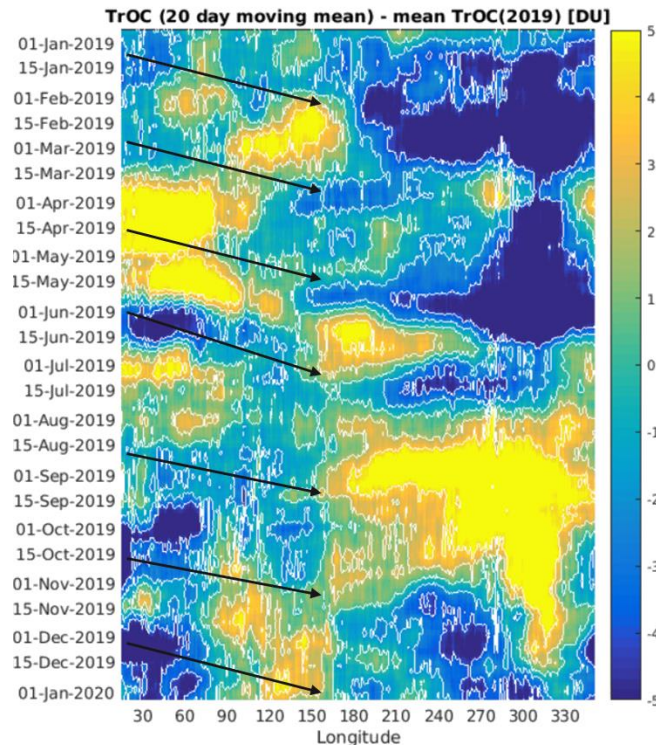


Madden Julian Oscillation

MJO = quasi-periodic (30-60 days) phenomenon over Indo-Pacific warm pool.

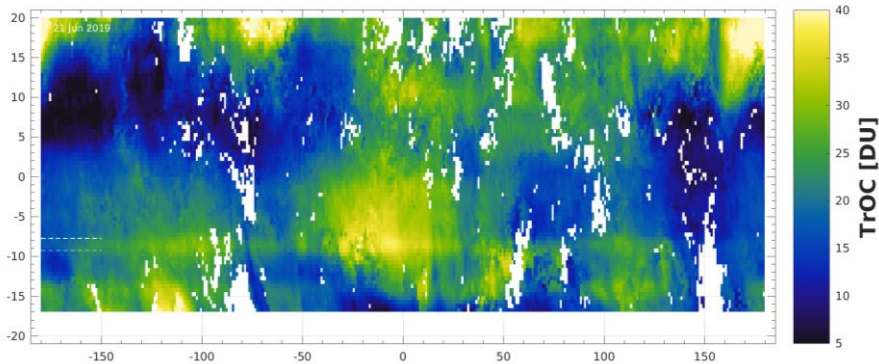
An **active/inactive** MJO phase brings **enhanced/reduced** convection leading to **depleted/enhanced** levels of tropospheric O₃.

Oscillations (5-10 DU) in TROPOMI data over innermost tropics (left) coincide with MJO index by NOAA CPC (right).



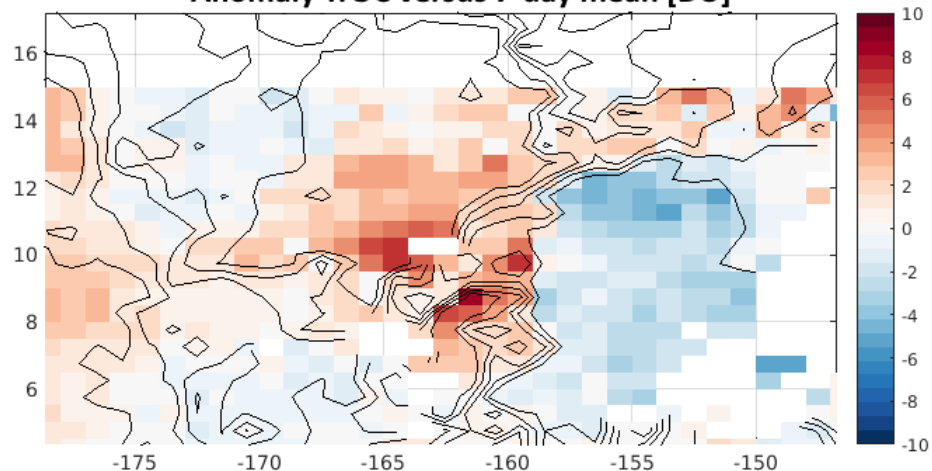
TROPOMI : random sampling errors

1. Striping up to ~ 0.5 -1 DU due to sampling error for stratospheric reference column



2. Correlated anomalies of up to 5 DU at smallest scale due to sampling error for total column

Anomaly TrOC versus 7-day mean [DU]



TROPOMI clearly offers added value w.r.t. heritage missions

- It outperforms other satellites in terms of **precision, resolution** and **coverage**
- Its **bias** is less than 2 DU w.r.t. ozonesonde and other satellite sensors
- At highest resolution correlated (sampling) errors < 5 DU should be taken into consideration
- TROPOMI will be added to GOME-type Climate Data Record

More information

- AMTD paper: <https://doi.org/10.5194/amt-2020-123>
- S5P-TROPOMI Validation Data Analysis Facility: <https://mpc-vdaf.tropomi.eu/index.php/tropospheric-ozone>
- TROPOMI Quarterly Validation Reports: https://mpc-vdaf.tropomi.eu/index.php?option=com_vdaf&view=showReport&format=rawhtml&id=48

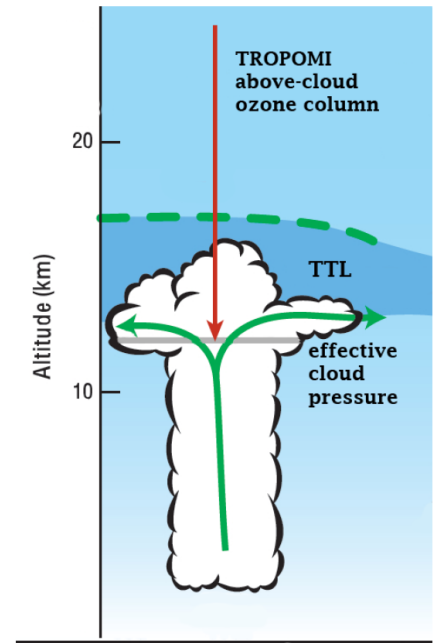
Related contributions in this session

- Heue et al. (EGU21-14237)
- Eichmann et al. (EGU21-13343)
- Ziemke et al. (EGU-13945)
- Orfanos-Cheuquelaf et al. (EGU-12189)

Backup slides

S5P TROPOMI tropical tropospheric ozone column product

- Convective Cloud Differential (CCD) technique using
 - TROPOMI total ozone column data (GODFIT v4)
 - TROPOMI cloud data (OCRA/ROCINN_CRB)
- Represents
 - O₃ column surface-270 hPa
 - daily product, 0.5°x1° between 20°S-20°N
 - cloud-free 3-day moving average
- Processed at DLR with L2_O3_TCL OFFL processor v01.01.05-08
- Available operationally since 30 Apr 2018 on the Copernicus data hub: <https://scihub.copernicus.eu>



Atmospheric Measurement Techniques

Tropical tropospheric ozone column retrieval for GOME-2

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Abstract. This paper presents the operational retrieval of tropical tropospheric ozone column (TTCO) data for

Atmospheric Measurement Techniques

Trends of tropical tropospheric ozone from 20 years of European satellite measurements and perspectives for the Sentinel-5 Precursor

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