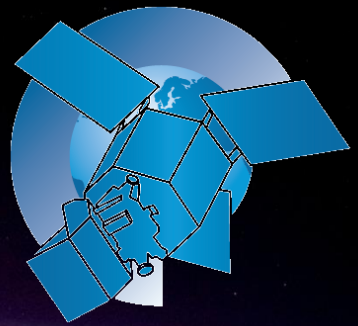
TROPOMI tropical tropospheric ozone column data

Geophysical assessment and comparison to ozonesondes, GOME-2B and OMI



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Daan Hubert, K.-P. Heue, J.-C. Lambert, T. Verhoelst, M. Allaart, S. Compernolle, P. Cullis, A. Dehn, C. Félix, B. Johnson, A. Keppens, D. Kollonige, C. Lerot, D. Loyola, M. Maata, S. Mitro, M. Mohamad, A. Piters, F. Romahn, H. Selkirk, F.R. da Silva, R. Stauffer, A. Thompson, P. Veefkind, H. Vömel, J. Witte, and C. Zehner

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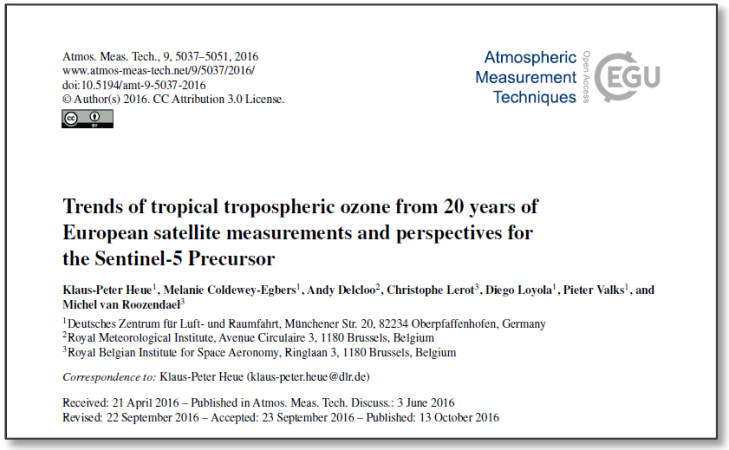
CEOS AC-VC-16 teleconference - June 8-12, 2020

Two years of TROPOMI tropospheric ozone column data

processed at DLR with L2_O3_TCL OFFL processor v01.01.05-08



Atmos. Meas. Tech., 9, 5037–5051, 2016
www.atmos-meas-tech.net/9/5037/2016/
doi:10.5194/amt-9-5037-2016
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Atmospheric Measurement Techniques

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

Klaus-Peter Heue[1], Melanie Coldewey-Egbers[1], Andy Delcloo[2], Christophe Lerot[3], Diego Loyola[1], Pieter Valks[1], and Michel van Roozendael[3]

[1]Deutsches Zentrum für Luft- und Raumfahrt, Münchener Str. 20, 82234 Oberpfaffenhofen, Germany
[2]Royal Meteorological Institute, Avenue Circulaire 3, 1180 Brussels, Belgium
[3]Royal Belgian Institute for Space Aeronomy, Ringlaan 3, 1180 Brussels, Belgium

Correspondence to: Klaus-Peter Heue (klaus-peter.heue@dlr.de)

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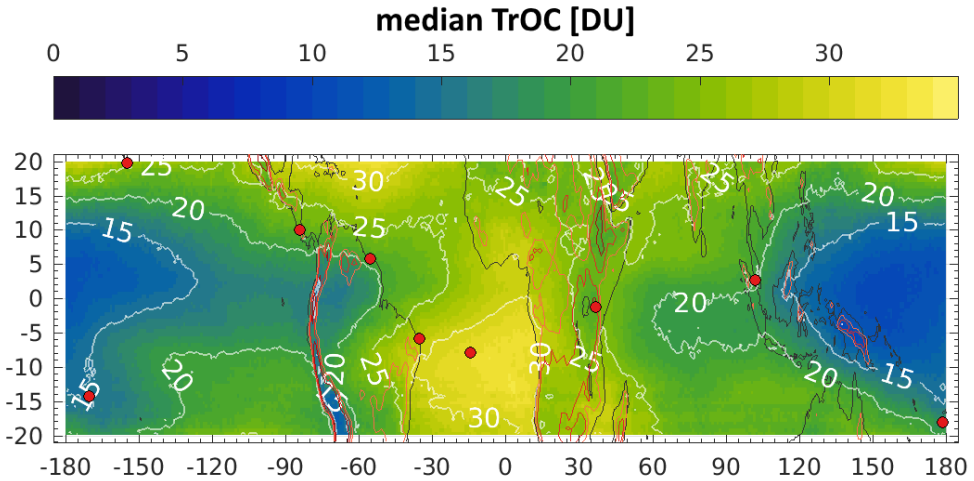


Convective Cloud Differential (CCD) technique using

- TROPOMI total ozone column data (GODFIT v4)
- TROPOMI cloud data (OCRA/ROCINN_CRB)
- GOME/SCIAMACHY/GOME-2/OMI heritage

Represents

- (cloud-free) O_3 column surface-270 hPa
- daily sampled 3-day moving average
- 20°S-20°N, 0.5° lat. x 1° long.

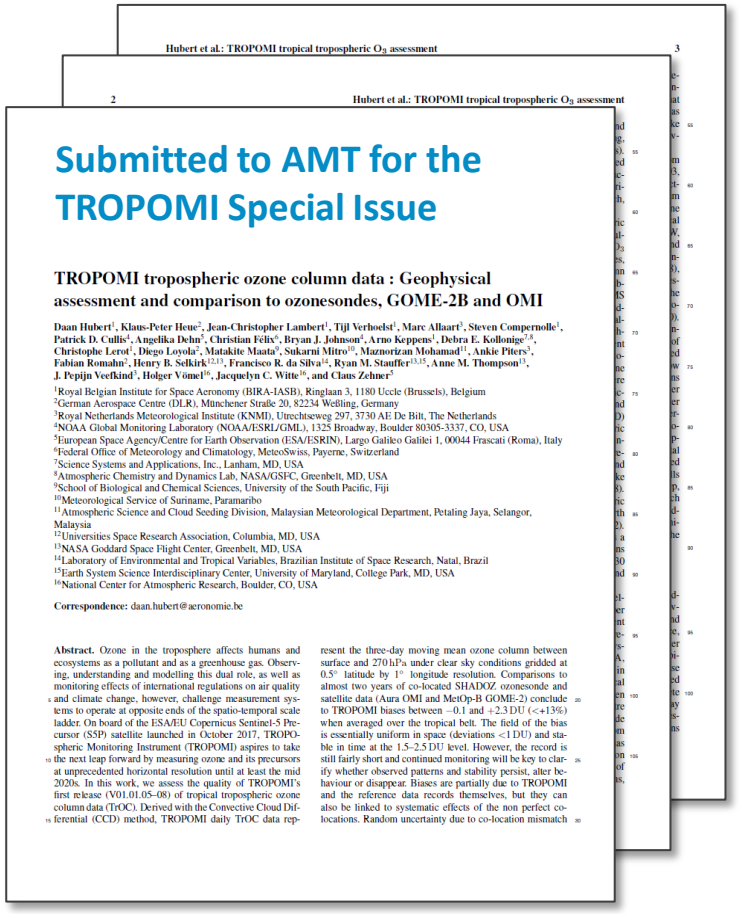
Contains modified Copernicus S5P data post-processed at BIRA-IASB

S5P data available publicly since 30 Apr 2018 at https://scihub.copernicus.eu

Assessment of TROPOMI tropospheric ozone (CCD)

Methodology

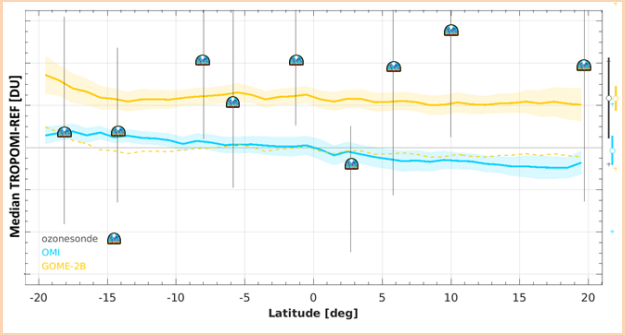
- Comparison to SHADOZ ozonesonde and to GOME-2 & OMI satellite data
- Estimates of bias & dispersion
  + analysis of space/time variations
- Reduction of random mismatch errors
  via analysis of co-located triplets
- Estimates of sampling errors (as gridded data product)
- Assessment of geophysical cycles and patterns: annual, biomass burning, MJO…



Quality Indicators for tropical tropospheric ozone from the Sentinels

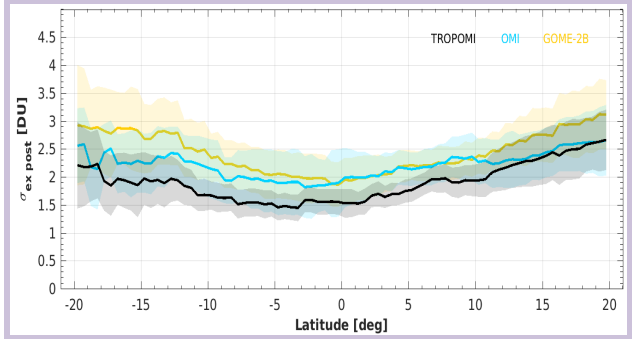
Bias

- < 25% ? (systematic error mission requirement)
- Overall :
- Dependences SAT-to-SAT :
  - meridian :
  - zonal :
  - seasonal :



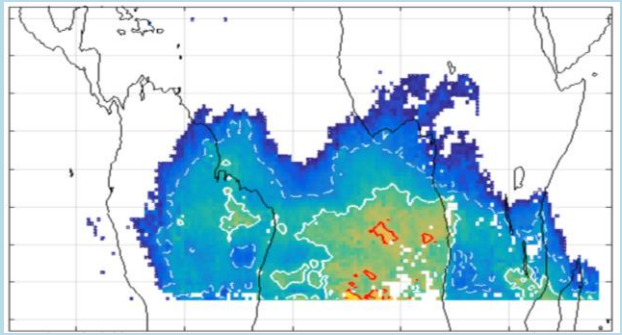
Dispersion

- < 25 % ? (uncertainty mission requirement)
- From pairwise :
- From triplets :
- Dependences SAT-to-SAT:
  - meridian :
- Sampling error :



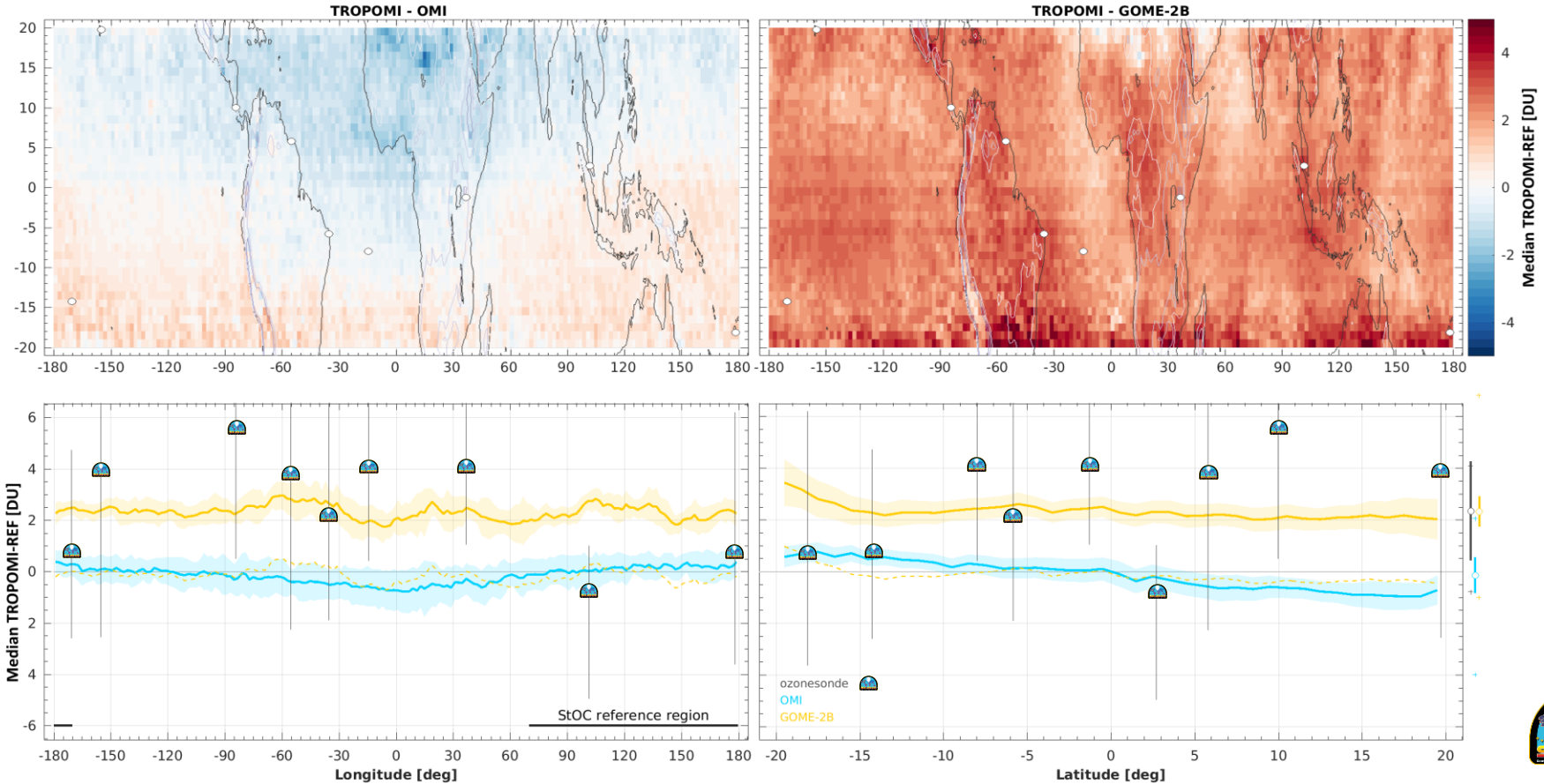
Geophysical patterns & signals

- Zonal wave one ?
- Biomass burning season ?
- Annual + semi-annual cycles ?
- Madden-Julian Oscillation ?
- Other known features ?



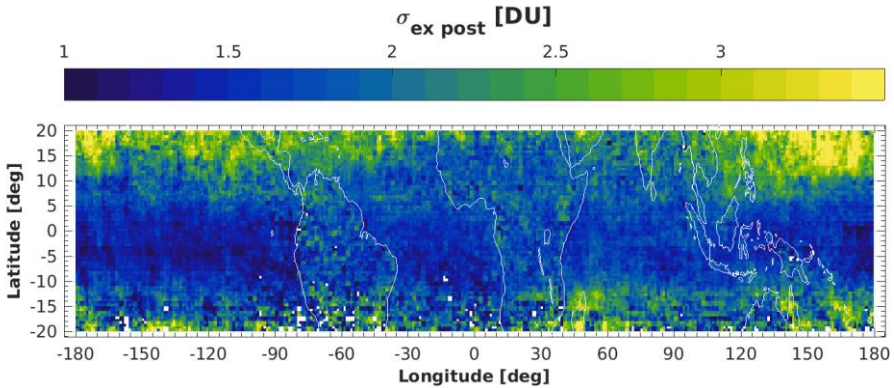
Bias vs sonde/satellite : 0.1-2.3 DU (<13%)

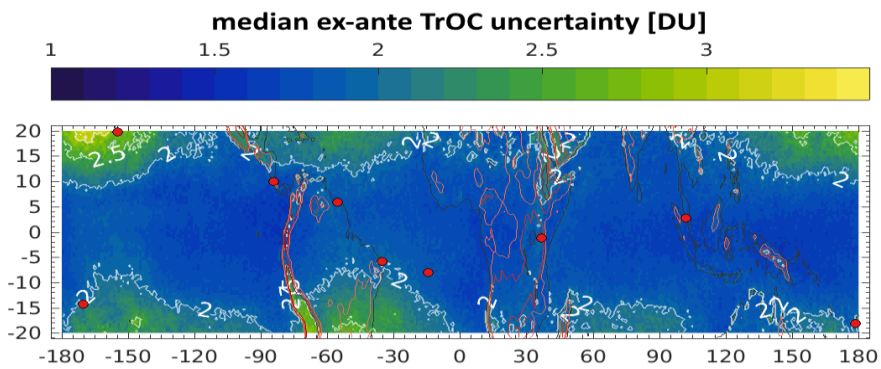
meets mission requirement (<25%)

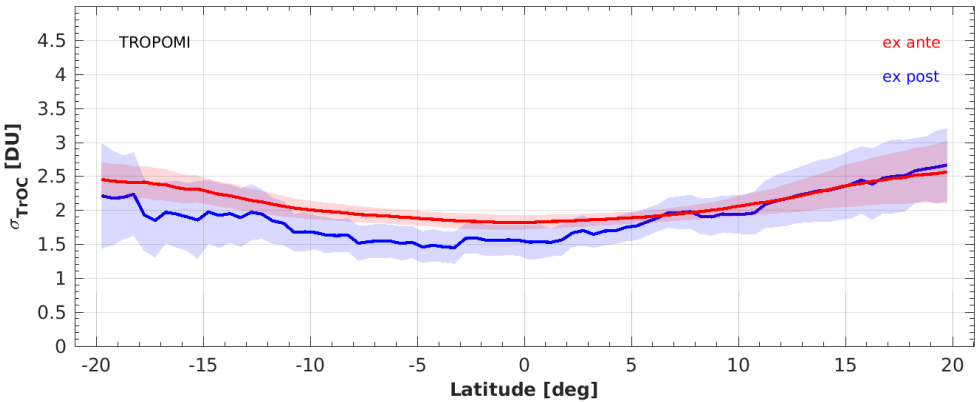


Uncertainty (dispersion): < 1.5-2.5 DU (8-13%)

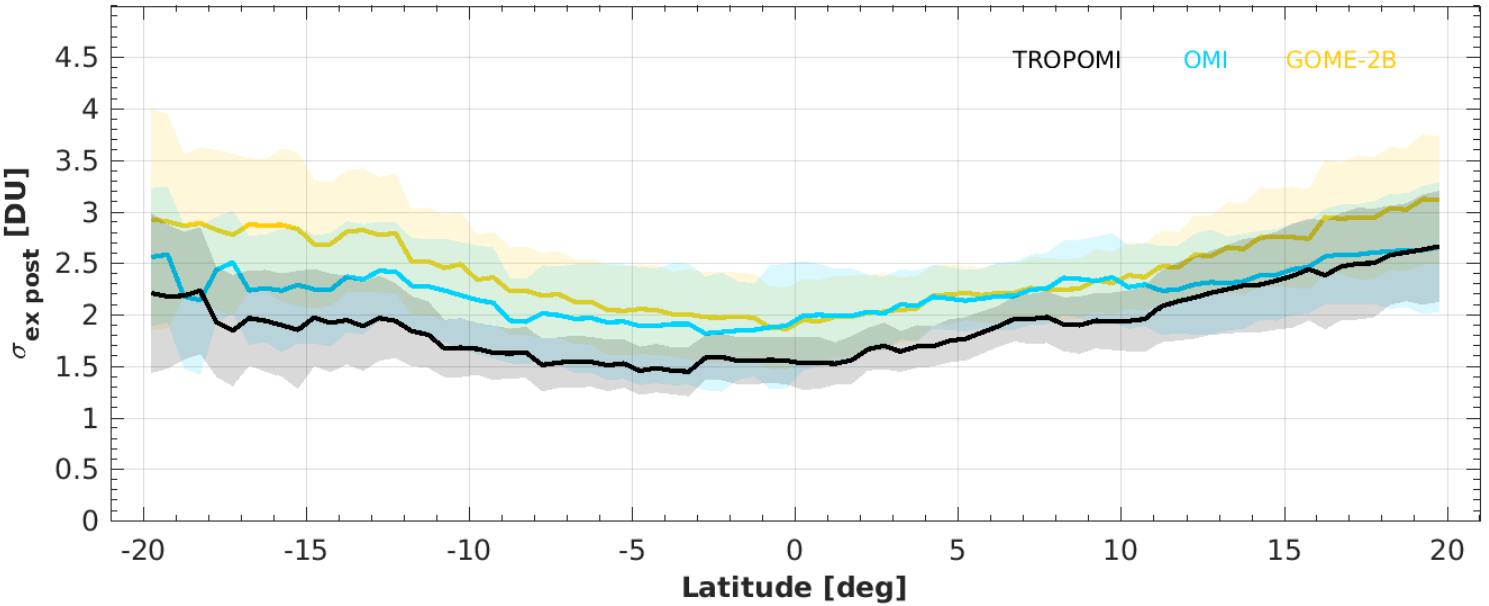
meets mission requirement (<25%)







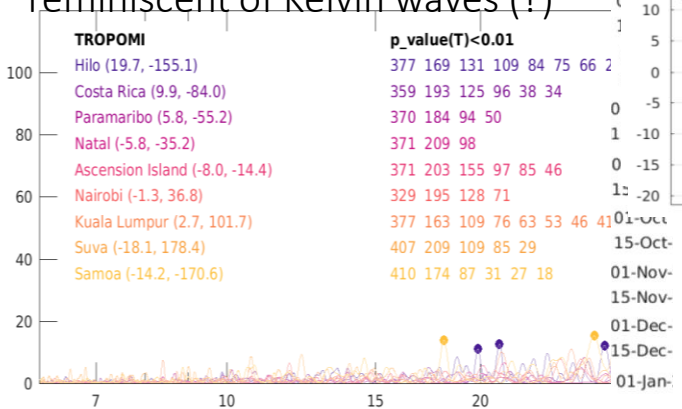
Comparison to similar GOME-2B and OMI CCD data

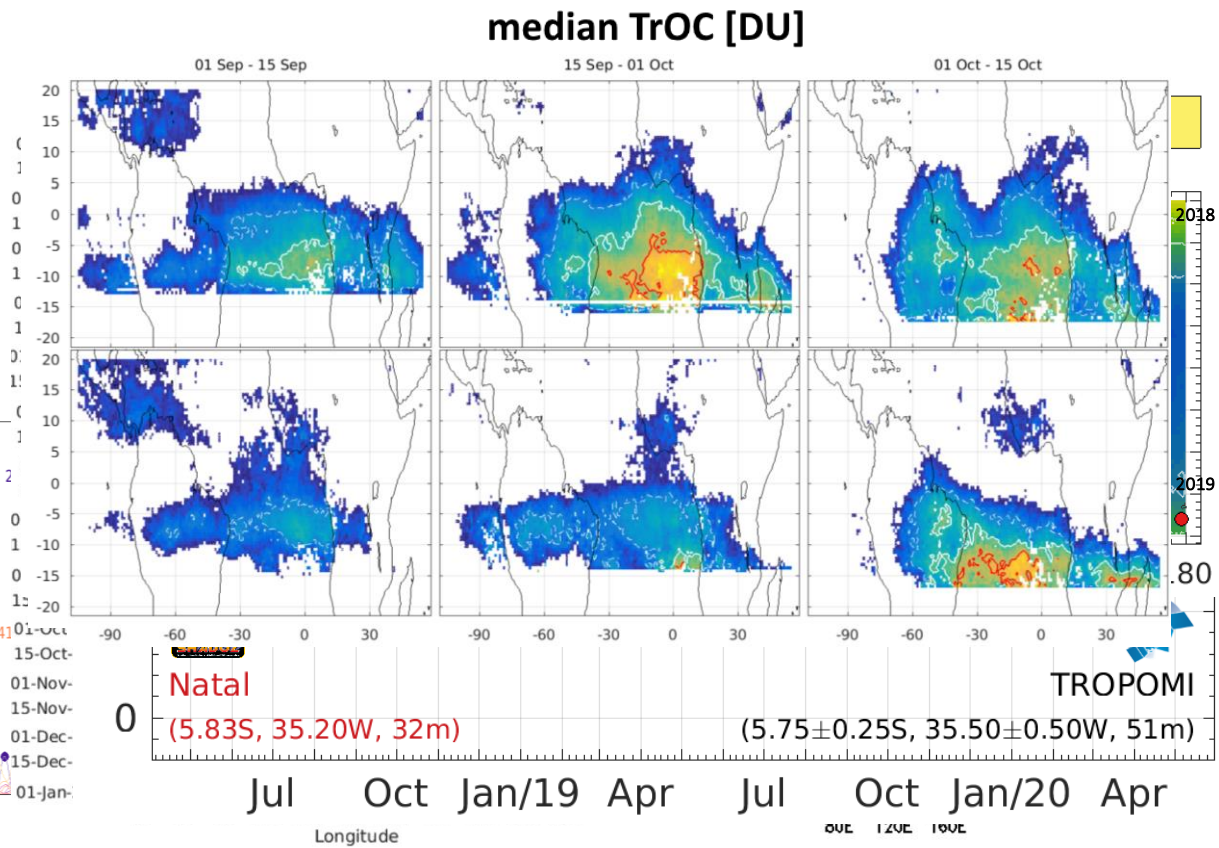


~20-25% better precision & 6x better sampling resolution

How does TROPOMI capture known signals and patterns of tropical ozone ?

- ✓ Zonal wave one
- ✓ Biomass burning
- ✓ Annual & semi-annual cycles
- ✓ Madden-Julian Oscillation
- • Higher-frequency signals reminiscent of Kelvin waves (?)





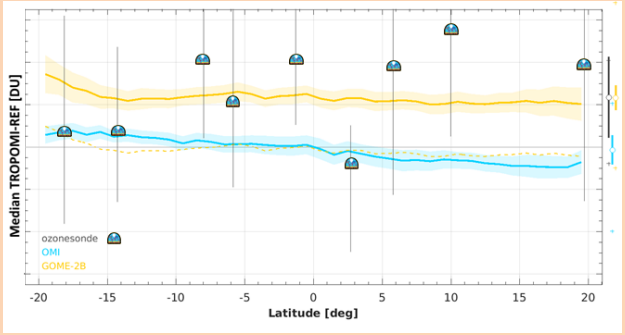
Overview of S5P TROPOMI data quality

S5P data 2018/04-2020/04 processed at DLR with L2_O3_TCL OFFL processor v01.01.05-08

Bias

✓ <25% (mission requirement on systematic error)

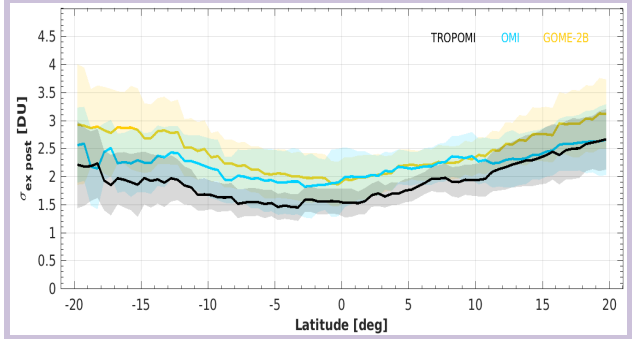
- Overall : -0.1 … +2.3 DU or -0.3 … +13 %
- Dependences SAT-to-SAT :
  - meridian : 0.3-1.1 DU
  - zonal : 0-1.0 DU
  - seasonal : 1.2-2.4 DU



Dispersion

✓ <25 % (mission requirement on uncertainty)

- From pairwise : 2.6-4.6 DU or 14-23 %
- From triplets : 1.5-2.5 DU or 8-13 %
- Dependences SAT-to-SAT:
  - meridian : 1.0 DU
- Sampling error : 1-5 DU



Geophysical patterns & signals

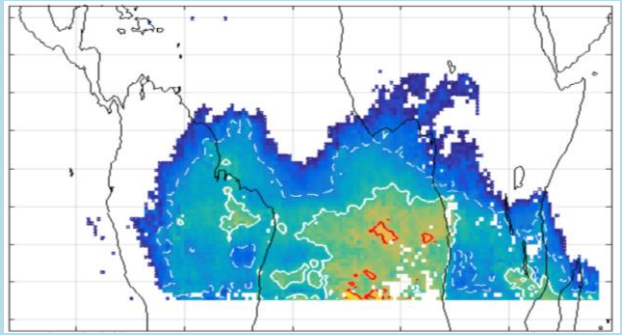
✓ Zonal wave one

✓ Biomass burning season

✓ Annual + semi-annual cycles

✓ Madden-Julian Oscillation

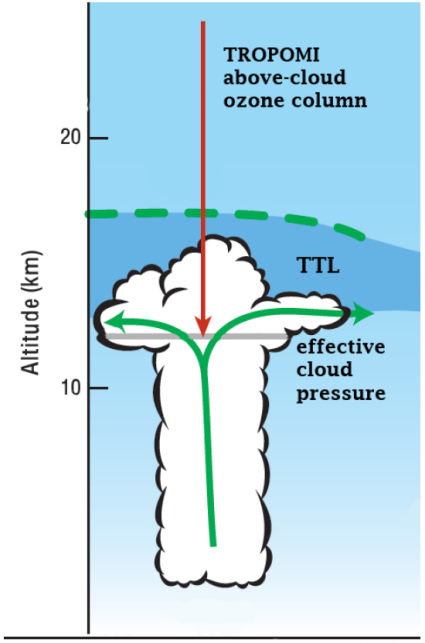
- …

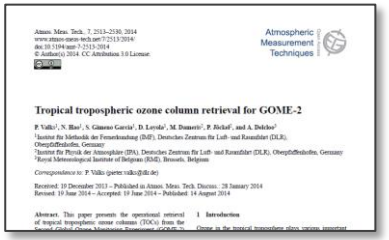


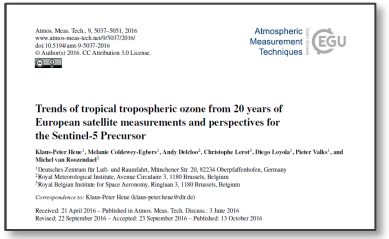
Backup slides

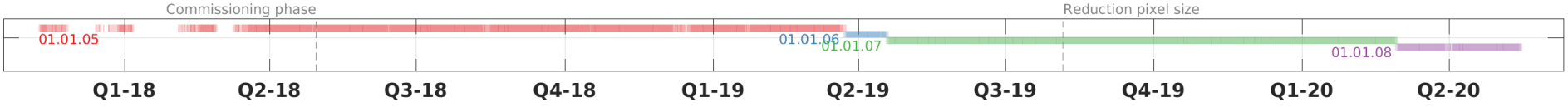
S5P TROPOMI tropical tropospheric ozone column product

- Convective Cloud Differential (CCD) technique using
  - TROPOMI total ozone column data (GODFIT v4)
  - TROPOMI cloud data (OCRA/ROCINN_CRB)
- Represents
  - O_3 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

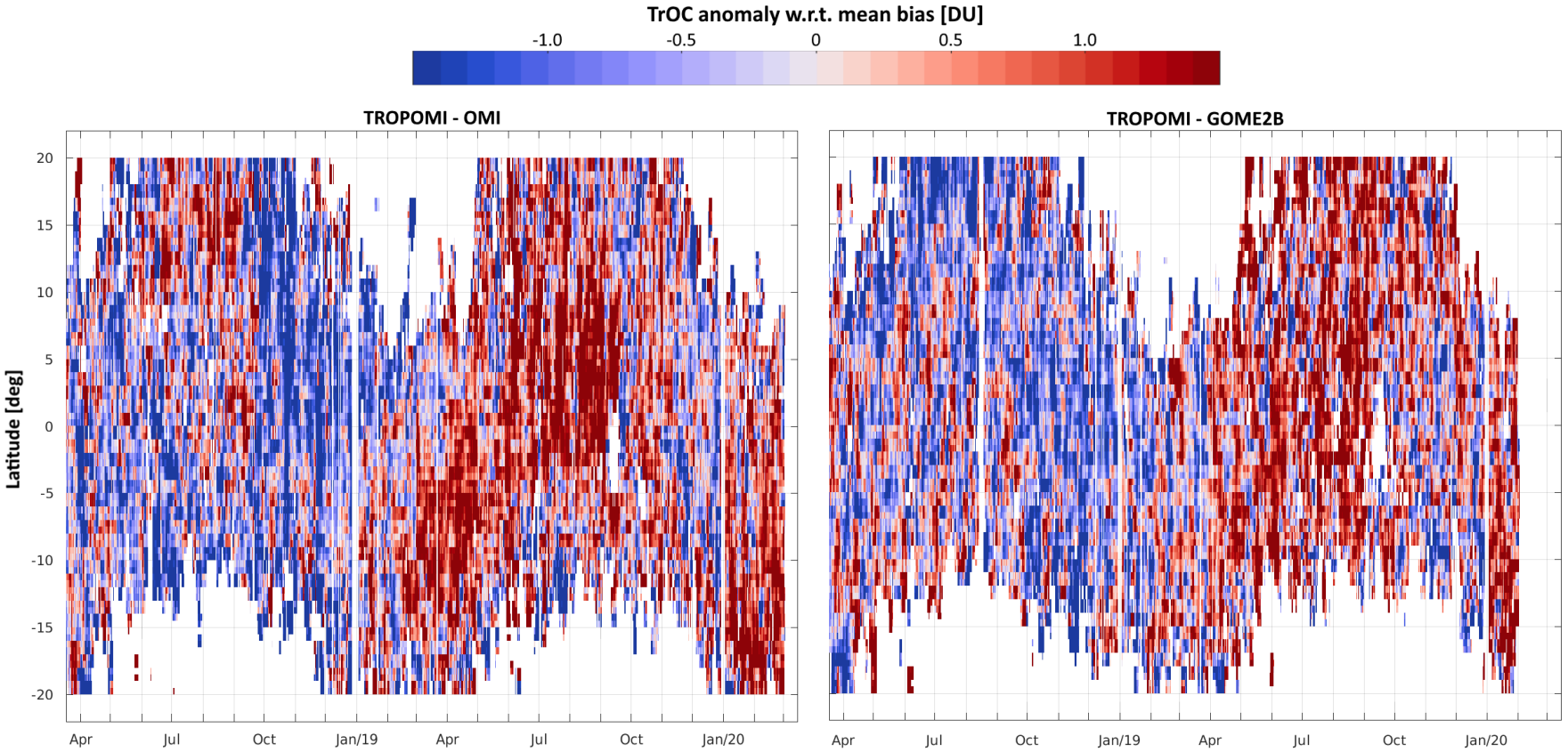



Tropical tropospheric ozone column retrieval for GOME-2

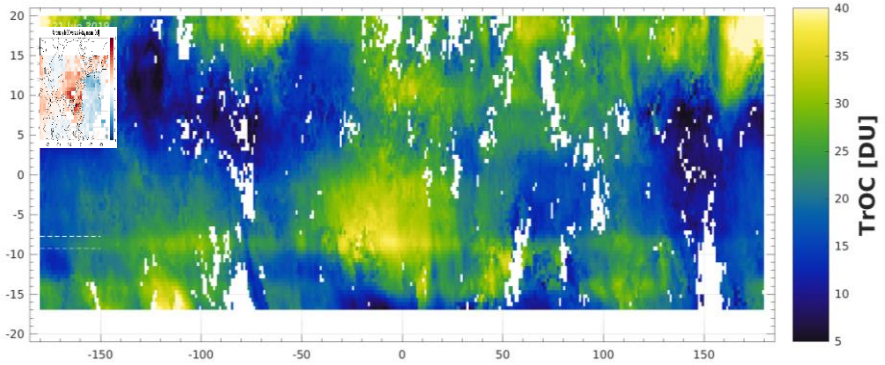

Trends of tropical tropospheric ozone from 20 years of European satellite measurements and perspectives for the Sentinel-5 Precursor



Bias between satellites: Early signs of a seasonal pattern



Random sampling errors : 1-5 DU



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

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