



Initial Validation of TROPOMI Ozone Profile Data Based on Recalibrated Spectra

A. Keppens (arno.keppens@aeronomie.be), J.-C. Lambert, D. Hubert, S. Compernolle, T. Verhoelst, S5P MPC VDAF, and S5PVT CHEOPS-5p

BIRA-IASB, Brussels, Belgium

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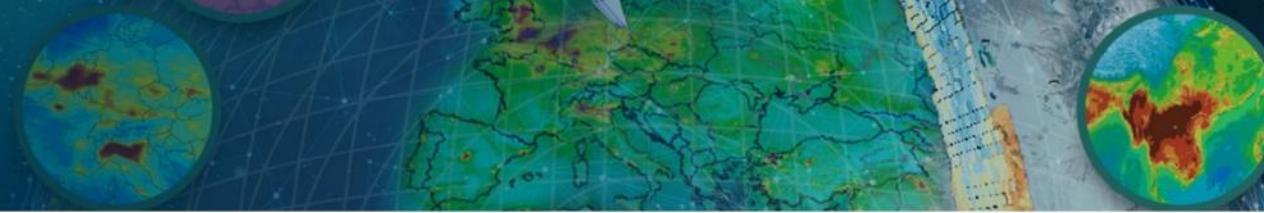
TROPOMI ozone profile data



- S5P MPC DDS5 processed in September 2021
- NL-L2 O3_PR processor V2.3.0, from recalibrated L1b V2.0.0
- 14 pre-selected orbits, maximizing # co-locations with FRM (> 100)
- Period: from 2018/05/09 to 2020/07/15

- Operational processing just started! (Nov. 17, 2021)
- Updated soft-calibration reduces across-track striping

Validation tools



BIRA-IASB Multi-TASTE versatile validation system:

- Daily gridded maps: global, Europe, North-America
- Consistency checks with total and tropospheric ozone products
- Data / information content studies
- FRM comparisons + dependencies (S5P MPC VDAF and S5PVT)
- Delta-validation exercises upon updates

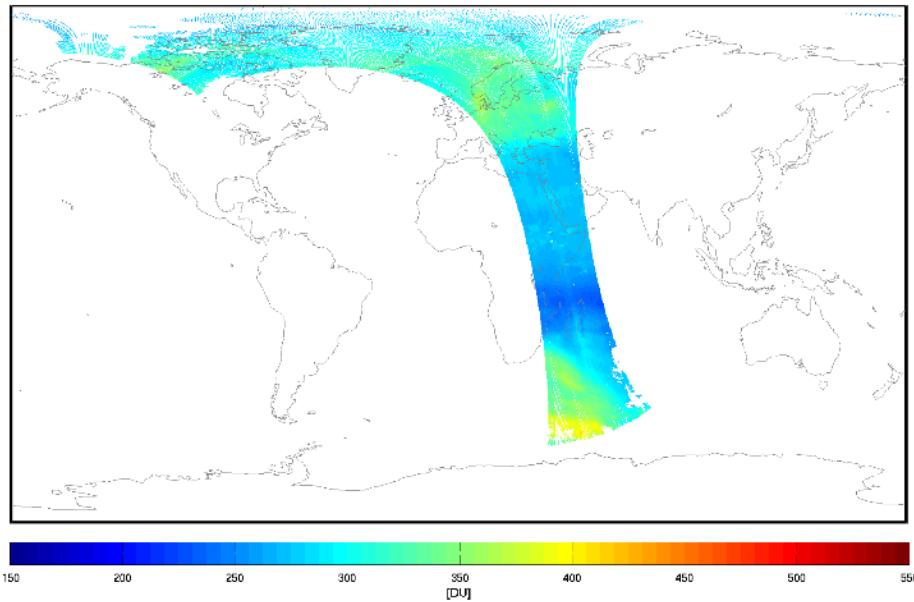
S5P MPC:

- Automated Validation Server (S&T)
- PYCAMA correlation studies (KNMI)

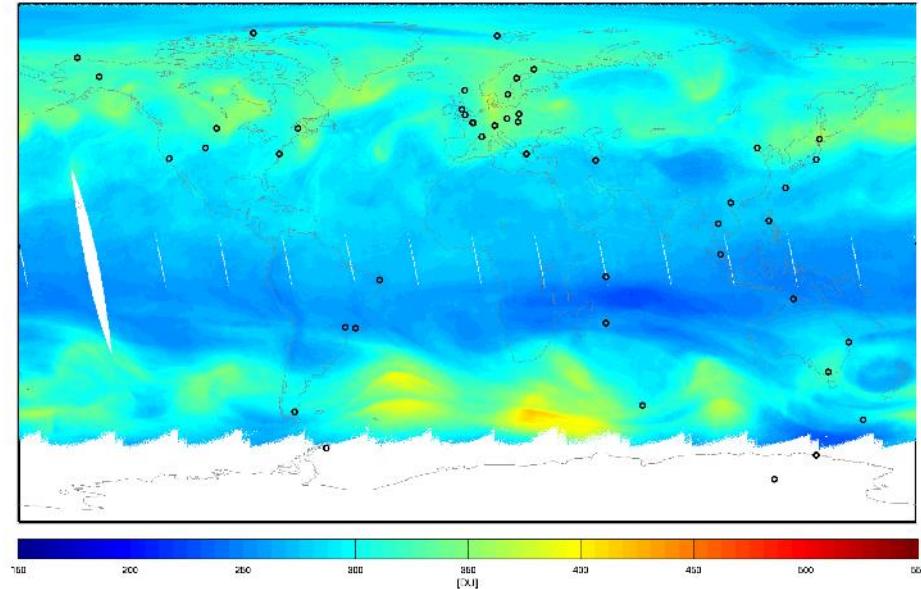
Daily global maps: total columns



Sentinel-5P/TROPOMI: O₃ column number density (Integrated column)
20200715



Sentinel-5P/TROPOMI: O₃ column number density
20200715

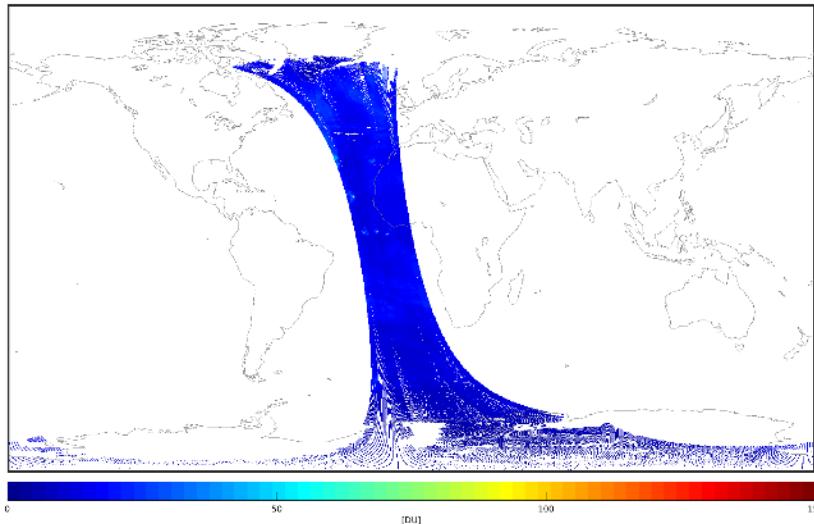


Molecule:
O₃ column number density
Date Range:
20200715
Quality value:
> 50
Grid:
0.25° x 0.25°
Processing stream:
OFL
Processor version number:
02.51.03

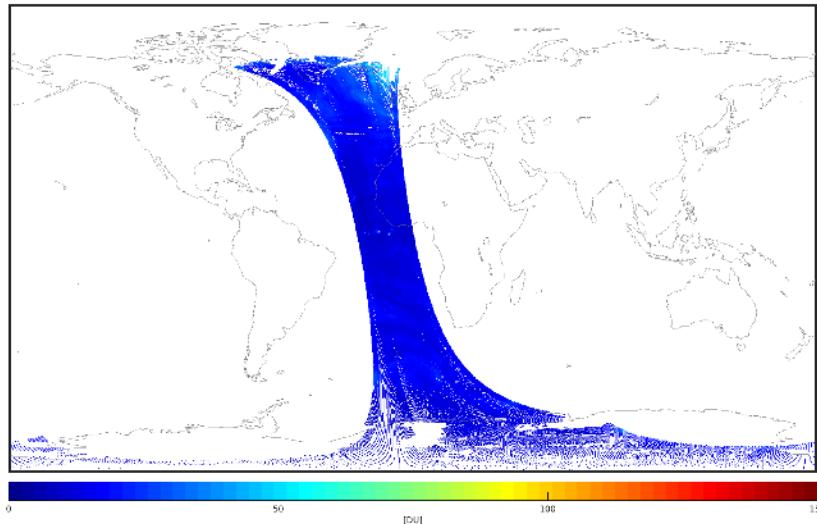
Daily global maps: 6 subcolumns



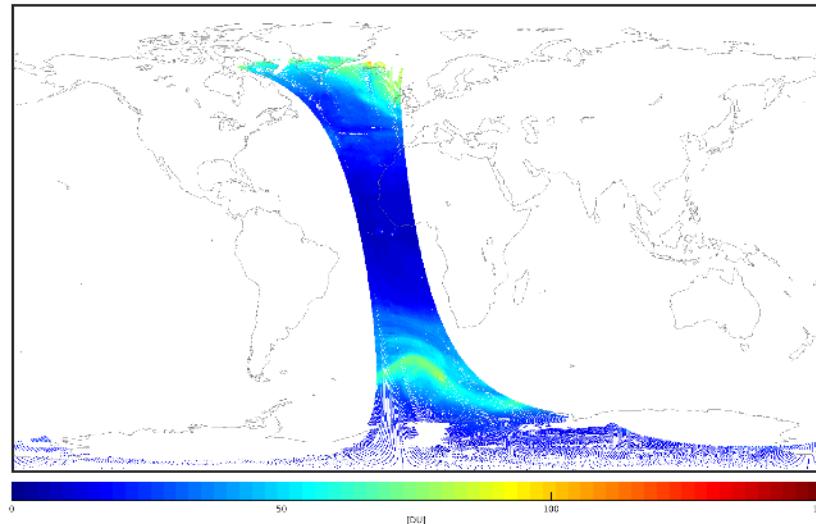
Sentinel-5P/TROPOMI: O₃ column number density (layer 1: 0.0 - 6000.0km
20211101



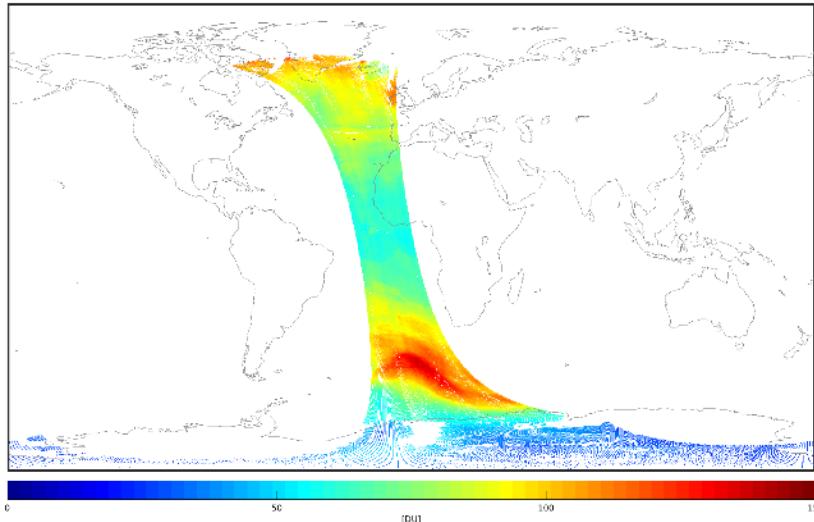
Sentinel-5P/TROPOMI: O₃ column number density (layer 2: 6000.0 - 12000.0km
20211101



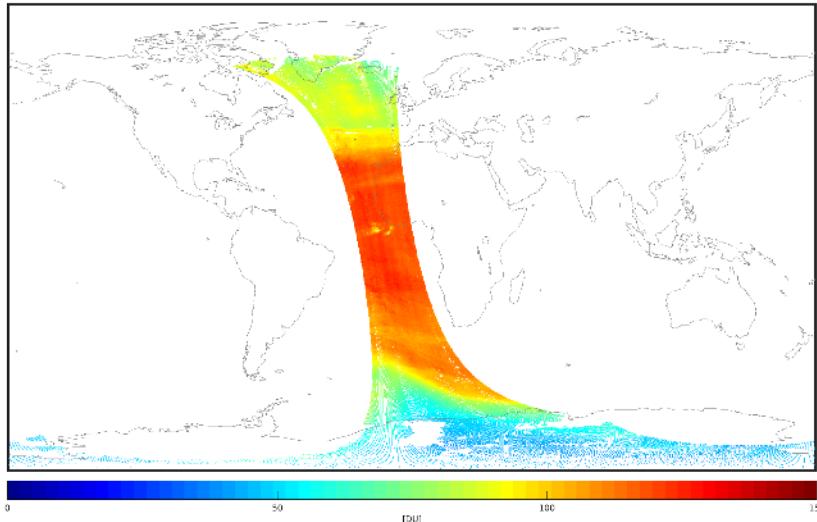
Sentinel-5P/TROPOMI: O₃ column number density (layer 3: 12000.0 - 18000.0km
20211101



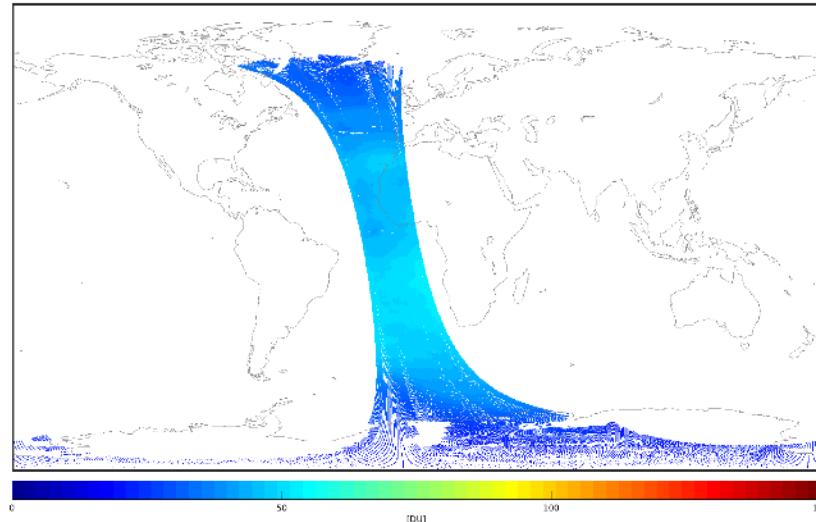
Sentinel-5P/TROPOMI: O₃ column number density (layer 4: 18000.0 - 24000.0km
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Sentinel-5P/TROPOMI: O₃ column number density (layer 5: 24000.0 - 32000.0km
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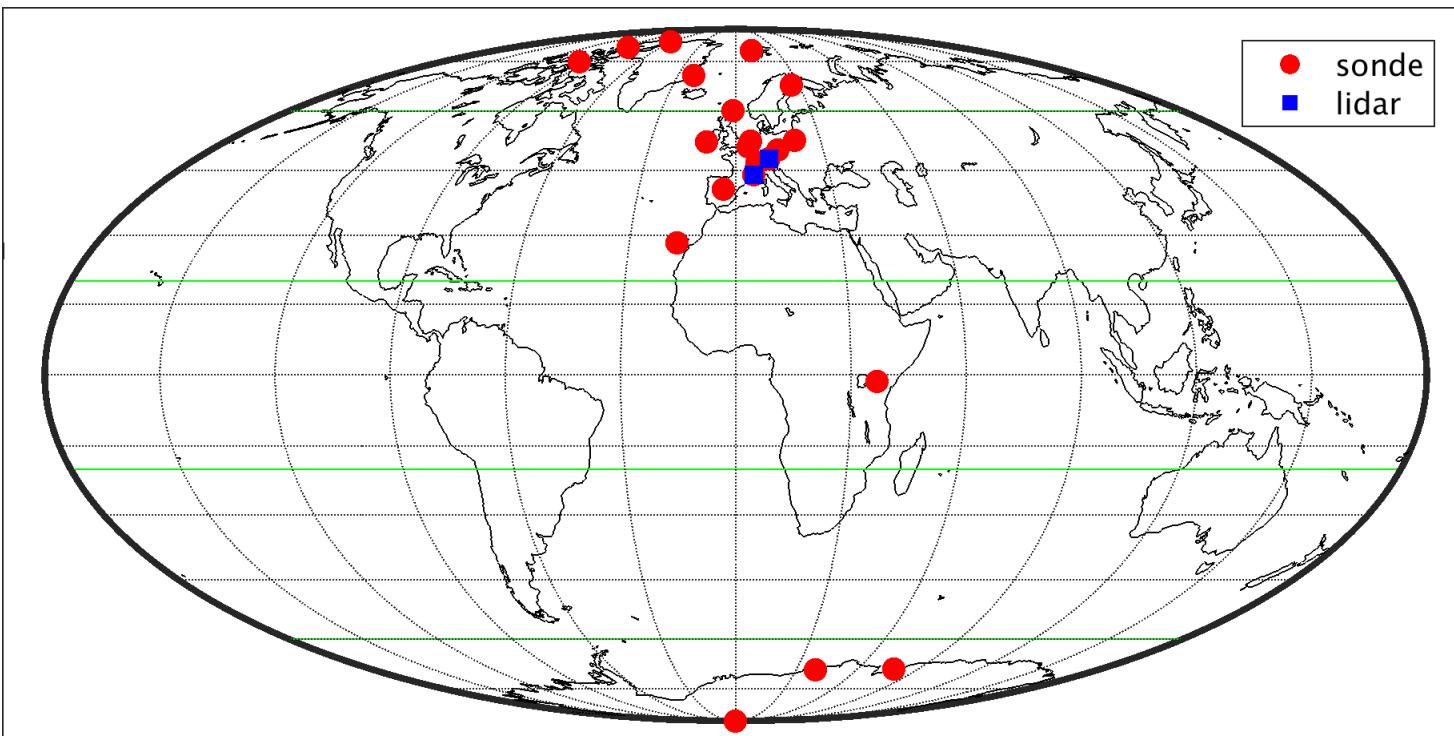


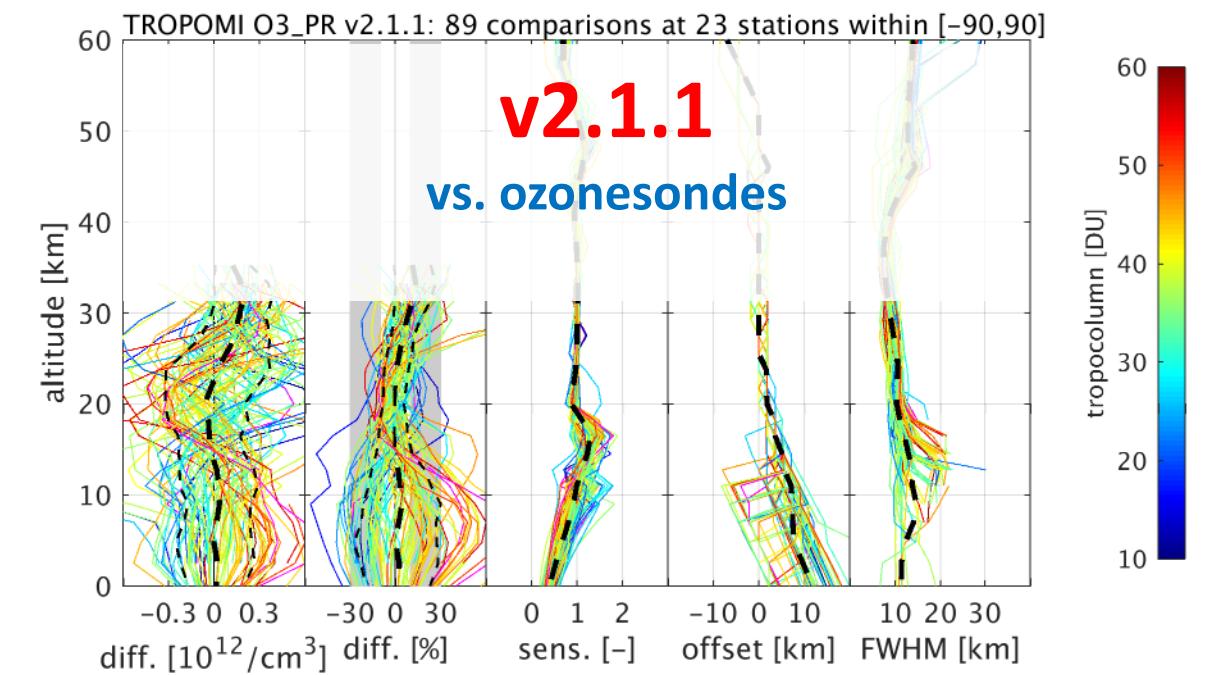
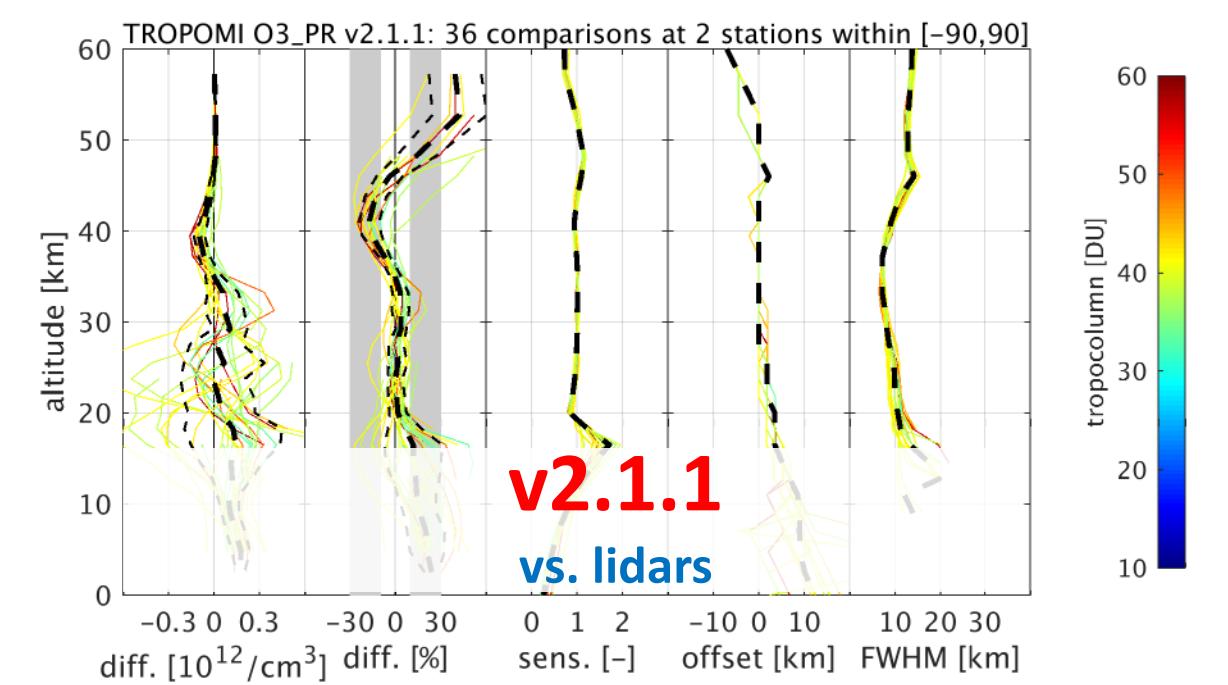
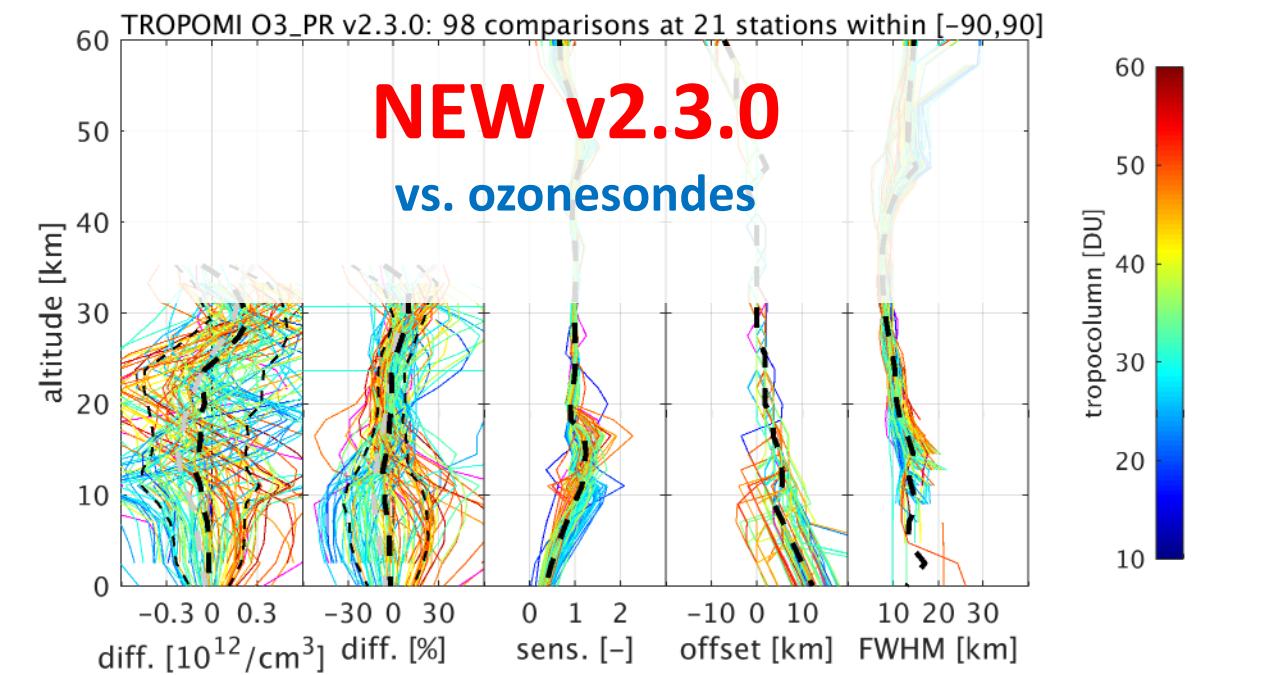
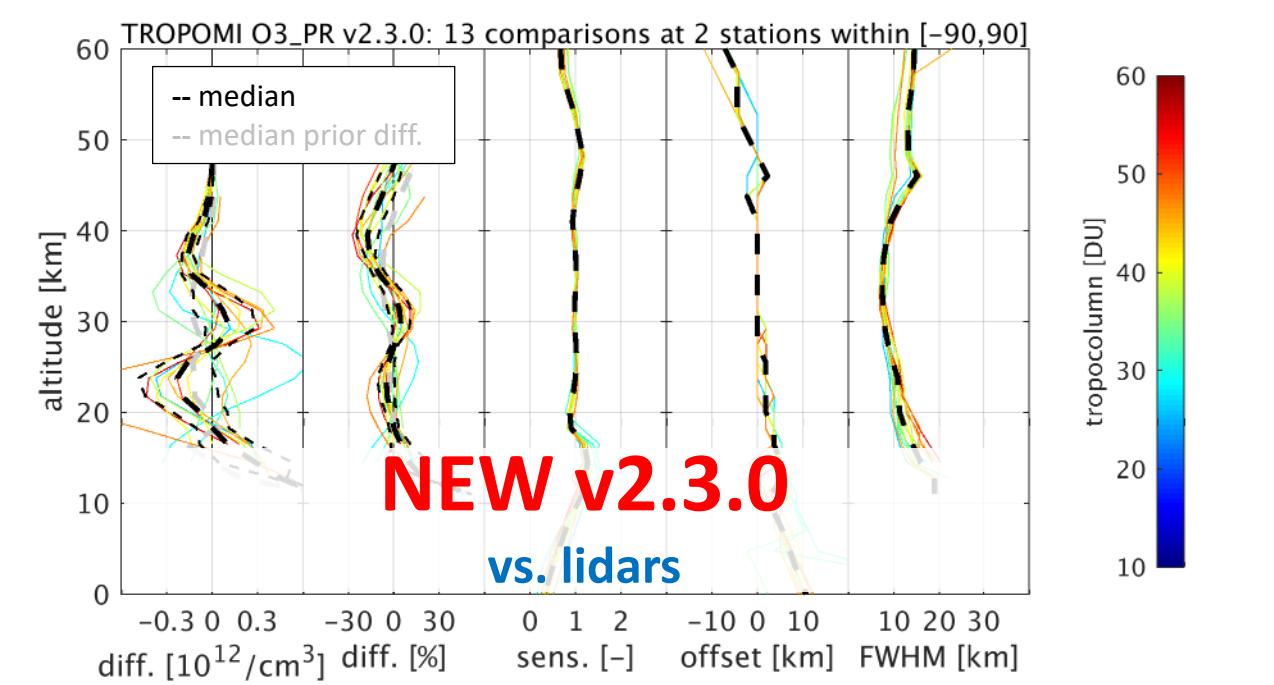
Sentinel-5P/TROPOMI: O₃ column number density (layer 6: 32000.0 - 77000.0km
20211101



FRM data and settings

- FRM through EVDC (as for Automated Validation Server)
 - NDACC/SHADOZ/WOUDC ozonesonde
 - NDACC/TOLNET tropospheric and stratospheric lidar
- Co-location criteria: same day ($\pm 12\text{h}$), closest (overpass) pixel with QA > 0.5
- 111 co-located data pairs at
 - 21 ozonesonde stations
 - 2 lidar stations
- Mass-conserved regridding and AK smoothing of FRM



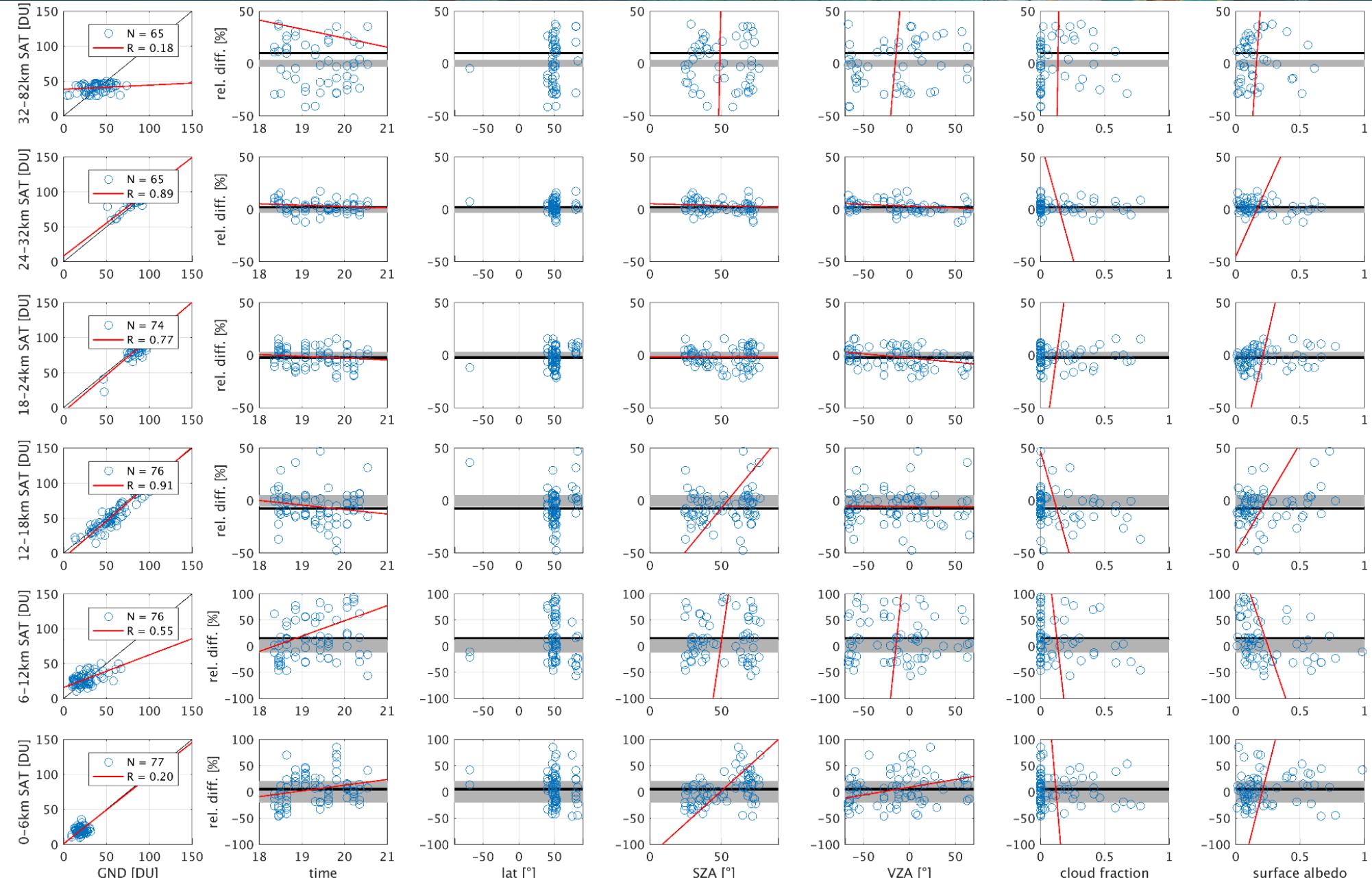


PRELIMINARY information content



- Roughly 6 DFS (AK trace)
- Sensitivity (AK row sum) of 0.5 at surface compensated by UTLS peak > 1
- 10-15 km vertical resolution (AK FWHM), min. 7 km at 35 km altitude
- About 10 km retrieval offset towards surface
- UTLS profile, DFS, and sensitivity outliers for high surface albedo
(needs screening?)

Subcolumn comparisons and dependencies (sonde)



PRELIMINARY comparison results



- Profile bias < 10 % (20 % dispersion) in troposphere and UTLS is amazingly good for nadir ozone profile retrievals
- Apparent bias dependence on tropospheric column to be verified
- # comparisons too small for other dependencies
- Vertical oscillation in stratospheric bias (5-10 % dispersion), possibly due to large a-priori error in mid and high stratosphere (> 20 %)
- High correlation with FRM for 12-32 km subcolumns

PRELIMINARY compliance assessment

- Science Requirements Document (2008) and ATBD (2021):

Sub column	PBL ¹⁾	0 - 6 km	6-12 km	12-18 km	18-50 km
Required accuracy	$\leq 60\%$	$\leq 20\%$	$\leq 12\%$	$\leq 5\%$	$\leq 3\%$

¹⁾ In practice the pressure at the top of the planetary boundary layer is not known and results for this sub column cannot be provided. Simulation studies can be used to estimate the accuracy for the PBL.

- Scientific Validation Implementation plan (2016):

Parameter	Data Product	Vertical Resolution	Accuracy	Precision
Ozone	Ozone Profile	6 km	10-30%	10%

Documentation at <https://sentinel.esa.int/web/sentinel/technical-guides/sentinel-5p/products-algorithms>

PRELIMINARY conclusions

- Integrated profile consistent with total column retrieval
- Slight striping along orbit (reduced with updated soft-calibration)
- Bias below 10 % (20 % dispersion) in troposphere and UTLS
- Vertical oscillation in stratospheric bias (5-10 % dispersion)
- More comparisons required for effect of influence quantities
- Compliance mostly (just) met / to be confirmed
- Screening?
 - retrievals that deviate non-physically from a-priori
 - reduced DFS and sensitivity at high surface albedo