The GOME-type Tropical Tropospheric Ozone Essential Climate Variable (GTTO-ECV) satellite data record and an updated S5P-BASCOE dataset

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28 April 2023

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  - Harmonisation
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  - Trends
- S5P-BASCOE
  - Principle
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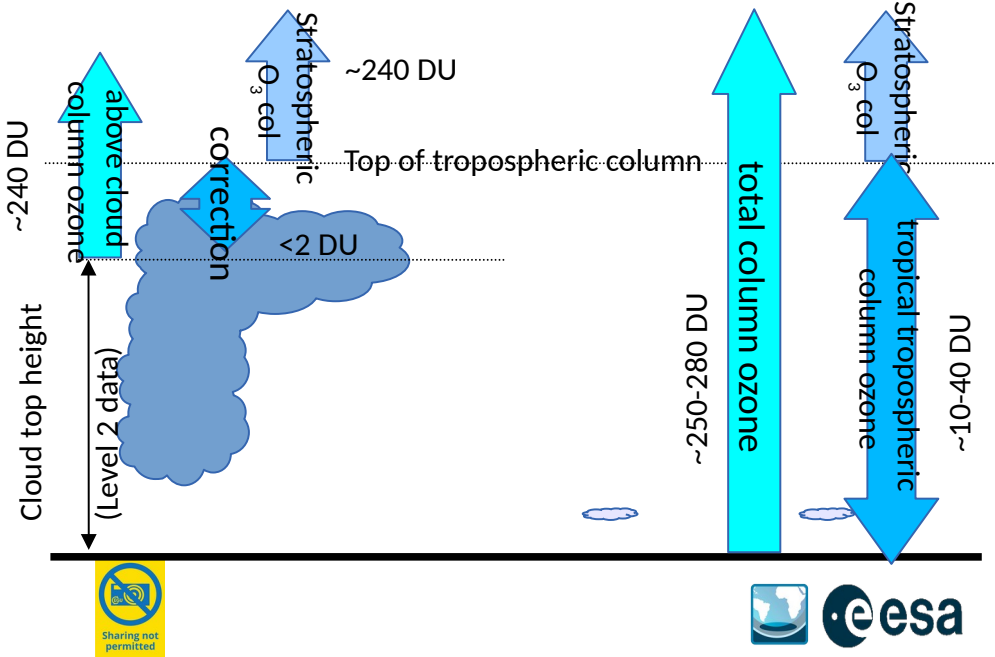
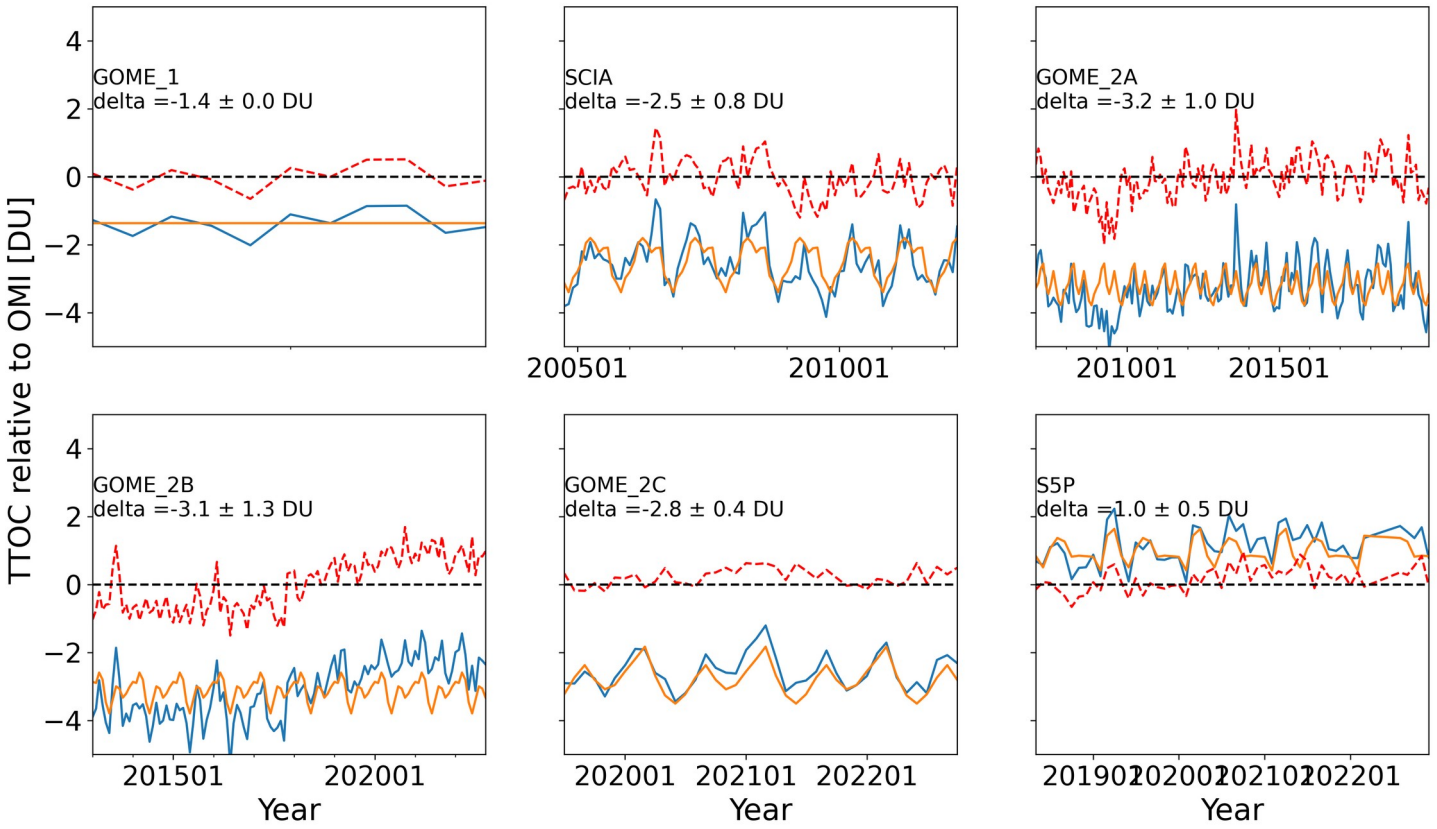
CCD Specifications

- Definition of tropopause, close to the top of deep convective clouds 200 or 270 hPa
- Stratospheric column is averaged over 70°E to 200 °E

- spatial & temporal sampling, 1°x1° x 1month



Harmonisation



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Trend Results

- TOAR Workshop March 2023:
- Fit Trends from 1995 to 2006 or 2008
- And from 2008 to 2022
- In addition an a “non Covid” case can be studied 2008 to 2019

- For the trends the percentile trends are recommended

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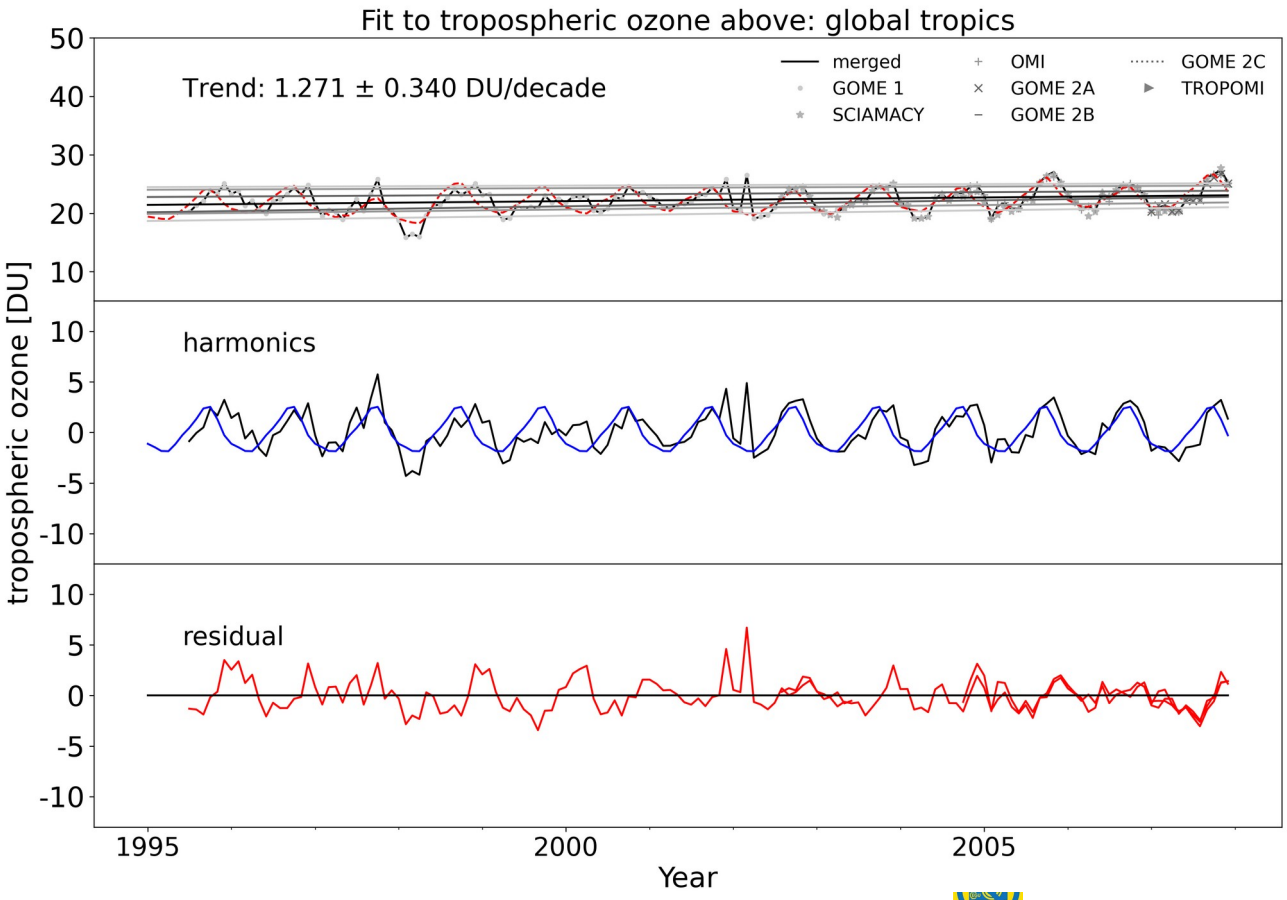
Trend between 1995 and 2008



Increase
~ 1.27 DU/decade

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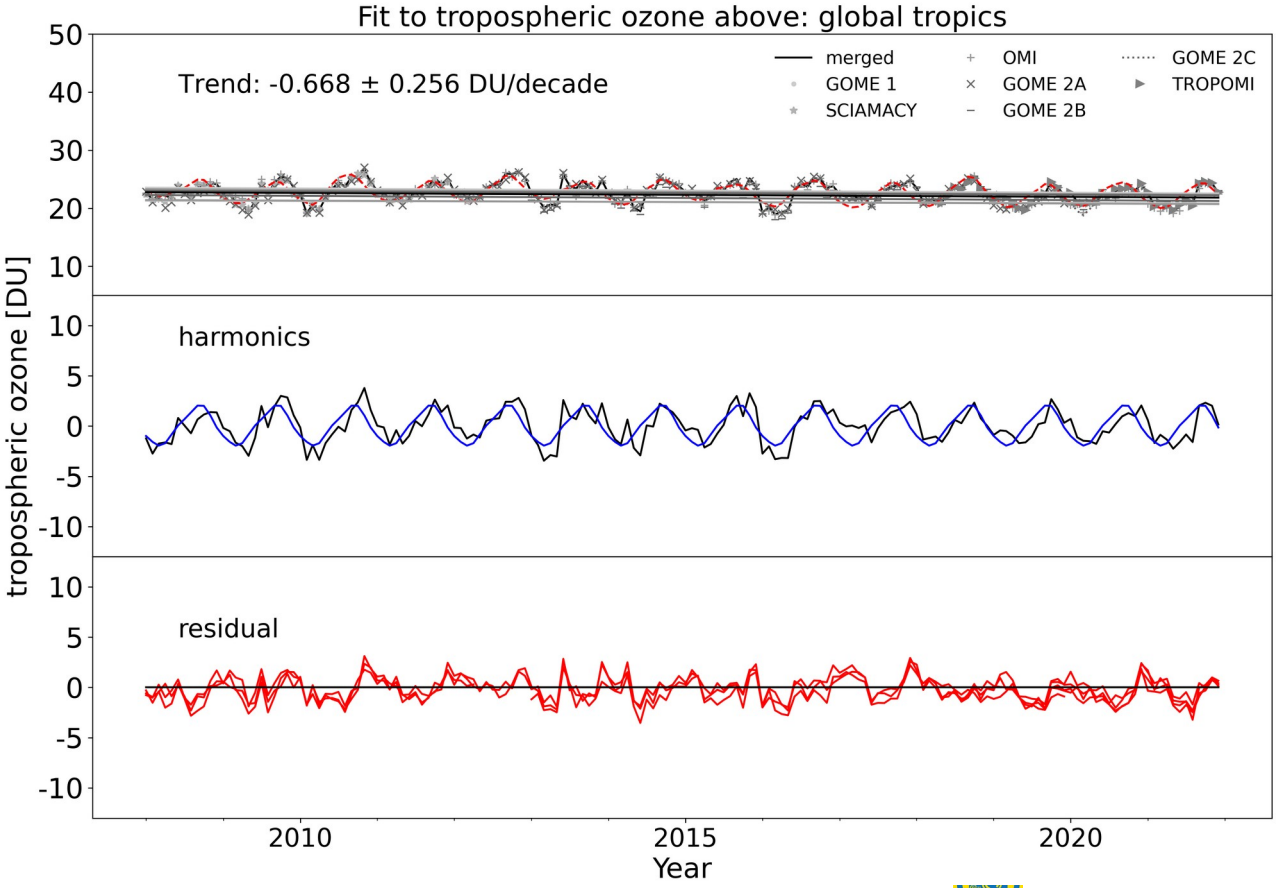
Trend between 2008 and 2022



Decrease
~ 0.67 DU/decade

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Summary and outlook CCD

- Harmonized CCD tropical tropospheric dataset from 1995-2022
- Mean tropical trend +1.2 DU/decade up to 2008
- -0.67 DU/decade between 2008 and 2022

- Estimate trend in ppb/decade
- Calculate tropical total ozone burden (Tg) and change
- Update publication from 2016

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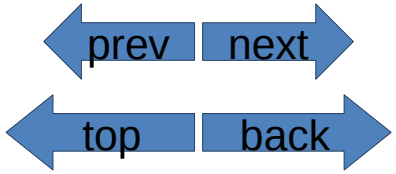
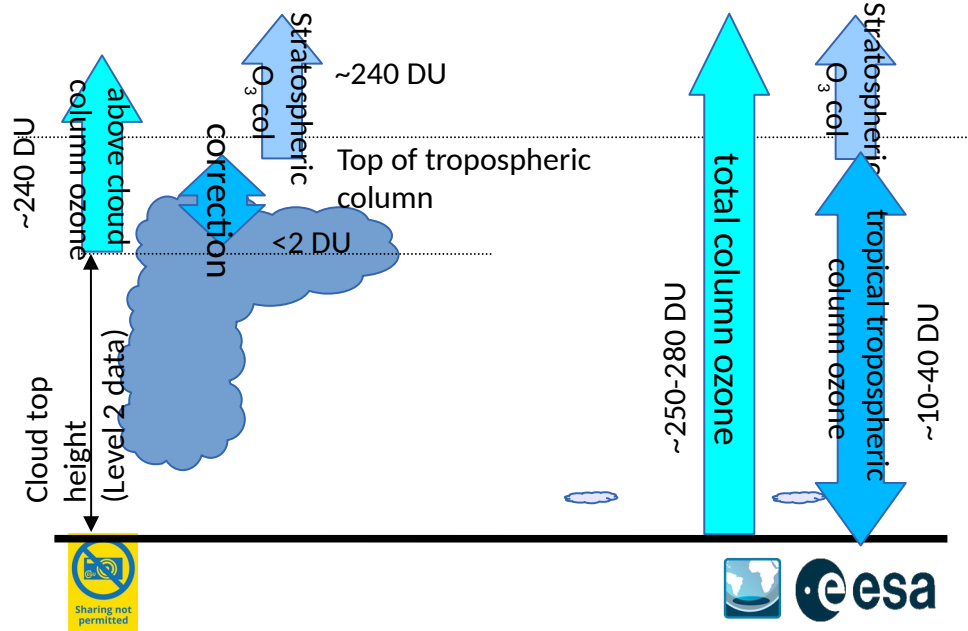
details CCD Specifications

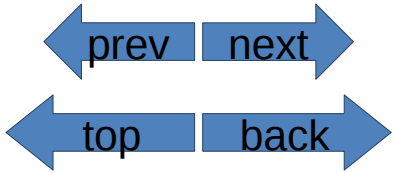
- definition tropospheric column, close to the top of deep convective clouds
- S5P CCD data reach up to 270 hPa whereas for GOME_1 to GOME_2 200 hPa was used
- Two data sets (with S5P to 270 hPa or to 200 hPa without S5P)
- Stratospheric column is averaged over 70°E to 190 °E (=170°W)
- CCD files also contain averaged VMR
- spatial & temporal sampling, 1°x1° x 1month
- S5P data are averaged to the spatial and temporal resolution



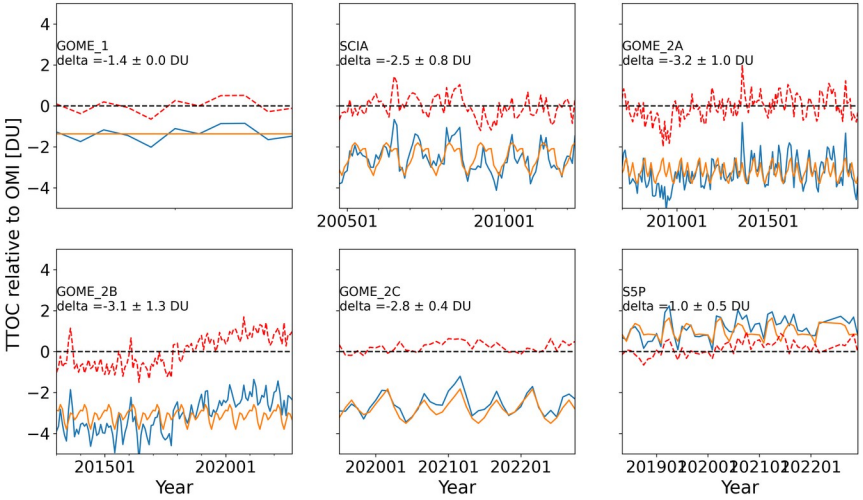


Harmonisation

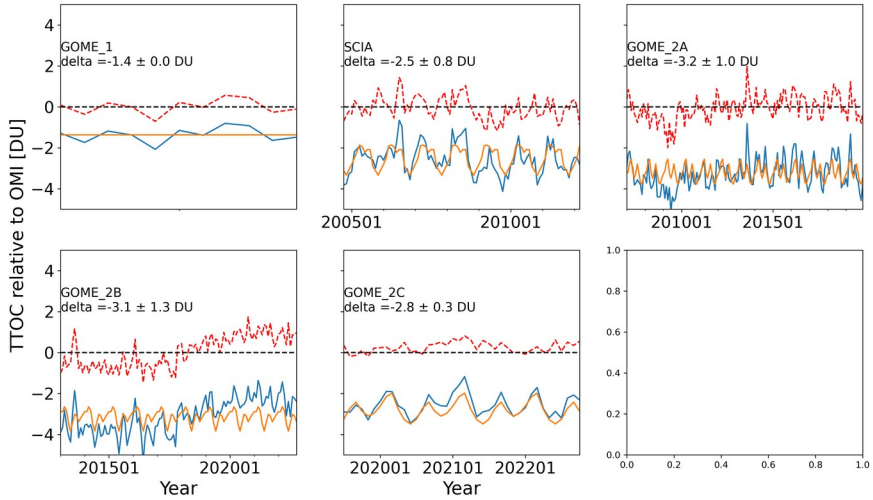
- The mean difference (given in the figures) and the mean annual cycle relative OMI is subtracted/added to the measurements
- For GOME_1 the harmonized data set (SCIAMACHY) is used as reference. Due to short period of tropical overlap (one year) we use the mean difference between GOME-1 and SCIAMACHY here.



Harmonisation 2



270 hPa top level
with S5P included



- 200 hPa top level
without S5P included

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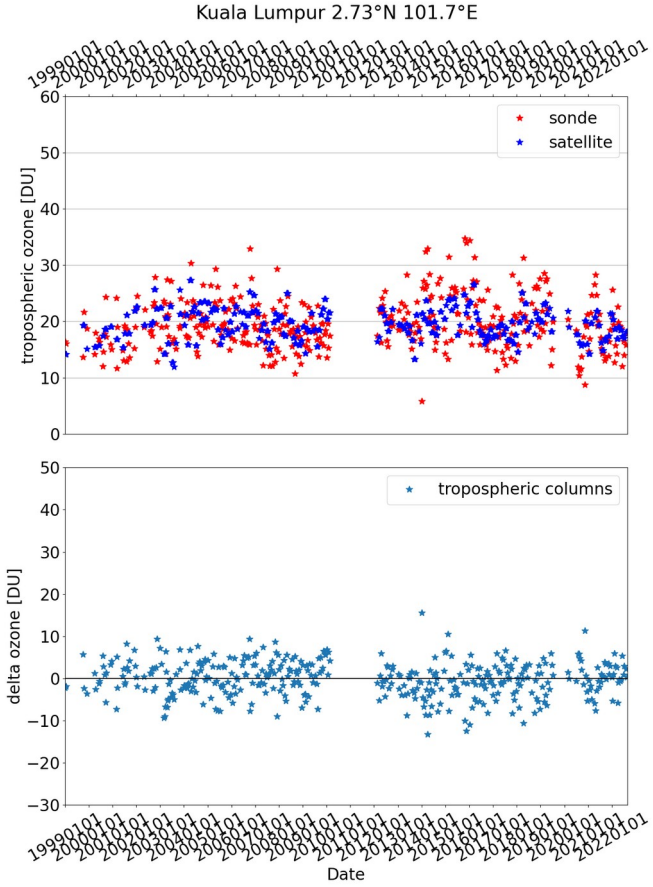
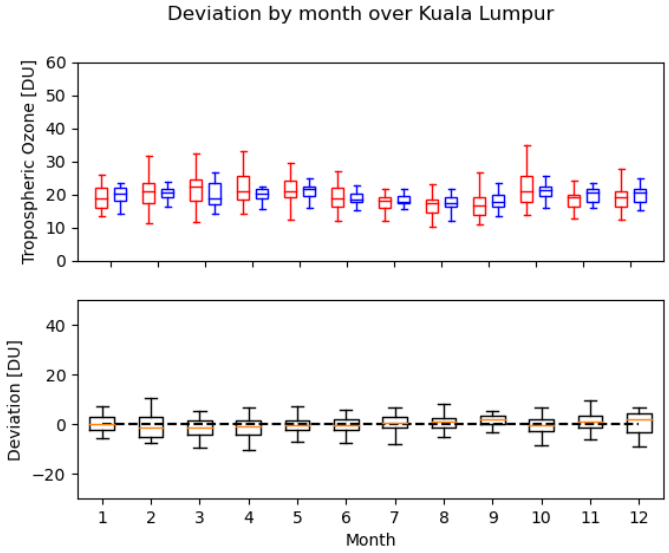
Validation Kuala Lumpur





The sonde data are integrated up to 270/200 hPa and averaged over one month before comparing to the grid cell (1°x1°) that contains the sounding station

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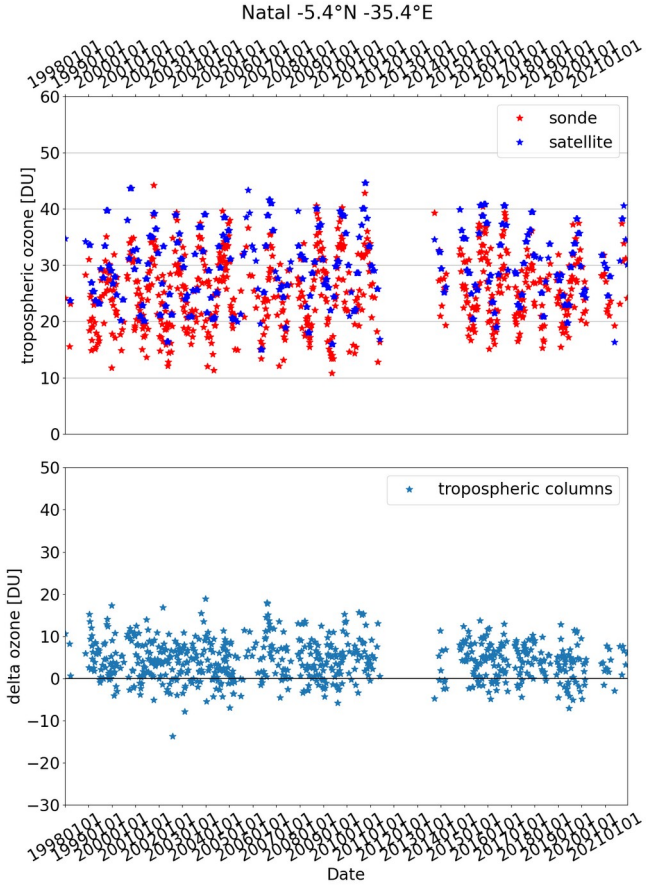
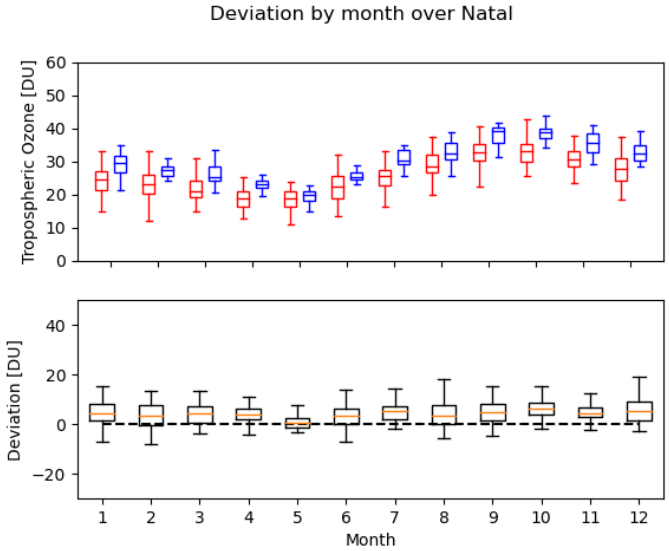
Sharing not permitted

Validation Natal





very good agreement for May
Larger deviation for higher columns (Aug.-Sep.)

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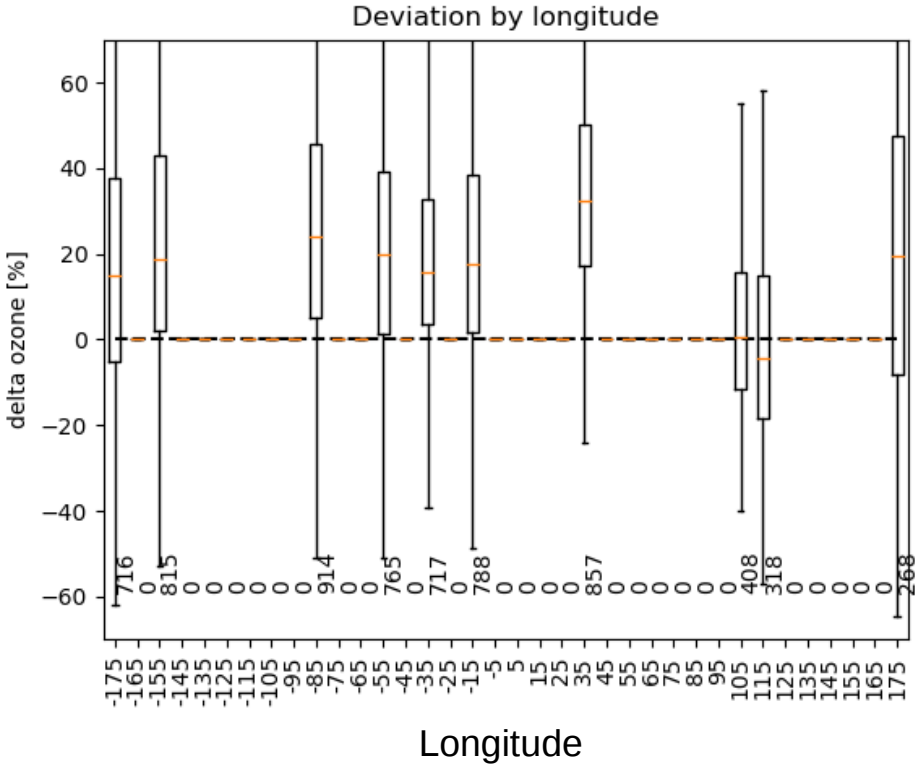
Validation overview



Except for the east Asian stations (Kuala Lumpur and Java) we observe a positive bias (~20%) relative to the sondes.
This finding is independent on top level of the CCD data (200/270 hPa)

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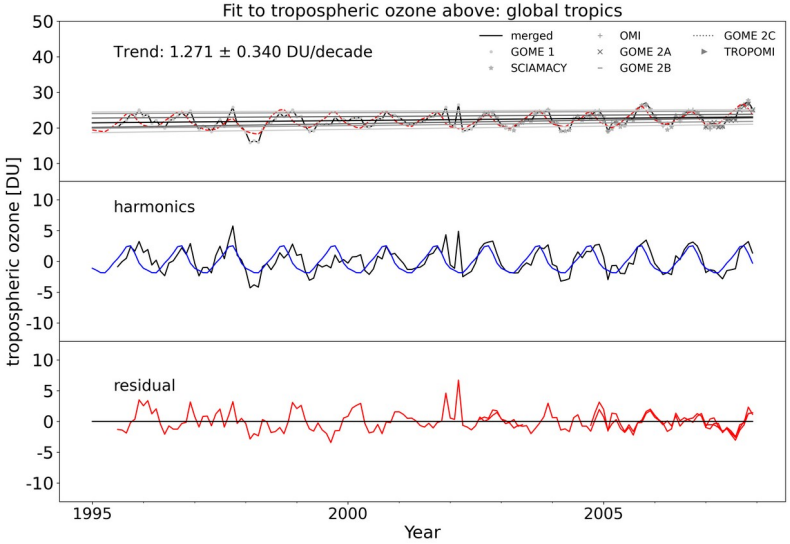
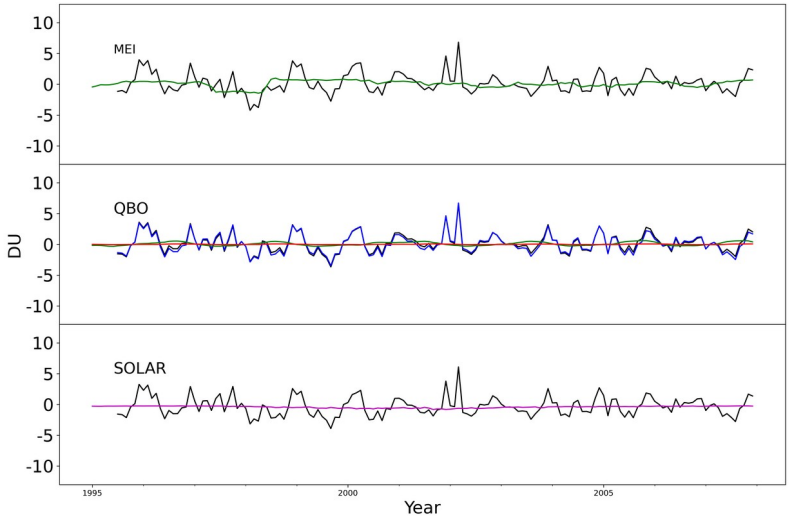
Trends 1995-2008

Beside the linear function a set of harmonic functions and the indices for ENSO (MEI), QBO and Solar flux were fitted.





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Trends 1995-2008

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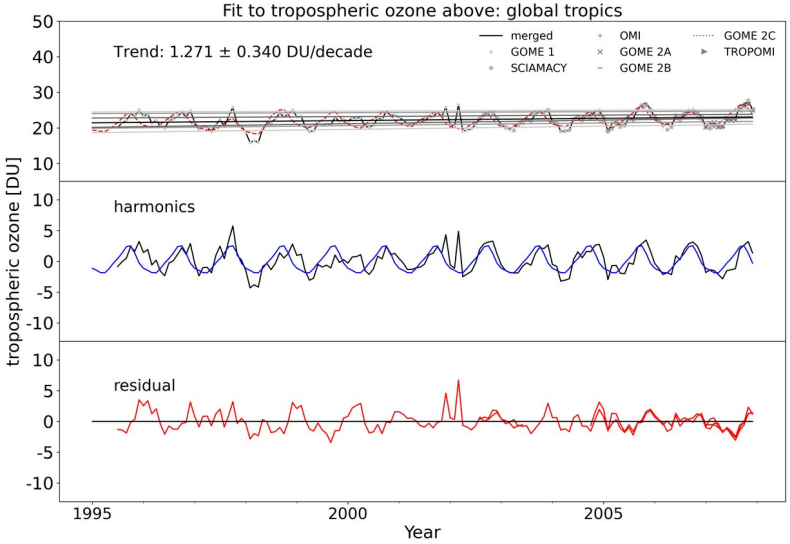

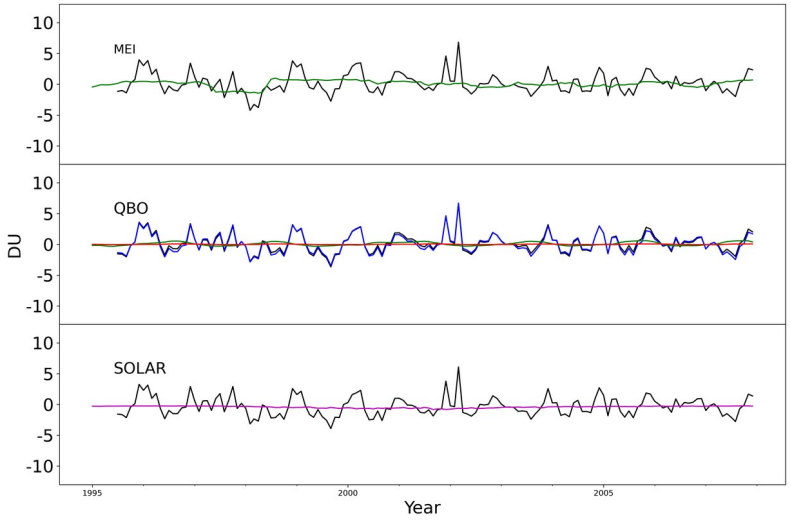

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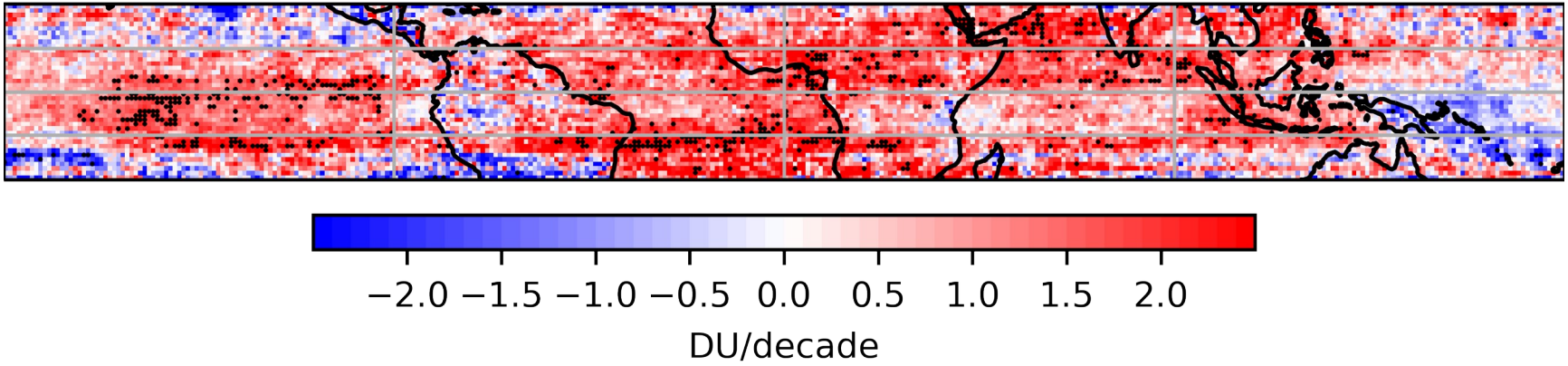
Trends 1995-2008 (2)

The same fit was applied for each grid point, the median slope is shown here, the dots indicate significant trends

trend in tropospheric column ozone



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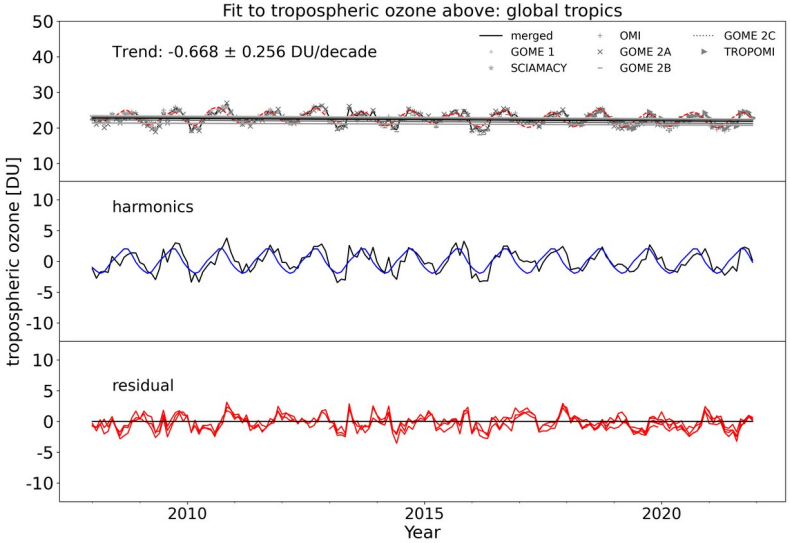
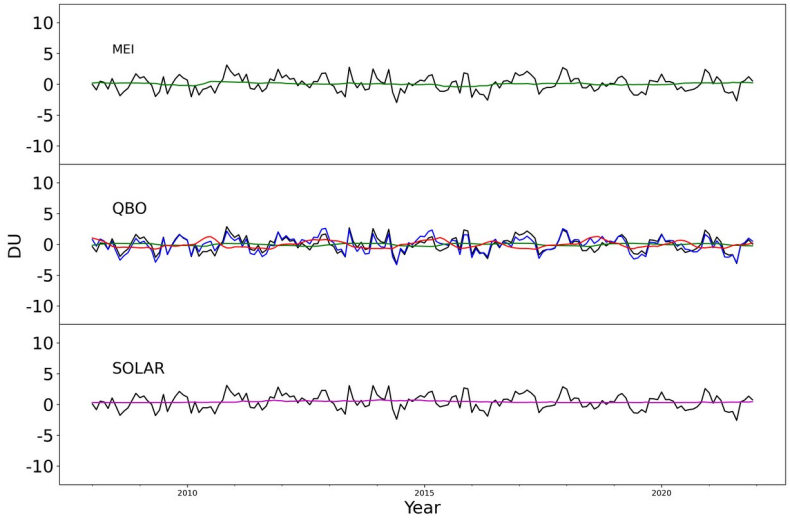
Trends 2008-2022

Beside the linear function a set of harmonic functions and the indices for ENSO (MEI), QBO and Solar flux were fitted.





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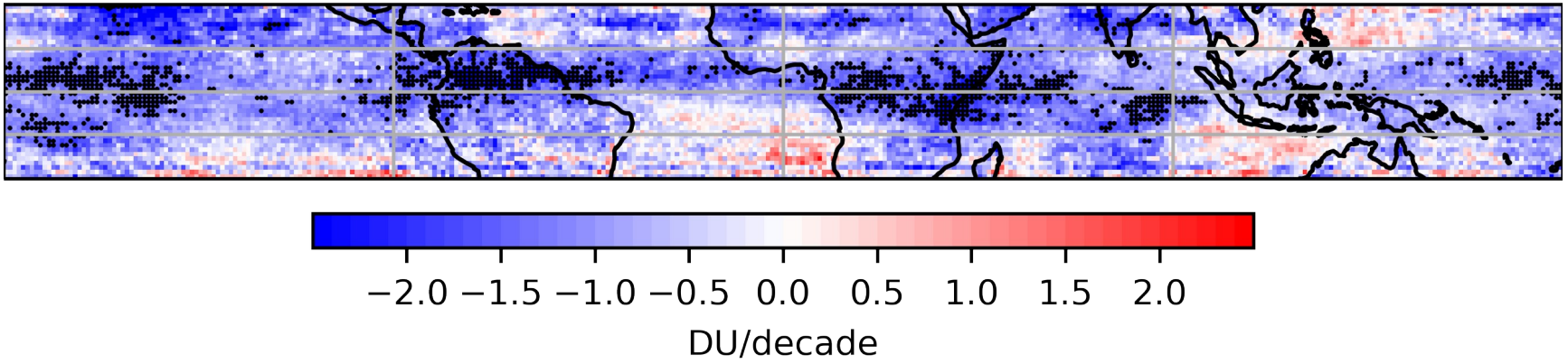
Trends 2008-2022 (2)

The same fit was applied for each grid point, the median slope is shown here, the dots indicate significant trends

trend in tropospheric column ozone



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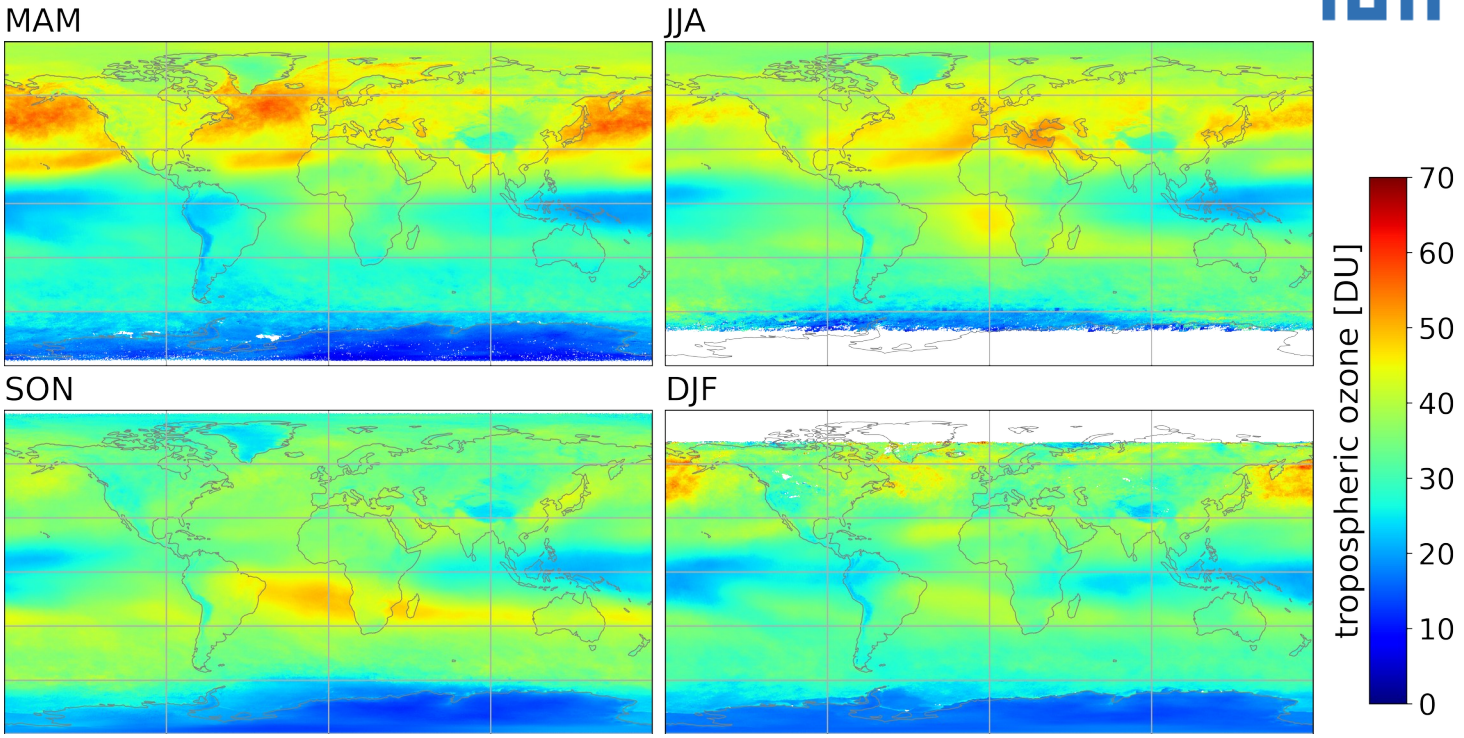
S5P - BASCOE tropospheric ozone



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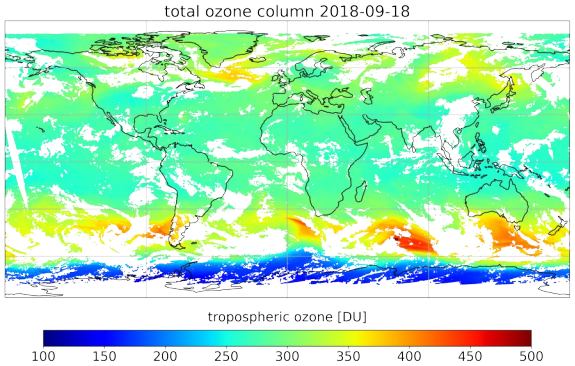
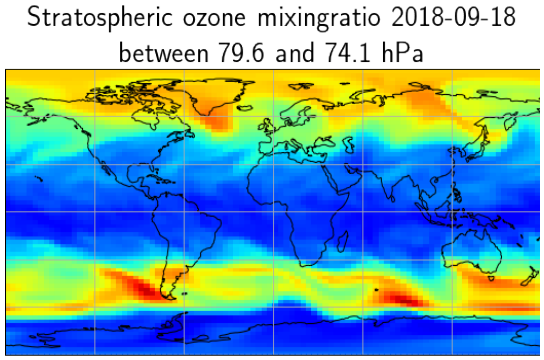
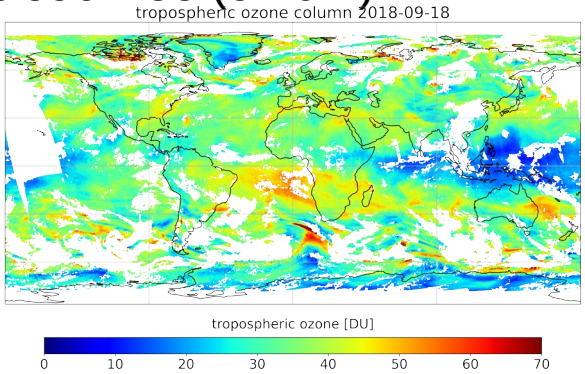
S5P - BASCOE



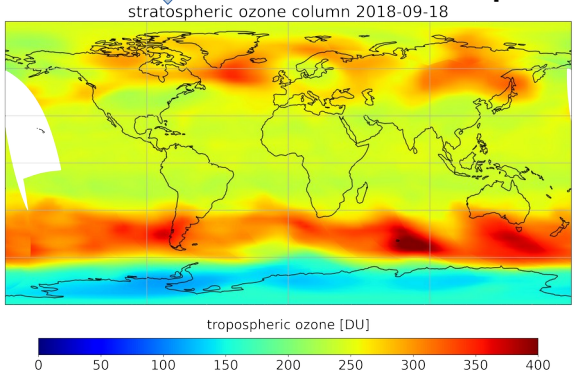


TROPOMI total column ozone cloud free (cf<0.2)

BASCOE ozone profile integrated above tropopause and interpolated to TROPOMI pixel



Subtract stratospheric from total column



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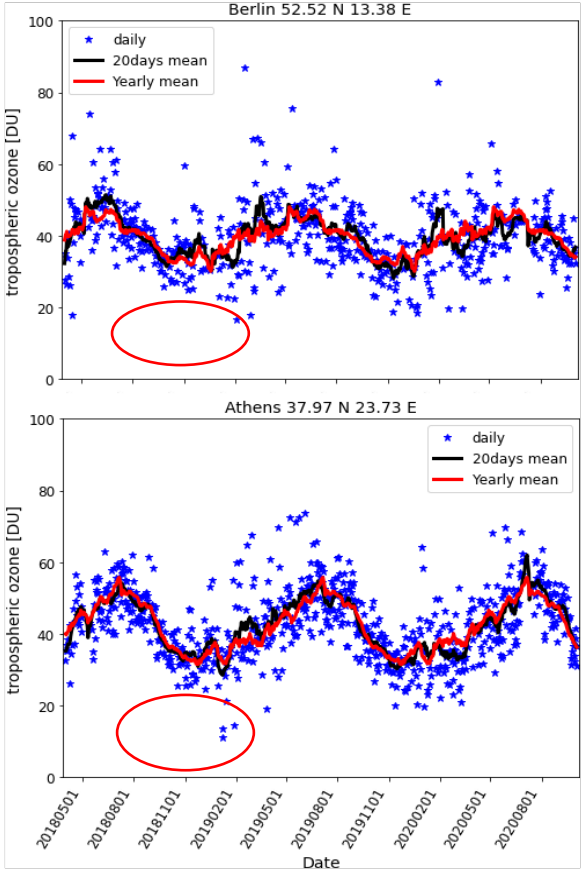
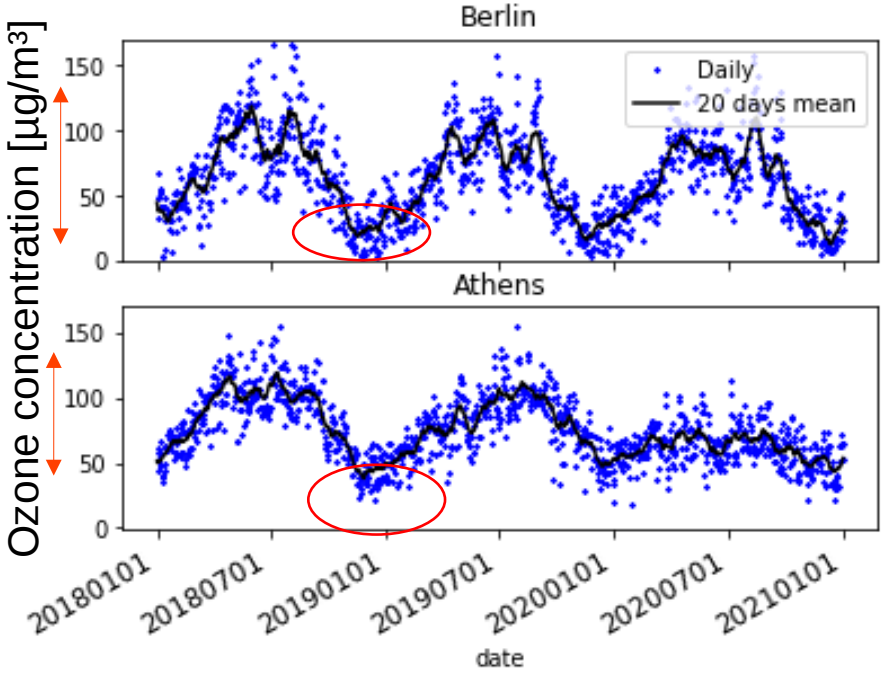
Heue et al AMT 2022

Columns and surface concentrations



Winter column above zero concentration close to zero

Winter column above zero concentration above zero



https://discomap.eea.europa.eu/map/fme/AirQualityExport.html

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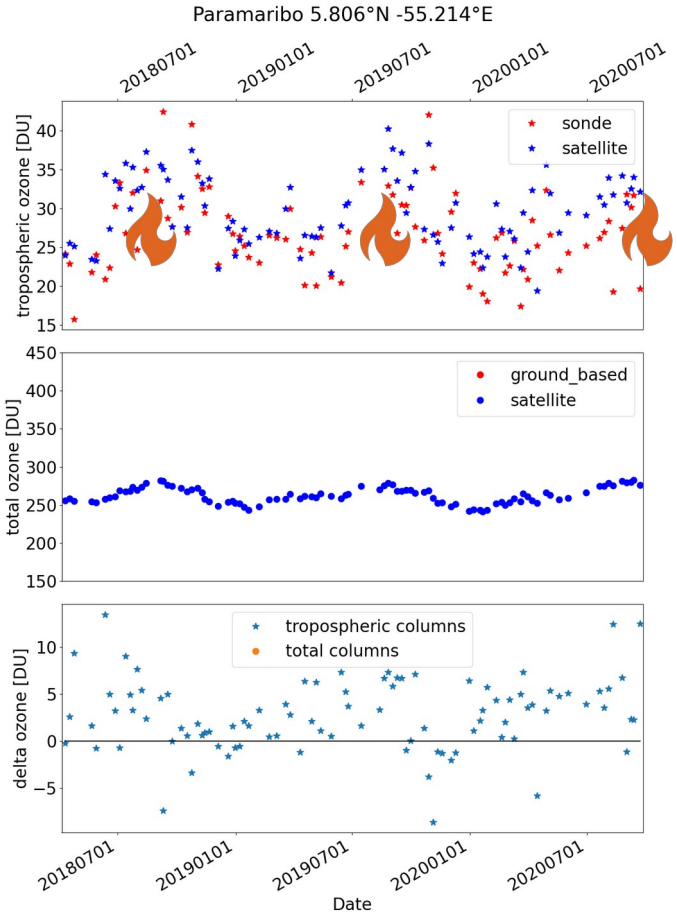
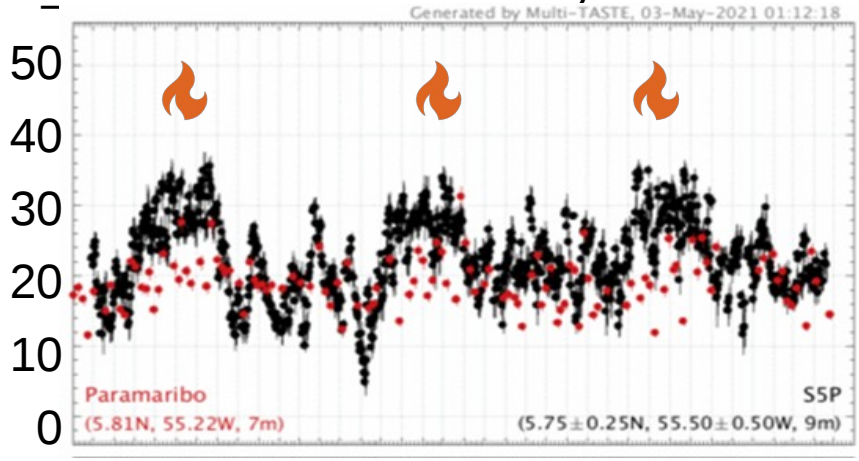
Validation example



- Overestimation during the burning season (~5 DU)
- But better agreement compared to the CCD data (~10DU)

S5P_ CCD validation courtesy of D. Hubert (BIRA)



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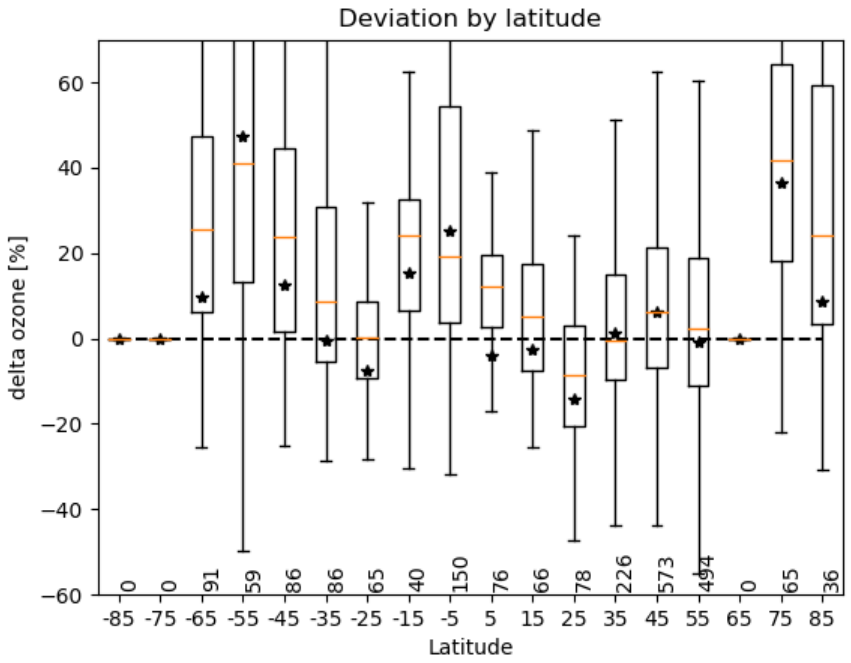
Mean deviations from sondes per 10° latitude bin



- Sonde profile integrated up to the tropopause
- S5P-BASCOE data averaged 25 km around sonde stations (~ 2000 comparisons)

	Du	%
S5P-CCD	0.91 ± 5.67	-0.82 ± 21.71
OMPS-MERRA2	3.33 ± 7.64	14.59 ± 31.51
Sondes	2.8 ± 9.4	15.5 ± 29.9

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Outlook

- The algorithm was developed for S5P and can be used for NRTI and OFFL data
- can be applied to other data set like GOME-2A total columns
- We plan to apply it to harmonized total ozone columns GTO-ECV

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