

The GOME-type Tropical Tropospheric Ozone Essential Climate Variable (GTTO-ECV) satellite data record between 1995 and 2023





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Jeroen van Gent, Michel van Roozendael, Daan Hubert

17^h April 2024



Overview

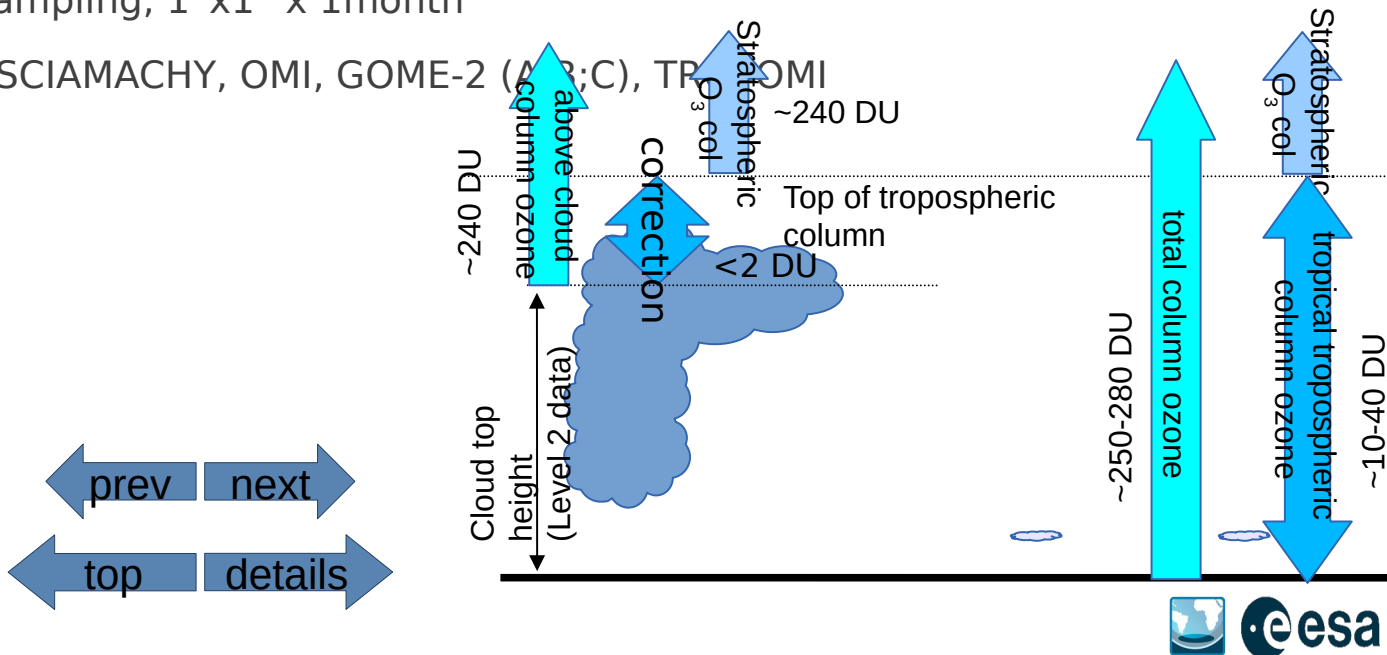
CCD (convective cloud Differential) tropics only

- } Principle 
- } Harmonisation 
- } (Trends) 
- } 2023 

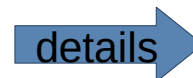
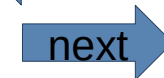
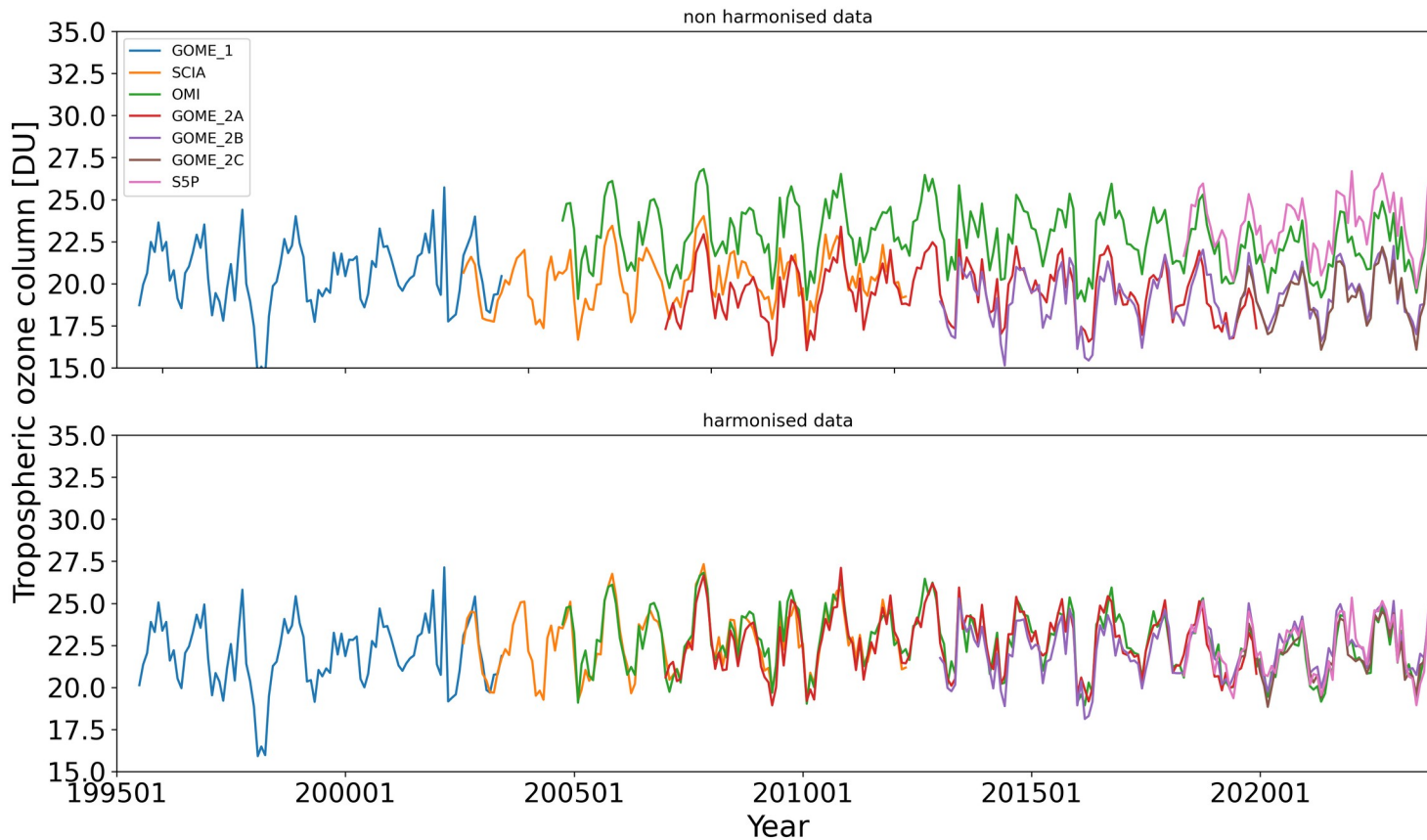
CCD Specifications

definition tropospheric column, close to the top of deep convective clouds

- 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
- Applied to GOME_1, SCIAMACHY, OMI, GOME-2 (A, B; C), TRAVIS, OMI

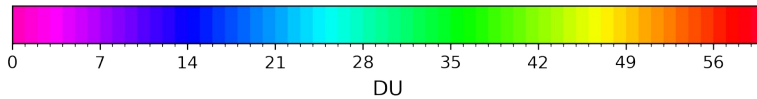
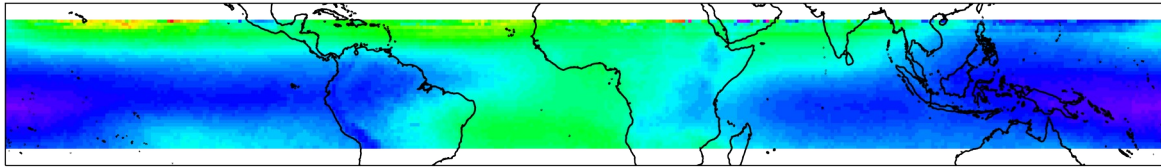


Harmonisation

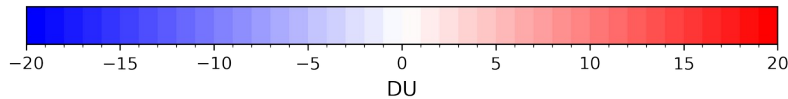
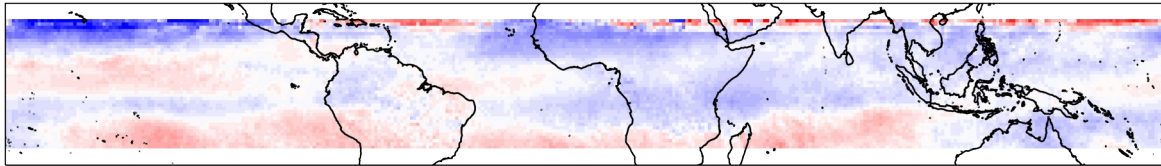


Tropical tropospheric ozone in 2023

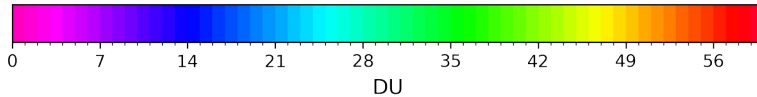
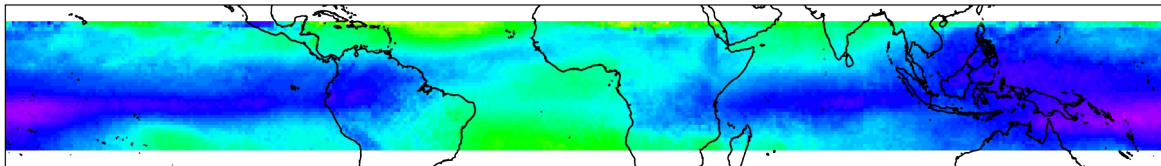
Climatological mean for January



Difference to Climatological mean



January 2023

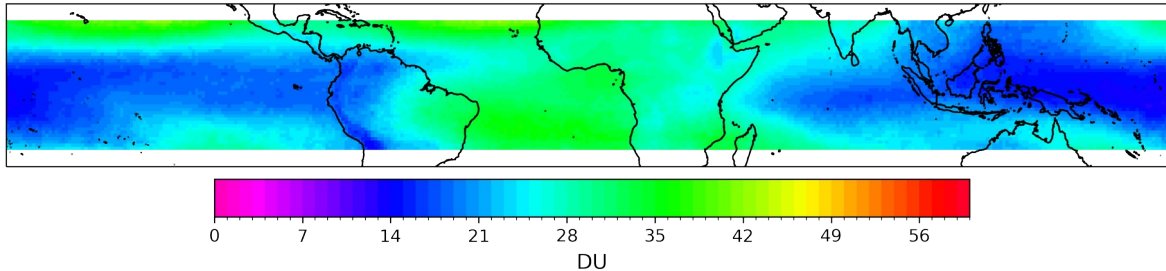


Nothing special in
January 2023.
Deviation within the
usual yearly scatter:
Up 15 DU
Mean ~5DU

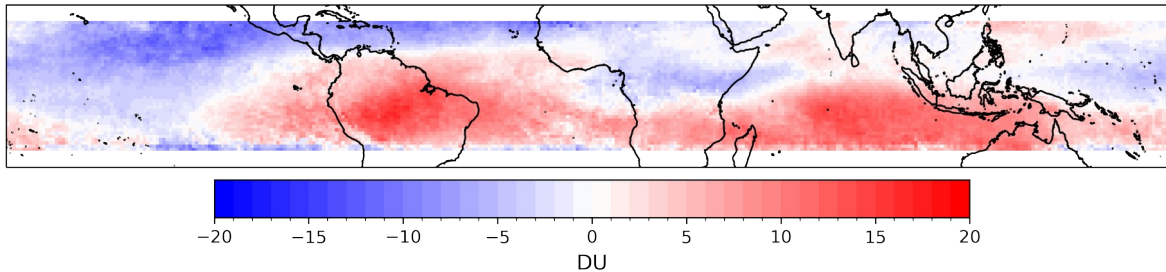


Tropical tropospheric ozone 2023 (November)

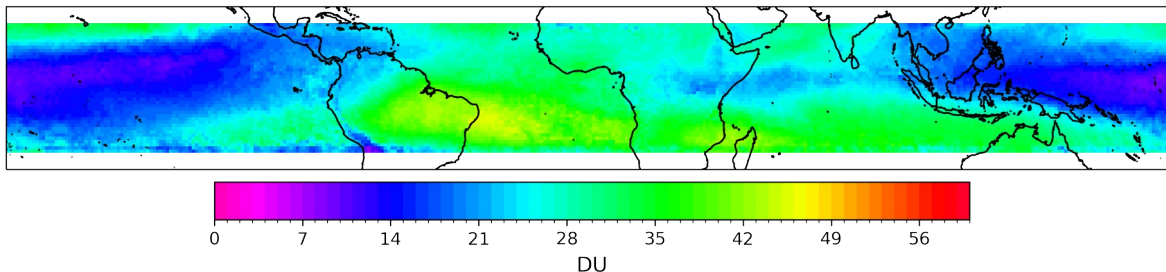
Climatological mean for November



Difference to Climatological mean

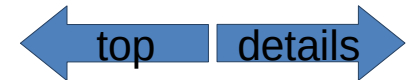


November 2023



Strong increase in tropospheric ozone over South America and the Indian ocean

Similar for October but weaker in December

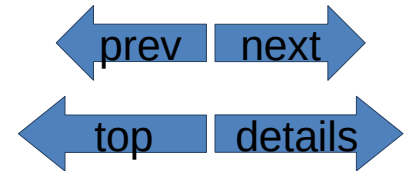


Drought and ozone?

Is the enhanced tropospheric O₃ column we observe real and related to the drought in the Amazonian rain forest?



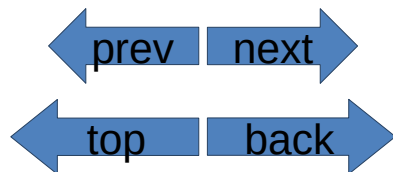
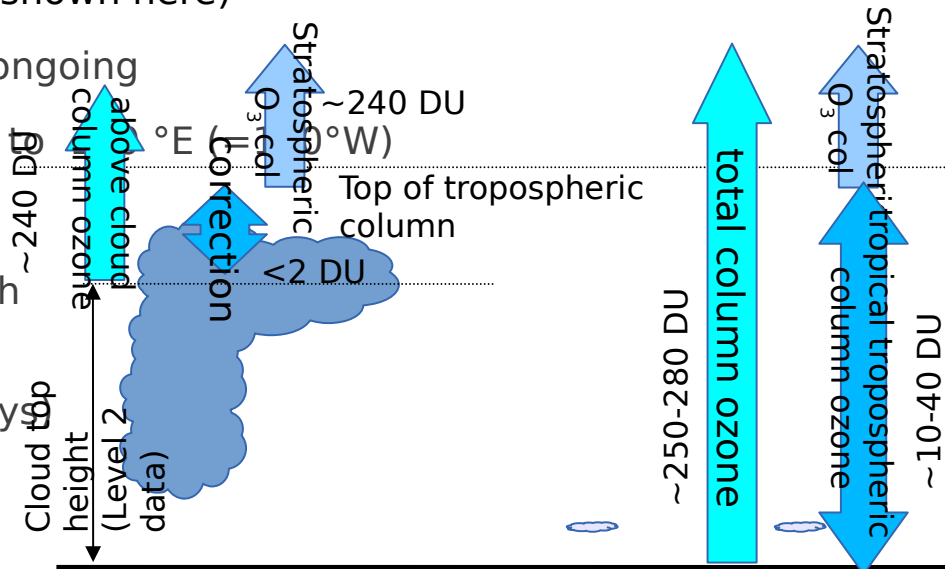
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Harbor in Manaus, The water level in the Rio Negro dropped by 4 meter.



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:
 - › 270 hPa operational S5P RPRO data (shown here)
 - › 200 hPa S5P internally reprocessing ongoing
- Stratospheric column is averaged over 70°E
- CCD files also contain averaged VMR
- spatial & temporal sampling, 1°x1° x 1month
- S5P data are averaged to the spatial and temporal resolution (op. 0.5° x 1°x 3 day)



Details Harmonisation

SCIAMACHY, GOME_2 (A,B,C), S5P

- Subtract mean bias between reference (OMI) and other instruments.
- Calculate mean annual cycle difference
- Correct for mean annual cycle

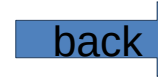
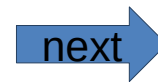
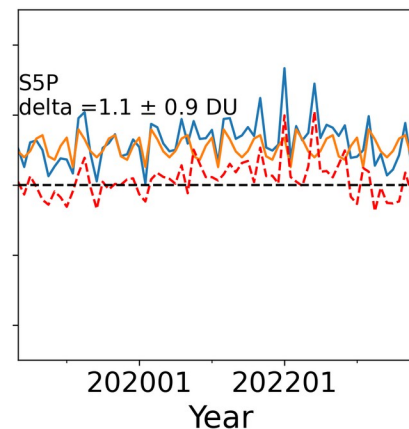
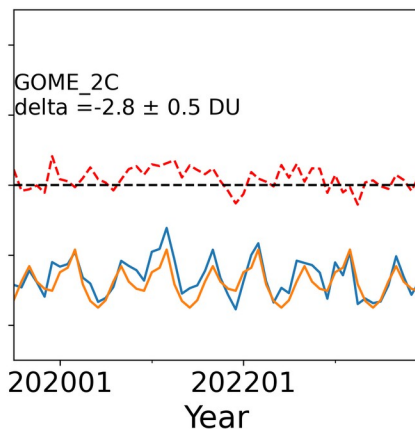
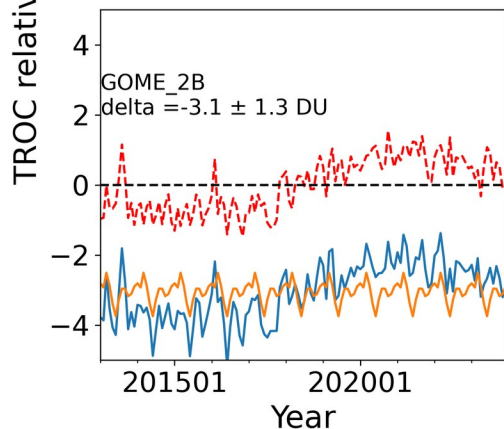
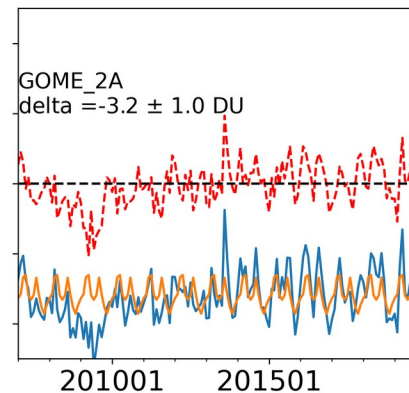
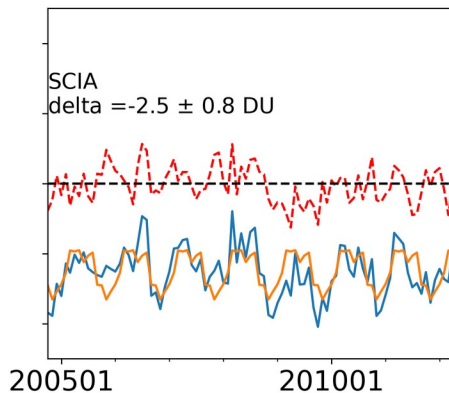
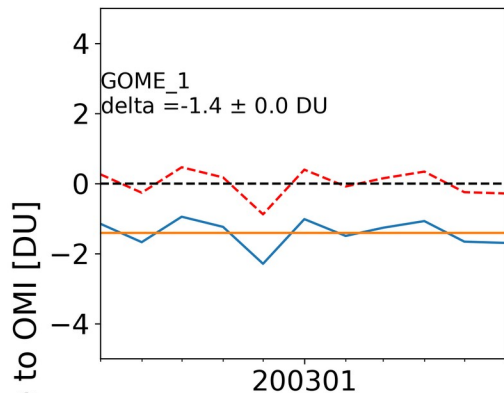
<=> deseasonalized bias correction plus

GOME_1 (insufficient overlap to OMI)

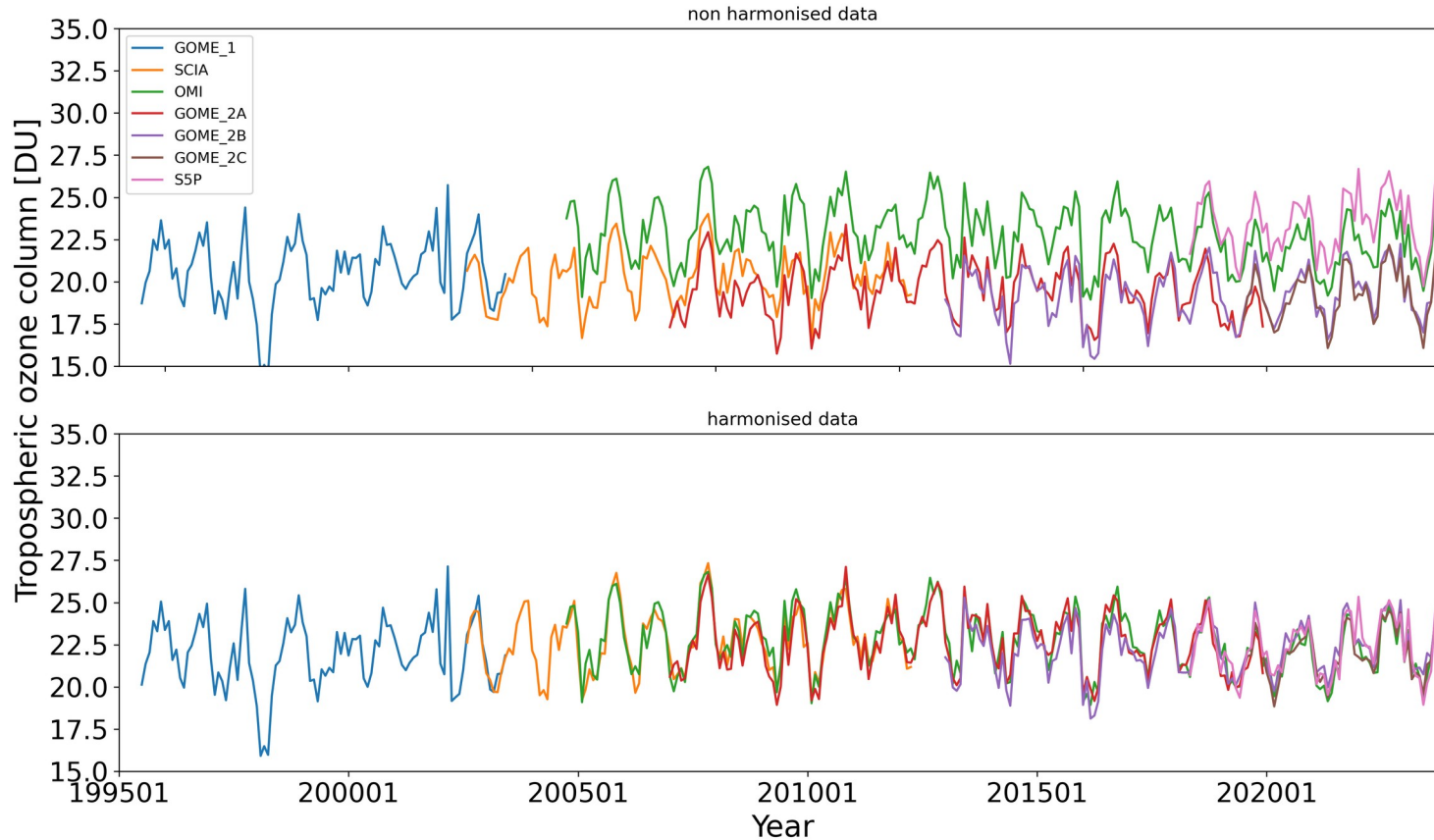
- Subtract mean bias between reference (**harmonised SCIAMACHY**)
- Calculate mean annual cycle difference
- Correct for mean annual cycle
- <=> deseasonalized bias correction plus



Harmonisation I



Harmonisation II



← prev

next →

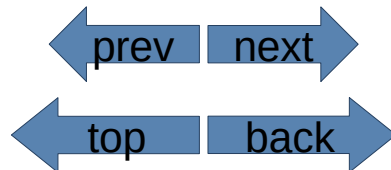
← top

back →

Trends Trend between 1995 and 2007

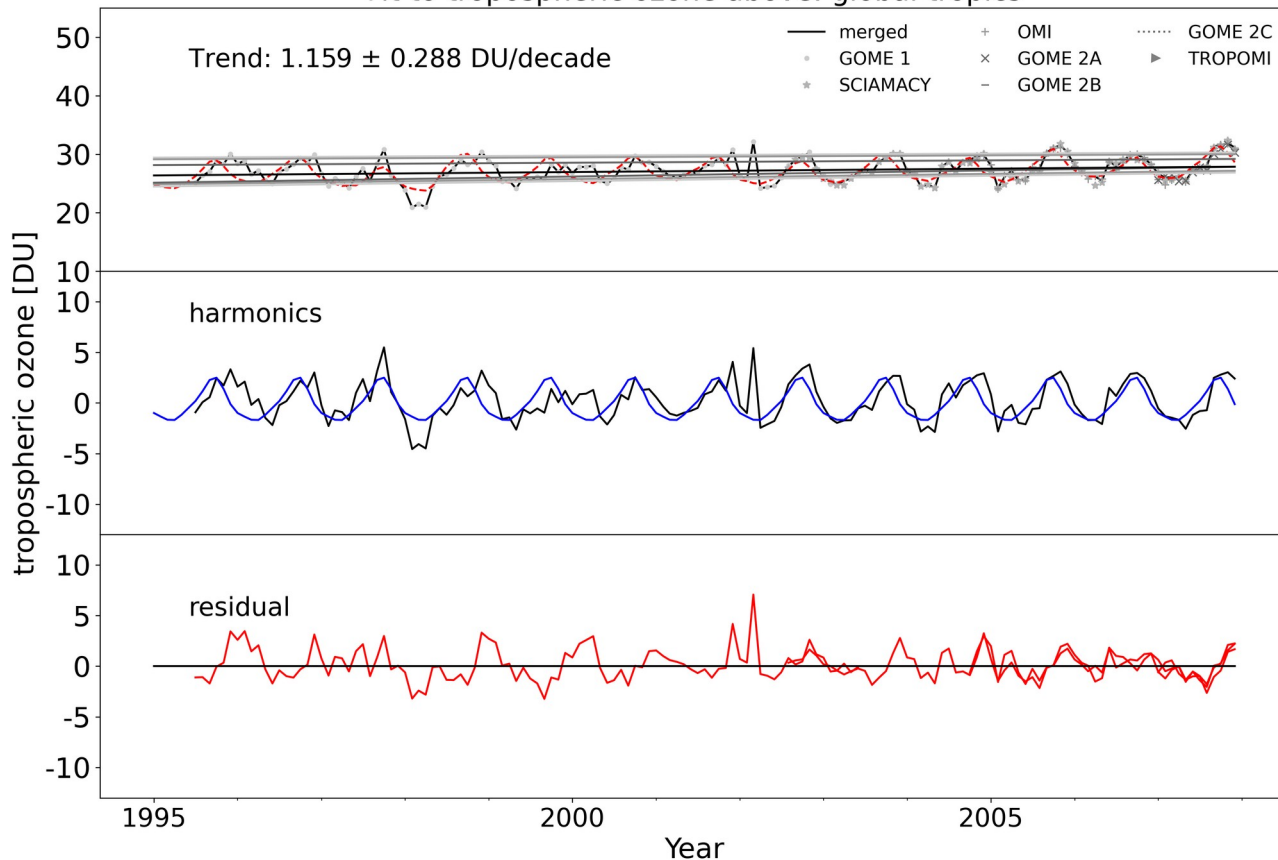
Fit Trends from 1995 to 2006 or end 2007 practical reason
And from 2008 to 2022

For the trends the percentile trends are recommended

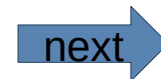


Trend between 1995 and 2007

Fit to tropospheric ozone above: global tropics



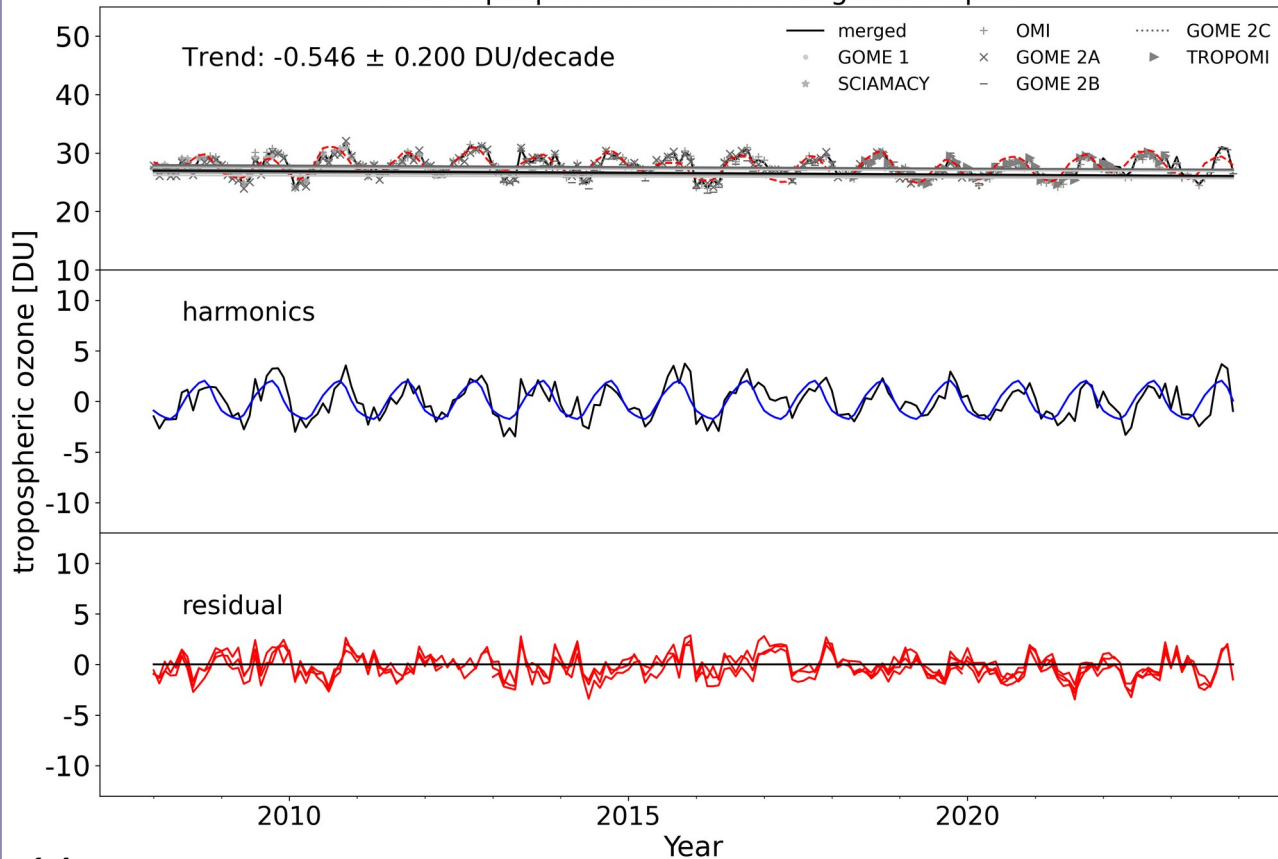
Increase
~ 1.16 DU/decade



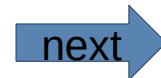
Trend between 2008 and 2022



Fit to tropospheric ozone above: global tropics



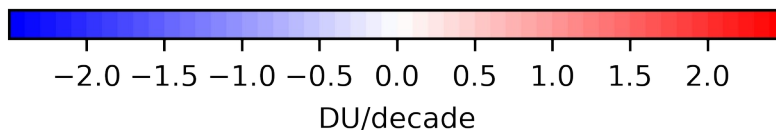
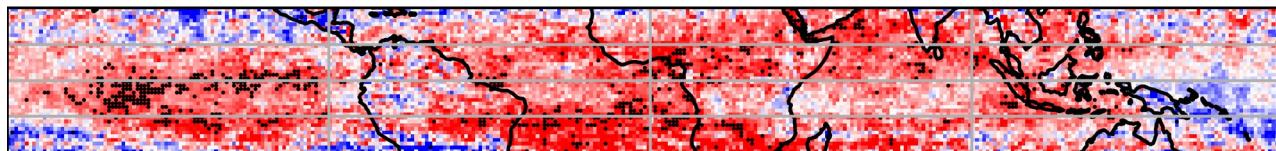
Decrease
~ 0.55 DU/decade



Regional trends

1995-2007

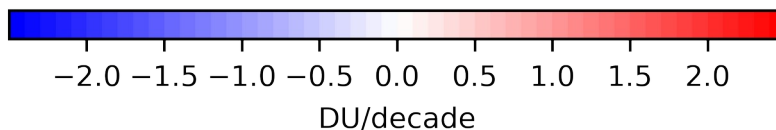
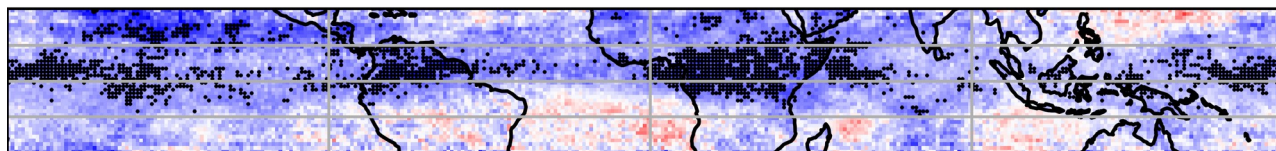
trend in tropospheric column ozone



Mostly positive trends except for New Guinea region

2008-2023

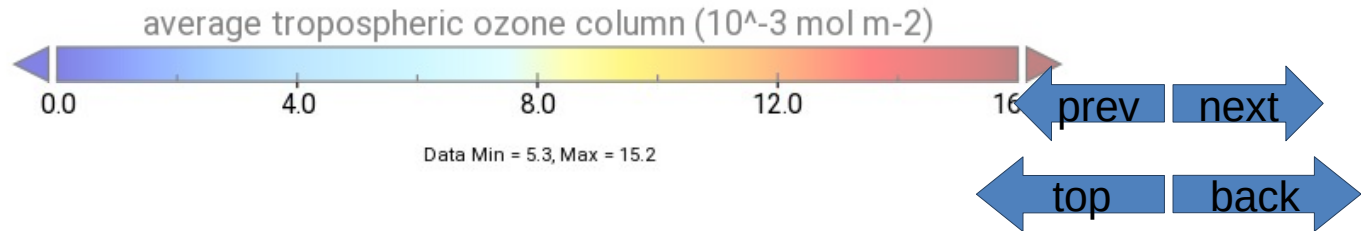
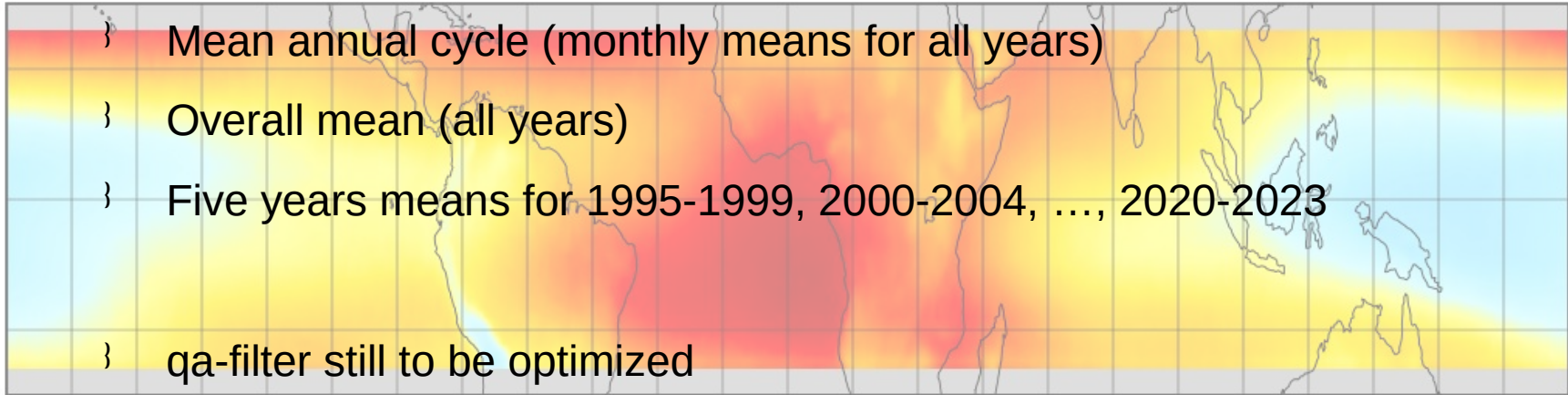
trend in tropospheric column ozone



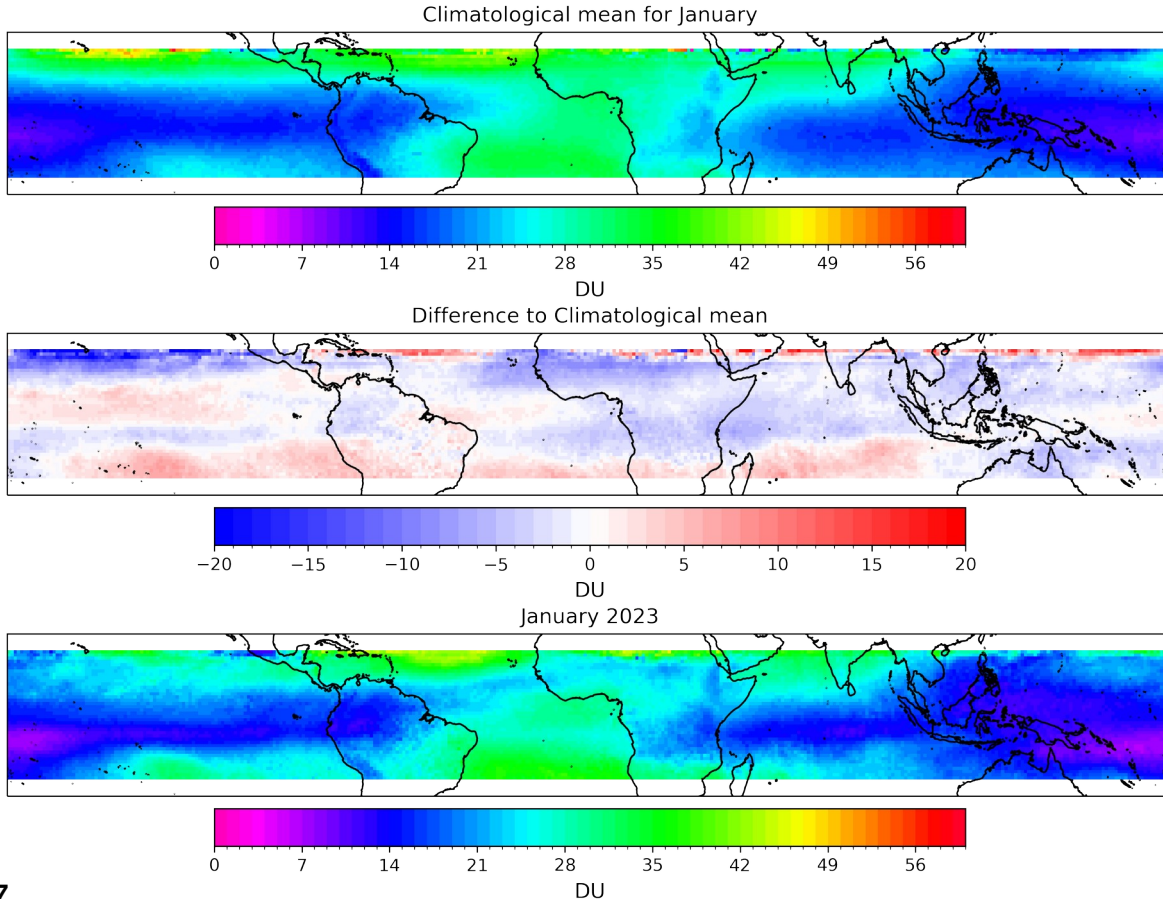
Mostly negative trends except for southern parts



Harmonized tropospheric columns and mixing ratio



Details Tropical tropospheric ozone in 2023

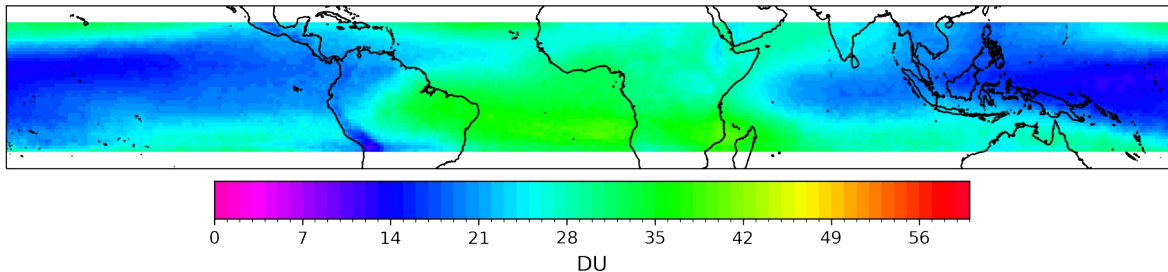


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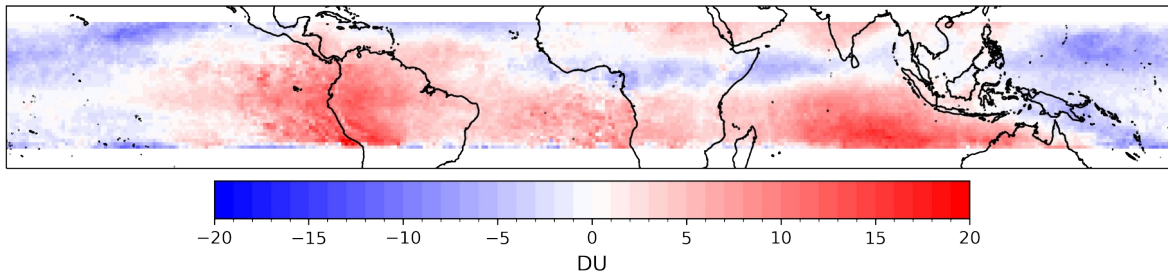


Ozone in October 2023

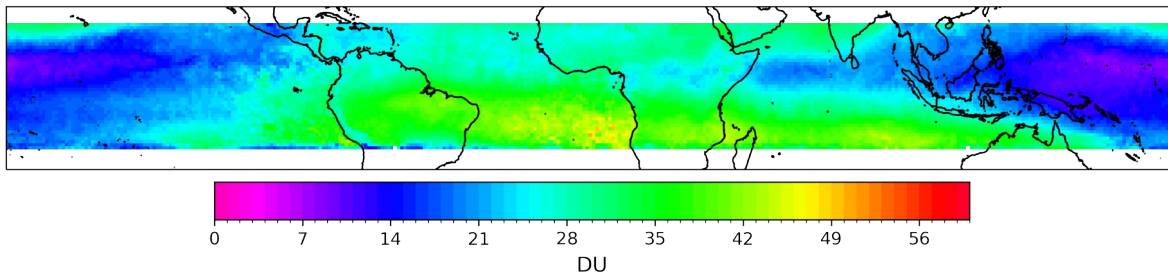
Climatological mean for October



Difference to Climatological mean



October 2023

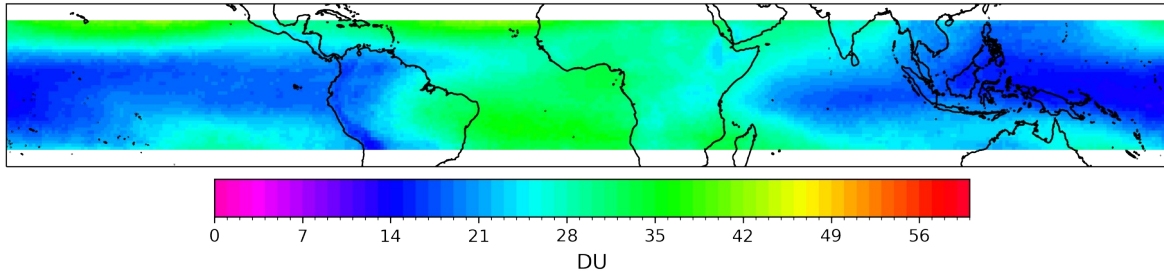


Strong increase in
tropospheric ozone
over South America
and the Indian ocean

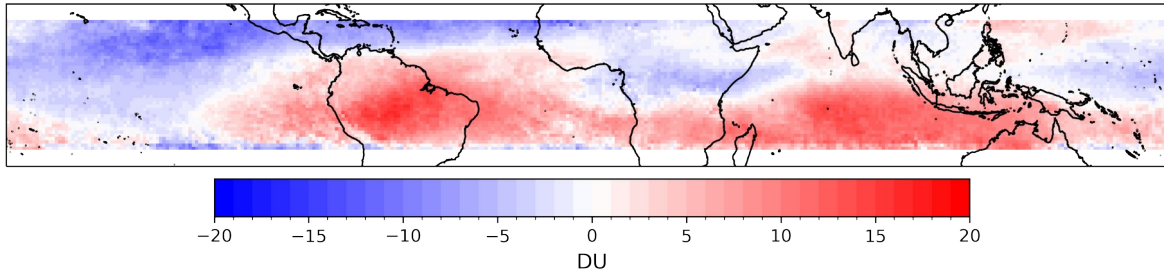


Ozone in November 2023

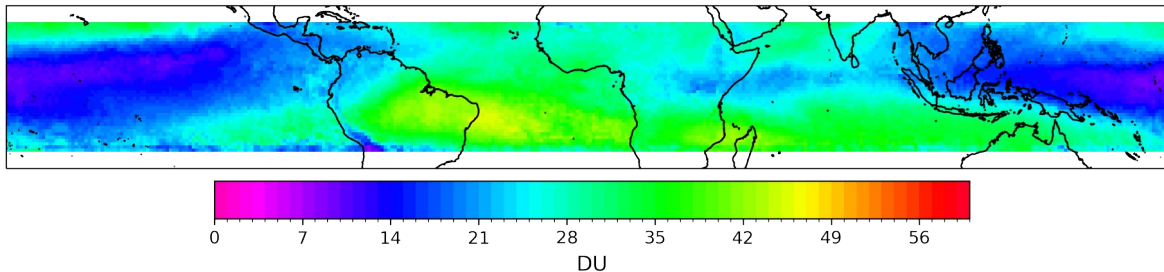
Climatological mean for November



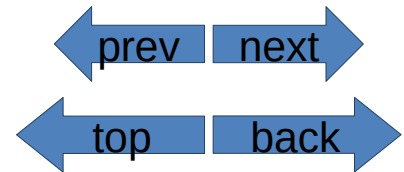
Difference to Climatological mean



November 2023

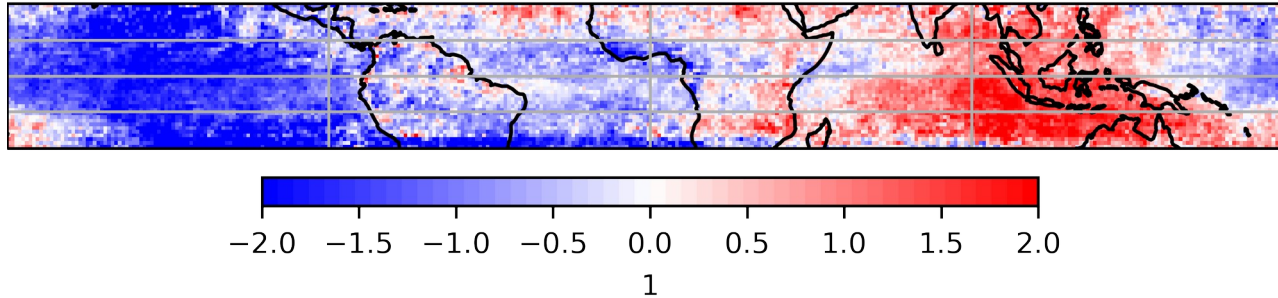


Strong increase in
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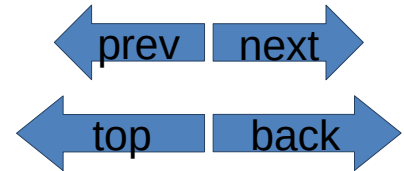
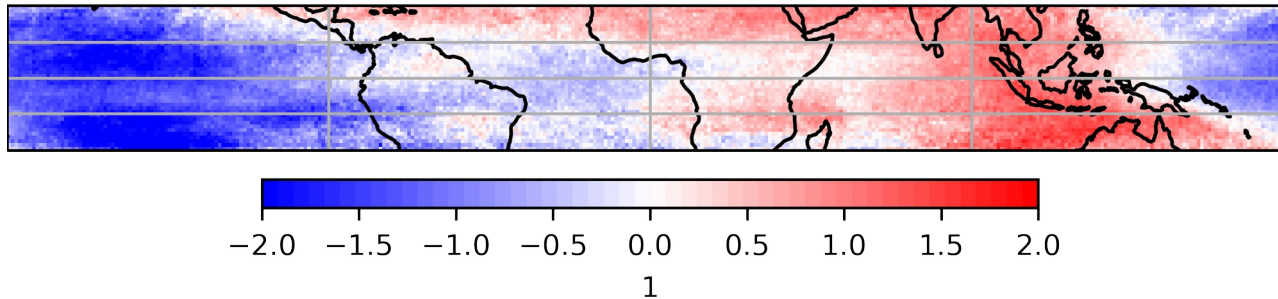
ENSO correlation (preliminary results)

fit coefficient ENSO column ozone 1995-2007



Strong correlation over South East Asia and anti-correlation over the Pacific.
Hardly any correlation over South America

fit coefficient ENSO column ozone 2008-2023



Summary and outlook CCD



- Harmonized CCD tropical tropospheric data set from 1995-2023
- Mean tropical trend
 - } up to 2007 +1.15 DU/decade or 4.3 Tg/decade
 - } between 2008 and 2028 -0.55 DU/decade or \sim -2 Tg/decade
- Increase in October and November 2023
- Publication for TOAR-II special issue in preparation

