

Tropospheric ozone columns from TROPOMI and BASCOE

K.-P. Heue¹, D. Loyola¹, W. Zimmer¹, S. Chabrillat², Q. Errera²,

1) Institut für Methodik der Fernerkundung am Deutschen Zentrum für Luft- und Raumfahrt (DLR), Germany

2) Koninklijk Belgisch Instituut voor Ruimte-Aeronomie / Institut royal d'Aéronomie Spatiale de Belgique, Belgium

CEOS AC-VC 16, June 10, 2020

Knowledge for Tomorrow



Overview

- Method
 - **DLR research product:** S5P-BASCOE/MLS tropospheric column
 - Combine the operational Copernicus S5P total columns with BASCOE/MLS
- Sonde based validation
- Results
 - Global
 - Northern America
 - Central Africa
 - South America
 - Europe

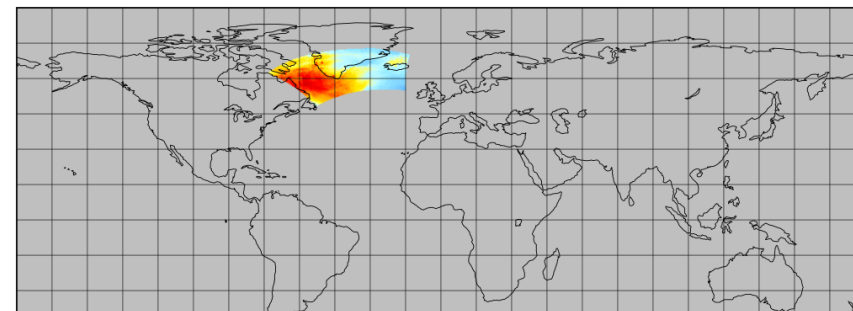


Method Tropospheric O3

- TROPOMI NRTI total ozone column
- TROPOMI Total ozone columns
 - for cloud free observation (cloud fraction < 0.2)
 - for one day

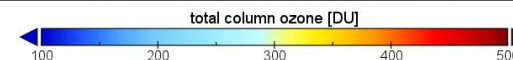
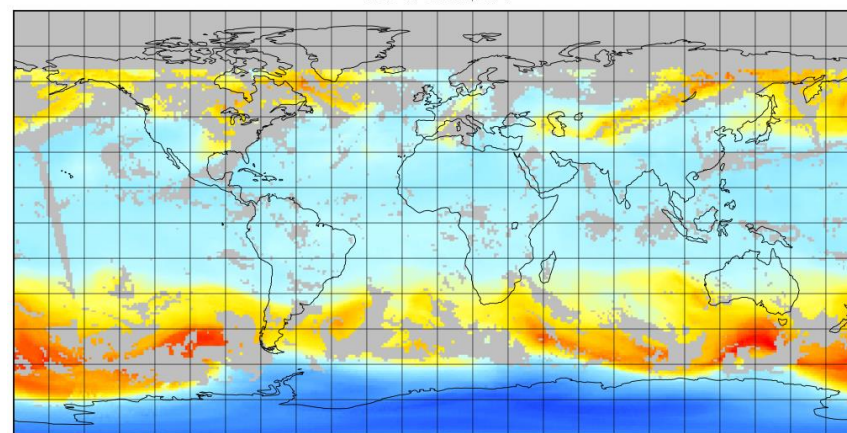
S5P NRTI total ozone column

2018-11-02 15:05:42-15:10:42, DLR BIRA



S5p total ozone column

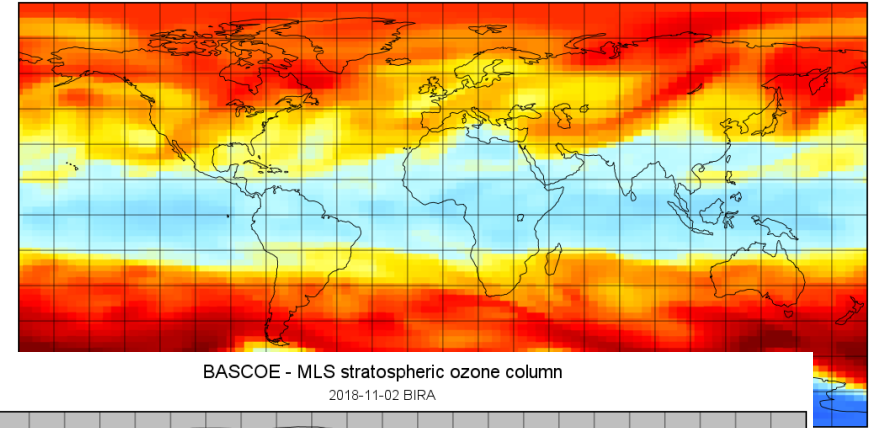
2018-11-02 DLR,BIRA



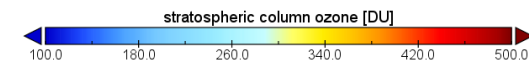
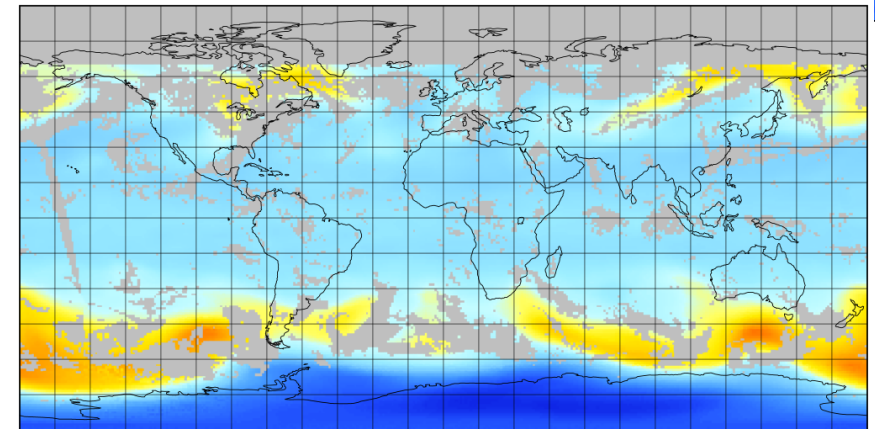
Method Tropospheric O₃

- TROPOMI NRTI total ozone column
- TROPOMI Total ozone columns
 - for cloud free observation
 - for one day gridded
- BASCOE/MLS stratospheric ozone mixing ratios and tropopause pressure
- Integrate mixing ratio above tropopause
- Interpolate linear in time and place to S5P observations

BASCOE-MLS o3 gas-phase volume mixing ratio
2018-11-02, BIRA



BASCOE - MLS stratospheric ozone column
2018-11-02 BIRA



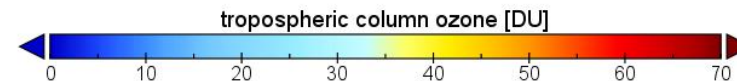
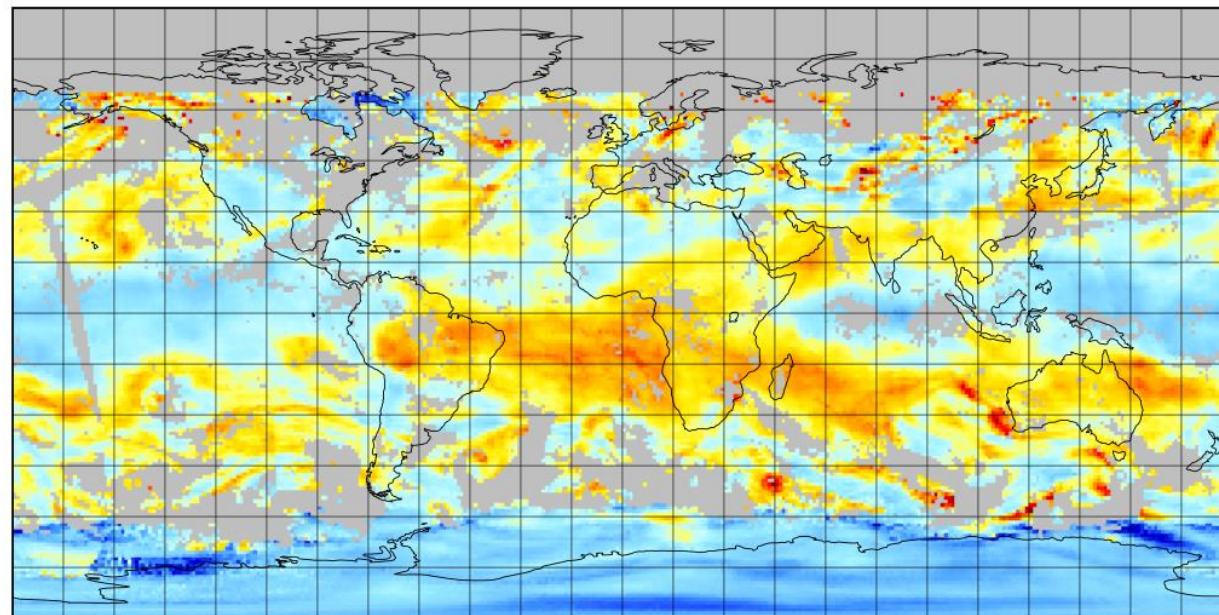
Method Tropospheric O₃

- TROPOMI NRTI total ozone column
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 - for cloud free observation
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- BASCOE/MLS stratospheric ozone mixing ratios and tropopause pressure
- Integrate mixing ratio above tropopause
- Interpolate linear in time and place to S5P observations

- Subtract stratospheric from total ozone column

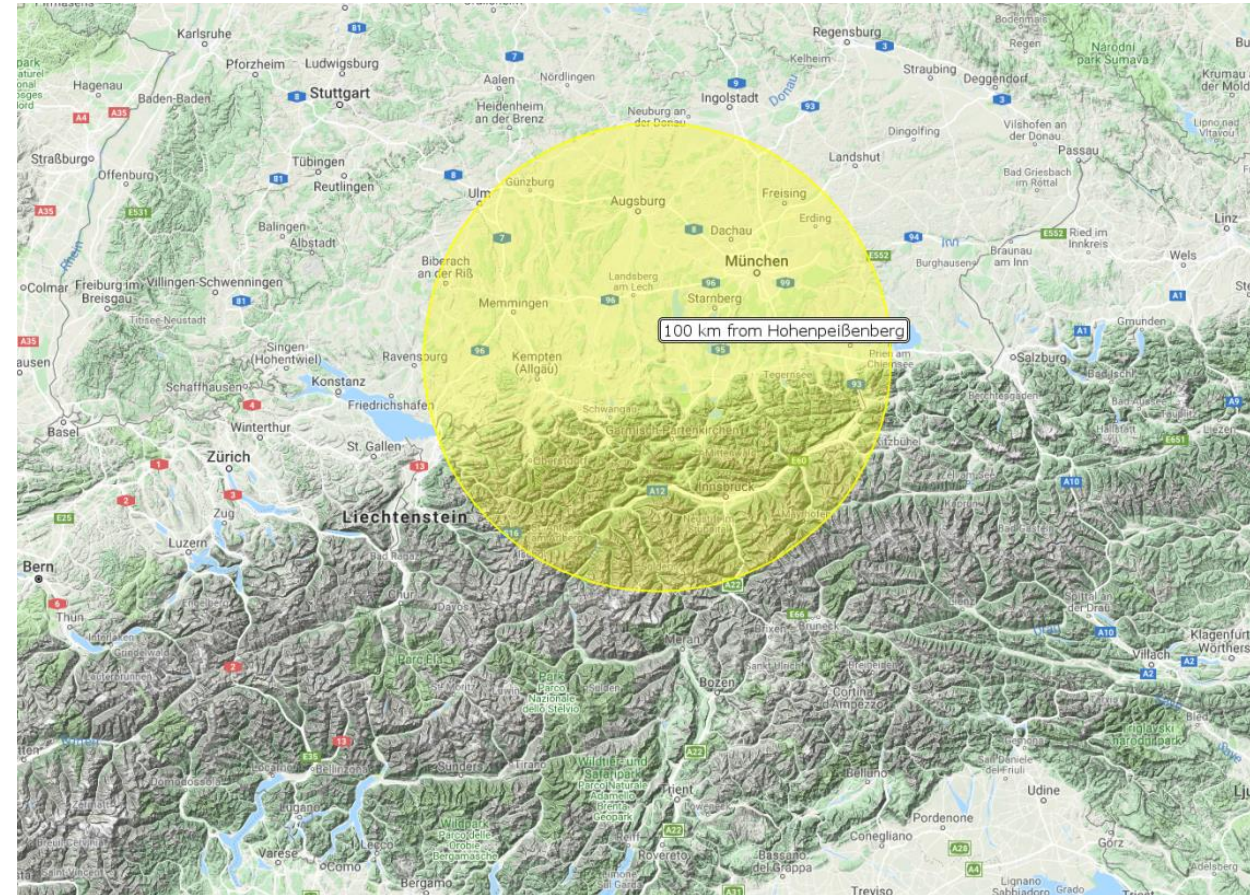
S5p - BASCOE tropospheric ozone column

2018-11-02 DLR,BIRA



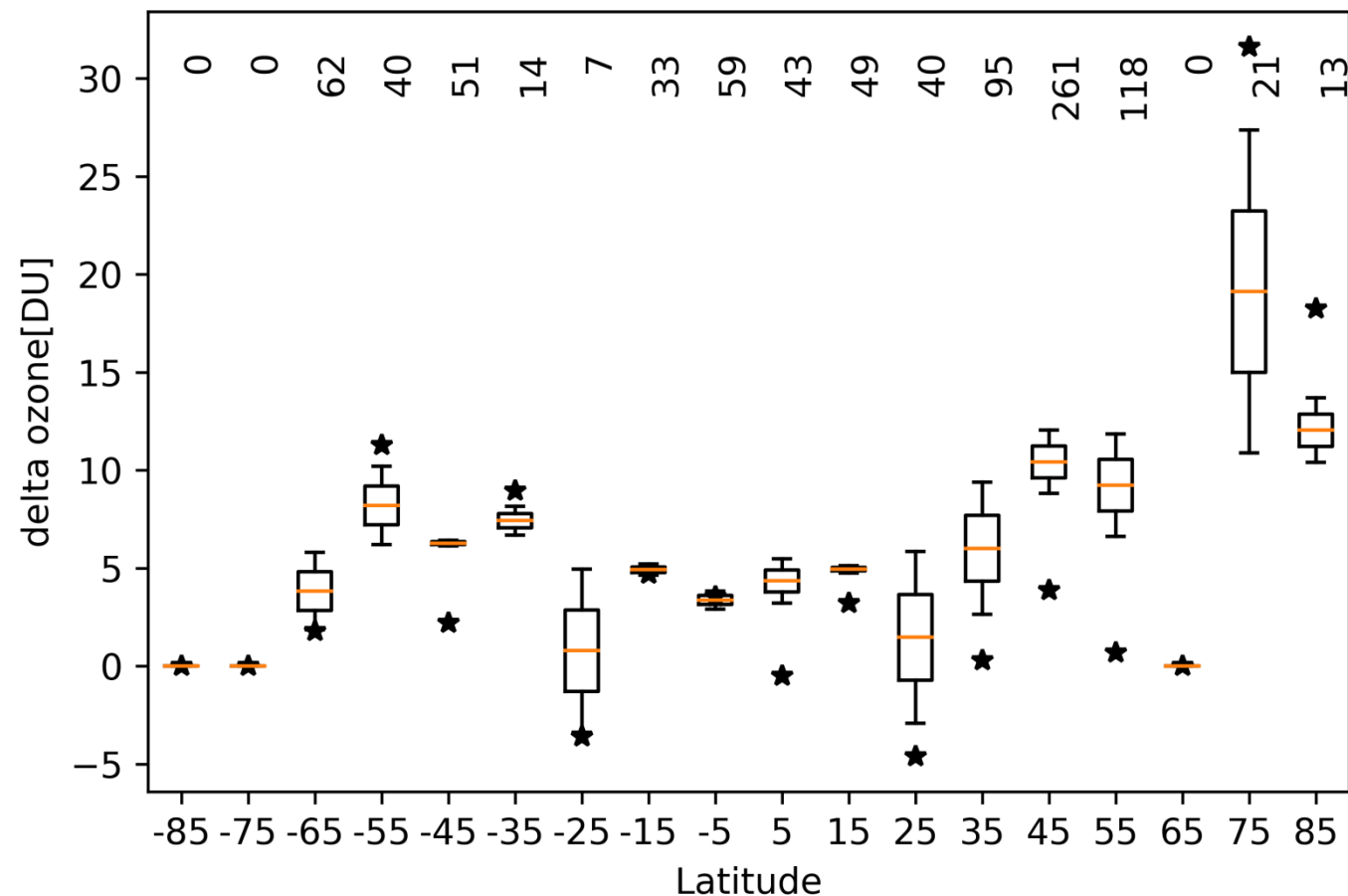
Sondebased Validation (I)

- S5P BASCOE Daily tropospheric ozone data and tropopause height
- Integrate sonde data up to Tropopause level
- Mean of TROPOMI tropospheric ozone within 100km around the station
- Closest Measurement to station



Sonde based Validation (II)

Deviation by latitude



Mean Validation for April 2018 to October 2019

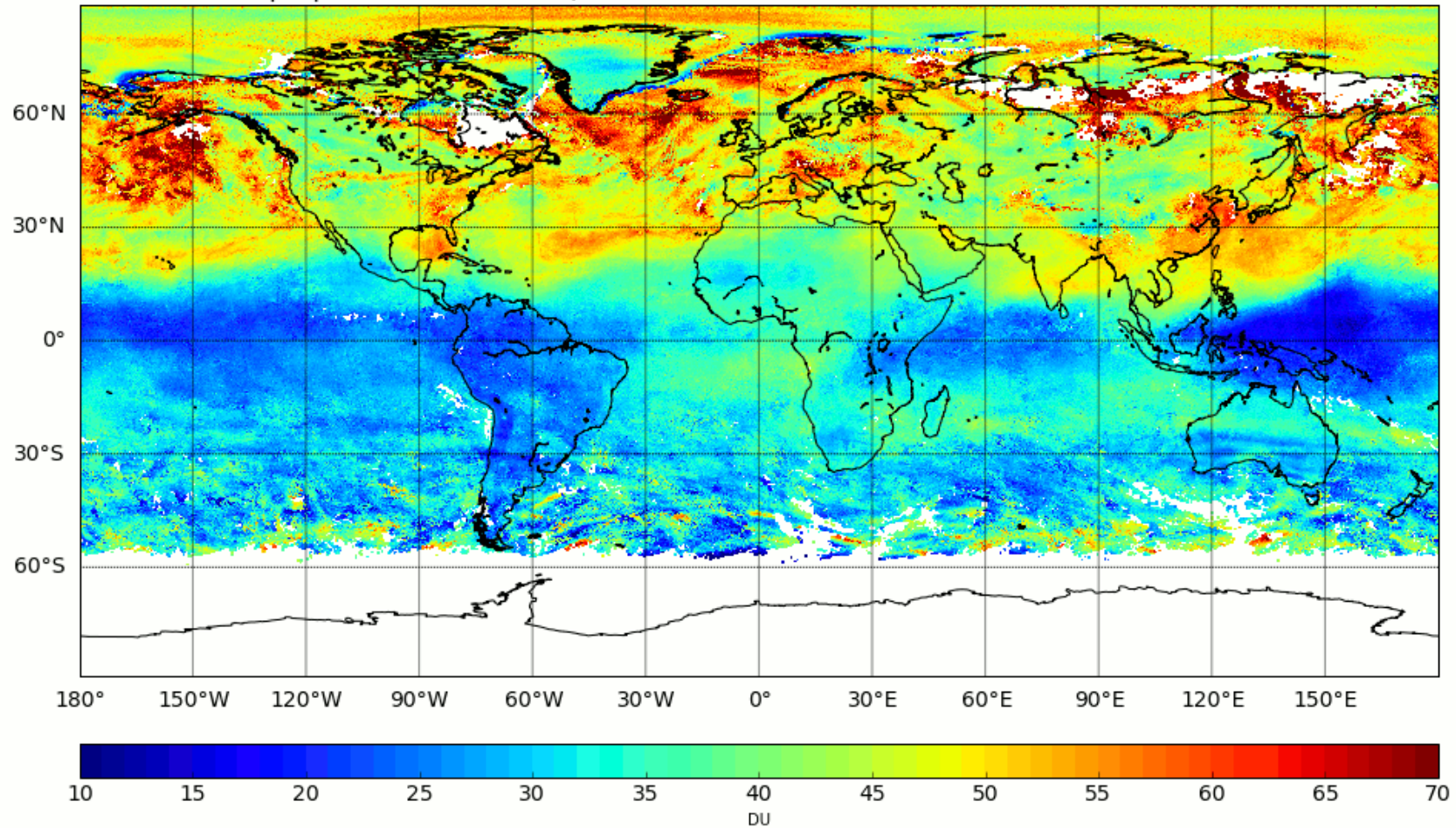
- highest number of sonde data in Northern mid-latitude
- Mostly positive bias
- Largest deviations in polar regions

Thanks to all the PIs of the Soundings stations for providing the data to SHADOZ and to the World Ozone and Ultraviolet Radiation Data Centre



Example results

Global tropospheric ozone column, 2018-05-14 to 2018-05-20

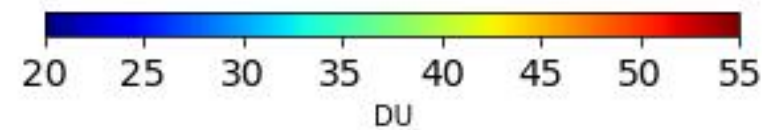
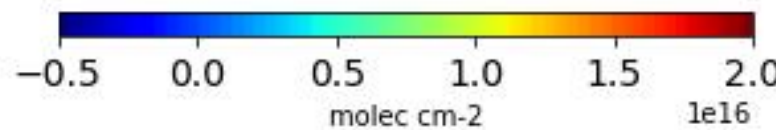
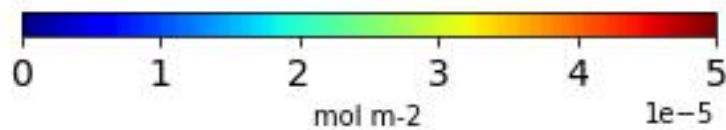
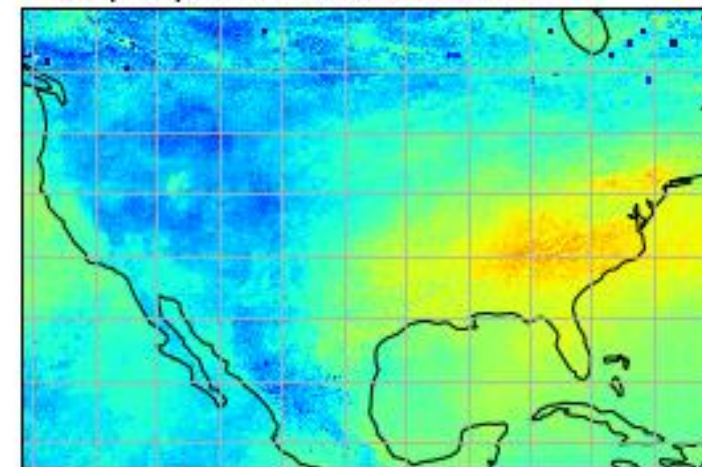
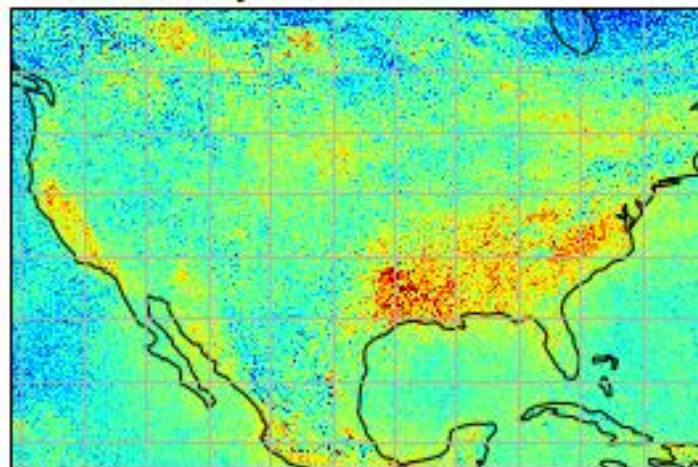
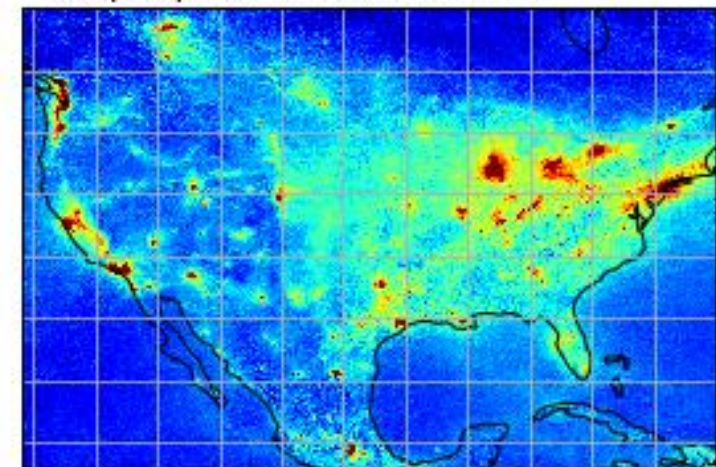


North America, Ozone and Precursors, 2018-09

tropospheric NO₂ column

formaldehyde column

tropospheric ozone column

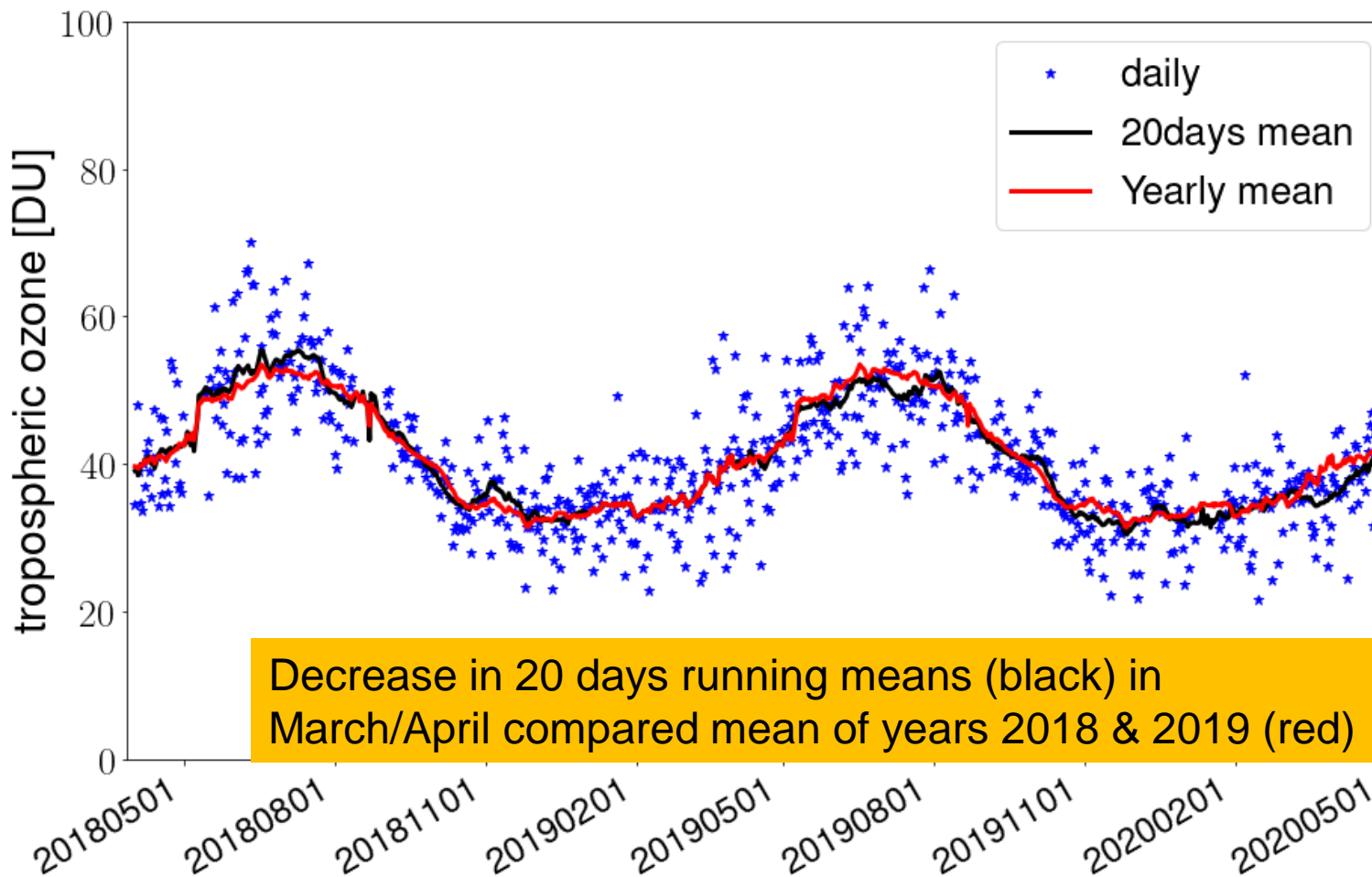


S5P HCHO Courtesy of Isabelle de Smedt and Ka Lok Chan
S5P NO₂ Courtesy of Henk Eskes and Jos van Geffen



Time series 100km radius around Atlanta Georgia USA

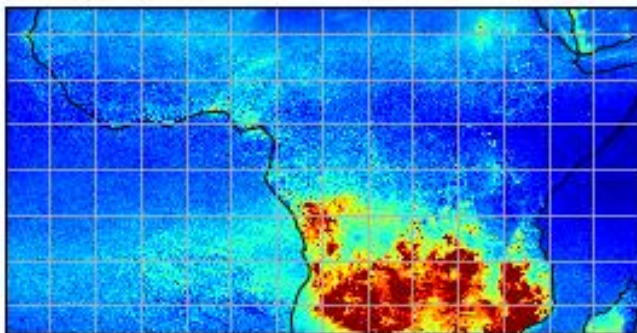
Atlanta 33.77 N -84.38 E



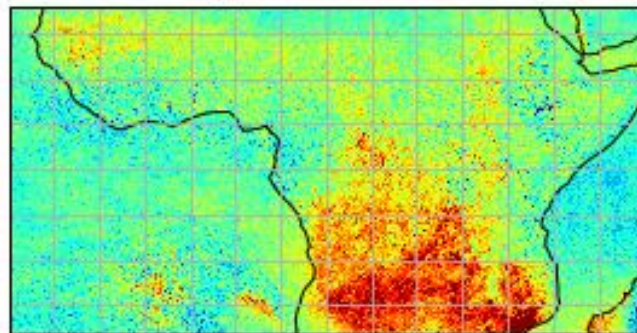
Central Africa September 2018 and 2019

2018

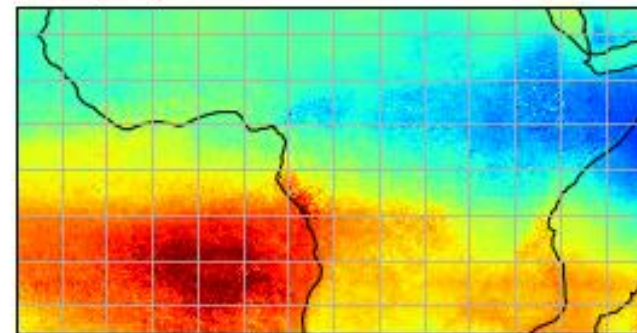
tropospheric NO2 column



formaldehyde column

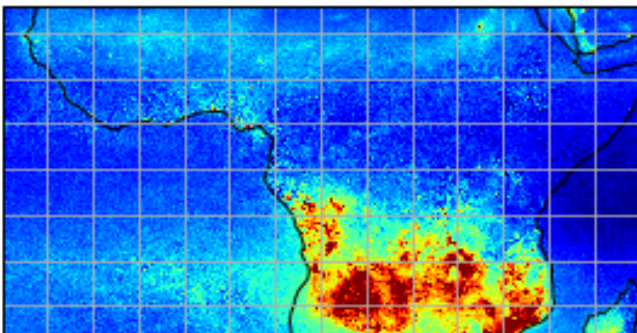


tropospheric ozone column

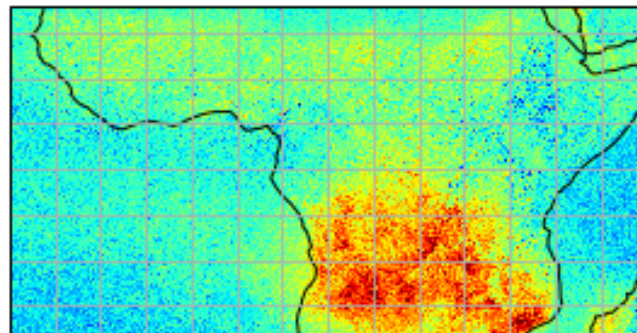


2019

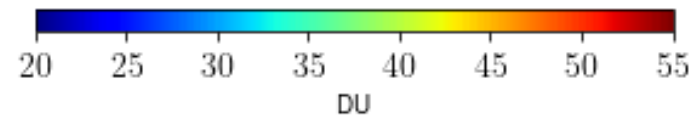
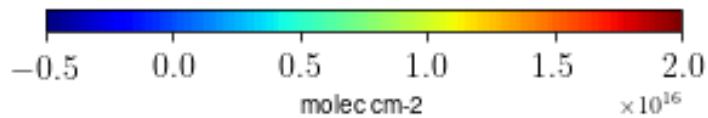
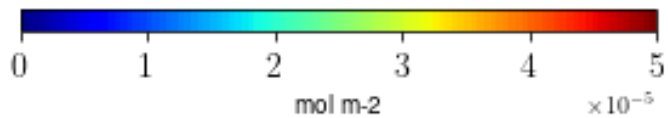
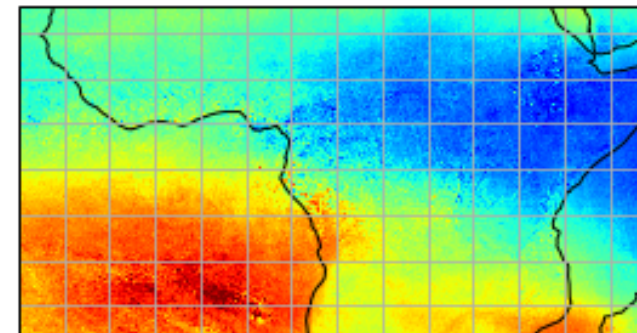
tropospheric NO2 column



formaldehyde column



tropospheric ozone column

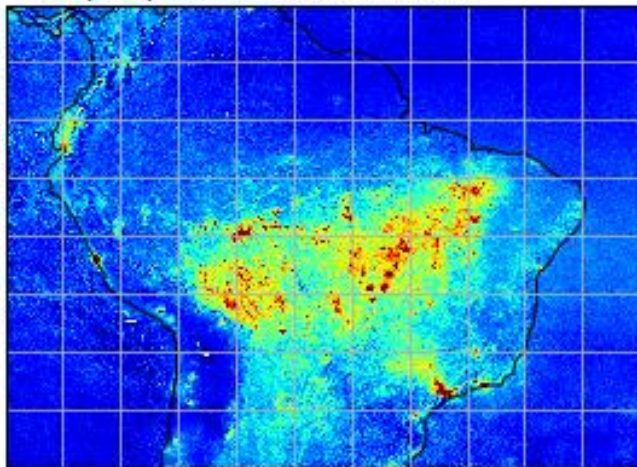




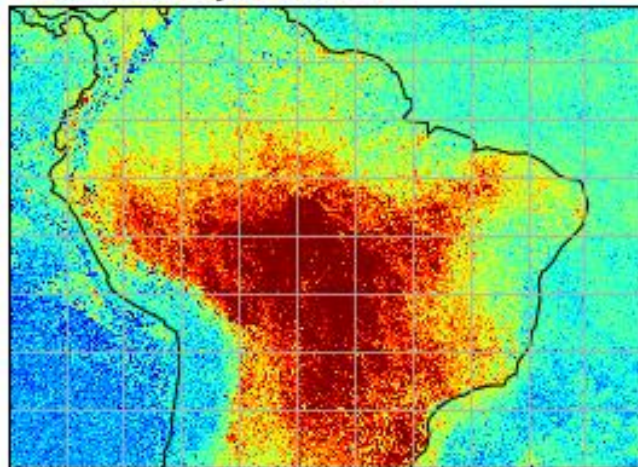
South America, Ozone and Precursors, 2018-09

2018

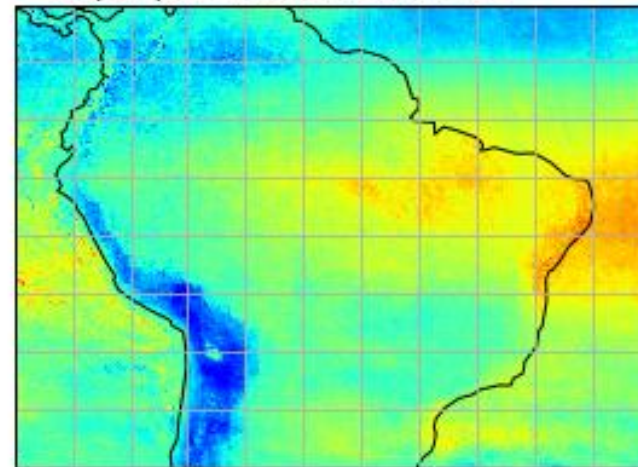
tropospheric NO₂ column



formaldehyde column

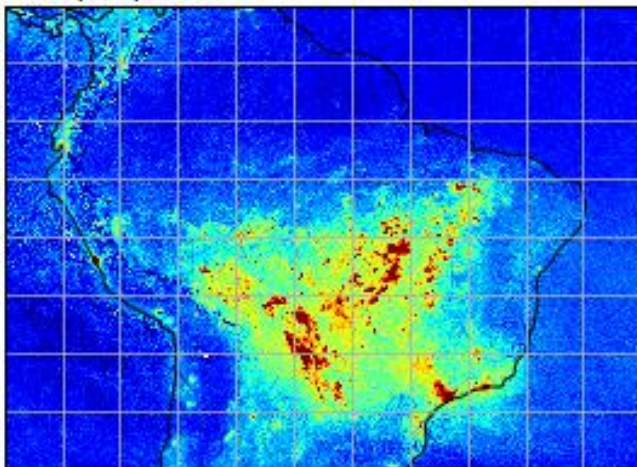


tropospheric ozone column

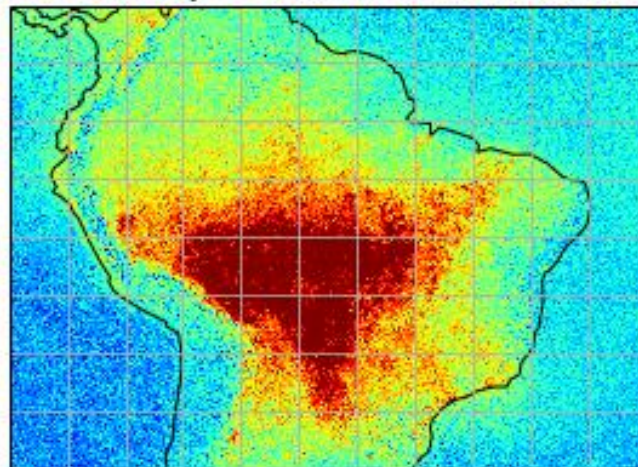


2019

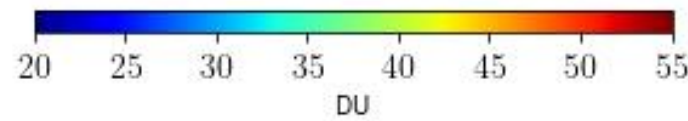
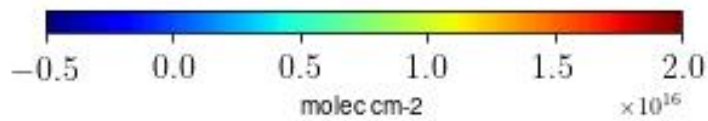
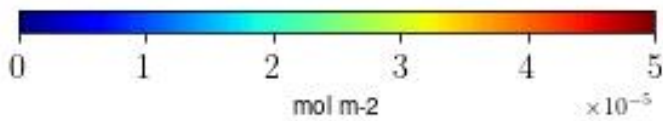
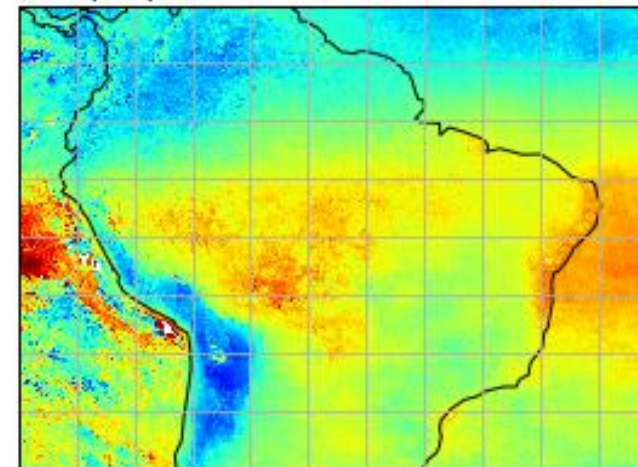
tropospheric NO₂ column



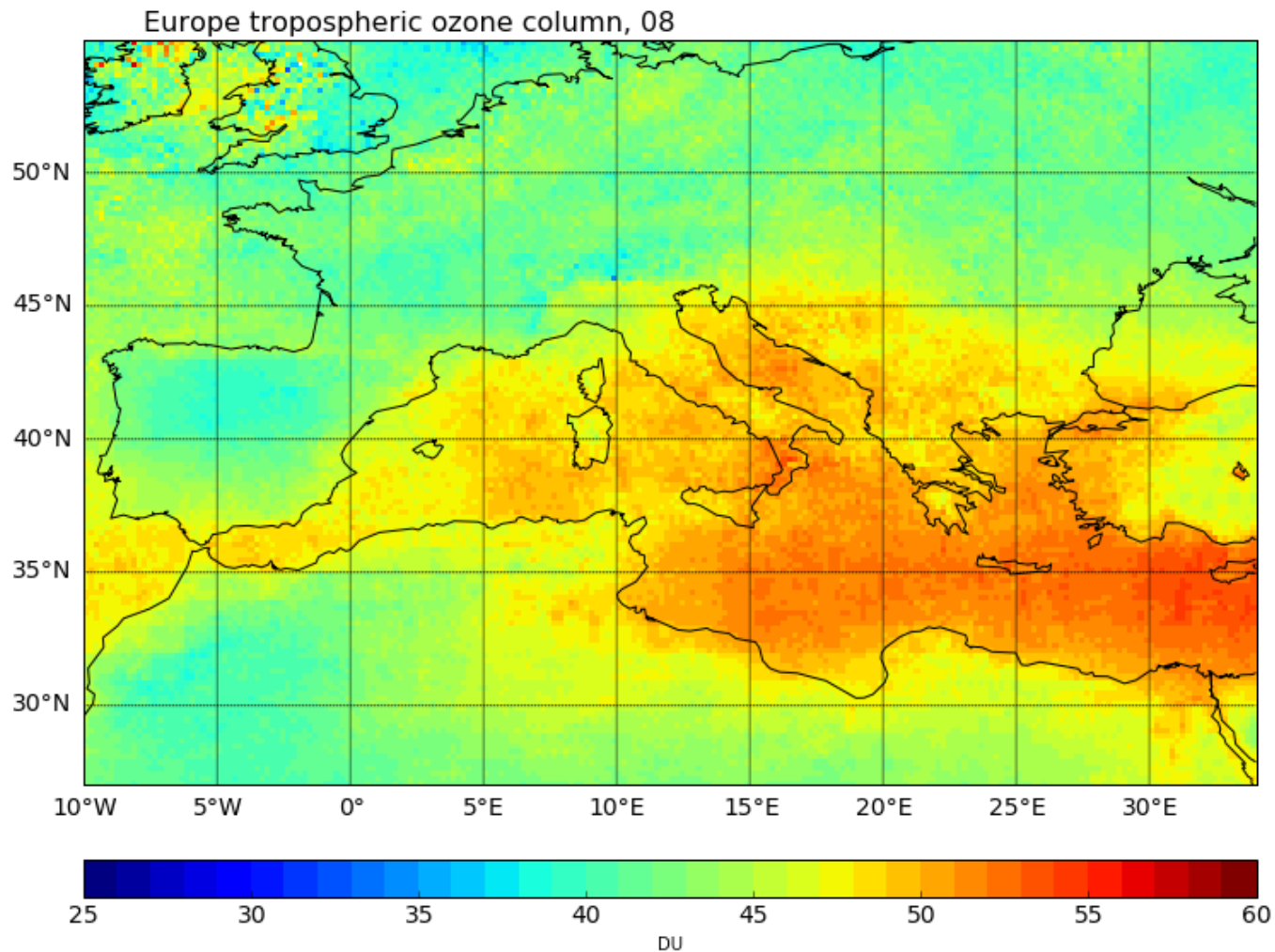
formaldehyde column



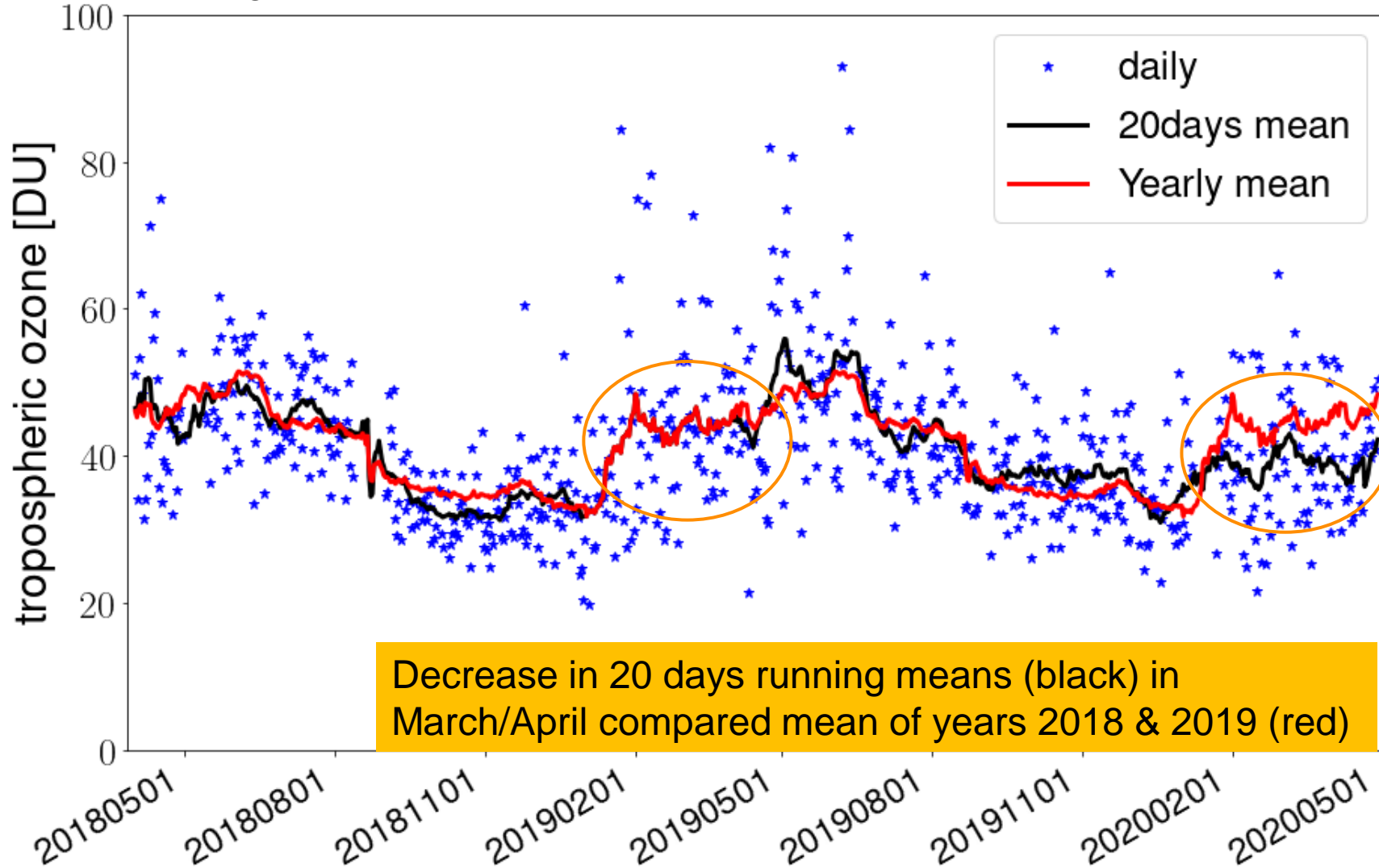
tropospheric ozone column



Europe and Mediterranean Sea in August



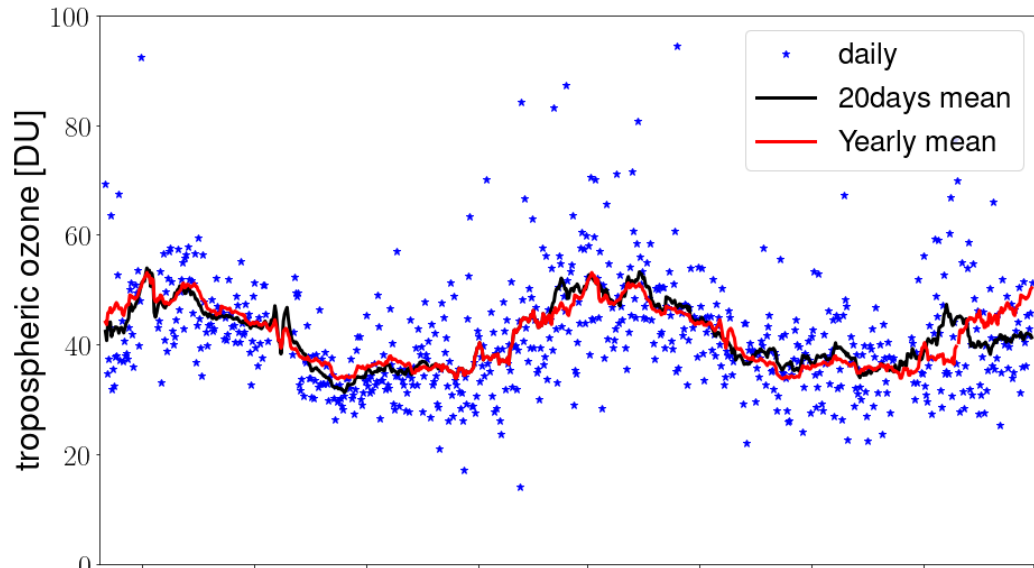
Paris 48.85 N 2.35 E
averaged over 100 km around the centre (Notre Dame)



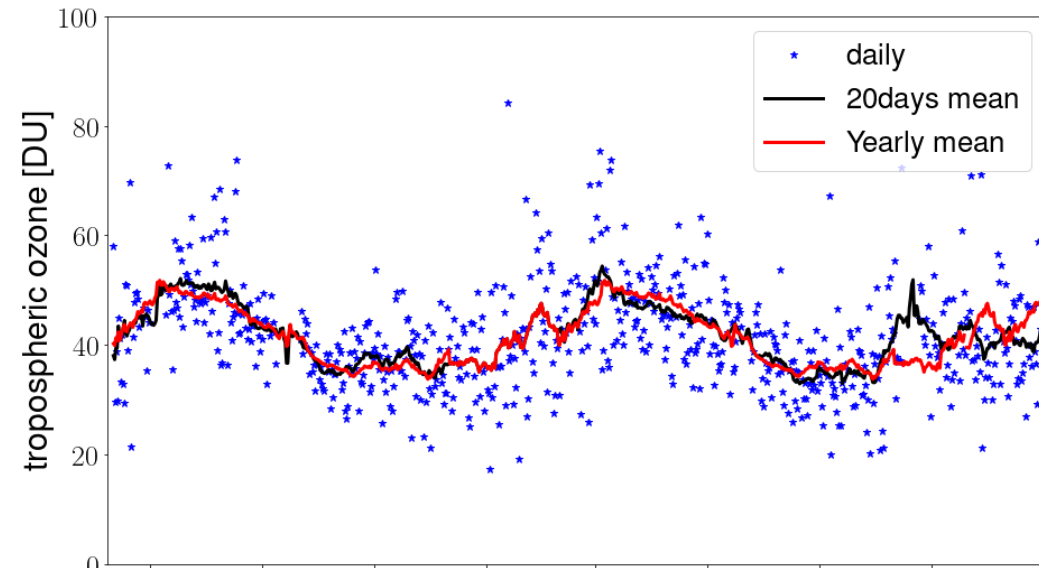
Decrease in 20 days running means (black) in March/April compared mean of years 2018 & 2019 (red)



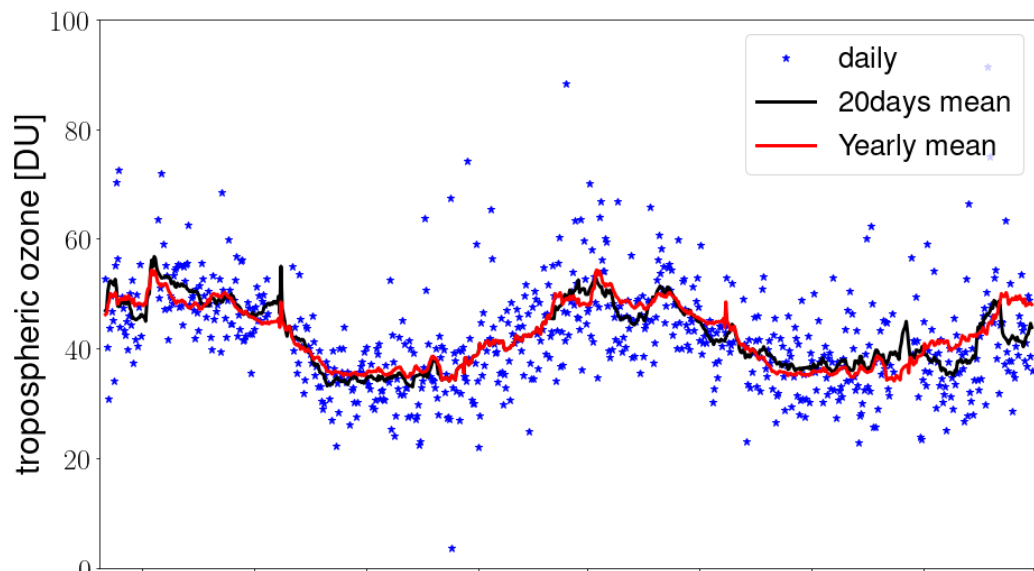
Bruxelles 50.85 N 4.35 E



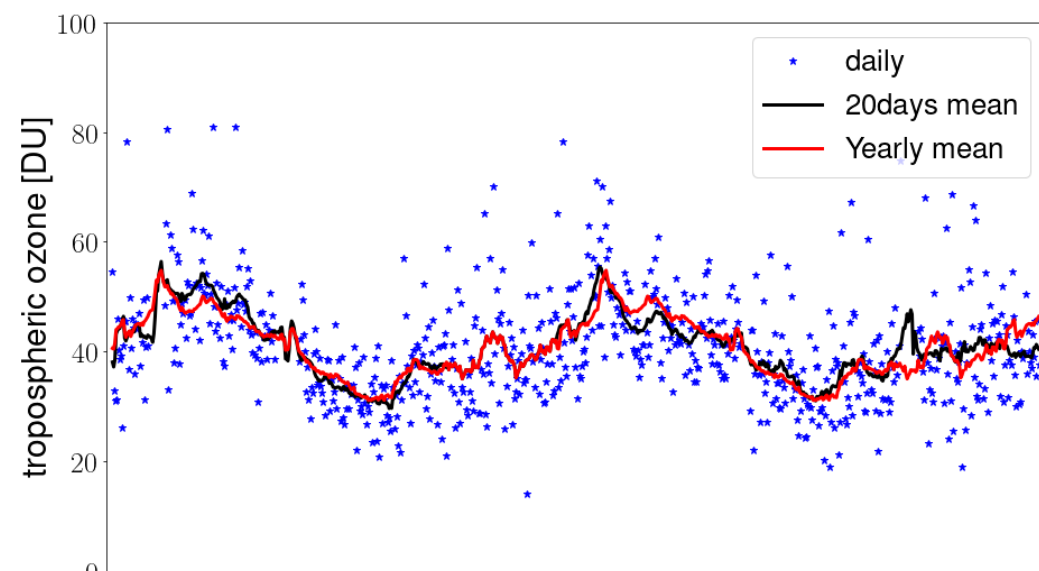
Berlin 52.52 N 13.38 E



Milano 45.46 N 9.19 E



München 48.14 N 11.57 E



Conclusion

- S5P BASCOE/MLS tropospheric ozone retrieval works fine
- Bias with respect to soundings is partially caused by the albedo and the total column
- High tropospheric ozone columns were observed over
 - South eastern US – transport to the east Atlantic
 - Mediterranean Sea
- Correlations between NO_2 , HCHO and Tropospheric O_3 for Africa and South America
- Decrease in March/April around many cities
 - Corona virus effect? To be further investigated

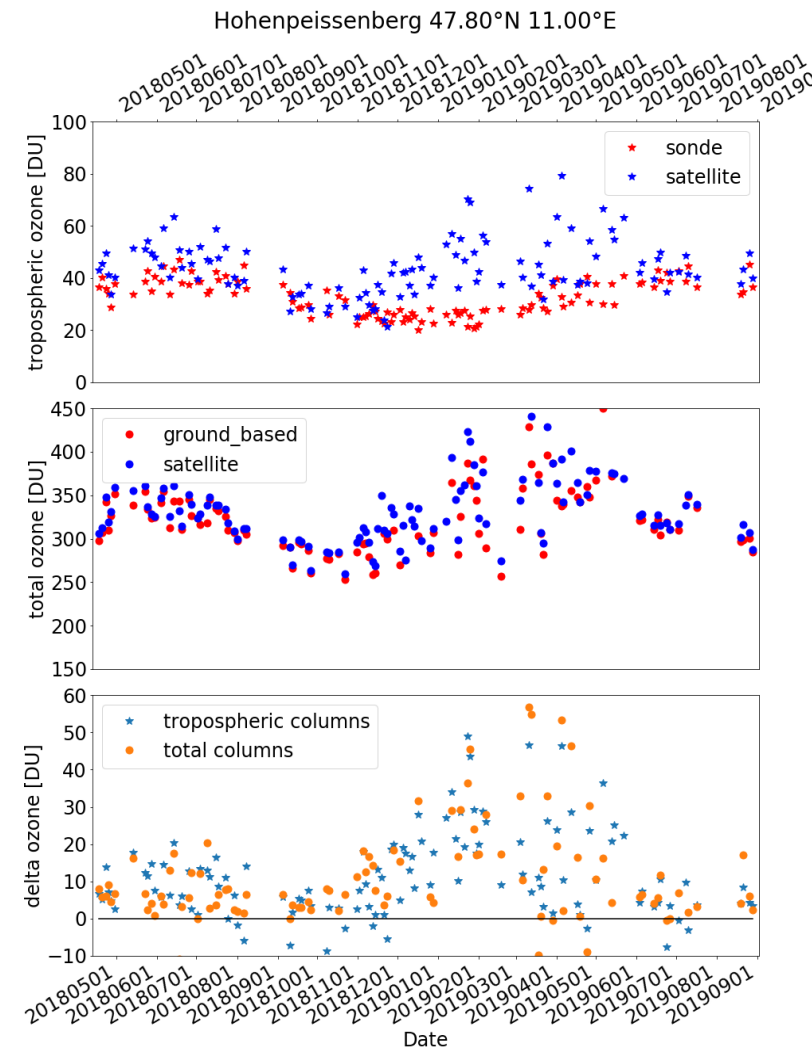
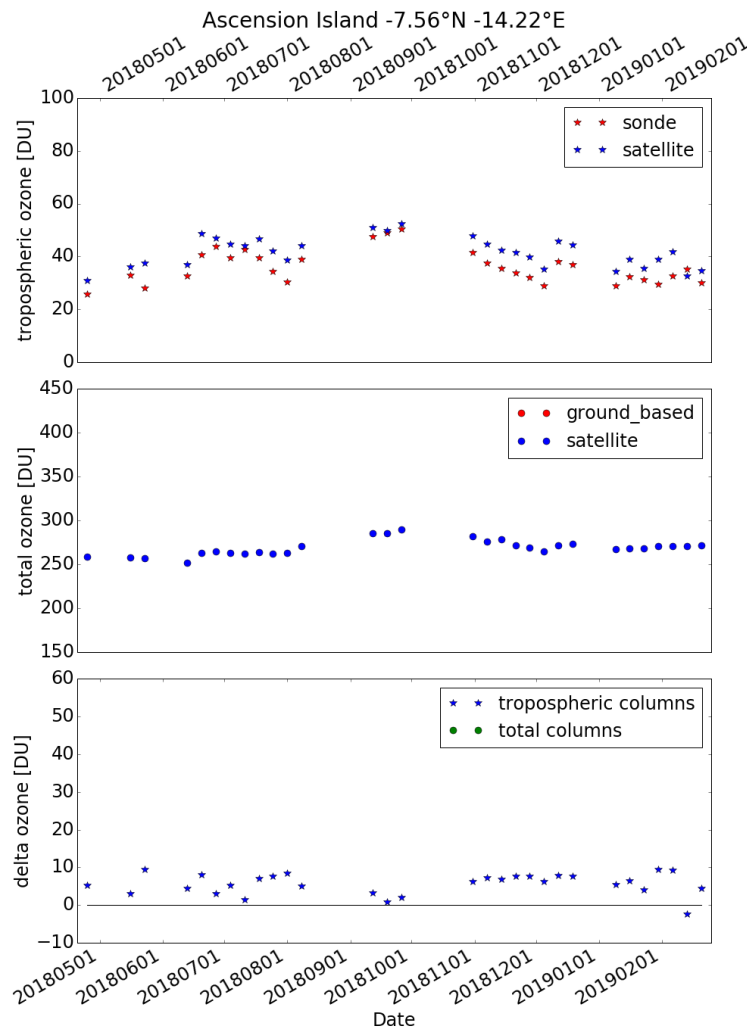
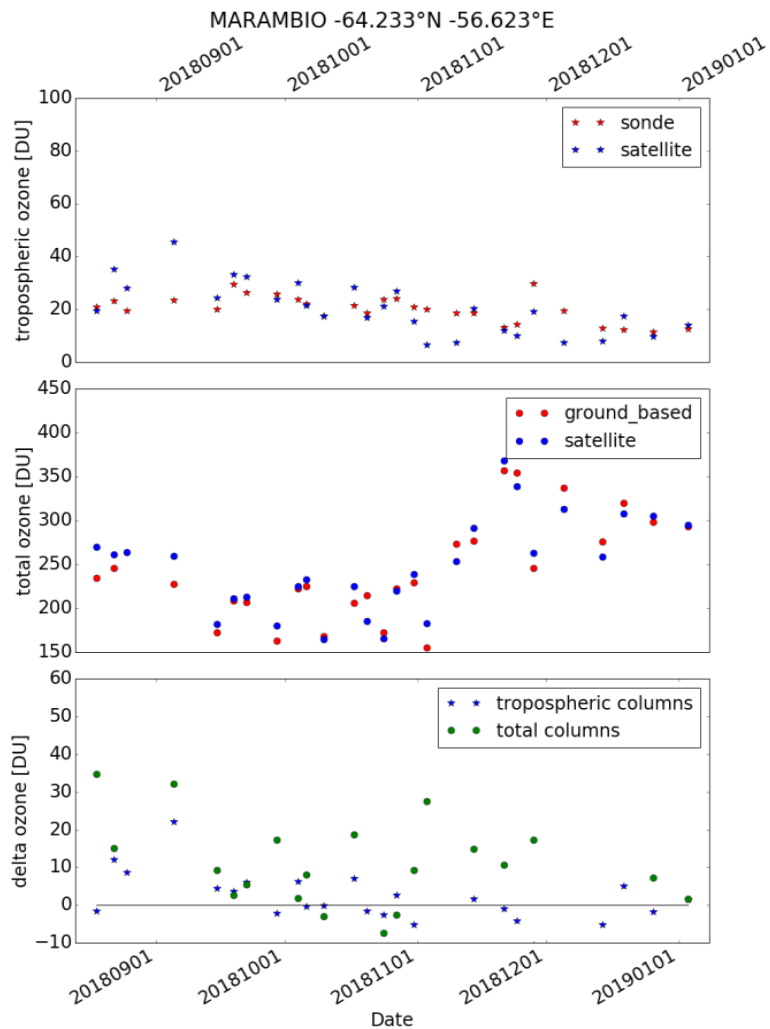
Acknowledgment

This analysis contains modified Copernicus Sentinel-5 Precursor data (2018-2020) processed by DLR.





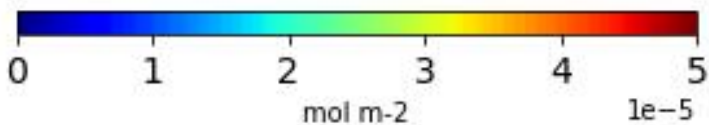
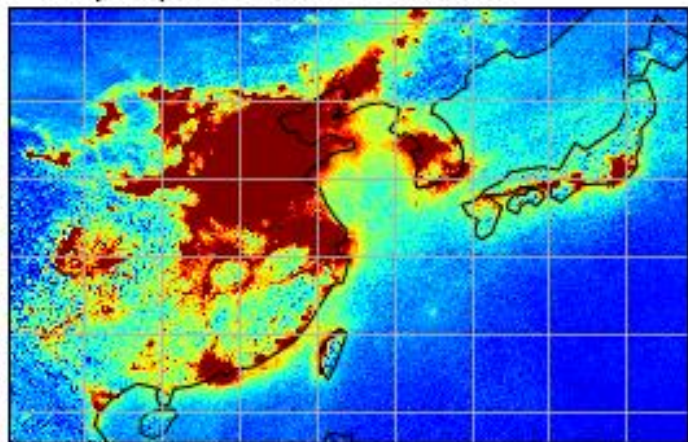
Sondebased Validation (III)



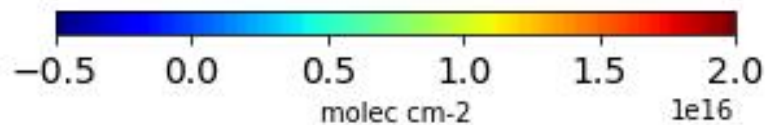
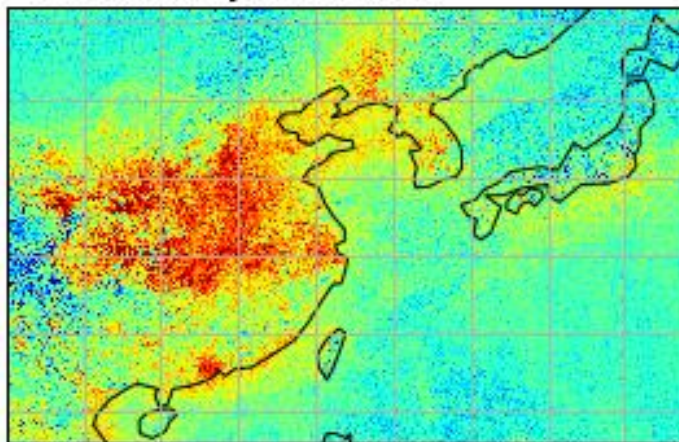
East Asia September

Asia, Ozone and Precursors, 2018-09

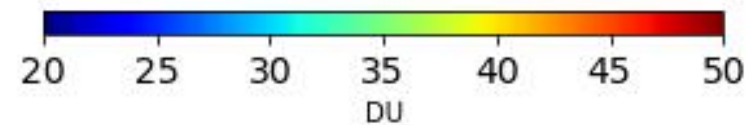
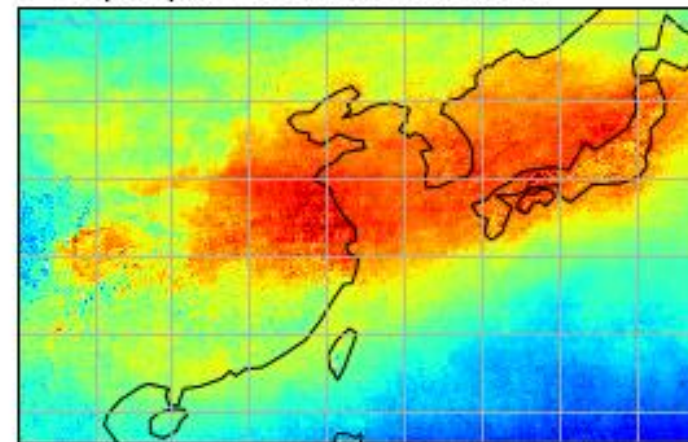
tropospheric NO₂ column



formaldehyde column

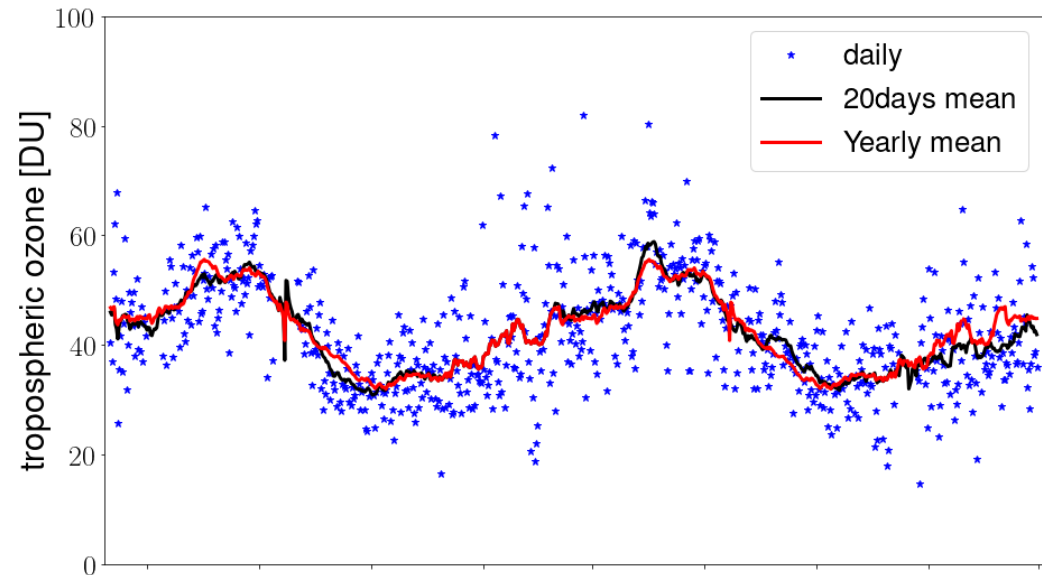


tropospheric ozone column

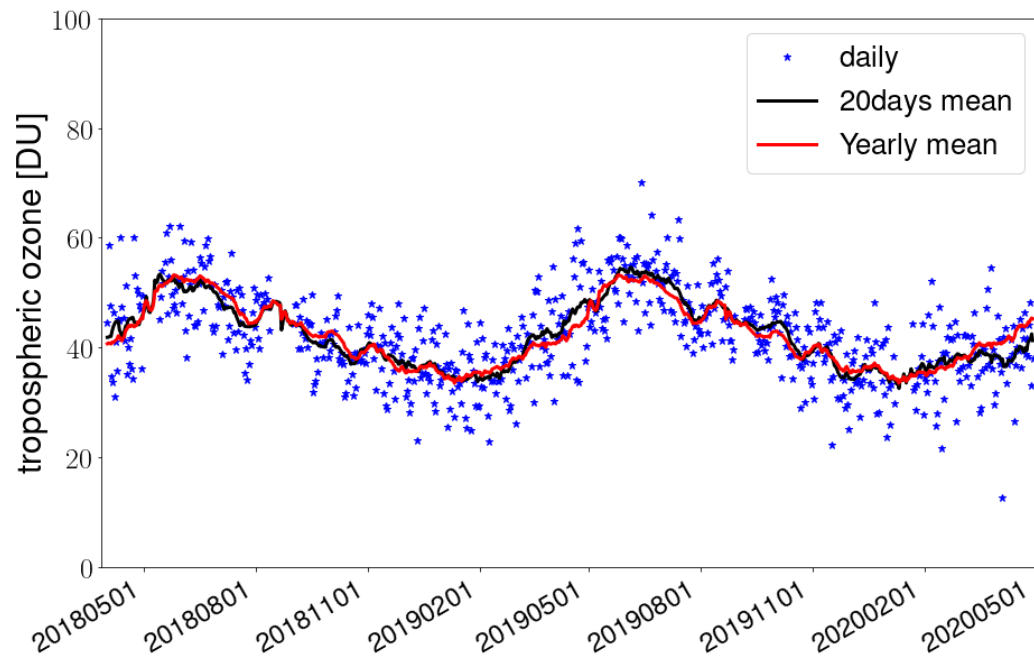




Beijing 39.90 N 116.39 E



Wuhan 30.60 N 114.27 E



Hong Kong 22.28 N 114.19 E

