

The background of the slide features a central image of Earth from space, with a satellite in orbit. Surrounding the Earth are several circular inset images showing global maps of water vapor and cloud cover. The text 'ATMOS 2021' is prominently displayed in the center, and the main title 'TROPOMI Observations of Total Column Water Vapour in the Visible Blue Band' is written in large white letters across the middle.

ATMOS 2021

TROPOMI Observations of Total Column Water Vapour in the Visible Blue Band

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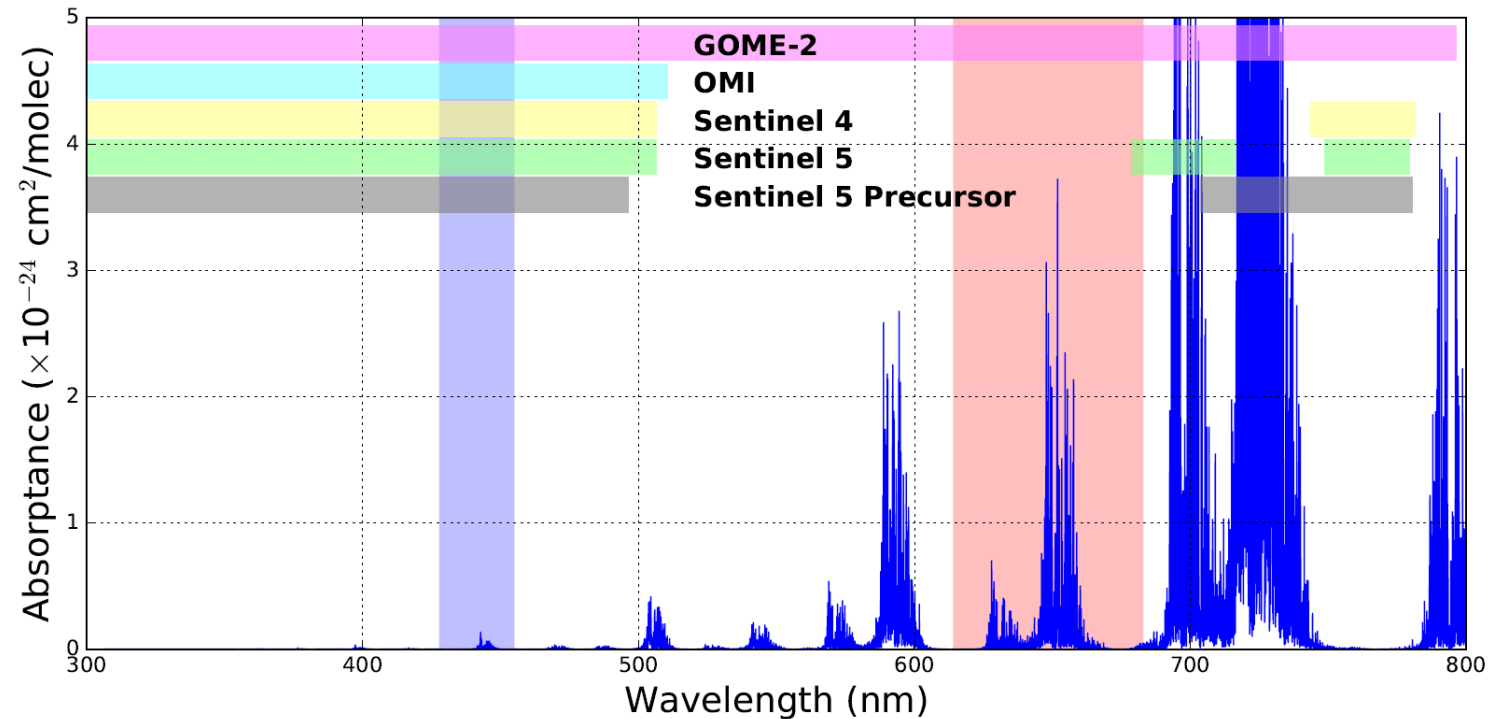
(2) Rutherford Appleton Laboratory Space, Harwell Oxford, United Kingdom

(3) National Space Science Center, Chinese Academy of Sciences, Beijing, China

DD/MM/YYYY

Motivation

- Water vapor is the most important natural greenhouse gas in the troposphere
- Continuous monitoring of the spatio-temporal variation of water vapor on a global scale is important for climate study
- Water vapor typically retrieved in the red band (e.g., GOME-2)
- However, this wavelength band is not available to most of the current and forthcoming sensors (e.g., OMI, S4, S5, S5P)



DOAS retrieval of water vapour slant column



DOAS fit window

TROPOMI: **435 – 455nm**

Reference spectrum

Daily irradiance spectrum

Absorption cross section

H₂O vapor (296K) (HITRAN, Rothman et al., 2009)

NO₂ (220K) (Vandaele et al., 2002),

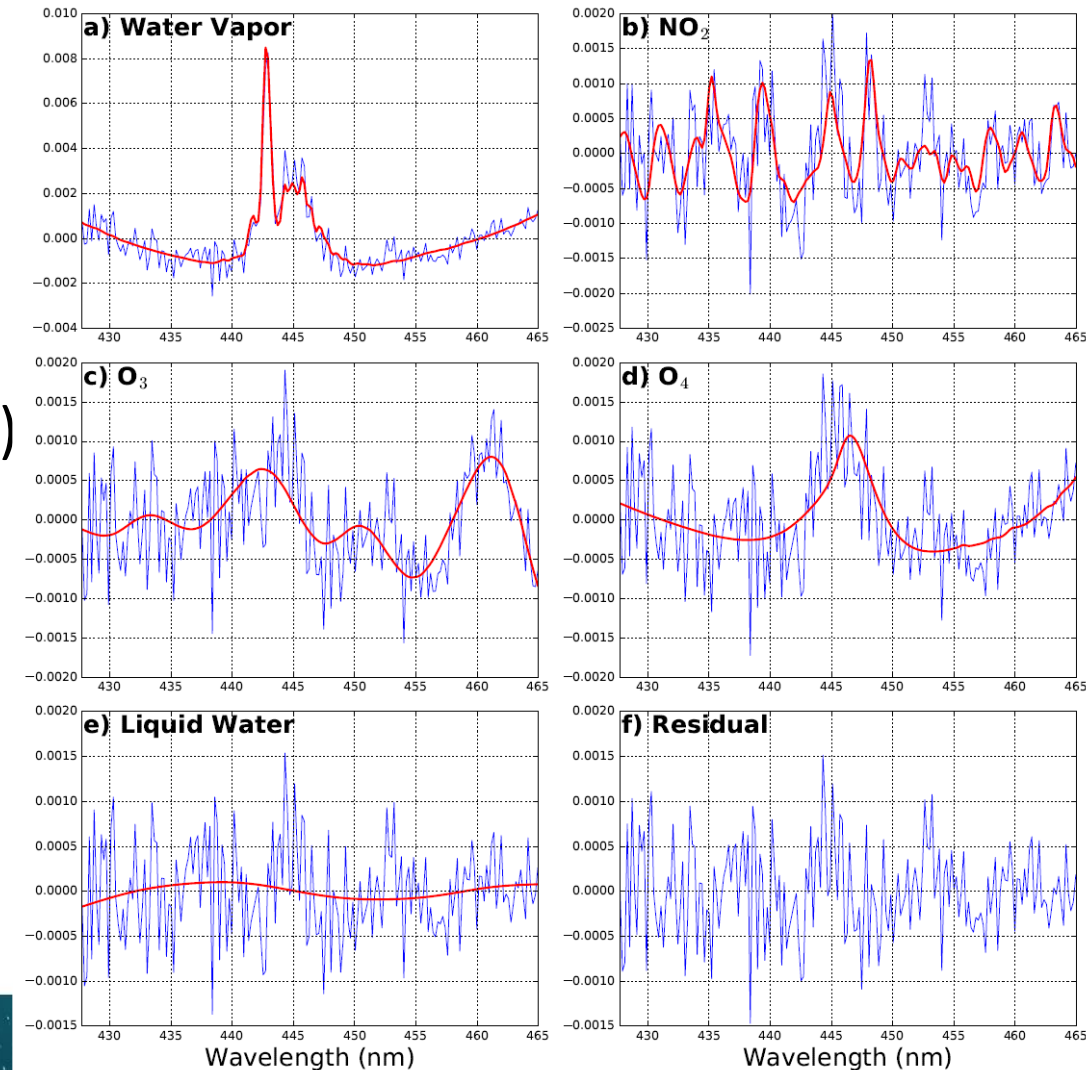
O₃ (228K) (Brion et al., 1998)

O₄ (293K) (Thalman and Volkamer, 2013)

H₂O liquid (297K) (Pope and Fry, 1997)

Ring spectrum

4th order polynomial



Air mass factor calculation

Box AMF look-up table (442nm)

Viewing zenith angle: 0 – 75° (10)

Solar zenith angle: 0 – 88° (20)

Relative azimuth angle : 0 – 180° (7)

Surface albedo: 0 – 1 (14)

Surface pressure: 121 – 1063hPa (17)

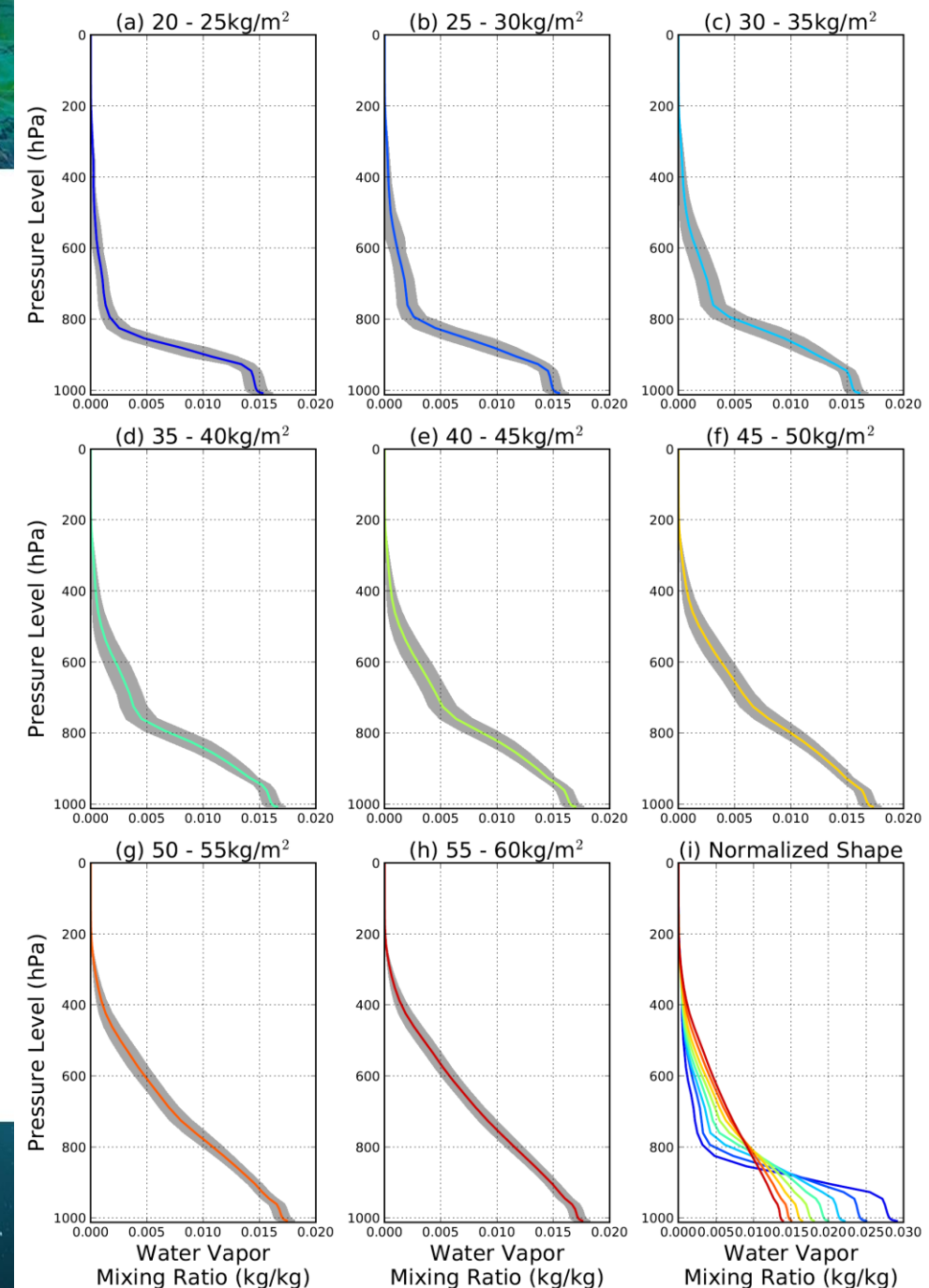
Pressure level: 0.001 – 1063hPa (64)

Surface albedo

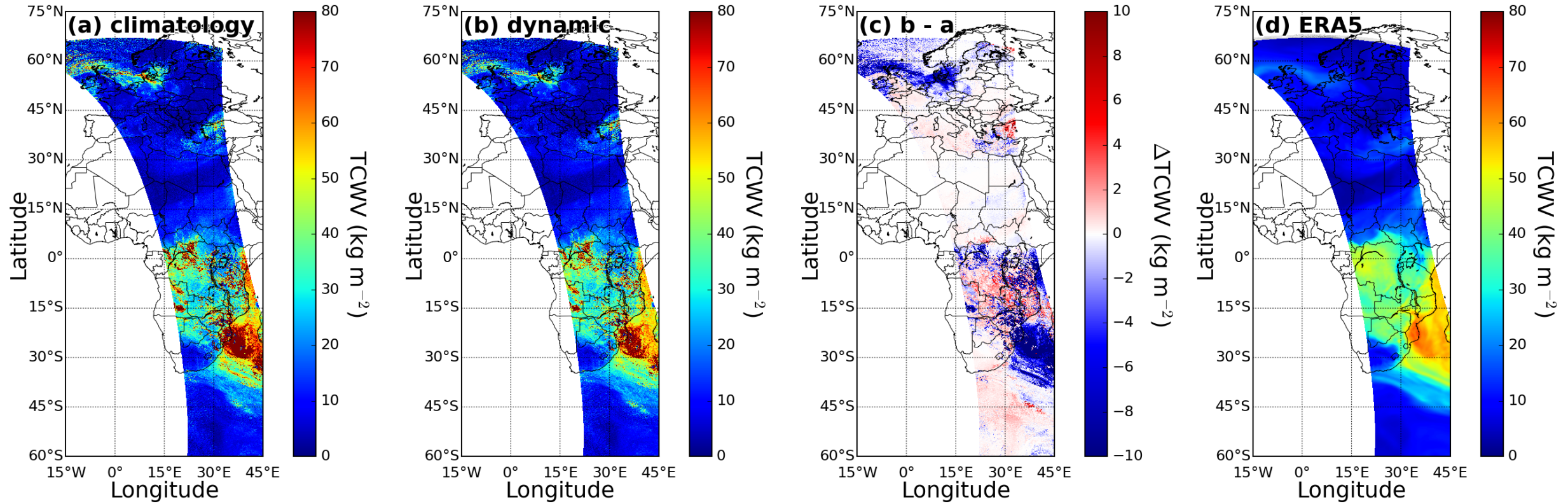
GE_LER 435-455 nm (Loyola et al., 2020)

A priori profile

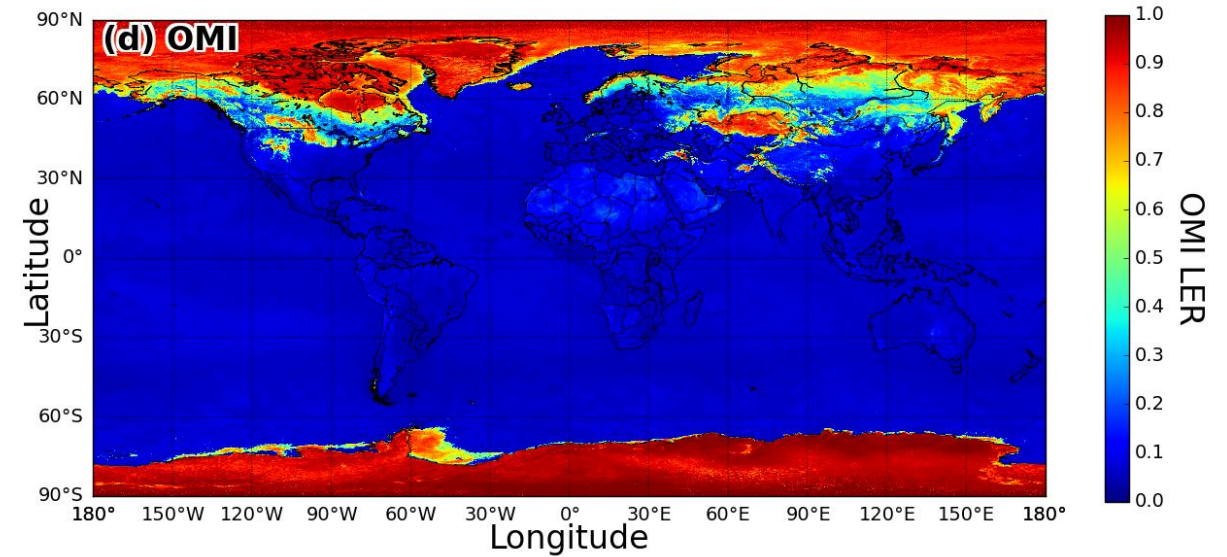
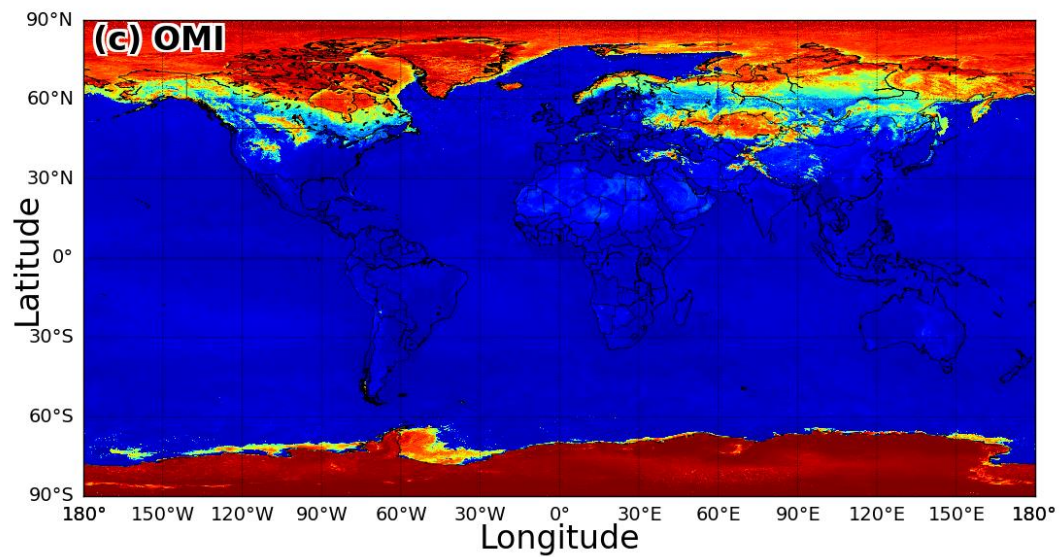
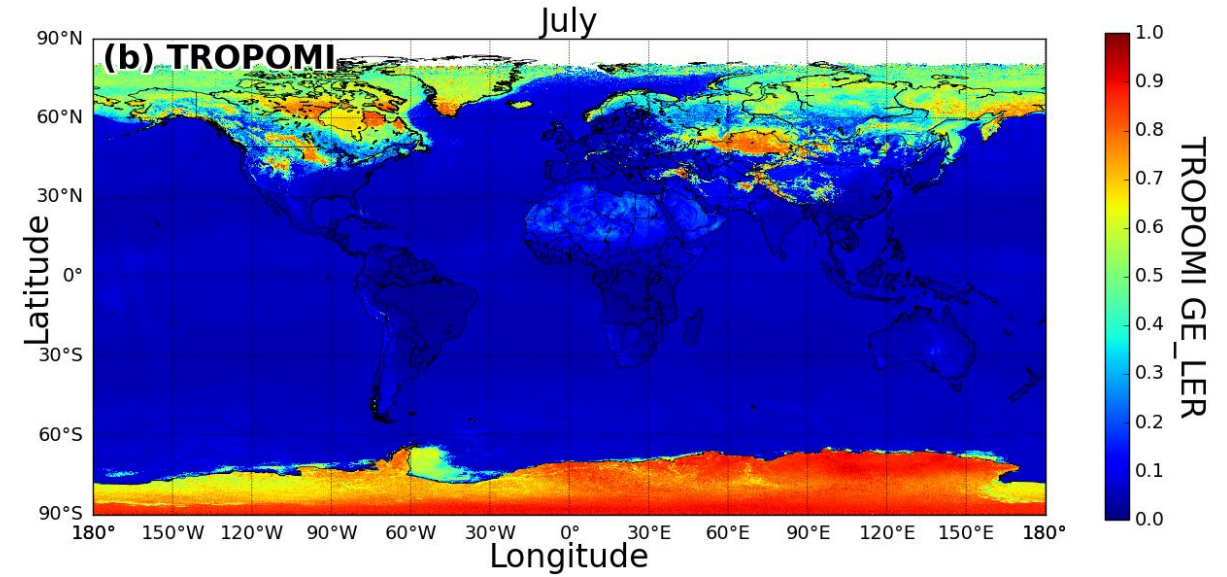
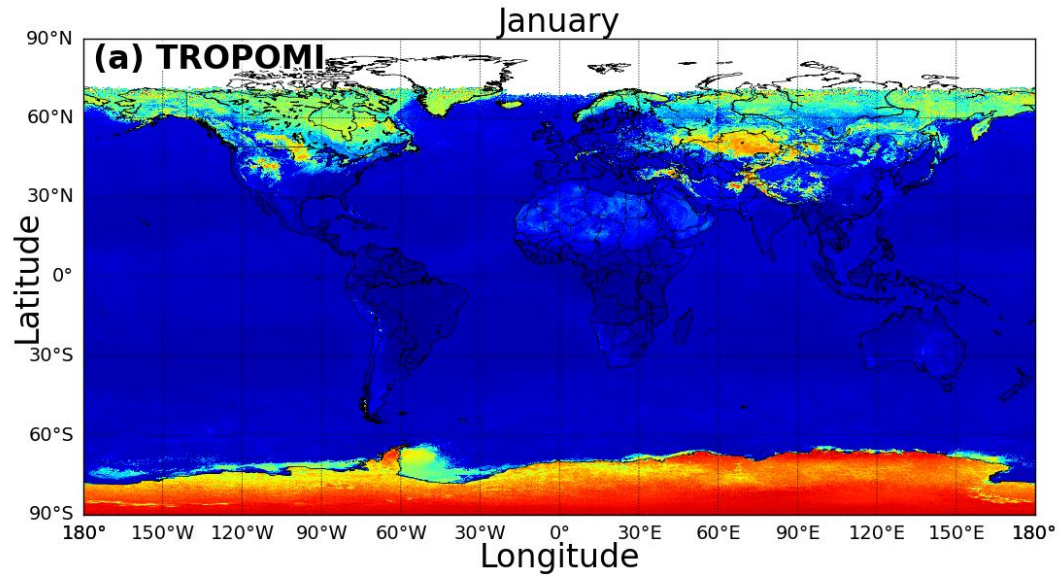
Dynamic approach using monthly LUT
from statistical analysis historical
profiles



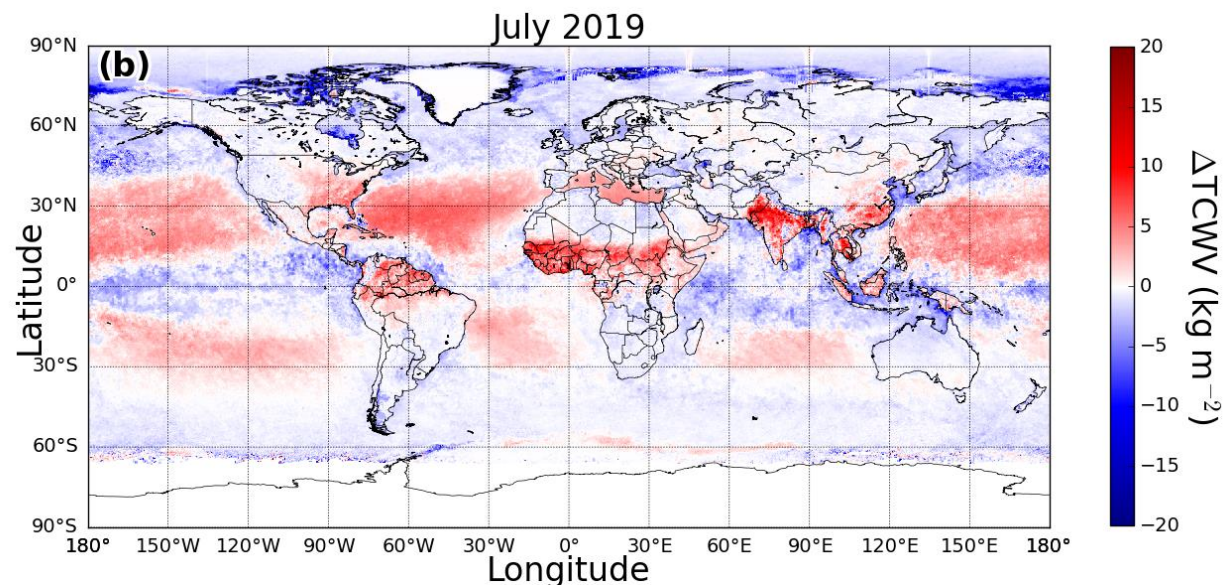
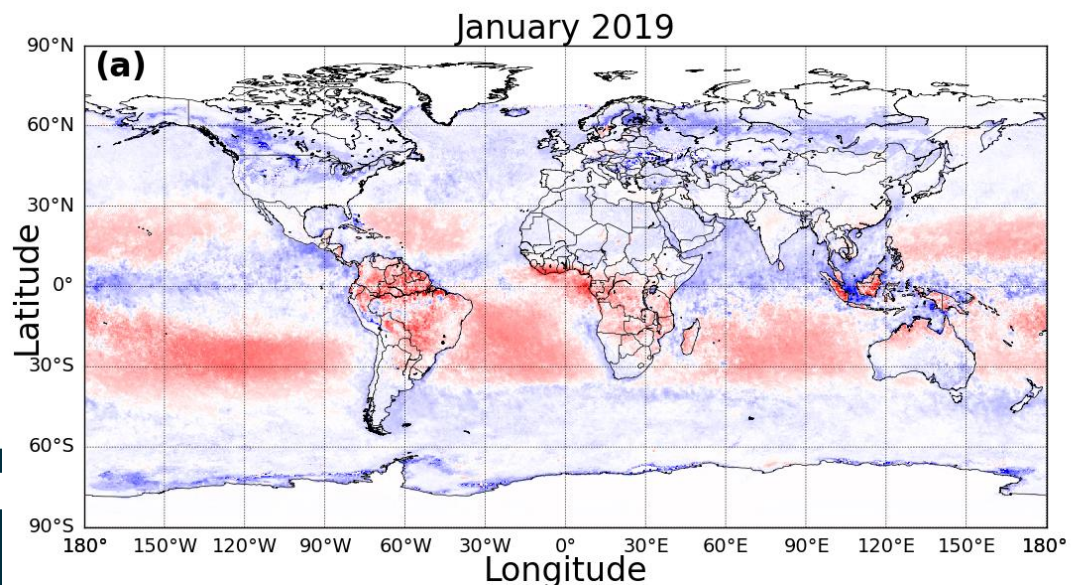
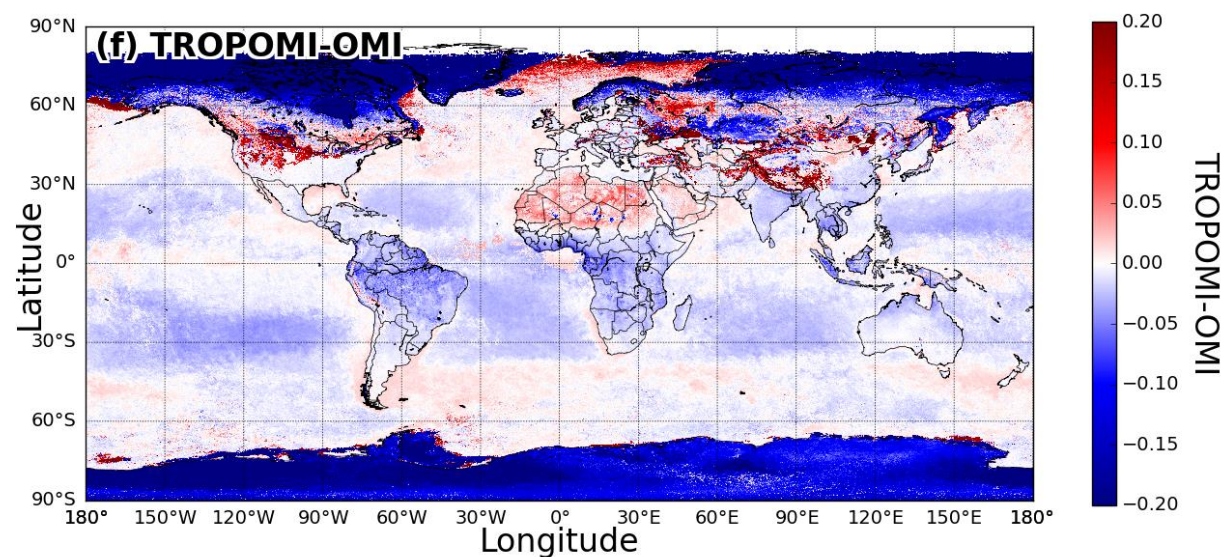
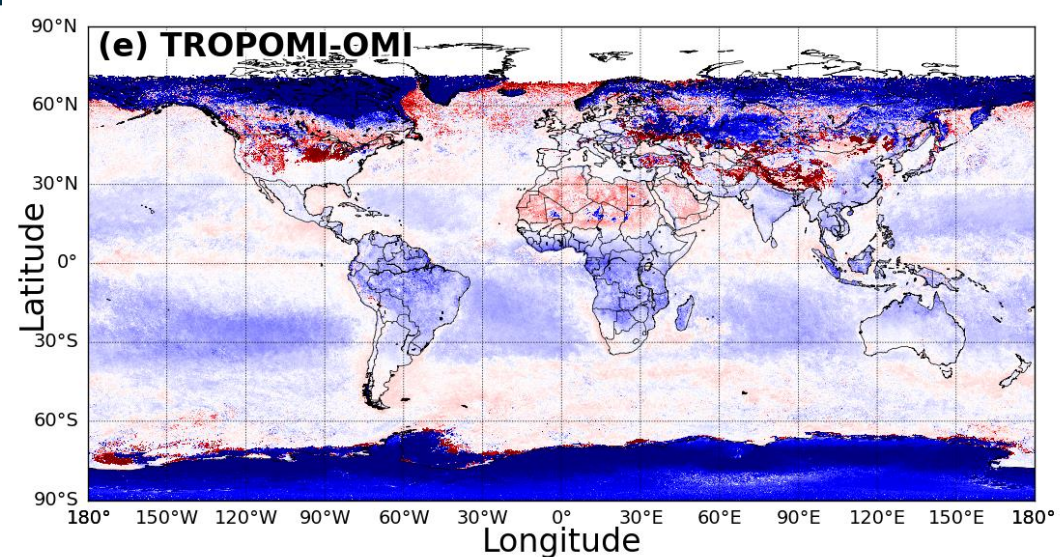
A-priori water vapour profiles



Albedo

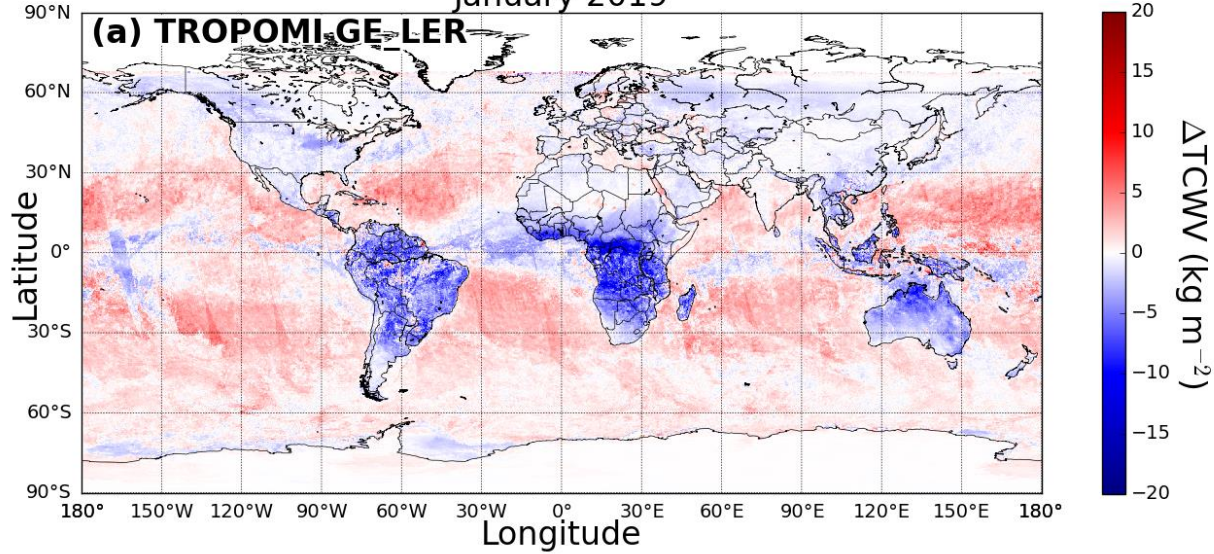


Albedo – Compare to OMI LER

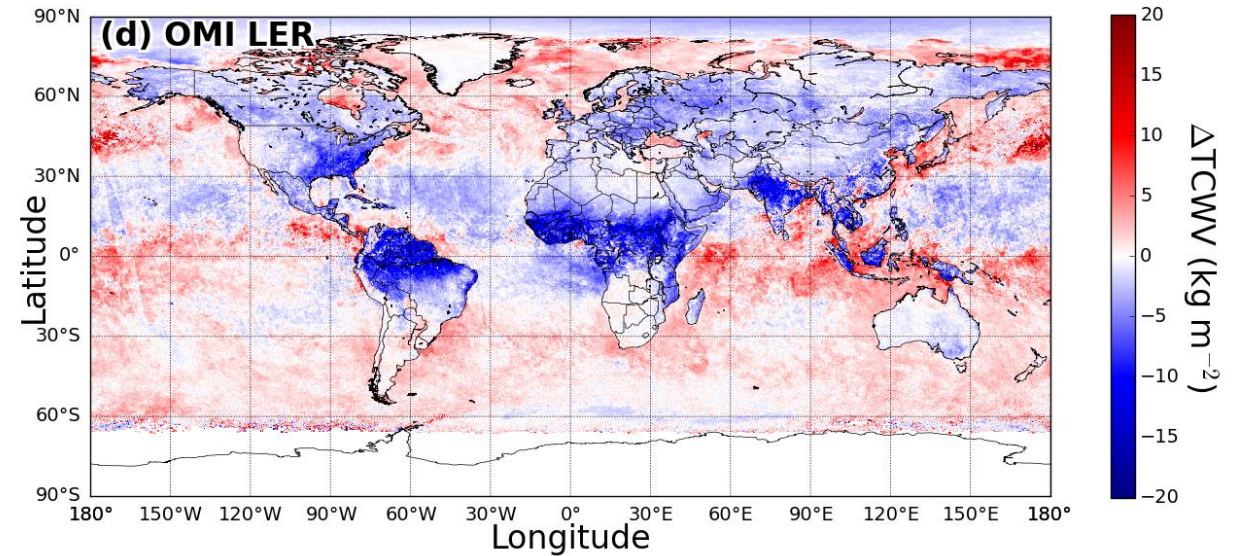
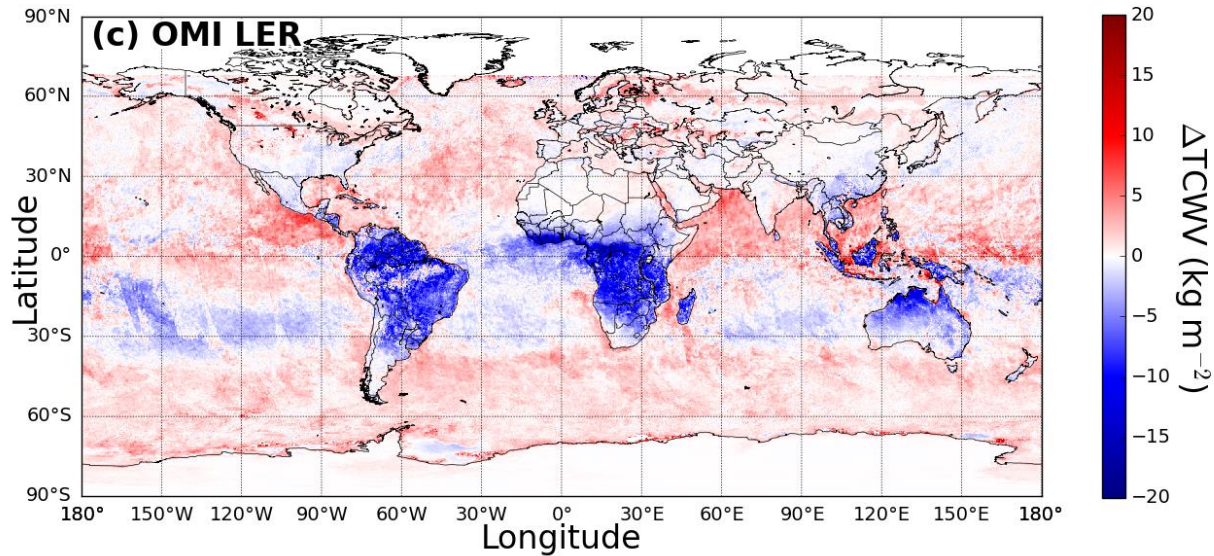
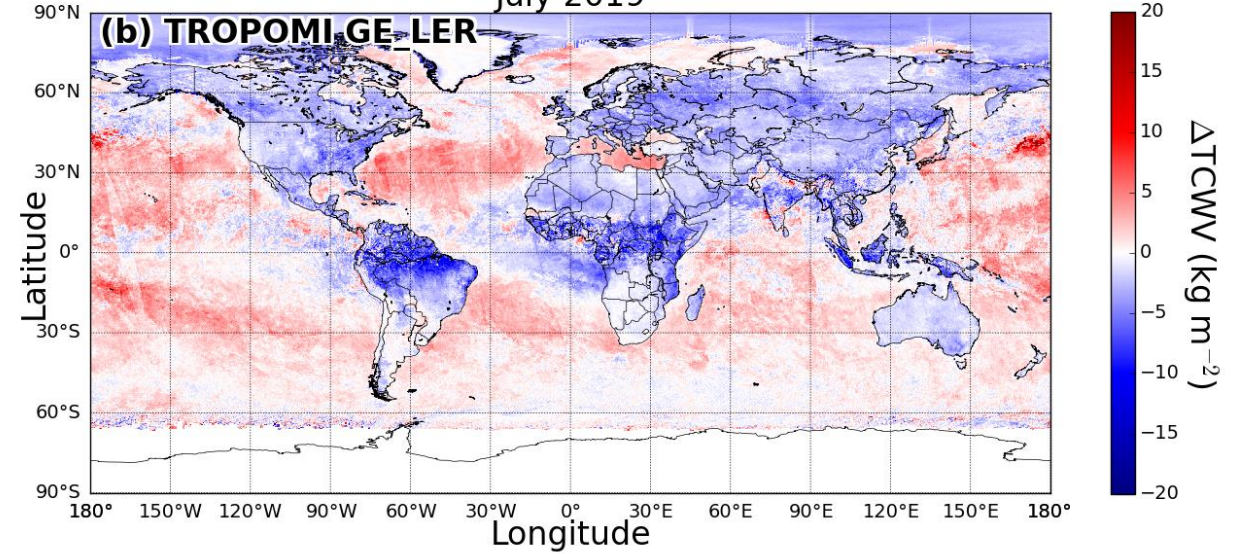


Albedo – Compare to ERA5

January 2019



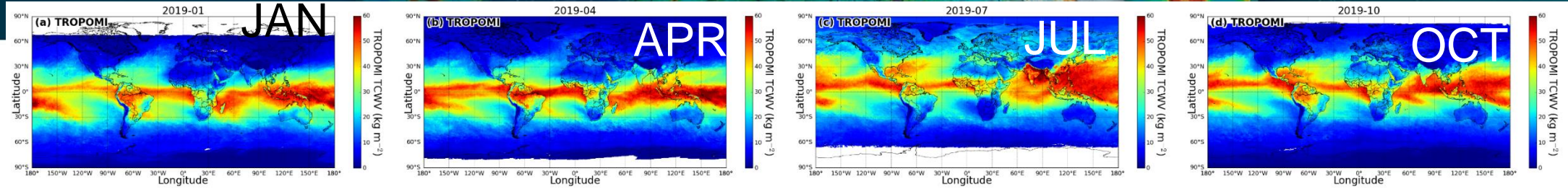
July 2019



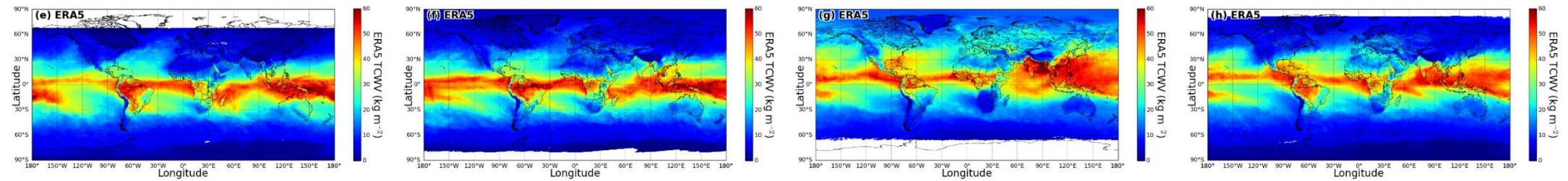
Validation



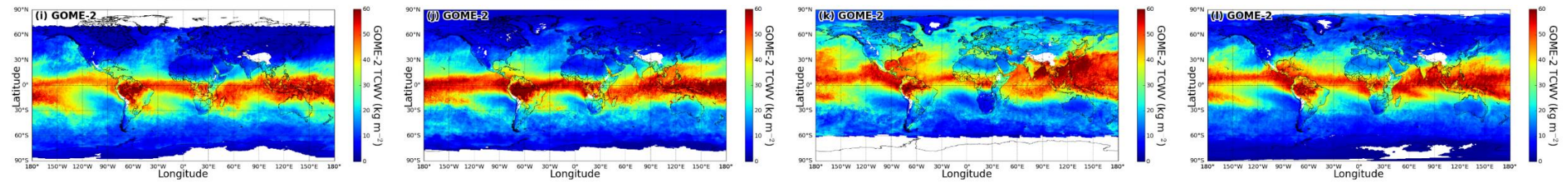
TROPOMI



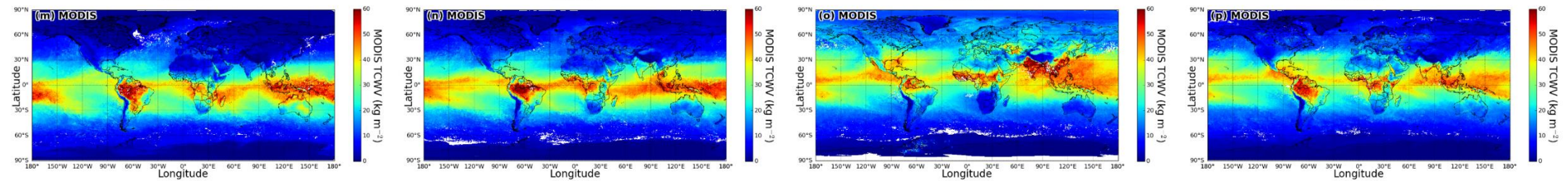
ERA5



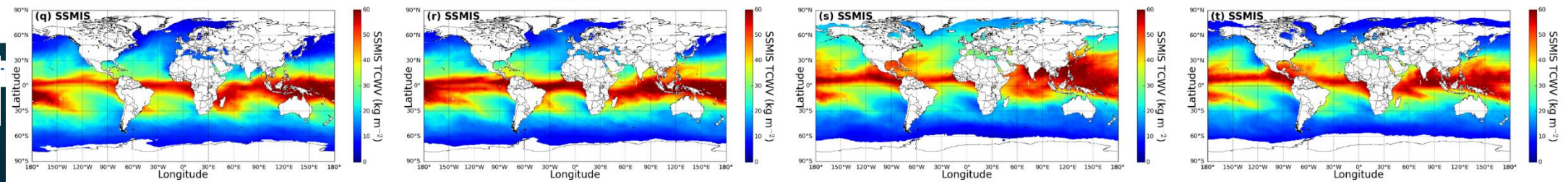
GOME-2



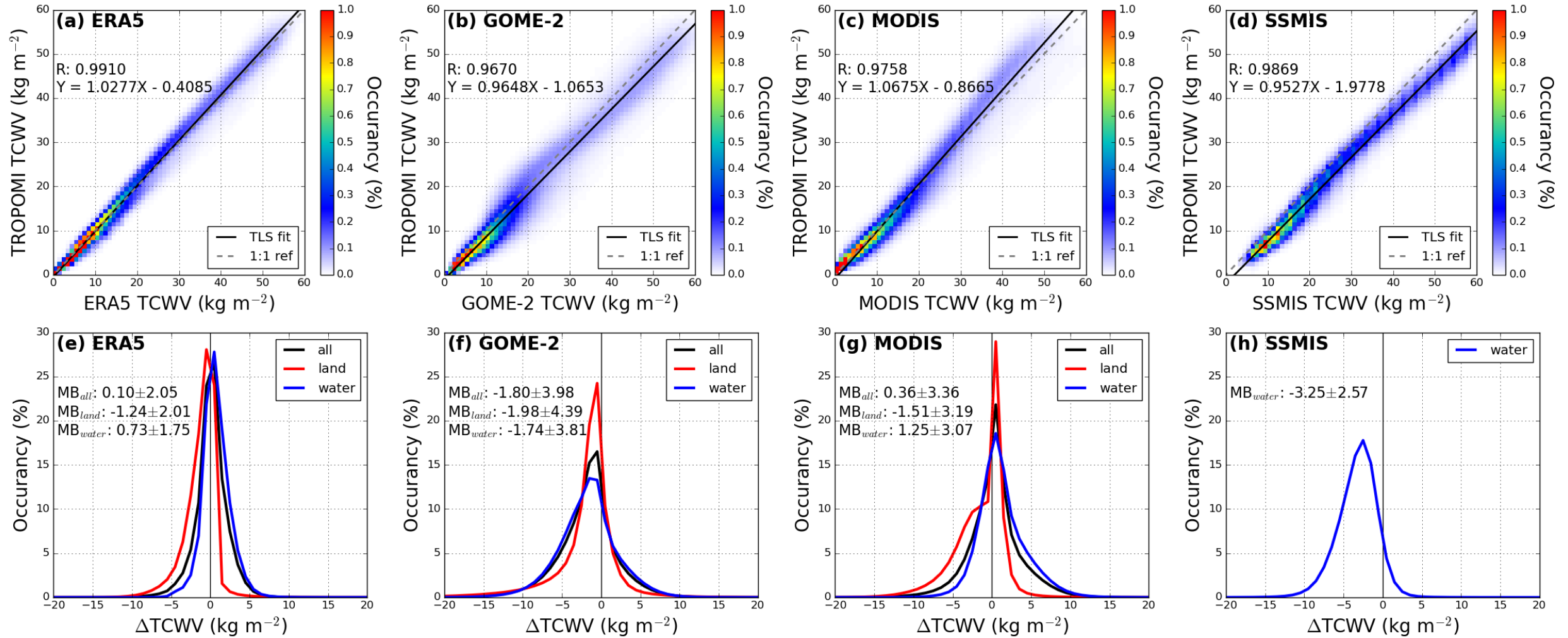
MODIS



SSMIS

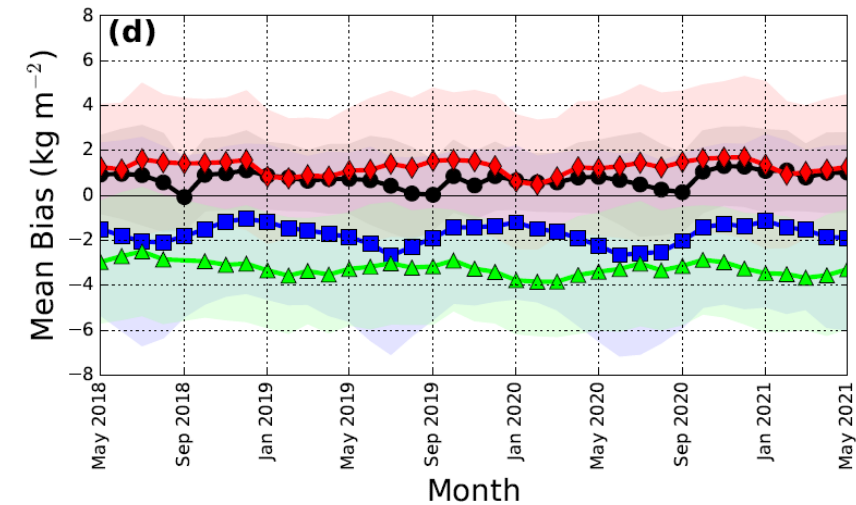
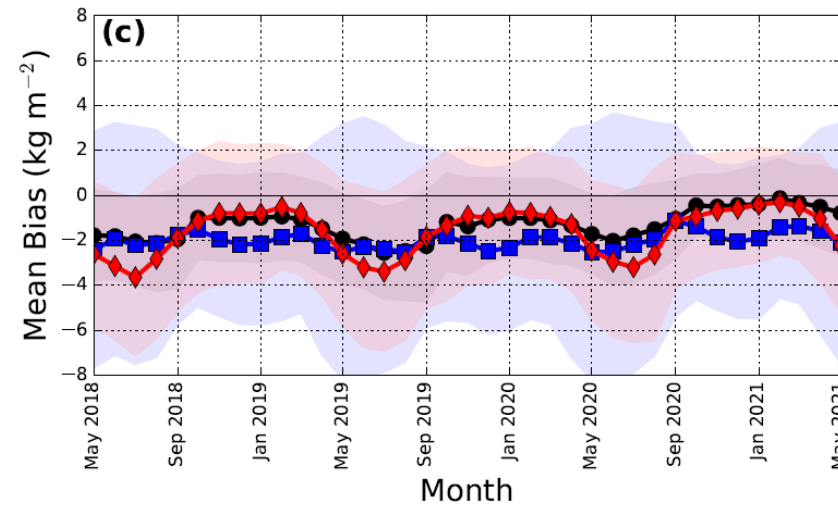
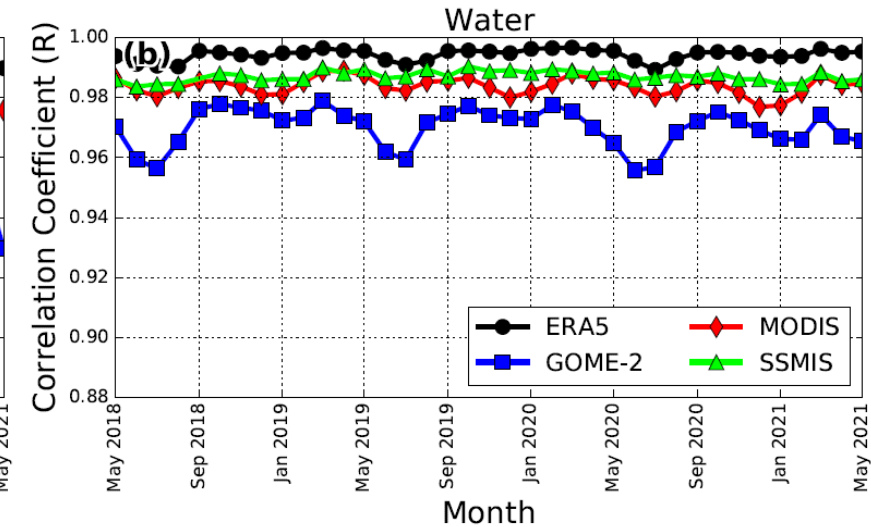
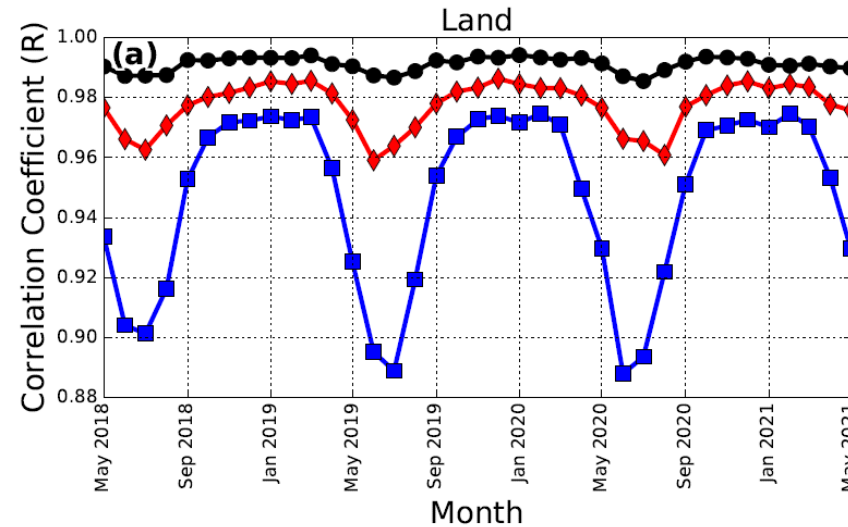


Validation



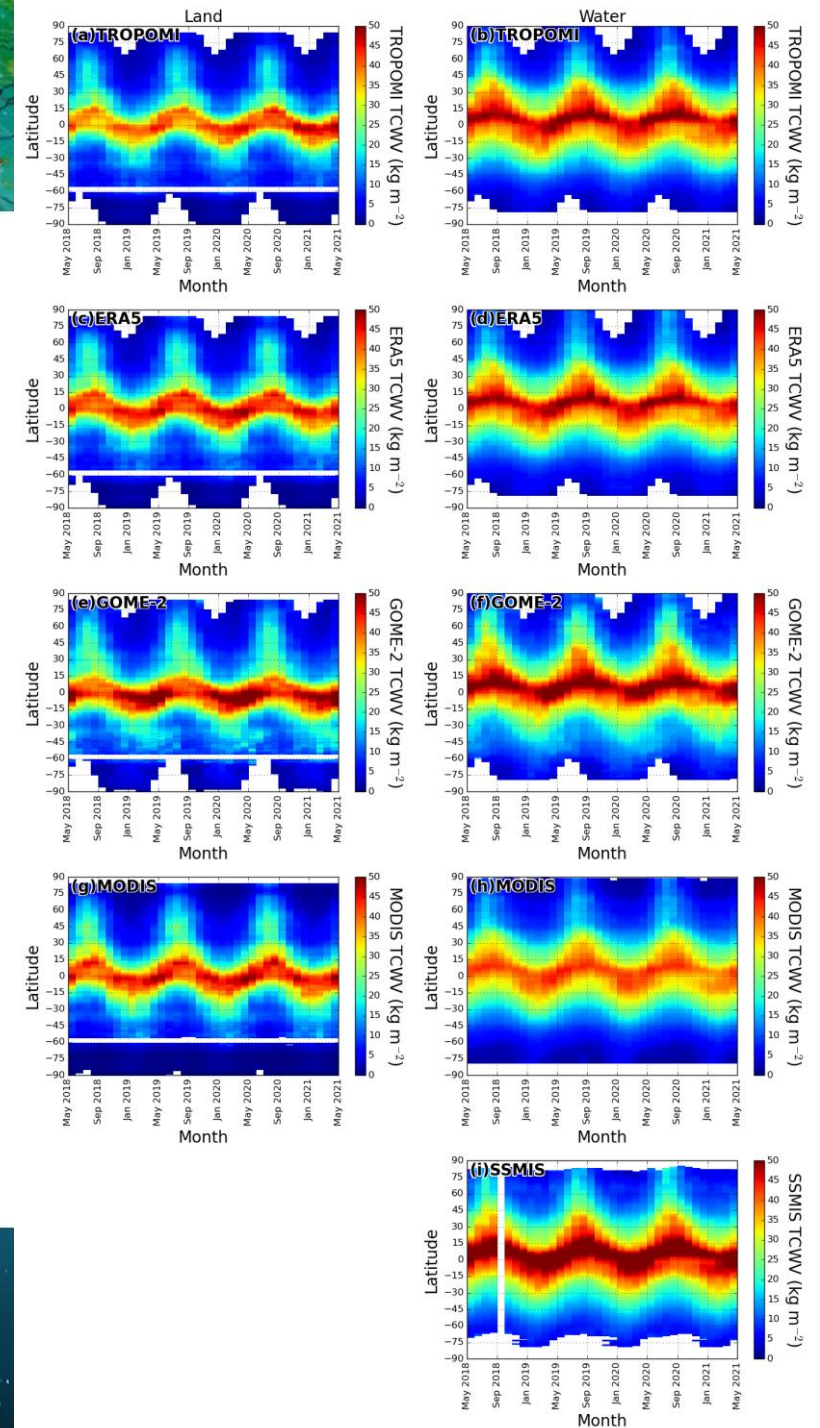
Validation - Statistic

- Bias between TROPOMI and GOME-2 is partly related to the difference in overpass time
- TCWV is in general 4-6% higher in morning (GOME-2 overpass) than that at noon (TROPOMI overpass)
- This effect also shows a seasonal pattern



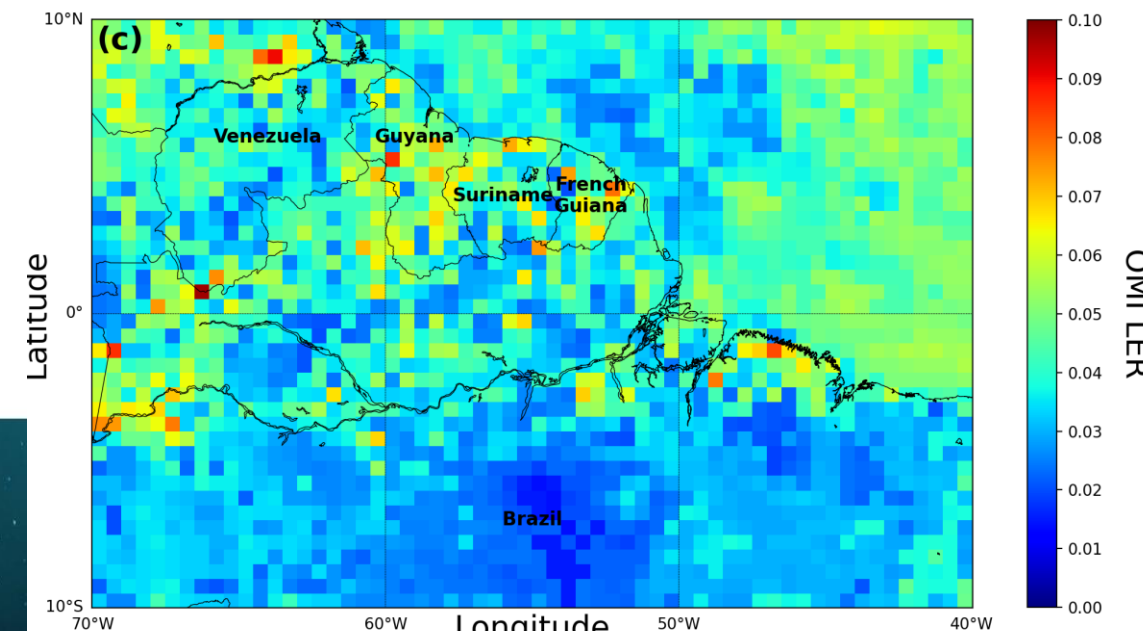
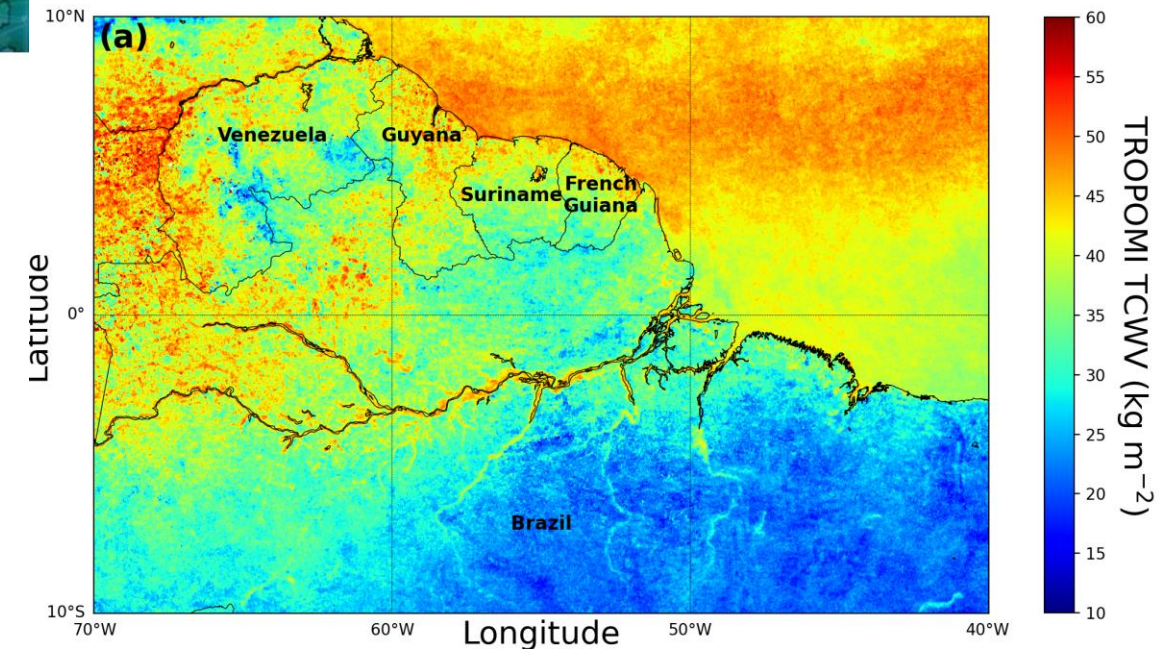
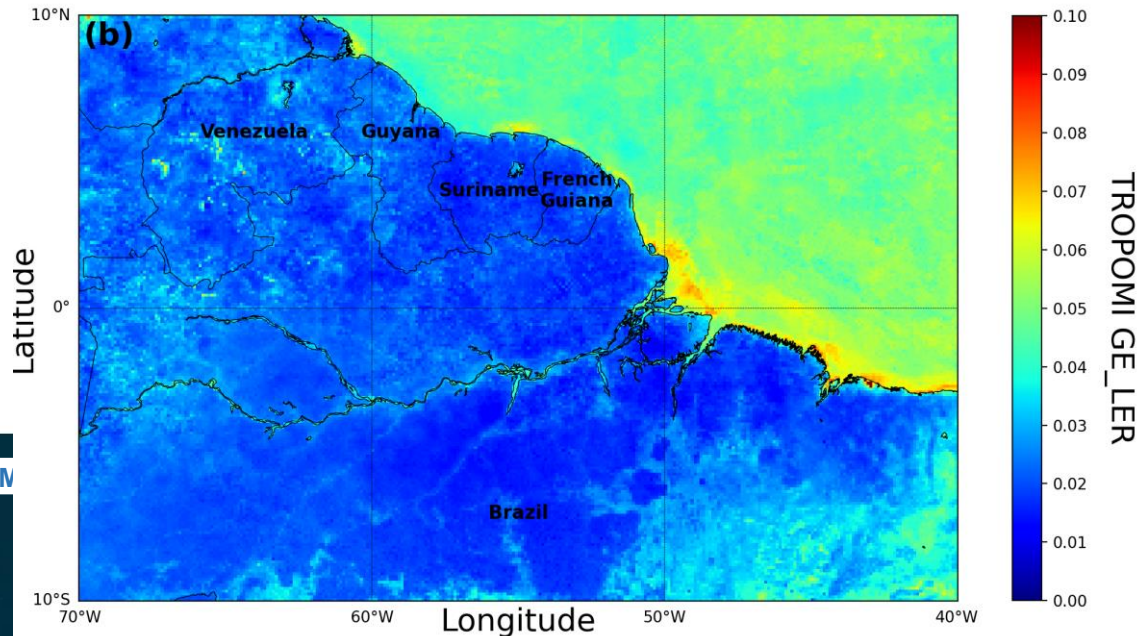
Validation

- TROPOMI data is in general consistent with other reference data sets
- Larger dry bias ($\sim 5\text{kg/m}^2$) is observed at $0\text{--}30^\circ\text{S}$ over land compared to GOME-2
- This bias is less significant in the Northern Hemisphere
- The north-south dependency of discrepancy between GOME-2 and TROPOMI is mainly related to the differences in overpass time



Fine scale features

- Enhancement of TCWV over main stream and branches of Amazon river
- TROPOMI LER also shows higher albedo over rivers compared to the surroundings



Summary and conclusion

- The TROPOMI TCWV retrieval algorithm
 - Derive TCWV in the visible blue band (435-455nm)
 - A dynamical a-priori technique
 - Using GE_LER albedo derived from TROPOMI
- Comparison to ERA5 reanalysis, GOME-2, MODIS and SSMIS satellite observations
 - Very good agreement (R: 0.97-0.99, Bias: -3.25-0.36kg/m²)
- The example of fine scale features of water vapour observed over Amazon indicates the improved spatial resolution of TROPOMI can be useful for local and regional climate study

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Thank you!