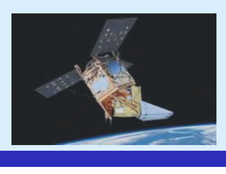
Vertically-resolved tropospheric nitrogen dioxide (NO_2) and ozone (O_3) from cloud-slicing TROPOMI

Eloïse A. Marais (e.marais@ucl.ac.uk)[1], Rebekah P. Honer[1]

[1] Department of Geography, University College London



NEW DATA RETRIEVAL MOTIVATION

There are no widespread, routine observations of vertically-resolved tropospheric nitrogen dioxide (NO_2) and ozone (O_3).

Traditional satellite observations offer one piece of vertical information and aircraft observations and ozonesondes are sparse and intermittent.

We apply the cloud-slicing technique to TROPOMI (satellite) observations to retrieve NO_2 and O_3 in 5 discrete layers throughout the troposphere .

STEPS AND RESULTS OF CLOUD-SLICING TROPOMI O_3 AND NO_2

IN: TROPOMI level 2 swath of total integrated columns, cloud fraction, cloud top height

↓

Retain pixels above optically thick clouds that divide the troposphere

↓

Aggregate on 1^0 x 1^0 target grid. Retain gridboxes with at least 10 pixels

↓

Retain gridboxes with small stratospheric column variability

↓

Retain representative cloud top height absolute (min/max) and relative (standard deviation) range

↓

Discard statistical outliers

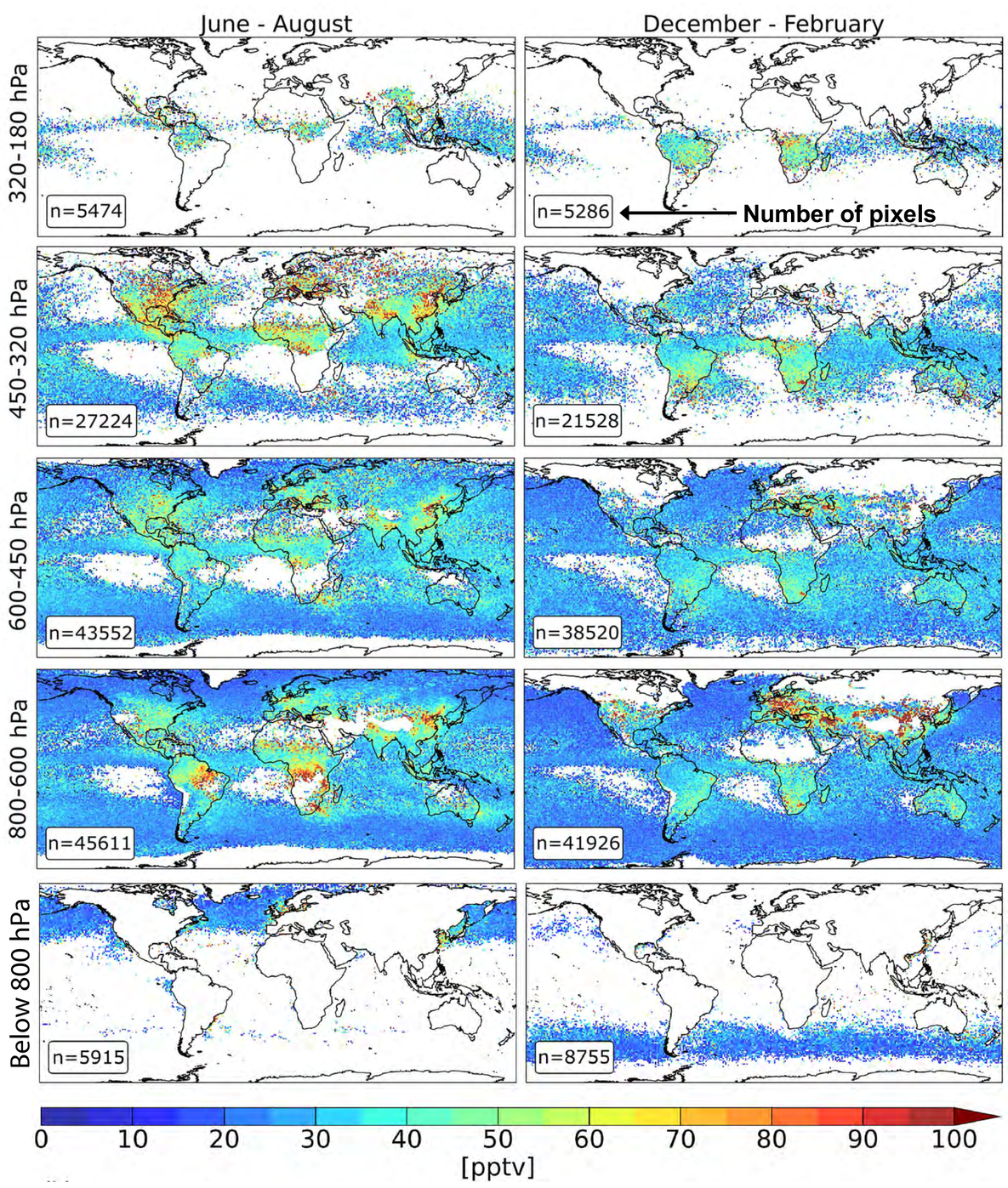
↓

Theil-Sen regression of retained partial columns against cloud top heights

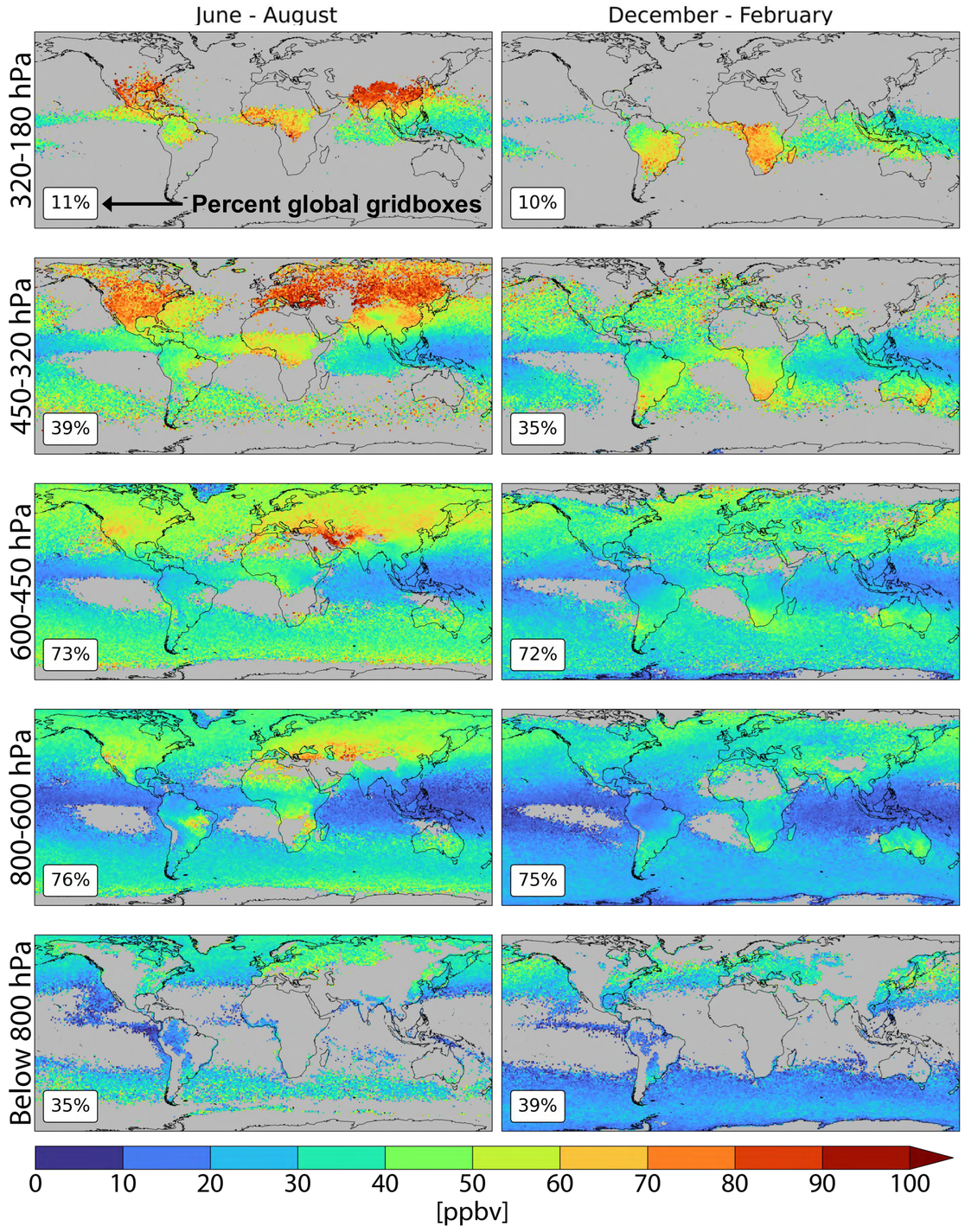
↓

Convert slope to mixing ratios

OUT: Vertically-resolved seasonal mean tropospheric NO_2



OUT: Vertically-resolved seasonal mean tropospheric O_3



Method developed using synthetic columns from GEOS-Chem output at fine resolution (~25-31 km) and sampled at the TROPOMI overpass time

Cloud-sliced NO_2 validated against NASA DC8 aircraft observations and cloud-sliced O_3 validated against global ozonesonde networks

Our method use by Harvard collaborators to derive free tropospheric NO_2 columns from the geostationary instrument TEMPO (under review in PNAS)

DATA AVAILABLE ON THE UCL DATA REPOSITORY

Seasonal multiyear mean cloud-sliced NO_2: https://doi.org/10.5522/04/25782336 (*passed peer review*)

Seasonal multiyear mean cloud-sliced O_3: https://doi.org/10.5522/04/29882786 (*still to undergo peer review*)

ACKNOWLEDGEMENTS AND REFERENCES

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Cloud-sliced TROPOMI NO_2 published (Horner et al., 2024, https://acp.copernicus.org/articles/24/13047/2024/) and O_3 in progress (Horner et al., 2025). PNAS

TEMPO free tropospheric NO_2 in review (https://doi.org/10.48550/arXiv.2504.20337).