THE UNIVERSITY of EDINBURGH
School of GeoSciences

Evaluating Tropospheric Ozone in UKCA with aircraft (IAGOS), satellite (OMI) and Ozonesonde observational data over South Asia

Alok Pandey[1], David Stevenson[1],

Alcide Zhao[1], Krishan Kumar[2], Luke Surl[3], Brian Kerridge[4], Richard Pope[5]

[1]School of Geosciences, University of Edinburgh, Edinburgh, UK; [2]School of Environmental Sciences, Jawaharlal Nehru University, New Delhi, India; [3]CNRS/LATMOS, Place Jussieu, Paris, France; [4]RAL CCLRC Rutherford Appleton Laboratory, Harwell Science and Innovation Campus, Didcot, UK; [5]School of Earth and Environment, University of Leeds, Leeds, UK

COMMONWEALTH SCHOLARSHIPS

Email: Alok.Pandey@ed.ac.uk

ACAM 2019 (26-28 June 2019)

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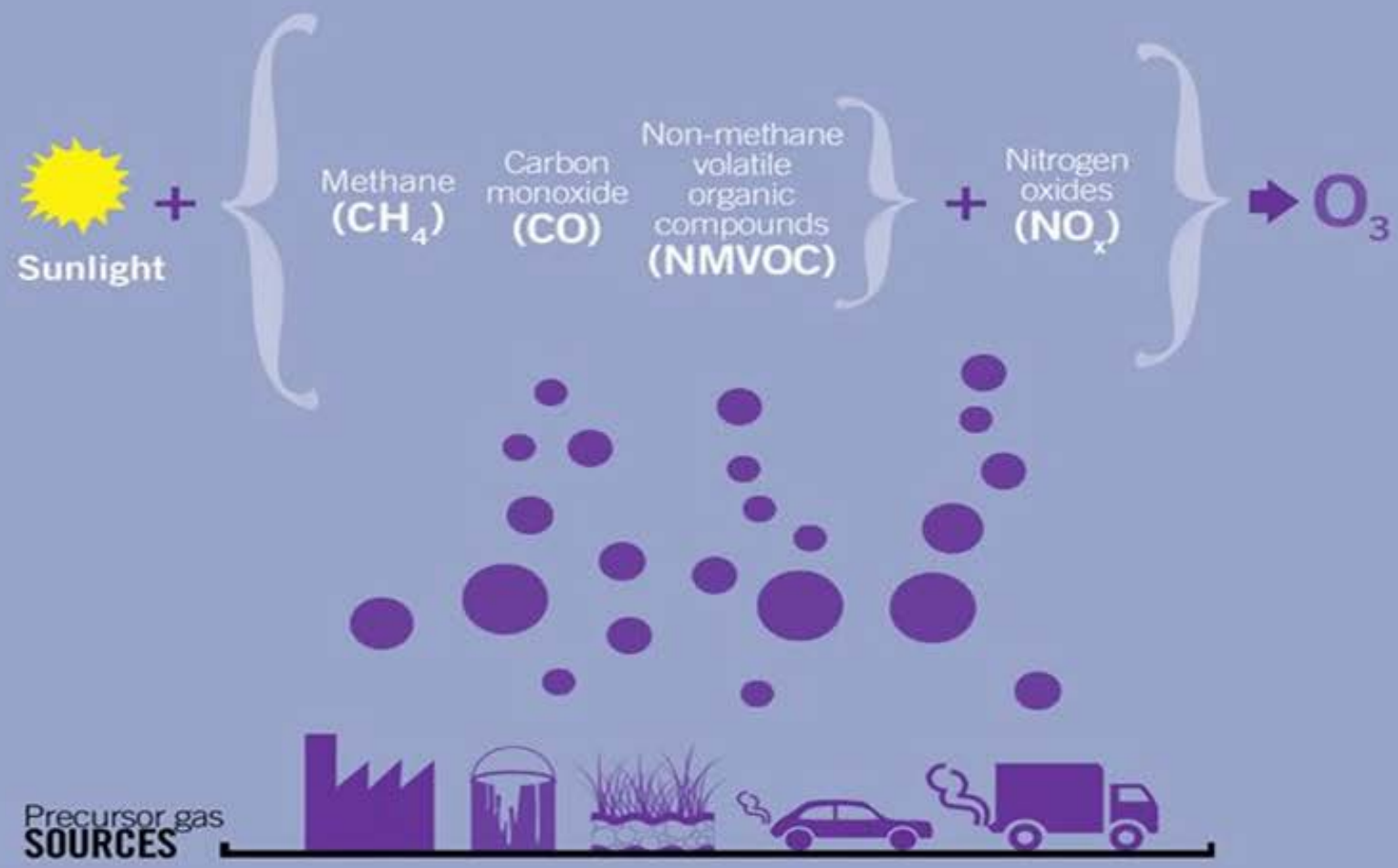
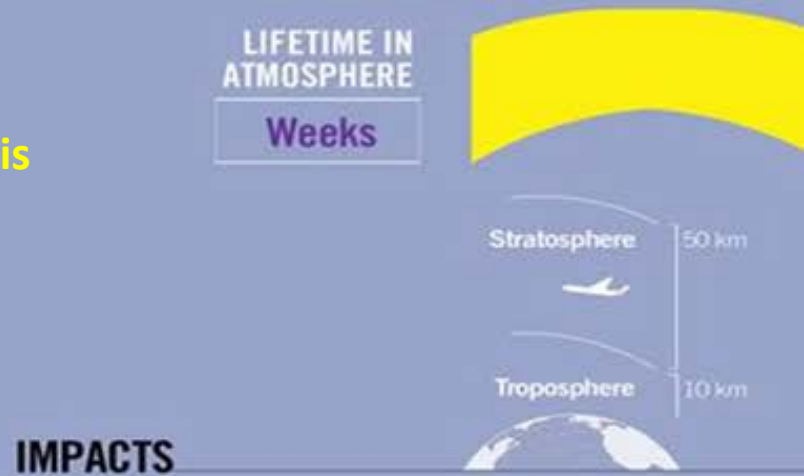
Tropospheric Ozone (O_3) – Why Important?

Tropospheric Ozone is a major air and climate pollutant. It causes warming and is highly reactive oxidant, harmful to crop production and human health





IMPACTS

O_3 precursors can be carried round the globe, making it a **transboundary pollution problem**

Tropospheric O_3 **warms the atmosphere**

O_3 damages plants and affects **agricultural production**:

- Reducing photosynthesis
- Reducing the plants ability to sequester carbon
- Reducing health and productivity of crops

O_3 air pollution causes over **150 thousand premature deaths** every year, and **millions more chronic diseases**, particularly in children and the elderly

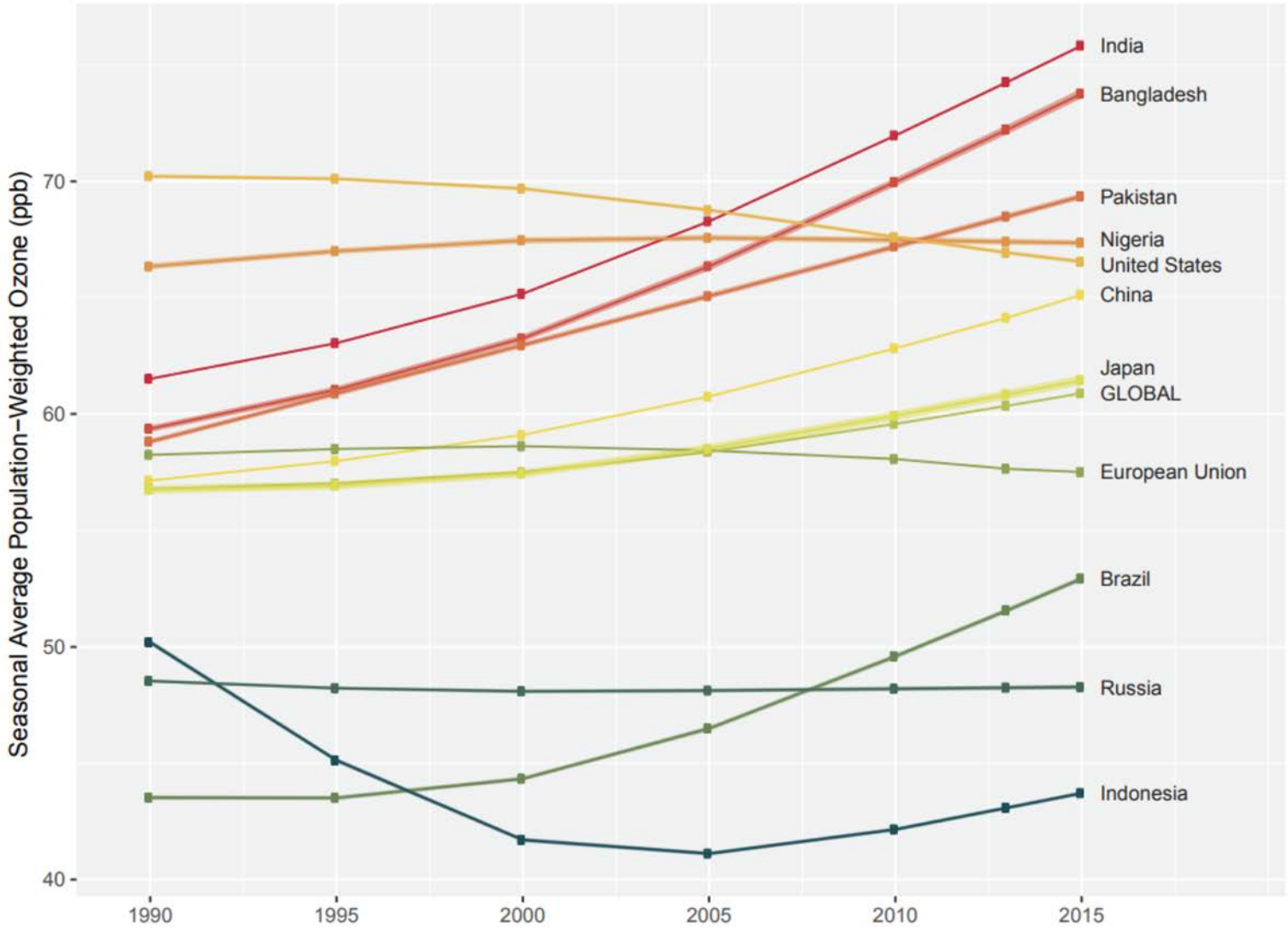
(Image source: CCAC)

Tropospheric Ozone over South Asia

Li et al 2019 (PNAS): Observed surface O_3 up 1-3 ppb/yr in E China

Ziemke et al 2018 (ACP): Satellite trop. O_3 shows big (~15-20% of background ozone) rises from near East to S/E Asia

Zhang et al 2016 (Nature Geosci): Modelled tropospheric O_3 burden up; mainly driven by emission increases from S/E Asia



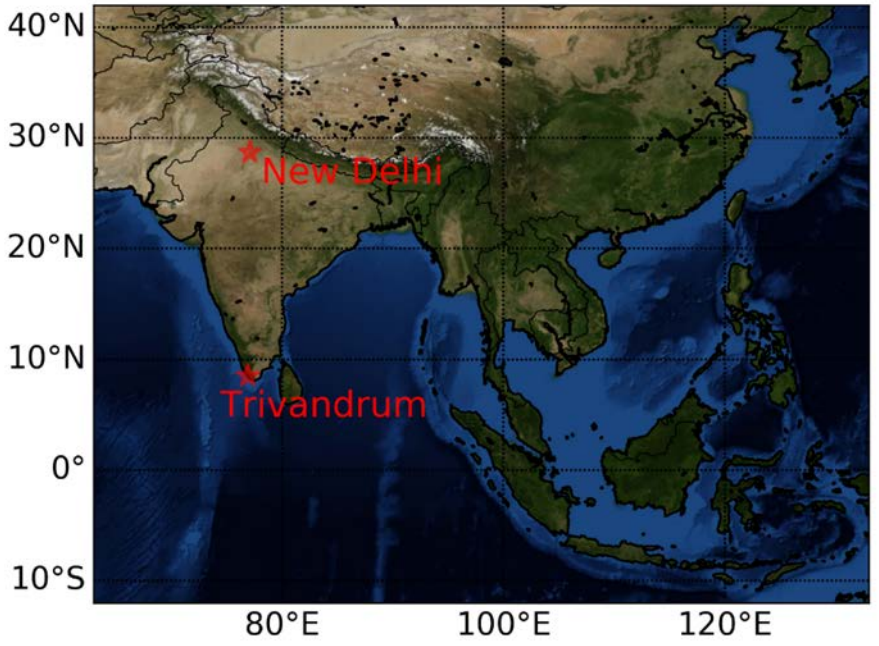
(SOGA Report 2017)

Methodology

Model: United Kingdom Chemistry and Aerosol (UKCA) v8.4

Nudged with ECMWF ERA-Interim Meteorological data

Time varying emissions



Observations:

Aircraft - In-service Aircraft for a Global Observing System (IAGOS)

Ozonesonde network data

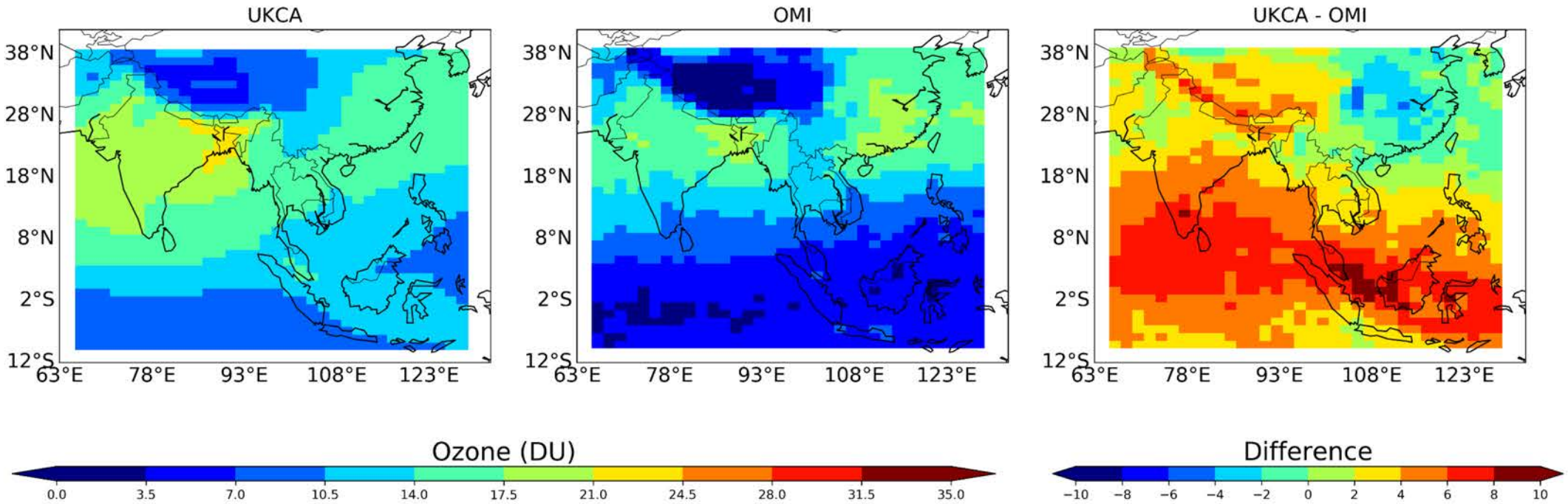
Satellite - OMI derived lower tropospheric (LT) ozone data (sufrace – 450 hPa)

Approximation/bias in UKCA and OMI O_3 comparison

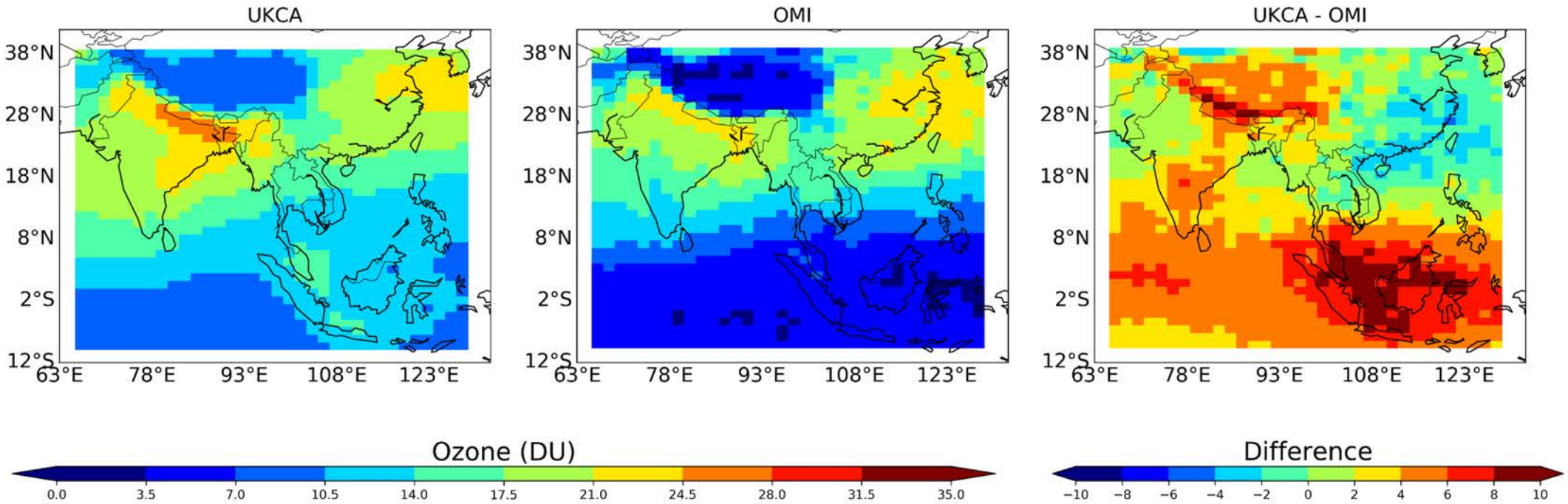
OMI derived LT ozone data used in this work are monthly and have bias due to averaging kernels!

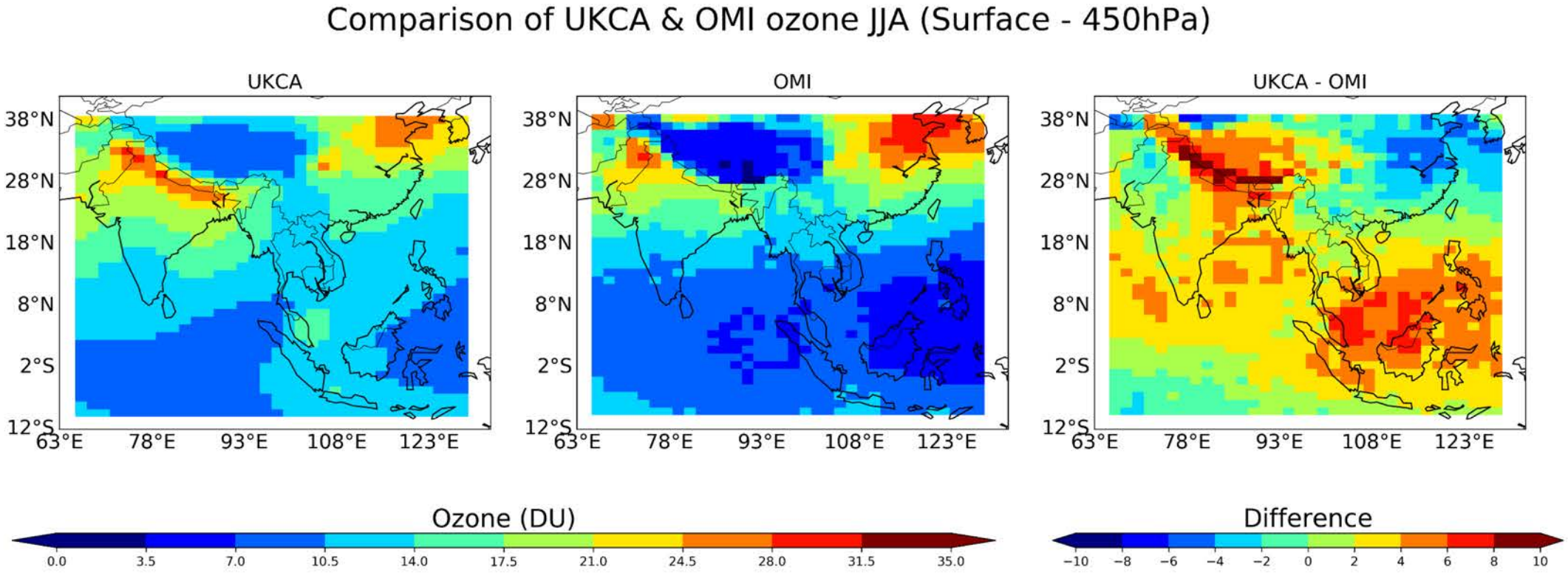
A more robust comparison is going on using applications of individual satellite averaging kernel on UKCA model data processing

Comparison of UKCA & OMI ozone DJF (Surface - 450hPa)

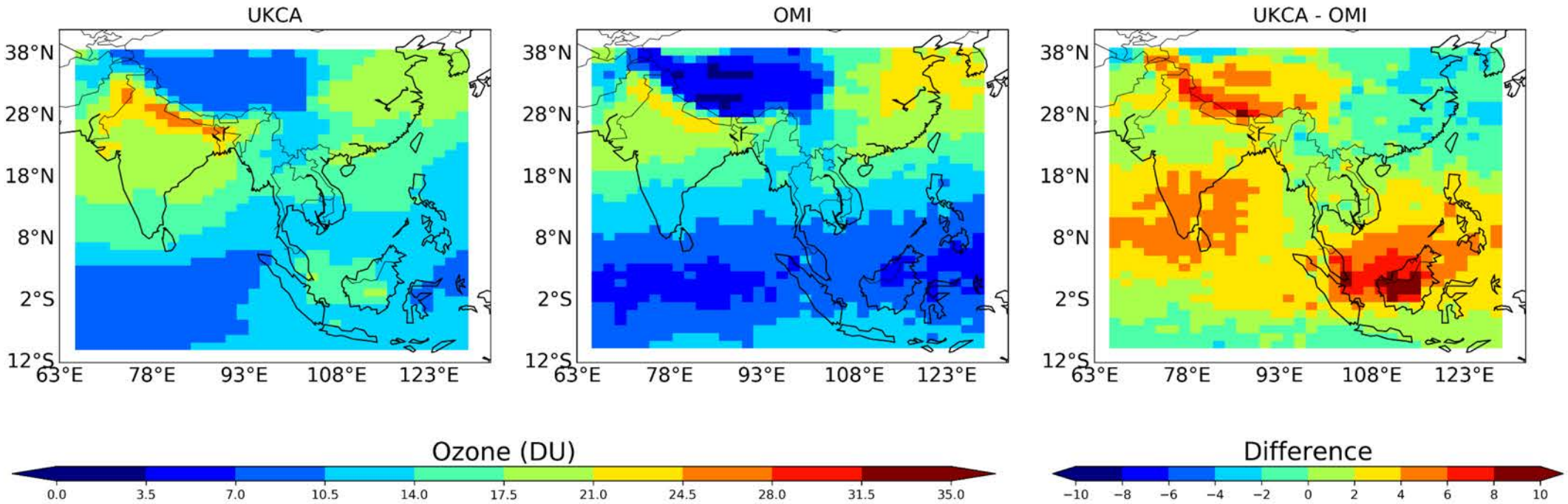


Comparison of UKCA & OMI ozone MAM (Surface - 450hPa)

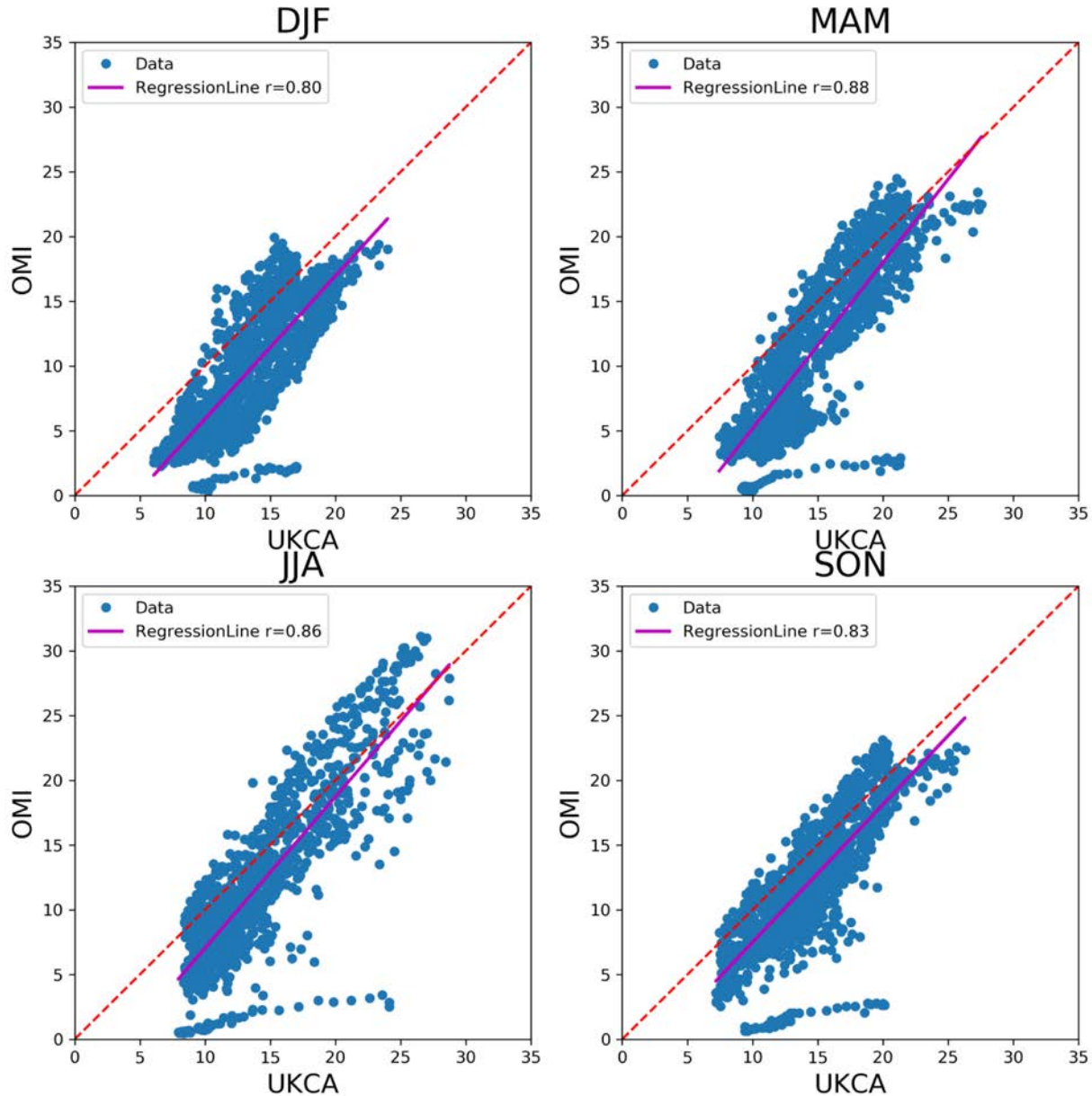



Comparison of UKCA & OMI ozone JJA (Surface - 450hPa)
UKCA
OMI
UKCA - OMI
38°N
28°N
18°N
8°N
2°S
12°S
63°E
78°E
93°E
108°E
123°E
Ozone (DU)
0.0
3.5
7.0
10.5
14.0
17.5
21.0
24.5
28.0
31.5
35.0
Difference
−10
−8
−6
−4
−2
0
2
4
6
8
10

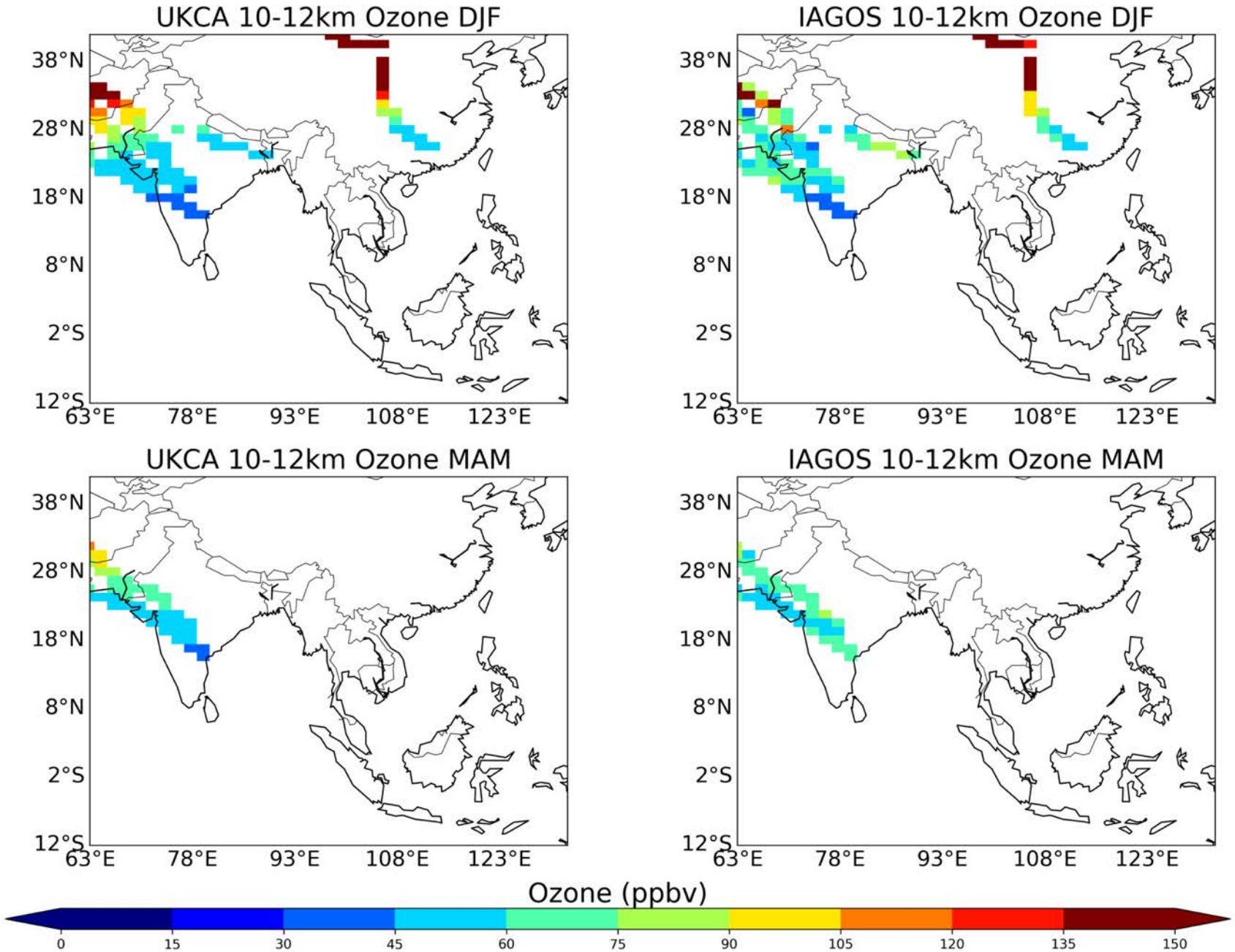
Comparison of UKCA & OMI ozone SON (Surface - 450hPa)



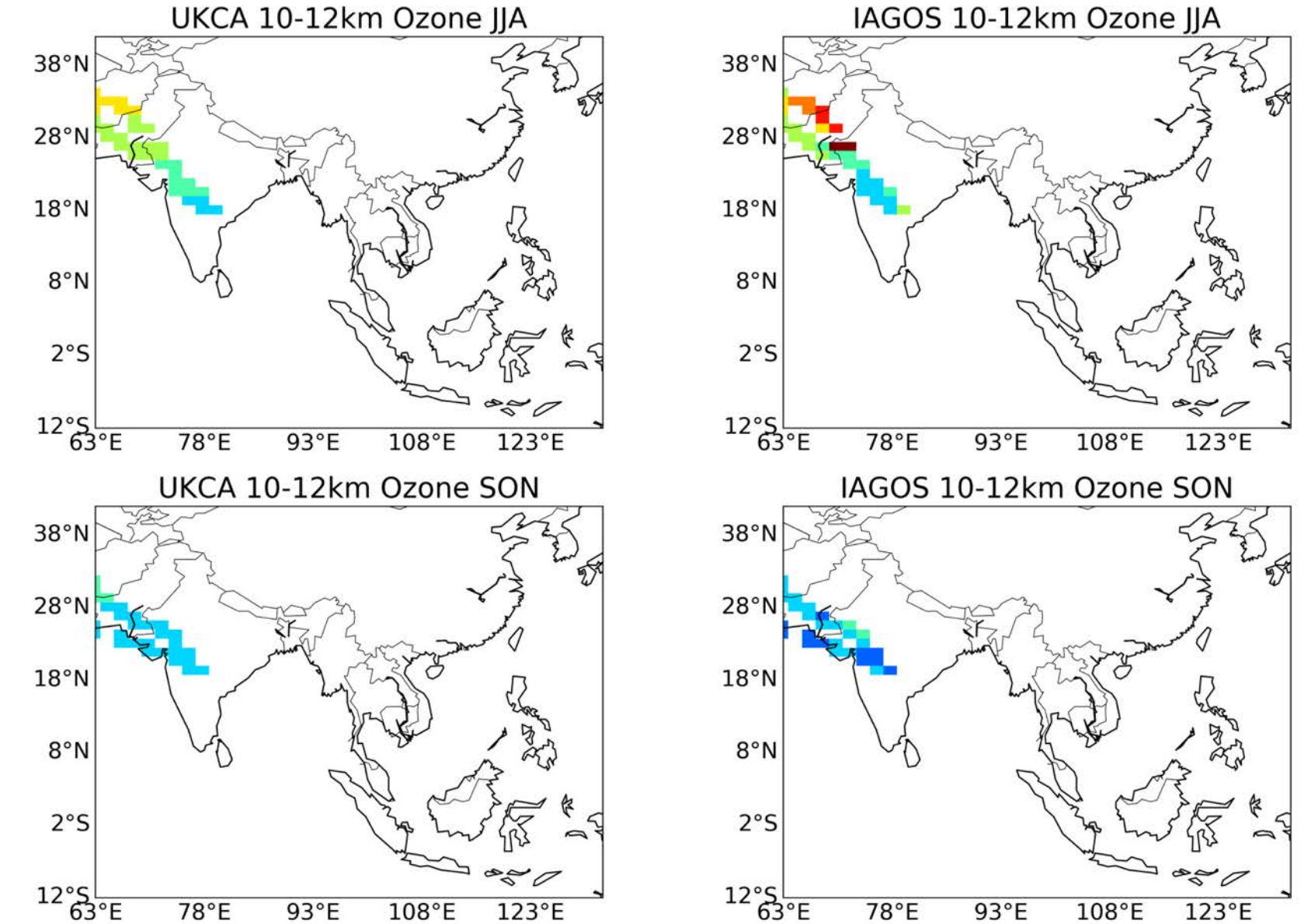
Scatter plots of UKCA and OMI



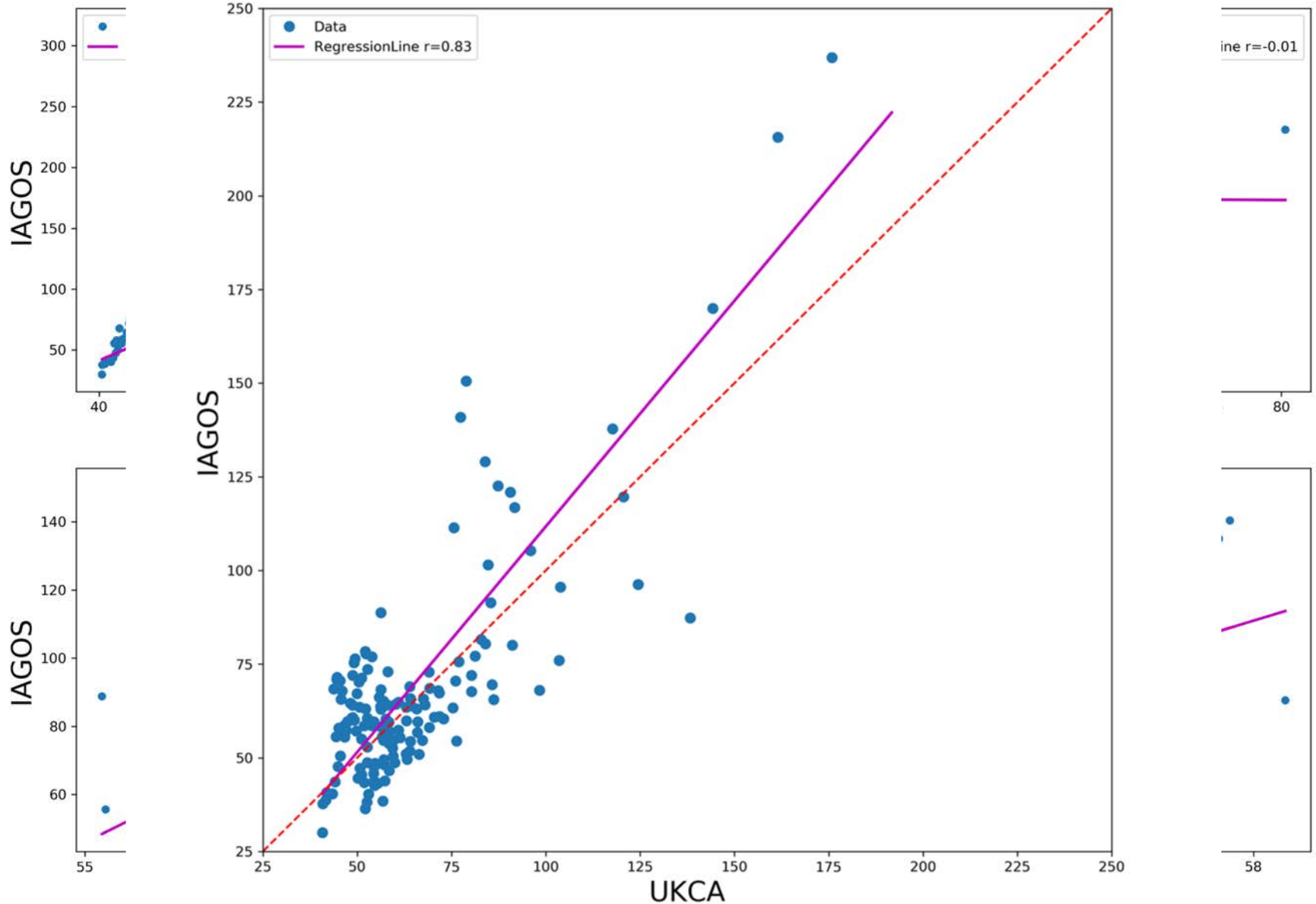
Comparison of UKCA and IAGOS 10-12km Ozone



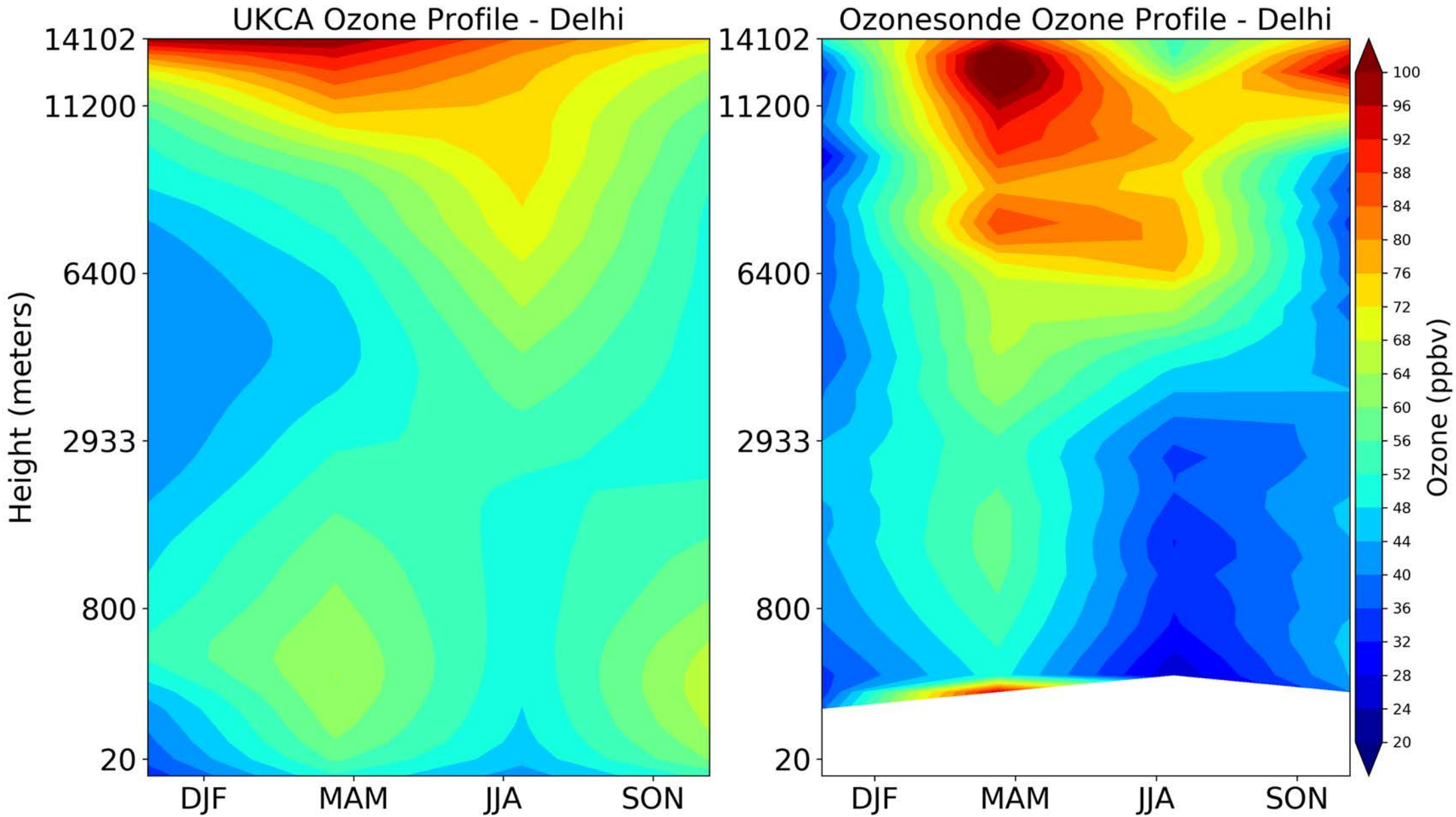
Comparison of UKCA and IAGOS 10-12km Ozone



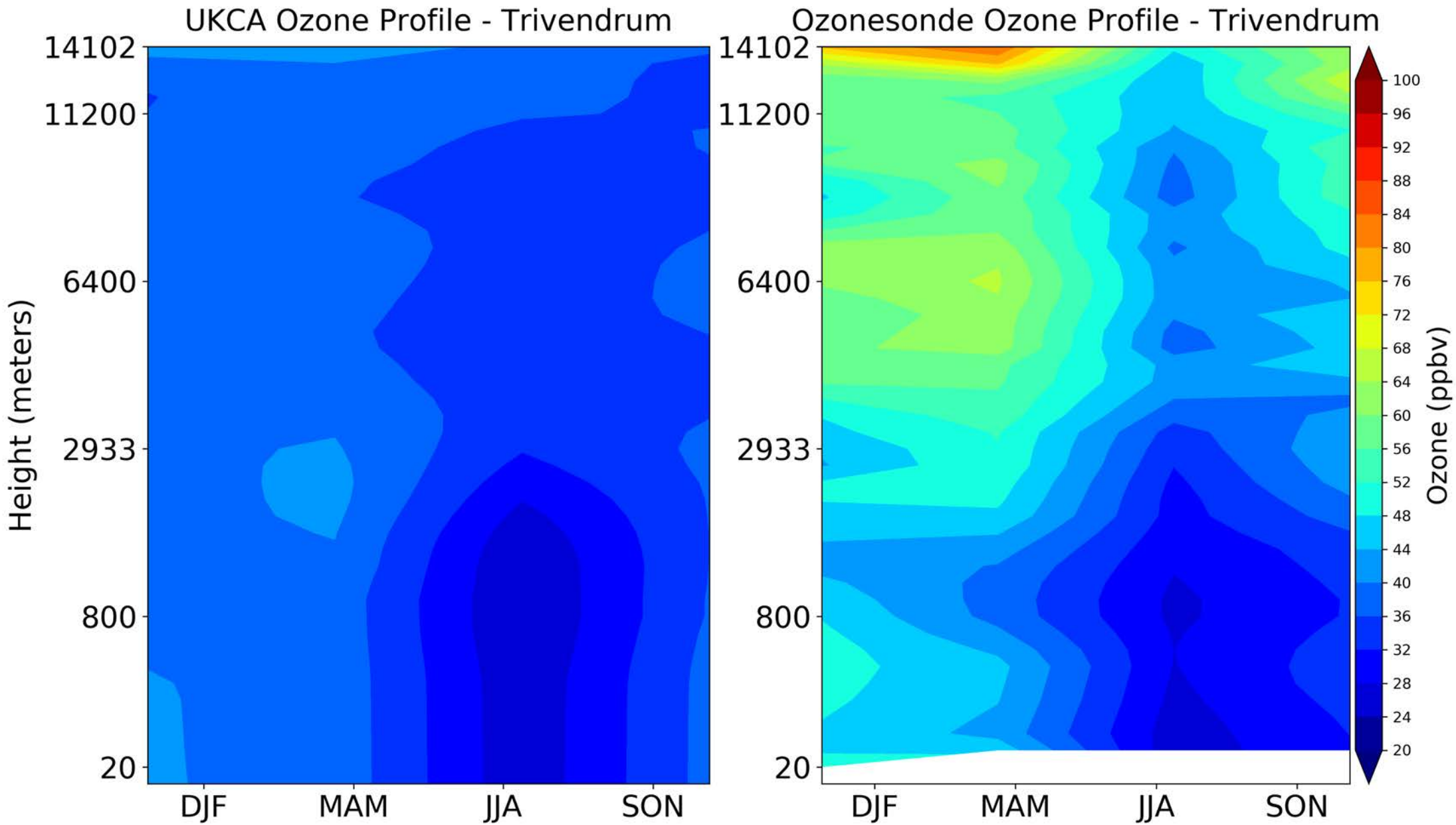
Scatter plots of UKCA and IAGOS



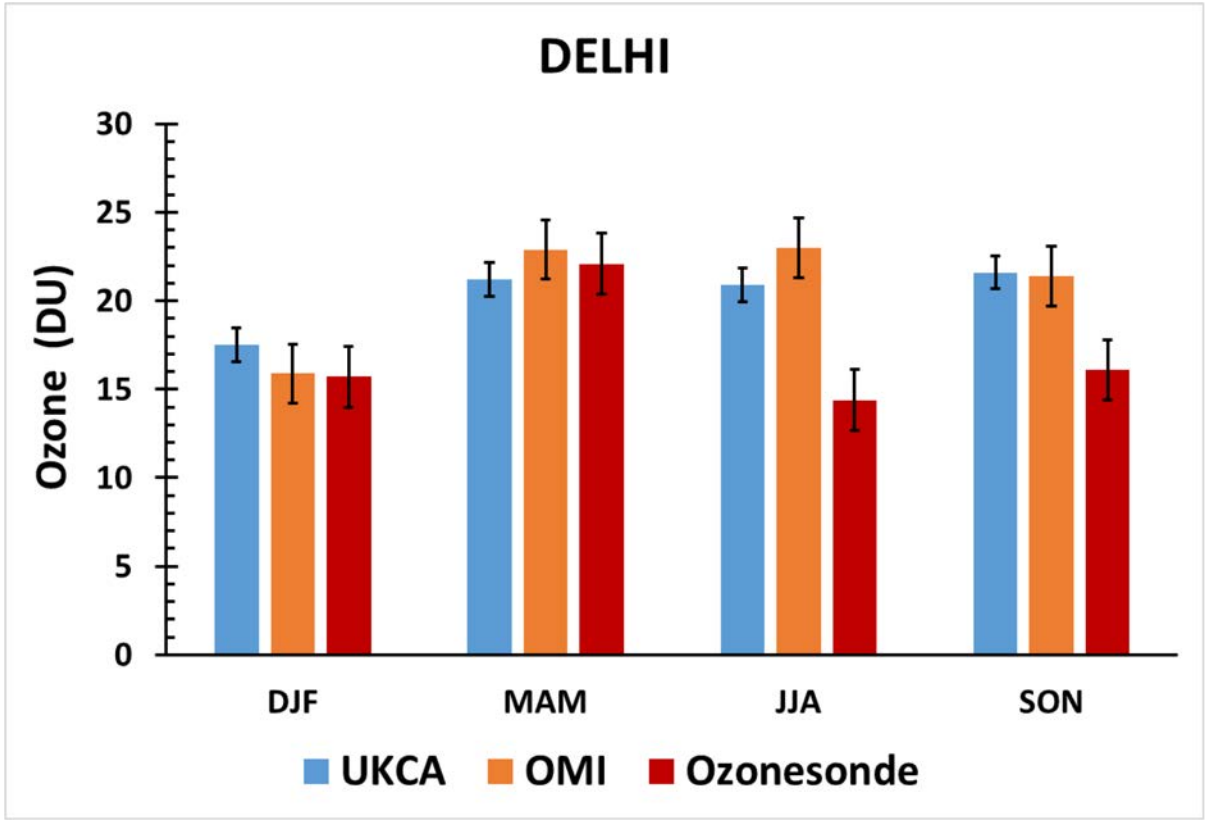
UKCA and Ozonesonde Vertical Profile Comparison

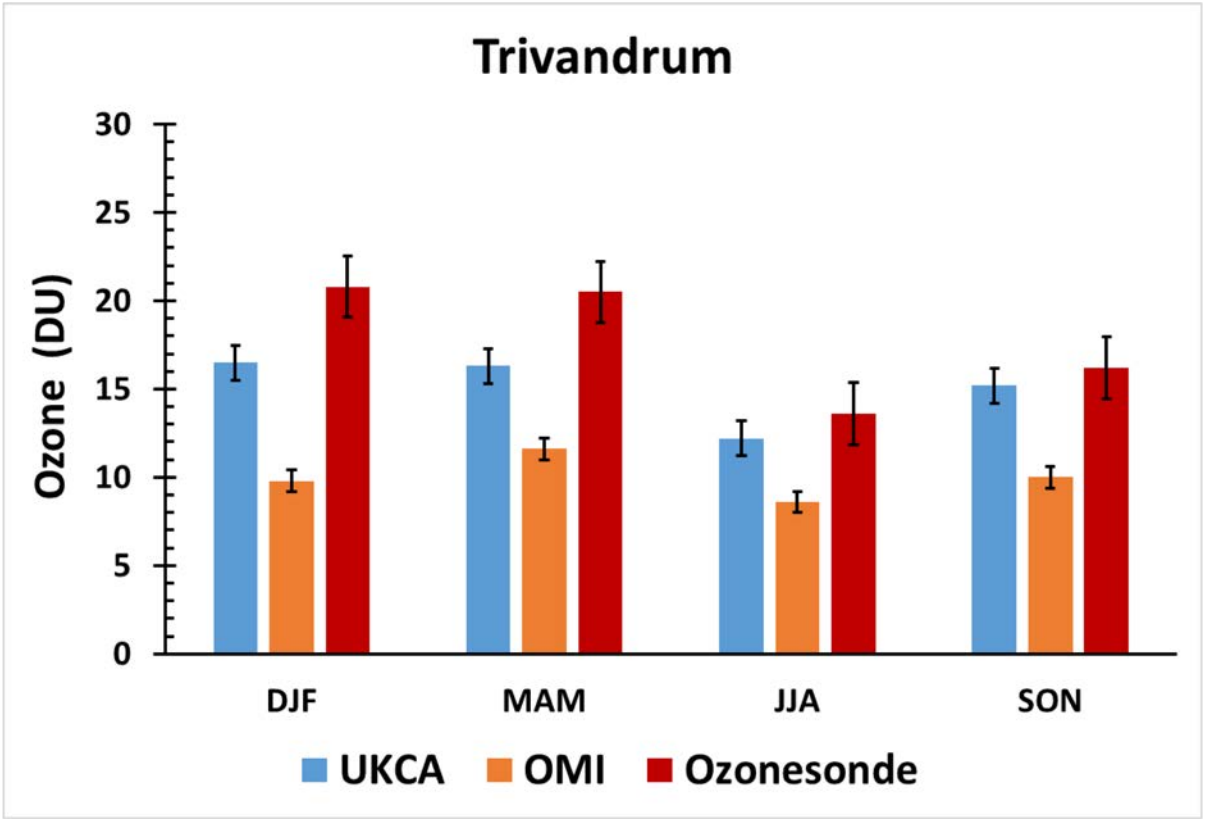


UKCA and Ozonesonde Vertical Profile Comparison



Inter comparison of UKCA, OMI and Ozonesonde Ozone over Delhi and Trivandrum for four seasons in 2009 (in DU)





Summary

We evaluate UKCA v8.4 simulation with ozone observations from (a) the OMI satellite instrument, (b) the IAGOS datasets and (c) Ozonesonde over South Asia. The major conclusions are:

- ❖ UKCA v8.4 shows an effective simulation of lower tropospheric (LT) ozone and seasonal variation over South Asia.
- ❖ UKCA is picking the right higher ozone at the LT MAM at Delhi and lower ozone in monsoon months at Delhi as well as Trivandrum.
- ❖ Lower troposphere UKCA, OMI and Ozonesonde ozone column is comparable in DJF & MAM over Delhi whereas during JJA & SON UKCA and OMI are comparable but far away from the Ozonesonde observations.

- The study will be extended for more time period and other air pollutants will be also incorporated; a newer UKCA model version (v11.0) will be used.
- Like to incorporate quality control observational data. If any one have any lead, please notify. Happy to collaborate!

Thank You!