Validation of satellite observations for monitoring long-term changes in air quality in cities

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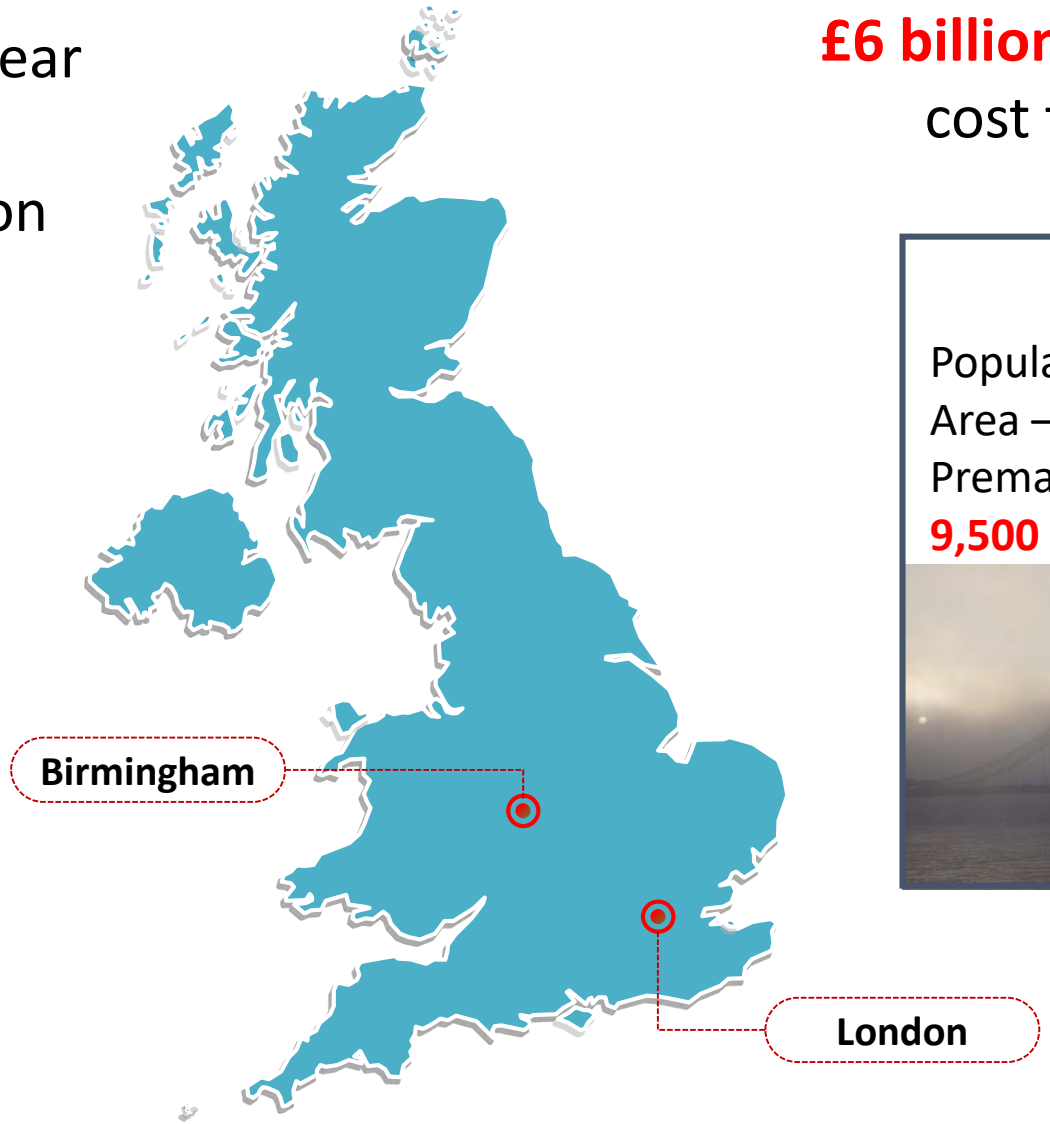
NCAS Air Quality Symposium (13th-14th Nov'18)

Courtesy – Library of Birmingham

TARGET CITIES & POLLUTANTS IN UNITED KINGDOM

40,000 early deaths each year in UK attributed to ***fine particles*** and ***NO_2*** pollution

£6 billion -Associated health cost to UK each year

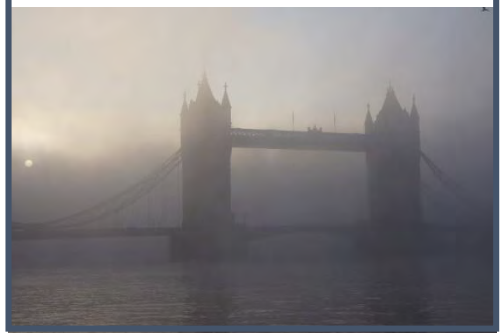


Birmingham

Population[A] – 1.13 Mn
Area – 268 km^2
Premature deaths[B] - **900**

London

Population[A] – 8.82 Mn
Area – 1572 km^2
Premature deaths[B] – **9,500**



[A] Population for mid 2017; Source Office for National Statistics
[B] Figures by Royal College of Physicians and King's College London

LONG-TERM RECORD OF NO_2 FROM OZONE MONITORING INSTRUMENT (OMI)

OMI/Aura NO_2 Cloud-Screened Total and Tropospheric Column L3 Global Gridded 0.25 degree x 0.25 degree V3

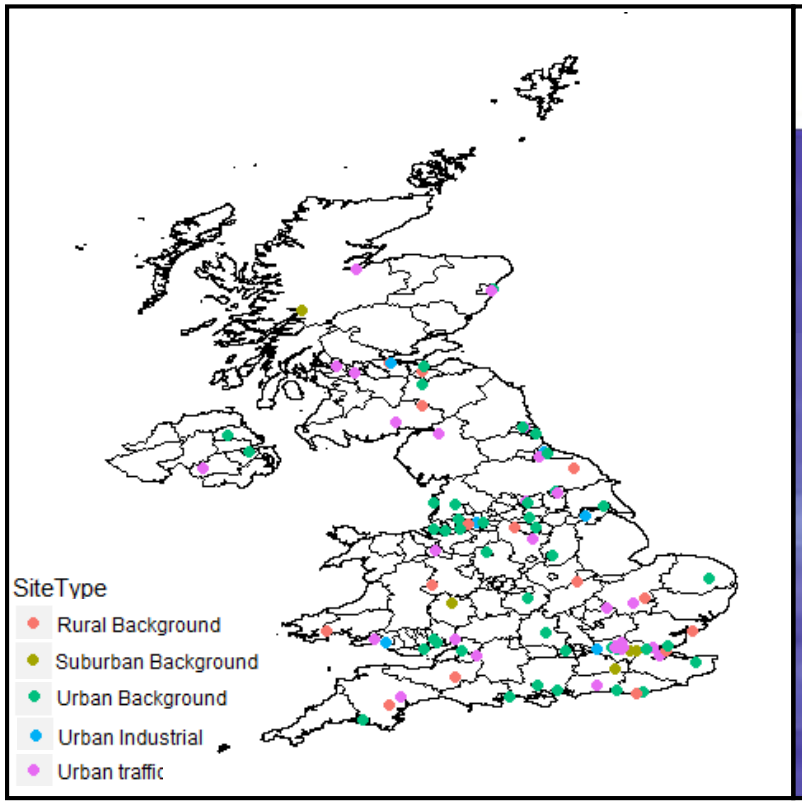
Temporal coverage: 2004-10-01 - Present

Satellite overpass time: 1345 LT

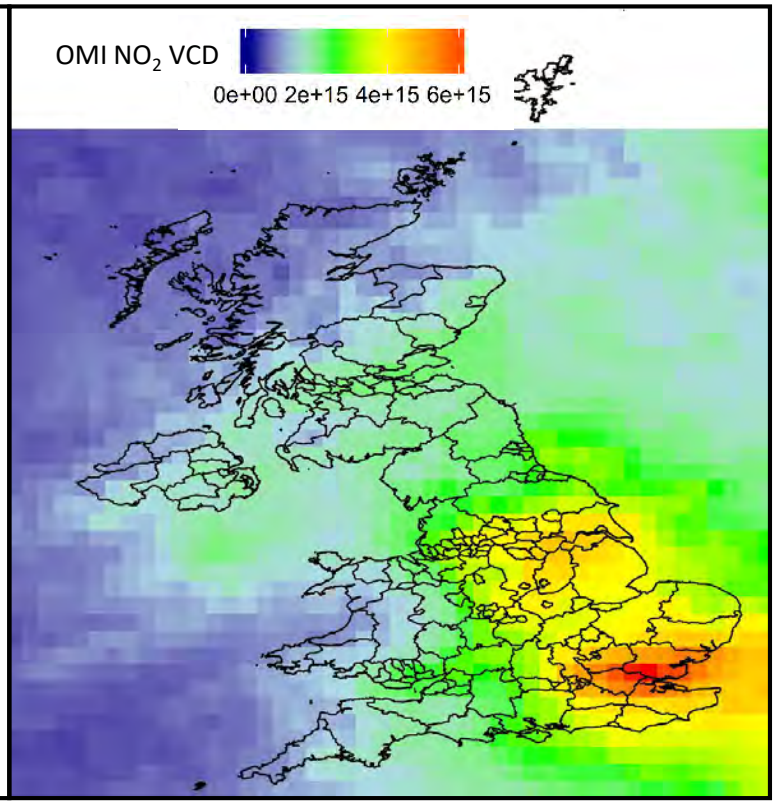
Nadir-viewing
UV/Visible
270-500nm

Retrieval of NO_2
1) Concentration along the viewing path (SCD)
2) Use AMF to compute the vertical column (VCD)

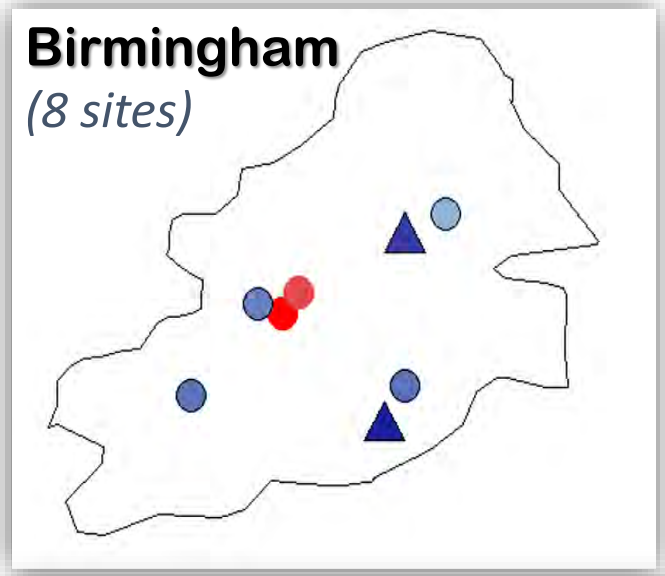
DEFRA NO_2 coverage (2017)



Mean OMI NO_2 (2017)

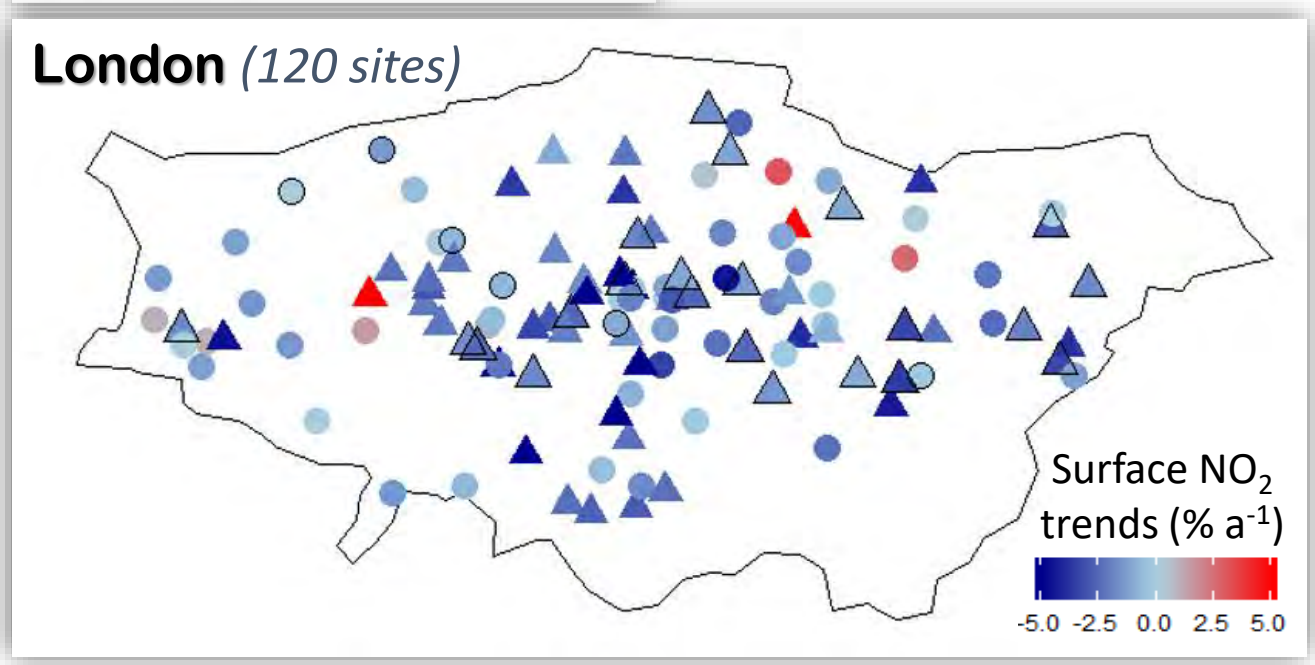


SURFACE MONITORING OF NO_2 IN BIRMINGHAM AND LONDON



Sparse and periodic network

Sites with temporal overlap and consistent month-to-month variability are outlined



Dense but periodic network

Trends and locations of NO_2 monitoring sites in Birmingham and London

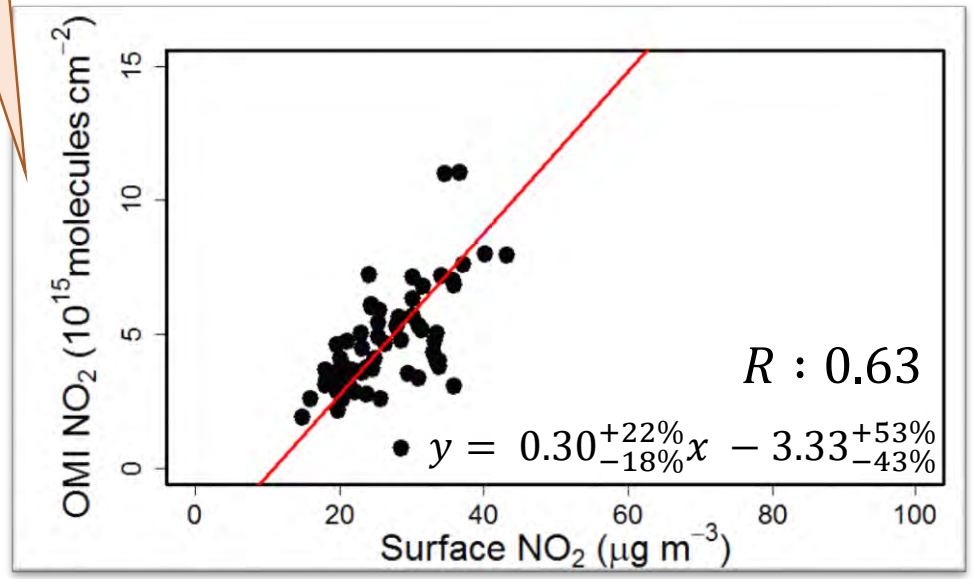
Data sources

- ❑ Department of Environment Food & Rural Affairs(DEFRA)
- ❑ Birmingham City Council (BCC)
- ❑ London Air Quality Network (LAQN)

VALIDATION OF SATELLITE OBSERVATIONS

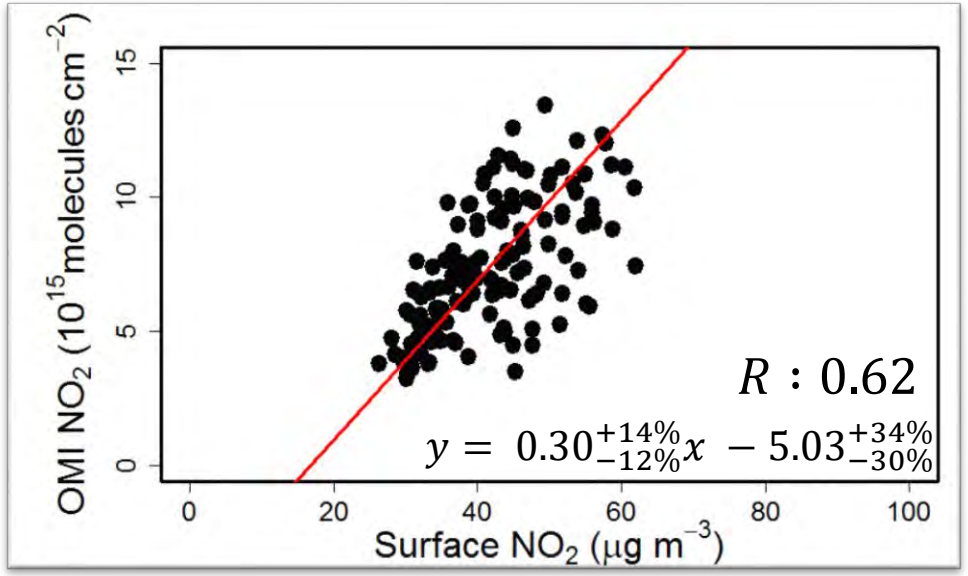
Area-weighted mean

Satellite vs Surface NO_2 (Birmingham)



(March 2011 – September 2016)

Satellite vs Surface NO_2 (London)



(January 2005 – April 2018)

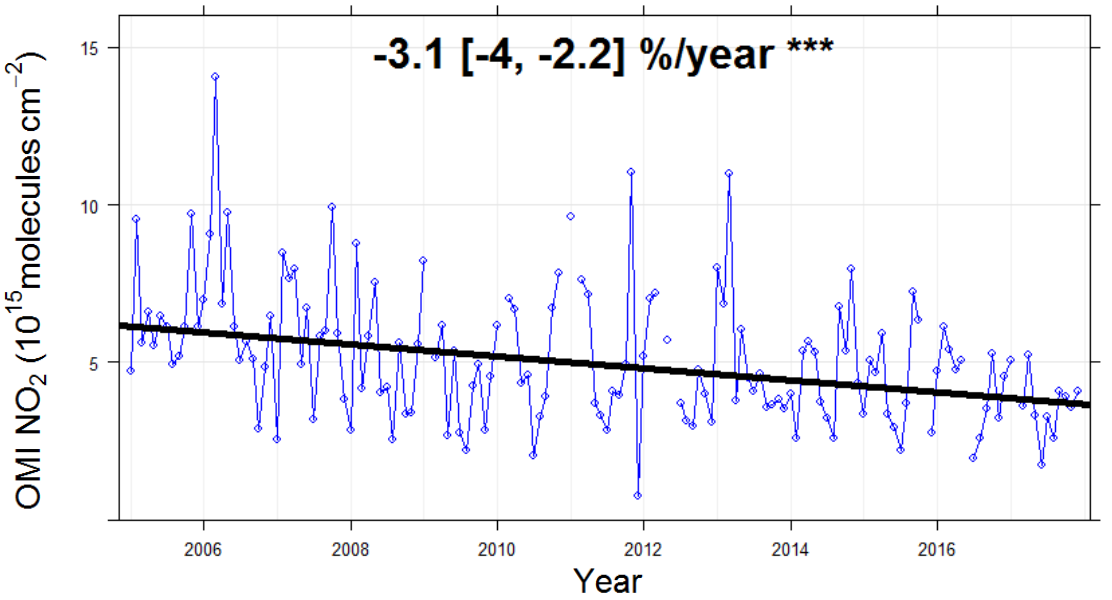
Mean concentration of spatially correlated sites

- Long-term record of OMI NO_2 can be used to monitor long-term changes in city-wide NO_2

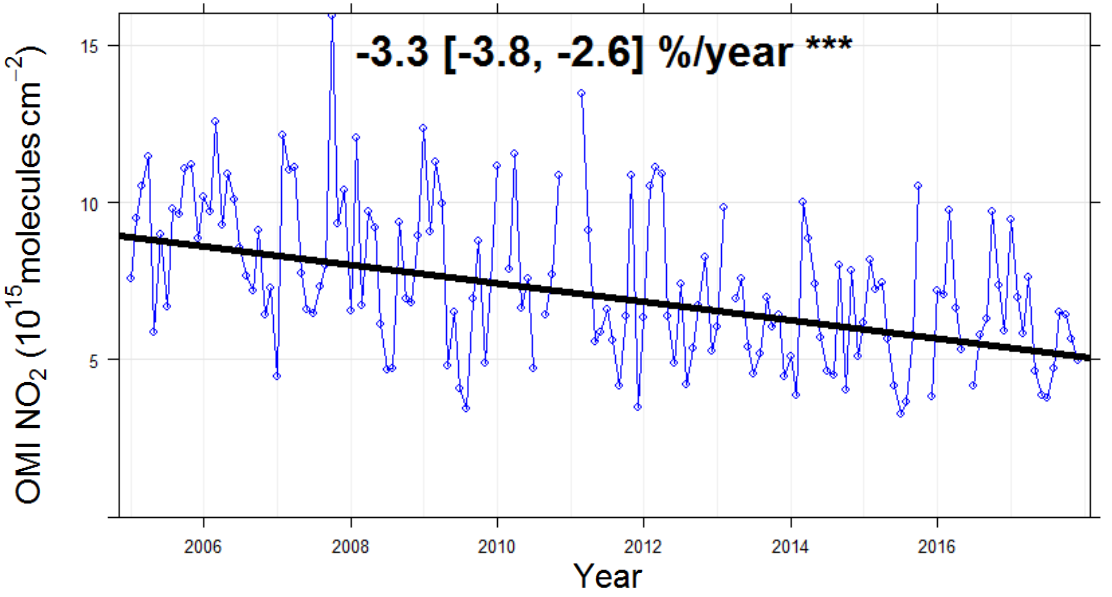
LONG-TERM TRENDS IN CITY-WIDE MONTHLY MEAN OMI NO_2

- Significant decline in OMI NO_2 (and precursor NO_x emissions)
- Trends in OMI NO_2 for London (**3.3 %/year**) are steeper than trends in surface NO_2 for London (**1.8 %/year**)

OMI NO_2 trends for Birmingham (2005-2017)



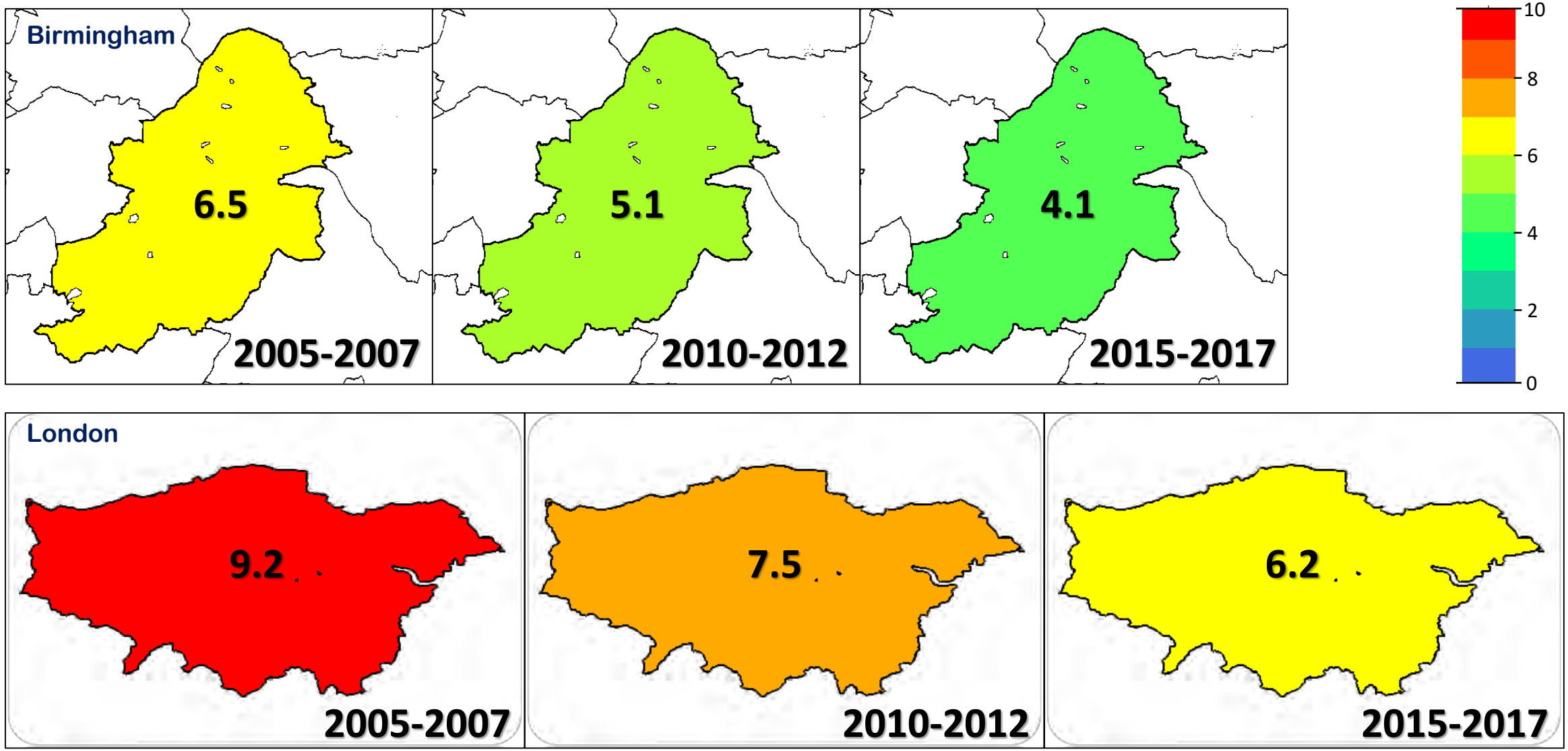
OMI NO_2 trends for London (2005-2017)



MULT-YEAR MEANS OF OMI NO_2 VCD IN BIRMINGHAM AND LONDON

- OMI NO_2 decreased by **40%** for Birmingham and by **43%** for London (2005-2017)

Colour legend (OMI NO_2) (x 10^{15} molecules cm^{-2})



CONCLUSION

- Consistent satellite and ground-based NO_2 give us confidence to apply satellite observations to monitor air quality in Birmingham and London
- OMI NO_2 declined by 40% in Birmingham and 43% in London from 2005 to 2017

NEXT STEPS

- Apply the same approach to **New Delhi** and **Kanpur**
- Interpret **NO_x emission** trends with a model
- Apply the same approach to other pollutants:

  SO_2, formaldehyde, ammonia

- Validate Defra air quality monitoring tools