

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

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UNIVERSITY OF
BIRMINGHAM



defra

Department for Environment
Food and Rural Affairs



Birmingham City Council



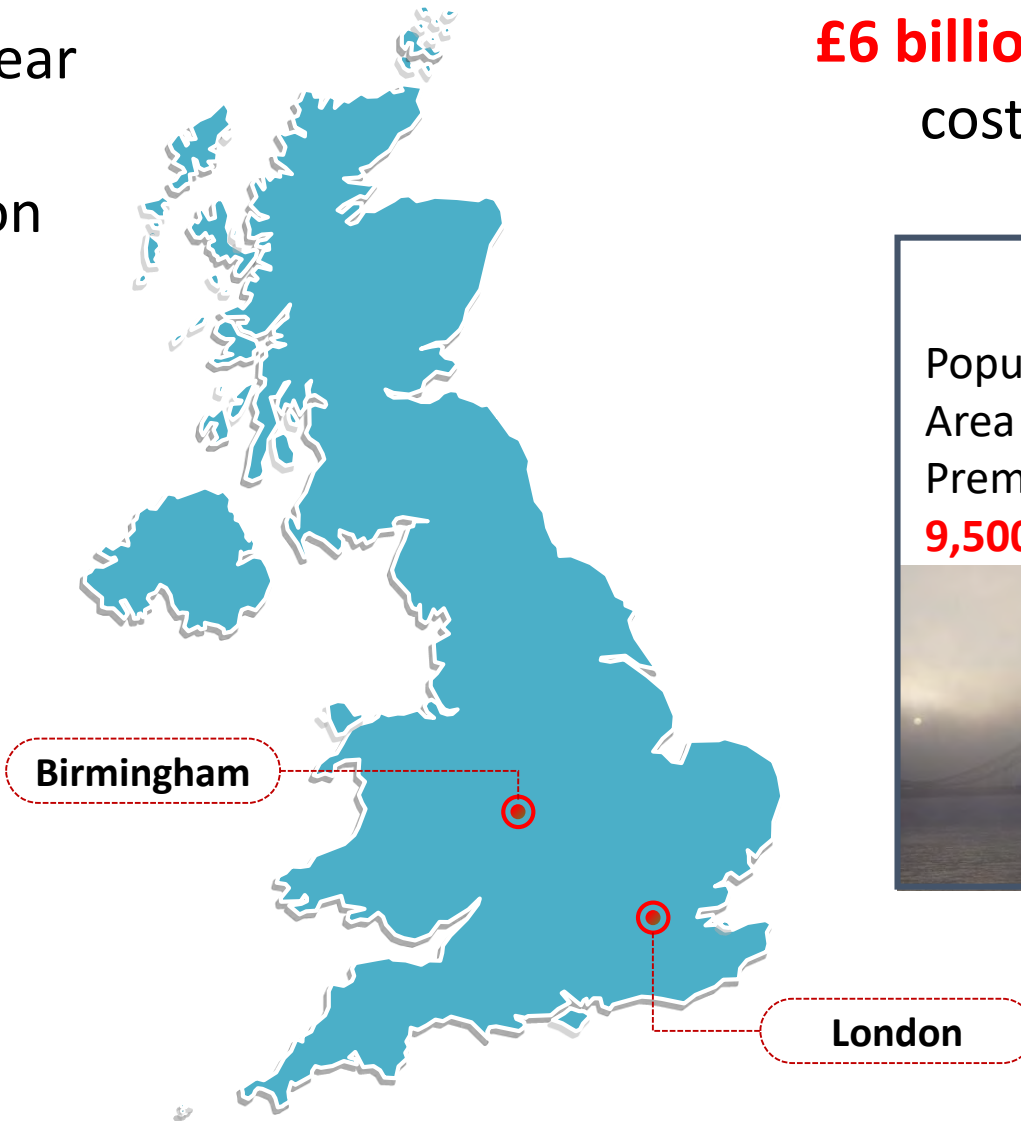
London Air

TARGET CITIES & POLLUTANTS IN UNITED KINGDOM

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

Birmingham

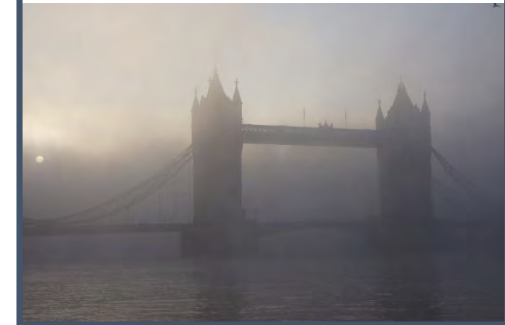
Population^A – 1.13 Mn
Area – 268 km²
Premature deaths^B - **900**



£6 billion -Associated health
cost to UK each year

London

Population^A – 8.82 Mn
Area – 1572 km²
Premature deaths^B –
9,500



London

^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 NO₂ FROM OZONE MONITORING INSTRUMENT (OMI)

OMI/Aura NO₂ Cloud-Screened Total and Tropospheric Column L3 Global Gridded 0.25 degree x 0.25 degree V3

*Temporal coverage:
2004-10-01 - Present*

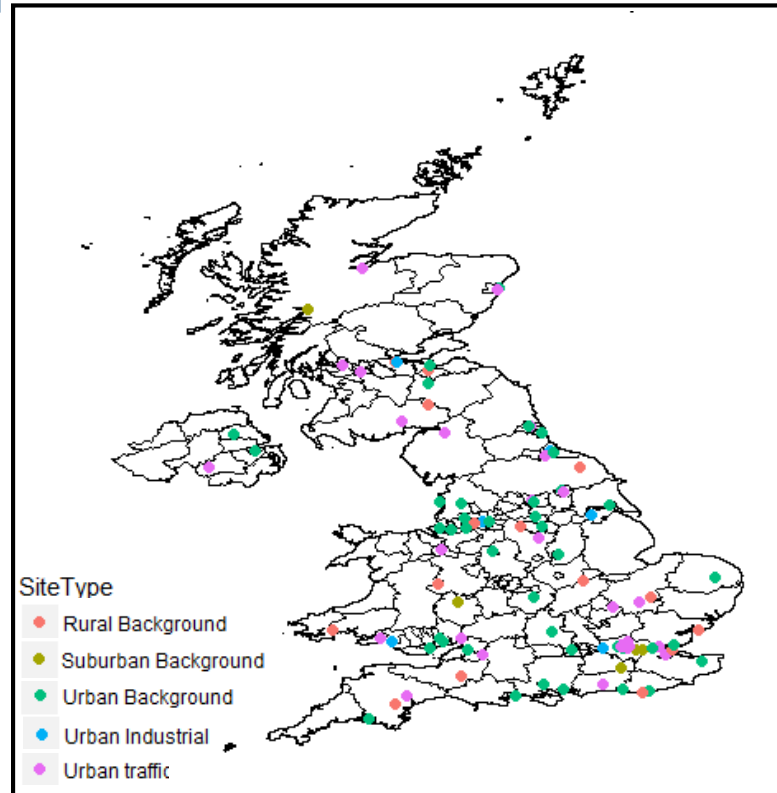
*Satellite overpass
time: 1345 LT*

Nadir-viewing
UV/Visible
270-500nm

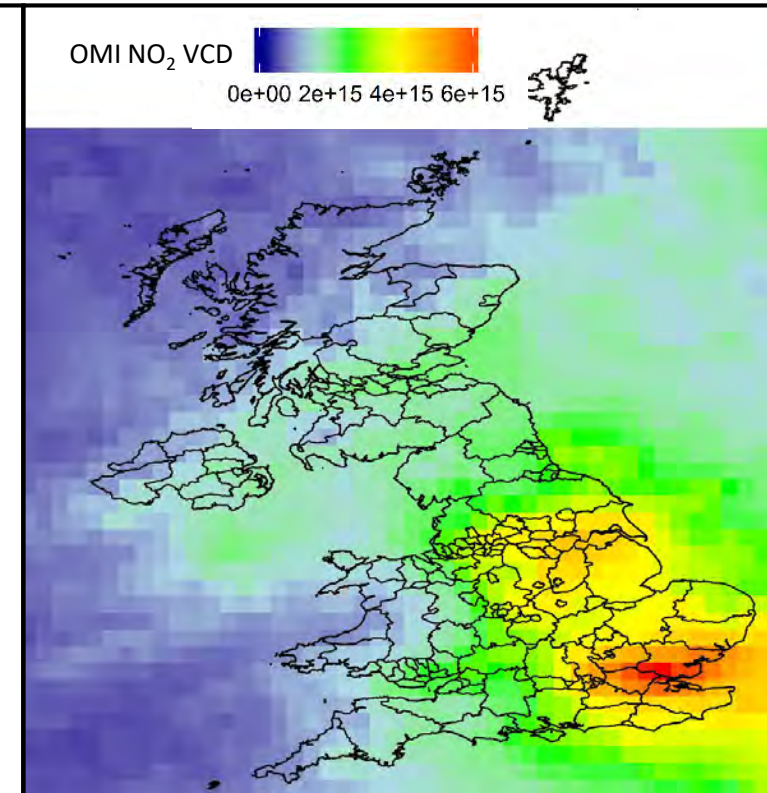
Retrieval of NO₂

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

DEFRA NO₂ coverage (2017)

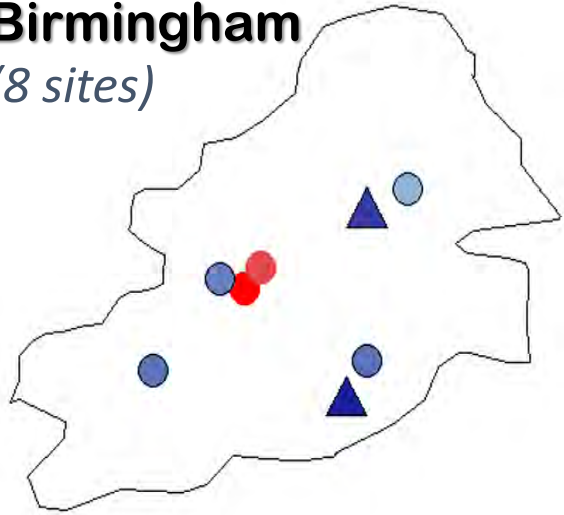


Mean OMI NO₂ (2017)



SURFACE MONITORING OF NO₂ IN BIRMINGHAM AND LONDON

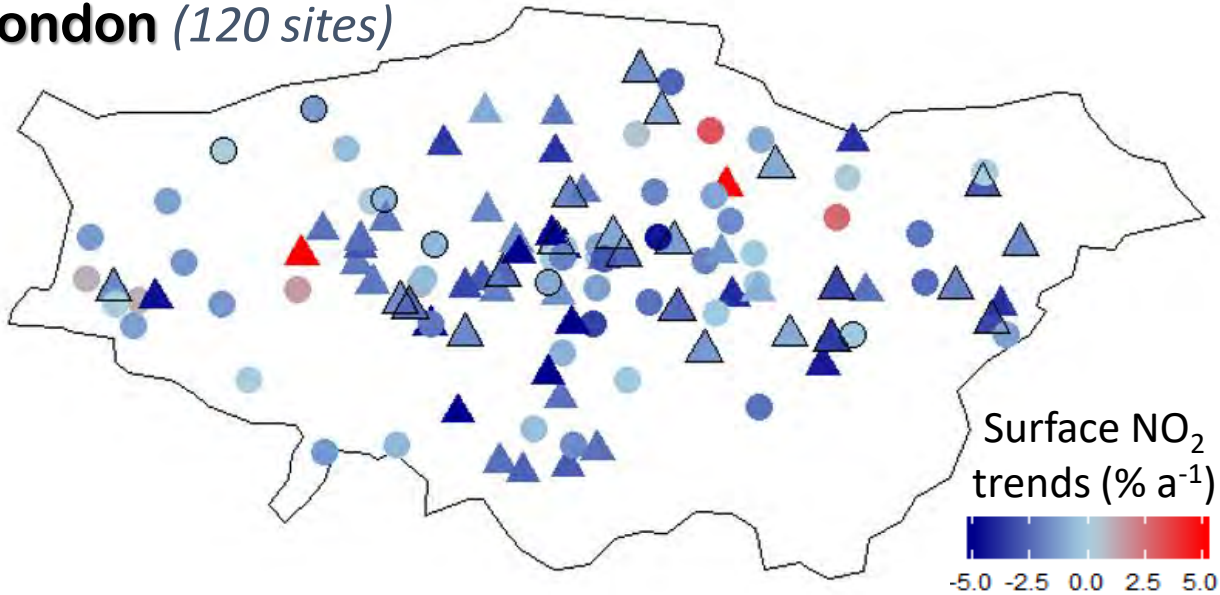
Birmingham
(8 sites)



*Sparse and
periodic
network*

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

London (120 sites)



*Dense but
periodic
network*

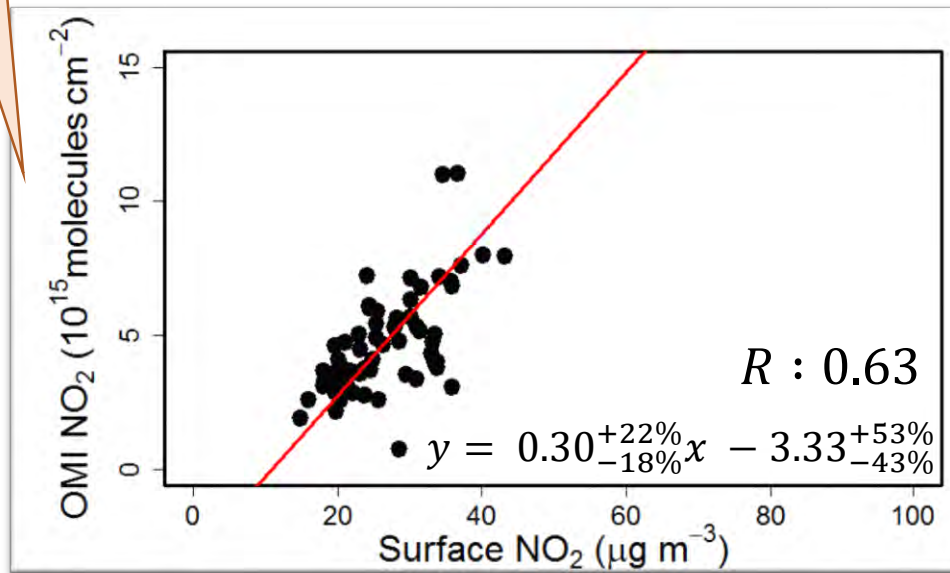
Data sources

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

VALIDATION OF SATELLITE OBSERVATIONS

Area-weighted
mean

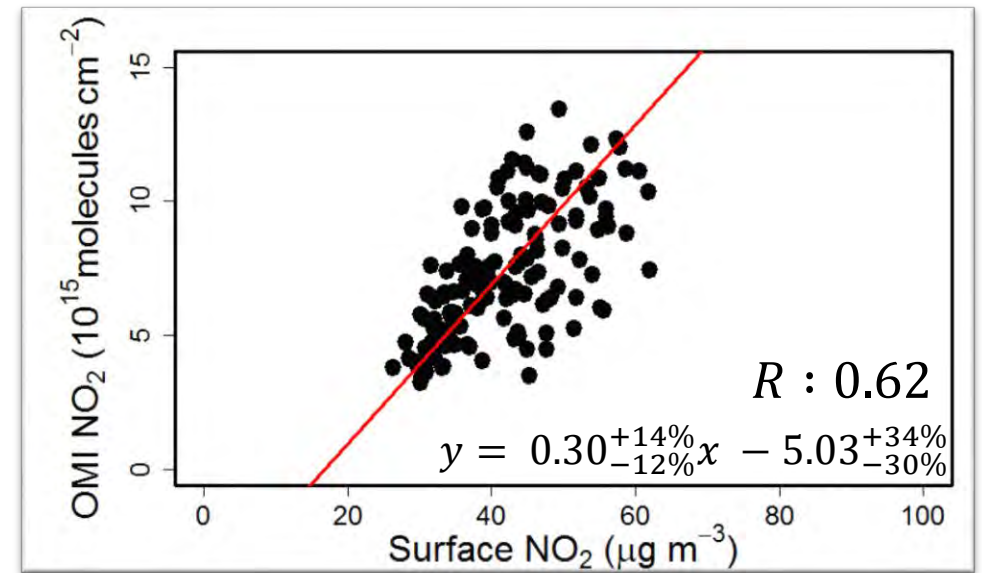
Satellite vs Surface NO₂ (Birmingham)



(March 2011 – September 2016)

Mean concentration of
spatially correlated sites

Satellite vs Surface NO₂ (London)



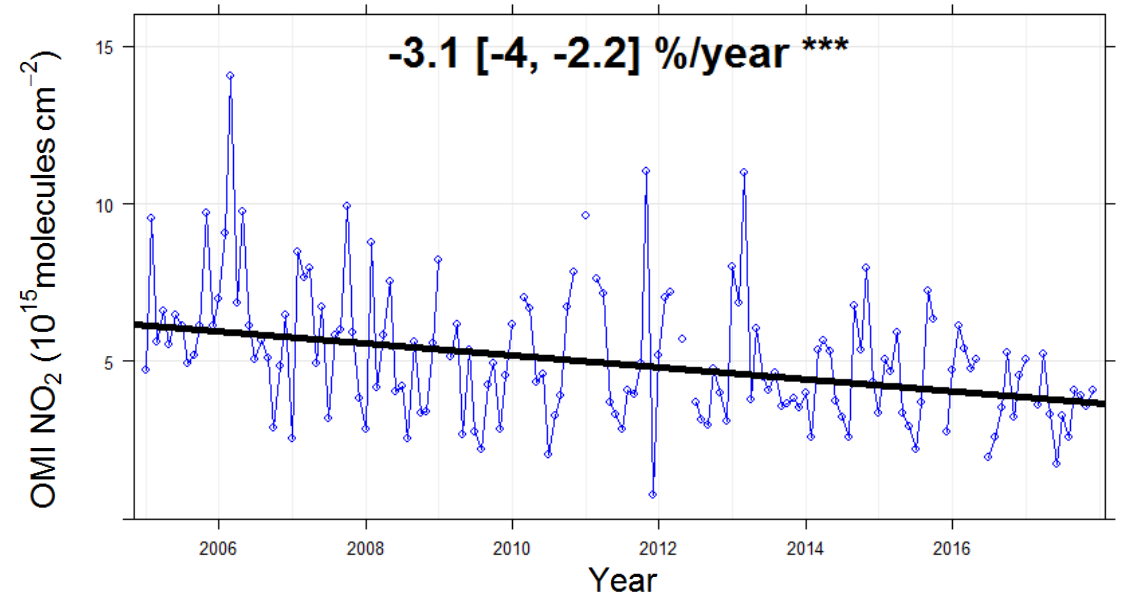
(January 2005 – April 2018)

- Long-term record of OMI NO₂ can be used to monitor long-term changes in city-wide NO₂

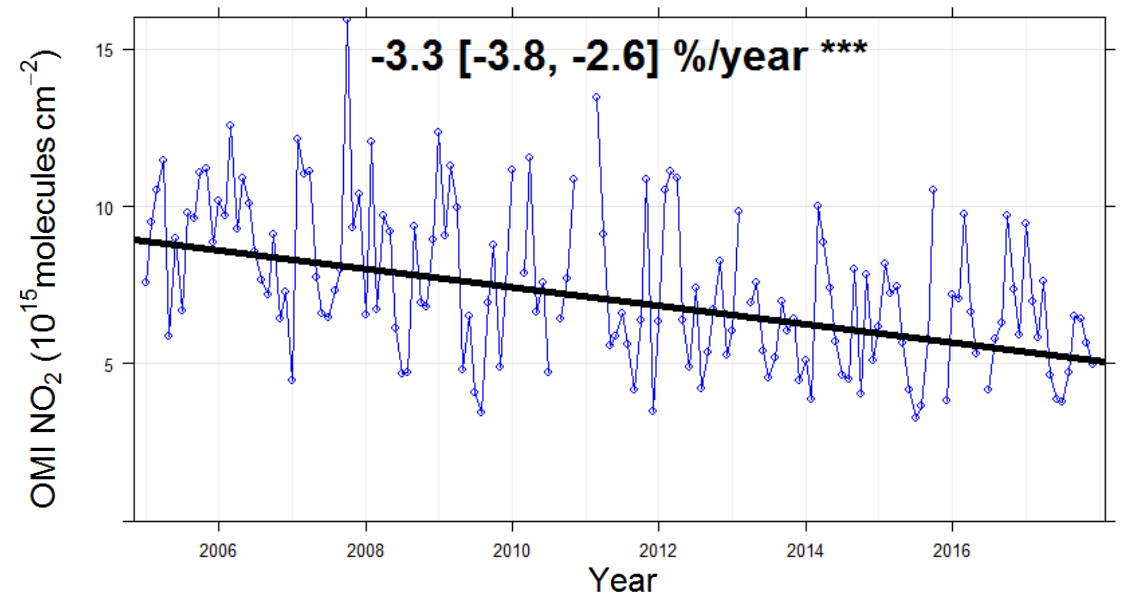
LONG-TERM TRENDS IN CITY-WIDE MONTHLY MEAN OMI NO₂

- Significant decline in OMI NO₂ (and precursor NO_x emissions)
- Trends in OMI NO₂ for London (**3.3 %/year**) are steeper than trends in surface NO₂ for London (**1.8 %/year**)

OMI NO₂ trends for Birmingham (2005-2017)



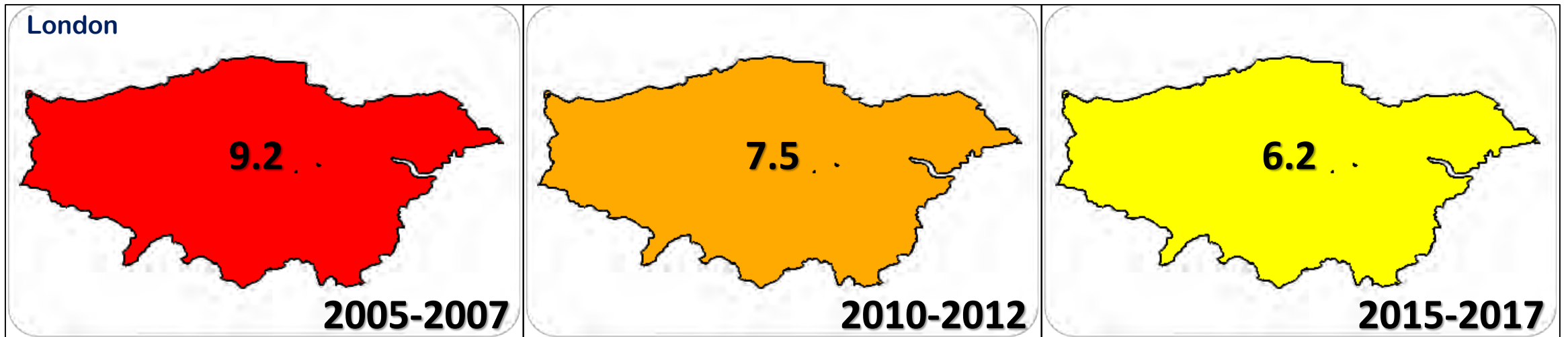
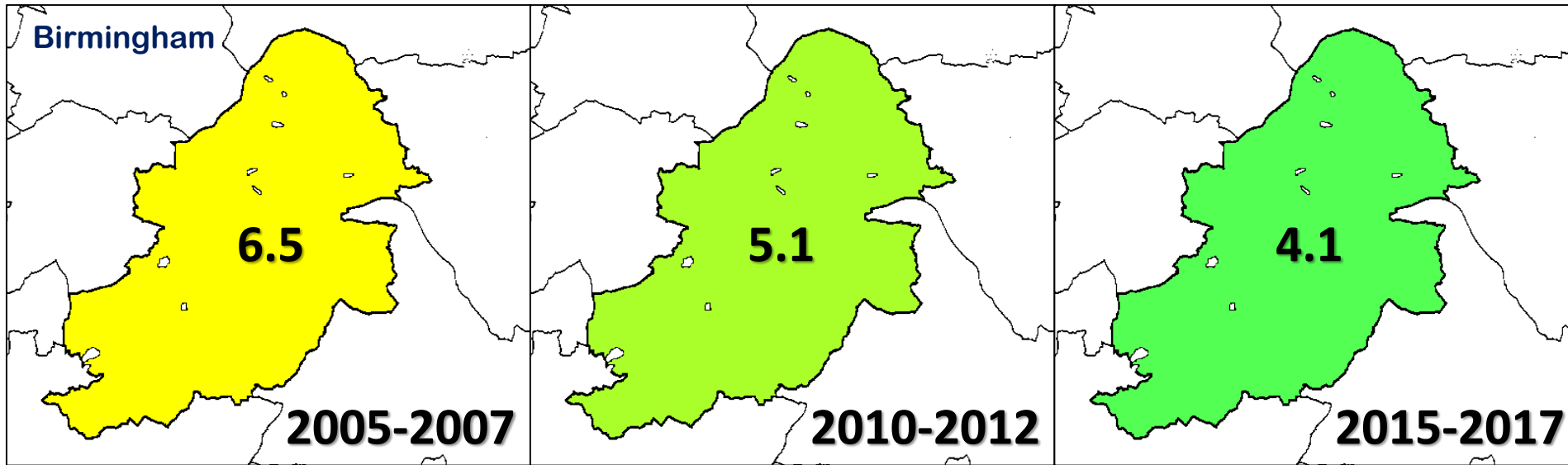
OMI NO₂ trends for London (2005-2017)



MULT-YEAR MEANS OF OMI NO₂ VCD IN BIRMINGHAM AND LONDON

- OMI NO₂ decreased by **40%** for Birmingham and by **43%** for London (2005-2017)

Colour legend (OMI NO₂)
($\times 10^{15}$ molecules cm^{-2})



CONCLUSION

- Consistent satellite and ground-based NO₂ give us confidence to apply satellite observations to monitor air quality in Birmingham and London
- OMI NO₂ 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:
SO₂, formaldehyde, ammonia
- Validate Defra air quality monitoring tools